CDCTRG 2D performance with full hit algorithm
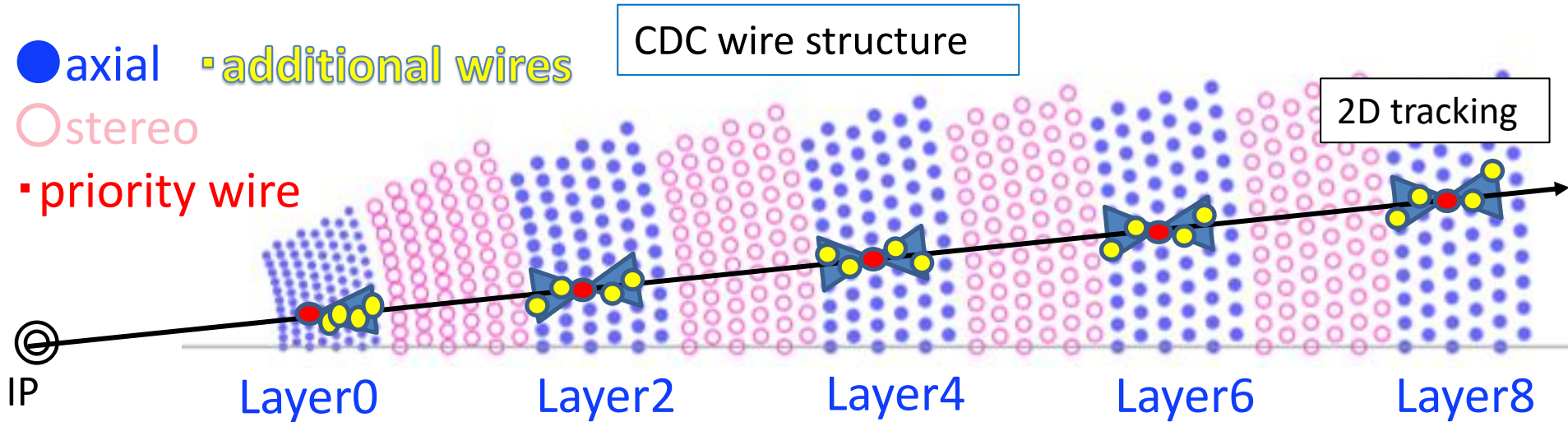## 2022/8/25
T.Koga

Motivation

-study efficiency and fake track rejection performance of new 2D

-TSIM is performed to collision data taken in 2022b

Fullhit 2D algorithm

-Modify 2D to use all hit patterns inside TSF to reject fake track

-Firmware development is finished by Ping,
and Koga takes over commissioning work for his graduation

-Parameter of Hough is the same as present 2D, except for hit threshold
  -Present 2D: the number of tracked TSF >=4
  -New 2D: the number of tracked hit >=20 (Nth)

Dataset: efficiency study

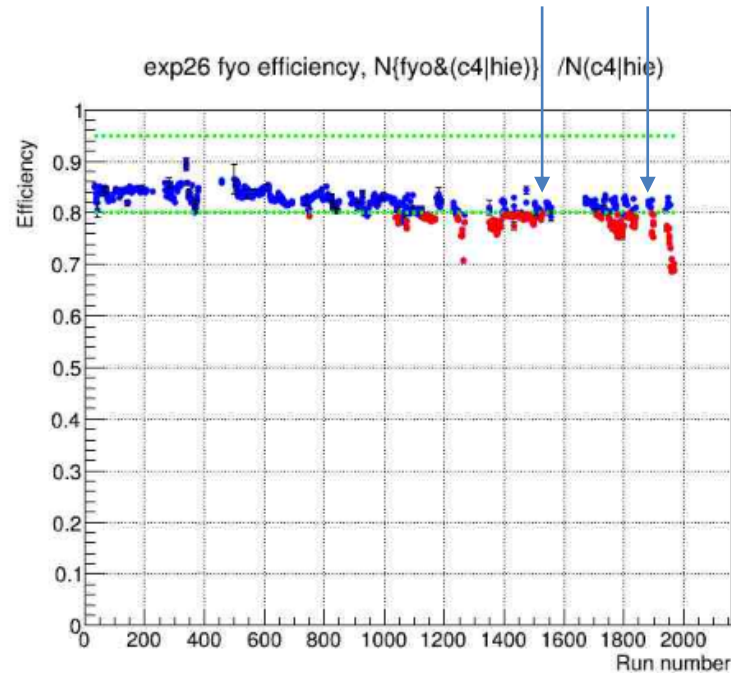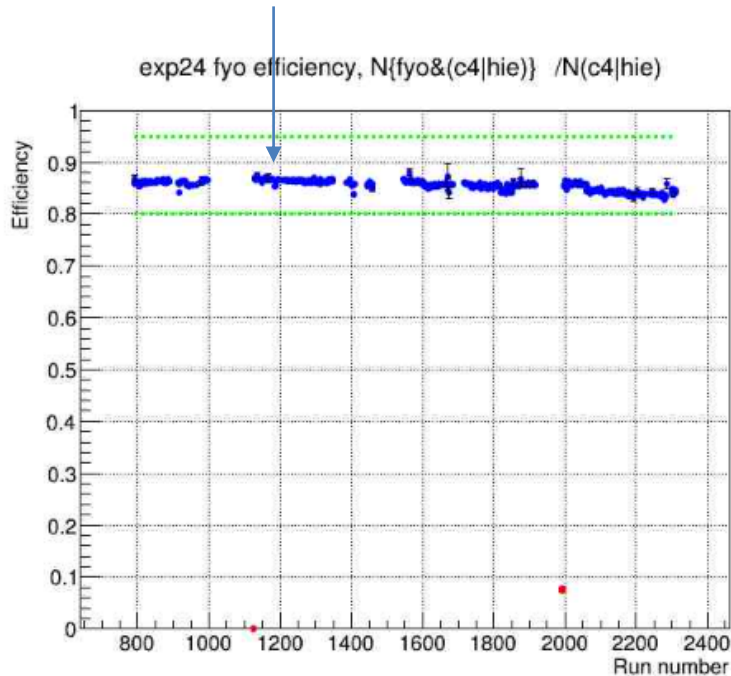-3/21 exp24run1184, physics, beam_reco_filter
L=~2.0×10^{34}, L1 rate=~3kHz, CDC leak current=~40μA

-6/13 exp26run1506, debug, beam_reco_filter, **lower TDC threshold -20mV**
L=~3.5×10^{34}, L1 rate=~8kHz, CDC leak current=~200μA

-6/18 exp26run1893, physics, beam_reco_filter
L=~3.0×10^{34}, L1 rate=~5kHz, CDC leak current=~200μA

4

Analysis with offline track

-Offline dimuon track is selected from collision data
  -impact parameter |d0|<1cm, |z0|<1cm: select cosmic through IP
  -first cdc layer<5, last cdc layer>50:   select long track from SL0 to SL8
  -HLT skim = mumutight

-Track matching is applied to trigger tracks, both tsim and firmware
  -Δφ<20deg.
  -Δpt<

-Compare efficiency and trigger rate
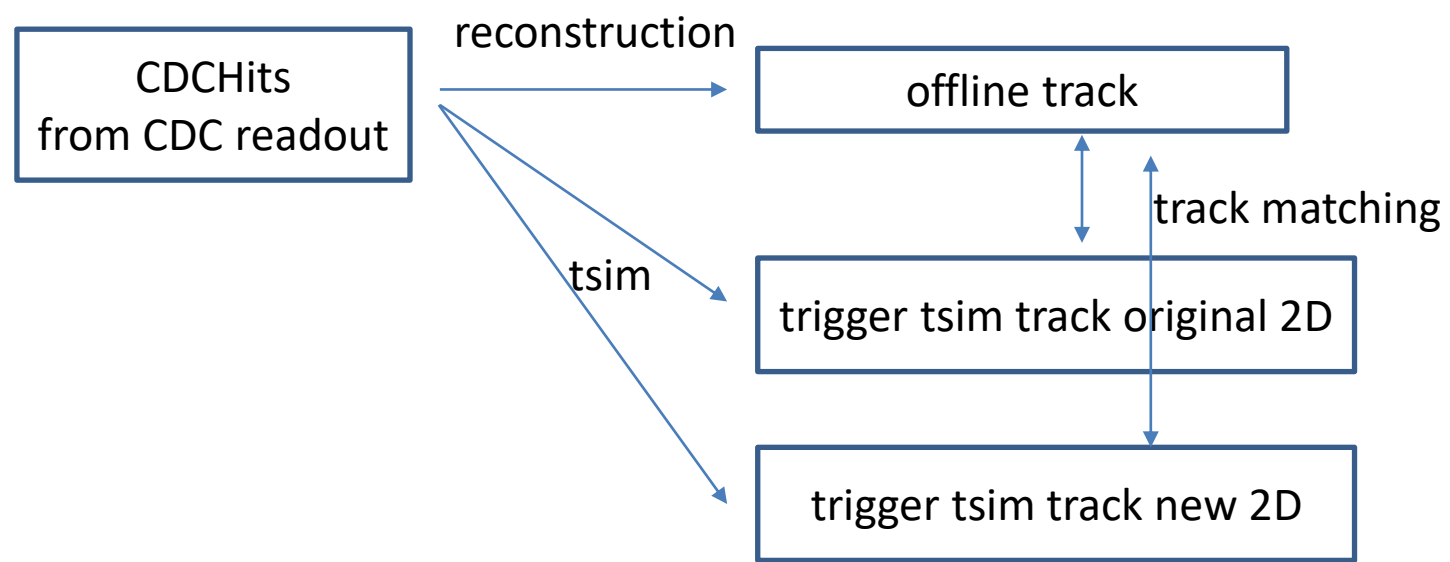
track matching efficiency

-Full-hit2D Hit threshold = 15
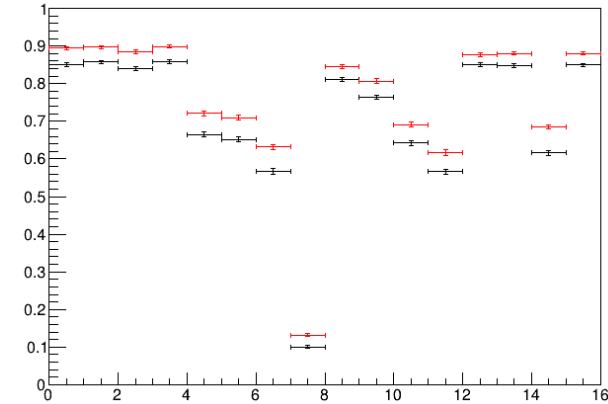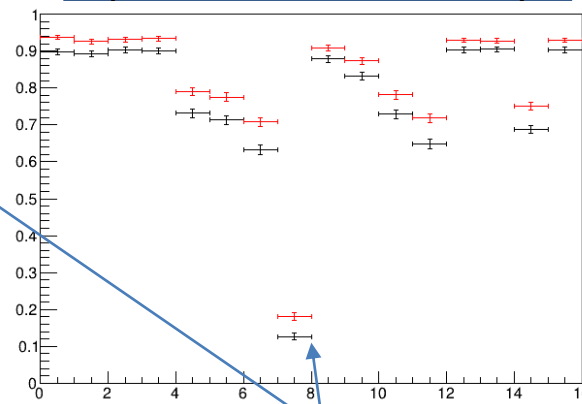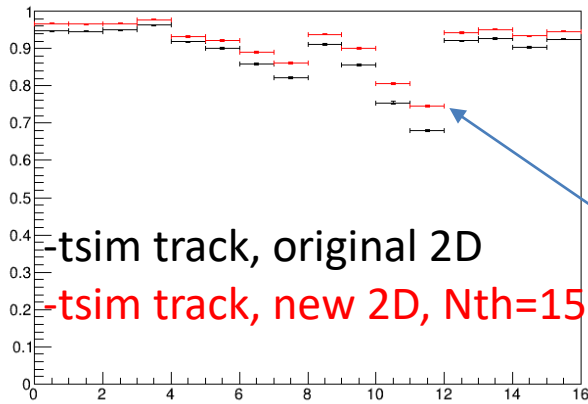

3/21 exp24run1184

6/13 exp26run1506
(lower TDC threshold)

6/18 exp26run1893

matching efficiency

-tsim track, original 2D
-tsim track, new 2D, Nth=15

trackφ(slotID)   Dips due to CDC readout dead channel (not CDCTRG)

track matching efficiency

-Full-hit2D Hit threshold = 15-19

-Efficiency decreases due to low hit efficiency
 -due to low gain, which is not simulated and seen on data only

		Efficiency at slot0		
	Nth	**exp24run1184**	**exp26run1506**	**exp26run1893**
original 2D	4	0.946	0.893	0.857
	5	0.614	0.448	0.369
new 2D	15	0.966	0.926	0.897
	16	0.943	0.886	0.850
	17	0.910	0.846	0.799
	18	0.856	0.776	0.713
	19	0.776	0.666	0.599

track matching efficiency: Add ADC information

-2D code is modified on TSIM to use ADC information
  -TSF: no ADC is used
  -2D: only CDChits with ADC=[10,600] is used for Hough mapping.

-Track matching efficiency is checked again
  -keeping high efficiency

Efficiency at slot0			

	Nth	exp24run1184	exp26run1506	exp26run1893
original 2D	4	0.946	0.893	0.857
	5	0.614	0.448	0.369
new 2D 10<ADC<700	10	0.998	0.995	0.988
	15	0.952	0.904	0.872
new 2D 20<ADC<400	10	0.997	0.990	0.985
	15	0.937	0.875	0.843

Track rate reduction

-Check #2D tracks and 2D track rates with original 2D and new 2D
  -exp26run1780, beam_reco_monitor
  -L=~4.0×10^{34}, L1 rate=~8kHz, CDC leak current=~250µA

-Even with rough idea,
2D track rate reduce ~30%, while keeping efficiency with 20<ADC<400.
  -further optimization is possible

|	Nth	event rate of #2D track>0 exp26run1780	dimuon efficiency exp24run1184
original 2D	4	3.4kHz	0.946
new 2D	16	not yet	0.943
new 2D	18	not yet	0.856
new 2D 10<ADC<700	15	2.9kHz	0.952
new 2D 20<ADC<400	15	2.4kHz	0.937

Summary

-study efficiency and fake track rejection performance of new 2D

-TSIM is performed to collision data taken in 2022b

-Due to low hit efficiency than simulation, Nth=16 is needed to keep
 efficiency.

-By using ADC information in addition, 2D track rate reduce ~30%,
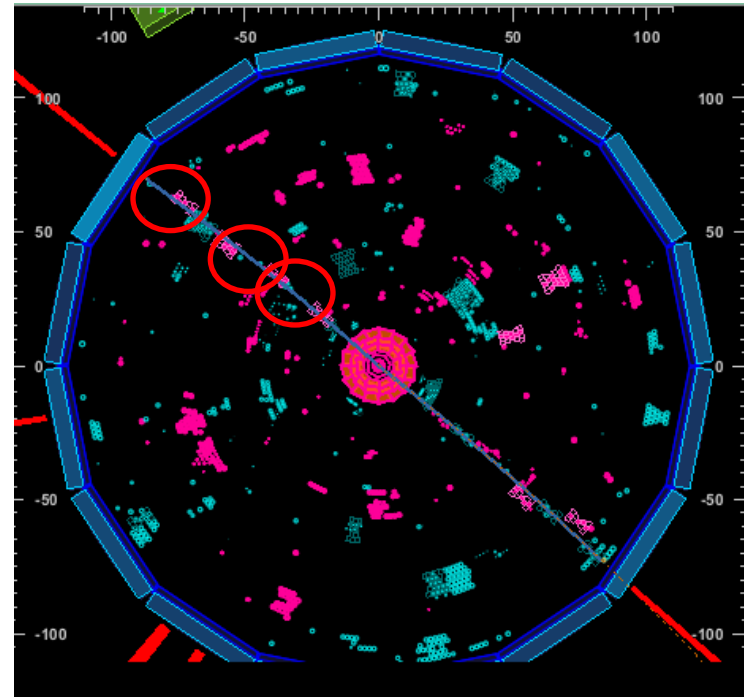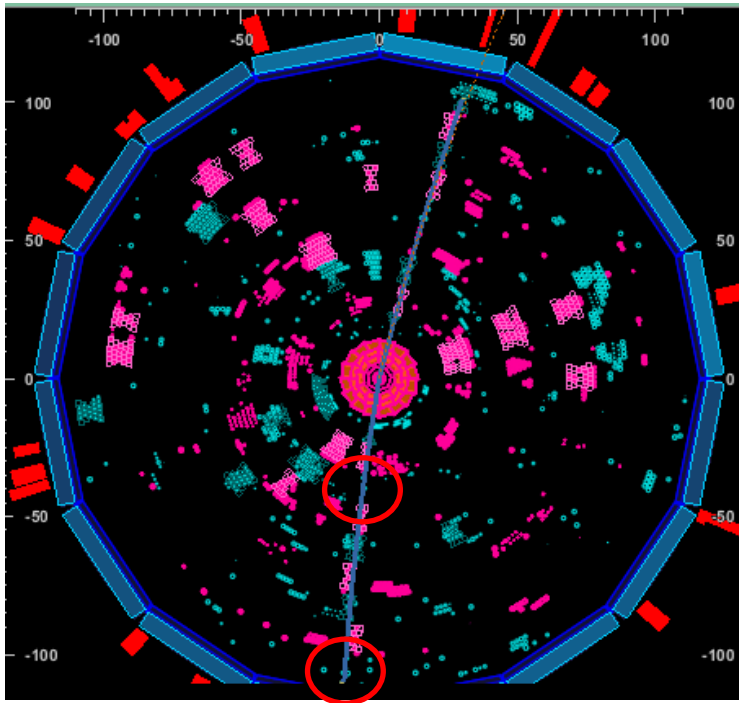 while keeping efficiency. Further optimization is possible.

backup

Dataset

-exp26run1780, physics, beam_reco_monitor

-L=~4.0×10^{34}, L1 rate=~8kHz, CDC leak current=~250μA
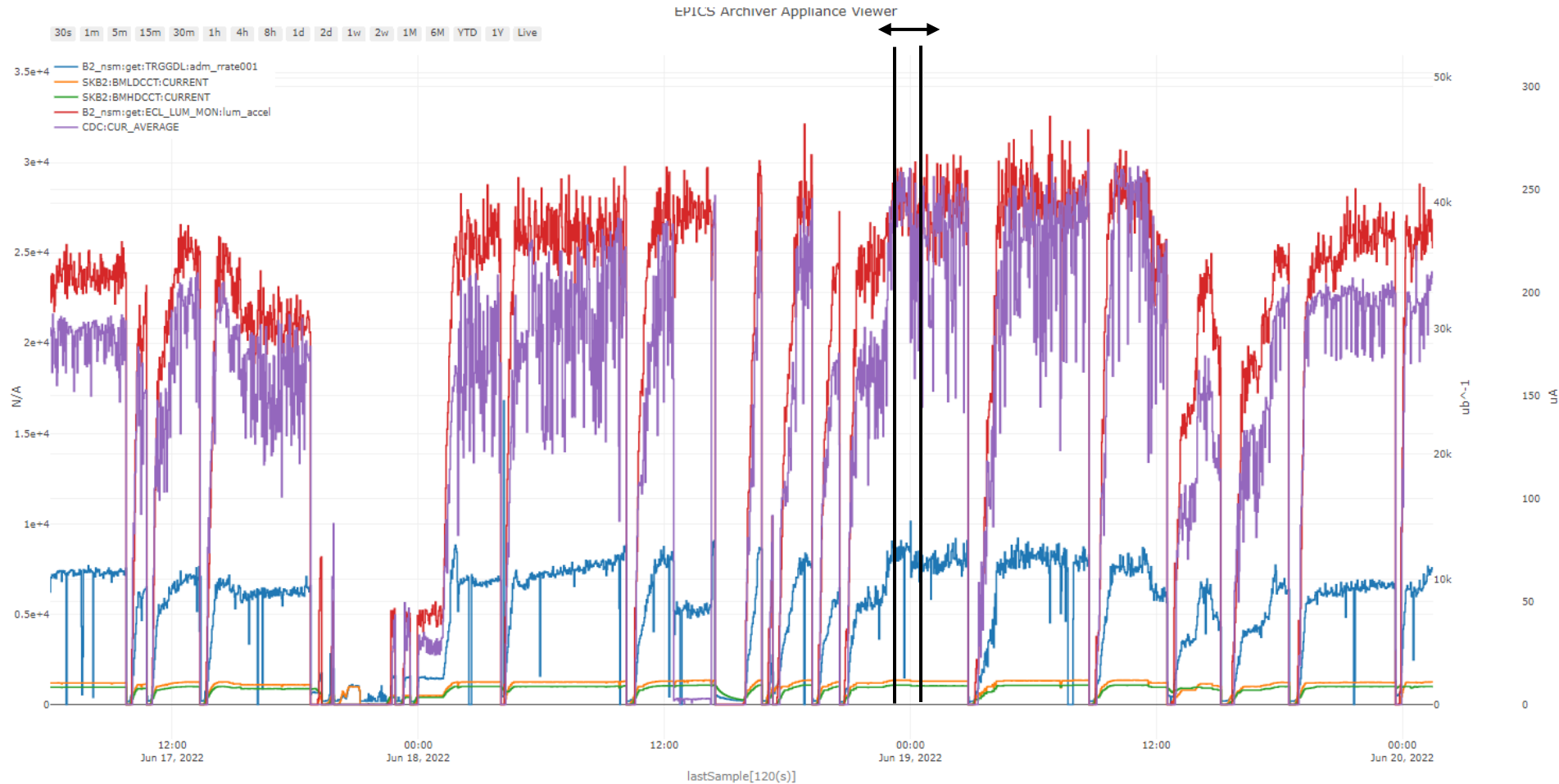
Example of bad events

-TSF is missing due to low gain and hit efficiency

Track finding efficiency: #hit dependence with TSIM

-Change Nth of TSIM for comparison.
 Impact to efficiency is large, even with small changes of the Nth.

-It seems #CDChits of FW is smaller than TSIM about ~1 hit per track.

-offline track
-matched firmware track
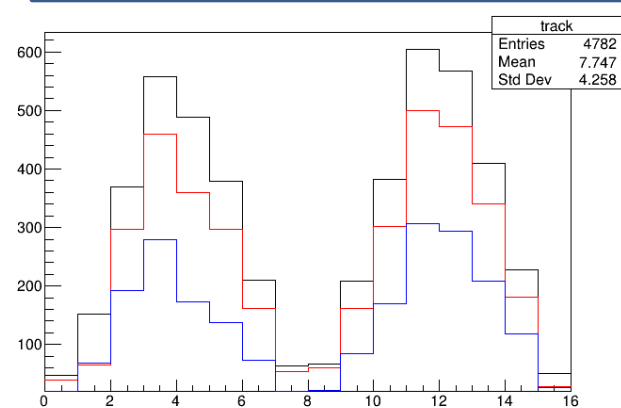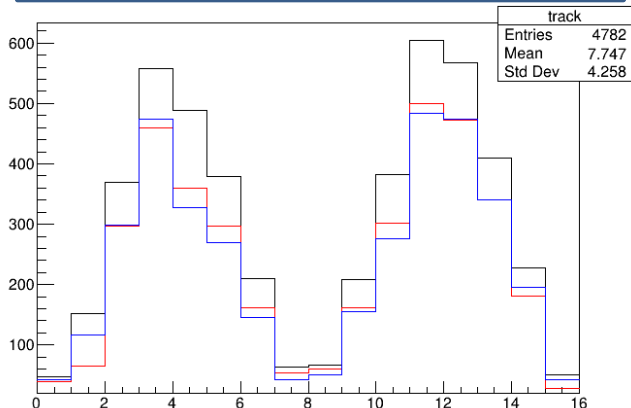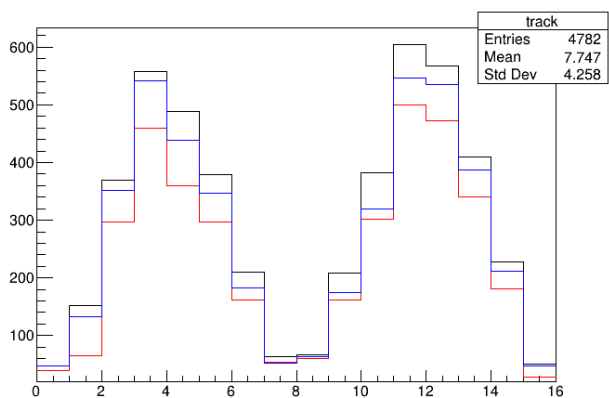-matched tsim track

data-MC agreement
improved with Nth=21(TSIM)

Nth=20(data), Nth=20(TSIM)

Nth=20(data), Nth=21(TSIM)
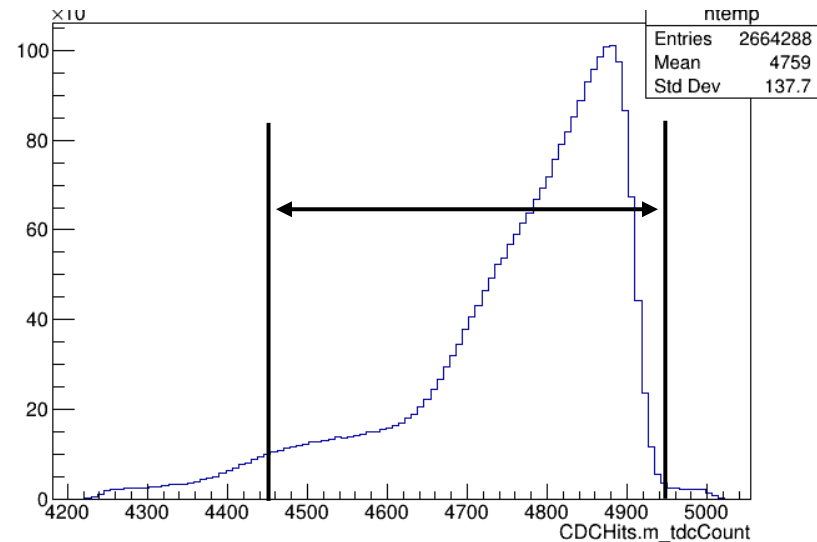
Nth=20(data), Nth=22(TSIM)
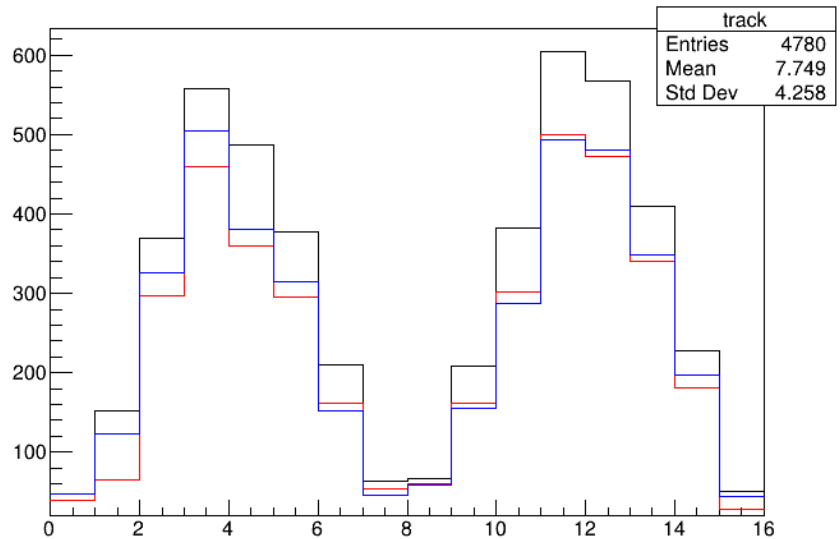
TSIM modification

-TSIM is modified to use the same timing window as firmware
 -tdc=4450--4950

-Data-MC agreement is improved but not perfect. Asymmetry is seen.
→ Need further investigation

TDC of CDCHits

Fullhit, Nth=20 after modification

trackφ(slotID)

Summary

-Performance evaluation of new 2D firmware with full-hit algorithm
 by using cosmic

-It seems #CDChits of FW is smaller than TSIM about ~0.5(?) hit per track.
→Need further investigation.

-Next:
  -study fake track rejection performance with collision data in 2022b,
   optimize Nth and other Hough parameters.