

CDCFE crosstalk filtering update
2023/1/9
T.Koga

Motivation

- Improve crosstalk filtering on CDCFE

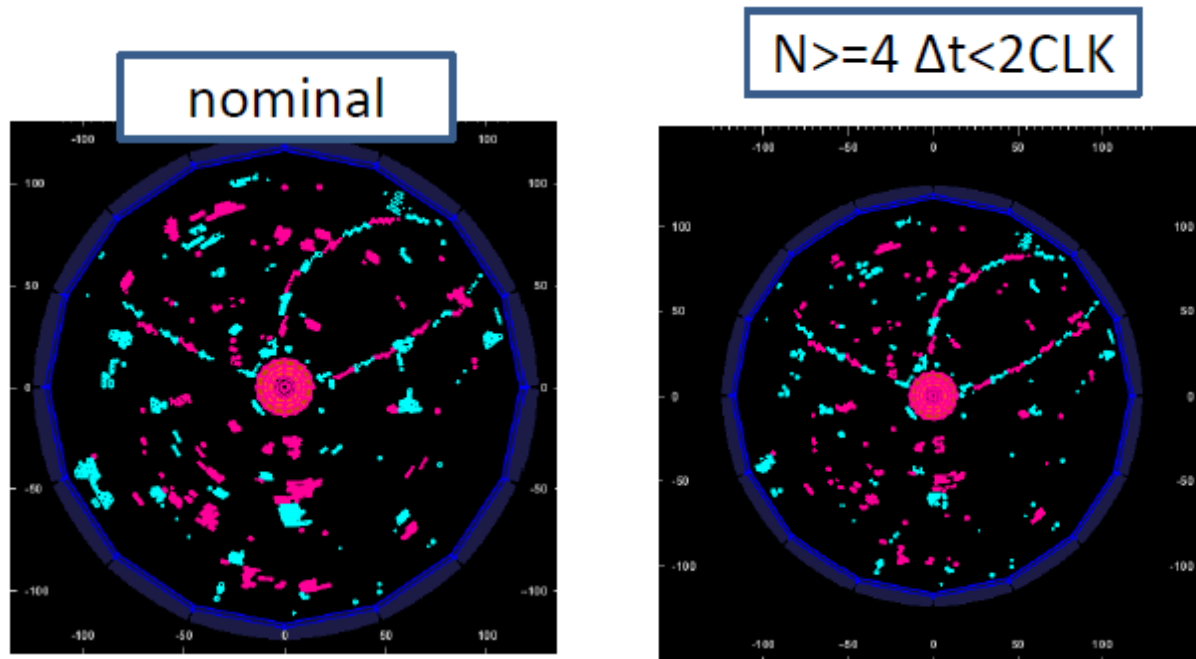
Present crosstalk filtering on CDCFE

-Implemented since 2020

https://www.dropbox.com/s/56flcl9dtcfey4e/koga_cdcwaveform_2019_9_2.pdf?dl=0

-If more than 4 hits on a ASIC coincide within 16ns, hits are judged as crosstalk and not sent to TRG

- CDC has ~300 CDCFE
- a CDCFE has 6 ASICs
- a ASIC has 8 wires

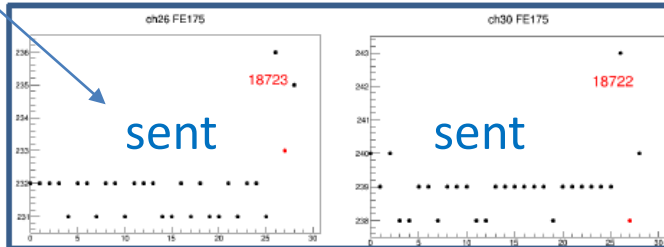


Remained crosstalk

- Crosstalk on the same ASIC is rejected well
- Crosstalk between the different ASIC is not rejected

Waveform: crosstalk FE175

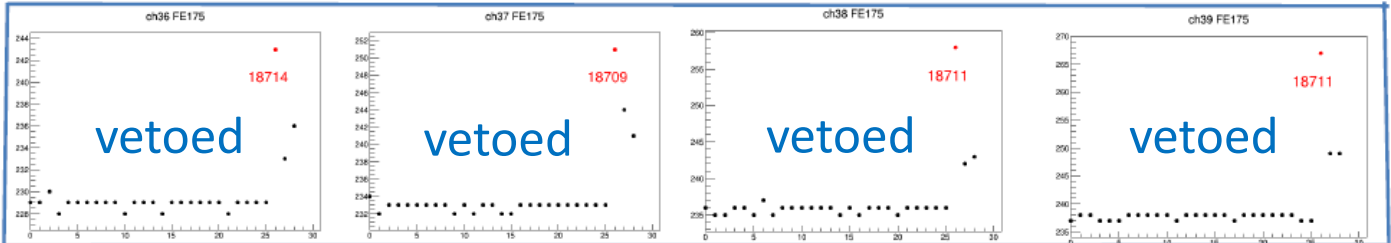
next next ASIC



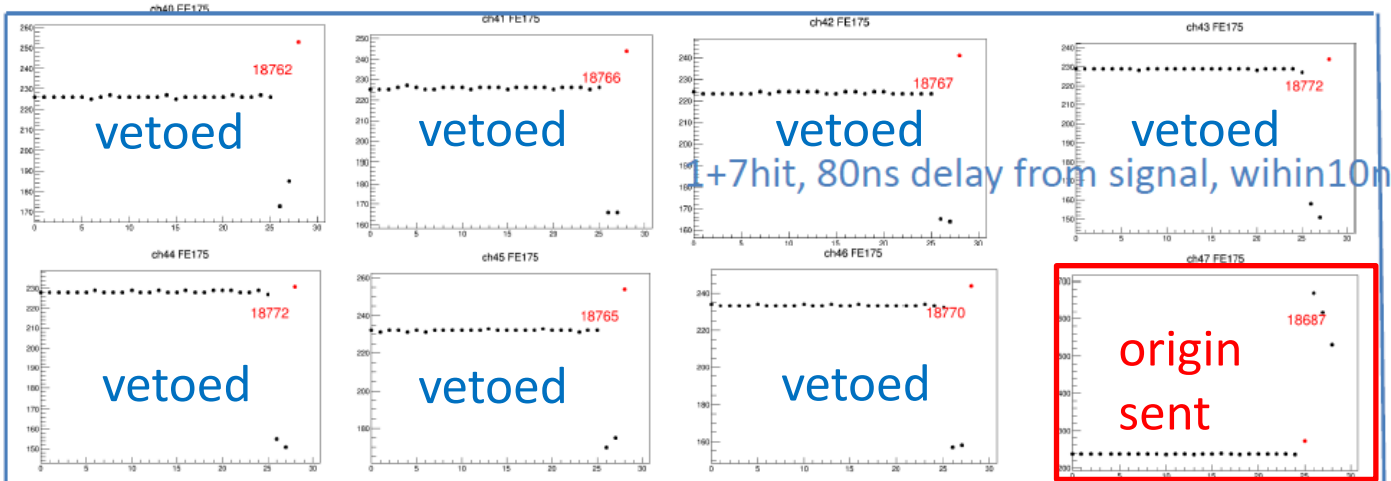
2hit, 35ns delay from signal, within 10ns

4hit, 20ns delay from signal, within 10ns

next ASIC



ASIC



New tight crosstalk filtering

- 1. If more than 4 hits on a ASIC coincide within 16ns, hits are judged as crosstalk and not sent to TRG. (now)
- 2. If 1. happen, all hits on the same CDCFE within 64ns before the coincidence are not sent to TRG. (new)
- 3. If ADC sum of three sampling points is less than 10, hits are not sent to TRG. (new, option with ADC info)

-advantage: further crosstalk reduction

-dis-advantage: ~64ns deadtime induced if crosstalk happens.
Latency increased by 2. ~64ns, 3.~500ns.

New crosstalk filtering

- Crosstalk on the same ASIC is rejected well
- Crosstalk between the different ASIC and CDCFE are rejected too

Waveform: crosstalk FE175

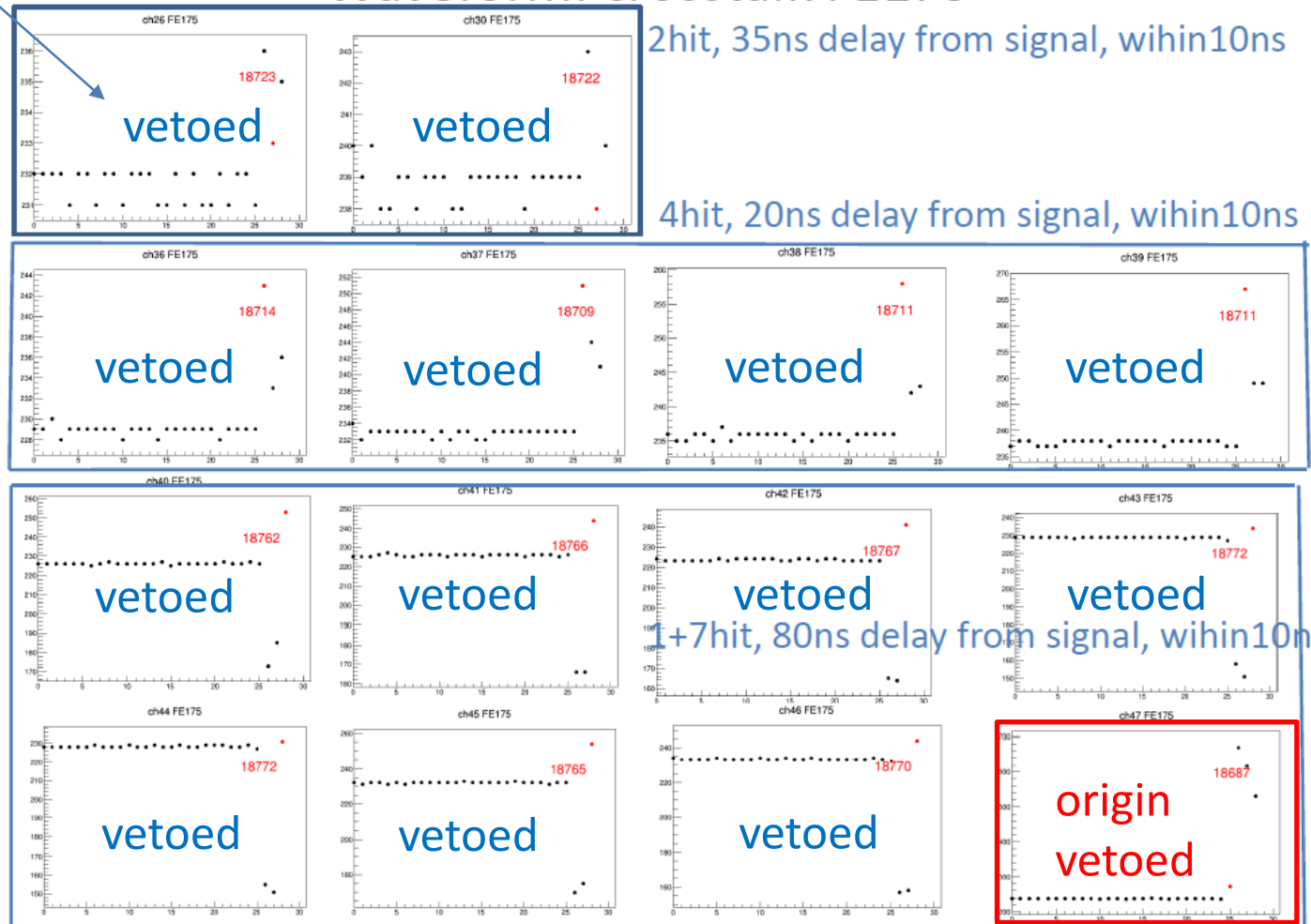
2hit, 35ns delay from signal, within 10ns

4hit, 20ns delay from signal, within 10ns

next next ASIC

next ASIC

ASIC



New tight crosstalk filtering

not 3 samplings, instead
CDC ADC with full sampling

-Comparison of event display@exp26run1780HLT1f00000

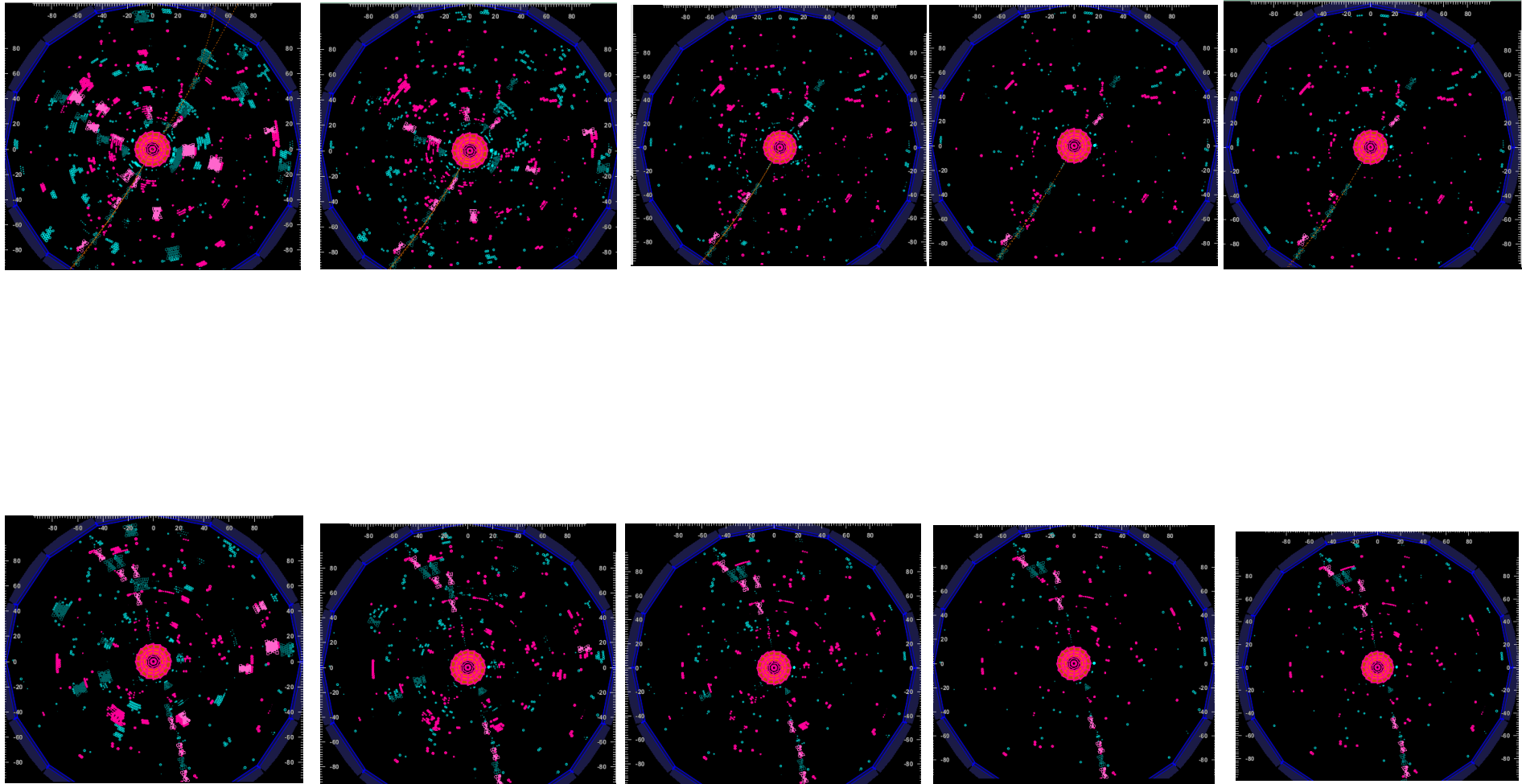
No filtering

Present filtering

New filtering

New filtering,
Nth=>3

New filtering,
ADC⊗



New tight crosstalk filtering

not 3 samplings, instead
CDC ADC with full sampling

-Comparison of event display@exp26run1780HLT1f00000

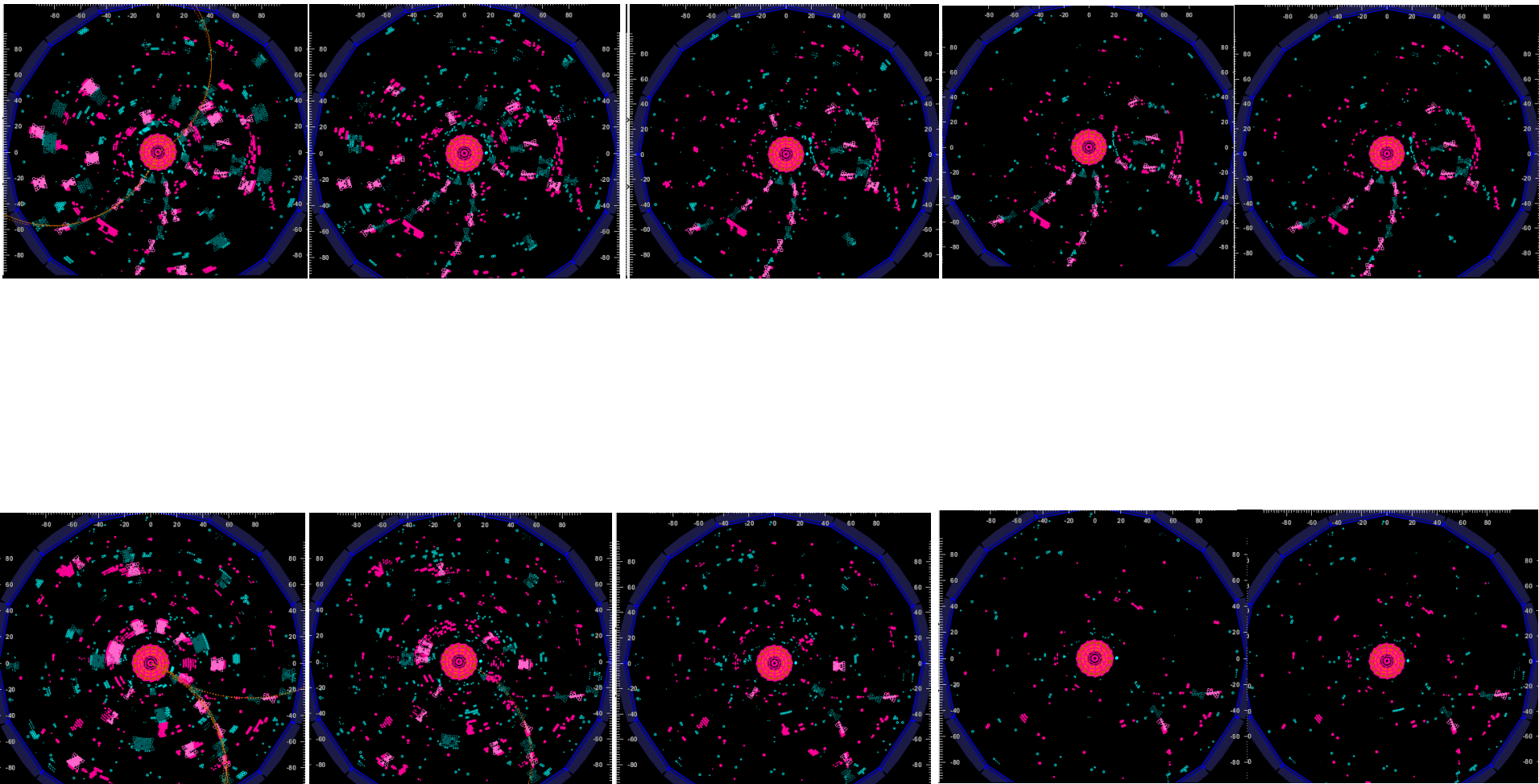
No filtering

Present filtering

New filtering

New filtering,
Nth=>3

New filtering,
ADC⊗



New tight crosstalk filtering

not 3 samplings, instead
CDC ADC with full sampling

-Comparison of event display@exp26run1780HLT1f00000

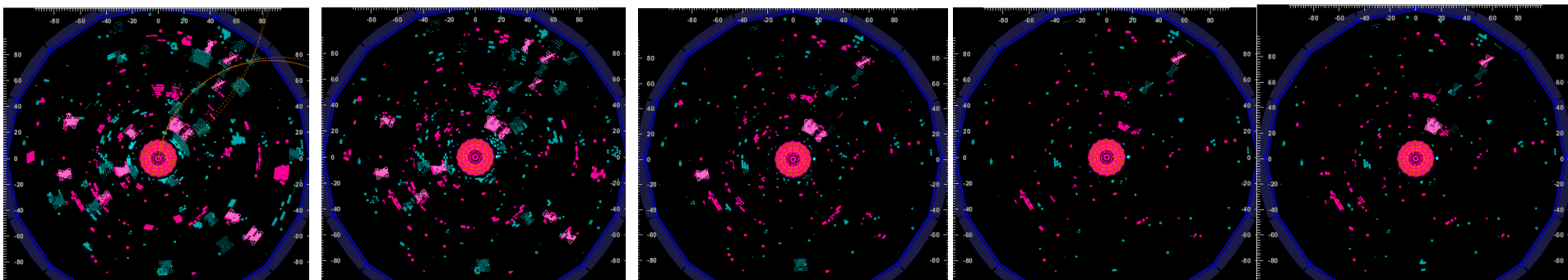
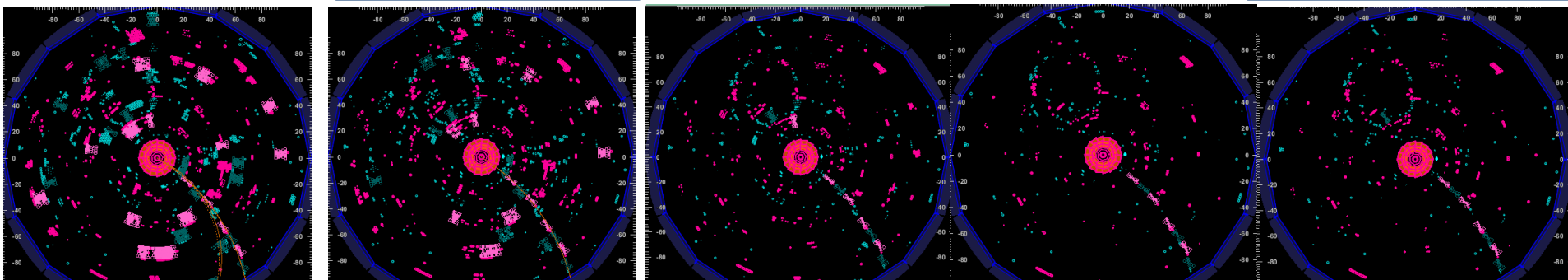
No filtering

Present filtering

New filtering

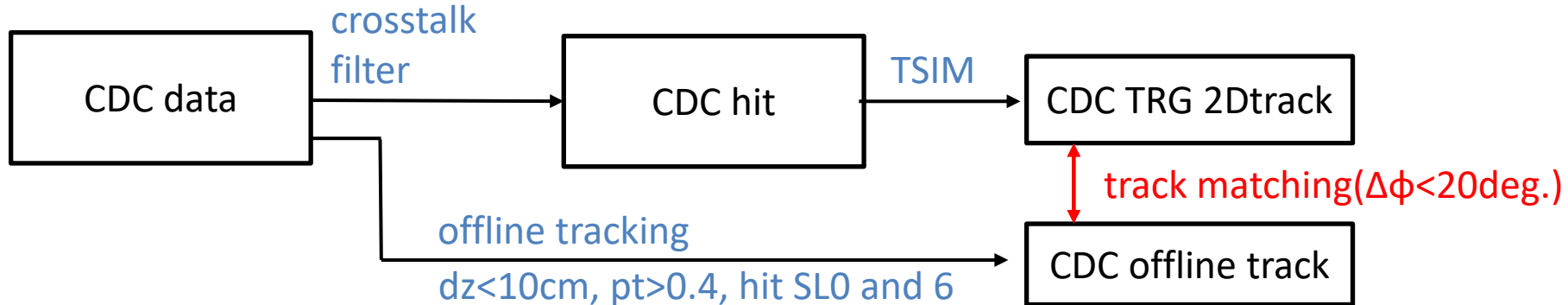
New filtering,
Nth=>3

New filtering,
ADC⊗



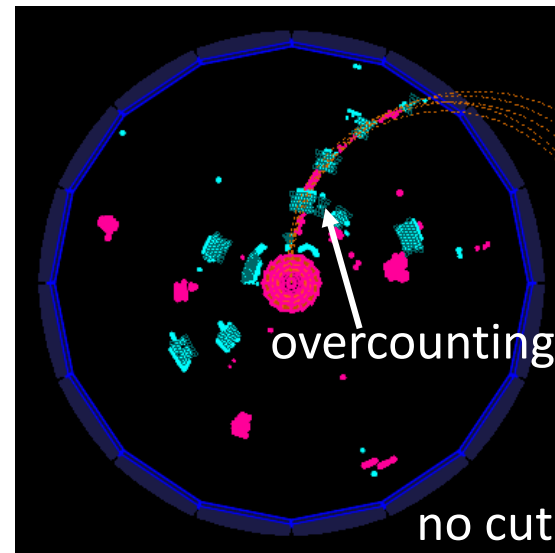
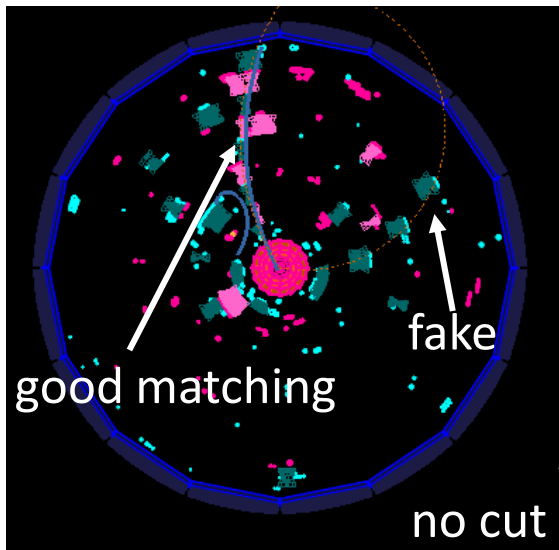
Performance evaluation with fast TSIM

-Performance of ADC cut is estimated with TSIM



-Followings are evaluated:

- efficiency = $\text{\#matched offline track} / \text{\#offline track}$
- fake rate = $\text{\#not matched trigger track} / \text{\#trigger track}$
- over counting rate = $\text{\#matched offline track, matched trigger track} > 1 / \text{\#offline track}$



Performance

-not yet..

	hit threshold on ASIC	efficiency	#fff event	#ffo event
no filtering	4			
present filtering	4			
new filtering	4			
new filtering	3			
new filtering, ADC	4			

Summary

- Improve crosstalk filtering on CDCFE by tightening condition
- new filtering with $N_{th} \geq 3$ looks nice

-Next

- TSF and 2D parameter optimization study with the new filtering
 - is it possible to loosen TSF requirement to ≥ 3 wire hits in SL ?
(maybe no hope but let me try)
 - is it possible to loosen 2D #hits threshold ?
- CDCFE firmware modification (maybe I will take over from Yun-tsung)

backup

```
-basf2 ./unpack_cdccross.py -i  
/group/belle2/TMP/Data/Raw/e0026/r01780/sub00/physics.0026.01780.HLT1.f00000.root -n 1000
```

```
#Run TSIM with degitized CDCTRG Hit  
main.add_module('CDCTriggerTSF',  
                InnerTSLUTFile=Belle2.FileSystem.findFile("data/trg/cdc/innerLUT_Bkg_p0.70_b0.80.coe"),  
                OuterTSLUTFile=Belle2.FileSystem.findFile("data/trg/cdc/outerLUT_Bkg_p0.70_b0.80.coe"),  
                CDCHitCollectionName='CDCHits',  
                #Crosstalk_tdcfilter=False)  
                Crosstalk_tdcfilter=True,  
                ADC_cut_enable=True,  
                ADC_cut_threshold=10)  
                #TSHitCollectionName='CDCTriggerSegmentHits')
```