

# Run78

# $d(K^-, n) \rightarrow \Sigma^0 \pi^0$ spectrum

# analysis status

2020/08/20

# Change from PRL

- Correction of the missing mass  $d(K^-, n)^*\Sigma^0\pi^0$  spectrum
- Correction points
  - Target length 10  $\rightarrow$  12.5 cm (full length of the target cell)
  - Acceptance estimation by SIM (Generation point change by target length)
  - **Acceptance estimation by SIM (upstream condition (T0 multi =1, Beam defining..))**
  - Induced Kaon Number from Scaler has some bag (check w/ inoue-san) 59.5  $\rightarrow$  58.3 G
  - **CDS  $\pi$ - momentum vertex (w/ beam track  $\rightarrow$  w/ backward track)**
  - Beam Track (XY 3 layer hit  $\rightarrow$  XY 4 layer hit)
  - CDC track efficiency 0.934  $\rightarrow$  0.977
  - Forward Neutron acceptance
  - Doraemonn magnetic field value for CDC Tracking 0.715  $\rightarrow$  0.7142 T (tuned by K0 peak)
  - NC momentum correction @high dE (use same correction as inoue-san)
- Data skip ; 103,124 ,404 ,635 ,636 ,643
  - Target density 0 (run $\leq$ 133) bug

# Status

Almost half yield of the previous (inoue-analysis) spectrum  
Acceptance was underestimated due to the lack of upstream condition

## To do

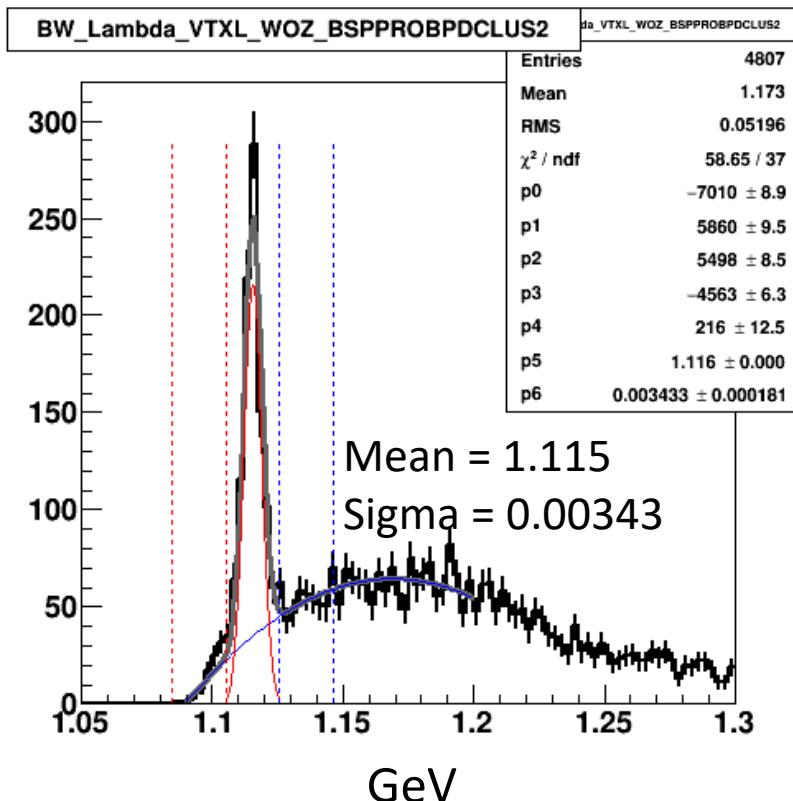
- Check  $d(K^-, n)\Sigma^+ + \pi^-$  analysis again.  
Same decrease of the yield is expected  
(same underestimation of the acceptance)
- Check the detail of the change of vertex for the CDS  $\pi^-$  momentum.
- Vertex point (Lambda momentum x Beam Track)  
DCA center point  $\rightarrow$  Lambda momentum side
- Backward track XY 3 layer  $\rightarrow$  XY 4 layer  
for hint of the backward proton tracking efficiency
- Proton hit pattern @ BPD comparing w/ SIM  
check the acceptance for the backward proton
- Proton momentum vs vertex z distribution comparing w/ SIM  
check the stretch part of the fiducial volume

# BACK UP (Status)

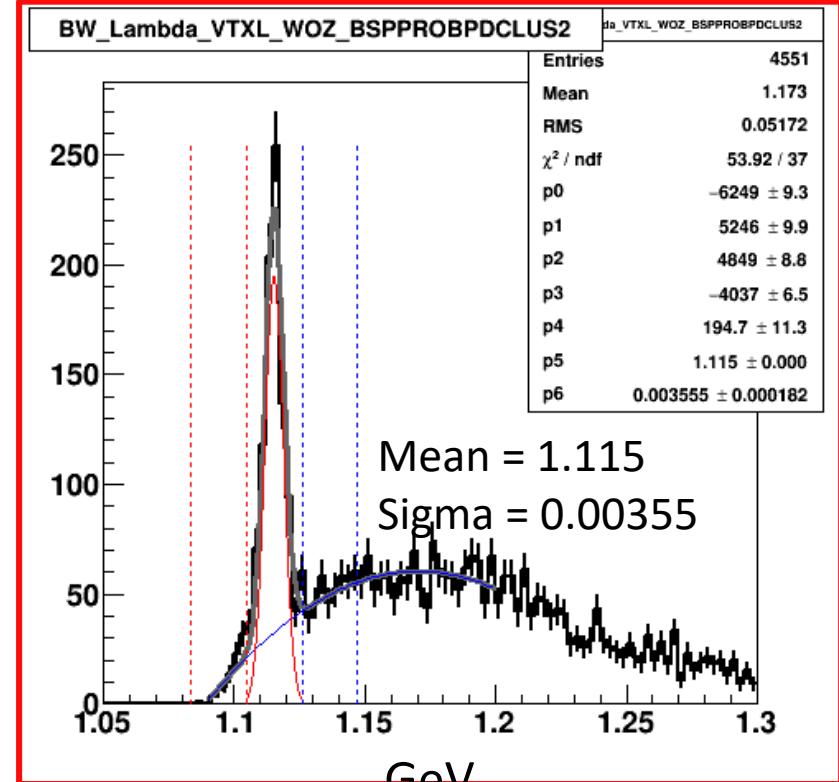
# $p, \pi$ - invariant mass

$\Lambda$  reconstruction from  $p \pi^-$  invariant mass

before



after

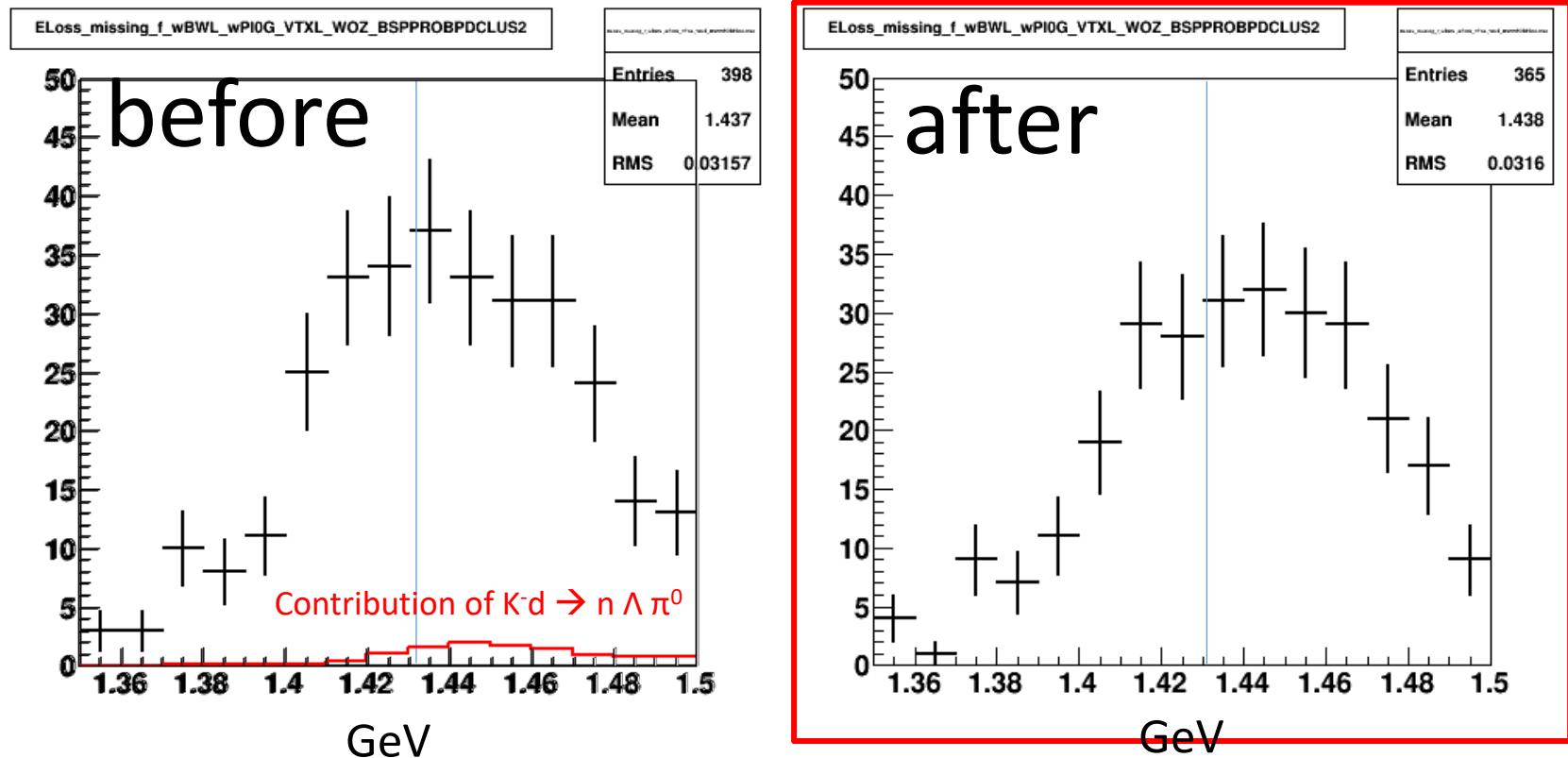


Distribution -almost no change

Event number -5% due to data skip and  $\pi$ - momentum vertex

# $d(K^-, n)\pi^0\pi^0$ missing mass

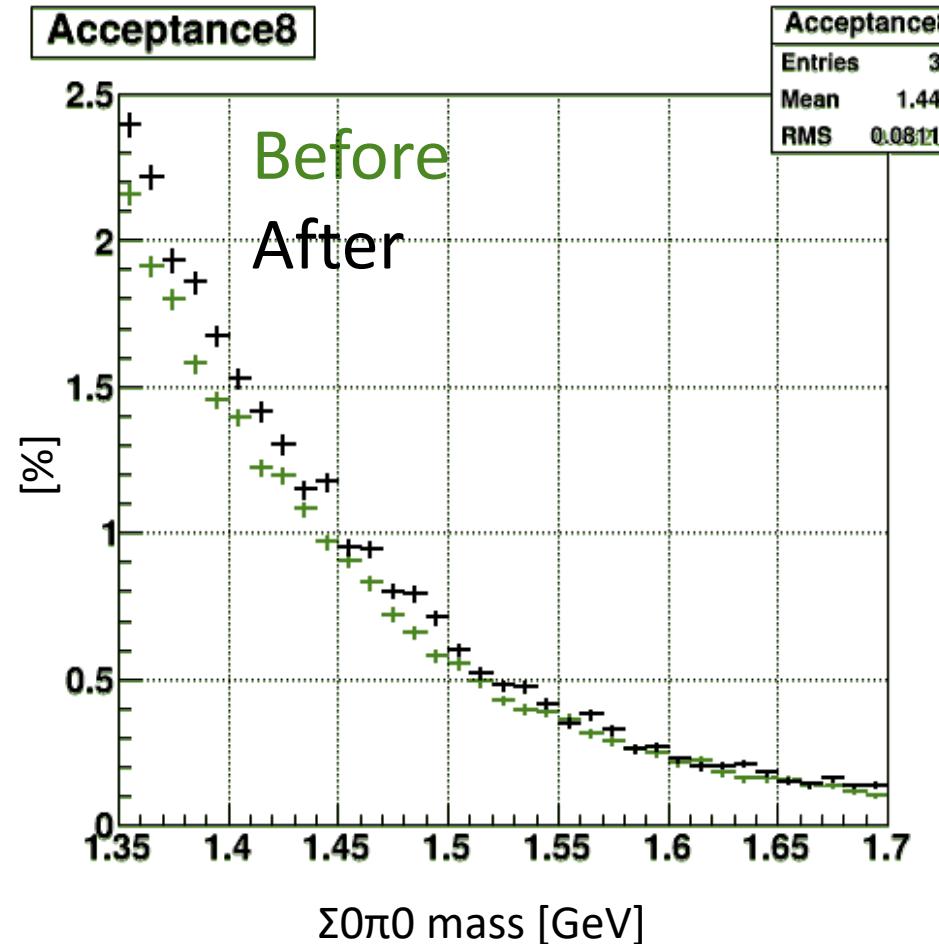
- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-)X$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$



Spectrum shape –not much change

# Acceptance estimation

- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)

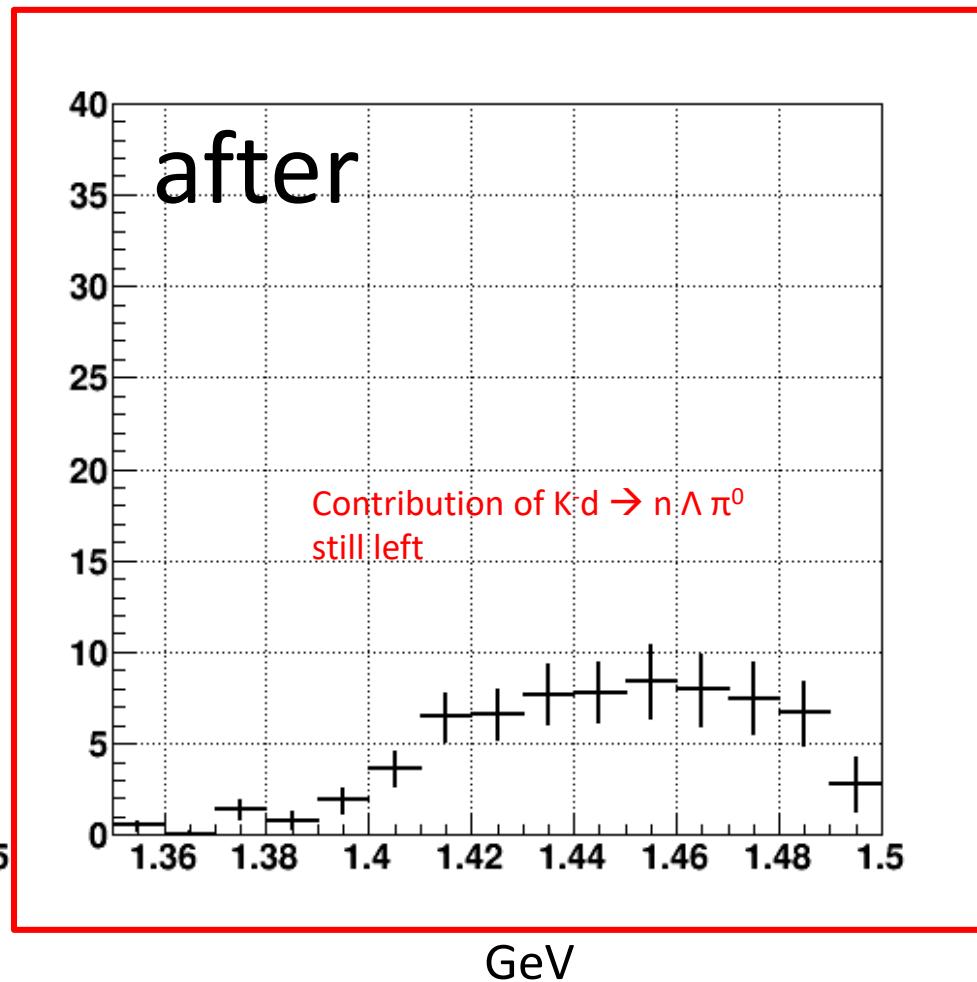
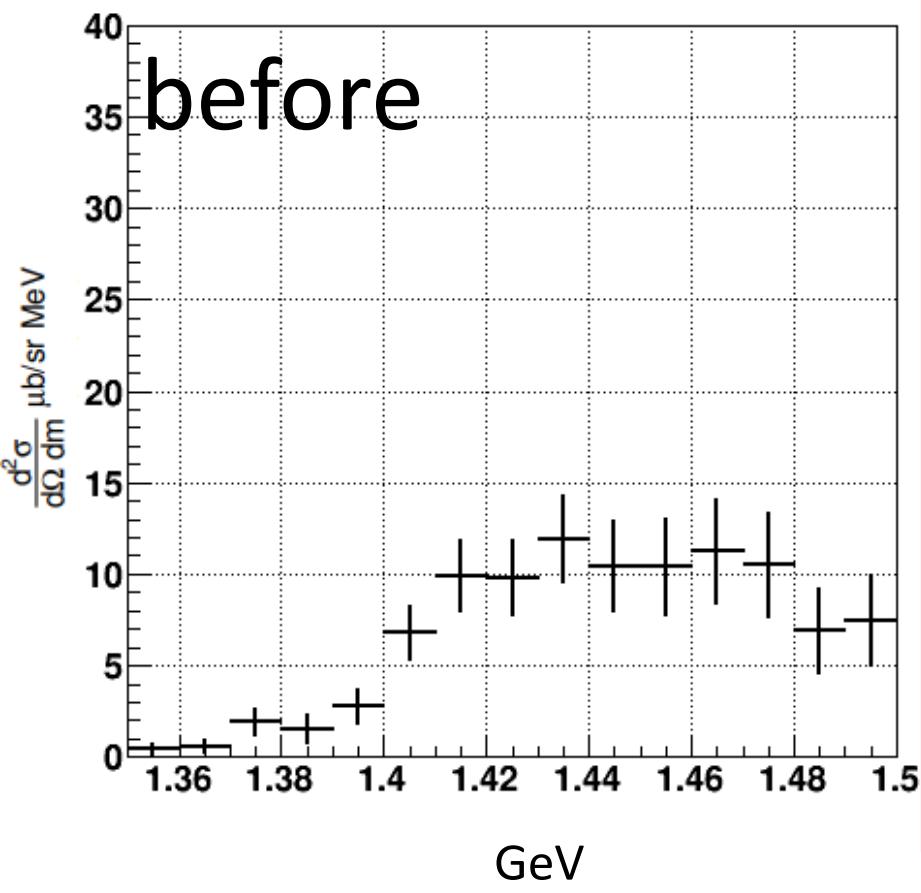


- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)/dX \quad 0.18 < X < 0.30 \text{ GeV}$

Acceptance was underestimated due to the lack of upstream condition

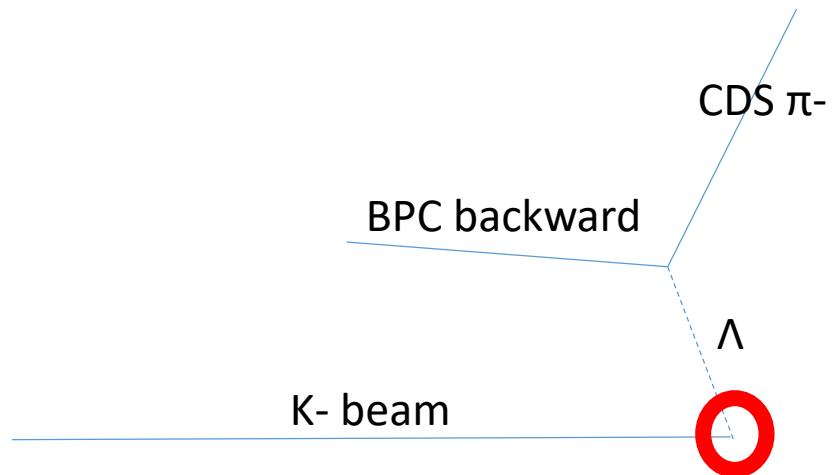
- Lumi ;  $8083 \pm 160$  [/ub]
  - Scaler Kaon 58.3 G
  - Survival ratio  $0.314 \pm 0.000350$
  - DAQ eff  $0.7708 \pm 0.0000128$
  - Trig. KCDH1  $0.9527 \pm 0.0003$
  - Trig. Neutral  $0.9999 \pm 0.0000067$
- $\Omega\text{-nc}$  ;  $0.0214832 \pm 0.000207563$  [sr]
- $\varepsilon\text{-nc}$  ;  $0.291 \pm 0.015$
- $\varepsilon\text{-bpc}$  ;  $0.999 \pm 0.000$
- $\varepsilon\text{-cdc}$  ;  $0.977 \pm 0.004$
- Acc ; simulation (including BR ( $\Sigma 0 \pi 0$ ) 0.639)

# Cross Section



Almost half yield of the previous (inoue-analysis) spectrum<sup>9</sup>

# Z vertex distribution



SIM

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

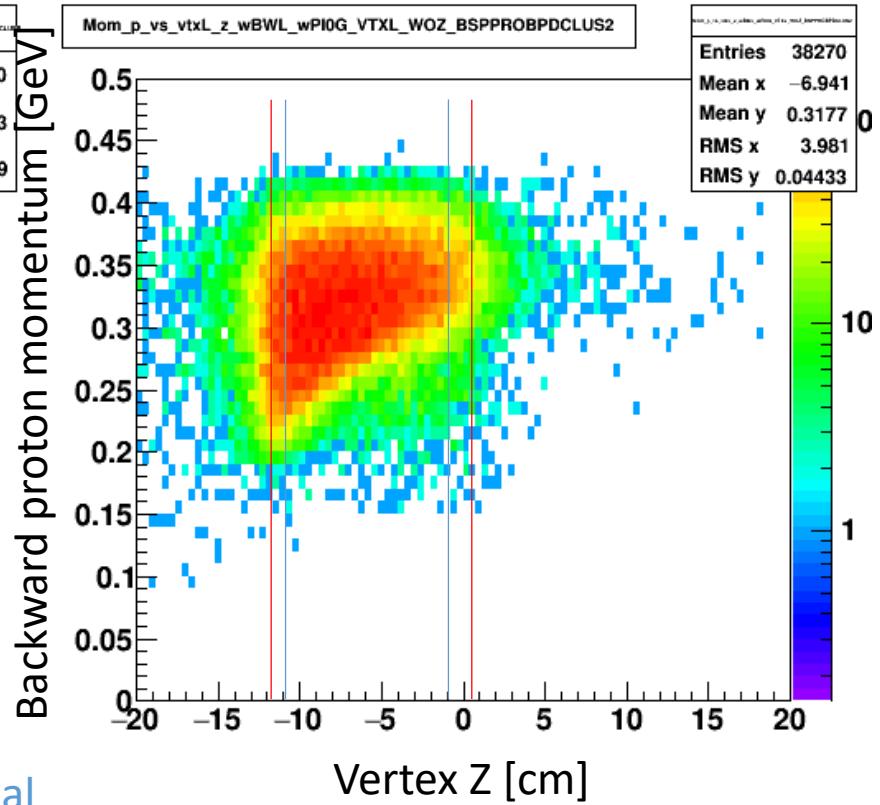
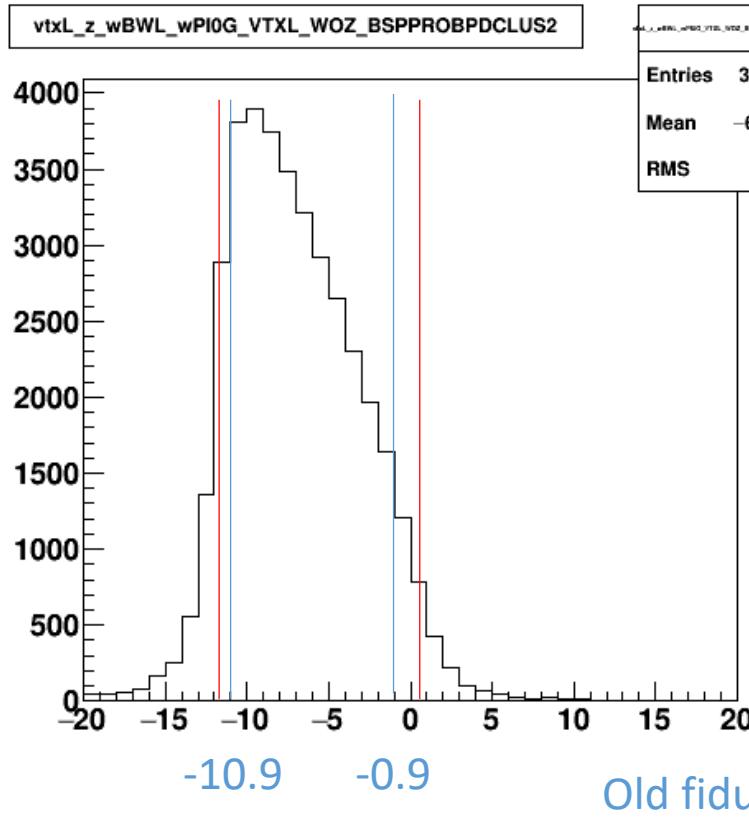
Condition

Same as final spectrum

- $\Lambda$  selection

- $d(K-, np\pi^-)''X''$   $0.18 < x < 0.30$  GeV

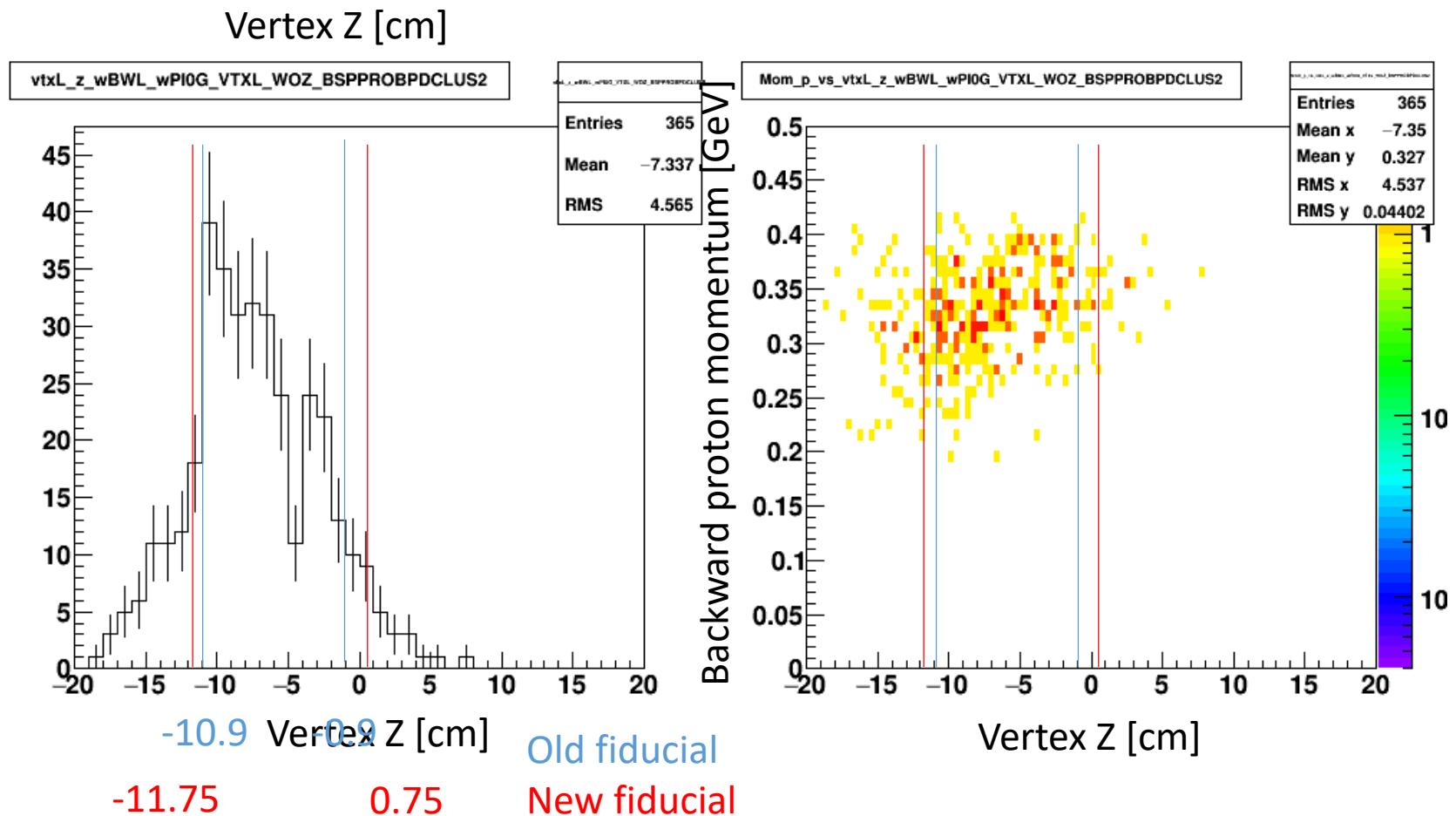
Vertex Z [cm]



# Data (Run78)

Condition  
Same as final spectrum  

- $\Lambda$  selection
- $d(K^-, p\bar{\pi}^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



SIM

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

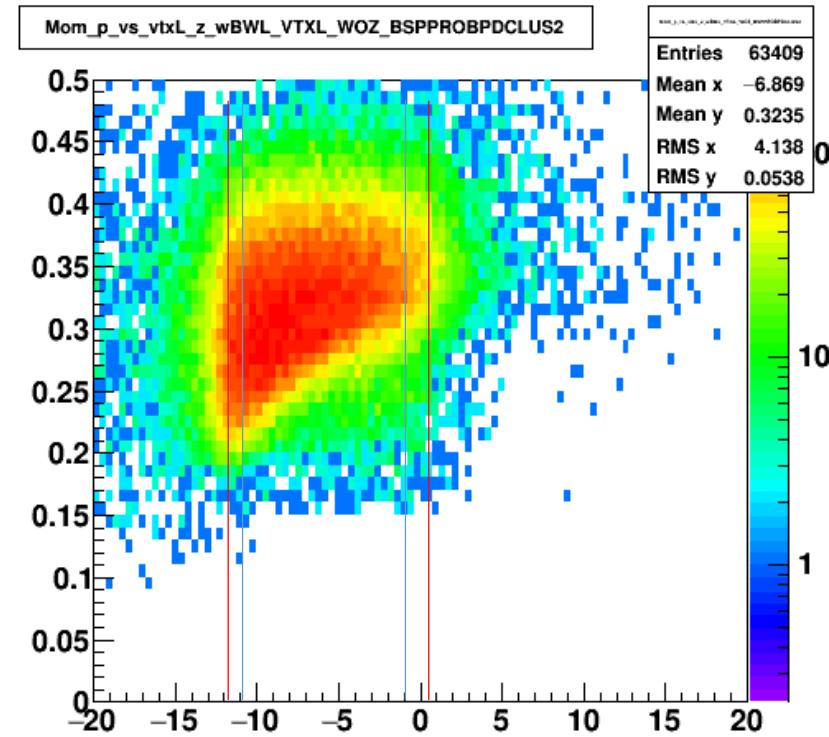
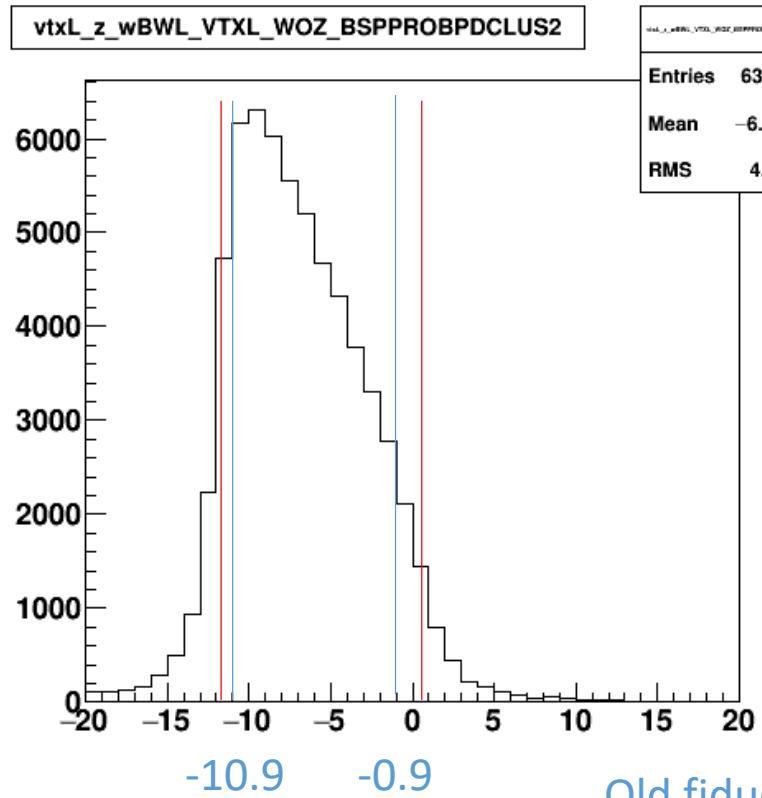
Condition

Same as final spectrum

- $\wedge$  selection

- $d(K_d \rightarrow n \Sigma 0 \pi^-) / d\chi \sim 0.18 < \chi < 0.30 \text{ GeV}$

Vertex Z [cm]



Old fiducial

-11.75

0.75

New fiducial

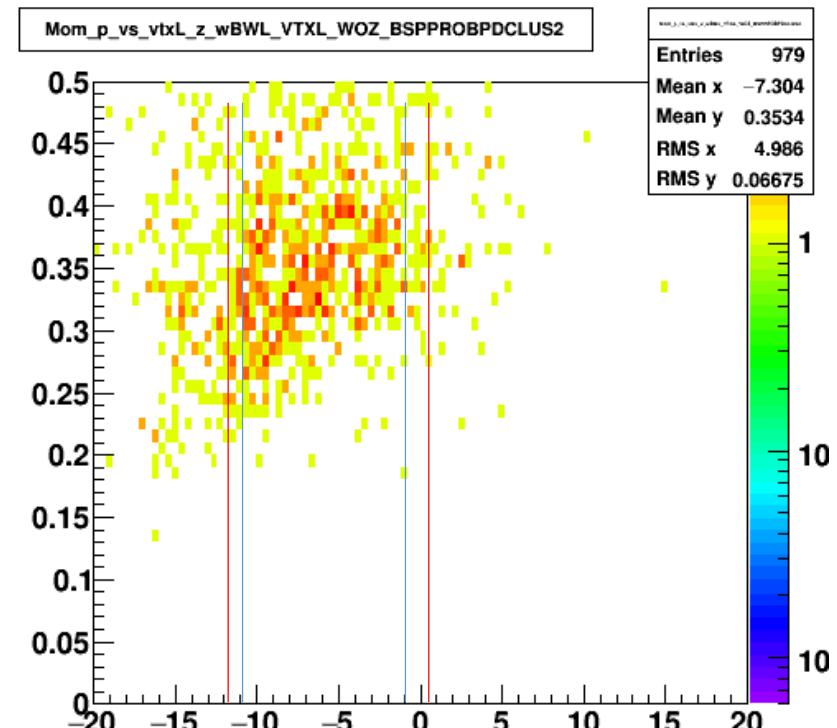
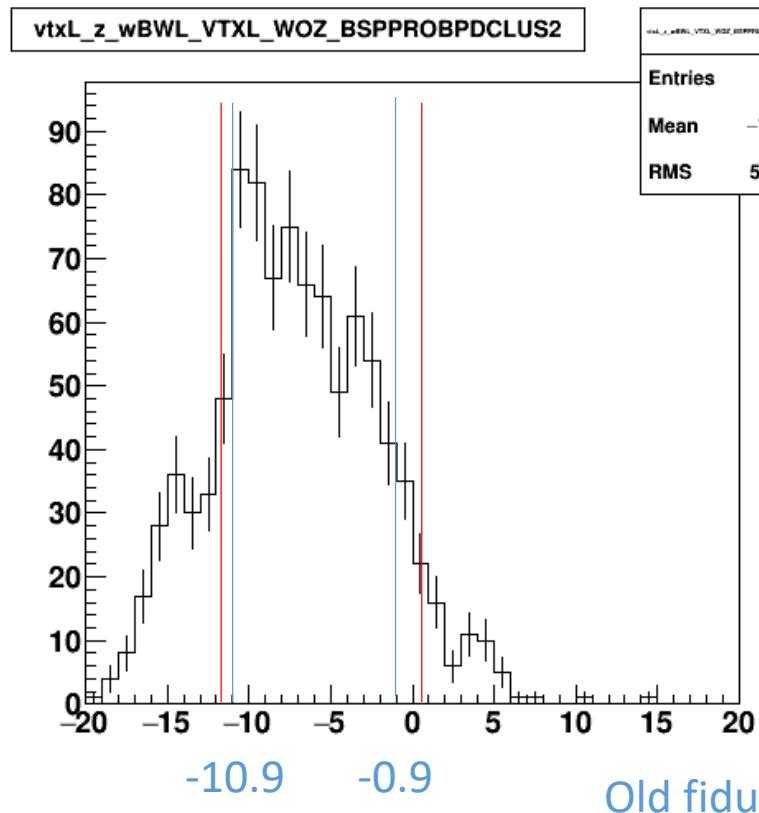
# Data (Run78)

Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

Vertex Z [cm]

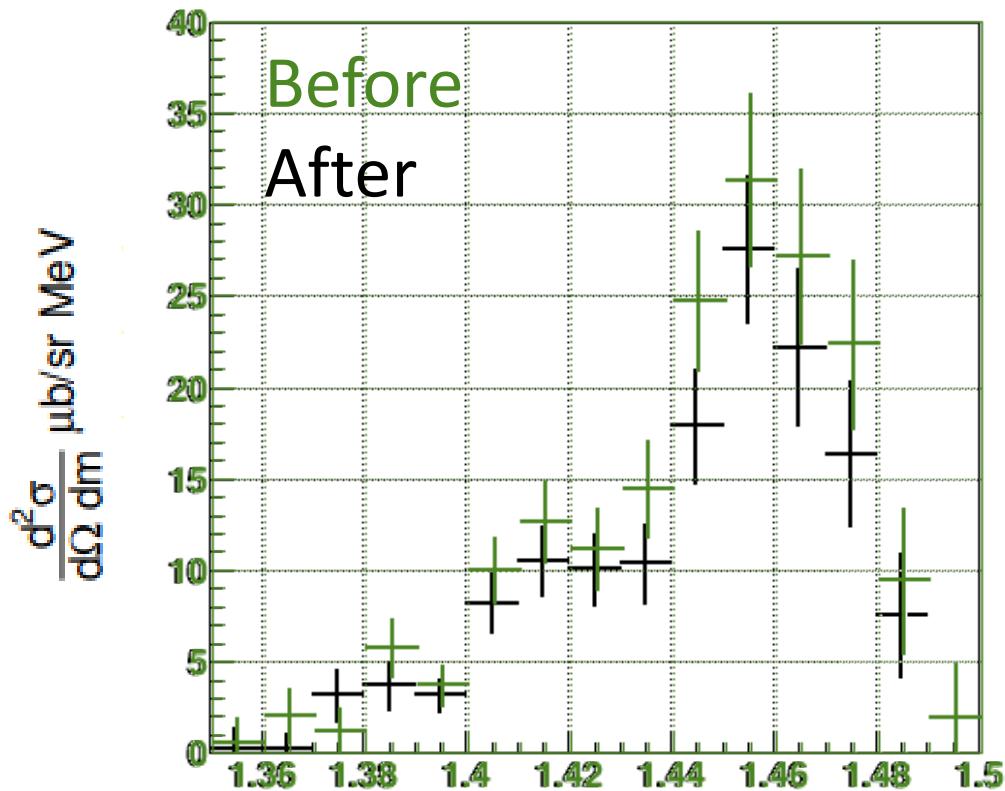


# $d(K^-, n) \rightarrow \Sigma^+ + \pi^-$ analysis

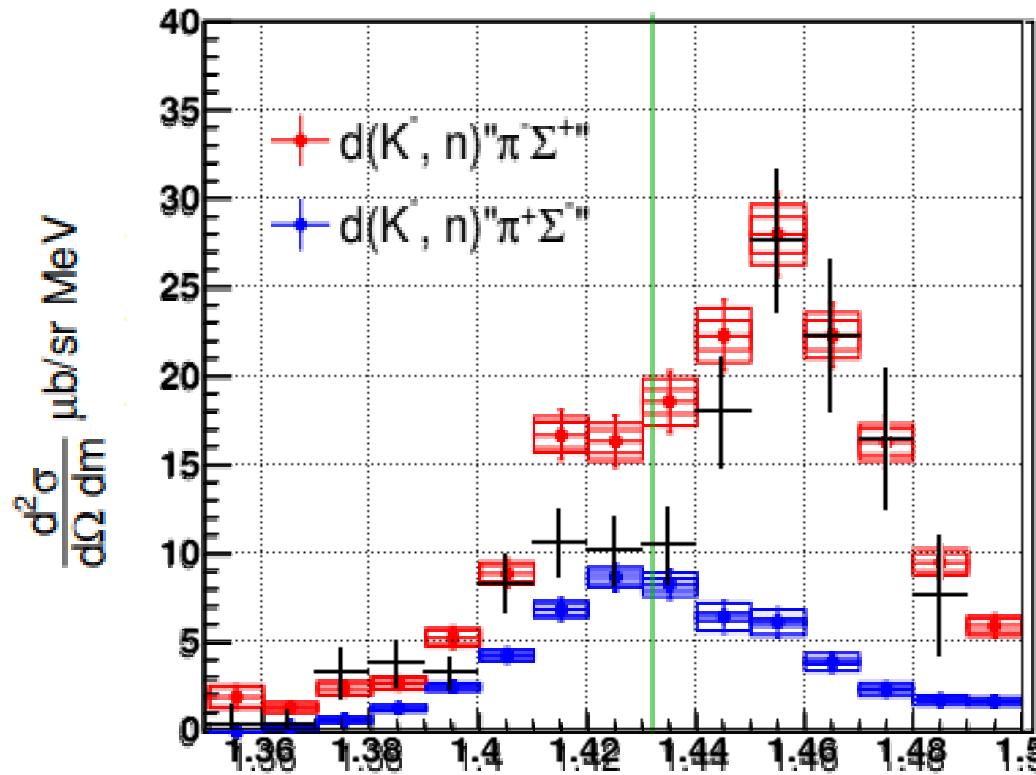
## Difference from Page2

- Target length 10 cm (not change)
- CDS  $\pi^-$  momentum vertex (w/ beam track ) (not change)

# $d(K^-, n)''\Sigma + \pi^-$ spectrum

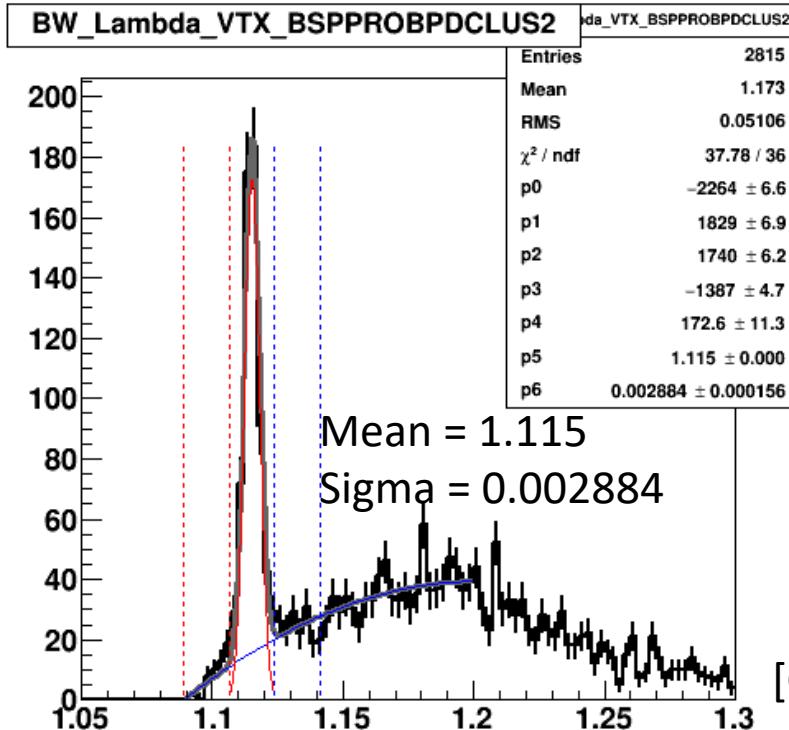


# $d(K^-, n)''\Sigma + \pi^-$ spectrum

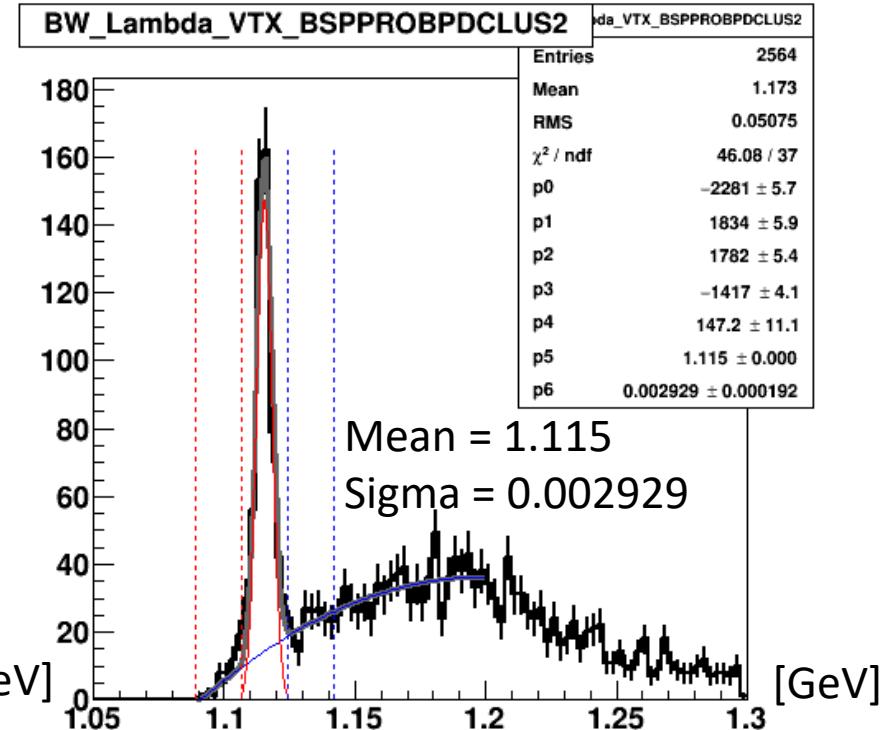


# $p, \pi$ - invariant mass

Before



after



Event Number -9 % (data 6 run skip/ Beam track XY 3  $\rightarrow$  4)

Proton momentum is analyzed as  $\Sigma$  decay in both figures

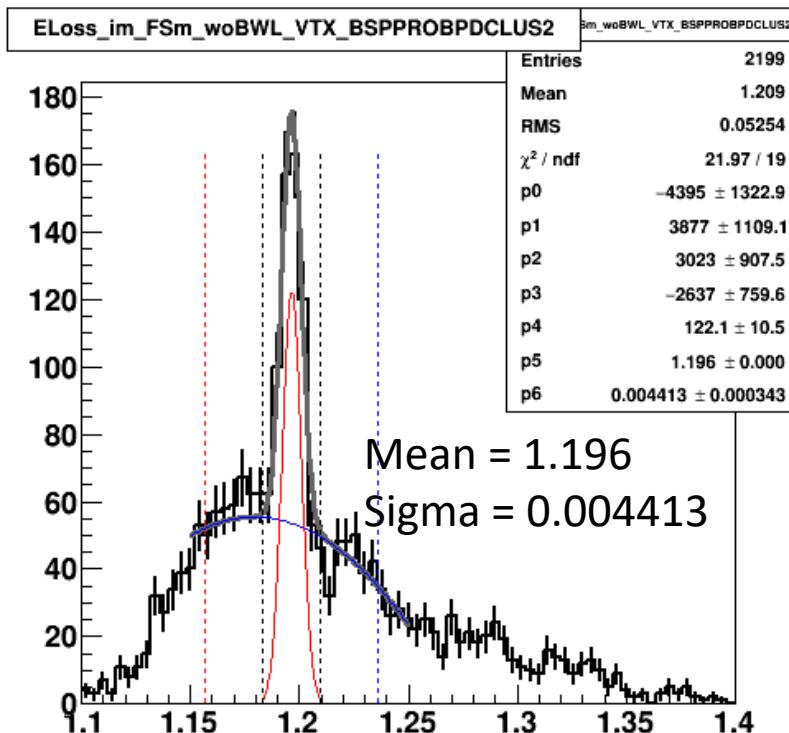
Need to correct analysis as  $\Lambda$  decay proton

$\Lambda$  rejection  $\pm 3\sigma$  around peak

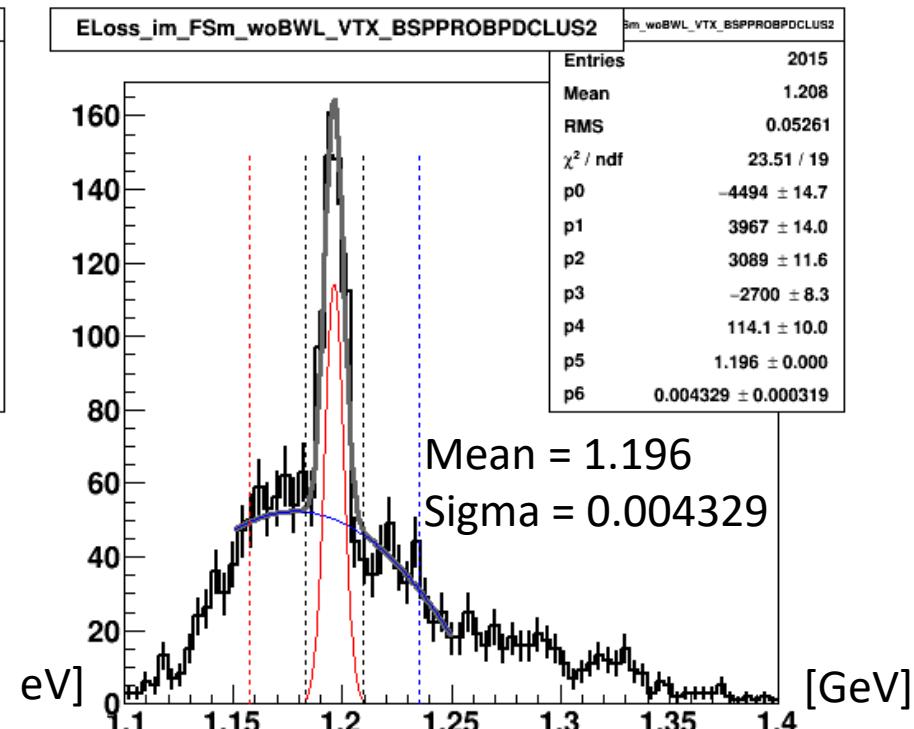
# $n\pi$ - invariant mass

$\Lambda$  is rejected from  $p,\pi$  invariant

Before



after

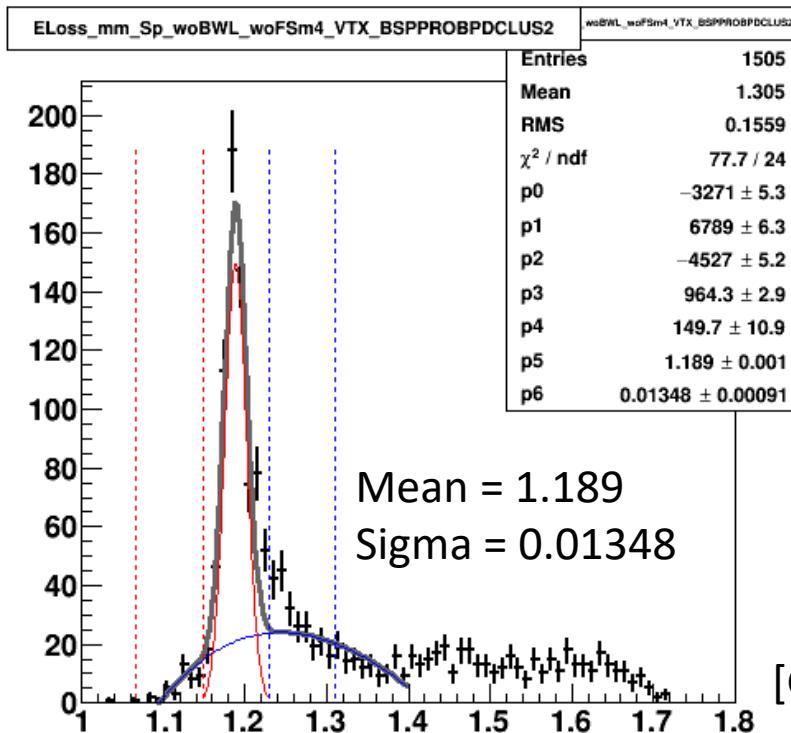


$\Sigma$ - rejection  $\pm 3\sigma$  around peak

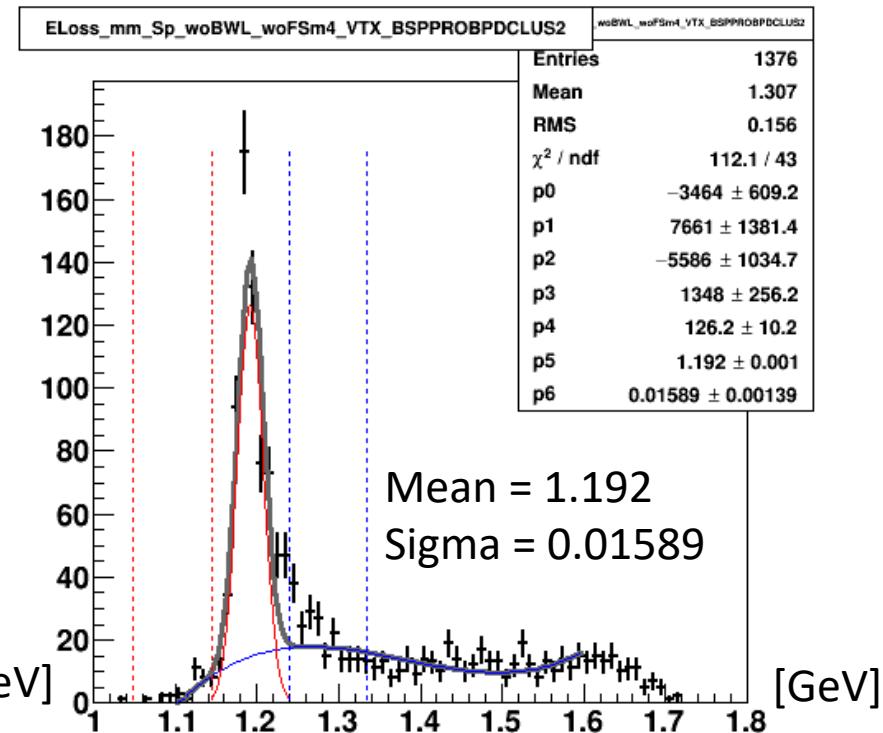
# $d(K^-, np\pi^-)''X''$ missing mass

$\Lambda$  is rejected from  $p, \pi$  invariant  
 $\Sigma^-$  is rejected from  $n, \pi^-$  invariant

Before



after

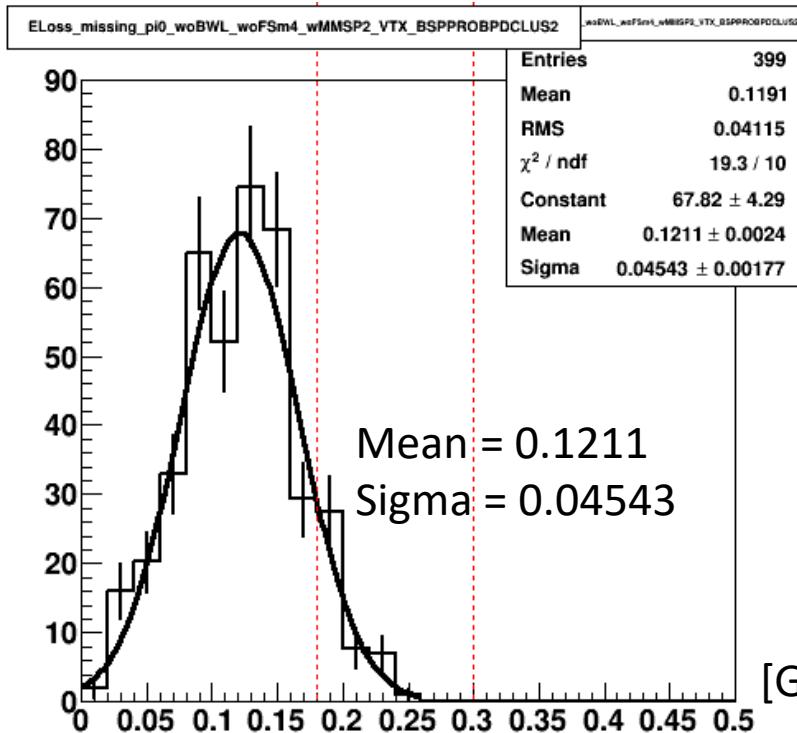


$\Sigma^+$  selection  $\pm 3\sigma$  around peak

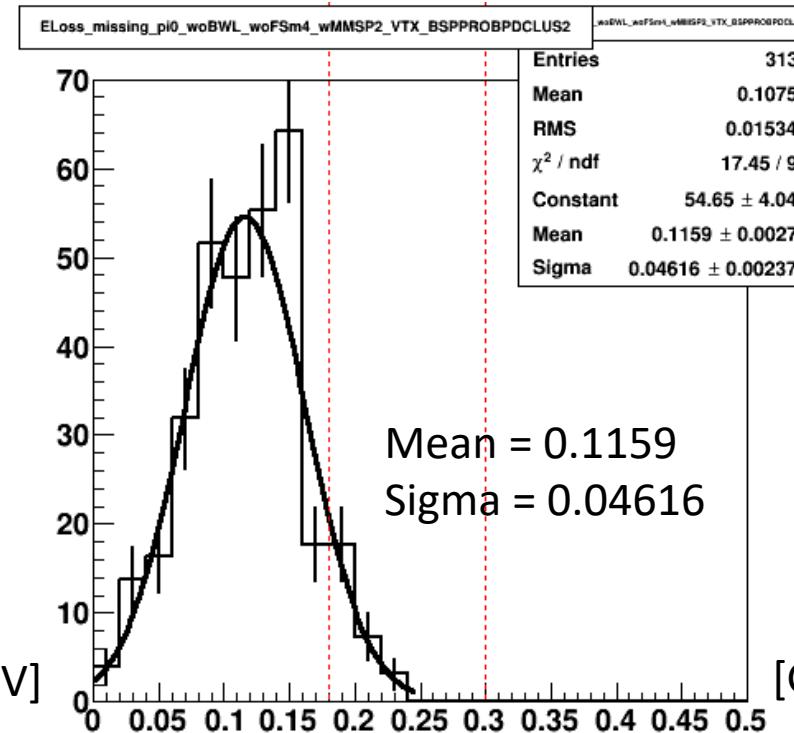
# $d(K-n\pi^-)$ missing mass

$\Lambda$  is rejected from  $p, \pi$  invariant  
 $\Sigma^-$  is rejected from  $n, \pi^-$  invariant  
 $\Sigma^+$  is selected from missing mass  $d(K, n\pi^-)$   
w/ subtraction of BG in  $\Sigma^+$

Before



after

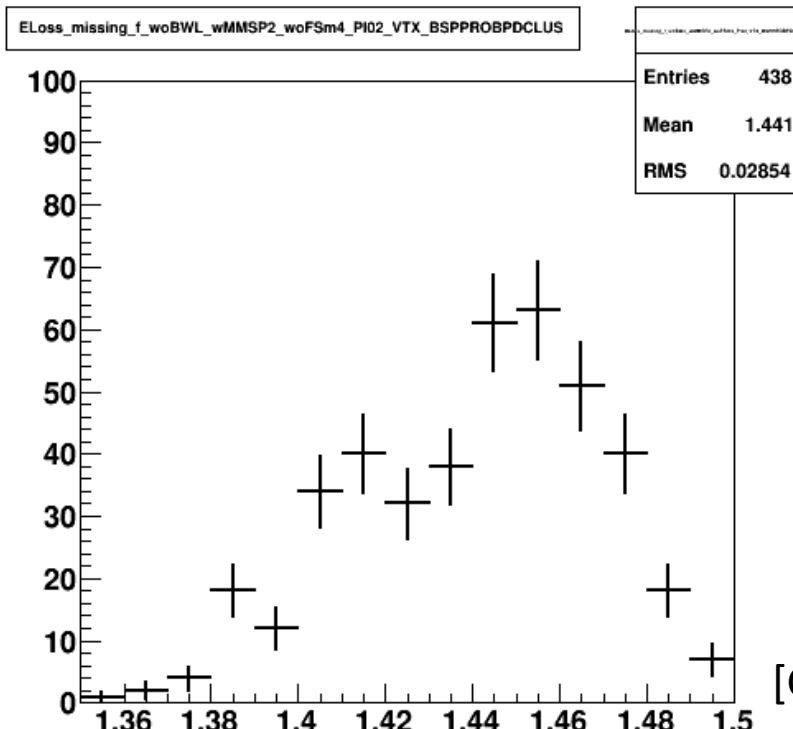


$\pi^0$  selection  $\pm 3\sigma$  around peak

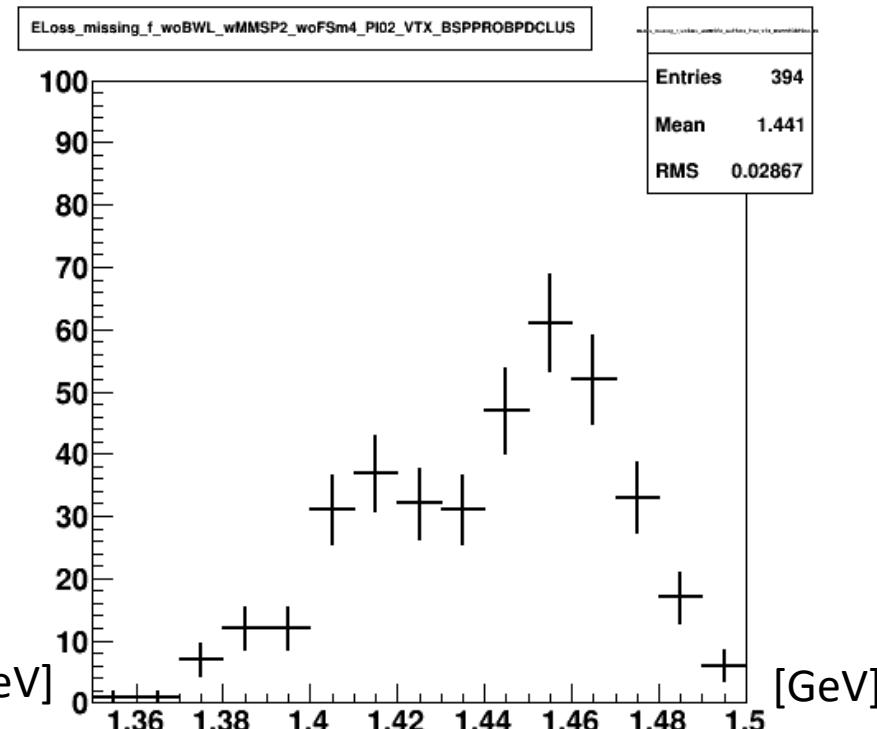
# $d(K^-, n)\Sigma^+ \pi^-$ spectrum

$\Lambda$  is rejected from  $p, \pi$  invariant  
 $\Sigma^-$  is rejected from  $n, \pi^-$  invariant  
 $\Sigma^+$  is selected from missing mass  $d(K^-, n\pi^-)$   
 $\pi^0$  is selected from missing mass  $d(K^-, n\rho\pi^-)$

Before



after



# Acceptance estimation

- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition (T0 multi =1, Beam track defining..)
- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X''$   $0.18 < X < 0.30 \text{ GeV}$



- Lumi ;  $8083 \pm 160$  [/ub]  $\times (10.0/12.5)$ <sub>Target length 12.5 -> 10 cm</sub>
  - Scaler Kaon 58.3 G
  - Survival ratio  $0.314 \pm 0.000350$
  - DAQ eff  $0.7708 \pm 0.0000128$
  - Trig. KCDH1  $0.9527 \pm 0.0003$
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- $\varepsilon$ -bpc ;  $0.999 \pm 0.000$
- $\varepsilon$ -cdc ;  $0.977 \pm 0.004$
- Acc ; simulation (including BR ( $\Sigma 0 \pi 0$ ) 0.639)

# Proton hit pattern by BPC @ BPD

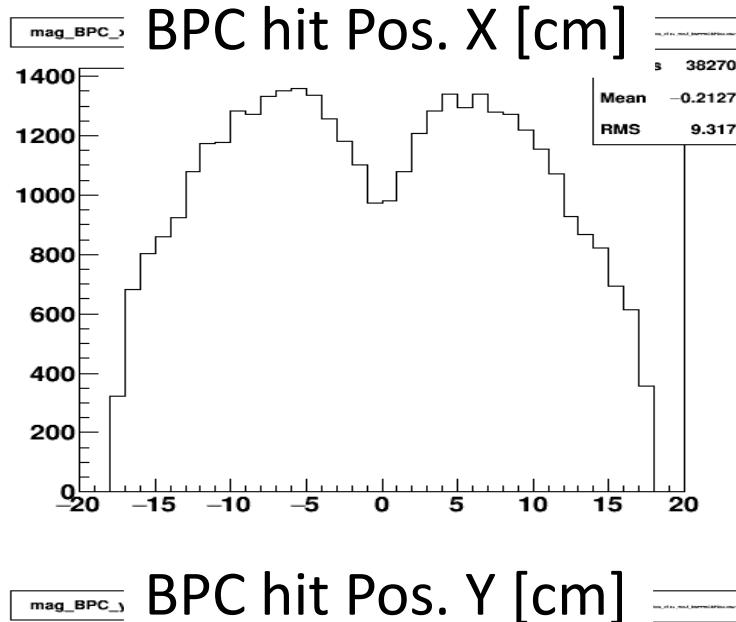
- Condition
  - After the backward proton analysis
    - TOF BPD-T0 > 4 ns
    - BPD cluster dE > 3 MeV
    - BPD-BPC matching

# Proton hit pattern by BPC @ BPD

SIM

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

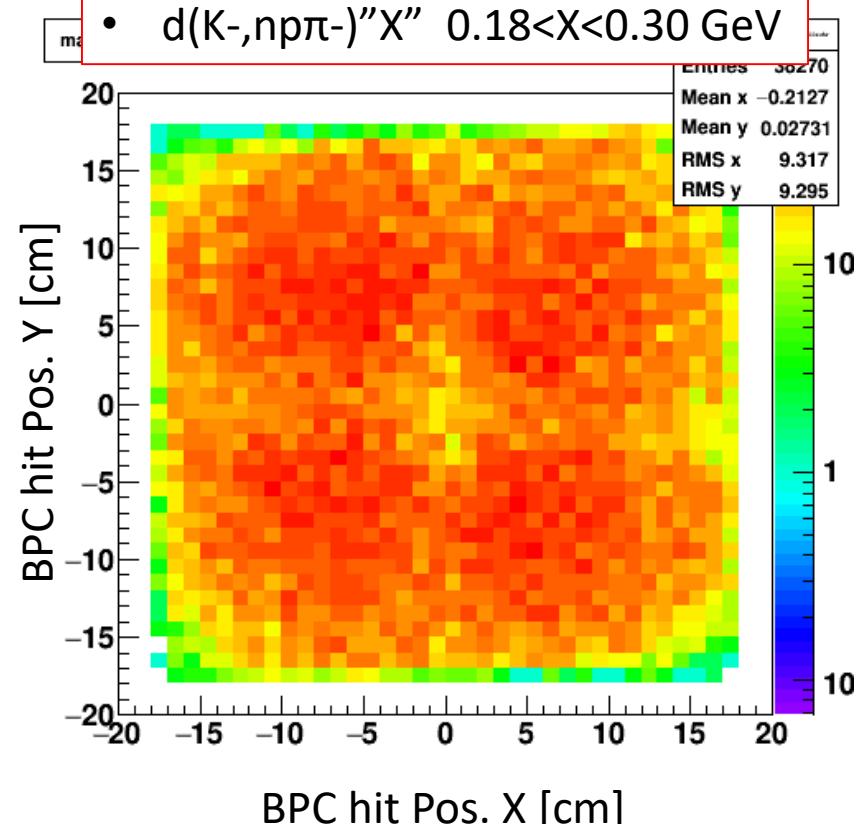
(spectrum shape ; cross Section P.9 left figure )



Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

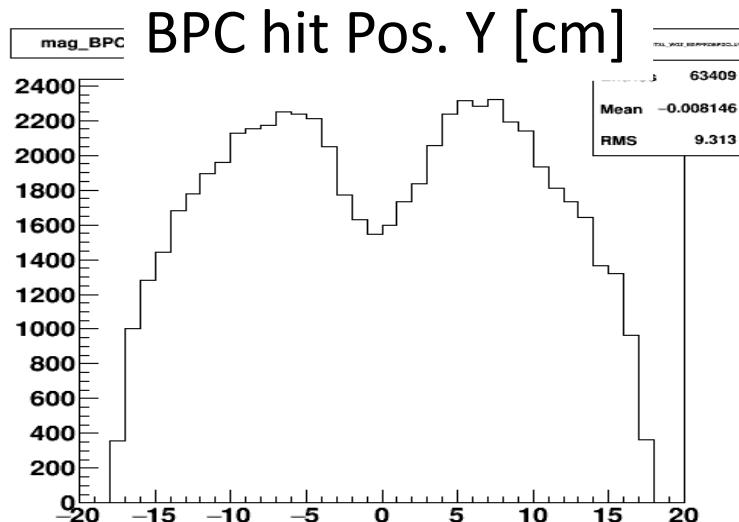
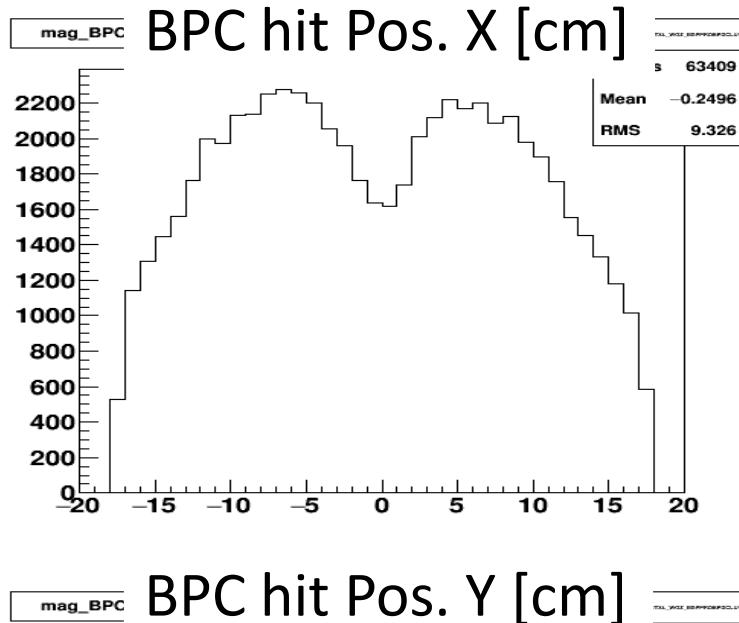


# Proton hit pattern by BPC @ BPD

SIM

K-d  $\rightarrow$ n  $\Sigma 0\pi 0$

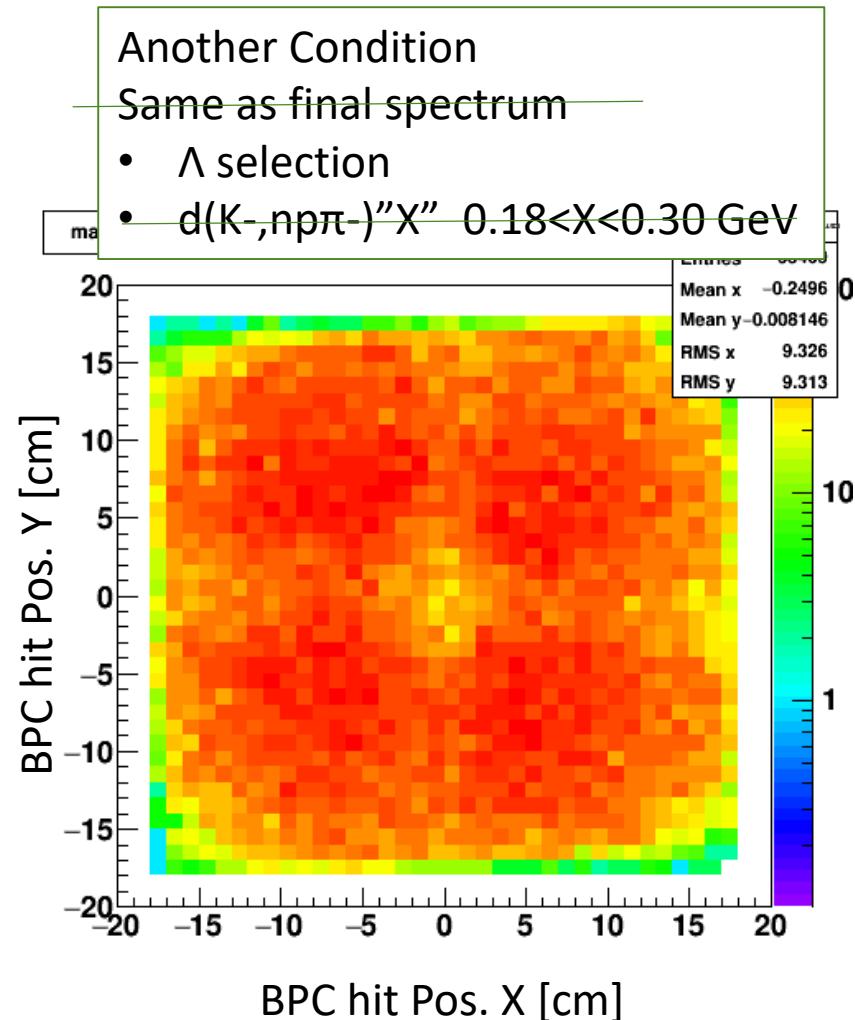
(spectrum shape ; cross Section P.9 left figure )



Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

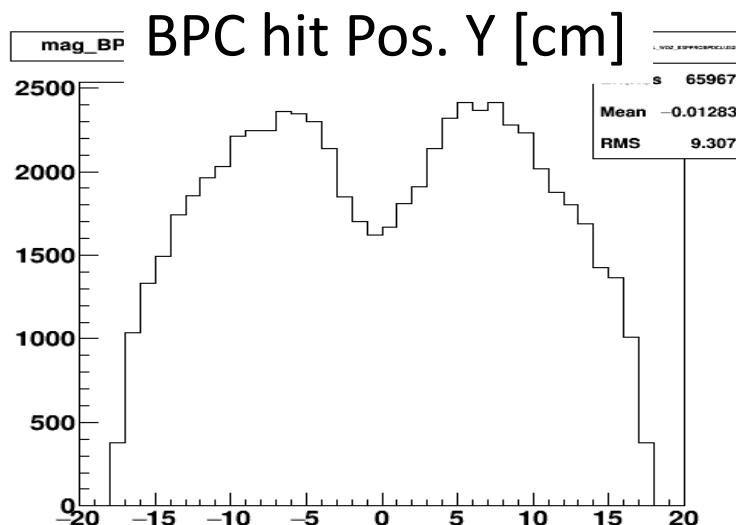
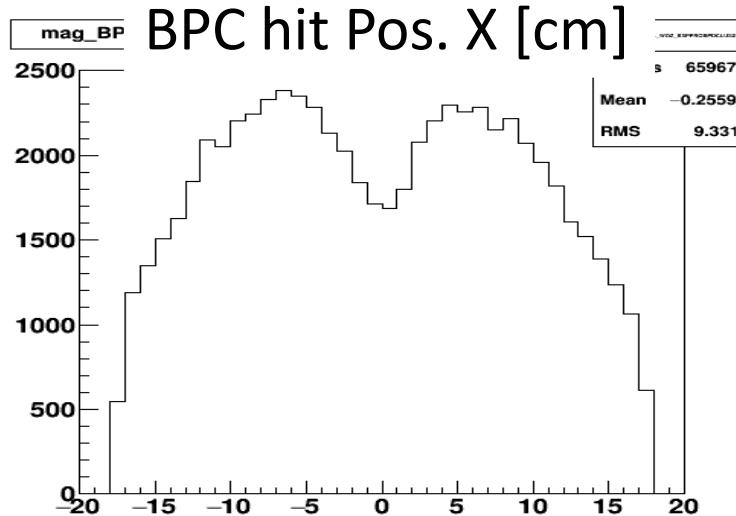


# Proton hit pattern by BPC @ BPD

SIM

K-d  $\rightarrow$ n  $\Sigma 0\pi 0$

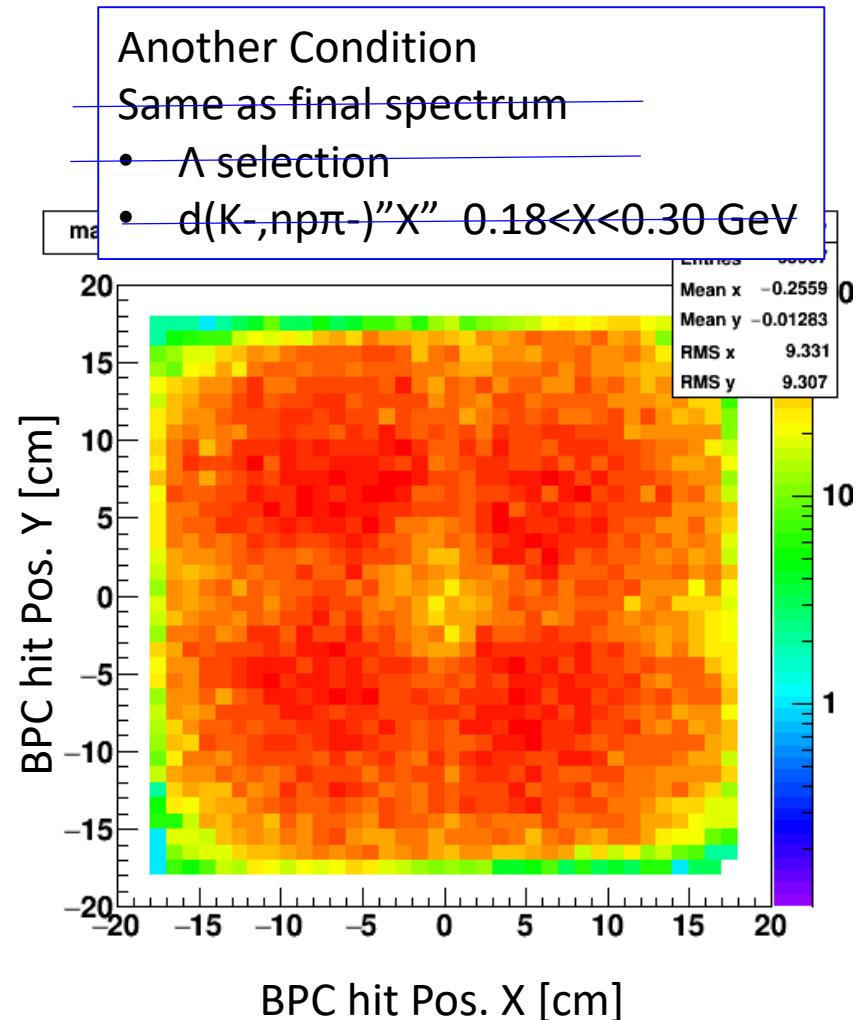
(spectrum shape ; cross Section P.9 left figure )



Another Condition

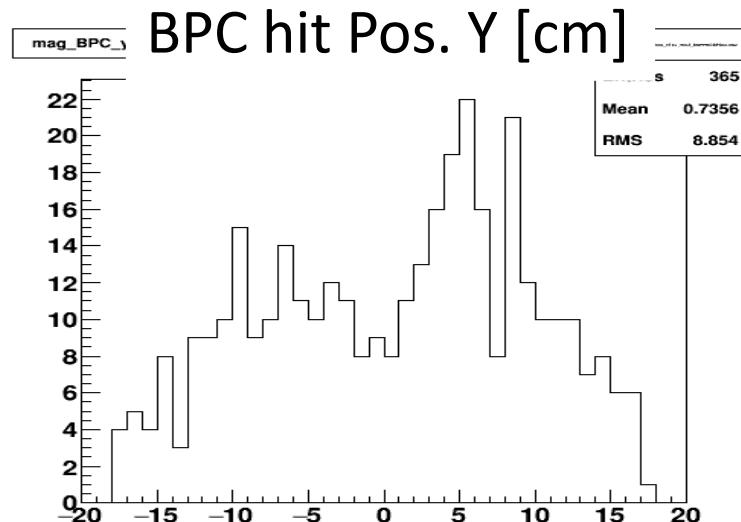
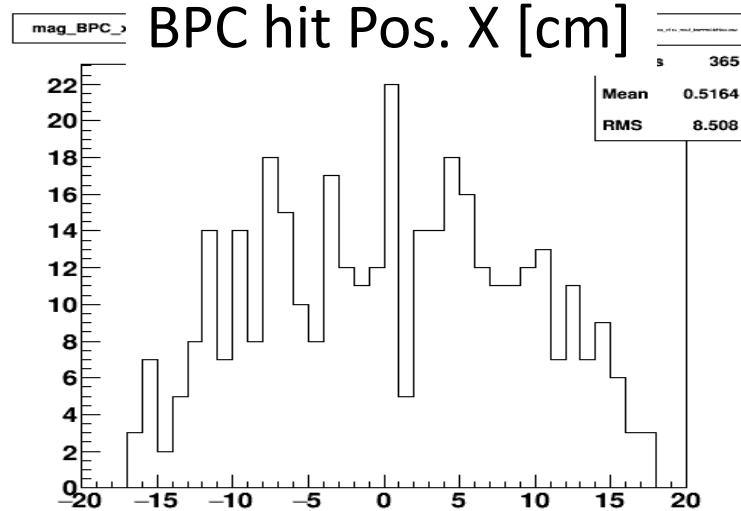
Same as final spectrum

- $\Lambda$  selection
- $d(K, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



# Proton hit pattern by BPC @ BPD

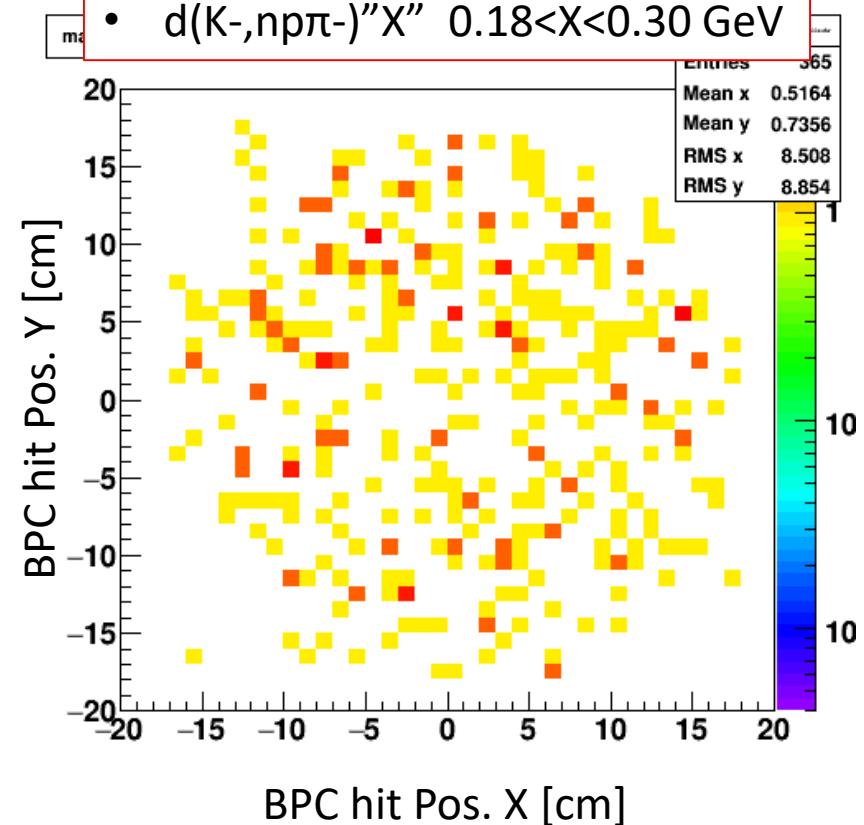
Data (Run78)



Another Condition

Same as final spectrum

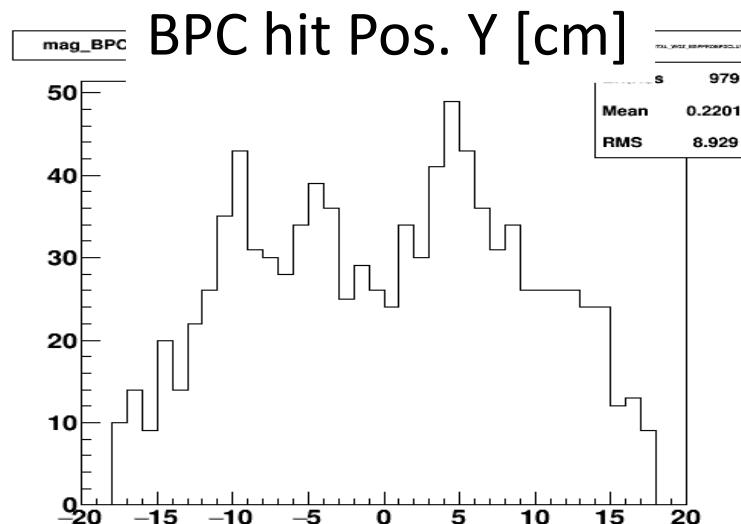
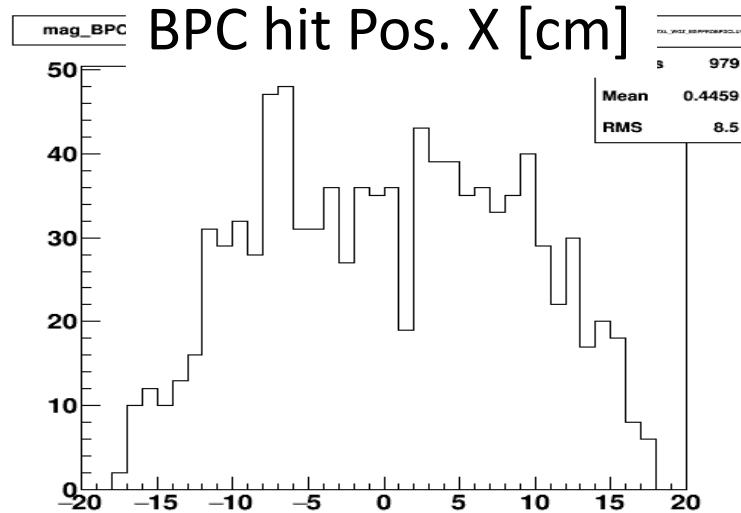
- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV



Event is not enough to compare the hit pattern w/ SIM

# Proton hit pattern by BPC @ BPD

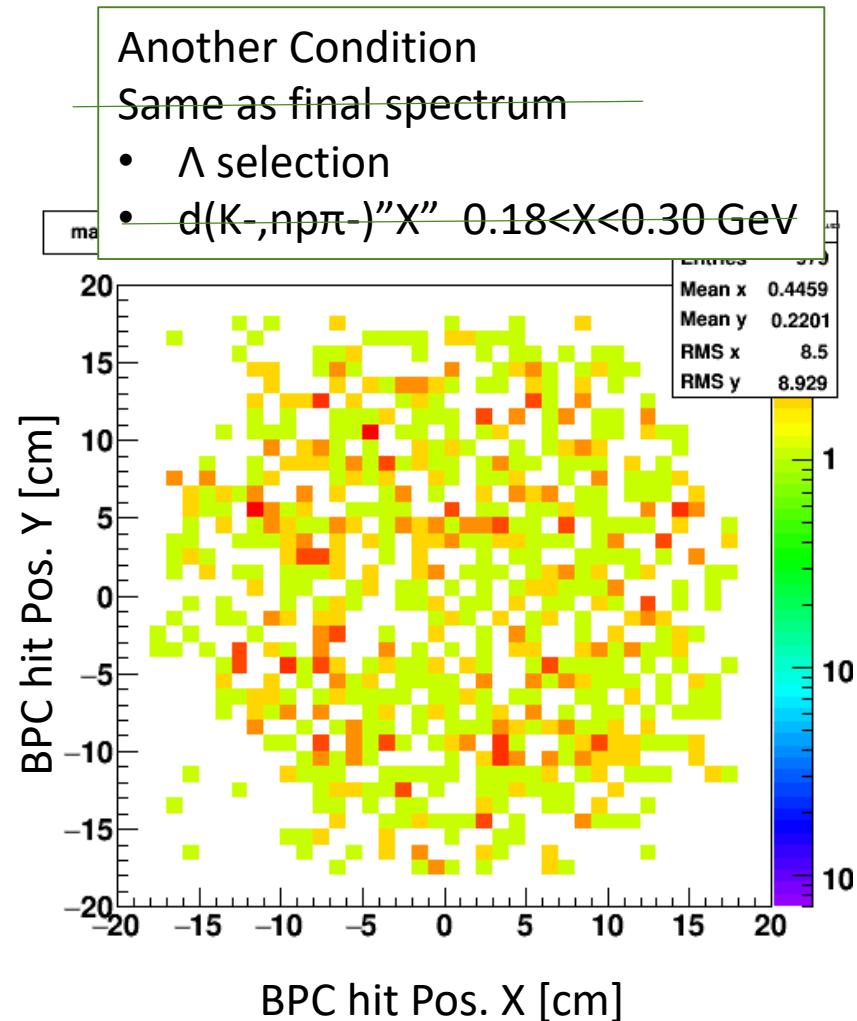
Data (Run78)



Another Condition

Same as final spectrum

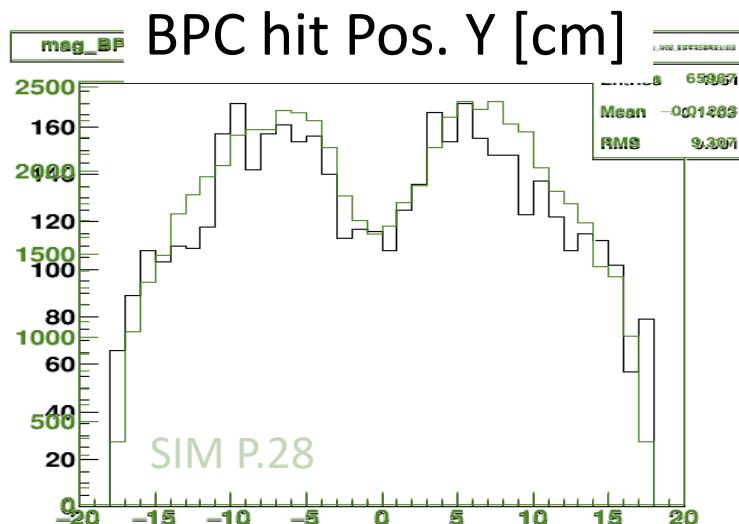
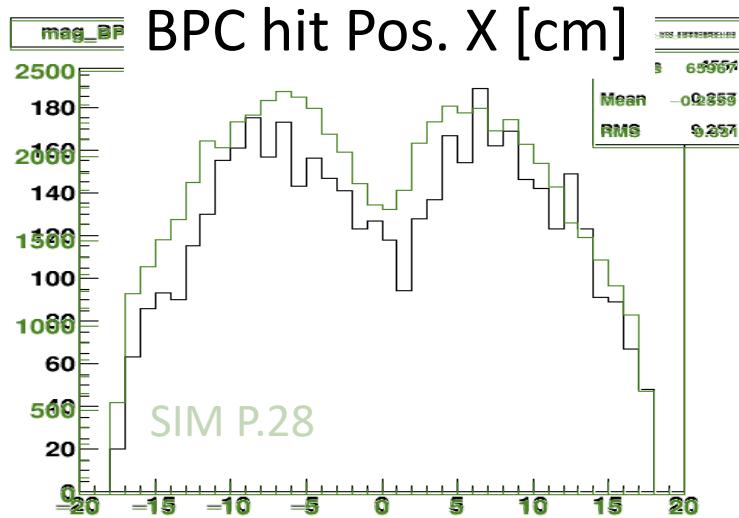
- $\Lambda$  selection
- $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



Event is not enough to compare the hit pattern w/ SIM

# Proton hit pattern by BPC @ BPD

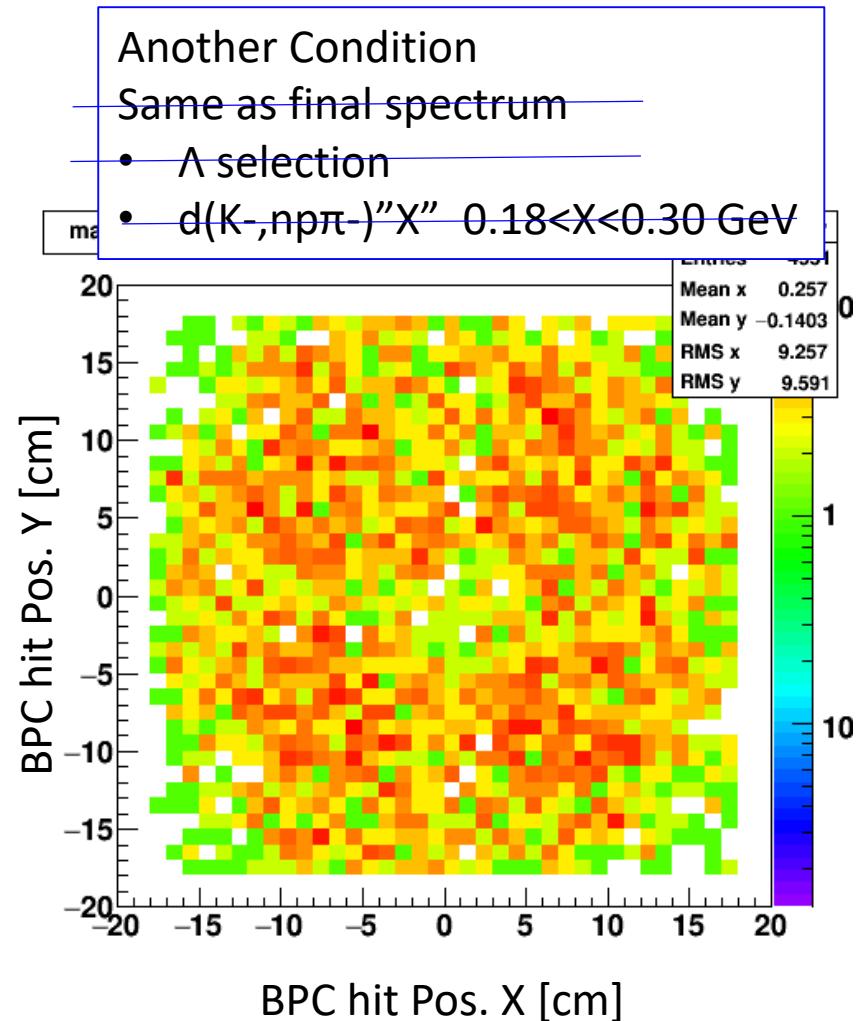
Data (Run78)



Another Condition

Same as final spectrum

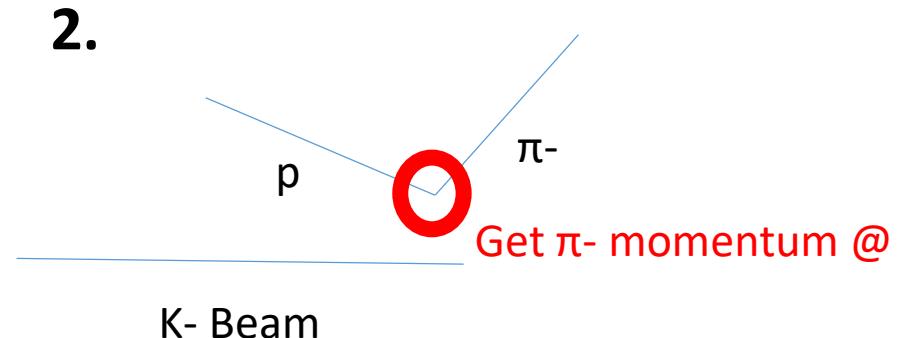
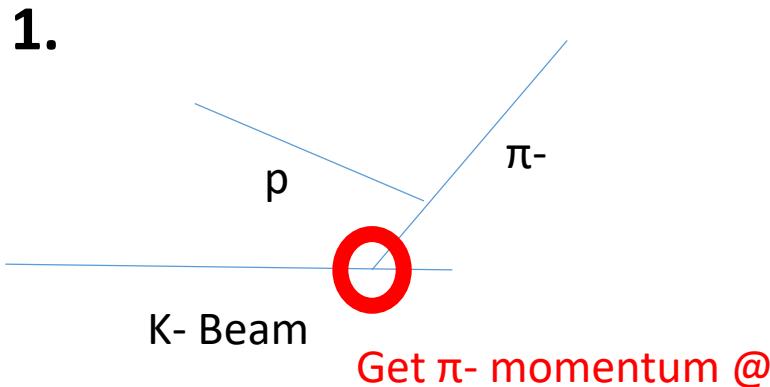
- $\Lambda$  selection
- $d(K, np\pi^-)X \quad 0.18 < X < 0.30 \text{ GeV}$



Almost consistent w/ SIM ?

# Dependence on CDS $\pi$ - momentum vertex

- Comparing by  $\pi$ - momentum vertex
  1. Vertex w/BPC Beam track ( $K^-$ )
  2. Vertex w/BPC Backward track ( $p$ )



Data (Run78)

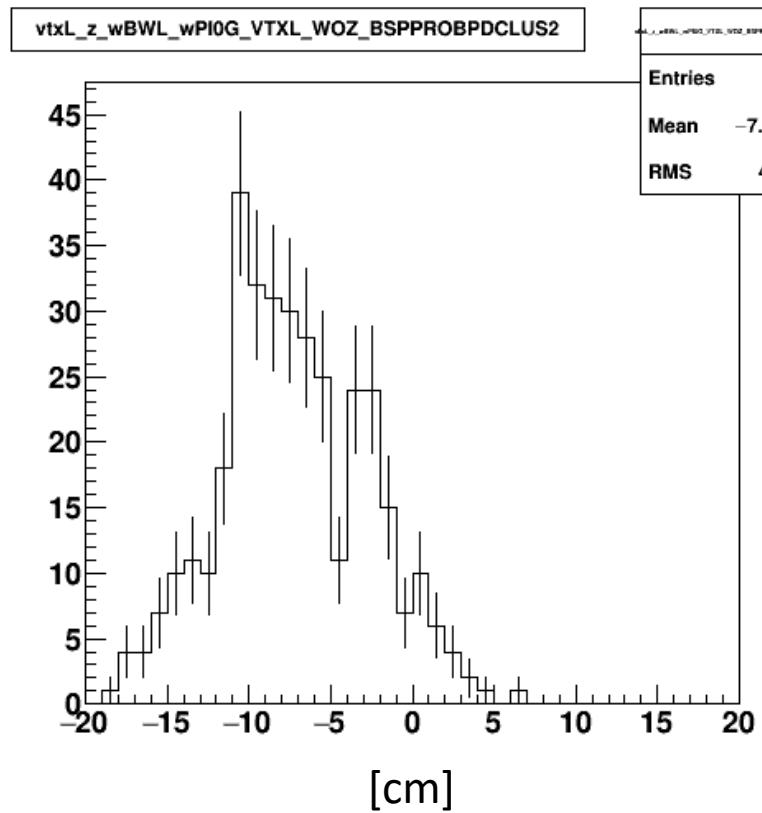
## Vertex Lambda Z [cm]

Condition

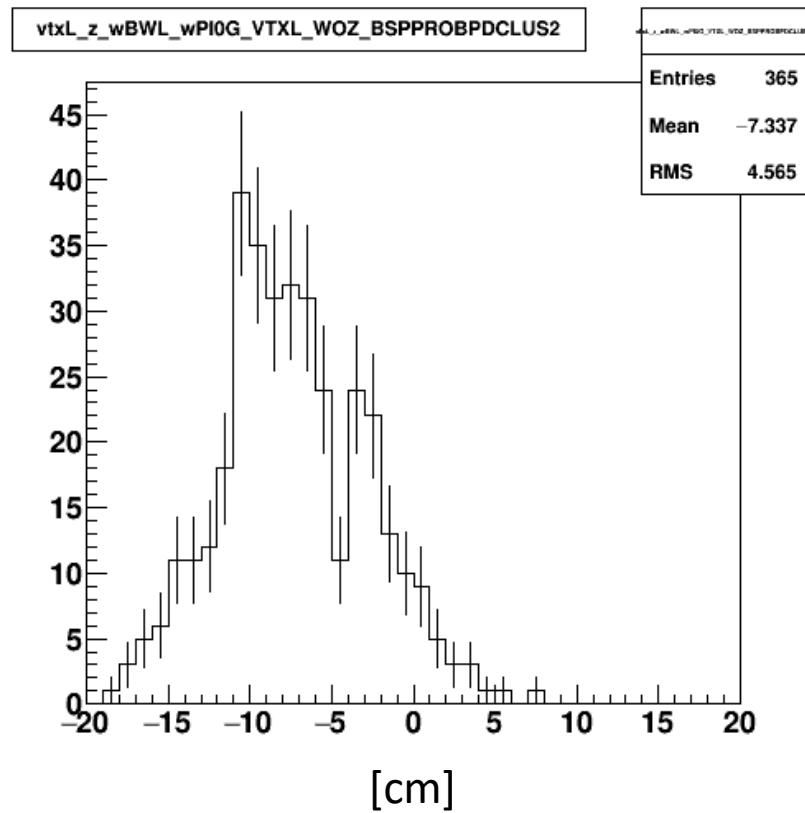
Same as final spectrum

- $\Lambda$  selection
- $d(K^-, p\bar{\pi}^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

1. Vertex w/BPC Beam track (K-)



2. Vertex w/BPC Backward track (p)



Distribution -almost no change

Z vertex resolution seem to be same by changing  $\pi^-$  momentum vertex

Data (Run78)

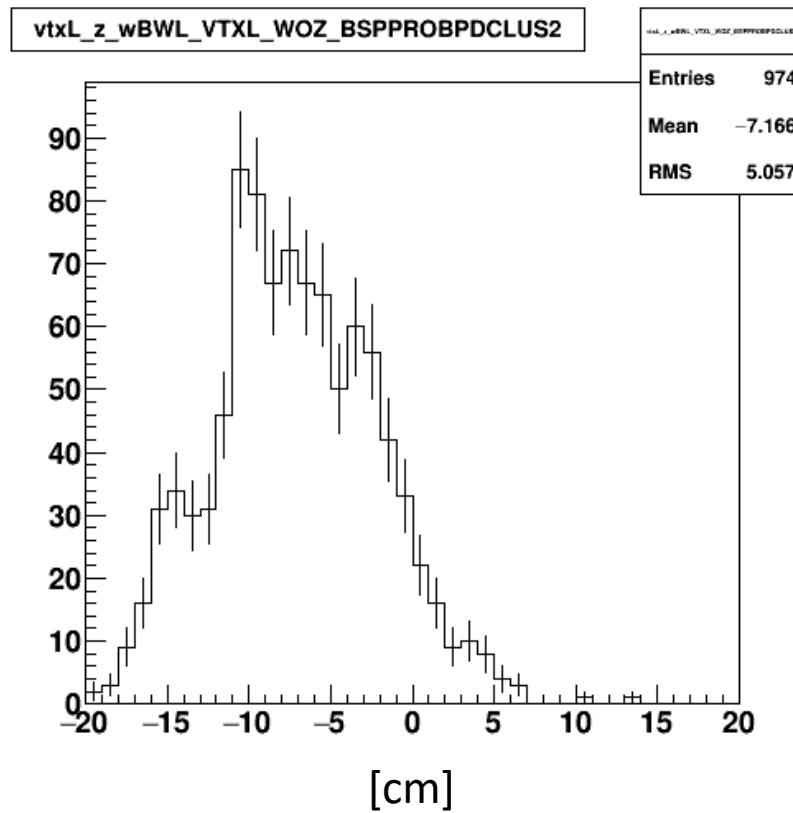
## Vertex Lambda Z [cm]

Condition

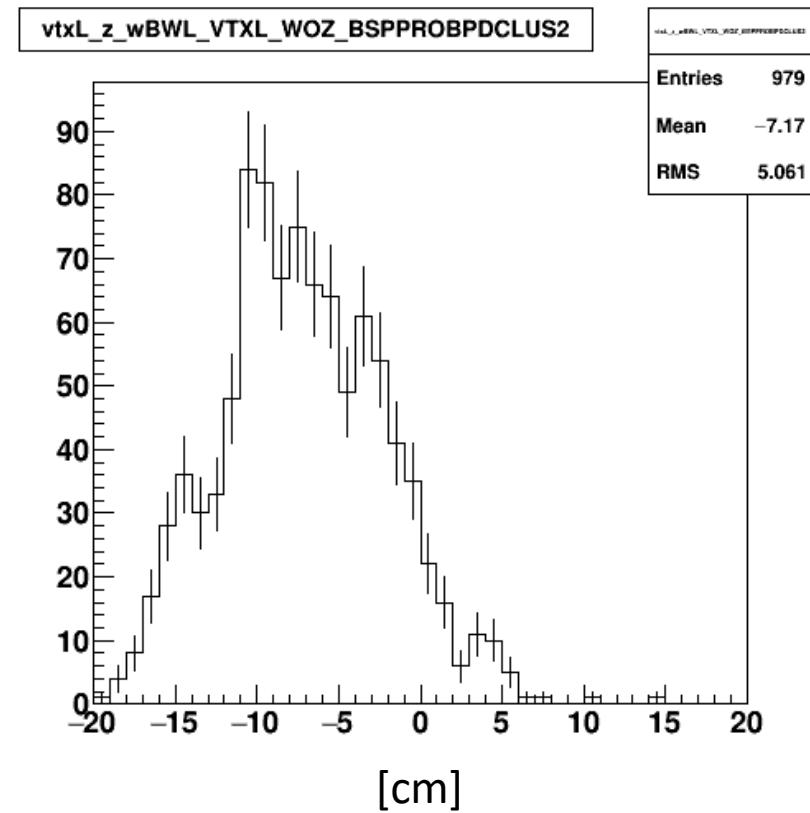
Same as final spectrum

- $\Lambda$  selection
- $d(K_-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

1. Vertex w/BPC Beam track (K-)



2. Vertex w/BPC Backward track (p)



Distribution -almost no change

Z vertex resolution seem to be same by changing  $\pi^-$  momentum vertex

# Backward BPC tracking

BPC is XY 4plane

- X,Y >=3hit
- X,Y =4hit

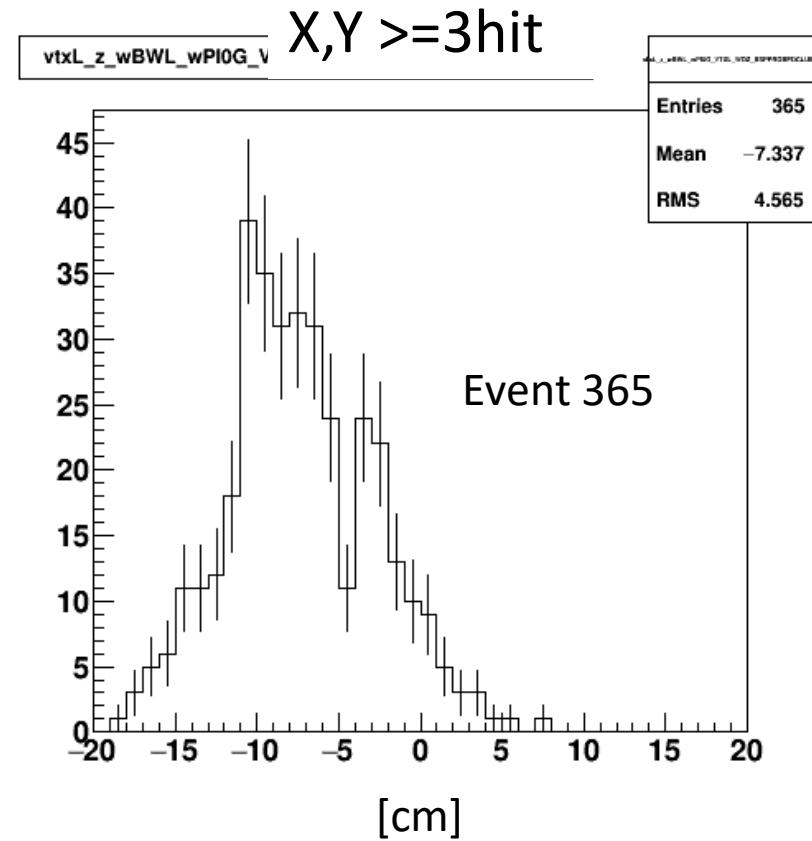
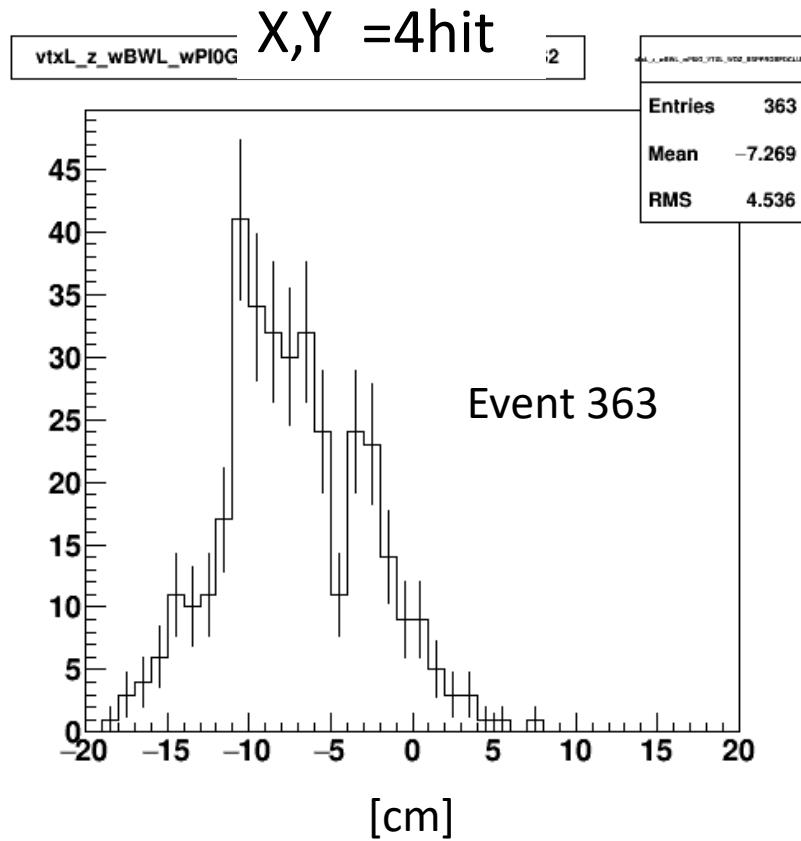
# Data (Run78)

## Vertex Lambda Z [cm]

Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



Originally  $X,Y \geq 4\text{hit}$  event is dominant in this condition ?<sub>36</sub>

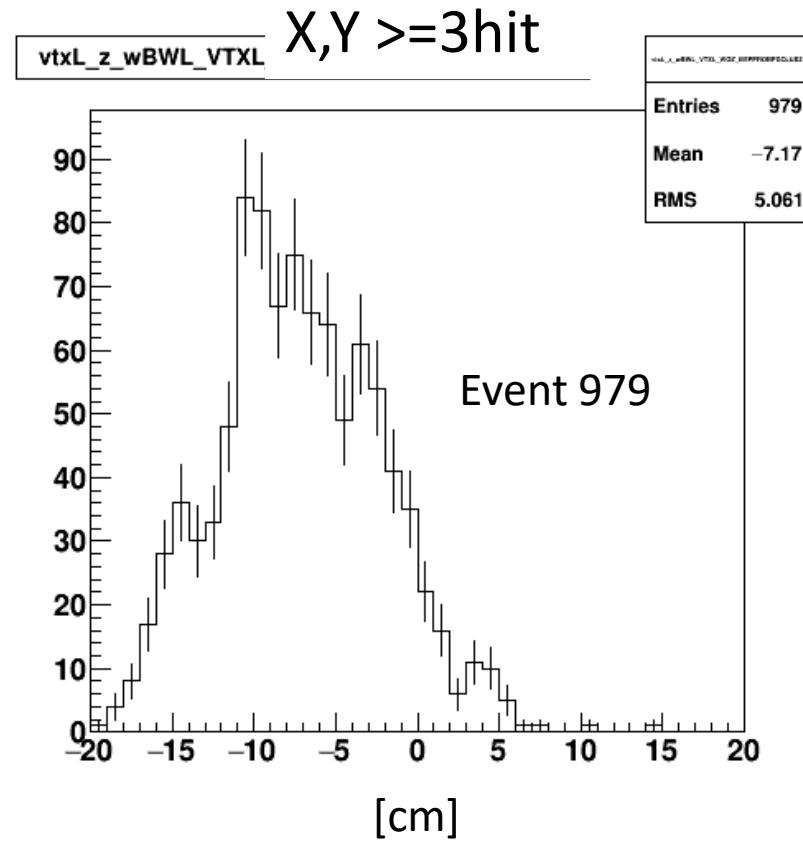
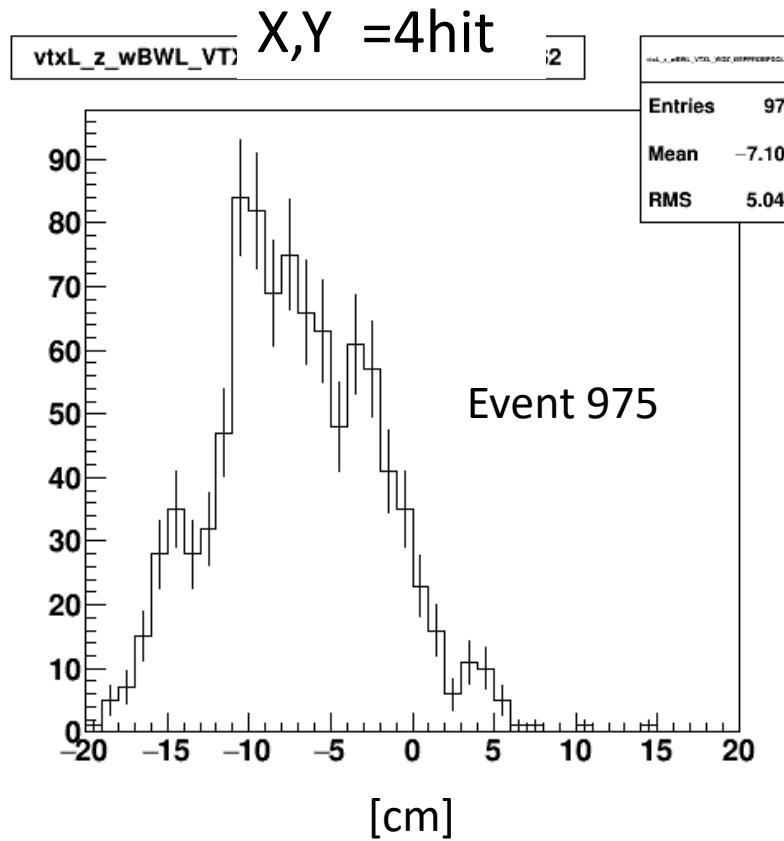
Data (Run78)

## Vertex Lambda Z [cm]

### Condition

Same as final spectrum

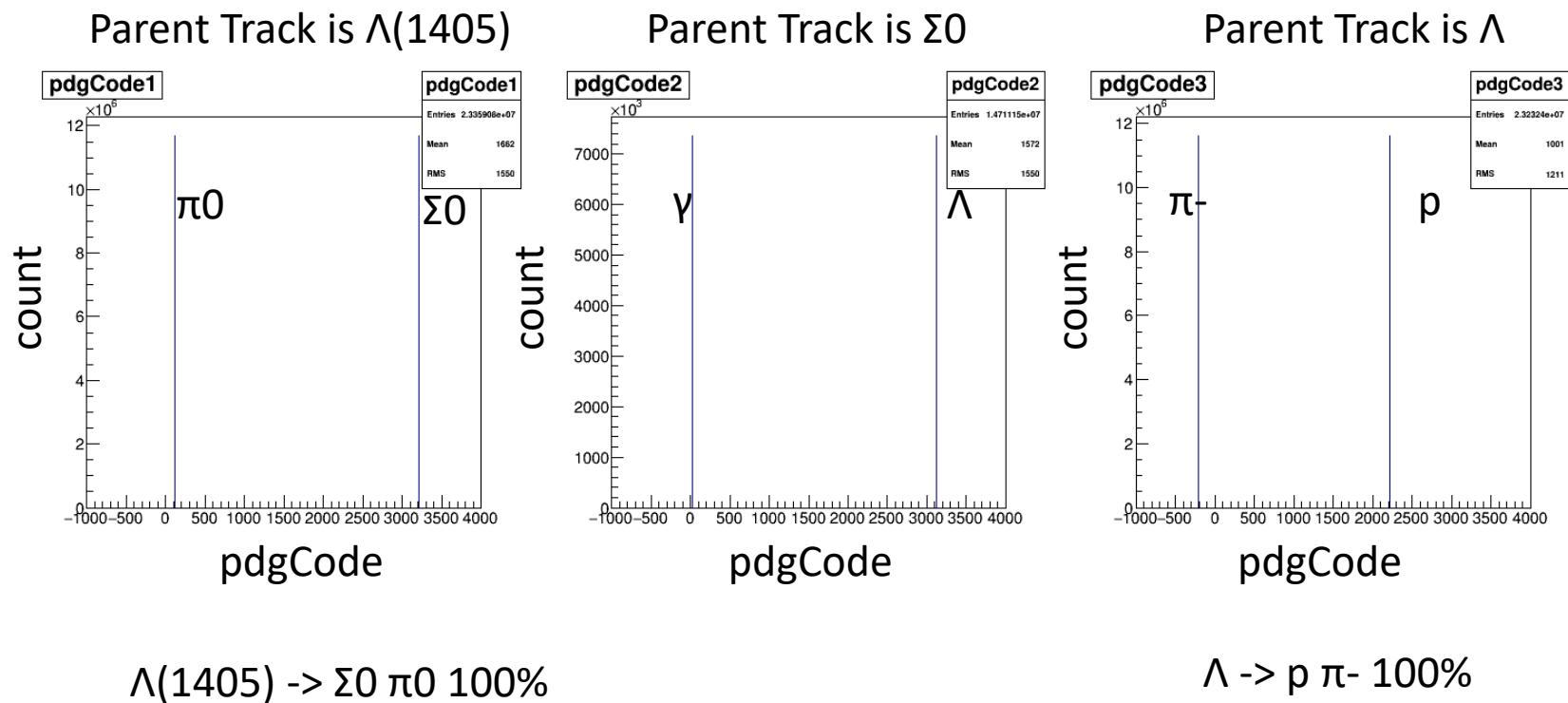
- $\Lambda$  selection
- $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



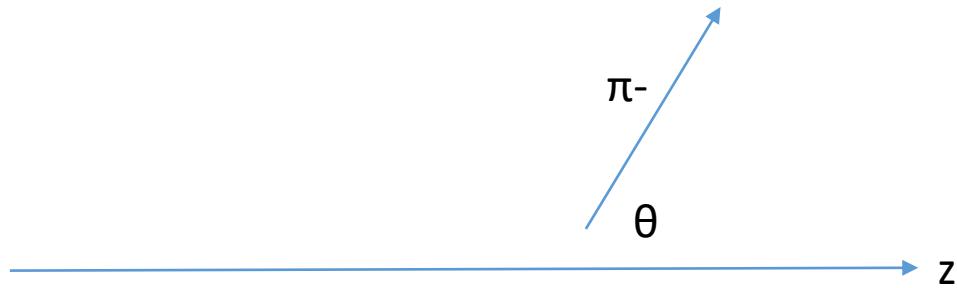
Originally  $X,Y = 4$  hit event is dominant in this condition ?

# SIM $\Sigma$ 0 $\pi$ 0 generation check

Require 2 tracks for the Parent Track

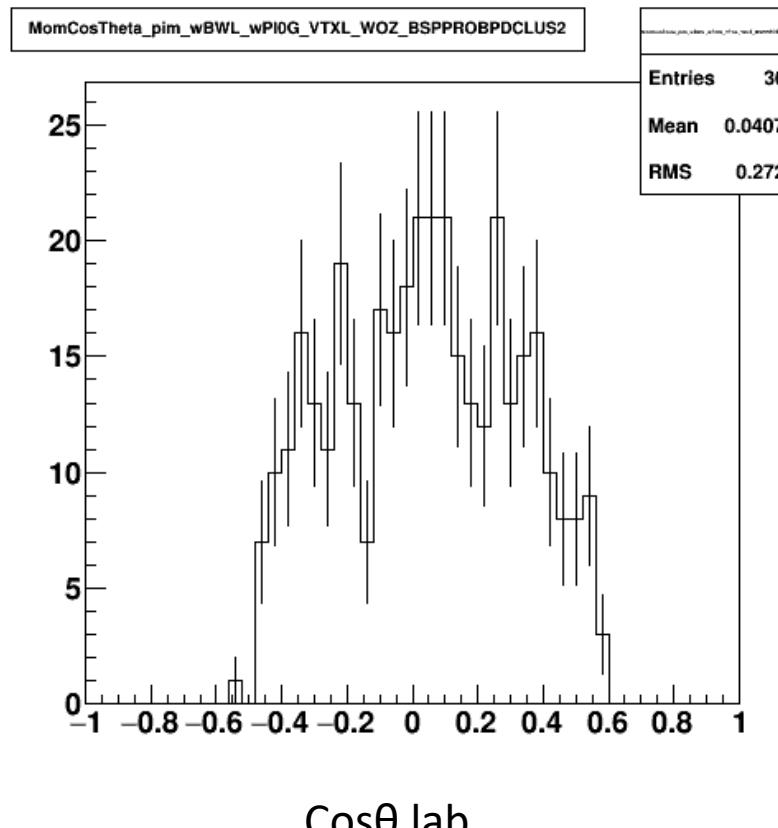


# CDS $\pi$ - momentum $\cos\theta$



# CDS $\pi$ - momentum $\text{Cos}\theta$

Data (Run78)

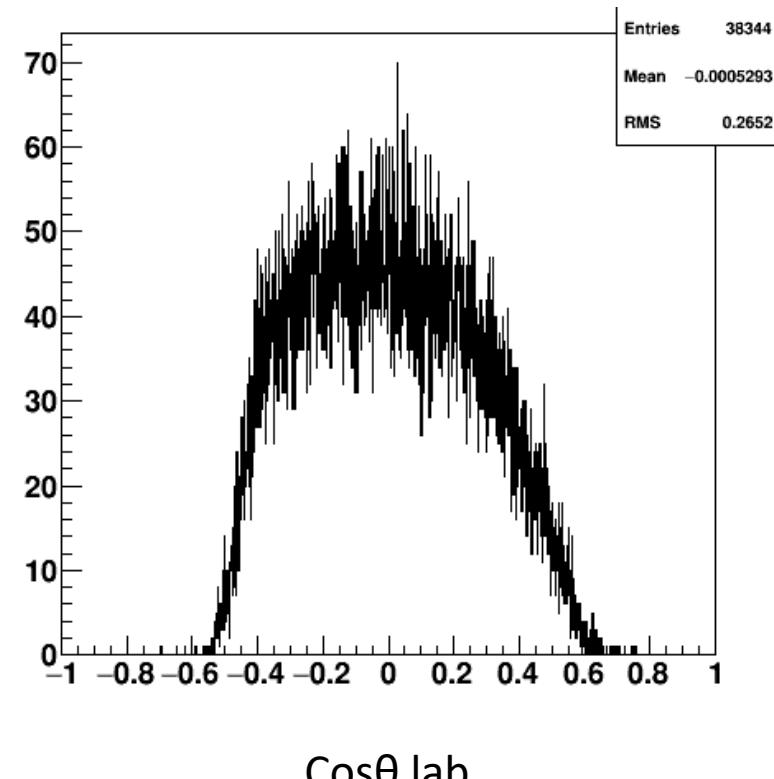


Condition  
Same as final spectrum  
•  $\Lambda$  selection  
•  $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30 \text{ GeV}$

SIM

$K-d \rightarrow n \Sigma 0 \pi 0$

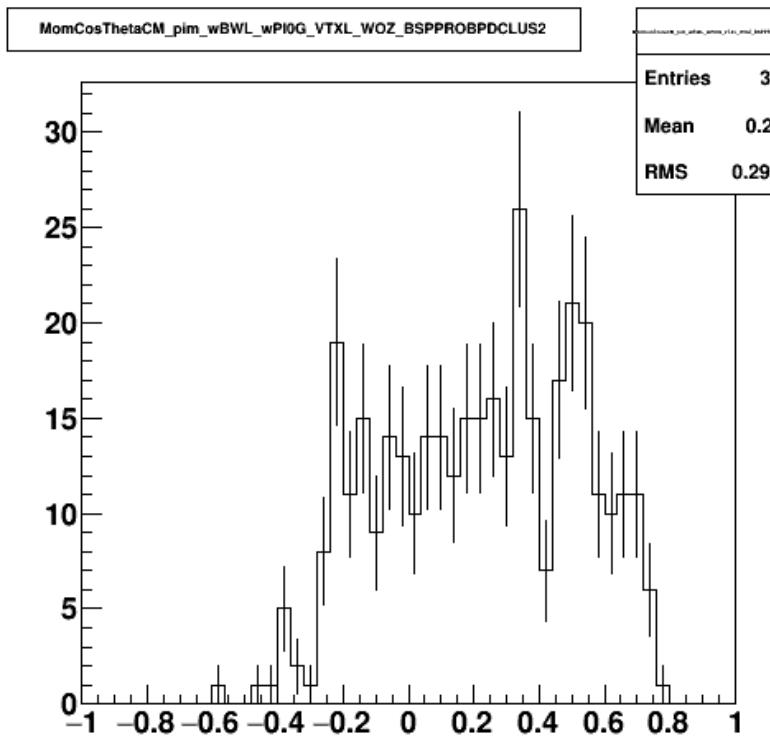
(spectrum shape ; cross Section P.9 left figure )



Almost consistent w/ SIM

# CDS $\pi$ - momentum $\text{Cos}\theta$

Data (Run78)

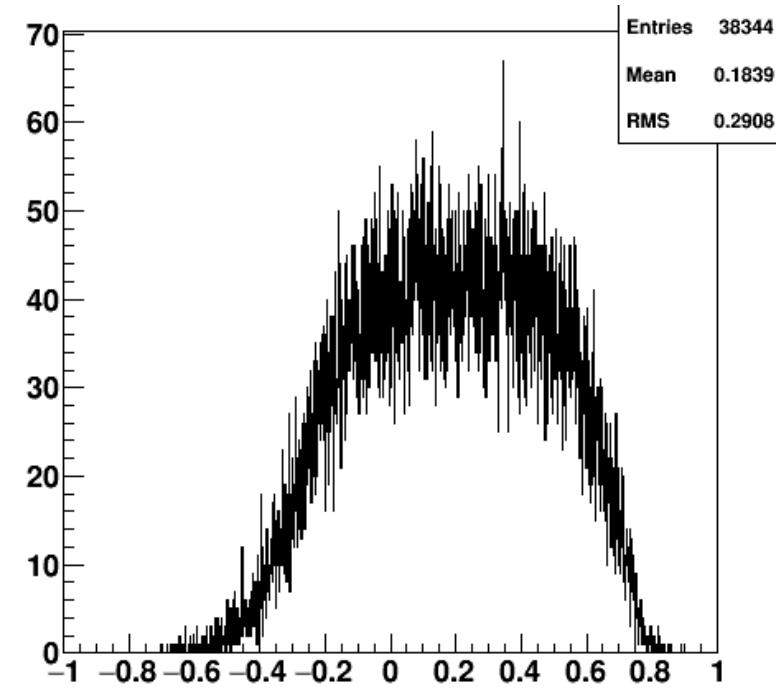


$\text{Cos}\theta \text{ CM } \Sigma 0\pi 0$

SIM

$K-d \rightarrow n \Sigma 0\pi 0$

(spectrum shape ; cross Section P.9 left figure )



$\text{Cos}\theta \text{ CM } \Sigma 0\pi 0$

Almost consistent w/ SIM

Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30 \text{ GeV}$

# Event number dependence on proton hit range of BPC @ BPD

- R<13~16

# Event number dependence on proton hit range of BPC @ BPD

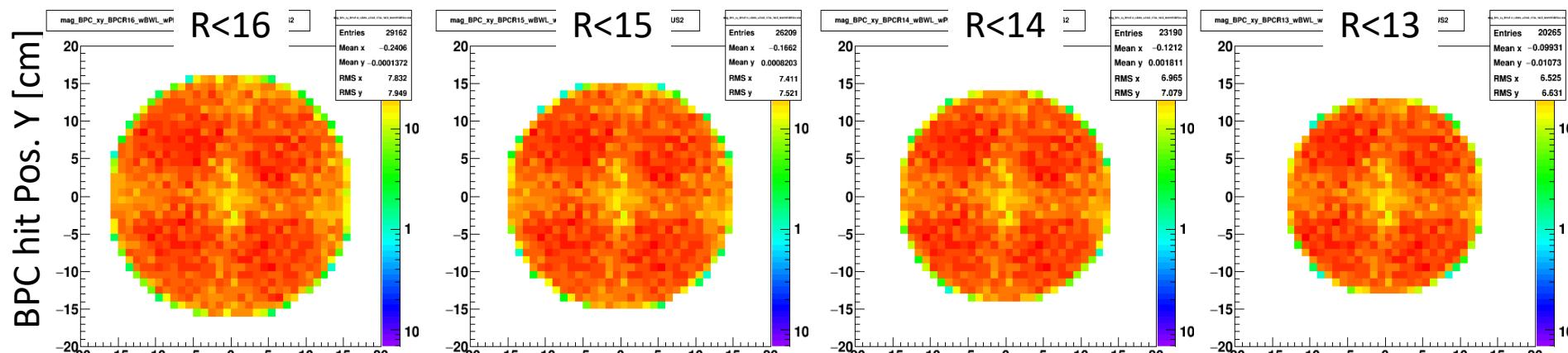
SIM

$K^- \rightarrow n \Sigma^0 \pi^0$

(spectrum shape ; cross Section P.9 left figure )

Another Condition  
Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV



BPC hit Pos. X [cm]

Event Number

- 38270

R<16 29162 76.2 %

R<15 26209 68.4 %

R<14 23190 60.5 %

R<13 20265 52.9 %

# Event number dependence on proton hit range of BPC @ BPD

SIM

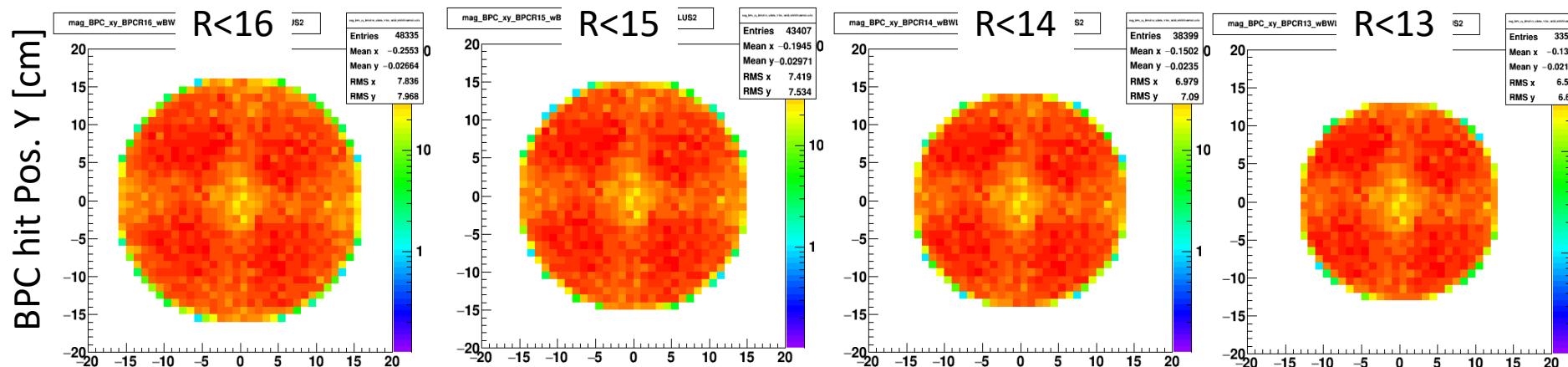
$K-d \rightarrow n \Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



BPC hit Pos. X [cm]

Event Number

- 63409

R<16 48335 76.2 %

R<15 43407 68.4 %

R<14 38399 60.5 %

R<13 33508 52.8 %

# Event number dependence on proton hit range of BPC @ BPD

SIM

$K-d \rightarrow n \Sigma 0 \pi 0$

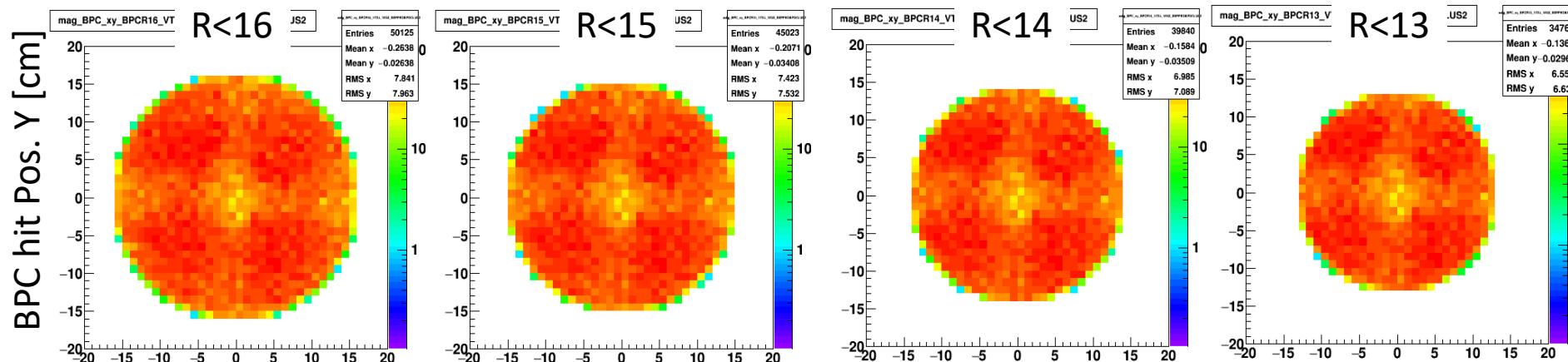
(spectrum shape ; cross Section P.9 left figure )

Another Condition

Same as final spectrum

- $\Lambda$  selection

•  $d(K_d, n \rho \pi) / X \cdot 0.18 < X < 0.30 \text{ GeV}$



BPC hit Pos. X [cm]

Event Number

- 65967

$R < 16$  50125 75.9 %

$R < 15$  45023 68.2 %

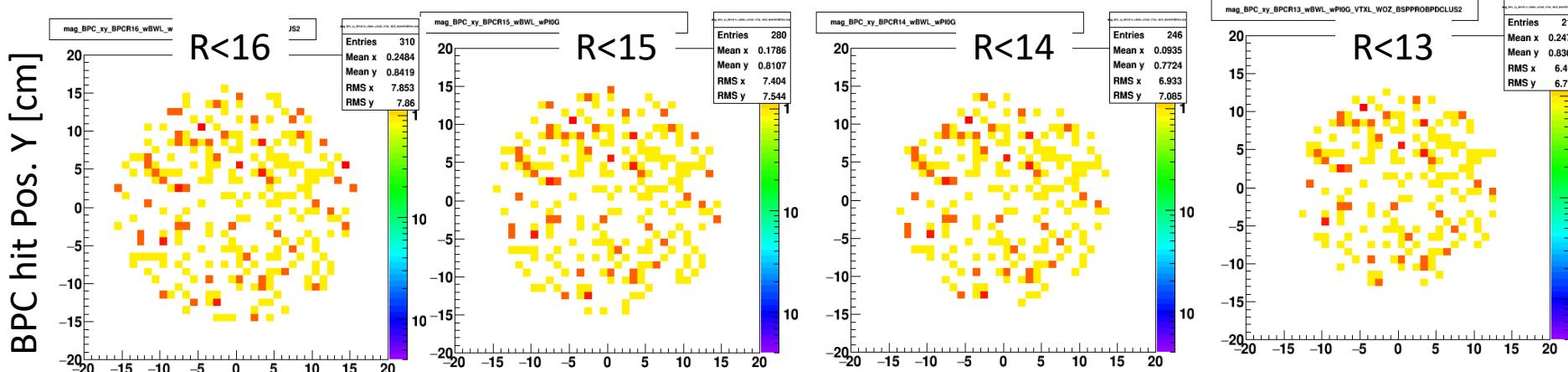
$R < 14$  39840 60.3 %

$R < 13$  34767 52.7 %

# Event number dependence on proton hit range of BPC @ BPD

Data (Run78)

- Another Condition  
Same as final spectrum
- $\Lambda$  selection
  - $d(K_-, \eta p \pi^-)''X''$   $0.18 < X < 0.30$  GeV



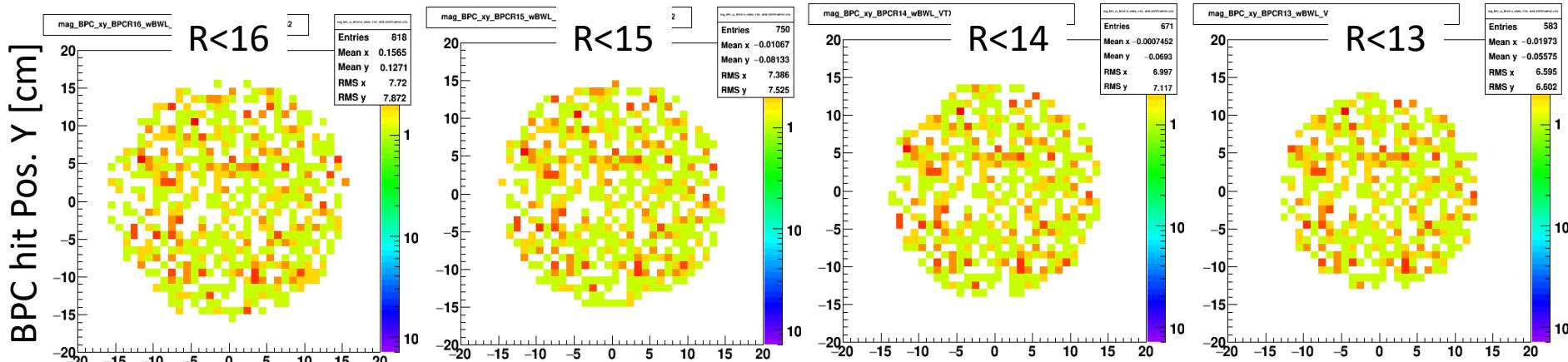
BPC hit Pos. X [cm]

Event Number

-	365	
R < 16	310	84.9 %
R < 15	280	76.7 %
R < 14	246	67.3 %
R < 13	218	59.7 %

# Event number dependence on proton hit range of BPC @ BPD

Data (Run78)



BPC hit Pos. X [cm]

Event Number

-	979	
R < 16	818	83.5 %
R < 15	750	76.6 %
R < 14	671	68.5 %
R < 13	583	59.5 %

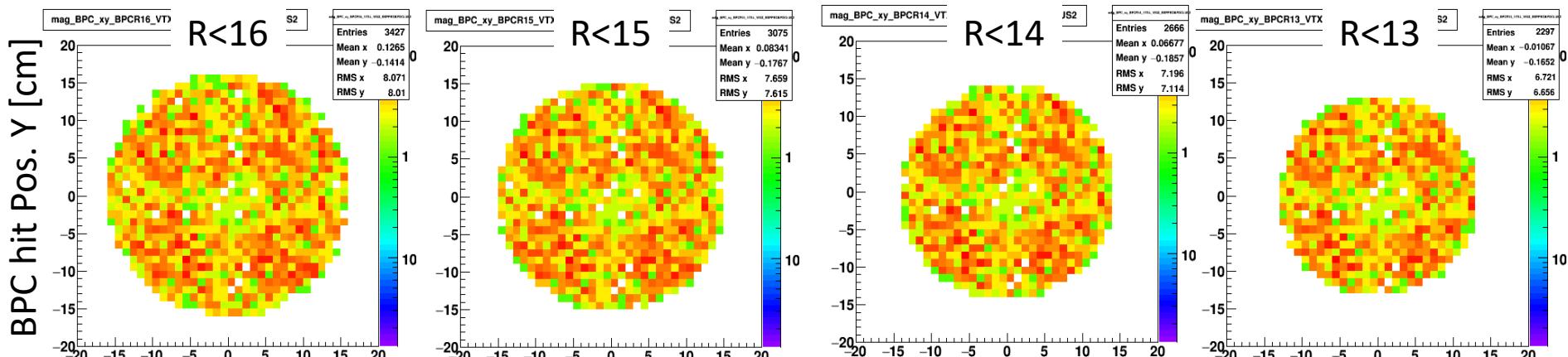
Another Condition  
Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

# Event number dependence on proton hit range of BPC @ BPD

Data (Run78)

- Another Condition  
Same as final spectrum
- $\Lambda$  selection
  - $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



BPC hit Pos. X [cm]

Event Number

- 4551

R<16	3427	75.3 %
R<15	3075	67.5 %
R<14	2666	58.5 %
R<13	2297	50.4 %

# Event number dependence on proton hit range of BPC @ BPD

- R<17~20

# Event number dependence on proton hit range of BPC @ BPD

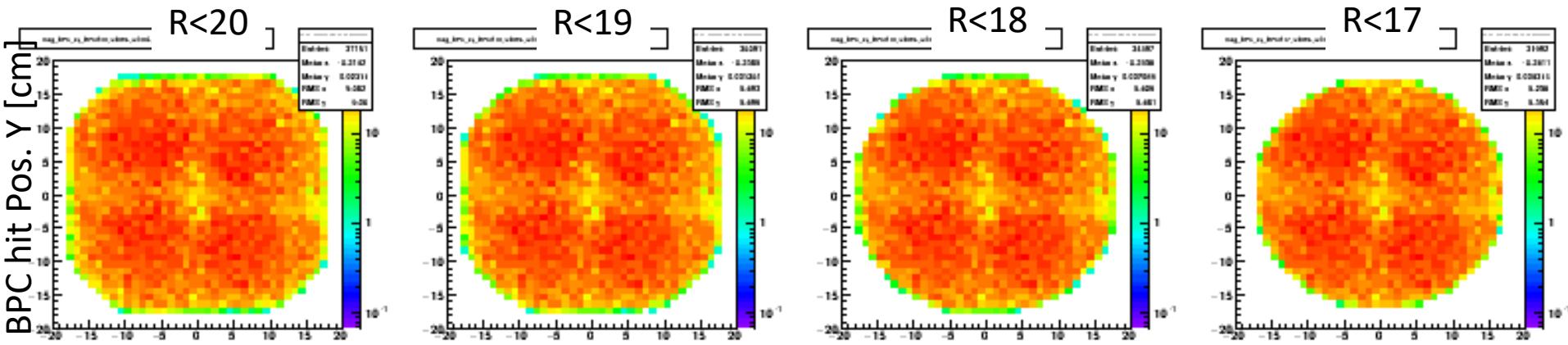
SIM

K-d  $\rightarrow$ n  $\Sigma 0\pi 0$

(spectrum shape ; cross Section P.9 left figure )

Another Condition  
Same as final spectrum

- $\Lambda$  selection
- $d(K_-, n p \pi^-)''X''$   $0.18 < X < 0.30$  GeV



BPC hit Pos. X [cm]

Event Number

- 38270

R<20 37151 97.0 %

R<19 36091 94.3 %

R<18 34497 90.1 %

R<17 31992 83.5 %

# Event number dependence on proton hit range of BPC @ BPD

SIM

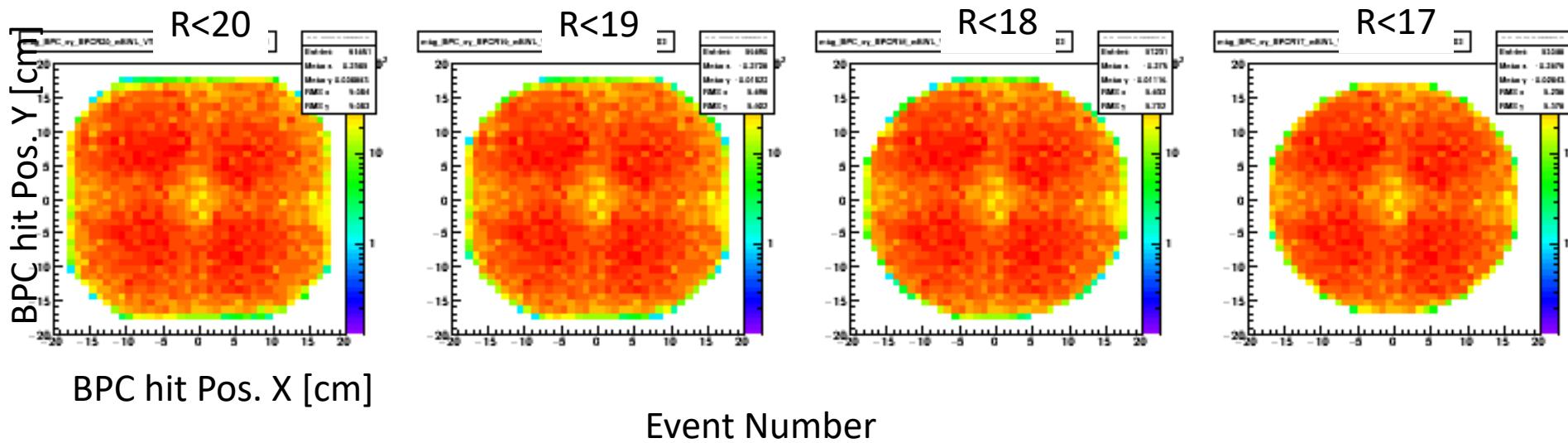
K-d  $\rightarrow$ n  $\Sigma 0\pi 0$

(spectrum shape ; cross Section P.9 left figure )

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K_d \rightarrow n \rho \pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



Event Number

- 63409

R<20 61651 97.2 %

R<19 59890 94.4 %

R<18 57231 90.2 %

R<17 53046 83.6 %

# Event number dependence on proton hit range of BPC @ BPD

SIM

$K-d \rightarrow n \Sigma 0 \pi 0$

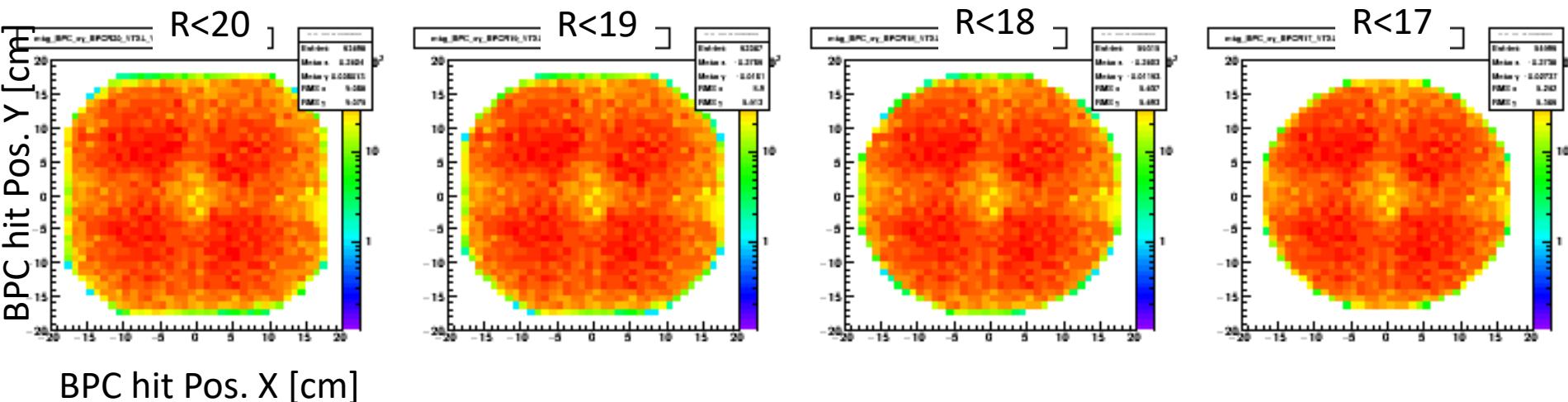
(spectrum shape ; cross Section P.9 left figure )

Another Condition

Same as final spectrum

- $\Lambda$  selection

•  $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



BPC hit Pos. X [cm]

Event Number

- 65967

R<20 63896 96.8 %

R<19 62067 94.0 %

R<18 59315 89.9 %

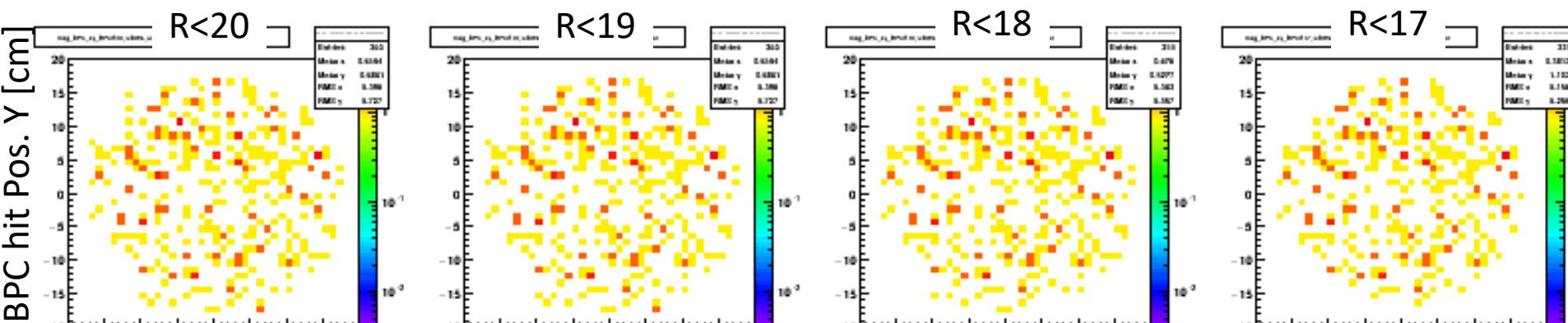
R<17 54999 83.3 %

# Event number dependence on proton hit range of BPC @ BPD

Data (Run78)

Another Condition  
Same as final spectrum

- $\Lambda$  selection
- $d(K^-, \eta p \pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



BPC hit Pos. X [cm]

Event Number

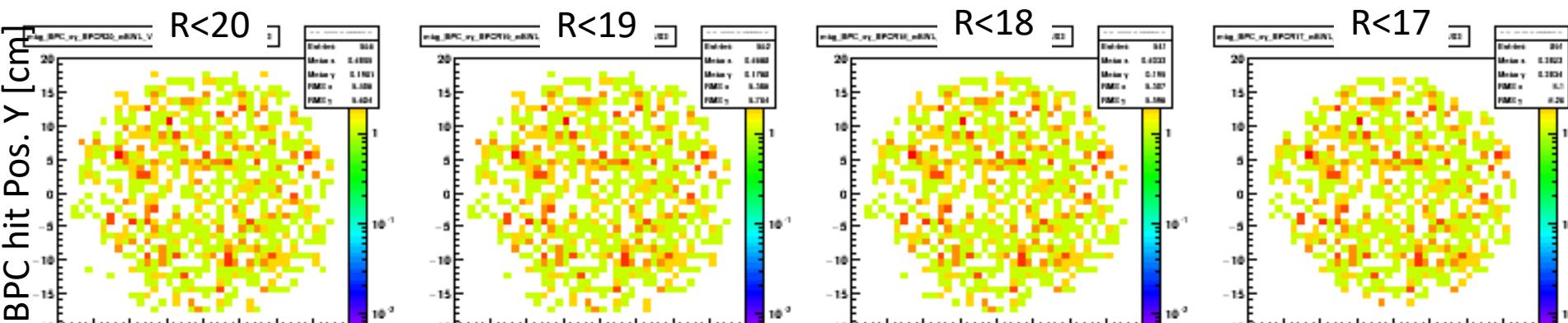
-	365	
R<20	360	98.6 %
R<19	360	98.6 %
R<18	354	96.9 %
R<17	337	92.3 %

# Event number dependence on proton hit range of BPC @ BPD

Data (Run78)

Another Condition  
Same as final spectrum

- $\Lambda$  selection
- $d(K_-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



BPC hit Pos. X [cm]

Event Number

-	979	
R<16	968	98.8 %
R<15	962	98.2 %
R<14	941	96.1 %
R<13	891	91.0 %

# Event number dependence on proton hit range of BPC @ BPD

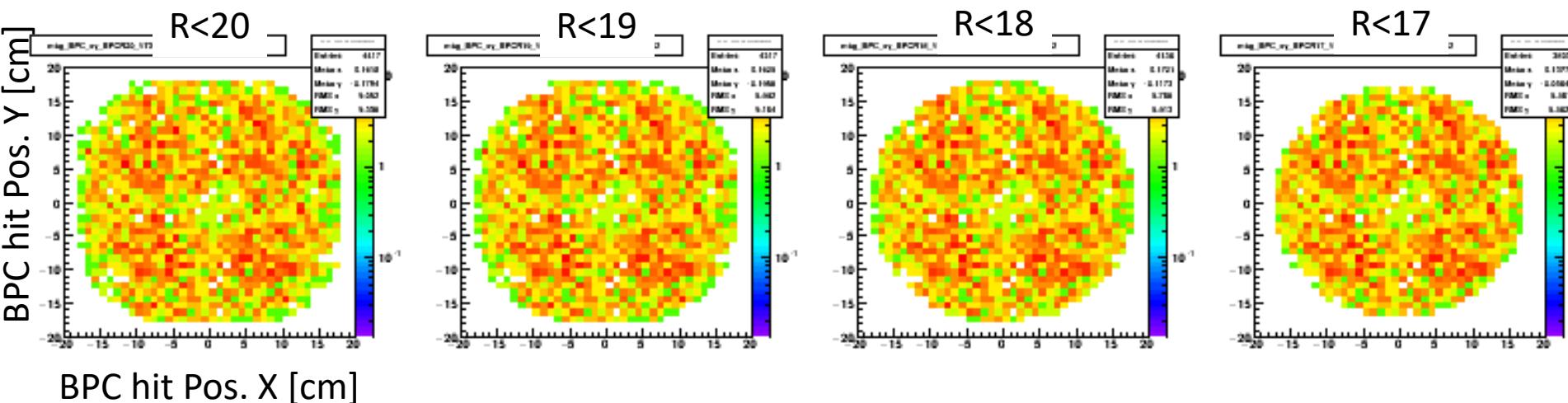
Data (Run78)

Another Condition

Same as final spectrum

- $\Lambda$  selection

- $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



Event Number

- 4551

R<20 4417 97.0 %

R<19 4317 94.8 %

R<18 4136 90.8 %

R<17 3803 83.5 %

# Backward proton momentum

- BPC hit pos  $X < 0$ ,  $Y < 0$
- BPC hit pos  $R > 16$  cm

# Backward proton momentum

SIM

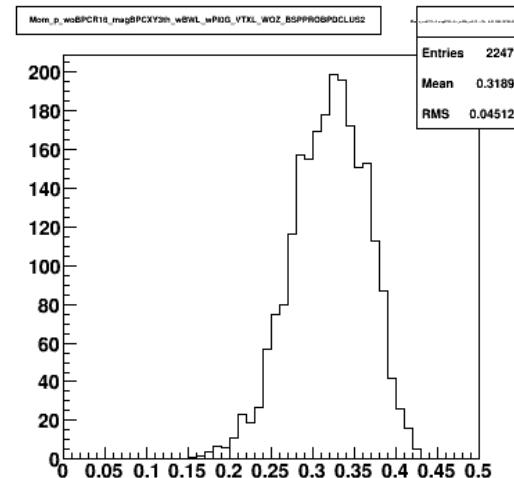
$K-d \rightarrow n \Sigma^0 \pi^0$

(spectrum shape ; cross Section P.9 left figure )

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

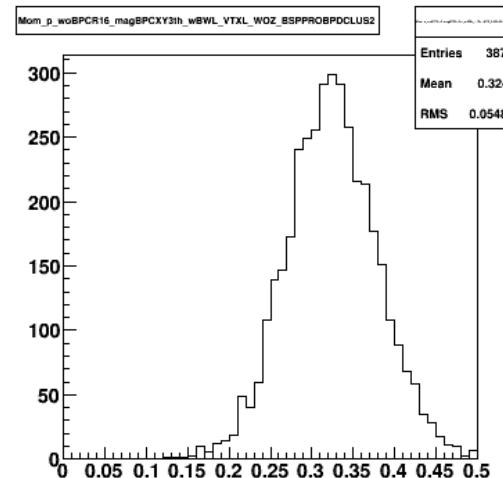


[GeV]

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

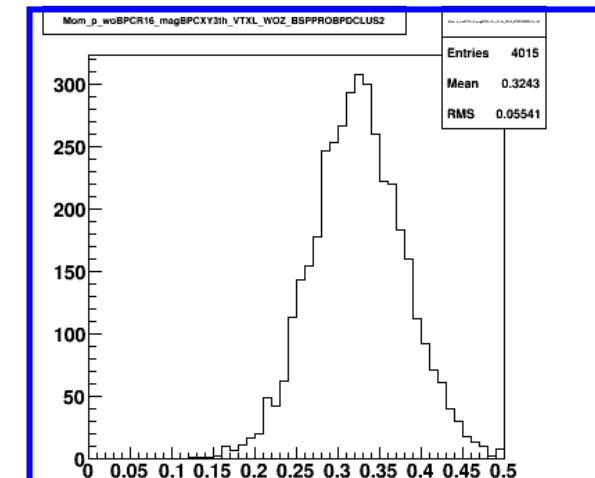


[GeV]

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV



[GeV]

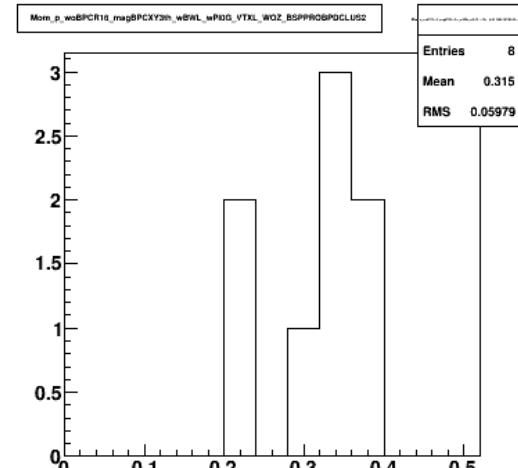
# Backward proton momentum

Data (Run78)

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-) / X \quad 0.18 < X < 0.30 \text{ GeV}$

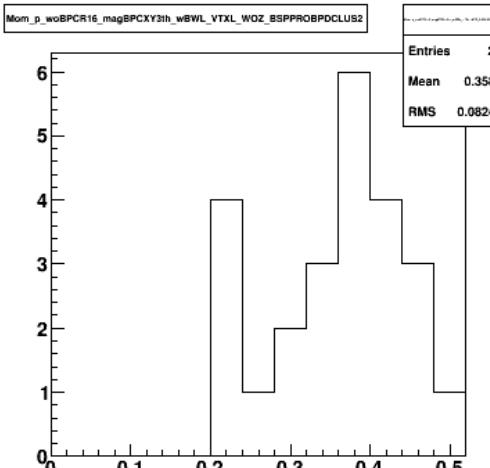


[GeV]

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-) / X \quad 0.18 < X < 0.30 \text{ GeV}$

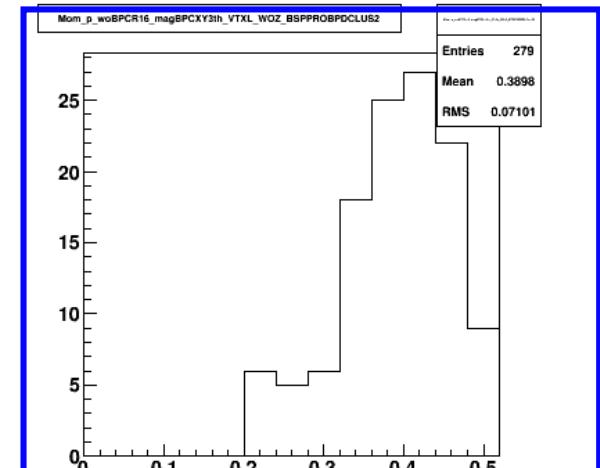


[GeV]

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-) / X \quad 0.18 < X < 0.30 \text{ GeV}$



[GeV]

High momentum distribution compared w/ SIM comes from  $\pi$

# Backward proton momentum

SIM

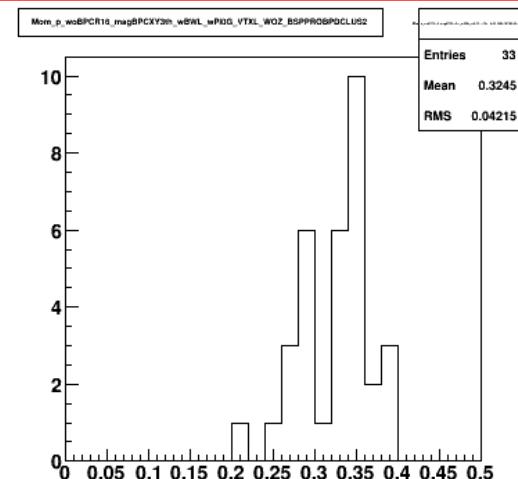
K-d  $\rightarrow$ n  $\Sigma+\pi^-$

(spectrum shape ; cross Section P.22 right figure )

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K_-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

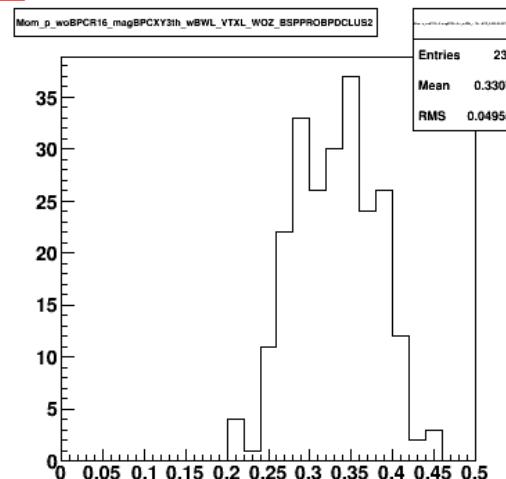


[GeV]

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K_-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

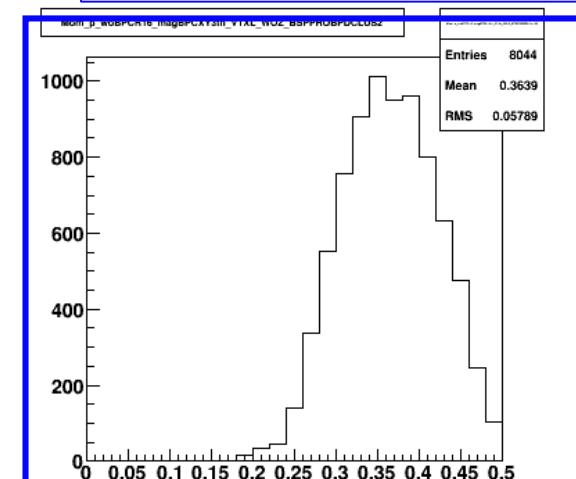


[GeV]

Another Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K_-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV



[GeV]

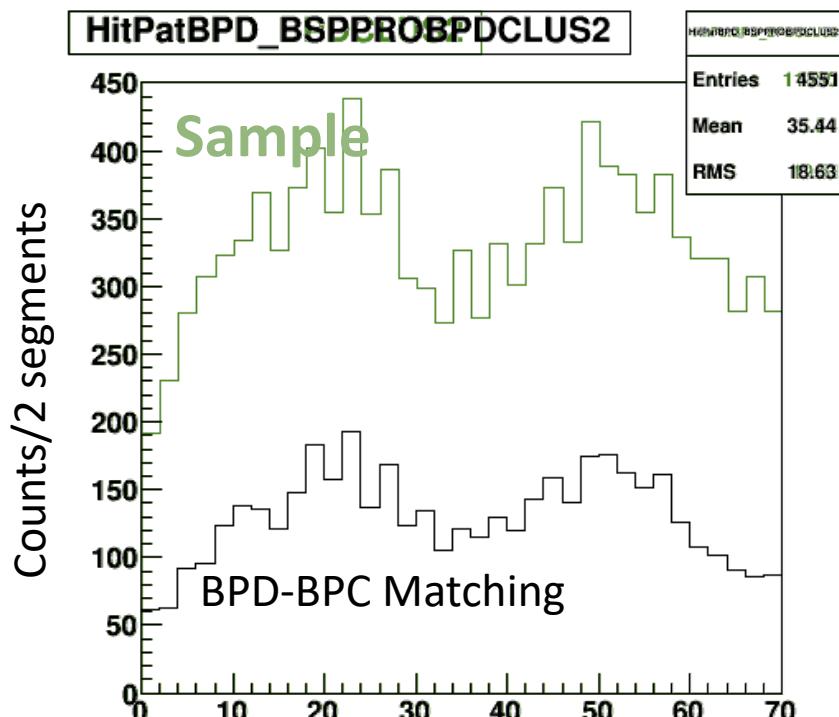
Little lower than the data distribution ?

# BPC backward tracking for the BPD proton hit event

- Check the BPC backward tracking event for the BPD proton hit event
- Sample
  - Upstream analysis (same as final condition)
  - CDS  $\pi$ - PID (same as final condition)
  - forward neutron analysis (same as final condition)
    - Vertex is reconstructed by Beam track approximately
    - w/o the vertex ( $\pi$ - x beam) fiducial cut
  - BPD clustering  $dE > 3\text{MeV}$ 
    - Segment of a clustering ;TOF BPD-T0 > 4 ns
    - Time lag between 2 segments of a clustering ; $\pm 3\sigma$  from SIM distribution

# BPD hit pattern of backward proton

Data (Run78)

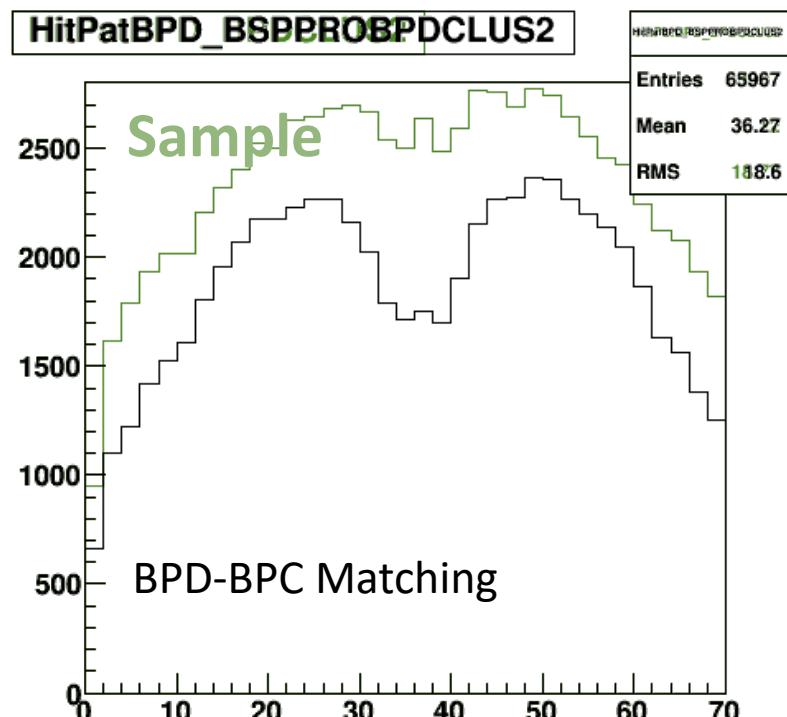


The youngest segment#  
of the BPD clustering

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)



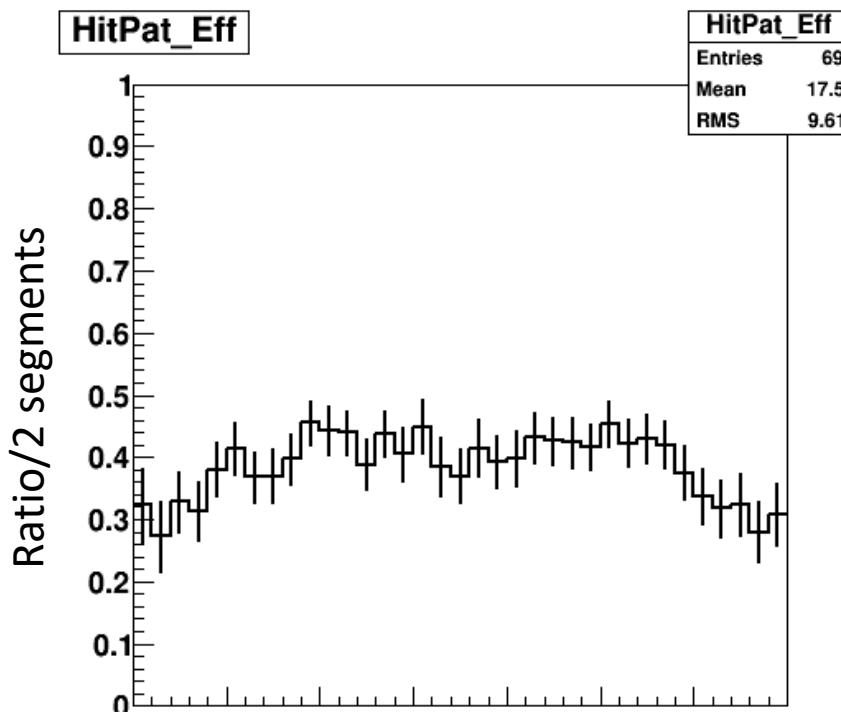
The youngest segment#  
of the BPD clustering

Vertex (lambda x beam) fiducial cut w/o Z  
is required in BPD-BPC Matching

# BPD hit pattern of backward proton

Ratio ; BPD-BPC Matching /**Sample**

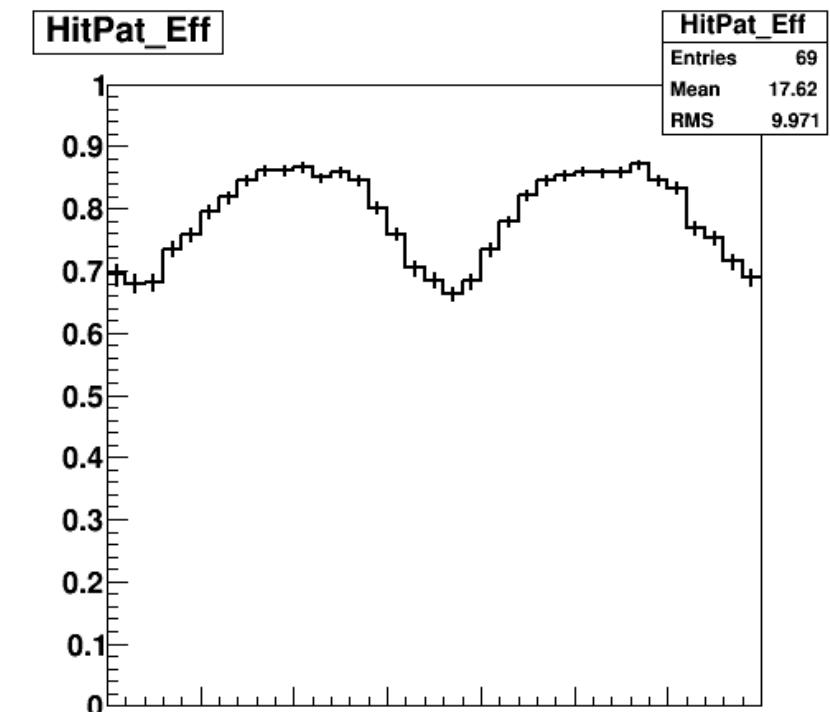
**Data (Run78)**



**SIM**

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

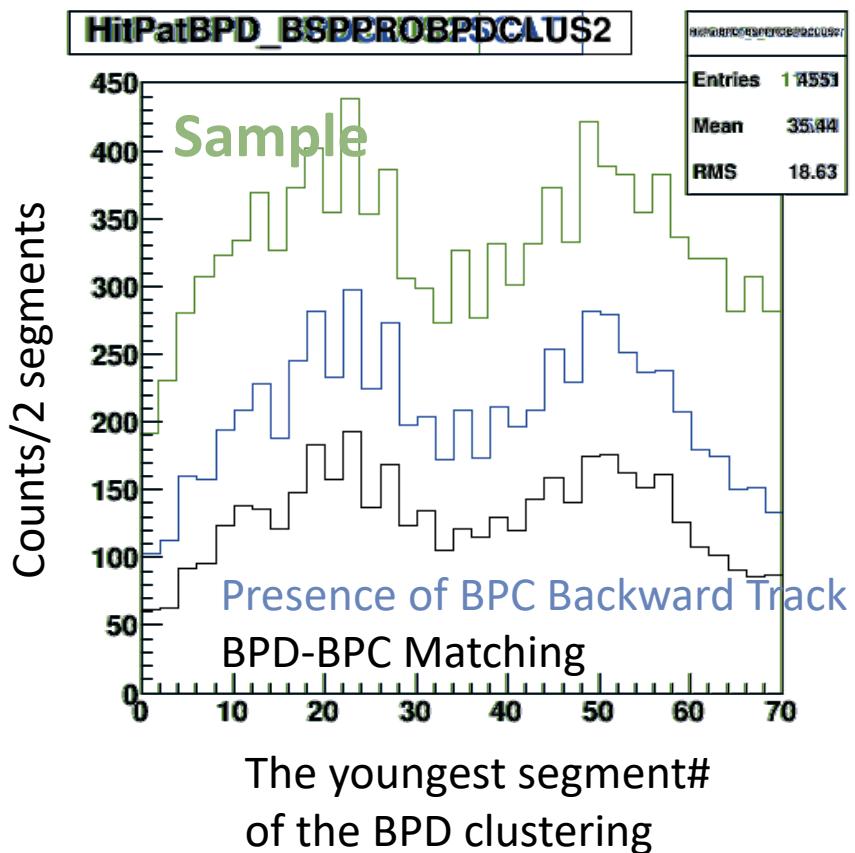


BPC backward tracking event is missed in data analysis ?

# BPD hit pattern of backward proton

Presence of BPC backward tracking event (before BPD-BPC Matching)

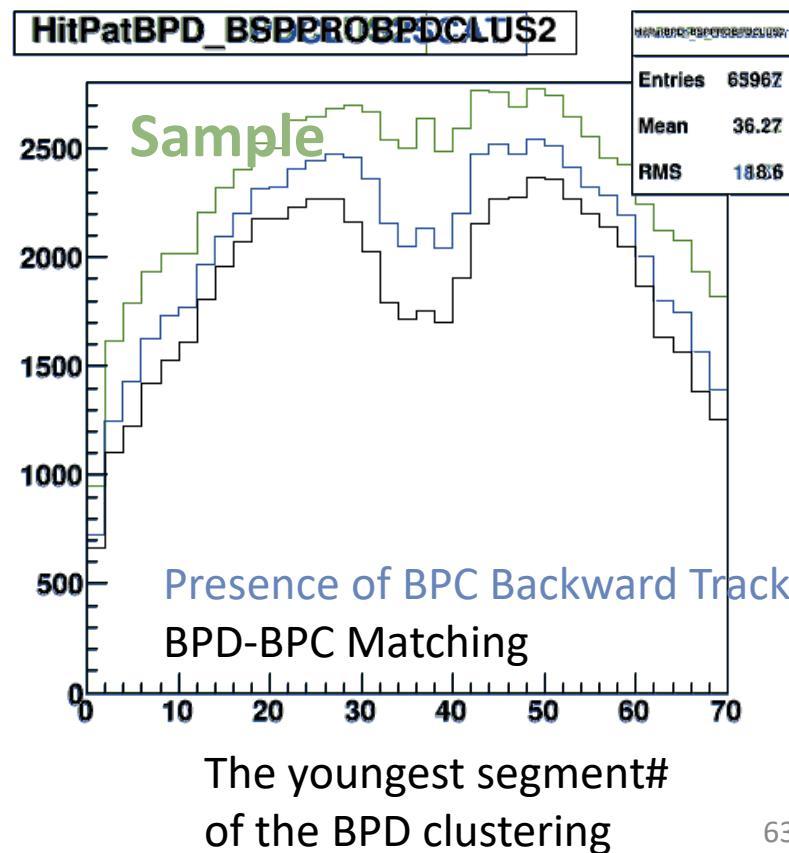
Data (Run78)



SIM

K-d ->n  $\Sigma 0 \pi 0$

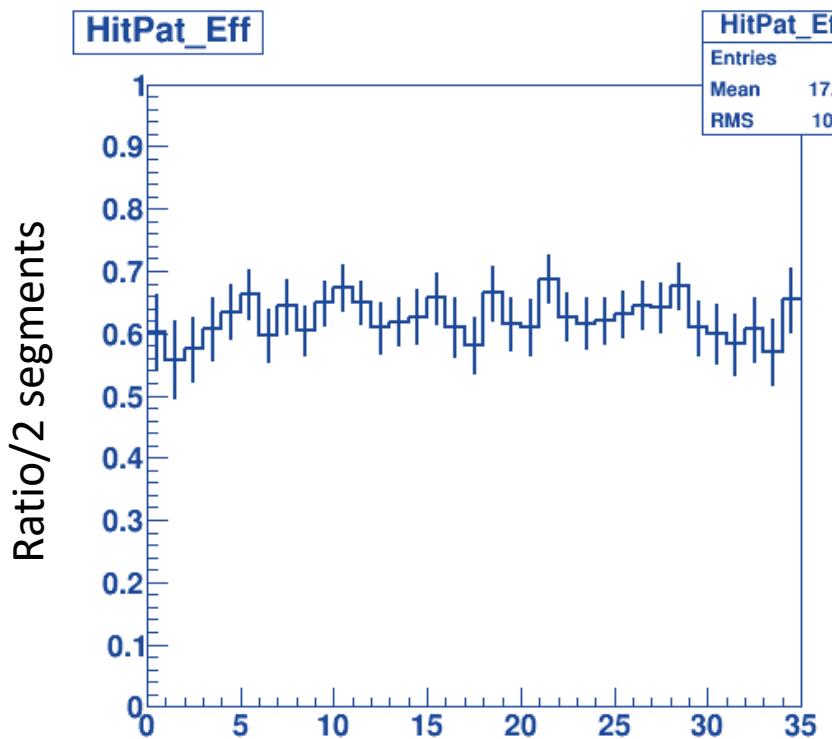
(spectrum shape ; cross Section P.9 left figure)



# BPD hit pattern of backward proton

Ratio ; Presence of BPC Backward Track/**Sample**

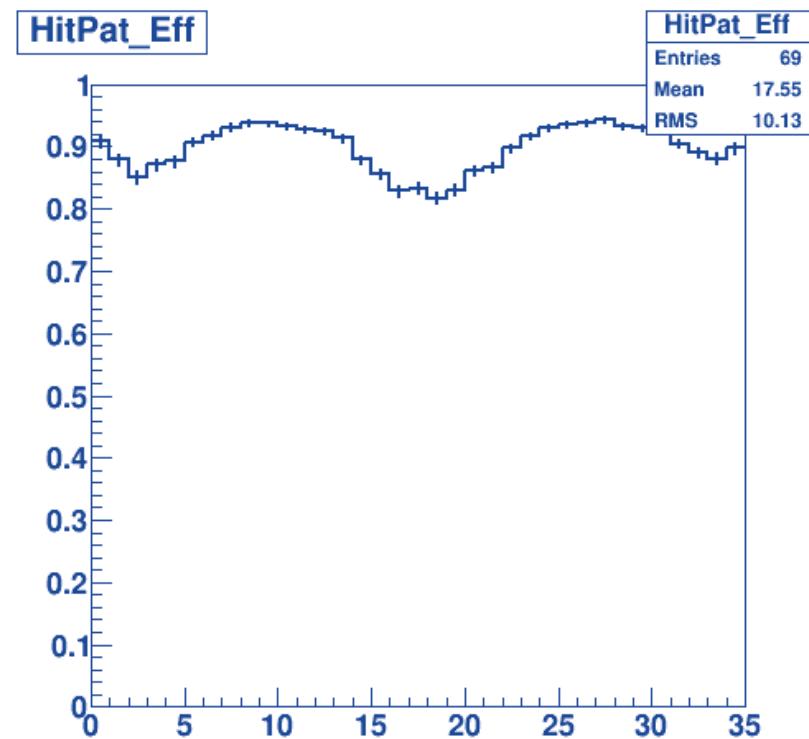
**Data (Run78)**



**SIM**

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

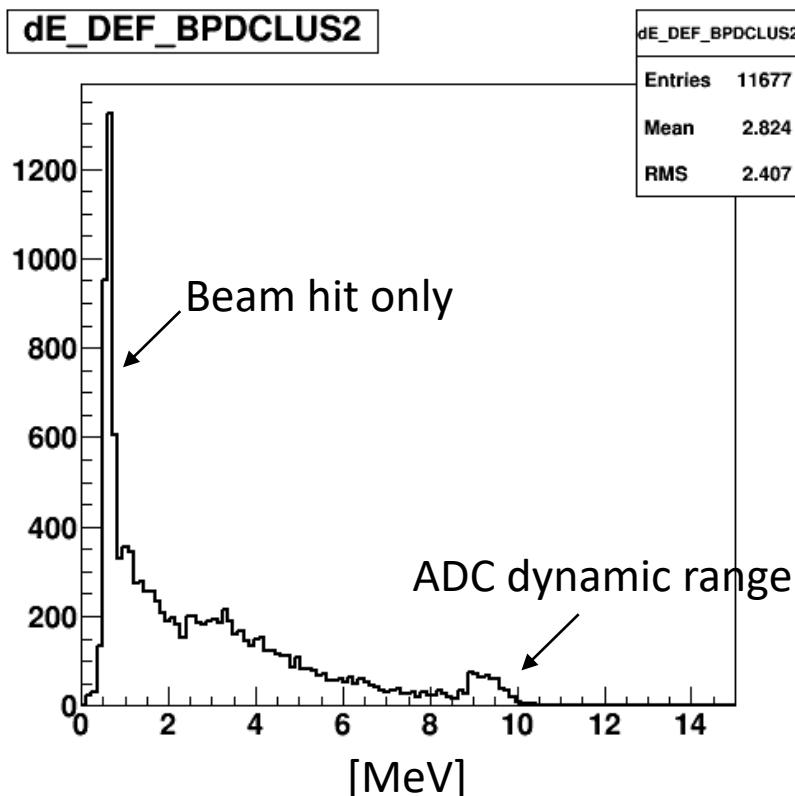


BPC backward tracking event is missed in data analysis ?

# dE DEF in the BPD proton hit event

Max dE events of DEF hit segments in the sample event

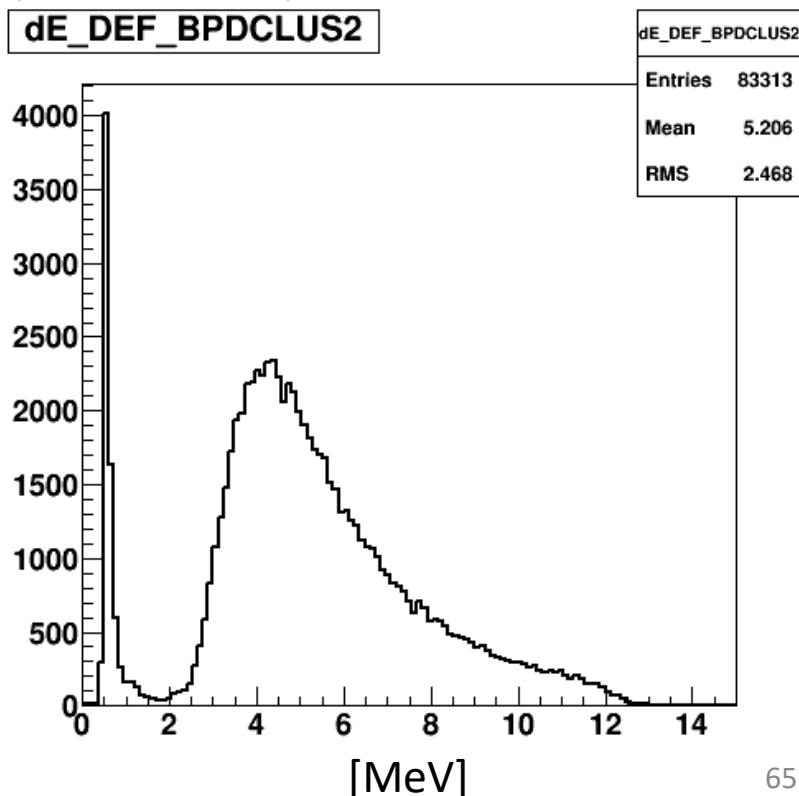
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

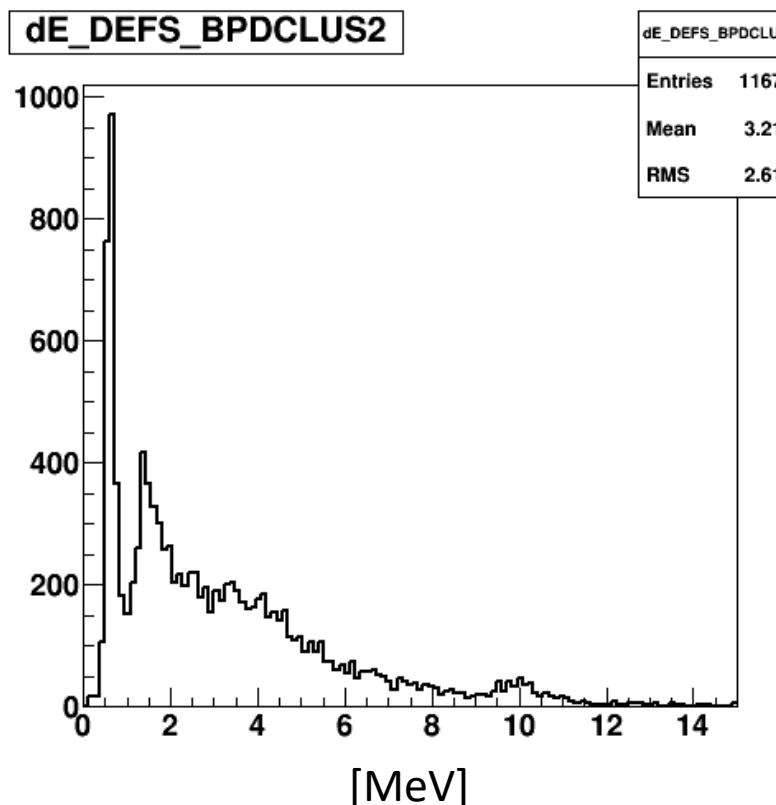
(spectrum shape ; cross Section P.9 left figure)



# dE DEF in the BPD proton hit event

Total dE of DEF hit segments in the sample event

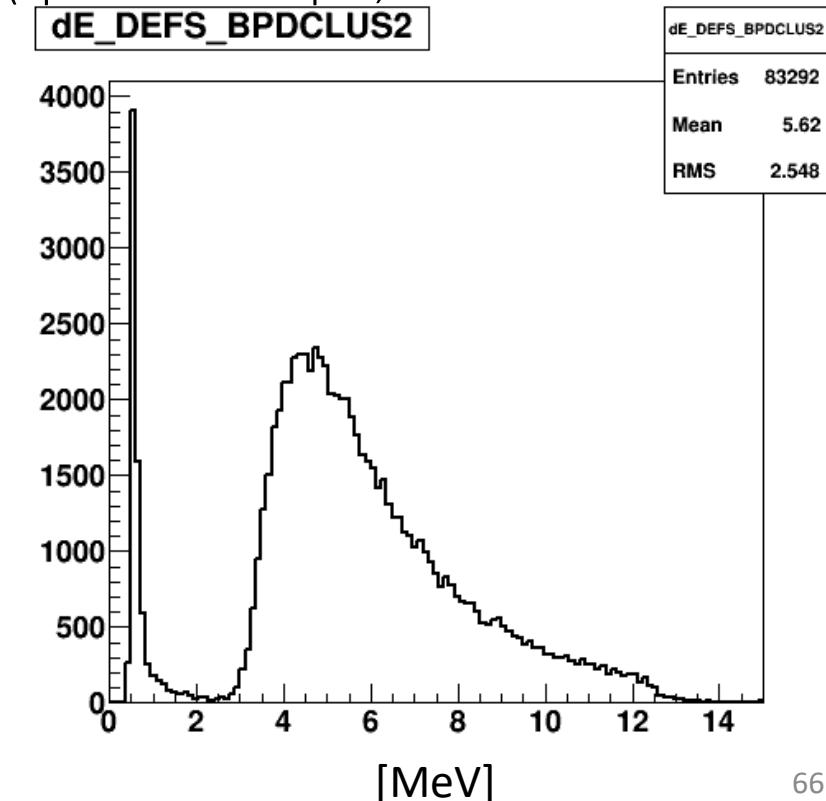
Data (Run78)



SIM

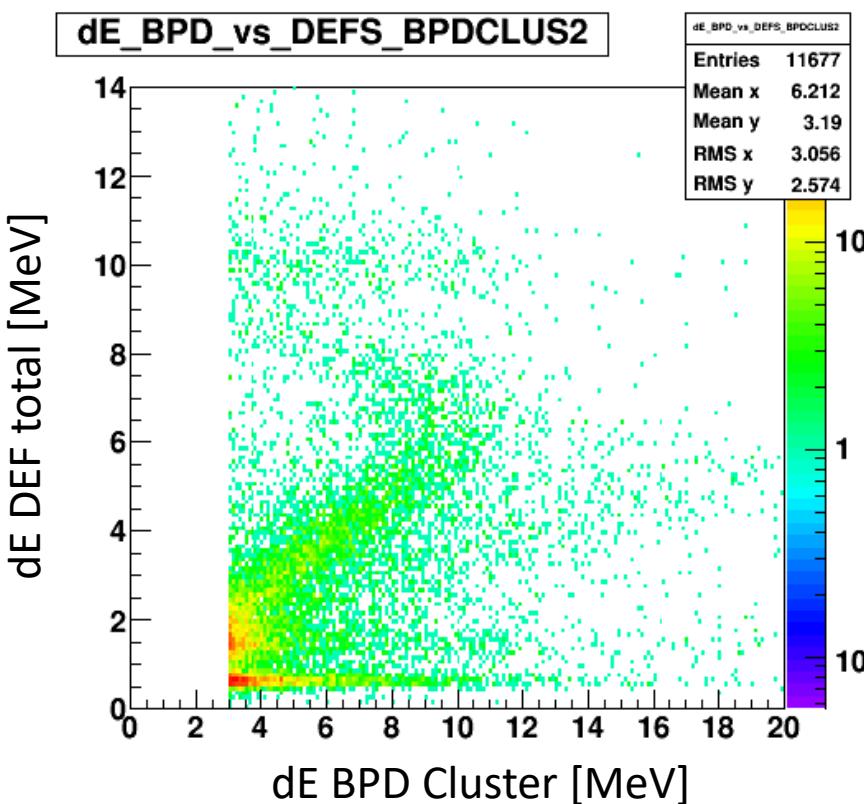
K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)



# dE BPD vs dE DEF in the BPD proton hit event in the sample event

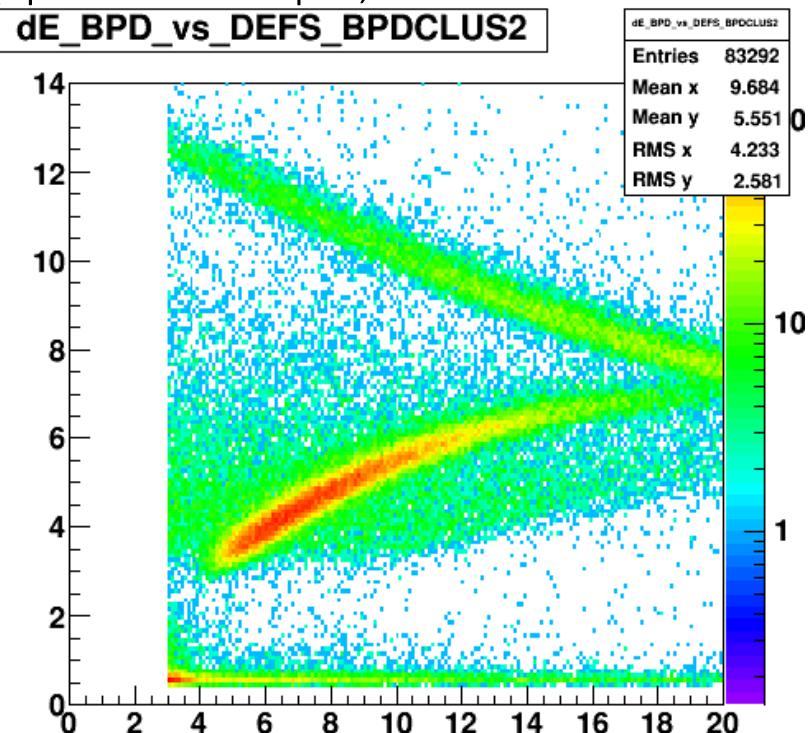
Data (Run78)



SIM

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

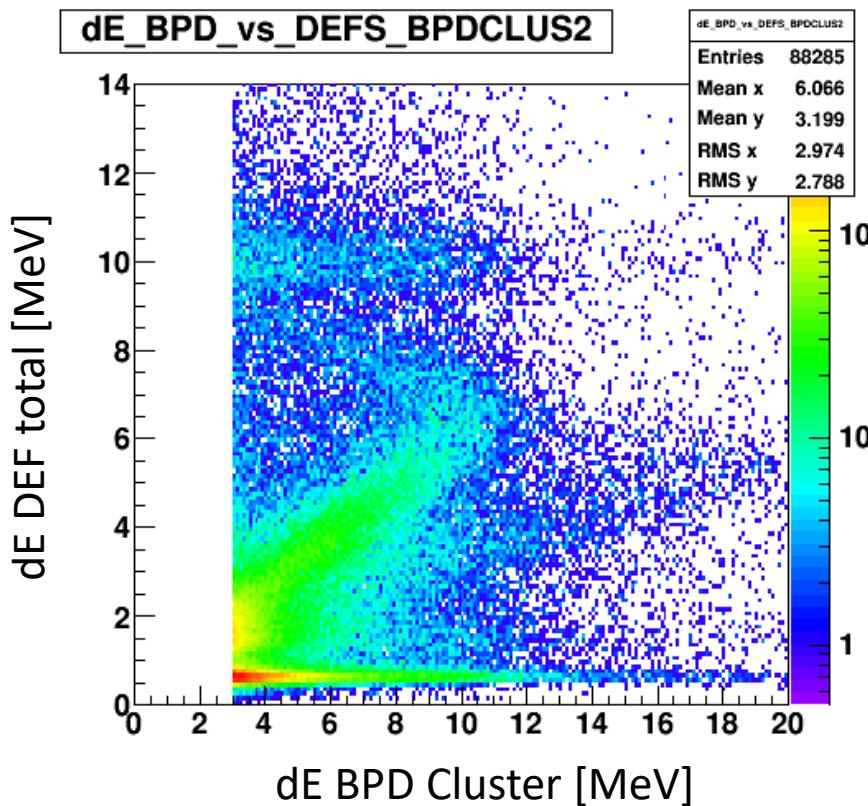
(spectrum shape ; cross Section P.9 left figure)



# dE BPD vs dE DEF in the BPD proton hit event in the sample event

## Data (Run78)

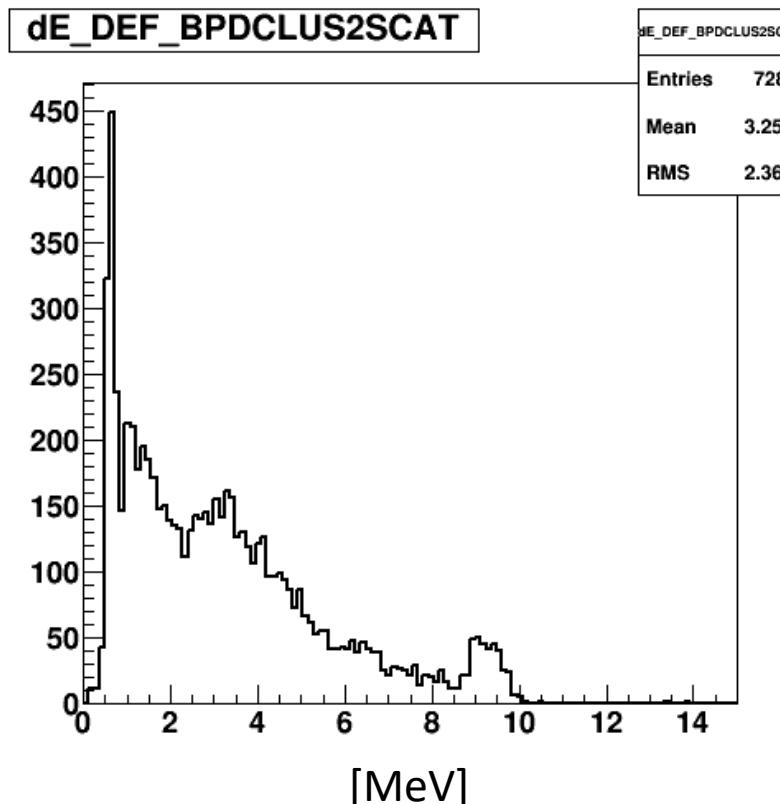
w/o forward neutron analysis for the increase of statistics



# dE DEF in the BPD proton hit event

Max dE events of DEF hit segments  
in the presence of BPC Backward Track event

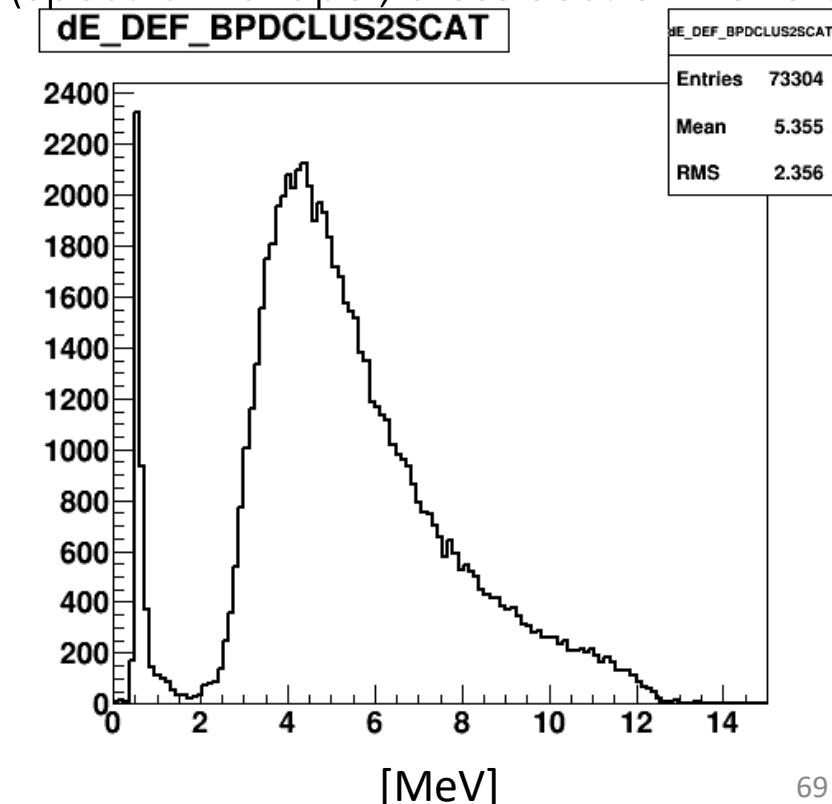
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

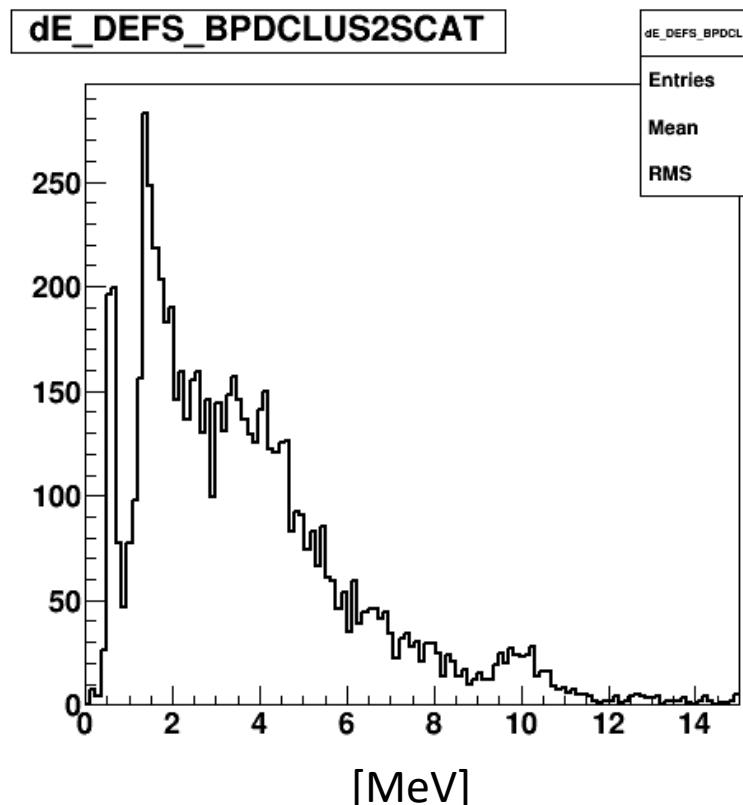
(spectrum shape ; cross Section P.9 left figure)



# dE DEF in the BPD proton hit event

Total dE of DEF hit segments  
in the presence of BPC Backward Track event

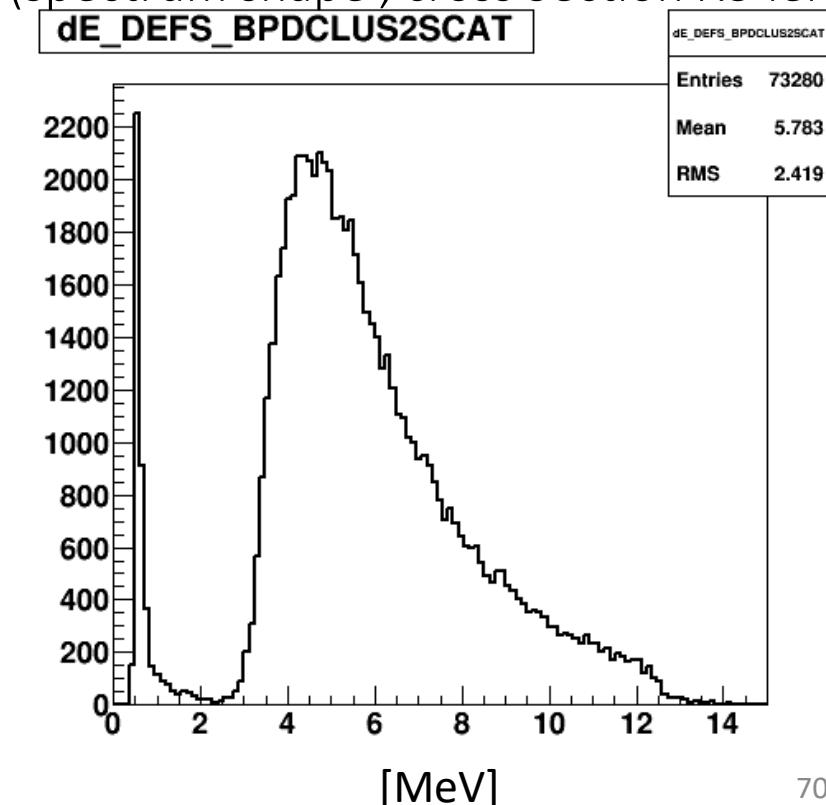
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

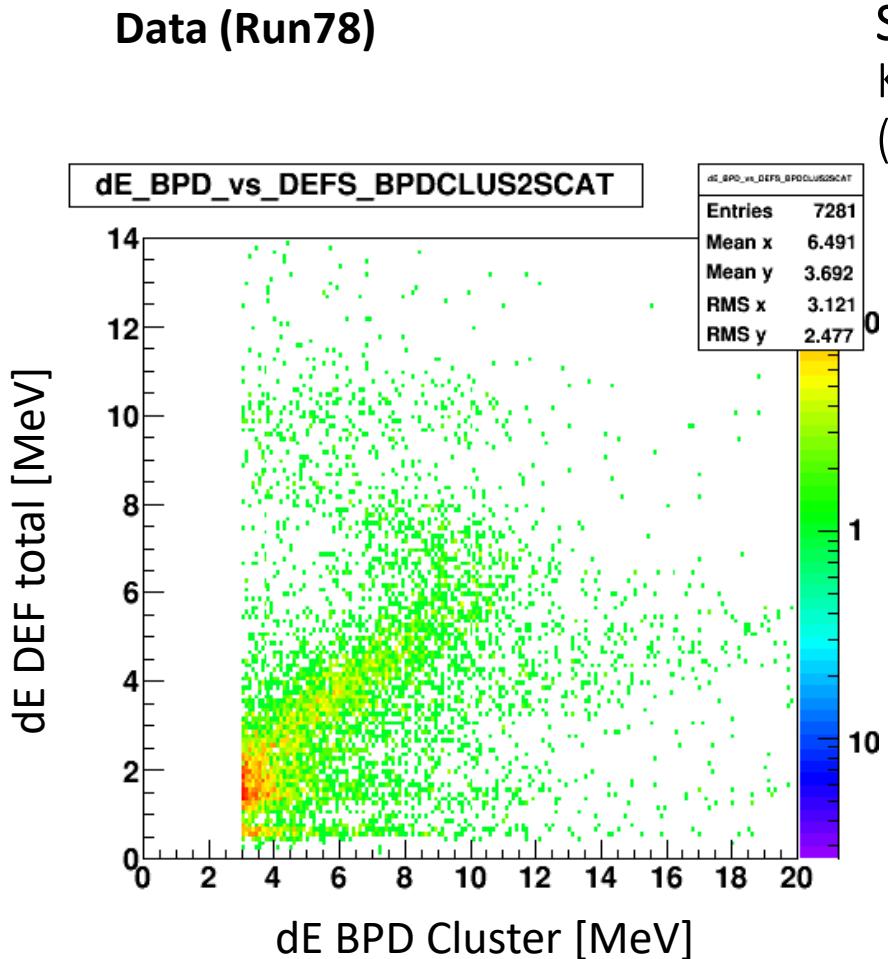
(spectrum shape ; cross Section P.9 left figure)



# dE BPD vs dE DEF in the BPD proton hit event

in the presence of BPC Backward Track event

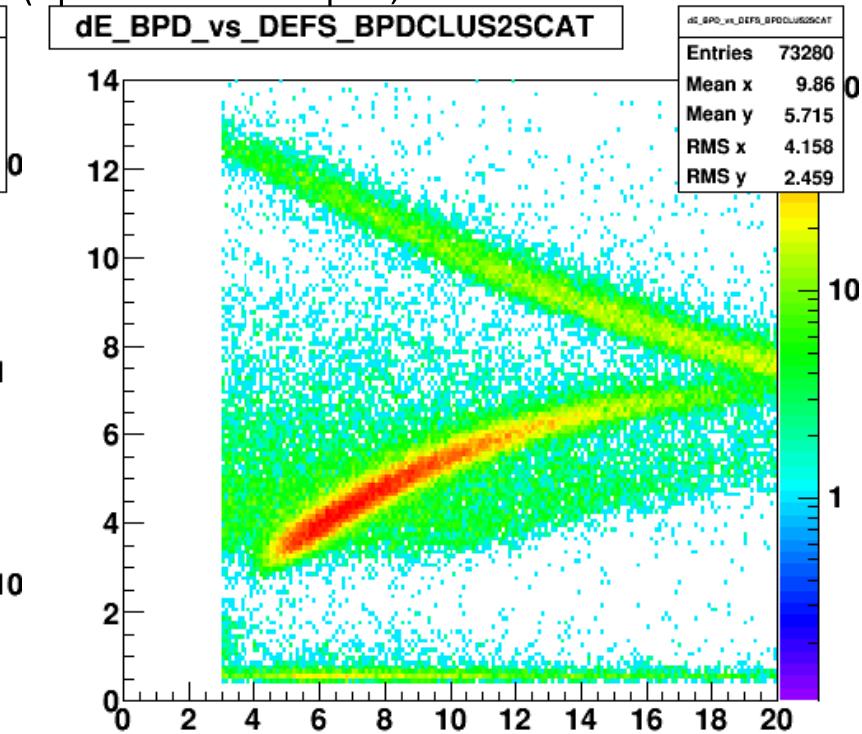
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

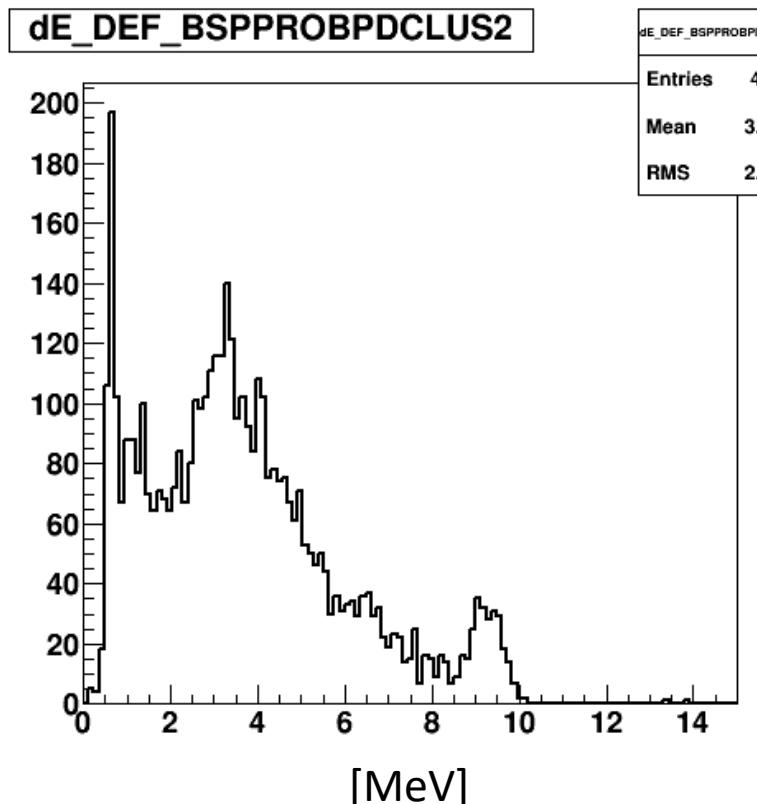
(spectrum shape ; cross Section P.9 left figure)



# dE DEF in the BPD proton hit event

Max dE events of DEF hit segments  
in the BPC-BPD Matching event

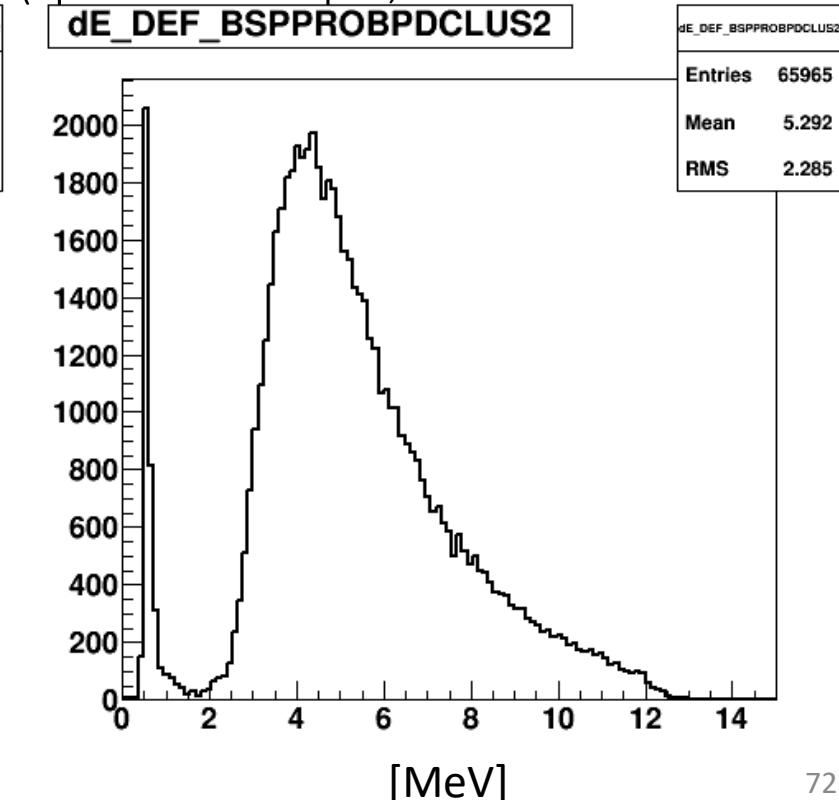
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

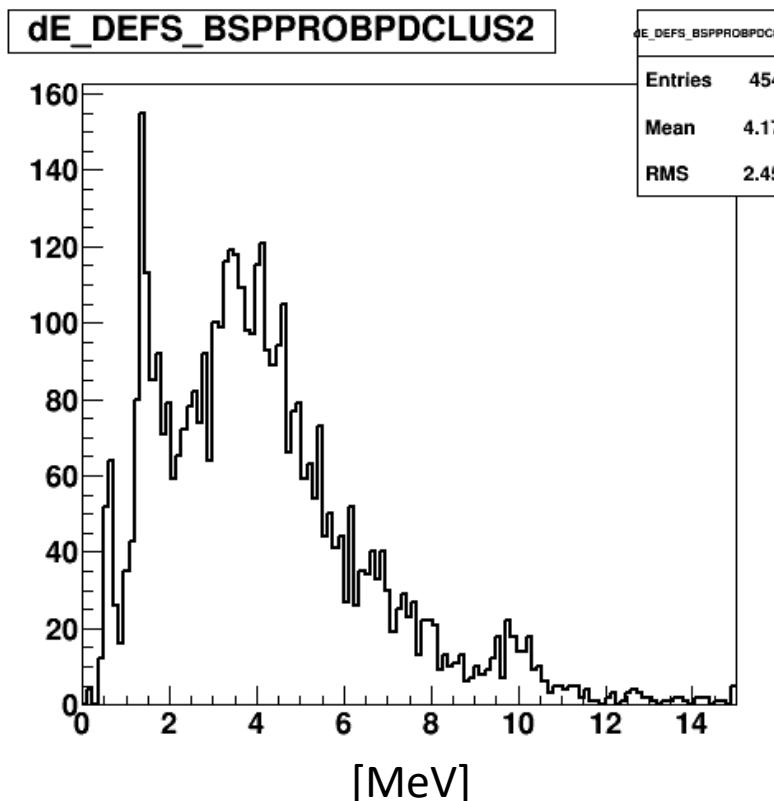
(spectrum shape ; cross Section P.9 left figure)



# dE DEF in the BPD proton hit event

Total dE of DEF hit segments  
in the BPC-BPD Matching event

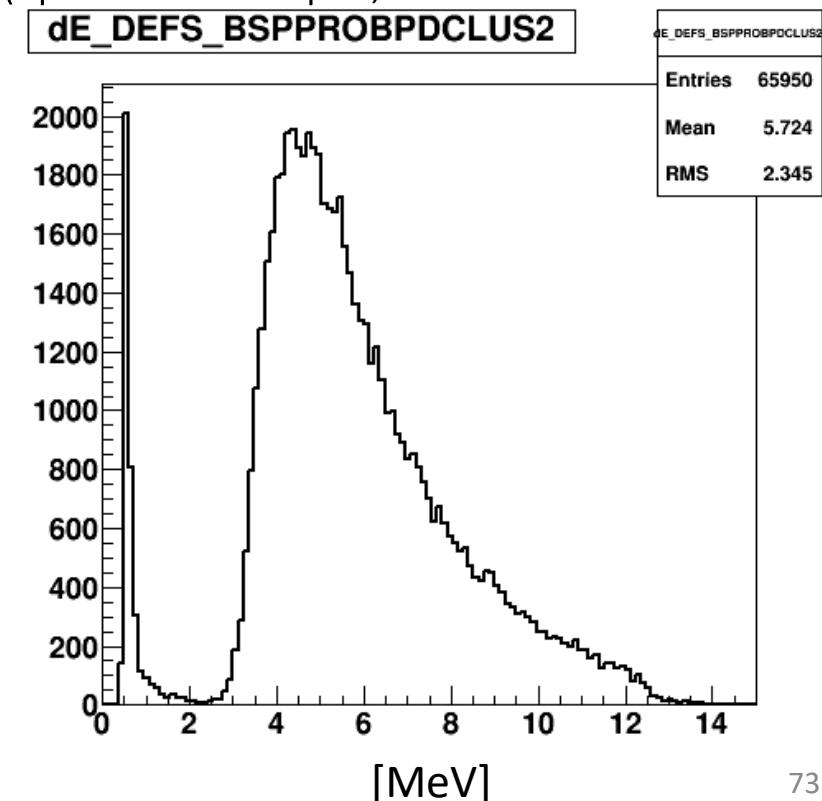
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

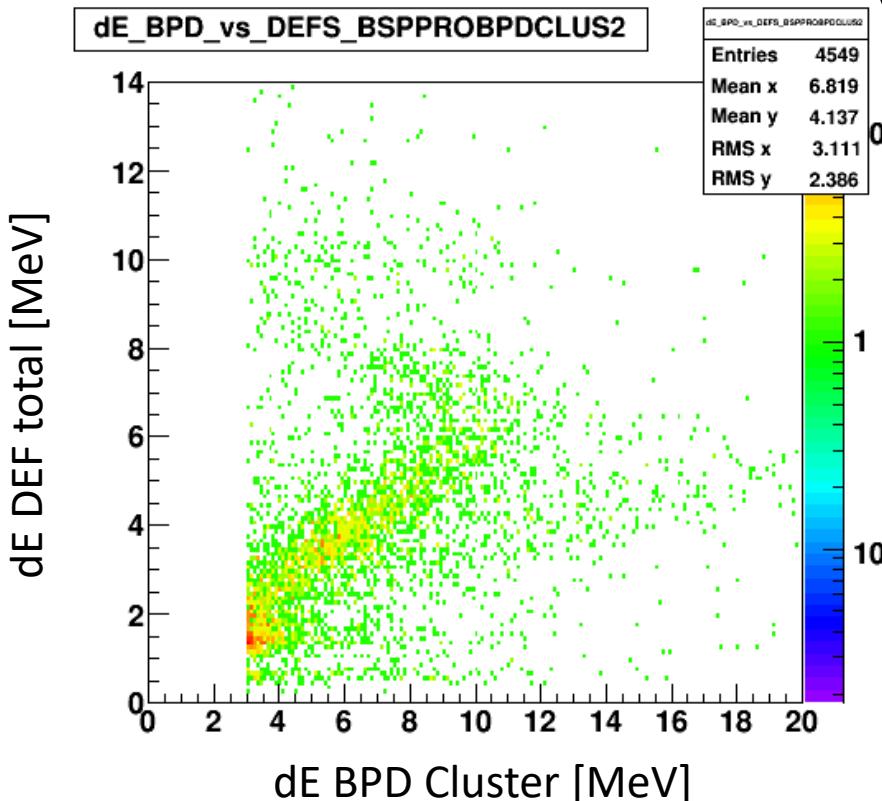
(spectrum shape ; cross Section P.9 left figure)



# dE BPD vs dE DEF in the BPD proton hit event

in the BPC-BPD Matching event

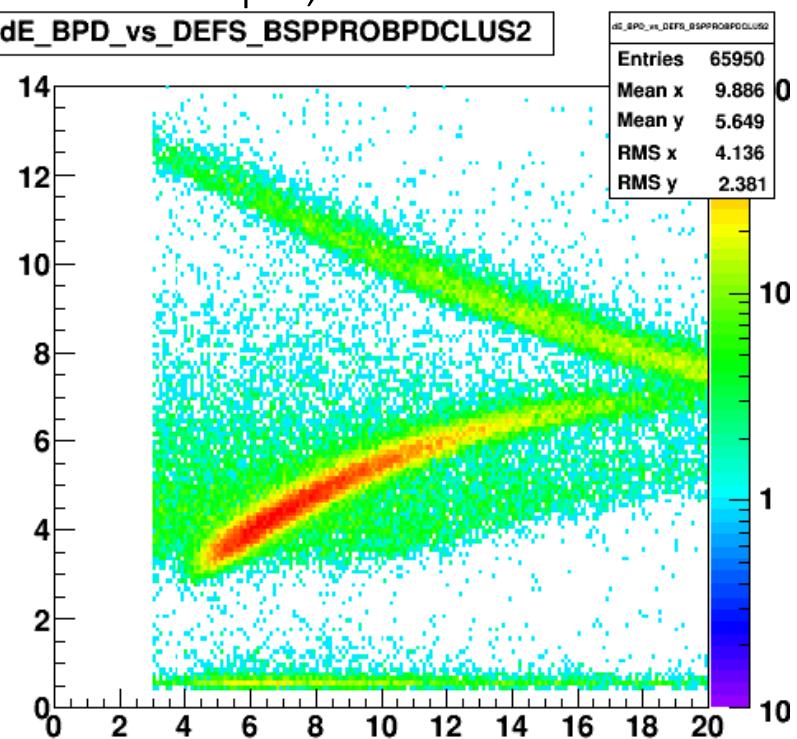
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

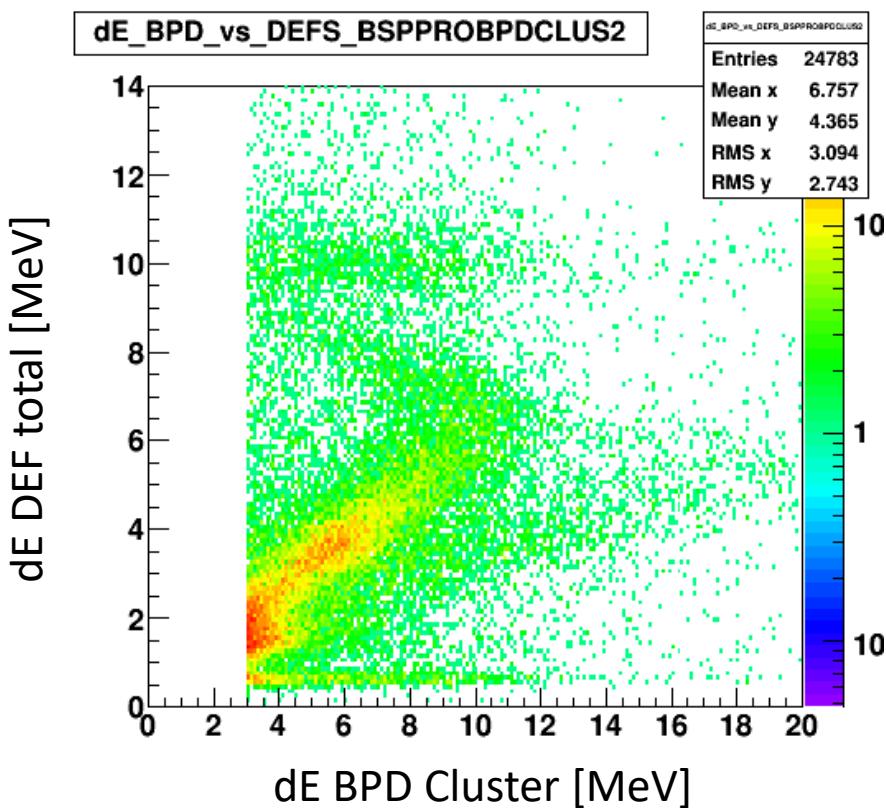
(spectrum shape ; cross Section P.9 left figure)



# dE BPD vs dE DEF in the BPD proton hit event in the BPC-BPD Matching event

Data (Run78)

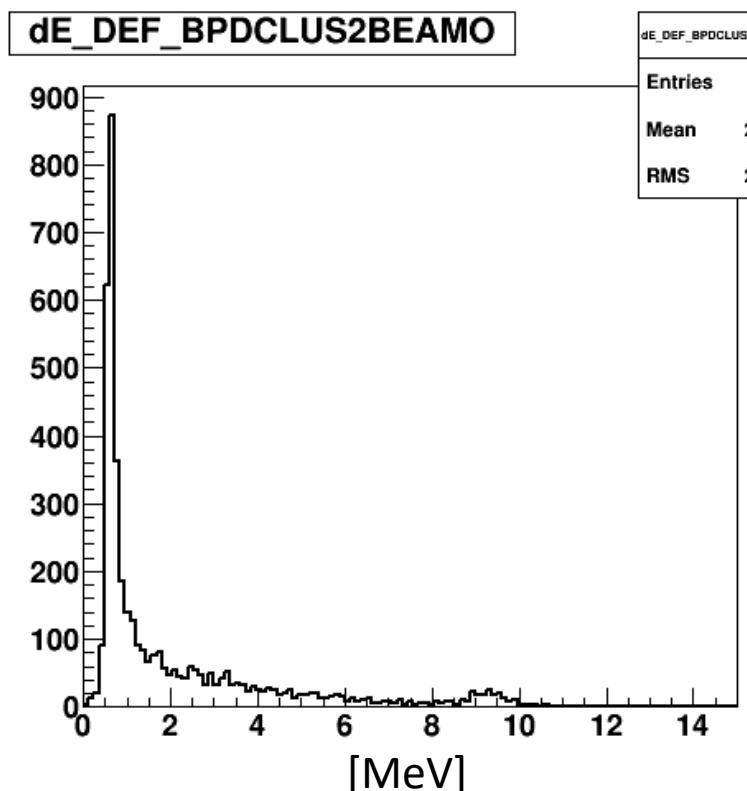
w/o forward neutron analysis for the increase of statistics



# dE DEF in the BPD proton hit event

Max dE events of DEF hit segments  
in the absence of the BPC Backward Track event

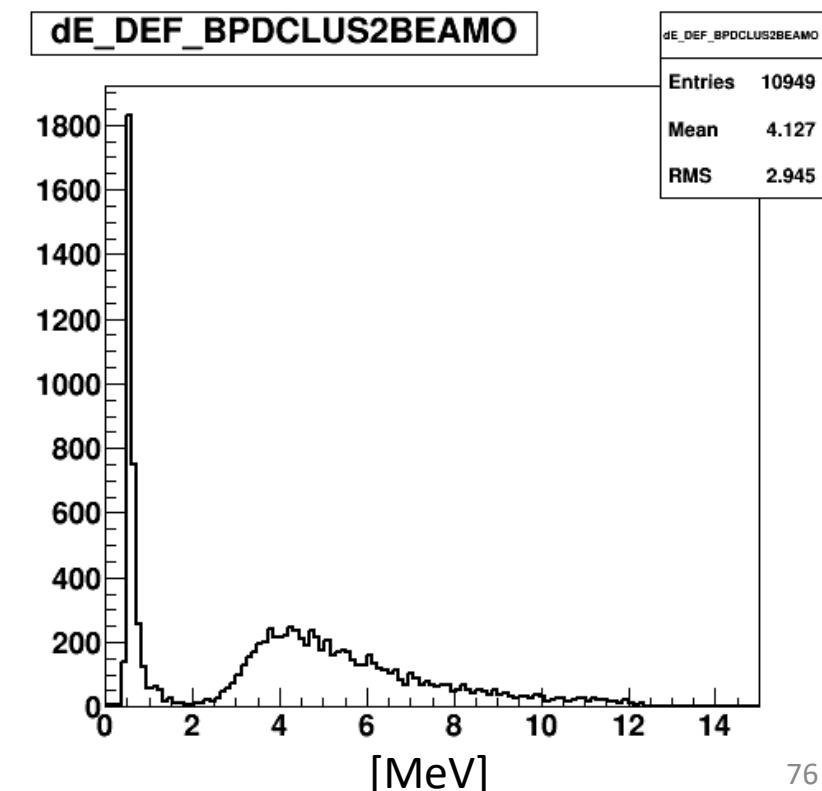
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

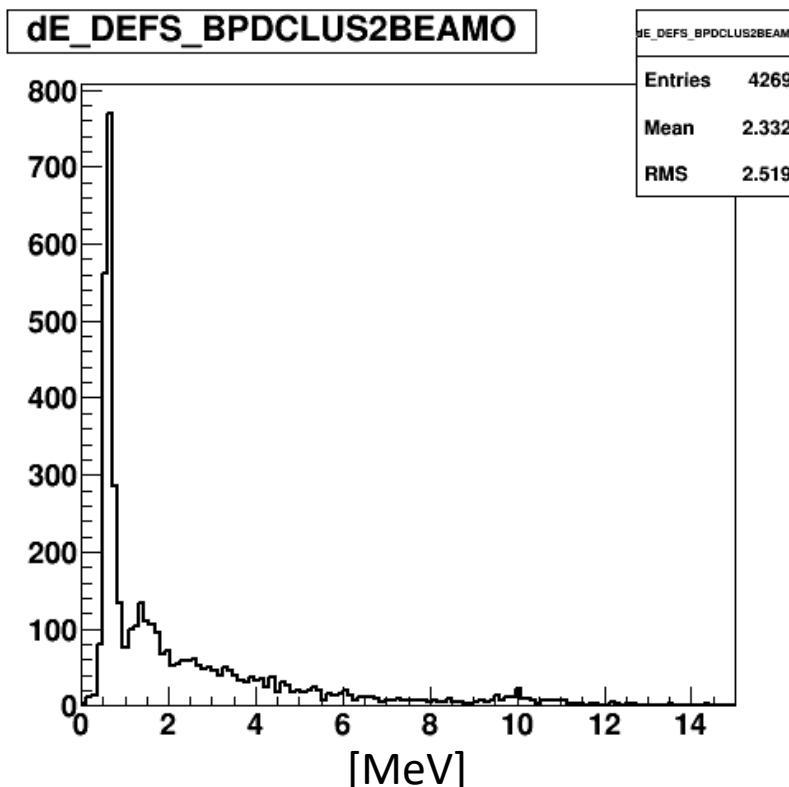


# dE DEF in the BPD proton hit event

Total dE of DEF hit segments

in the absence of the BPC Backward Track event

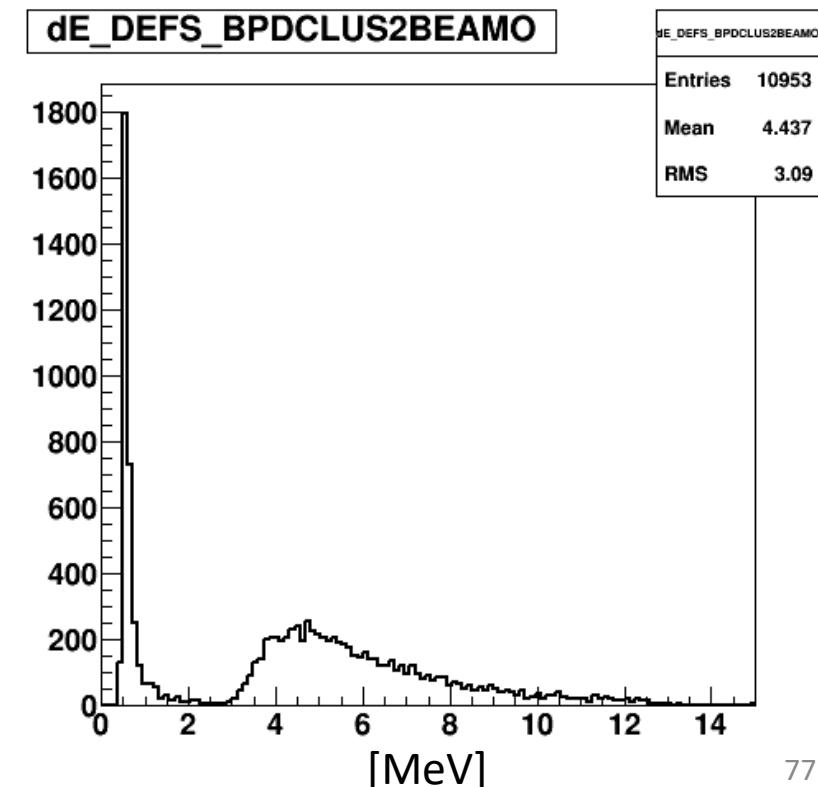
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

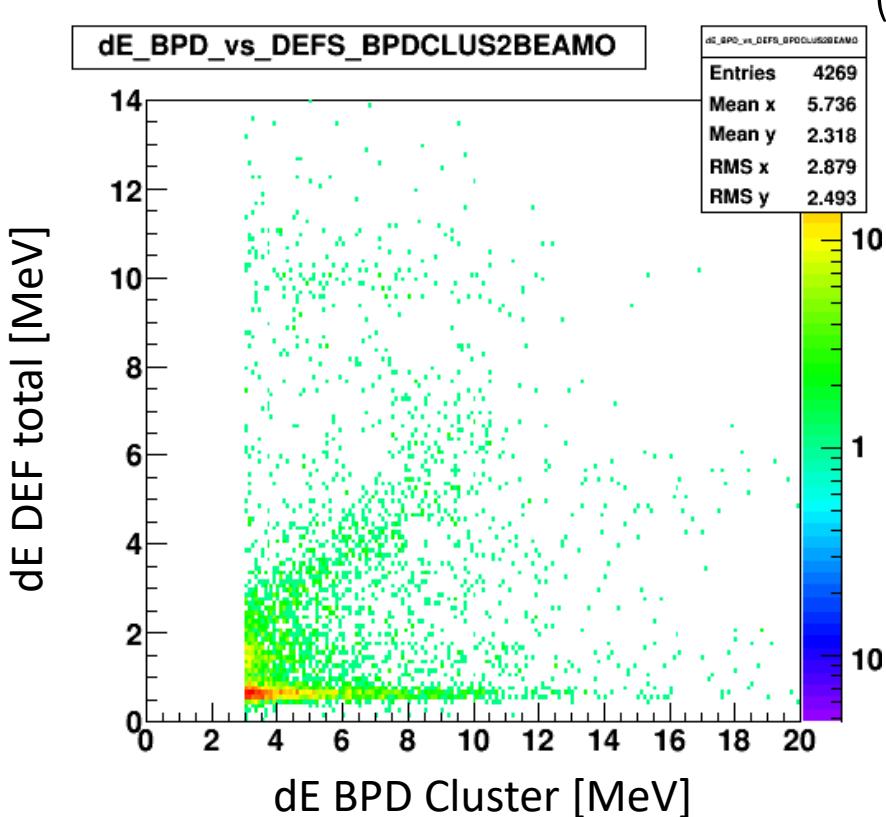
(spectrum shape ; cross Section P.9 left figure)



# dE BPD vs dE DEF in the BPD proton hit event

in the **absence** of the BPC Backward Track event

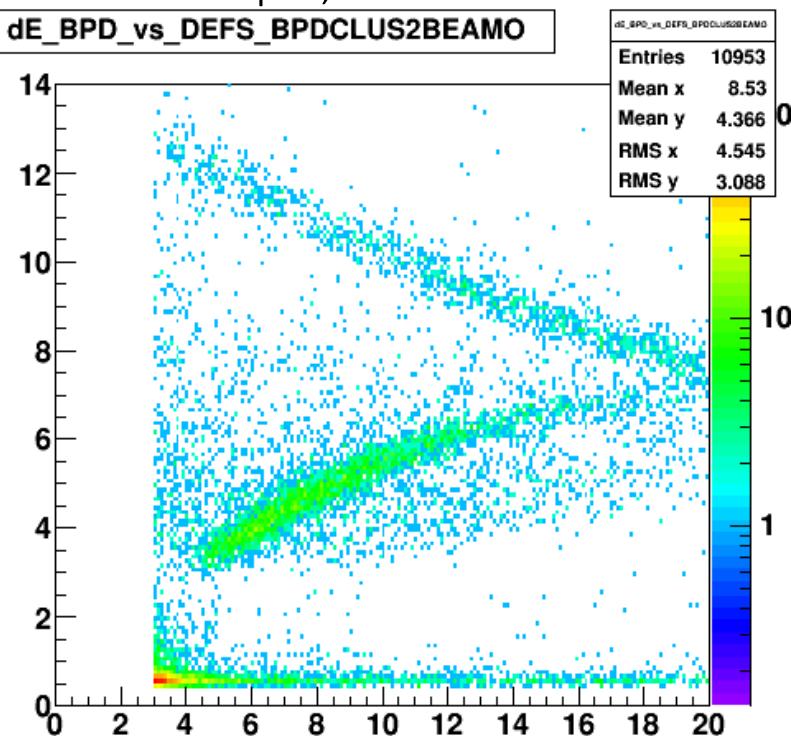
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

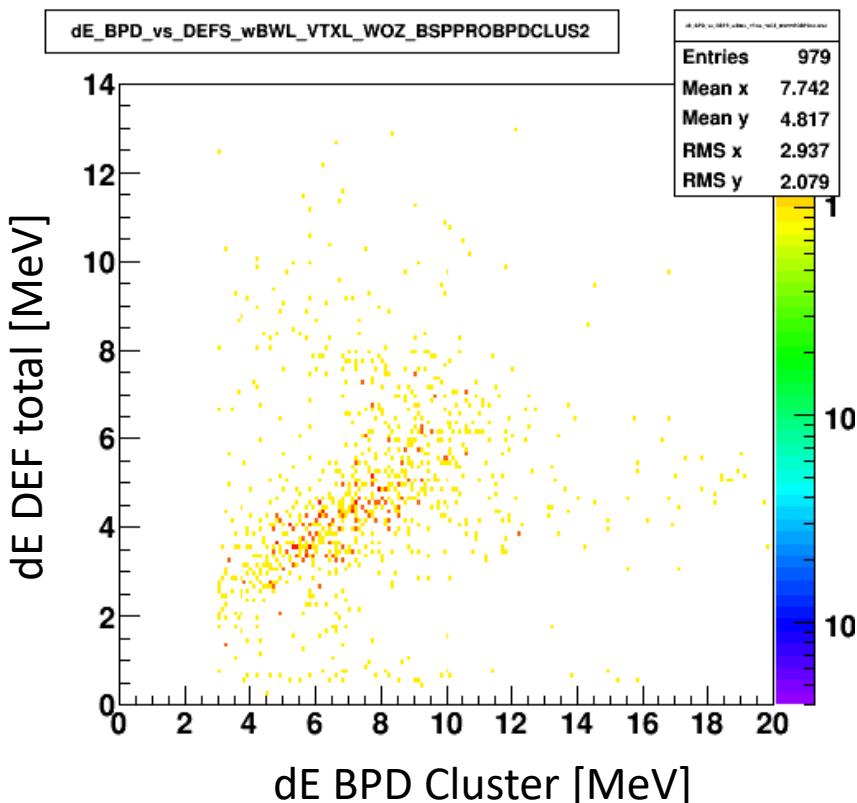
(spectrum shape ; cross Section P.9 left figure)



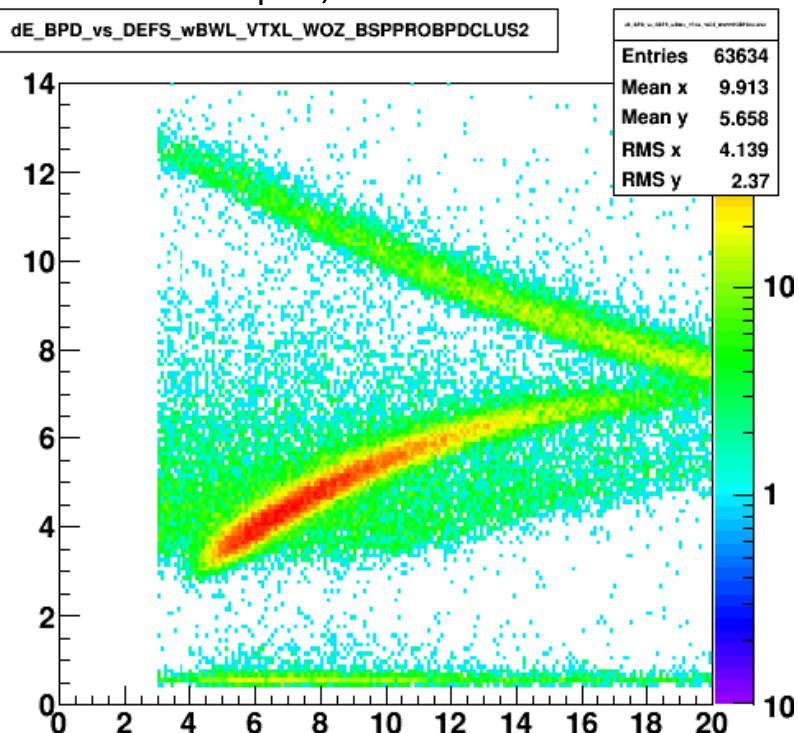
# dE BPD vs dE DEF in the BPD proton hit event

Another Condition  
Same as final spectrum  
•  $\Lambda$  selection  
•  $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

Data (Run78)



SIM  
 $K-d \rightarrow n \Sigma 0 \pi 0$   
(spectrum shape ; cross Section P.9 left figure)

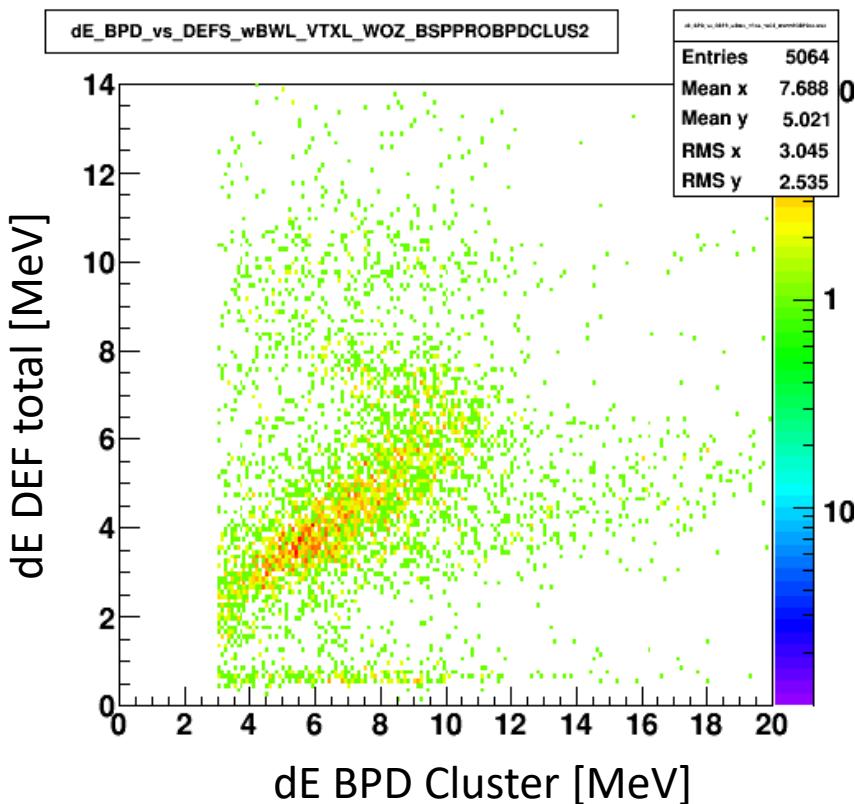


# dE BPD vs dE DEF in the BPD proton hit event

Another Condition  
Same as final spectrum  
•  $\Lambda$  selection  
•  $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

## Data (Run78)

w/o forward neutron analysis for the increase of statistics

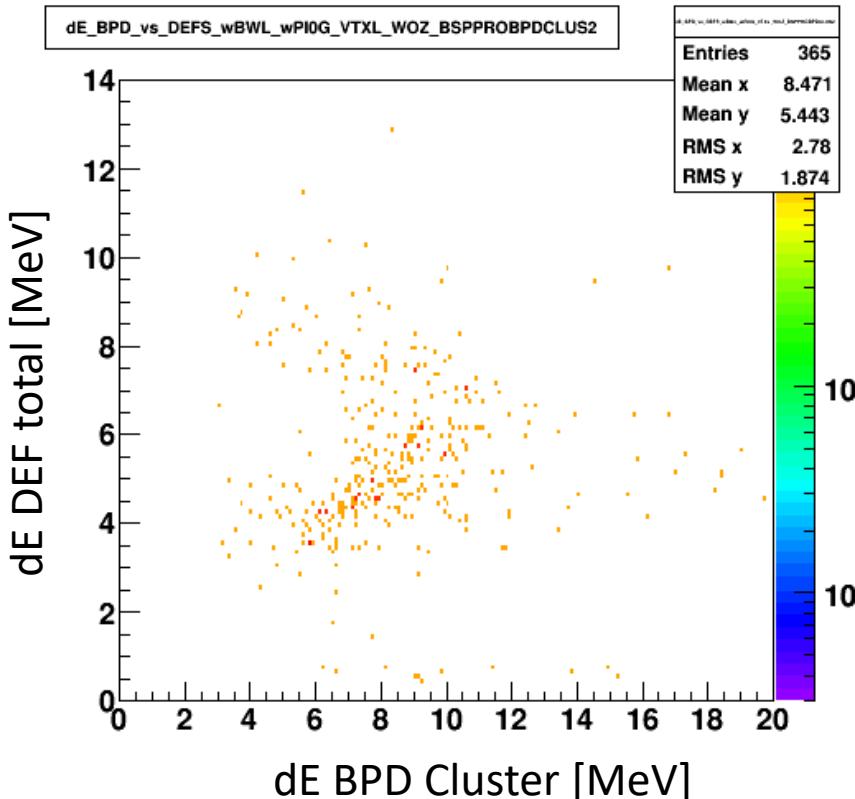


# dE BPD vs dE DEF in the BPD proton hit event

Another Condition  
Same as final spectrum  

- $\Lambda$  selection
- $d(K^-, \eta p \pi^-) "X" \quad 0.18 < X < 0.30 \text{ GeV}$

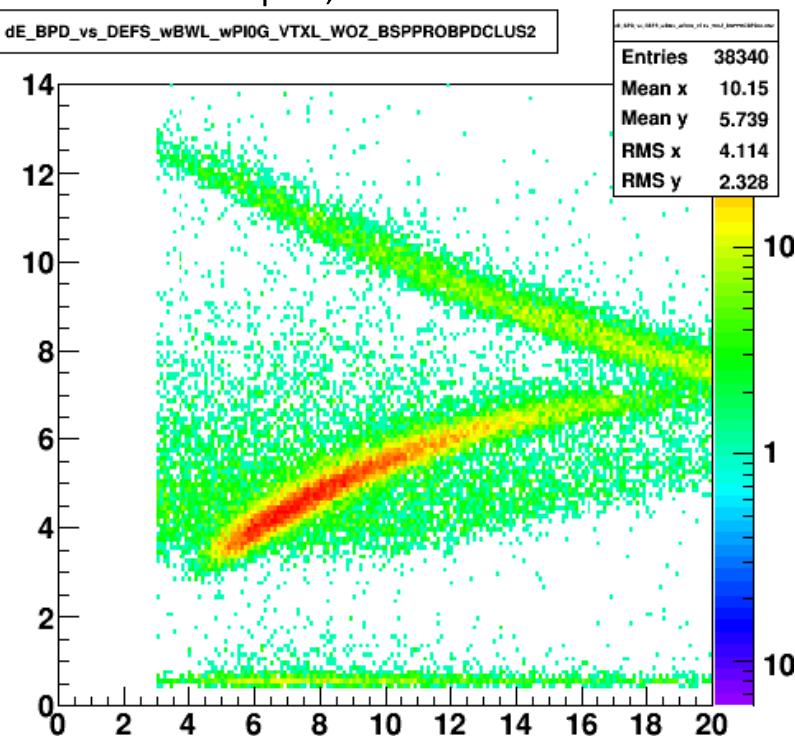
Data (Run78)



SIM

$K-d \rightarrow n \Sigma 0 \pi 0$

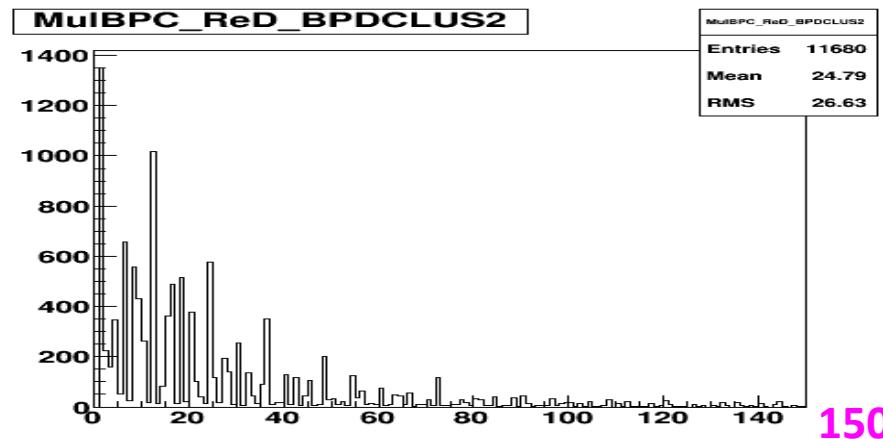
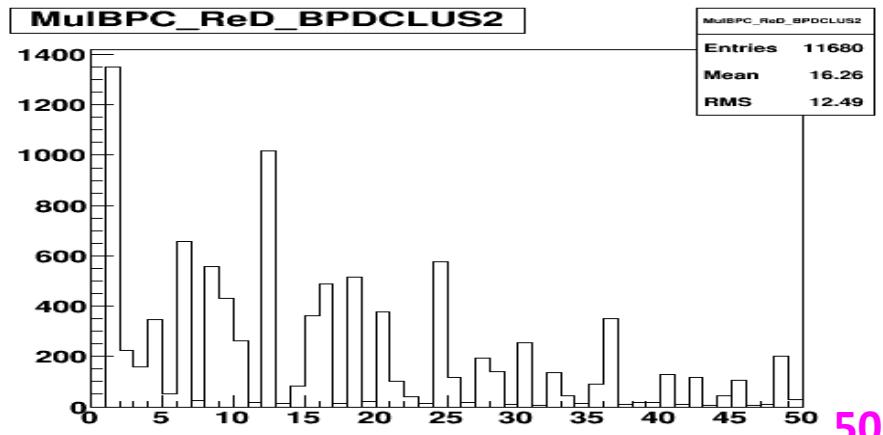
(spectrum shape ; cross Section P.9 left figure)



# BPC Track Multiplicity

## in the sample event

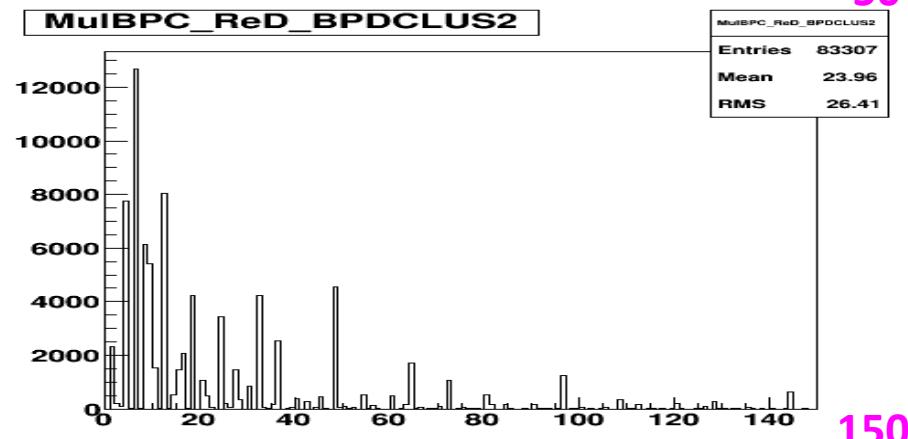
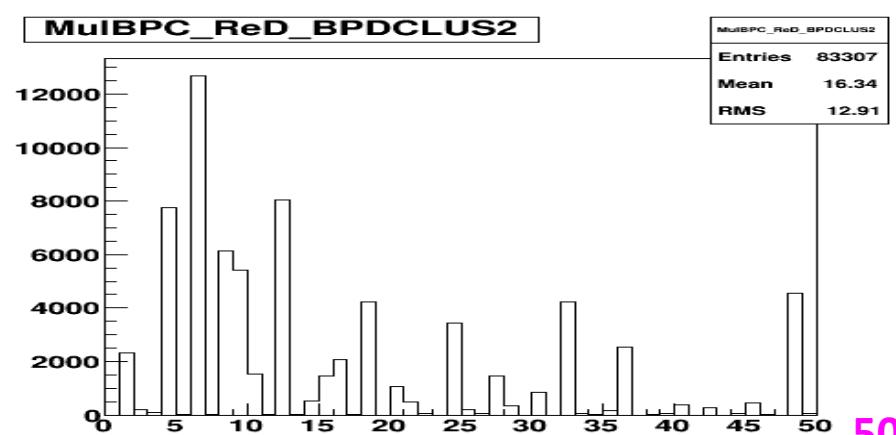
Data (Run78)



SIM

K-d ->n  $\Sigma 0 \pi 0$

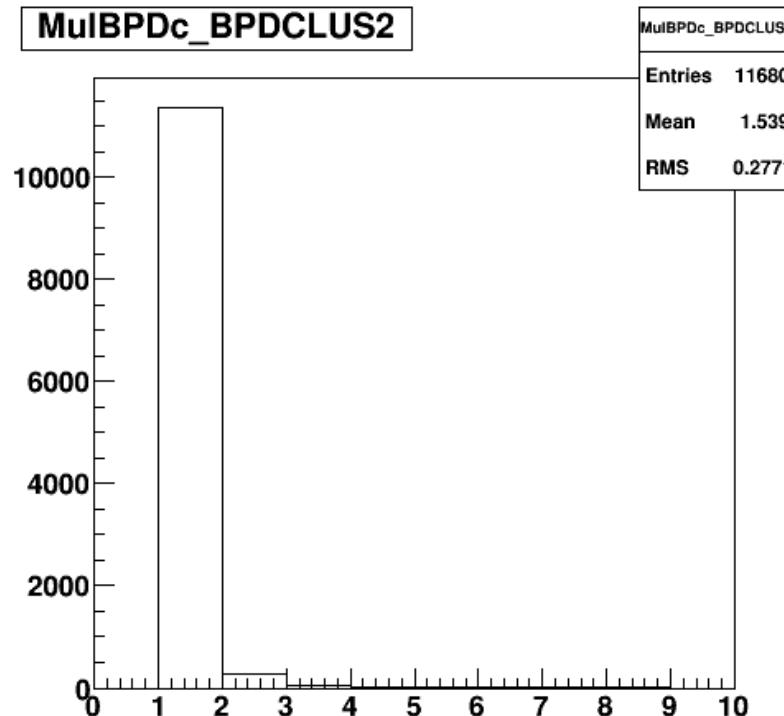
(spectrum shape ; cross Section P.9 left figure)



# BPD Cluster Multiplicity

## in the sample event

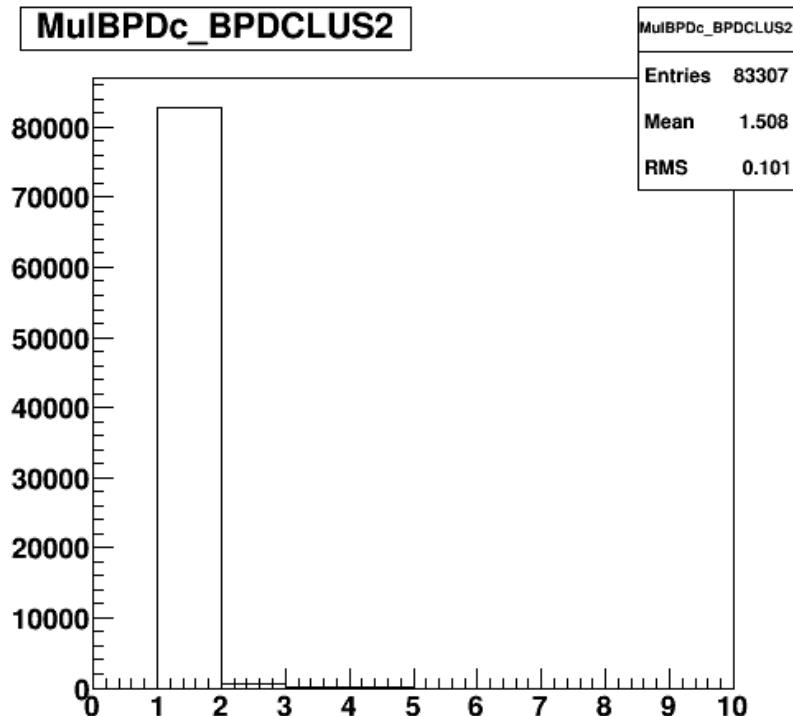
Data (Run78)



SIM

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

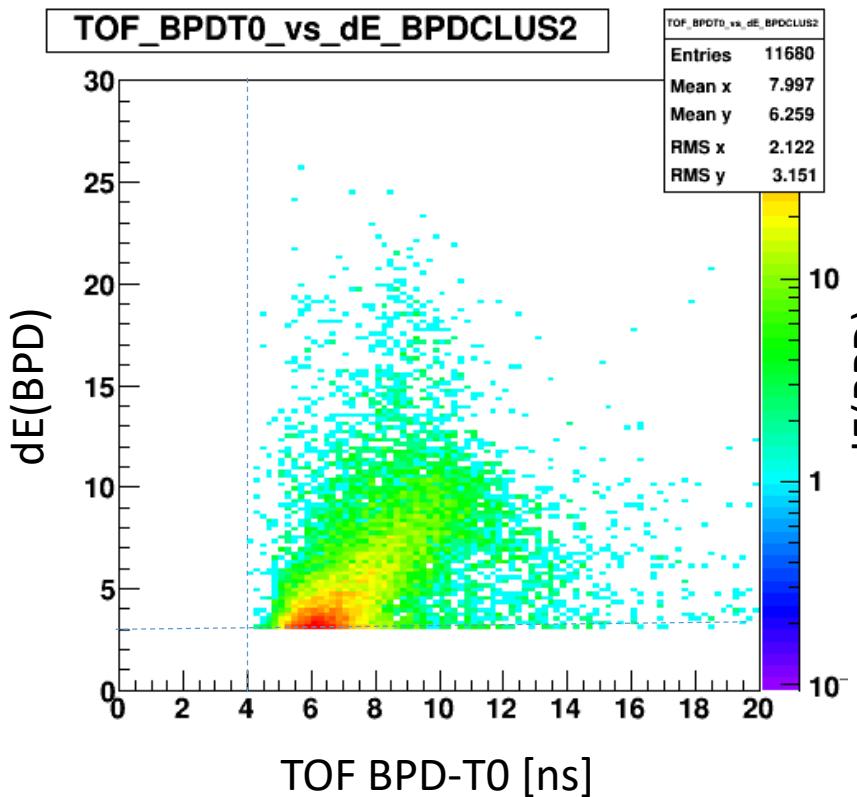
(spectrum shape ; cross Section P.9 left figure)



# TOF BPD-T0 vs dE(BPD)

in the sample event

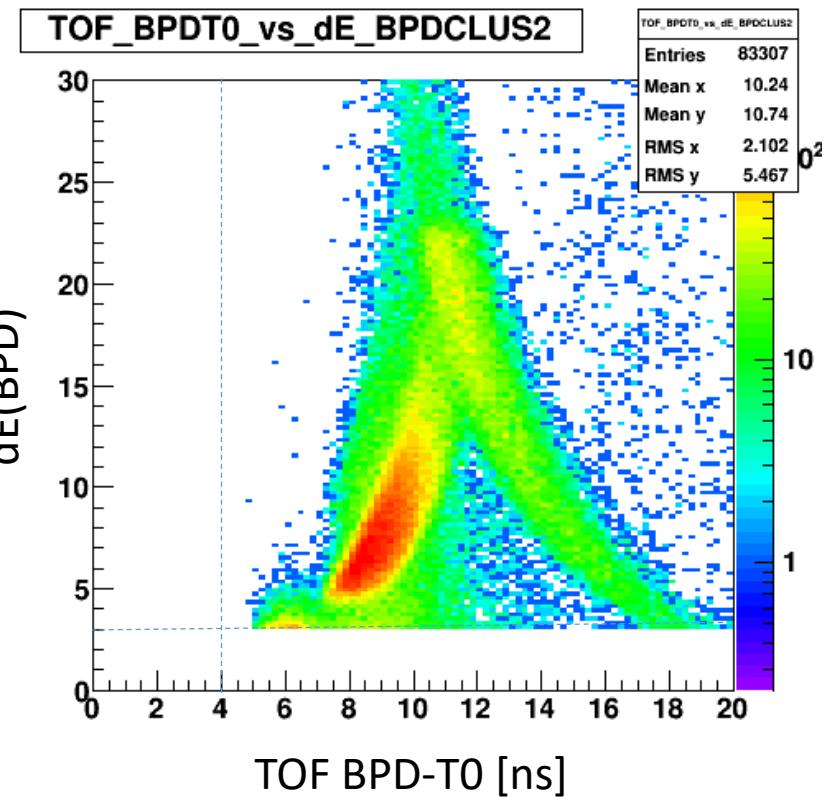
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

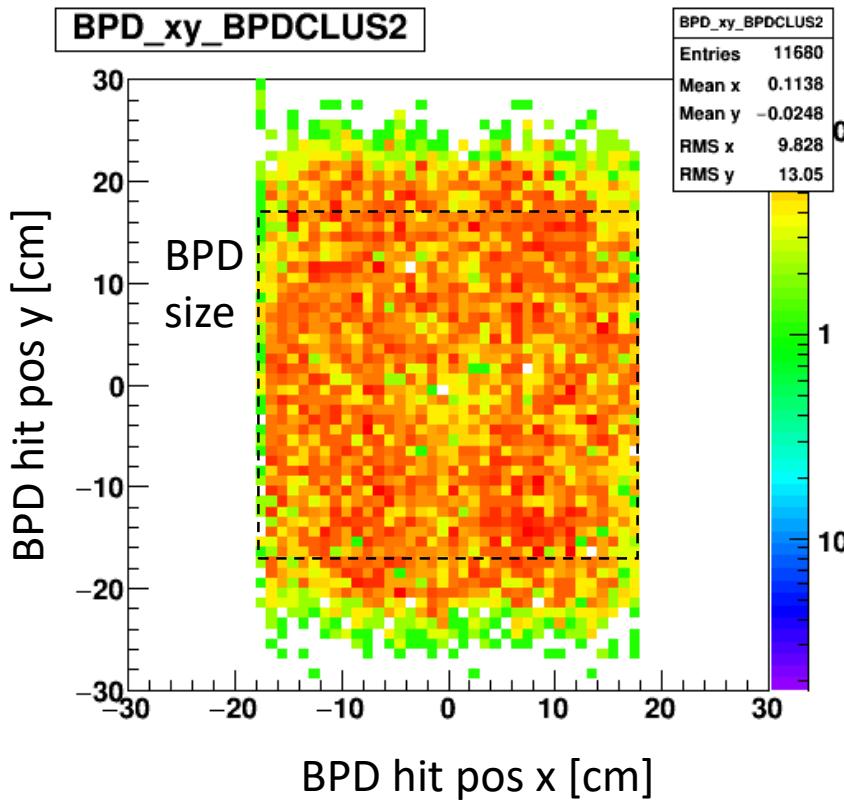


Signal after the AMP is saturated

# BPD hit Position in the sample event

BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

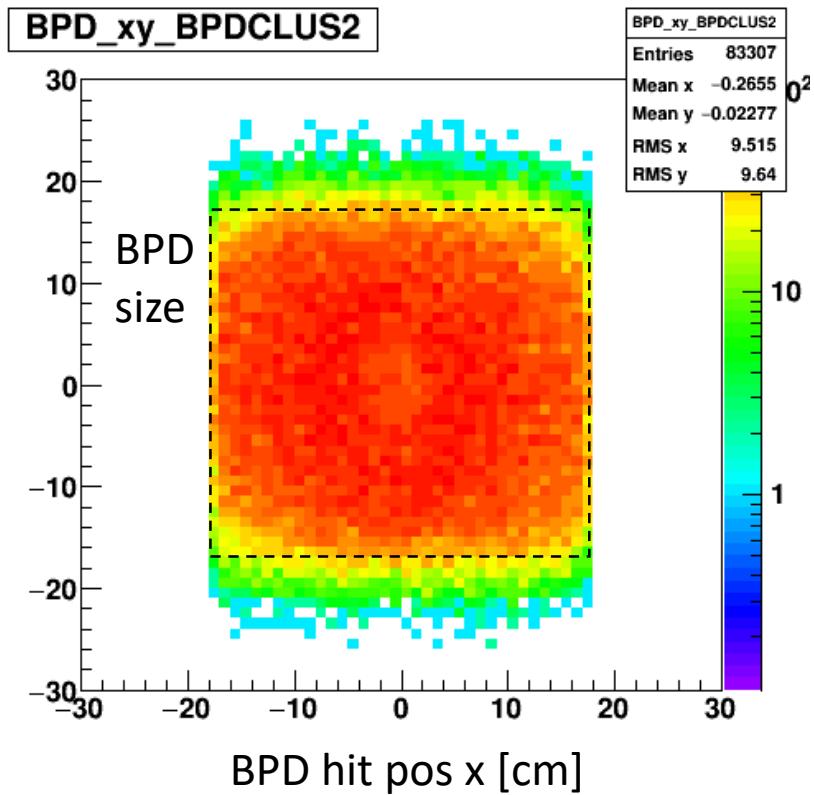
## Data (Run78)



SIM

K-d ->η Σ0π0

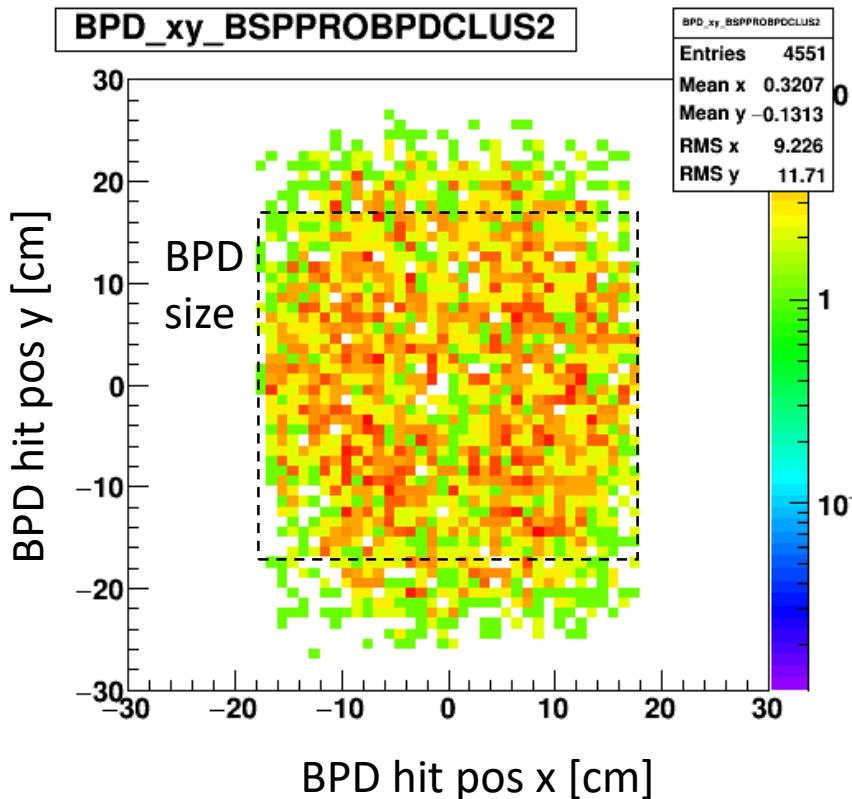
(spectrum shape ; cross Section P.9 left figure



# BPD hit Position

## in the BPC-BPD Matching event

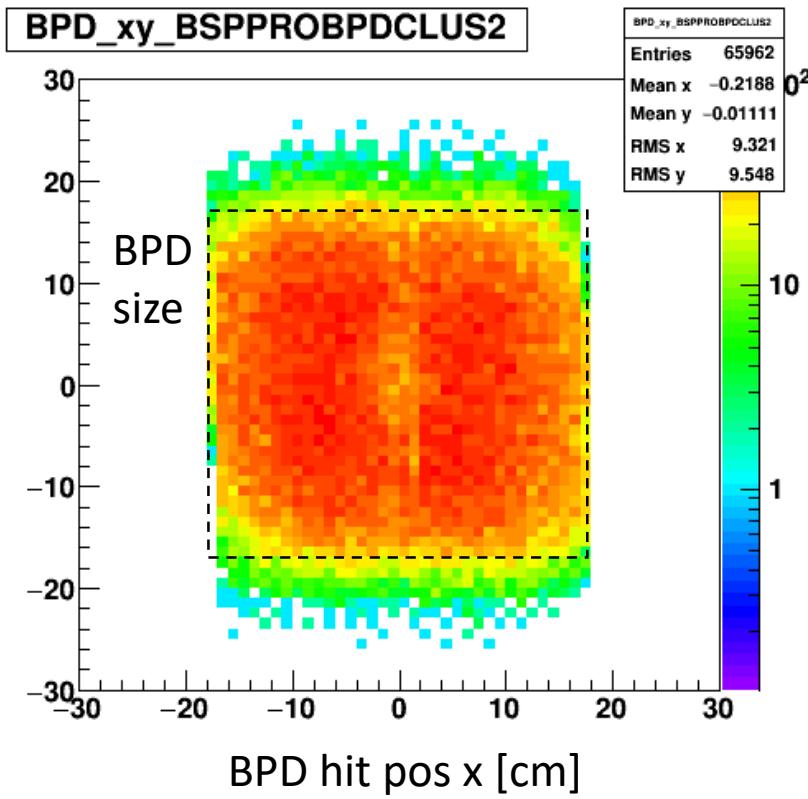
Data (Run78)



SIM

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)



# BPD hit Position

Data (Run78)

BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

SIM

K-d  $\rightarrow r_{\text{zero}}$

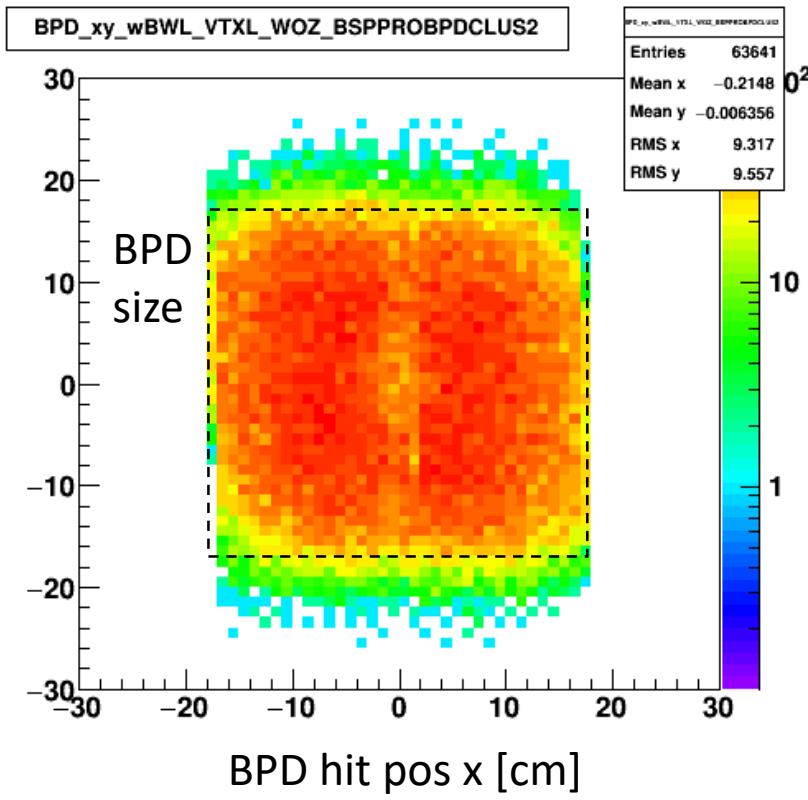
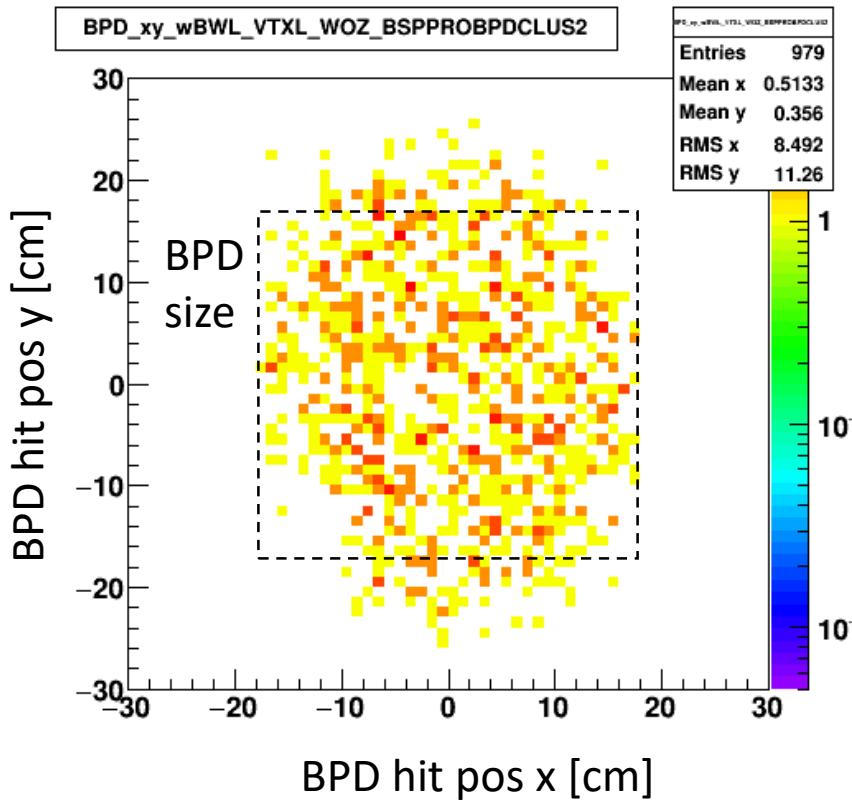
Another Condition

Same as final spectrum

- $\Lambda$  selection

$d(K^-, np\pi^-) \chi \quad 0.18 < X < 0.30 \text{ GeV}$

(spectrum shape ; cross Section P.9 left figure)



# BPD hit Position

Data (Run78)

BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

Another Condition  
Same as final spectrum

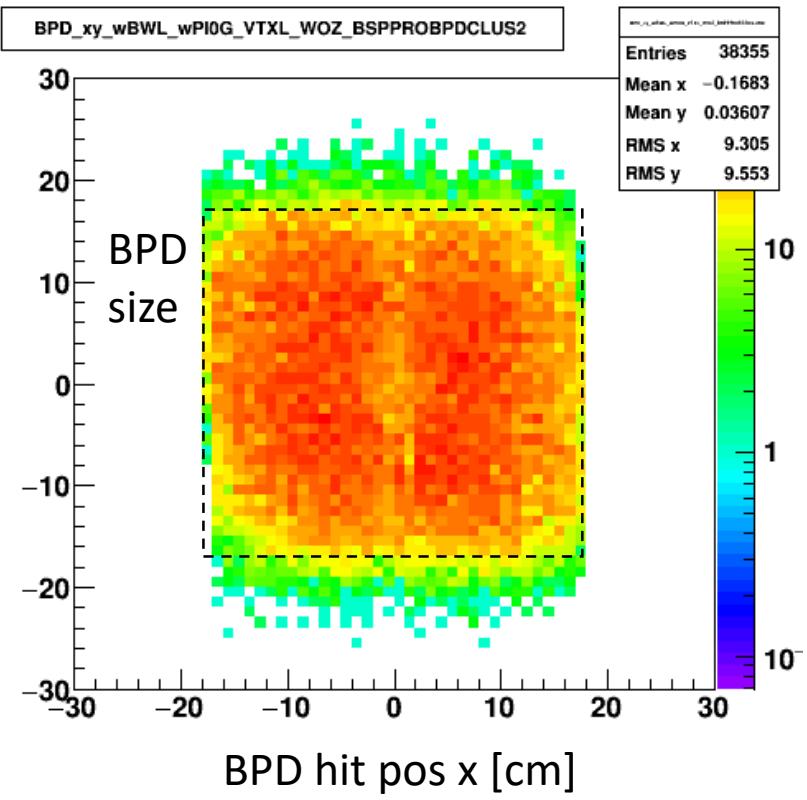
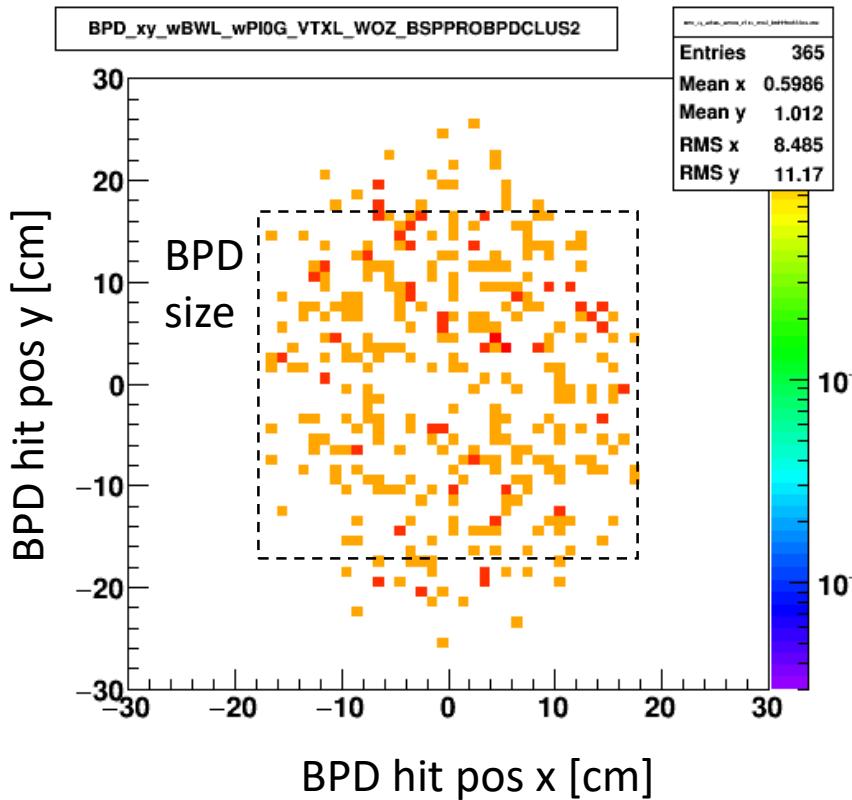
SIM

K-d  $\rightarrow \pi^+ \pi^- \pi^0$

- $\Lambda$  selection

- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

(spectrum shape ; cross Section P.9 left figure)

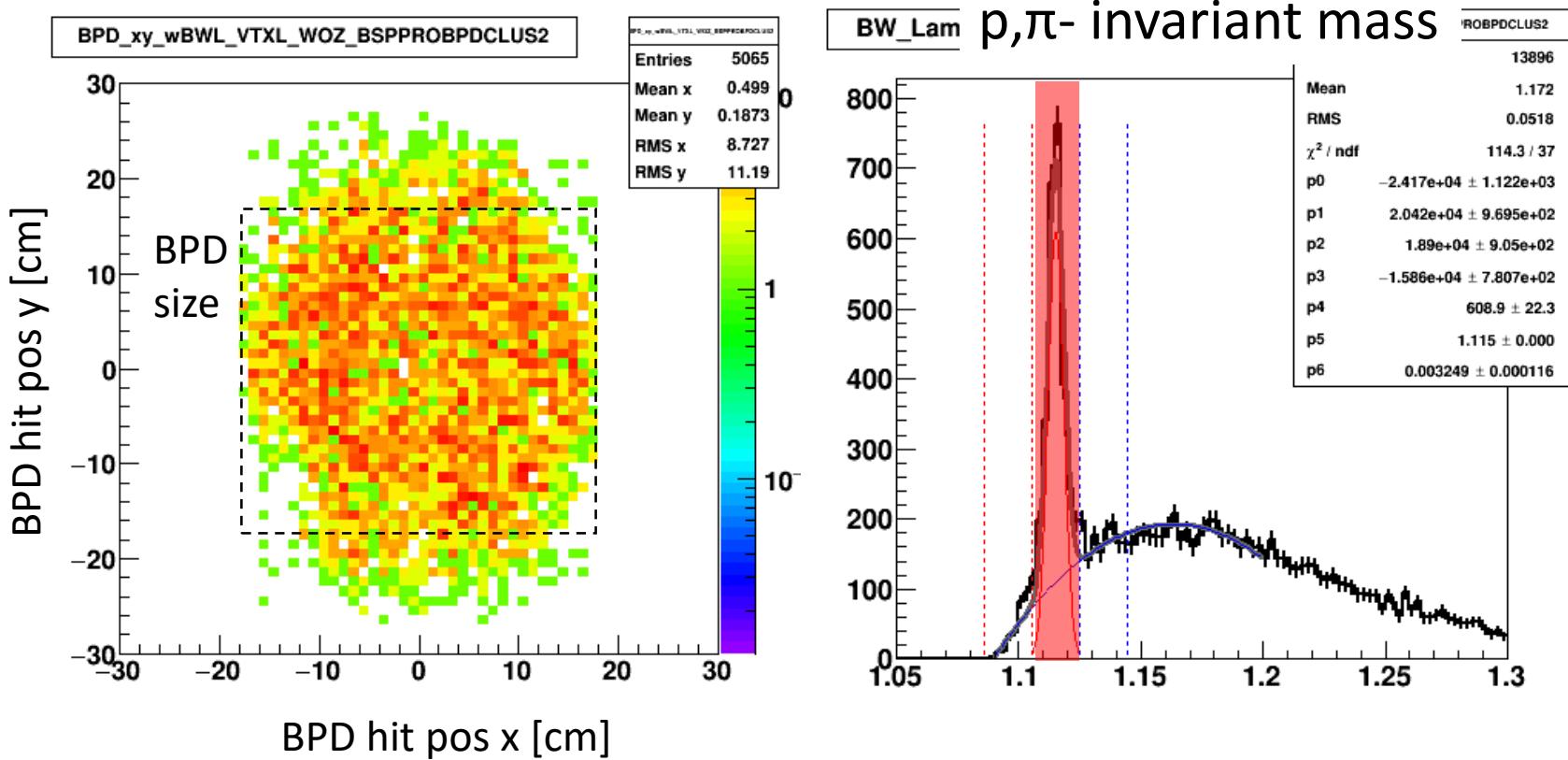


# BPD hit Position

BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

Data (Run78)

w/o forward neutron analysis for the increase of statistics  
•  $\Lambda$  selection

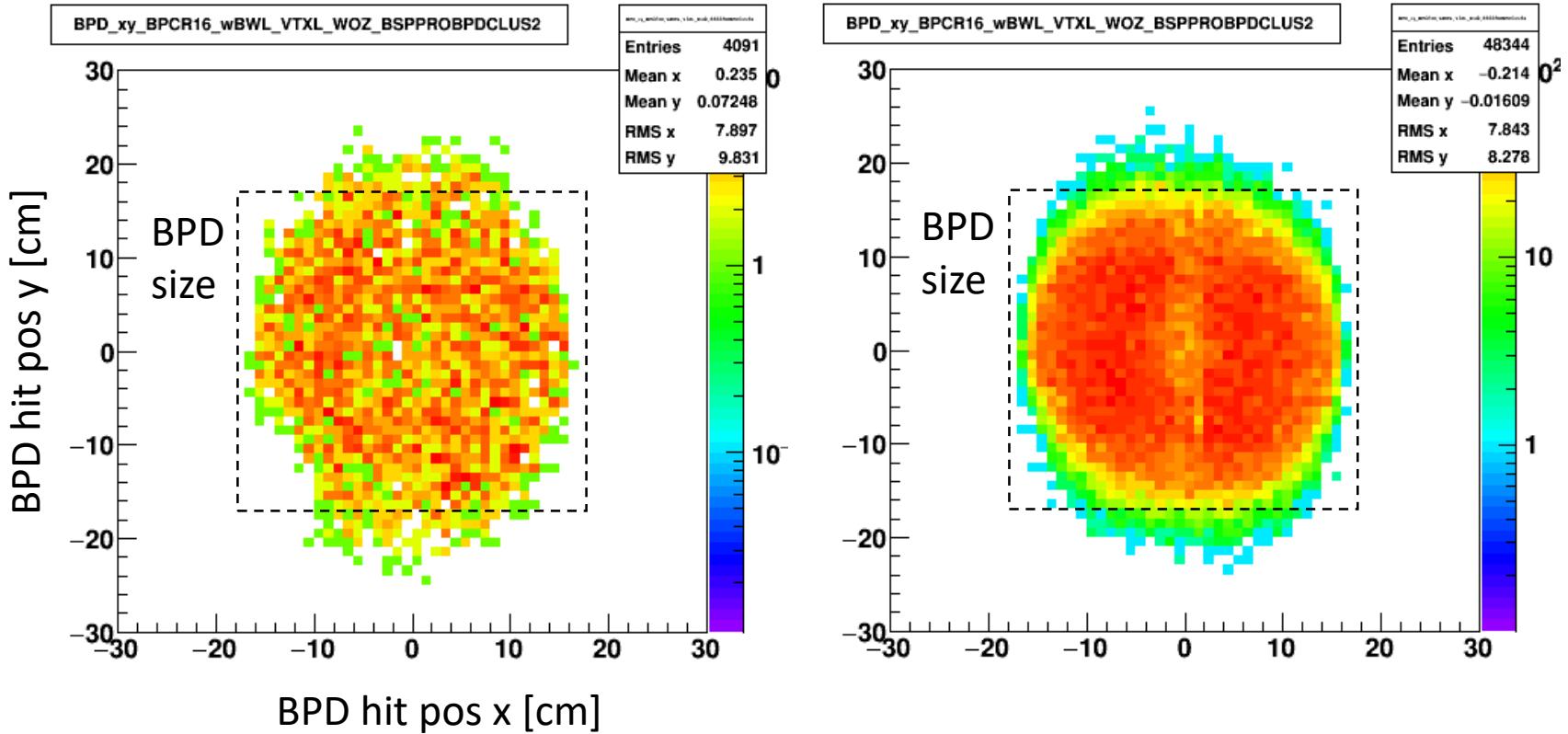


# BPD hit Position

BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

Data (Run78)

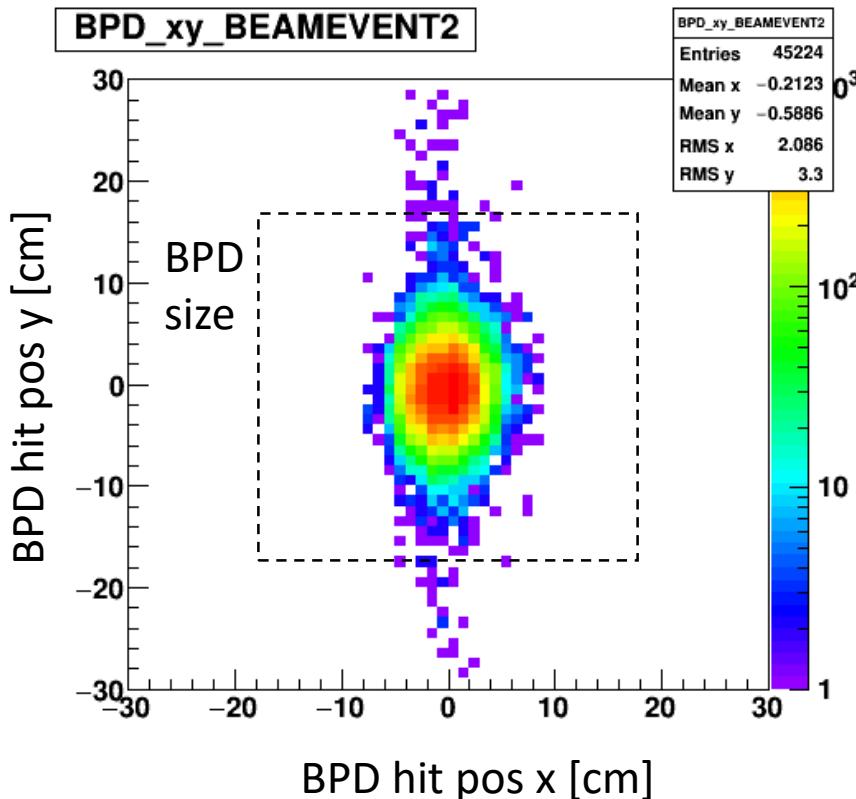
- w/o forward neutron analysis for the increase of statistics
- $\wedge$  selection
  - BPC hit pos @ BPD R<16 cm



# BPD hit Position

## K- Beam hit position

Data (Run78)

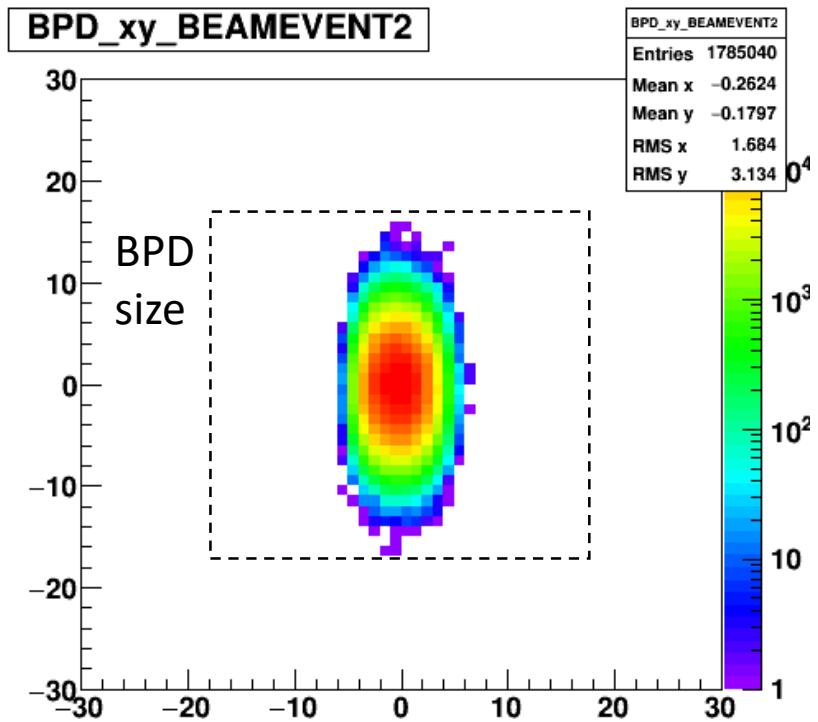


BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

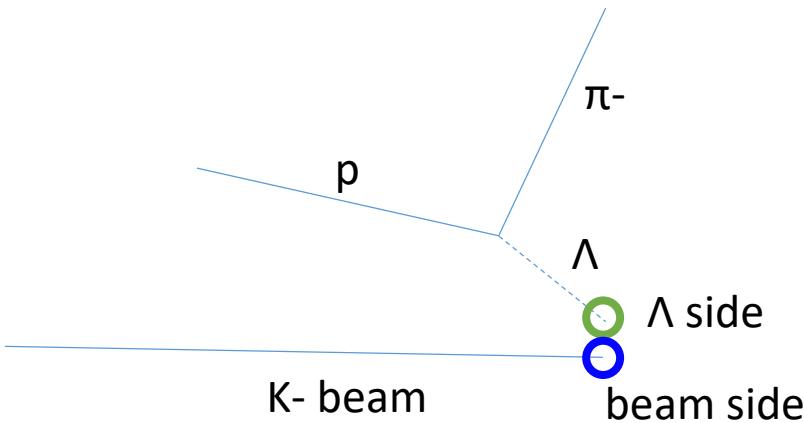
SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)



# Vertex check



Note;

- Vertex fiducial cut w/o z was performed by the mean position of  $\Lambda$  and beam sides.
- Vertex lambda shown above was  $\Lambda$  side

# Vertex check

SIM  
 $K-d \rightarrow n \Sigma^0 \pi^0$   
 (spectrum shape ; cross  
 Section P.9 left  
 figure )

mean

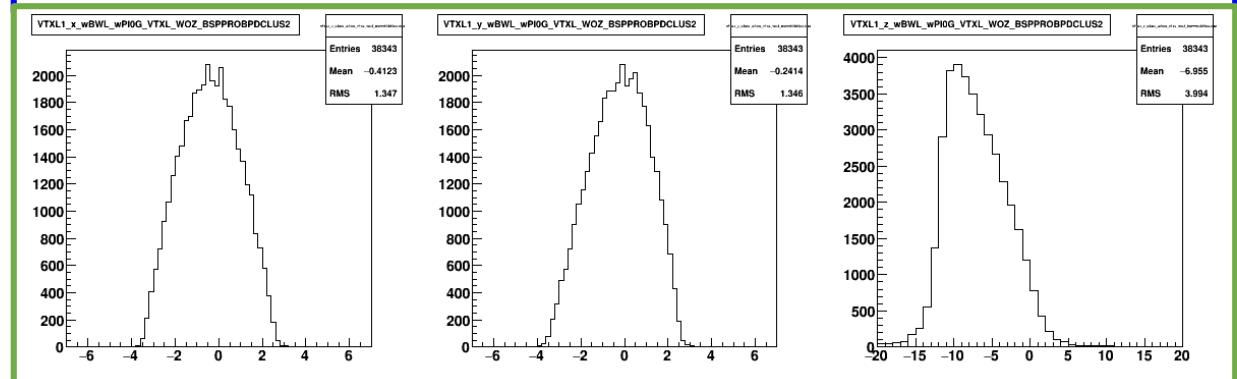
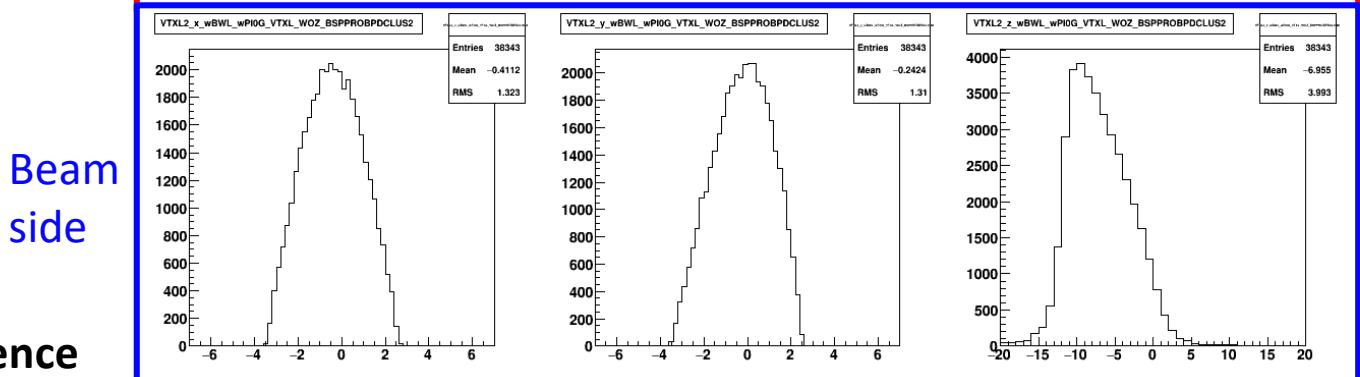
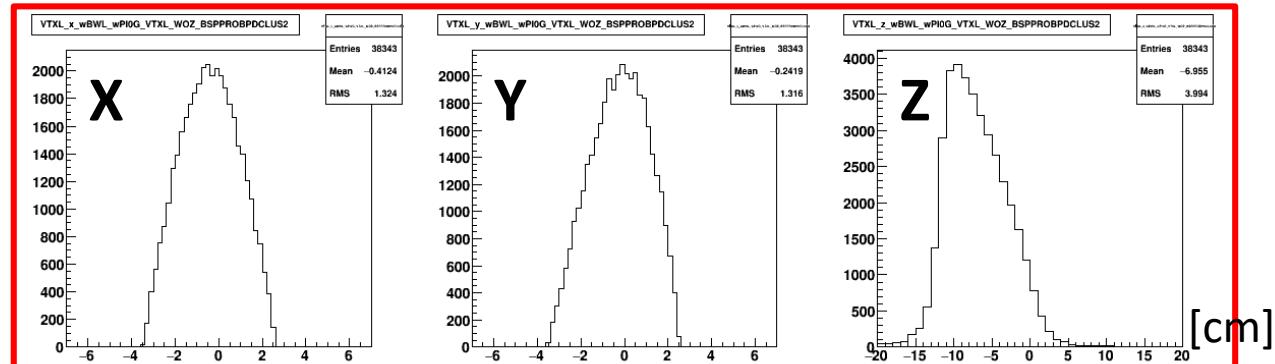
Beam side

No significant difference

$\Lambda$  side

Another Condition  
 Same as final spectrum

- $\Lambda$  selection
- $d(K-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV



# Vertex check

Another Condition  
Same as final spectrum

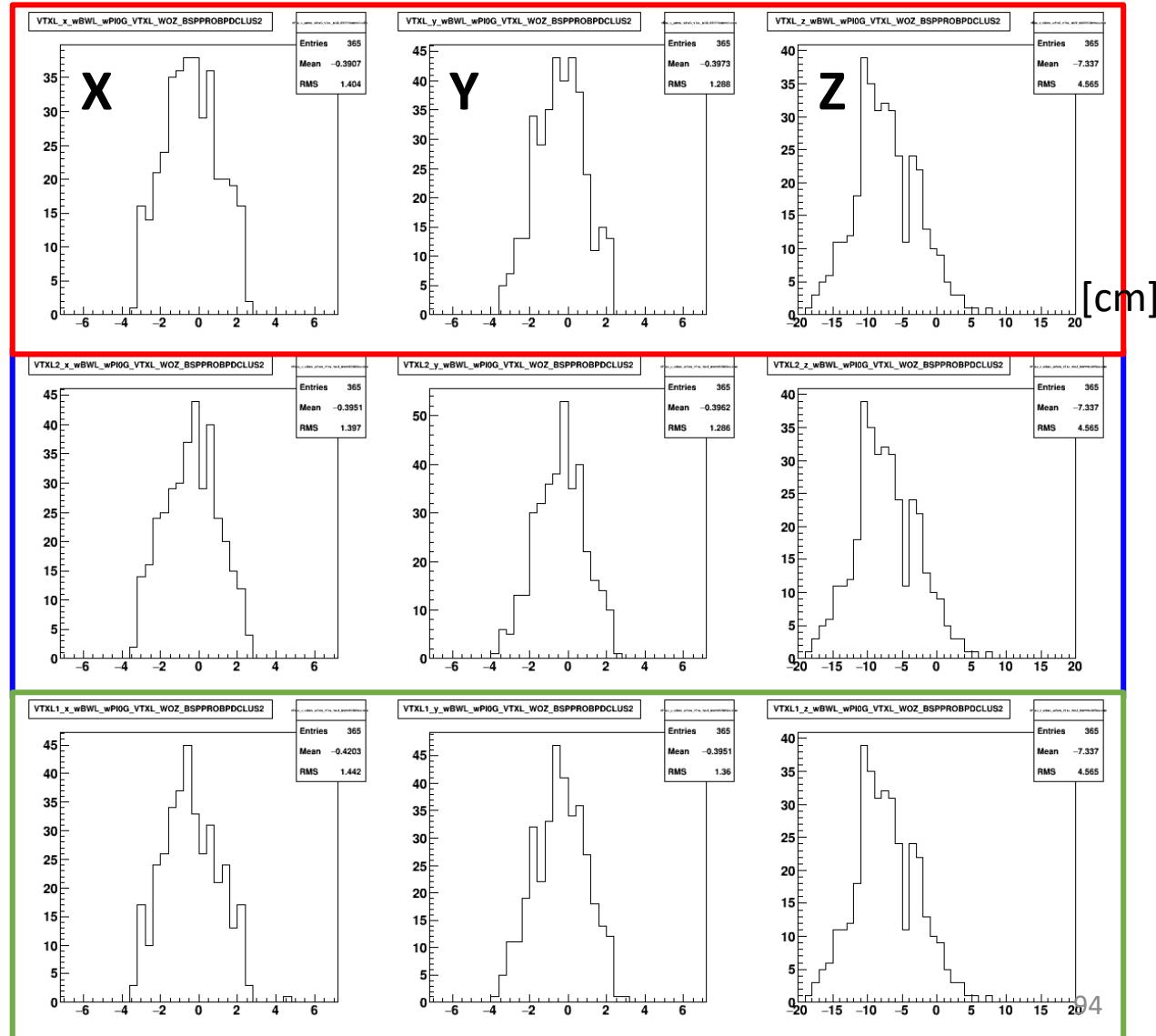
- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV

Data (Run78)

mean

Beam side

$\Lambda$  side



# Vertex check

SIM

$K-d \rightarrow n \Sigma^0 \pi^0$

(spectrum  
shape ; cross

Section P.9 left  
figure )

mean

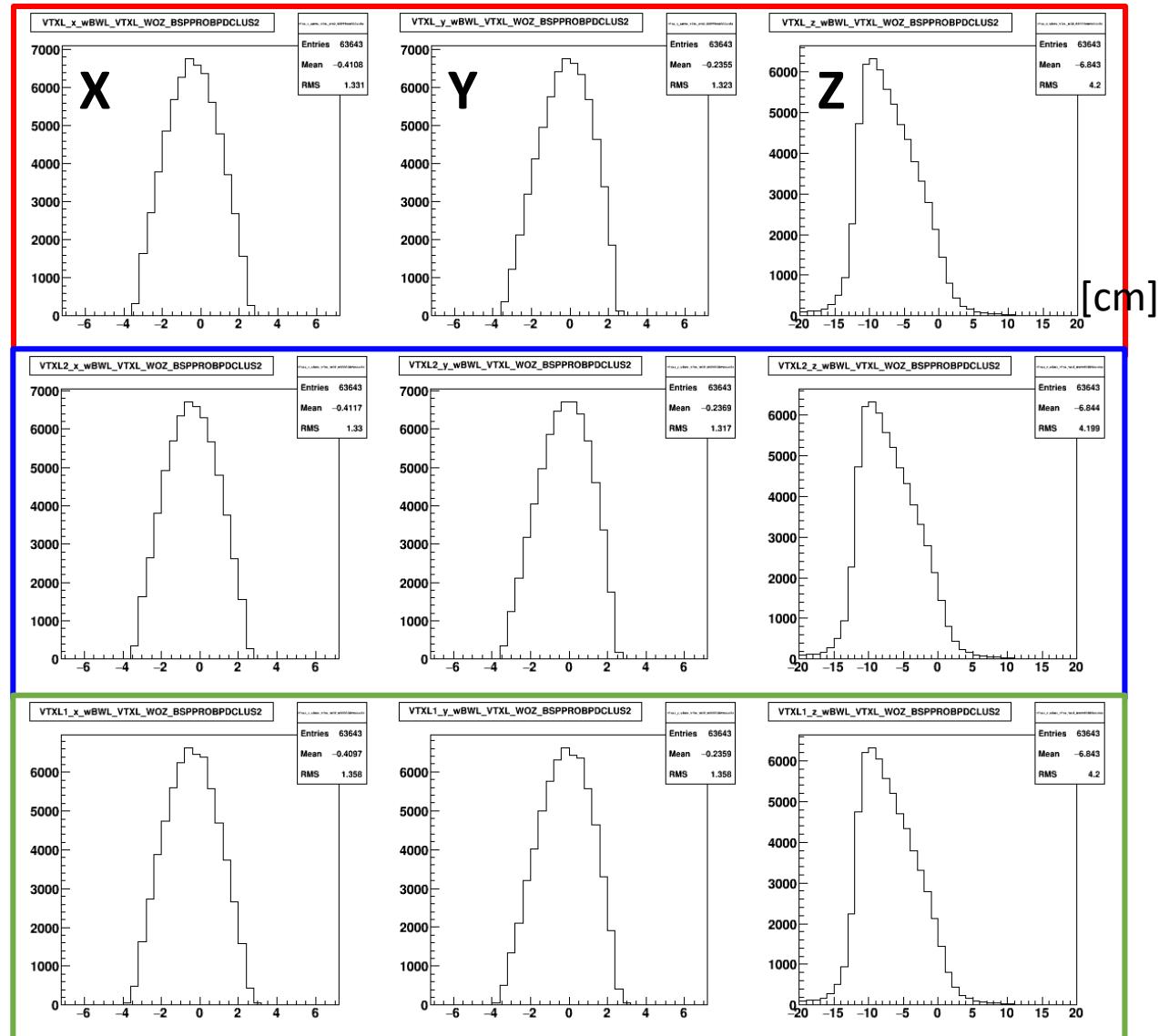
Beam  
side

No significant difference

$\Lambda$   
side

Another Condition  
Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV



# Vertex check

Another Condition  
Same as final spectrum

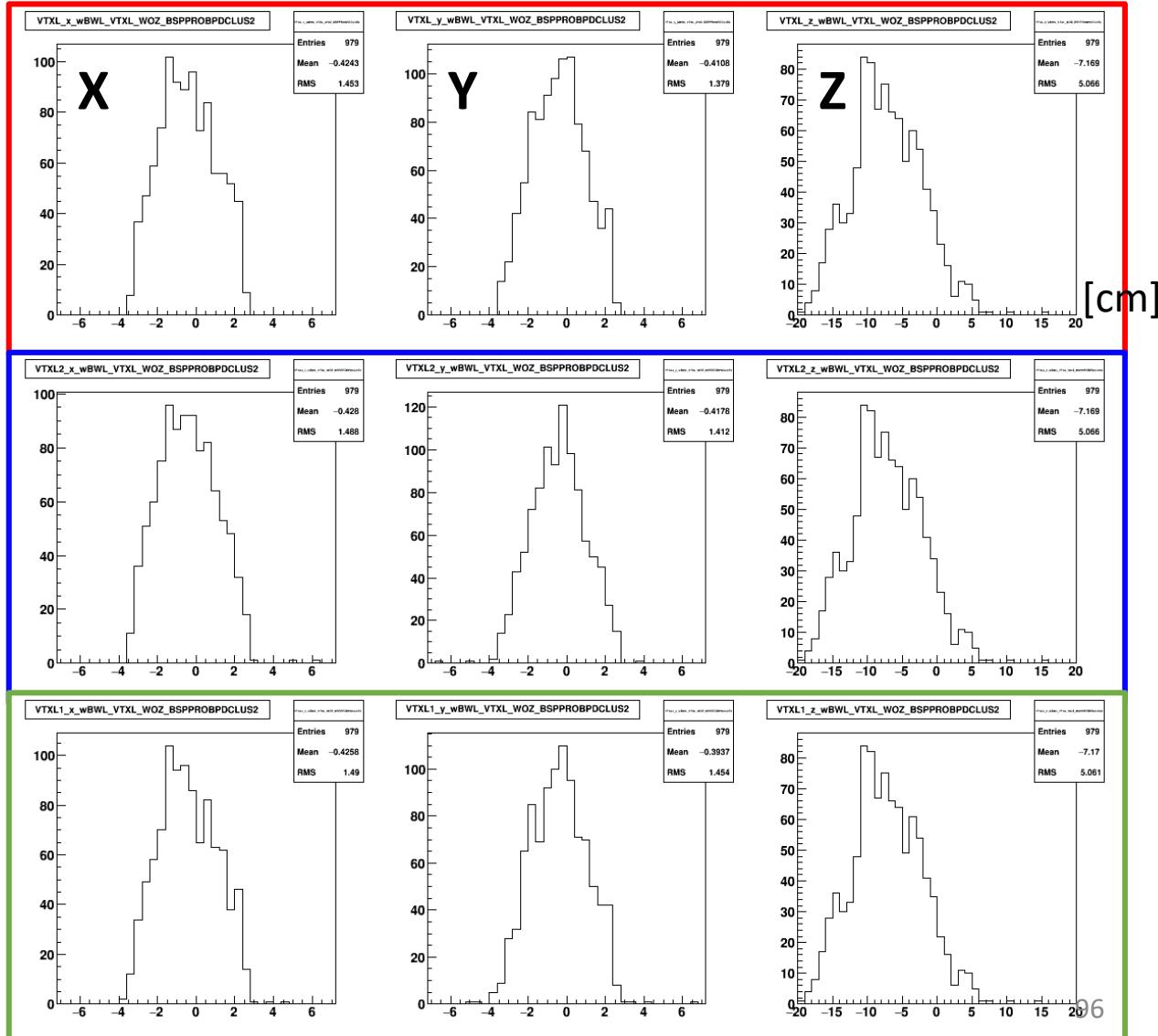
- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30 \text{ GeV}$

Data (Run78)

mean

Beam side

$\Lambda$  side

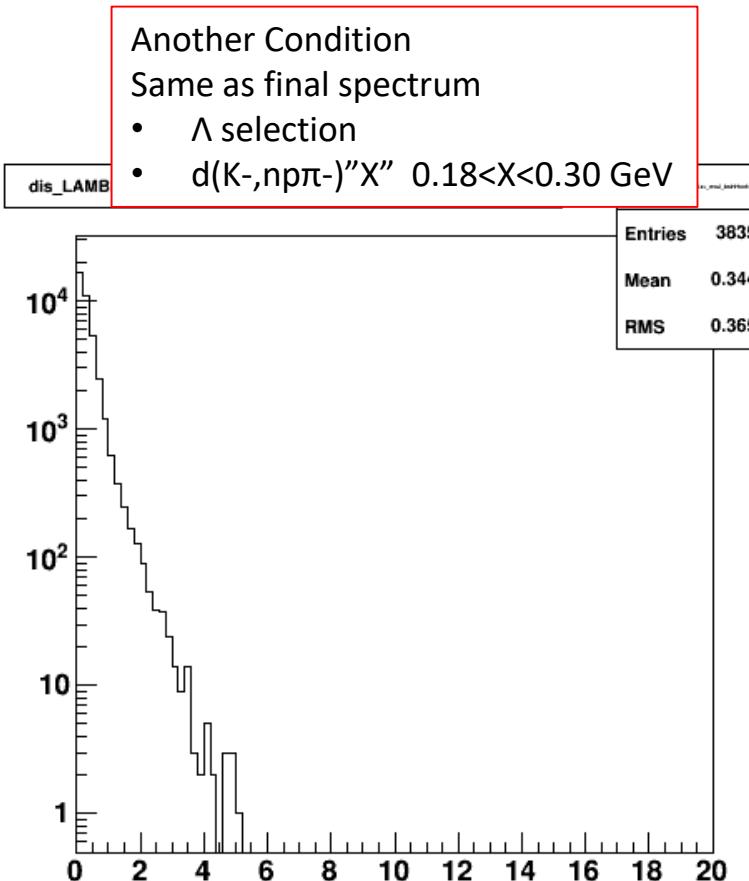
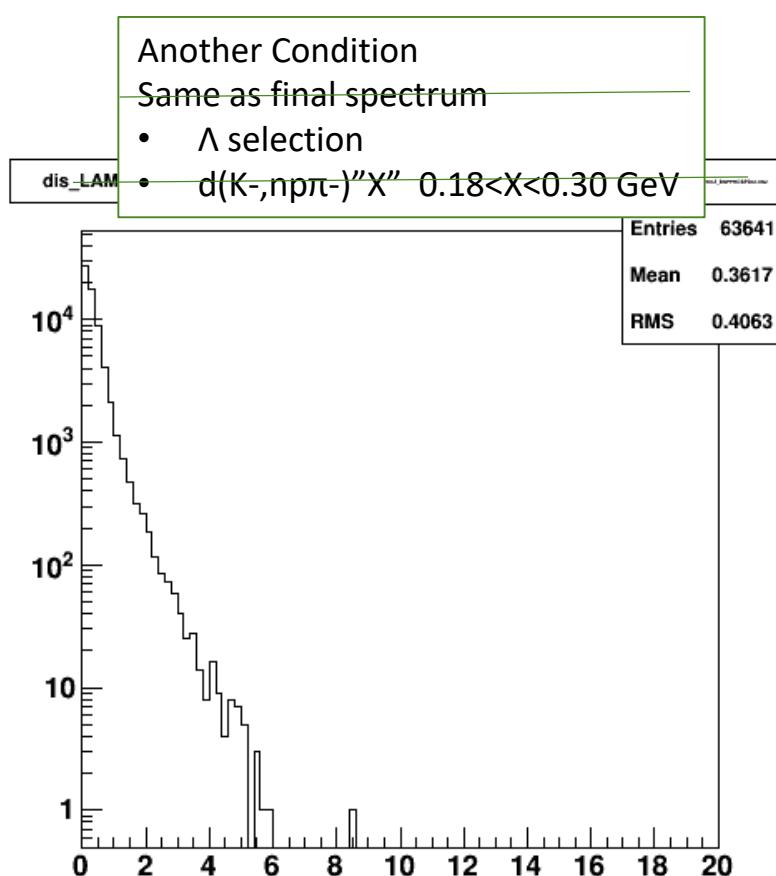
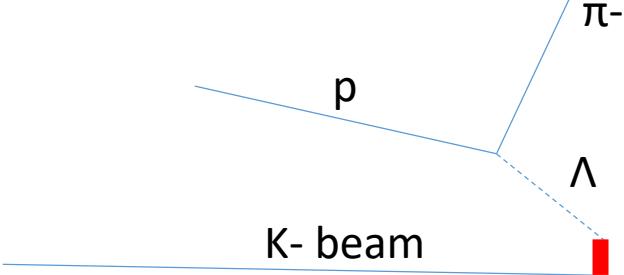


# DCA (Lambda x Beam)

SIM

$K^- \rightarrow n \Sigma^0 \pi^0$

(spectrum shape ; cross Section P.9 left figure )

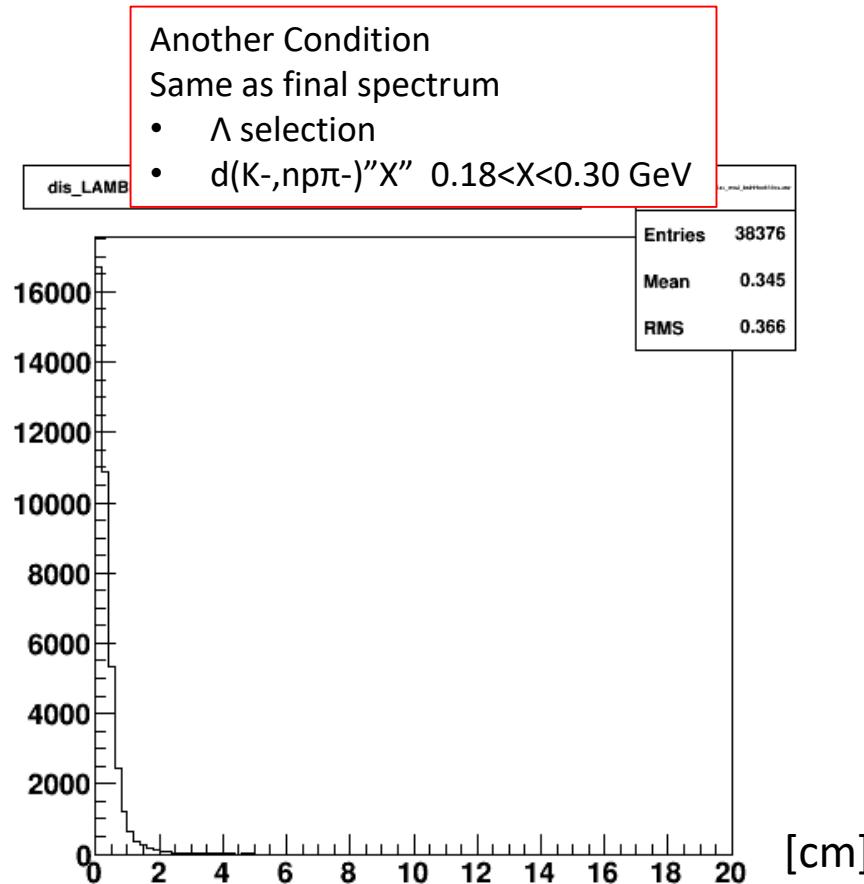
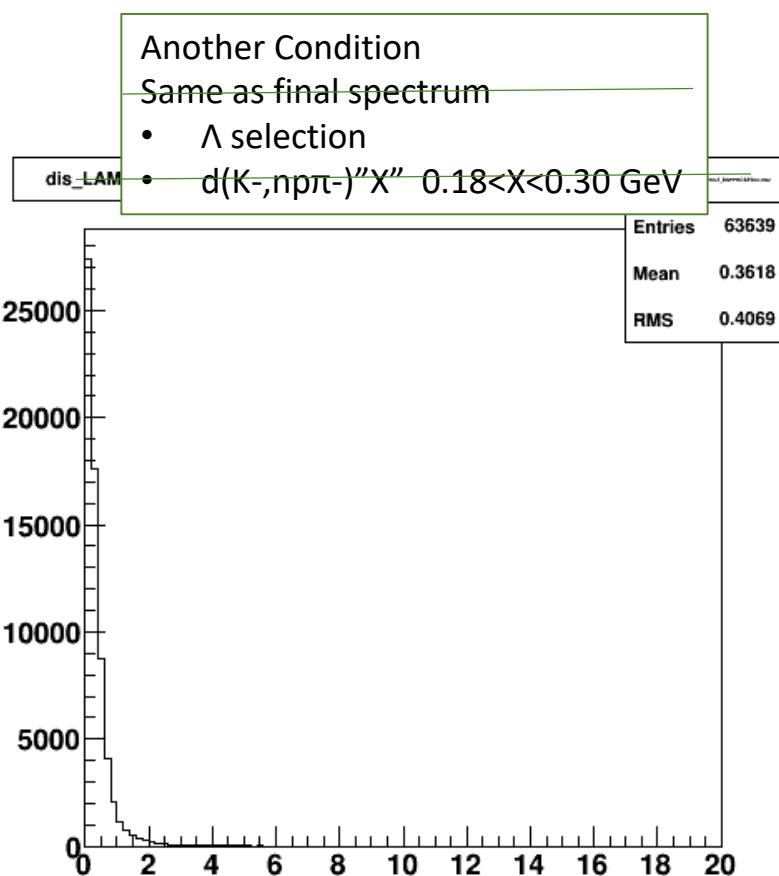
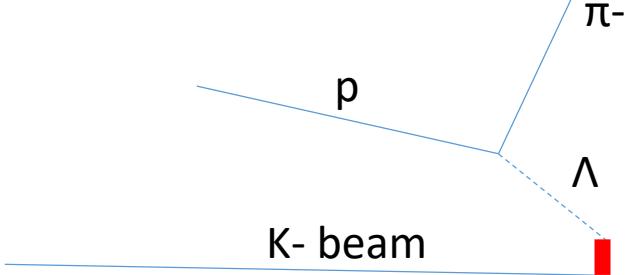


# DCA (Lambda x Beam)

SIM

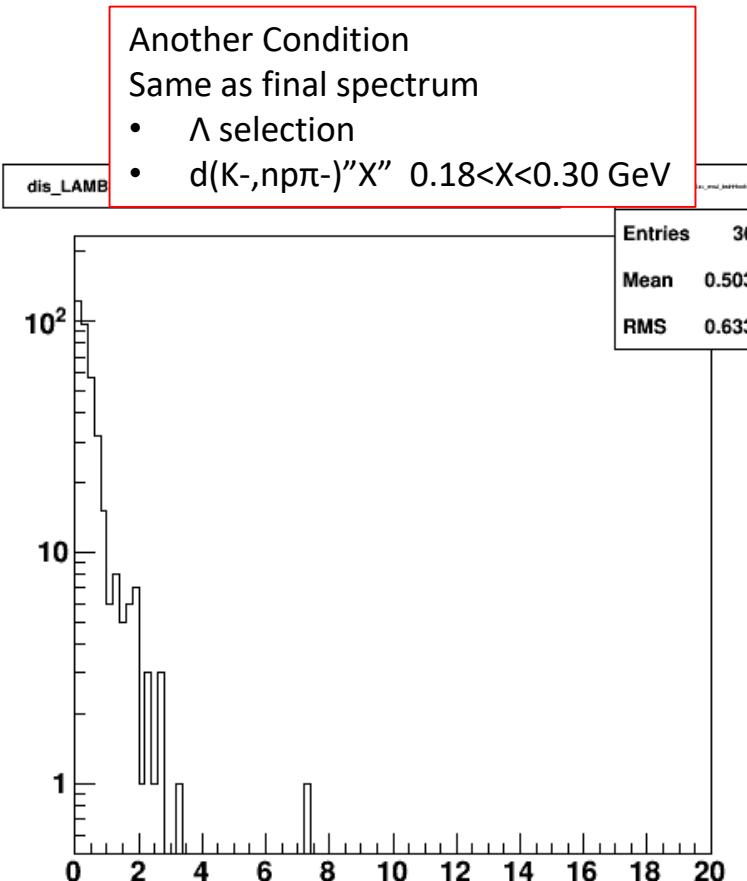
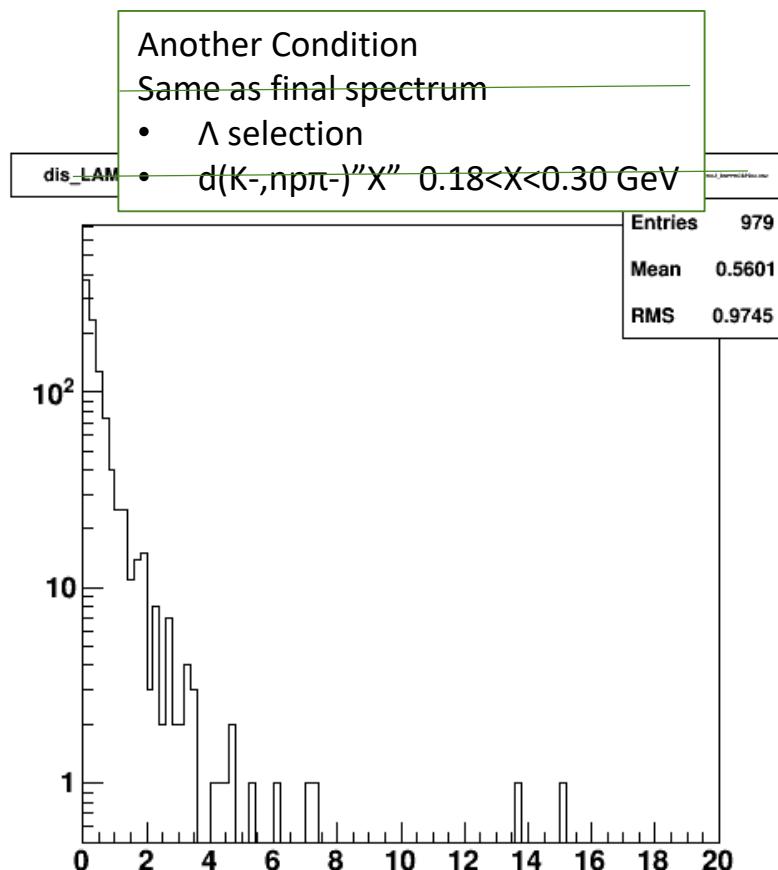
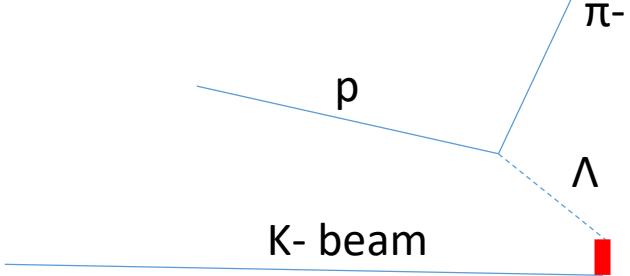
$K^- \rightarrow n \Sigma^0 \pi^0$

(spectrum shape ; cross Section P.9 left figure )



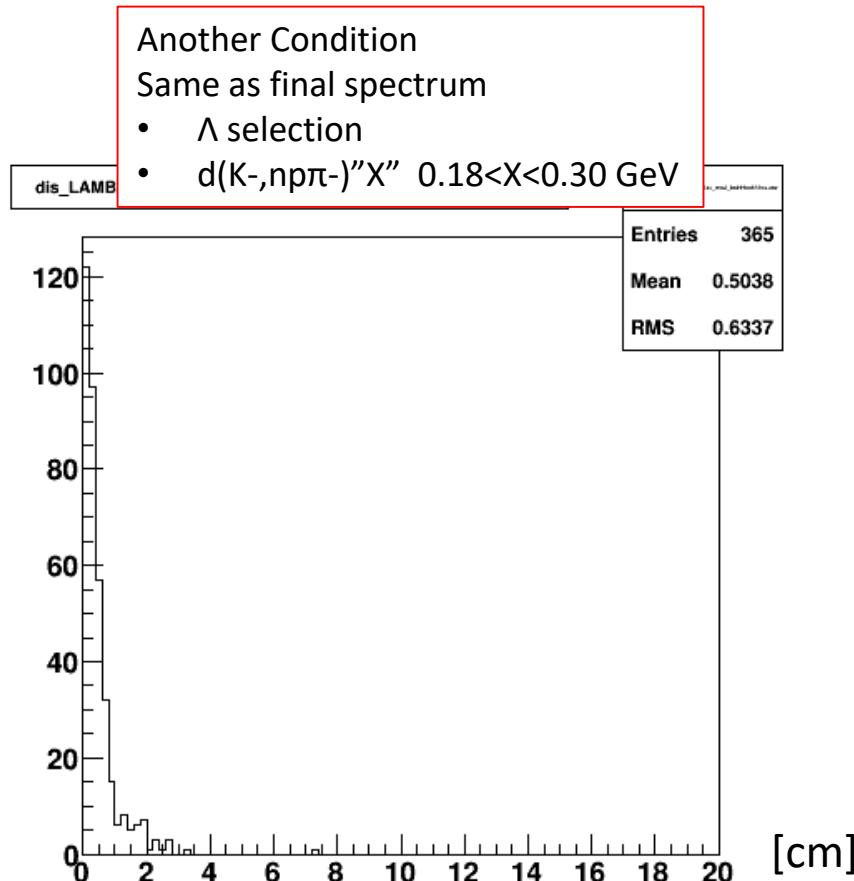
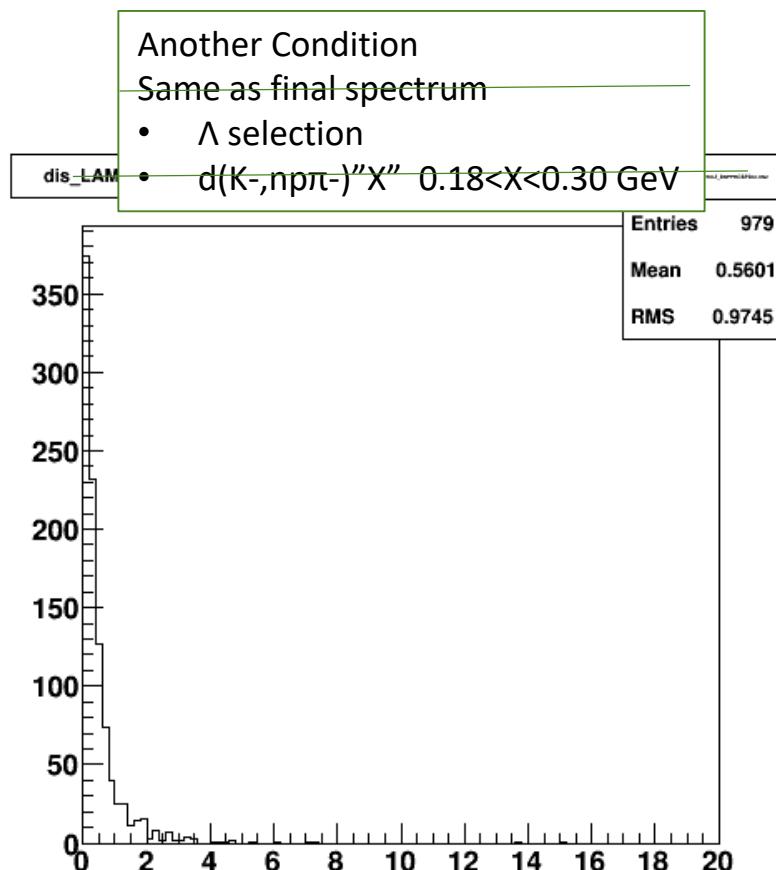
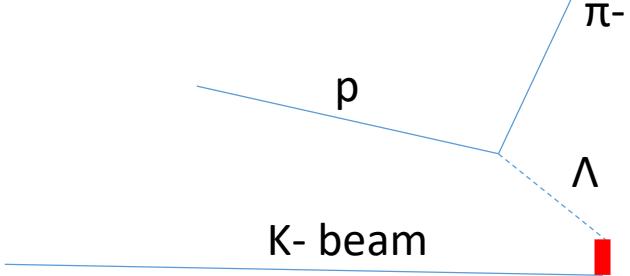
# DCA (Lambda x Beam)

Data (Run78)



# DCA (Lambda x Beam)

Data (Run78)

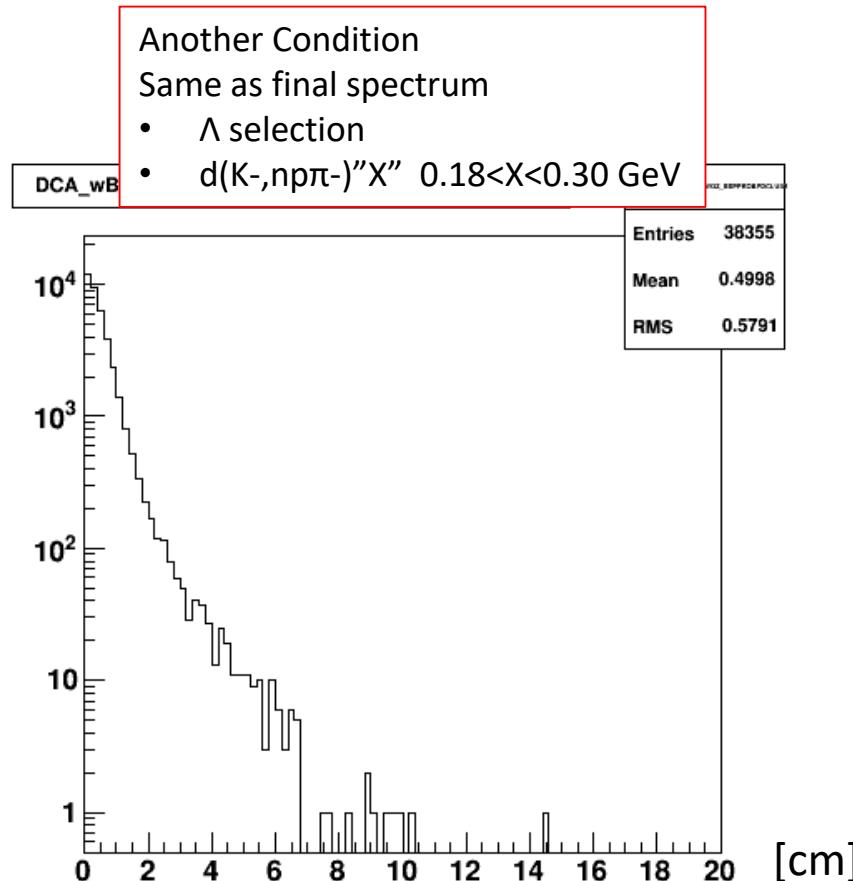
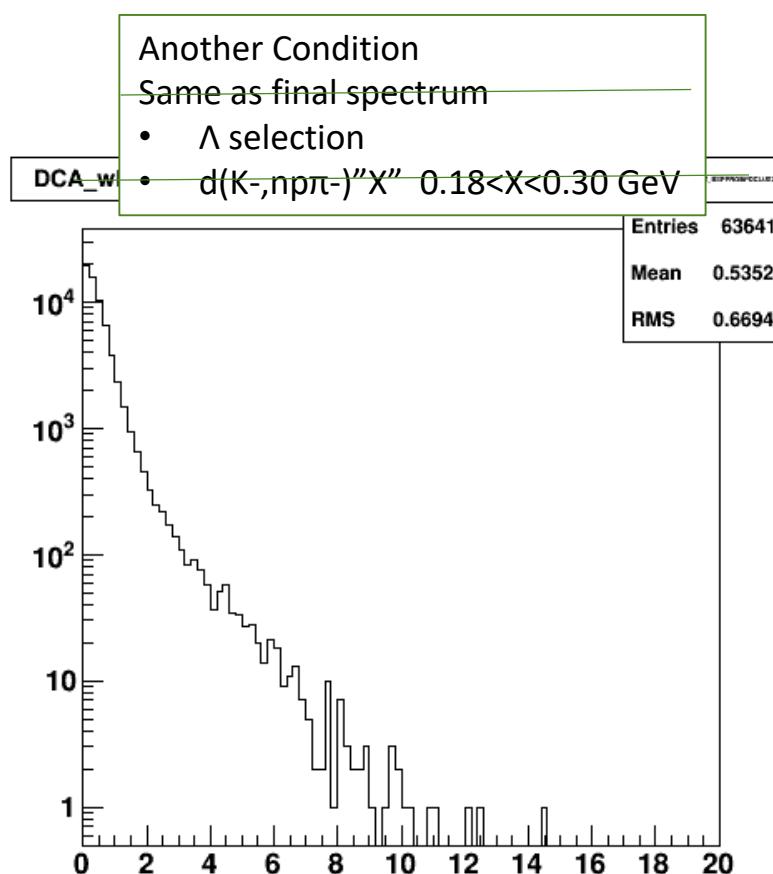
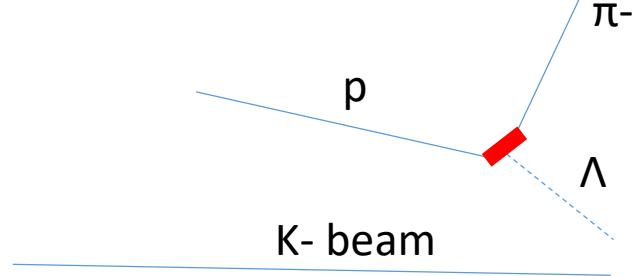


# DCA ( $p \times \pi^-$ )

SIM

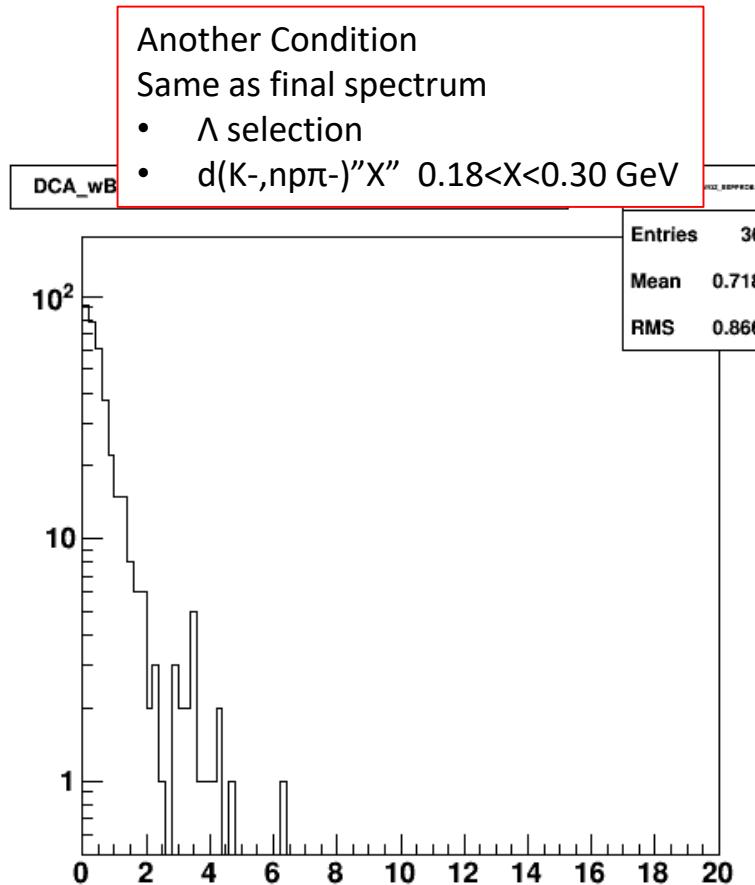
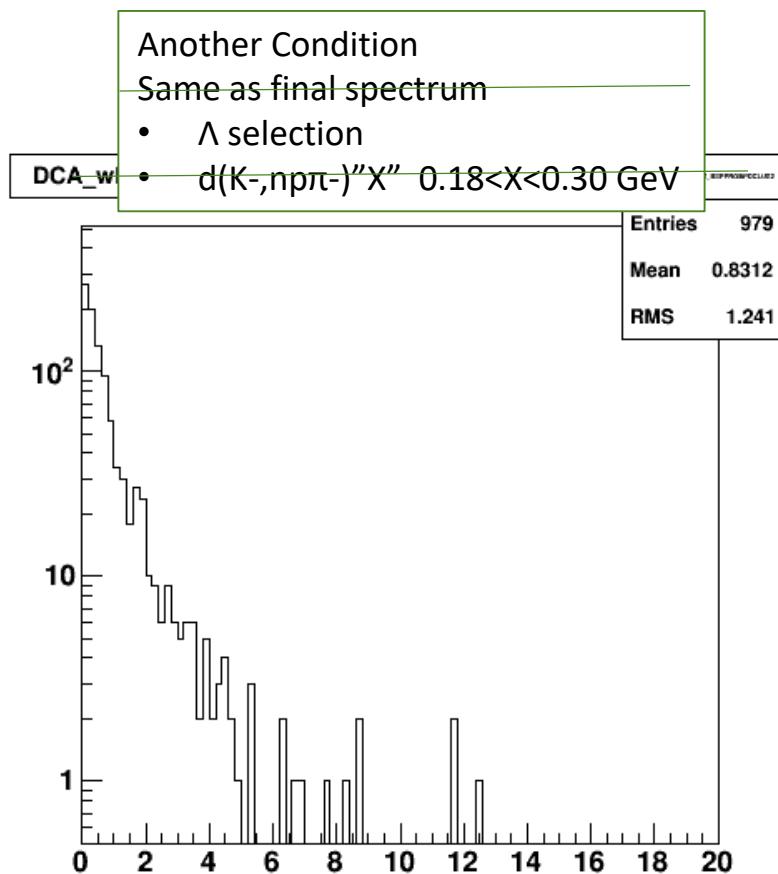
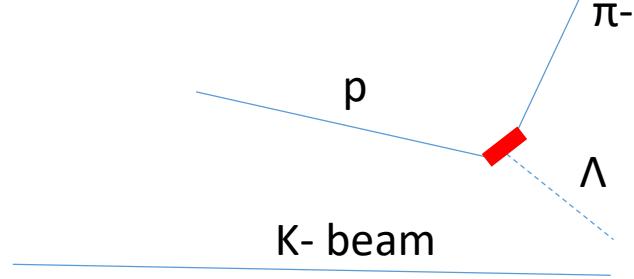
$K-d \rightarrow n \Sigma^0 \pi^0$

(spectrum shape ; cross Section P.9 left figure )



# DCA ( $p \times \pi^-$ )

Data (Run78)



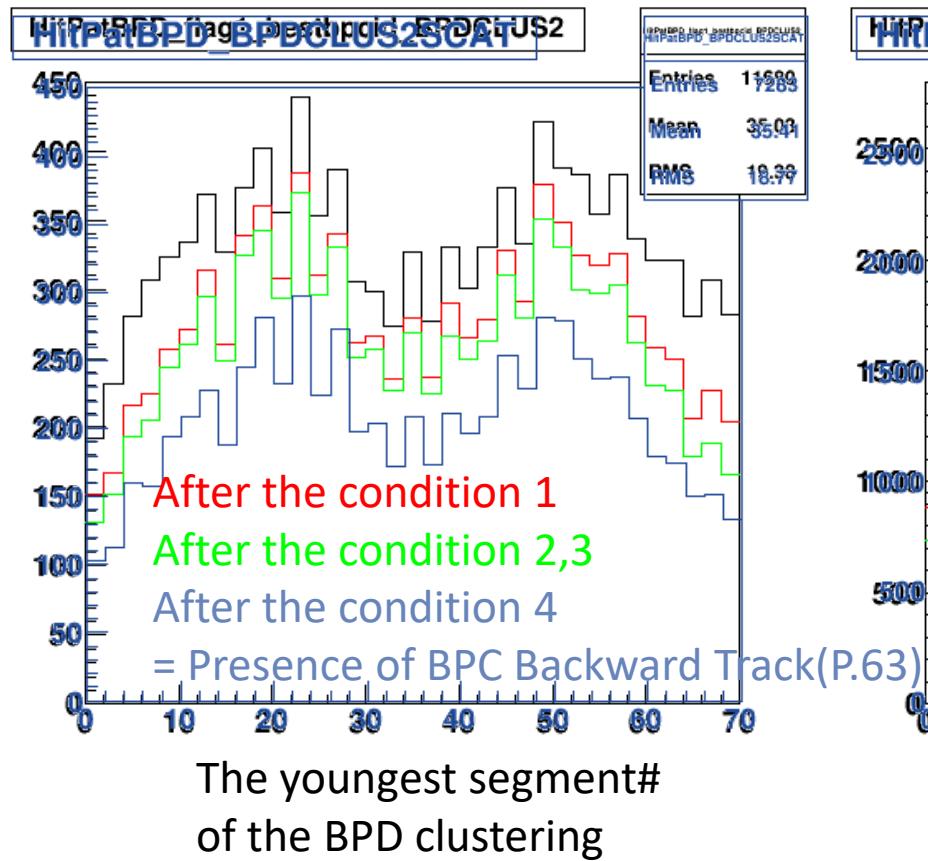
# Backward tracking conditions

1. Not same as Beam Track X, Beam Track Y
2. BPC hit pos @BPD y (**not** magnetic correction) ; -20~20 cm
3. BPC hit pos @BPD x,y (magnetic correction) ; -18~18 cm
4. Vertex lambda -> fiducial cut w/o z

2, 3 seem not to be best (proper) conditions.  
I set these conditions for BPD size roughly very old

# BPD hit pattern of backward proton

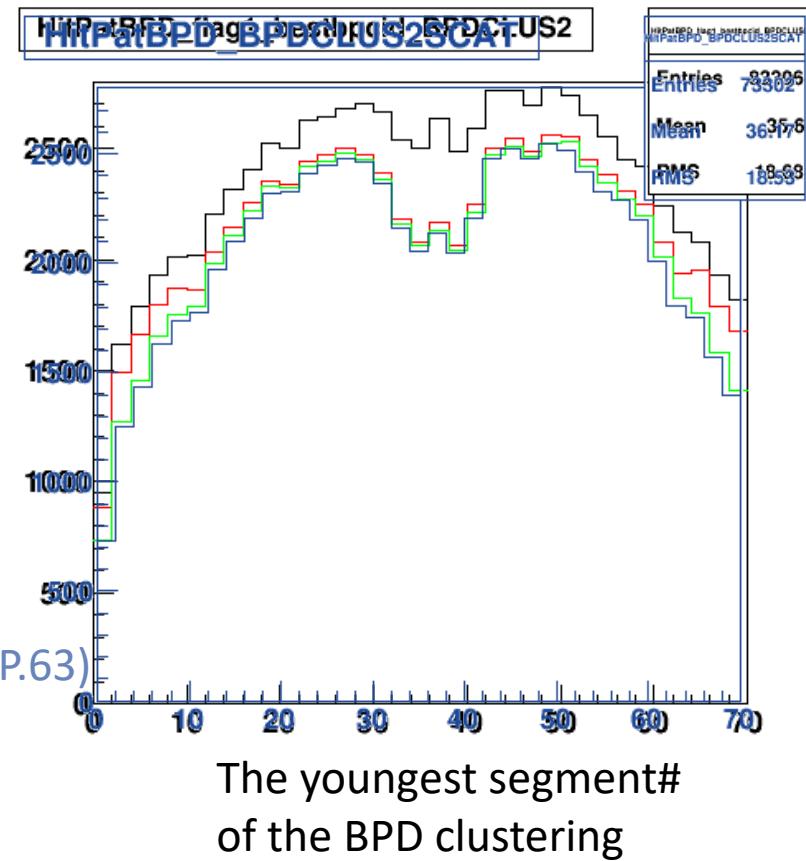
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

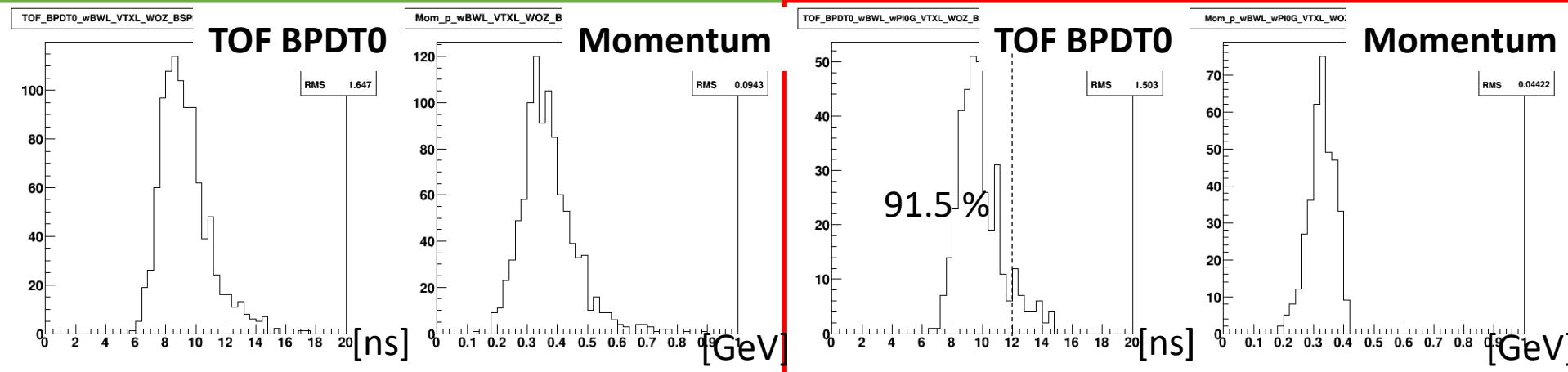
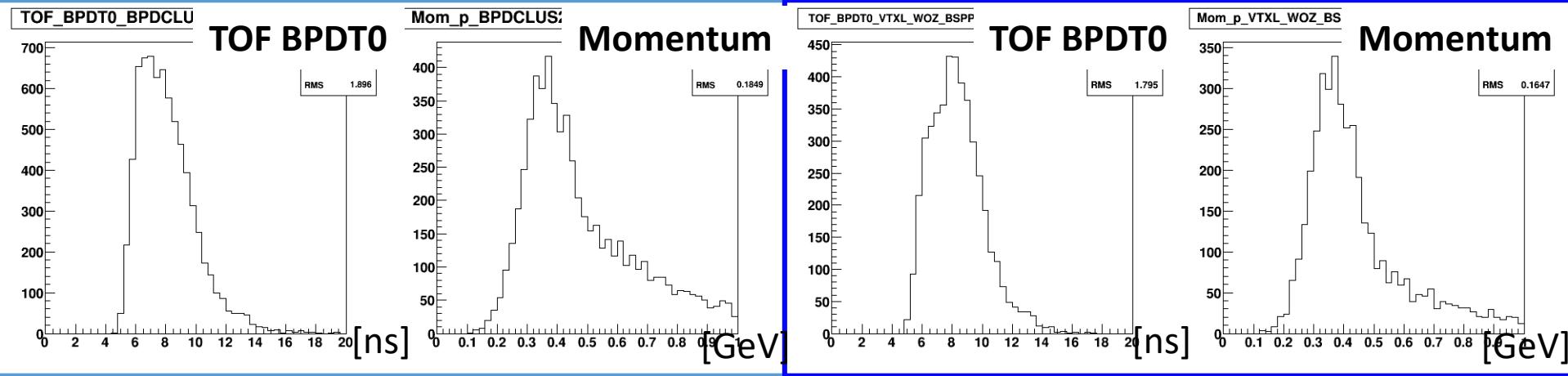
(spectrum shape ; cross Section P.9 left figure)



# Backward proton TOF, Momentum

Data (Run78)

Before BPD-BPC Matching	After BPD-BPC Matching
Λ selection	π0γ selection

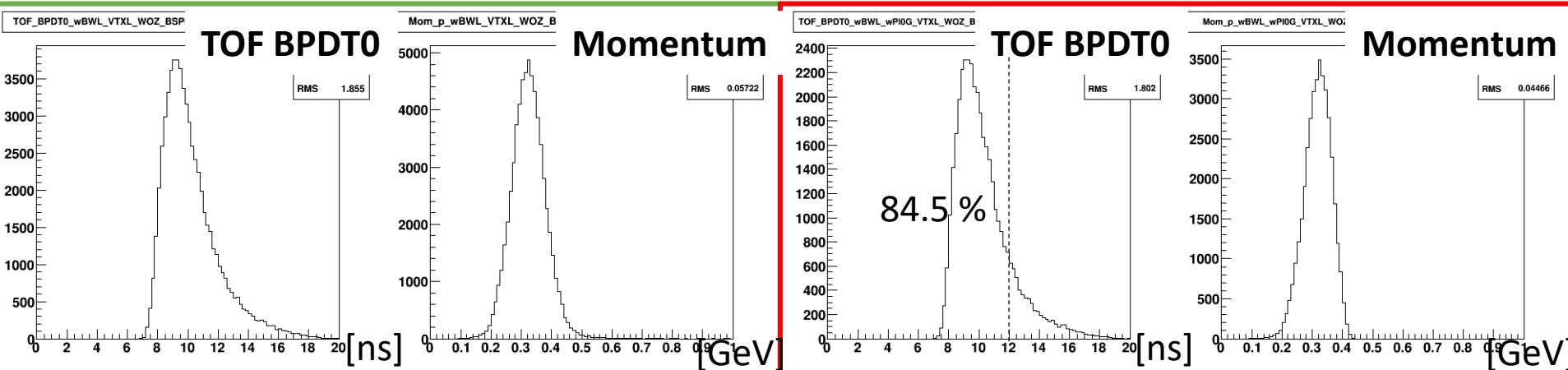
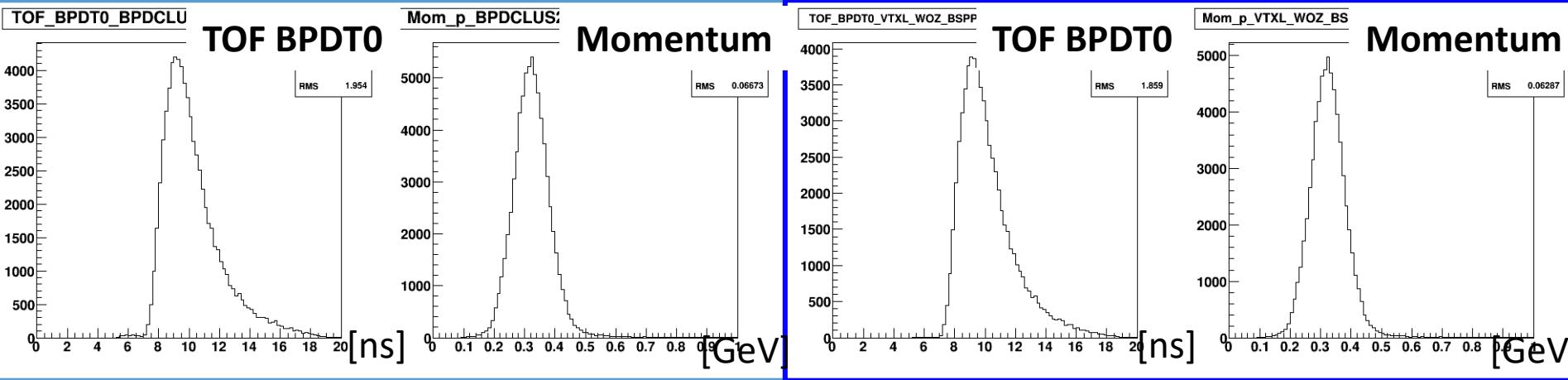


SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$   
(spectrum shape ;  
cross Section P.9  
left figure )

# Backward proton TOF, Momentum

Before BPD-BPC Matching	After BPD-BPC Matching
$\Lambda$ selection	$\pi 0 \gamma$ selection

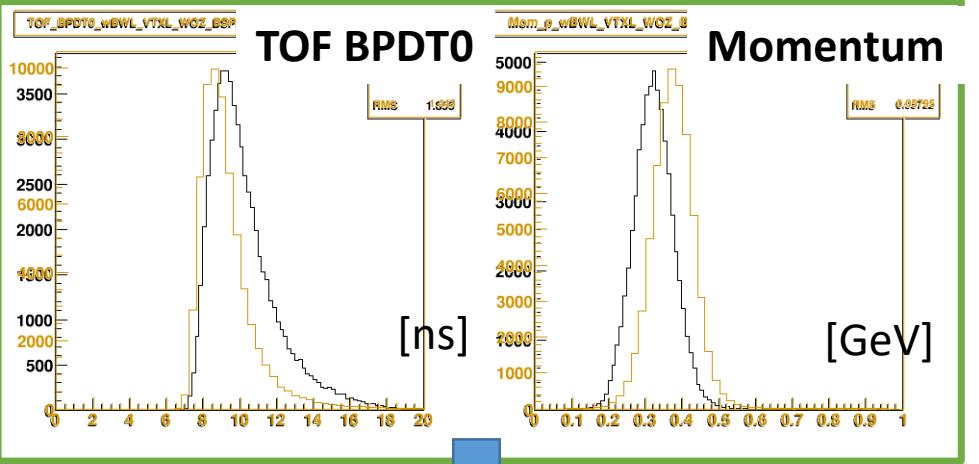


# Backward proton TOF, Momentum

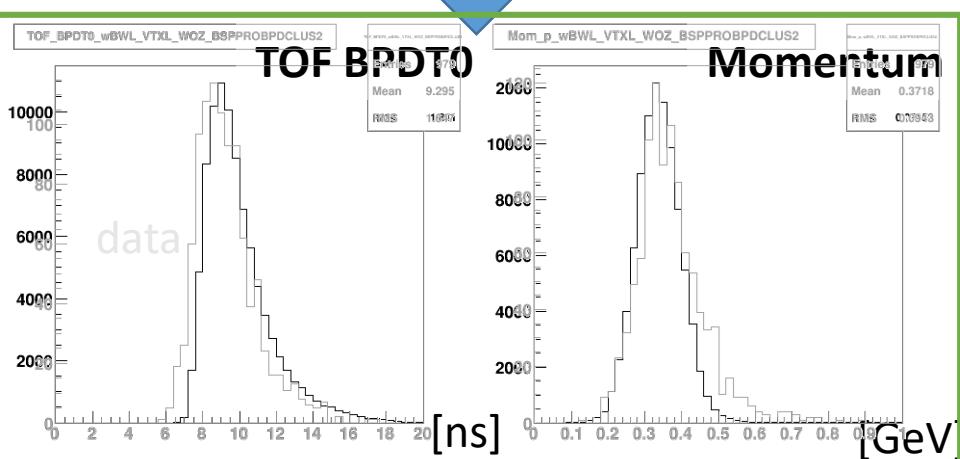
SIM K-d  $\rightarrow$ n  $\Sigma^0\pi^0$  (spectrum shape ; cross Section P.9 left figure )

SIM K-d  $\rightarrow$ n  $\Lambda\pi^0$

## $\Lambda$ selection



Mix K-d  $\rightarrow$ n  $\Sigma^0\pi^0$  & K-d  $\rightarrow$ n  $\Lambda\pi^0$   
Ratio  $\rightarrow$  Page. 112



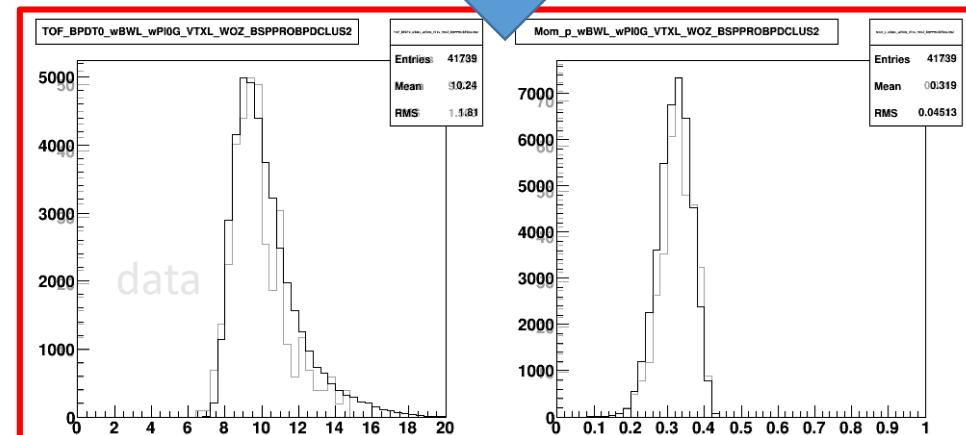
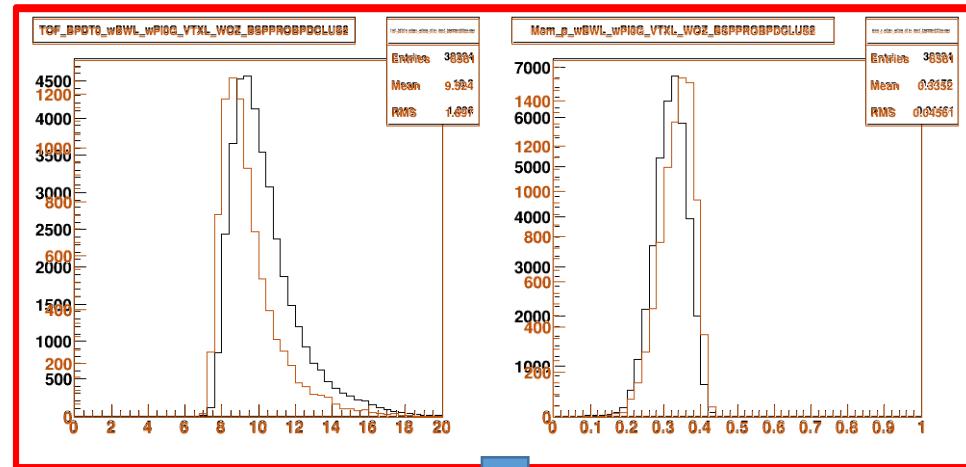
# Backward proton TOF, Momentum

SIM K-d  $\rightarrow n \Sigma 0\pi 0$  (spectrum shape ; cross Section P.9 left figure )

SIM K-d  $\rightarrow n \Lambda\pi 0$

$\pi 0\gamma$  selection

Mix K-d  $\rightarrow n \Sigma 0\pi 0$  & K-d  $\rightarrow n \Lambda\pi 0$   
Ratio  $\rightarrow$  Page. 112



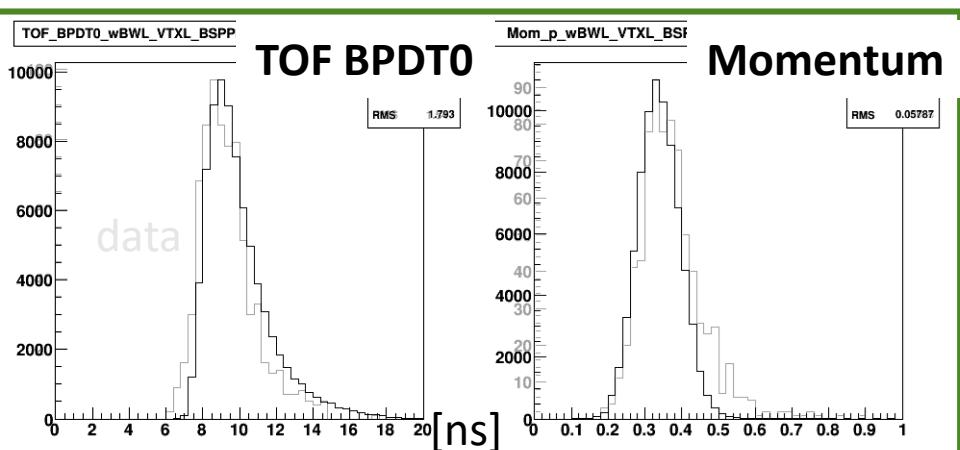
# Backward proton TOF, Momentum

Data (Run78)

## $\Lambda$ selection

- Fiducial cut w/  $Z$

Mix  $K-d \rightarrow n \Sigma 0\pi 0$  &  $K-d \rightarrow n \Lambda\pi 0$   
Ratio → Page. 112



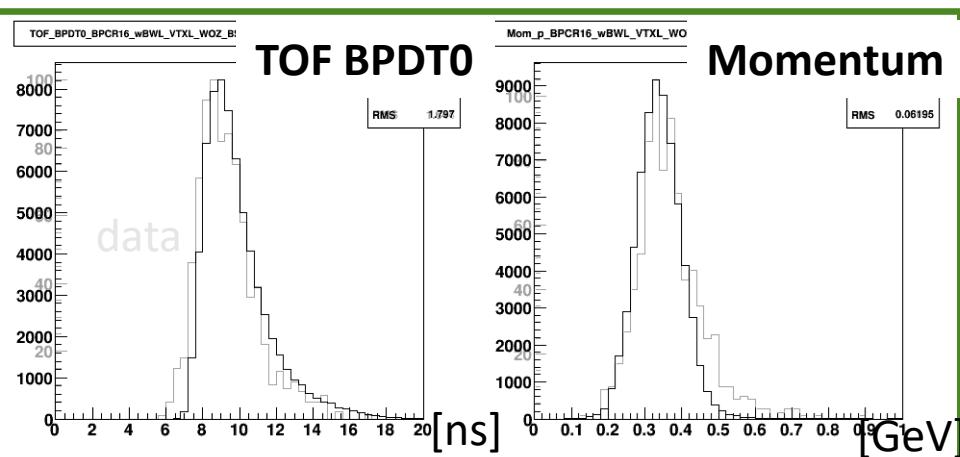
# Backward proton TOF, Momentum

Data (Run78)

## $\Lambda$ selection

- BPC hit pos @ BPD  $R < 16$  cm

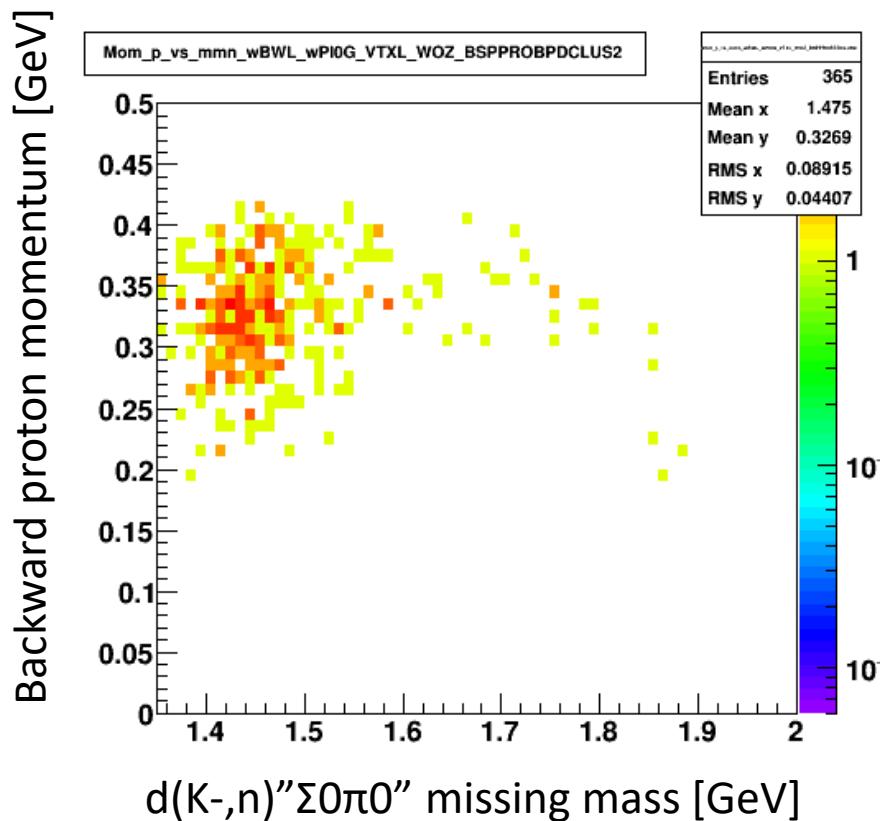
Mix  $K-d \rightarrow n \Sigma 0\pi 0$  &  $K-d \rightarrow n \Lambda\pi 0$   
Ratio → Page. 112



# $d(K-,n)\Sigma^0\pi^0$ missing mass vs backward proton momentum

Condition  
Same as final spectrum  
•  $\Lambda$  selection  
•  $d(K-,n\bar{p}\pi^-)\Sigma^0$   $0.18 < X < 0.30$  GeV

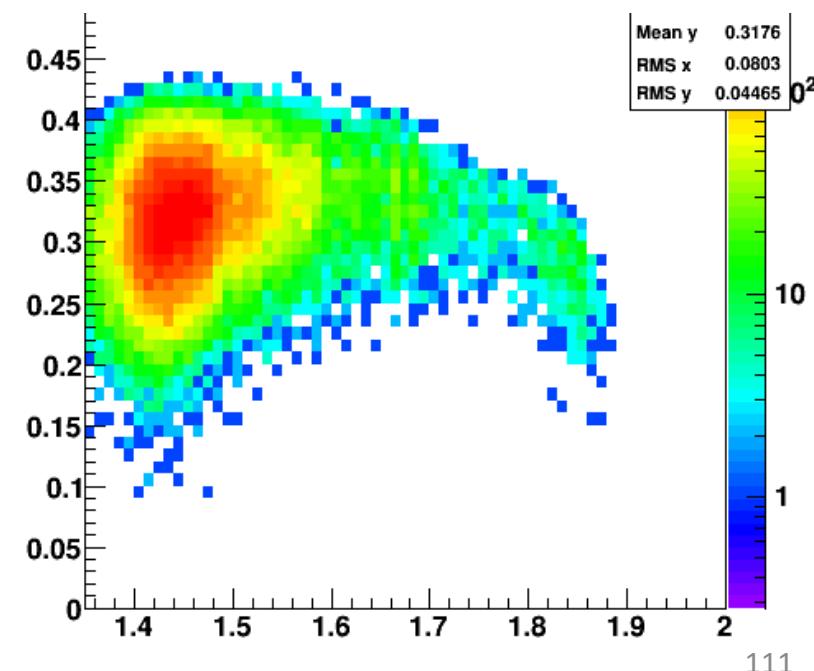
Data (Run78)



SIM

$K-d \rightarrow n \Sigma^0\pi^0$

(spectrum shape ; cross Section P.9 left figure)



# Re-analysis

- BPC hit pos  $R < 16, 17$
- Vertex Lambda w/ z

# Acceptance estimation

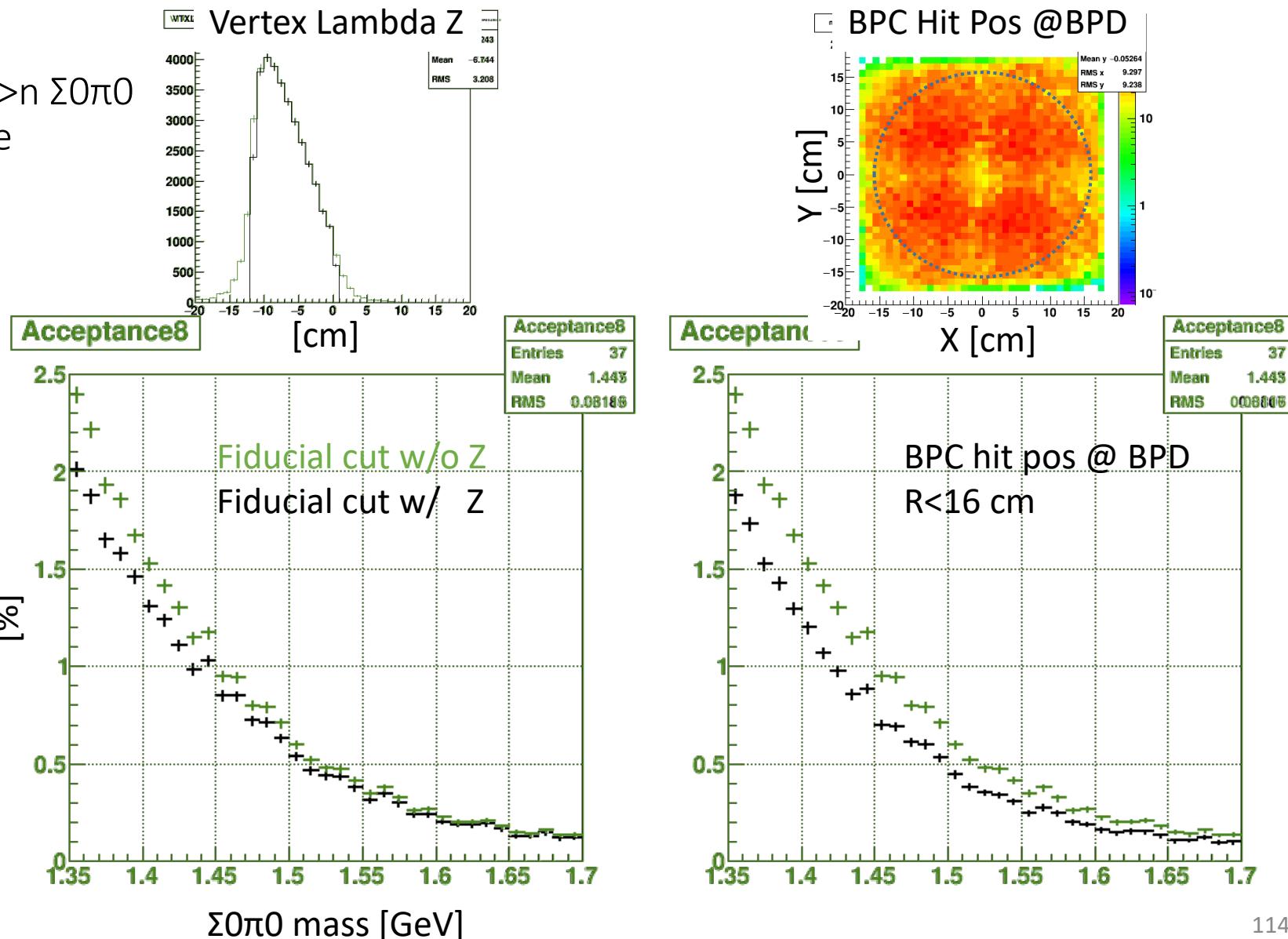
- Sample ;
  - $dE$  (NC) > 8 MeV –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0$  multi =1,  
Beam track defining..)



- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X''$   $0.18 < X < 0.30$  GeV

# Acceptance estimation

SIM  
 $K-d \rightarrow n \Sigma 0\pi 0$   
 Plane

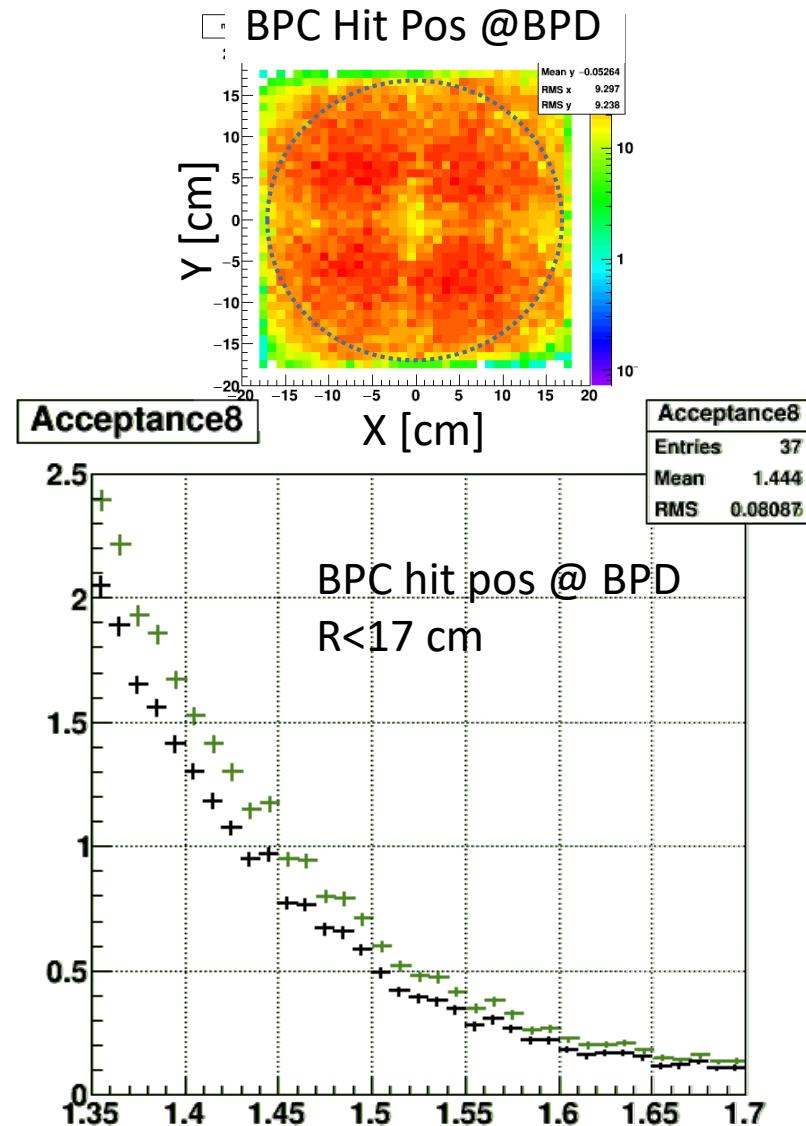


# Acceptance estimation

SIM

K-d  $\rightarrow$ n  $\Sigma 0\pi 0$

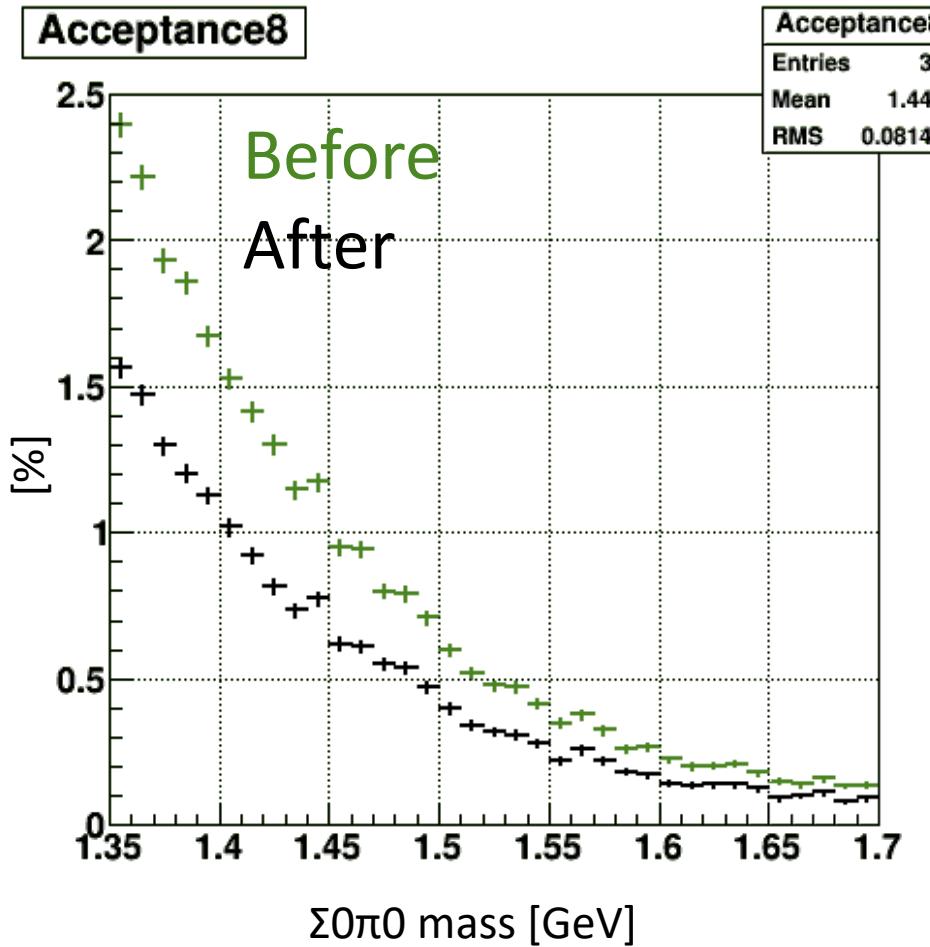
Plane



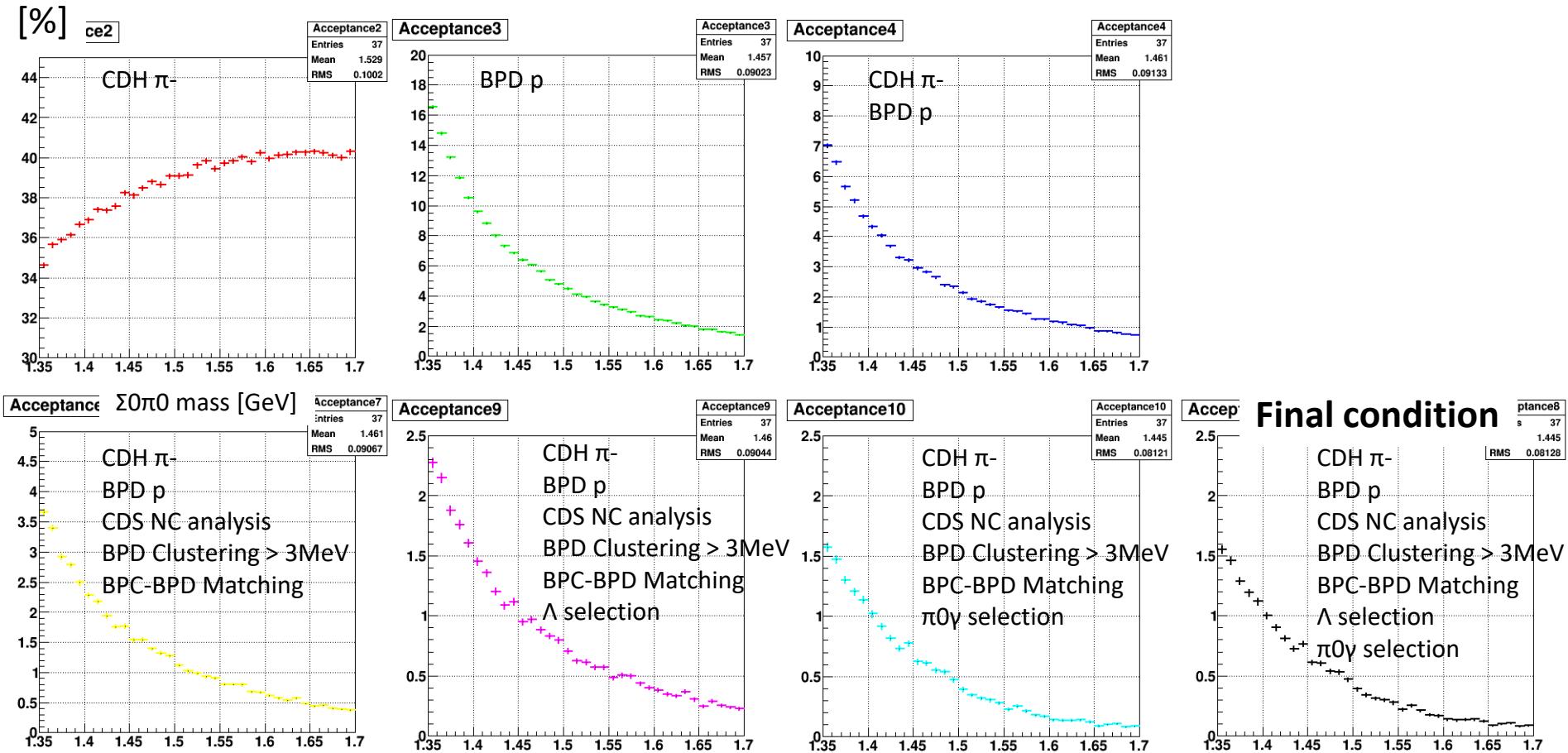
# Acceptance estimation

## Total

- Fiducial cut w/  $Z$
- BPC hit pos @ BPD  $R < 16$  cm



# Acceptance estimation

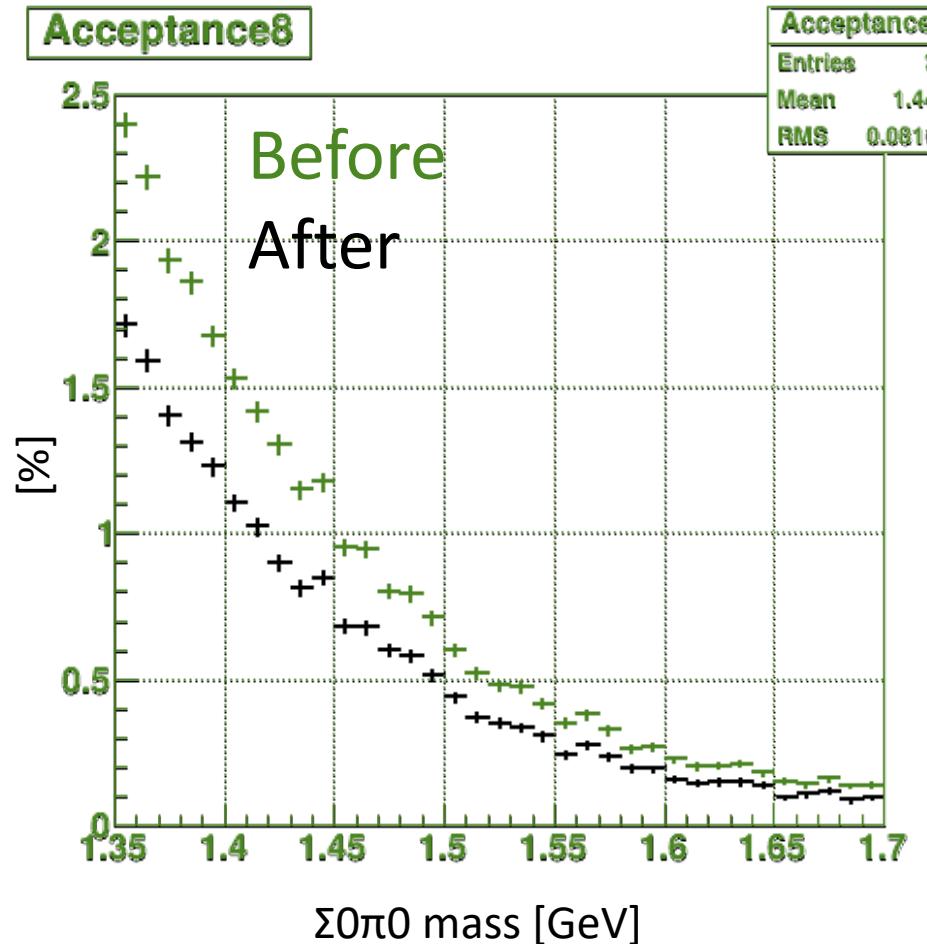


- Another condition
- Fiducial cut w/  $Z$
  - BPC hit pos @ BPD  $R < 16$  cm

# Acceptance estimation

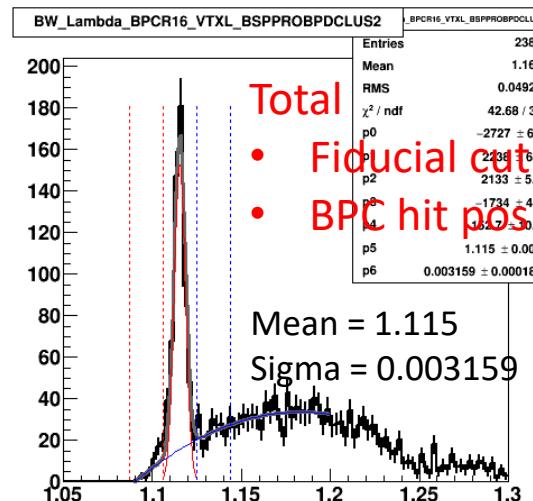
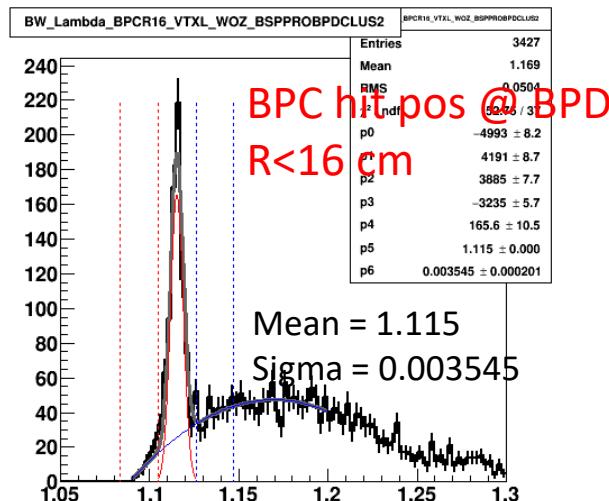
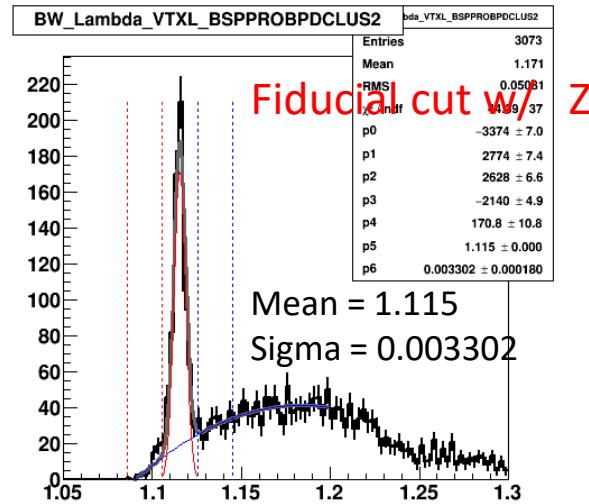
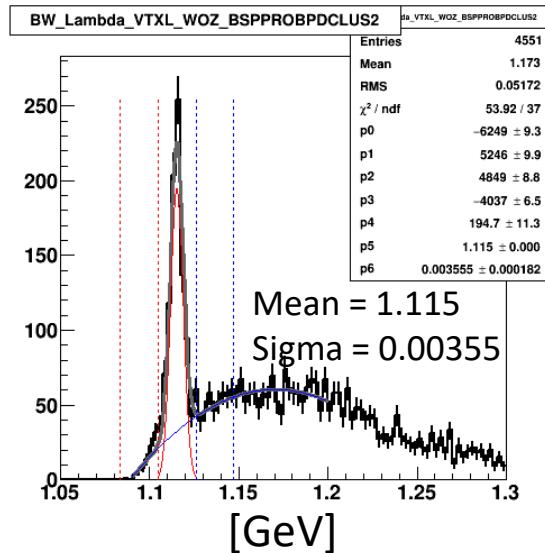
Total

- Fiducial cut w/  $Z$
- BPC hit pos @ BPD  $R < 17$  cm



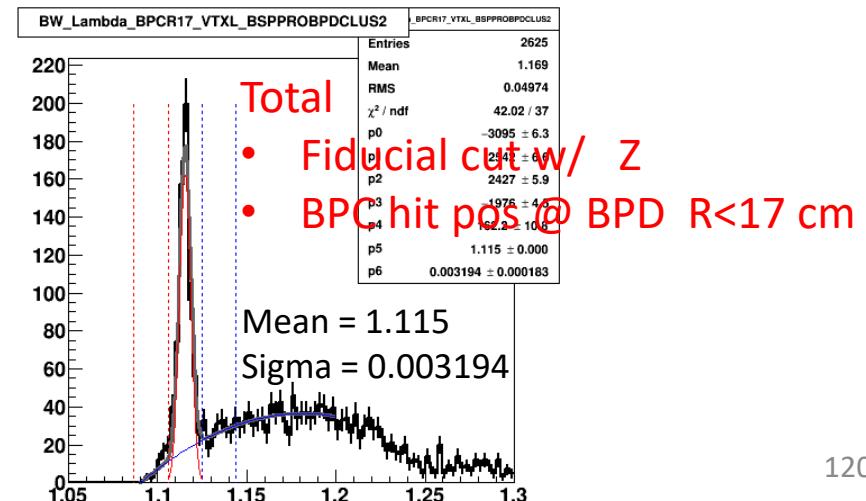
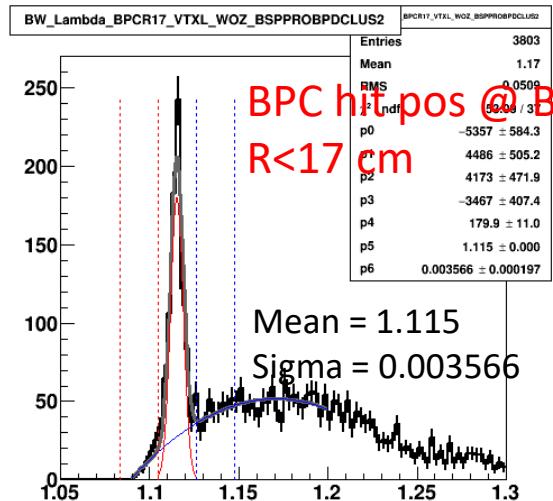
# $p, \pi$ - invariant mass

$\Lambda$  reconstruction from  $p \pi^-$  invariant mass



# $p, \pi$ - invariant mass

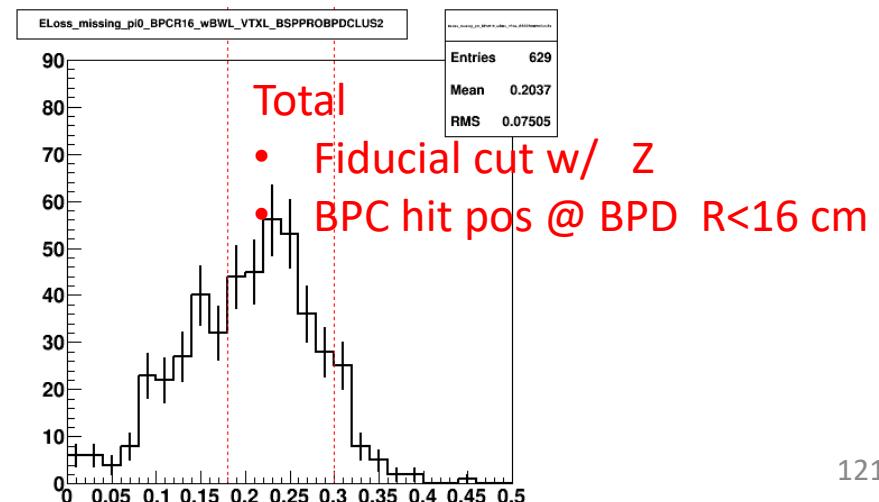
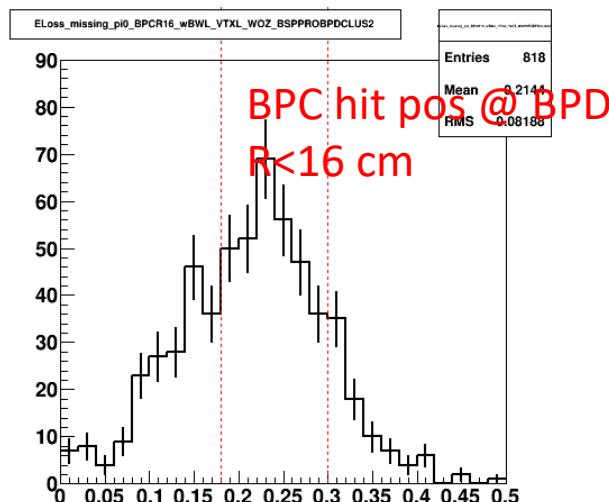
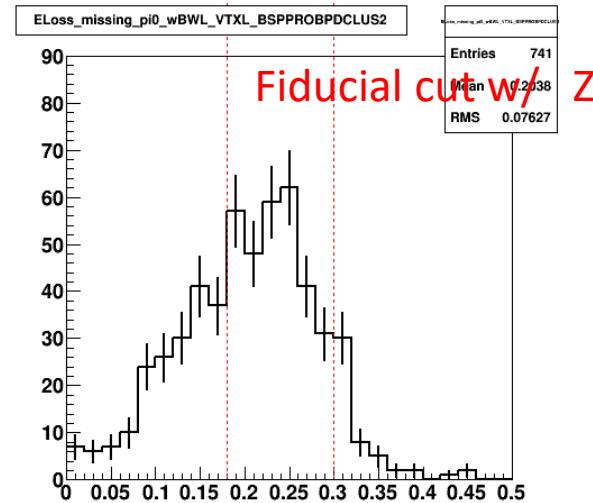
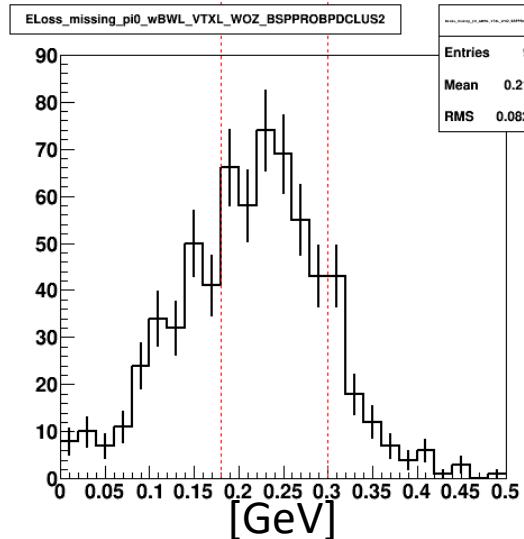
$\Lambda$  reconstruction from  $p \pi^-$  invariant mass



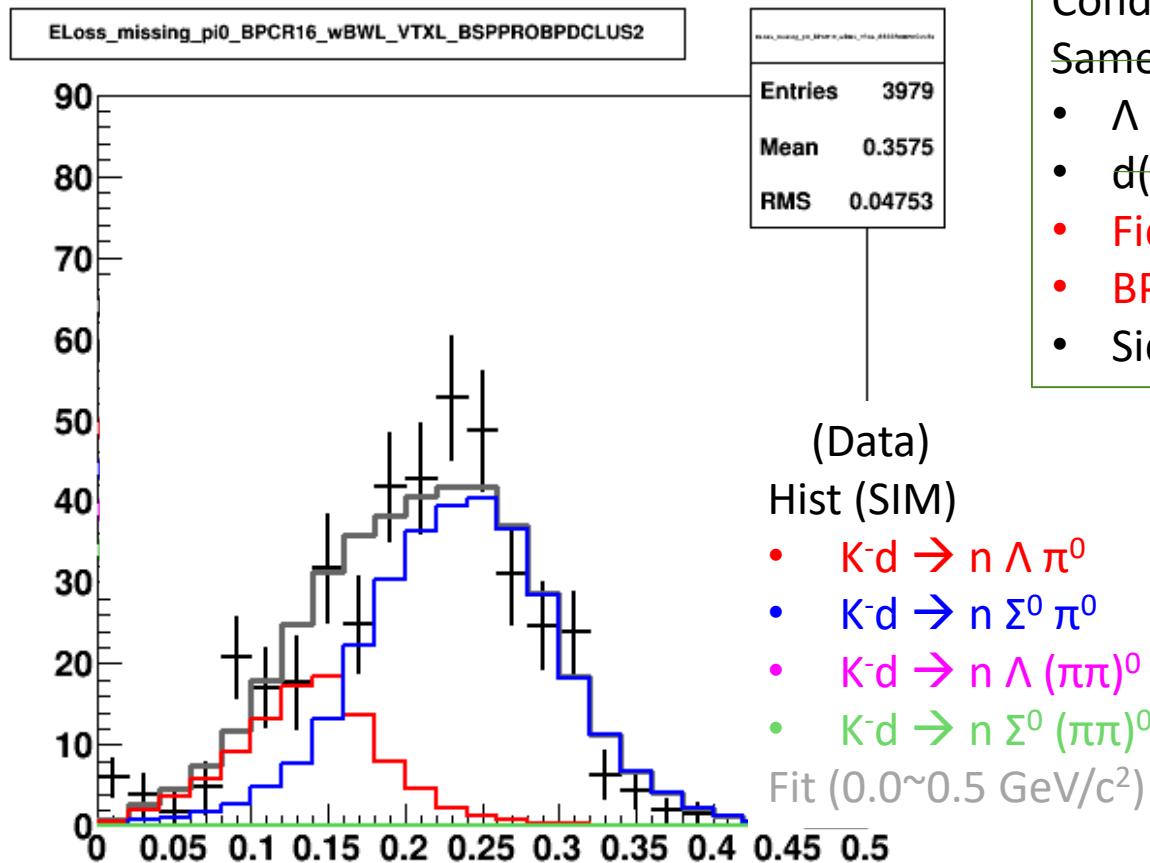
# $d(K^-, np\pi^-)''X''$ missing mass

## $\pi^0\gamma$ selection from $d(K^-, np\pi^-)''X''$ missing mass

Condition  
 Same as final spectrum  
 •  $\Lambda$  selection  
 •  $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



# Fitting of the $d(K^-, np\pi^-)''X''$ missing mass



## Condition

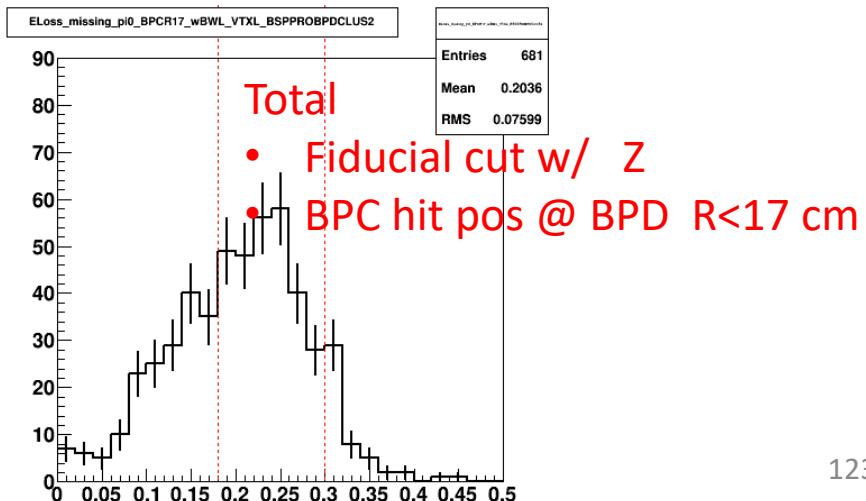
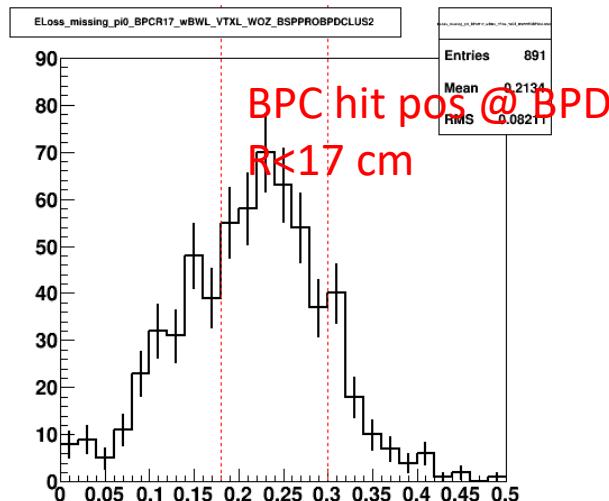
Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$
- Fiducial cut w/ Z
- BPC hit pos @ BPD R<16 cm
- Side-band of  $\Lambda$  is subtracted

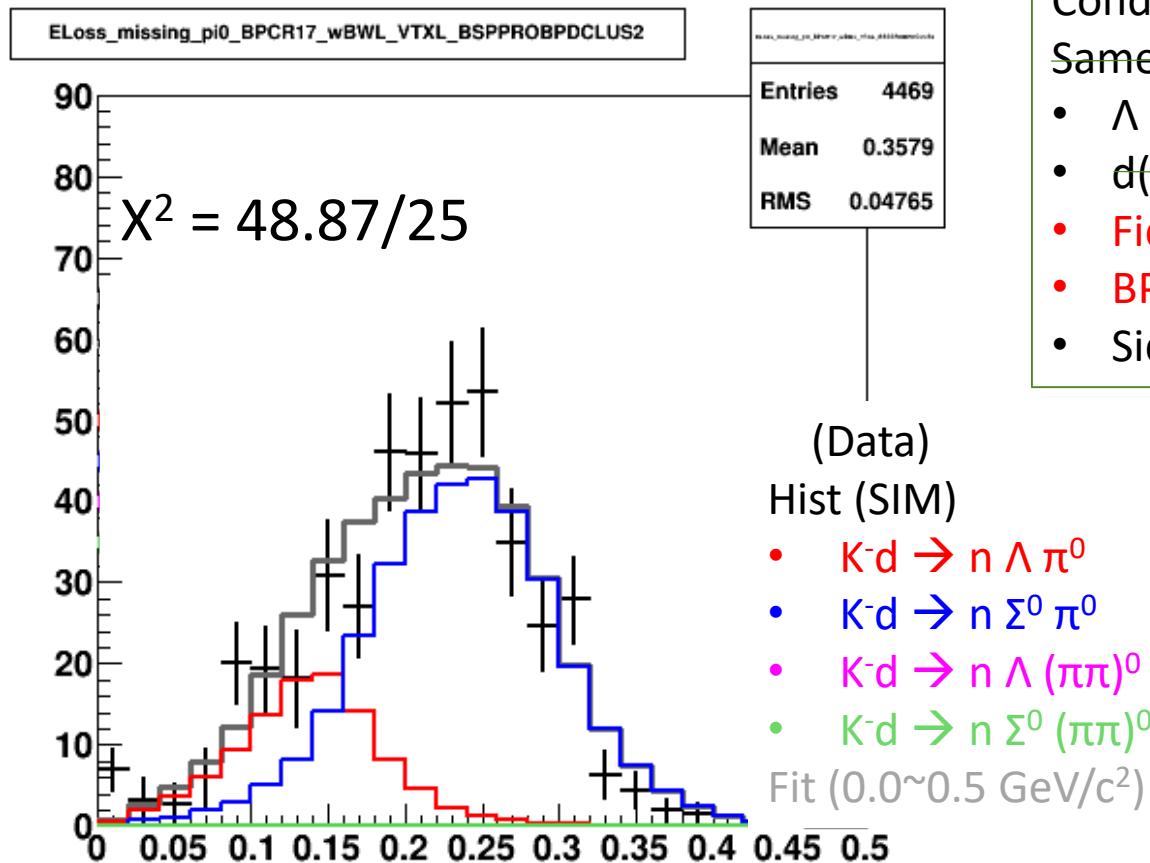
# $d(K^-, np\pi^-)''X''$ missing mass

$\pi 0 \gamma$  selection from  $d(K^-, np\pi^-)''X''$  missing mass

Condition
Same as final spectrum
• $\Lambda$ selection
• $d(K^-, np\pi^-)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



# Fitting of the $d(K^-, np\pi^-)''X''$ missing mass



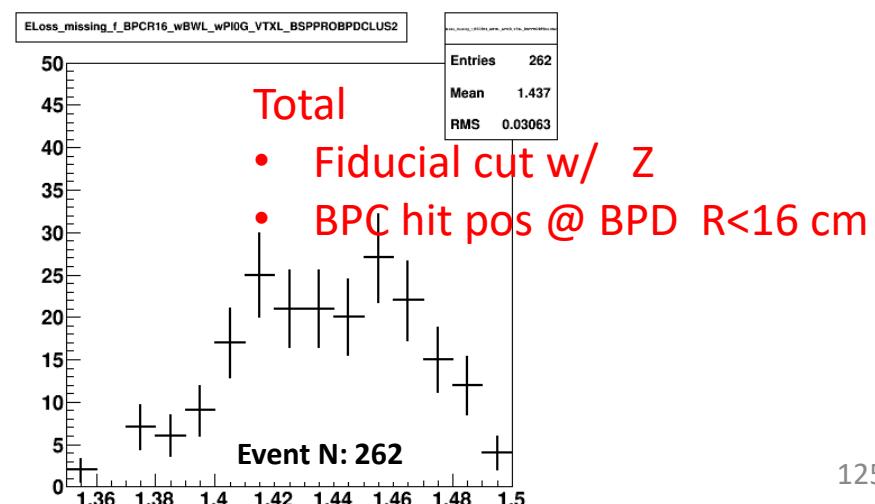
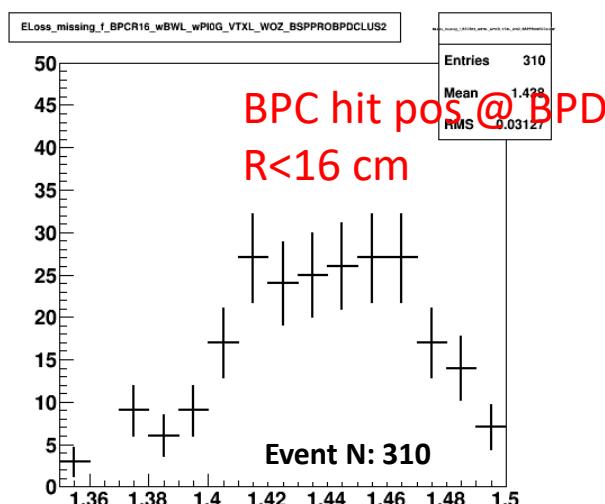
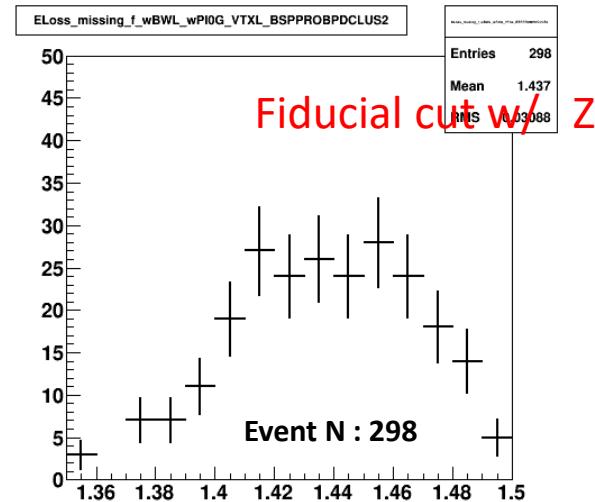
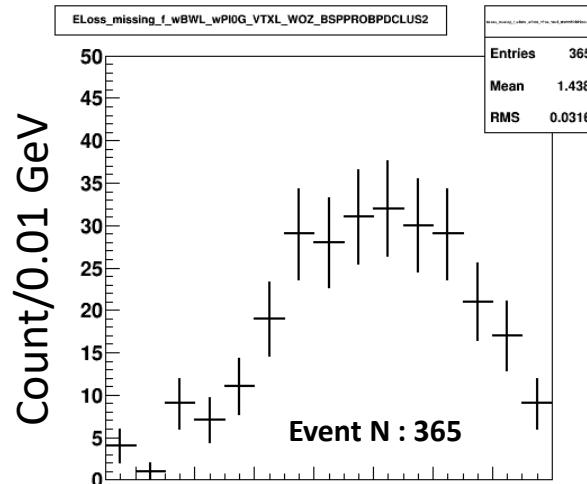
## Condition

Same as final spectrum

- $\Lambda$  selection
- $d(K^-, np\pi^-)''X''$   $0.18 < X < 0.30$  GeV
- Fiducial cut w/ Z
- BPC hit pos @ BPD R<17 cm
- Side-band of  $\Lambda$  is subtracted

# $d(K^-, n)\pi^0\pi^0$ missing mass

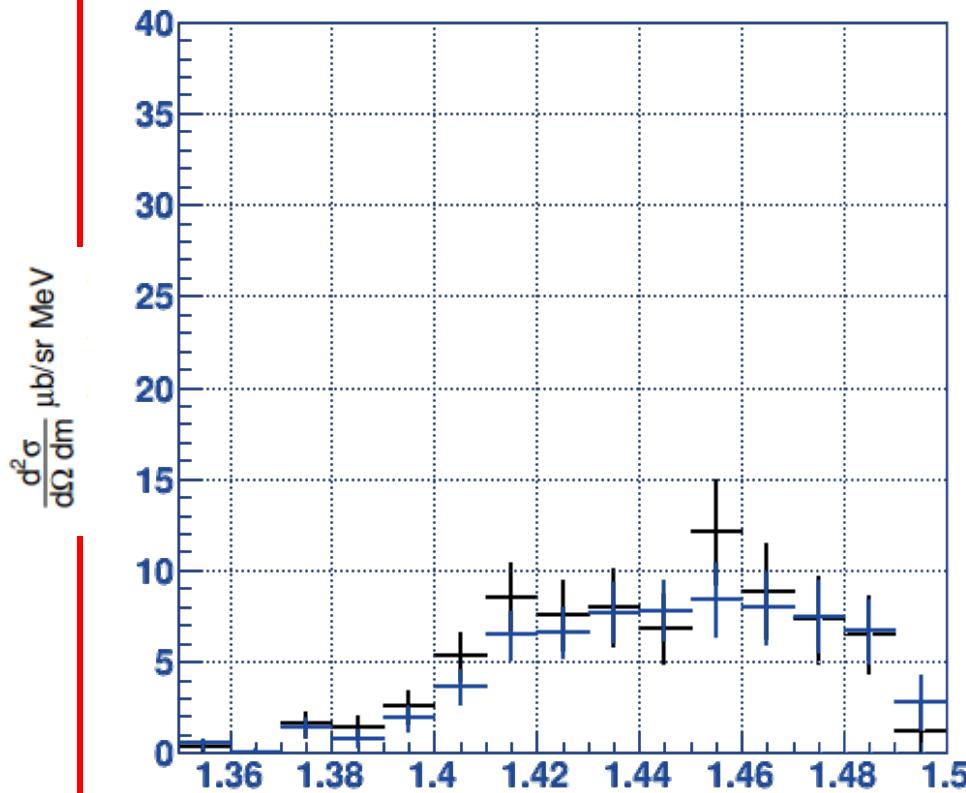
Condition  
Same as final spectrum  
 •  $\Lambda$  selection  
 •  $d(K^-, np\pi^-)X' \quad 0.18 < X < 0.30 \text{ GeV}$



# Cross Section

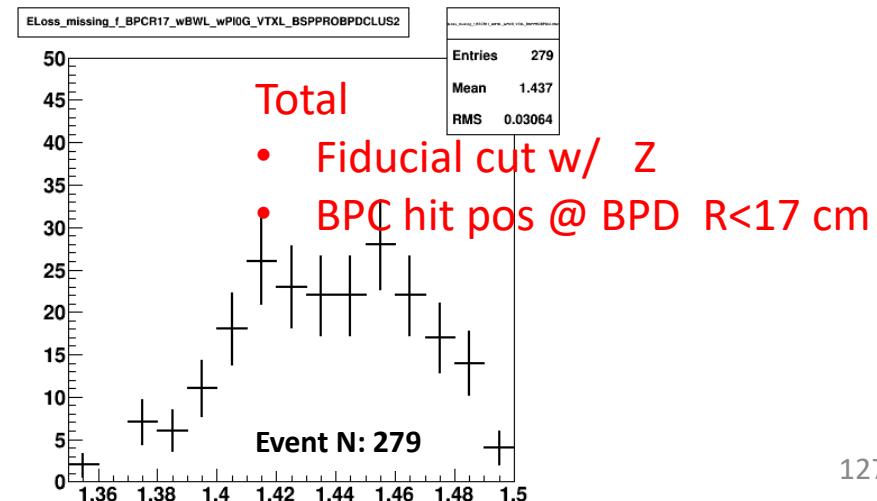
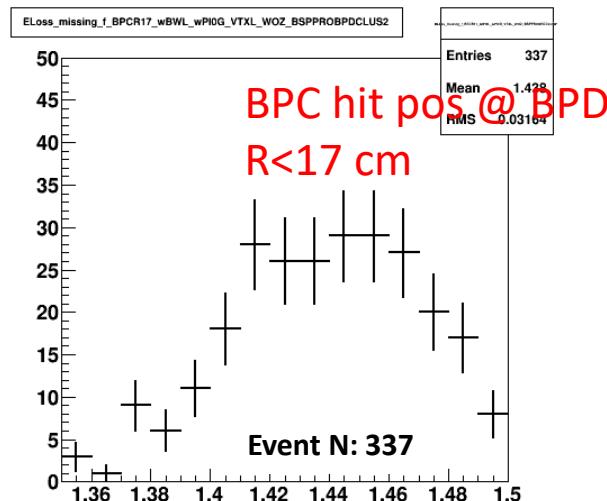
Total

- Fiducial cut w/ Z
- BPC hit pos @ BPD R<16 cm



# $d(K^-, n) \rightarrow \Sigma^0 \pi^0$ missing mass

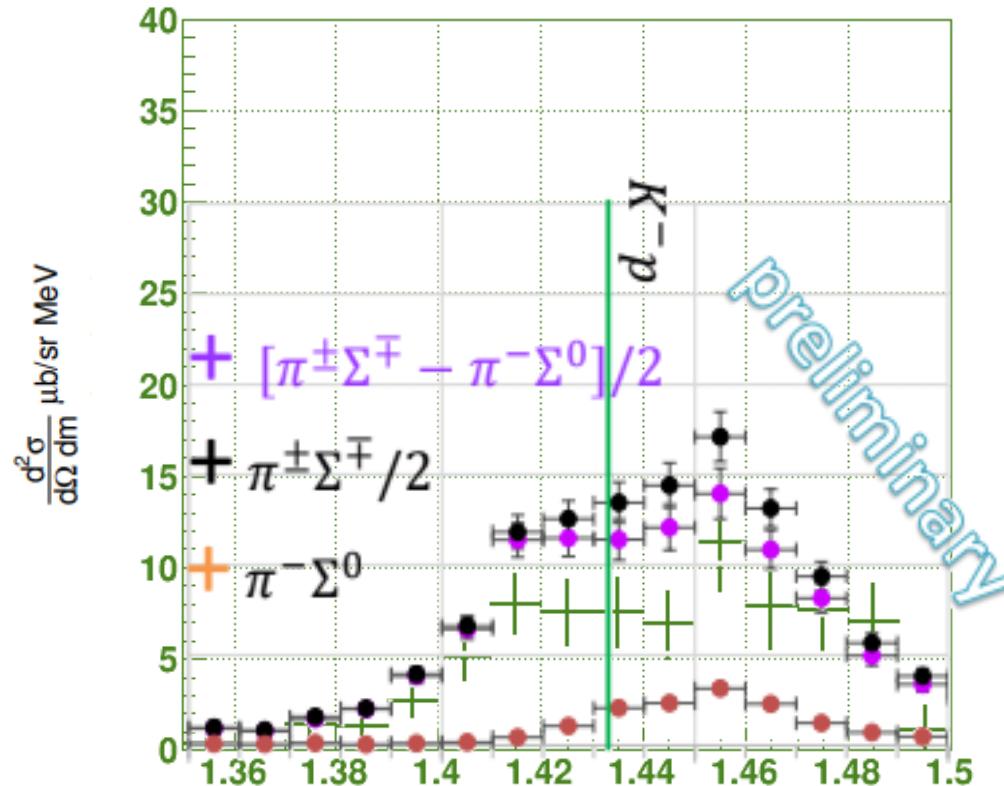
Condition  
Same as final spectrum  
•  $\Lambda$  selection  
•  $d(K^-, np\pi^-) X' \quad 0.18 < X < 0.30 \text{ GeV}$



# Cross Section

Total

- Fiducial cut w/ Z
- BPC hit pos @ BPD R<17 cm



# Same as Page.8

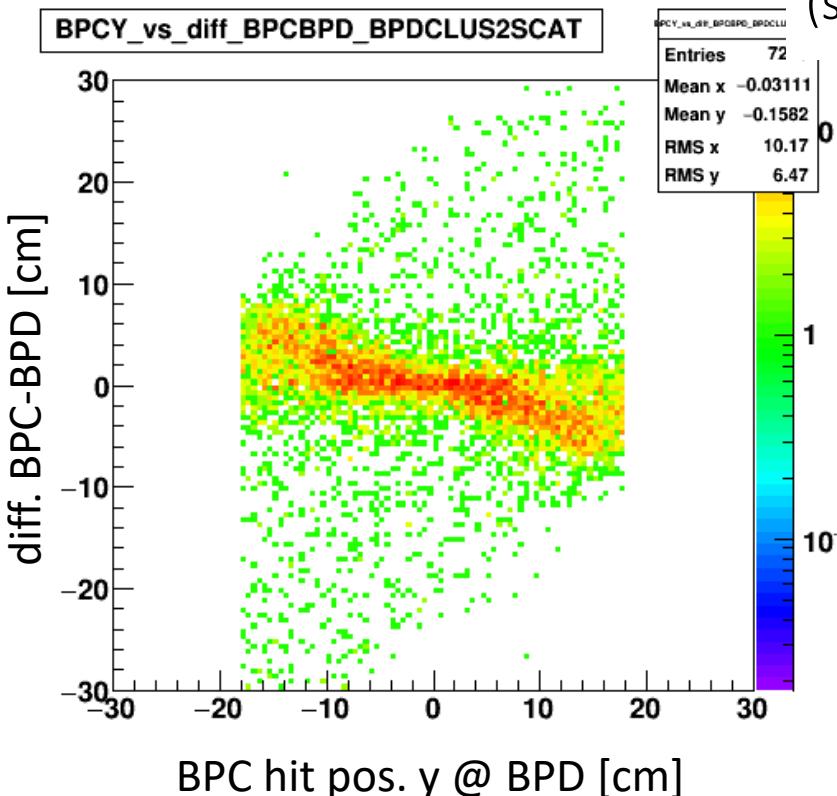
- Lumi ;  $8083 \pm 160$  [/ub]
  - Scaler Kaon 58.3 G
  - Survival ratio  $0.314 \pm 0.000350$
  - DAQ eff  $0.7708 \pm 0.0000128$
  - Trig. KCDH1  $0.9527 \pm 0.0003$
  - Trig. Neutral  $0.9999 \pm 0.0000067$
- $\Omega\text{-nc}$  ;  $0.0214832 \pm 0.000207563$  [sr]
- $\varepsilon\text{-nc}$  ;  $0.291 \pm 0.015$
- $\varepsilon\text{-bpc}$  ;  $0.999 \pm 0.000$
- $\varepsilon\text{-cdc}$  ;  $0.977 \pm 0.004$
- Acc ; simulation (including BR ( $\Sigma 0 \pi 0$ ) 0.639)

# Diff. BPC-BPD Y dependence on Y position

in the sample event  
(BPD Cluster > 3MeV) Page.60

w/ the presence of BPC Backward Track event

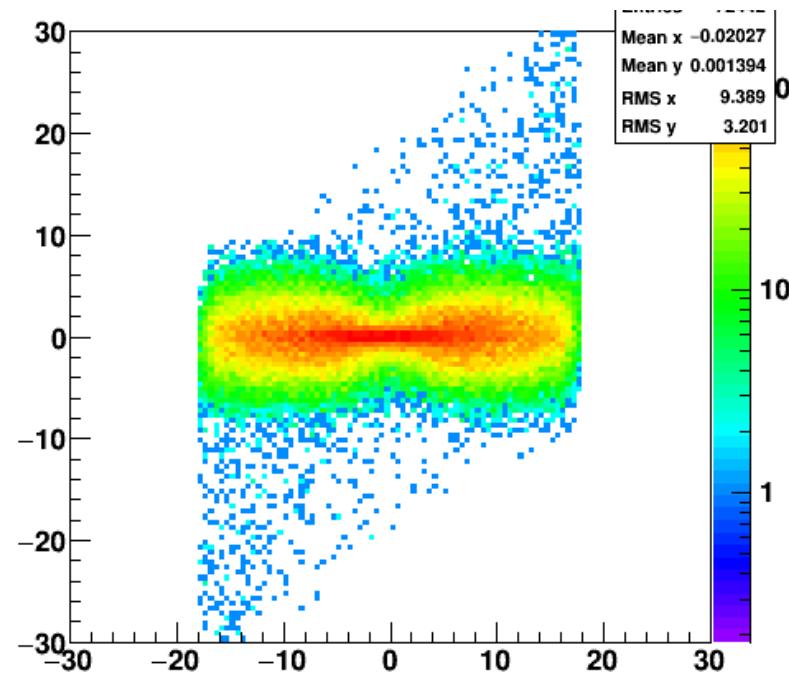
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )



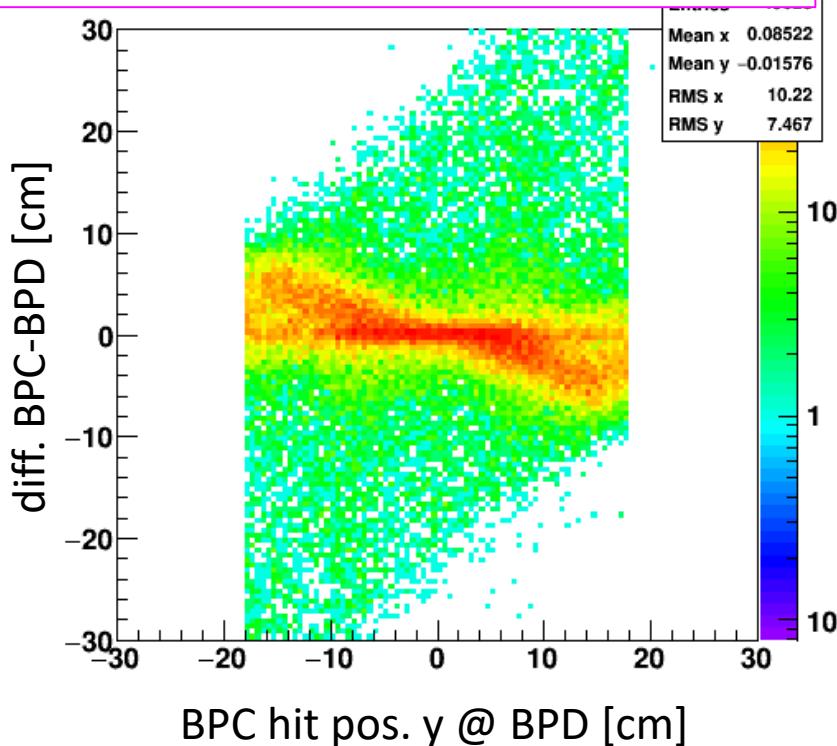
# Diff. BPC-BPD Y dependence on Y position

in the sample event  
(BPD Cluster > 3MeV) Page.60

w/ the presence of BPC Backward Track event

Data (Run78)

w/o forward neutron analysis for the increase of statistics



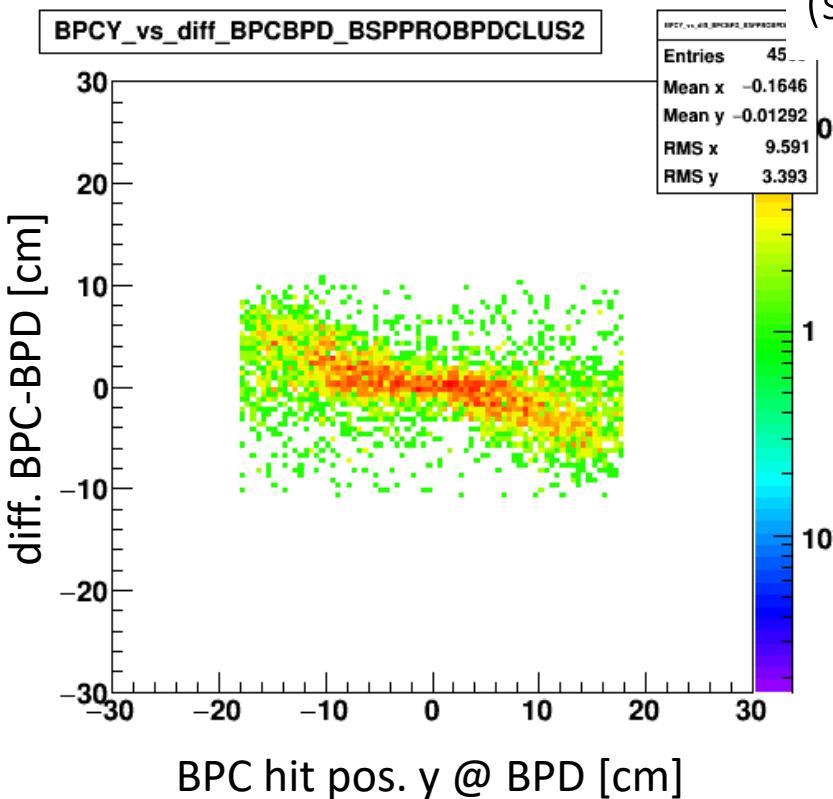
# Diff. BPC-BPD Y

in the sample event  
(BPD Cluster > 3MeV) Page.60

# dependence on Y position

w/ the BPC-BPD Matching event

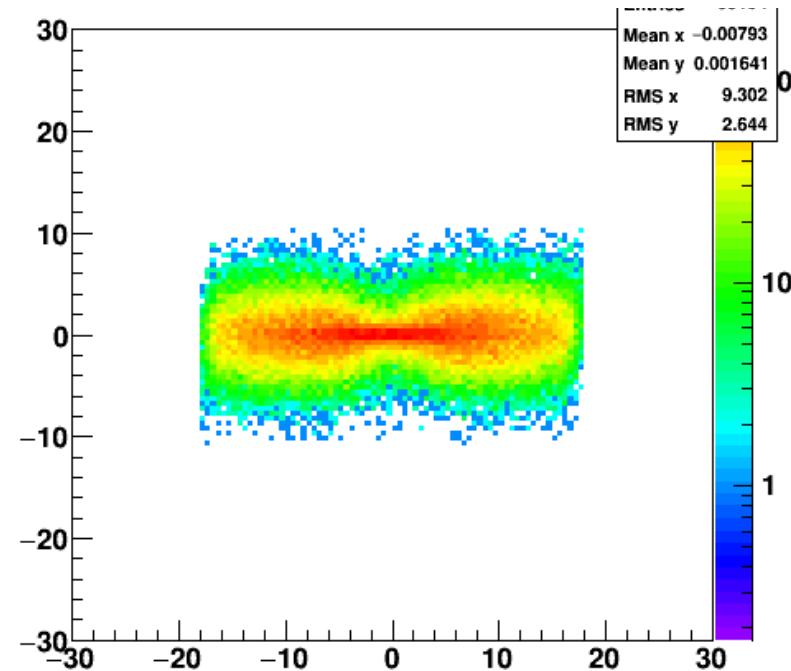
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )



# Diff. BPC-BPD Y

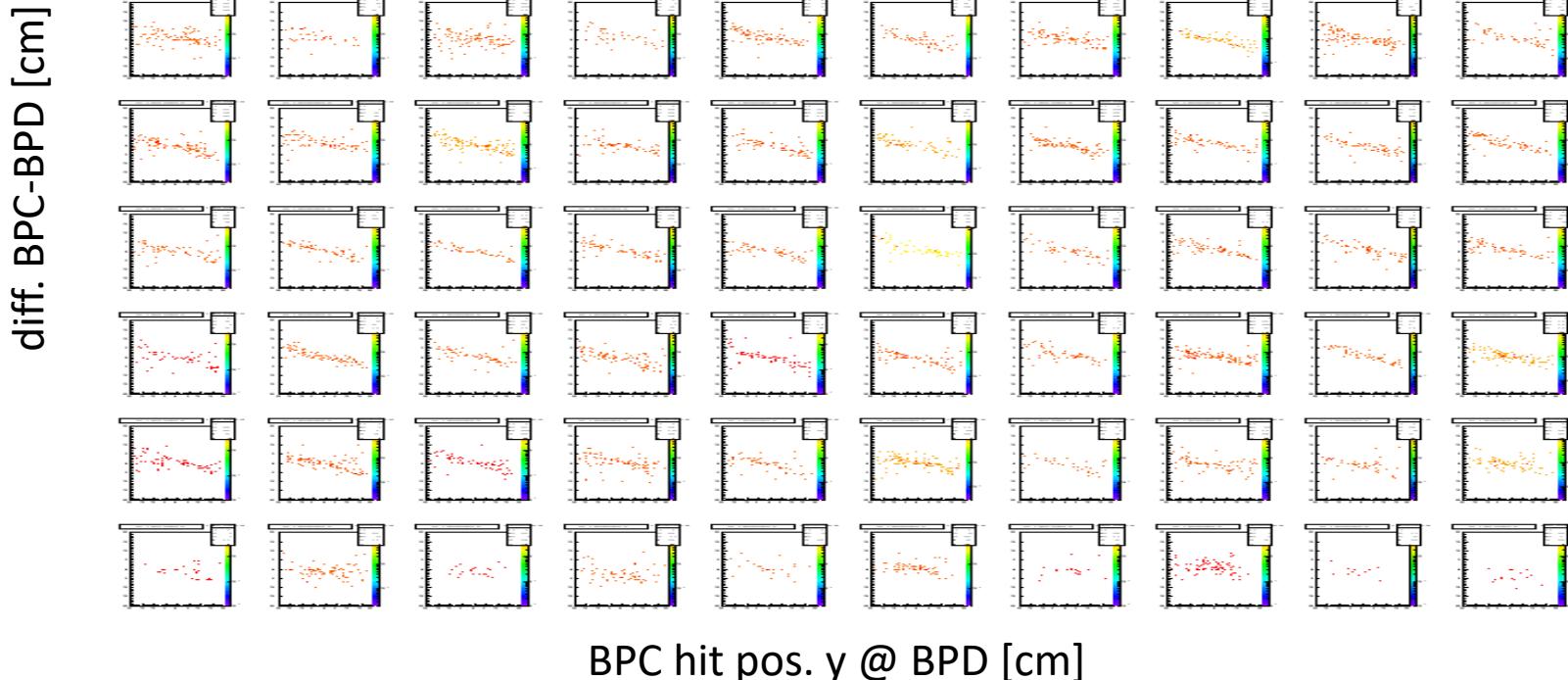
in the sample event  
(BPD Cluster > 3MeV) Page.60

# dependence on Y position

w/ the BPC-BPD Matching event

Data (Run78)

Every BPD Segment



# Diff. BPC-BPD Y

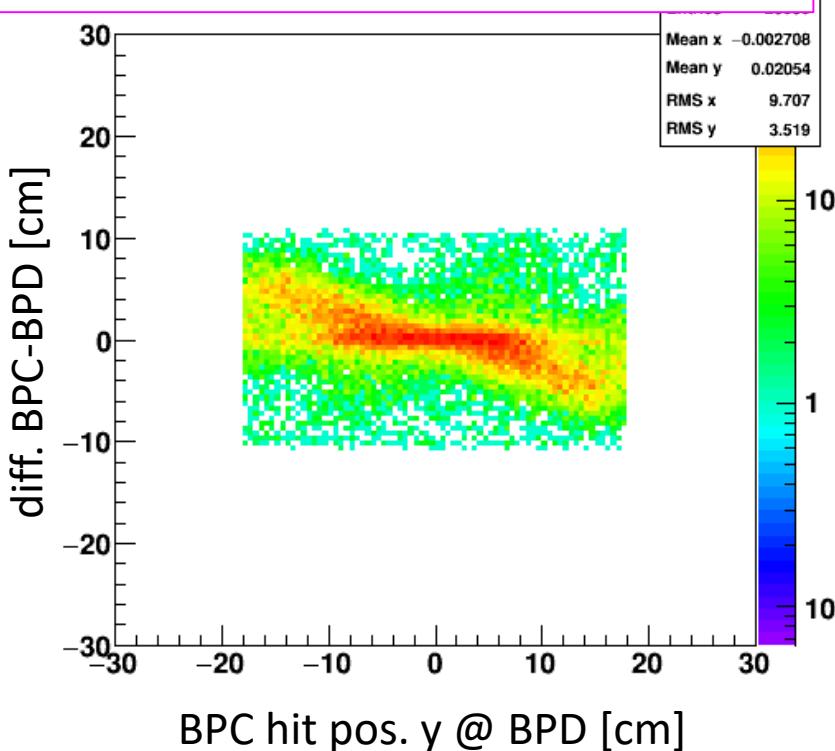
in the sample event  
(BPD Cluster > 3MeV) Page.60

# dependence on Y position

w/ the BPC-BPD Matching event

Data (Run78)

w/o forward neutron analysis for the increase of statistics



# dependence on Y position

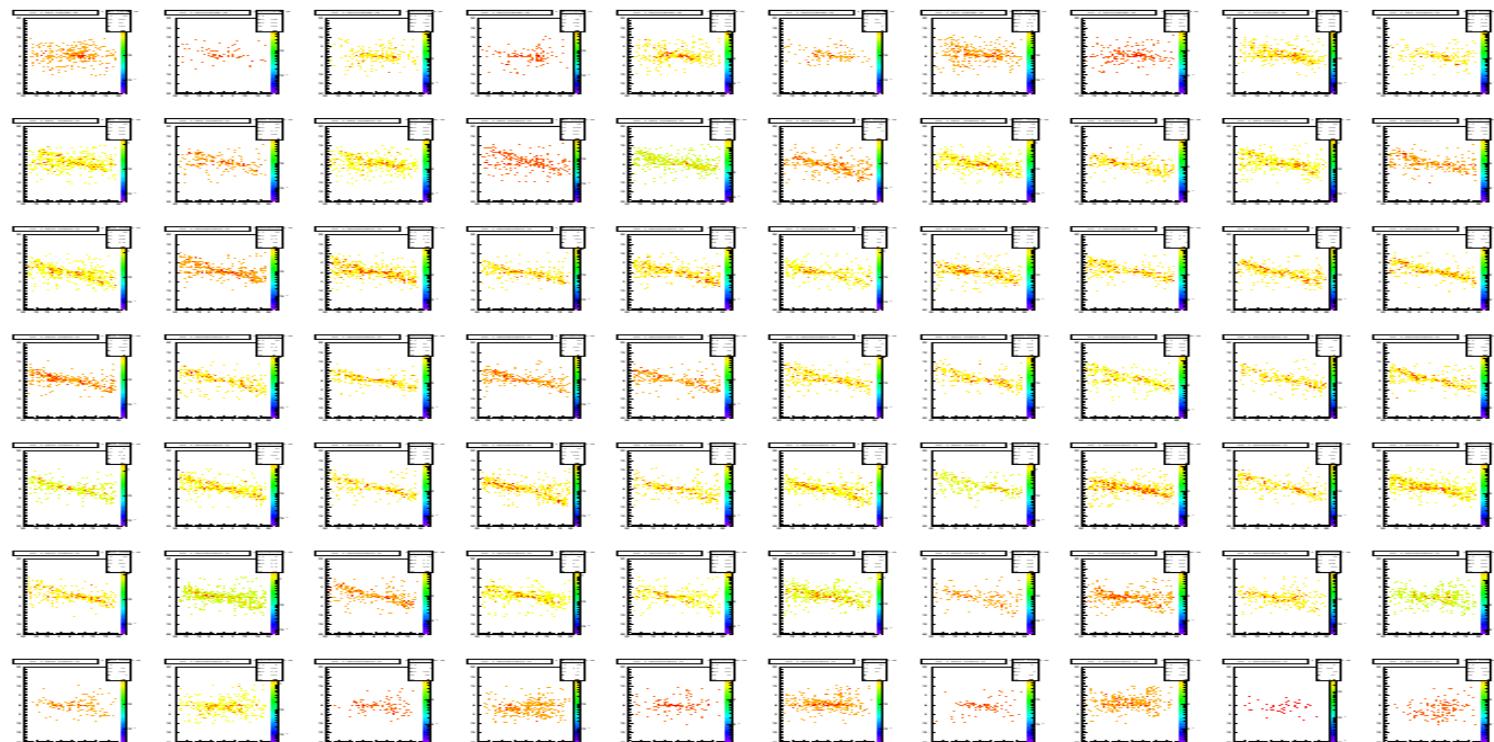
w/ the BPC-BPD Matching event

Data (Run78)

Every BPD Segment

w/o forward neutron analysis for the increase of statistics

diff. BPC-BPD [cm]



BPC hit pos. y @ BPD [cm]

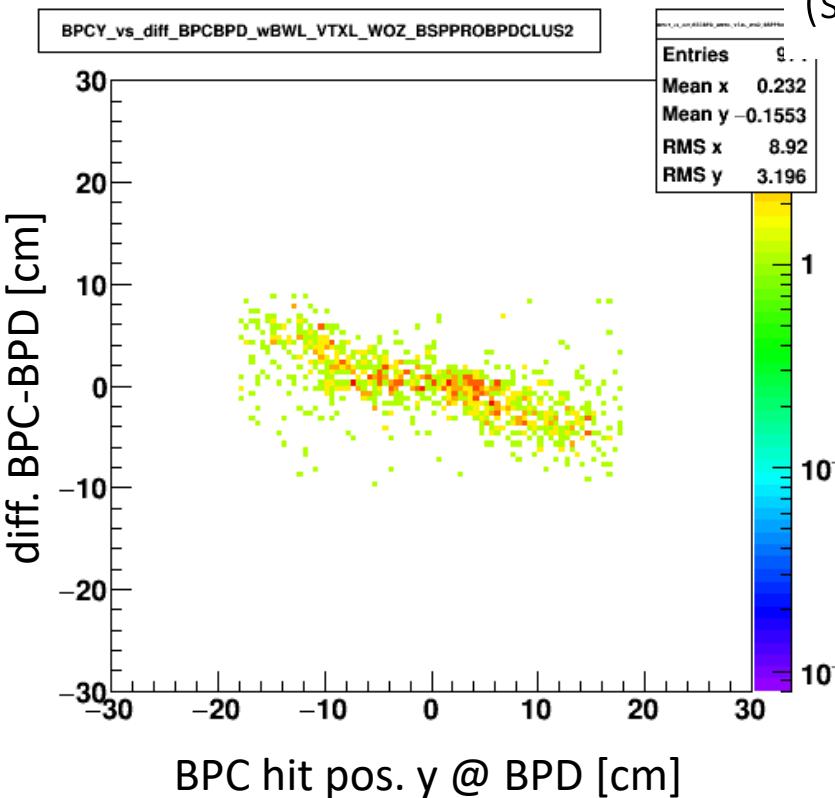
# Diff. BPC-BPD Y

in the sample event  
(BPD Cluster > 3MeV) Page.60

# dependence on Y position

## Λ selection

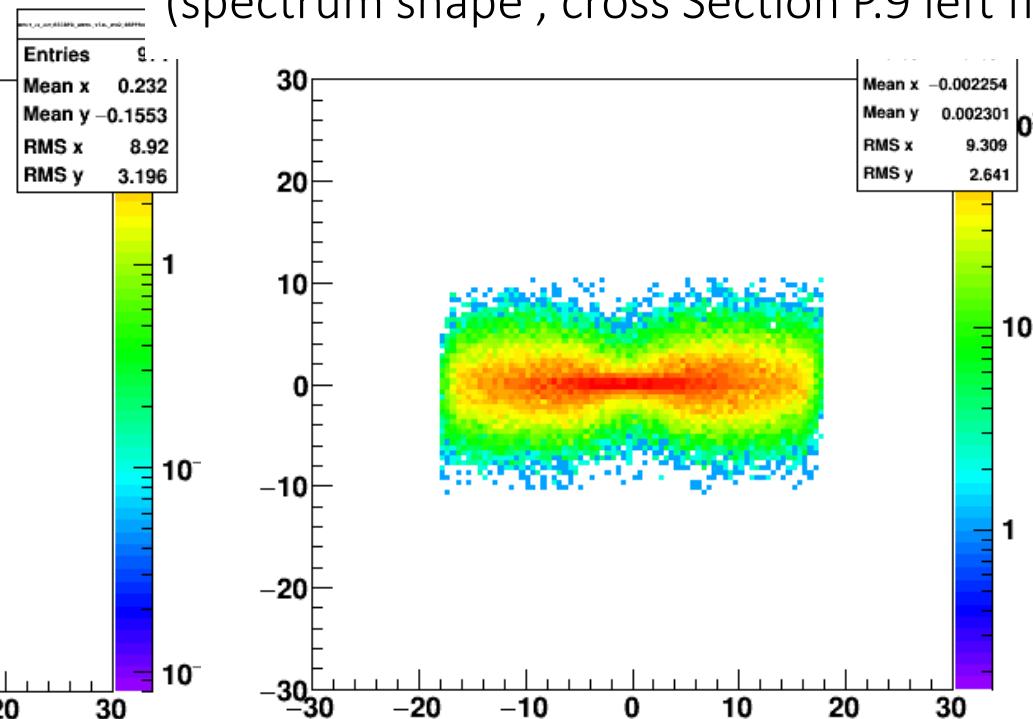
### Data (Run78)



### SIM

K-d  $\rightarrow$ n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )



# Diff. BPC-BPD Y

in the sample event  
(BPD Cluster > 3MeV) Page.60

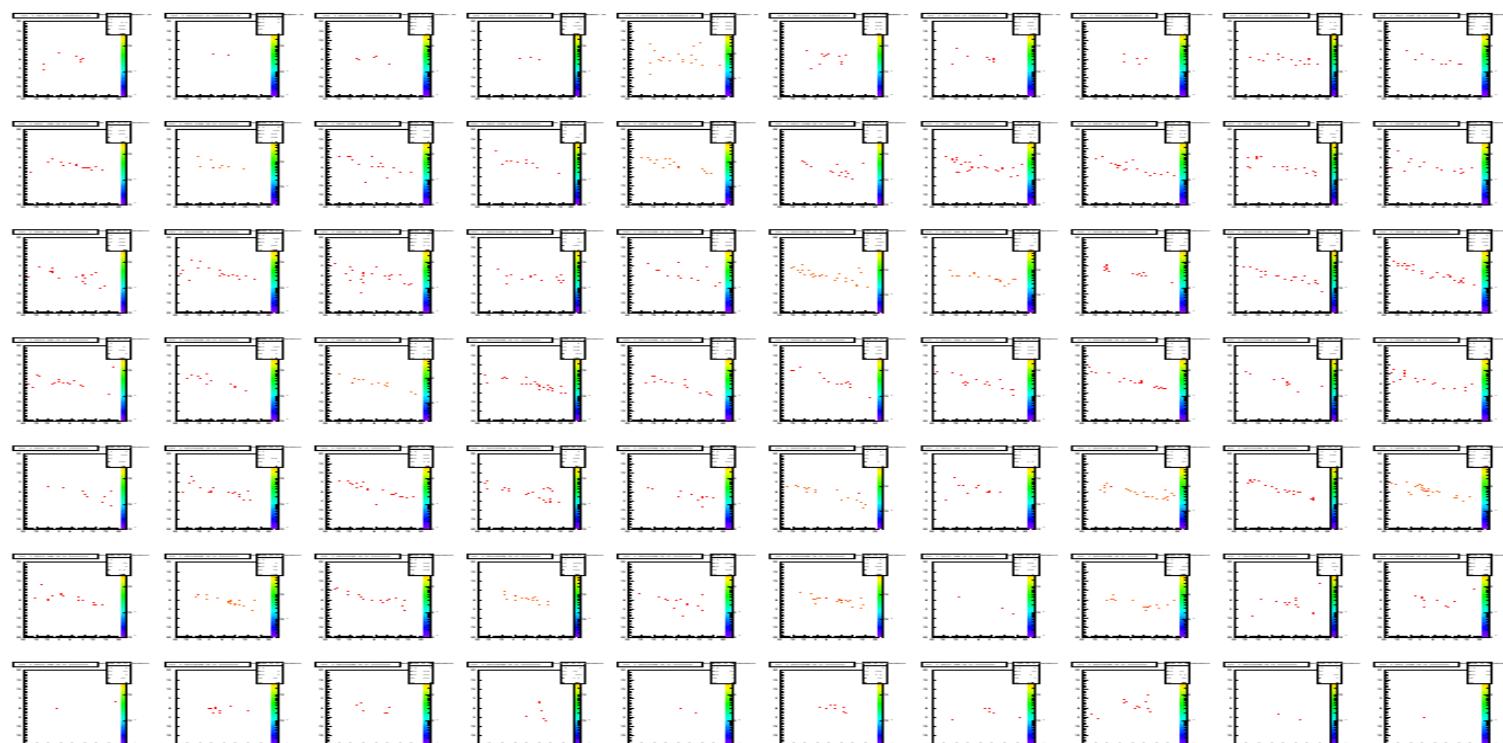
# dependence on Y position

Λ selection

Data (Run78)

Every BPD Segment

diff. BPC-BPD [cm]



BPC hit pos. y @ BPD [cm]

# Diff. BPC-BPD Y

in the sample event  
(BPD Cluster > 3MeV) Page.60

# dependence on Y position

Λ selection

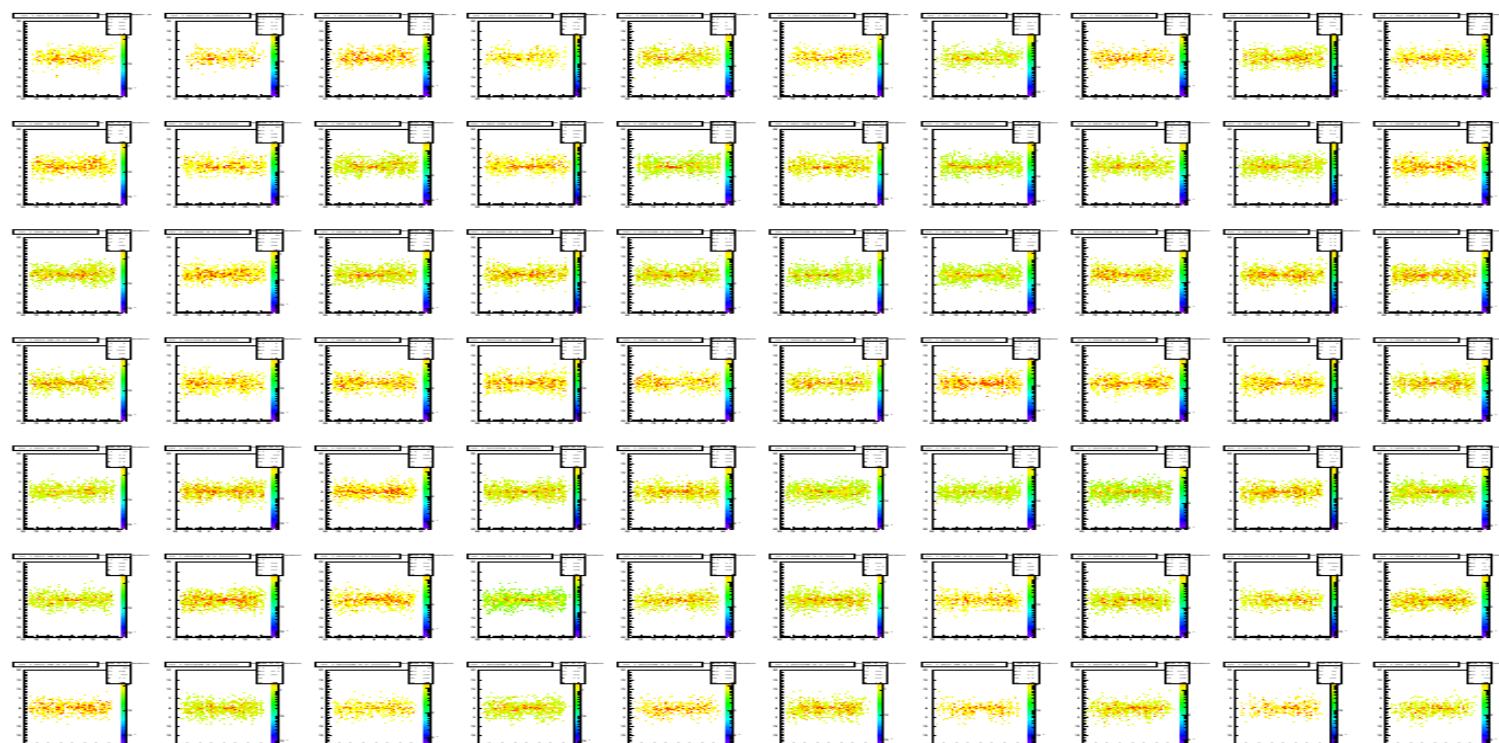
SIM

Every BPD Segment

$K-d \rightarrow n \Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

diff. BPC-BPD [cm]



BPC hit pos. y @ BPD [cm]

# Diff. BPC-BPD

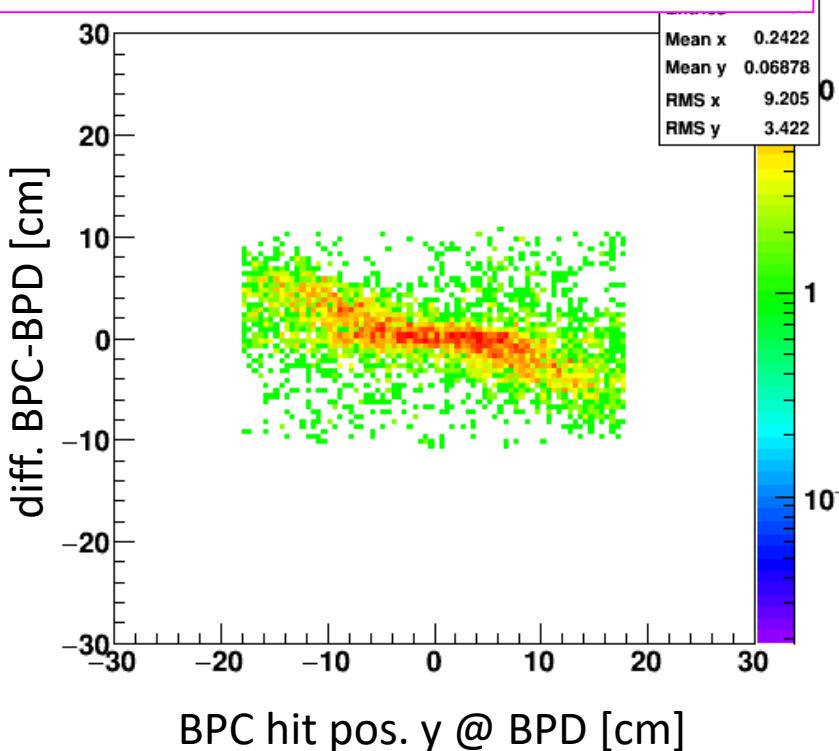
in the sample event  
(BPD Cluster > 3MeV) Page.60

# dependence on Y position

Λ selection

Data (Run78)

w/o forward neutron analysis for the increase of statistics



# Diff. BPC-BPD Y dependence on Y position

## Λ selection

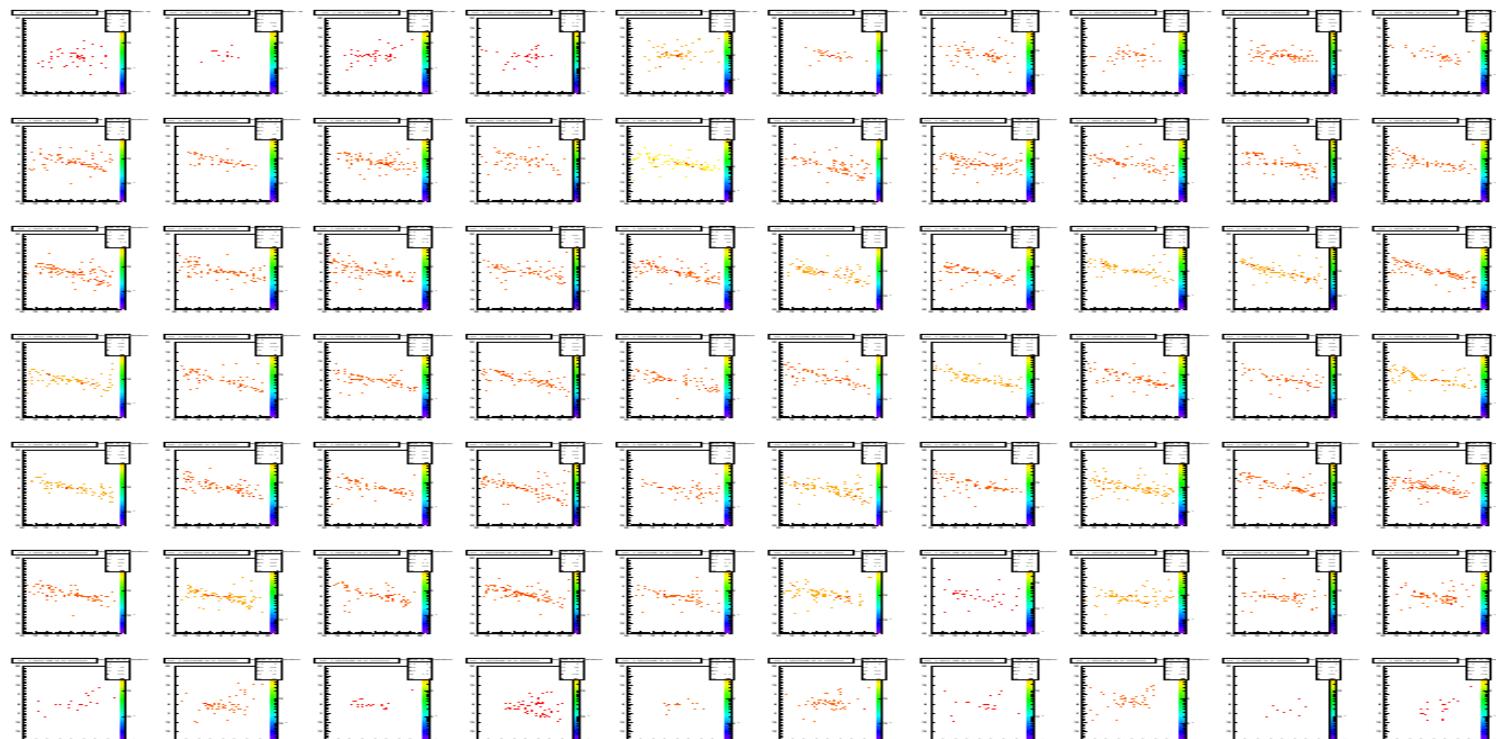
in the sample event  
(BPD Cluster > 3MeV) Page.60

Data (Run78)

Every BPD Segment

w/o forward neutron analysis for the increase of statistics

diff. BPC-BPD [cm]



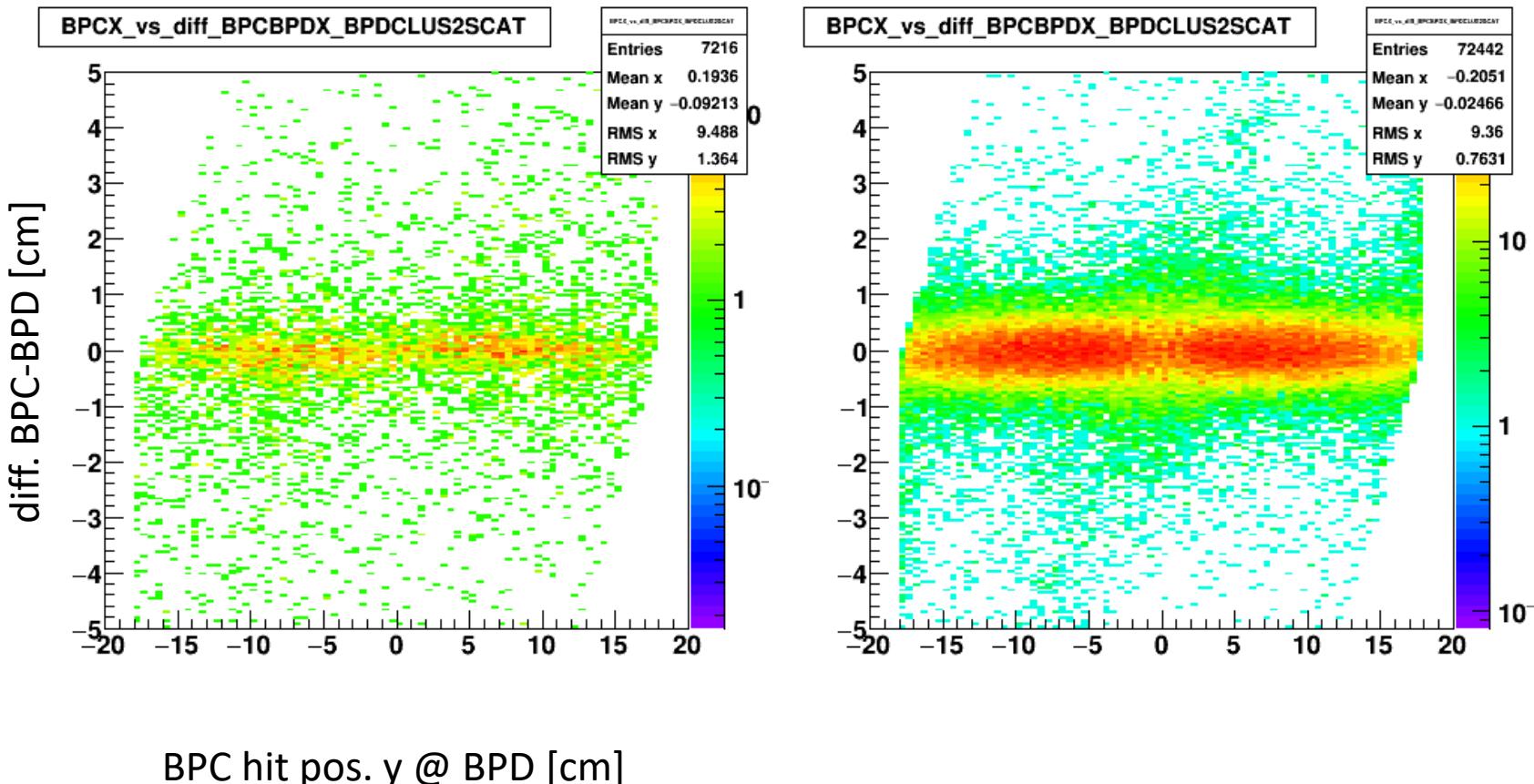
BPC hit pos. y @ BPD [cm]

# Diff. BPC-BPD X dependence on X position

in the sample event  
(BPD Cluster > 3MeV) Page.60

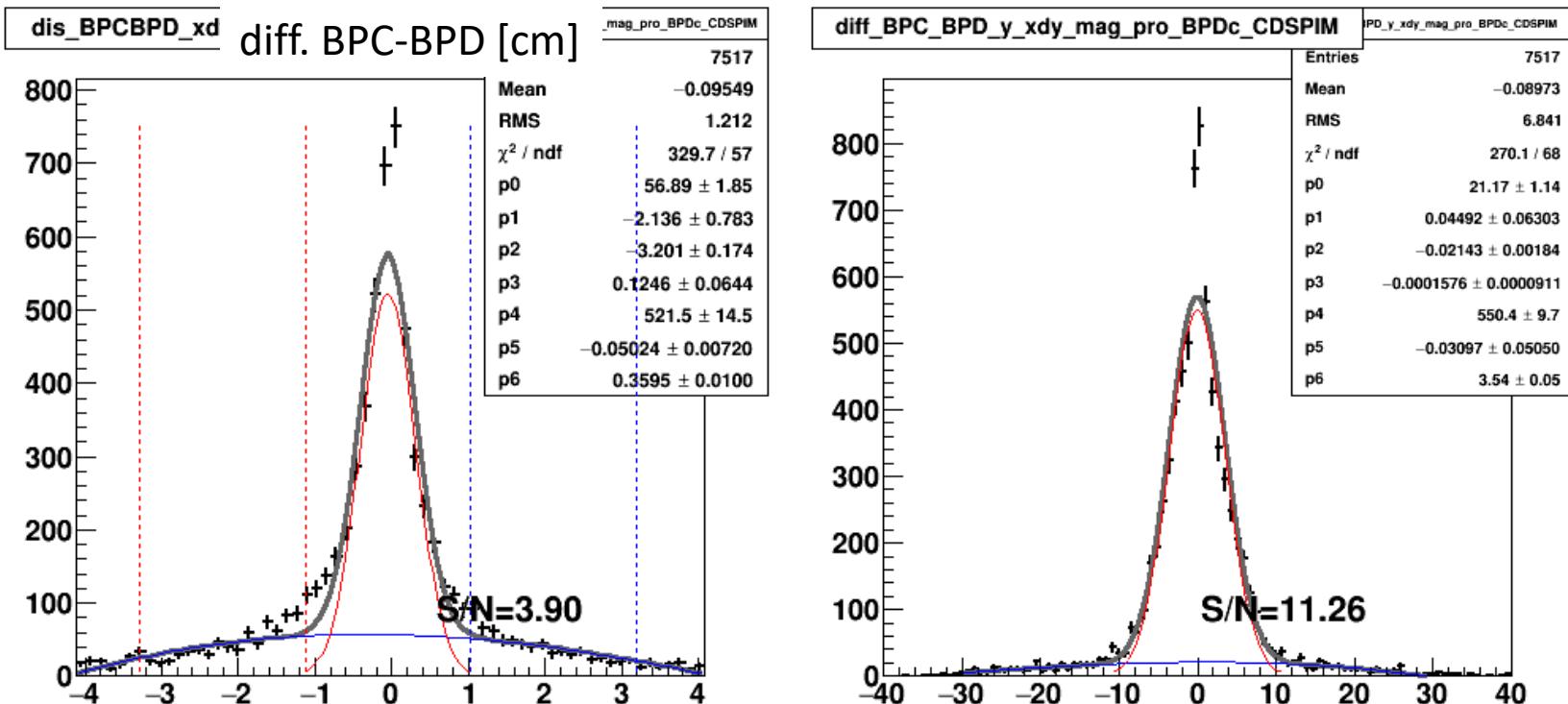
w/ the presence of BPC Backward Track event

Data (Run78)



# Diff. BPC-BPD X & Y

## Data (Run78)

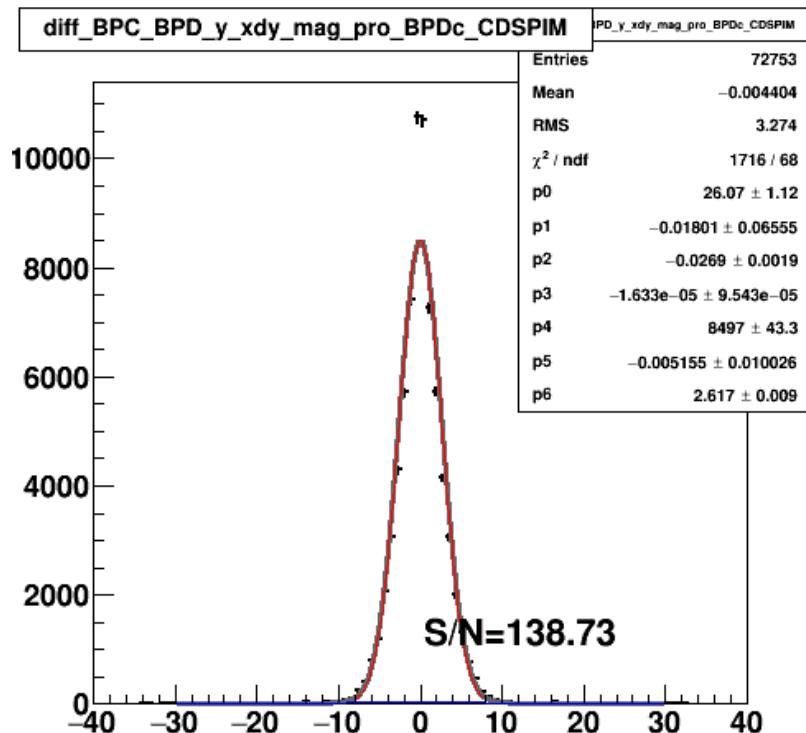
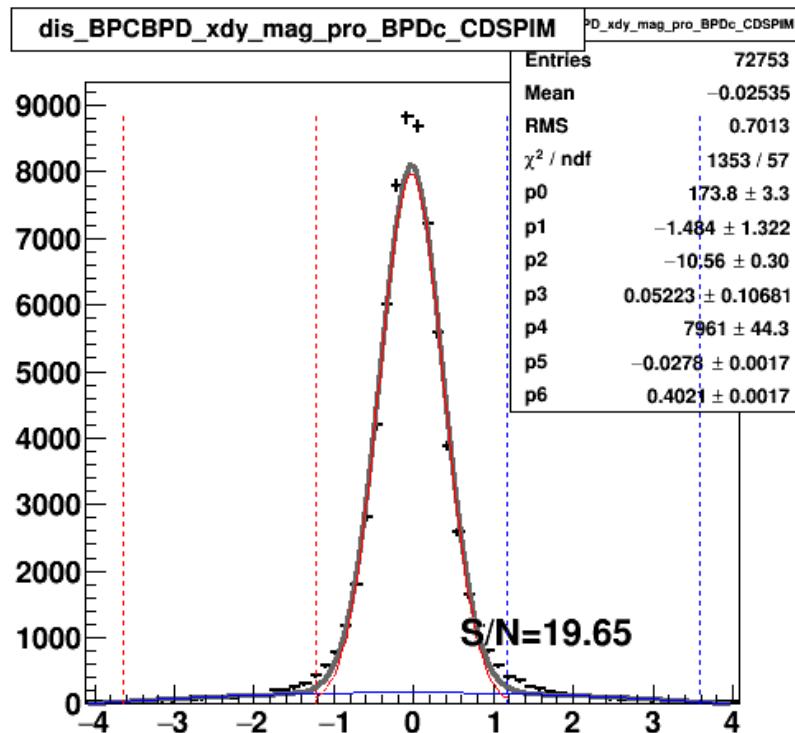


# Diff. BPC-BPD X & Y

SIM

$K-d \rightarrow n \Sigma^0 \pi^0$

(spectrum shape ; cross Section P.9 left figure )

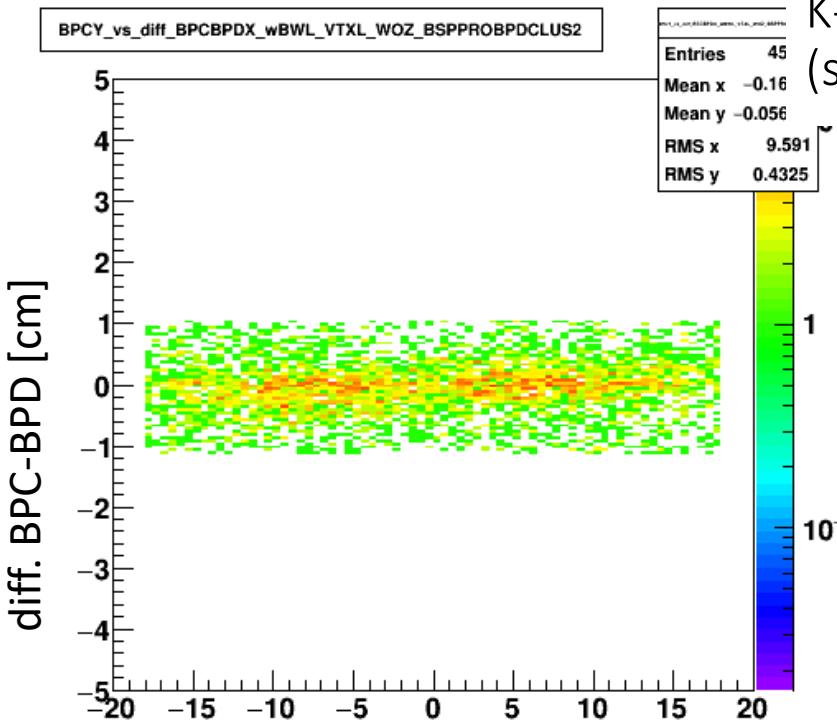


# Diff. BPC-BPD X dependence on X position

in the sample event  
(BPD Cluster > 3MeV) Page.60

## Λ selection

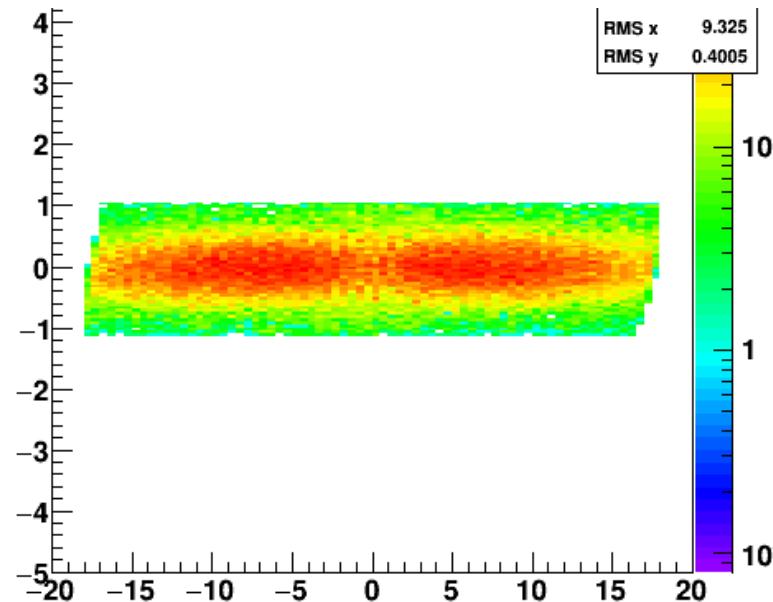
### Data (Run78)



### SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )



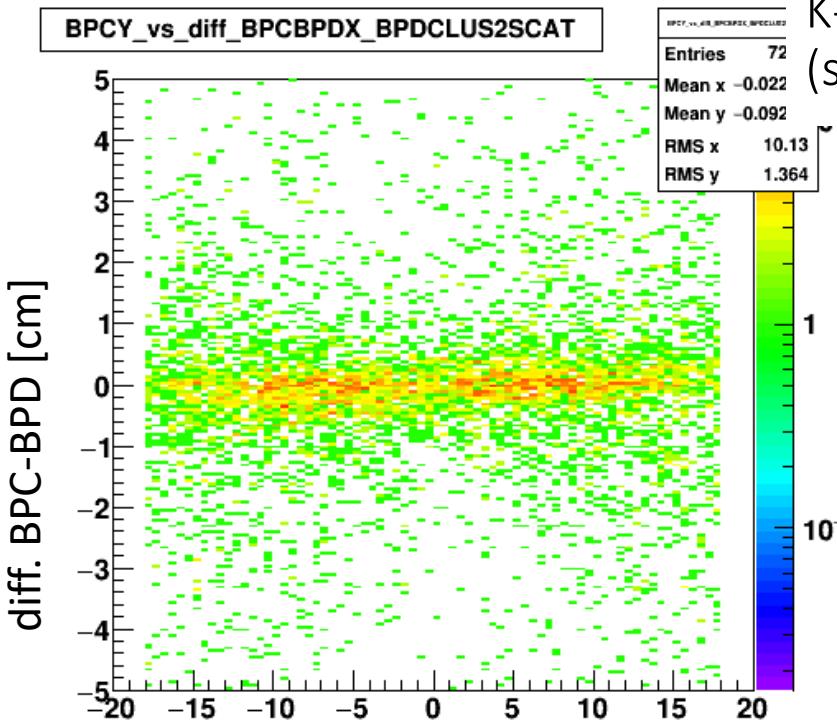
# Diff. BPC-BPD X

in the sample event  
(BPD Cluster > 3MeV) Page.60

# dependence on Y position

w/ the presence of BPC Backward Track event

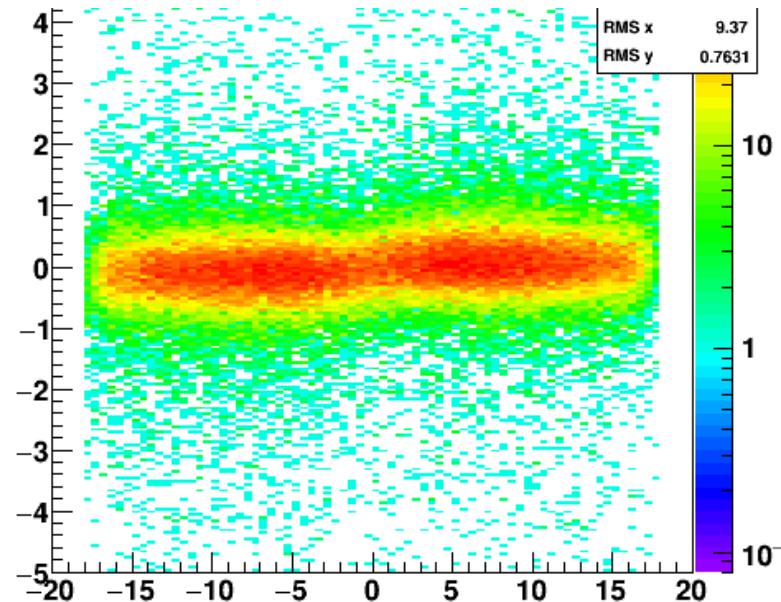
Data (Run78)



SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )



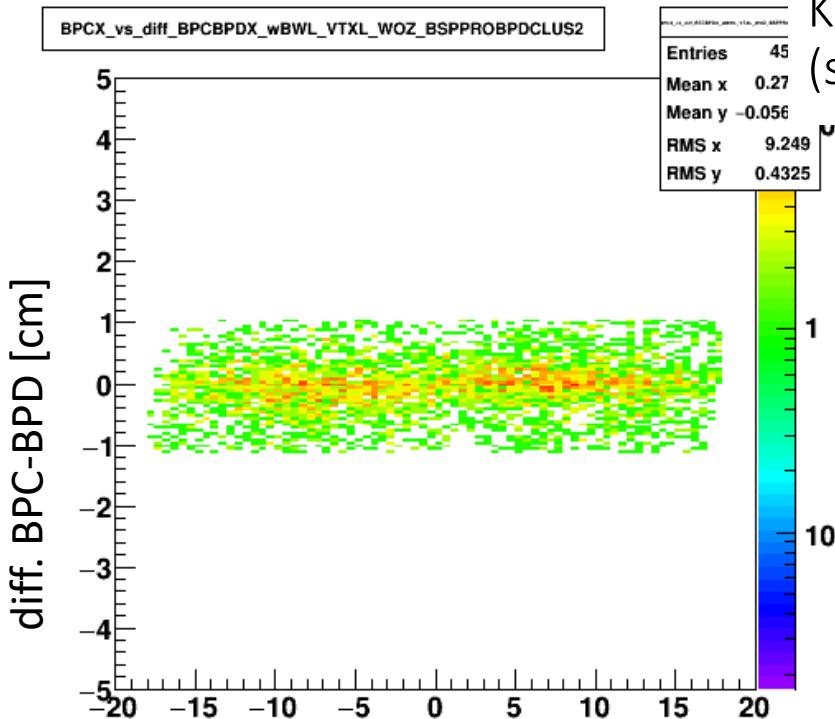
BPC hit pos. y @ BPD [cm]

# Diff. BPC-BPD X dependence on Y position

in the sample event  
(BPD Cluster > 3MeV) Page.60

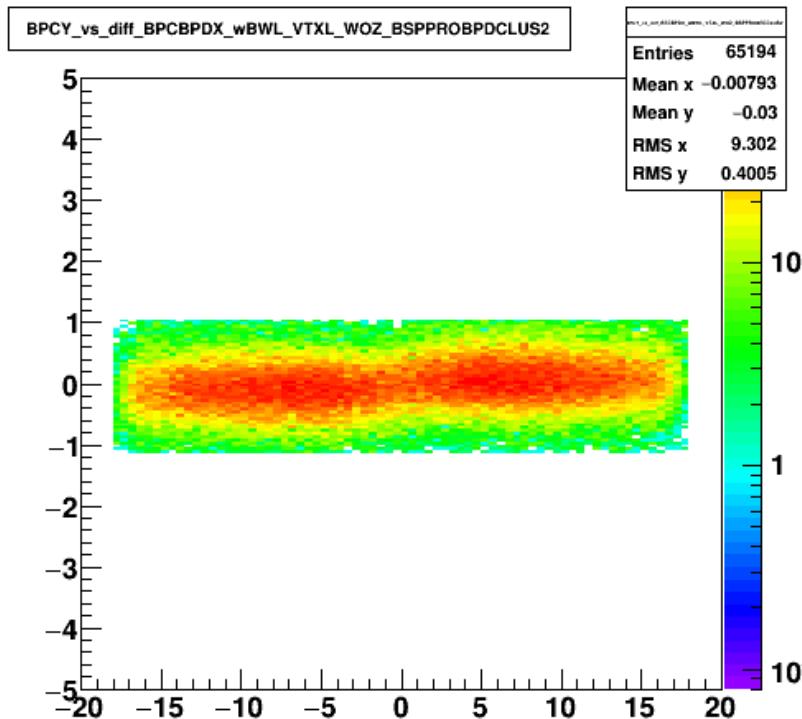
Λ selection

Data (Run78)



SIM

K-c  
(sp)

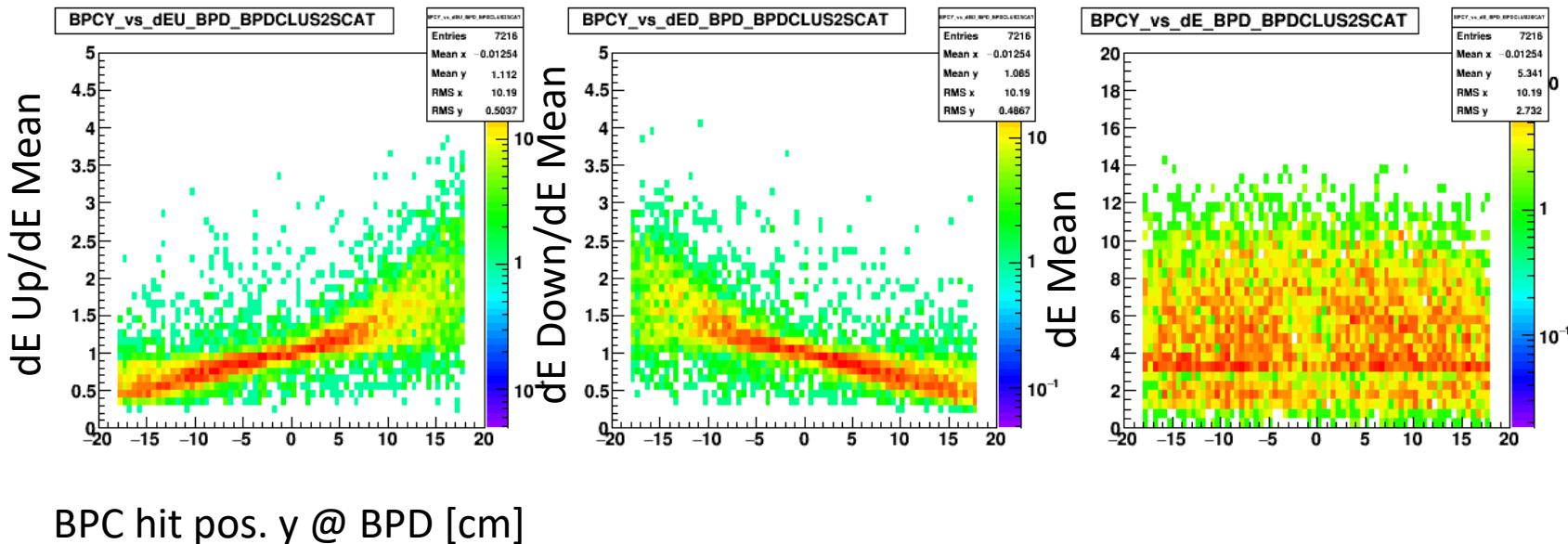


# dE (BPD up, down) dependence on Y position

in the sample event  
(BPD Cluster > 3MeV) Page.60

w/ the presence of BPC Backward Track event

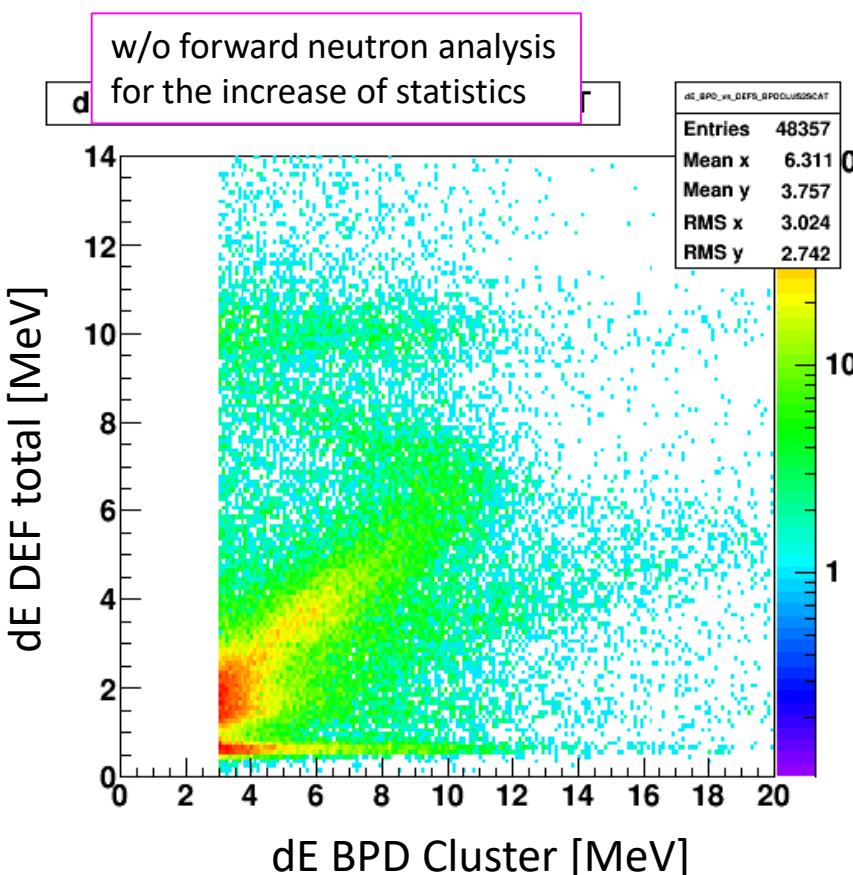
Data (Run78)



# dE BPD vs dE DEF in the BPD proton hit event

in the sample event  
(BPD Cluster > 3MeV) Page.60  
w/ the presence of  
BPC Backward Track event

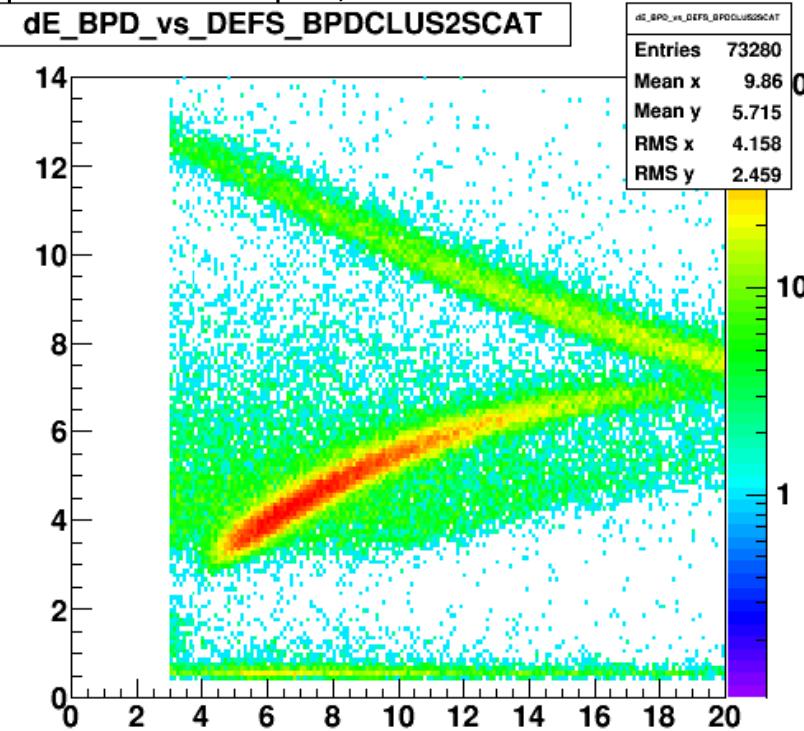
## Data (Run78)



## SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)



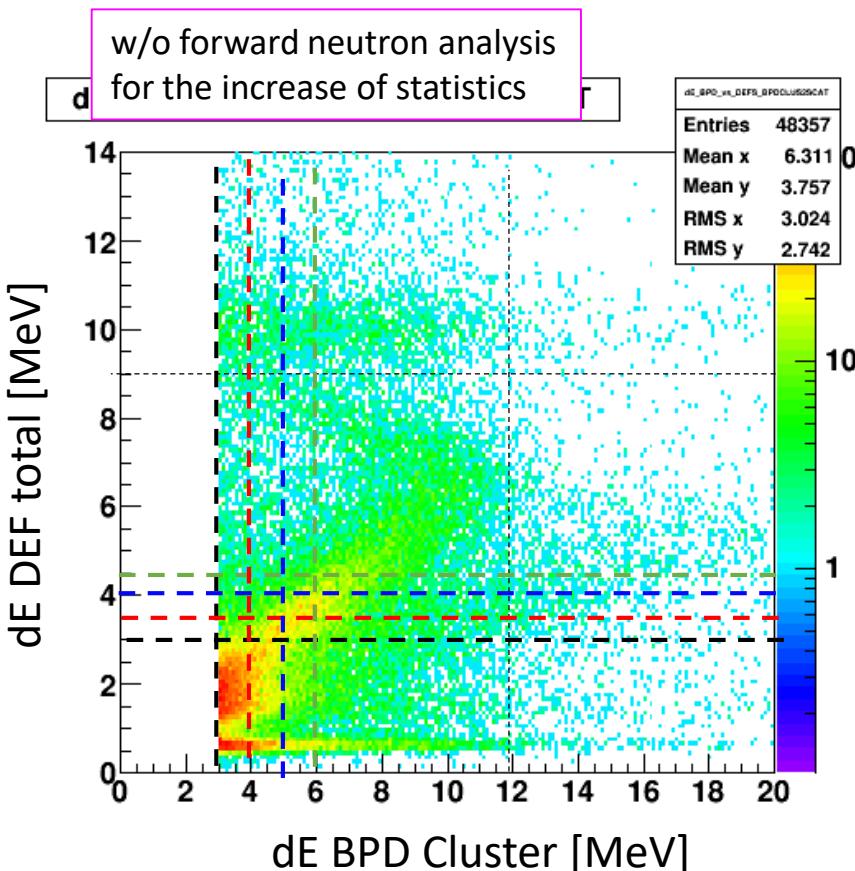
# dE BPD vs dE DEF

# in the BPD proton hit event

in the sample event  
(BPD Cluster > 3MeV) Page.60

w/ the presence of  
BPC Backward Track even

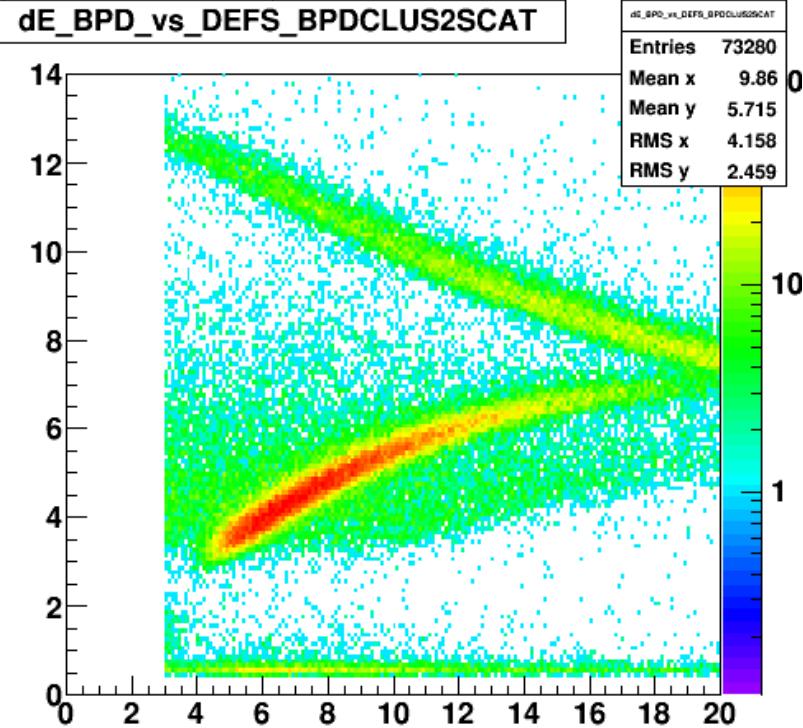
## Data (Run78)



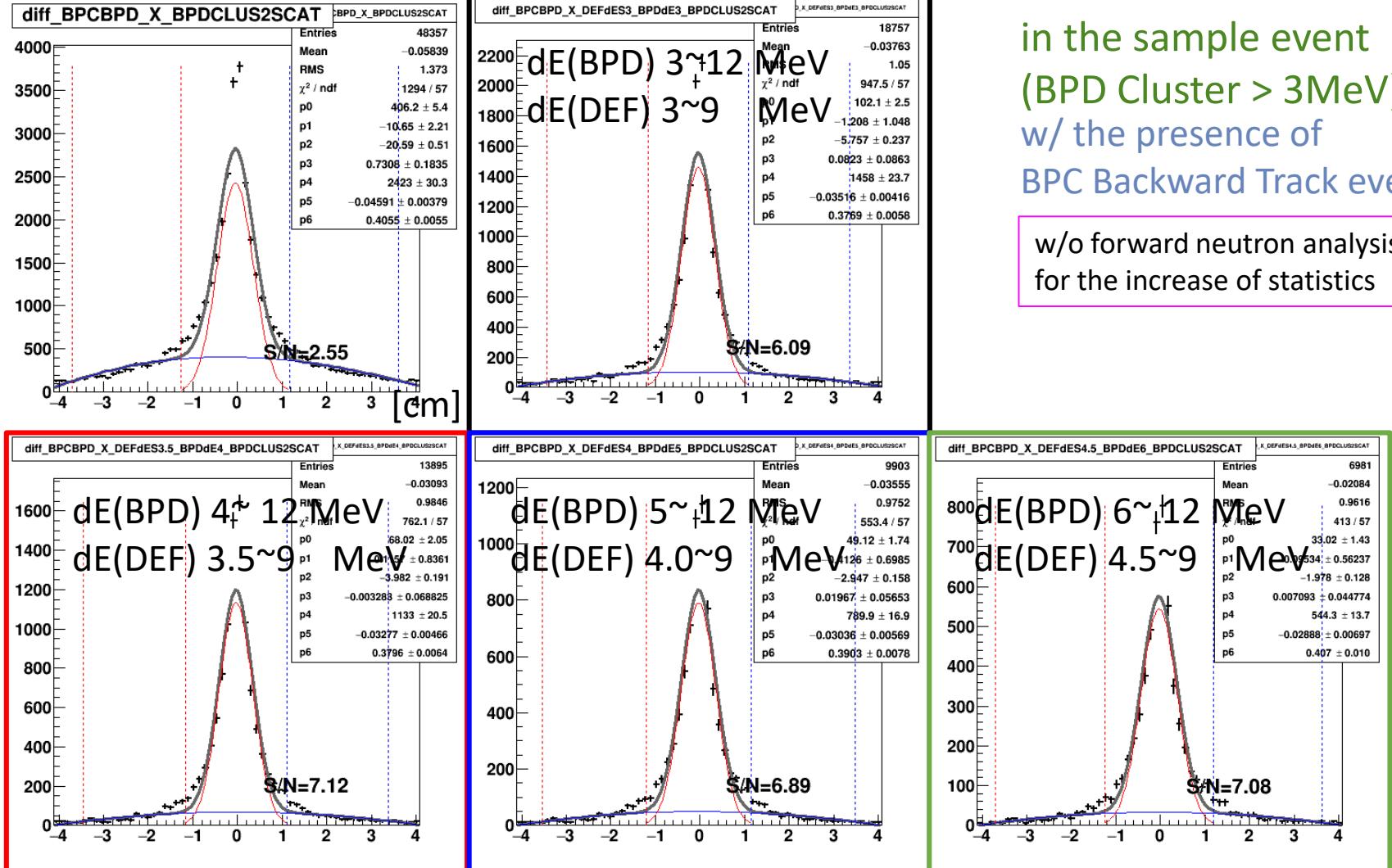
## SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

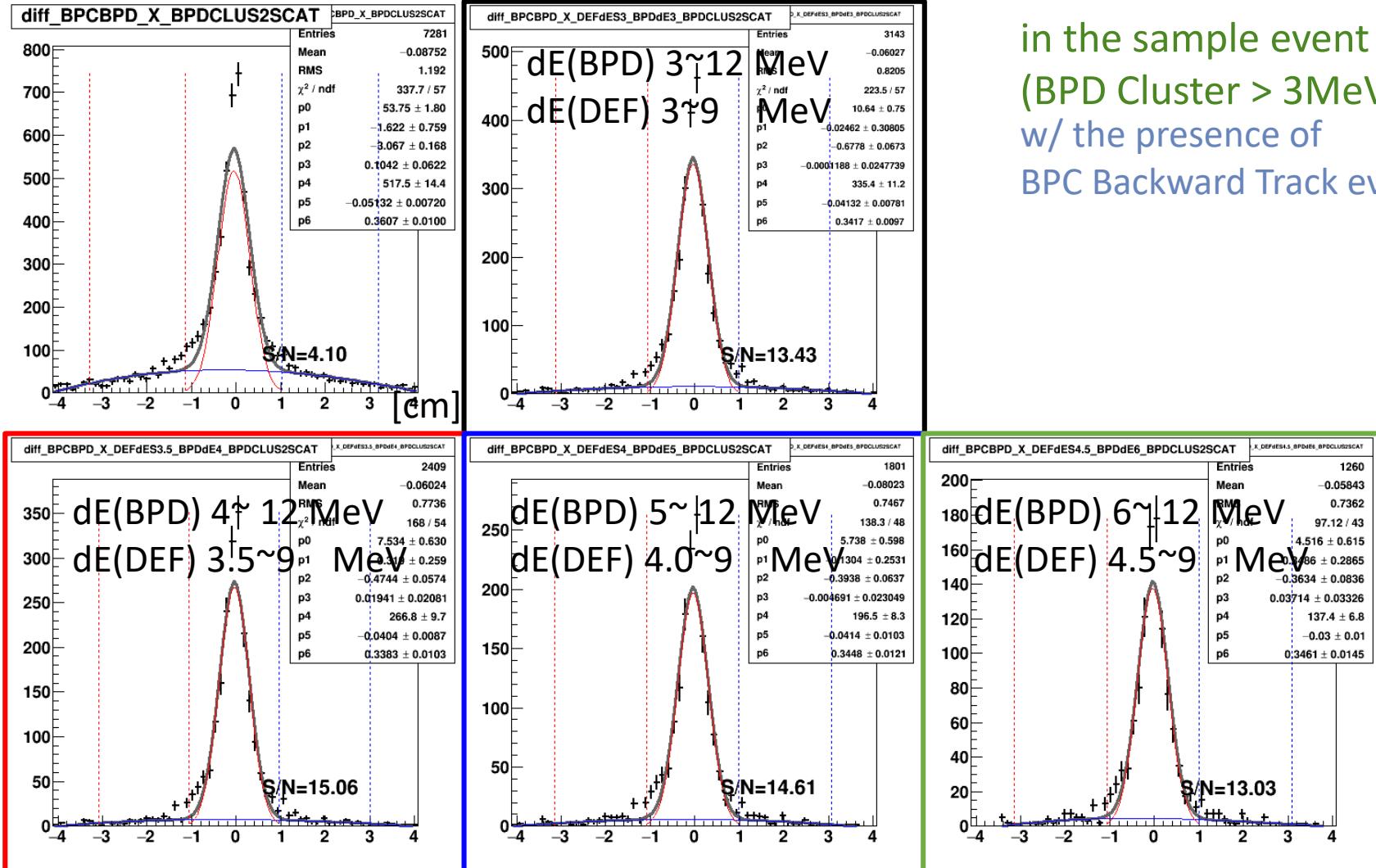


# diff. BPC-BPD Matching by changing BPD DEF Thre.

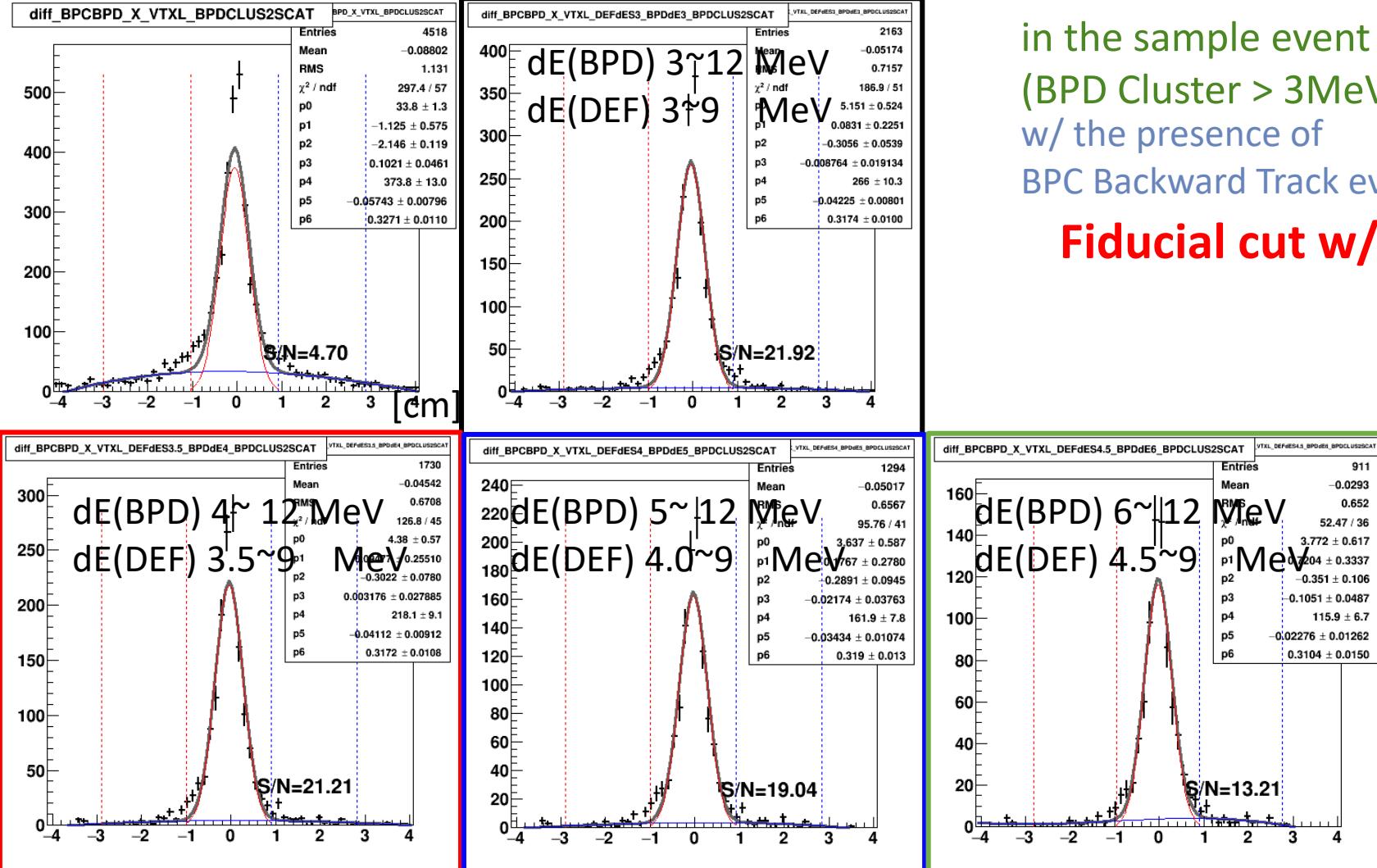


# diff. BPC-BPD Matching by changing BPD DEF Thre.

in the sample event  
(BPD Cluster > 3MeV) Page.60  
w/ the presence of  
BPC Backward Track event



# diff. BPC-BPD Matching by changing BPD DEF Thre.

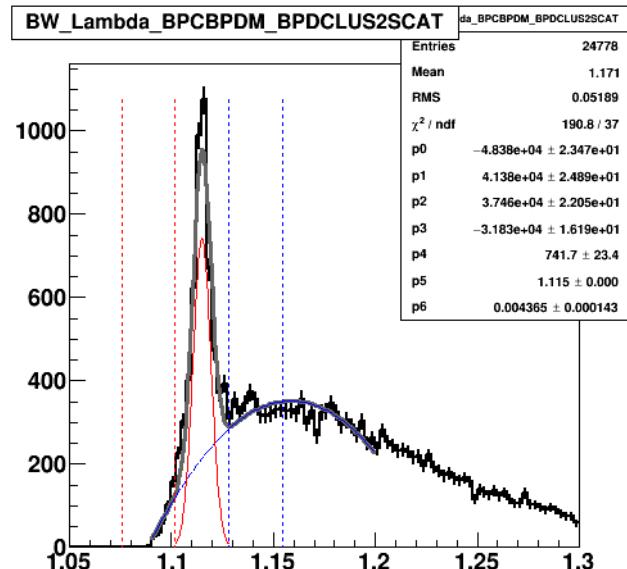


# p, $\pi$ - invariant mass w/, w/o BPD-BPC matching

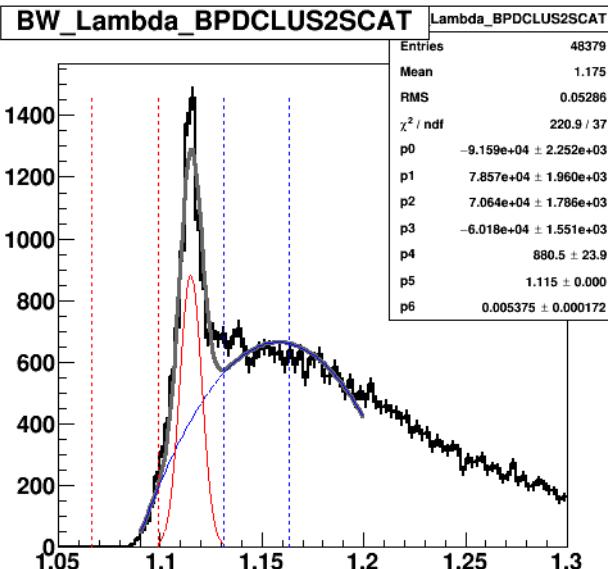
in the sample event  
(BPD Cluster > 3MeV) Page.6  
w/ the presence of  
BPC Backward Track event

w/o forward neutron analysis  
for the increase of statistics

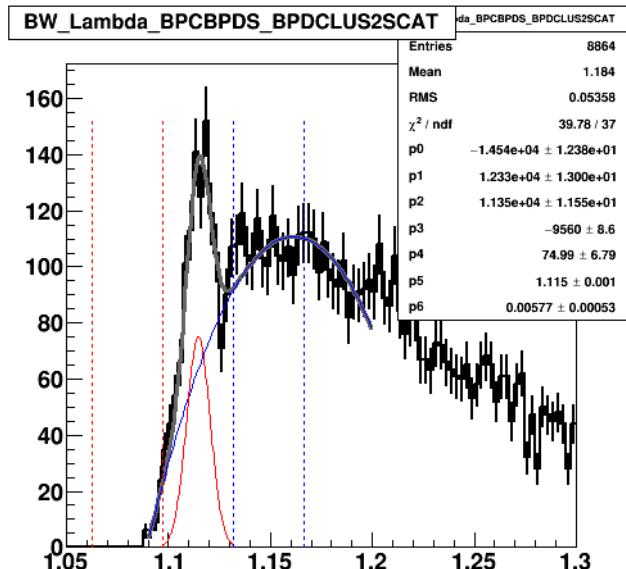
w/ BPC-BPD Matching



w/o BPC-BPD Matching

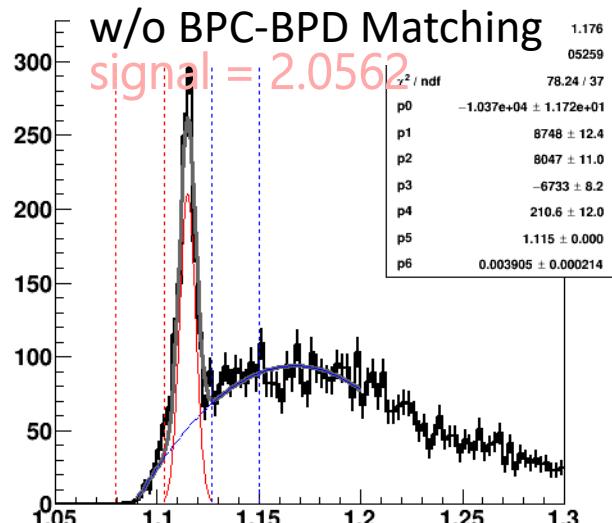
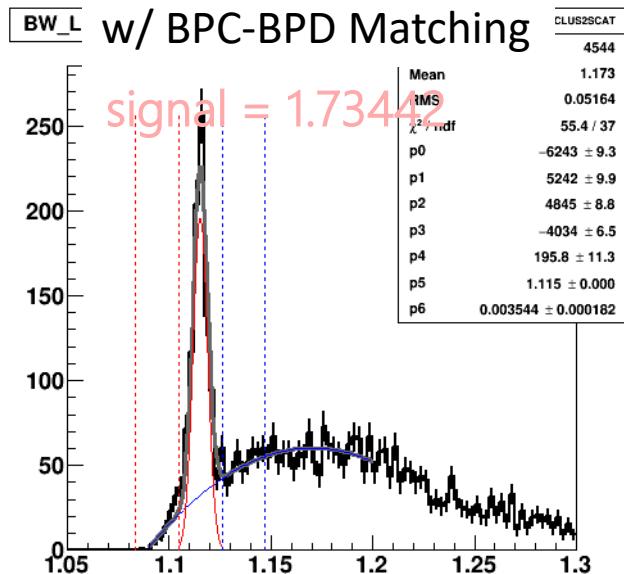


Side band of BPC-BPD Matching

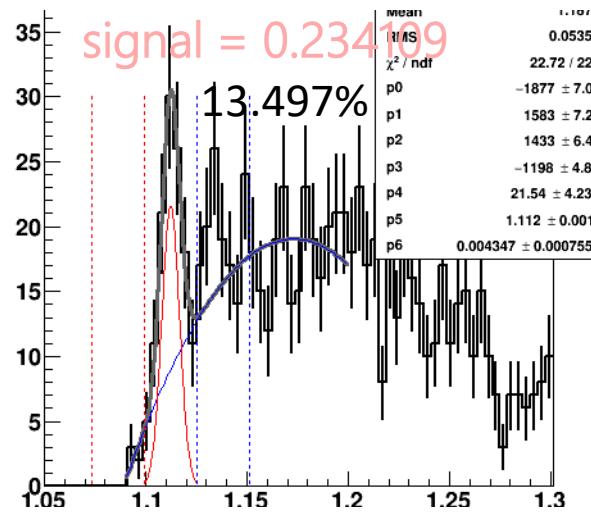


# p,π- invariant mass w/, w/o BPD-BPC matching

in the sample event  
(BPD Cluster > 3MeV) Page.6  
w/ the presence of



Side band of BPC-BPD Matching hard Track event

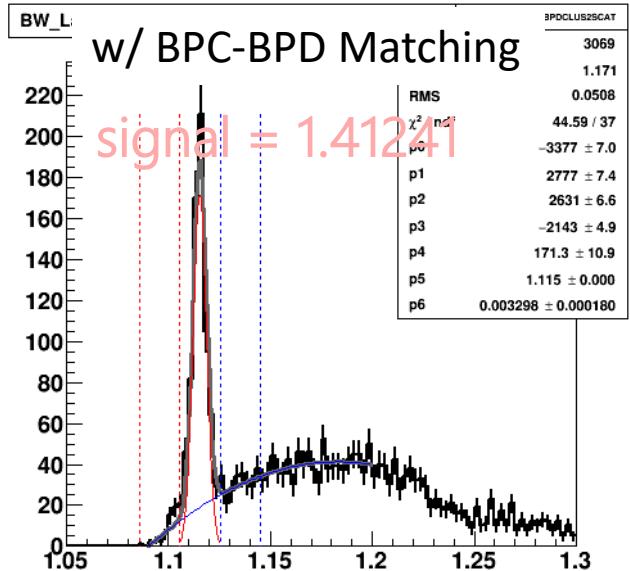


Excepting BPC-BPD Matching

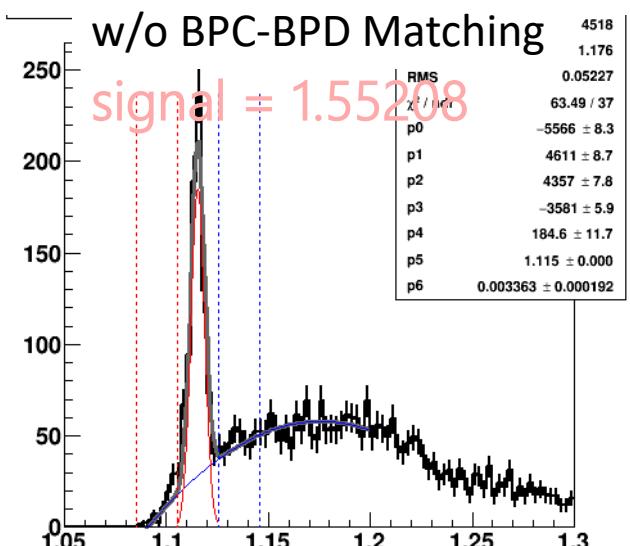


# p,π- invariant mass w/, w/o BPD-BPC matching

in the sample event  
(BPD Cluster > 3MeV) Page.6  
w/ the presence of

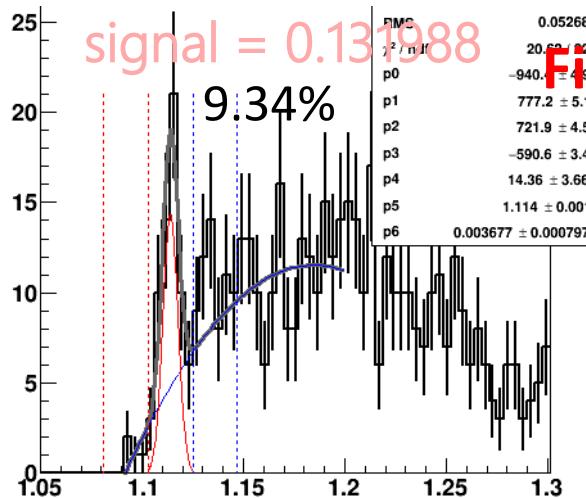


signal = 1.41241



signal = 1.55208

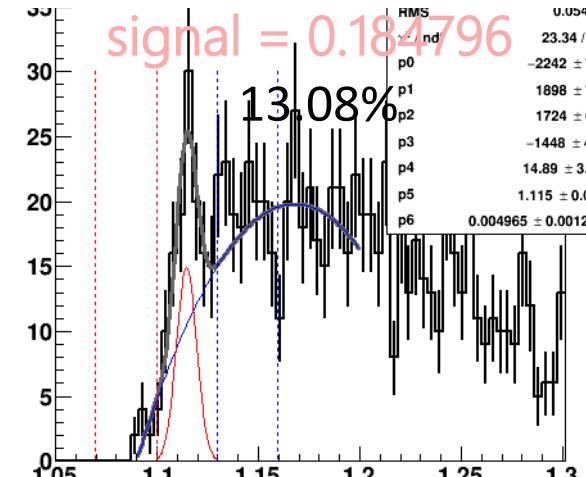
Side band of BPC-BPD Matching hard Track event



signal = 0.131988

9.34% Fiducial cut w/z

Excepting BPC-BPD Matching



signal = 0.184796

13.08%

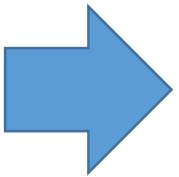


# BPC Backward Tracking efficiency

in the sample event  
(BPD Cluster > 3MeV) Page.60

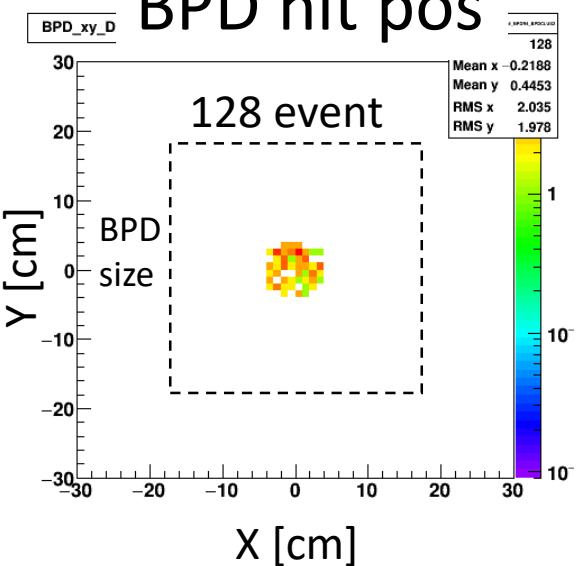
Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

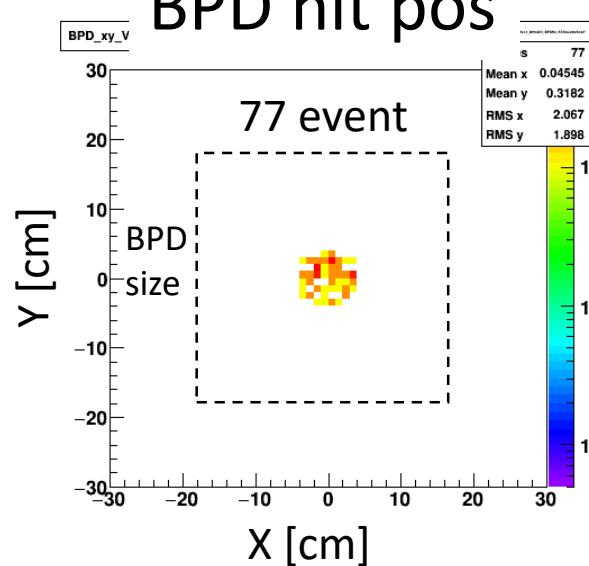


w/ the presence of  
BPC Backward Track event  
**Fiducial cut w/z**

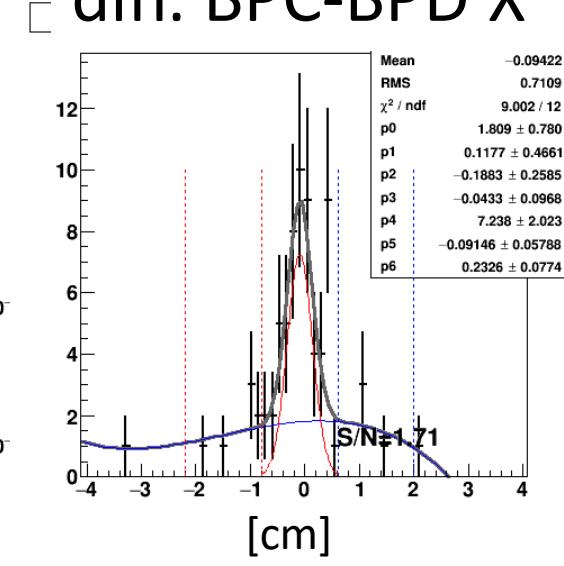
BPD hit pos



BPD hit pos



diff. BPC-BPD X



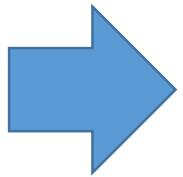
$60.1 \pm 4.3 \%$

# BPC Backward Tracking efficiency

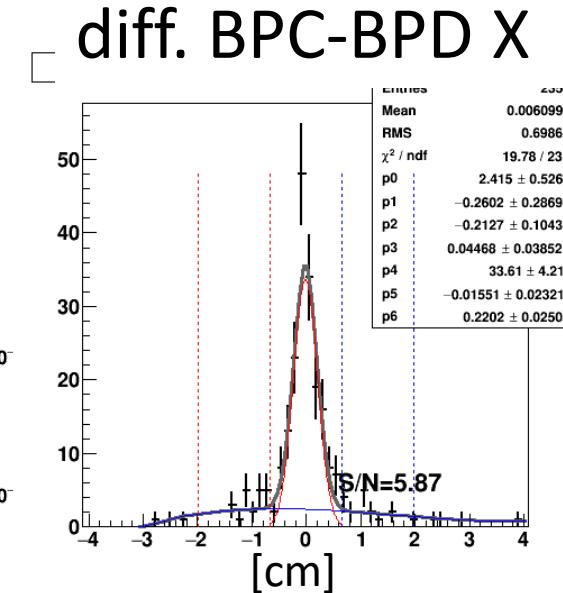
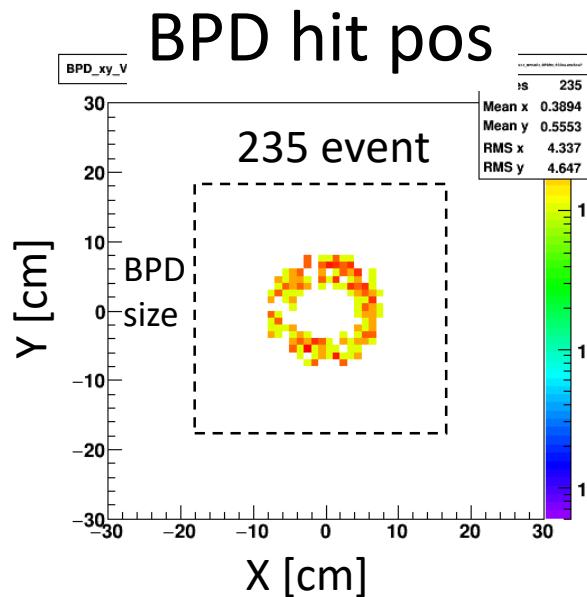
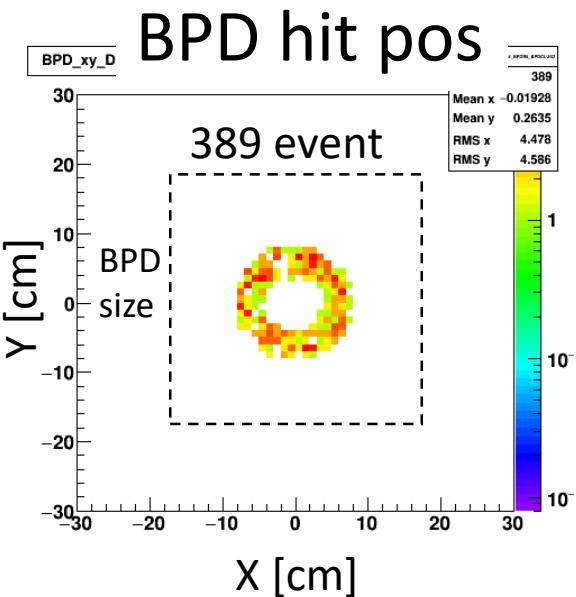
in the sample event  
(BPD Cluster > 3MeV) Page.60

Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8



w/ the presence of  
BPC Backward Track event  
**Fiducial cut w/z**



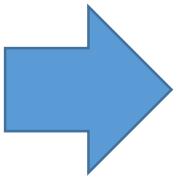
$60.4 \pm 2.4 \%$

# BPC Backward Tracking efficiency

in the sample event  
(BPD Cluster > 3MeV) Page.60

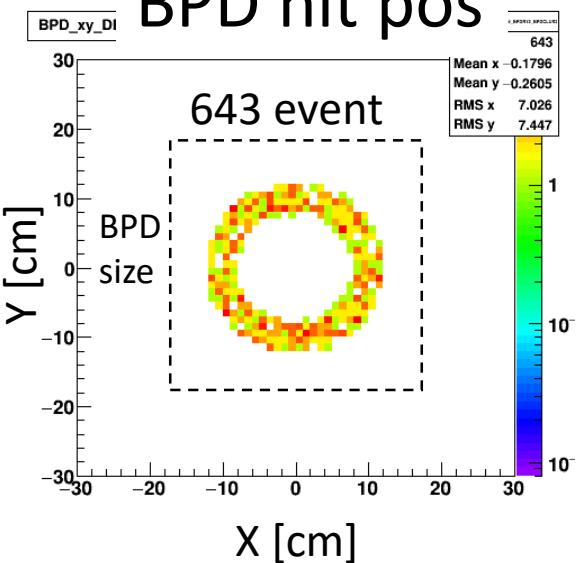
Sample

- $dE(BPD)$  4~12 MeV
- $dE(DEF)$  3.5~9 MeV
- BPD hit pos  $R < 8 \sim 12$

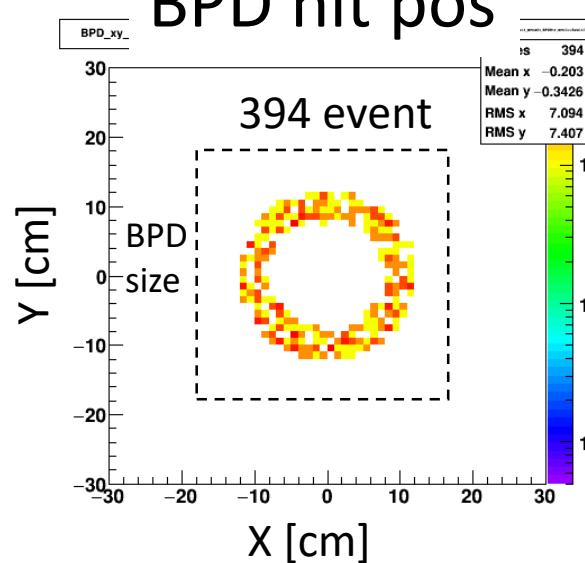


w/ the presence of  
BPC Backward Track event  
**Fiducial cut w/z**

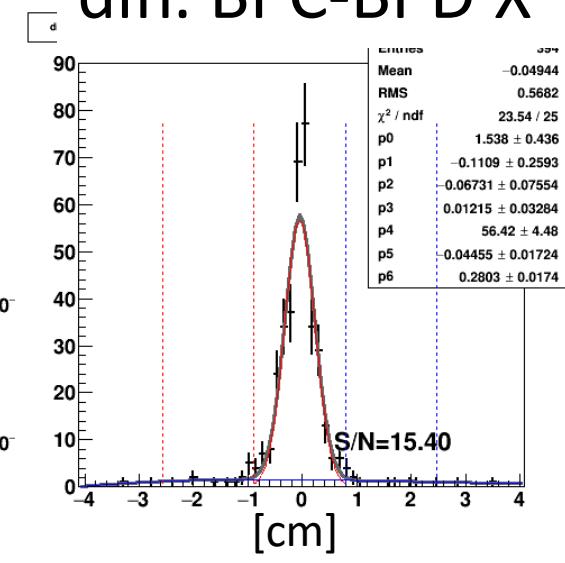
BPD hit pos



BPD hit pos



diff. BPC-BPD X



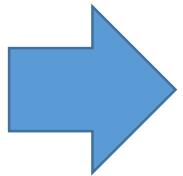
$$61.2 \pm 1.9 \%$$

# BPC Backward Tracking efficiency

in the sample event  
(BPD Cluster > 3MeV) Page.60

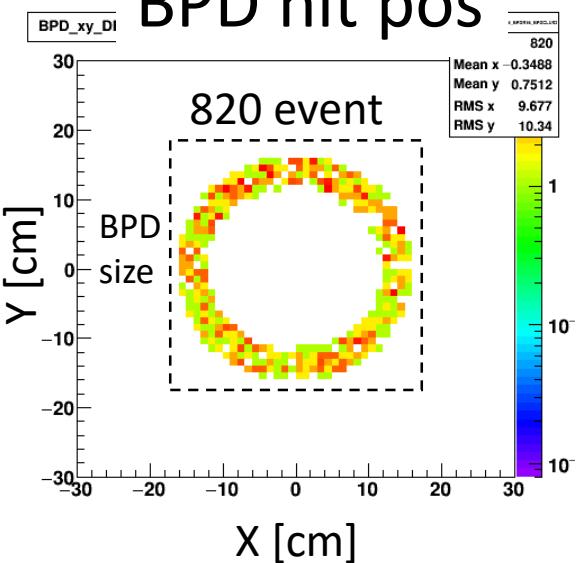
Sample

- $dE(BPD)$  4~12 MeV
- $dE(DEF)$  3.5~9 MeV
- BPD hit pos  $R < 12 \sim 16$

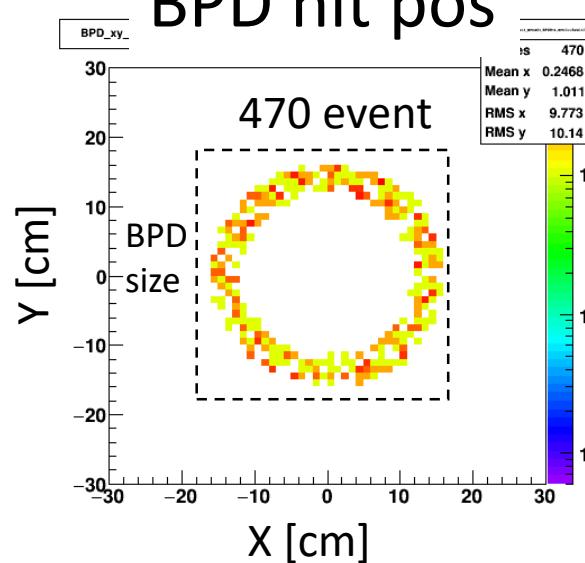


w/ the presence of  
BPC Backward Track event  
**Fiducial cut w/z**

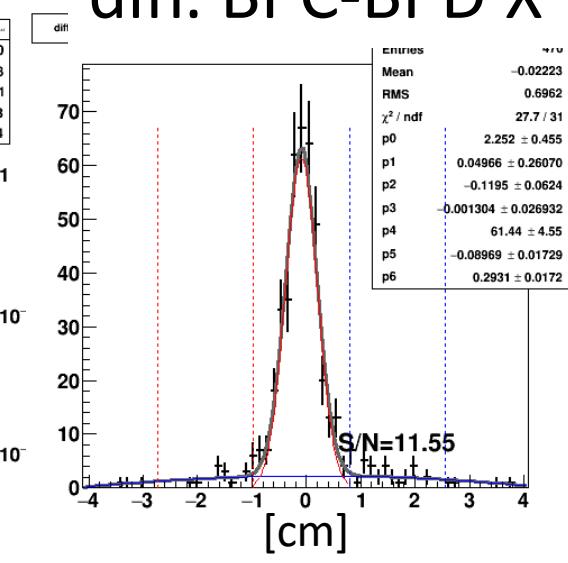
BPD hit pos



BPD hit pos



diff. BPC-BPD X



$57.3 \pm 1.7 \%$

BPC Backward  
Tracking efficiency  
w/ Beam region cut

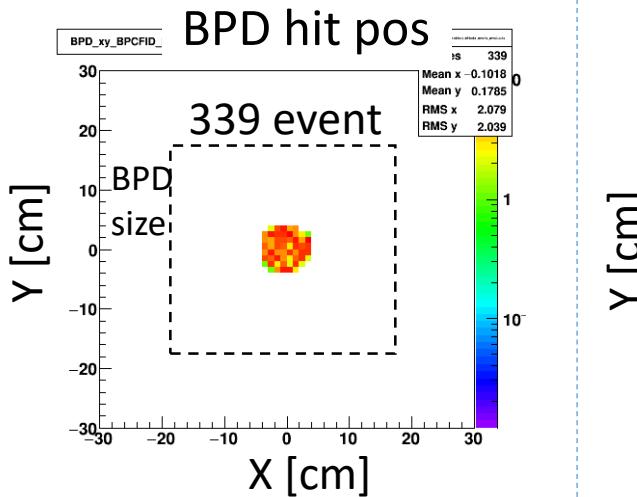
# BPC Backward Tracking efficiency

## Sample

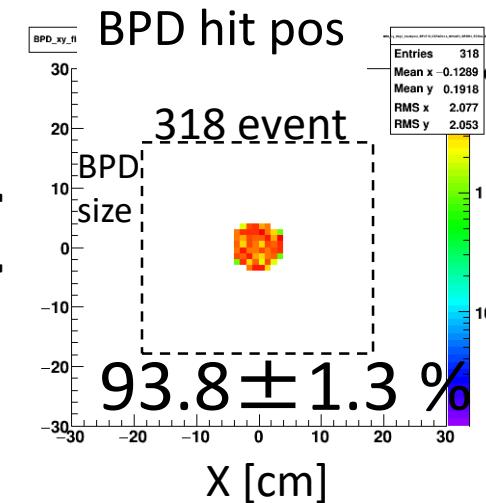
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

w/o forward neutron analysis for the increase of statistics

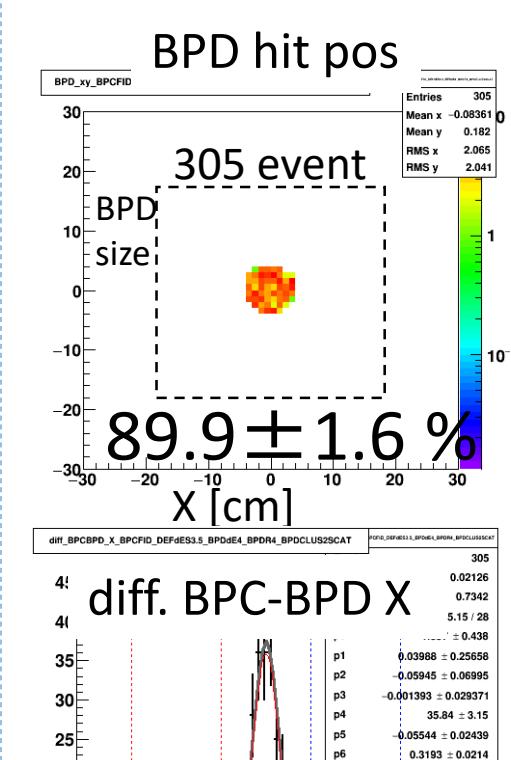
BEAM Track @ z=-5.5 cm  
Fiducial R<3 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



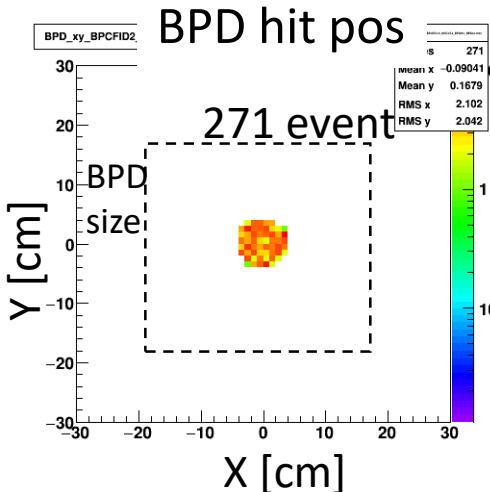
# BPC Backward Tracking efficiency

## Sample

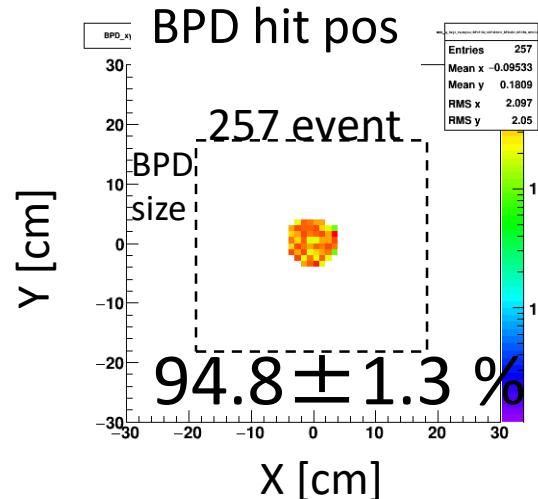
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

w/o forward neutron analysis for the increase of statistics

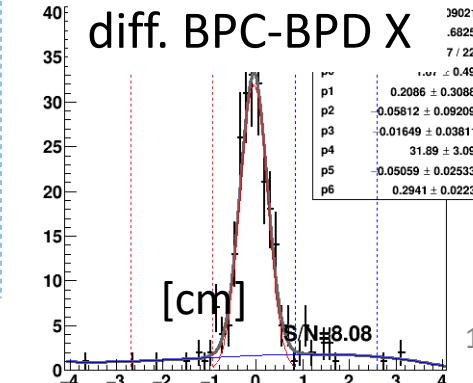
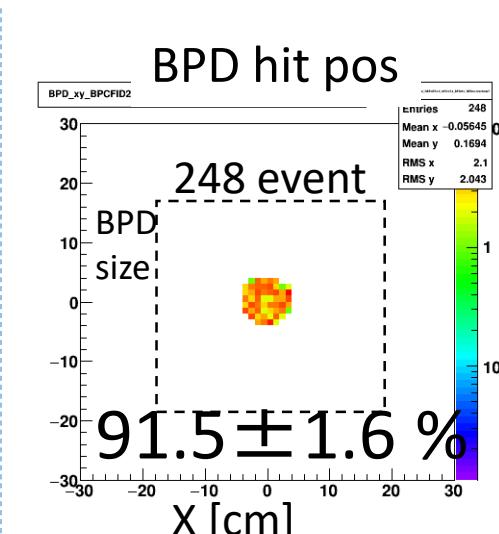
BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



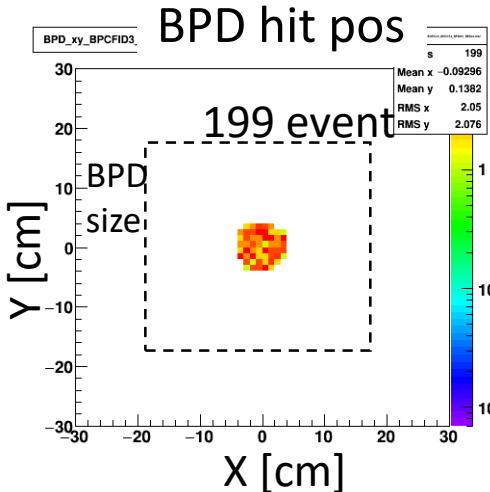
# BPC Backward Tracking efficiency

## Sample

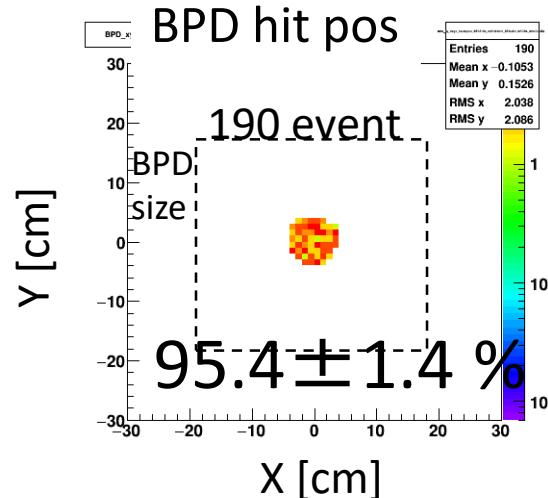
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

w/o forward neutron analysis for the increase of statistics

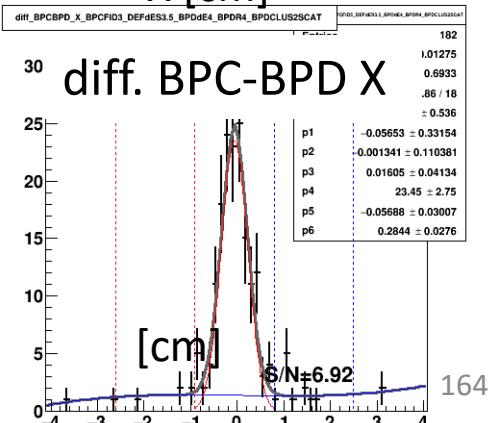
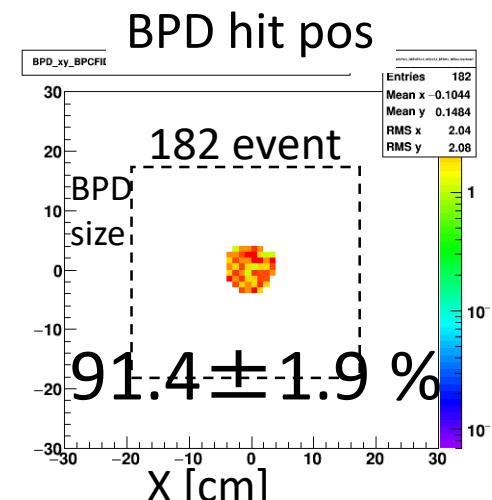
BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



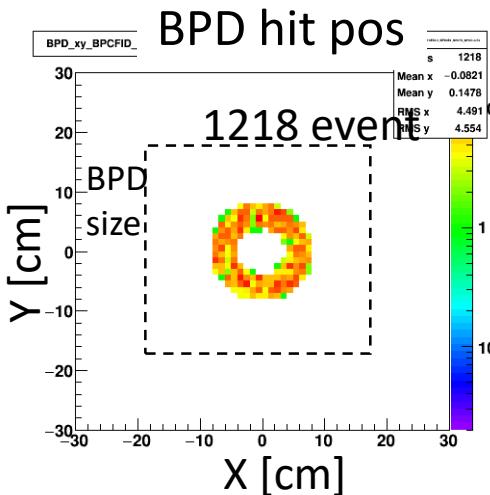
# BPC Backward Tracking efficiency

## Sample

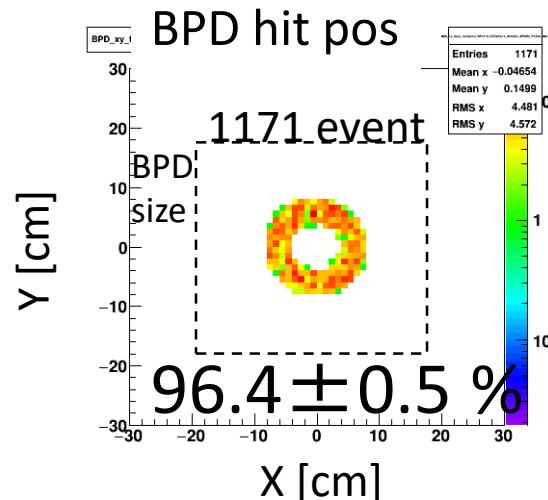
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

w/o forward neutron analysis for the increase of statistics

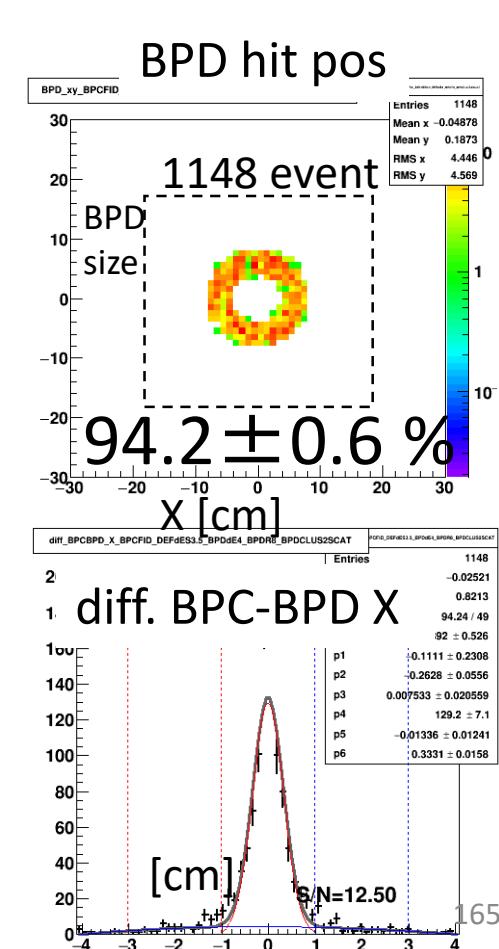
BEAM Track @ z=-5.5 cm  
 Fiducial R<3 cm



w/ the presence of  
 BPC Backward Track  
 Not same as Beam  
 Track X, Beam Track Y



w/ the presence of  
 BPC Backward Track event



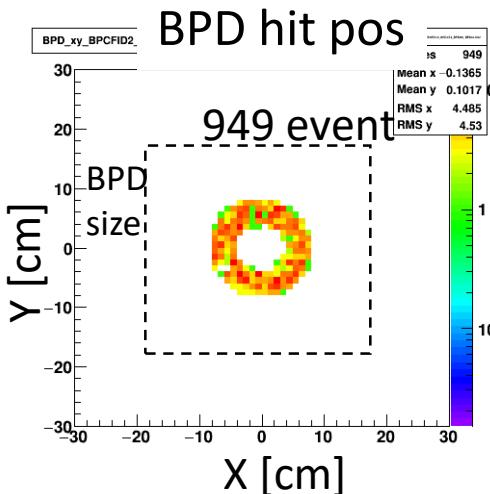
# BPC Backward Tracking efficiency

## Sample

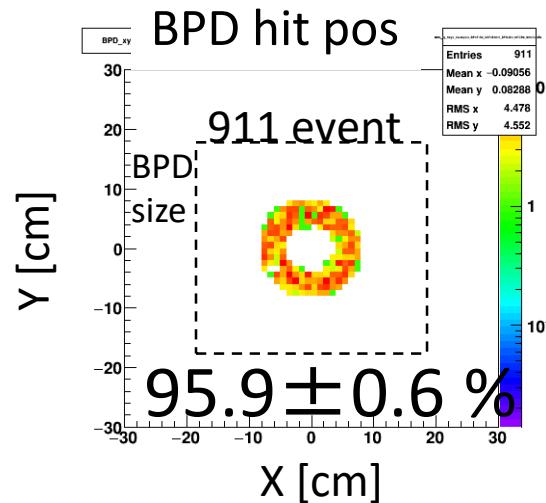
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

w/o forward neutron analysis for the increase of statistics

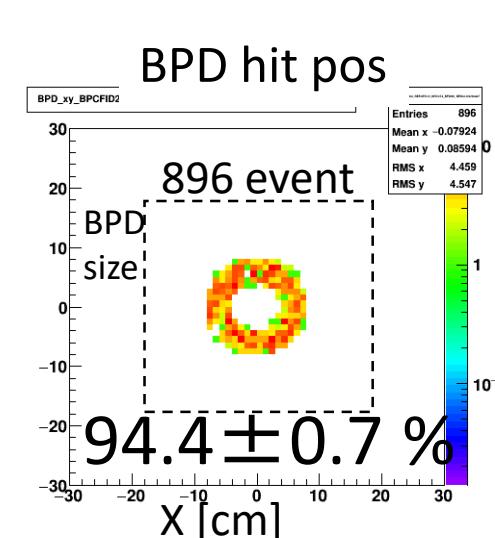
BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



S/N=13.63

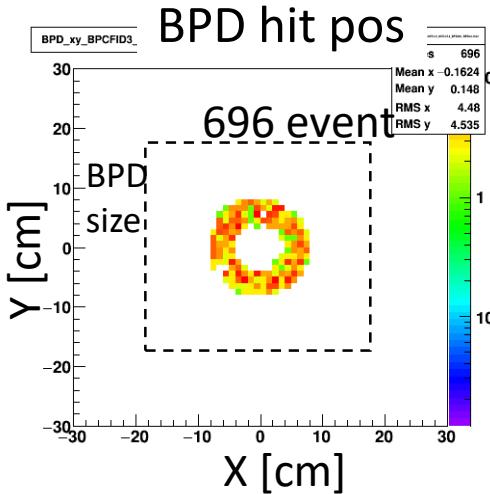
# BPC Backward Tracking efficiency

## Sample

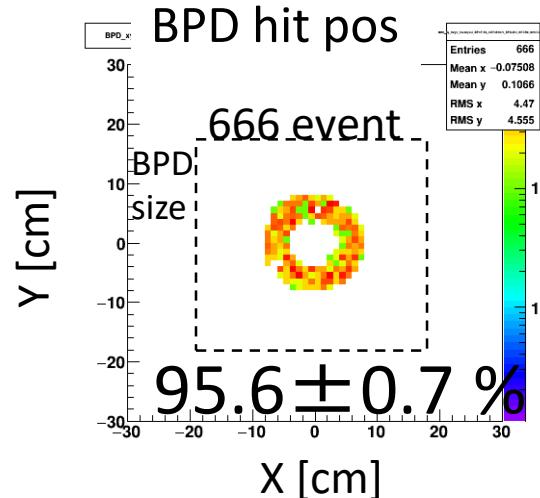
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

w/o forward neutron analysis for the increase of statistics

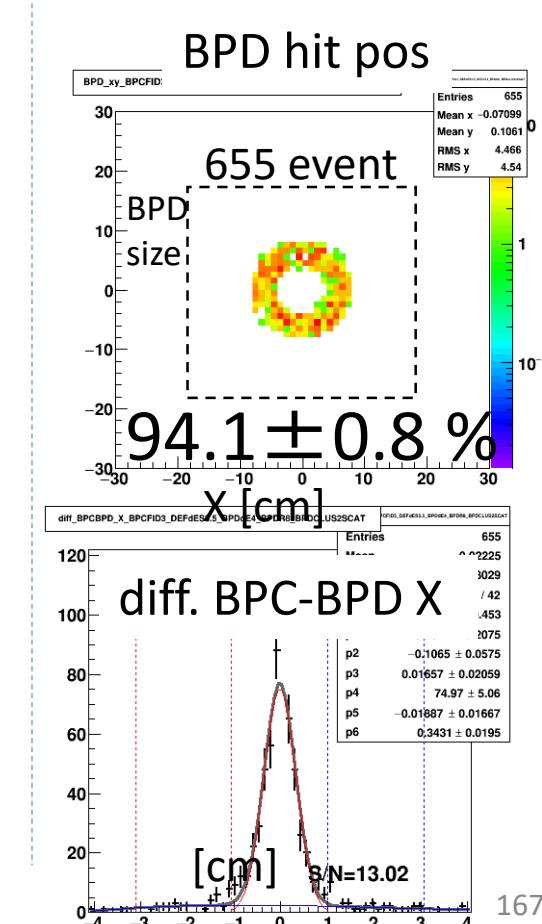
BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



w/ the presence of  
 BPC Backward Track  
 Not same as Beam  
 Track X, Beam Track Y



w/ the presence of  
 BPC Backward Track event



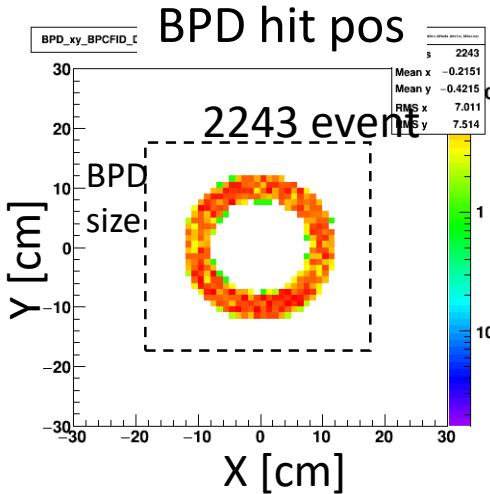
# BPC Backward Tracking efficiency

## Sample

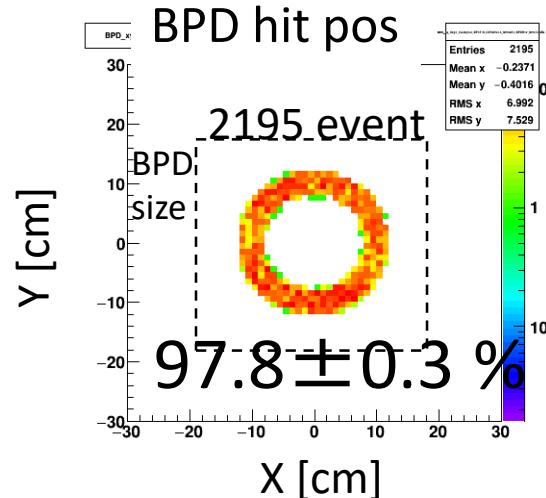
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

w/o forward neutron analysis for the increase of statistics

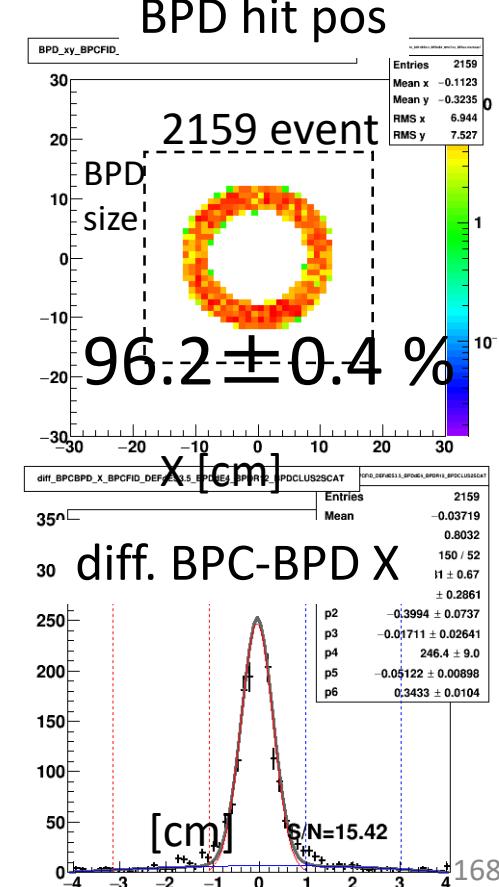
BEAM Track @ z=-5.5 cm  
Fiducial R<3 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



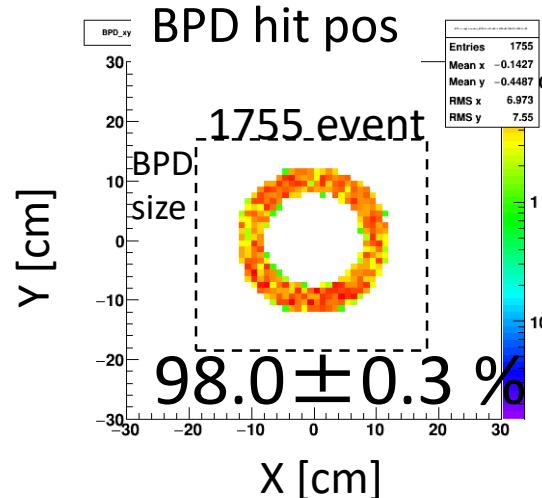
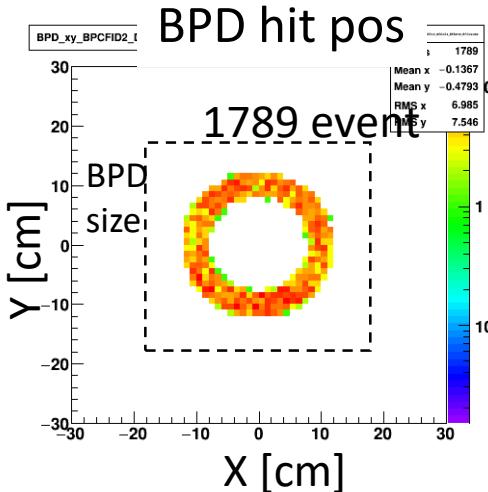
# BPC Backward Tracking efficiency

## Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

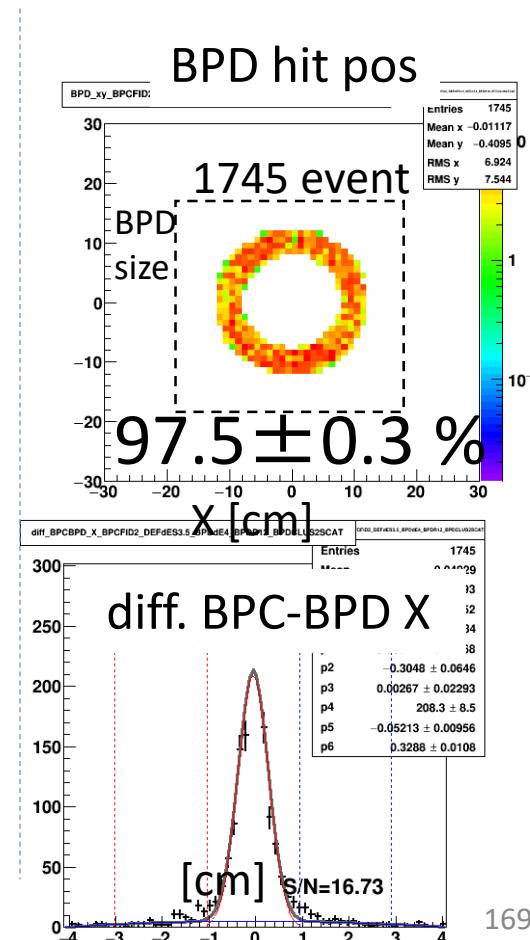
w/o forward neutron analysis for the increase of statistics

BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



w/ the presence of  
 BPC Backward Track  
 Not same as Beam  
 Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event



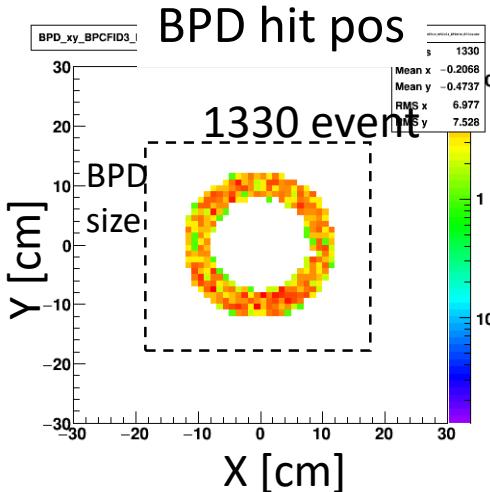
# BPC Backward Tracking efficiency

## Sample

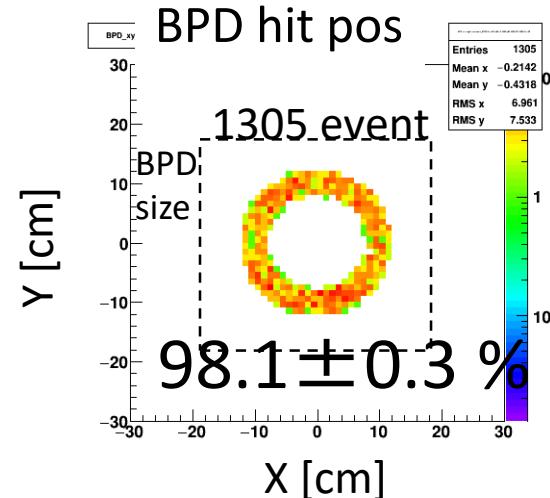
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

w/o forward neutron analysis for the increase of statistics

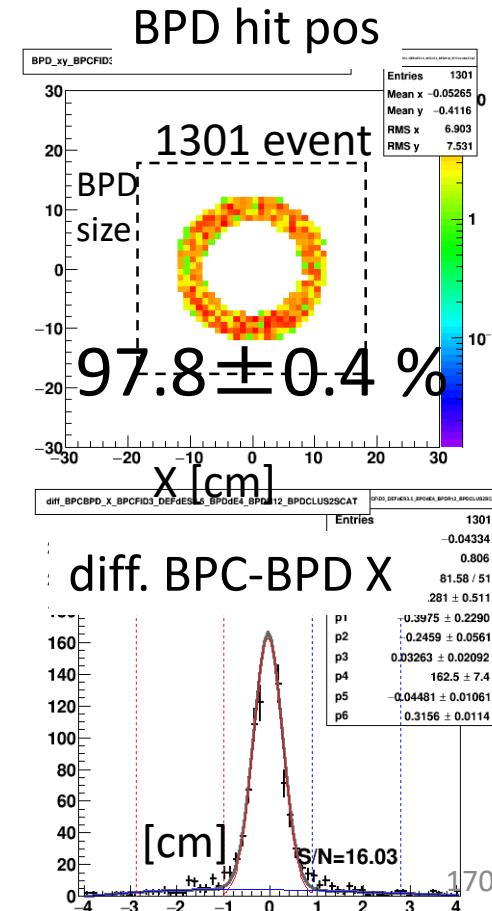
BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



in the sample event

(BPD Cluster > 3MeV) Page.60

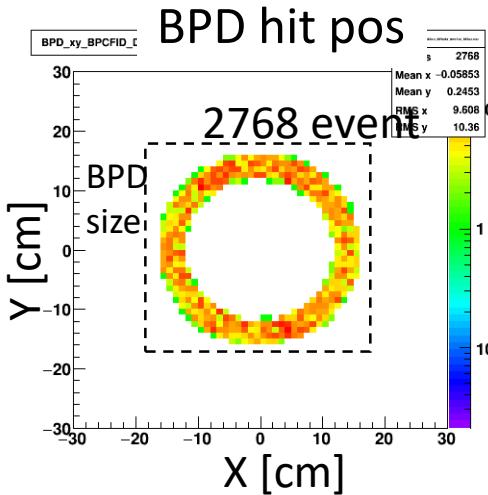
# BPC Backward Tracking efficiency

## Sample

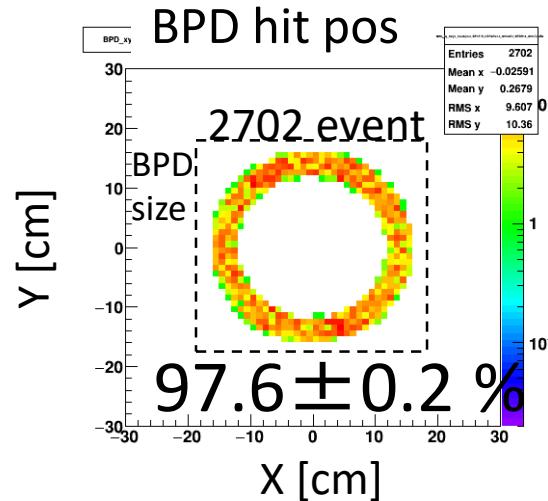
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

w/o forward neutron analysis for the increase of statistics

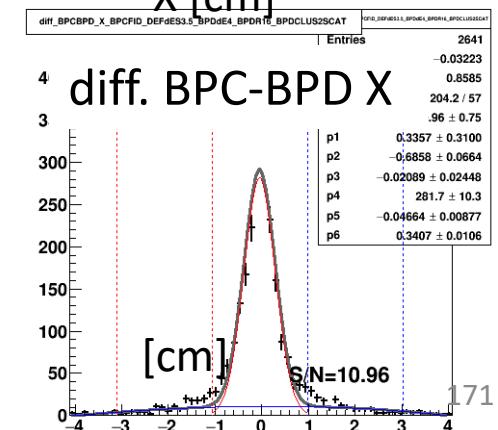
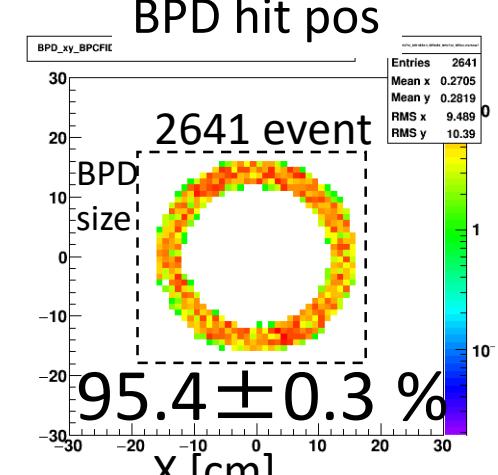
BEAM Track @ z=-5.5 cm  
Fiducial R<3 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



in the sample event

(BPD Cluster > 3MeV) Page.60

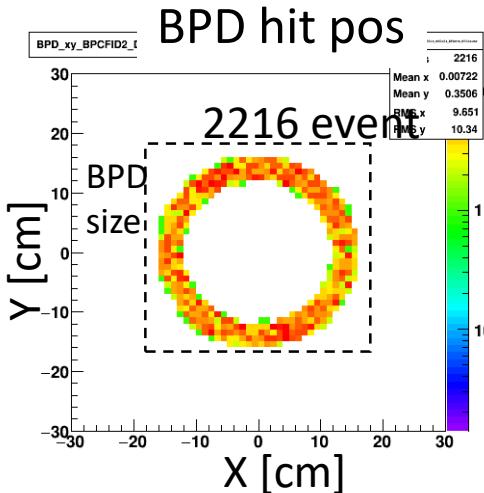
# BPC Backward Tracking efficiency

Sample

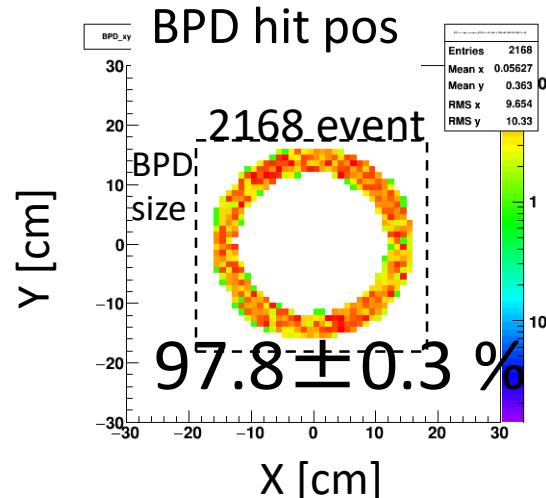
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

w/o forward neutron analysis for the increase of statistics

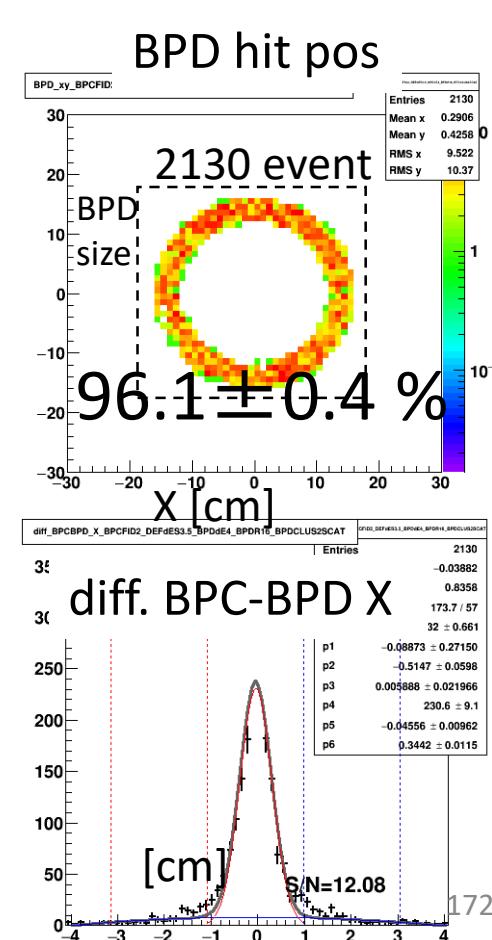
BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



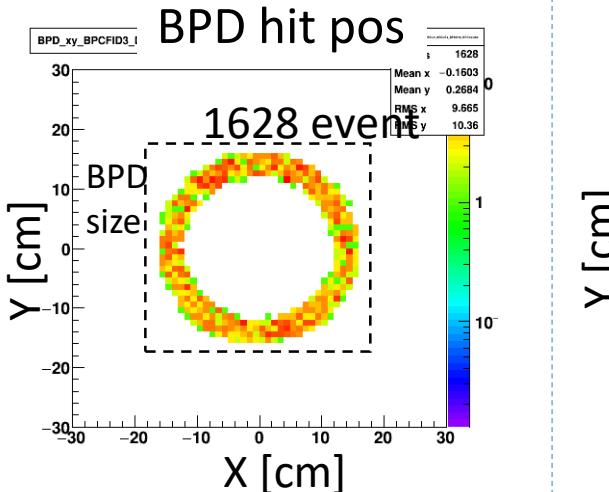
# BPC Backward Tracking efficiency

## Sample

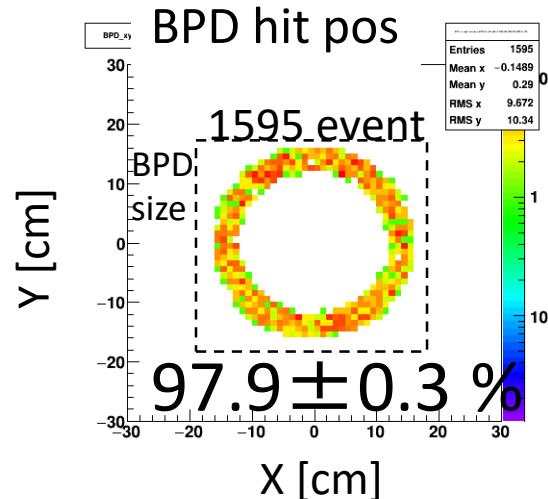
- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

w/o forward neutron analysis for the increase of statistics

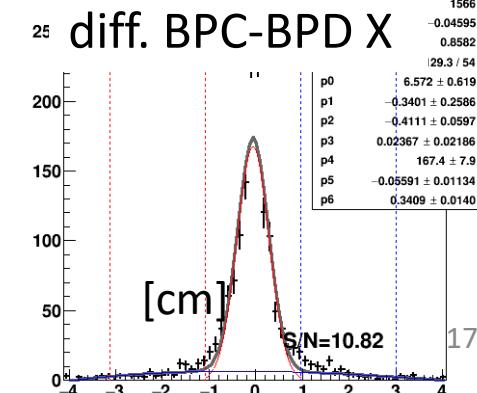
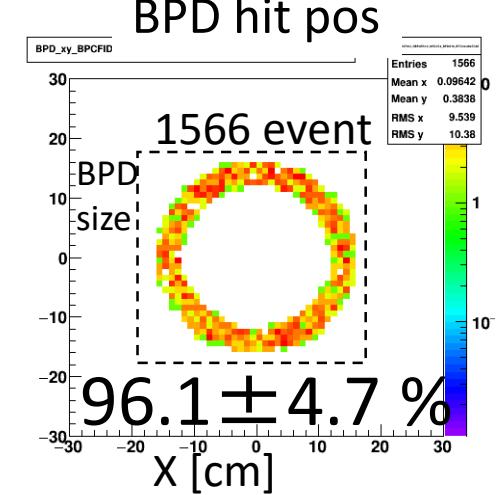
BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm



w/ the presence of  
BPC Backward Track  
Not same as Beam  
Track X, Beam Track Y



w/ the presence of  
BPC Backward Track event



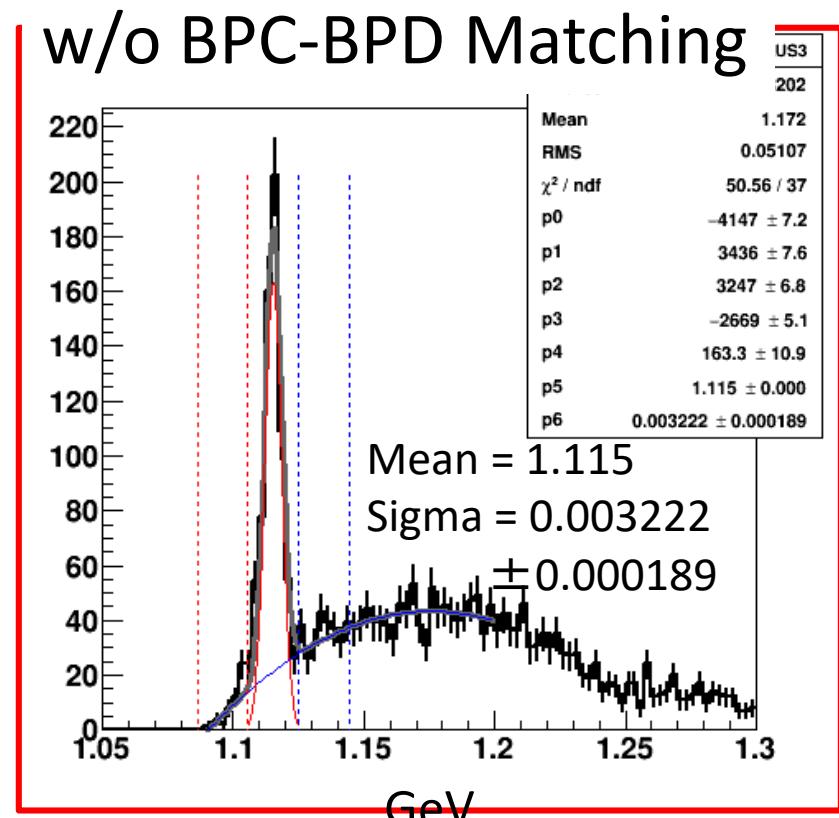
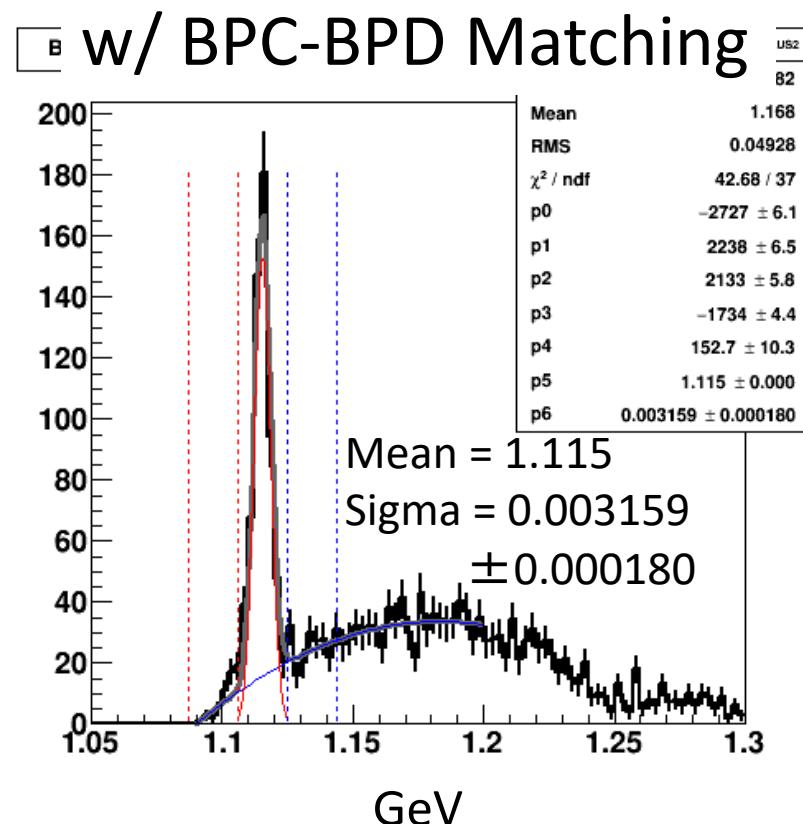
		ratio		ratio err	
R 0~4	Beam Fiducial R < 3	0.938053	0.899705	0.013093	0.016315
	Beam Fiducial R < 2.5	0.948339	0.915129	0.013445	0.016929
	Beam Fiducial R < 2	0.954774	0.914573	0.014731	0.019814
R 4~8	Beam Fiducial R < 3	0.961412	0.942529	0.005519	0.006669
	Beam Fiducial R < 2.5	0.959958	0.944152	0.006364	0.007454
	Beam Fiducial R < 2	0.956897	0.941092	0.007698	0.008925
R 8~12	Beam Fiducial R < 3	0.9786	0.96255	0.003056	0.004009
	Beam Fiducial R < 2.5	0.980995	0.975405	0.003228	0.003662
	Beam Fiducial R < 2	0.981203	0.978195	0.003724	0.004005
R 12~16	Beam Fiducial R < 3	0.976156	0.954118	0.0029	0.003977
	Beam Fiducial R < 2.5	0.978339	0.961191	0.003092	0.004103
	Beam Fiducial R < 2	0.97973	0.961916	0.003493	0.004744

# Re-analysis 2

- BPC hit pos  $R < 16$
- Vertex Lambda w/ z
- Comparing ;  
w/o BPC-BPD Matching vs w/ BPC-BPD Matching

# $p, \pi$ - invariant mass

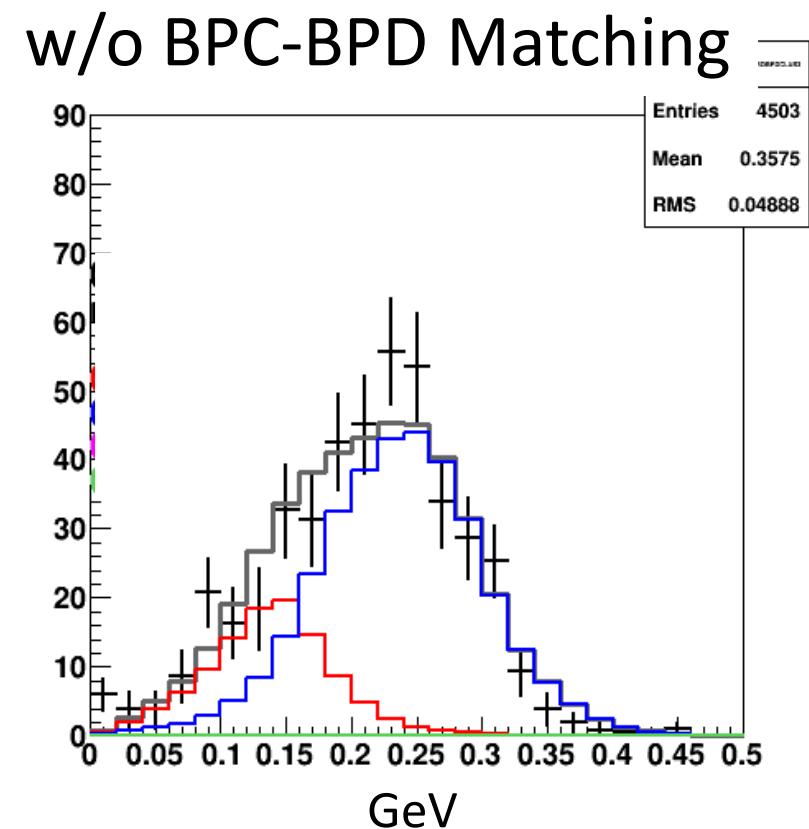
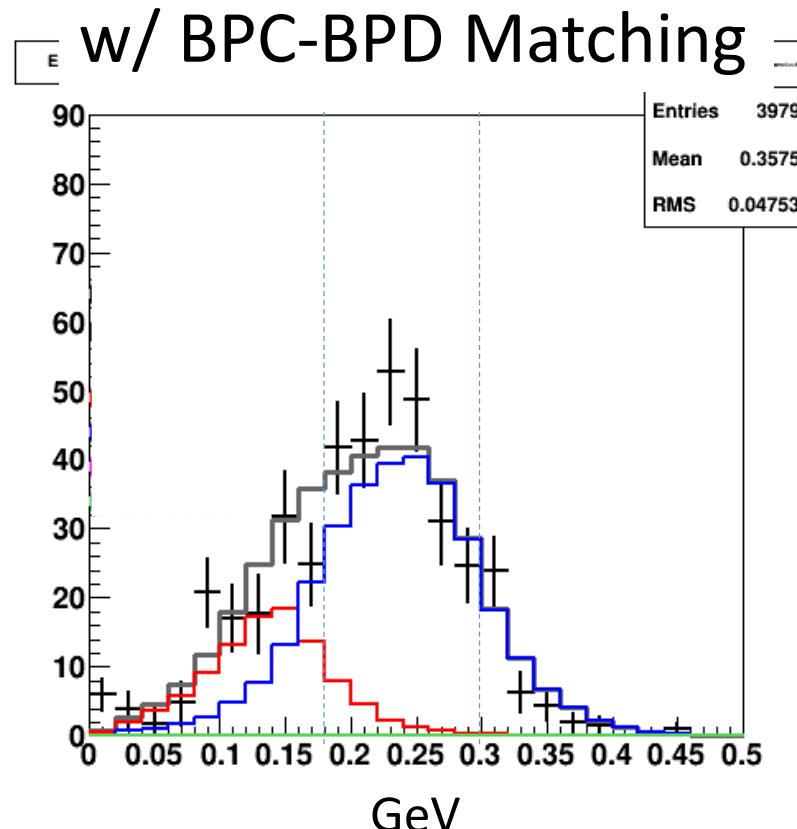
$\Lambda$  reconstruction from  $p \pi^-$  invariant mass



# Fitting of the $d(K^-, np\pi^-)''X$ missing mass

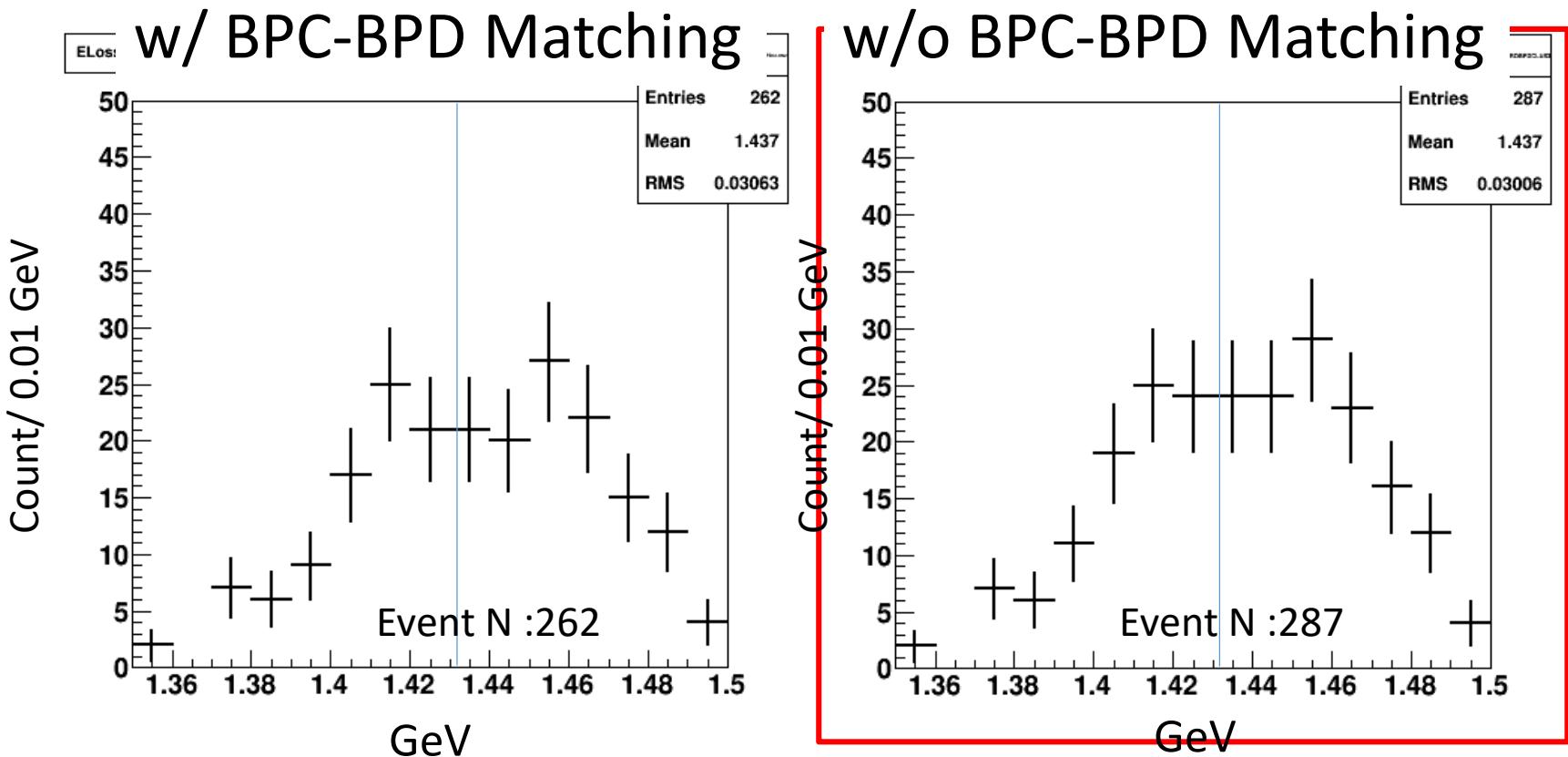
- $p, \pi$ - invariant mass  $\Lambda$  selection

$\pi 0 \gamma$  is selected from  $d(K^-, np\pi^-)''X$  missing mass



# $d(K^-, n)\pi^0\pi^0$ missing mass

- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-) X \quad 0.18 < X < 0.3 \text{ GeV}$  for  $\pi^0\gamma$

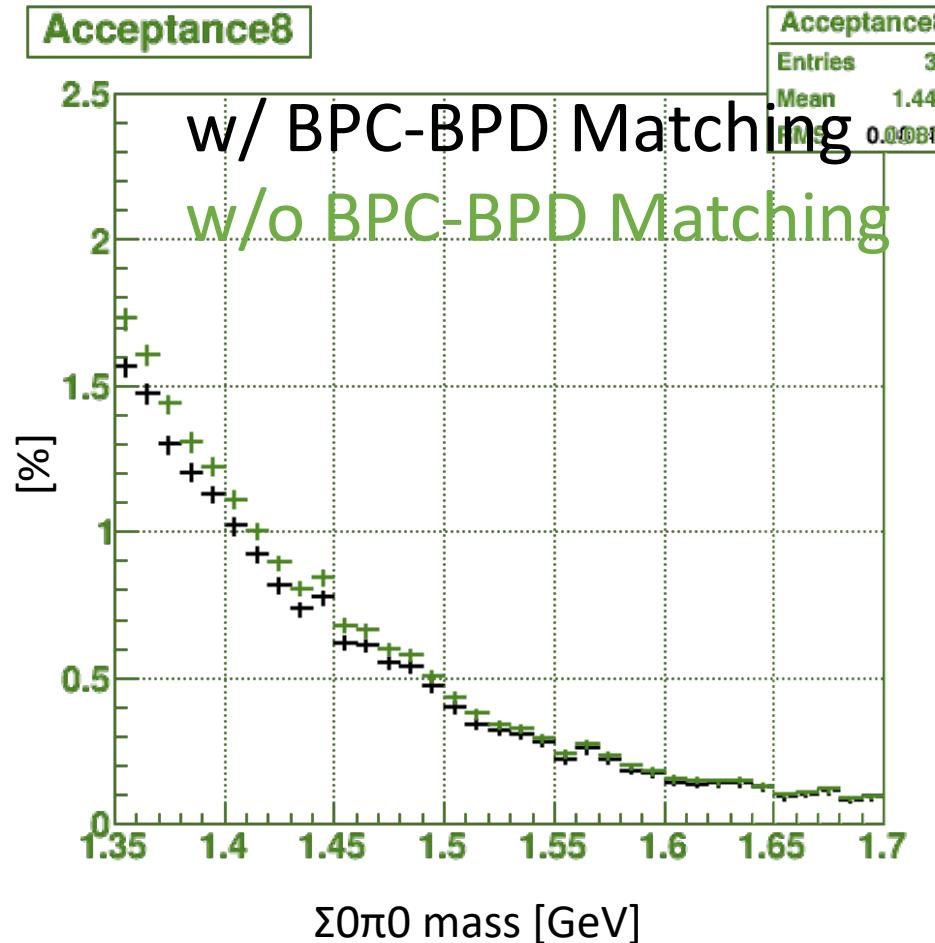


# Acceptance estimation

- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)

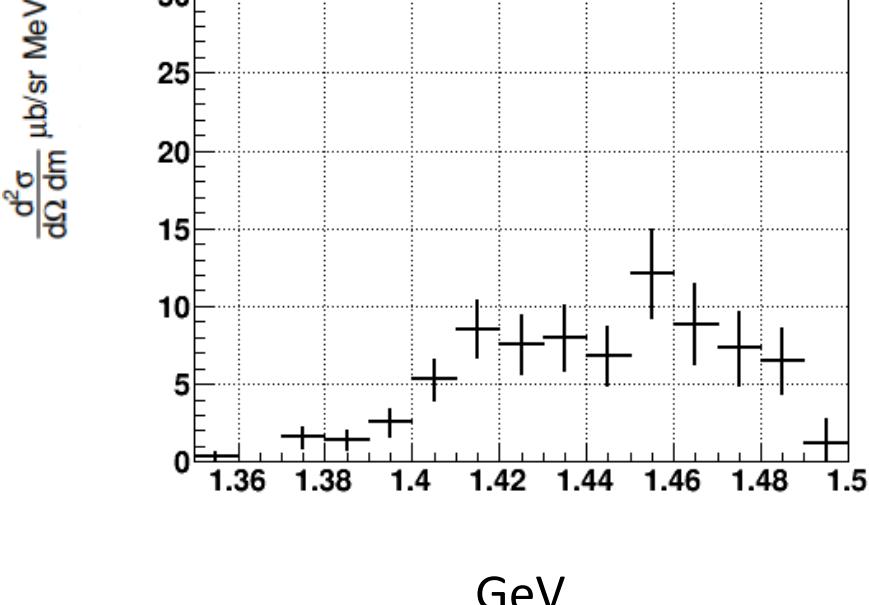


- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

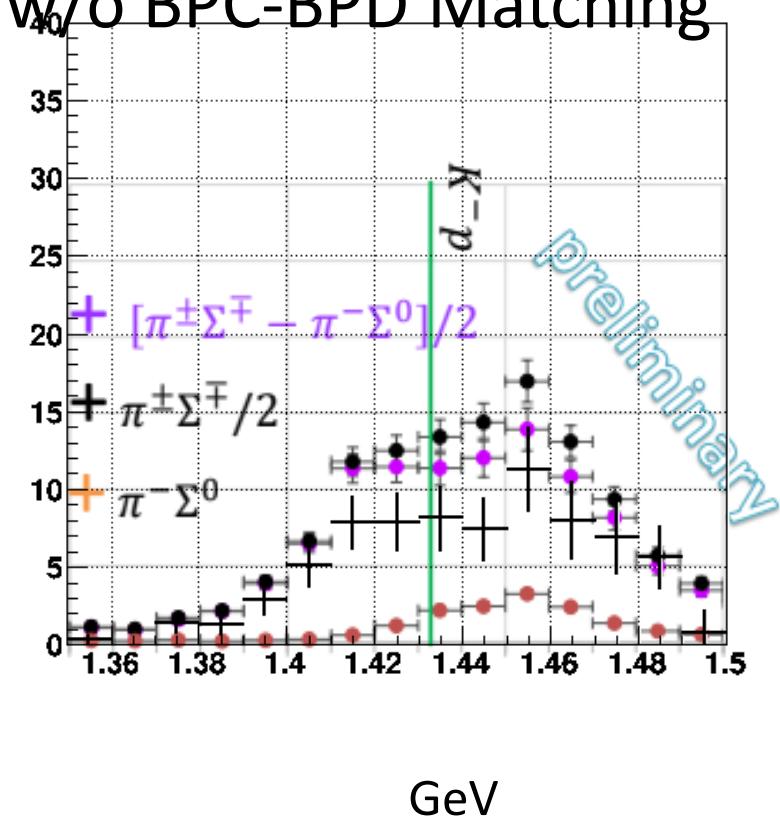


# Cross Section

w/ BPC-BPD Matching



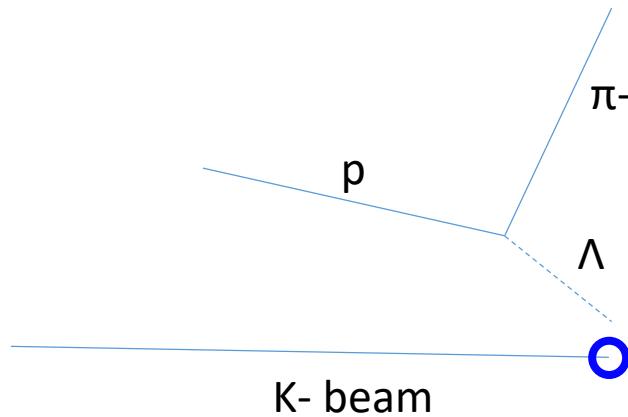
w/o BPC-BPD Matching



# Same as Page.8

- Lumi ;  $8083 \pm 160$  [/ub]
  - Scaler Kaon 58.3 G
  - Survival ratio  $0.314 \pm 0.000350$
  - DAQ eff  $0.7708 \pm 0.0000128$
  - Trig. KCDH1  $0.9527 \pm 0.0003$
  - Trig. Neutral  $0.9999 \pm 0.0000067$
- $\Omega\text{-nc}$  ;  $0.0214832 \pm 0.000207563$  [sr]
- $\varepsilon\text{-nc}$  ;  $0.291 \pm 0.015$
- $\varepsilon\text{-bpc}$  ;  $0.999 \pm 0.000$
- $\varepsilon\text{-cdc}$  ;  $0.977 \pm 0.004$
- Acc ; simulation (including BR ( $\Sigma 0 \pi 0$ ) 0.639)

# Vertex lambda resolution



- BPD Cluster > 3MeV
- BPC hit pos  $R < 16$
- w/o BPC-BPD Matching

# Target flame shadow by vertex XY plots

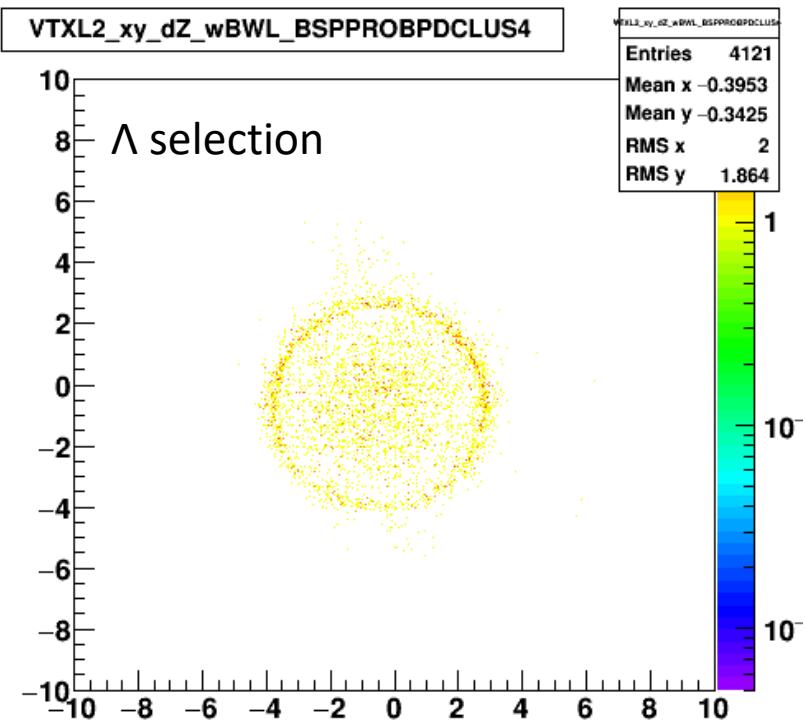
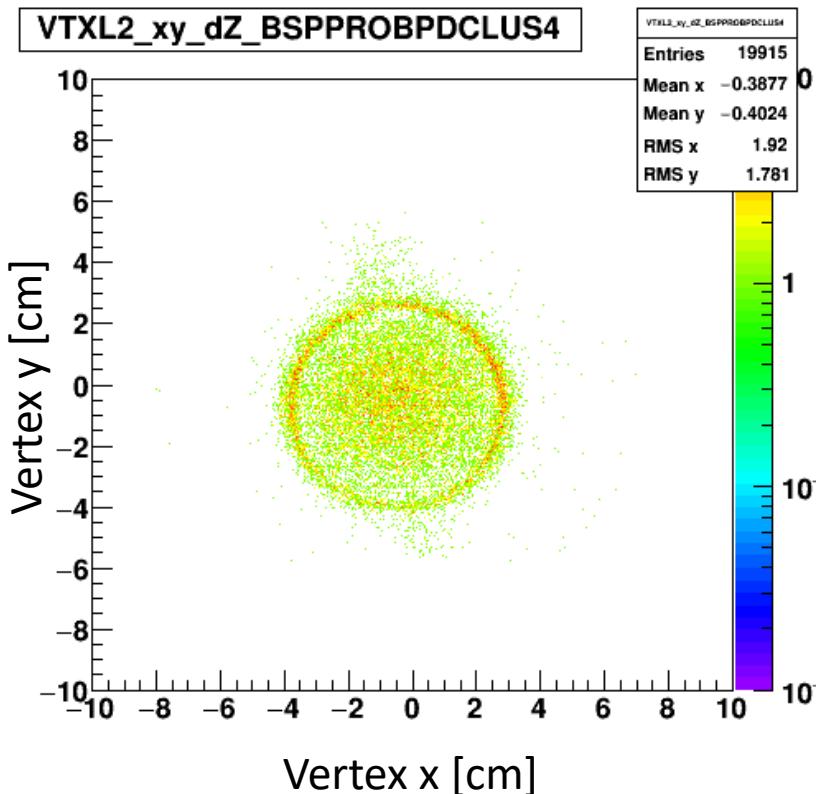
BPC hit pos R<16

in the sample event

(BPD Cluster > 3MeV) Page.60

Vertex Z cut (-10.9 ~ -0.9)

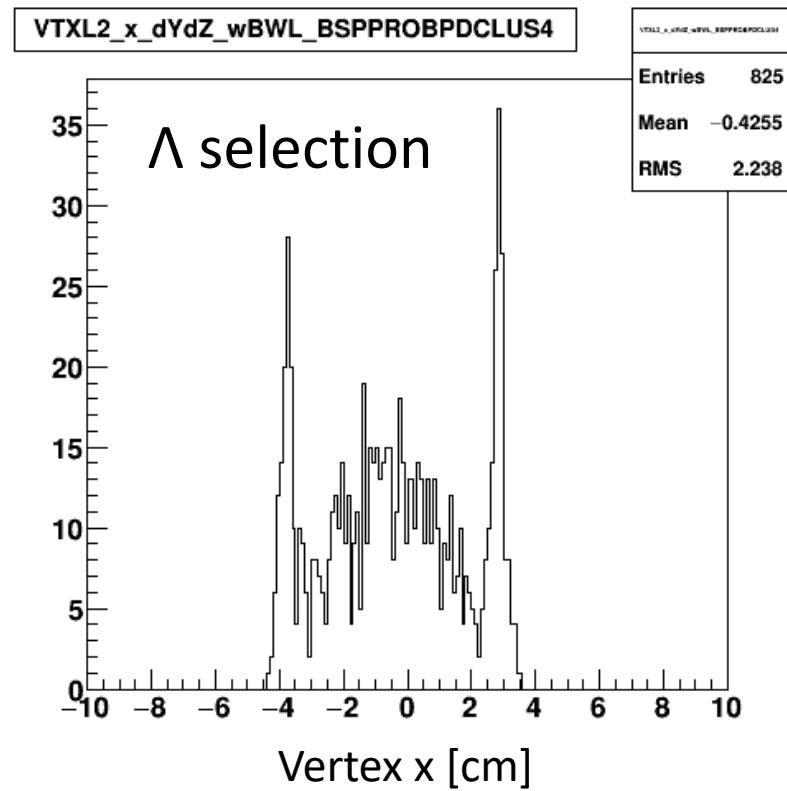
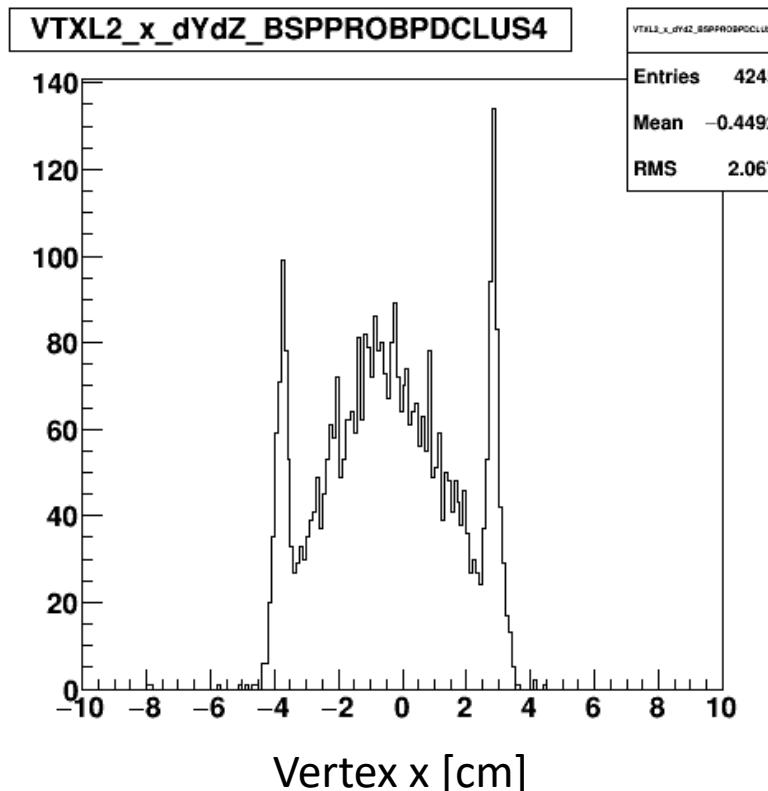
w/o forward neutron analysis for the increase of statistics



# Target cell width by vertex X

Vertex Z cut (-10.9 ~ -0.9)  
Vertex Y cut (-0.5 ~ 0.5)

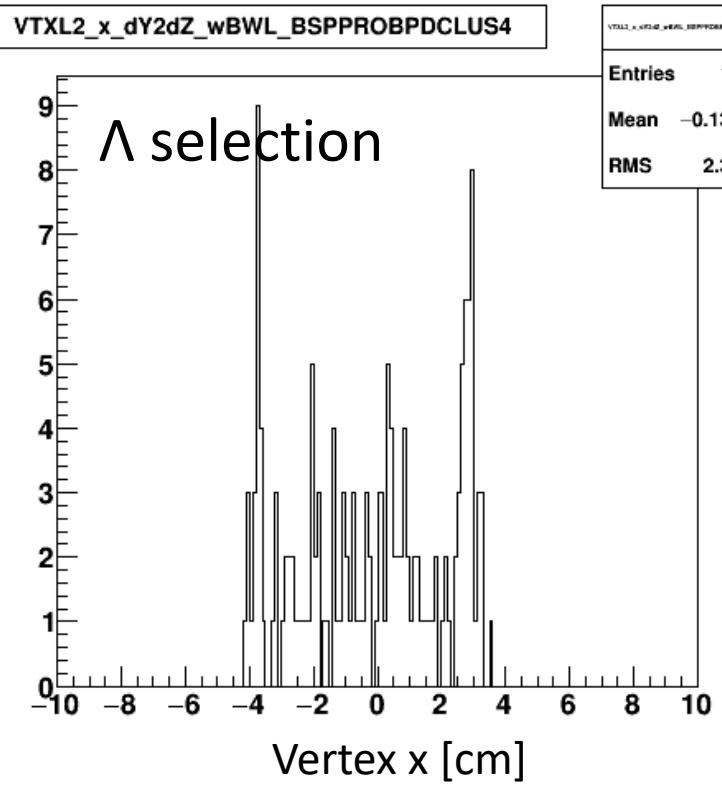
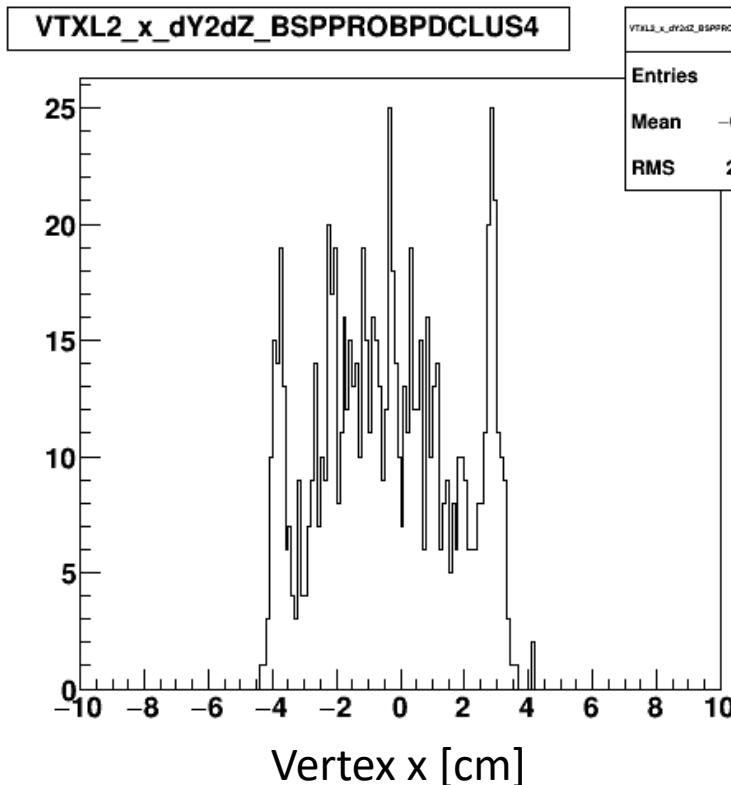
w/o forward neutron analysis for the increase of statistics



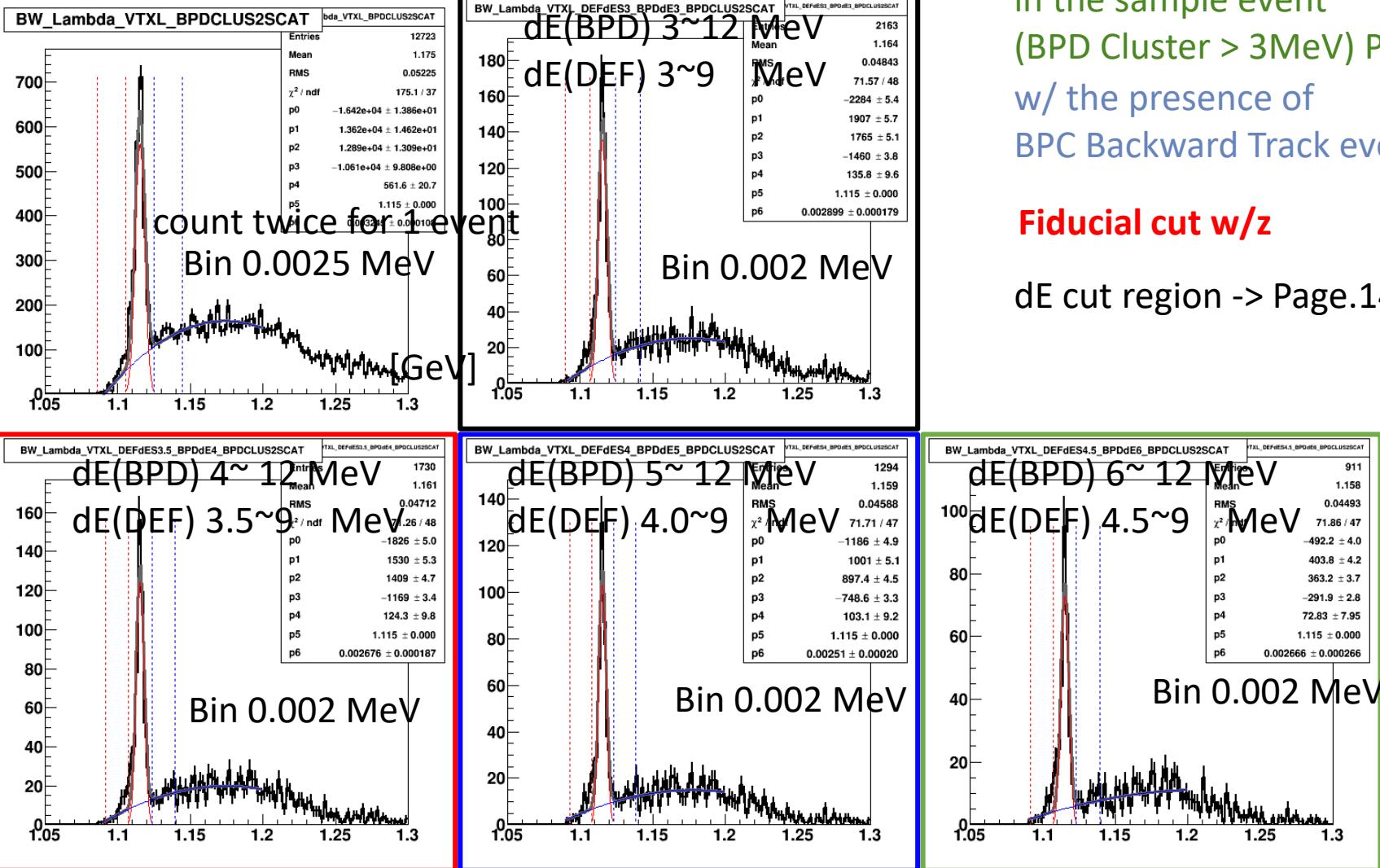
# Target cell width by vertex X

Vertex Z cut (-10.9 ~ -0.9)  
Vertex Y cut (-0.1 ~ 0.1)

w/o forward neutron analysis for the increase of statistics



# p, $\pi$ - invariant mass by changing BPD DEF Thre.



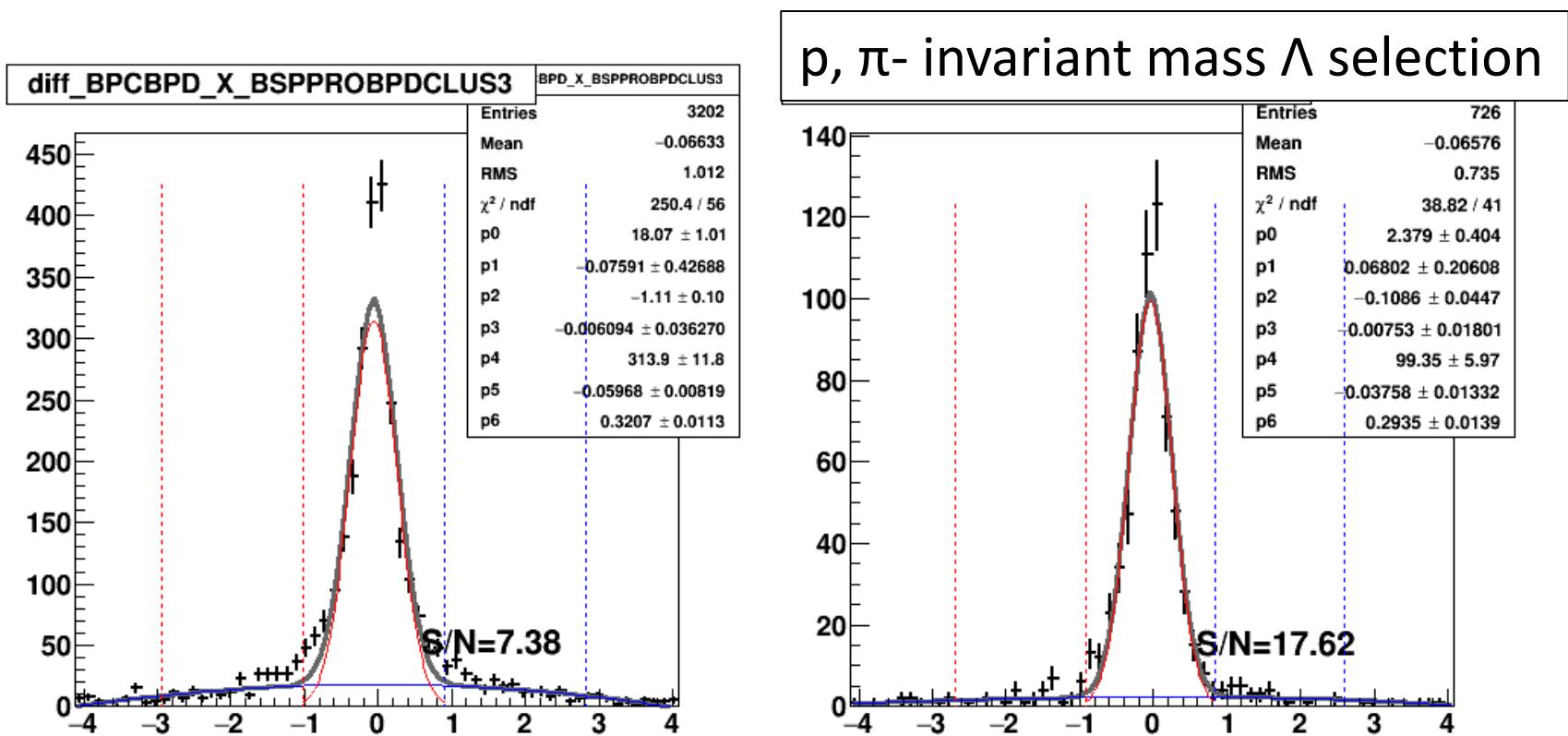
in the sample event  
(BPD Cluster > 3MeV) Page.60  
w/ the presence of  
BPC Backward Track event

Fiducial cut w/z

dE cut region -> Page.147

# Diff. BPC-BPD w/ $\Lambda$ selection

- in the sample event (BPD Cluster > 3MeV) Page.60
- w/ the presence of BPC Backward Track event
- BPC hit pos  $R < 16$
- Vertex Lambda w/ z

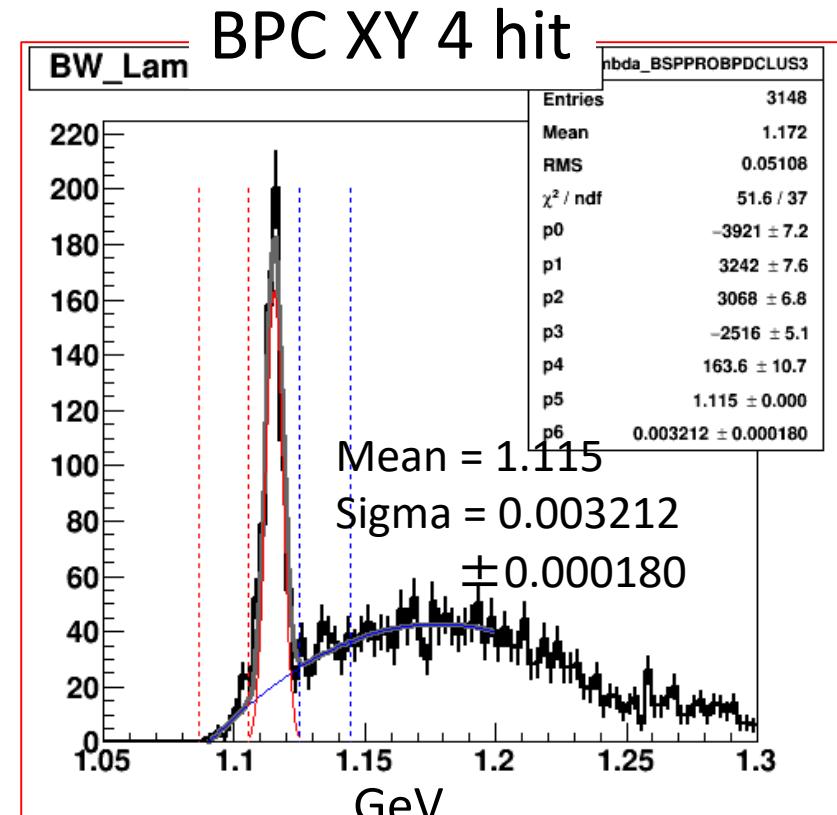
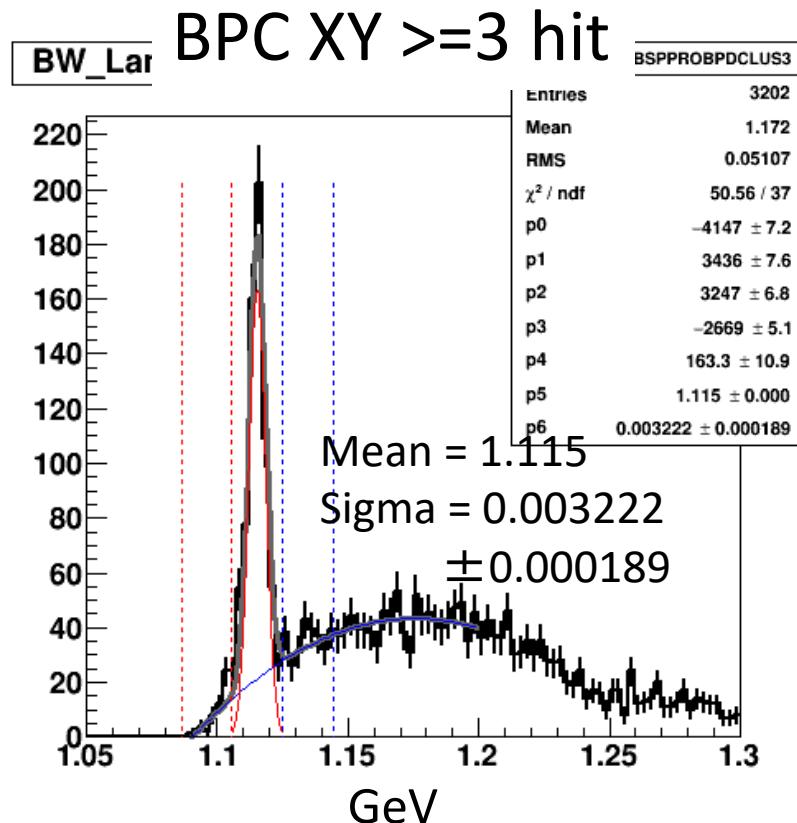


# Re-analysis 3

- Re-analysis 2
- $BPC\ XY \geq 3 \rightarrow BPC\ XY\ 4\ hit$

# $p, \pi$ - invariant mass

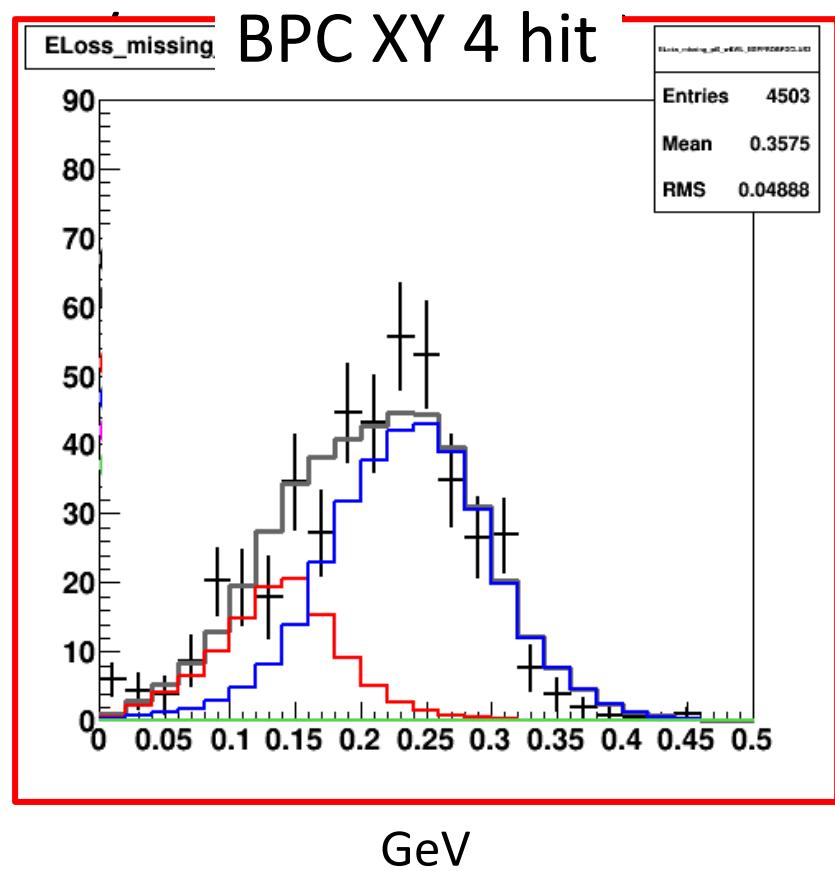
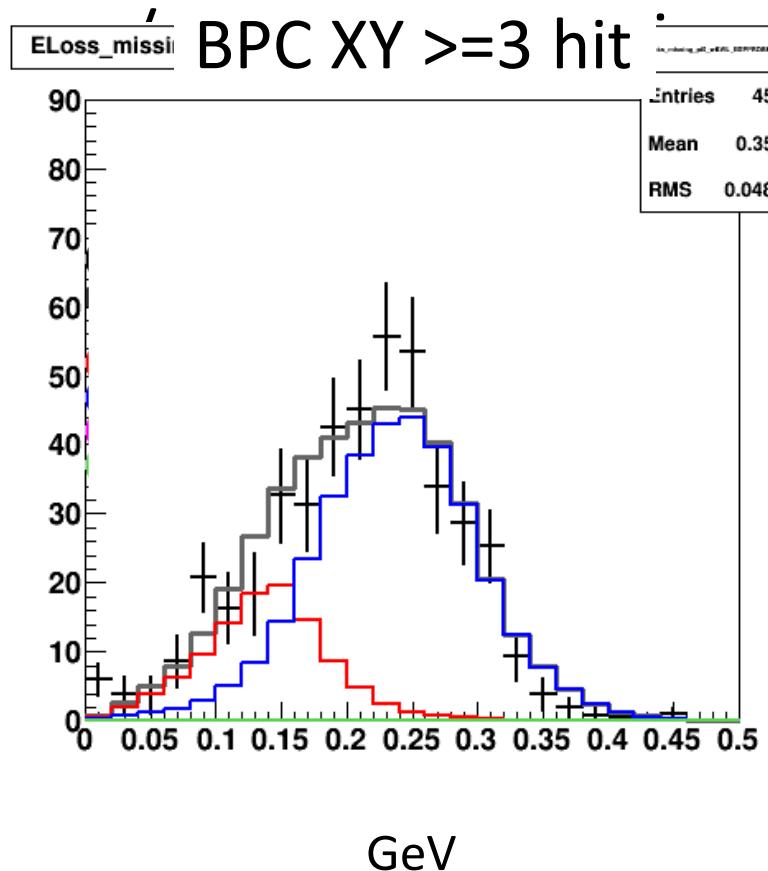
$\Lambda$  reconstruction from  $p \pi^-$  invariant mass



# Fitting of the $d(K^-, np\pi^-)''X$ missing mass

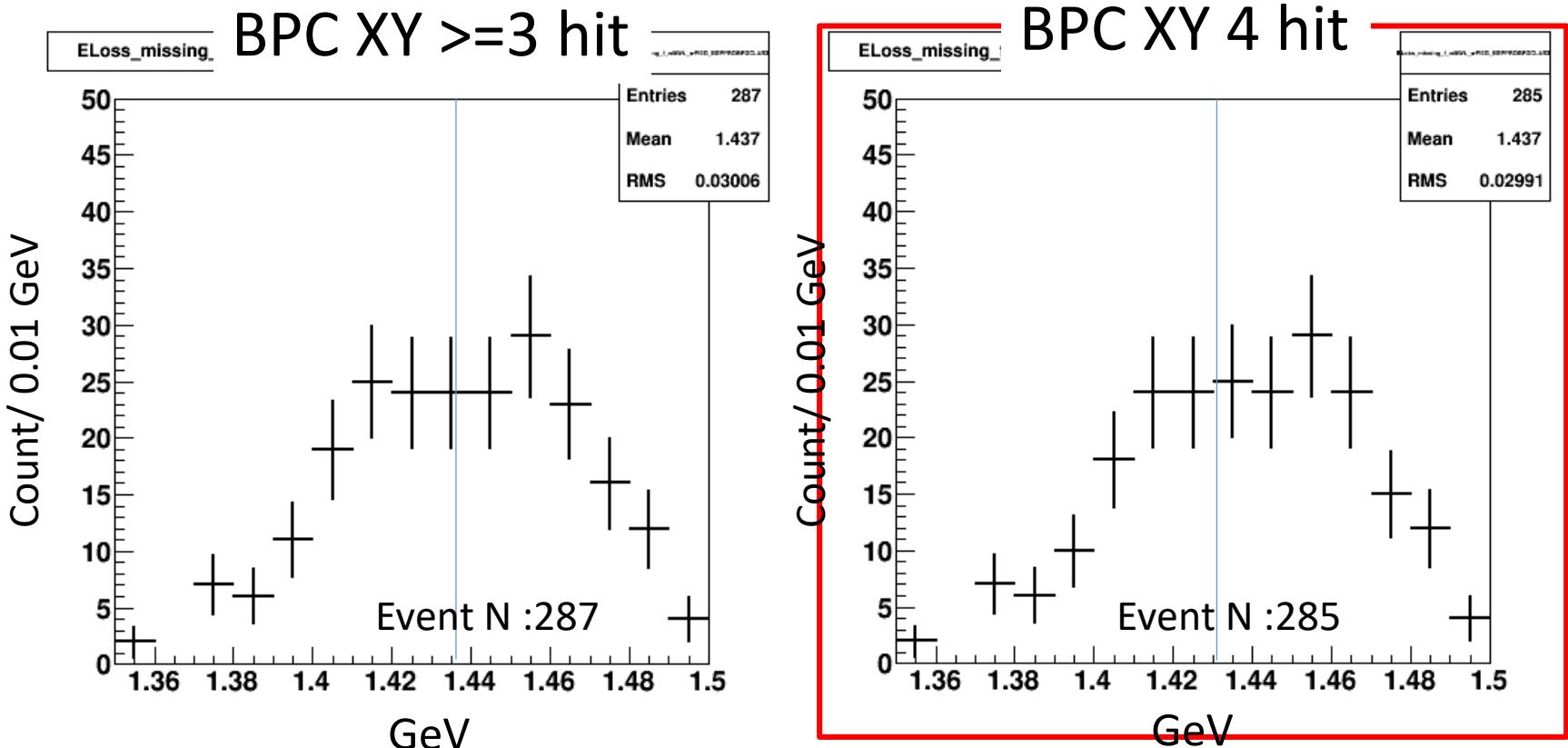
- p,  $\pi$ - invariant mass  $\Lambda$  selection

$\pi 0 \gamma$  is selected from  $d(K^-, np\pi^-)''X$  missing mass



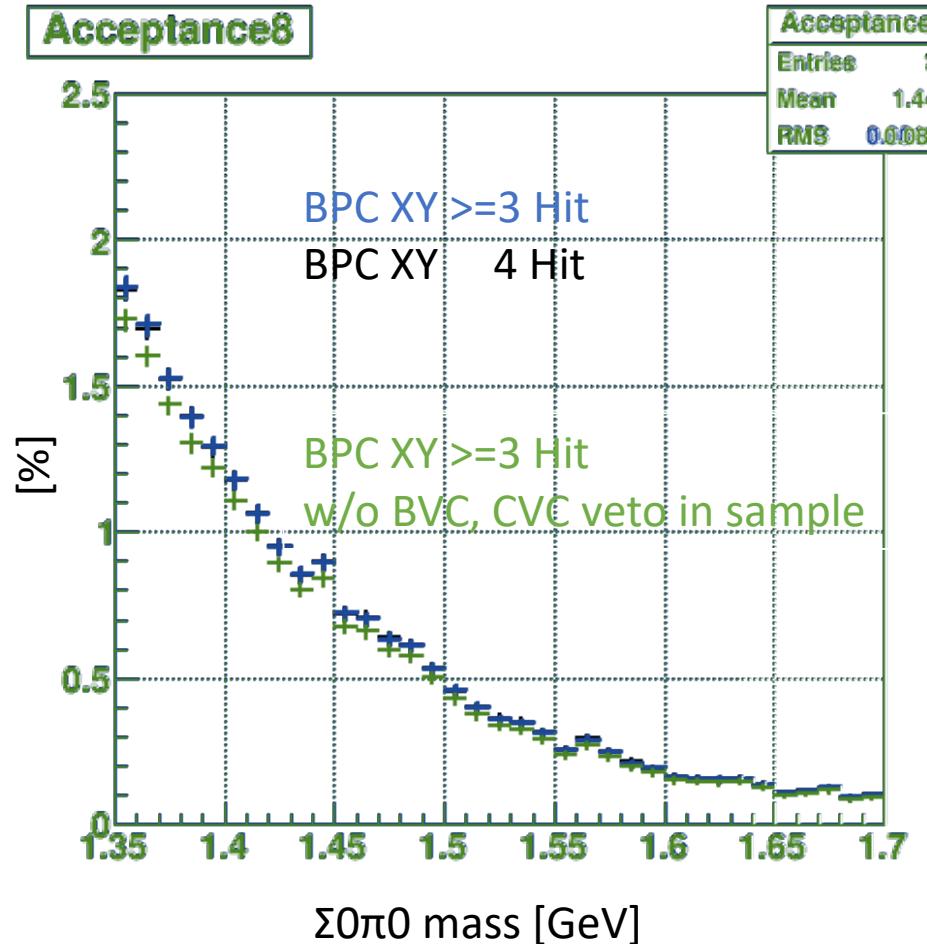
# $d(K^-, n)\pi^0\pi^0$ missing mass

- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-) X \quad 0.18 < X < 0.3 \text{ GeV}$  for  $\pi^0\gamma$

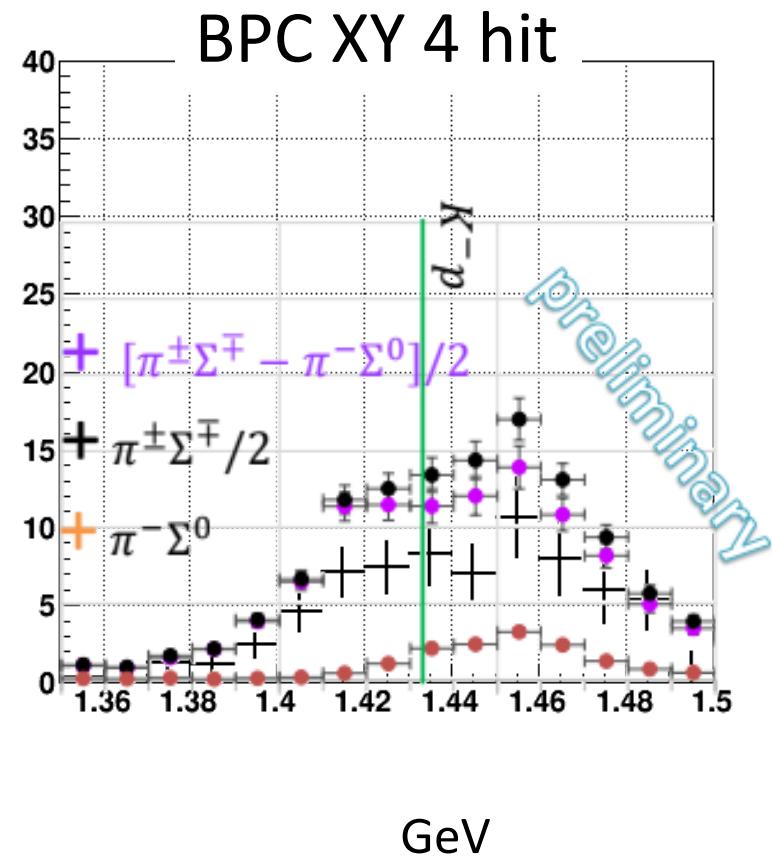
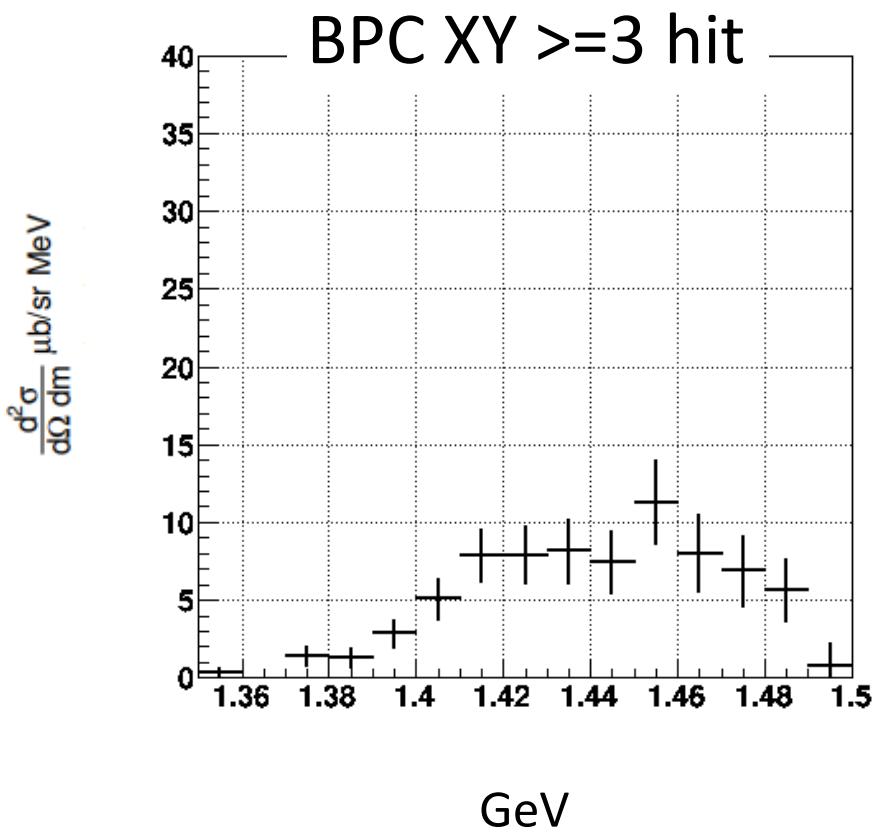


# Acceptance estimation

- Sample ;
  - $dE$  (NC) > 8 MeV –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0$  multi =1, Beam track defining..)
  - BVC, CVC veto in sample
- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)^+ X \quad 0.18 < X < 0.30 \text{ GeV}$



# Cross Section



# BPC Backward Tracking efficiency w/ Beam region cut 2

- BPC XY 4Hit
  - Run78 data (w/o forward analysis)
  - Run78 data
  - SIM

# BPD hit pos R<0~4

w/o forward neutron analysis for the increase of statistics

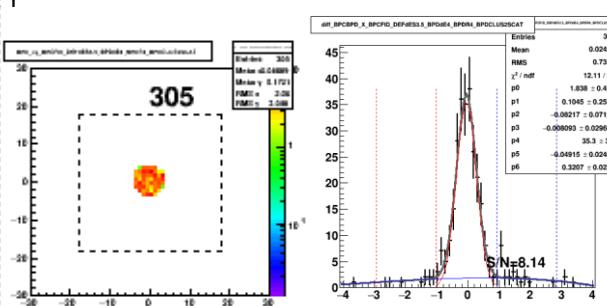
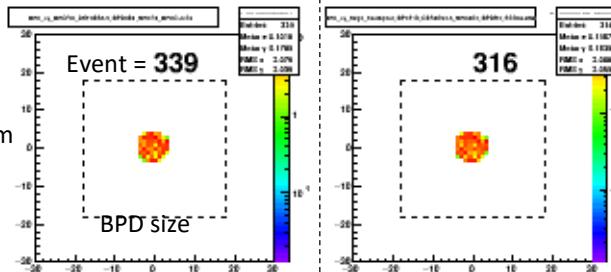
Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

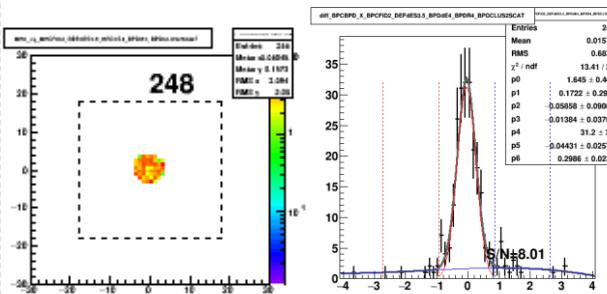
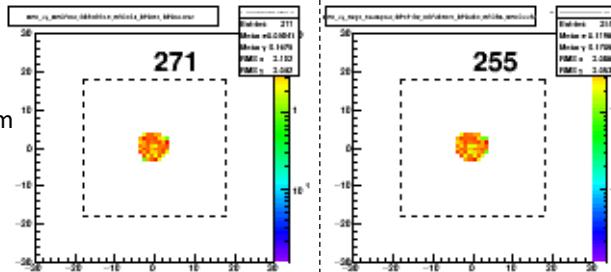
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

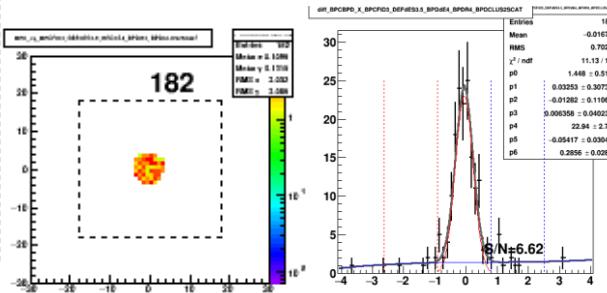
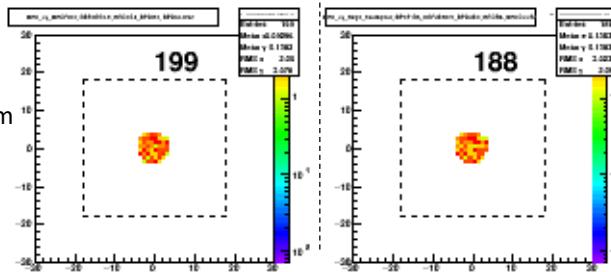
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



# BPD hit pos R<4~8

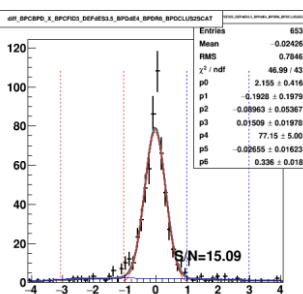
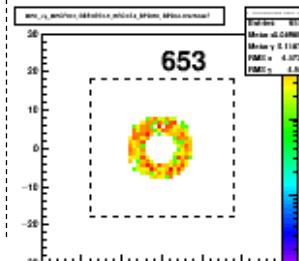
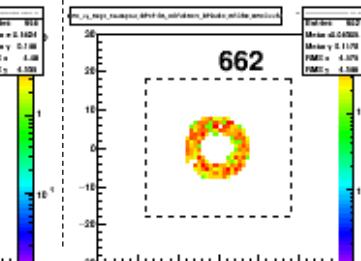
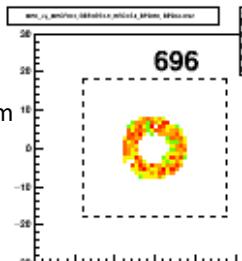
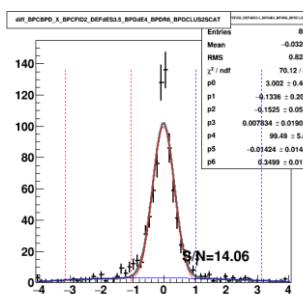
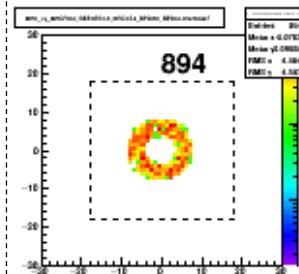
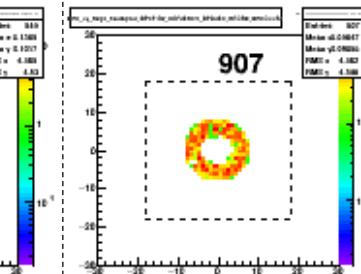
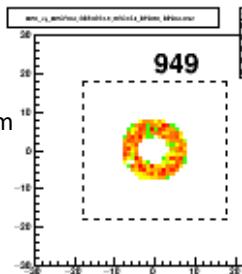
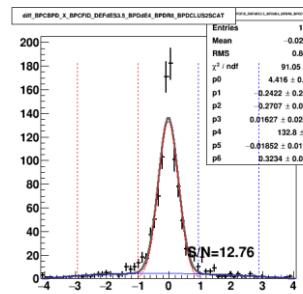
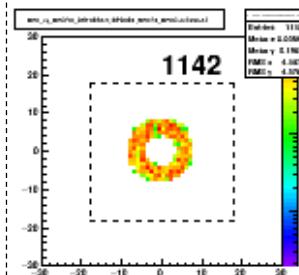
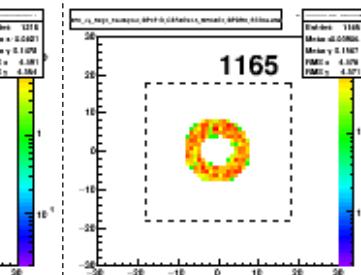
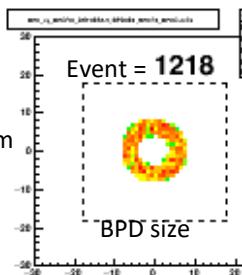
w/o forward neutron analysis for the increase of statistics

Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event



# BPD hit pos R<8~12

w/o forward neutron analysis for the increase of statistics

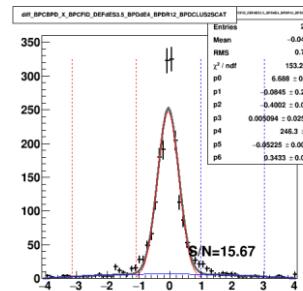
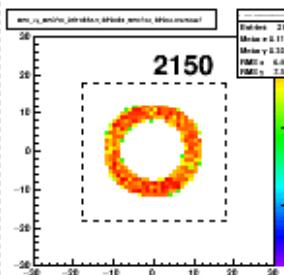
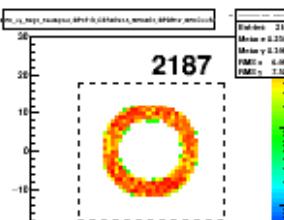
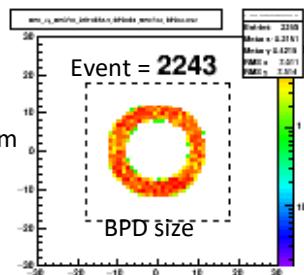
Sample

- $dE(BPD)$  4~12 MeV
- $dE(DEF)$  3.5~9 MeV
- BPD hit pos  $R < 8 \sim 12$

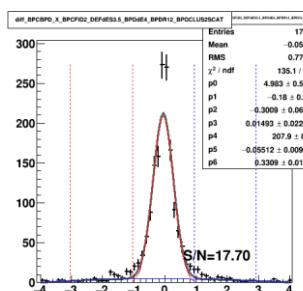
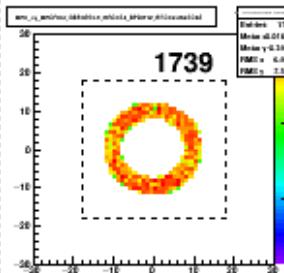
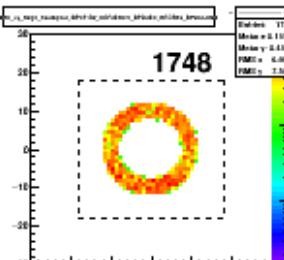
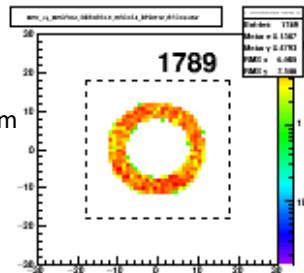
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

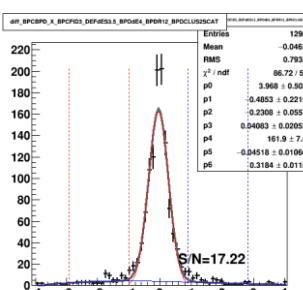
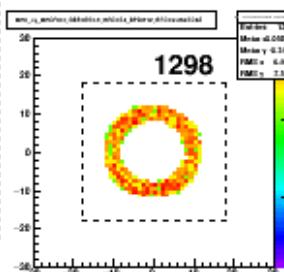
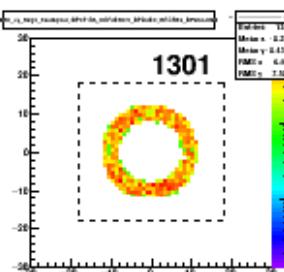
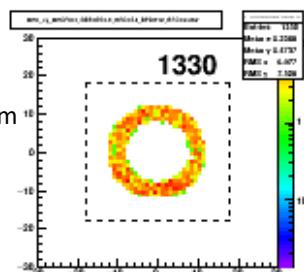
BEAM Track @  $z = -5.5$  cm  
 Fiducial  $R < 3.0$  cm



BEAM Track @  $z = -5.5$  cm  
 Fiducial  $R < 2.5$  cm



BEAM Track @  $z = -5.5$  cm  
 Fiducial  $R < 2.0$  cm



# BPD hit pos R<12~16

w/o forward neutron analysis for the increase of statistics

Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

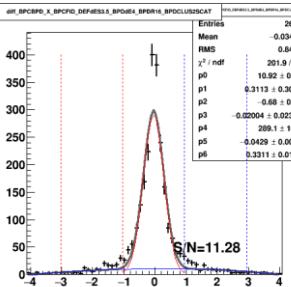
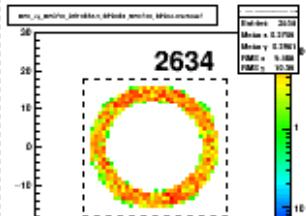
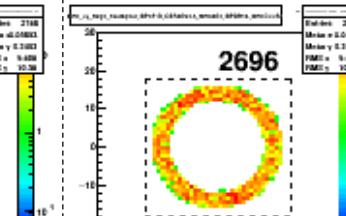
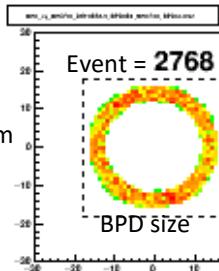
w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

w/ the presence of  
BPC Backward Track event

BEAM

Track @ z=-5.5 cm

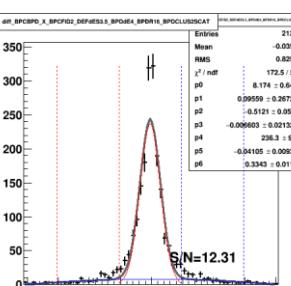
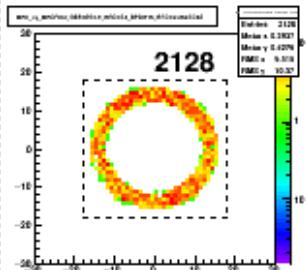
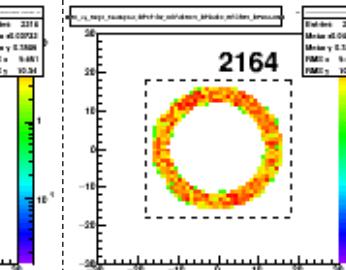
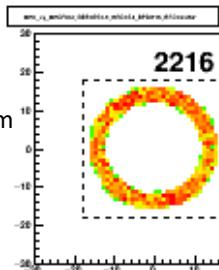
Fiducial R<3.0 cm



BEAM

Track @ z=-5.5 cm

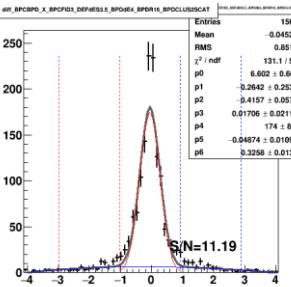
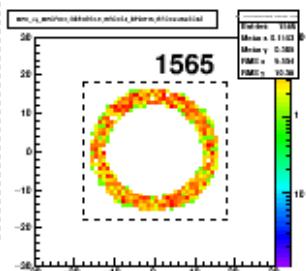
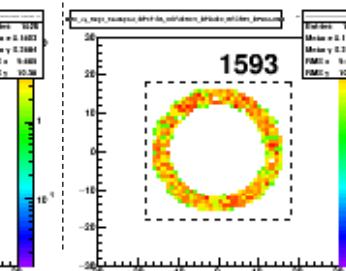
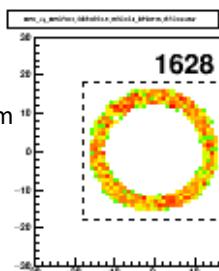
Fiducial R<2.5 cm



BEAM

Track @ z=-5.5 cm

Fiducial R<2.0 cm



		ratio		ratio err	
R 0~4	Beam Fiducial R < 3	0.932153	0.899705	0.013659	0.016315
	Beam Fiducial R < 2.5	0.940959	0.915129	0.014318	0.016929
	Beam Fiducial R < 2	0.944724	0.914573	0.016199	0.019814
R 4~8	Beam Fiducial R < 3	0.956486	0.937603	0.005846	0.006931
	Beam Fiducial R < 2.5	0.955743	0.942044	0.006676	0.007585
	Beam Fiducial R < 2	0.951149	0.938218	0.008171	0.009126
R 8~12	Beam Fiducial R < 3	0.975033	0.958538	0.003294	0.004209
	Beam Fiducial R < 2.5	0.977082	0.972051	0.003538	0.003897
	Beam Fiducial R < 2	0.978195	0.97594	0.004005	0.004202
R 12~16	Beam Fiducial R < 3	0.973988	0.95159	0.003025	0.00408
	Beam Fiducial R < 2.5	0.976534	0.960289	0.003216	0.004148
	Beam Fiducial R < 2	0.978501	0.961302	0.003595	0.00478

# BPD hit pos R<0~4

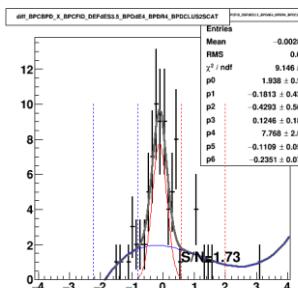
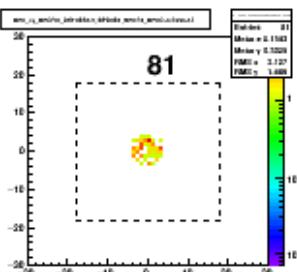
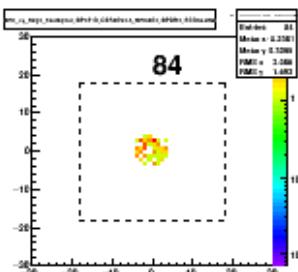
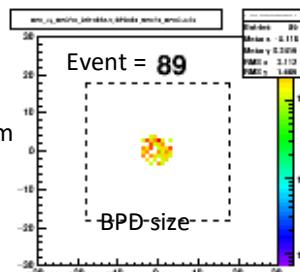
## Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

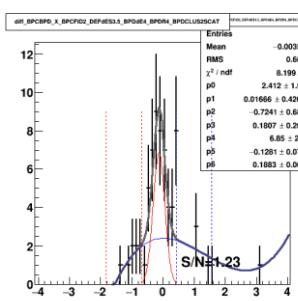
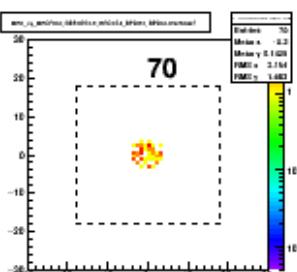
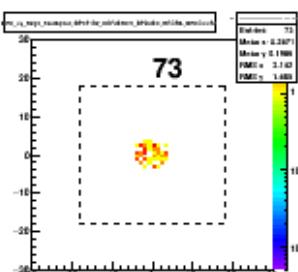
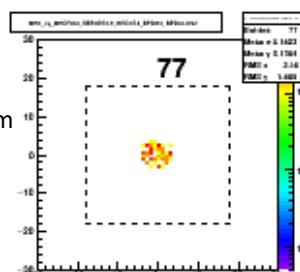
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

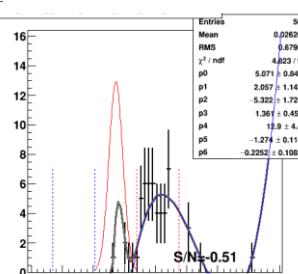
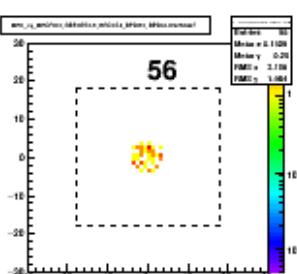
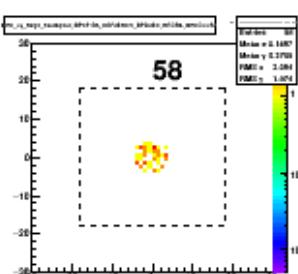
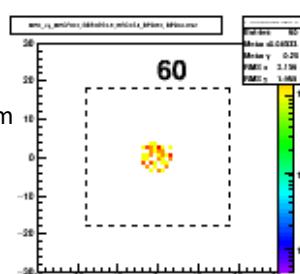
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



# BPD hit pos R<4~8

in the sample event  
(BPD Cluster > 3MeV) Page.60

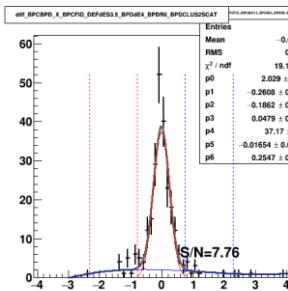
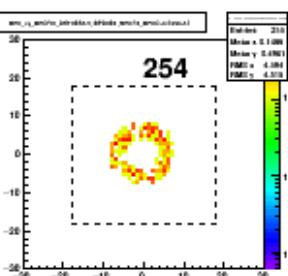
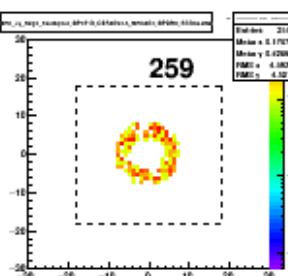
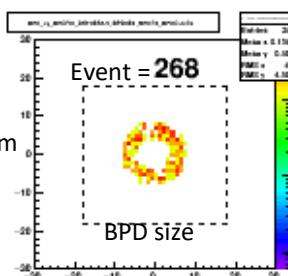
## Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

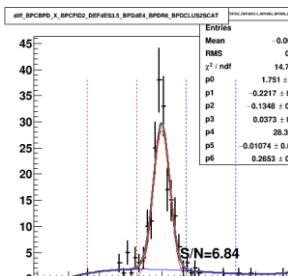
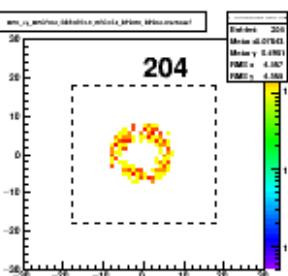
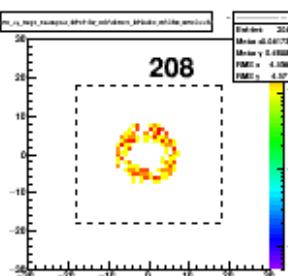
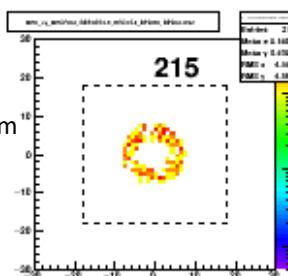
w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

w/ the presence of  
BPC Backward Track event

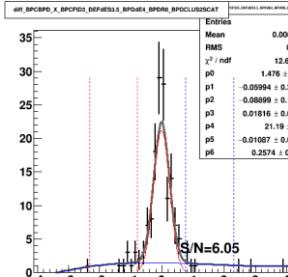
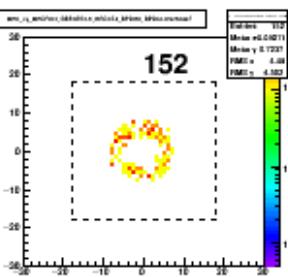
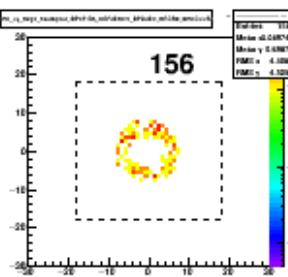
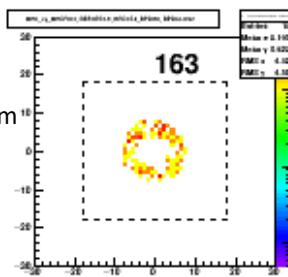
BEAM Track @ z=-5.5 cm  
Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm



in the sample event  
(BPD Cluster > 3MeV) Page.60

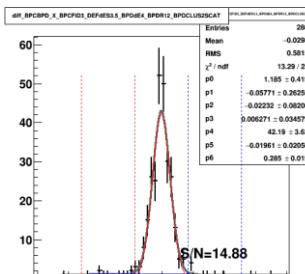
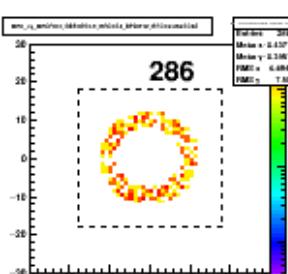
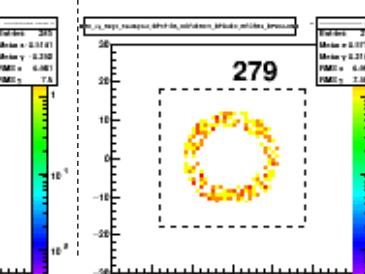
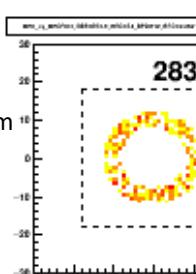
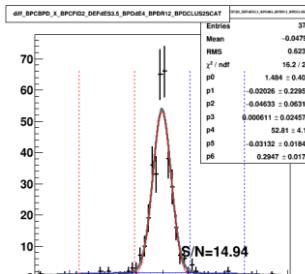
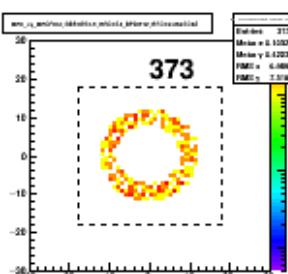
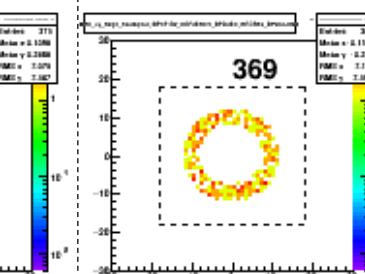
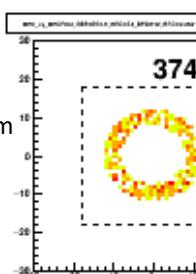
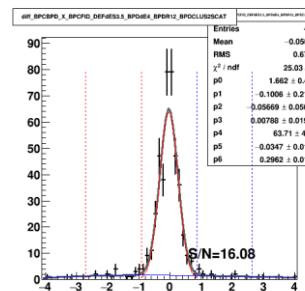
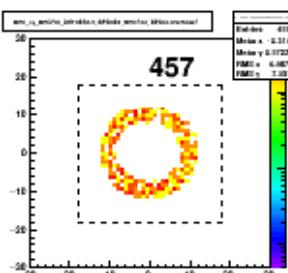
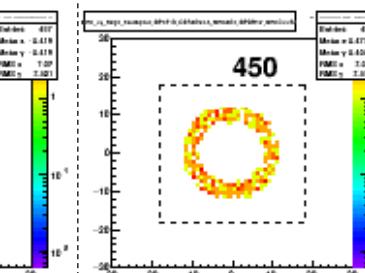
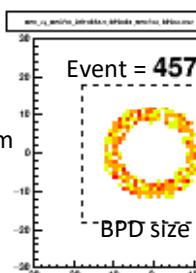
# BPD hit pos R<8~12

## Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

w/ the presence of  
BPC Backward Track event



# BPD hit pos R<12~16

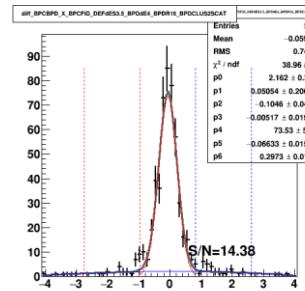
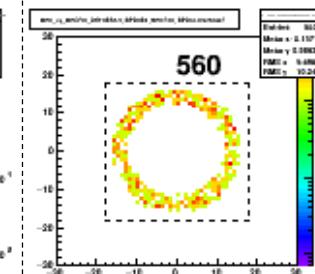
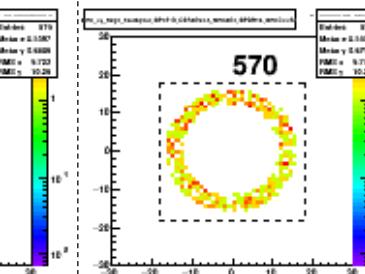
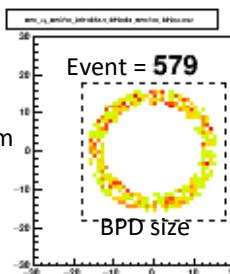
## Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

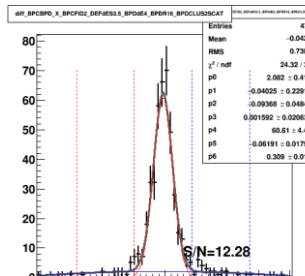
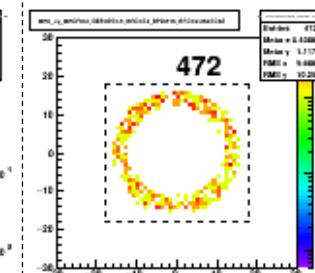
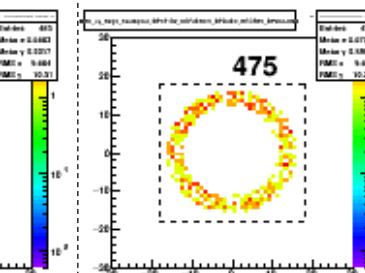
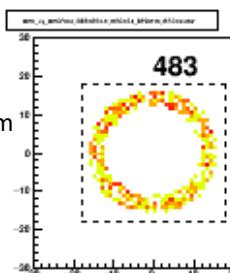
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

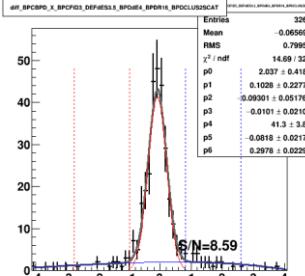
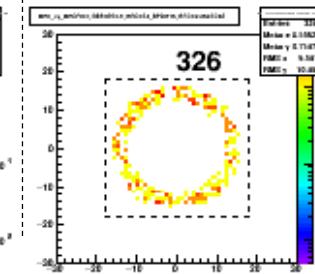
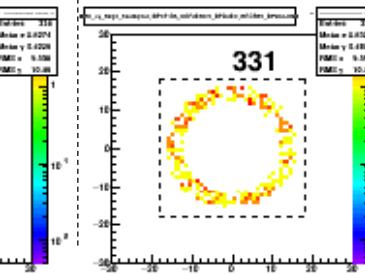
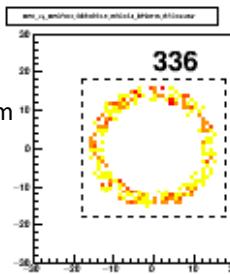
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



		ratio		ratio err	
R 0~4	Beam Fiducial R < 3	0.94382	0.910112	0.024408	0.030318
	Beam Fiducial R < 2.5	0.948052	0.909091	0.02529	0.032761
	Beam Fiducial R < 2	0.966667	0.933333	0.023174	0.032203
R 4~8	Beam Fiducial R < 3	0.966418	0.947761	0.011004	0.013592
	Beam Fiducial R < 2.5	0.967442	0.948837	0.012104	0.015026
	Beam Fiducial R < 2	0.957055	0.932515	0.015879	0.019649
R 8~12	Beam Fiducial R < 3	0.984683	1	0.005745	0
	Beam Fiducial R < 2.5	0.986631	0.997326	0.005939	0.00267
	Beam Fiducial R < 2	0.985866	1.010601	0.007017	#NUM!
R 12~16	Beam Fiducial R < 3	0.984456	0.967185	0.005141	0.007404
	Beam Fiducial R < 2.5	0.983437	0.977226	0.005807	0.006788
	Beam Fiducial R < 2	0.985119	0.970238	0.006605	0.00927

# BPD hit pos R<0~4

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

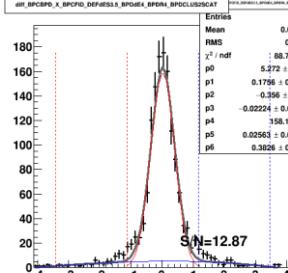
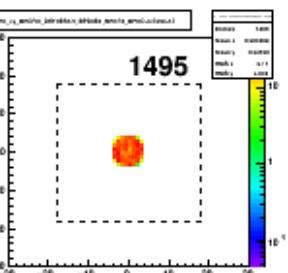
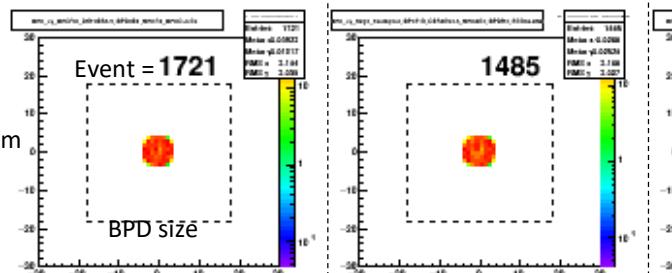
Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

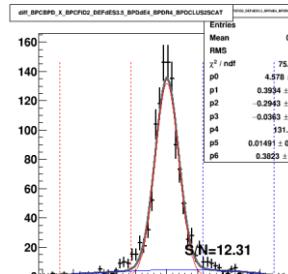
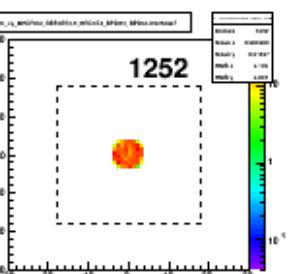
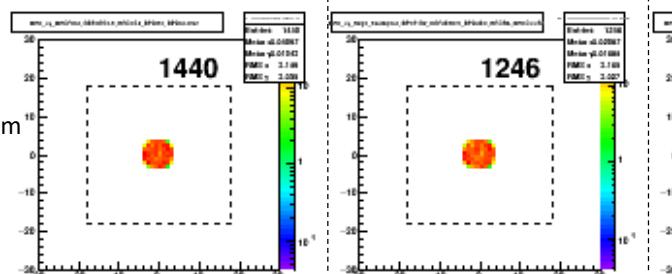
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



SN=12.87

Entries: 1495  
 Mean: 0.02332  
 RMS: 0.7639  
 $\chi^2 / ndf$ : 88.78 / 48  
 p0: 0.1795 ± 0.2409  
 p1: 0.1795 ± 0.0669  
 p2: 0.02224 ± 0.02325  
 p3: 158.1 ± 8.6  
 p4: 0.02543 ± 0.01020  
 p5: 0.02826 ± 0.01333

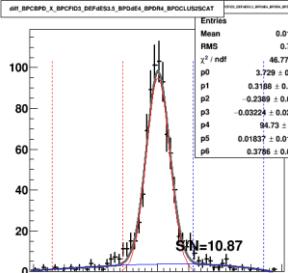
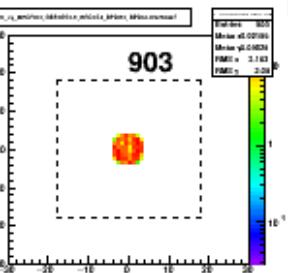
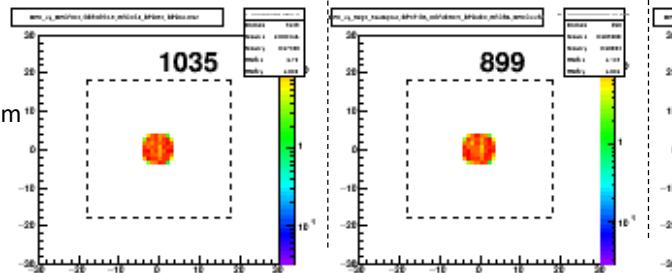
BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



SN=12.31

Entries: 1252  
 Mean: 0.01621  
 RMS: 0.7552  
 $\chi^2 / ndf$ : 75.44 / 45  
 p0: 0.3934 ± 0.4001  
 p1: 0.2943 ± 0.0581  
 p2: 0.0363 ± 0.0111  
 p3: 131.6 ± 6.3  
 p4: 0.01491 ± 0.01313  
 p5: 0.3823 ± 0.0149

BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



SN=10.87

Entries: 903  
 Mean: 0.01762  
 RMS: 0.7827  
 $\chi^2 / ndf$ : 46.77 / 43  
 p0: 0.3729 ± 0.2371  
 p1: 0.3198 ± 0.0271  
 p2: -0.2389 ± 0.0629  
 p3: 0.03232 ± 0.02299  
 p4: 94.73 ± 5.13  
 p5: 0.01837 ± 0.01567  
 p6: 0.3796 ± 0.0166

# BPD hit pos R<4~8

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

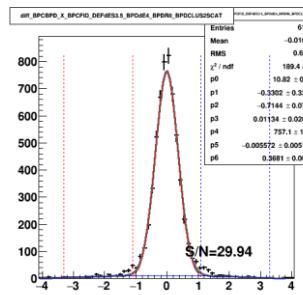
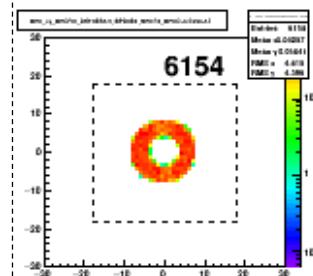
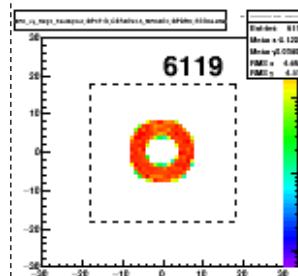
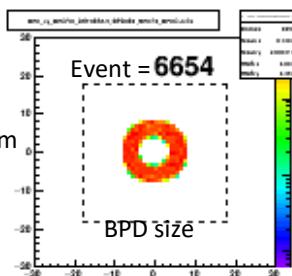
Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

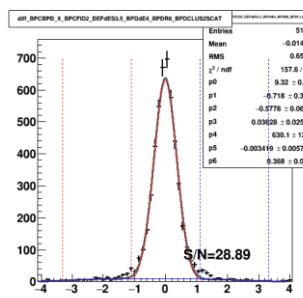
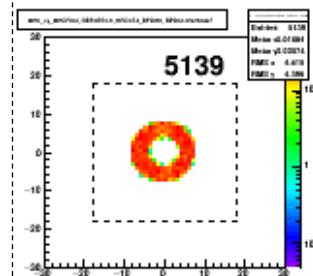
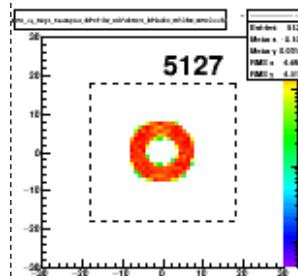
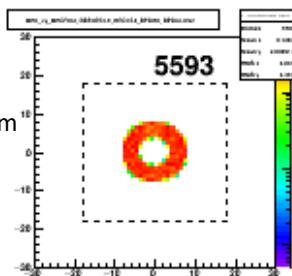
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

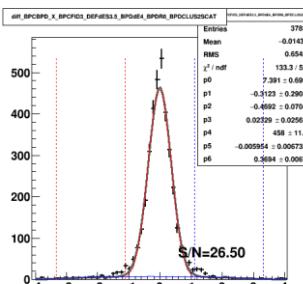
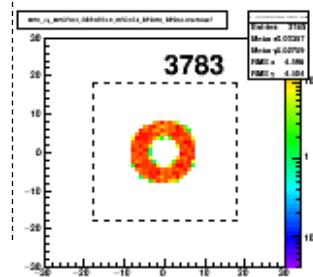
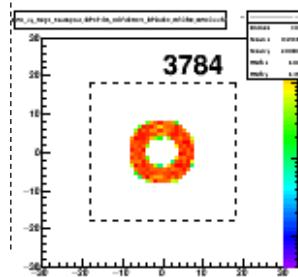
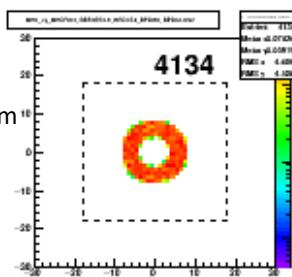
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



# BPD hit pos R<8~12

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

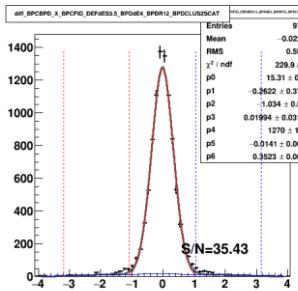
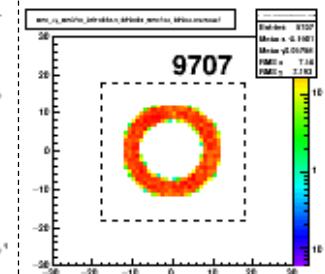
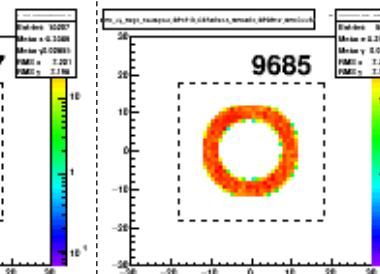
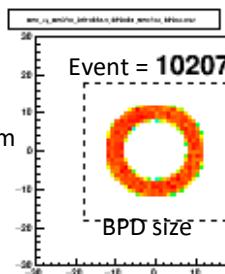
Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

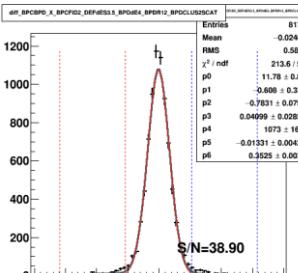
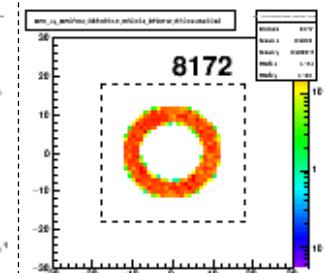
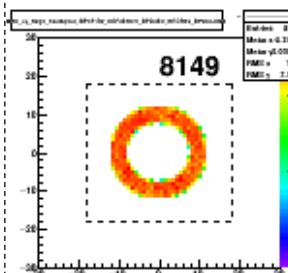
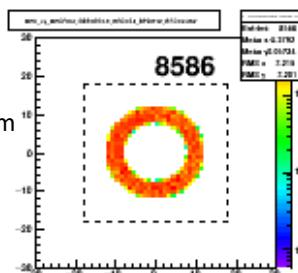
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

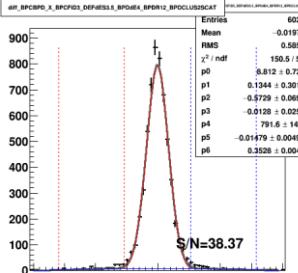
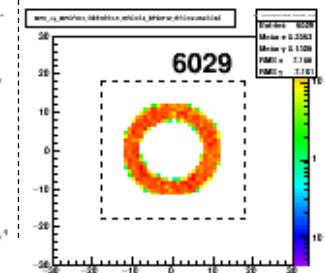
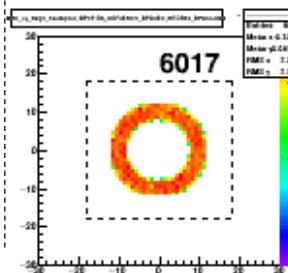
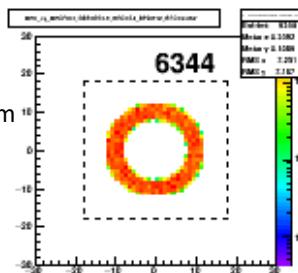
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



# BPD hit pos R<12~16

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

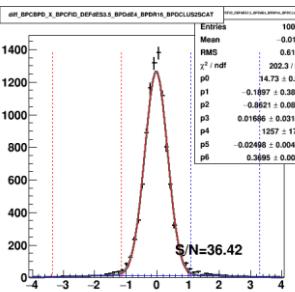
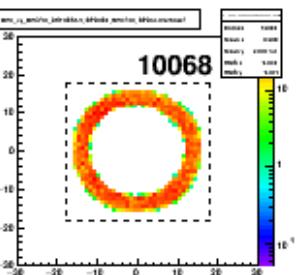
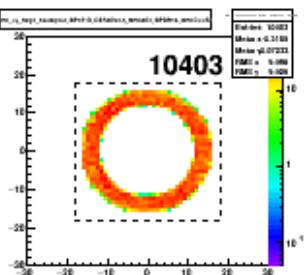
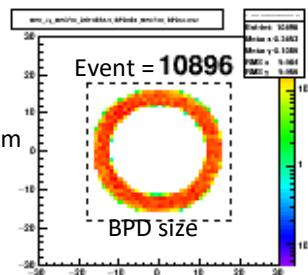
Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

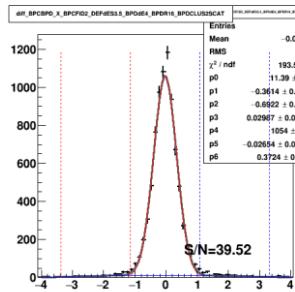
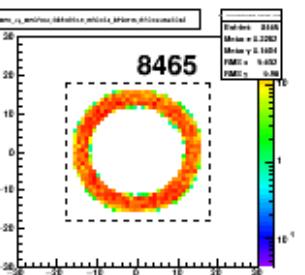
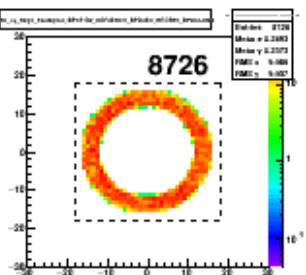
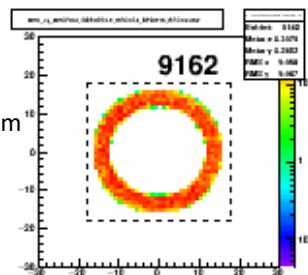
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

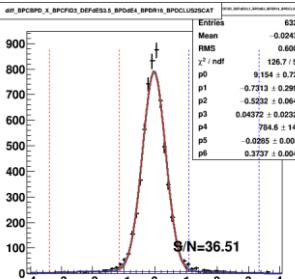
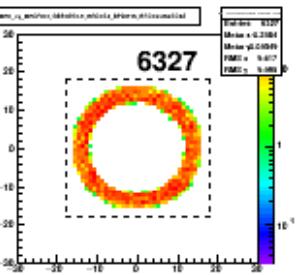
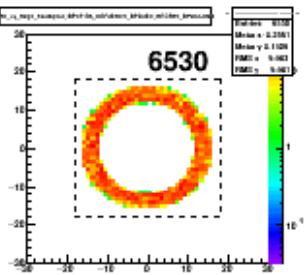
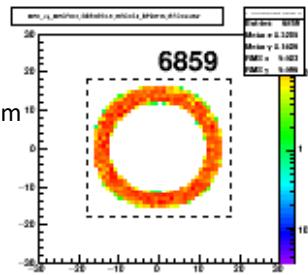
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



		ratio		ratio err	
R 0~4	Beam Fiducial R < 3	0.86287	0.868681	0.008292	0.008141
	Beam Fiducial R < 2.5	0.865278	0.869444	0.008997	0.008878
	Beam Fiducial R < 2	0.868599	0.872464	0.010501	0.010369
R 4~8	Beam Fiducial R < 3	0.919597	0.924857	0.003333	0.003232
	Beam Fiducial R < 2.5	0.916682	0.918827	0.003695	0.003652
	Beam Fiducial R < 2	0.915336	0.915094	0.00433	0.004335
R 8~12	Beam Fiducial R < 3	0.948859	0.951014	0.00218	0.002136
	Beam Fiducial R < 2.5	0.949103	0.951782	0.002372	0.002312
	Beam Fiducial R < 2	0.948455	0.950347	0.002776	0.002727
R 12~16	Beam Fiducial R < 3	0.954754	0.924009	0.001991	0.002539
	Beam Fiducial R < 2.5	0.952412	0.923925	0.002224	0.00277
	Beam Fiducial R < 2	0.952034	0.922438	0.00258	0.00323

# BPC Backward Tracking efficiency w/ Beam region cut 3

- BPC XY 4Hit
  - Run78 data (w/o forward analysis)
  - Run78 data
  - SIM
- BUG is fixed

# BPD hit pos R<0~4

w/o forward neutron analysis for the increase of statistics

Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

w/ the presence of  
BPC Backward Track event

Event =

BEAM Track @ z=-5.5 cm  
Fiducial R<3.0 cm

BPD size

BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm

BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm

# BPD hit pos R<4~8

w/o forward neutron analysis for the increase of statistics

Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

w/ the presence of  
BPC Backward Track event

Event =

BEAM Track @ z=-5.5 cm  
Fiducial R<3.0 cm

BPD size

BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm

BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm

# BPD hit pos R<8~12

w/o forward neutron analysis for the increase of statistics

Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

w/ the presence of  
BPC Backward Track event

Event =

BEAM Track @ z=-5.5 cm  
Fiducial R<3.0 cm

BPD size

BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm

BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm

# BPD hit pos R<12~16

w/o forward neutron analysis for the increase of statistics

Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

w/ the presence of  
BPC Backward Track event

Event =

BEAM Track @ z=-5.5 cm  
Fiducial R<3.0 cm

BPD size

BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm

BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm

		ratio		ratio err	
R 0~4	Beam Fiducial R < 3	0.932153	0.899705	0.013659	0.016315
	Beam Fiducial R < 2.5	0.940959	0.915129	0.014318	0.016929
	Beam Fiducial R < 2	0.944724	0.914573	0.016199	0.019814
R 4~8	Beam Fiducial R < 3	0.956486	0.937603	0.005846	0.006931
	Beam Fiducial R < 2.5	0.955743	0.942044	0.006676	0.007585
	Beam Fiducial R < 2	0.951149	0.938218	0.008171	0.009126
R 8~12	Beam Fiducial R < 3	0.975033	0.958538	0.003294	0.004209
	Beam Fiducial R < 2.5	0.977082	0.972051	0.003538	0.003897
	Beam Fiducial R < 2	0.978195	0.97594	0.004005	0.004202
R 12~16	Beam Fiducial R < 3	0.973988	0.95159	0.003025	0.00408
	Beam Fiducial R < 2.5	0.976534	0.960289	0.003216	0.004148
	Beam Fiducial R < 2	0.978501	0.961302	0.003595	0.00478

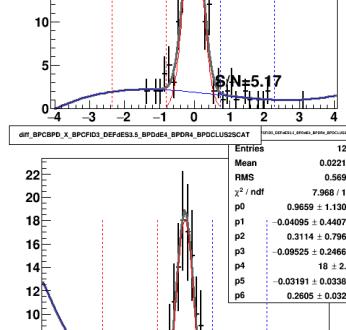
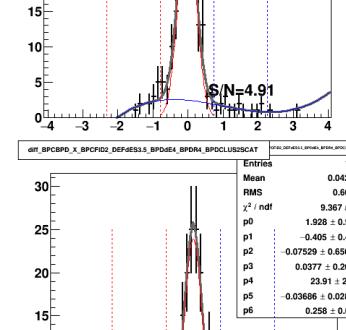
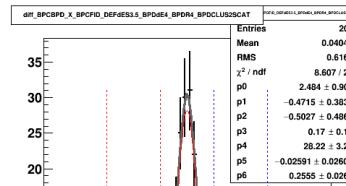
# BPD hit pos R<0~4

## Sample

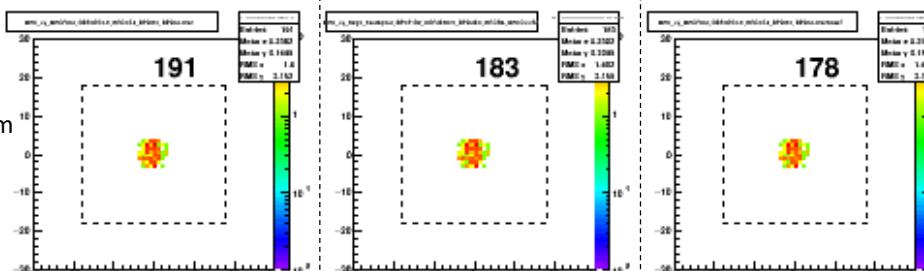
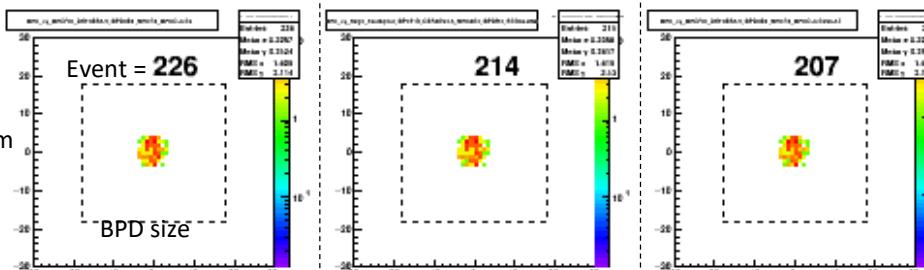
- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

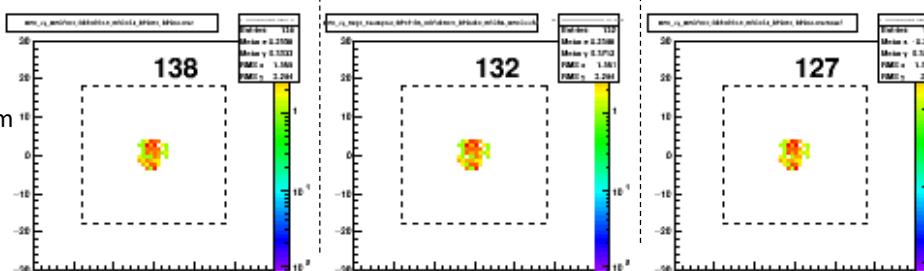
w/ the presence of  
 BPC Backward Track event



BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm

# BPD hit pos R<4~8

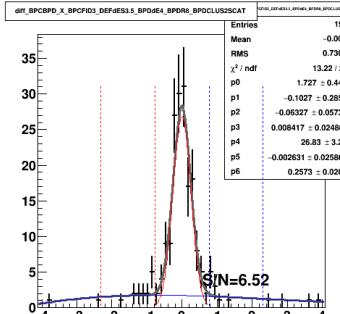
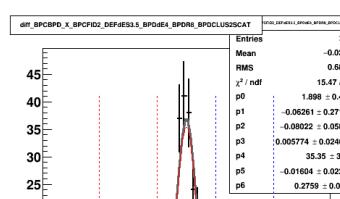
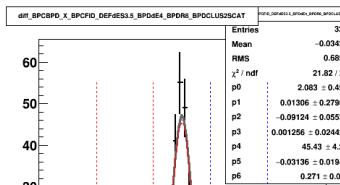
in the sample event  
(BPD Cluster > 3MeV) Page.60

## Sample

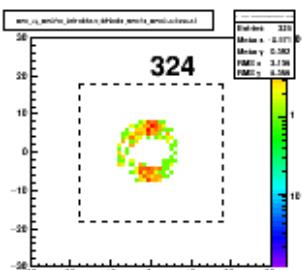
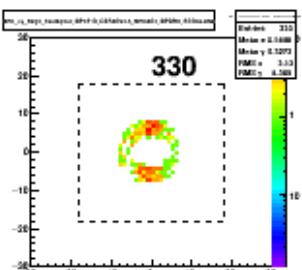
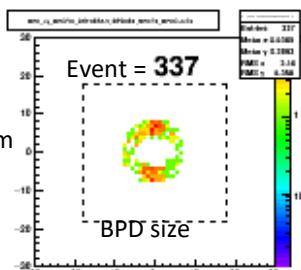
- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y

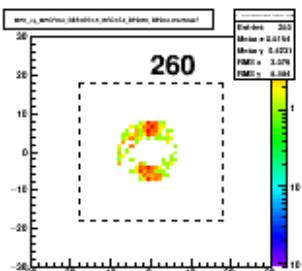
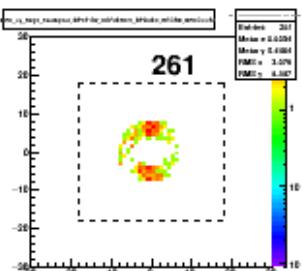
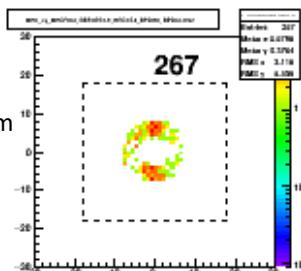
w/ the presence of  
BPC Backward Track event



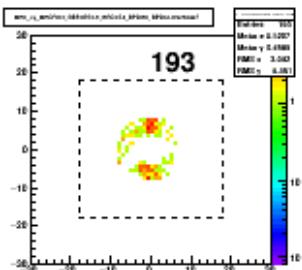
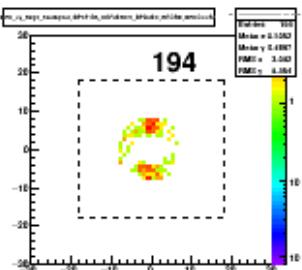
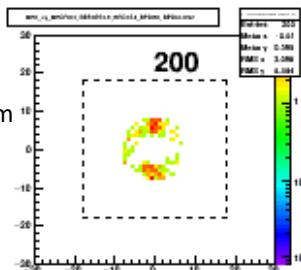
BEAM Track @ z=-5.5 cm  
Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm



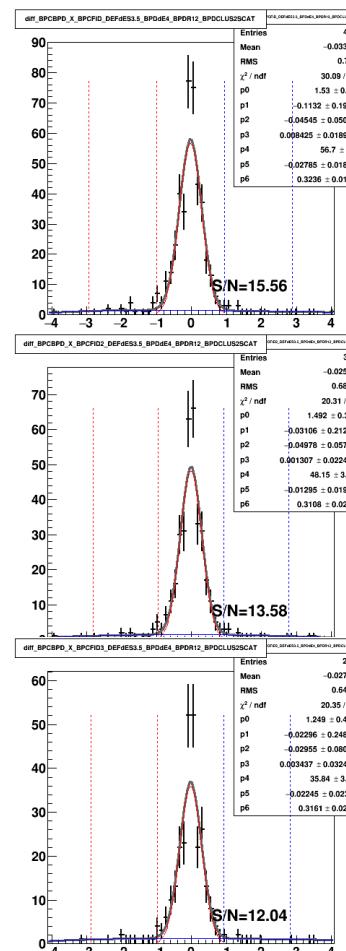
# BPD hit pos R<8~12

Sample

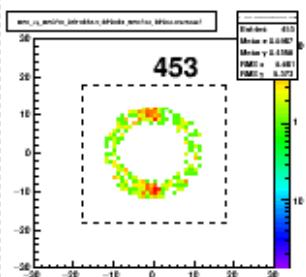
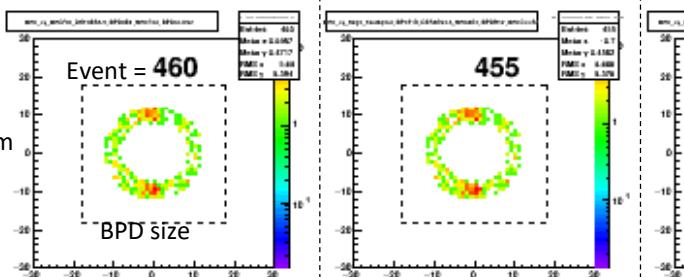
- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

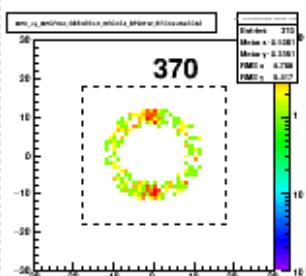
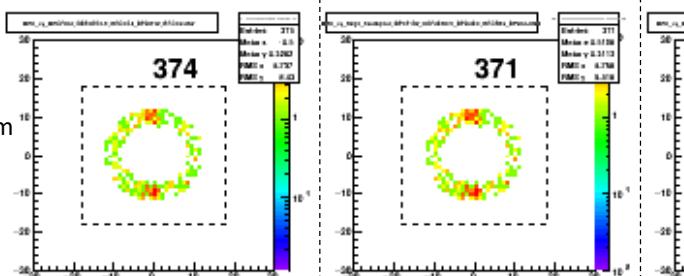
w/ the presence of  
 BPC Backward Track event



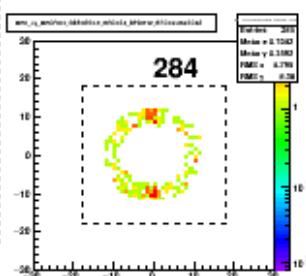
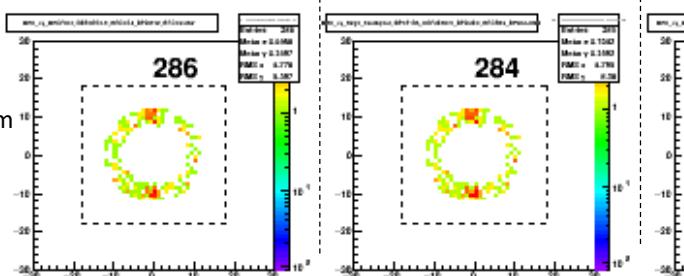
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



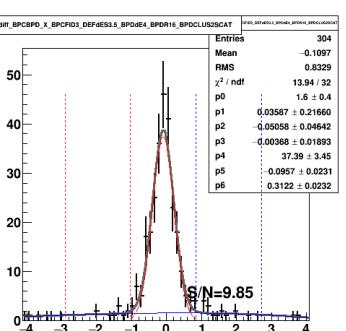
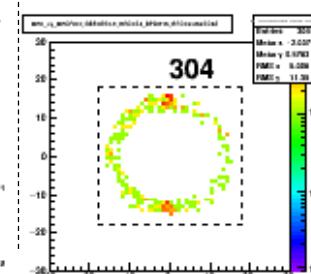
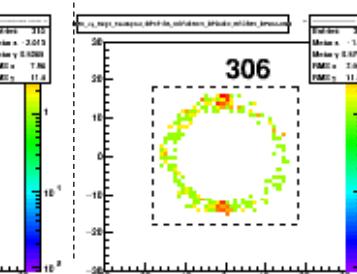
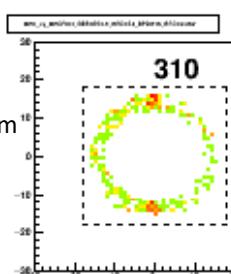
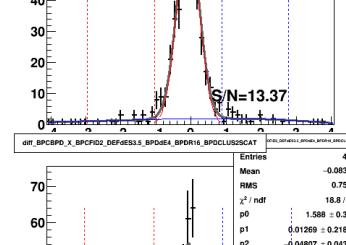
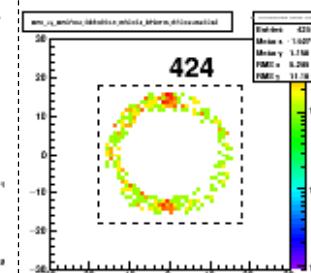
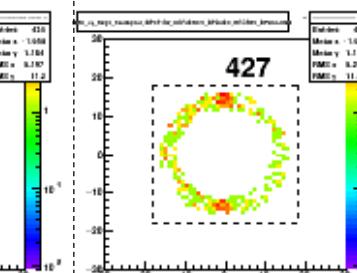
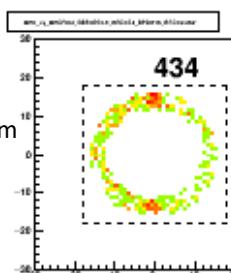
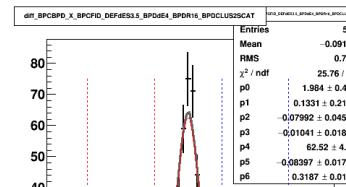
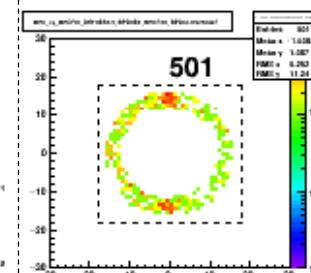
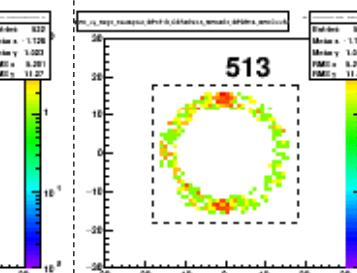
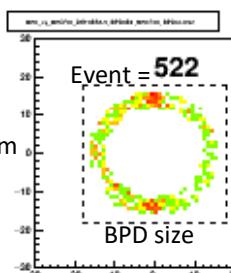
# BPD hit pos R<12~16

## Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event



		ratio		ratio err	
R 0~4	Beam Fiducial R < 3	0.946903	0.915929	0.014915	0.018459
	Beam Fiducial R < 2.5	0.958115	0.931937	0.014495	0.018223
	Beam Fiducial R < 2	0.956522	0.92029	0.01736	0.023056
R 4~8	Beam Fiducial R < 3	0.979228	0.961424	0.007769	0.010491
	Beam Fiducial R < 2.5	0.977528	0.973783	0.00907	0.009778
	Beam Fiducial R < 2	0.97	0.965	0.012062	0.012995
R 8~12	Beam Fiducial R < 3	0.98913	0.984783	0.004835	0.005708
	Beam Fiducial R < 2.5	0.991979	0.989305	0.004613	0.005319
	Beam Fiducial R < 2	0.993007	0.993007	0.004927	0.004927
R 12~16	Beam Fiducial R < 3	0.982759	0.95977	0.005697	0.0086
	Beam Fiducial R < 2.5	0.983871	0.976959	0.006047	0.007202
	Beam Fiducial R < 2	0.987097	0.980645	0.00641	0.007825

# BPD hit pos R<0~4

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

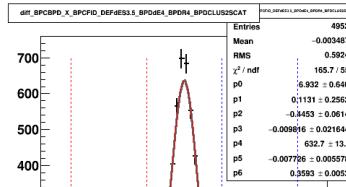
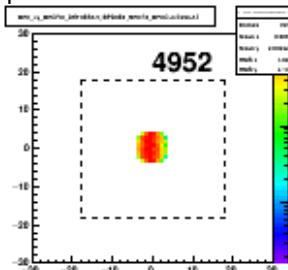
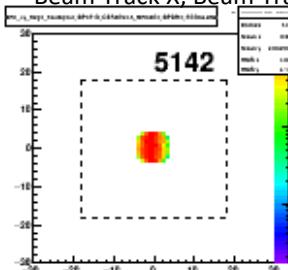
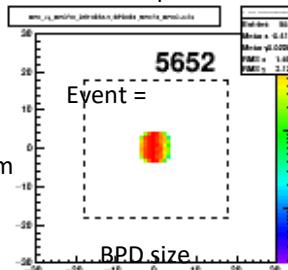
Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<0~4

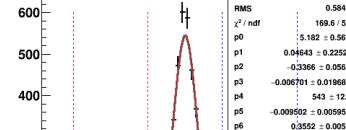
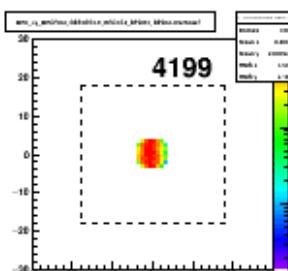
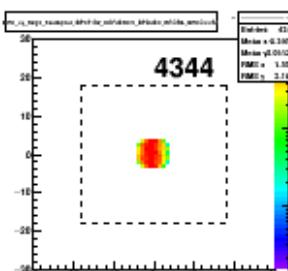
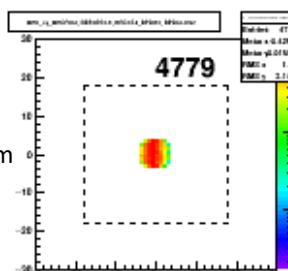
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

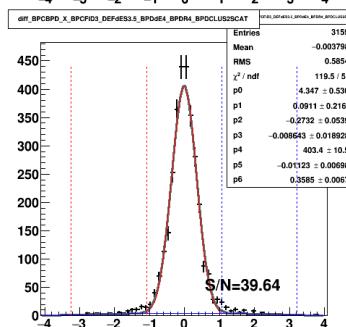
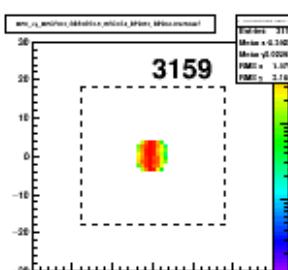
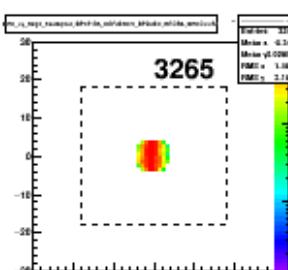
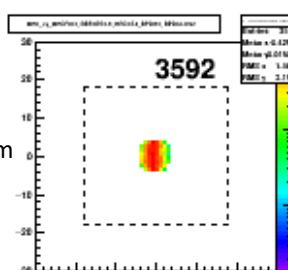
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



# BPD hit pos R<4~8

SIM

K-d ->n  $\Sigma 0 \pi 0$

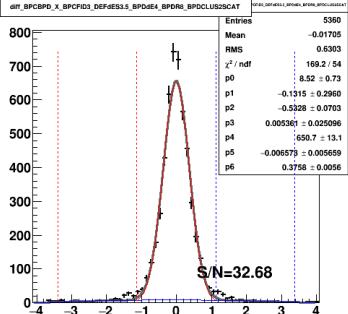
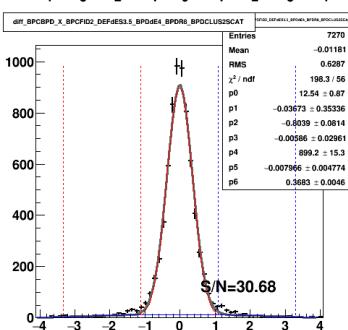
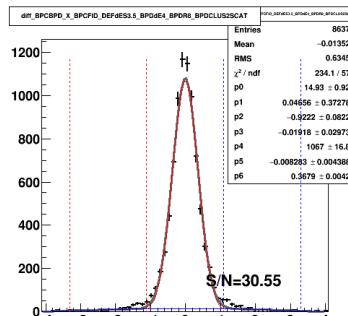
(spectrum shape ; cross Section P.9 left figure )

Sample

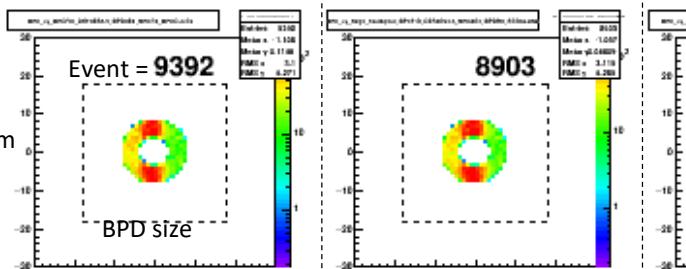
- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<4~8

w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

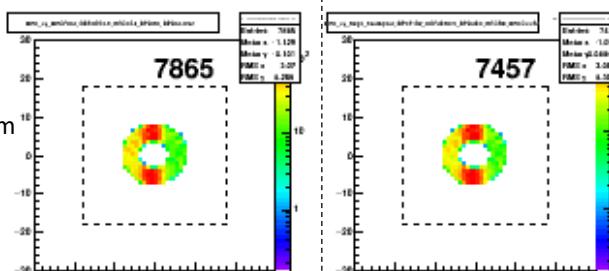
w/ the presence of  
 BPC Backward Track event



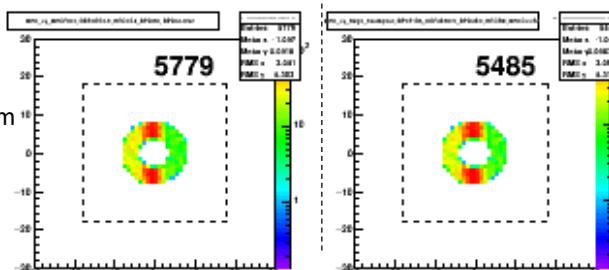
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



# BPD hit pos R<8~12

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

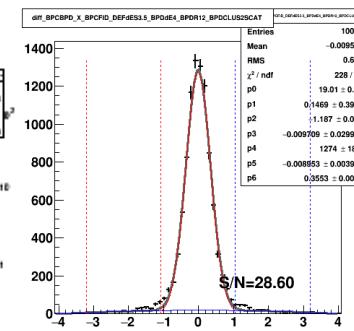
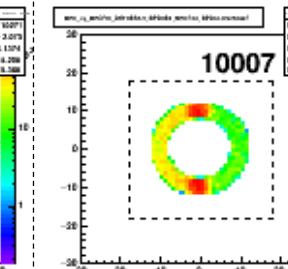
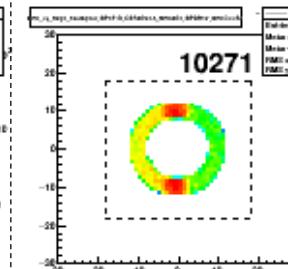
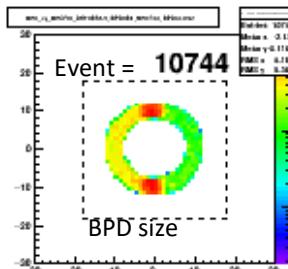
Sample

- dE(BPD) 4~12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<8~12

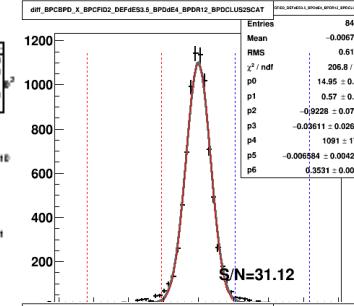
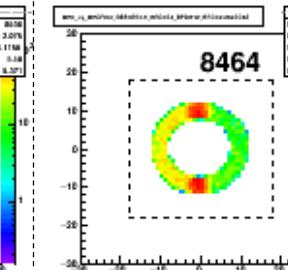
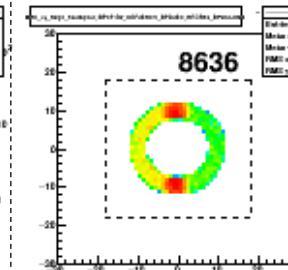
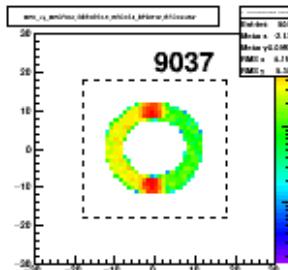
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

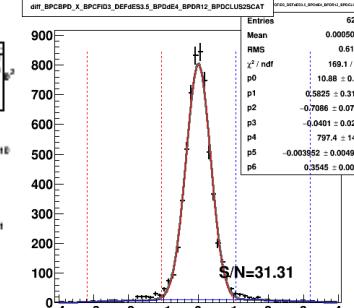
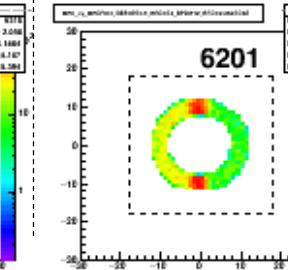
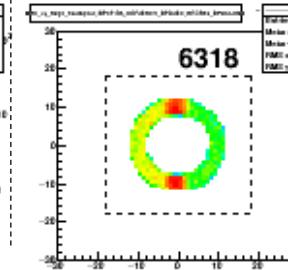
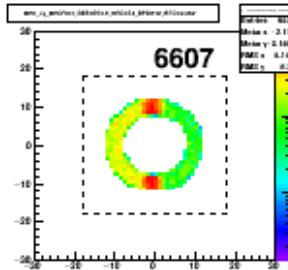
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



# BPD hit pos R<12~16

SIM

K-d ->n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure )

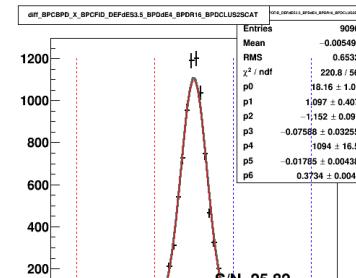
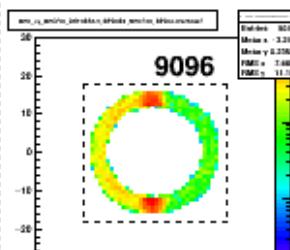
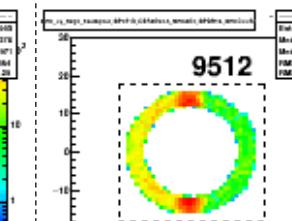
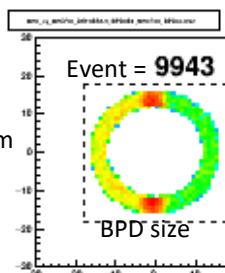
Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV
- BPD hit pos R<12~16

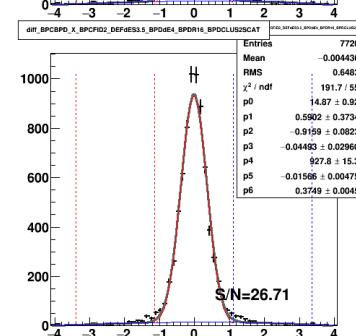
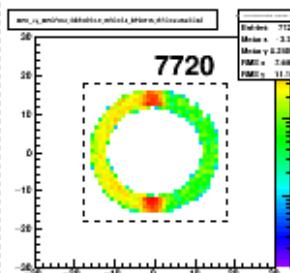
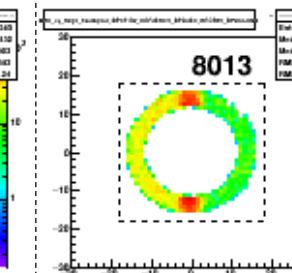
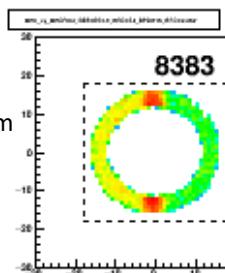
w/ the presence of  
 BPC Backward Track  
 Not same as  
 Beam Track X, Beam Track Y

w/ the presence of  
 BPC Backward Track event

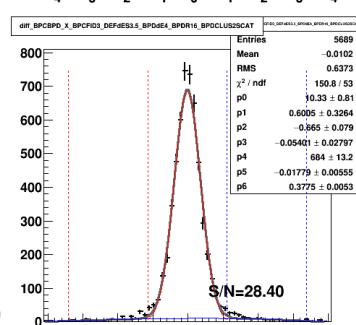
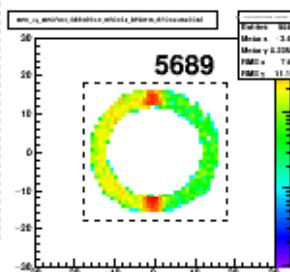
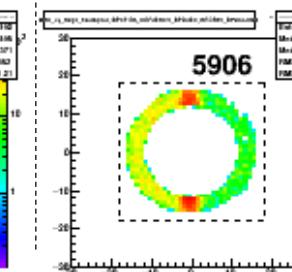
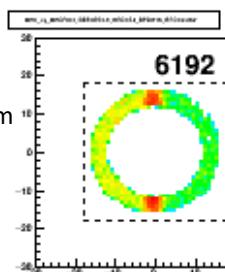
BEAM Track @ z=-5.5 cm  
 Fiducial R<3.0 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
 Fiducial R<2.0 cm



			ratio		ratio err
R 0~4	Beam Fiducial R < 3		0.909766	0.87615	0.003811 0.004382
	Beam Fiducial R < 2.5		0.908977	0.878636	0.004161 0.004724
	Beam Fiducial R < 2		0.908964	0.879454	0.0048 0.005433
R 4~8	Beam Fiducial R < 3		0.947934	0.919612	0.002292 0.002806
	Beam Fiducial R < 2.5		0.948125	0.924348	0.002501 0.002982
	Beam Fiducial R < 2		0.949126	0.927496	0.002891 0.003411
R 8~12	Beam Fiducial R < 3		0.955975	0.931404	0.001979 0.002439
	Beam Fiducial R < 2.5		0.955627	0.936594	0.002166 0.002563
	Beam Fiducial R < 2		0.956259	0.93855	0.002516 0.002955
R 12~16	Beam Fiducial R < 3		0.956653	0.914814	0.002042 0.0028
	Beam Fiducial R < 2.5		0.955863	0.920911	0.002243 0.002948
	Beam Fiducial R < 2		0.953811	0.918766	0.002667 0.003472

# To do

- $\Lambda$  side-band treatment
- $\Upsilon$  dependence of the diff. BPC-BPD  $y$ 
  - Slewing correction @ high dE of backward proton or light velocity ?
- $\Sigma^0\pi^0$  contamination in  $\Lambda\pi^0$ 
  - Fitting w/ SIM of  $K-d \rightarrow \Lambda\pi^0$
  - $\Lambda\pi^0$  spectrum is estimated from the data of the region less than 0.18 GeV in  $d(K^-, np\pi^-)$

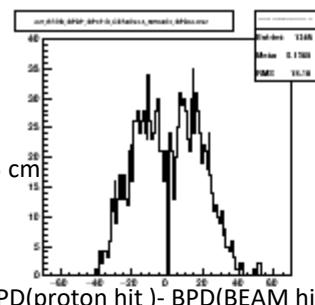
# Diff BPD(proton hit )- BPD(BEAM hit) Segment

Run78

Data

Sample

- dE(BPD) 4~ 12 MeV
- dE(DEF) 3.5~9 MeV

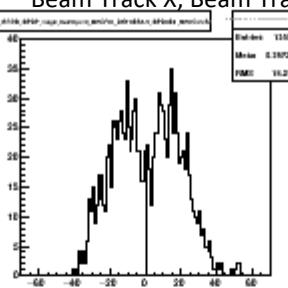


BPD(proton hit)- BPD(BEAM hit) seg

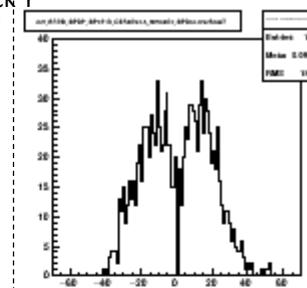
Definition of BEAM hit segment

- BPC Beam Track @ BPD
- TOF BPD-T0<4 ns

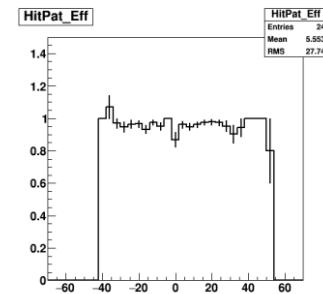
w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y



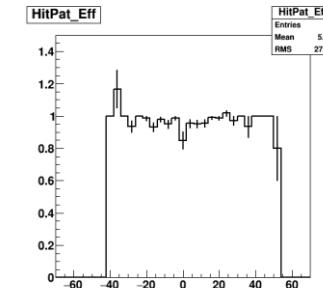
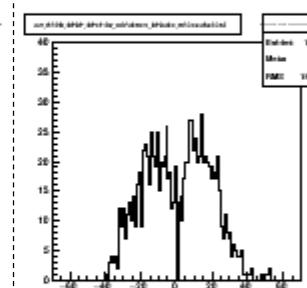
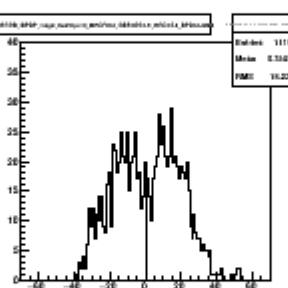
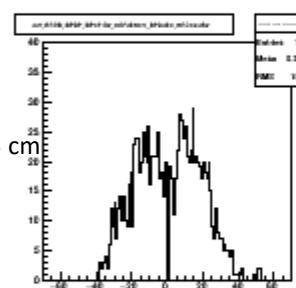
w/ the presence of  
BPC Backward Track event  
(Fiducial cut w/o Z)



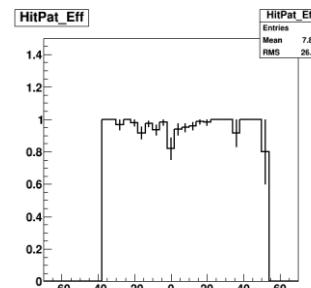
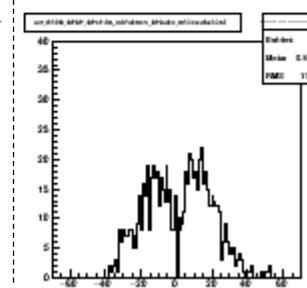
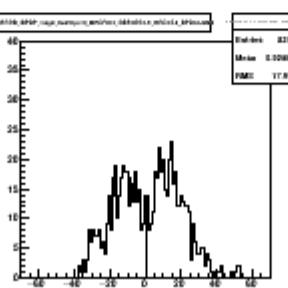
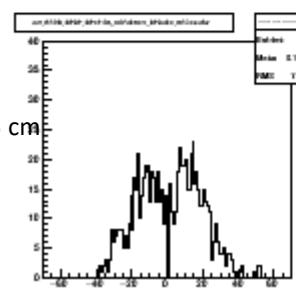
Ratio(Fiducial cut w/o Z /sample)



BEAM Track @ z=-5.5 cm  
Fiducial R<2.5 cm



BEAM Track @ z=-5.5 cm  
Fiducial R<2.0 cm



# Diff BPD(proton hit )- BPD(BEAM hit) Segment

SIM

$K-d \rightarrow n \Sigma 0\pi 0$

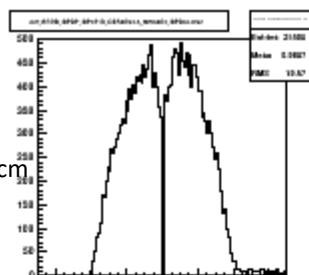
(spectrum shape ; cross Section P.9 left figure)

Sample

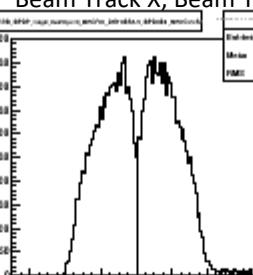
- $dE(BPD) 4 \sim 12$  MeV
- $dE(DEF) 3.5 \sim 9$  MeV

Definition of BEAM hit segment

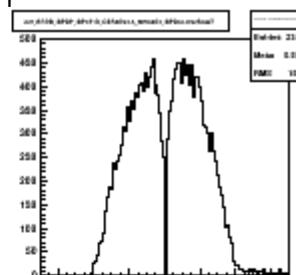
- BPC Beam Track @ BPD
- TOF BPD-T0<4 ns



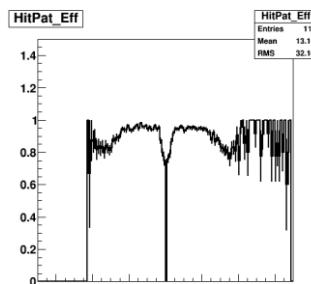
w/ the presence of  
BPC Backward Track  
Not same as  
Beam Track X, Beam Track Y



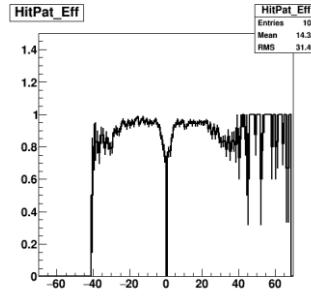
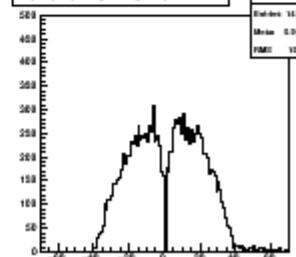
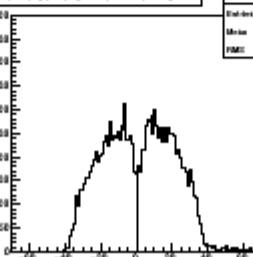
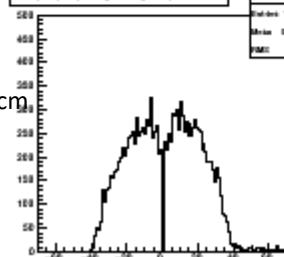
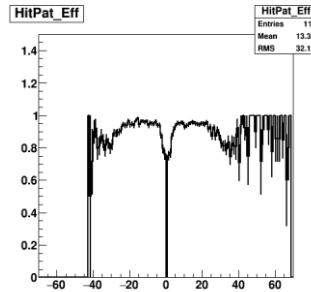
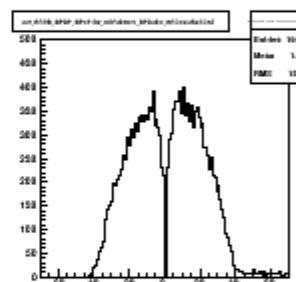
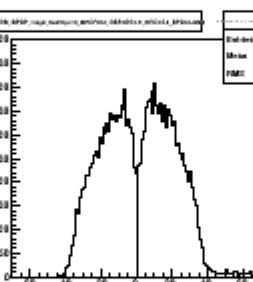
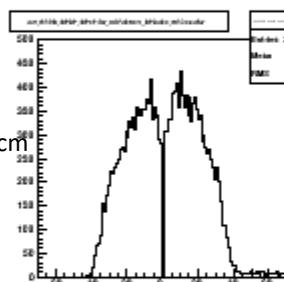
w/ the presence of  
BPC Backward Track event  
(Fiducial cut w/o Z)



Ratio(Fiducial cut w/o Z /sample)



BPD(proton hit )- BPD(BEAM hit) seg



# Re-analysis 3

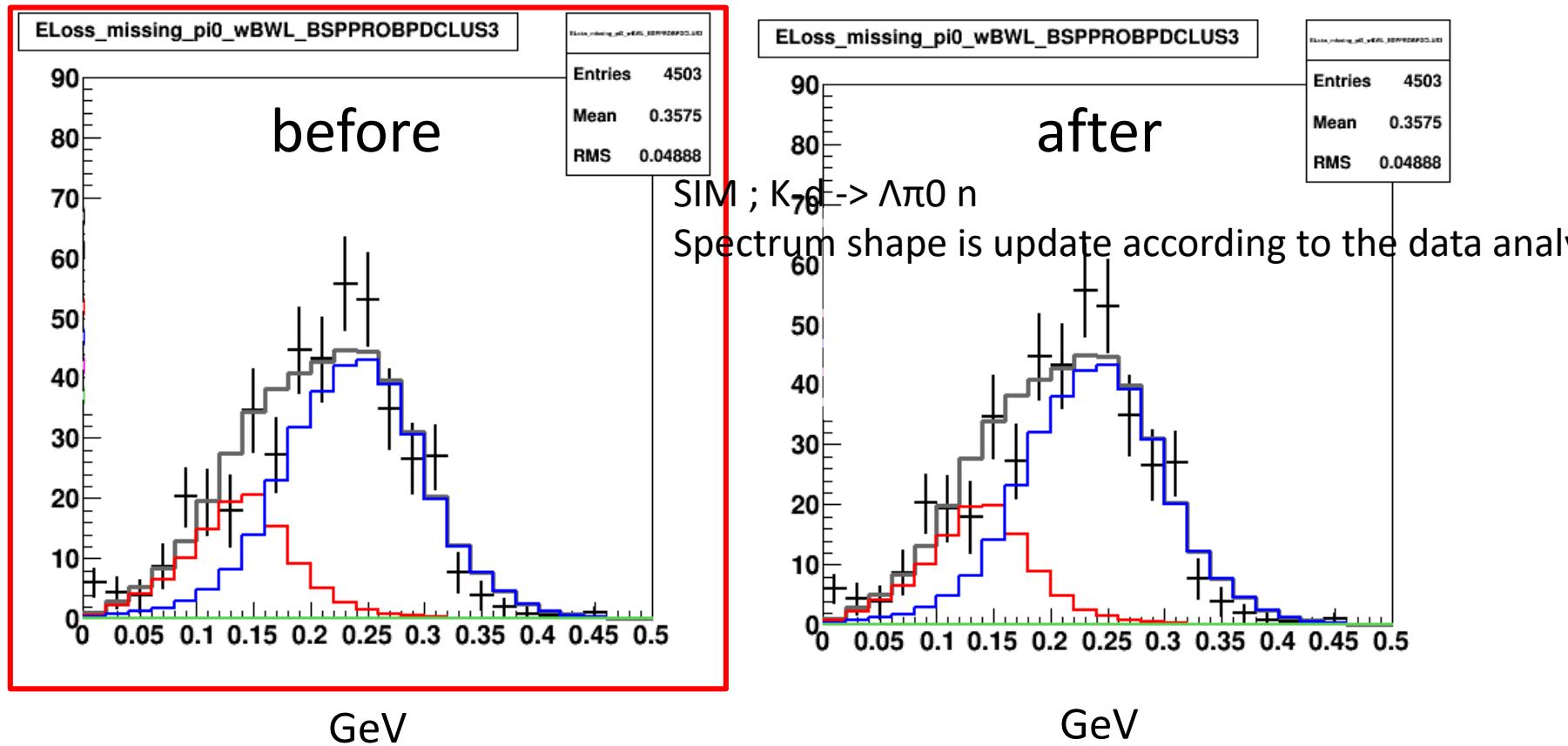
- SIM ;  $K-d \rightarrow \Lambda\pi^0 n$

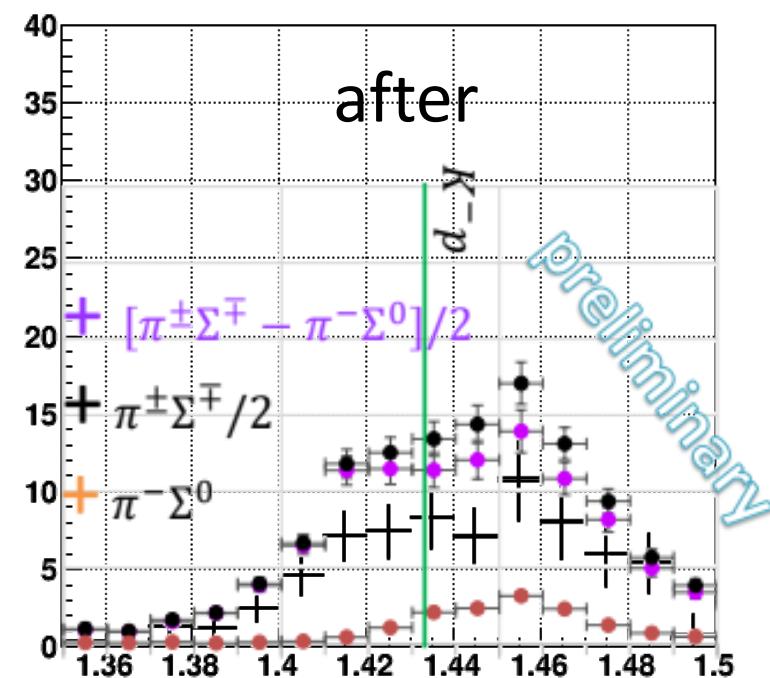
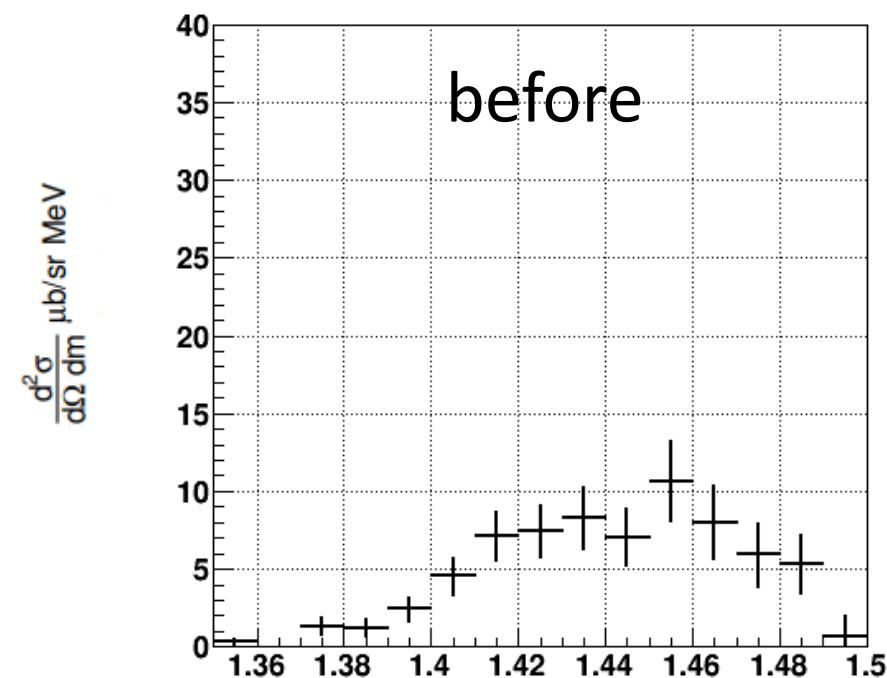
Neutron momentum distribution is update according to the data analysis.

# Fitting of the $d(K^-, np\pi^-)''X''$ missing mass

- p,  $\pi$ - invariant mass  $\Lambda$  selection

$\pi 0 \gamma$  is selected from  $d(K^-, np\pi^-)''X''$  missing mass





# figures

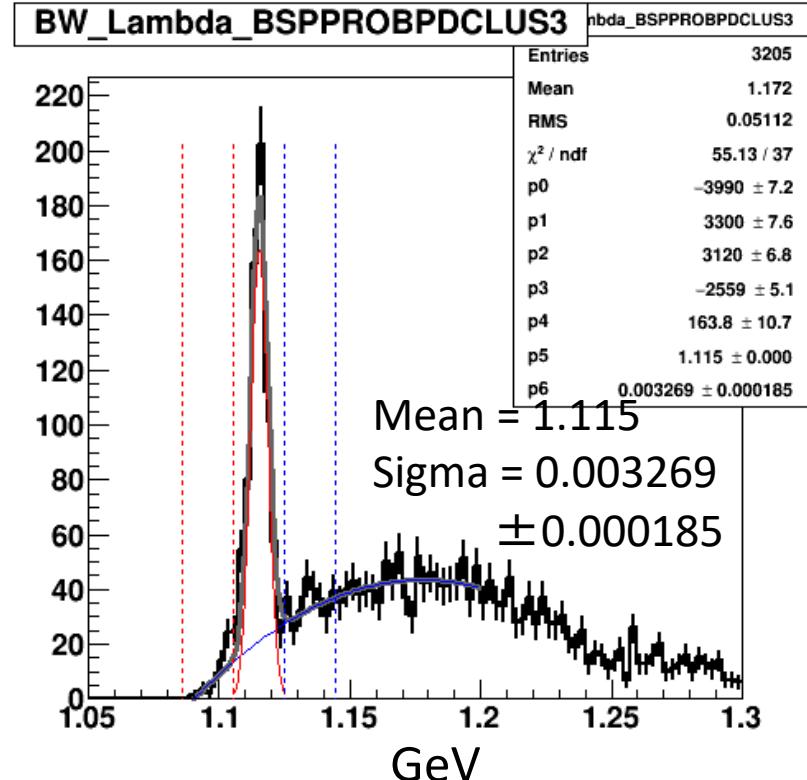
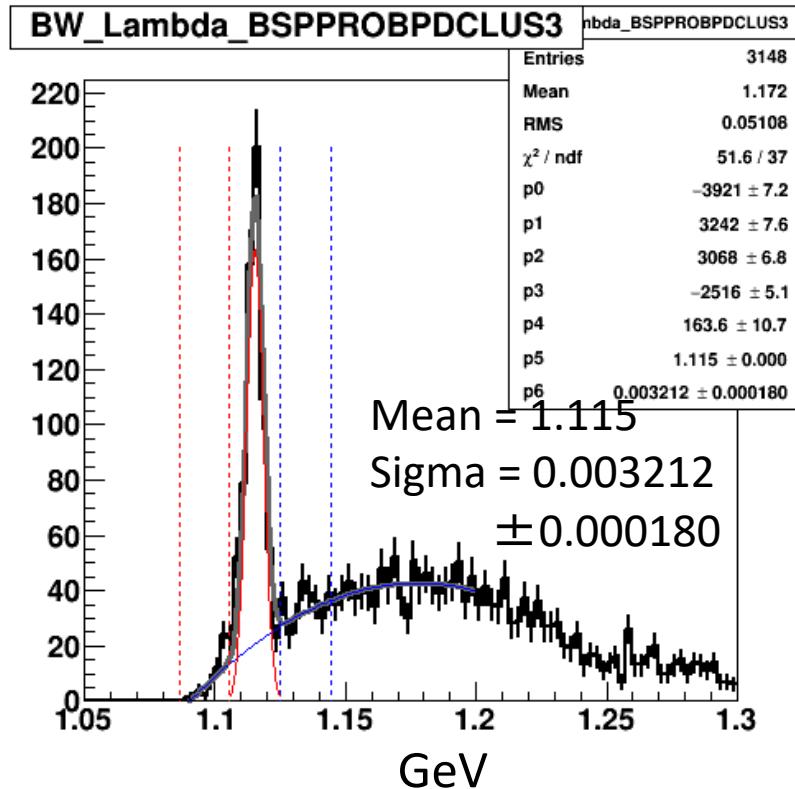
- mass :1.355 cs :0.348691 cs\_err :0.248664
- mass :1.365 cs :0 cs\_err :0
- mass :1.375 cs :1.34582 cs\_err :0.574449
- mass :1.385 cs :1.23326 cs\_err :0.58219
- mass :1.395 cs :2.47128 cs\_err :0.802703
- mass :1.405 cs :4.54529 cs\_err :1.20812
- mass :1.415 cs :7.13157 cs\_err :1.54387
- mass :1.425 cs :7.43093 cs\_err :1.73971
- mass :1.435 cs :8.34206 cs\_err :1.98834
- mass :1.445 cs :7.07798 cs\_err :1.86011
- mass :1.455 cs :10.7855 cs\_err :2.5666
- mass :1.465 cs :8.09944 cs\_err :2.40911
- mass :1.475 cs :6.00785 cs\_err :2.06845
- mass :1.485 cs :5.42346 cs\_err :1.89893
- mass :1.495 cs :0.735501 cs\_err :1.37617

# Re-analysis 4

- Bug in the selection of CDS 1  $\pi^-$  is fixed

# $p, \pi$ - invariant mass

$\Lambda$  reconstruction from  $p \pi^-$  invariant mass

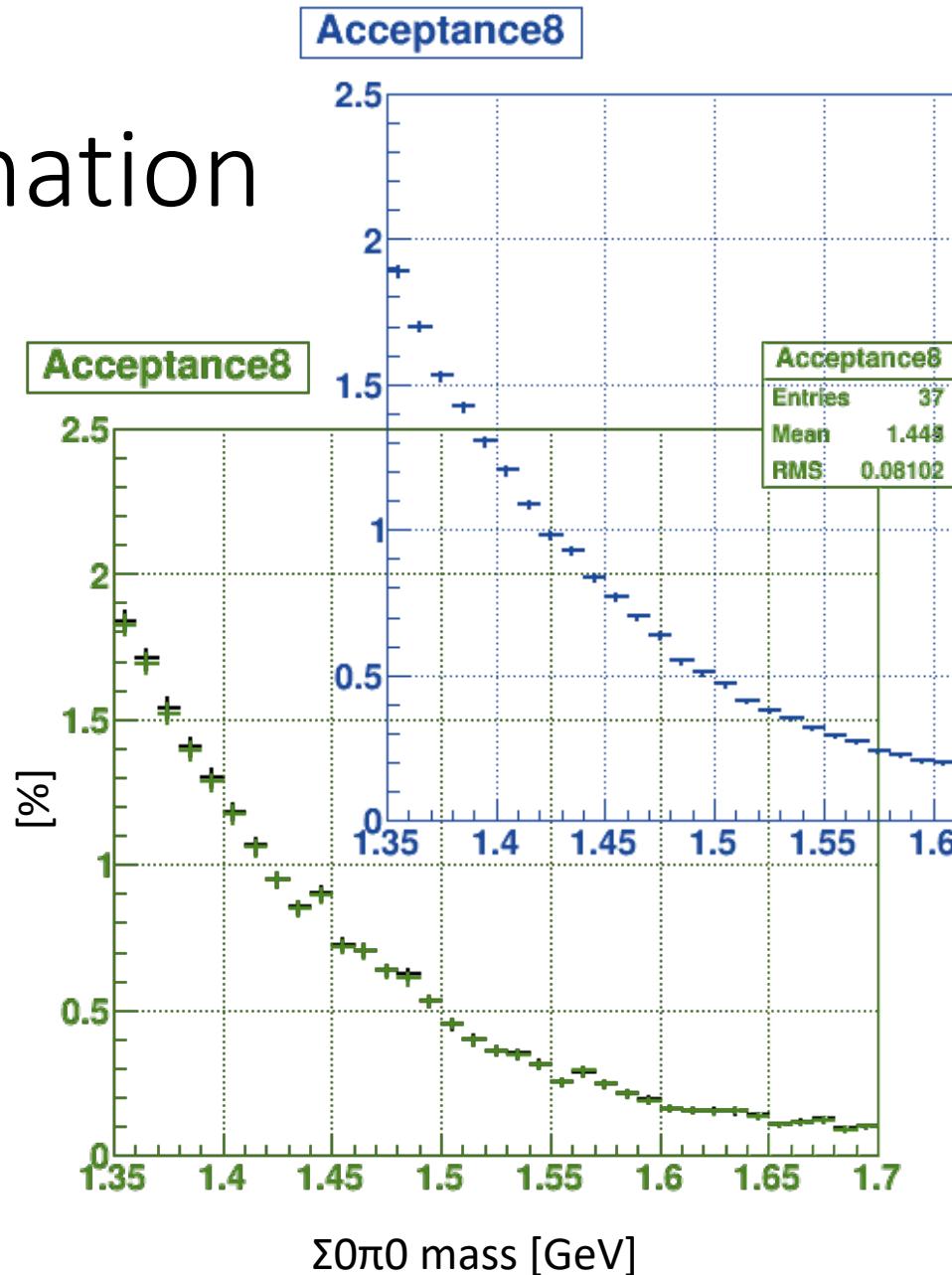


# Acceptance estimation

- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample



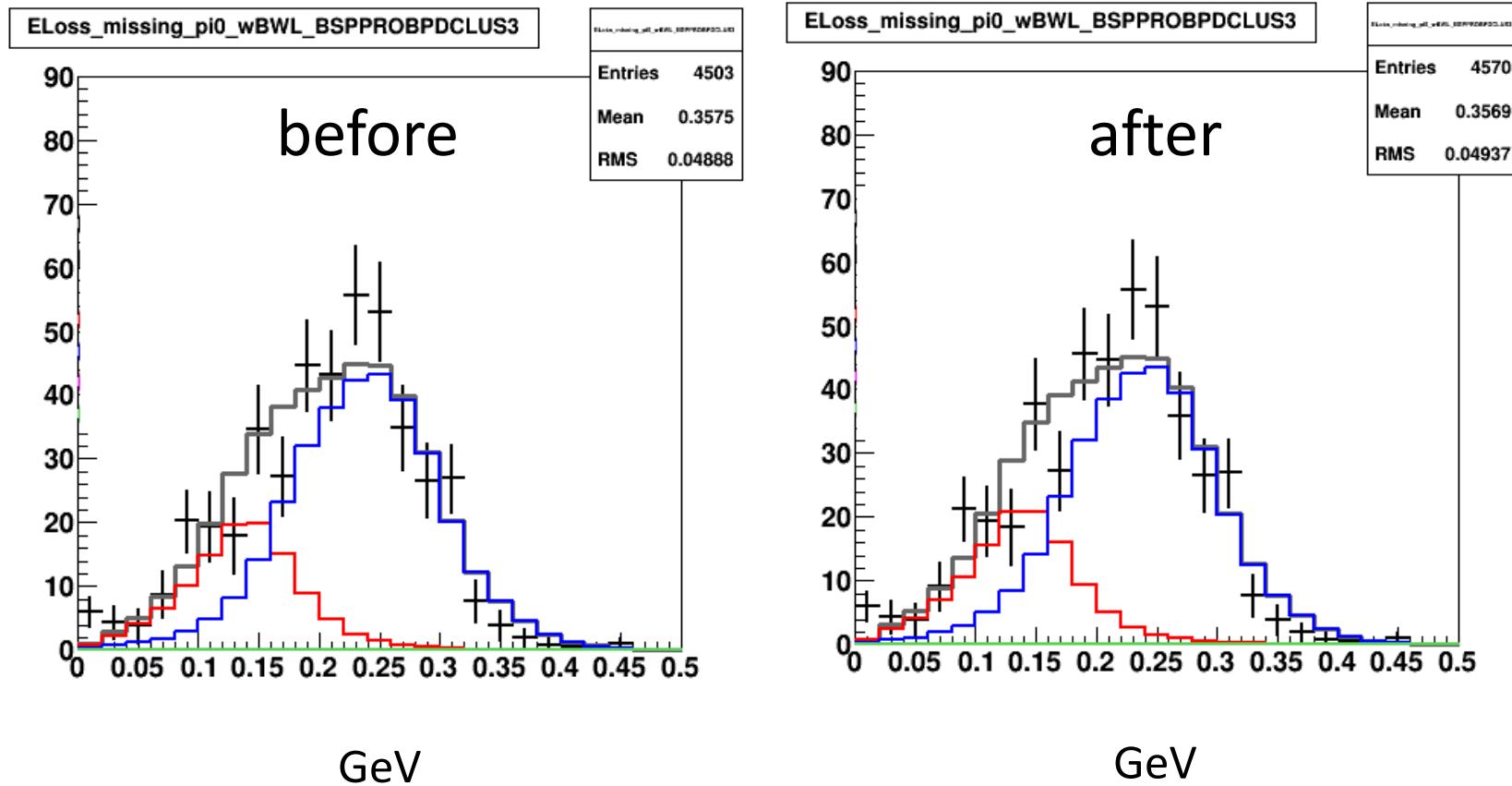
- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X''$   $0.18 < X < 0.30 \text{ GeV}$



# Fitting of the $d(K^-, np\pi^-)''X$ missing mass

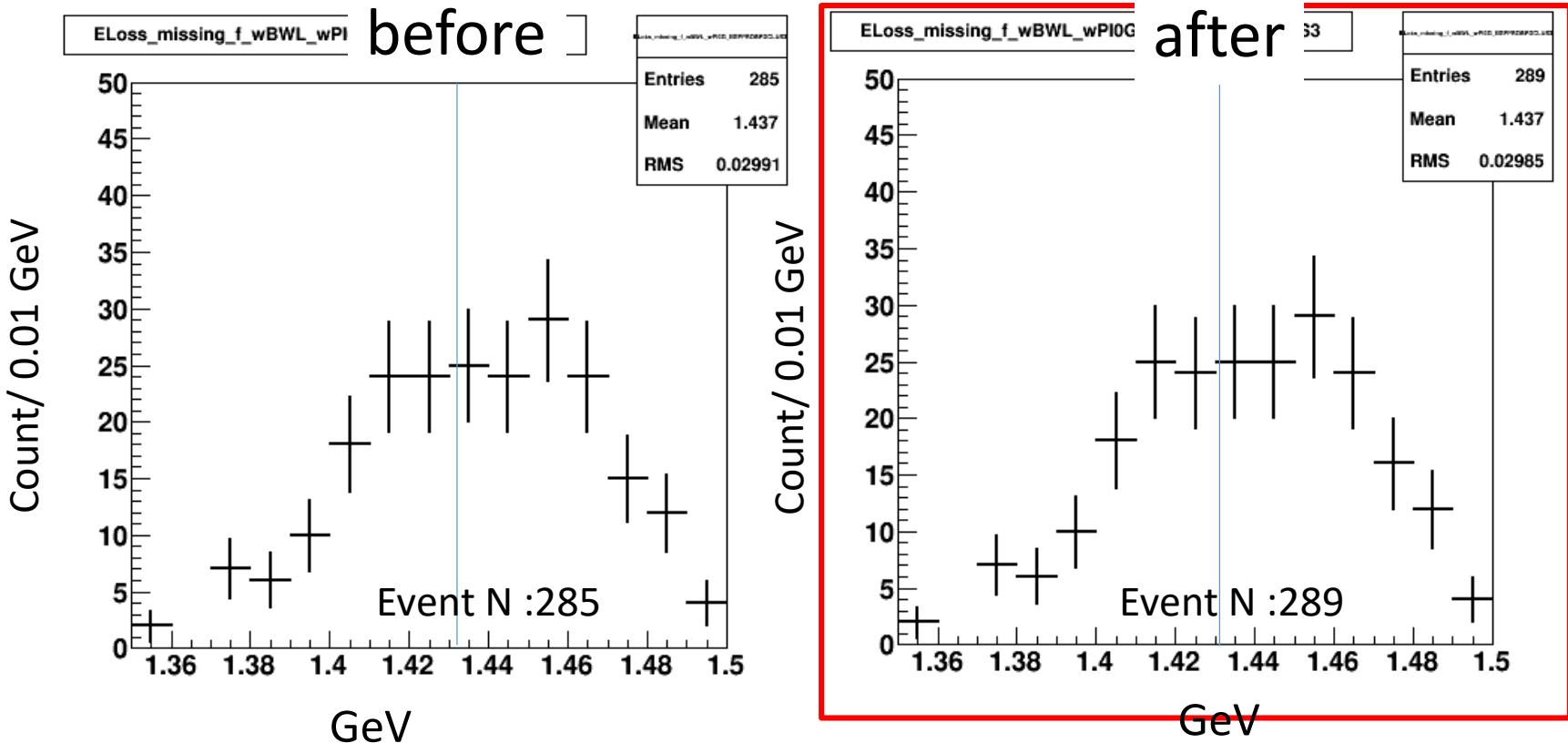
- $p, \pi$ - invariant mass  $\Lambda$  selection

$\pi 0 \gamma$  is selected from  $d(K^-, np\pi^-)''X$  missing mass

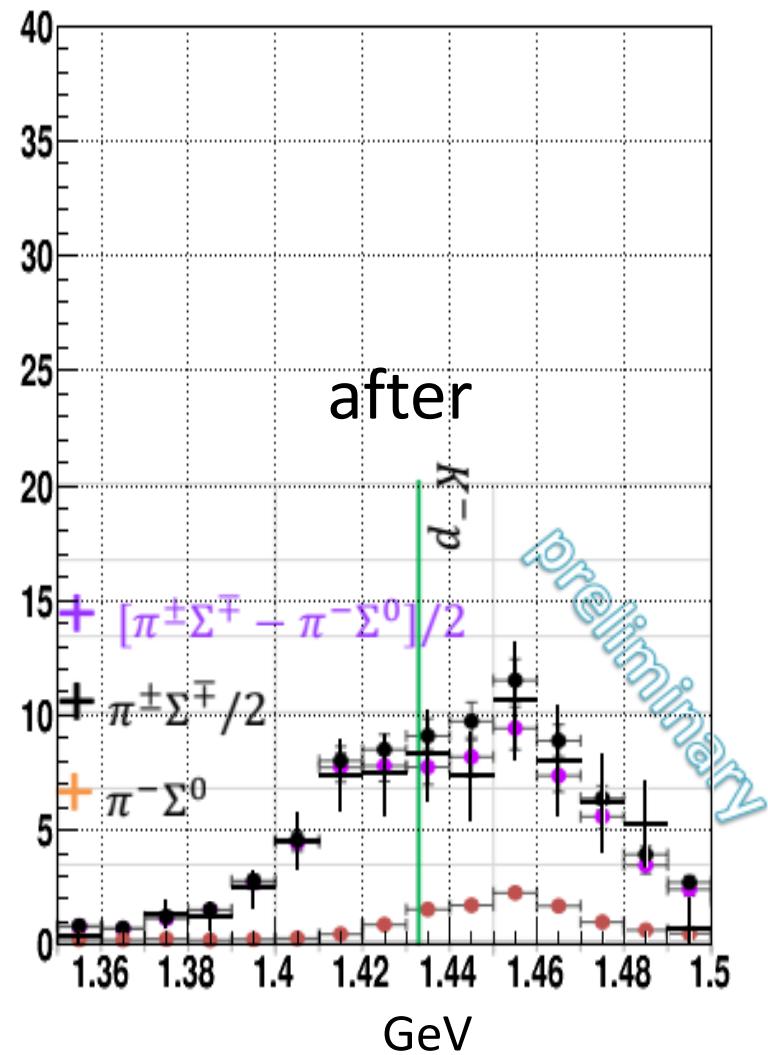
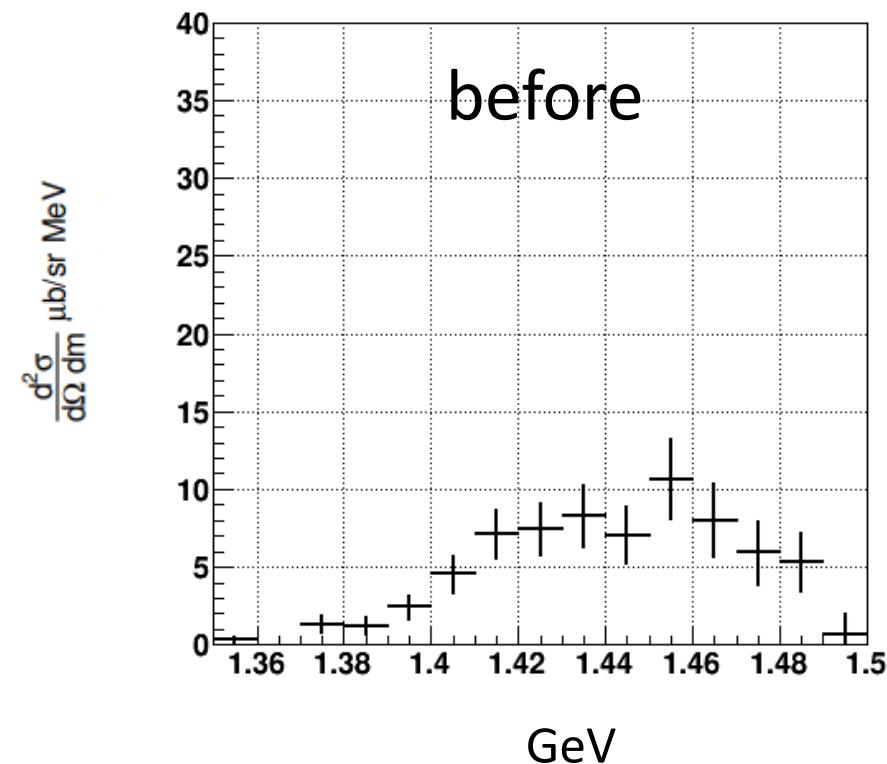


# $d(K^-, n)\pi^0\pi^0$ missing mass

- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-)X$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$



# Cross section



# figures

- mass :1.355 cs :0.346179 cs\_err :0.246933
- mass :1.365 cs :0 cs\_err :0
- mass :1.375 cs :1.32603 cs\_err :0.5671
- mass :1.385 cs :1.22679 cs\_err :0.577367
- mass :1.395 cs :2.43122 cs\_err :0.791853
- mass :1.405 cs :4.51364 cs\_err :1.20013
- mass :1.415 cs :7.38629 cs\_err :1.57117
- mass :1.425 cs :7.40469 cs\_err :1.73403
- mass :1.435 cs :8.26714 cs\_err :1.98047
- mass :1.445 cs :7.3345 cs\_err :1.87976
- mass :1.455 cs :10.6436 cs\_err :2.54383
- mass :1.465 cs :8.00324 cs\_err :2.39841
- mass :1.475 cs :6.15574 cs\_err :2.1419
- mass :1.485 cs :5.27499 cs\_err :1.85158
- mass :1.495 cs :0.685915 cs\_err :1.3693

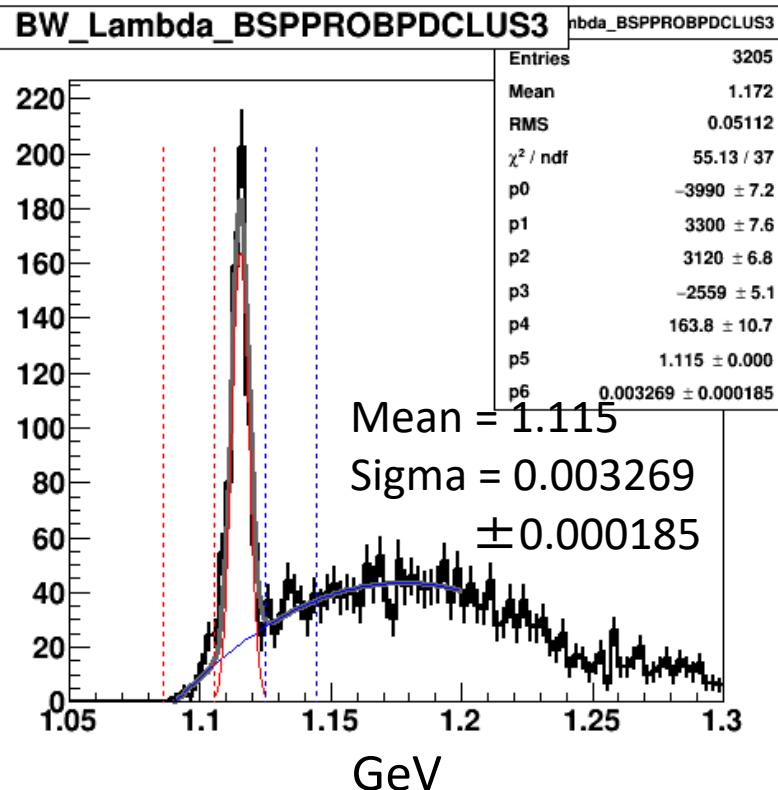
# Re-analysis 5

- Vertex Lambda fiducial cut w/z
  - Z -11.75 ~ 0.75 cm (loose) (Re-analysis 4)
  - Z -10.9 ~ -0.9 cm (tight)

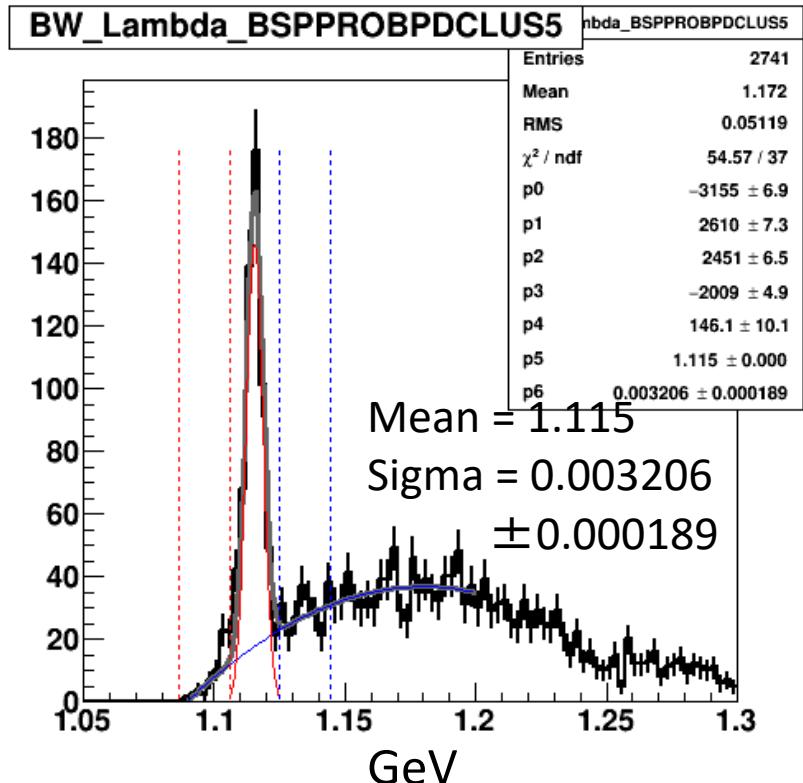
# $p, \pi$ - invariant mass

$\Lambda$  reconstruction from  $p \pi^-$  invariant mass

$Z -11.75 \sim 0.75 \text{ cm (loose)}$



$Z -10.9 \sim -0.9 \text{ cm (tight)}$

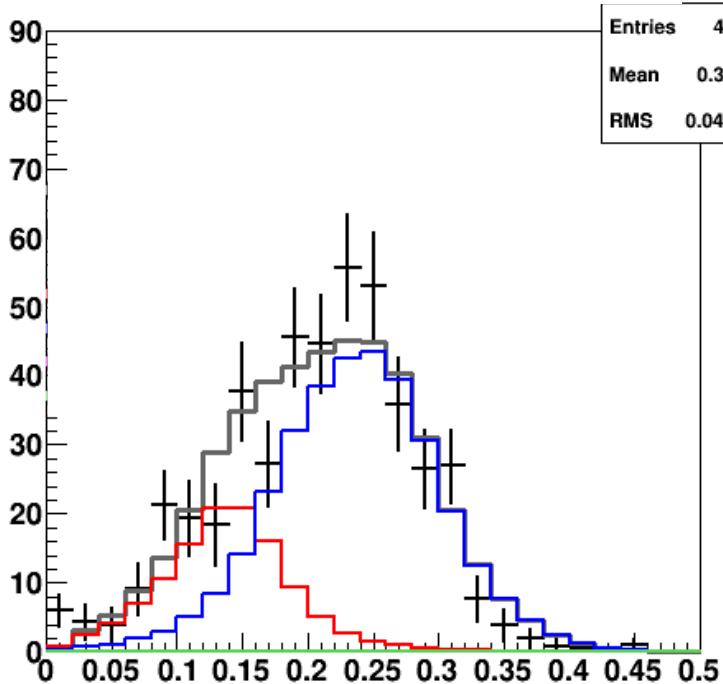


# Fitting of the $d(K^-, np\pi^-)''X$ missing mass

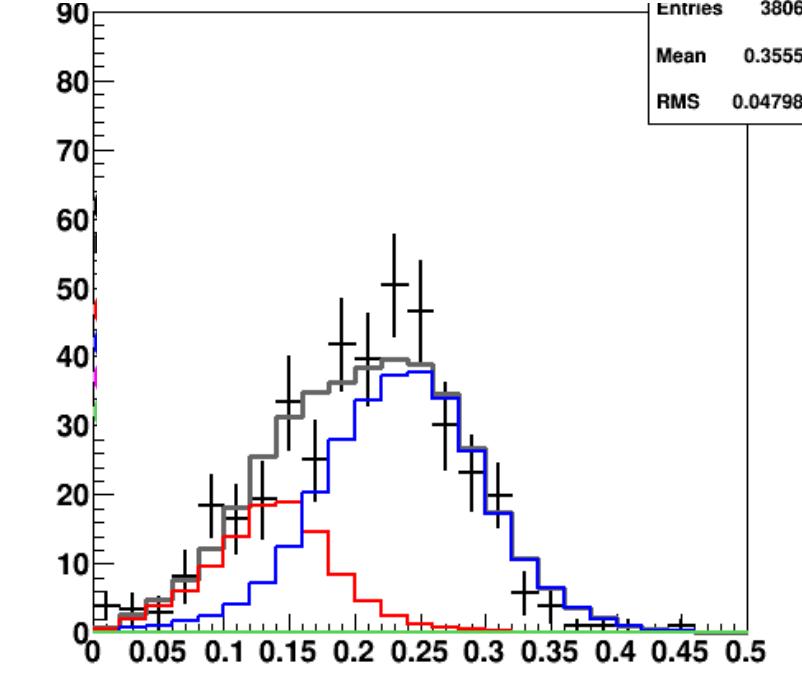
- $p, \pi$ - invariant mass  $\Lambda$  selection

$\pi 0\gamma$  is selected from  $d(K^-, np\pi^-)''X$  missing mass

Z -11.75 ~ 0.75 cm (loose)



Z -10.9 ~ -0.9 cm (tight)

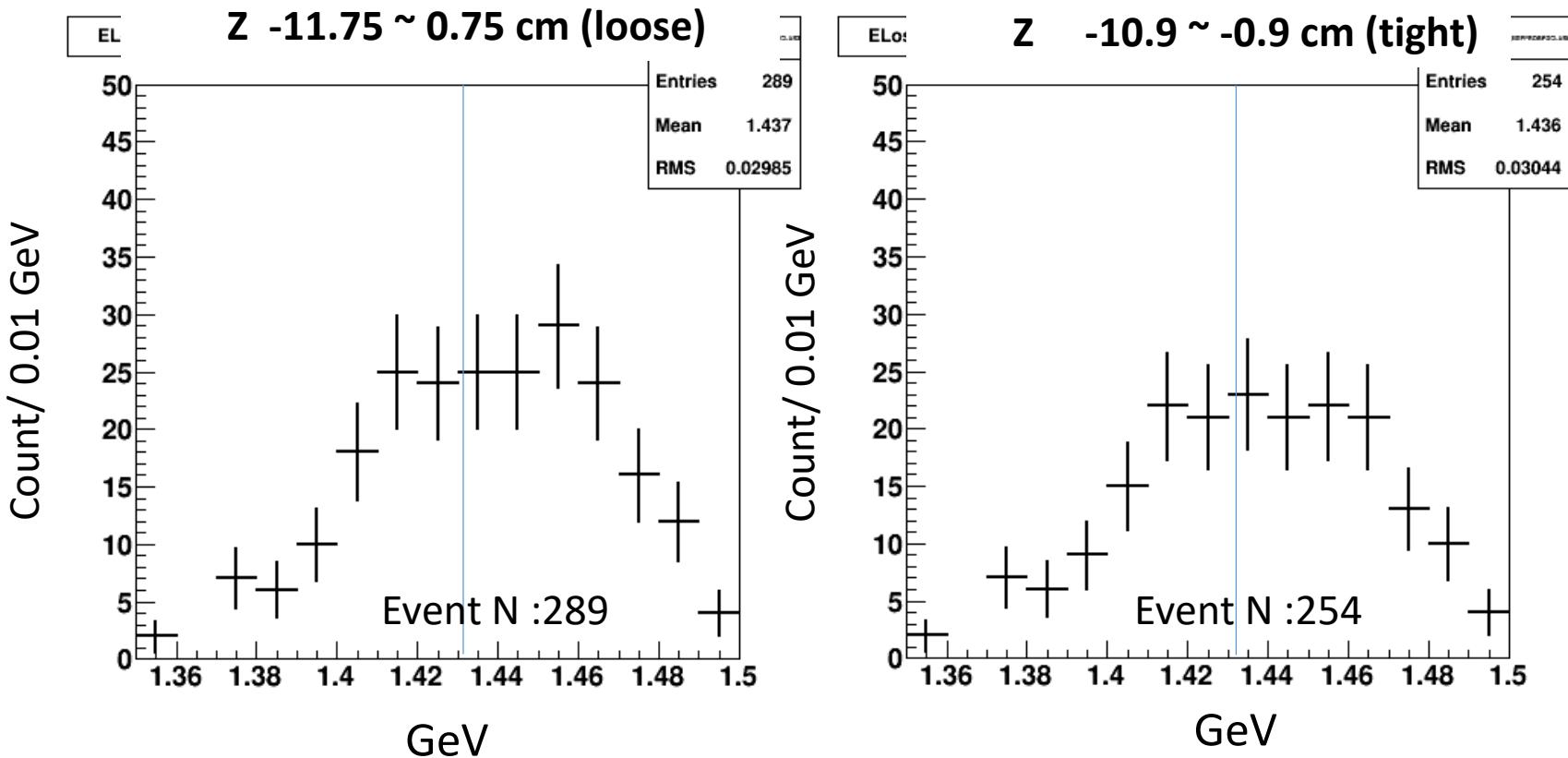


GeV

GeV

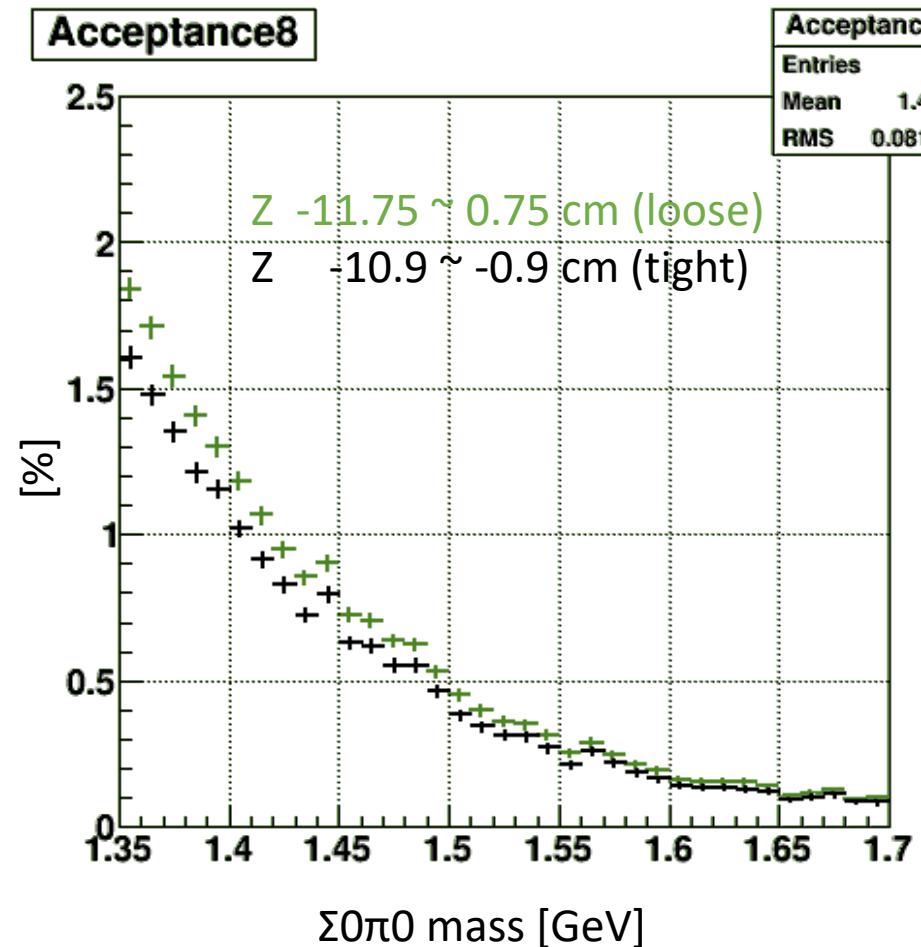
# $d(K^-, n)\pi^0\pi^0$ missing mass

- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-) X \quad 0.18 < X < 0.3 \text{ GeV}$  for  $\pi^0\gamma$



# Acceptance estimation

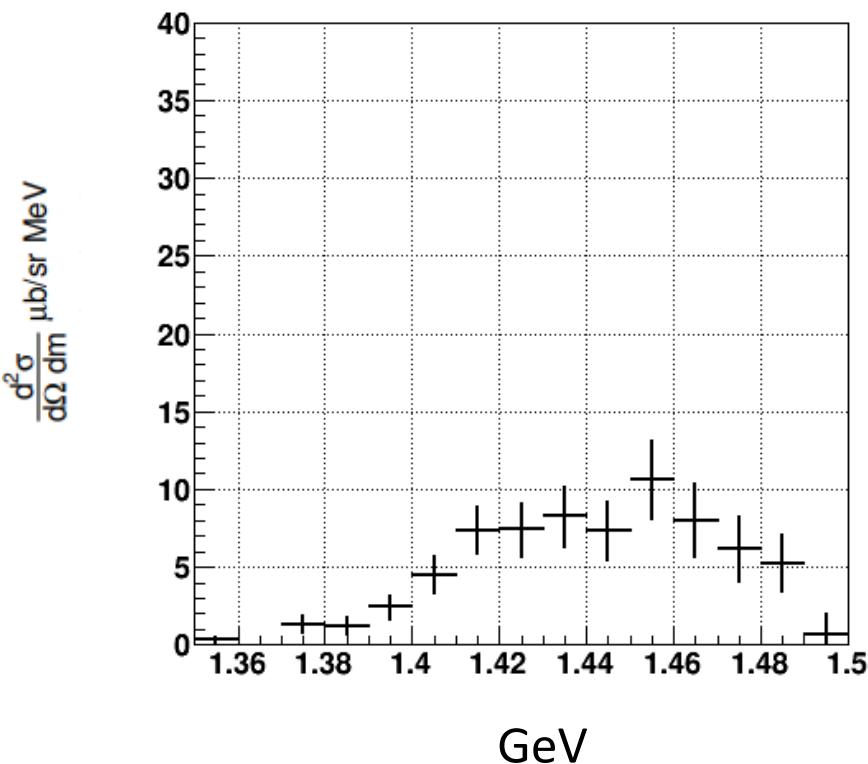
- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample



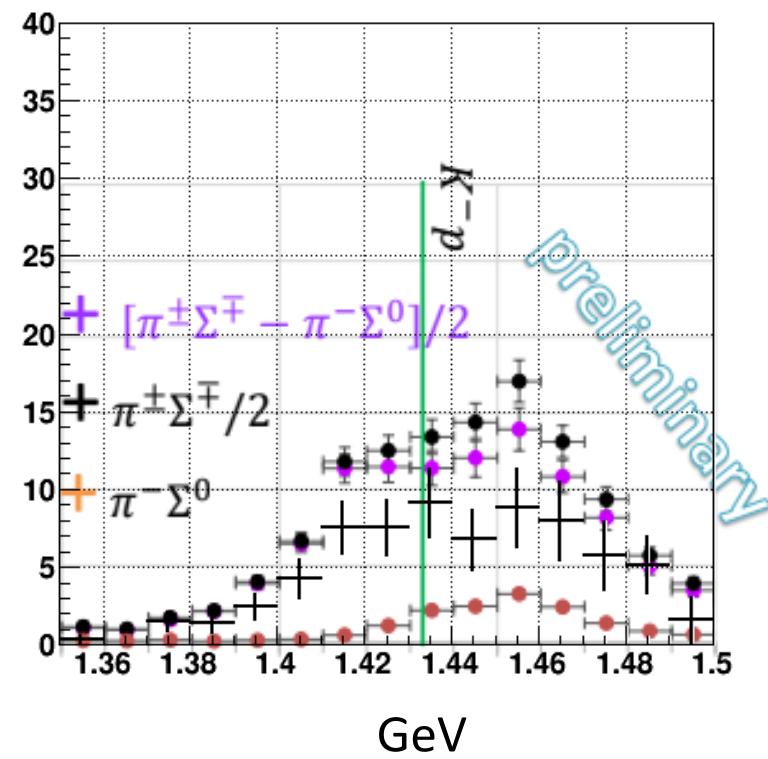
- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

# Cross section

Z -11.75 ~ 0.75 cm (loose)



Z -10.9 ~ -0.9 cm (tight)

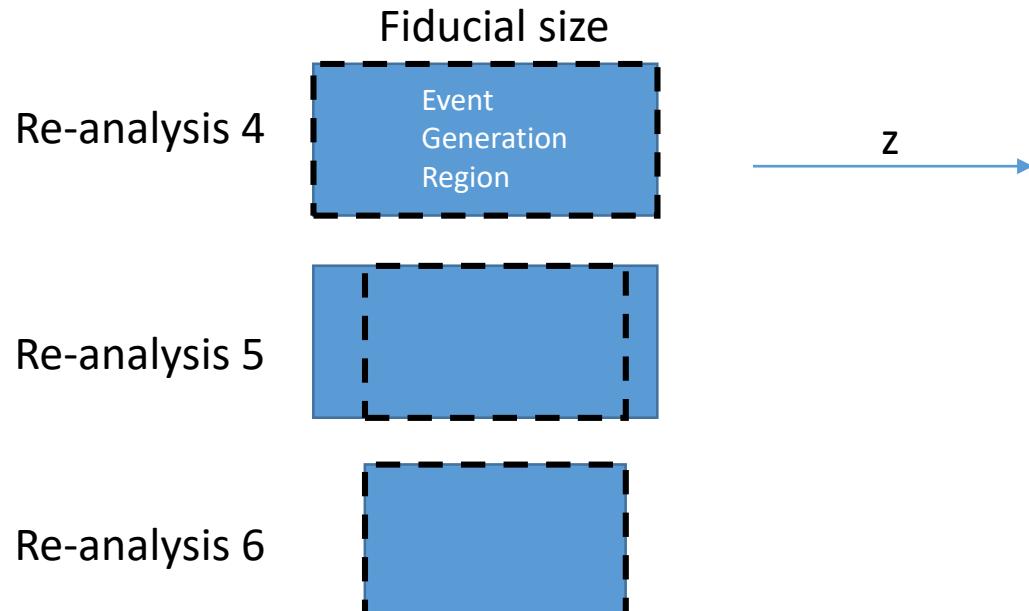


# figures

- mass :1.355 cs :0.39603 cs\_err :0.282577
- mass :1.365 cs :0 cs\_err :0
- mass :1.375 cs :1.50899 cs\_err :0.644419
- mass :1.385 cs :1.42015 cs\_err :0.667671
- mass :1.395 cs :2.46087 cs\_err :0.843512
- mass :1.405 cs :4.29829 cs\_err :1.26635
- mass :1.415 cs :7.57957 cs\_err :1.71264
- mass :1.425 cs :7.55786 cs\_err :1.84074
- mass :1.435 cs :9.15388 cs\_err :2.22244
- mass :1.445 cs :6.79582 cs\_err :1.95643
- mass :1.455 cs :8.79632 cs\_err :2.54267
- mass :1.465 cs :8.00105 cs\_err :2.55296
- mass :1.475 cs :5.73448 cs\_err :2.2071
- mass :1.485 cs :5.15926 cs\_err :1.88292
- mass :1.495 cs :1.57838 cs\_err :1.4753

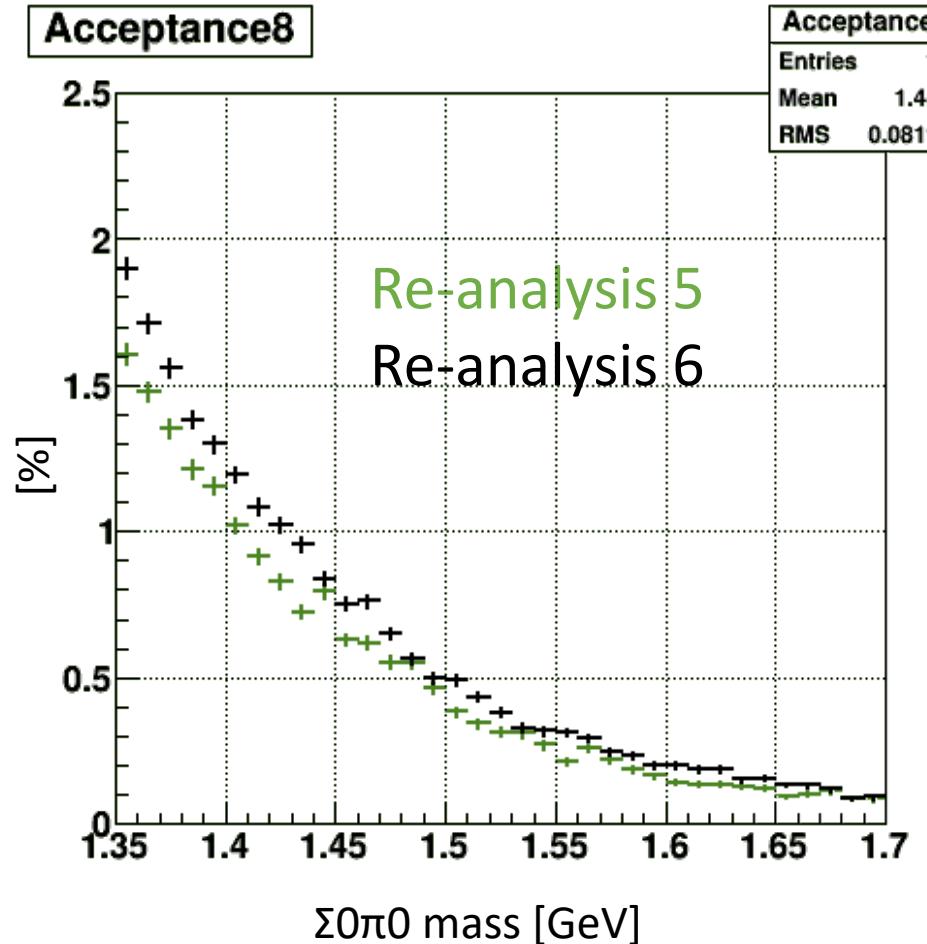
# Re-analysis 6

- Region of the event generation (SIM)
  - $Z$   $-11.75 \sim 0.75$  cm (loose) (Re-analysis 5)
  - $Z$   $-10.9 \sim -0.9$  cm (tight) (Re-analysis 6)
- The condition of fiducial cut about  $z$  position is same (tight) for both case.



# Acceptance estimation

- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample
- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X''$   $0.18 < X < 0.30 \text{ GeV}$

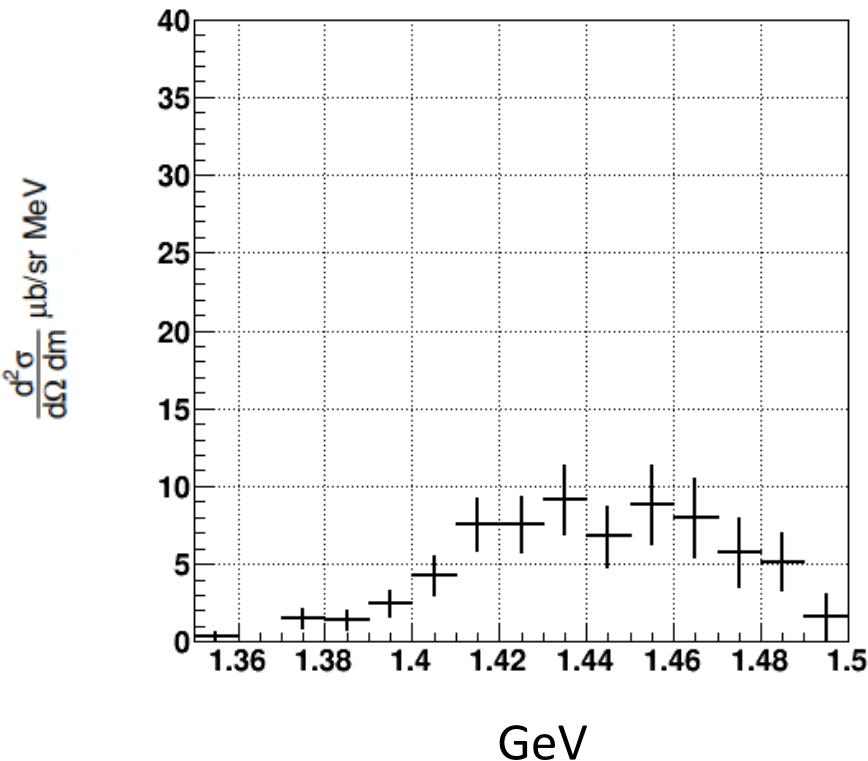


# Luminosity change from analysis 5

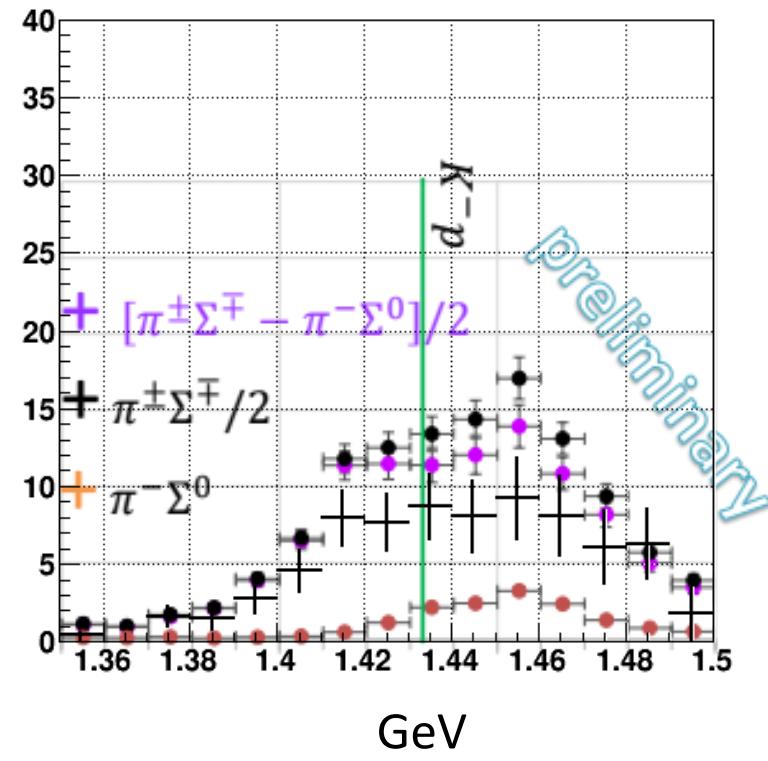
- Lumi ;  $8083 \pm 160$  [/ub]  $\times (10.0/12.5)$ <sub>Target length 12.5 -> 10 cm</sub>
  - Scaler Kaon 58.3 G
  - Survival ratio  $0.314 \pm 0.000350$
  - DAQ eff  $0.7708 \pm 0.0000128$
  - Trig. KCDH1  $0.9527 \pm 0.0003$
  - Trig. Neutral  $0.9999 \pm 0.0000067$
- $\Omega\text{-nc}$  ;  $0.0214832 \pm 0.000207563$  [sr]
- $\varepsilon\text{-nc}$  ;  $0.291 \pm 0.015$
- $\varepsilon\text{-bpc}$  ;  $0.999 \pm 0.000$
- $\varepsilon\text{-cdc}$  ;  $0.977 \pm 0.004$
- Acc ; simulation (including BR ( $\Sigma 0 \pi 0$ ) 0.639)

# Cross section

Re-analysis 5



Re-analysis 6



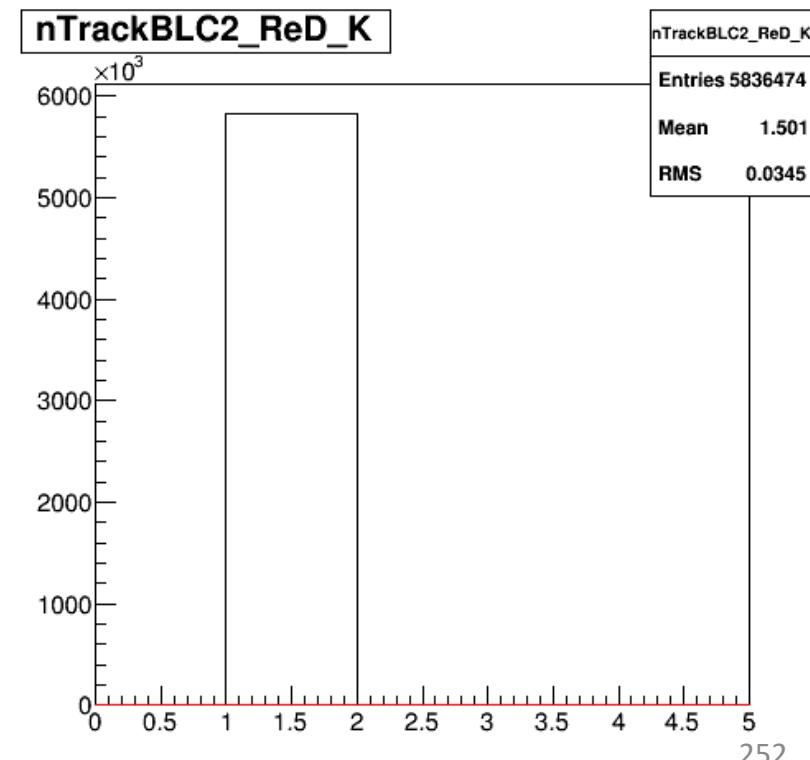
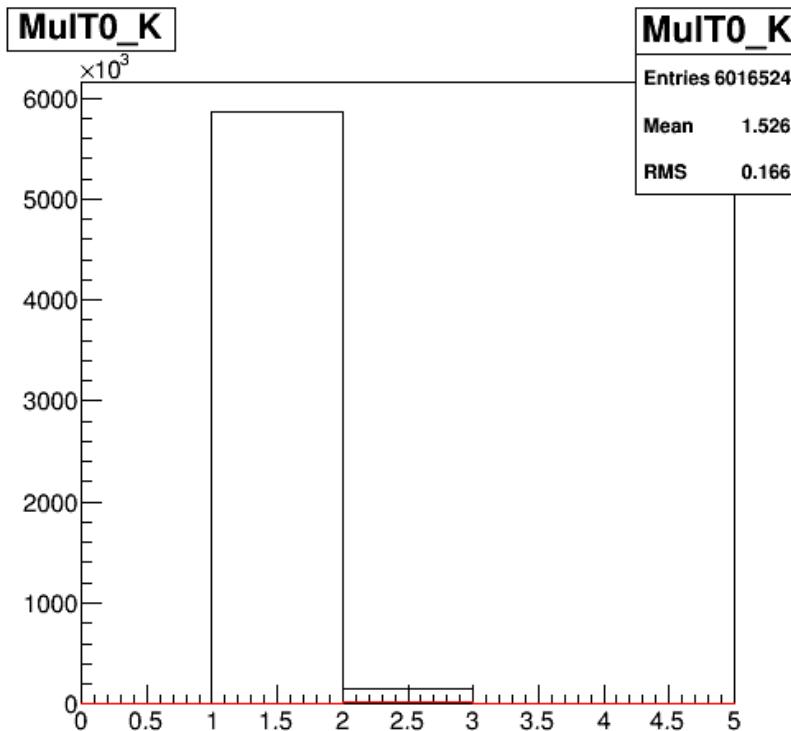
# figures

- mass :1.355 cs :0.419095 cs\_err :0.299068
- mass :1.365 cs :0 cs\_err :0
- mass :1.375 cs :1.63911 cs\_err :0.700199
- mass :1.385 cs :1.55792 cs\_err :0.732607
- mass :1.395 cs :2.74228 cs\_err :0.940387
- mass :1.405 cs :4.59524 cs\_err :1.35433
- mass :1.415 cs :7.97926 cs\_err :1.80355
- mass :1.425 cs :7.69122 cs\_err :1.87301
- mass :1.435 cs :8.70738 cs\_err :2.11237
- mass :1.445 cs :8.057 cs\_err :2.32101
- mass :1.455 cs :9.2366 cs\_err :2.66904
- mass :1.465 cs :8.1278 cs\_err :2.59219
- mass :1.475 cs :6.10582 cs\_err :2.34942
- mass :1.485 cs :6.32135 cs\_err :2.30794
- mass :1.495 cs :1.83779 cs\_err :1.71776

# Multiplicity T0, BLD2 Track in SIM

SIM;  $K-d \rightarrow n \Sigma^0 \pi^0$  plane mass distribution

- $K^+$  hit at least 1
- proton hit at least 1 or  
 $\pi^-$  hit at least 1  
in  $K^+$  hit at least 1
- $K^+$  Track at least 1
- proton Track at least 1 or  
 $\pi^-$  Track at least 1  
in  $K^+$  Track at least 1



# Acceptance correction factor

- K+ hit at least 1 & K+ Track at least 1      Sample Event-s
    - $T_0 \geq 2$  Hit or  $BLC_2 \geq 2$  Track      Event a

$$\begin{aligned}\text{Factor} &= (\text{Event-s} - \text{Event-a})/\text{Event-s} \\ &= 0.9781\end{aligned}$$

# Calculation of CrossSection

- CrossSection

$$= \text{data}/(\text{Lumi} \times \Omega_{\text{nc}} \times \varepsilon_{\text{nc}} \times \varepsilon_{\text{bpc}} \times \varepsilon_{\text{cdc}} \times \text{Acc})/\text{dMeV}$$

Lumi ;  $6466 \pm 160$  [/ub]

$\Omega_{\text{nc}}$  ;  $0.0214 \pm 0.0002$  [sr]

$\varepsilon_{\text{nc}}$  ;  $0.291 \pm 0.015$

$\varepsilon_{\text{bpc}}$  ;  $0.991 \pm 0.000$

$\varepsilon_{\text{cdc}}$  ;  $0.977 \pm 0.004$

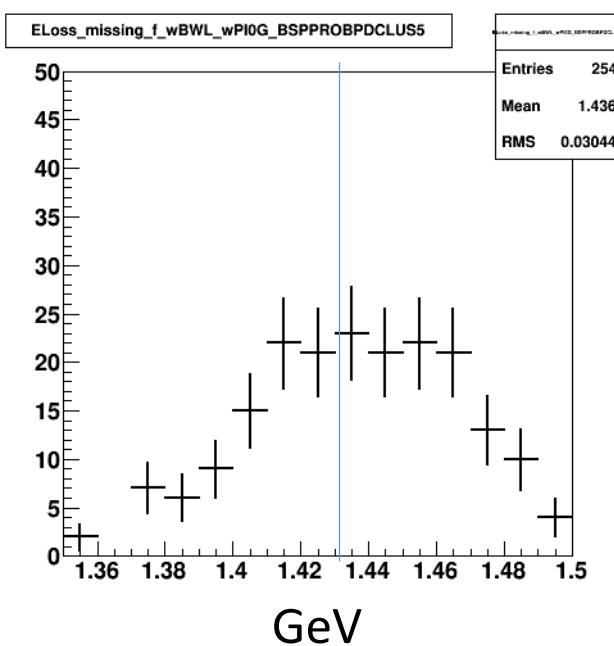
Acc ; simulation x 0.639 (BR;  $\Lambda \rightarrow p\pi^-$ )

$$\frac{d^2\sigma}{d\Omega dm} \mu\text{b/sr MeV}$$

# $d(K^-, n)\pi^0\pi^0$ missing mass

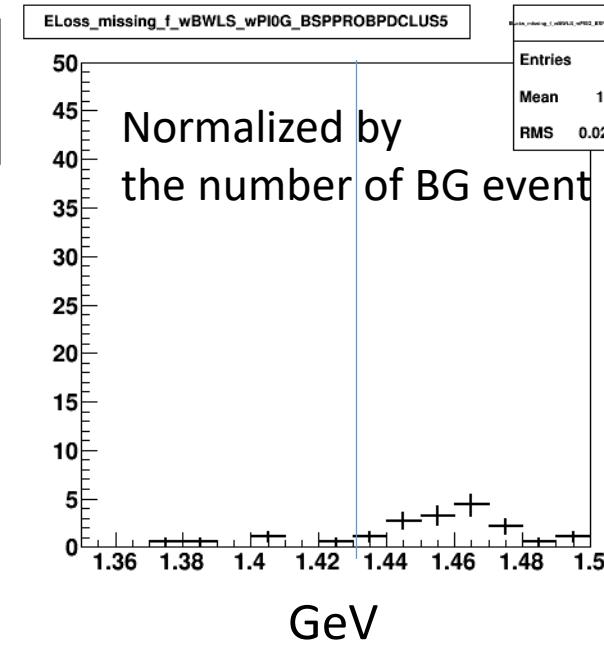
Spectrum (226 right)  
before subtraction of BGs

- p,  $\pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-) \pi^0 \pi^0$   $0.18 < X < 0.3$  GeV for  $\pi^0 \gamma$
- p,  $\pi$ - invariant mass  $\Lambda$  side-band
- $d(K^-, n p \pi^-) \pi^0 \pi^0$   $0.18 < X < 0.3$  GeV for  $\pi^0 \gamma$
- p,  $\pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-) \pi^0 \pi^0$   $0.18 < X < 0.3$  GeV for  $\pi^0 \gamma$



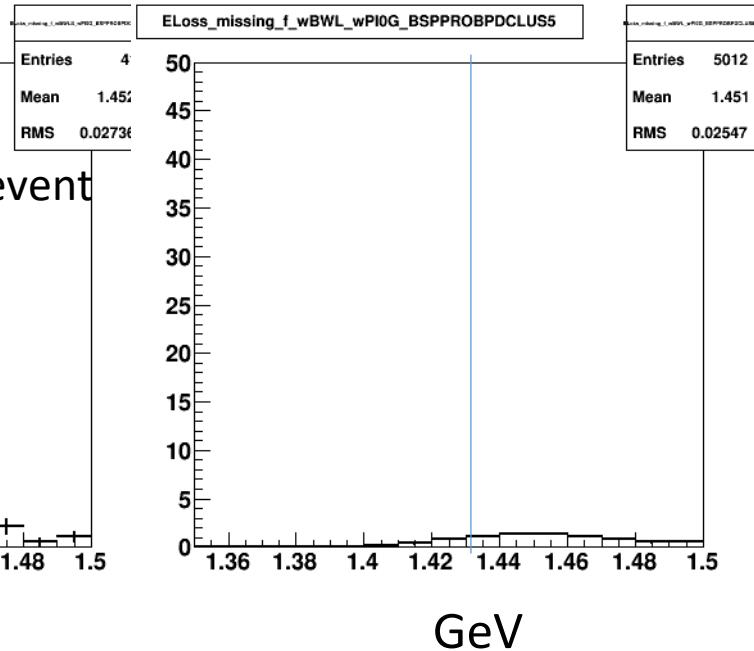
BG ; $\Lambda$  side-band

- p,  $\pi$ - invariant mass  $\Lambda$  side-band
- $d(K^-, n p \pi^-) \pi^0 \pi^0$   $0.18 < X < 0.3$  GeV for  $\pi^0 \gamma$

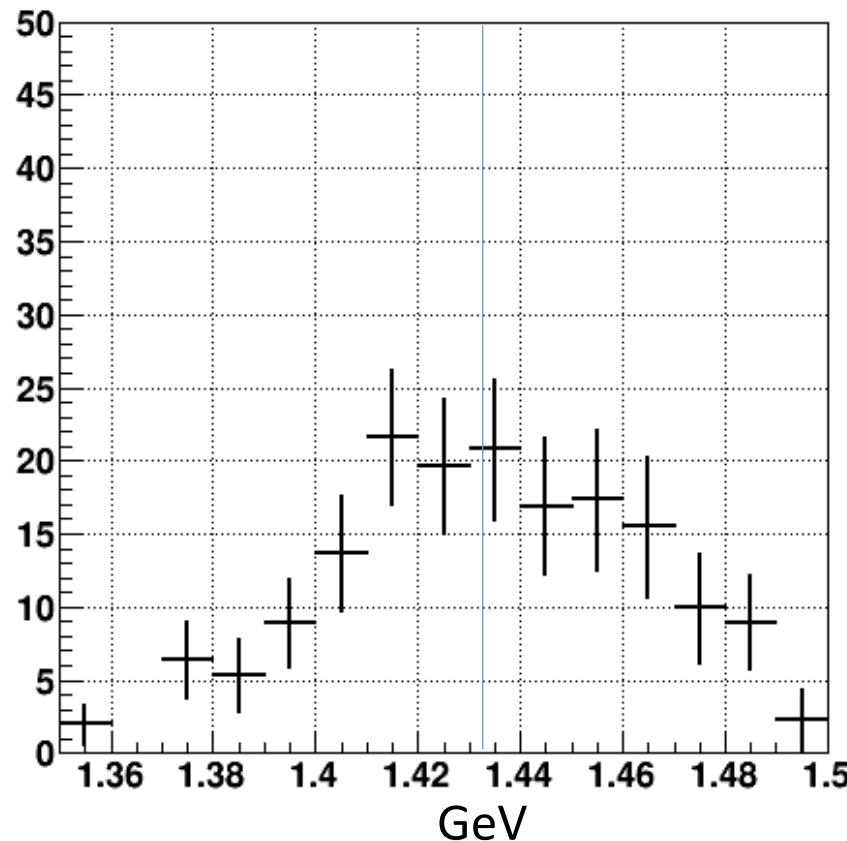


BG ; $K-d \rightarrow \Lambda \pi^0 n$

- p,  $\pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n p \pi^-) \pi^0 \pi^0$   $0.18 < X < 0.3$  GeV for  $\pi^0 \gamma$



# Spectrum after subtraction of BGs

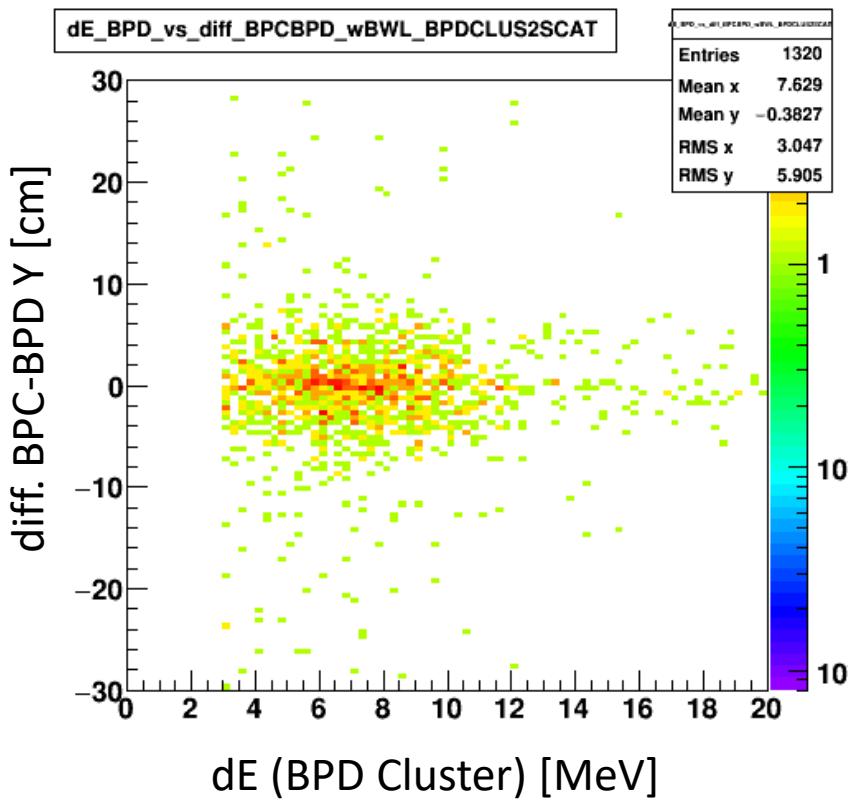


# Diff. BPC-BPD Y dependence on dE(BPD)

in the sample event  
(BPD Cluster > 3MeV) Page.60

Λ selection

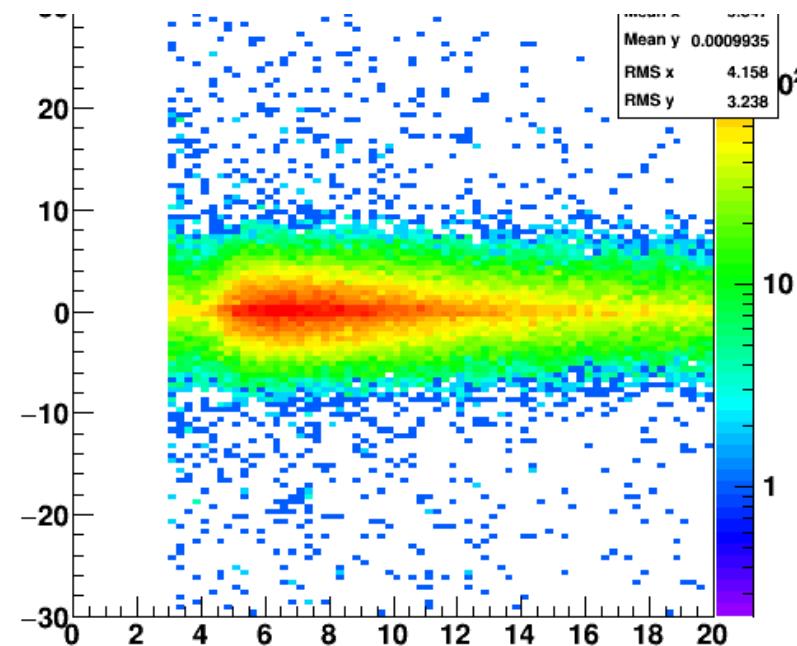
Data (Run78)



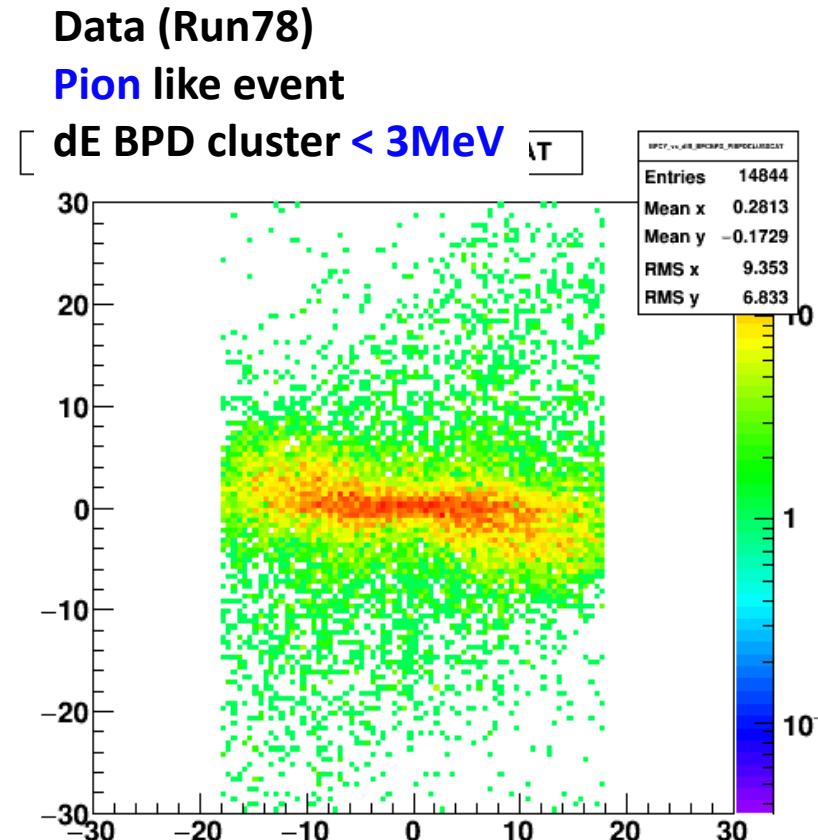
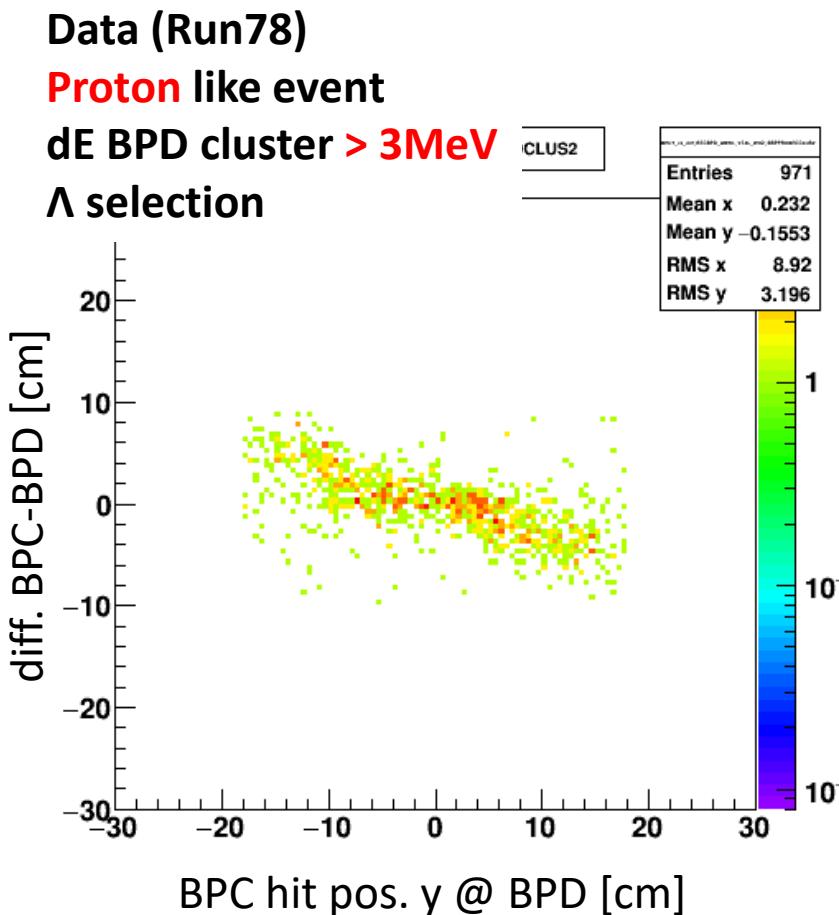
SIM

K-d → n Σ0π0

(spectrum shape ; cross Section P.9 left figure)



# Diff. BPC-BPD Y dependence on Y position



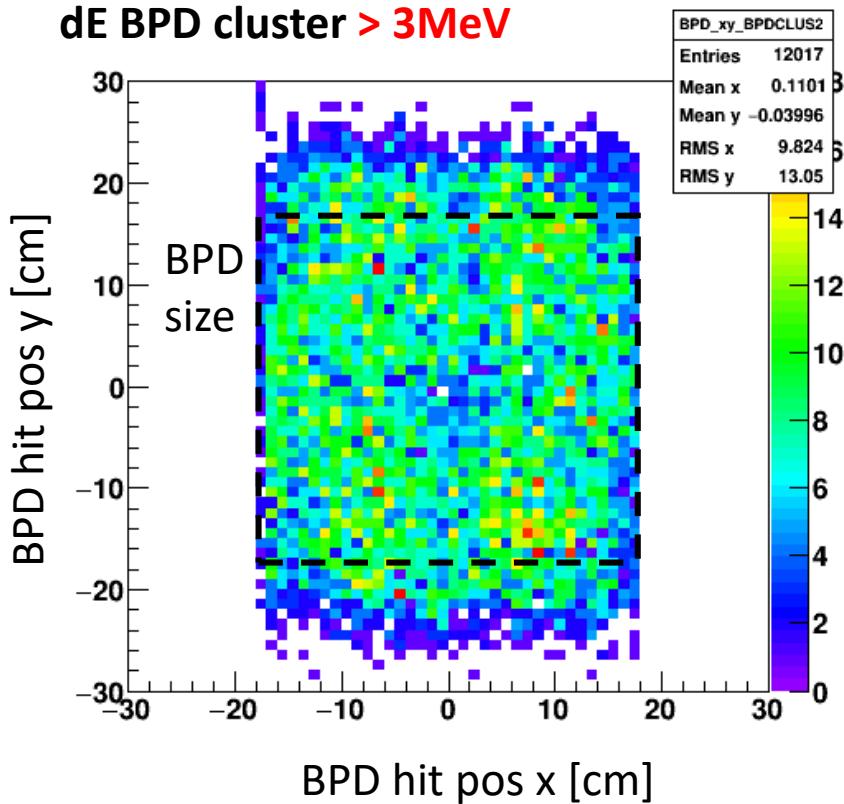
# BPD hit Position

BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

Data (Run78)

Proton like event

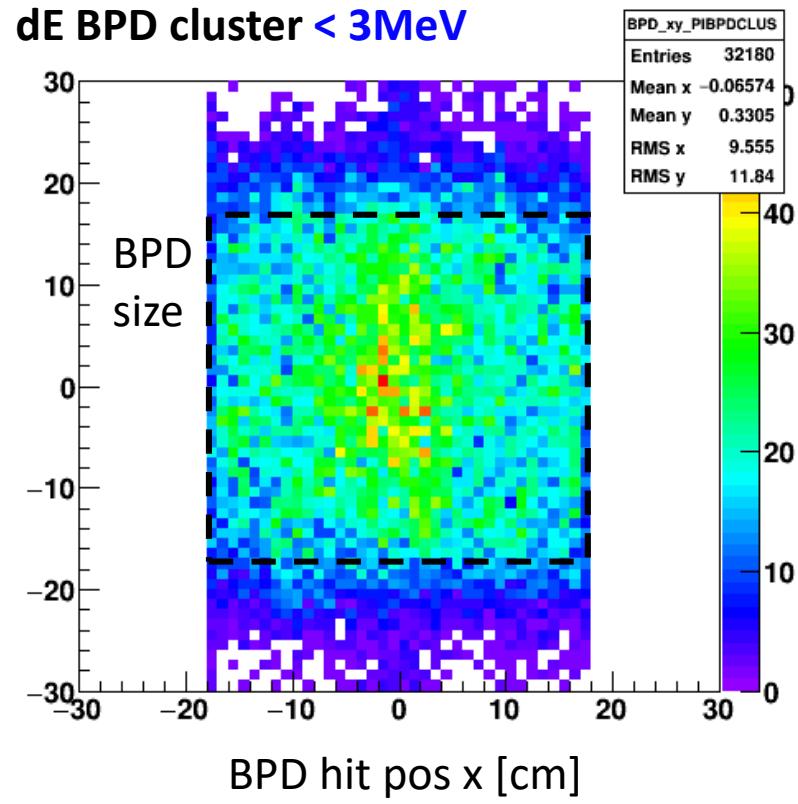
dE BPD cluster > 3MeV



Data (Run78)

Pion like event

dE BPD cluster < 3MeV

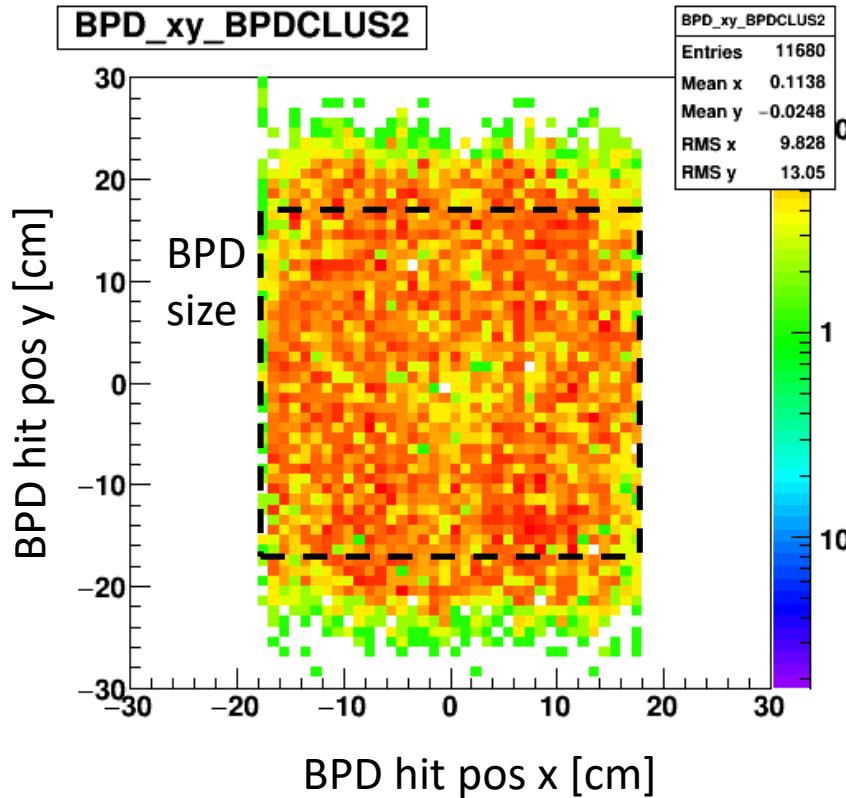


Same as P.85

# BPD hit Position in the sample event

BPD hit pos x ; segment geometry  
BPD hit pos y ; up - down

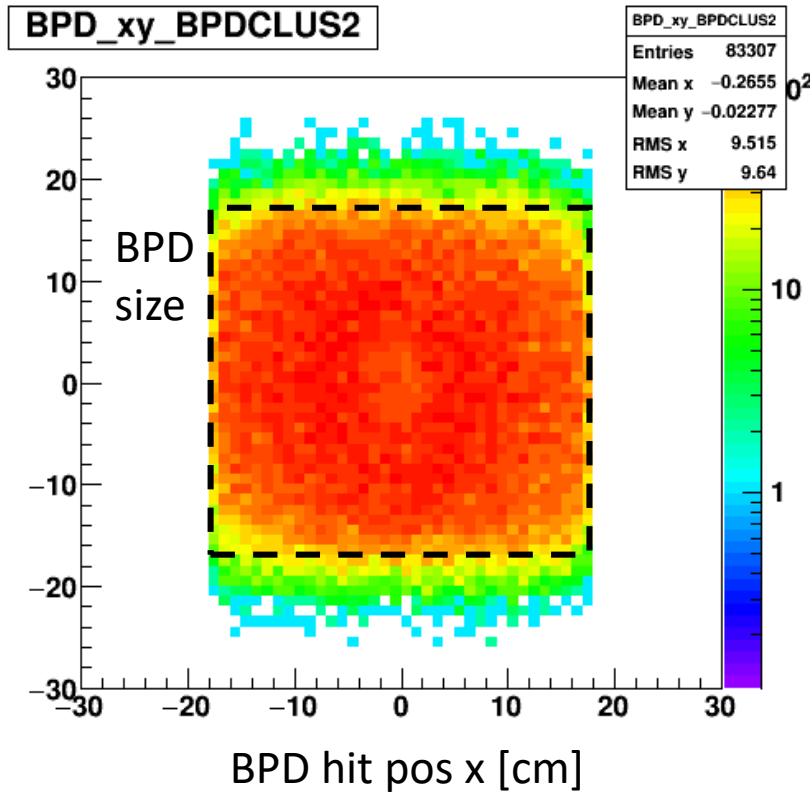
## Data (Run78)



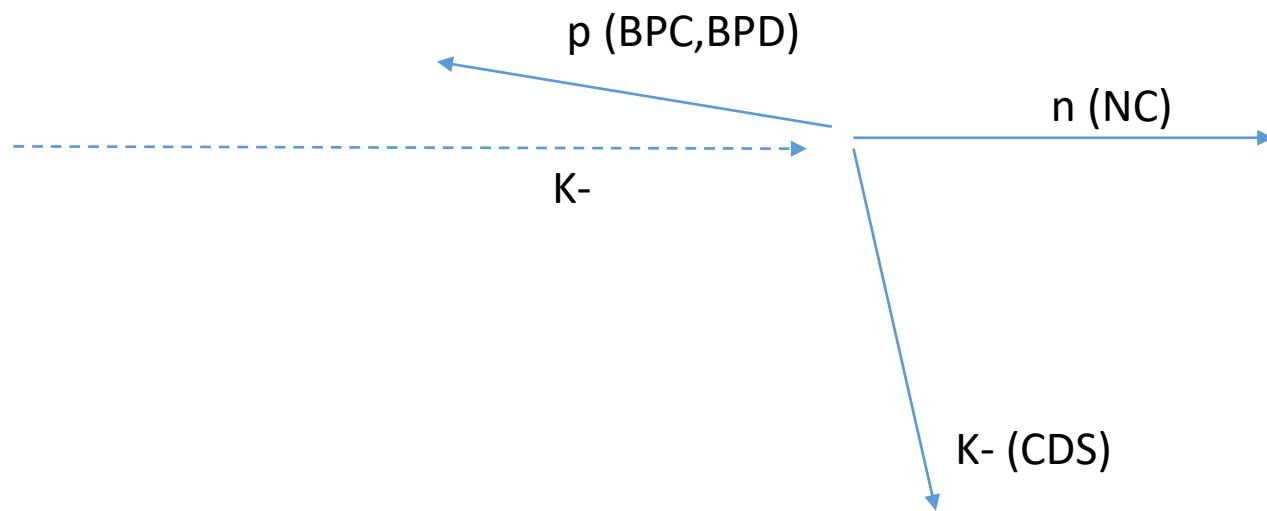
SIM

## K-d ->n Σ0π0

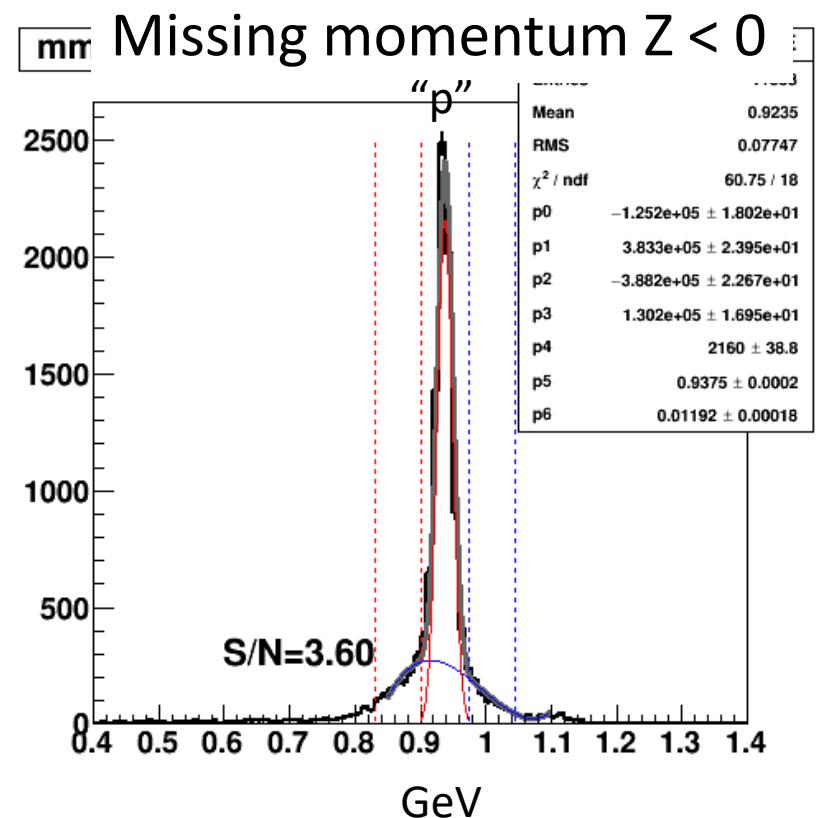
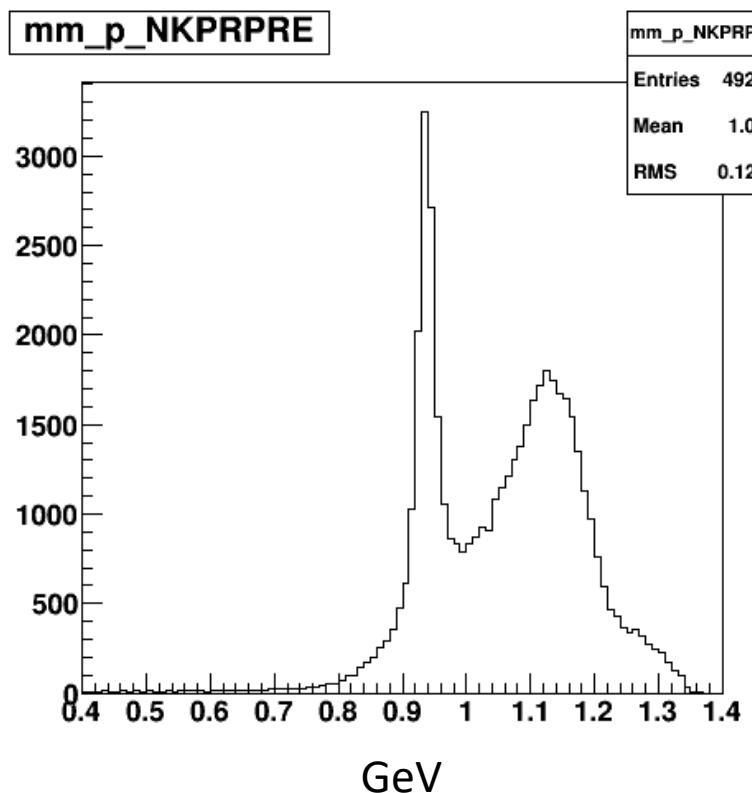
(spectrum shape ; cross Section P.9 left figure



# Backward efficiency study w/ $d(K-, nK-)''p''$

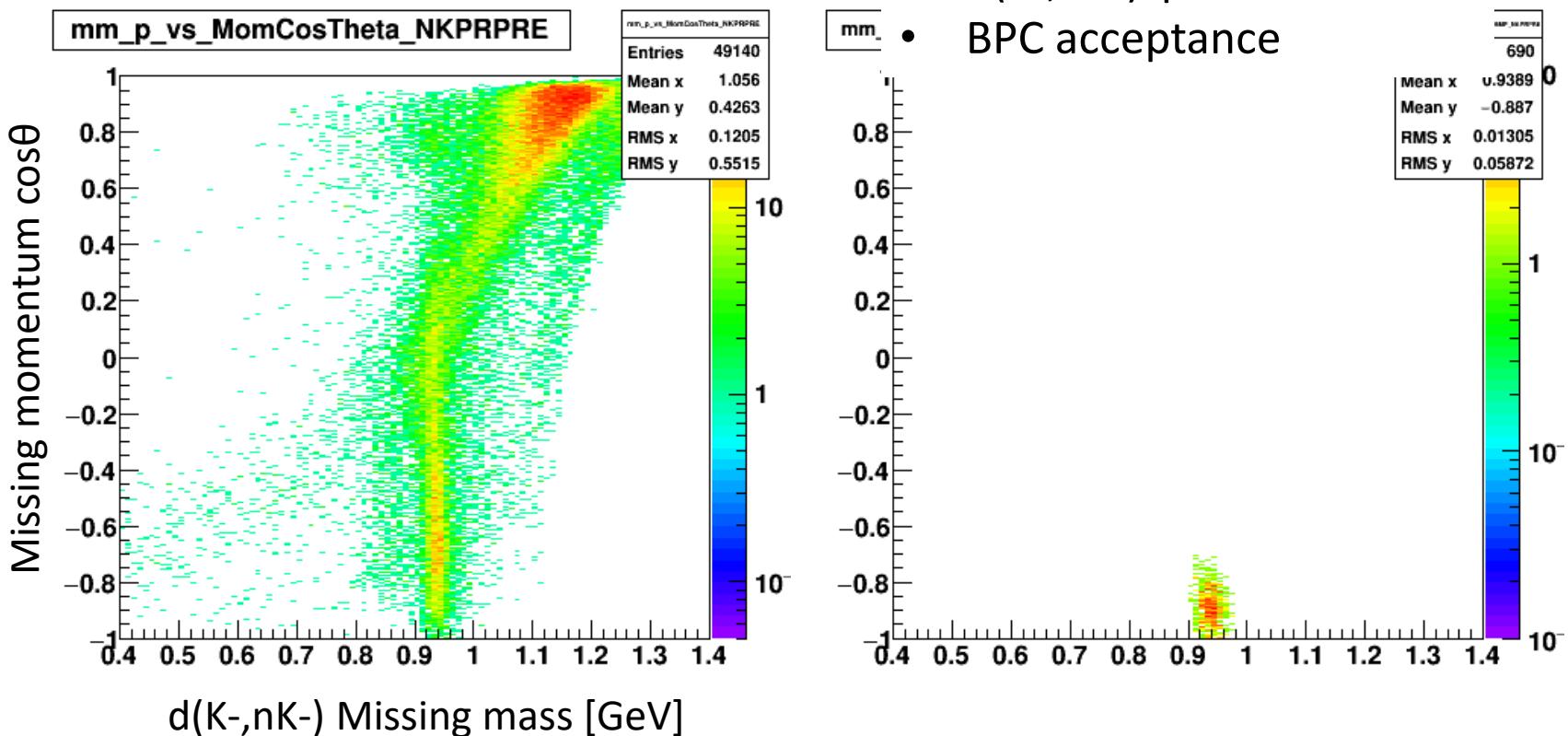


# $d(K^-, nK^-)$ missing mass



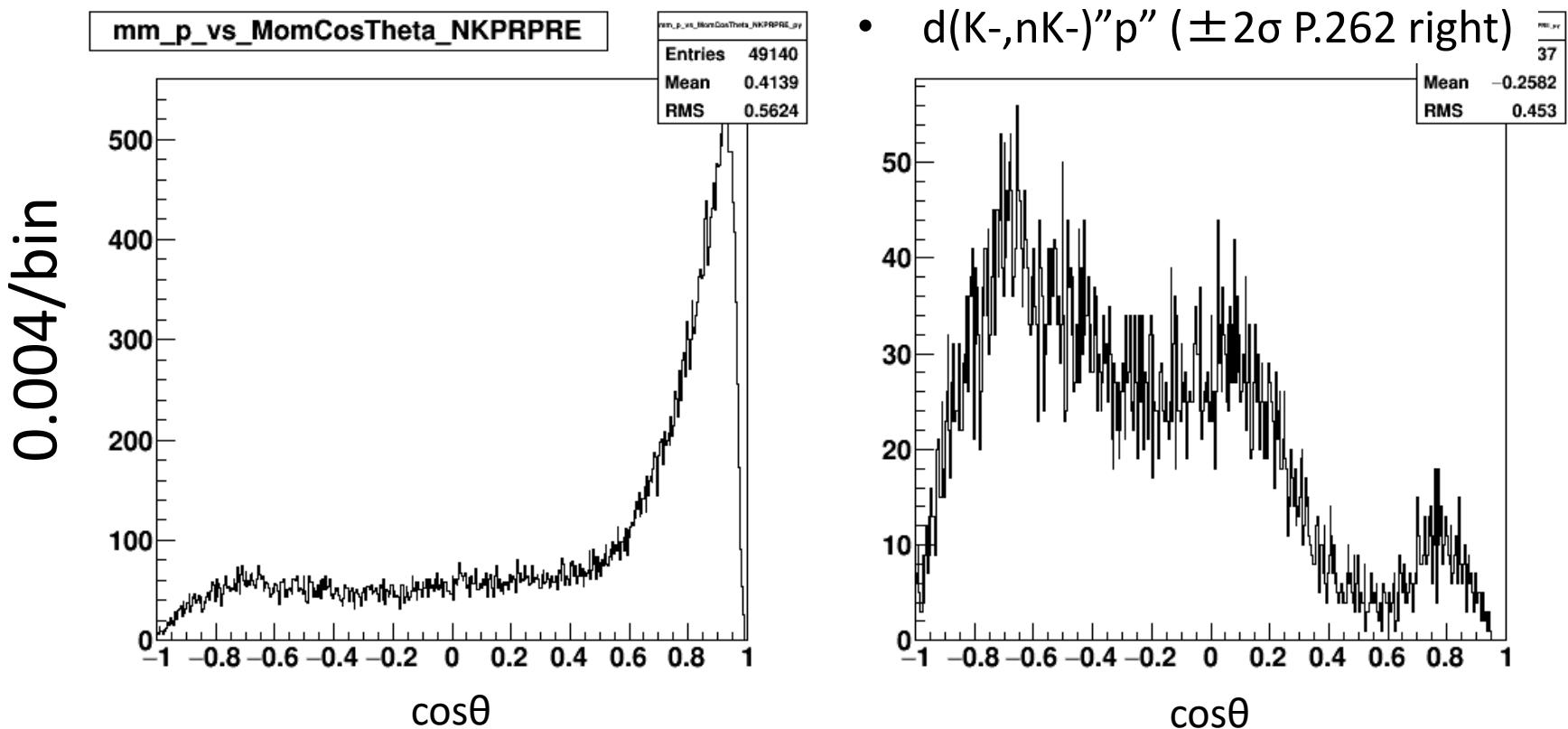
# $d(K^-, nK^-)$ Missing mass vs Missing momentum $\cos\theta$

- Missing momentum  $Z < 0$
- $d(K^-, nK^-)"p"$
- BPC acceptance



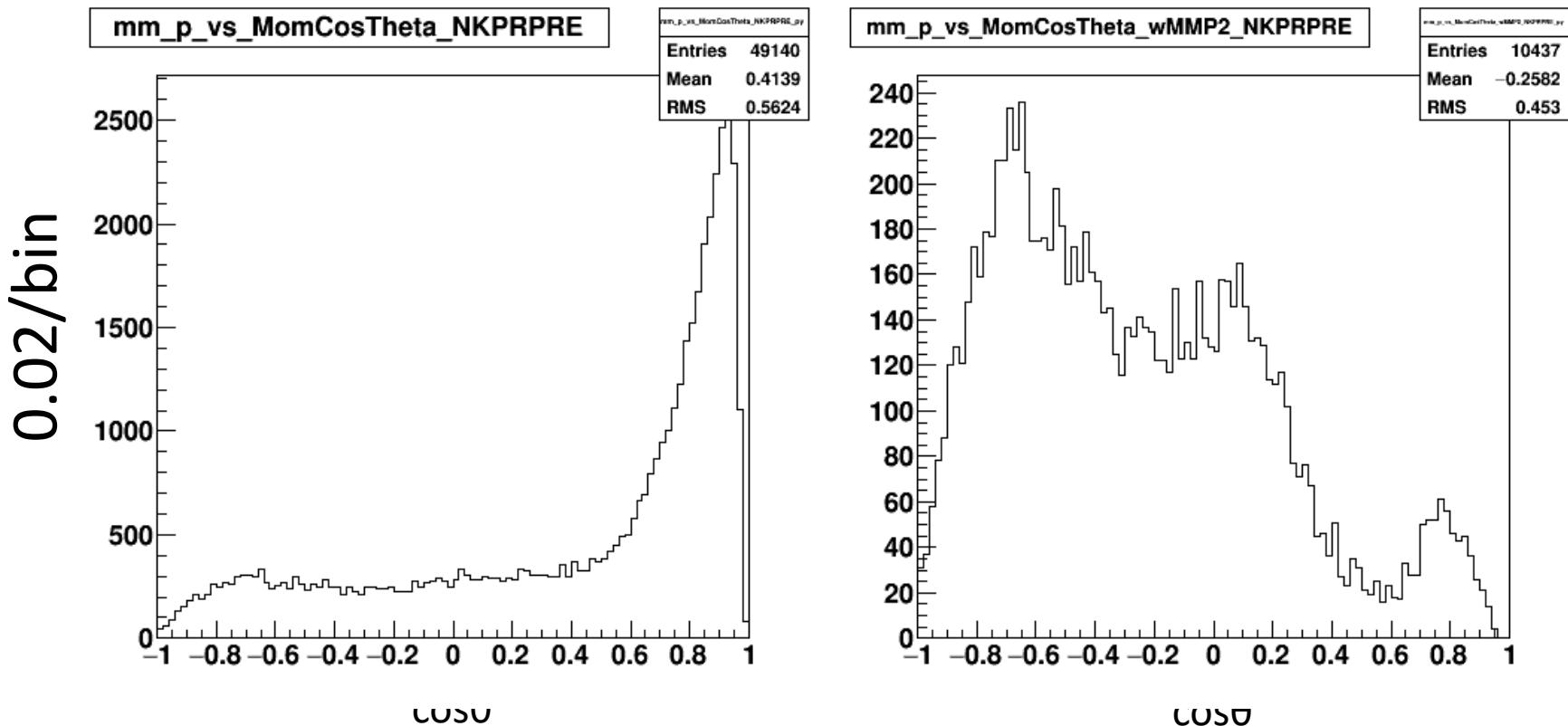
# Missing momentum $\cos\theta$

Projection of P.263 left on the vertical axis



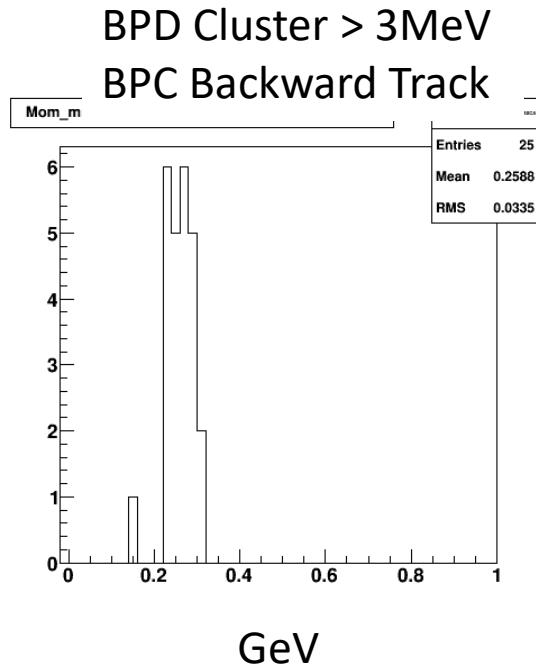
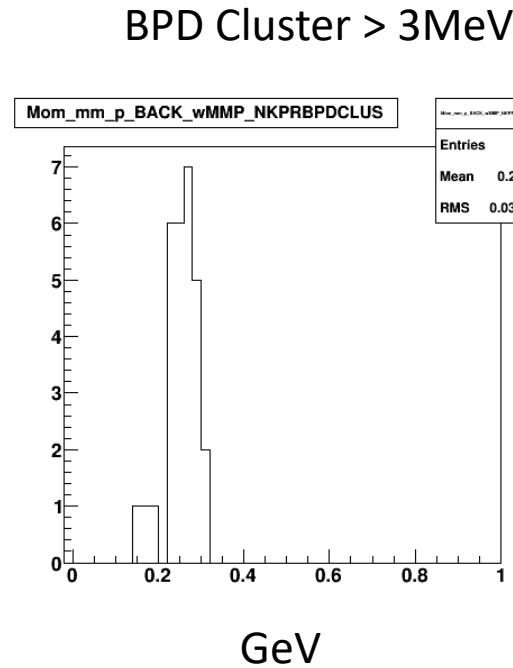
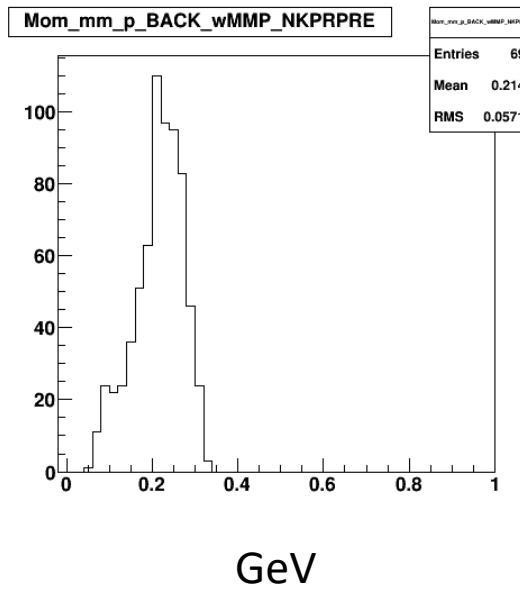
# Missing momentum $\cos\theta$

Projection of P.263 left on the vertical axis

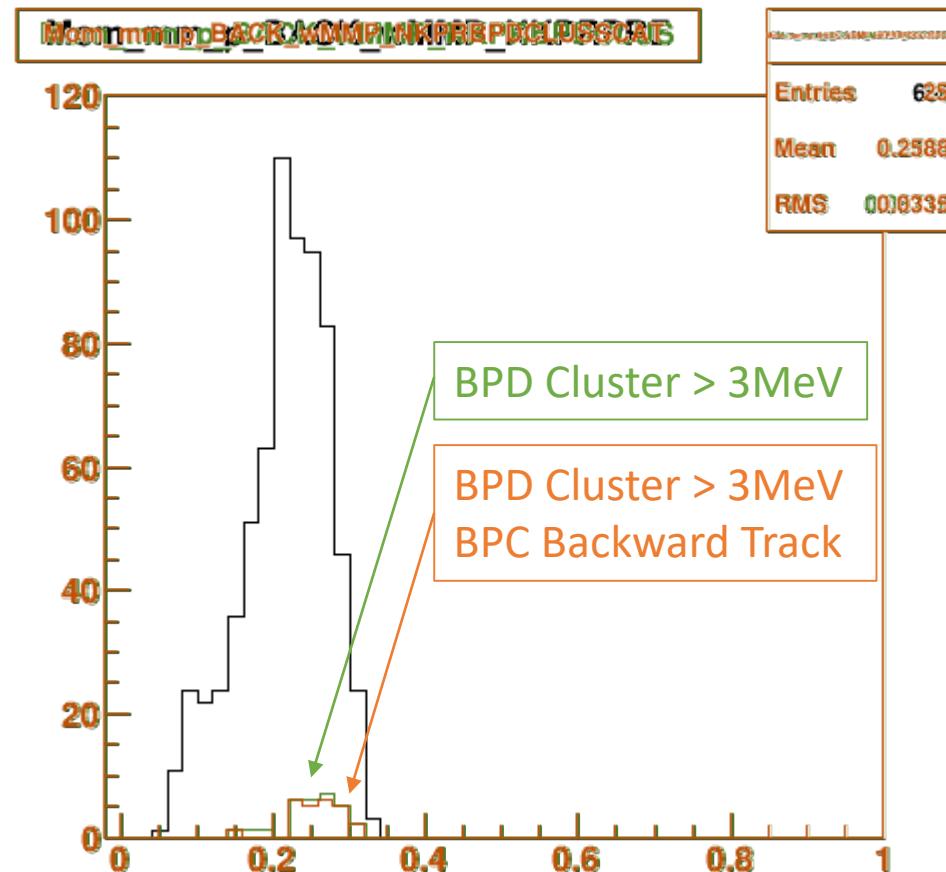


# Missing momentum

- Missing momentum  $Z < 0$
- $d(K^-, nK^-)''p''$
- BPC acceptance

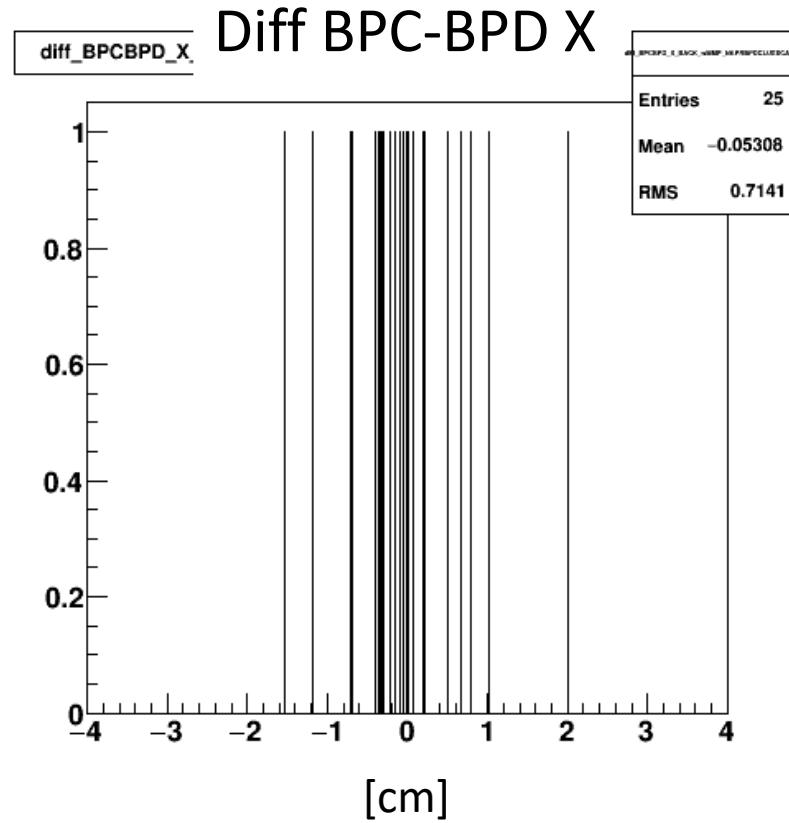
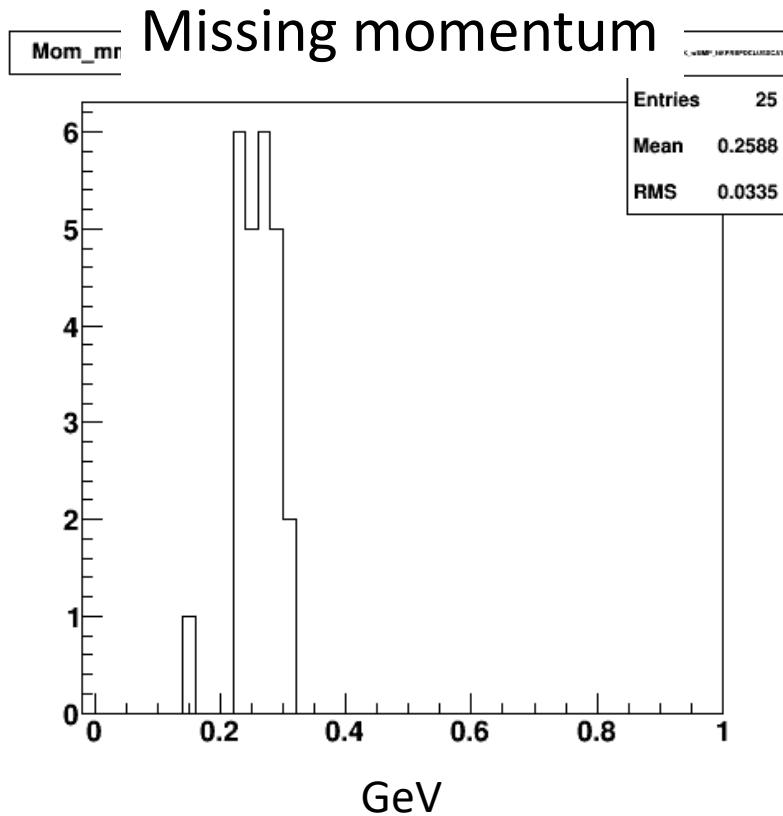


# Missing momentum (overlay)



# Diff. BPC-BPD X

- Missing momentum Z < 0
- $d(K_-, nK_-)''p''$
- BPC acceptance
- BPD Cluster > 3MeV
- BPC Backward Track

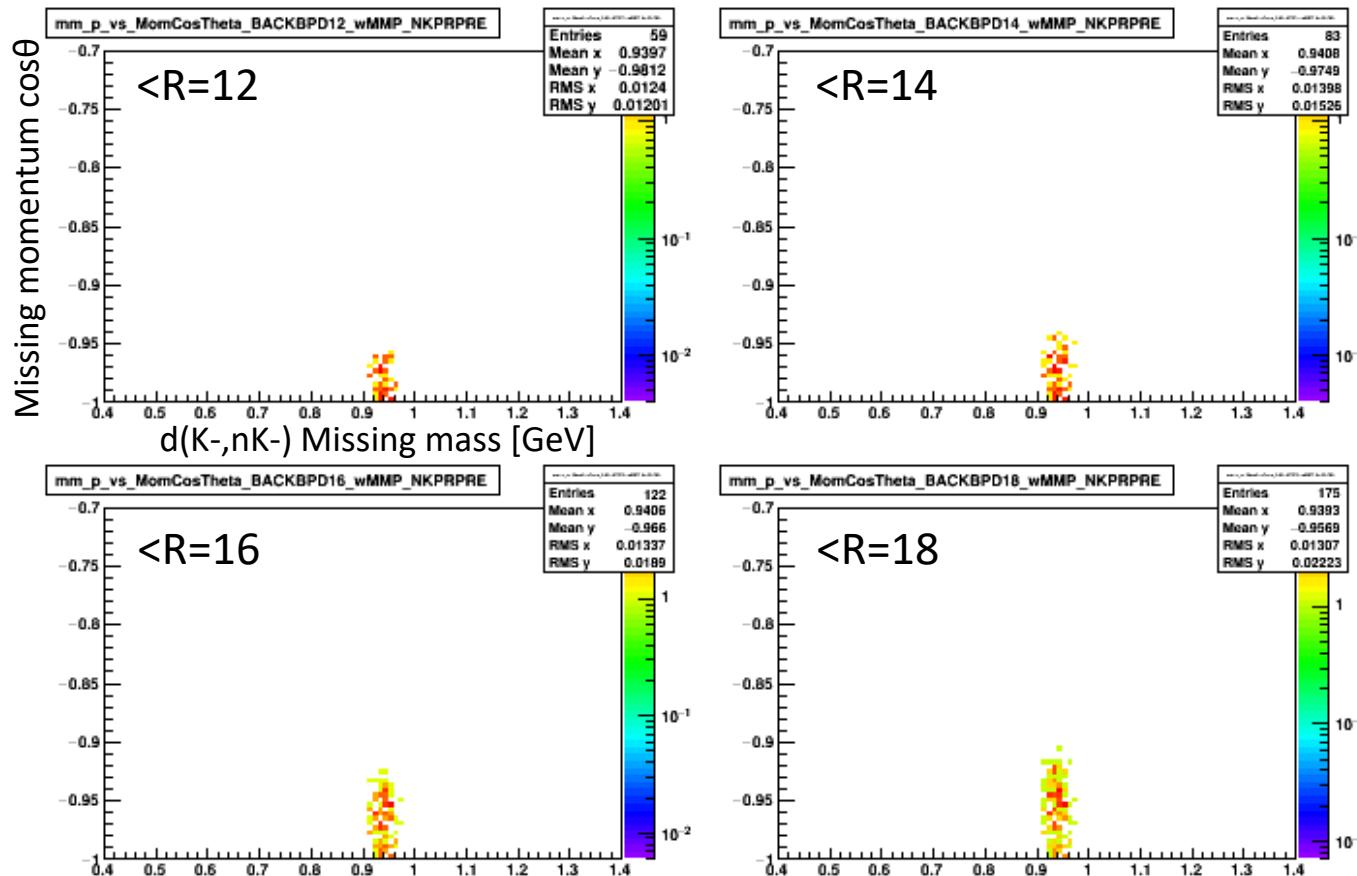


# Backward efficiency study w/ $d(K^-, nK^-)''p''$

- Dependence on BPD hit position of missing proton

# $d(K^-, nK^-)$ Missing mass vs Missing momentum $\cos\theta$

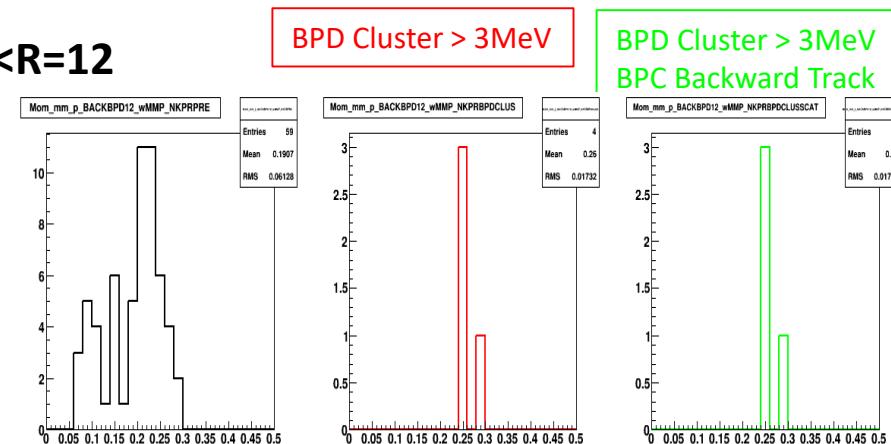
- Missing momentum  $Z < 0$
- $d(K^-, nK^-)"p"$
- BPD Hit position of missing proton  $< R$



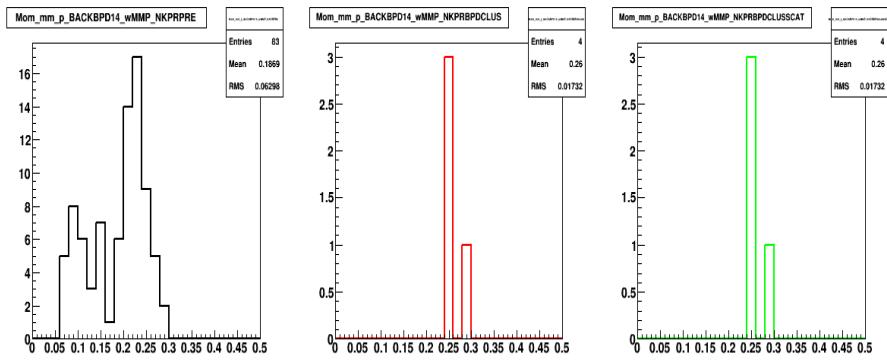
# Missing momentum

- Missing momentum  $Z < 0$
- $d(K,-nK^-)\pi^+$
- BPD Hit position of missing proton  $< R$

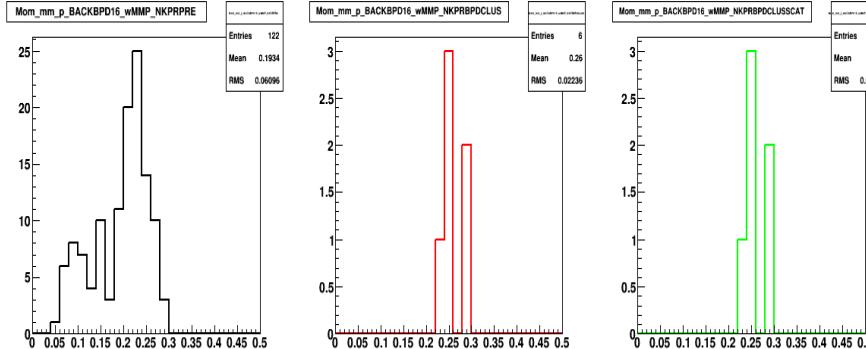
$< R = 12$



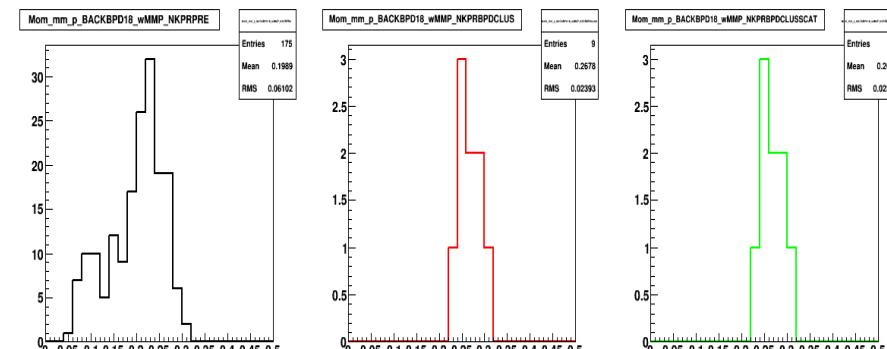
$< R = 14$



$< R = 16$



$< R = 18$



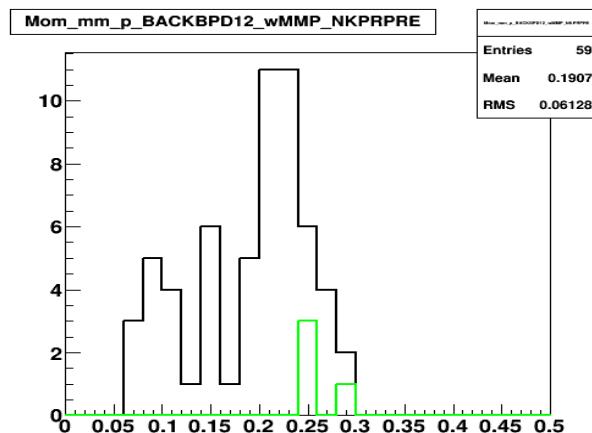
# Missing momentum

- Missing momentum  $Z < 0$
- $d(K,-nK^-)\pi^+$
- BPD Hit position of missing proton  $< R$

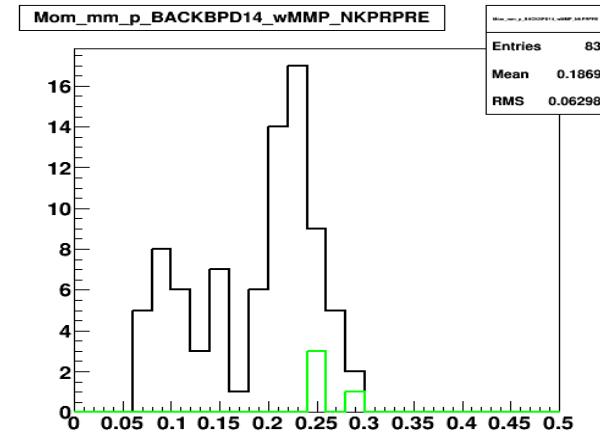
BPD Cluster  $> 3\text{MeV}$

BPD Cluster  $> 3\text{MeV}$   
BPC Backward Track

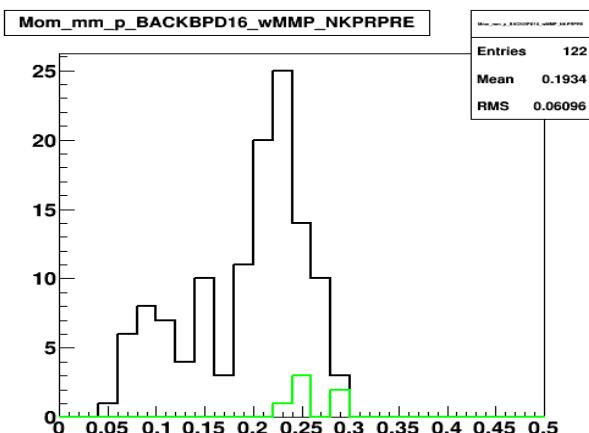
$< R = 12$



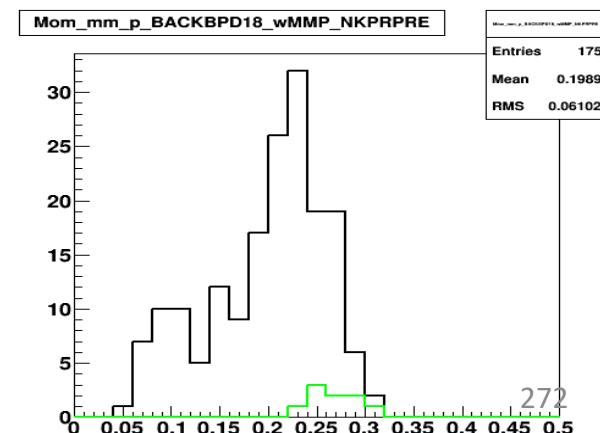
$< R = 14$



$< R = 16$



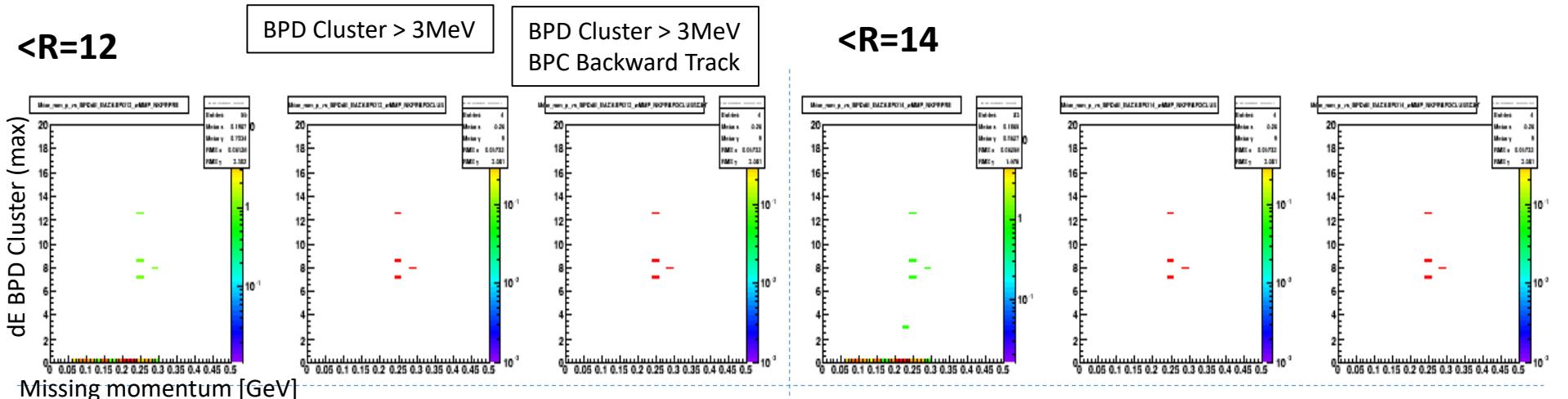
$< R = 18$



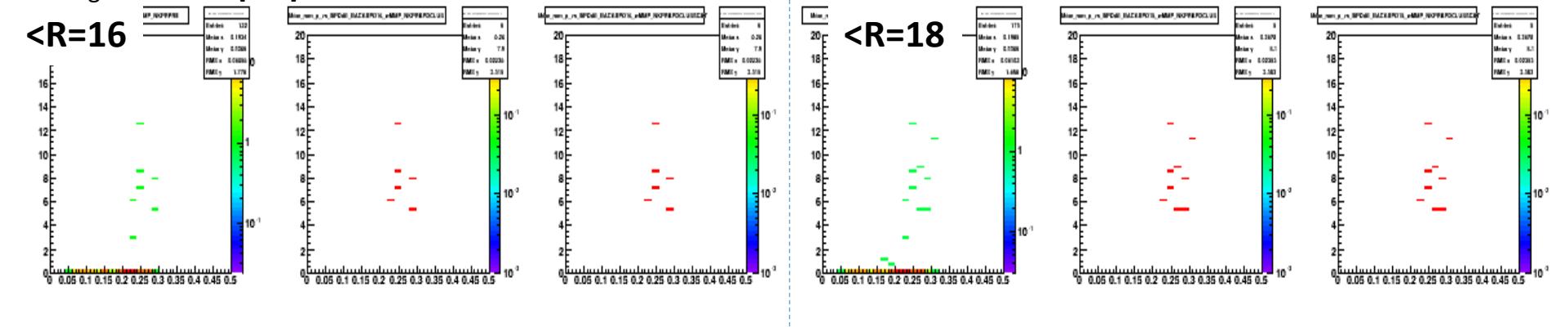
# Missing momentum vs dE BPD Cluster (max)

- Missing momentum Z < 0
- $d(K,-nK^-)\pi^+$
- BPD Hit position of missing proton < R

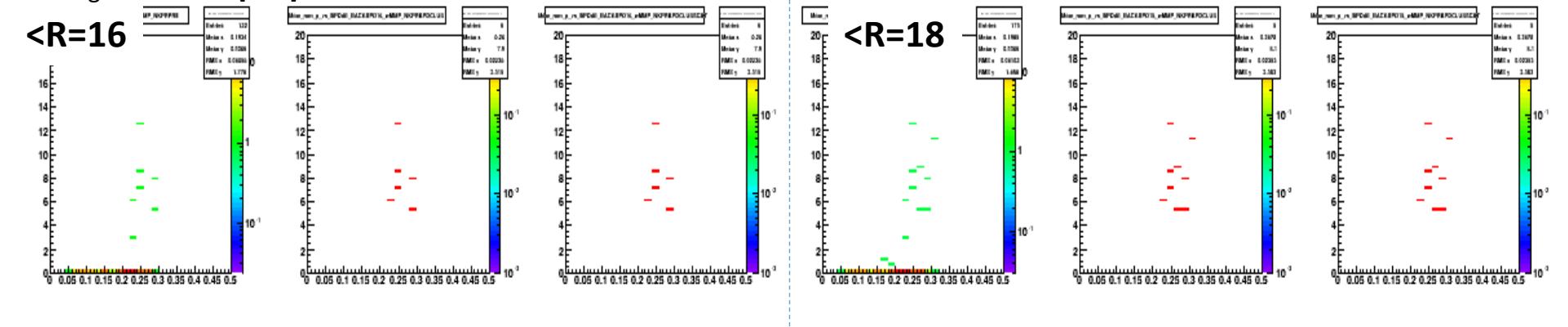
**<R=12**



**<R=14**



**<R=16**

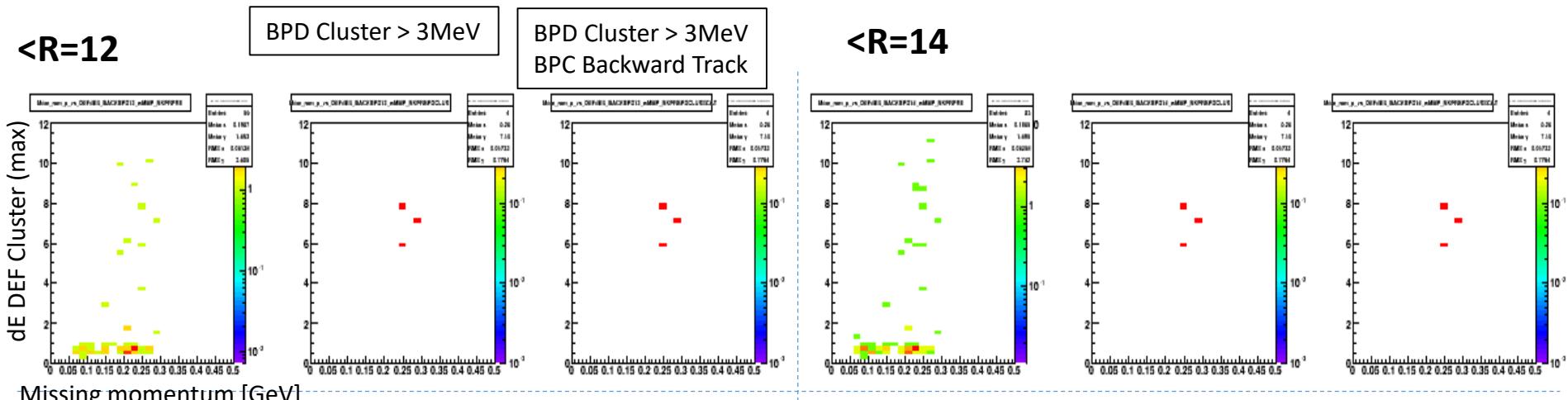


**<R=18**

# dE BPD Cluster (max) vs dE DEF (total)

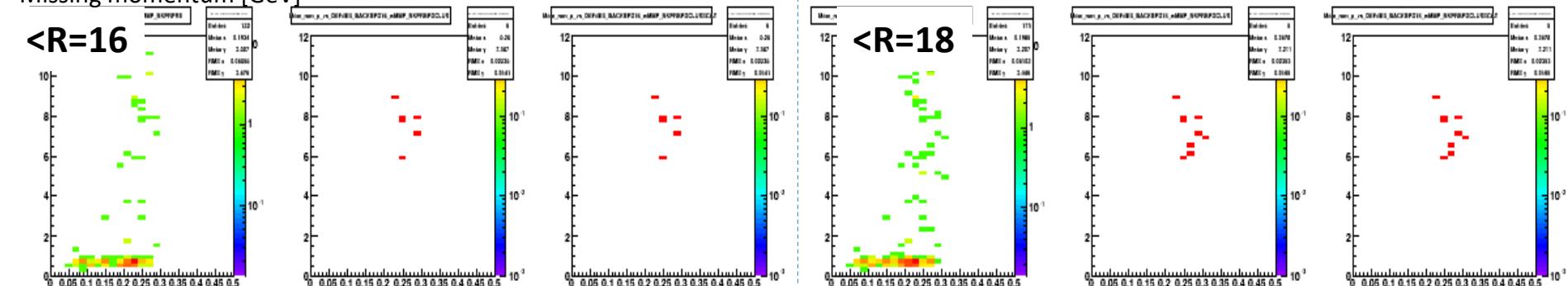
- Missing momentum Z < 0
- $d(K,-nK^-)\pi^+$
- BPD Hit position of missing proton < R

**<R=12**



Missing momentum [Gev]

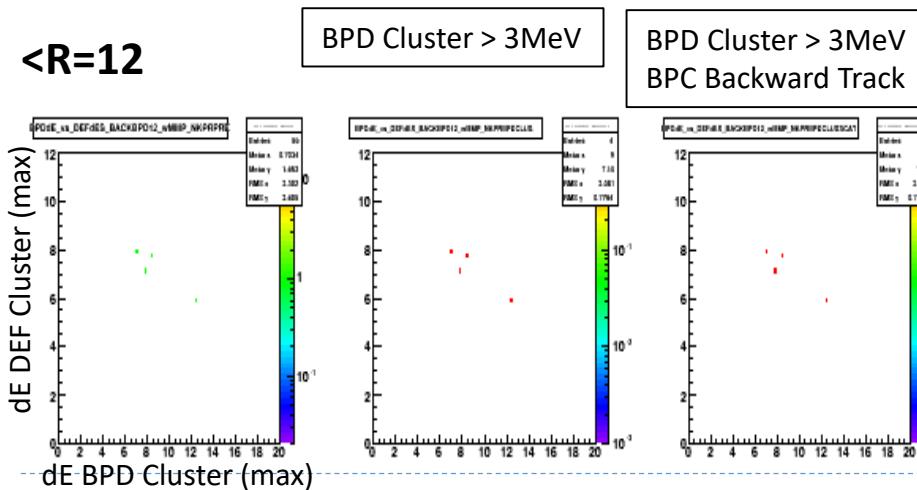
**<R=16**



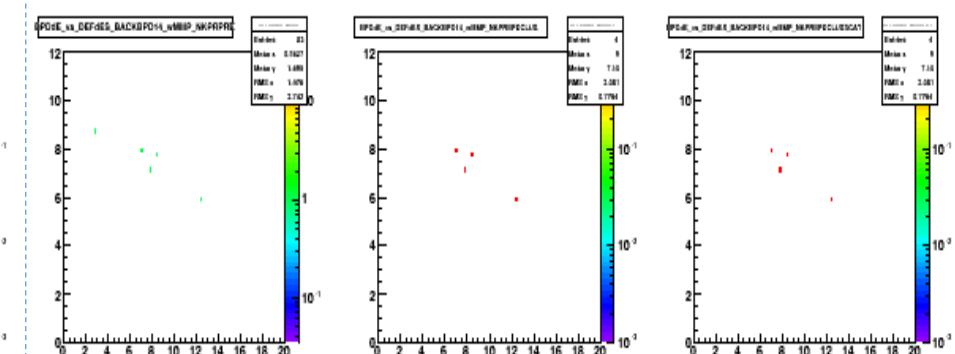
# Missing momentum vs dE DEF (total)

- Missing momentum Z < 0
- $d(K,-nK^-)''p''$
- BPD Hit position of missing proton < R

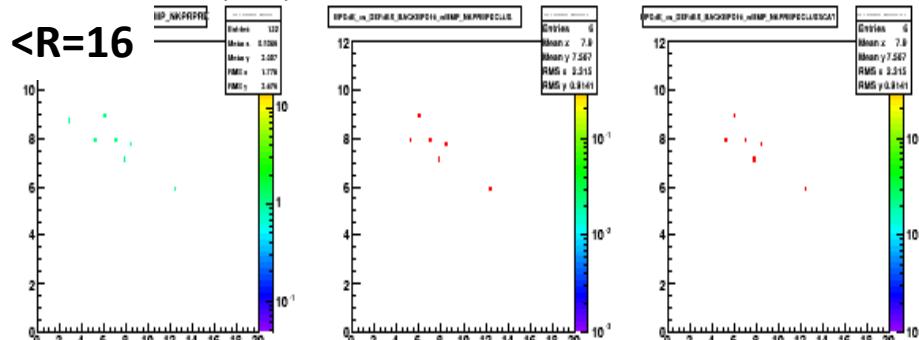
**<R=12**



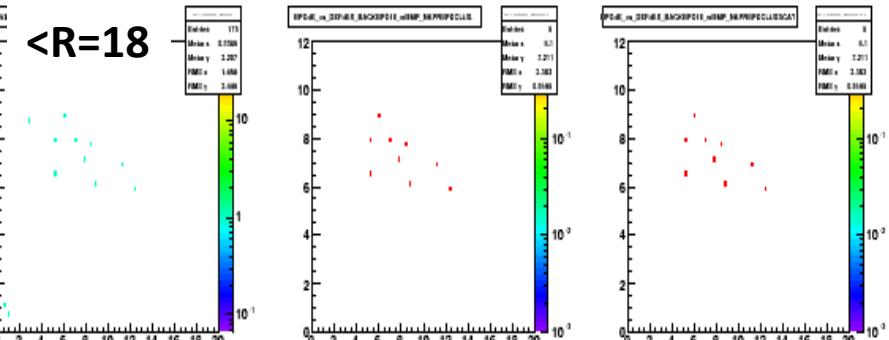
**<R=14**



**<R=16**

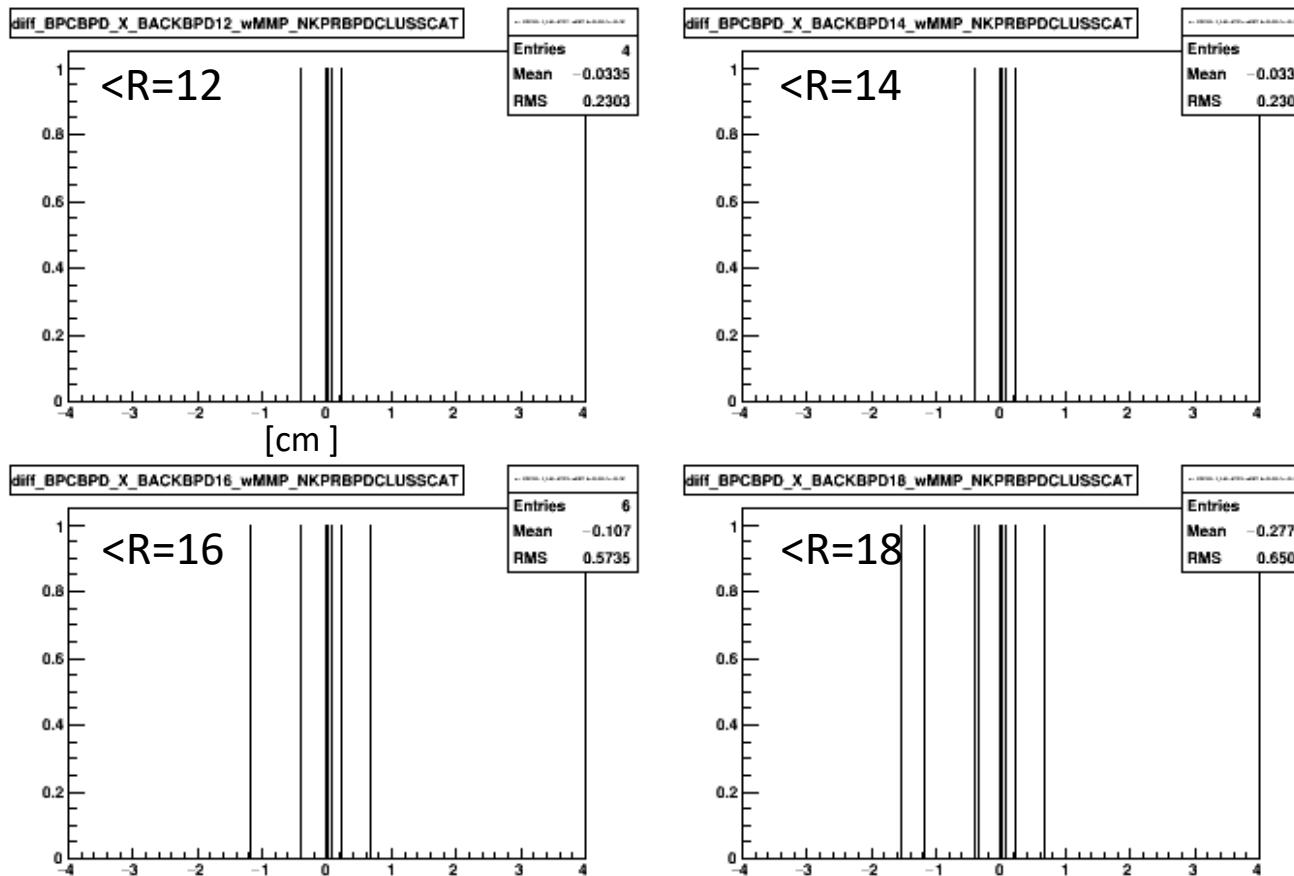


**<R=18**



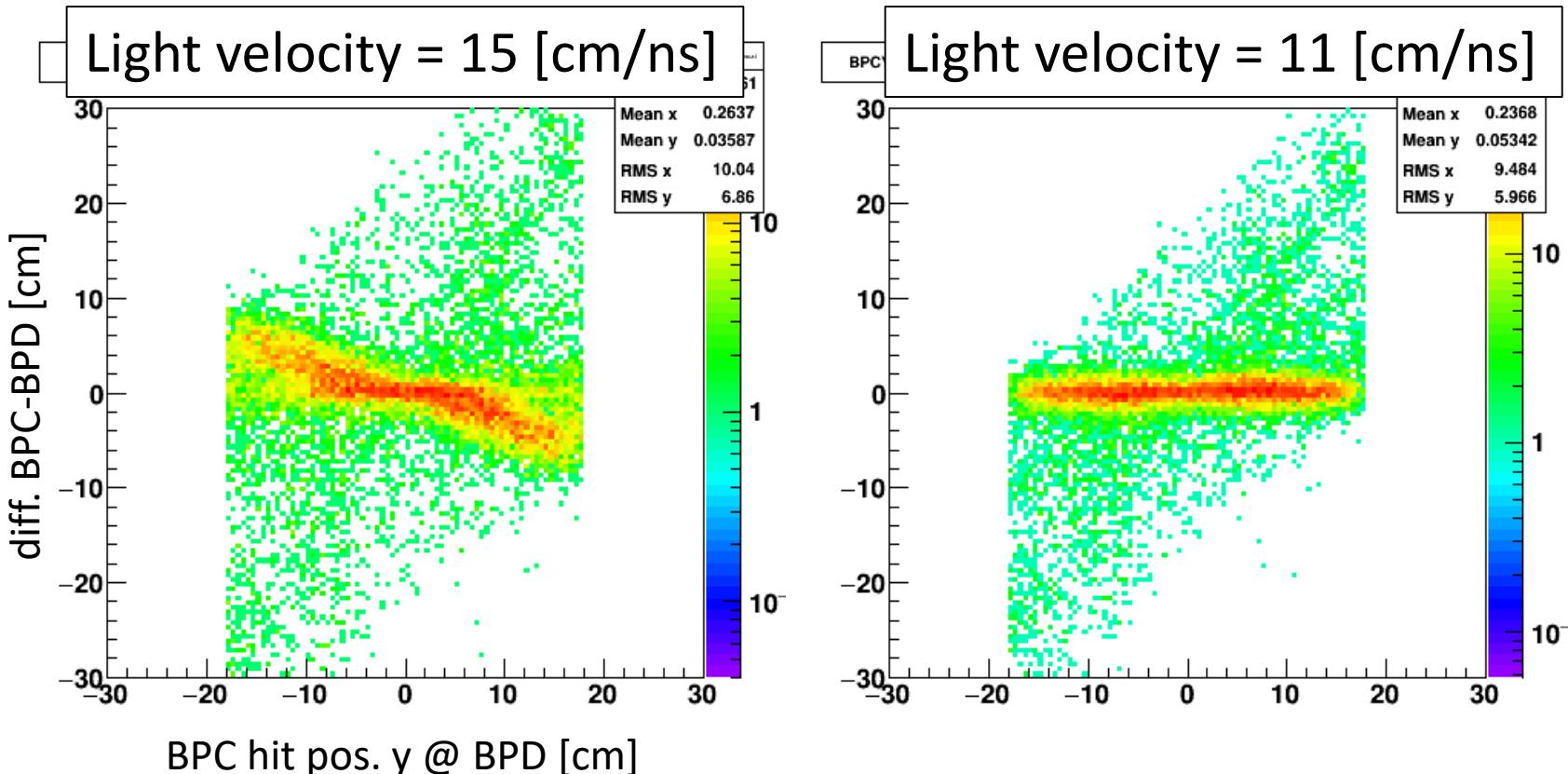
# Diff. BPC-BPD X

- Missing momentum Z < 0
- $d(K^-, \bar{n}K^-)''p''$
- BPD Hit position of missing proton < R
- BPD Cluster > 3MeV
- BPC Backward Track



# Diff. BPC-BPD Y dependence on Y position

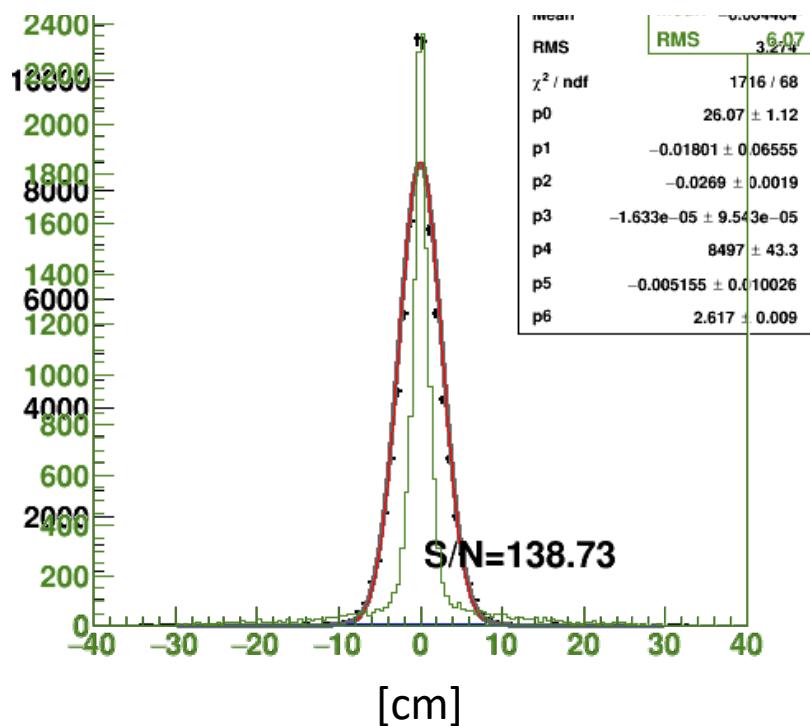
w/o forward neutron analysis for the increase of statistics



- in the sample event  
Page.60
- w/ the presence of  
BPC Backward Track event
- $dE(BPD) 4 \sim 12$  MeV
- $dE(DEF) 3.5 \sim 9$  MeV

# Diff. BPC-BPD Y

Y projection of right figure P.272  
Y projection of right figure P.130

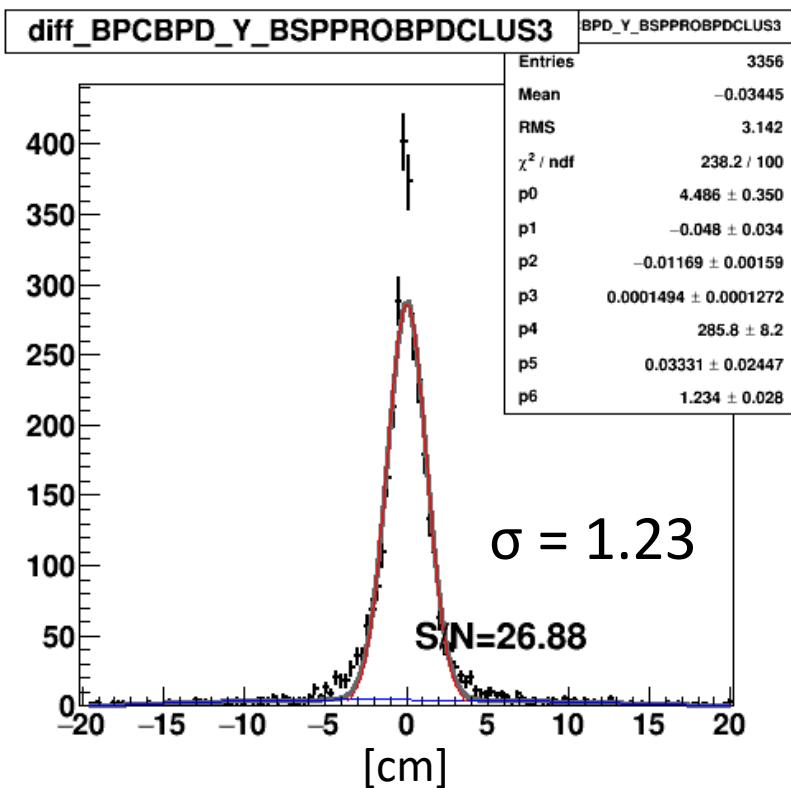


# Diff. BPC-BPD Y

## Condition

- BPC R<16 cm
- Vertex Lambda fiducial cut w/z (loose)
- Light velocity 15  $\rightarrow$  11 ns/cm
- BPD Clustering dE > 3 MeV

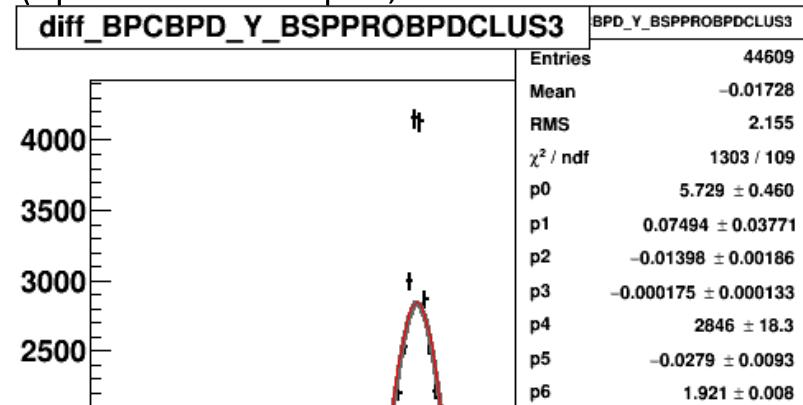
## Data (Run78)



## SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

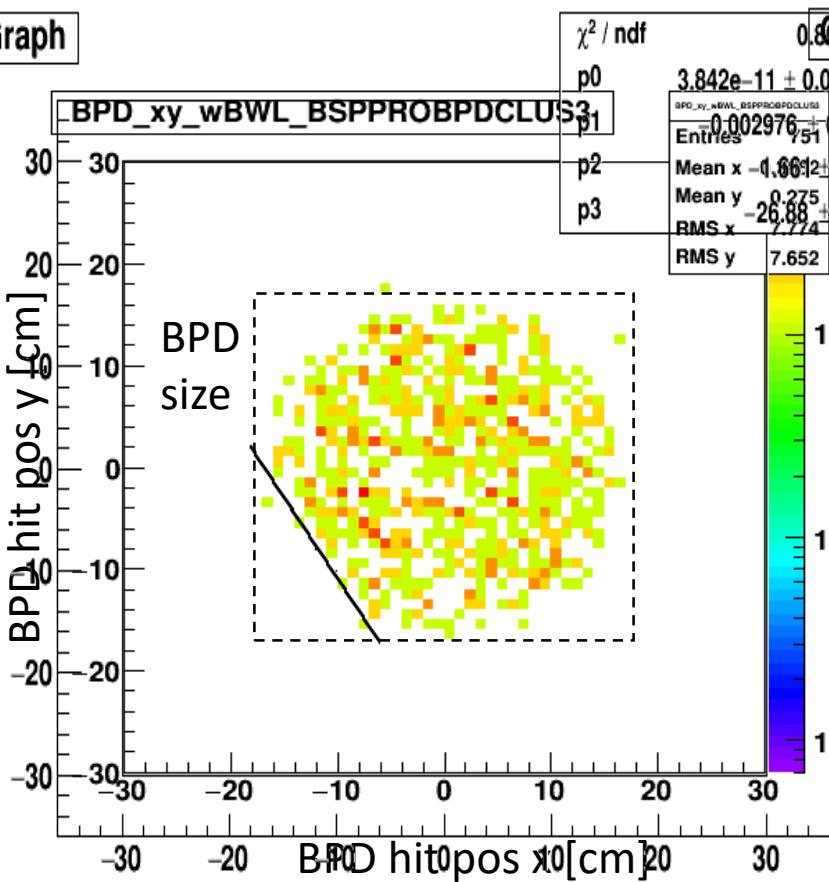


# BPD hit Position

BPD hit pos x ; segment geometry  
 BPD hit pos y ; up - down

Data (Run78)

Graph

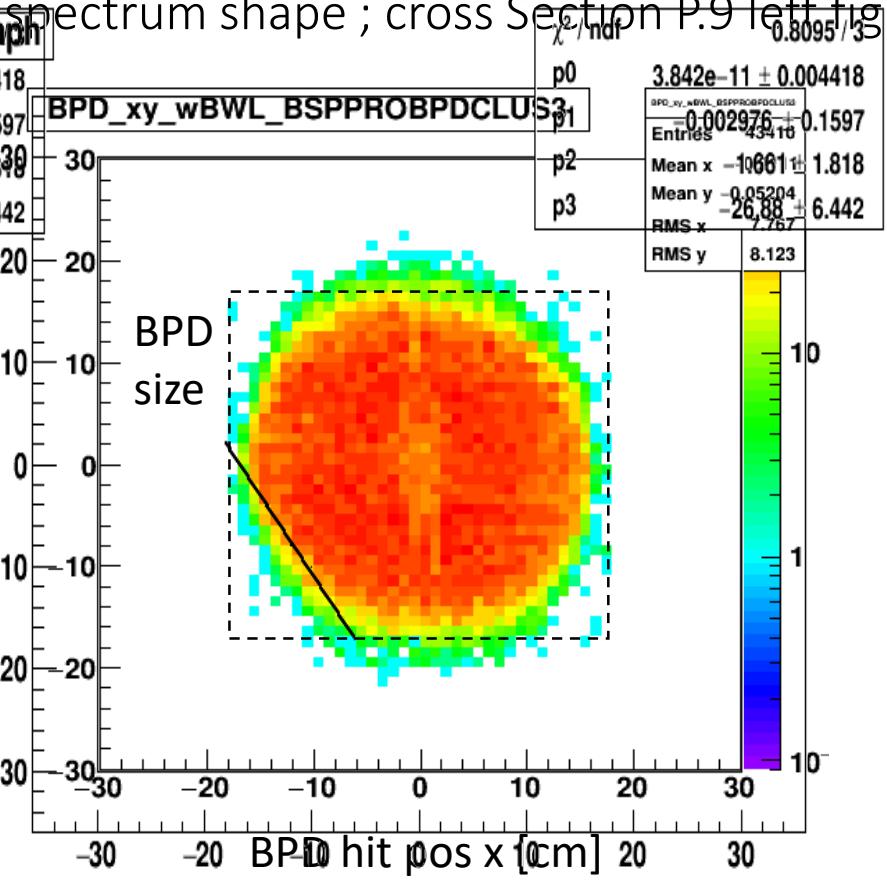


SIM

K-d  $\rightarrow$  n  $\Sigma 0 \pi 0$

(spectrum shape ; cross Section P.9 left figure)

Graph



# BPD hit Position

BPD hit pos x ; segment geometry

BPD hit pos y ; up - down

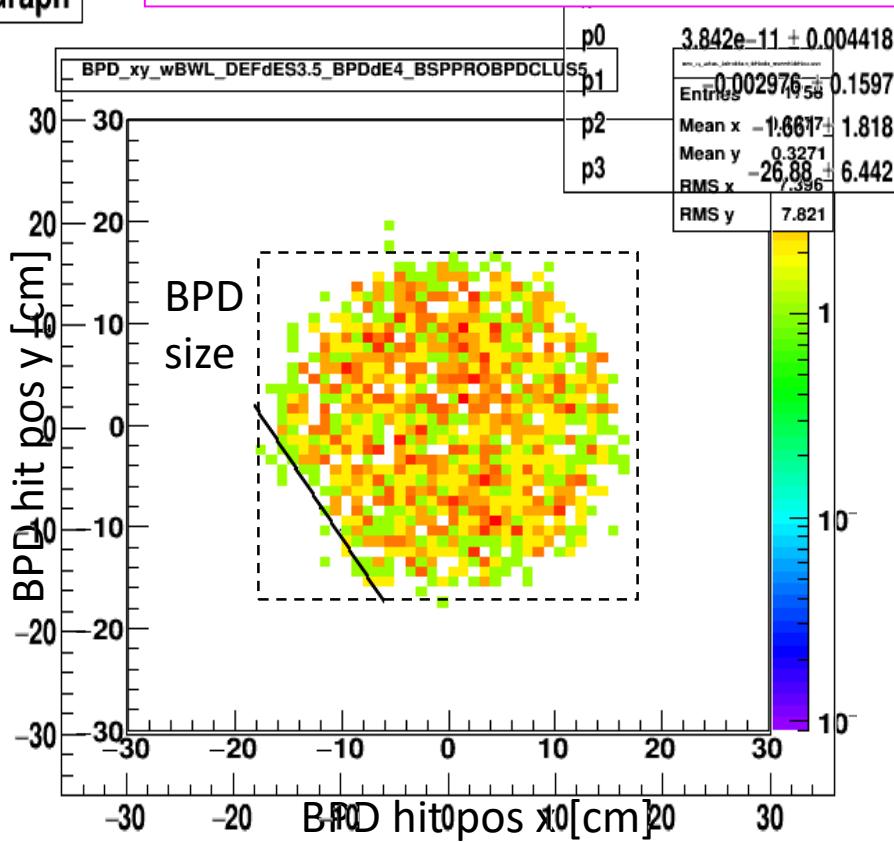
Data (Run78)

## Condition

- BPC R<16 cm
- Vertex Lambda fiducial cut w/z (loose)
- Light velocity 15 → 11 ns
- BPD Clustering  $dE > 3$  MeV
- $\Lambda$  selection
- $dE(BPD) 4 \sim 12$  MeV
- $dE(DEF) 3.5 \sim 9$  MeV

Graph

w/o forward neutron analysis for the increase of statistics



# BPD hit Position

BPD hit pos x ; segment geometry

BPD hit pos y ; up - down

Data (Run78)

Condition

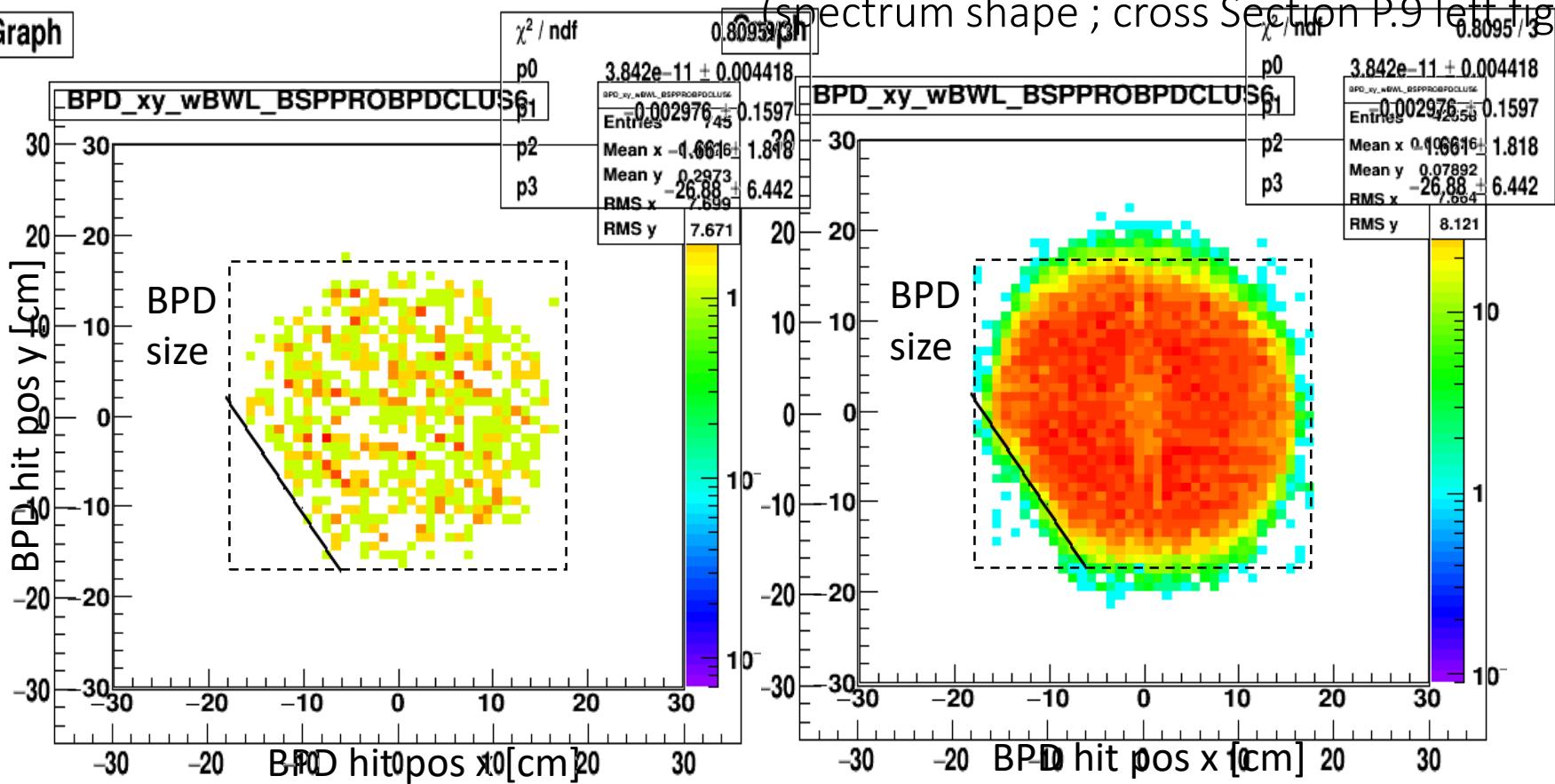
- BPC R<16 cm
- Vertex Lambda fiducial cut w/z (loose)
- Light velocity 15 → 11 ns
- BPD Clustering dE > 3 MeV
- Λ selection
- BPC cut @ BPD 3<sup>rd</sup> quadrant

SIM

K-d → n Σ0π0

(spectrum shape ; cross Section P.9 left figure)

Graph

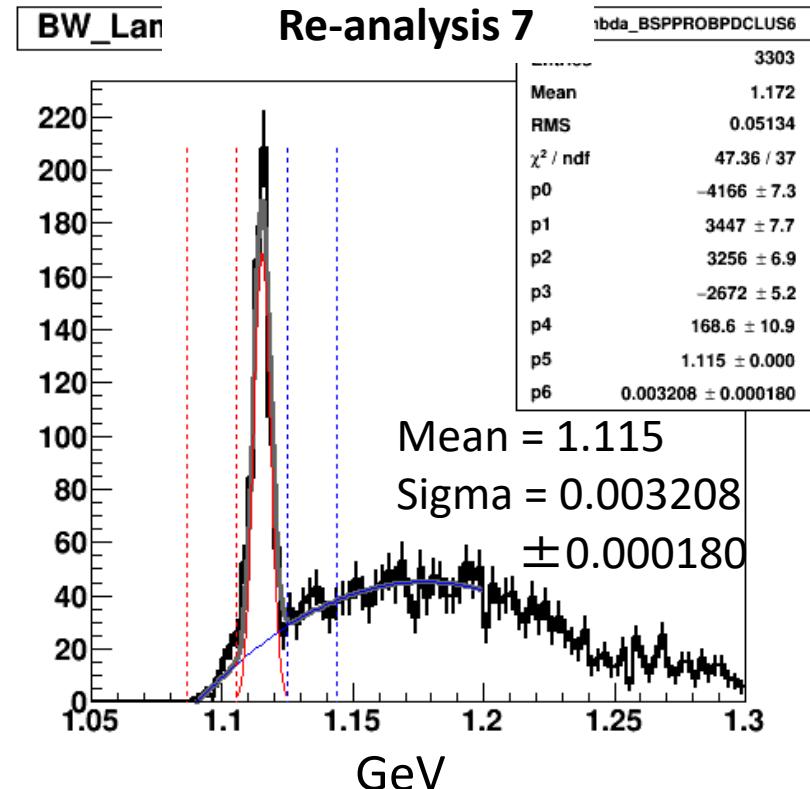
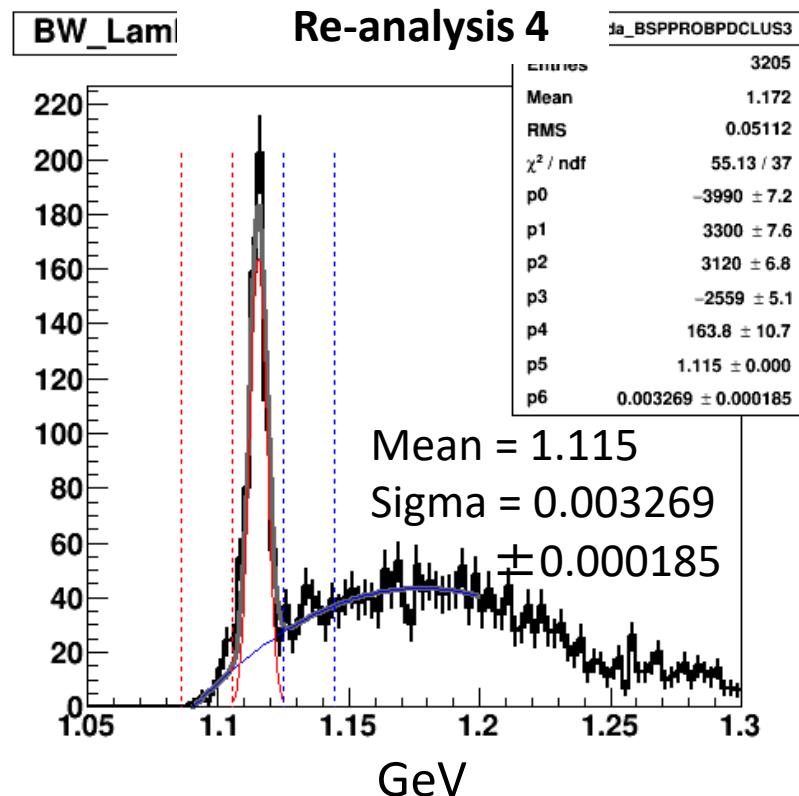


# Re-analysis 7

- Re-analysis 4 >P.233 (z vertex cut (loose))  
→ Light velocity 15 -> 11 ns  
+ BPC cut @ BPD 3<sup>rd</sup> quadrant

# $p, \pi$ - invariant mass

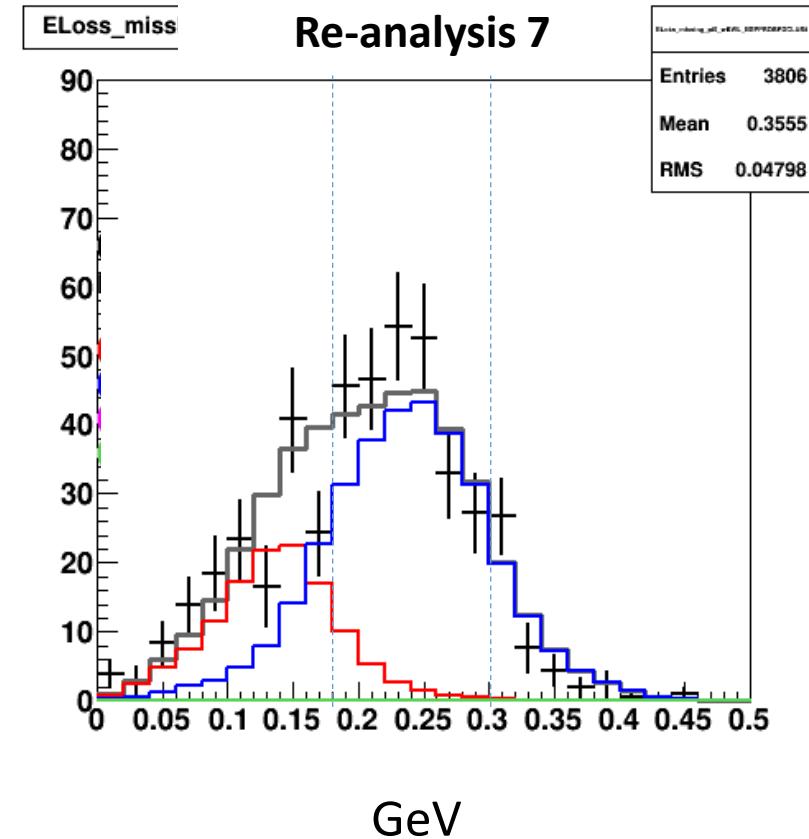
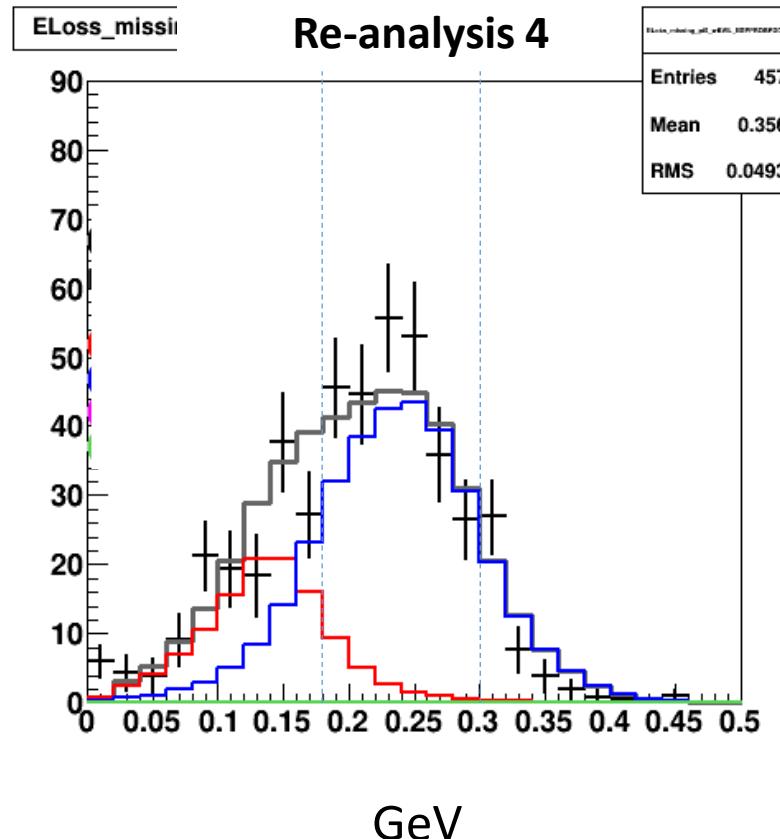
$\Lambda$  reconstruction from  $p \pi^-$  invariant mass



# Fitting of the $d(K^-, np\pi^-)''X''$ missing mass

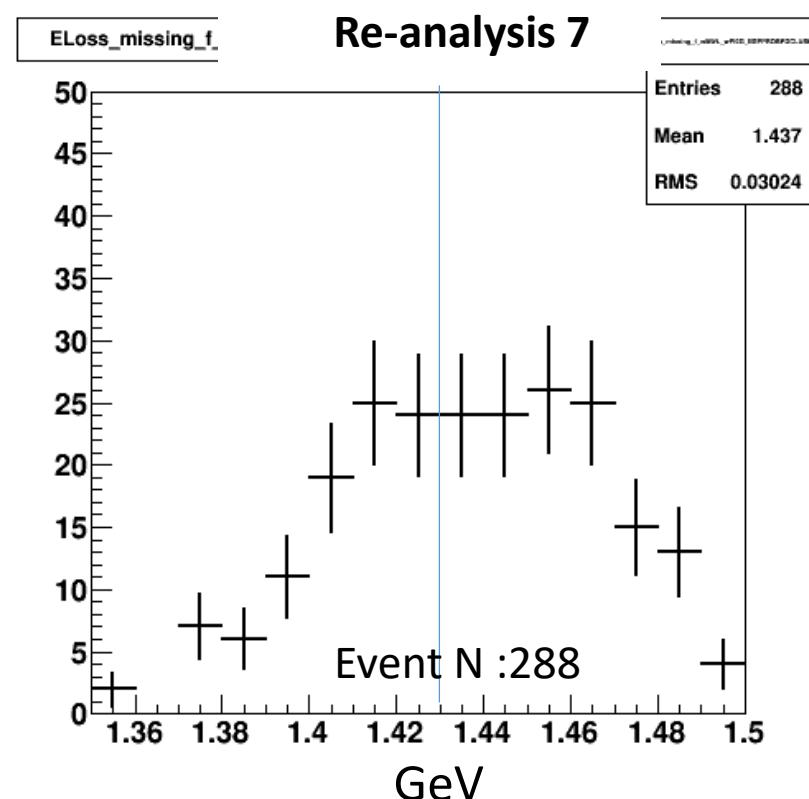
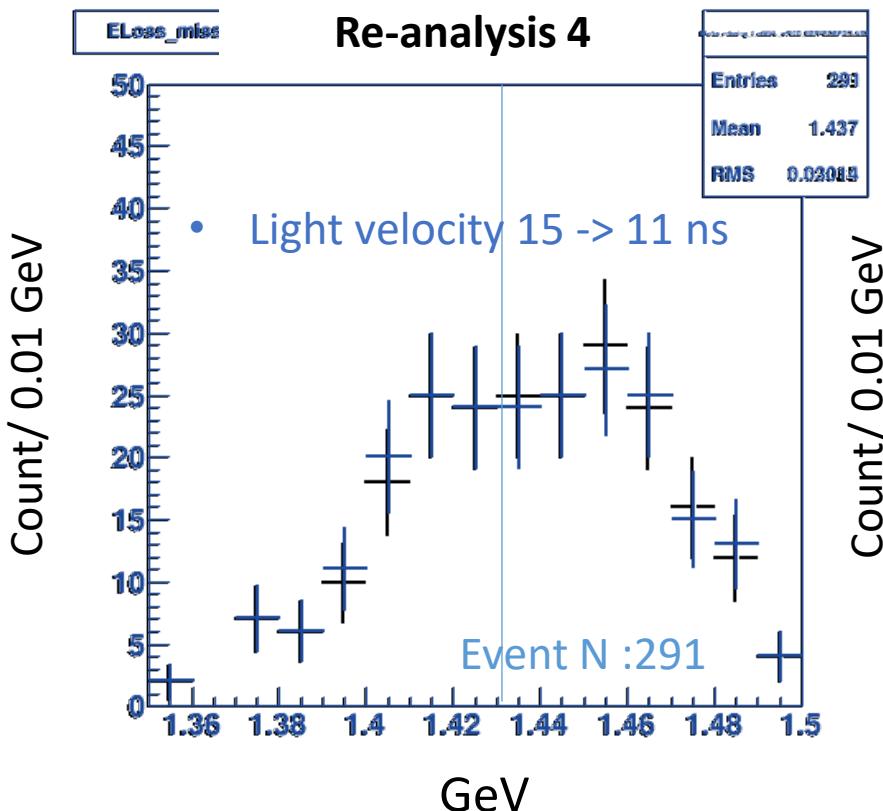
- $p, \pi$ - invariant mass  $\Lambda$  selection

$\pi 0 \gamma$  is selected from  $d(K^-, np\pi^-)''X''$  missing mass



# $d(K^-, n)\pi^0\pi^0$ missing mass

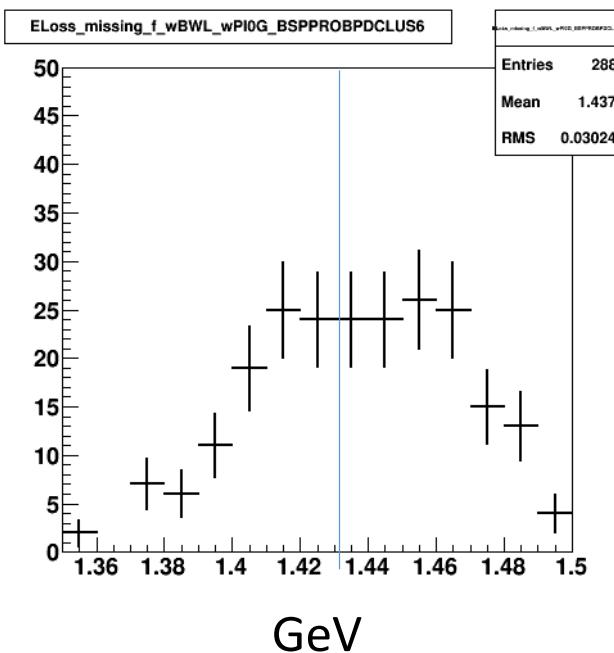
- p,  $\pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\rho\pi^-)\pi^0\gamma$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$



# $d(K^-, n)\pi^0\pi^0$ missing mass

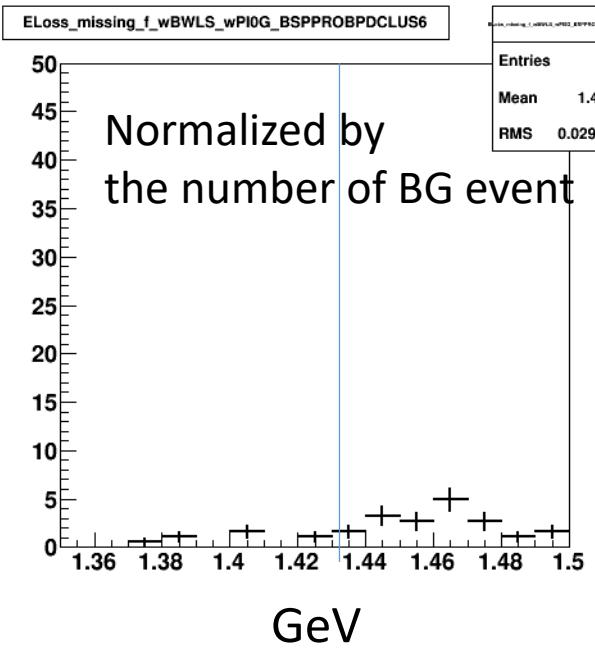
Spectrum (284 right)  
before subtraction of BGs

- p,  $\pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, np\pi^-)\pi^0\gamma$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$
- p,  $\pi$ - invariant mass  $\Lambda$  side-band
- $d(K^-, np\pi^-)\pi^0\gamma$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$
- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, np\pi^-)\pi^0\gamma$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$



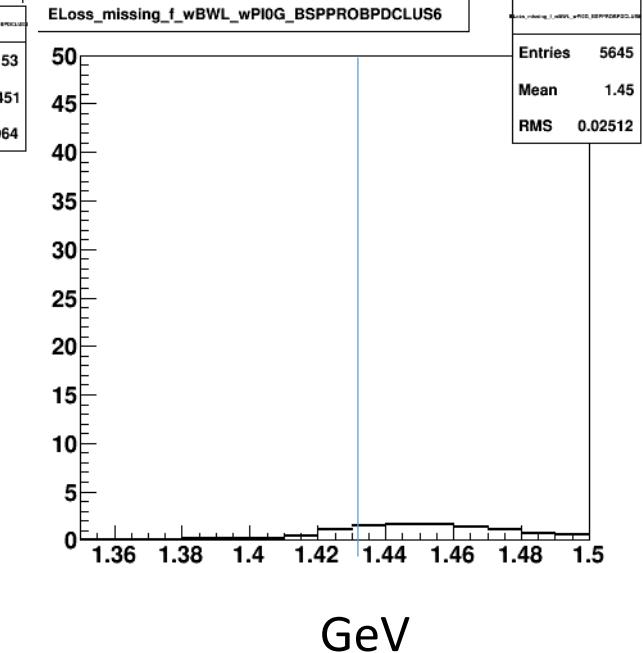
BG ; $\Lambda$  side-band

- p,  $\pi$ - invariant mass  $\Lambda$  side-band
- $d(K^-, np\pi^-)\pi^0\gamma$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$

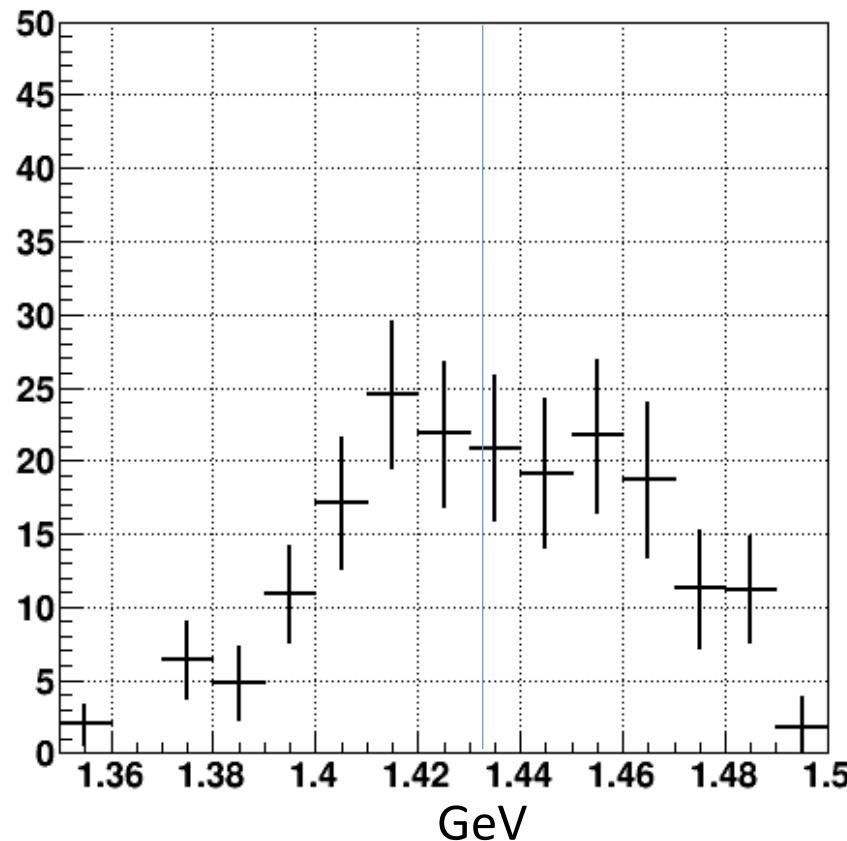


BG ; $K^- d \rightarrow \Lambda\pi^0 n$

- p,  $\pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, np\pi^-)\pi^0\gamma$   $0.18 < X < 0.3$  GeV for  $\pi^0\gamma$

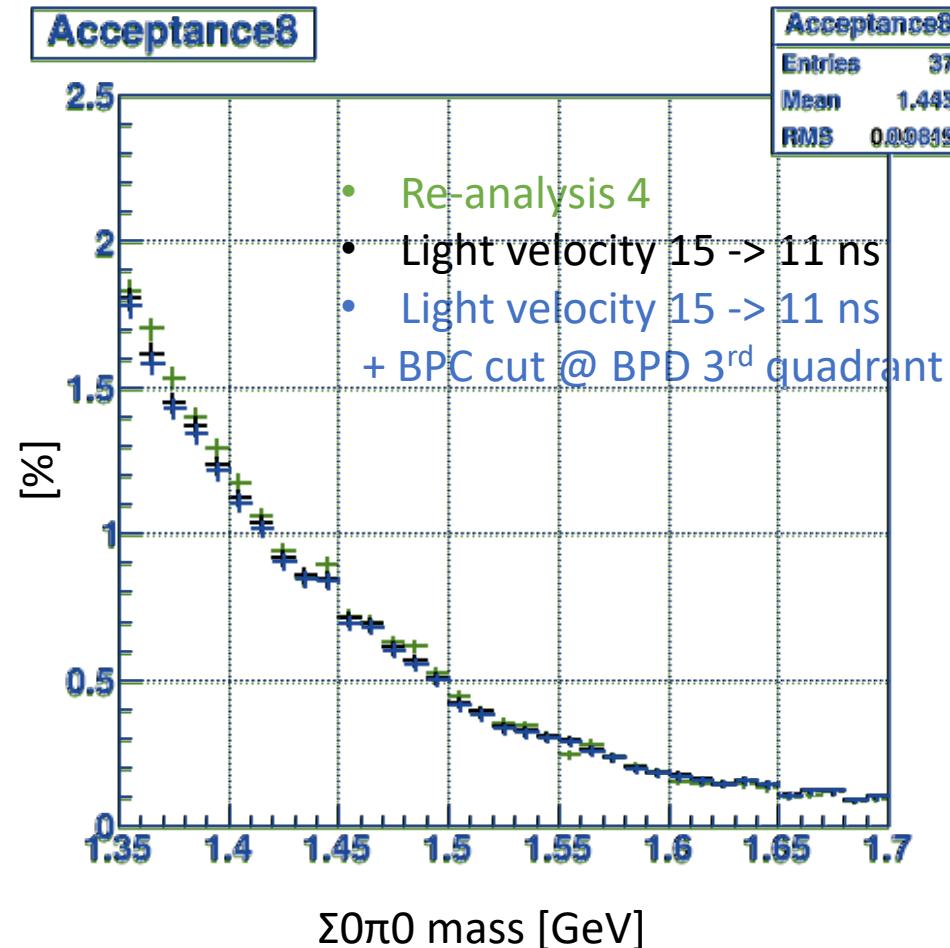


# Spectrum after subtraction of BGs



# Acceptance estimation

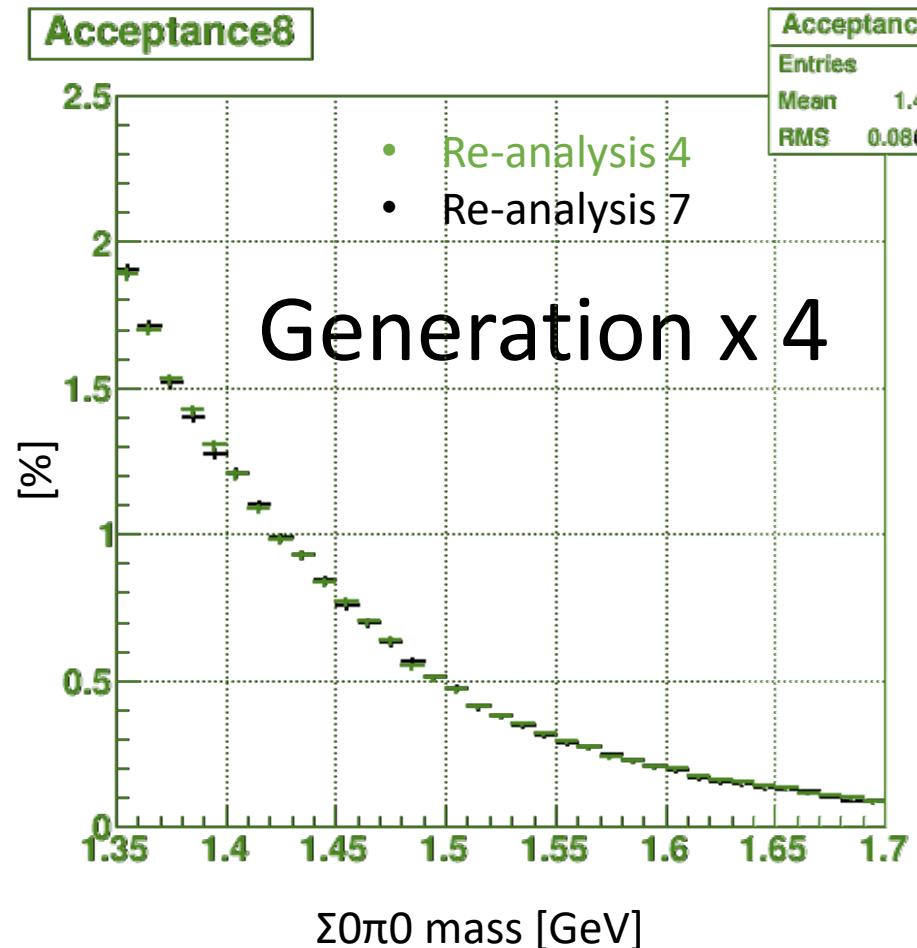
- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample



- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X''$   $0.18 < X < 0.30 \text{ GeV}$

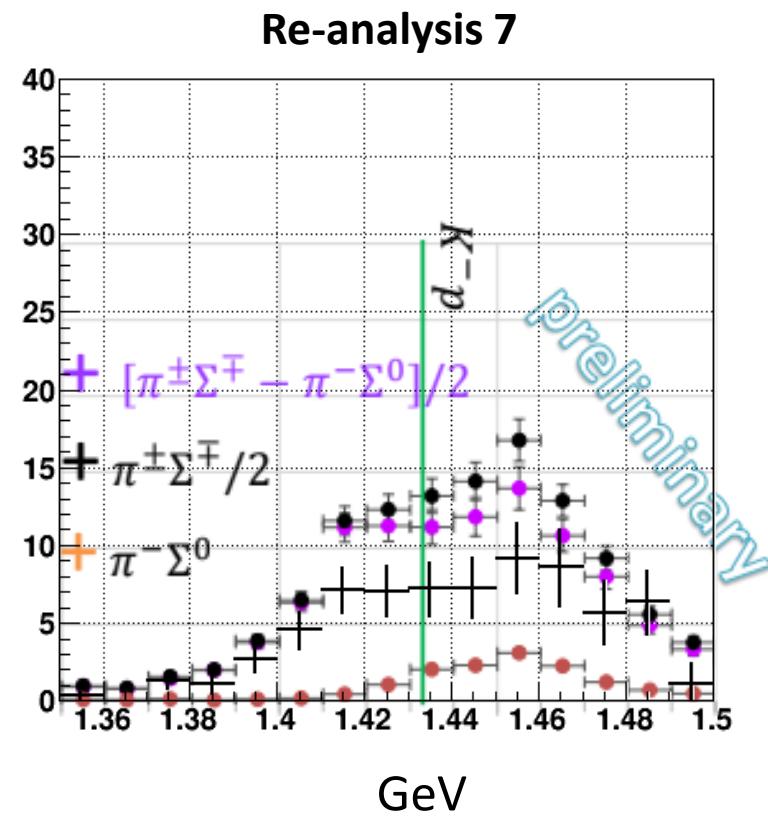
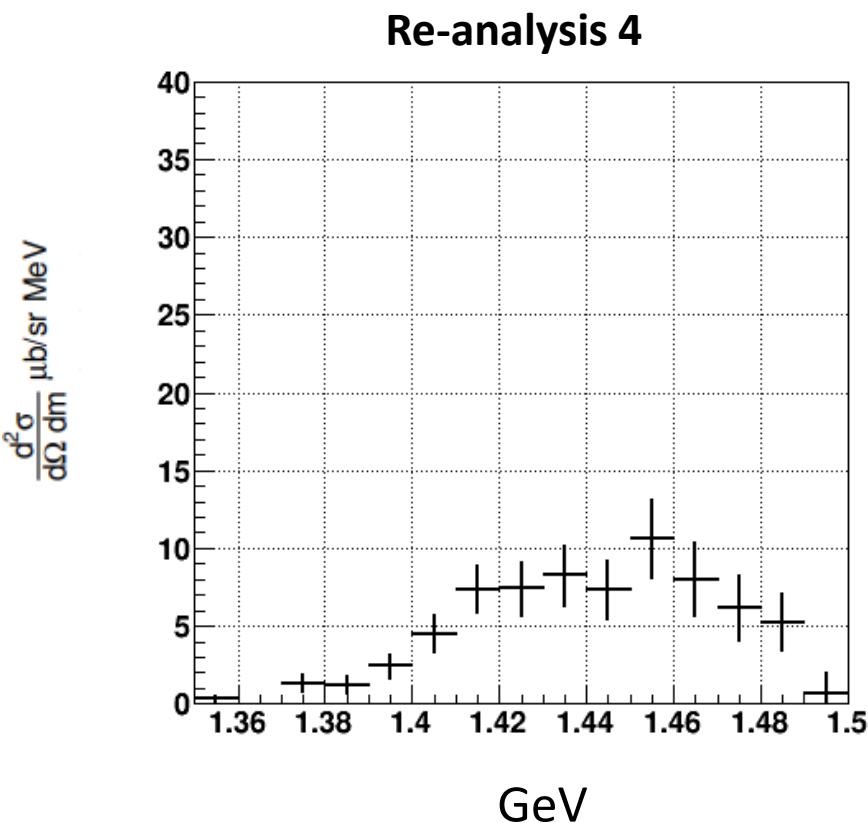
# Acceptance estimation

- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample



- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$

# Cross section



# figures

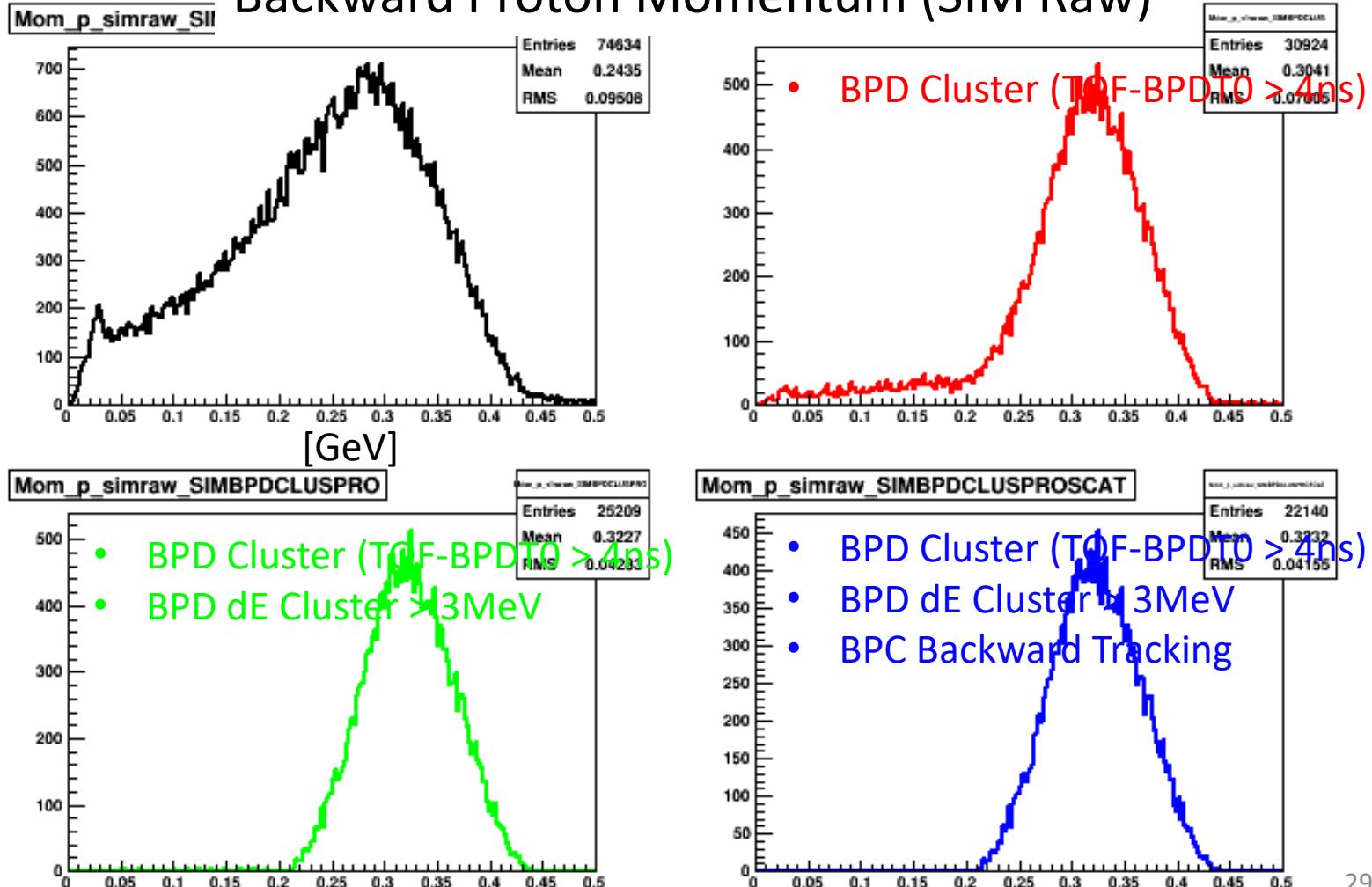
- mass :1.355 cs :0.332479 cs\_err :0.238521
- mass :1.365 cs :0 cs\_err :0
- mass :1.375 cs :1.34974 cs\_err :0.57471
- mass :1.385 cs :1.09445 cs\_err :0.589184
- mass :1.395 cs :2.72803 cs\_err :0.845955
- mass :1.405 cs :4.53438 cs\_err :1.2084
- mass :1.415 cs :7.13715 cs\_err :1.51048
- mass :1.425 cs :7.06406 cs\_err :1.65391
- mass :1.435 cs :7.20889 cs\_err :1.77301
- mass :1.445 cs :7.25296 cs\_err :1.97121
- mass :1.455 cs :9.17203 cs\_err :2.27919
- mass :1.465 cs :8.57356 cs\_err :2.46262
- mass :1.475 cs :5.68657 cs\_err :2.08338
- mass :1.485 cs :6.33485 cs\_err :2.11672
- mass :1.495 cs :1.08088 cs\_err :1.38367

# Backward proton acceptance study by SIM

- Condition
  - Upstream analysis (same as final condition)
  - CDS  $\pi$ - PID (same as final condition)
  - forward neutron analysis (same as final condition)
    - Vertex is reconstructed by Beam track approximately
    - w/o the vertex ( $\pi$ - x beam) fiducial cut
  - Fiducial cut of vertex proton (SIM Raw)
  - BPD hit position of proton momentum  $R < 14$  cm
- SIM data  
 $K-d \rightarrow n \Sigma^0 \pi^0$   
(spectrum shape ; cross Section P.9 left figure )

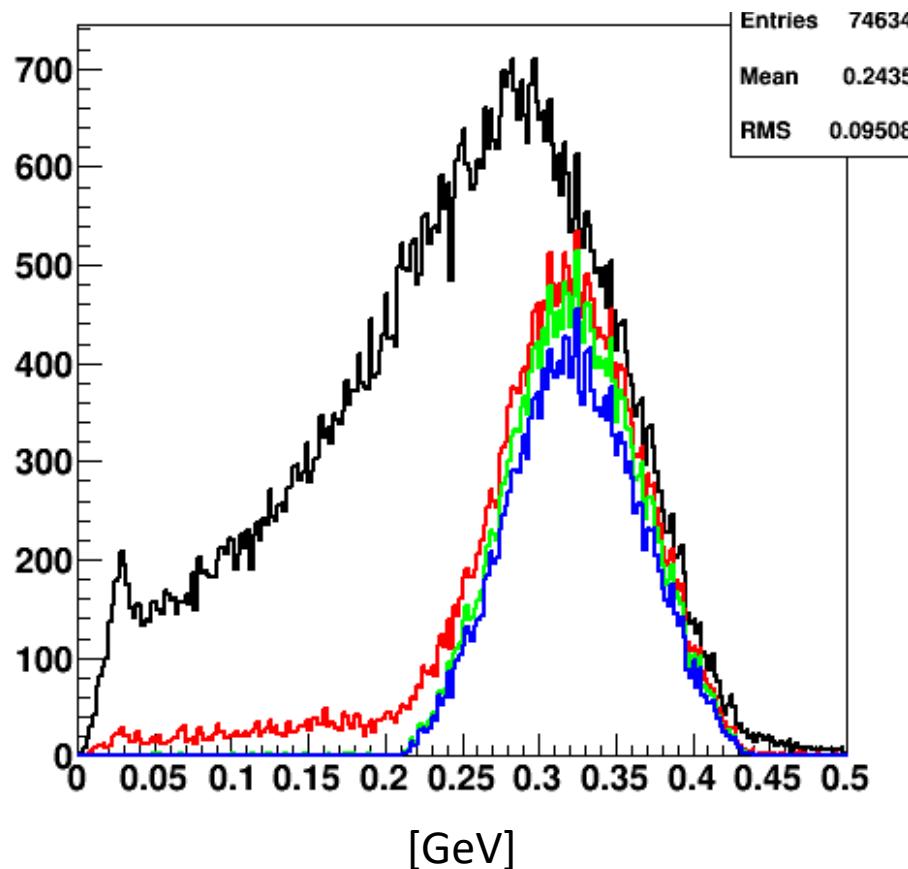
# Backward proton acceptance study by SIM

Backward Proton Momentum (SIM Raw)



# Backward proton acceptance study by SIM

Backward Proton Momentum (SIM Raw) –overlay of P.286



- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

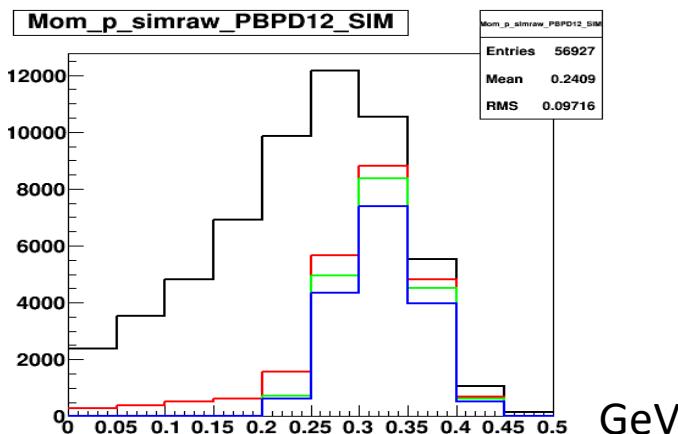
# Backward proton acceptance study by SIM

- BPD Hit position of sim raw proton momentum  $< R$

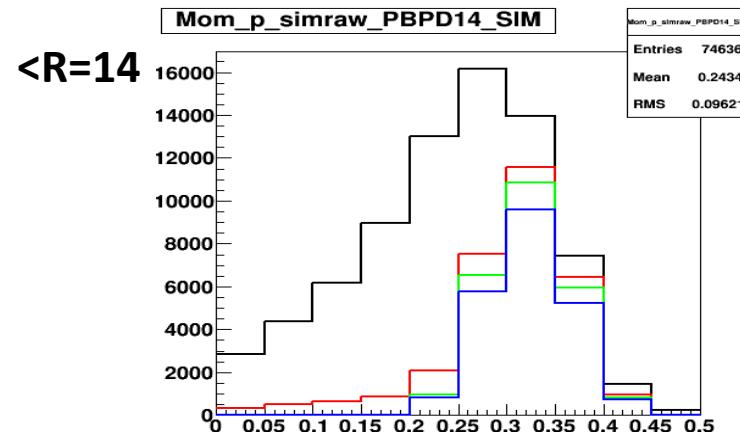
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)  
BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

## Backward Proton Momentum (SIM Raw) –overlay

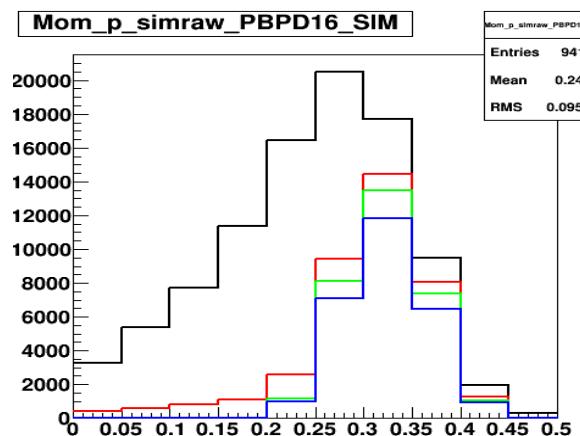
$< R = 12$



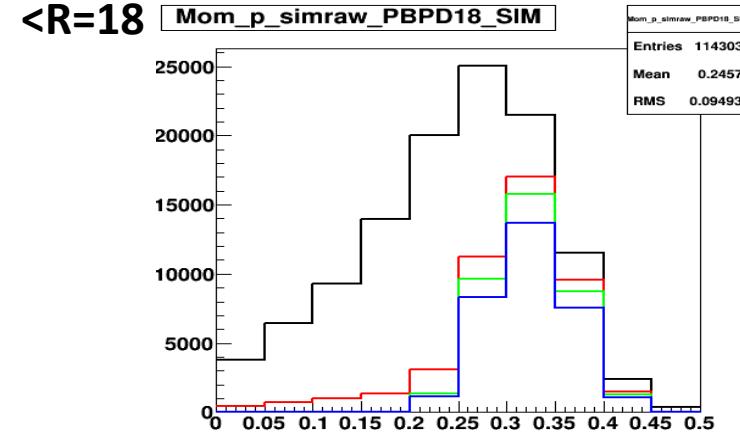
$< R = 14$



$< R = 16$



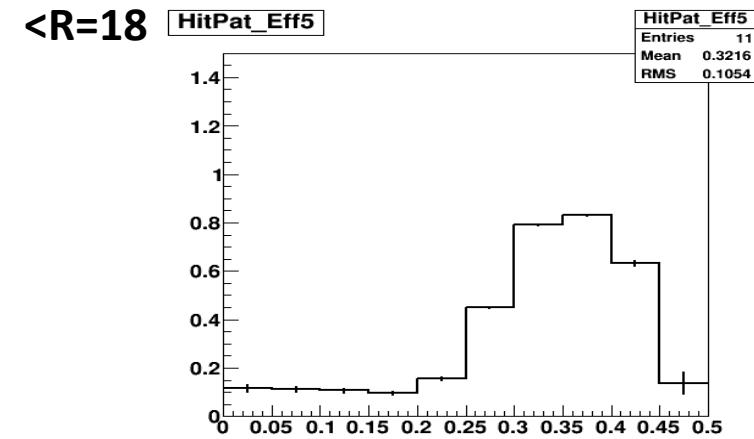
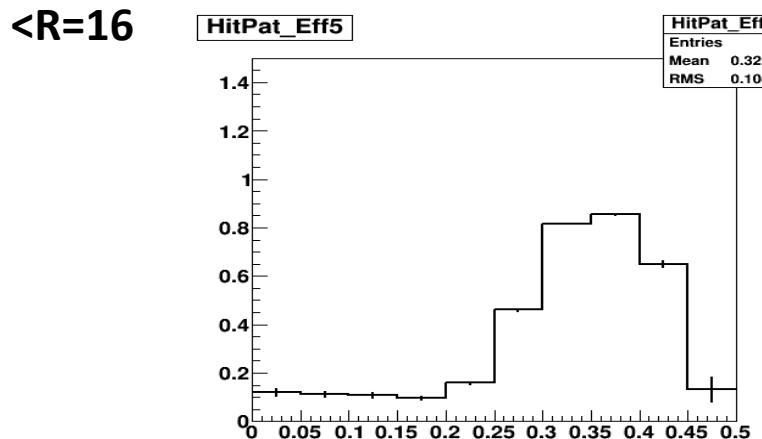
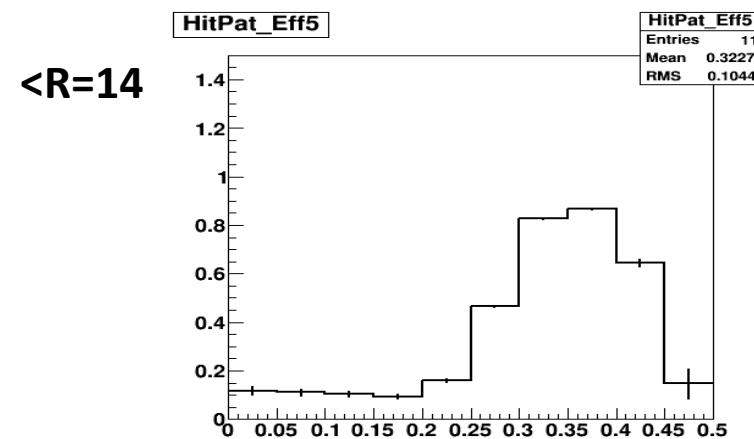
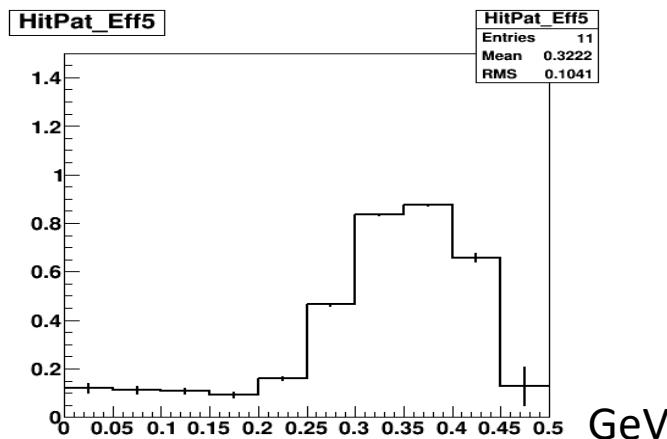
$< R = 18$



# Backward proton acceptance study by SIM

- BPD Hit position of sim raw proton momentum  $< R$

Ratio (Red/Black P.296)



# figures

<R=12

MeV	:25 Ratio :0.119297
MeV	:75 Ratio :0.112181
MeV	:125 Ratio :0.108524
MeV	:175 Ratio :0.0918974
MeV	:225 Ratio :0.160081
MeV	:275 Ratio :0.465281
MeV	:325 Ratio :0.836669
MeV	:375 Ratio :0.874254
MeV	:425 Ratio :0.658168
MeV	:475 Ratio :0.128571
MeV	:525 Ratio :0.125

<R=14

MeV	:25 Ratio :0.117212
MeV	:75 Ratio :0.111643
MeV	:125 Ratio :0.106235
MeV	:175 Ratio :0.0944785
MeV	:225 Ratio :0.161432
MeV	:275 Ratio :0.4659
MeV	:325 Ratio :0.828766
MeV	:375 Ratio :0.866002
MeV	:425 Ratio :0.644611
MeV	:475 Ratio :0.147321
MeV	:525 Ratio :0.125

<R=16

MeV	:25 Ratio :0.119062
MeV	:75 Ratio :0.112882
MeV	:125 Ratio :0.108164
MeV	:175 Ratio :0.0963315
MeV	:225 Ratio :0.158138
MeV	:275 Ratio :0.460129
MeV	:325 Ratio :0.816809
MeV	:375 Ratio :0.853367
MeV	:425 Ratio :0.649404
MeV	:475 Ratio :0.132492
MeV	:525 Ratio :0.142857

<R=18

MeV	:25 Ratio :0.115364
MeV	:75 Ratio :0.113519
MeV	:125 Ratio :0.107709
MeV	:175 Ratio :0.0965497
MeV	:225 Ratio :0.155793
MeV	:275 Ratio :0.449453
MeV	:325 Ratio :0.791537
MeV	:375 Ratio :0.830686
MeV	:425 Ratio :0.633404
MeV	:475 Ratio :0.137845
MeV	:525 Ratio :0.133333

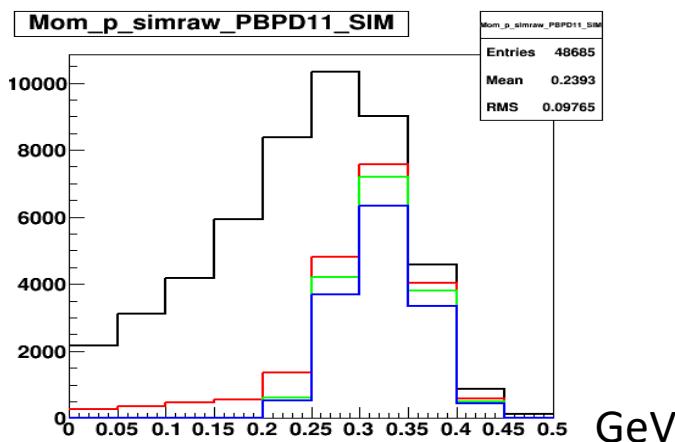
# Backward proton acceptance study by SIM

- BPD Hit position of sim raw proton momentum  $< R$

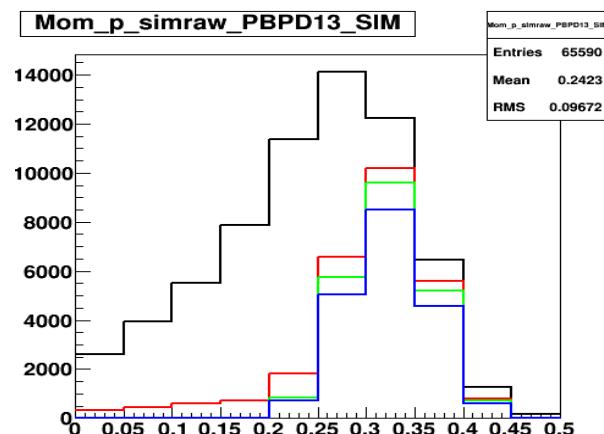
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)  
BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

## Backward Proton Momentum (SIM Raw) –overlay

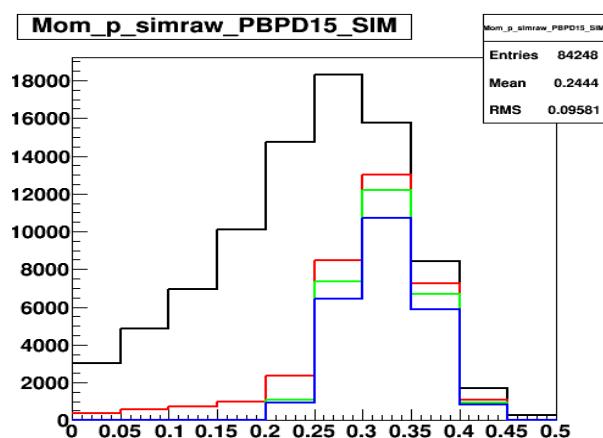
$< R = 11$



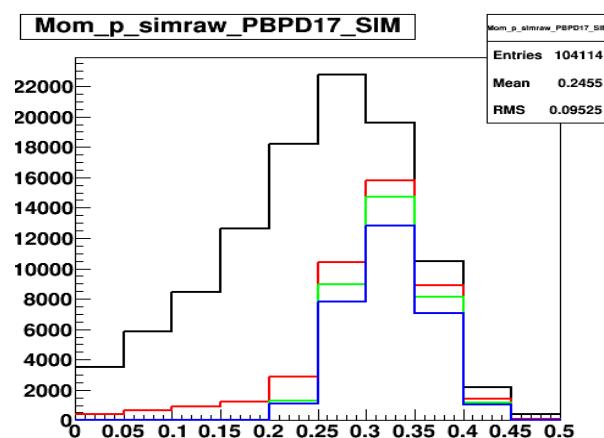
$< R = 13$



$< R = 15$



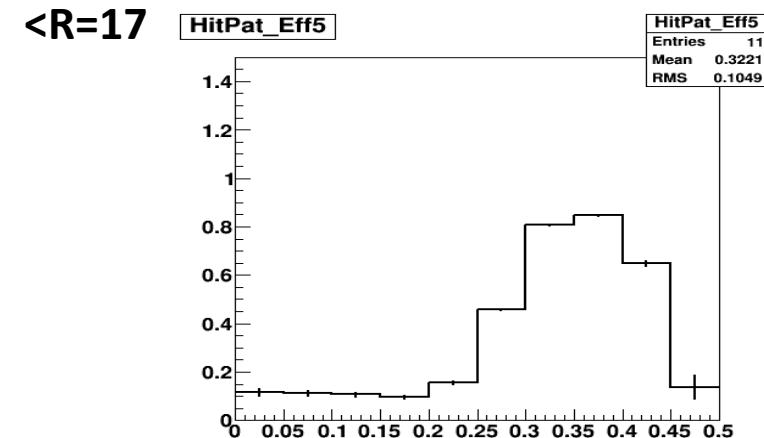
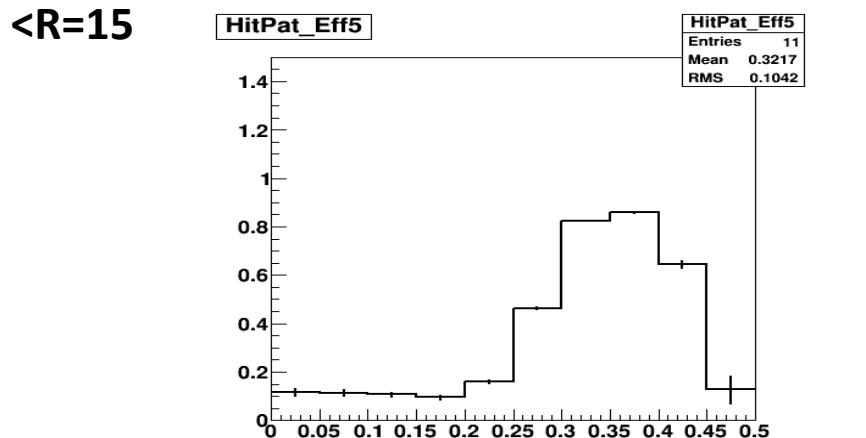
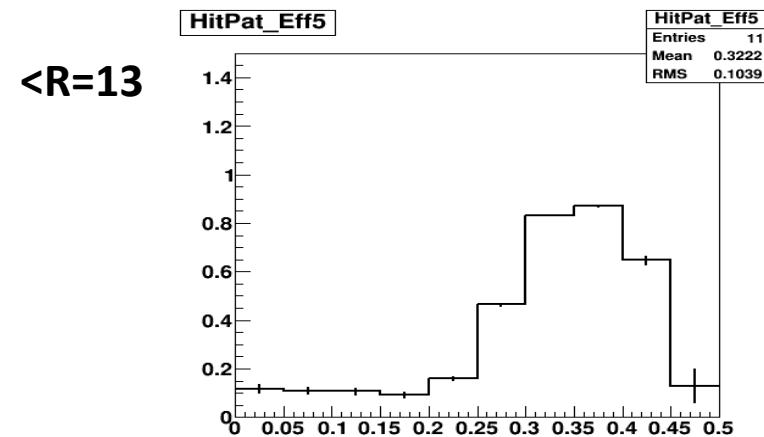
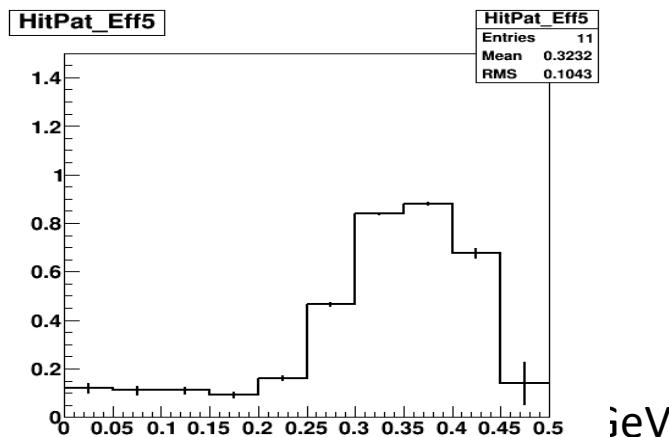
$< R = 17$



# Backward proton acceptance study by SIM

- BPD Hit position of sim raw proton momentum  $< R$

Ratio (Red/Black P.297)



# figures

<R=11

#Bin	Center GeV	Ratio	Error
0.025	0.120482	0.0201882	
0.075	0.111111	0.0168709	
0.125	0.110631	0.0146093	
0.175	0.0924299	0.0123838	
0.225	0.160744	0.0100039	
0.275	0.466106	0.00718532	
0.325	0.839978	0.00421549	
0.375	0.88088	0.00509321	
0.425	0.67552	0.0193569	
0.475	0.140351	0.0868377	
0.525	0.133333	0.24037	

<R=13

#Bin	Center GeV	Ratio	Error
0.025	0.117782	0.0183676	
0.075	0.109987	0.0150012	
0.125	0.106507	0.0127434	
0.175	0.0932708	0.0107195	
0.225	0.160884	0.00859604	
0.275	0.465577	0.0061493	
0.325	0.833306	0.00369248	
0.375	0.870092	0.00449029	
0.425	0.647385	0.0167155	
0.475	0.12973	0.0685869	
0.525	0.136364	0.198132	

<R=15

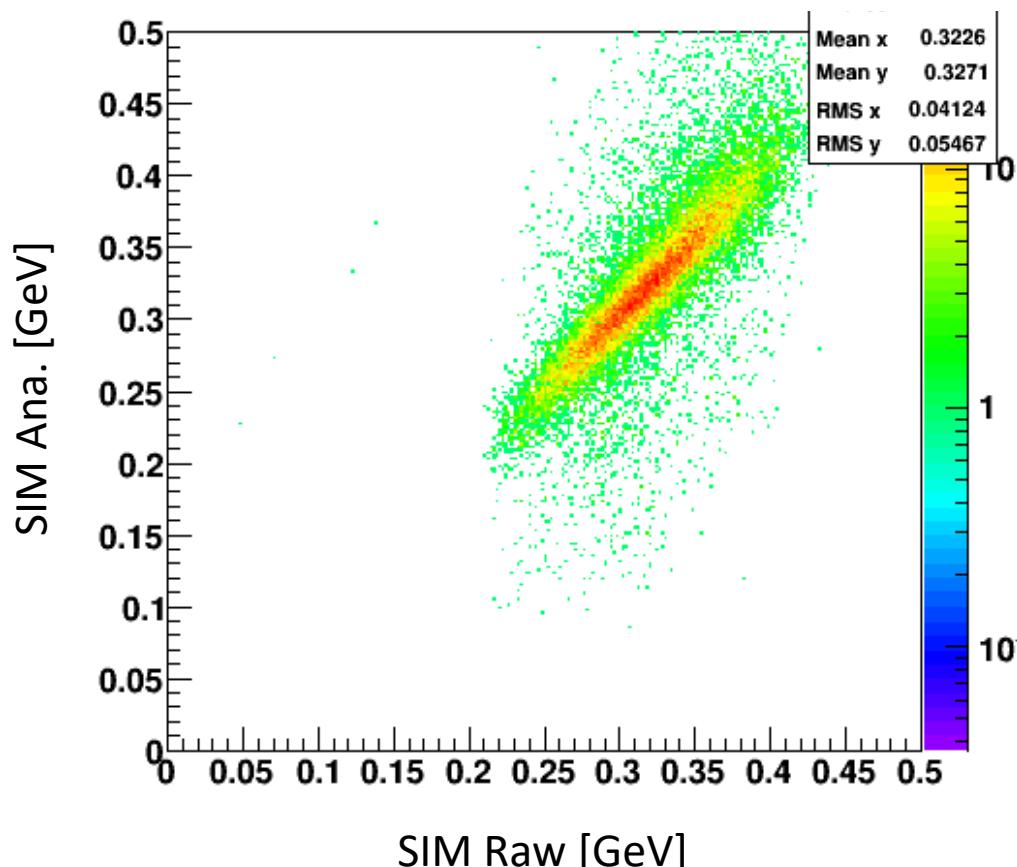
#Bin	Center GeV	Ratio	Error
0.025	0.115561	0.01704	
0.075	0.114151	0.0134981	
0.125	0.10657	0.0113585	
0.175	0.0953934	0.00945639	
0.225	0.16026	0.00754504	
0.275	0.463327	0.00541184	
0.325	0.824932	0.00333176	
0.375	0.859936	0.00407397	
0.425	0.644197	0.0144416	
0.475	0.126354	0.0561601	
0.525	0.16129	0.164485	

<R=17

#Bin	Center GeV	Ratio	Error
0.025	0.116549	0.0158087	
0.075	0.113478	0.0122903	
0.125	0.107396	0.0102693	
0.175	0.0967077	0.00846531	
0.225	0.156768	0.00680336	
0.275	0.45713	0.00488063	
0.325	0.808001	0.00313199	
0.375	0.848075	0.00380527	
0.425	0.647985	0.0127689	
0.475	0.137838	0.0482718	
0.525	0.128205	0.149512	

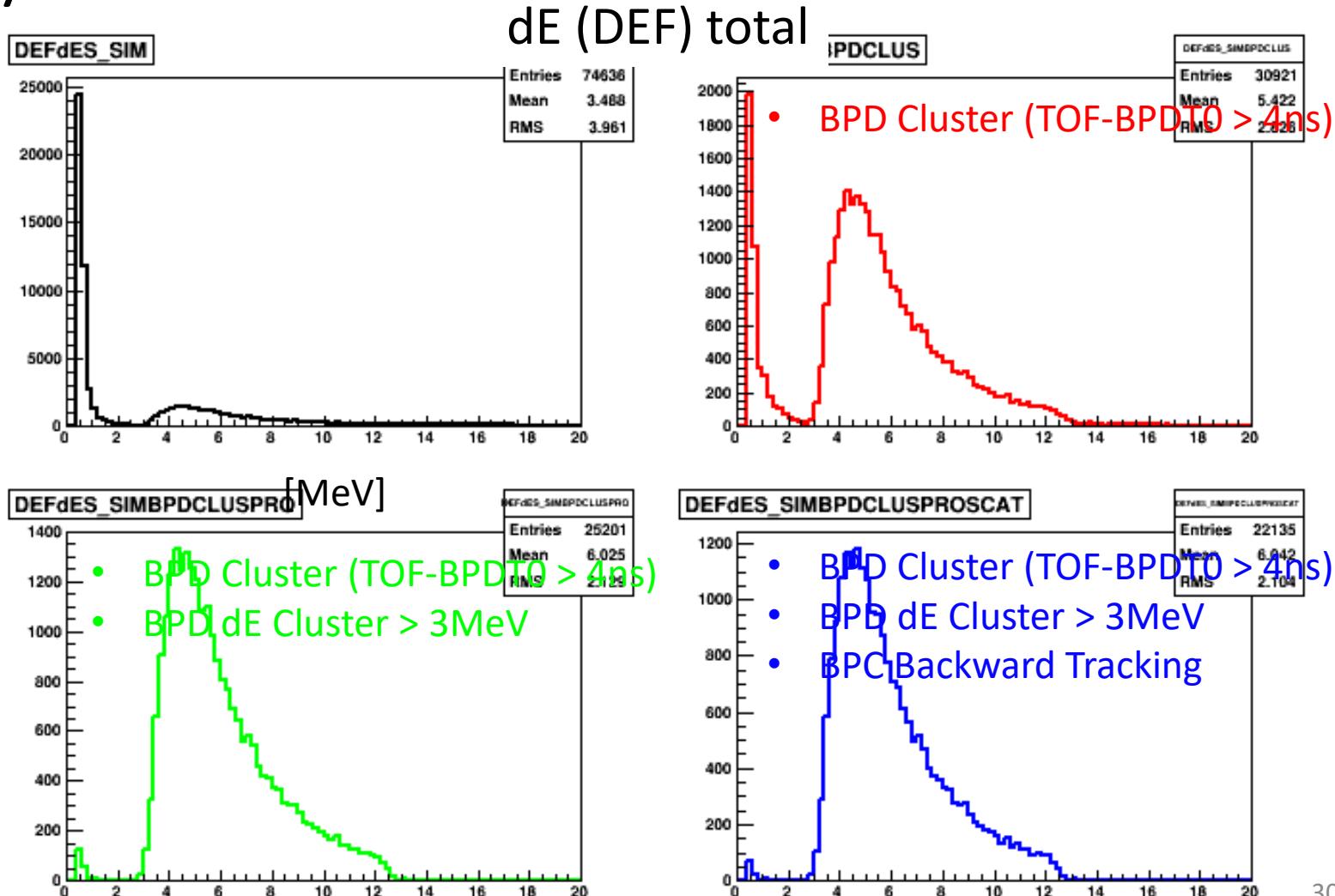
# Backward proton acceptance study by SIM

Backward Proton Momentum (SIM Raw vs SIM Ana.)

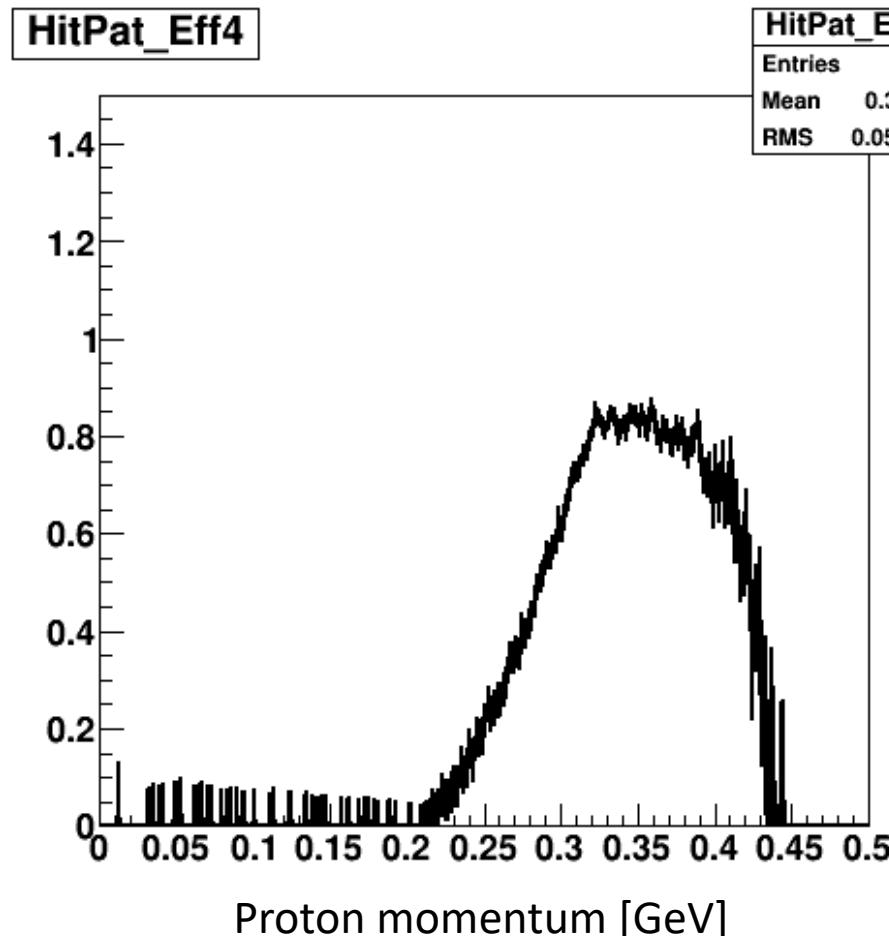


- BPD Cluster ( $\text{TOF-BPDT0} > 4\text{ns}$ )
- BPD dE Cluster  $> 3\text{MeV}$
- BPC Backward Tracking

# Backward proton acceptance study by SIM



# Acceptance ratio dependence on proton momentum



- BPD hit position of proton momentum  $R < 14$  cm



- BPD Cluster ( $TOF-BPDT0 > 4\text{ns}$ )
- BPD dE Cluster  $> 3\text{MeV}$

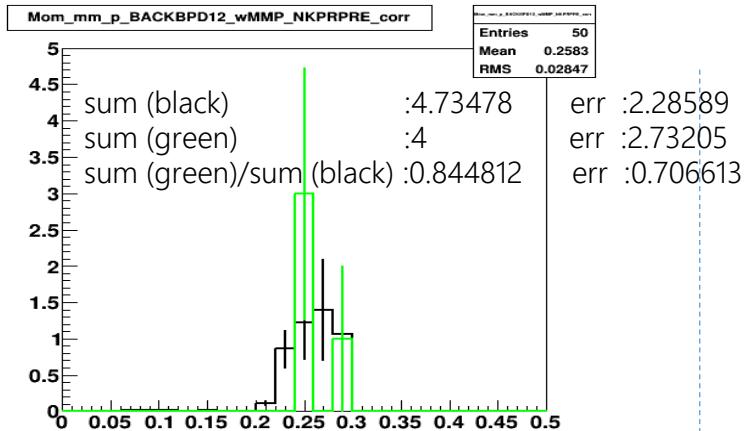
# Missing momentum

- Missing momentum Z < 0
- $d(K_-, nK_-)''p''$
- BPD Hit position of missing proton < R

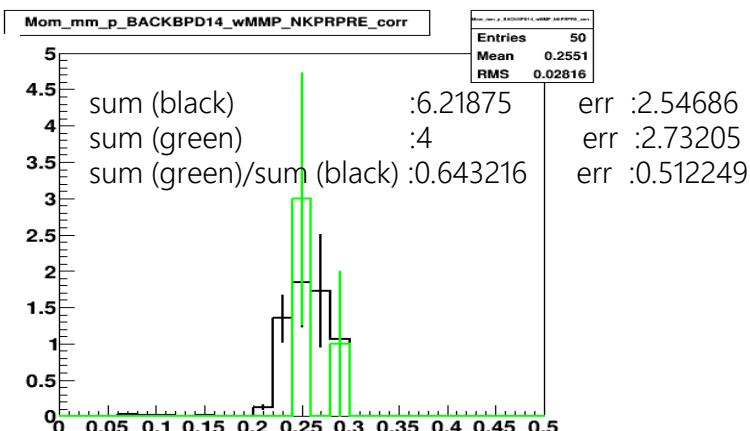
BPD Cluster > 3MeV  
BPC Backward Track

P.270 ; Black is corrected according to the ratio of P.296

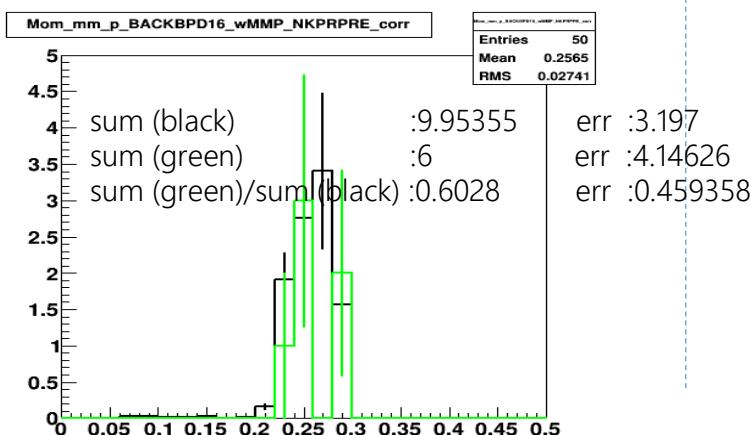
<R=12



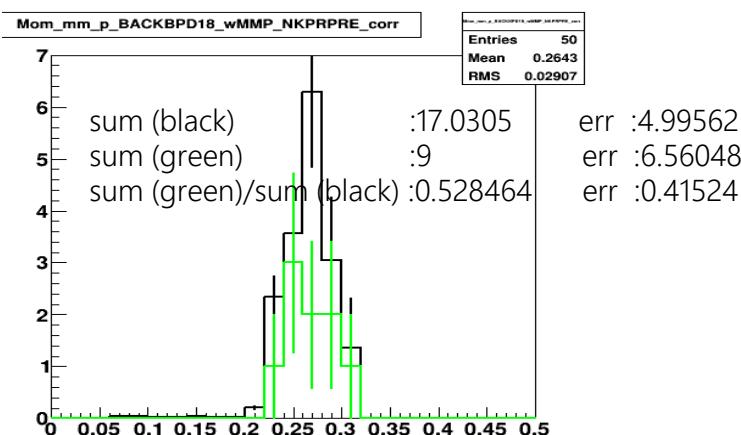
<R=14



<R=16



<R=18



# Backward proton efficiency

# $\Sigma 0\pi 0$ mass vs proton momentum

SIM

K-d  $\rightarrow$ n  $\Sigma 0\pi 0$

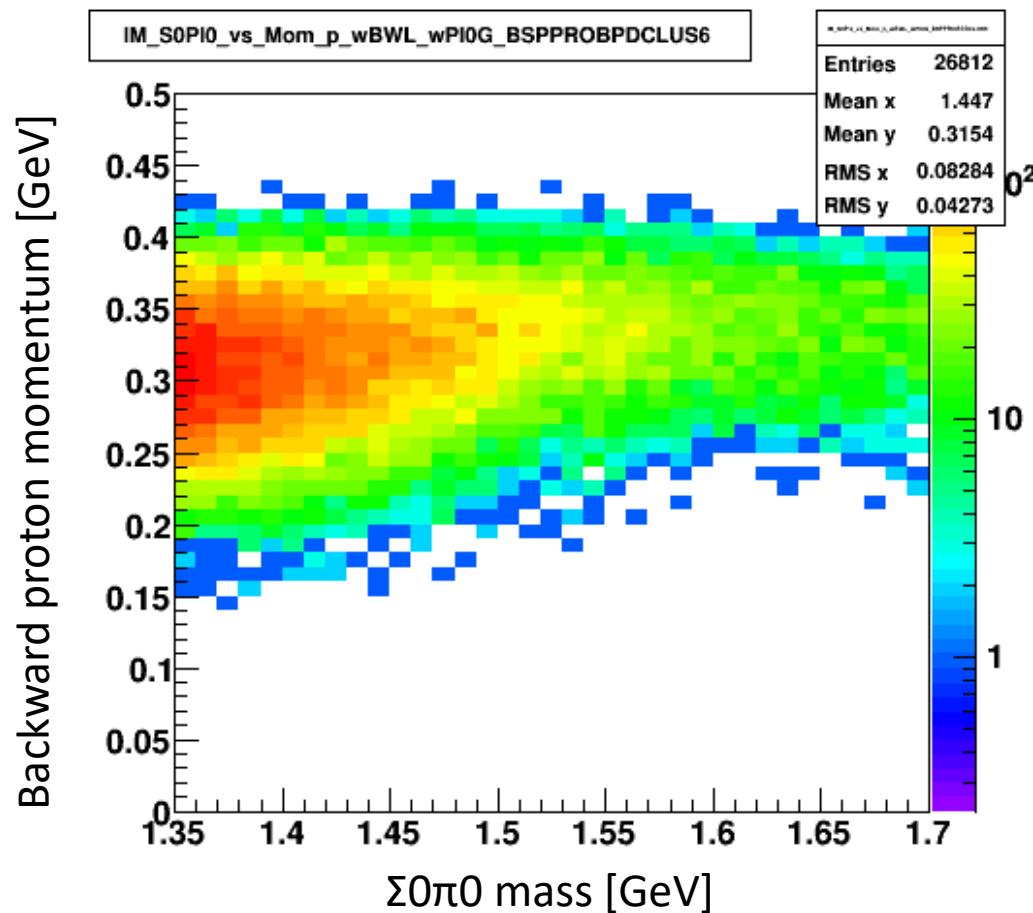
(spectrum shape ; cross  
Section P.9 left figure )

Condition

Re-analysis 7

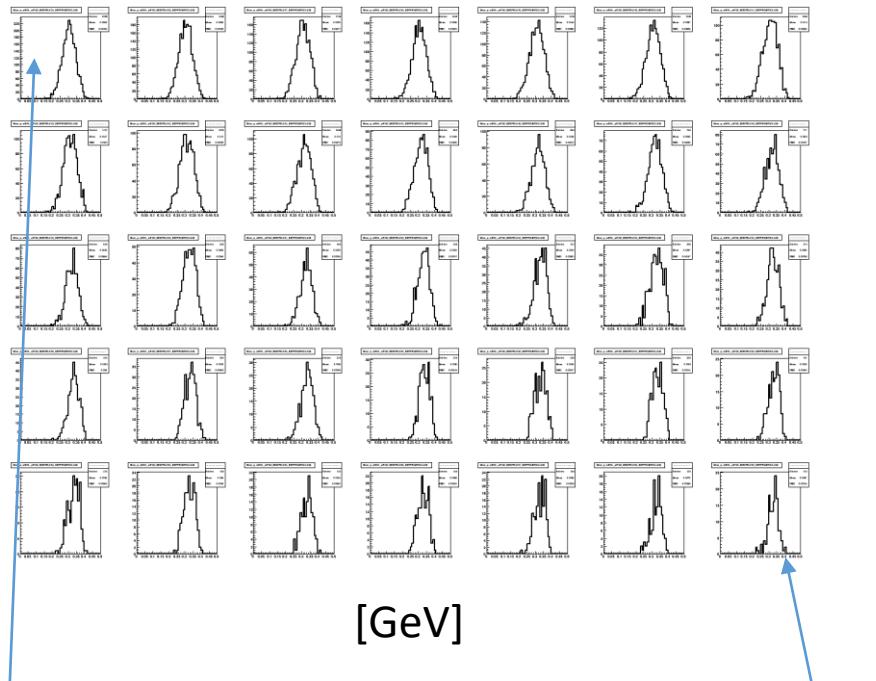
- p,  $\pi$ - invariant mass  $\Lambda$  selection
- d(K-,n $\Lambda$ ) $"X"$   $0.18 < X < 0.30$  GeV

- Backward proton momentum  
; analysis value
- $\Sigma 0\pi 0$  mass  
; sim raw value



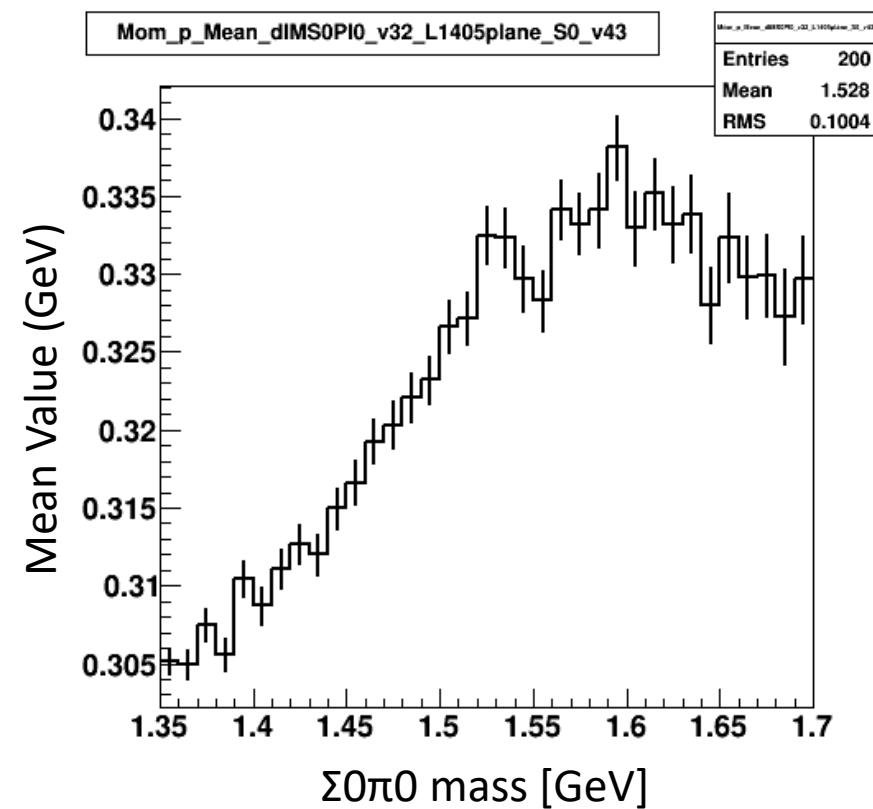
# Proton momentum every $\Sigma\pi 0$ mass

Proton momentum distribution  
every  $\Sigma\pi 0$  mass ( $\Delta 0.010\text{GeV}$ )



$\Sigma\pi 0$  mass  
0.135~0.136

$\Sigma\pi 0$  mass  
0.169~0.170



$\rightarrow 0.30\text{--}0.35\text{ GeV}$

# Missing momentum

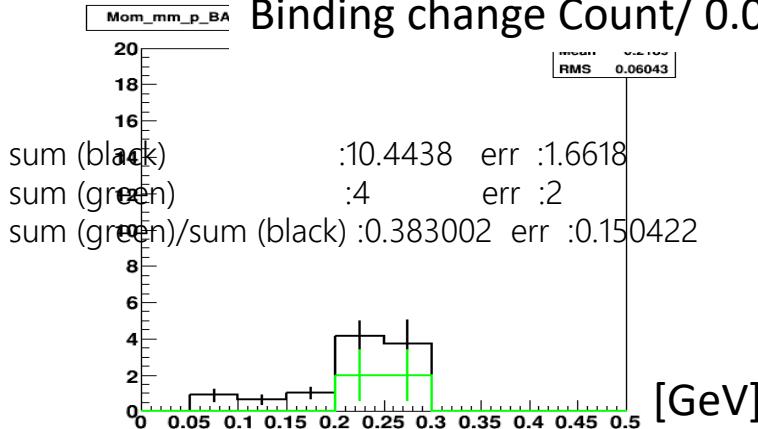
- Missing momentum Z < 0
- $d(K_-, nK_-)''p''$
- BPD Hit position of missing proton < R

BPD Cluster  
TOF BPD-T0 > 4ns

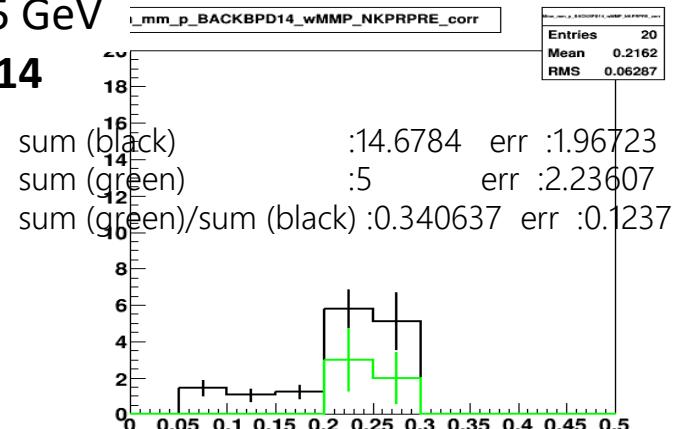
**Black = (Black of P.272 x the ratio of P.297)**

Binding change Count/ 0.020 -> 0.05 GeV

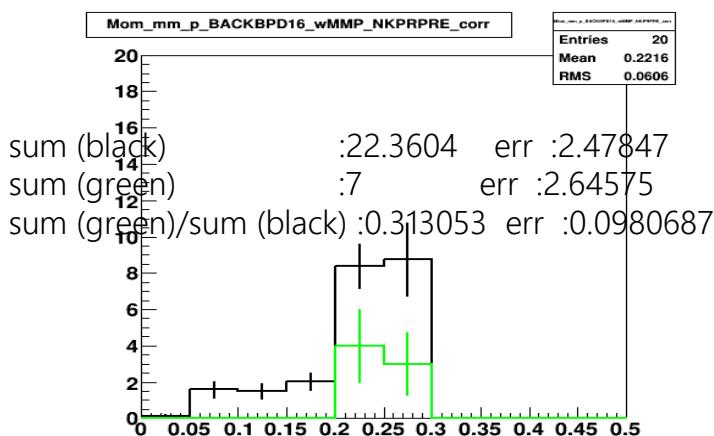
<R=12



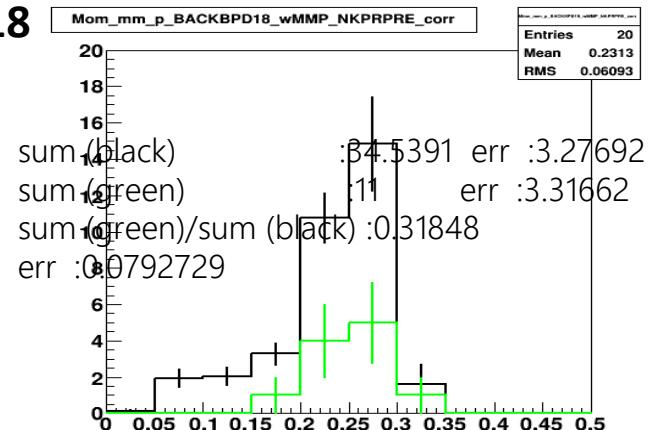
<R=14



<R=16



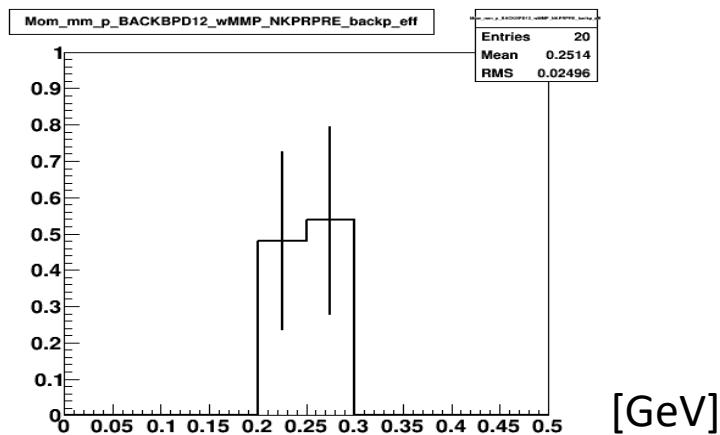
<R=18



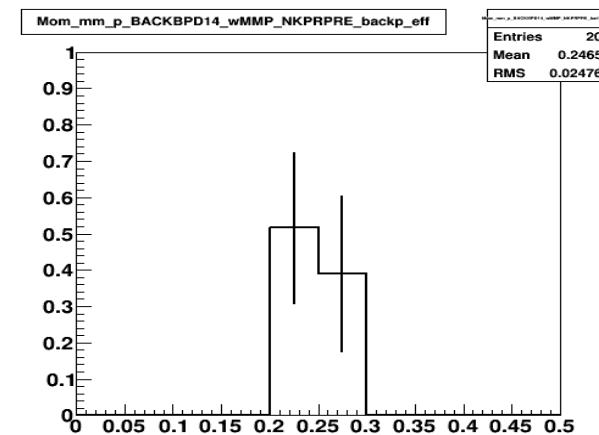
# Efficiency dependence on Missing momentum

## Efficiency (Green/Black P.309)

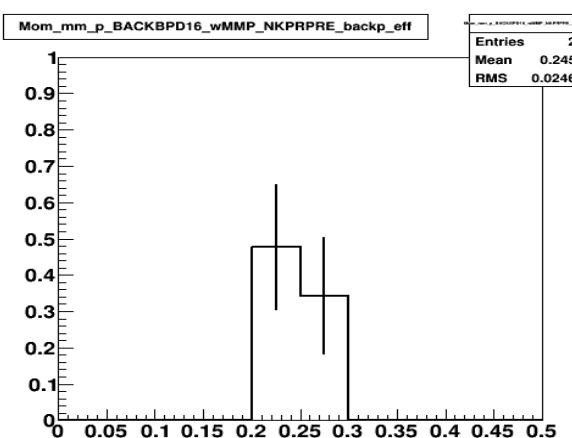
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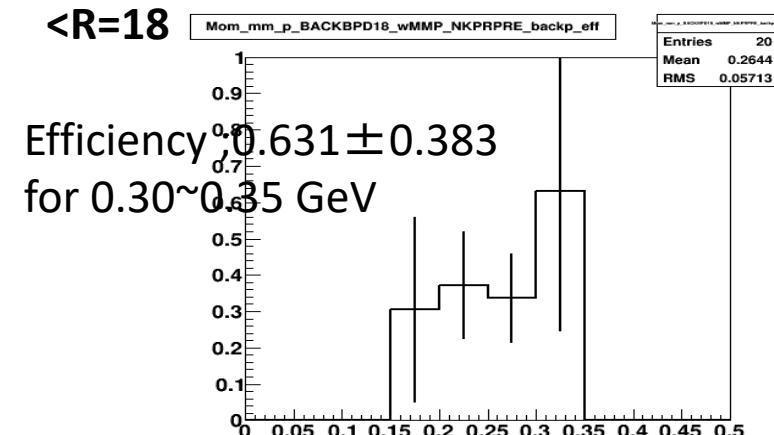
<R=14



<R=16



<R=18

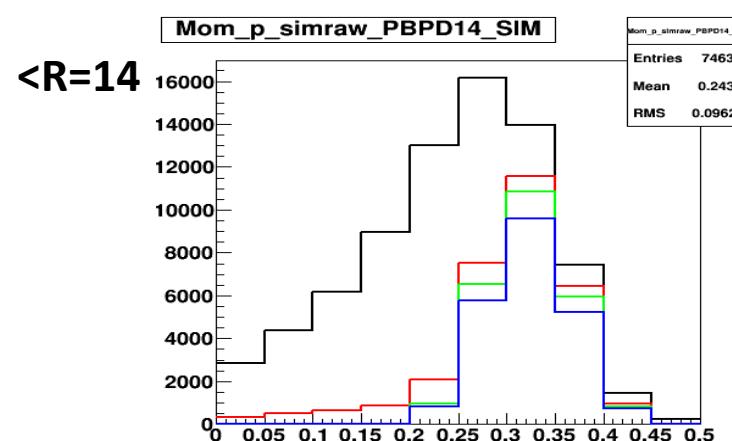
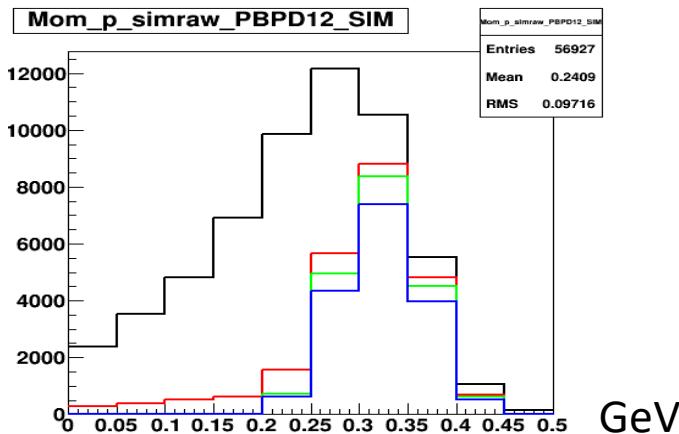


# Backward proton acceptance study by SIM

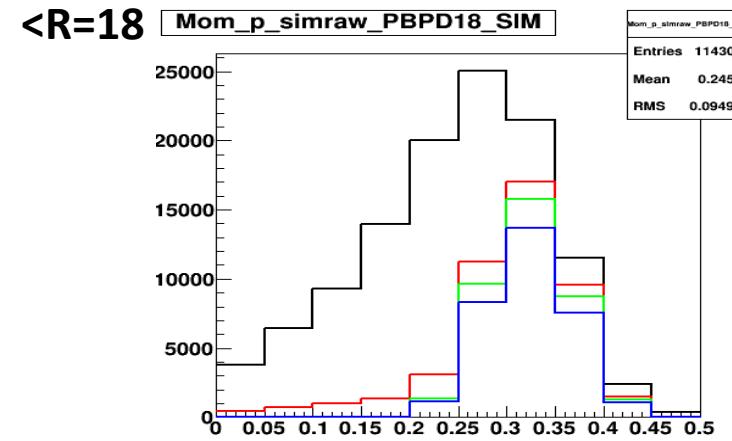
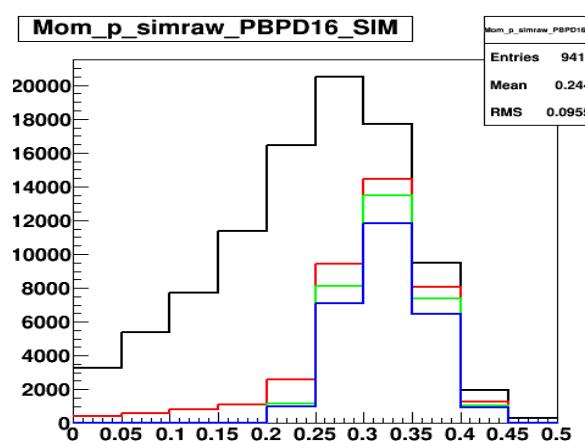
- Missing momentum Z < 0
- $d(K_-, nK_-)''p''$
- BPD Hit position of missing proton < R
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

## Backward Proton Momentum (SIM Raw) –overlay

**<R=12**



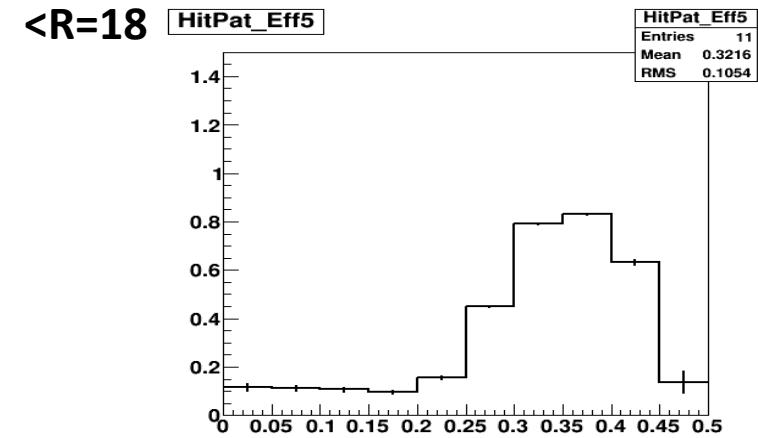
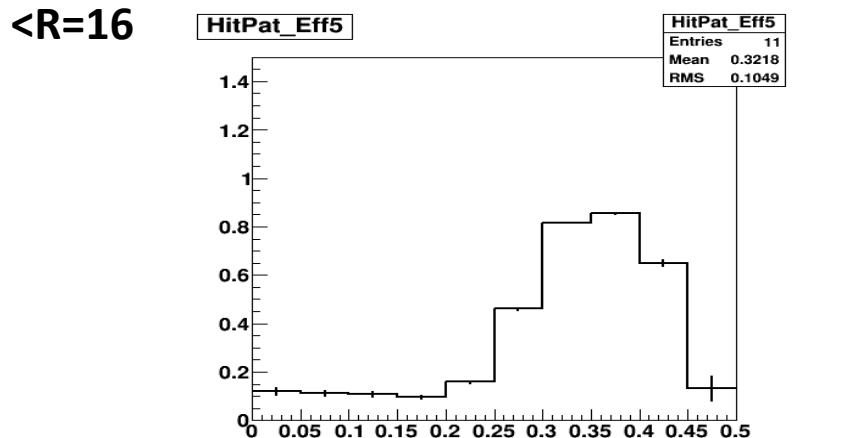
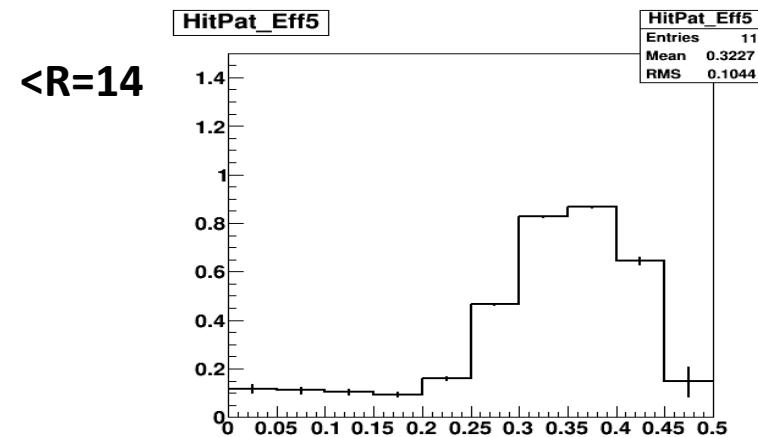
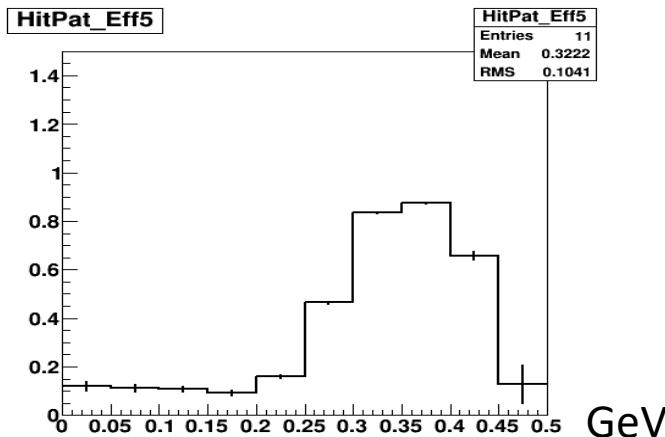
**<R=16**



# Backward proton acceptance study by SIM

- Missing momentum Z < 0
- d(K-,nK-)”p”
- BPD Hit position of missing proton < R

Ratio (Red/Black P.294)

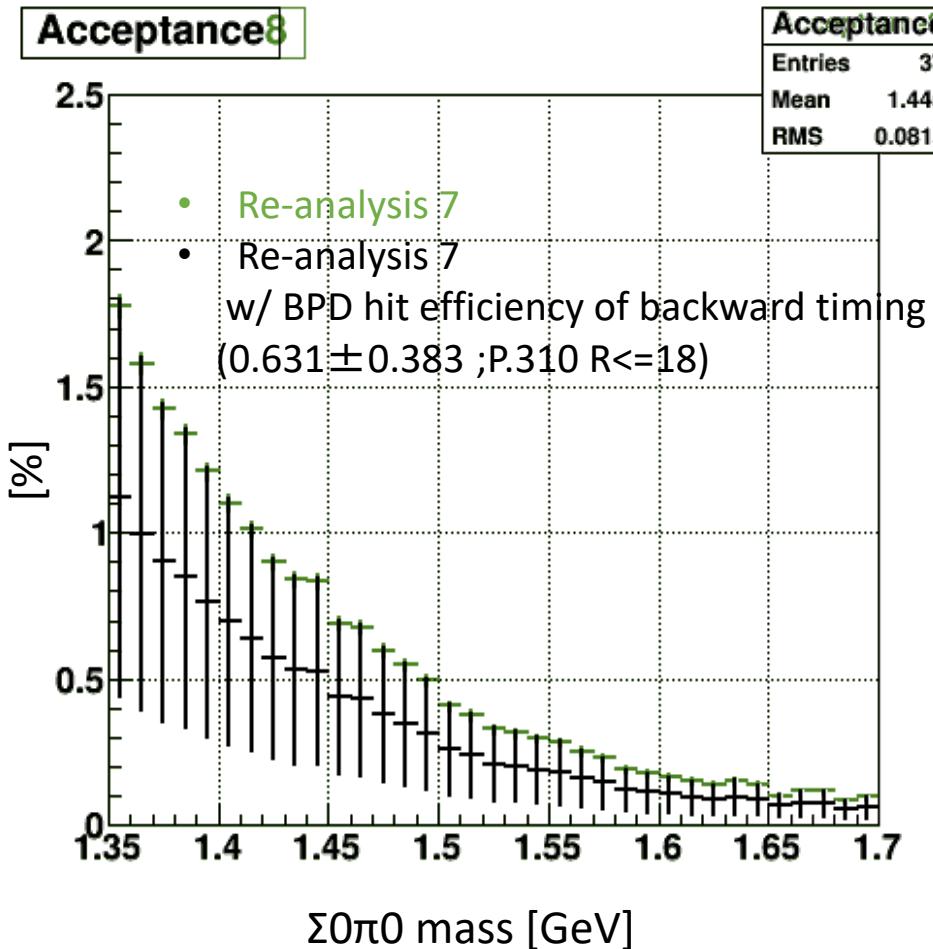


# Acceptance estimation

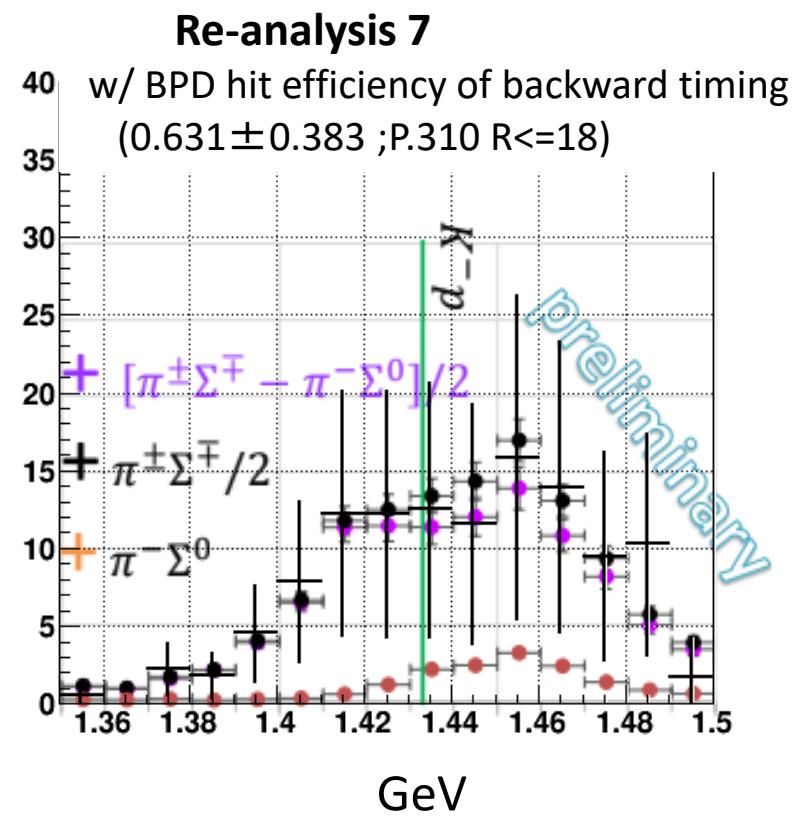
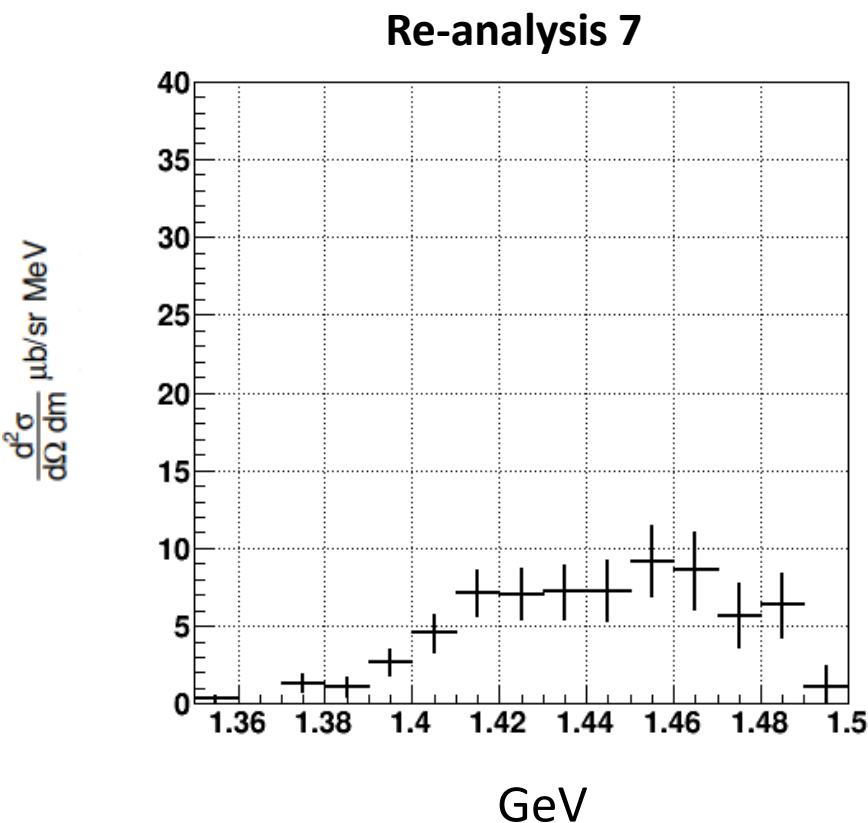
- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample



- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X'' \quad 0.18 < X < 0.30 \text{ GeV}$



# Cross section

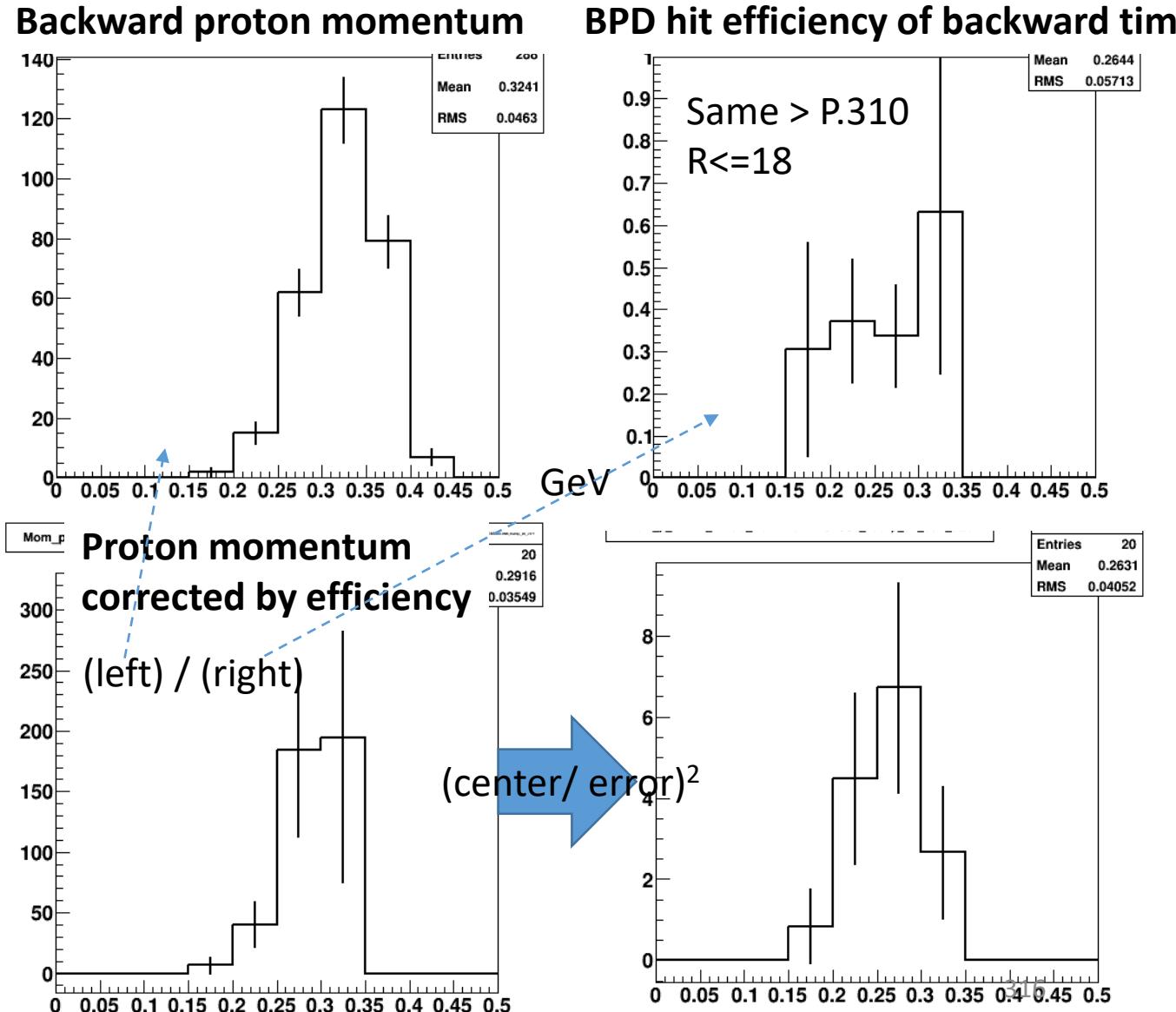


# Backward proton efficiency 2

- Weighted average of the efficiency (P.310)

# Backward proton momentum

- Run78 Data
- Condition
  - Re-analysis 7
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K, n\Lambda)''X''$   $0.18 < X < 0.30$  GeV



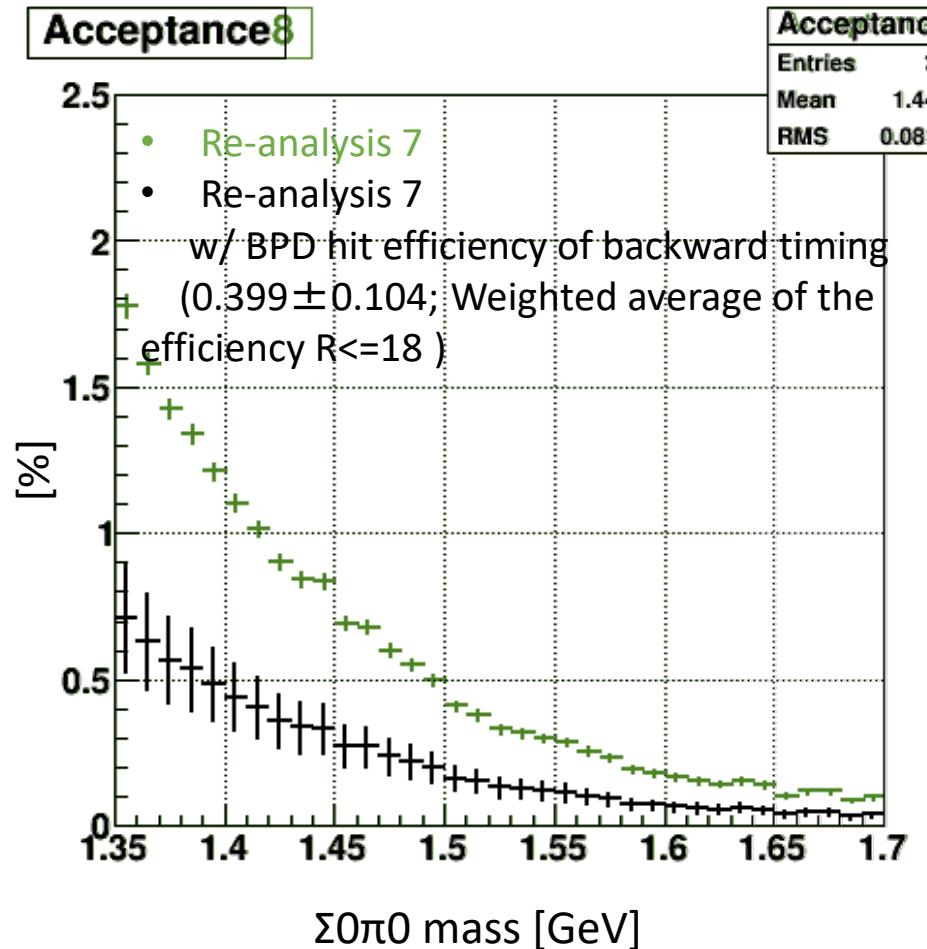
# BPD hit efficiency of backward timing

Weighted average of the efficiency

$$\begin{aligned} & (\text{P.314 right-up} \times \text{P.314 right-down})/\text{entry} \\ \rightarrow & 0.399 \pm 0.104 \end{aligned}$$

# Acceptance estimation

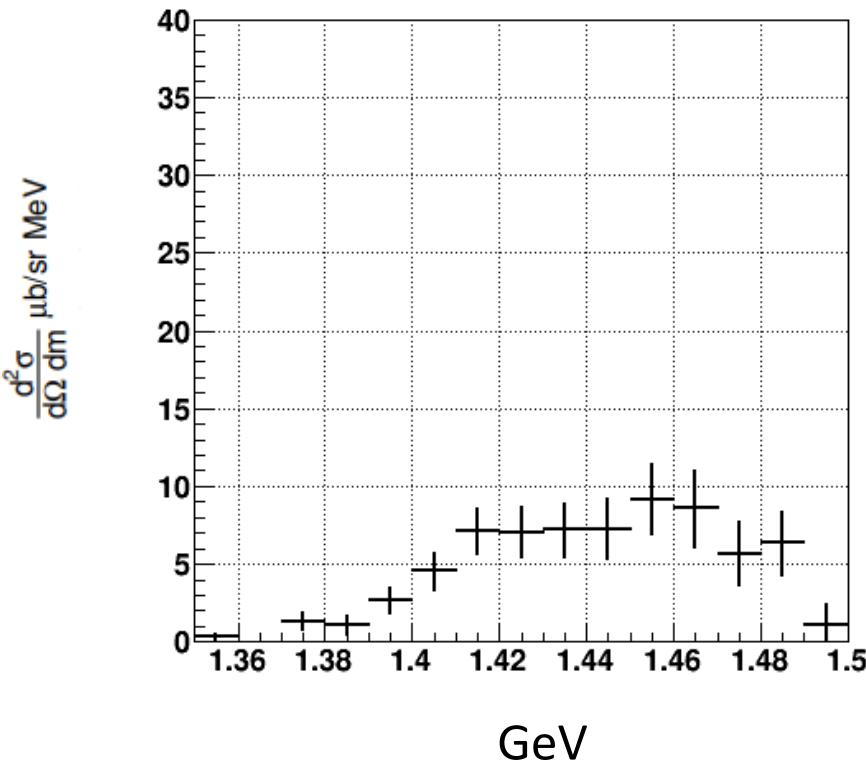
- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample



- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)^* X \quad 0.18 < X < 0.30 \text{ GeV}$

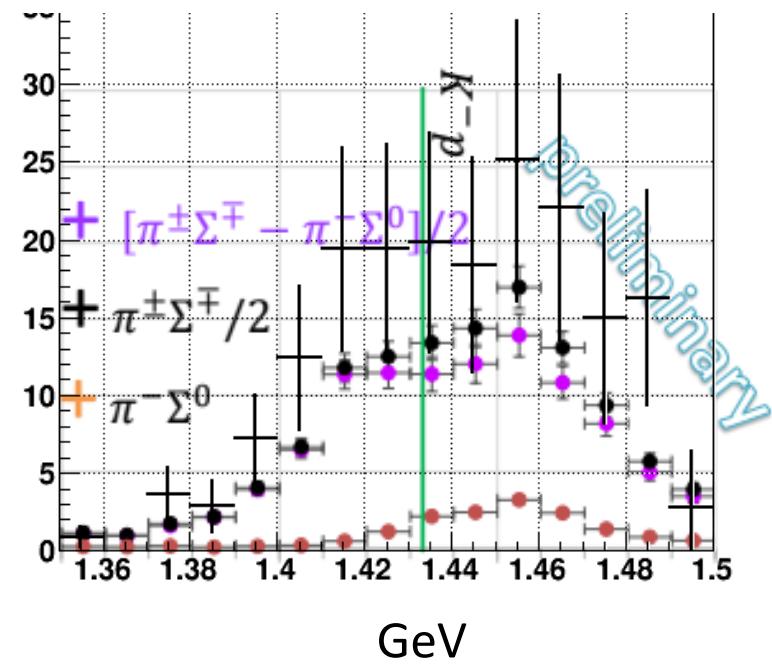
# Cross section

Re-analysis 7



Re-analysis 7

w/ BPD hit efficiency of backward timing  
( $0.399 \pm 0.104$ ; Weighted average of the efficiency  $R \leq 18$ )



# Backward proton efficiency 3

- Estimation by  $K-d \rightarrow p\Lambda\pi^-$
- Weighted average of the efficiency

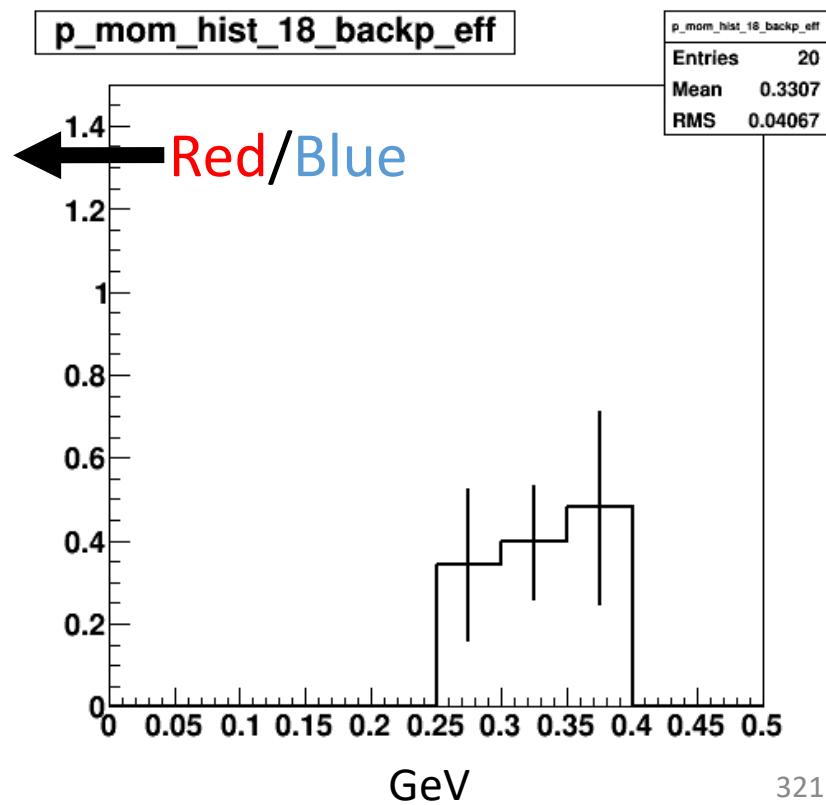
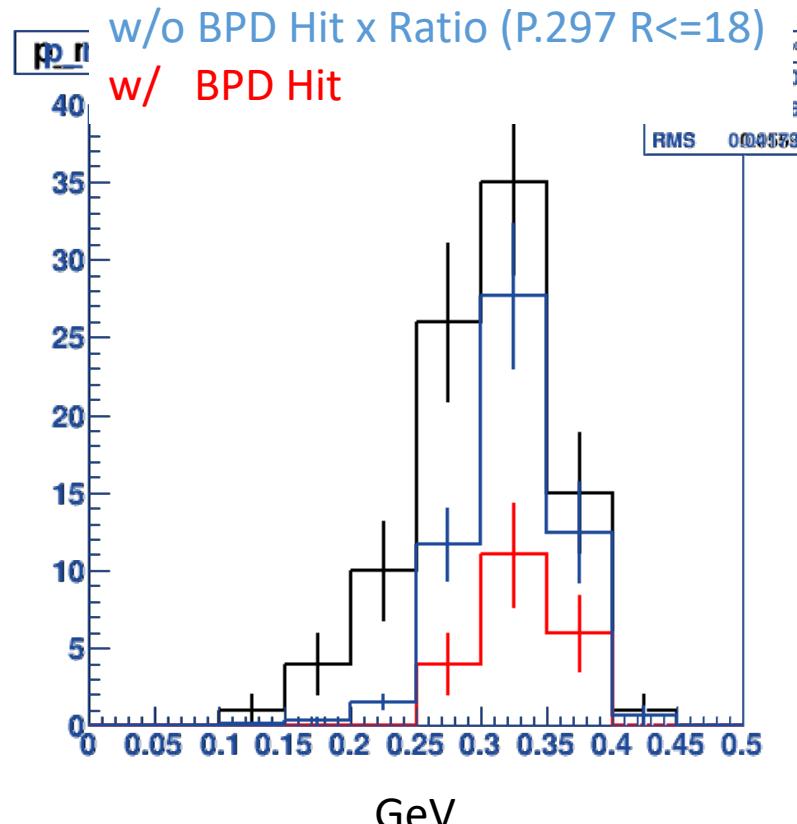
# BPD hit efficiency of backward timing

- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

R<=18

Missing momentum distribution    BPD hit efficiency of backward timing

w/o BPD Hit

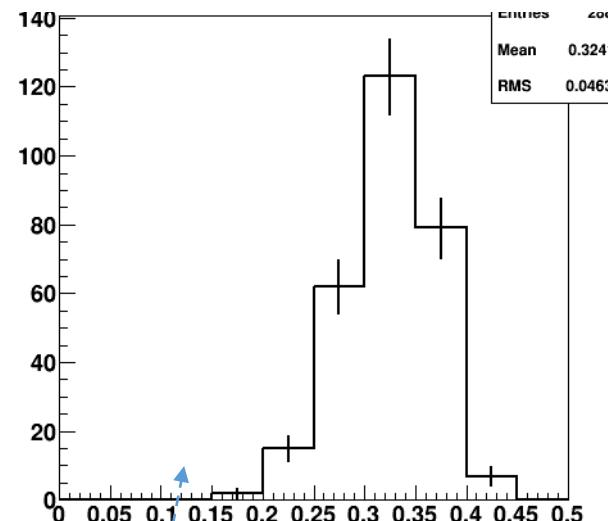


# Backward proton momentum

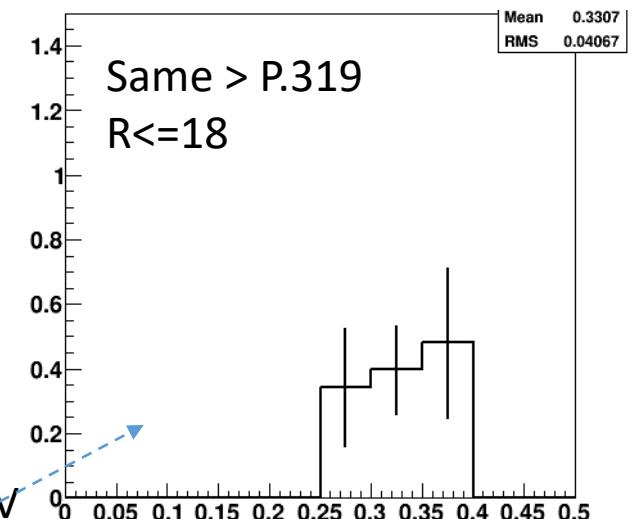
$R \leq 18$

- Run78 Data
- Condition
  - Re-analysis 7
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K, n\Lambda)''X''$   $0.18 < X < 0.30$  GeV

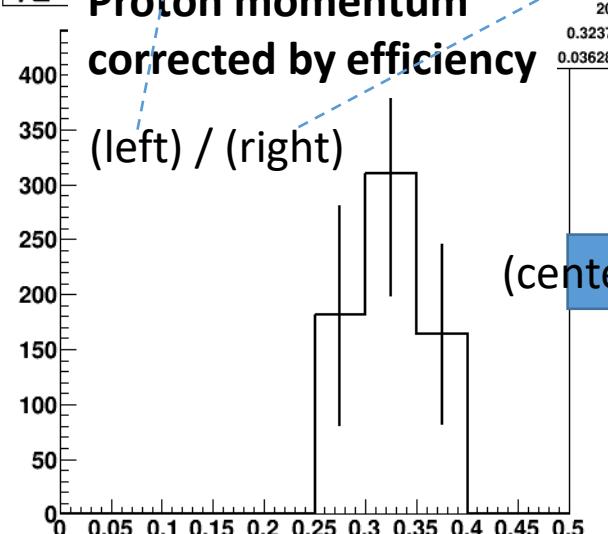
Backward proton momentum



BPD hit efficiency of backward tim

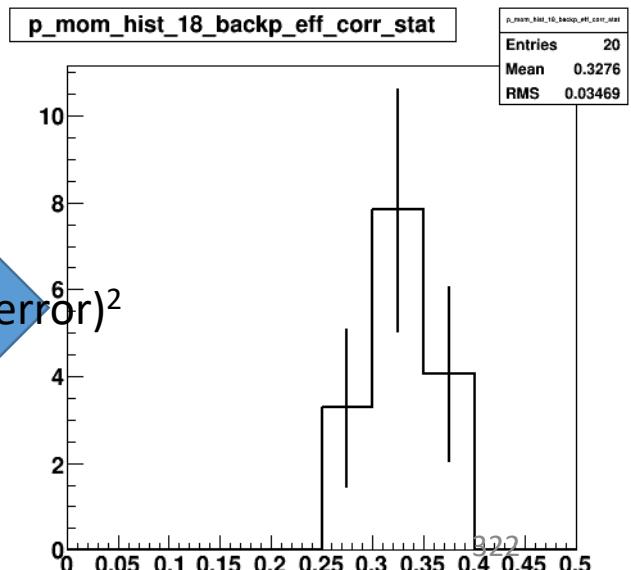


p<sub>m</sub> Proton momentum corrected by efficiency



(center/ error)<sup>2</sup>

p\_mom\_hist\_18\_backp\_eff\_corr\_stat



# BPD hit efficiency of backward timing

R<=18

Weighted average of the efficiency

(P.320 right-up x P.320 right-down)/entry

→ 0.407 ± 0.104

# BPD hit efficiency of backward timing

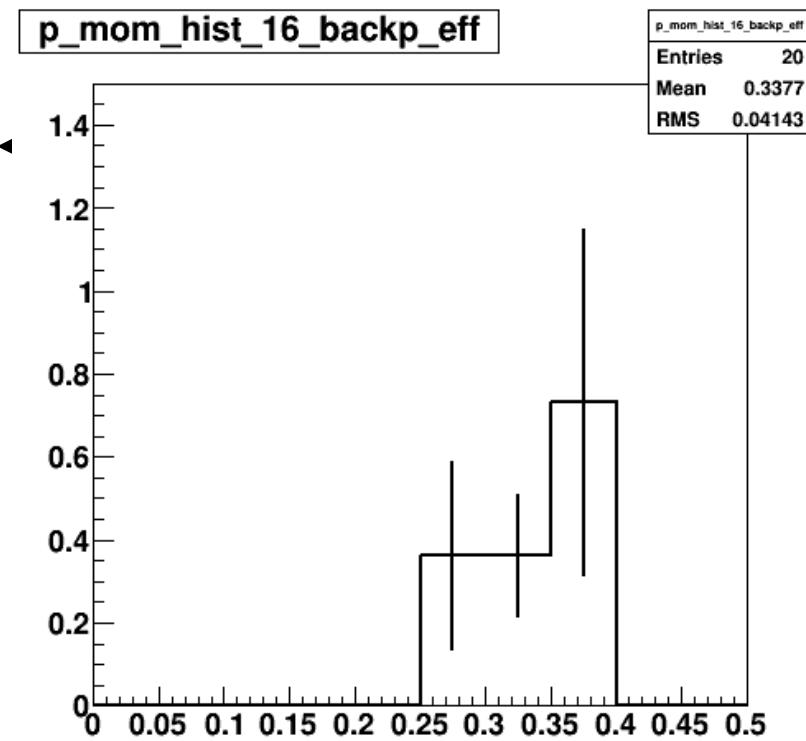
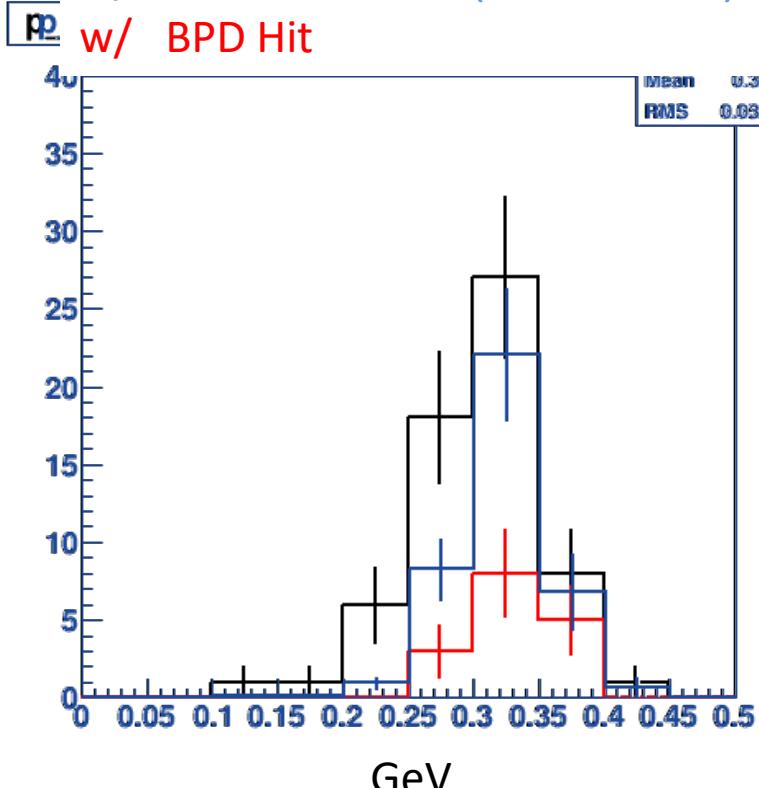
- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

R<=16

Missing momentum distribution    BPD hit efficiency of backward timing

w/o BPD Hit

w/o BPD Hit x Ratio (P.297 R<=16)

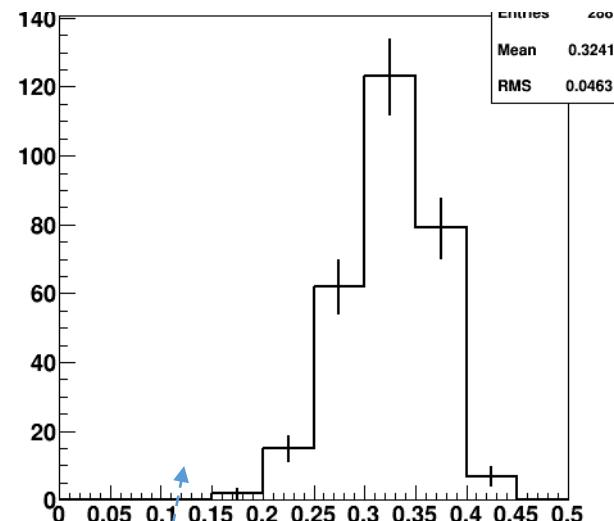


# Backward proton momentum

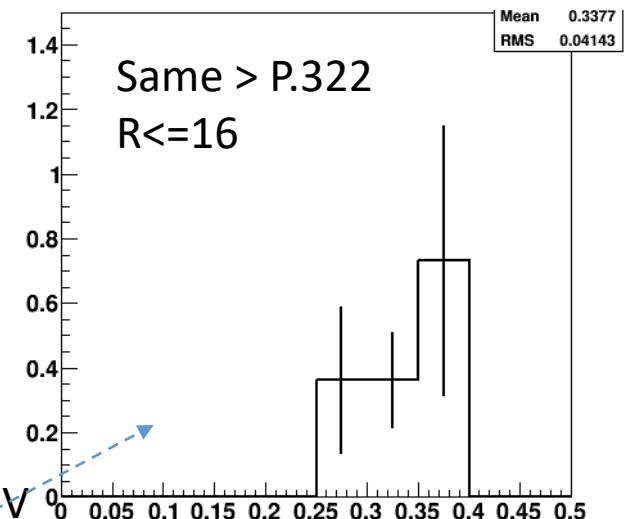
$R \leq 16$

- Run78 Data
- Condition
  - Re-analysis 7
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K^-, n\Lambda)^+ X \quad 0.18 < X < 0.30 \text{ GeV}$

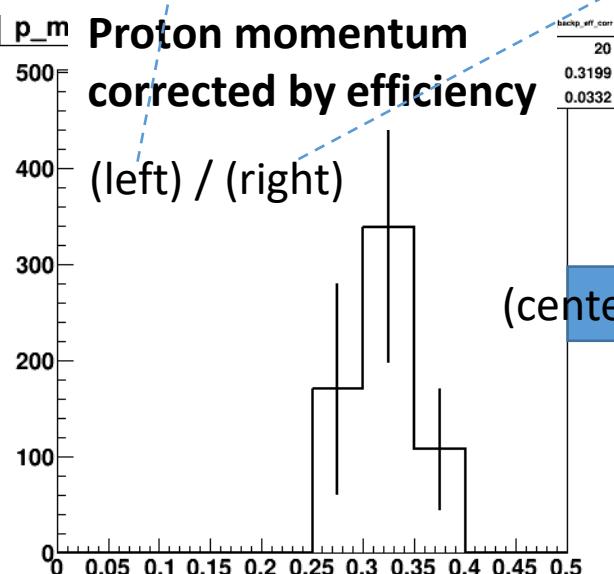
Backward proton momentum



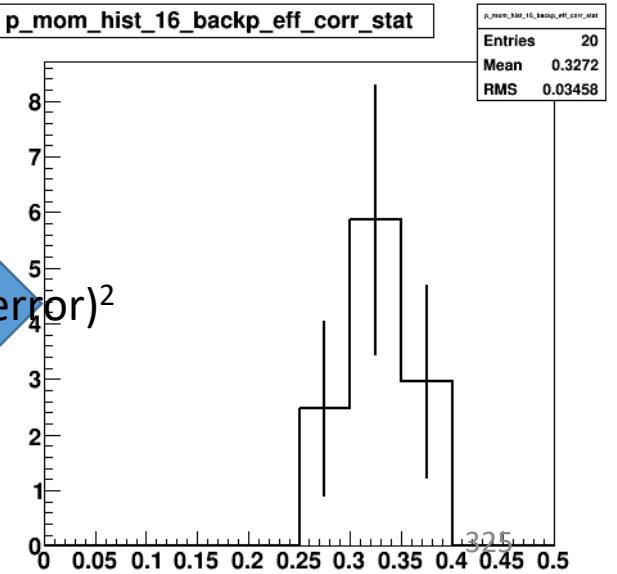
BPD hit efficiency of backward tim



$p_m$  Proton momentum corrected by efficiency



$p\_mom\_hist\_16\_backp\_eff\_corr\_stat$



(left) / (right)

(center/ error)<sup>2</sup>

# BPD hit efficiency of backward timing

R<=16

Weighted average of the efficiency

(P.323 right-up x P.323 right-down)/entry

→ 0.459±0.136

# BPD hit efficiency of backward timing

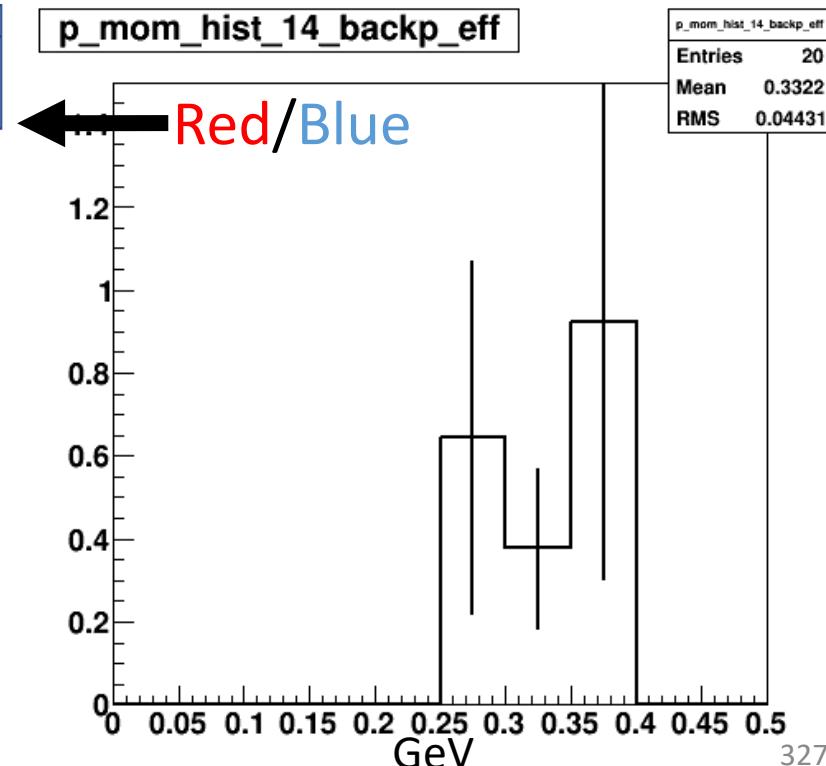
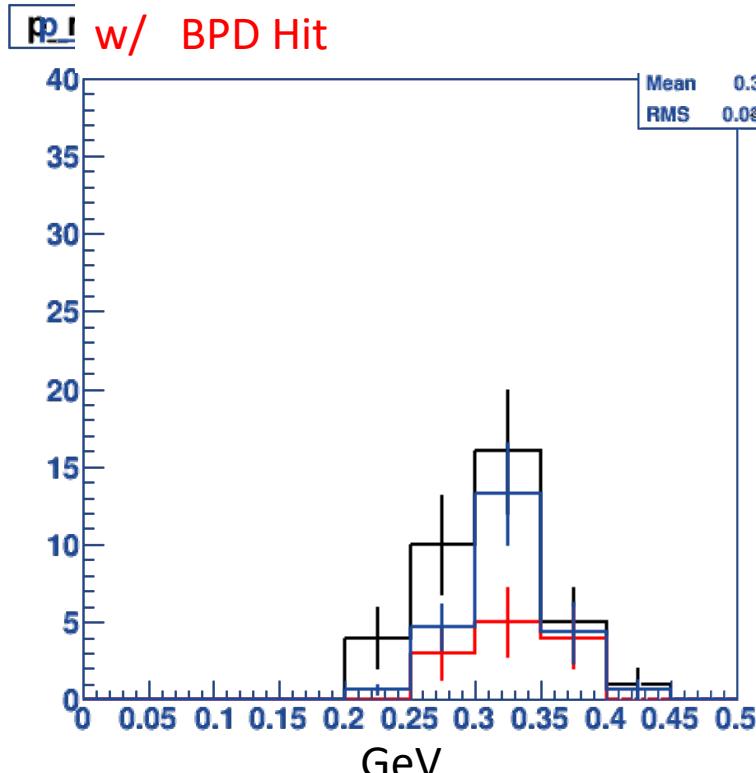
- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

$R \leq 14$

Missing momentum distribution    BPD hit efficiency of backward timing

w/o BPD Hit

w/o BPD Hit x Ratio (P.297  $R \leq 14$ )

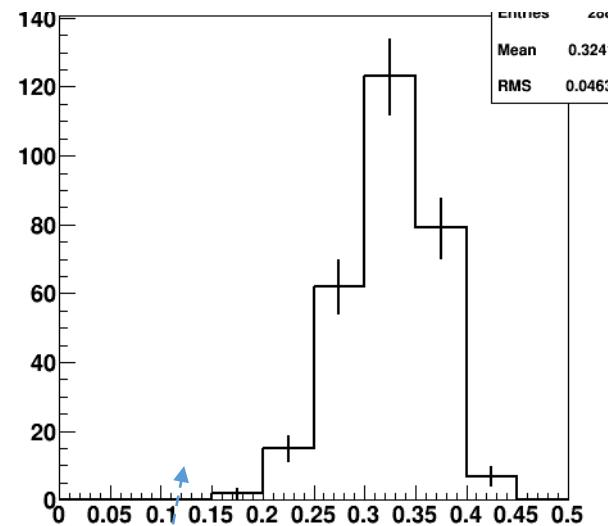


# Backward proton momentum

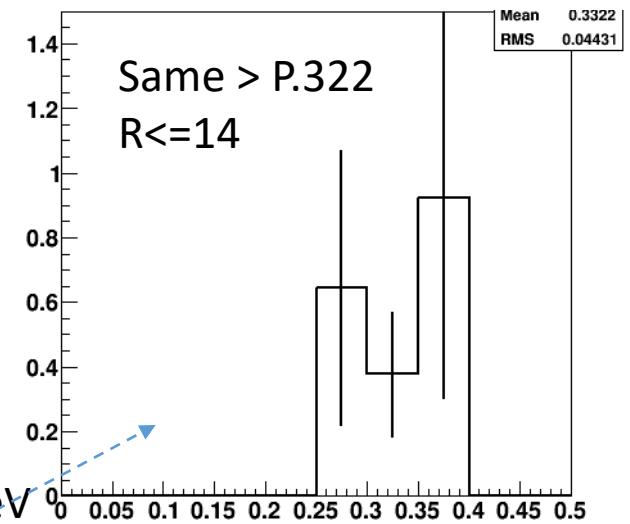
$R \leq 14$

- Run78 Data
- Condition
  - Re-analysis 7
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K^-, n\Lambda)^+ X$   $0.18 < X < 0.30$  GeV

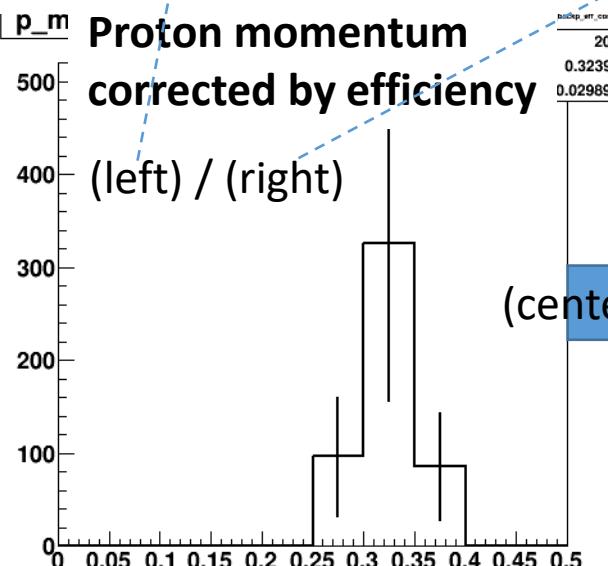
Backward proton momentum



BPD hit efficiency of backward tim

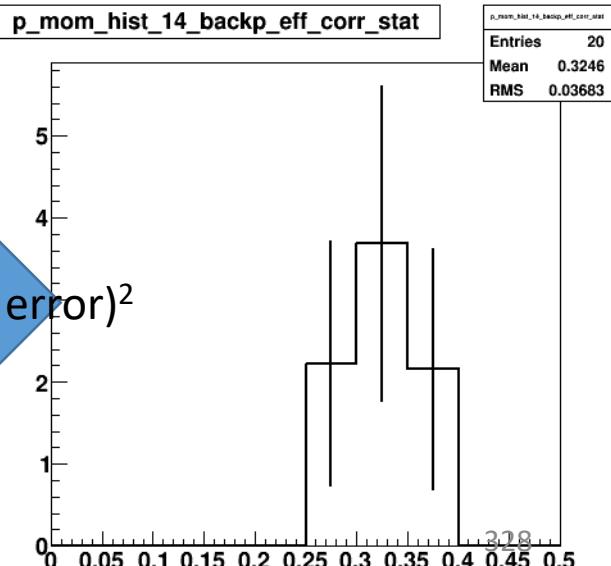


Proton momentum corrected by efficiency



(center/ error)<sup>2</sup>

p\_mom\_hist\_14\_backp\_eff\_corr\_stat



# BPD hit efficiency of backward timing

R<=14

Weighted average of the efficiency

(P.326 right-up x P.326 right-down)/entry

→  $0.590 \pm 0.209$

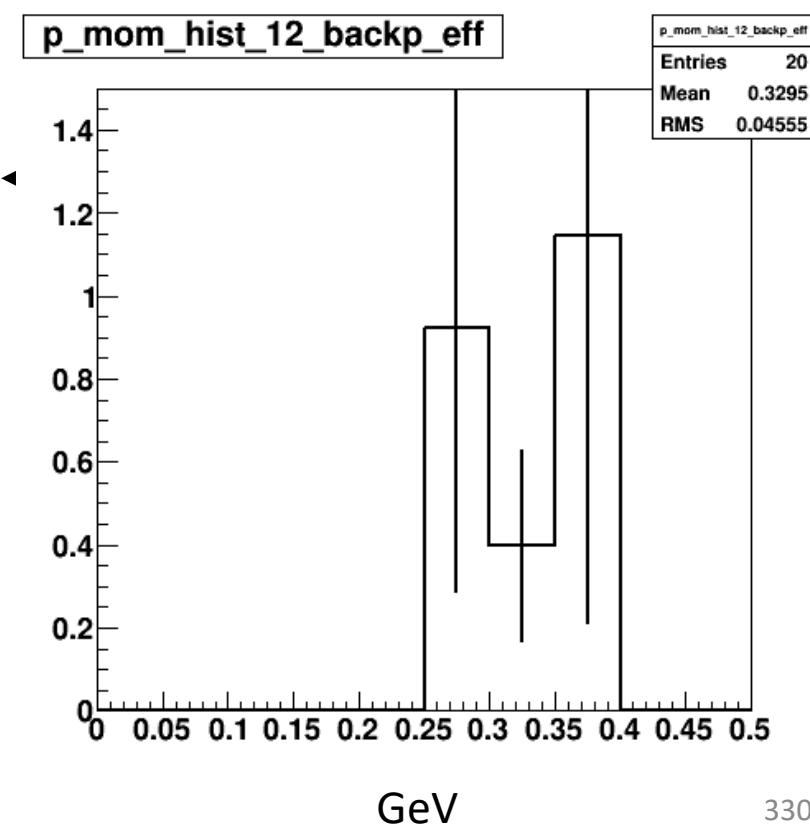
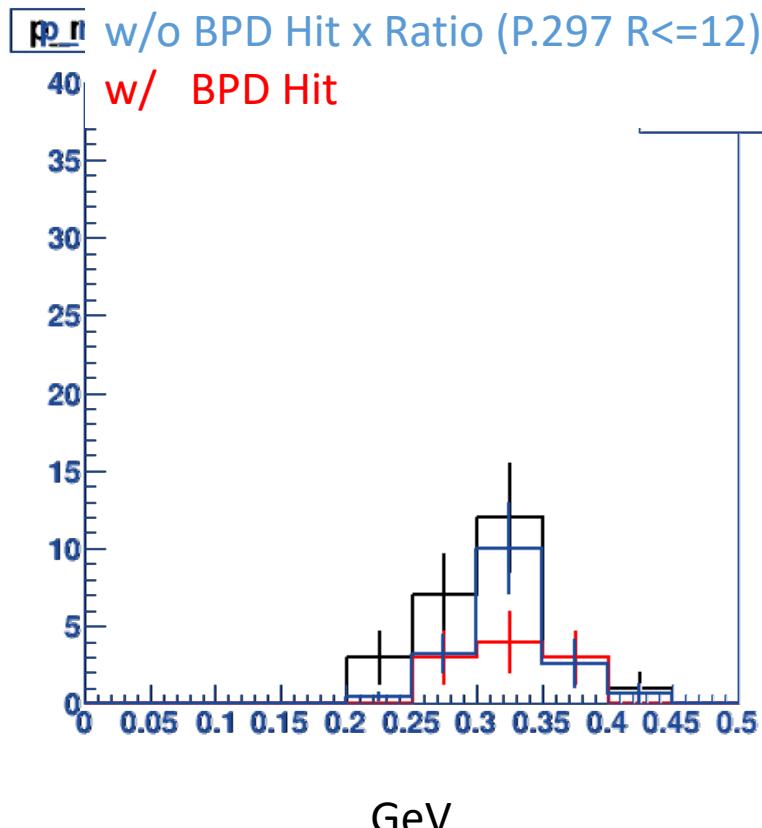
# BPD hit efficiency of backward timing

- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

$R \leq 12$

Missing momentum distribution    BPD hit efficiency of backward timing

w/o BPD Hit

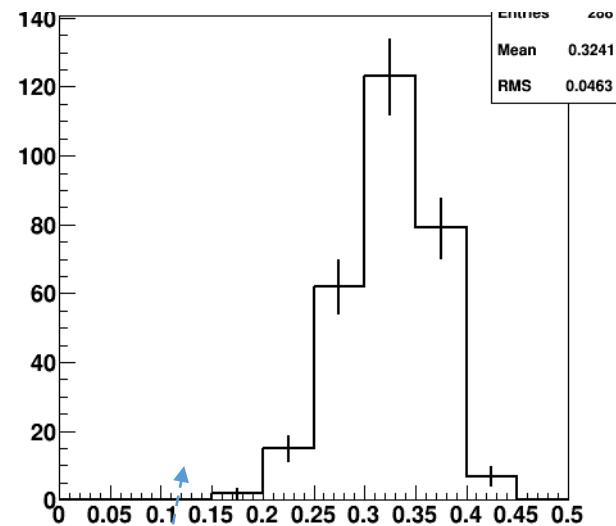


# Backward proton momentum

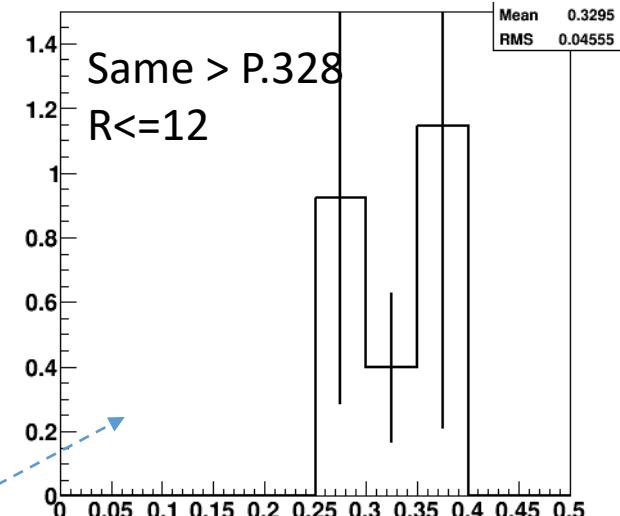
$R \leq 12$

- Run78 Data
- Condition
  - Re-analysis 7
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K^-, n\Lambda)^+ X$   $0.18 < X < 0.30$  GeV

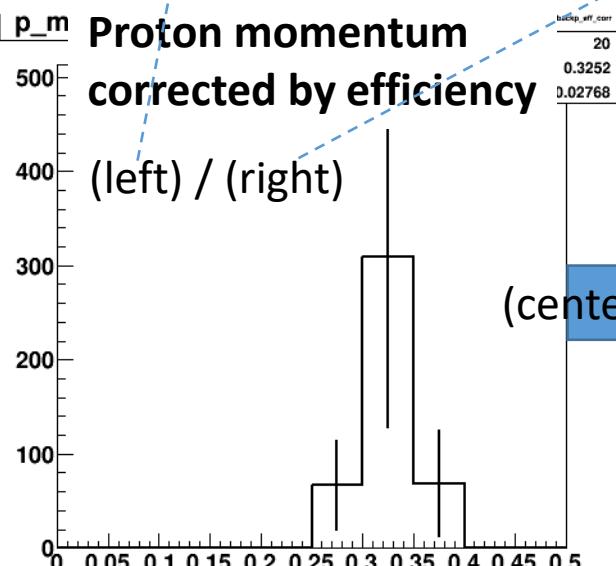
Backward proton momentum



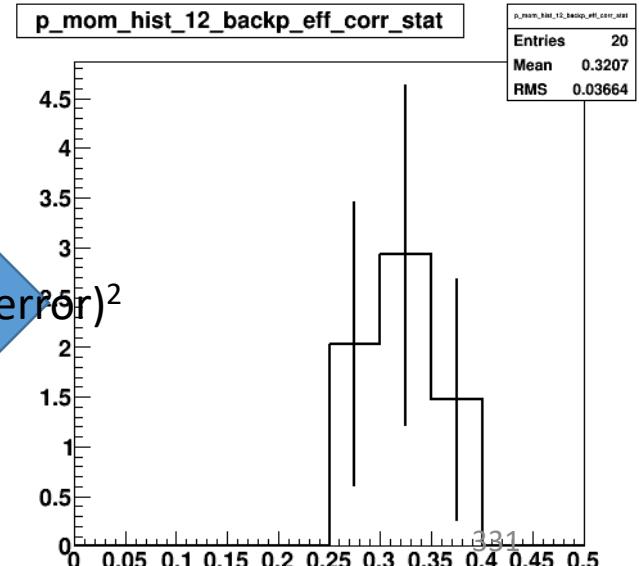
BPD hit efficiency of backward tim



$p_m$  Proton momentum corrected by efficiency



(center/ error)<sup>2</sup>



# BPD hit efficiency of backward timing

R<=12

Weighted average of the efficiency

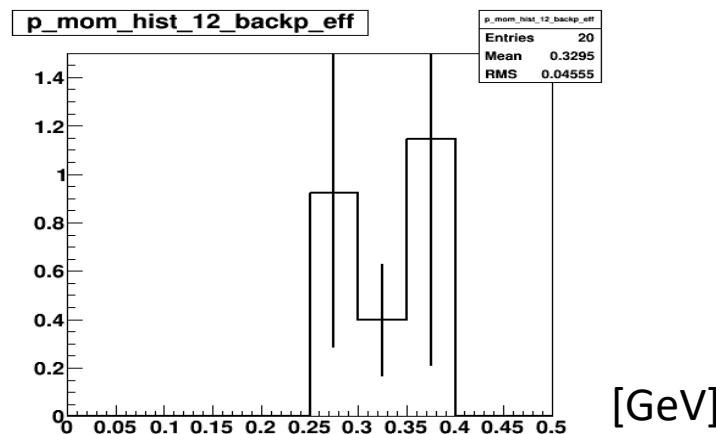
(P.329 right-up x P.329 right-down)/entry

→ 0.734 ± 0.289

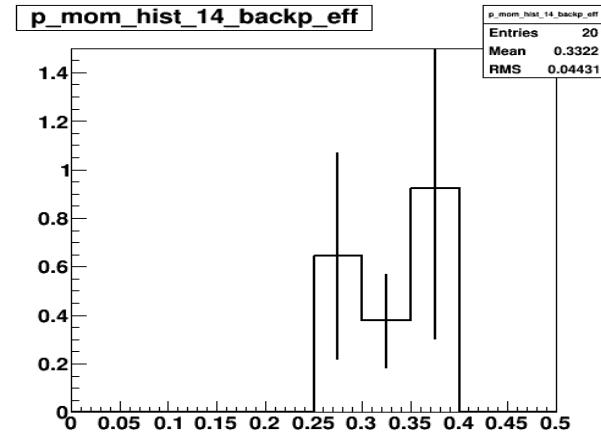
# Summary BPD hit efficiency of backward timing

## Dependence on missing proton momentum

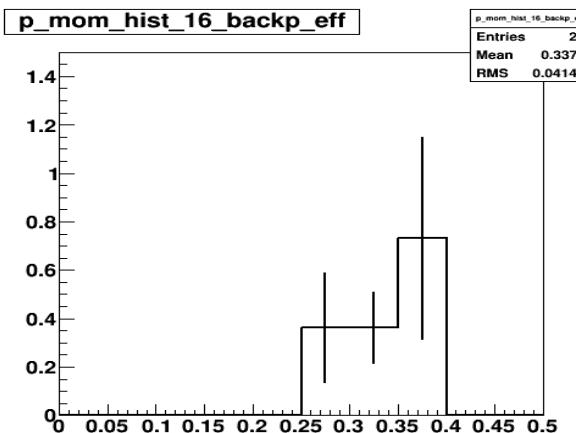
<R=12



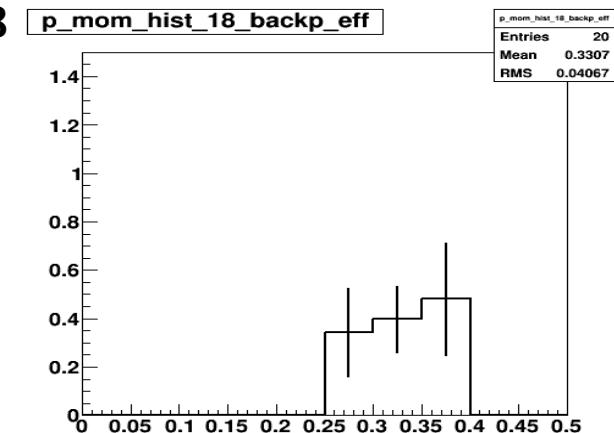
<R=14



<R=16



<R=18



# Summary

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

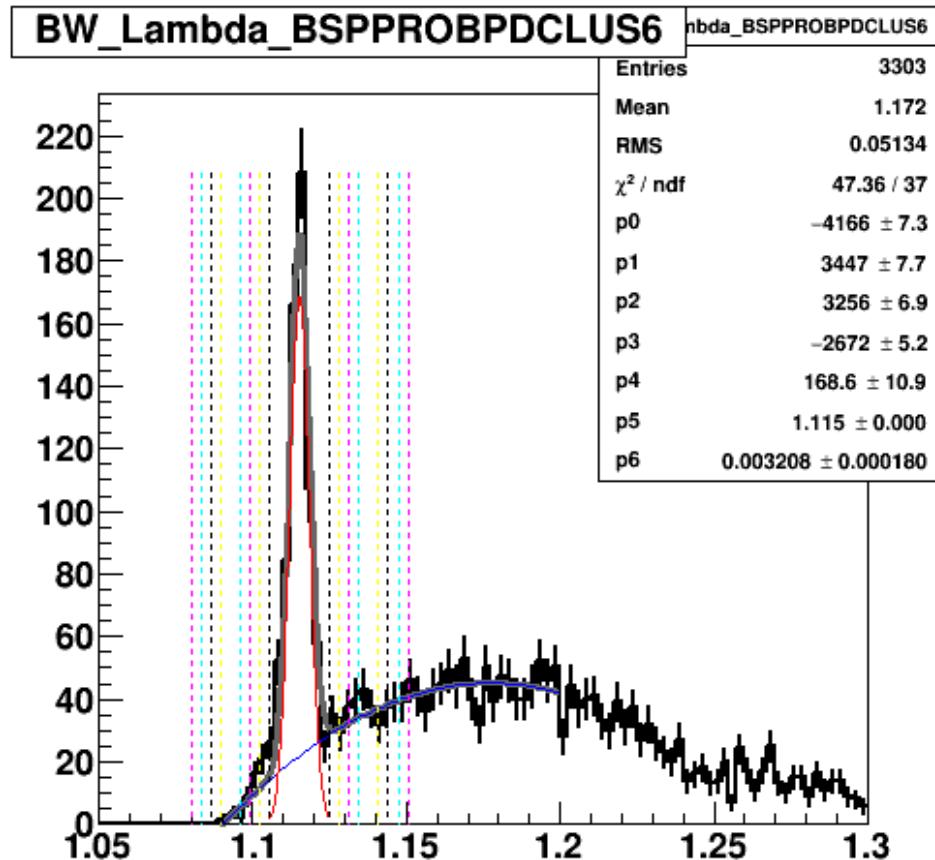
( $R \leq 12$ )  $0.734 \pm 0.289$

( $R \leq 14$ )  $0.596 \pm 0.209$

( $R \leq 16$ )  $0.459 \pm 0.136$

( $R \leq 18$ )  $0.407 \pm 0.104$

# $p, \pi$ - invariant mass $\Lambda$ selection side-band check



Noise/(left + right)

0.826093

0.545186

0.557957

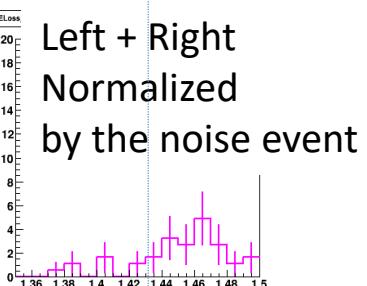
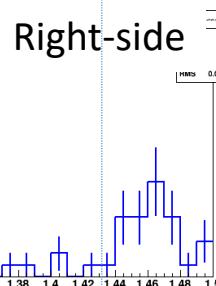
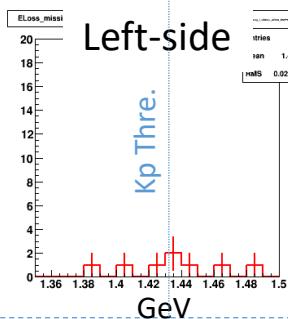
0.851582

select region  
in the  $p, \pi$ - invariant mass

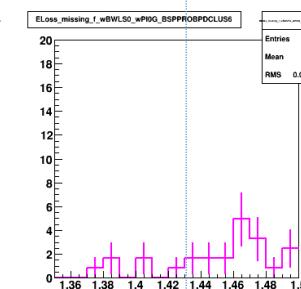
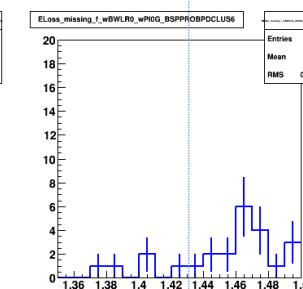
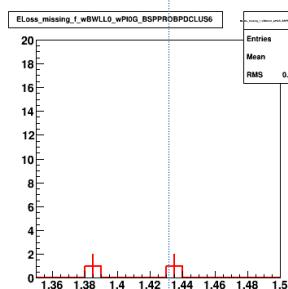
(default)

Center  $\pm 6\sigma$   
Width  $\pm 3\sigma$

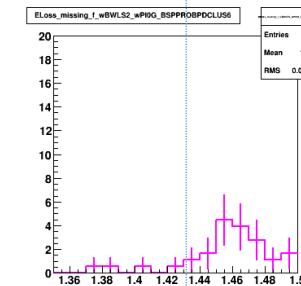
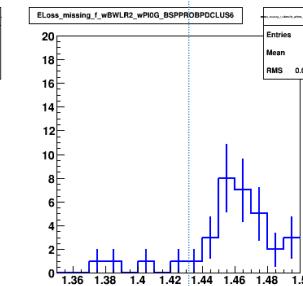
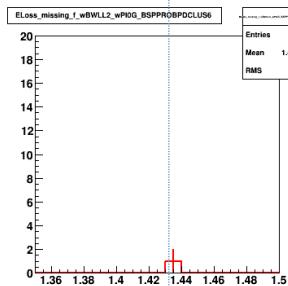
## $d(K, n)$ missing mass ( $\pi 0 \gamma$ selection)



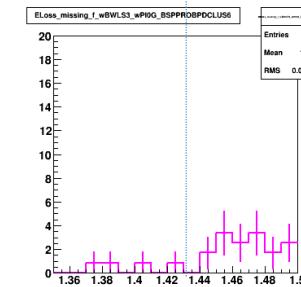
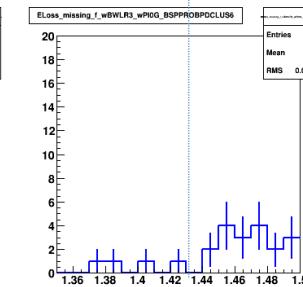
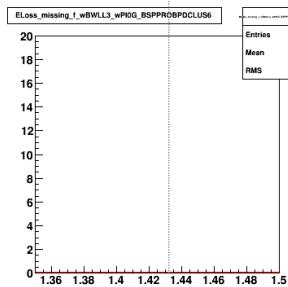
Center  $\pm 6\sigma$   
Width  $\pm 2\sigma$



Center  $\pm 8\sigma$   
Width  $\pm 3\sigma$



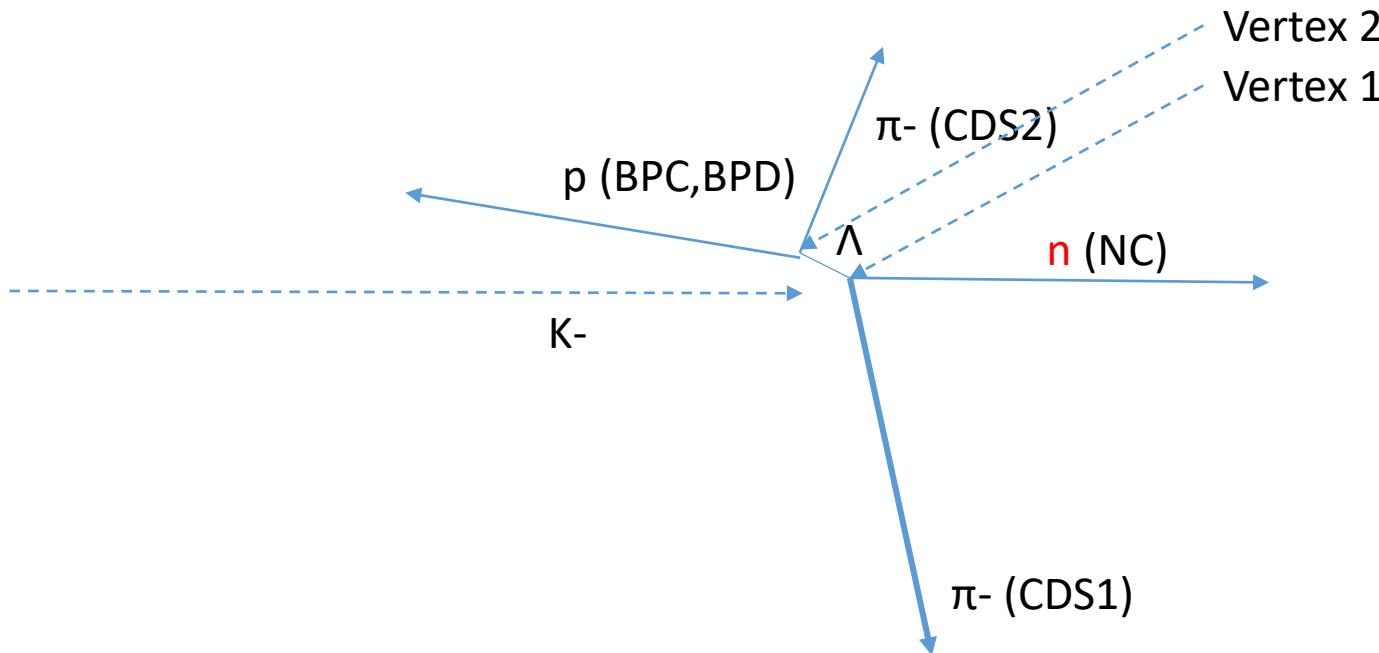
Center  $\pm 8\sigma$   
Width  $\pm 2\sigma$



# Backward proton acceptance study by SIM ( $K^- \rightarrow n + \pi^-$ )

SIM data

$K^- \rightarrow n + \pi^-$  (use  $n$  instead of  $p$  ; – ignore charge conservation)  
(spectrum shape ( $\Lambda\pi^-$  mass); plane  $0.135 \sim 0.170$  GeV)



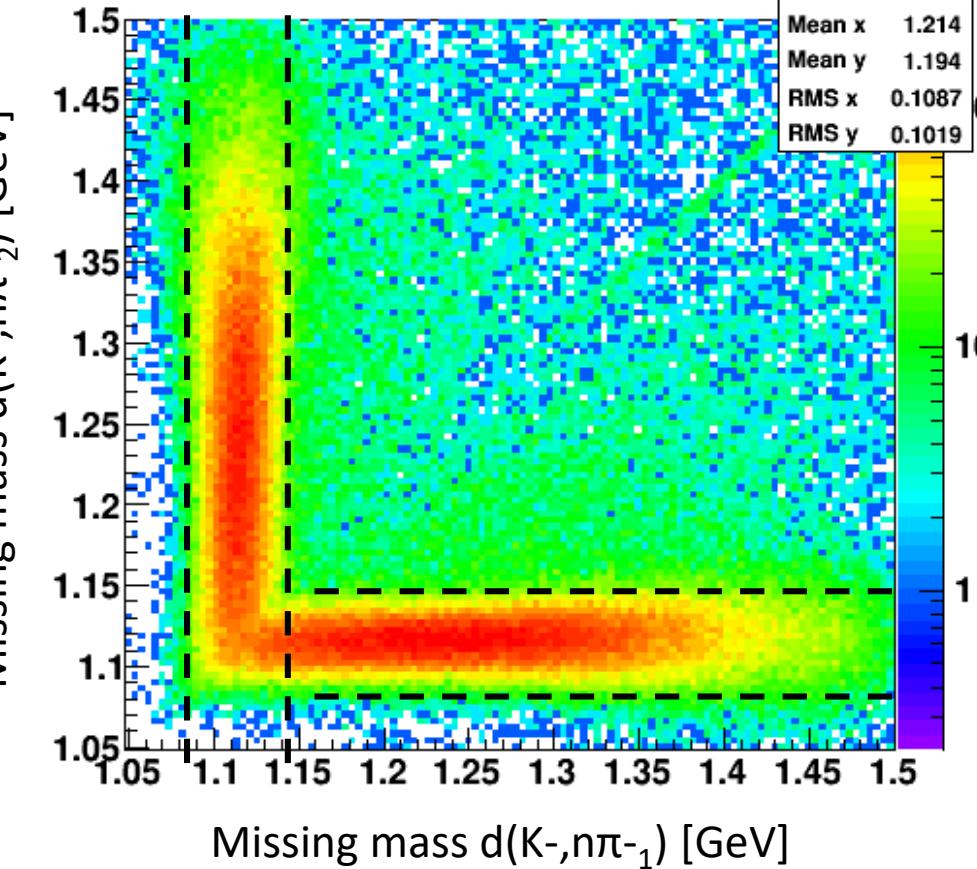
- Vertex 1 ;  $\pi^-$  (CDS1)  $\times K^-$
- Vertex 2 ;  $\Lambda$  (missing momentum)  $\times \pi^-$  (CDS2)

# Backward proton acceptance study by SIM ( $K^-d \rightarrow n \wedge \pi^-$ )

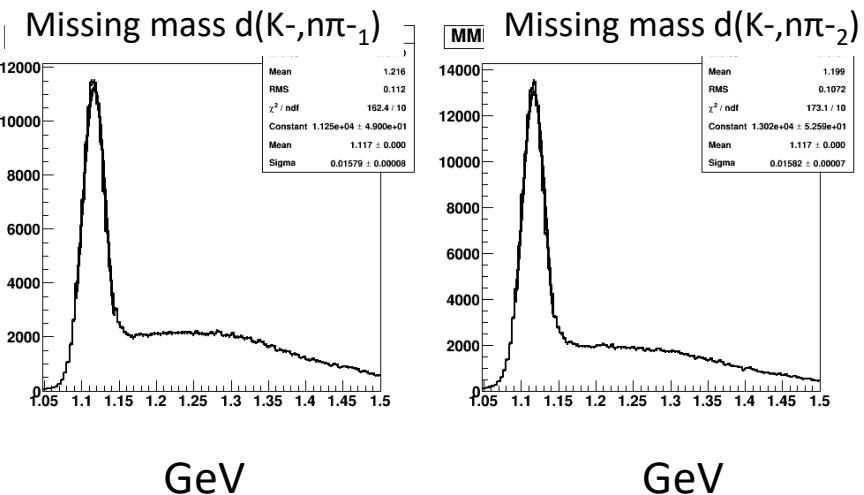
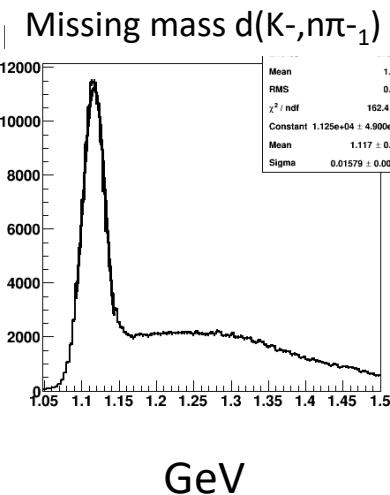
- Condition
  - Upstream analysis (same as final condition)
  - CDS 2 $\pi^-$  PID (start points ;vertex 1 vertex 2)
  - forward neutron analysis (start point ;vertex 1)
  - Vertex 1 Fiducial Cut
  - $\Lambda$  ID by missing mass  $d(K^-, n\pi^- \text{-(CDS1)})$
  - Backward proton momentum – missing momentum  $d(K^-, n\pi^-\pi^-)$

$d(K^-, n\pi^-_1)$  vs  $d(K^-, n\pi^-_2)$

MML2\_vs\_MML3\_SIM2



MML2\_vs\_MML3\_SIM2



GeV

GeV

Mean = 1.116  
Sigma = 0.015

$\rightarrow \Lambda \text{ ID } \pm 3 \sigma$

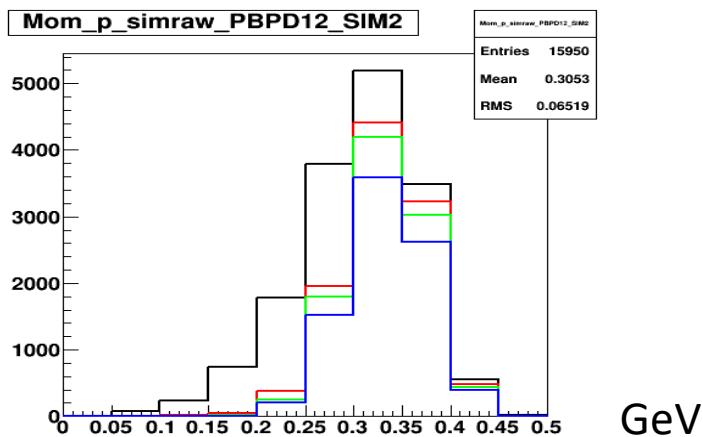
# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

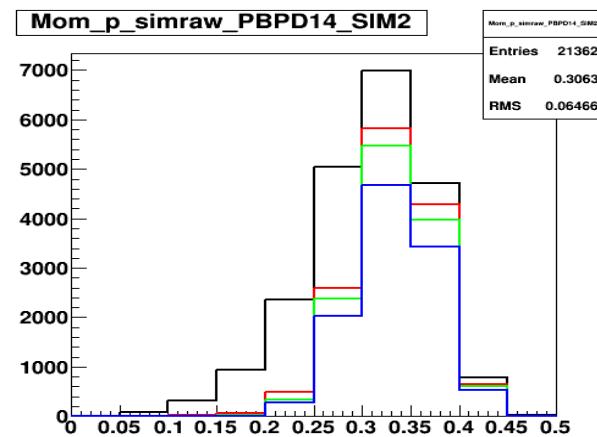
## Backward Proton Momentum

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

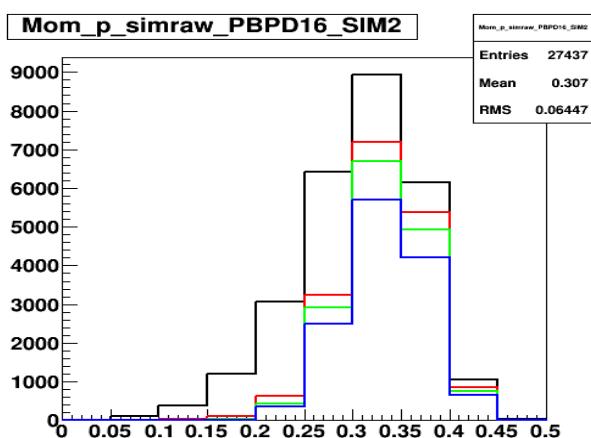
$< R = 12$



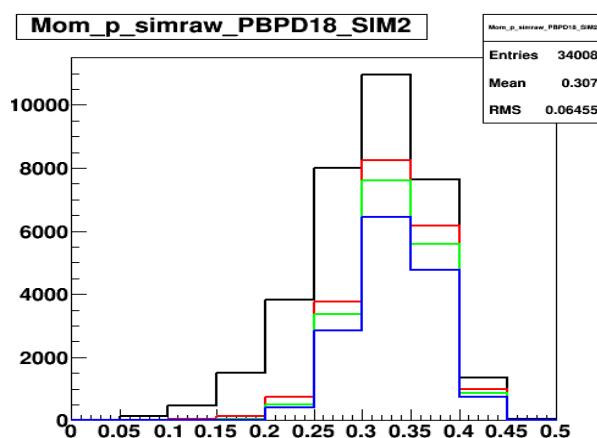
$< R = 14$



$< R = 16$



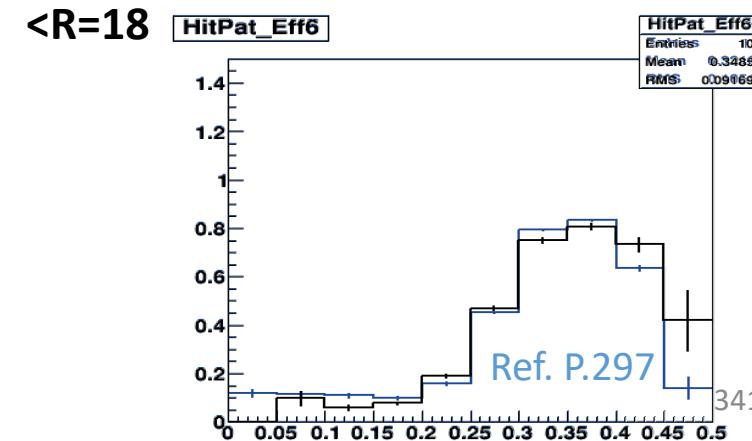
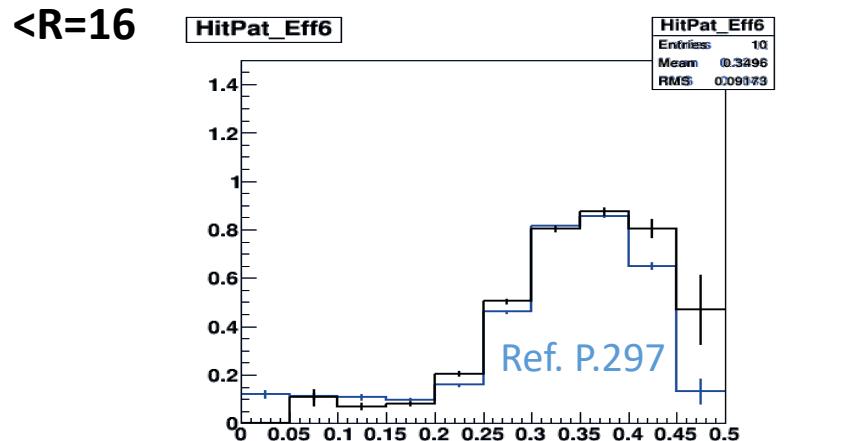
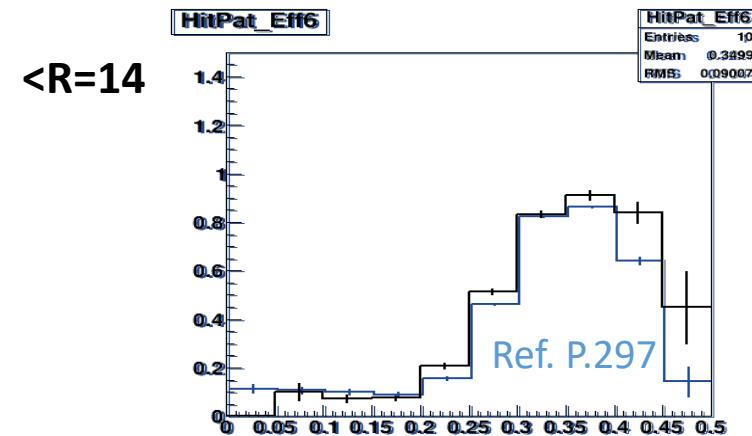
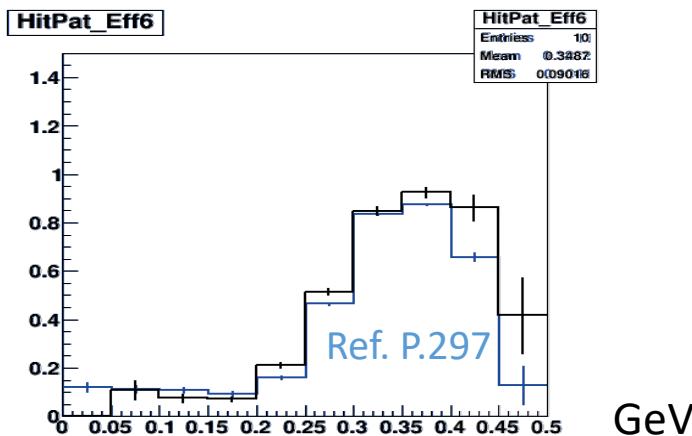
$< R = 18$



# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

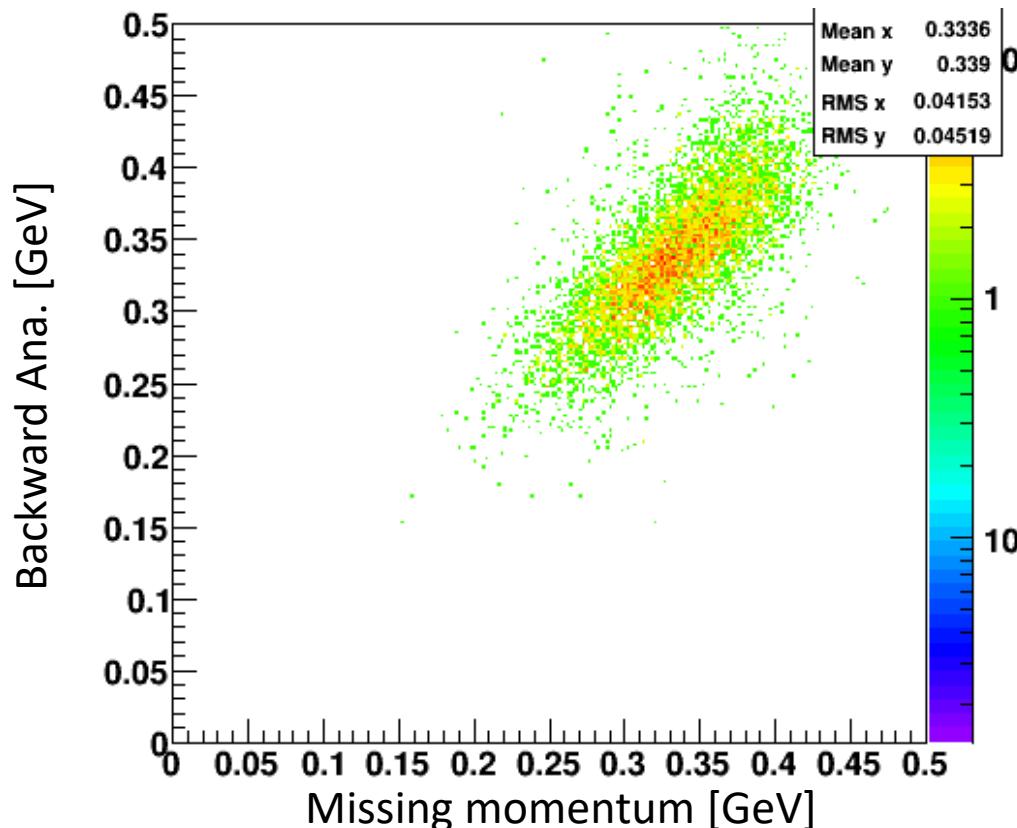
- BPD Hit position of proton momentum  $< R$

Ratio (Red/Black P.340)



# Backward proton acceptance study by SIM ( $K-d \rightarrow n \wedge \pi^-$ )

Backward Proton Momentum (Missing momentum vs Backward Ana.)



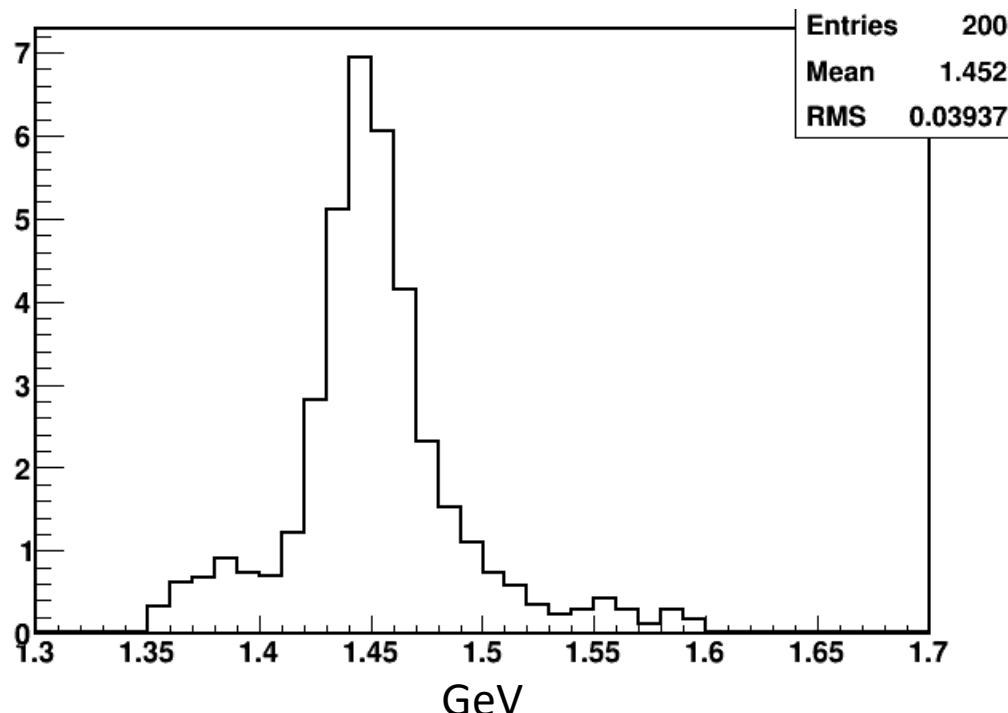
- BPD Cluster ( $TOF-BPDT0 > 4ns$ )
- BPD dE Cluster  $> 3MeV$
- BPC Backward Tracking

# Backward proton acceptance study by SIM ( $K-d \rightarrow n \wedge \pi^-$ ) 2

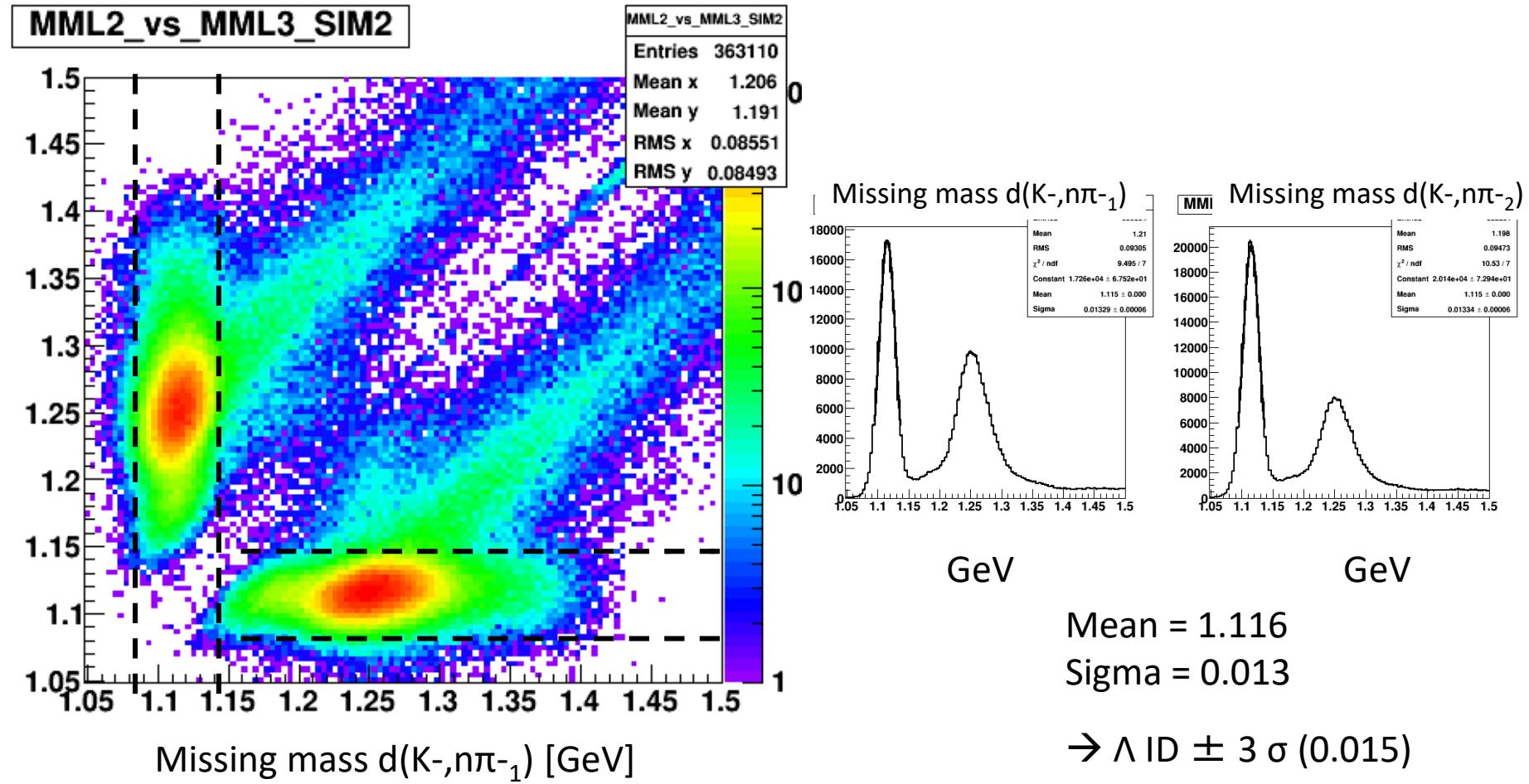
SIM data

$K-d \rightarrow n \wedge \pi^-$  (use  $n$  instead of  $p$  ;– ignore charge conservation)  
(spectrum shape ( $\Lambda\pi^-$  mass); Cross section spectrum)

Missing mass  $d(K-, p)\Lambda\pi^-$  spectrum shape



# $d(K^-, n\pi^-_1)$ vs $d(K^-, n\pi^-_2)$



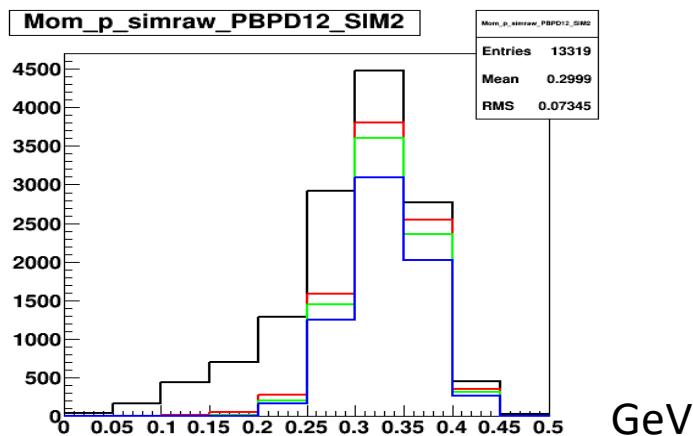
# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

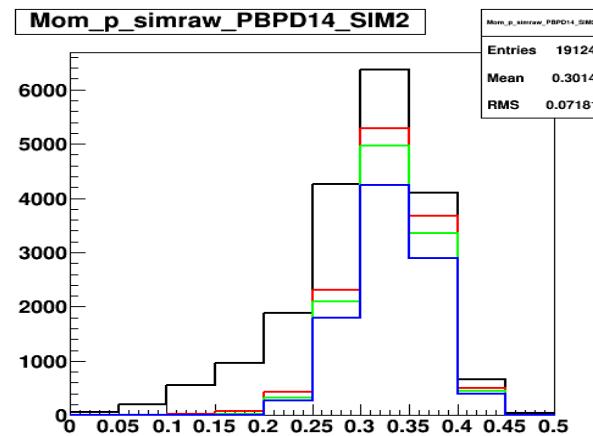
## Backward Proton Momentum

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

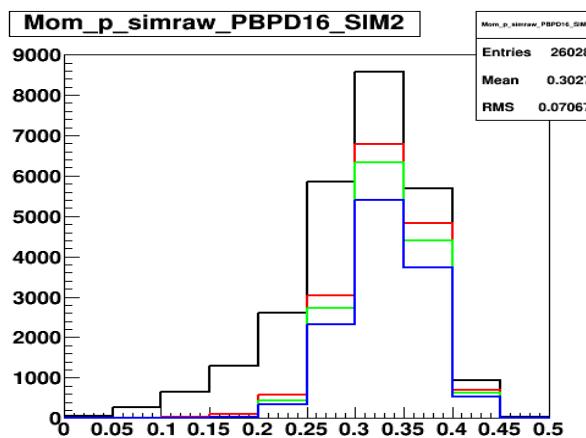
$< R = 12$



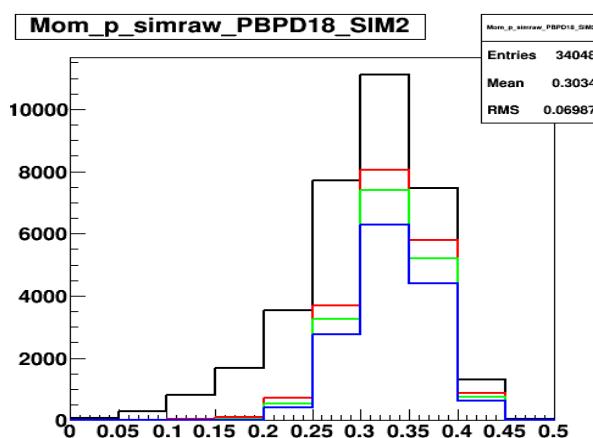
$< R = 14$



$< R = 16$



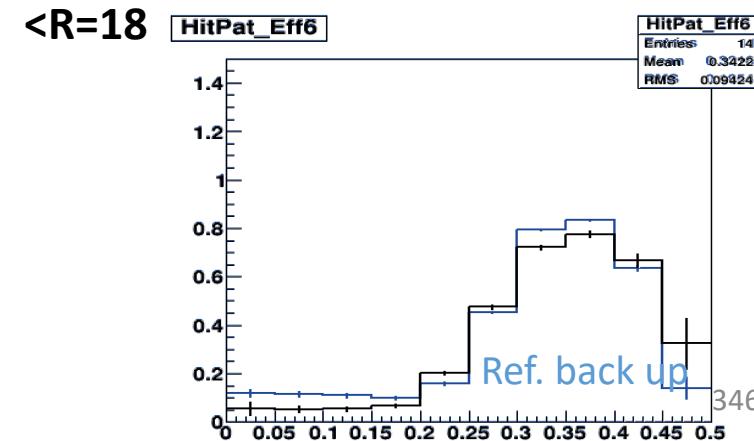
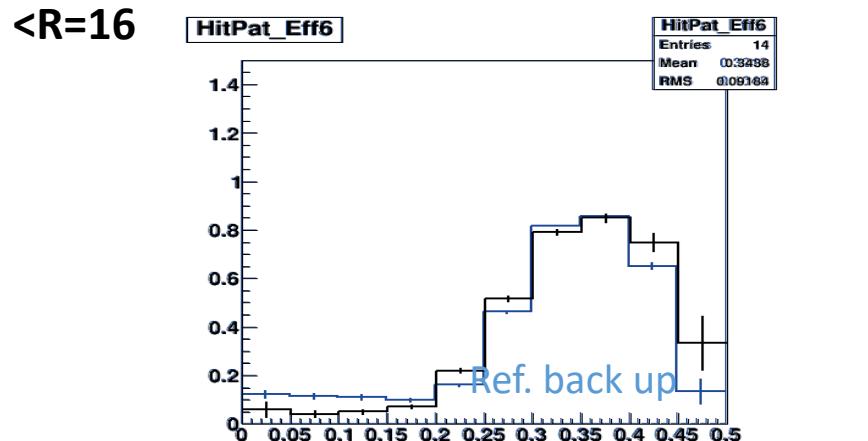
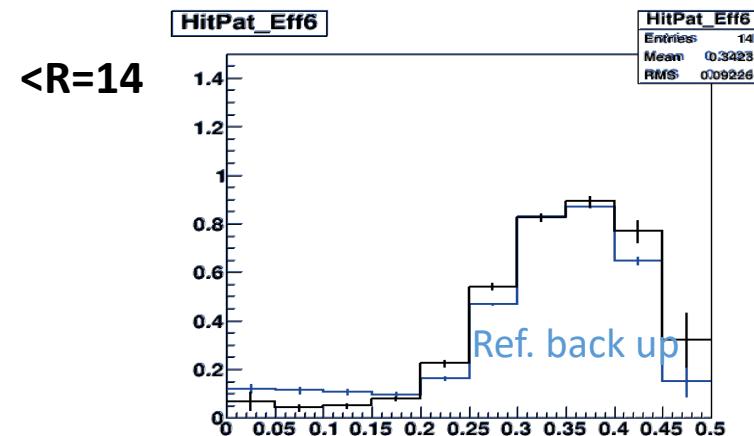
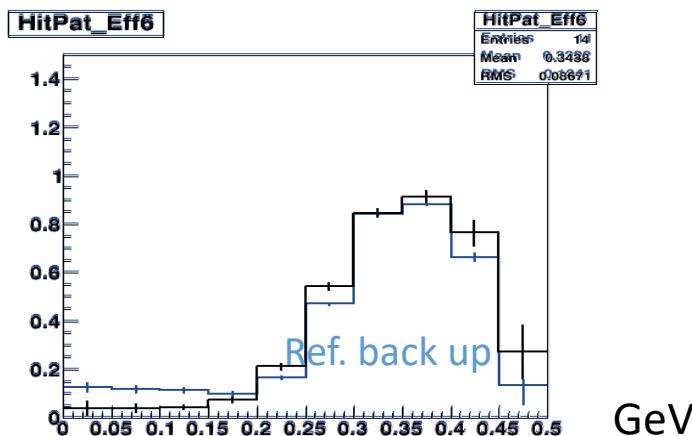
$< R = 18$



# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

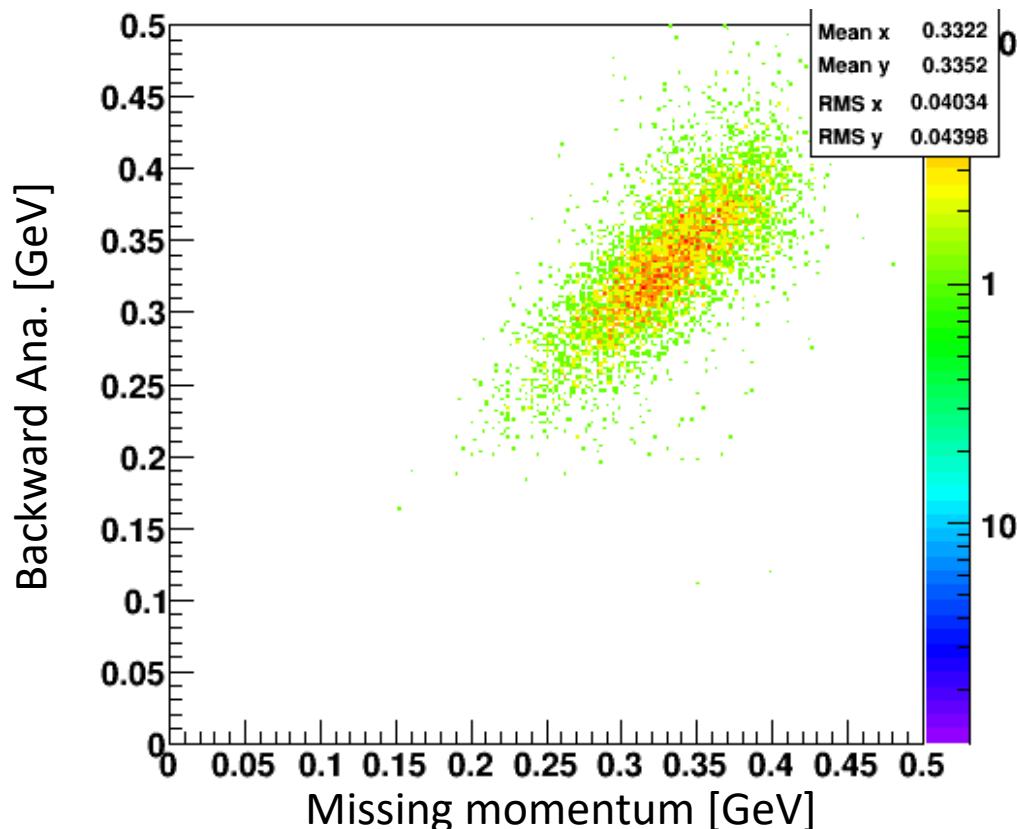
- BPD Hit position of proton momentum  $< R$

Ratio (Red/Black P.345)



# Backward proton acceptance study by SIM ( $K-d \rightarrow n \wedge \pi^-$ )

Backward Proton Momentum (Missing momentum vs Backward Ana.)



- BPD Cluster ( $TOF-BPDT0 > 4ns$ )
- BPD dE Cluster  $> 3MeV$
- BPC Backward Tracking

# Additional materials between Target - BPD

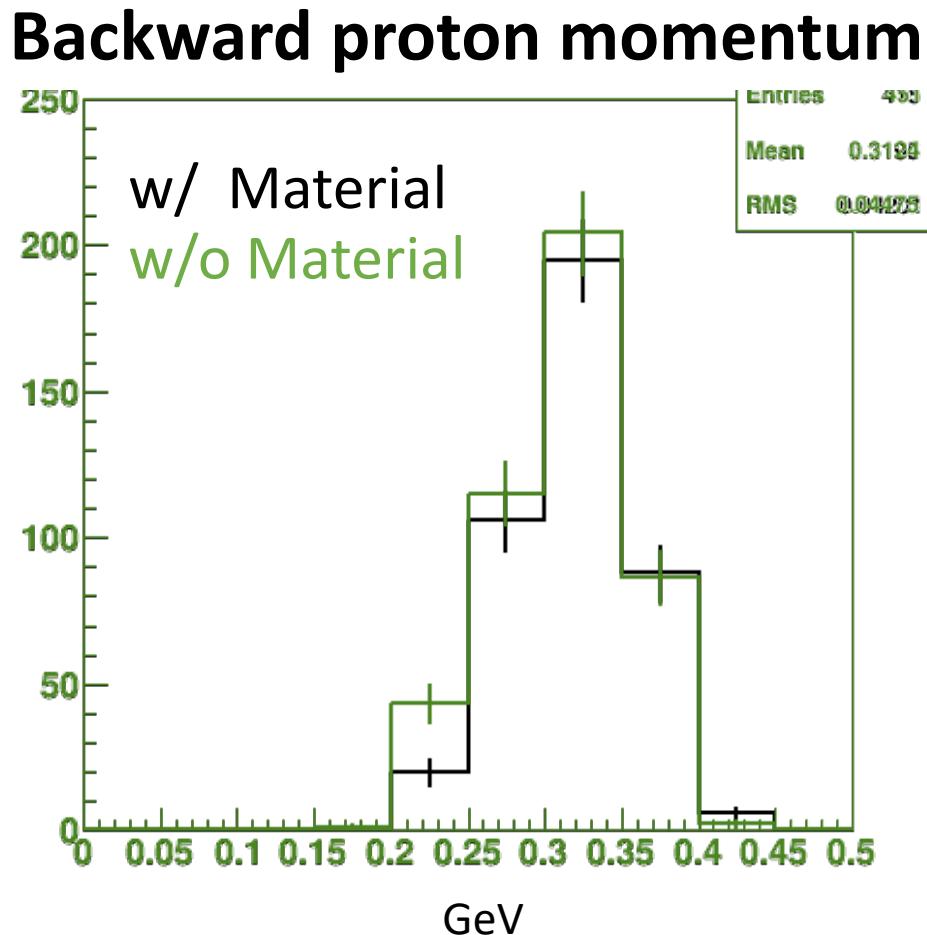
		Width [cm]	number
• Target	• Super insulator ESR (Mylar)	0.0225(x0.84)	1
	• Super insulator(net) Mylar	0.02	1
• DEF	• Reflective film ESR (Mylar)	0.01(x0.84)	2
	• Blackout sheet Polyvinyl	0.01	1
• BPC	• Window film Mylar	0.0012	2
	• Cathode film Carbon Aramid (Nylon66)	0.001	9
• BPD	• Reflective film ESR (Mylar)	0.01(x0.84)	1
	• Blackout Tape Polyester (PET)	0.007	1

# Materials detail

- ESR 1.17 g/cc
- Mylar C<sub>5</sub>H<sub>4</sub>O<sub>2</sub> 1.39 g/cc
- Polyvinyl C<sub>2</sub>H<sub>3</sub>Cl<sub>1</sub> 1.40 g/cc
- Nylon66 (C<sub>12</sub>H<sub>22</sub>N<sub>2</sub>O<sub>2</sub>)<sub>n</sub> 1.14 g/cc

# Comparison w/ Material and w/o Material

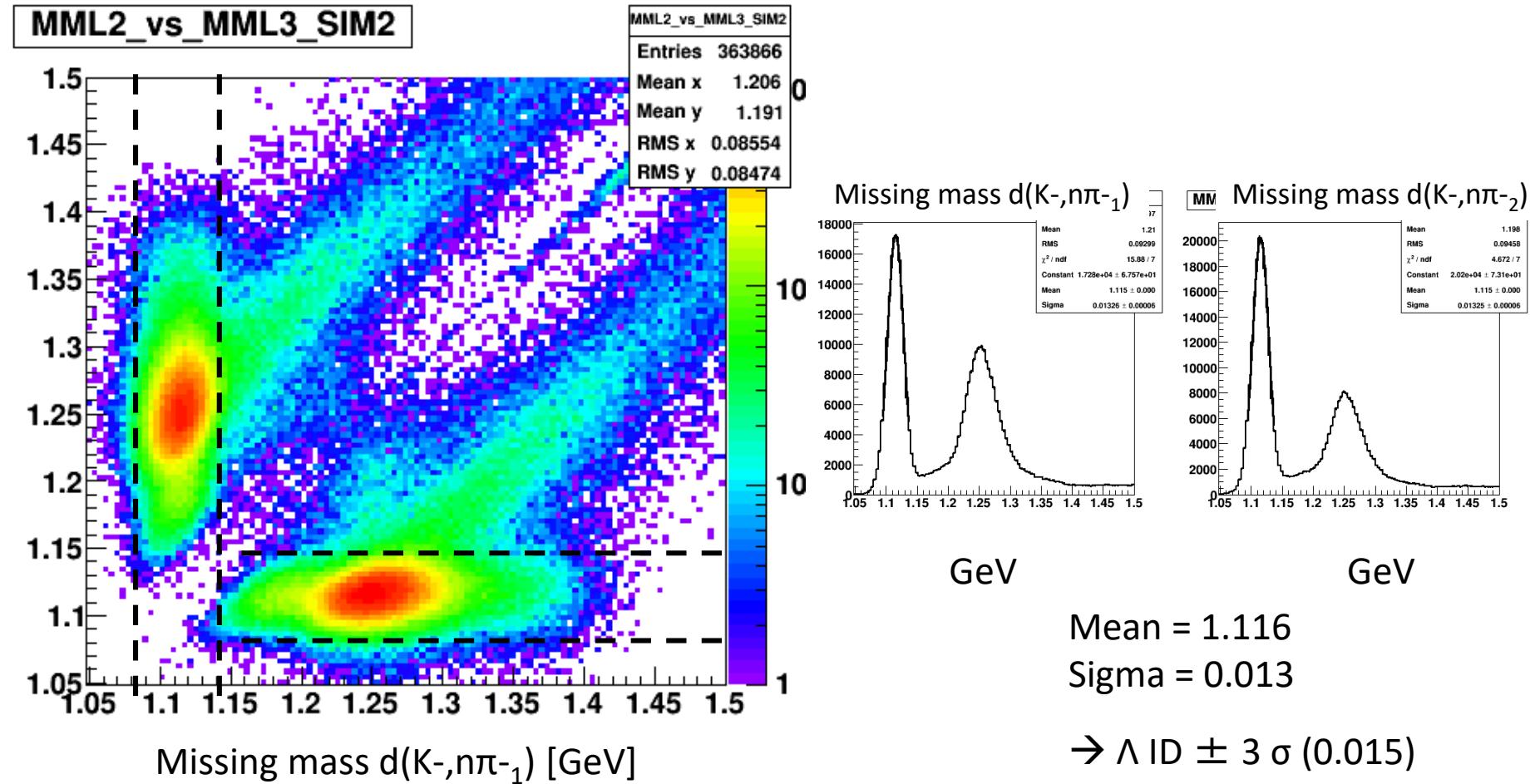
- SIM data( $K-d \rightarrow n \Sigma^0 \pi^0$ ; plane)
- Condition
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K^-, n\Lambda)''X''$   $0.18 < X < 0.30$  GeV



# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 3

- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 2
- Additional materials between Target - BPD

# $d(K^-, n\pi^-_1)$ vs $d(K^-, n\pi^-_2)$



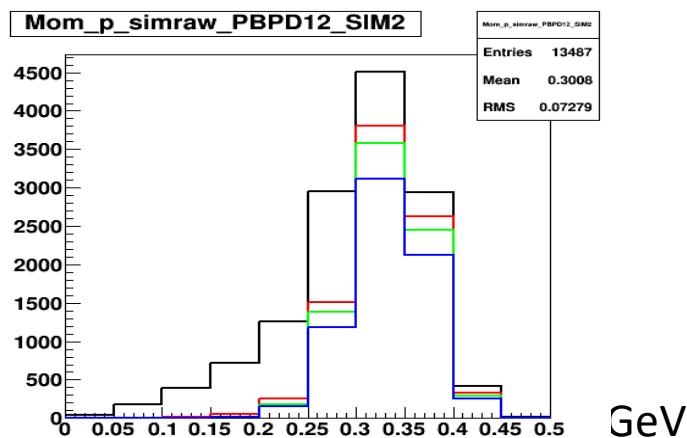
# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

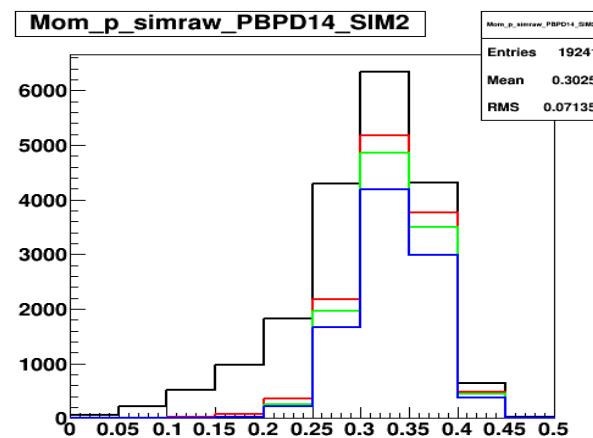
## Backward Proton Momentum

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

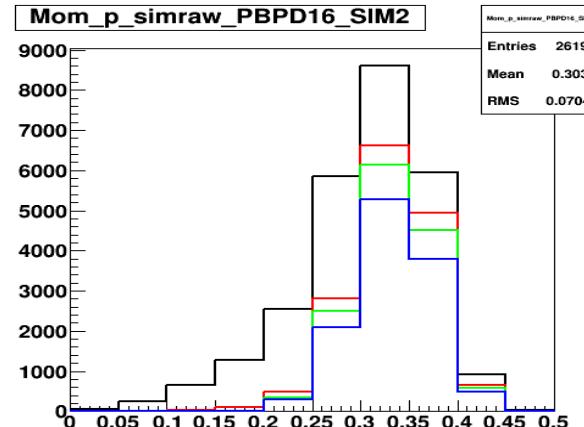
$< R = 12$



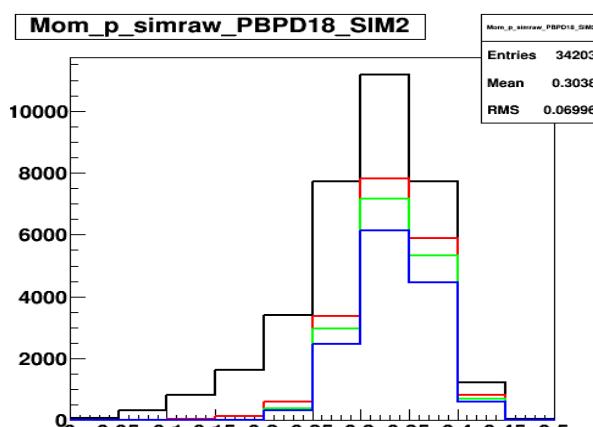
$< R = 14$



$< R = 16$



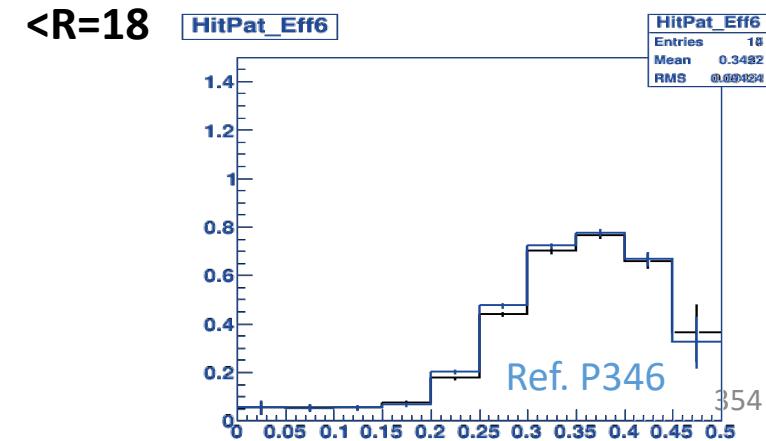
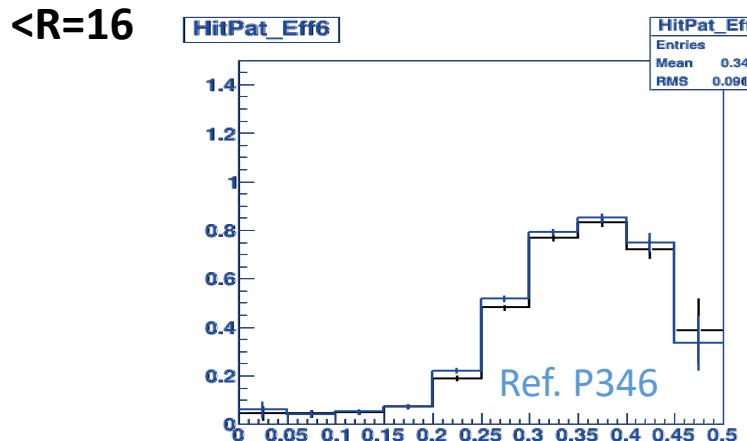
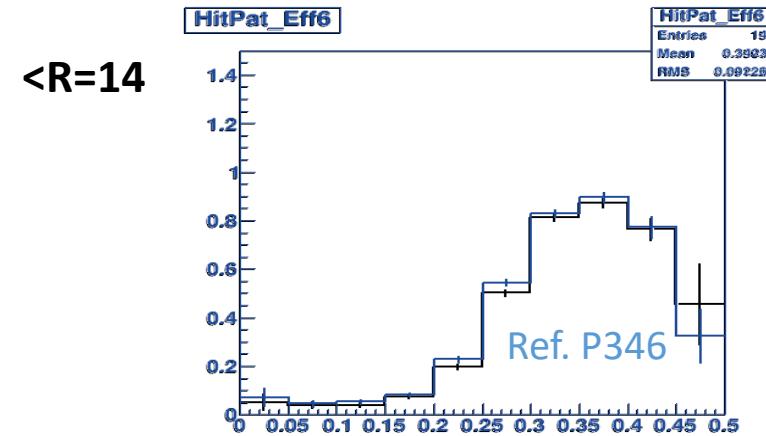
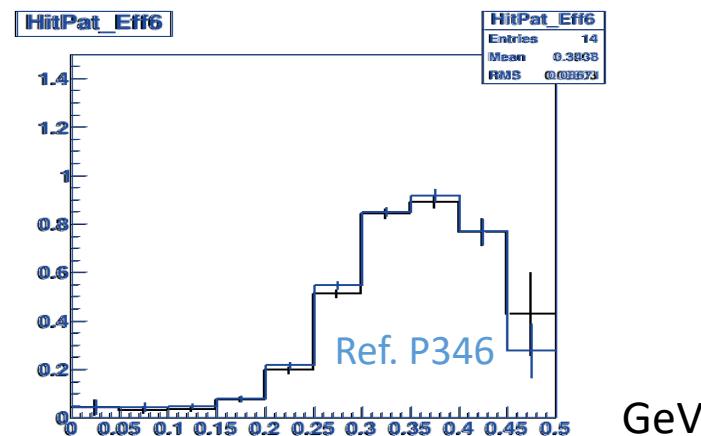
$< R = 18$



# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

Ratio (Red/Black P.353)



# Backward proton acceptance study by SIM ( $K-d \rightarrow n \wedge \pi^-$ )

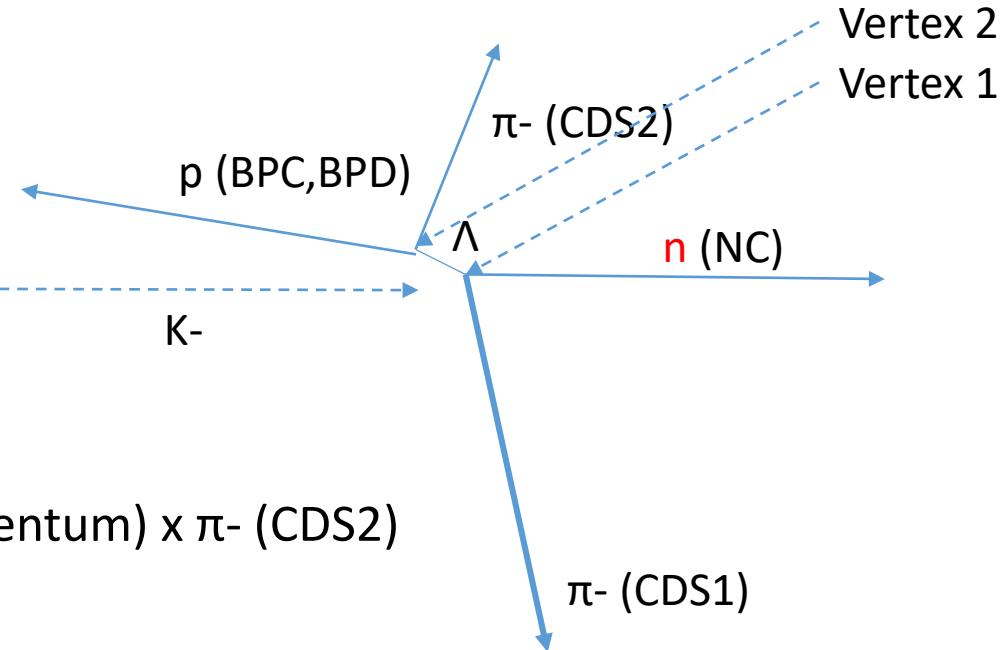
Backward Proton Momentum (Missing momentum vs Backward Ana.)

Backward Ana. [GeV]

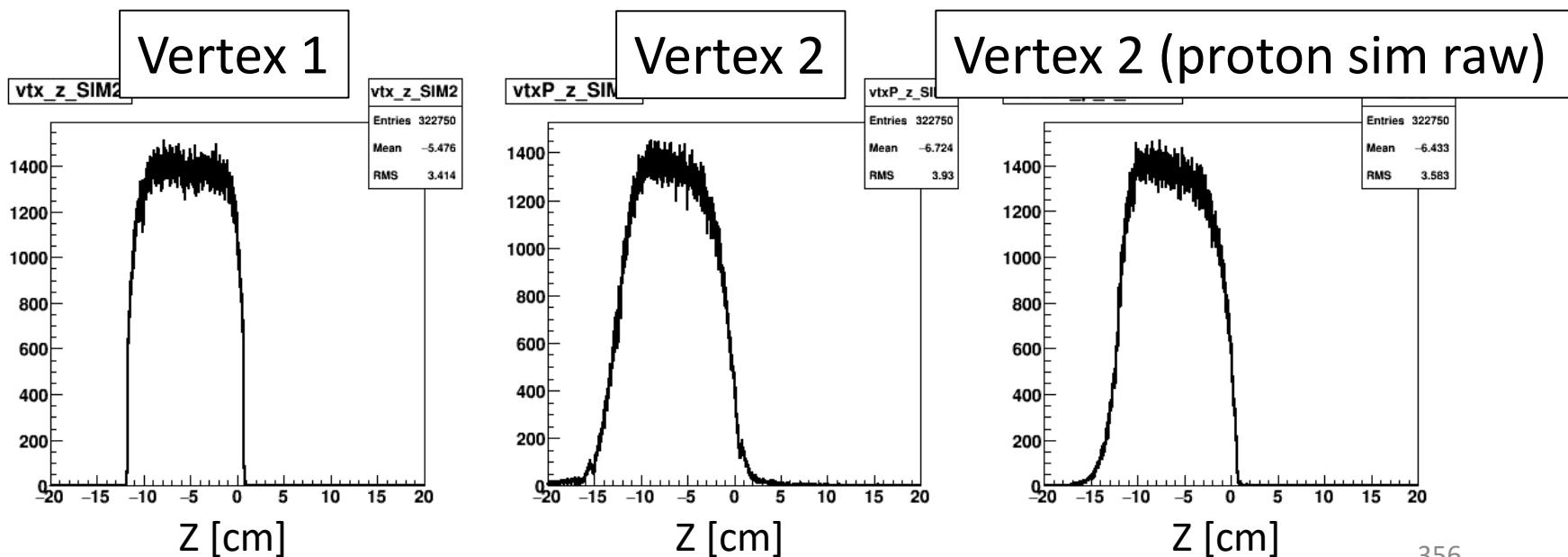
Missing momentum [GeV]

- BPD Cluster ( $TOF-BPDT0 > 4ns$ )
- BPD dE Cluster  $> 3MeV$
- BPC Backward Tracking

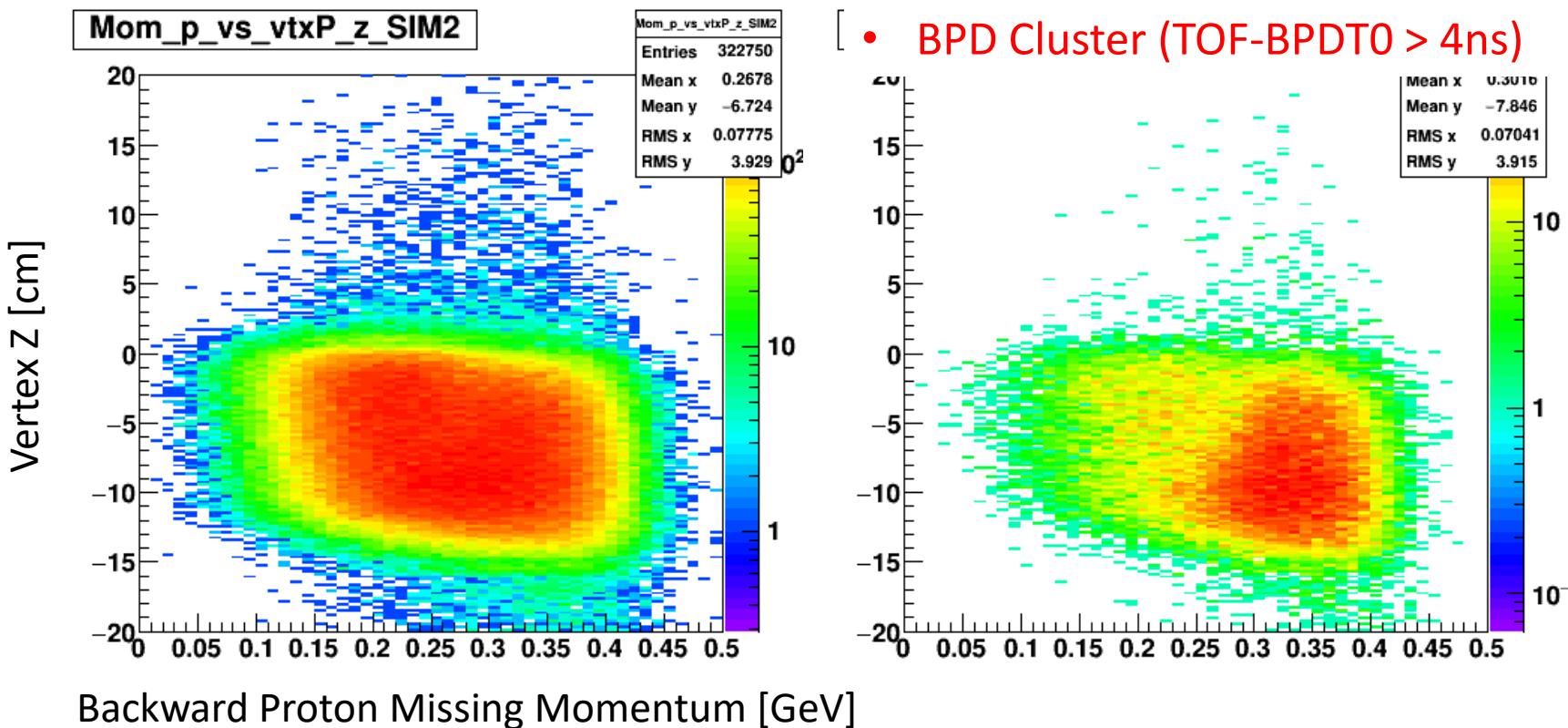
# Check Vertex



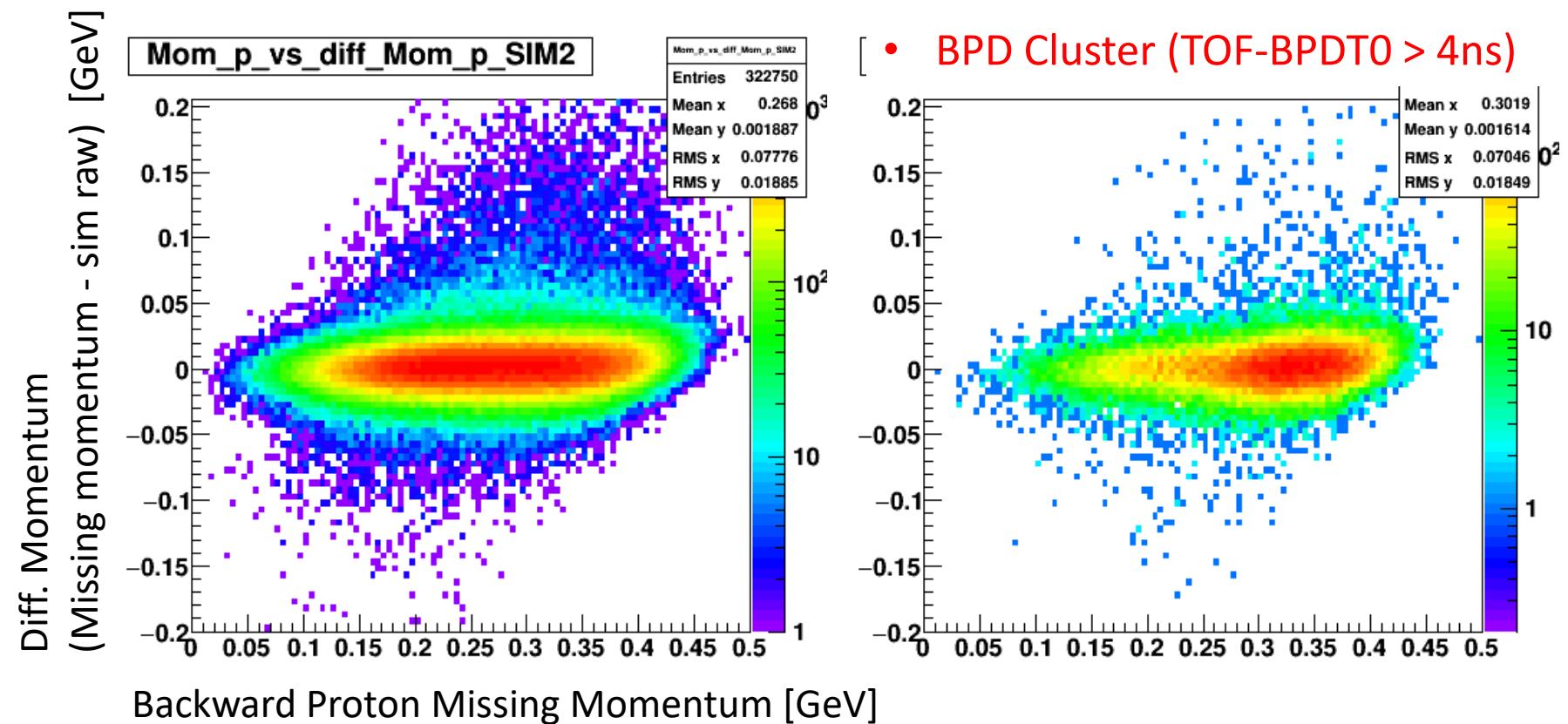
- Vertex 1 ;  $\pi^-$  (CDS1) x  $K^-$
- Vertex 2 ;  $\Lambda$  (missing momentum) x  $\pi^-$  (CDS2)



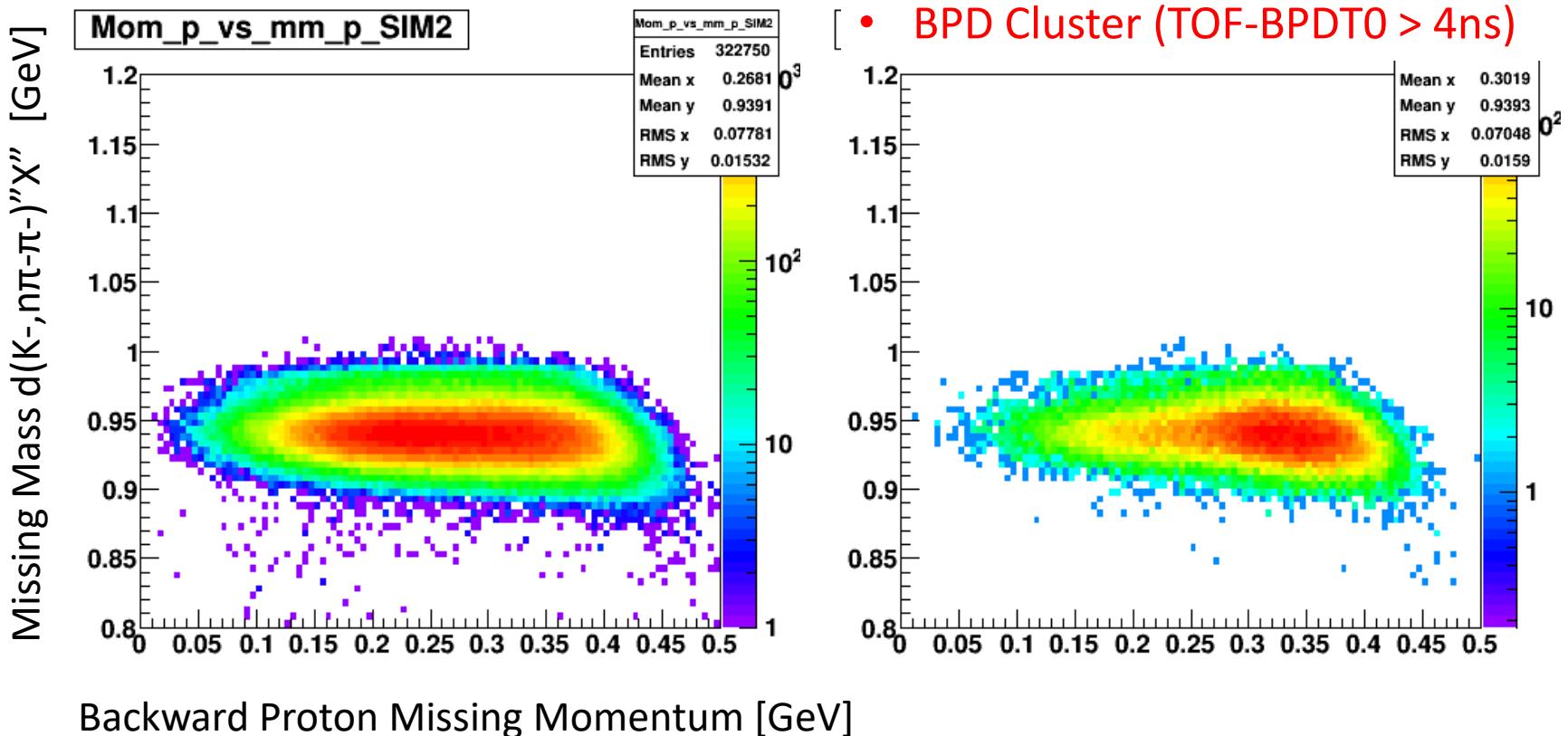
# Momentum dependence on Vertex Z



# Momentum dependence on diff. SIM

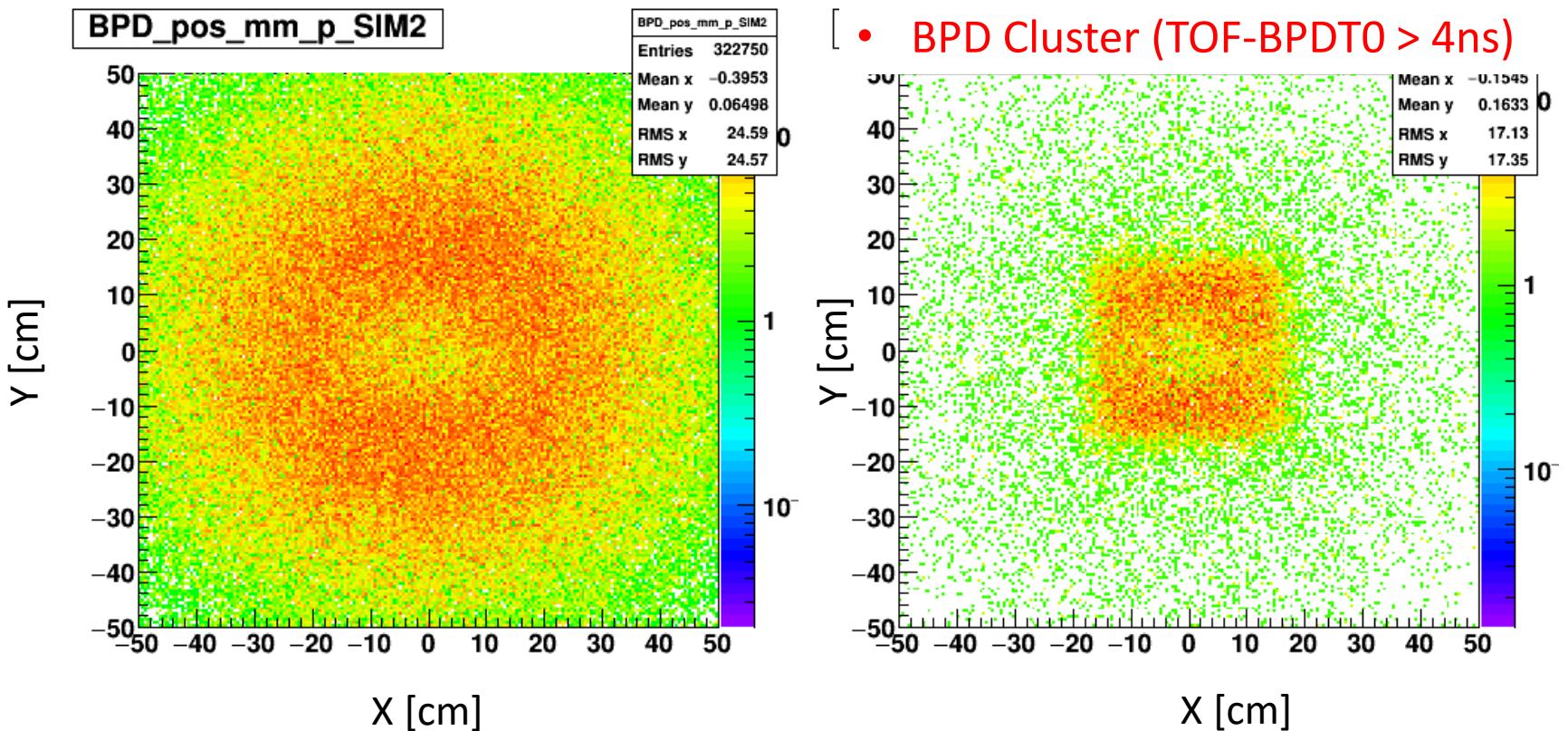


# Momentum dependence on $d(\bar{K}, n\pi^-\pi^-)''p''$



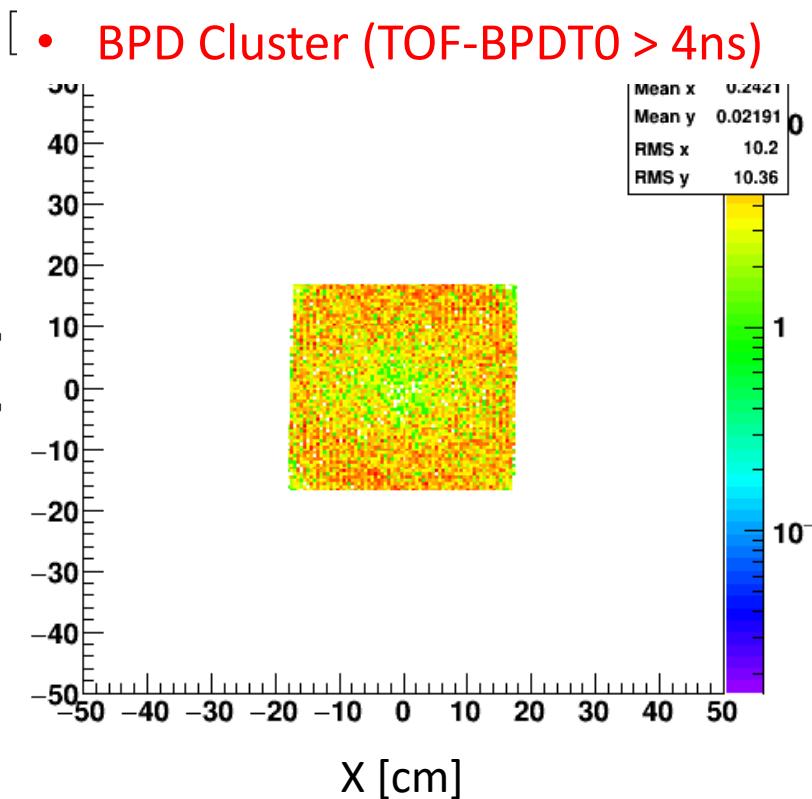
# BPD Hit Position

Hit Position from Missing Momentum



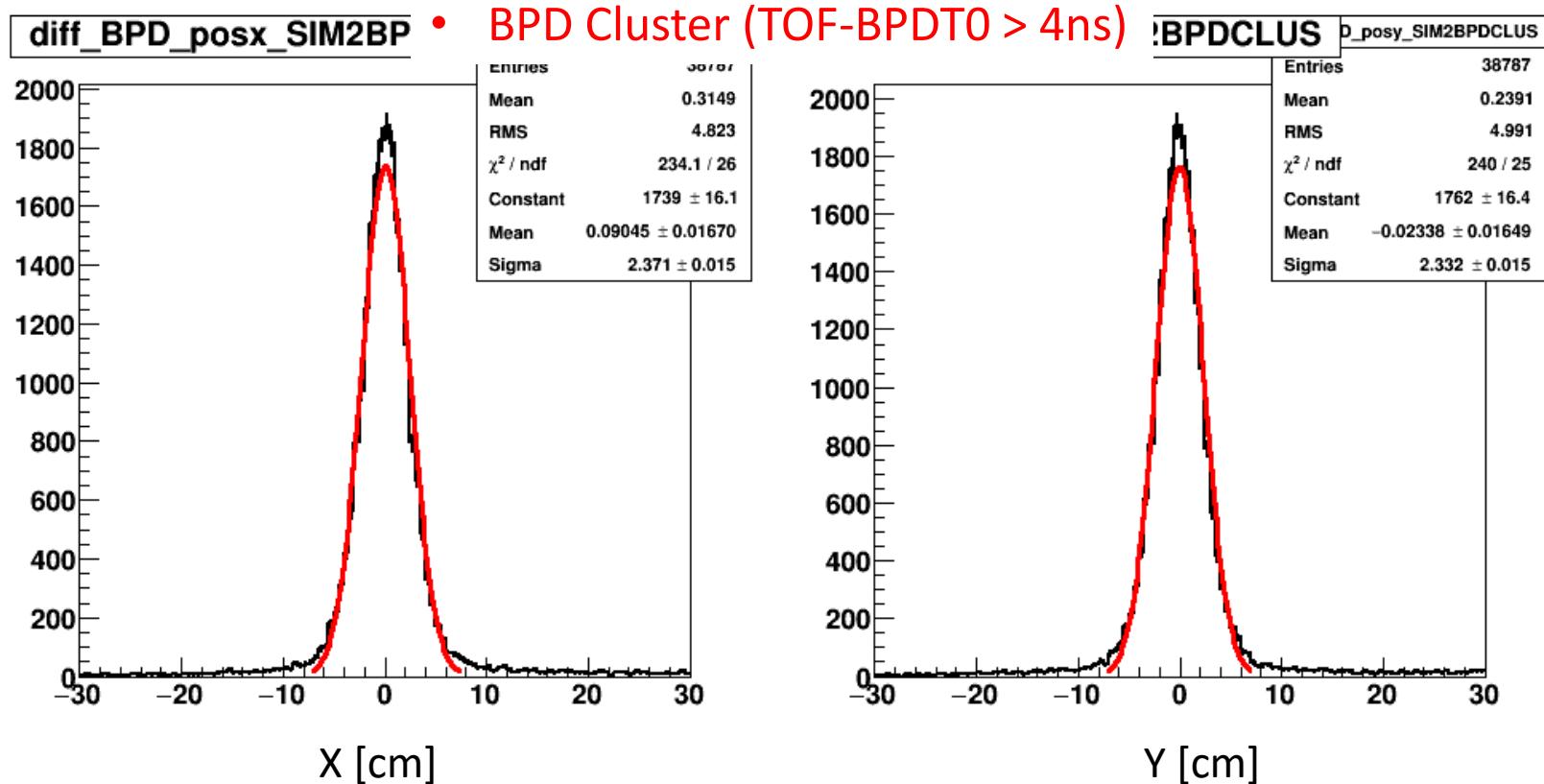
# BPD Hit Position

Hit Position from SIM Raw

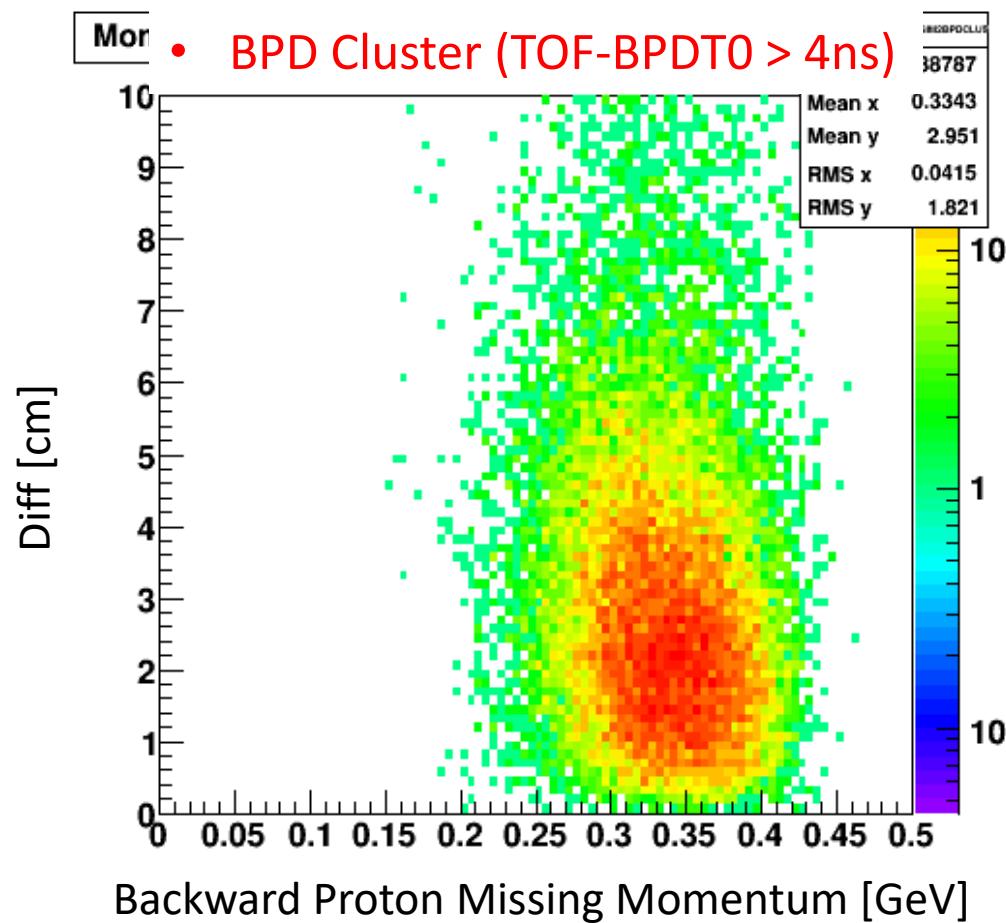


# Diff. BPD Hit Position

Hit Position from SIM Raw - Hit Position from Missing Momentum



# Momentum dependence on diff. BPD Hit Position

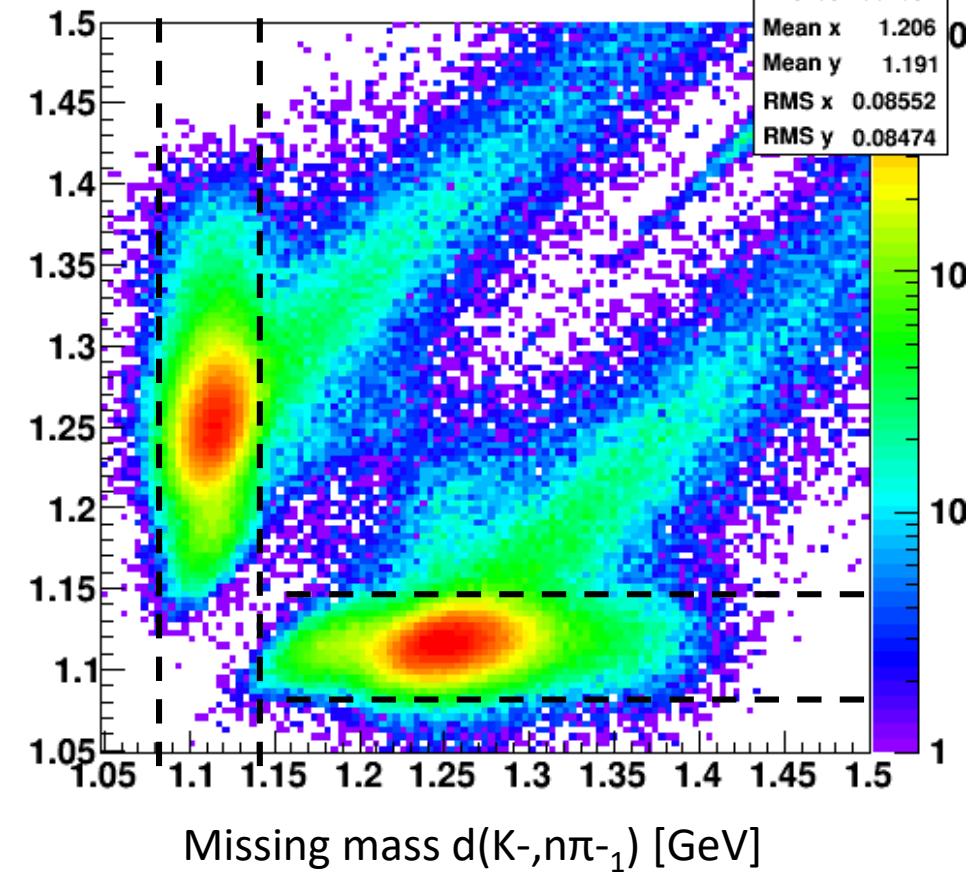


# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 4

- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 3
- Bag in the calculation of the vertex was fixed  
Momentum forward neutron =0 in Momentum  $\Lambda$

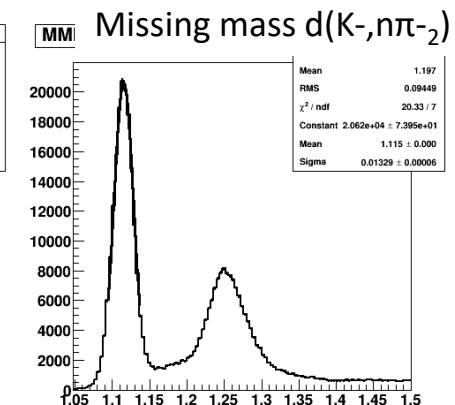
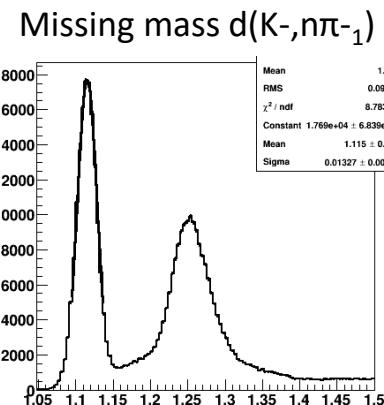
$d(K^-, n\pi^-_1)$  vs  $d(K^-, n\pi^-_2)$

MML2\_vs\_MML3\_SIM2



MML2\_vs\_MML3\_SIM2

Entries	364354
Mean x	1.206
Mean y	1.191
RMS x	0.08552
RMS y	0.08474



Mean = 1.115  
Sigma = 0.013

$\rightarrow \Lambda \text{ ID} \pm 3\sigma (0.015)$

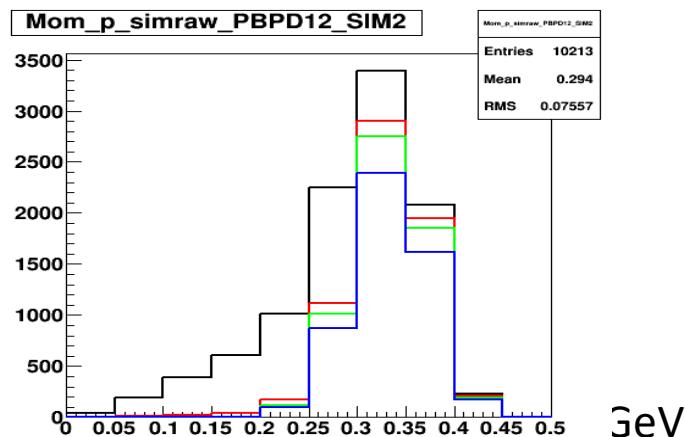
# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

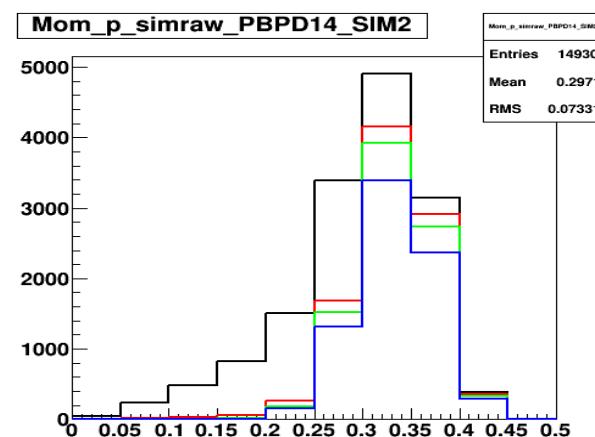
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

## Backward Proton Momentum

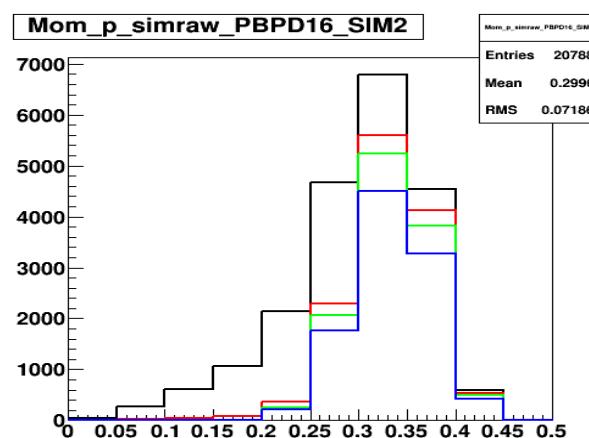
$< R = 12$



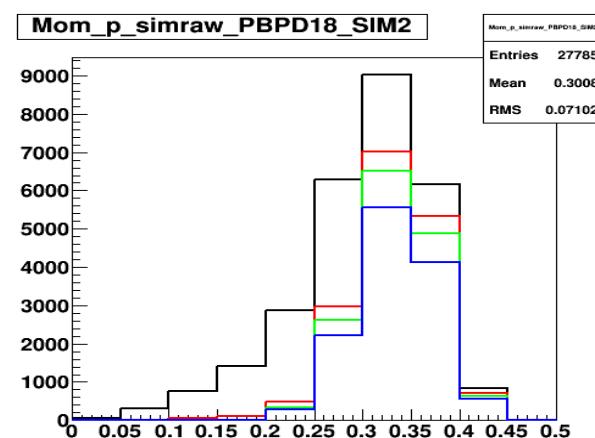
$< R = 14$



$< R = 16$



$< R = 18$

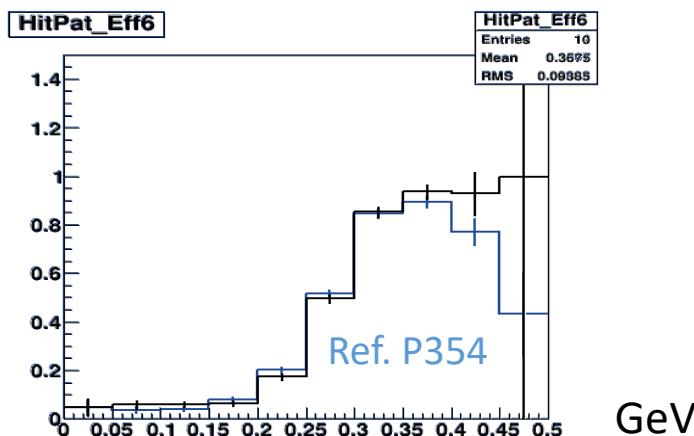


# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

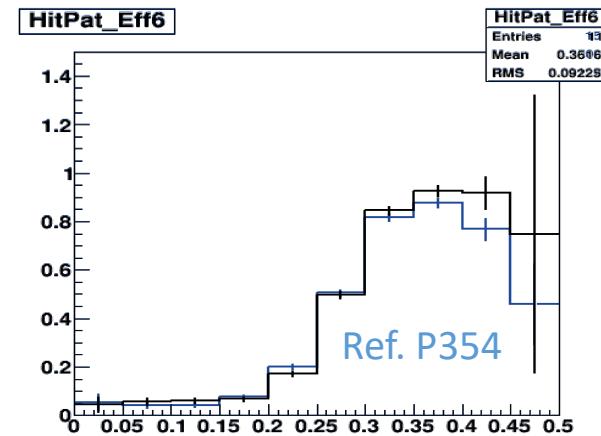
- BPD Hit position of proton momentum  $< R$

Ratio (Red/Black P.366)

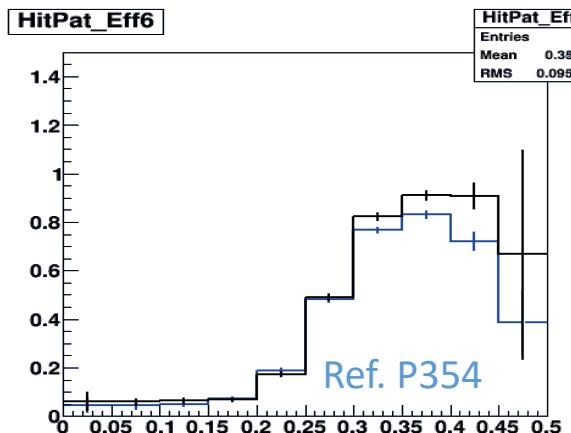
$<R=12$



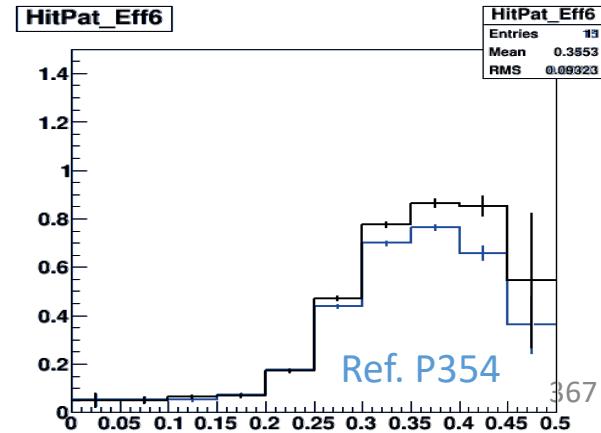
$<R=14$



$<R=16$



$<R=18$

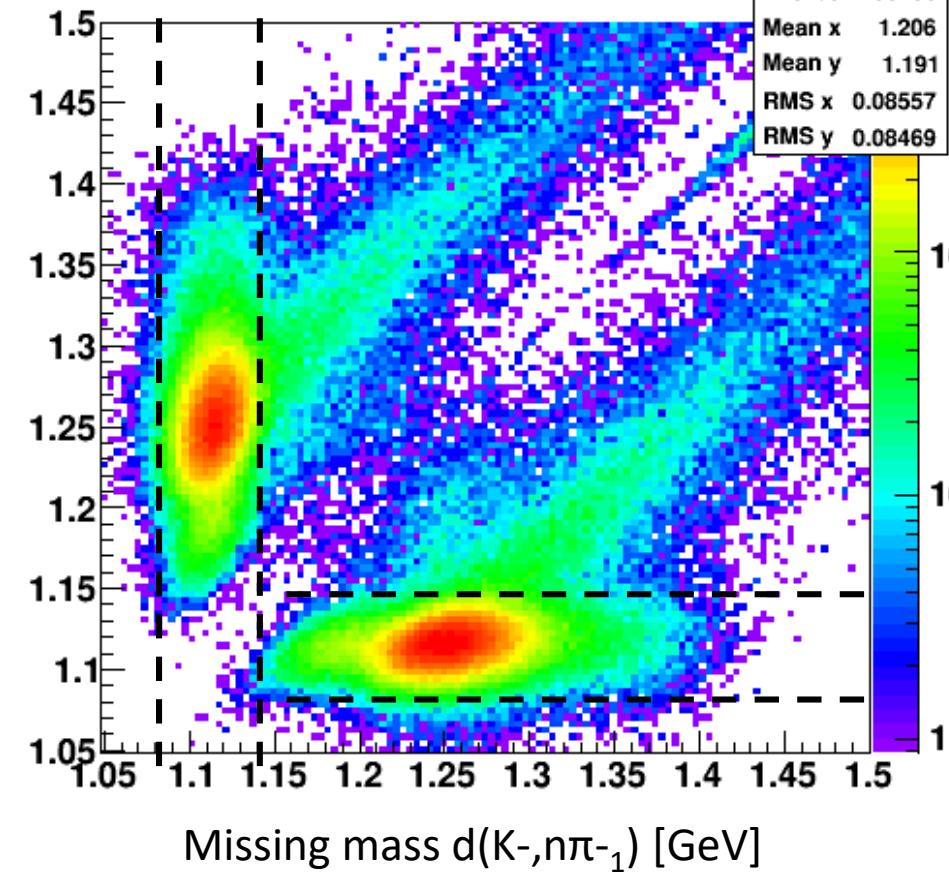


# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 5 (for lambda)

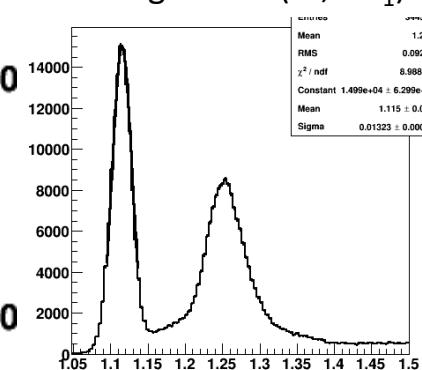
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 4
- Vertex 1 fiducial cut loose -> tight

$d(K^-, n\pi^-_1)$  vs  $d(K^-, n\pi^-_2)$

MML2\_vs\_MML3\_SIM2T

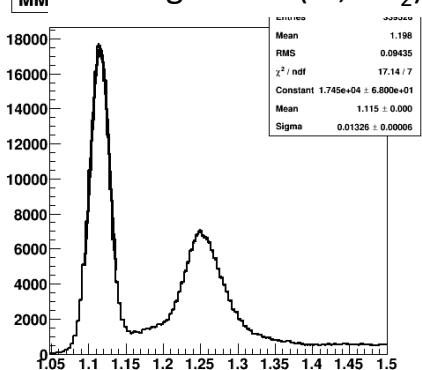


Missing mass  $d(K^-, n\pi^-_1)$



GeV

Missing mass  $d(K^-, n\pi^-_2)$



GeV

Mean = 1.115  
Sigma = 0.013

$\rightarrow \Lambda \text{ ID} \pm 3 \sigma (0.015)$

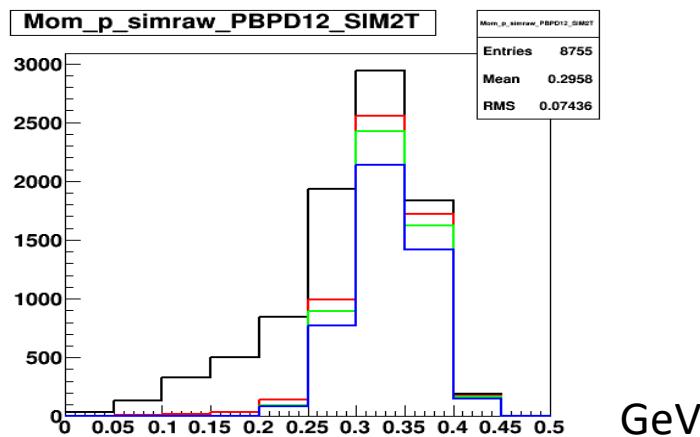
# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

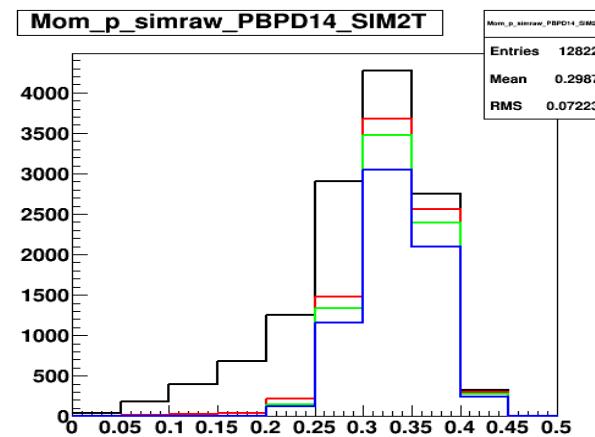
## Backward Proton Momentum

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

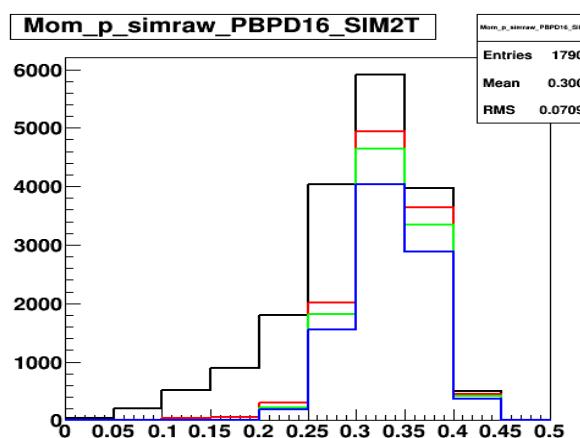
$< R = 12$



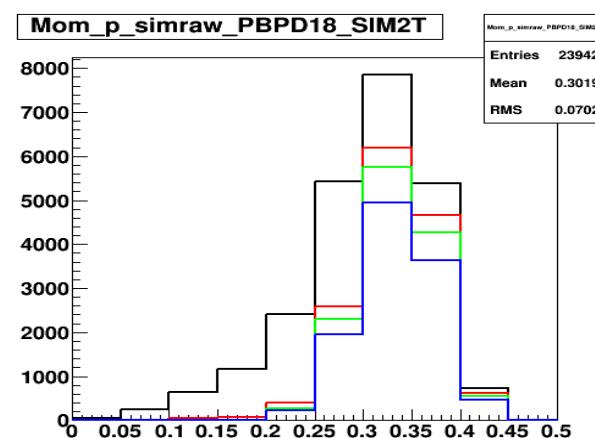
$< R = 14$



$< R = 16$



$< R = 18$

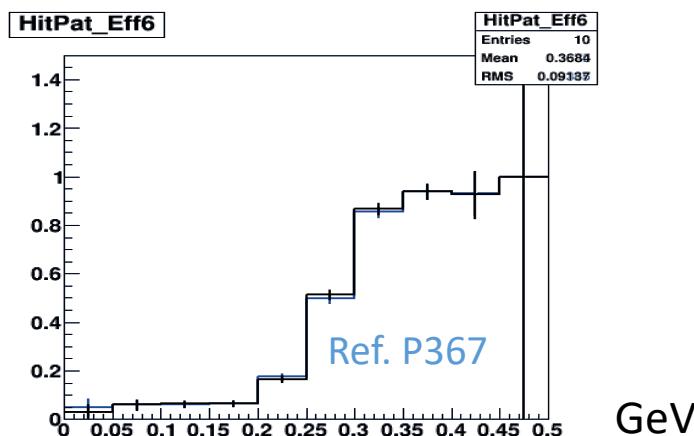


# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

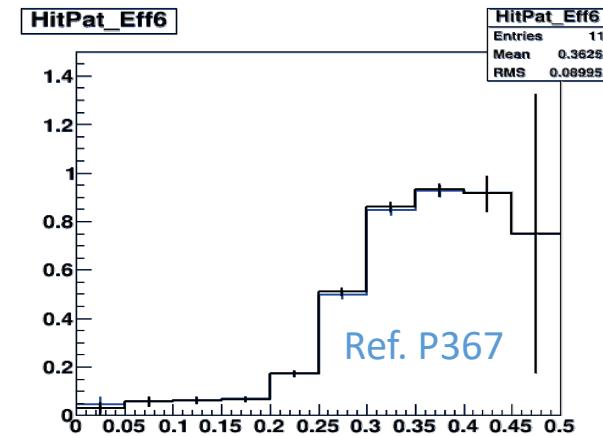
- BPD Hit position of proton momentum  $< R$

Ratio (Red/Black P.370)

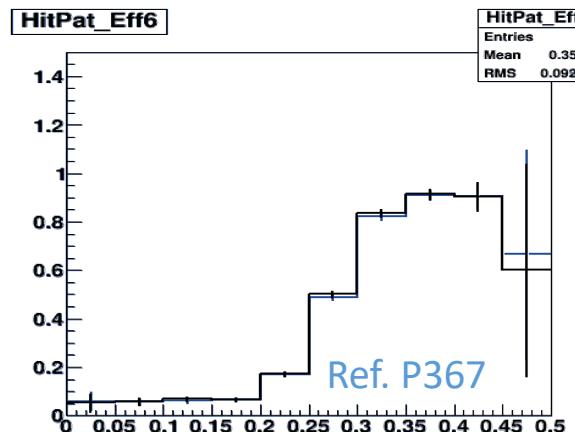
$<R=12$



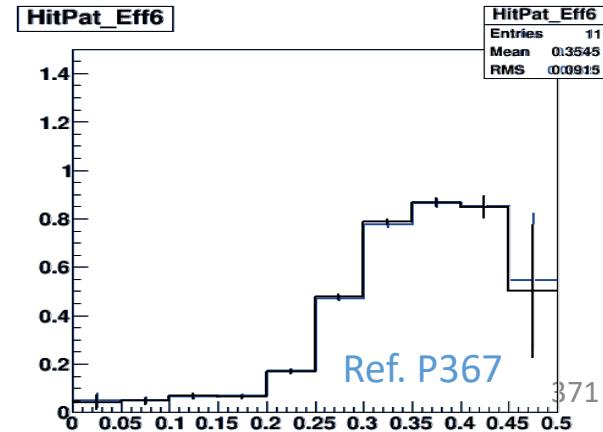
$<R=14$



$<R=16$



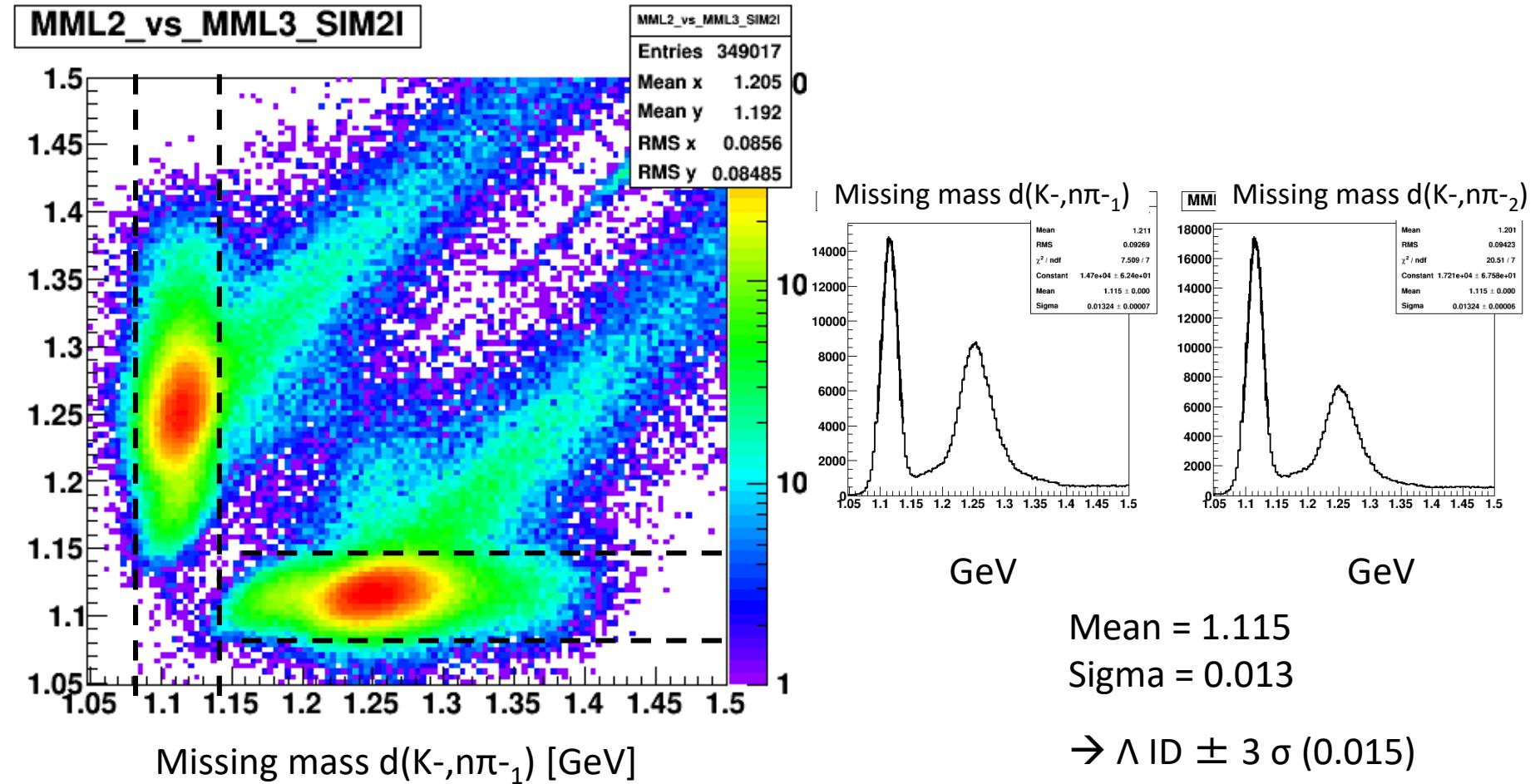
$<R=18$



# Backward proton acceptance study by SIM ( $K^-d \rightarrow n \Lambda \pi^-$ ) 6 (for min)

- Vertex ;  $K^-$  Beam  $\times \pi^-$  minimum DCA

# $d(K^-, n\pi^-_1)$ vs $d(K^-, n\pi^-_2)$



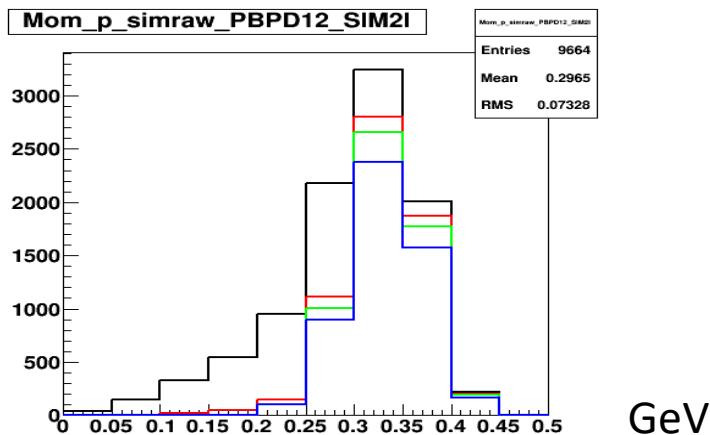
# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

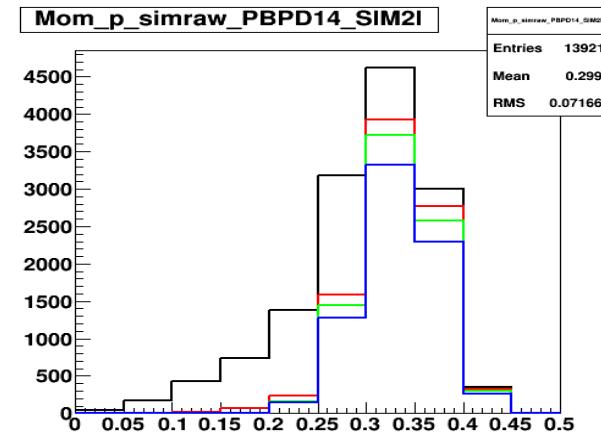
## Backward Proton Momentum

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

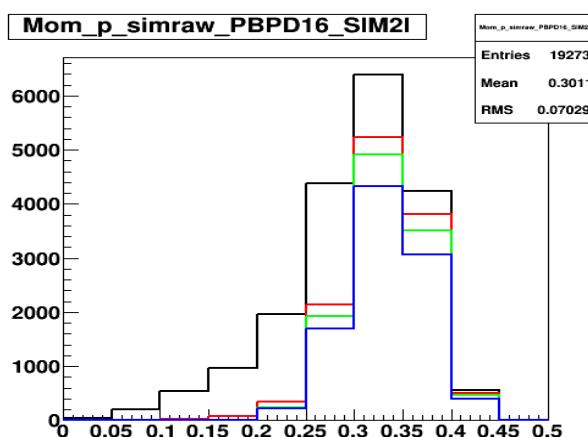
$< R = 12$



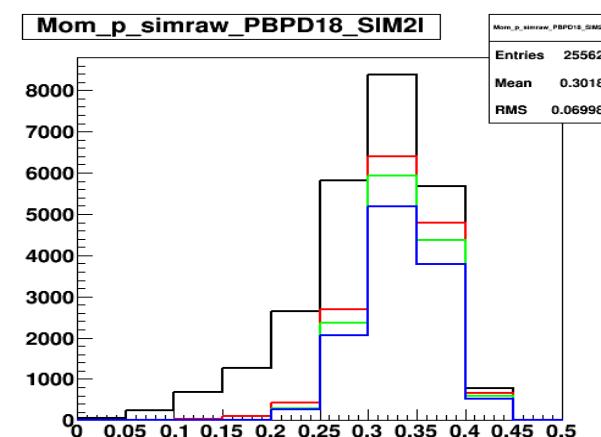
$< R = 14$



$< R = 16$



$< R = 18$

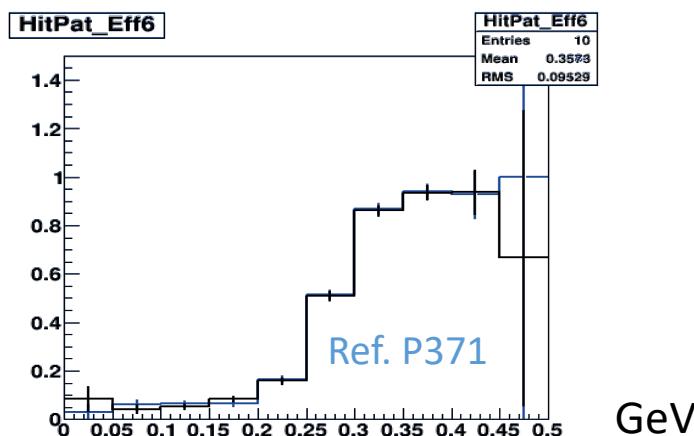


# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

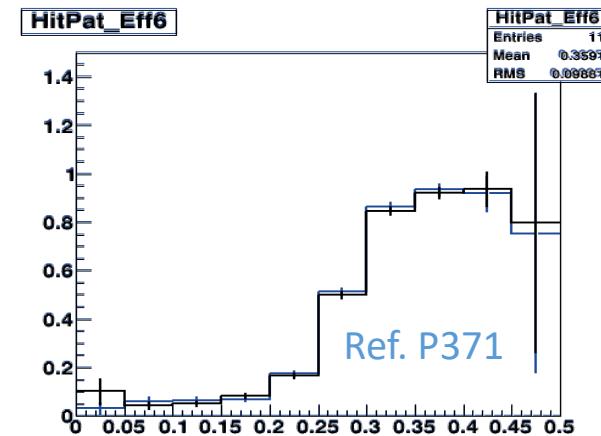
- BPD Hit position of proton momentum  $< R$

Ratio (Red/Black P.374)

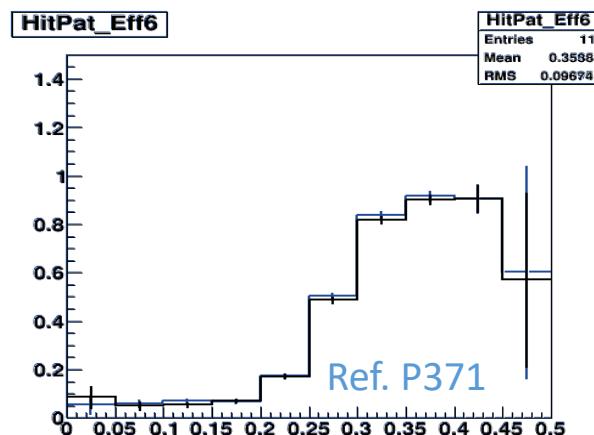
$<R=12$



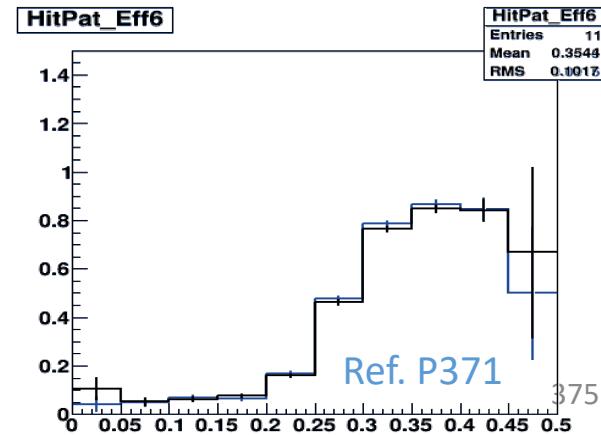
$<R=14$



$<R=16$



$<R=18$

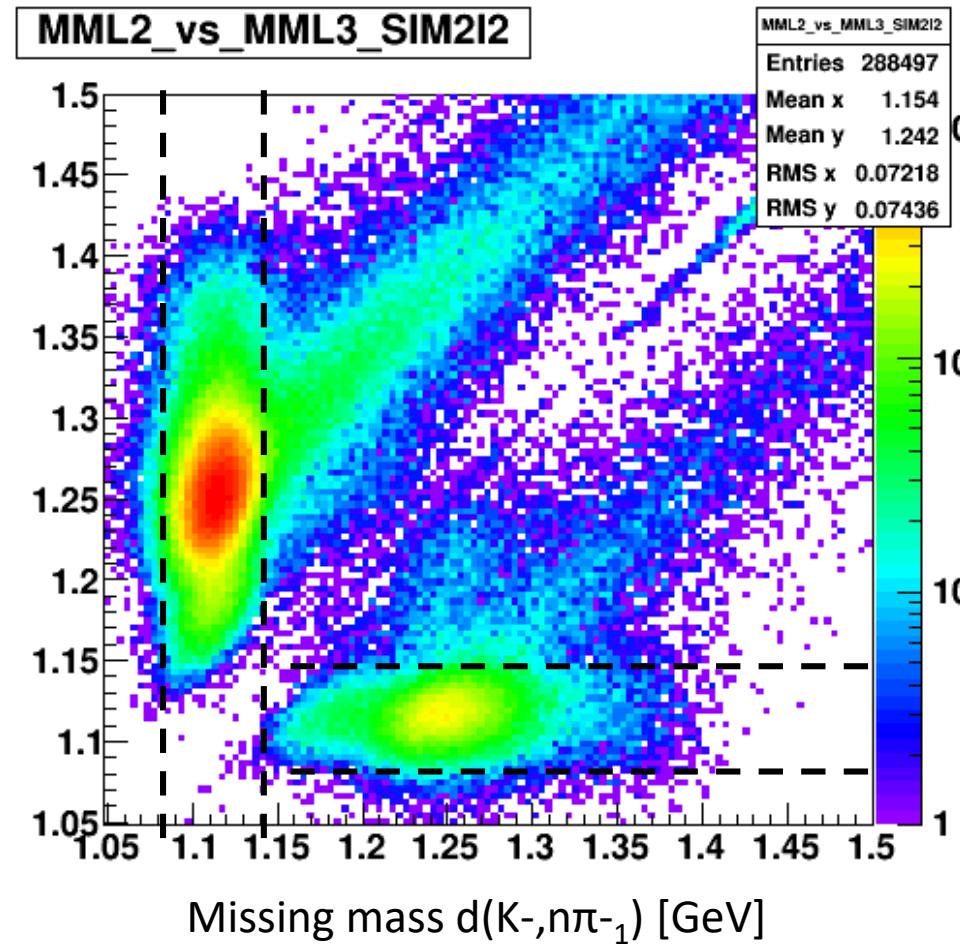


# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 7 (for diff)

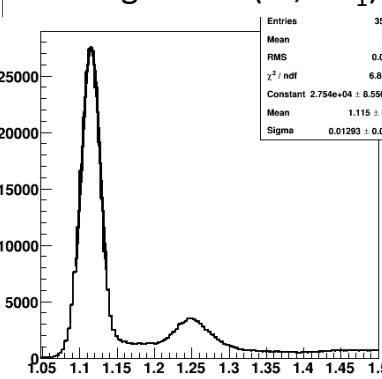
- Vertex ;  $\Lambda$  momentum  $\times \pi^-$  maximum DCA

# $d(K^-, n\pi^-_1)$ vs $d(K^-, n\pi^-_2)$

Missing mass  $d(K^-, n\pi^-_2)$  [GeV]

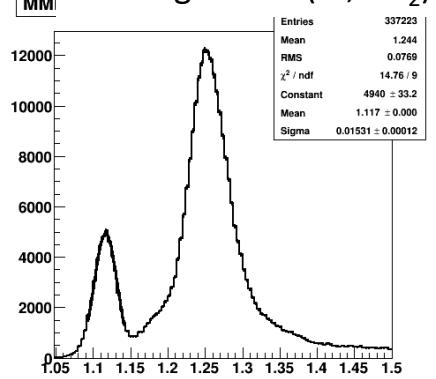


Missing mass  $d(K^-, n\pi^-_1)$



GeV  
Mean = 1.115  
Sigma = 0.012

Missing mass  $d(K^-, n\pi^-_2)$



GeV  
Mean = 1.117  
Sigma = 0.015

$\rightarrow \Lambda \text{ ID } \pm 3 \sigma (0.015)$

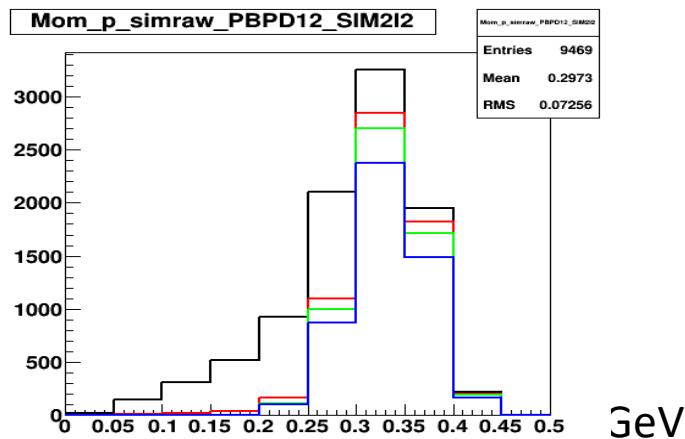
# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

- BPD Hit position of proton momentum  $< R$

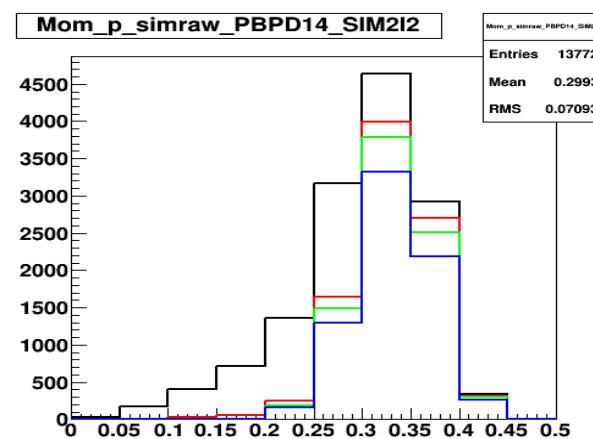
## Backward Proton Momentum

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

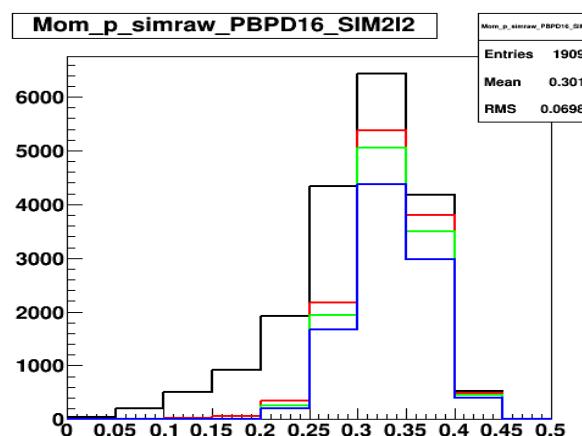
$< R = 12$



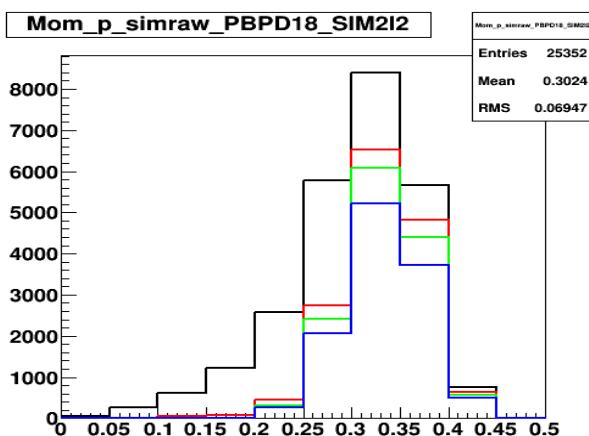
$< R = 14$



$< R = 16$



$< R = 18$

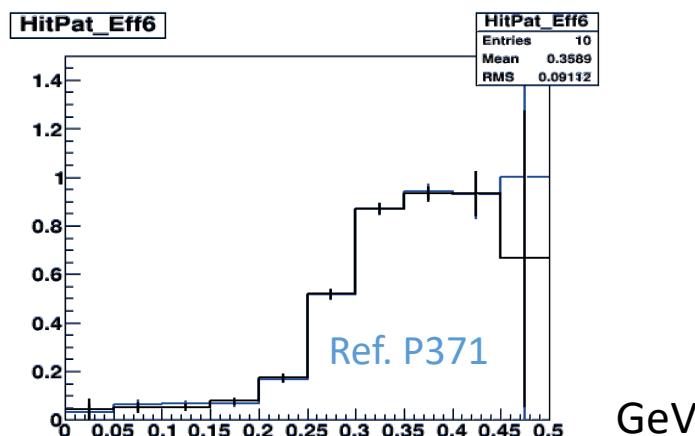


# Backward proton acceptance study by SIM ( $K-d \rightarrow n \Lambda \pi^-$ )

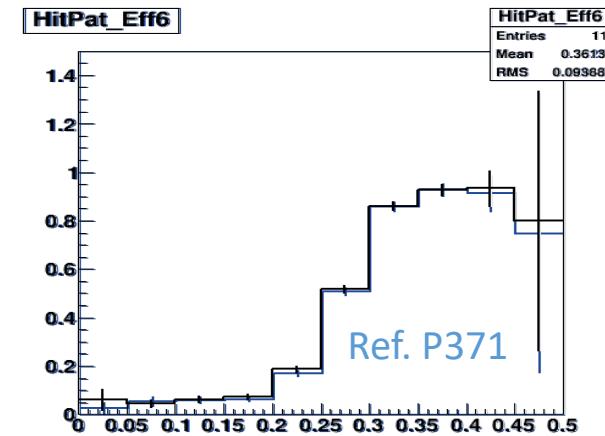
- BPD Hit position of proton momentum  $< R$

Ratio (Red/Black P.374)

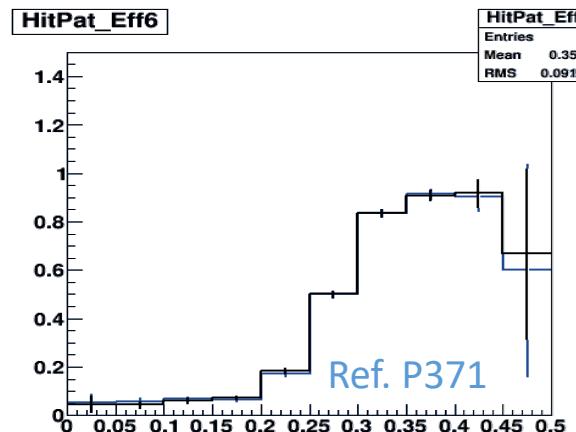
$<R=12$



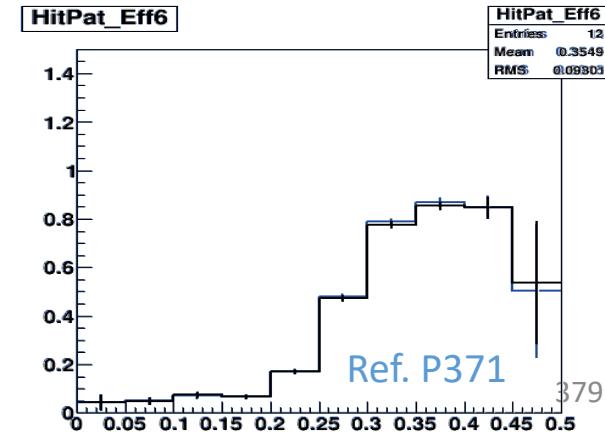
$<R=14$



$<R=16$



$<R=18$



# Backward proton efficiency 4

- Estimation by  $K-d \rightarrow p\Lambda\pi^-$  (lambda)
- Acceptance estimation by SIM  $K-d \rightarrow n\Lambda\pi^-$
- Weighted average of the efficiency
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 5

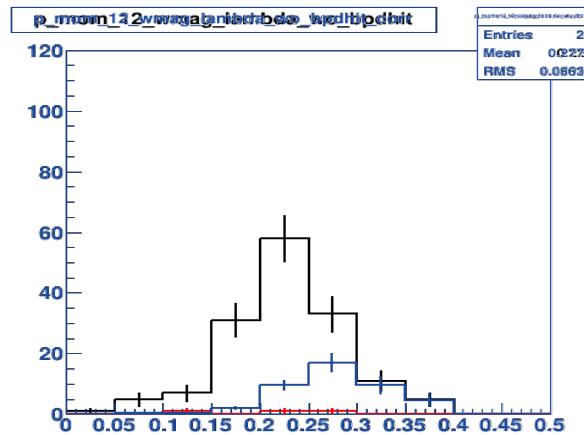
Error in vertex calculation

# Backward proton Missing momentum

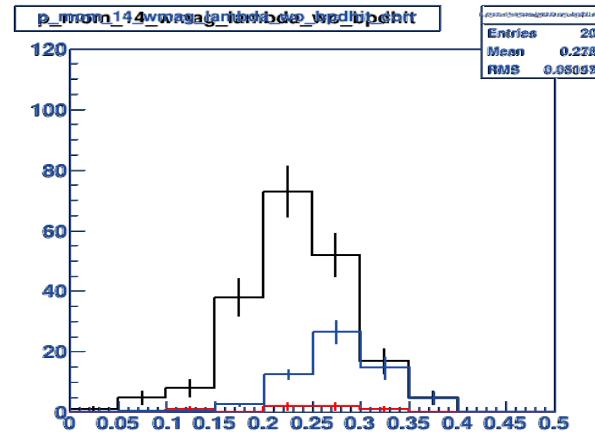
- $K-d \rightarrow p_{\text{forward}} \Lambda \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

w/o BPD Hit  
w/o BPD Hit x Ratio (P.297)  
w/ BPD Hit

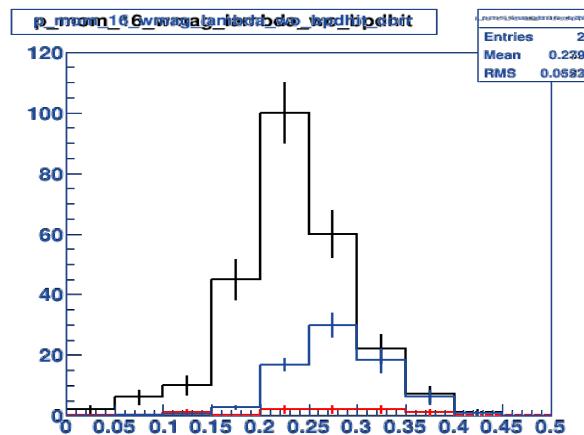
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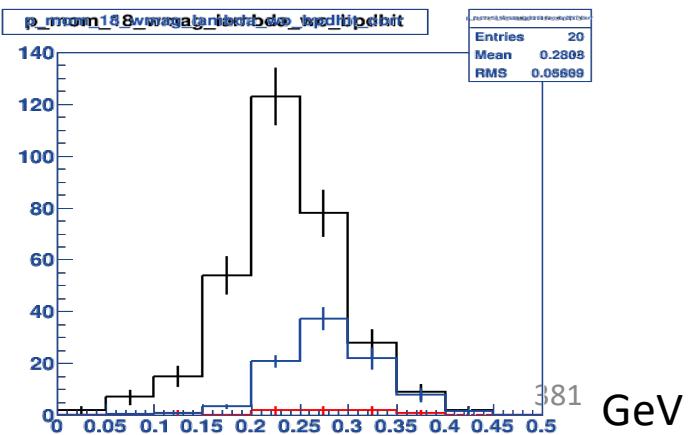
<R=14



<R=16



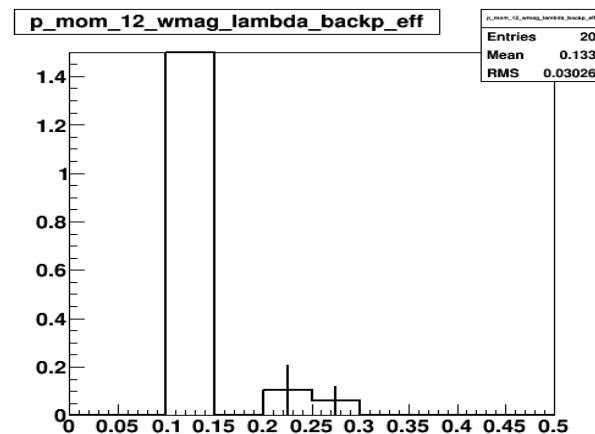
<R=18



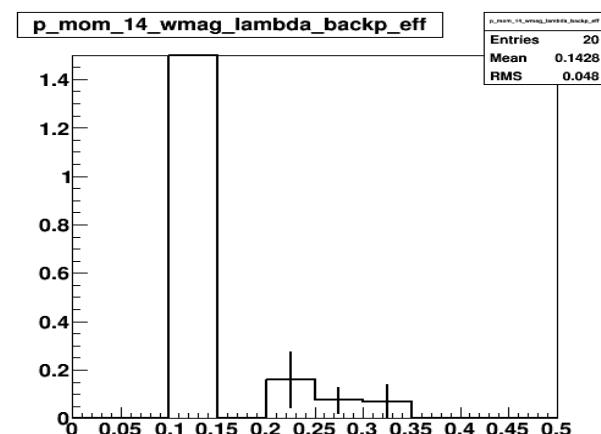
# BPD hit efficiency dependence on missing momentum

Red/Blue

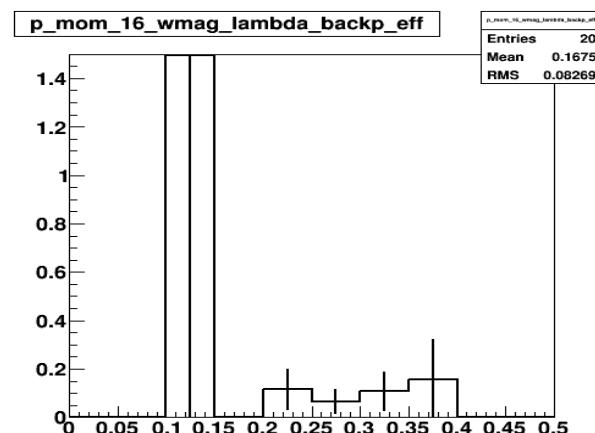
<R=12



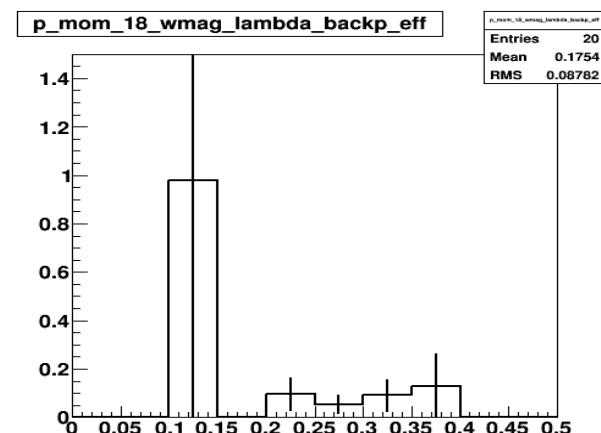
<R=14



<R=16



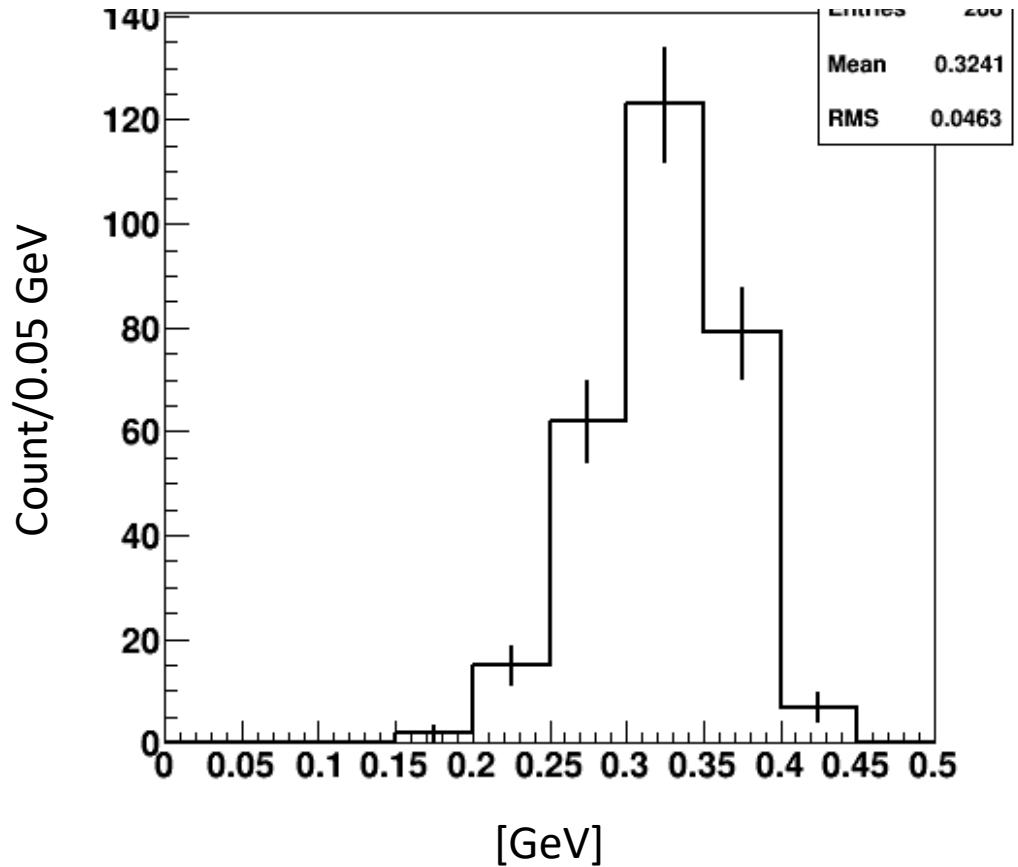
<R=18



# Backward proton momentum

- Run78 Data
- Condition
  - Re-analysis 7
  - p, $\pi$ - invariant mass  $\Lambda$  selection
  - d(K-,n $\Lambda$ )"X"  $0.18 < X < 0.30$  GeV

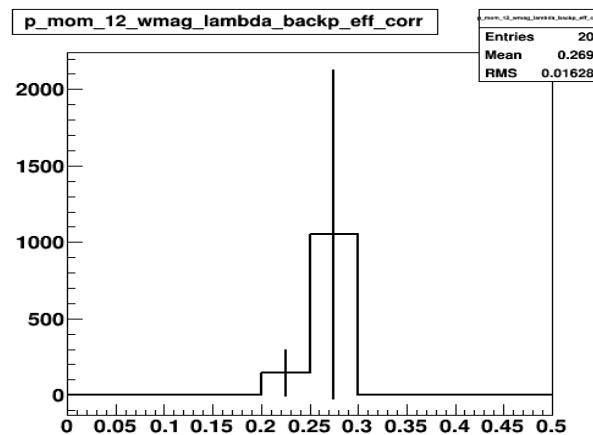
**Momentum  
by the analysis of backward detectors**



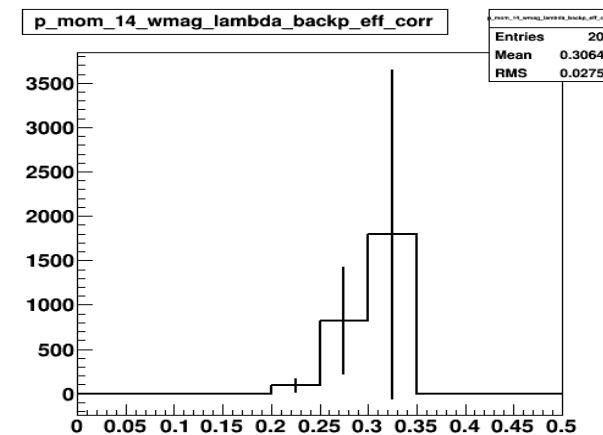
# Proton momentum corrected by efficiency

## Backward proton momentum/BPD hit efficiency

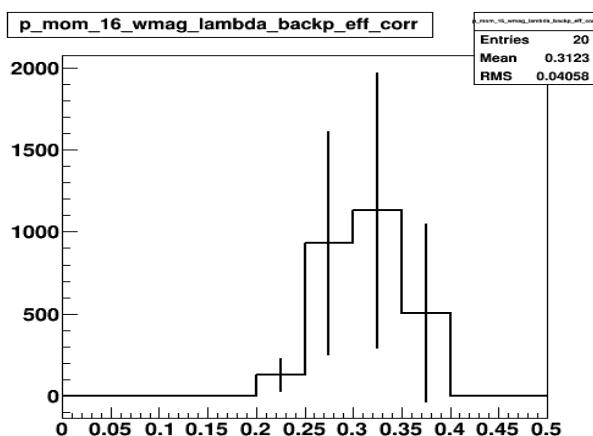
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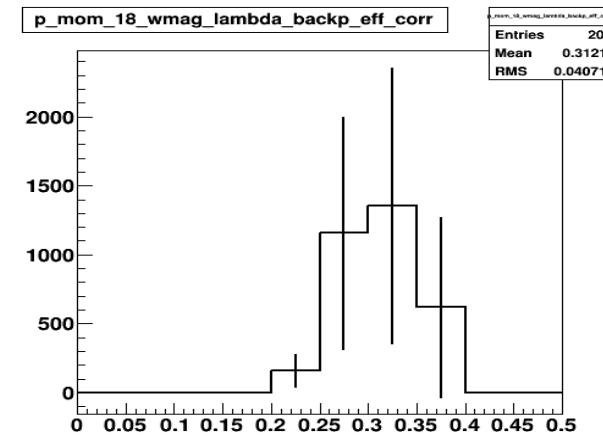
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<R=16



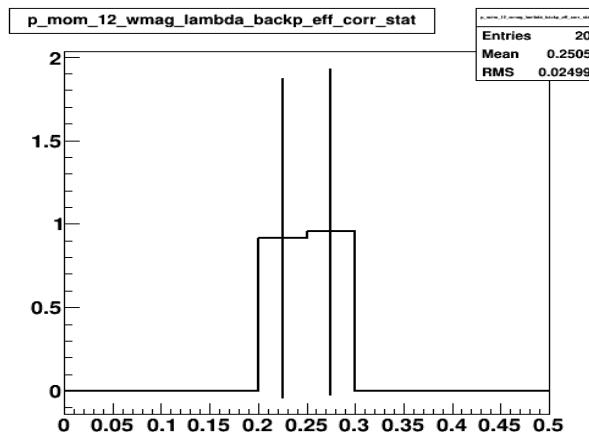
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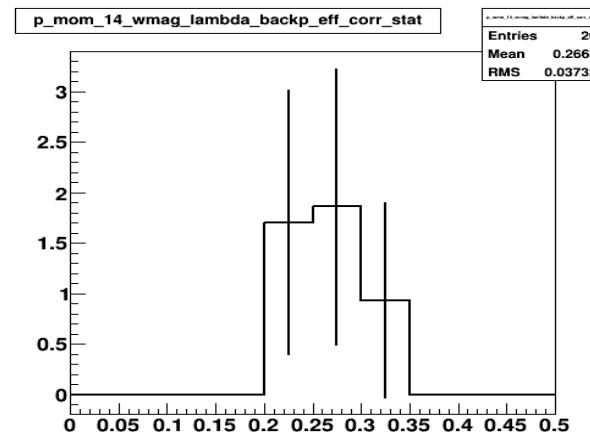
# Backward proton momentum

Backward proton momentum/BPD hit efficiency → (center/ error)<sup>2</sup>

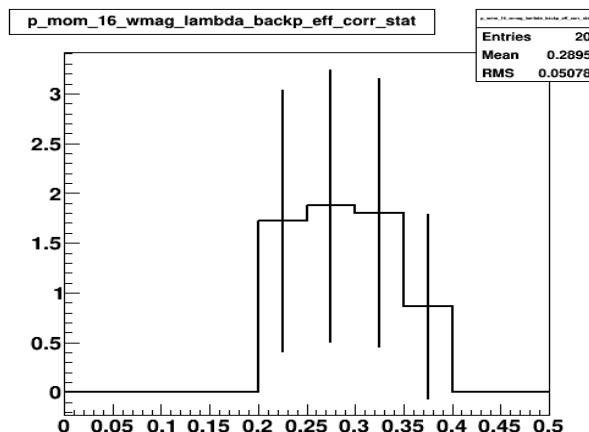
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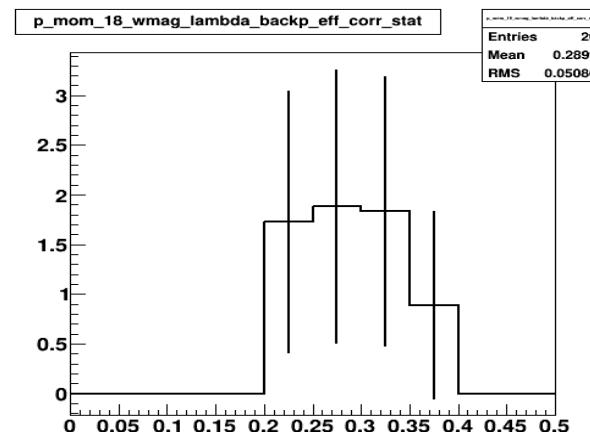
<R=14



<R=16



<R=18



# Summary

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

( $R \leq 12$ )  $0.080 \pm 0.059$

( $R \leq 14$ )  $0.106 \pm 0.050$

( $R \leq 16$ )  $0.105 \pm 0.041$

( $R \leq 18$ )  $0.086 \pm 0.034$

Error in vertex calculation

# Backward proton efficiency 5

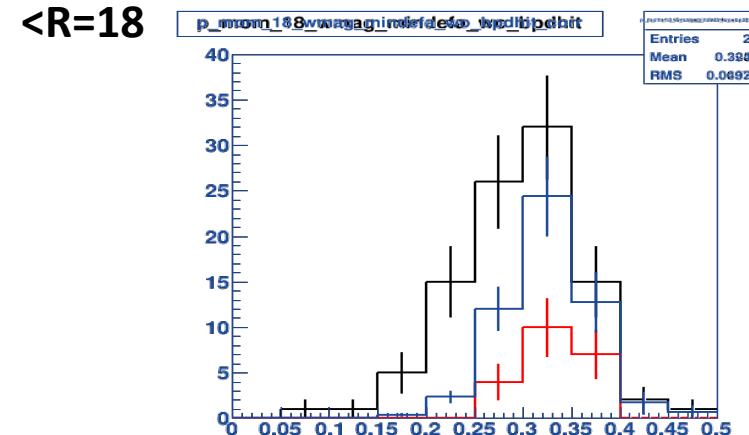
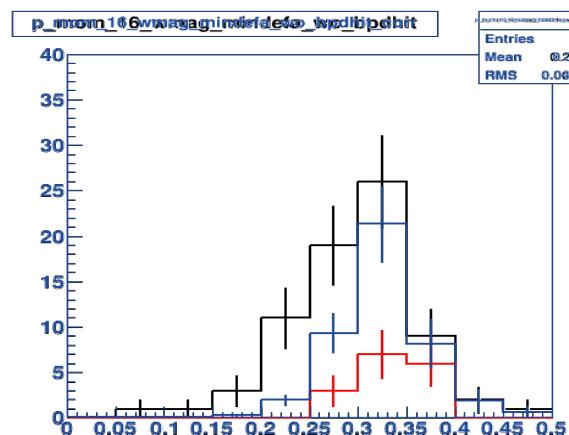
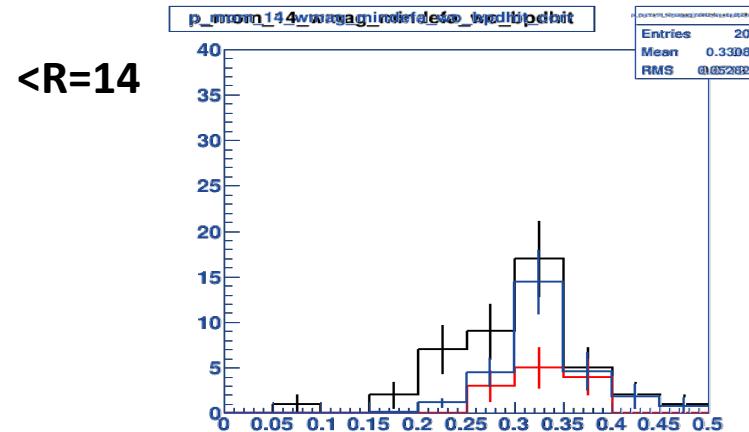
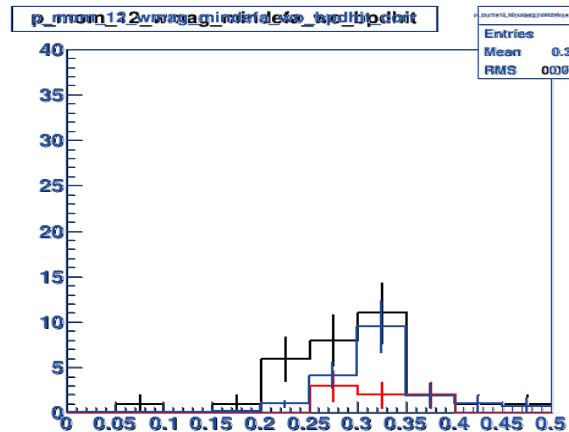
- Estimation by  $K-d \rightarrow p\Lambda\pi^-$  (min)
- Acceptance estimation by SIM  $K-d \rightarrow n\Lambda\pi^-$
- Weighted average of the efficiency
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n\Lambda\pi^-$ ) 6

Error in vertex calculation

# Backward proton Missing momentum

- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

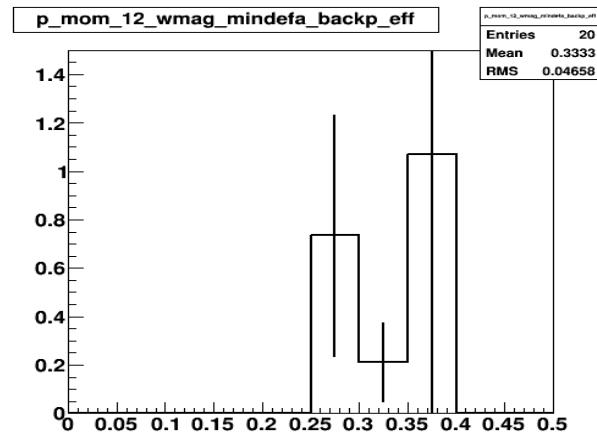
w/o BPD Hit  
 w/o BPD Hit x Ratio (P.297)  
 w/ BPD Hit



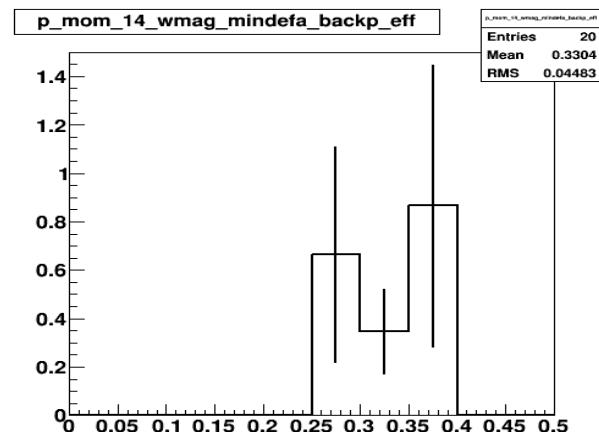
# BPD hit efficiency dependence on missing momentum

Red/Blue

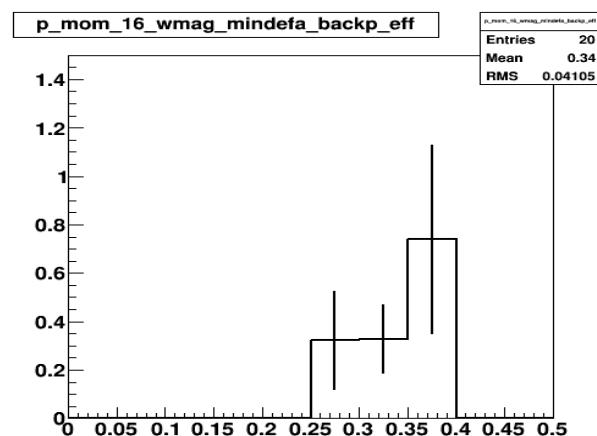
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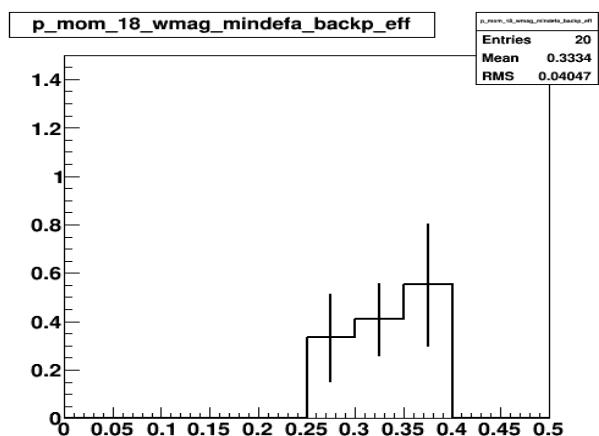
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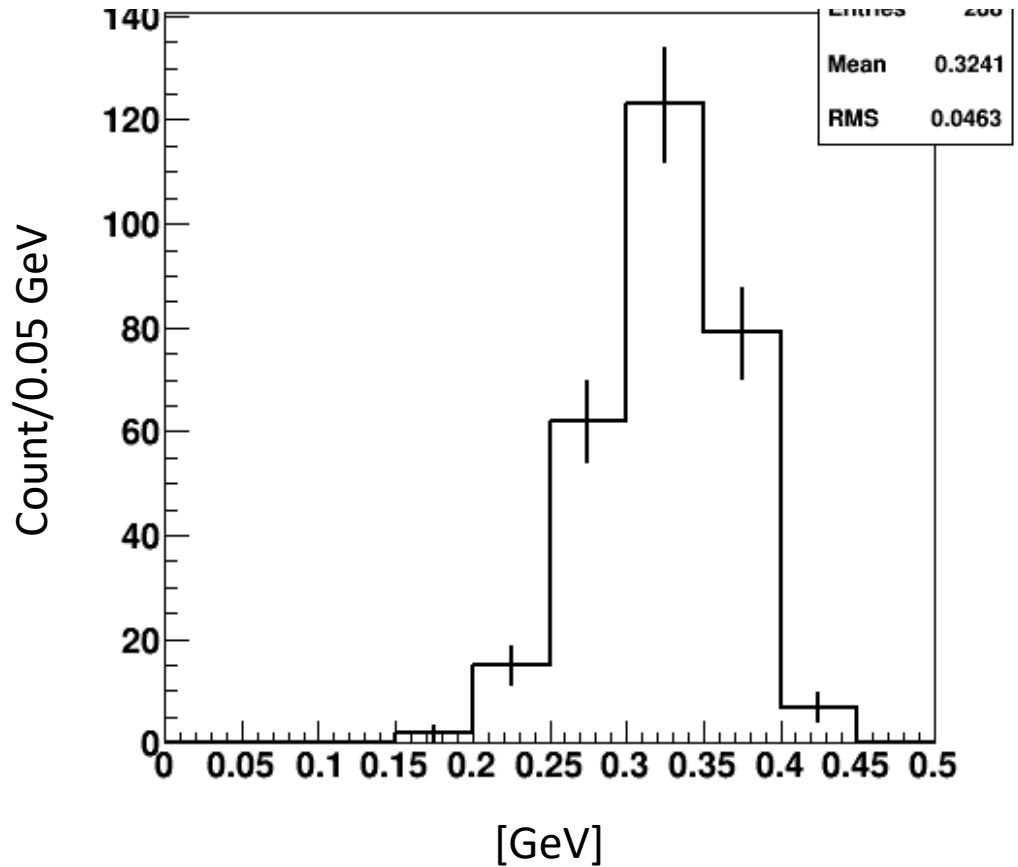
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# Backward proton momentum

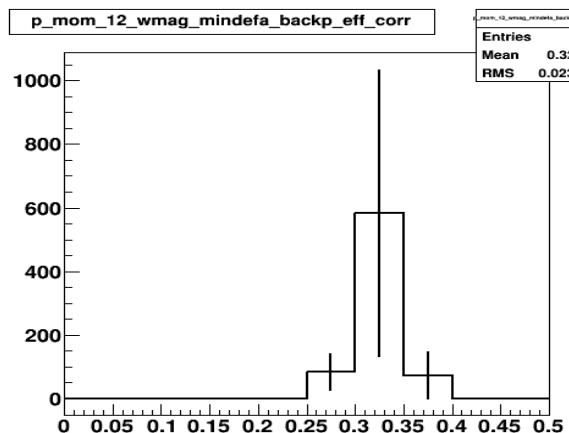
- Run78 Data
- Condition
  - Re-analysis 7
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K-, n\Lambda)''X''$   $0.18 < X < 0.30$  GeV

**Momentum  
by the analysis of backward detectors**

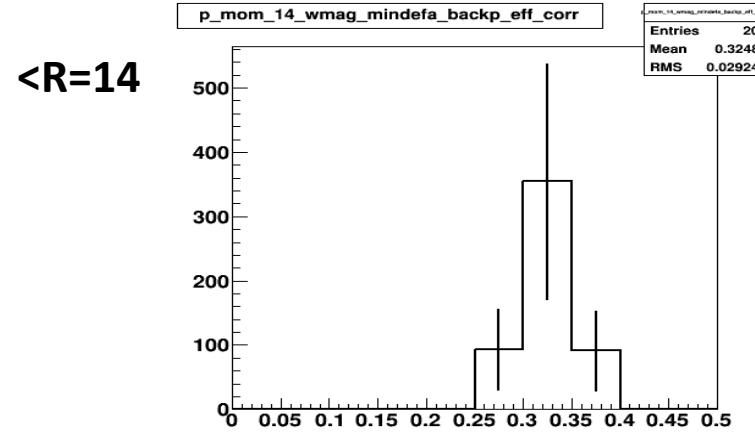


# Proton momentum corrected by efficiency

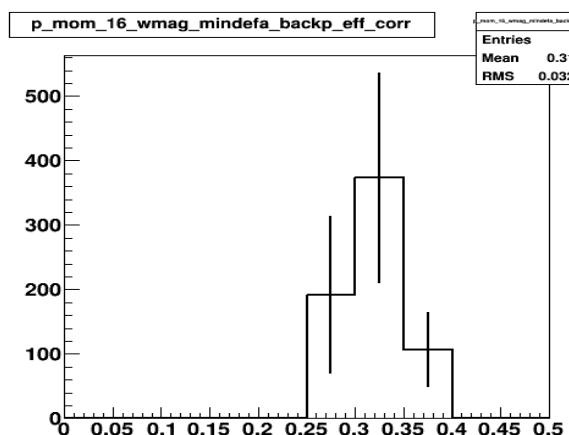
## Backward proton momentum/BPD hit efficiency



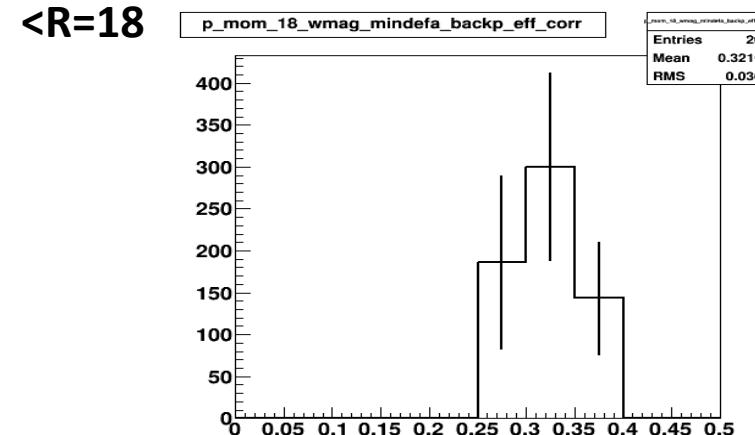
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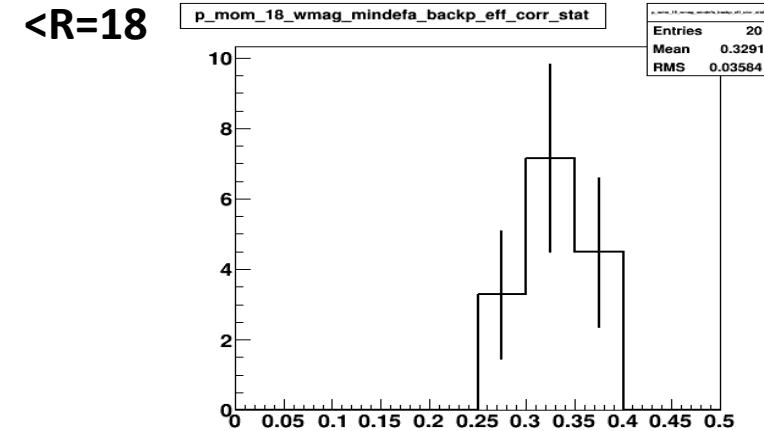
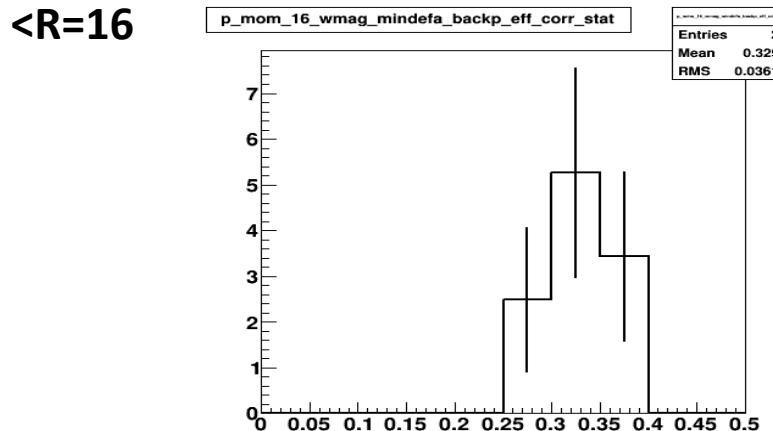
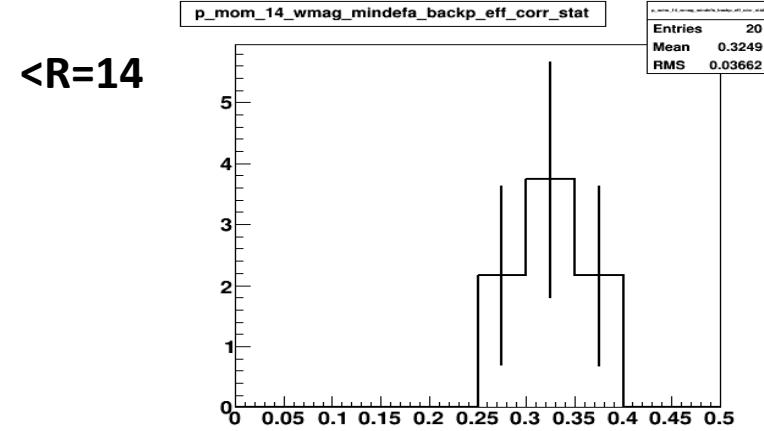
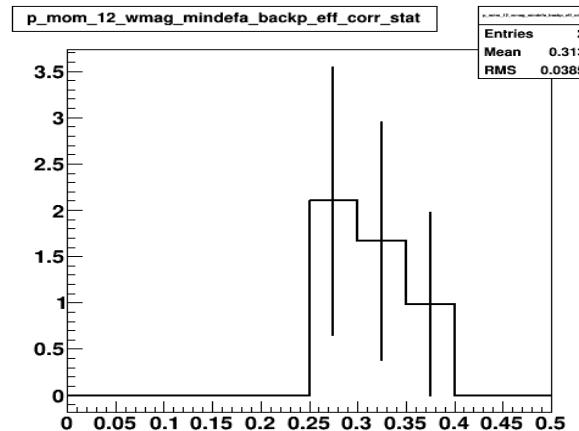


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# Backward proton momentum

Backward proton momentum/BPD hit efficiency → (center/ error)<sup>2</sup>



# Summary

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

( $R \leq 12$ )  $0.620 \pm 0.284$

( $R \leq 14$ )  $0.571 \pm 0.201$

( $R \leq 16$ )  $0.453 \pm 0.135$

( $R \leq 18$ )  $0.435 \pm 0.112$

Error in vertex calculation

# Backward proton efficiency 6

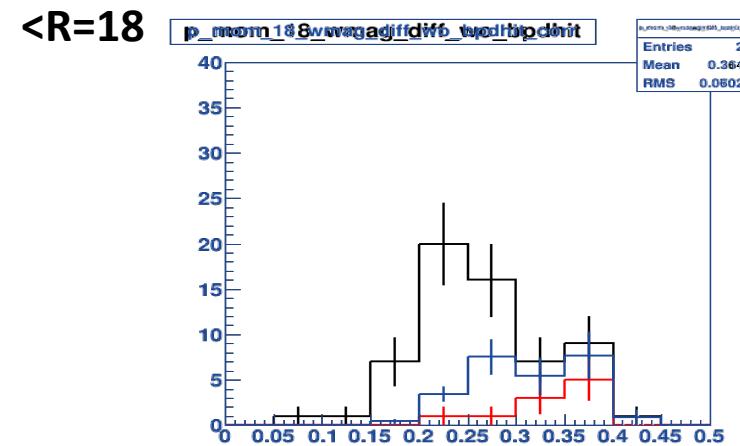
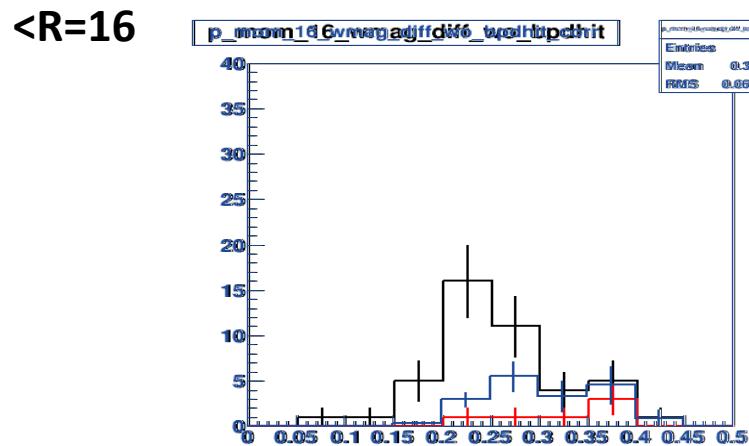
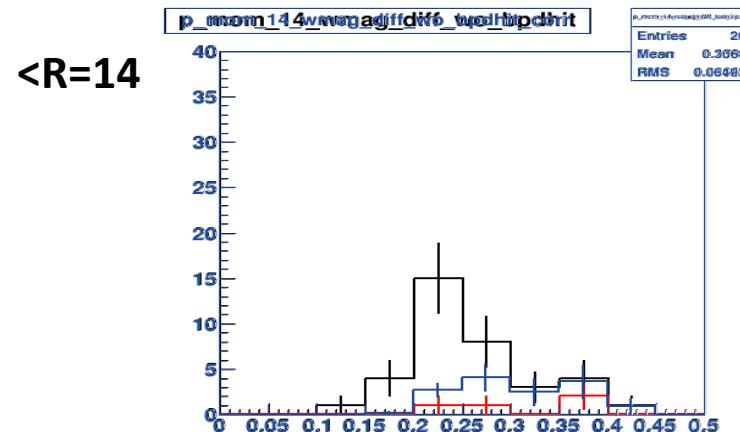
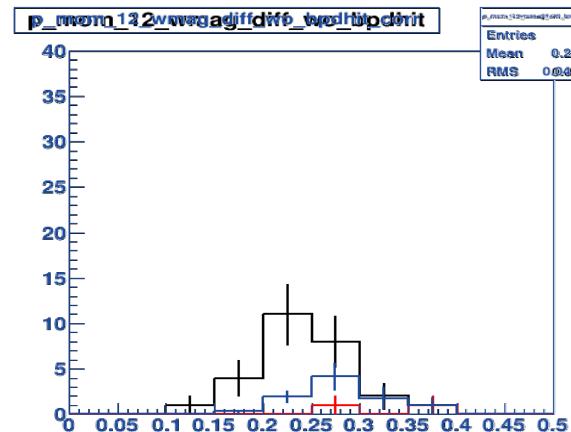
- Estimation by  $K-d \rightarrow p\Lambda\pi^-$  (diff)
- Acceptance estimation by SIM  $K-d \rightarrow n\Lambda\pi^-$
- Weighted average of the efficiency
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n\Lambda\pi^-$ ) 7

Error in vertex calculation

# Backward proton Missing momentum

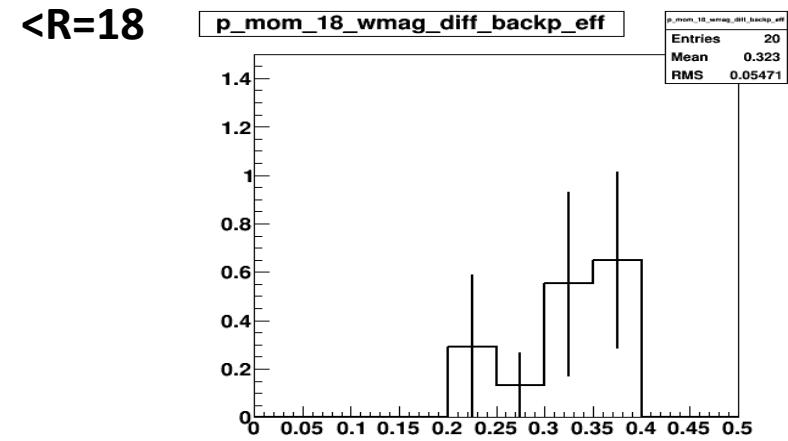
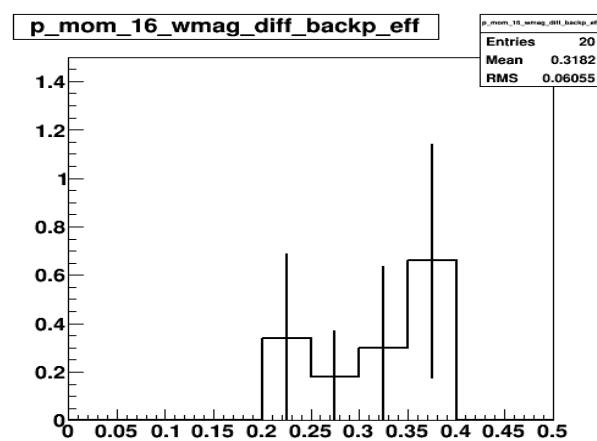
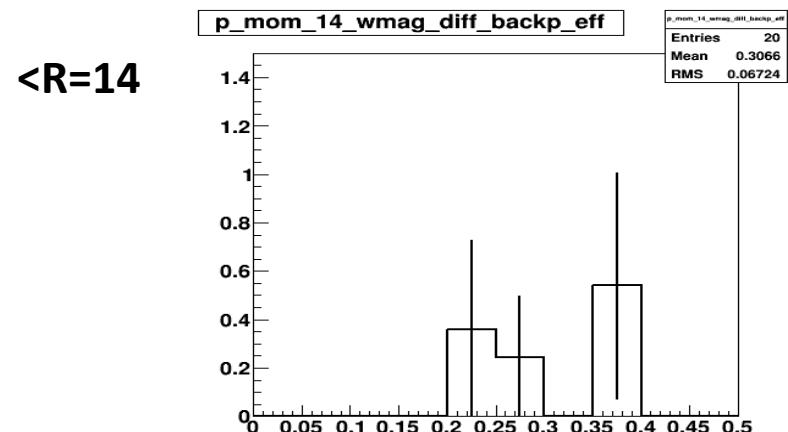
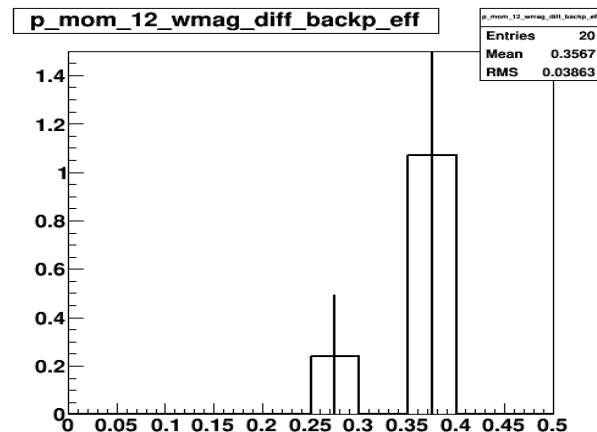
- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

w/o BPD Hit  
w/o BPD Hit x Ratio (P.297)  
w/ BPD Hit



# BPD hit efficiency dependence on missing momentum

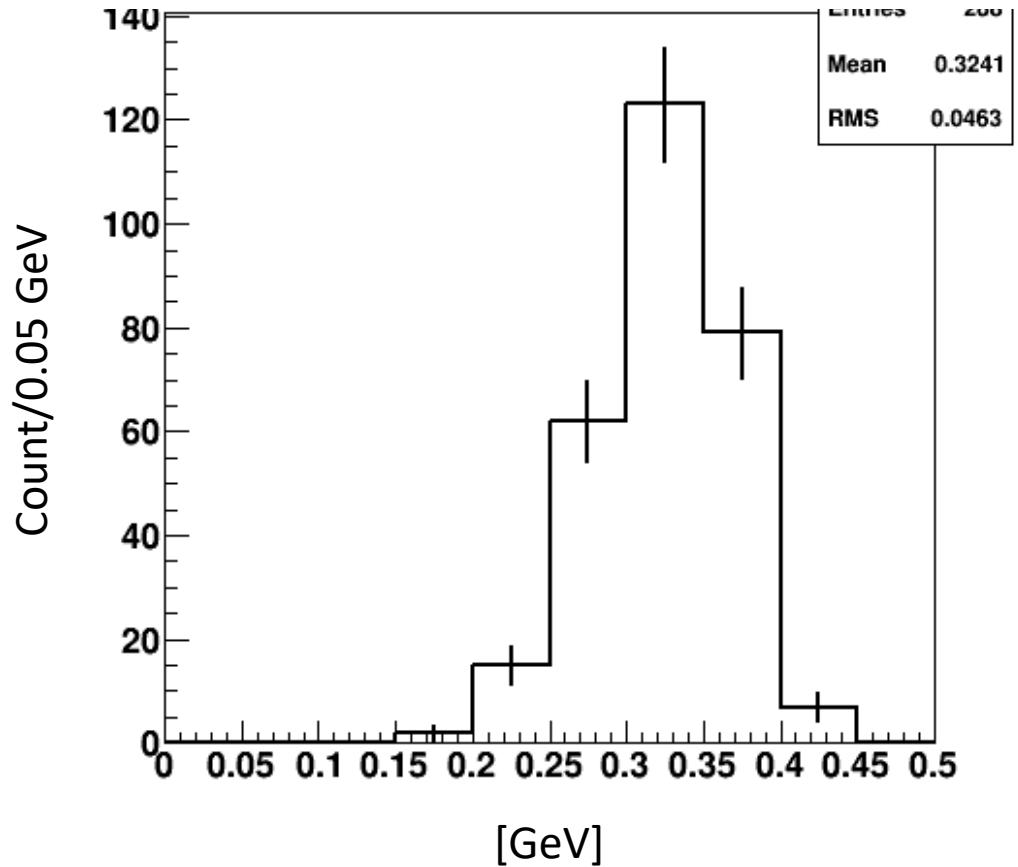
Red/Blue



# Backward proton momentum

- Run78 Data
- Condition
  - Re-analysis 7
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K-, n\Lambda)''X''$   $0.18 < X < 0.30$  GeV

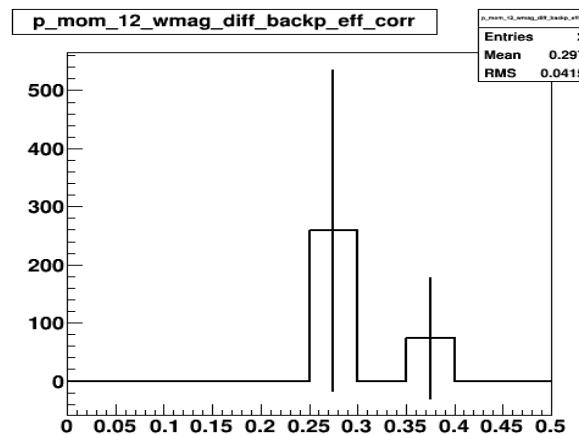
**Momentum  
by the analysis of backward detectors**



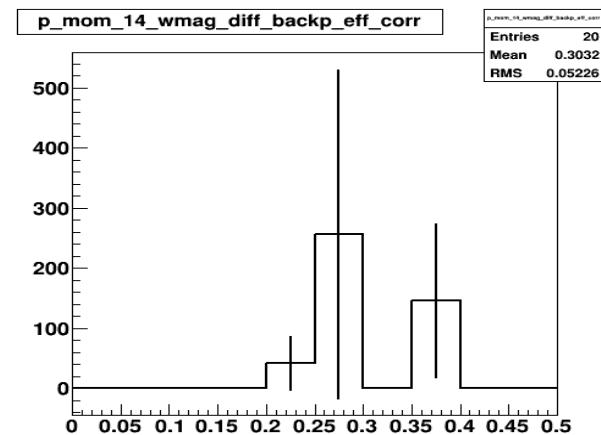
# Proton momentum corrected by efficiency

## Backward proton momentum/BPD hit efficiency

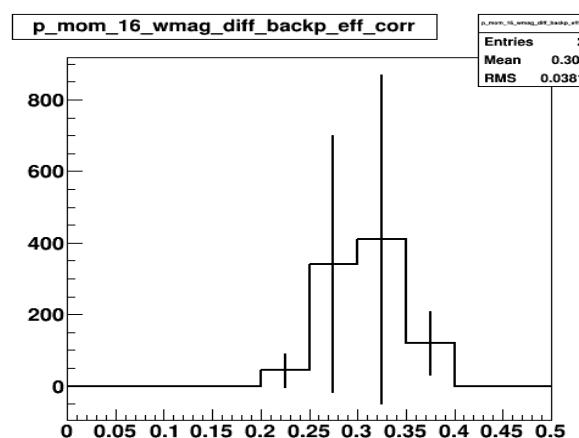
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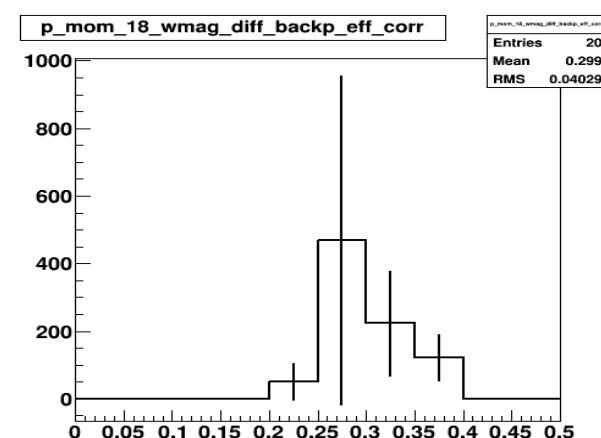
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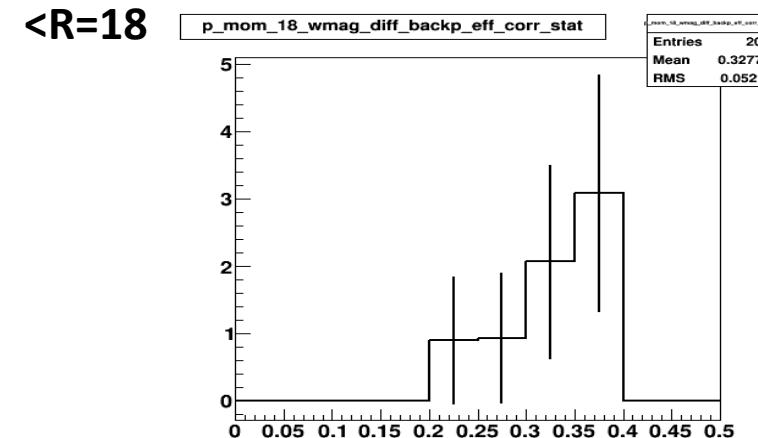
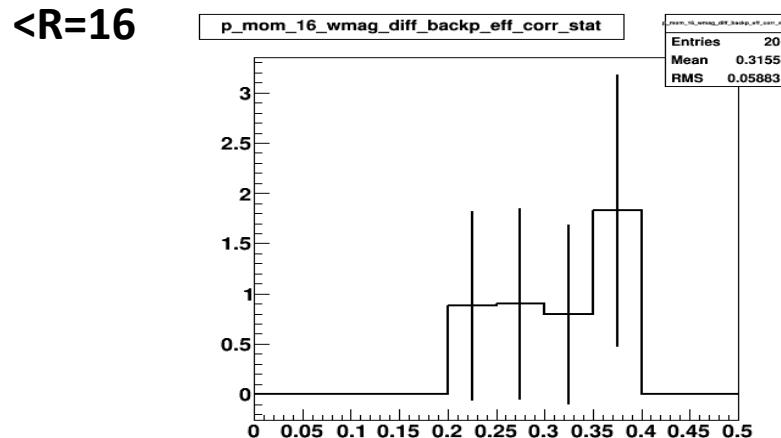
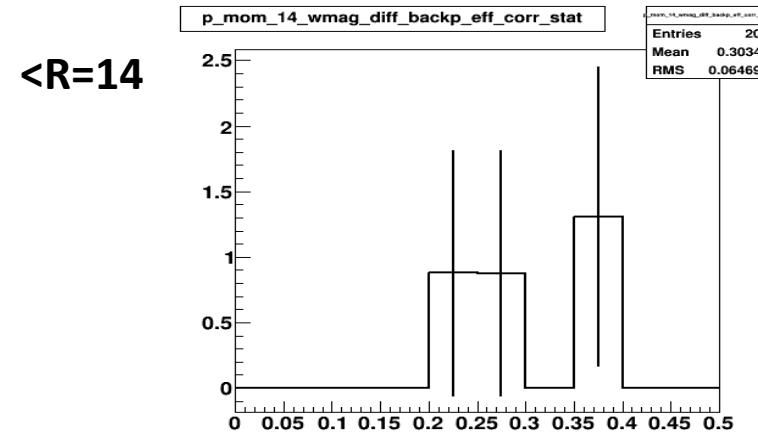
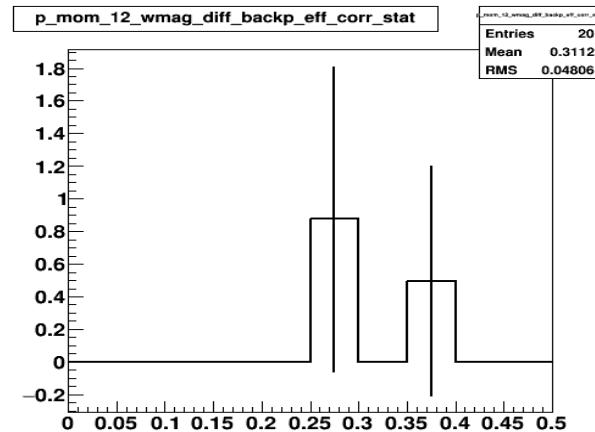


<R=18



# Backward proton momentum

Backward proton momentum/BPD hit efficiency → (center/ error)<sup>2</sup>



# Summary

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

( $R \leq 12$ )  $0.540 \pm 0.461$

( $R \leq 14$ )  $0.402 \pm 0.229$

( $R \leq 16$ )  $0.433 \pm 0.206$

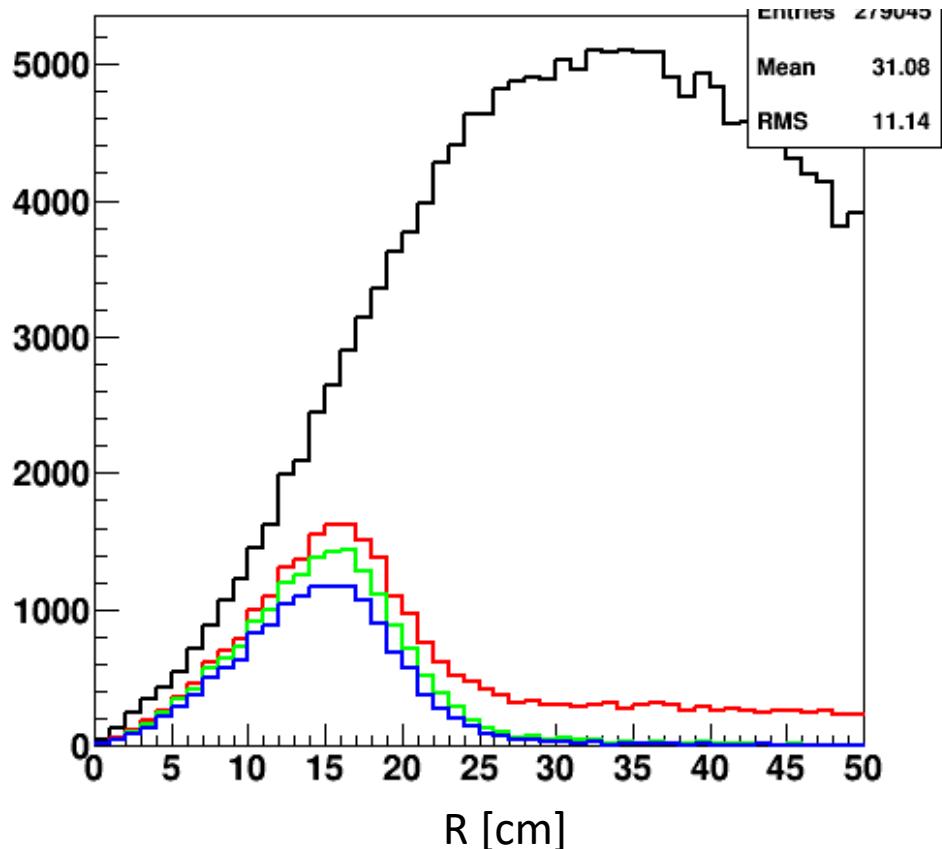
( $R \leq 18$ )  $0.506 \pm 0.191$

Error in vertex calculation

# BPD Hit Position

SIM ( $K-d \rightarrow n \Lambda \pi^-$ ; backward proton acceptance study 5)

Hit Position from Missing Momentum  $d(K-,n\pi-\pi-)''p''$



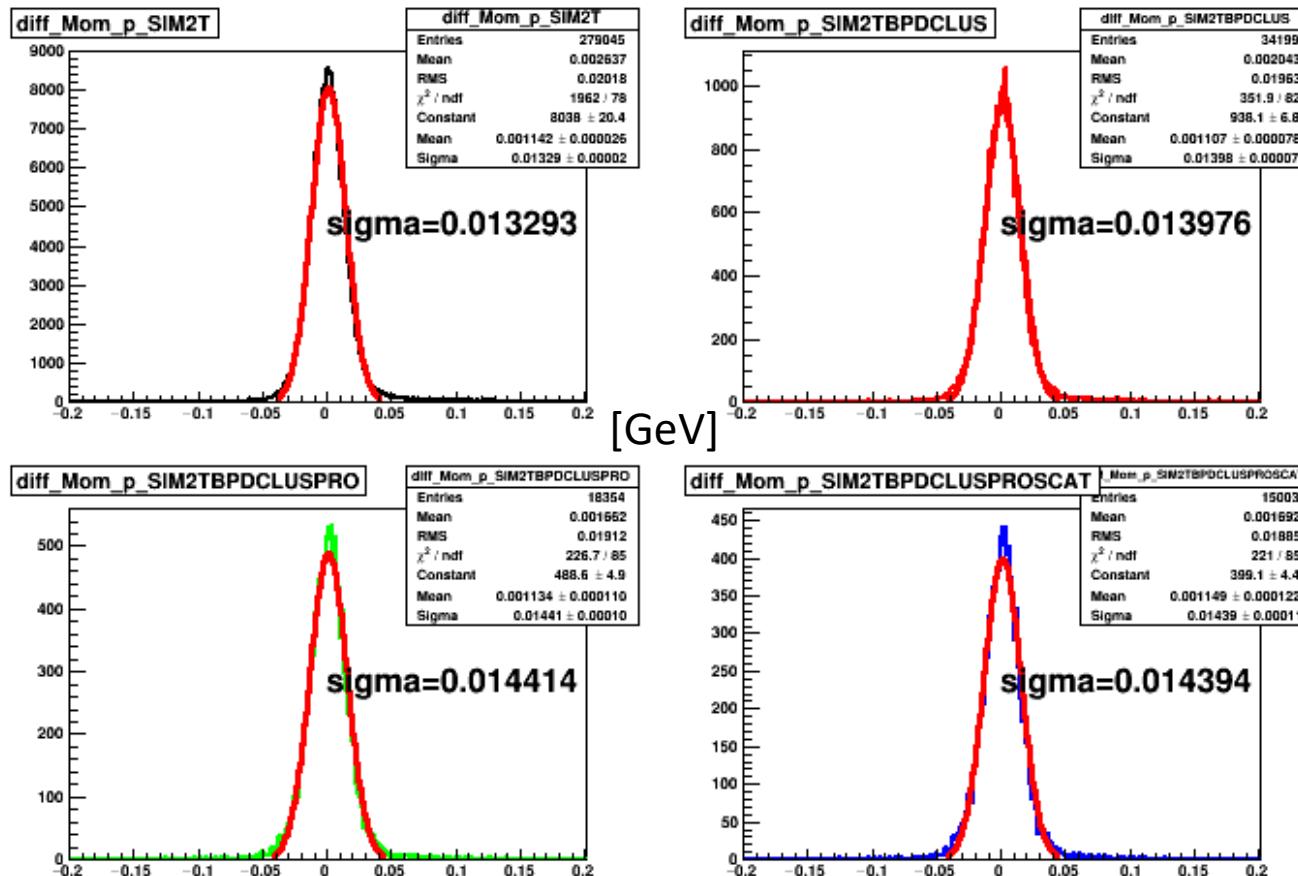
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

# Difference between ana & raw

Momentum Difference of Backward proton  
(Missing momentum - sim raw momentum)

Vertex condition (label ;lambda)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

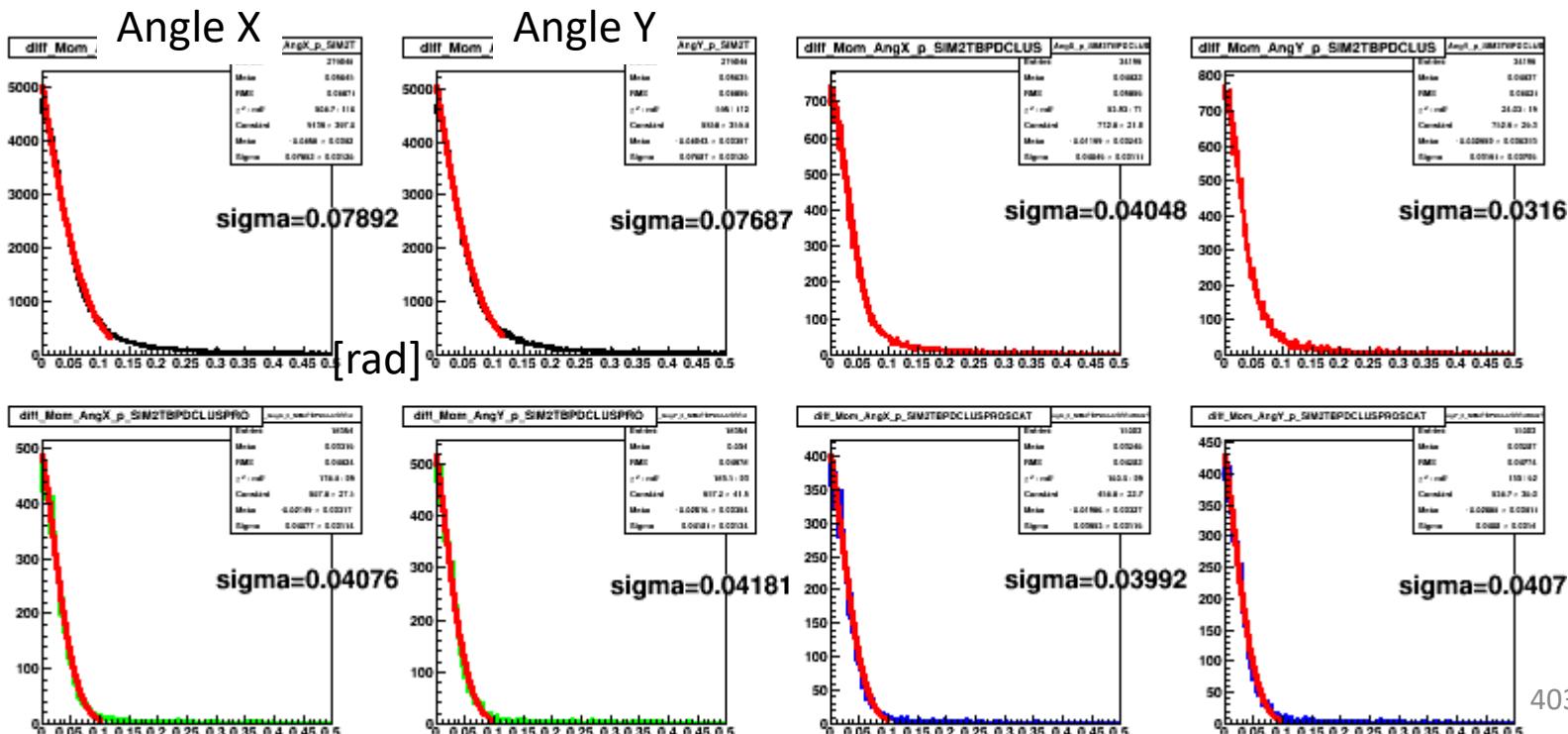


# Difference between ana & raw

Momentum Angle Difference of Backward proton  
 (Missing momentum - sim raw momentum)

Vertex condition (label ;lambda)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

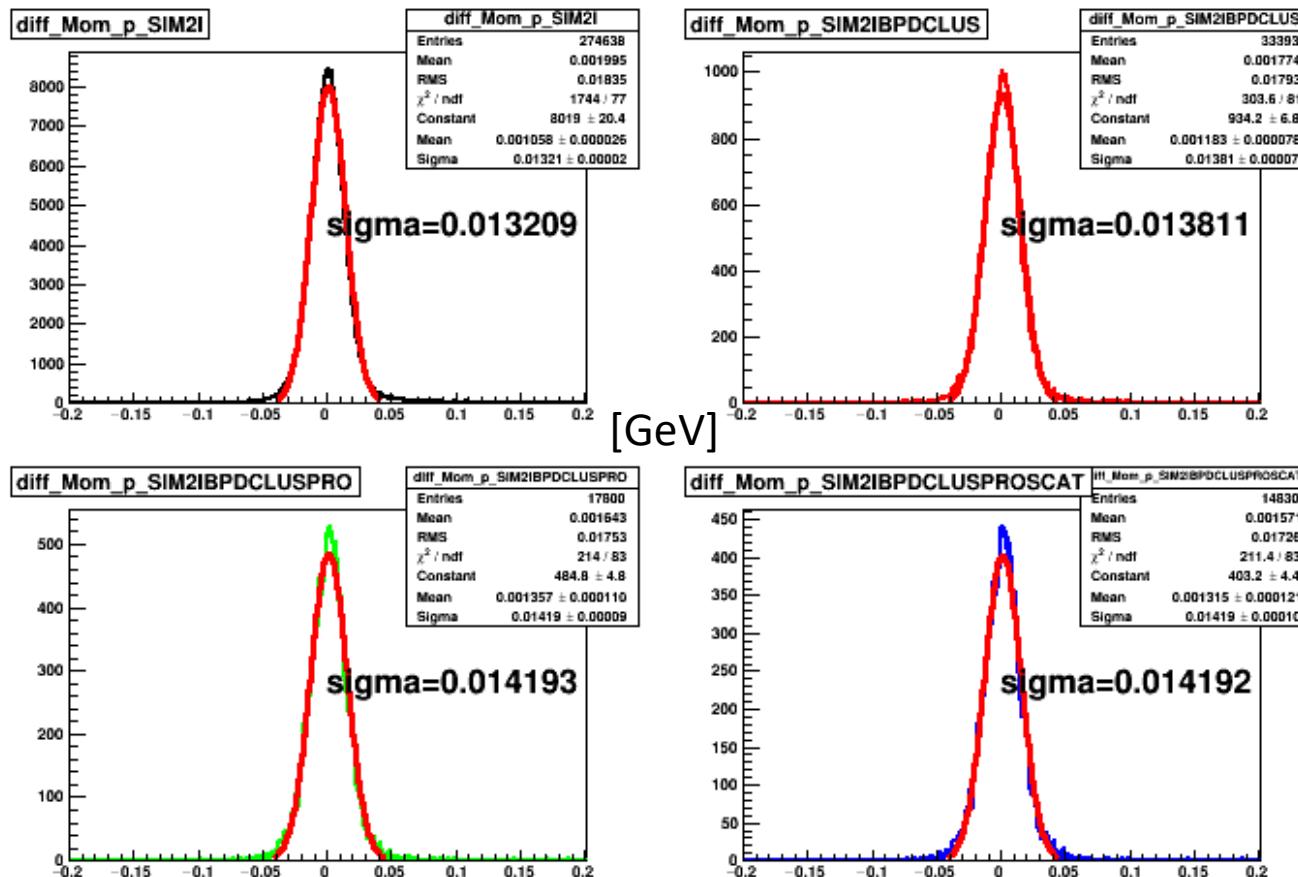


# Difference between ana & raw

Momentum Difference of Backward proton  
(Missing momentum - sim raw momentum)

Vertex condition (label ;min)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

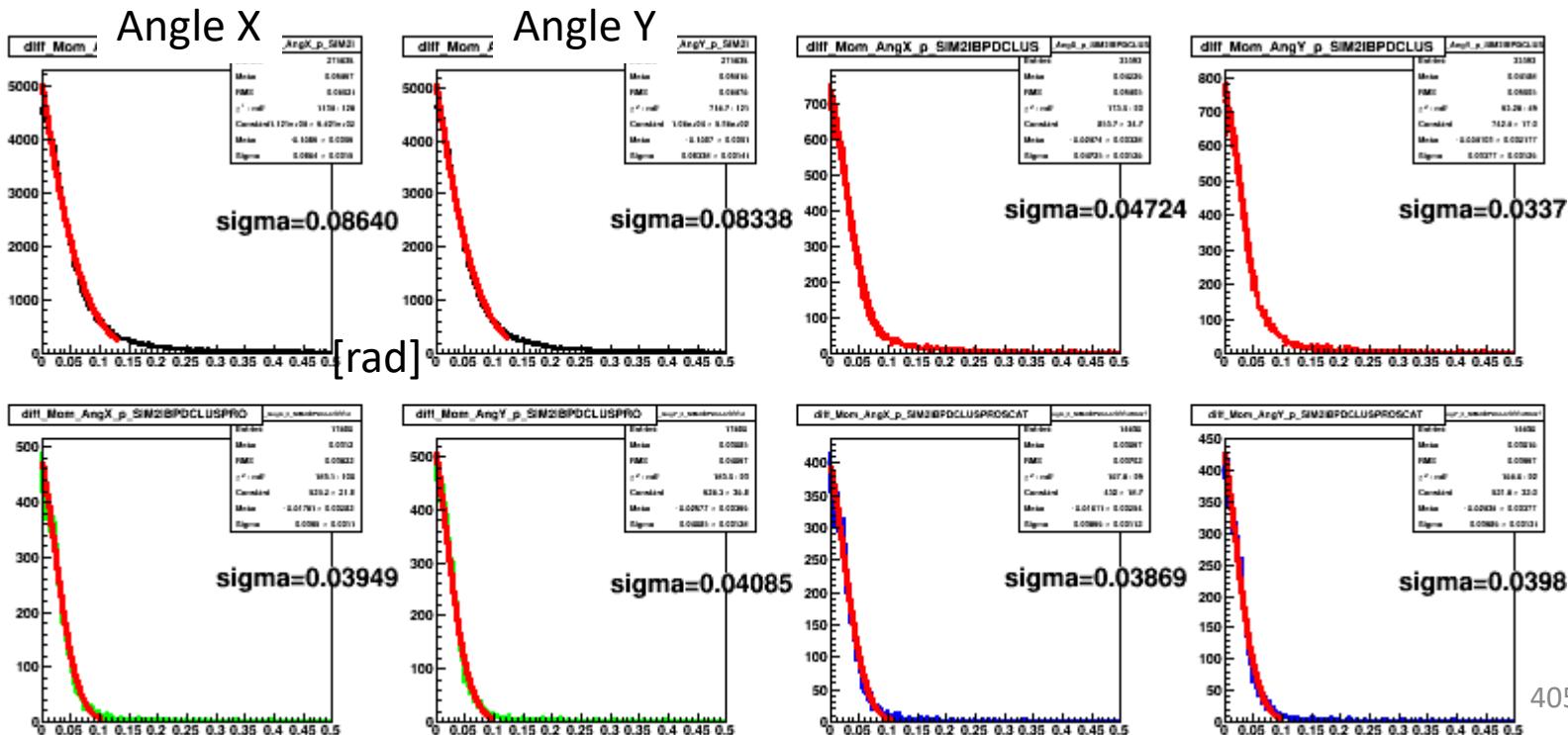


# Difference between ana & raw

Momentum Angle Difference of Backward proton  
 (Missing momentum - sim raw momentum)

Vertex condition (label ;min)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

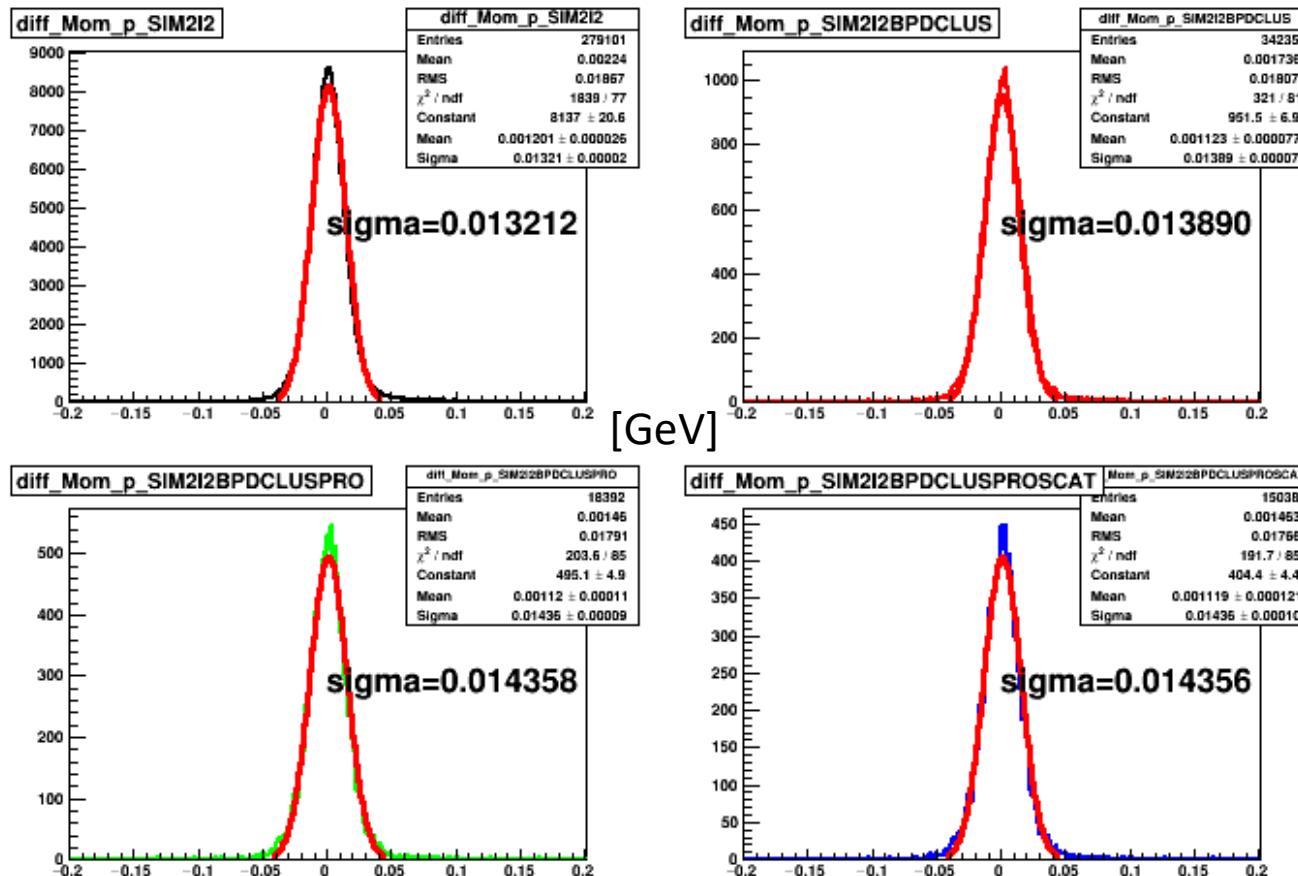


# Difference between ana & raw

Momentum Difference of Backward proton  
(Missing momentum - sim raw momentum)

Vertex condition (label ;diff)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

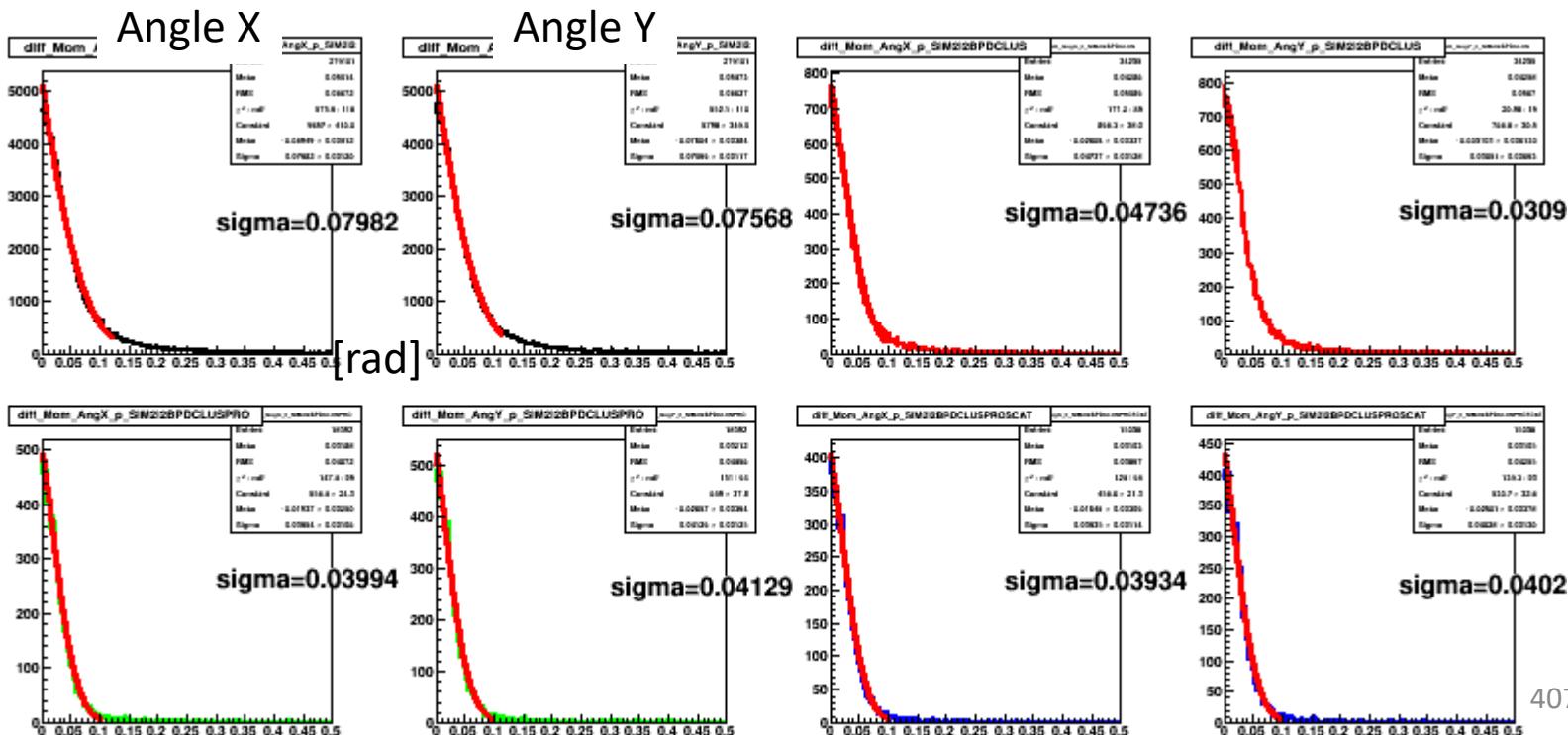


# Difference between ana & raw

Momentum Angle Difference of Backward proton  
(Missing momentum - sim raw momentum)

Vertex condition (label ;diff)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking



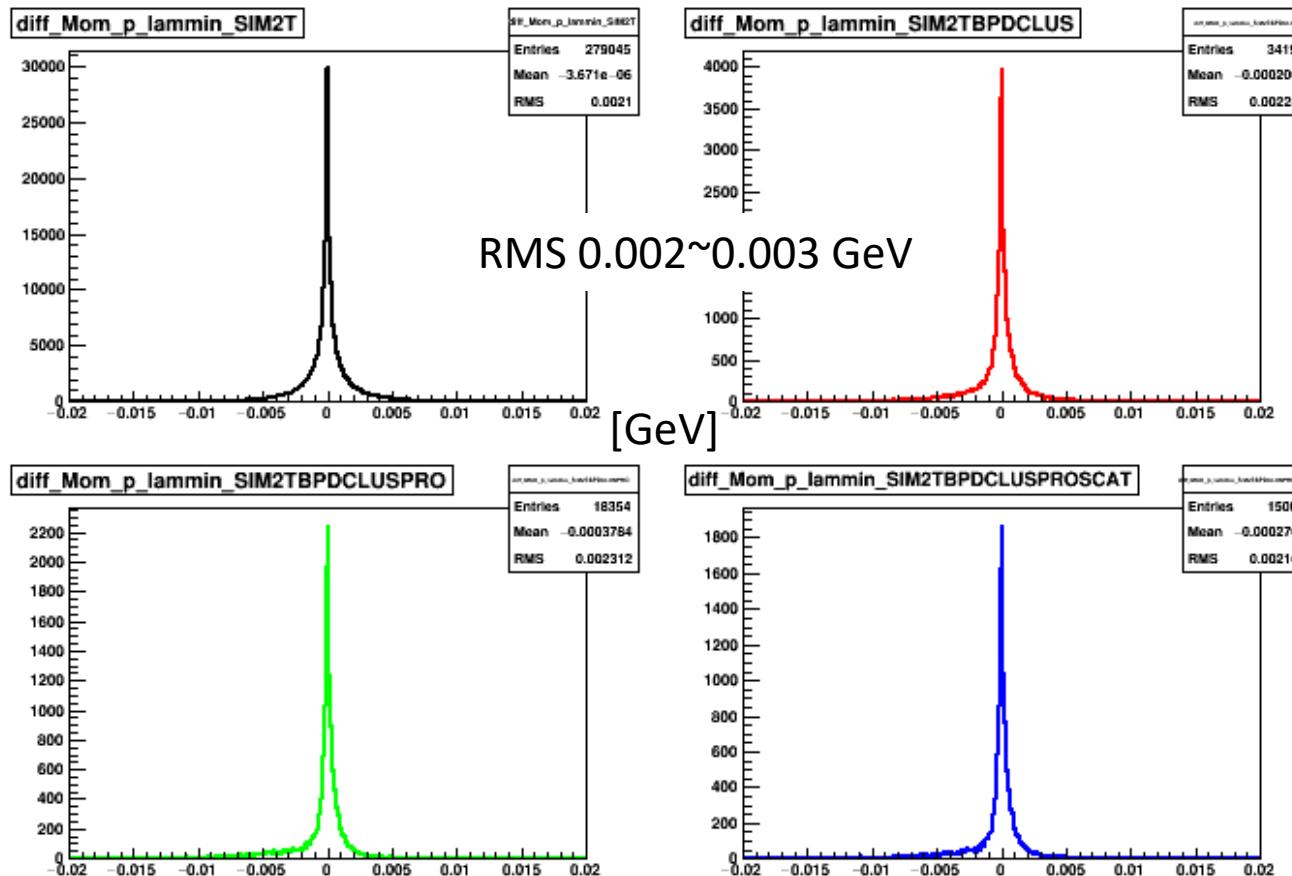
# Difference between lambda & min

Momentum Angle Difference of Backward proton  
(Missing momentum – Missing momentum)

Vertex condition (label ;lambda)

Vertex condition (label ;min)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking



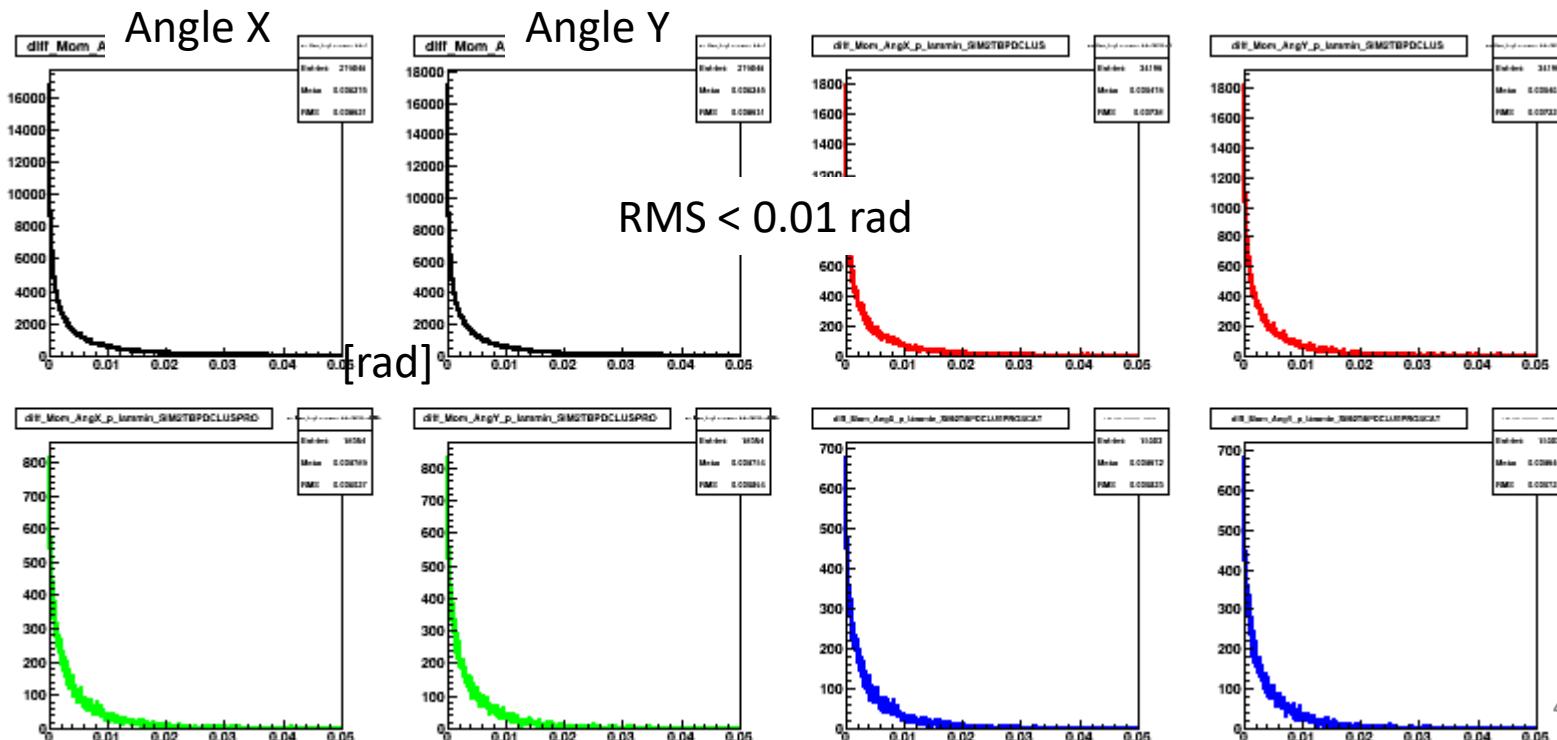
# Difference between lambda & min

Momentum Angle Difference of Backward proton  
(Missing momentum – Missing momentum)

Vertex condition (label ;lambda)

Vertex condition (label ;min)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

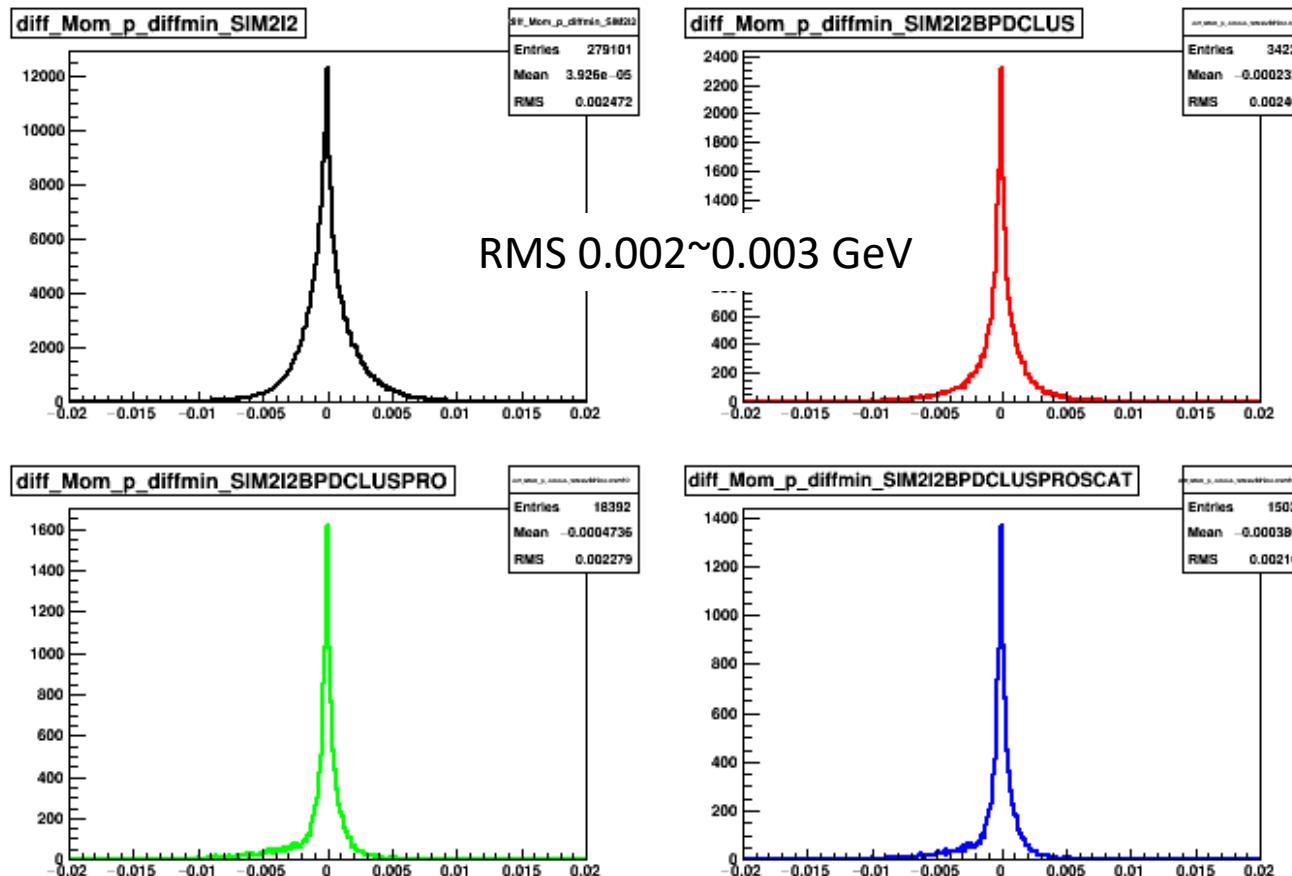


# Difference between diff & min

Momentum Angle Difference of Backward proton  
(Missing momentum – Missing momentum)

Vertex condition (label ;diff)      Vertex condition (label ;min)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking

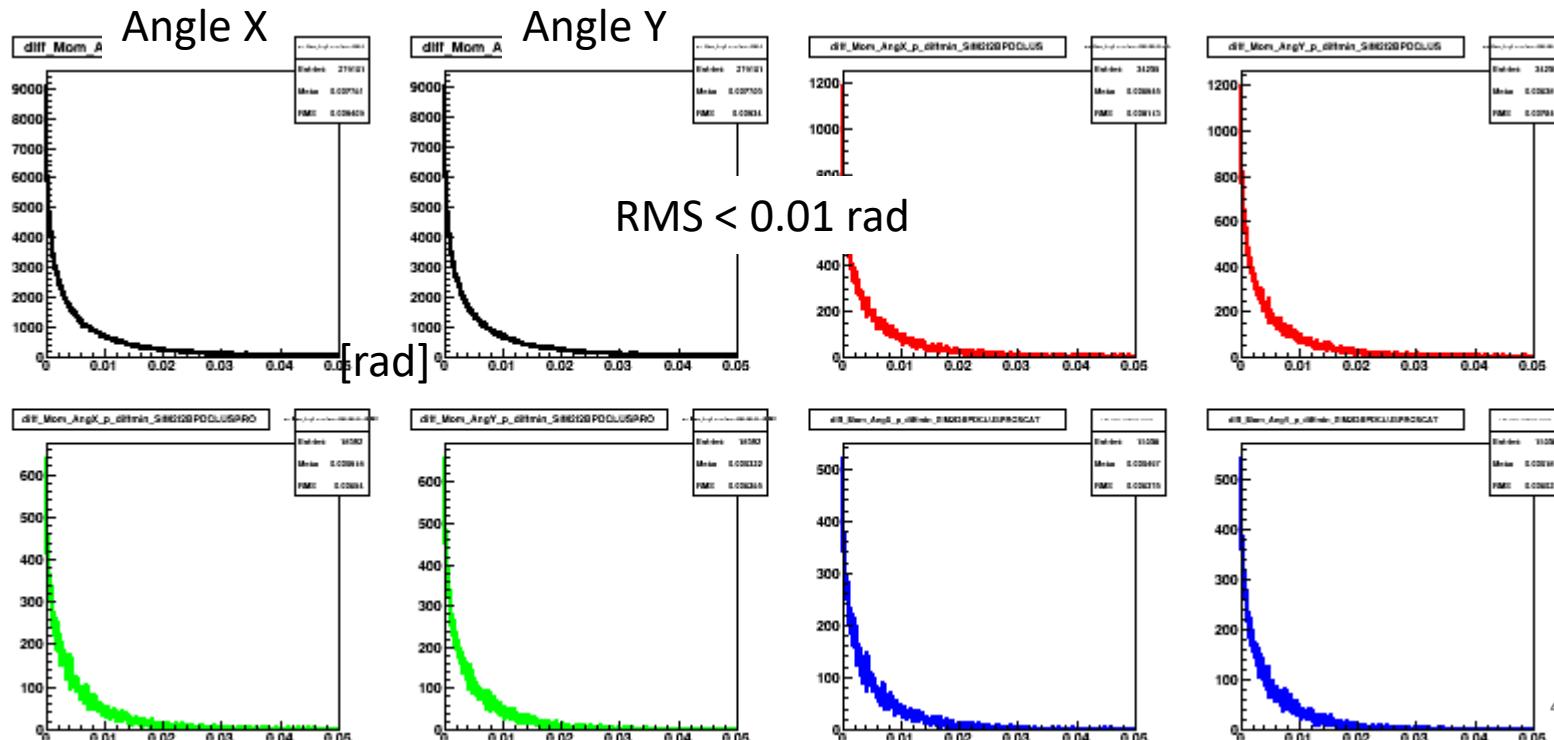


# Difference between diff & min

Momentum Angle Difference of Backward proton  
(Missing momentum – Missing momentum)

Vertex condition (label ;diff)      Vertex condition (label ;min)

- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPD Cluster (TOF-BPDT0 > 4ns)
- BPD dE Cluster > 3MeV
- BPC Backward Tracking



# Backward proton efficiency 7

- Estimation by  $K-d \rightarrow p\Lambda\pi^-$  (lambda) v2
- Acceptance estimation by SIM  $K-d \rightarrow n\Lambda\pi^-$
- Weighted average of the efficiency
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 5

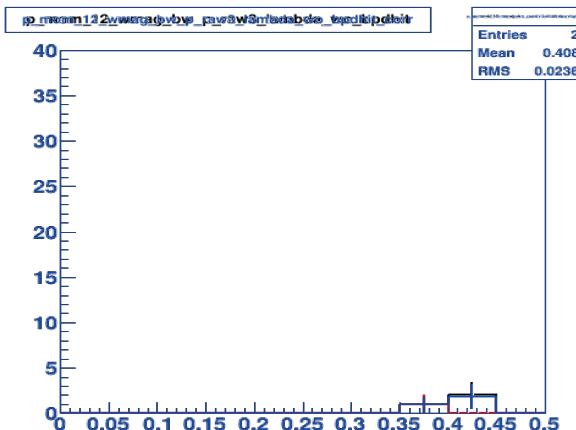
Error in vertex calculation

# Backward proton Missing momentum

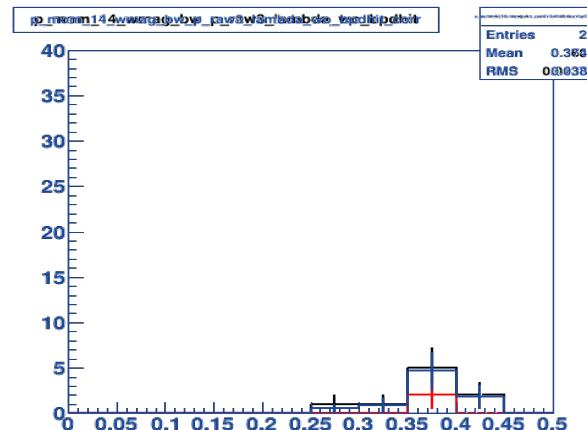
- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

w/o BPD Hit  
w/o BPD Hit x Ratio (P.297)  
w/ BPD Hit

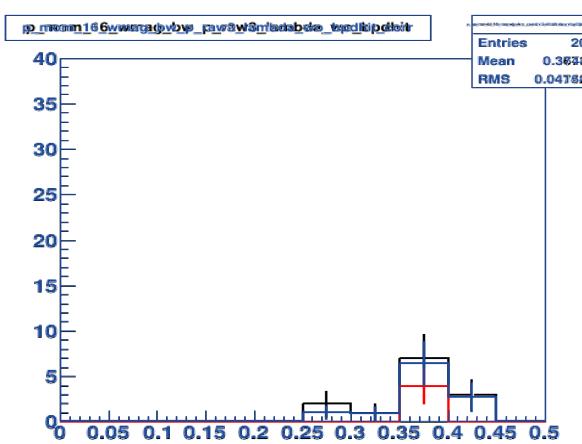
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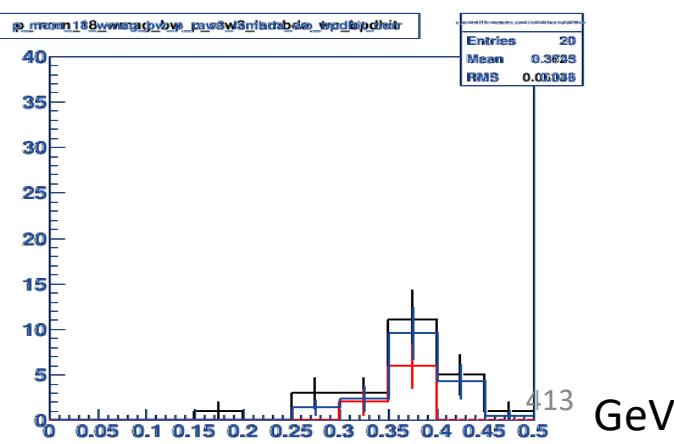
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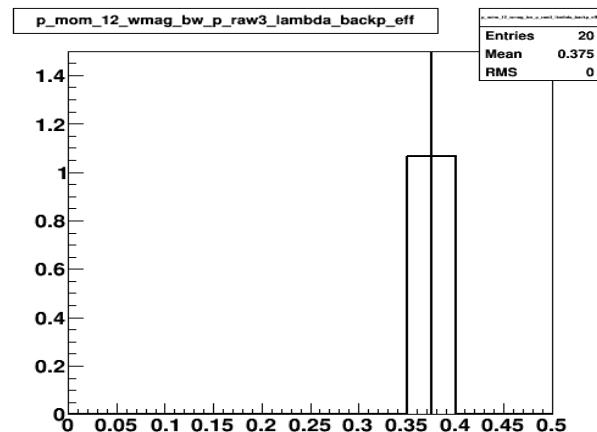


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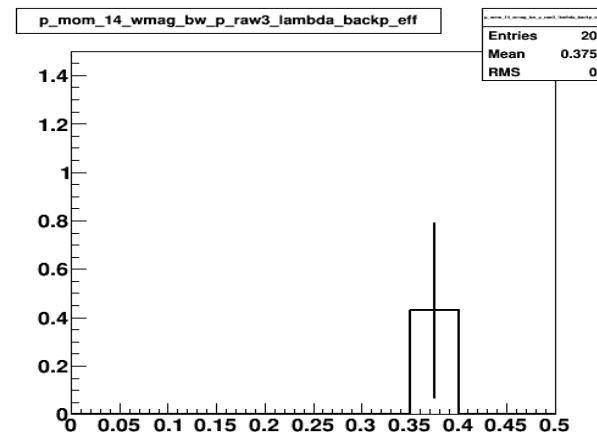
# BPD hit efficiency dependence on missing momentum

Red/Blue

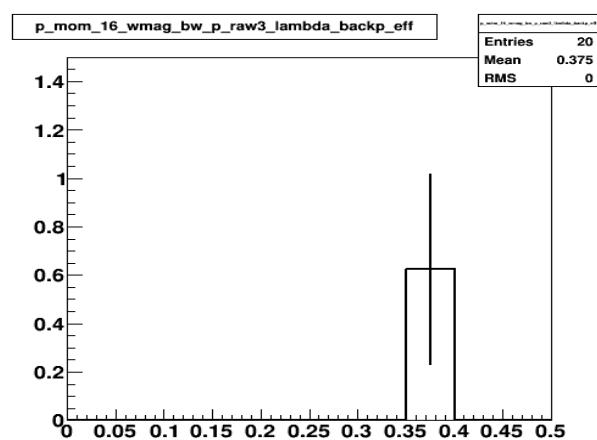
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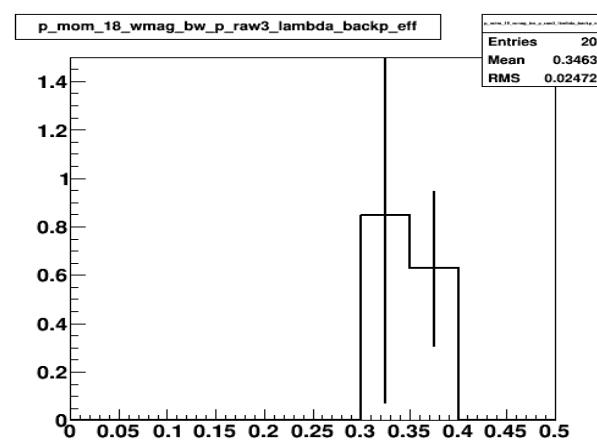
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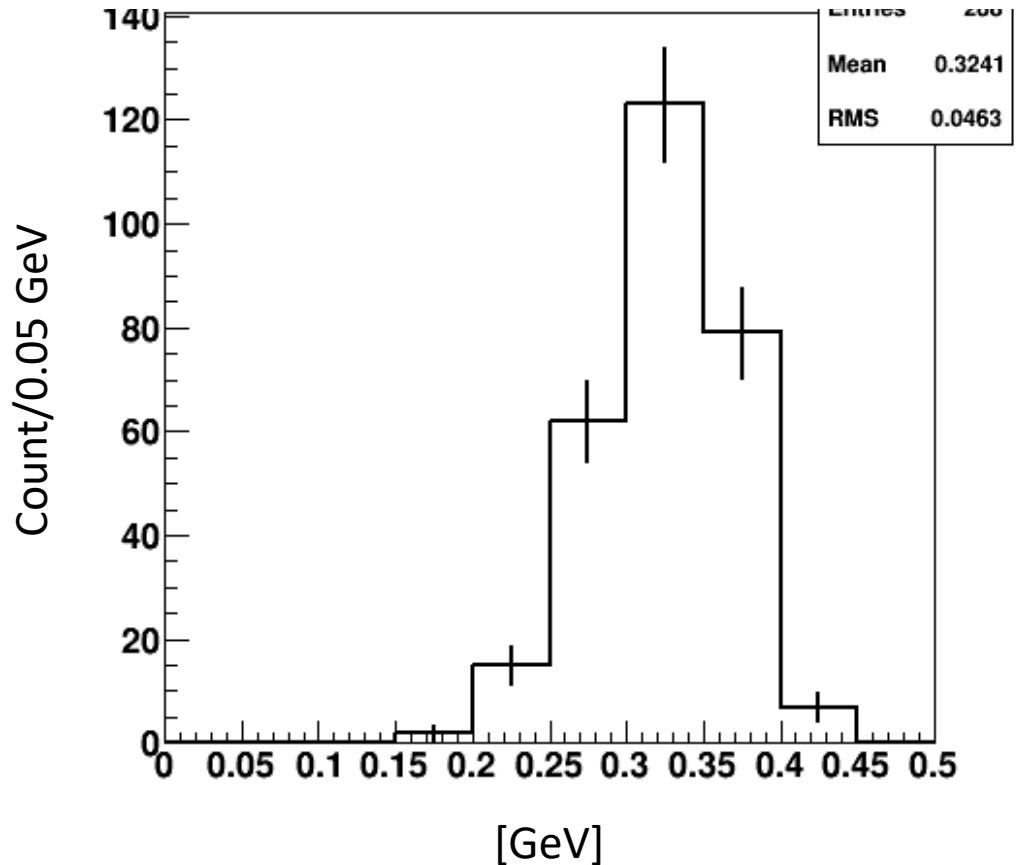
<R=18



# Backward proton momentum

- Run78 Data
- Condition
  - Re-analysis 7
  - p, $\pi$ - invariant mass  $\Lambda$  selection
  - d(K-,n $\Lambda$ )"X"  $0.18 < X < 0.30$  GeV

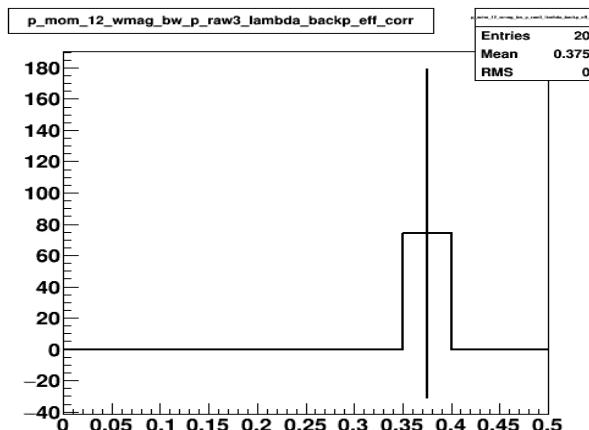
**Momentum  
by the analysis of backward detectors**



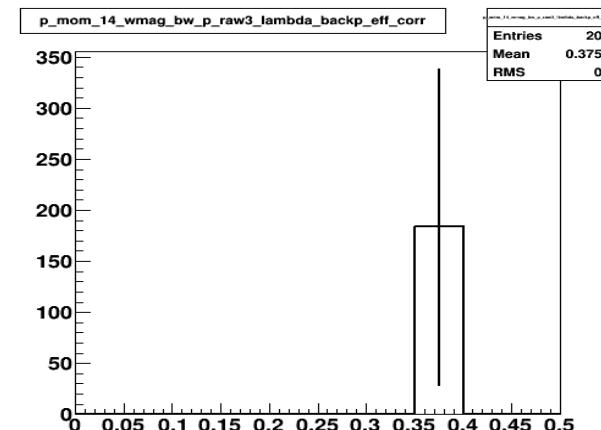
# Proton momentum corrected by efficiency

## Backward proton momentum/BPD hit efficiency

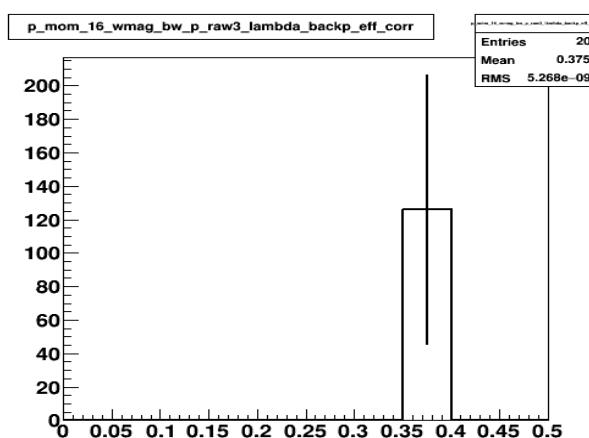
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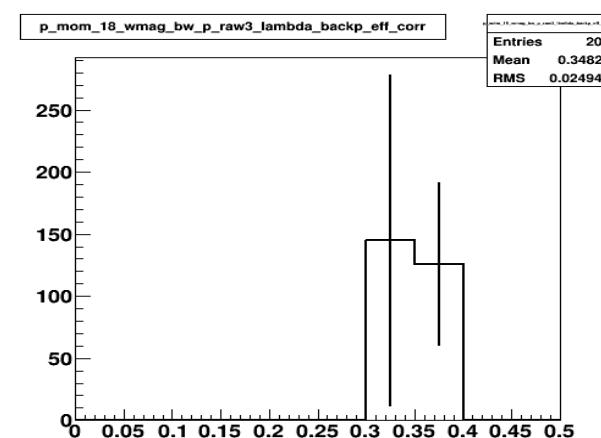
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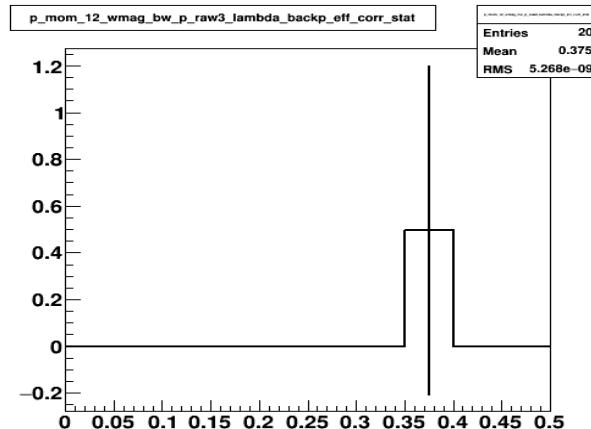
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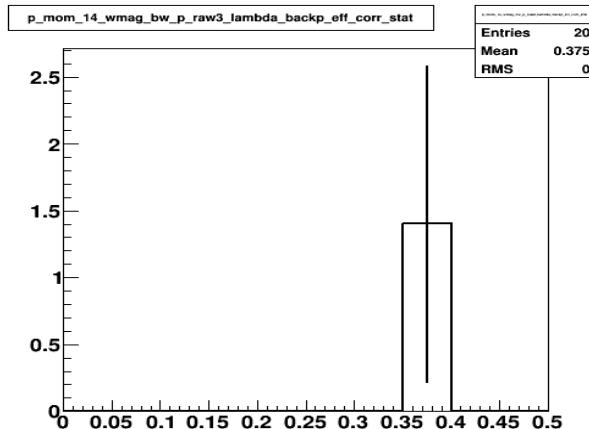
# Backward proton momentum

Backward proton momentum/BPD hit efficiency → (center/ error)<sup>2</sup>

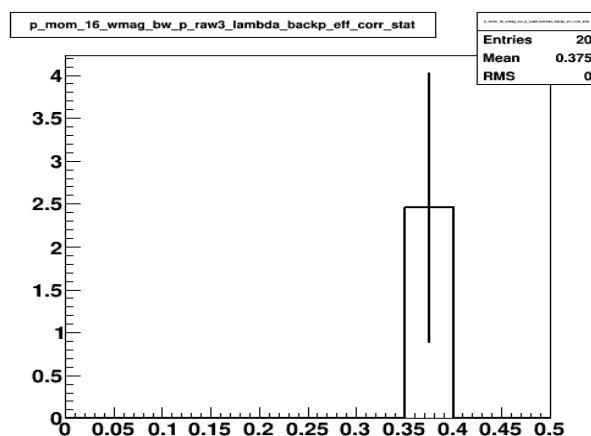
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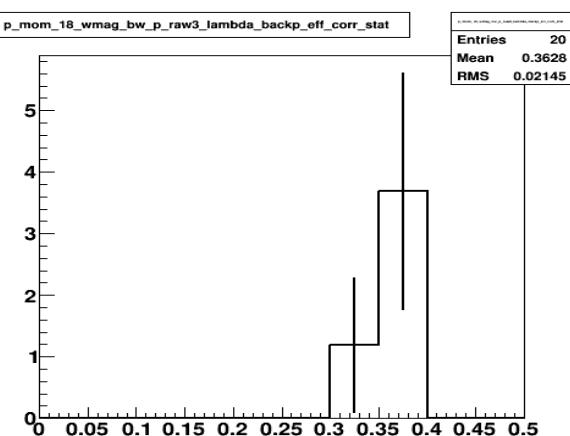
<R=14



<R=16



<R=18



# Summary

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

( $R \leq 12$ )  $1.064 \pm 1.510$

( $R \leq 14$ )  $0.430 \pm 0.363$

( $R \leq 16$ )  $0.625 \pm 0.398$

( $R \leq 18$ )  $0.681 \pm 0.308$

Error in vertex calculation

# Backward proton efficiency 8

- Estimation by  $K-d \rightarrow p\Lambda\pi^-$  (diff) v2
- Acceptance estimation by SIM  $K-d \rightarrow n\Lambda\pi^-$
- Weighted average of the efficiency
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 7

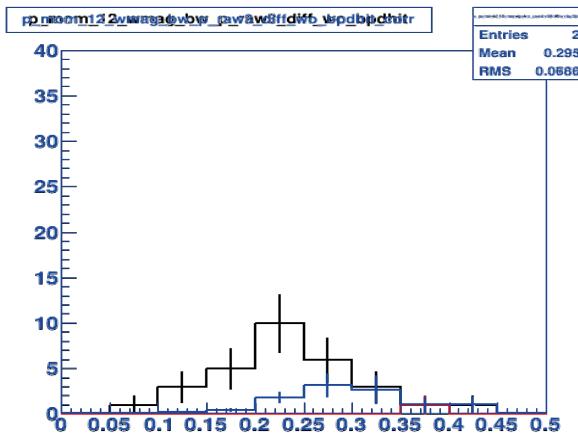
Error in vertex calculation

# Backward proton Missing momentum

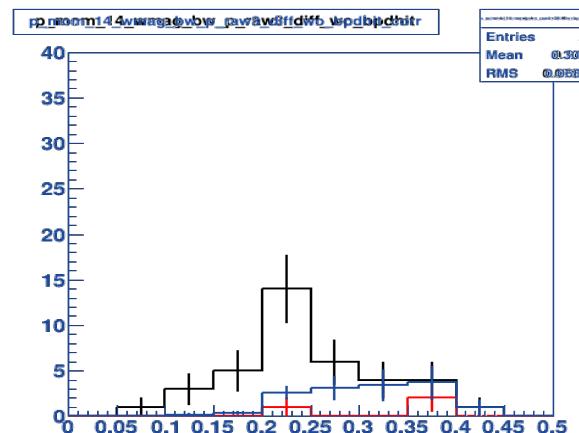
- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

w/o BPD Hit  
w/o BPD Hit x Ratio (P.297)  
w/ BPD Hit

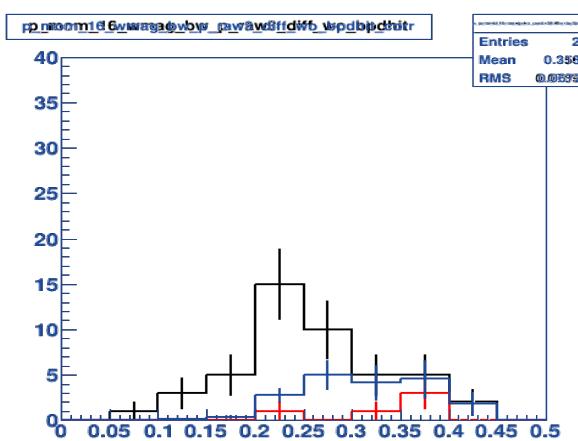
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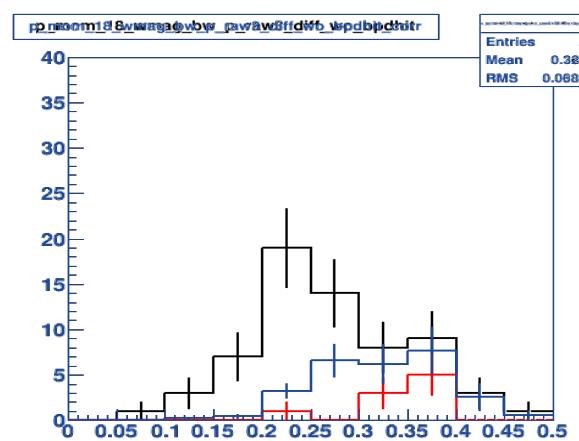
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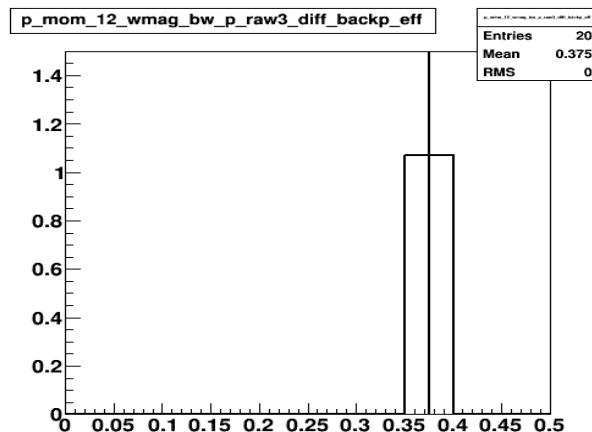
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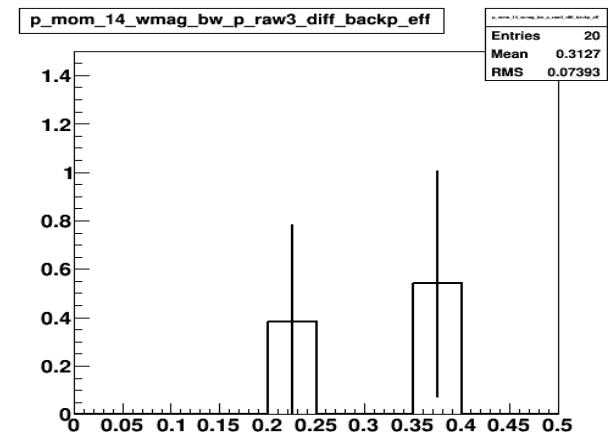
# BPD hit efficiency dependence on missing momentum

Red/Blue

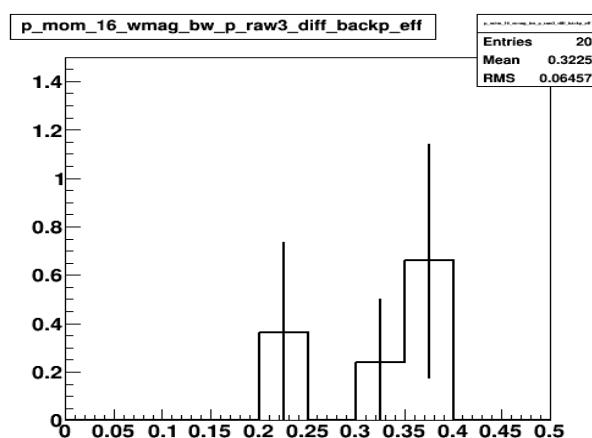
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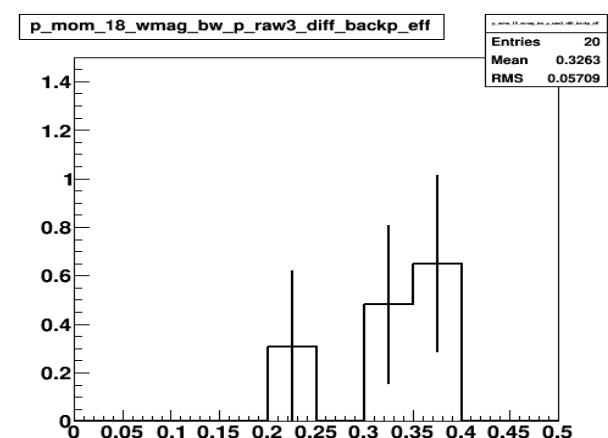
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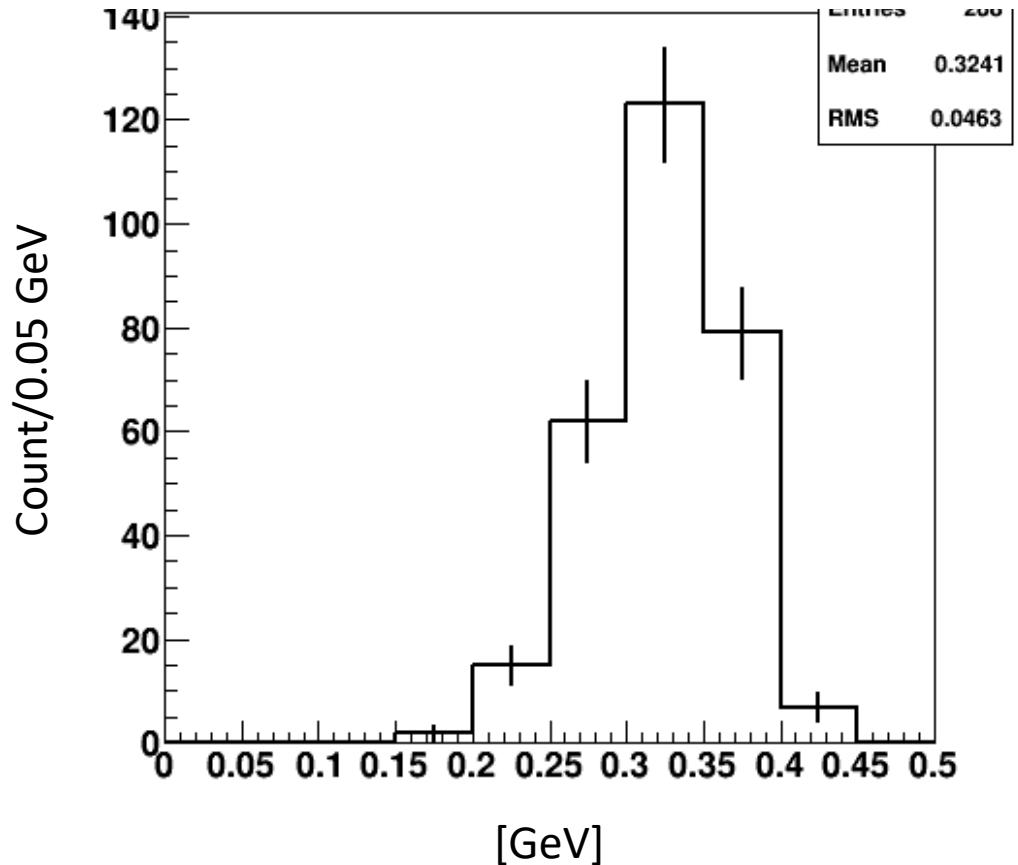
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# Backward proton momentum

- Run78 Data
- Condition
  - Re-analysis 7
  - p, $\pi$ - invariant mass  $\Lambda$  selection
  - d(K-,n $\Lambda$ )"X"  $0.18 < X < 0.30$  GeV

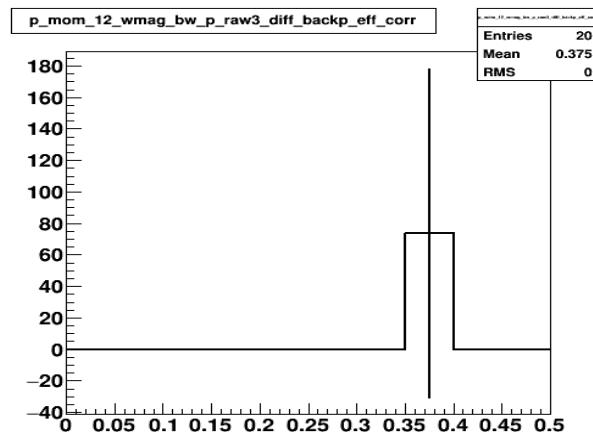
**Momentum  
by the analysis of backward detectors**



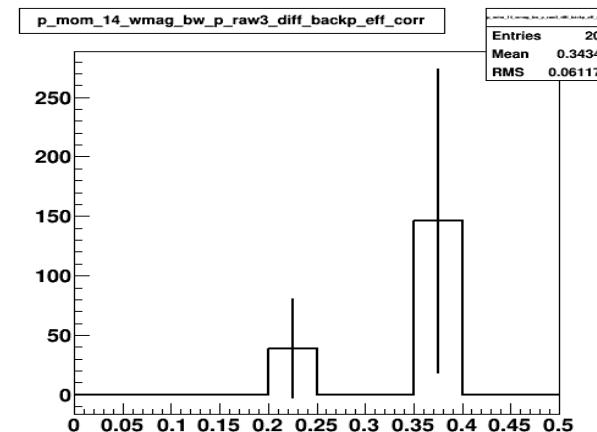
# Proton momentum corrected by efficiency

## Backward proton momentum/BPD hit efficiency

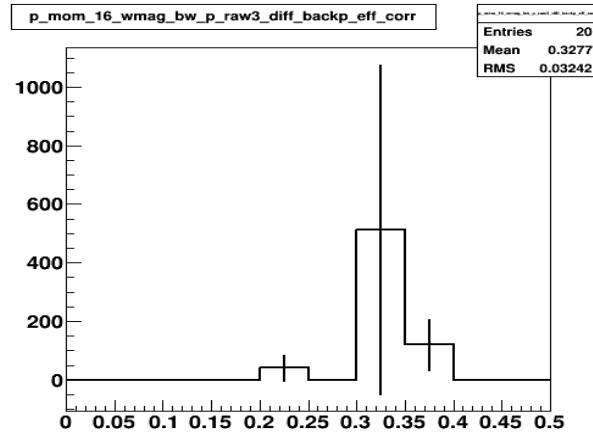
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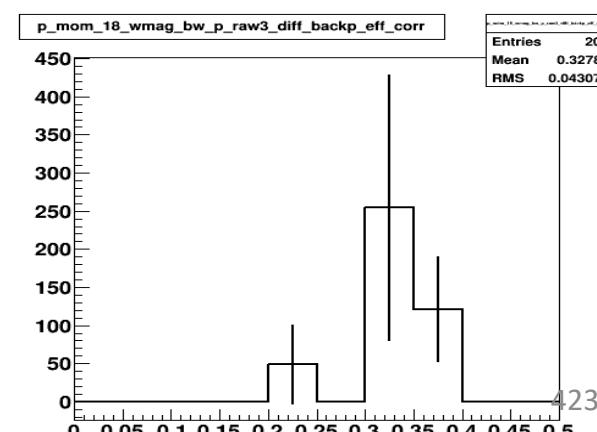
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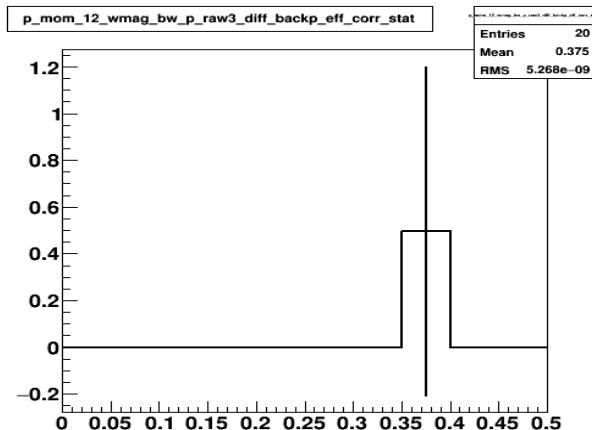
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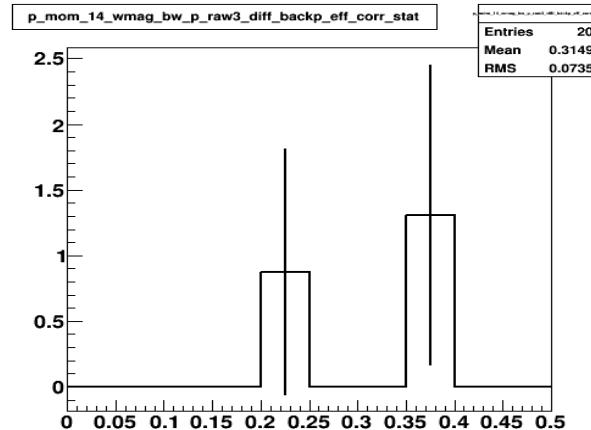
# Backward proton momentum

Backward proton momentum/BPD hit efficiency → (center/ error)<sup>2</sup>

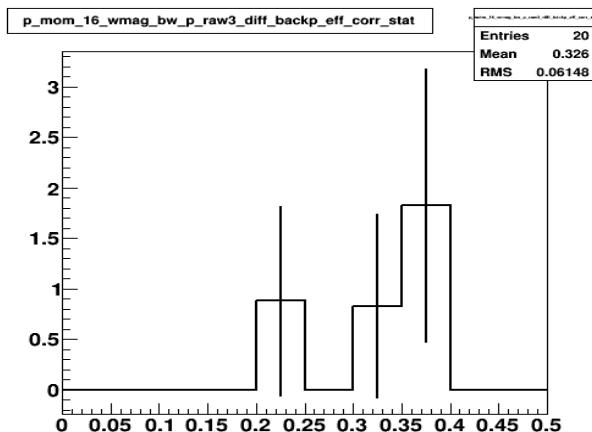
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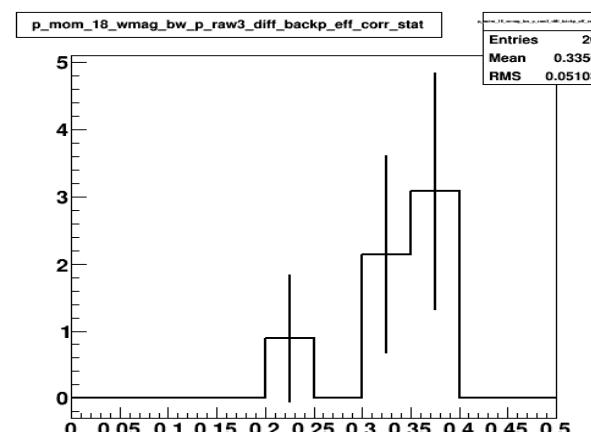
<R=14



<R=16



<R=18



# Summary

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

( $R \leq 12$ )  $1.071 \pm 1.520$

( $R \leq 14$ )  $0.477 \pm 0.322$

( $R \leq 16$ )  $0.487 \pm 0.259$

( $R \leq 18$ )  $0.541 \pm 0.218$

Error in vertex calculation

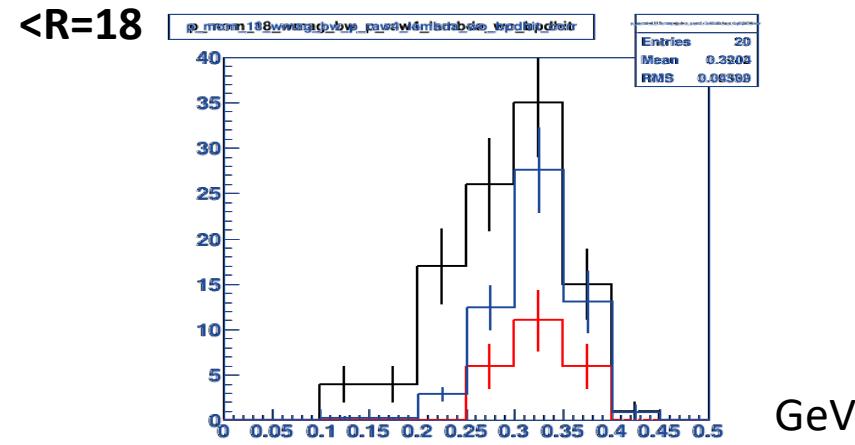
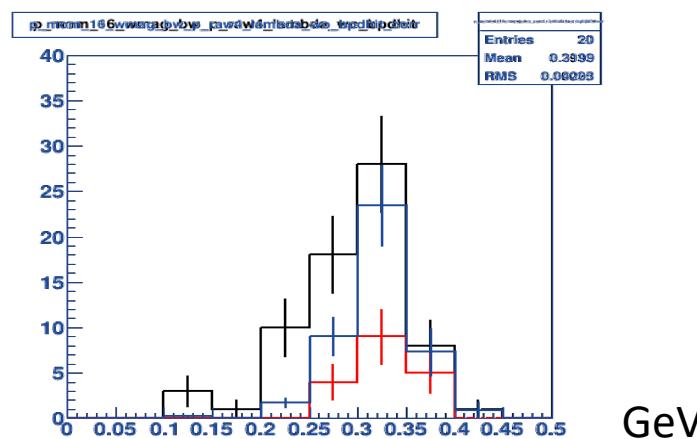
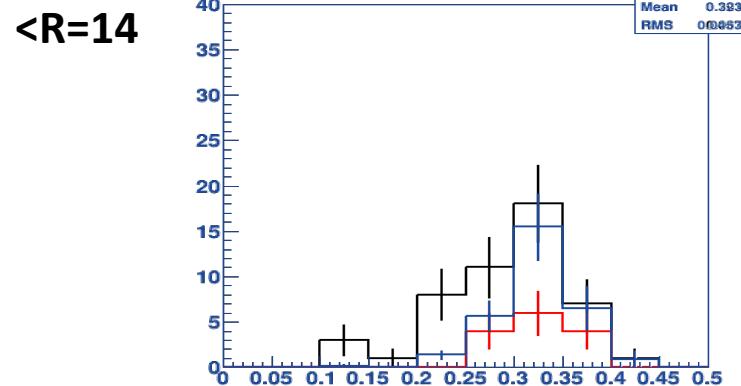
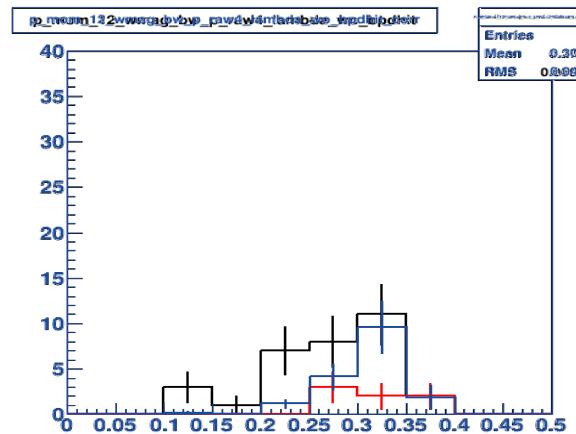
# Backward proton efficiency 9

- Estimation by  $K-d \rightarrow p\Lambda\pi^-$  (lambda) v3
- Acceptance estimation by SIM  $K-d \rightarrow n\Lambda\pi^-$
- Weighted average of the efficiency
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 5
- Error in vertex calculation is fixed

# Backward proton Missing momentum

- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

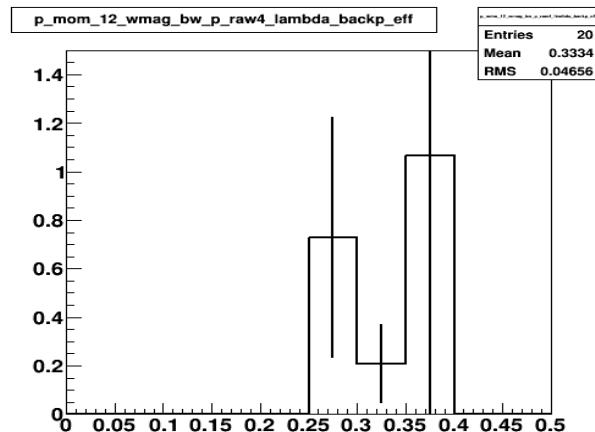
w/o BPD Hit  
w/o BPD Hit x Ratio (P.297)  
w/ BPD Hit



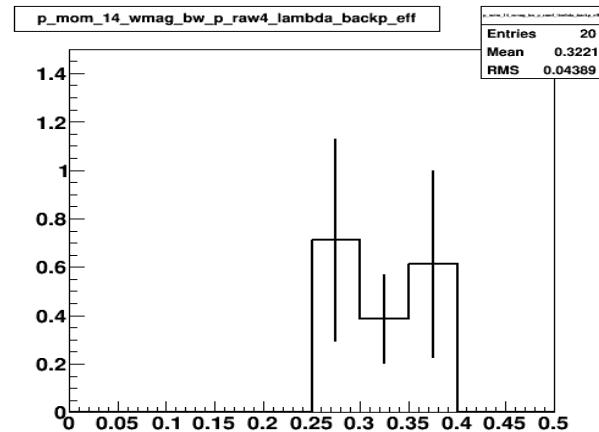
# BPD hit efficiency dependence on missing momentum

Red/Blue

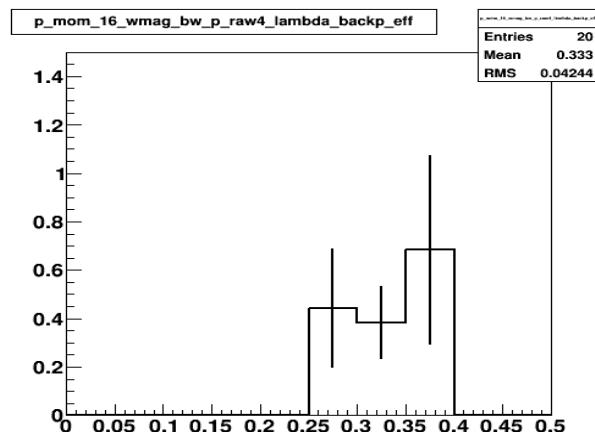
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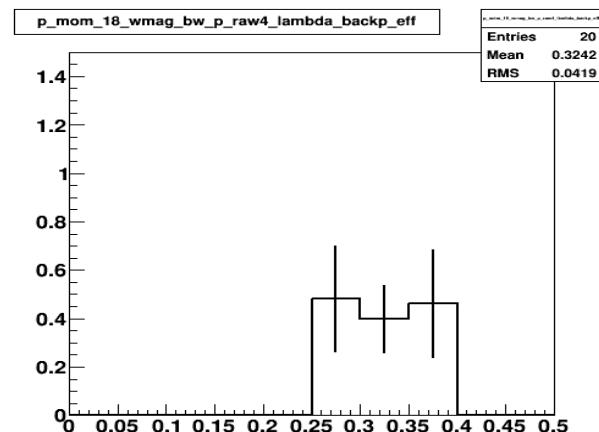
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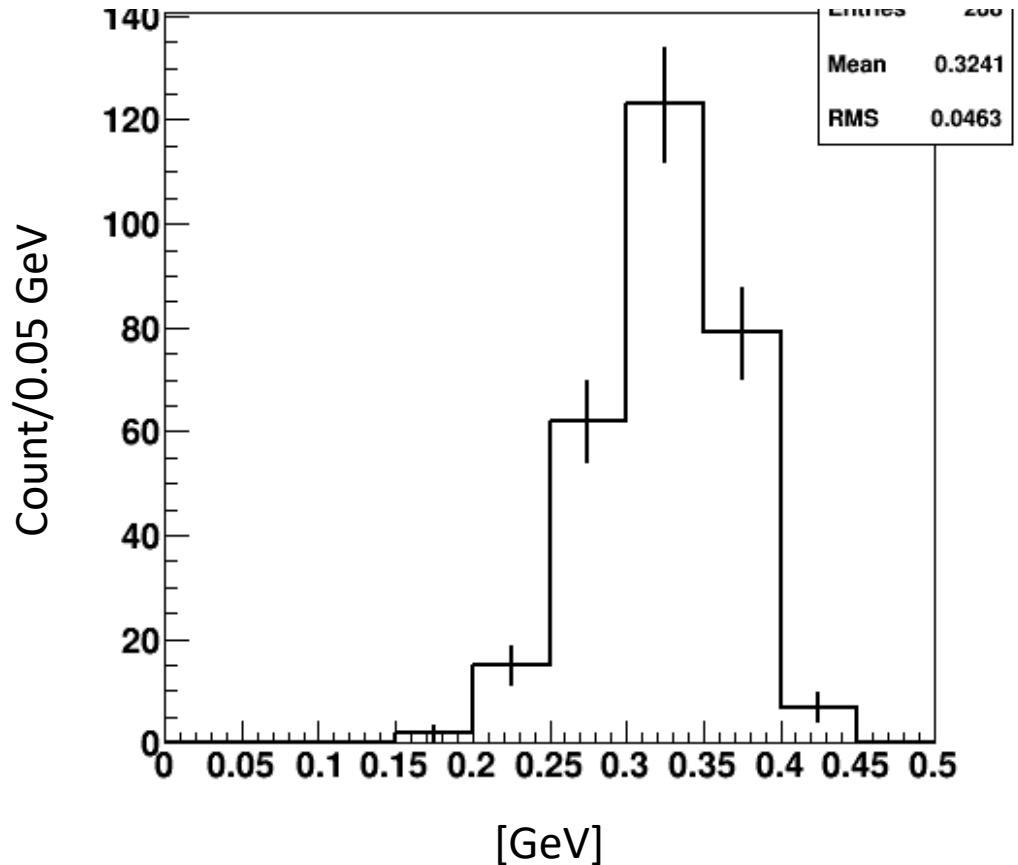
<R=18



# Backward proton momentum

- Run78 Data
- Condition
  - Re-analysis 7
  - p, $\pi$ - invariant mass  $\Lambda$  selection
  - d(K-,n $\Lambda$ )"X"  $0.18 < X < 0.30$  GeV

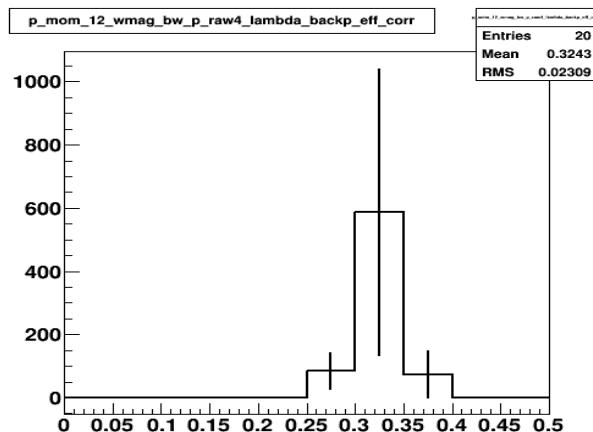
**Momentum  
by the analysis of backward detectors**



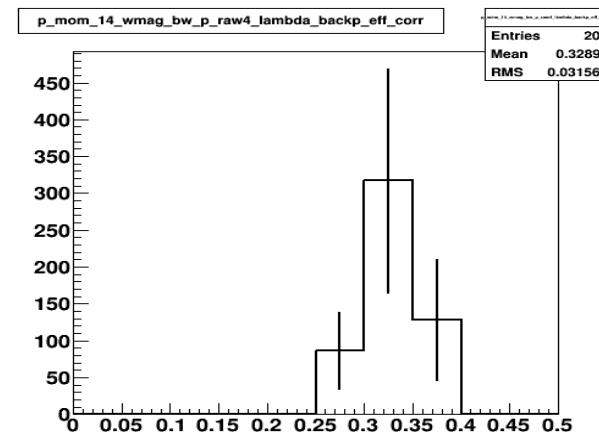
# Proton momentum corrected by efficiency

## Backward proton momentum/BPD hit efficiency

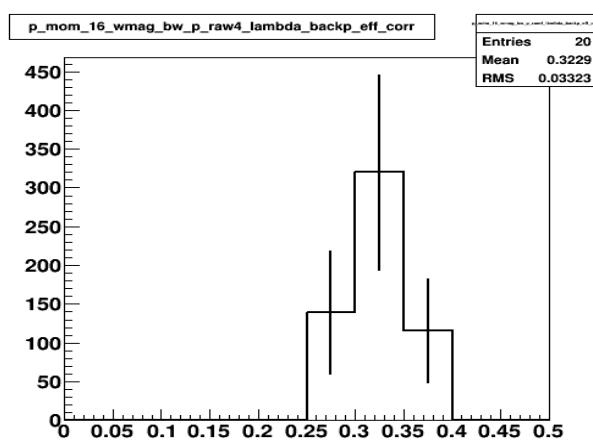
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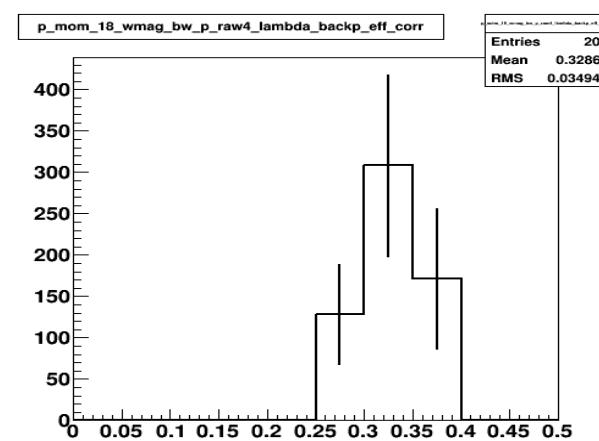
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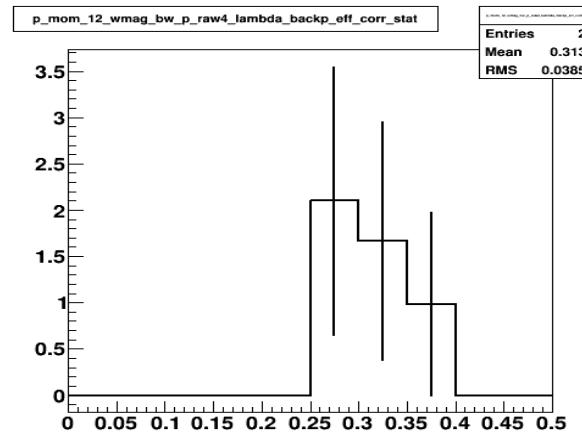
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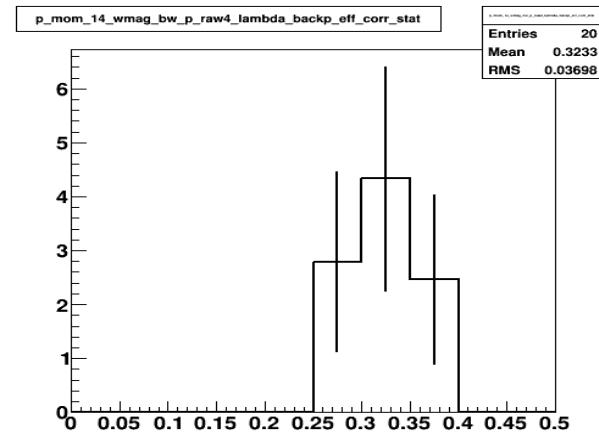
# Backward proton momentum

Backward proton momentum/BPD hit efficiency → (center/ error)<sup>2</sup>

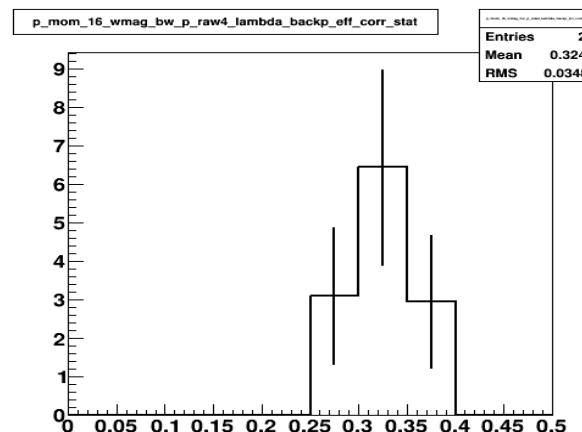
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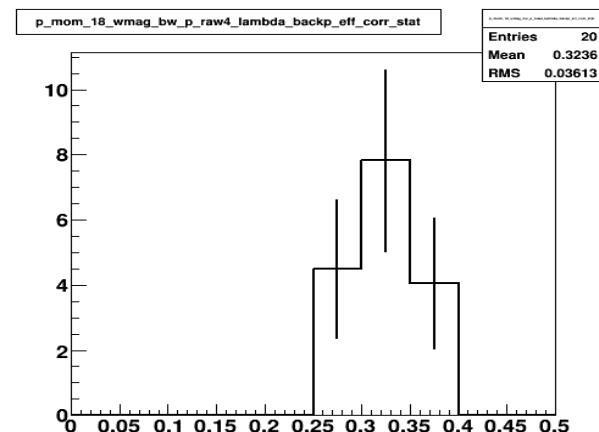
<R=14



<R=16



<R=18



# Summary (lambda v3)

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

( $R \leq 12$ )  $0.616 \pm 0.137$

( $R \leq 14$ )  $0.540 \pm 0.087$

( $R \leq 16$ )  $0.470 \pm 0.066$

( $R \leq 18$ )  $0.437 \pm 0.053$

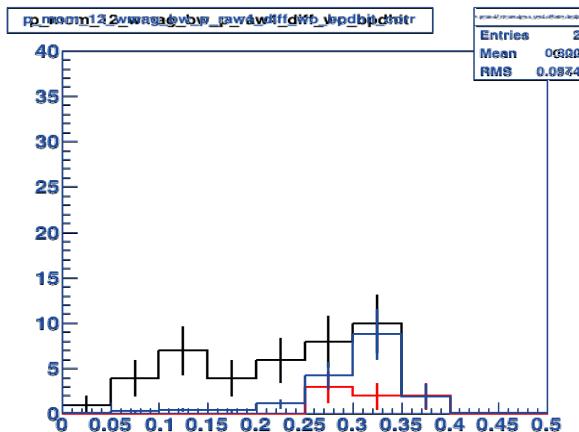
# Backward proton efficiency 10

- Estimation by  $K-d \rightarrow p\Lambda\pi^-$  (diff) v3
- Acceptance estimation by SIM  $K-d \rightarrow n\Lambda\pi^-$
- Weighted average of the efficiency
- Backward proton acceptance study  
by SIM ( $K-d \rightarrow n \Lambda \pi^-$ ) 7
- Error in vertex calculation is fixed

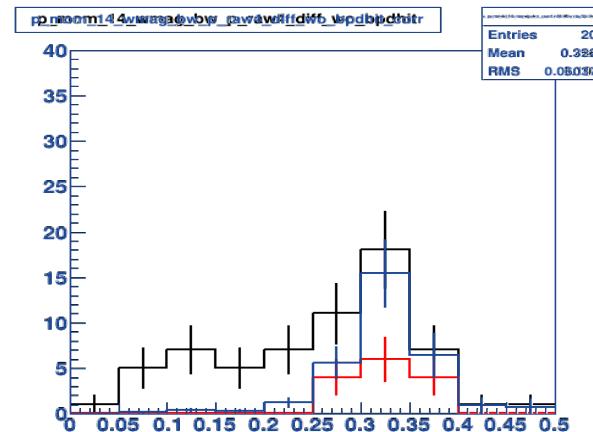
# Backward proton Missing momentum

- $K-d \rightarrow p_{\text{forward}} \wedge \pi^-$   
 $\rightarrow p_{\text{forward}} p_{\text{backward}} \pi^-\pi^-$

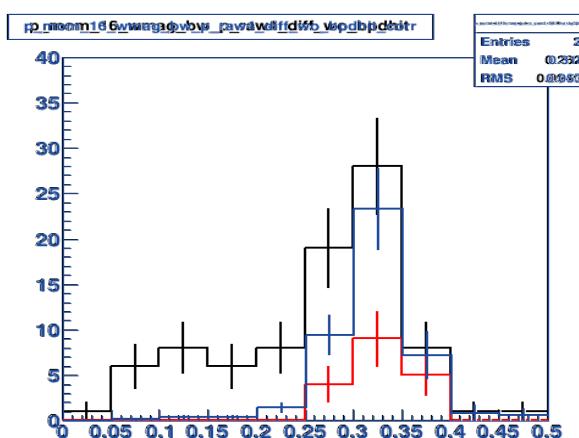
w/o BPD Hit  
w/o BPD Hit x Ratio (P.297)  
w/ BPD Hit



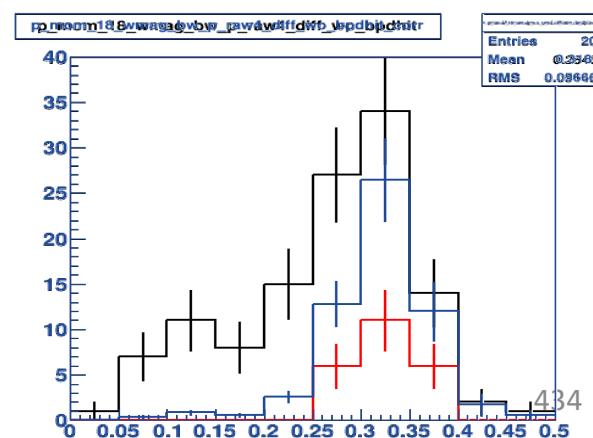
<R=14



<R=16



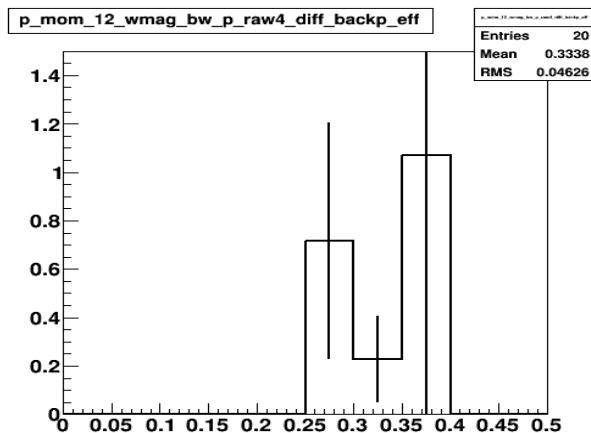
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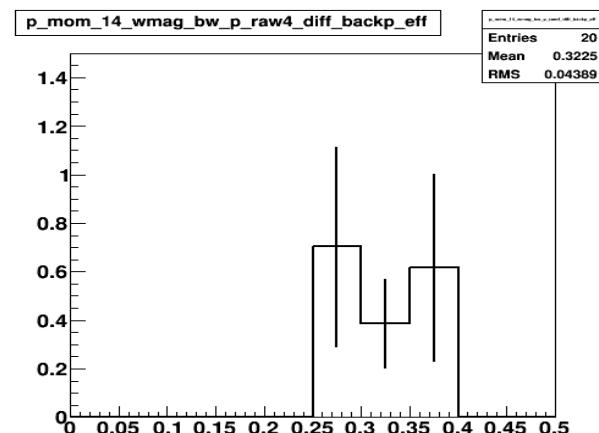
# BPD hit efficiency dependence on missing momentum

Red/Blue

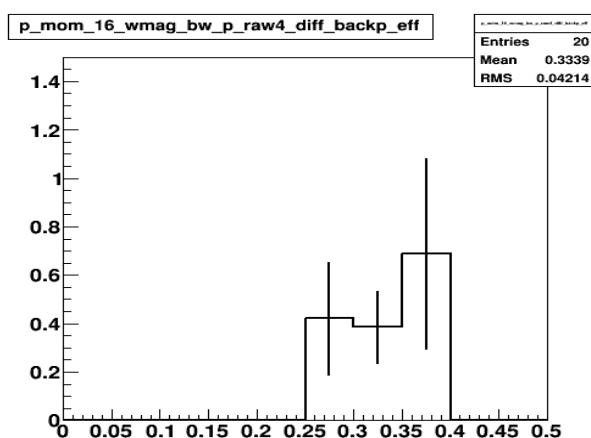
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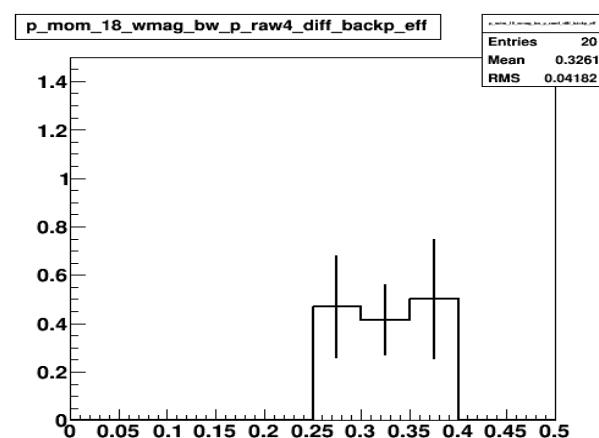
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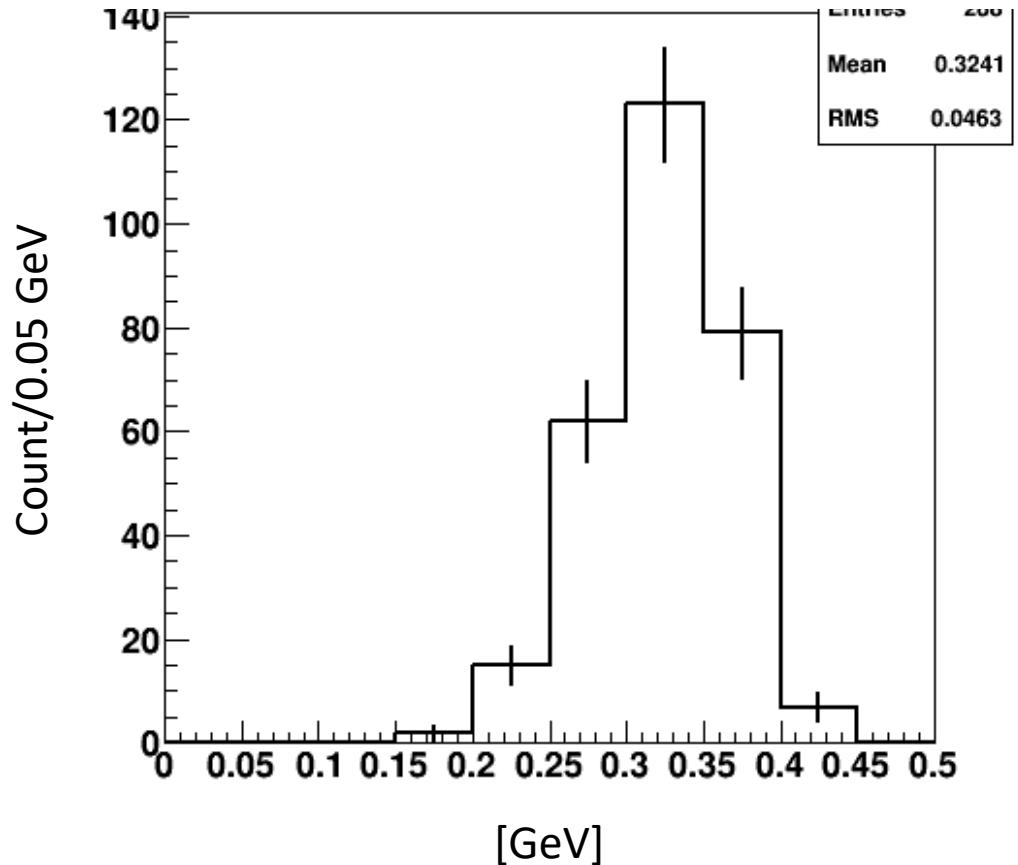
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# Backward proton momentum

- Run78 Data
- Condition
  - Re-analysis 7
  - p, $\pi$ - invariant mass  $\Lambda$  selection
  - d(K-,n $\Lambda$ )"X"  $0.18 < X < 0.30$  GeV

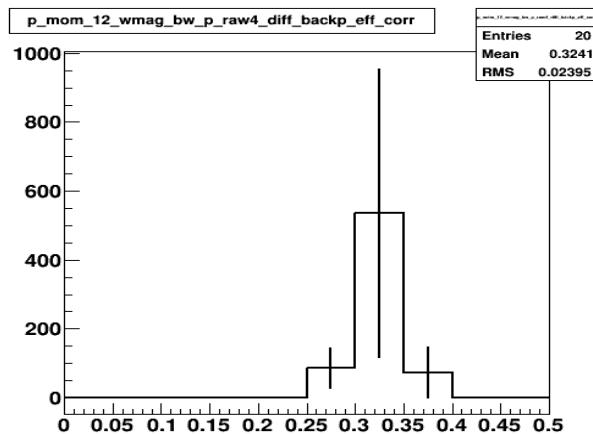
**Momentum  
by the analysis of backward detectors**



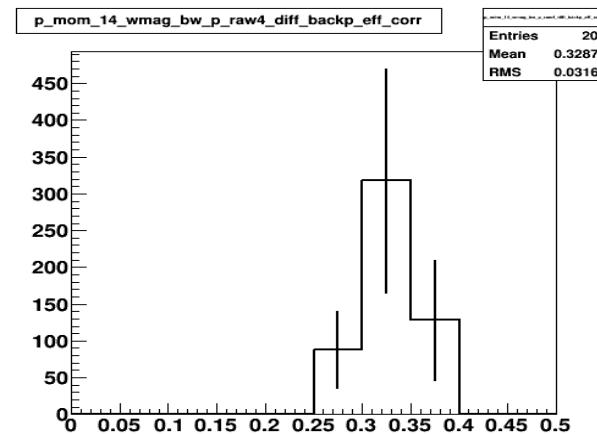
# Proton momentum corrected by efficiency

## Backward proton momentum/BPD hit efficiency

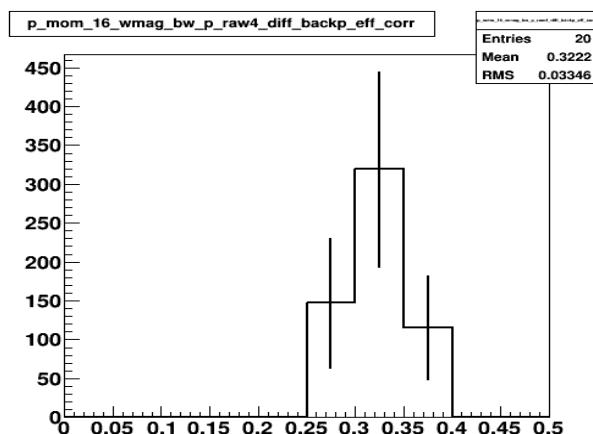
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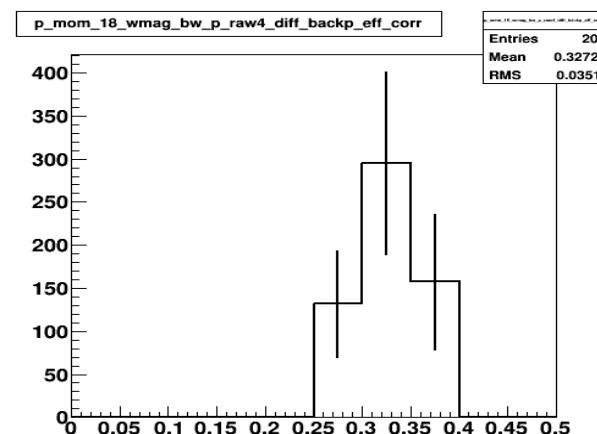
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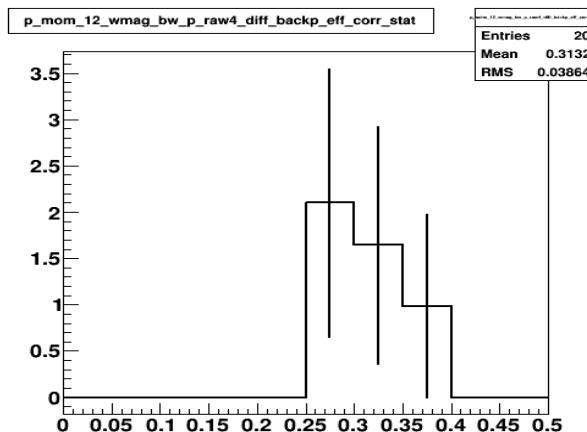
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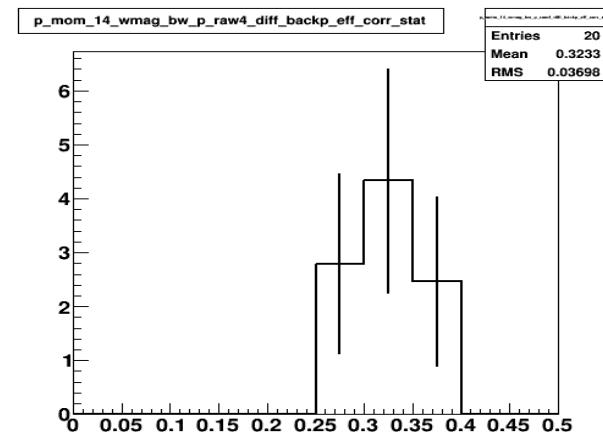
# Backward proton momentum

Backward proton momentum/BPD hit efficiency → (center/ error)<sup>2</sup>

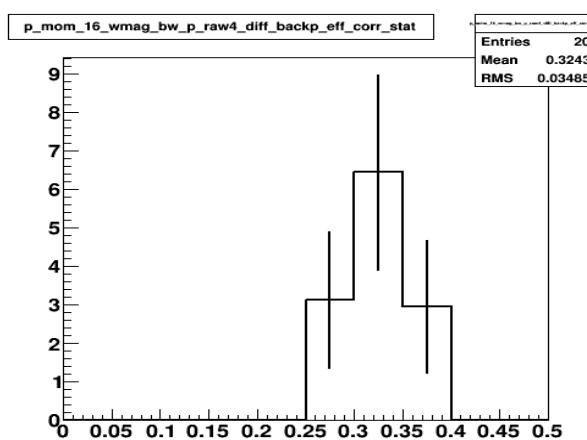
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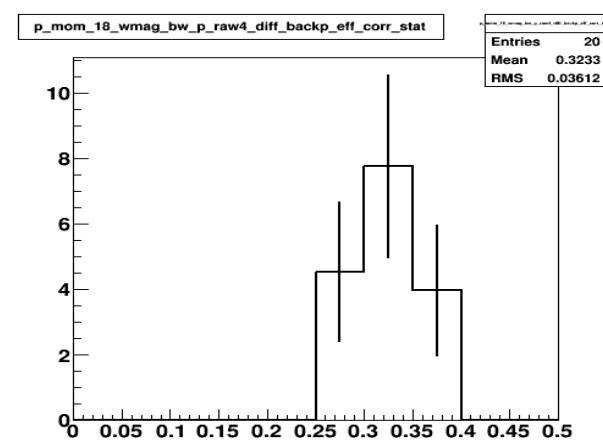
<R=14



<R=16



<R=18



# Summary (diff v3)

## BPD hit efficiency of backward timing

Weighted average

of the efficiency

( $R \leq 12$ )  $0.621 \pm 0.138$

( $R \leq 14$ )  $0.538 \pm 0.086$

( $R \leq 16$ )  $0.465 \pm 0.065$

( $R \leq 18$ )  $0.452 \pm 0.055$

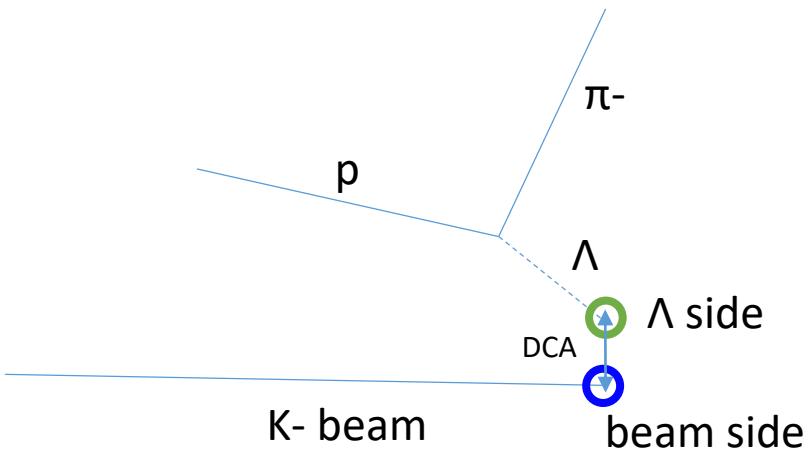
# Correction of data analysis

- Correction of data analysis condition
  - Additional material between Target-BPD
    - Energy loss correction for backward proton momentum
  - Vertex treatment
    - Center of both sides → beam side
  - BPD Clustering timing
    - 2 segments cluster
      - BPD Timing younger # → larger dE

# Additional materials between Target - BPD

		Width [cm]	number
• Target	• Super insulator ESR (Mylar)	0.0225(x0.84)	1
	• Super insulator(net) Mylar	0.02	1
• DEF	• Reflective film ESR (Mylar)	0.01(x0.84)	2
	• Blackout sheet Polyvinyl	0.01	1
• BPC	• Window film Mylar	0.00025	2
	• Cathode film Carbon Aramid (Nylon66)	0.001	9
• BPD	• Reflective film ESR (Mylar)	0.01(x0.84)	1
	• Blackout Tape Polyester (PET)	0.007	1

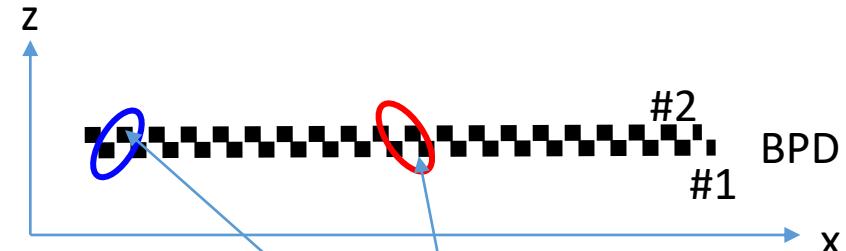
# Vertex check



Note;

- Center of both sides → beam side

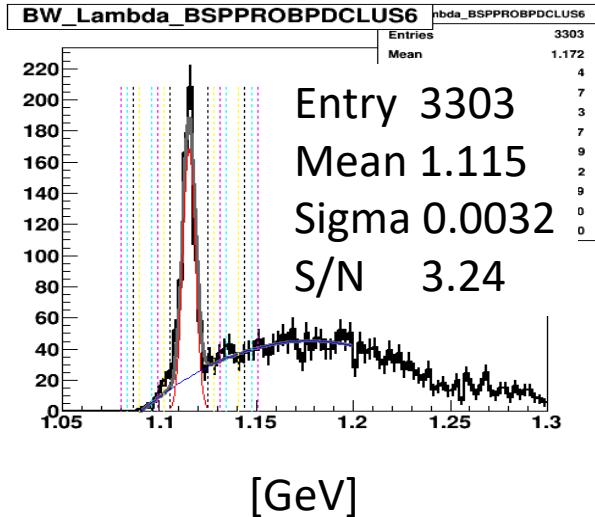
# BPD Clustering



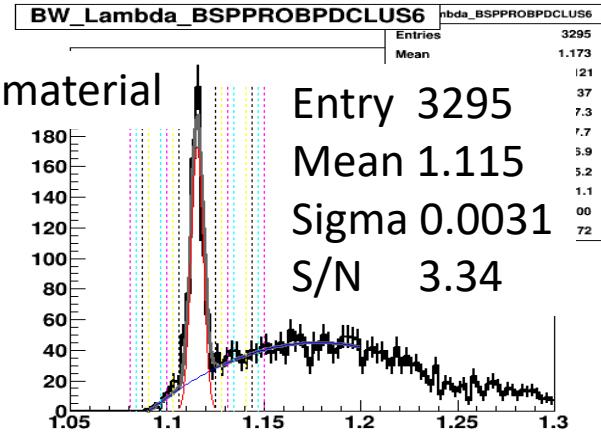
BPD timing for the 2 segments cluster  
younger # → larger dE

# $p, \pi$ - invariant mass

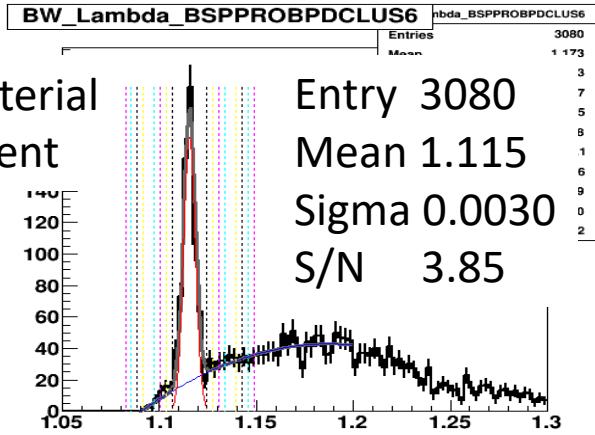
- original



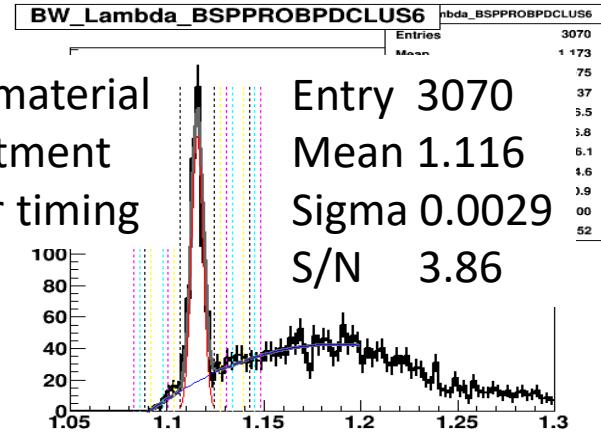
- Additional material



- Additional material
- Vertex treatment



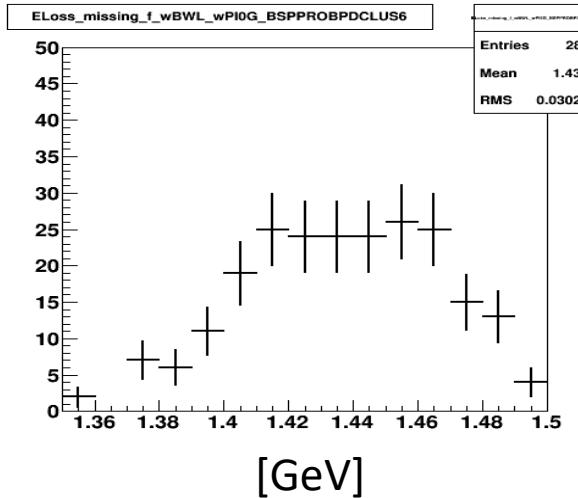
- Additional material
- Vertex treatment
- BPD Cluster timing



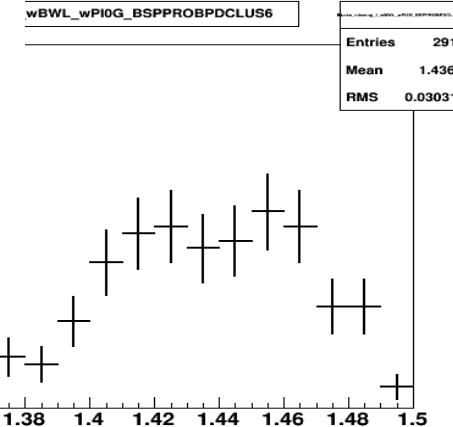
# $d(K^-, n)\Sigma^0\pi^0$ missing mass

- Condition
  - $p, \pi$ - invariant mass  $\Lambda$  selection
  - $d(K^-, n\Lambda)X$   $0.18 < X < 0.30$  GeV

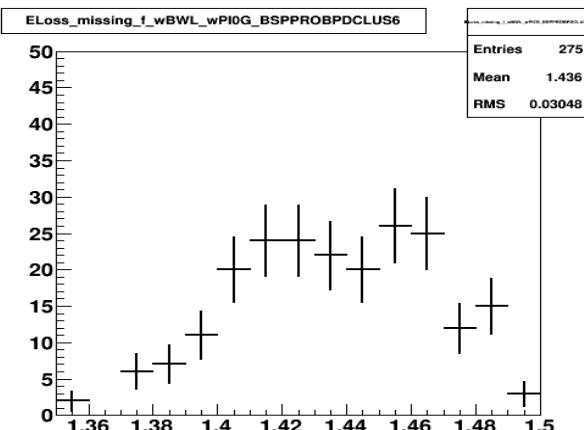
- original



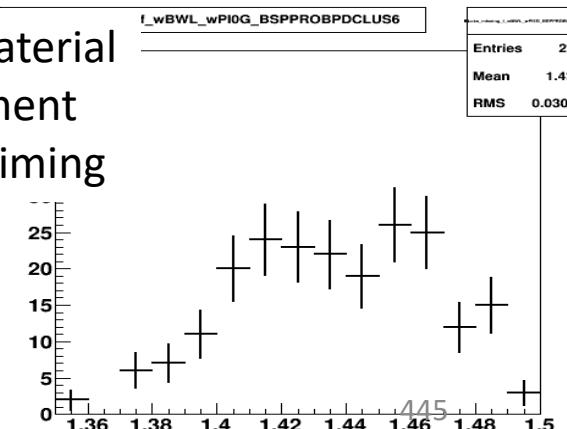
- Additional material



- Additional mate
- Vertex treatmer



- Additional material
- Vertex treatment
- BPD Cluster timing



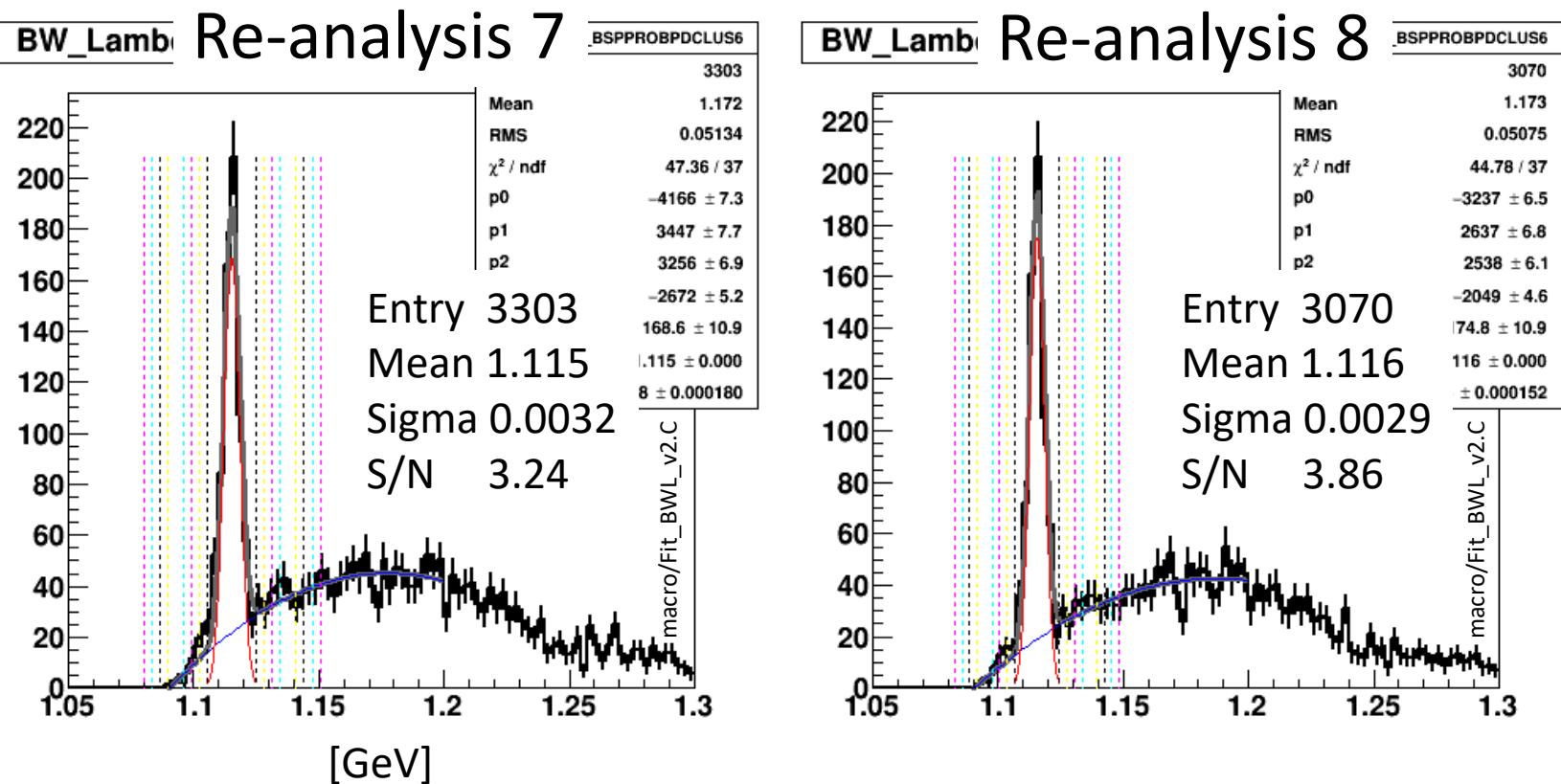
# Re-analysis 8

- Difference from Re-analysis 7
  - Additional material
  - Vertex treatment
  - BPD Cluster timing
  - Bug in Re-analysis 7 acceptance estimation
    - w/o BPC materials (ASD pole wire-flame housing etc..)

Data Name

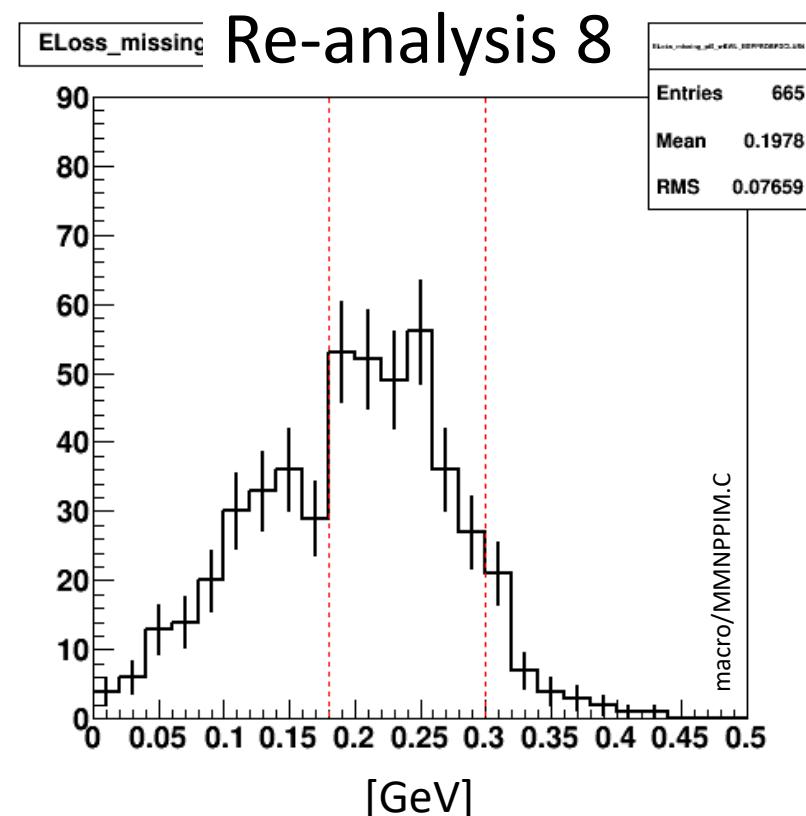
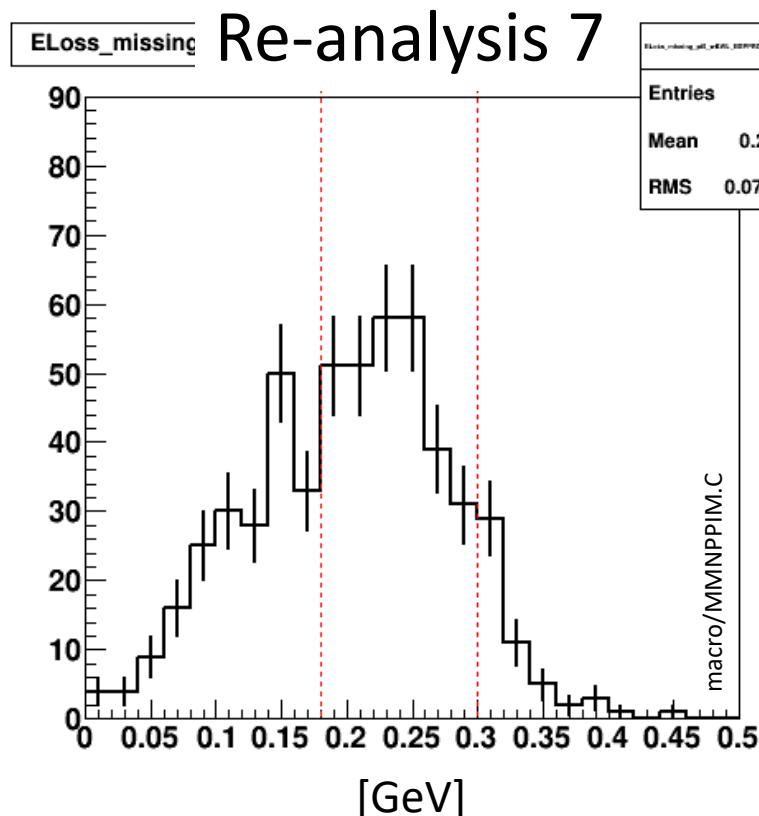
Re-analysis 7	Re-analysis 8
v32_Run78_S0PIOwBPDTRIG_v41	v35_Run78_S0PIOwBPDTRIG_v46
v32_L1405plane_S0_v44	vv2_L1405plane_S0_v57

# $p, \pi$ - invariant mass



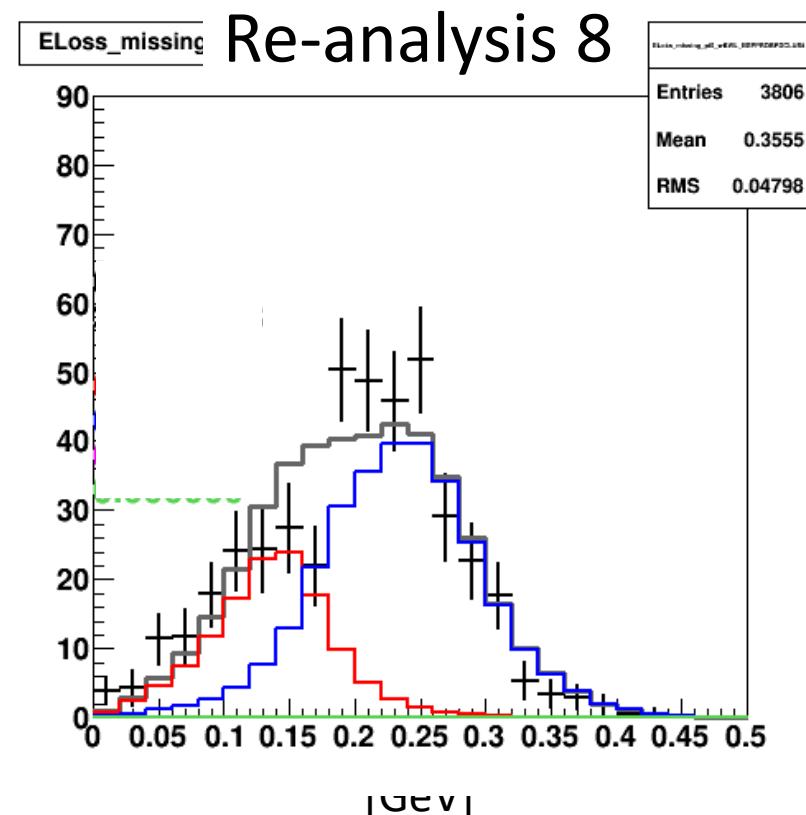
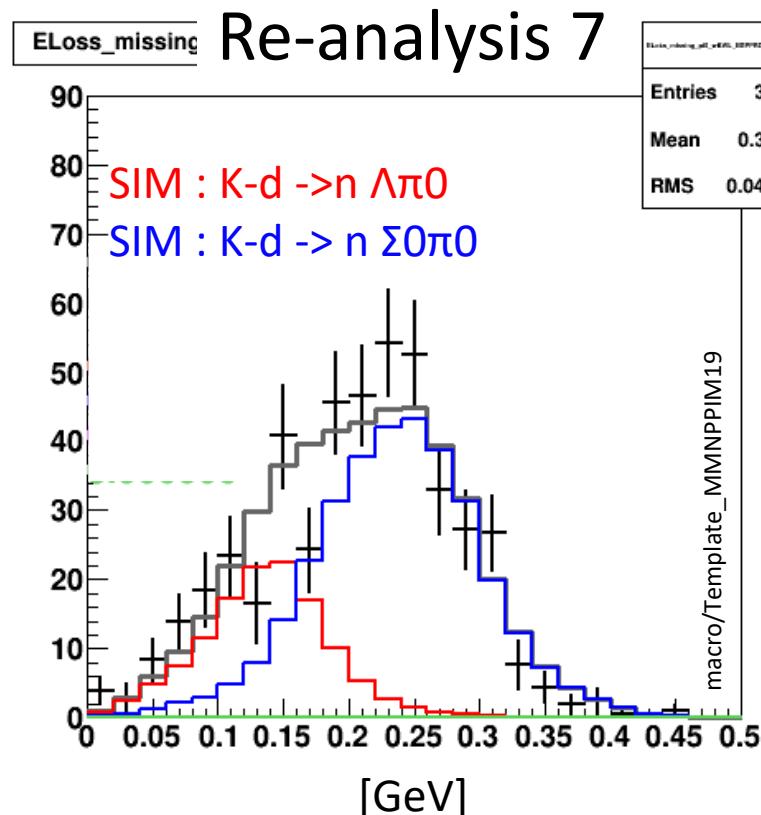
# $d(K^-, n\Lambda)$ missing mass

$\Lambda$  selection from  $p, \pi$ - invariant mass  
w/o subtraction of BG in  $\Lambda$



# Fitting of $d(K^-, n\Lambda)$ missing mass

$\Lambda$  selection from  $p, \pi$ - invariant mass  
w/ subtraction of BG in  $\Lambda$



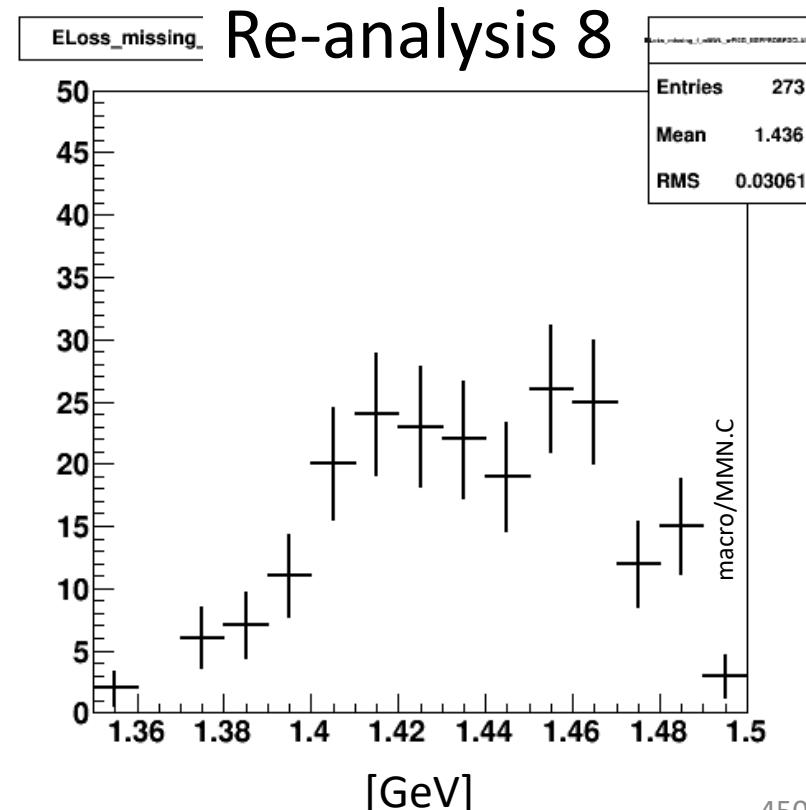
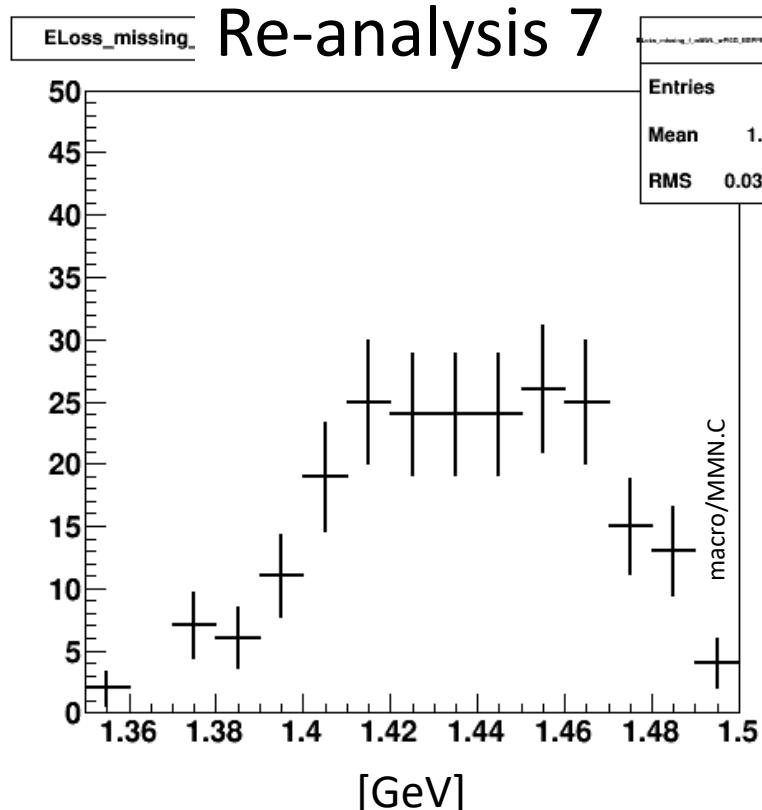
# $d(K_-, n)\Lambda\bar{\Lambda} \pi^0$ missing mass

$\Lambda$  selection from  $p, \pi$ - invariant mass

$d(K_-, n\Lambda)\Lambda\bar{\Lambda} X$   $0.18 < X < 0.30$  GeV

w/o subtraction of BG in  $\Lambda$

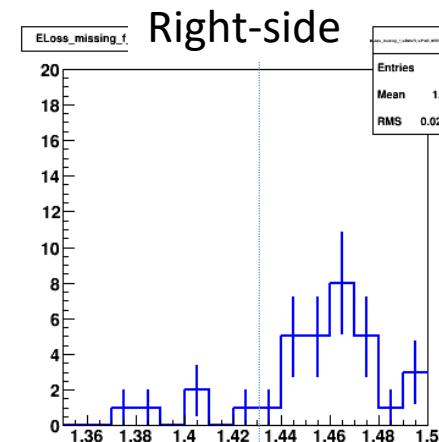
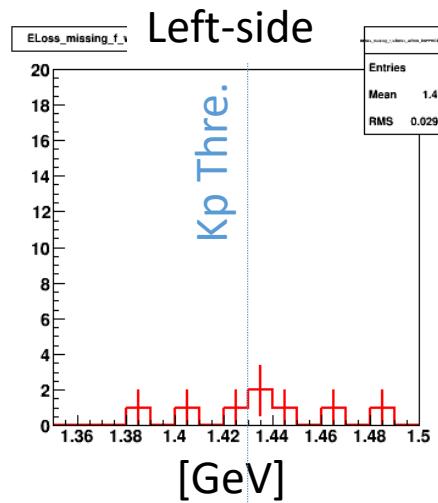
w/o subtraction  $\Lambda\pi^0$  contribution



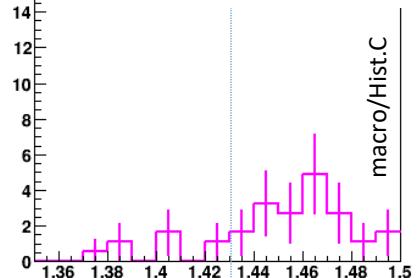
# BG in $\Lambda$ selection estimated by side-band

**d(K-,n) missing mass ( $\pi^0\gamma$  selection)**

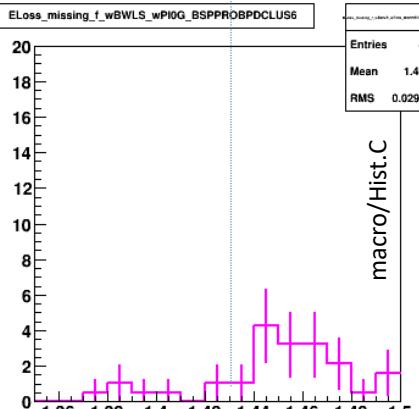
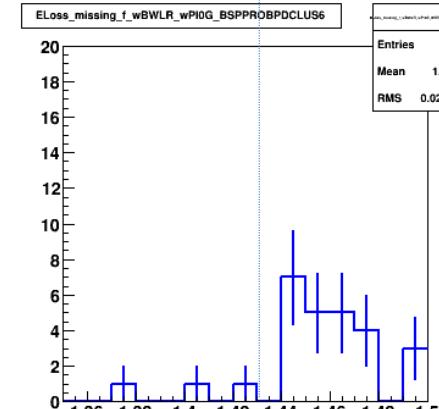
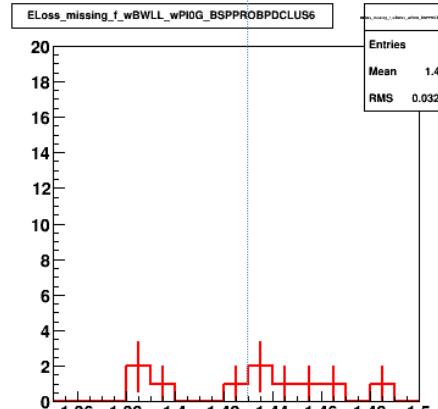
Re-analysis 7



**Left + Right  
Normalized  
by the noise event**

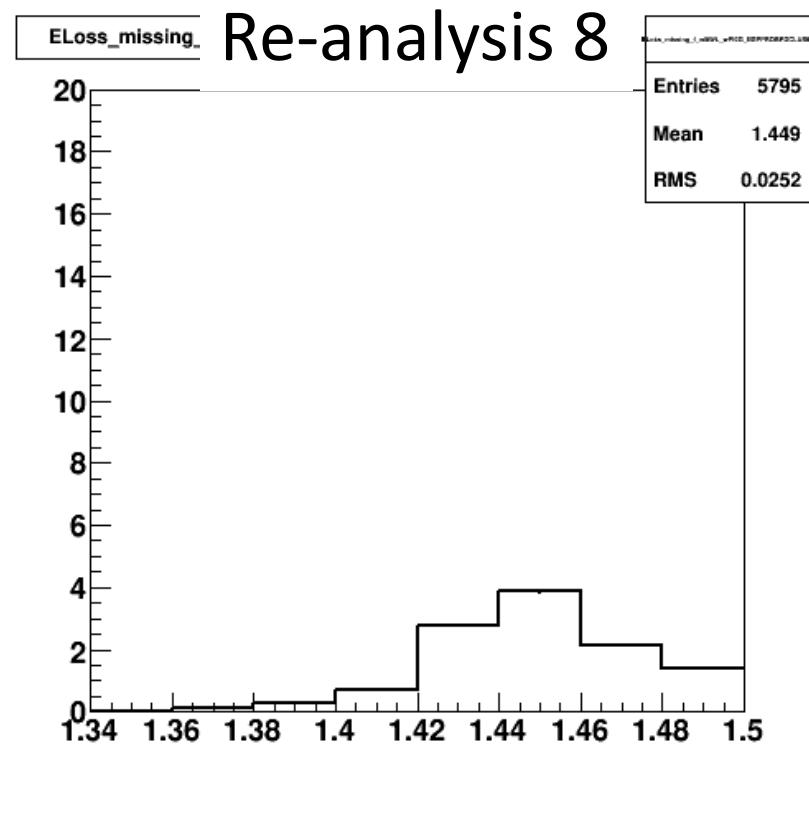
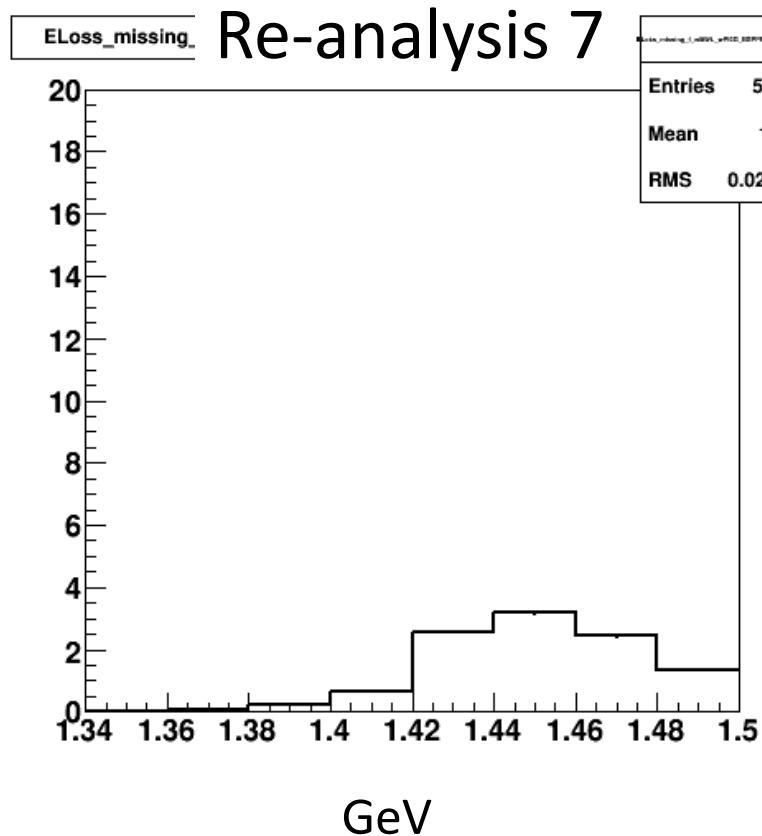


Re-analysis 8



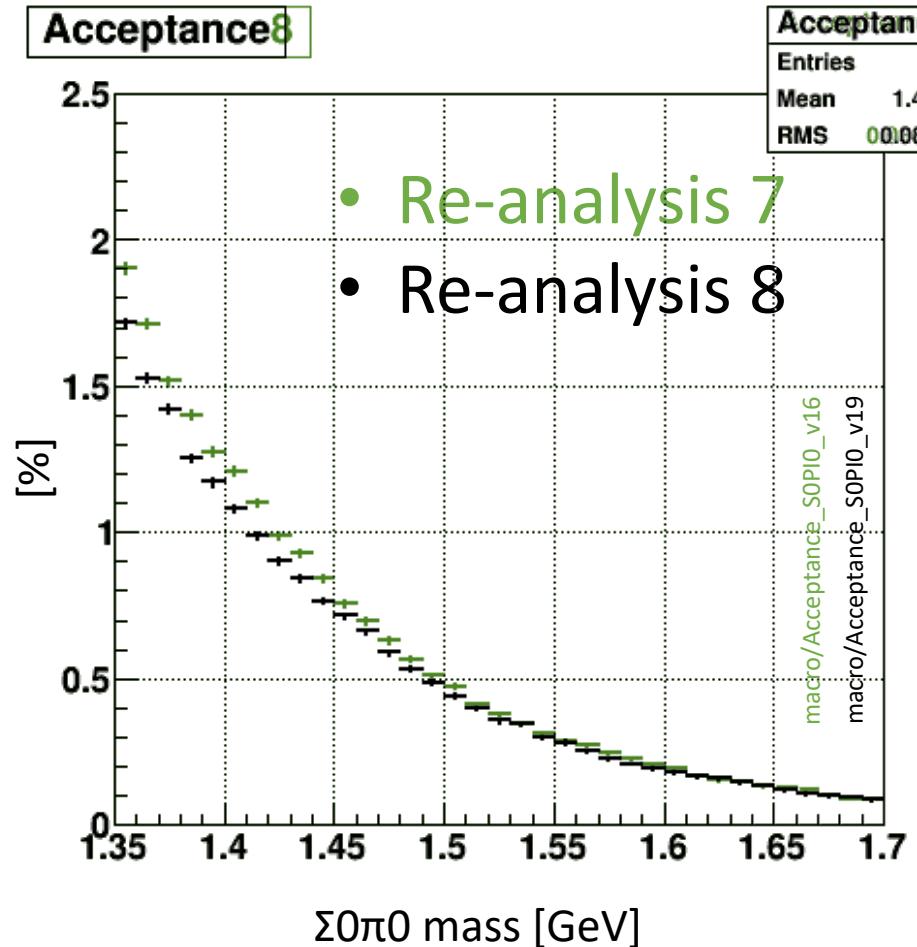
BG ; K-d  $\rightarrow \Lambda\pi^0 n$

d(K-,n) missing mass ( $\pi^0\gamma$  selection)



# Acceptance estimation

- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample

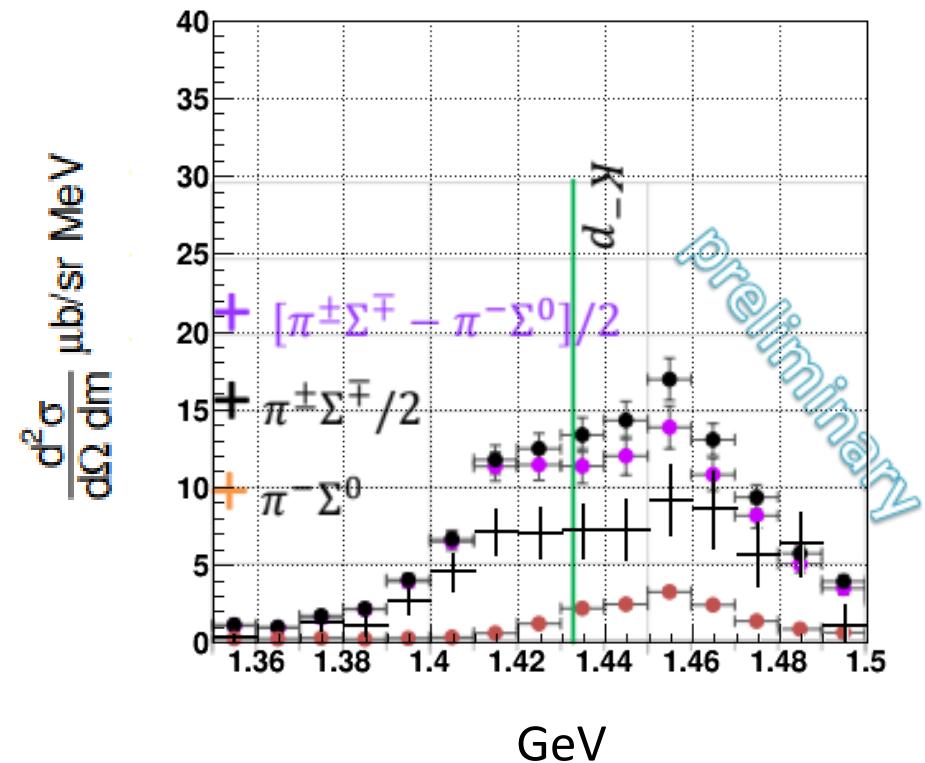


- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)/X \quad 0.18 < X < 0.30 \text{ GeV}$

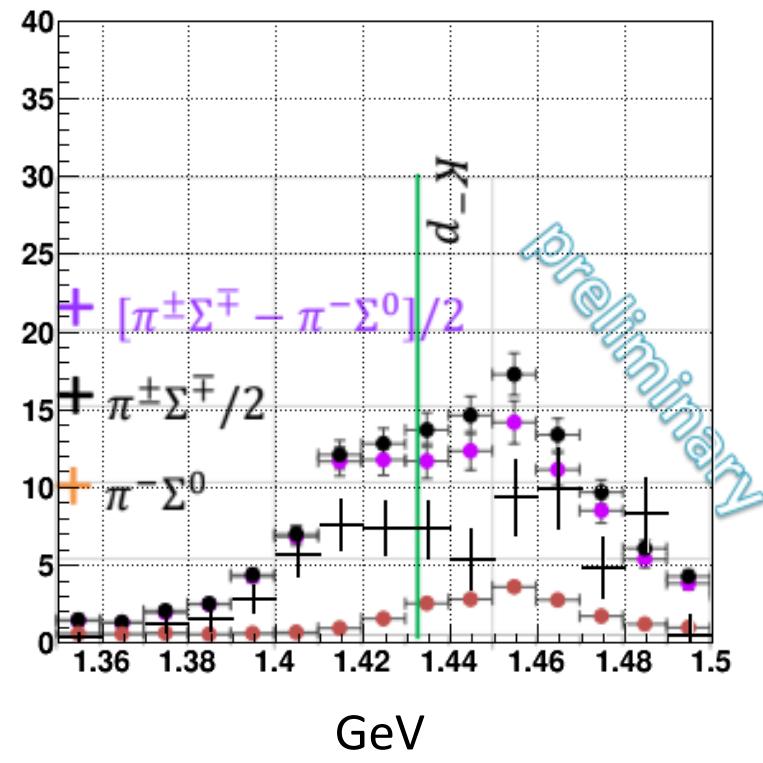
- Lumi ;  $8083 \pm 160$  [/ $\mu$ b]
  - Scaler Kaon 58.3 G
  - Survival ratio  $0.314 \pm 0.000350$
  - DAQ eff  $0.7708 \pm 0.0000128$
  - Trig. KCDH1  $0.9527 \pm 0.0003$
  - Trig. Neutral  $0.9999 \pm 0.0000067$
- $\Omega\text{-nc}$  ;  $0.0214832 \pm 0.000207563$  [sr]
- $\varepsilon\text{-nc}$  ;  $0.291 \pm 0.015$
- $\varepsilon\text{-bpc}$  ;  $0.999 \pm 0.000$
- $\varepsilon\text{-cdc}$  ;  $0.977 \pm 0.004$
- Acc ; simulation (including BR ( $\Sigma 0 \pi 0 \rightarrow p\pi - \gamma\pi 0$ ; 0.639))

# Cross section

Re-analysis 7



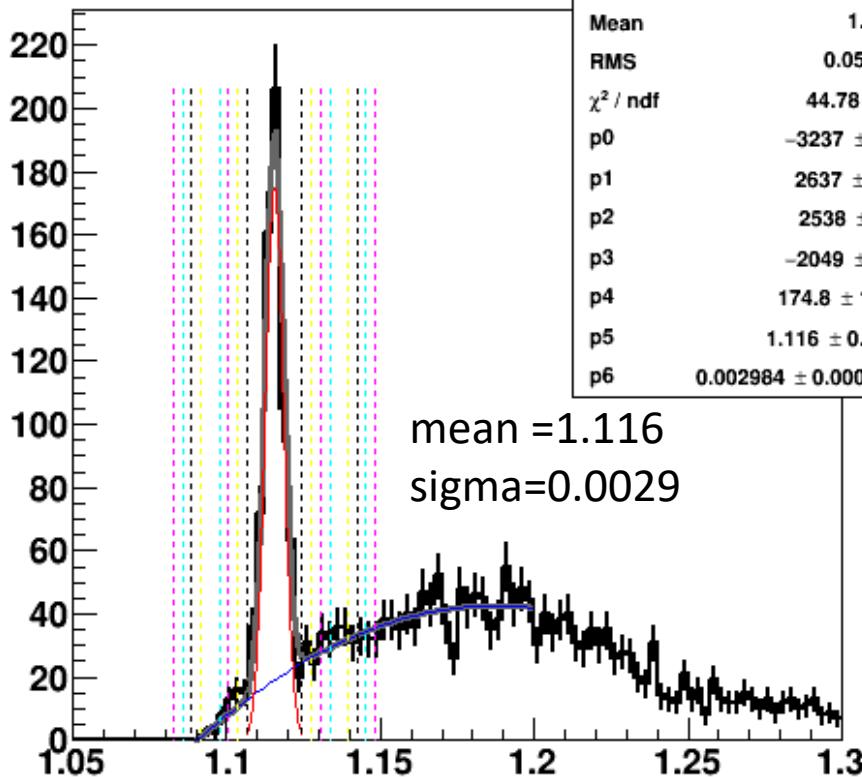
Re-analysis 8



# p, $\pi$ - invariant mass $\Lambda$ selection side-band check

Re-analysis 8

nbda_BSPPROBPDCLUS6	
Entries	3070
Mean	1.173
RMS	0.05075
$\chi^2 / \text{ndf}$	44.78 / 37
p0	$-3237 \pm 6.5$
p1	$2637 \pm 6.8$
p2	$2538 \pm 6.1$
p3	$-2049 \pm 4.6$
p4	$174.8 \pm 10.9$
p5	$1.116 \pm 0.000$
p6	$0.002984 \pm 0.000152$



Noise/(left + right)

0.549898

0.805597

0.535486

0.837758

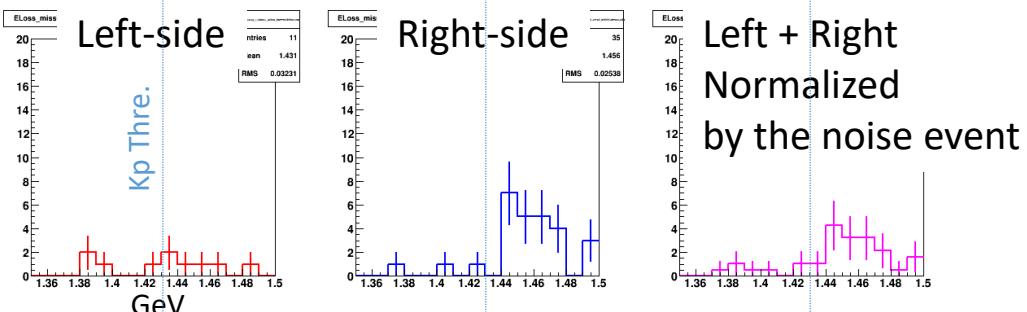
# Re-analysis 8

(default)

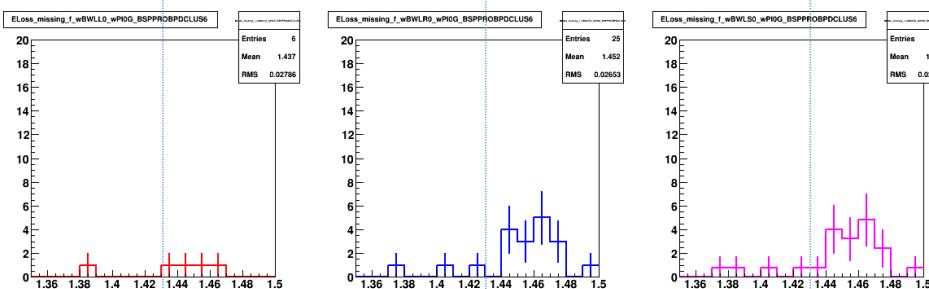
select region  
in the  $p, \pi$ - invariant mass

Center  $\pm 6\sigma$   
Width  $\pm 3\sigma$

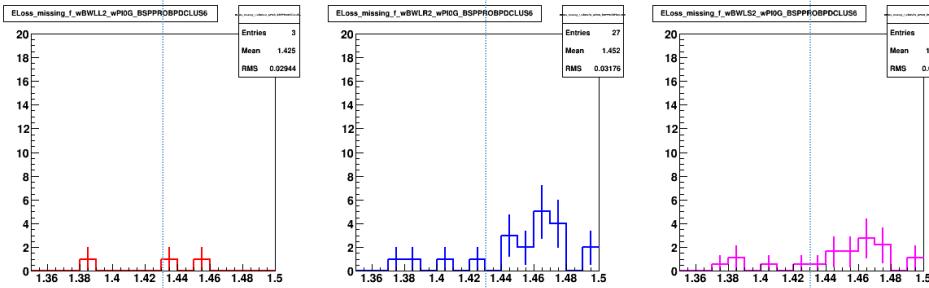
## $d(K, n)$ missing mass ( $\pi 0 \gamma$ selection)



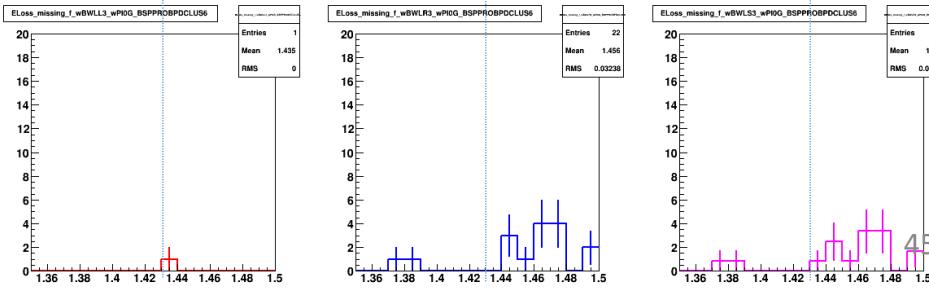
Center  $\pm 6\sigma$   
Width  $\pm 2\sigma$



Center  $\pm 8\sigma$   
Width  $\pm 3\sigma$



Center  $\pm 8\sigma$   
Width  $\pm 2\sigma$



# Re-analysis 2 ( $d(K^-, n)^{\prime\prime}\Sigma^+ \pi^-$ )

## Difference from Page 15 (Re-analysis 1)

- Same condition as  $d(K^-, n)^{\prime\prime}\Sigma^0 \pi^0$  Re-analysis 8
  - Re-analysis log
    - BPC hit pos  $R < 16$
    - w/o BPC-BPD Matching
    - BPC XY  $\geq 3 \rightarrow$  BPC XY 4 hit
    - Light velocity 15  $\rightarrow$  11 ns
    - BPC cut @ BPD 3<sup>rd</sup> quadrant
    - Additional material
    - BPD Cluster timing

Data Name

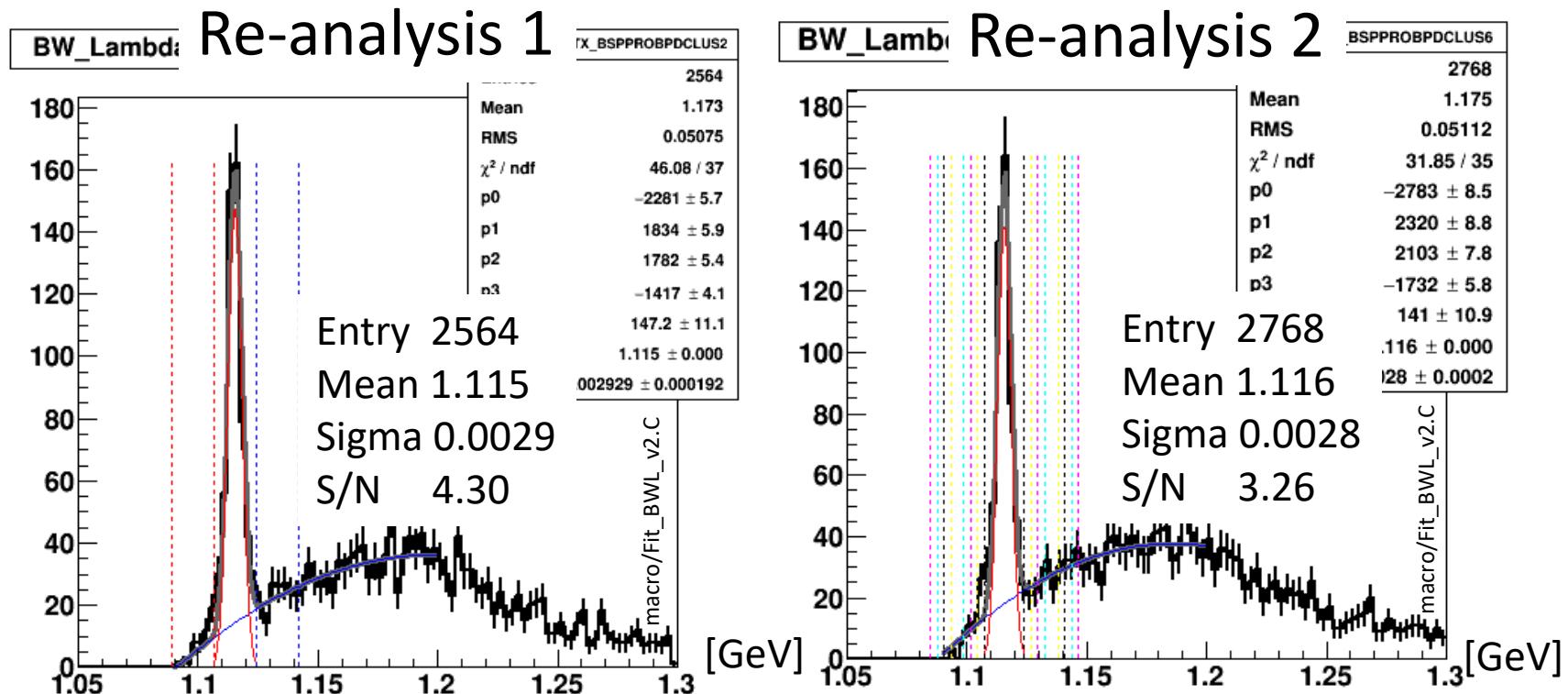
Re-analysis 1

v27\_Run78\_SPPIMwBPDTRIG\_v39SP  
v27\_L1405plane\_SP\_v27

Re-analysis 2

vv2\_Run78\_SPPIMwBPDTRIG\_v46SP  
vv2\_L1405plane\_SP\_v28

# $p, \pi$ - invariant mass

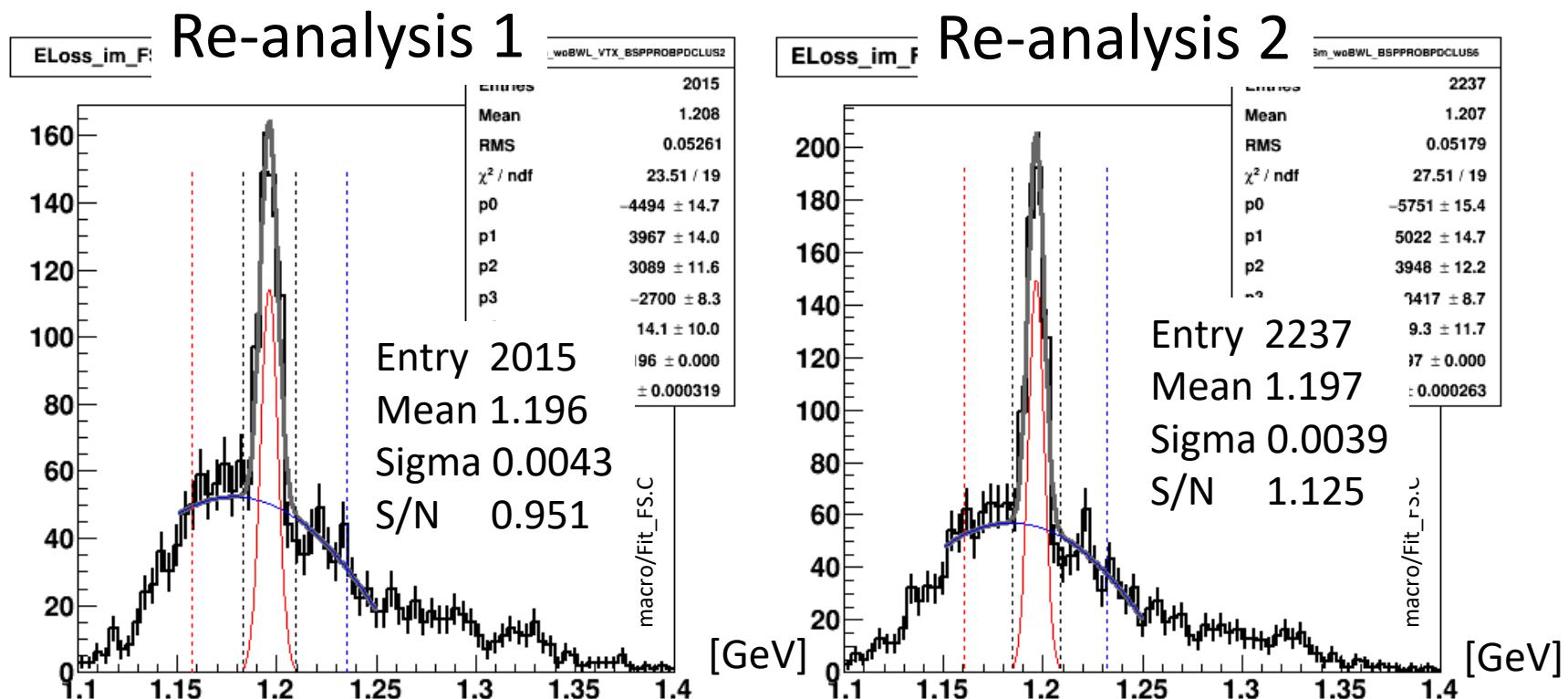


Proton momentum is analyzed as  $\Sigma$  decay in both figures  
Need to correct analysis as  $\Lambda$  decay proton

$\Lambda$  rejection  $\pm 3\sigma$  around peak

# $n\pi$ - invariant mass

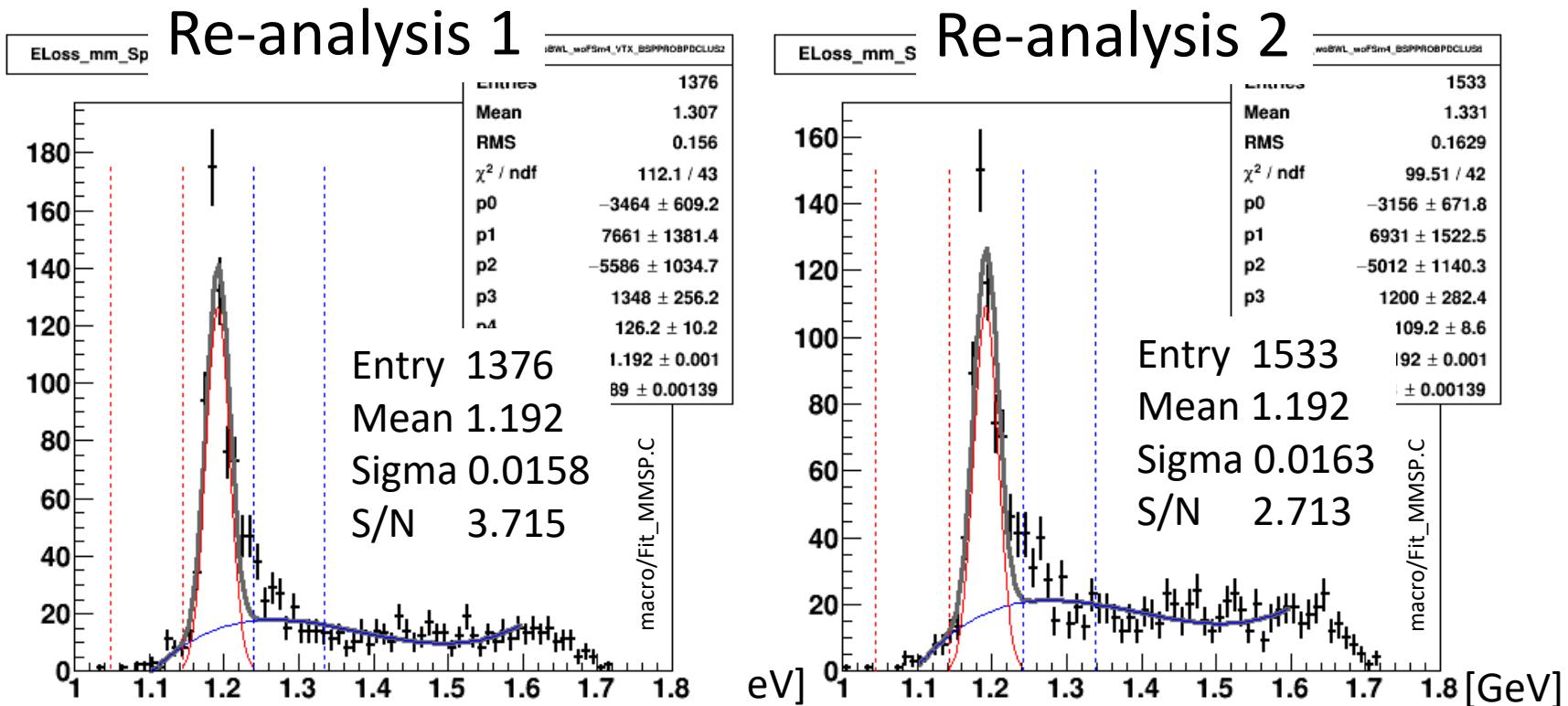
$\Lambda$  is rejected from  $p,\pi$  invariant



$\Sigma$ - rejection  $\pm 3\sigma$  around peak

# $d(K^-, np\pi^-)''X''$ missing mass

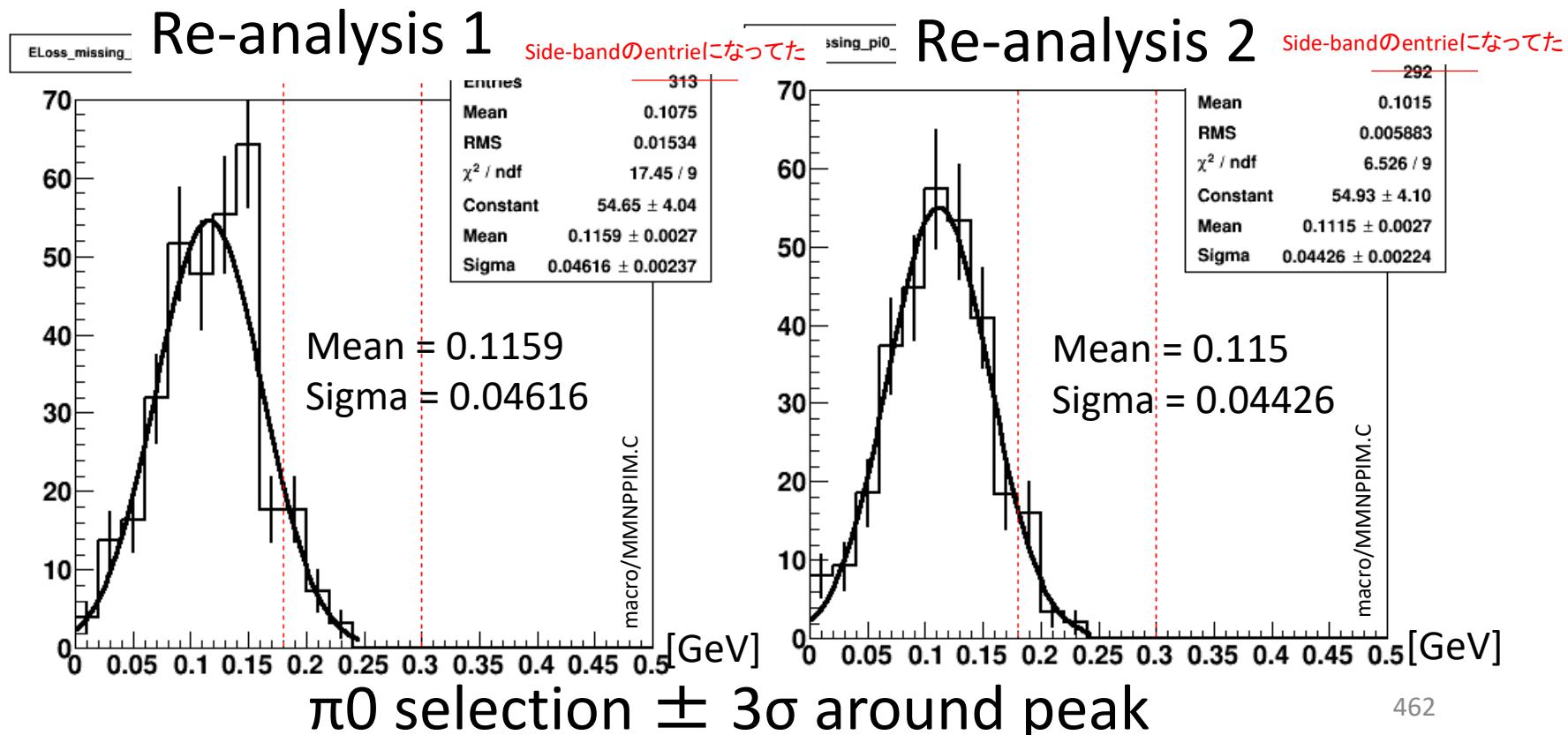
$\Lambda$  is rejected from  $p, \pi$  invariant  
 $\Sigma^-$  is rejected from  $n, \pi^-$  invariant



$\Sigma^+$  selection  $\pm 3\sigma$  around peak

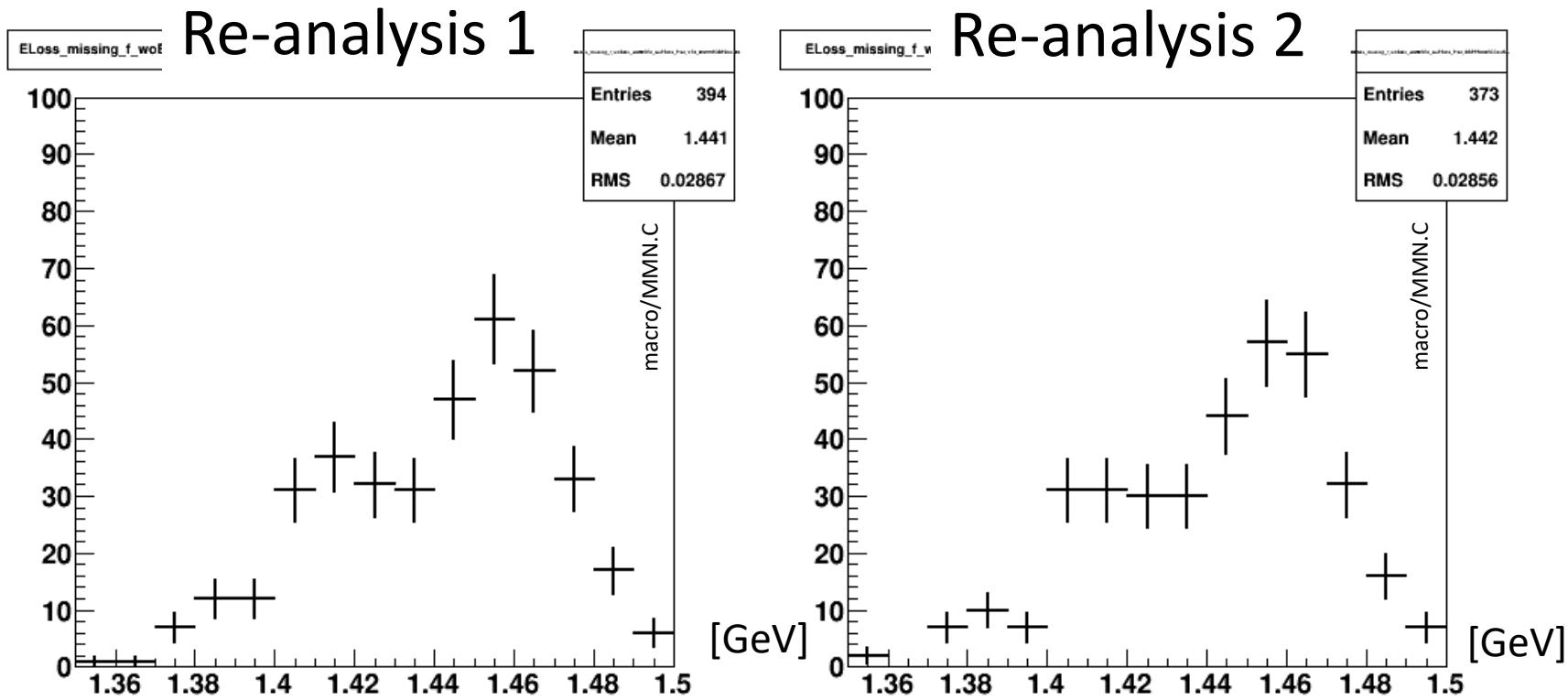
# $d(K-n\pi^-)$ missing mass

$\Lambda$  is rejected from  $p, \pi$  invariant  
 $\Sigma^-$  is rejected from  $n, \pi^-$  invariant  
 $\Sigma^+$  is selected from missing mass  $d(K^-, n\pi^-)$   
w/ subtraction of BG in  $\Sigma^+$   
 $\pi^0$  is selected from missing mass  $d(K^-, n\pi^-)$



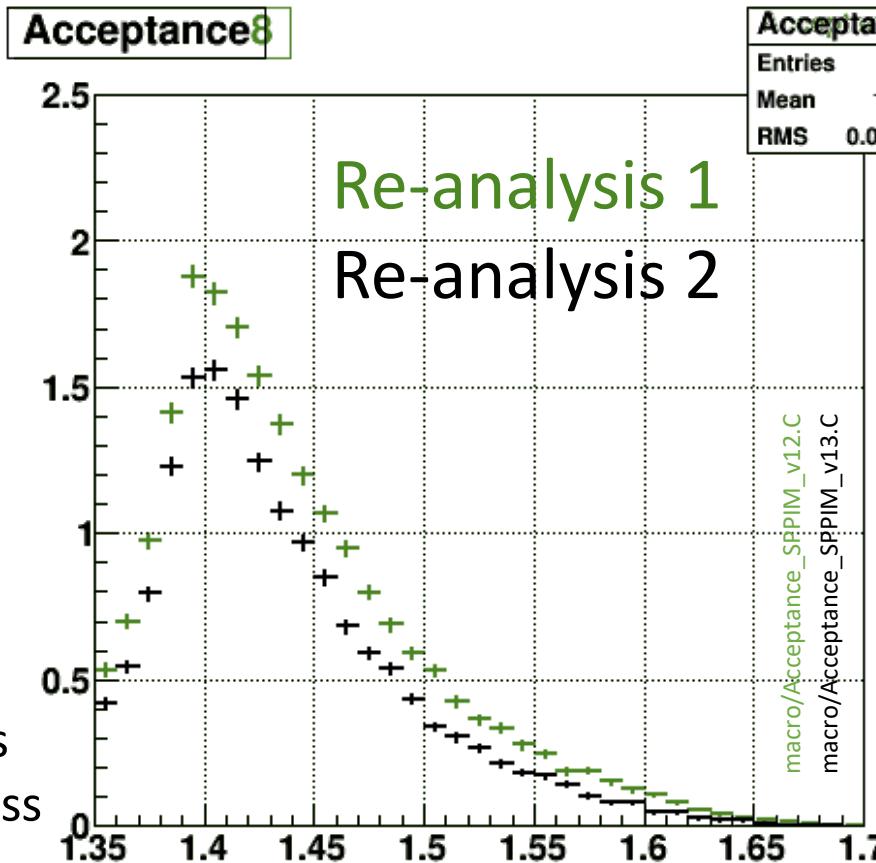
# $d(K^-, n)''\Sigma + \pi^-$ spectrum

$\Lambda$  is rejected from  $p, \pi$  invariant  
 $\Sigma^-$  is rejected from  $n, \pi^-$  invariant  
 $\Sigma^+$  is selected from missing mass  $d(K^-, n\pi^-)$   
 $\pi^0$  is selected from missing mass  $d(K^-, n\rho\pi^-)$



# Acceptance estimation

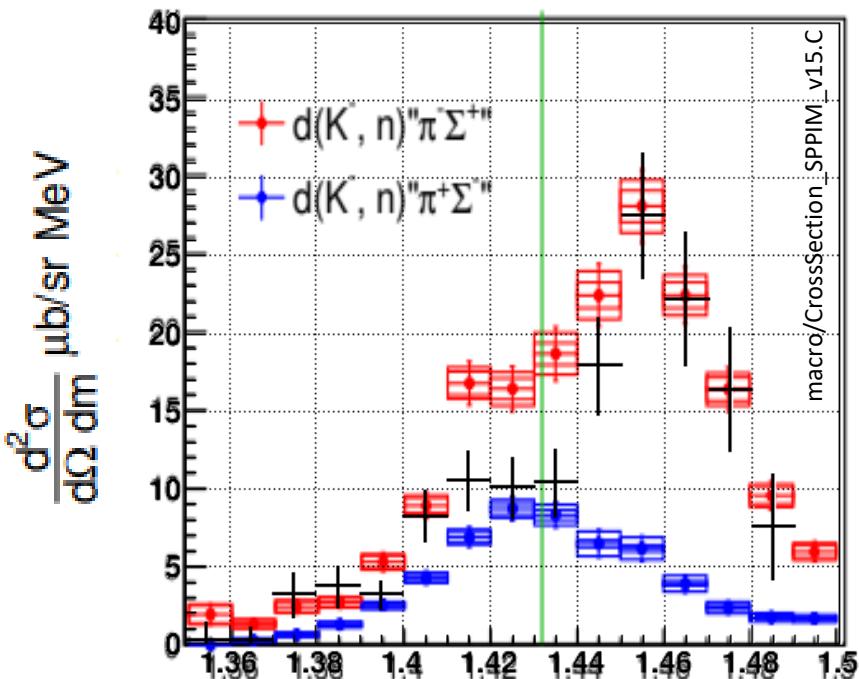
- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition
  - ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - **BVC, CVC veto in sample (Re-analysis 2)**



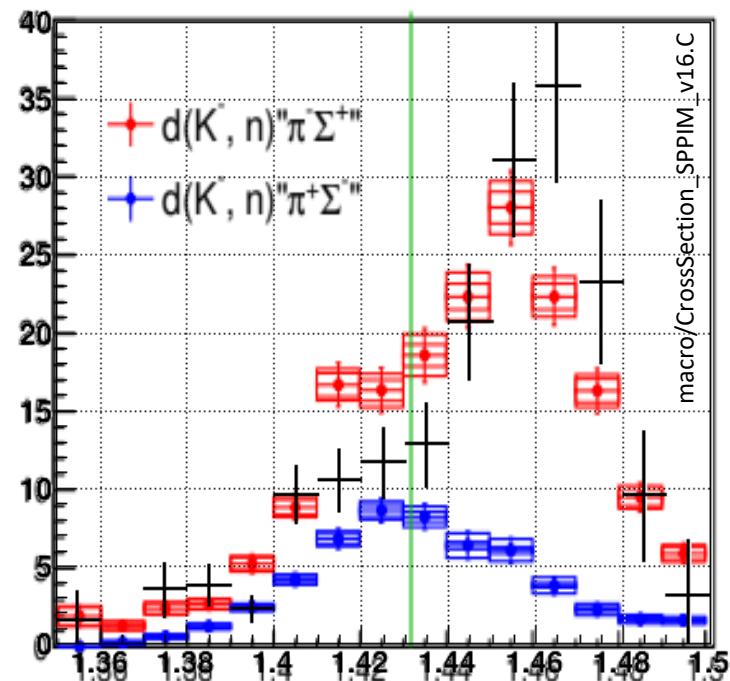
- Lumi ;  $8083 \pm 160 [\text{fb}] \times (10.0/12.5)$  Target length 12.5  $\rightarrow$  10 cm
  - Scaler Kaon 58.3 G
  - Survival ratio  $0.314 \pm 0.000350$
  - DAQ eff  $0.7708 \pm 0.0000128$
  - Trig. KCDH1  $0.9527 \pm 0.0003$
  - Trig. Neutral  $0.9999 \pm 0.0000067$
- $\Omega\text{-nc}$  ;  $0.0214832 \pm 0.000207563$  [sr]
- $\varepsilon\text{-nc}$  ;  $0.291 \pm 0.015$
- $\varepsilon\text{-bpc}$  ;  $0.999 \pm 0.000$
- $\varepsilon\text{-cdc}$  ;  $0.977 \pm 0.004$
- Acc ; simulation (including BR ( $\Sigma + \pi^- \rightarrow \pi^0 p \pi^-$ ; 0.516))

# Cross Section

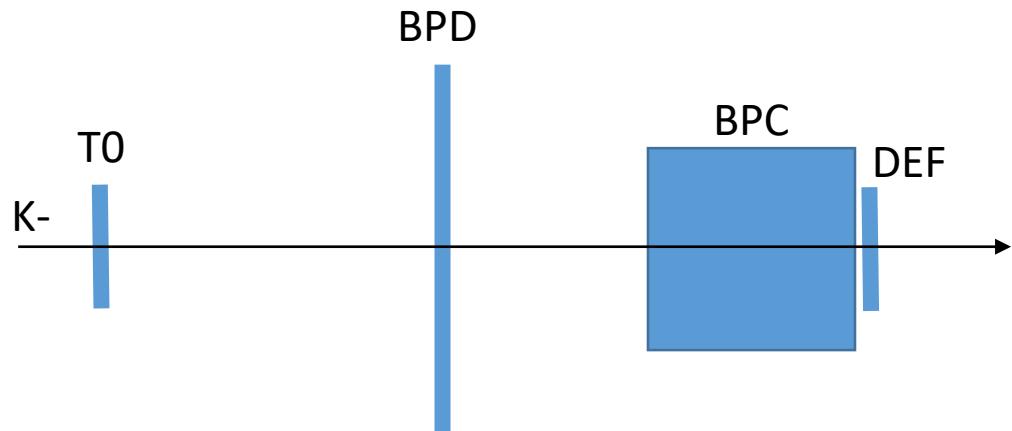
Re-analysis 1



Re-analysis 2

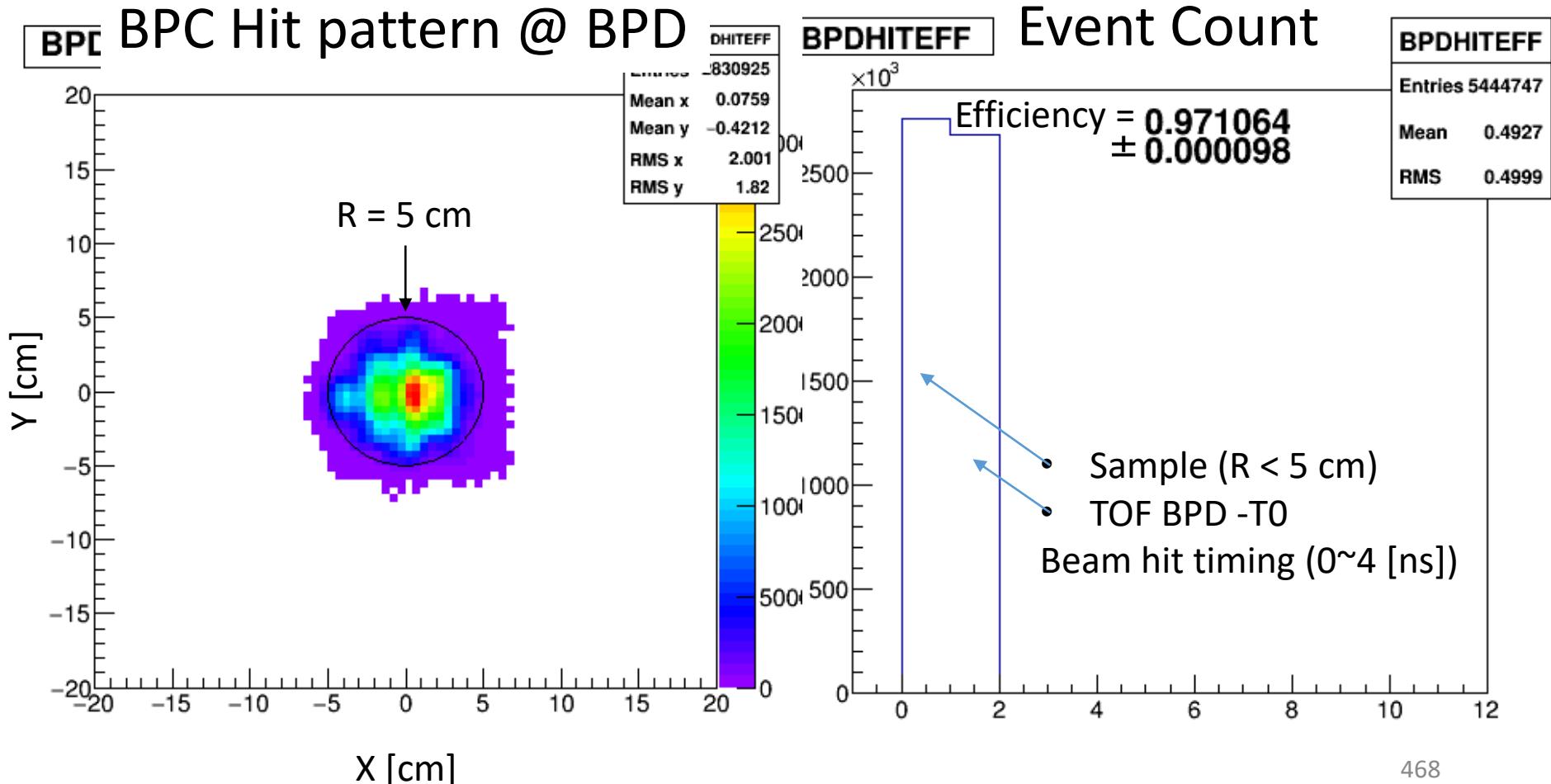


# BPD Hit efficiency by BPC Beam Track & DEF Hit

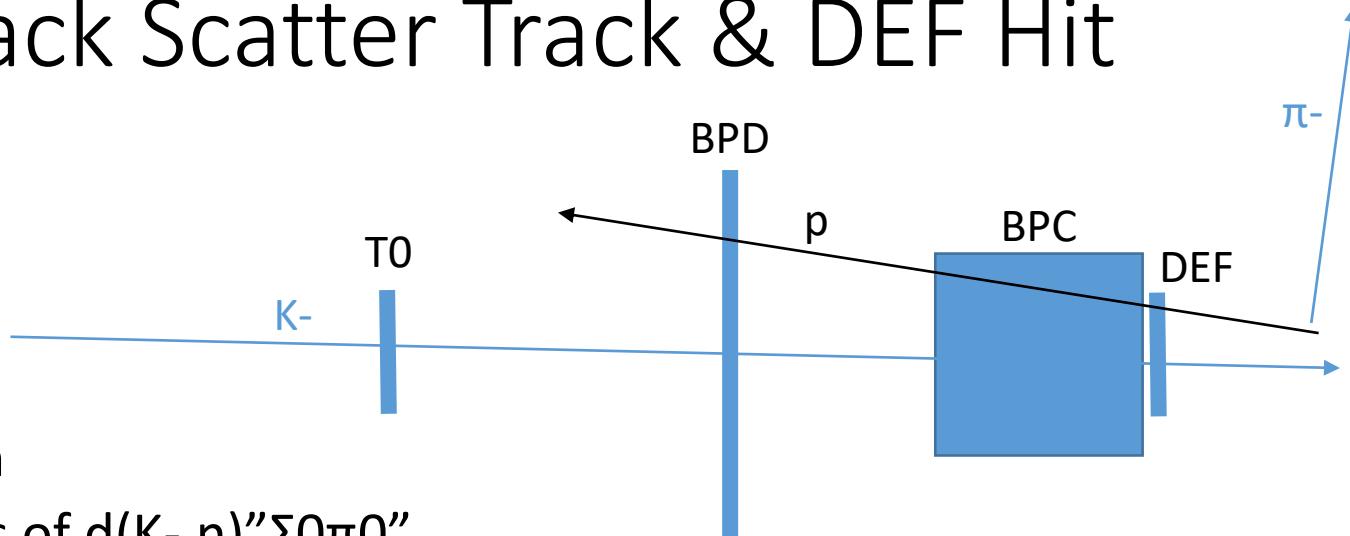


- Upstream condition
  - same as the analysis of  $d(K^-, n) \rightarrow \Sigma^0 \pi^0$
- T0 1Hit DEF 1Hit
- BPC All layer 1Hit
- BPC Hit position @DEF = DEF Hit segment
- BPC Hit position @BPD < R = 5 cm

# BPD Hit efficiency by BPC Beam Track & DEF Hit

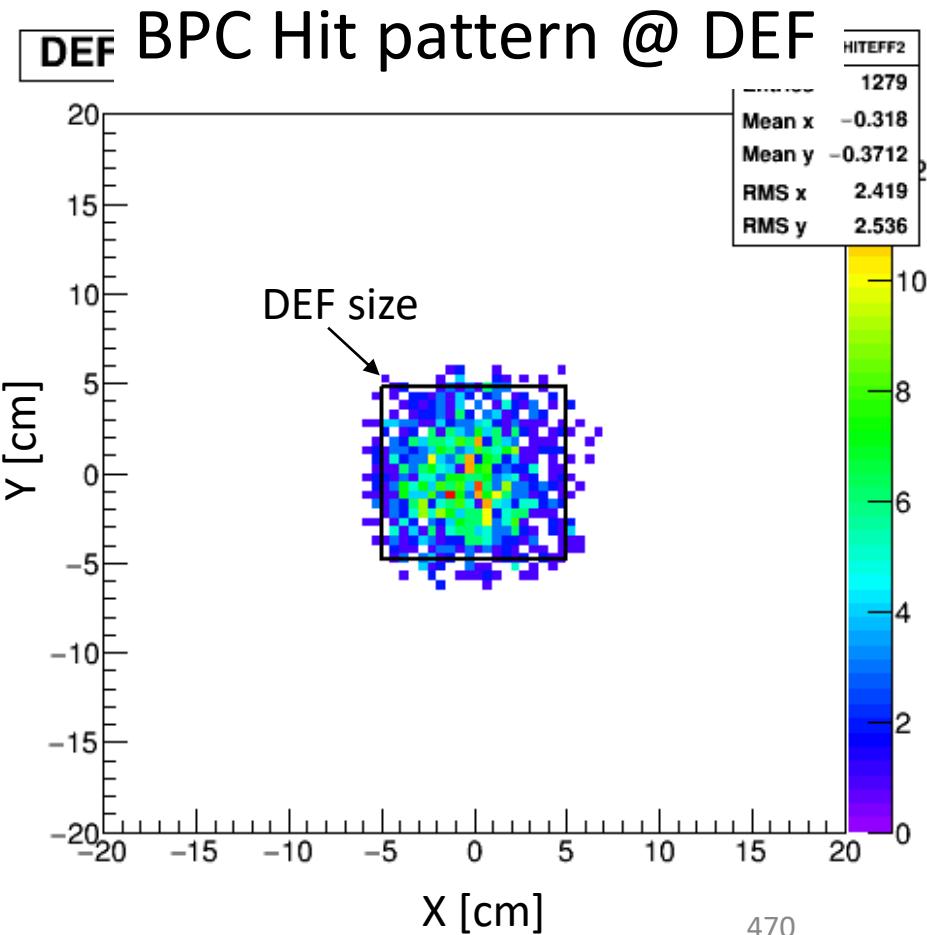
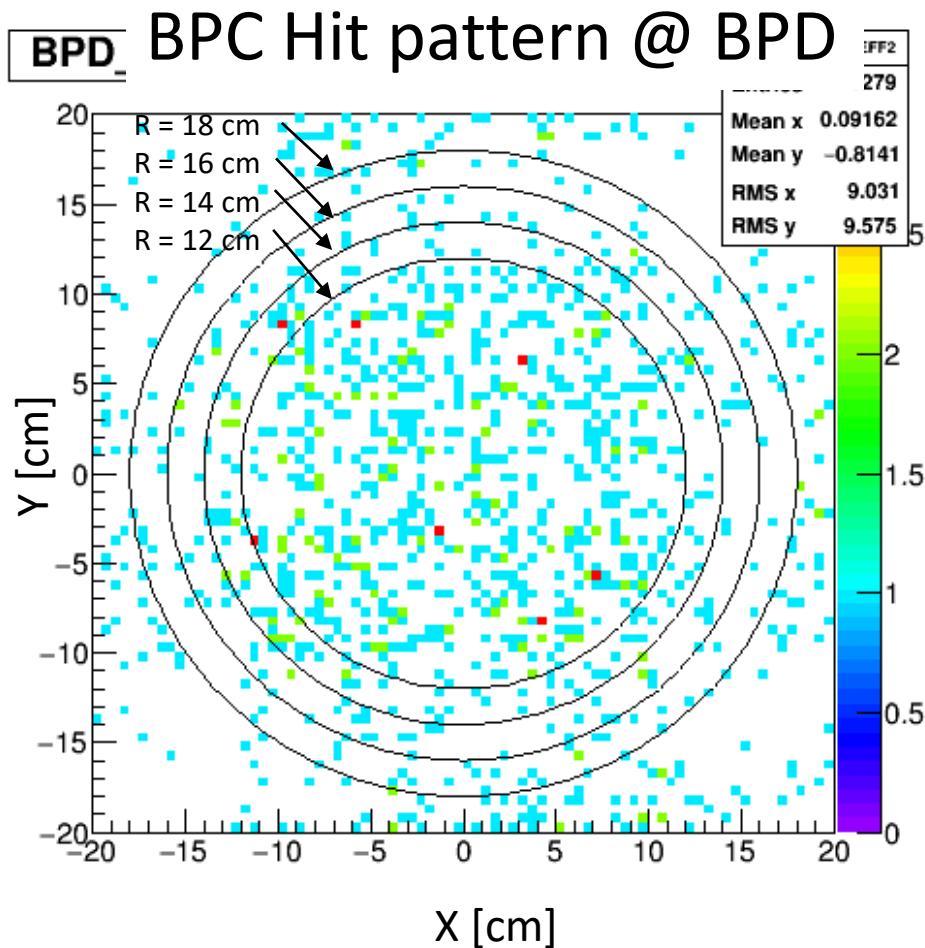


# BPD Hit efficiency by BPC Back Scatter Track & DEF Hit



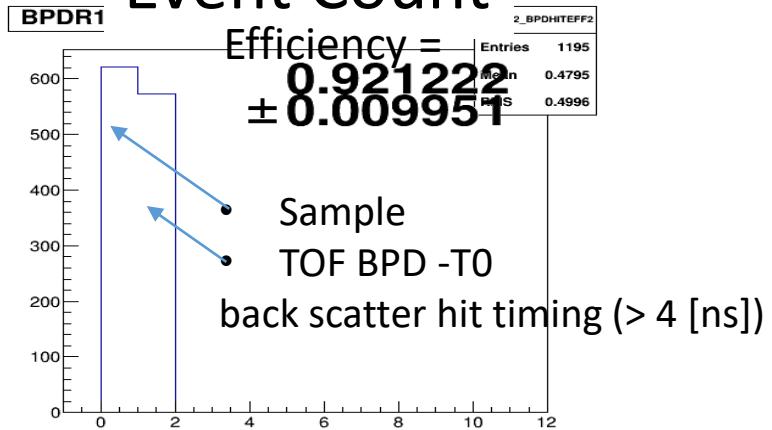
- Upstream condition  
same as the analysis of  $d(K^-, n) \Sigma^0 \pi^0$
- DEF  $dE > 3.5$  MeV
- BPC All layer 2Hit
- CDS 1Track, PID  $\pi^-$
- BPC Back Scatter Track - no Beam Track wire
- Fiducial cut by the vertex of BPC Back Scatter Track & CDS Track
- BPC Hit position @BPD  $< R = 18, 16, 14, 12$  cm
- BPC Hit position @DEF  $<$  DEF size
- w/o NC Hit for high statistics

# BPD Hit efficiency by BPC Back Scatter Track & DEF Hit

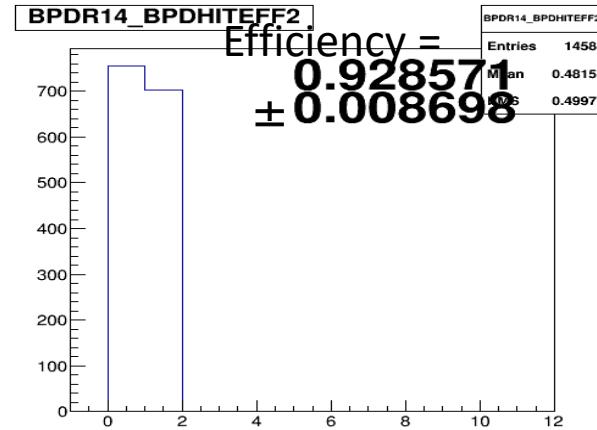


# BPD Hit efficiency by BPC Back Scatter Track & DEF Hit

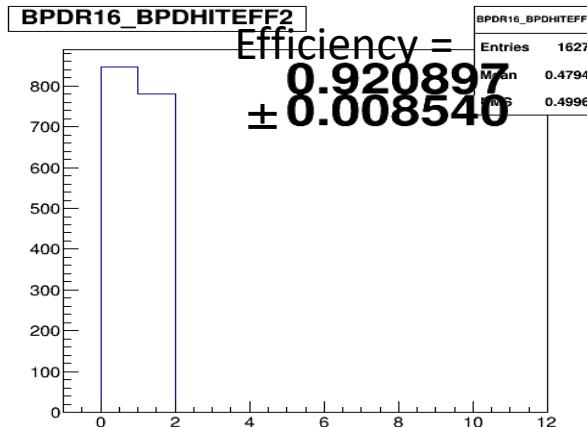
## Event Count



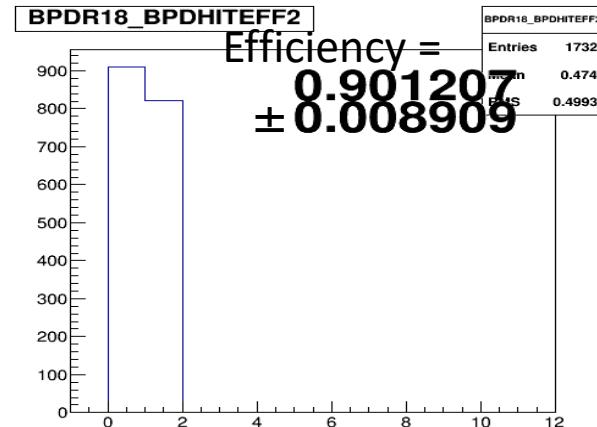
## <R=14



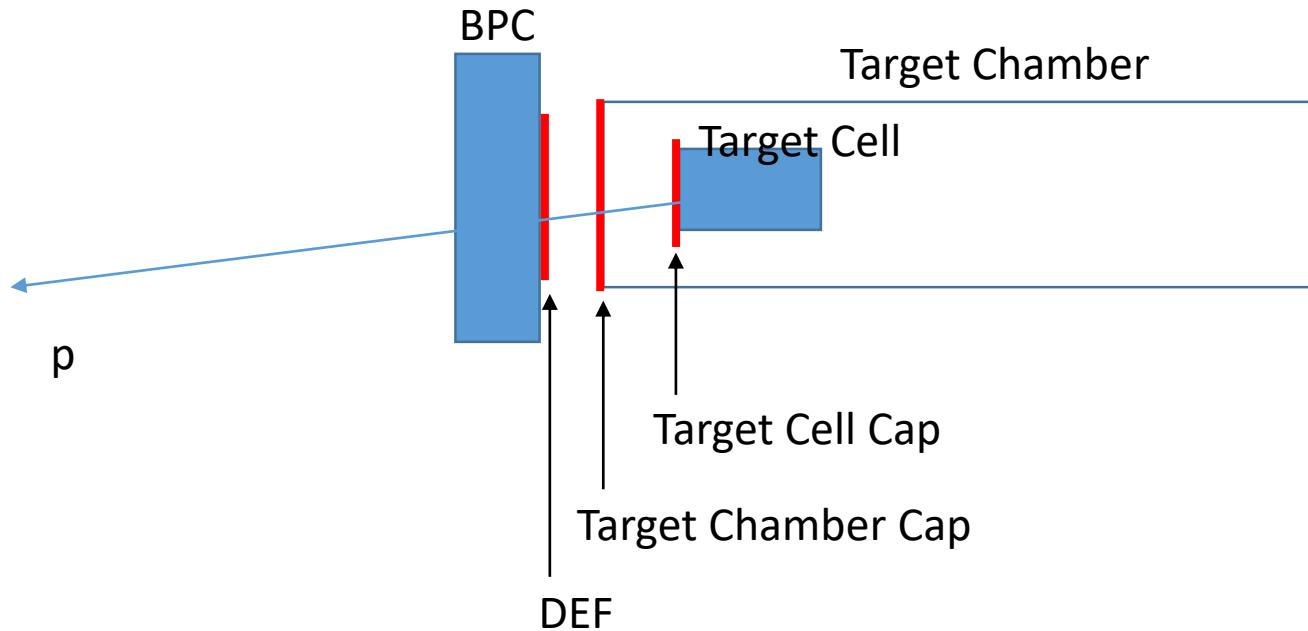
## <R=16



## <R=18



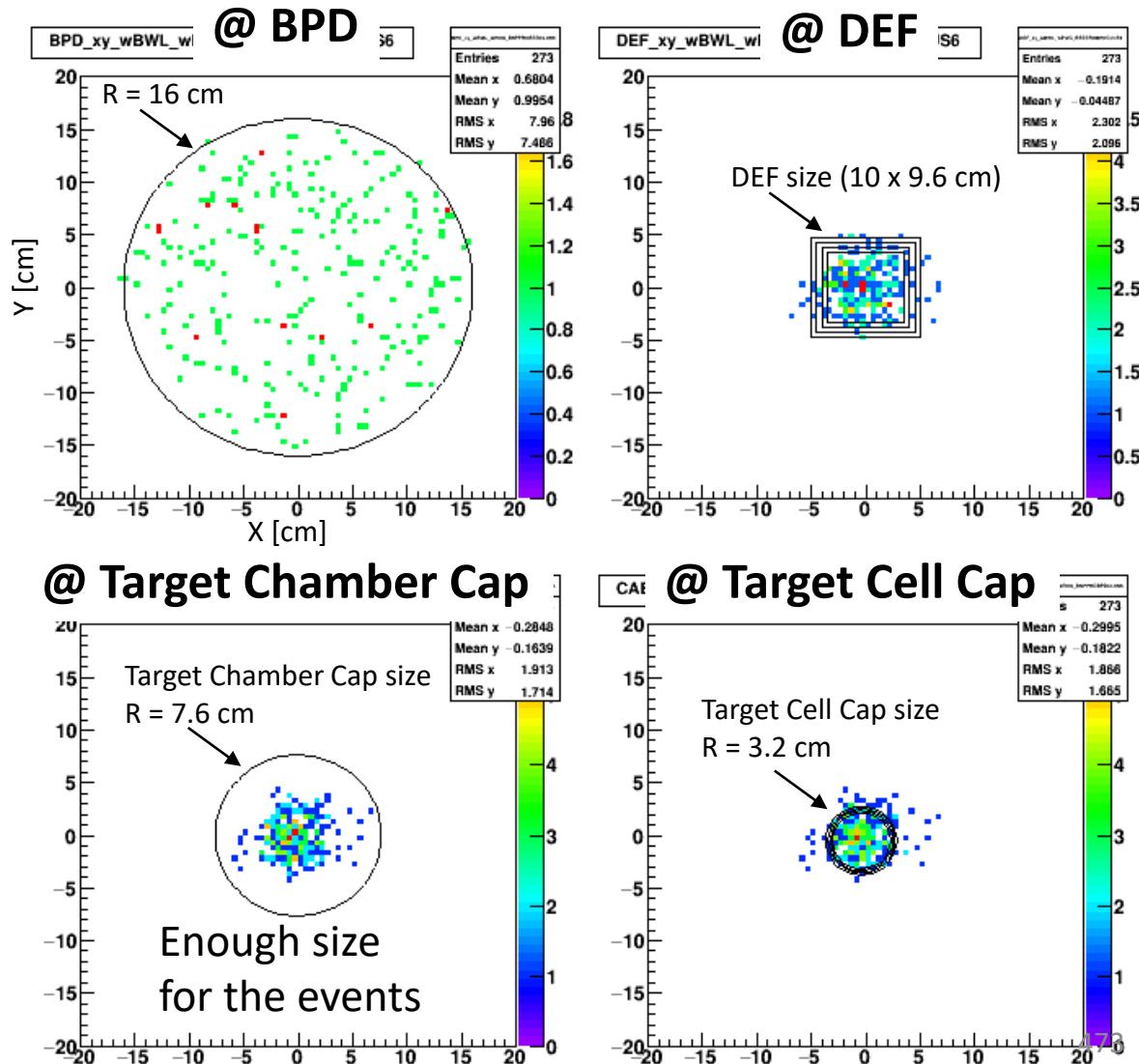
# Influence of the event from the edge of [DEF] [Target Chamber Cap] [Target Cell Cap]



# Influence of the event from the edge of [DEF] [Target Chamber Cap] [Target Cell Cap]

## BPC Hit Pattern

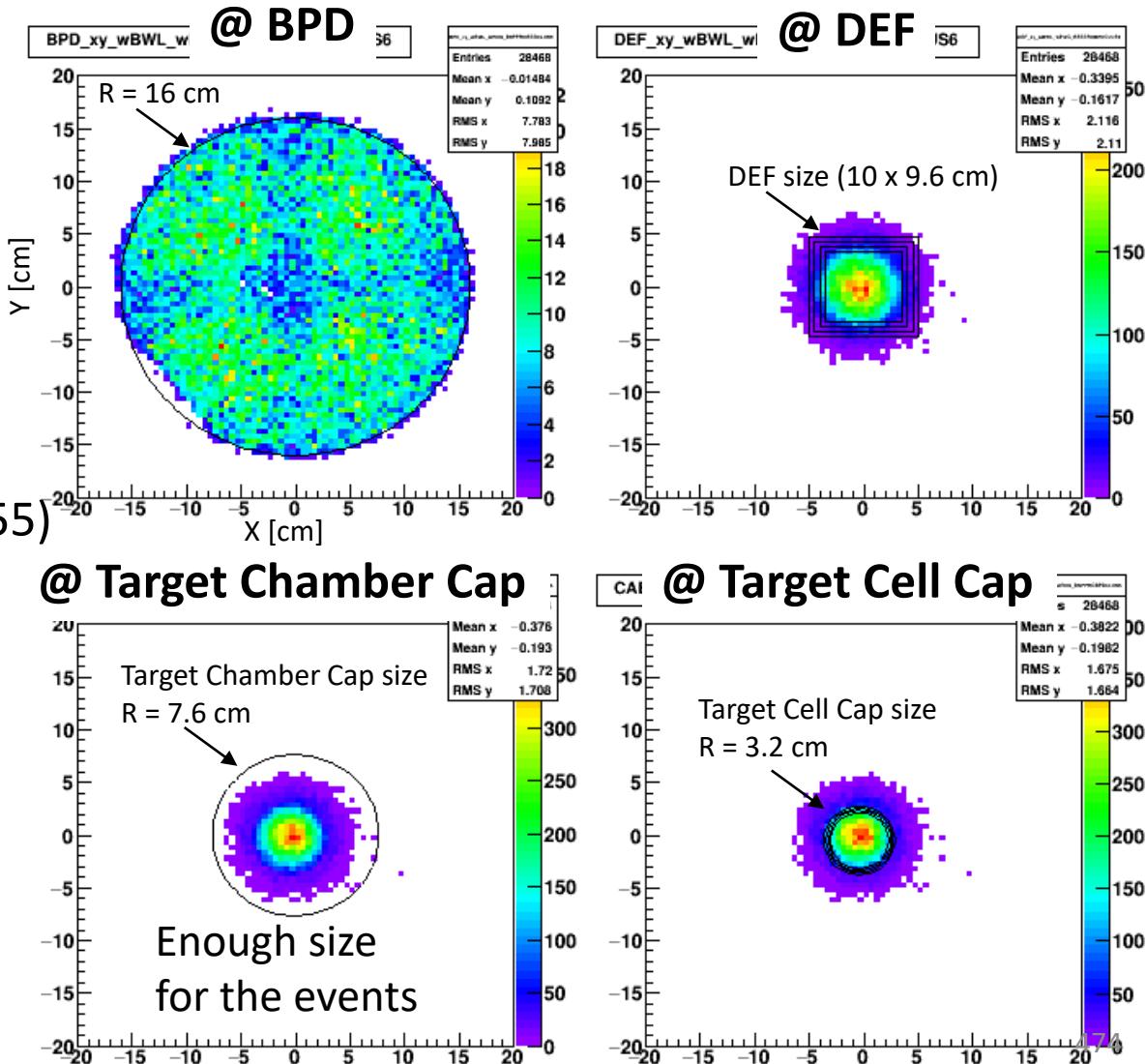
- Run78 Data
- Condition
- $\Sigma^0\pi^0$  spectrum



# Influence of the event from the edge of [DEF] [Target Chamber Cap] [Target Cell Cap]

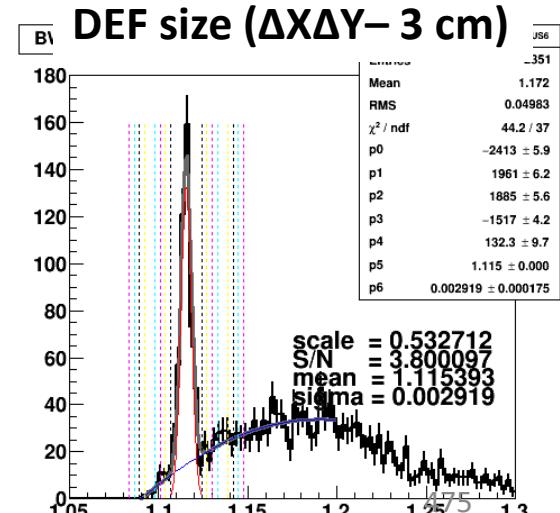
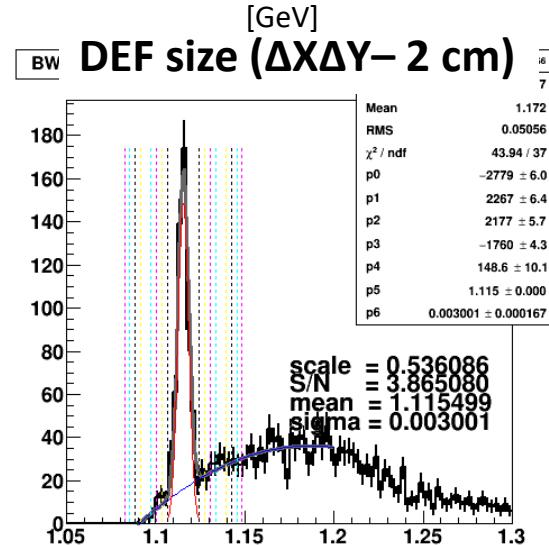
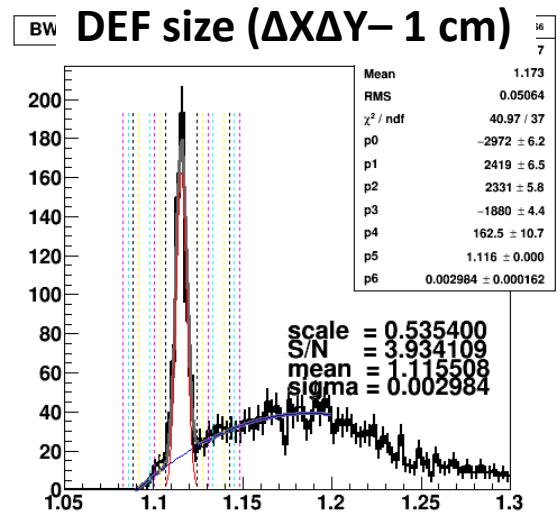
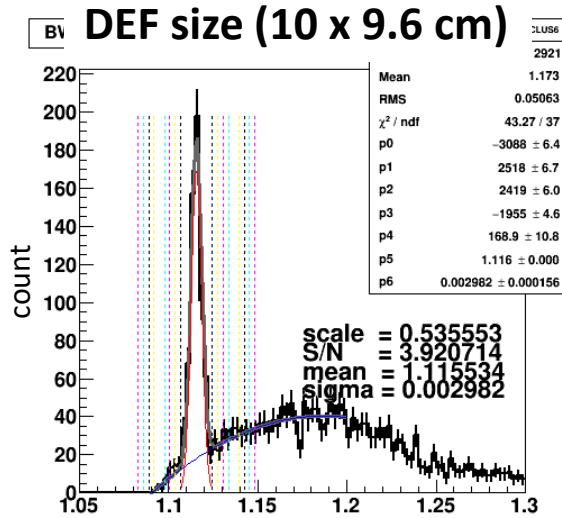
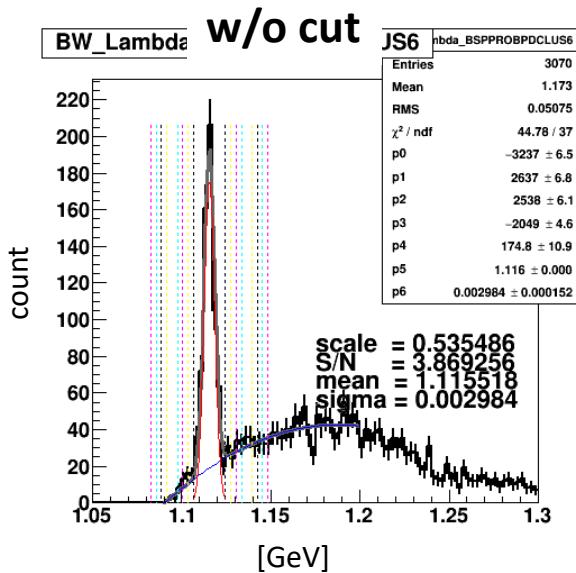
## BPC Hit Pattern

- SIM data  
 $K-d \rightarrow n \Sigma 0 \pi 0$   
 $\Sigma 0 \pi 0$  mass shape ( $\rightarrow P.455$ )
- Condition  
 $\Sigma 0 \pi 0$  spectrum



# Dependence on the cut by the size of DEF

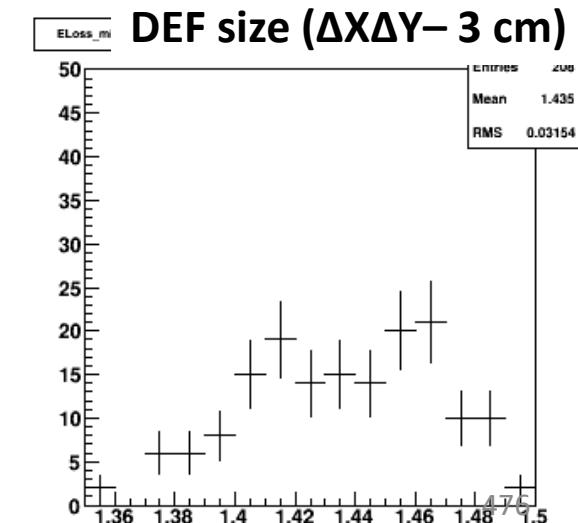
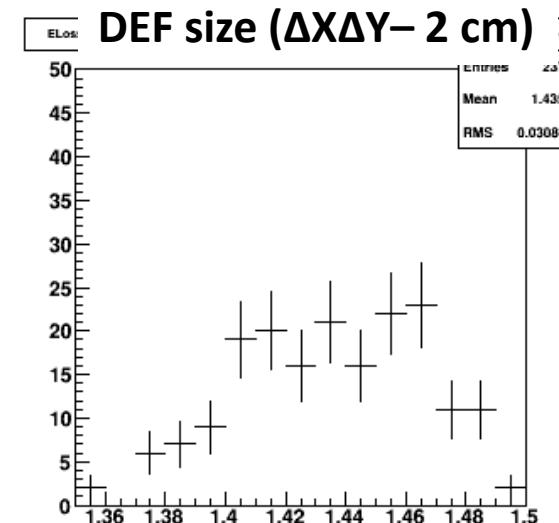
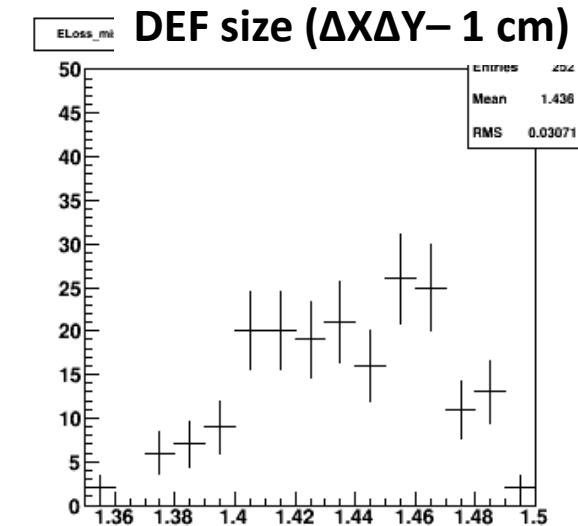
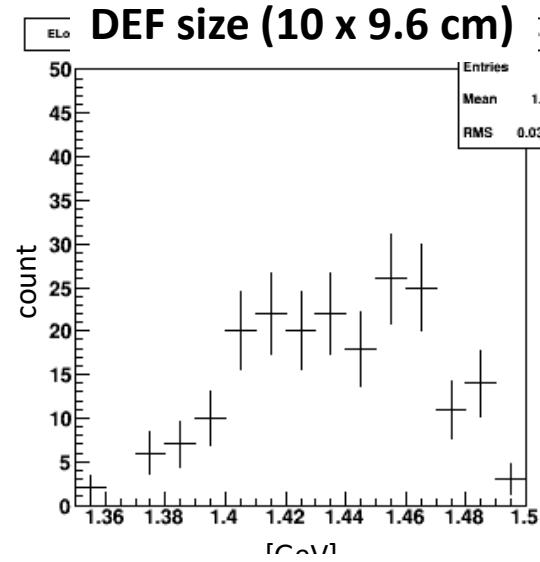
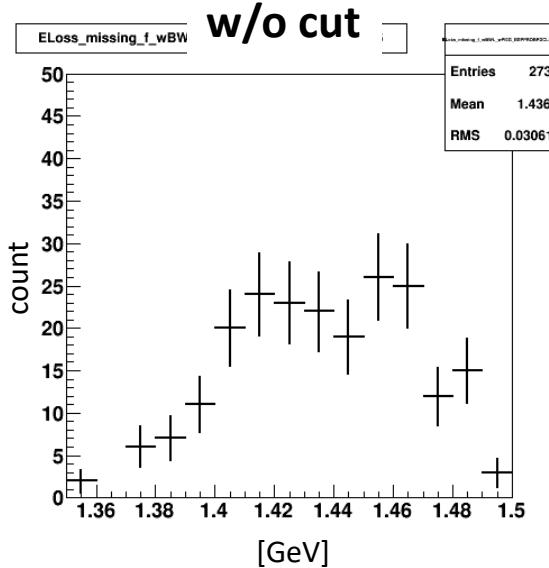
$p, \pi$ - invariant mass



# Dependence on the cut by the size of DEF

$d(K\text{-}n)\pi^0\pi^0$  missing mass

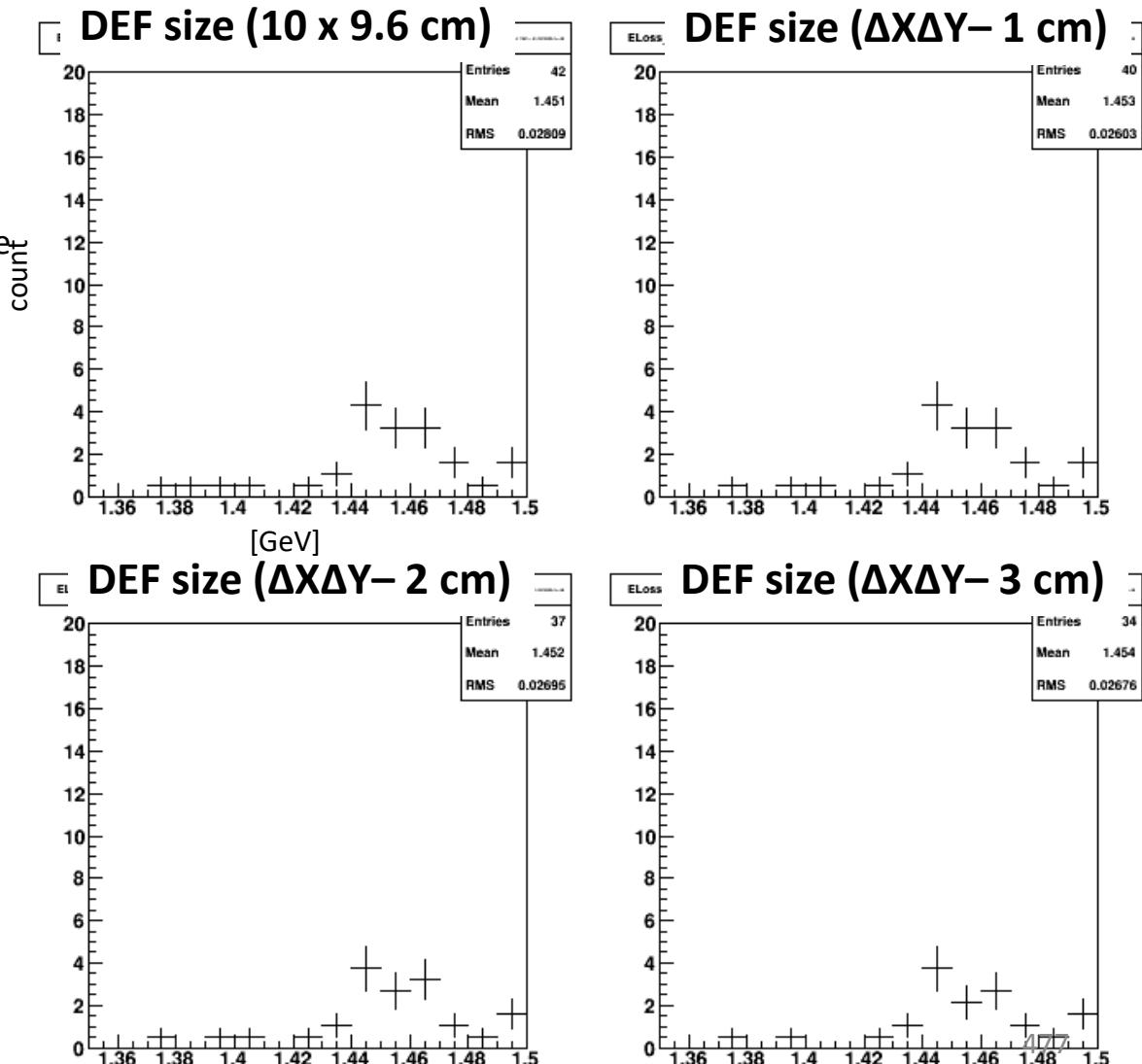
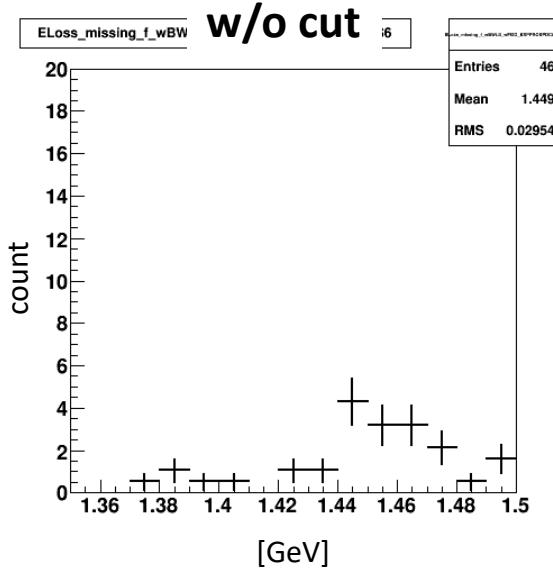
- $\Lambda$  selection from  $p, \pi$ - invariant mass
- $d(K\text{-}n\Lambda)\pi^0 X$   $0.18 < X < 0.30$  GeV
- w/o subtraction of BG in  $\Lambda$
- w/o subtraction  $\Lambda\pi^0$  contribution



# Dependence on the cut by the size of DEF

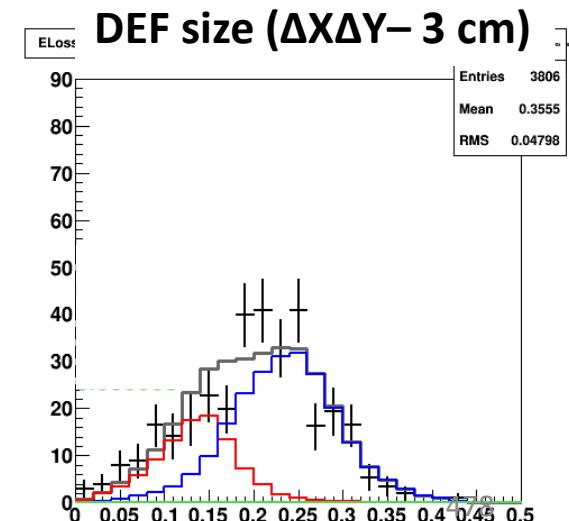
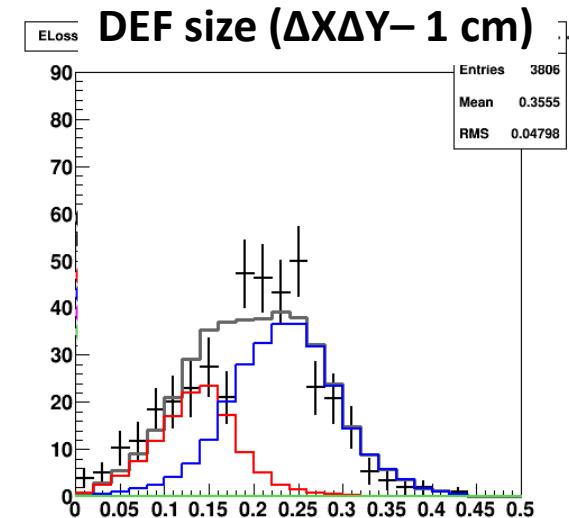
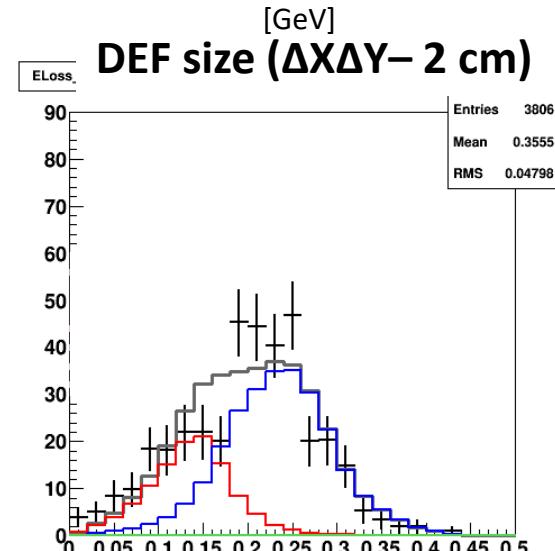
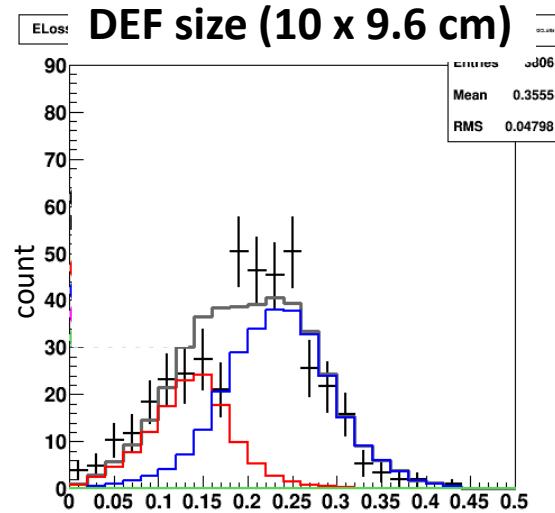
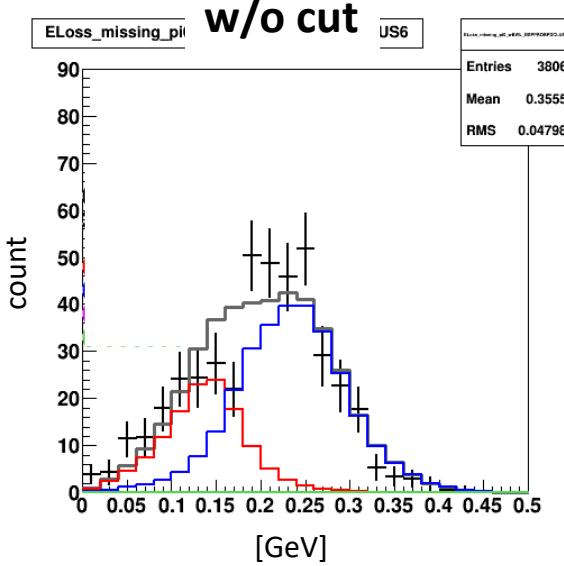
$d(K_-, n)\pi^0$  missing mass

- BG from  $\Lambda$  selection
- $\Lambda$  side-band event normalized by noise
- $d(K_-, n\Lambda)X$   $0.18 < X < 0.30$  GeV



# Dependence on the cut by the size of DEF

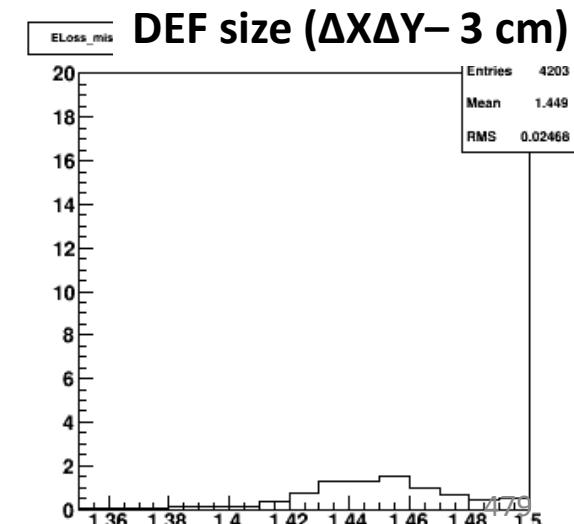
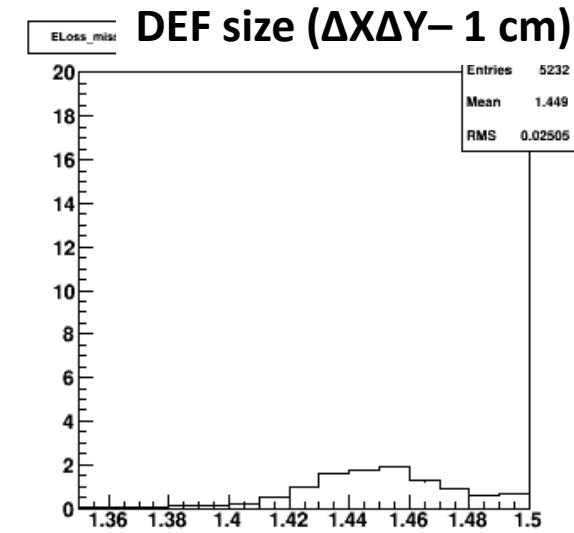
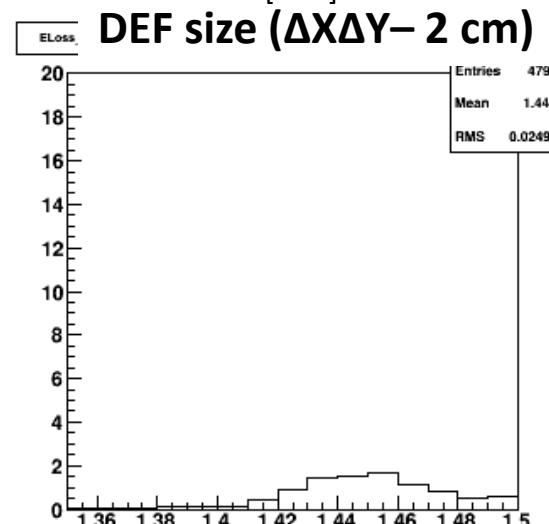
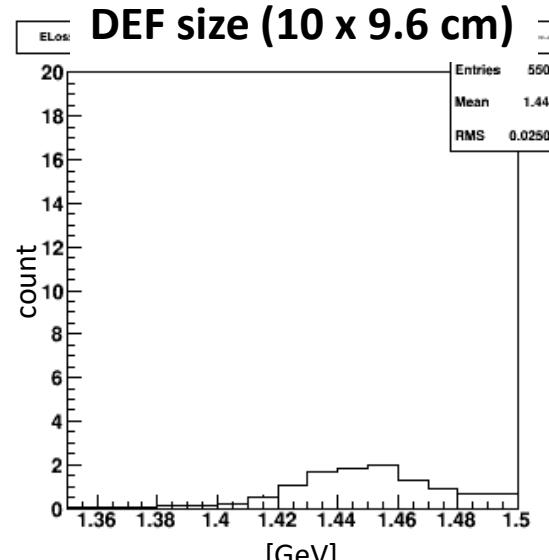
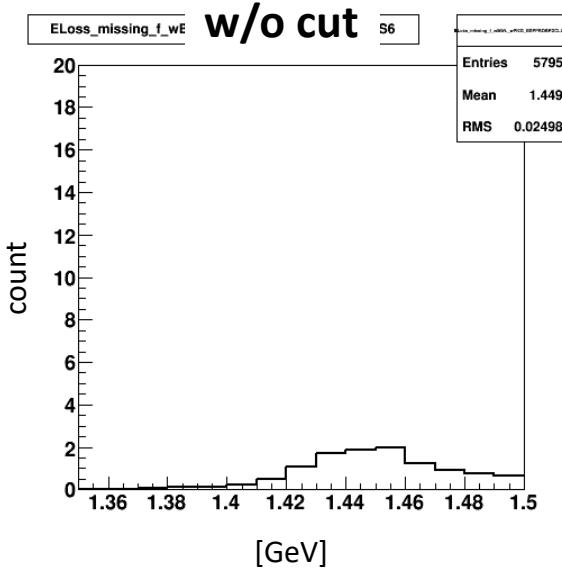
Fitting of  $d(K^-, \eta p \pi^-)$



# Dependence on the cut by the size of DEF

$d(K^-, n)\pi^0\pi^0$  missing mass

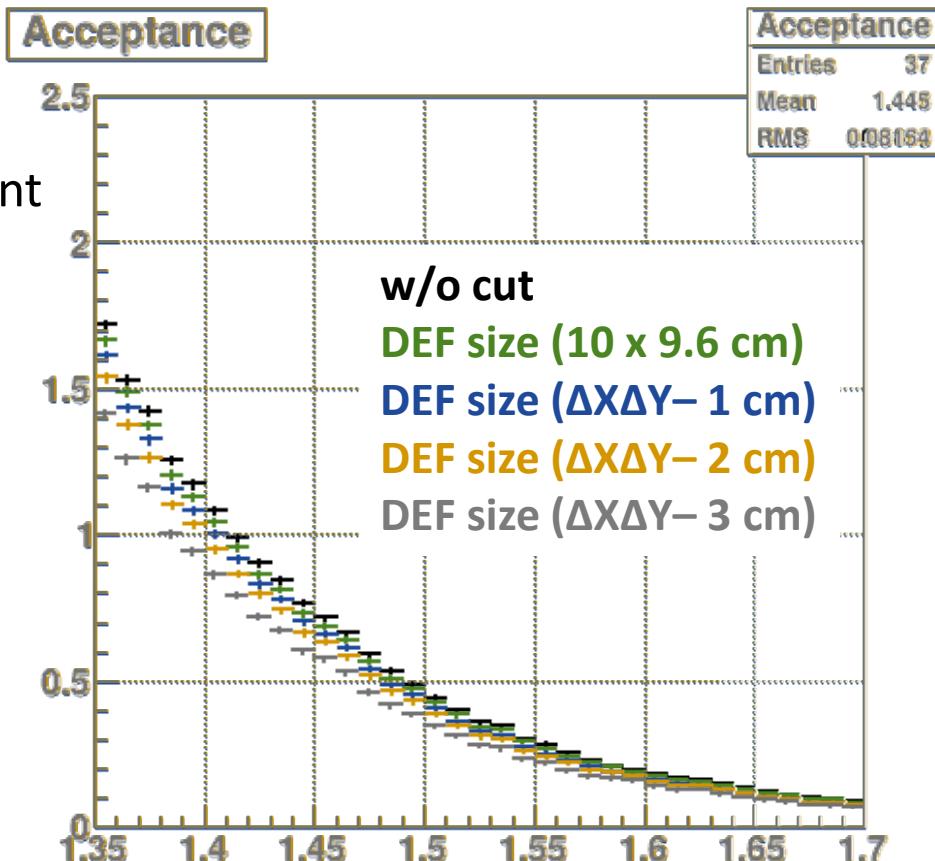
- BG from  $K^-d \rightarrow n\Lambda\pi^0$



# Dependence on the cut by the size of DEF

## Acceptance estimation

- Sample ;
  - $dE$  (NC) > 8 MeV –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0$  multi =1, Beam track defining..)
  - BVC, CVC veto in sample



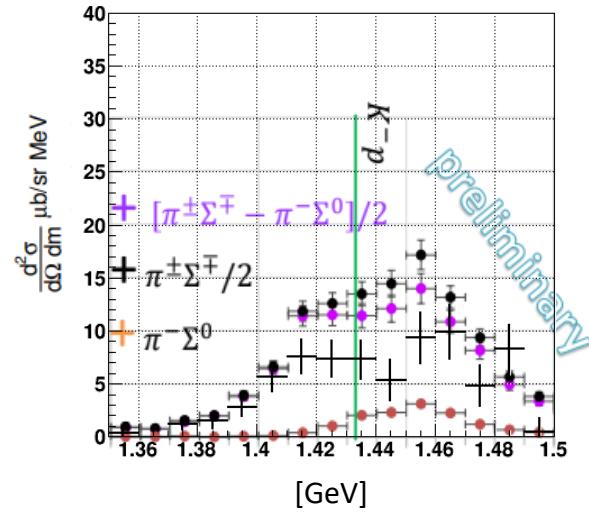
# Dependence on the cut by the size of DEF

$d(K^-, n) \Sigma^0 \pi^0$

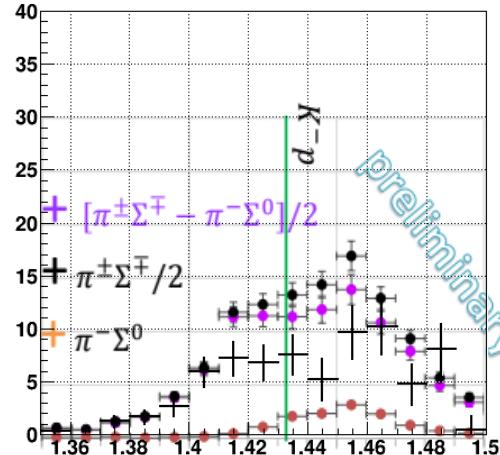
Cross Section

- Λ selection from p, π- invariant mass
- $d(K^-, n\Lambda)' X' 0.18 < X < 0.30$  GeV
- w/ subtraction of BG in Λ
- w/ subtraction  $\Lambda\pi^0$  contribution

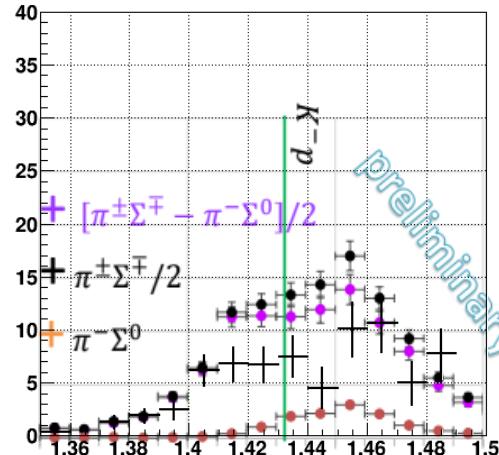
w/o cut



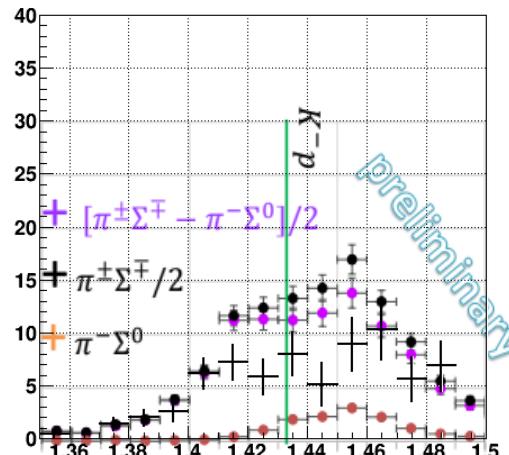
DEF size (10 x 9.6 cm)



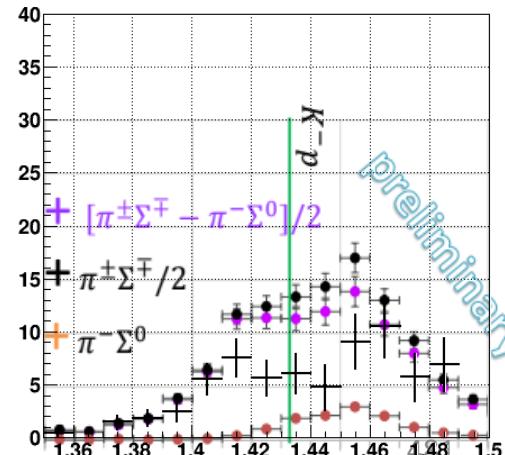
DEF size ( $\Delta X \Delta Y - 1$  cm)



DEF size ( $\Delta X \Delta Y - 2$  cm)

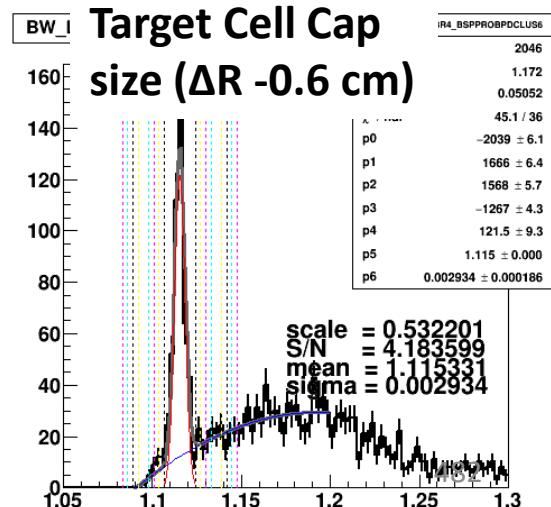
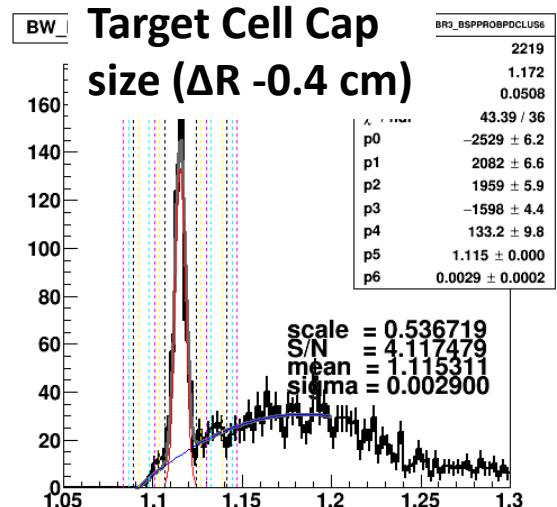
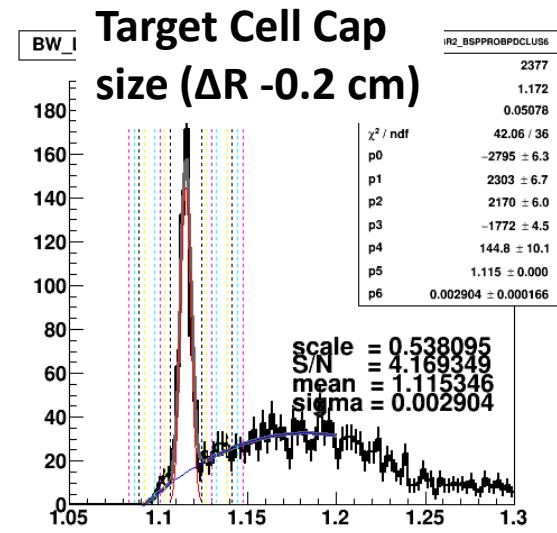
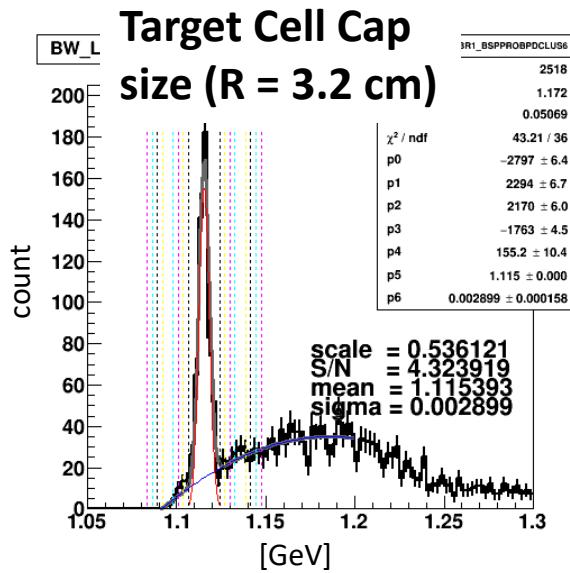
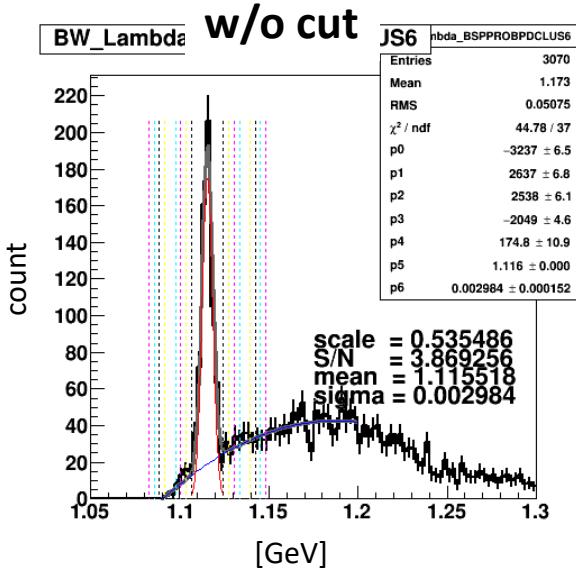


DEF size ( $\Delta X \Delta Y - 3$  cm)



# Dependence on the cut by the size of Target Cell Cap

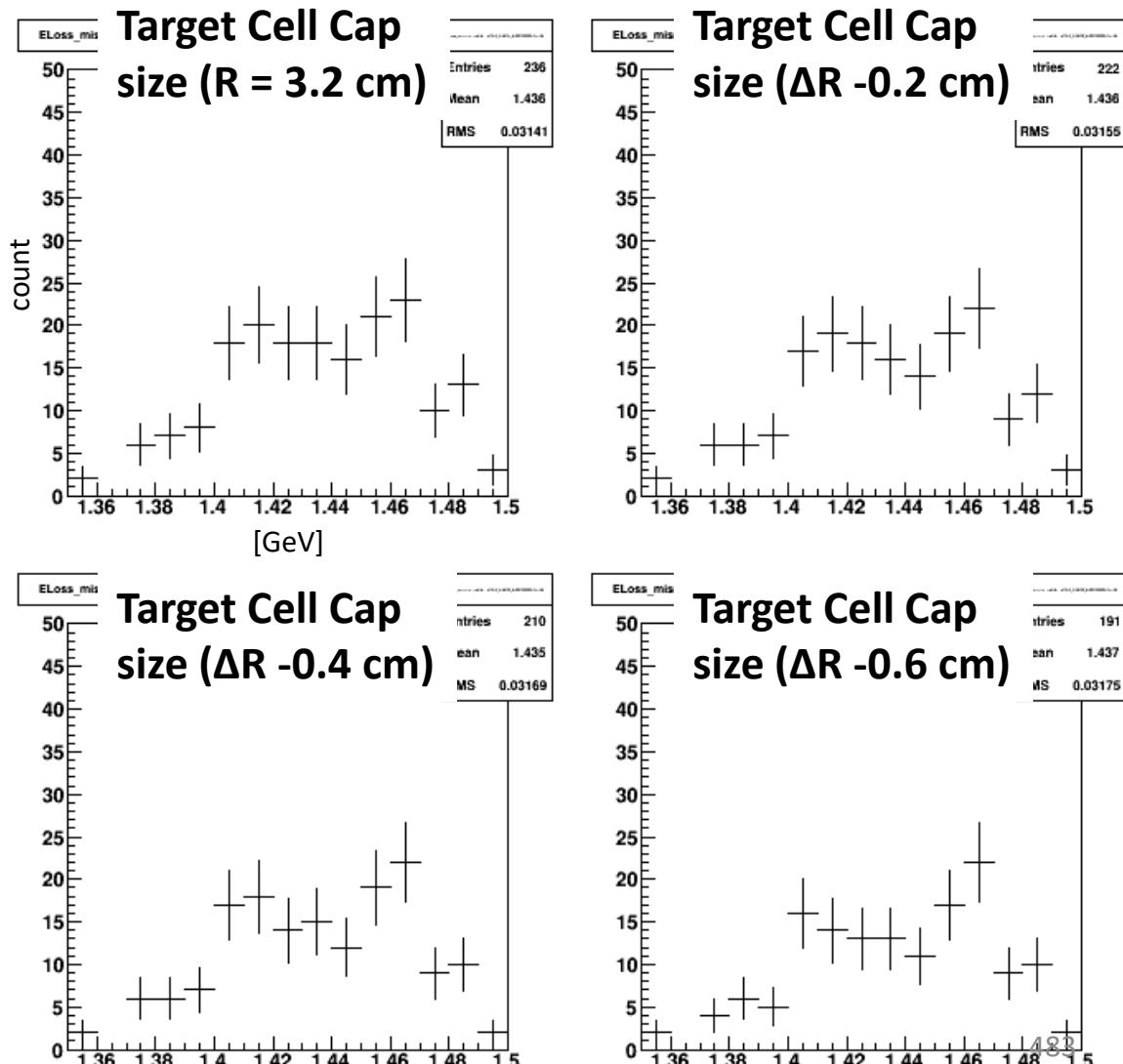
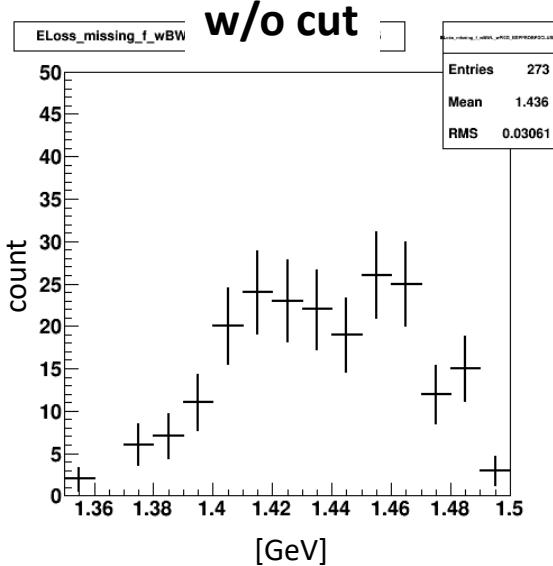
$p, \pi$ - invariant mass



# Dependence on the cut by the size of Target Cell Cap

$d(K\text{-},n)\Sigma^0\pi^0$   
missing mass

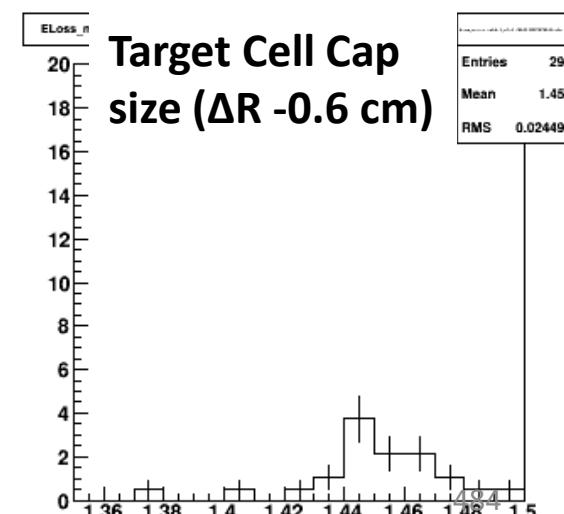
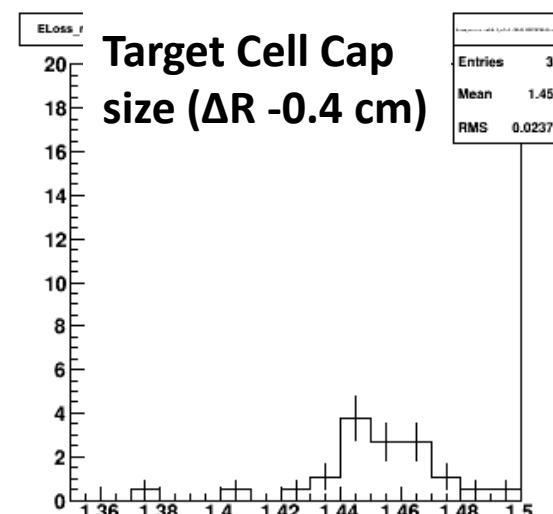
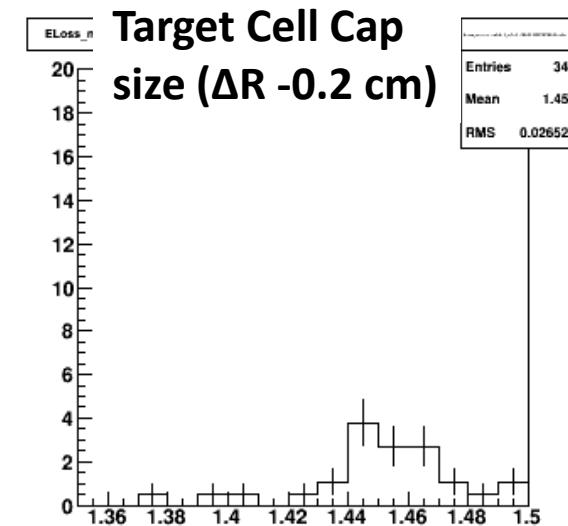
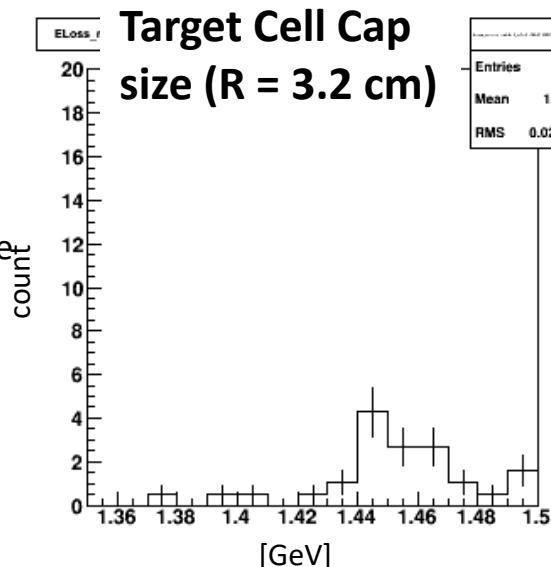
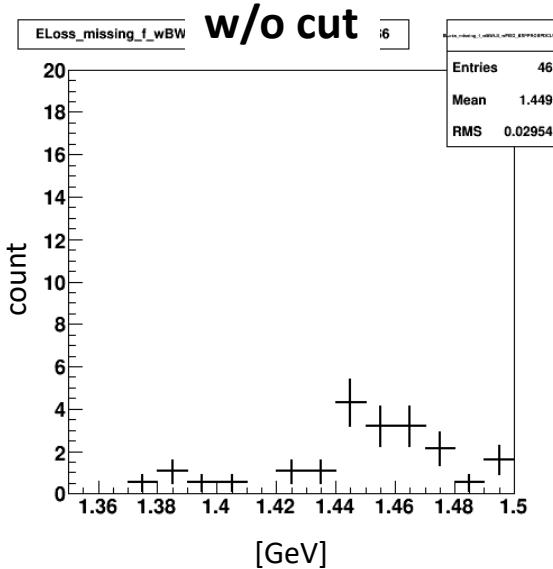
- $\Lambda$  selection from  $p,\pi$ - invariant mass
- $d(K\text{-},n\Lambda)X$   $0.18 < X < 0.30$  GeV
- w/o subtraction of BG in  $\Lambda$
- w/o subtraction  $\Lambda\pi^0$  contribution



# Dependence on the cut by the size of Target Cell Cap

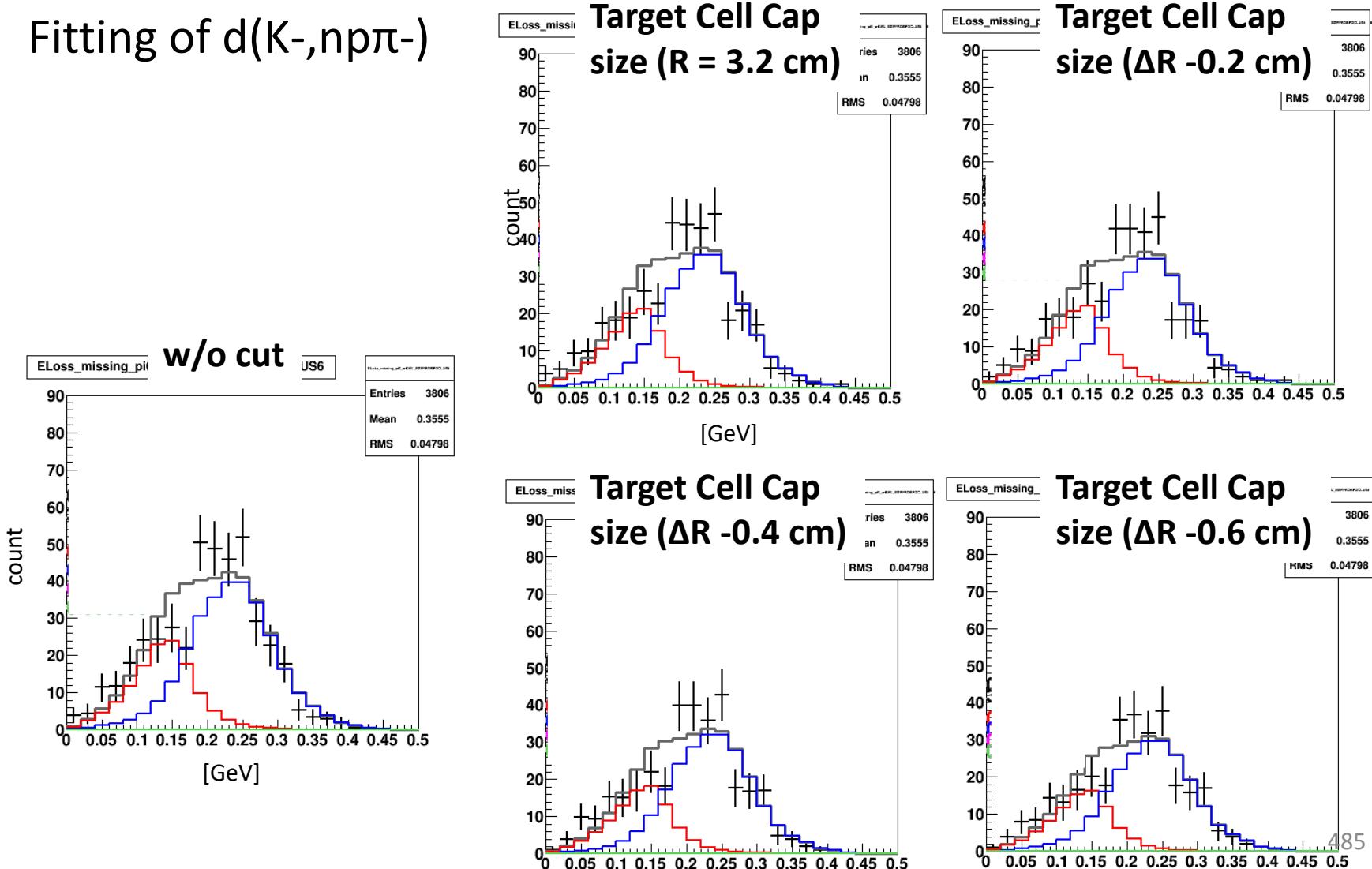
$d(K_-, n)\Sigma 0\pi^0$  missing mass

- BG from  $\Lambda$  selection
- $\Lambda$  side-band event normalized by noise
- $d(K_-, n\Lambda)X$   $0.18 < X < 0.30$  GeV



# Dependence on the cut by the size of Target Cell Cap

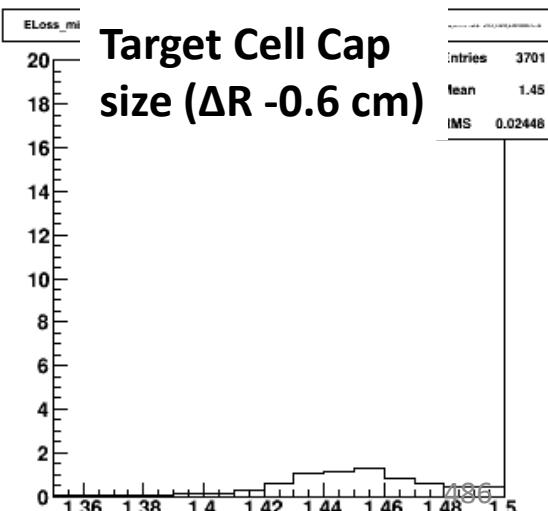
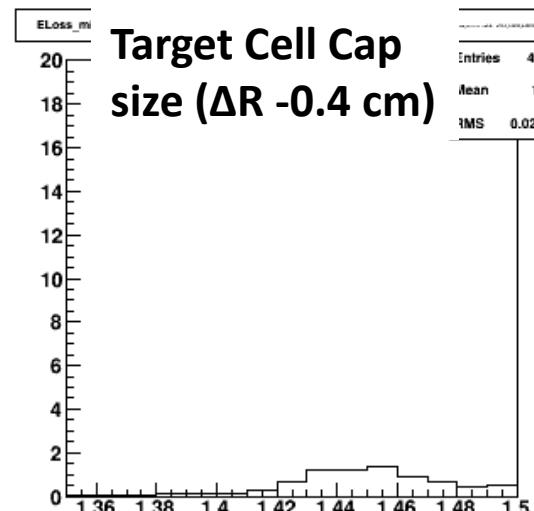
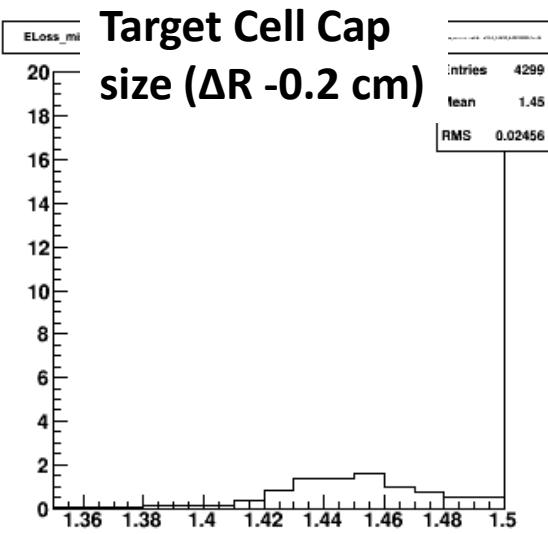
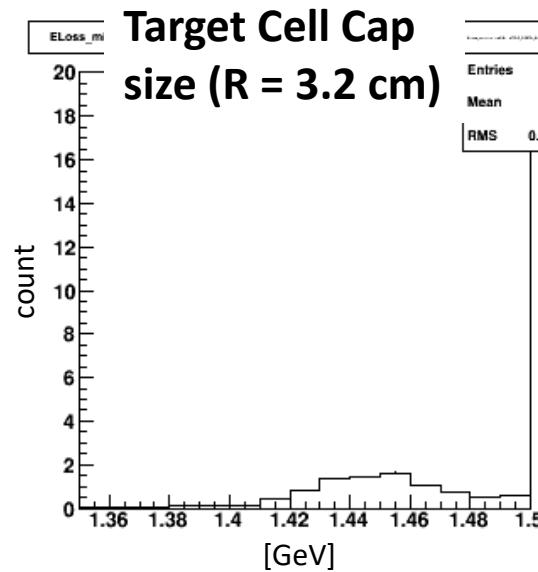
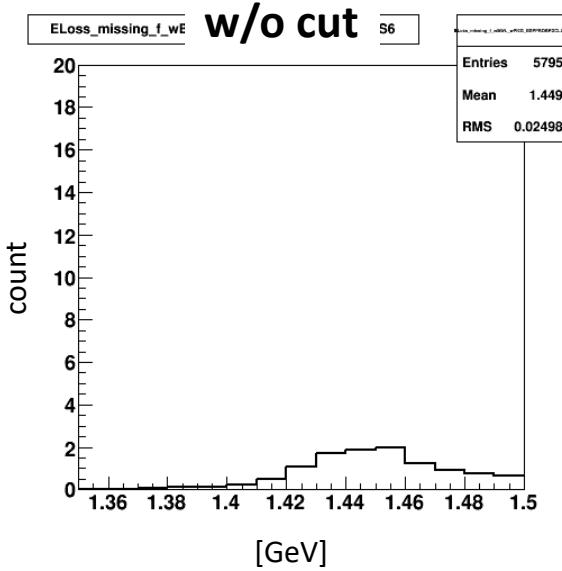
Fitting of  $d(K^-, np\pi^-)$



# Dependence on the cut by the size of Target Cell Cap

$d(K^-, n)\pi^0$  missing mass

- BG from  $K-d \rightarrow n\Lambda\pi^0$



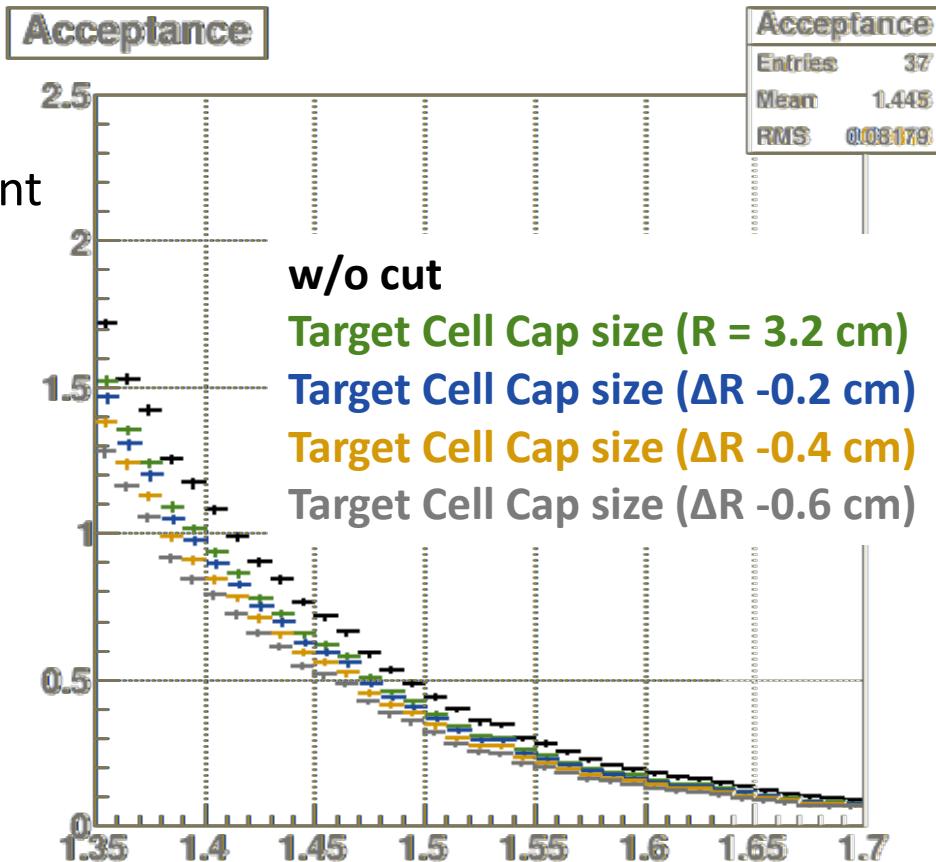
# Dependence on the cut by the size of Target Cell Cap

## Acceptance estimation

- Sample ;
  - $dE$  (NC) > 8 MeV –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0$  multi =1, Beam track defining..)
  - BVC, CVC veto in sample



- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda) \pi^+ X$   $0.18 < X < 0.30$  GeV

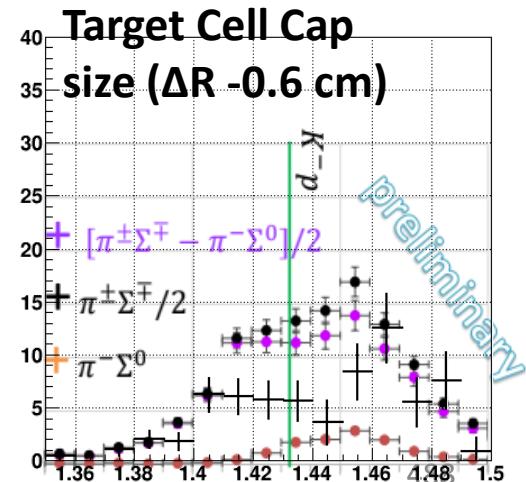
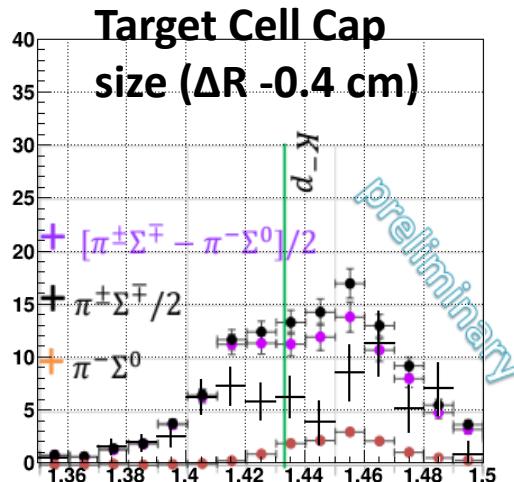
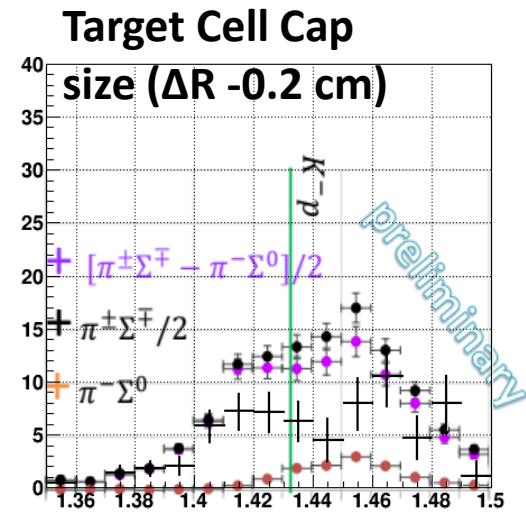
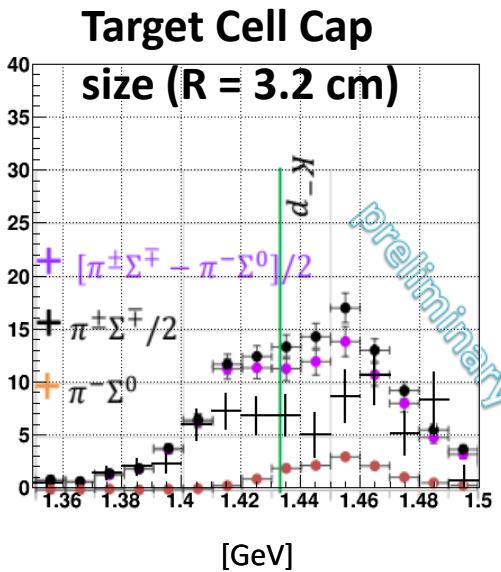
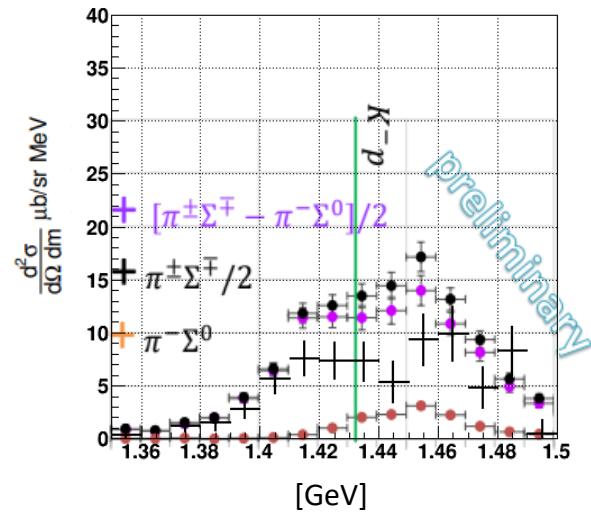


# Dependence on the cut by the size of Target Cell Cap

## $d(K\text{-},n)\Sigma^0\pi^0$ Cross Section

- $\Lambda$  selection from  $p, \pi$ - invariant mass
- $d(K\text{-},n\Lambda)X$   $0.18 < X < 0.30$  GeV
- w/o subtraction of BG in  $\Lambda$
- w/o subtraction  $\Lambda\pi^0$  contribution

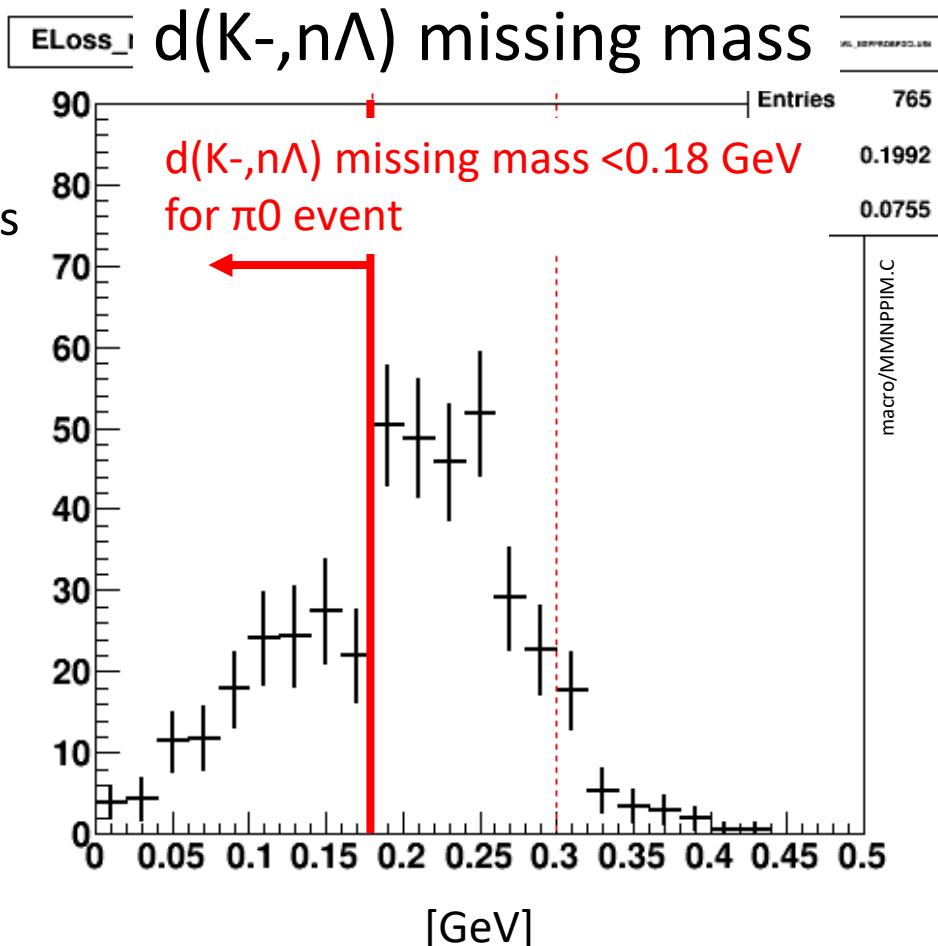
w/o cut



d(K-,n)"Λπ0" analysis

# $d(K^-, n\Lambda)\pi^0$ spectrum

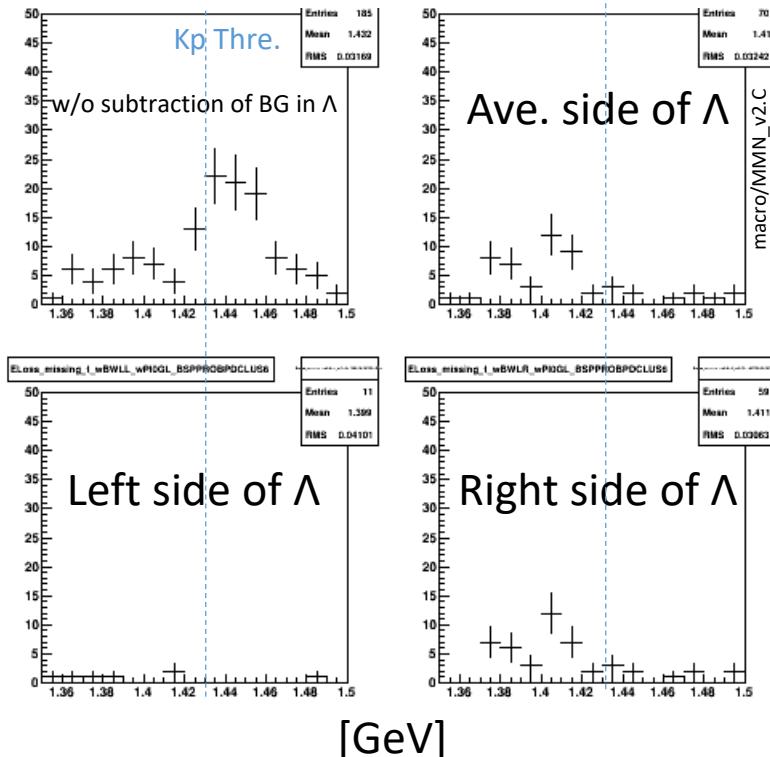
- Run78 data
- Condition
  - $\Lambda$  selection from  $p, \pi$ - invariant mass
  - w/ subtraction of BG in  $\Lambda$



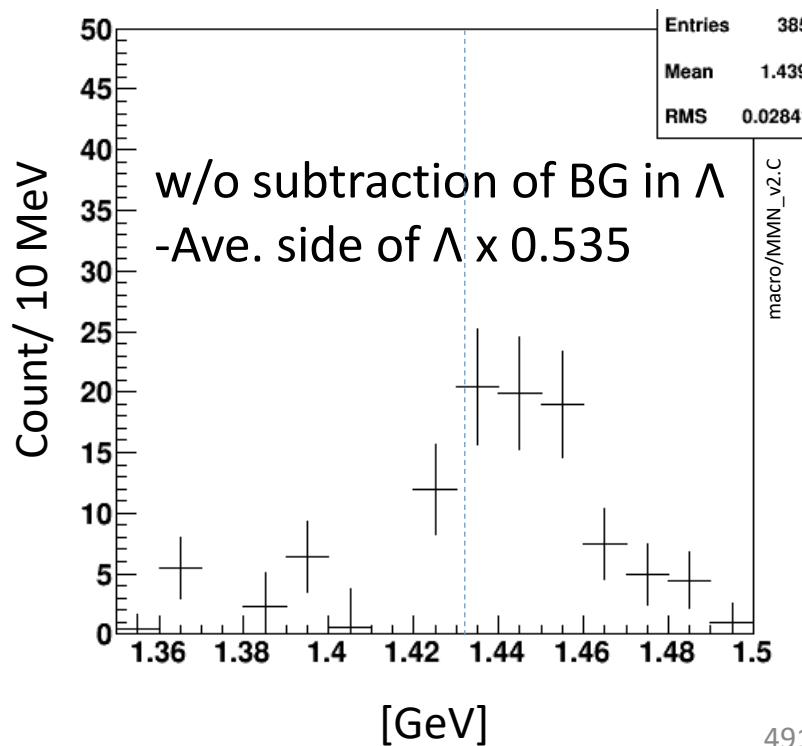
# $d(K^-, n)\Lambda\pi^0$ spectrum

- Run78 data
- Condition
  - $\Lambda$  selection from  $p, \pi$ - invariant mass
  - $d(K^-, n\Lambda)$  missing mass  $< 0.18$  GeV

$d(K^-, n)\Lambda\pi^0$  missing mass



$d(K^-, n)\Lambda\pi^0$  missing mass



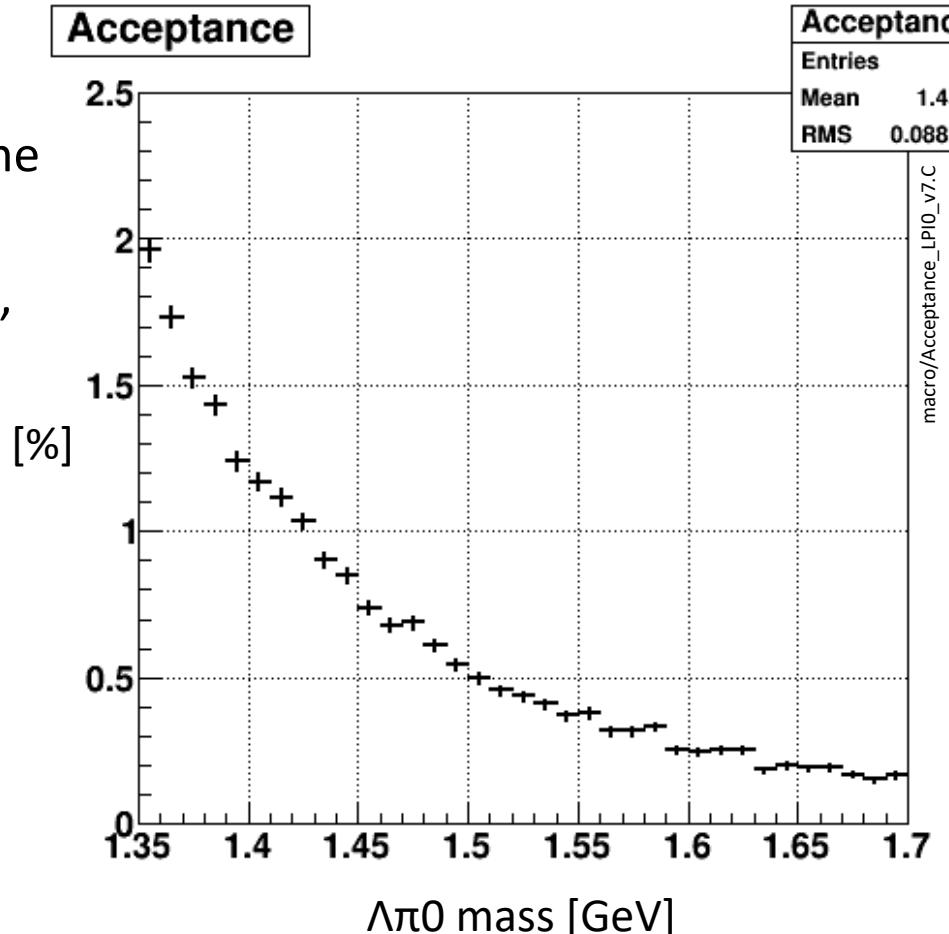
# Dependence on the cut by the size of Target Cell Cap

## Acceptance estimation

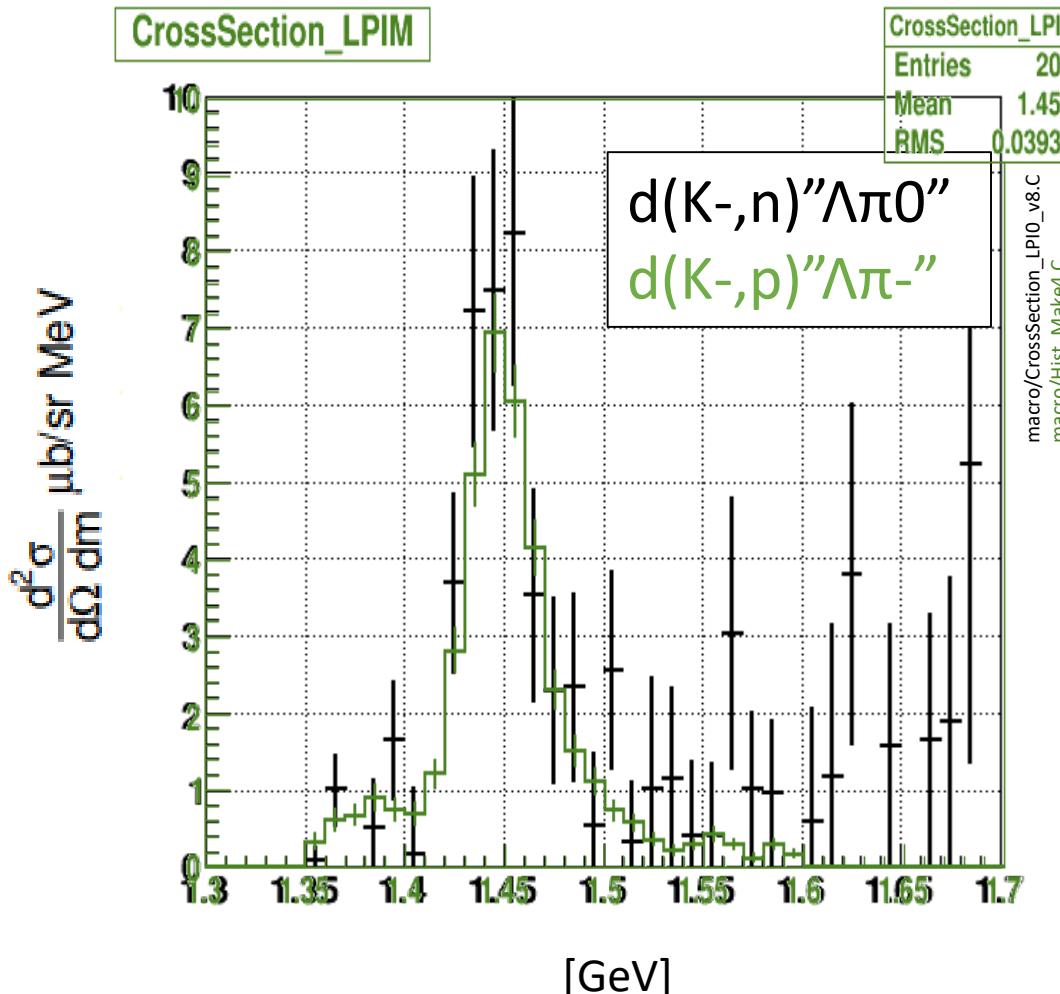
- Sample ;
  - $dE$  (NC) > 8 MeV –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0$  multi =1,  
Beam track defining..)
  - BVC, CVC veto in sample



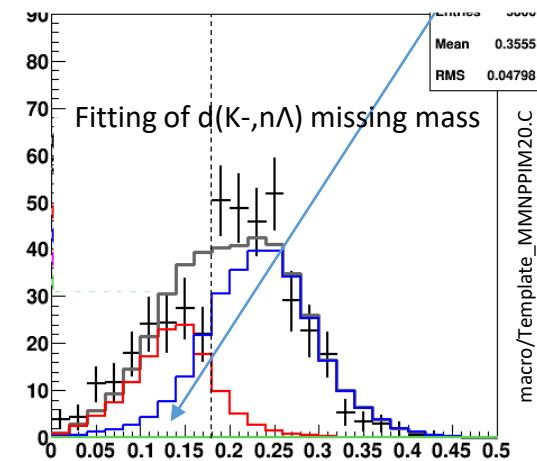
Acceptance	
Entries	41
Mean	1.454
RMS	0.08812



# $d(K^-,n)\pi^0$ Cross Section



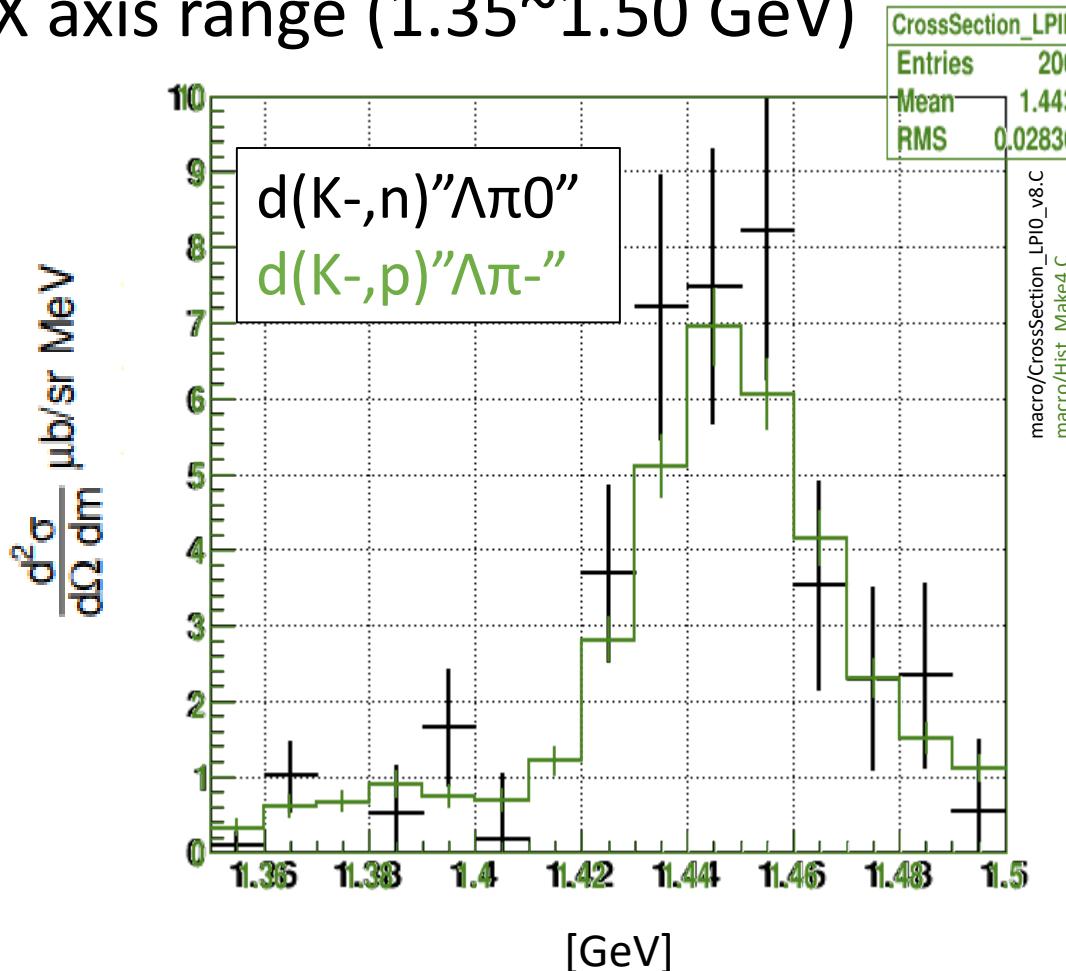
w/o subtraction of  $\Sigma^0\pi^0$



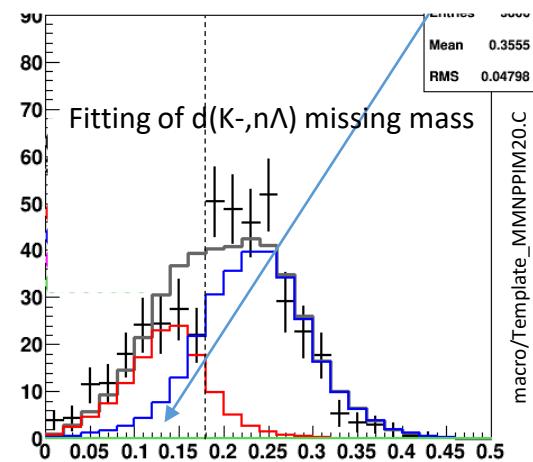
Luminosity & efficiencies same as  $d(K^-,n)\Sigma^0\pi^0 \rightarrow$  Page. 454

# $d(K^-,n)\Lambda\pi^0$ Cross Section

X axis range (1.35~1.50 GeV)



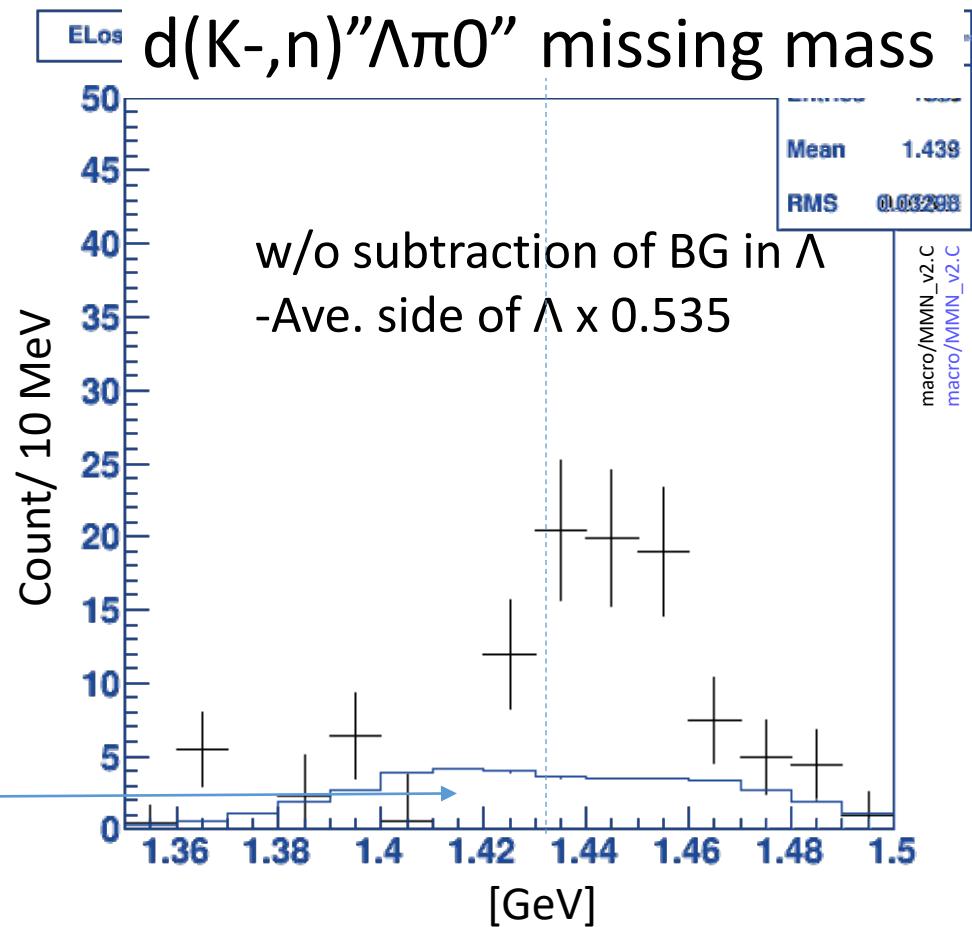
w/o subtraction of  $\Sigma^0\pi^0$



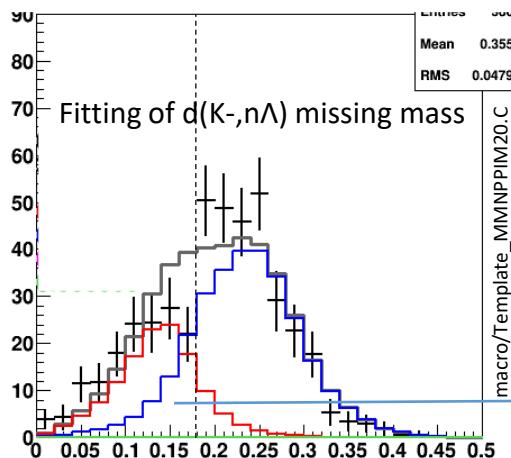
Luminosity & efficiencies same as  $d(K^-,n)\Sigma^0\pi^0 \rightarrow$  Page. 454

# Contribution from $\Sigma 0 \pi 0$

- Run78 data
- Condition
  - $\Lambda$  selection from  $p, \pi$ - invariant mass
  - $d(K^-, n\Lambda)$  missing mass  $< 0.18$  GeV

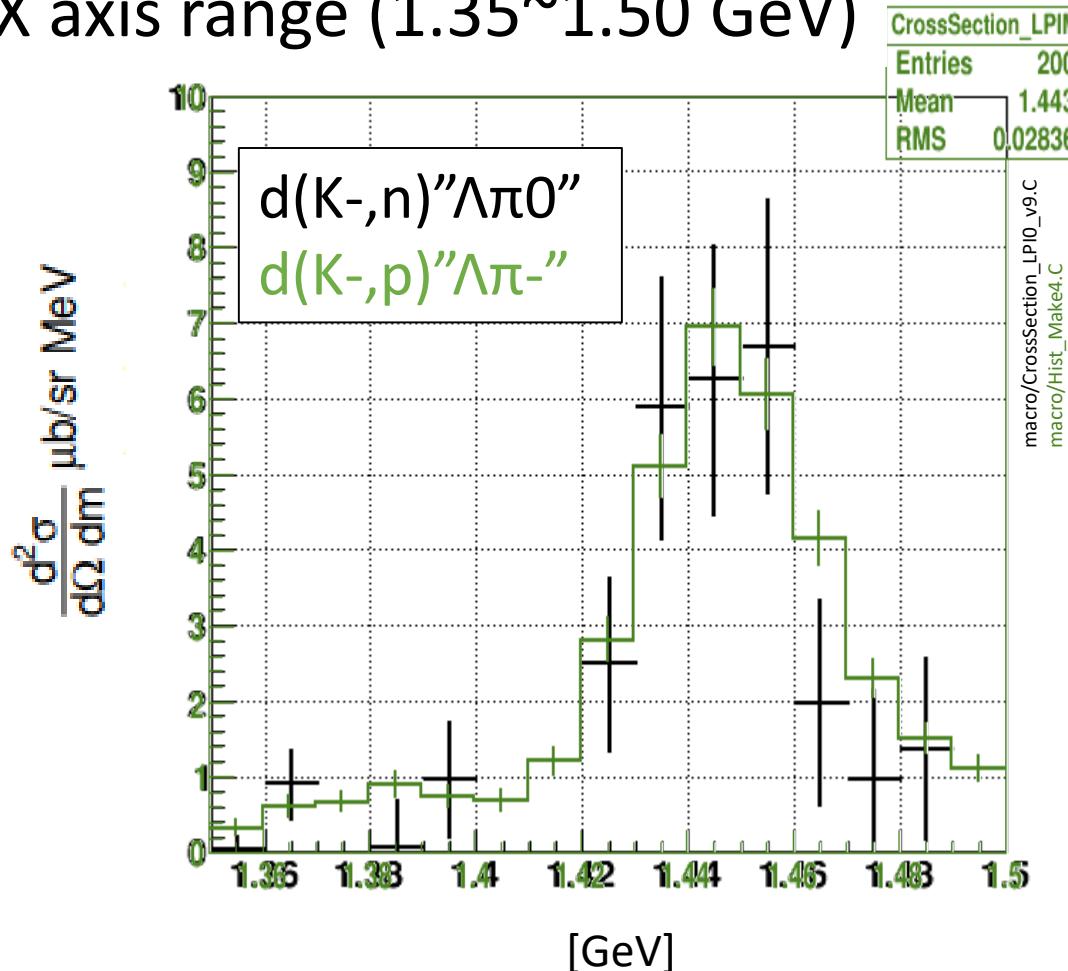


## Contribution from $\Sigma 0 \pi 0$

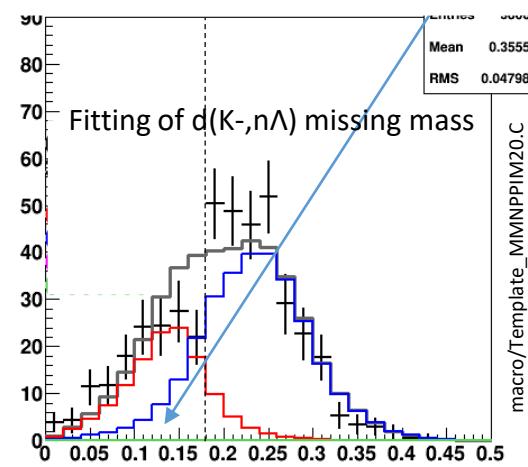


# $d(K^-,n)\Lambda\pi^0$ Cross Section

X axis range (1.35~1.50 GeV)



w/ subtraction of  $\Sigma^0\pi^0$

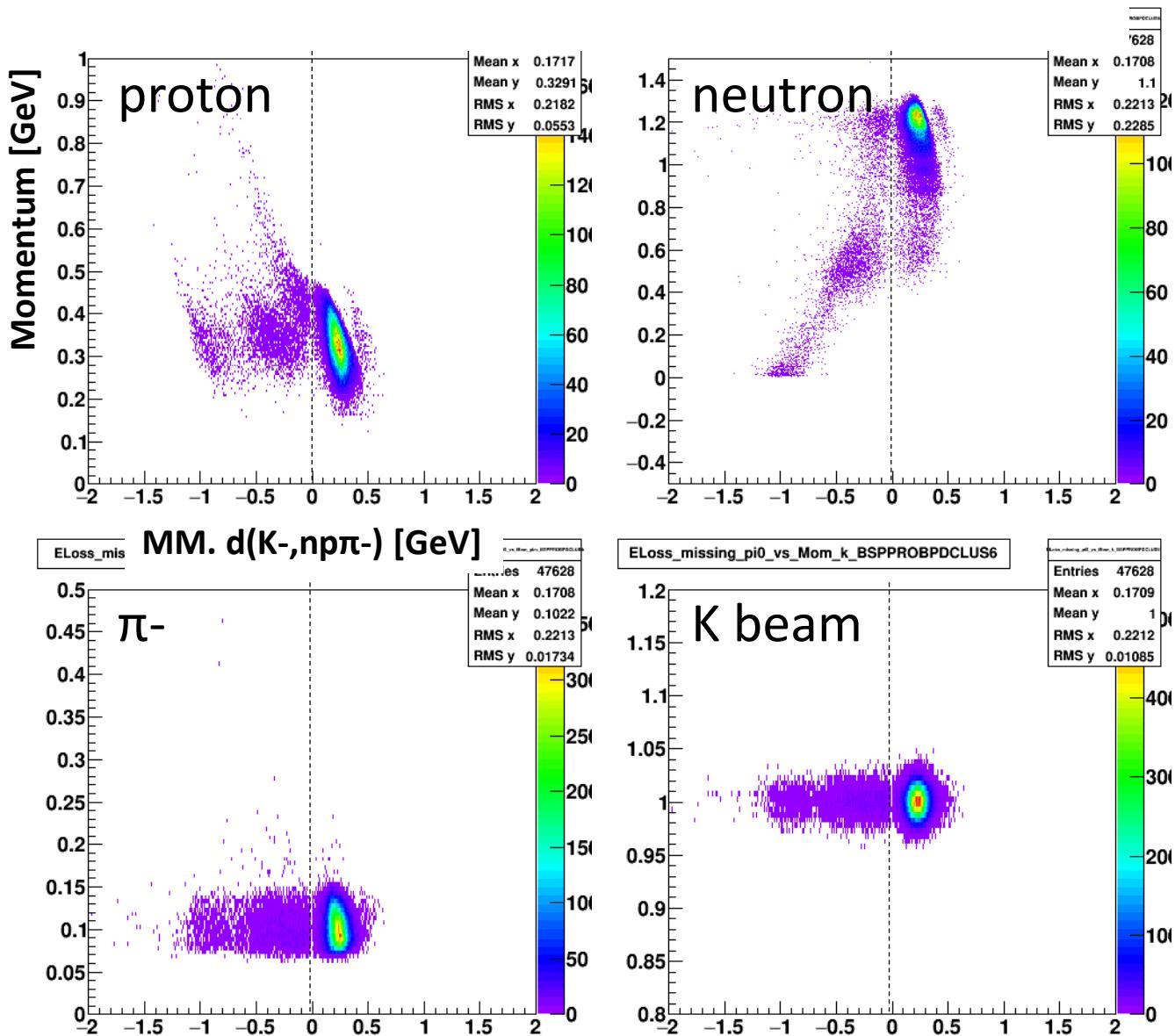


Luminosity & efficiencies same as  $d(K^-,n)\Sigma^0\pi^0 \rightarrow$  Page. 454

Search for the reason of  
 $d(K^-, n\pi^-)$  negative event

# Momentum dependence

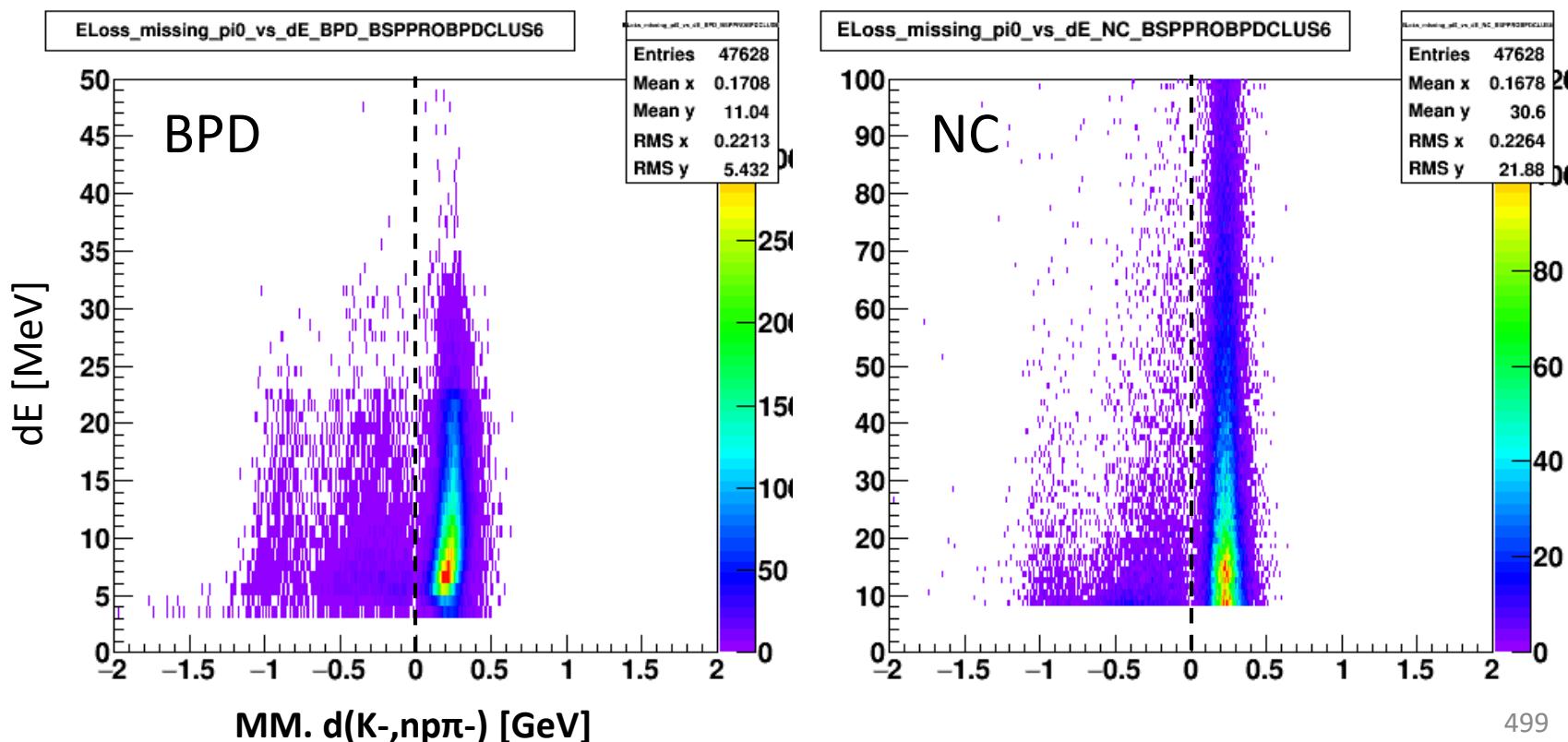
- SIM K-d  $\rightarrow n \Sigma 0 \pi 0$ 
  - $\Sigma 0 \pi 0$  mass use CS
- Condition
  - PID NC neutron
  - PID BPD proton
  - PID CDS  $\pi^-$
- (before selection of  $\Lambda$ )



# Detector dE dependence

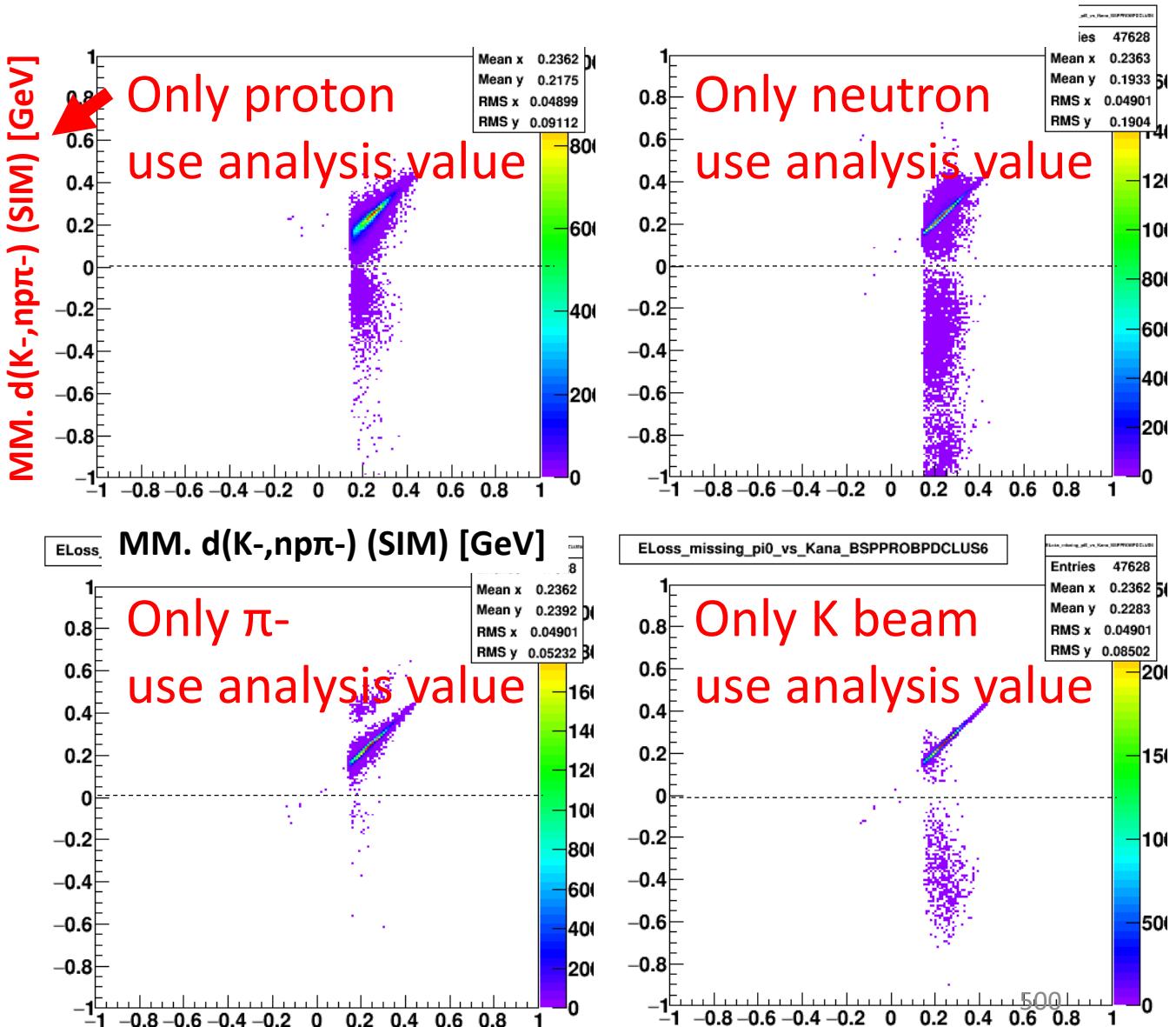
- SIM K-d  $\rightarrow$  n  $\Sigma 0\pi 0$ 
  - $\Sigma 0\pi 0$  mass use CS
- Condition
  - PID NC neutron
  - PID BPD proton
  - PID CDS  $\pi^-$

(before selection of  $\Lambda$ )



# Comparison w/ SIM direct value

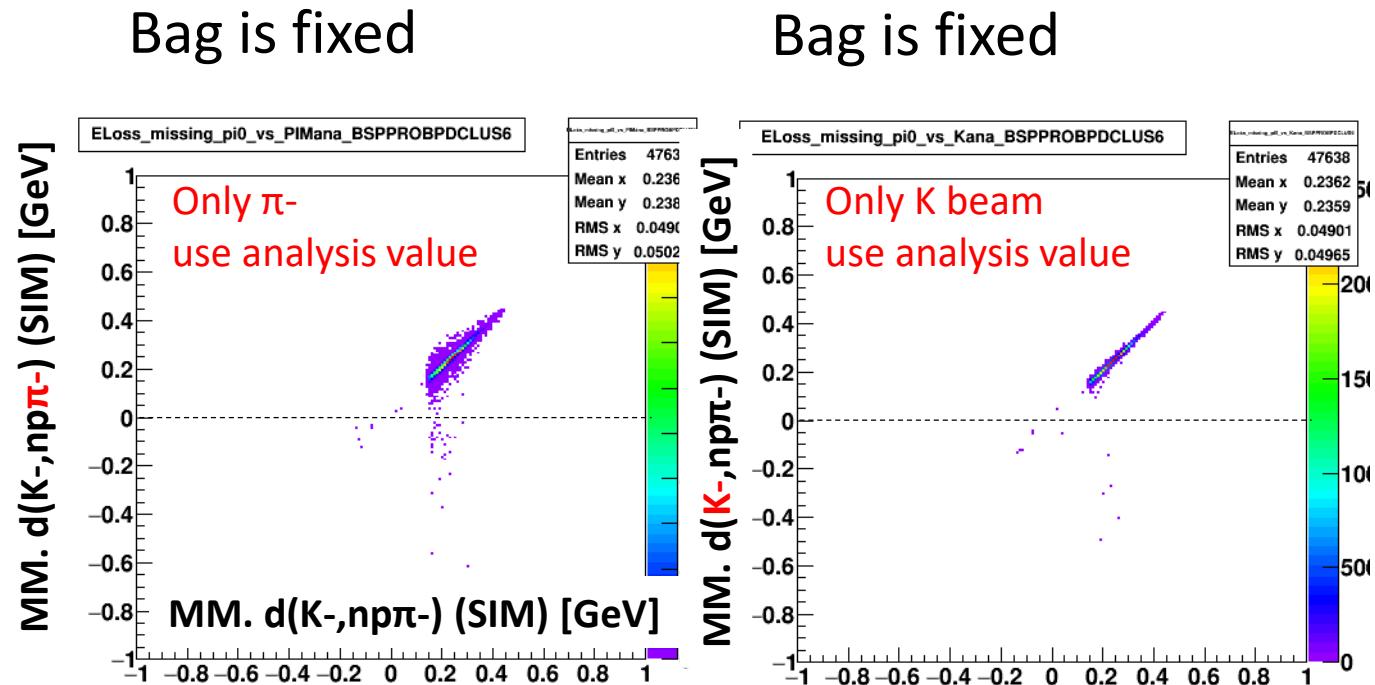
- SIM K-d  $\rightarrow n \Sigma 0 \pi 0$ 
    - $\Sigma 0 \pi 0$  mass use CS
  - Condition
    - PID NC neutron
    - PID BPD proton
    - PID CDS  $\pi^-$
- (before selection of  $\Lambda$ )



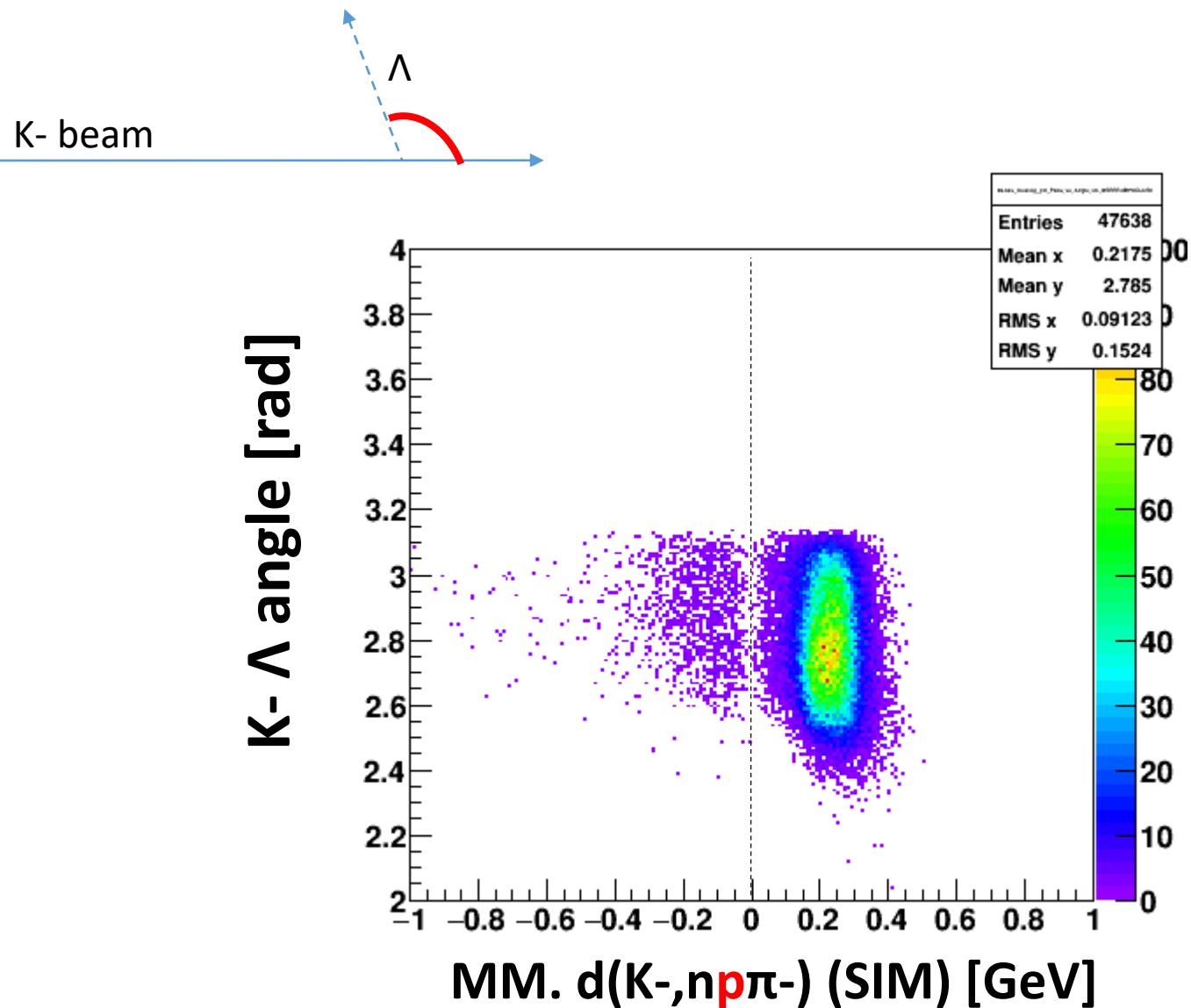
# Bag fixes in $\pi$ -, $K$ - momentum

Simple bug in code of  $\pi$ -,  $K$ - momentum

- $\pi$ - - only simulation code -> affects analysis of simulation
- $K$ - - only problem here -> no affects analysis



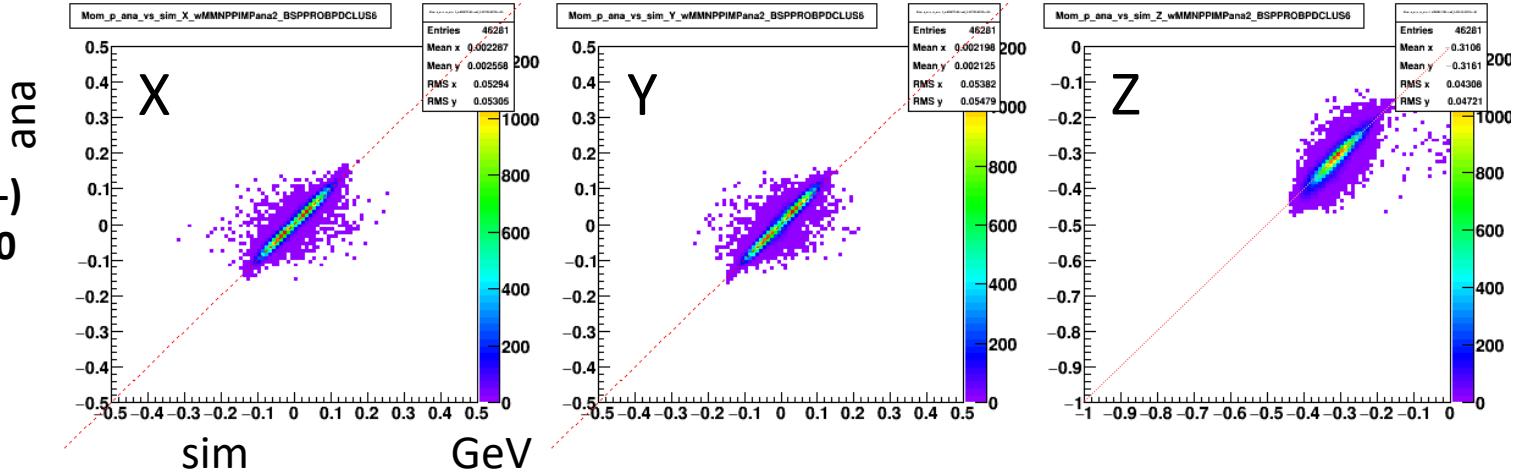
# $K$ - $\Lambda$ angle dependence



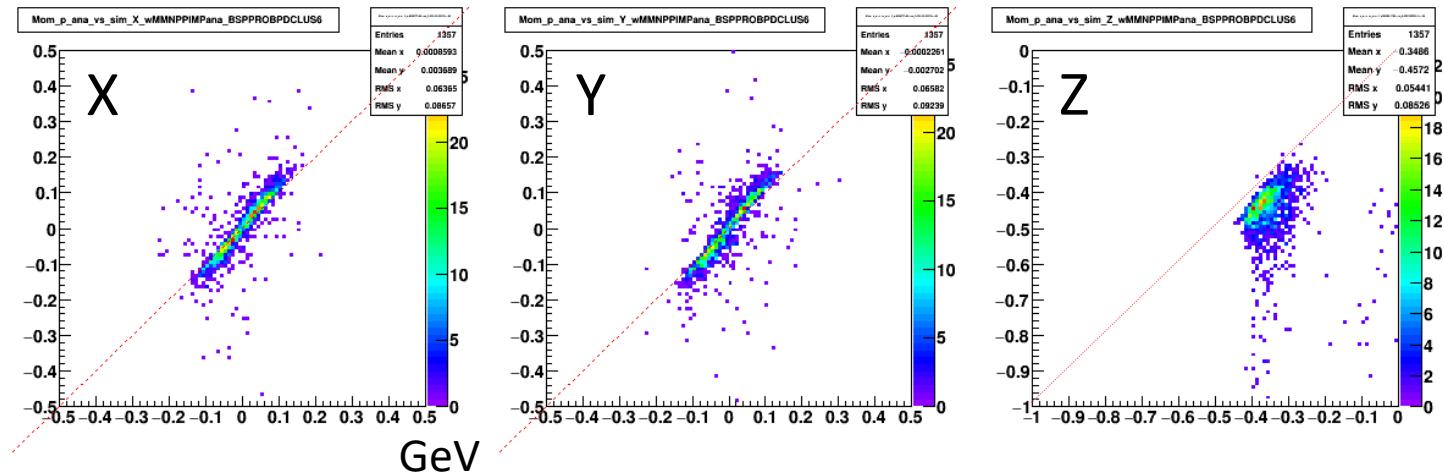
# Momentum between sim & ana

2-D plots of sim & ana

MM. d( $K_-, p\pi^-$ )  
(SIM) [GeV] > 0

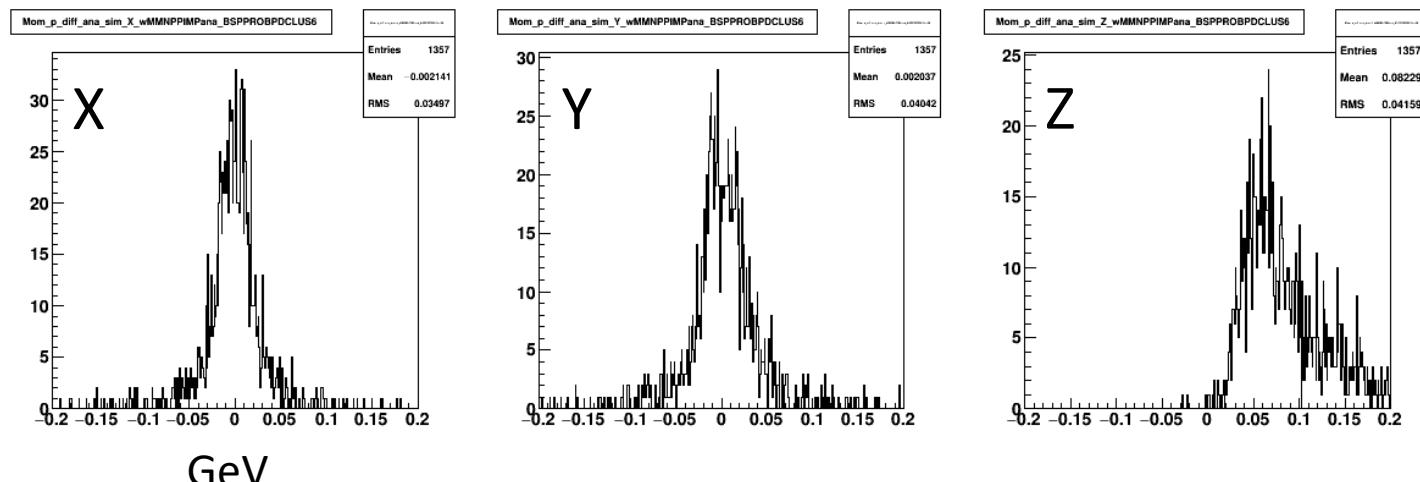
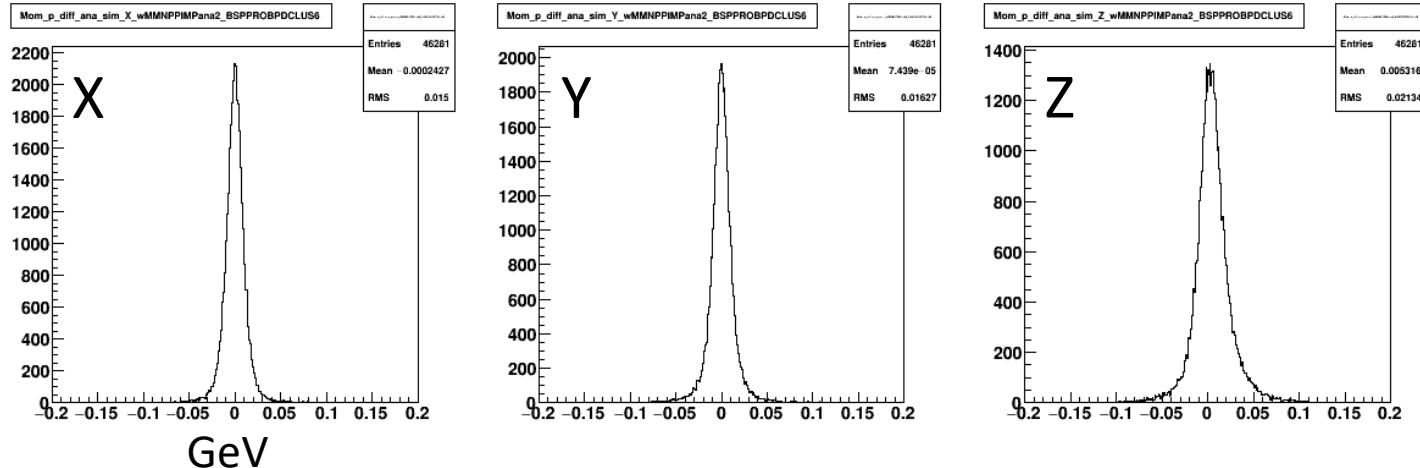


MM. d( $K_-, p\pi^-$ )  
(SIM) [GeV] < 0



# Momentum between sim & ana

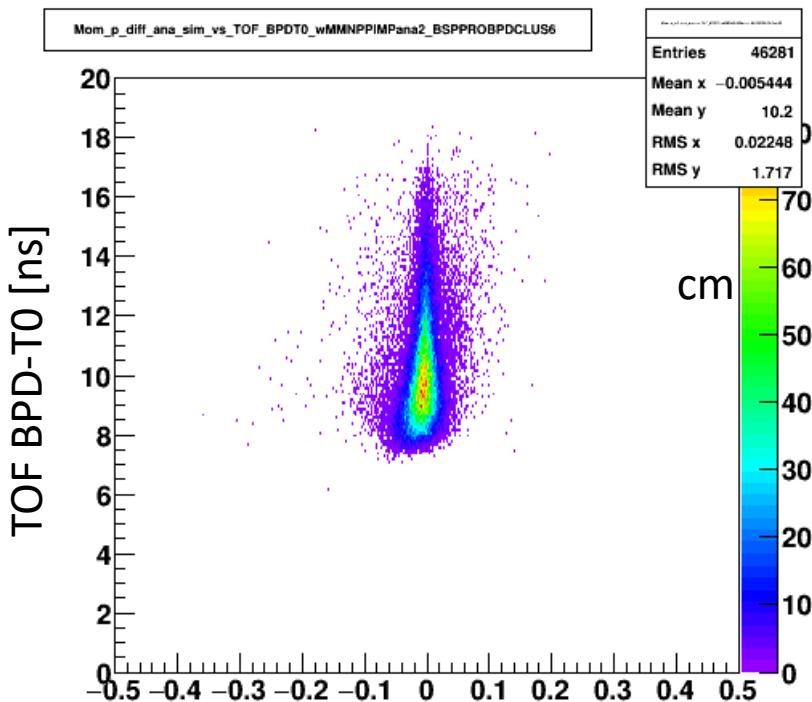
Momentum difference between simulation & analysis



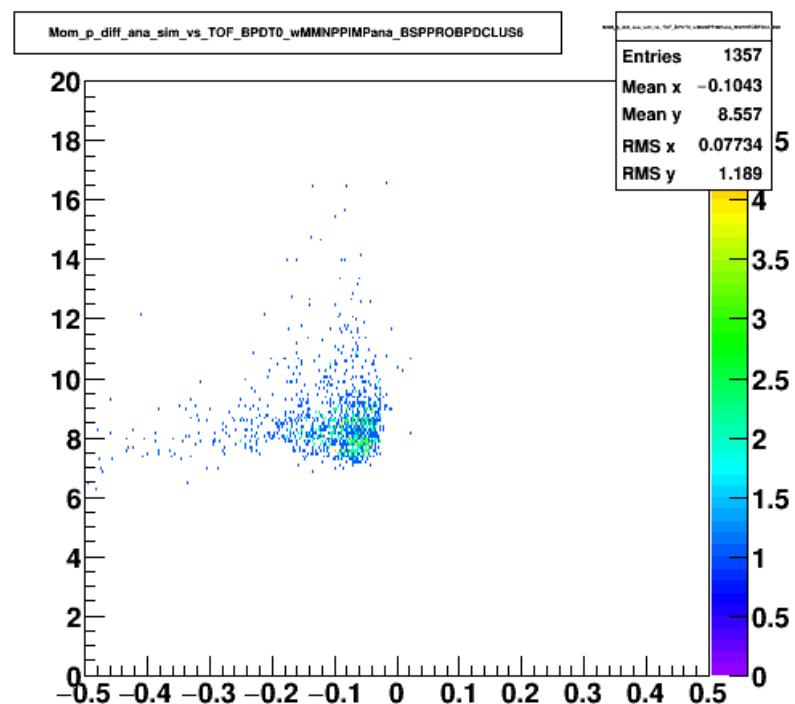
Z momentum  $\Delta \sim 50$  MeV in MM. d( $K_-, np\pi^-$ ) < 0, and X Y resolutions are bad

# TOF BPD-T0 dependence

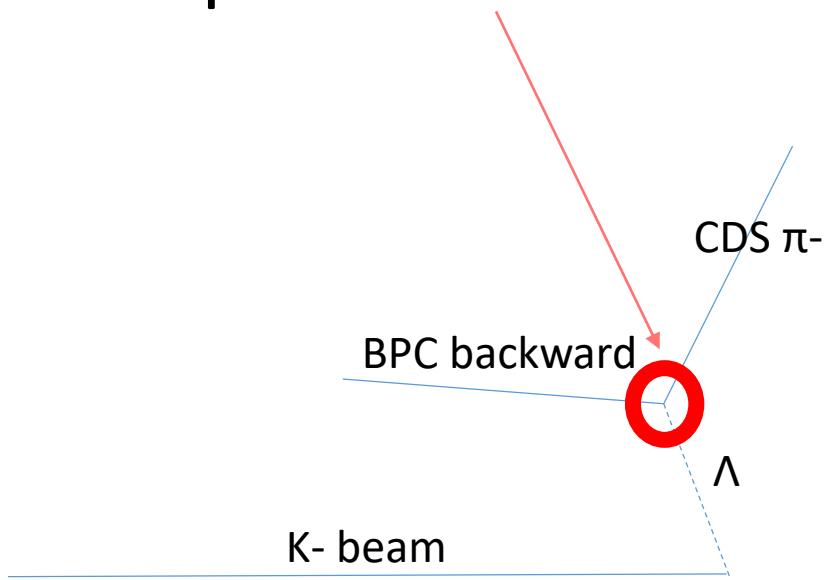
MM.  $d(K^-, np\pi^-)$   
(SIM) [GeV] > 0



MM.  $d(K^-, np\pi^-)$   
(SIM) [GeV] < 0

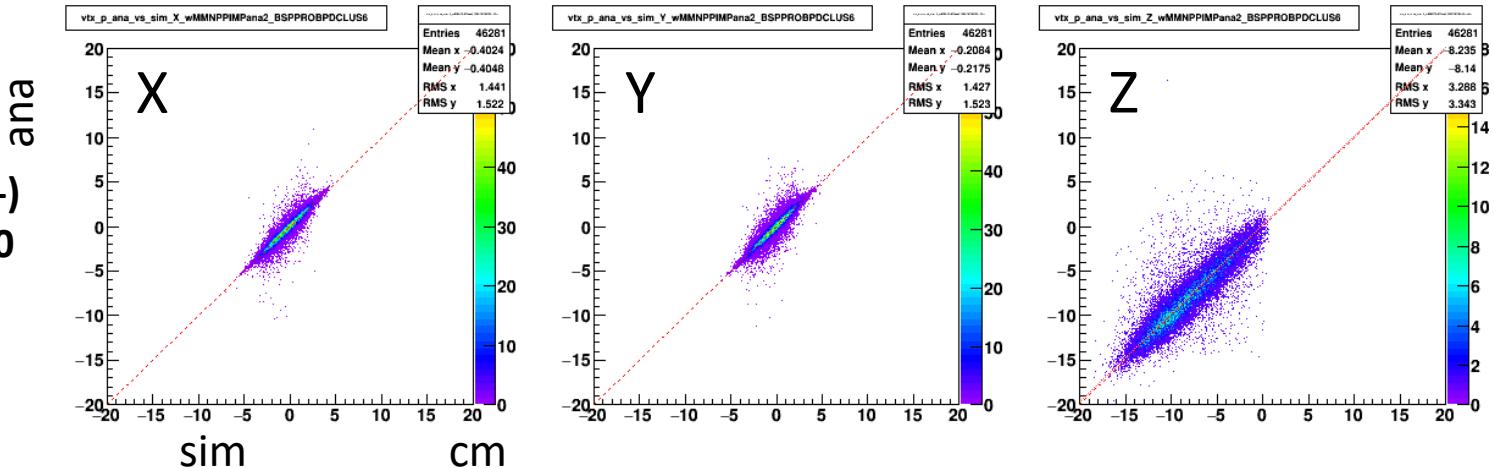


# Vertex proton

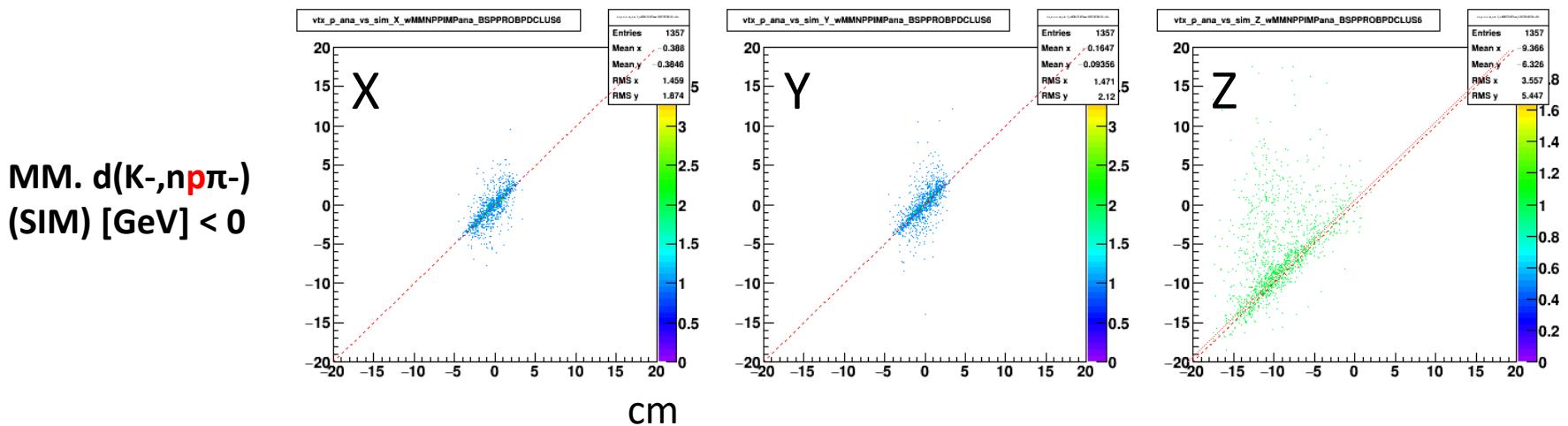


# Vertex proton between sim & ana

2-D plots of sim & ana

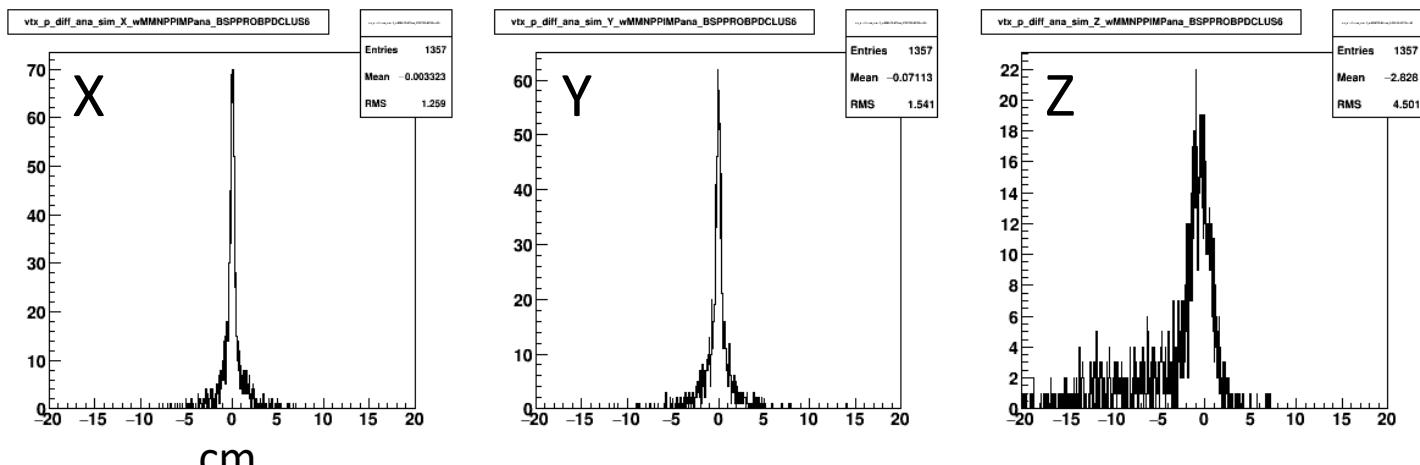
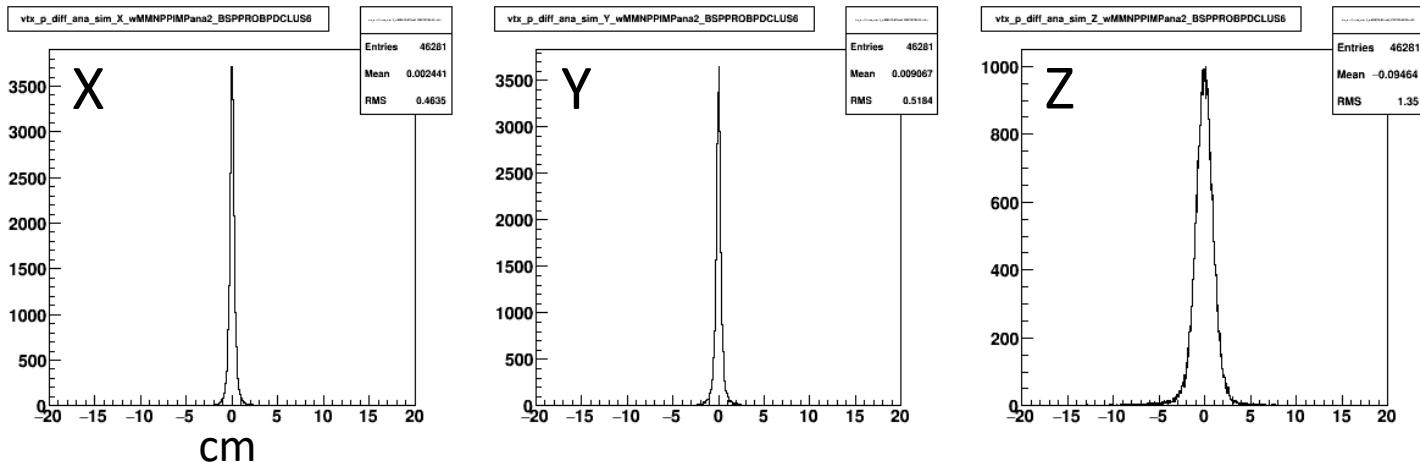


**MM. d( $K_-, p\pi^-$ )  
(SIM) [GeV] < 0**



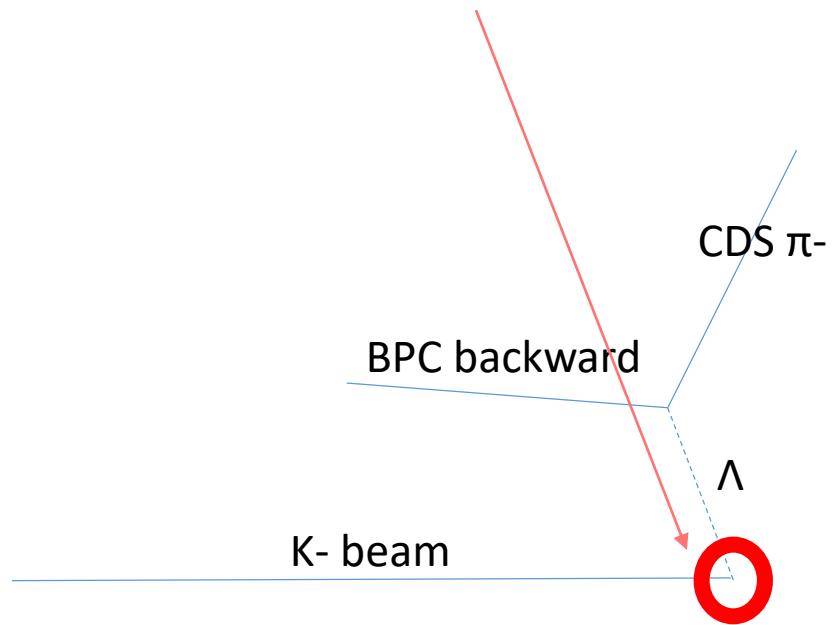
# Vertex proton between sim & ana

Vertex difference between simulation & analysis



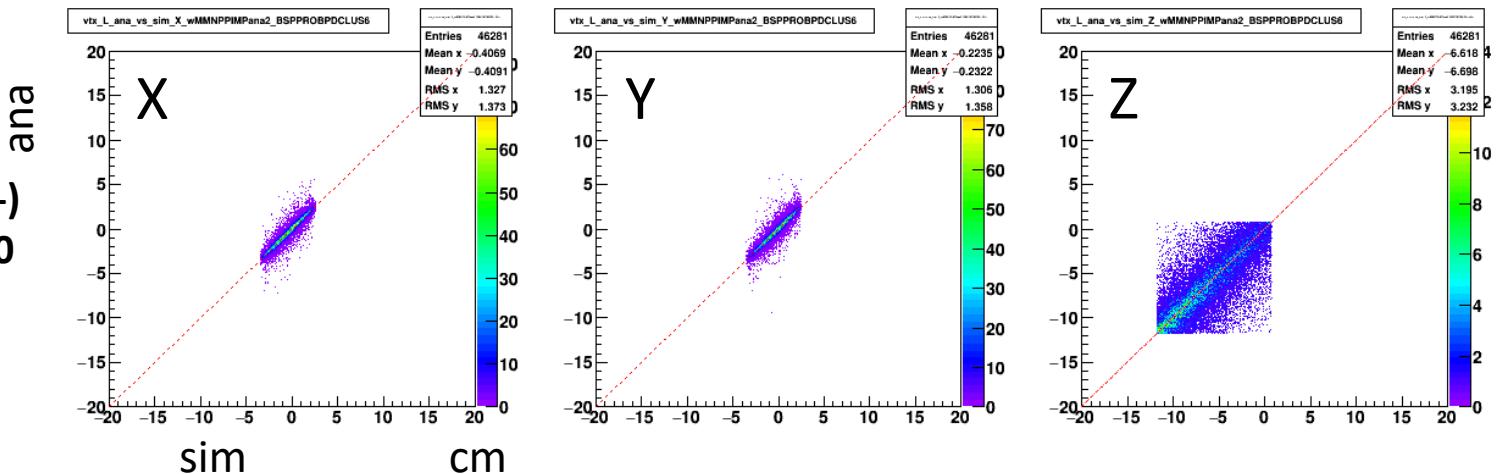
Some mismatch event in MM. d( $K$ -, $n p \pi^-$ ) (SIM) [GeV] < 0,  
Vertex z is ana > sim

# Vertex lambda

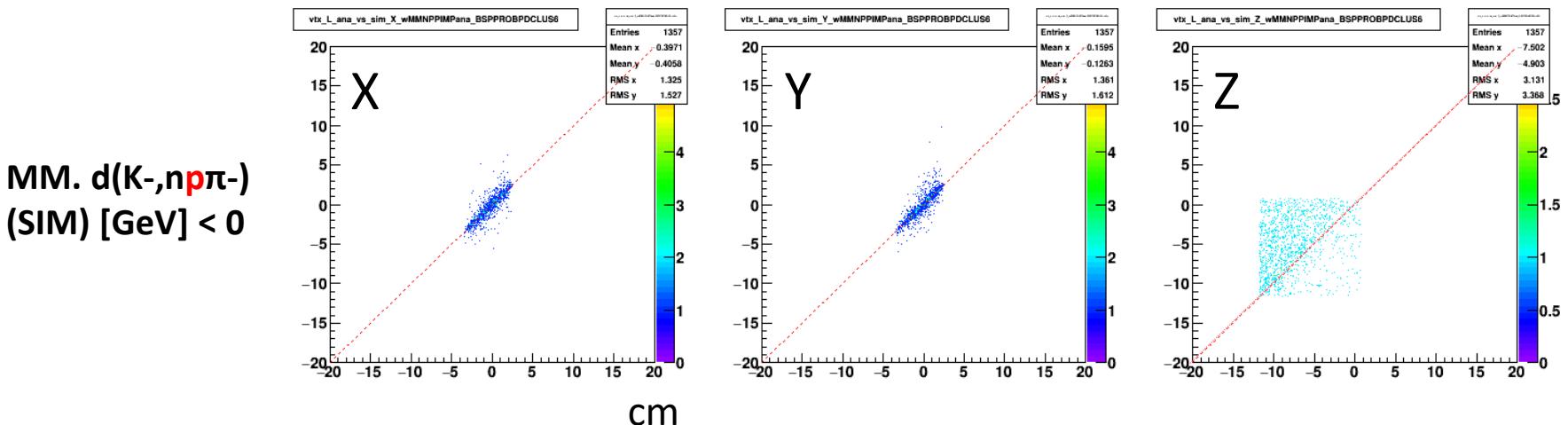


# Vertex proton between sim & ana

2-D plots of sim & ana



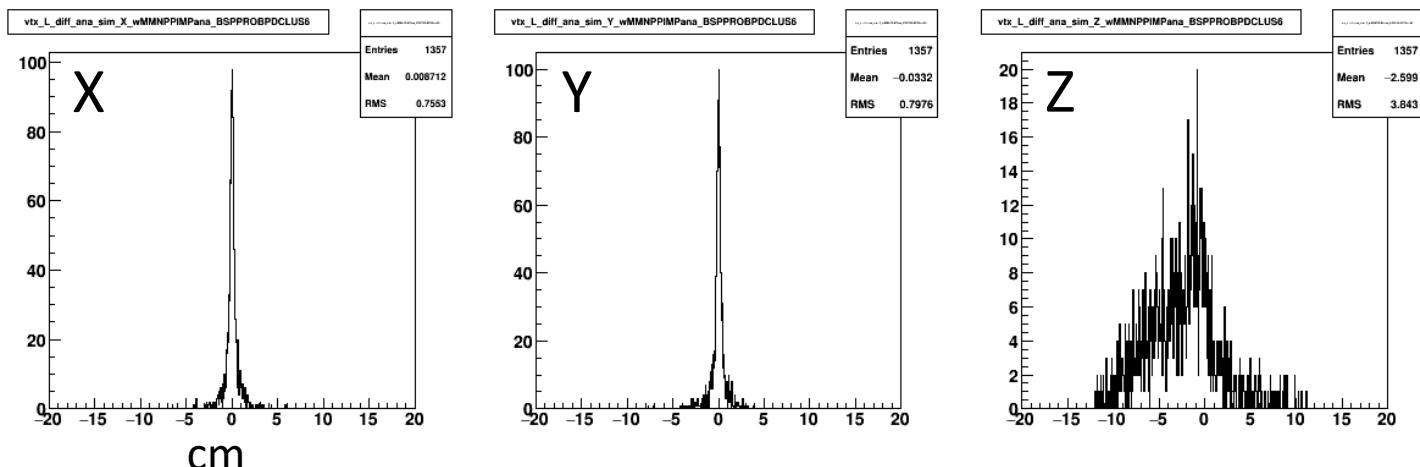
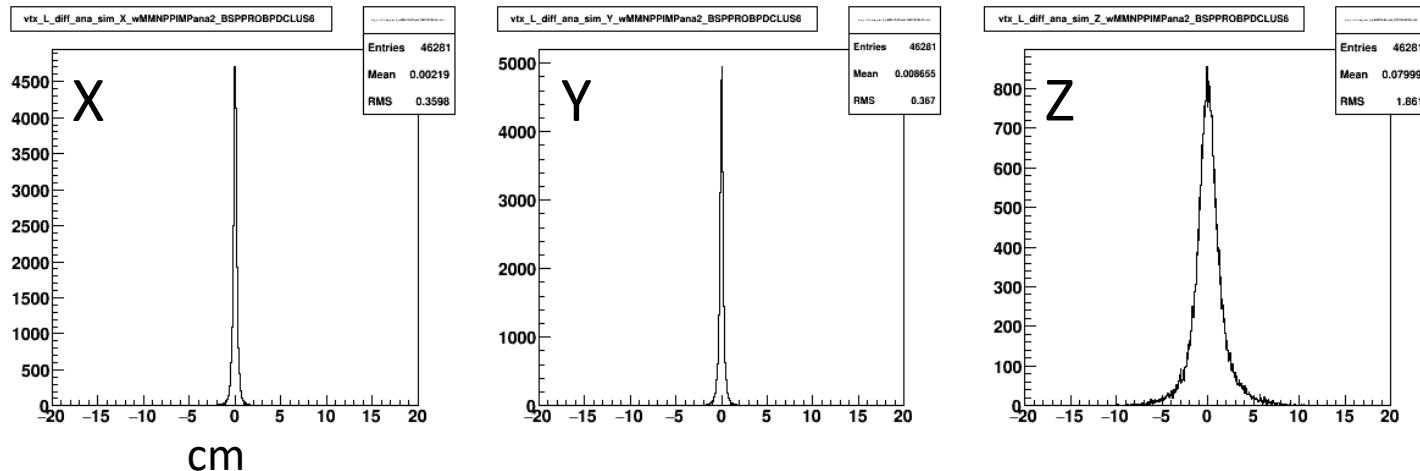
**MM. d( $K_-, np\pi^-$ ) (SIM) [GeV] < 0**



Vertex z in MM. d( $K_-, np\pi^-$ ) (SIM) [GeV] < 0 is strange

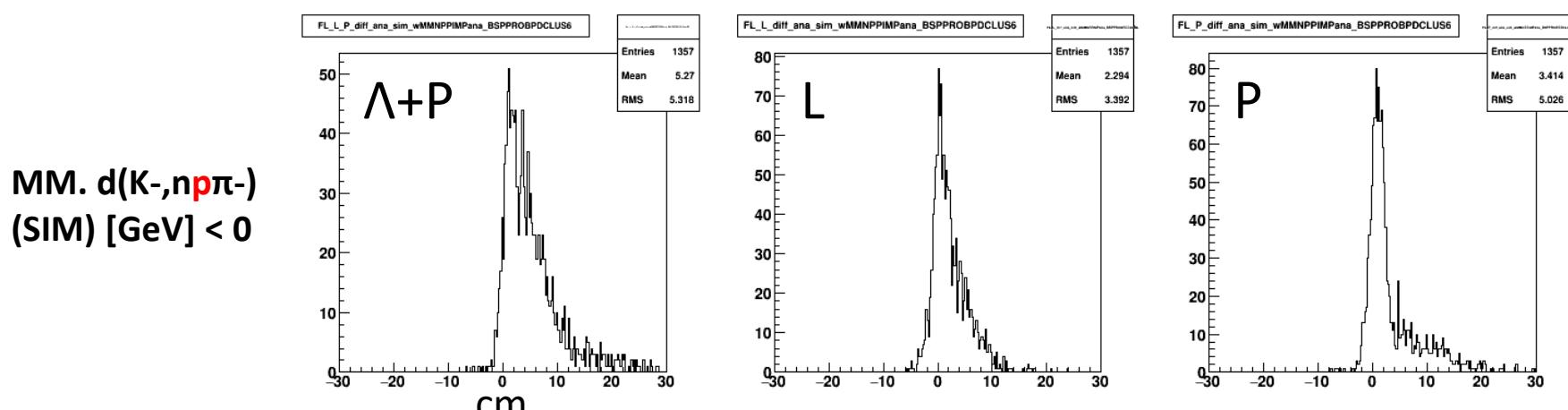
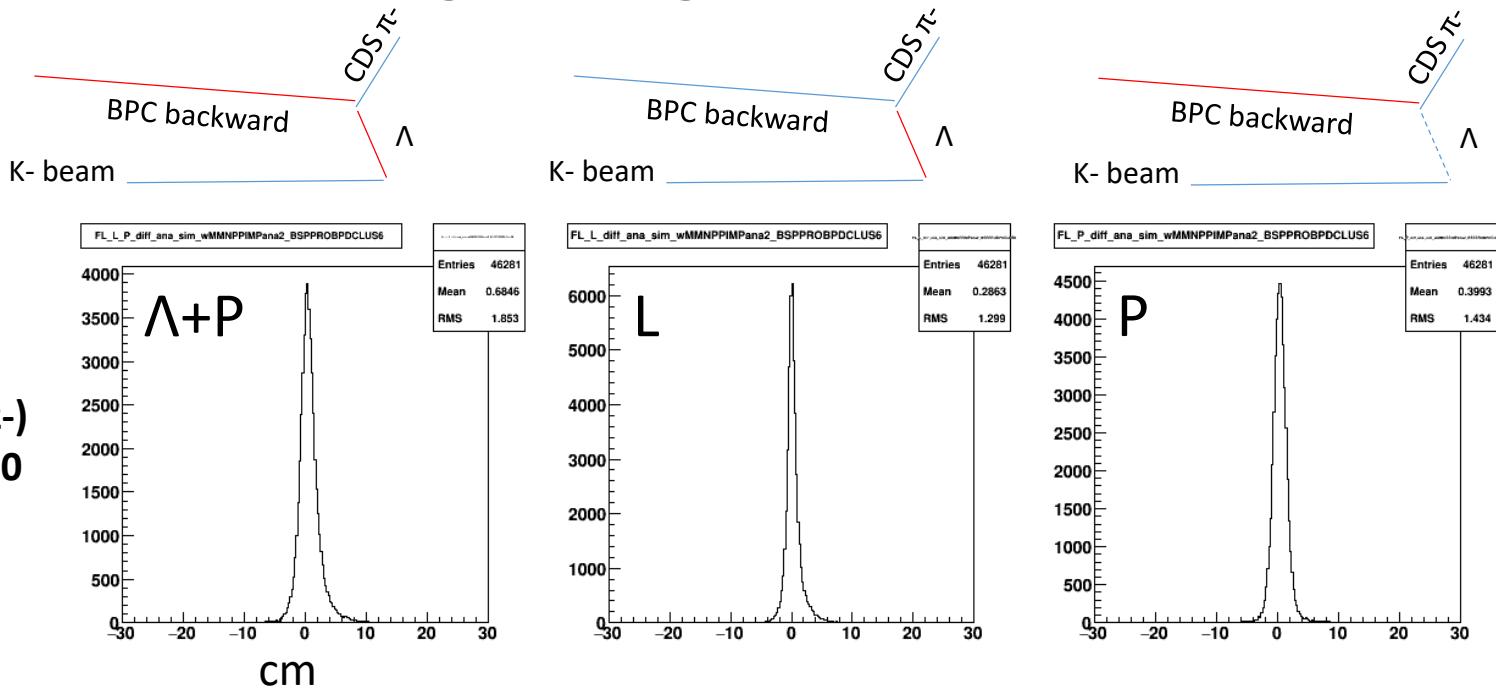
# Vertex proton between sim & ana

Vertex difference between simulation & analysis



Vertex z in MM. d( $K_-, p\pi^-$ ) (SIM) [GeV] < 0 is strange

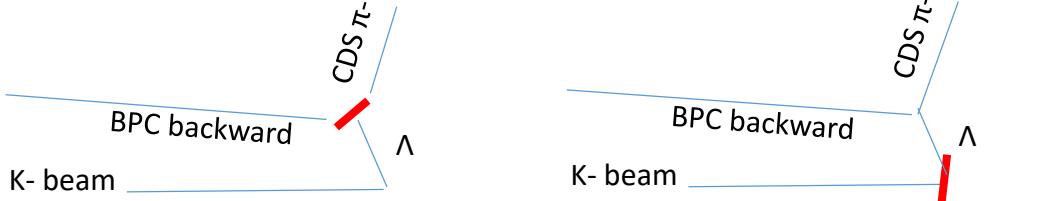
# Difference of flight length between sim & ana



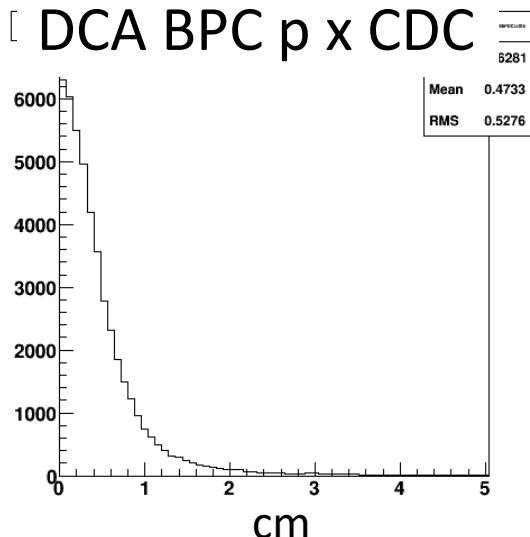
Some mismatch event in MM. d(K-,np $\pi^-$ ) (SIM) [GeV] < 0, flight length is ana > sim

# DCA

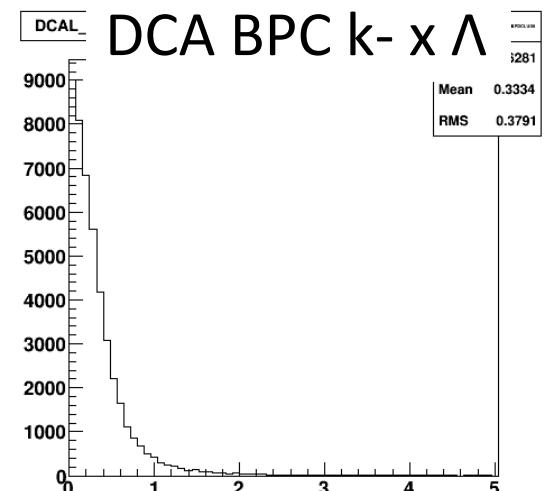
MM.  $d(K, \pi\pi)$   
(SIM) [GeV] > 0



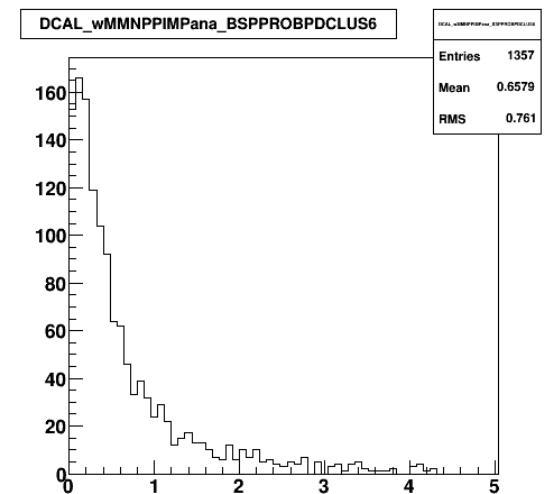
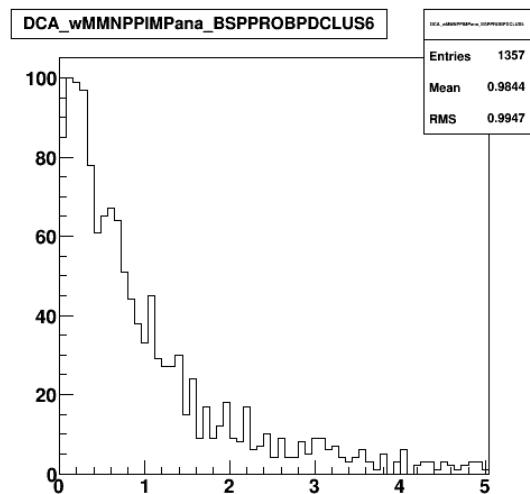
[ DCA BPC p x CDC



[ DCA BPC k- x  $\Lambda$

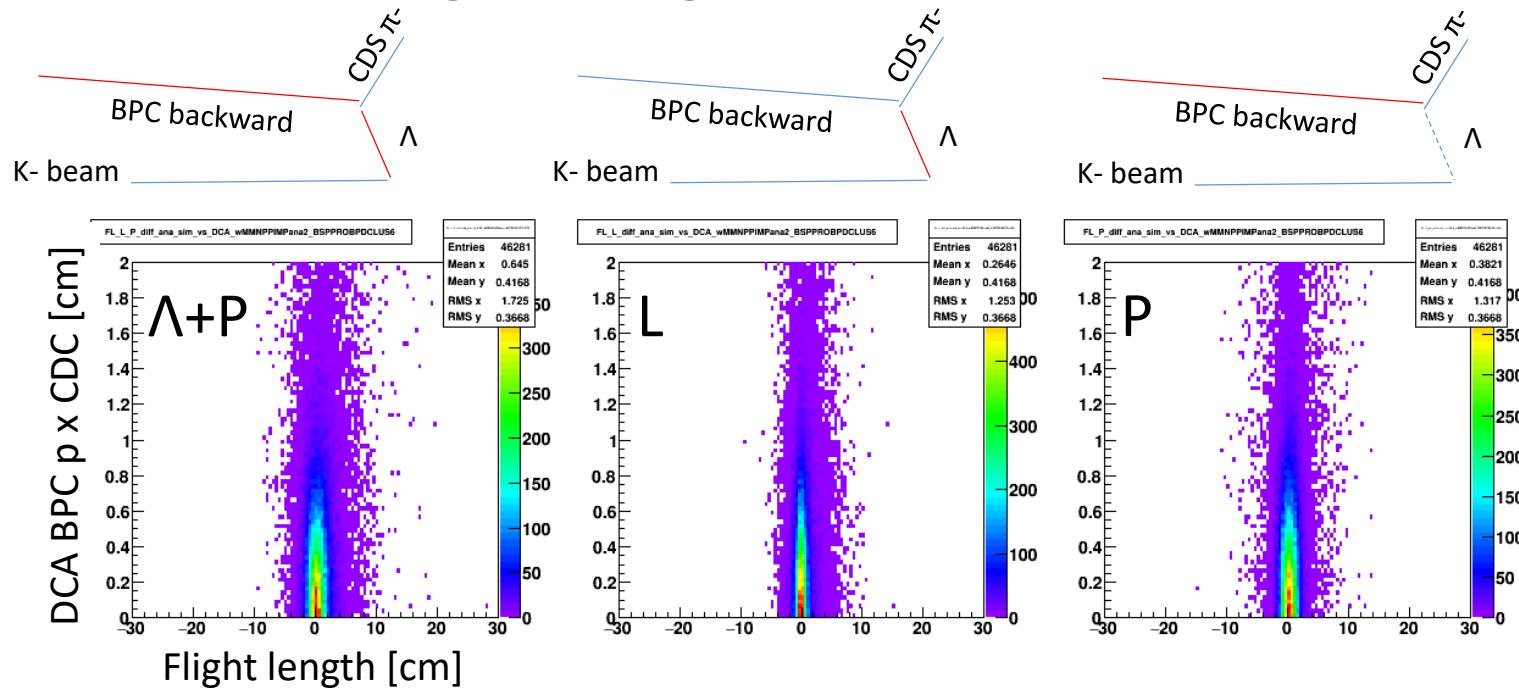


MM.  $d(K, \pi\pi)$   
(SIM) [GeV] < 0

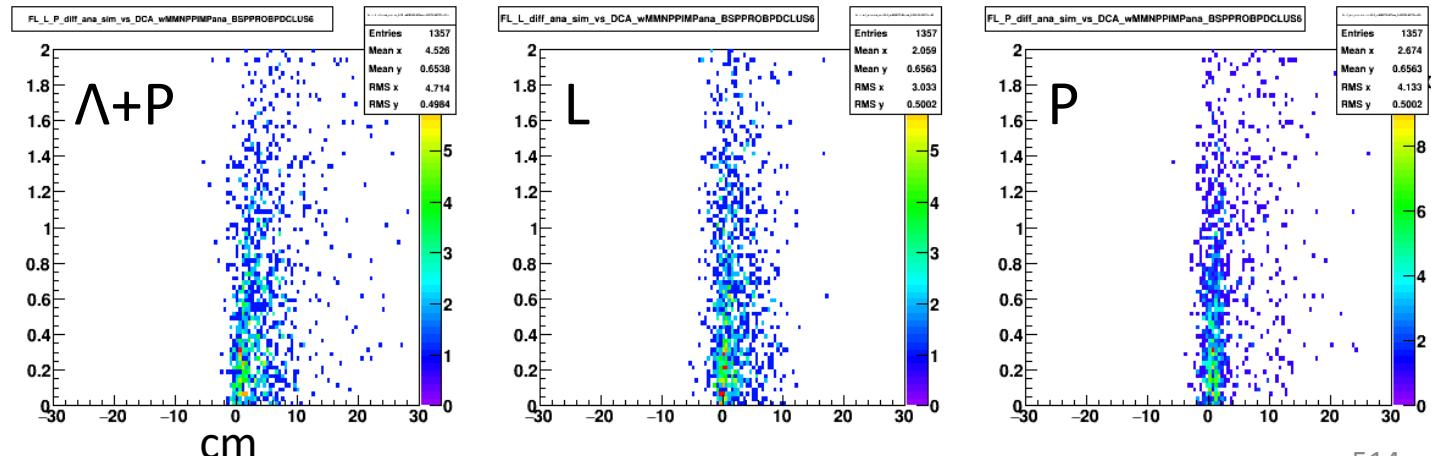


# 2-D plots w/ DCA

## Difference of flight length between sim & ana

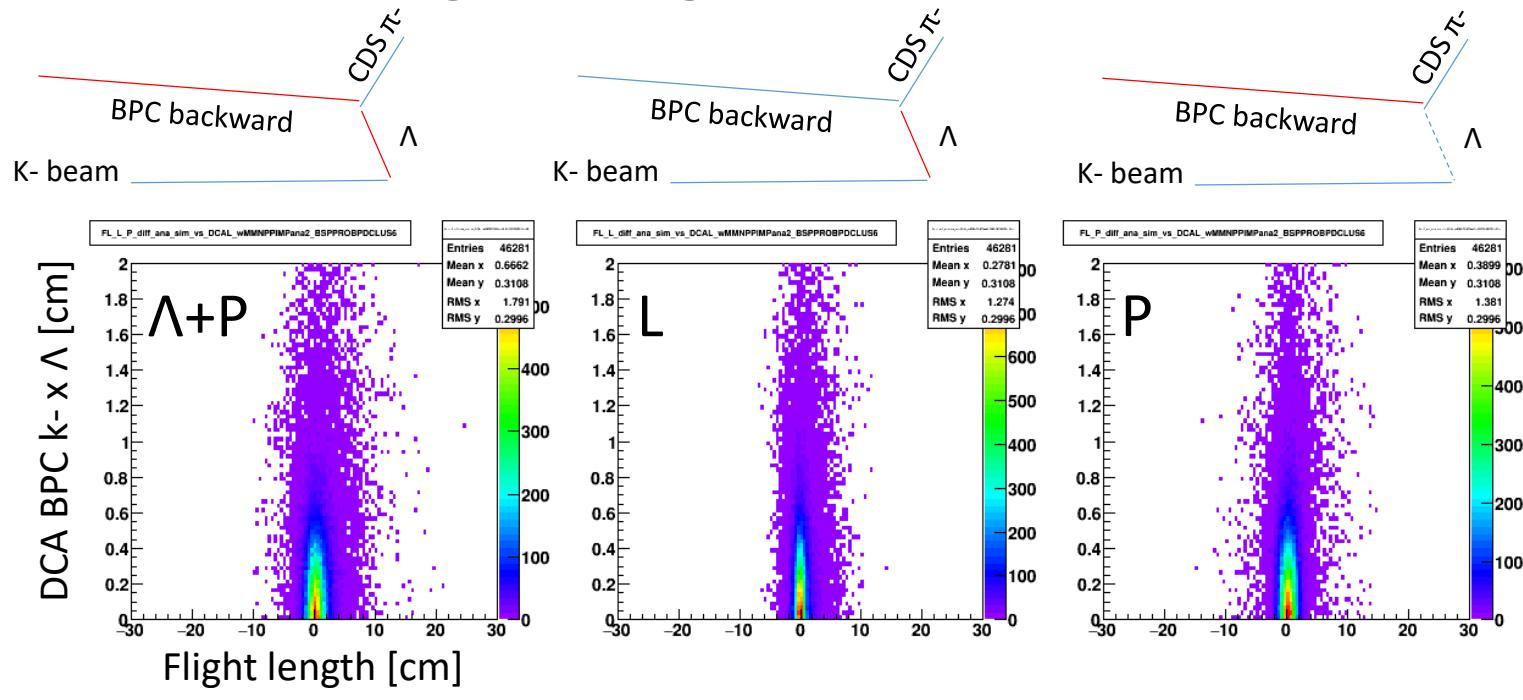


MM.  $d(K, n\pi^-)$   
(SIM) [GeV] < 0



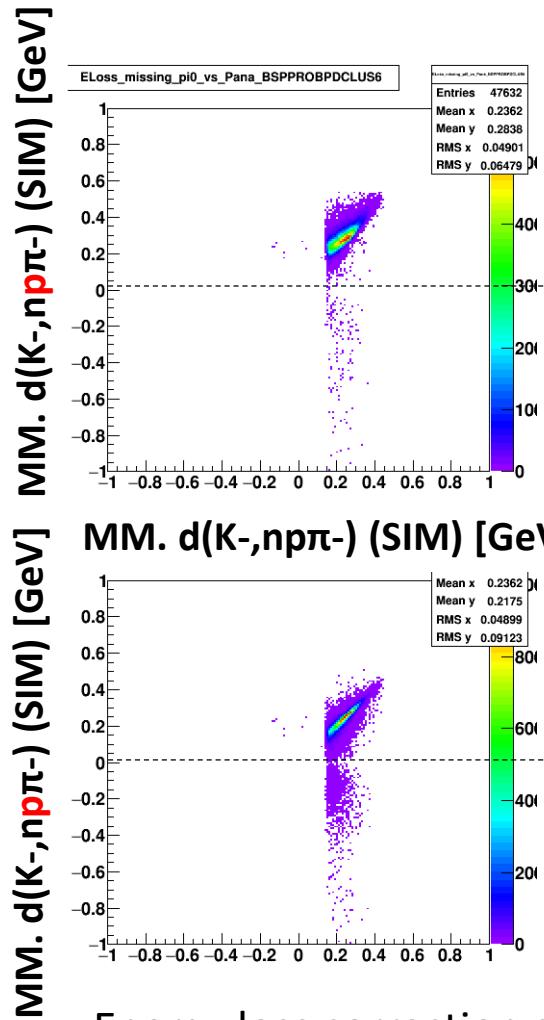
# 2-D plots w/ DCA

## Difference of flight length between sim & ana



# Proton momentum w/o Energy loss correction

Only p  
use analysis value  
(w/o Energy loss correction)



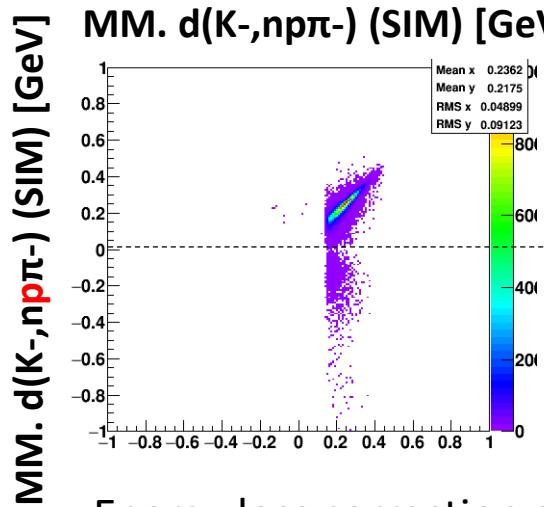
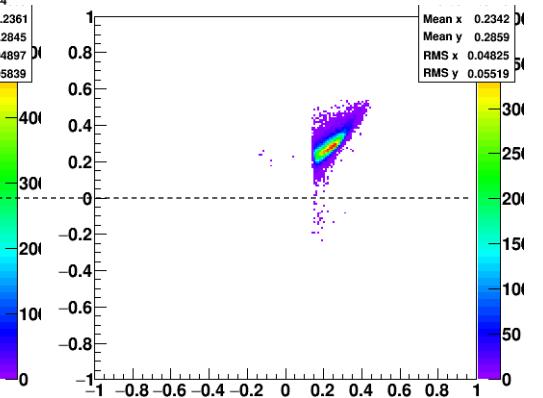
- Select BPD CDH hit from SIM ID

hit from SIM ID

- Select BPD CDH hit from SIM ID
- Vertex p - inside of fiducial

hit from SIM ID

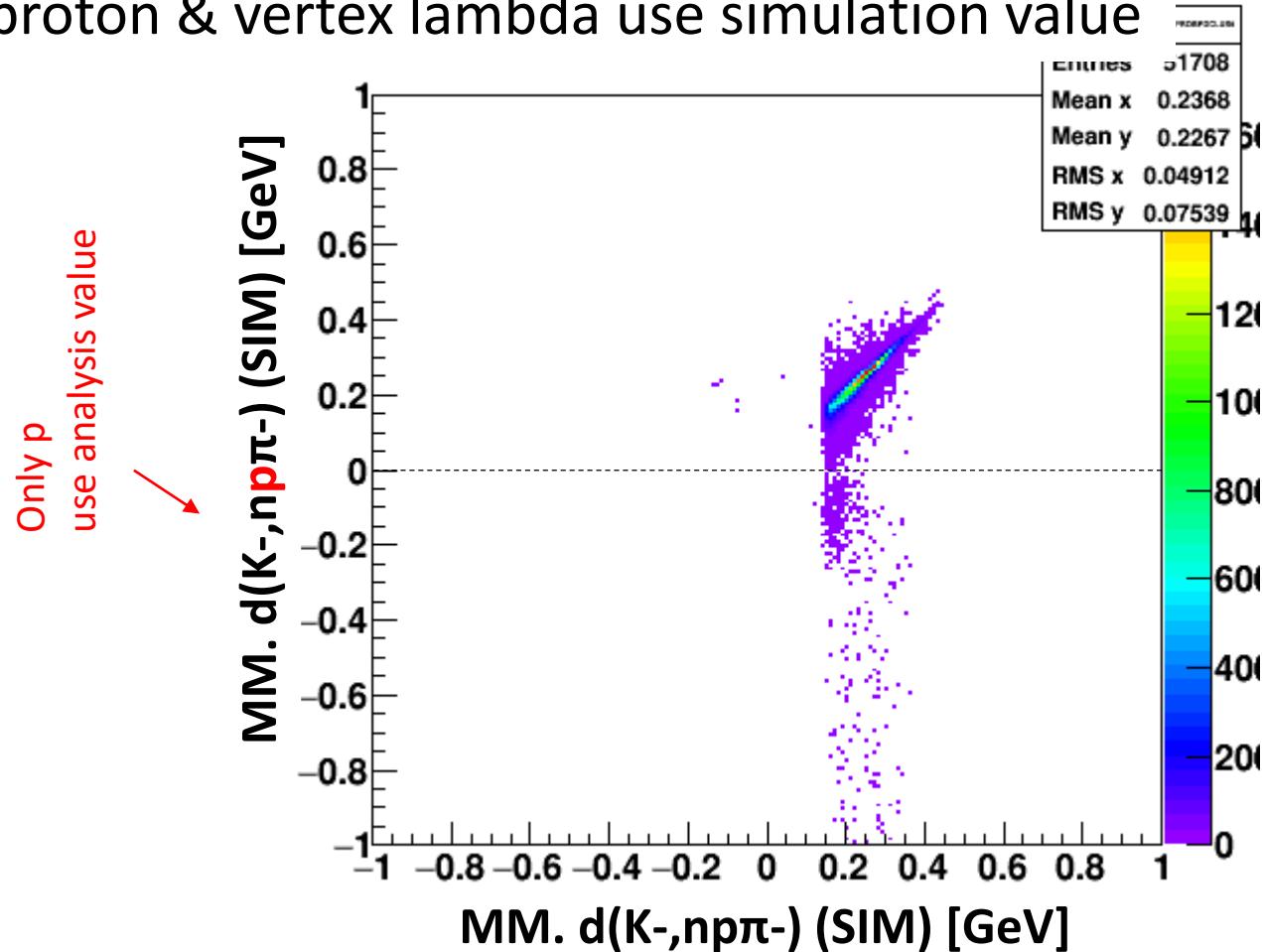
• Vertex p - inside of fiducial



Energy loss correction seems to generate some negative event

# Vertex exchanged by SIM value

- Vertex proton & vertex lambda use simulation value



Negative events still remain

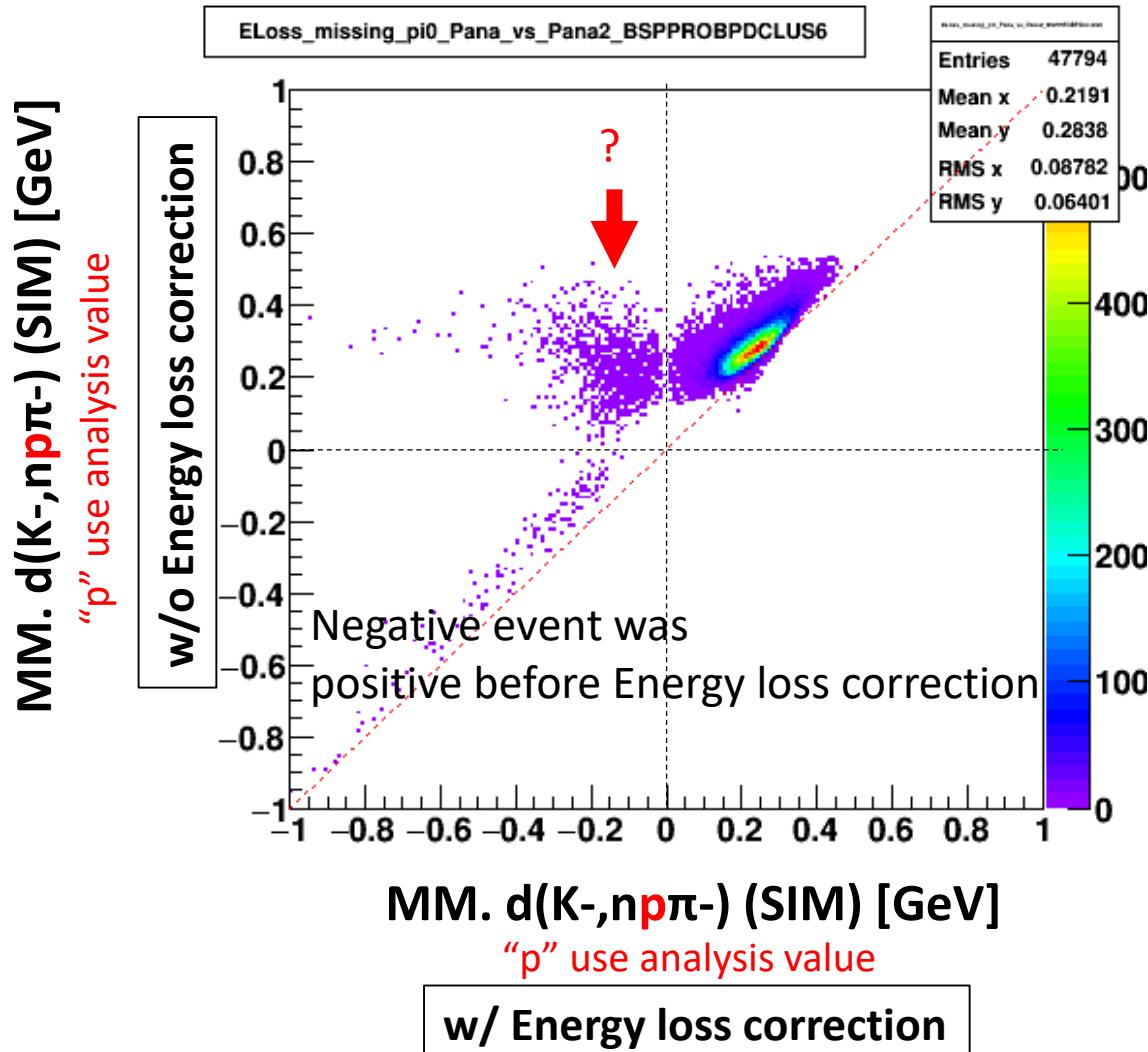
# Summary & to do

- Bag of  $\pi$ - momentum in simulation is fixed
- Energy loss correction for backward proton generate some  $d(K^-, n\rho\pi^-)$  negative event which distort vertex point of lambda
- To do
  - check the part of Energy loss correction for backward proton about flag condition

# Search for the reason of MM. $d(K^-, n\bar{p}\pi^-)$ negative

- “p” use analysis value

# MM. d(K-,n $\bar{p}$ $\pi^-$ ) w/ Energy loss correction vs w/o



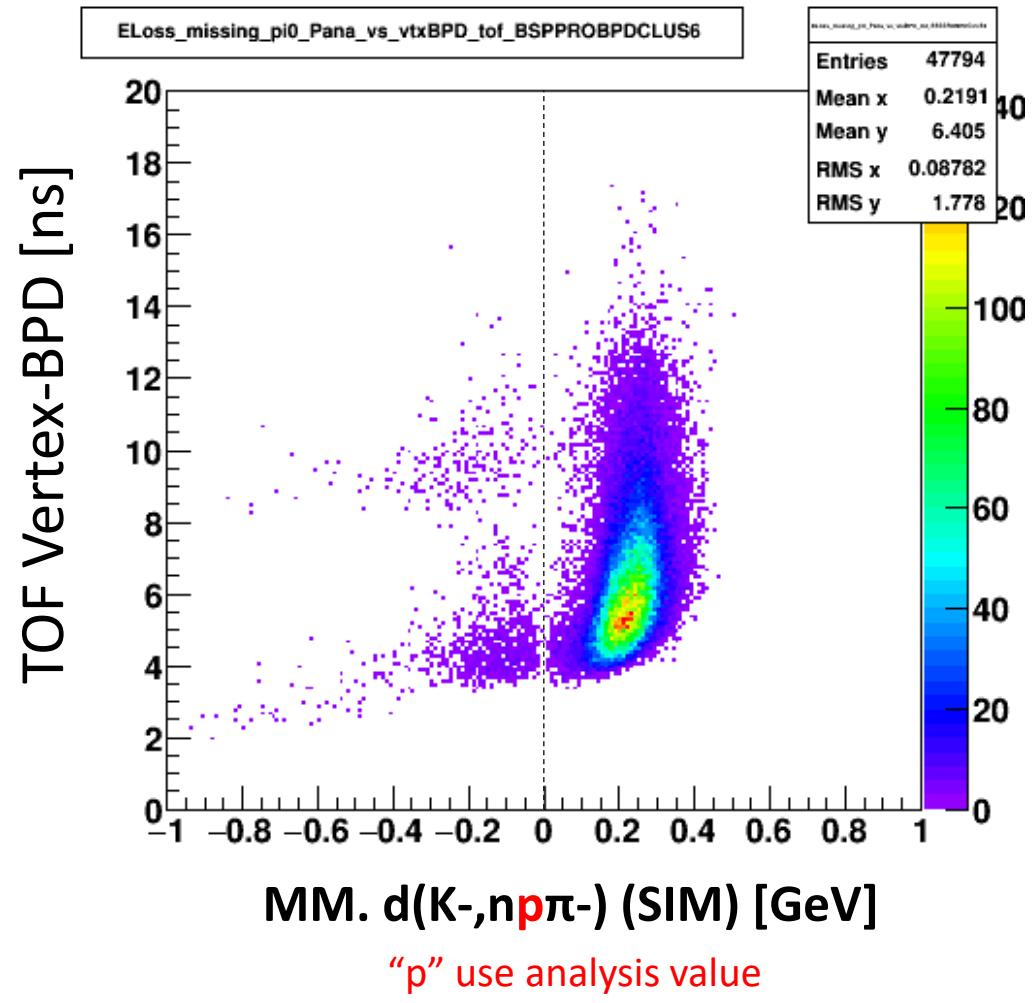
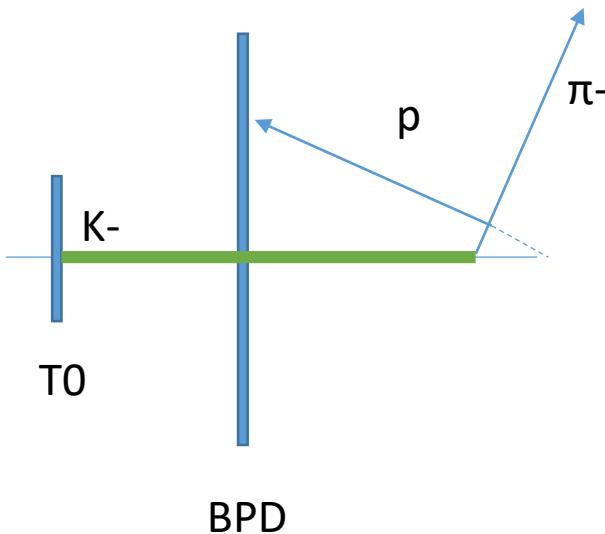
# Dependence on TOF Vertex-BPD

Vertex ; DCA of CDC  $\pi^-$  & BPC Beam K-

TOF Vertex-BPD

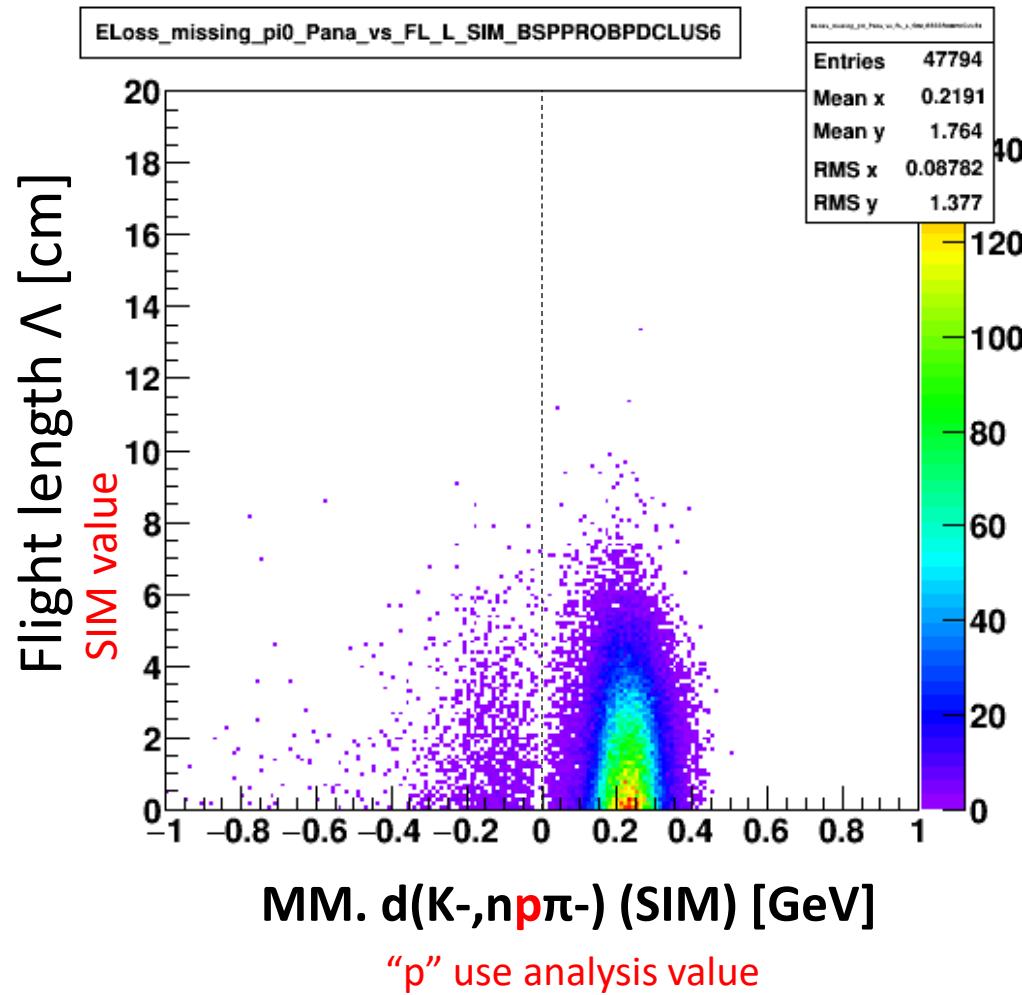
= TOF BPD-T0

- TOF (Beam (T0->Vertex) )



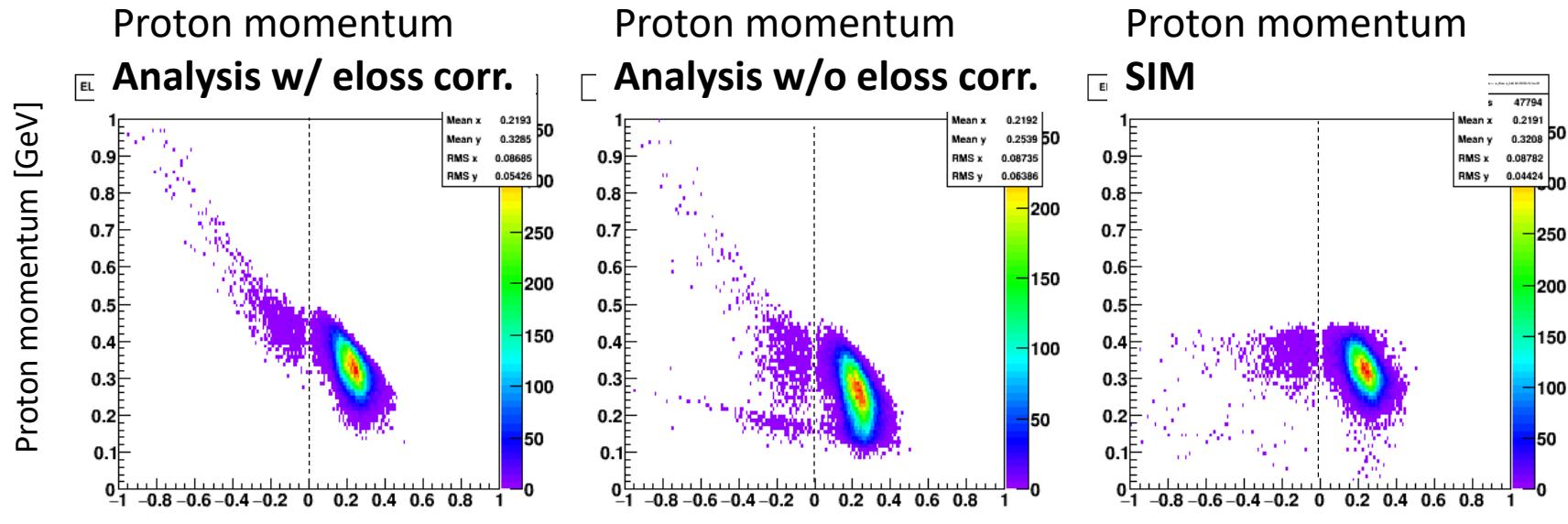
Negative event seems to be located in fast ones

# Dependence on Flight length $\Lambda$



Negative event is not depend on Flight length  $\Lambda$

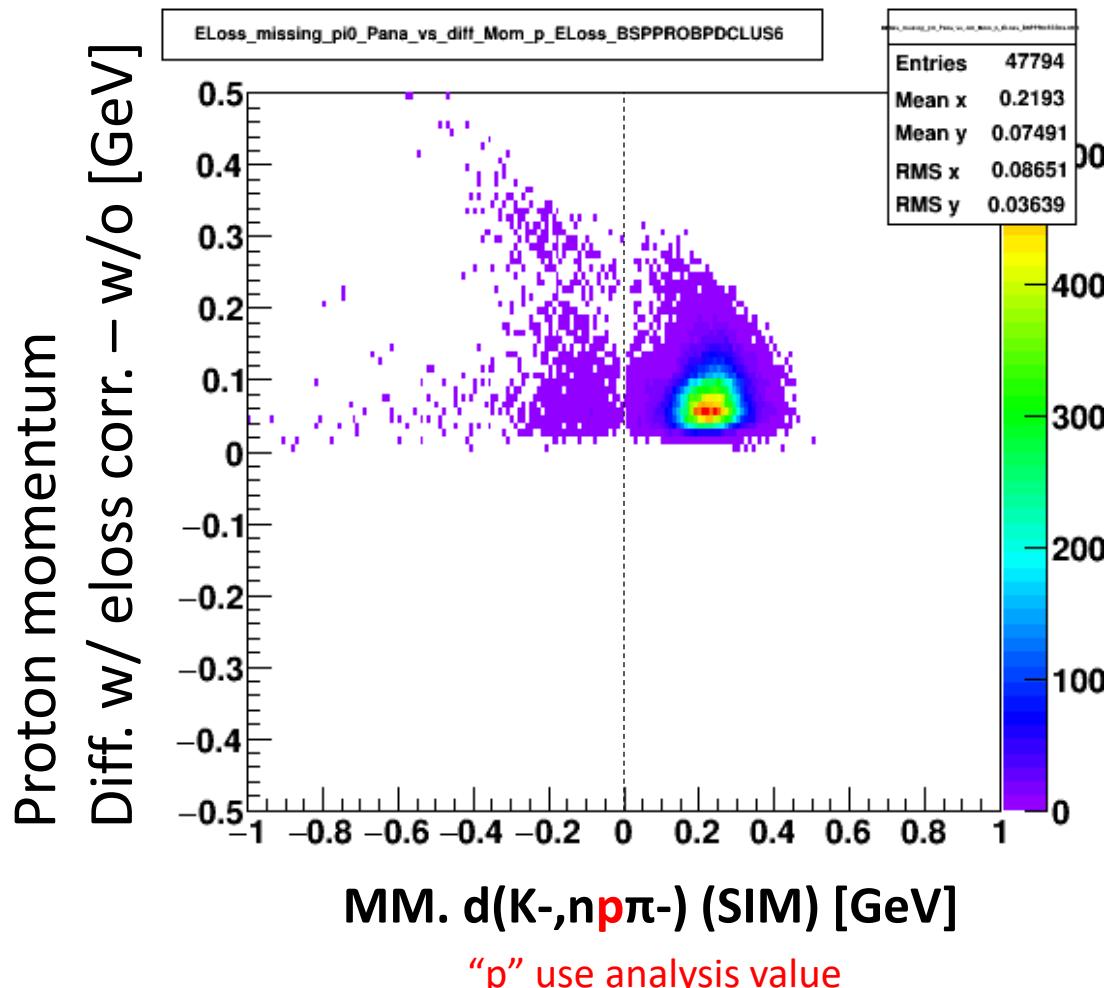
# Dependence on proton momentum



MM.  $d(K^-, np\pi^-)$  (SIM) [GeV]

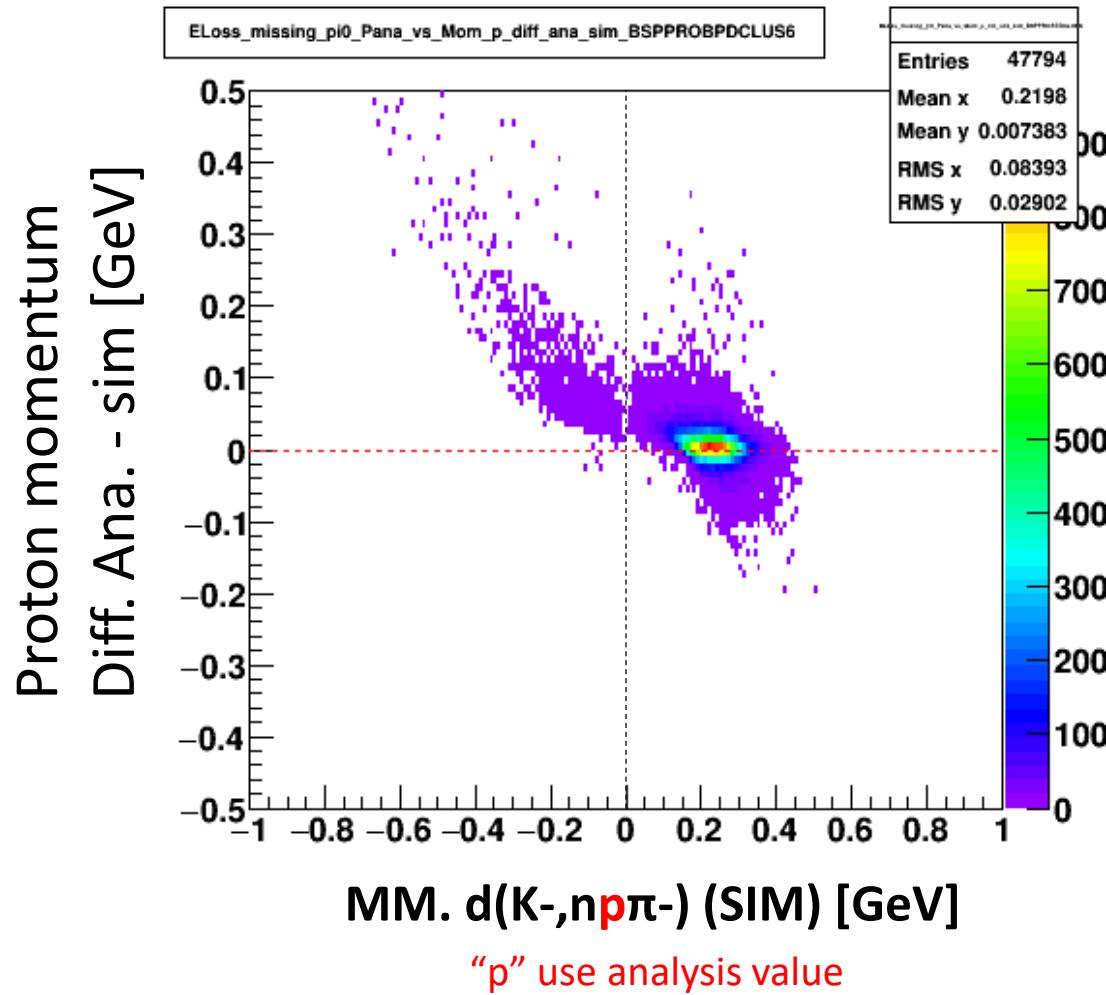
"p" use analysis value

# Dependence on proton momentum diff. energy loss correction



Negative event seems to be not depend on proton momentum diff. eloss corr

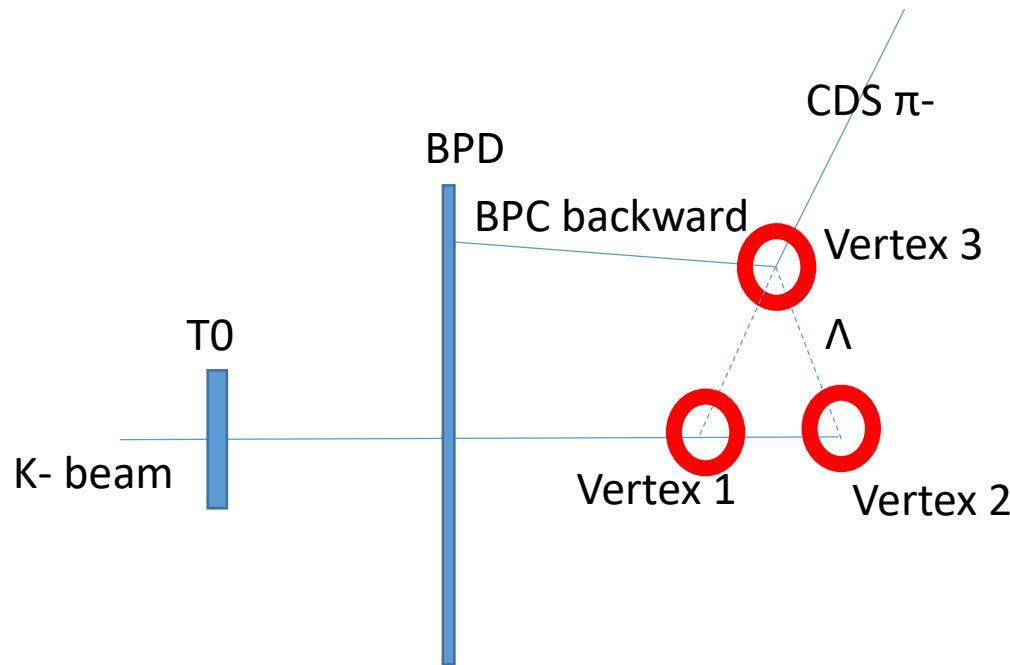
# Dependence on proton momentum diff. analysis - simulation



Negative event seems to be higher than true momentum

# Correction of the calculation of backward proton momentum

# Vertex of the $\Sigma^0\pi^0$ reaction



Vertex 1 DCA  $K^-$  &  $\pi^-$

Vertex 2 DCA  $\Lambda$  &  $K^-$  Beam

Vertex 3 DCA  $p$  &  $\pi^-$

# After

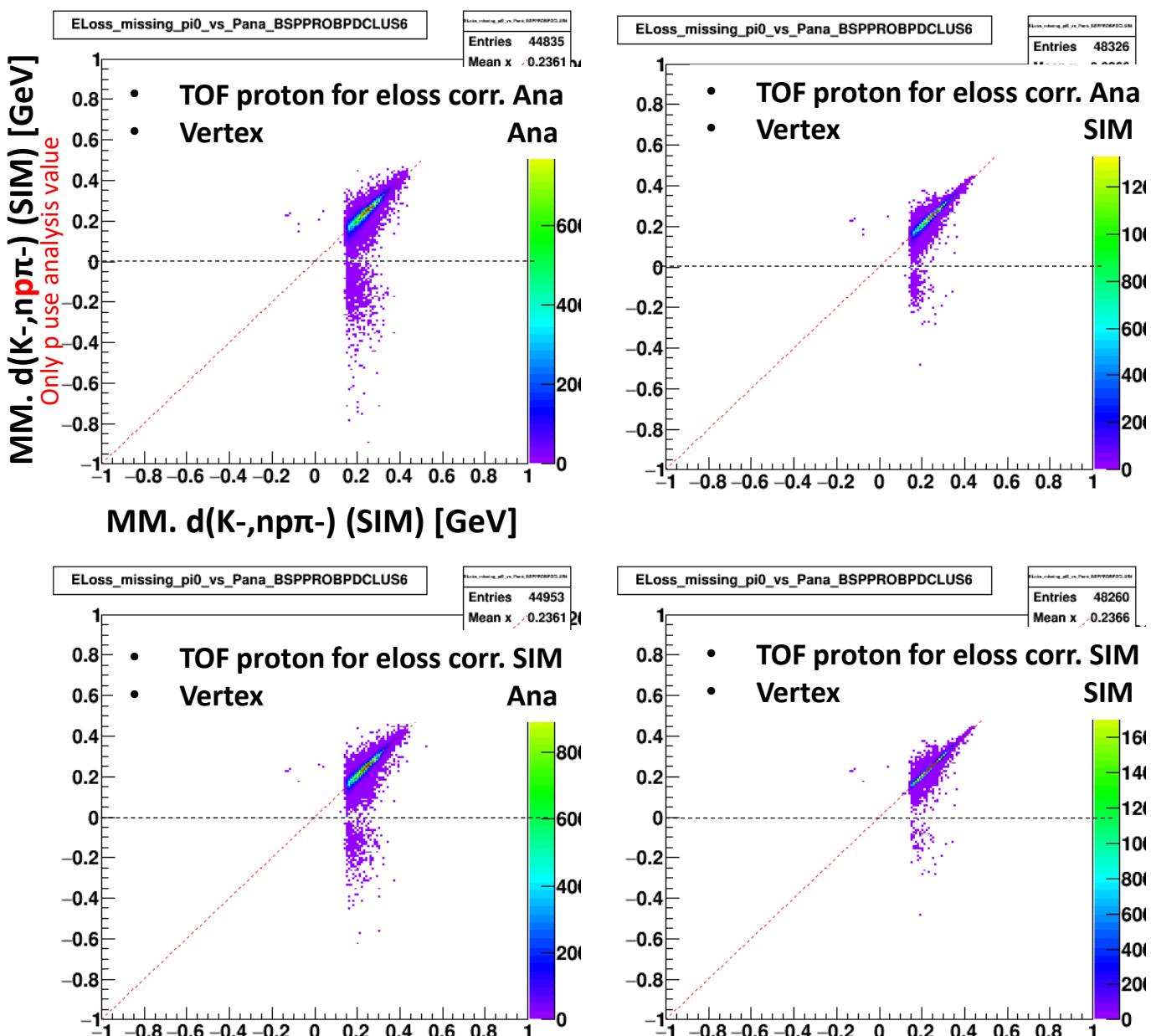
## Process of the calculation of proton momentum

1. TOF BPD-T0 subtracted by TOF Beam ( $T0 \rightarrow \text{vertex 1}$ )
2. Eloss correction by using the TOF 1.
3. Lambda momentum is ~~fixed~~ and, Lambda vertex is also ~~fixed~~.
4. TOF BPD-T0 subtracted by TOF Beam ( $T0 \rightarrow \text{vertex 2}$ ) and TOF Lambda ( $\text{vertex 2} \rightarrow \text{vertex 3}$ )
5. Eloss correction by using the TOF 4.

iteration

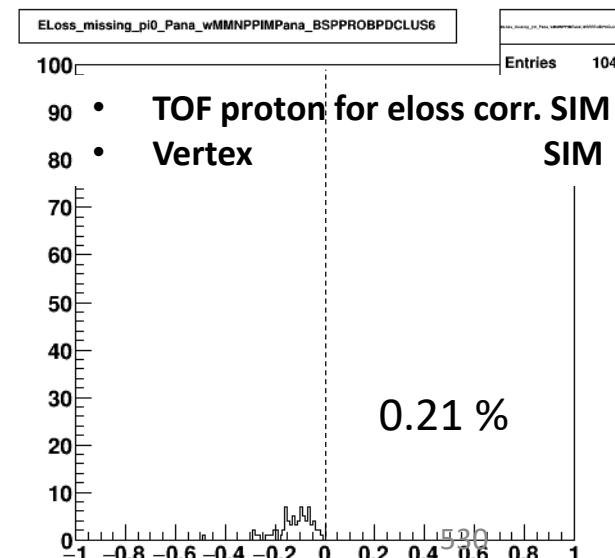
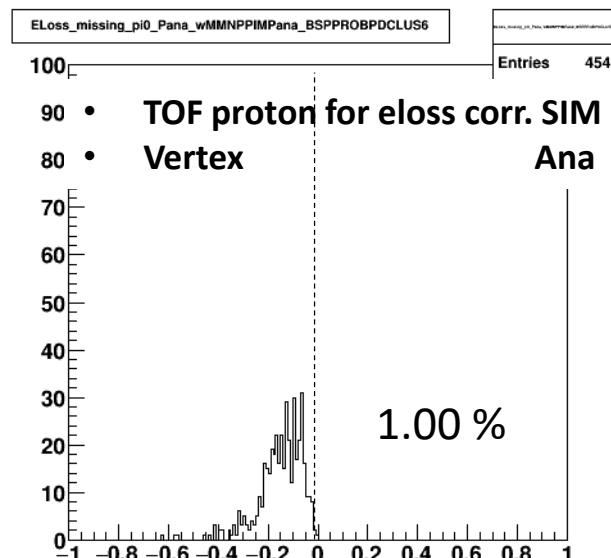
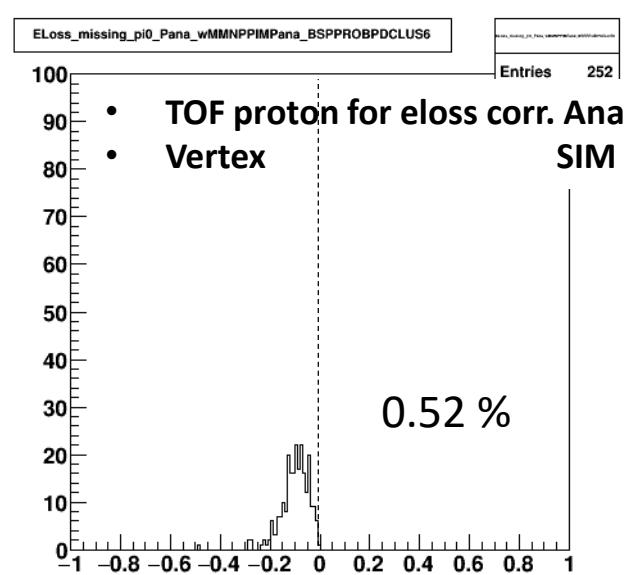
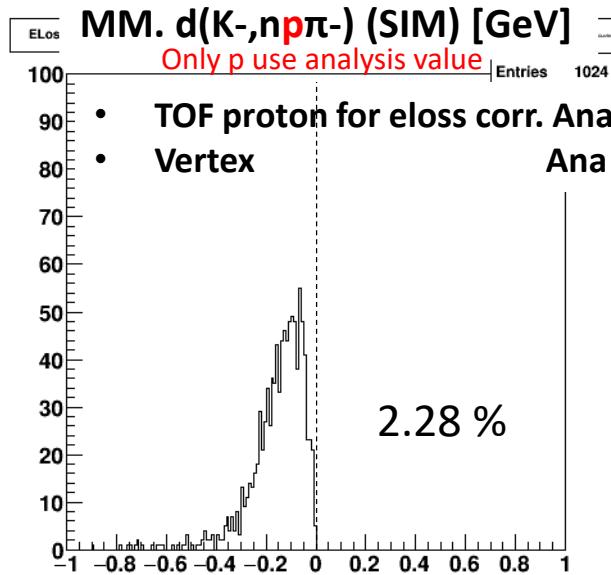
# MM. $d(K^-, n p \pi^-)$ (SIM) vs MM. $d(K^-, n p \pi^-)$ w/ SIM value

- SIM  $K-d \rightarrow n \Sigma 0 \pi 0$ 
  - $\Sigma 0 \pi 0$  mass use CS
- Condition
  - PID NC neutron
  - PID BPD proton
  - PID CDS  $\pi^-$
- (before selection of  $\Lambda$ )
  - Select BPD CDH hit from SIM ID



# $d(K\text{-}, np\pi^-)$ (SIM) negative event distribution w/ SIM value

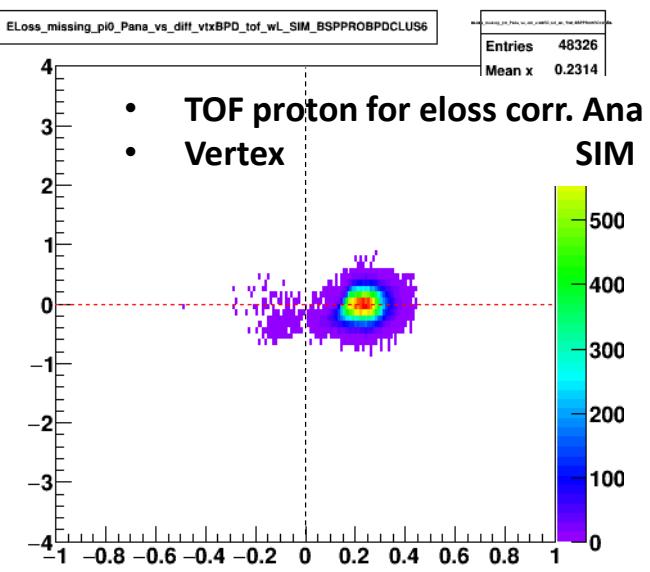
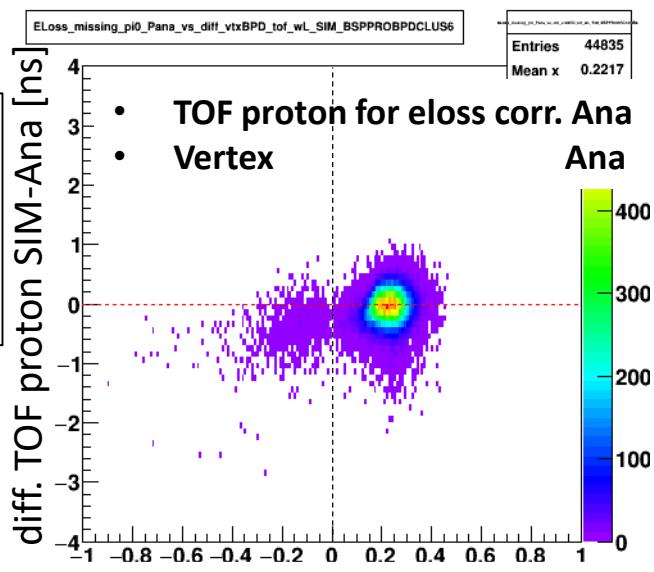
- SIM  $K\text{-}d \rightarrow n \Sigma 0\pi^0$ 
  - $\Sigma 0\pi^0$  mass use CS
- Condition
  - PID NC neutron
  - PID BPD proton
  - PID CDS  $\pi^-$
- (before selection of  $\Lambda$ )
  - Select BPD CDH hit from SIM ID



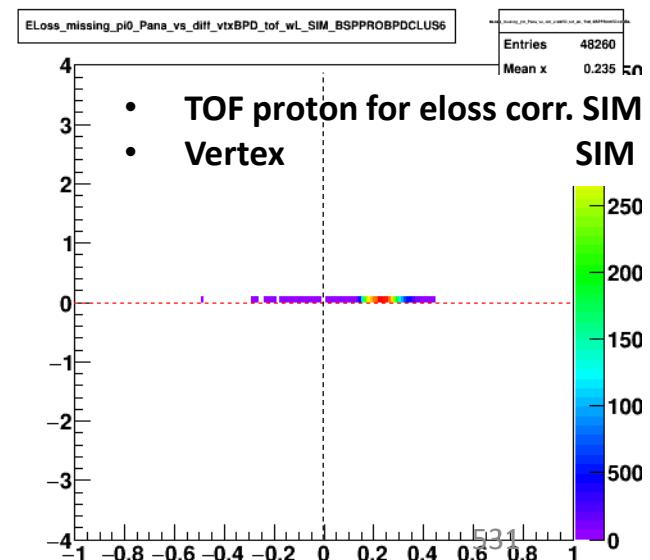
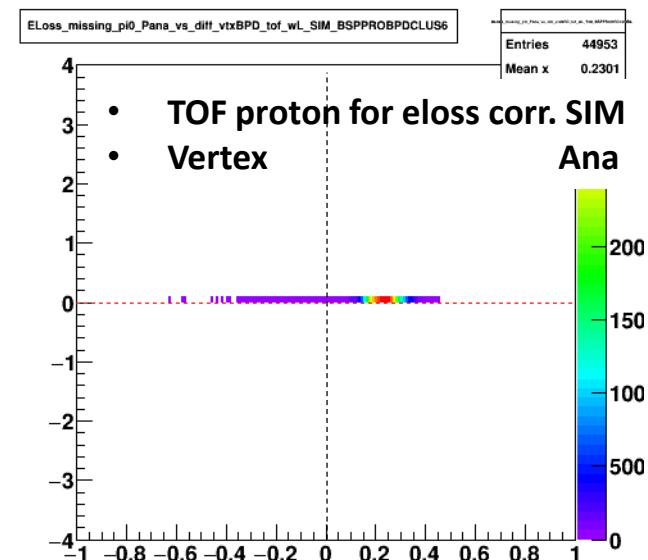
# $d(K^-, n p \pi^-)$ (SIM) vs diff. TOF proton SIM-Ana w/ SIM value

TOF proton =  
 TOF BPD-T0  
 - TOF Beam ( $T_0 \rightarrow$  vertex  $\Lambda$ )  
 - TOF  $\Lambda$

- SIM  $K^- d \rightarrow n \Sigma^0 \pi^-$ 
  - $\Sigma^0 \pi^-$  mass use CS
- Condition
  - PID NC neutron
  - PID BPD proton
  - PID CDS  $\pi^-$
- (before selection of  $\Lambda$ )
  - Select BPD CDH hit from SIM ID



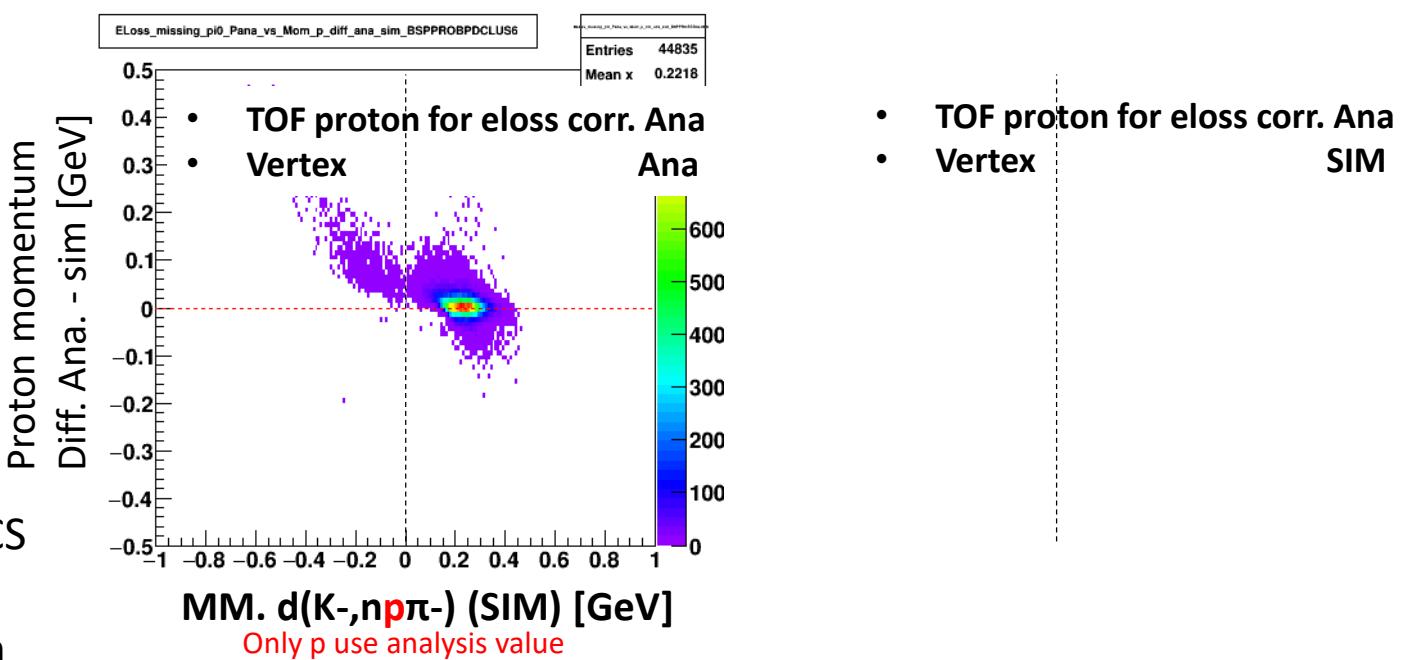
**MM.  $d(K^-, n p \pi^-)$  (SIM) [GeV]**  
 Only p use analysis value



b31

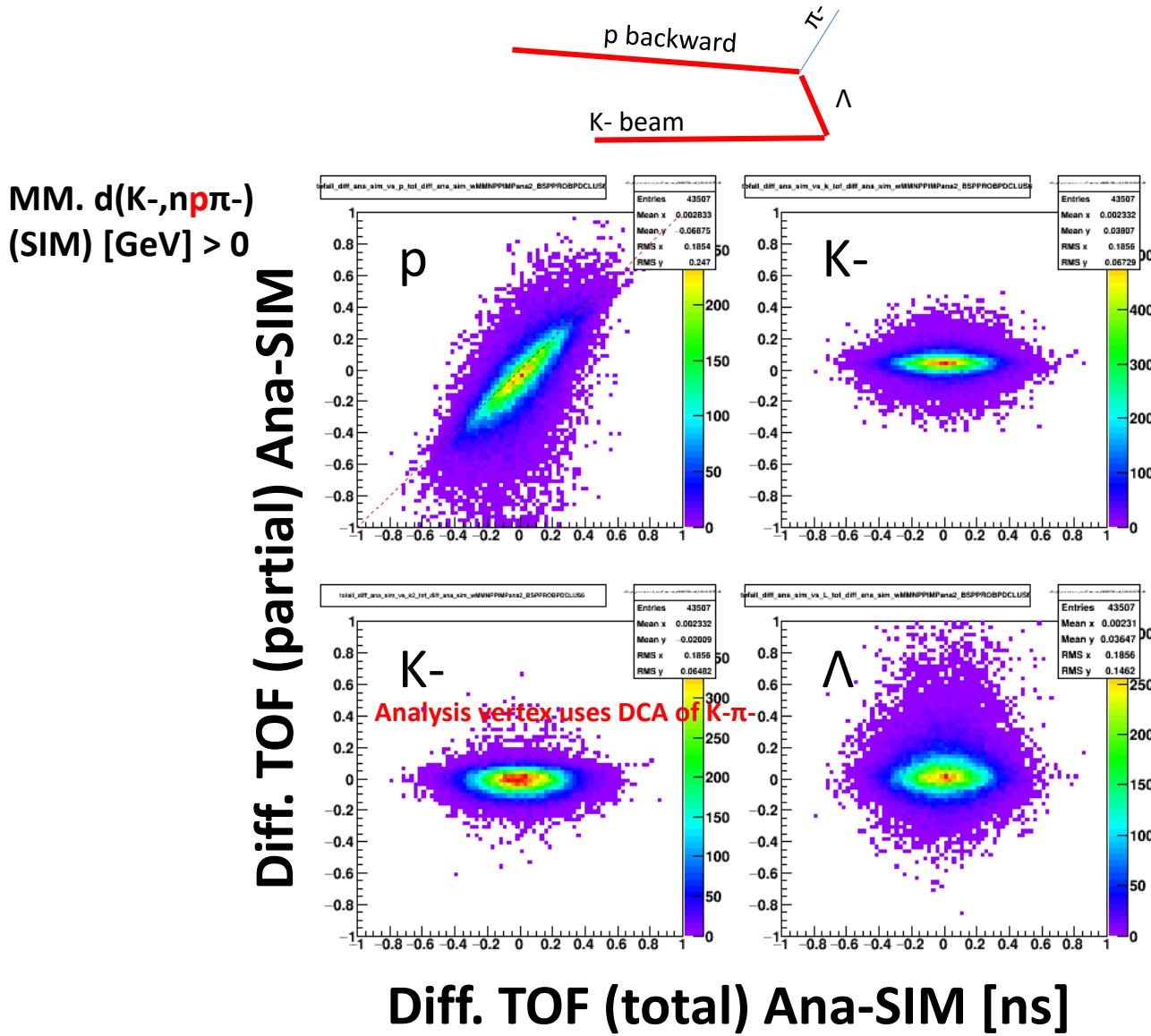
# $d(K\text{-}, n p \pi^-)$ (SIM) vs diff. proton momentum Ana-sim w/ SIM value

- SIM  $K\text{-}d \rightarrow n \Sigma 0 \pi^0$ 
  - $\Sigma 0 \pi^0$  mass use CS
- Condition
  - PID NC neutron
  - PID BPD proton
  - PID CDS  $\pi^-$
- (before selection of  $\Lambda$ )
  - Select BPD CDH hit from SIM ID



- TOF proton for eloss corr. SIM  
• Vertex
- TOF proton for eloss corr. SIM  
• Vertex

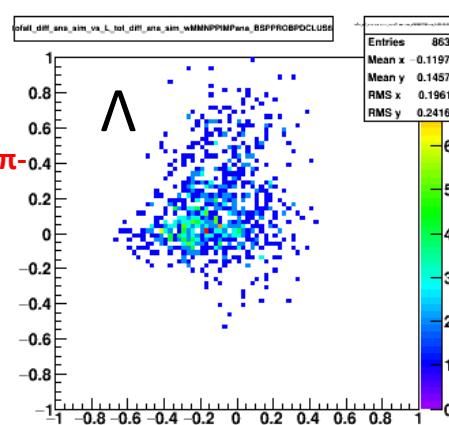
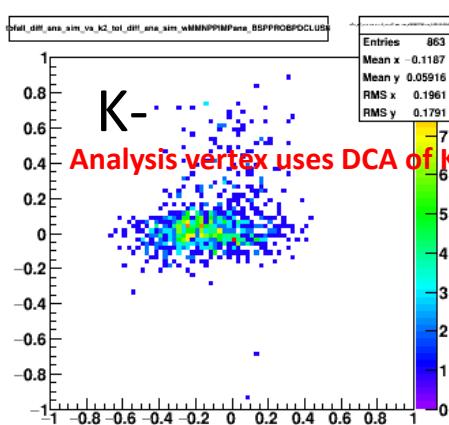
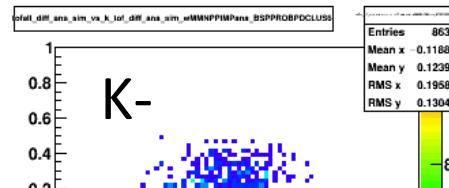
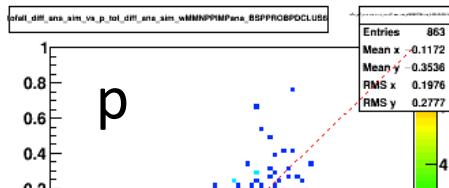
# Diff. TOF Ana-SIM total vs partial



# Diff. TOF Ana-SIM total vs partial

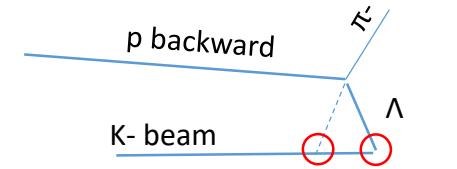
MM.  $d(K_-, np\pi^-)$   
(SIM) [GeV] < 0

Diff. TOF (partial) Ana-SIM



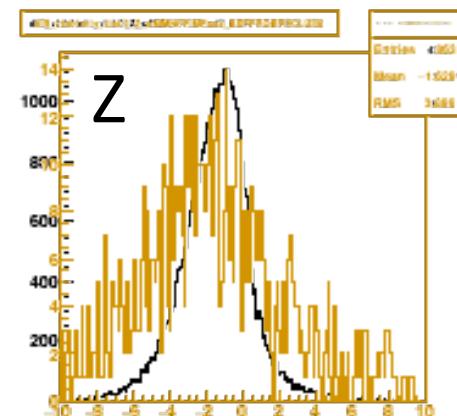
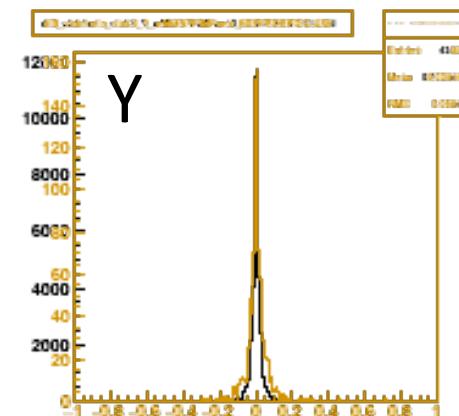
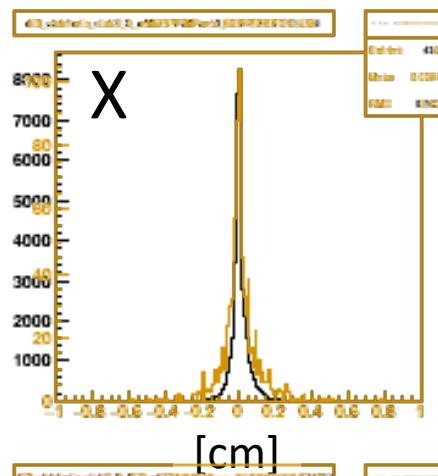
Diff. TOF (total) Ana-SIM [ns]

# Diff. Vertex K- $\pi$ - K- $\Lambda$

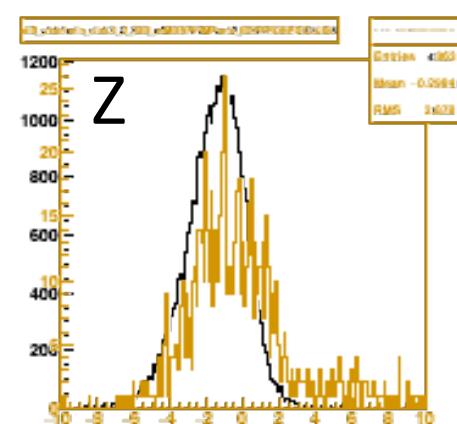
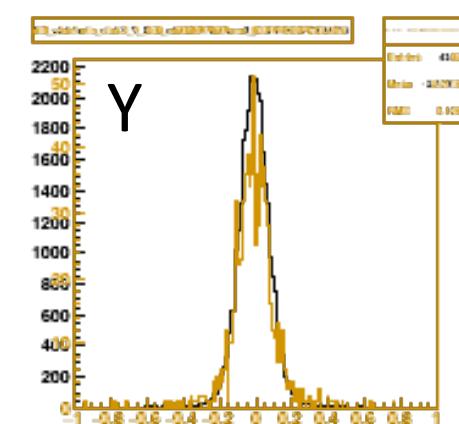
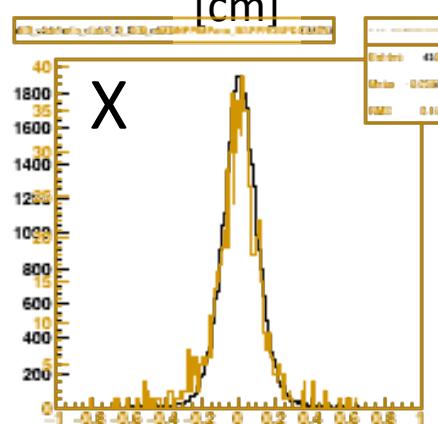


**MM. d(K-,np $\pi$ -)**  
**(SIM) [GeV] > 0**

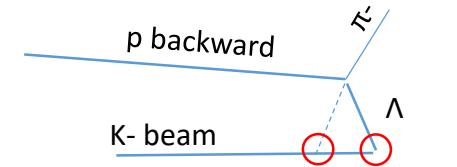
Diff. Vertex  
 K- $\pi$ - K- $\Lambda$



Diff. Vertex  
 K- $\pi$ - K- $\Lambda$  (SIM)

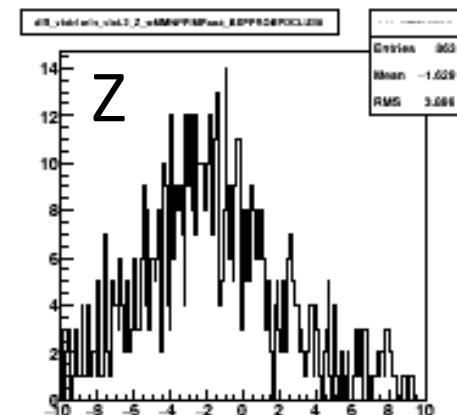
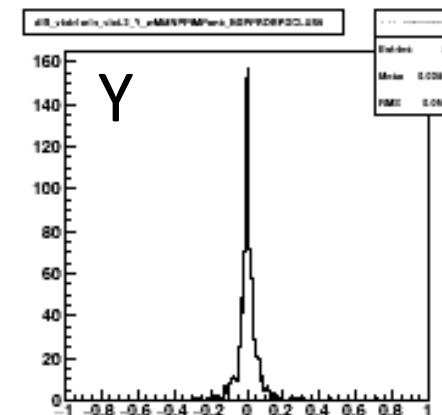
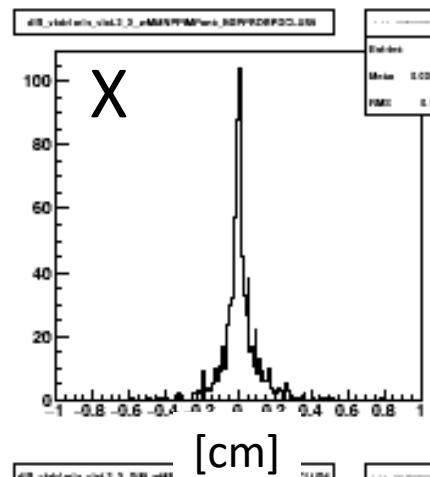


# Diff. Vertex K- $\pi$ - K- $\Lambda$

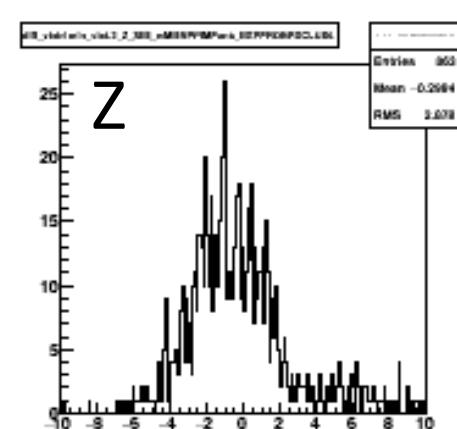
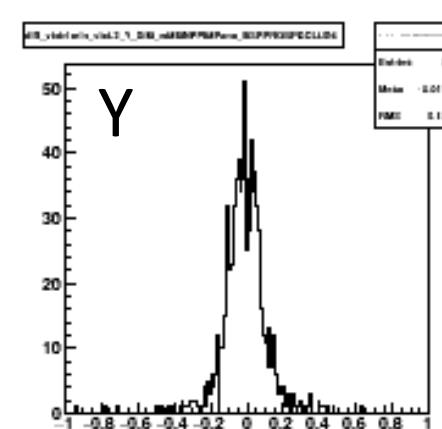
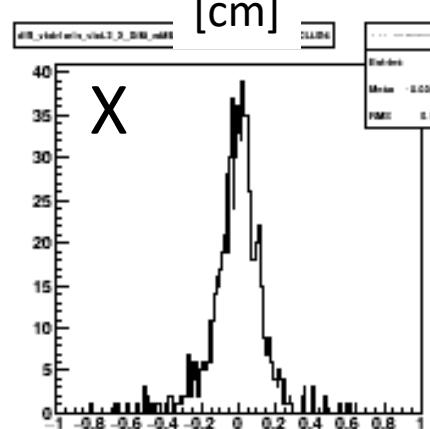


MM. d(K-,np $\pi$ -)  
(SIM) [GeV] < 0

Diff. Vertex  
K- $\pi$ - K- $\Lambda$



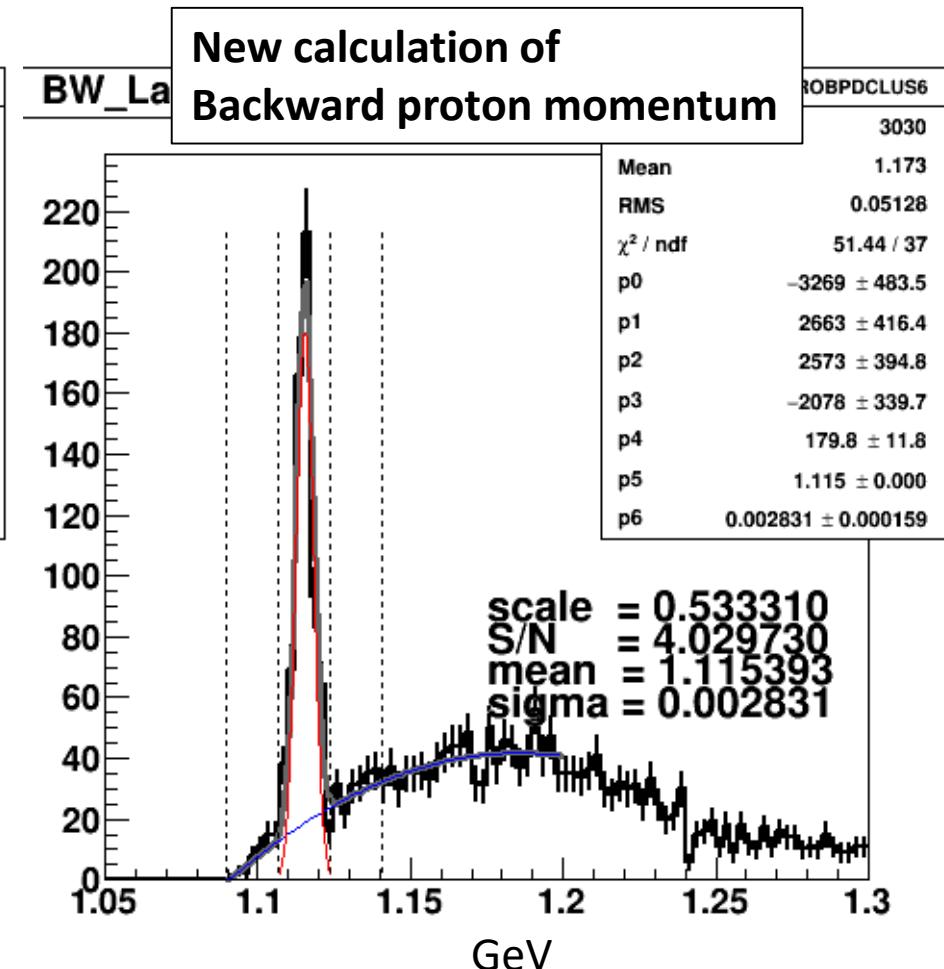
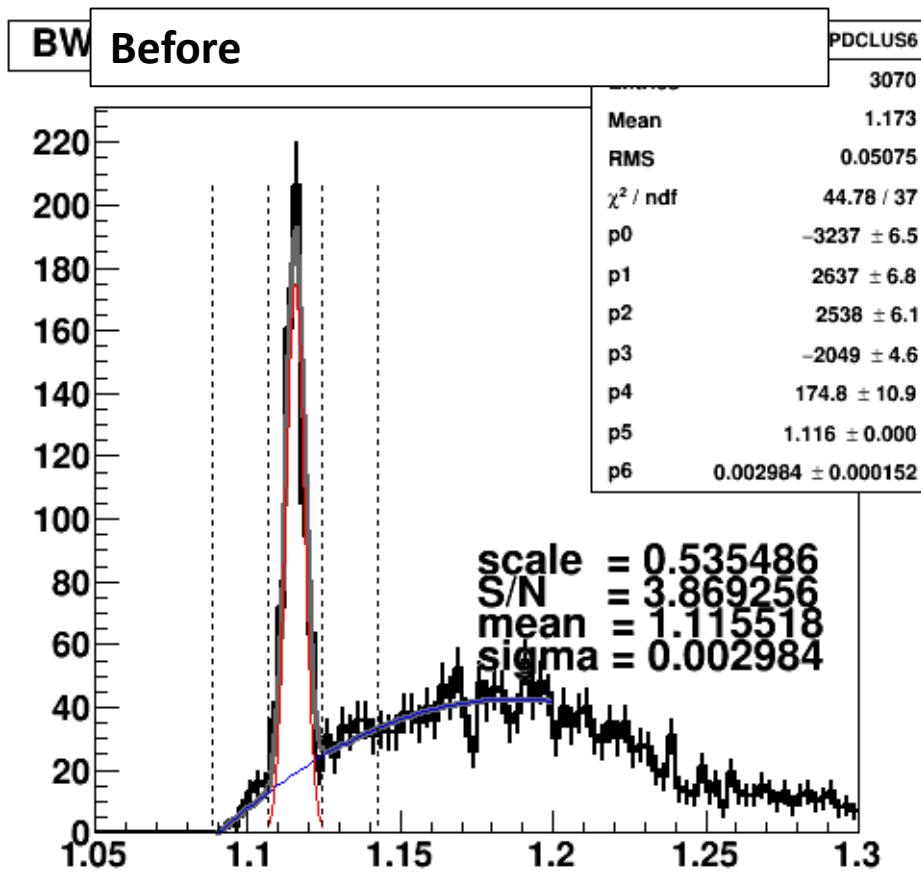
Diff. Vertex  
K- $\pi$ - K- $\Lambda$  (SIM)





# New calculation of Backward proton momentum

Invariant mass ( $p, \pi^-$ )

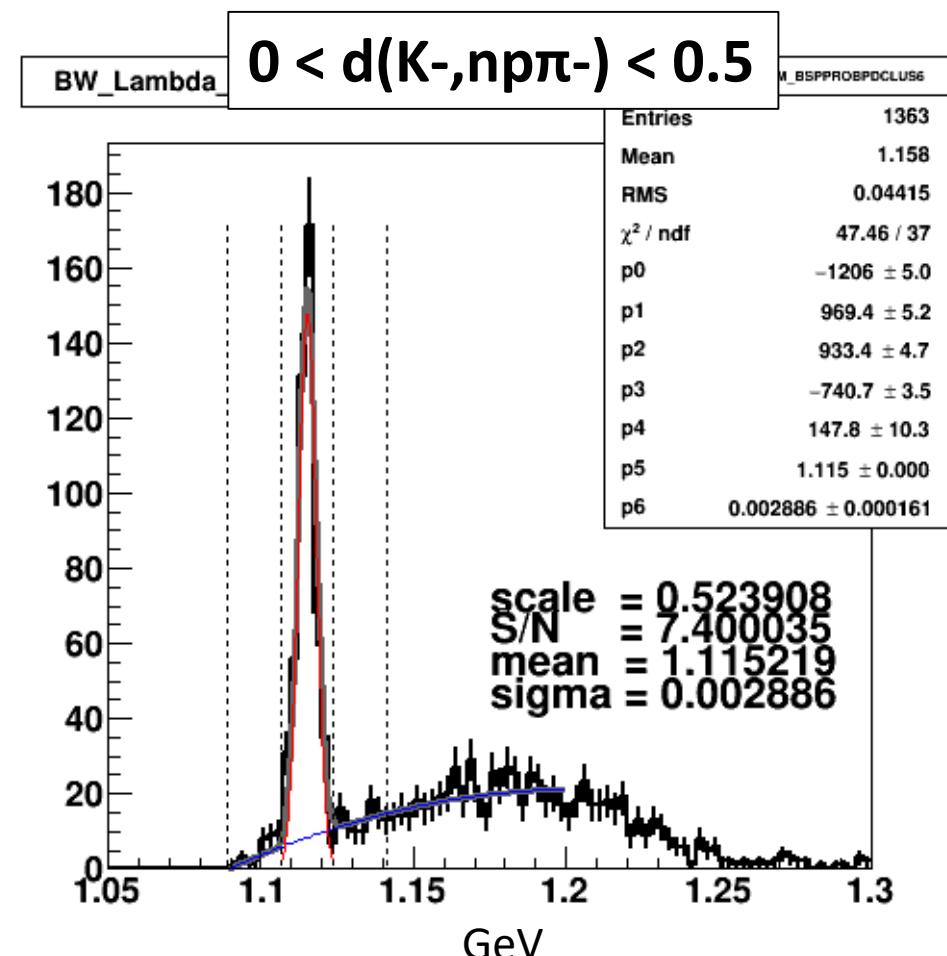
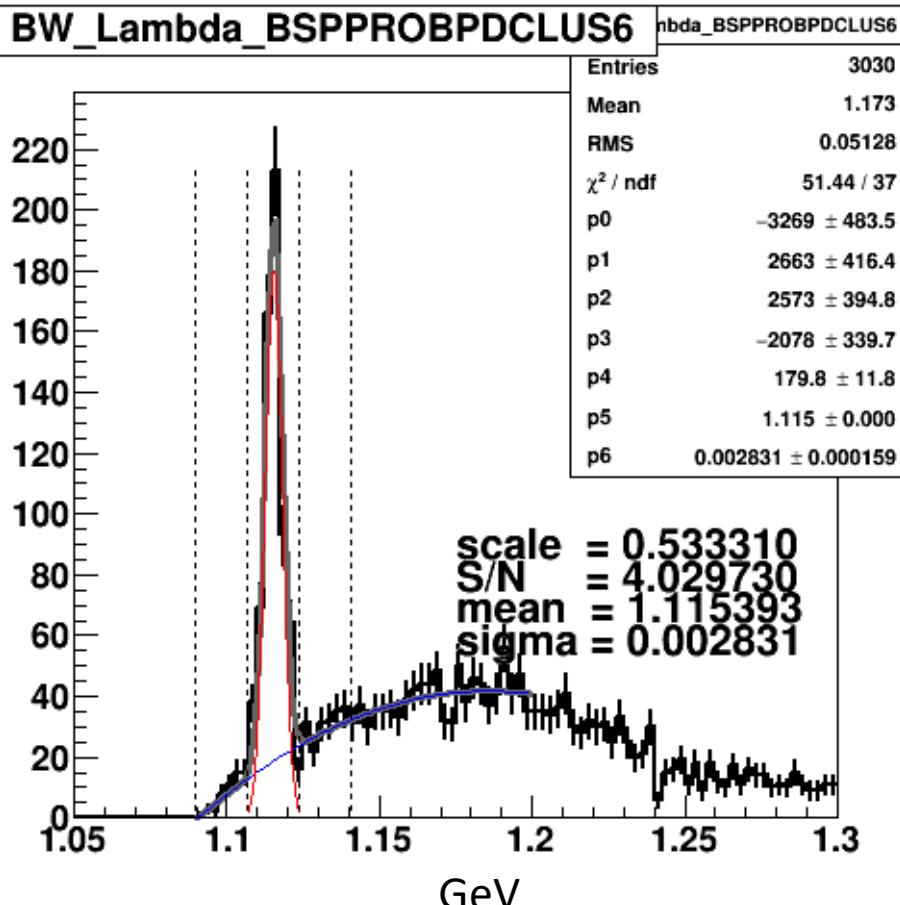


Scale = noise/side-band

S/N & resolution become a little better

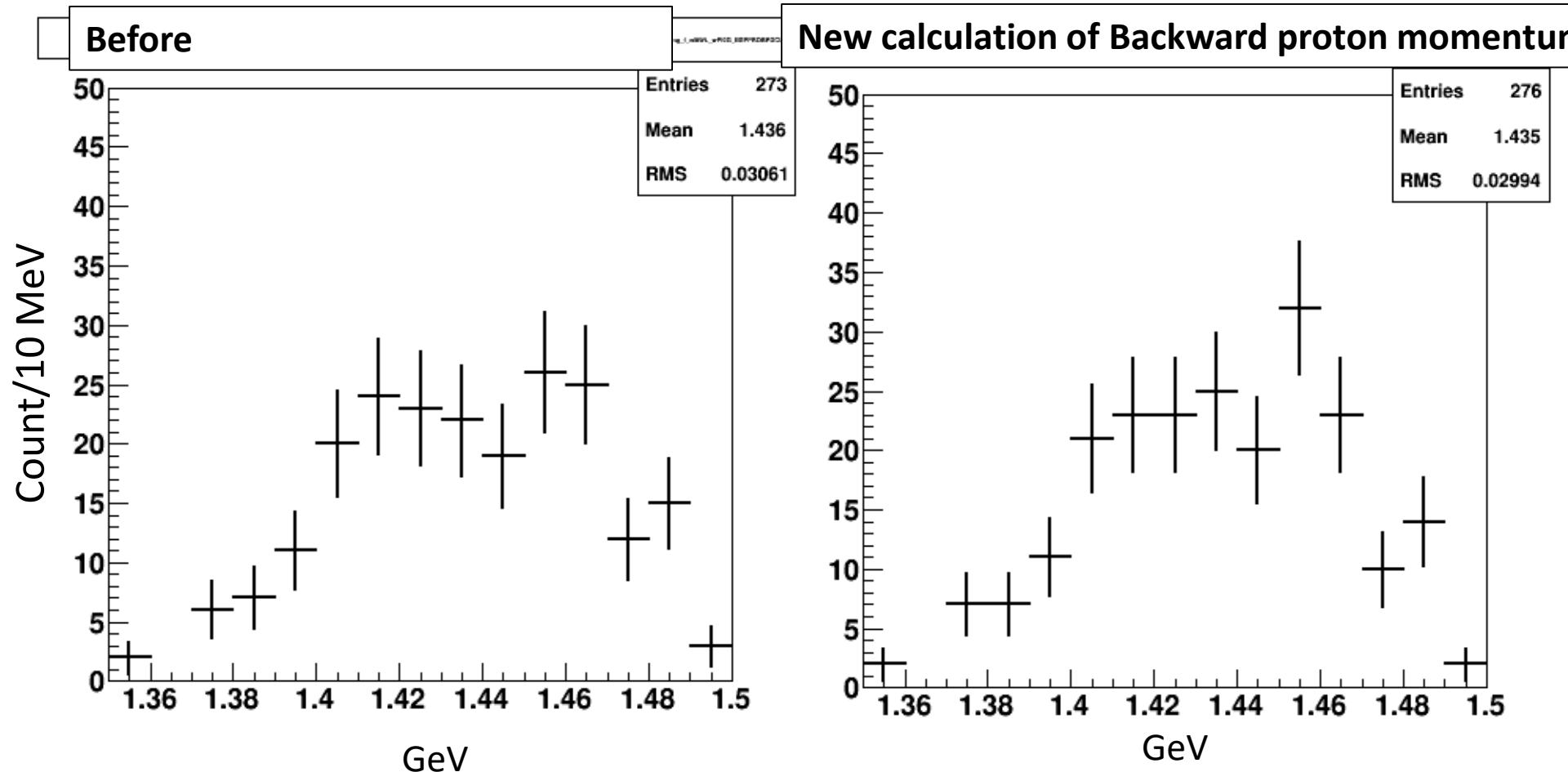
# Cut of $d(K^-, np\pi^-)$ negative event

New calculation of  
Backward proton momentum



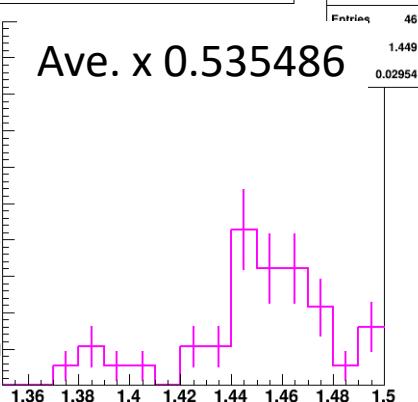
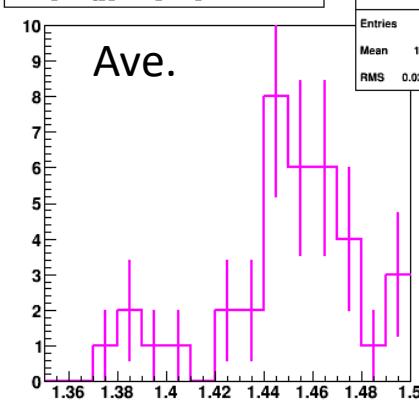
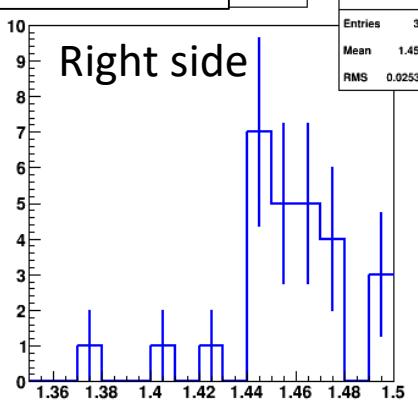
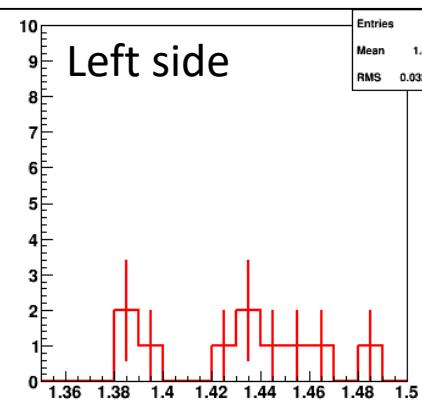
# $d(K^-, n)$ missing mass

- $\Lambda$  selection
- $0.18 < d(K^-, np\pi^-) < 0.3$
- Before subtraction of BG  $\Lambda$  selection

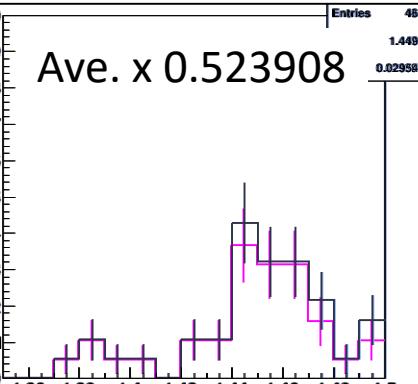
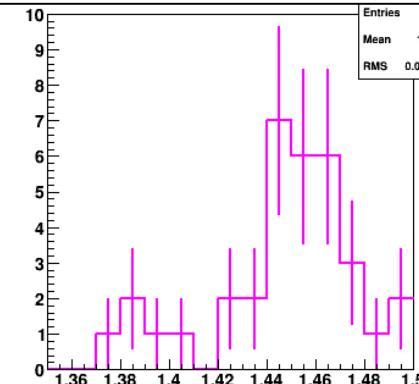
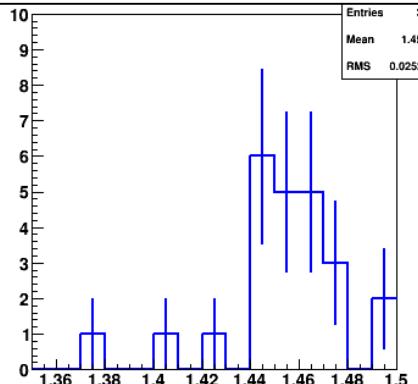
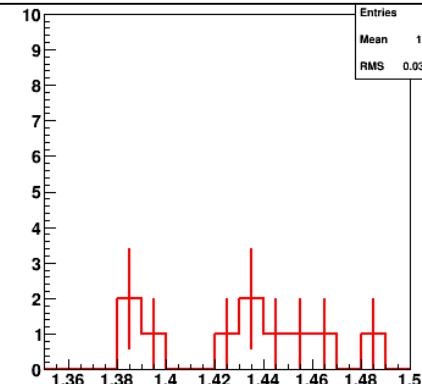


# BG by side-band of invariant ( $p, \pi$ ) $d(K^-, n)$ missing mass

**Before**



New calculation of Backward proton momentum + BG is estimated by  $d(K^-, np\pi^-)$  positive event



BG estimated by side-band does not so change

# BG estimation by SIM

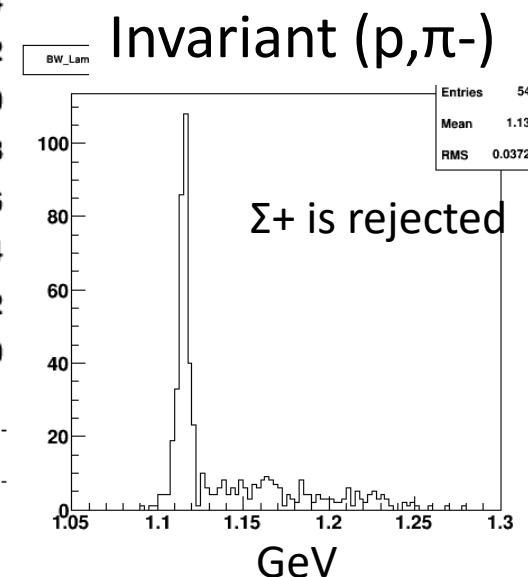
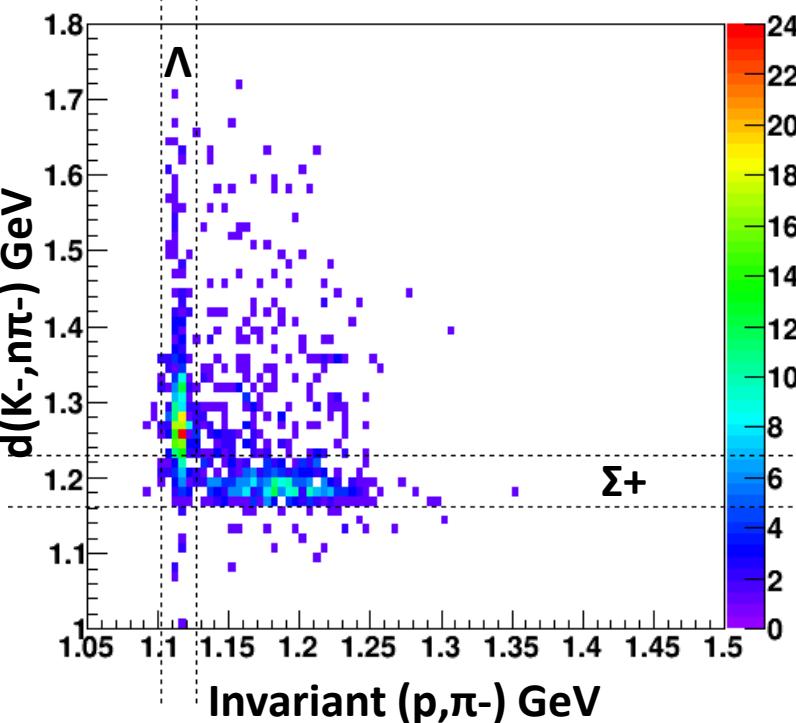
## BG candidate

- $K^- d \rightarrow n \Sigma^+ \pi^- \rightarrow n (\rho \pi^0) \pi^-$
- $K^- d \rightarrow \Sigma^- \rho \pi^0 \rightarrow (n \pi^-) \rho \pi^0$

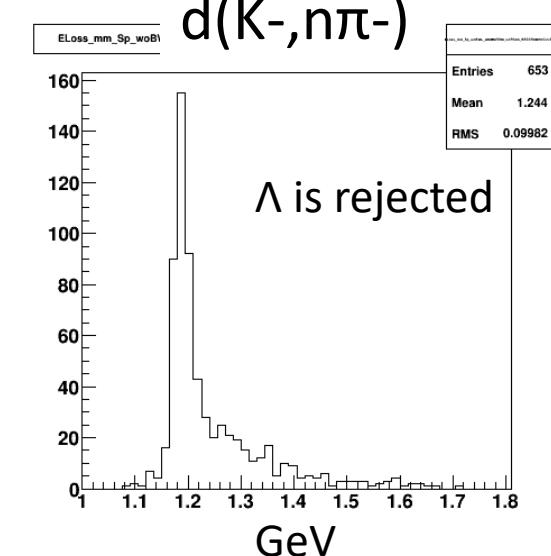
# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject

p, n is analyzed as  $\Sigma^0\pi^0$  mode



$\Sigma^+$  is rejected



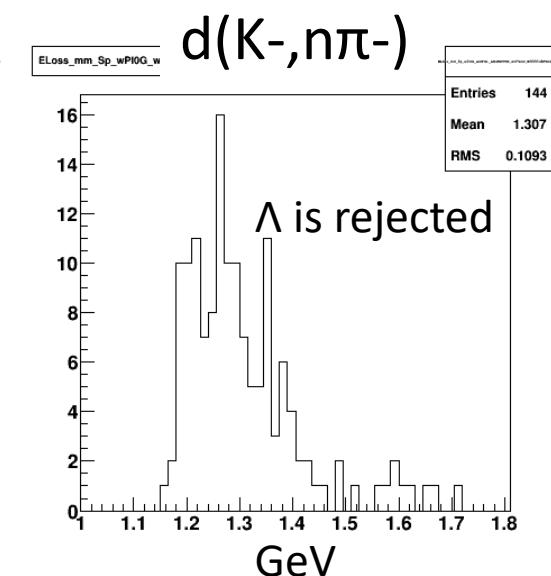
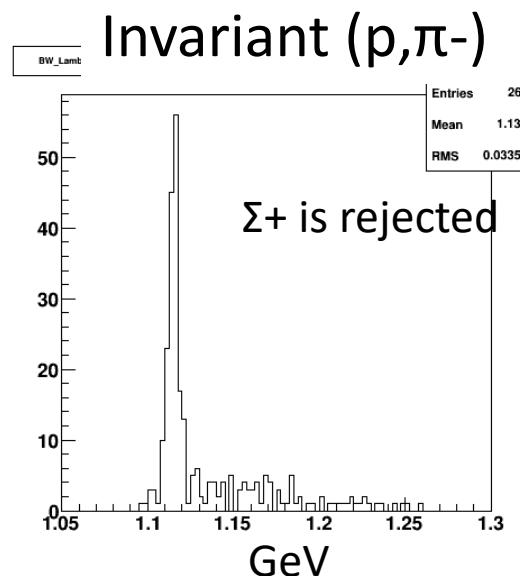
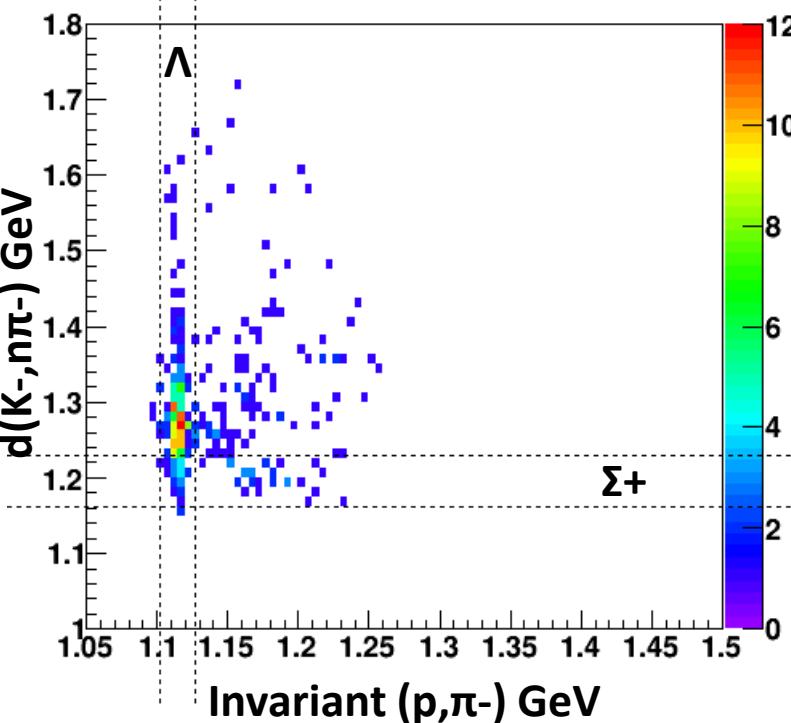
$\Lambda$  is rejected

Some unknown event still remain

# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $0.18 < d(K^-, n\pi^-) < 0.30$  - $\pi^0\gamma$

p, n is analyzed as  $\Sigma^0\pi^0$  mode

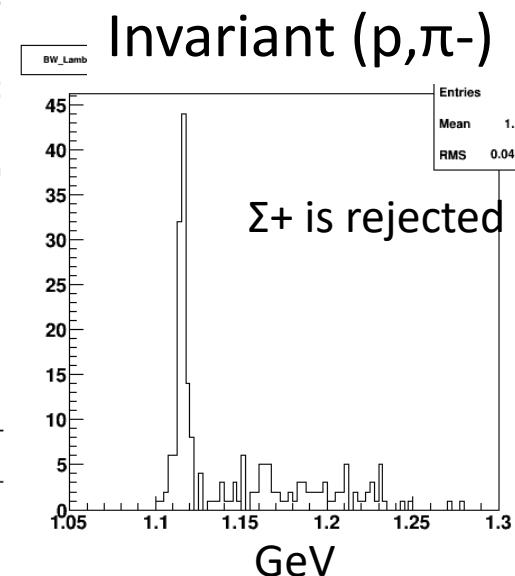
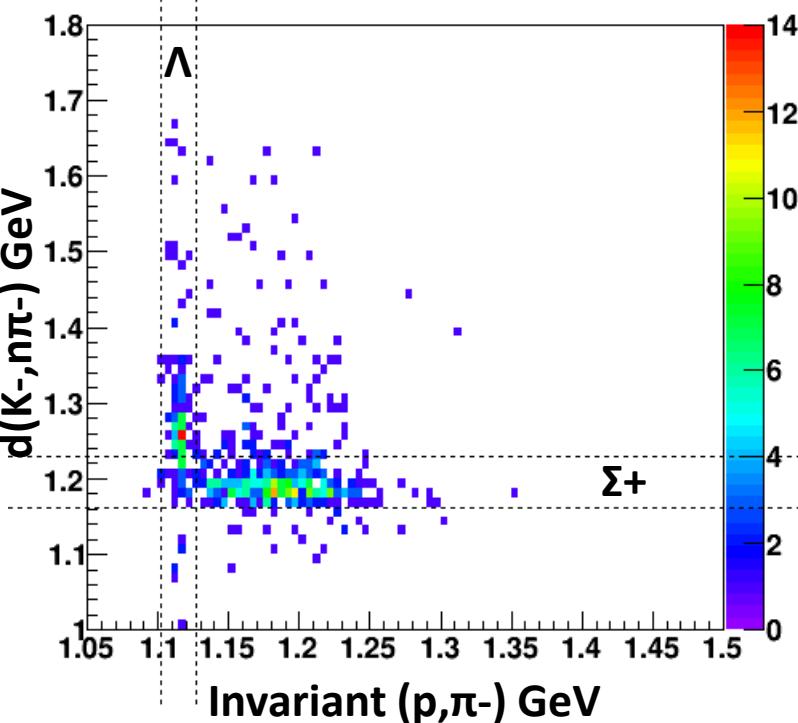


Some unknown event still remain

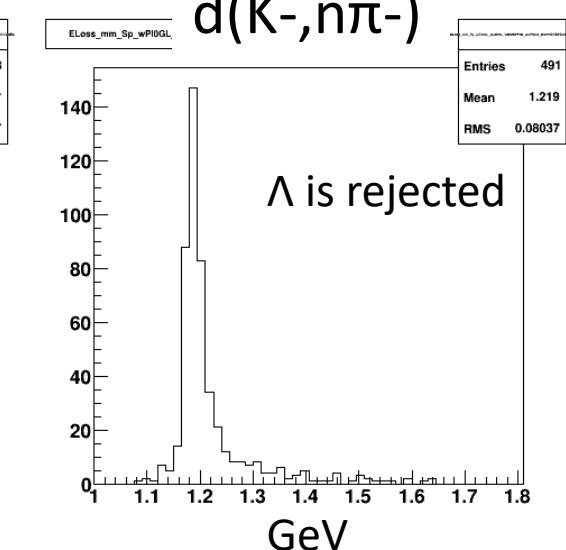
# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $0 < d(K^-, n\pi^-) < 0.18$  - $\pi^0$

p, n is analyzed as  $\Sigma^0\pi^0$  mode



$\Sigma^+$  is rejected

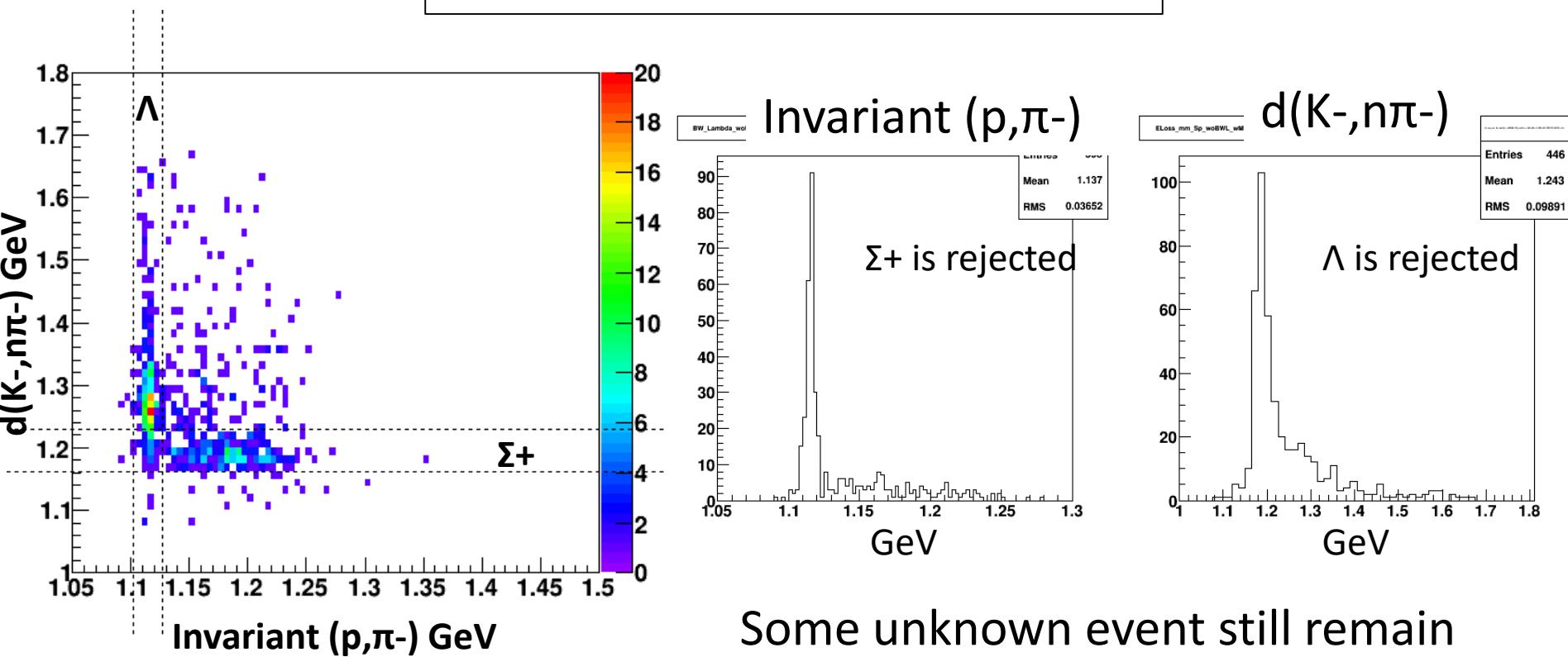


$\Lambda$  is rejected

Some unknown event still remain

# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

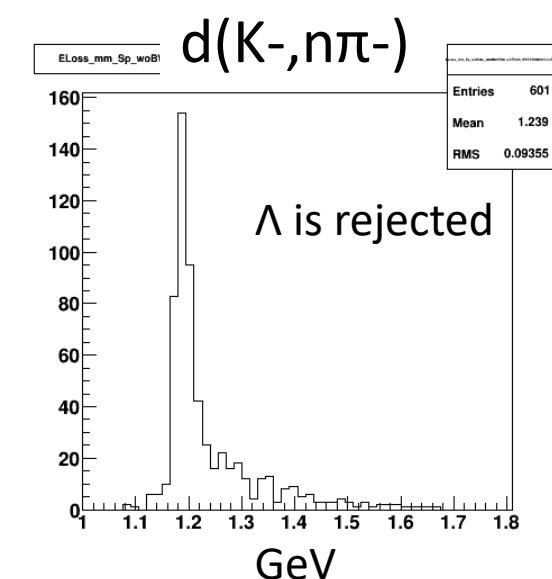
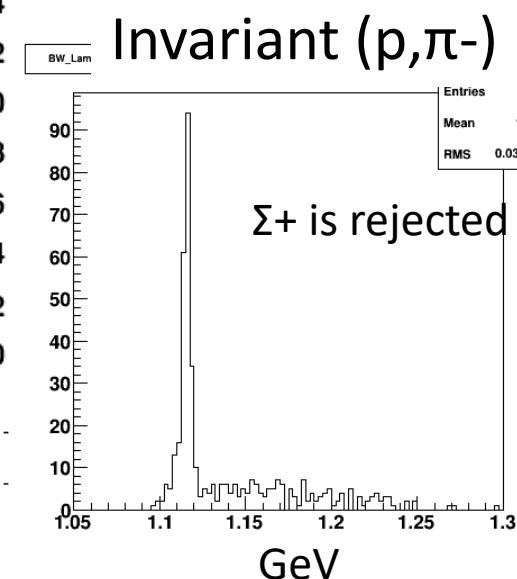
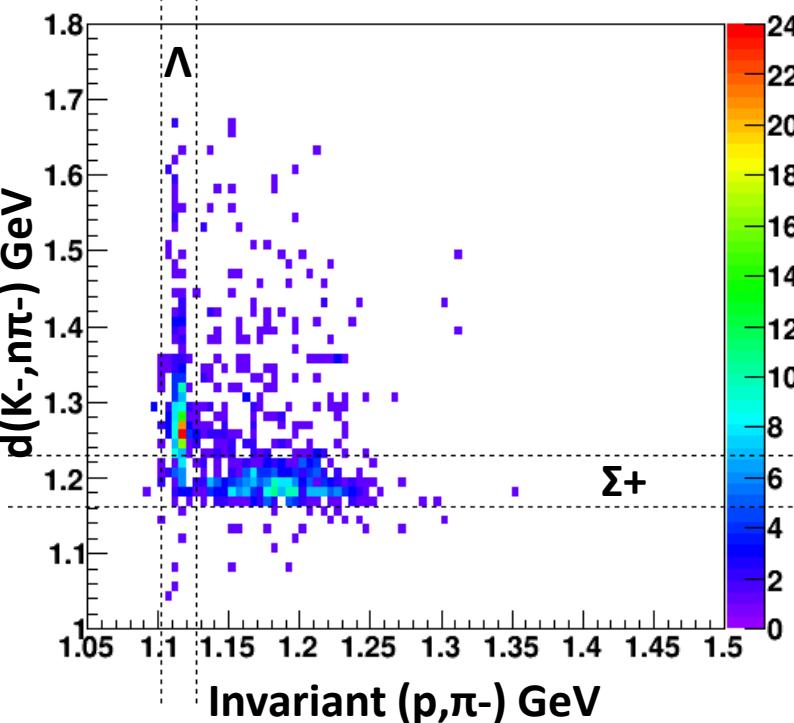
- $0 < d(K^-, n p \pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- **BPD dE > 4.0 MeV**
- **DEF dE > 3.5 MeV** - more tight backward proton condition



# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject

p, n is analyzed as  $\Sigma^+\pi^-$  mode

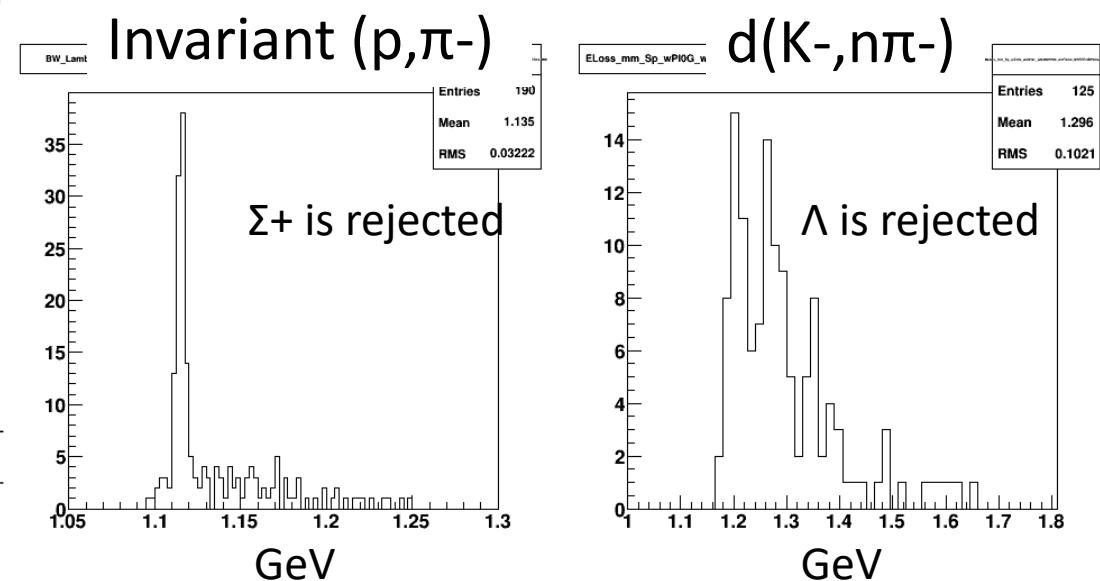
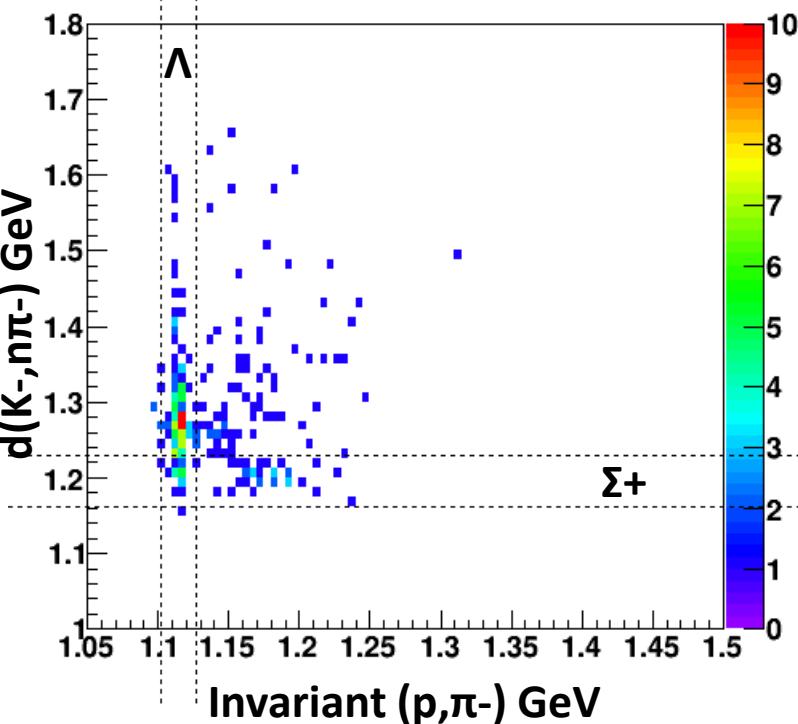


Some unknown event still remain

# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $0.18 < d(K^-, n\pi^-) < 0.30$  - $\pi^0\gamma$

p, n is analyzed as  $\Sigma^+\pi^-$  mode

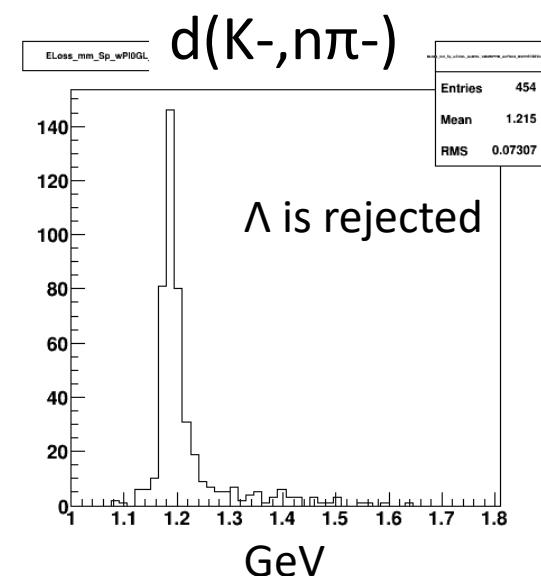
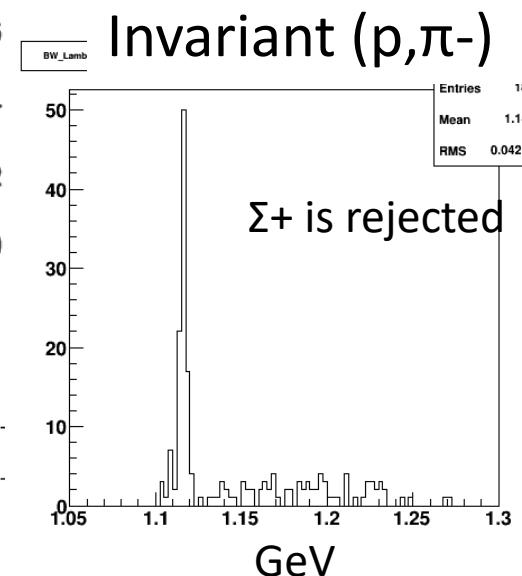
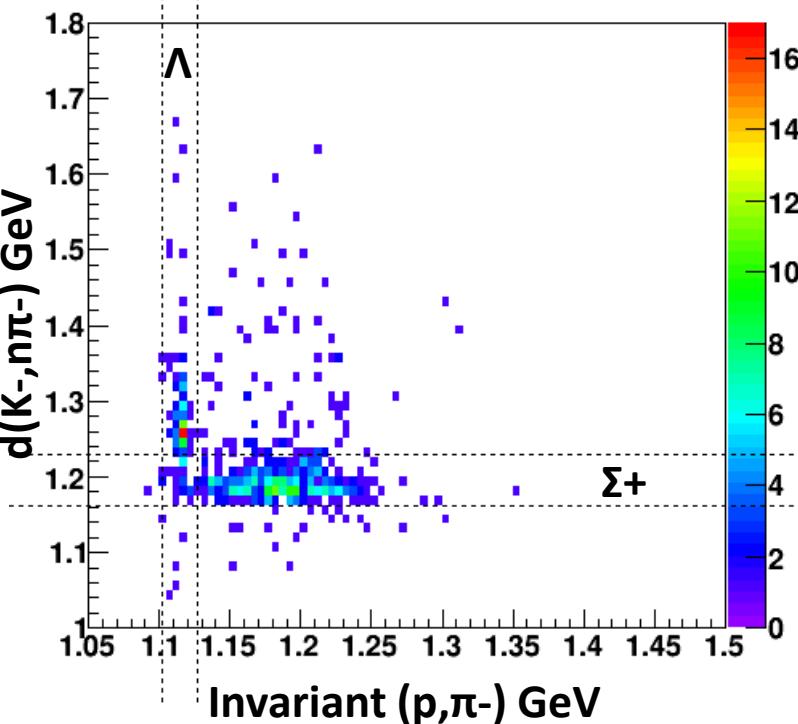


Some unknown event still remain

# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $0 < d(K^-, n\pi^-) < 0.18$  - $\pi^0$

p, n is analyzed as  $\Sigma^+ \pi^-$  mode



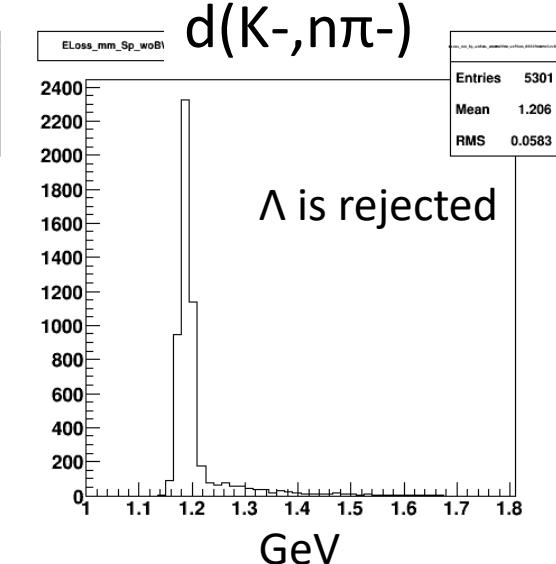
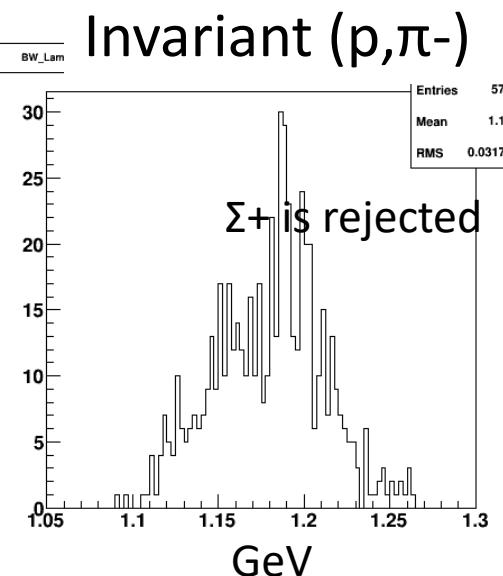
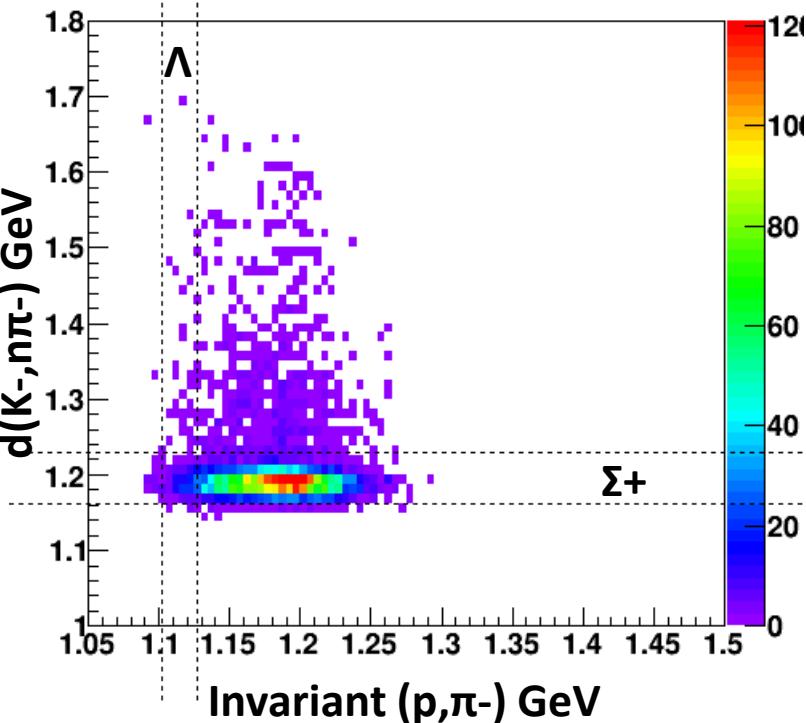
Some unknown event still remain

# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject

p, n is analyzed as  $\Sigma^+\pi^-$  mode

SIM ;  $K^-d \rightarrow n \Sigma^+\pi^-$   
L1405 mass shape use CS



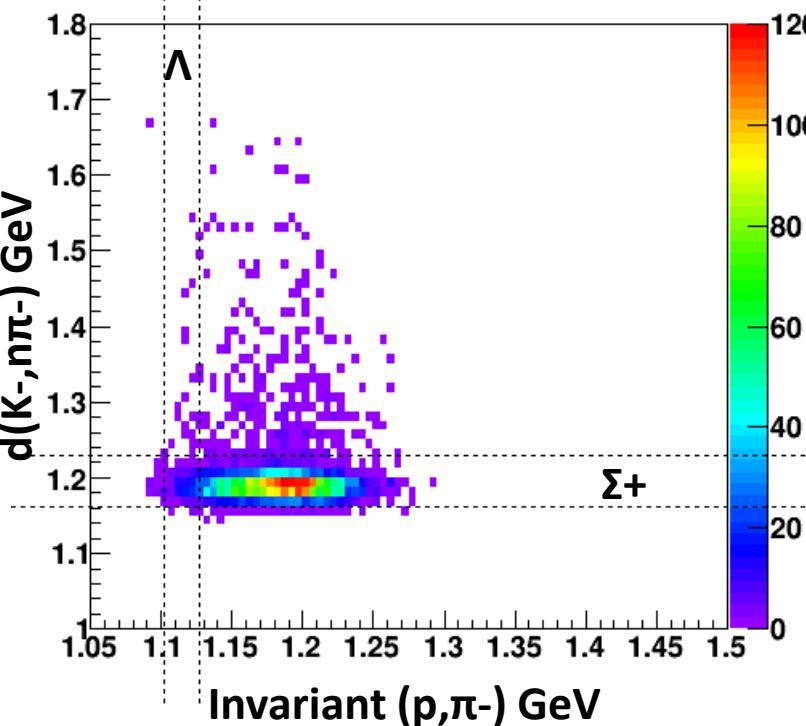
Some unknown event still remain

# Event except for $\Lambda$ , $\Sigma^+$ , $\Sigma^-$

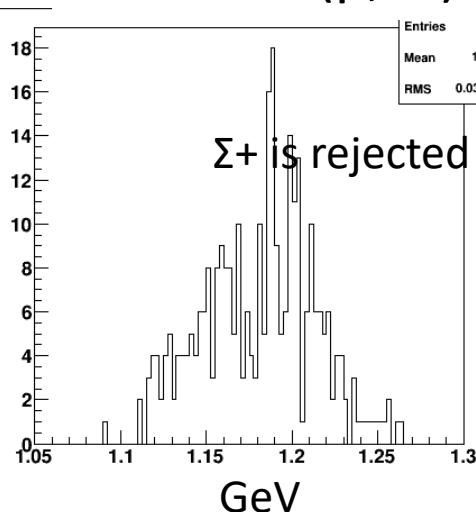
- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $0 < d(K^-, n\pi^-) < 0.18$  - $\pi^0$

$p, n$  is analyzed as  $\Sigma^+ \pi^-$  mode

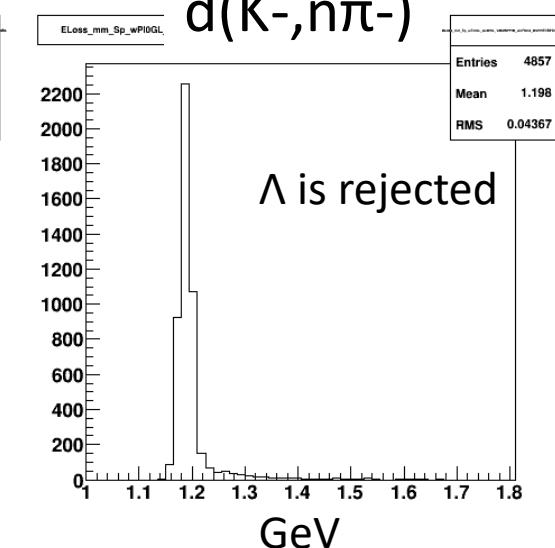
SIM ;  $K-d \rightarrow n \Sigma^+ \pi^-$   
L1405 mass shape use CS



Invariant ( $p, \pi^-$ )

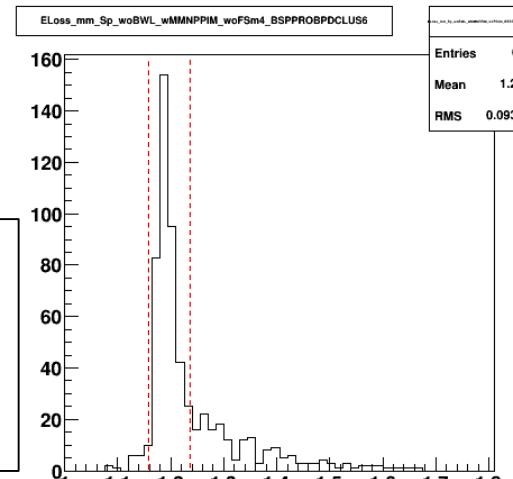


$d(K^-, n\pi^-)$



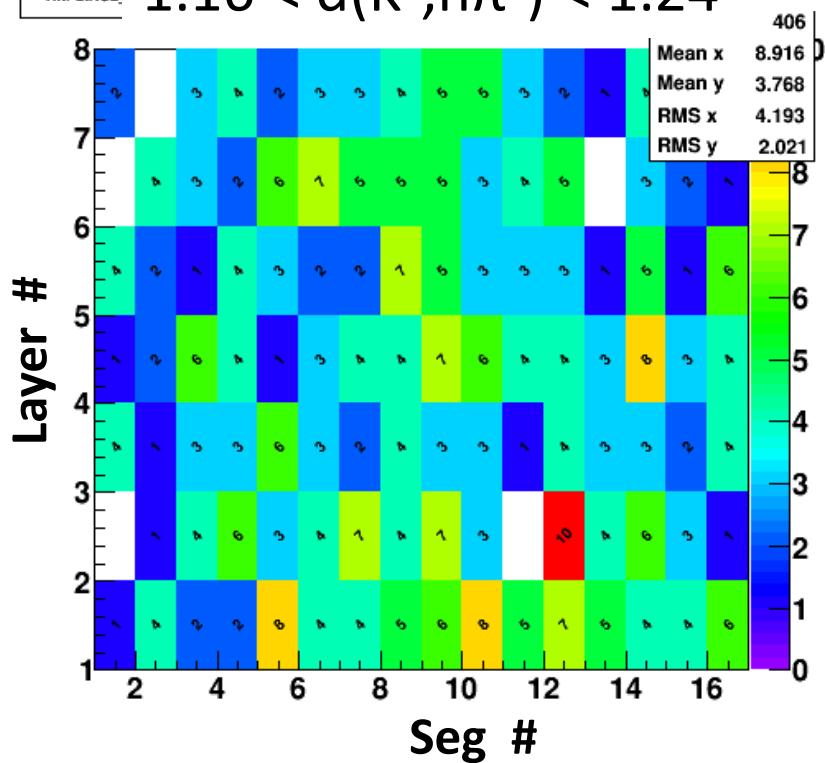
Some unknown event still remain

# NC Hit Pattern

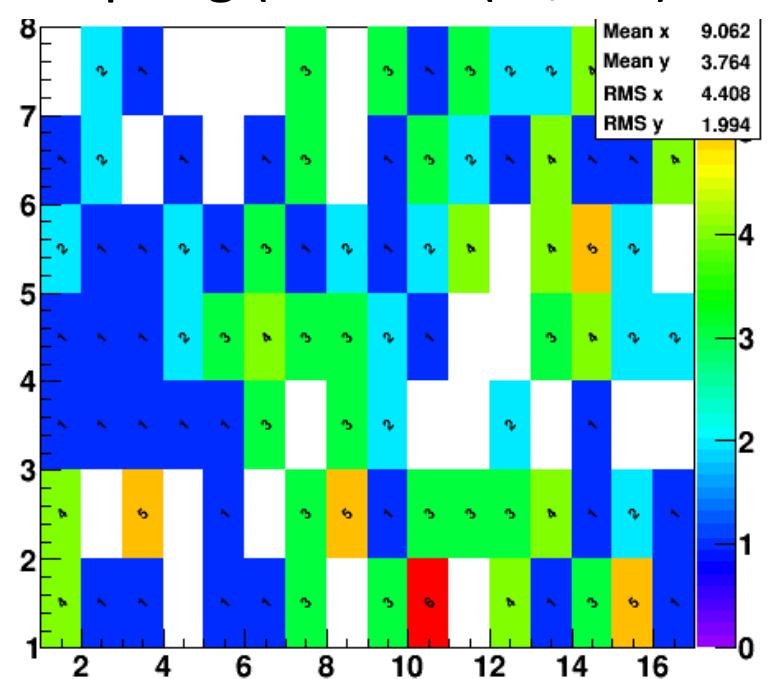


- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma$ - from Invariant ( $n, \pi$ ) reject
- $\Lambda$  is rejected

HitPatNC2:  $1.16 < d(K^-, n\pi^-) < 1.24$

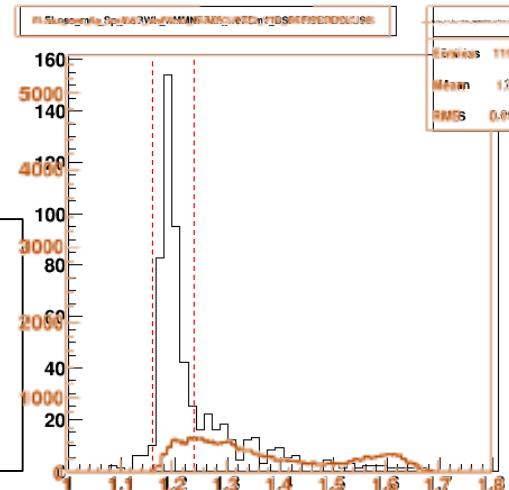


| Excepting ( $1.16 < d(K^-, n\pi^-) < 1.24$ )

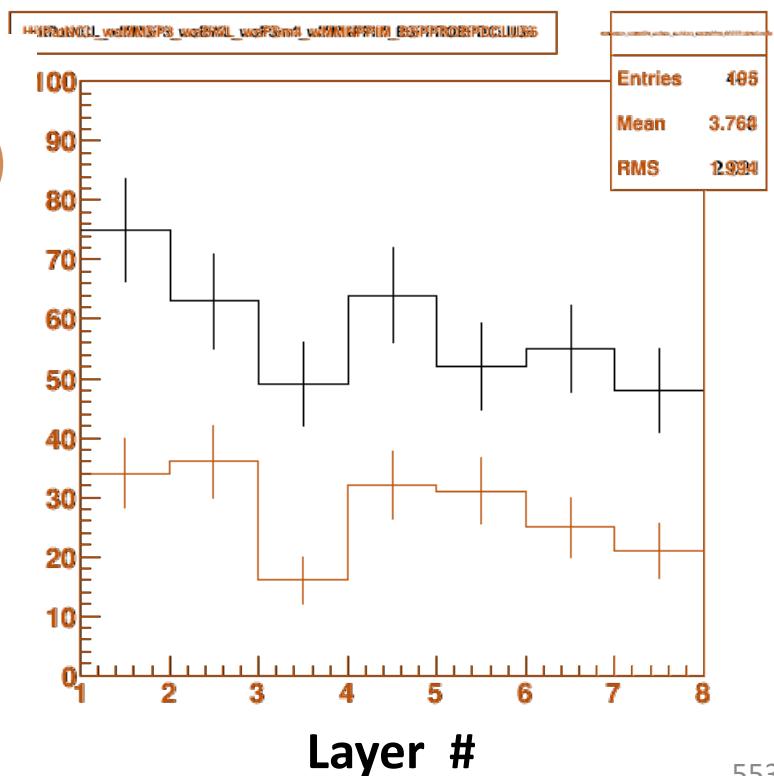


# NC Hit Pattern

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma$ - from Invariant ( $n, \pi$ ) reject
- $\Lambda$  is rejected

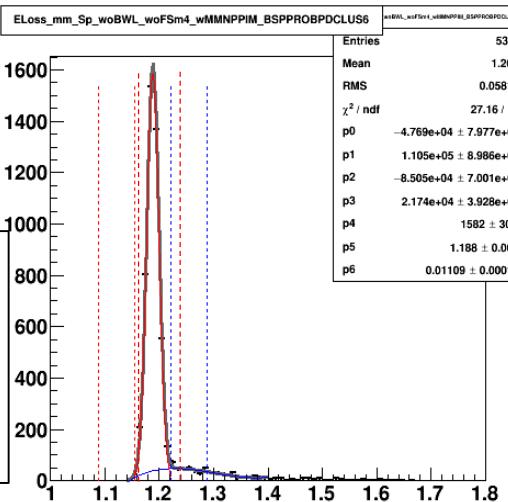


- $1.16 < d(K^-, n\pi^-) < 1.24$
- Excepting ( $1.16 < d(K^-, n\pi^-) < 1.24$ )



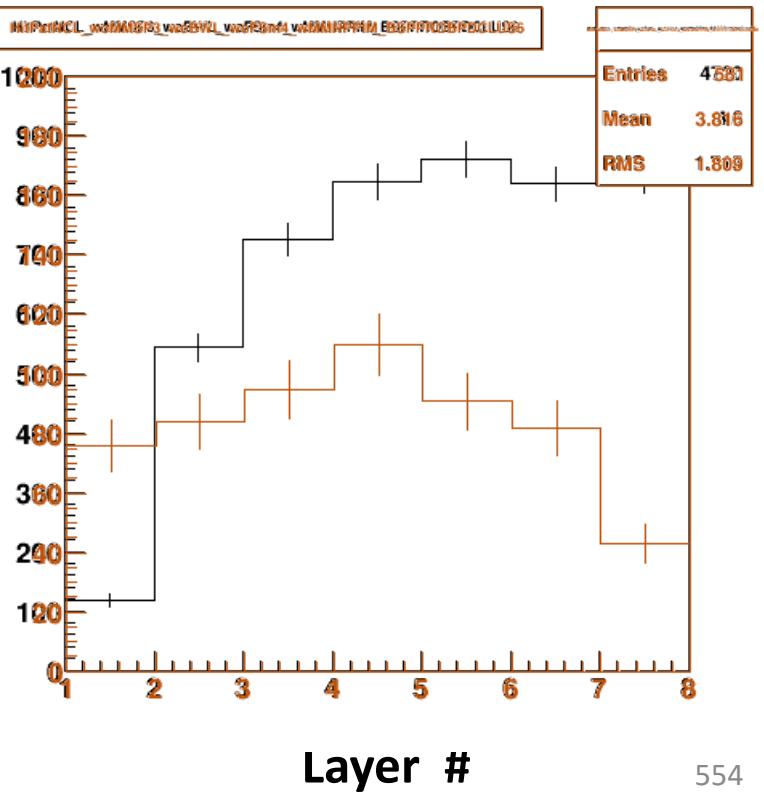
# NC Hit Pattern

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma$ - from Invariant ( $n, \pi$ ) reject
- $\Lambda$  is rejected



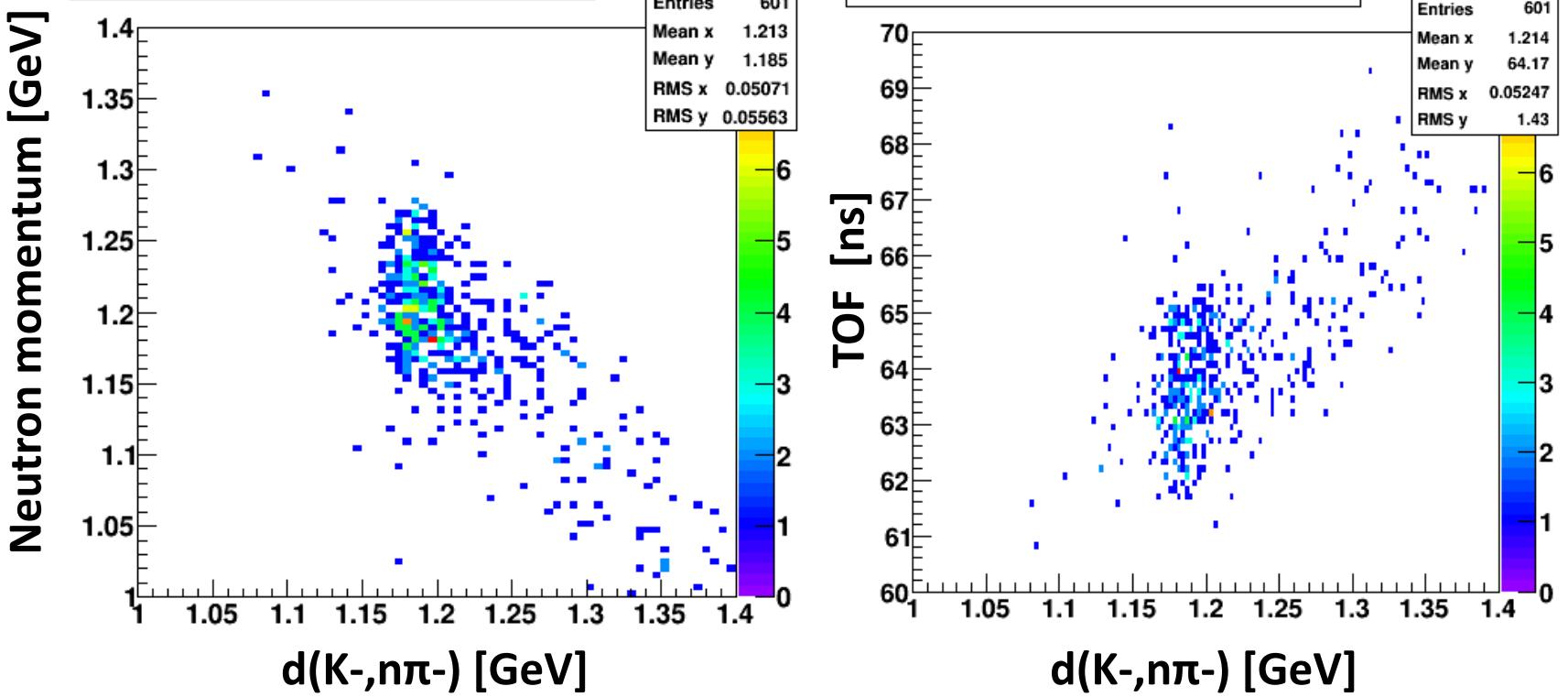
- $1.16 < d(K^-, n\pi^-) < 1.24$
- Excepting  $(1.16 < d(K^-, n\pi^-) < 1.24)$

SIM ; K-d  $\rightarrow n \Sigma + \pi^-$   
L1405 mass shape use CS

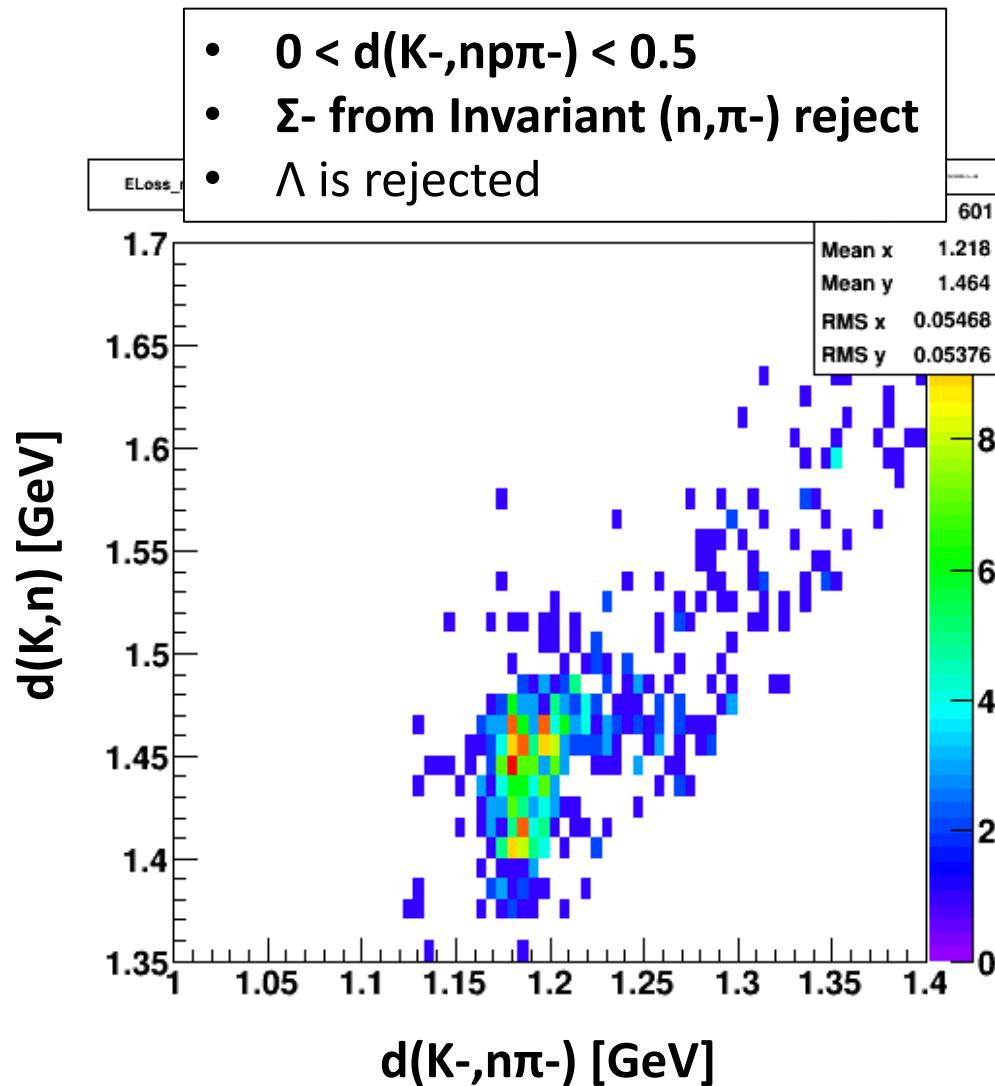


# $d(\text{K}^-, \text{n}\pi^-)$ vs Neutron momentum

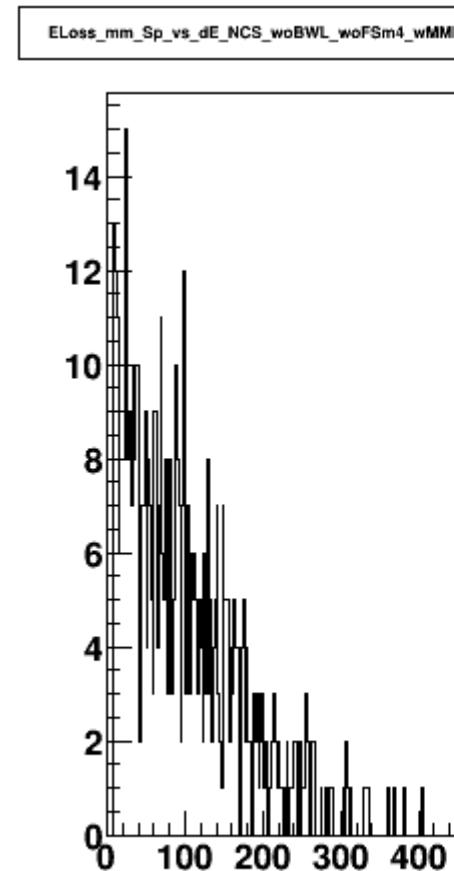
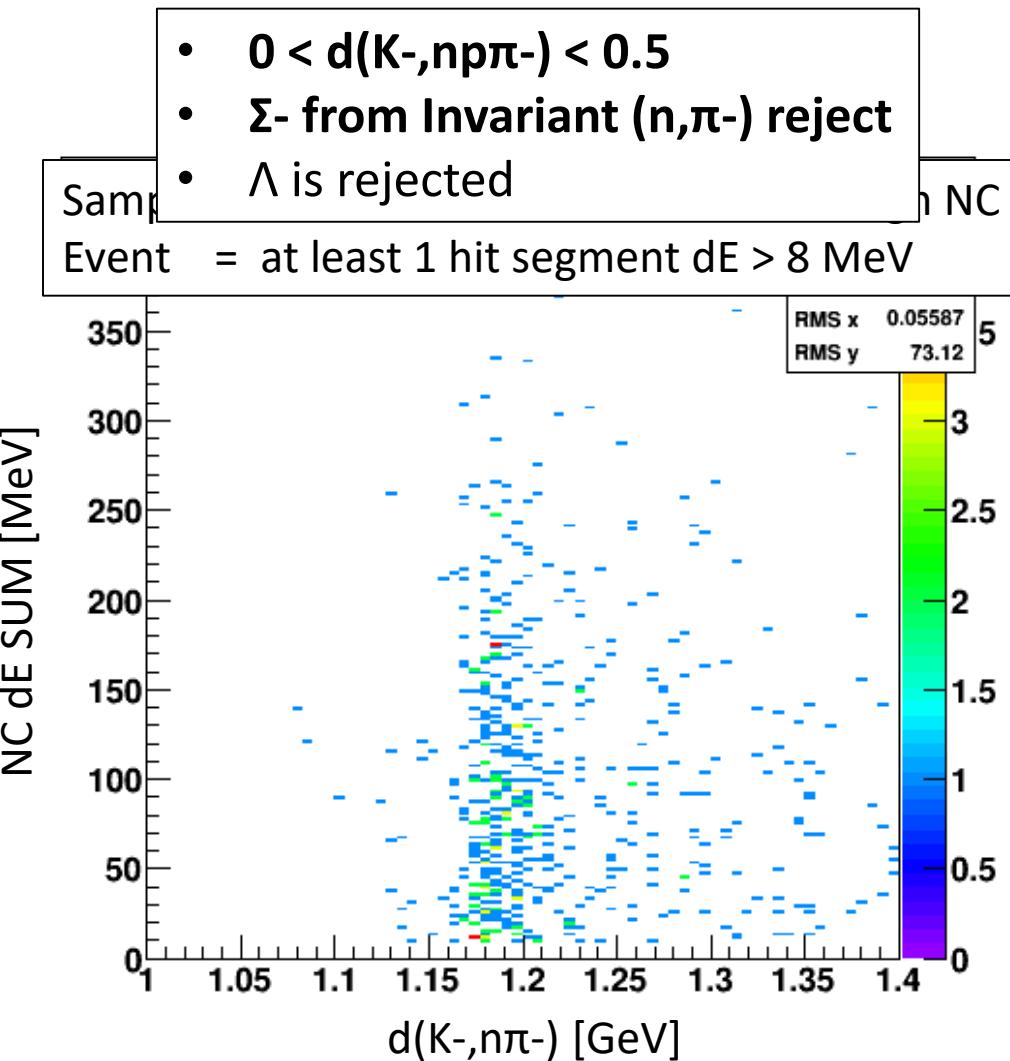
- $0 < d(\text{K}^-, \text{n}\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $\text{n}, \pi^-$ ) reject
- $\Lambda$  is rejected



# $d(K^-, n\pi^-)$ vs $d(K^-, n)$



# NC dE SUM

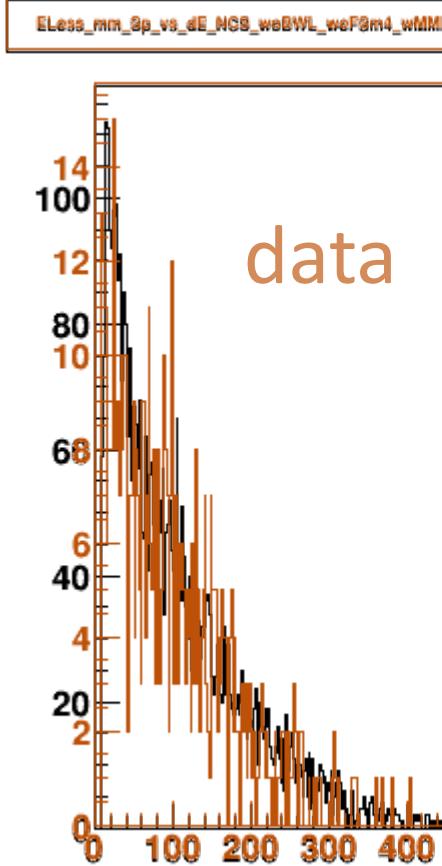
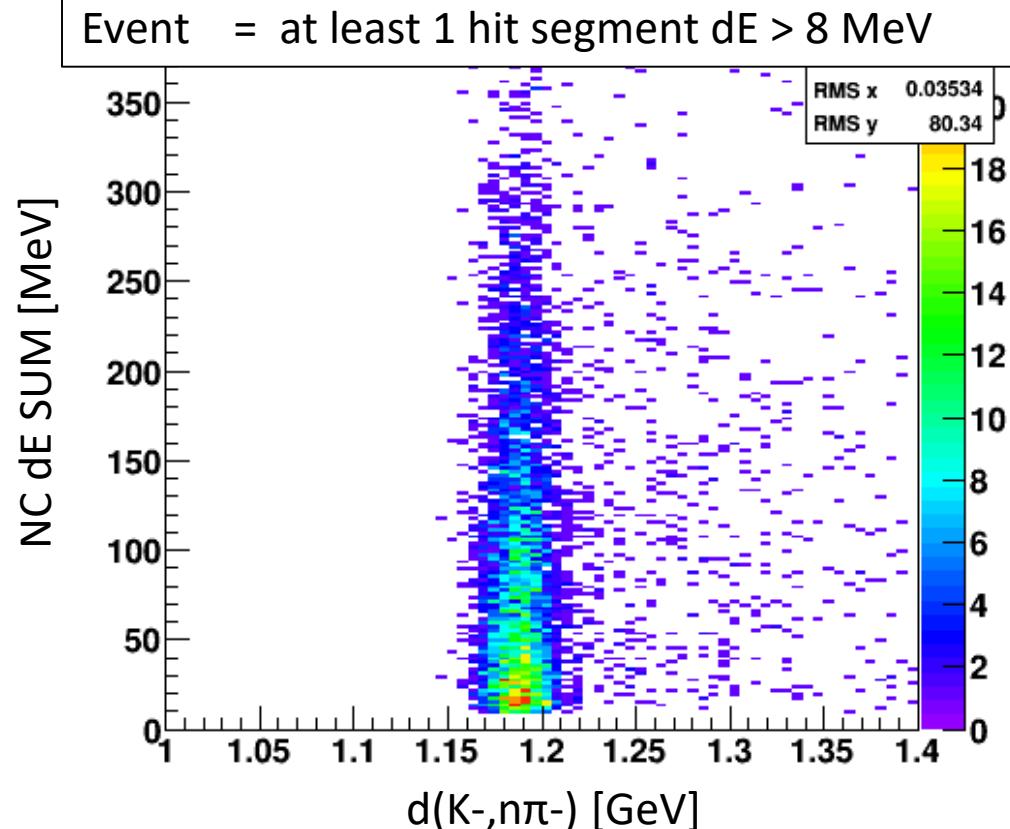


# NC dE SUM

SIM ;  $K-d \rightarrow n \Sigma + \pi^-$

L1405 mass shape use

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma$ - from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

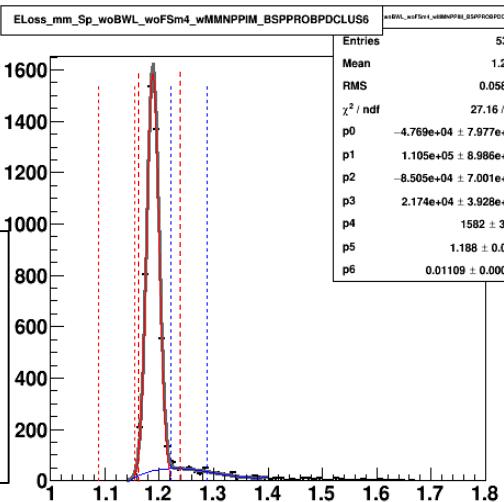


# Re-analysis 9

- Bug in the selection of NC hit segment of SIM is fixed

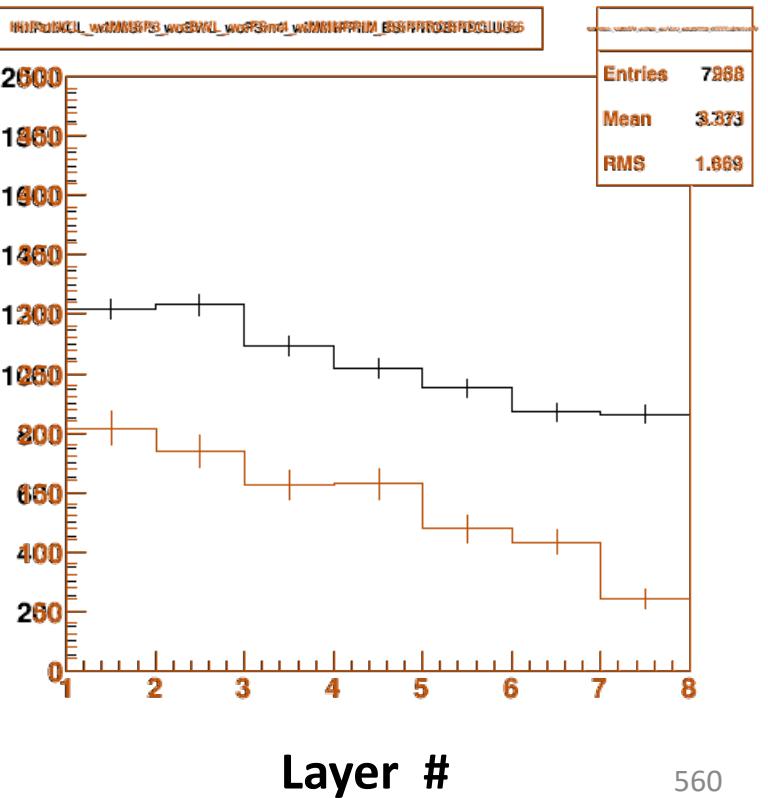
# NC Hit Pattern

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected



- $1.16 < d(K^-, n\pi^-) < 1.24$
- Excepting  $(1.16 < d(K^-, n\pi^-) < 1.24)$

SIM ;  $K-d \rightarrow n \Sigma+\pi^-$   
 $\Sigma+\pi^-$  mass shape use analysis result

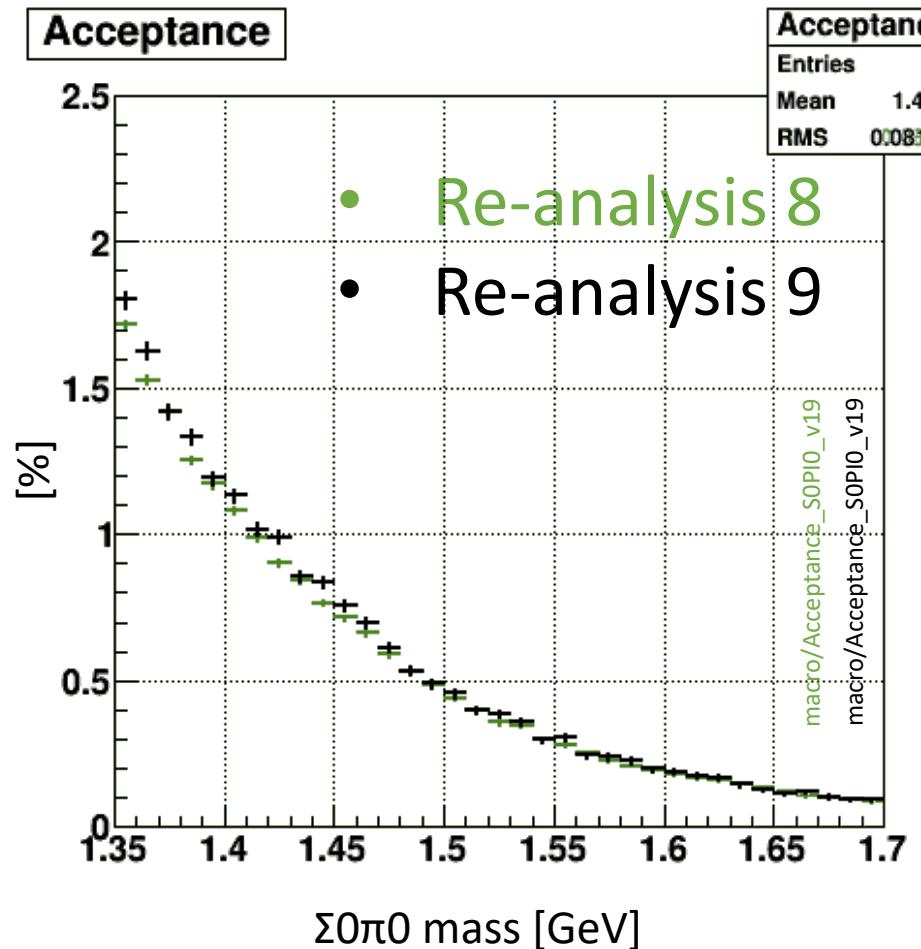


Layer #

560

# Acceptance estimation

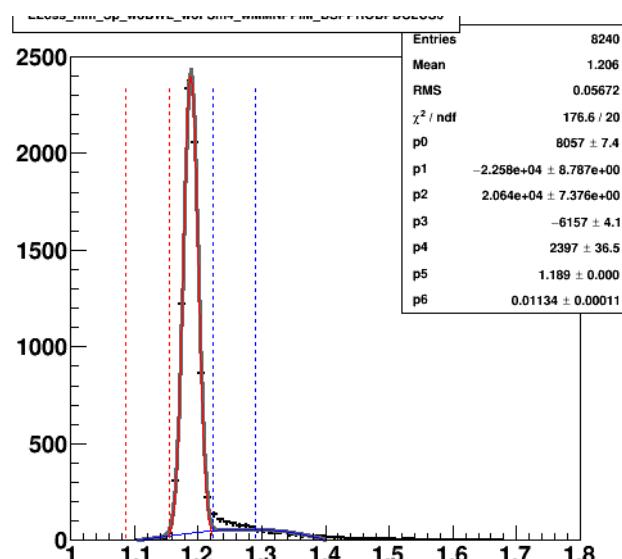
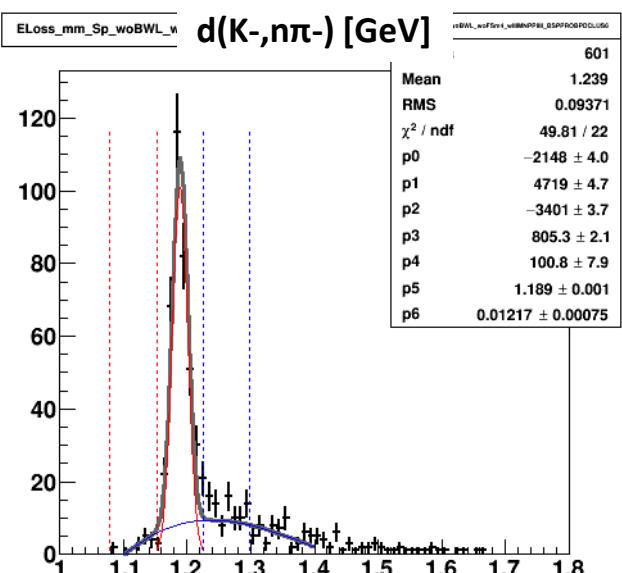
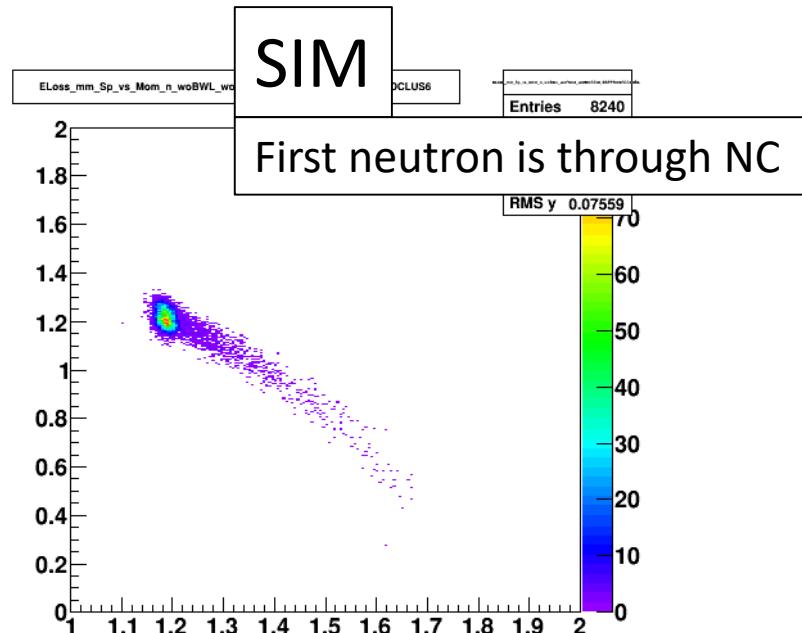
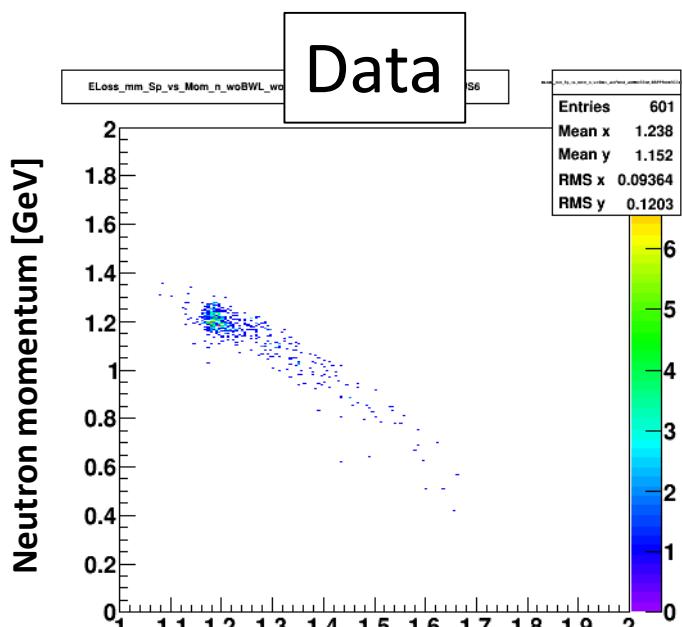
- Sample ;
  - $dE(\text{NC}) > 8 \text{ MeV}$  –at least 1 segment
  - First neutron is through NC
  - Upstream condition ( $T_0 \text{ multi} = 1$ , Beam track defining..)
  - BVC, CVC veto in sample



- $p, \pi$ - invariant mass  $\Lambda$  selection
- $d(K^-, n\Lambda)''X''$   $0.18 < X < 0.30 \text{ GeV}$

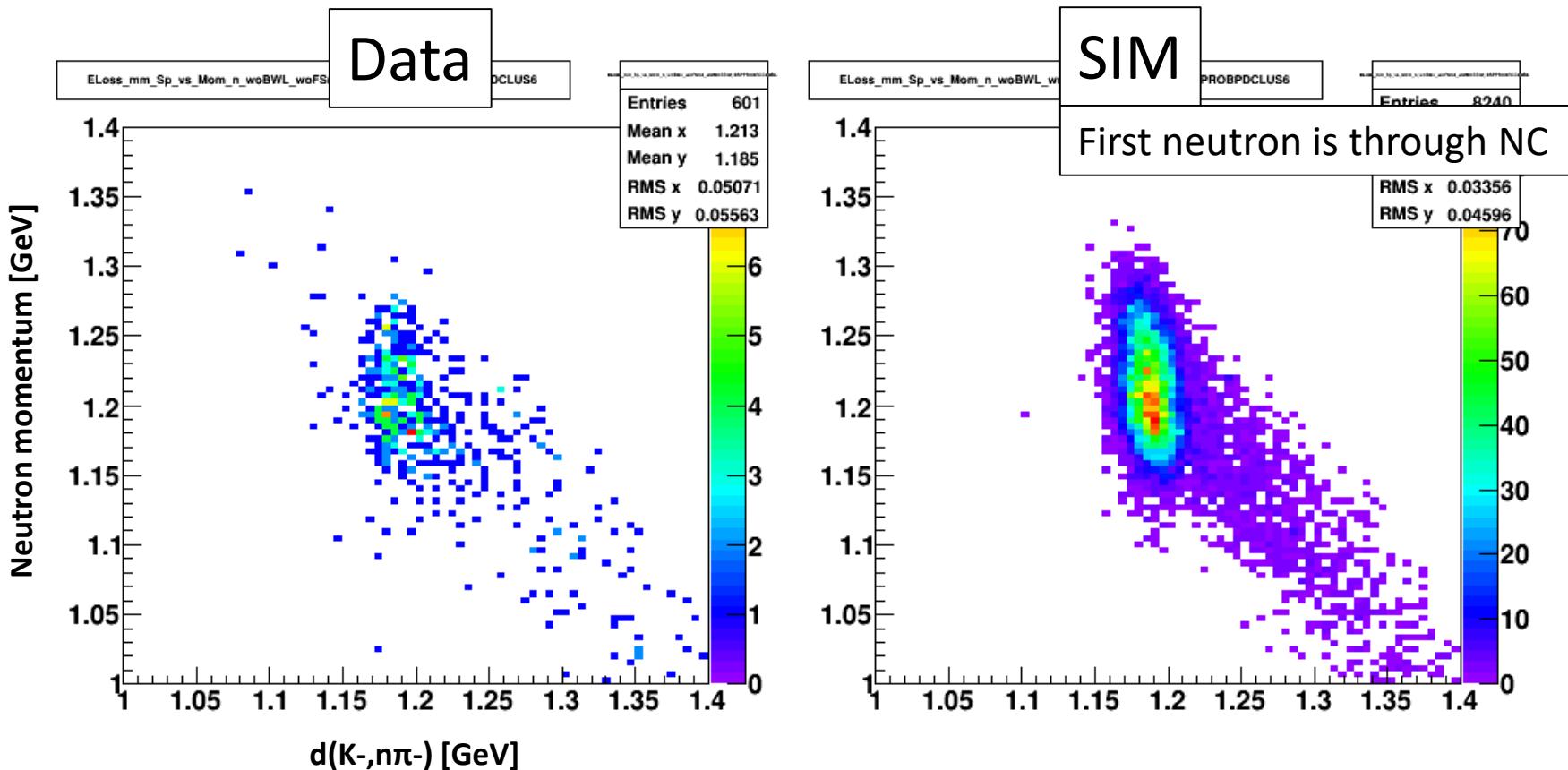
- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

# Data vs SIM



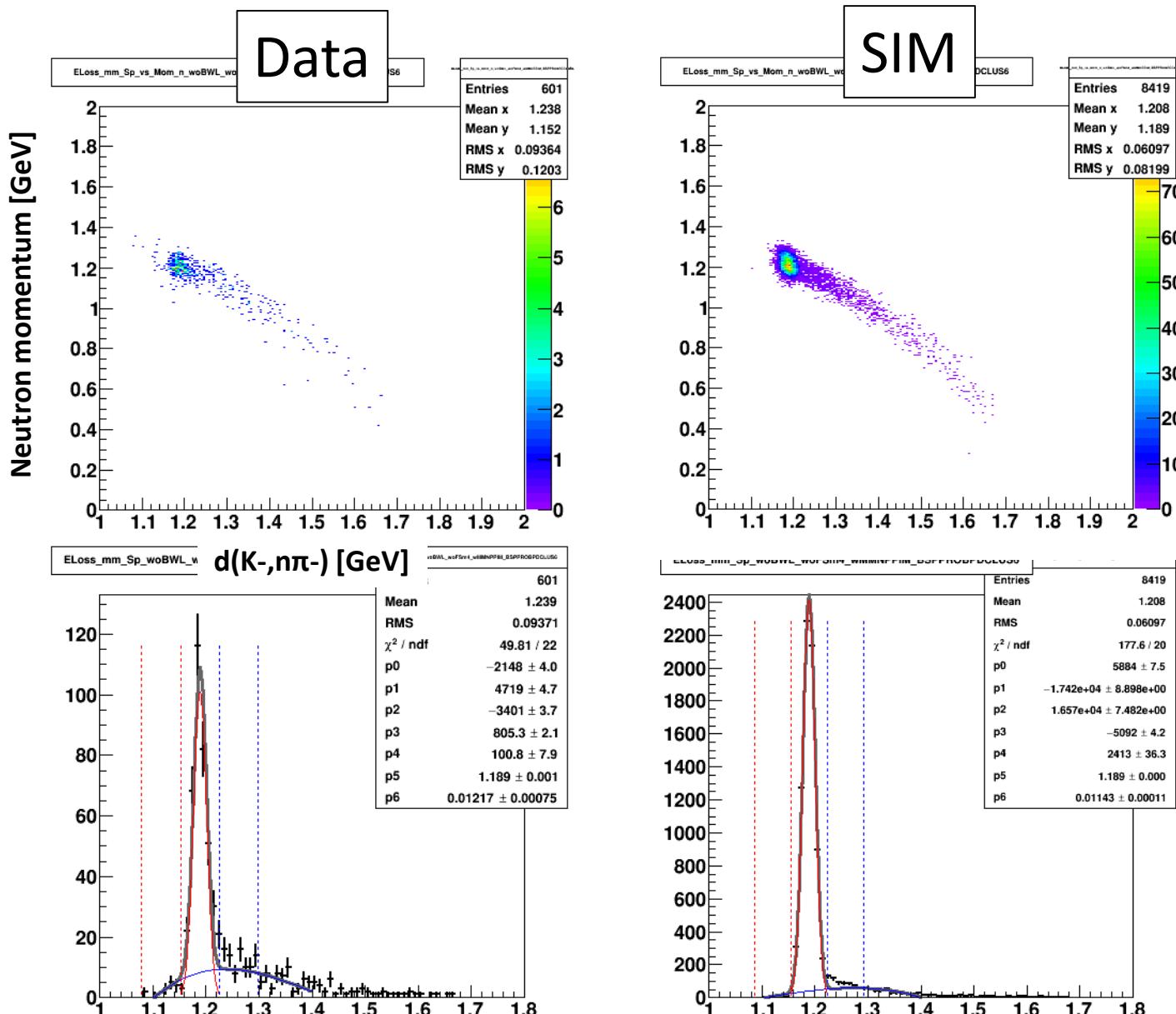
# Data vs SIM

- $0 < d(K^-, \eta\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $\eta, \pi^-$ ) reject
- $\Lambda$  is rejected



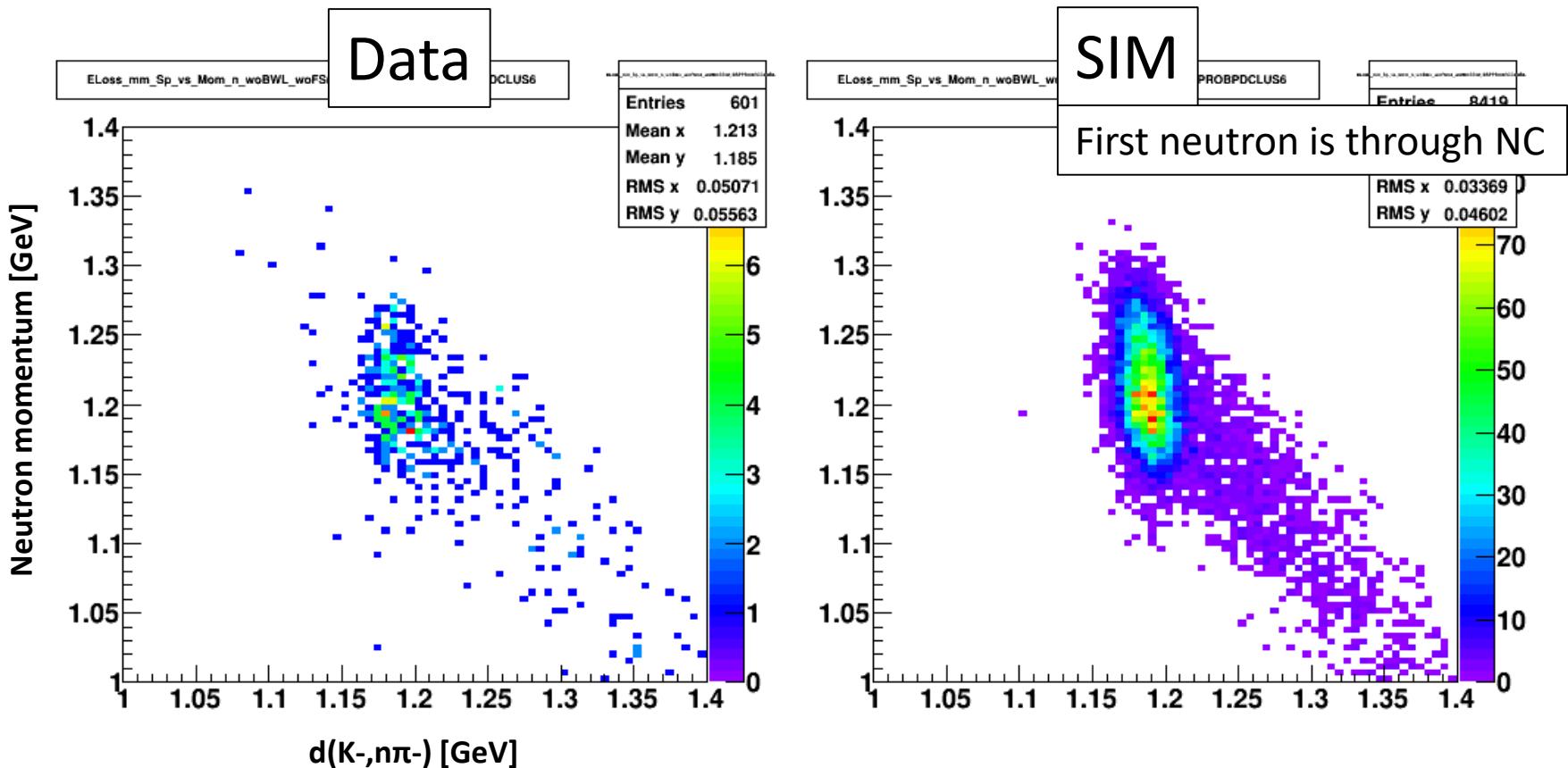
- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

# Data vs SIM



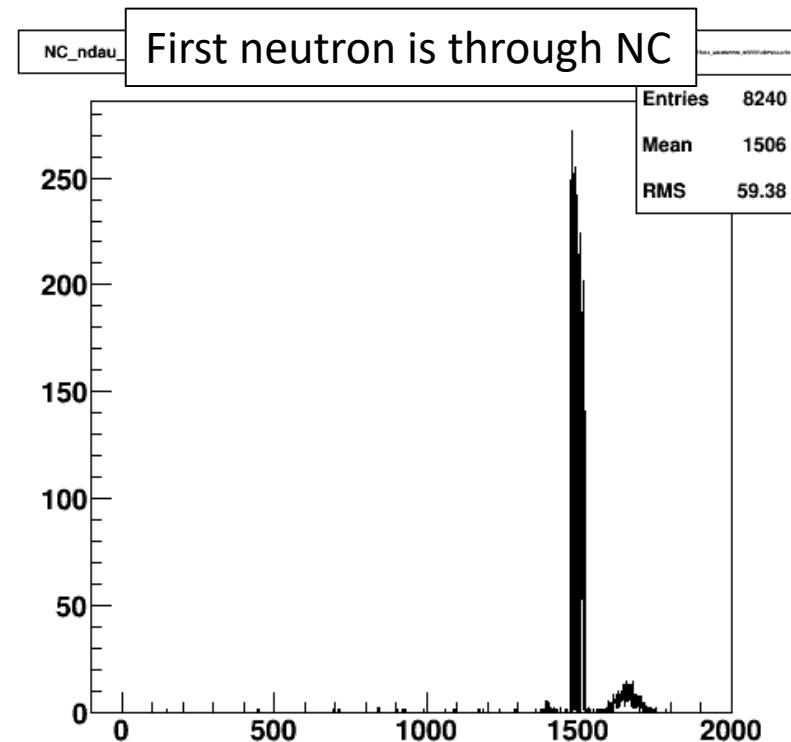
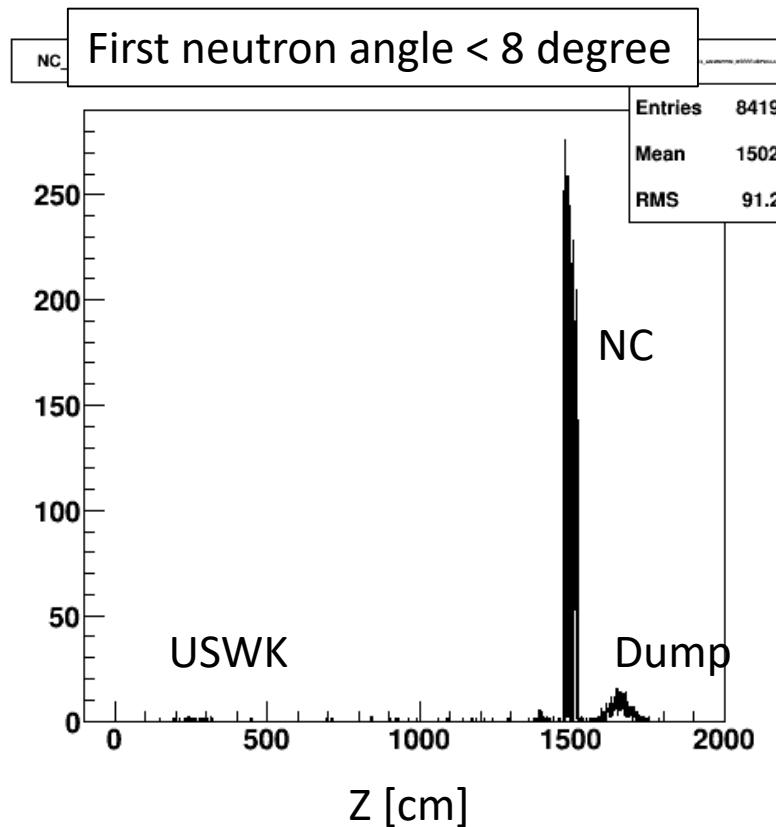
# Data vs SIM

- $0 < d(K^-, \eta\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $\eta, \pi^-$ ) reject
- $\Lambda$  is rejected



# First neutron hit Z position

- $0 < d(K^-, n p \pi^-) < 0.5$
- $\Sigma$ - from Invariant ( $n, \pi^-$ ) rejection
- $\Lambda$  is rejected



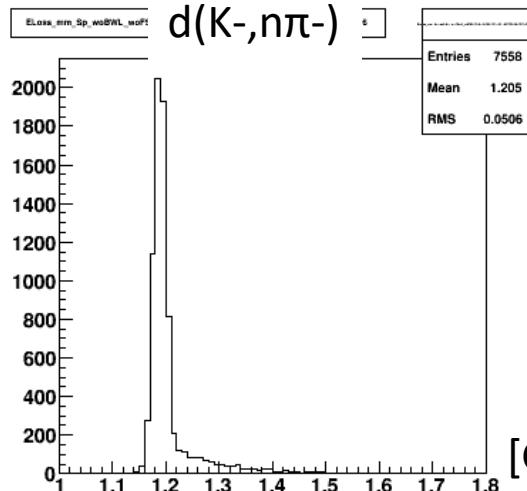
Contribution from USWK is small

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma$ - from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

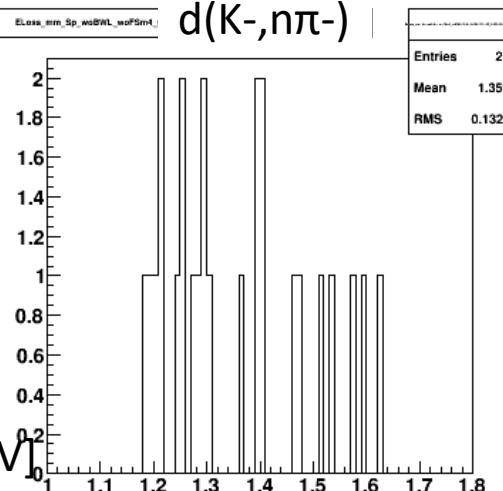
# $d(K^-, n\pi^-)$

# first neutron hit pos dependence

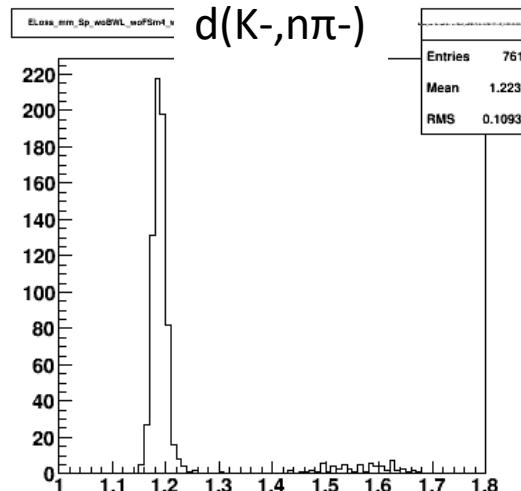
NC



USWK

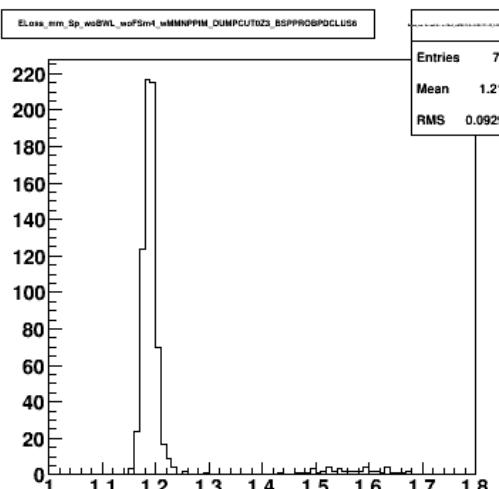
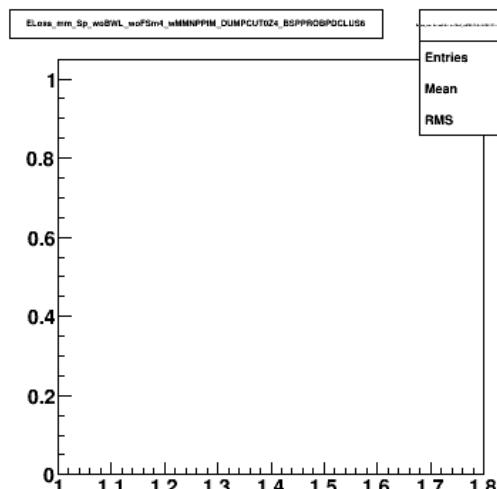
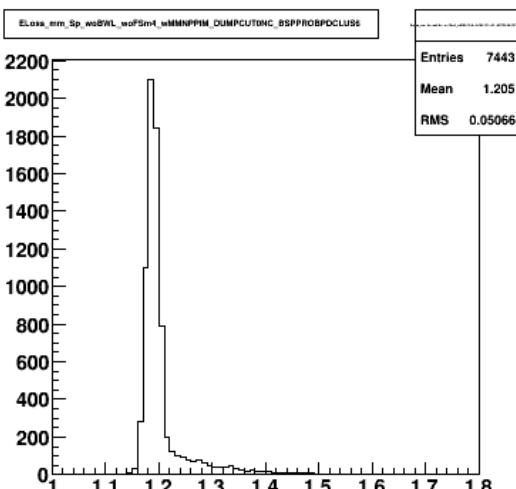


Dump



First neutron angle < 8 degree

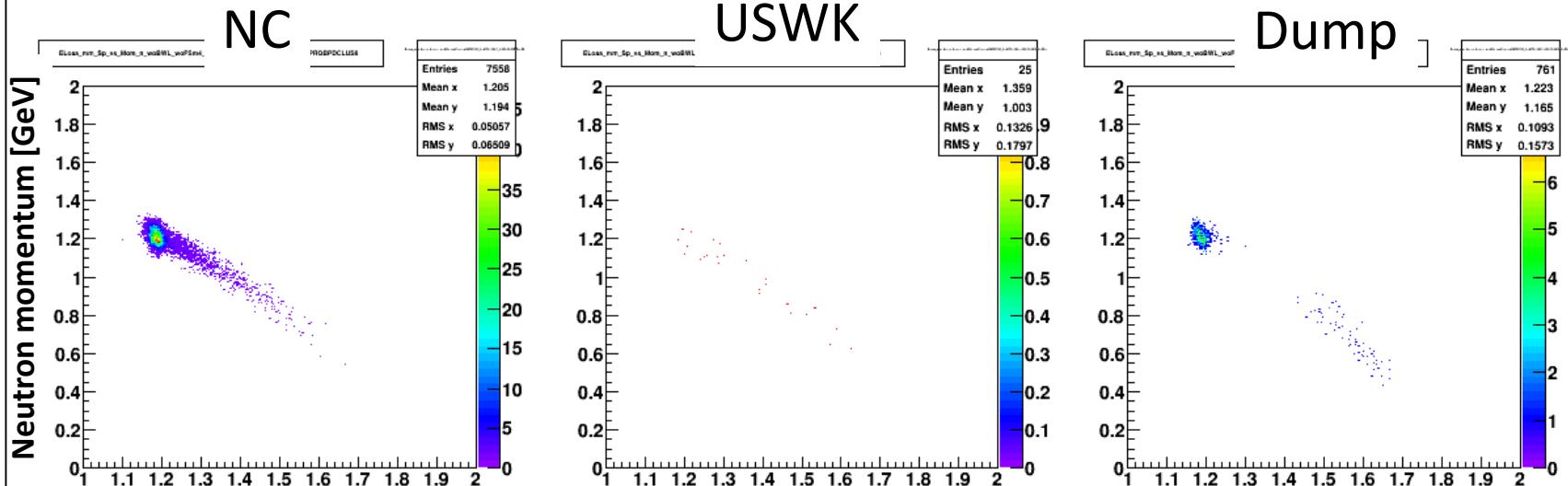
First neutron is through NC



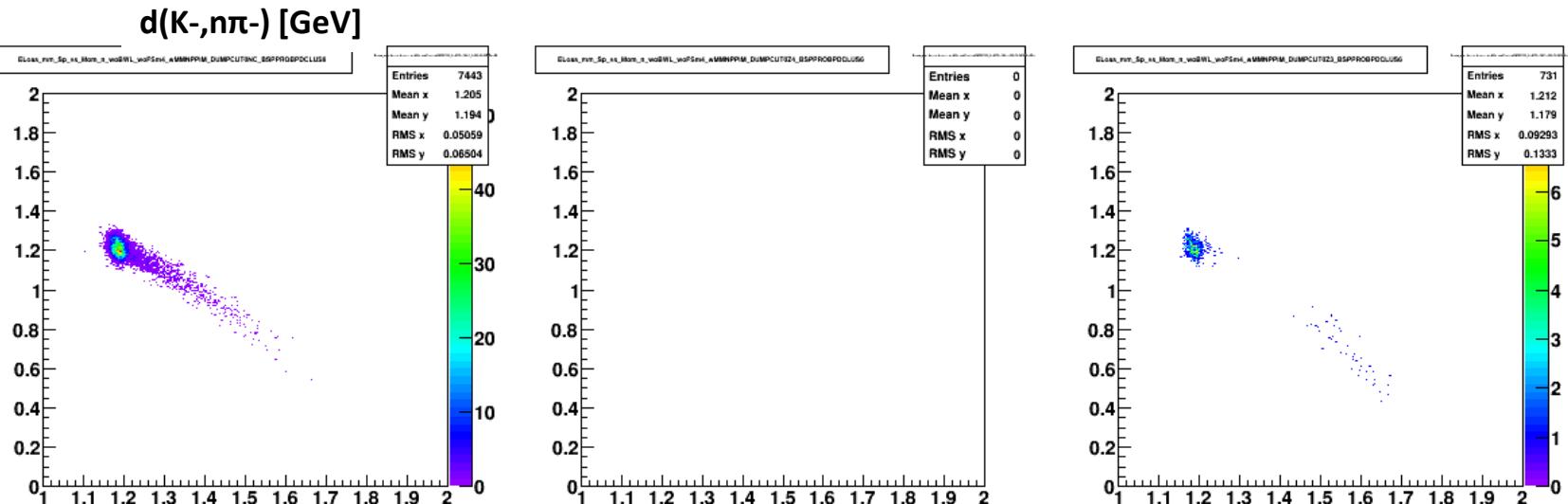
Contribution from USWK is small

# $d(K^-, n\pi^-)$ vs neutron momentum first neutron hit pos dependence

First neutron angle < 8 degree



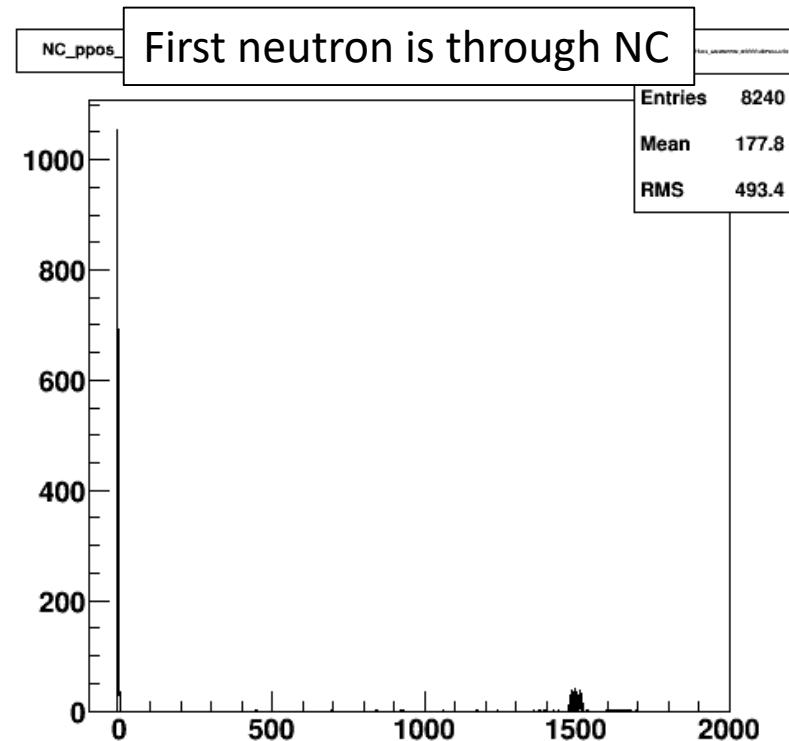
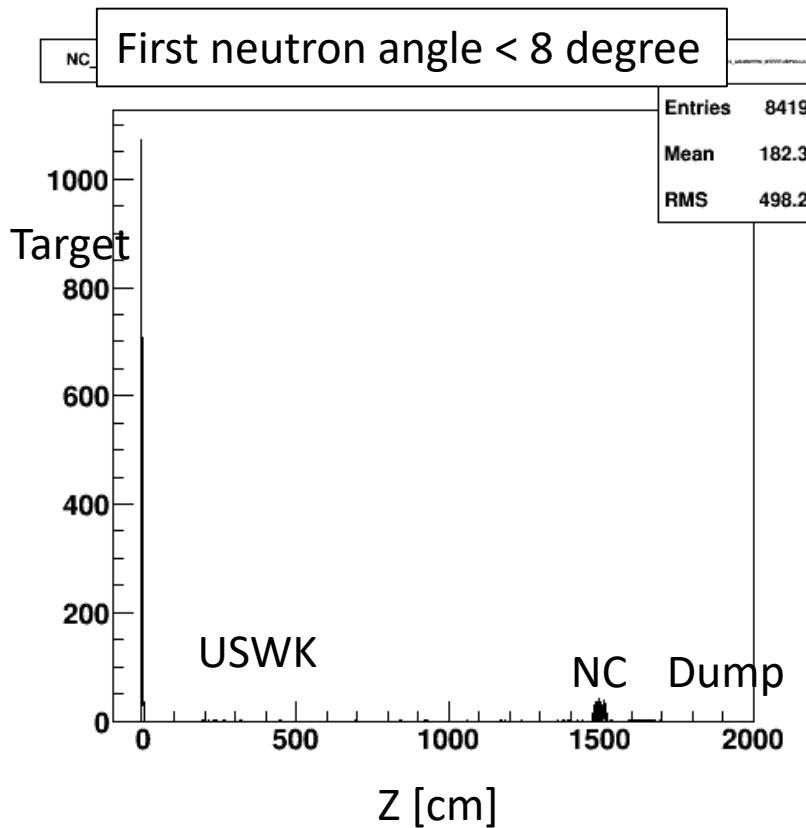
First neutron is through NC



Contribution from USWK is small

# Vertex z position parent of NC hit

- $0 < d(K^-, n\bar{p}\pi^-) < 0.5$
- $\Sigma$ - from Invariant ( $n, \pi^-$ ) rejection
- $\Lambda$  is rejected



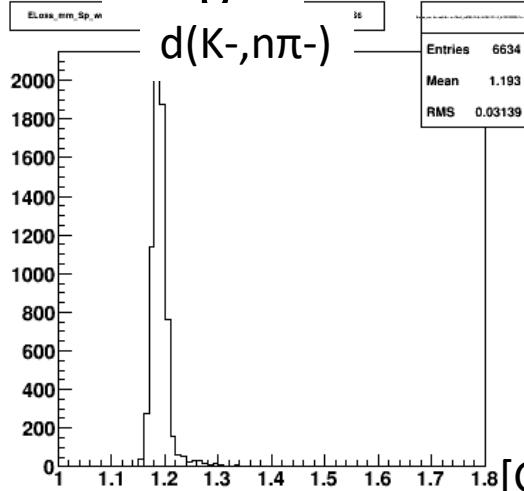
# $d(K^-, n\pi^-)$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

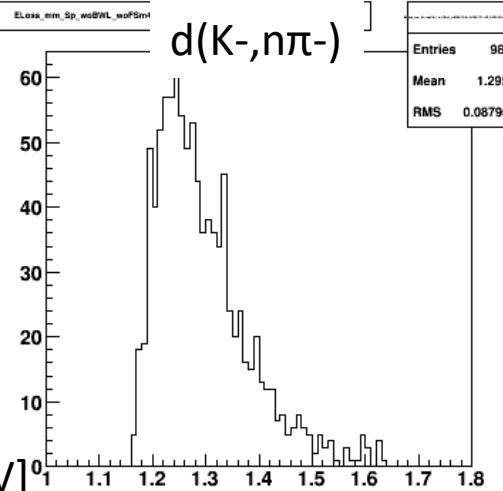
## vertex z position dependence

First neutron angle  $< 8$  degree

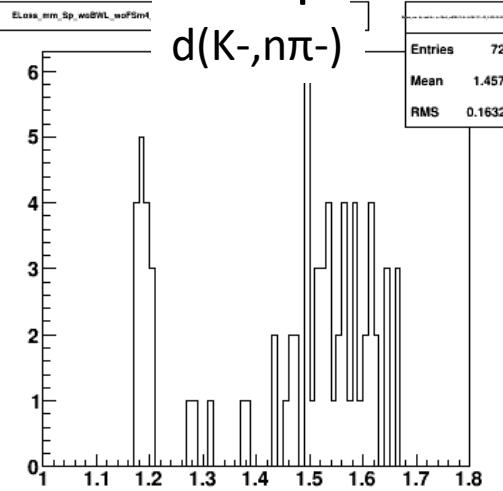
Target



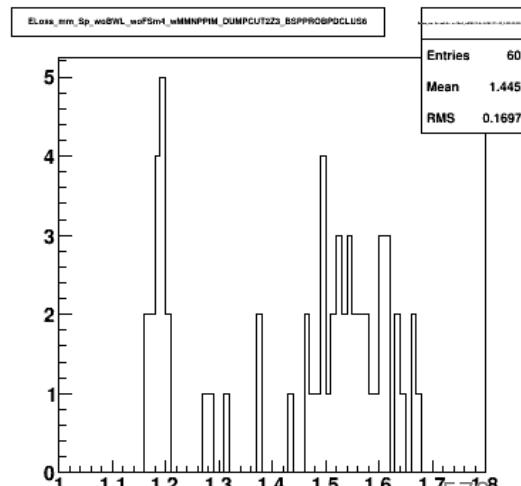
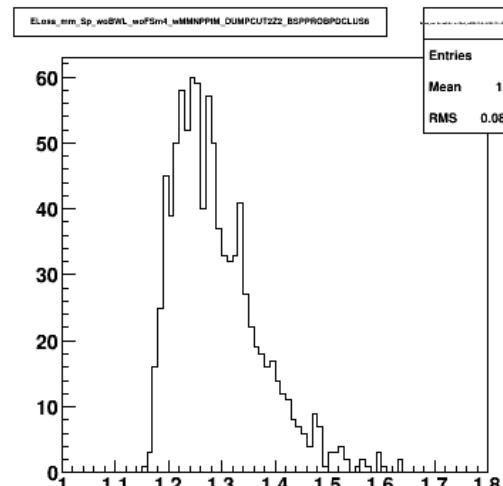
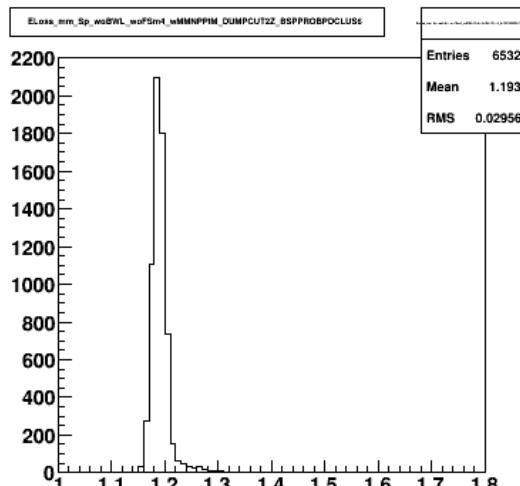
NC



Dump



First neutron is through NC



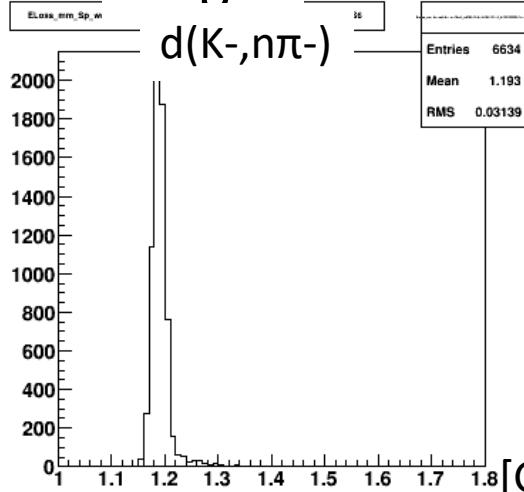
# $d(K^-, n\pi^-)$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

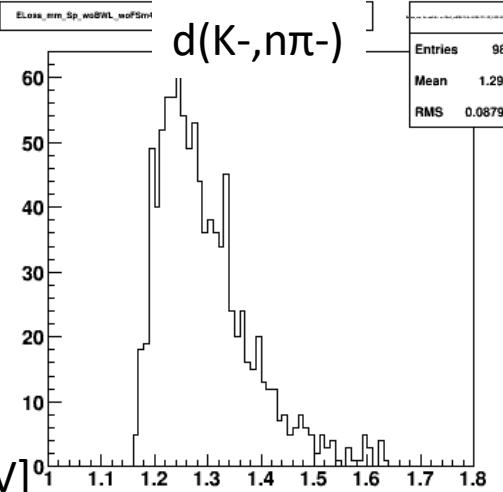
## vertex z position dependence

First neutron angle  $< 8$  degree

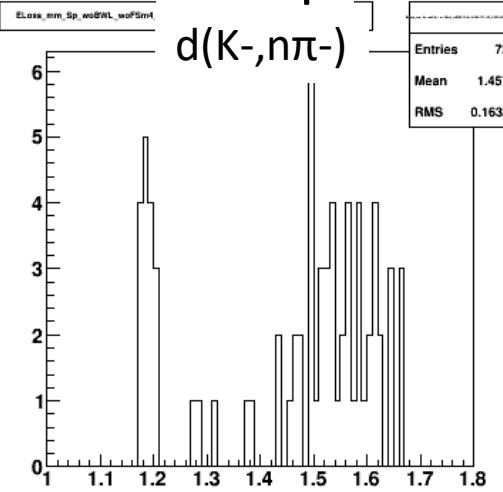
Target



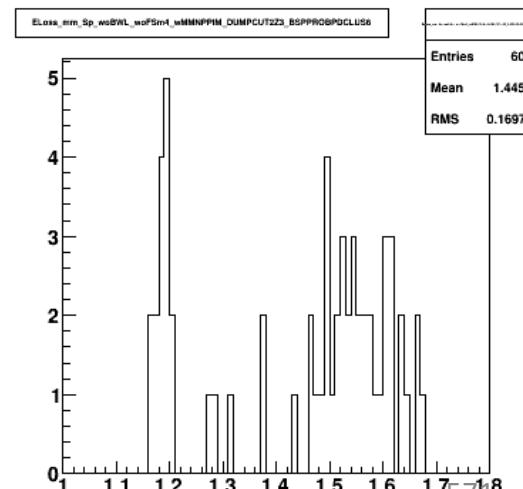
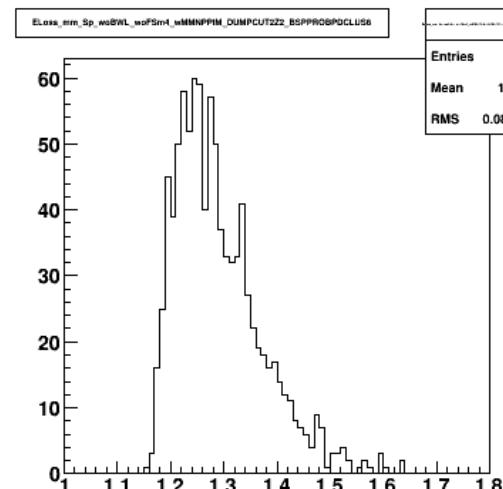
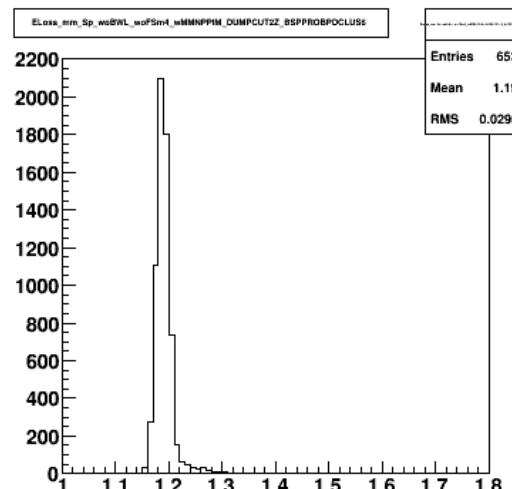
NC



Dump



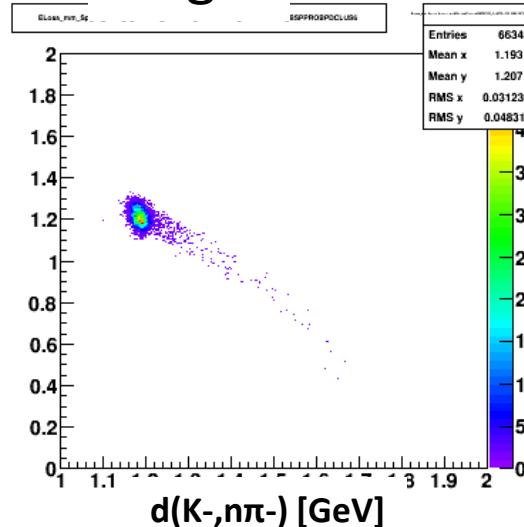
First neutron is through NC



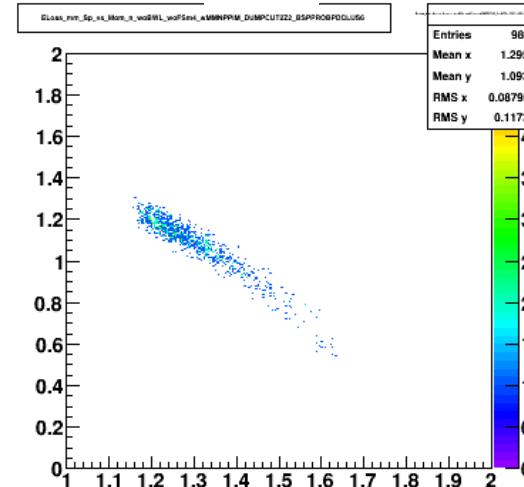
# $d(K^-, n\pi^-)$ vs neutron momentum vertex z position dependence

First neutron angle < 8 degree

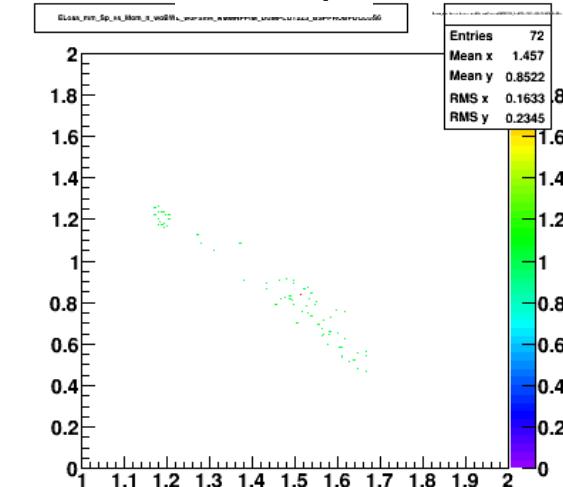
Target



NC

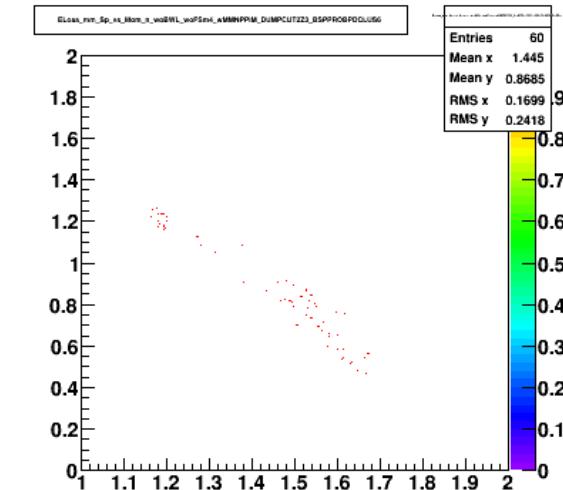
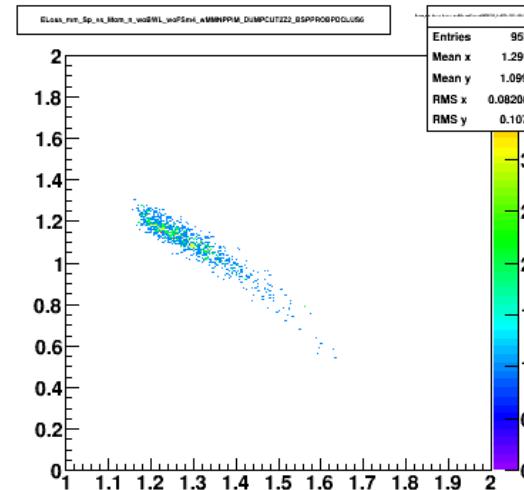
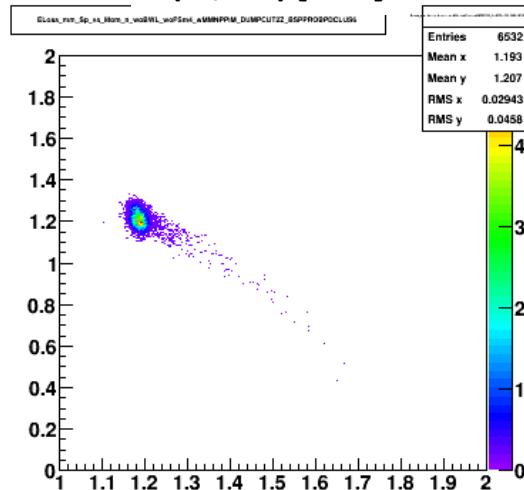


Dump



First neutron is through NC

$d(K^-, n\pi^-)$  [GeV]



# Re-analysis 10

Change of the logic for NC hit segment selection

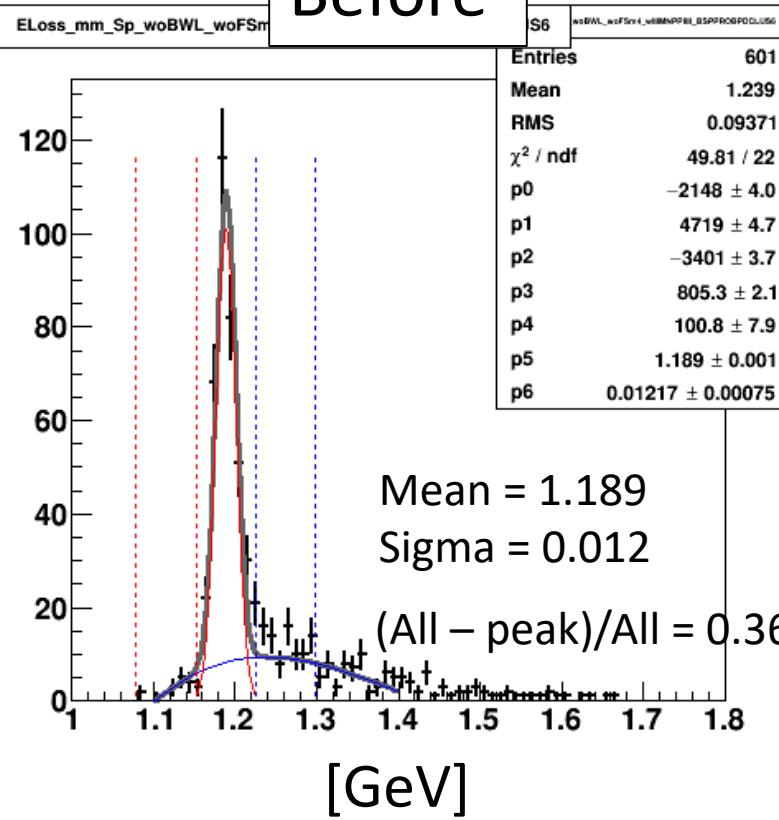
- dE max seg in the first layer over Thre. (8MeV)  
-> first timing over Thre. (8 MeV)

# MM. $d(K^-, n\pi^-)$

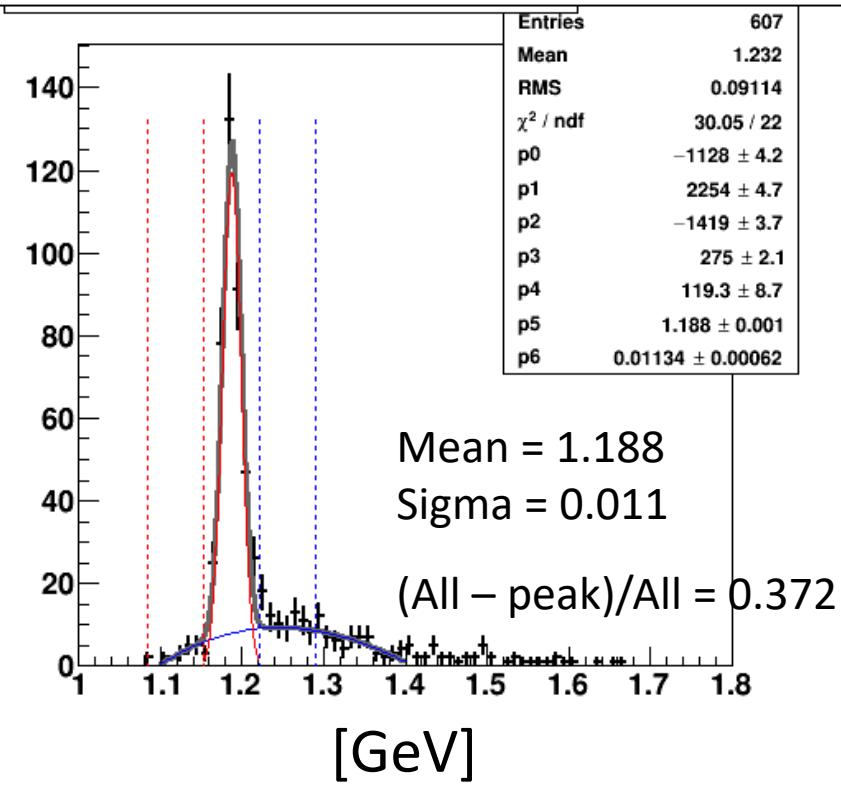
- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

**Data**

Before



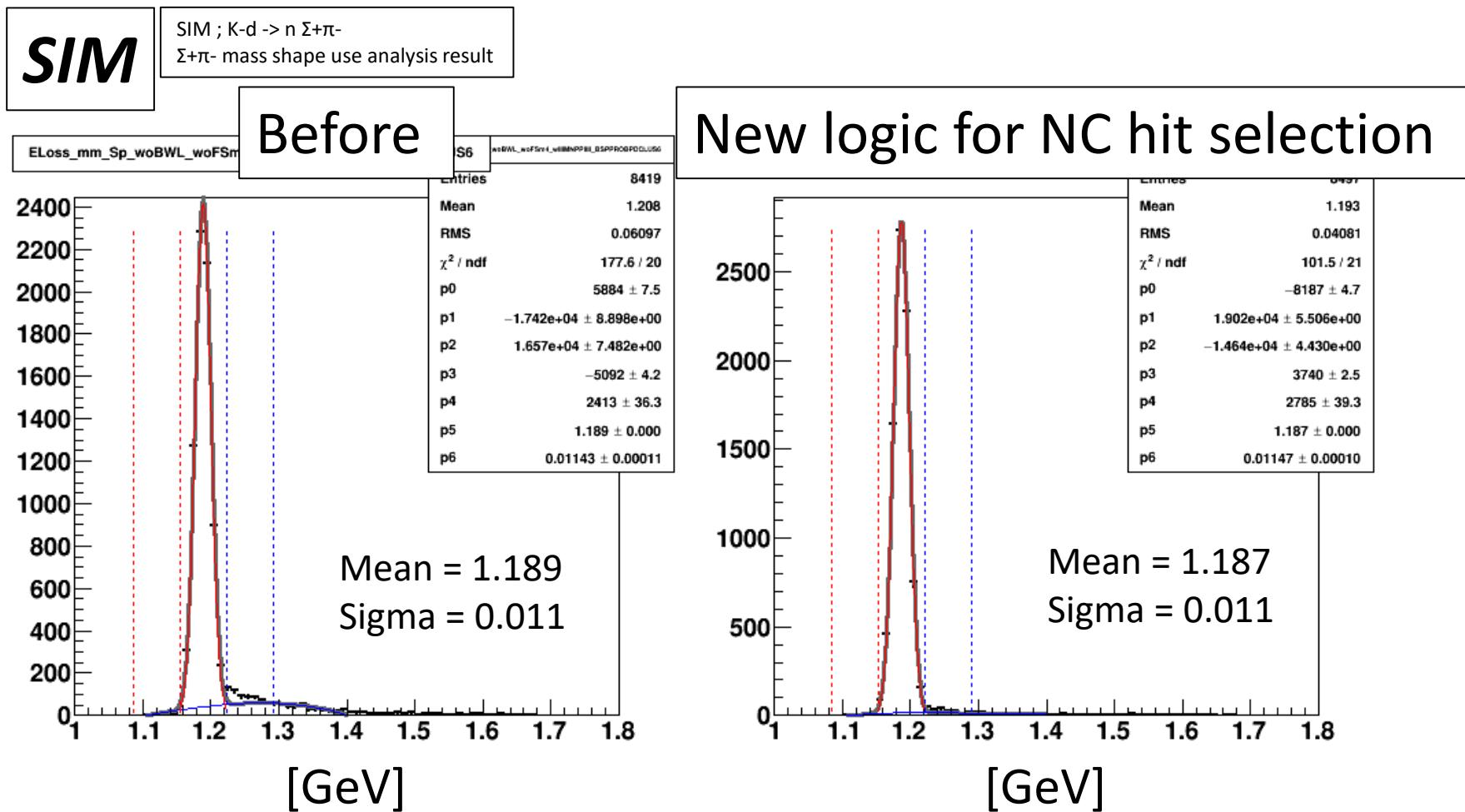
New logic for NC hit selection



$\Sigma^+$  peak becomes a little sharp, but tail component still remains.

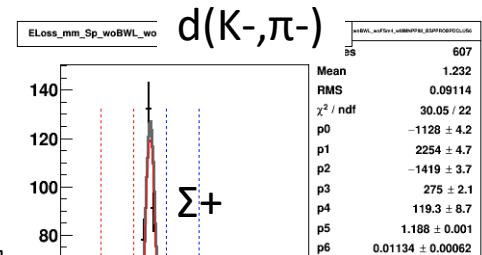
# MM. $d(K^-, n\pi^-)$

- $0 < d(K^-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected

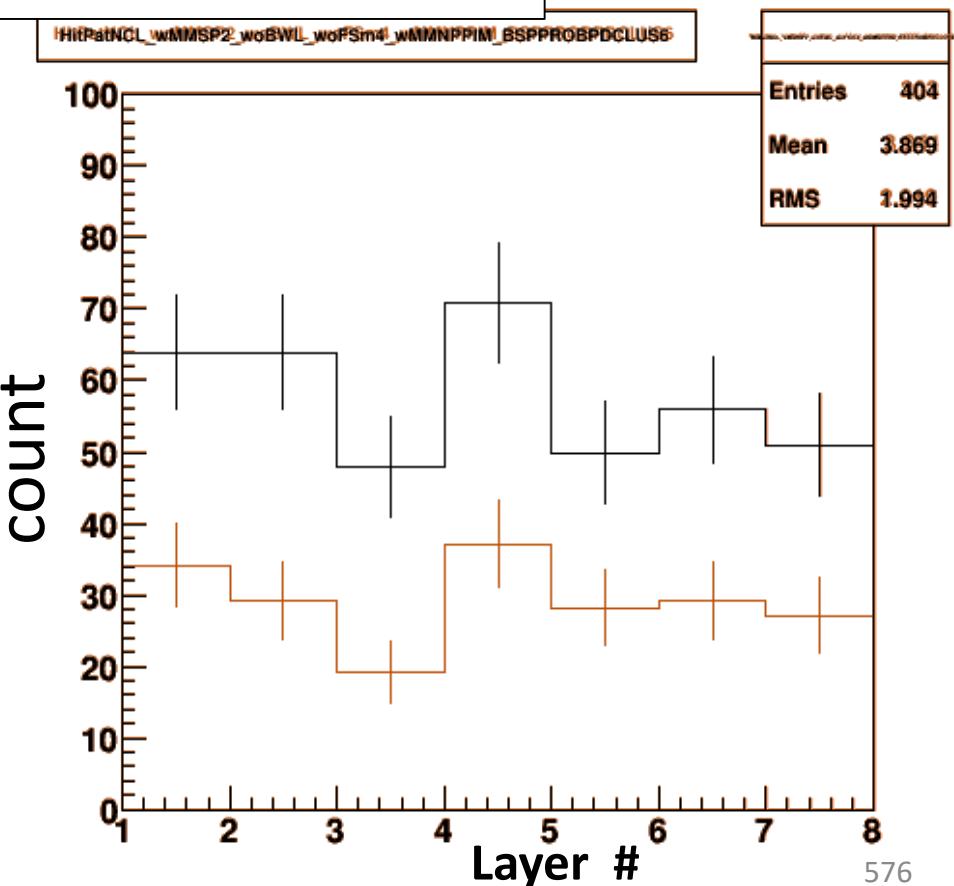


Tail component is almost nothing.

# NC Hit Pattern

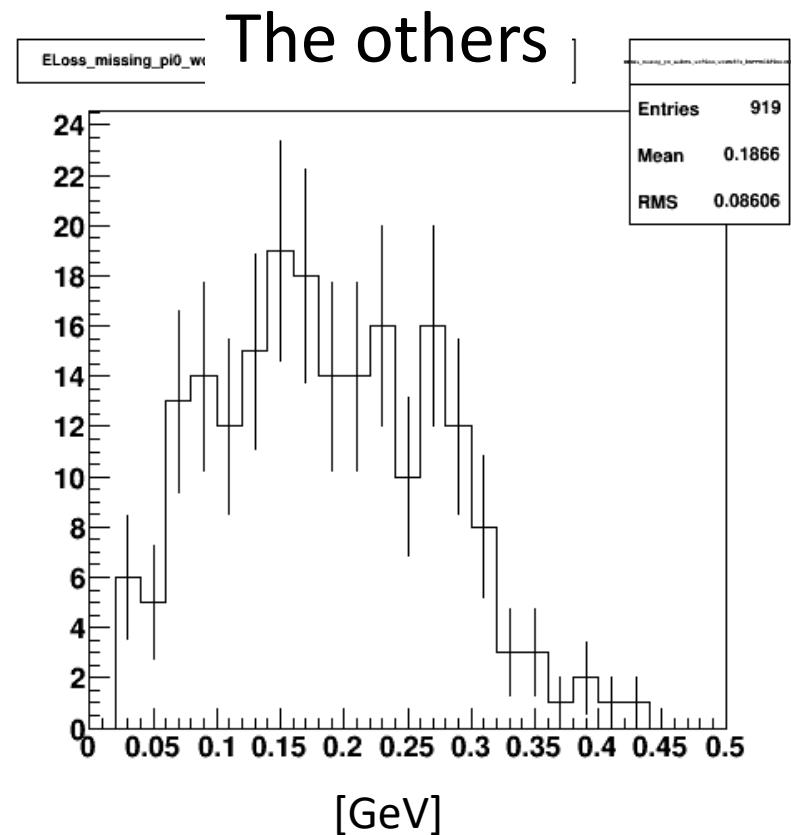
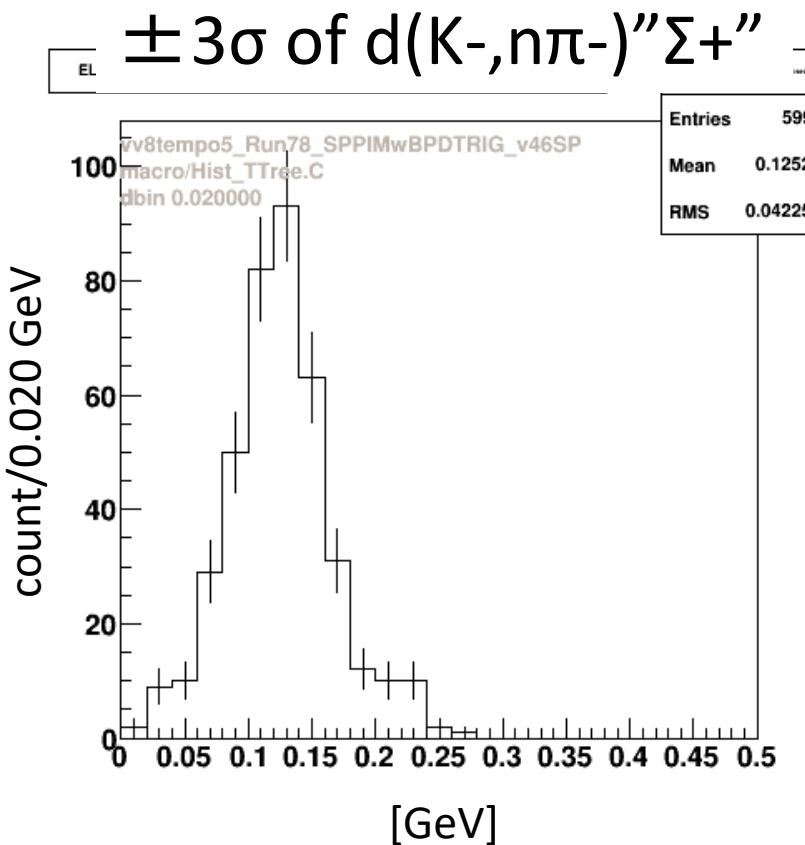


- $0 < d(K-, n\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) reject
- $\Lambda$  is rejected



# MM. $d(K^-, n\pi^-)$

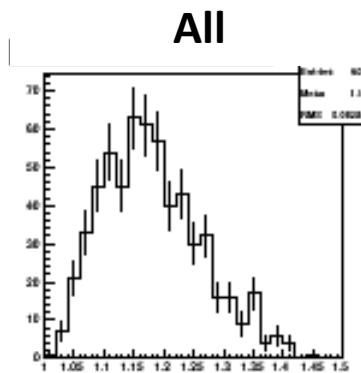
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) is rejected
- $\Lambda$  from Invariant ( $p, \pi^-$ ) is rejected



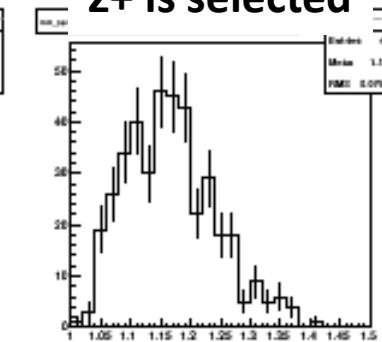
# MM. $d(K^-, p\pi^-)$

- $0 < d(K^-, p\pi^-) < 0.5$
- $\Sigma$  from Invariant ( $n, \pi^-$ ) is rejected
- $\Lambda$  from Invariant ( $p, \pi^-$ ) is rejected

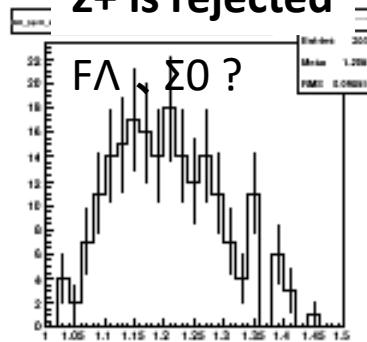
All



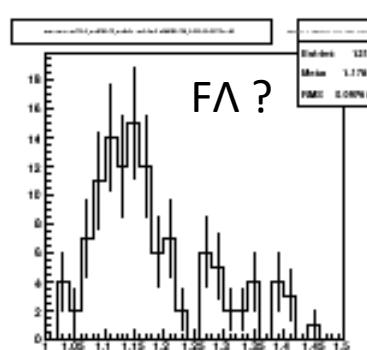
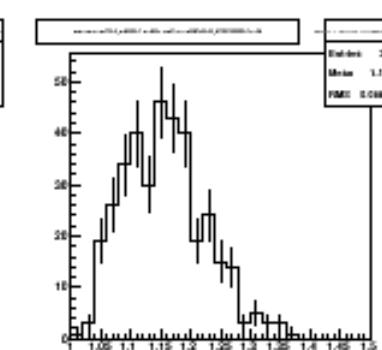
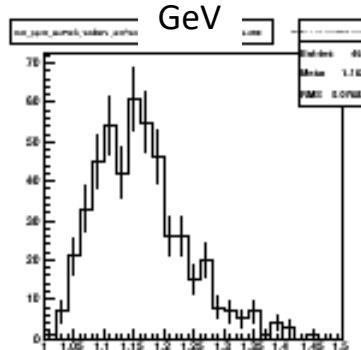
$\Sigma^+$  is selected



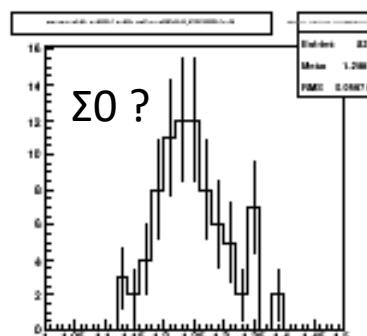
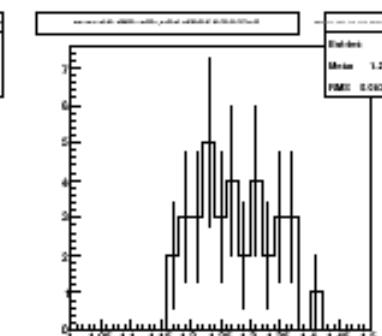
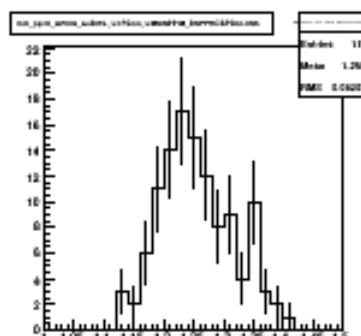
$\Sigma^+$  is rejected



$\pi^0$  ;  
 $0.00 < d(K^-, p\pi^-) < 0.18$



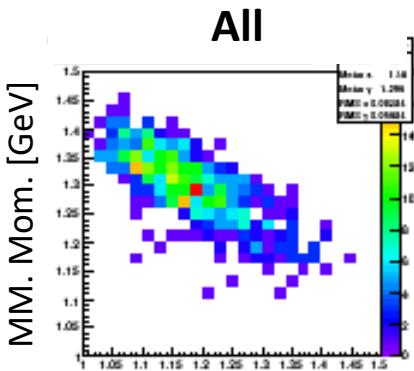
$\pi^0\gamma$  ;  
 $0.18 < d(K^-, p\pi^-) < 0.30$



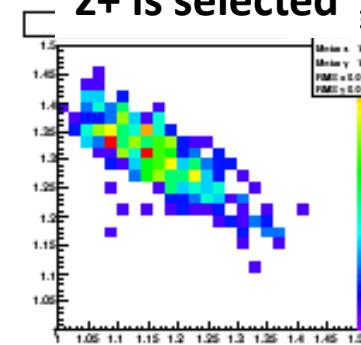
# MM. $d(K^-, p\pi^-)$ vs MM. Momentum

- $0 < d(K^-, p\pi^-) < 0.5$
- $\Sigma$  from Invariant ( $n, \pi^-$ ) is rejected
- $\Lambda$  from Invariant ( $p, \pi^-$ ) is rejected

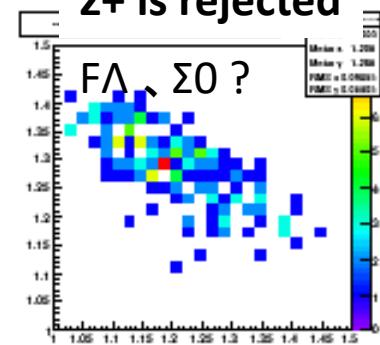
All



$\Sigma^+$  is selected



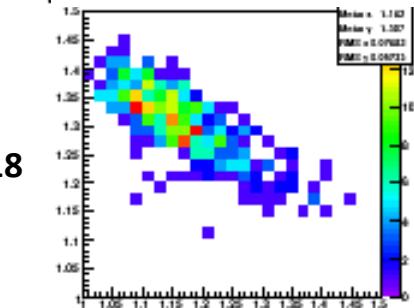
$\Sigma^+$  is rejected



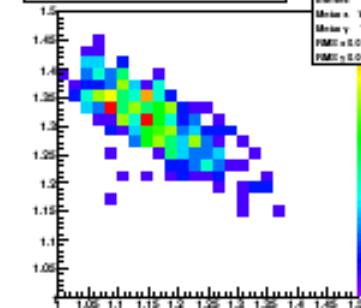
$\pi^0$  ;

$0.00 < d(K^-, p\pi^-) < 0.18$

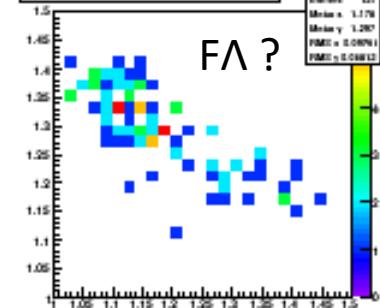
MM.  $d(K^-, p\pi^-)$  [GeV]



$\Sigma^+$  is selected



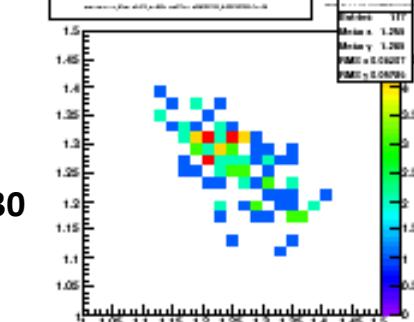
$F\Lambda$  ?



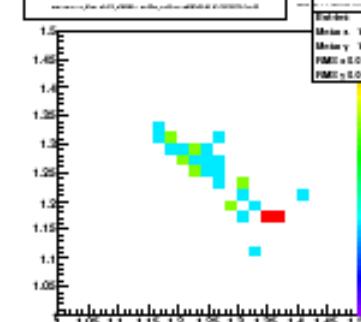
$\pi^0\gamma$  ;

$0.18 < d(K^-, p\pi^-) < 0.30$

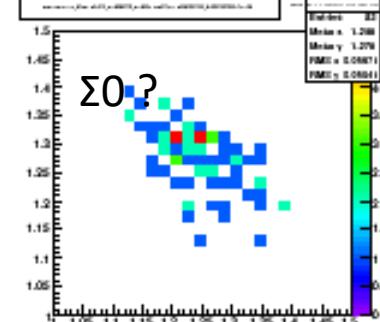
MM.  $d(K^-, p\pi^-)$  [GeV]



$\Sigma^+$  is selected



$\Sigma^0$  ?



# MM. $d(K^-, np)$

- $0 < d(K^-, np\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) is rejected
- $\Lambda$  from Invariant ( $p, \pi^-$ ) is rejected

All

All

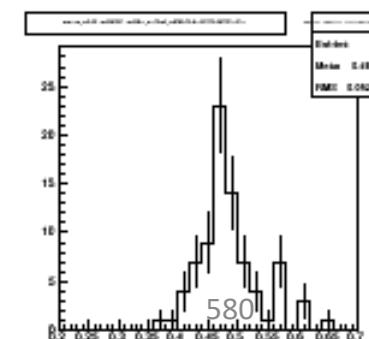
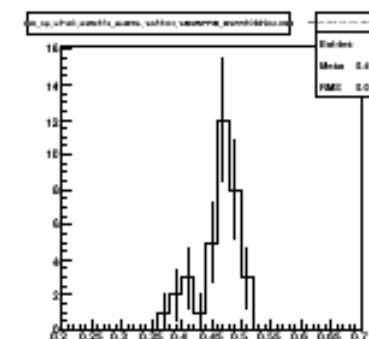
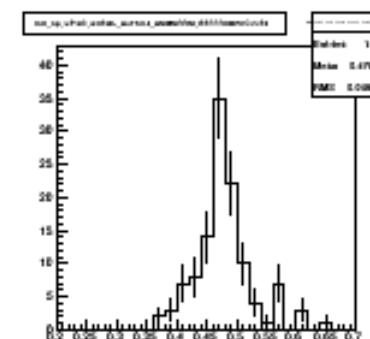
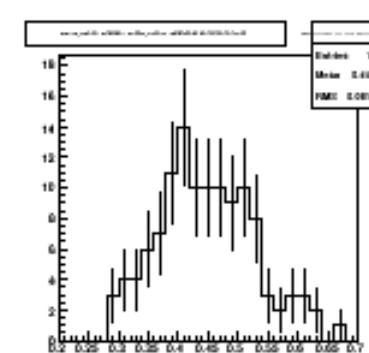
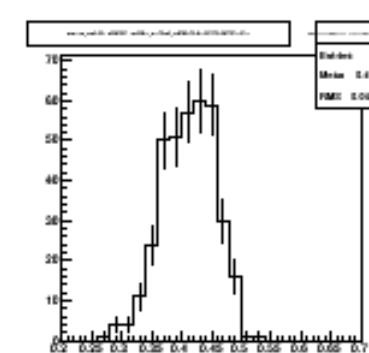
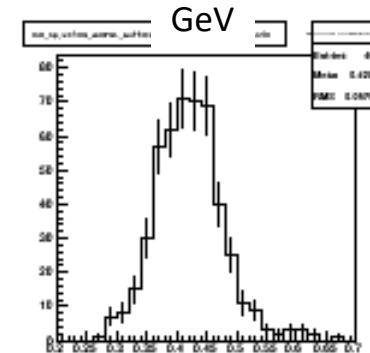
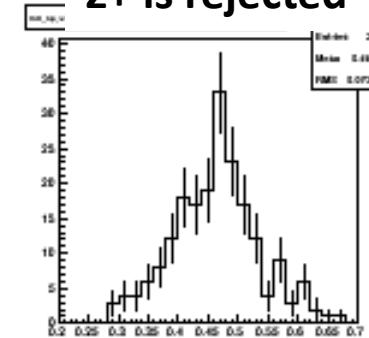
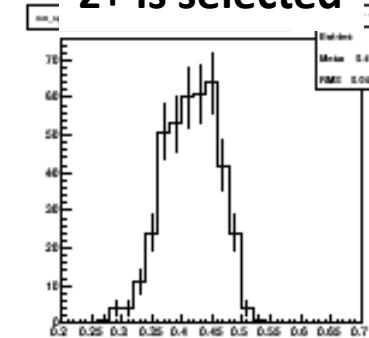
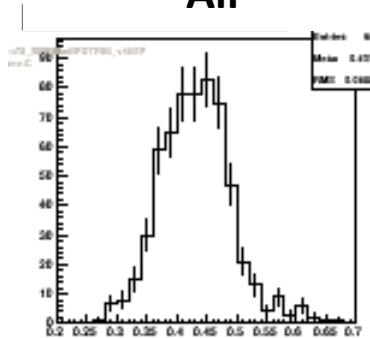
$\Sigma^+$  is selected

$\Sigma^+$  is rejected

$\pi^0$  ;  
 $0.00 < d(K^-, np\pi^-) < 0.18$

GeV

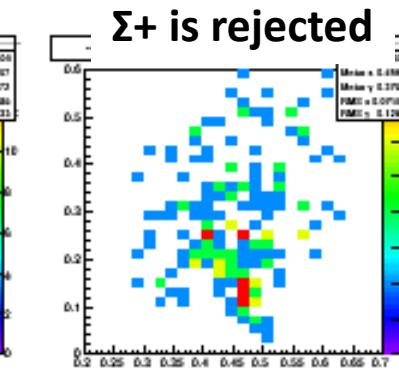
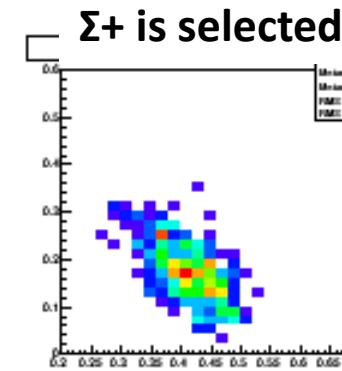
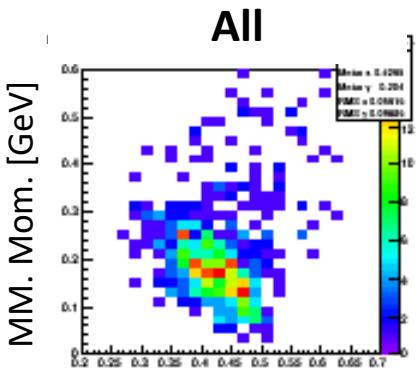
$\pi^0\gamma$  ;  
 $0.18 < d(K^-, np\pi^-) < 0.30$



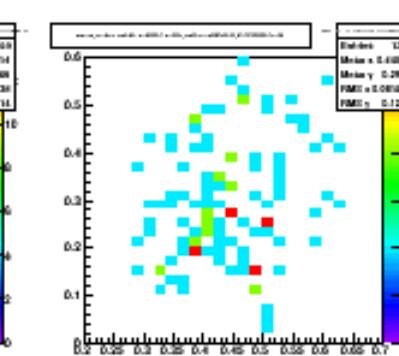
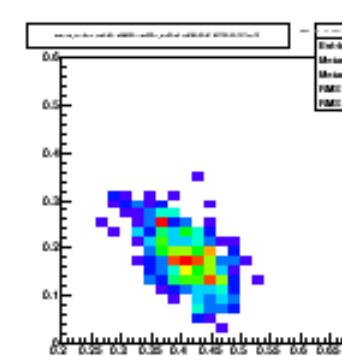
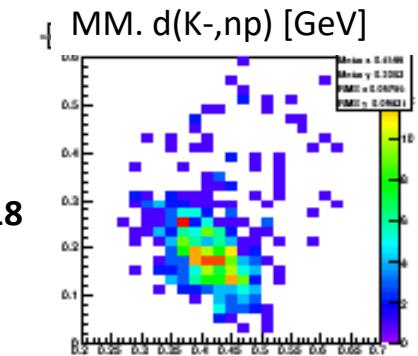
# MM. $d(K^-, np)$ vs MM. Momentum

- $0 < d(K^-, np\pi^-) < 0.5$
- $\Sigma$  from Invariant ( $n, \pi^-$ ) is rejected
- $\Lambda$  from Invariant ( $p, \pi^-$ ) is rejected

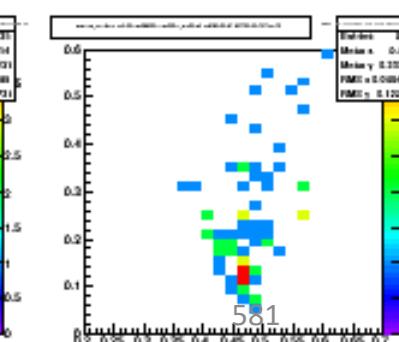
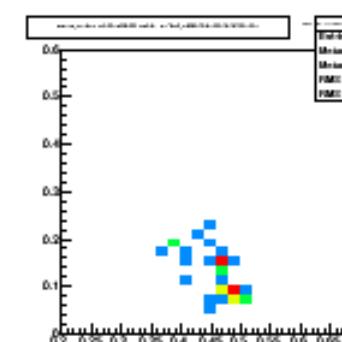
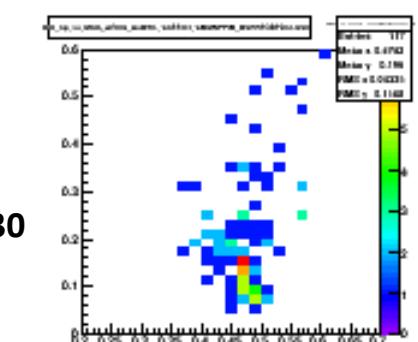
All



$\pi^0$  ;  
 $0.00 < d(K^-, np\pi^-) < 0.18$

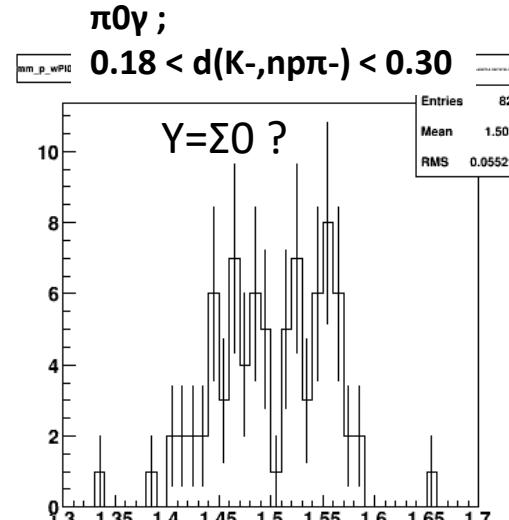
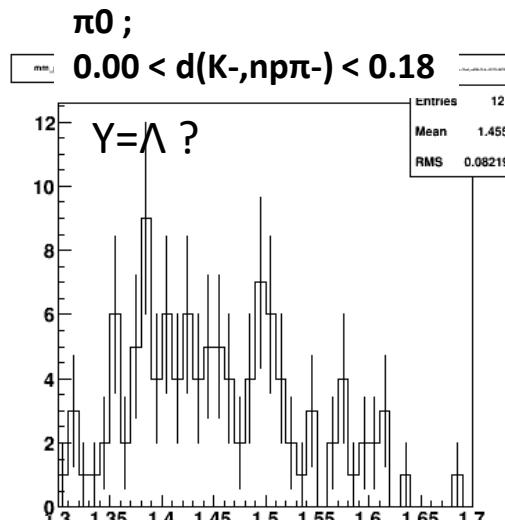
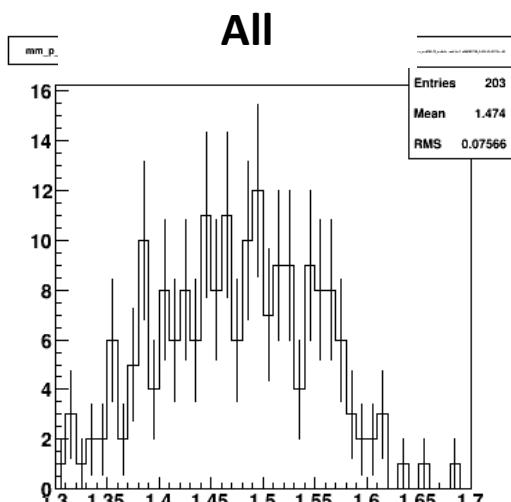


$\pi^0\gamma$  ;  
 $0.18 < d(K^-, np\pi^-) < 0.30$



# MM. d(K-,p)"Yπ"

- $0 < d(K^-, p\pi^-) < 0.5$
- $\Sigma^-$  from Invariant ( $n, \pi^-$ ) is rejected
- $\Lambda$  from Invariant ( $p, \pi^-$ ) is rejected
- $\Sigma^+$  from MM. d( $n, p\pi^-$ ) is rejected

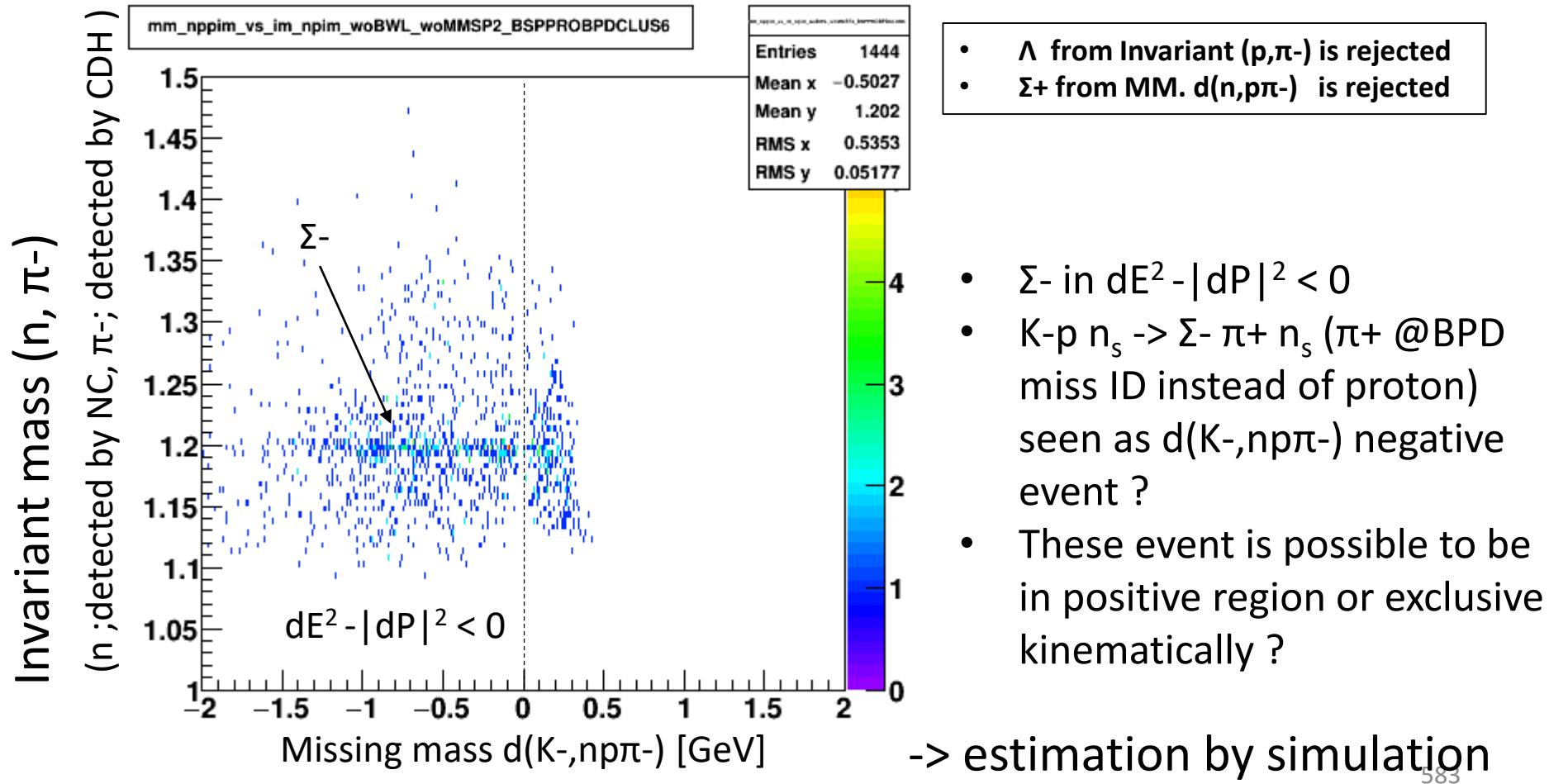


GeV

# Possibility of BG of pion w/ high dE @BPD

(BPD dE Thre. > 3 MeV)

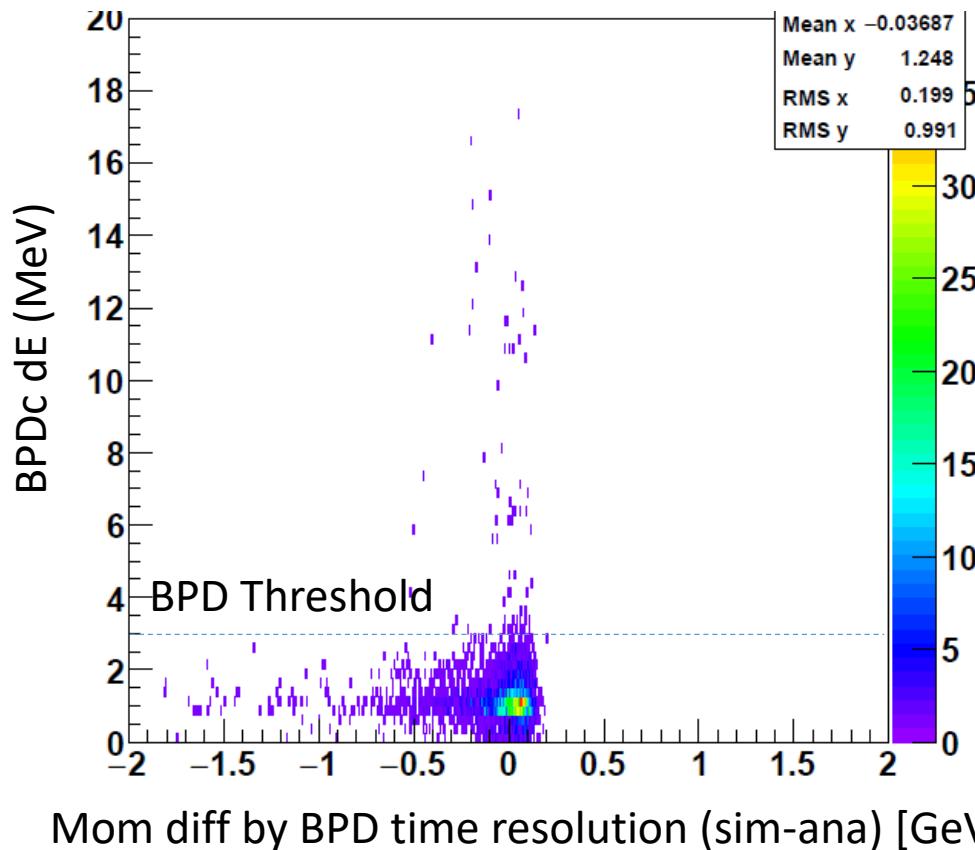
- Pion contamination in backward proton



- $\Sigma^-$  from IM.  $d(n, \pi^-)$  is rejected

$K-p n_s \rightarrow \Sigma^- \pi^+ n_s$  (Backward analysis as  $\pi^+$ )

BPD accept only  $\pi^+$  from the SIM reaction ID



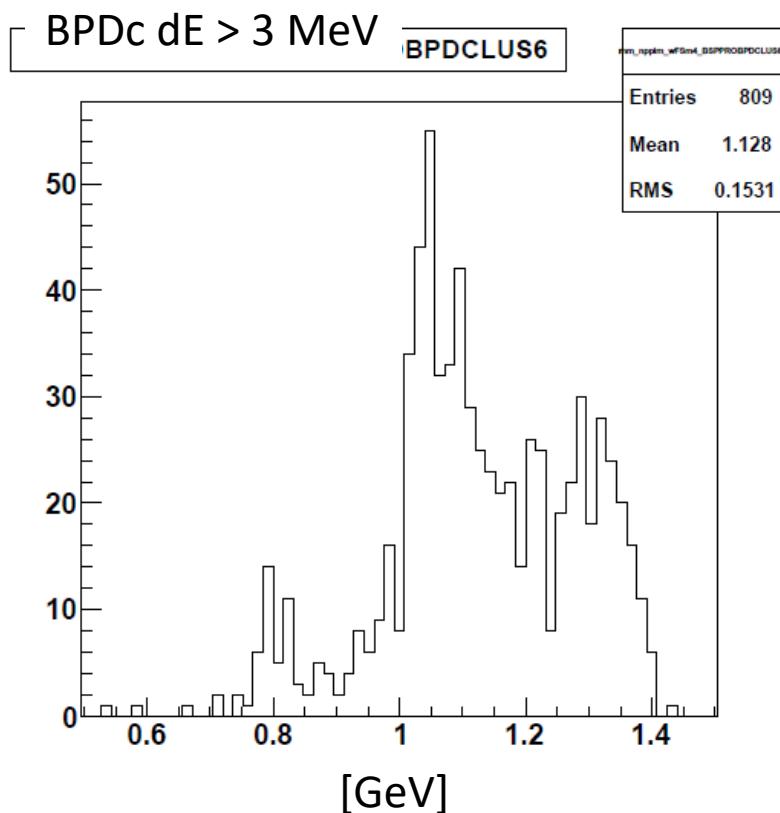
$dE > 3$  MeV is almost nothing compared w/  $dE < 3$  MeV

# MM. $d(K^-, n\pi^+ \pi^-)$

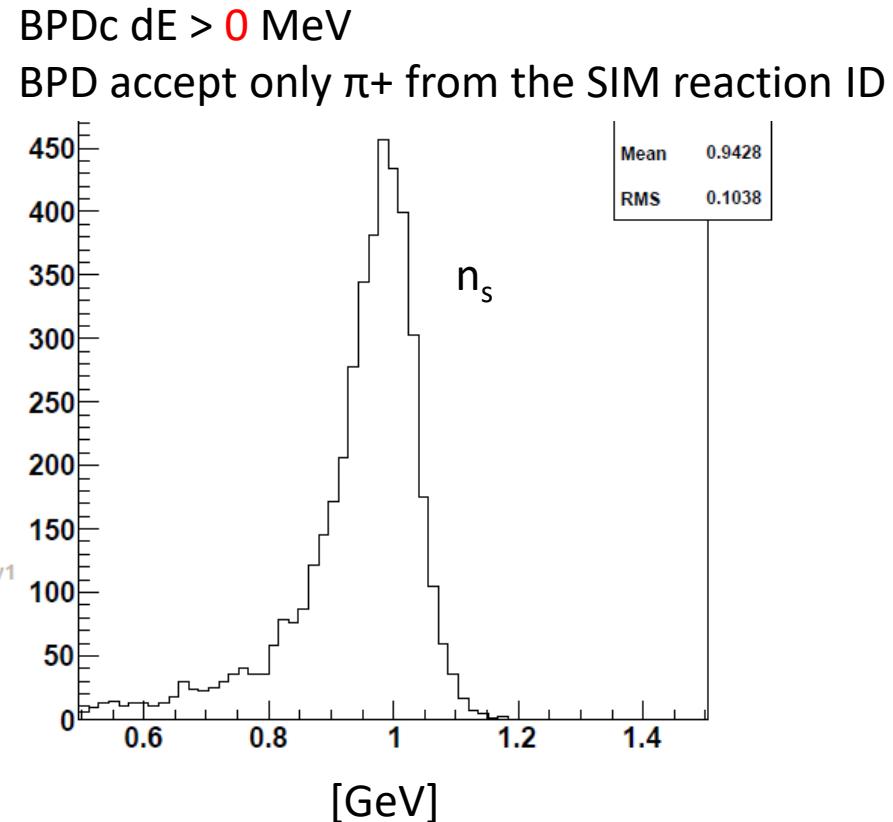
- $\Sigma$ - from IM. ( $n, \pi^-$ ) is rejected

$K^- p \rightarrow \Sigma^- \pi^+ n_s$  (Backward analysis as  $\pi^+$ )

## Data



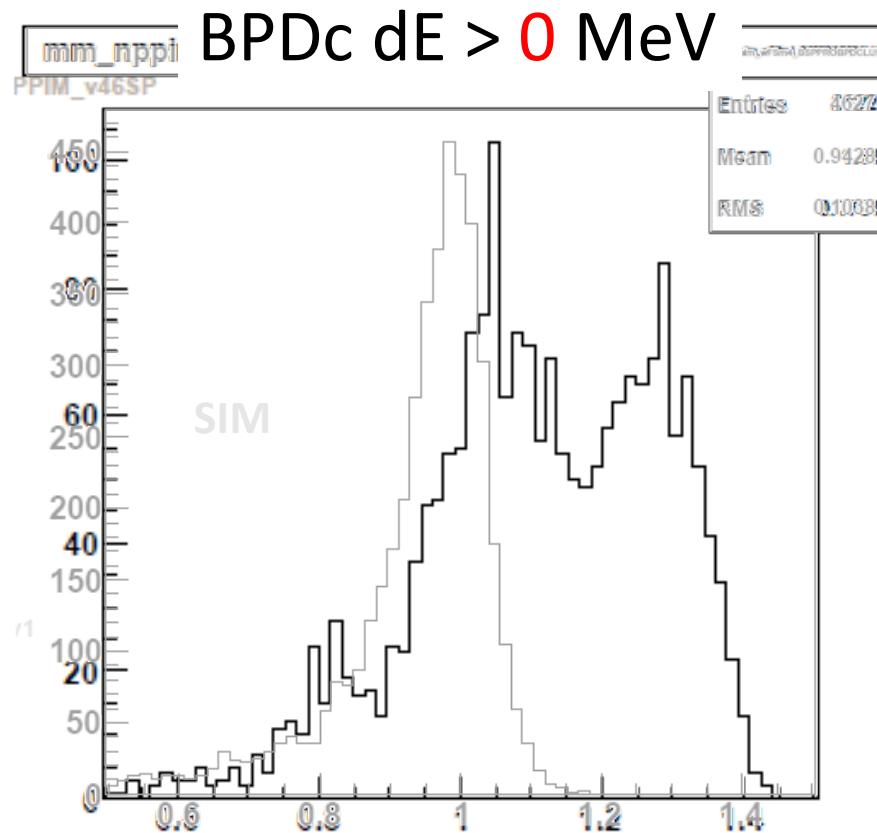
## SIM



$n_s$  peak seems to be different from SIM  
I don't understand the data distribution

- $\Sigma$ - from IM. ( $n, \pi^-$ ) is rejected

# Data

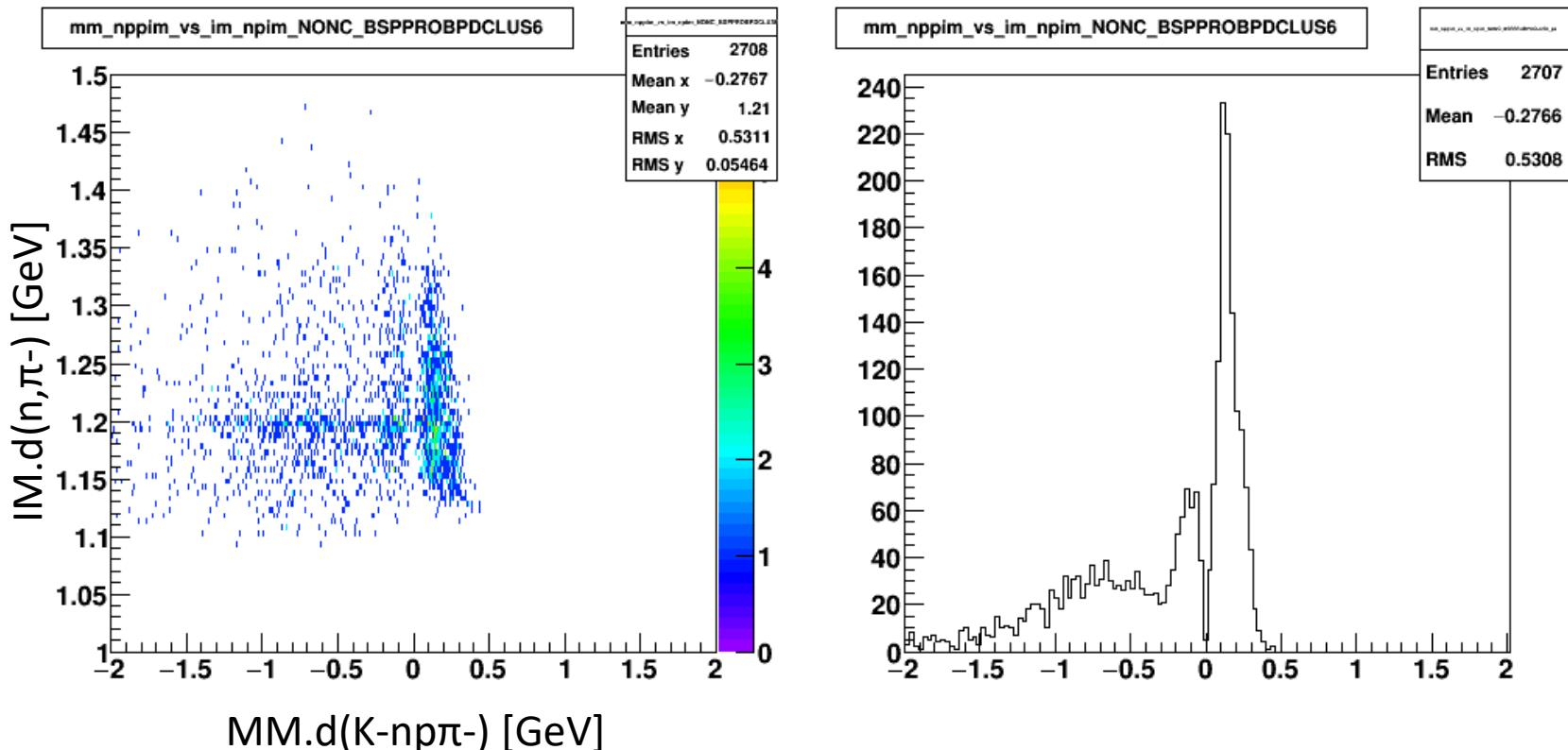


$n\pi$  peak seems to be different from SIM  
I don't understand the data distribution

# $MM.d(K-, np\pi^-)$ vs $IM.(n,\pi^-)$

Data

p, n is analyzed as  $\Sigma + \pi^-$  mode

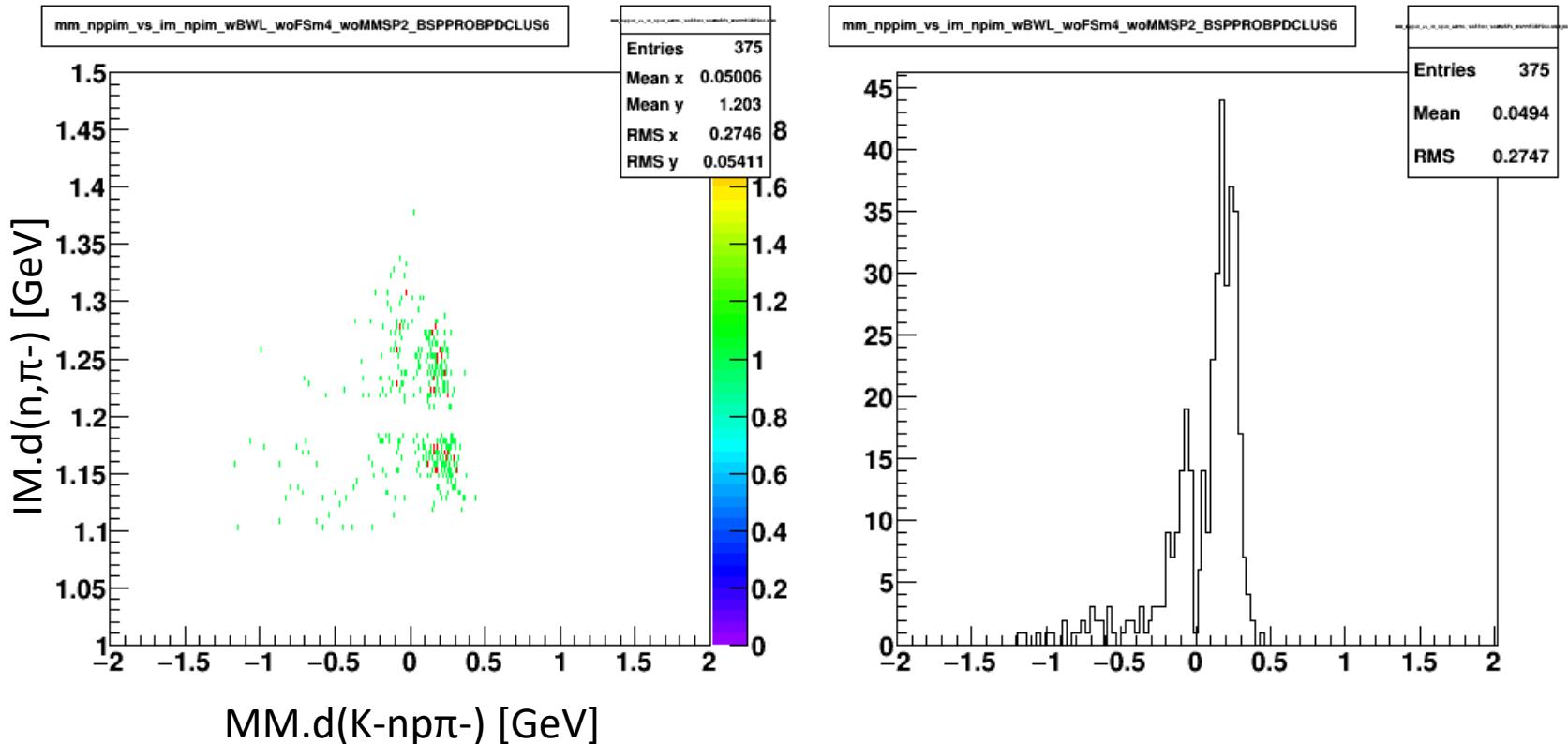


- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is selected

# MM. $d(K^-, n\pi^-)$ vs IM. $(n, \pi^-)$

Data

p, n is analyzed as  $\Sigma^+\pi^-$  mode

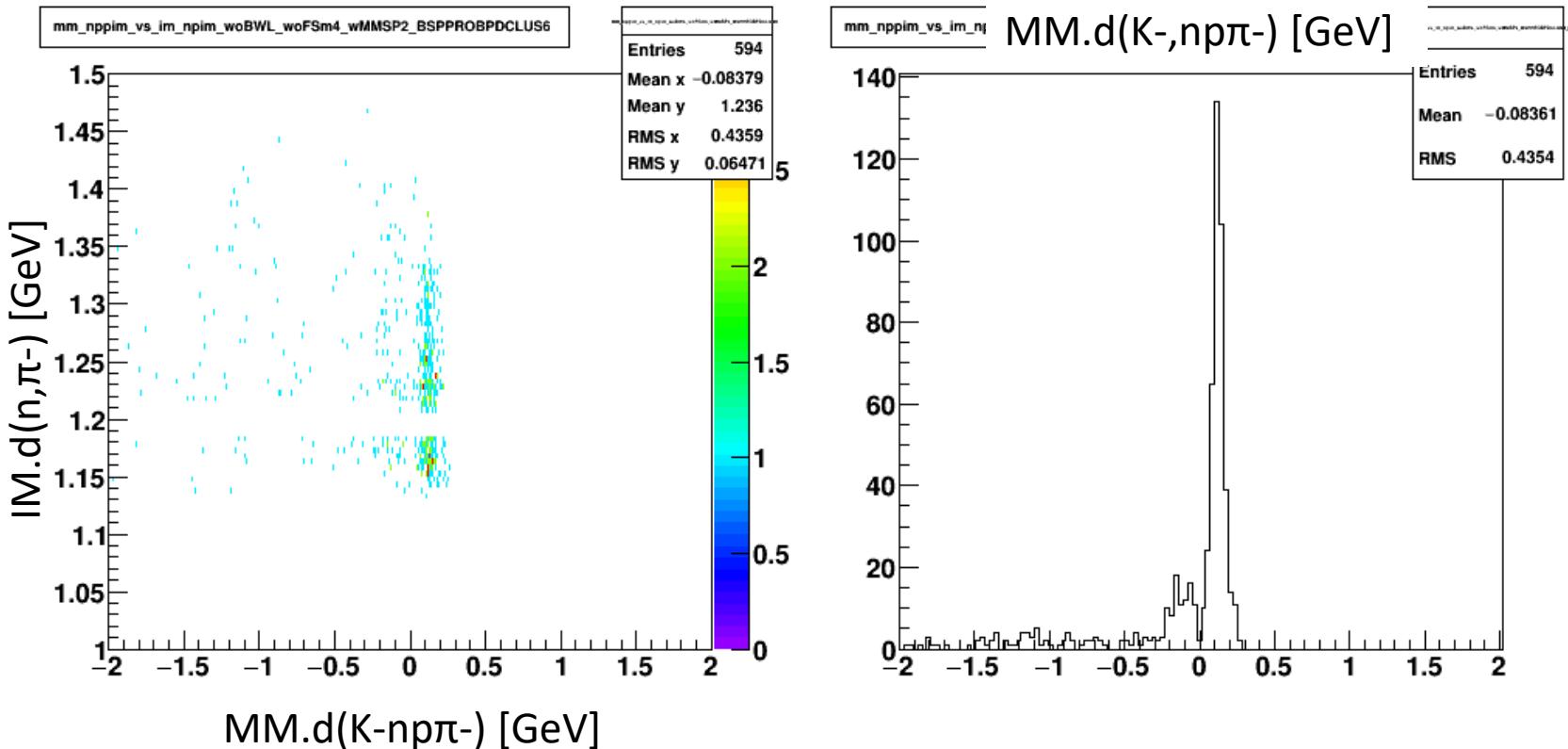


- $\Sigma^+$  from MM.  $d(K_-, np\pi^-)$  is selected
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K_-, np\pi^-)$ vs IM. $(n, \pi^-)$

Data

p, n is analyzed as  $\Sigma^+\pi^-$  mode

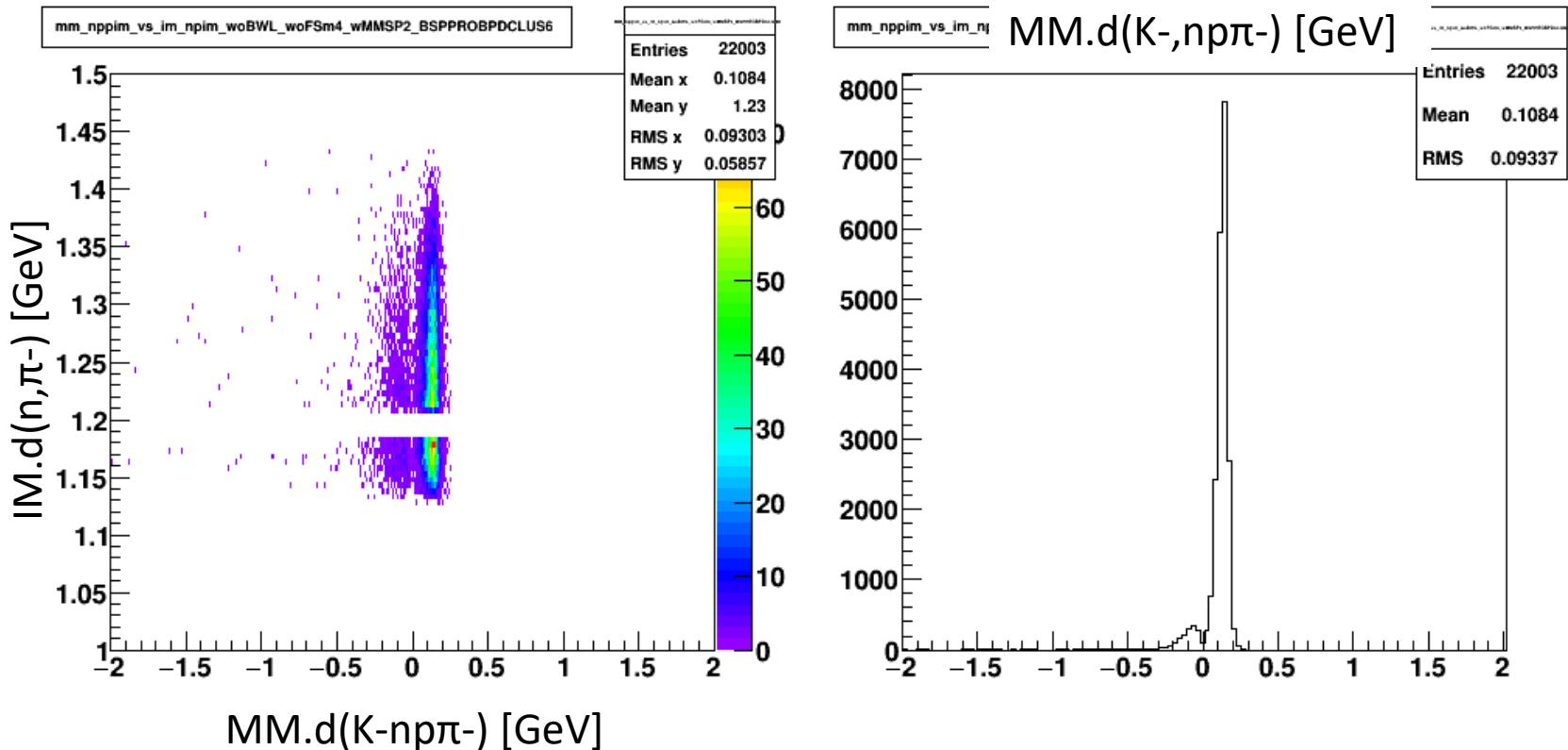


- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is selected
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM.d( $K_-, n\pi^-$ ) vs IM.( $n, \pi^-$ )

**SIM**

K-d  $\rightarrow n \Sigma^+ \pi^- ; \Sigma^+ \pi^-$  mass shape use analysis result  
p, n is analyzed as  $\Sigma^+ \pi^-$  mode

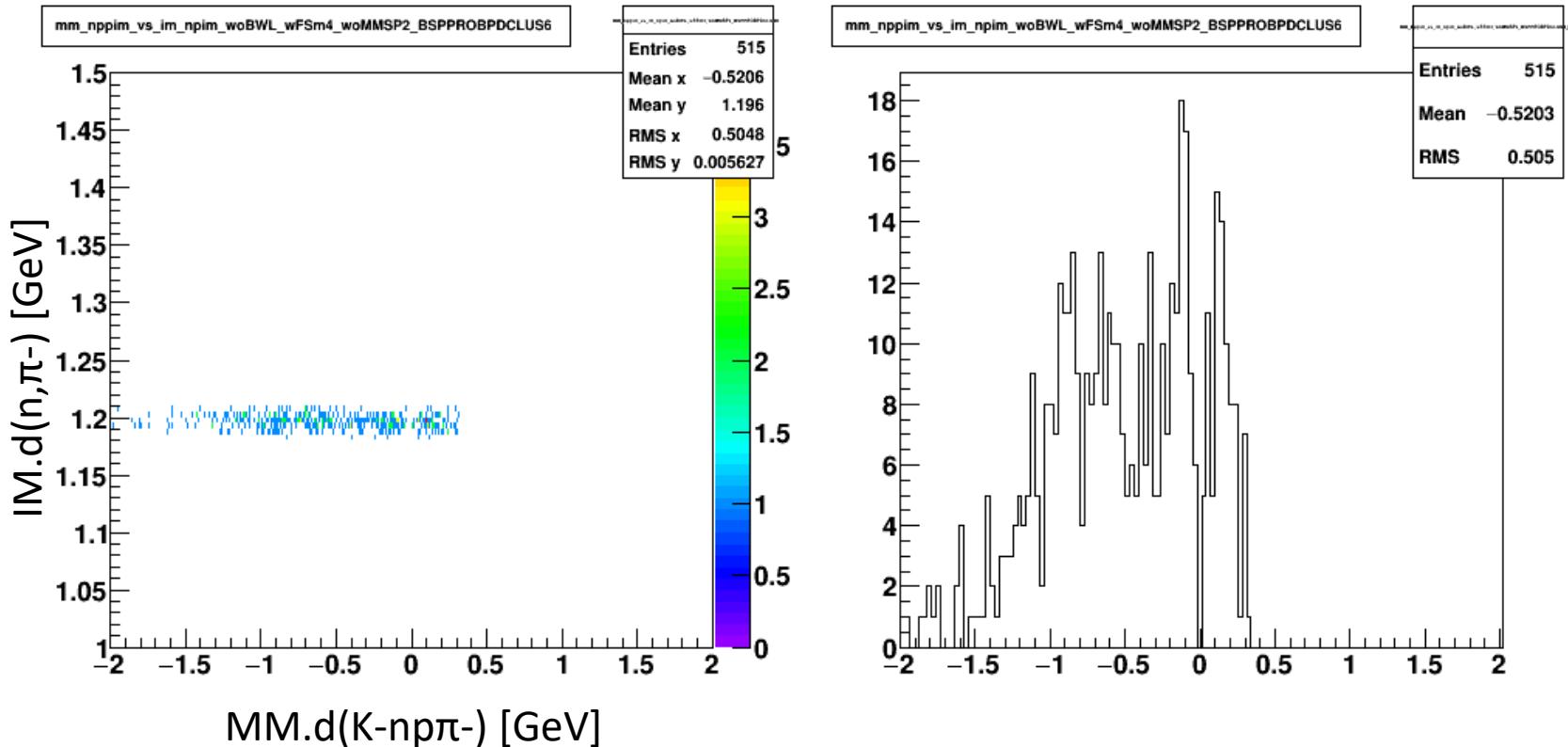


- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is selected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$ vs IM. $(n, \pi^-)$

Data

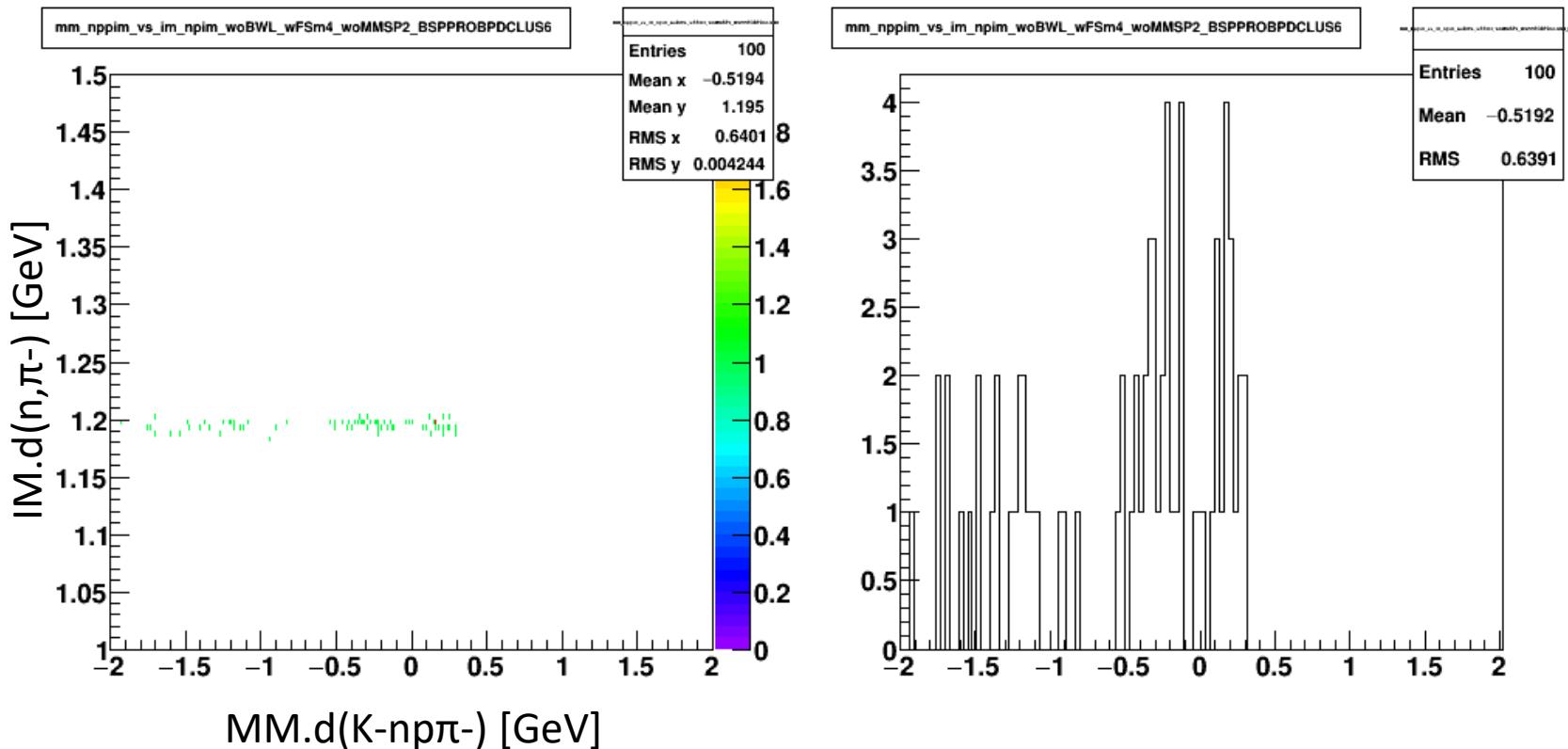
p, n is analyzed as  $\Sigma^+\pi^-$  mode



- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is selected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$ vs IM. $(n, \pi^-)$

**SIM**

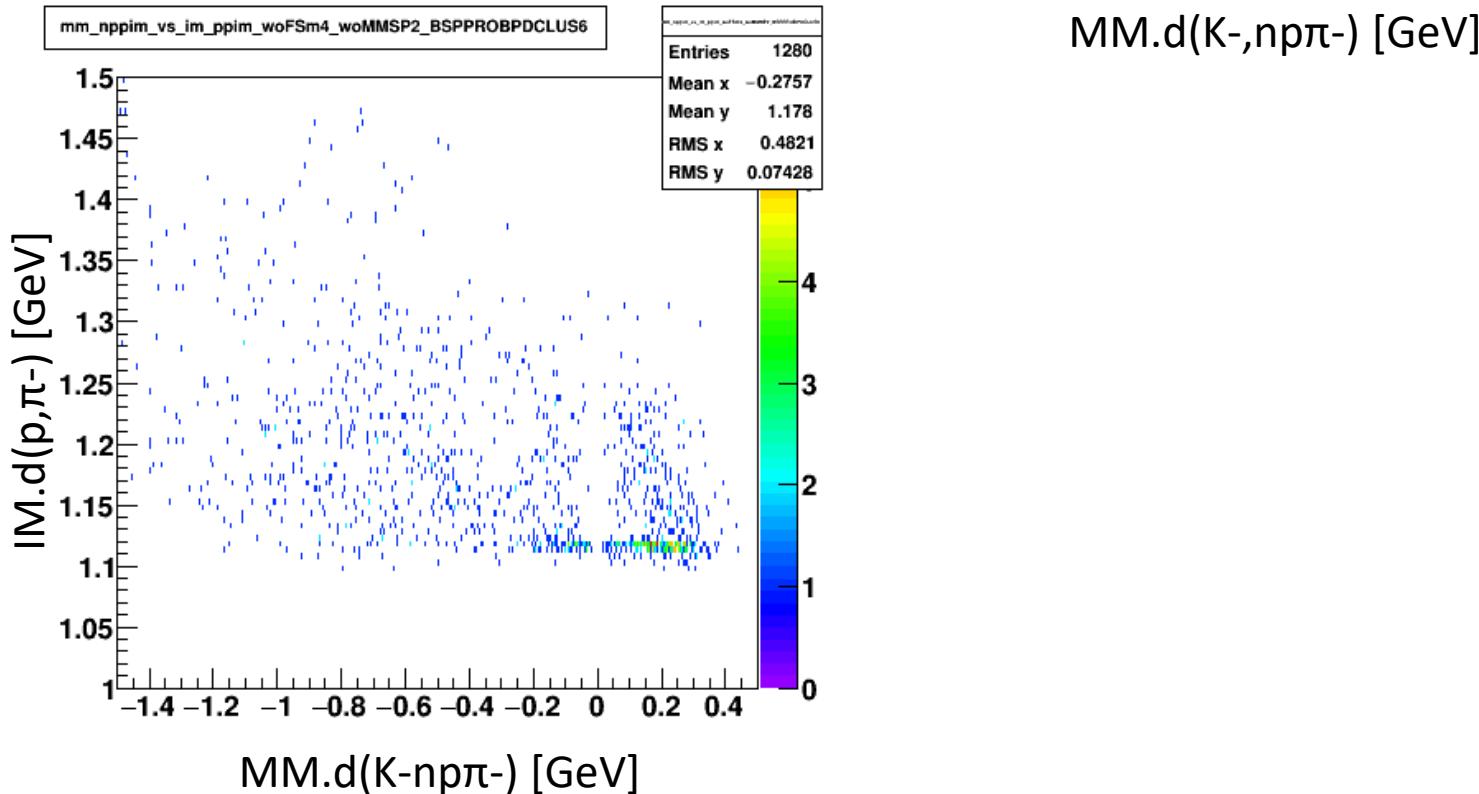


- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is selected
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$ vs IM. $(p, \pi^-)$

Data

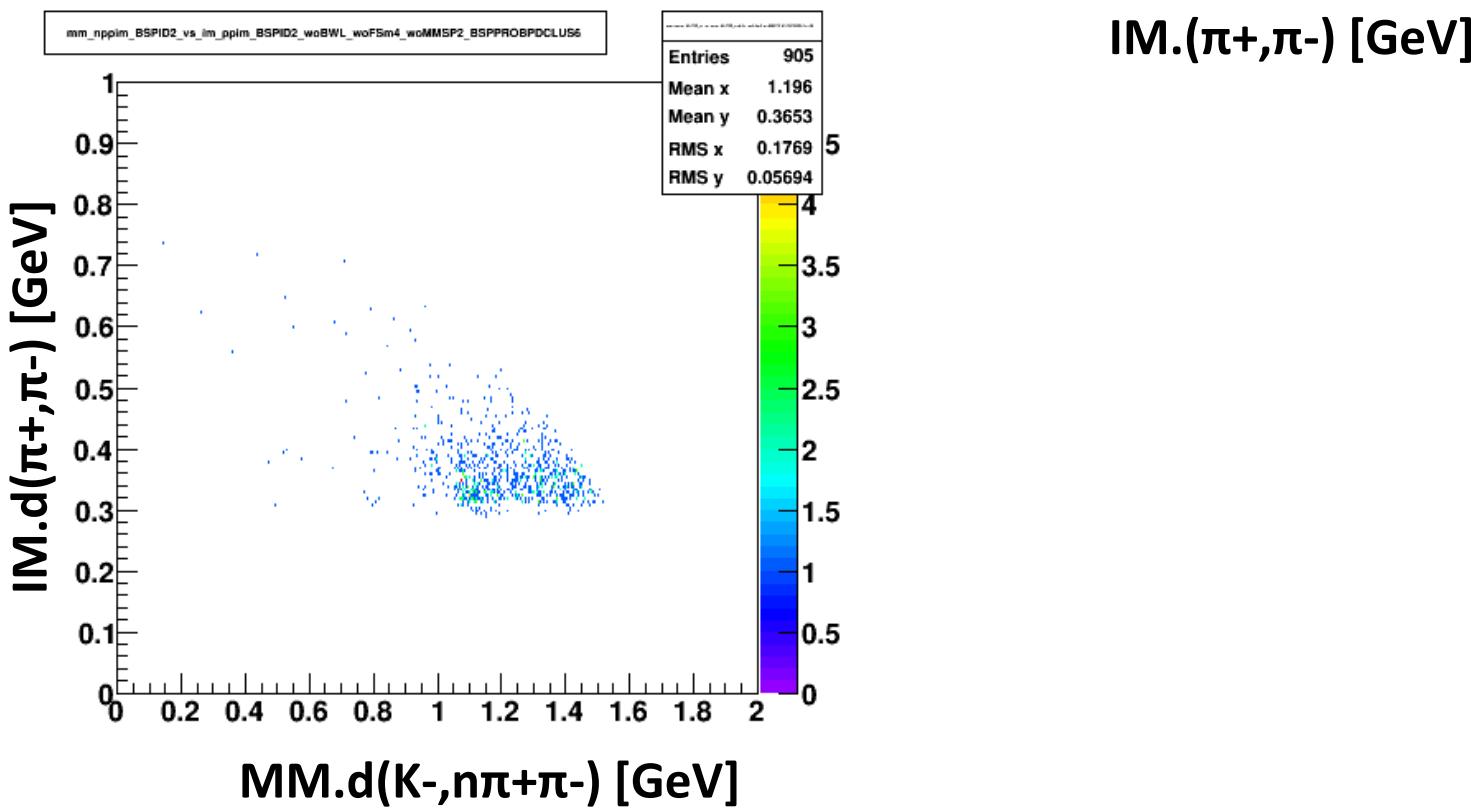
p, n is analyzed as  $\Sigma^+\pi^-$  mode



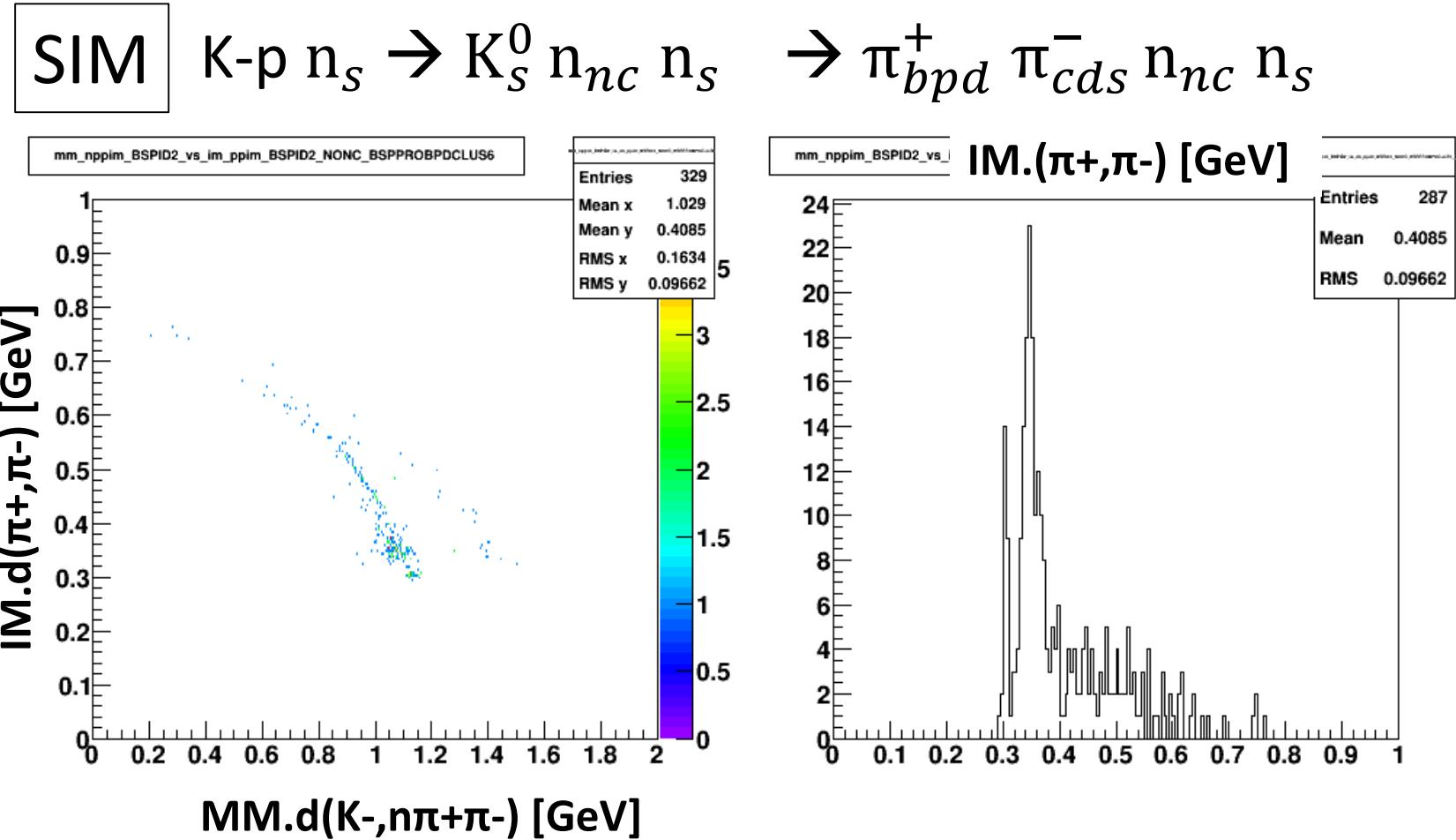
- $\Sigma^+$  from MM.  $d(K^-, n\pi^+ + \pi^-)$  is rejected
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is selected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^+ + \pi^-)$ vs IM. $(\pi^+, \pi^-)$

## Data



# $MM.d(K^-, n\pi^+ + \pi^-)$ vs $|M.(\pi^+, \pi^-)|$

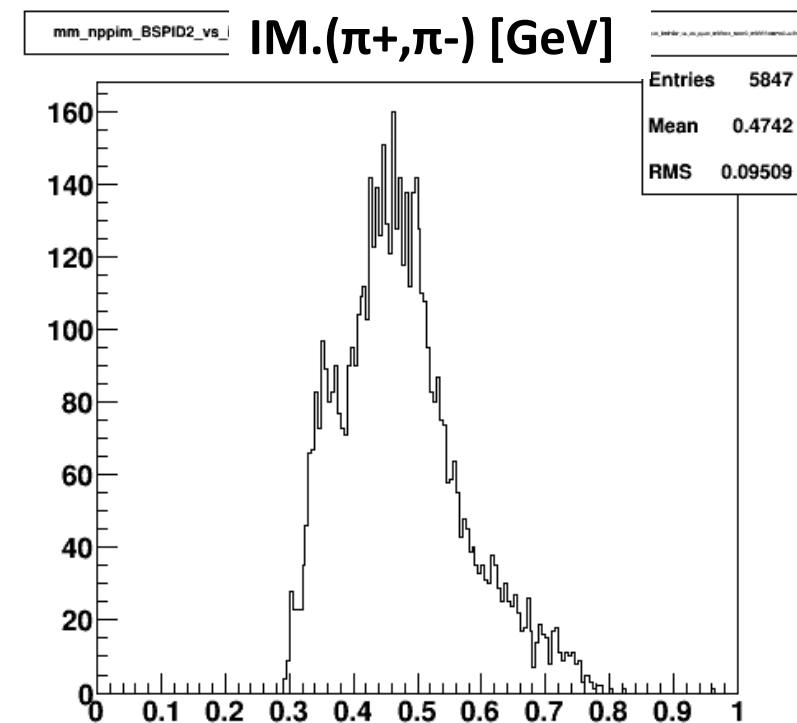
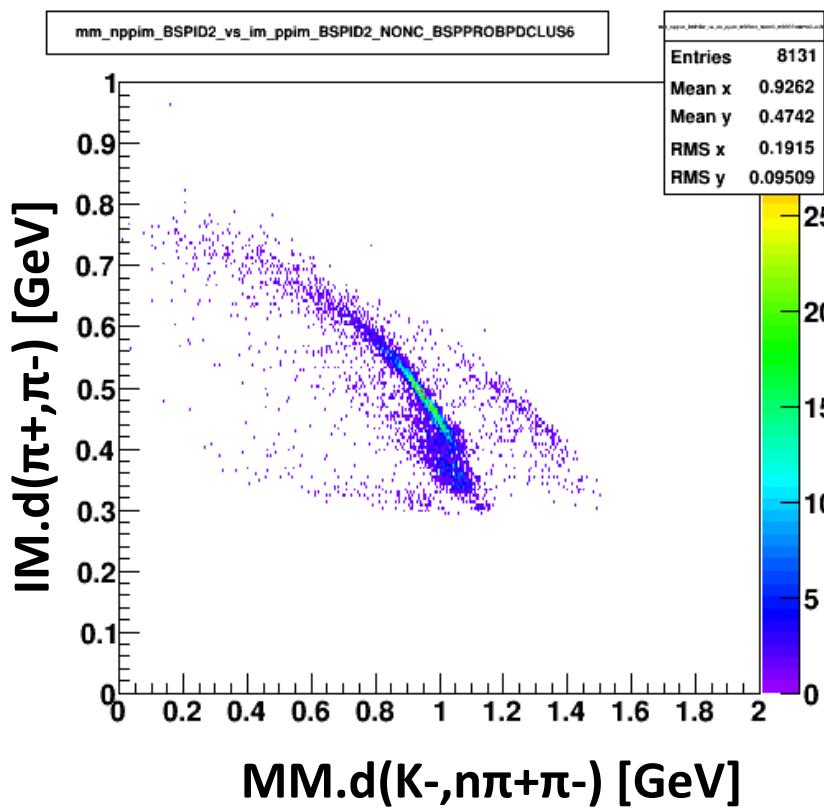


**BPDc dE > 0 MeV**

MM.d( $K^-, n\pi^+ + \pi^-$ ) vs IM.( $\pi^+, \pi^-$ )

SIM

$K-p \ n_s \rightarrow K_s^0 \ n_{nc} \ n_s \rightarrow \pi_{bpd}^+ \ \pi_{cds}^- \ n_{nc} \ n_s$



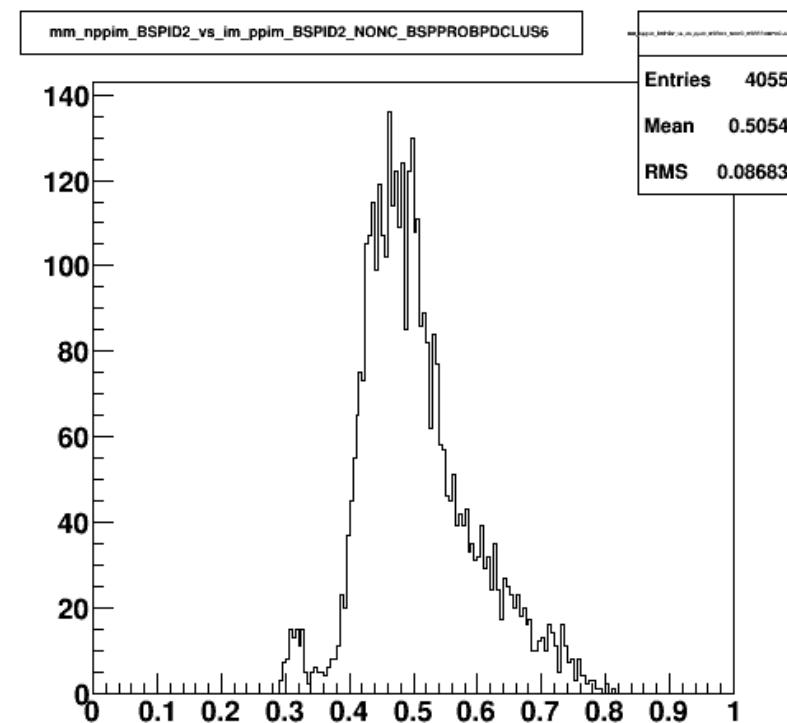
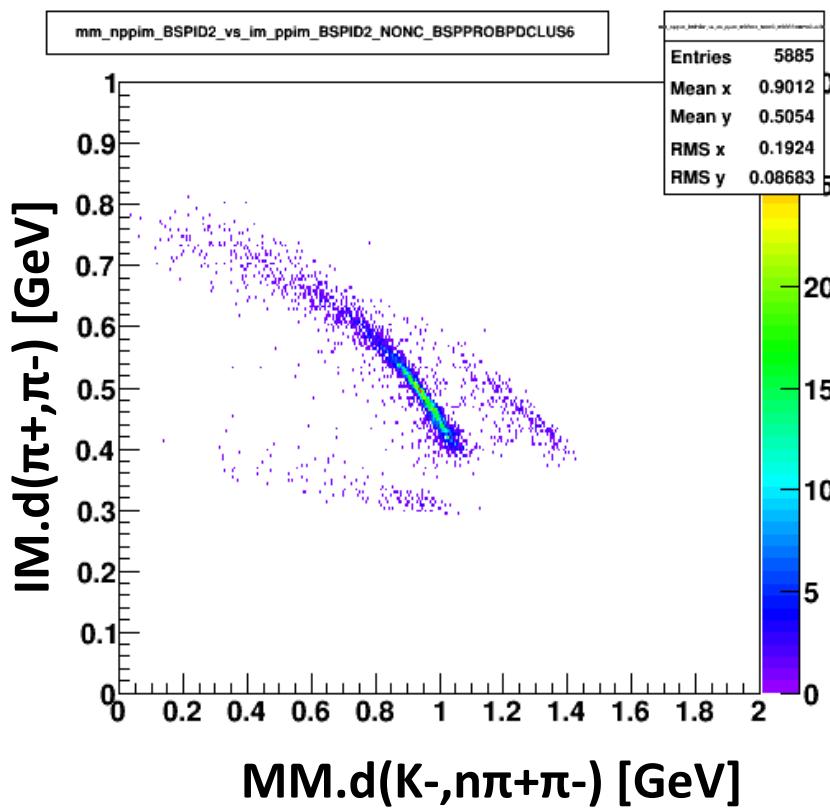
Beta

**BPDc dE > 0 MeV, BPD hit particle ( $\pi^+$ ) Identified by SIM**

MM.d( $K^-$ , $n\pi^+\pi^-$ ) vs IM.( $\pi^+,\pi^-$ )

SIM

$K-p \ n_s \rightarrow K_s^0 \ n_{nc} \ n_s \rightarrow \pi_{bpd}^+ \ \pi_{cds}^- \ n_{nc} \ n_s$

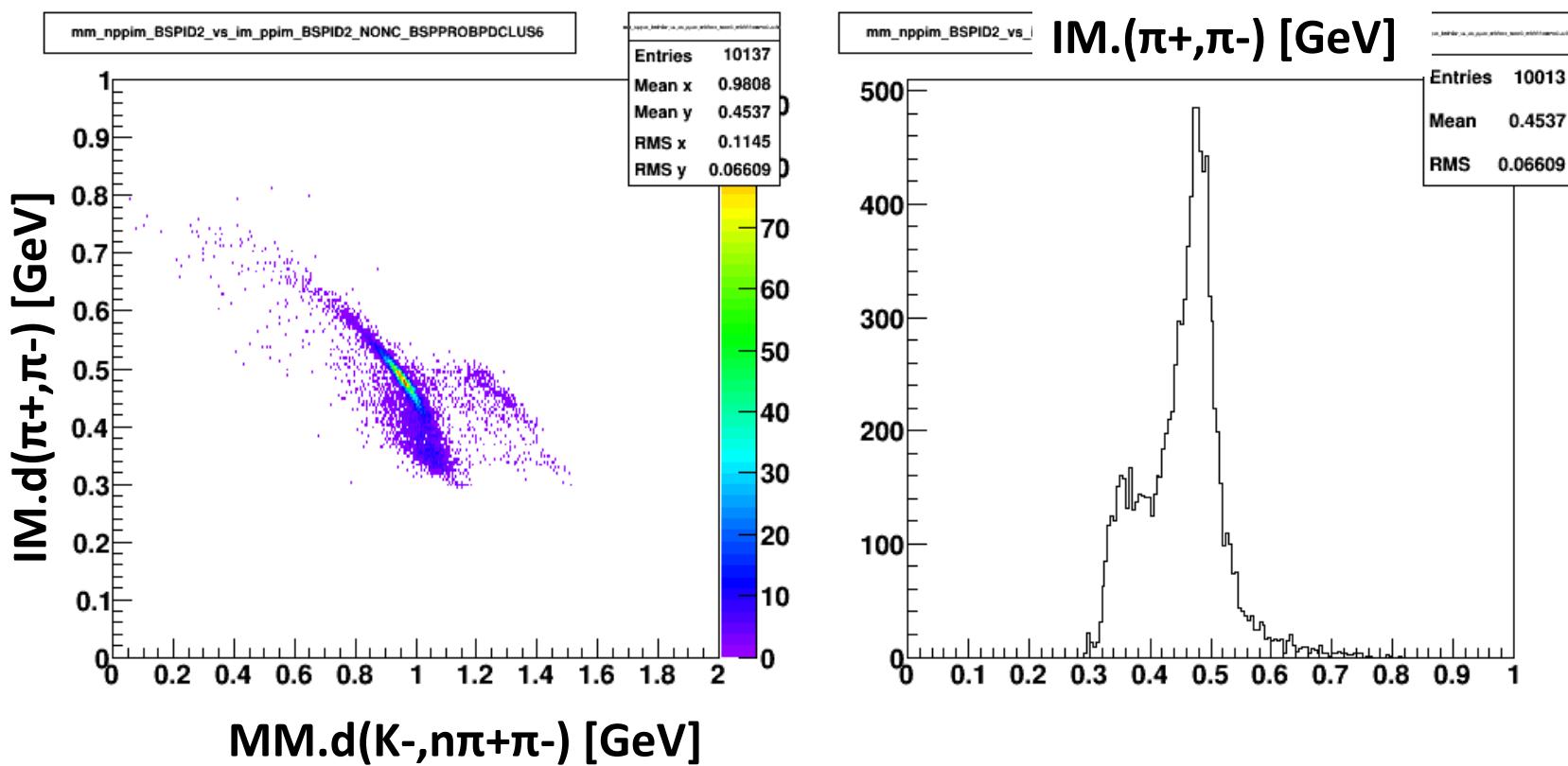


**BPDc dE > 0 MeV, w/o BPD Reso, w/o  $\pi^+$  Eloss Corr.**

MM.d( $K^-$ , $n\pi^+\pi^-$ ) vs IM.( $\pi^+,\pi^-$ )

SIM

$K-p \ n_s \rightarrow K_s^0 \ n_{nc} \ n_s \rightarrow \pi_{bpd}^+ \ \pi_{cds}^- \ n_{nc} \ n_s$



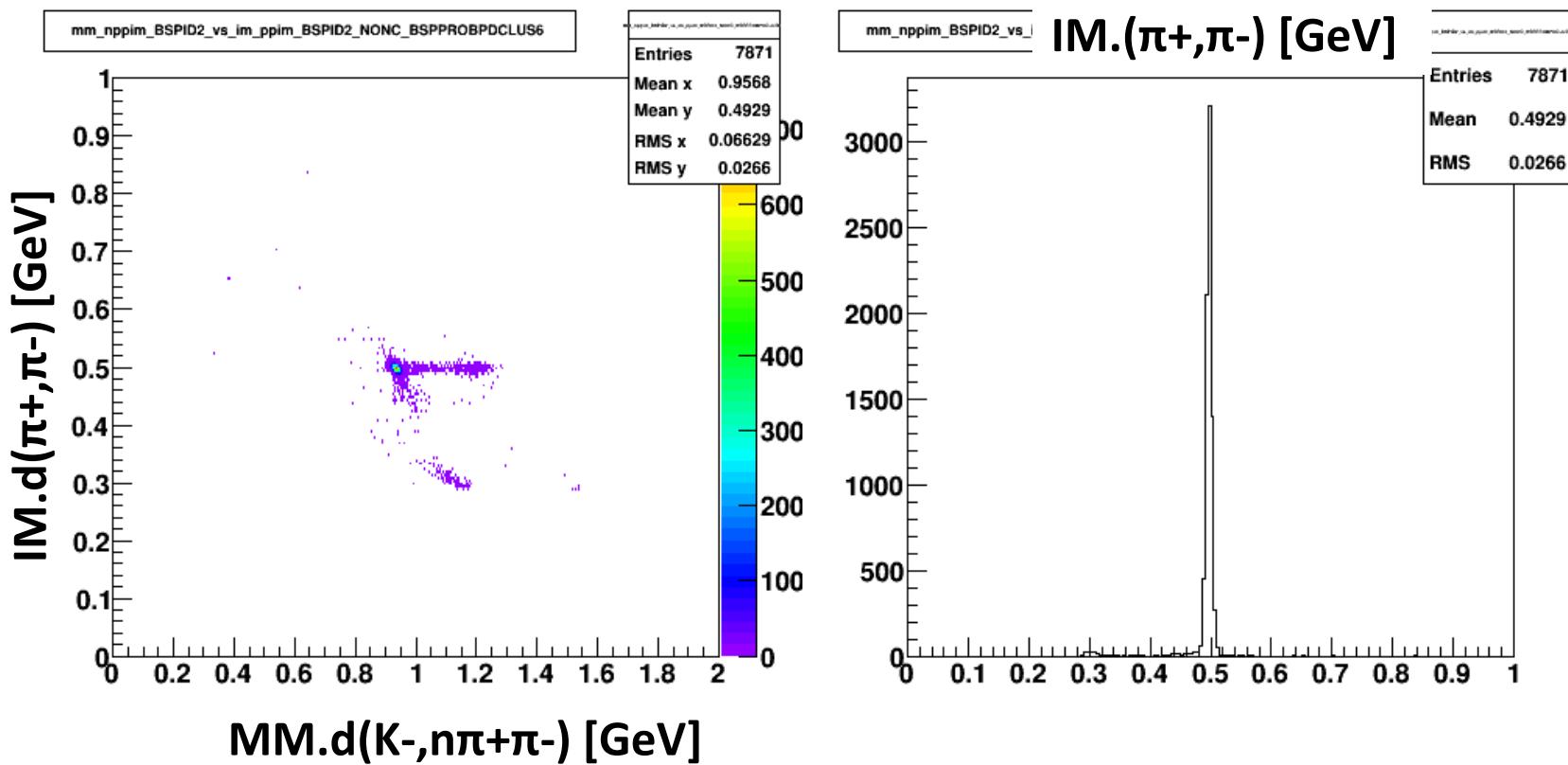
Beta

BPDc dE > 0 MeV,  $\pi^+$  momentum is true value

MM.d( $K^-$ , $n\pi^+\pi^-$ ) vs IM.( $\pi^+,\pi^-$ )

SIM

$K-p \ n_s \rightarrow K_s^0 \ n_{nc} \ n_s \rightarrow \pi_{bpd}^+ \ \pi_{cds}^- \ n_{nc} \ n_s$



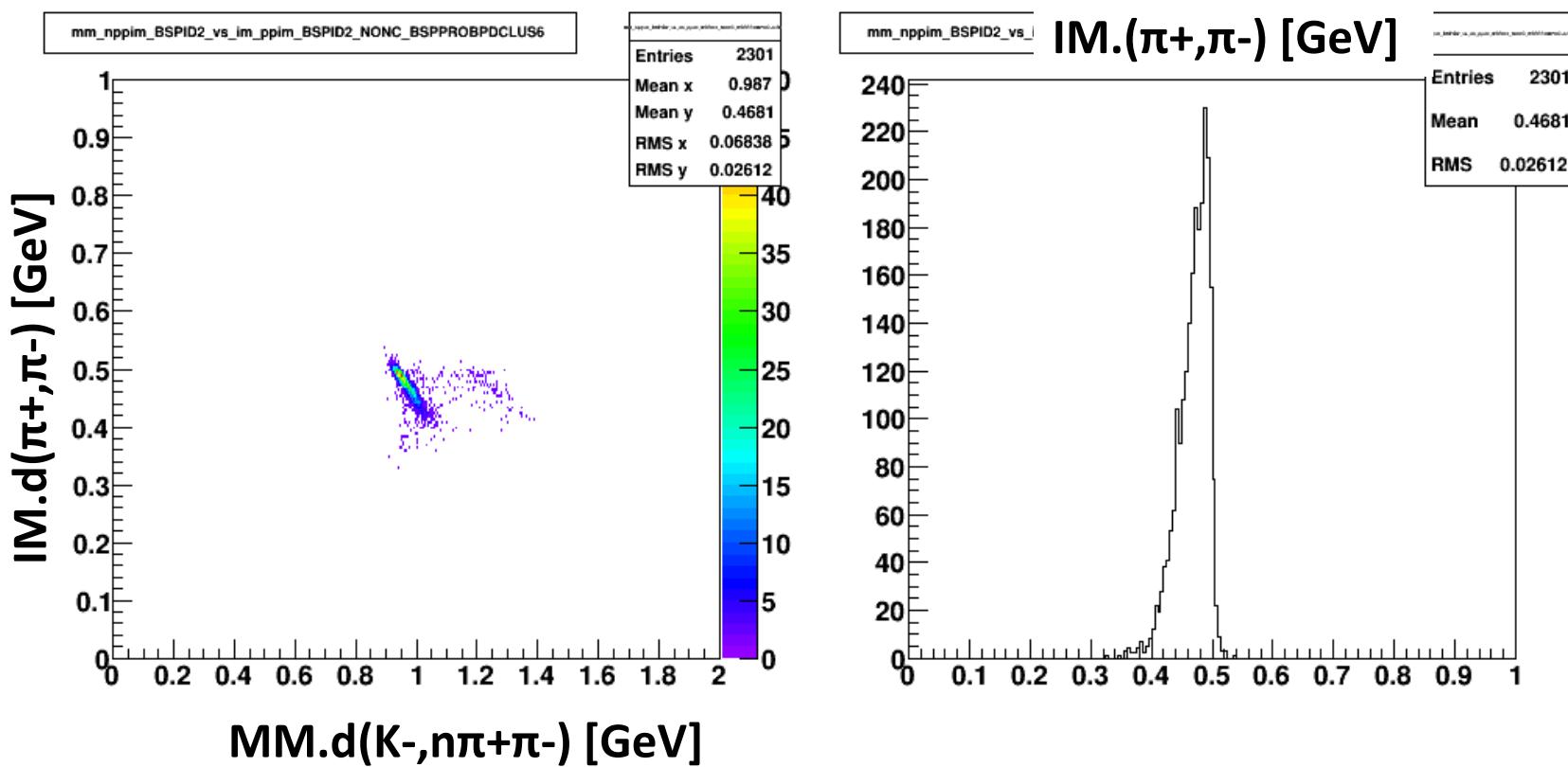
Beta

**BPDc dE > 0 MeV、 w/o BPD Reso、 Vertex = is true value**

MM.d( $K^-, n\pi^+ + \pi^-$ ) vs IM.( $\pi^+, \pi^-$ )

SIM

$K-p \ n_s \rightarrow K_s^0 \ n_{nc} \ n_s \rightarrow \pi_{bpd}^+ \ \pi_{cds}^- \ n_{nc} \ n_s$



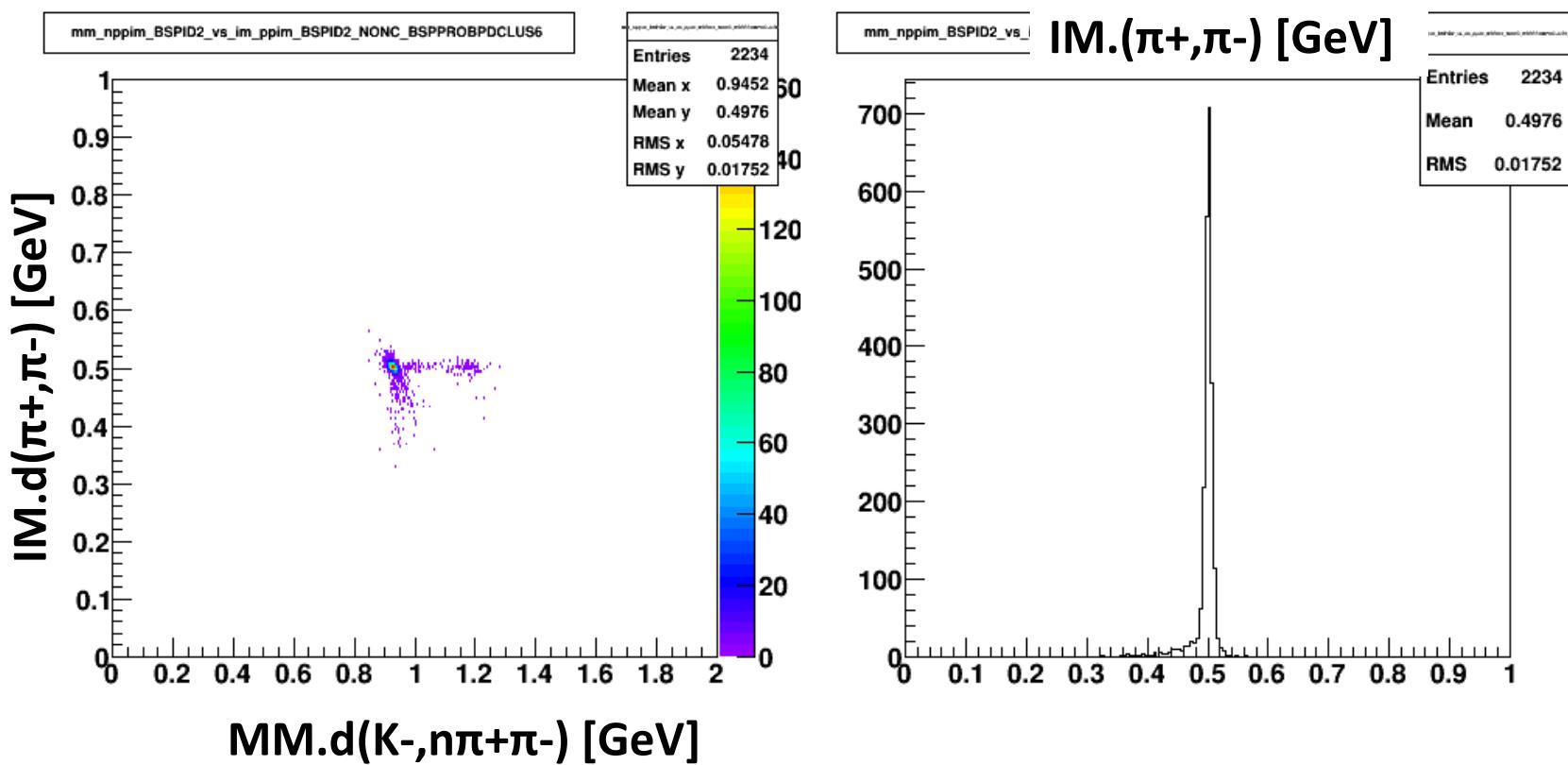
Beta

**BPDc dE > 0 MeV、 w/o BPD Reso、 subtract by K0 SIM TOF、**

MM.d( $K^-$ , $n\pi^+\pi^-$ ) vs IM.( $\pi^+,\pi^-$ )

SIM

$K-p \ n_s \rightarrow K_s^0 \ n_{nc} \ n_s \rightarrow \pi_{bpd}^+ \ \pi_{cds}^- \ n_{nc} \ n_s$



# Status (To do)

- Explanation of the tail component of  $d(K_-, n\pi^-)\pi^+$ 
  - $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma 0 \pi^-$ 
    - Estimation by SIM
    - Mass distribution of  $\Lambda \pi^-$ ,  $\Sigma 0 \pi^-$  by MM.  $d(K_-, p)\pi^-$  of the data
    - BG estimation by fitting of the data IM. ( $p, \pi^-$ ) & MM.  $d(K_-, n\pi^-)$  w/ SIM of  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma 0 \pi^-$
- Explanation of  $d(K_-, n\pi^-)$  negative event
  - $K-d \rightarrow p \Sigma^-$ 
    - for the explanation of  $\Sigma^-$  ID event from IM. ( $n, \pi^-$ )
  - miss ID of  $\pi^+ @BPD$ 
    - Indication of small acceptance ?
    - Reaction ID by  $\pi^+$  is difficult due to bad resolution
  - leak from the positive side by resolution
    - Difference between data and SIM, how about an effect on efficiency
    - Check the leak from the proton of all reaction by SIM

# $\pi^+ @ \text{BPD miss ID as proton}$

- |   | ID   |
|---|--|
| • $K-p n_s \rightarrow \Sigma^+ \pi_{cds}^- n_s \rightarrow n_{nc} \pi_{bpd}^+ \pi_{cds}^- n_s$ | $\Sigma^+$ from $\text{IM}(\pi_{bpd}^+ n_s)$                                     |
| • $K-p n_s \rightarrow \Sigma^- \pi_{bpd}^+ n_s \rightarrow n_{nc} \pi_{cds}^- \pi_{bpd}^+ n_s$ | $\Sigma^-$ from $\text{IM}(n_{nc} \pi_{cds}^-)$ <small>Already mentioned</small> |
| • $K-p n_s \rightarrow K_s^0 n_{nc} n_s \rightarrow \pi_{bpd}^+ \pi_{cds}^- n_{nc} n_s$         | $K_s^0$ from $\text{IM}(\pi_{bpd}^+ \pi_{cds}^-)$                                |
| • $K-d \rightarrow \Sigma^- \pi_{bpd}^+ n_{nc} \rightarrow n \pi_{cds}^- \pi_{bpd}^+ n_{nc}$    | $\Sigma^-$ from MM. $d(K-, n_{nc} \pi_{bpd}^+)$                                  |
| • $K-d \rightarrow \Sigma^+ \pi_{cds}^- n_{nc} \rightarrow n \pi_{bpd}^+ \pi_{cds}^- n_{nc}$    | $\Sigma^+$ from MM. $d(K-, n_{nc} \pi_{cds}^+)$                                  |

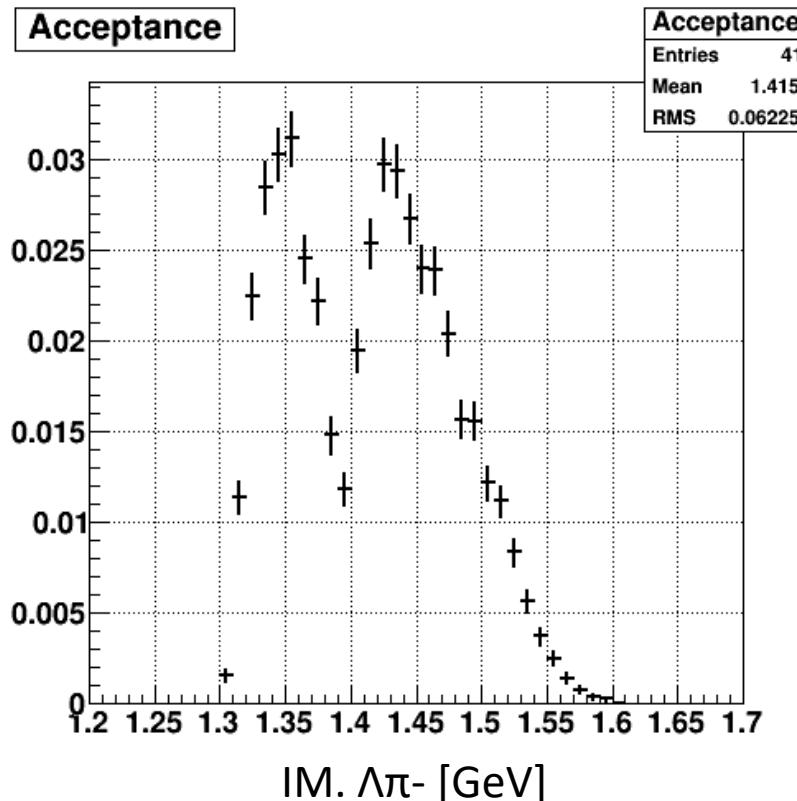
-> estimation by simulation  
to confirm to be negligible

# Acceptance

- MM.  $d(K^-, n\pi^-)$   $0 \sim 0.18$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

SIM

$K^- d \rightarrow p \Lambda \pi^-$



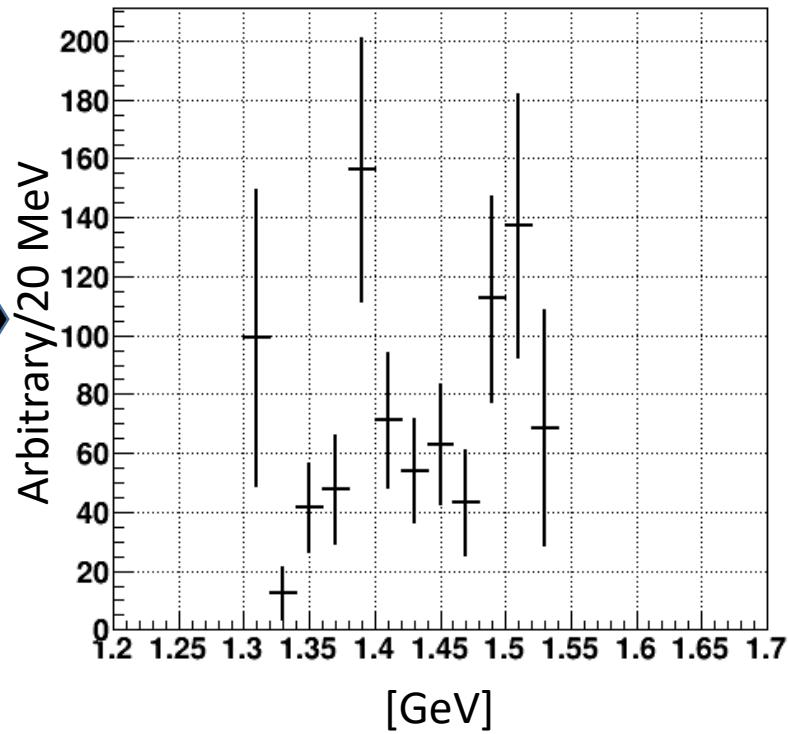
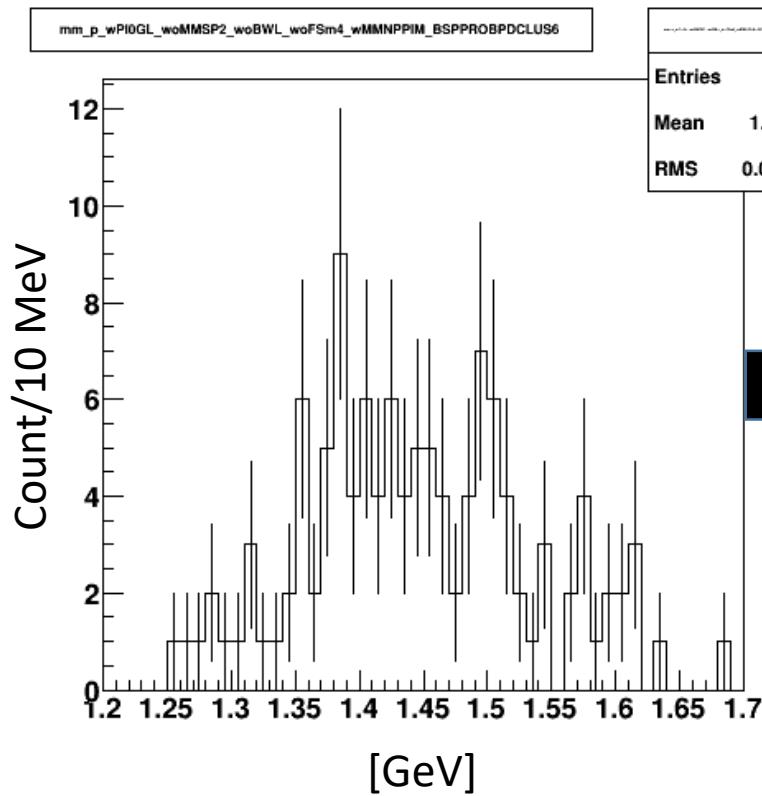
macro/Acceptance\_LPIMP.C  
vv8tempo44\_LPIMPplane\_v3

# Spectrum correction

- MM.  $d(K^-, p\pi^-)$   $0 \sim 0.18$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

Data

MM.  $d(K^-, p)\pi^- \Lambda$



macro/Hist\_TTree.C (1296)

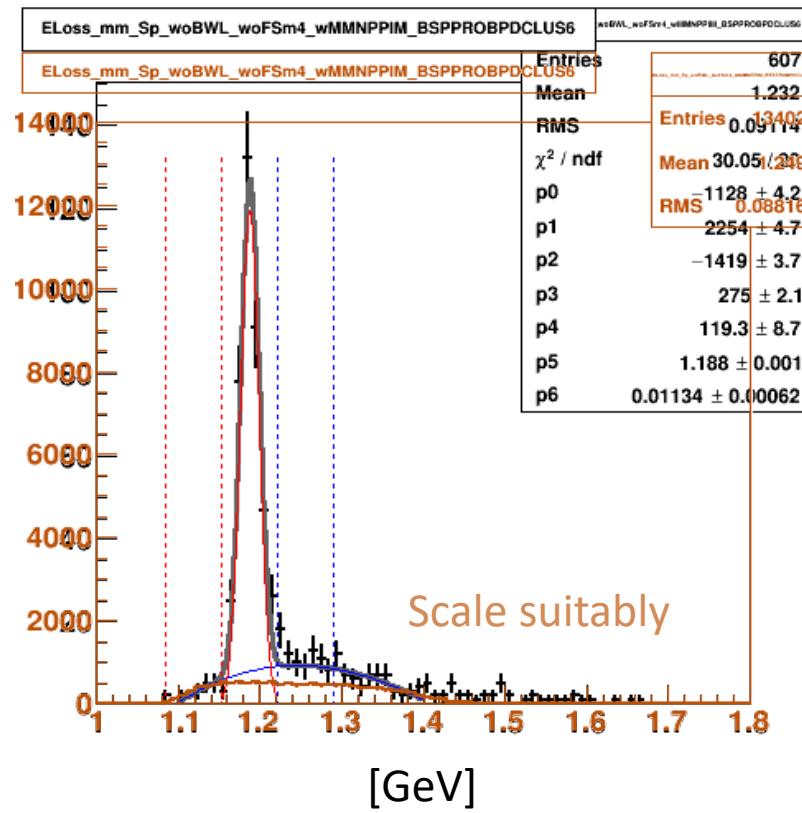
vv8tempo6\_Run78\_SPPIMwBPDTRIG\_v46SP

macro/CrossSection\_LPIMP\_rebin.C

- MM.  $d(K^-, n\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

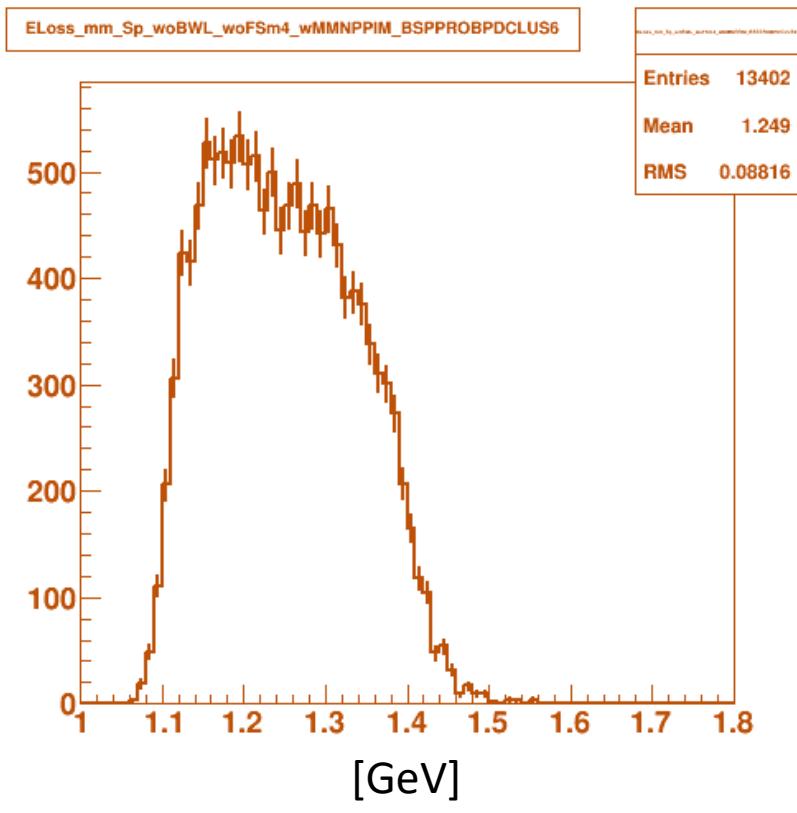
# MM. $d(K^-, n\pi^-)$

Data



macro/Fit\_MMSP\_v2.C (598)  
vv8tempo1\_Run78\_SPPIMwBPDTTRIG\_v46SP

SIM  $K^- d \rightarrow p \Lambda \pi^-$

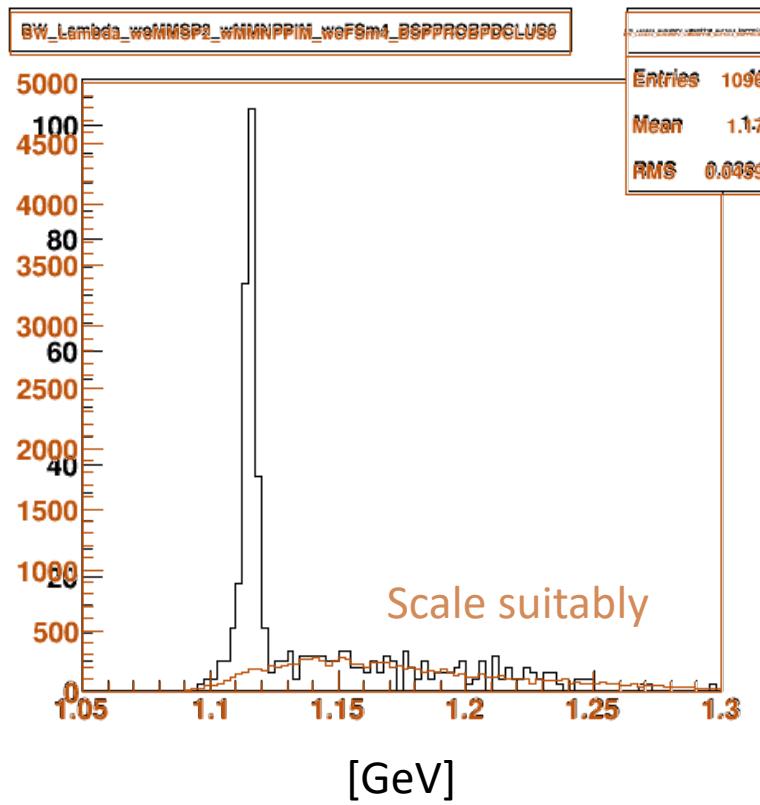


macro/Hist\_TTree.C (598)  
vv8tempo44\_LPIMPcs\_v1

# IM. ( $p, \pi^-$ )

- MM.  $d(K^-, n\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

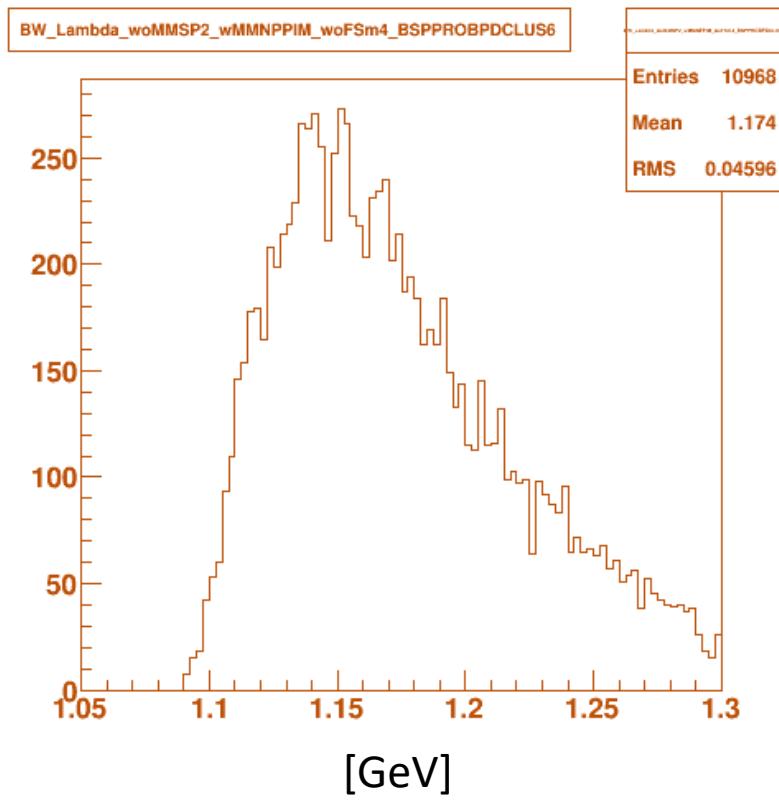
**Data**



macro/Hist\_TTree.C (1371)  
vv8tempo1\_Run78\_SPPIMwBPDTIG\_v46SP

**SIM**

$K^- d \rightarrow p \Lambda \pi^-$



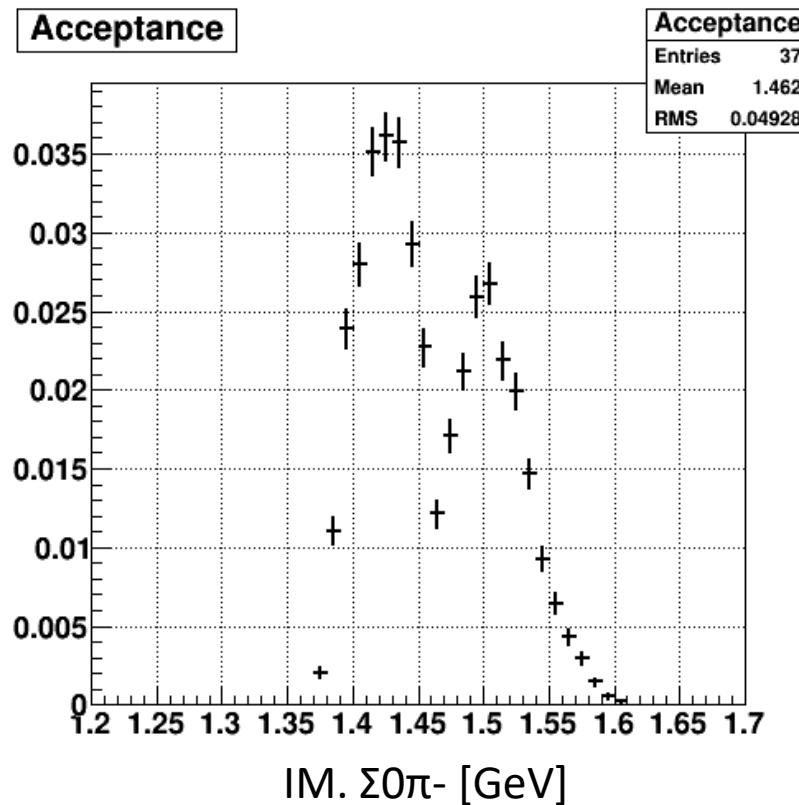
macro/Hist\_TTree.C (1371)  
vv8tempo44\_LPIMPcs\_v1

- MM.  $d(K^-, n\pi^-)$   $0.18 \sim 0.30$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

# Acceptance

**SIM**

$K^- d \rightarrow p \Sigma^0 \pi^-$



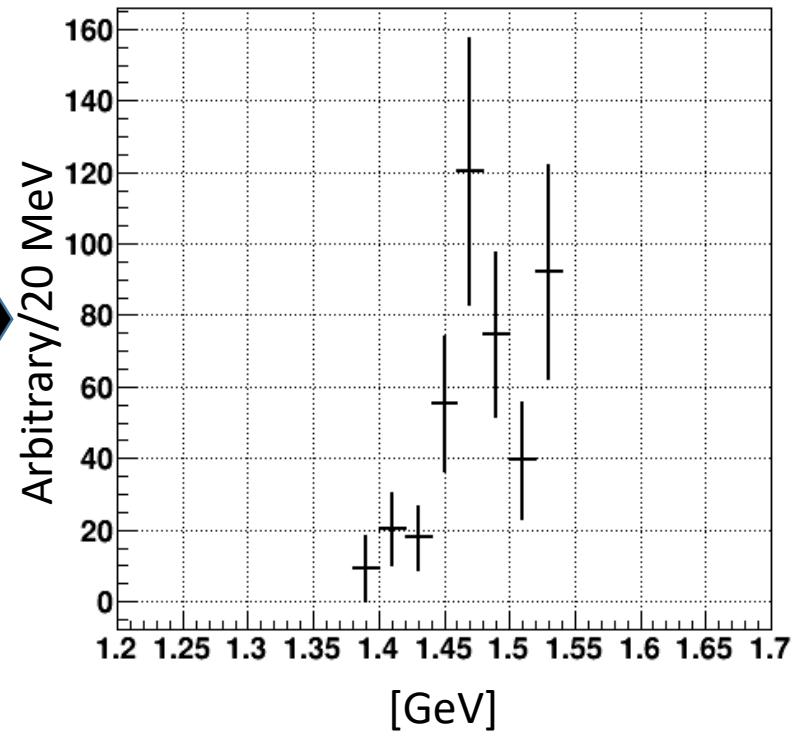
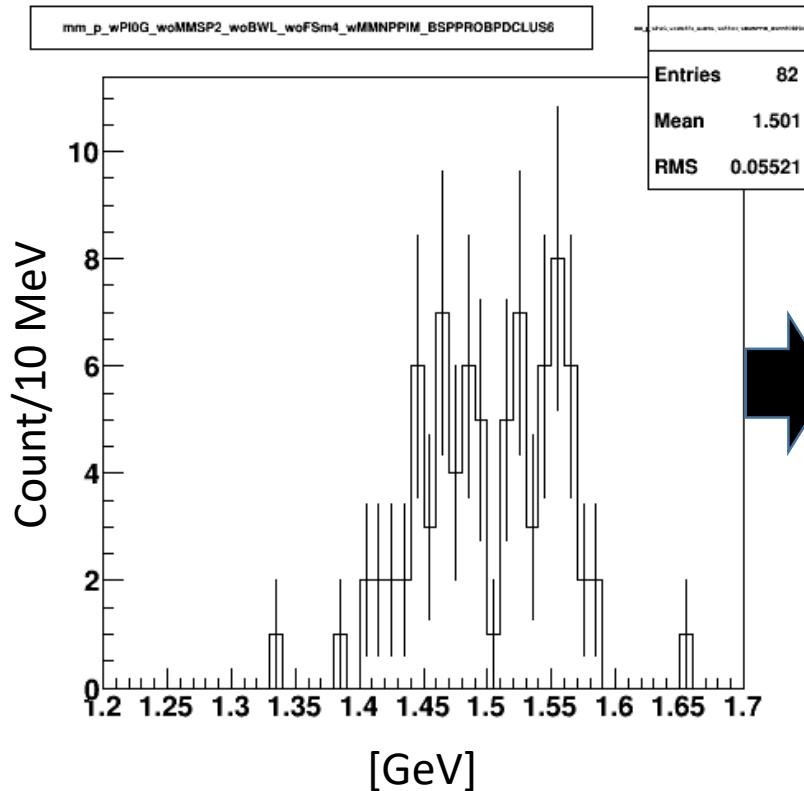
macro/Acceptance\_S0PIMP.C  
vv8tempo44\_LPIMPplane\_v1

# Spectrum correction

- MM.  $d(K^-, p\pi^-)$   $0.18 \sim 0.30$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^+)$  is rejected

Data

MM.  $d(K^-, p)\Sigma^0\pi^-$



macro/Hist\_TTree.C (1297)

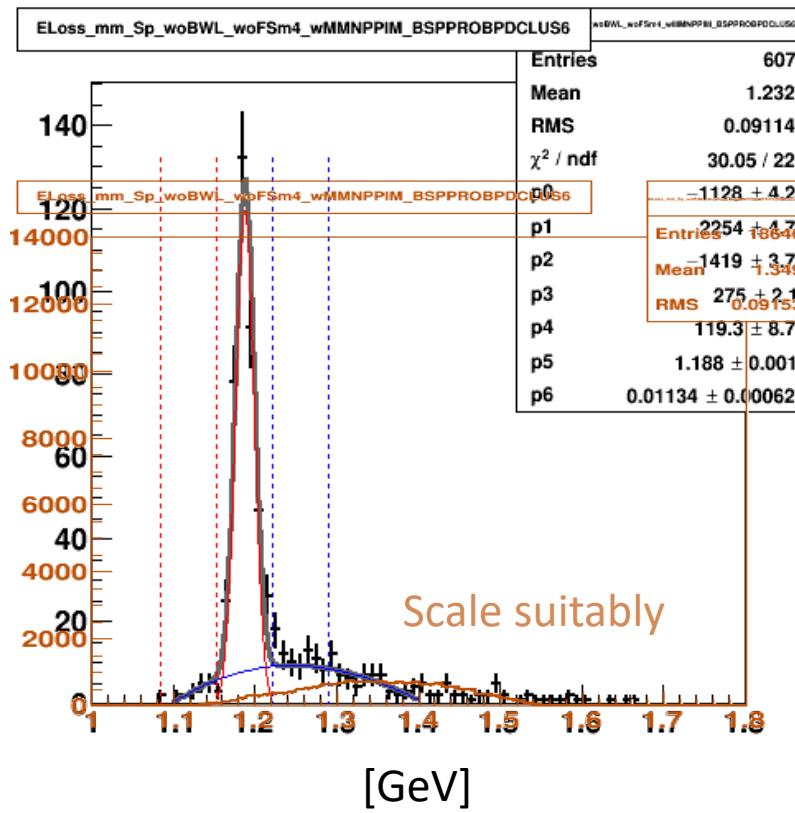
vv8tempo6\_Run78\_SPPIMwBPDTRIG\_v46SP

macro/CrossSection\_S0PIMP\_rebin.C

- MM.  $d(K^-, n\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

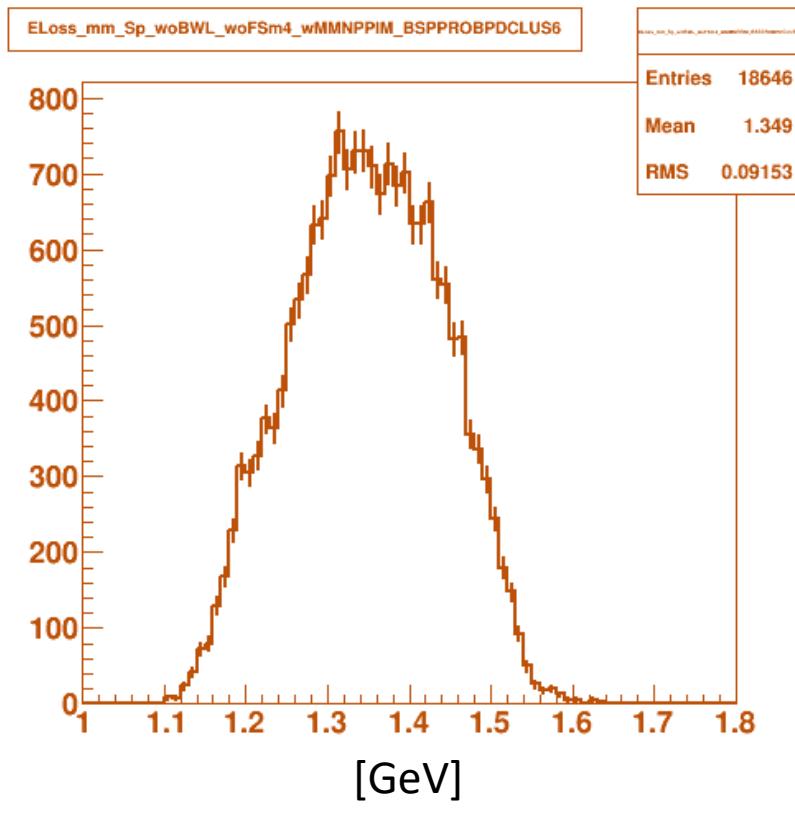
# MM. $d(K^-, n\pi^-)$

Data



macro/Fit\_MMSP\_v2.C (598)  
vv8tempo1\_Run78\_SPPIMwBPDTTRIG\_v46SP

SIM  $K^- d \rightarrow p \Sigma^- \pi^-$

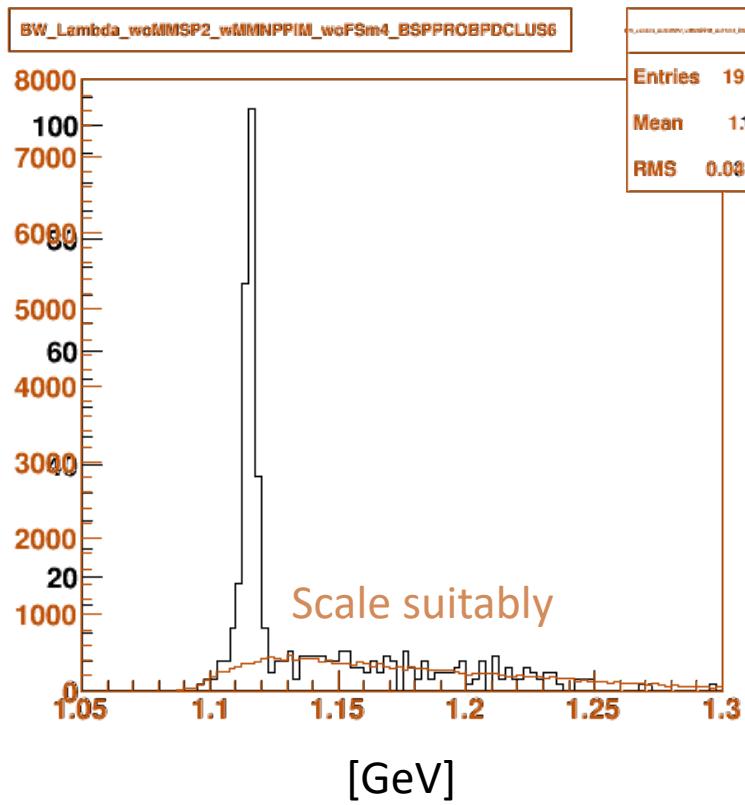


macro/Hist\_TTree.C (598)  
vv8tempo44\_SOPIMPcs\_v1

- MM.  $d(K^-, \eta\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

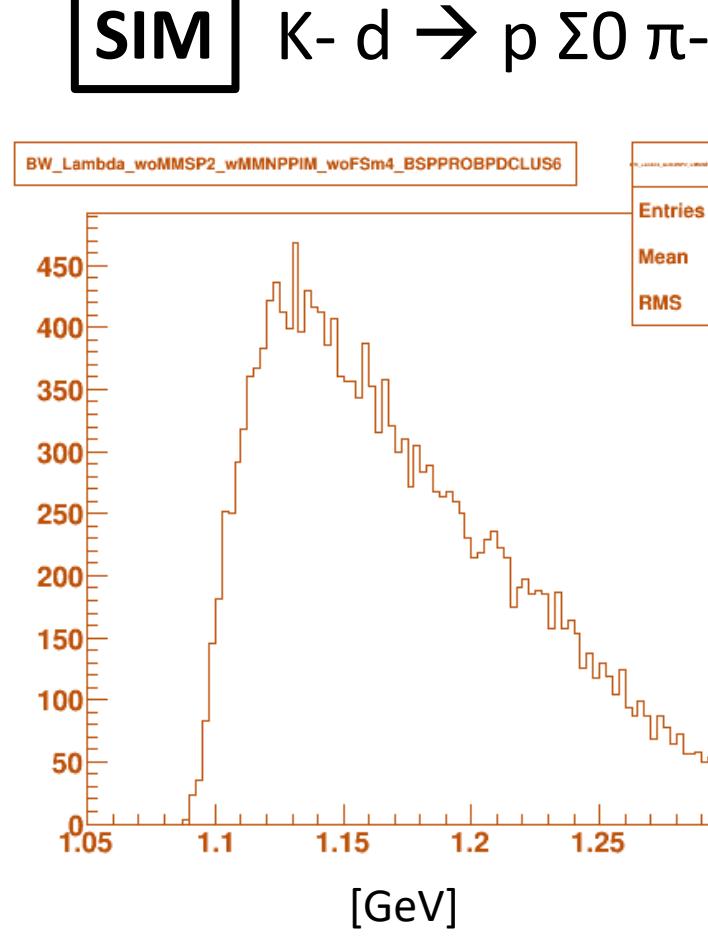
# IM. ( $p, \pi^-$ )

**Data**



macro/Hist\_TTree.C (1371)  
vv8tempo1\_Run78\_SPPIMwBPDTIG\_v46SP

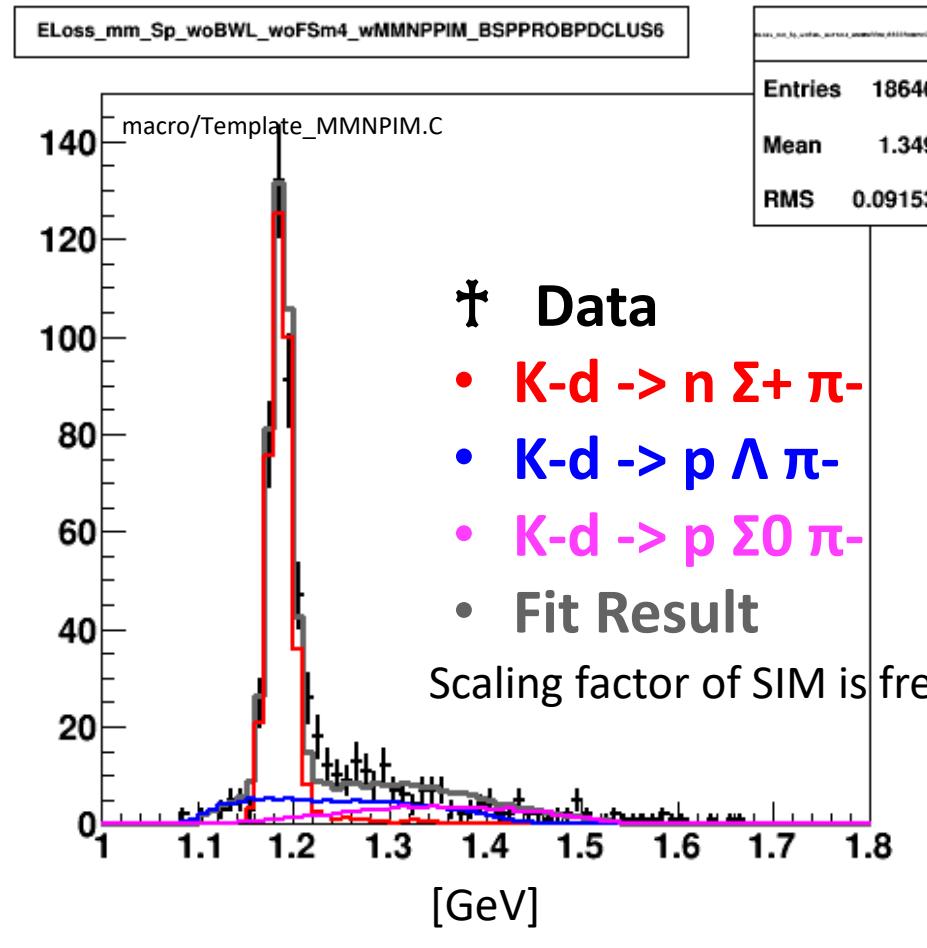
**SIM**



macro/Hist\_TTree.C (1371)  
vv8tempo44\_SOPIMPcs\_v1

- MM.  $d(K_-, n\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# Fitting of MM. $d(K_-, n\pi^-)$

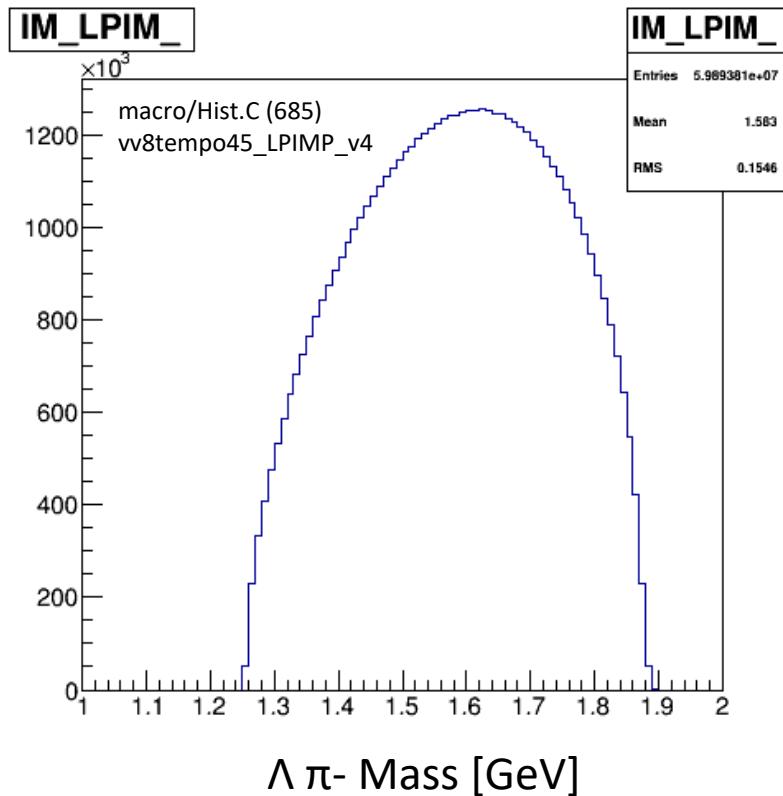


SIM2 ; $K^- d \rightarrow p Y \pi^-$

- Generate in phase space

# Generate

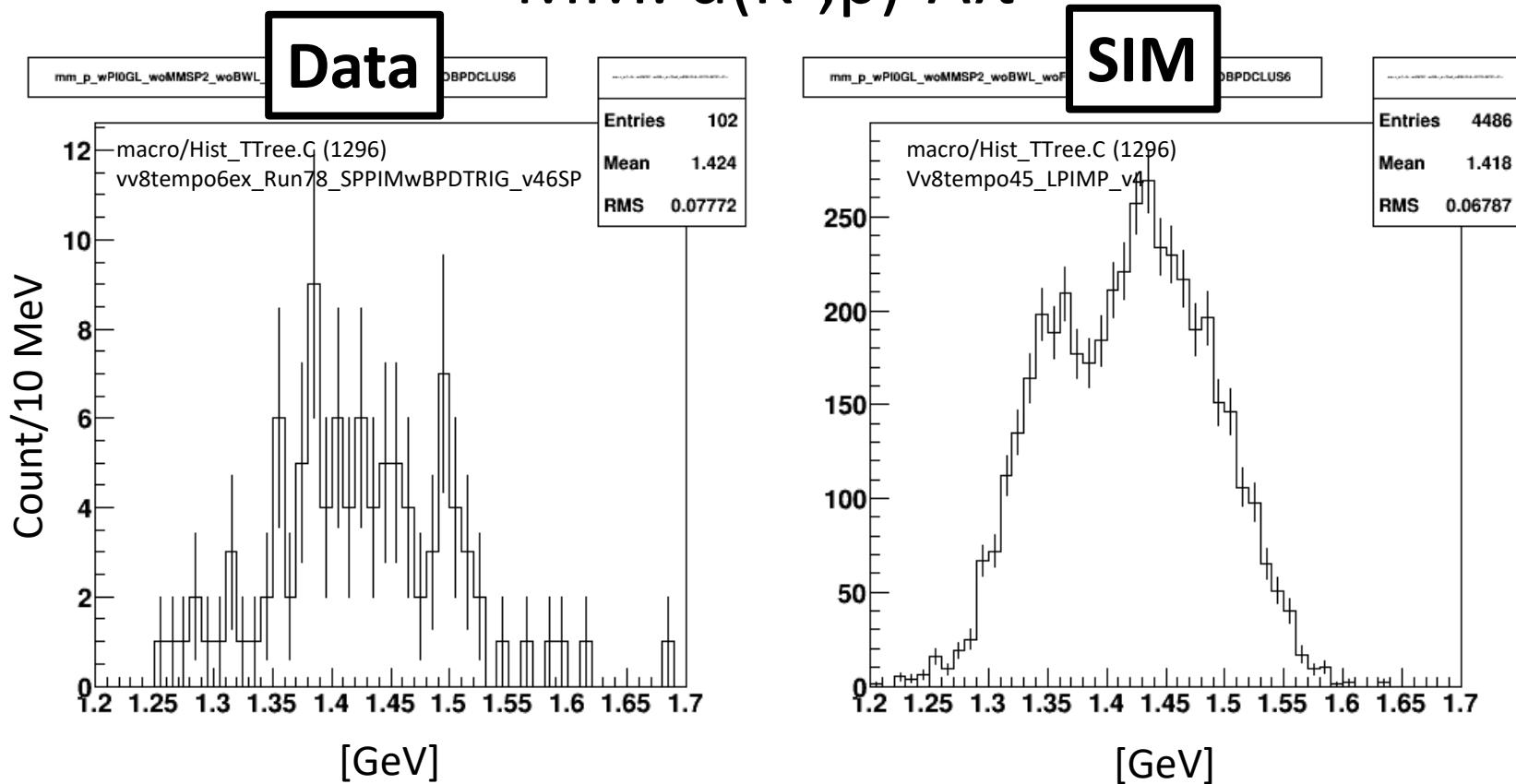
**SIM**  $K^- d \rightarrow p \Lambda \pi^-$



# Spectrum of $\Lambda\pi^-$

- MM.  $d(K^-, p\pi^-)$   $0 \sim 0.18$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

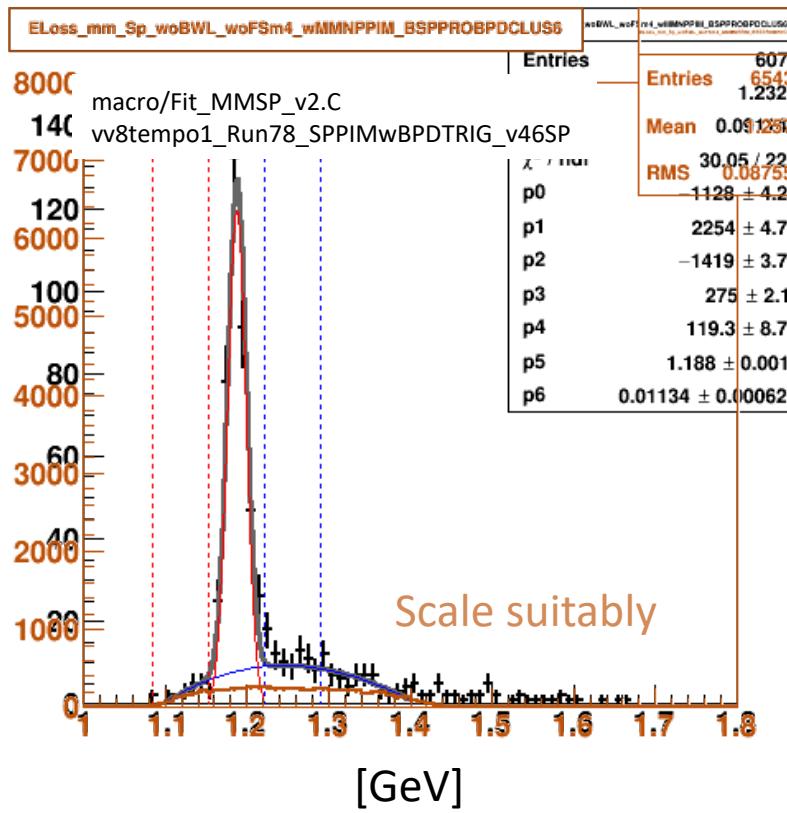
MM.  $d(K^-, p)\pi^-$ " $\Lambda\pi^-$ "



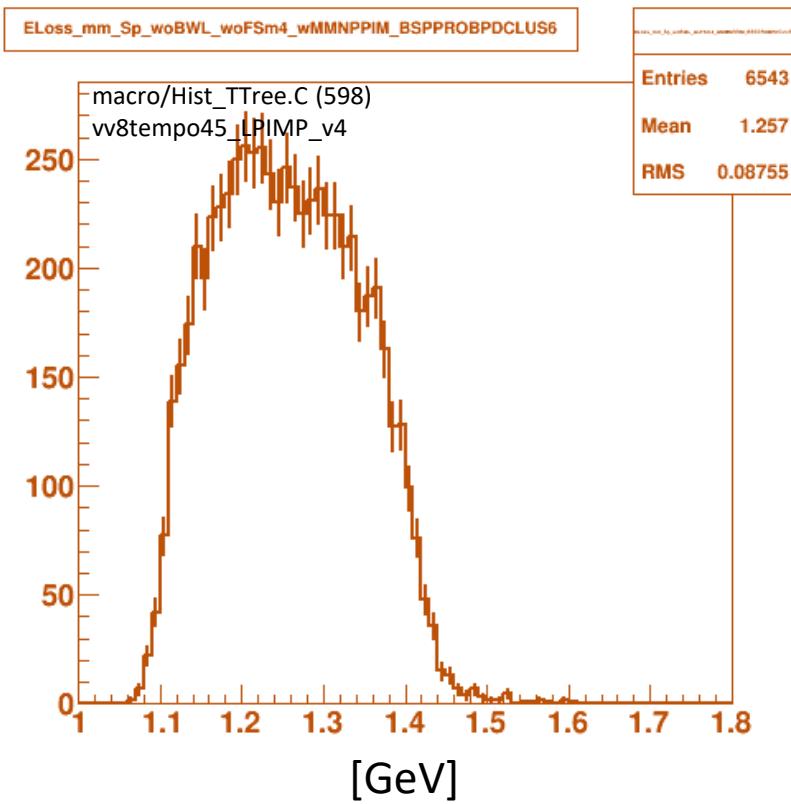
- MM.  $d(K^-, n\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$

Data

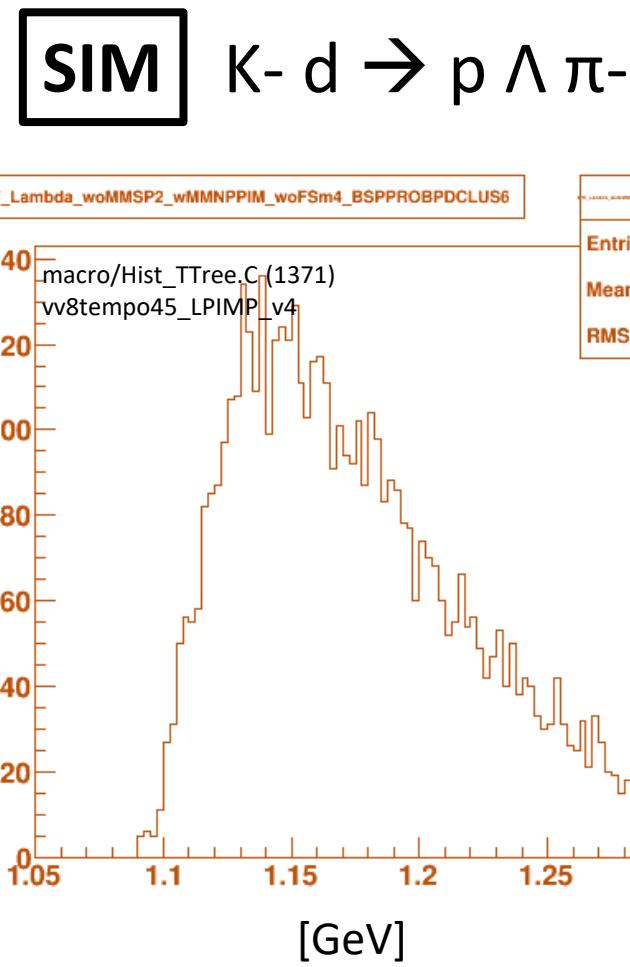
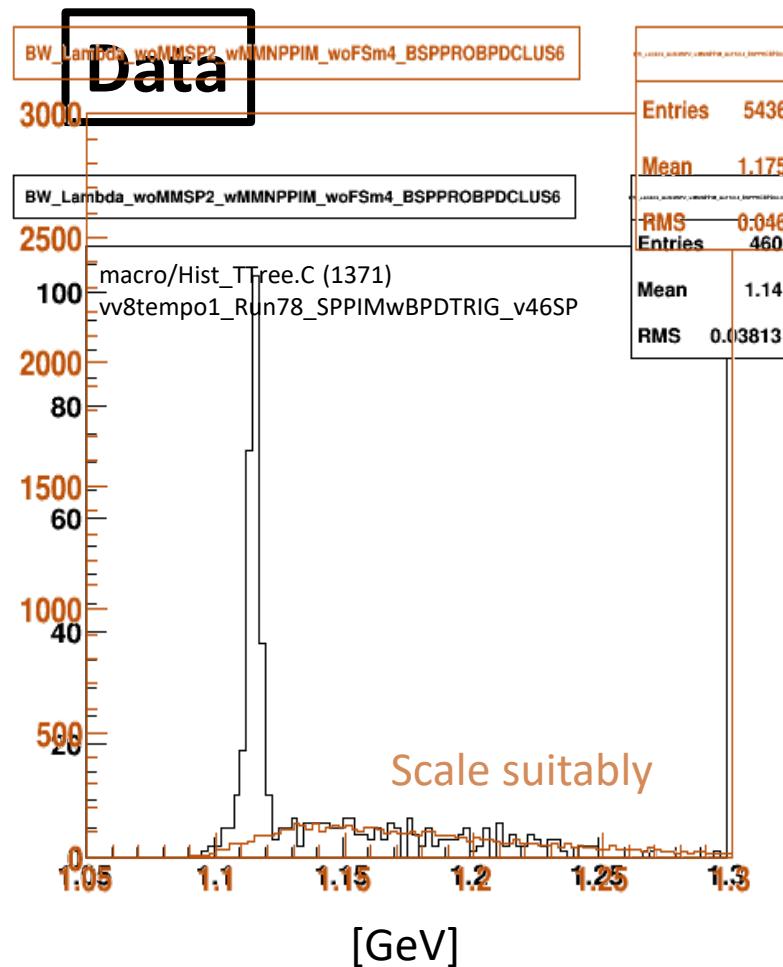


SIM  $K^- d \rightarrow p \Lambda \pi^-$



- MM.  $d(K^-, \eta\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

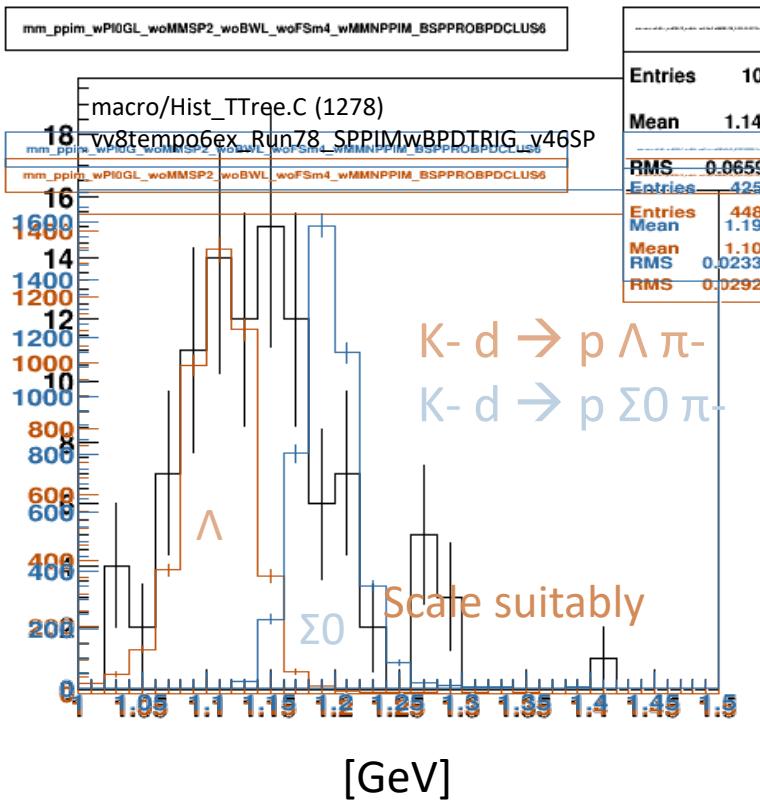
# IM. ( $p, \pi^-$ )



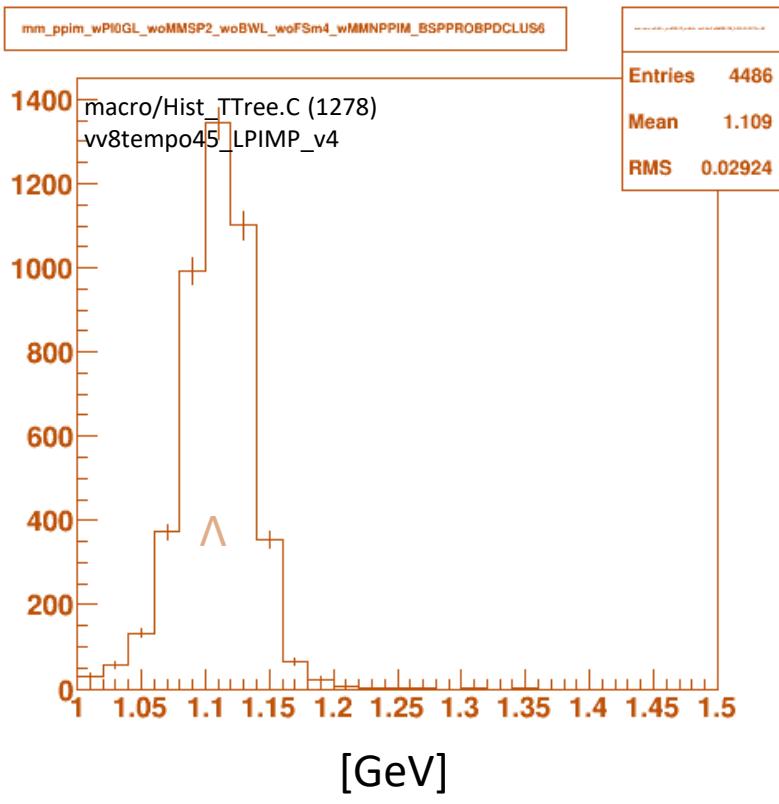
# MM. $d(K^-, p\pi^-)$

- MM.  $d(K^-, \eta\eta\pi^-)$  0~0.18
- $\Sigma^-$  from IM.  $(\eta, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, \eta\eta\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

Data

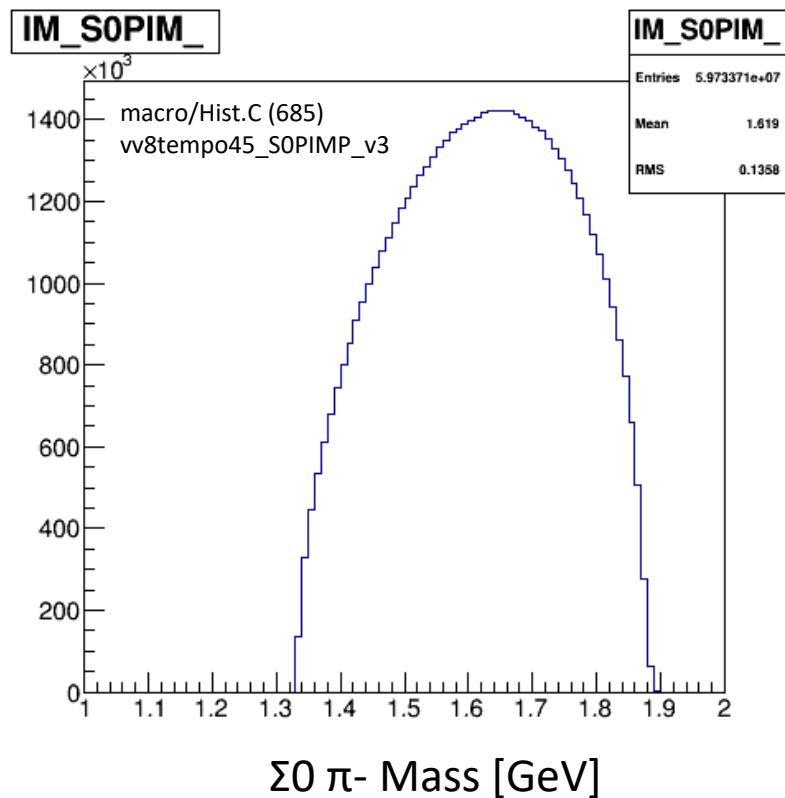


SIM



# Generate

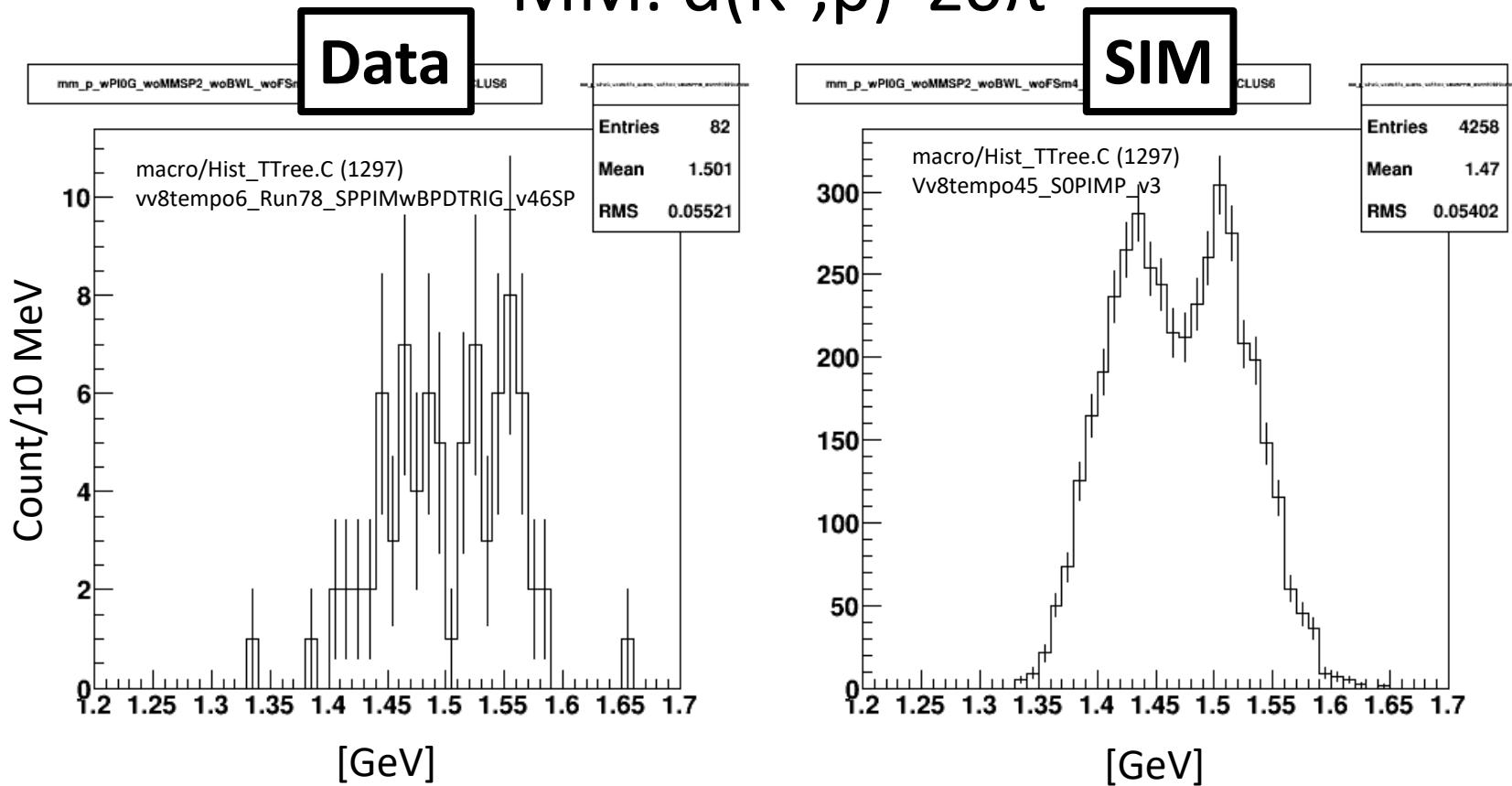
**SIM**  $K^- d \rightarrow p \Sigma^0 \pi^-$



# Spectrum of $\Sigma^0\pi^-$

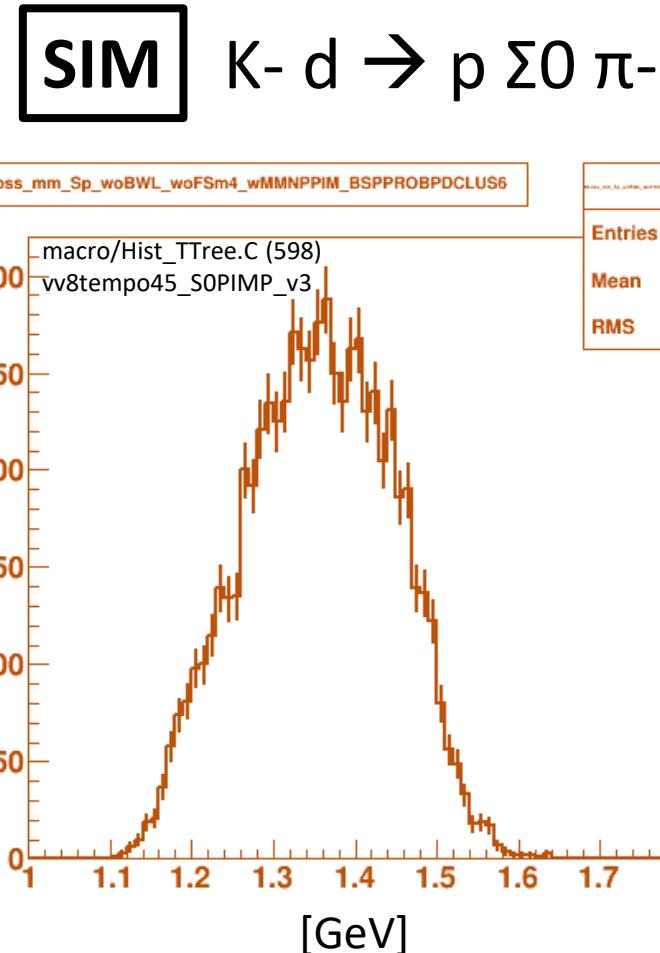
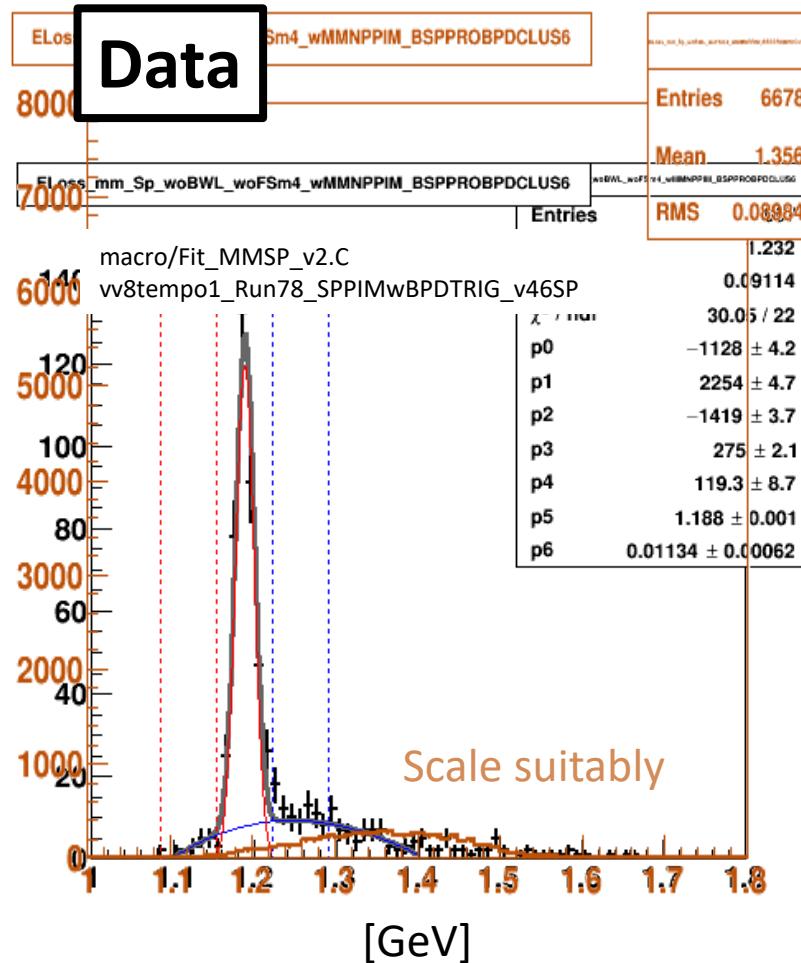
- MM.  $d(K_-, p\pi^-)$   $0.18 \sim 0.30$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected

MM.  $d(K_-, p)\pi^- \Sigma^0\pi^-$



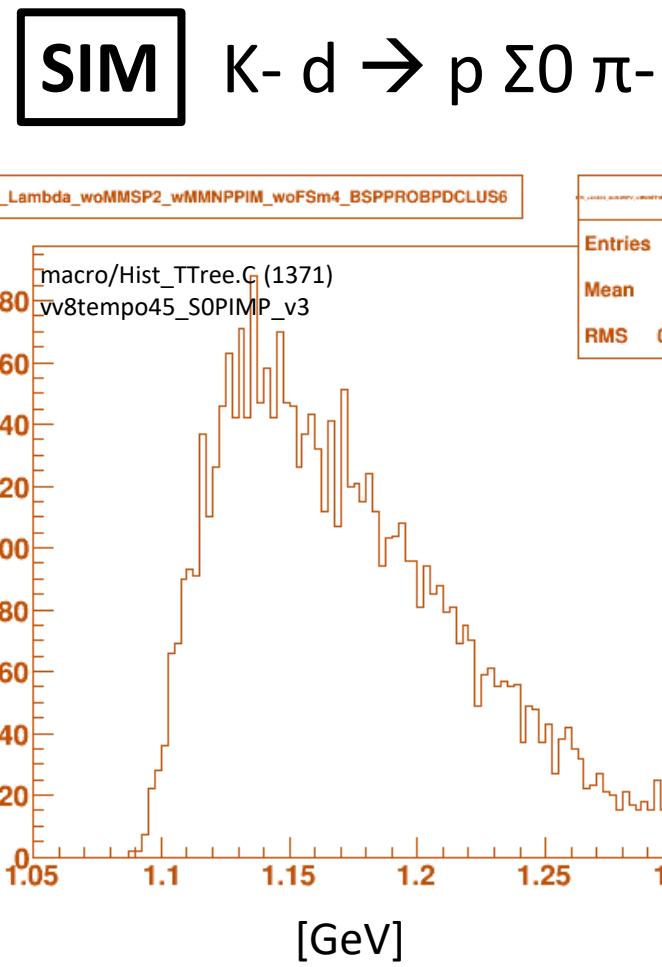
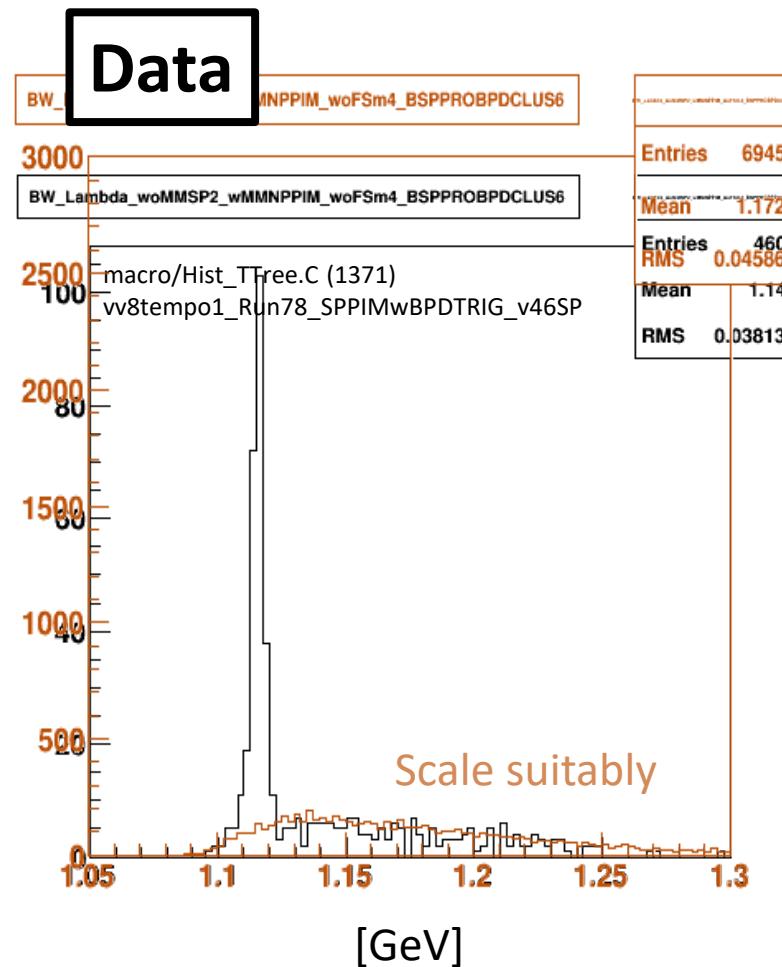
- MM.  $d(K^-, n\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$



- MM.  $d(K^-, \eta\pi^-) > 0$
- $\Sigma^-$  from IM.  $(\eta, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, \eta\pi^-)$  is rejected

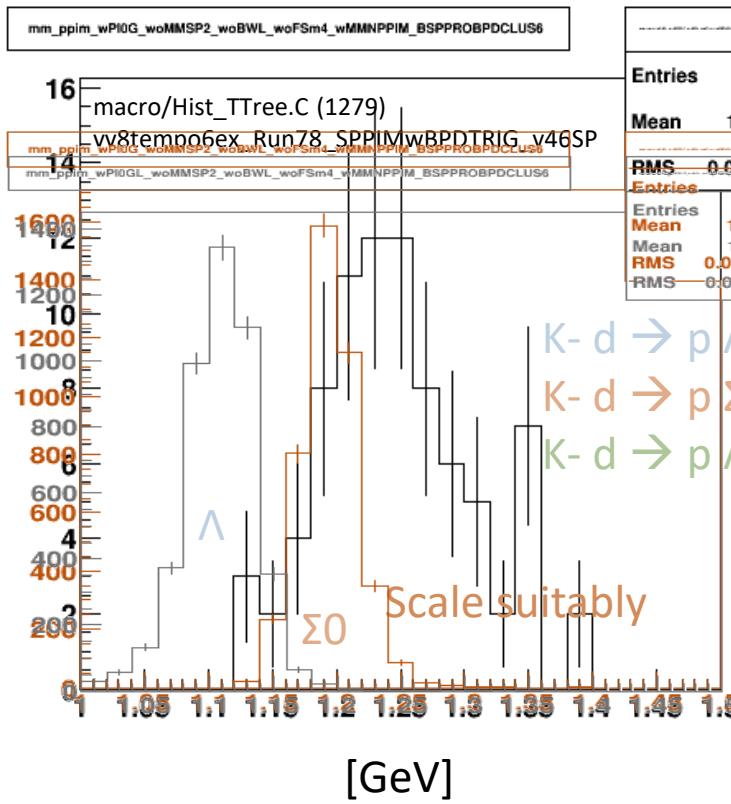
# IM. ( $p, \pi^-$ )



# MM. $d(K^-, p\pi^-)$

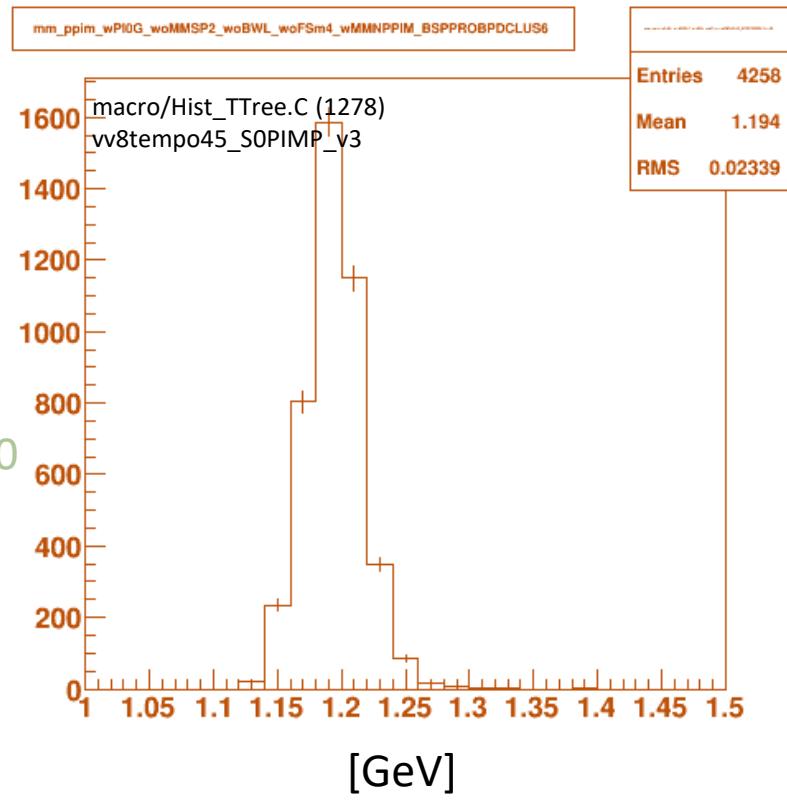
- MM.  $d(K^-, \eta\eta\pi^-)$  0.18~0.30 GeV
- $\Sigma^-$  from IM.  $(\eta, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, \eta\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

Data



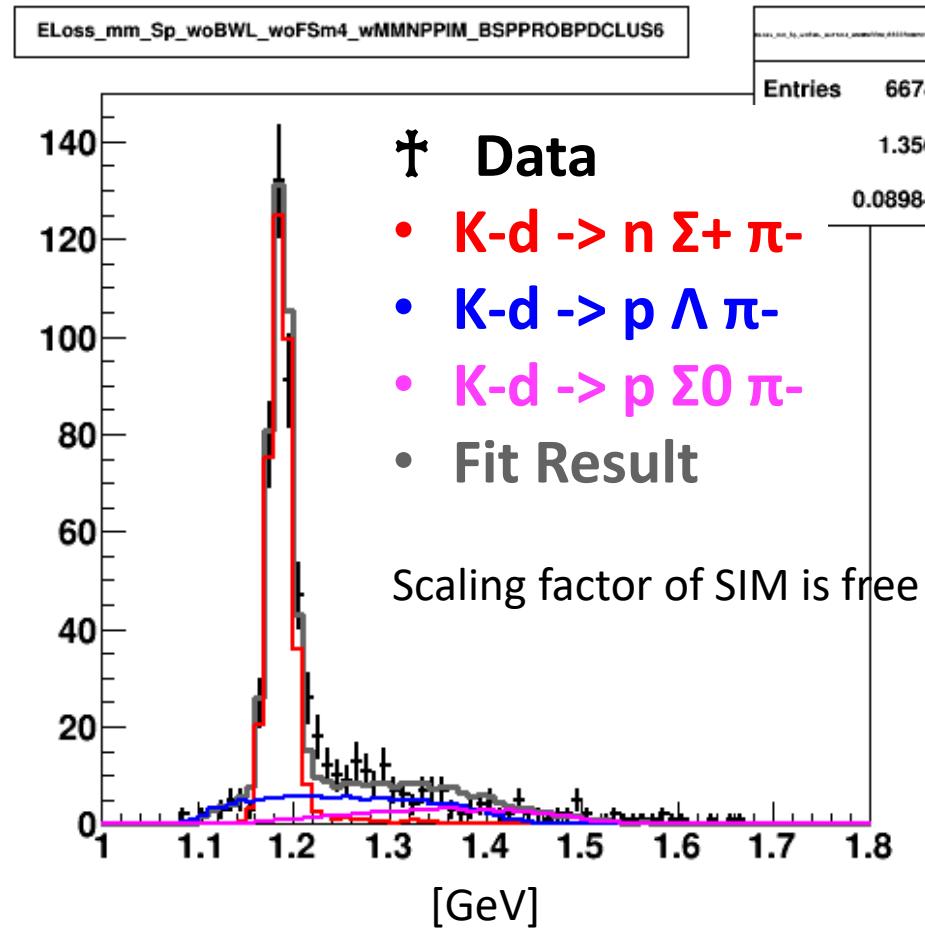
SIM

$K^- d \rightarrow p \Sigma^0 \pi^-$



- MM.  $d(K^-, n\pi^-) > 0$
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# Fitting of MM. $d(K^-, n\pi^-)$

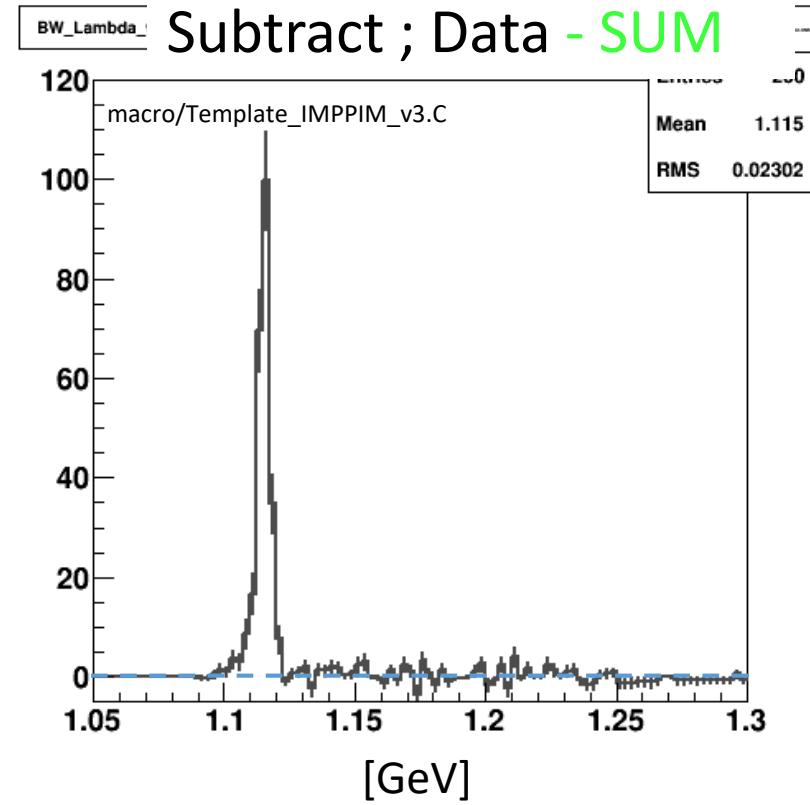
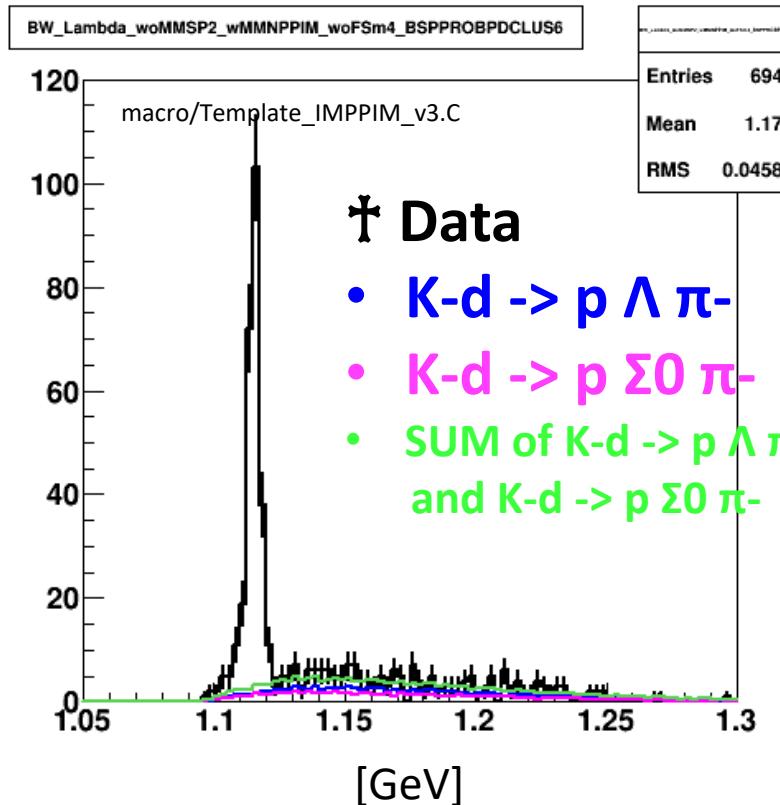


# BG of IM. (p, $\pi^-$ )

by  $K-d \rightarrow p \wedge \pi^- K-d \rightarrow p \Sigma^0 \pi^-$

w/ scale factor by Fitting of MM.(K-,n $\pi^-$ )

- MM.  $d(K^-, n\pi^-) > 0$
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected



Scaling factor of SIM is decided by P.622

# IM. ( $p,\pi^-$ ) BG estimation for $\Sigma^0\pi^0$ analysis

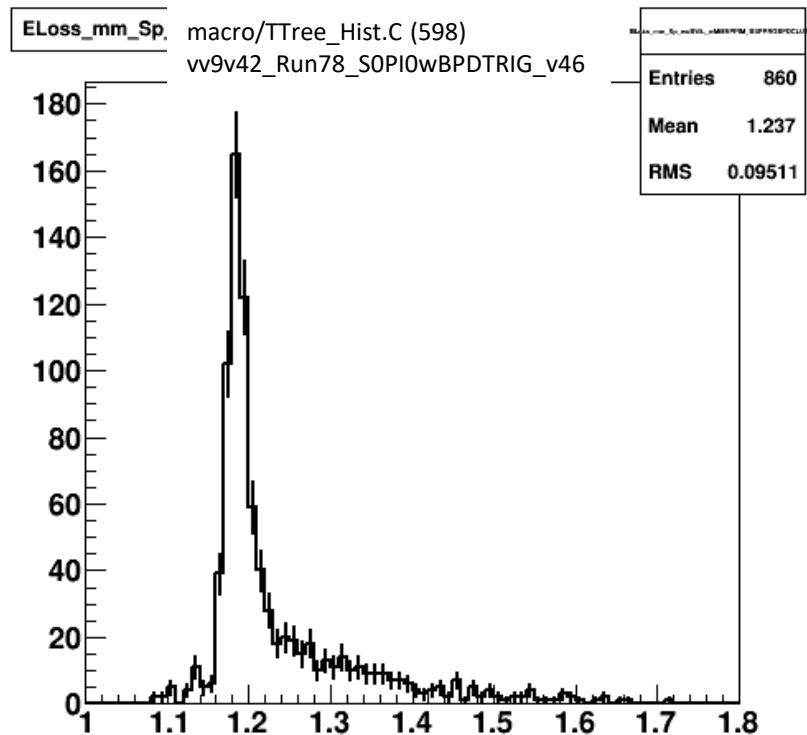
Difference from  $\Sigma^+\pi^-$

- w/o rejection of  $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$
- w/o rejection of  $\Sigma^-$  from IM. ( $n, \pi^-$ )
- Backward p, Forward n vertex is adjusted for  $\Sigma^0\pi^0$  analysis
- Target length 10  $\rightarrow$  12.5 cm
- SIM is  $\Sigma^+\pi^-$  analysis temporary

- MM.  $d(K^-, n\pi^-) > 0$
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

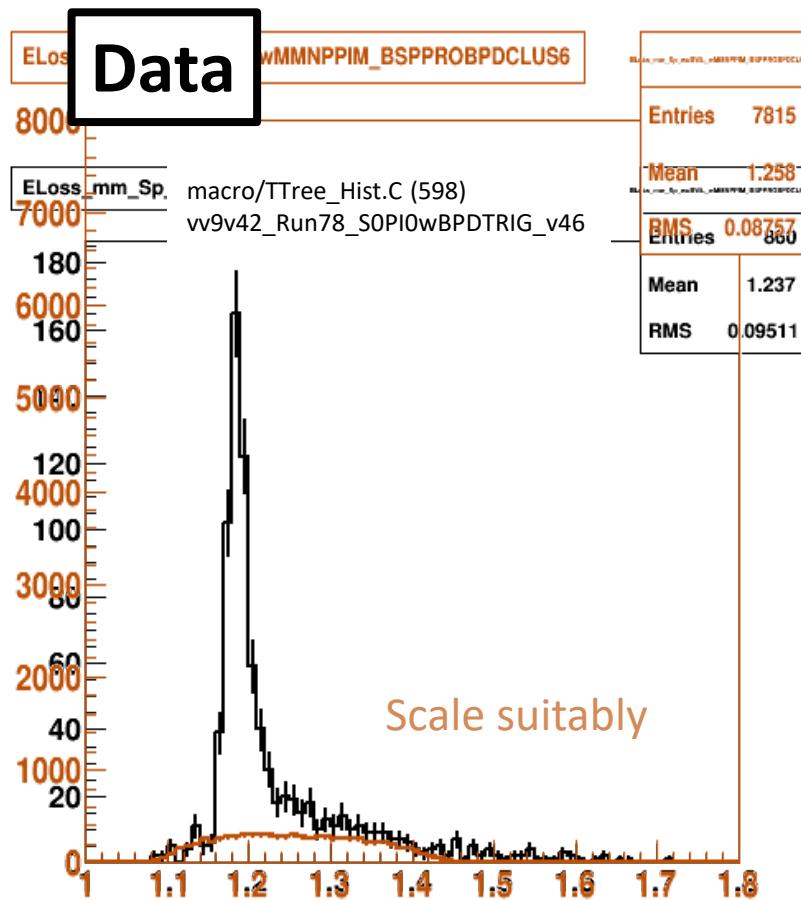
# MM. $d(K^-, n\pi^-)$

## Data

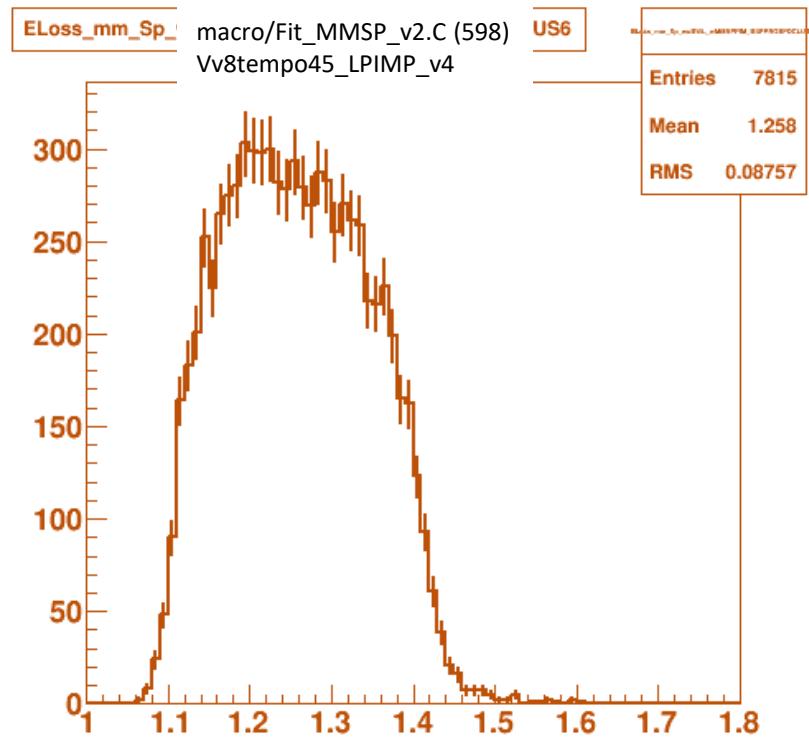


- MM.  $d(K^-, n\pi^-) > 0$
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$

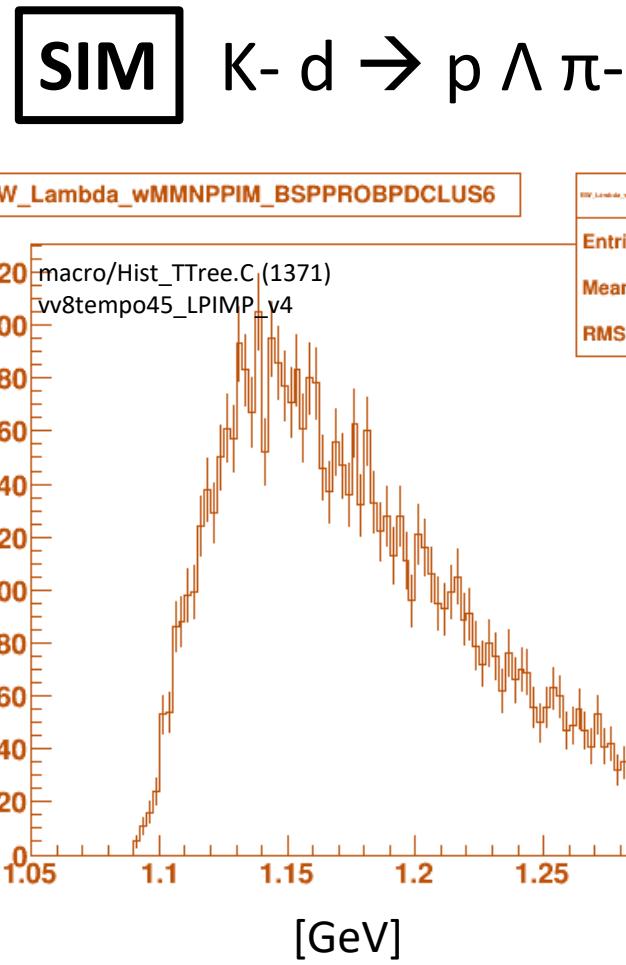
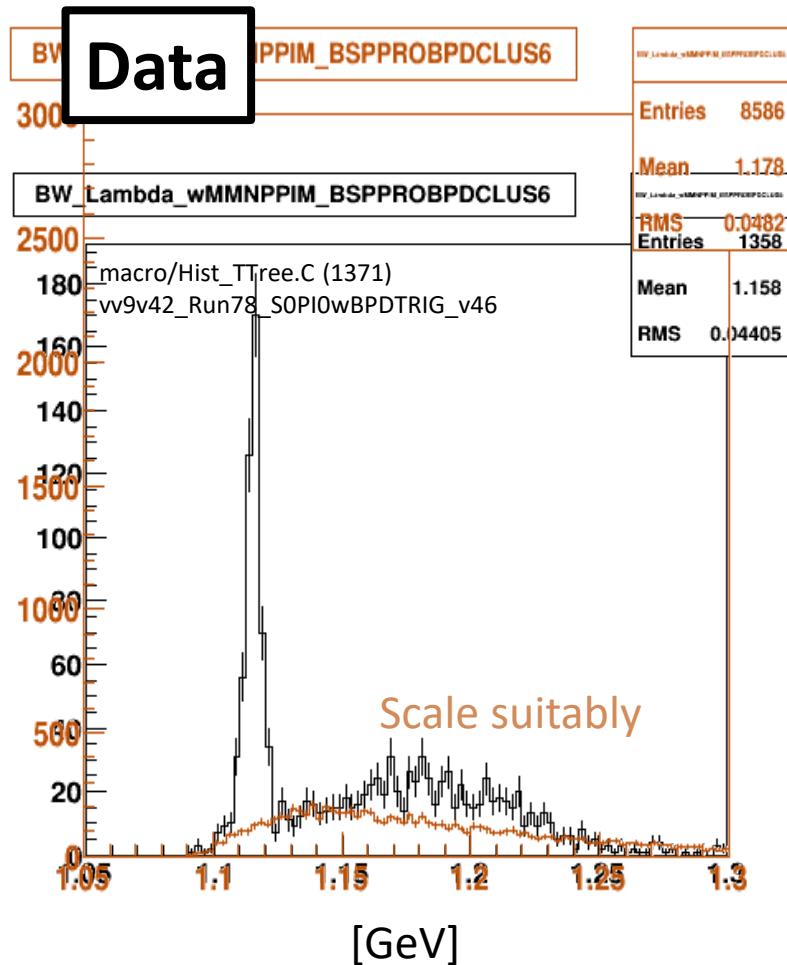


**SIM**  $K^- d \rightarrow p \Lambda \pi^-$



- MM.  $d(K, \pi\pi) > 0$

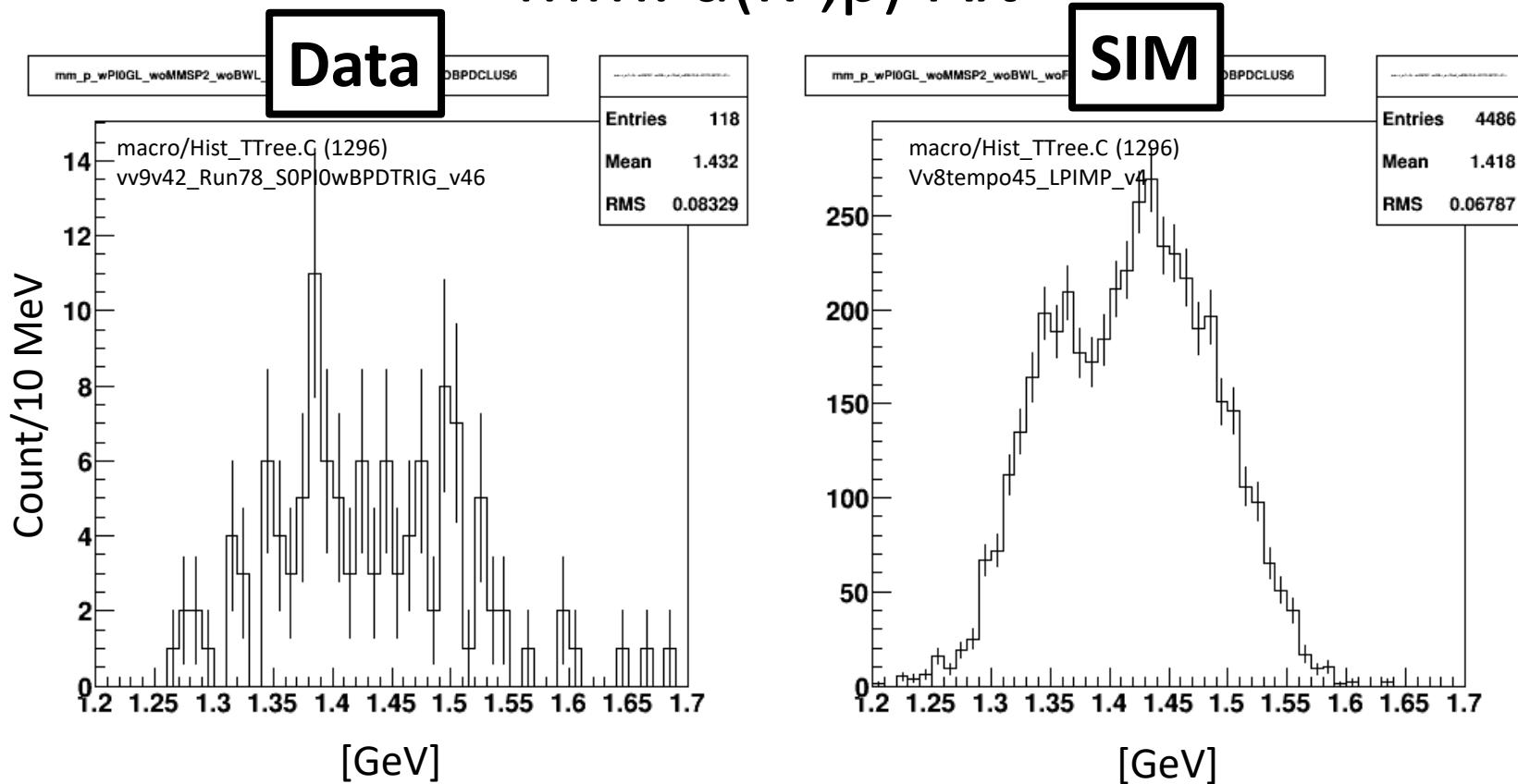
# IM. ( $p, \pi^-$ )



# Spectrum of $\Lambda\pi^-$

- MM.  $d(K_-, p\pi^-)$   $0 \sim 0.18$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected

MM.  $d(K_-, p)\pi^-$ " $\Lambda\pi^-$ "

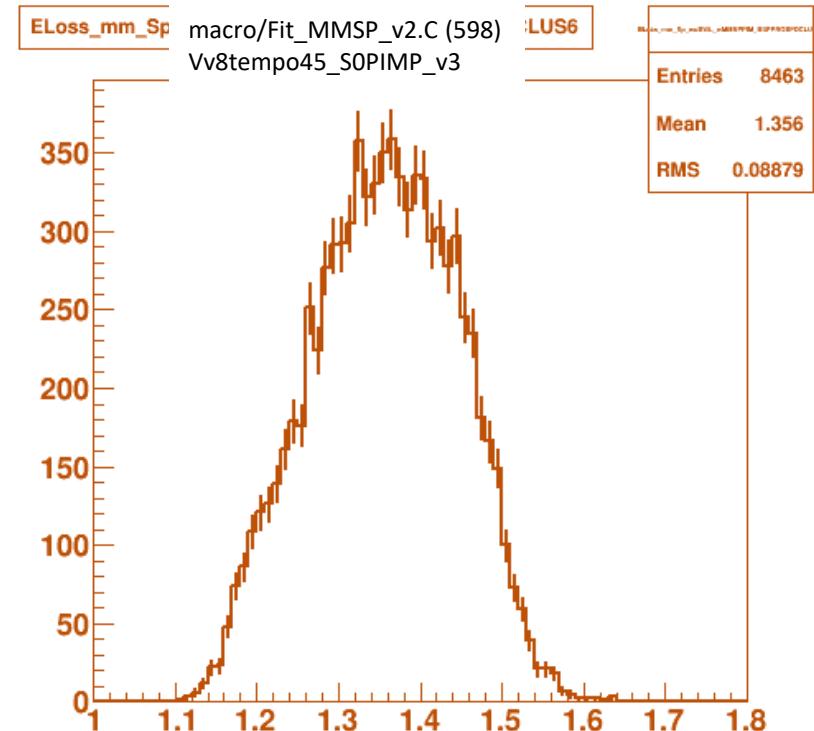
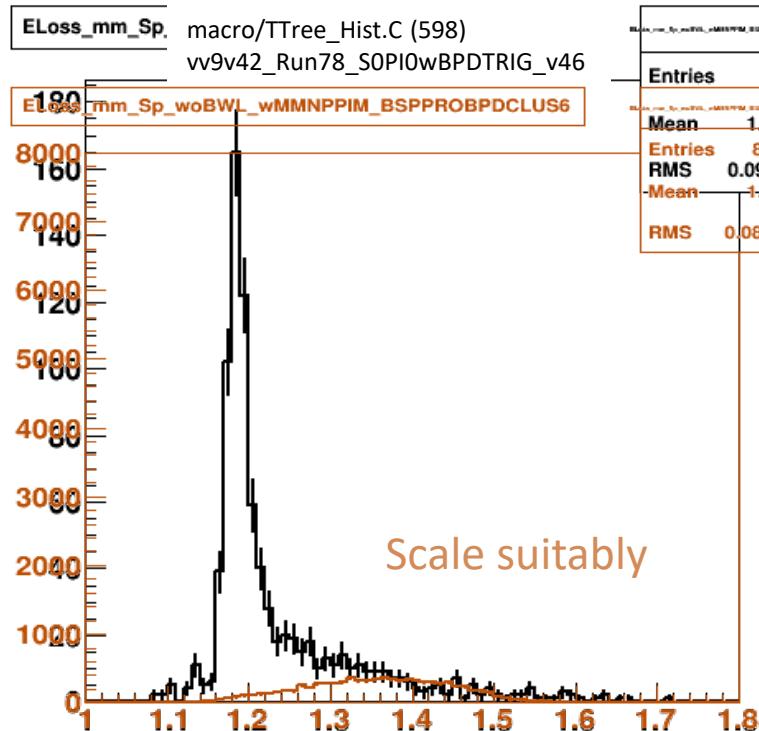


- MM.  $d(K^-, n\pi^-) > 0$
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$

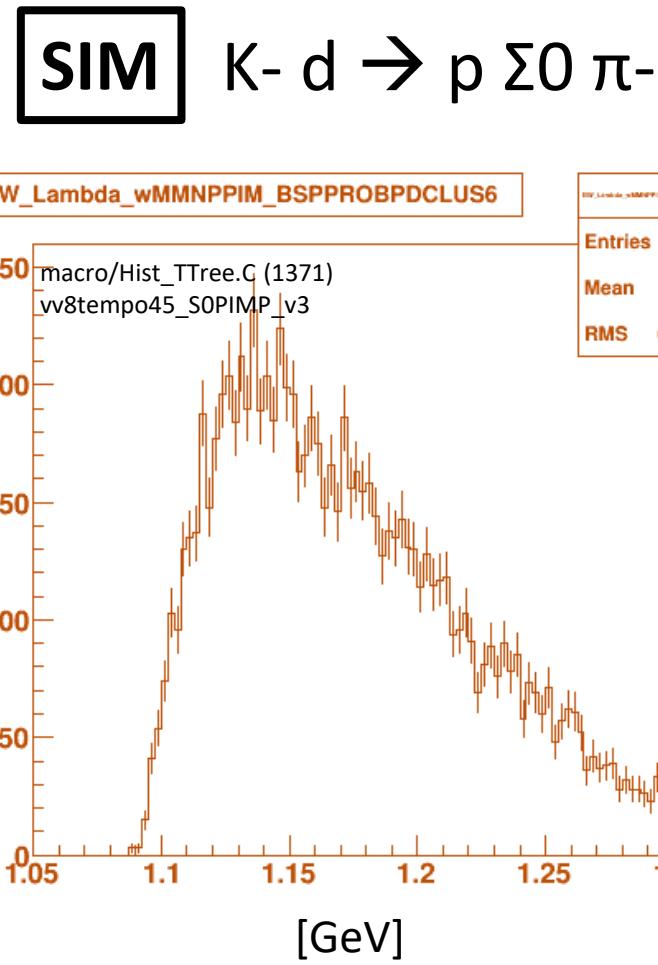
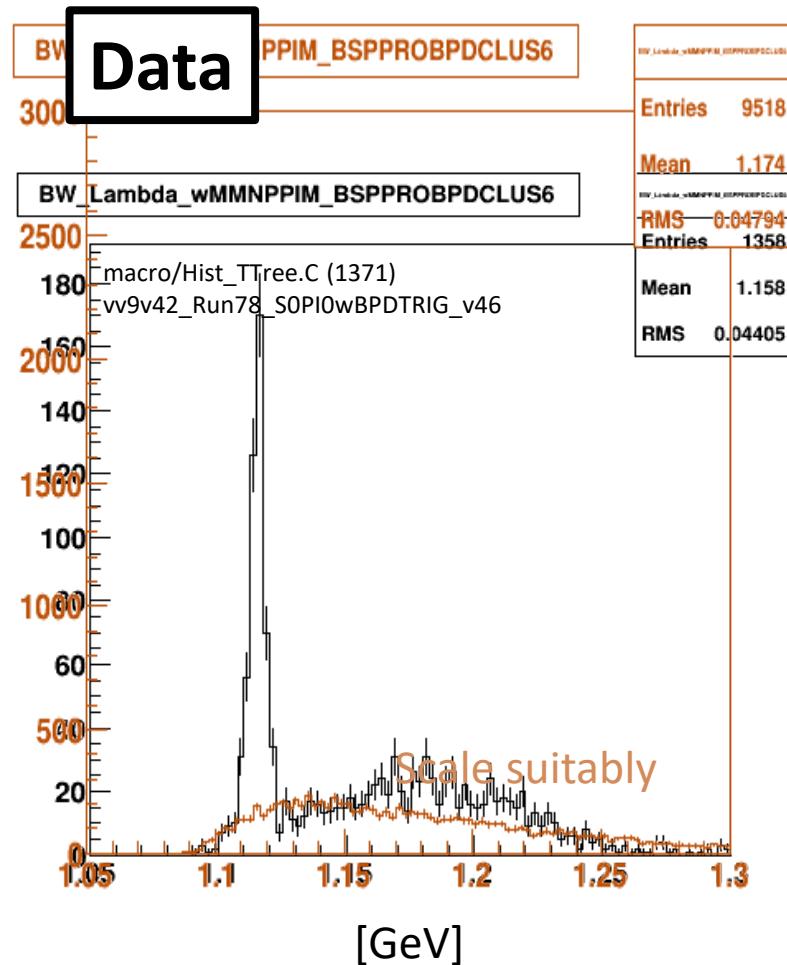
**SIM**

$K^- d \rightarrow p \Sigma^0 \pi^-$



- MM.  $d(K, \pi\pi) > 0$

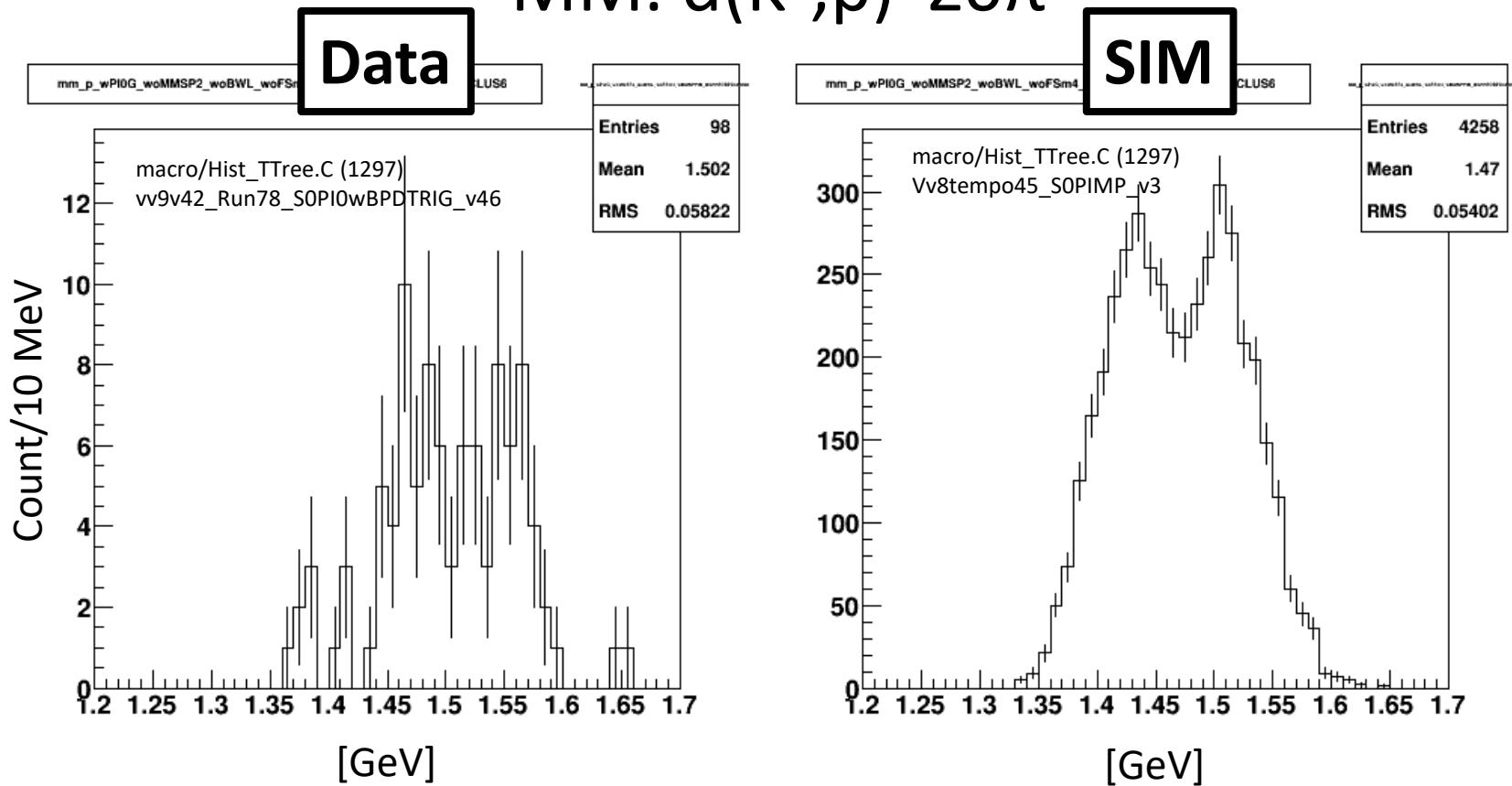
# IM. ( $p, \pi^-$ )



# Spectrum of $\Sigma^0\pi^-$

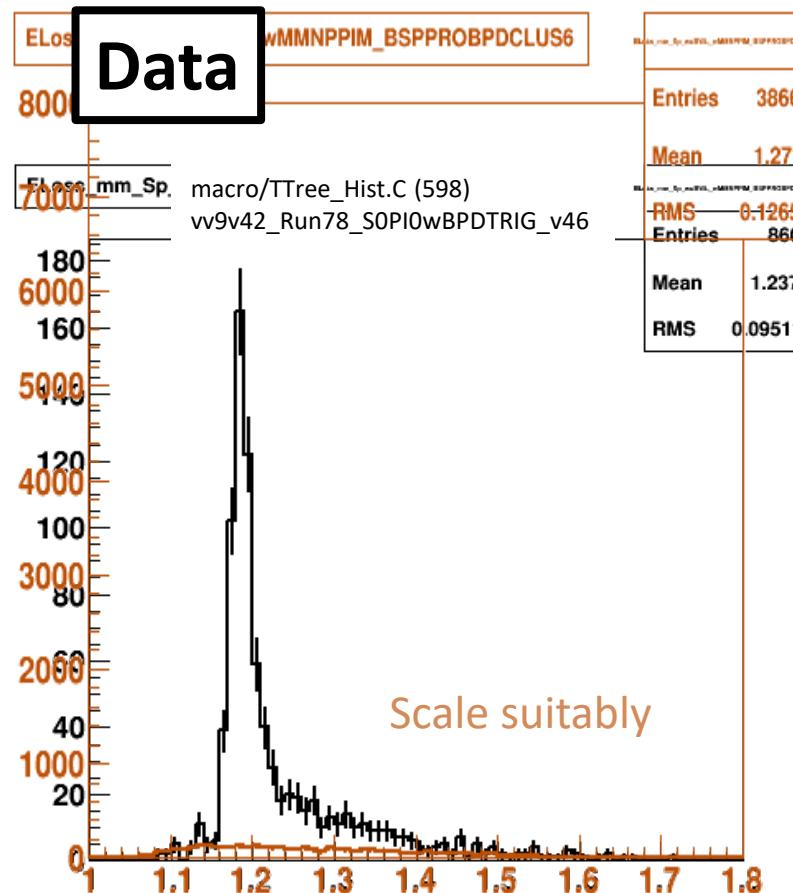
- MM.  $d(K_-, p\pi^-)$   $0.18 \sim 0.30$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected

MM.  $d(K_-, p)\pi^- \Sigma^0\pi^-$

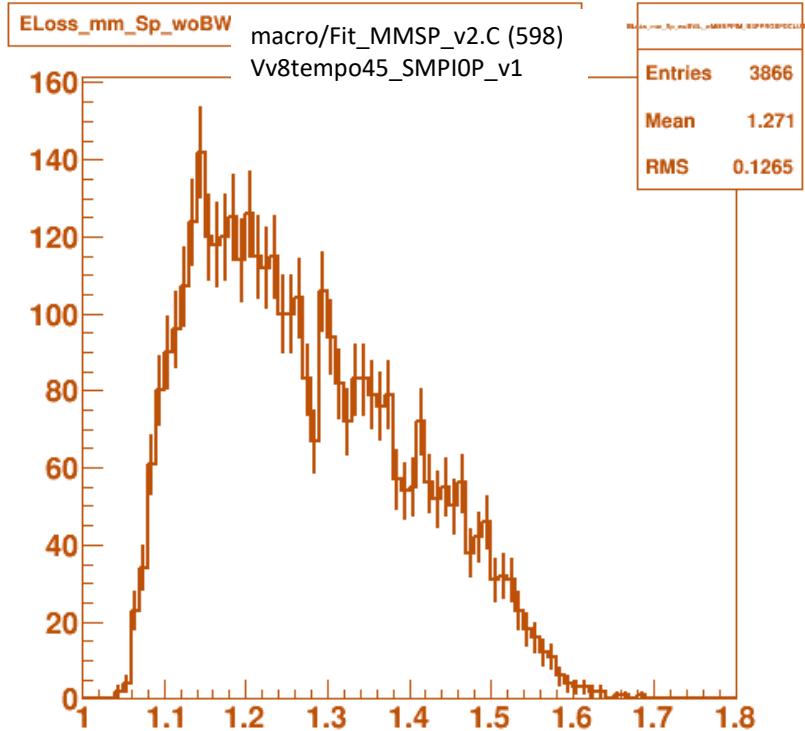


- MM.  $d(K^-, n\pi^-) > 0$
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

# MM. $d(K^-, n\pi^-)$

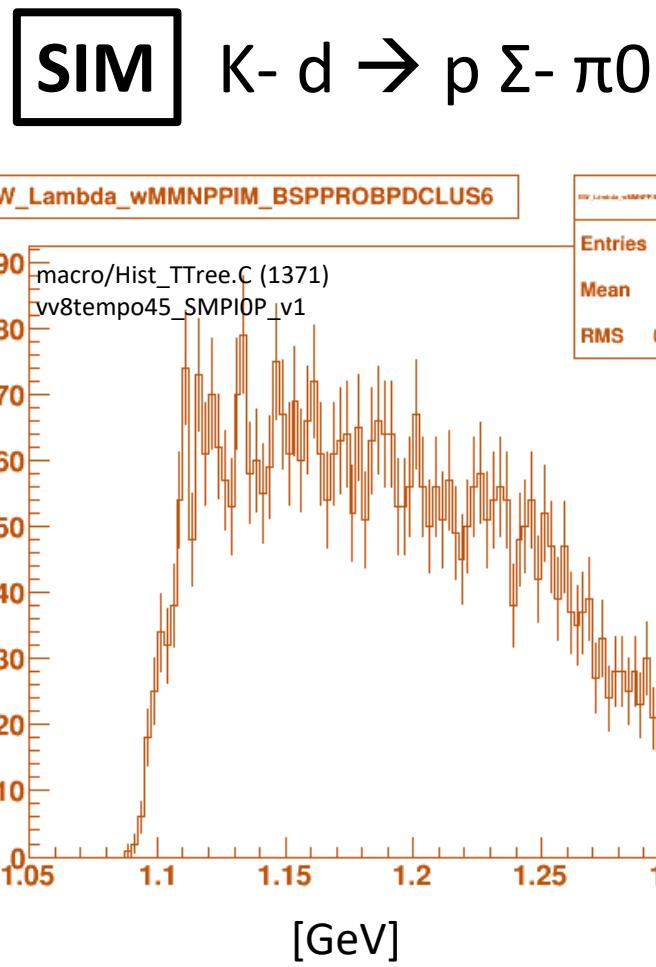
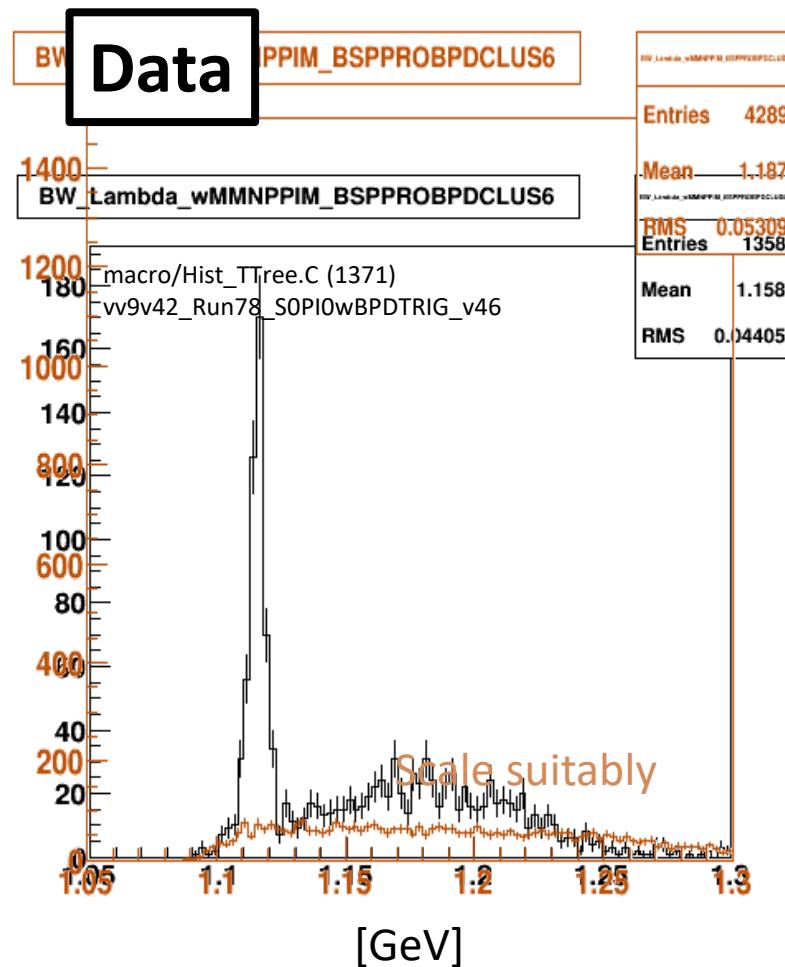


**SIM**  $K^- d \rightarrow p \Sigma^- \pi^0$



- MM.  $d(K, \pi\pi) > 0$

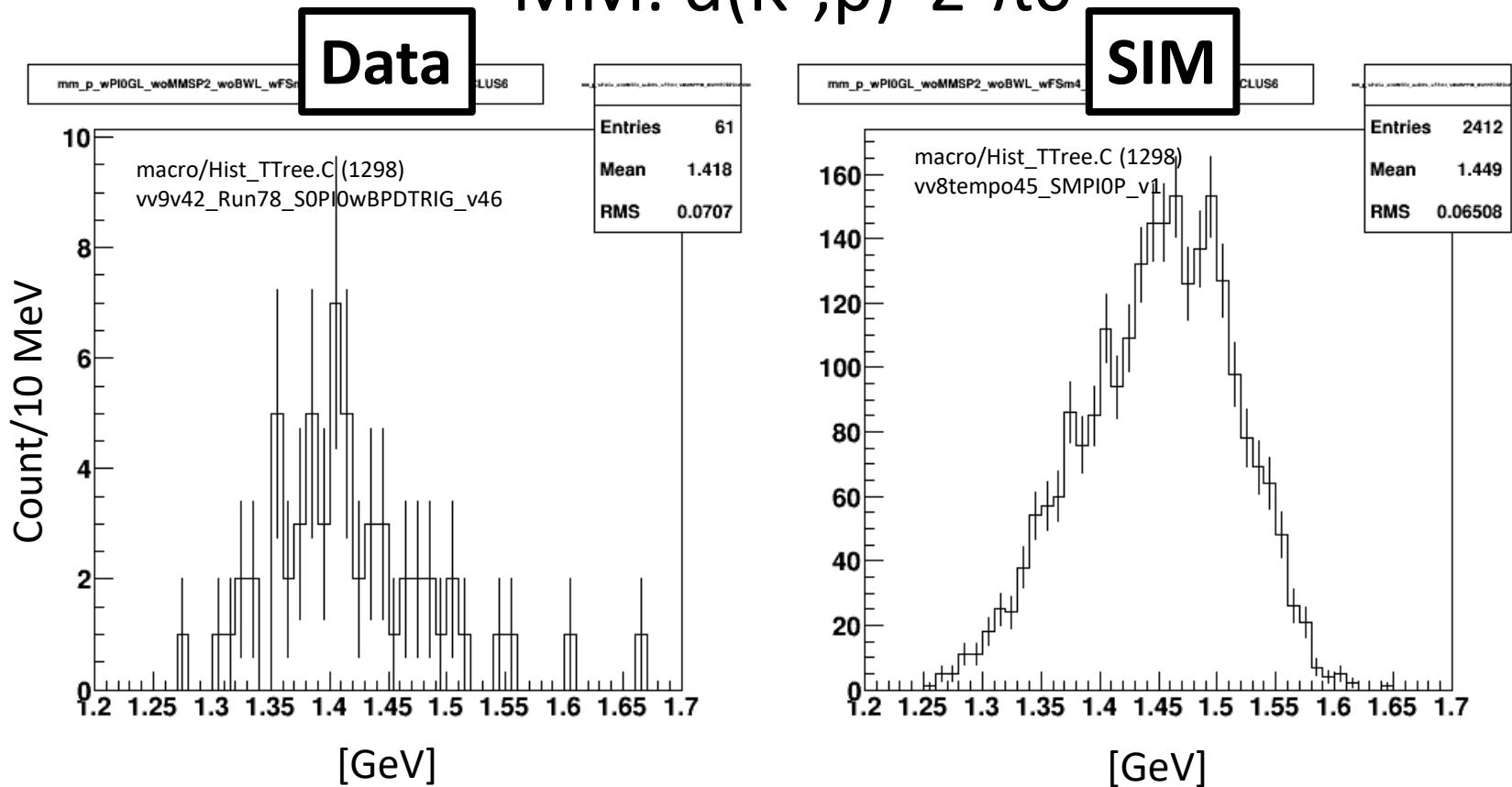
# IM. ( $p, \pi^-$ )



# Spectrum of $\Sigma$ - $\pi^0$

- MM.  $d(K^-, p\pi^-)$   $0.00 \sim 0.18$  GeV
- $\Sigma$  from IM.  $(n, \pi^-)$  is selected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

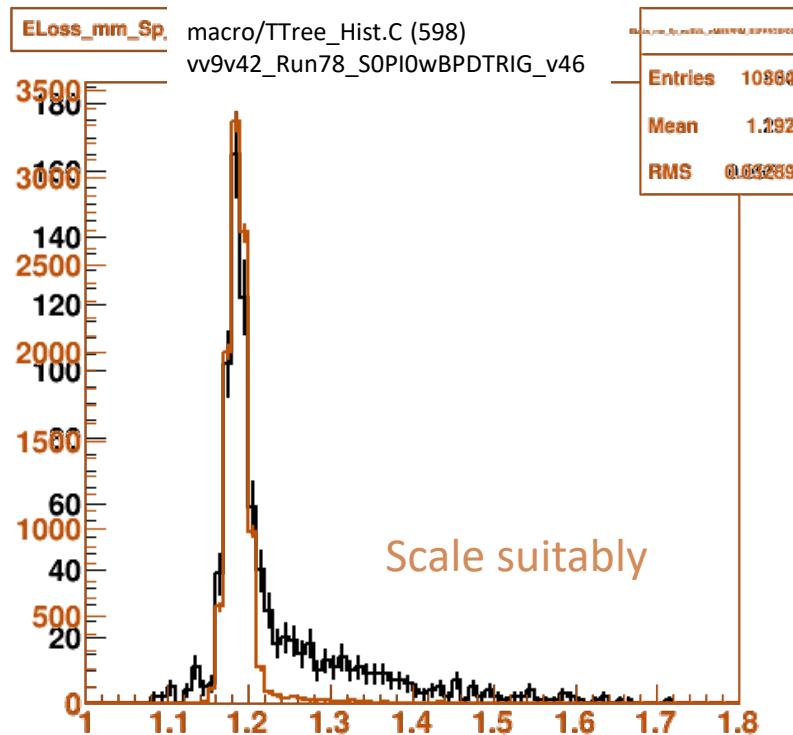
MM.  $d(K^-, p)\Sigma-\pi^0$



- MM.  $d(K^-, n\pi^-) > 0$
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

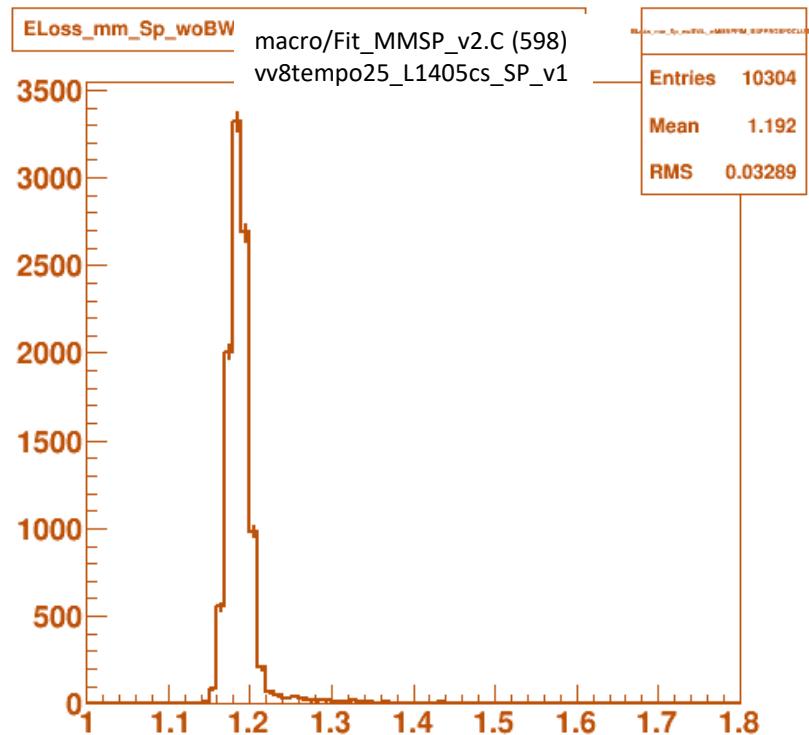
# MM. $d(K^-, n\pi^-)$

**Data**



**SIM**

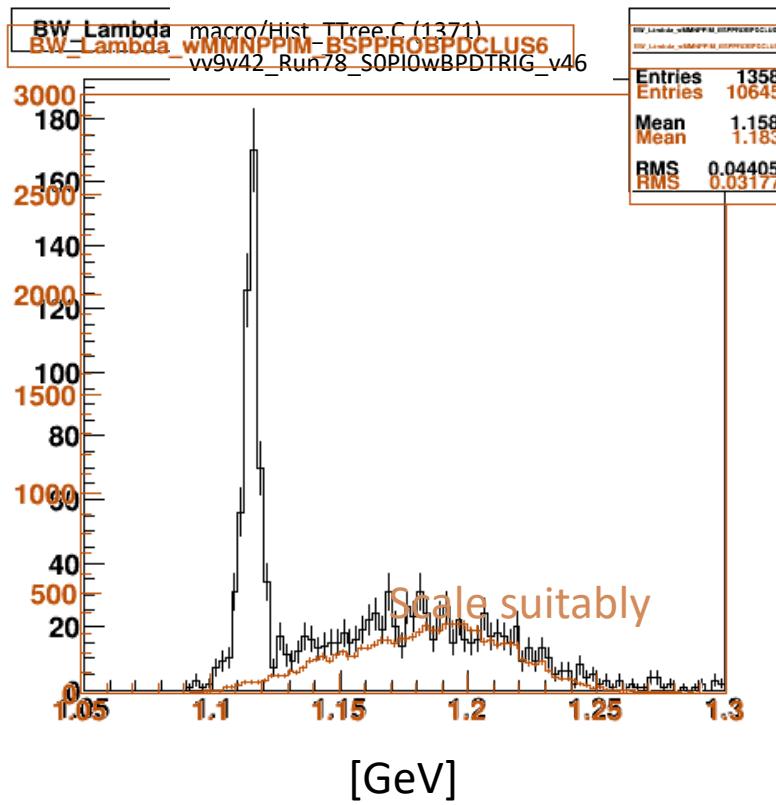
$K^- d \rightarrow n \Sigma^+ \pi^-$



- MM.  $d(K, \pi\pi) > 0$

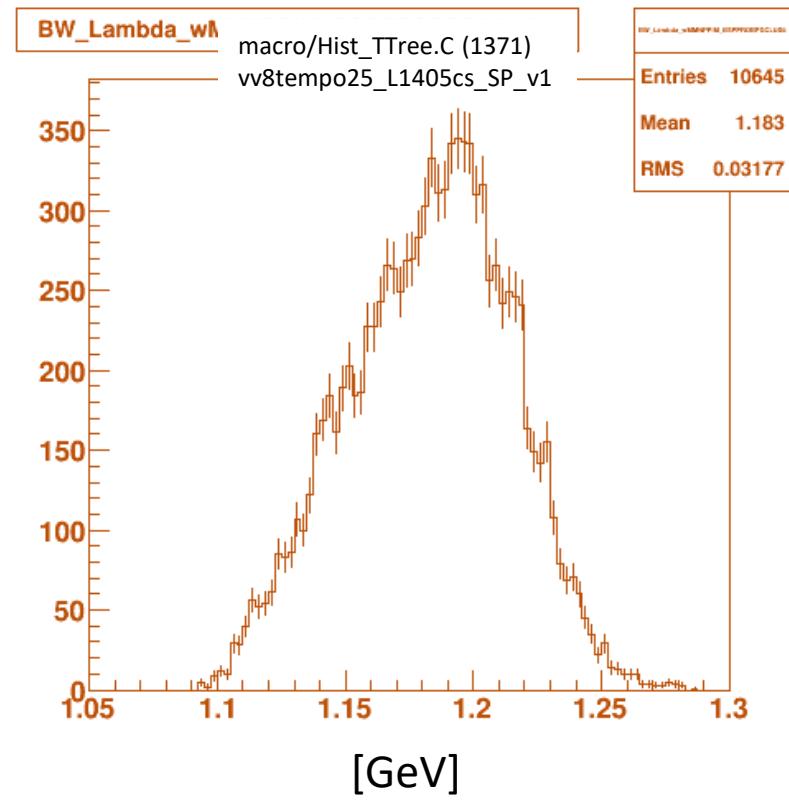
# IM. ( $p, \pi^-$ )

**Data**



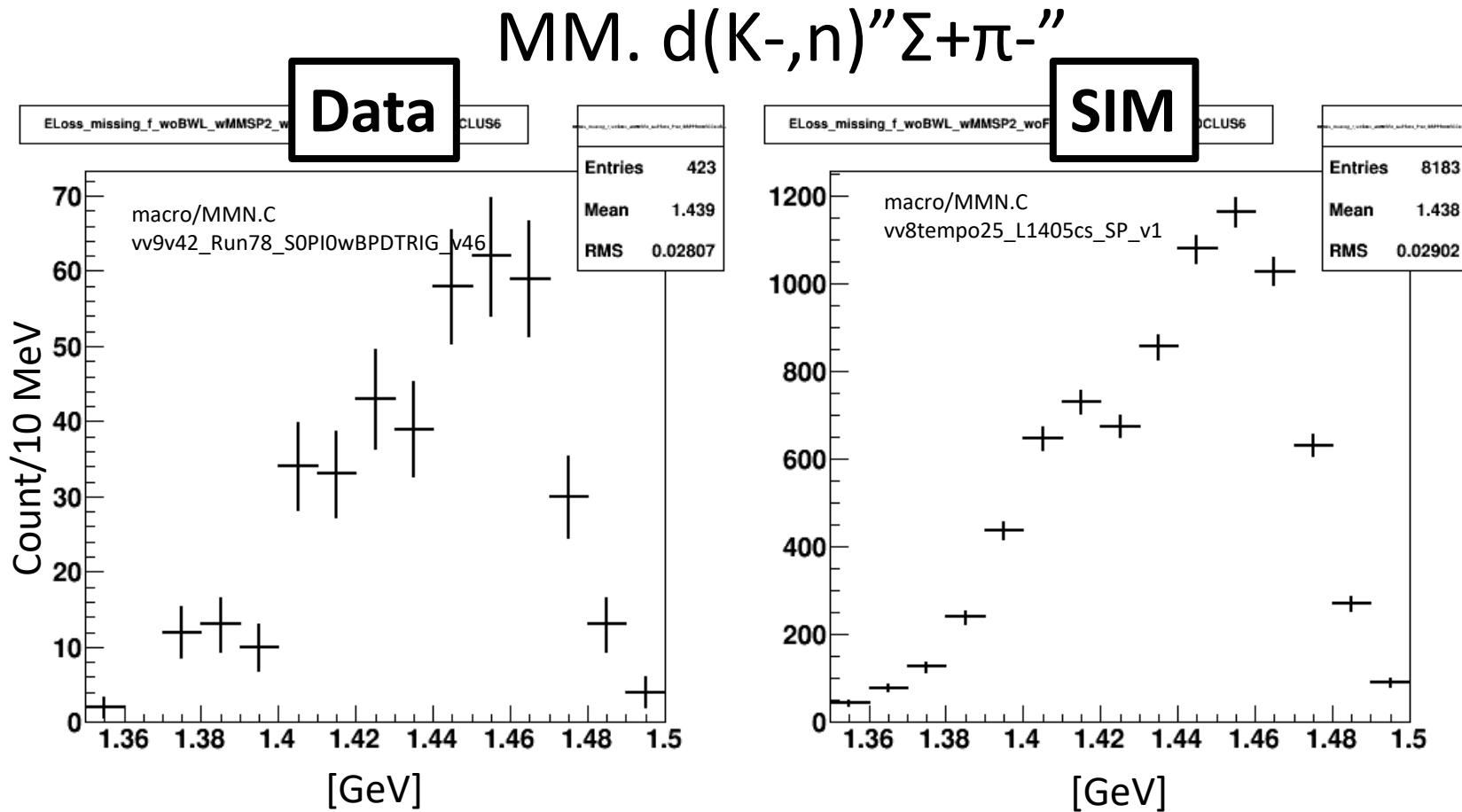
**SIM**

$K^- d \rightarrow n \Sigma^+ \pi^-$



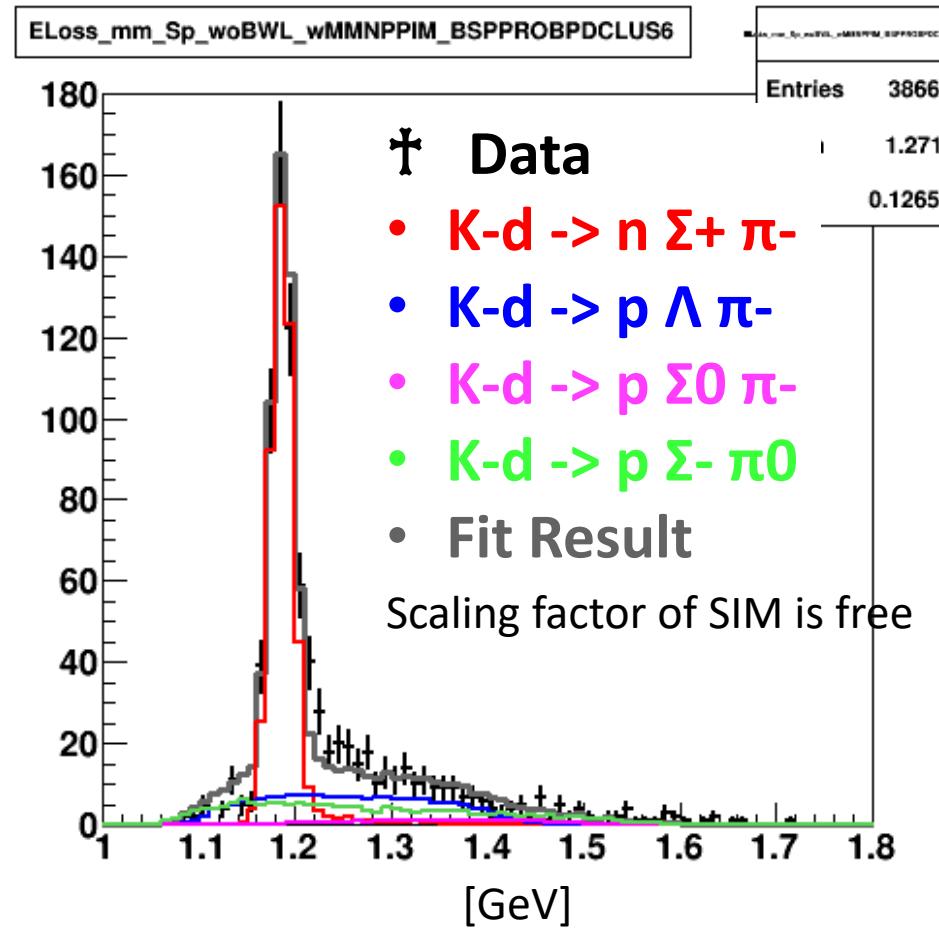
# Spectrum of $\Sigma^+ \pi^-$

- MM.  $d(K^-, n\pi\pi^-)$  “ $\pi^0$ ”
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is selected



- MM.  $d(K_-, n\pi^-) > 0$
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

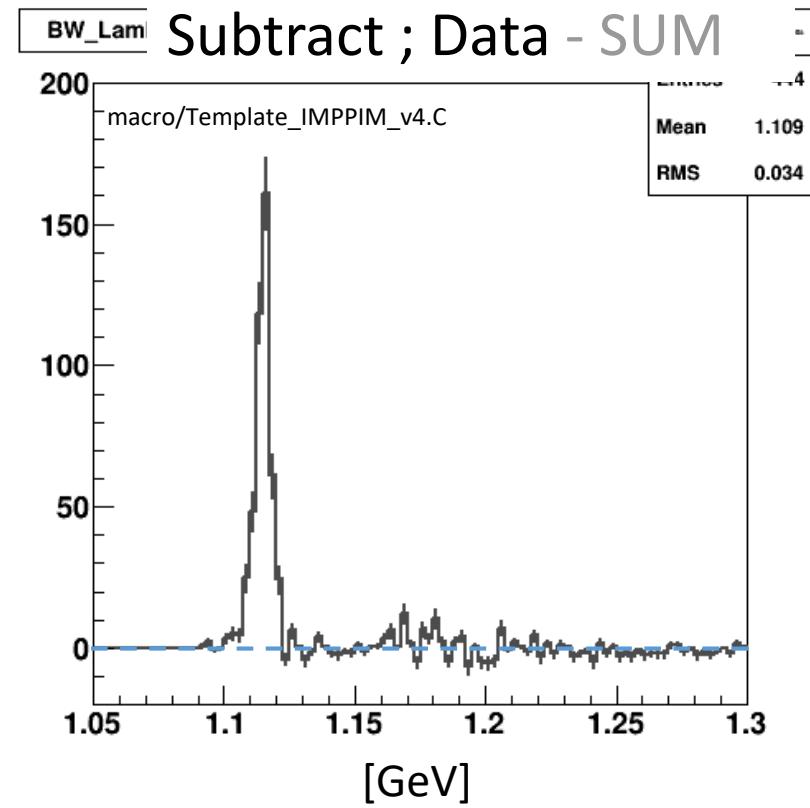
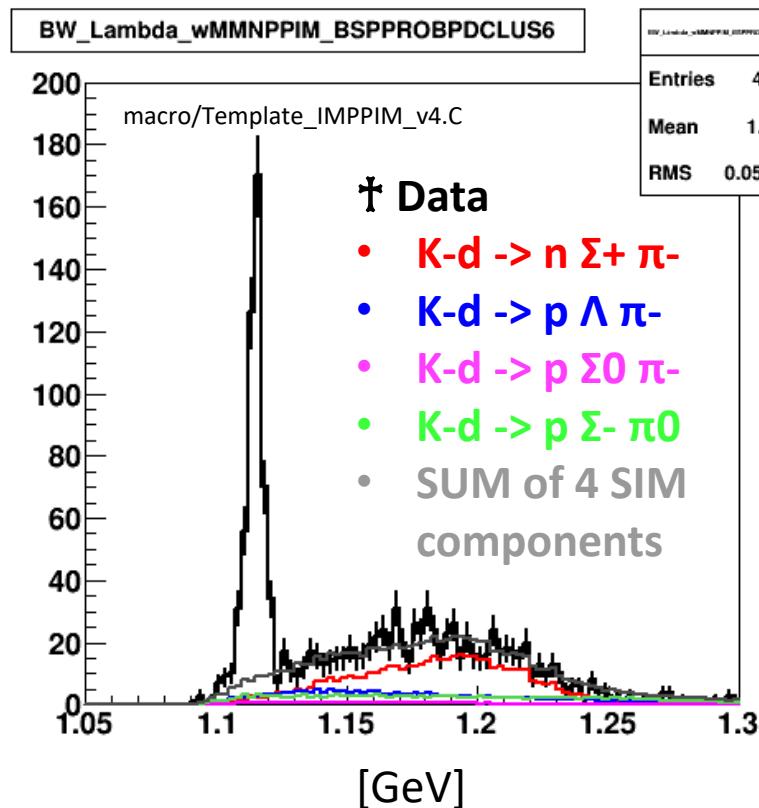
# Fitting of MM. $d(K_-, n\pi^-)$



Contribution from  $p \Sigma^0 \pi^-$  by fitting seems to be too small compared w/  $\Sigma^+ \pi^-$  analysis (P.622). Fitting does not work well.

- MM.  $d(K^-, n\pi^-) > 0$

BG of IM. ( $p, \pi^-$ )  
 by  $K^-d \rightarrow p \wedge \pi^- K^-d \rightarrow p \Sigma^0 \pi^-$   
 w/ scale factor by Fitting of MM.( $K^-, n\pi^-$ )



Scaling factor of SIM is decided by P.634

# Event ratio

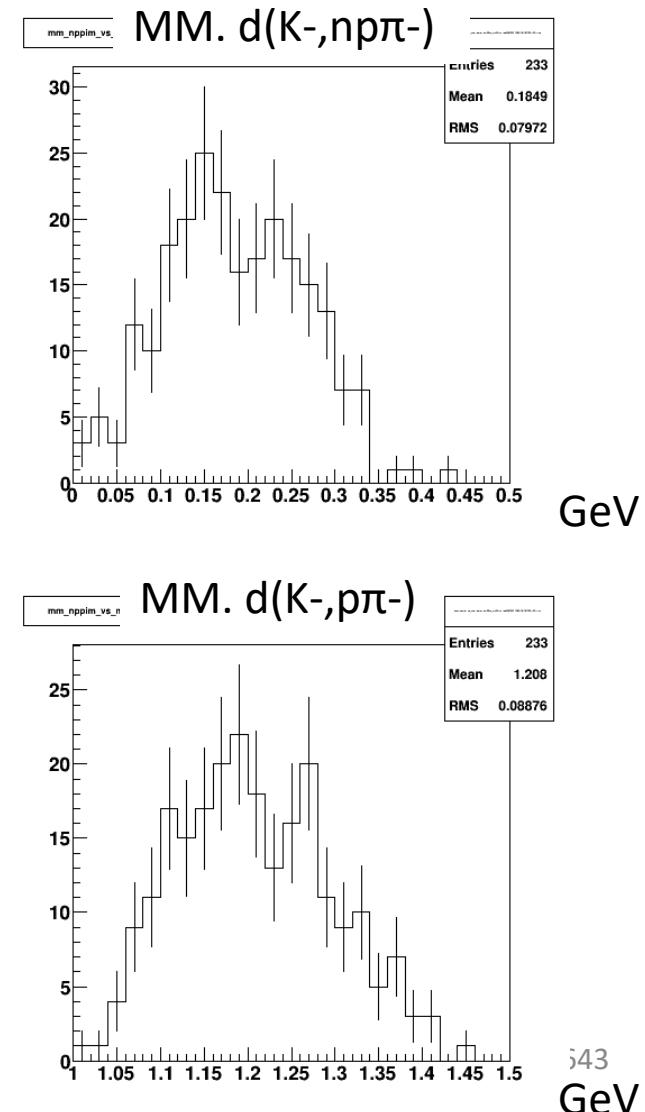
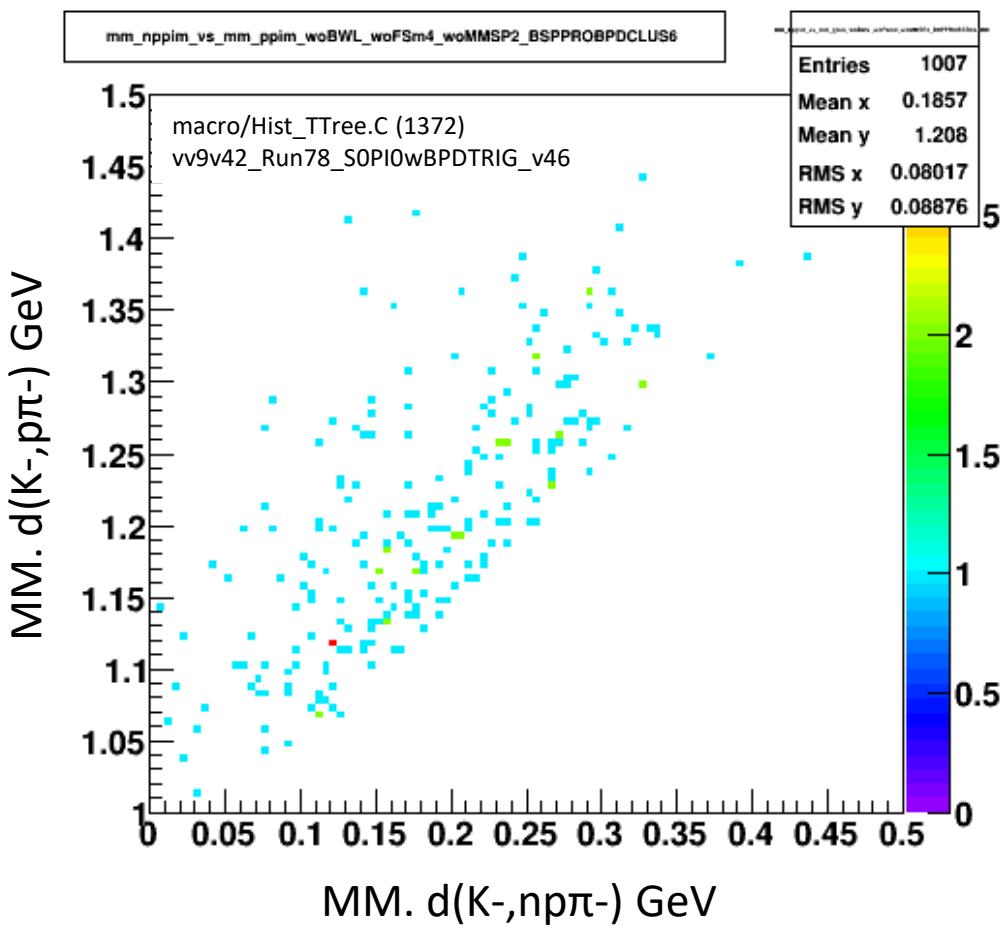
	Data	SIM	Fit err %
• $K-d \rightarrow n \Sigma^+ \pi^-$	1	1	5.6
• $K-d \rightarrow p \Lambda \pi^-$	0.278	0.286	19.3
• $K-d \rightarrow p \Sigma^0 \pi^-$	0.231	0.040	79.0
• $K-d \rightarrow p \Sigma^- \pi^0$	0.144	0.278	24.1

Contribution from  $p \Sigma^0 \pi^-$  by fitting seems to be too small

Fitting of MM.  $d(K-,n\pi^-)$  w/ above 4 components does not work well.

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

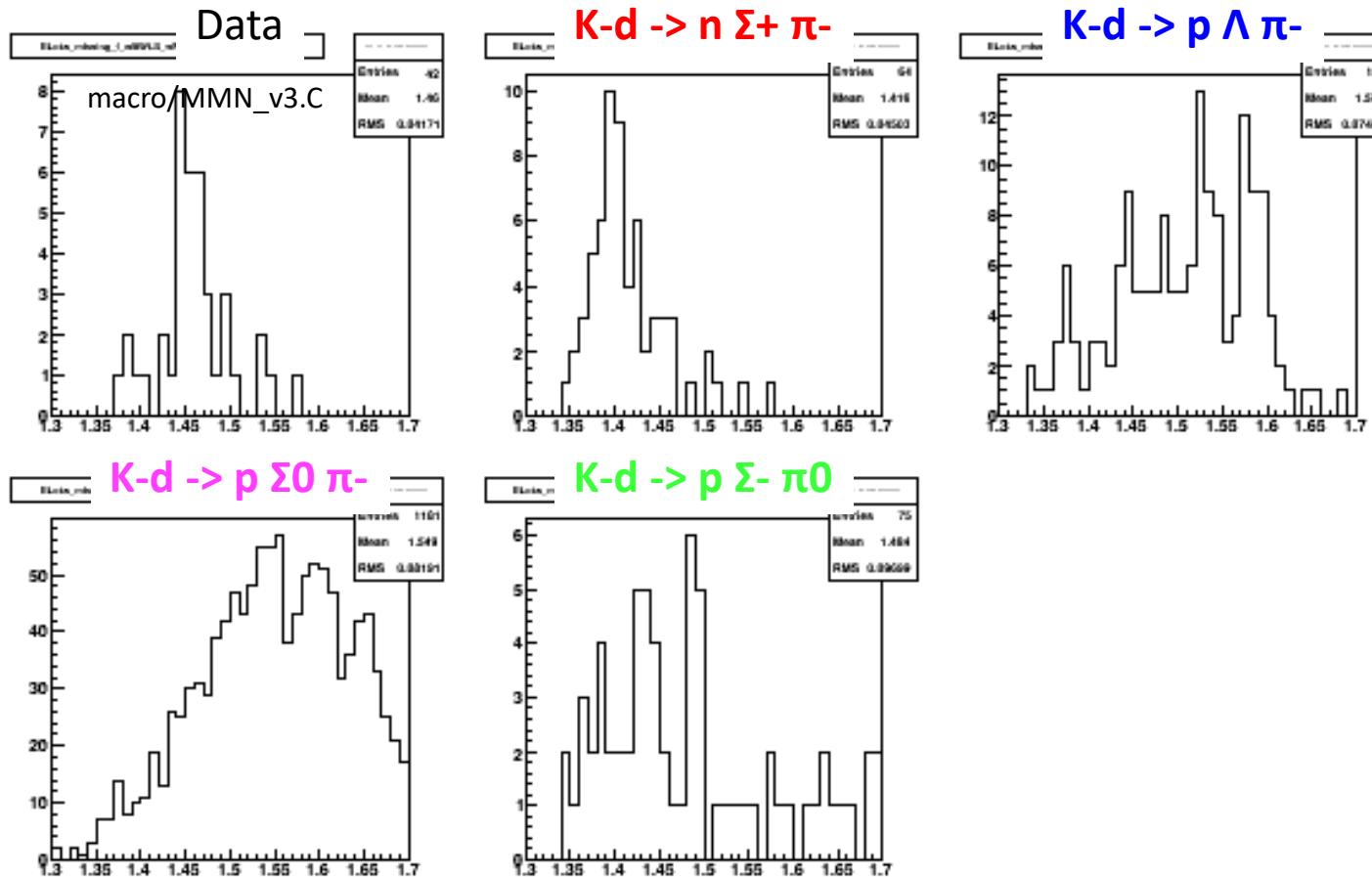
# MM. $d(K^-, n\pi^-)$ vs MM. $d(K^-, p\pi^-)$



- MM.  $d(K_-, n\pi^-)$  0.18~0.30
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

# MM. $d(K_-, n)$

$\Lambda$  side-band Ave.



# IM. ( $p, \pi^-$ ) BG estimation for $\Sigma^0\pi^0$ analysis

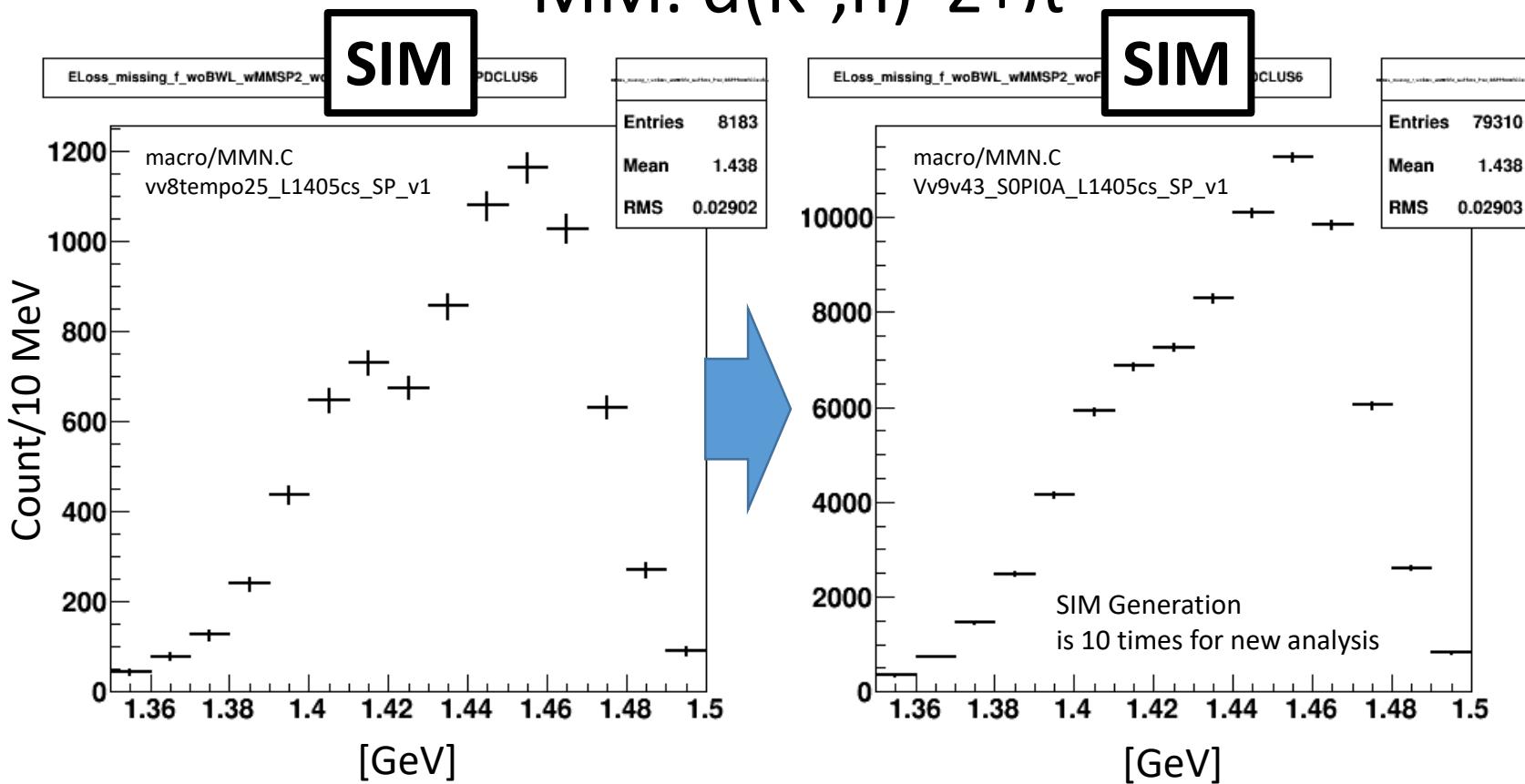
Difference from  $\Sigma^+\pi^-$

- w/o rejection of  $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$
- w/o rejection of  $\Sigma^-$  from IM. ( $n, \pi^-$ )
- Backward p, Forward n vertex is adjusted for  $\Sigma^0\pi^0$  analysis
- Target length 10  $\rightarrow$  12.5 cm
- ~~SIM is  $\Sigma^+\pi^-$  analysis temporary~~
  - Target length still 10 cm

# Spectrum of $\Sigma^+ \pi^-$

- MM.  $d(K^-, n\pi\pi^-)$  “ $\pi^0$ ”
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is selected

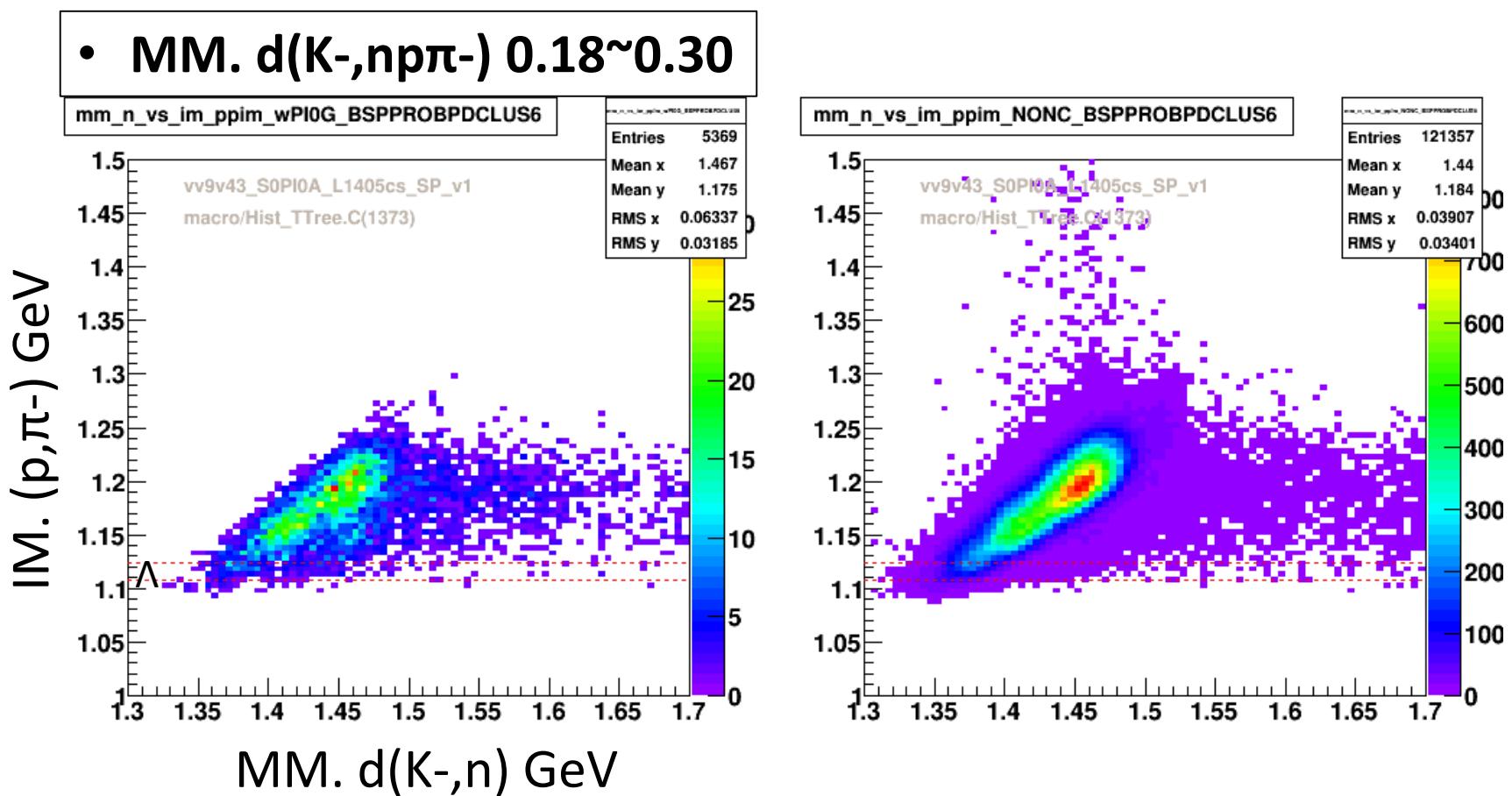
MM.  $d(K^-, n)\Sigma^+ \pi^-$



# MM. d(K-,n) vs IM. (p, $\pi$ -)

**SIM**; K-d  $\rightarrow$  n  $\Sigma + \pi^-$

- MM. d(K-,n $\pi$ ) 0.18~0.30

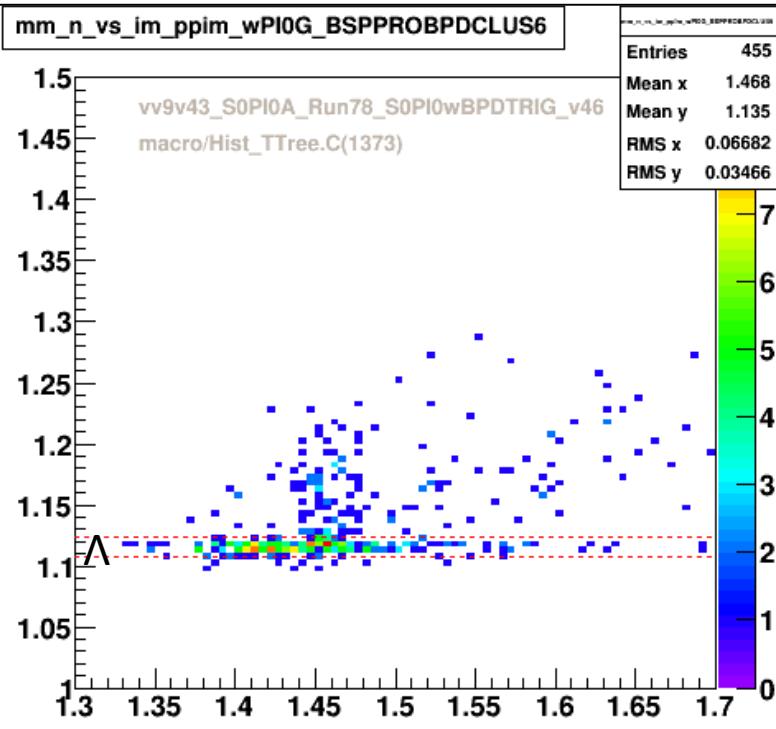


# MM. d(K-,n) vs IM. (p, $\pi$ -)

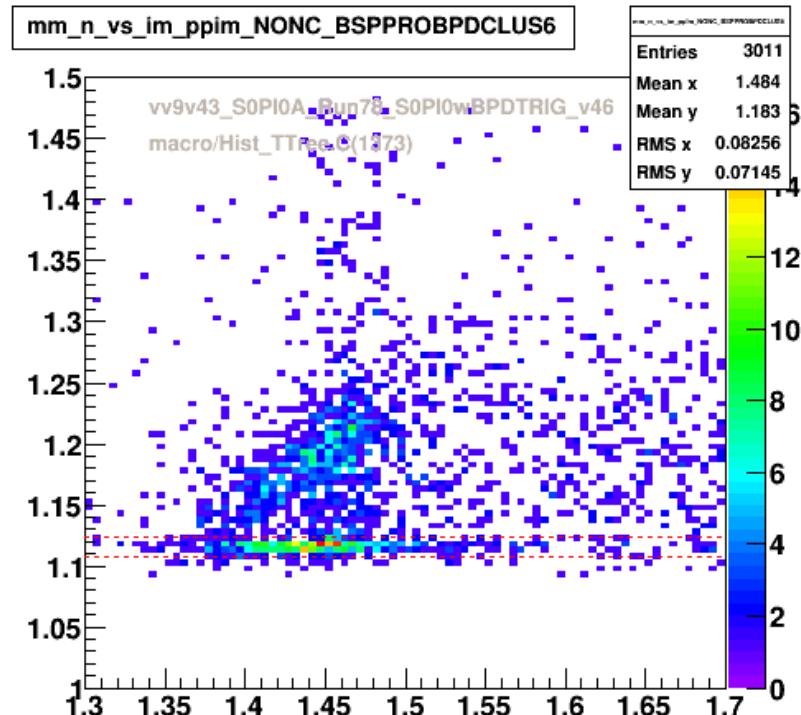
## Data

- MM. d(K-,n) 0.18~0.30

IM. (p, $\pi$ -) GeV



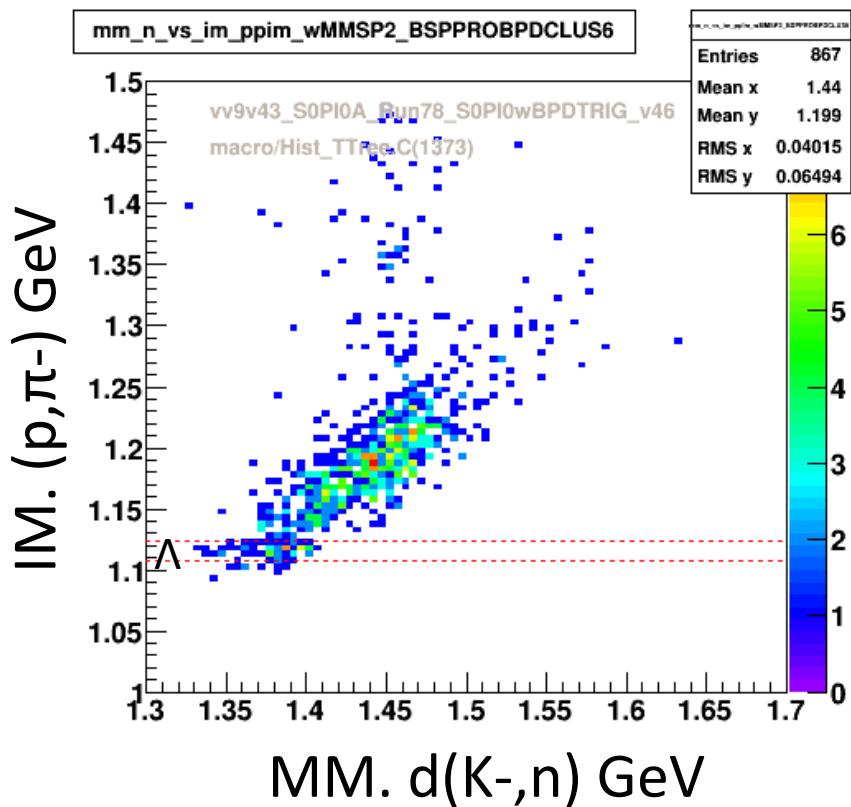
MM. d(K-,n) GeV



# MM. d(K-,n) vs IM. (p, $\pi$ -)

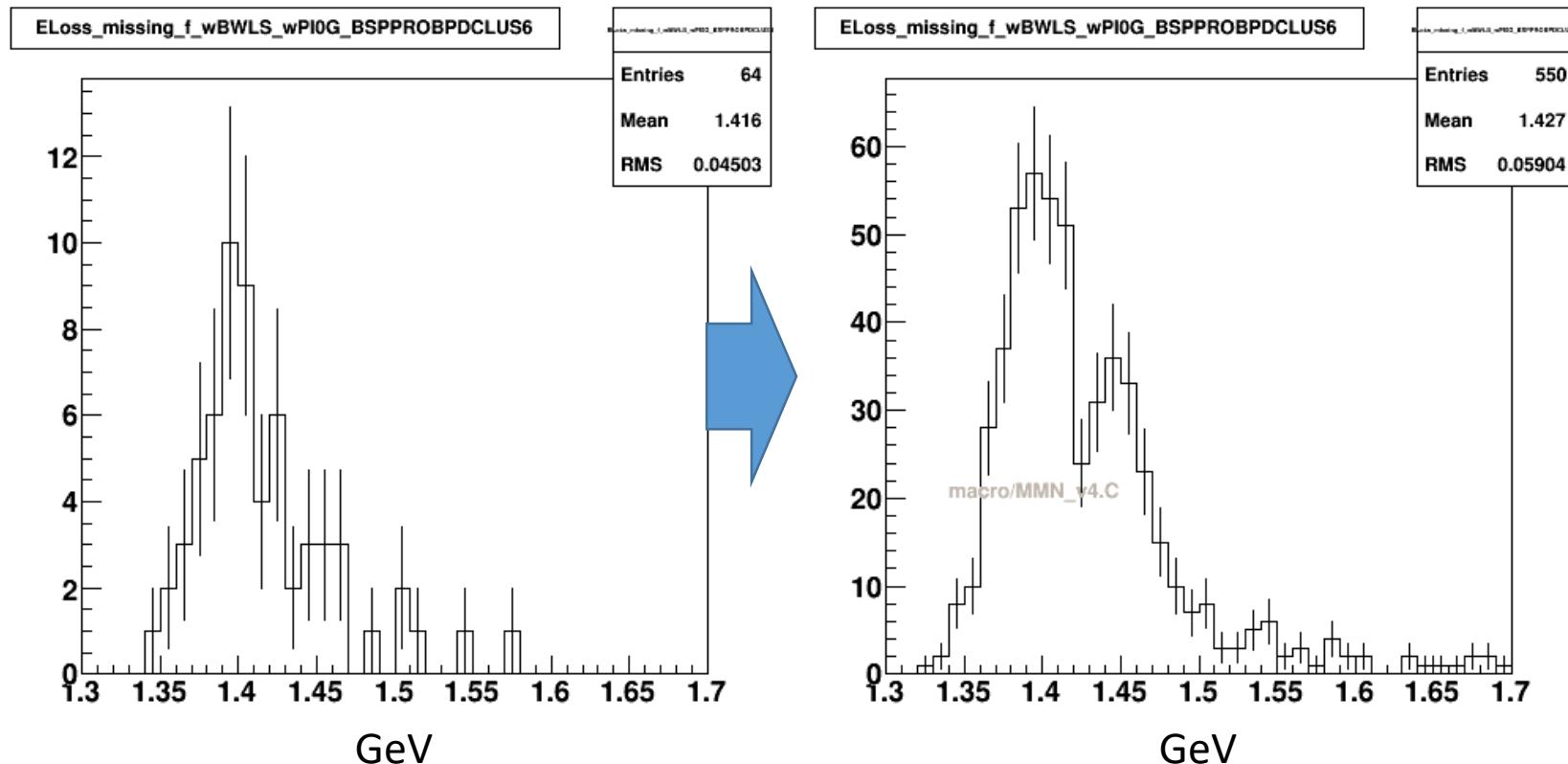
## Data

- $\Sigma^+$  from MM. d(K-,n $\pi$ -) selection



# MM. d(K-,n) $\Sigma^+ \pi^-$

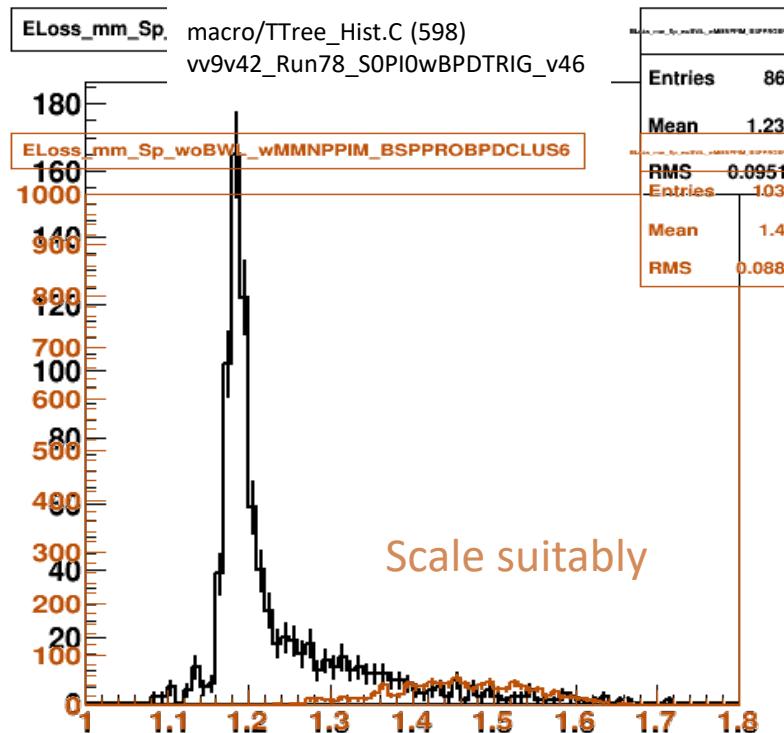
## $\Lambda$ side-band Ave.



- MM.  $d(K^-, n\pi^-) > 0$
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

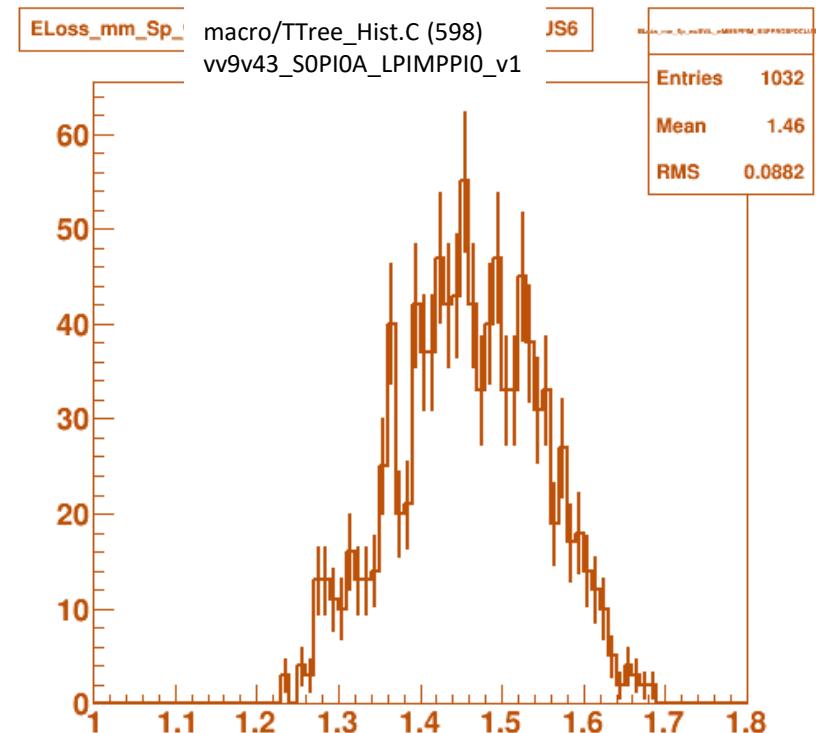
# MM. $d(K^-, n\pi^-)$

**Data**



**SIM**

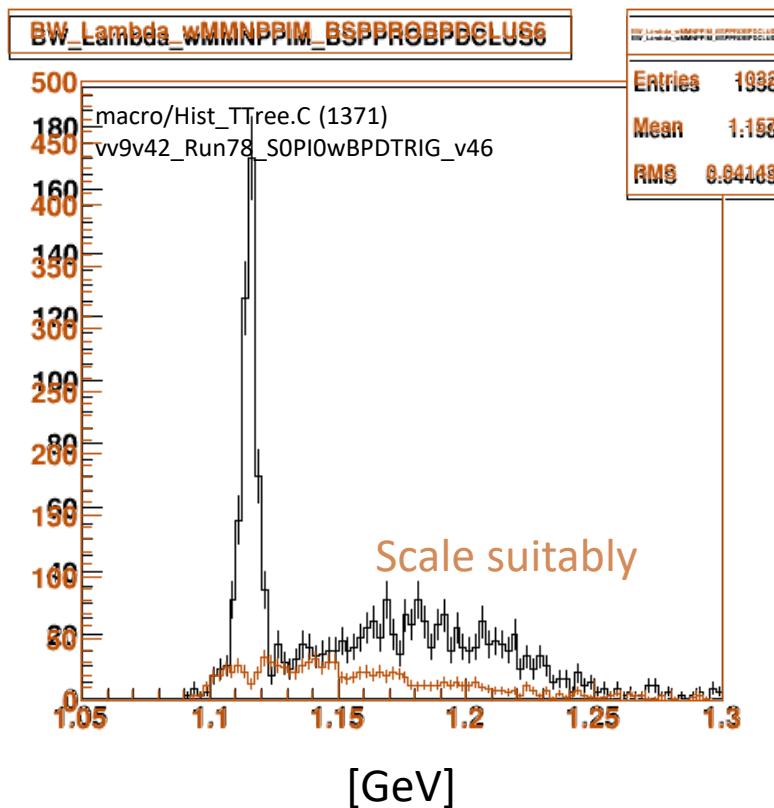
$K^- d \rightarrow p \Lambda \pi^- \pi^0$



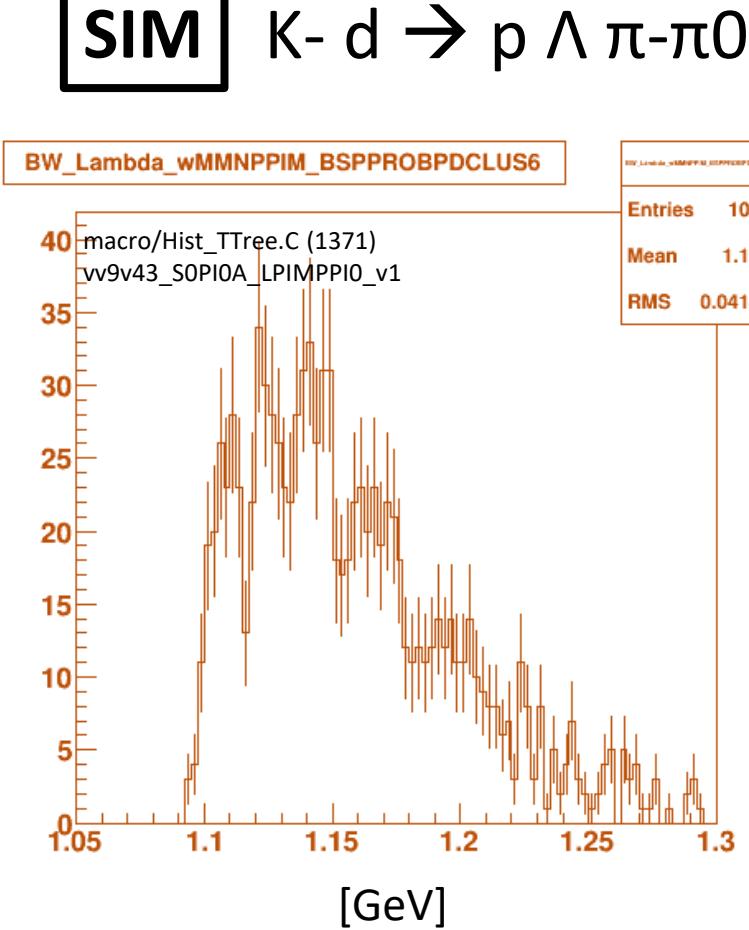
- MM.  $d(\Lambda, \pi^+\pi^-) > 0$

# IM. ( $p, \pi^-$ )

**Data**



**SIM**



# Spectrum of $\Lambda\pi^-\pi^0$

- MM.  $d(K^-, p\pi^-)$   $0.18 \sim 0.30$  GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected

MM.  $d(K^-, p)\Lambda\pi^-\pi^0$

Data

macro/Hist\_TTree.C (1296)  
vv9v42\_Run78\_SOPI0wBPDTRIG\_v46

SIM

macro/Hist\_TTree.C (1296)  
Vv8tempo45\_LPIMP\_v4

Count/10 MeV

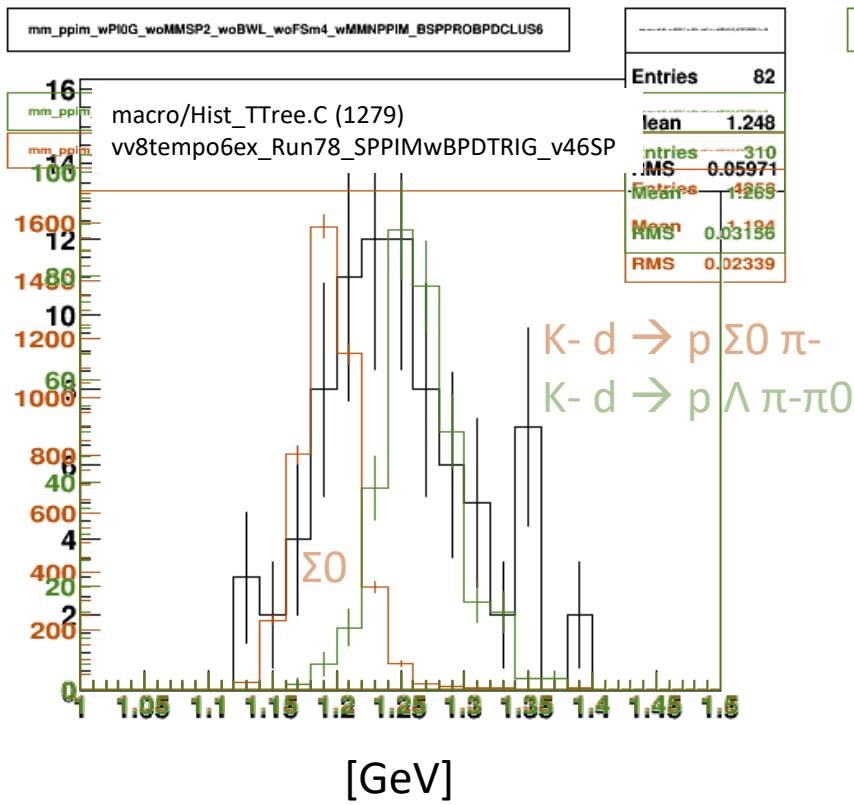
[GeV]

[GeV]

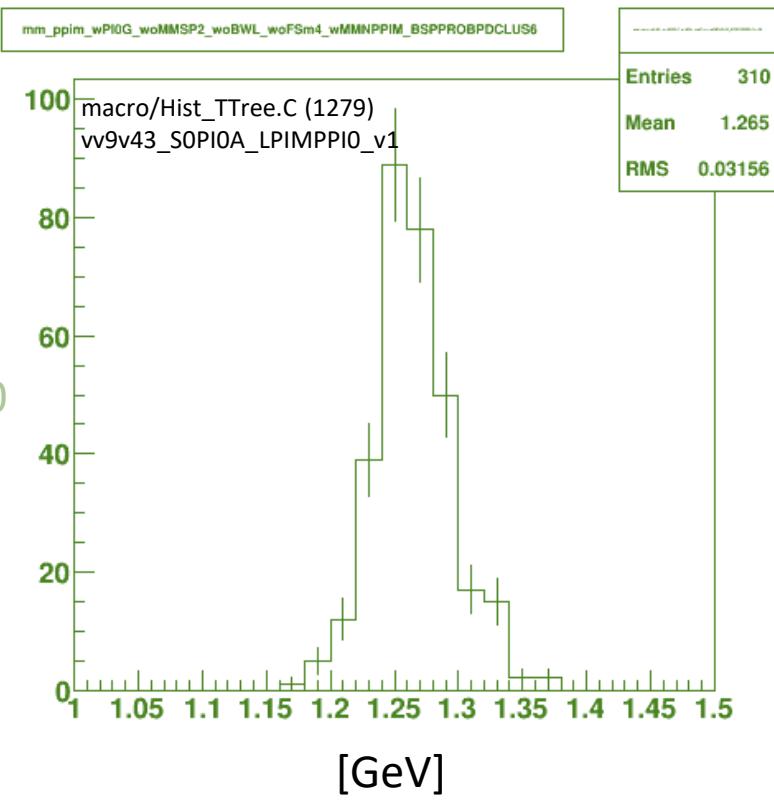
# MM. $d(K^-, p\pi^-)$

- MM.  $d(K^-, \eta\eta\pi^-)$  0.18~0.30 GeV
- $\Sigma^-$  from IM.  $(\eta, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, \eta\eta\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected

**Data**

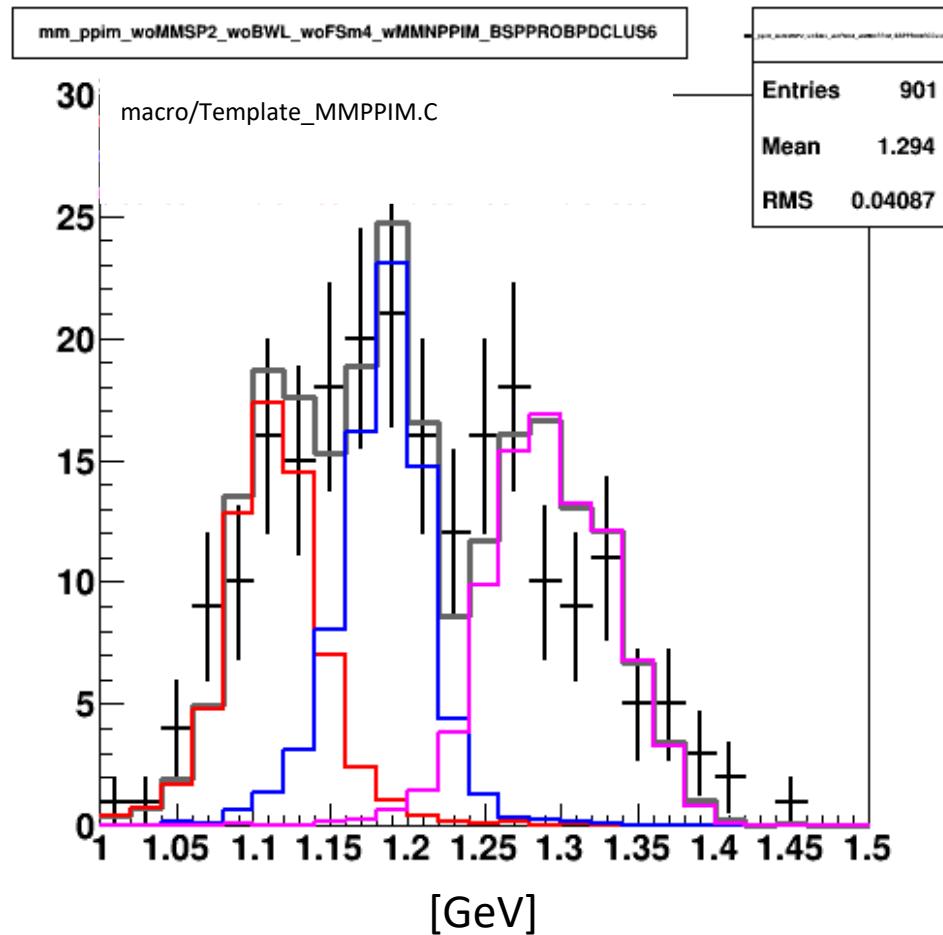


**SIM**



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

# Fitting of MM. $d(K^-, p\pi^-)$



## † Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- Fit Result

Scaling factor of SIM is free

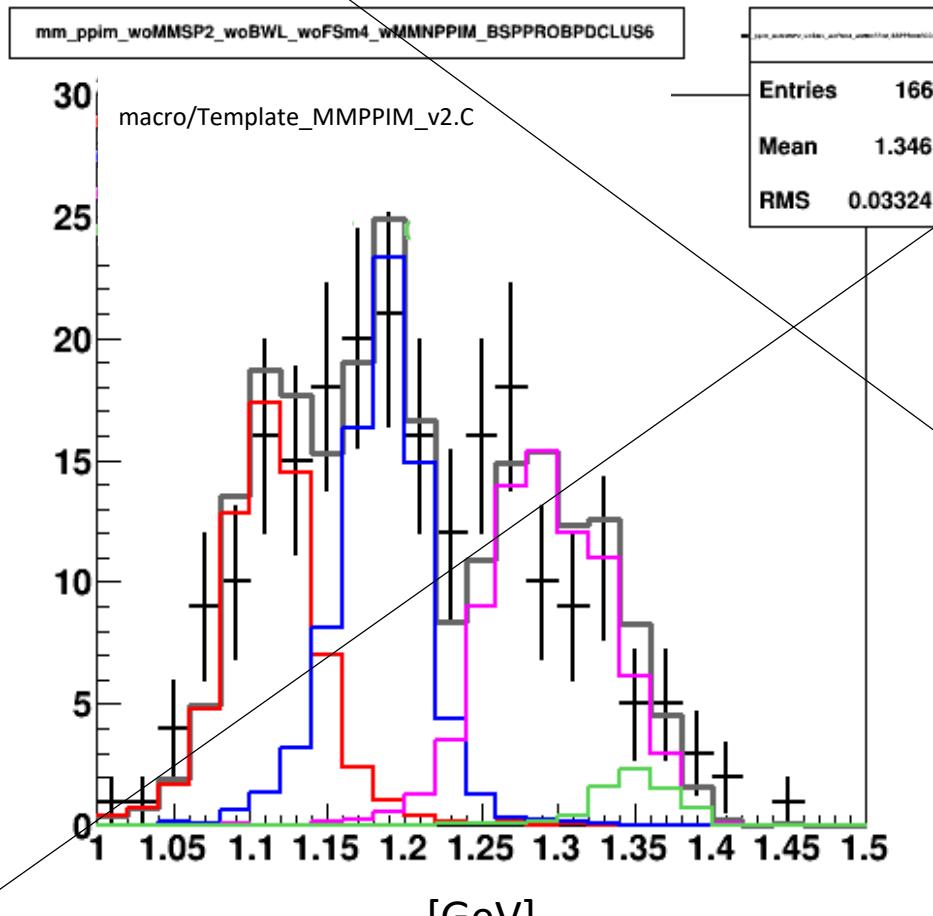
Fit Range

1.00 ~ 1.50 GeV

Chi2/ndf = 31.21/25

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

# Fitting of MM. $d(K^-, p\pi^-)$



† Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- Fit Result

Scaling factor of SIM is free

Fit Range  
1.00 ~ 1.50 GeV

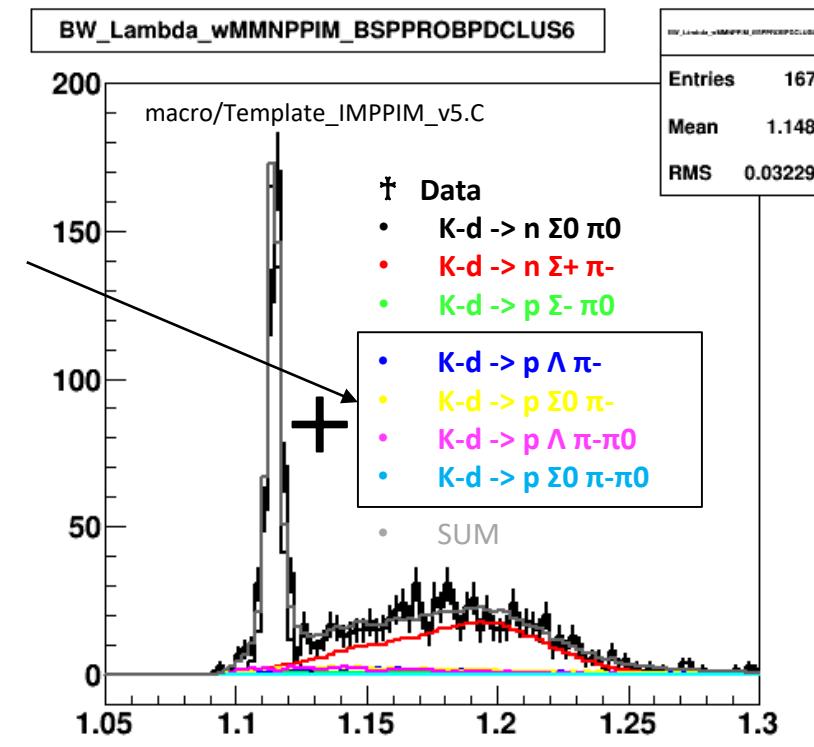
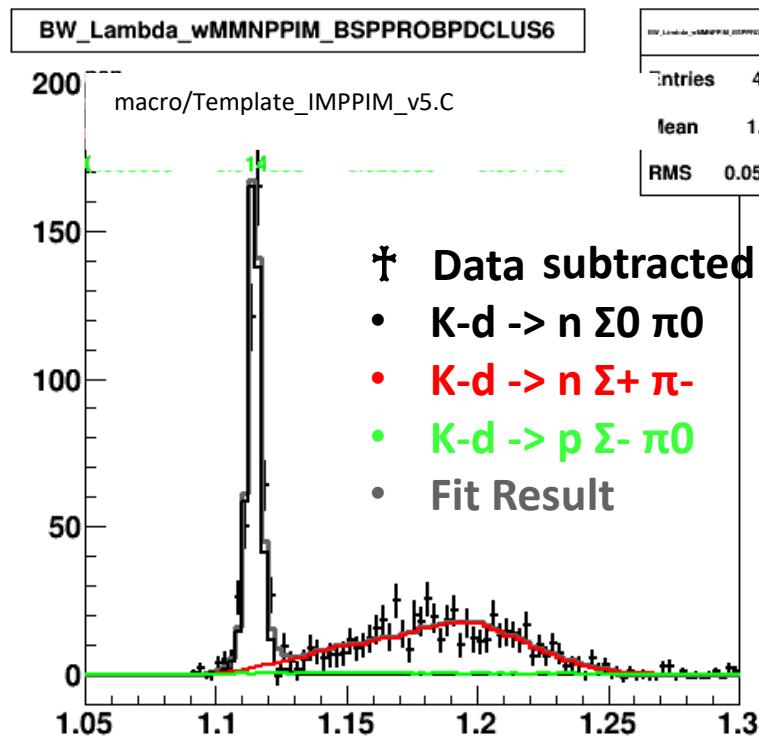
$\chi^2/ndf = 29.84/25$

$K-d \rightarrow p \Lambda \pi^- \pi^0, K-d \rightarrow p \Sigma^0 \pi^- \pi^0$  の  $\Lambda$  rejection が入ってない。

- MM.  $d(K, \eta\pi\pi) > 0$

# Fitting of IM. ( $p, \pi^-$ )

- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Sigma^+ \pi^-$ ,  $K-d \rightarrow p \Sigma^- \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^-\pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^-\pi^0$



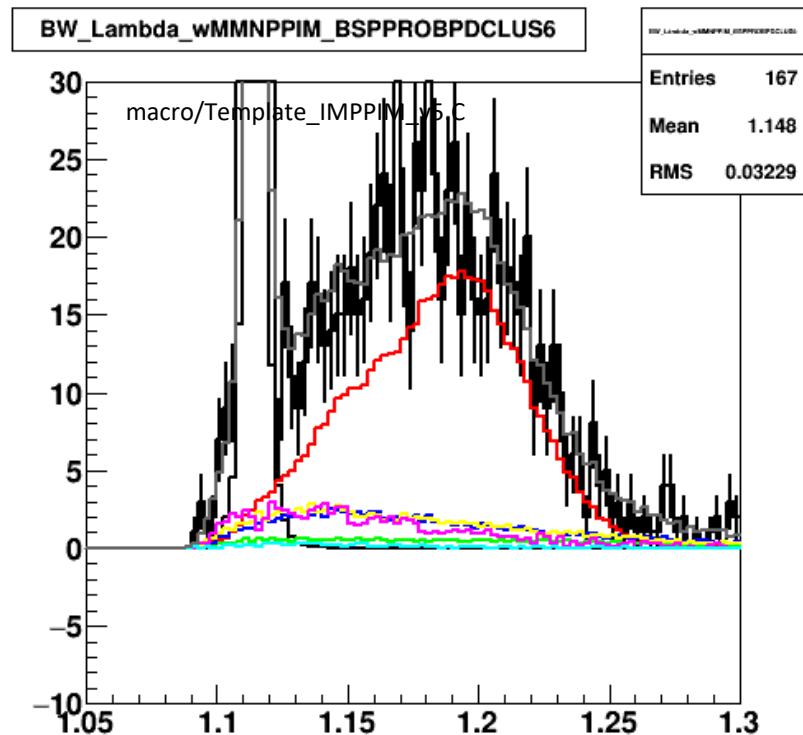
Scaling factor of SIM is free

Fit Range

1.09 ~ 1.25 GeV

- MM.  $d(K, \pi\pi) > 0$

# Scale change



- † Data
- $K-d \rightarrow n \Sigma 0 \pi 0$
  - $K-d \rightarrow n \Sigma + \pi -$
  - $K-d \rightarrow p \Lambda \pi - \pi 0$
  - $K-d \rightarrow p \Sigma - \pi 0$

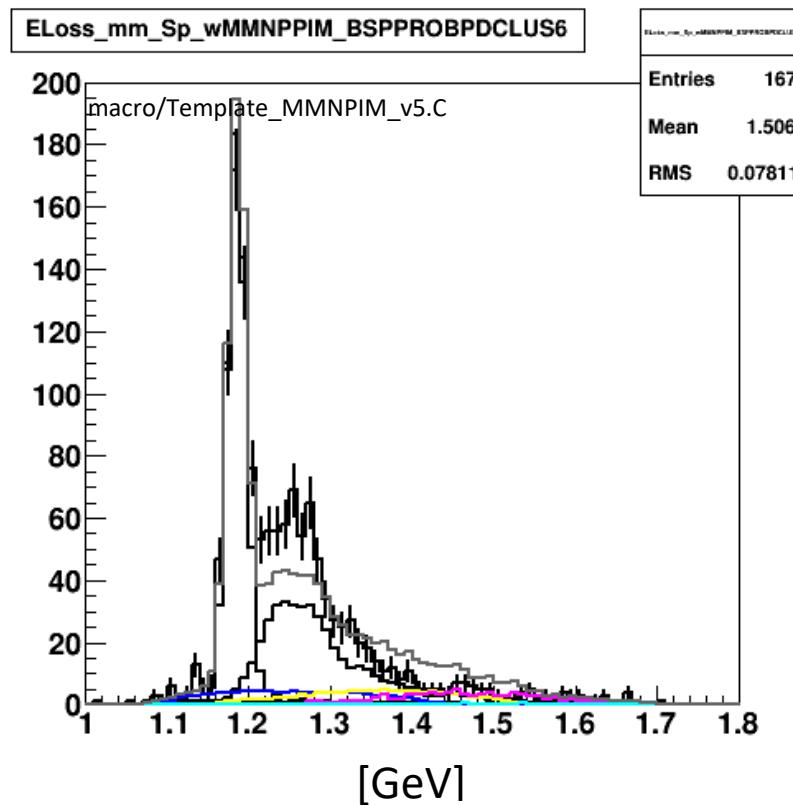


- $K-d \rightarrow p \Lambda \pi -$
- $K-d \rightarrow p \Sigma 0 \pi -$
- $K-d \rightarrow p \Lambda \pi - \pi 0$
- $K-d \rightarrow p \Sigma 0 \pi - \pi 0$  658

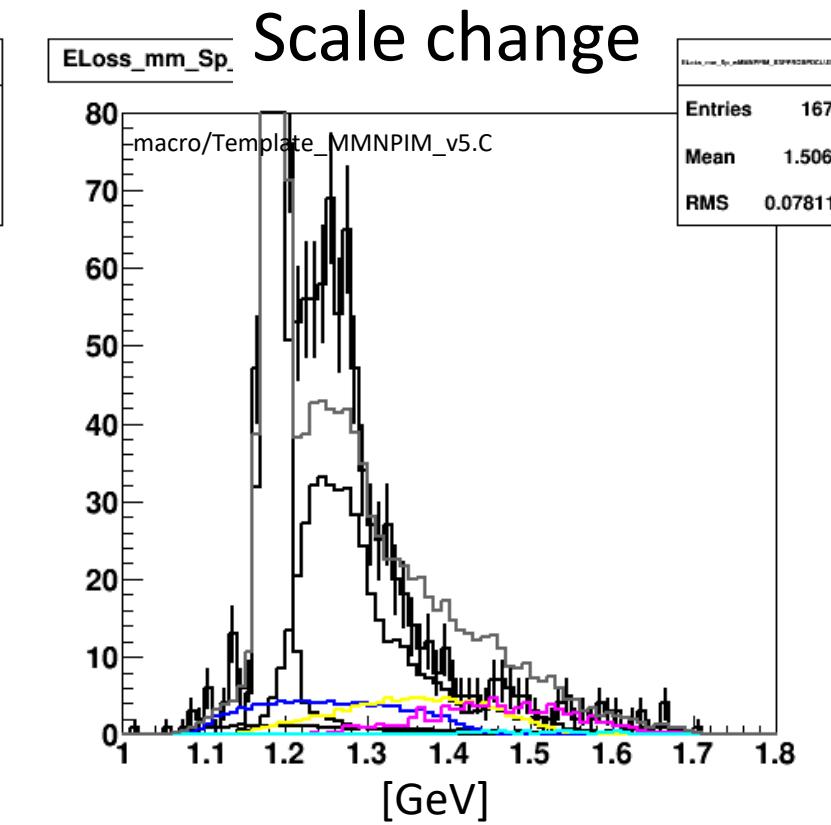
- SUM

- MM.  $d(K_-, n\pi^-) > 0$

# MM. $d(K_-, n\pi^-)$



- † Data
- $K-d \rightarrow p \Lambda \pi^-$
  - $K-d \rightarrow p \Sigma^0 \pi^-$
  - $K-d \rightarrow p \Lambda \pi^+ \pi^-$
  - $K-d \rightarrow p \Sigma^- \pi^0$



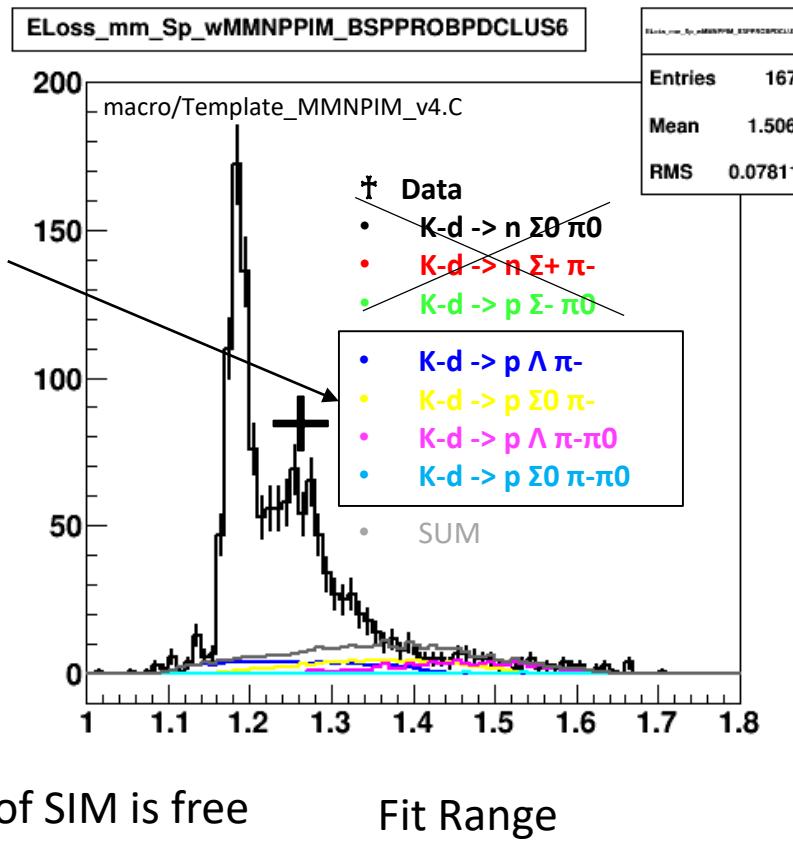
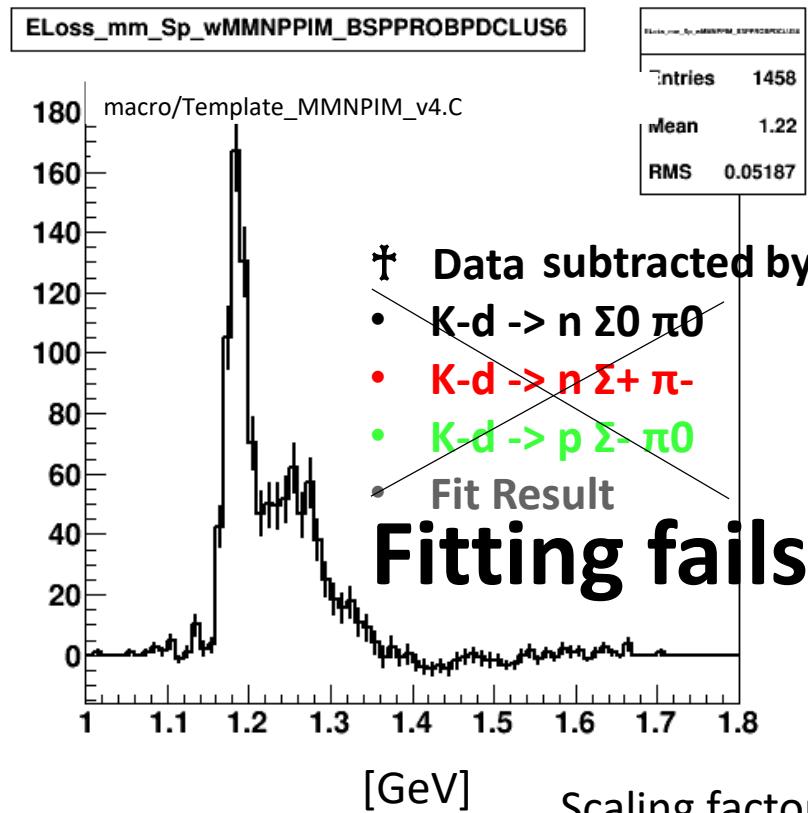
- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^+ \pi^-$
- $K-d \rightarrow p \Sigma^- \pi^0$

- SUM

- MM.  $d(K^-, n\pi^-) > 0$

# Fitting of MM. $d(K^-, n\pi^-)$

- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Sigma^+ \pi^-$ ,  $K-d \rightarrow p \Sigma^- \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^- \pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$



Chi2/ndf =

660

- MM.  $d(K^-, np\pi^-)$  0.18~0.30
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

# MM. $d(K^-, n)$

## $\Lambda$ side-band Ave.

Data

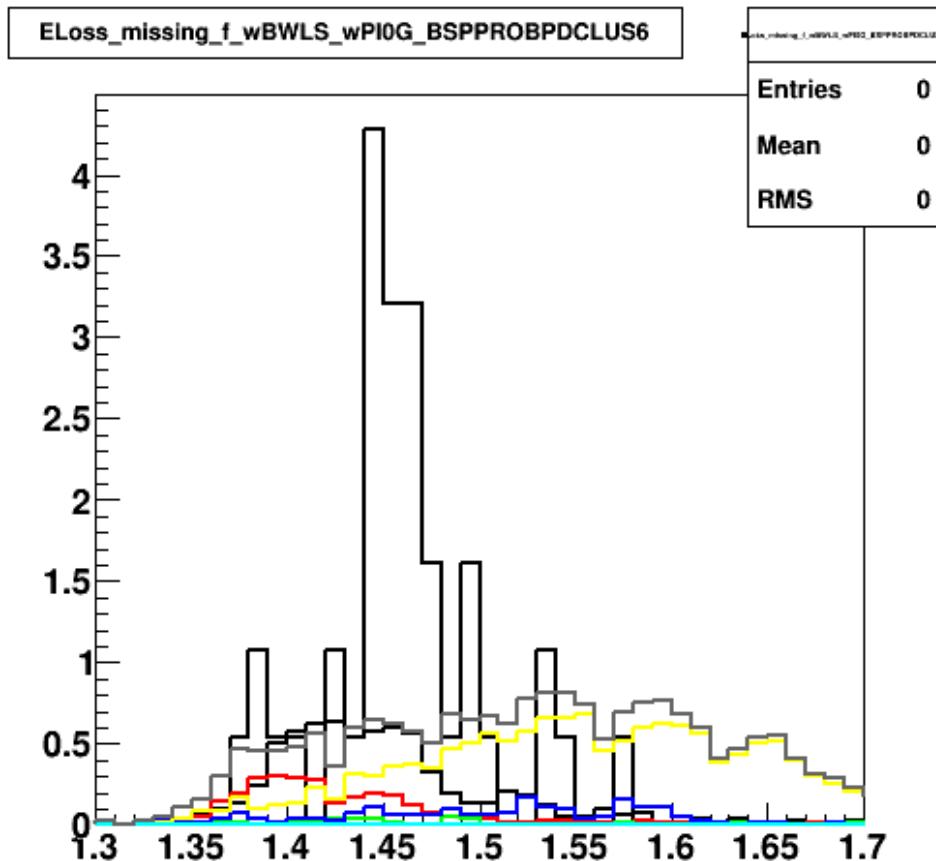
$K-d \rightarrow n \Sigma^+ \pi^-$

$K-d \rightarrow p \Lambda \pi^-$

macro/MMN\_v5.C

$K-d \rightarrow p \Sigma^0 \pi^-$

$K-d \rightarrow p \Sigma^- \pi^0$



# To do

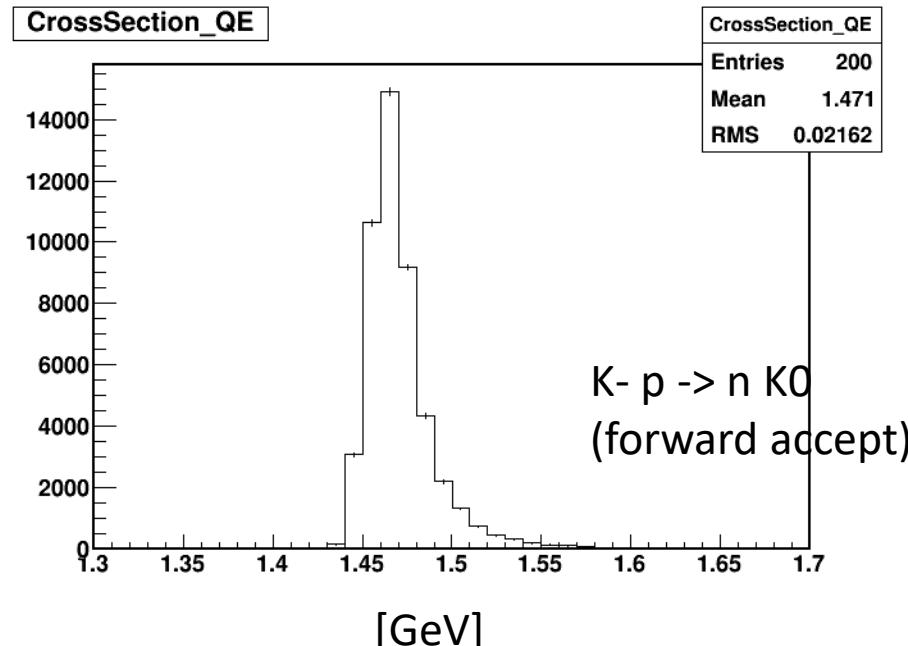
- Check another possibilities
  - Check NC layer hit pattern & tail ratio w/ calculation of multi scat. probability
  - SIM can explain that the tail comes from NC response or not ?
  - Slow scattered charged particle @ before layer less than Thre.
  - $K-p \rightarrow \Delta K_0_L$  ( $K_0_L$  hit NC)

# SIM

K- br

1	6.35200e-01	mu-	nu_mu
2	2.11600e-01	pi-	pi0
3	5.59000e-02	pi-	pi- pi+
4	1.73000e-02	pi-	pi0 pi0
5	4.82000e-02	nu_e	e- pi0
6	3.18000e-02	nu_mu	mu- pi0

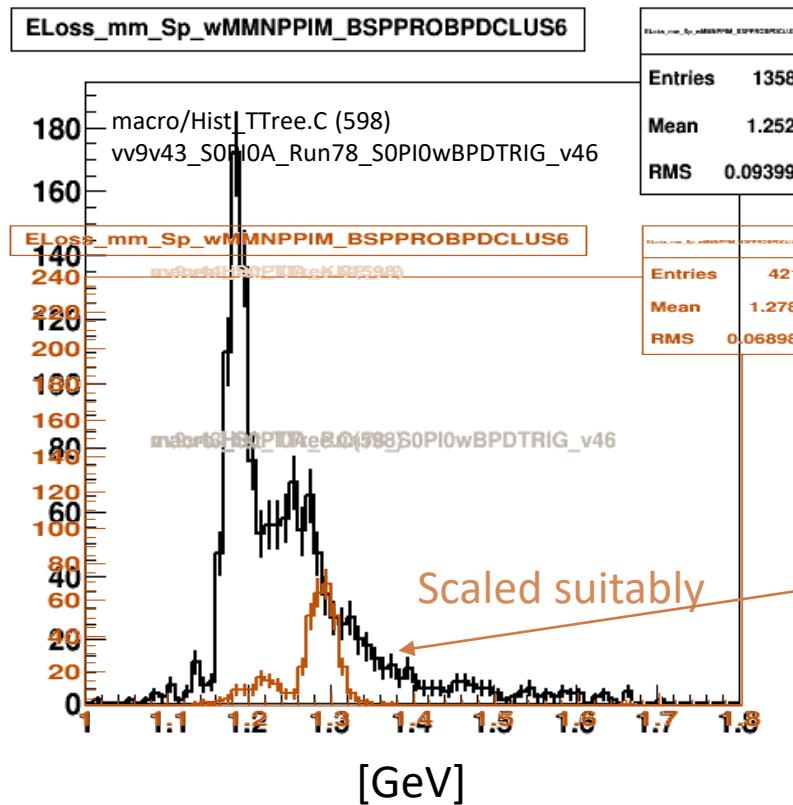
- $K^- d \rightarrow n K^- p$ 
  - Forward neutron -quasi-elastic
  - K- br same as knucl default
  - K-p mass distribution



- MM.  $d(K^-, np\pi^-) > 0$

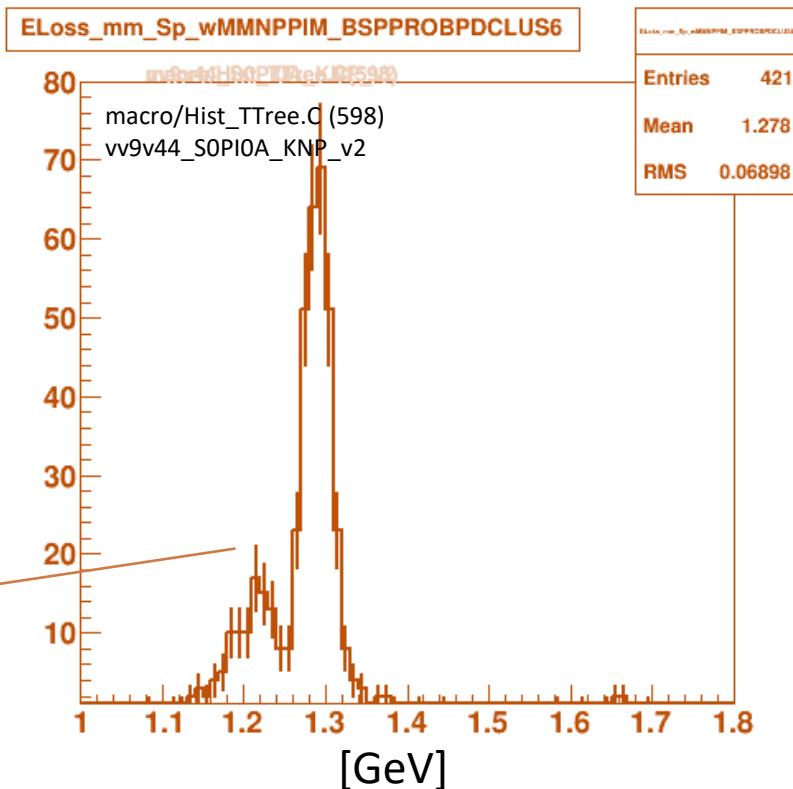
# MM. $d(K^-, np\pi^-)$

**Data**



**SIM**

$K-d \rightarrow n K-p$

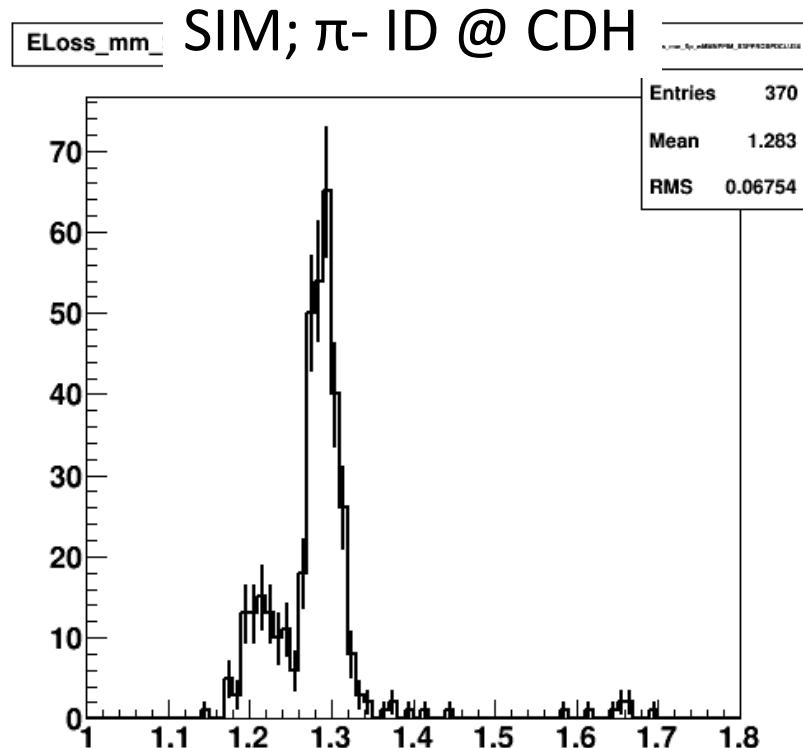
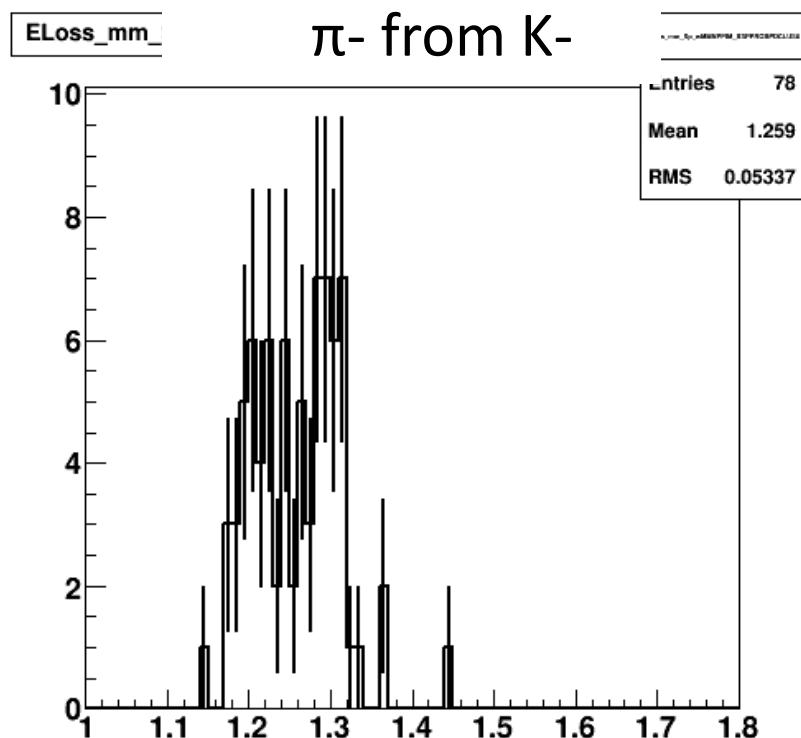


# MM. $d(K^-, n\pi^-)$ w/ SIM Info

**SIM**

$K-d \rightarrow n K-p$

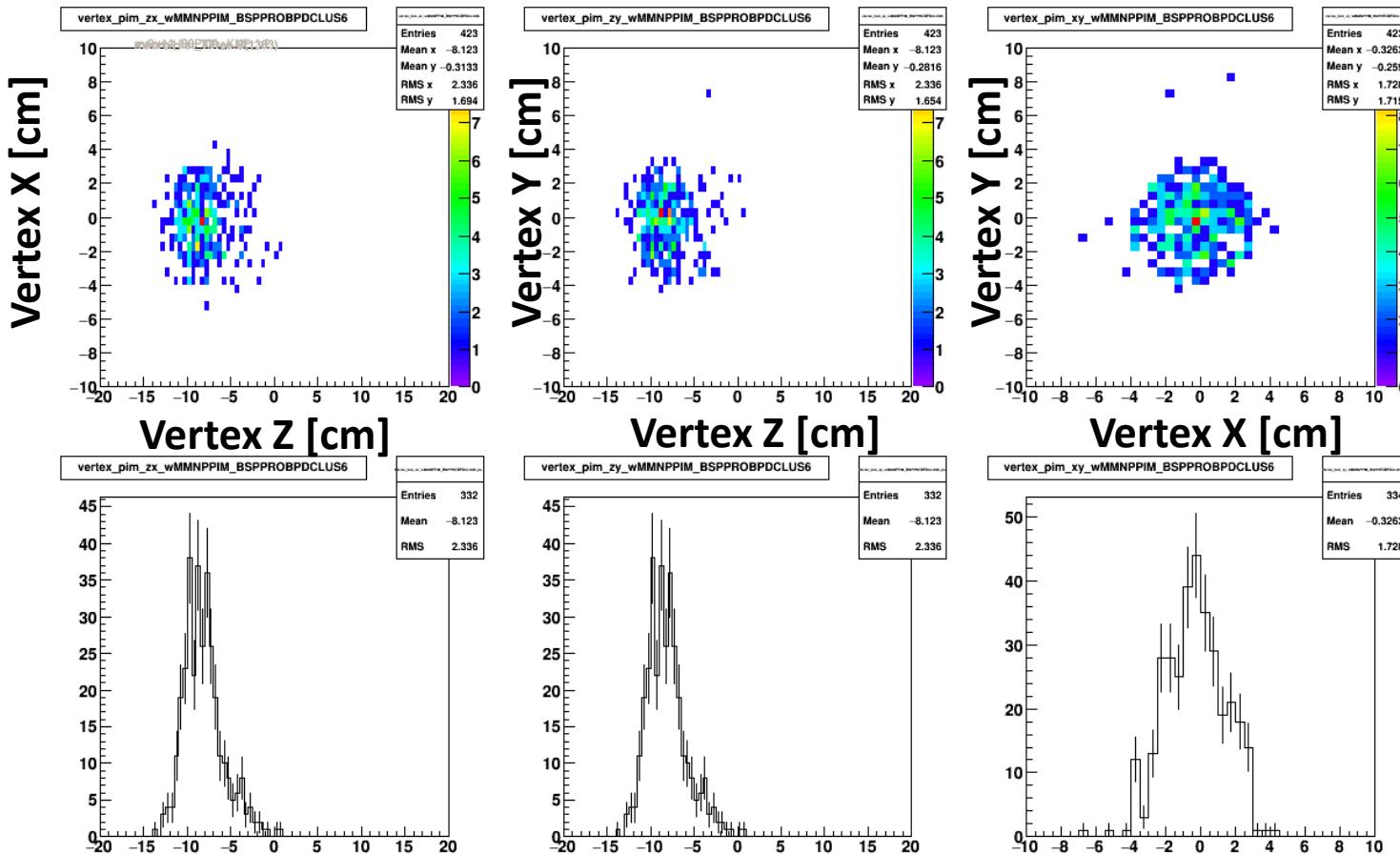
SIM;  $\pi^-$  ID @ CDH



- MM.  $d(K_-, np\pi^-) > 0$

# Vertex $\pi^-$ from SIM value

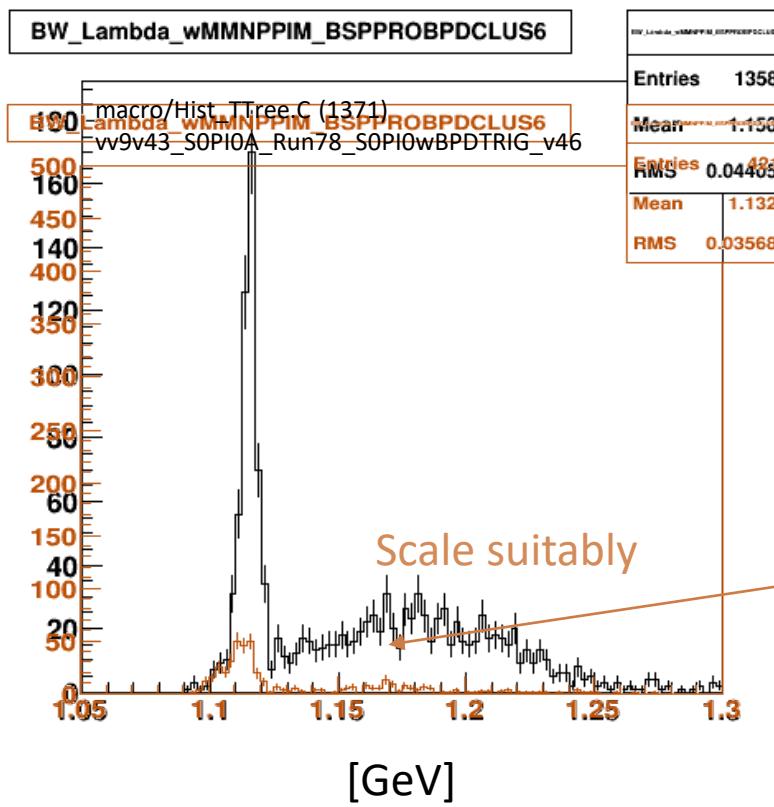
**SIM**  $K-d \rightarrow n K-p$



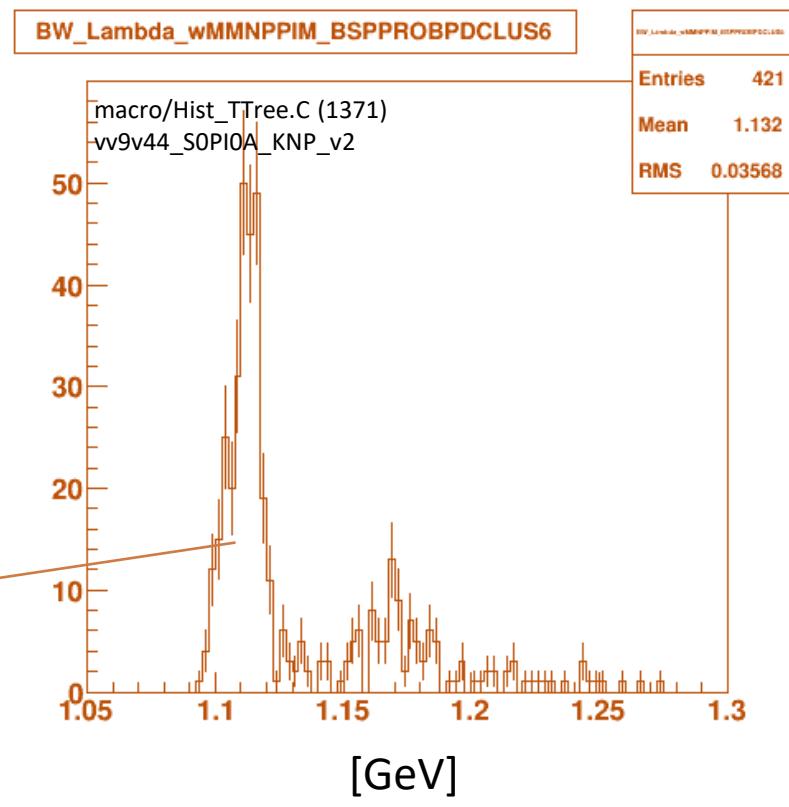
- MM.  $d(K, \eta\pi\pi) > 0$

# IM. ( $p, \pi^-$ )

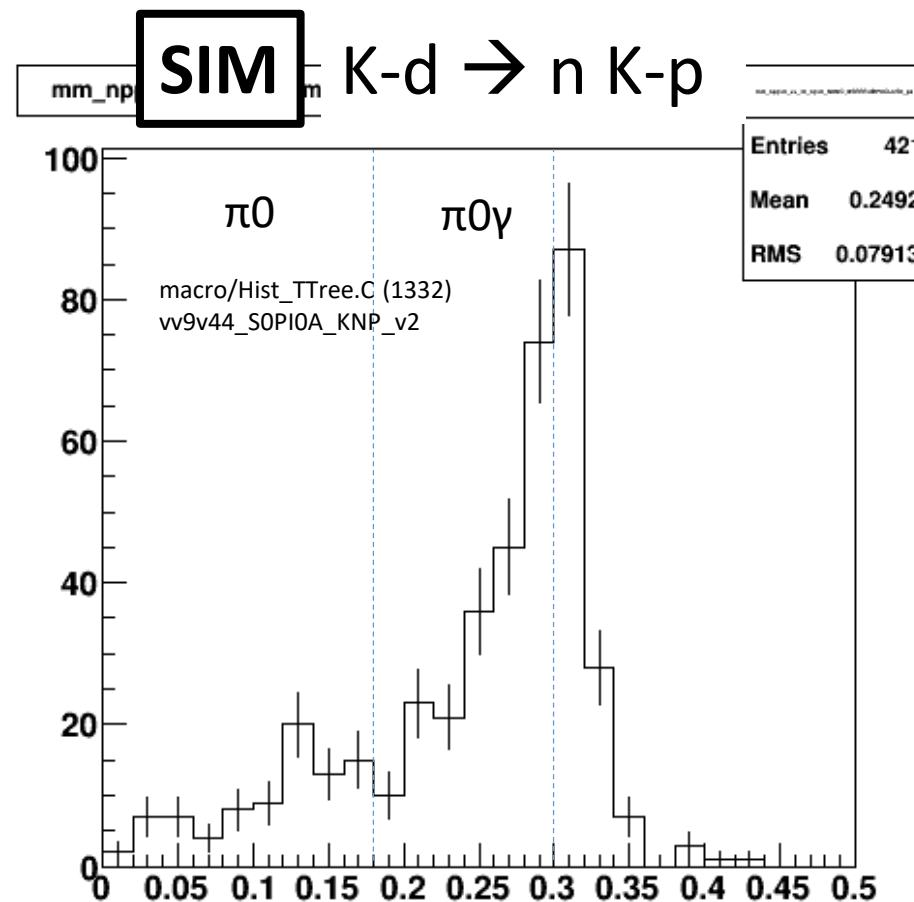
**Data**



**SIM**  $K-d \rightarrow n K-p$



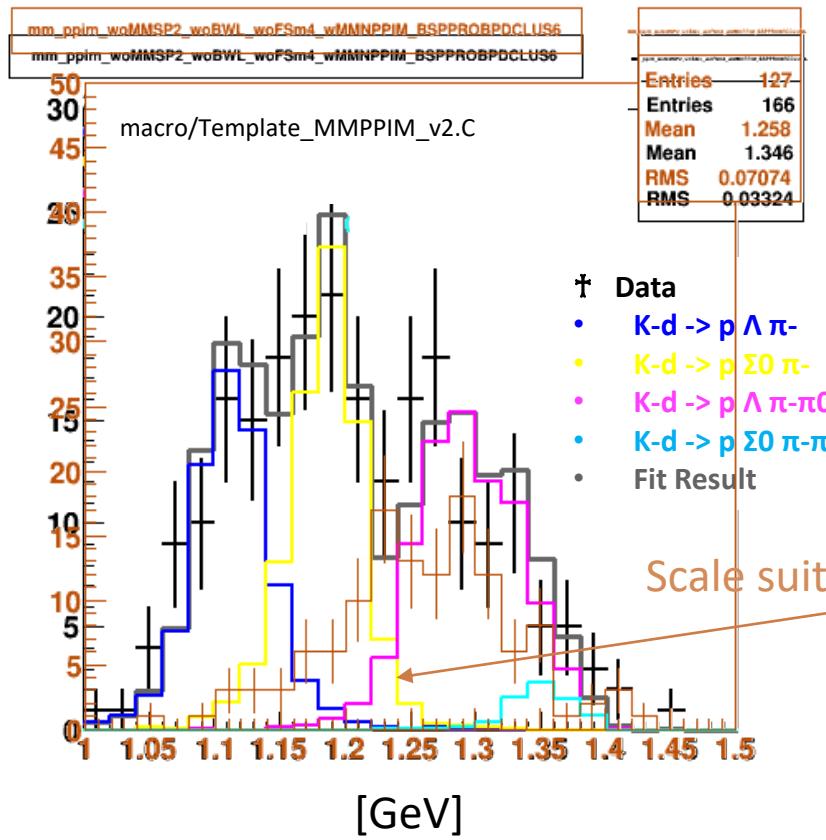
# MM. d(K-, npπ-)



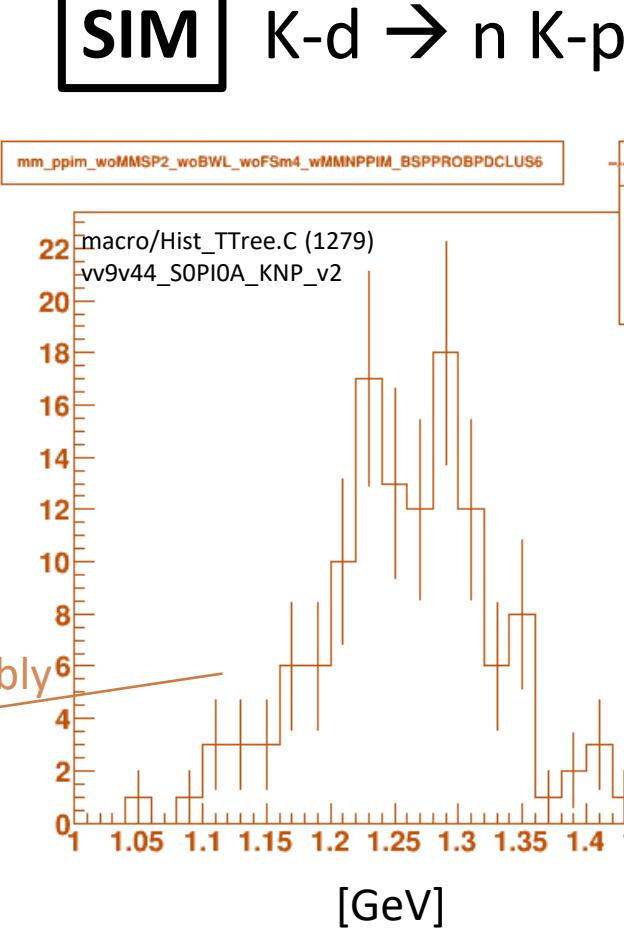
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

# MM. $d(K^-, p\pi^-)$

**Data**



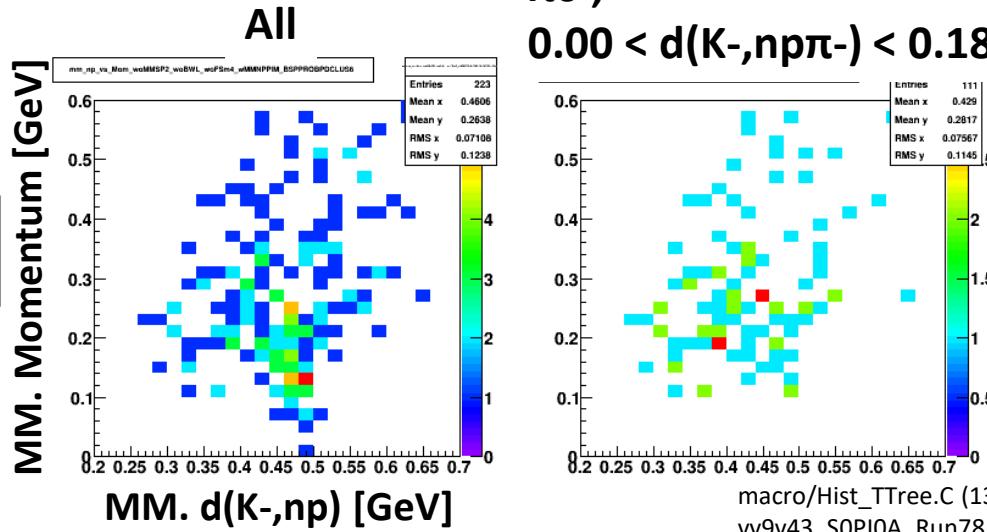
**SIM**



# MM. d(K-,np) vs MM. Momentum

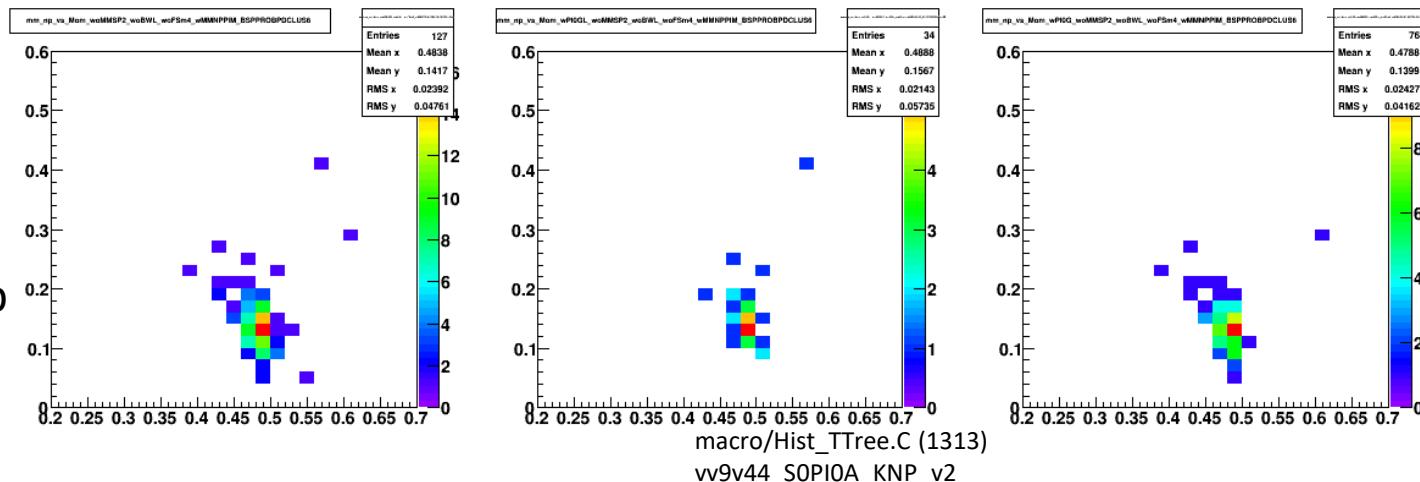
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

Data



SIM

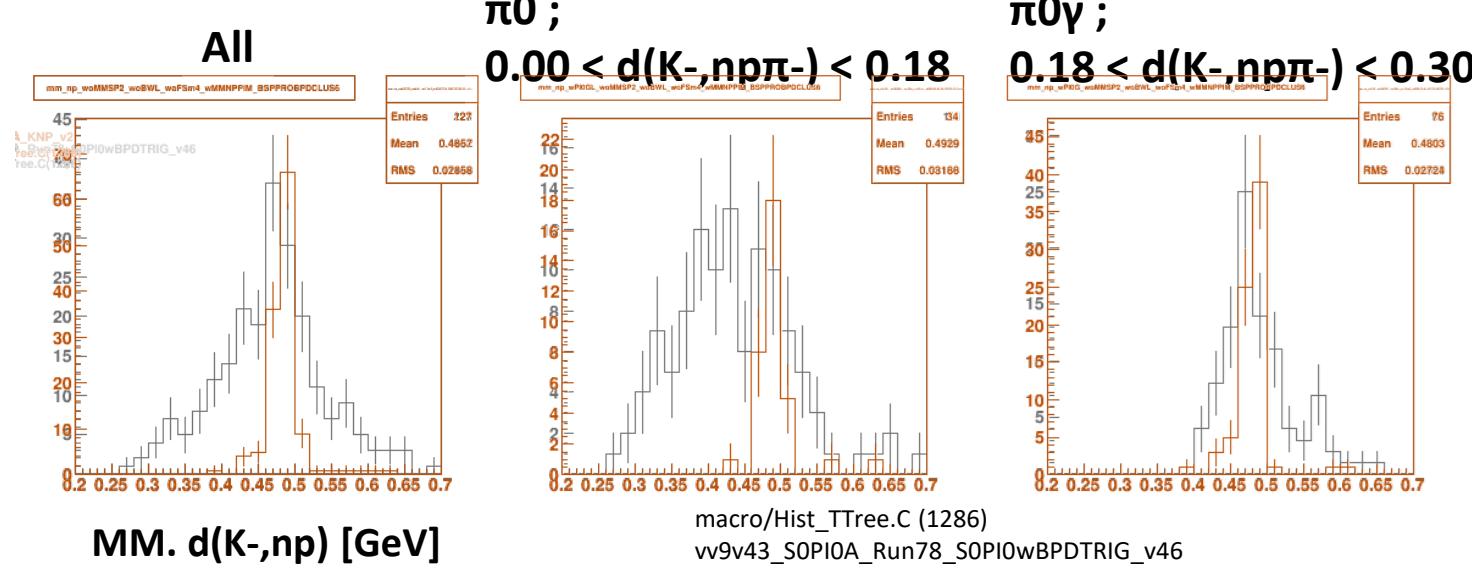
$K-d \rightarrow n K-p$



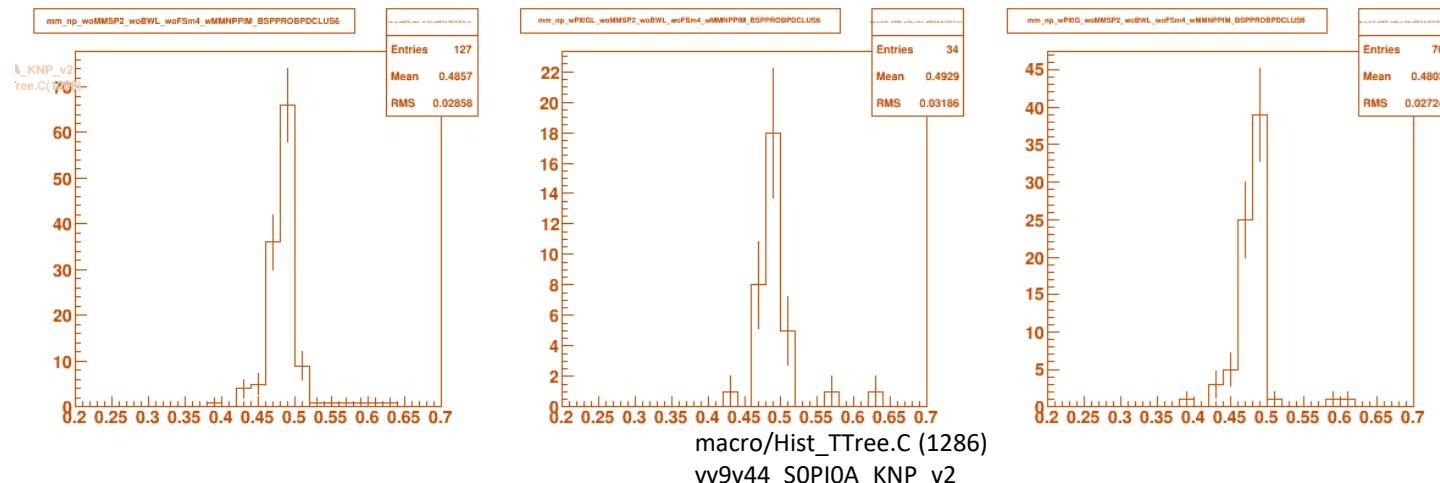
# MM. $d(K_-, np)$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

Data



SIM

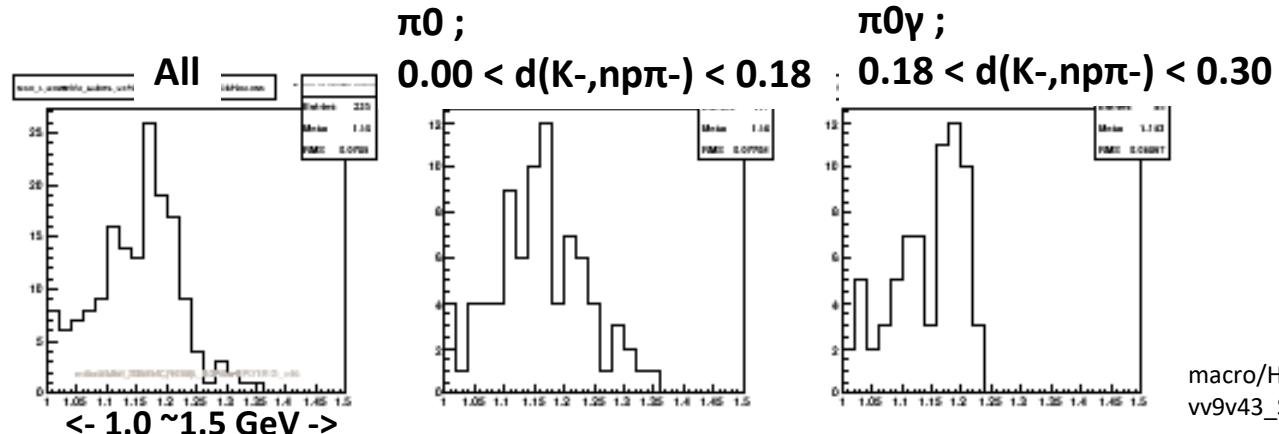


# Momentum distribution

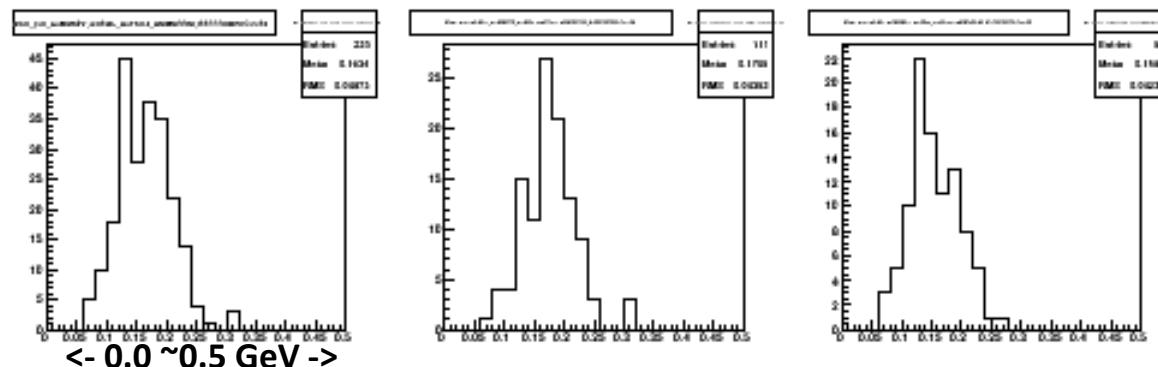
- $\Sigma$ - from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

Data

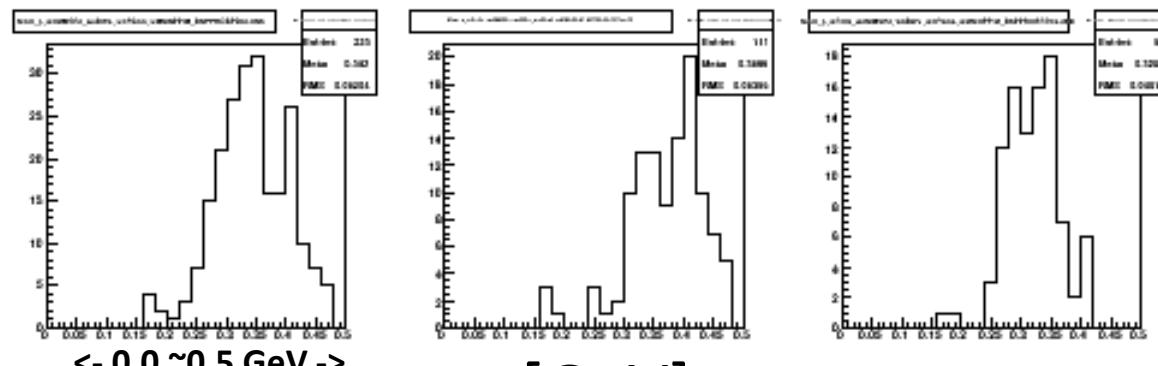
$n$



$\pi^-$



$p$



[GeV]

macro/Hist\_TTree.C (1274)  
vv9v43\_S0PI0A\_Run78\_S0PI0wBPD

# Momentum distribution

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

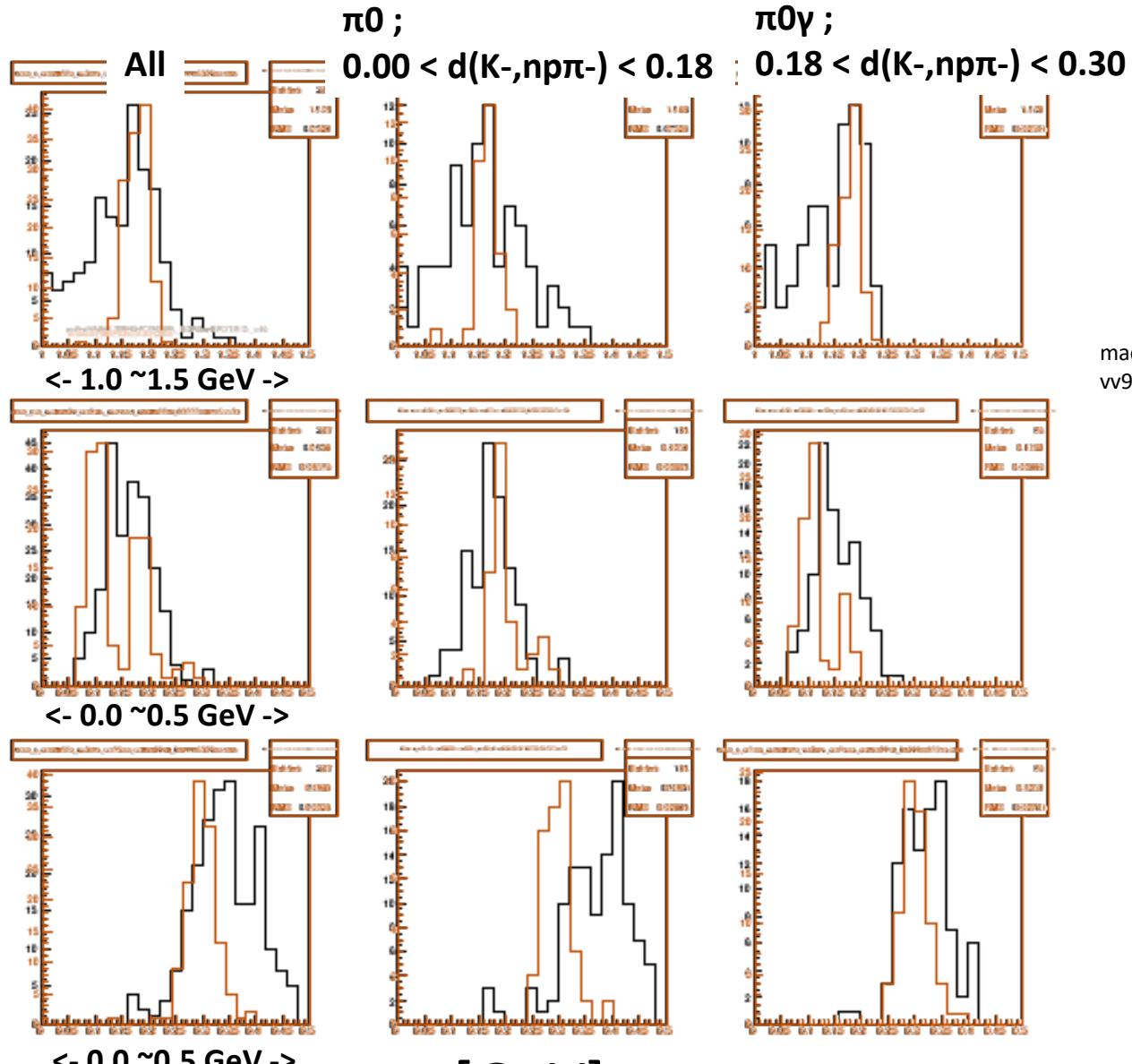
**SIM**

$K-d \rightarrow n K-p$

$n$

$\pi^-$

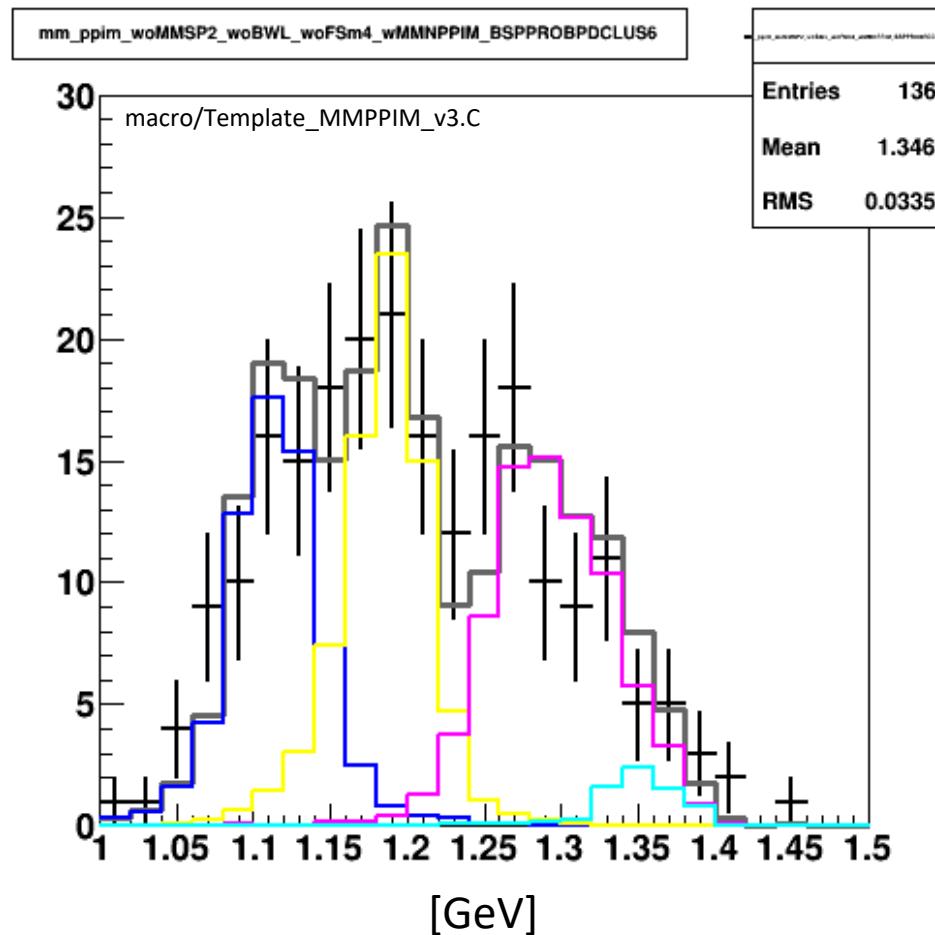
$p$



macro/Hist\_TTree.C (1274)  
vv9v44\_SOPI0A\_KNP\_v2

# Fitting of MM. $d(K^-, p\pi^-)$

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected



## † Data

- $K^-d \rightarrow p \Lambda \pi^-$
- $K^-d \rightarrow p \Sigma^0 \pi^-$
- $K^-d \rightarrow p \Lambda \pi^- \pi^0$
- $K^-d \rightarrow p \Sigma^0 \pi^- \pi^0$

## Fit Result

Scaling factor of SIM is free

Fit Range

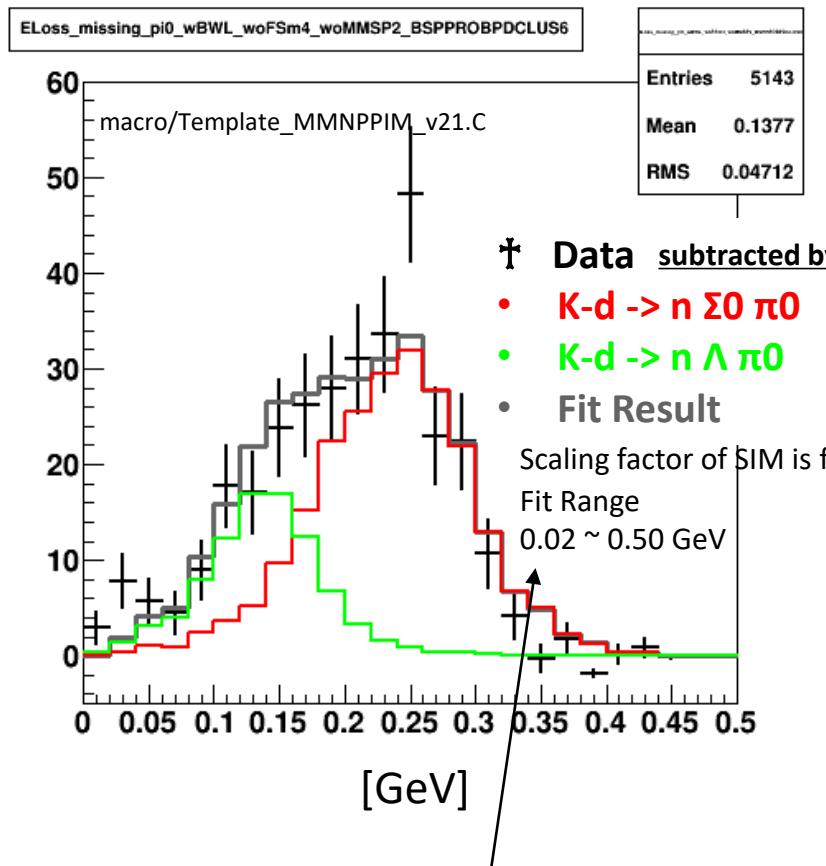
1.00 ~ 1.50 GeV

$\text{Chi}^2/\text{ndf} = 29.76/25$

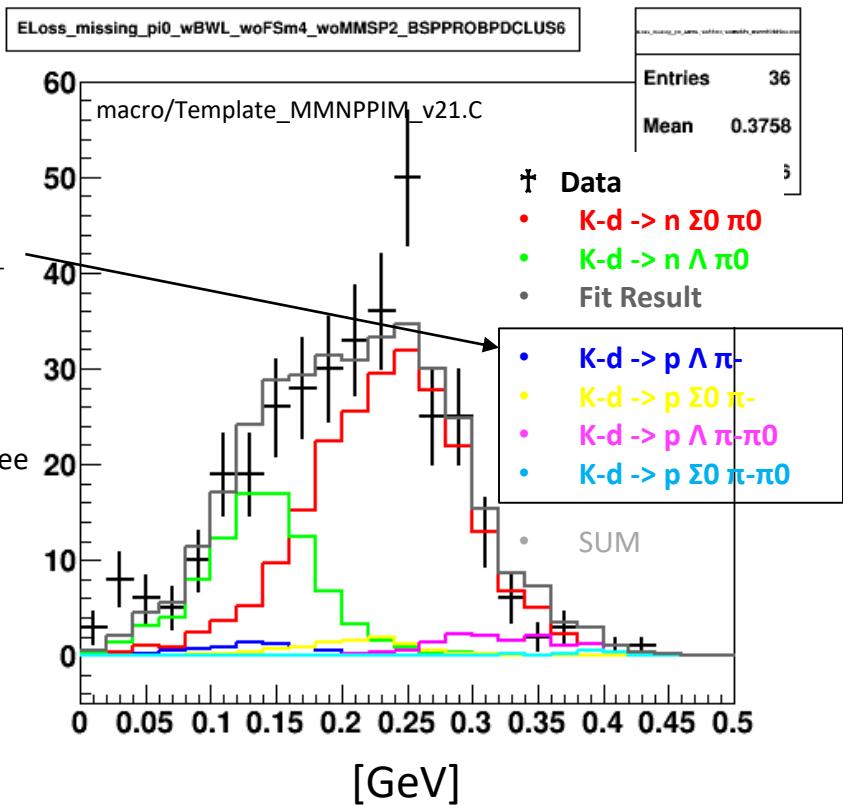
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

# Fitting of MM. $d(K^-, n\pi^-)$

- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Lambda \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^- \pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$

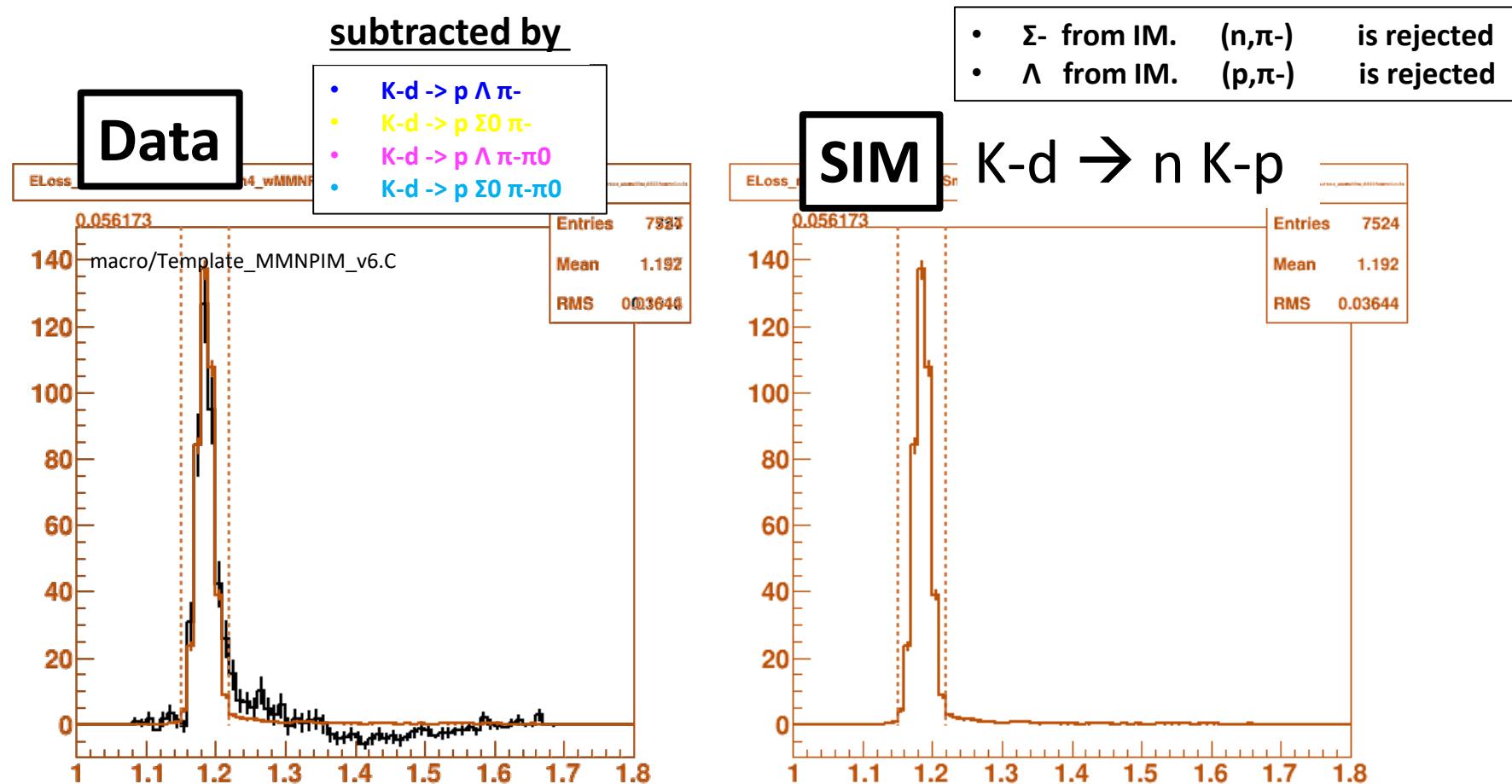


0.00~0.50だとfitできない?



$K-d \rightarrow n \Sigma^+ \pi^- ;$

Scaled by event # of  $d(K-,n\pi)^{\prime\prime}\Sigma^{\prime\prime}$



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected

# Result from P.675~677

† Data  
 •  $K-d \rightarrow n \Sigma + \pi^-$

- $K-d \rightarrow n \Sigma^0 \pi^0$
- $K-d \rightarrow n \Lambda \pi^0$

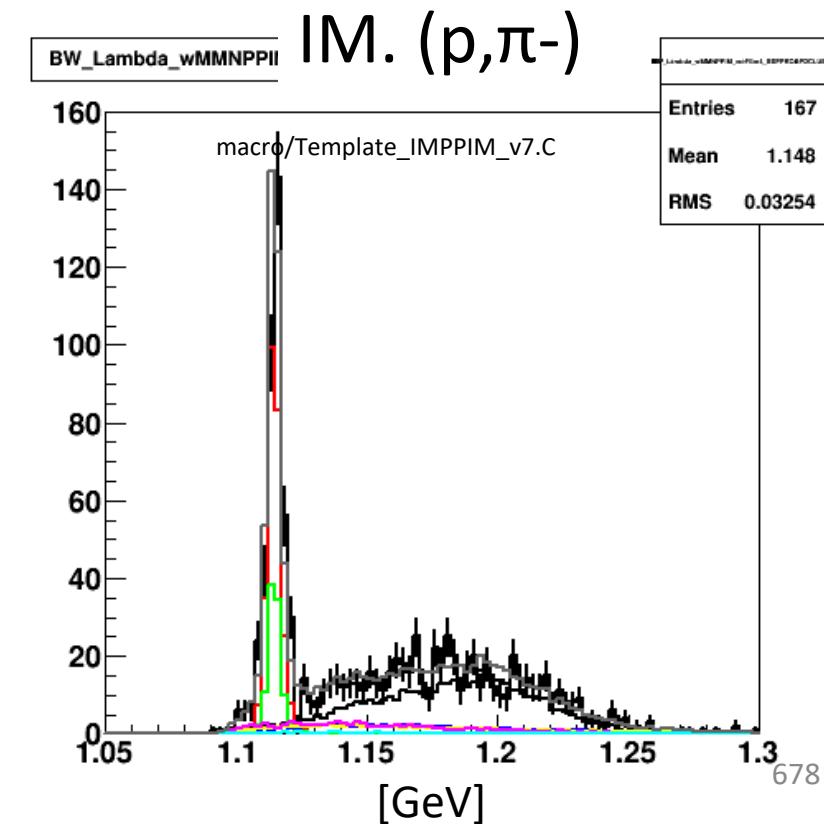
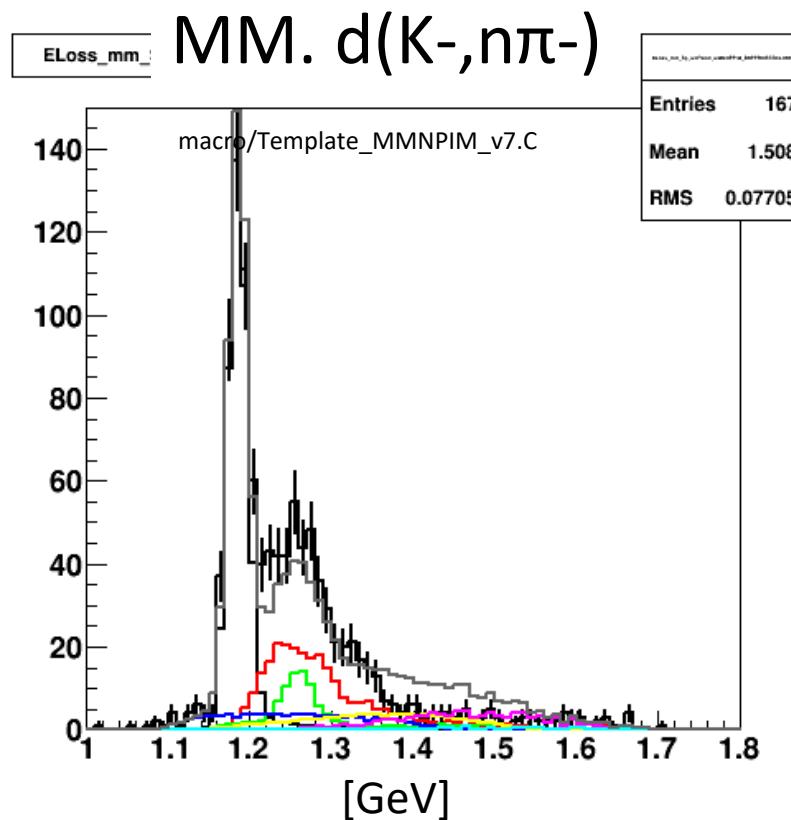
- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$

How to decide scaling

$\rightarrow P.677$

$\rightarrow P.676$

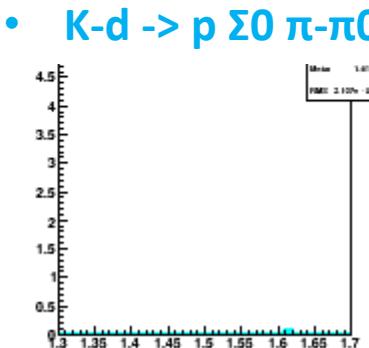
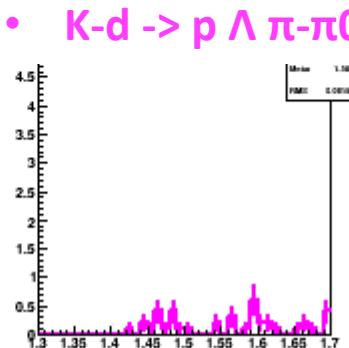
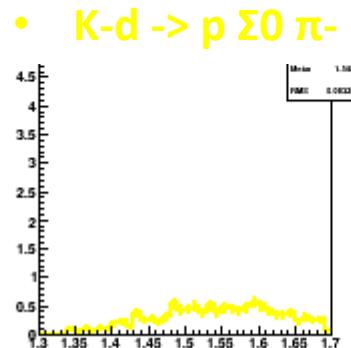
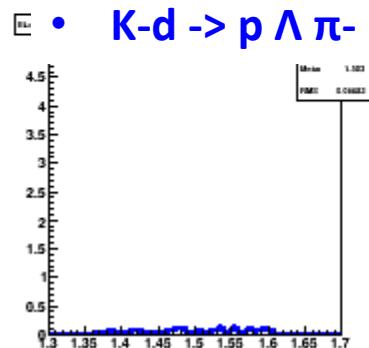
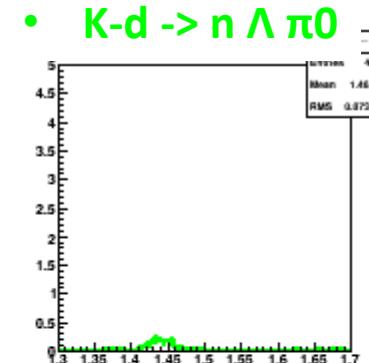
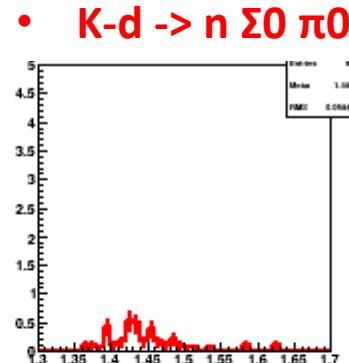
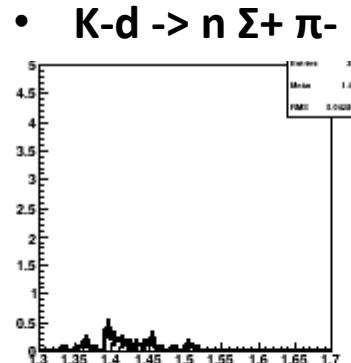
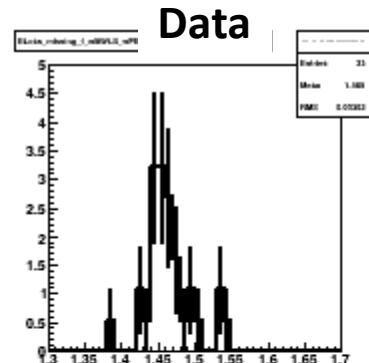
$\rightarrow P.675$



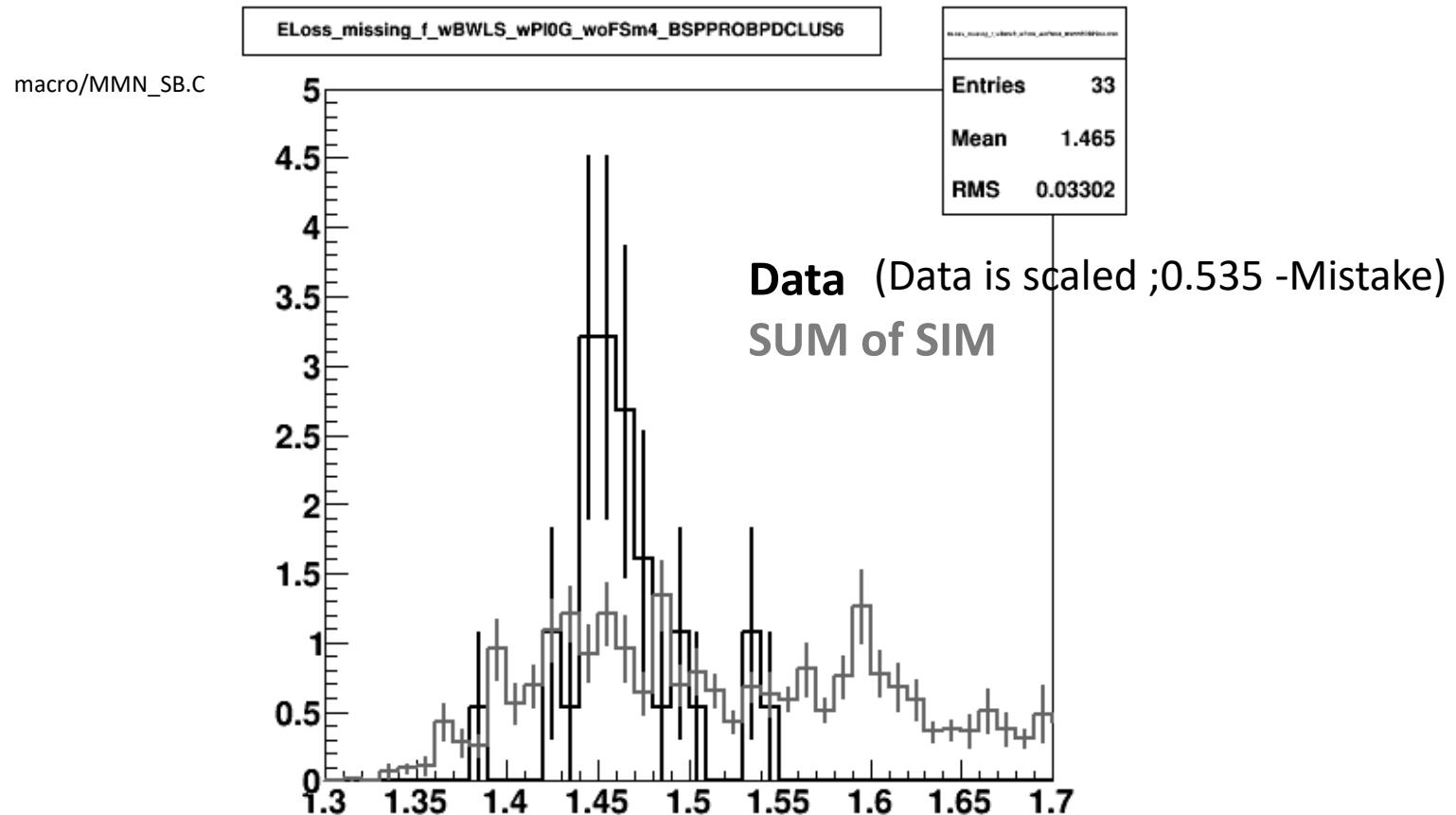
- MM.  $d(K^-, n \rho \pi^-)$  0.18~0.30 GeV
- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected

# MM. $d(K^-, n)$ from $\Lambda$ side-band

macro/MMN\_SB.C



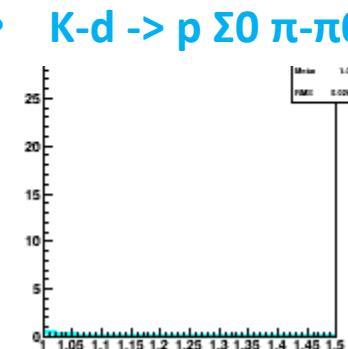
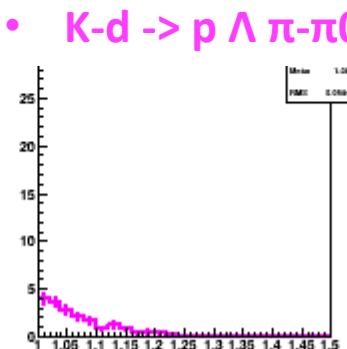
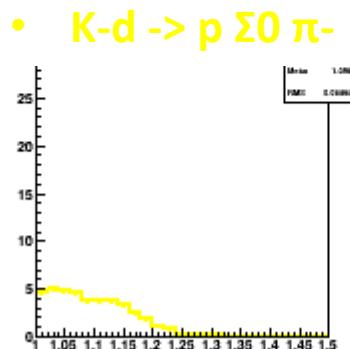
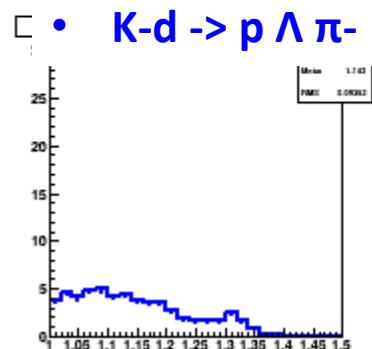
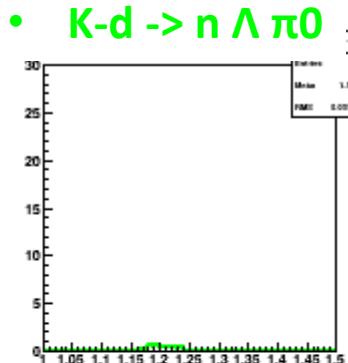
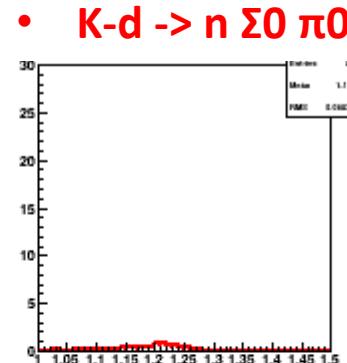
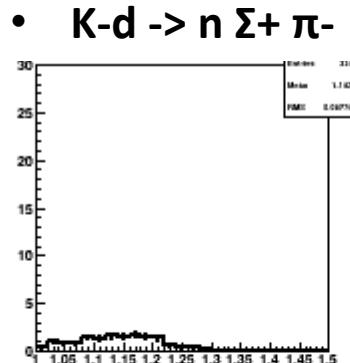
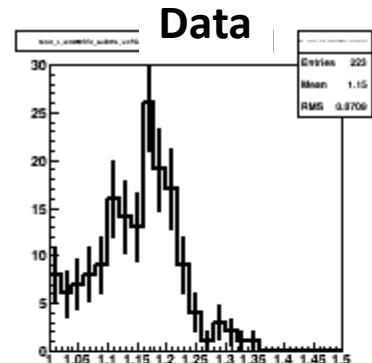
# SUM of side-band spectrum



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

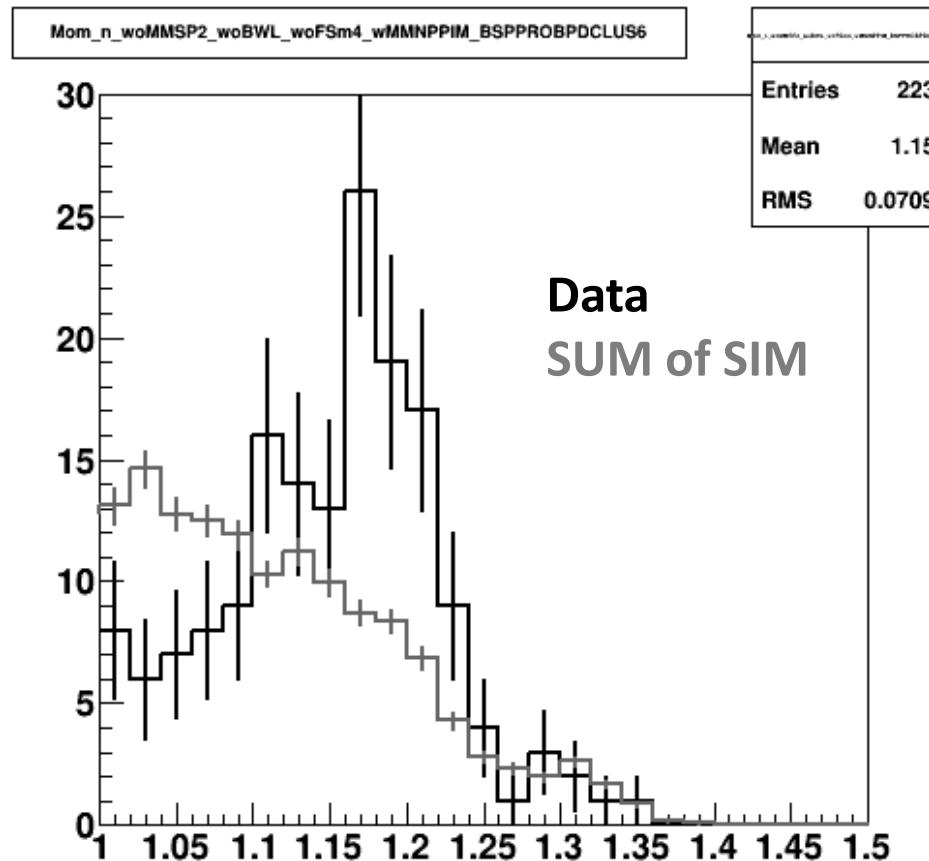
# Neutron momentum distribution

macro/Mom\_N.C



# Neutron momentum distribution

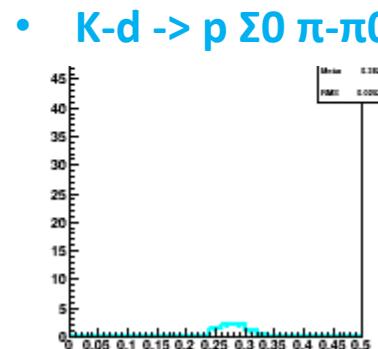
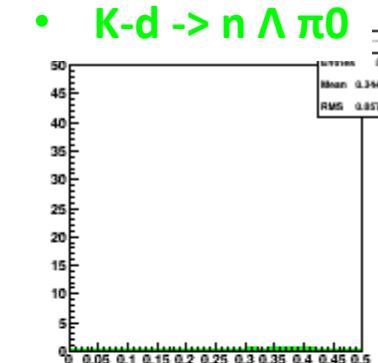
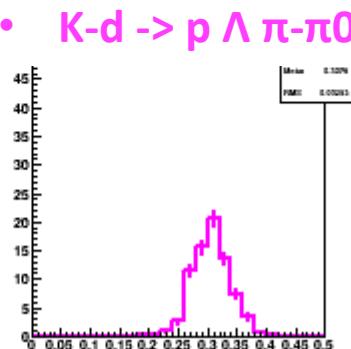
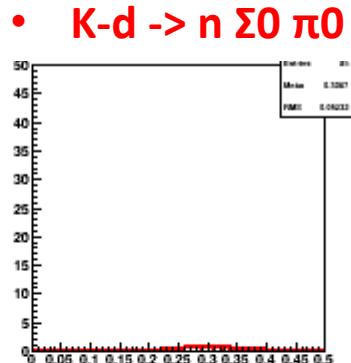
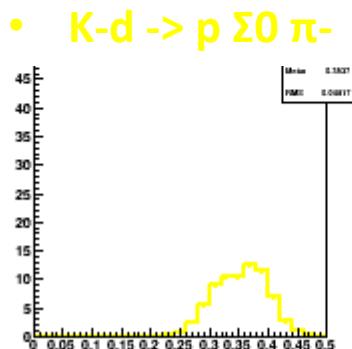
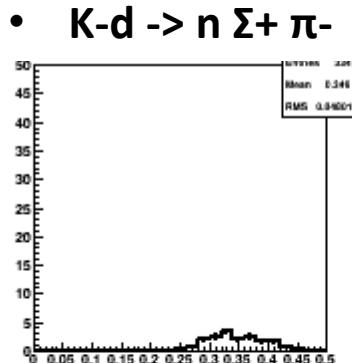
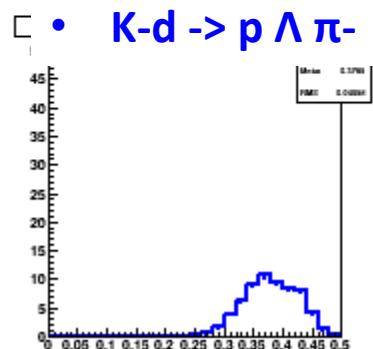
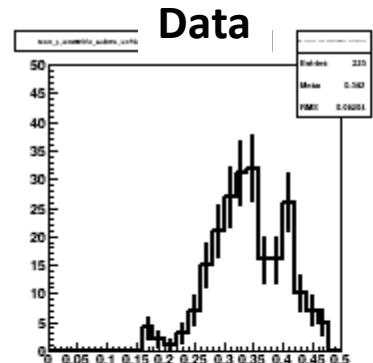
macro/Mom\_N.C



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

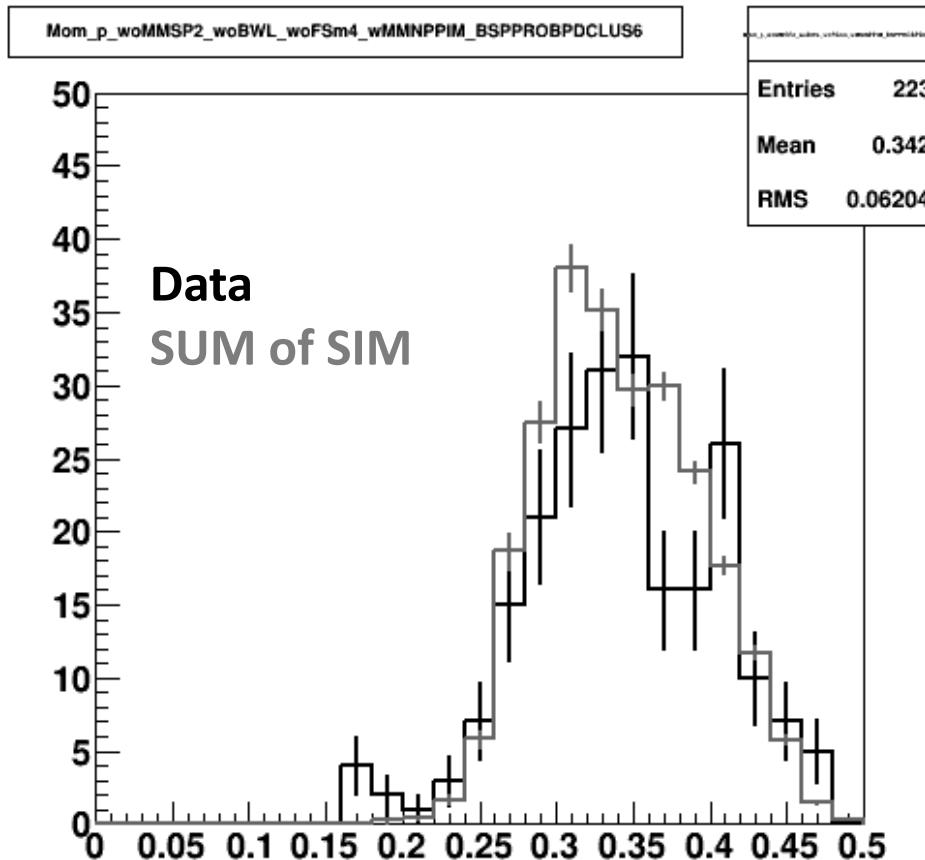
# Proton momentum distribution

macro/Mom\_P.C



# Proton momentum distribution

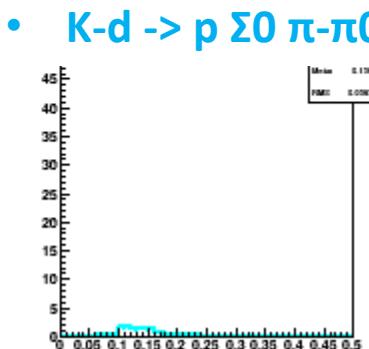
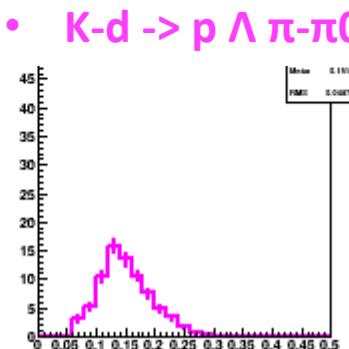
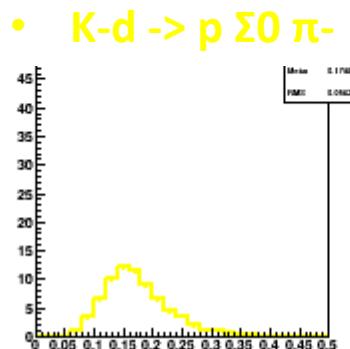
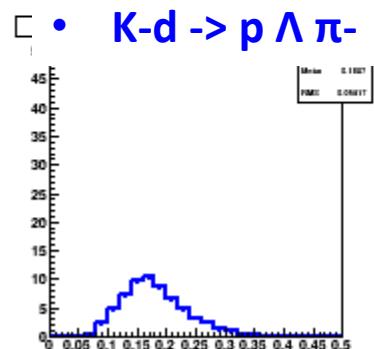
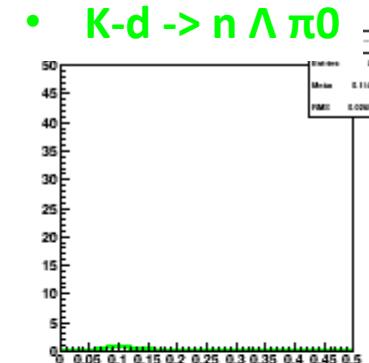
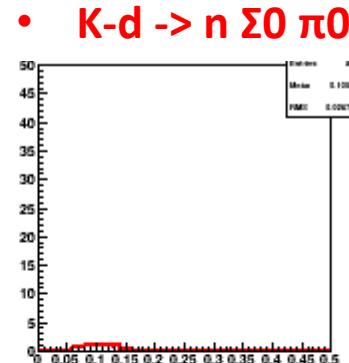
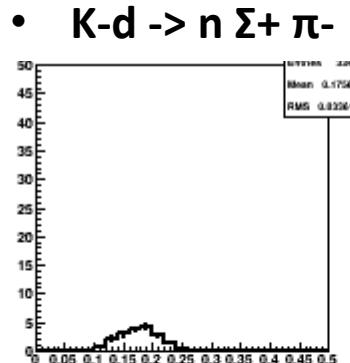
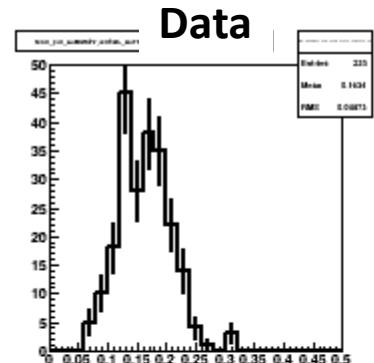
macro/Mom\_P.C



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

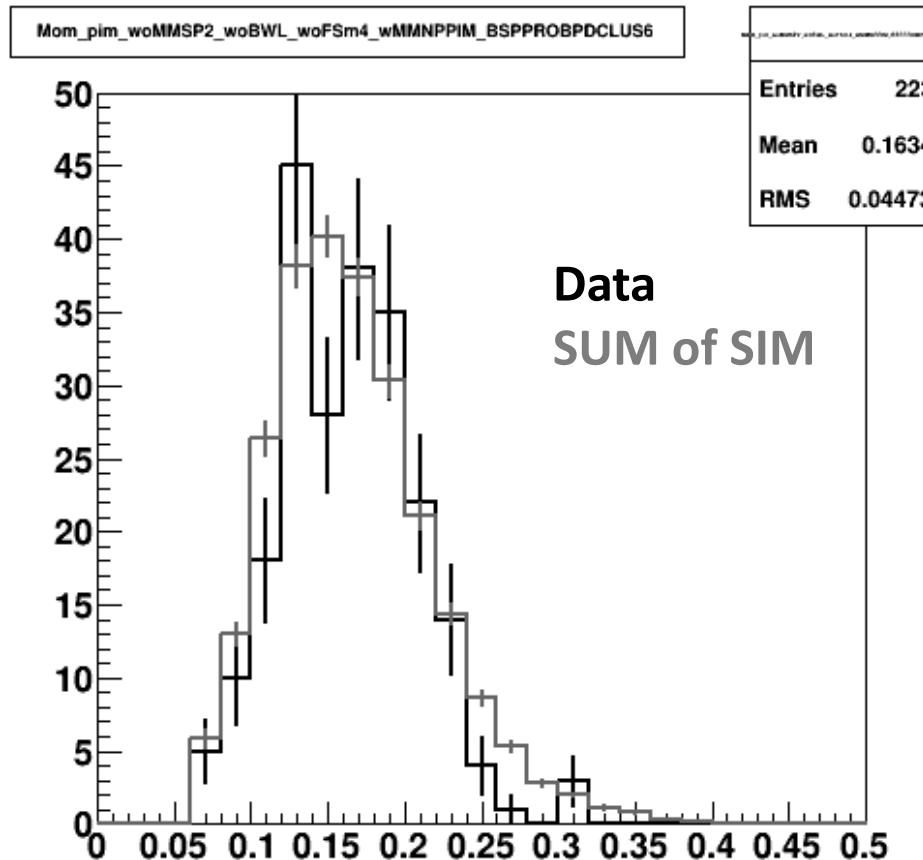
# $\pi^-$ momentum distribution

macro/Mom\_P.C



# $\pi$ - momentum distribution

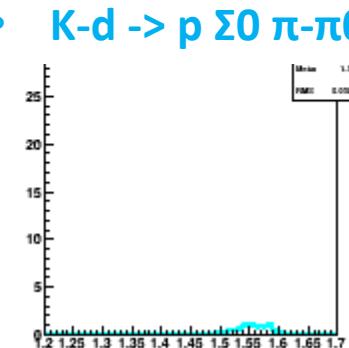
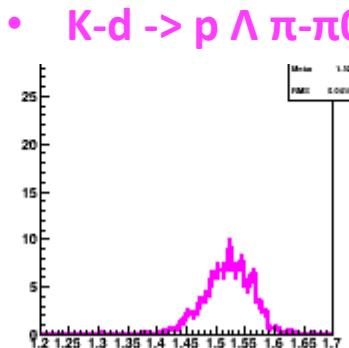
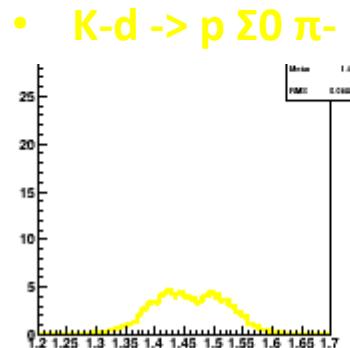
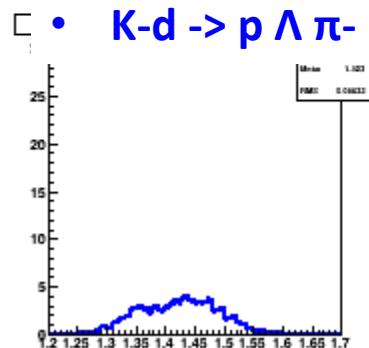
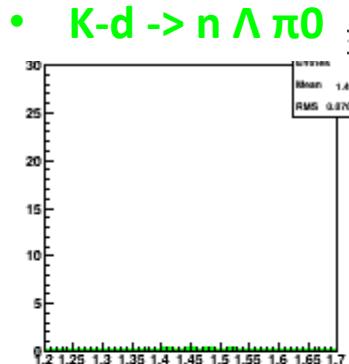
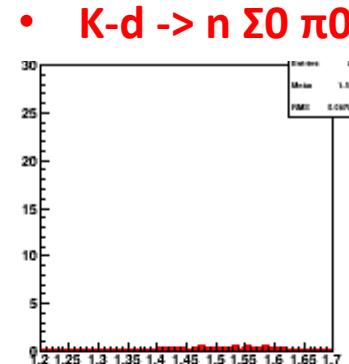
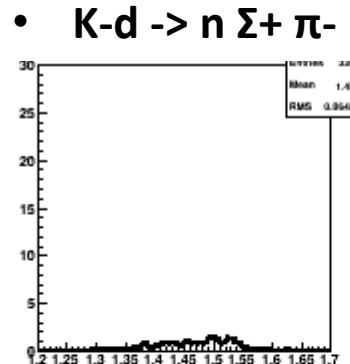
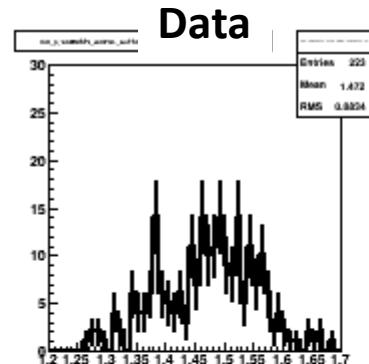
macro/Mom\_P.C



- $\Sigma$ - from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

# MM. $d(K^-, p)$ distribution

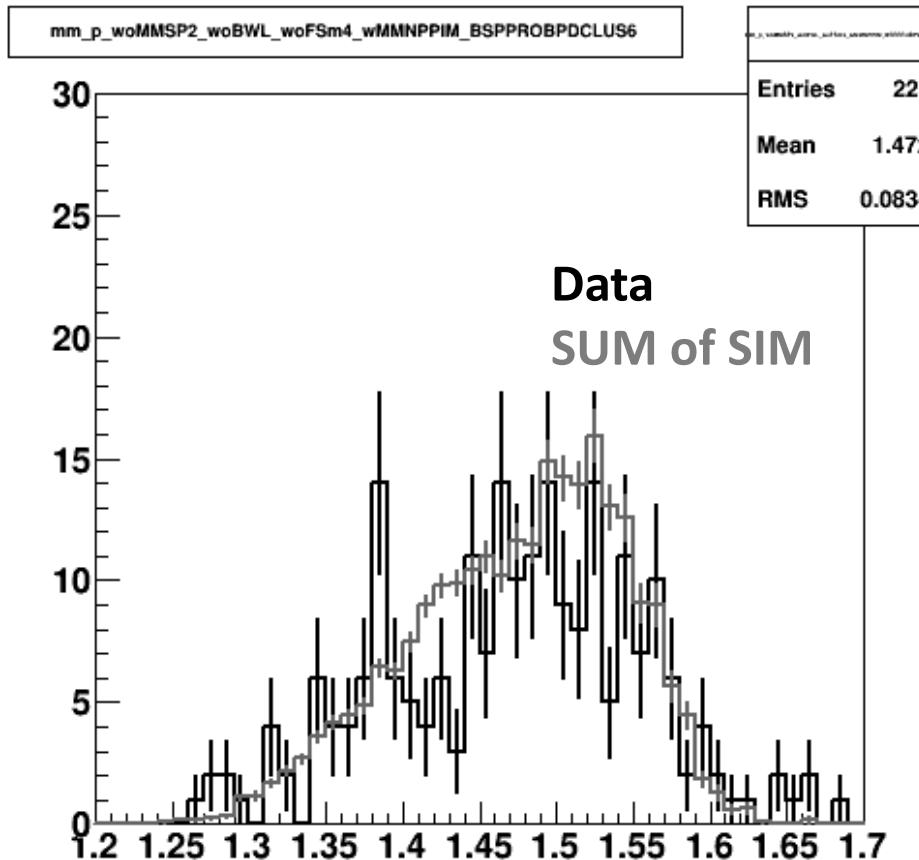
macro/MMP.C



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

# MM. $d(K^-, p)$ distribution

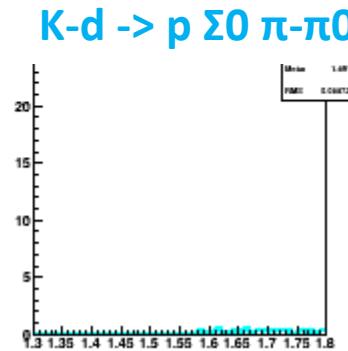
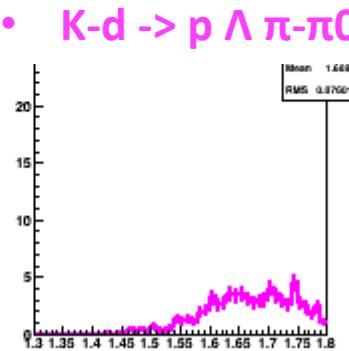
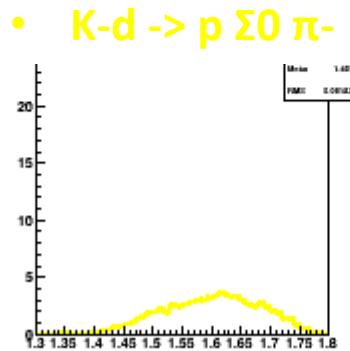
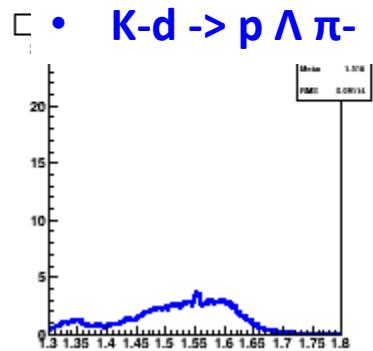
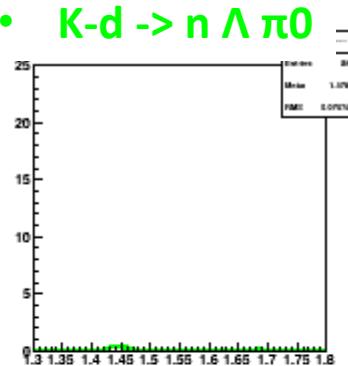
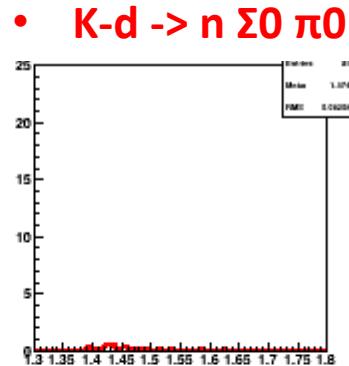
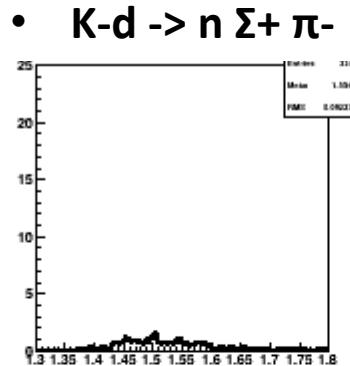
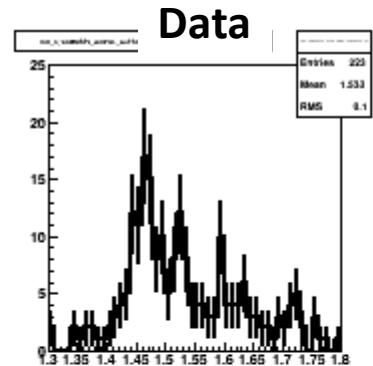
macro/MMP.C



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

# MM. $d(K^-, n)$ distribution

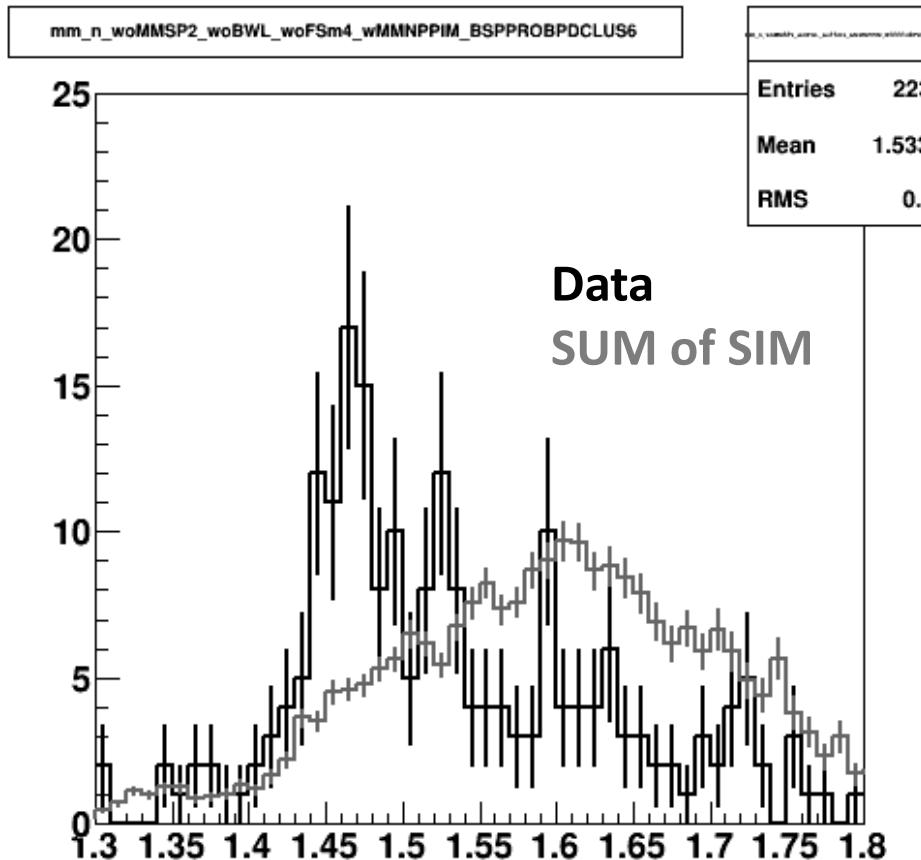
macro/MMN\_v6.C



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

# MM. $d(K^-, n)$ distribution

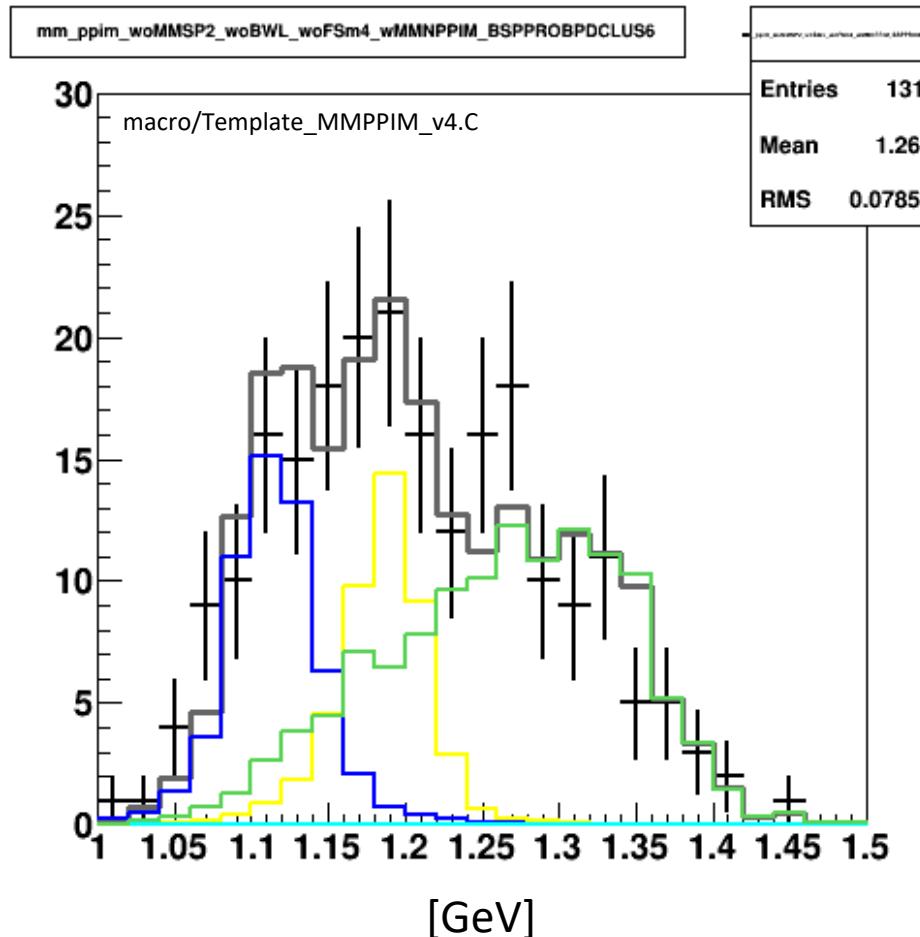
macro/MMN\_v6.C



# Fitting of MM. $d(K_-, p\pi^-)$

w/  $K-d \rightarrow K^- p n$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected



## † Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$  (crossed out)
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$  (crossed out)
- $K-d \rightarrow K^- p n$
- Fit Result

Scaling factor of SIM is free

Fit Range

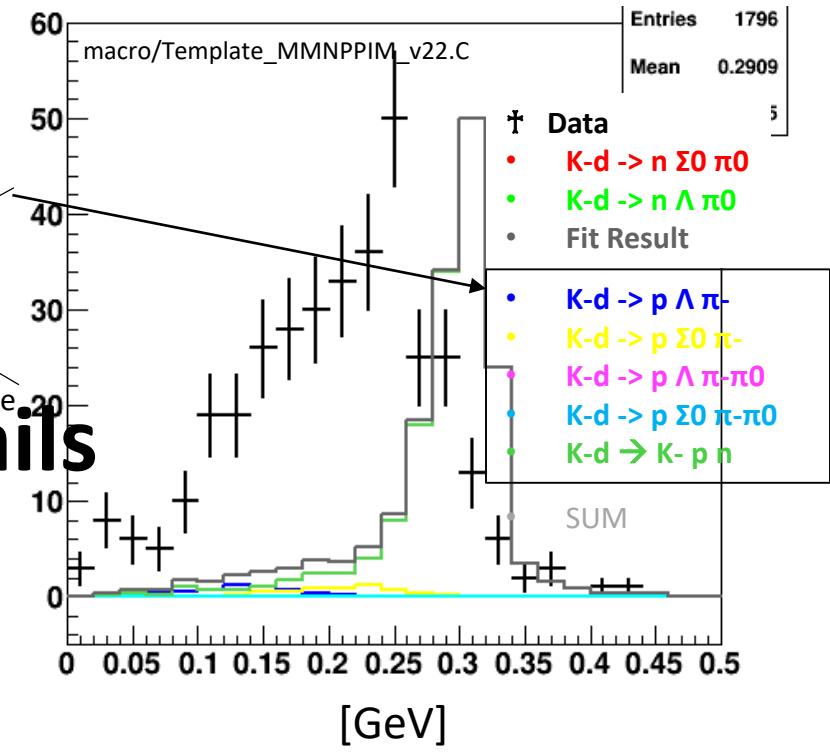
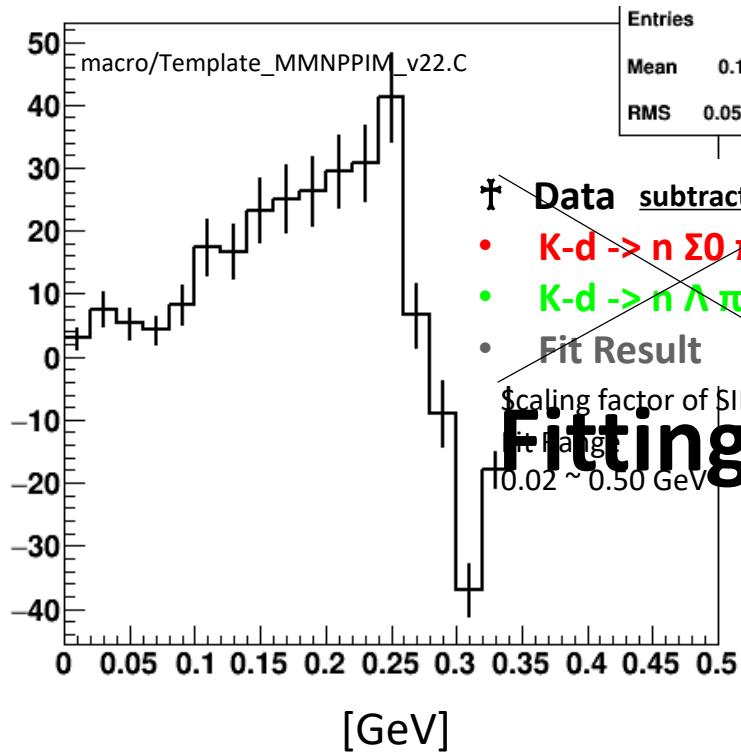
1.00 ~ 1.50 GeV

Chi2/ndf = 18.52/25

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

# Fitting of MM. $d(K^-, n\pi^-)$

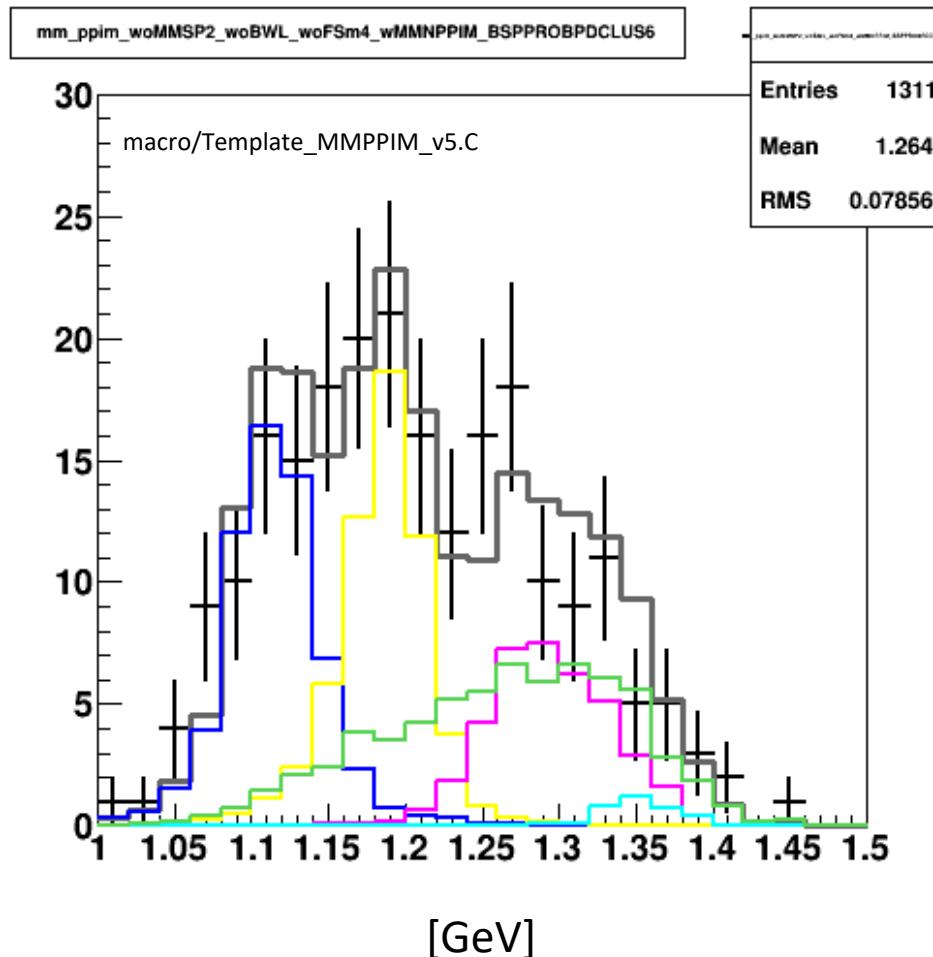
- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Lambda \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^- \pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$ ,  $K-d \rightarrow K^- p n$



# Fitting of MM. $d(K_-, p\pi^-)$

w/  $K-d \rightarrow K^- p n$

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected



## † Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$  Constrain ~50 %
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$  Constrain ~50 %
- $K-d \rightarrow K^- p n$
- **Fit Result**

Scaling factor of SIM is free

Fit Range

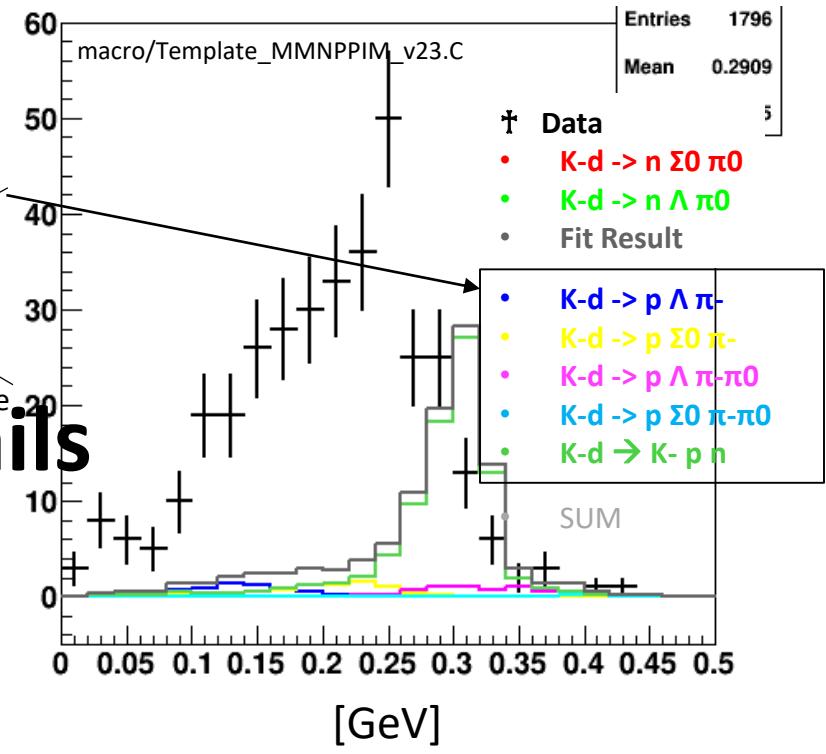
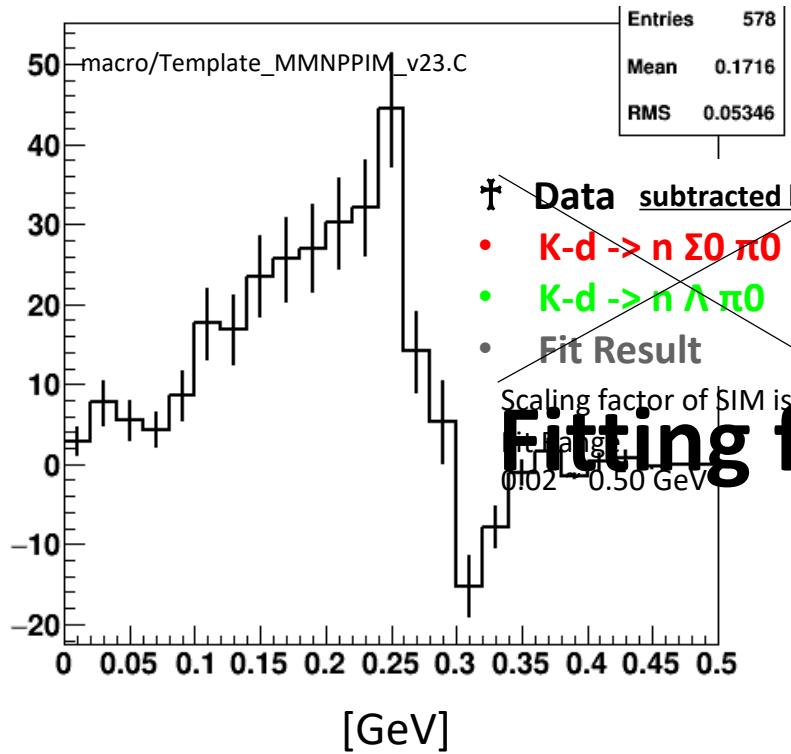
1.00 ~ 1.50 GeV

Chi2/ndf = 20.16/25

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

# Fitting of MM. $d(K^-, n\pi^-)$

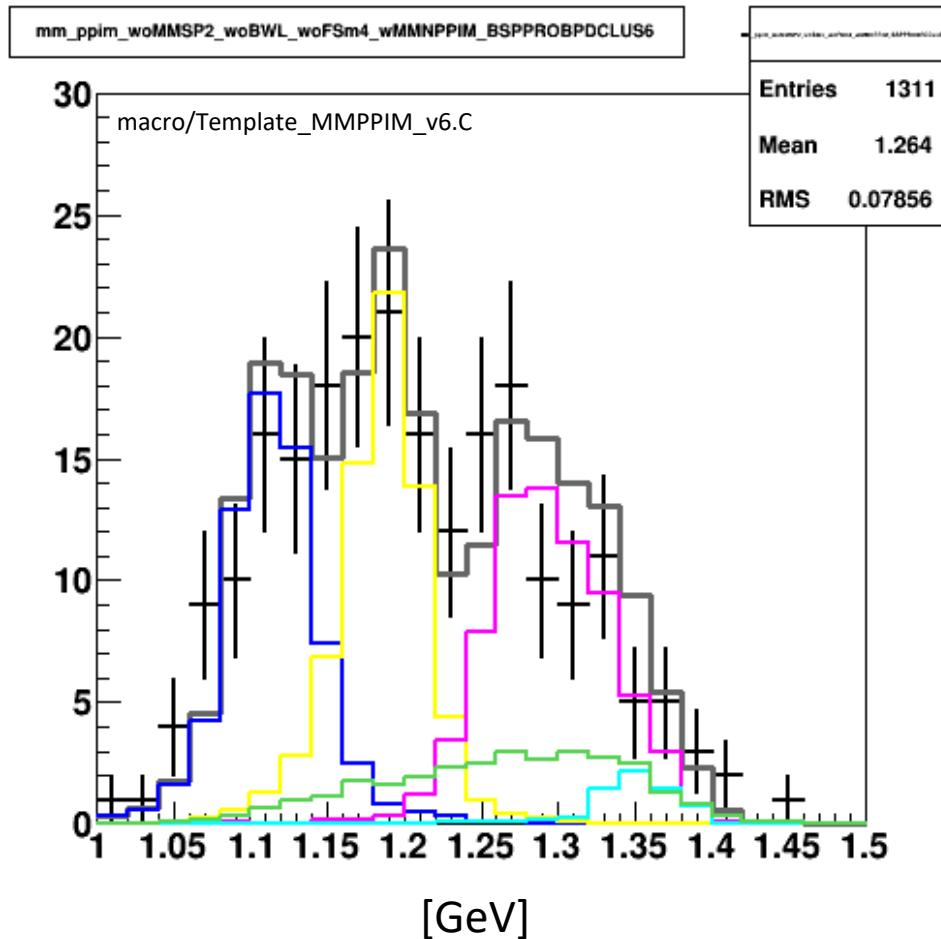
- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Lambda \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^- \pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$ ,  $K-d \rightarrow K^- p n$



# Fitting of MM. $d(K_-, p\pi^-)$

w/  $K-d \rightarrow K^- p n$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected



## † Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$  Constrain ~90 %
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$  Constrain ~90 %
- $K-d \rightarrow K^- p n$
- **Fit Result**

Scaling factor of SIM is free

Fit Range

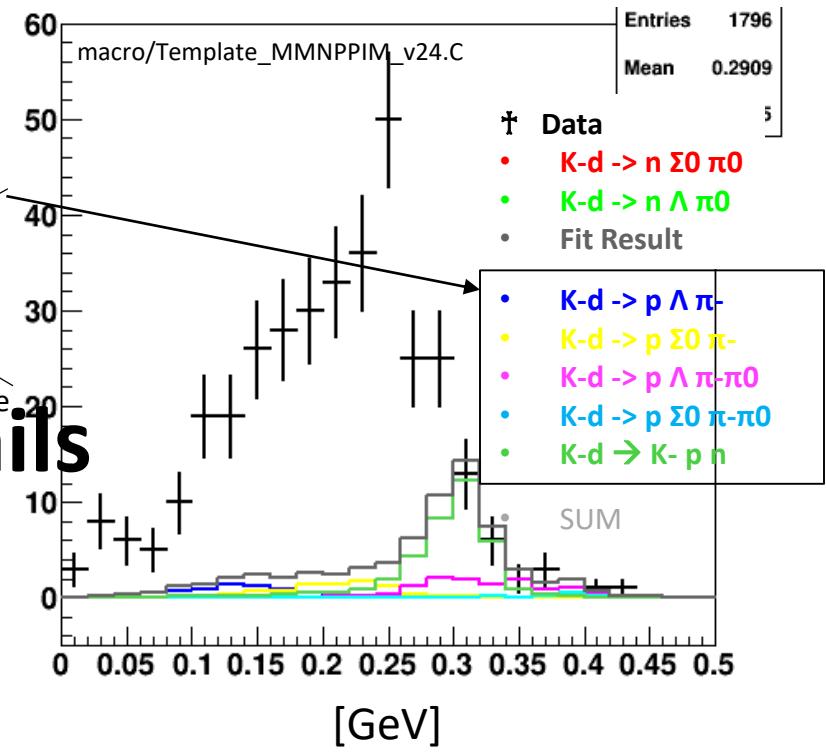
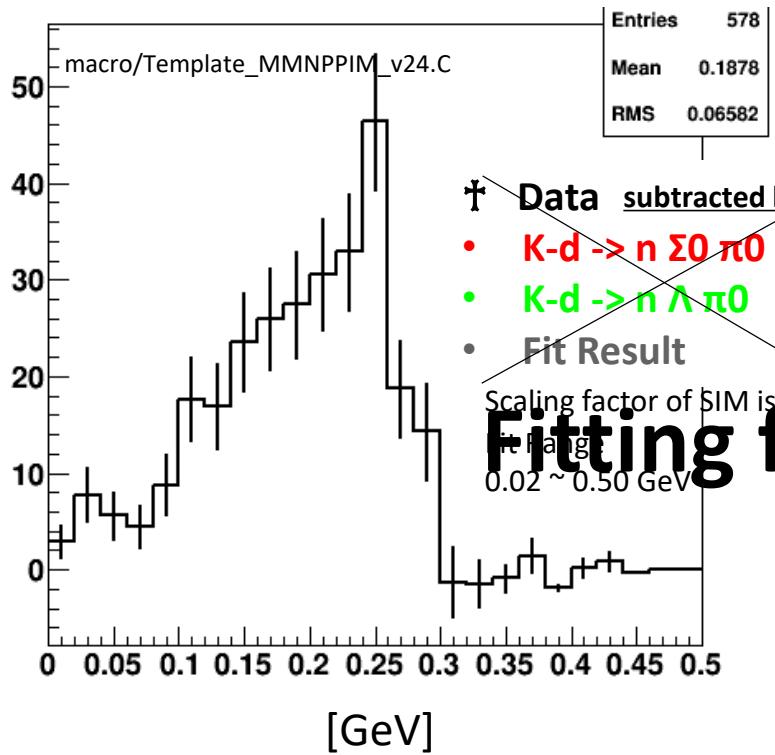
1.00 ~ 1.50 GeV

Chi2/ndf = 25.10/25

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

# Fitting of MM. $d(K^-, n\pi^-)$

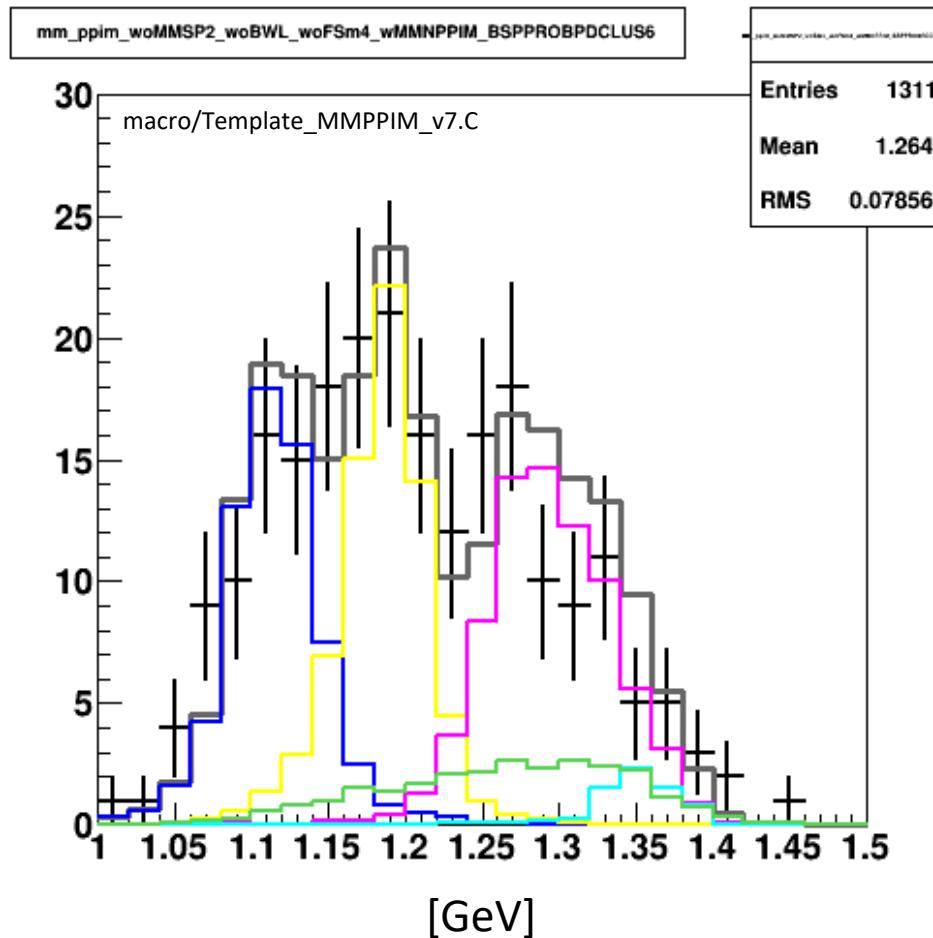
- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Lambda \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^- \pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$ ,  $K-d \rightarrow K^- p n$



# Fitting of MM. $d(K_-, p\pi^-)$

w/  $K-d \rightarrow K^- p n$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected



## † Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$  Constrain ~95 %
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$  Constrain ~95 %
- $K-d \rightarrow K^- p n$
- **Fit Result**

Scaling factor of SIM is free

Fit Range

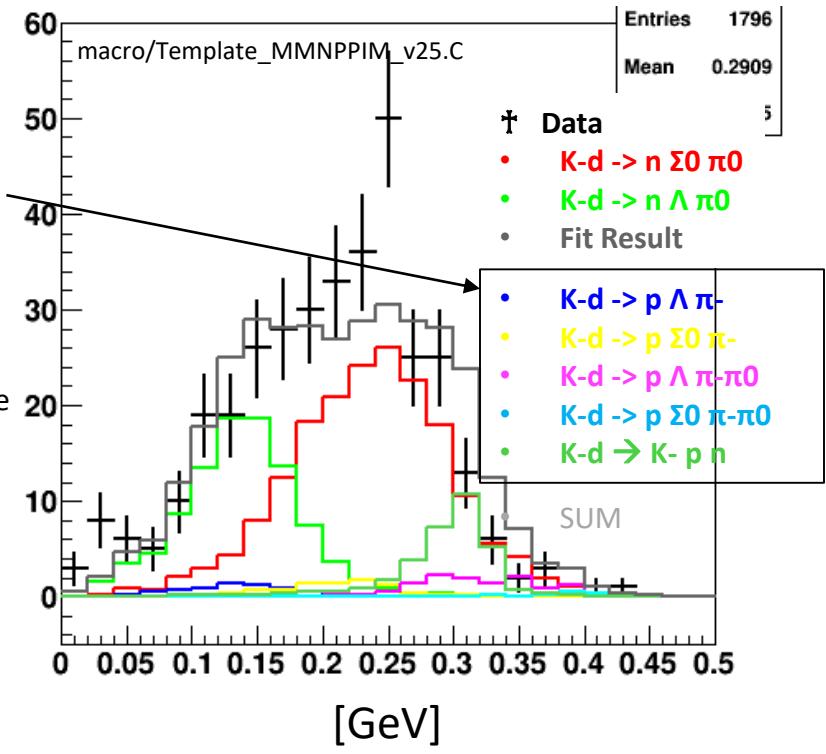
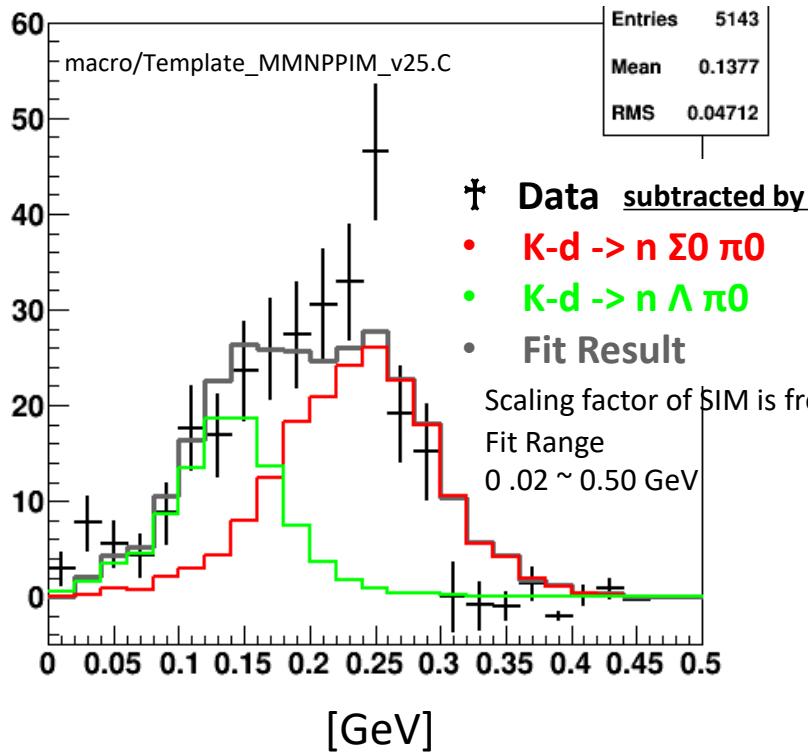
1.00 ~ 1.50 GeV

Chi2/ndf = 26.07/25

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

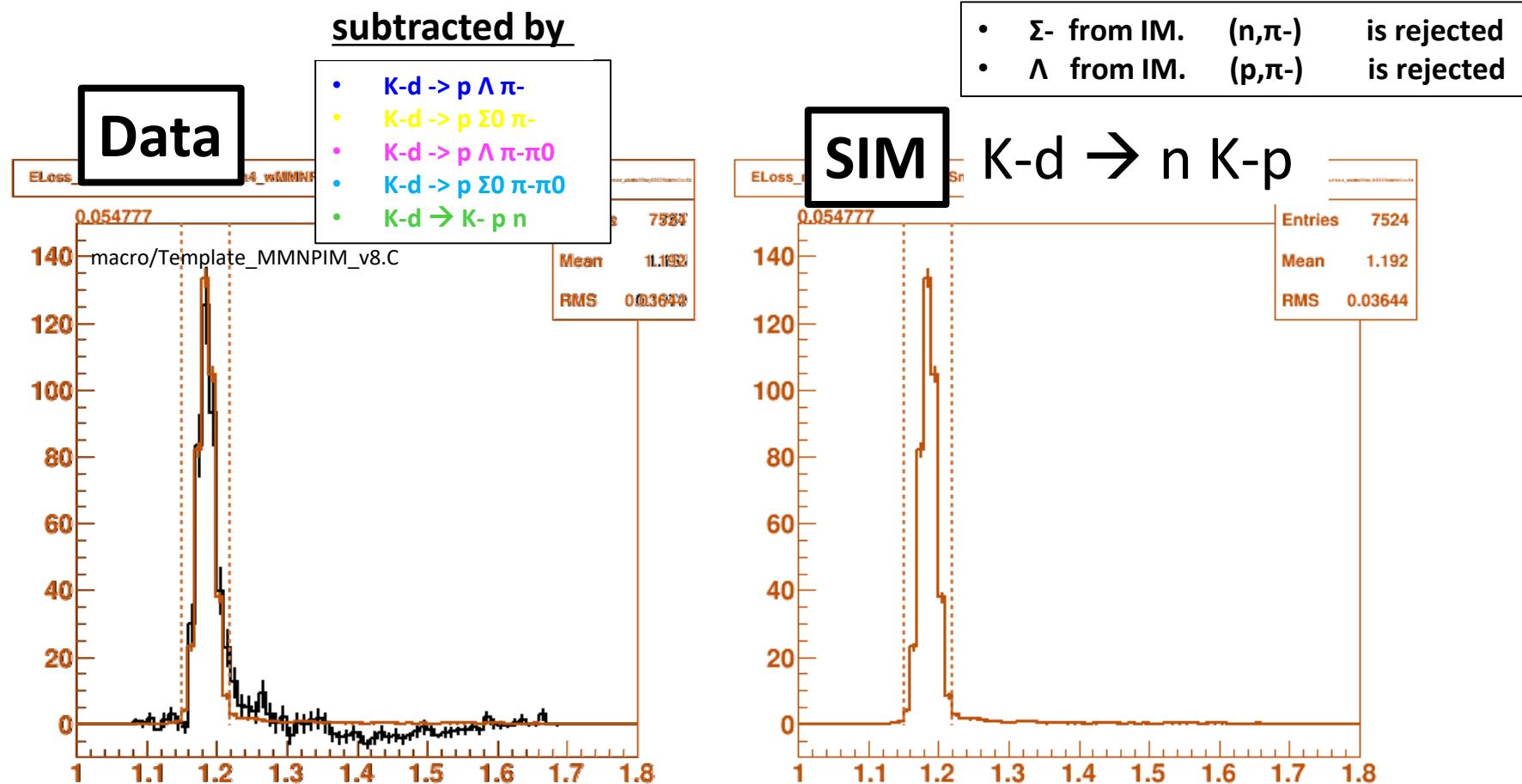
# Fitting of MM. $d(K^-, n\pi^-)$

- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Lambda \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^- \pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$ ,  $K-d \rightarrow K^- p n$



$K-d \rightarrow n \Sigma^+ \pi^-$  ;

Scaling by event # of  $d(K-,n\pi)^{\prime\prime}\Sigma^+$ "



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected

# Result from P.687~689

† Data  
 •  $K-d \rightarrow n \Sigma + \pi^-$

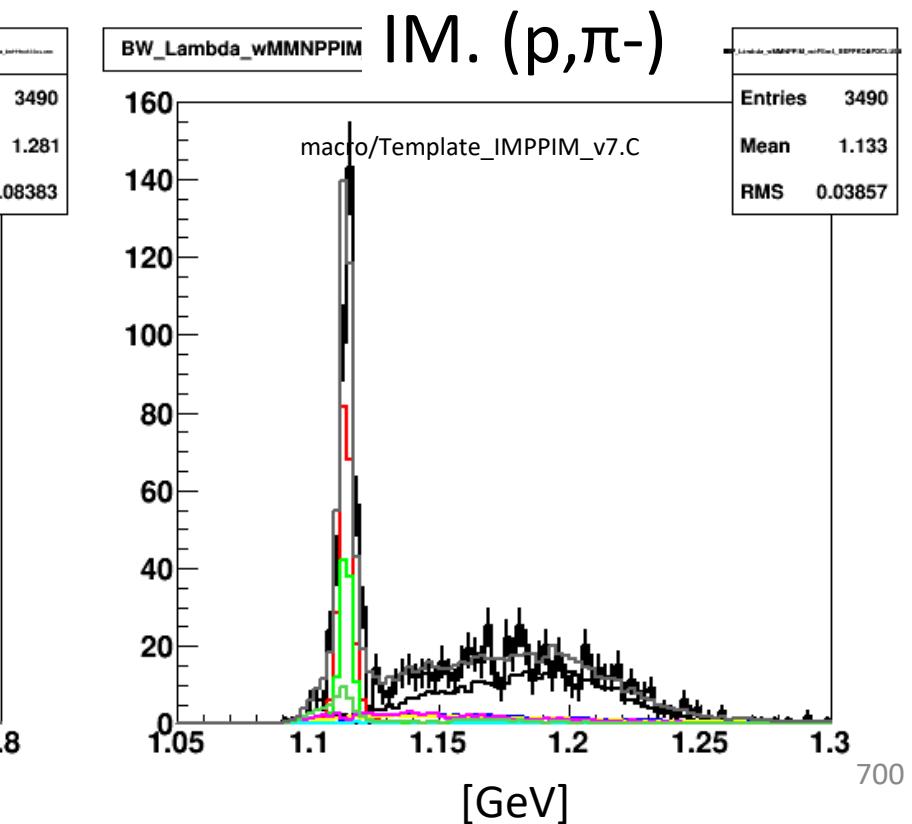
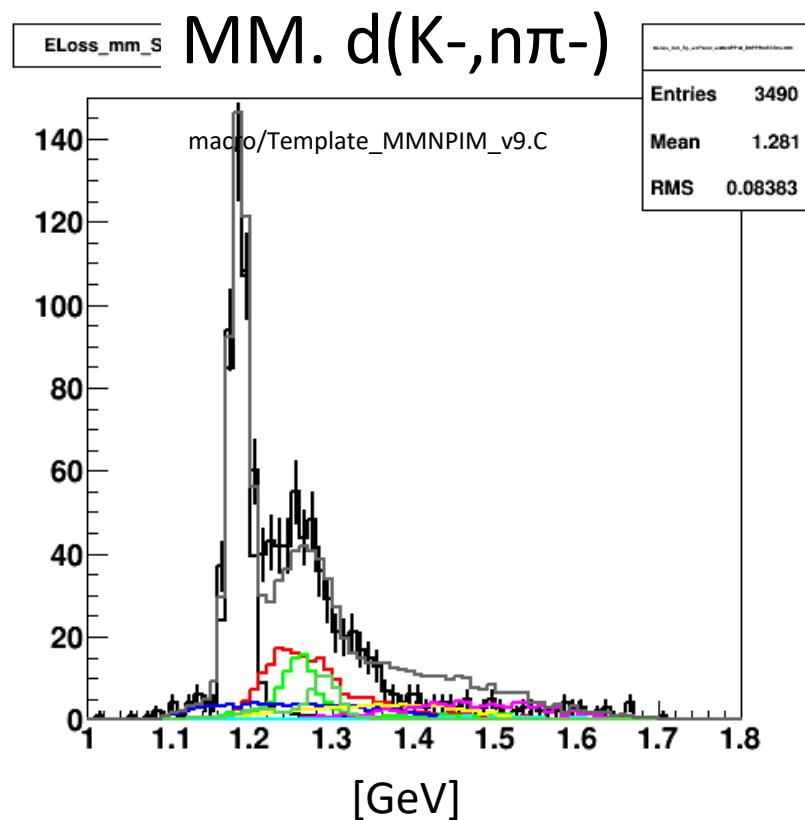
- $K-d \rightarrow n \Sigma^0 \pi^0$
- $K-d \rightarrow n \Lambda \pi^0$
- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- $K-d \rightarrow K^- p n$

How to decide scaling

$\rightarrow P.689$

$\rightarrow P.688$

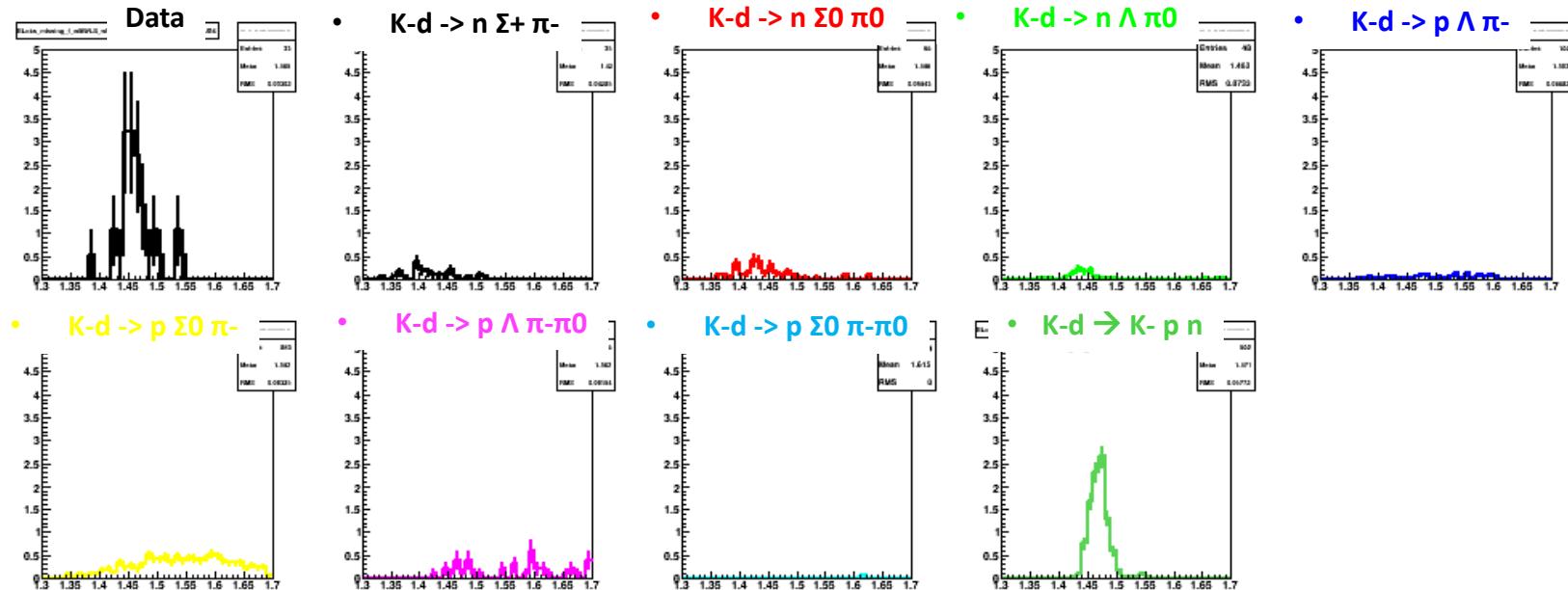
$\rightarrow P.687$



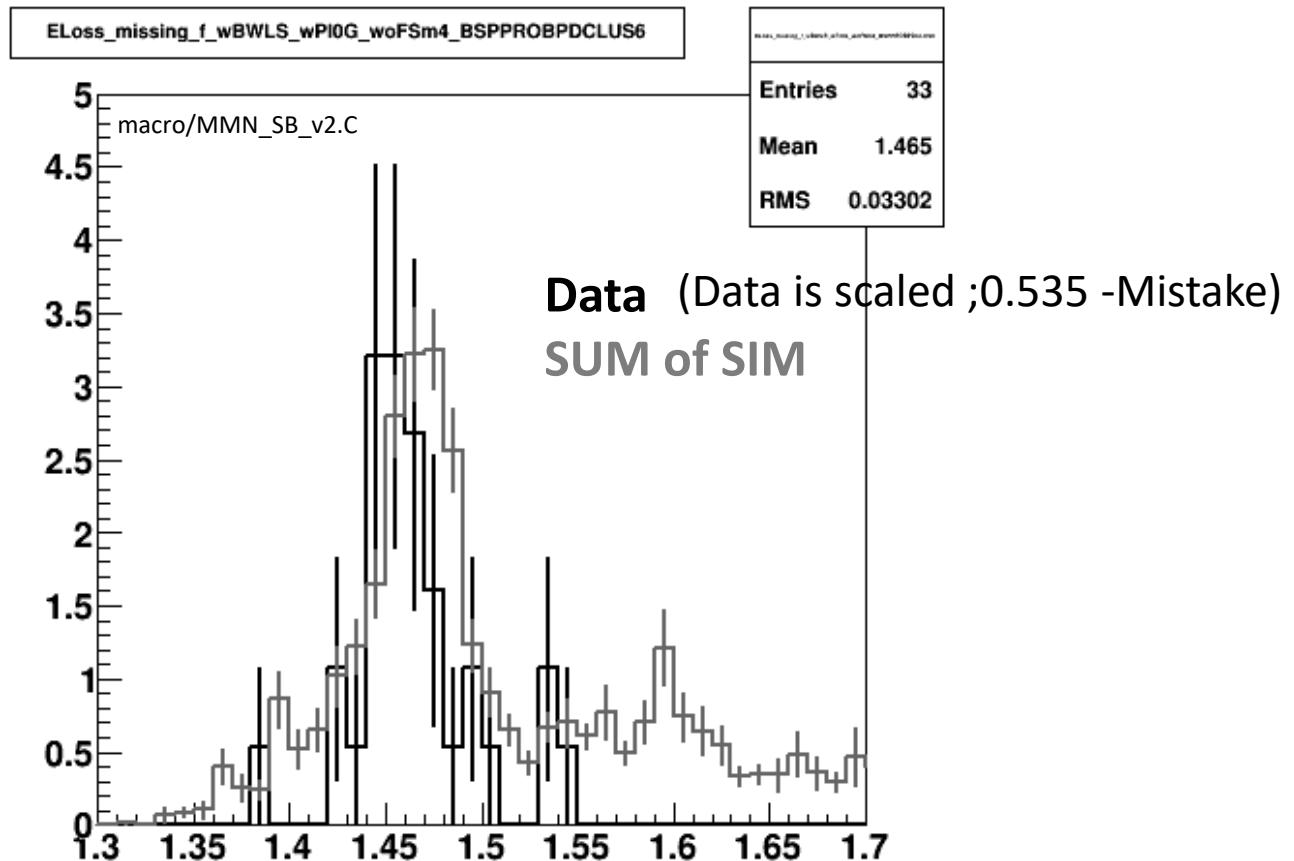
- MM.  $d(K^-, n \rho \pi^-)$  0.18~0.30 GeV
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected

# MM. $d(K^-, n)$ from $\Lambda$ side-band

macro/MMN\_SB\_v2.C



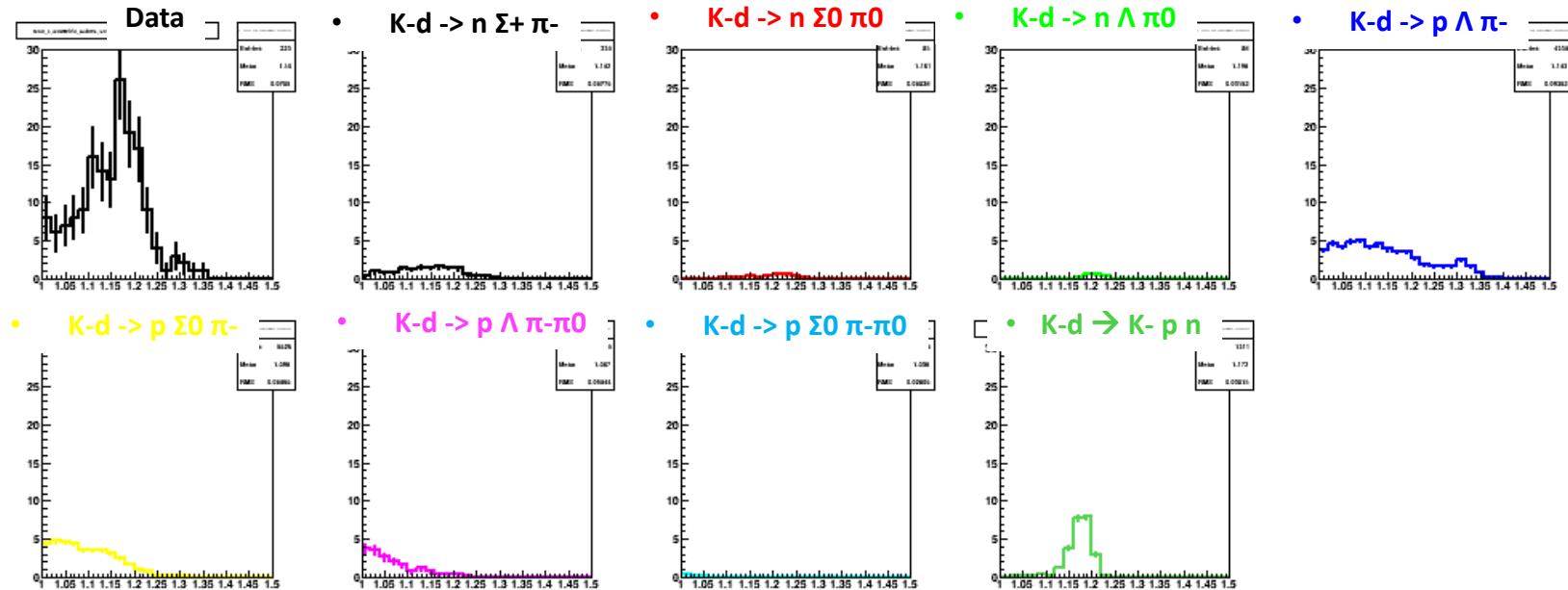
# SUM of side-band spectrum



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

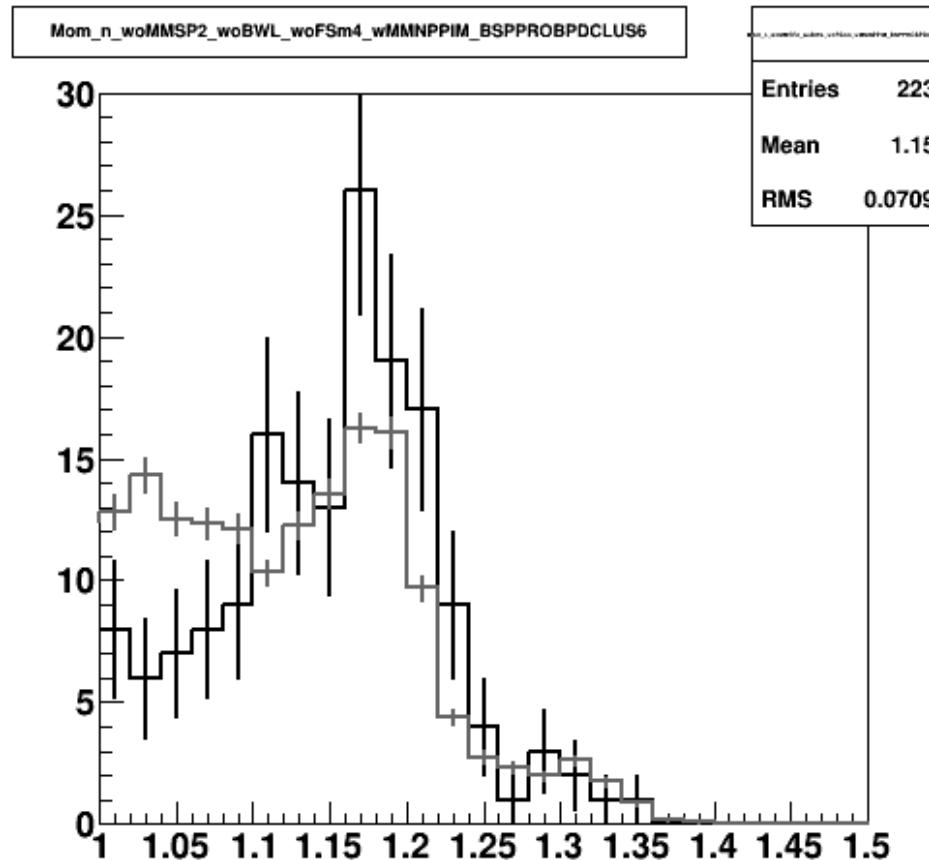
# Neutron momentum distribution

macro/Mom\_N\_v2.C



# Neutron momentum distribution

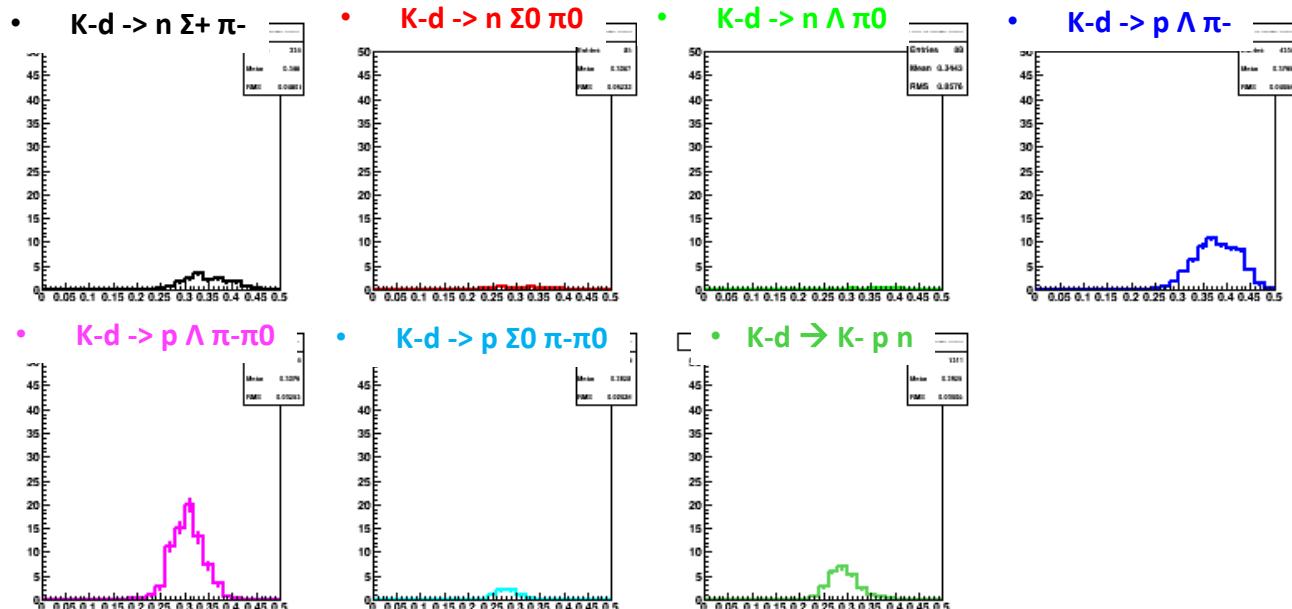
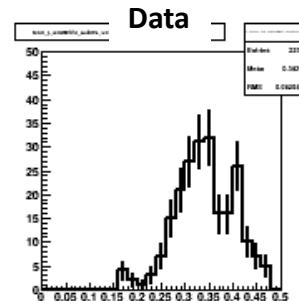
macro/Mom\_N\_v2.C



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

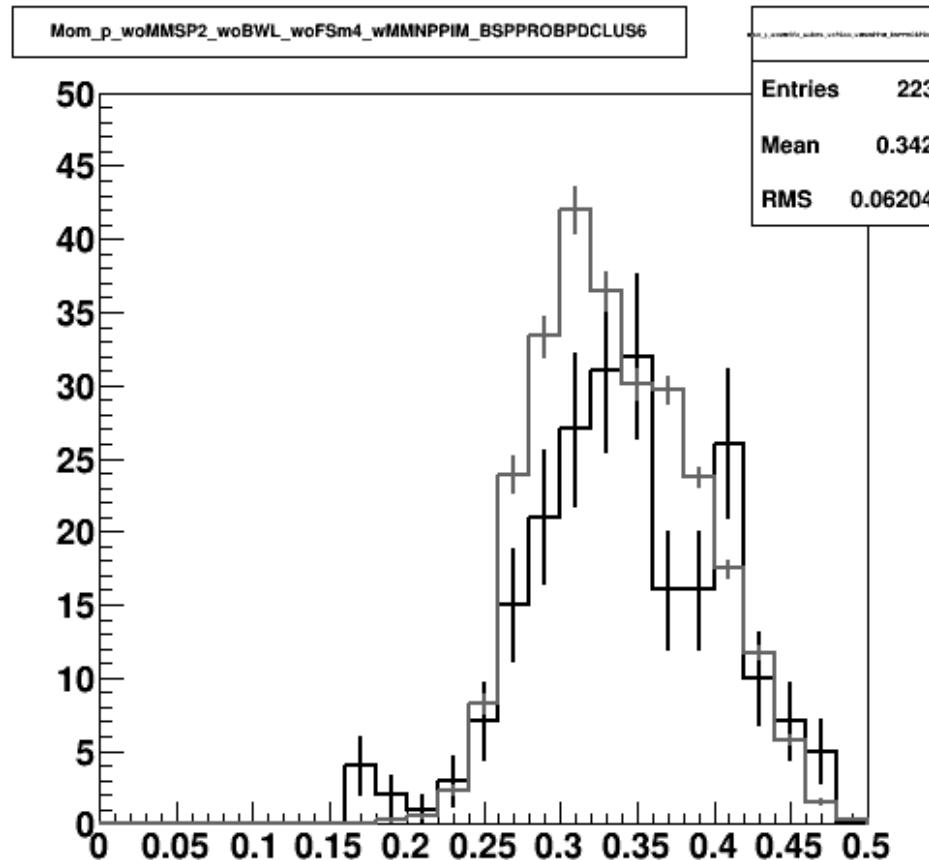
# Proton momentum distribution

macro/Mom\_P\_v2.C



# Proton momentum distribution

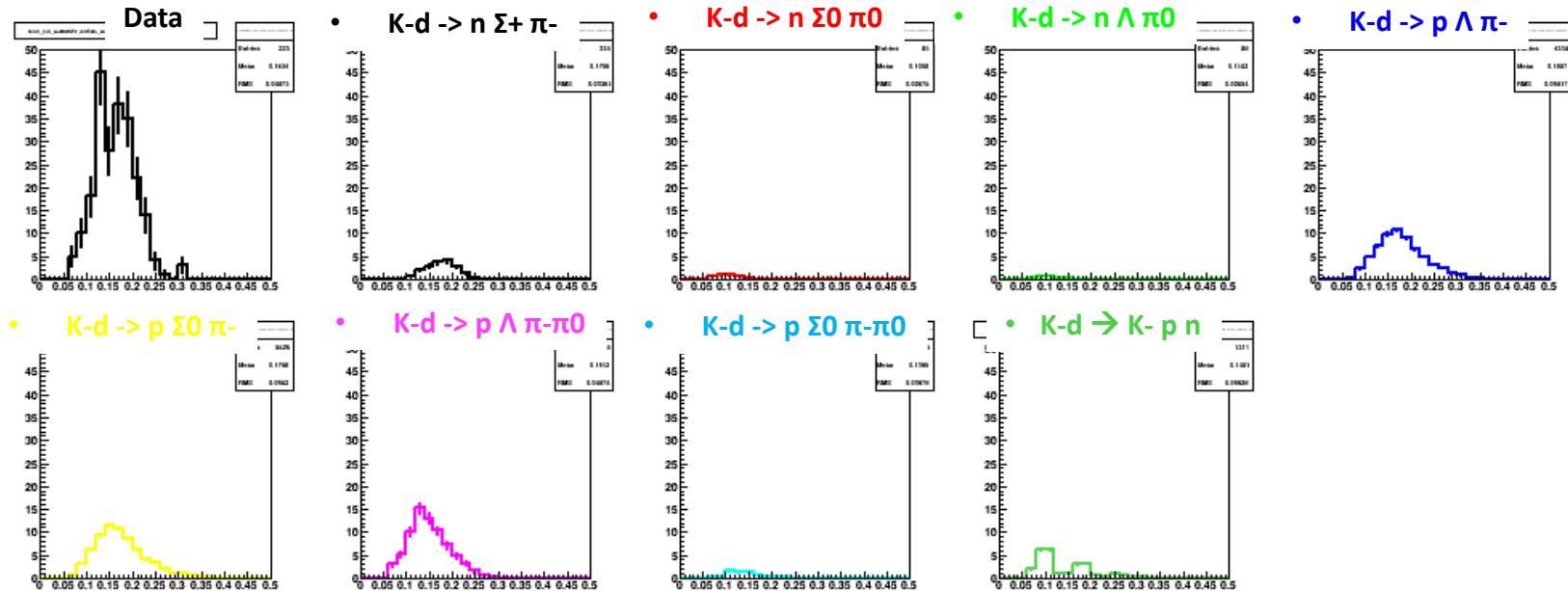
macro/Mom\_P\_v2.C



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected

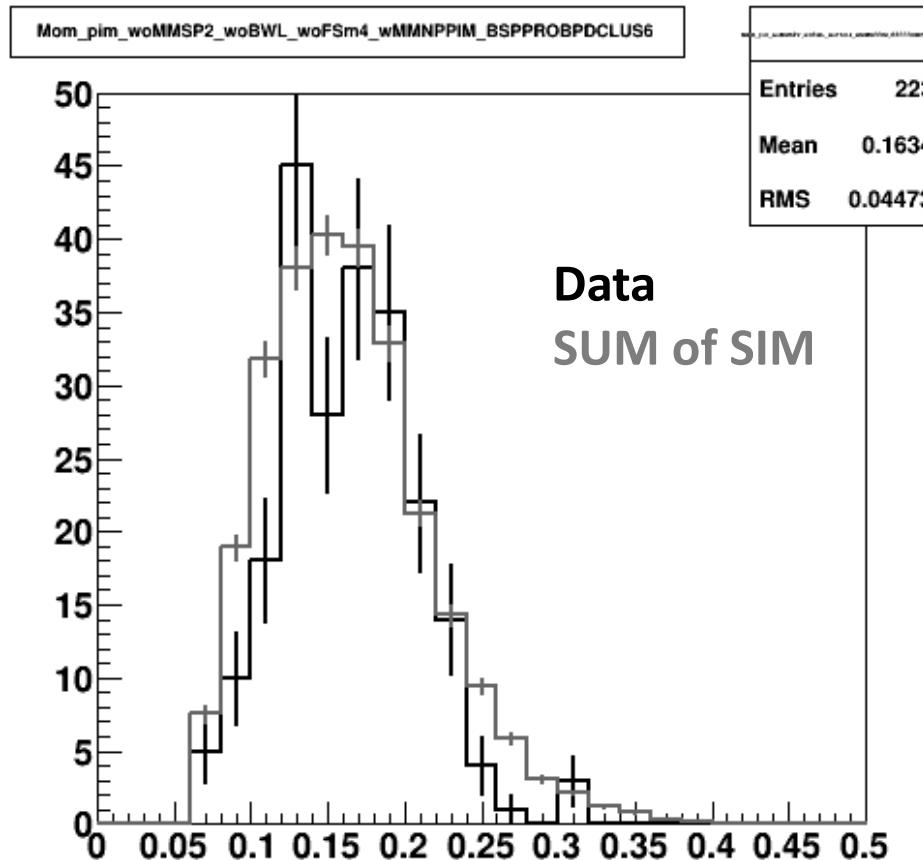
# $\pi^-$ momentum distribution

macro/Mom\_PIM\_v2.C



# $\pi$ - momentum distribution

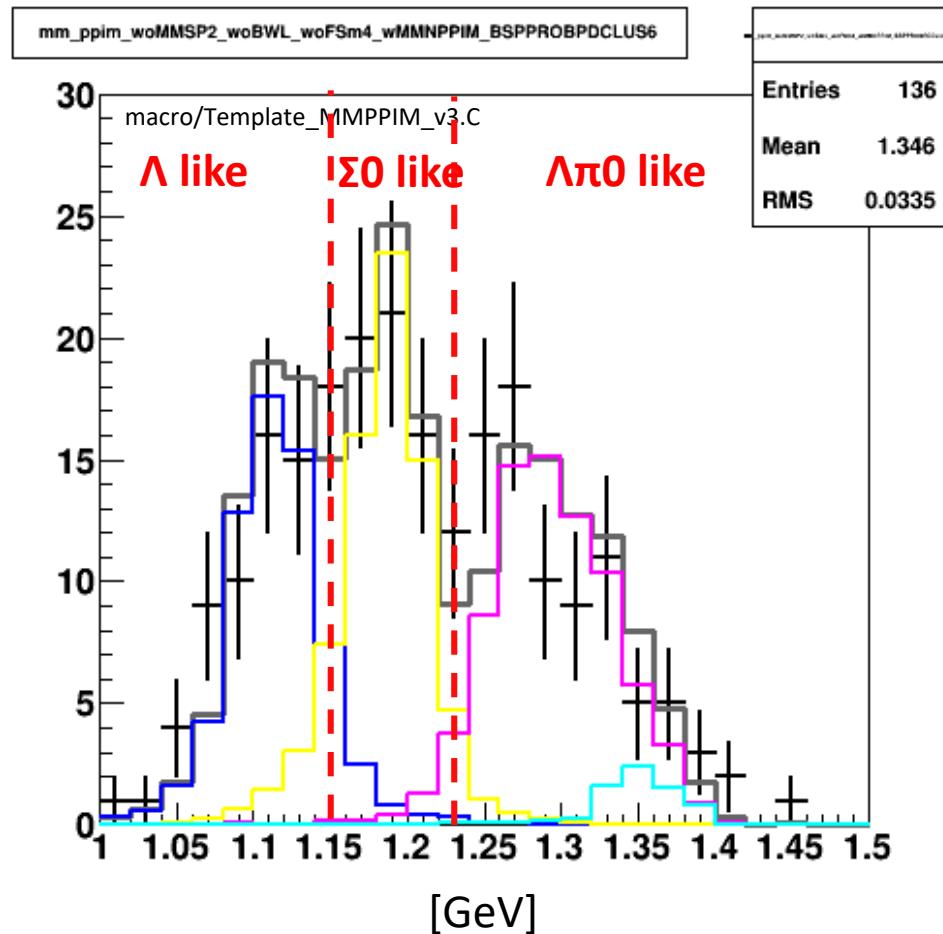
macro/Mom\_PIM\_v2.C



- w/o **K-d → K- p n**
  - MM.  $d(K-,p)$  distribution
    - All
    - $d(K-,n\bar{p}\pi^-)$  0.00~0.18 ( $Y=\Lambda$  like)
    - **$d(K-,p\pi^-)$  1.00~1.15 ( $Y=\Lambda$  like)**
    - $d(K-,n\bar{p}\pi^-)$  0.18~0.30 ( $Y=\Sigma^0$  like)
    - **$d(K-,p\pi^-)$  1.15~1.23 ( $Y=\Sigma^0$  like)**
    - **$d(K-,p\pi^-)$  1.23~1.50 ( $Y=\Lambda\pi^0$  like)**
  - MM.  $d(K-,n)$  distribution
    - All
    - $d(K-,n\bar{p}\pi^-)$  0.00~0.18 ( $Y=\Lambda$  like)
    - **$d(K-,p\pi^-)$  1.00~1.15 ( $Y=\Lambda$  like)**
    - $d(K-,n\bar{p}\pi^-)$  0.18~0.30 ( $Y=\Sigma^0$  like)
    - **$d(K-,p\pi^-)$  1.15~1.23 ( $Y=\Sigma^0$  like)**
    - **$d(K-,p\pi^-)$  1.23~1.50 ( $Y=\Lambda\pi^0$  like)**
- w/ **K-d → K- p n**

# Fitting of MM. $d(K^-, p\pi^-)$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$



## † Data

- $K^- d \rightarrow p \Lambda \pi^-$
- $K^- d \rightarrow p \Sigma^0 \pi^-$
- $K^- d \rightarrow p \Lambda \pi^- \pi^0$
- $K^- d \rightarrow p \Sigma^0 \pi^- \pi^0$

## Fit Result

Scaling factor of SIM is free

Fit Range

1.00 ~ 1.50 GeV

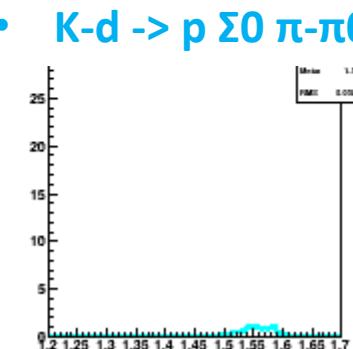
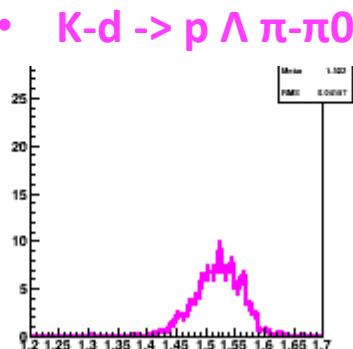
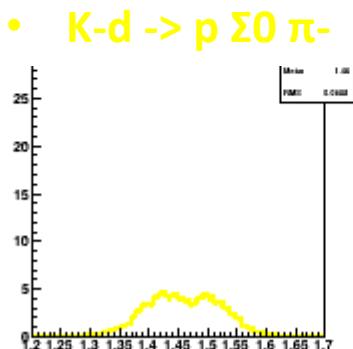
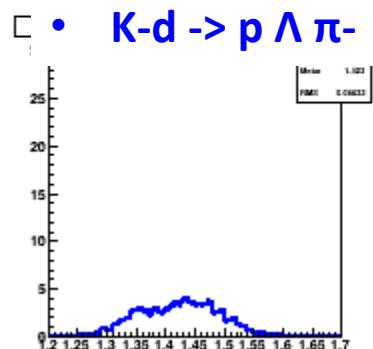
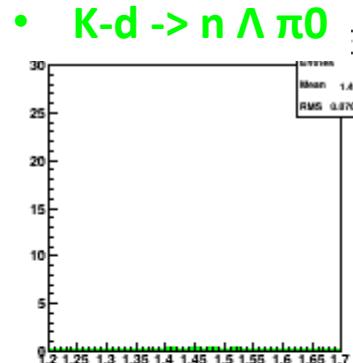
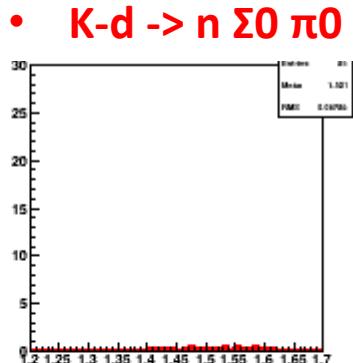
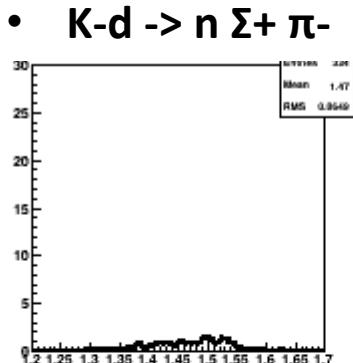
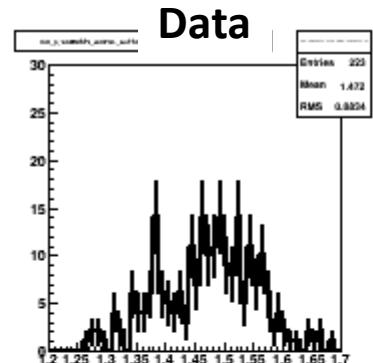
Chi2/ndf = 29.76/25

All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP.C

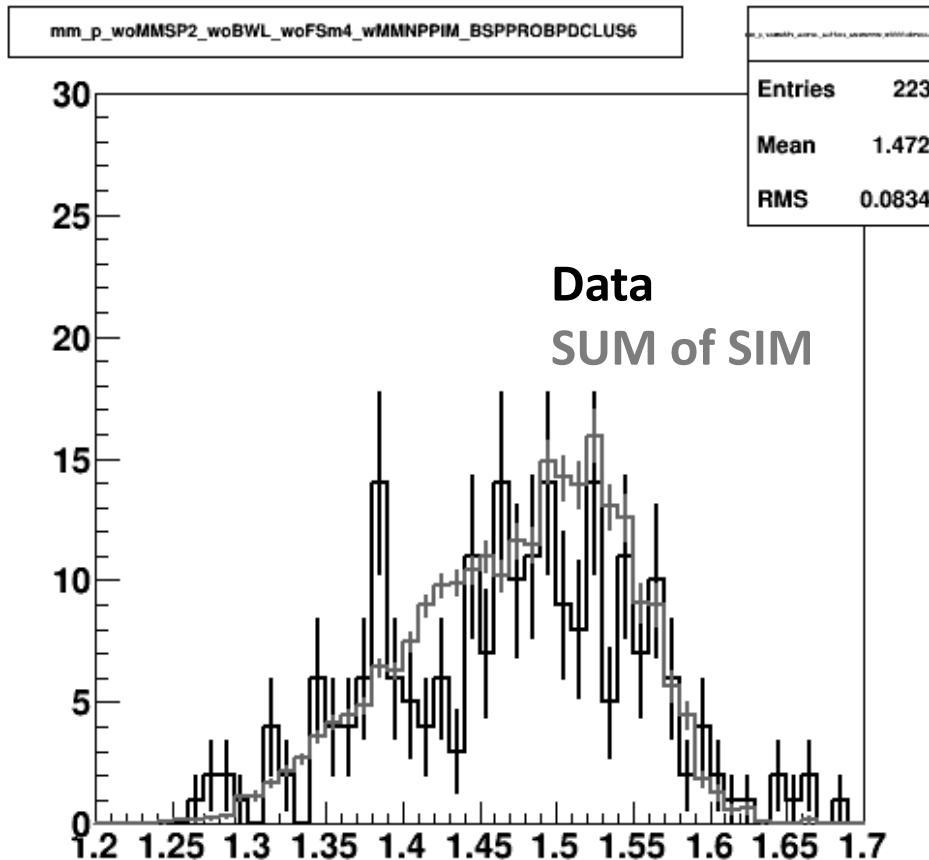


All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP.C

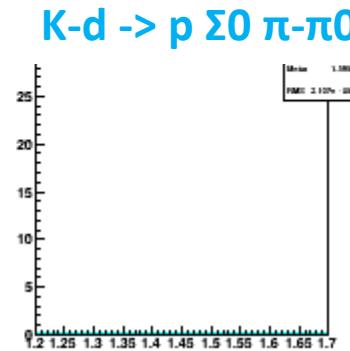
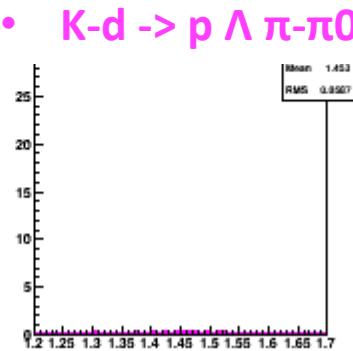
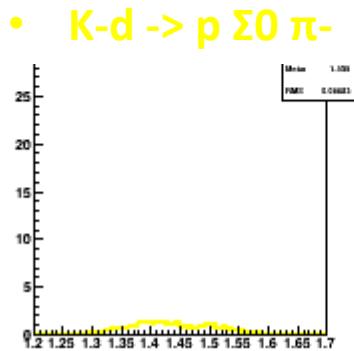
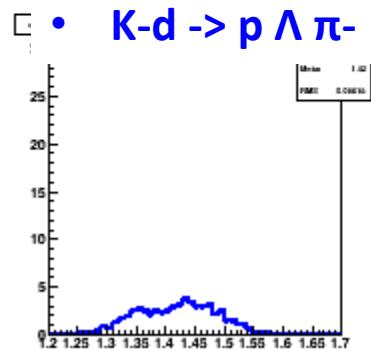
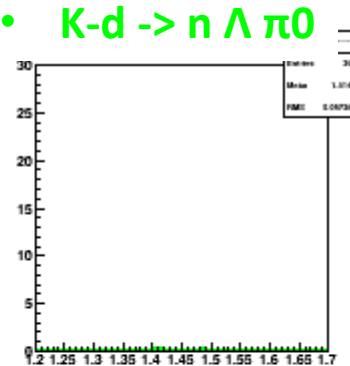
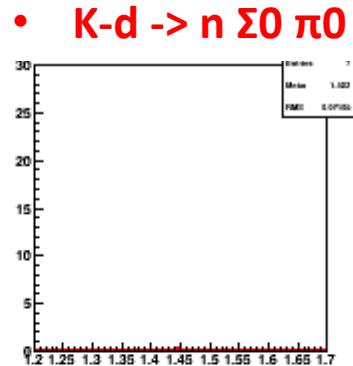
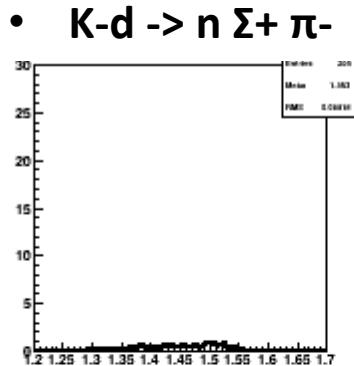
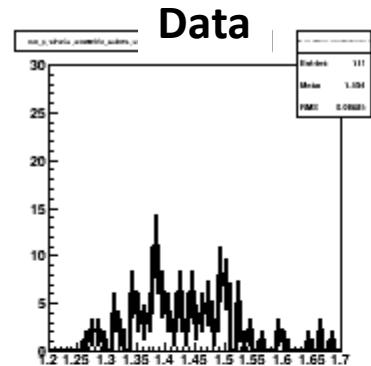


$d(K_-, np\pi^-)$  0.00~0.18 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, np\pi^-)$  0.00~0.18

# MM. $d(K_-, p)$ distribution

macro/MMP.C

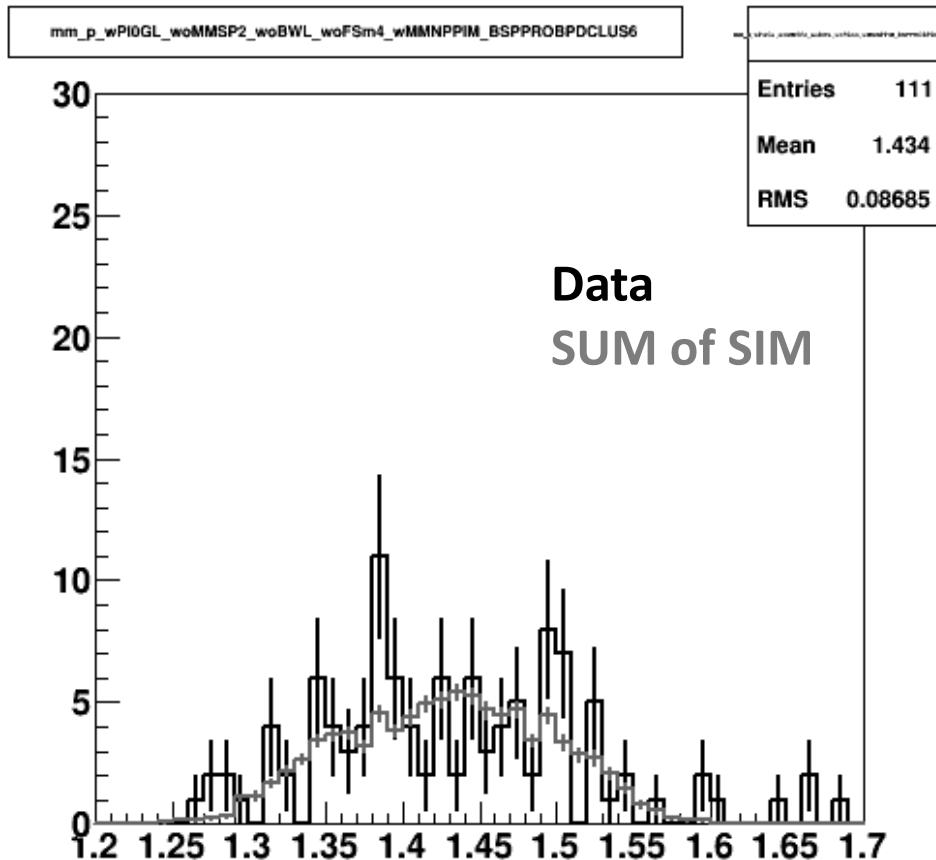


$d(K_-, np\pi^-)$  0.00~0.18 ( $\gamma = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, np\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, np\pi^-)$  0.00~0.18

# MM. $d(K_-, p)$ distribution

macro/MMP.C

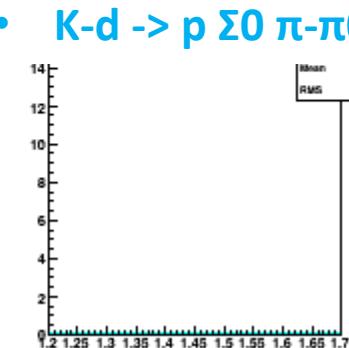
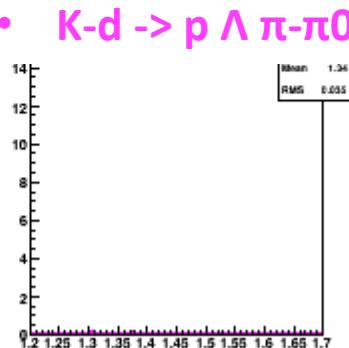
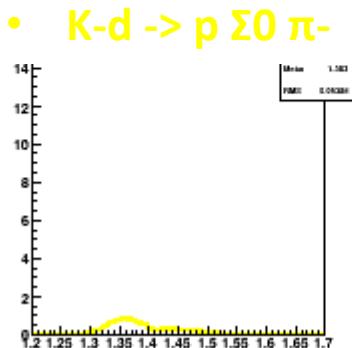
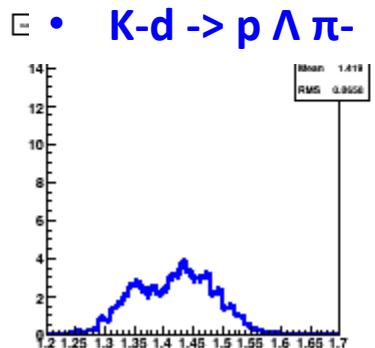
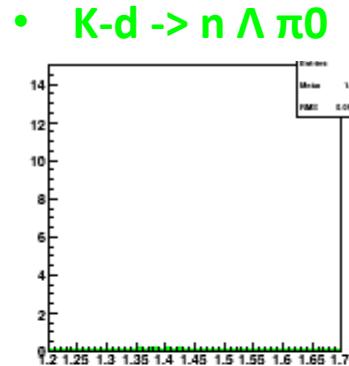
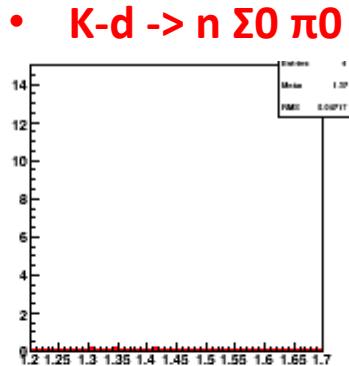
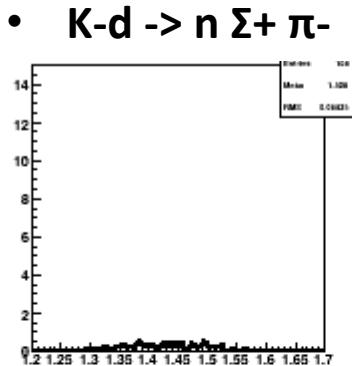
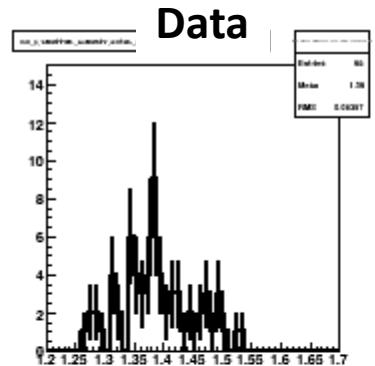


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP.C

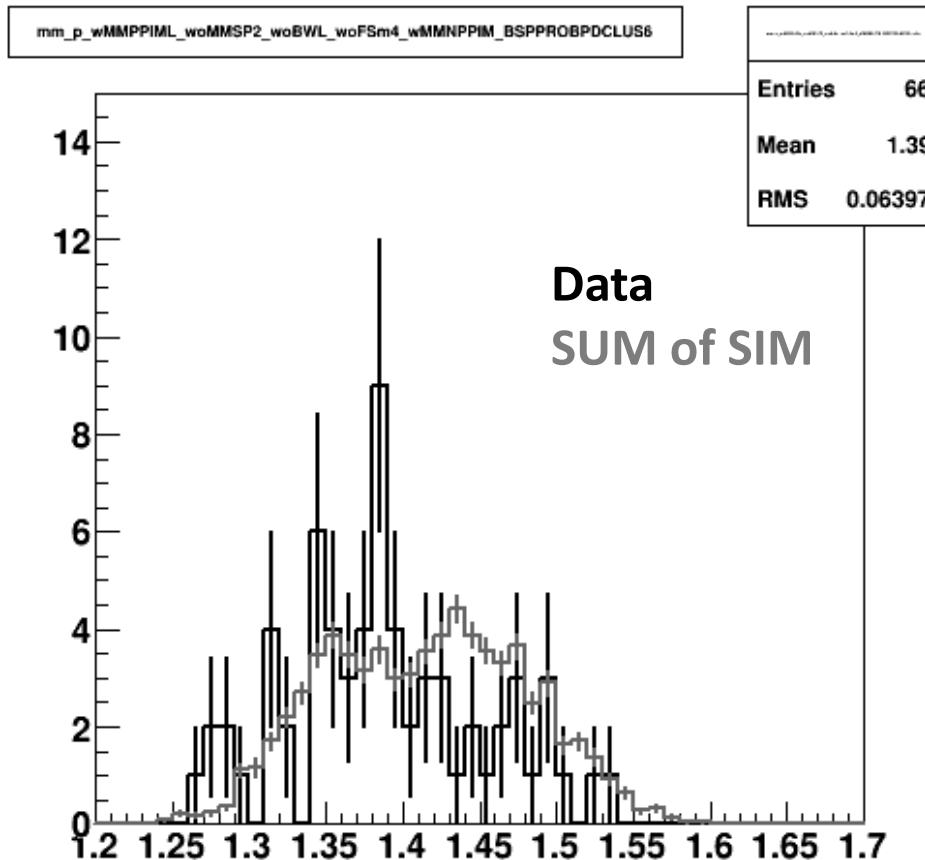


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP.C

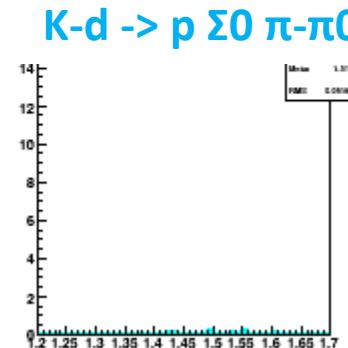
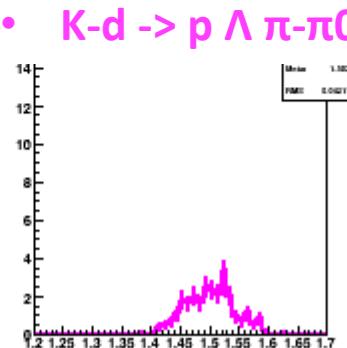
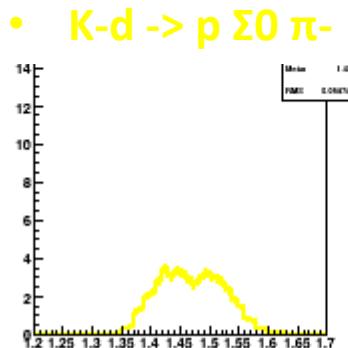
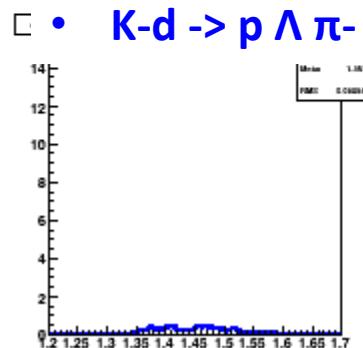
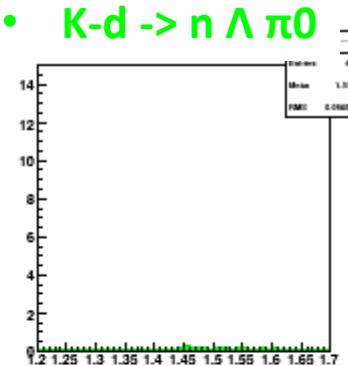
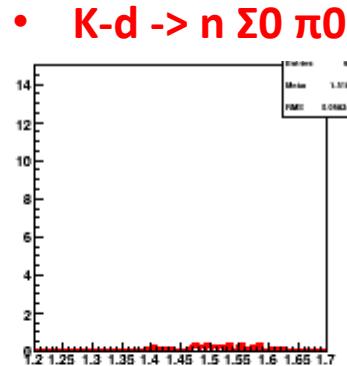
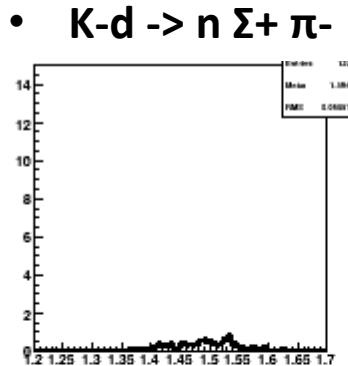
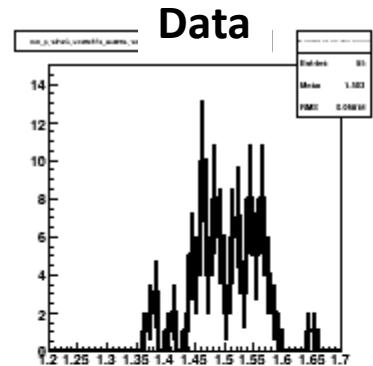


$d(K_-, np\pi^-)$   $0.18 \sim 0.30$  ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $d(K_-, np\pi^-)$   $0.18 \sim 0.30$

# MM. $d(K_-, p)$ distribution

macro/MMP.C

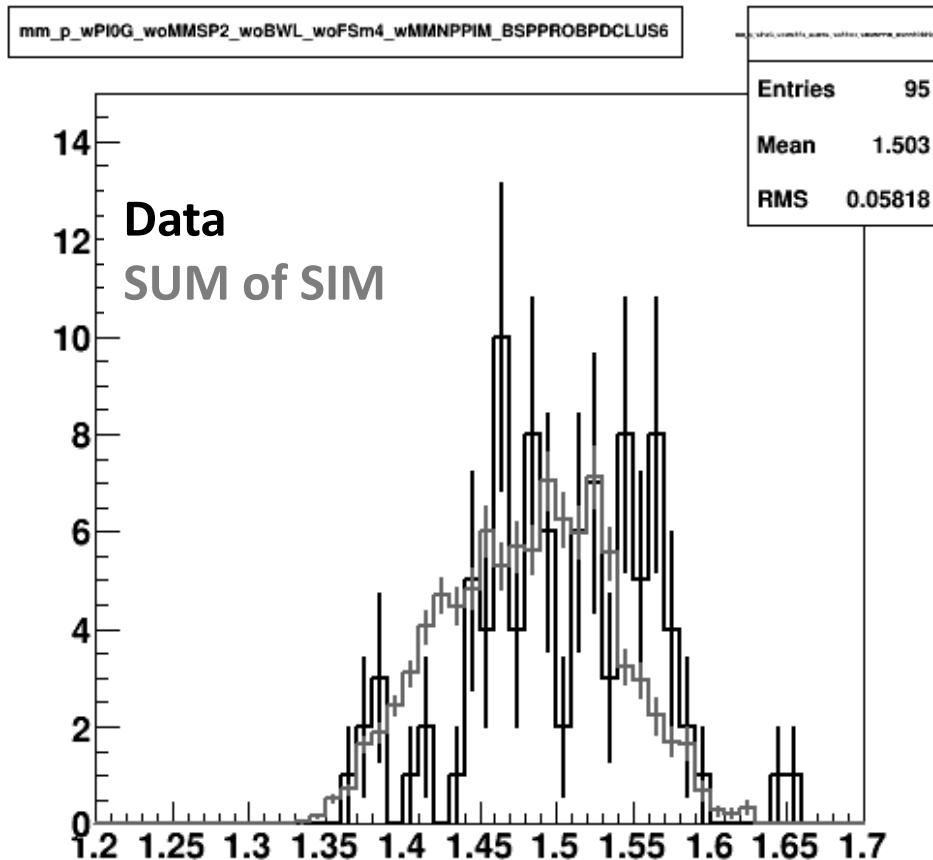


$d(K_-, np\pi^-)$  0.18~0.30 ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, np\pi^-)$  0.18~0.30

# MM. $d(K_-, p)$ distribution

macro/MMP.C

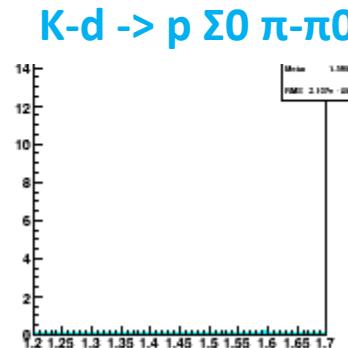
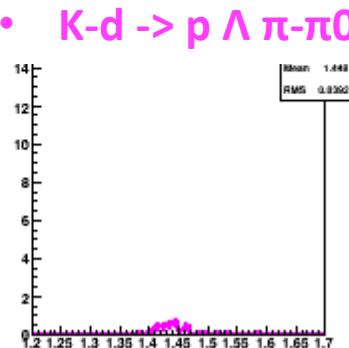
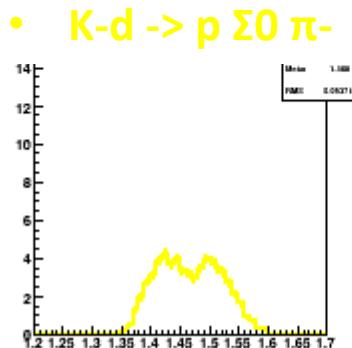
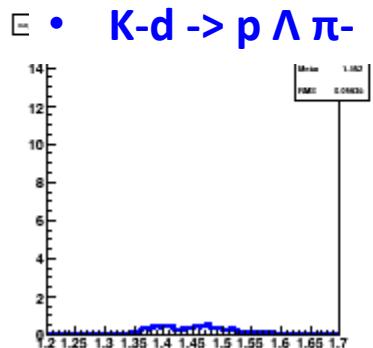
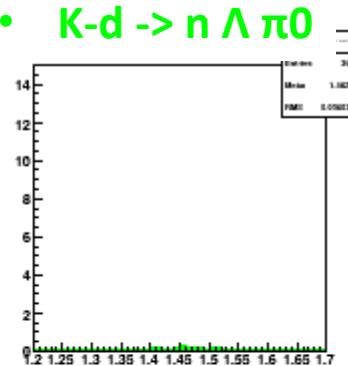
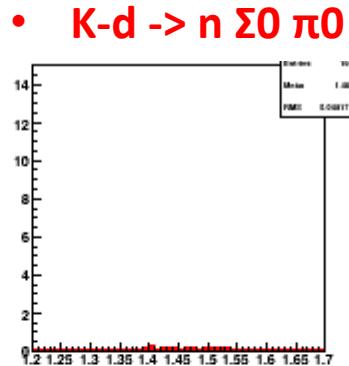
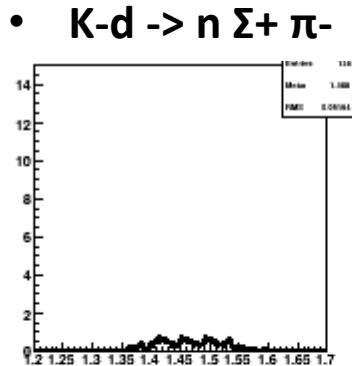
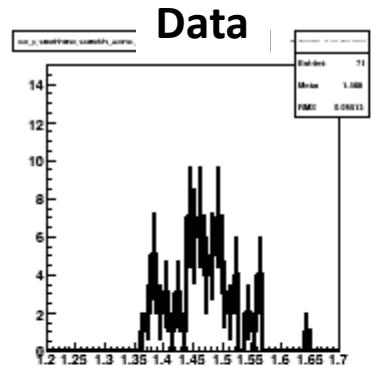


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP.C

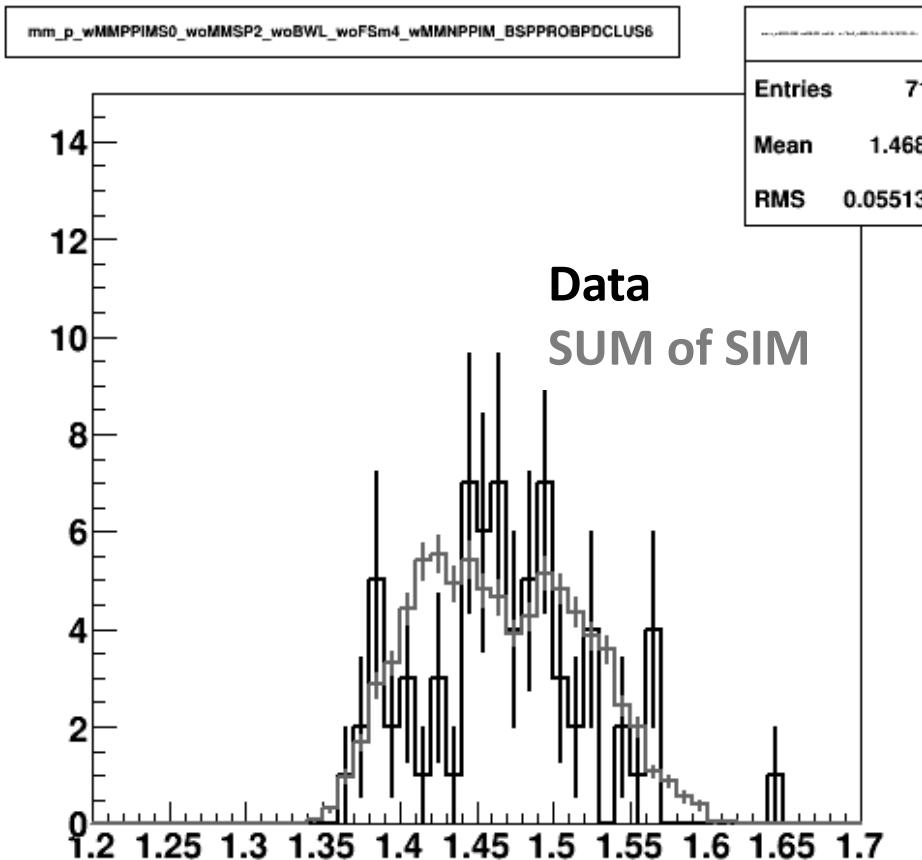


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP.C



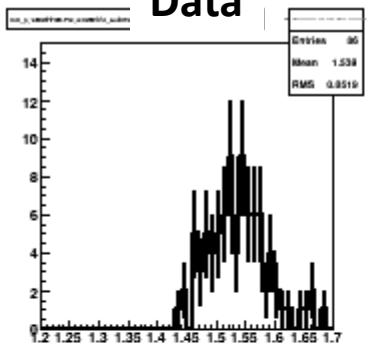
$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

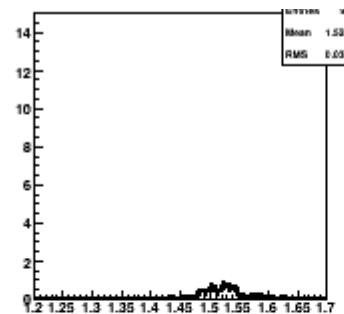
# MM. $d(K^-, p)$ distribution

macro/MMP.C

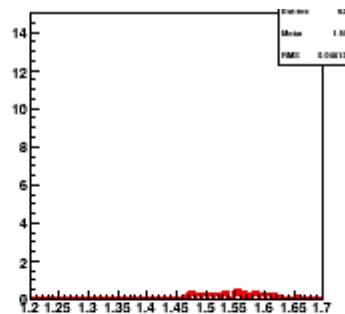
Data



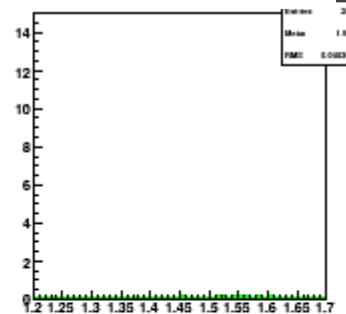
•  $K^-\bar{d} \rightarrow n \Sigma^+ \pi^-$



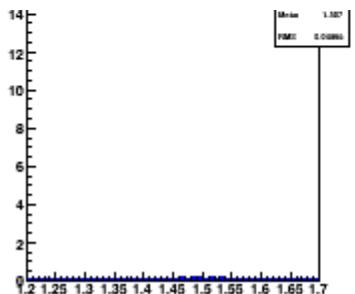
•  $K^-\bar{d} \rightarrow n \Sigma^0 \pi^0$



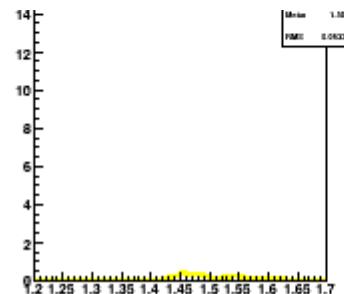
•  $K^-\bar{d} \rightarrow n \Lambda \pi^0$



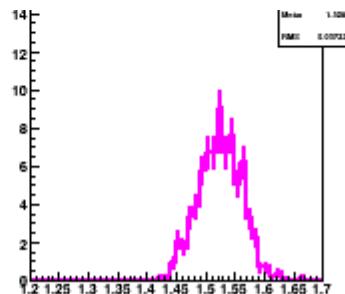
•  $K^-\bar{d} \rightarrow p \Lambda \pi^-$



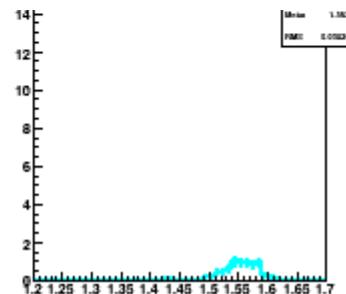
•  $K^-\bar{d} \rightarrow p \Sigma^0 \pi^-$



•  $K^-\bar{d} \rightarrow p \Lambda \pi^- \pi^0$



•  $K^-\bar{d} \rightarrow p \Sigma^0 \pi^- \pi^0$

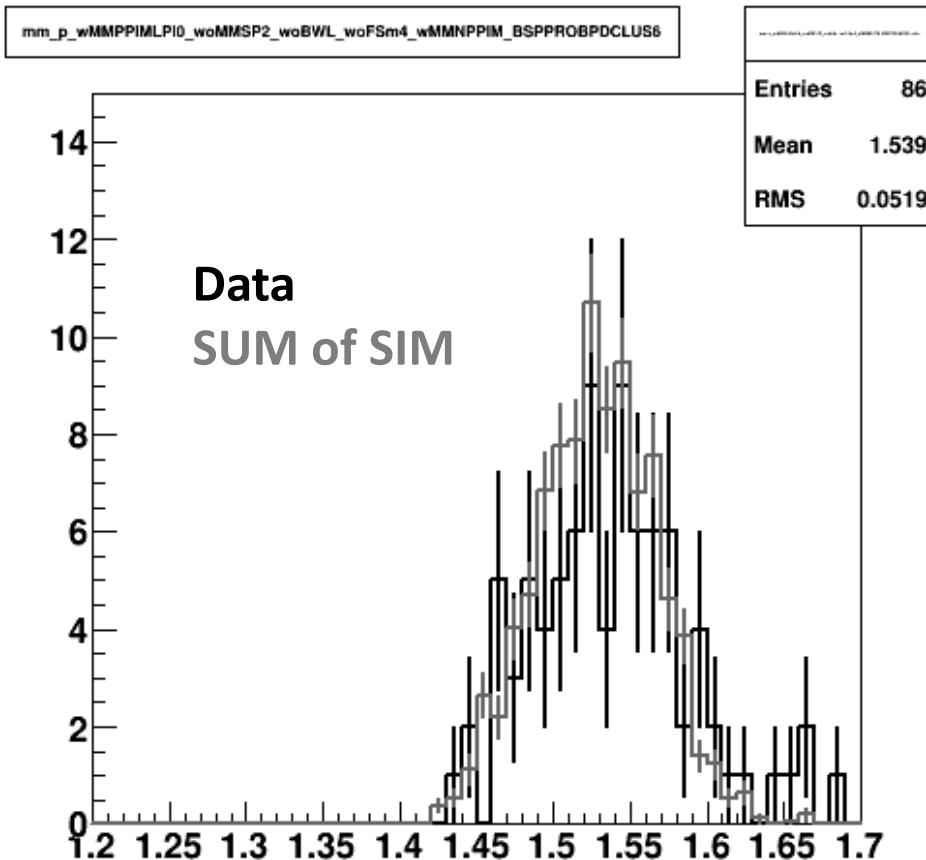


$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP.C

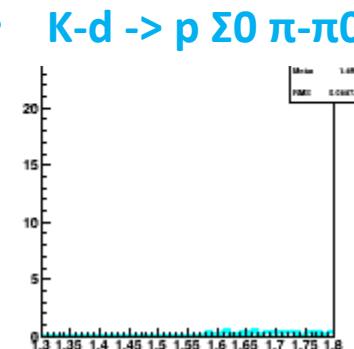
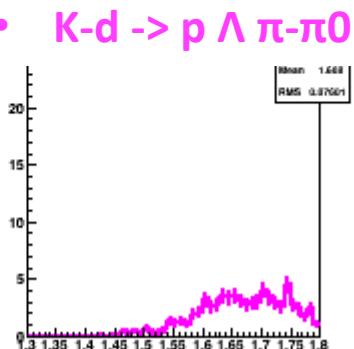
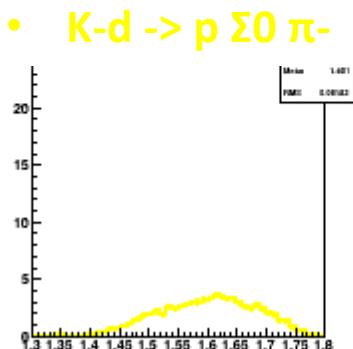
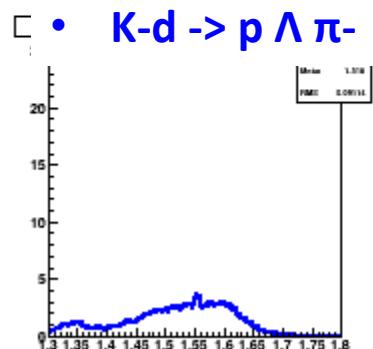
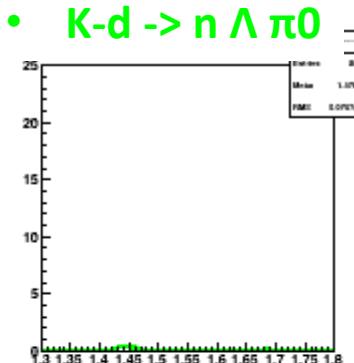
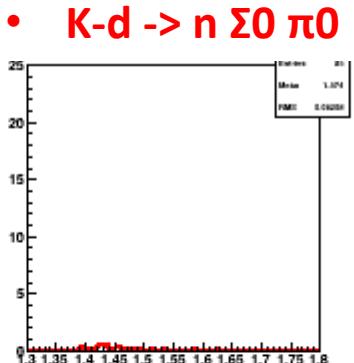
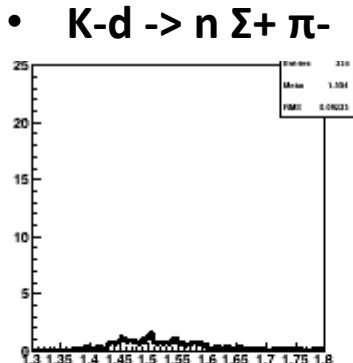
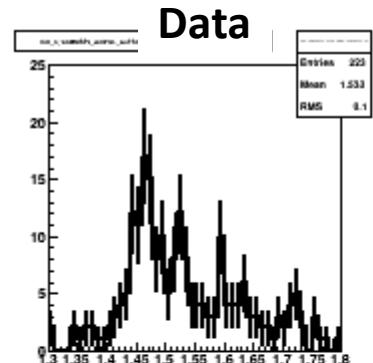


All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C

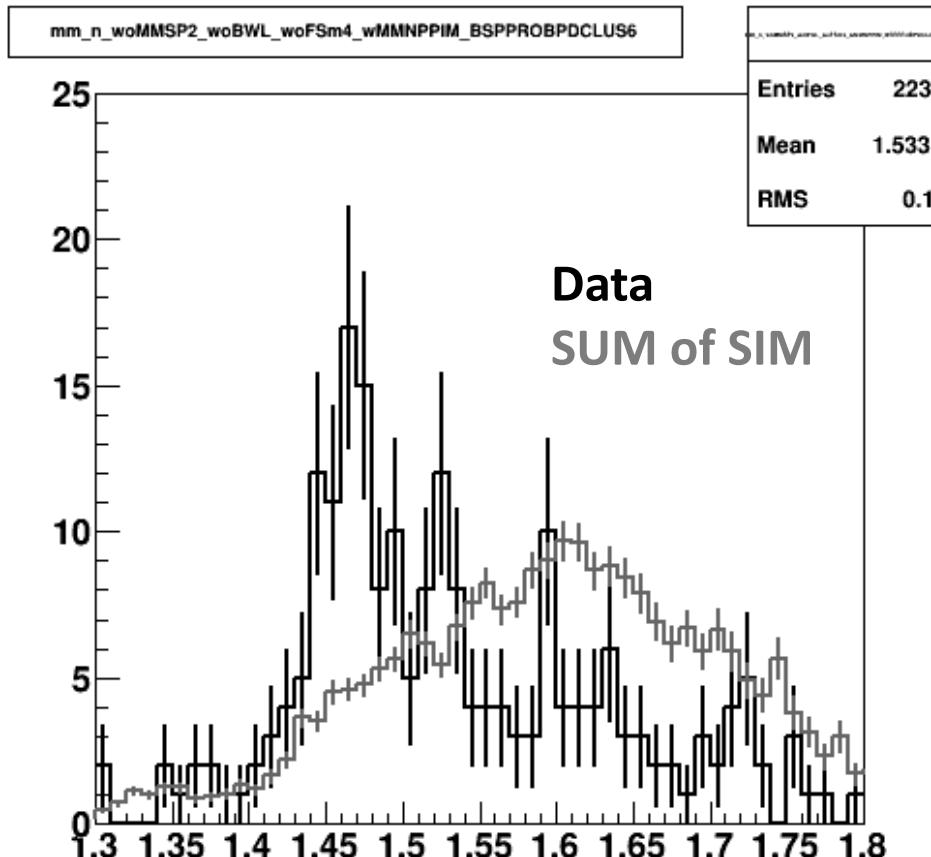


All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C

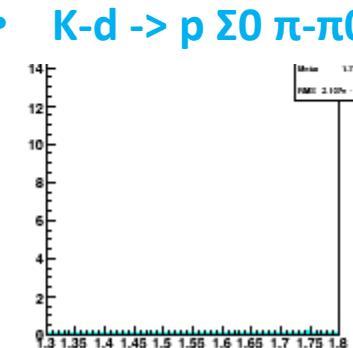
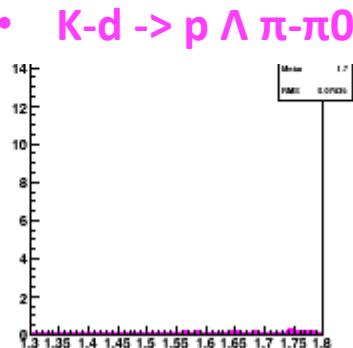
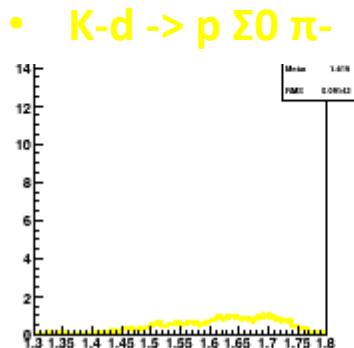
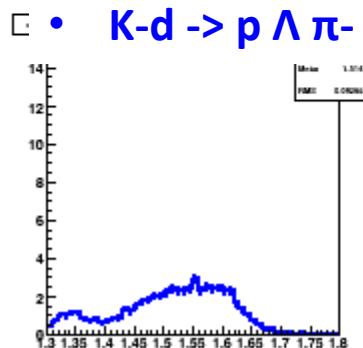
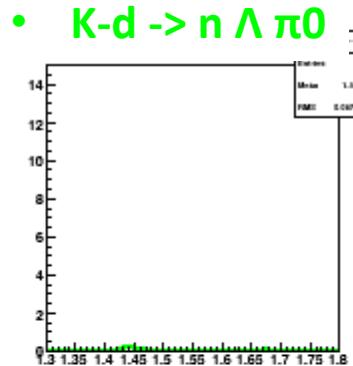
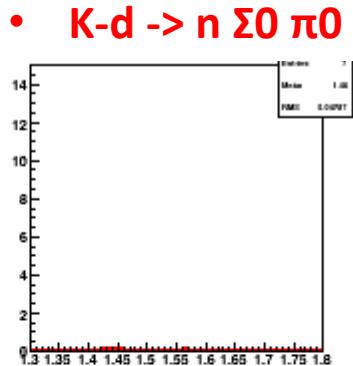
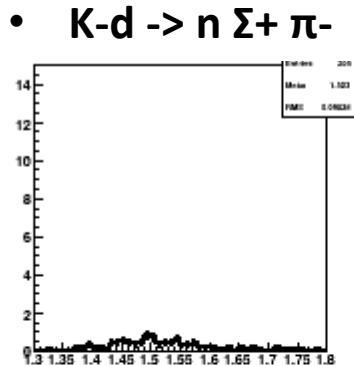
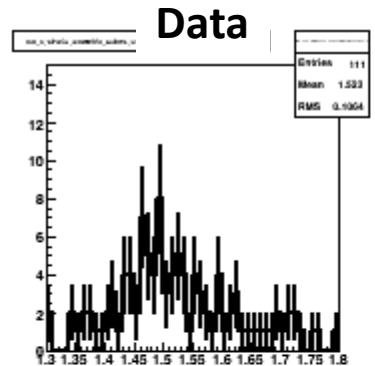


$d(K_-, n p \pi^-)$  0.00~0.18 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n \pi^+)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, n p \pi^-)$  0.00~0.18

# MM. $d(K_-, n)$ distribution

macro/MMN\_v6.C

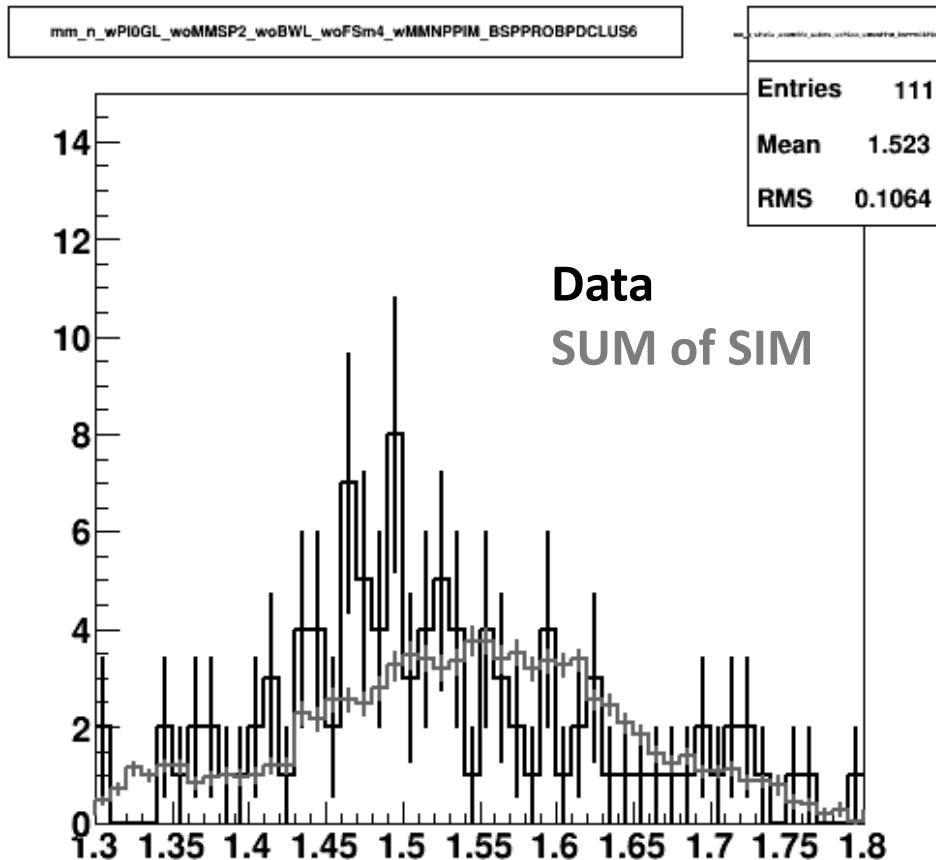


$d(K_-, n \rho \pi^-)$  0.00~0.18 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $d(K_-, n \rho \pi^-)$  0.00~0.18

# MM. $d(K_-, n)$ distribution

macro/MMN\_v6.C

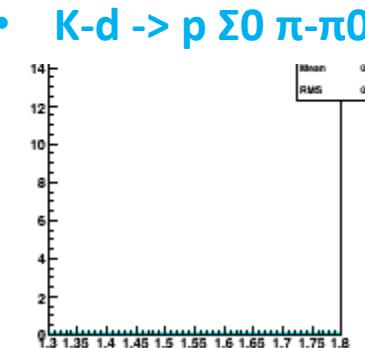
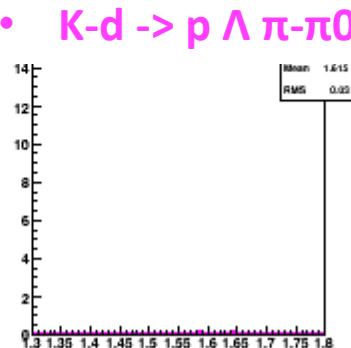
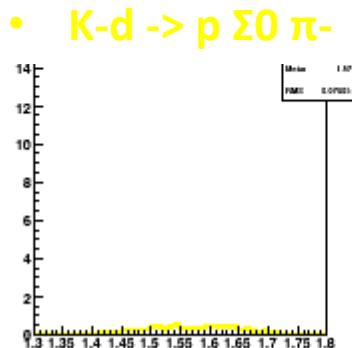
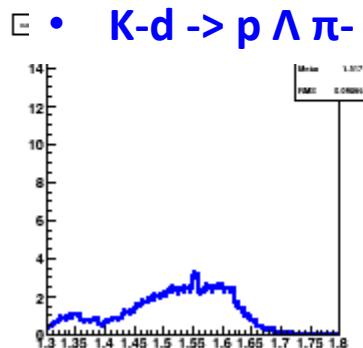
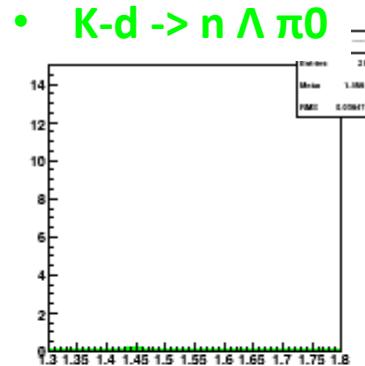
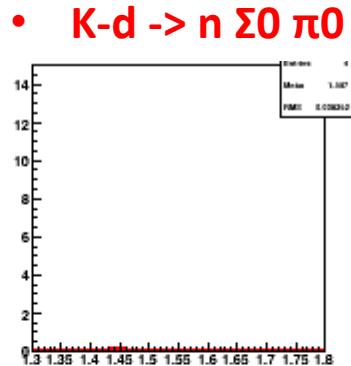
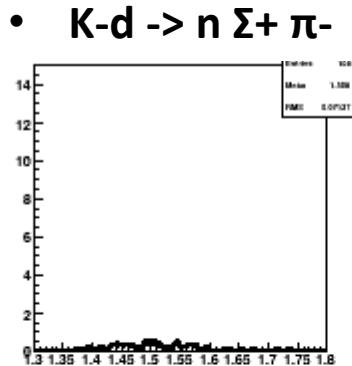
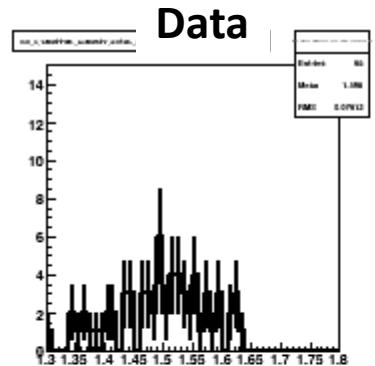


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C

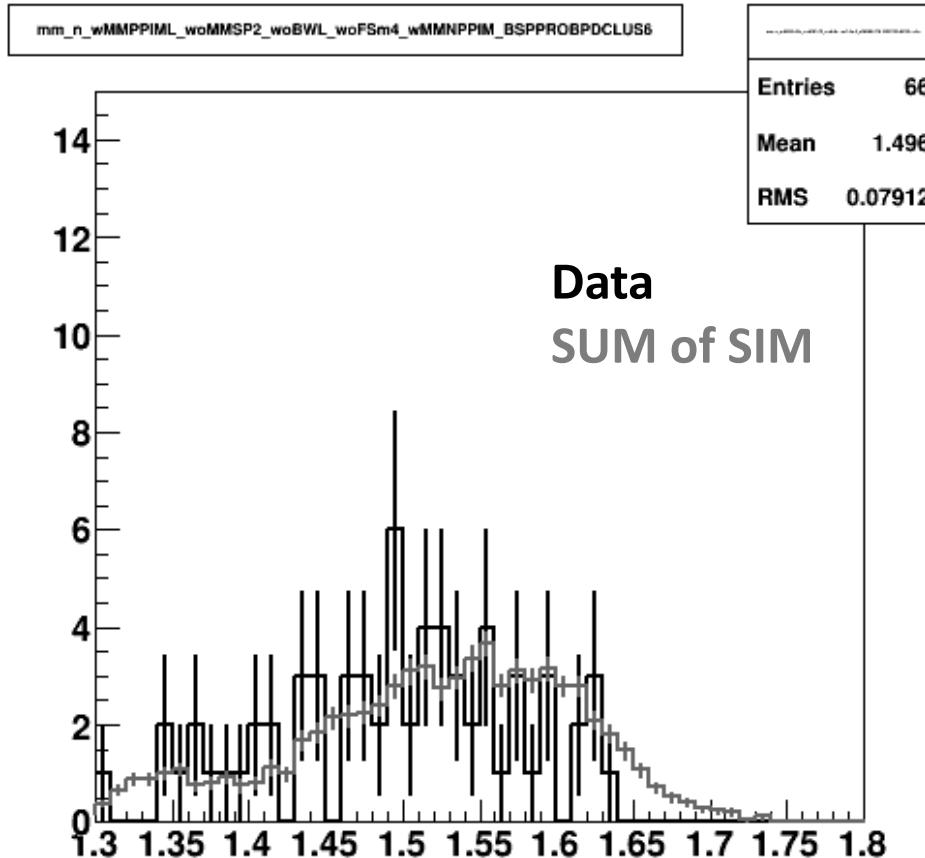


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
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- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C

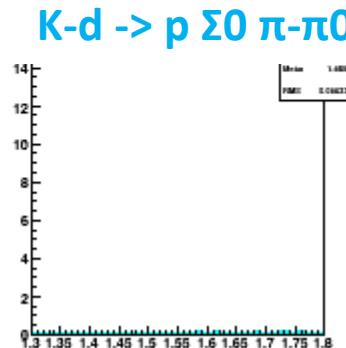
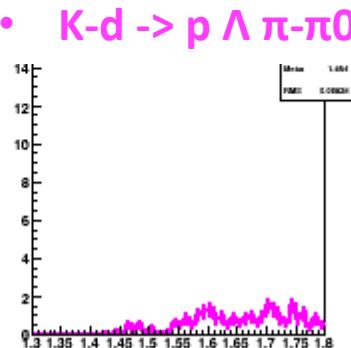
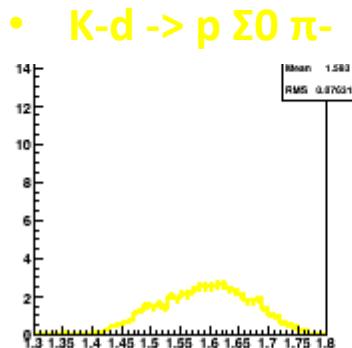
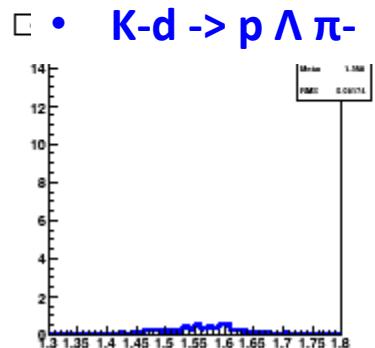
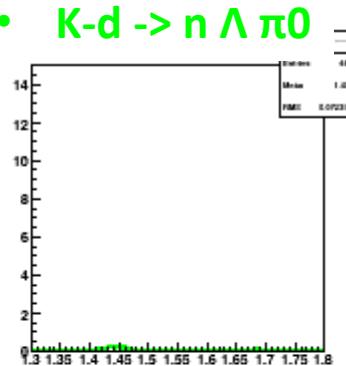
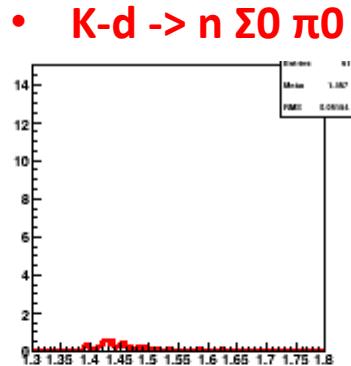
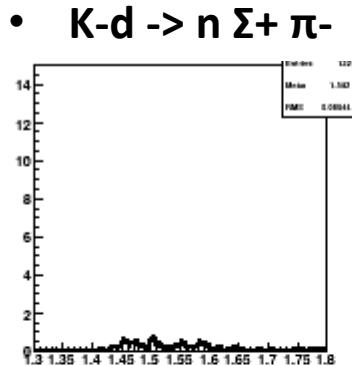
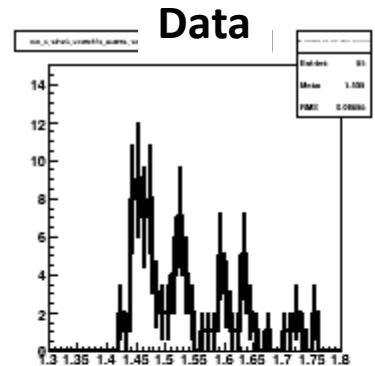


$d(K_-, n \rho \pi^-)$   $0.18 \sim 0.30$  ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n \pi^+)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $d(K_-, n \rho \pi^-)$   $0.18 \sim 0.30$

# MM. $d(K_-, n)$ distribution

macro/MMN\_v6.C

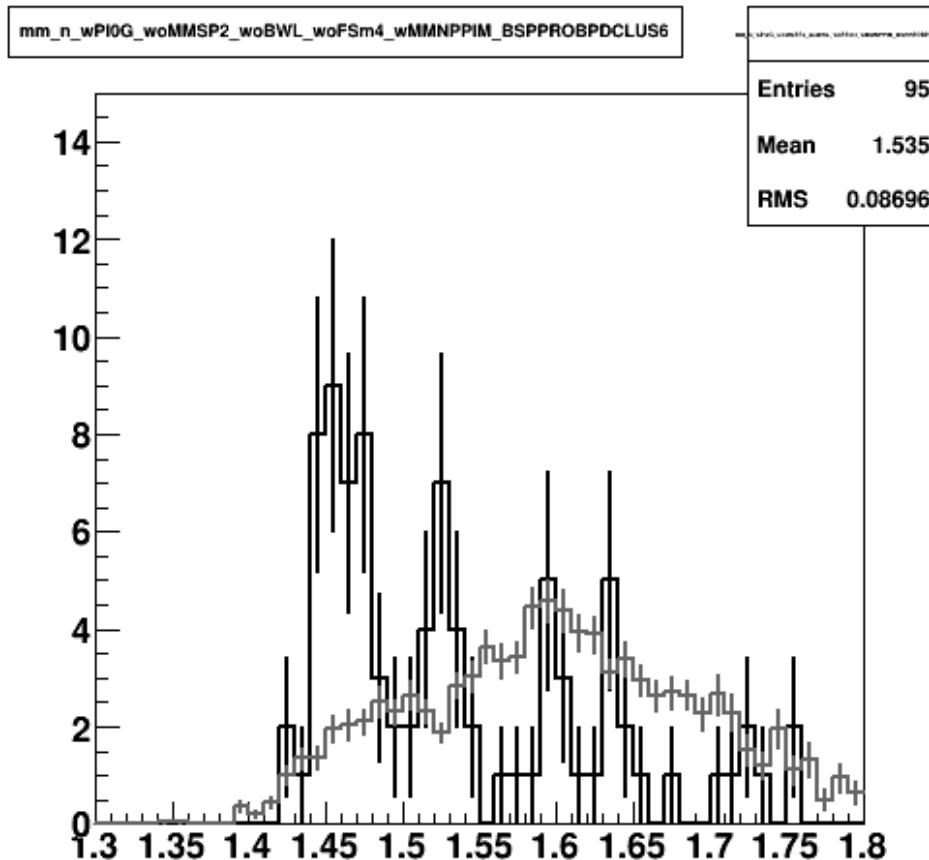


$d(K_-, n\bar{p}\pi^-)$  0.18~0.30 ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\bar{p}\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, n\bar{p}\pi^-)$  0.18~0.30

# MM. $d(K_-, n)$ distribution

macro/MMN\_v6.C

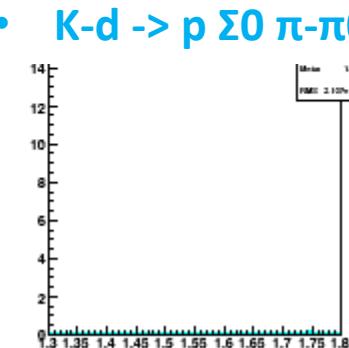
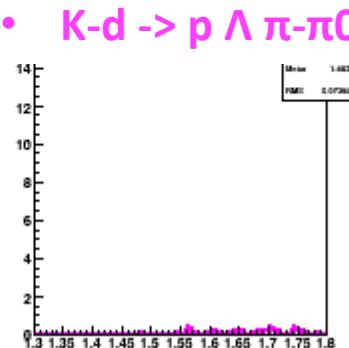
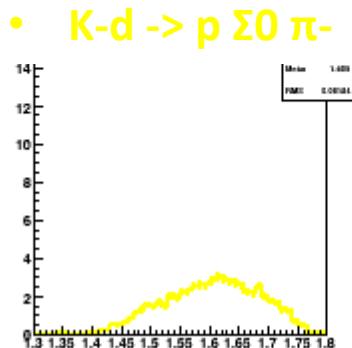
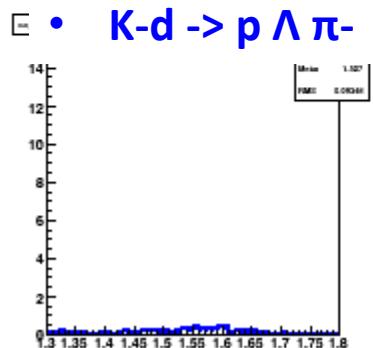
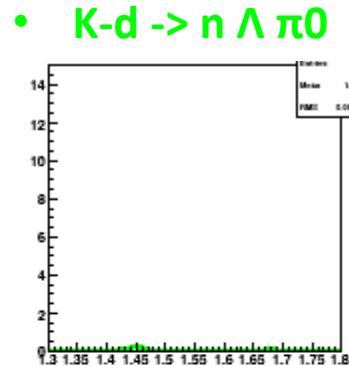
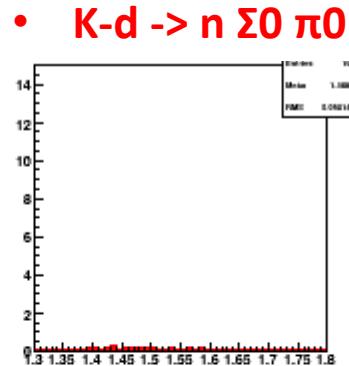
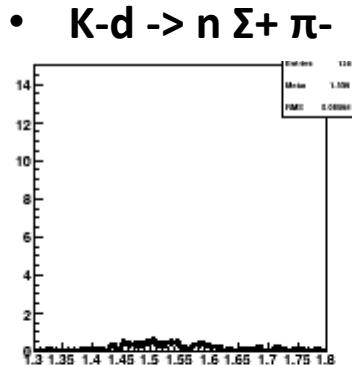
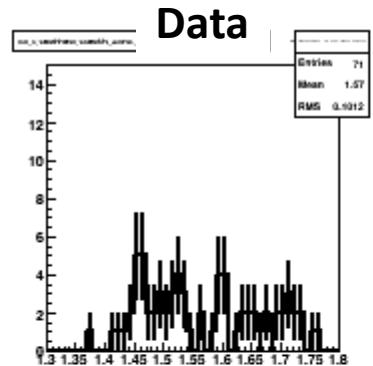


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C

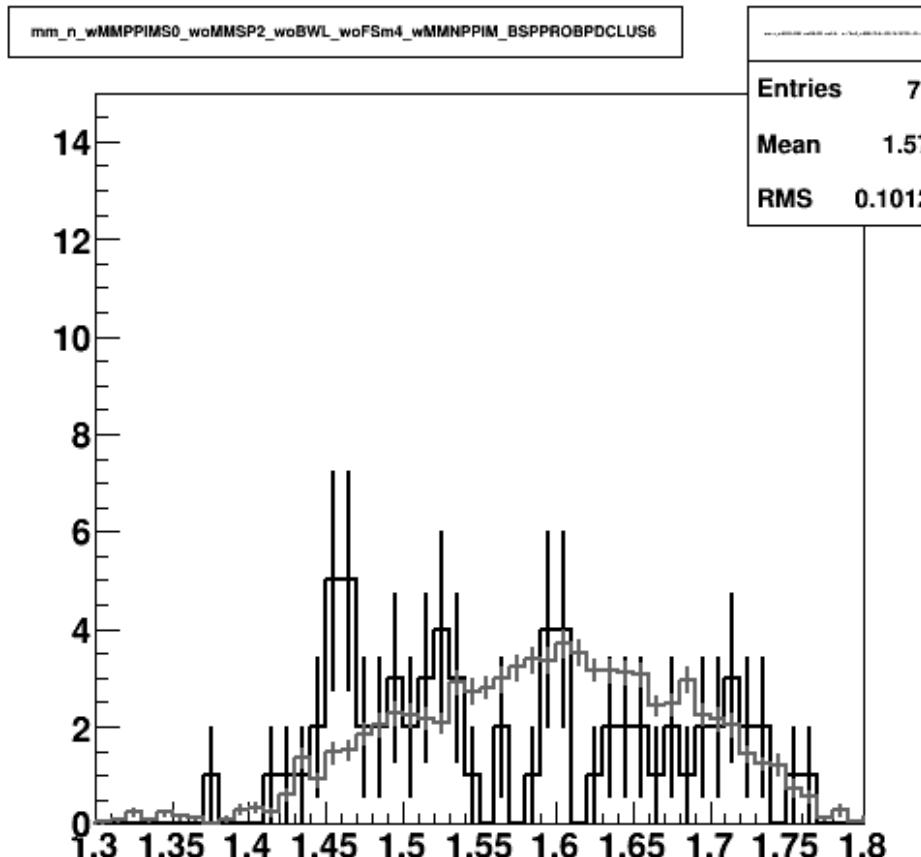


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C

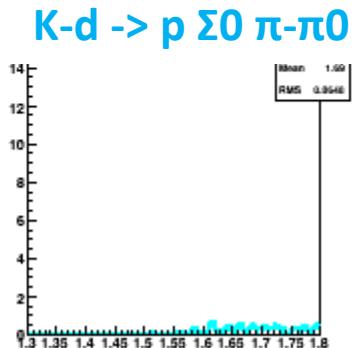
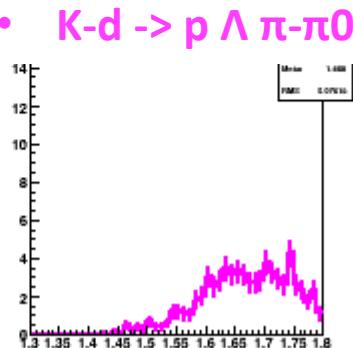
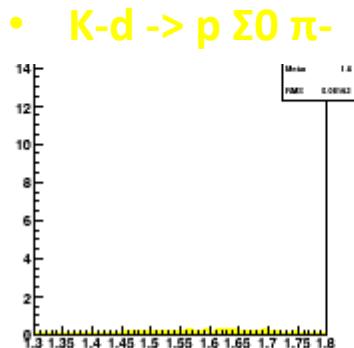
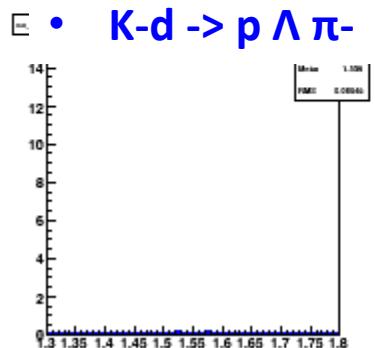
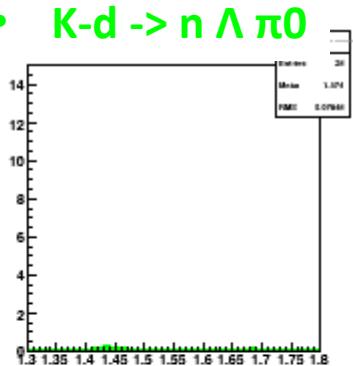
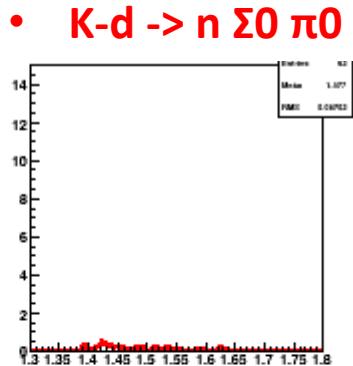
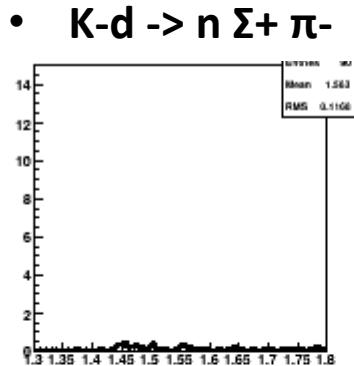
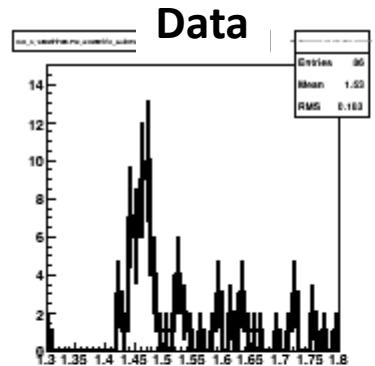


$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C

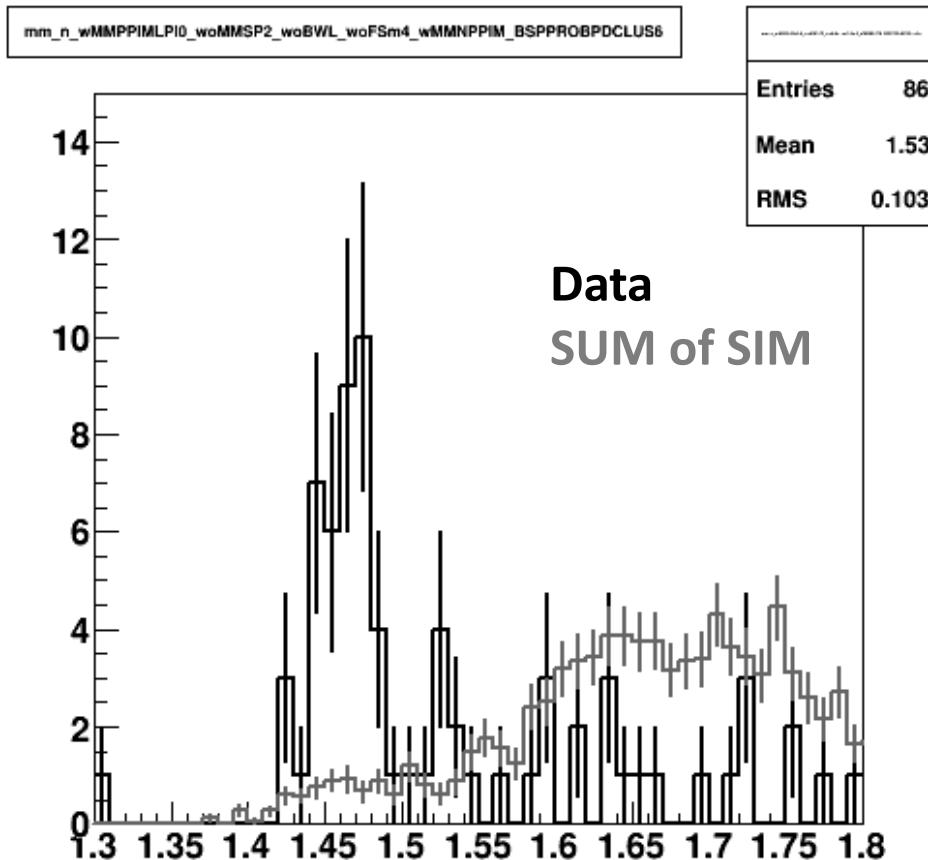


$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v6.C



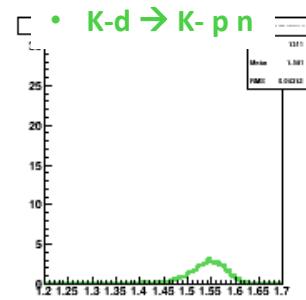
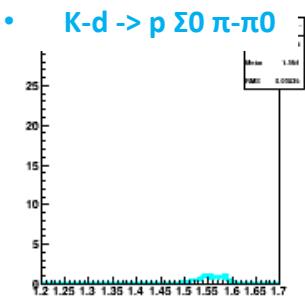
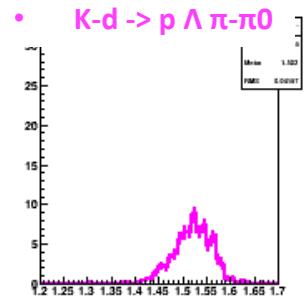
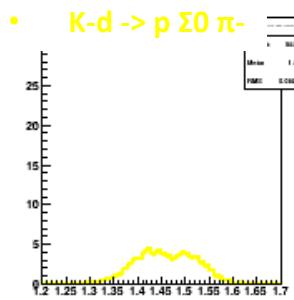
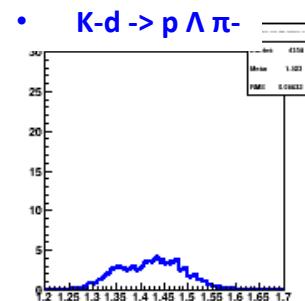
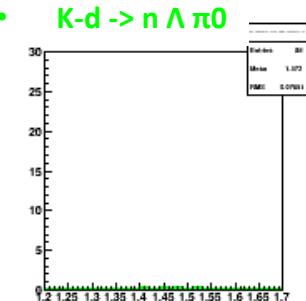
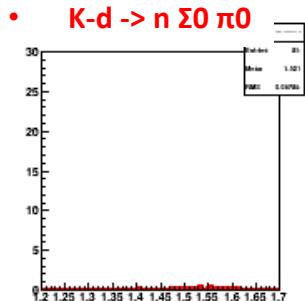
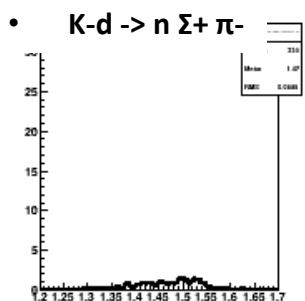
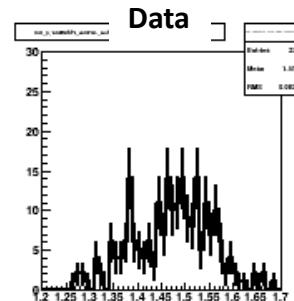
w/  $K^- d \rightarrow K^- p n$

All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

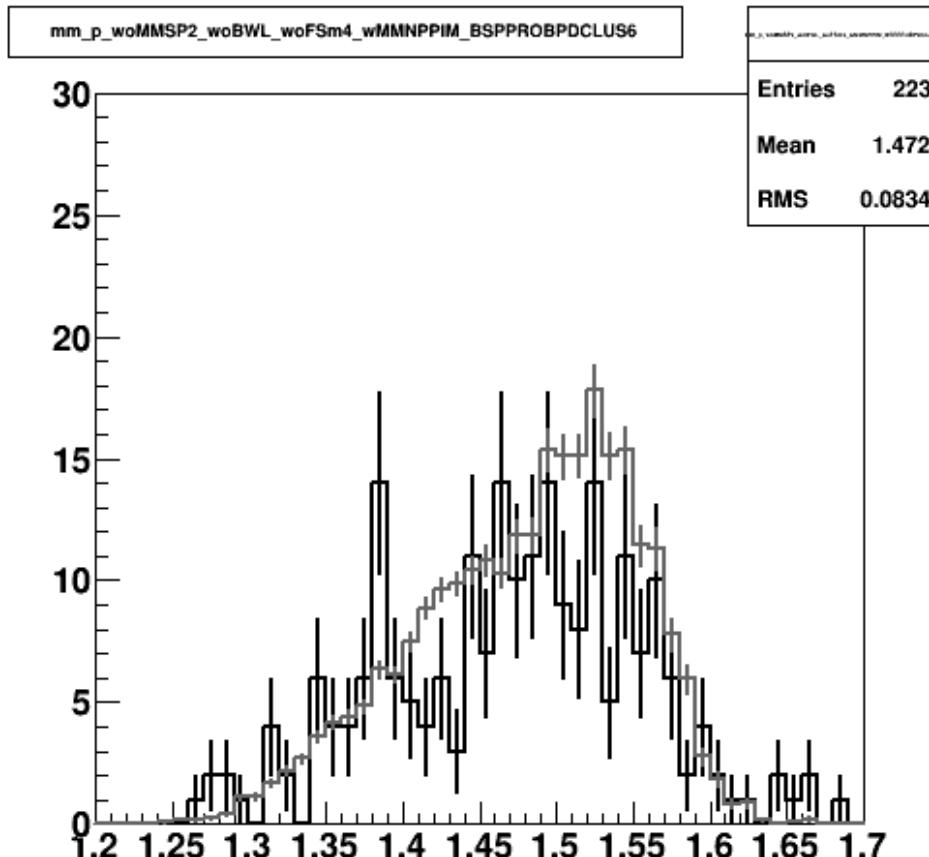


All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

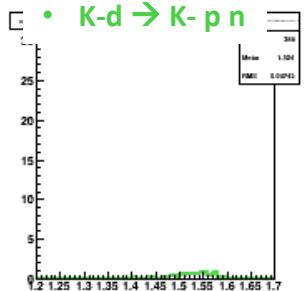
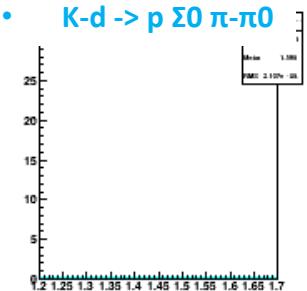
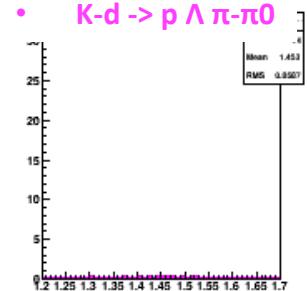
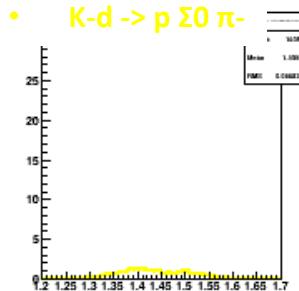
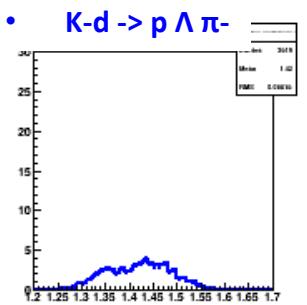
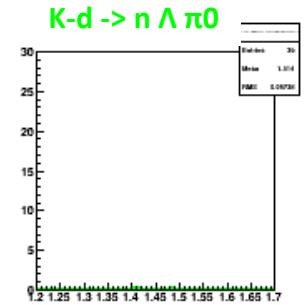
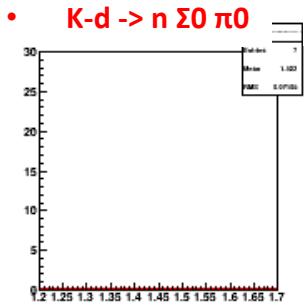
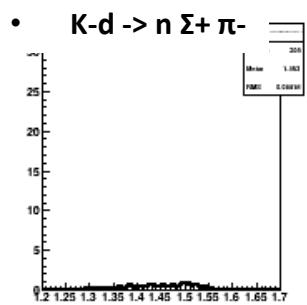
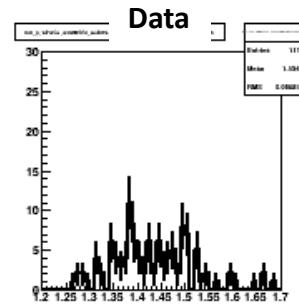


$d(K_-, np\pi^-)$  0.00~0.18 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, np\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, np\pi^-)$  0.00~0.18

# MM. $d(K_-, p)$ distribution

macro/MMP\_v2.C

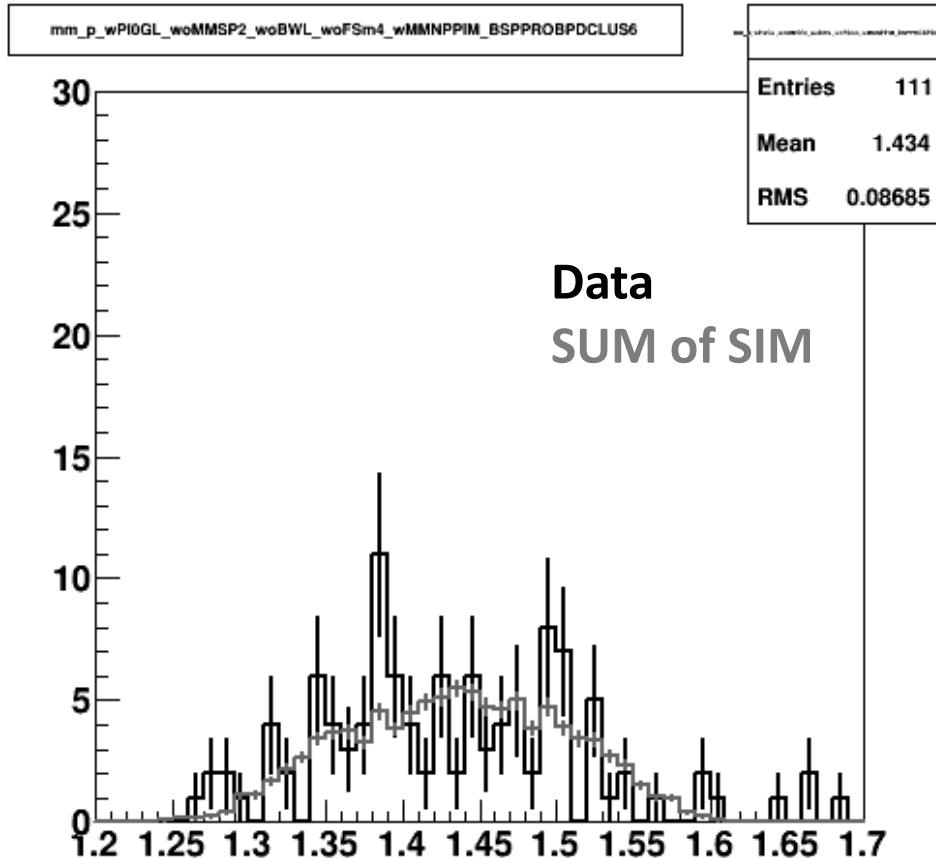


$d(K_-, np\pi^-)$  0.00~0.18 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, np\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, np\pi^-)$  0.00~0.18

# MM. $d(K_-, p)$ distribution

macro/MMP\_v2.C

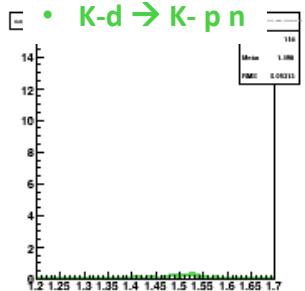
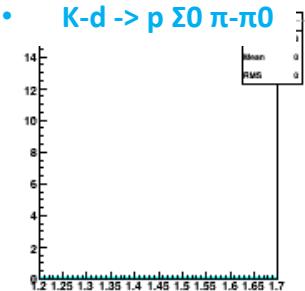
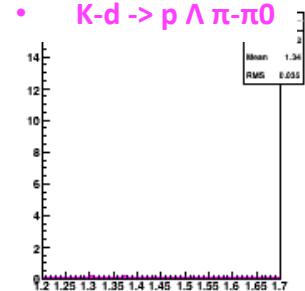
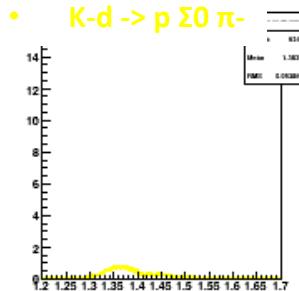
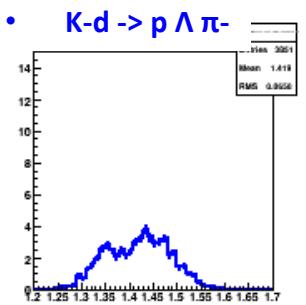
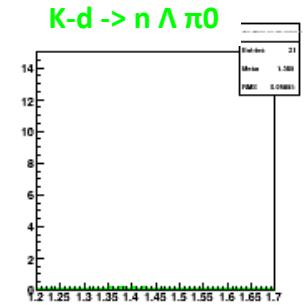
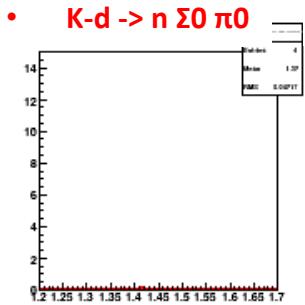
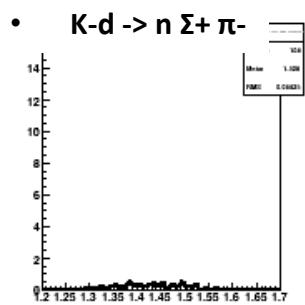
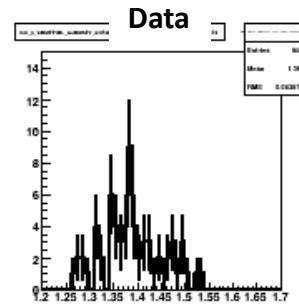


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

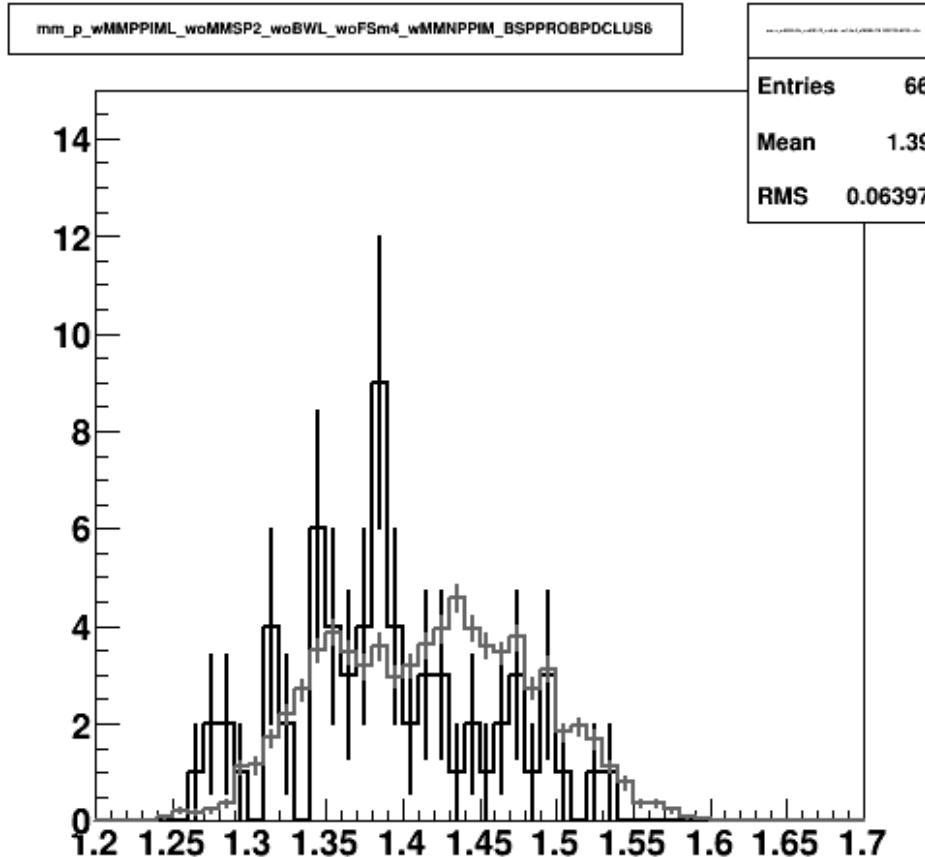


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

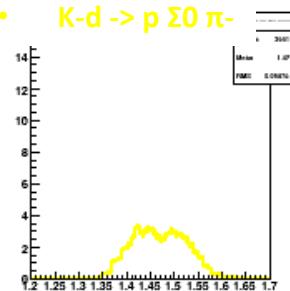
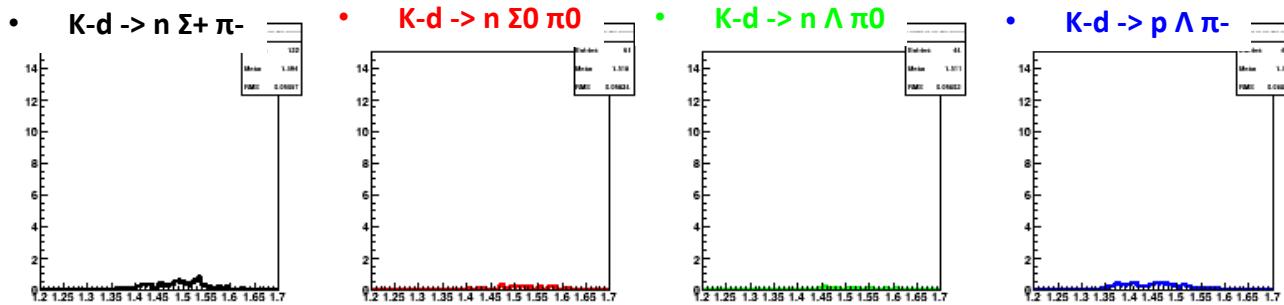
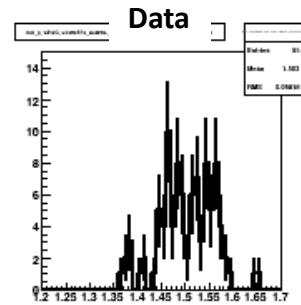


$d(K_-, np\pi^-)$  0.18~0.30 ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, np\pi^-)$  0.18~0.30

# MM. $d(K_-, p)$ distribution

macro/MMP\_v2.C

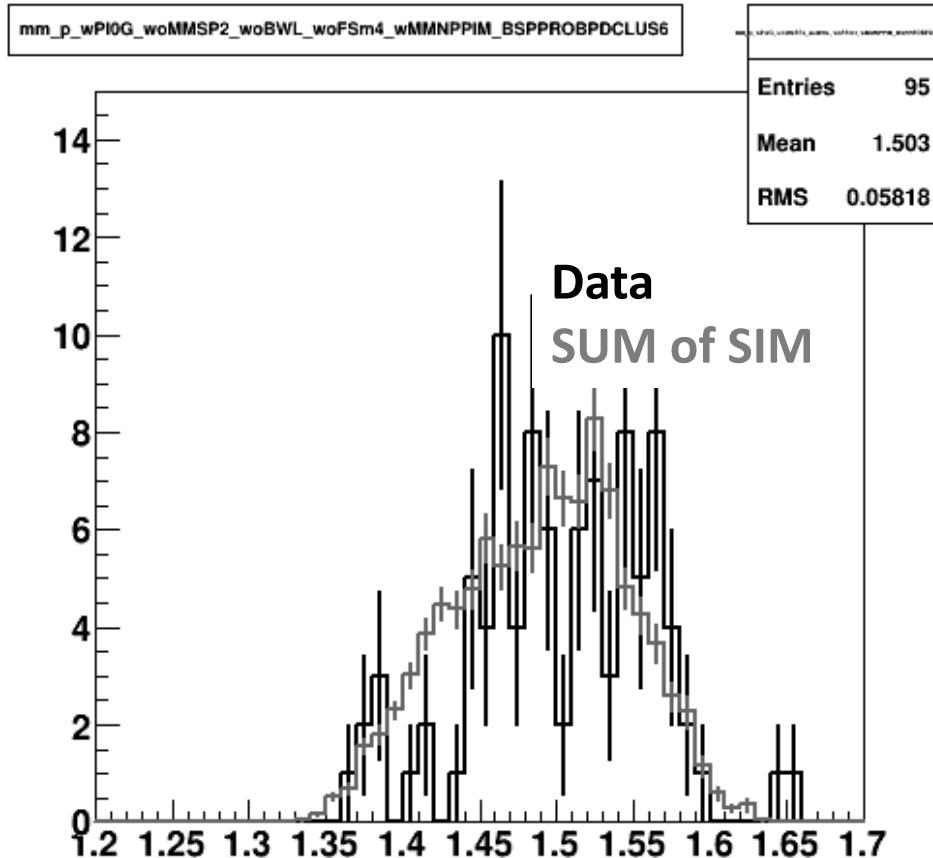


$d(K_-, np\pi^-)$   $0.18 \sim 0.30$  ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $d(K_-, np\pi^-)$   $0.18 \sim 0.30$

# MM. $d(K_-, p)$ distribution

macro/MMP\_v2.C

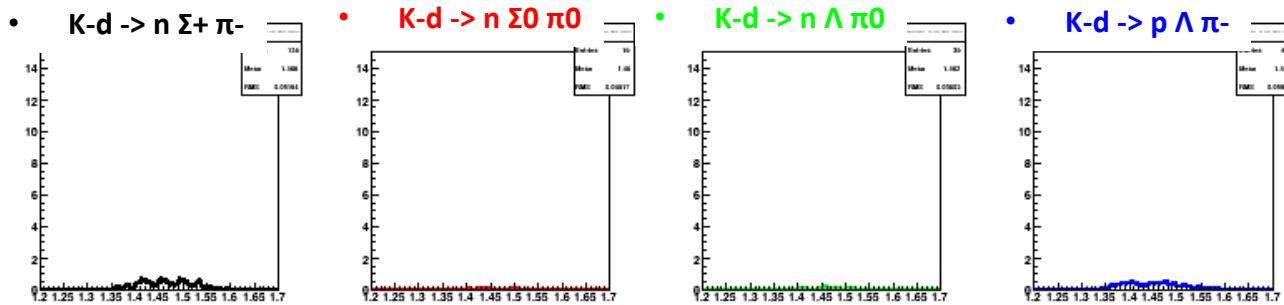
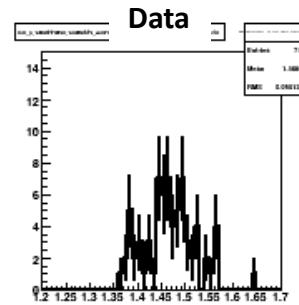


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

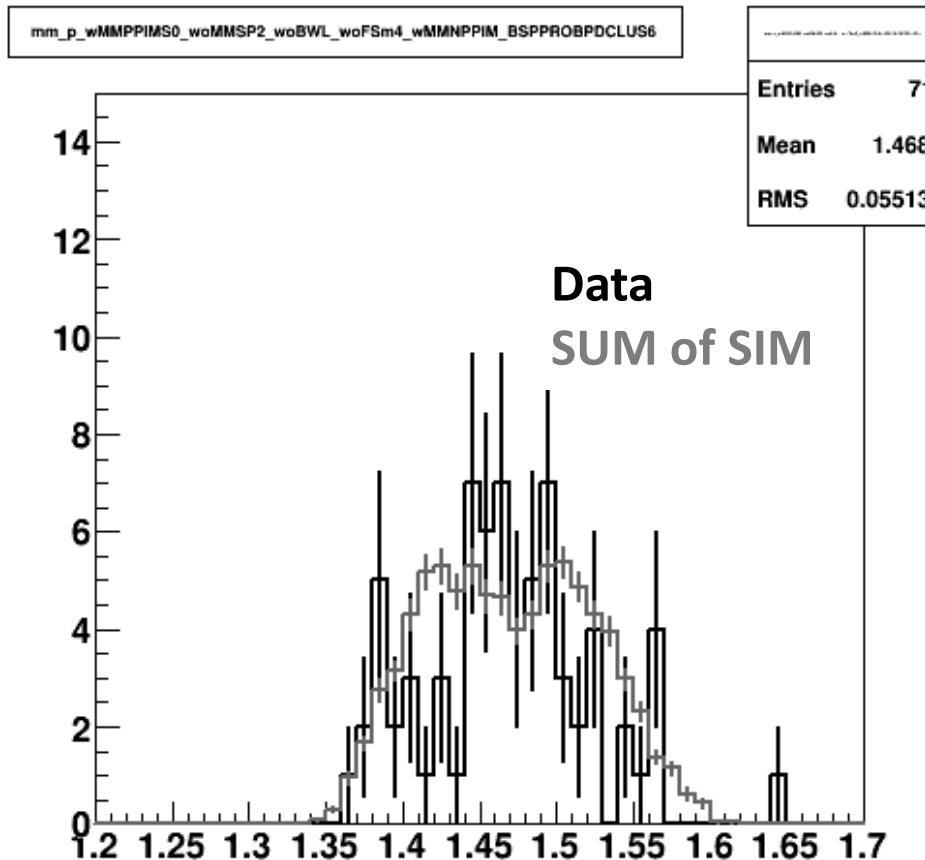


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

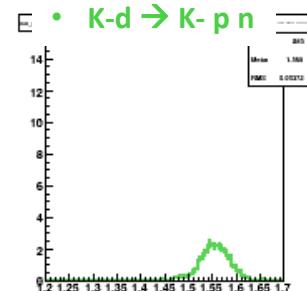
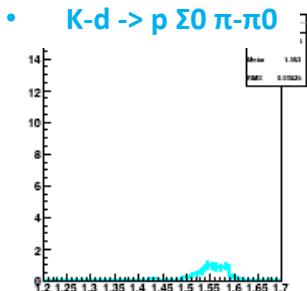
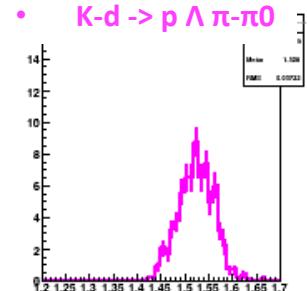
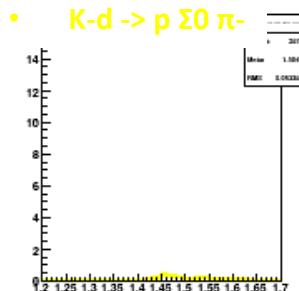
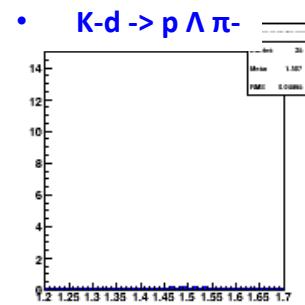
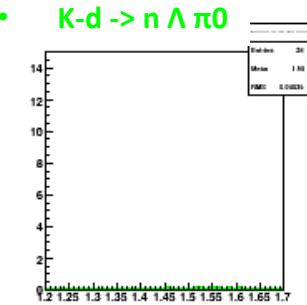
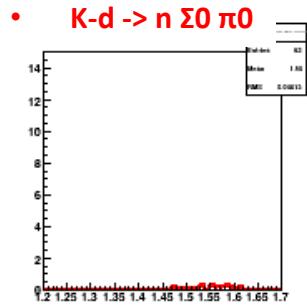
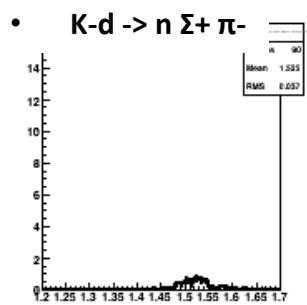
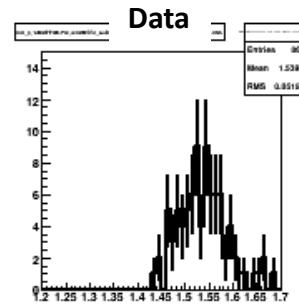


$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

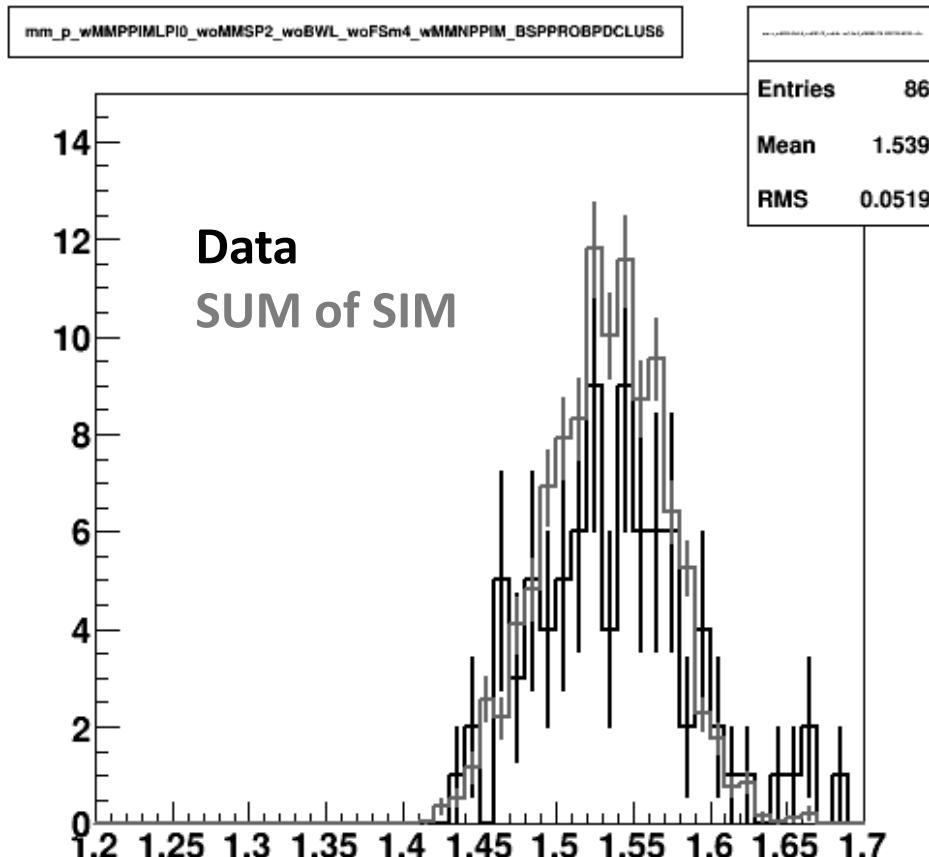


$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution

macro/MMP\_v2.C

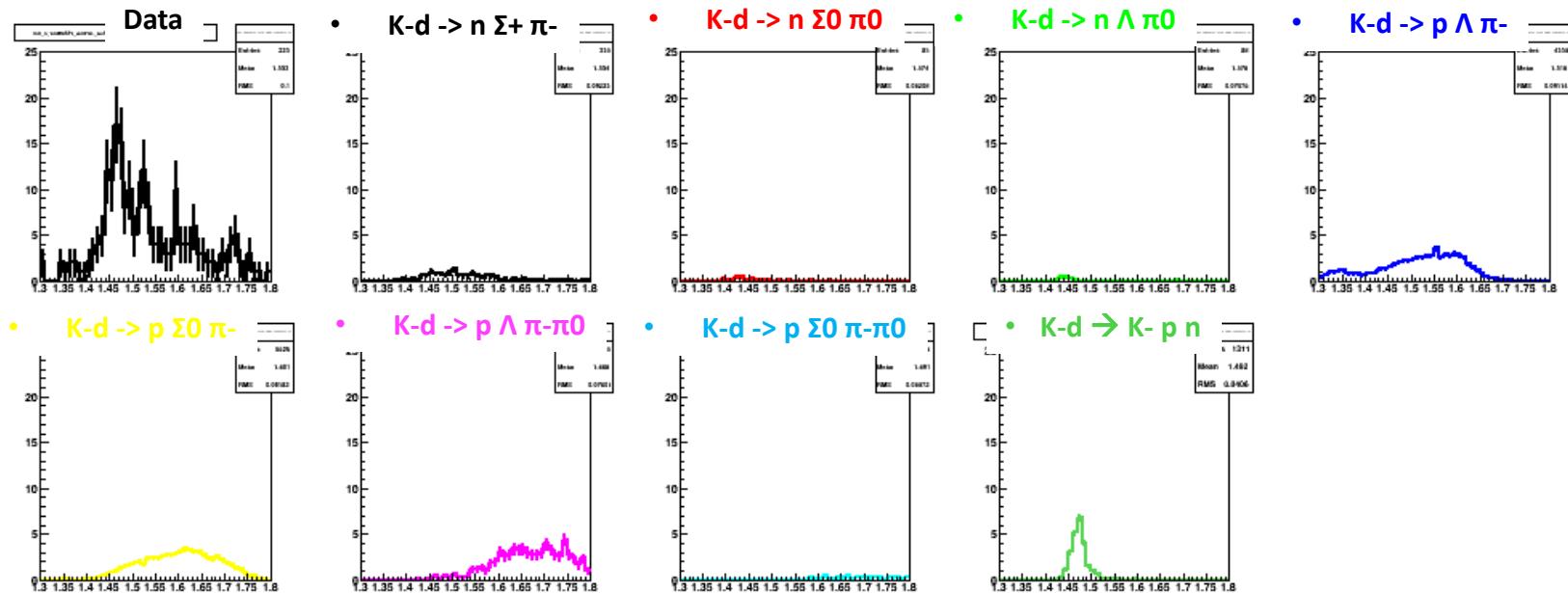


All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

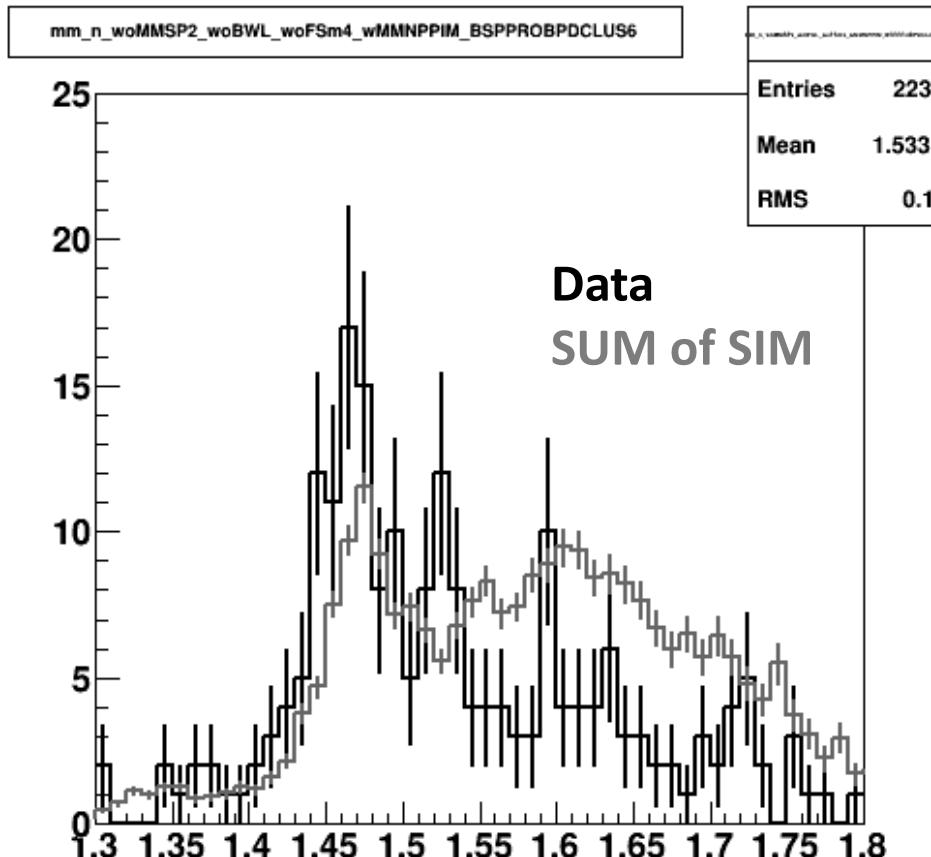


All

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

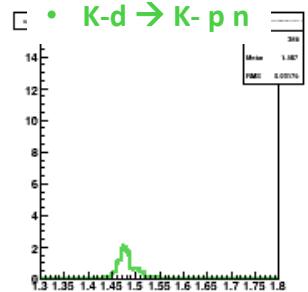
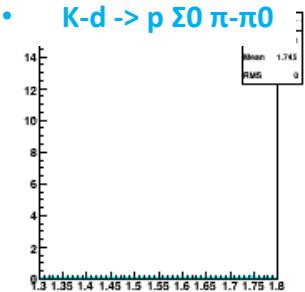
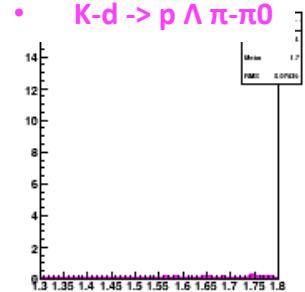
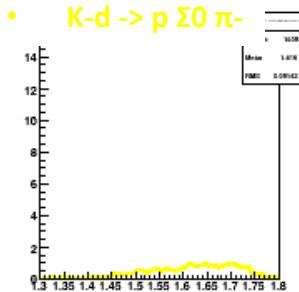
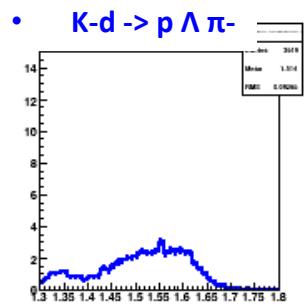
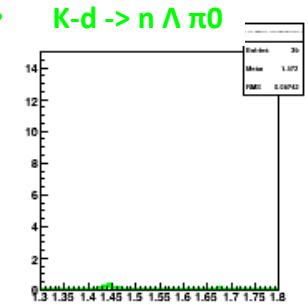
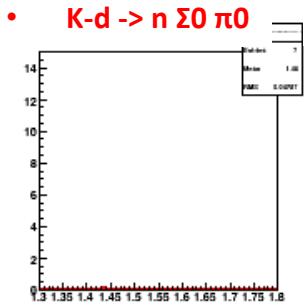
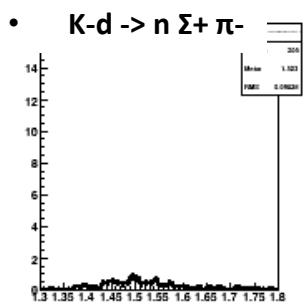
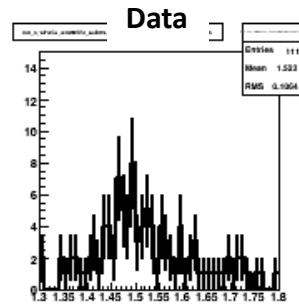


$d(K_-, n p \pi^-)$  0.00~0.18 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n \pi^+)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, n p \pi^-)$  0.00~0.18

# MM. $d(K_-, n)$ distribution

macro/MMN\_v7.C

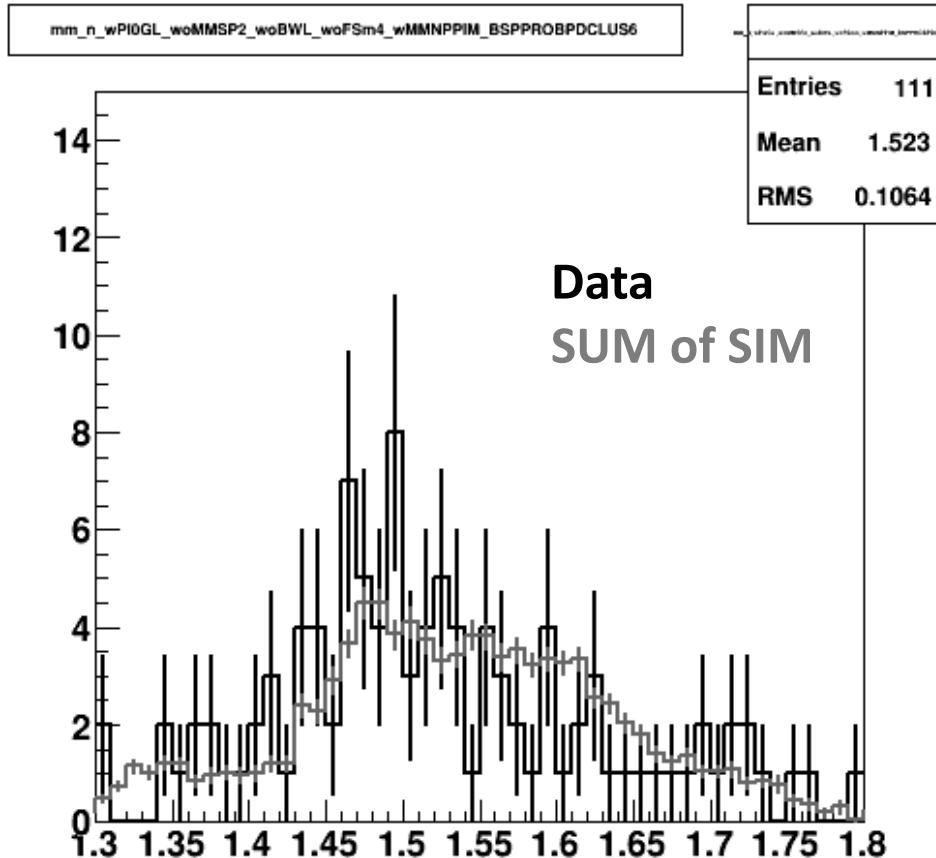


$d(K_-, n \rho \pi^-)$  0.00~0.18 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n \pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $d(K_-, n \rho \pi^-)$  0.00~0.18

# MM. $d(K_-, n)$ distribution

macro/MMN\_v7.C

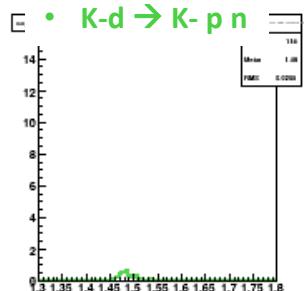
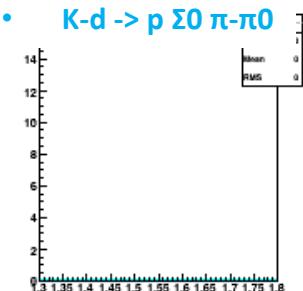
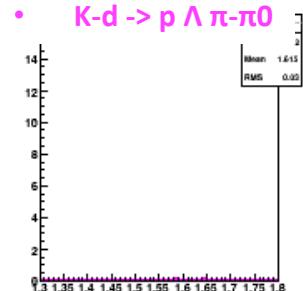
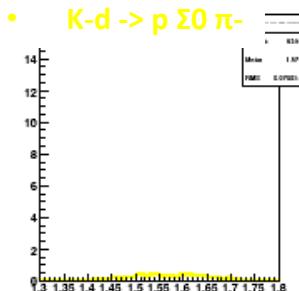
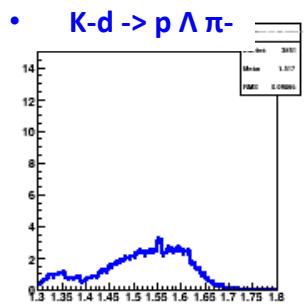
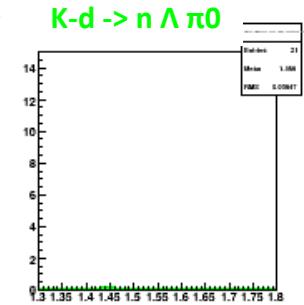
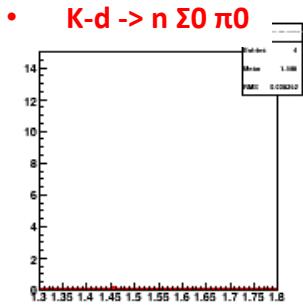
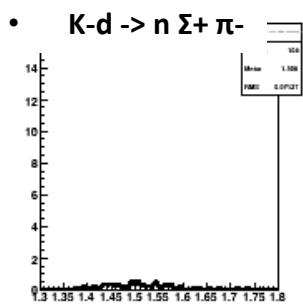
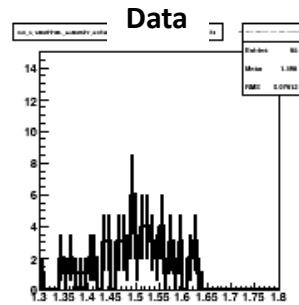


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

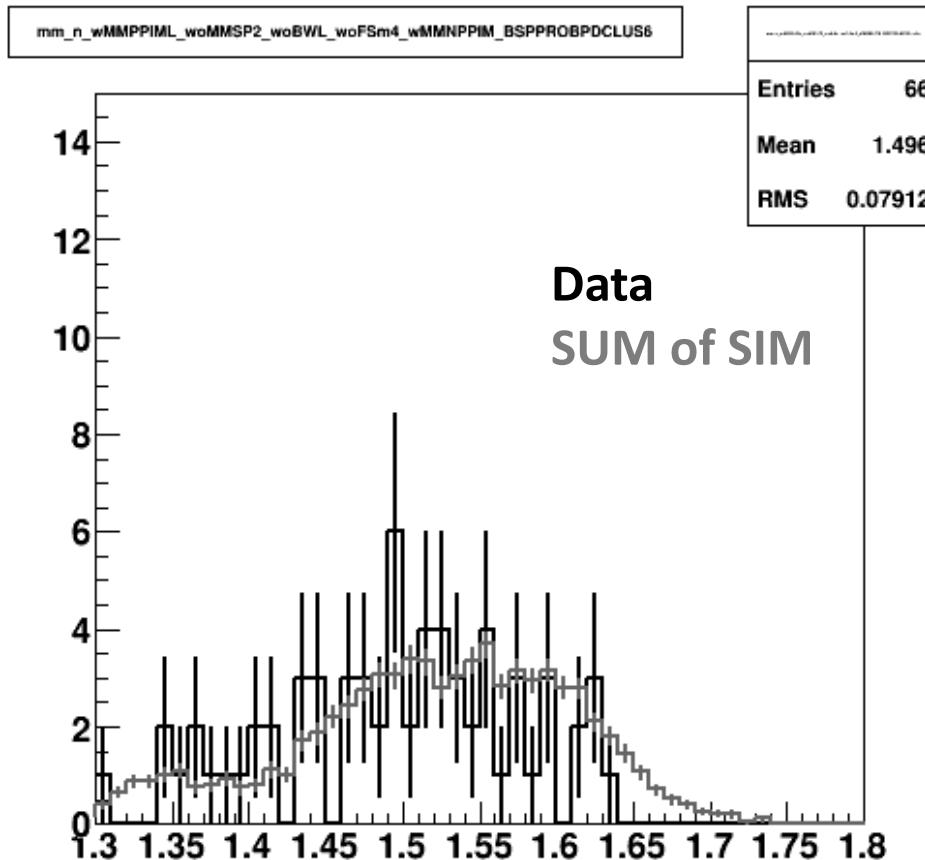


$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

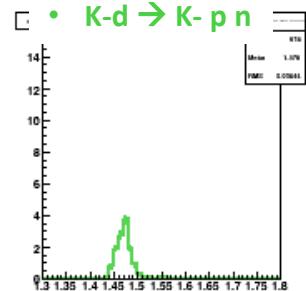
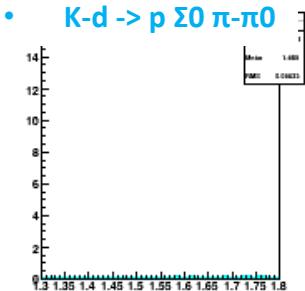
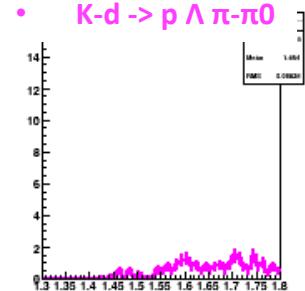
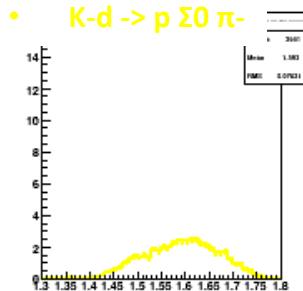
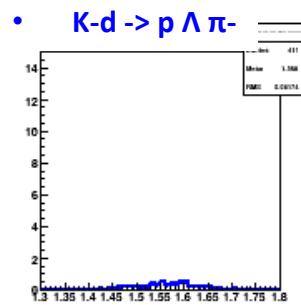
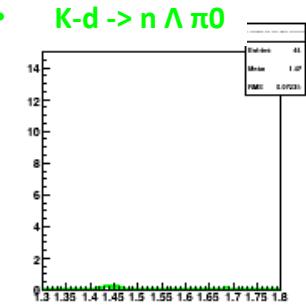
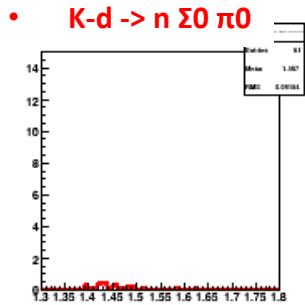
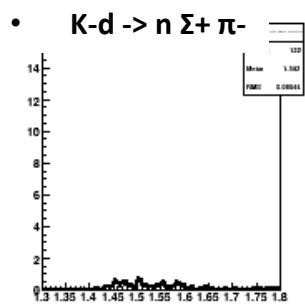
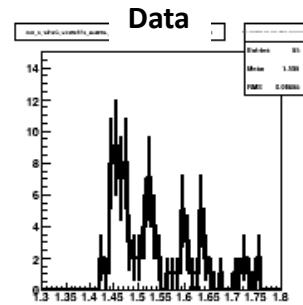


$d(K_-, n p \pi^-)$  0.18~0.30 ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n p \pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $d(K_-, n p \pi^-)$  0.18~0.30

# MM. $d(K_-, n)$ distribution

macro/MMN\_v7.C

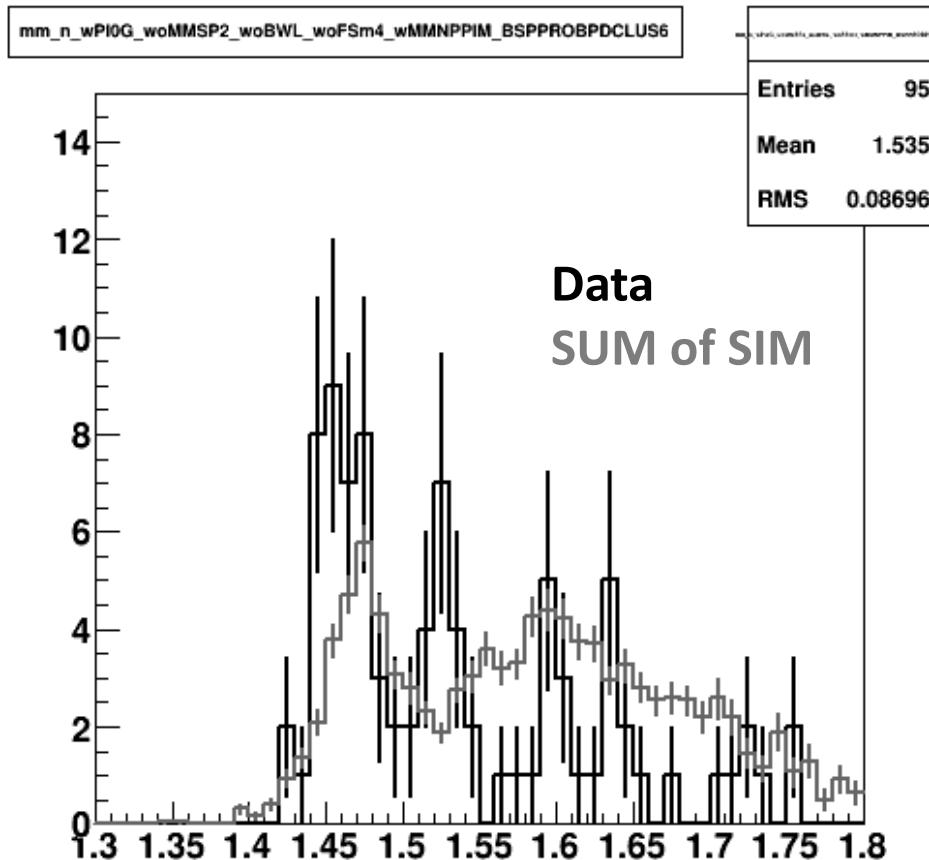


$d(K_-, n\bar{p}\pi^-)$   $0.18 \sim 0.30$  ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\bar{p}\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $d(K_-, n\bar{p}\pi^-)$   $0.18 \sim 0.30$

# MM. $d(K_-, n)$ distribution

macro/MMN\_v7.C

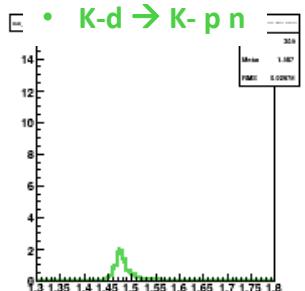
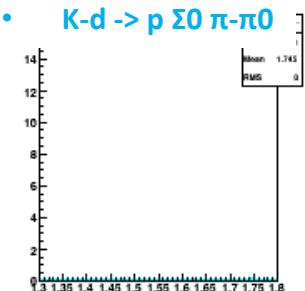
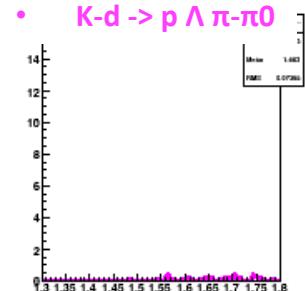
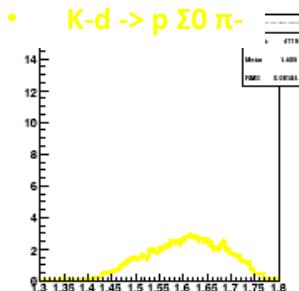
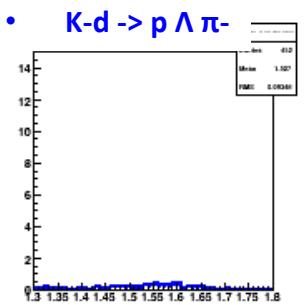
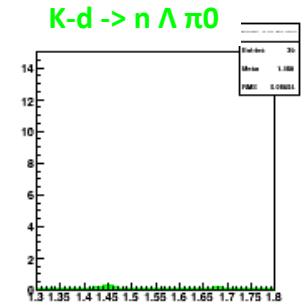
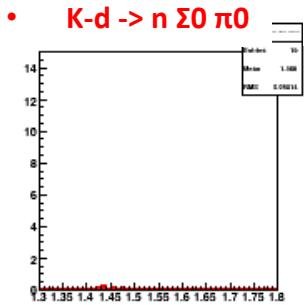
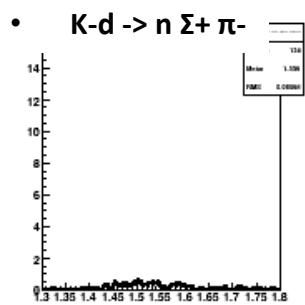
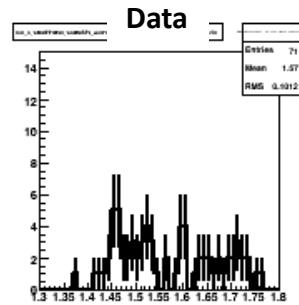


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma 0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

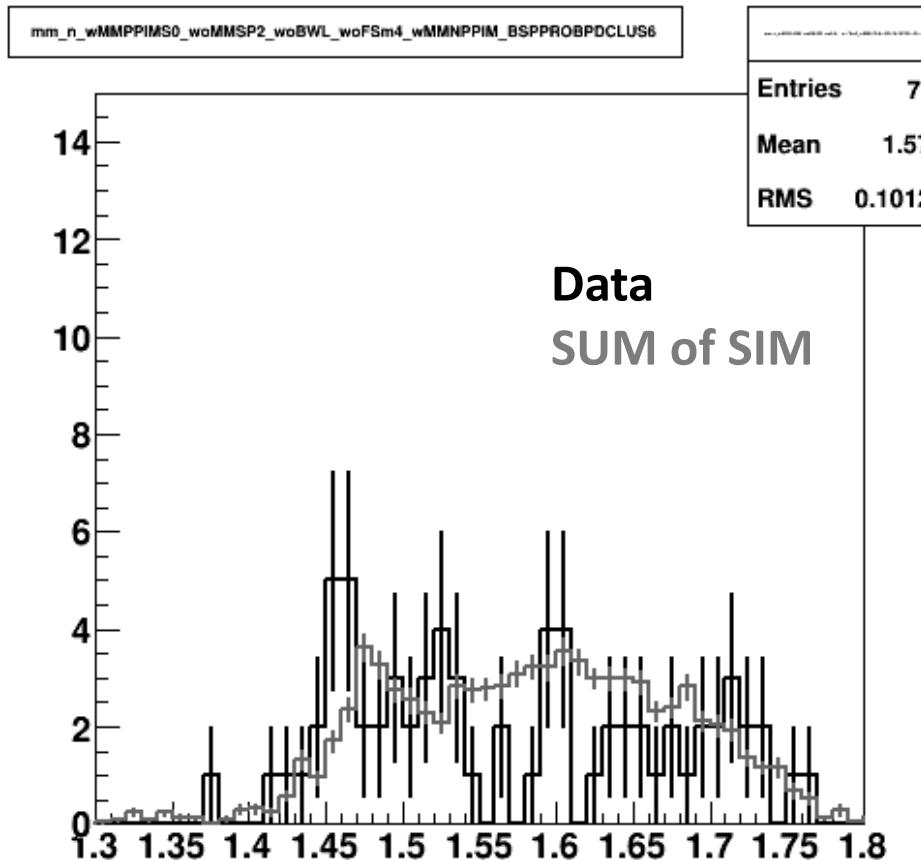


$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma^0$  like)

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

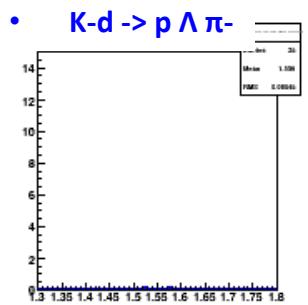
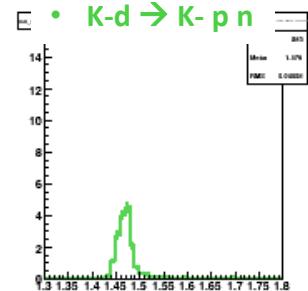
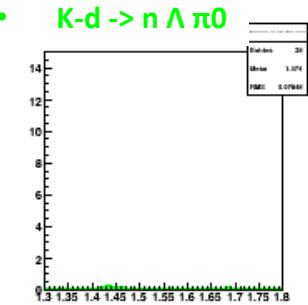
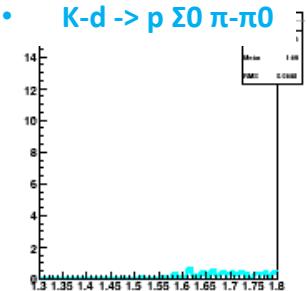
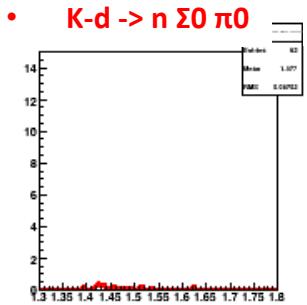
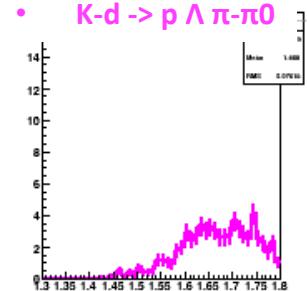
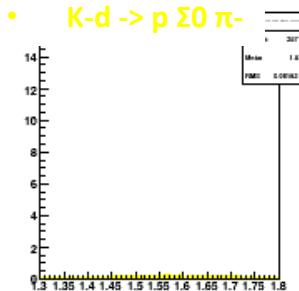
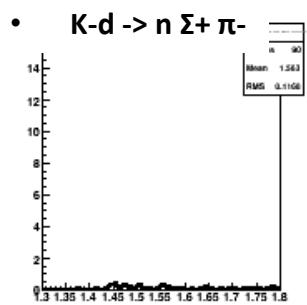
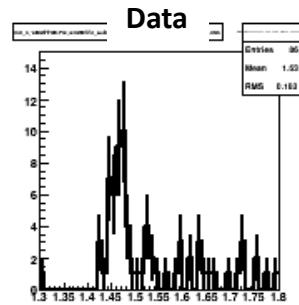


$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

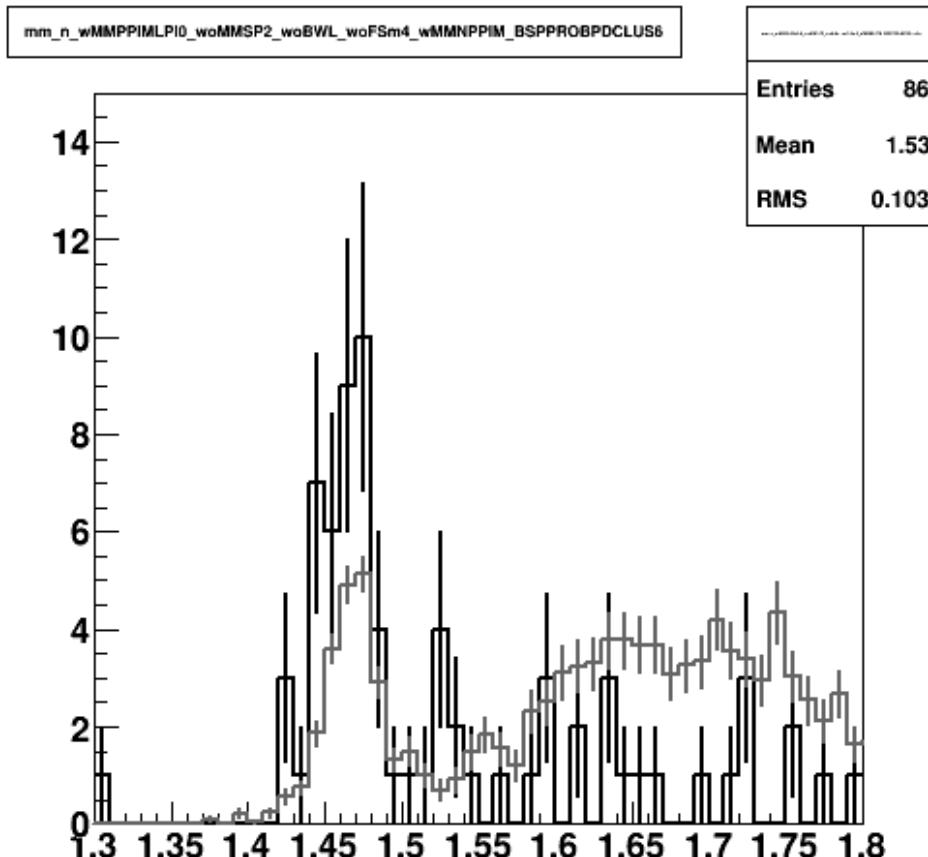


$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi^0$  like)

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

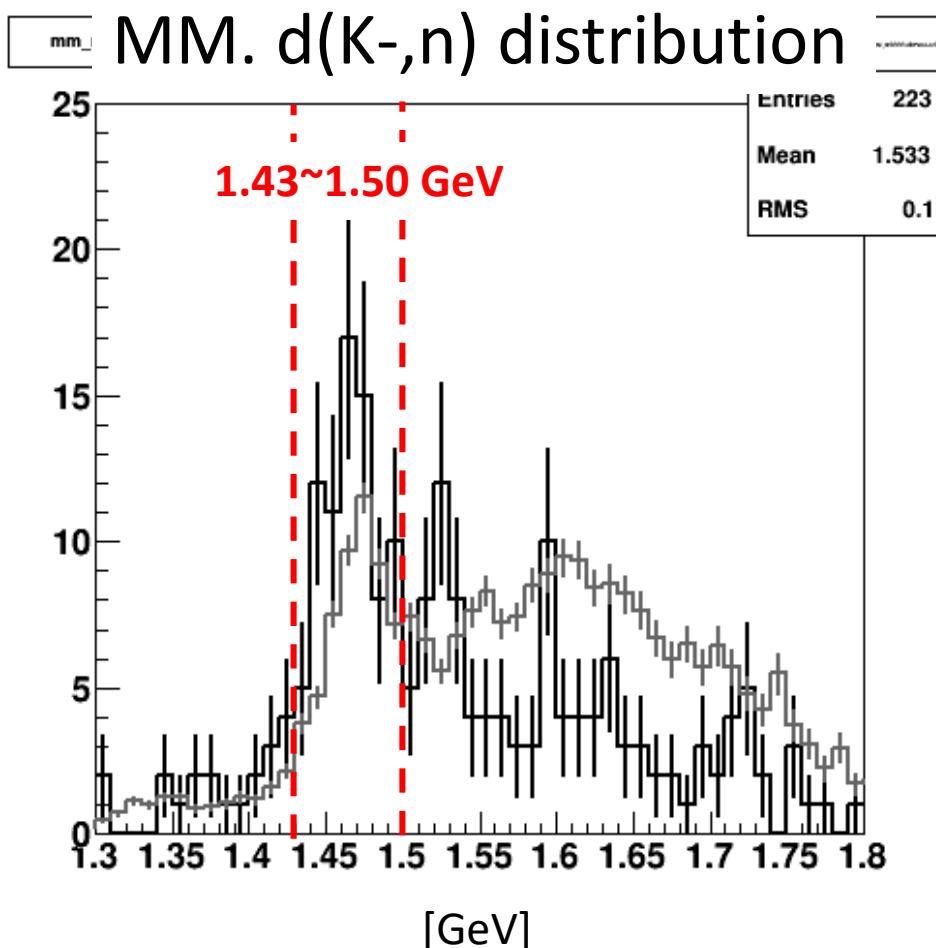
# MM. $d(K^-, n)$ distribution

macro/MMN\_v7.C

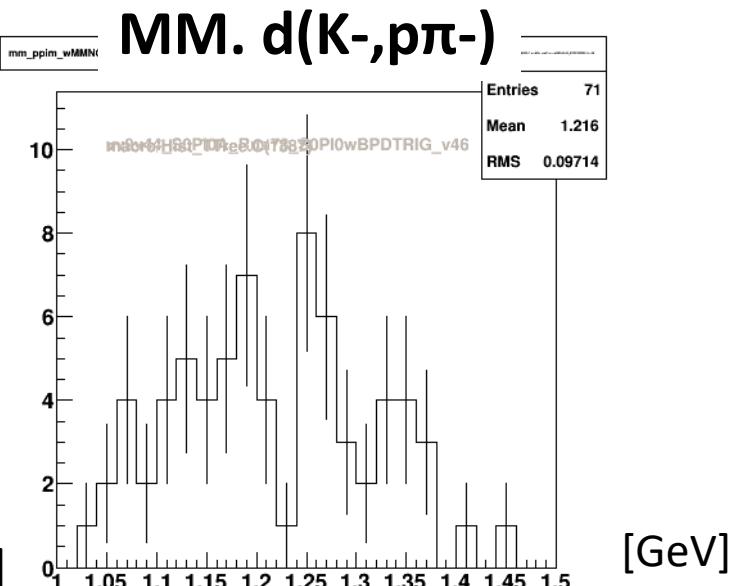
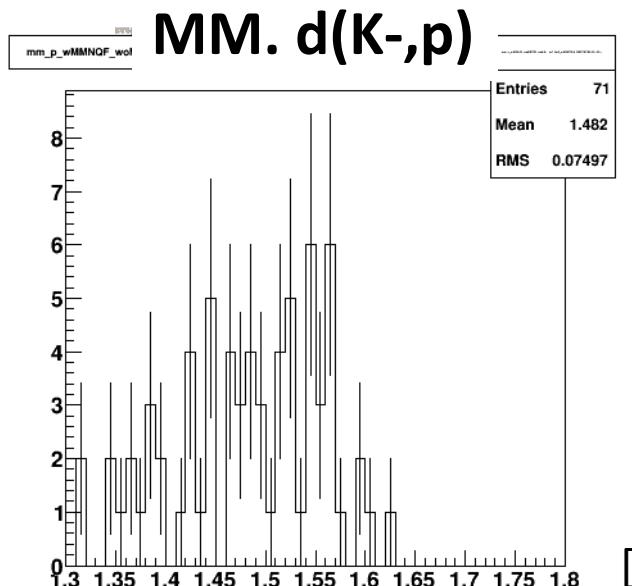
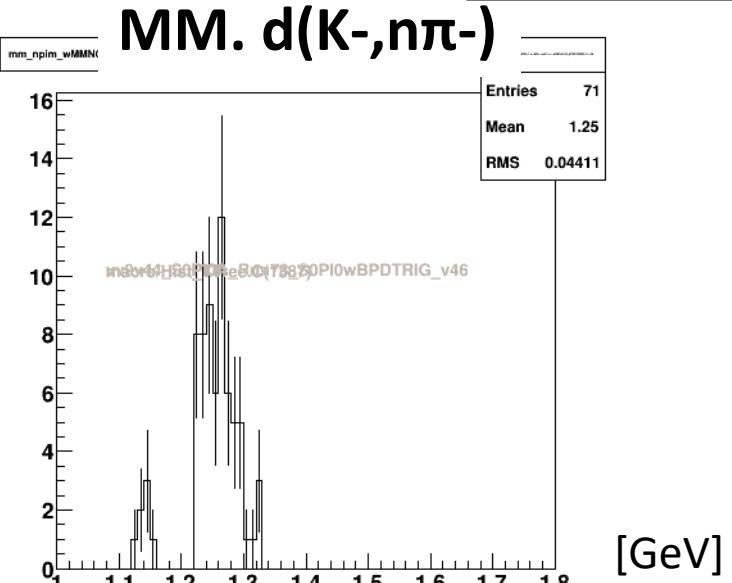
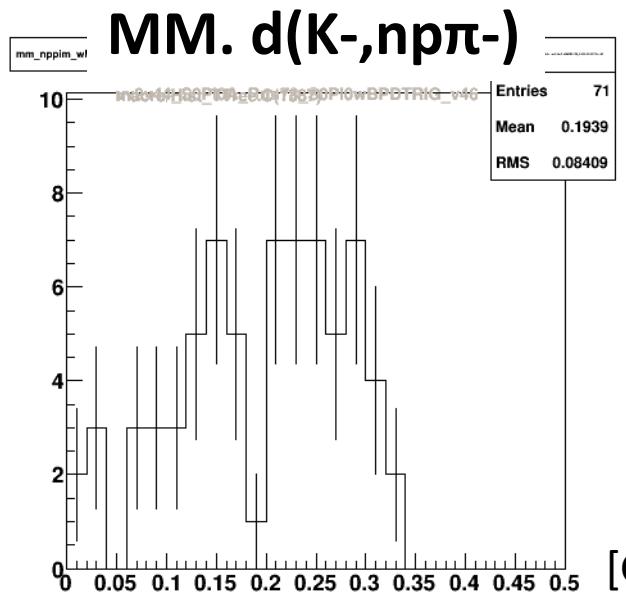


- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

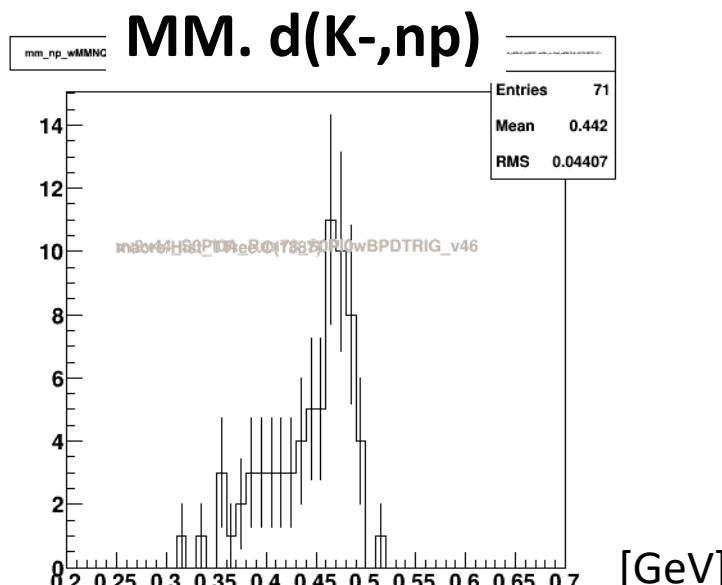
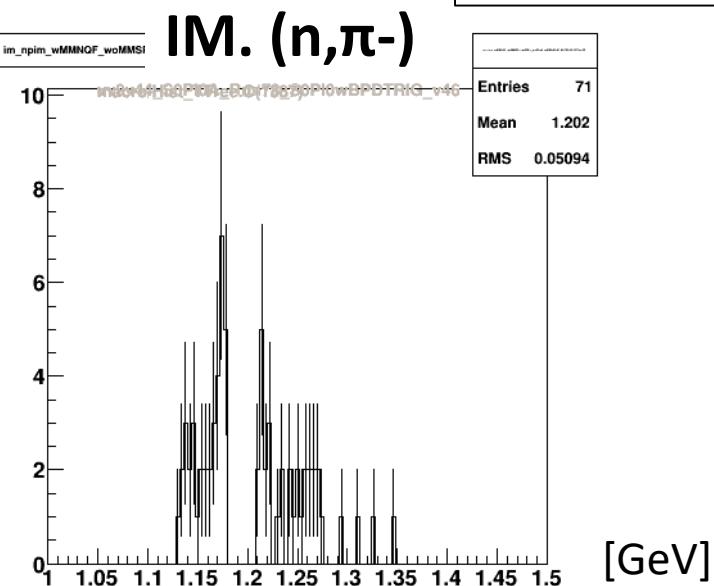
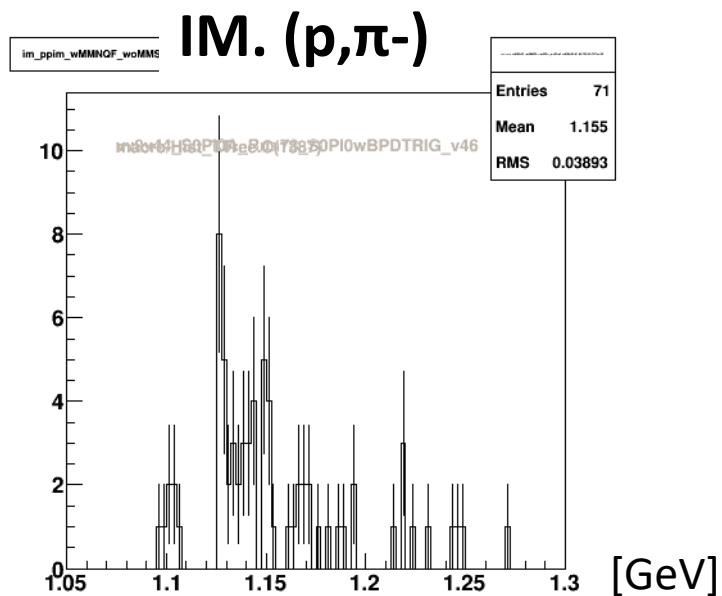
# QF select



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

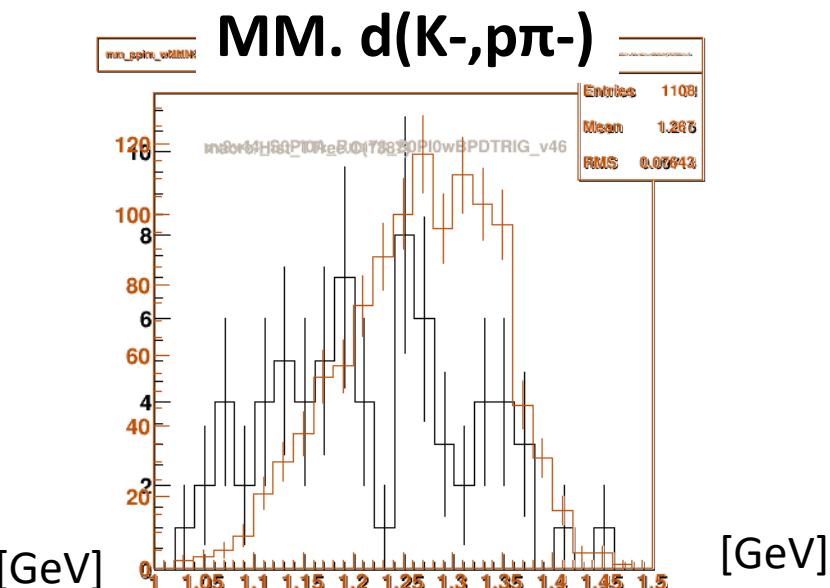
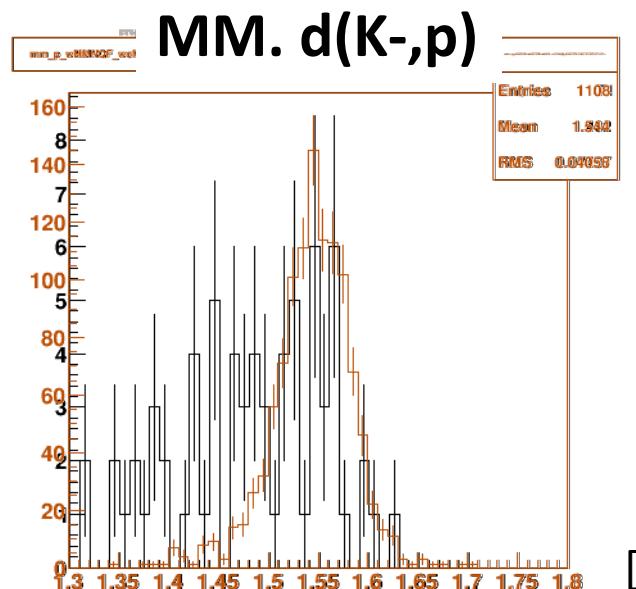
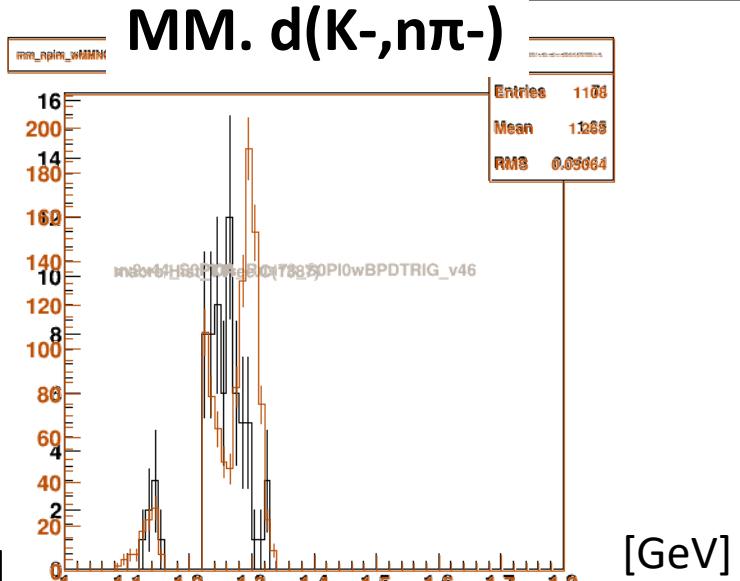
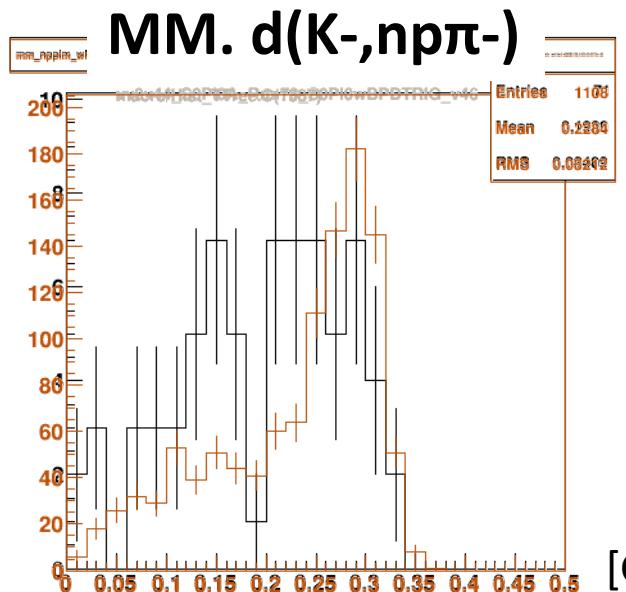


- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



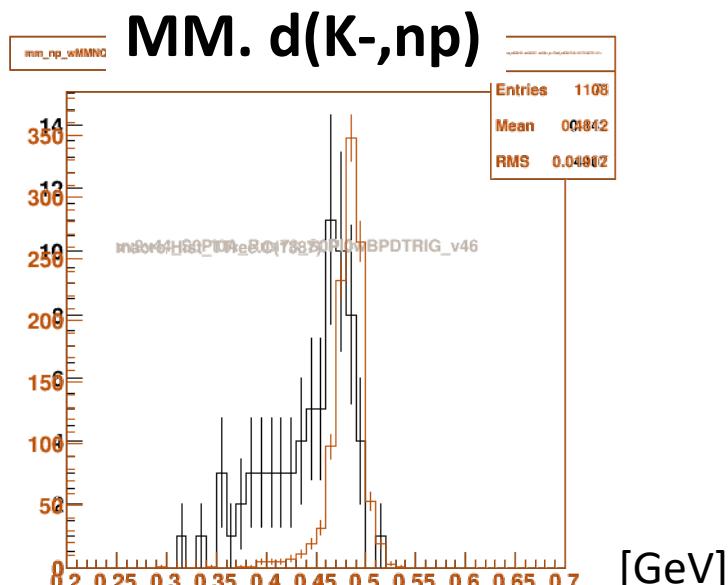
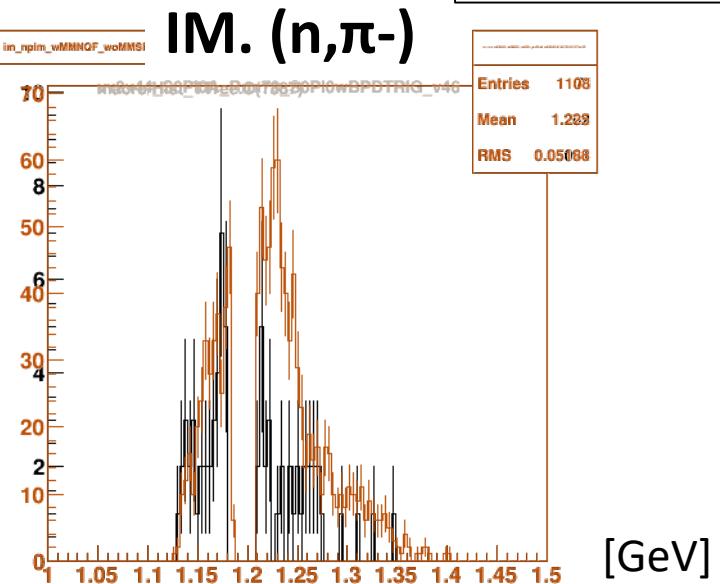
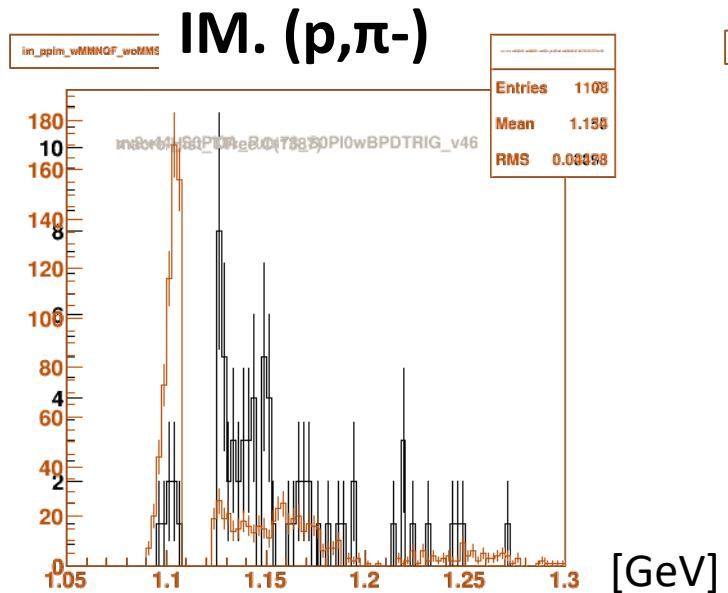
SIM ;  $K-d \rightarrow K^- p n$

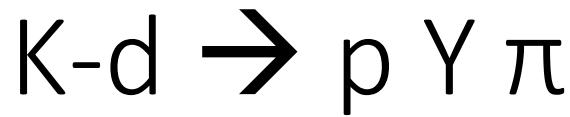
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



SIM ;  $K-d \rightarrow K-p\pi$

- $\Sigma^-$  from IM. ( $n,\pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K,n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p,\pi^-$ ) is rejected
- $0 < d(K,n\pi^-)$
- $d(K,n) 1.43 \sim 1.50$  select

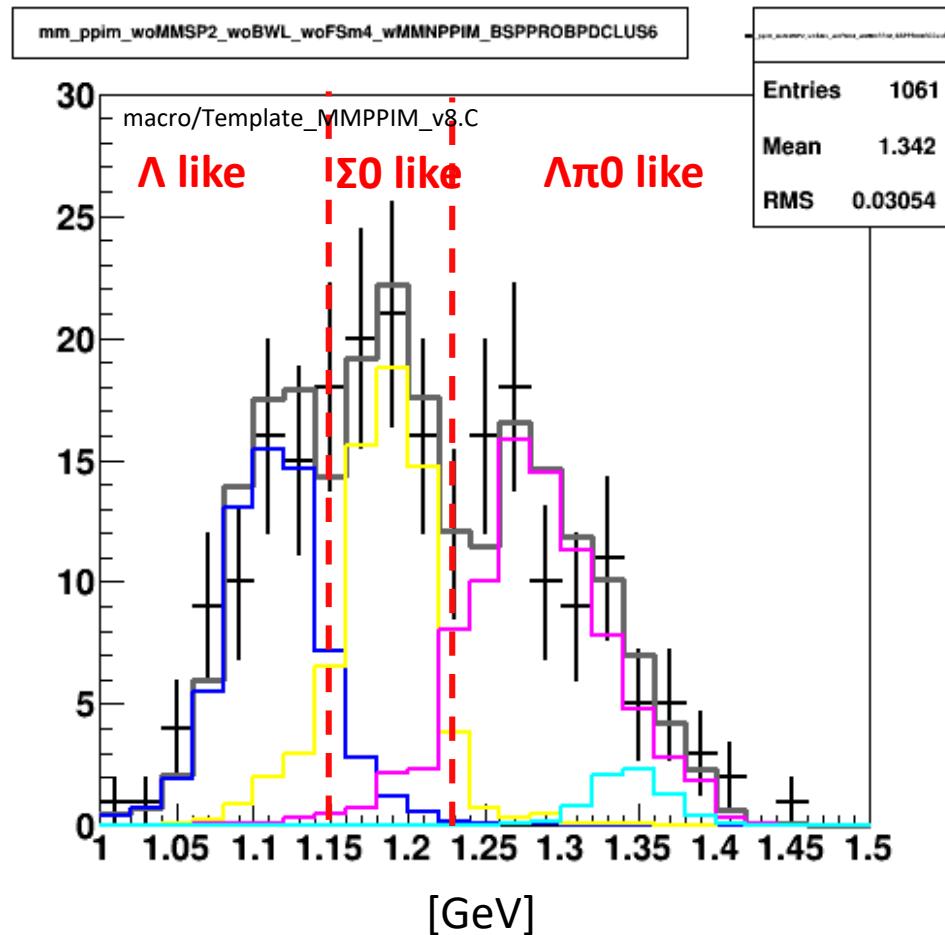




- SIM Generate
  - phase space  $\rightarrow$  MM.  $d(K^-, p)$  distribution

# Fitting of MM. $d(K^-, p\pi^-)$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$



## † Data

- $K^- d \rightarrow p \Lambda \pi^-$
- $K^- d \rightarrow p \Sigma^0 \pi^-$
- $K^- d \rightarrow p \Lambda \pi^- \pi^0$
- $K^- d \rightarrow p \Sigma^0 \pi^- \pi^0$

## Fit Result

Scaling factor of SIM is free

Fit Range

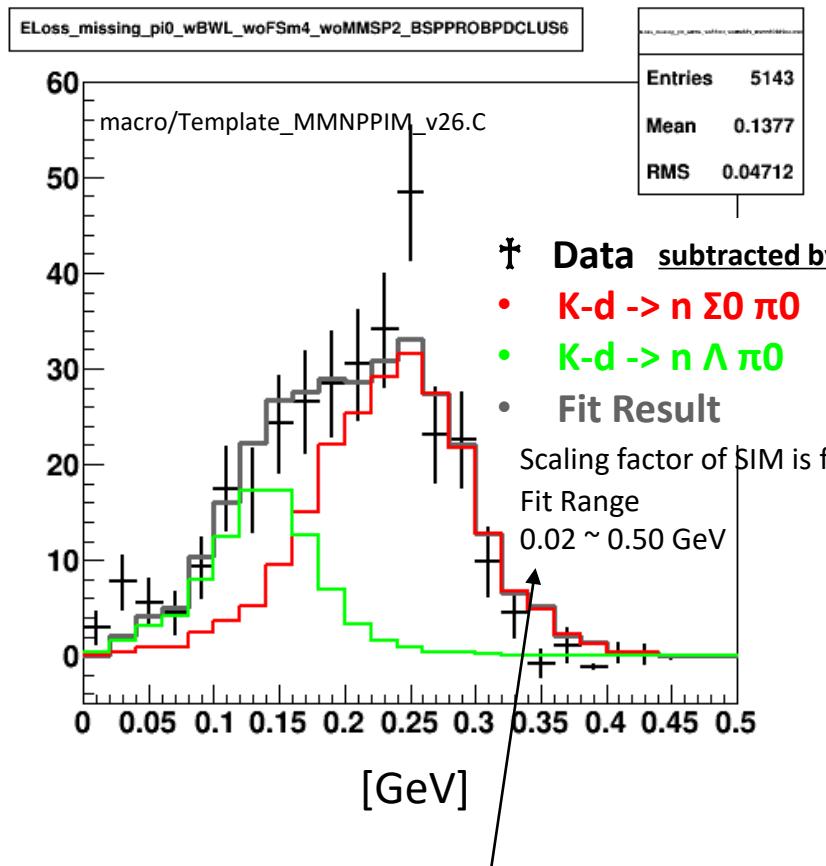
1.00 ~ 1.50 GeV

Chi2/ndf = 18.26/25

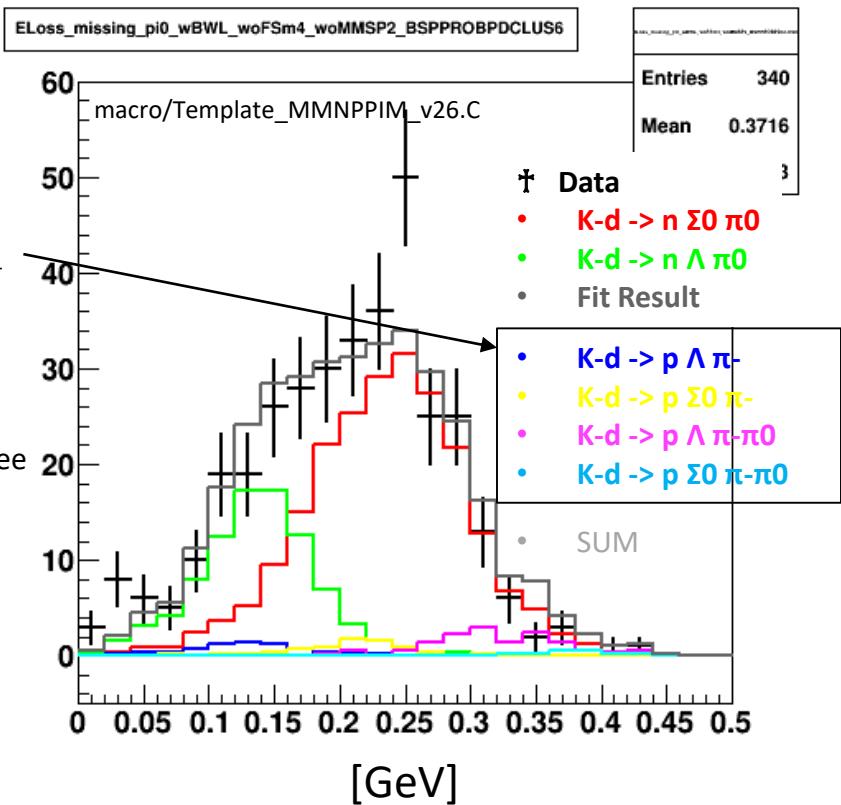
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is selected

# Fitting of MM. $d(K^-, n\pi^-)$

- Fitting w/  $K-d \rightarrow n \Sigma^0 \pi^0$ ,  $K-d \rightarrow n \Lambda \pi^0$
- Data is subtracted by  $K-d \rightarrow p \Lambda \pi^-$ ,  $K-d \rightarrow p \Sigma^0 \pi^-$ ,  $K-d \rightarrow p \Lambda \pi^- \pi^0$ ,  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$

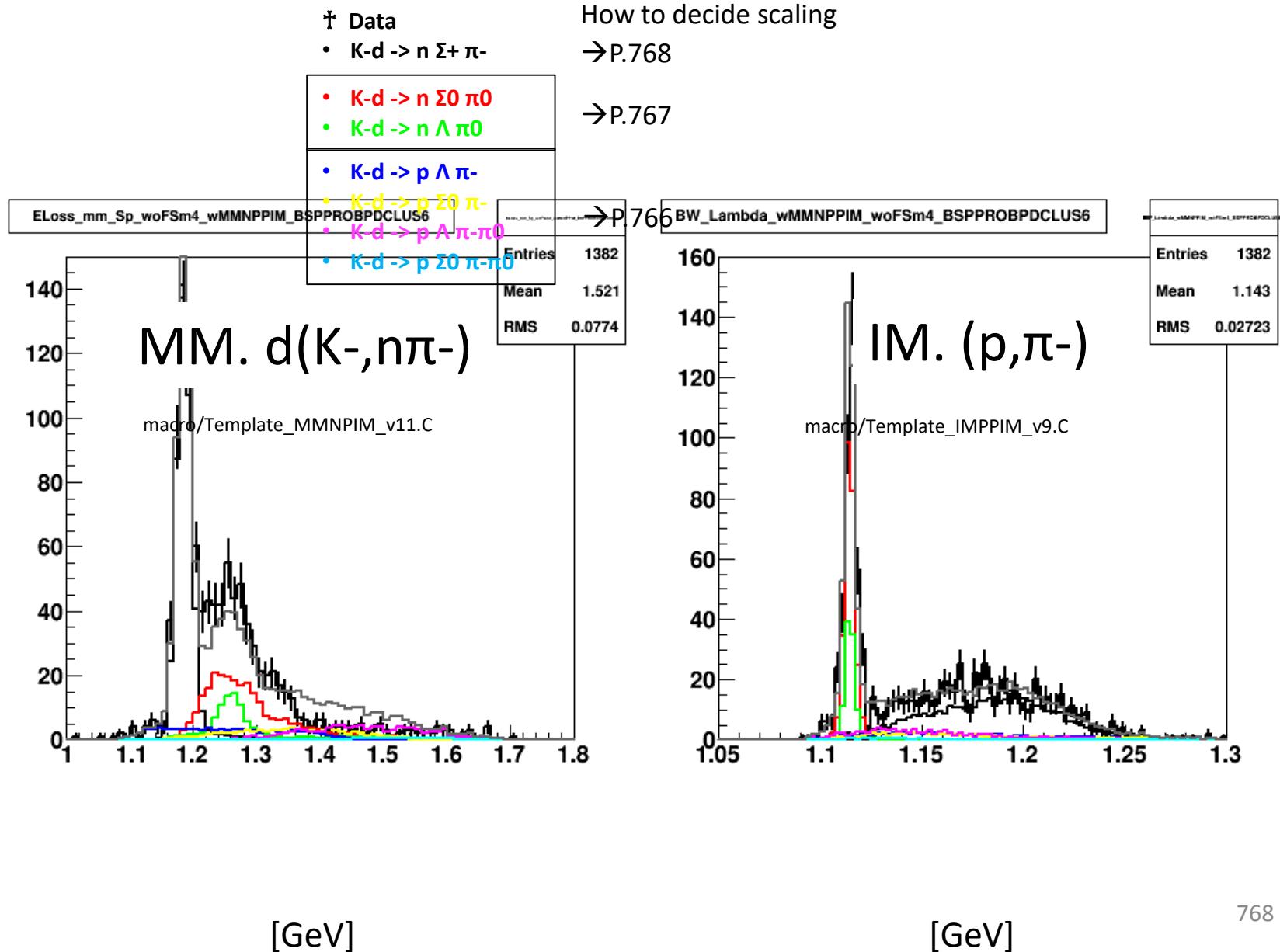


0.00~0.50だと fit できない?



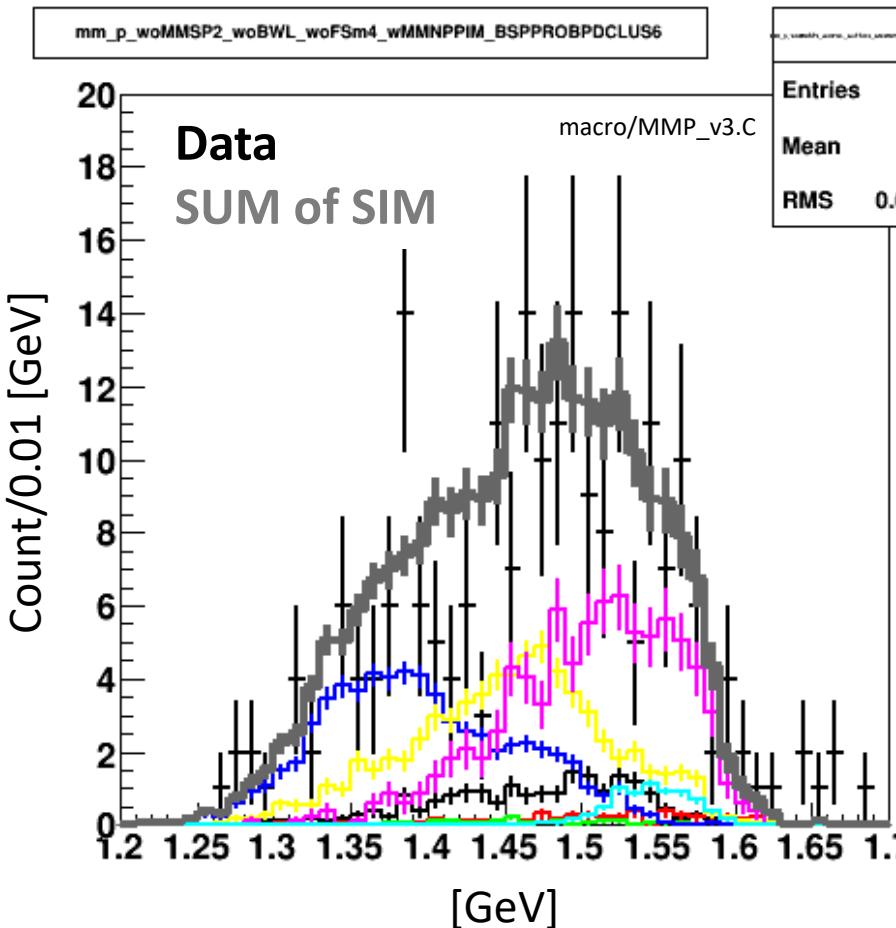
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# Result from P.766~768



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# MM. $d(K^-, p)$ distribution



$\dagger$  Data

•  $K-d \rightarrow n \Sigma^+ \pi^-$

•  $K-d \rightarrow n \Sigma^0 \pi^0$

•  $K-d \rightarrow n \Lambda \pi^0$

•  $K-d \rightarrow p \Lambda \pi^-$

•  $K-d \rightarrow p \Sigma^0 \pi^-$

•  $K-d \rightarrow p \Lambda \pi^- \pi^0$

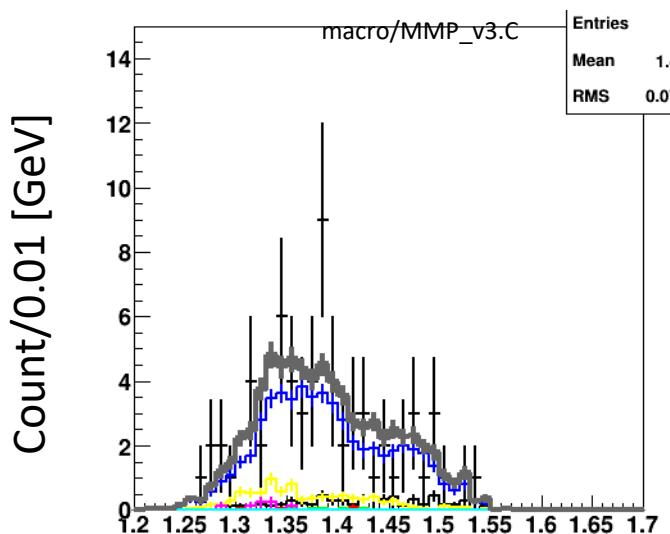
•  $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$

SUM

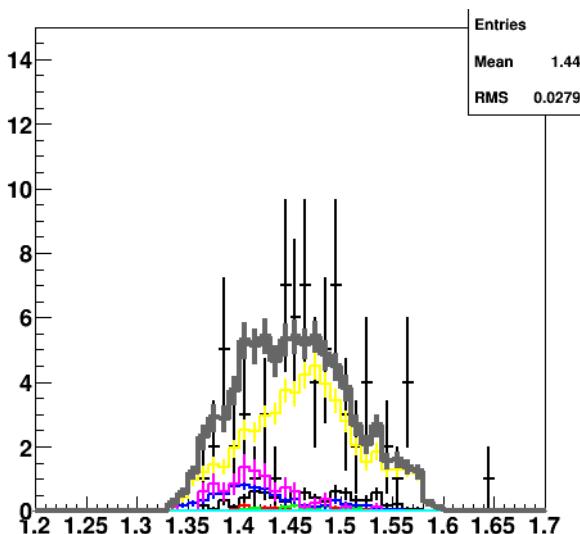
# MM. $d(K^-, p)$ distribution

- $\Sigma^-$  from IM.  $(n, \pi^-)$  is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM.  $(p, \pi^-)$  is rejected
- $0 < d(K^-, n\pi^-)$

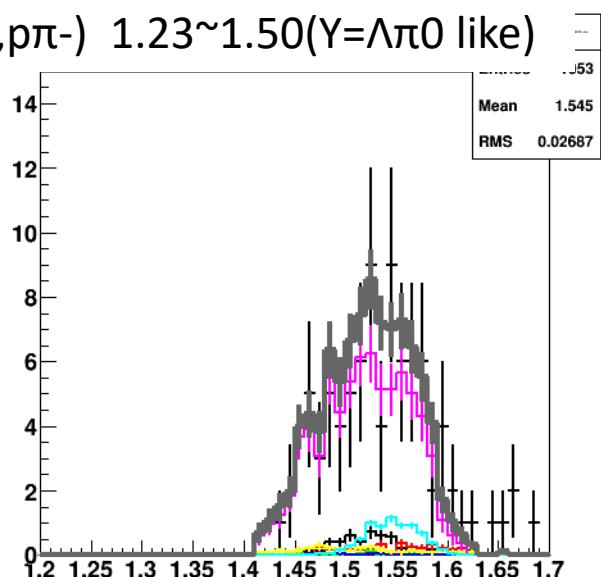
$d(K^-, p\pi^-)$  1.00~1.15 ( $\Upsilon = \Lambda$  like)



$d(K^-, p\pi^-)$  1.15~1.23 ( $\Upsilon = \Sigma 0$  like)



$d(K^-, p\pi^-)$  1.23~1.50 ( $\Upsilon = \Lambda\pi 0$  like)



† Data

•  $K-d \rightarrow n \Sigma^+ \pi^-$

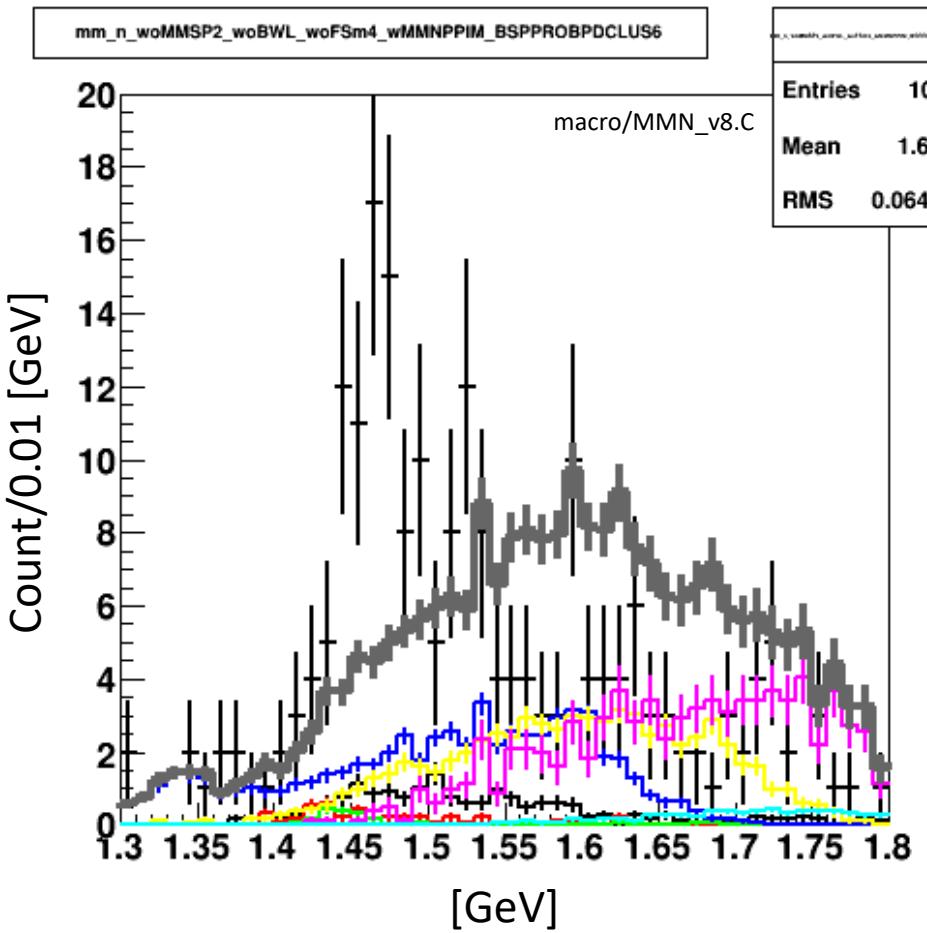
- $K-d \rightarrow n \Sigma 0 \pi 0$
- $K-d \rightarrow n \Lambda \pi 0$

• SUM

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma 0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi 0$
- $K-d \rightarrow p \Sigma 0 \pi^- \pi 0$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^+ \pi^-)$

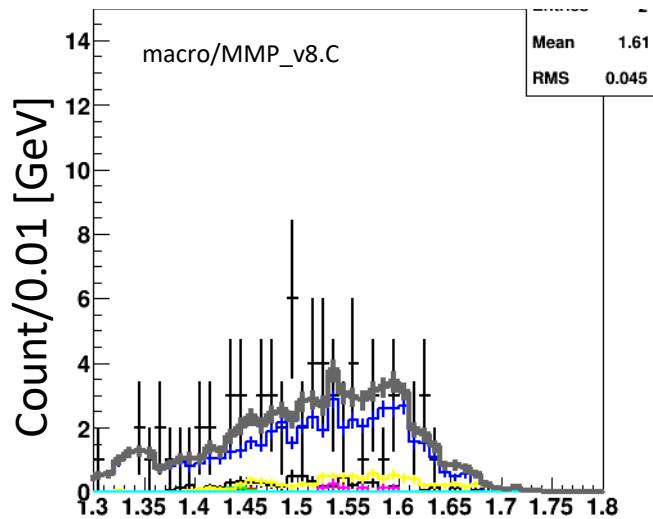
# MM. $d(K^-, n)$ distribution



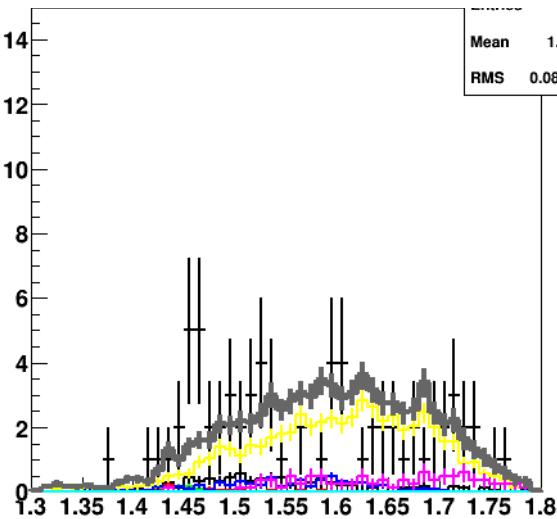
# MM. $d(K_-, n)$ distribution

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K_-, n\pi^-)$

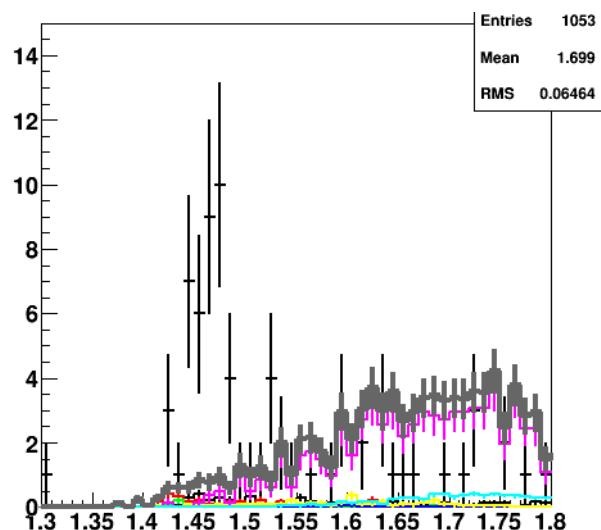
$d(K_-, p\pi^-)$  1.00~1.15 (Y=Λ like)



$d(K_-, p\pi^-)$  1.15~1.23 (Y=Σ0 like)



$d(K_-, p\pi^-)$  1.23~1.50 (Y=Λπ0 like)



† Data

•  $K-d \rightarrow n \Sigma^+ \pi^-$

- $K-d \rightarrow n \Sigma^0 \pi^0$
- $K-d \rightarrow n \Lambda \pi^0$

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$

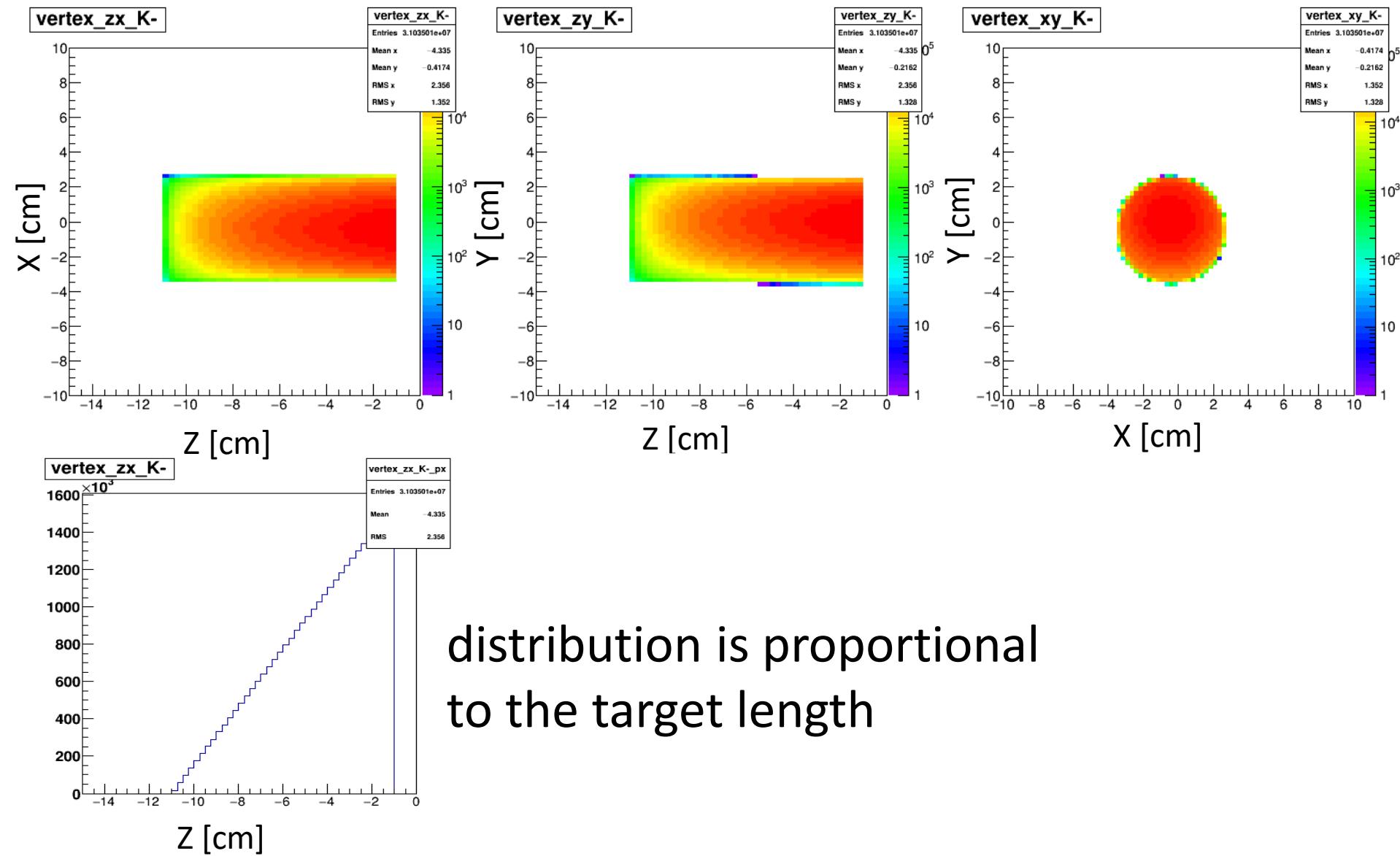
• SUM

# 2 successive reactions to explain QF peak in BG

- K- “n”  $\rightarrow$  K- n ; “n” is bound in a deuteron
- K- “p(n)”  $\rightarrow$  Y  $\pi$  ; “p(n)” is in different deuteron
- Reaction mode
  - K-p
    - $\Sigma^0\pi^0$
    - $\Sigma^+\pi^-$
    - $\Sigma^-\pi^+$  -no backward proton
    - $\pi^0\Lambda$
  - K-n
    - $\Sigma^0\pi^-$
    - $\Sigma^-\pi^0$  -no backward proton
    - $\Lambda\pi^-$

- Vertex distribution
  - 1<sup>st</sup> reaction : uniformly in z axis -> in proportion to the depth from edge of the target in z axis to fit all generated event in the target length
  - 2<sup>nd</sup> reaction : uniformly along recoiled K- direction from 1<sup>st</sup> reaction point

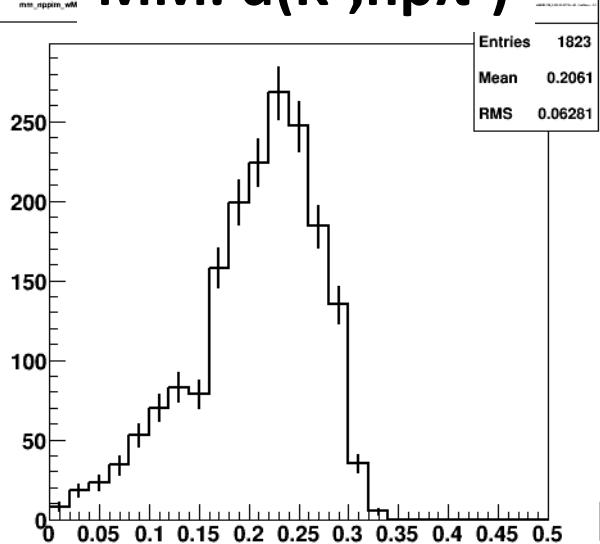
# 1<sup>st</sup> reaction vertex distribution



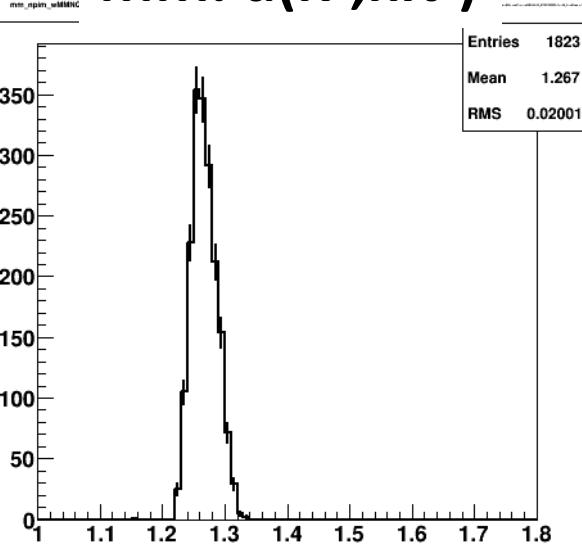
K- “p” -> Λ π0

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

## MM. $d(K, n\pi^-)$

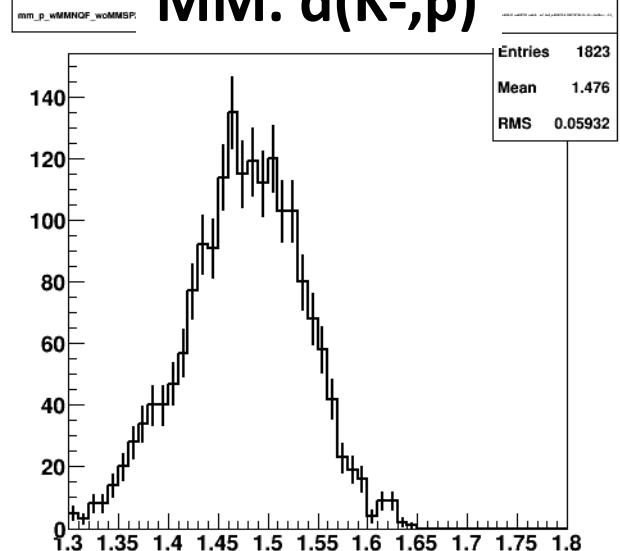


## MM. $d(K, n\pi^-)$

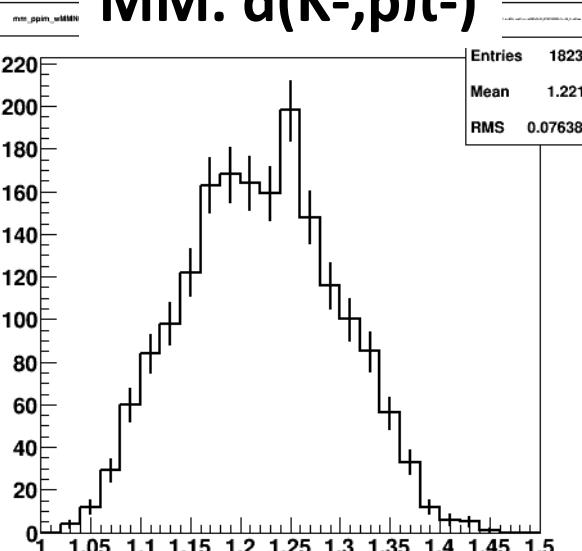


[GeV]

## MM. $d(K, p)$



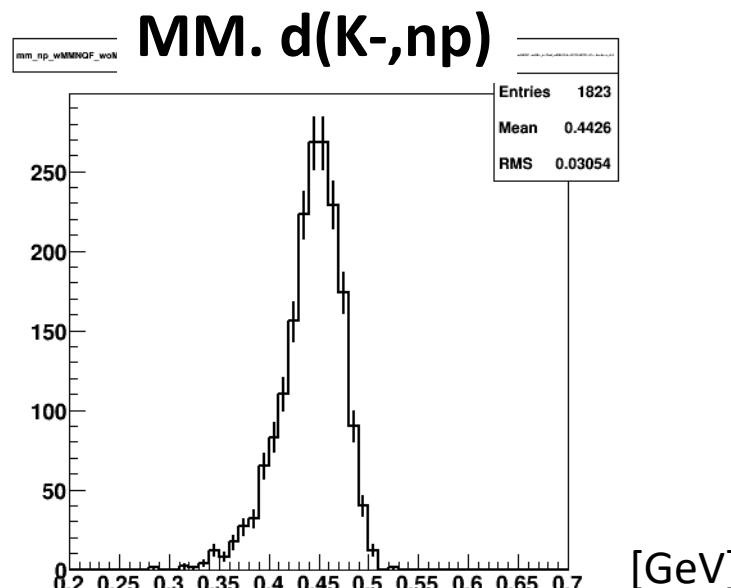
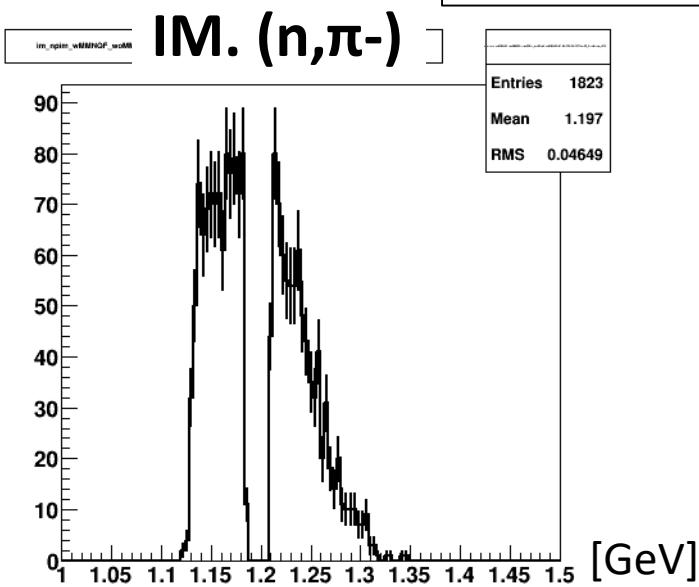
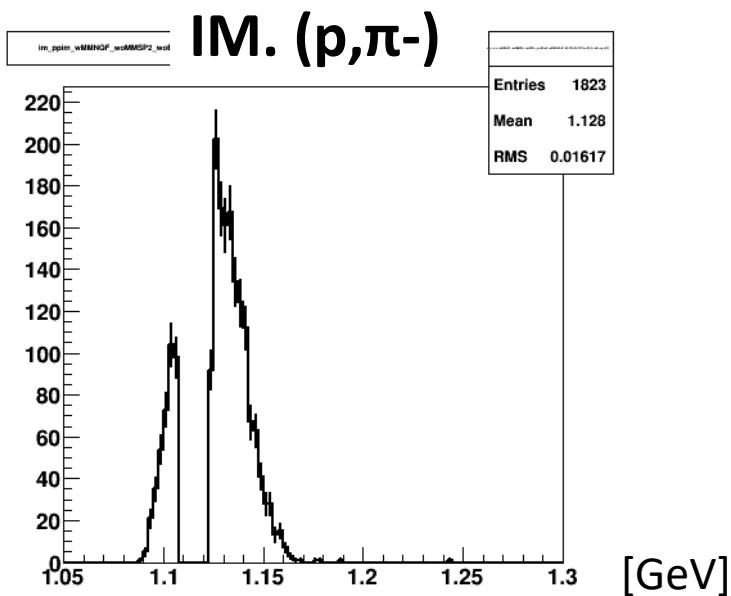
## MM. $d(K, p)$



[GeV]

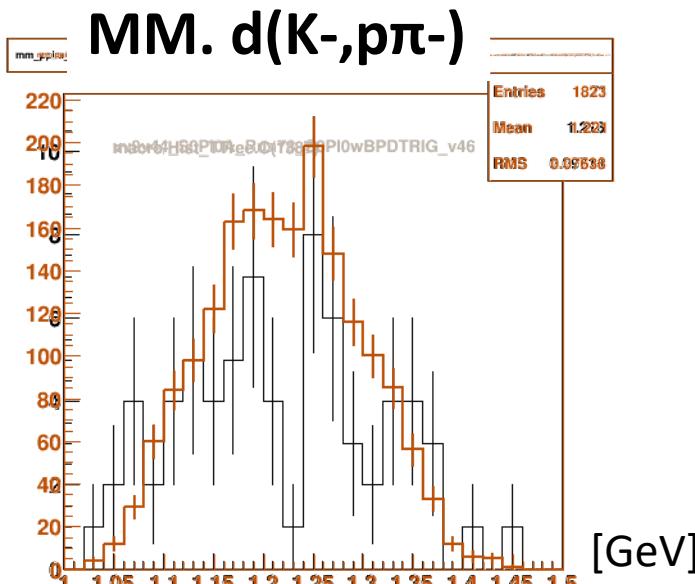
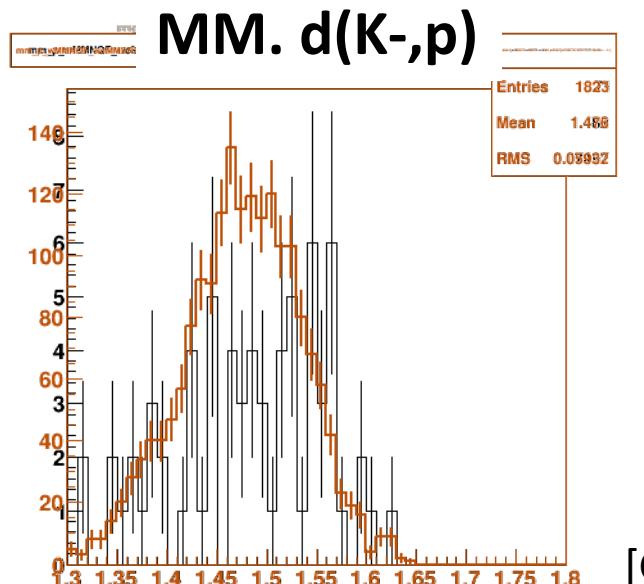
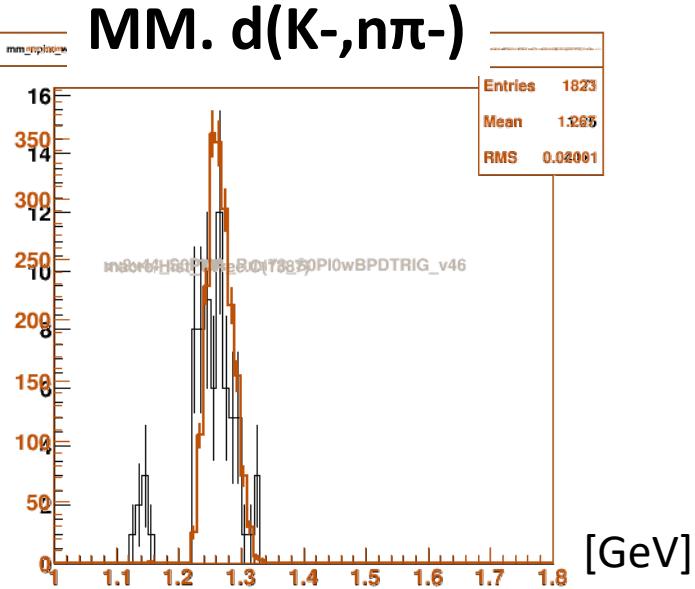
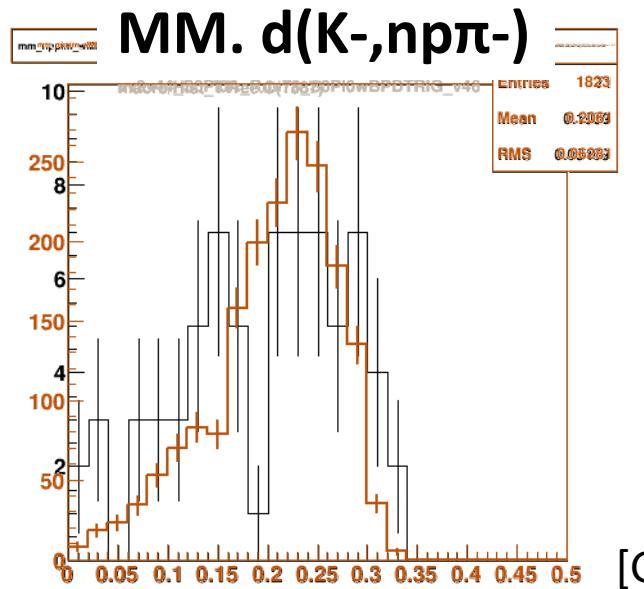
[GeV]

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



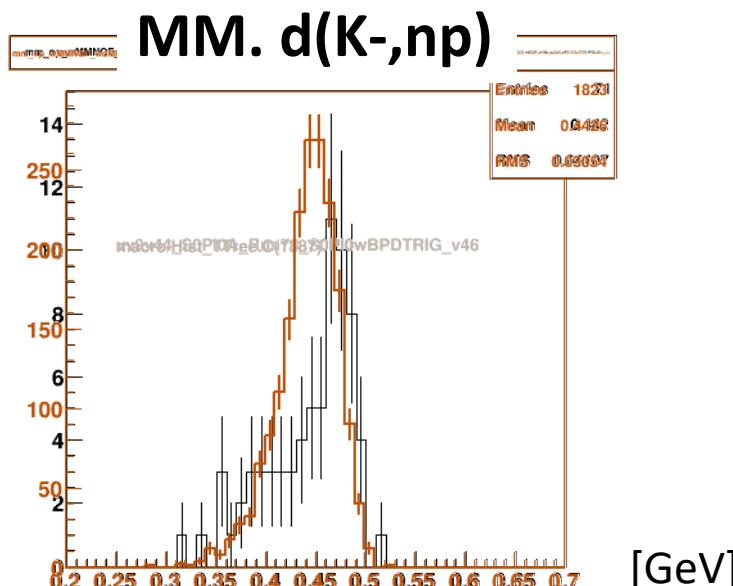
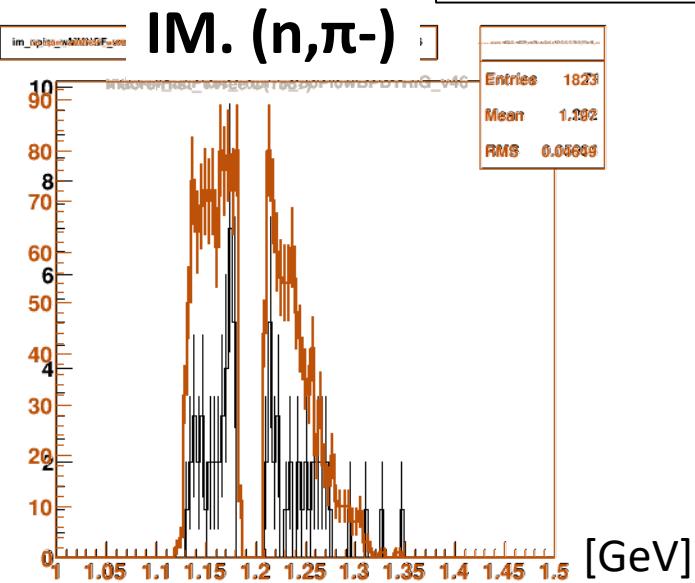
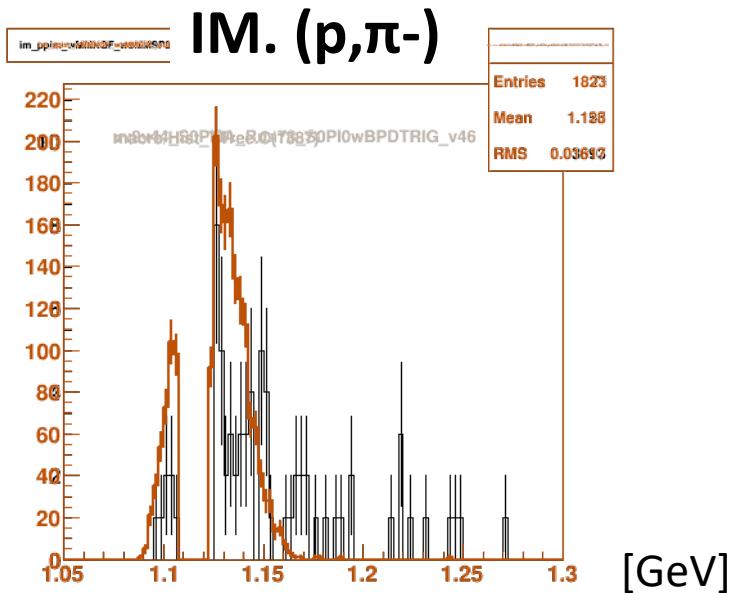
# Overlay with data

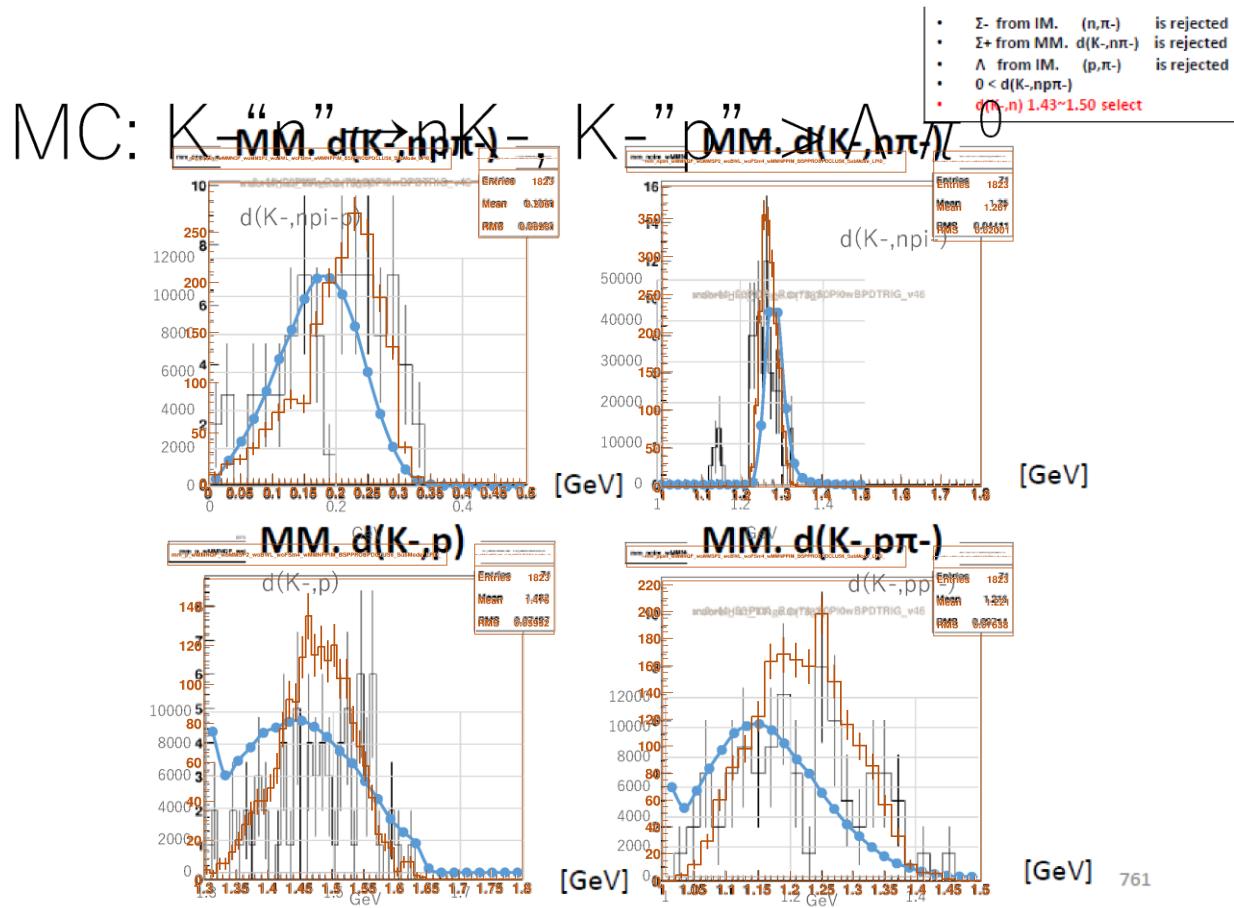
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

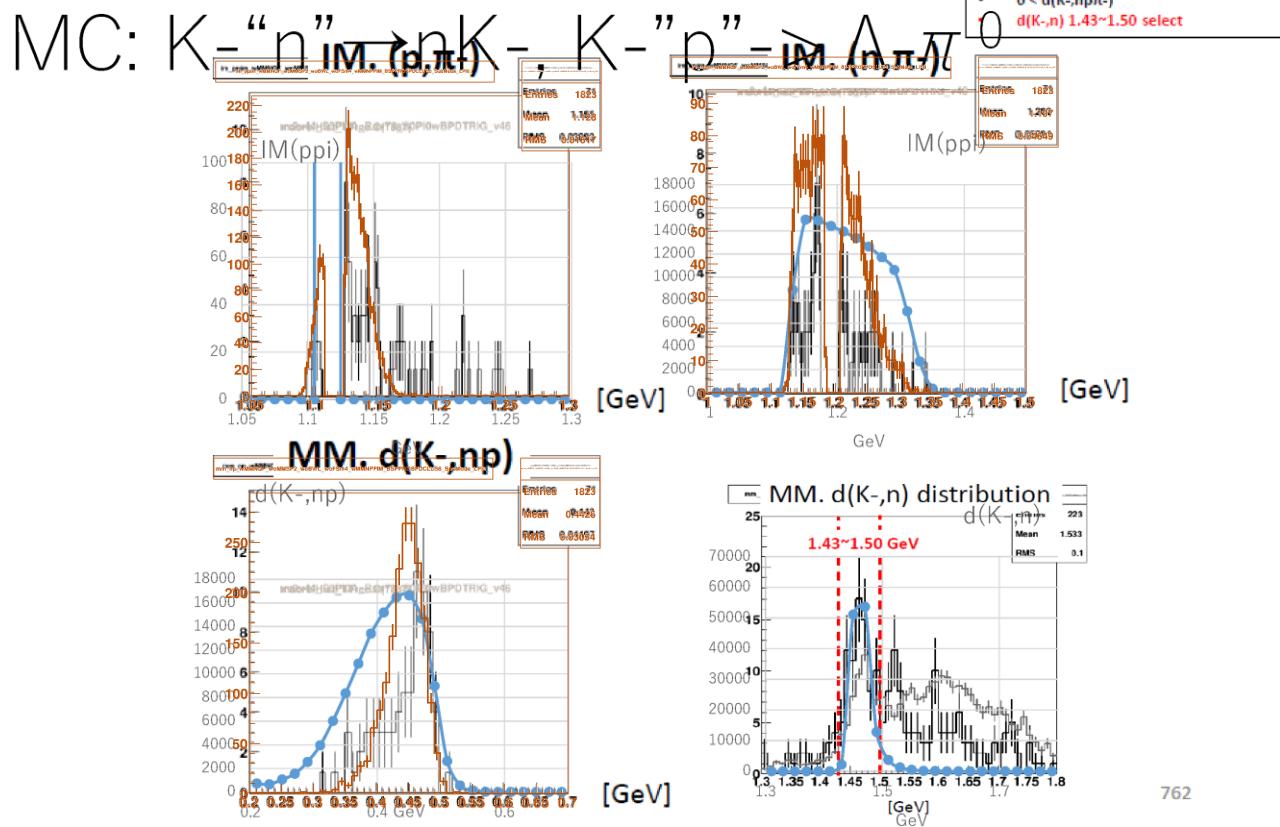


# Overlay with data

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

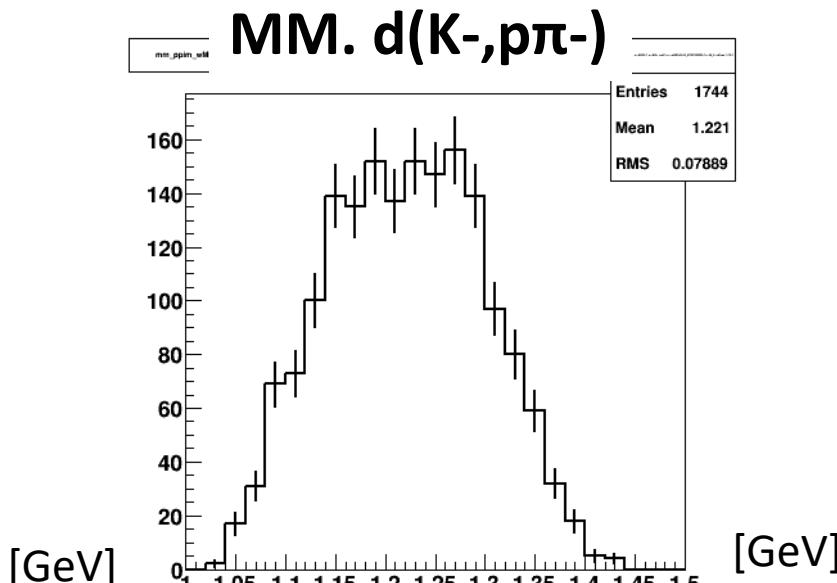
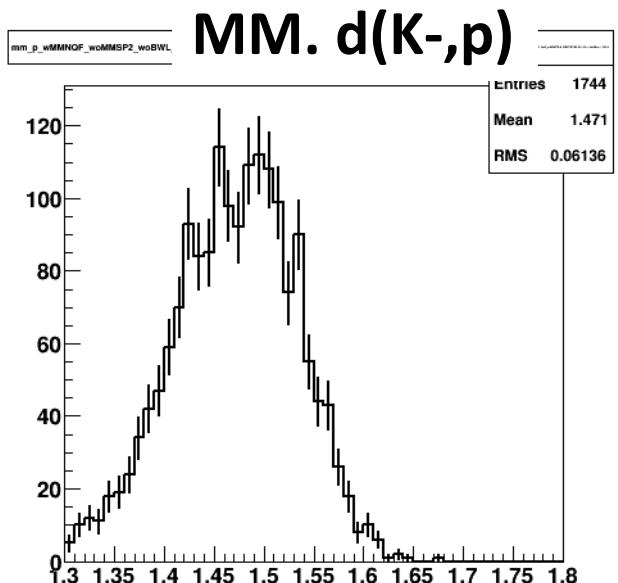
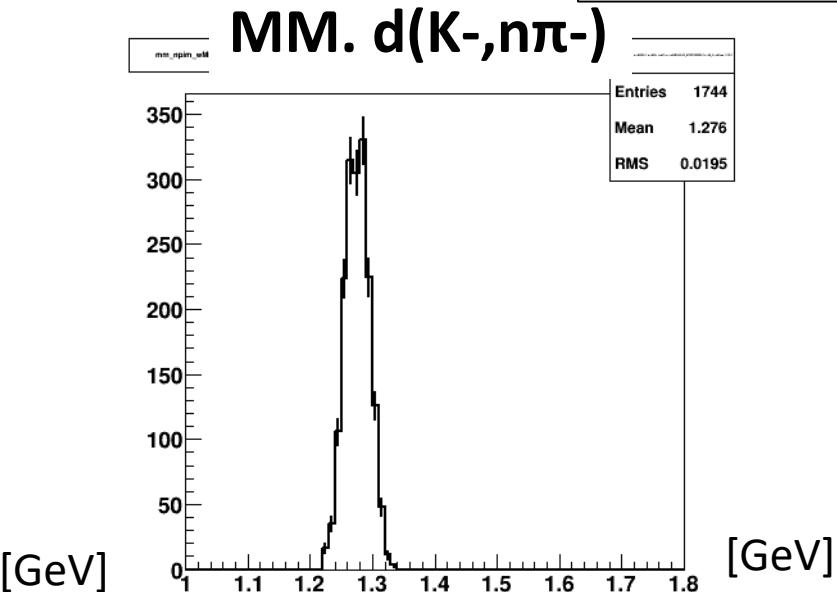
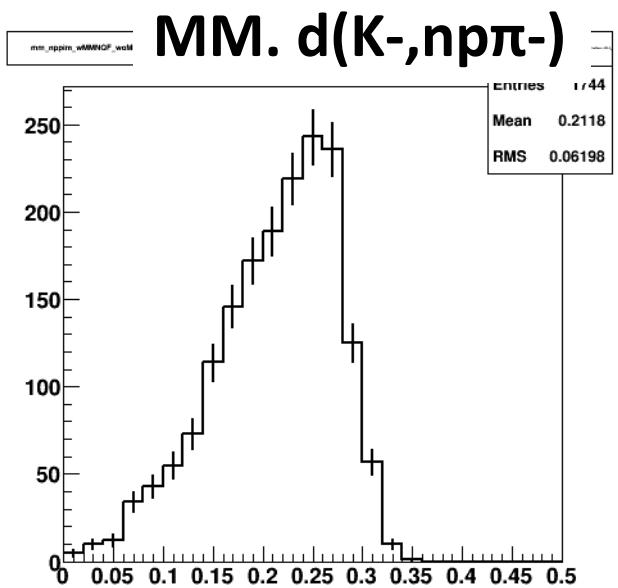






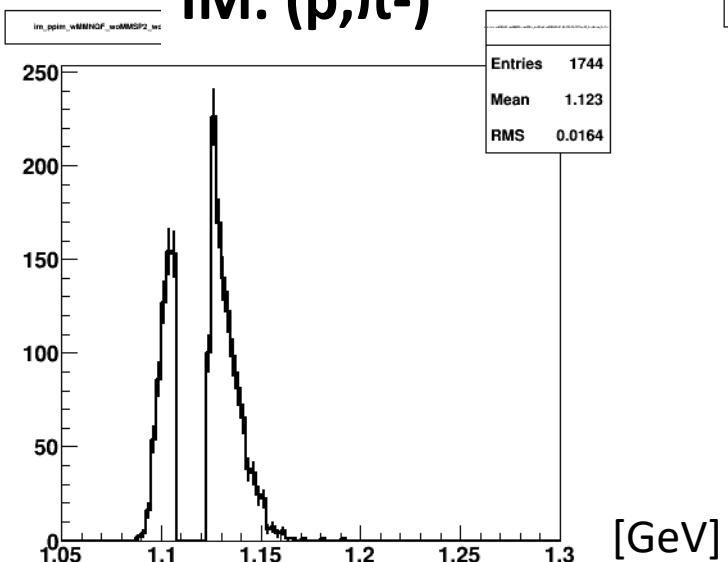
K- “p” ->  $\Sigma^0 \pi^0$

- $\Sigma$ - from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

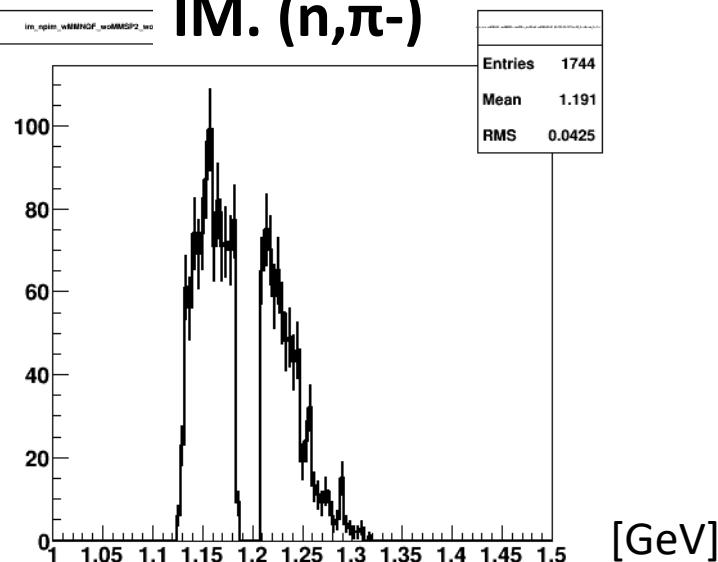


- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

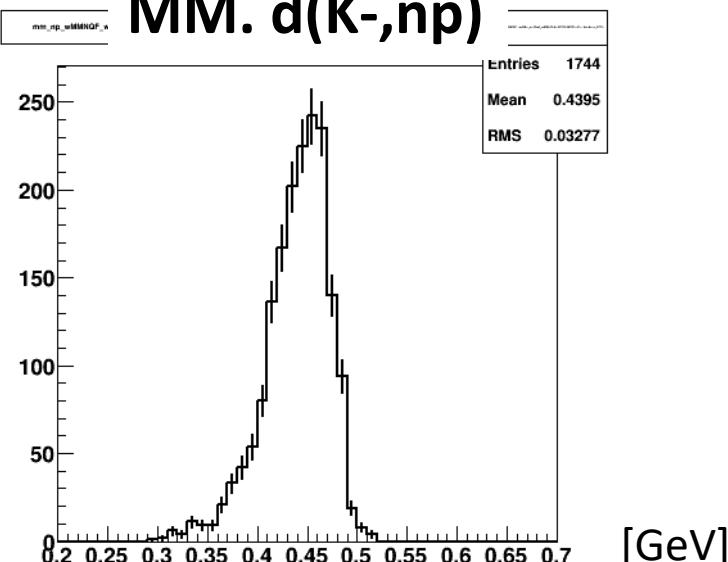
## IM. ( $p, \pi^-$ )



## IM. ( $n, \pi^-$ )

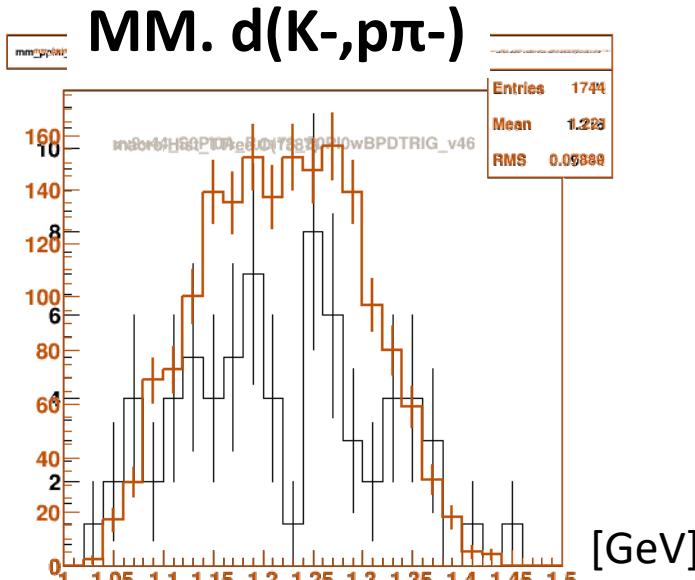
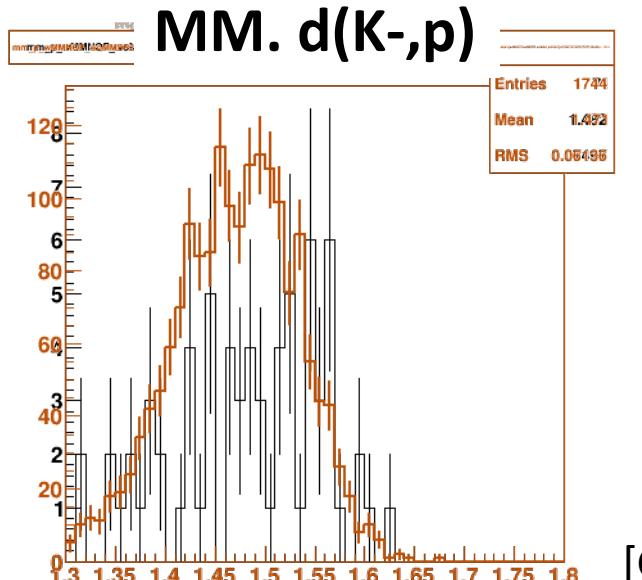
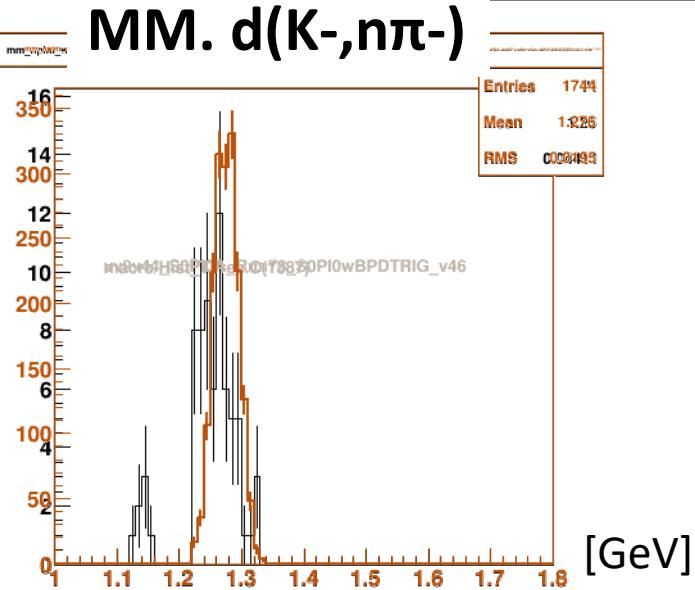
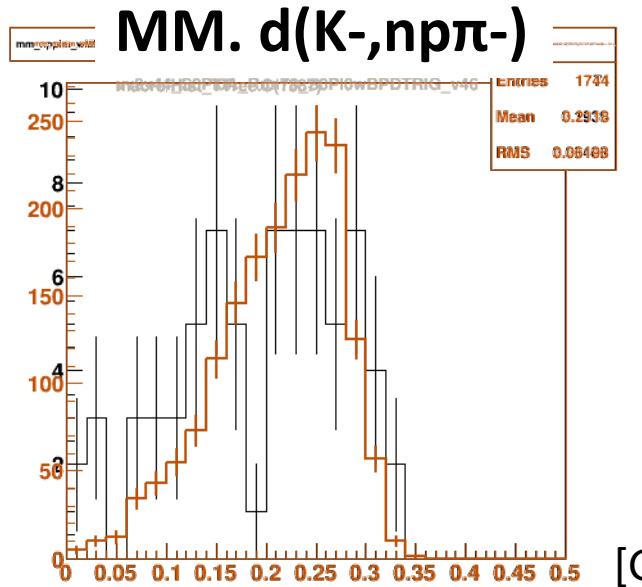


## MM. $d(K^-, np)$



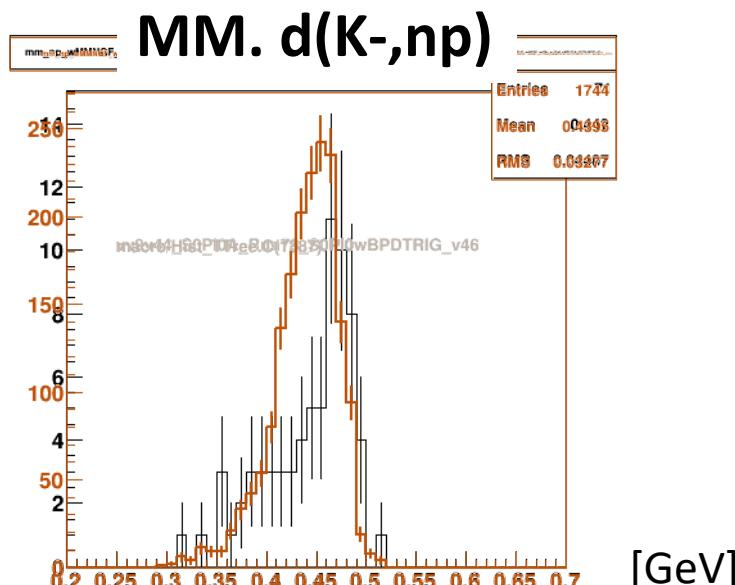
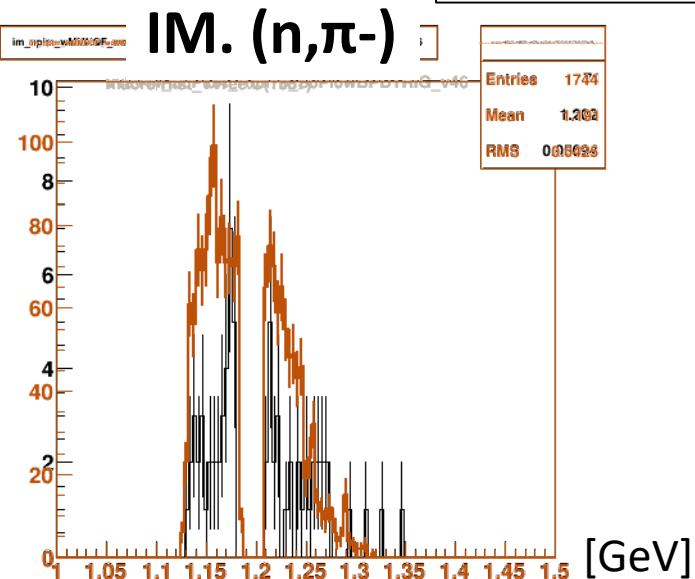
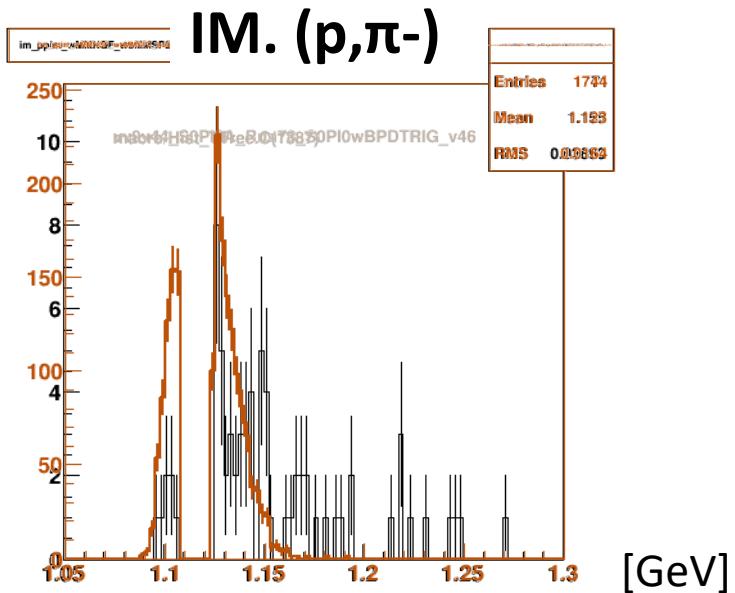
# Overlay with data

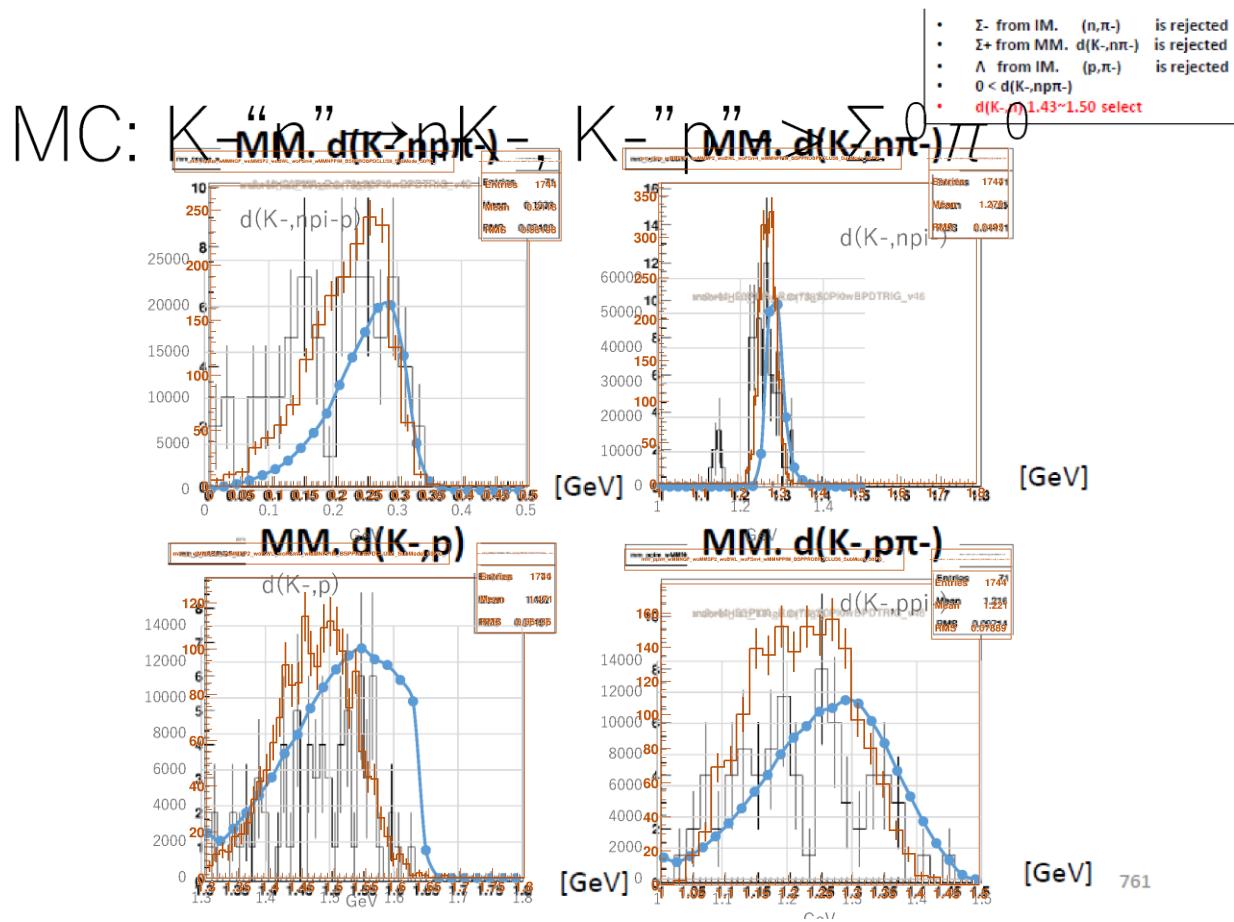
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



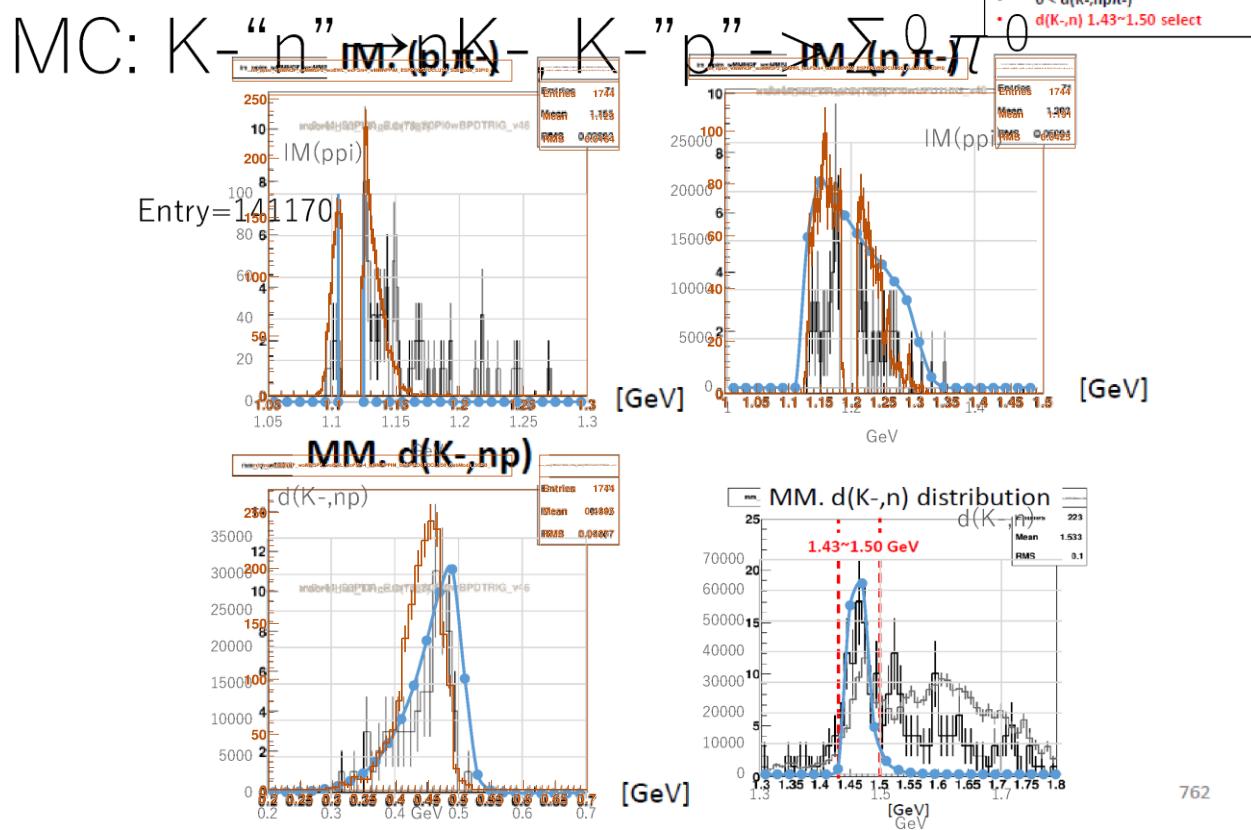
# Overlay with data

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



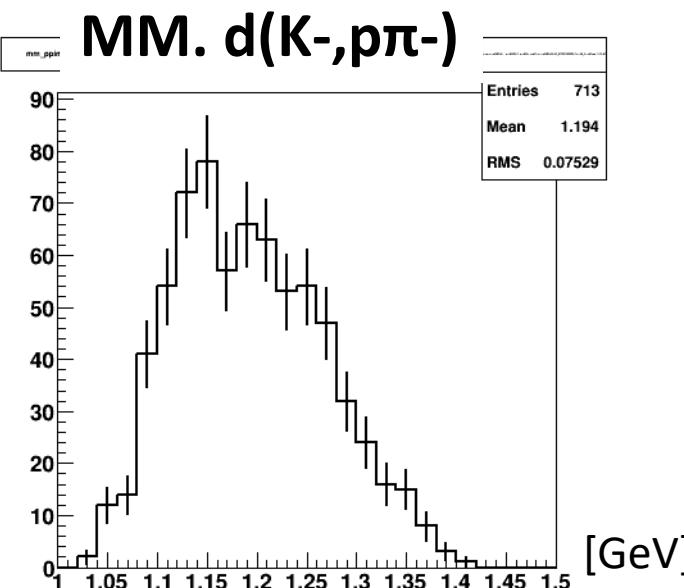
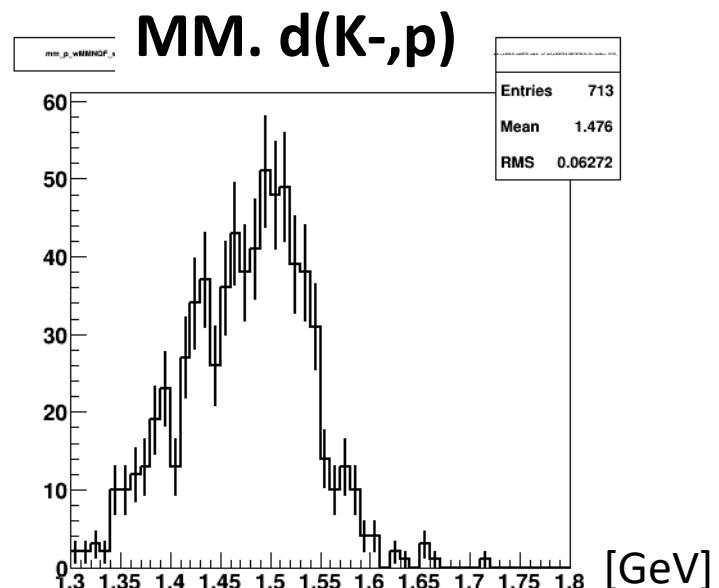
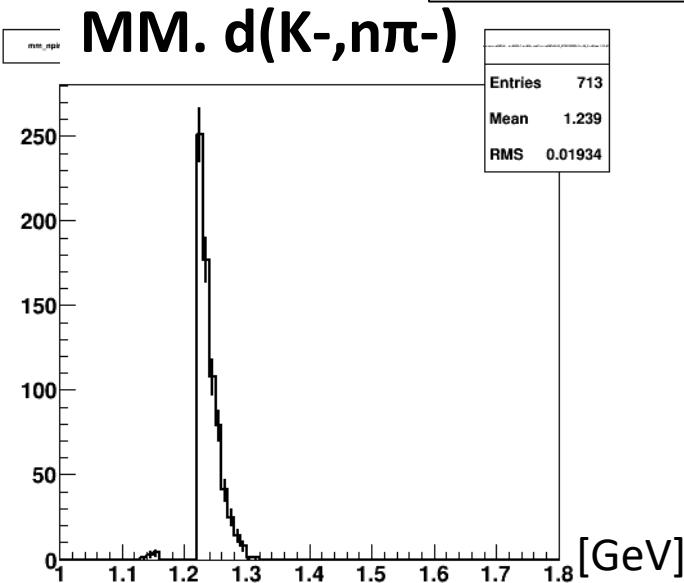
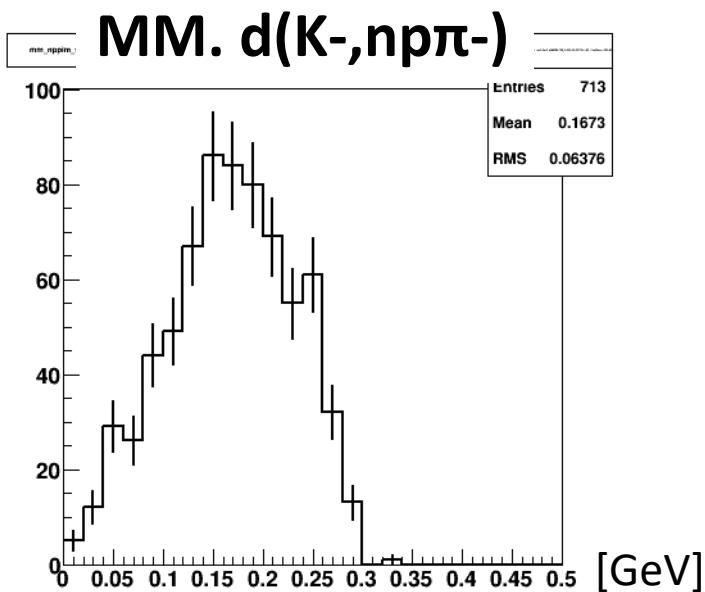


- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

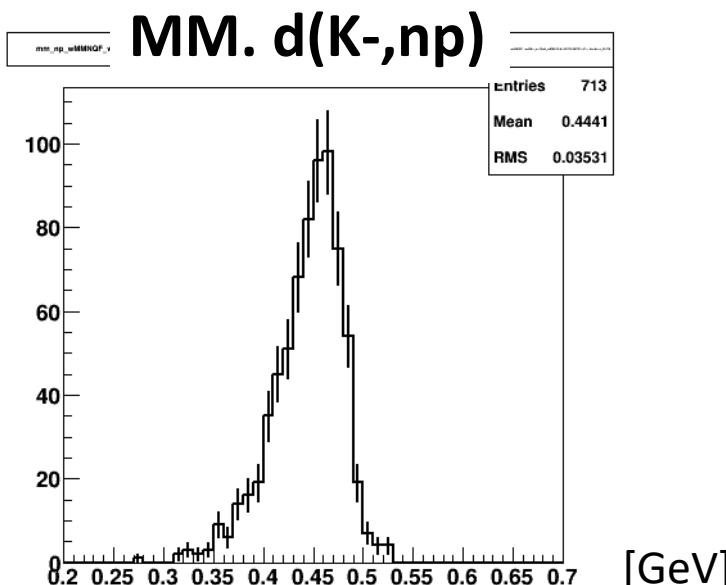
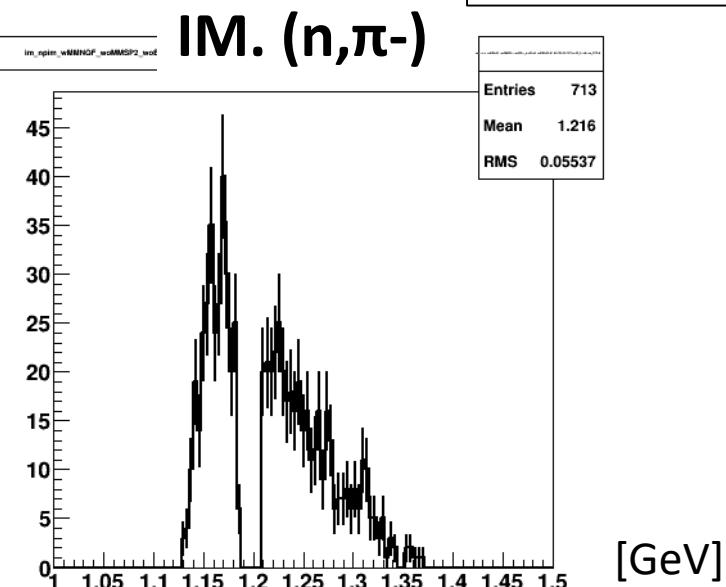
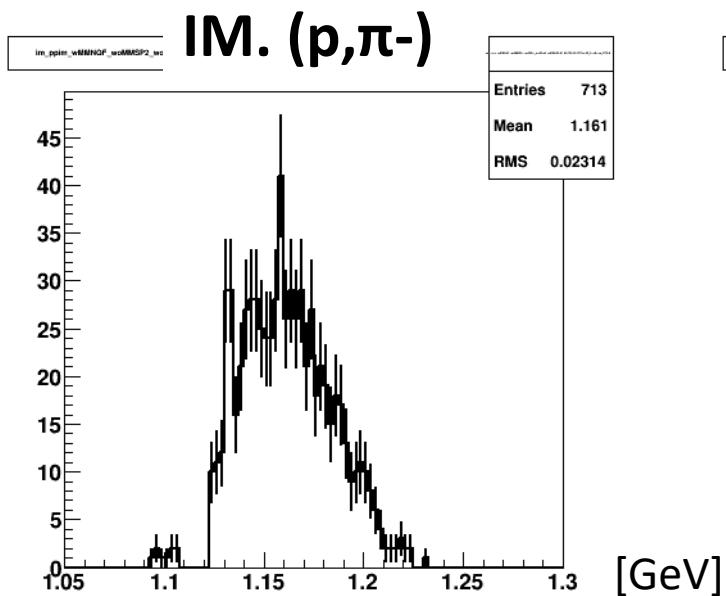


K- “p” ->  $\Sigma^+$   $\pi^-$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

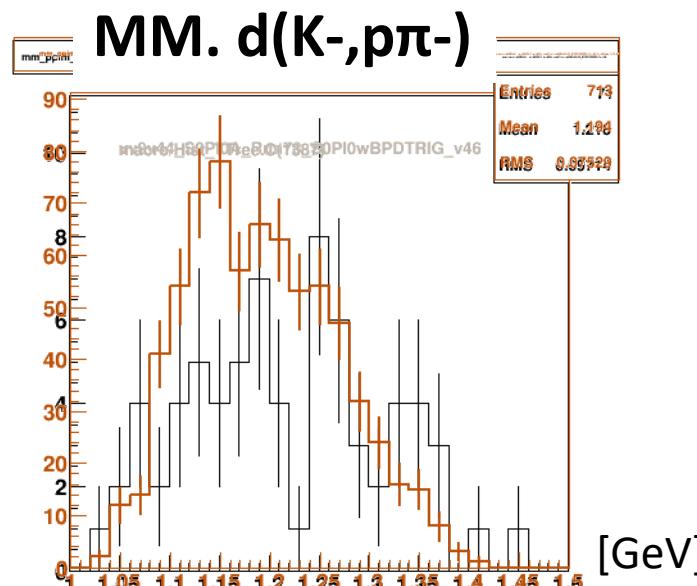
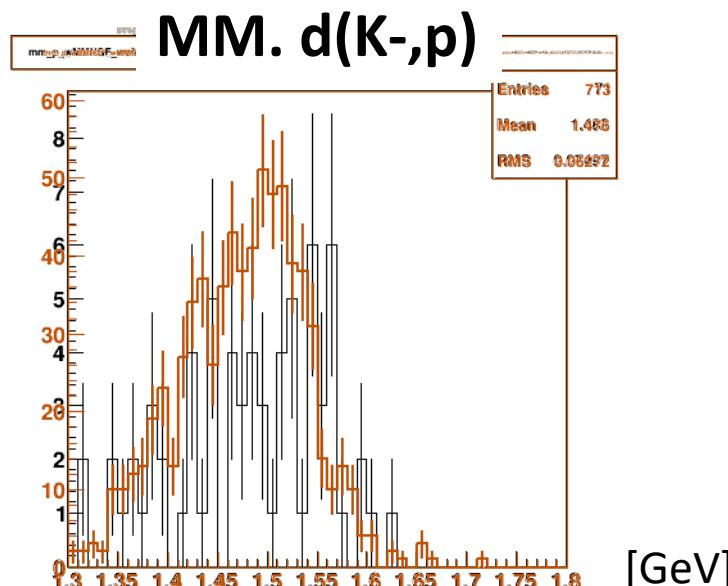
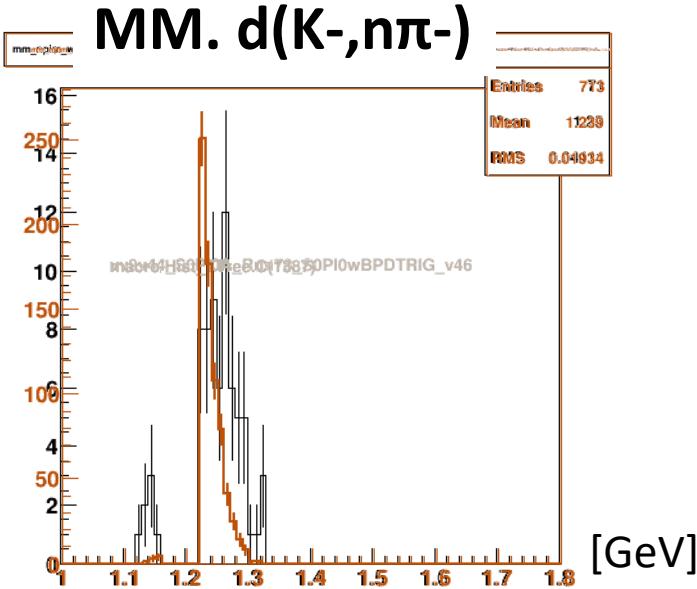
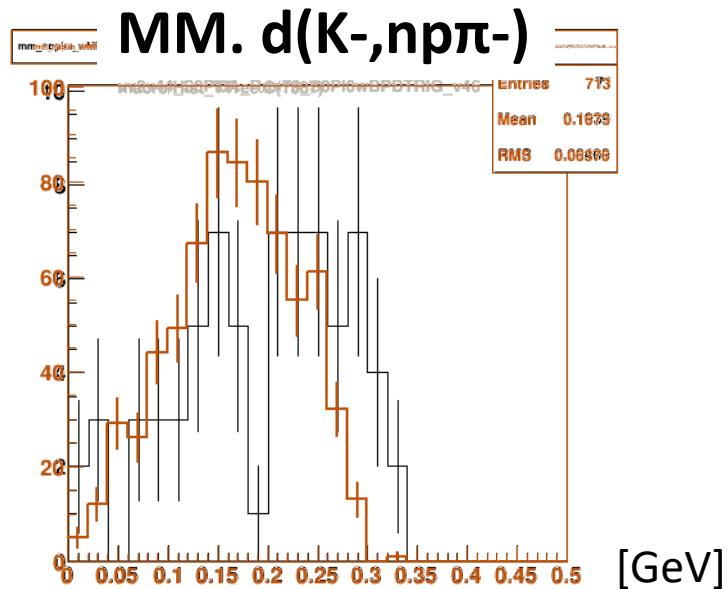


- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



# Overlay with data

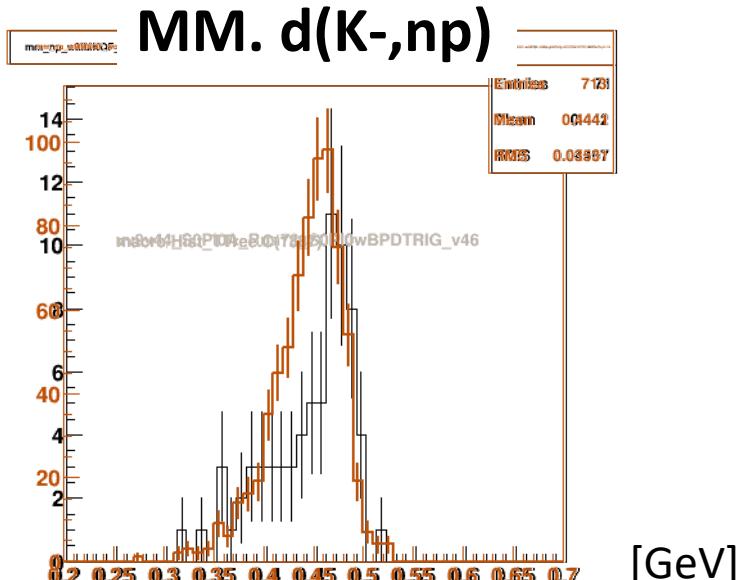
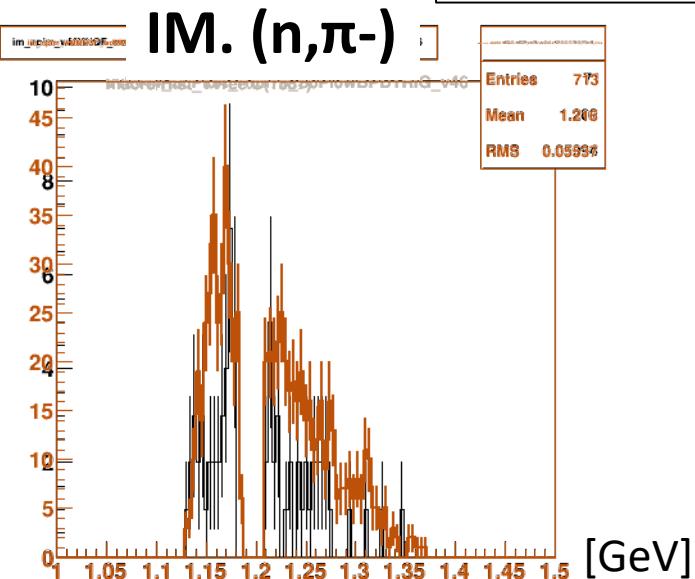
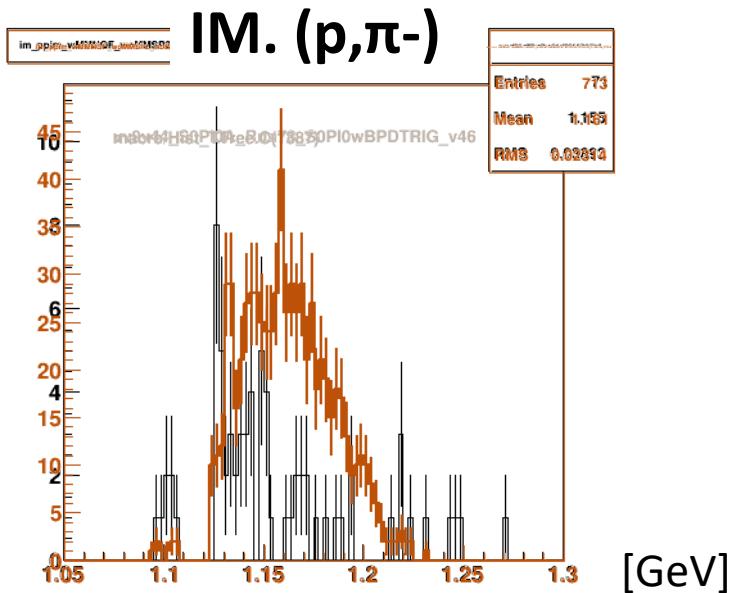
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



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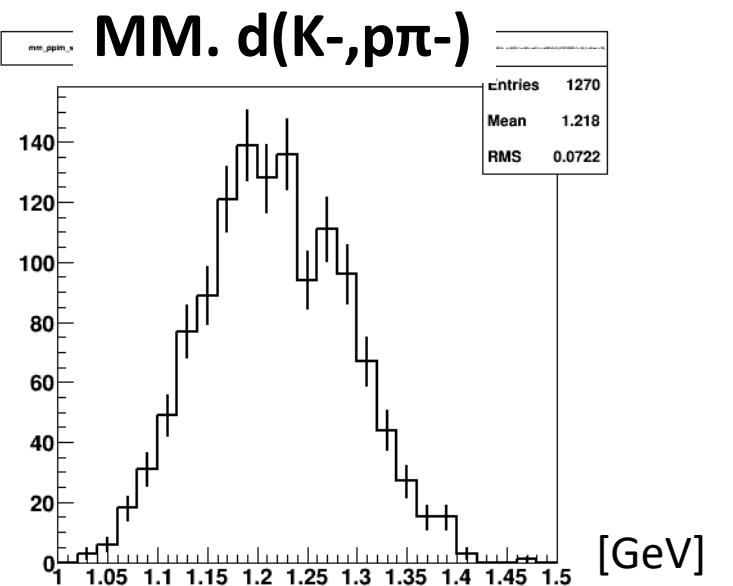
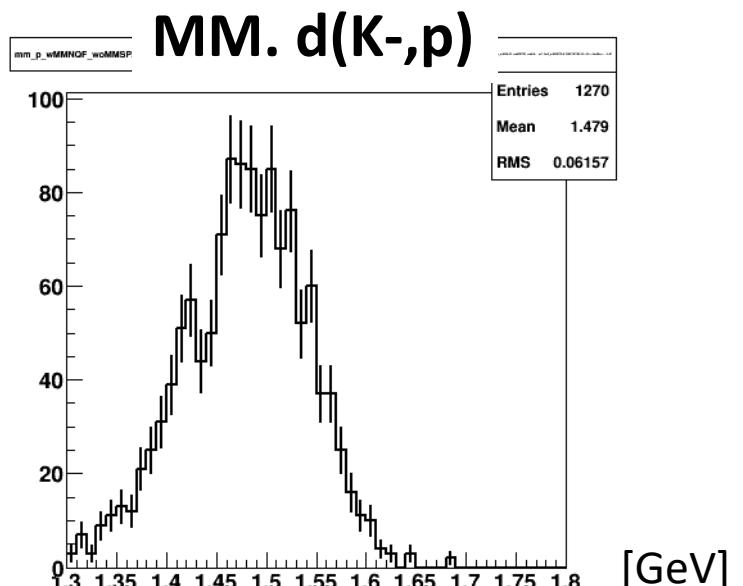
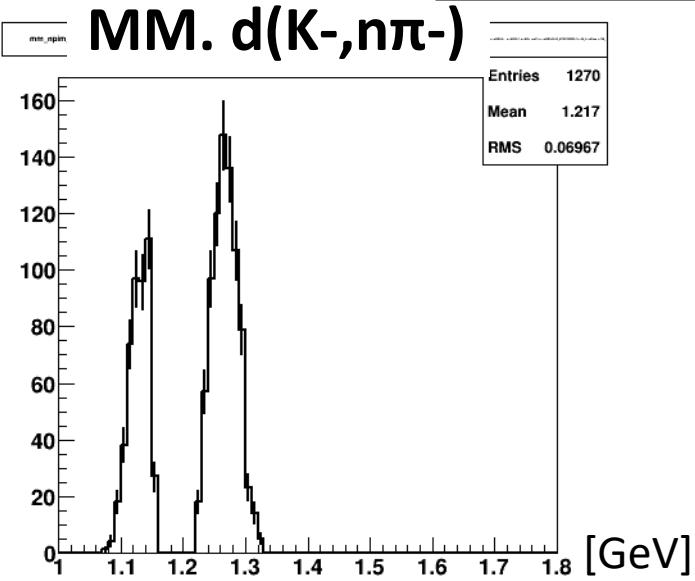
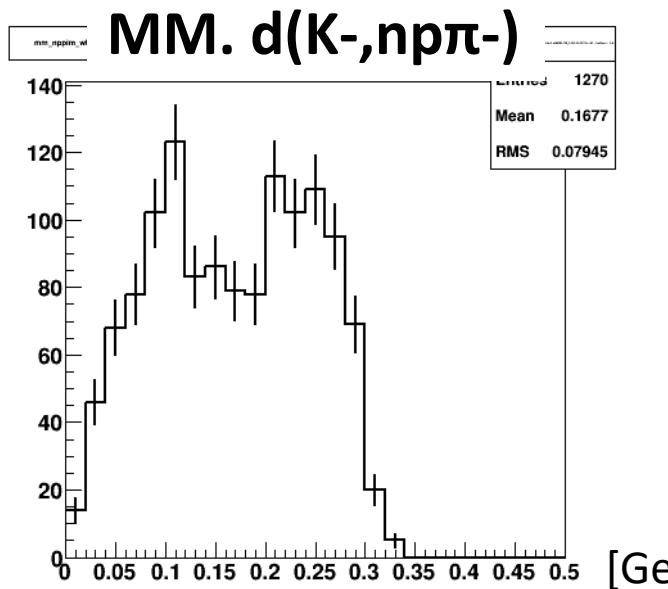
# Overlay with data

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

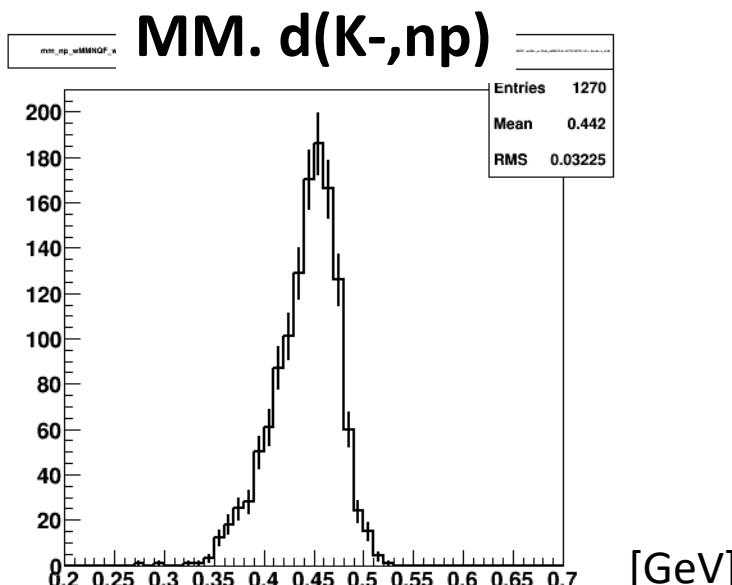
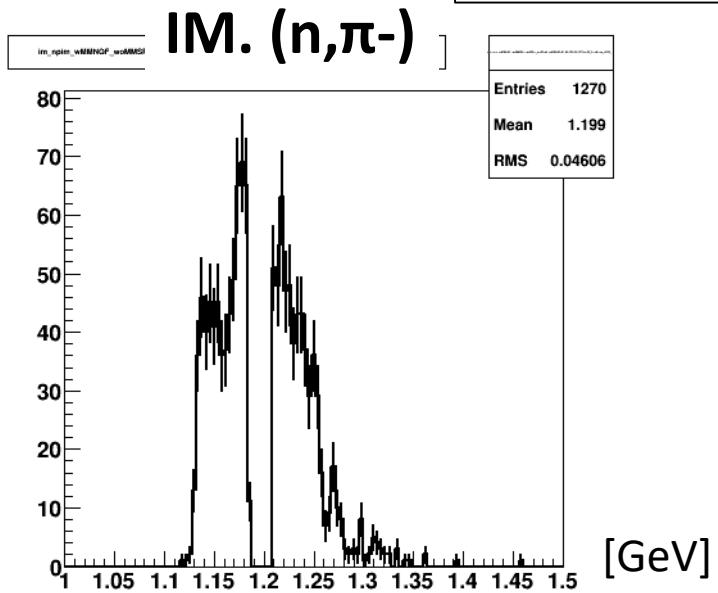
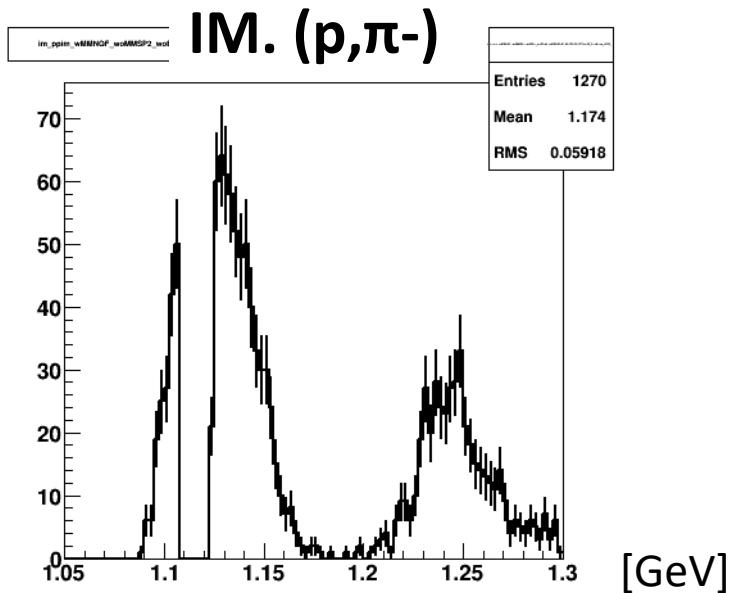


K- “n” -> Λ π-

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

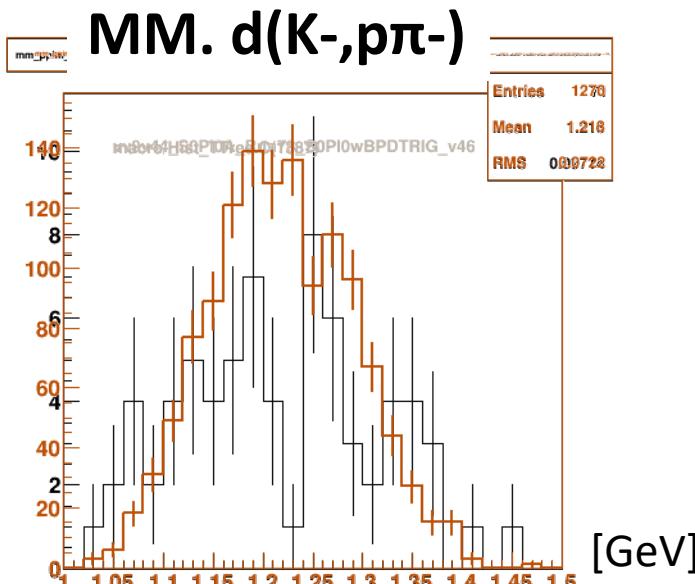
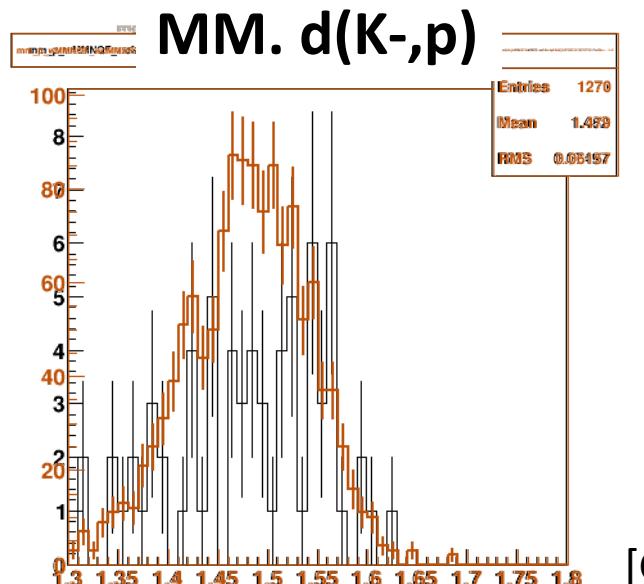
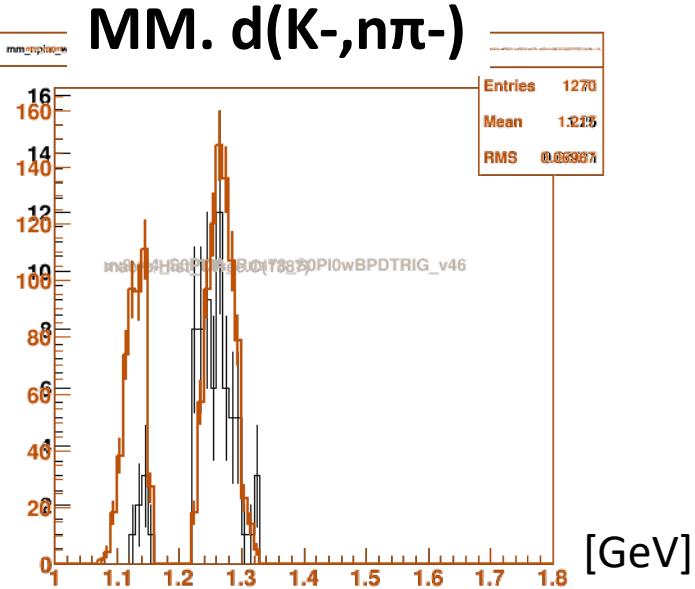
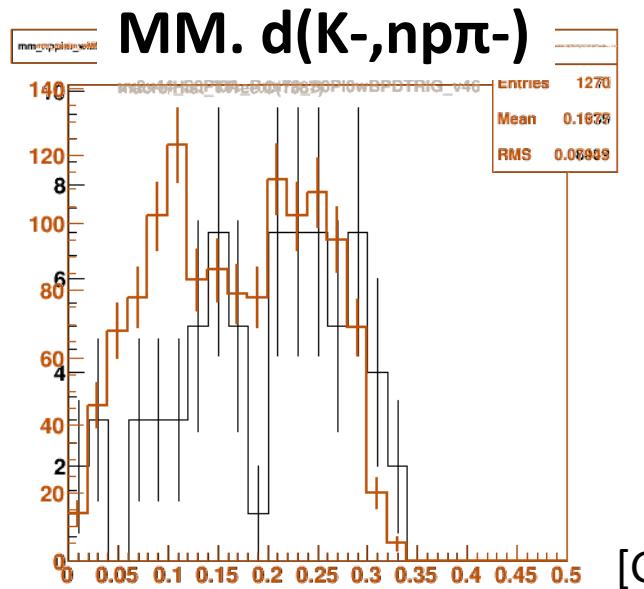


- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



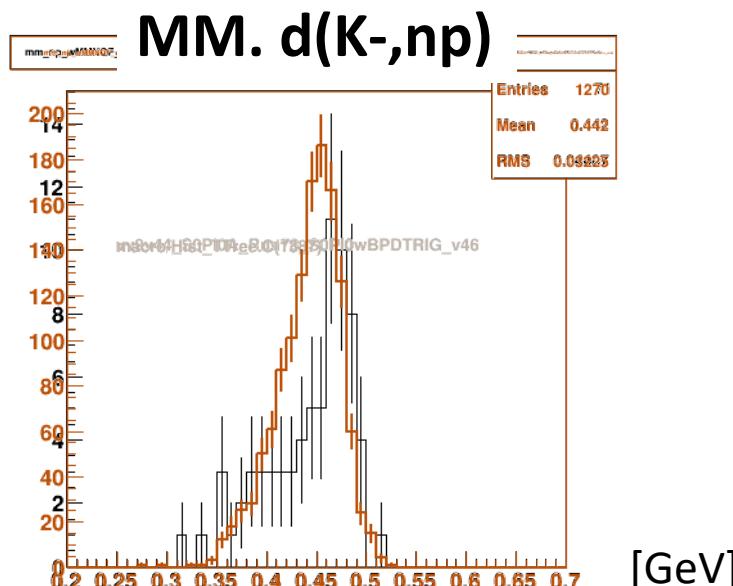
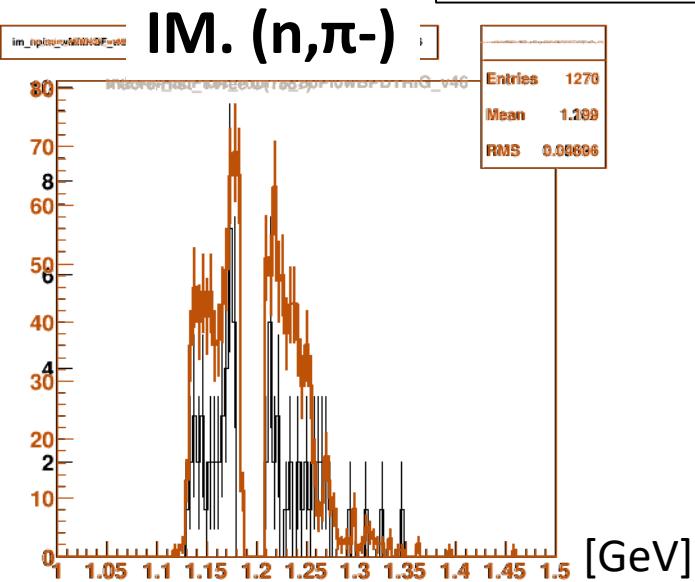
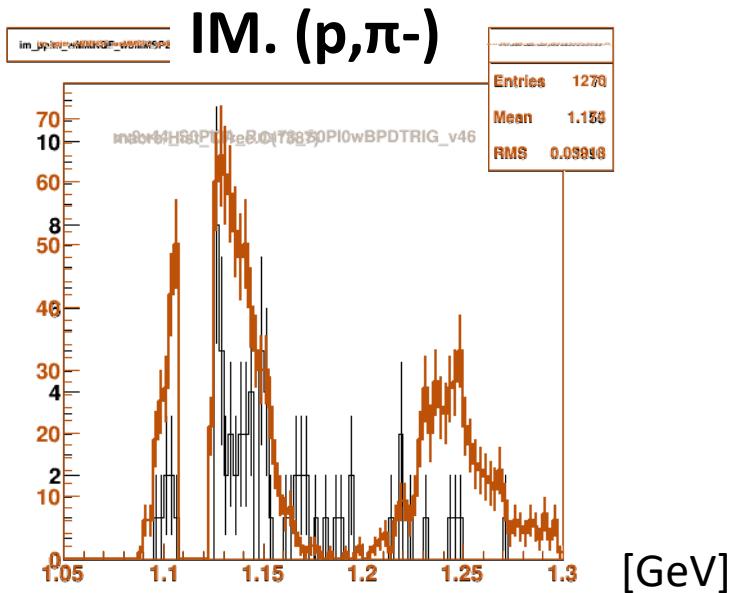
# Overlay with data

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



# Overlay with data

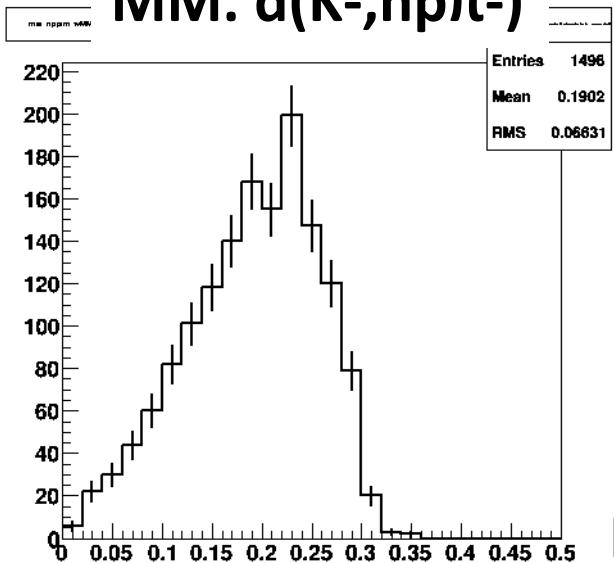
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



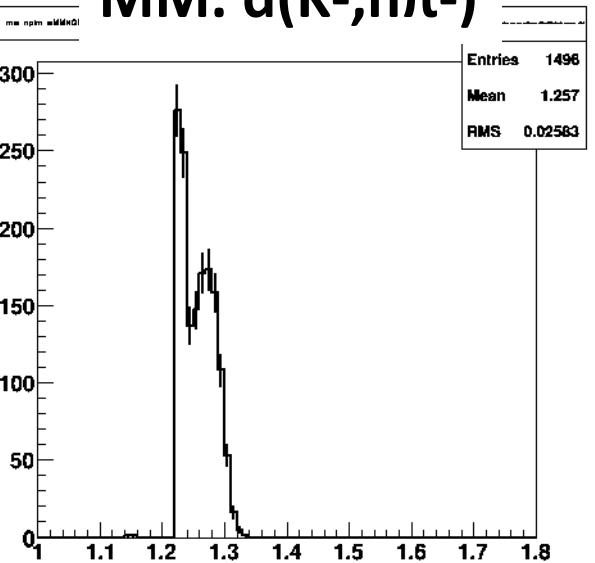
K- “n” ->  $\Sigma^0 \pi^-$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

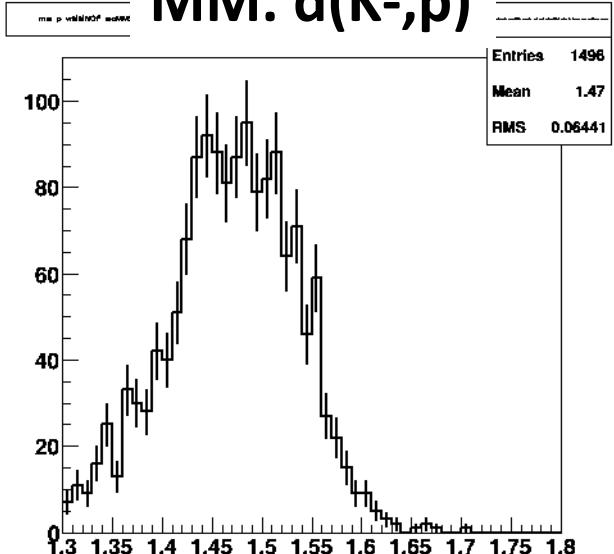
## MM. $d(K, n\pi^-)$



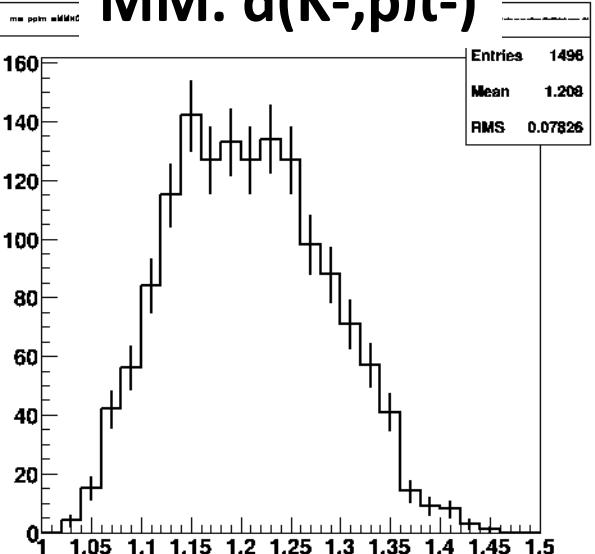
## MM. $d(K, n\pi^-)$



## MM. $d(K, p)$



## MM. $d(K, p\pi^-)$

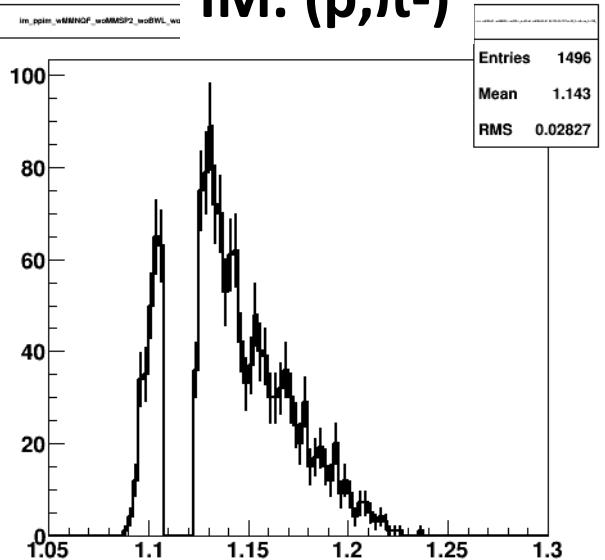


[GeV]

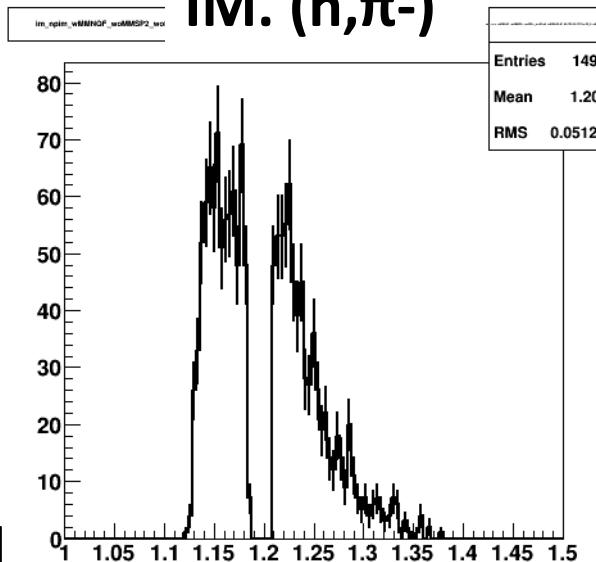
[GeV]

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select

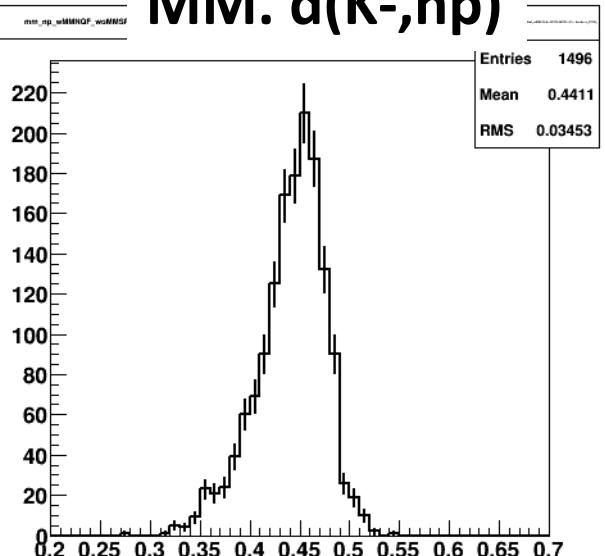
## IM. ( $p, \pi^-$ )



## IM. ( $n, \pi^-$ )

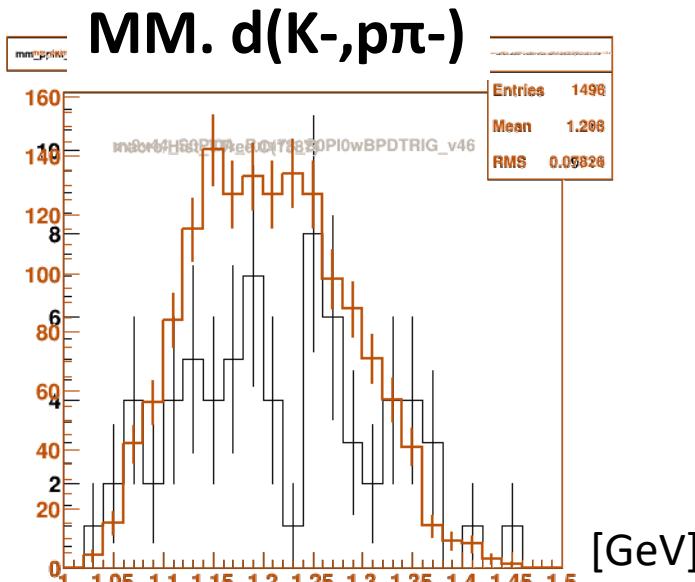
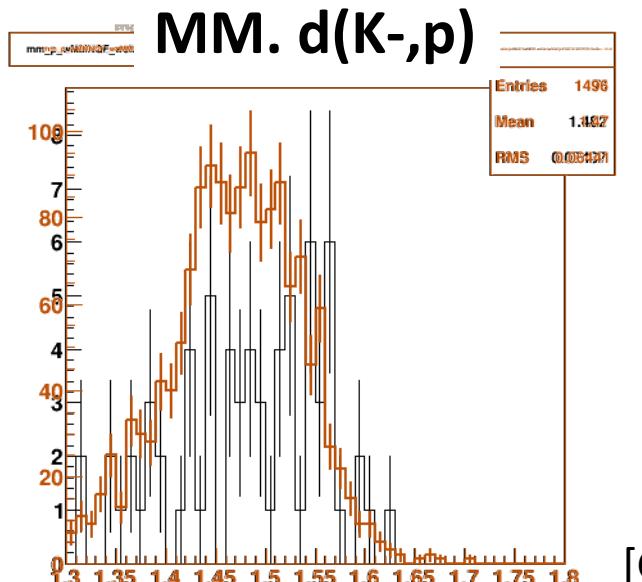
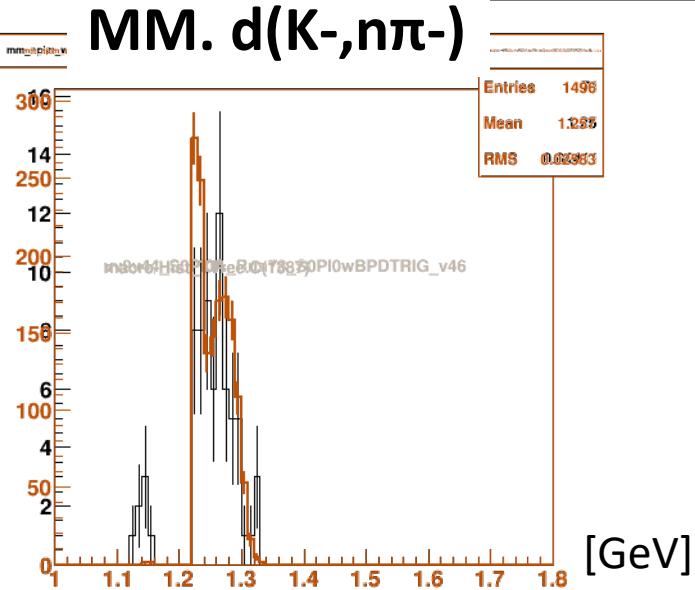
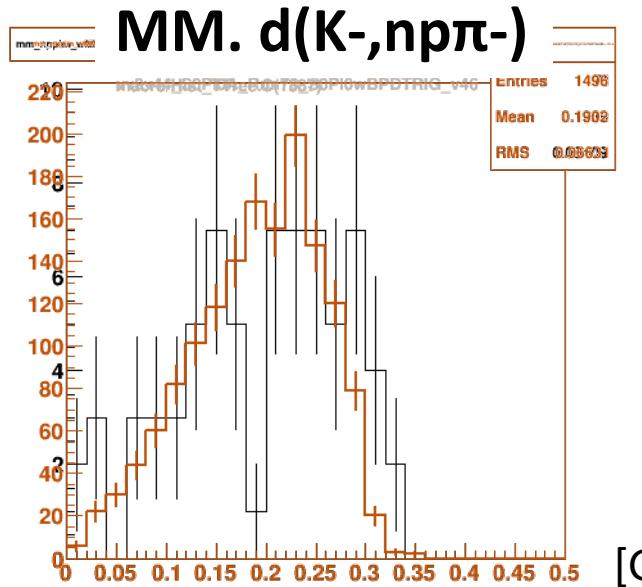


## MM. $d(K, np)$



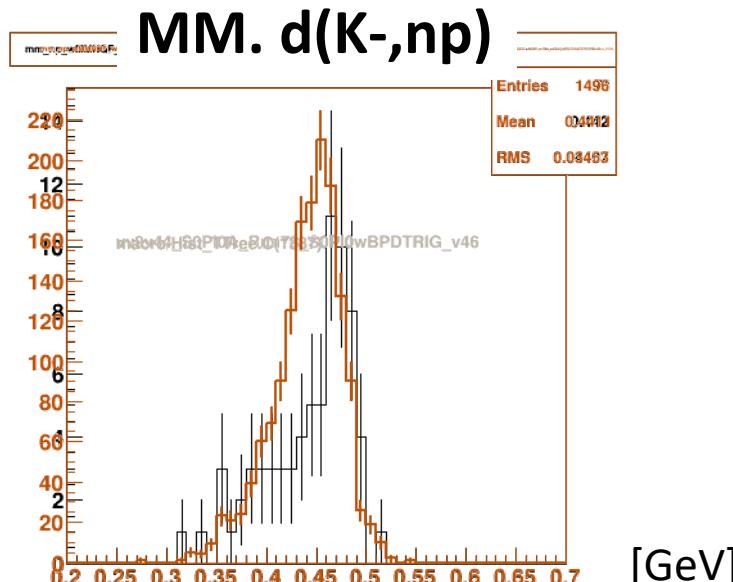
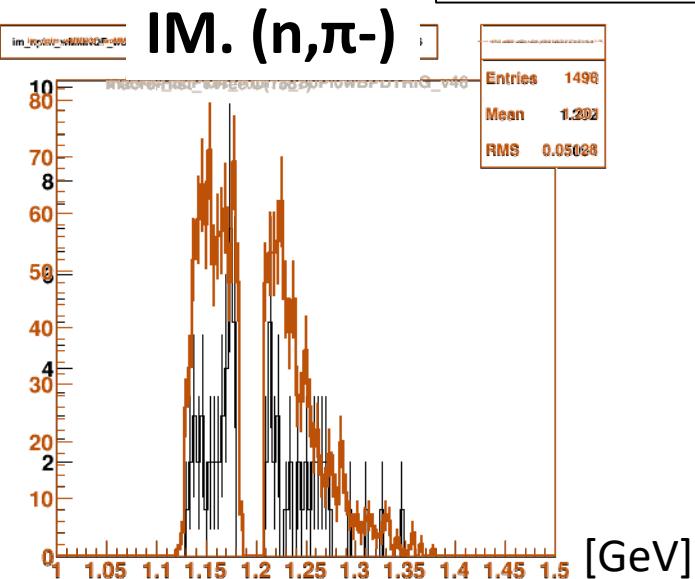
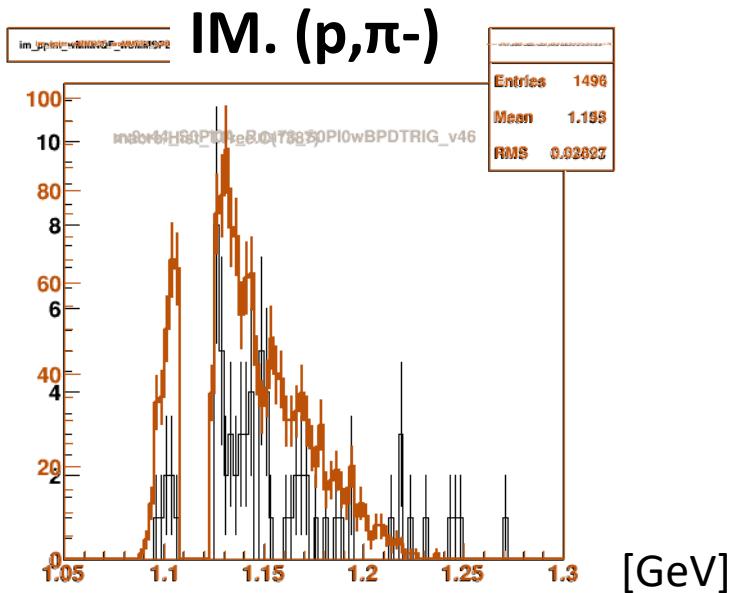
# Overlay with data

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, n\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



# Overlay with data

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Sigma^+$  from MM.  $d(K, n\pi^-)$  is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K, np\pi^-)$
- $d(K, n) 1.43 \sim 1.50$  select



- Knuc! MC of 2 successive reactions ( $K^-$  “p”  $\rightarrow \Lambda\pi^0$ ,  $\Sigma^0\pi^0$ ) seems to possible to explain BG
- With more statics
- To do
  - Decision of these ratio in the data BG (w/  $K^- d \rightarrow p \gamma \pi$ )

# BG SIM estimation

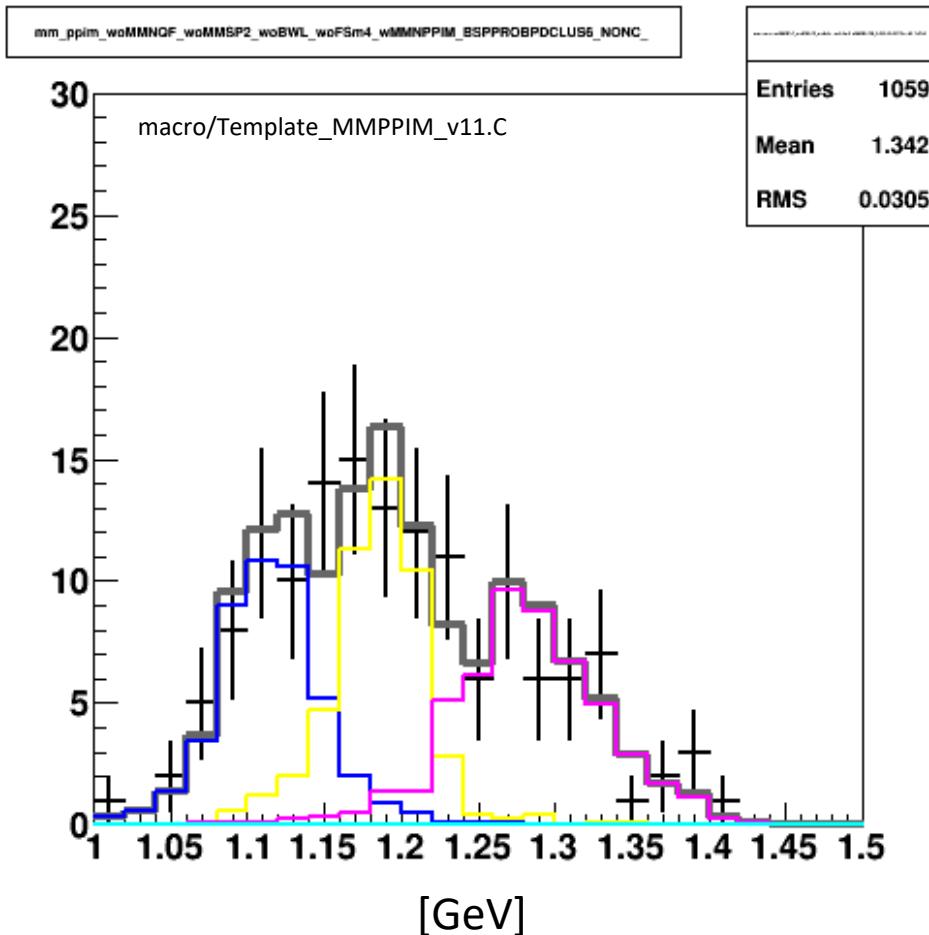
- $K^- d \rightarrow p Y \pi$ 
  - $K-d \rightarrow p \Lambda \pi^-$
  - $K-d \rightarrow p \Sigma^0 \pi^-$
  - $K-d \rightarrow p \Lambda \pi^- \pi^0$
  - $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
  - data shape of MM.  $d(K^-, p)$
- 2 successive reaction
  - $K^- "n" \rightarrow K^- n$  ; "n" is bound in a deuteron
  - $K^- "p(n)" \rightarrow Y \pi$  ; "p(n)" is in different deuteron
  - w/o Eloss correction for 1<sup>st</sup> scattered  $K^-$
  - Vertex distribution
    - 1<sup>st</sup> reaction : uniformly in z axis  $\rightarrow$  in proportion to the depth from edge of the target in z axis to fit all generated event in the target length
    - 2<sup>nd</sup> reaction : uniformly along recoiled  $K^-$  direction from 1<sup>st</sup> reaction point

# Reaction mode of 2<sup>nd</sup> reaction

- K-p            Isospin ratio
  - $\Sigma^0\pi^0$  (1/6)
  - $\Sigma^+\pi^-$  (1/6)
  - $\Sigma^-\pi^+$  (1/6) -no backward proton
  - $\pi^0\Lambda$  (1/2)
- K-n
  - $\Sigma^0\pi^-$  (1/2)
  - $\Sigma^-\pi^0$  (1/2) -no backward proton
  - $\Lambda\pi^-$  (1)

# Fitting of MM. $d(K^-, p\pi^-)$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) rejected
- $0 < d(K^-, n\pi^-)$
- $d(K^-, n)$  **1.43~1.50 rejected**



## † Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- Fit Result

Scaling factor of SIM is free

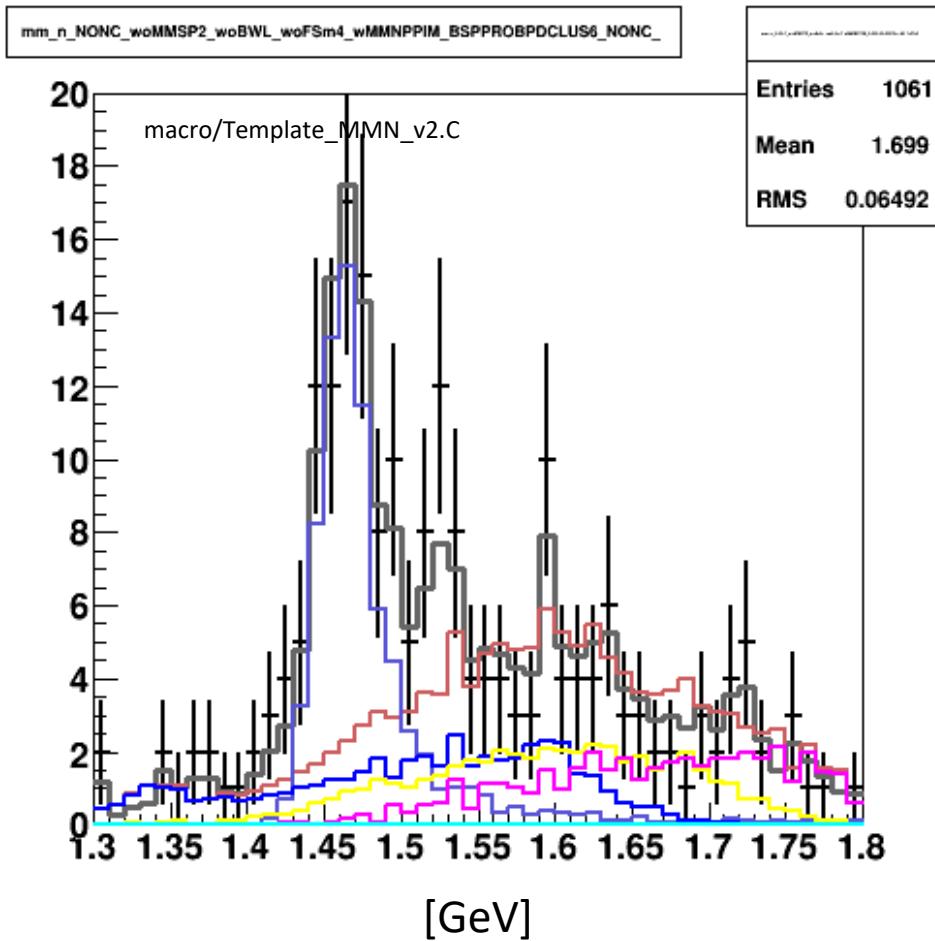
Fit Range

1.00 ~ 1.50 GeV

$\text{Chi}^2/\text{ndf} = 13.4/25$

# Fitting of MM. $d(K_-, n)$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) rejected
- $\Sigma^+$  from MM.  $d(K_-, n\pi^-)$  rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) rejected
- $0 < d(K_-, n\pi\pi^-)$



## † Data

- $K-d \rightarrow p \gamma \pi$ 
  - $K-d \rightarrow p \Lambda \pi^-$
  - $K-d \rightarrow p \Sigma^0 \pi^-$
  - $K-d \rightarrow p \Lambda \pi^- \pi^0$
  - $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- 2 successive
- Fit Result

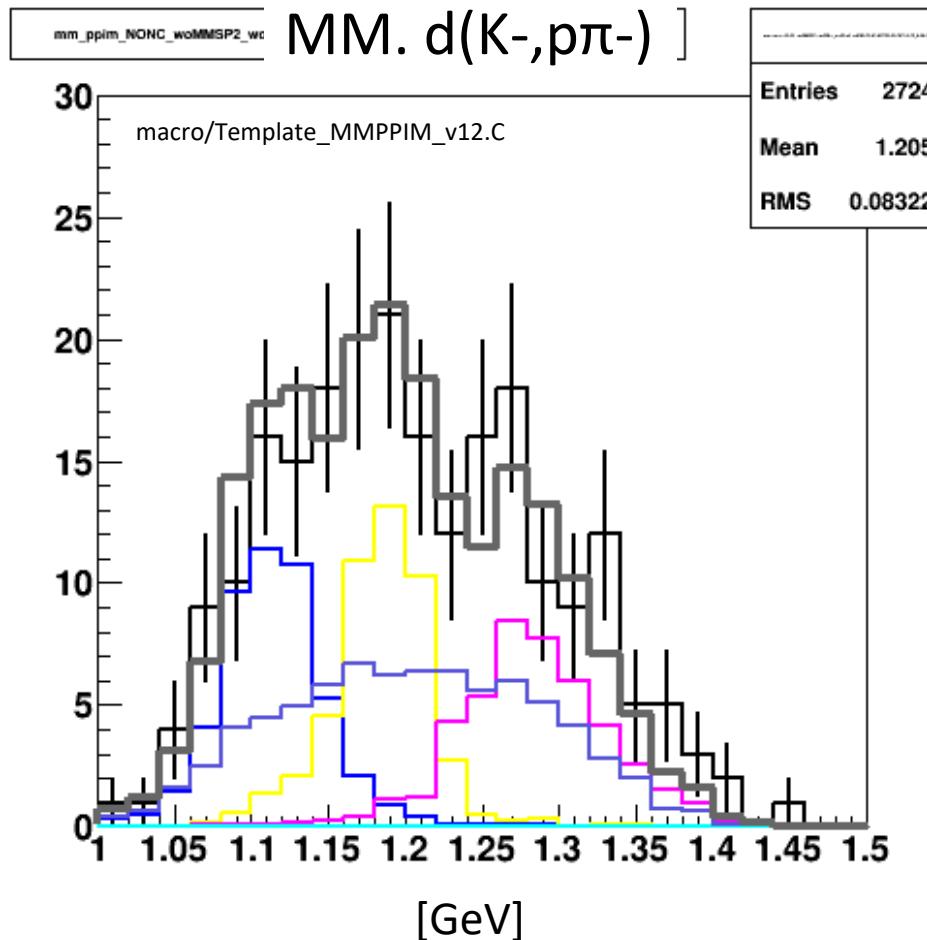
- The relative ratio of 4 components in  $K-d \rightarrow p \gamma \pi$  is fixed by fitting of MM.  $d(K_-, p\pi^-)$  P.807
- Scaling factors of SIM ( $K-d \rightarrow p \gamma \pi$ , 2 successive) are free

Fit Range  
1.30 ~ 1.80 GeV

$\text{Chi}^2/\text{ndf} = 32.0/50$

# Fitting result

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) rejected
- $0 < d(K^-, n\pi^-)$

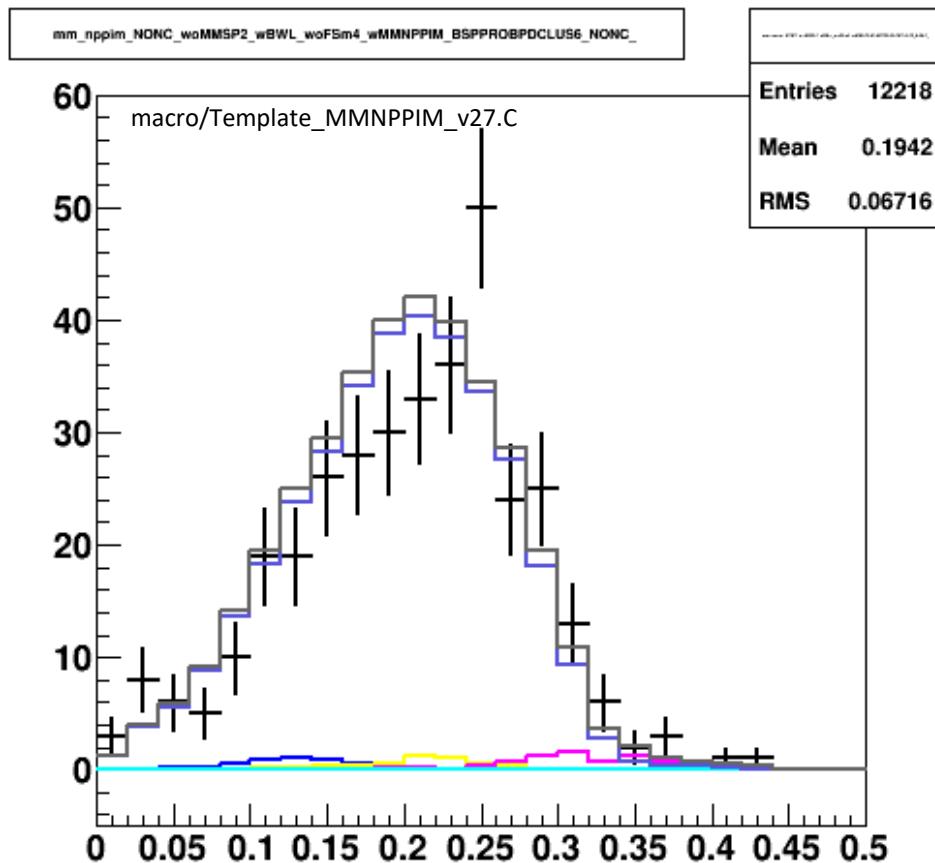


## † Data

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi-\pi^0$
- $K-d \rightarrow p \Sigma^0 \pi-\pi^0$
- 2 successive
- SUM

# MM. $d(K^-, n\Lambda)$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) selected
- $0 < d(K^-, n\pi^-)$



## † Data

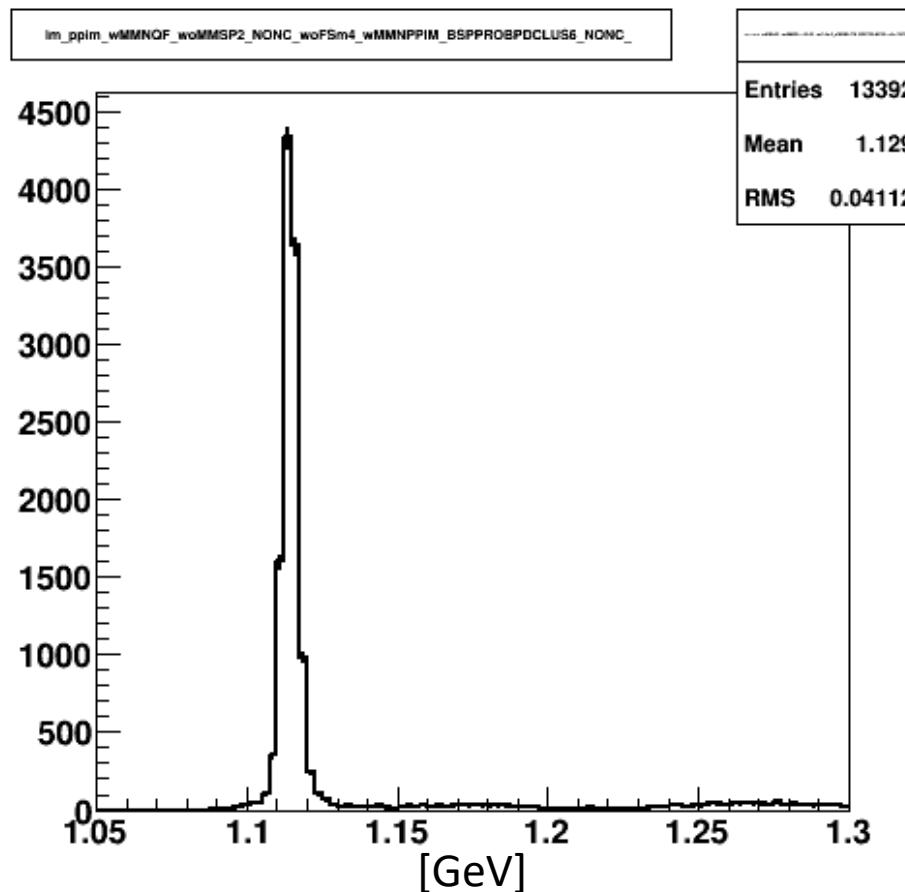
- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- 2 successive
- SUM

$\Lambda$  from IM. ( $p, \pi^-$ ) of 2 successive is too large  
No room for  $K-d \rightarrow n \Sigma^+ \pi^-$ ,  $n \Lambda \pi^0$

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) rejected
- $\Sigma^+$  from MM.  $d(K^-, n\pi^-)$  rejected
- $0 < d(K^-, n\pi^-)$
- $d(K^-, n)$   **$1.43 \sim 1.50$  selected**

# IM. ( $p, \pi^-$ )

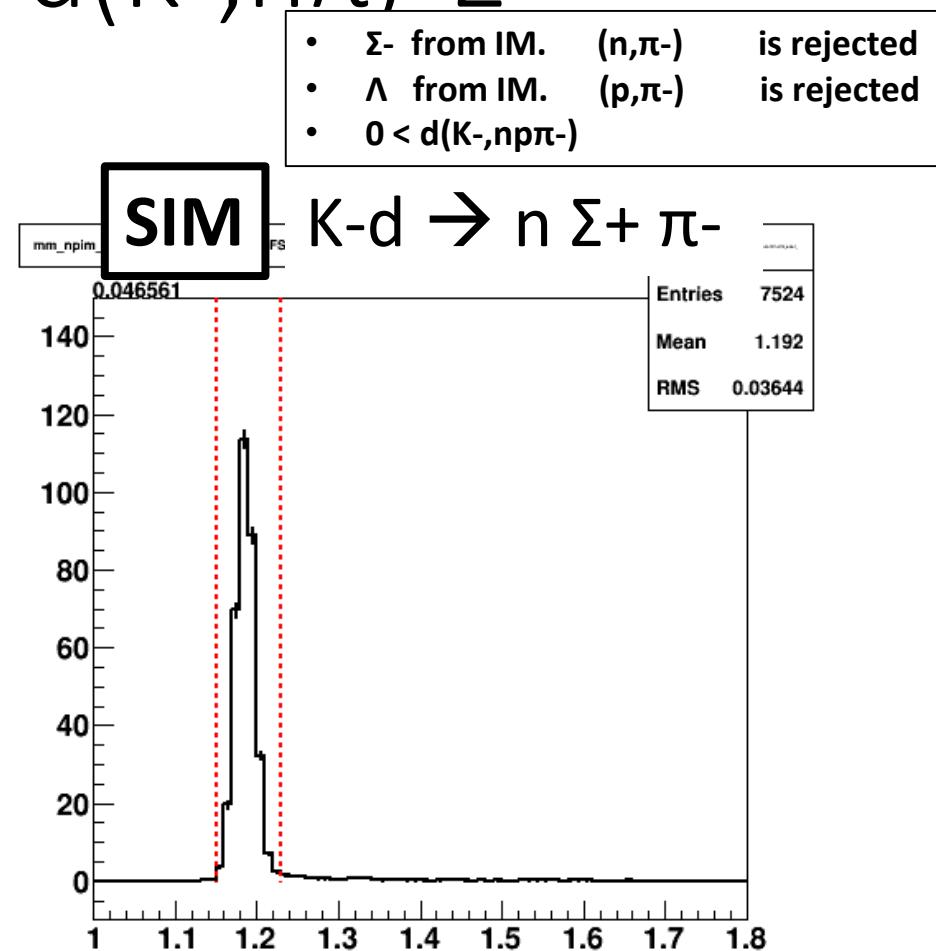
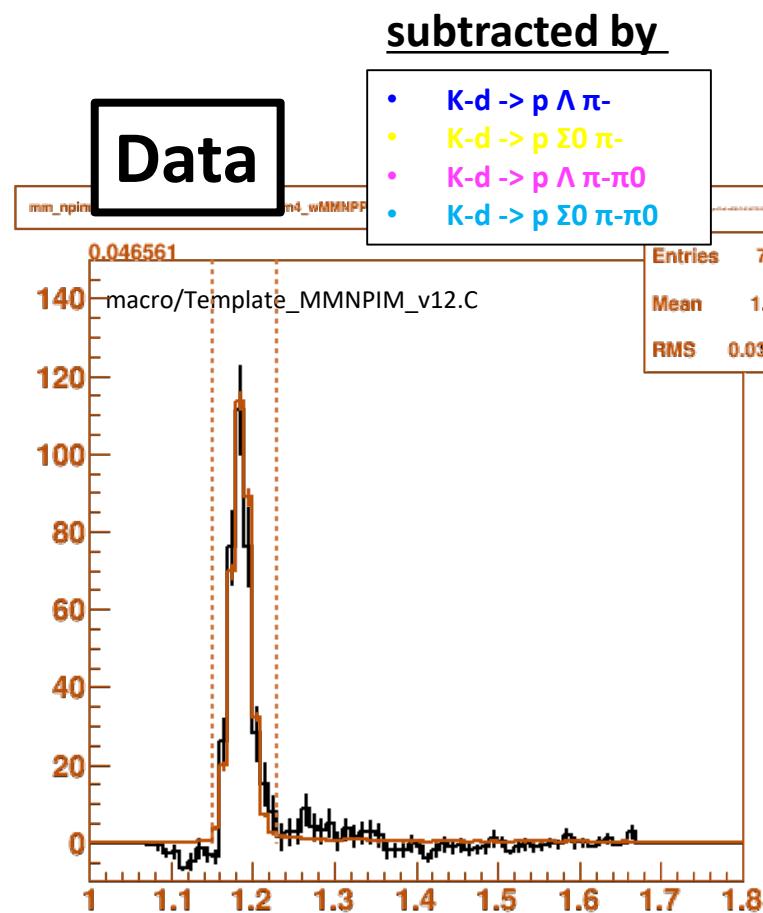
SIM ; 2 successive reaction (sum of 2<sup>nd</sup> reactions)



2 successive make  $\Lambda$  peak in IM. ( $p, \pi^-$ )

$K-d \rightarrow n \Sigma^+ \pi^-$  ;

Scaled by event # of  $d(K-,n\pi)^{\prime\prime}\Sigma^+$ "

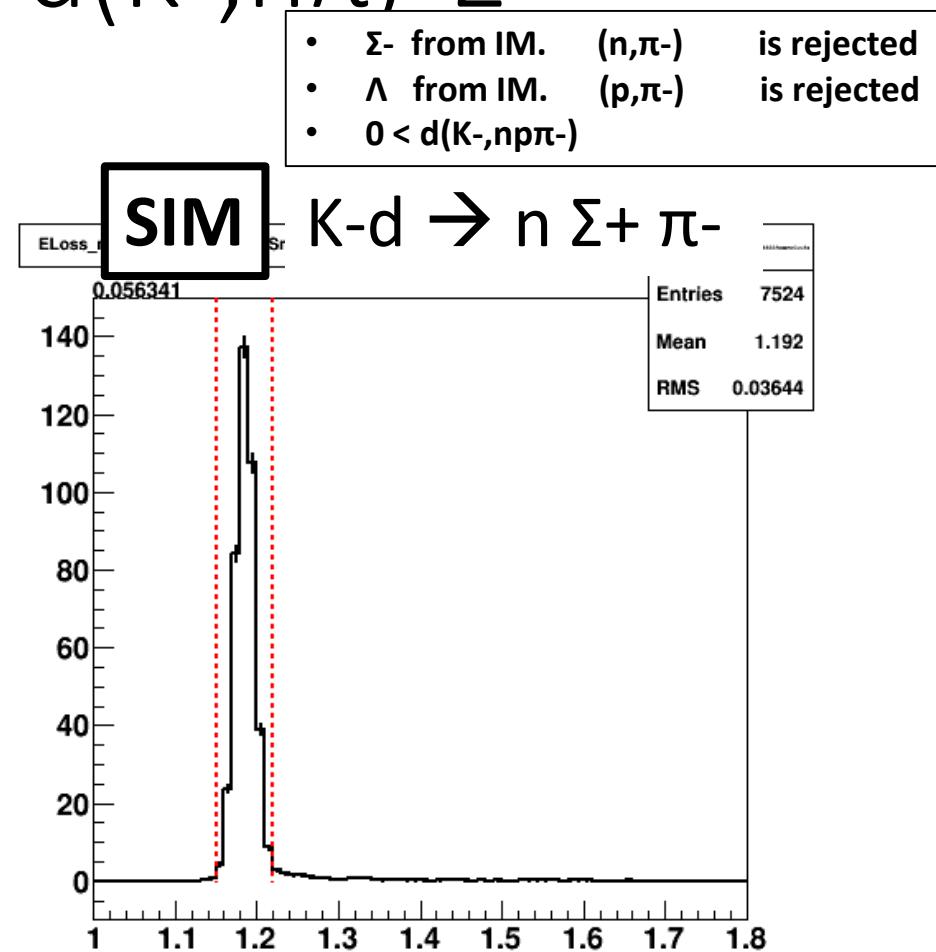
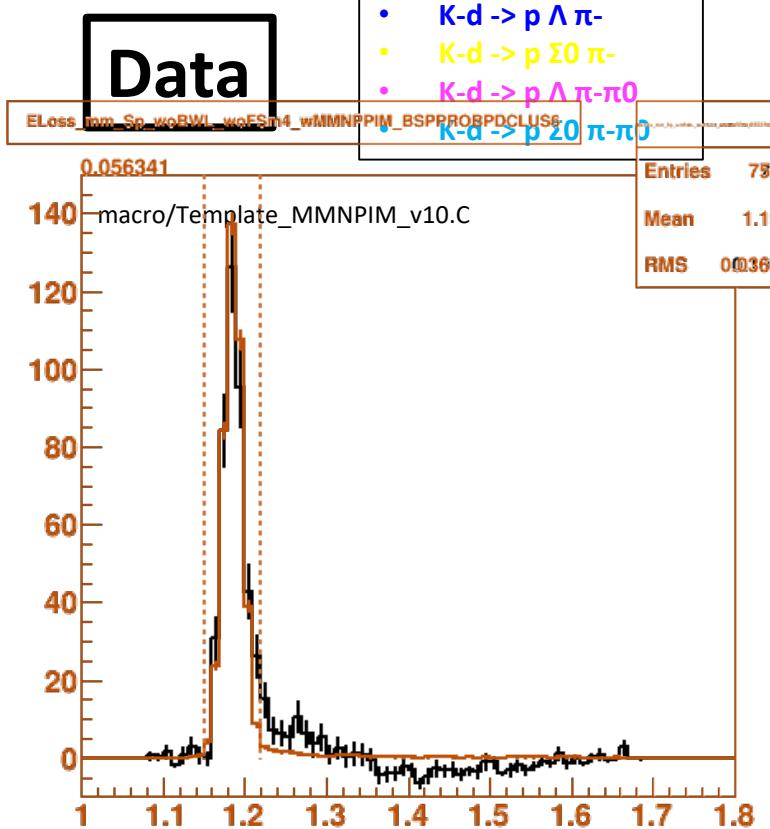


- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K-, n\pi\pi^-)$

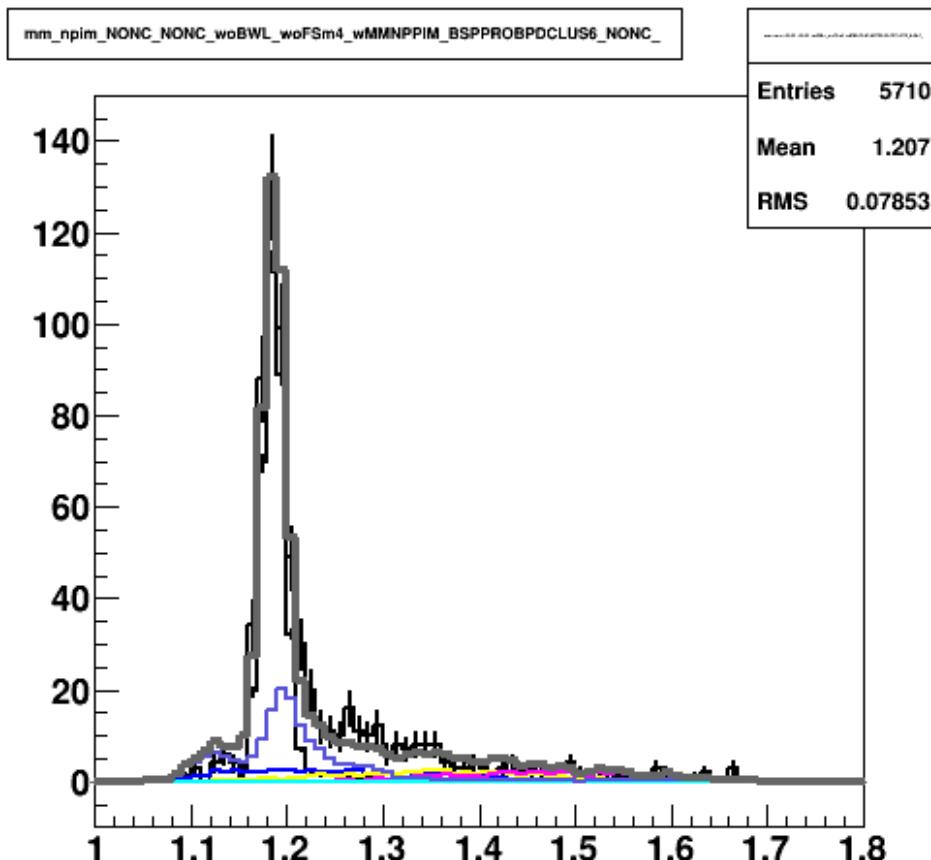
$K-d \rightarrow n \Sigma^+ \pi^-$  ;

Scaled by event # of  $d(K-,n\pi)^{\prime\prime}\Sigma^+$

before



# MM. $d(K^-, n\pi^-)$ w/ BG components



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

## † Data

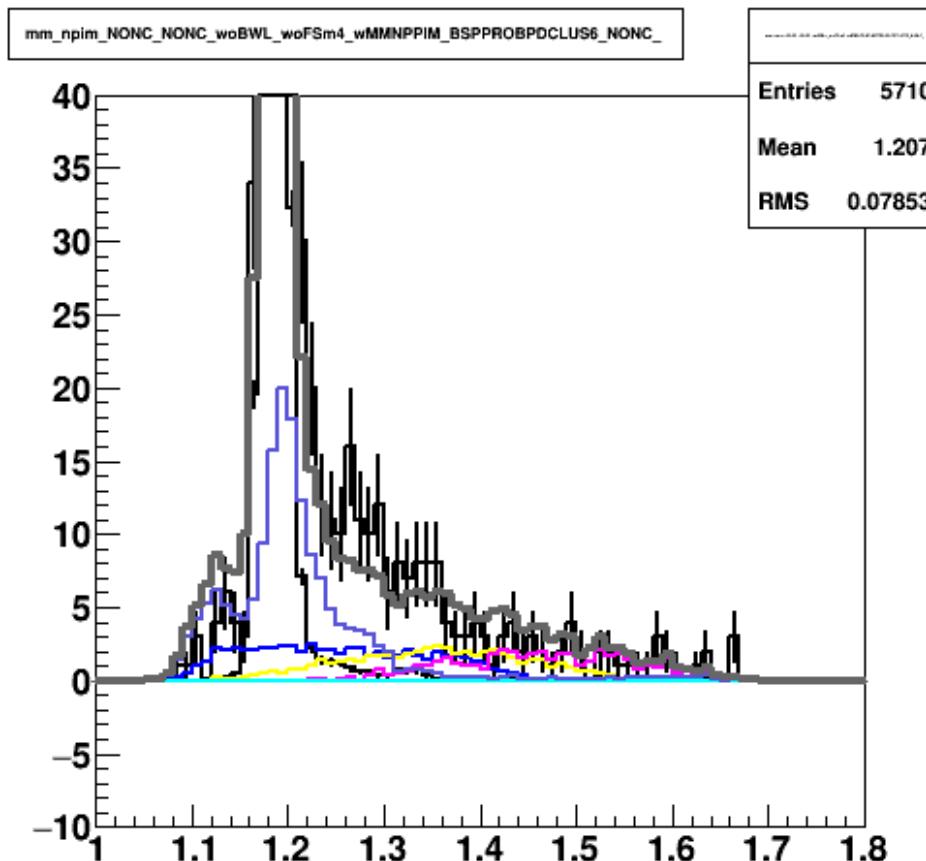
- $K-d \rightarrow n \Sigma^+ \pi^-$

## BG

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- 2 successive
- SUM

The tail of  $\Sigma^+$  seems to be explained by these BGs

# MM. $d(K^-, n\pi^-)$ w/ BG components



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\Lambda$  from IM. ( $p, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

## † Data

- $K-d \rightarrow n \Sigma^+ \pi^-$

## BG

- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- 2 successive
- SUM

The tail of  $\Sigma^+$  seems to be explained by these BGs

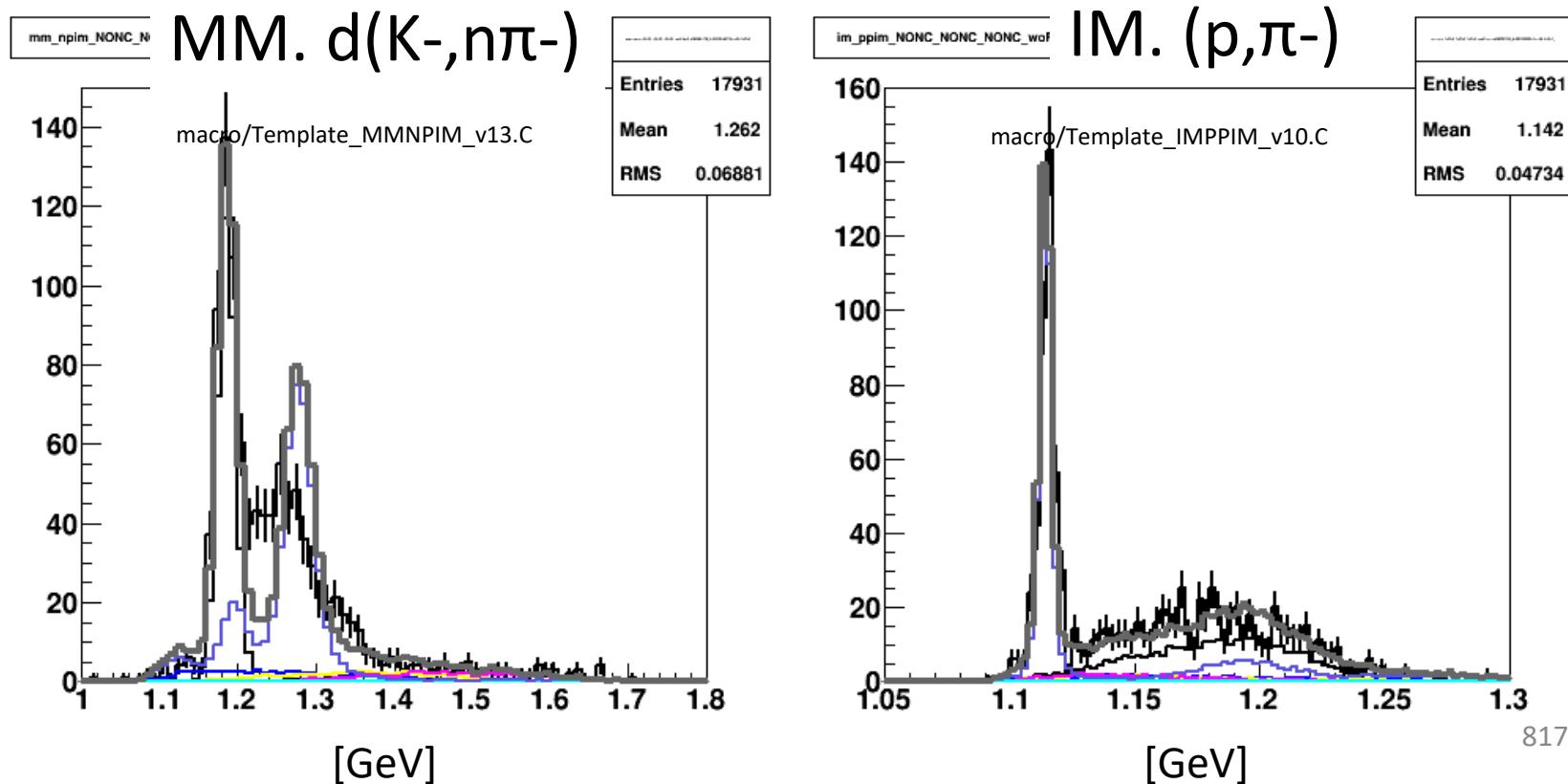
- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi\pi^-)$

# Fitting Results

† Data

- $K-d \rightarrow n \Sigma + \pi^-$

- $K-d \rightarrow n \Sigma^0 \pi^0$
- $K-d \rightarrow n \Lambda \pi^0$
- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$
- 2 successive



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi^-)$

# Result from P.766~768

before

- † Data
- $K-d \rightarrow n \Sigma + \pi^-$

- $K-d \rightarrow n \Sigma^0 \pi^0$
- $K-d \rightarrow n \Lambda \pi^0$

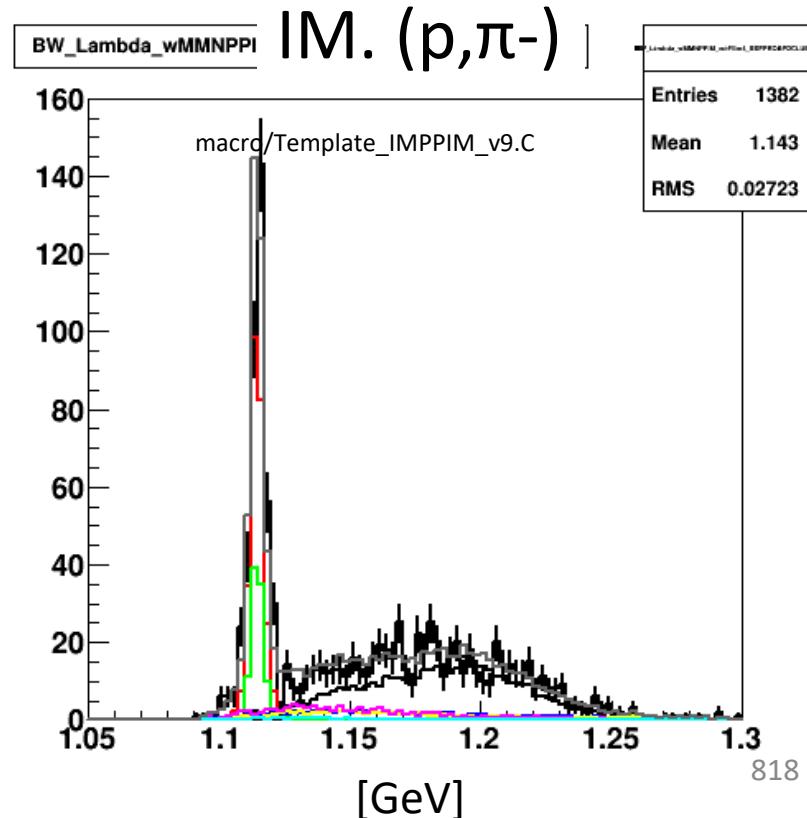
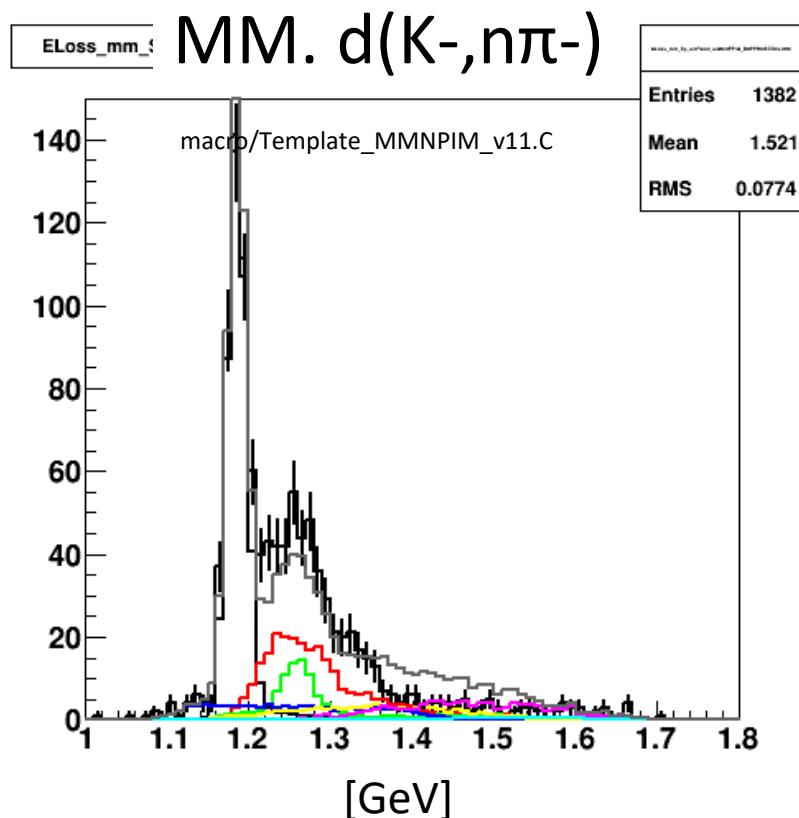
- $K-d \rightarrow p \Lambda \pi^-$
- $K-d \rightarrow p \Sigma^0 \pi^-$
- $K-d \rightarrow p \Lambda \pi^- \pi^0$
- $K-d \rightarrow p \Sigma^0 \pi^- \pi^0$

How to decide scaling

$\rightarrow$ P.768

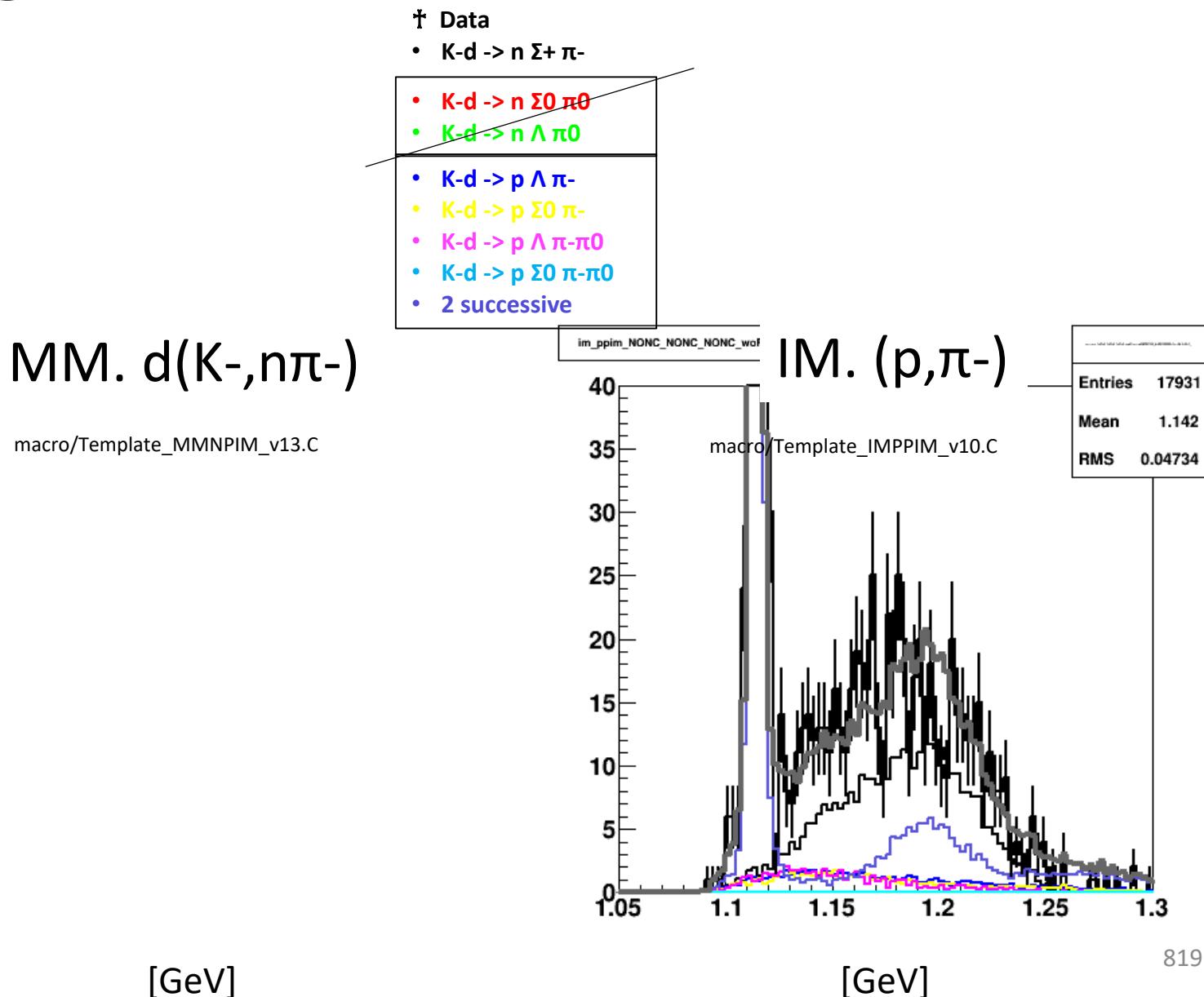
$\rightarrow$ P.767

$\rightarrow$ P.766



# Fitting Results

- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $0 < d(K^-, n\pi\pi^-)$



- $\Sigma^-$  from IM. ( $n, \pi^-$ ) is rejected
- $\pi^0 \gamma$ ;  $0.18 < d(K^-, n p \pi^-) < 0.30$

# MM. $d(K^-, n)$ of $\Lambda$ Side-band IM.( $p, \pi^-$ )

