

$d(K^-, n)'' \pi^\mp \Sigma^\pm''$ Analysis

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June 19, 2019

Contents — Revised Cross Section

- $d(K^-, n)''\pi^\mp\Sigma^\pm$ Cross Section — Condition Optimization
Revised target density by Kawasaki-kun.
 $0.1613[g/cm^3]$ run $\leqq 133$ 、 $0.1617[g/cm^3]$ run $\geqq 134$
 - NC resolution in MC
 - and $d(K^-, n\pi^+\pi^-)''n''$ window setting.
- $d(K^-, n)''K^0n''$ Cross Section
 - Acceptance Correction $\sim K^0 \cos\theta$ and mom.

$$\frac{d^2\sigma}{d\Omega dM_{d(K^-, n)}} = F \sum M(\cos\theta, p) \times \frac{1}{A(\cos\theta, p)}$$

This correction was adopted event-by-event.

- To check $d(K^-, nK^0)''n''$ momentum.

$d(K^-, n)'' \pi^\mp \Sigma^\pm$ Analysis

$K^- d \rightarrow n\pi^+\pi^- n$ event fitting

- ① $K^- d \rightarrow K^0 n n_{detected}$
- ② $K^- d \rightarrow n \pi^\mp \Sigma_{forward}^\pm \Sigma_{forward}^\pm \rightarrow \pi^\pm n_{detected}$
- ③ $K^- d \rightarrow \pi^\mp \Sigma^\pm n_{detected}$

Each fittings was performed by data and template distribution reproduced by MC sim.[1]
1. and 2. reactions was simulated using previous experimental angular distribution [2]
These strength were estimated by fitting of invariant masses, $\pi^+\pi^-(K^0)$, $n\pi^+(\Sigma^-)$, $n\pi^+(\Sigma^+)$

$K^- d \rightarrow \pi^\pm \Sigma^\pm n_{detected}$ were separated by fitting of $d(K^-, n\pi^\mp) \Sigma^\pm$ dist., which was performed bin-by-bin of $d(K^-, n) X$.

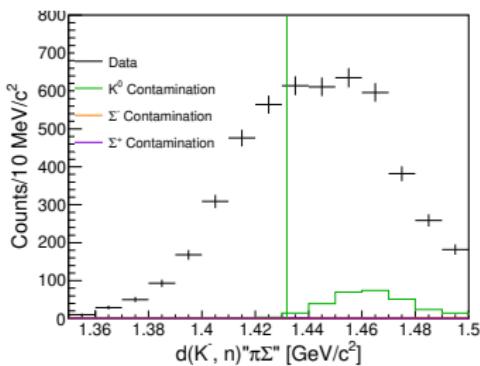
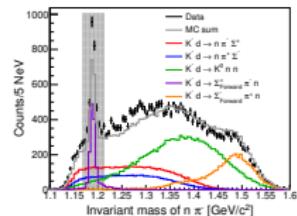
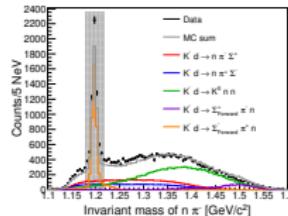
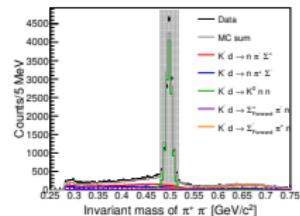
These fittings were performed iteration due to differenet event sample.
In each fitting, the strength which was dicided by another fitting was fixed.

 R. Barlow and C. Beeston, Comp. Phys. Comm. 77 (1993) 219-228

 Nucl. Phys. B90, 349

$K^- d \rightarrow n\pi^+\pi^- n''$ IM fit for K^0 and $\Sigma_{forwrad}$ prod.

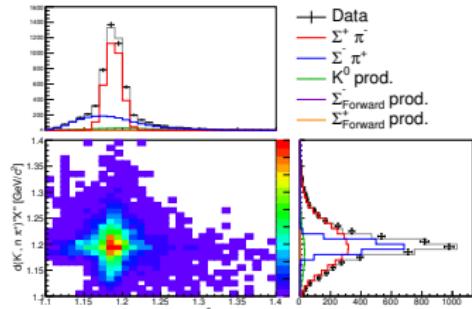
- $K^- d \rightarrow K^0 n'' n_{detected}$
- $K^- d \rightarrow n'' \pi^\pm \Sigma_{forward}^\pm \Sigma_{forward}^\pm \rightarrow \pi^\pm n_{detected}$
- $K^- d \rightarrow \pi^\mp n'' \Sigma^\pm n_{detected}$



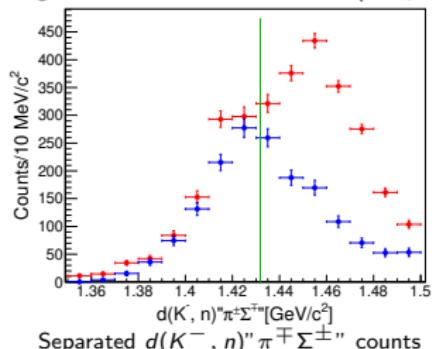
Left figure shows events rejecting K^0 and $\Sigma_{forwrad}$ prod.
 Gray hatched region indicates rejection region.
 Each contamination was estimated by MC sim
 represented at up figures.

In this spectrum, each $\pi^\mp \Sigma^\pm$ mode are included,
 which are separated by $d(K^-, n\pi^\mp)''\Sigma^\pm$ fitting.

Separation of $d(K^-, n)'' \pi^\mp \Sigma^\pm$

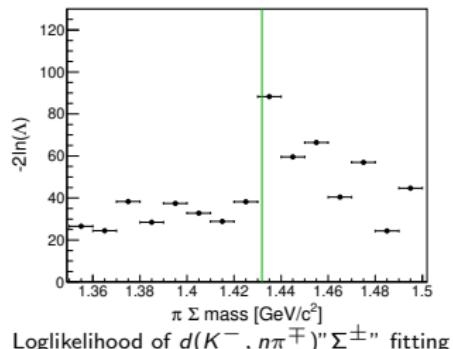


The figure shows summed all bin of $d(K^-, n)'' X''$.

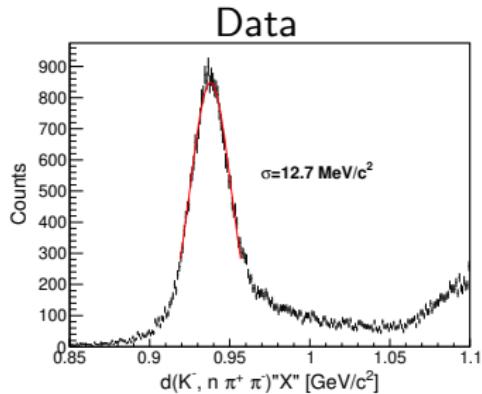


- $d(K^-, n)'' \pi^- \Sigma^{+''}$
In $d(K^-, n\pi^-)'' X''$, Σ^+ peak is seen like up figure
In $d(K^-, n\pi^+)'' X''$, widely distribution like side figure
- $d(K^-, n)'' \pi^+ \Sigma^{-''}$
Opposite charge of $d(K^-, n)'' \pi^- \Sigma^{+''}$.

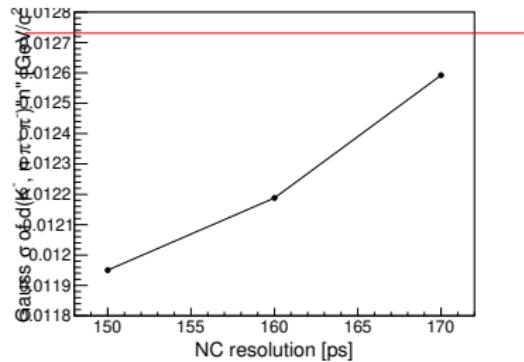
bin-by-bin result in p.20,21



NC resolution in MC sim



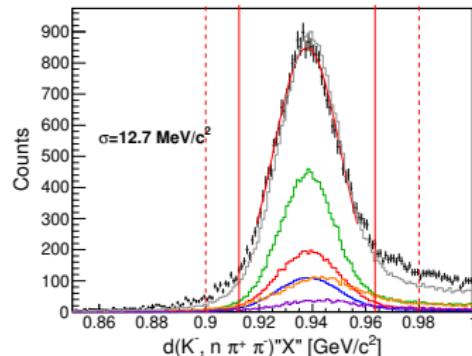
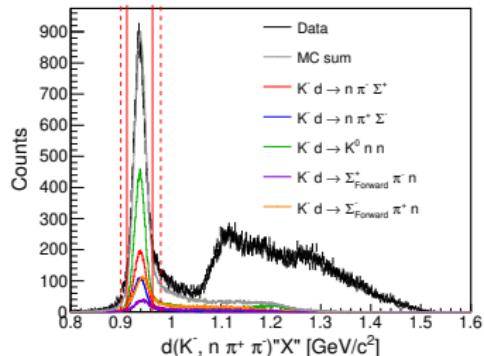
$d(K^-, n\pi^+\pi^-)'' n''$ peak $\sigma \sim 12.7 \text{ [GeV}/c^2]$



Relation of NC resolution and σ of
 $d(K^-, n\pi^+\pi^-)'' n''$

NC resolution use 170ps.

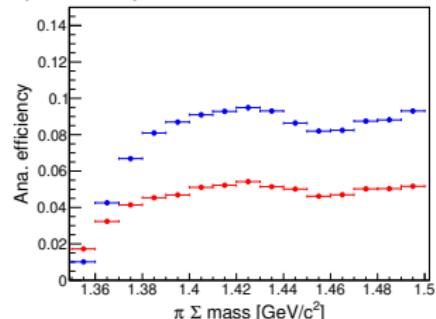
$d(K^-, n\pi^+\pi^-)"n"$ window selection



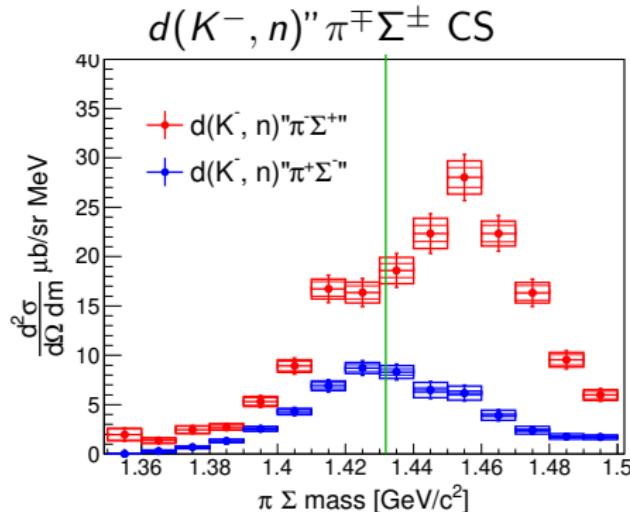
Right figure shows zoom up around "n" region.
Dotted line indicate before selection, solid line indicate 2σ selection.
I chose 2σ selection to avoid tail components.

Cross Section of $d(K^-, n)\pi^\mp\Sigma^\pm$

$d(K^-, n)''\pi^\mp\Sigma^\pm$ Acceptance



Same procedure for data analysis was adopted.
This include analysis efficiency

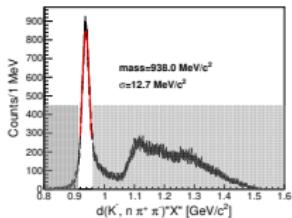


Inner box indicates statistical error,
Outer box includes fitting error,
Error bar was added $F_{counte} \rightarrow CS$ error.
Each error was calculated by squared average.

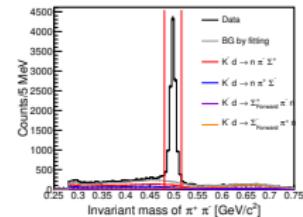
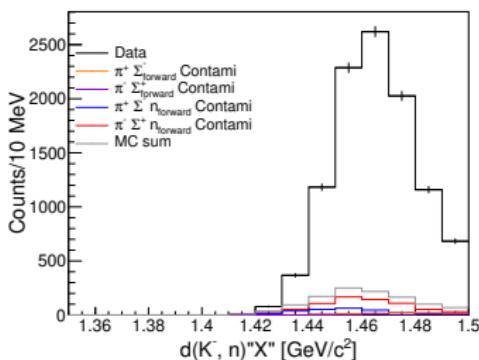
Luminosity includes revised target density by Kawasaki-kun

$d(K^-, nK^0)'' n''$ Analysis

$d(K^-, nK^0)'' n''$ event



Event Sample : $d(K^-, n\pi^+\pi^-)'' n''$

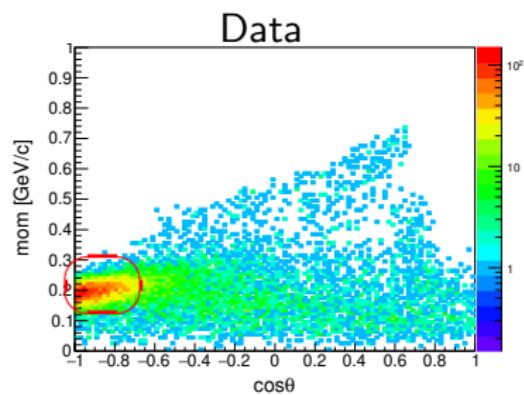
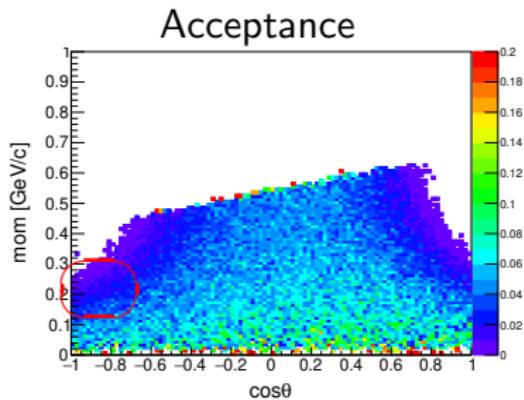


K^0 selection.

Color plots indicates background events,
7 which were estimated by template fittings.

Left figure shows $d(K^-, nK^0)'' n''$ events spectrum.
Color plots indicate background reaction.

$K^0 \cos \theta_{K_0}$ vs mom_{K_0}

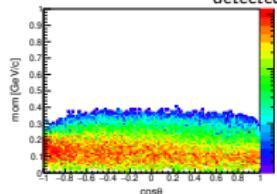


Data events concentrate around red frame($\cos\theta \sim -1, p = 0.2 GeV/c$).
In this region, acceptance is smaller than central region of $\cos\theta$.

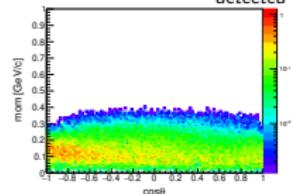
$K^0 \cos\theta_{K_0}$ vs mom_{K_0} (Background)

Each background dist.

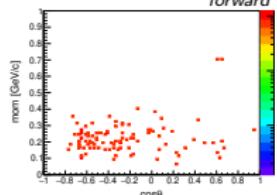
$K^- d \rightarrow \pi^- \Sigma^+ n_{\text{detected}}$



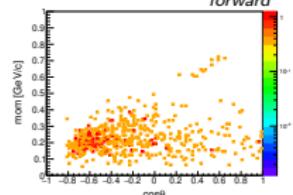
$K^- d \rightarrow \pi^+ \Sigma^- n_{\text{detected}}$



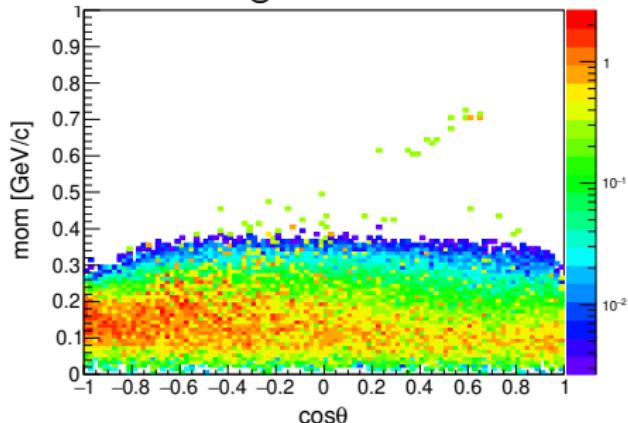
$K^- d \rightarrow n^- \pi^+ \Sigma^+_{\text{forward}}$



$K^- d \rightarrow n^- \pi^+ \Sigma^-_{\text{forward}}$



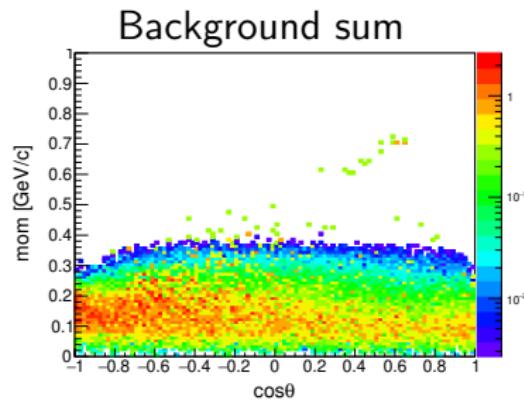
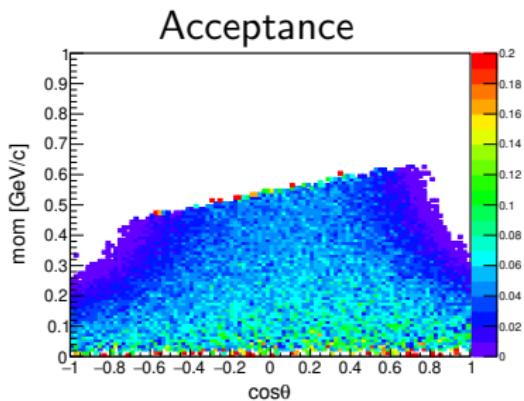
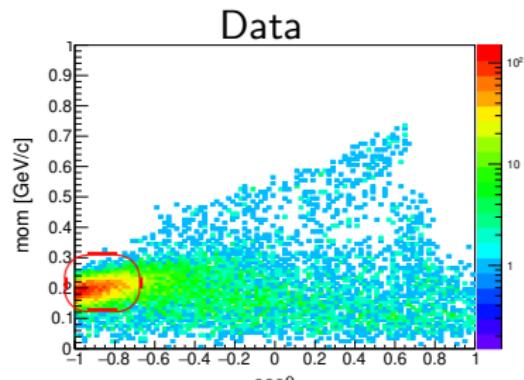
Background sum



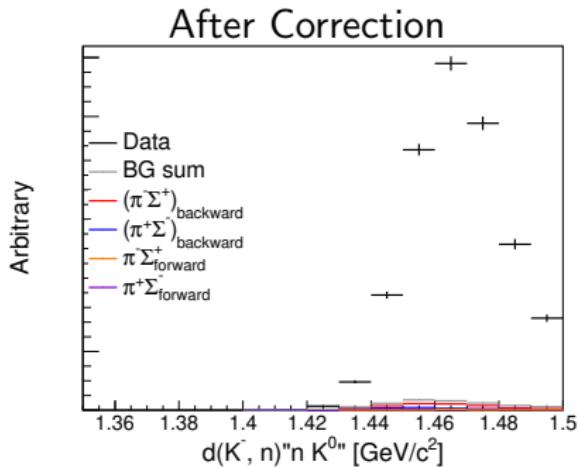
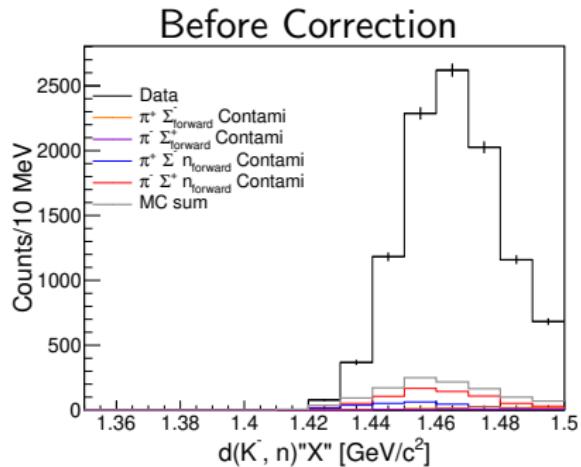
Background spreads more wider region than data.

$K^0 \cos\theta_{K_0}$ vs mom_{K_0}

Data concentrates in red frame region.
Background spreads whole region.

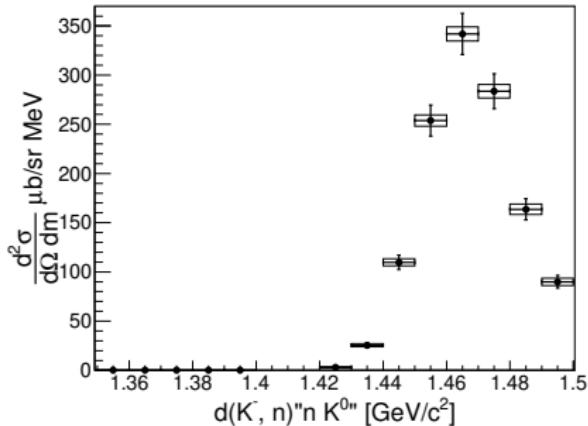


$d(K^-, n)'' K^0 n''$ Spectrum — Acceptance Corrected



Data concentrates region has small acceptance.
Acceptance correction enhance $d(K^-, n)'' K^0 n''$.

Cross Section of $d(K^-, n)'' n K^0''$



Conversion factor shows down tables.

Statistical error indicate Box.

Each errors are evaluated by squared average.

Item	value	error	ratio
Luminosity	5.162×10^3	0.014×10^3	2.6%
NC(System) eff	0.291	0.016	5.0%
CDC eff	0.977	0.004	0.41%
sum			5.65%

Summary and to do

- I adopt revised target thickness by Kawasaki-kun.
- I optimize NC resolution and $d(K^-, n\pi^+\pi^-)"n"$ window
→ NC resolution $\sigma = 150ps \rightarrow \sigma = 170ps$ to reproduce missing "n" peak.
→ I adopt 2σ selection of missing "n" window.
- I evaluate background $d(K^-, nK^0)"n"$ events.
- I revised $d(K^-, n)"\pi^\mp\Sigma^\pm"$ and $d(K^-, n)"K^0n"$ cross section.

Back Up

Scaling Factor

Item	value	error	ratio
Luminosity	5.162×10^3	0.014×10^3	2.6%
NC(System) eff	0.291	0.016	5.0%
CDC eff	0.977	0.004	0.41%
sum			5.65%

Revised target thickness by Kawasaki-kun.

$0.1613[g/cm^3]$ run ≤ 133 、 $0.1617[g/cm^3]$ run ≥ 134

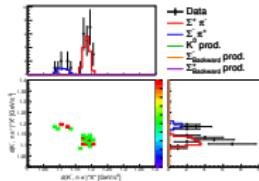
Luminosity was estimated run-by-run, and summed up.

NC efficiency

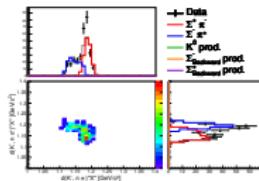
	item	error	Remarks
Intrinsic NC	0.317	0.016	Using H_2 target data of $K^- d \rightarrow K^0 n$ reaction
Overkill _{CVC \cup BVC}	0.081	0.007	Estimation using production data
NC efficiency	0.291	0.16	error was calculated by squared average

$d(K^-, n\pi^\mp)'' \Sigma^\pm$ フィッティング
 $(K^-, n)'' X'': 1.35 \sim 1.44 [\text{GeV}/c^2]$

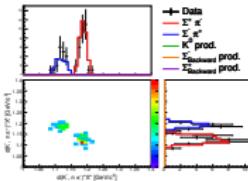
$$d(K^-, n)'' X'': 1.35 \sim 1.36 [GeV/c^2]$$



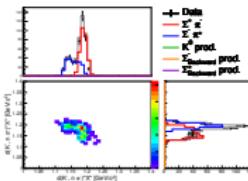
$$d(K^-, n)'' X'': 1.39 \sim 1.40 [GeV/c^2]$$



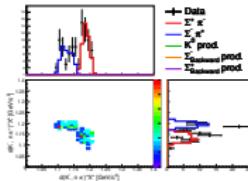
$$d(K^-, n)''X'': 1.36 \sim 1.37 [GeV/c^2]$$



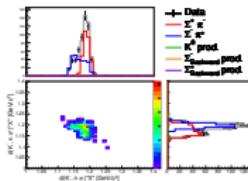
$$d(K^-, n)''X'': 1.40 \sim 1.41 [GeV/c^2]$$



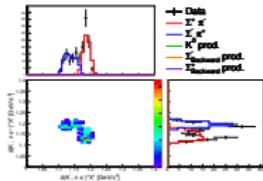
$$d(K^-, n)''X'' : 1.37 \sim 1.38 [GeV/c^2]$$



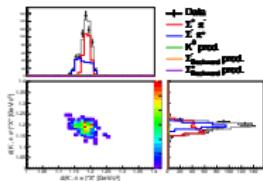
$$d(K^-, n)''X'' : 1.42 \sim 1.43 [GeV/c^2]$$



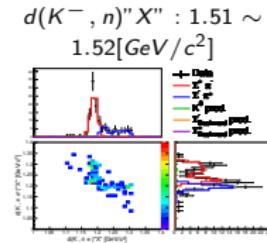
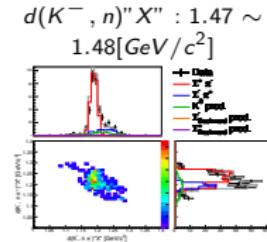
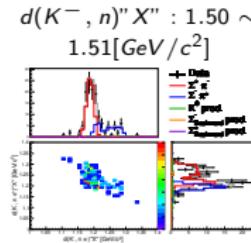
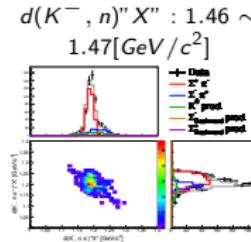
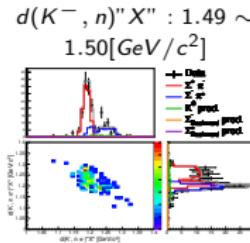
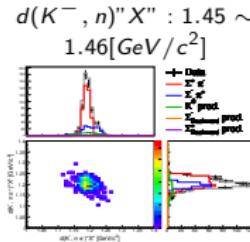
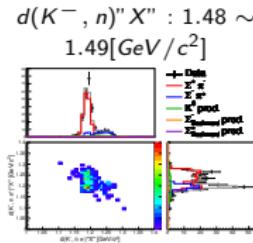
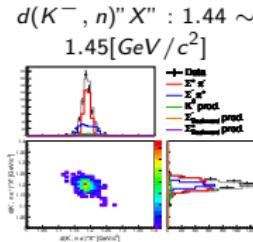
$$d(K^-, n)''X'': 1.38 \\ 1.39 [GeV/c^2]$$



$$d(K^-, n)''X'': 1.43 \sim 1.44 [GeV/c^2]$$



$d(K^-, n\pi^\mp)\Sigma^\pm$ フィッティング $(K^-, n)X'$: $1.44 \sim 1.52 [GeV/c^2]$



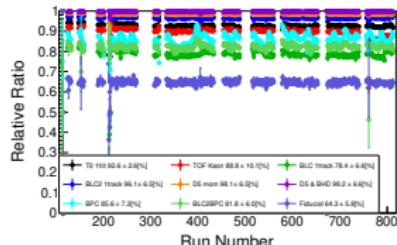
ビームライン解析リスト

p.24~p.28

- ① T0 1 ヒット
- ② BHD-T0 TOF が Kaon
- ③ BLC1 1 トラック
- ④ BLC2 1 トラック
- ⑤ ビーム運動量解析
- ⑥ ビーム運動量と BHD セグメントの適合
- ⑦ BPC 1 トラック
- ⑧ BLC2 と BPC の接続
- ⑨ ビームが標的に当たっているか

照射された Kaon の数

相対比率

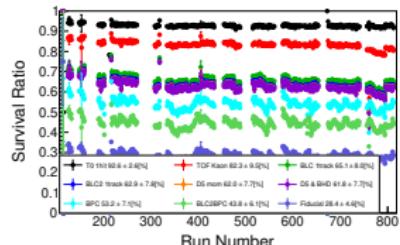


前の条件に対する有効なイベントの比率

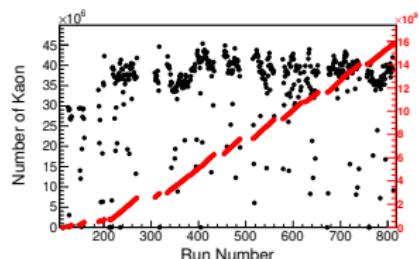
照射された Kaon の数はスケーラーの値を
Kaon ビームとして解析できた比率で計算す
る

p.22 参照

生き残り率

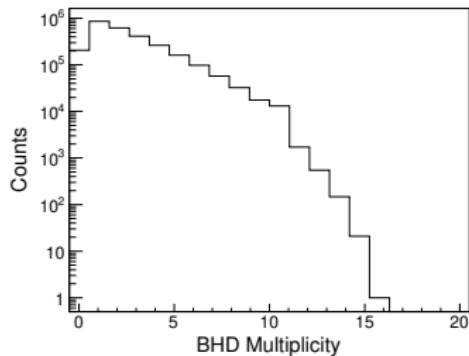
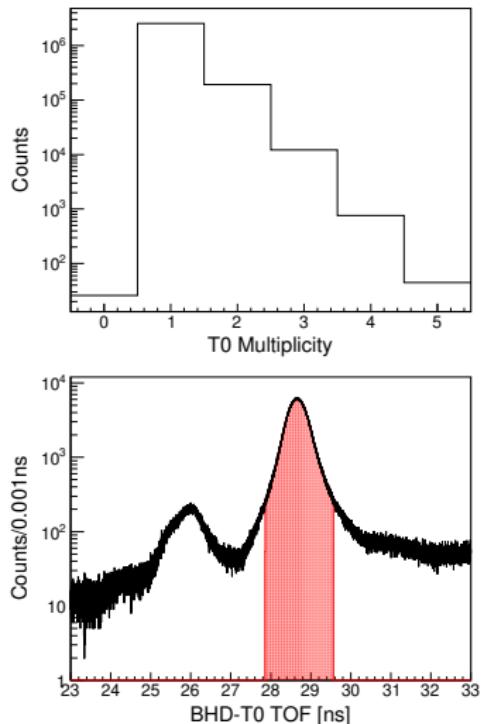


最初の条件に対する有効なイベントの比率
照射された Kaon の数



黒は各ランの照射された数
赤は照射された数の総和

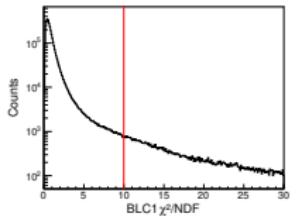
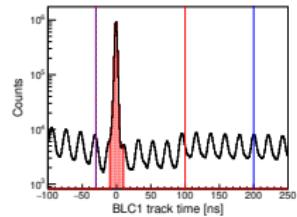
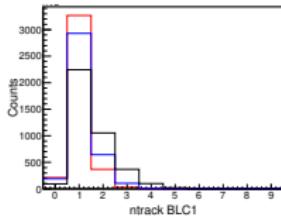
BHD-T0 解析



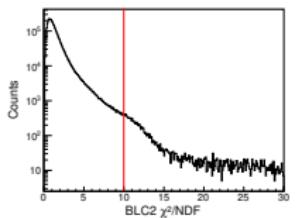
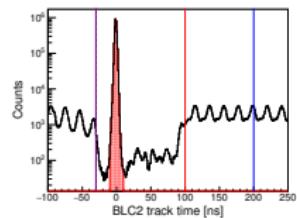
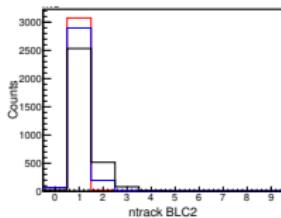
- T0 が 1 ヒットのイベントを選ぶ
BHD の 1hit はイベントを減らしすぎる
ので要求しない
- BHD-T0 TOF は 3σ で要求 (赤領域)。

BLC1/2 解析

BLC1



BLC2



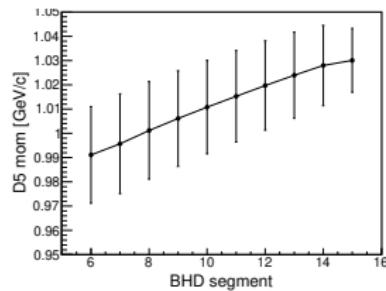
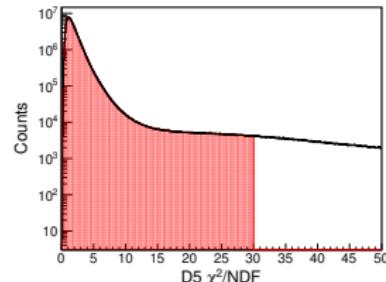
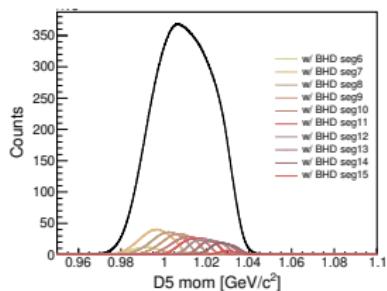
トラックの数、黒線はすべて
青は $-50 \sim 200$ ns の時間窓
赤は $-50 \sim 100$ ns の時間窓

トラックの通過した時間
0 にビームに同期したピークが見える
 $-50 \sim 100$ ns に 1 トラック
それがビームに同期している（赤領域）
であることを要求する

χ^2/NDF 分布、
10 以下（赤線）であるものを
ビームとみなす。

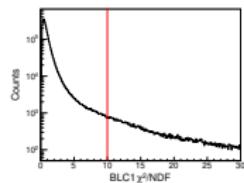
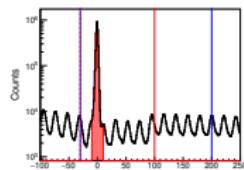
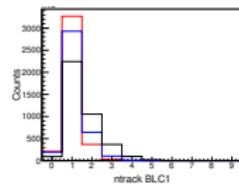
ビーム運動解析—BLC1-D5-BLC2

ビームの運動量解析は BLC1/2 に挟まれた D5 マグネットの輸送行列で BLC1 と BLC2 のトラックをつなぐことで行う。
繋がれたトラックの $\chi^2/NDF < 30$ (赤線) をビームとみなす。
BHD のヒットセグメントと 3σ 以内の相関があることを要求する。

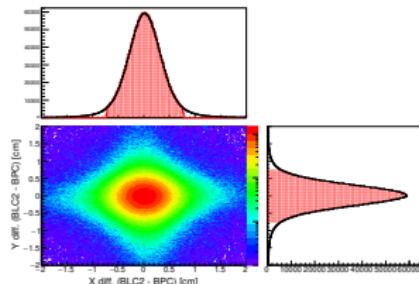


左図は解析されたビームの運動量、色線は BHD が 1 ヒットのイベントでの BHD のヒットセグメントと運動量の関係
右図は、各 BHD セグメントとビーム運動量の中心地とビームとして受け入れる領域 3σ を示している

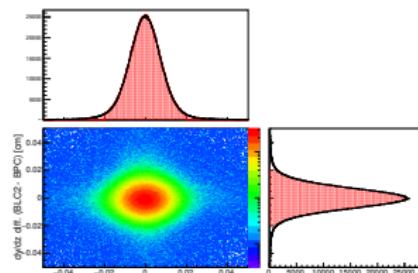
BPC 解析



BPC 単体の解析とビーム選別は p.25 の BLC と同様



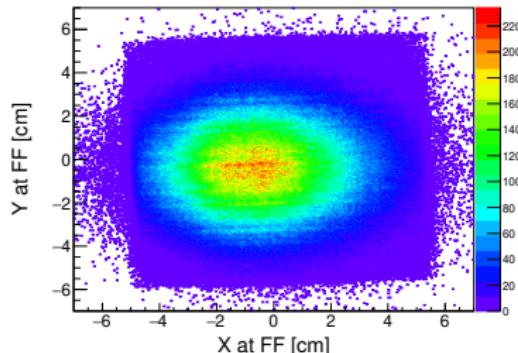
BLC2 と BPC の位置の違い、
BLC2 と BPC の中心点に外装して評価してある



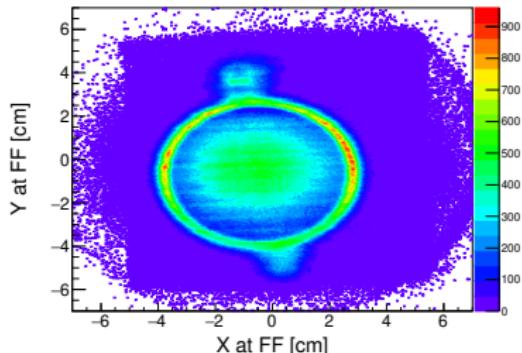
BLC2 と BPC のトラックの向きの違い

BLC2 と BPC の接続は位置、向きとも 3σ の範囲内（赤領域）で接続できることを要求する。

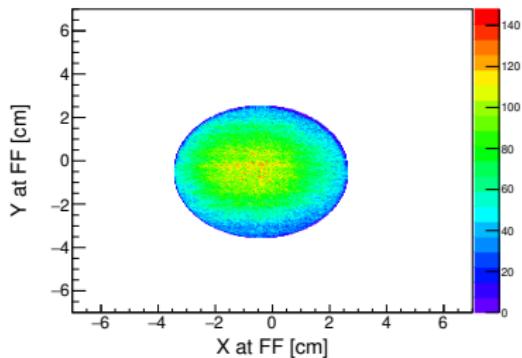
ターゲット中心でのビームプロファイル



バイアスのない Kaon トリガーでのプロファイル



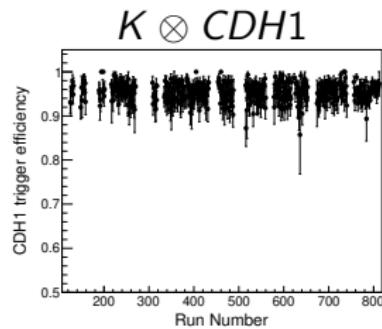
CDH2 ヒットのトリガー、反応を要求、でのプロファイル



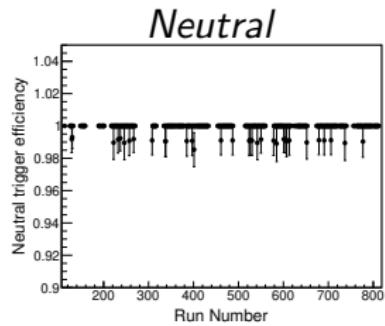
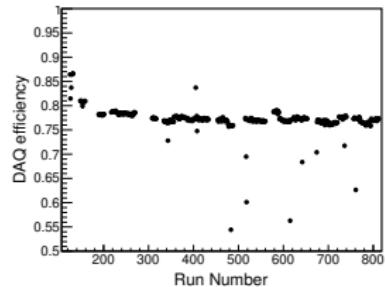
右図の領域を液体 D_2 標的に当たった Kaon ビームとして Kaon トリガー中の実際の Kaon であるイベントの割合を評価する。

トリガー & DAQ 効率

Eff_{DAQ} , Eff_{Ntrig} はラン毎に評価
 Eff_{trig} は $Eff_{K \otimes CDH1} \times Eff_{Neutral}$ で評価

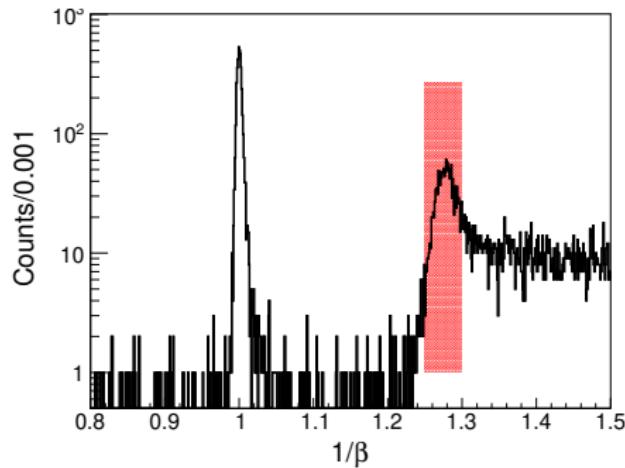


バイアスのない Kaon トリガーを母数にする



バイアスのない $K \otimes CDH1$ トリガーを母数にする

CVC/BVC による NC 検出器群のオーバーキル

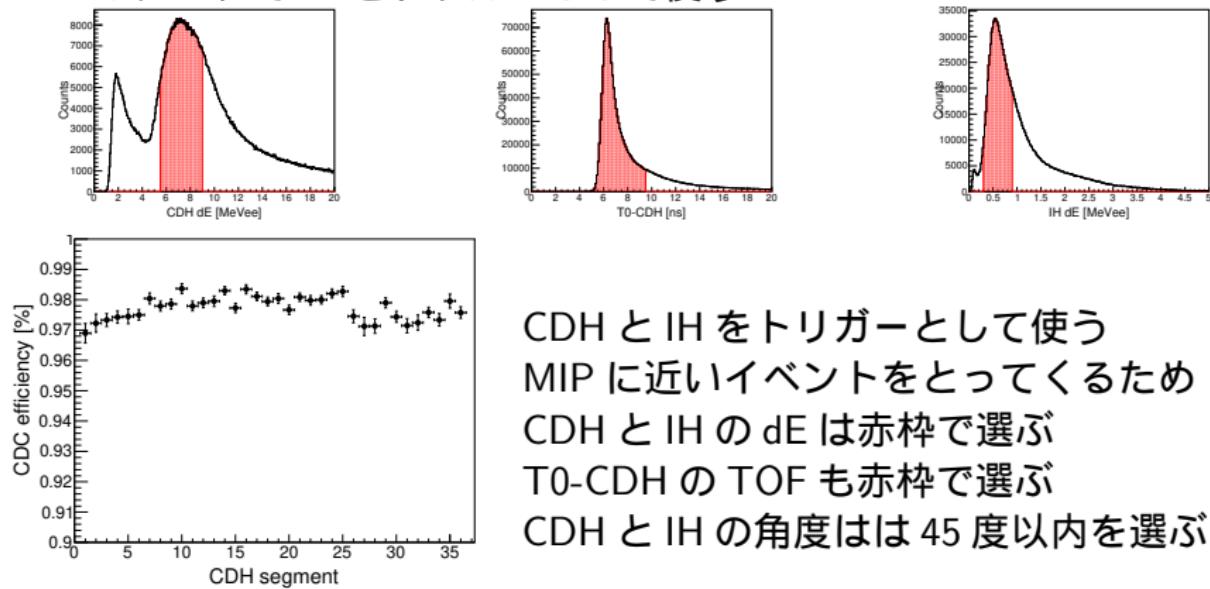


Neutral トリガー以外で取得されたイベントを使い、NC レイヤー 1 を荷電粒子のベトカウンターに使う。
NC レイヤー 2 ~ 7 で $1/\beta$ を測定し (右図)、赤領域を純弾性散乱イベントとして母数イベントとする。

$$(\text{CVC または BVC がなったイベント}) / (\text{全母数イベント}) = 8.1 \pm 0.7\%$$

CDC 検出効率

Run78 でが IH がアンインストールされている
Run68 のデータで IH をトリガーとして使う



トリガーになった CDH ごとの CDC 検出効率