Detector Time Window Cuts

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Detector time window cuts

- The time window cut is made on a time difference between the ADC and TDC times on a PMT basis for all the detectors except the Drift Chamber, which cut on the raw drift times for each plane.

- Necessary to reduce sources of background that slips into the detector time windows when detecting the physics signals of interest.

- The time difference is defined in hcana as:

$$\text{AdcTdcDiffTime} = \text{TdcTime[ipmt]} - \text{AdcPulseTime[ipmt]} \quad \text{HODO}$$
$$\text{AdcTdcDiffTime} = \text{HodoStartTime} - \text{AdcPulseTime[ipmt]} \quad \text{CER, HGCER, NGCER, CAL, AERO}$$

- where the HodoStartTime is the Hodoscope time projected at the focal plane, and the TdcTime, AdcPulseTime is the detector (TDC,ADC) pulse time for a given PMT in that detector.

- The [impt] index emphasizes the leaf variables are arrays whose indices are the PMTs, but do NOT form part of the leaf name.

Detector variables for HMS and SHMS

HMS:

Detector	*hcana* Leaf Name	Place-Holders
Hodoscopoes	`H.hod.[pl].Good[side]AdcTdcDiffTime[ipmt]` `H.hod.[pl].Good[side]AdcMult[ipmt]`	`[pl]:1x|1y|2x|2y [side]:Pos|Neg`
Calorimeter	`H.cal.[pl].good[side]AdcTdcDiffTime[ipmt]` `H.cal.[pl].good[side]AdcMult[ipmt]`	`[pl]:1pr|2ta|3ta|4ta [side]:Pos|Neg`
Cherenkov	`H.cer.goodAdcTdcDiffTime[ipmt]` `H.cer.goodAdcMult[ipmt]`	
Drift Chamber	`H.dc.[pl].rawtdc` `H.dc.[pl].nhit`	`[pl]:1u1|1u2|...2x2|2v1|...`

SHMS:

Detector	*hcana* Leaf Name	Place-Holders
Hodoscopoes	`P.hod.[pl].Good[side]AdcTdcDiffTime[ipmt]` `P.hod.[pl].Good[side]AdcMult[ipmt]`	`[pl]:1x|1y|2x|2y [side]:Pos|Neg`
Pre-Shower	`P.cal.pr.good[side]AdcTdcDiffTime` `P.cal.pr.good[side]AdcMult[ipmt]`	`[side]:Pos|Neg`
Calorimeter	`P.cal.fly.goodAdcTdcDiffTime[ipmt]` `P.cal.fly.goodAdcMult[ipmt]`	
Cherenkov	`P.[det].goodAdcTdcDiffTime[ipmt]` `P.[det].goodAdcMult[ipmt]`	`[det]:hgcer|ngcer`
Drift Chamber	`P.dc.[pl].rawtdc` `P.dc.[pl].nhit`	`[pl]:1u1|1u2|...2x2|2v1|...`

Things to do before replay

- Set the reference time cuts in param files.

    1. /group/c-polhe3/Users/murchhana/hallc_replay/PARAM/HMS/GEN/h_reftime_cut.param

    2. /group/c-polhe3/Users/murchhana/hallc_replay/PARAM/SHMS/GEN/p_reftime_cut.param

    3. /group/c-polhe3/Users/murchhana/hallc_replay/PARAM/TRIG/thms.param

    4. /group/c-polhe3/Users/murchhana/hallc_replay/PARAM/TRIG/tshms.param

- Make the software time window cuts wider for the detectors working on-

    1. Cherenkov (pngcer_cuts.param, hCER_cuts.param)

    2. Hodoscope

Set Reference time cuts in PARAM file

- Set the determined ref time cuts for SHMS and HMS in param files and redid the replay before proceeding with the detector time window cuts.

```
; Cut to select the Reference time when multiple hits in reference time
; The units in channels for the module (CAEN tdc or FADC)
; negative value refcut means that the first reference time greater than the abs(refcut)
;    is used as reftime. If no ref time is found  greater than the abs(refcut) then first
;    reference time is used.
; positive value refcut means that the the first reference time greater than the abs(refcut)
;    is used as reftime. If no ref time is found  greater than the abs(refcut) then no
;    reference time is used and warning message is produced.
; Cut is on reference time per detector.

; no cuts
; hdc_tdcrefcut=-100000.
; hhodo_tdcrefcut=-100000.
; hhodo_adcrefcut=-100000.
; hcer_adcrefcut=-100000.
; hcal_adcrefcut=-100000.

; determined for fall 2019 startup
; cut variable = hDCREF2
;hdc_tdcrefcut=-20000.
; cut variable = hT2
;hhodo_tdcrefcut=-1200.
; cut variable = hFADC_TREF_ROC1
;hhodo_adcrefcut=-3000.
;hcer_adcrefcut=-3000.
;hcal_adcrefcut=-3000.



; determined for 2020 A1N experiment
; cut variable = hDCREF2
hdc_tdcrefcut=-20000.
; cut variable = hT2
hhodo_tdcrefcut=-1400.
; cut variable = hFADC_TREF_ROC1
hhodo_adcrefcut=-3400.
hcer_adcrefcut=-3400.
hcal_adcrefcut=-3400.
```

Location:
/group/c-polhe3/Users/murchhana/hallc_replay/PARAM/HMS/GEN/h_reftime_cut.param

```
; Cut to select the Reference time when multiple hits in reference time
; The units in channels for the module (CAEN tdc or FADC)
; negative value refcut means that the first reference time greater than the abs(refcut)
;    is used as reftime. If no ref time is found  greater than the abs(refcut) then first
;    reference time is used.
; positive value refcut means that the the first reference time greater than the abs(refcut)
;    is used as reftime. If no ref time is found  greater than the abs(refcut) then no
;    reference time is used and warning message is produced.
; Cut is on reference time per detector.

; no cuts
; pdc_tdcrefcut=-100000.
; phodo_tdcrefcut=-100000.
; phodo_adcrefcut=-100000.
; pngcer_adcrefcut=-100000.
; phgcer_adcrefcut=-100000.
; paero_adcrefcut=-100000.
; pcal_adcrefcut=-100000.

; determined for fall 2019 startup
; cut variable = pDCREF(min)
;pdc_tdcrefcut=-14500.
; cut variable = pT1
;phodo_tdcrefcut=-3600.
; cut variable = pFADC_TREF_ROC2
;phodo_adcrefcut=-4500.
;pngcer_adcrefcut=-4500.
;phgcer_adcrefcut=-4500.
;paero_adcrefcut=-4500.
;pcal_adcrefcut=-4500.



;determined from 2020 A1N experiment
; cut variable = pDCREF(min)
pdc_tdcrefcut=-14400.
; cut variable = pT1
phodo_tdcrefcut=-3400.
; cut variable = pFADC_TREF_ROC2
phodo_adcrefcut=-4200.
pngcer_adcrefcut=-4200.
phgcer_adcrefcut=-4200.
paero_adcrefcut=-4200.
pcal_adcrefcut=-4200.
```

Location:
/group/c-polhe3/Users/murchhana/hallc_replay/PARAM/SHMS/GEN/p_reftime_cut.param

Set Reference time cuts in PARAM file

- Set the determined ref time cuts for SHMS and HMS in param files and redid the replay before proceeding with the detector time window cuts.

Location:
 /group/c-polhe3/Users/murchhana/hallc_replay/PARAM/TRIG/thms.param

Location:
 /group/c-polhe3/Users/murchhana/hallc_replay/PARAM/TRIG/tshms.param

Loose software cuts for Cherenkov

- Made the software cuts wider for both SHMS and HMS cherenkovs before replaying the runs.

```
; HMS Cherenkov Cuts parameter files

; Track matching reduced chi2 cut values
hcer_red_chi2_min = 0.0
hcer_red_chi2_max = 25.0

; Track matching beta cut values
hcer_beta_min = 0.0
hcer_beta_max = 1.2

; Track matching normalized energy (E/p) cut values
hcer_enorm_min = 0.0
hcer_enorm_max = 1.5

; Track matching delta p (dp) cut values
hcer_dp_min = -20.0
hcer_dp_max = 25.0

; NPE Threshold for good hit (for measureing effic.)
hcer_npe_thresh = 0.5

; ADC time window cut values used to select "good" ADC events
hcer_adc_tdc_offset= 0.

; fall 2019 startup
; cut variable is H.cer.goodAdcTdcDiffTime
;hcer_adcTimeWindowMin =   60.,   60.
;hcer_adcTimeWindowMax =  200., 200.


; 2020 A1N experiment
; cut variable is H.cer.goodAdcTdcDiffTime
hcer_adcTimeWindowMin = -1000., -1000.
hcer_adcTimeWindowMax = 1000., 1000.
```

hCER.param

```
; Track matching reduced chi2 cut values
pngcer_red_chi2_min = 0.0
pngcer_red_chi2_max = 25.0

; Track matching beta cut values
pngcer_beta_min = 0.0
pngcer_beta_max = 1.2

; Track matching normailized energy (E/p) cut values
pngcer_enorm_min = 0.0
pngcer_enorm_max = 1.5

; Track matching delta p (dp) cut values
pngcer_dp_min = -20.0
pngcer_dp_max = 25.0

; NPE Threshold for "good" hit (for measureing effic.)
pngcer_npe_thresh = 0.5

; ADC time window cut values used to select "good" ADC events
pngcer_adc_tdc_offset   =  200.0

; fall 2019 startup
; cut variable is P.ngcer.goodAdcTdcDiffTime
;pngcer_adcTimeWindowMin = -20.0, -20.0, -20.0, -20.0
;pngcer_adcTimeWindowMax = 80.0, 80.0, 80.0, 80.0


; 2020 A1N experiment
; cut variable is P.ngcer.goodAdcTdcDiffTime
pngcer_adcTimeWindowMin = -1000.0, -1000.0, -1000.0, -1000.0
pngcer_adcTimeWindowMax = 1000.0, 1000.0, 1000.0, 1000.0
```
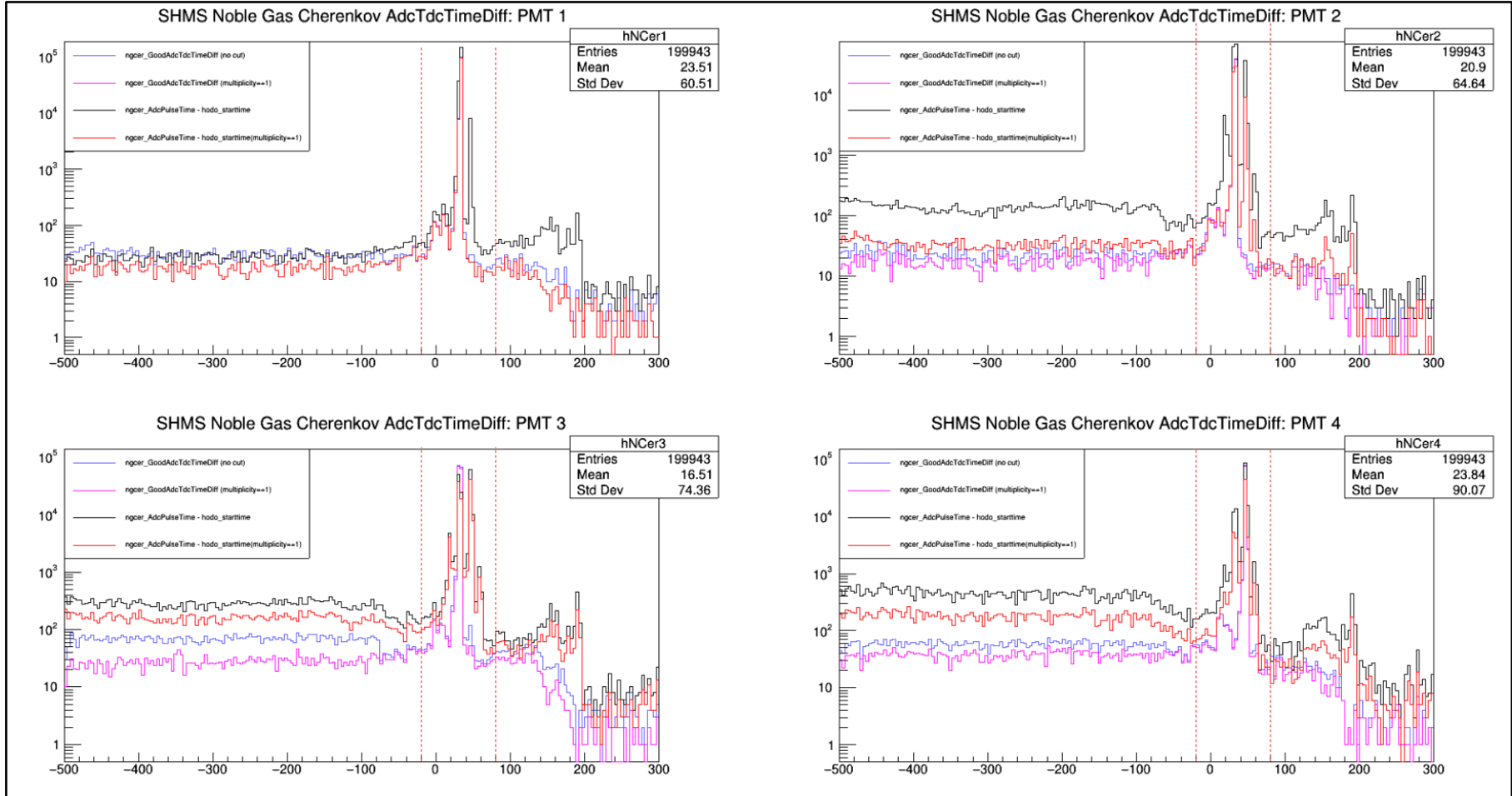
pngcer.param

Loose software cuts for Hodoscope

- Made the software cuts wider for both SHMS and HMS hodoscopes before replaying the runs.

hhodo.param

phodo.param

SHMS run : 09779

- 1-pass elastic,Longitudinal
- Ep = -2.129 GeV, 8.5 deg
- Trigger: EL-CLEAN (TRIG3)

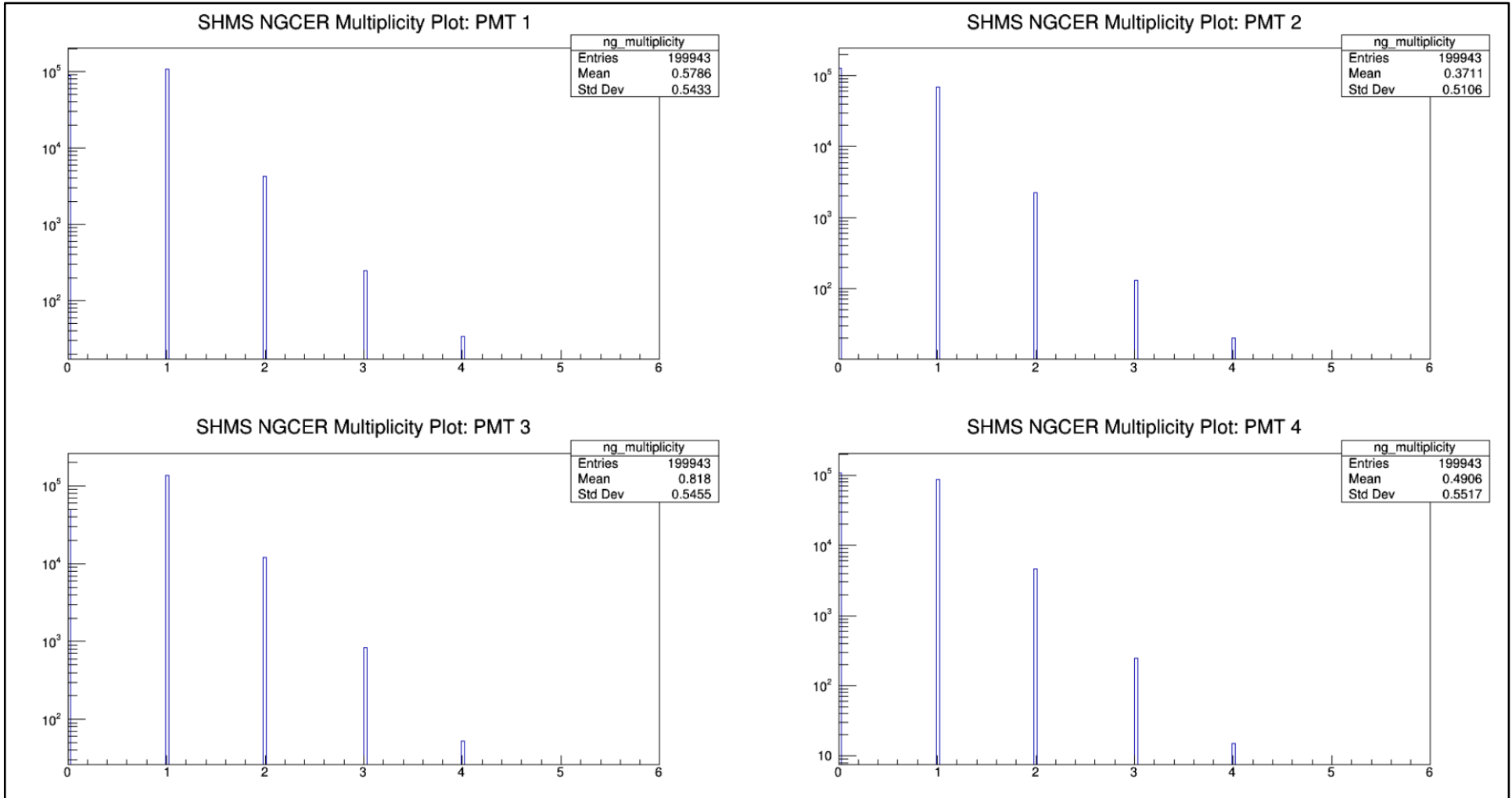# SHMS run 09779 : NGCER

- **Original cut: min -20, max 80**

- P.ngcer.goodAdcTdcDiffTime [ipmt]

- P.hod.starttime – P.ngcer.adcPulseTime [ipmt]
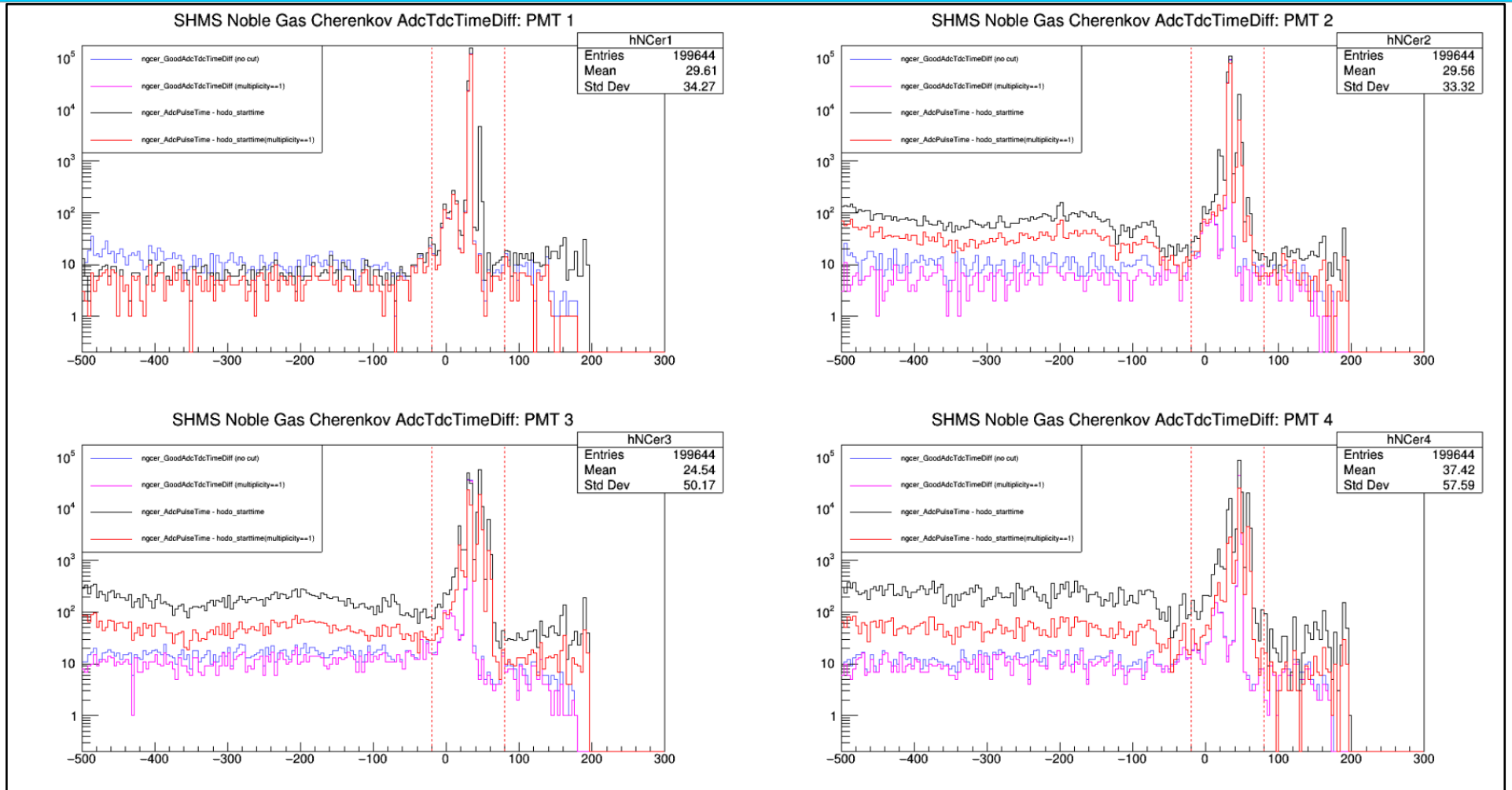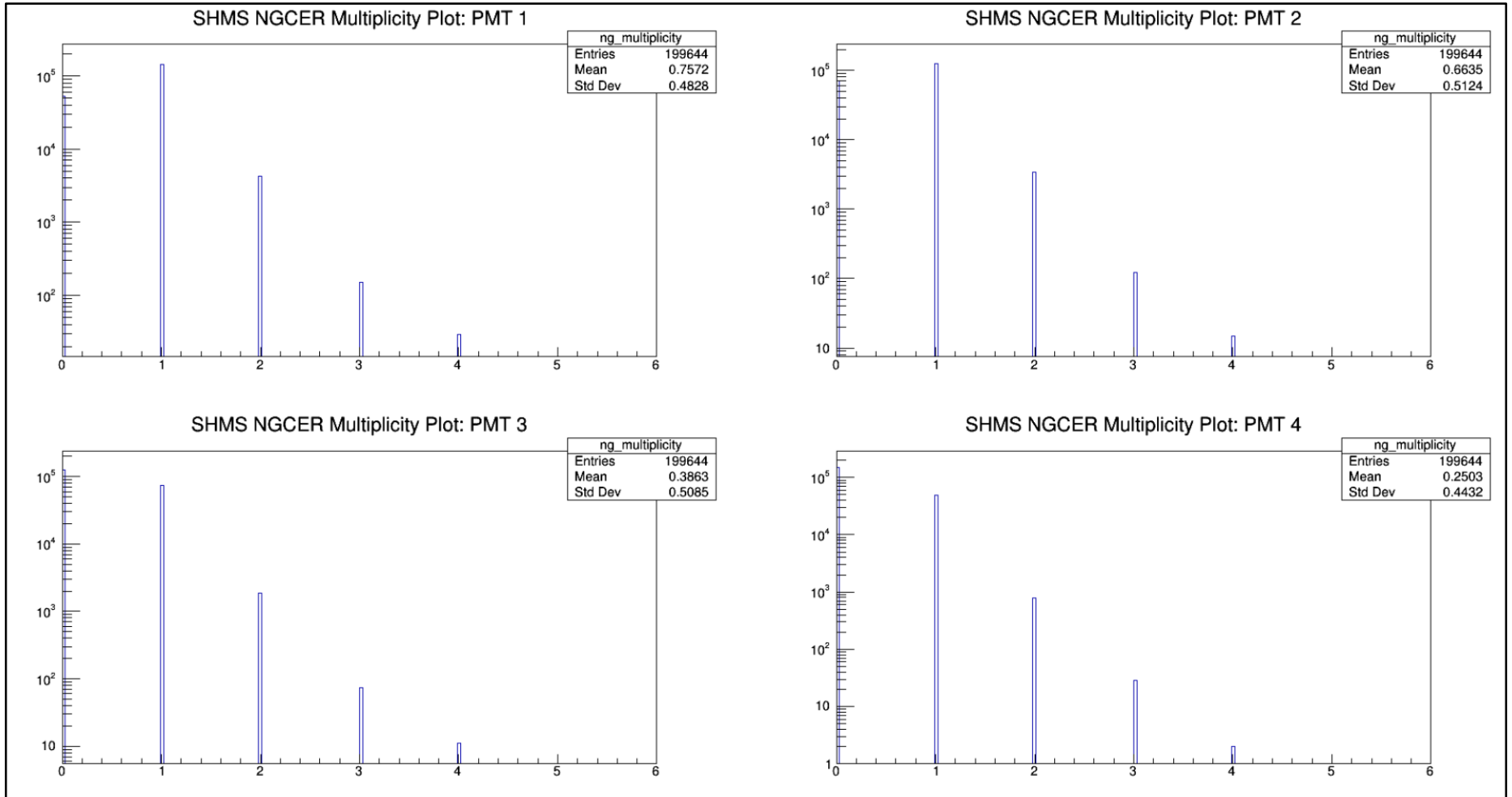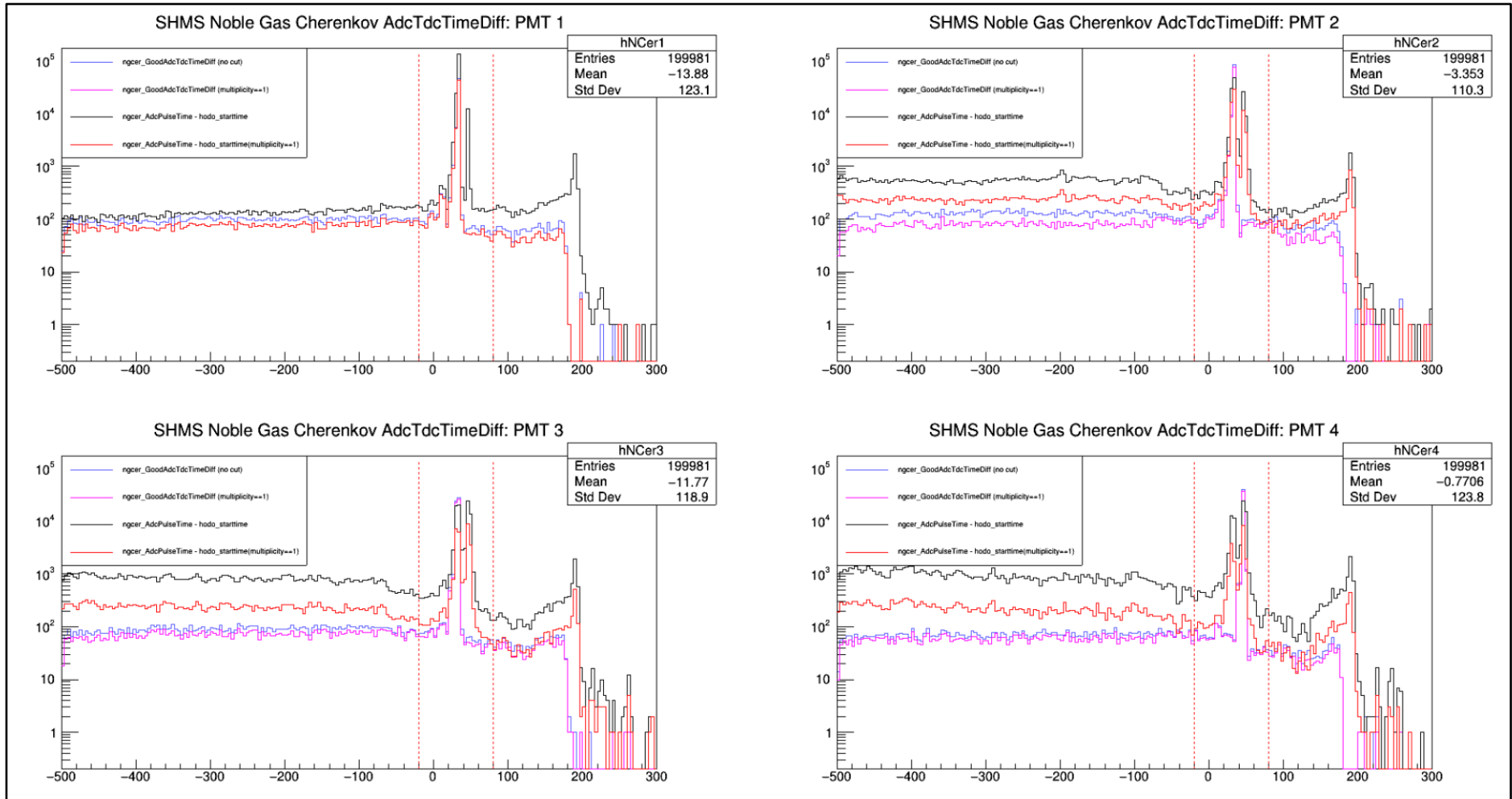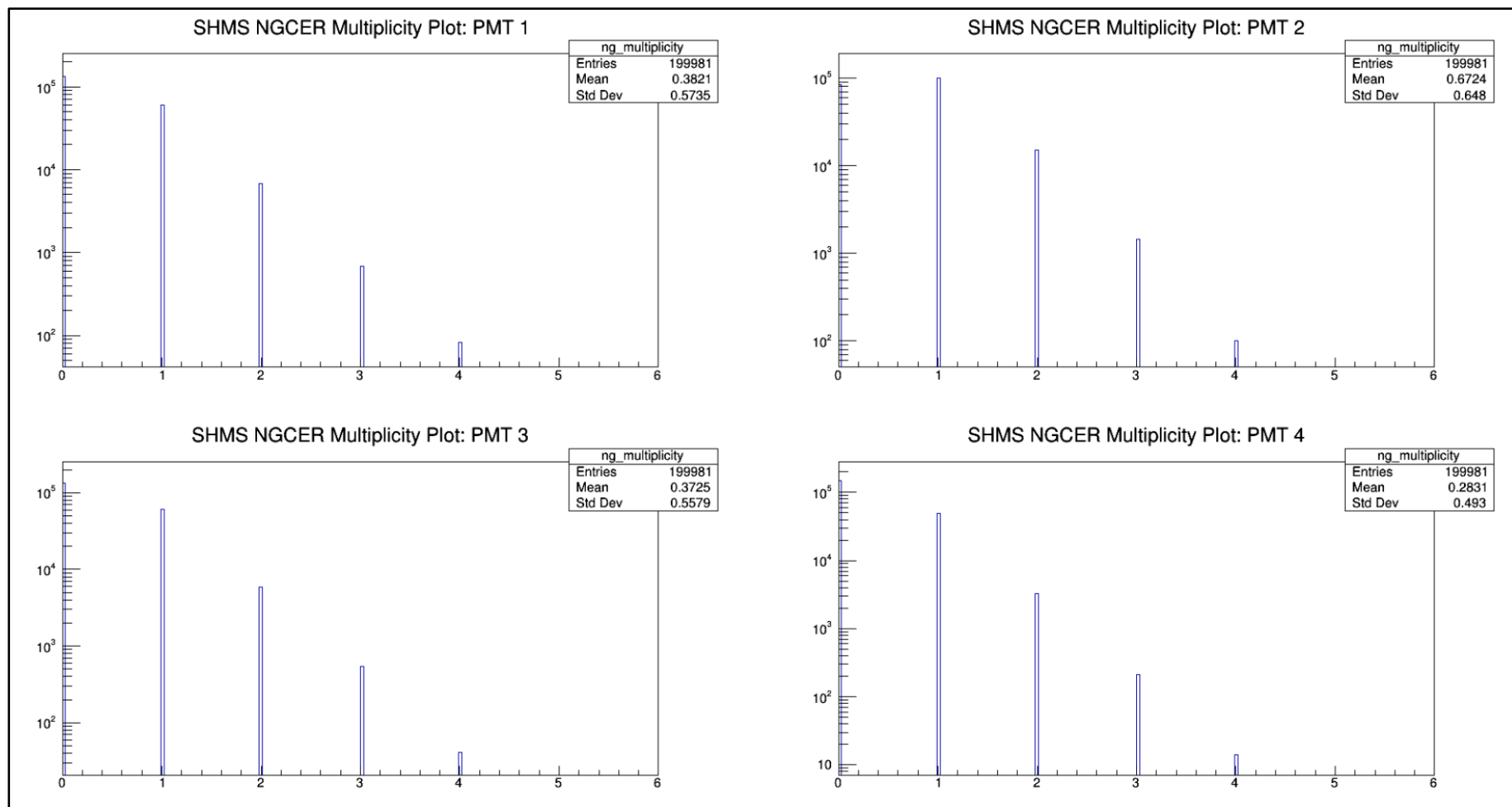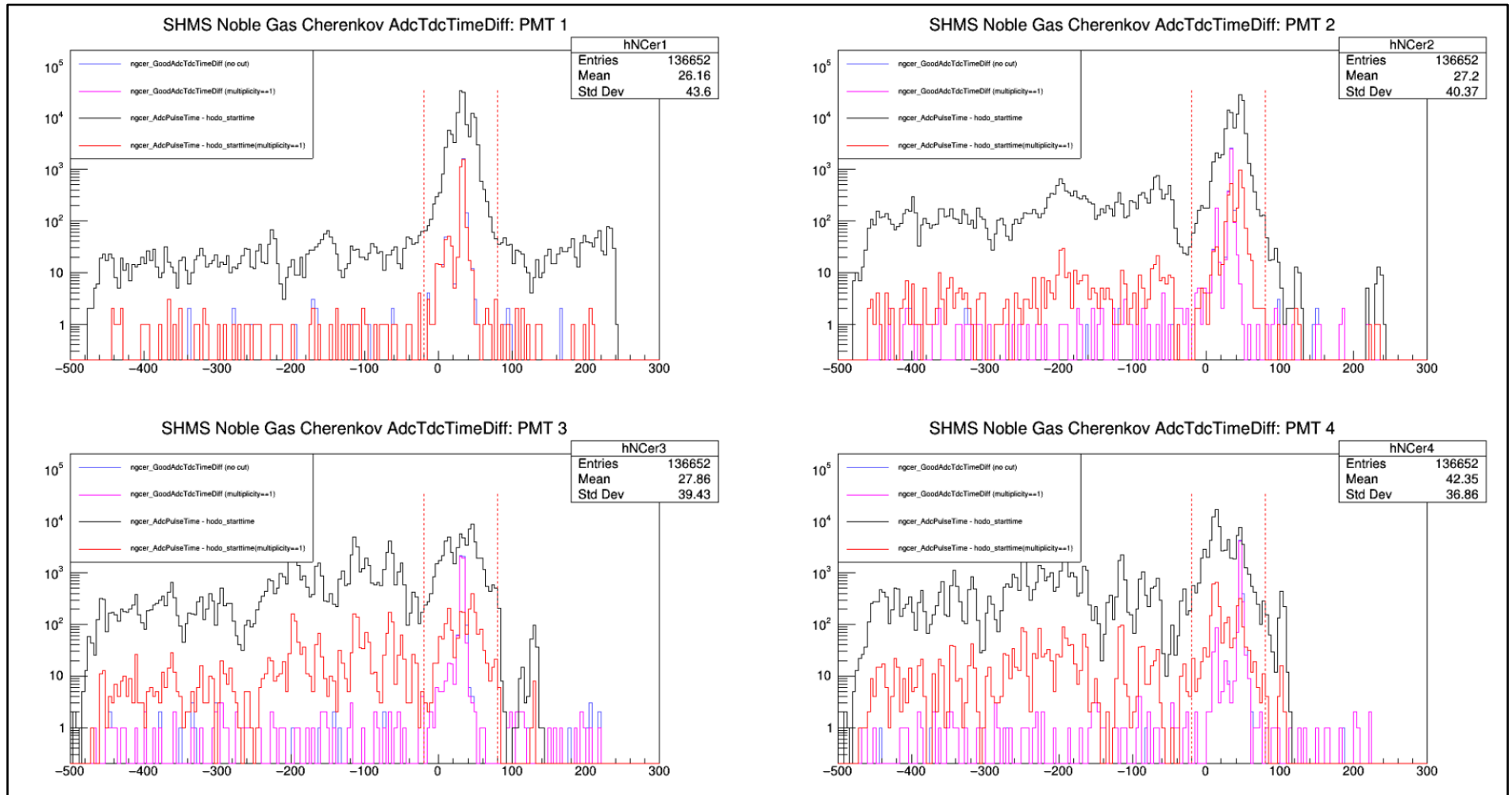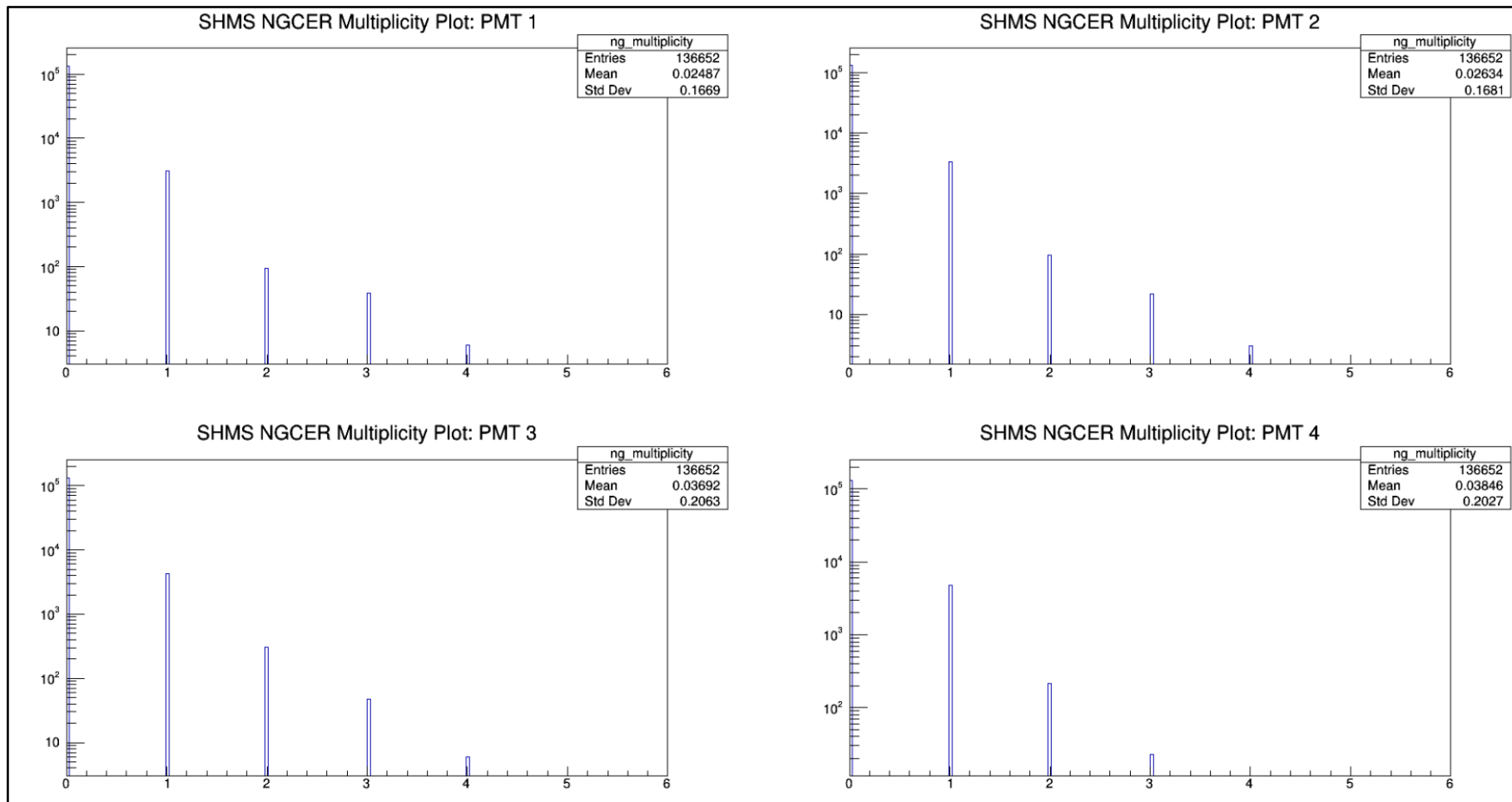
Difference?

SHMS run 09779 : NGCER

- hcana leaf name: P.ngcer.goodAdcMult [ipmt]

SHMS run : 09781

- Optics sieve in delta scan
- Ep = -2.129 GeV, 8.5 deg
- Trigger: EL-CLEAN (TRIG3)

SHMS run 09781 : NGCER

- **Original cut: min -20, max 80**

- P.ngcer.goodAdcTdcDiffTime [ipmt]

- P.hod.starttime – P.ngcer.adcPulseTime [ipmt]

Difference?

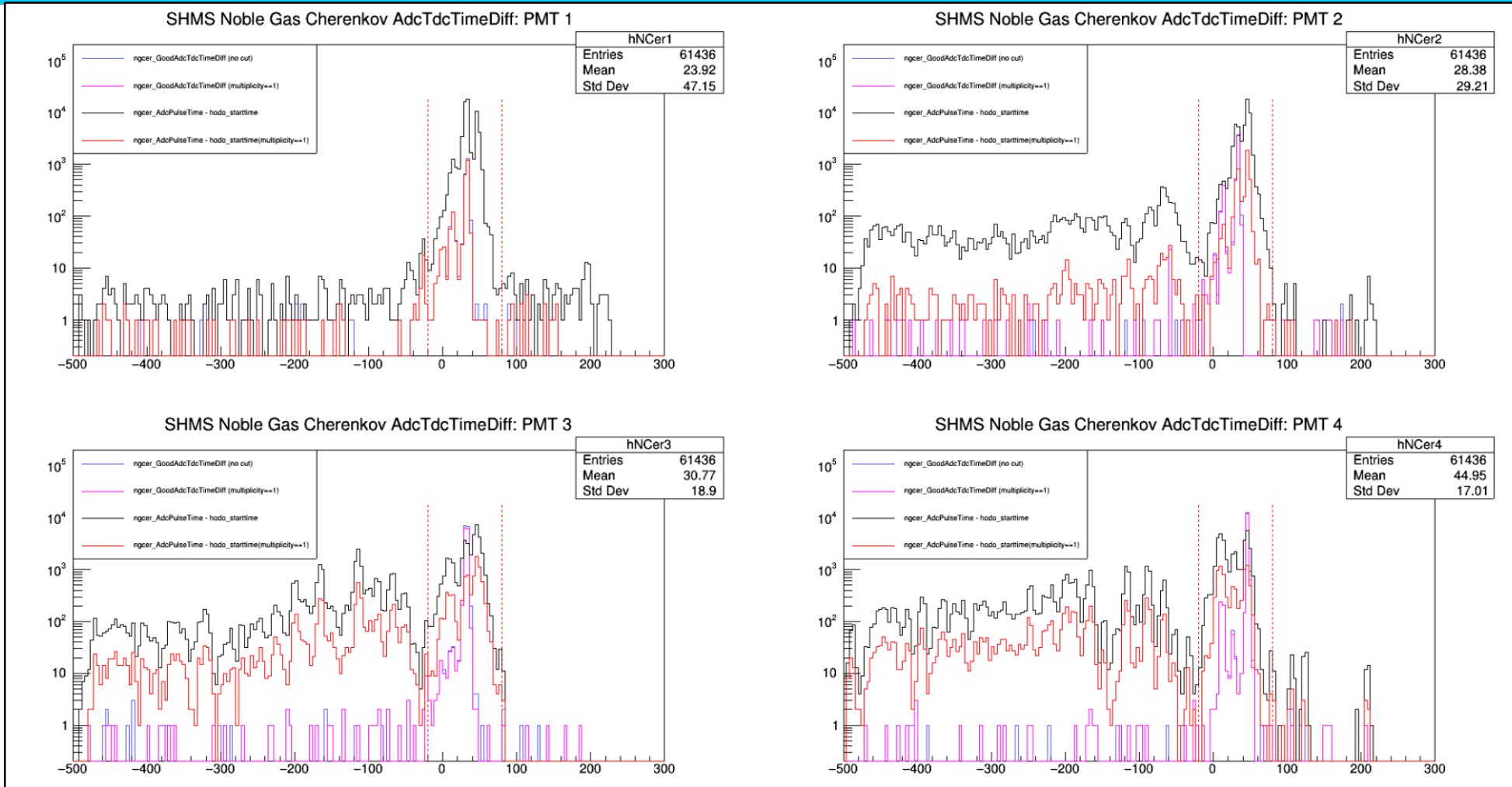# SHMS run 09781 : NGCER

- hcana leaf name: P.ngcer.goodAdcMult [ipmt]

SHMS run : 09740

- Delta 1232
- Ep = -1.797 GeV, 8.5 deg
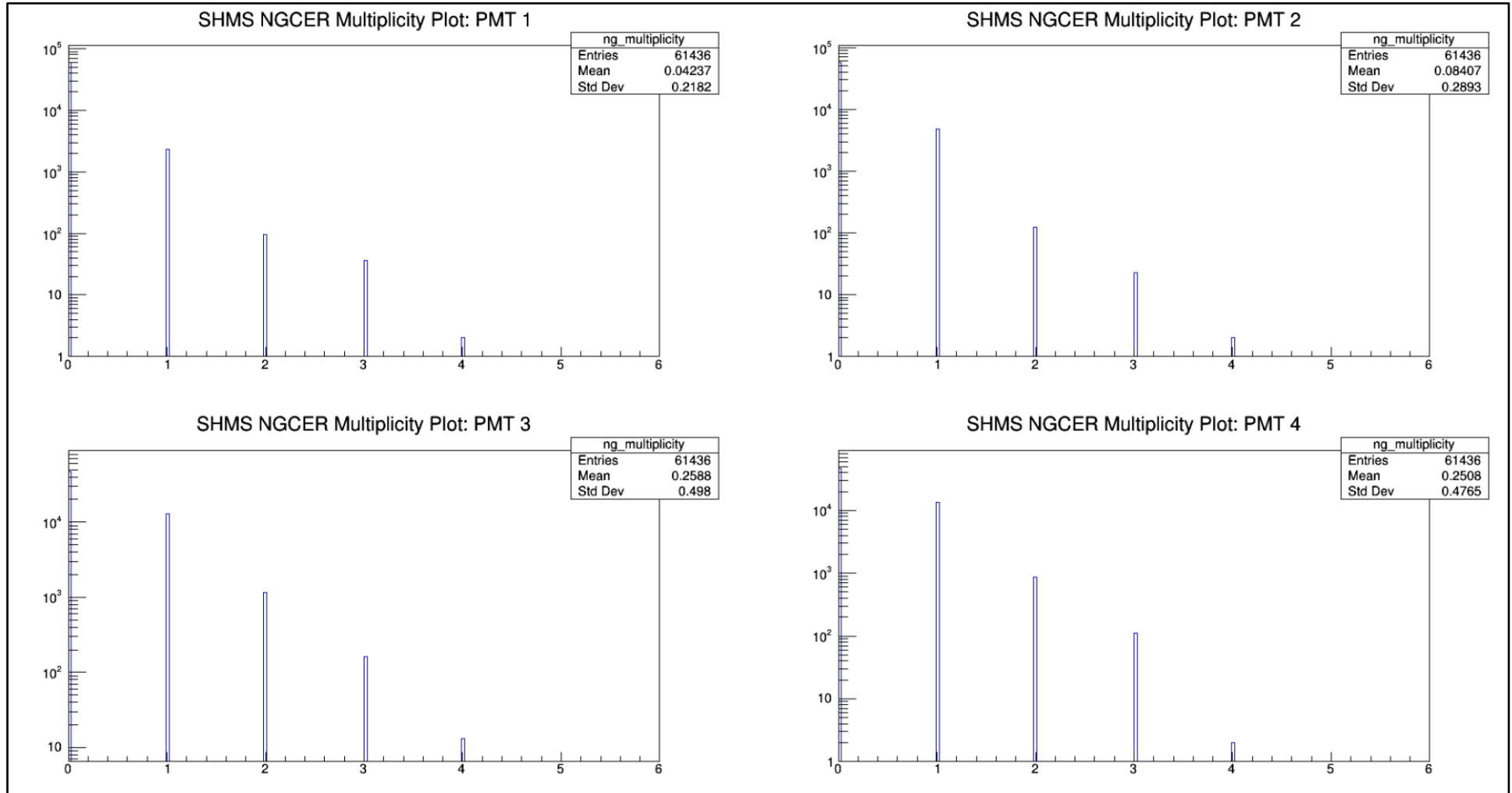- Trigger: EL-CLEAN (TRIG3)

SHMS run 09740 : NGCER

- **Original cut: min -20, max 80**

- P.ngcer.goodAdcTdcDiffTime [ipmt]

- P.hod.starttime – P.ngcer.adcPulseTime [ipmt]
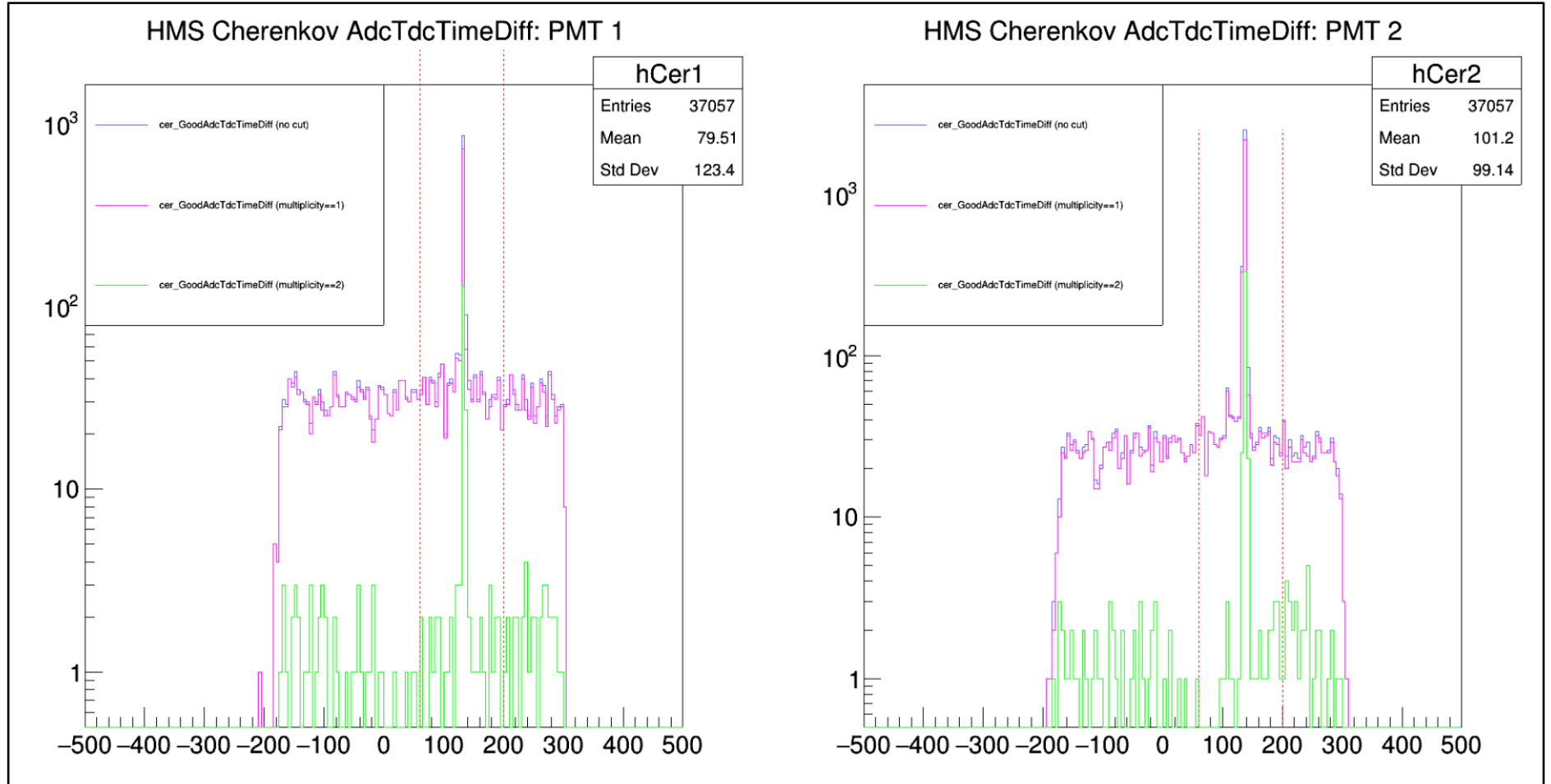
Difference?

SHMS run 09740 : NGCER

- hcana leaf name: P.ngcer.goodAdcMult [ipmt]

SHMS run : 10614

- DIS, Longitudinal
- Ep = -3.5 GeV, 30 deg
- Trigger: ¾ (TRIG1)

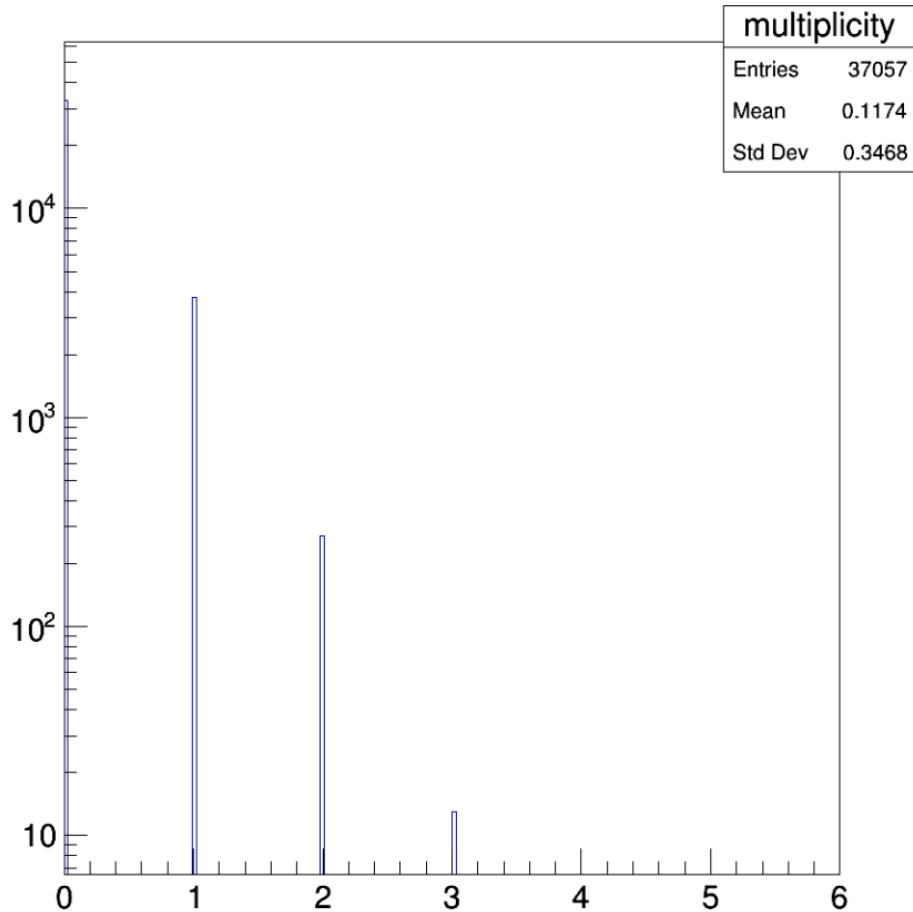# SHMS run 10614 : NGCER

- **Original cut: min -20, max 80**

- P.ngcer.goodAdcTdcDiffTime [ipmt]

- P.hod.starttime – P.ngcer.adcPulseTime [ipmt]

Difference?

SHMS run 10614 : NGCER

- hcana leaf name: P.ngcer.goodAdcMult [ipmt]

SHMS run : 10793

- C-Optics/Sieve
- Ep = 5.6 GeV, 18 deg
- Trigger: EL-REAL (TRIG2)

SHMS run 10793 : NGCER

- P.ngcer.goodAdcTdcDiffTime [ipmt]

Difference?

- **Original cut: min -20, max 80**

- P.hod.starttime – P.ngcer.adcPulseTime [ipmt]

SHMS run 10793: NGCER

- hcana leaf name: P.ngcer.goodAdcMult [ipmt]

HMS run : 03408

- DIS, Longitudinal
- Ep = -3.5 GeV/c, 30 deg
- Trigger: 3/4 (TRIG1)

HMS run 3408: CER

- **Original cut: min 60, max 200**

- H.cer.goodAdcTdcDiffTime [ipmt]
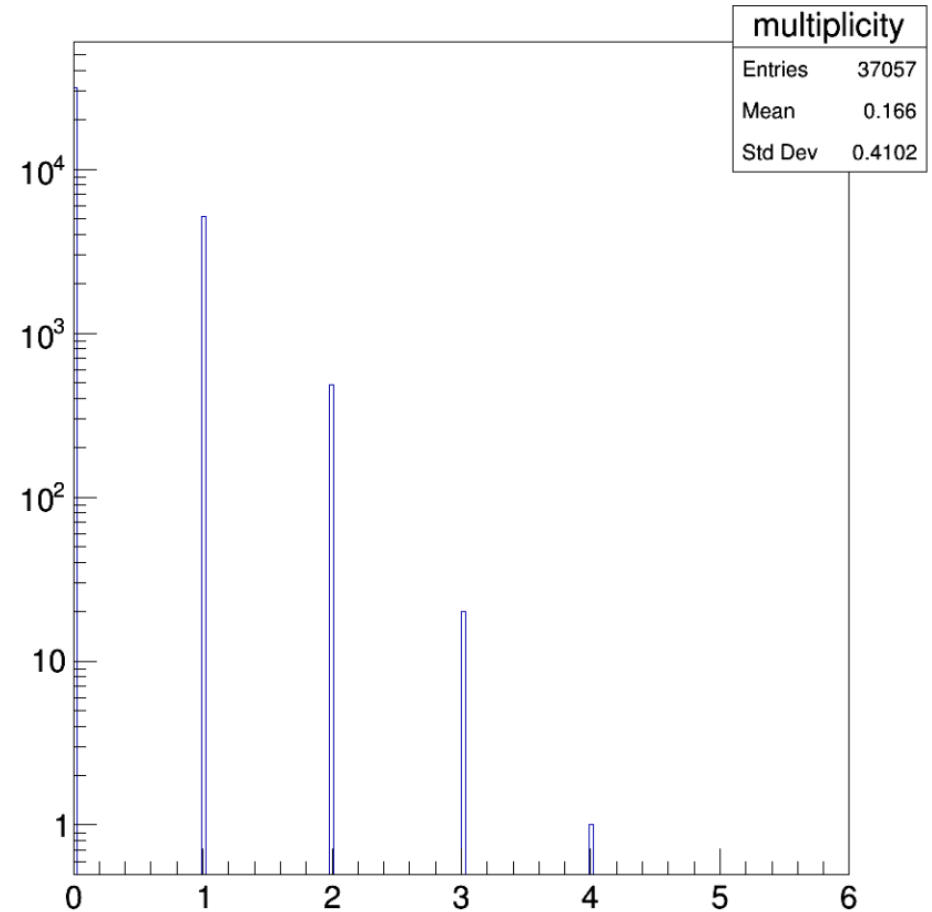
- H.hod.starttime – H.cer.adcPulseTime [ipmt]

?

HMS run 3408: CER
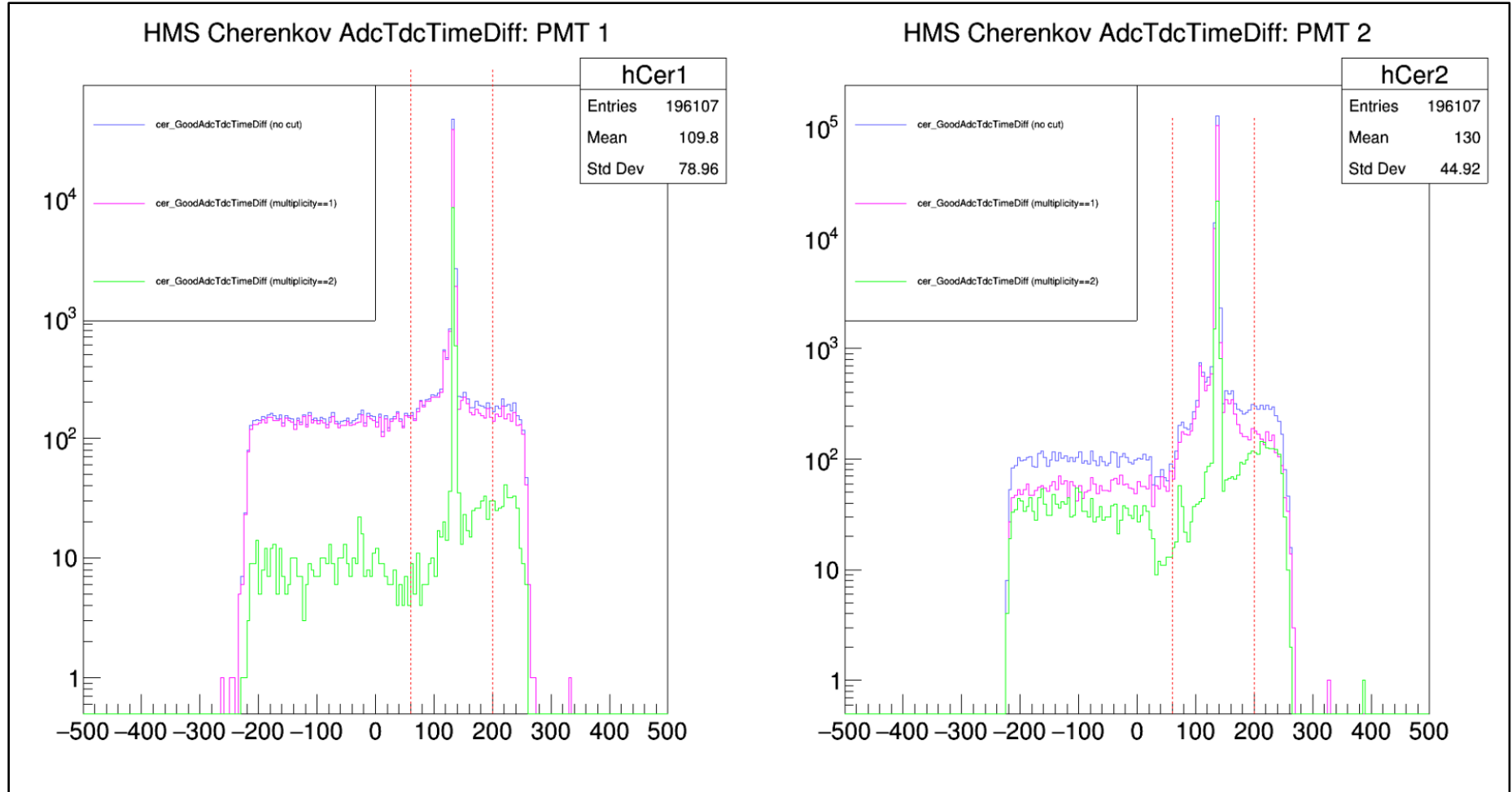
- hcana leaf name: H.cer.goodAdcMult [ipmt]

HMS run : 02608

- 1-pass elastic, Longitudinal
- Ep = -2.148 GeV/c, 11.7 deg
- Trigger: EL-CLEAN (TRIG3)
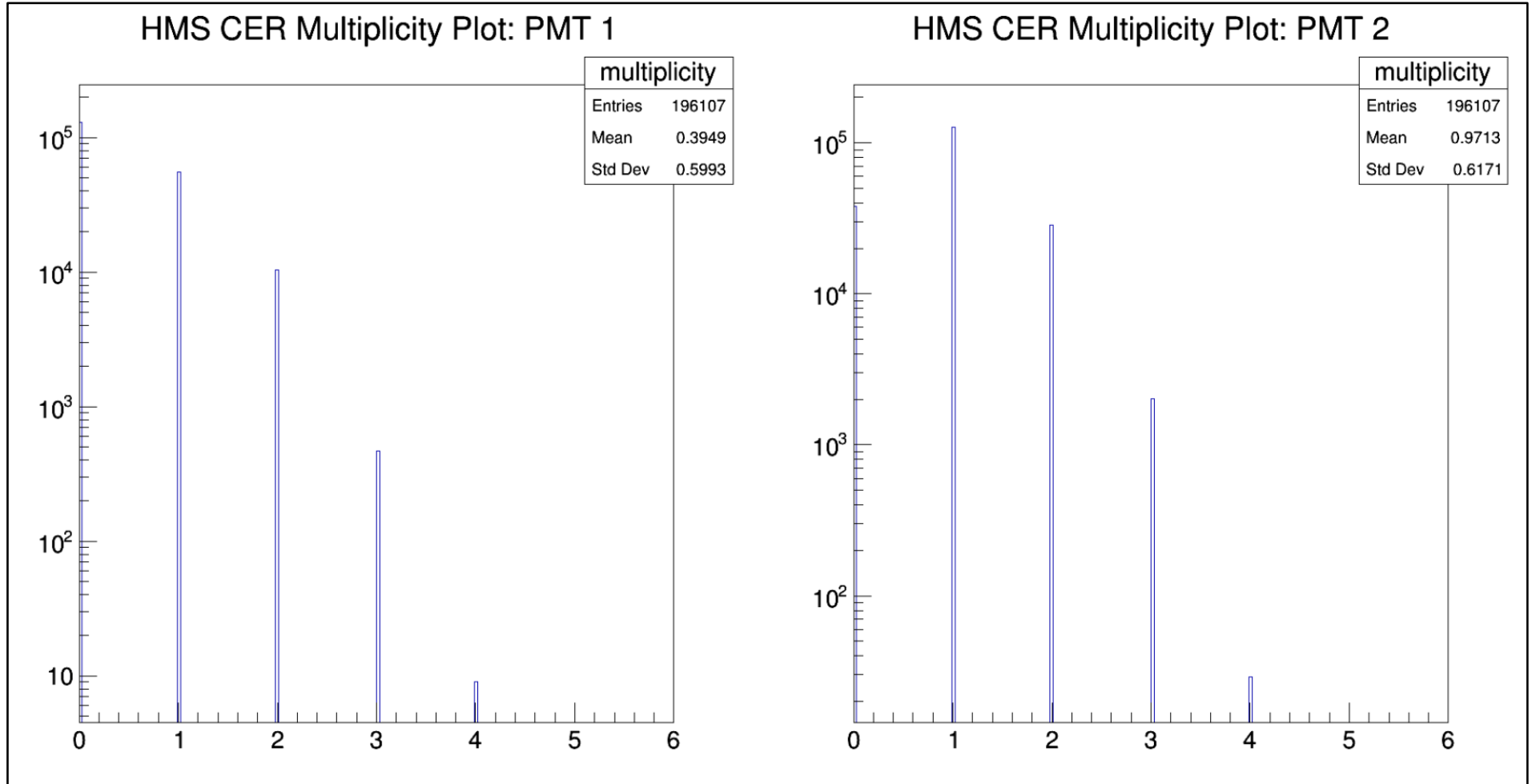
- **Original cut: min 60, max 200**

- H.cer.goodAdcTdcDiffTime [ipmt]

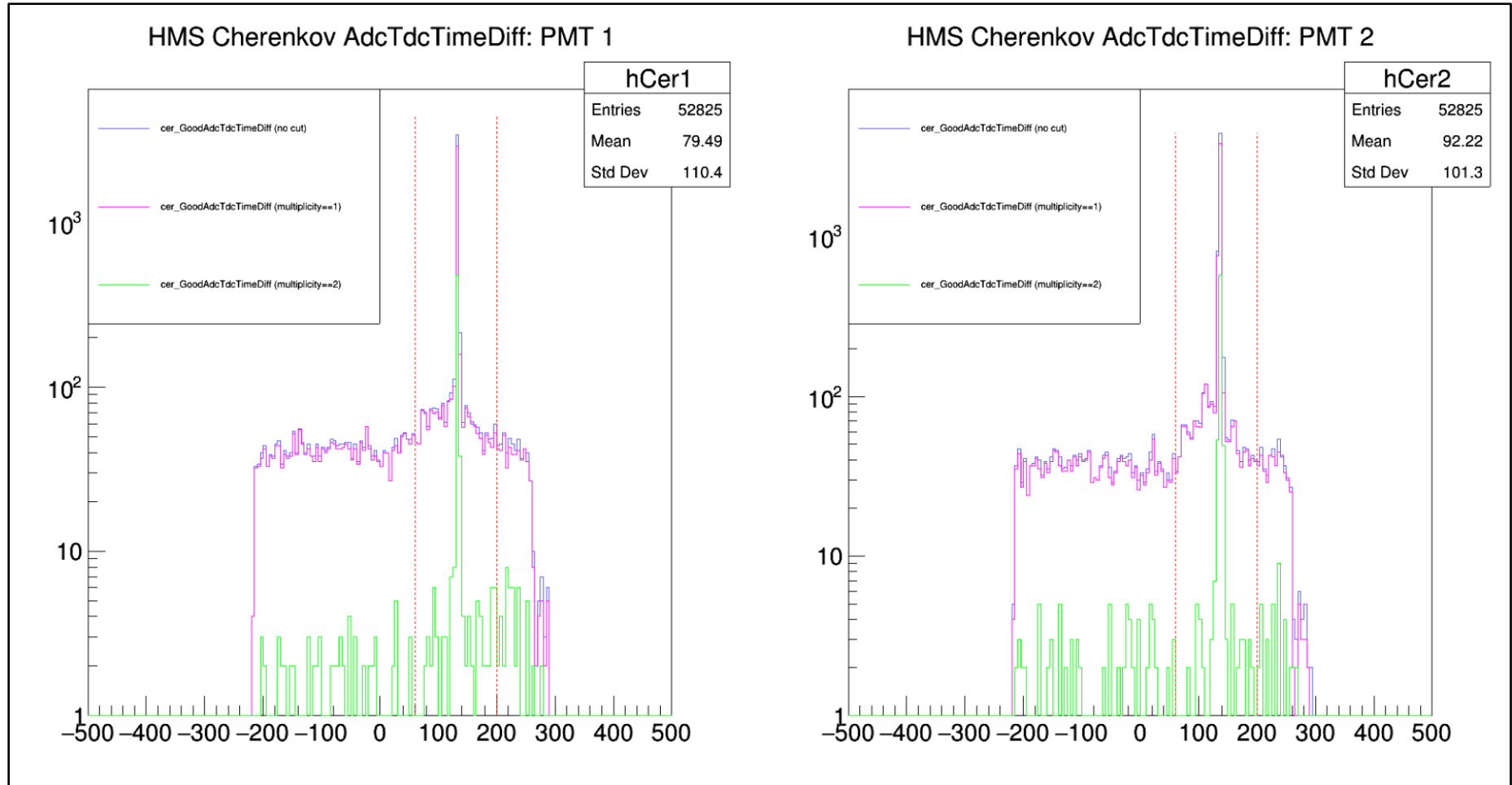- H.hod.starttime – H.cer.adcPulseTime[ipmt]

HMS run 2608: CER

- hcana leaf name: H.cer.goodAdcMult [ipmt]

HMS run : 03616

- C-Optics/Sieve
- Ep = -4.0 GeV/c, 20 deg
- Trigger: EL-REAL (TRIG2)
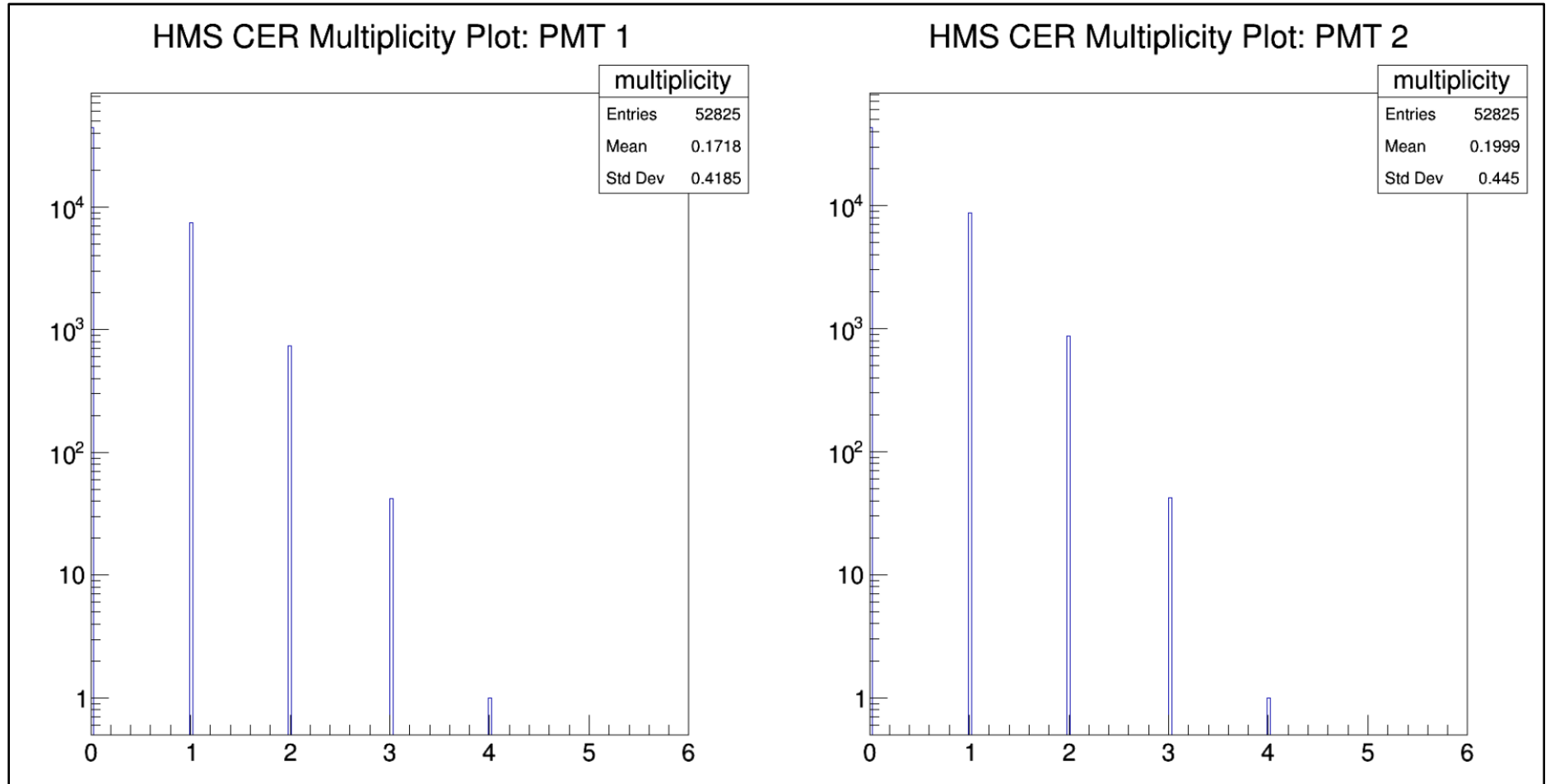
HMS run 3616: CER

- **Original cut: min 60, max 200**

- H.cer.goodAdcTdcDiffTime [ipmt]

- H.hod.starttime – H.cer.adcPulseTime [ipmt]

?

HMS run 3616: CER

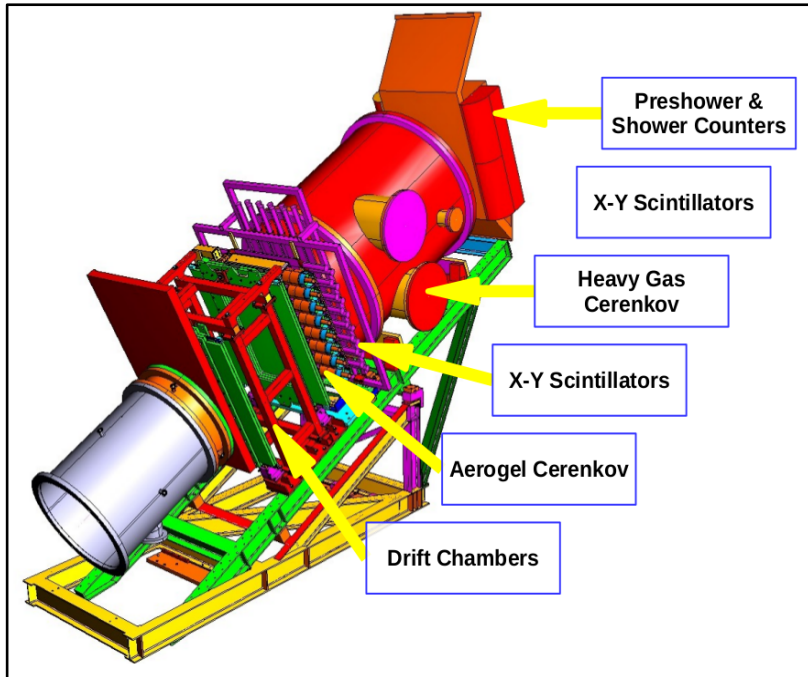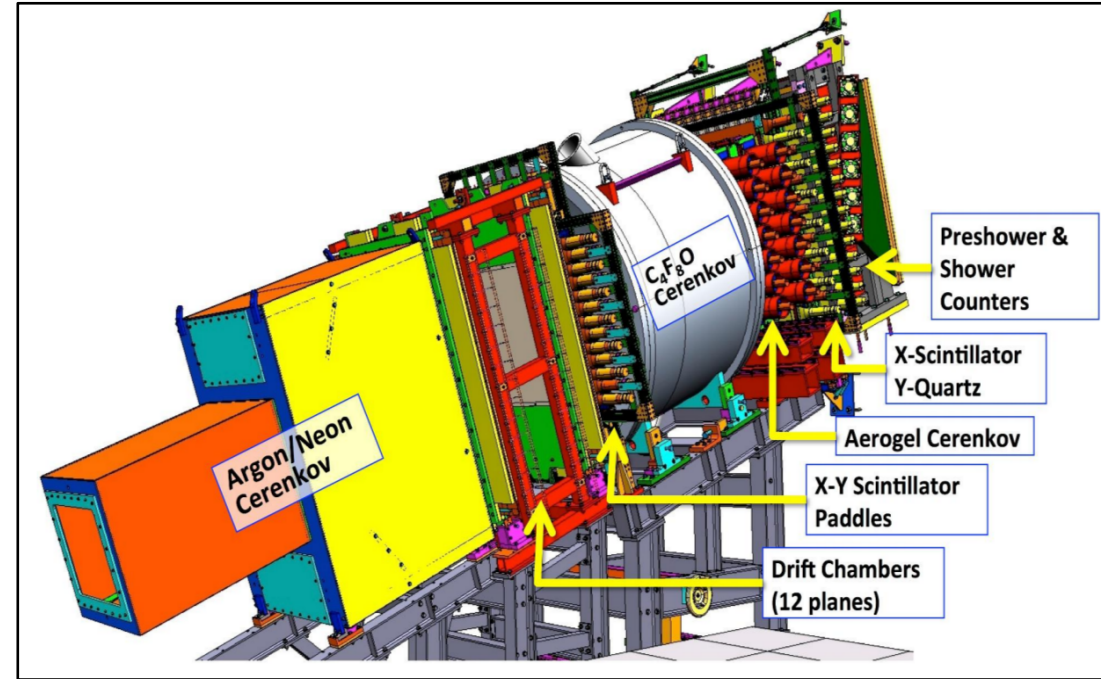- hcana leaf name: H.cer.goodAdcMult [ipmt]

Questions

- The detector time window plots for SHMS run 10614 (trigger ¾) and 10793 (trigger EL_REAL) is not very clean in comparison with runs 9779,9781,9740 (trigger EL-CLEAN). Why?

- What is the difference between the following?

  1. Plotting P.hgcer.goodAdcTdcDiffTime [ipmt]

  2. Plotting P.hod.starttime – P.ngcer.adcPulseTime [ipmt]

- Where is the branch H.cer.adcPulseTime [ipmt] ? Cannot find it !

Spectrometers and detectors

HMS detectors

Preshower & Shower Counters

X-Y Scintillators

Heavy Gas Cerenkov

X-Y Scintillators

Aerogel Cerenkov

Drift Chambers

SHMS detectors

C_4F_8O Cerenkov

Argon/Neon Cerenkov

Preshower & Shower Counters

X-Scintillator Y-Quartz

Aerogel Cerenkov

X-Y Scintillator Paddles

Drift Chambers (12 planes)

Spectrometer	Central momentum (GeV/c)	Momentum acceptance	Momentum resolution	Scattering angle	Solid angle acceptance (msr)	Horizontal acceptance (mrad)	Vertical acceptance (mrad)
HMS	0.5 - 7.5	(-9.0% , +9.0%)	0.02%	12.5° - 90°	8.1	± 32	± 85
SHMS	2.0 – 11.0	(-10% , +22%)	0.03% - 0.08%	5.5° - 40°	> 4.0	± 24	± 40