

# **CaFe: SHMS Hodoscope HV Study**

## **“Identifying Issue in Data”**

C. Yero

Aug 23, 2022

The following slides ONLY cover issues observed with the data.

For motivation of the SHMS Hodo HV study, please refer to:

[https://hallcweb.jlab.org/wiki/images/9/93/SHMS\\_PaddleOFF\\_for\\_CaFeStudy.pdf](https://hallcweb.jlab.org/wiki/images/9/93/SHMS_PaddleOFF_for_CaFeStudy.pdf)

[https://hallcweb.jlab.org/wiki/images/5/5b/SHMS\\_PaddleOFF\\_for\\_CaFeStudy\\_part2.pdf](https://hallcweb.jlab.org/wiki/images/5/5b/SHMS_PaddleOFF_for_CaFeStudy_part2.pdf)

[https://hallcweb.jlab.org/wiki/images/a/a7/SHMS\\_PaddleOFF\\_for\\_CaFeStudy\\_part3.pdf](https://hallcweb.jlab.org/wiki/images/a/a7/SHMS_PaddleOFF_for_CaFeStudy_part3.pdf)

# Identify Potential Issue in Data

*During CaFe Optics/Elastics run (Aug 08, 2022), an incident happened during our last run 16037, which is investigated in the slides that follow*

## HC-Log Entry (Aug 08 Swing) : <https://logbooks.jlab.org/entry/4025938>

Run 16037 -- CaFe Heep SHMS Hodo HV Test, Turned off S1X[1-6] S2X[1-6], 25uA. <https://logbooks.jlab.org/entry/4026086>

During this run, GH starts setting up the HMS for the next momentum, as per Jacob's instructions. PS4=-1.

21:00 -- Shortly after the beginning of this run, MCC calls to ask what we changed. It seems that changing the HMS caused the beam spot to move on the dump.

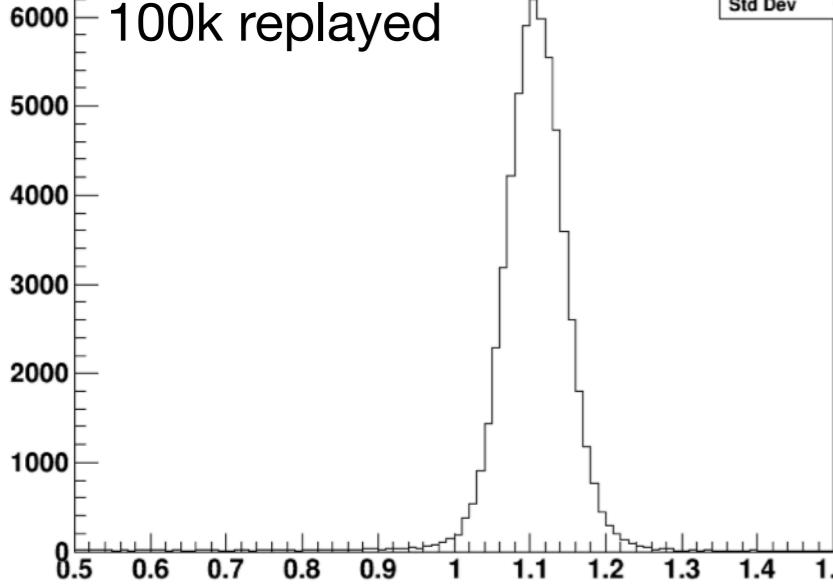
A bit surprising, since the angle is 12.50deg. The HMS fringe field at this momentum must be huge!

Almost immediately after, HMS Q3 trips. <https://logbooks.jlab.org/entry/4026088>

P.cal.etottracknorm

h100k		
Entries	100000	
Mean	1.103	
Std Dev	0.06359	

100k replayed

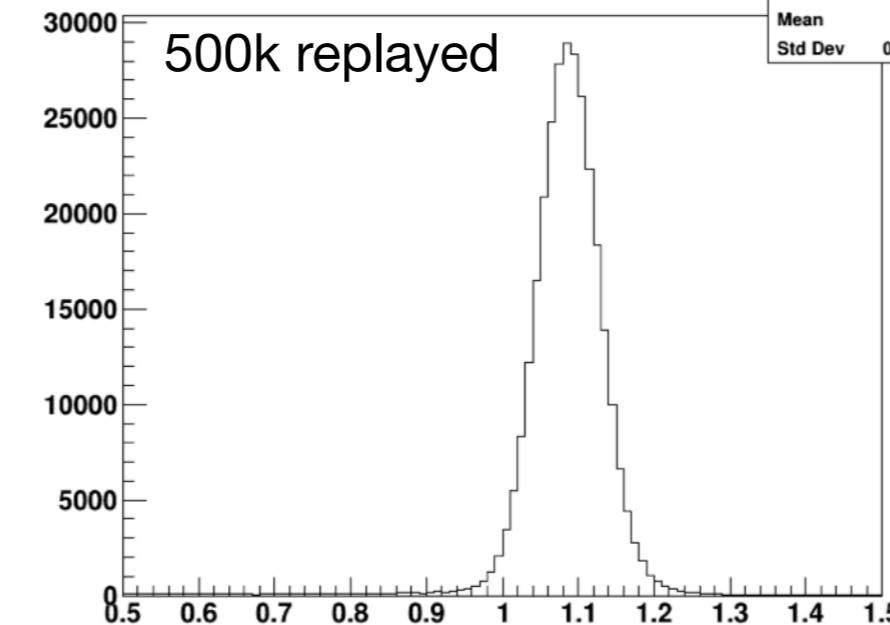


Run 16037 | SHMS Hodo S1X[1-6], S2X[1-6] HV OFF

P.cal.etottracknorm

h500k		
Entries	500000	
Mean	1.083	
Std Dev	0.06407	

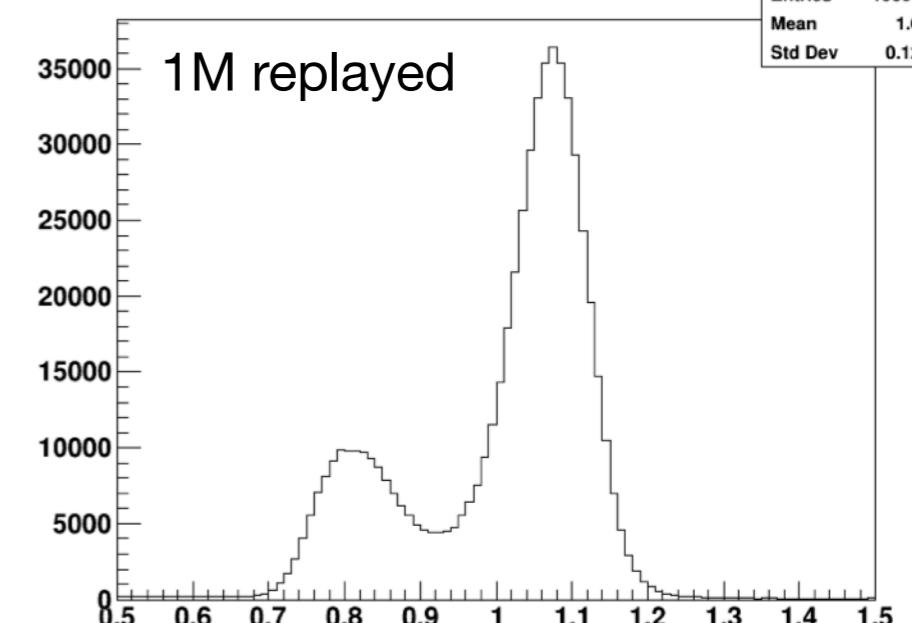
500k replayed



P.cal.etottracknorm

h1M		
Entries	1000000	
Mean	1.007	
Std Dev	0.1223	

1M replayed



\* somewhere between 500k and 1M, a weird bump starts to show up

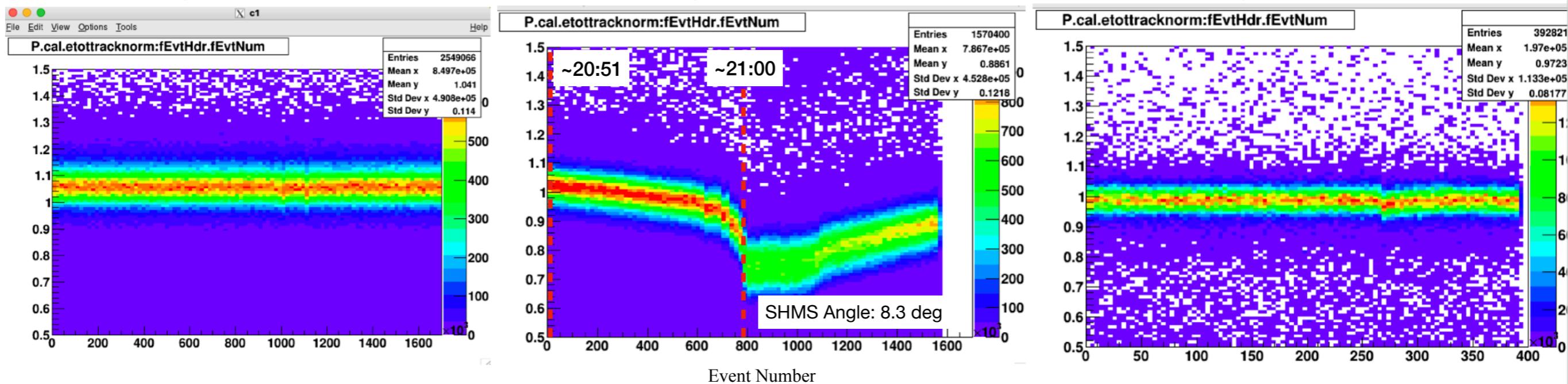
\* I tried calibrating calorimeter, but bump still show up

# SHMS Calorimeter Energy Deposited / Track Momentum vs. Event Number

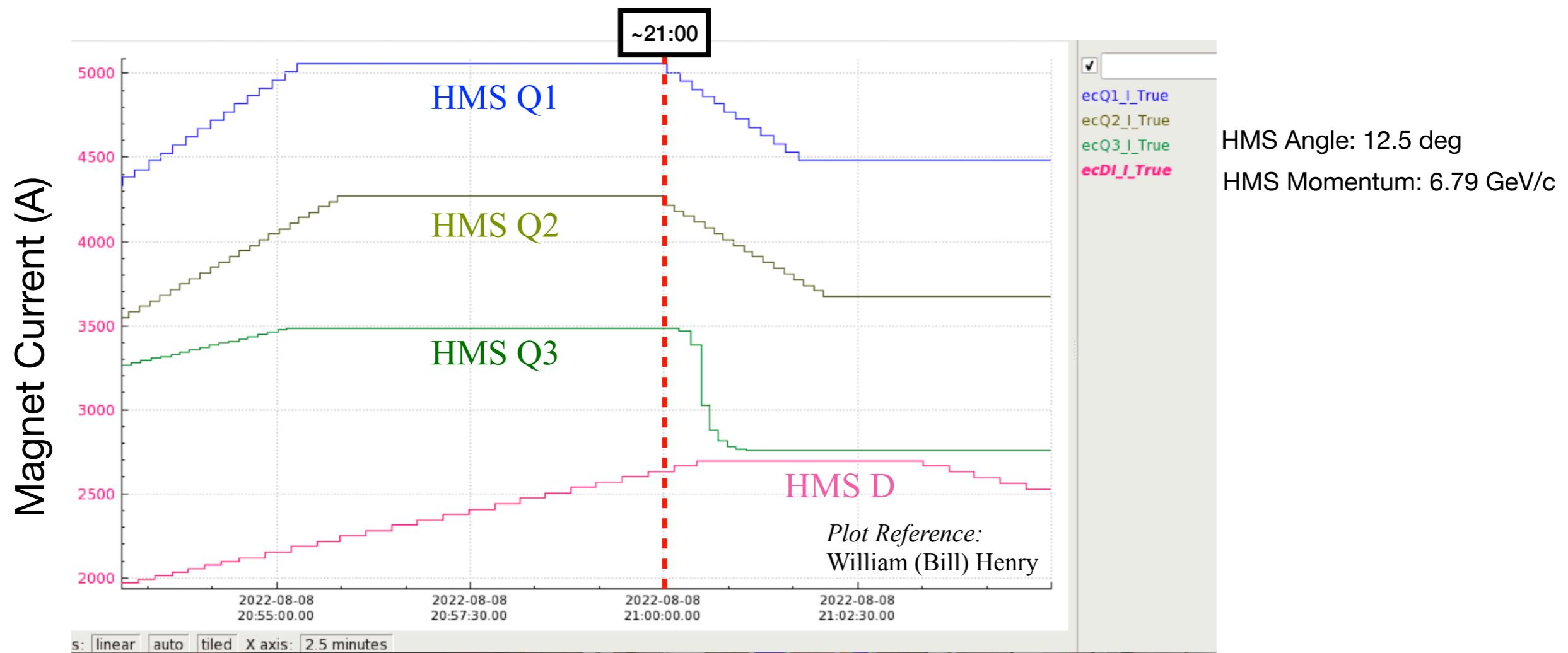
Run 16036 | time: 20:32 - 20:47

Run 16037 | time: 20:53 - 21:05

Run 16039 | time: 21:44 - 21:47



## HMS Magnets Current Ramp-Up

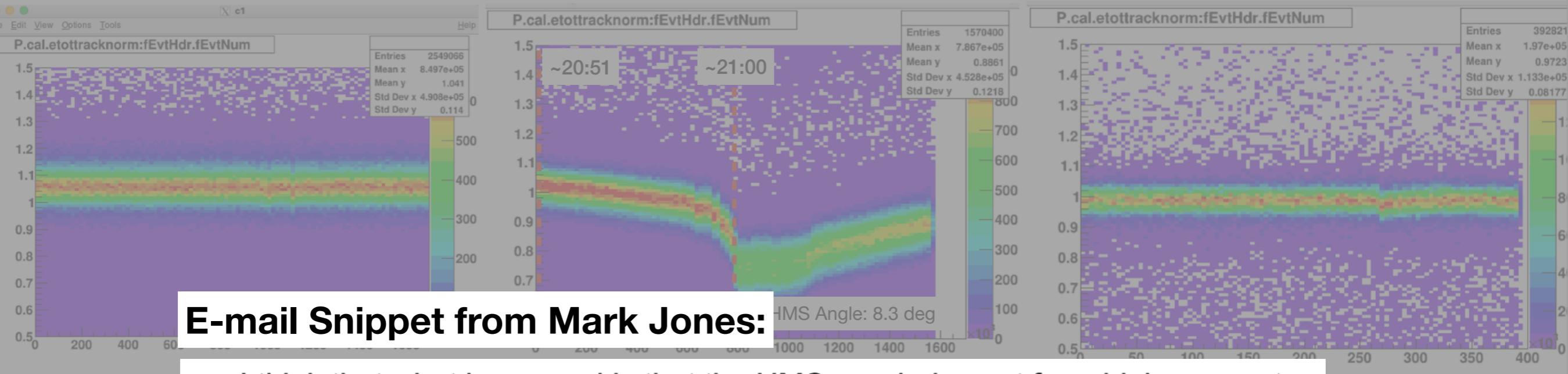


# SHMS Calorimeter Energy Deposited / Track Momentum vs. Event Number

Run 16036 | time: 20:32 - 20:47

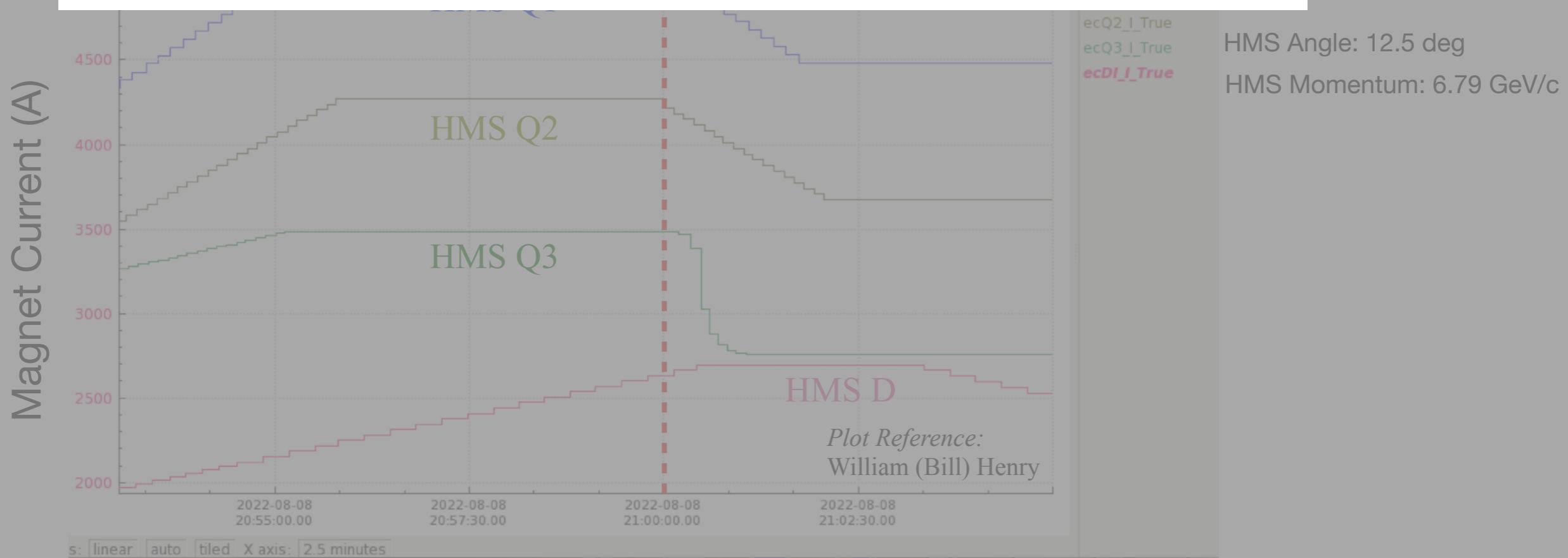
Run 16037 | time: 20:53 - 21:05

Run 16039 | time: 21:44 - 21:47



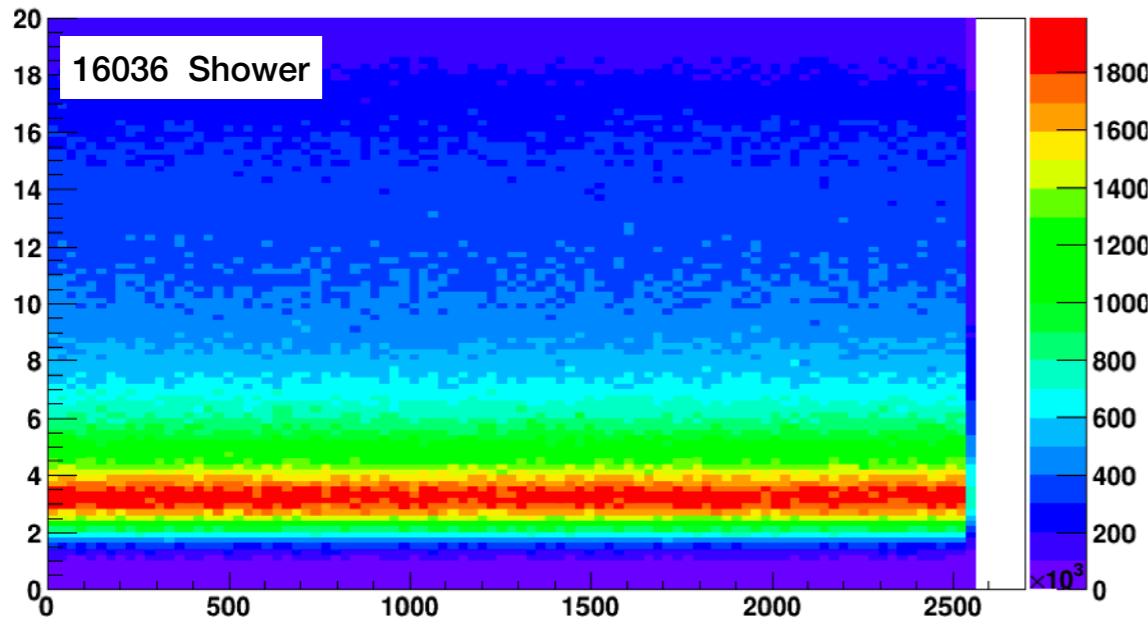
## E-mail Snippet from Mark Jones:

I think that what happened is that the HMS was being set for a high momentum while the SHMS was taking data and the field from the HMS was effecting the SHMS calorimeter PMTs. The SHMS calorimeter PMT stick out of the back of the SHMS hut. I would look at the HMS currents during this run.

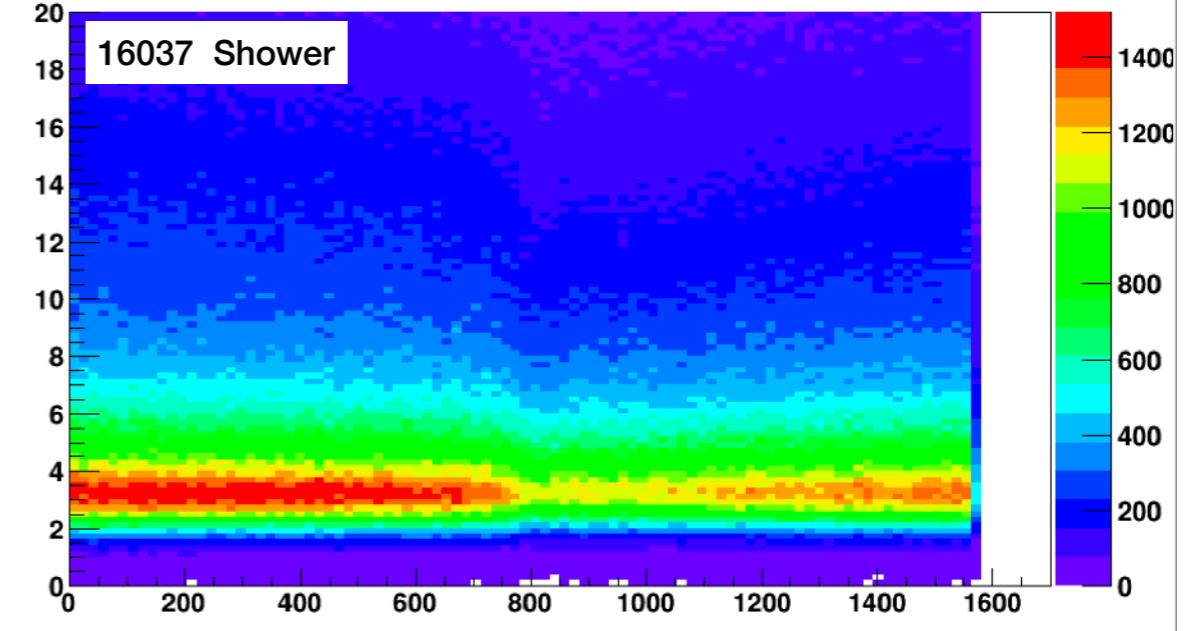


# Calorimeter fADC Pulse Integral vs. Event Number

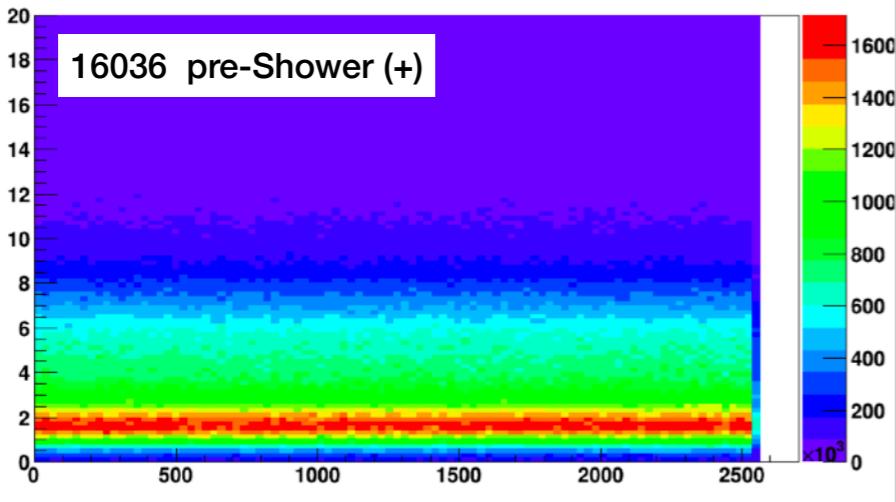
P.cal.fly.adcPulseInt:g.evnum



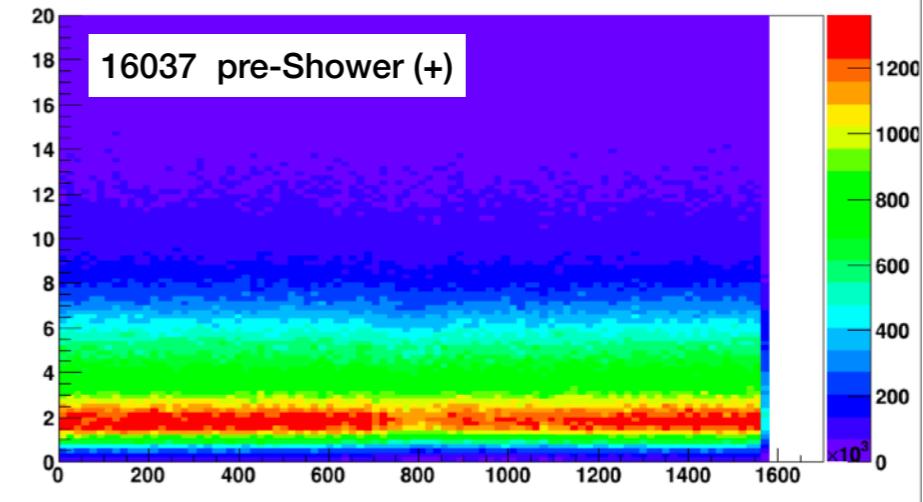
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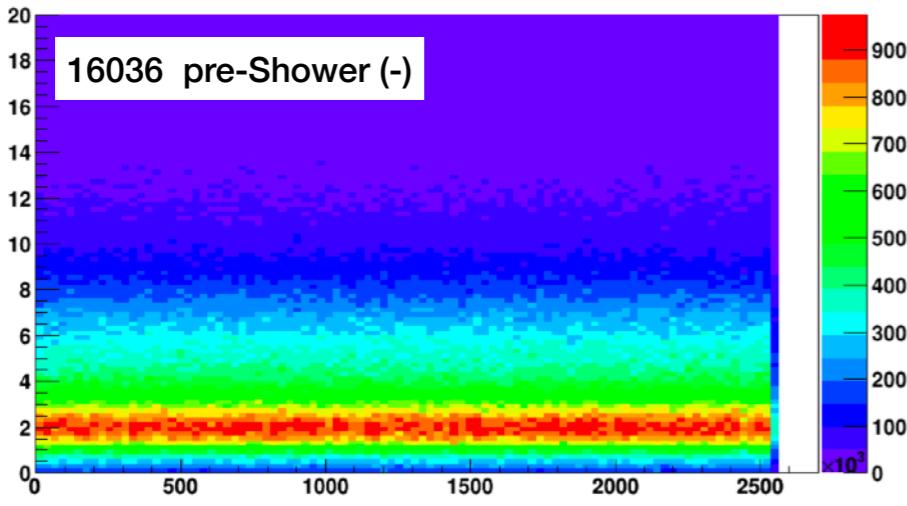
P.cal.pr.posAdcPulseInt:g.evnum



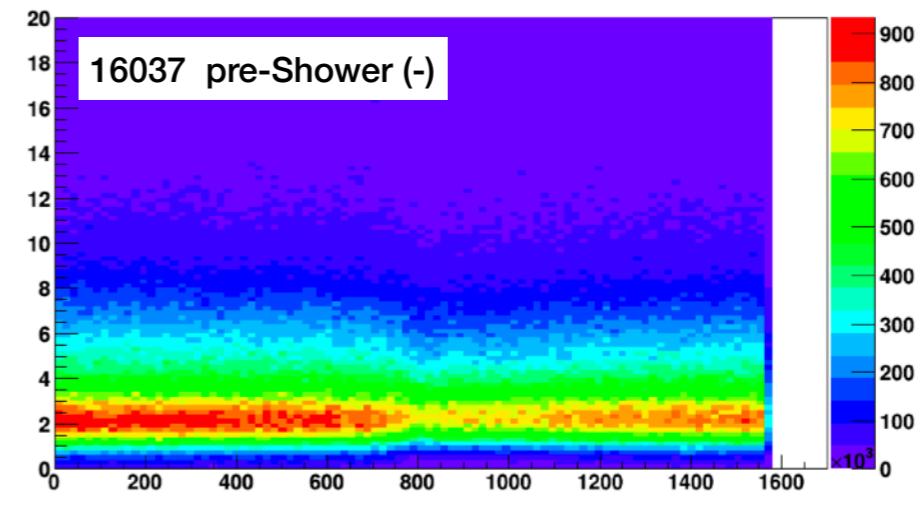
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P.cal.pr.negAdcPulseInt:g.evnum

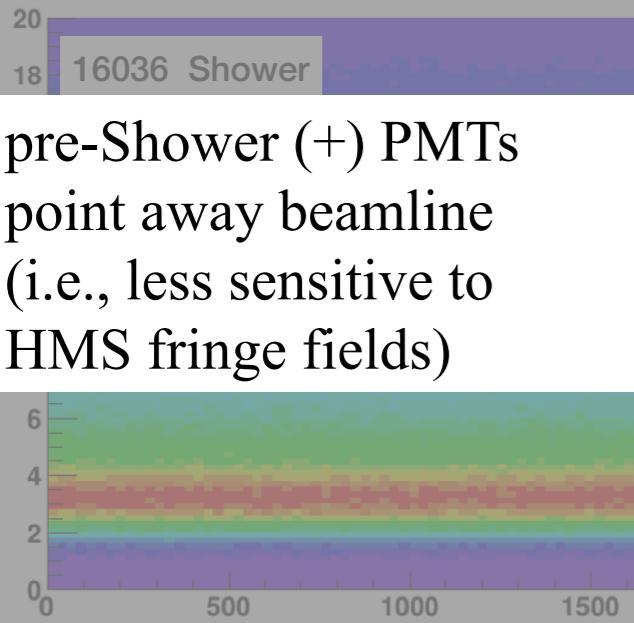


P.cal.pr.negAdcPulseInt:g.evnum

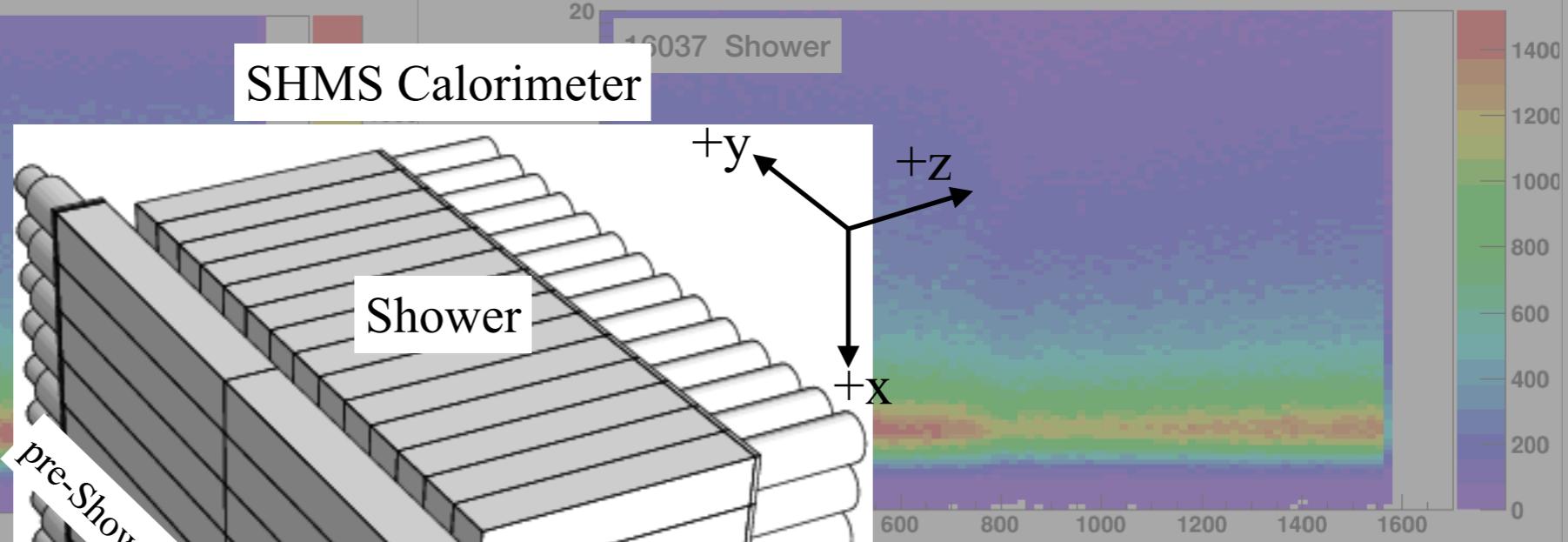


# fADC Pulse Integral vs. Event Number

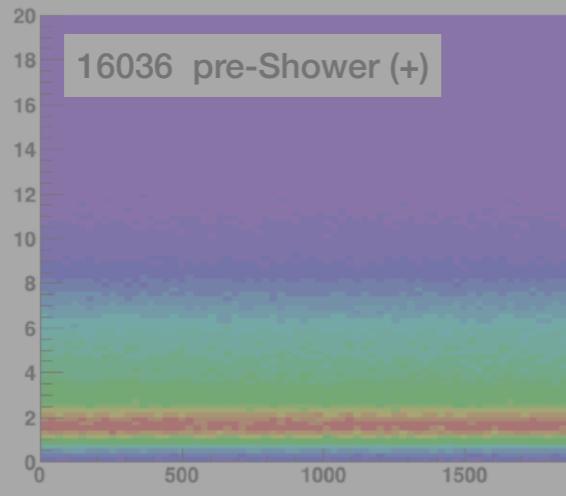
P.cal.fly.adcPulseInt:g.evnum



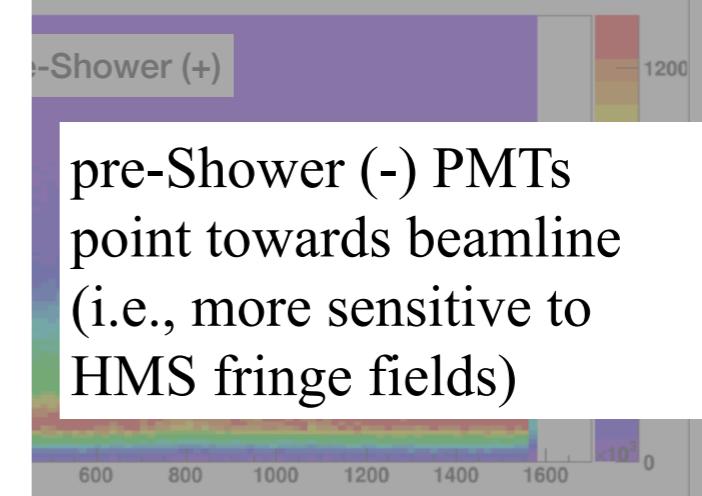
P.cal.fly.adcPulseInt:g.evnum



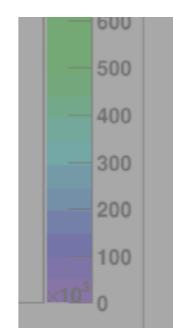
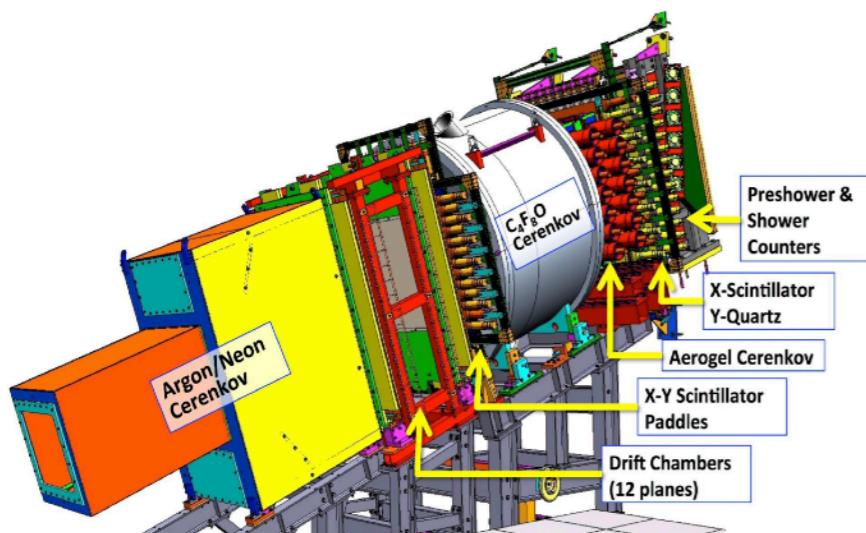
P.cal.pr.posAdcPulseInt:g.evnum



t:g.evnum

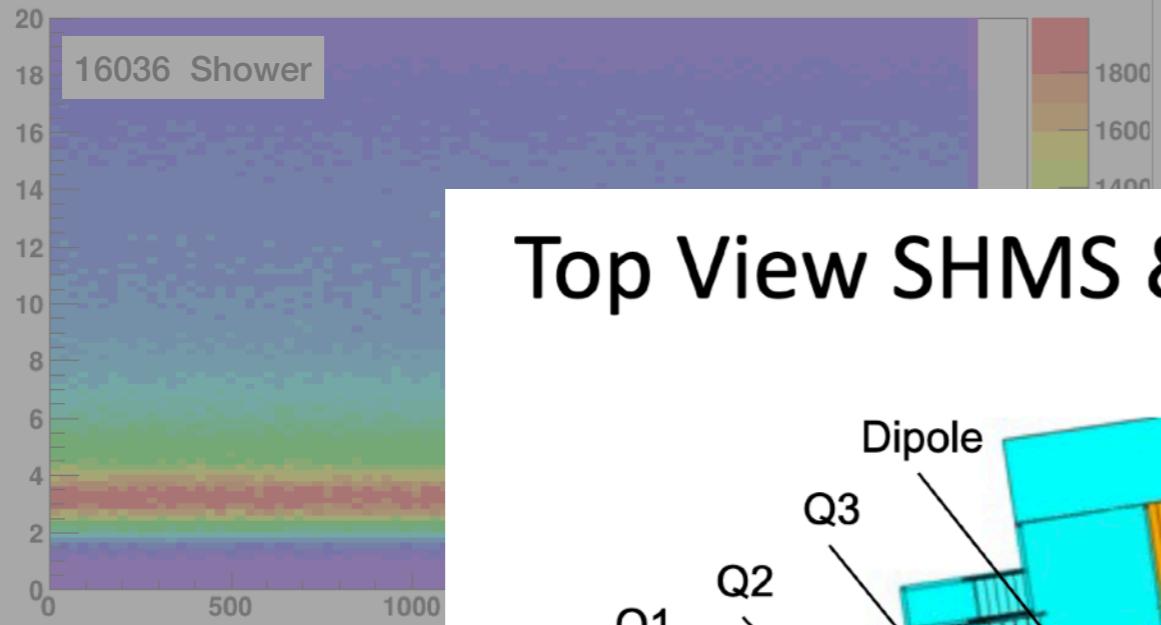


## Particle Detectors inside the SHMS

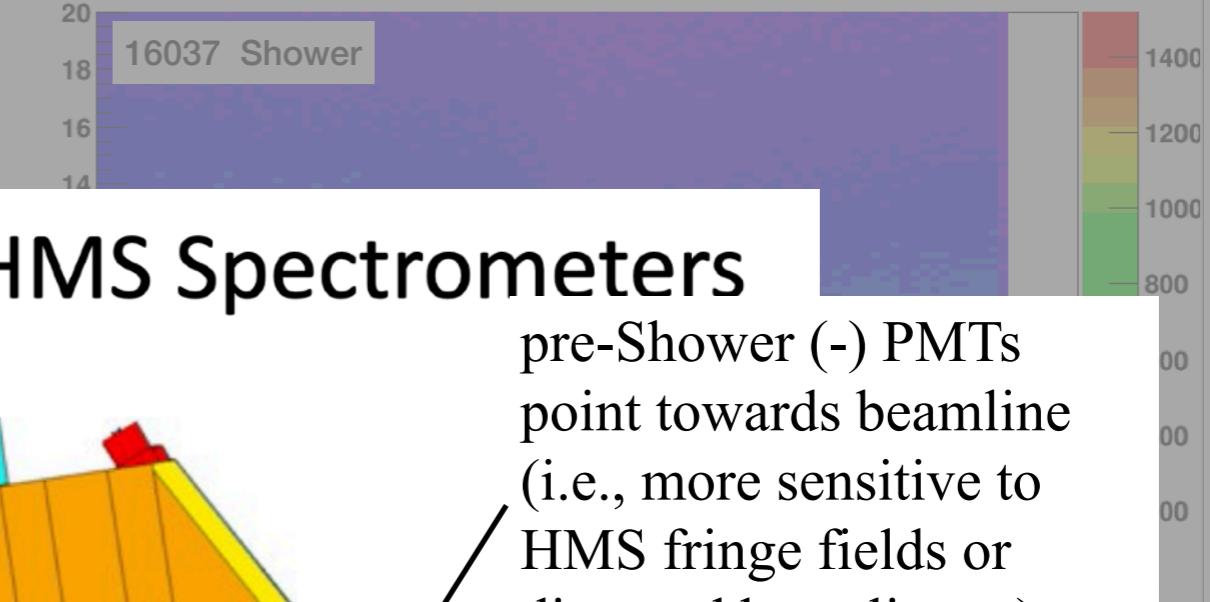


# fADC Pulse Integral vs. Event Number

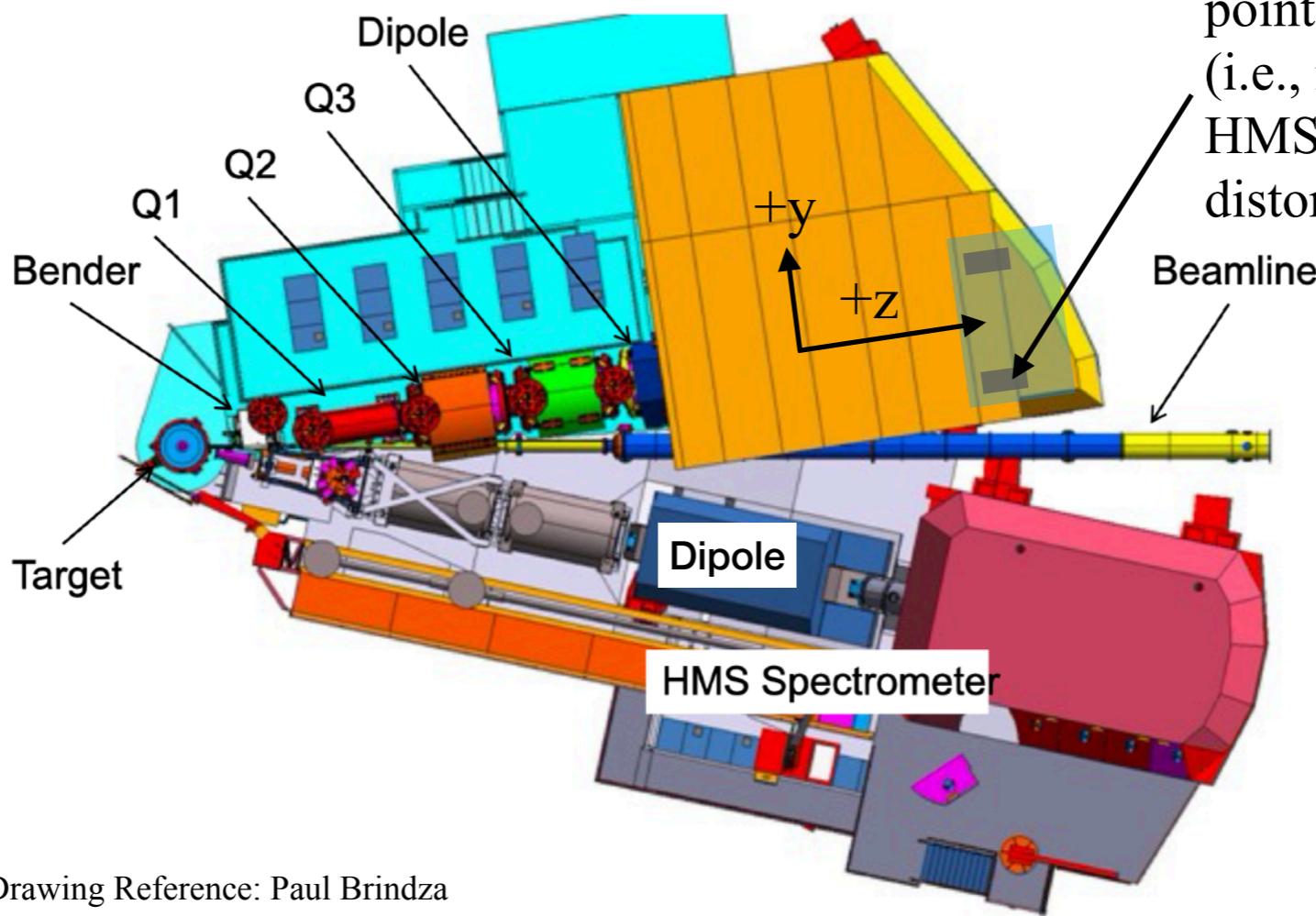
P.cal.fly.adcPulseInt:g.evnum



P.cal.fly.adcPulseInt:g.evnum

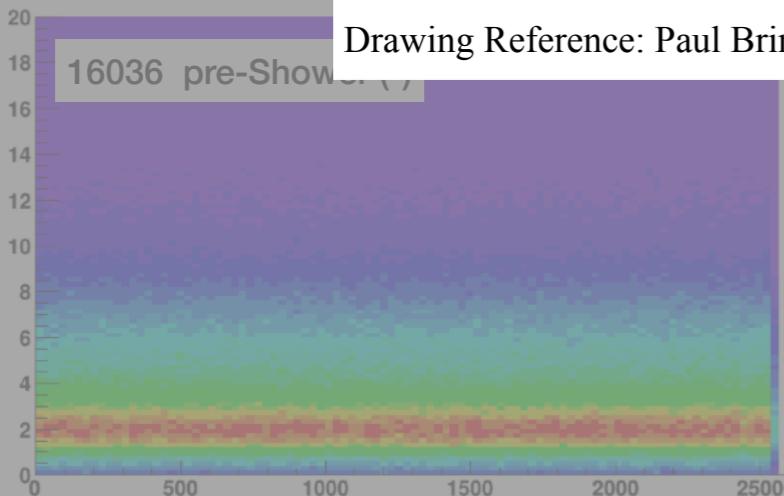


## Top View SHMS & HMS Spectrometers



pre-Shower (-) PMTs  
point towards beamline  
(i.e., more sensitive to  
HMS fringe fields or  
distorted beamline e-)

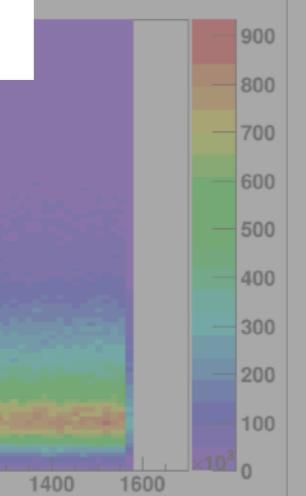
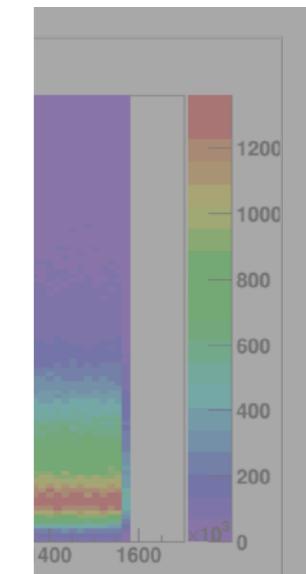
P.cal.pr.negAdcPulseInt:g.evnum



Drawing Reference: Paul Brindza

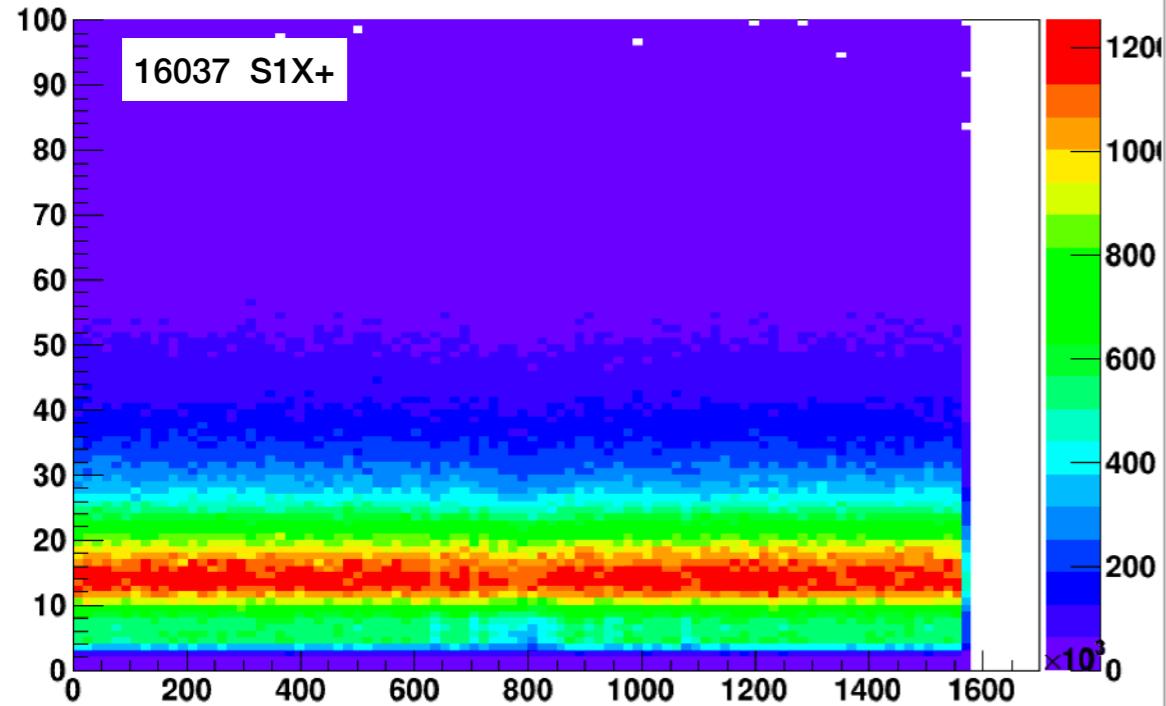
Could have the right side  
of other detectors (i.e.,  
Hodoscope S1X -, S2X-  
also been affected?  
(see next slide)

16037 pre-Shower (-)

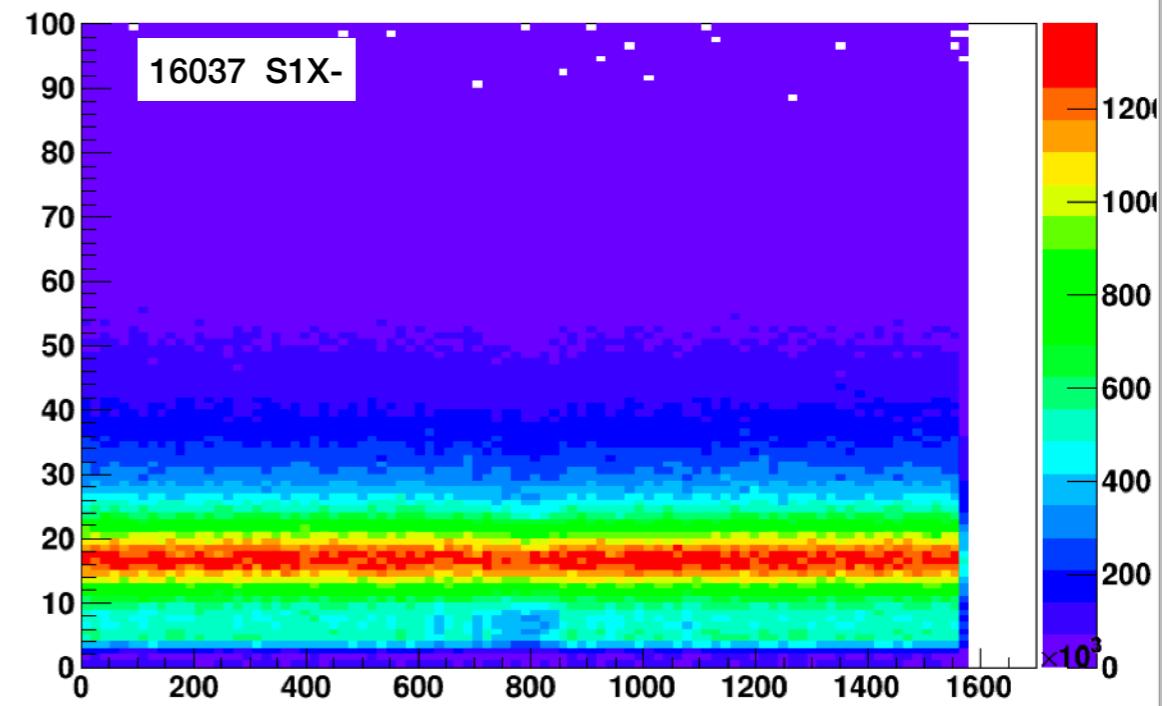


# Hodoscopes fADC Pulse Integral vs. Event Number

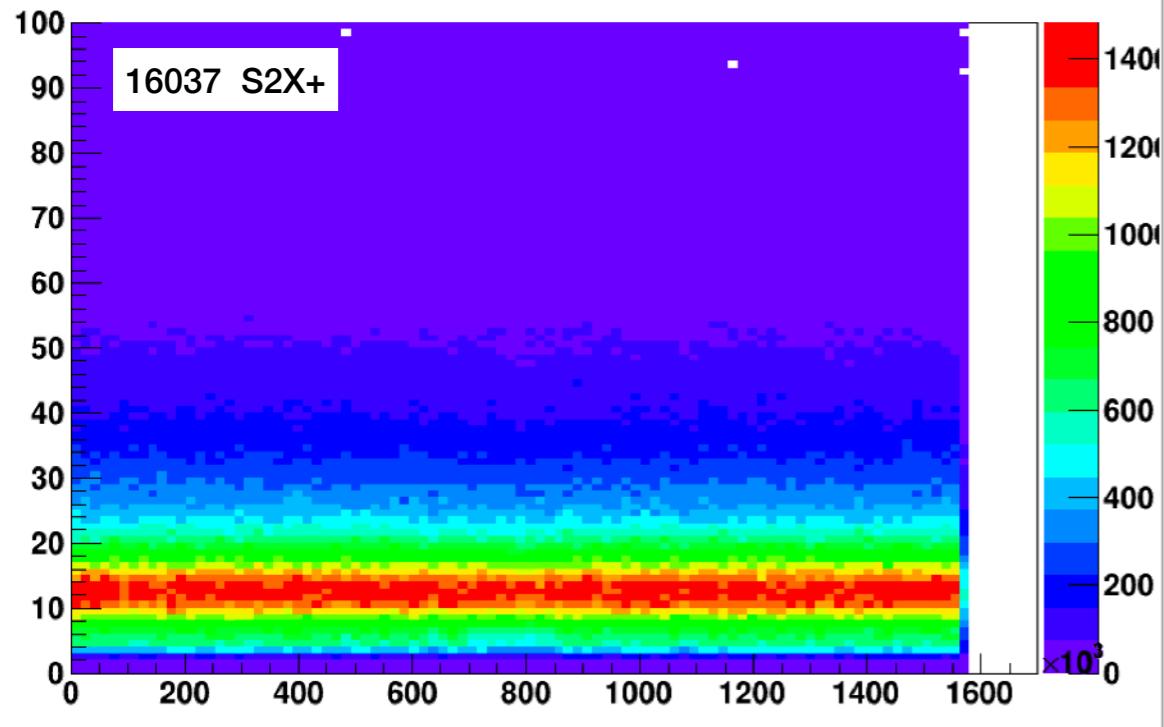
P.hod.1x.posAdcPulseInt:g.evnum



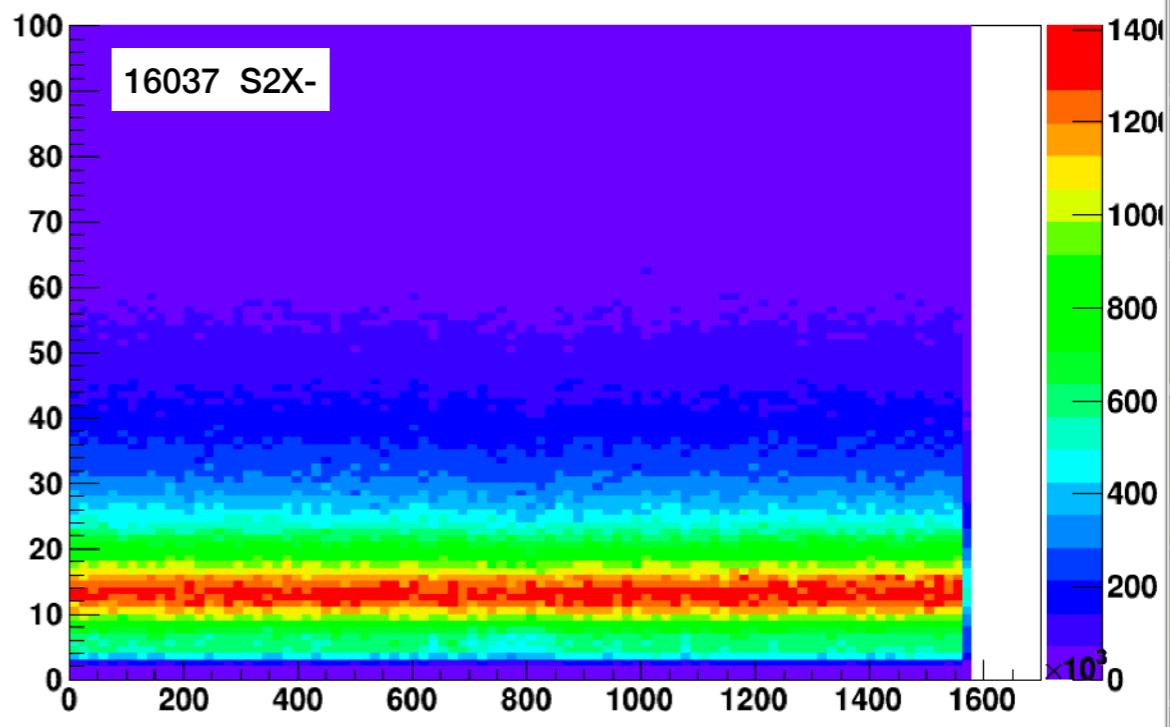
P.hod.1x.negAdcPulseInt:g.evnum



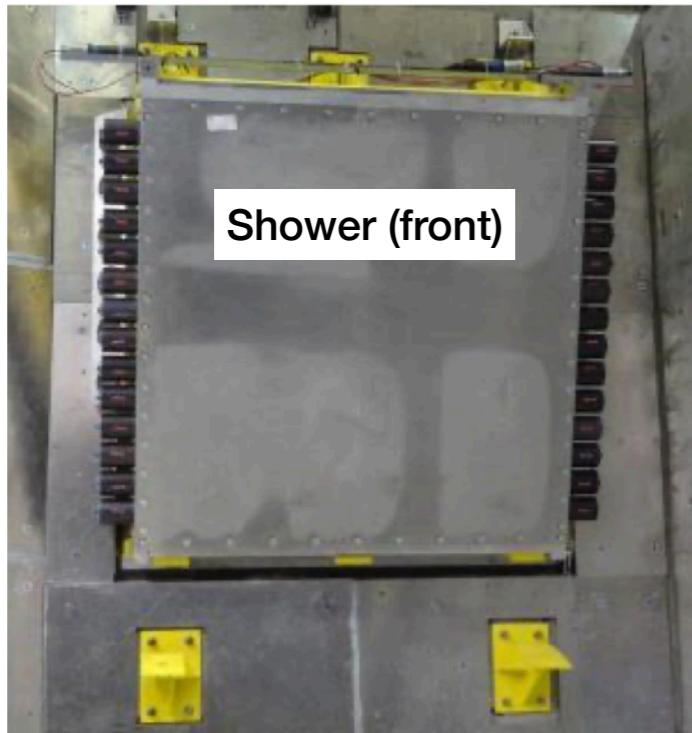
P.hod.2x.posAdcPulseInt:g.evnum



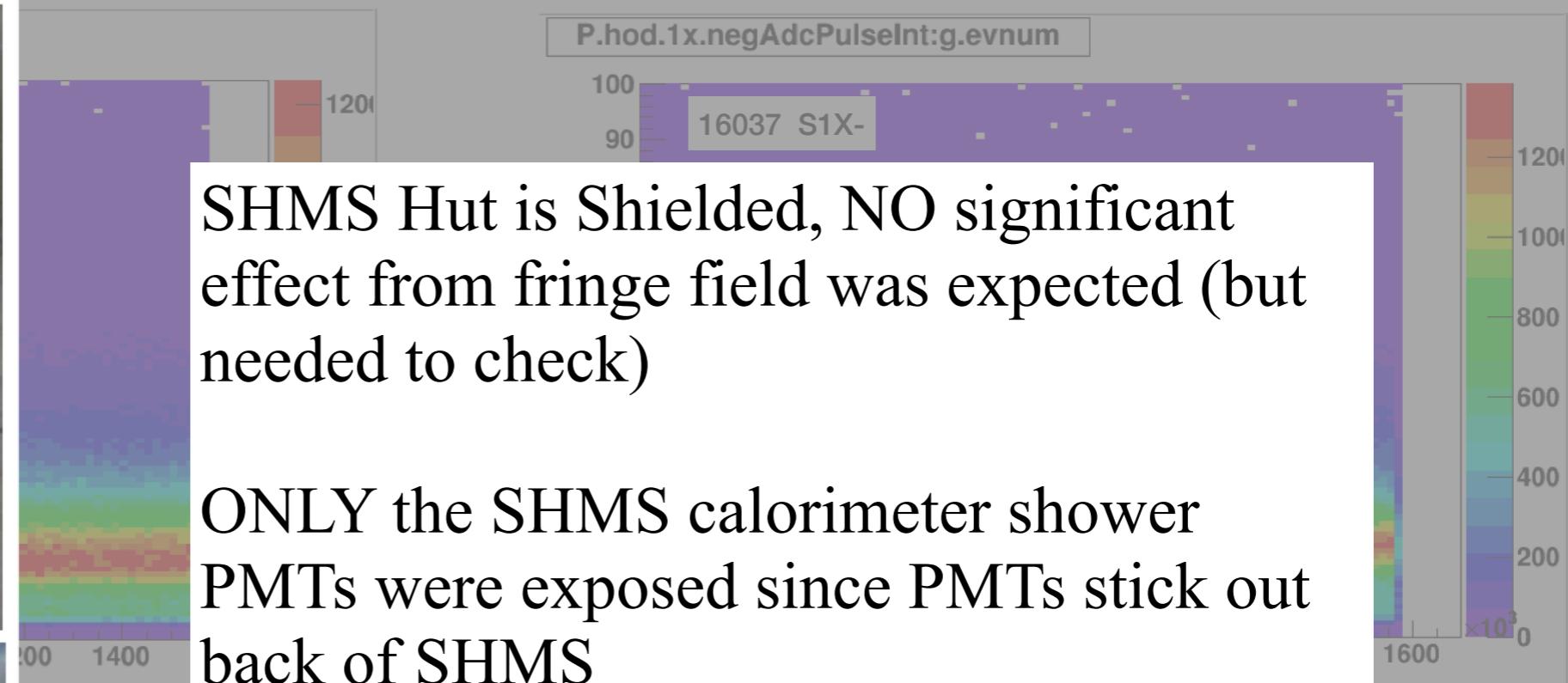
P.hod.2x.negAdcPulseInt:g.evnum



# SHMS fADC Pulse Integral vs. Event Number



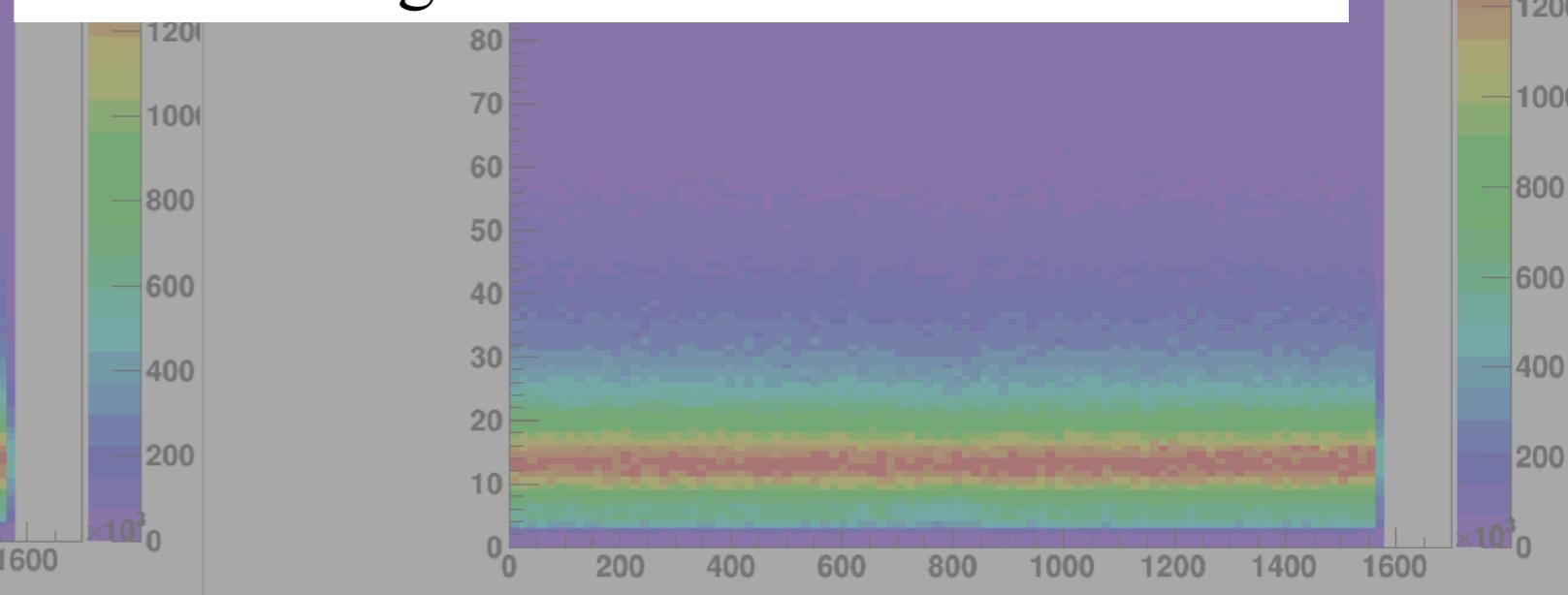
Picture Ref: Hamlet Mkrtchyan



SHMS Hut is Shielded, NO significant effect from fringe field was expected (but needed to check)

ONLY the SHMS calorimeter shower PMTs were exposed since PMTs stick out back of SHMS

(my speculation) HMS D fringe fields distorted path of beamline e- which leaked through the back of the SHMS



# Implications on SHMS Hodo HV Study

- Calorimeter (**shower** + **pre-shower**) PMTs HV, and hence, fADC signal subject to HMS fringe fields during run 16037
  - **pre-Shower** (in hardware trigger),
    - \* T2 (SHMS EL-REAL) trigger counts affected ?
    - \* T1 (SHMS 3/4 trigger counts not affected (use as benchmark))
  - **shower** (not in hardware trigger) but . . .  
(calorimeter energy was affected => software cut changes)

need to quantify effect on invariant mass W counts !

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## Study 1: Quantify effect of HMS fringe fields on T2 scaler counts

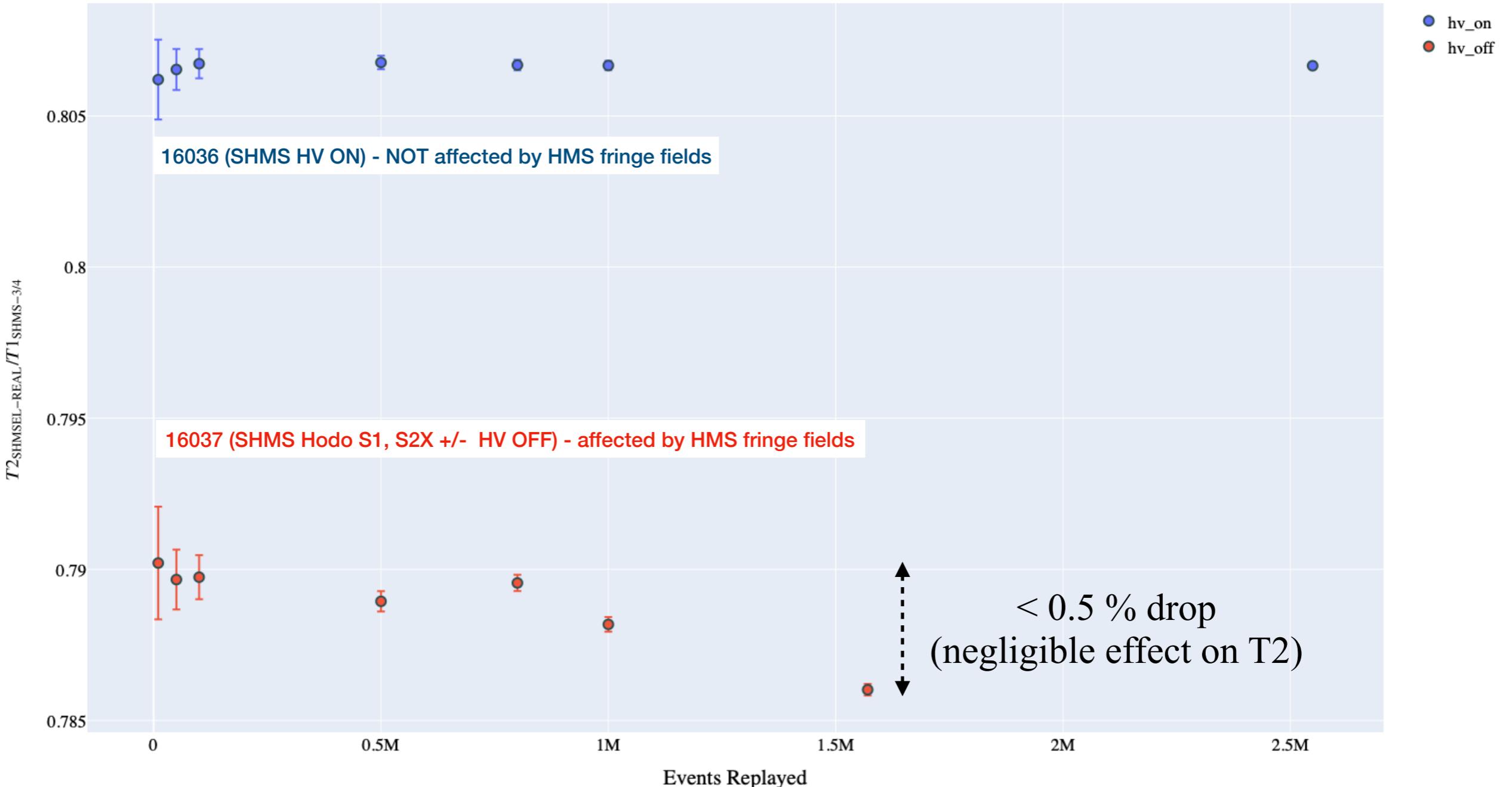
(calorimeter energy was affected => software cut changes)

- Ratio T2 (SHMS EL-REAL) / T1 (SHMS 3/4) vs. Events Replayed

- \* T1 (unaffected by fringe) used as benchmark to compare to affected T2
- \* T2 more restrictive trigger => T2 Counts < T1 Counts
- \* T2 / T1 = constant (within error) for any given event sample replayed  
(if T2 affected by fringe field, it should drop relative to T1)

# Scaler Counts Ratio T2 / T1

Ratio SHMS EL-REAL to Scin. 3/4 Scaler Counts

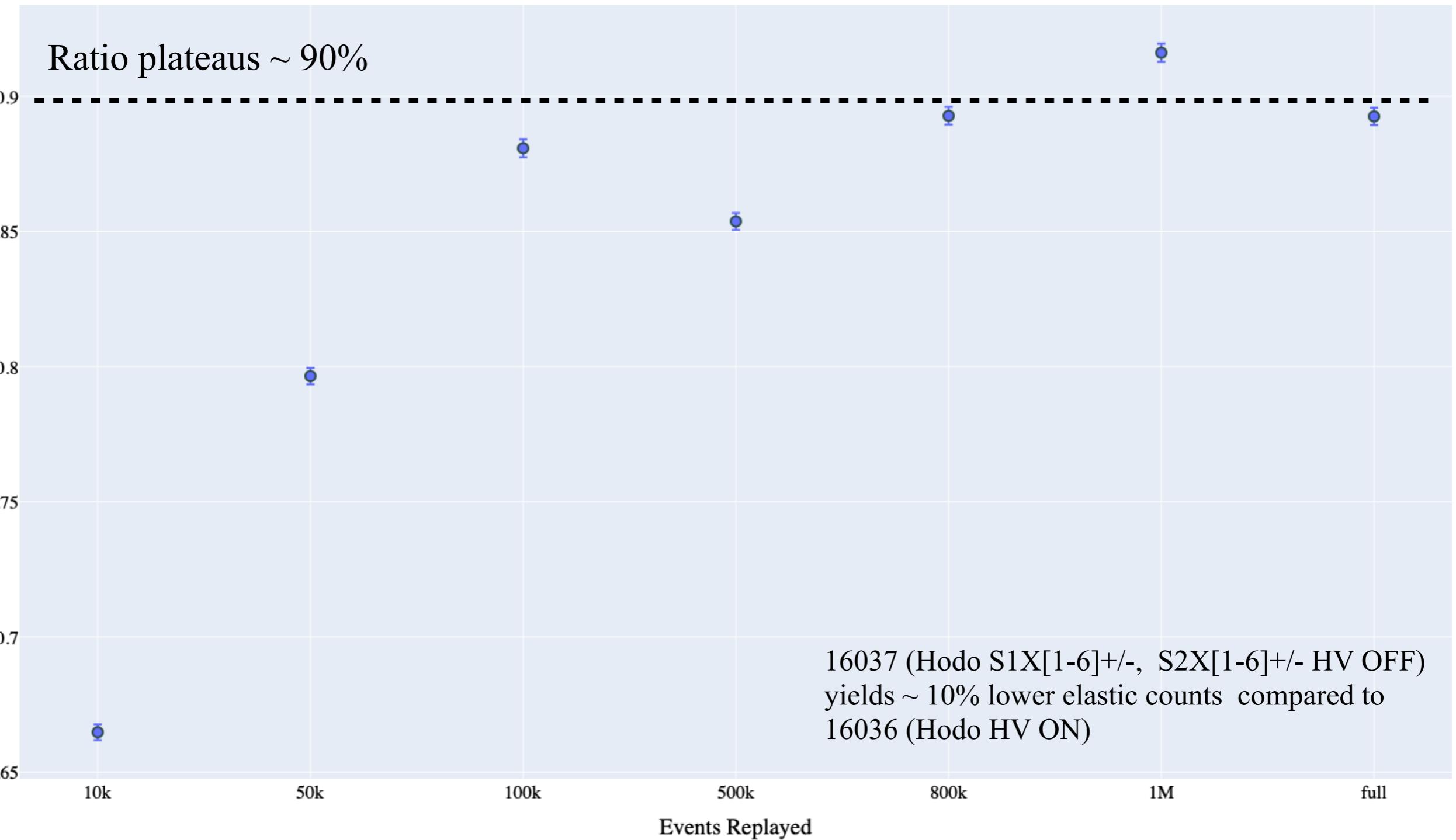


## Study 2: Quantify effect of HMS fringe fields on elastic counts W

- Ratio W (run 16037) / W (run 16036) vs. Events Replayed
  - \* elastic counts defined as: integrated W [0.85, 1.05] GeV
- ~~Calorimeter (**shower** + **pre shower**) DMTs HV and hence, tADC signal subject to HMS fringe fields during run 16037~~
  - **pre-Shower** (in hardware trigger),
    - \* T2 (SHMS EL-REAL) trigger counts affected ?
    - \* T1 (SHMS 3/4 trigger counts not affected (use as benchmark)
  - **shower** (not in hardware trigger) but . . .  
(calorimeter energy was affected => software cut changes)

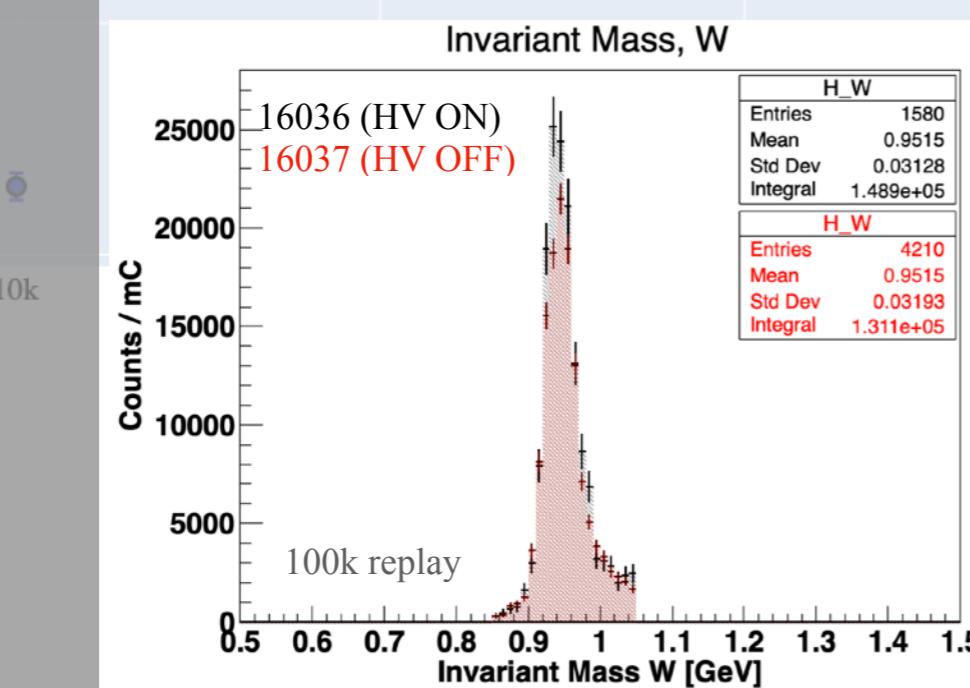
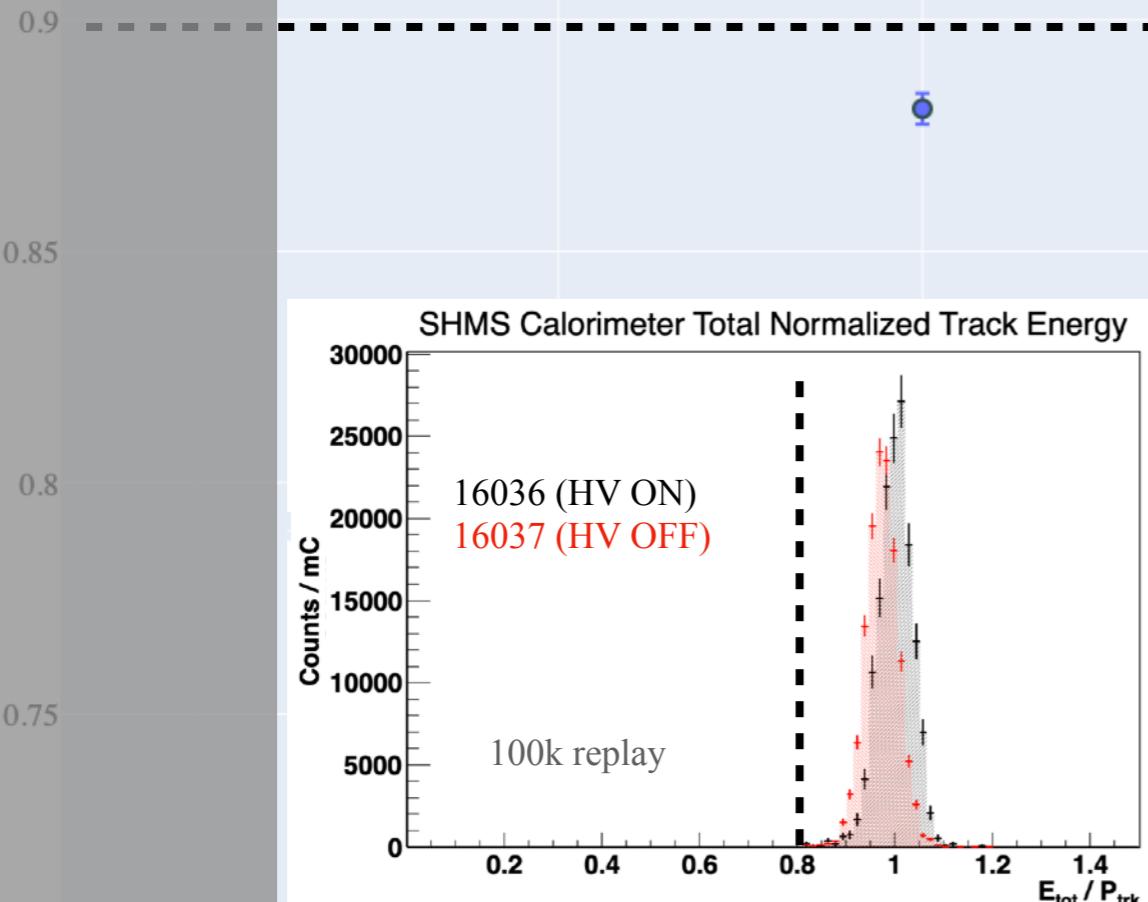
need to quantify effect on invariant mass W counts !

## Ratio of Invariant Mass W



## Ratio of Invariant Mass W

Ratio plateaus  $\sim 90\%$



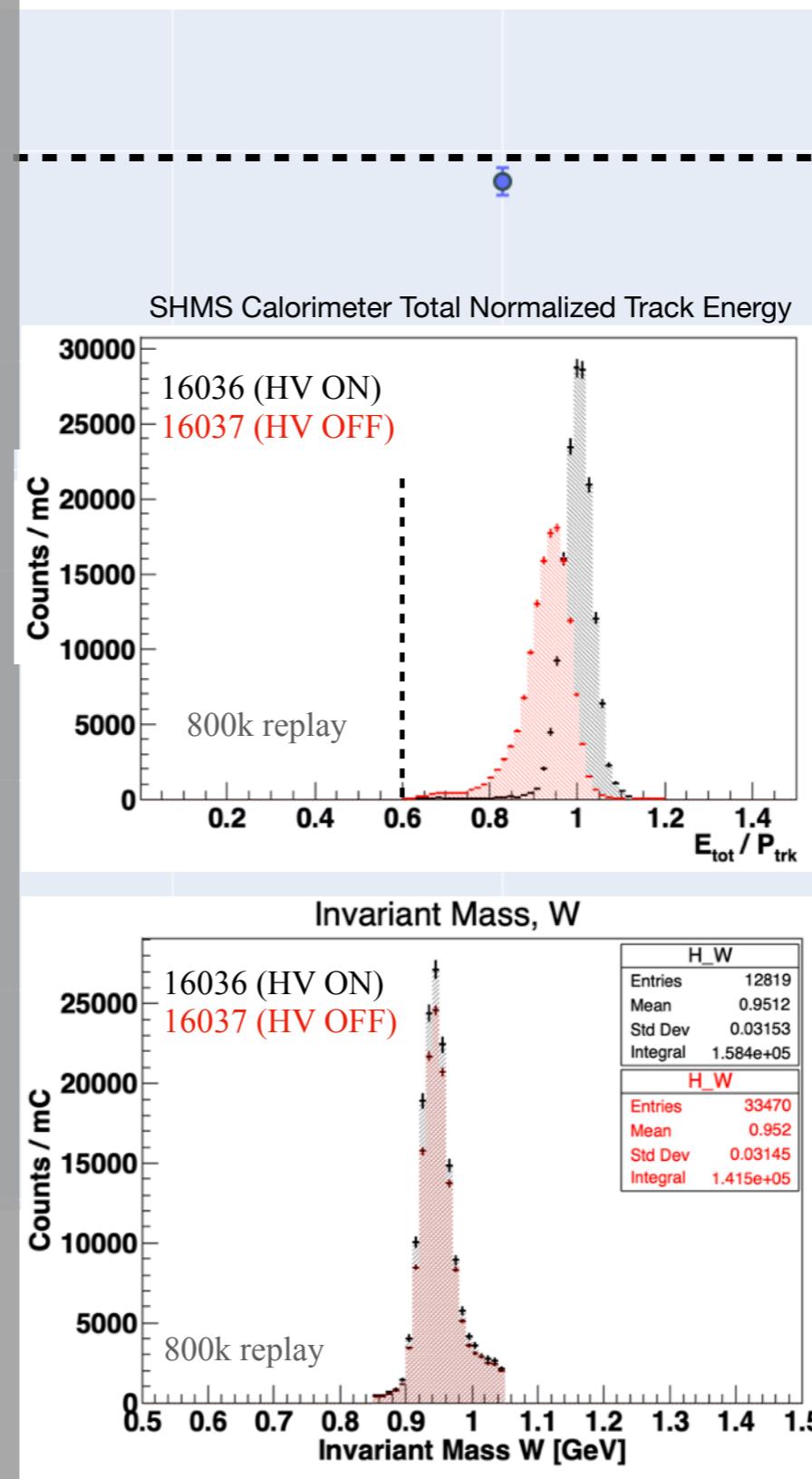
16037 (Hodo S1X[1-6]+/-, S2X[1-6]+/- HV OFF)  
yields  $\sim 10\%$  lower elastic counts compared to  
16036 (Hodo HV ON)

500k      800k      1M      full

Events Replayed

## Ratio of Invariant Mass W

Ratio plateaus ~ 90%



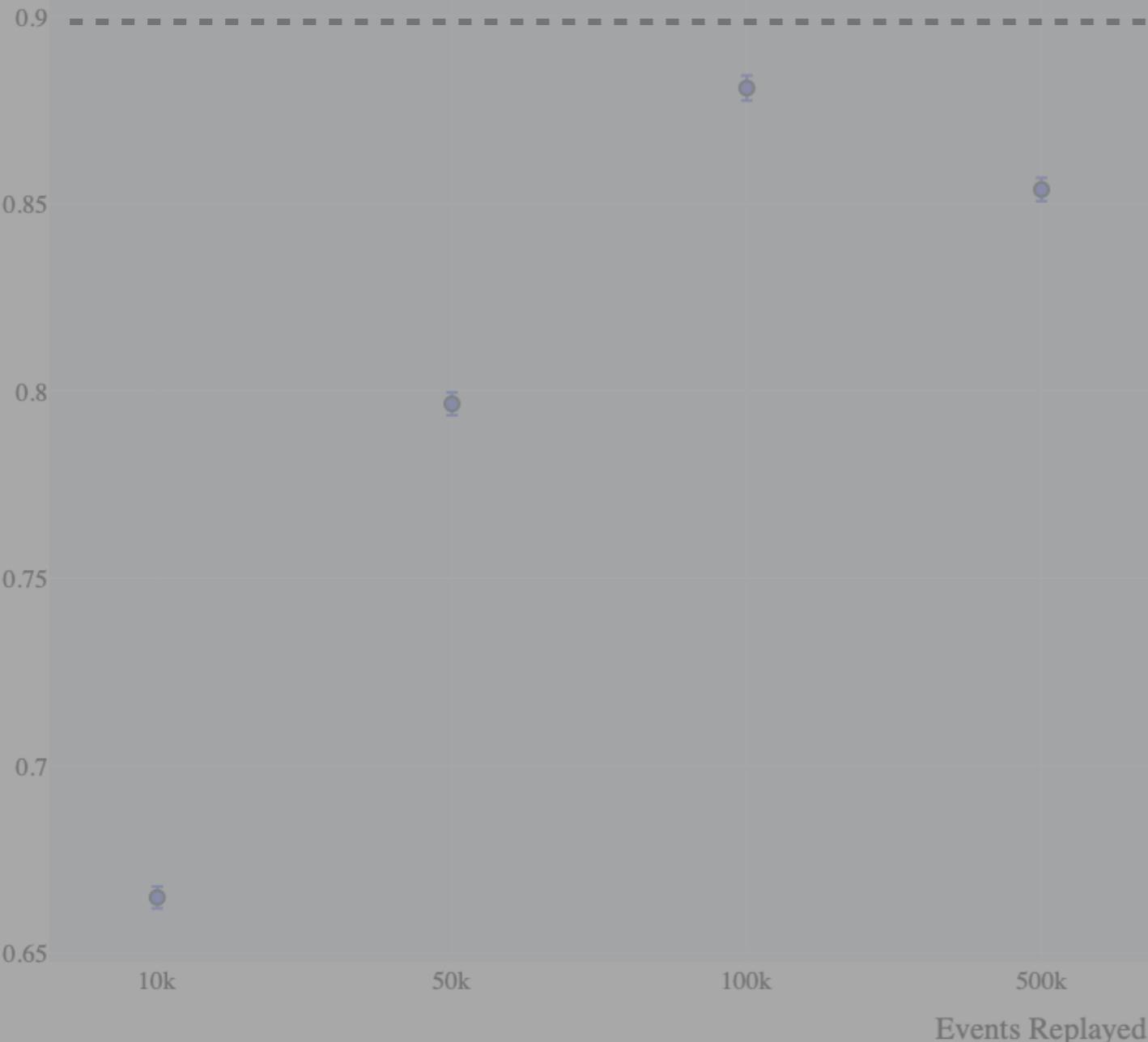
S2X[1-6]+/- HV OFF)  
counts compared to

1M

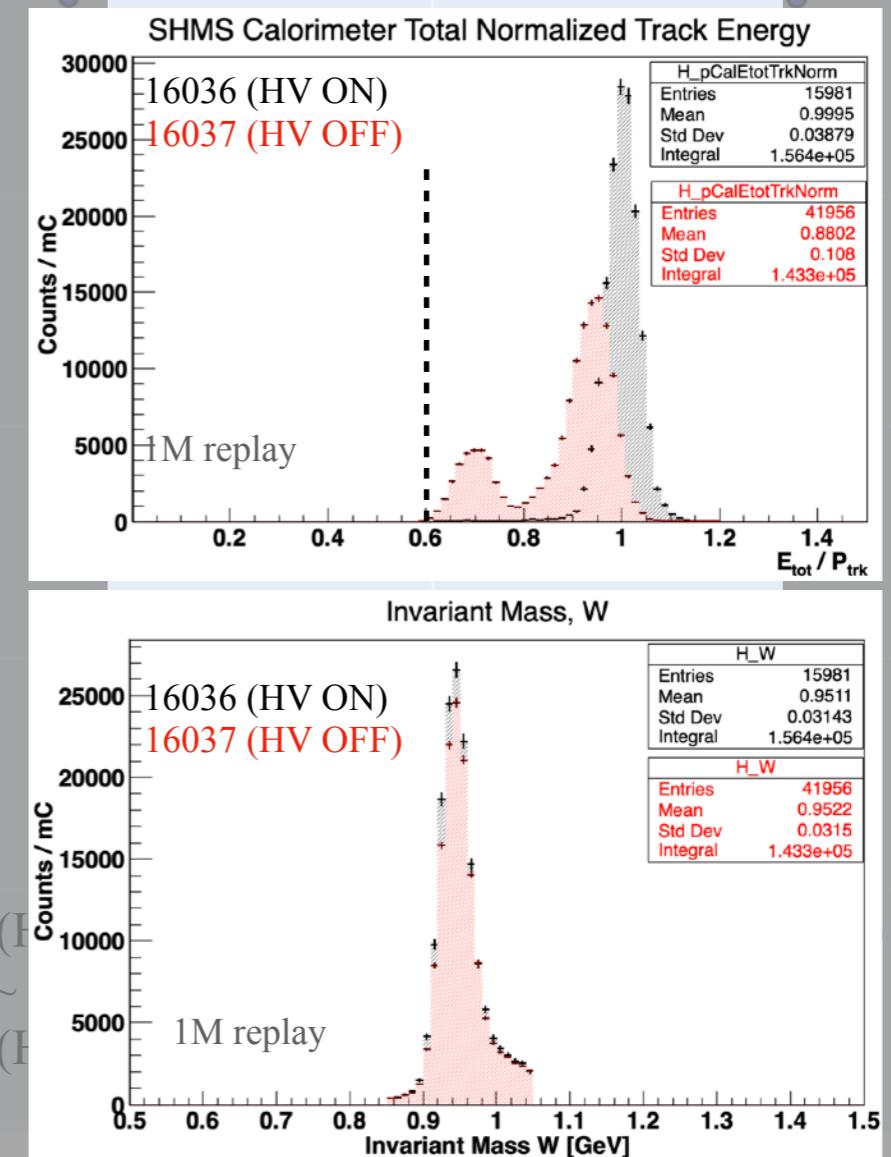
full

## Ratio of Invariant Mass W

Ratio plateaus ~ 90%



16037 (F)  
yields ~  
16036 (F)



# Summary

- HMS fringe fields impacted CaFe run 16037 (SHMS Hodo HV OFF)
- Only SHMS Shower calorimeter was significantly impacted (i.e., needed to modify software cut)
- $H(e, e')$  singles elastic counts  $\sim 10\%$  lower for HV OFF compared to HV ON

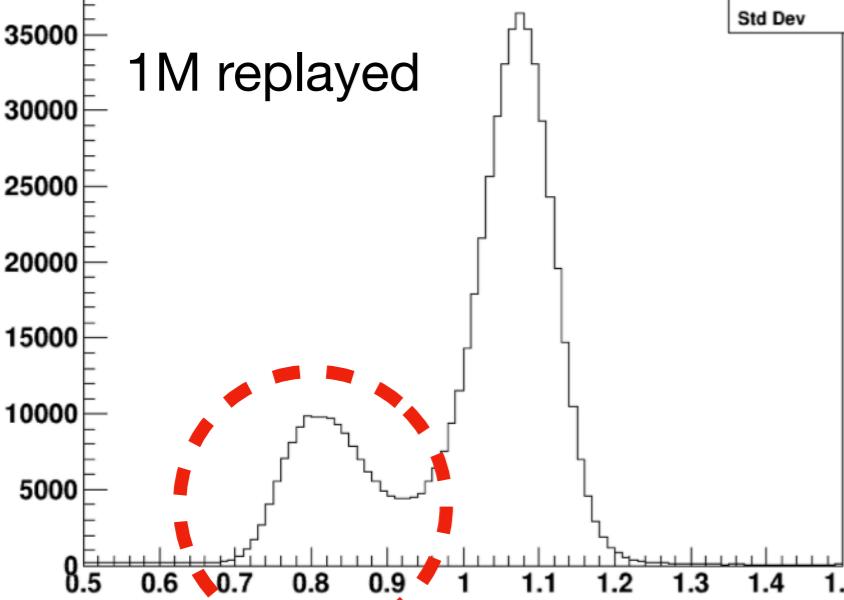
What is causing  $\sim 10\%$  discrepancy in our data ?

- simulation may have over-estimated the effect of turning OFF hodoscope paddles?
- even though no apparent issues due to HMS fringe fields were found, this study should be re-taken during CaFe, but with the following conditions:
  - 1) only coincidence trigger
  - 2) allow one more scintillator paddle in S1X,S2X to be ON (i.e., S1X[1-5], S2X[1-5] HV OFF)

# Back-Up Slides

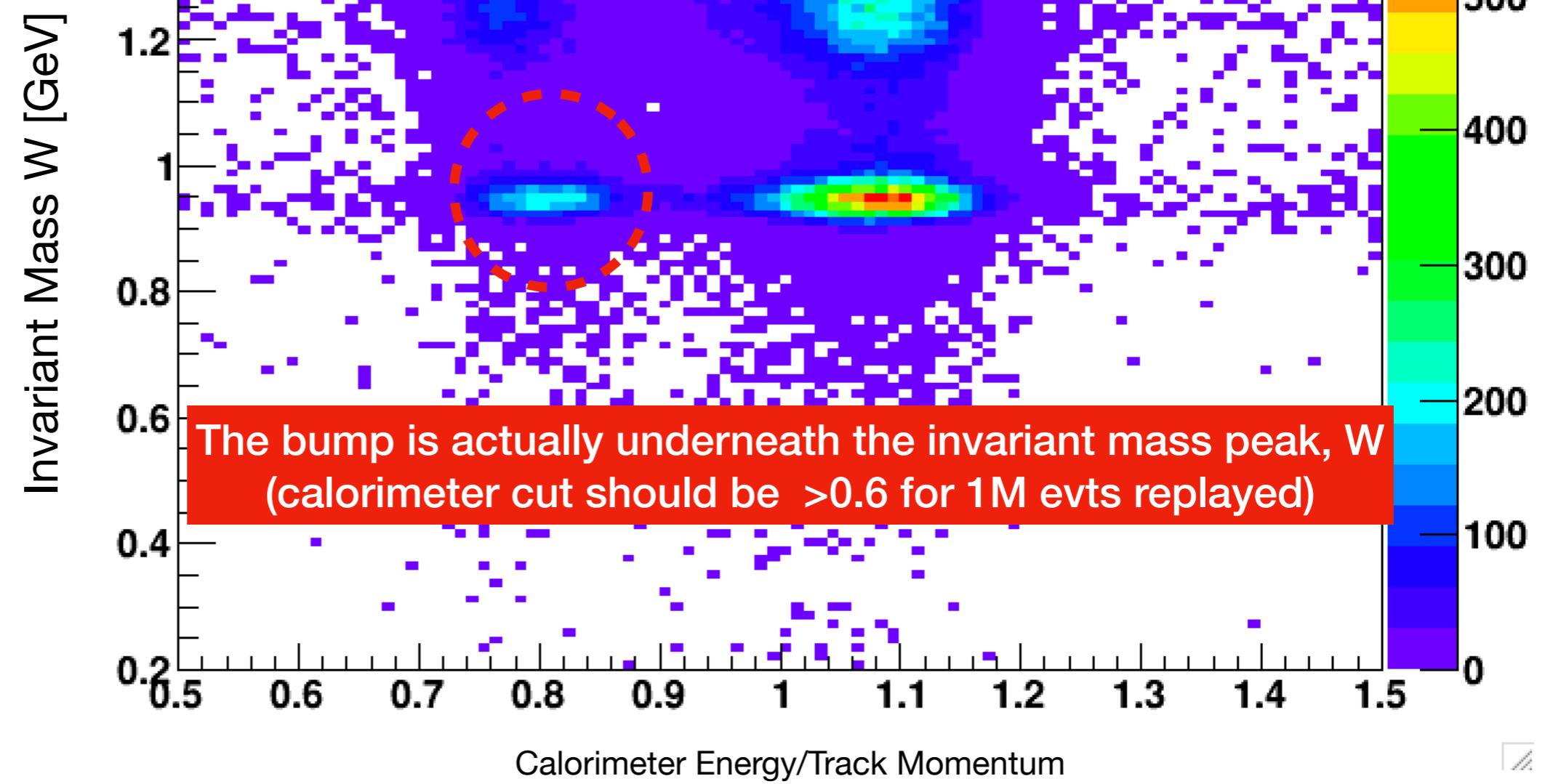
P.cal.etottracknorm

h1M  
Entries 1000000  
Mean 1.007  
Std Dev 0.1223

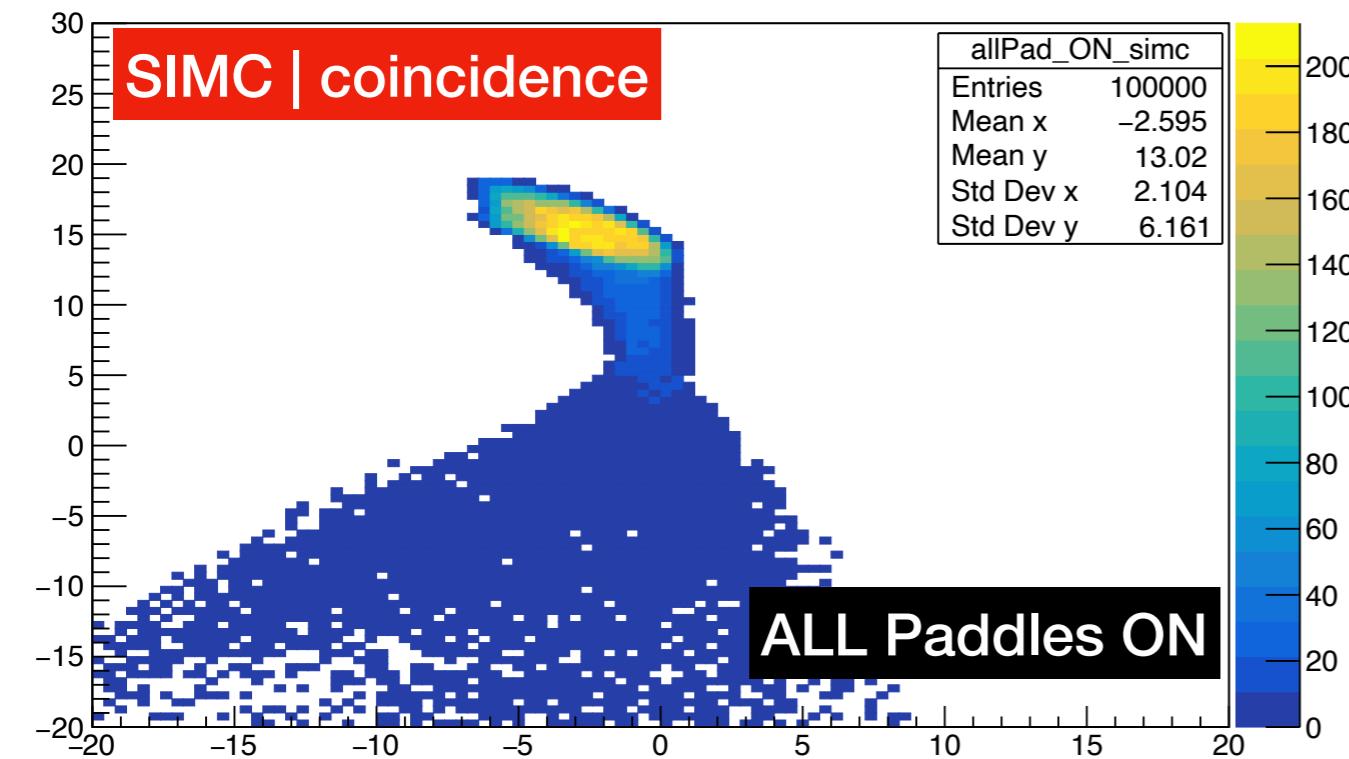


Invariant Mass W:P.cal.etottracknorm

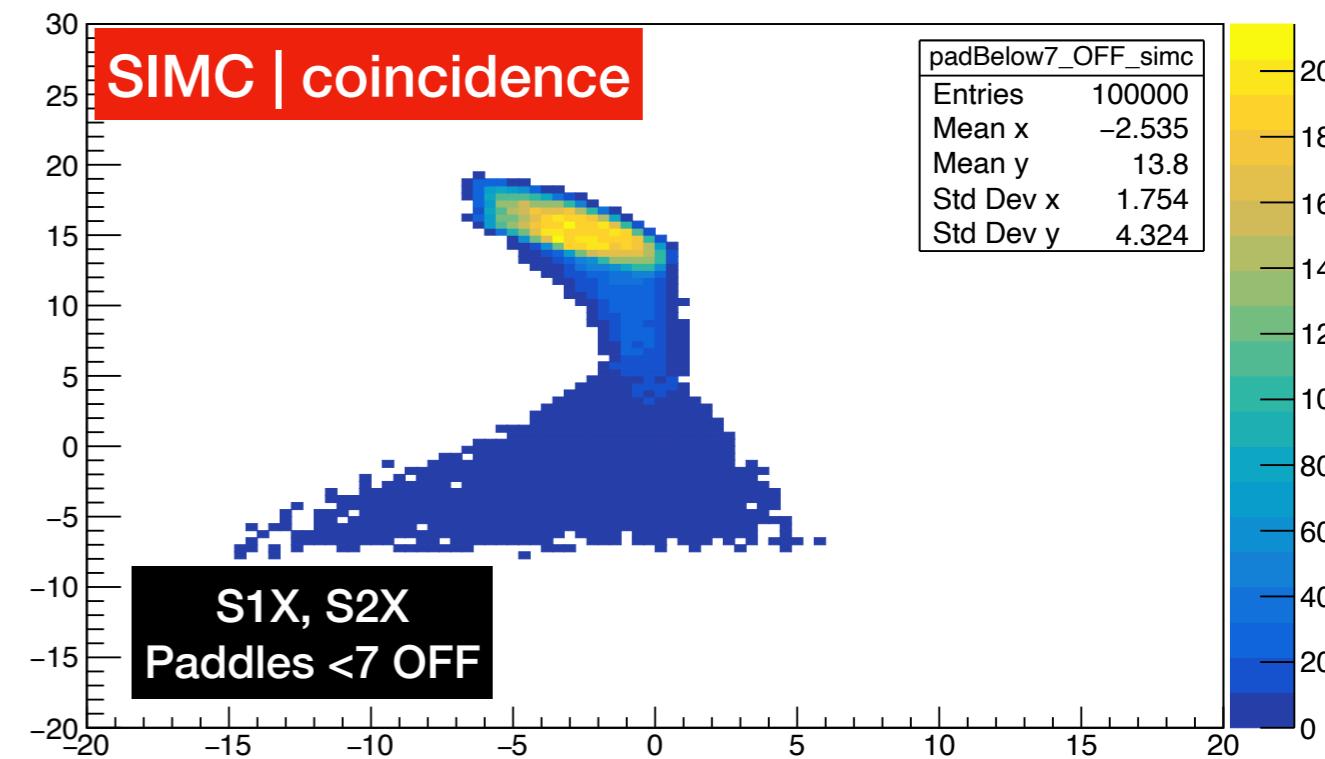
Entries 1000000  
Mean x 1.005  
Mean y 1.226  
Std Dev x 0.1307  
Std Dev y 0.2037



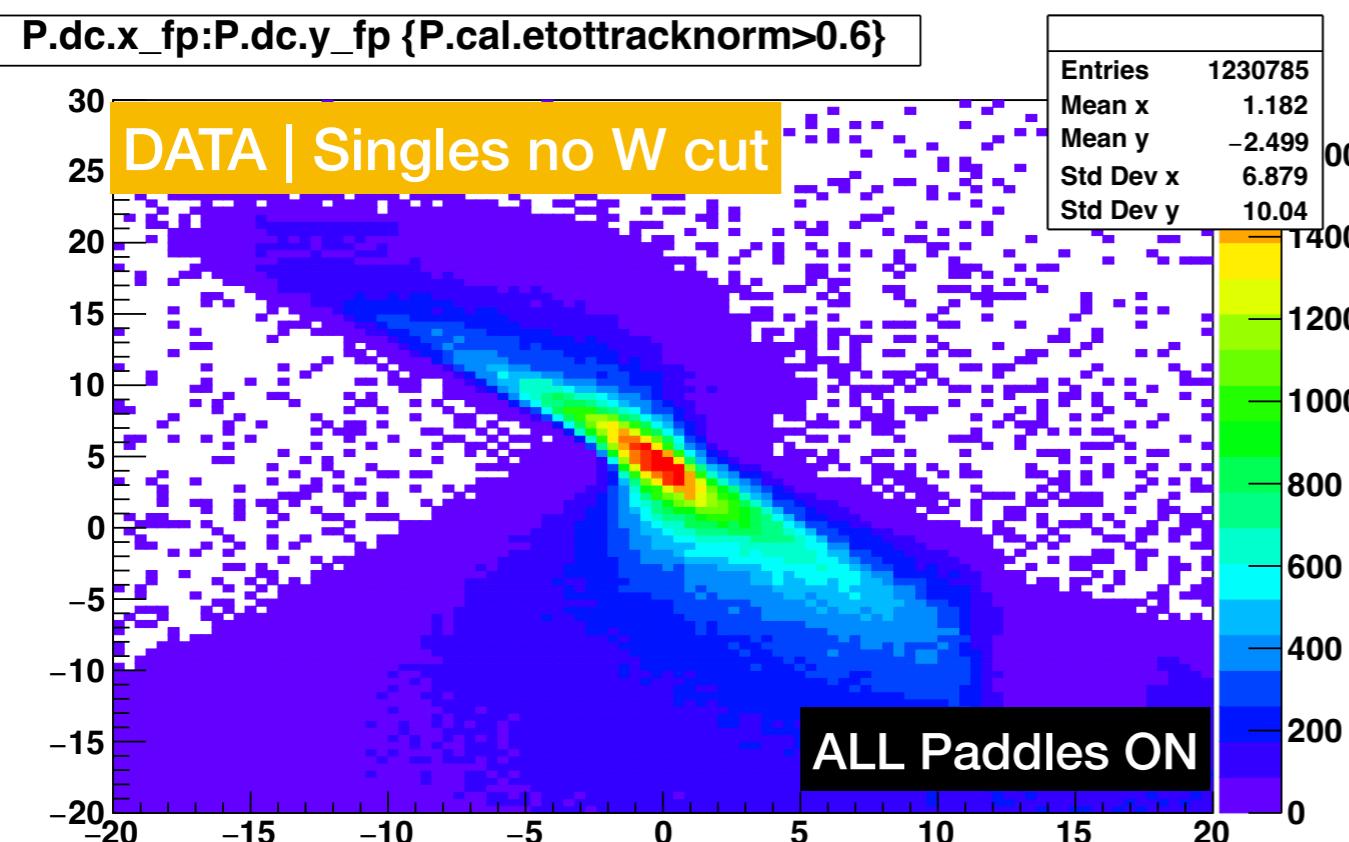
ssxfp:ssyfp {Weight\*0.891790E+06/100000.}



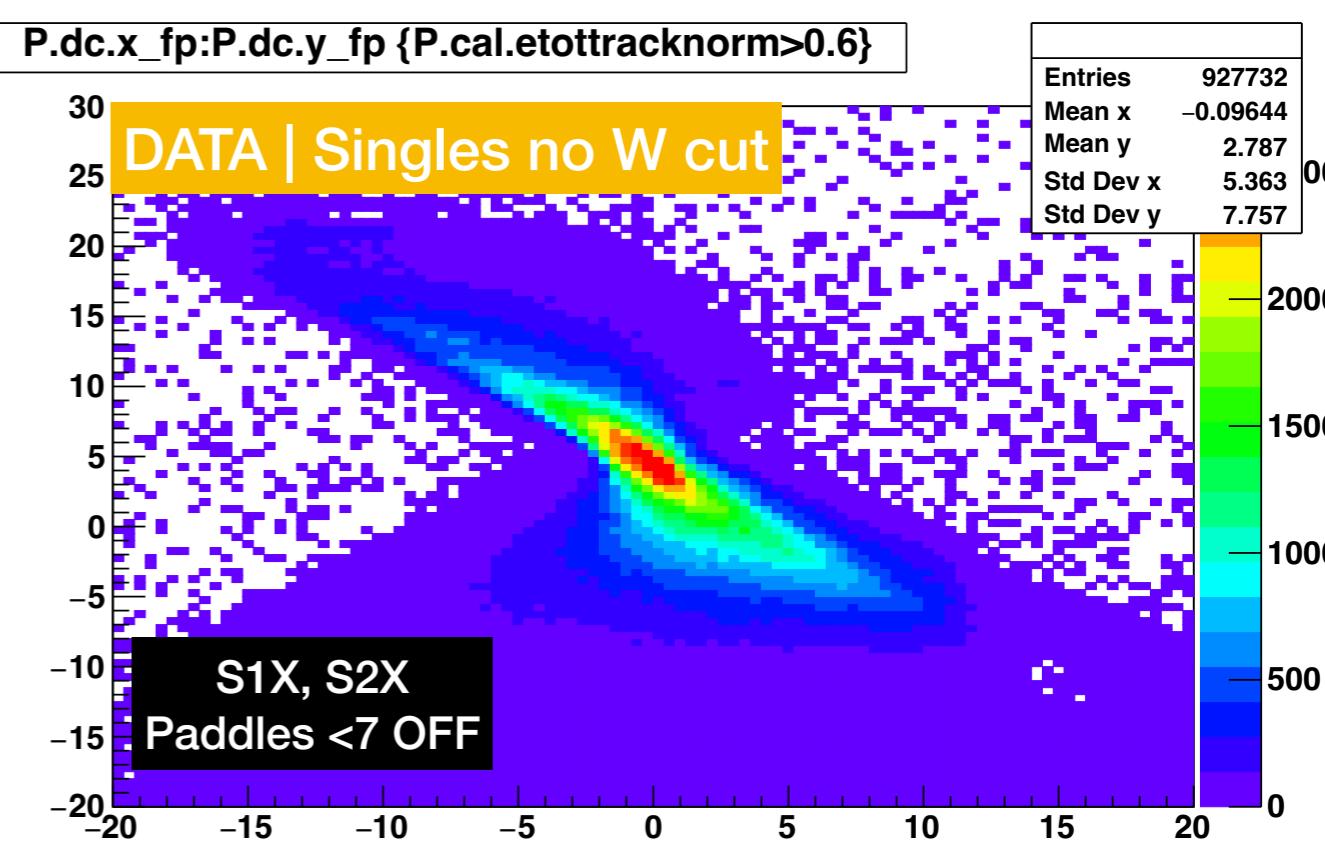
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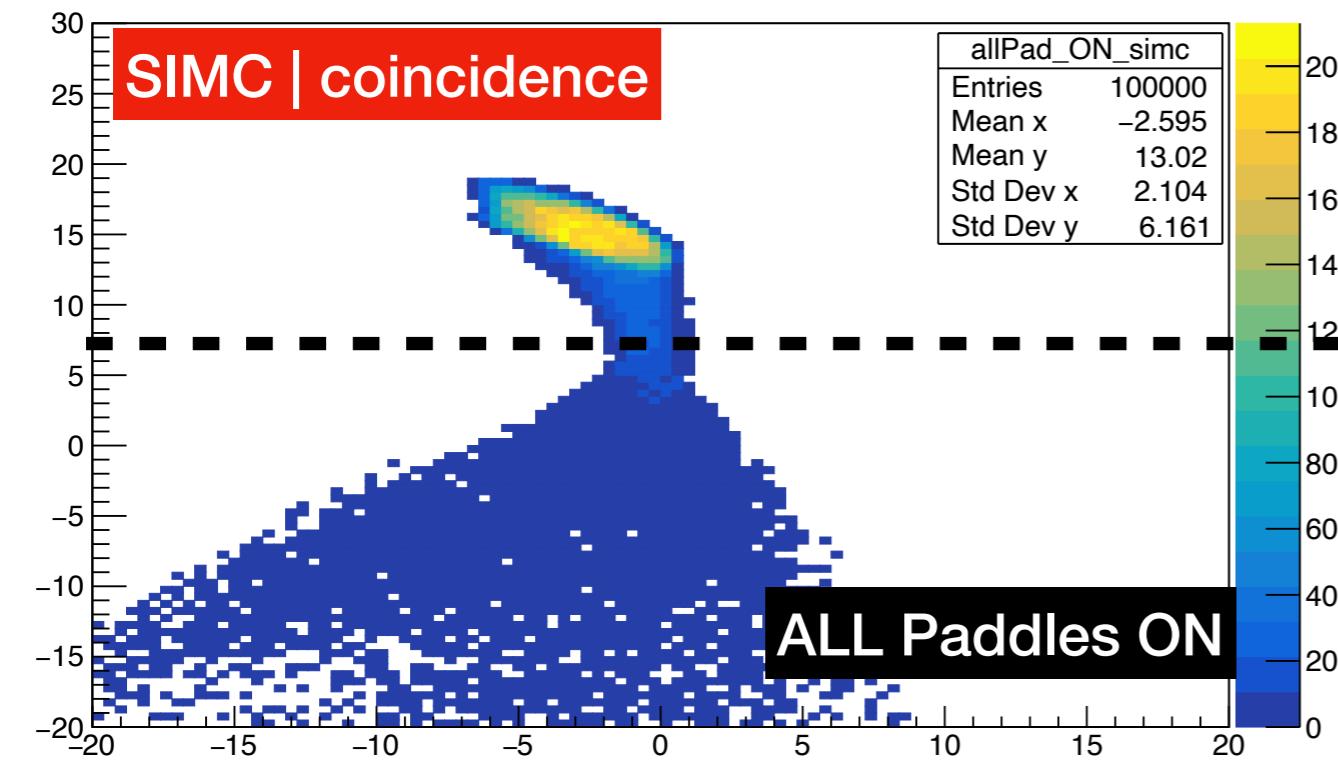
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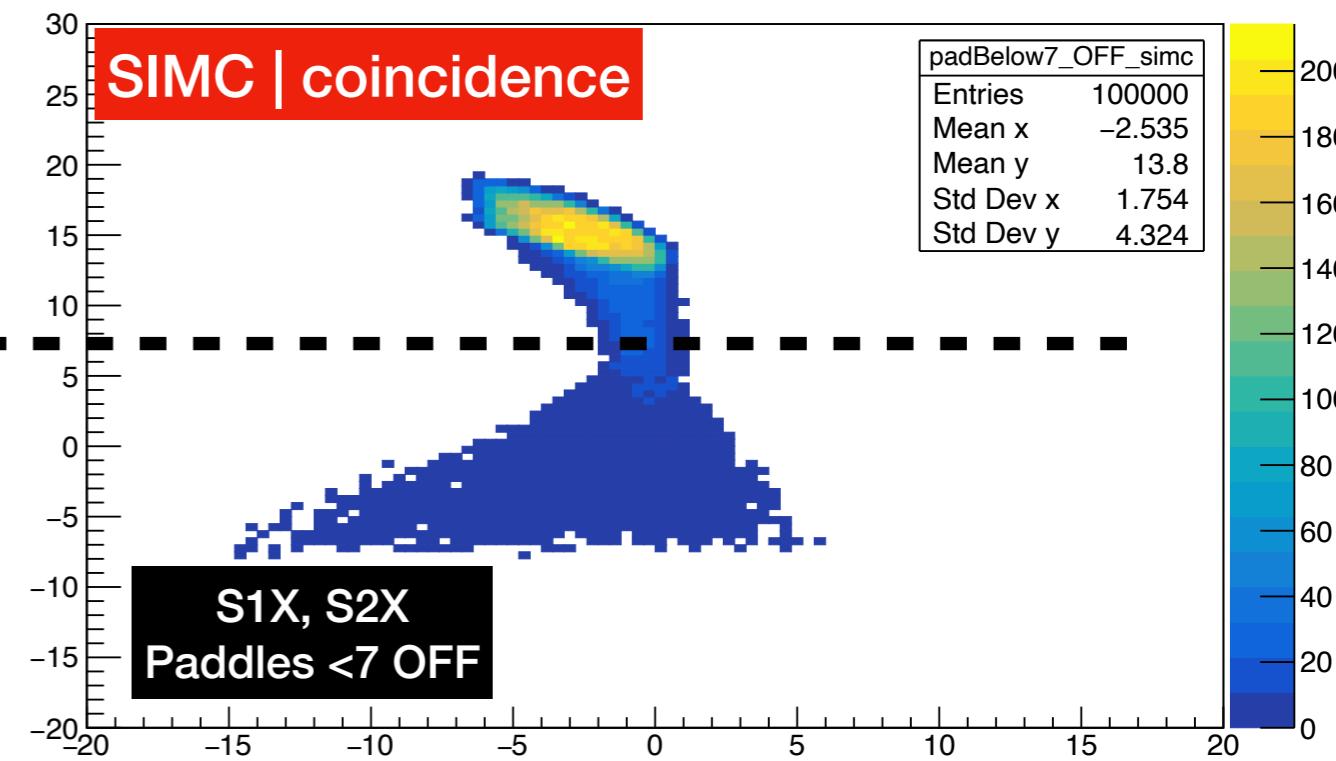
P.dc.x\_fp:P.dc.y\_fp {P.cal.etottracknorm>0.6}



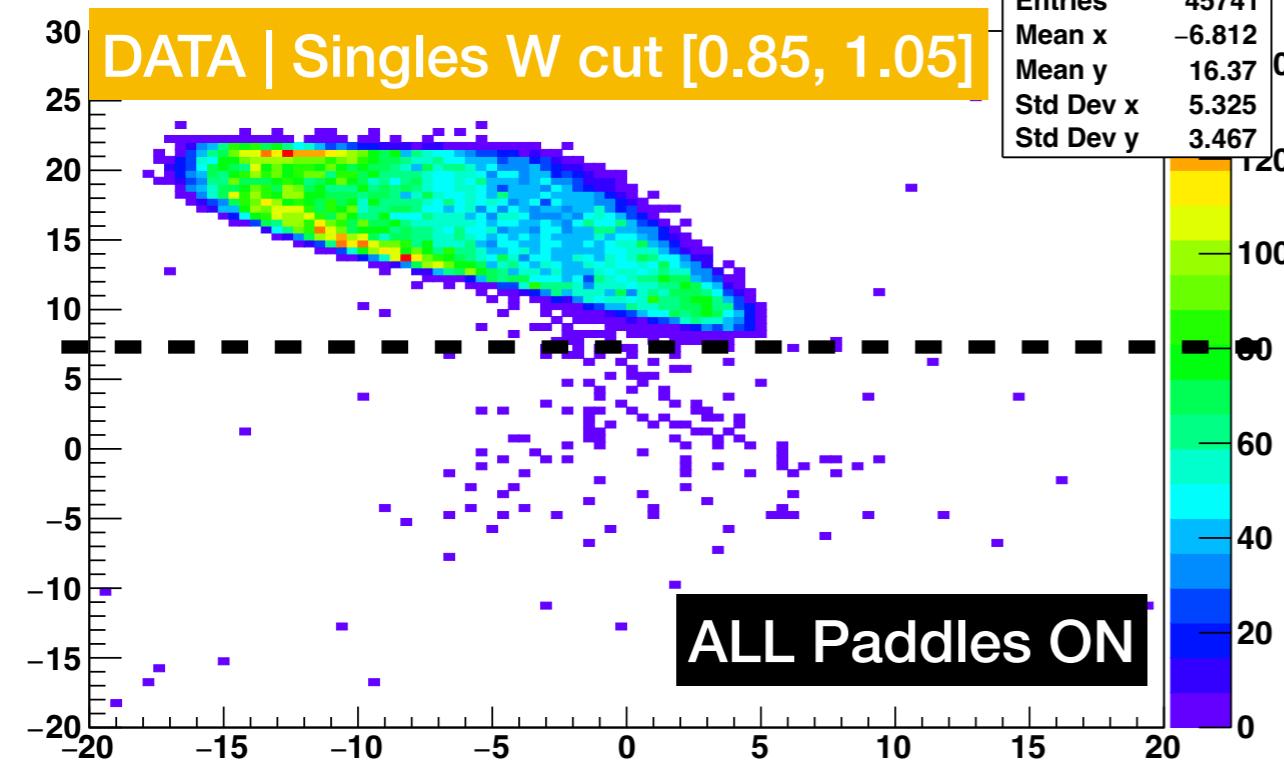
ssxfp:ssyfp {Weight\*0.891790E+06/100000.}



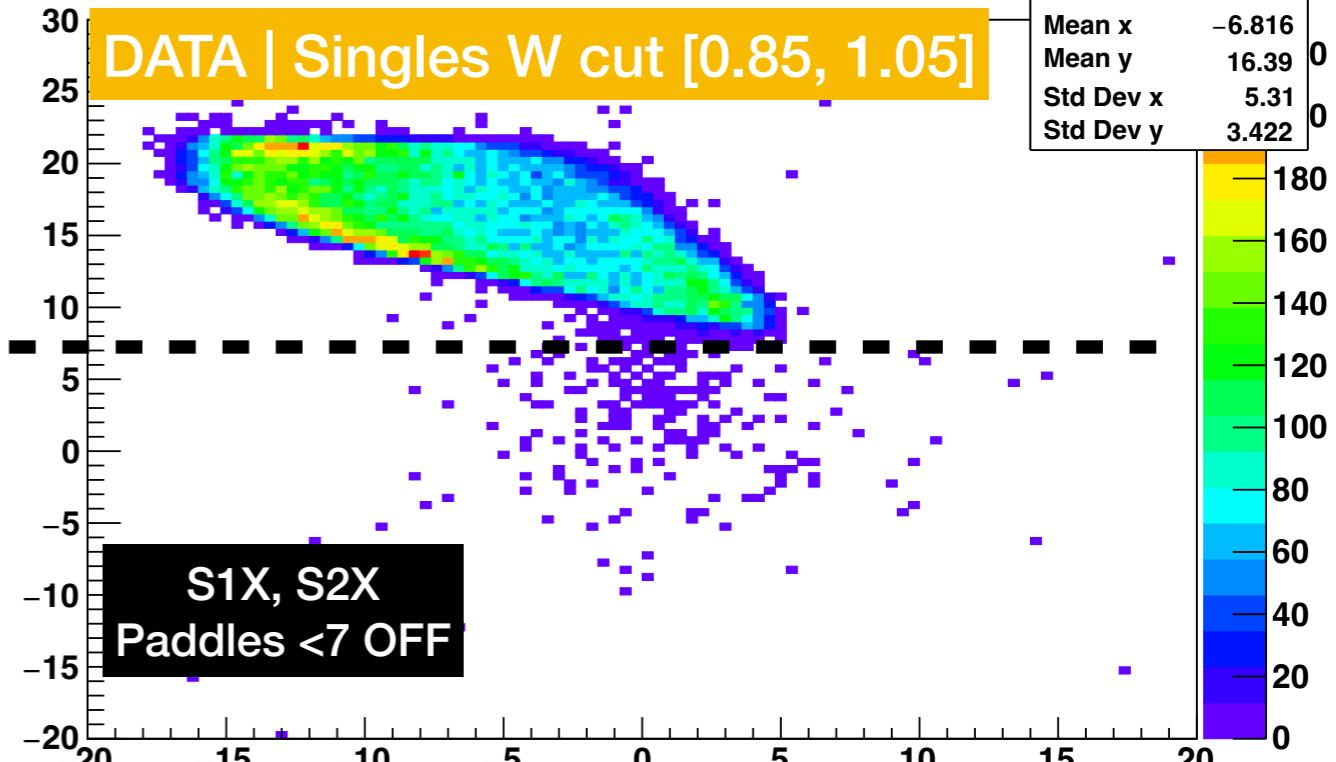
ssxfp:ssyfp {Weight\*0.854215E+06/100000.}



P.dc.x\_fp:P.dc.y\_fp {P.kin.primary.W>0.85&&P.kin.primary.W<1.05&&P.cal.etottracknorm>0.6}

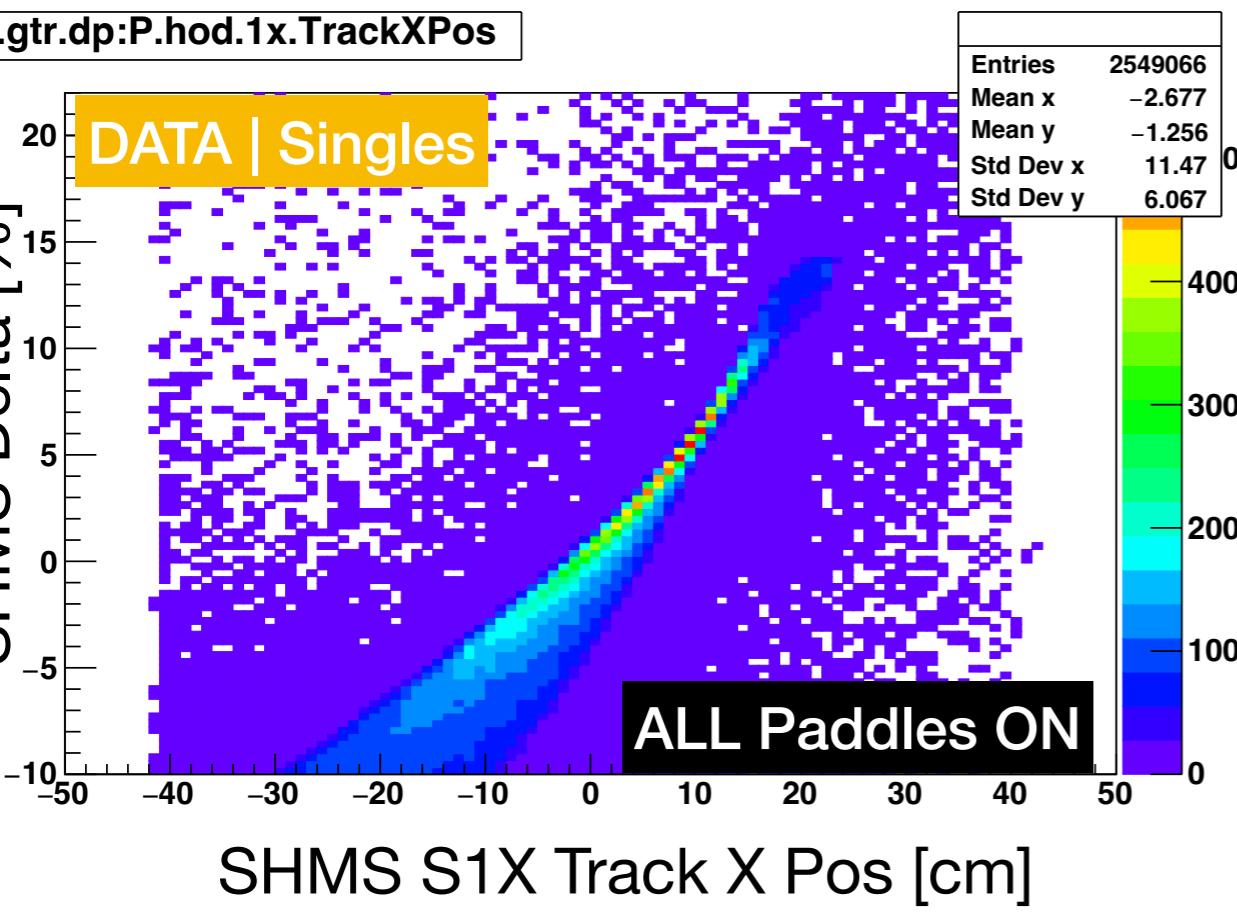


P.dc.x\_fp:P.dc.y\_fp {P.kin.primary.W>0.85&&P.kin.primary.W<1.05&&P.cal.etottracknorm>0.6}



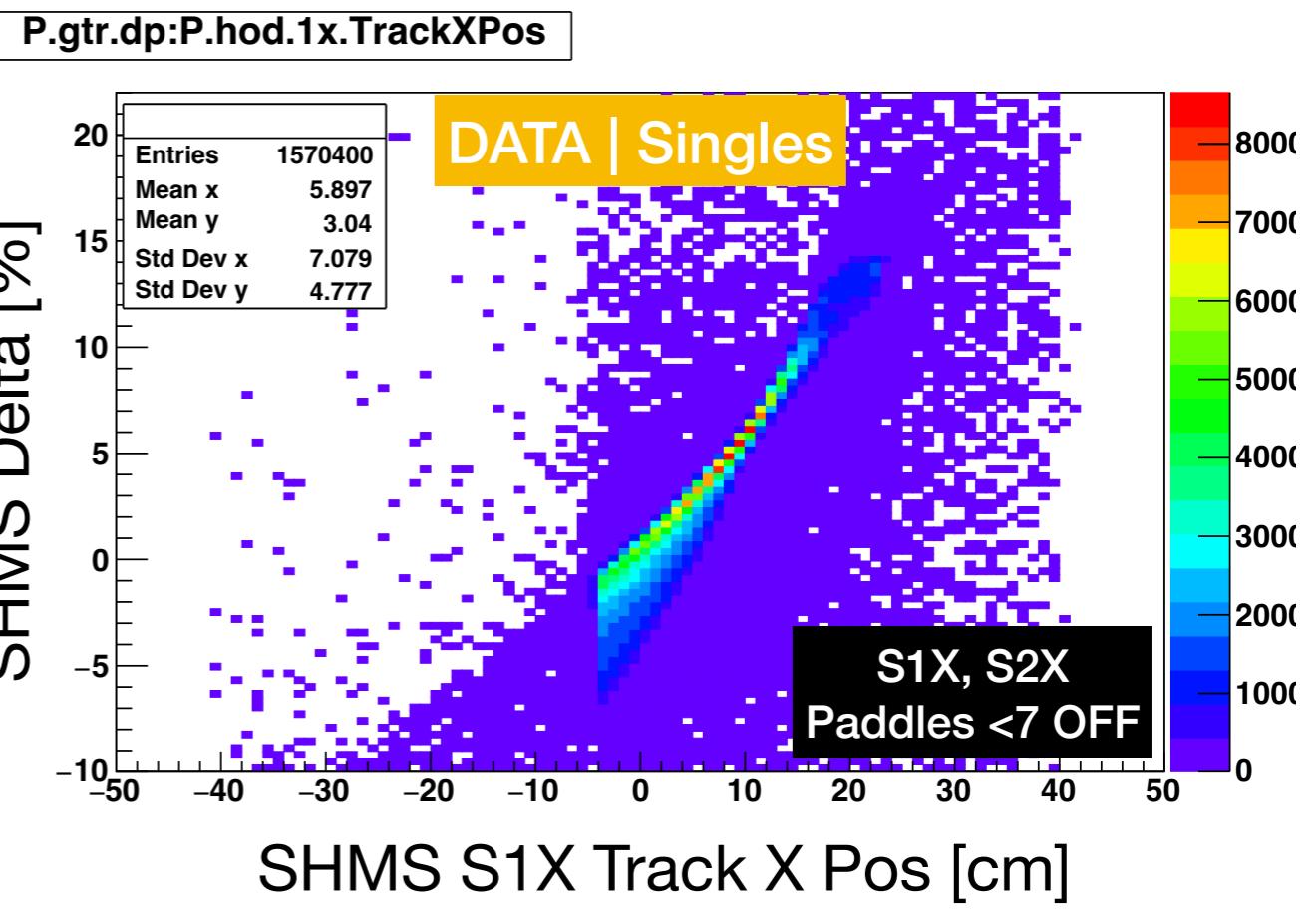
P.gtr.dp:P.hod.1x.TrackXPos

SHMS Delta [%]



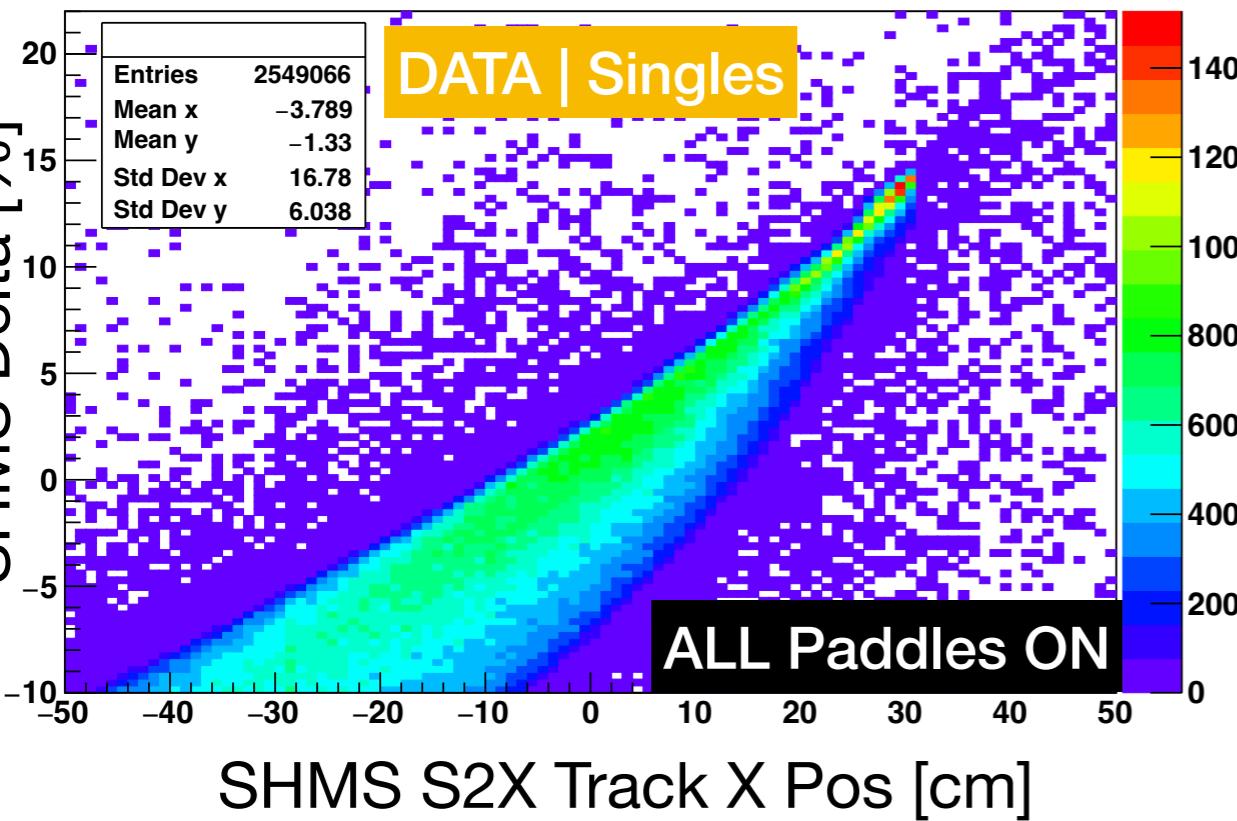
P.gtr.dp:P.hod.1x.TrackXPos

SHMS Delta [%]



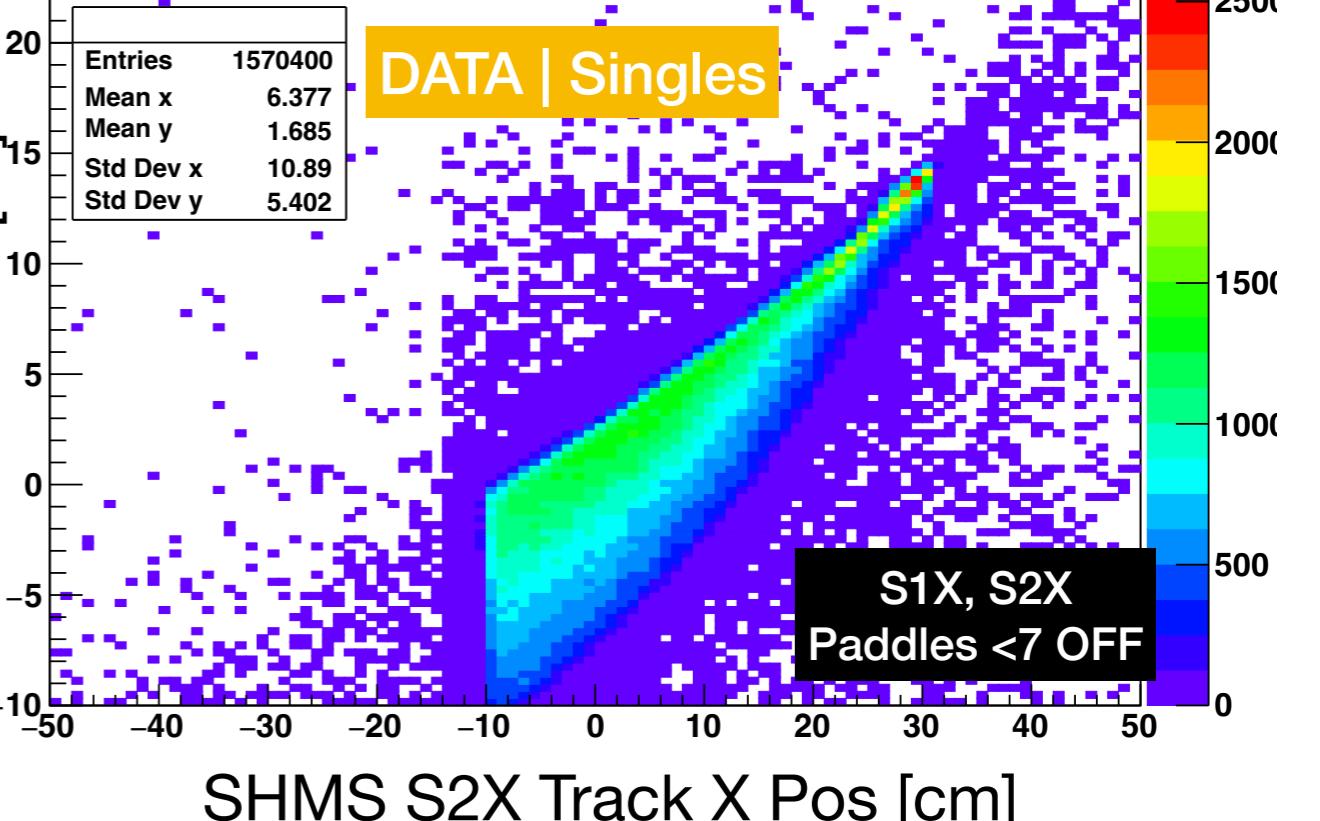
P.gtr.dp:P.hod.2x.TrackXPos

SHMS Delta [%]



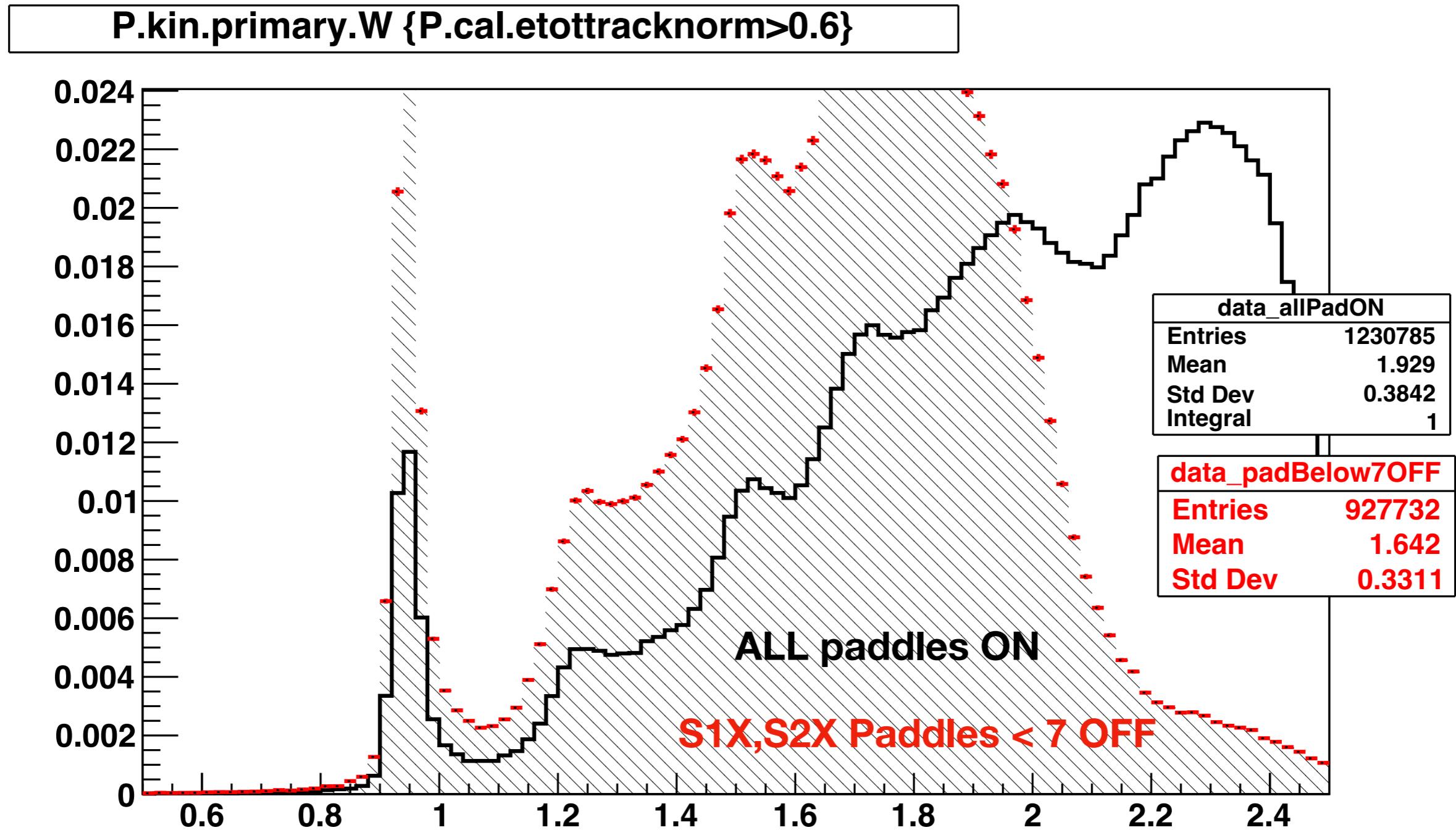
P.gtr.dp:P.hod.2x.TrackXPos

SHMS Delta [%]



\* cut-off on vertical track position on S1X (~ -4 cm) and S2X (~ -10 cm)

# Data Invariant Mass Normalized to Area of 1

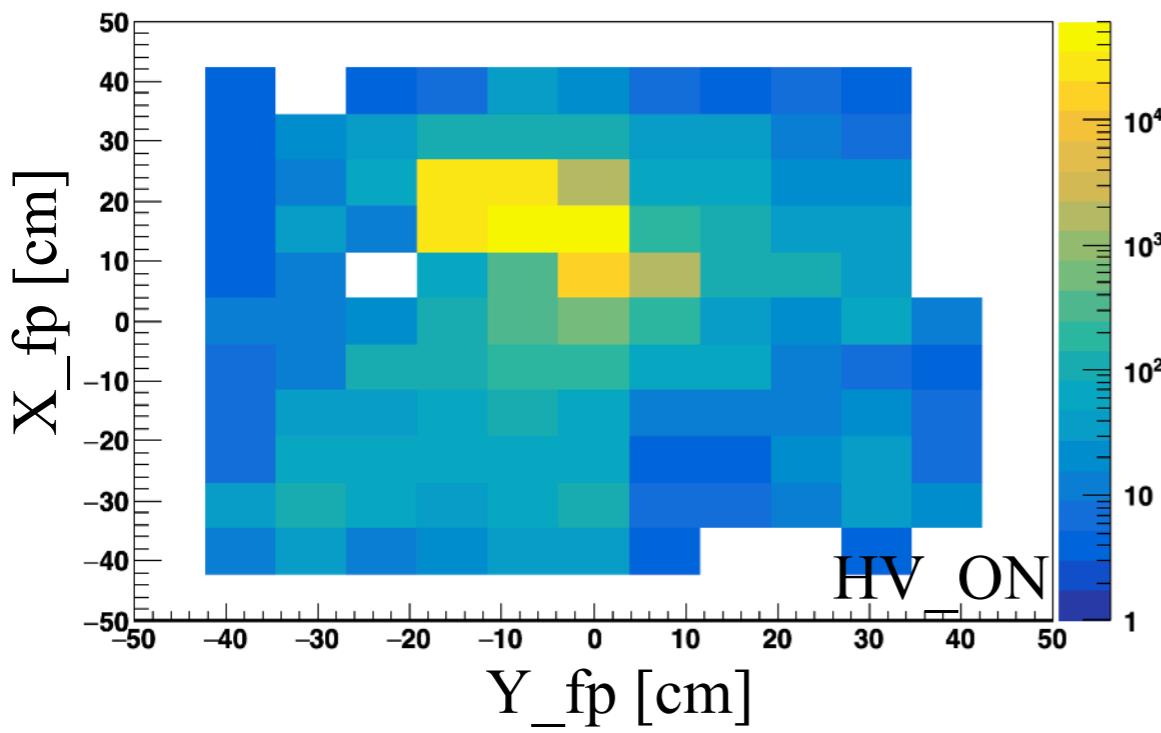


The effect of turning off paddles S1X,S2X <7 is cut-off on DIS region

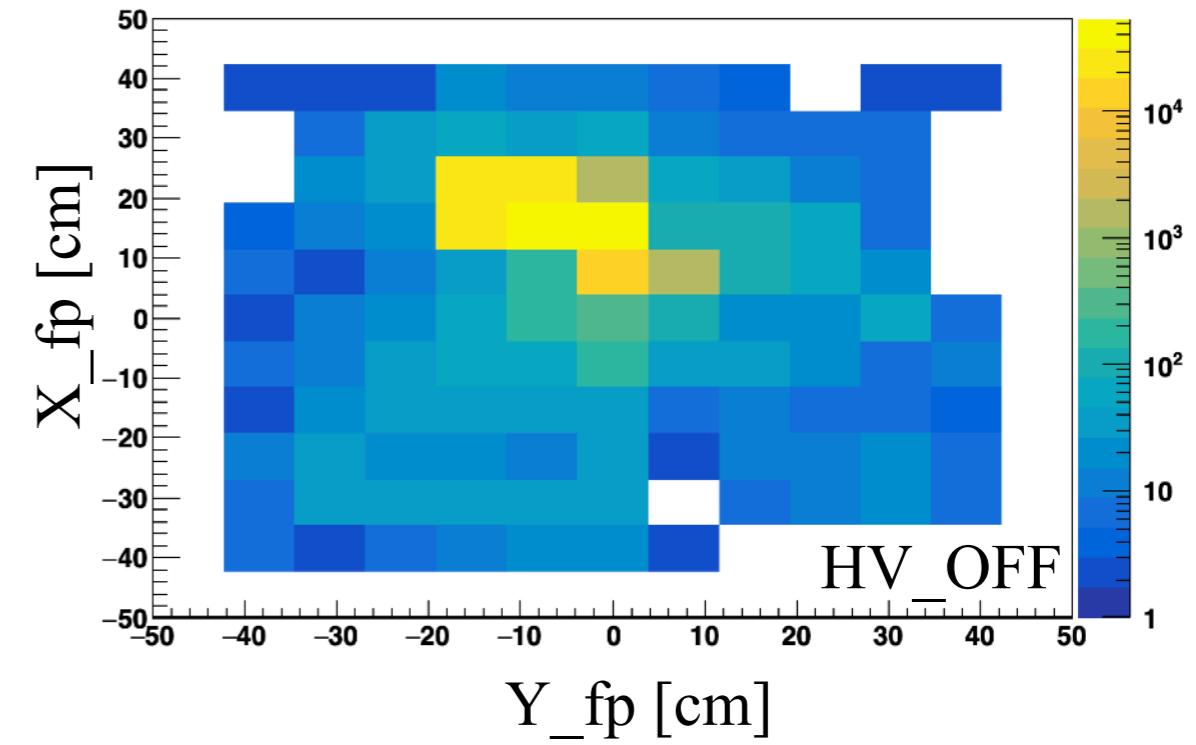
# **SHMS Hodoscopes X vs. Y Histos for HV OFF / HV ON Study**

# SHMS DC Focal Plane

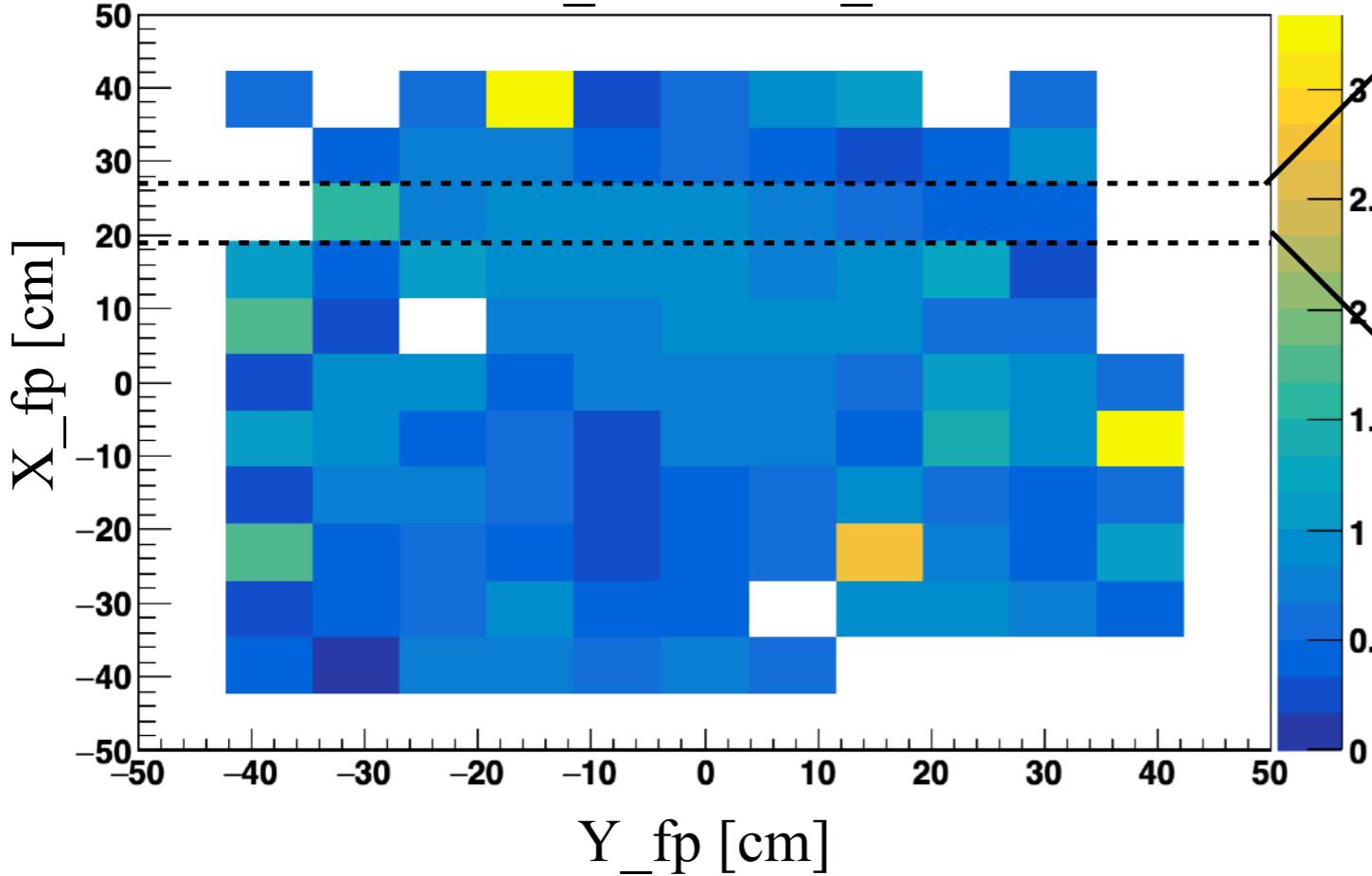
P.dc.x\_fp:P.dc.y\_fp {P.kin.primary.W>0.85&&P.kin.primary.W<1.05}



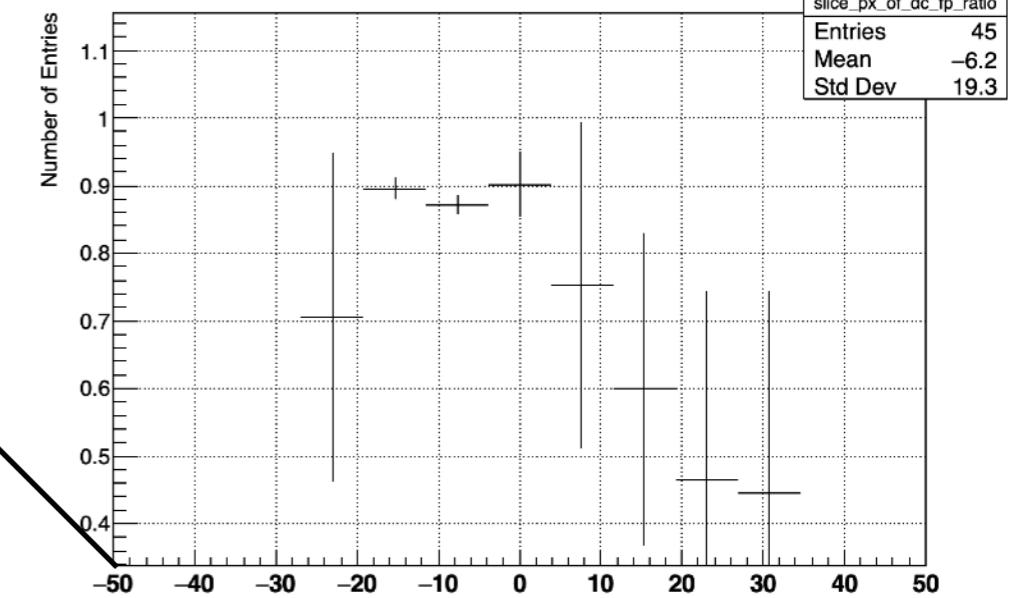
P.dc.x\_fp:P.dc.y\_fp {P.kin.primary.W>0.85&&P.kin.primary.W<1.05}



HV\_OFF / HV\_ON



ProjectionX of biny=10 [y=19..27]



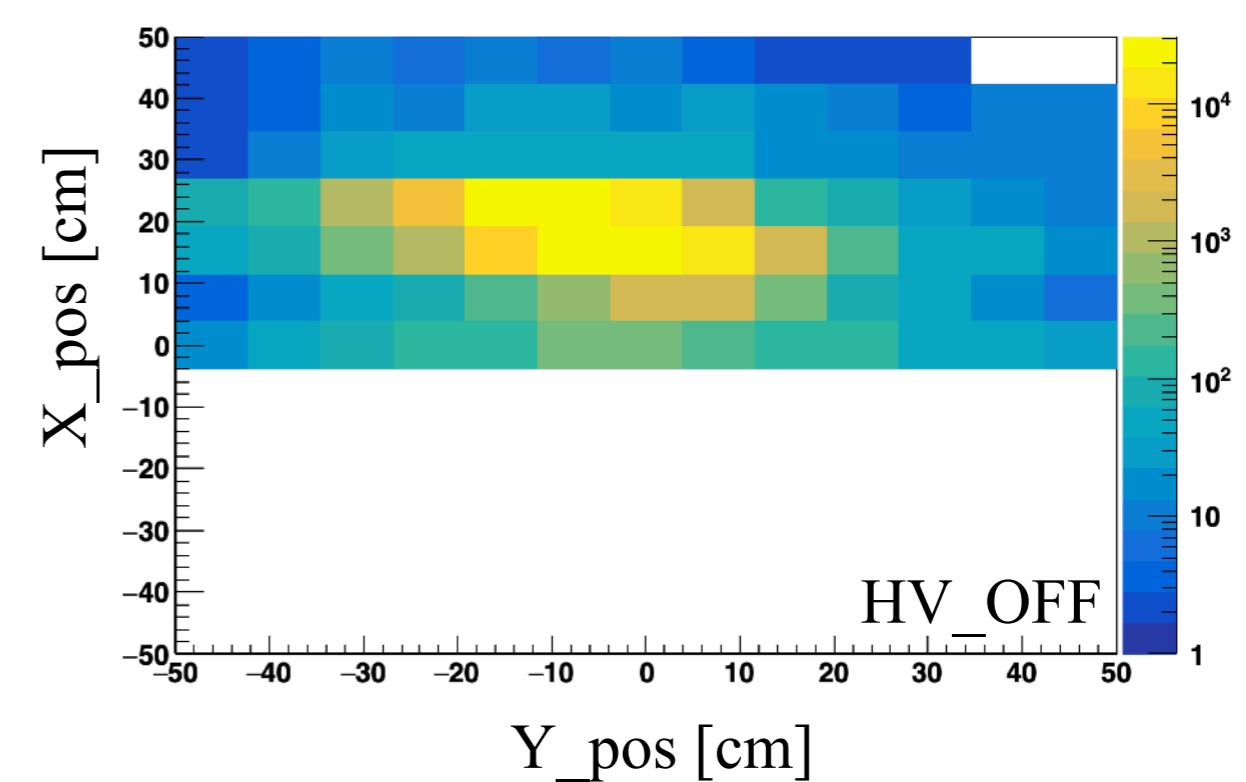
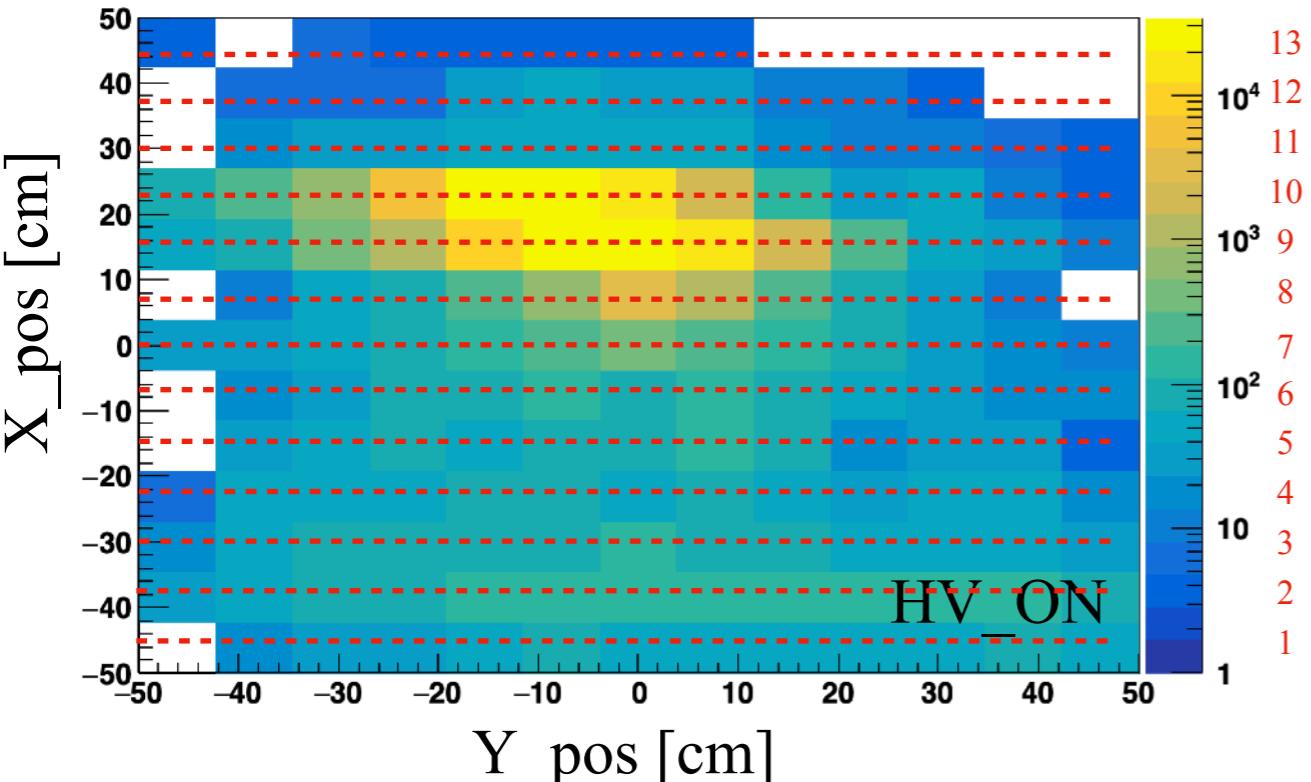
# SHMS S1X Hit Position

--- paddle center +/- 4 cm

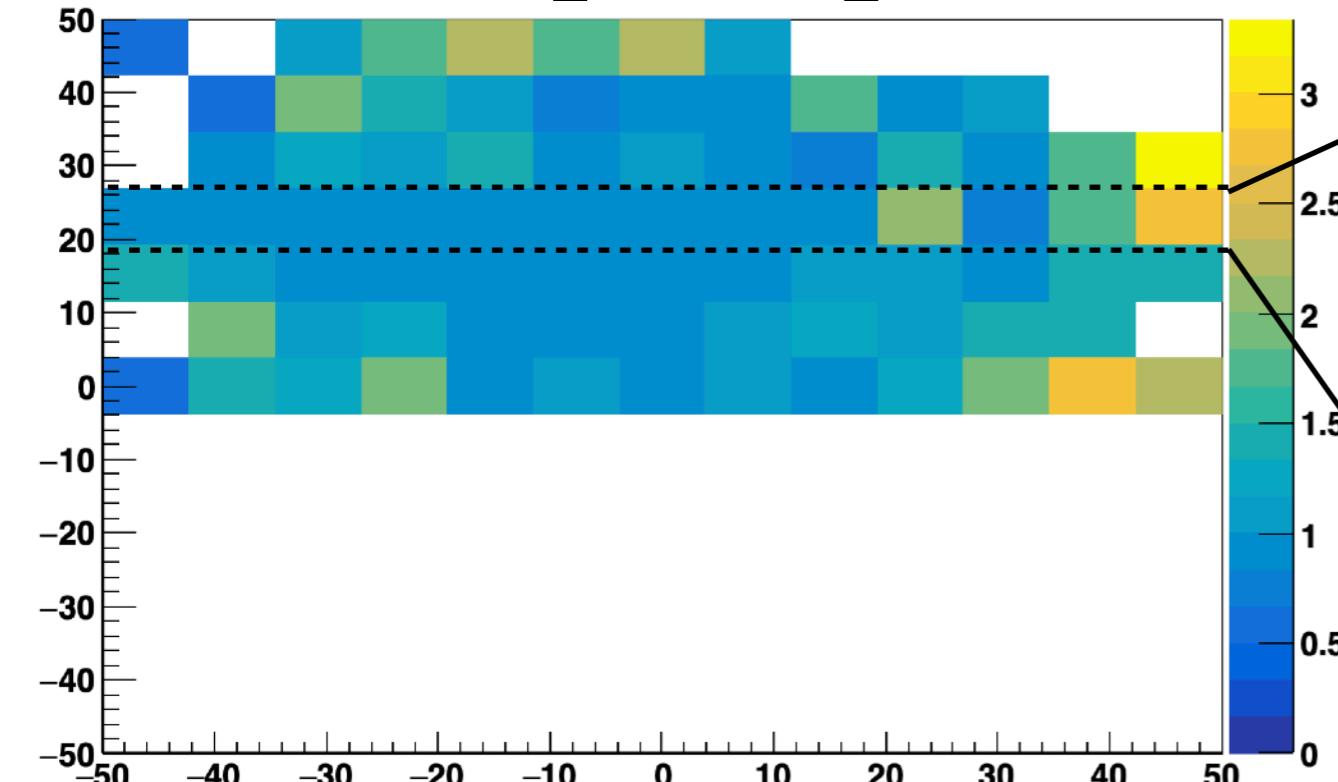
P.hod.1x.ScinXPos:P.hod.1x.ScinYPos {P.kin.primary.W>0.85&&P.kin.primary.W<1.05}

Paddle Number

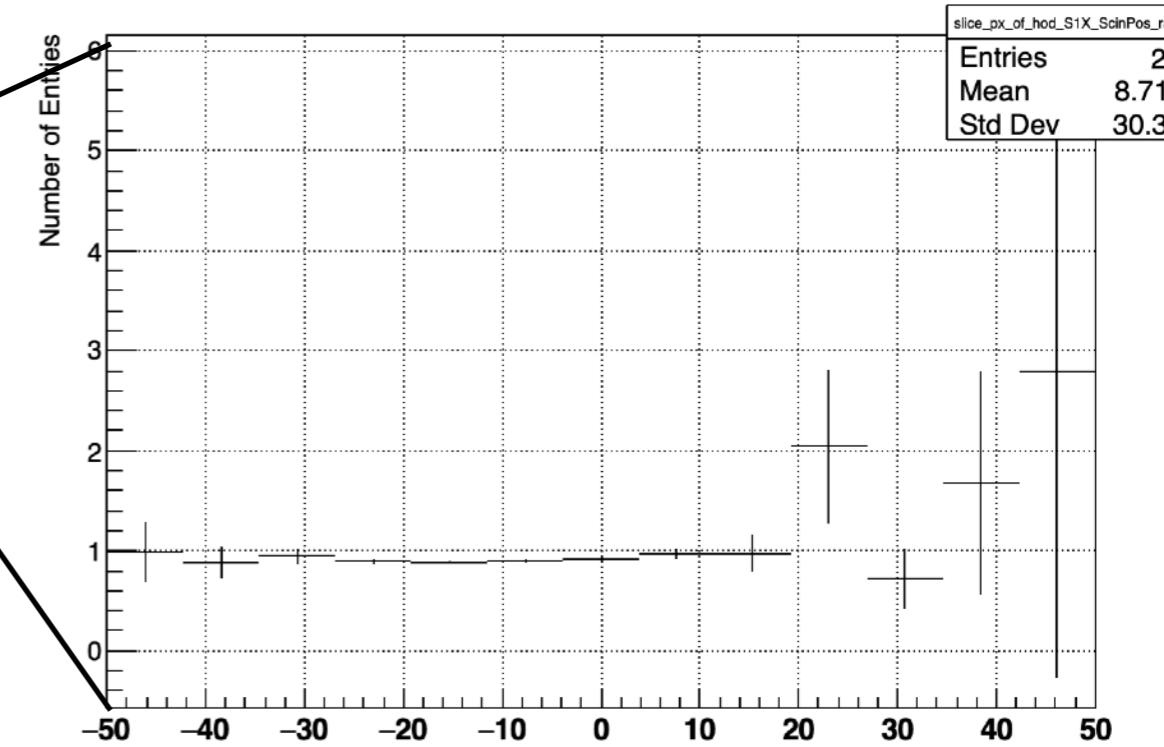
P.hod.1x.ScinXPos:P.hod.1x.ScinYPos {P.kin.primary.W>0.85&&P.kin.primary.W<1.05}



S1X HV\_OFF / HV\_ON

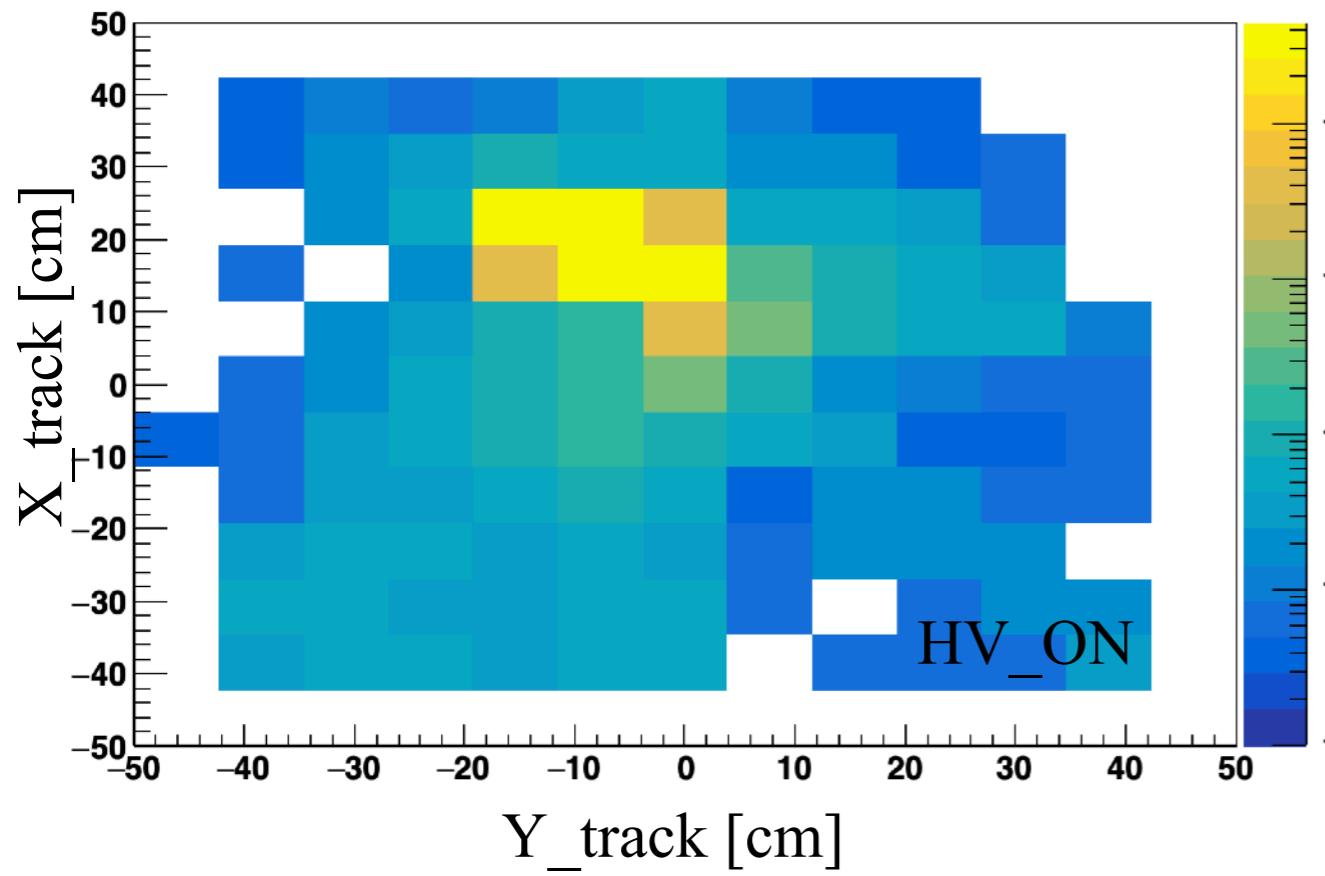


ProjectionX of biny=10 [y=19..27]

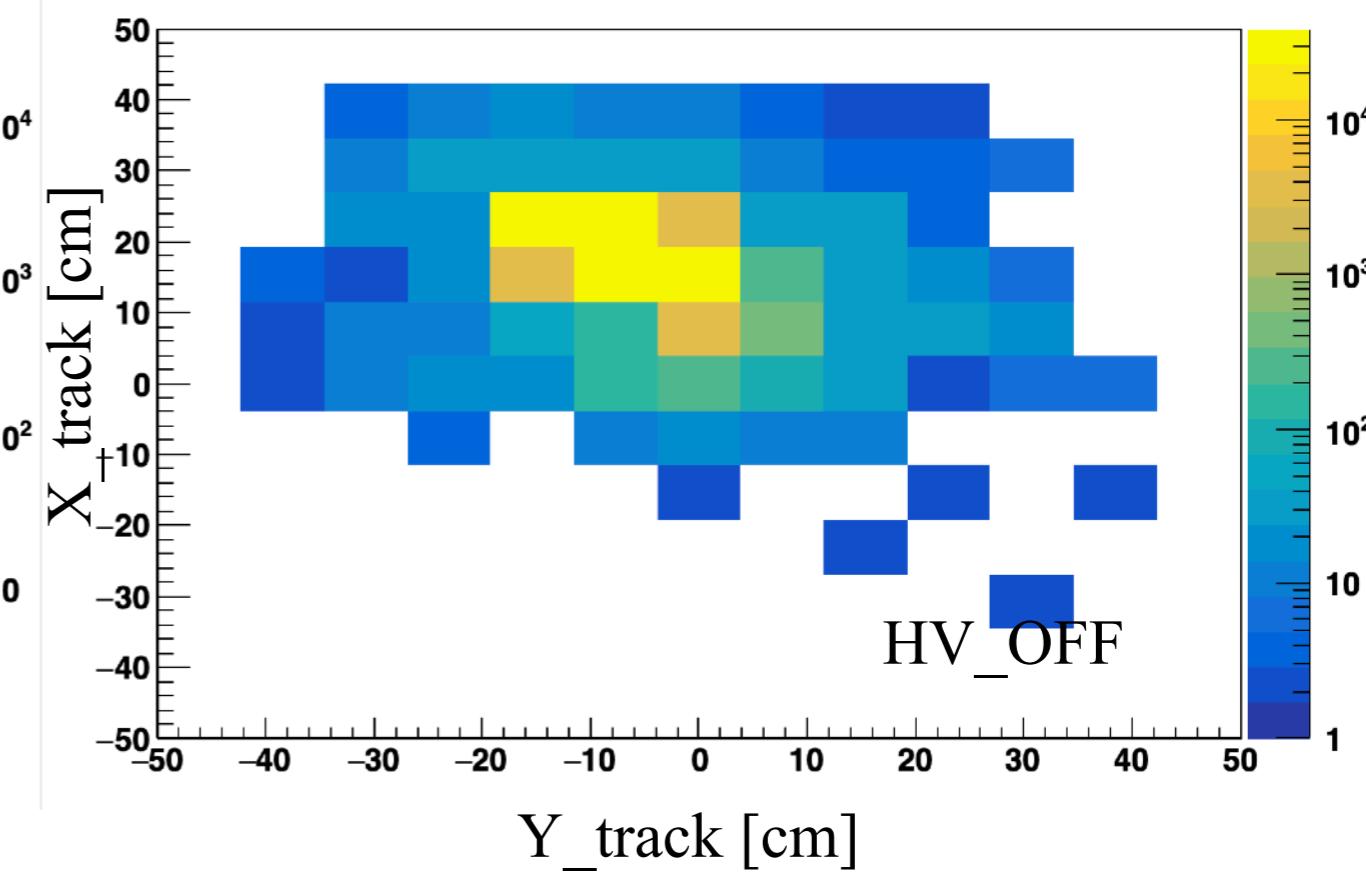


# SHMS S1X Projected Track

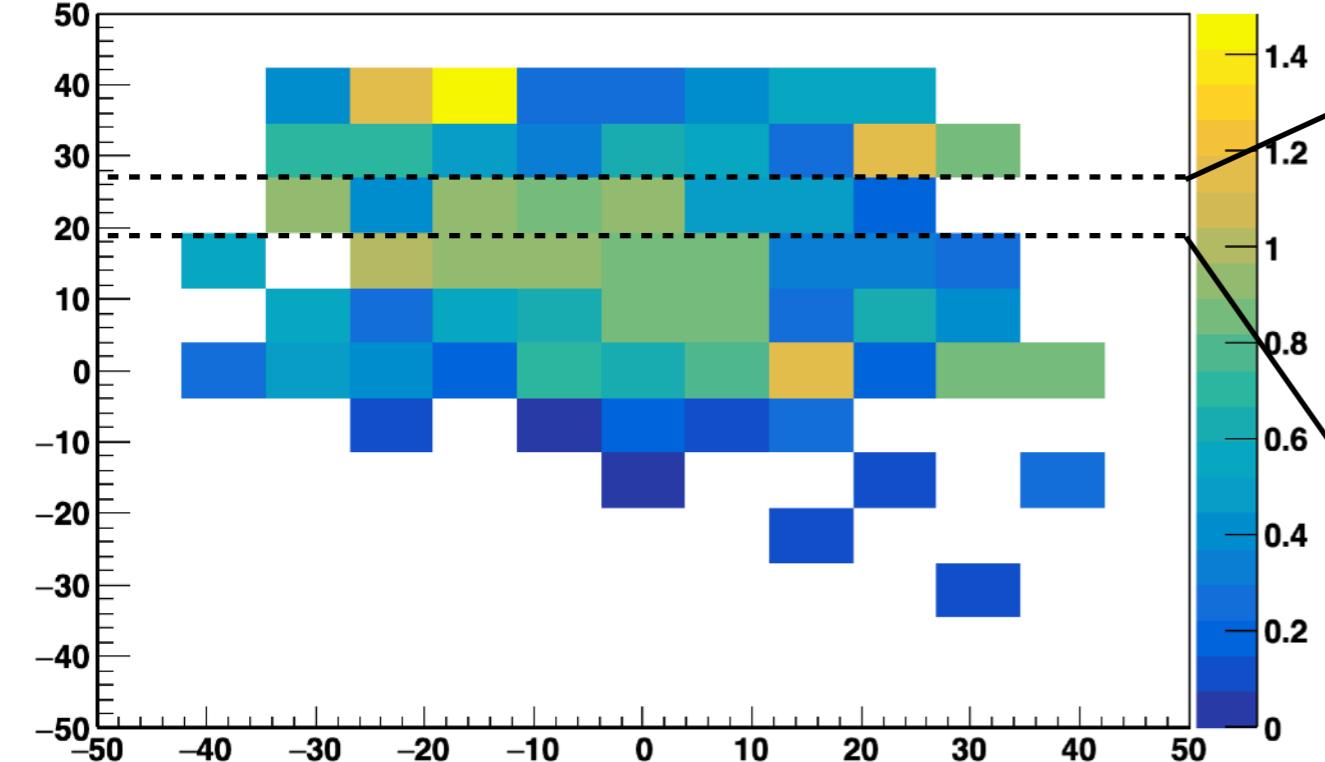
P.hod.1x.TrackXPos:P.hod.1x.TrackYPos {P.kin.primary.W>0.85&&P.kin.primary.W<1.05}



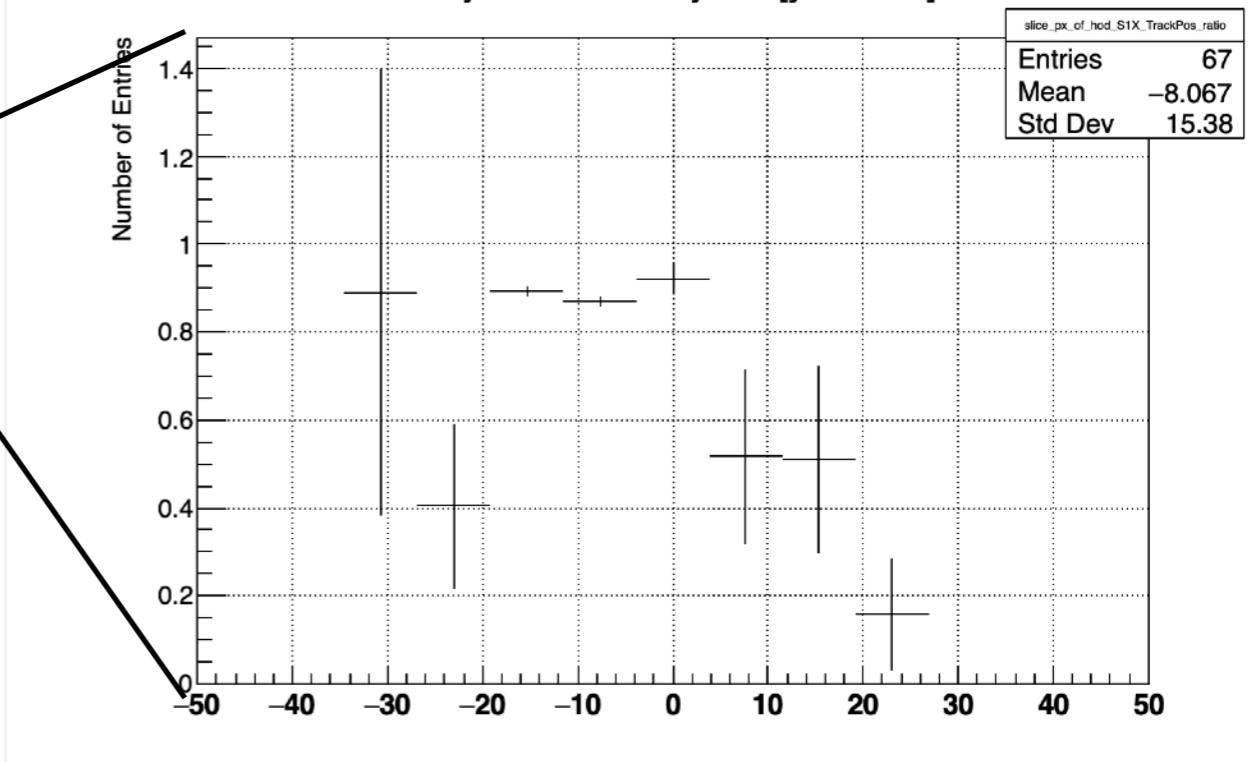
P.hod.1x.TrackXPos:P.hod.1x.TrackYPos {P.kin.primary.W>0.85&&P.kin.primary.W<1.05}



S1X HV\_OFF / HV\_ON



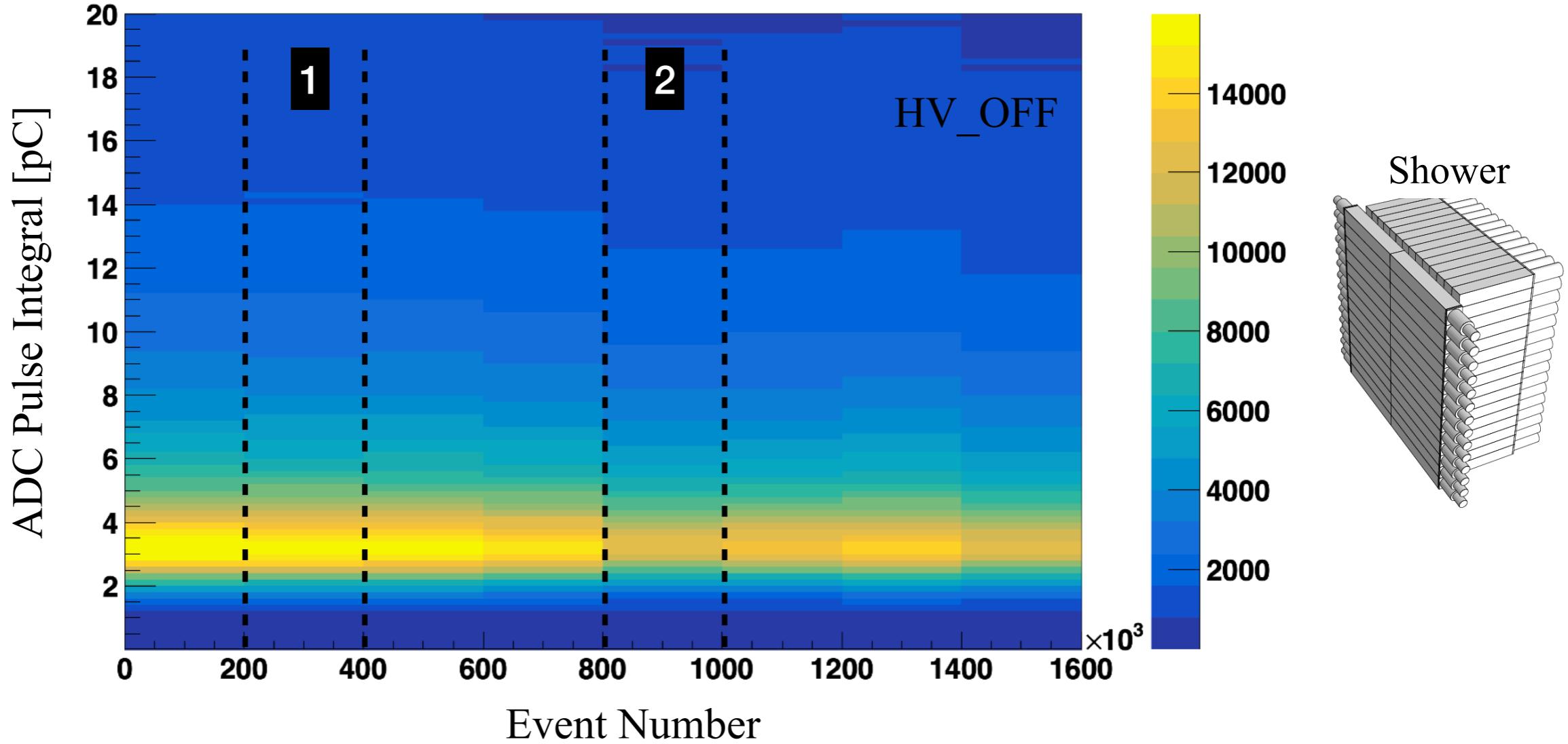
ProjectionX of biny=10 [y=19..27]



# **SHMS Calorimeter fADC Pulse Histos for HV OFF / HV ON Study**

# SHMS Shower

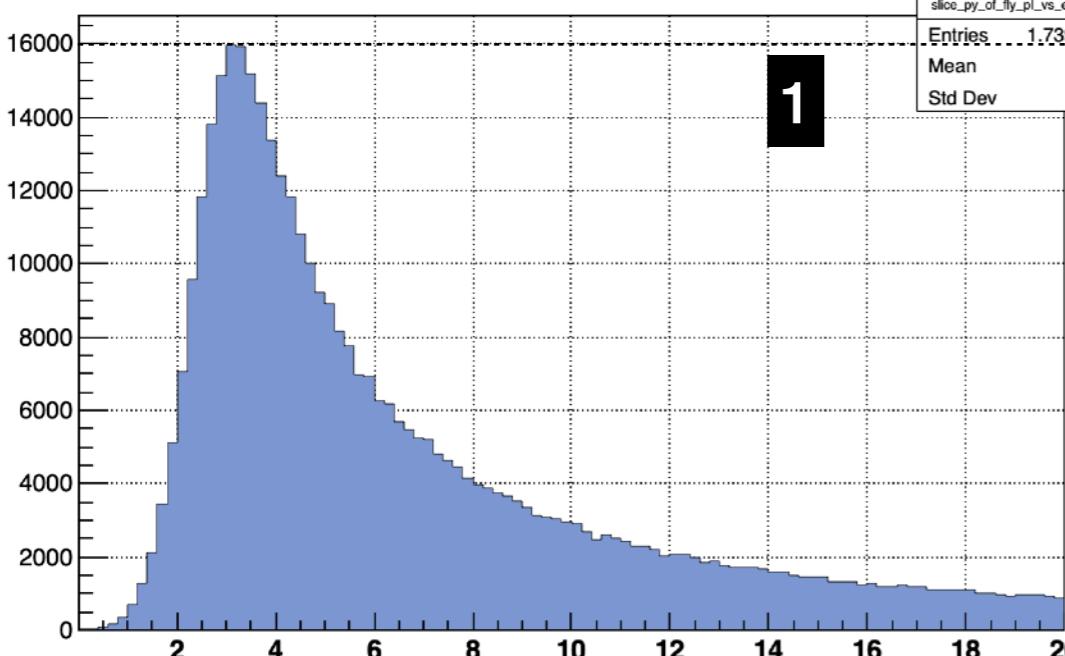
P.cal.fly.goodAdcPulseInt:g.evnum



ProjectionY of binx=2 [x=200000.000000..400000.000000]

slice_py_of_fly_pl_vs_evNum_hvOFF		
Entries	1.739373e+07	
Mean	6.582	
Std Dev	4.313	

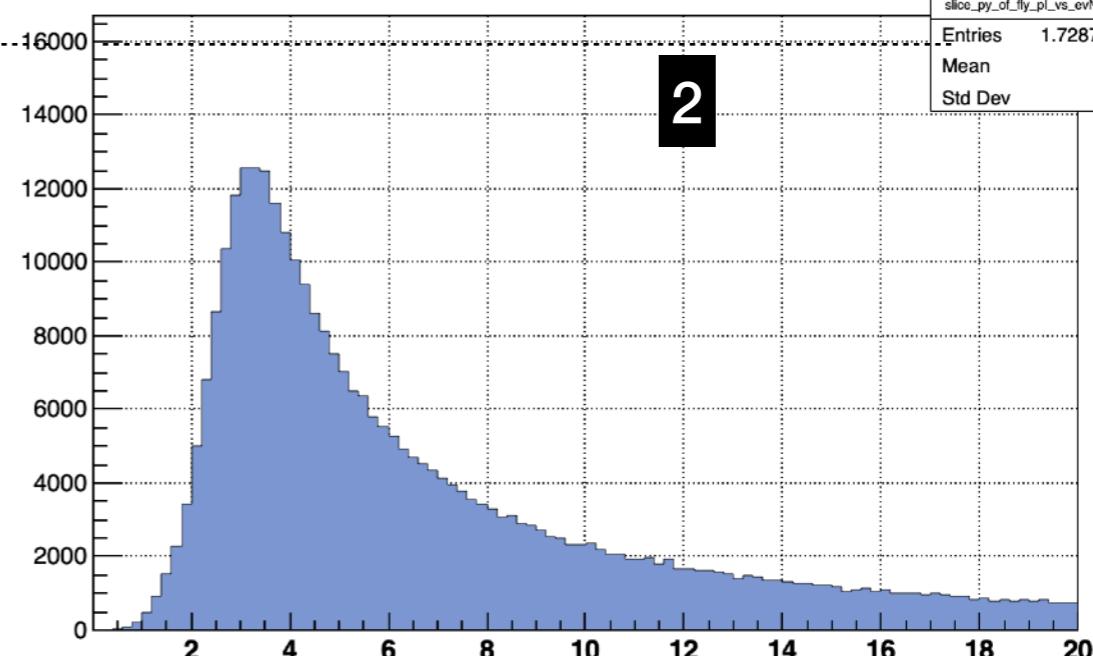
Number of Entries



ProjectionY of binx=5 [x=800000.000000..1000000.000000]

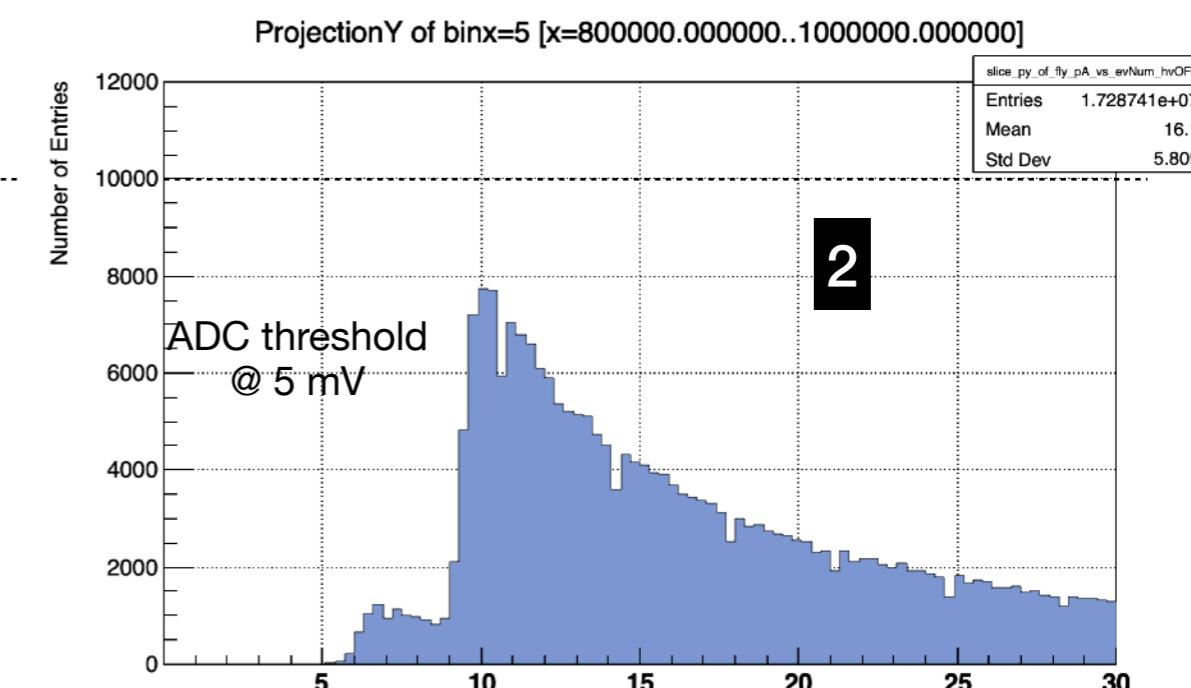
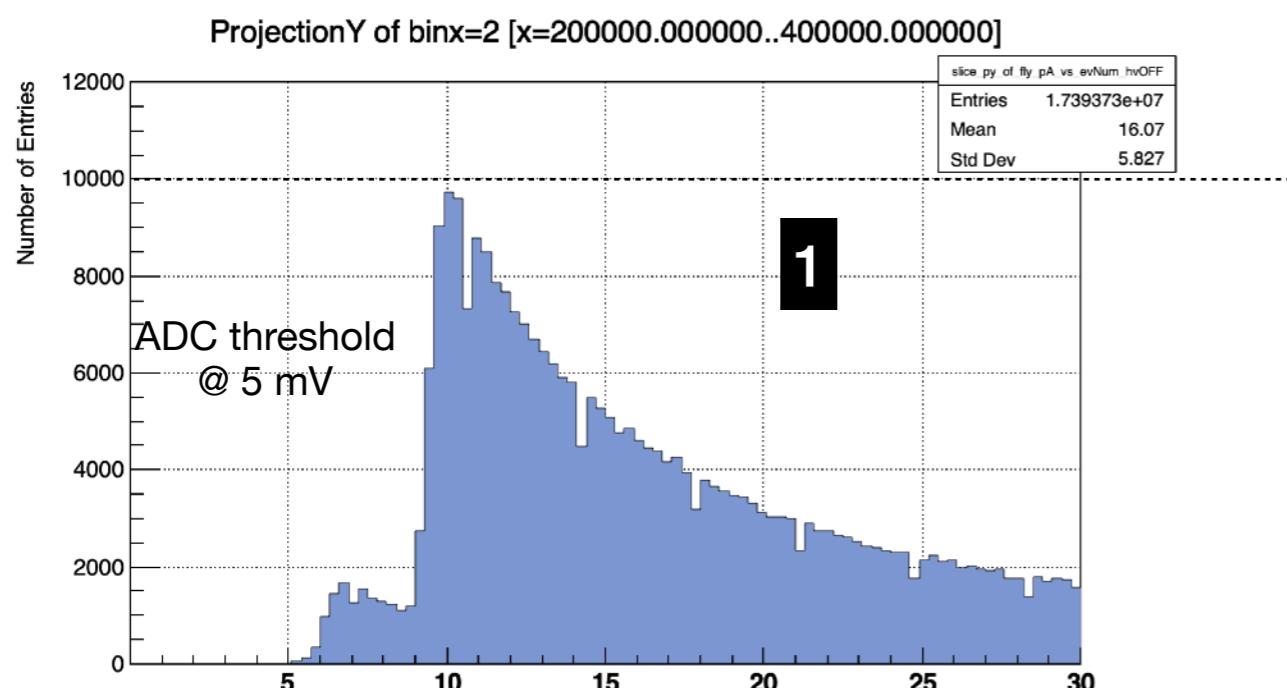
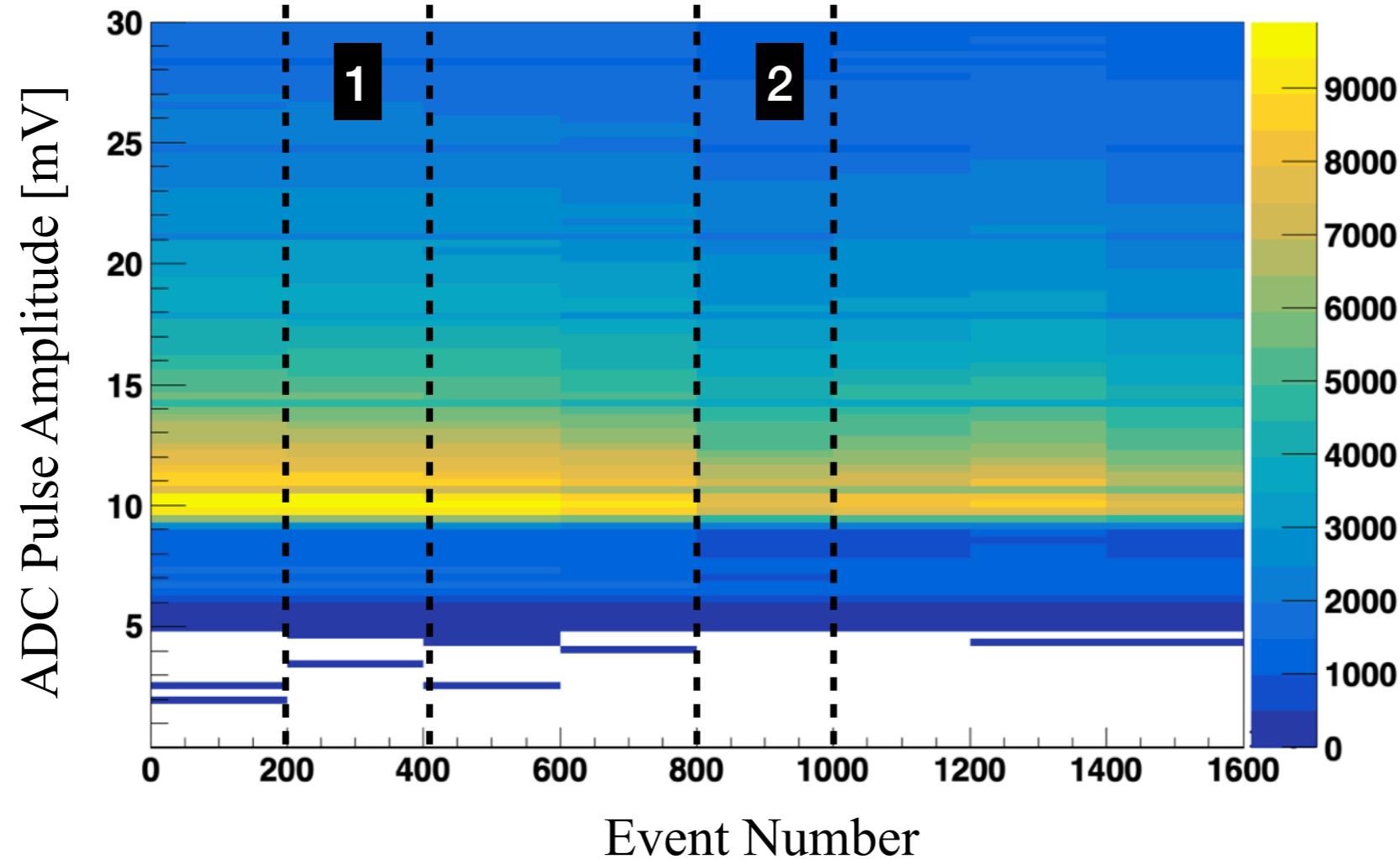
slice_py_of_fly_pl_vs_evNum_hvOFF		
Entries	1.728741e+07	
Mean	6.687	
Std Dev	4.329	

Number of Entries



# SHMS Shower

P.cal.fly.goodAdcPulseAmp:g.evnum



SHMS CALORIMETER SHOWER MAP (FRONT VIEW)														
HV PATCH LABEL (hut)	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN 11	COLUMN 12	COLUMN 13	COLUMN 14
ROW 1 sSH01	1	17	33	49	65	81	97	113	129	145	161	177	193	209
	HV:C1-R1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1	10-1	11-1	12-1	13-1	14-1
	SGL:C1-R1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	9-1	10-1	11-1	12-1	13-1	14-1
ROW 2 sSH02	2	18	34	50	66	82	98	114	130	146	162	178	194	210
	HV:C1-R2	2-2	3-2	4-2	5-2	6-2	7-2	8-2	9-2	10-2	11-2	12-2	13-2	14-2
	SGL:C1-R2	2-2	3-2	4-2	5-2	6-2	7-2	8-2	9-2	10-2	11-2	12-2	13-2	14-2
ROW 3 sSH03	3	19	35	51	67	83	99	115	131	147	163	179	195	211
	HV:C1-R3	2-3	3-3	4-3	5-3	6-3	7-3	8-3	9-3	10-3	11-3	12-3	13-3	14-3
	SGL:C1-R3	2-3	3-3	4-3	5-3	6-3	7-3	8-3	9-3	10-3	11-3	12-3	13-3	14-3
ROW 4 sSH04	4	20	36	52	68	84	100	116	132	148	164	180	196	212
	HV:C1-R4	2-4	3-4	4-4	5-4	6-4	7-4	8-4	9-4	10-4	11-4	12-4	13-4	14-4
	SGL:C1-R4	2-4	3-4	4-4	5-4	6-4	7-4	8-4	9-4	10-4	11-4	12-4	13-4	14-4
ROW 5 sSH05	5	21	37	53	69	85	101	117	133	149	165	181	197	213
	HV:C1-R5	2-5	3-5	4-5	5-5	6-5	7-5	8-5	9-5	10-5	11-5	12-5	13-5	14-5
	SGL:C1-R5	2-5	3-5	4-5	5-5	6-5	7-5	8-5	9-5	10-5	11-5	12-5	13-5	14-5
ROW 6 sSH06	6	22	38	54	70	86	102	118	134	150	166	182	198	214
	HV:C1-R6	2-6	3-6	4-6	5-6	6-6	7-6	8-6	9-6	10-6	11-6	12-6	13-6	14-6
	SGL:C1-R6	2-6	3-6	4-6	5-6	6-6	7-6	8-6	9-6	10-6	11-6	12-6	13-6	14-6
ROW 7 sSH07	7	23	39	55	71	87	103	119	135	151	167	183	199	215
	HV:C1-R7	2-7	3-7	4-7	5-7	6-7	7-7	8-7	9-7	10-7	11-7	12-7	13-7	14-7
	SGL:C1-R7	2-7	3-7	4-7	5-7	6-7	7-7	8-7	9-7	10-7	11-7	12-7	13-7	14-7
ROW 8 sSH08	8	24	40	56	72	88	104	120	136	152	168	184	200	216
	HV:C1-R8	2-8	3-8	4-8	5-8	6-8	7-8	8-8	9-8	10-8	11-8	12-8	13-8	14-8
	SGL:C1-R8	2-8	3-8	4-8	5-8	6-8	7-8	8-8	9-8	10-8	11-8	12-8	13-8	14-8
ROW 9 sSH09	9	25	41	57	73	89	105	121	137	153	169	185	201	217
	HV:C1-R9	2-9	3-9	4-9	5-9	6-9	7-9	8-9	9-9	10-9	11-9	12-9	13-9	14-9
	SGL:C1-R9	2-9	3-9	4-9	5-9	6-9	7-9	8-9	9-9	10-9	11-9	12-9	13-9	14-9
ROW 10 sSH10	10	26	42	58	74	90	106	122	138	154	170	186	202	218
	HV:C1-R10	2-10	3-10	4-10	5-10	6-10	7-10	8-10	9-10	10-10	11-10	12-10	13-10	14-10
	SGL:C1-R10	2-10	3-10	4-10	5-10	6-10	7-10	8-10	9-10	10-10	11-10	12-10	13-10	14-10
ROW 11 sSH11	11	27	43	59	75	91	107	123	139	155	171	187	203	219
	HV:C1-R11	2-11	3-11	4-11	5-11	6-11	7-11	8-11	9-11	10-11	11-11	12-11	13-11	14-11
	SGL:C1-R11	2-11	3-11	4-11	5-11	6-11	7-11	8-11	9-11	10-11	11-11	12-11	13-11	14-11
ROW 12 sSH12	12	28	44	60	76	92	108	124	140	156	172	188	204	220
	HV:C1-R12	2-12	3-12	4-12	5-12	6-12	7-12	8-12	9-12	10-12	11-12	12-12	13-12	14-12
	SGL:C1-R12	2-12	3-12	4-12	5-12	6-12	7-12	8-12	9-12	10-12	11-12	12-12	13-12	14-12
ROW 13 sSH13	13	29	45	61	77	93	109	125	141	157	173	189	205	221
	HV:C1-R13	2-13	3-13	4-13	5-13	6-13	7-13	8-13	9-13	10-13	11-13	12-13	13-13	14-13
	SGL:C1-R13	2-13	3-13	4-13	5-13	6-13	7-13	8-13	9-13	10-13	11-13	12-13	13-13	14-13
ROW 14 sSH14	14	30	46	62	78	94	110	126	142	158	174	190	206	222
	HV:C1-R14	2-14	3-14	4-14	5-14	6-14	7-14	8-14	9-14	10-14	11-14	12-14	13-14	14-14
	SGL:C1-R14	2-14	3-14	4-14	5-14	6-14	7-14	8-14	9-14	10-14	11-14	12-14	13-14	14-14
ROW 15 sSH15	15	31	47	63	79	95	111	127	143	159	175	191	207	223
	HV:C1-R15	2-15	3-15	4-15	5-15	6-15	7-15	8-15	9-15	10-15	11-15	12-15	13-15	14-15
	SGL:C1-R15	2-15	3-15	4-15	5-15	6-15	7-15	8-15	9-15	10-15	11-15	12-15	13-15	14-15
ROW 16 sSH16	16	32	48	64	80	96	112	128	144	160	176	192	208	224
	HV:C1-R16	2-16	3-16	4-16	5-16	6-16	7-16	8-16	9-16	10-16	11-16	12-16	13-16	14-16
	SGL:C1-R16	2-16	3-16	4-16	5-16	6-16	7-16	8-16	9-16	10-16	11-16	12-16	13-16	14-16