

CaFe: SHMS Hodoscope HV Study

“Identifying Issue in Data”

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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/5/5b/SHMS_PaddleOFF_for_CaFeStudy_part2.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.

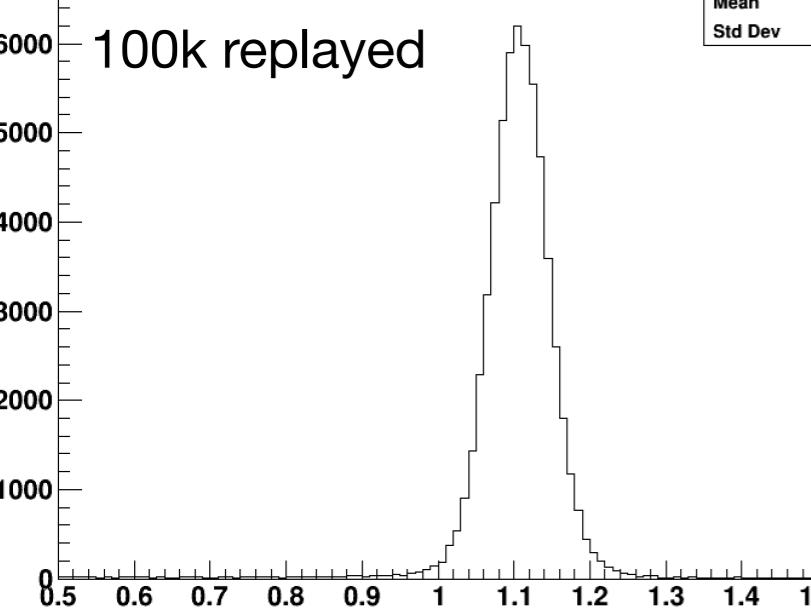
A bit surprising, since the angle is 12.50deg. The HMS fringe field at this momentum must be huge!

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

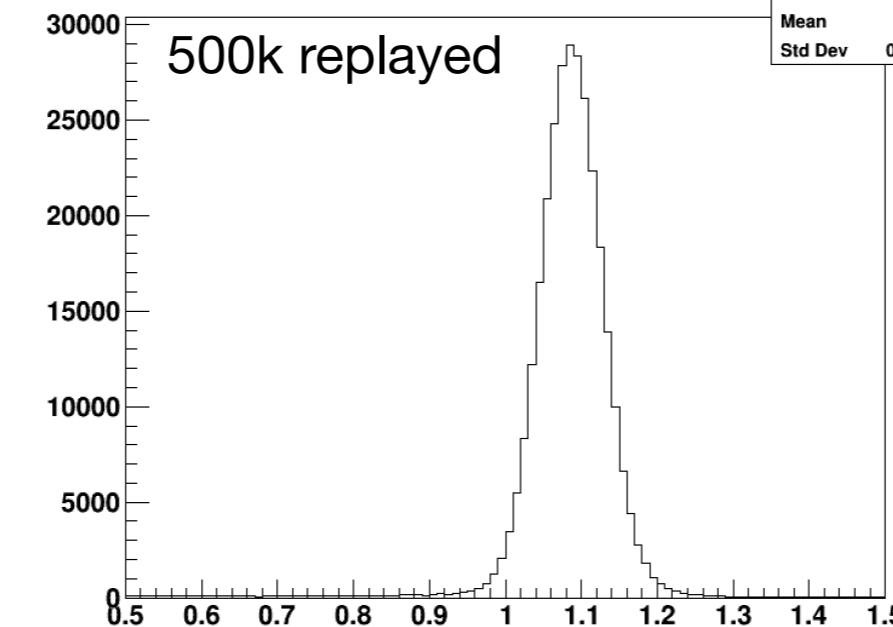


Run 16037 | SHMS Hodo S1X[1-6], S2X[1-6] HV OFF

P.cal.etottracknorm

h500k	
Entries	500000
Mean	1.083
Std Dev	0.06407

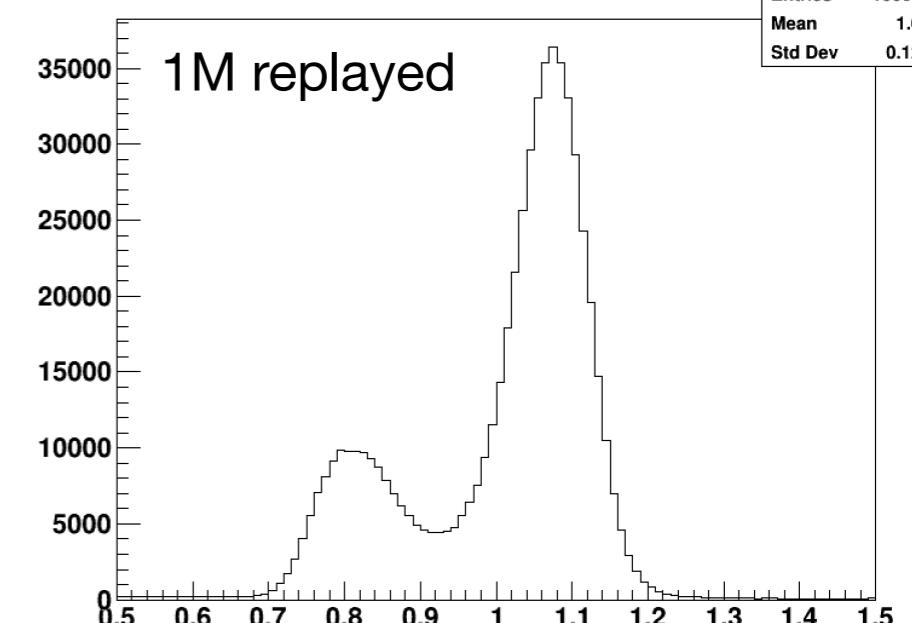
500k replayed



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

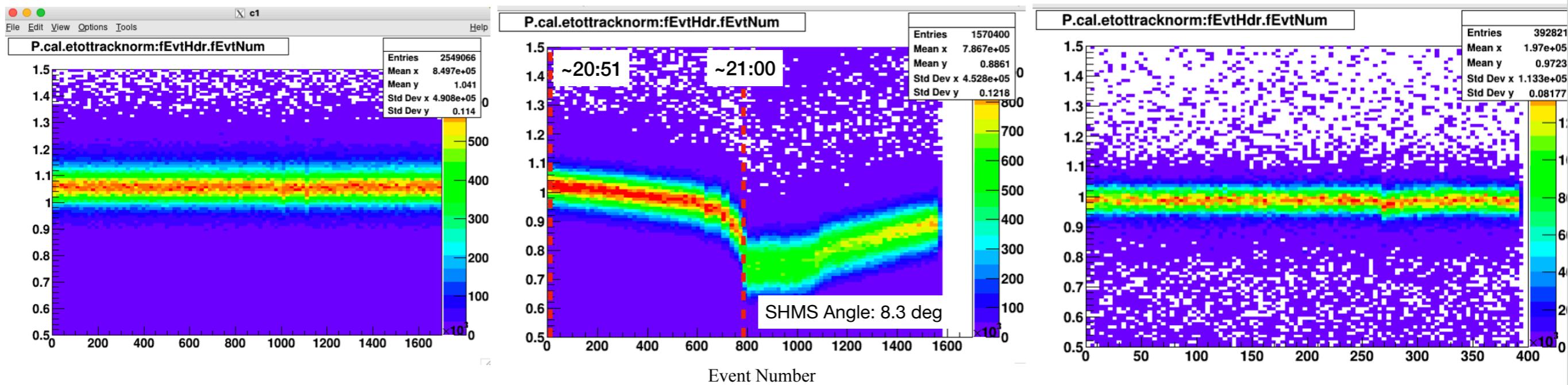
* I tried calibrating calorimeter, but bump still show up

SHMS Calorimeter Energy Deposited / Track Momentum vs. Event Number

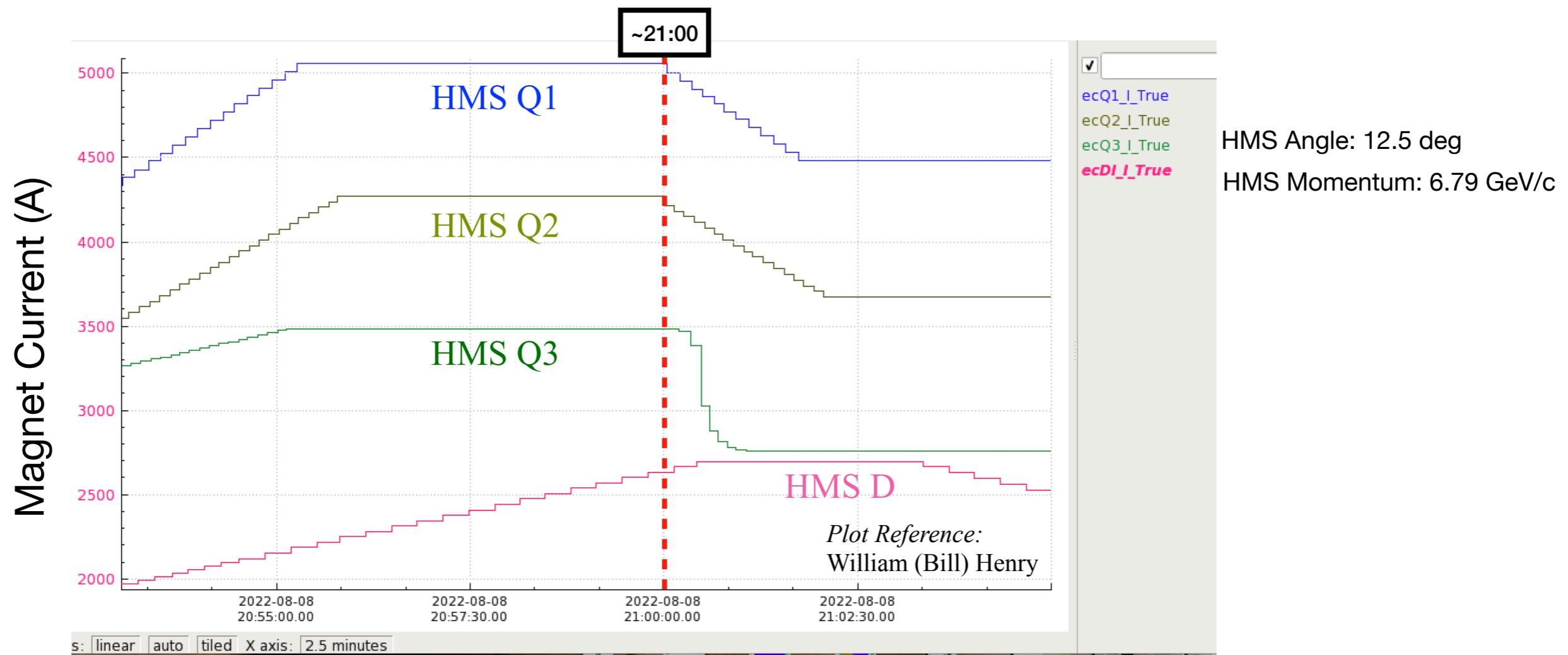
Run 16036 | time: 20:32 - 20:47

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

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



HMS Magnets Current Ramp-Up

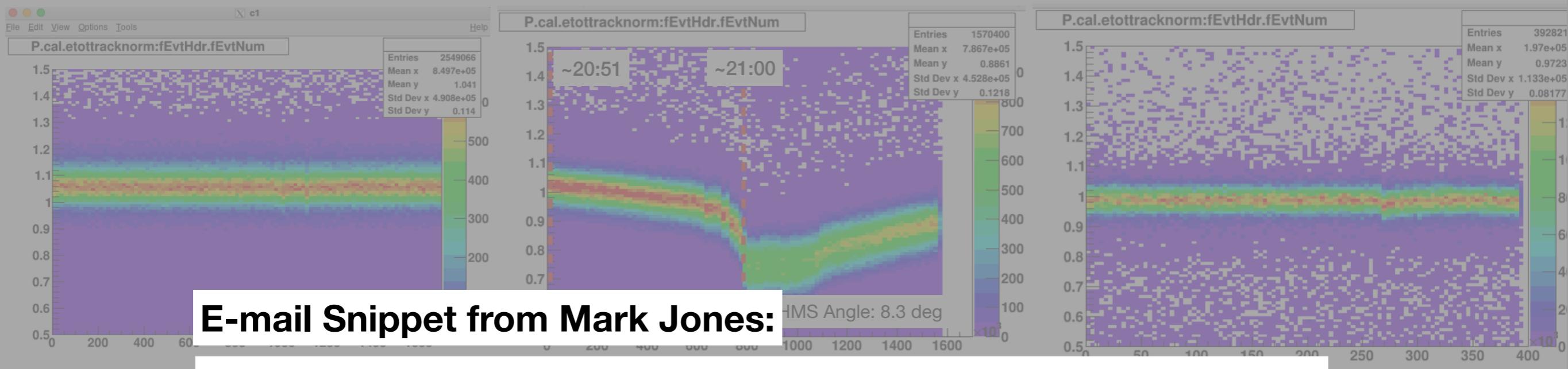


SHMS Calorimeter Energy Deposited / Track Momentum vs. Event Number

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

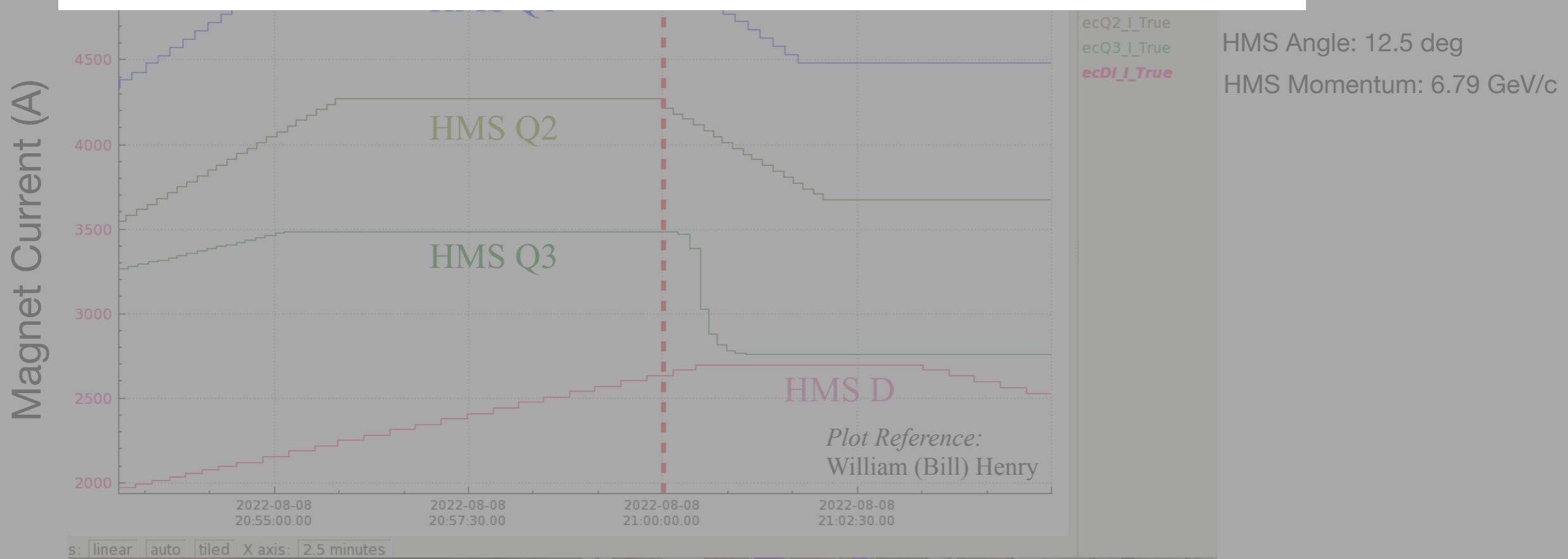
Run 16037 | time: 20:53 - 21:05

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

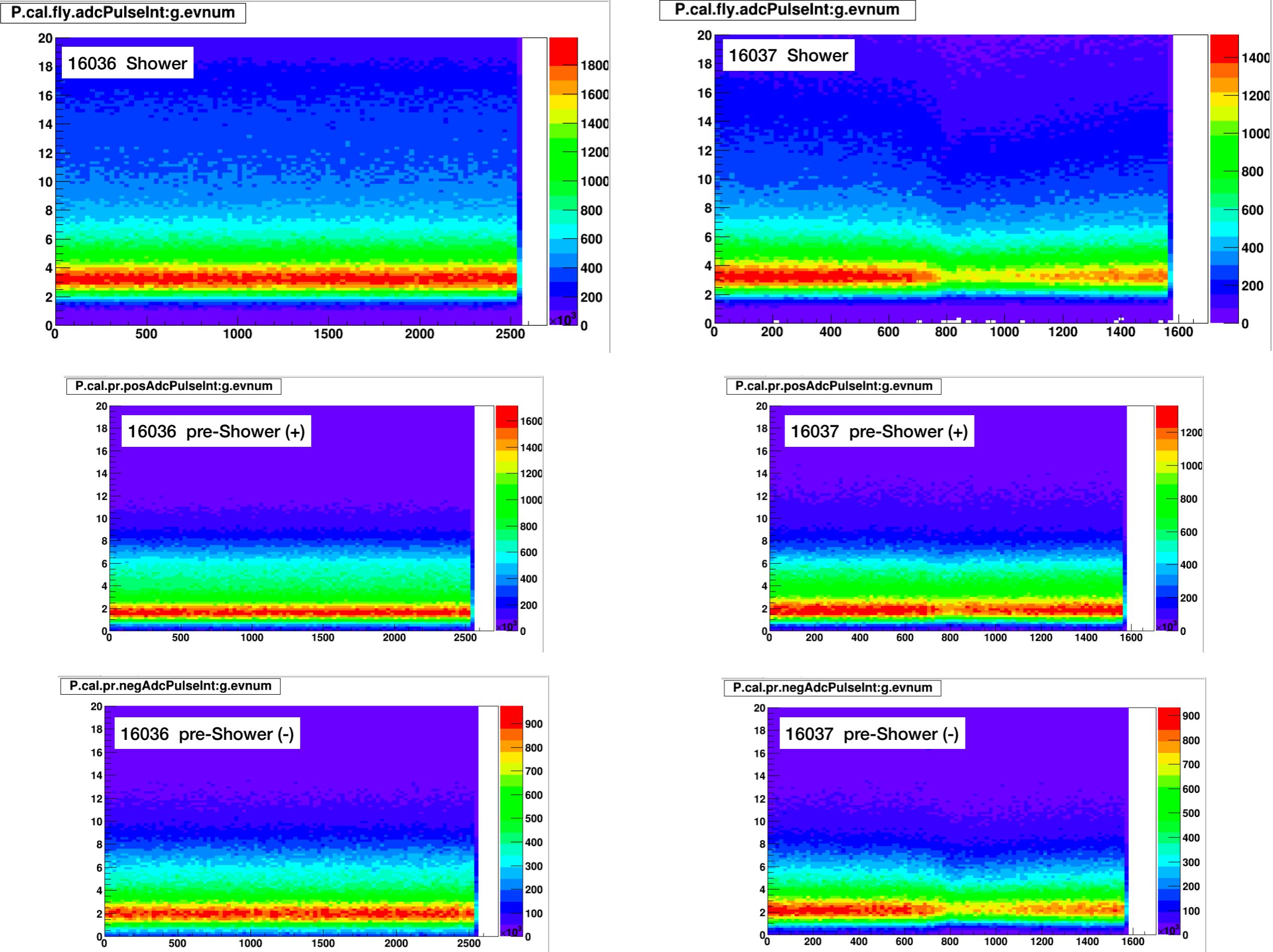


E-mail Snippet from Mark Jones:

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

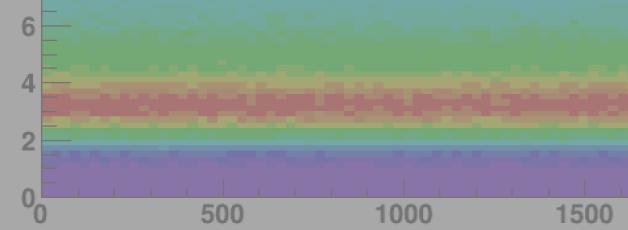


fADC Pulse Integral vs. Event Number

P.cal.fly.adcPulseInt:g.evnum

20
18
16036 Shower

pre-Shower (+) PMTs
point away beamline
(i.e., less sensitive to
HMS fringe fields)



P.cal.fly.adcPulseInt:g.evnum

20
18
16037 Shower

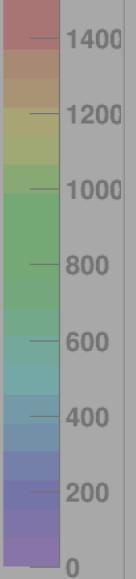
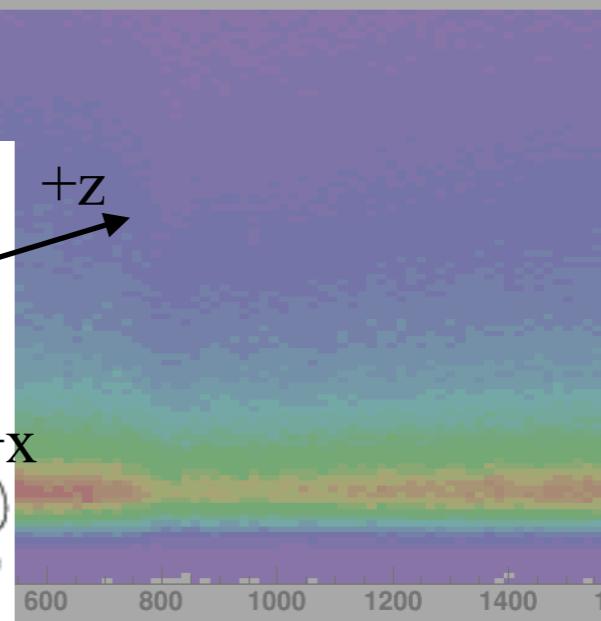
SHMS Calorimeter

+y
+z
+x

Shower

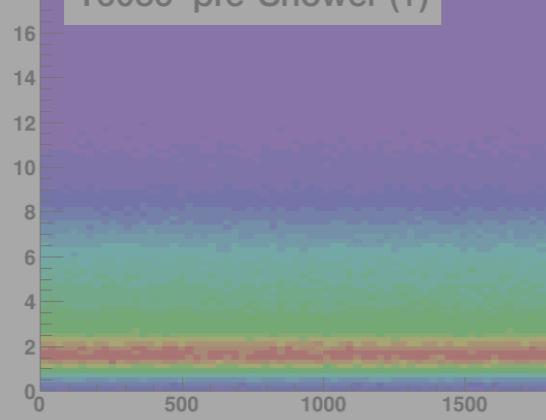
pre-Shower (+)

pre-Shower (-)



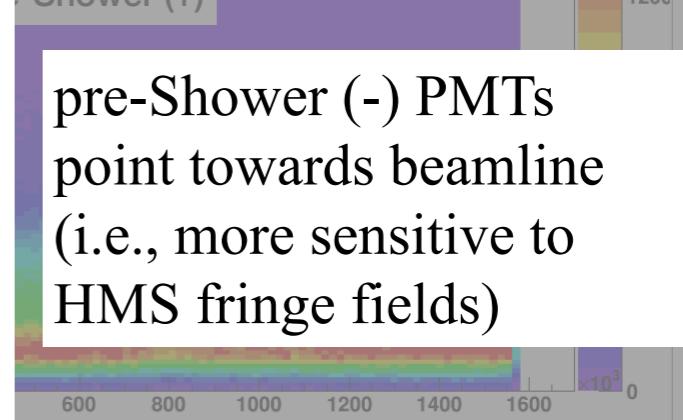
P.cal.pr.posAdcPulseInt:g.evnum

20
18
16036 pre-Shower (+)



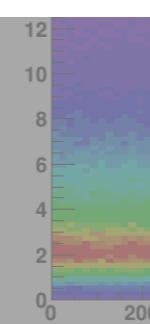
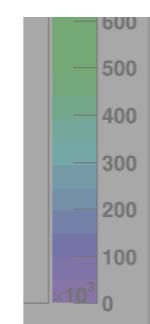
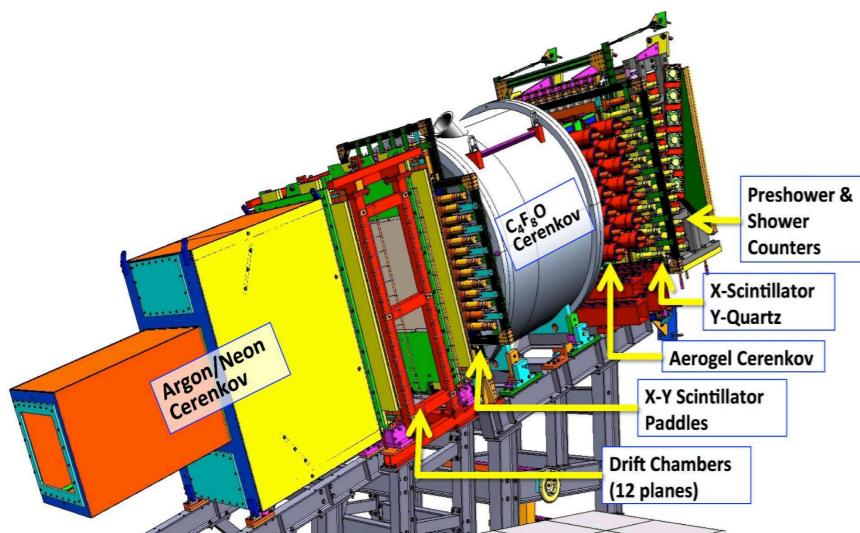
t:g.evnum

18
16036 pre-Shower (-)



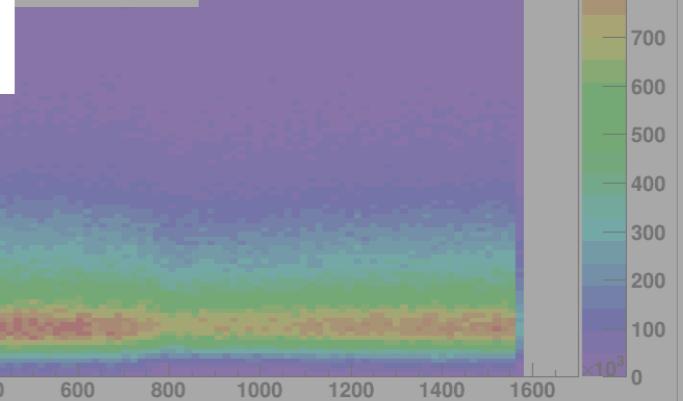
pre-Shower (-) PMTs
point towards beamline
(i.e., more sensitive to
HMS fringe fields)

Particle Detectors inside the SHMS



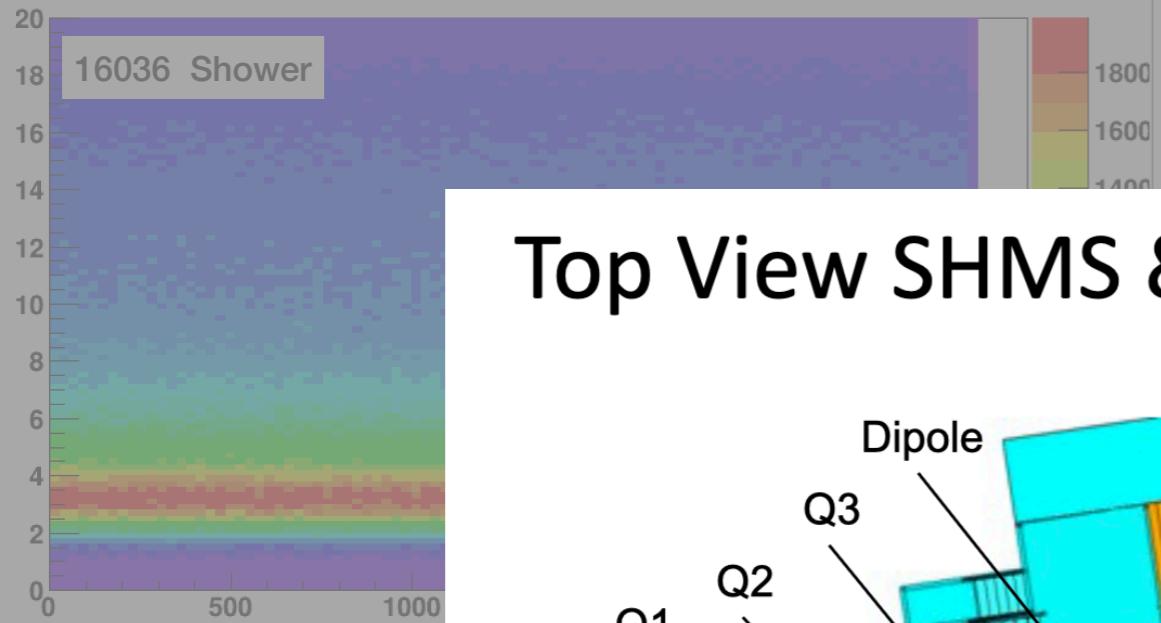
t:g.evnum

18
16036 Shower (-)

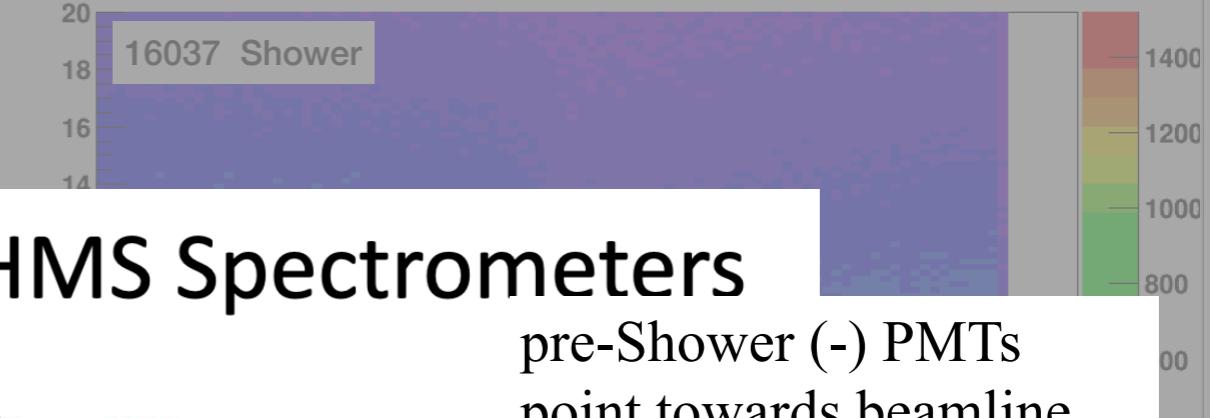


fADC Pulse Integral vs. Event Number

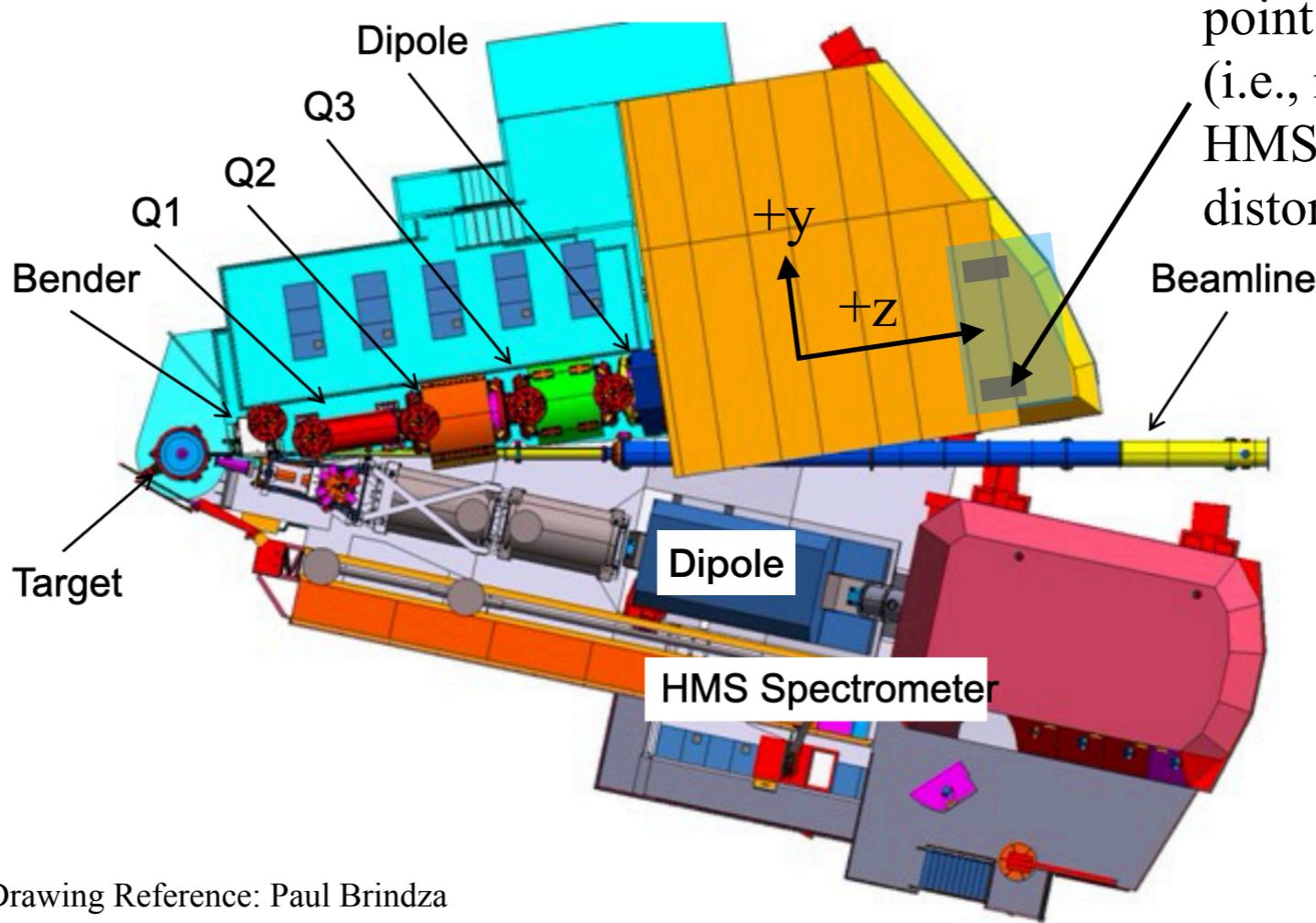
P.cal.fly.adcPulseInt:g.evnum



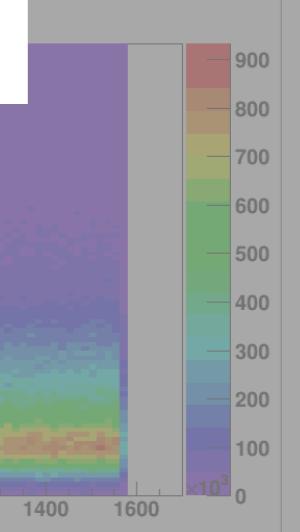
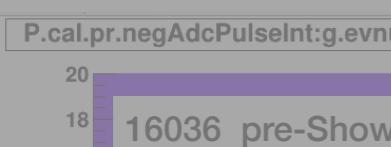
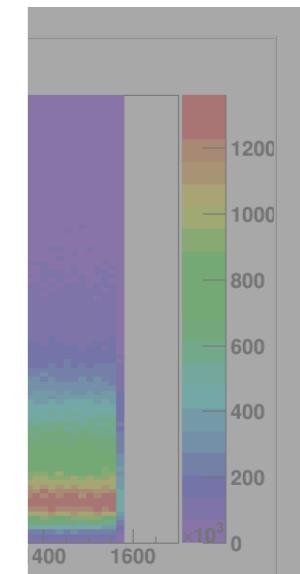
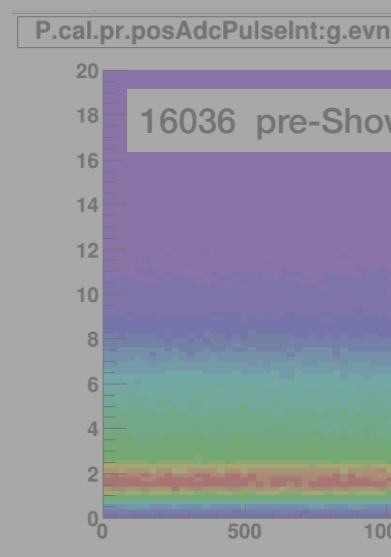
P.cal.fly.adcPulseInt:g.evnum



Top View SHMS & HMS Spectrometers



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

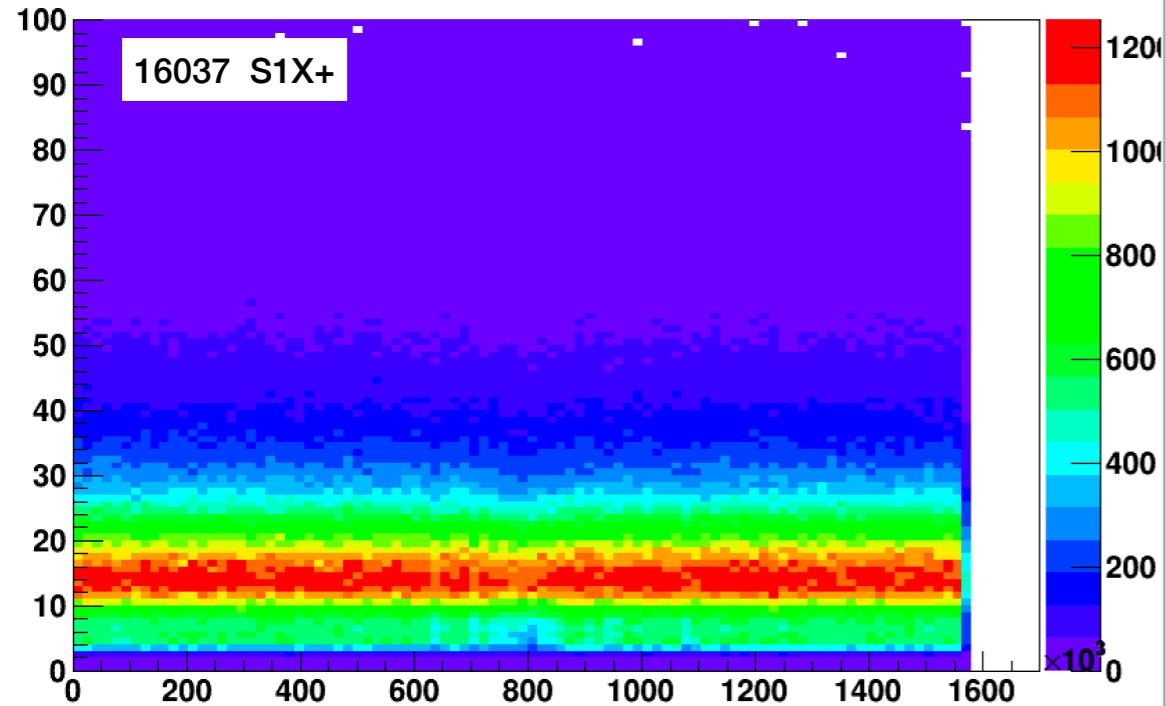


Drawing Reference: Paul Brindza

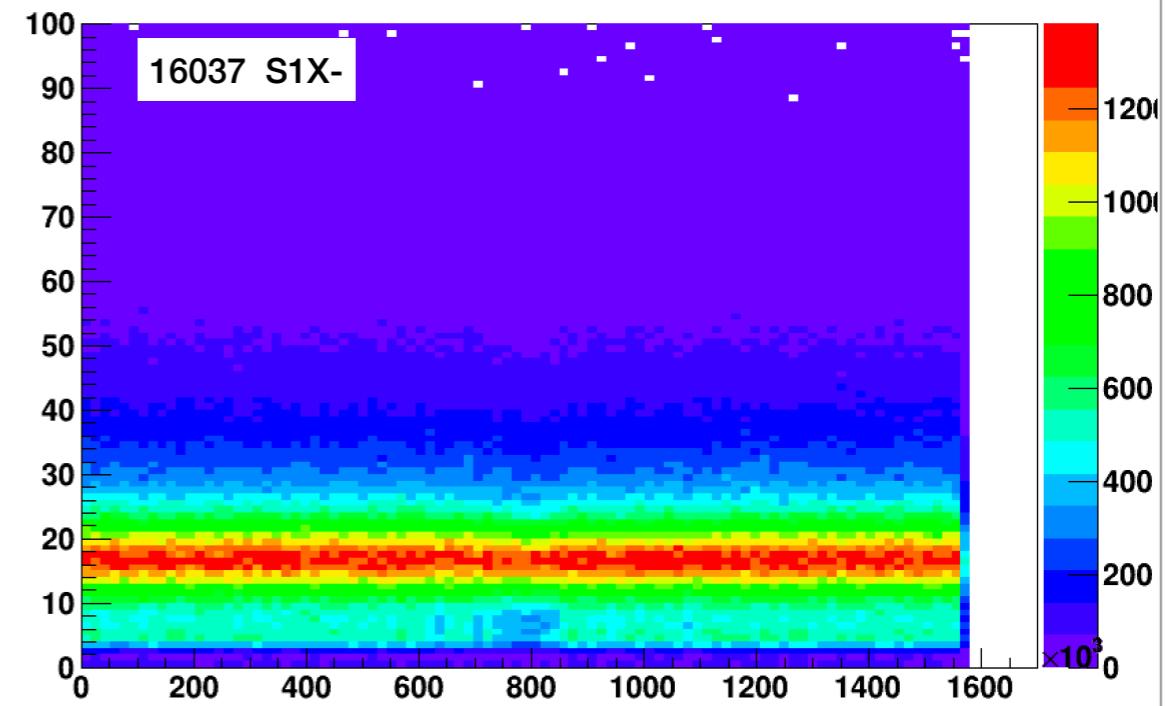
Could have the right side
of other detectors (i.e.,
Hodoscope S1X -, S2X-
also been affected?
(see next slide)

Hodoscopes fADC Pulse Integral vs. Event Number

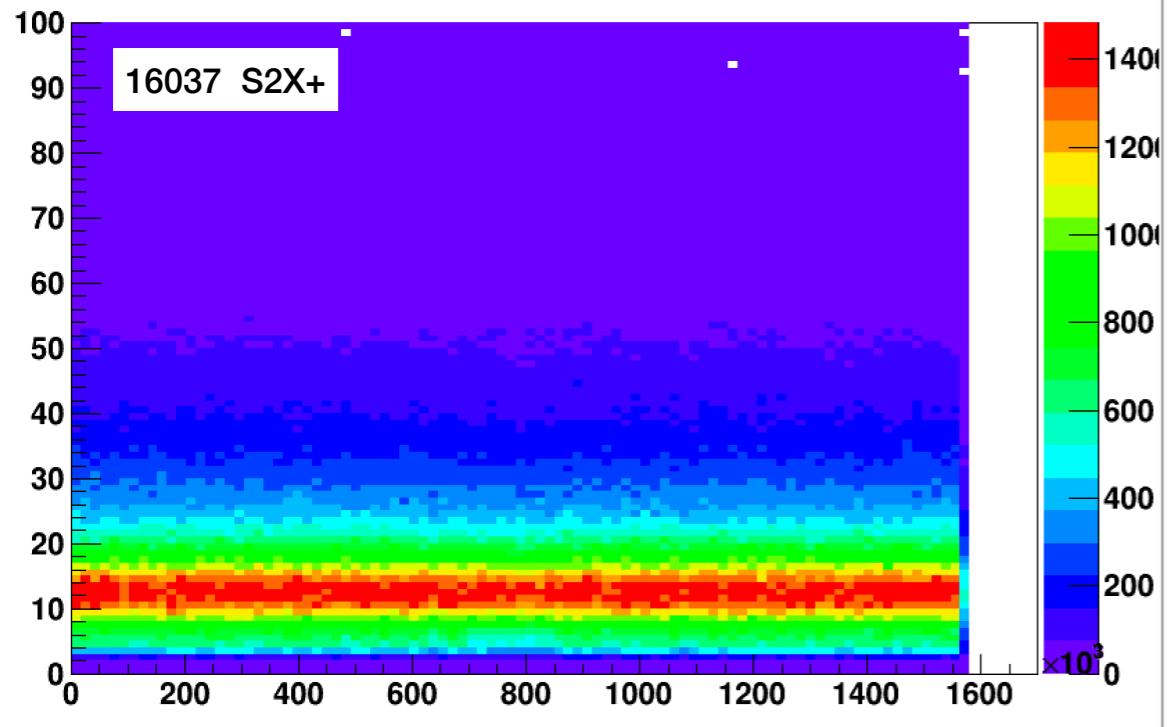
P.hod.1x.posAdcPulseInt:g.evnum



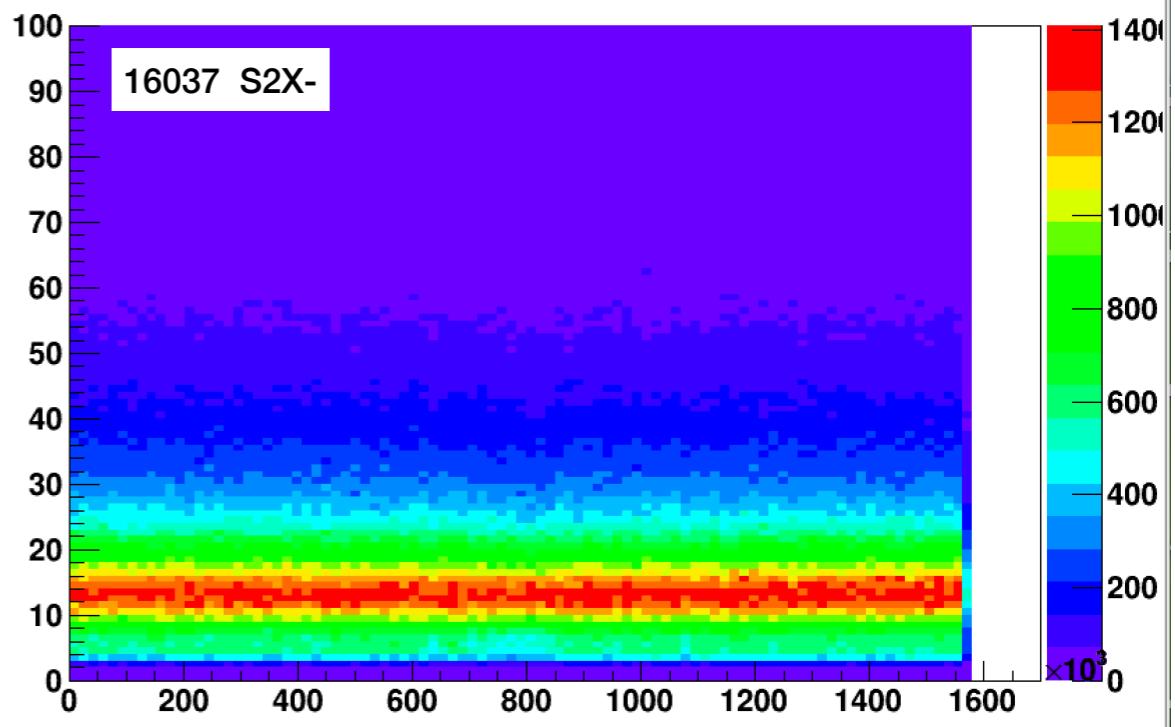
P.hod.1x.negAdcPulseInt:g.evnum



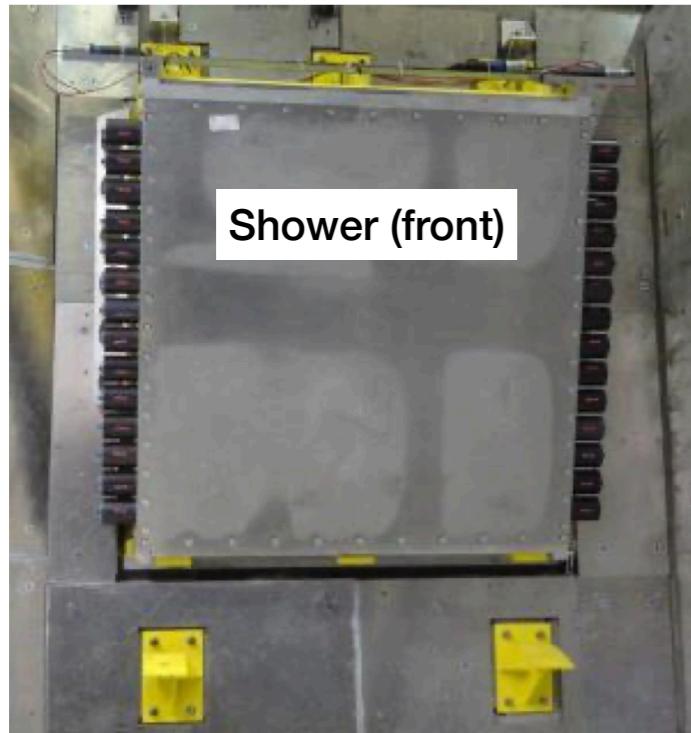
P.hod.2x.posAdcPulseInt:g.evnum



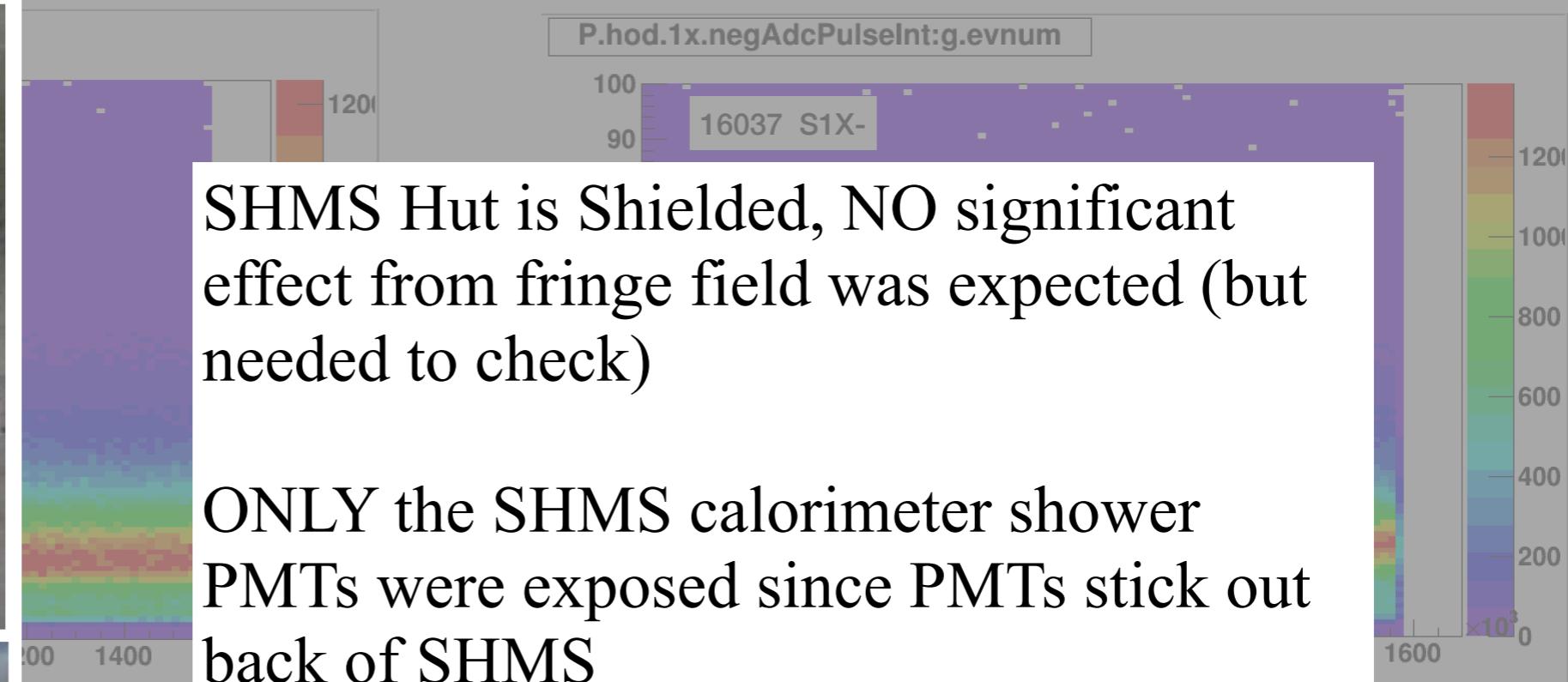
P.hod.2x.negAdcPulseInt:g.evnum



SHMS fADC Pulse Integral vs. Event Number



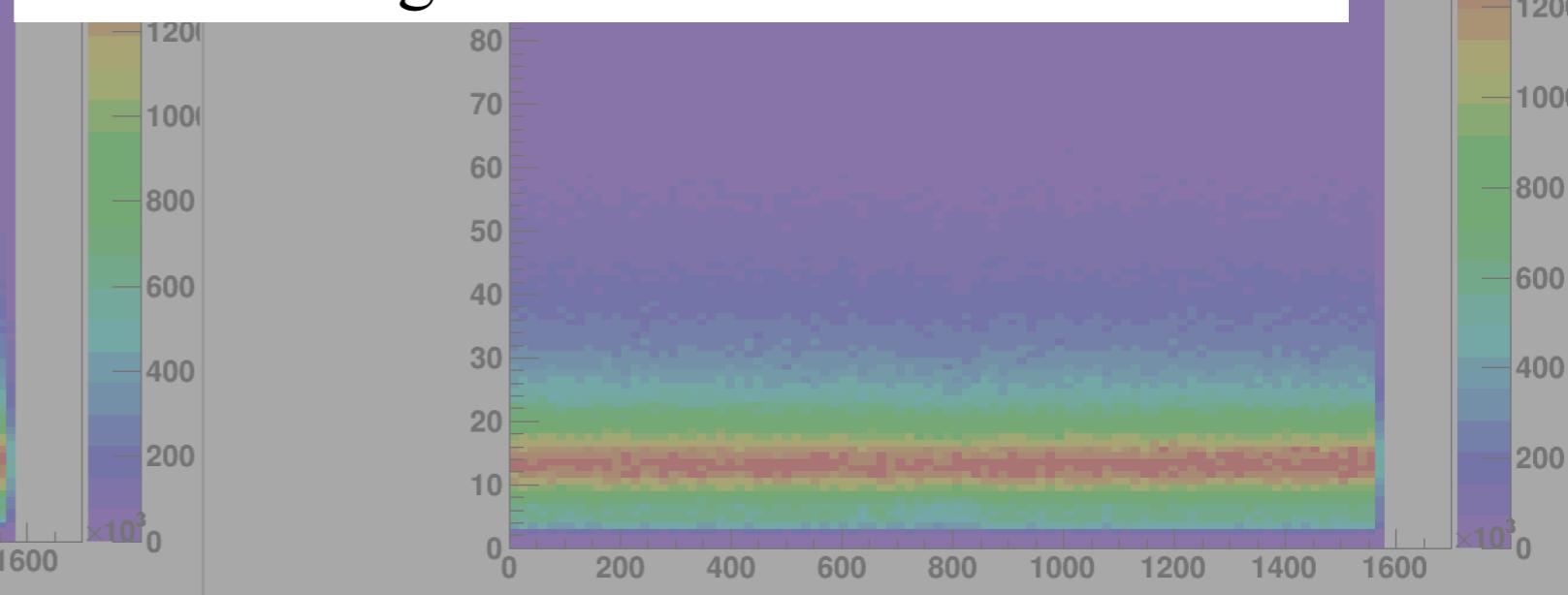
Picture Ref: Hamlet Mkrtchyan



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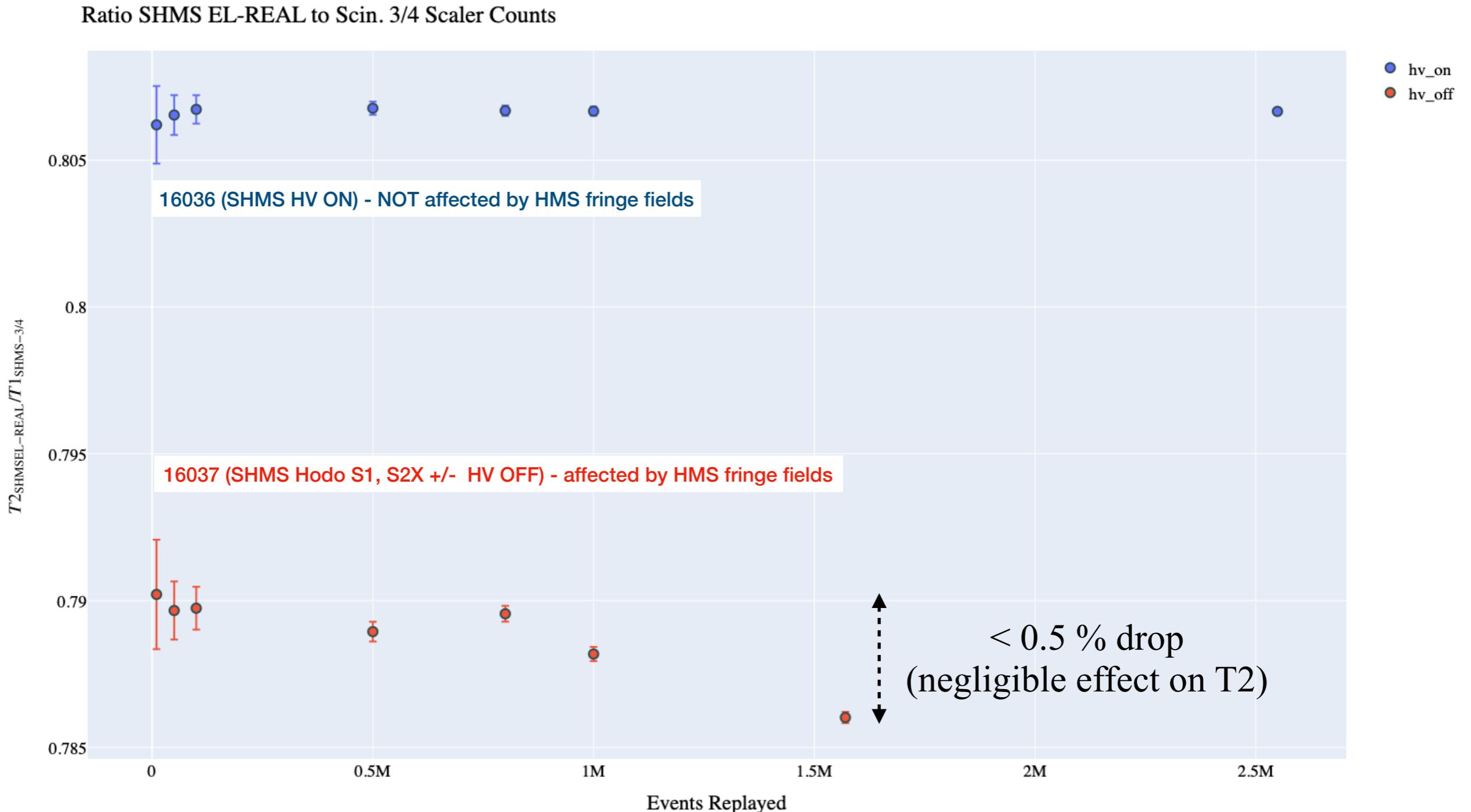
Study 1: Quantify effect of HMS fringe fields on T2 scaler counts

(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

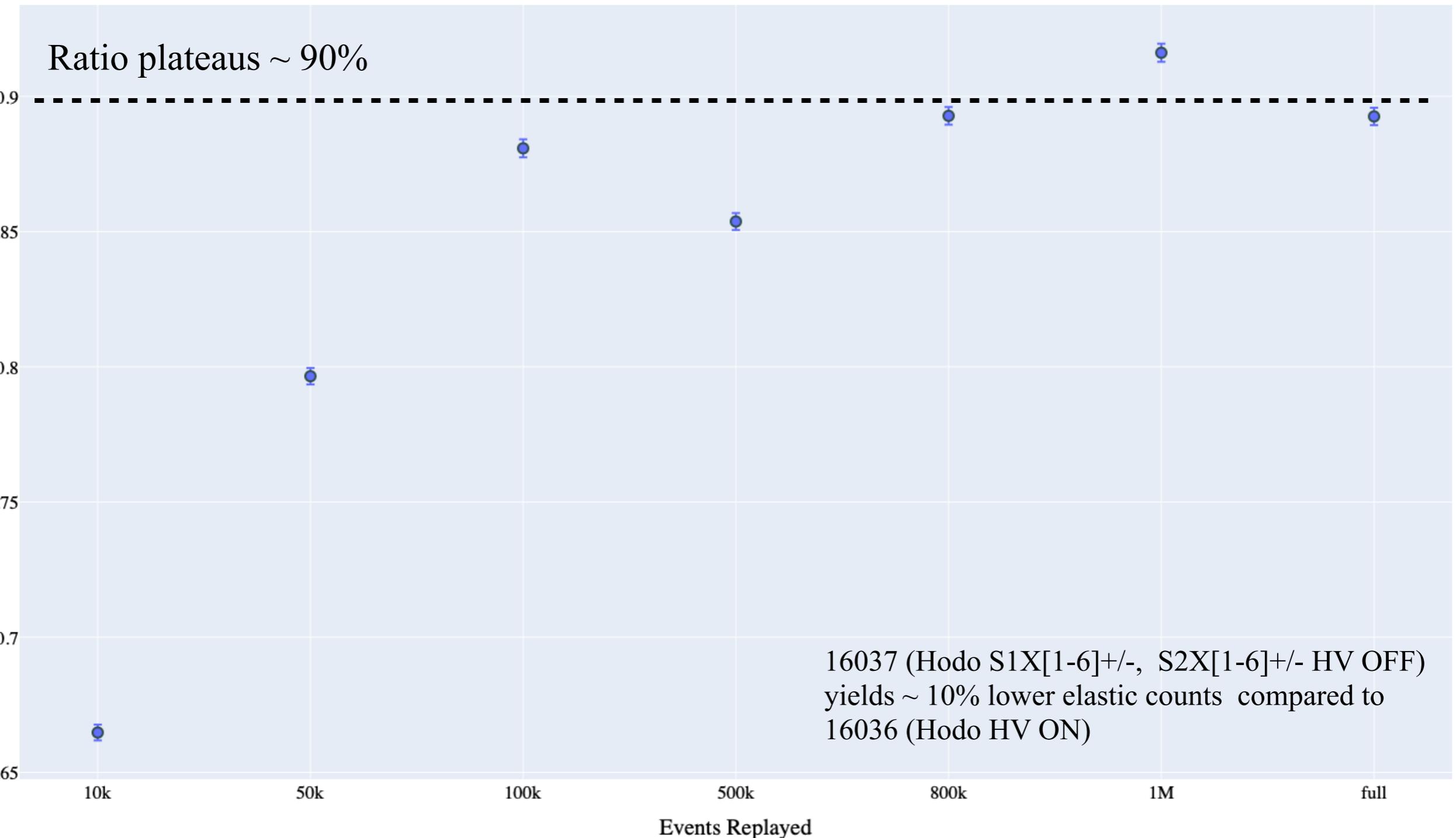


Study 2: Quantify effect of HMS fringe fields on elastic counts W

- 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)

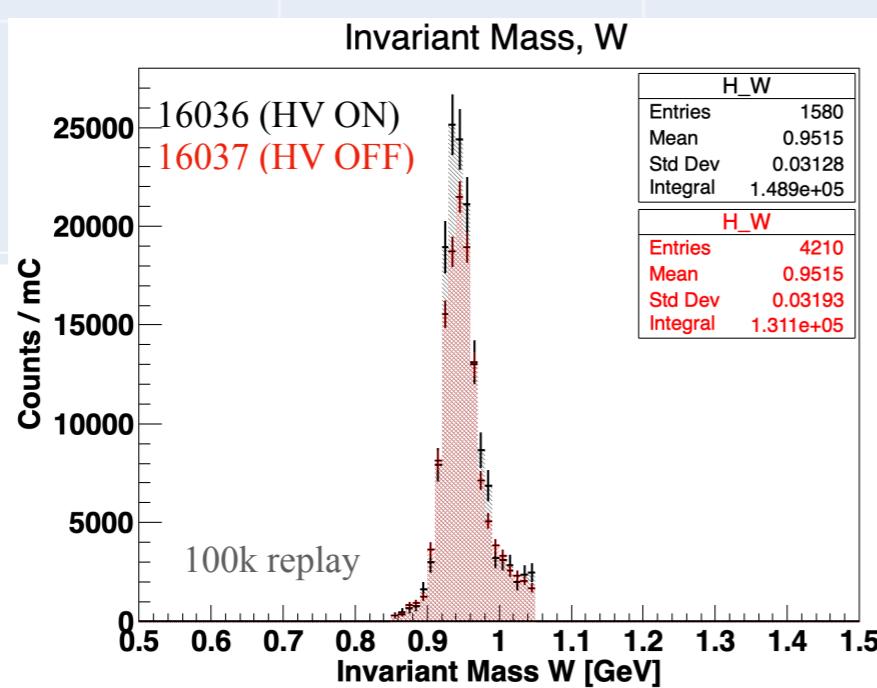
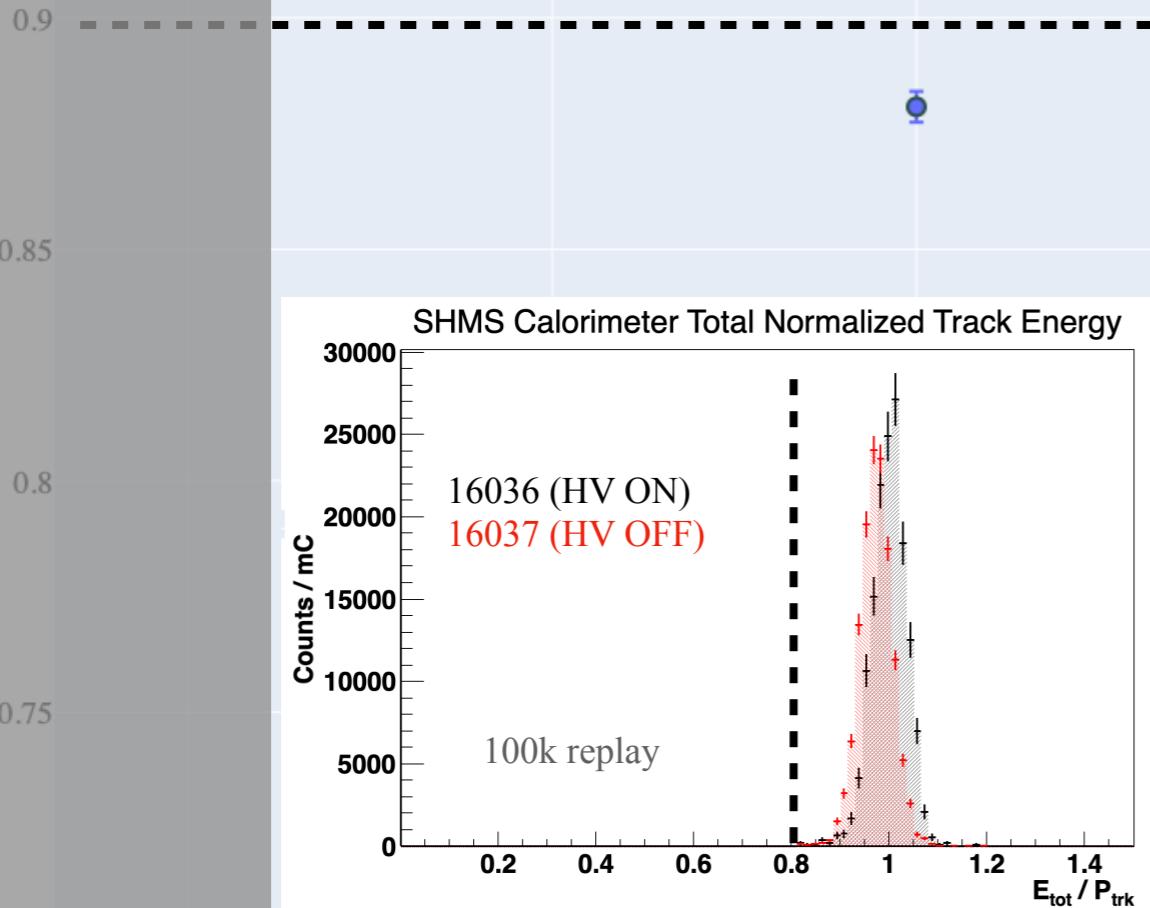
need to quantify effect on invariant mass W counts !

Ratio of Invariant Mass W



Ratio of Invariant Mass W

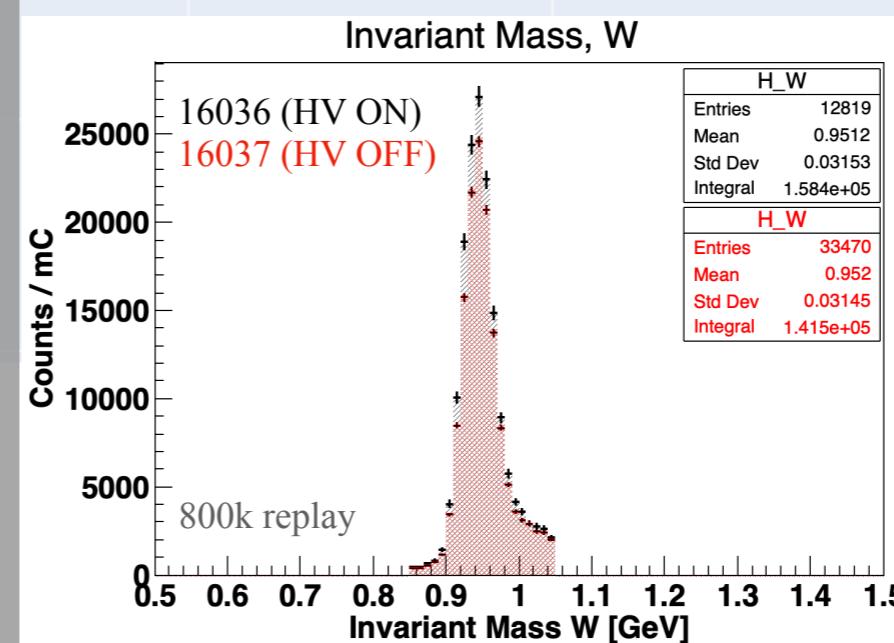
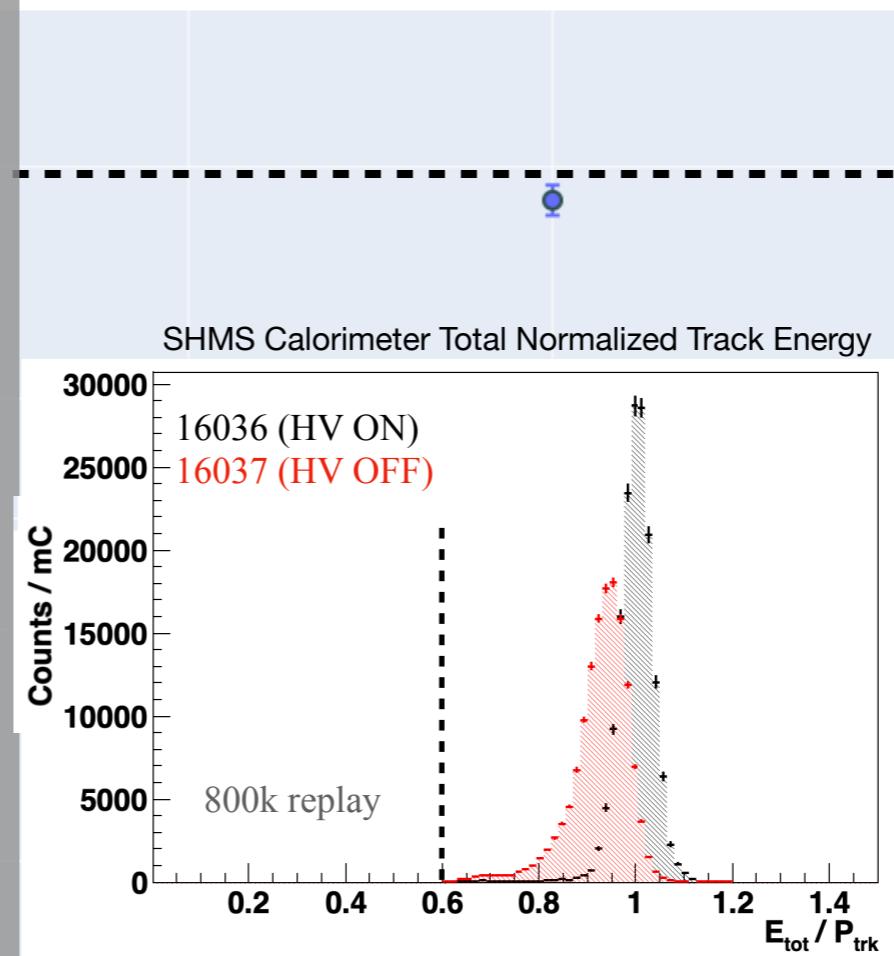
Ratio plateaus $\sim 90\%$



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

Ratio of Invariant Mass W

Ratio plateaus ~ 90%

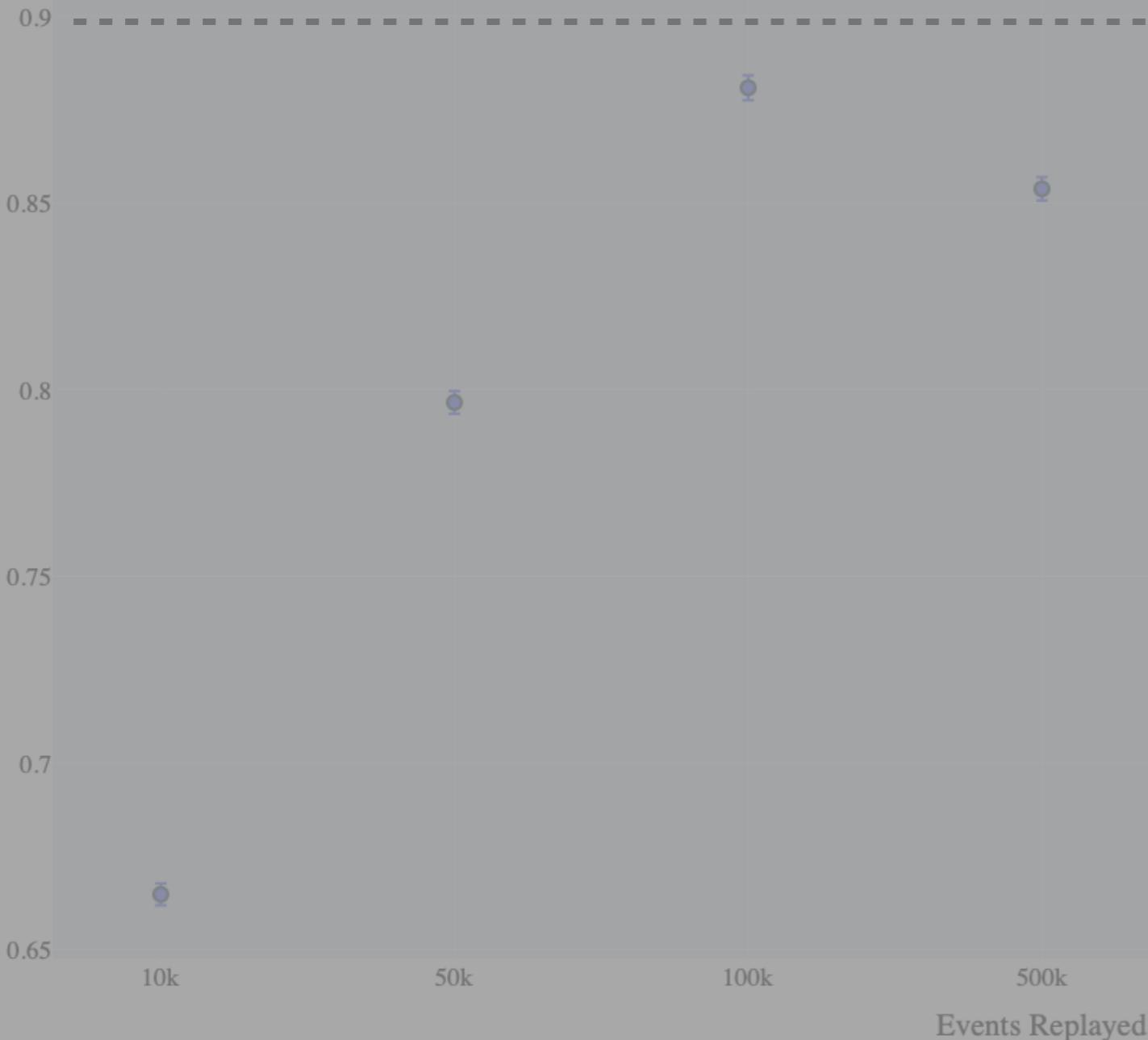


S2X[1-6]+/- HV OFF)
counts compared to

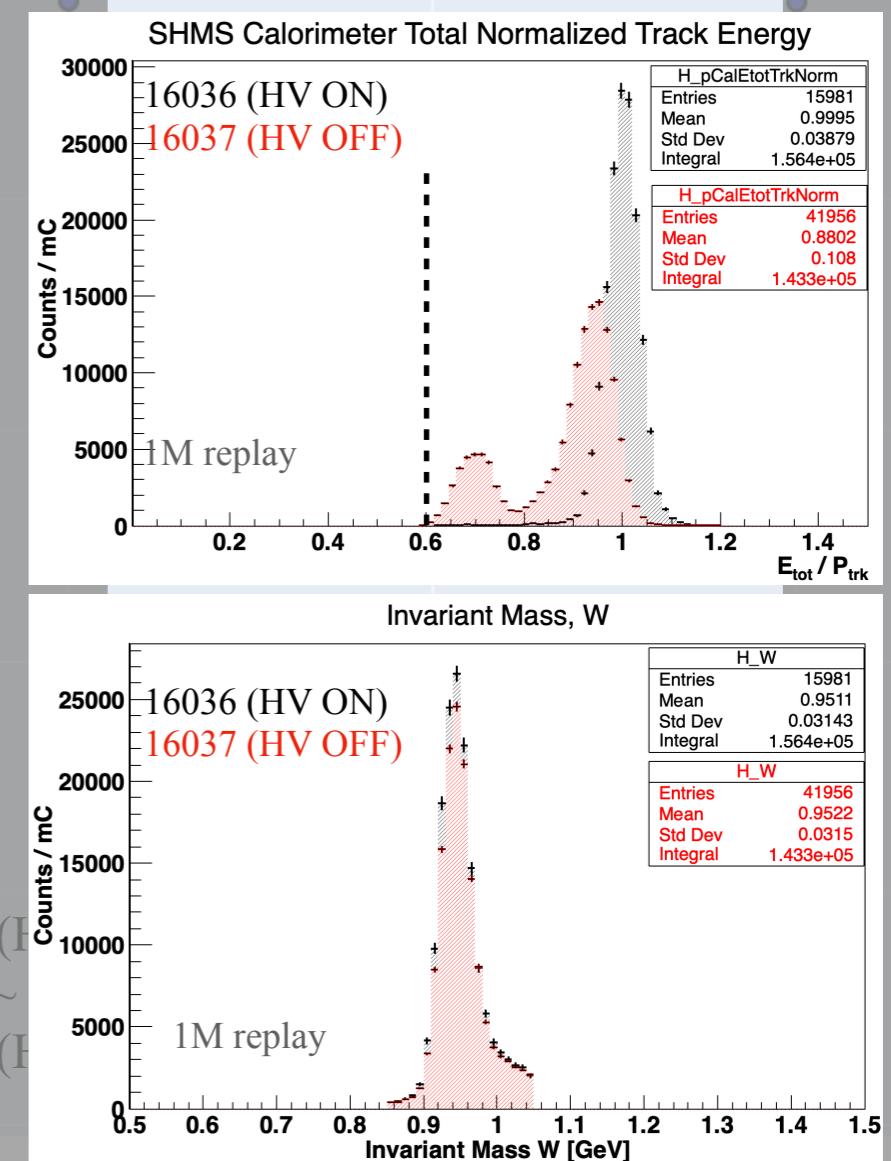
1M full

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

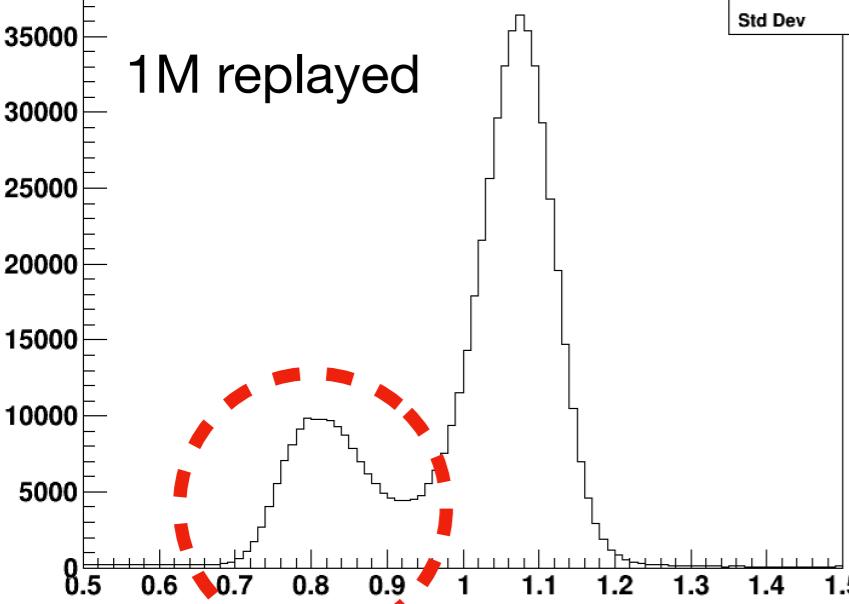
What is causing $\sim 10\%$ discrepancy in our data ?

- 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

