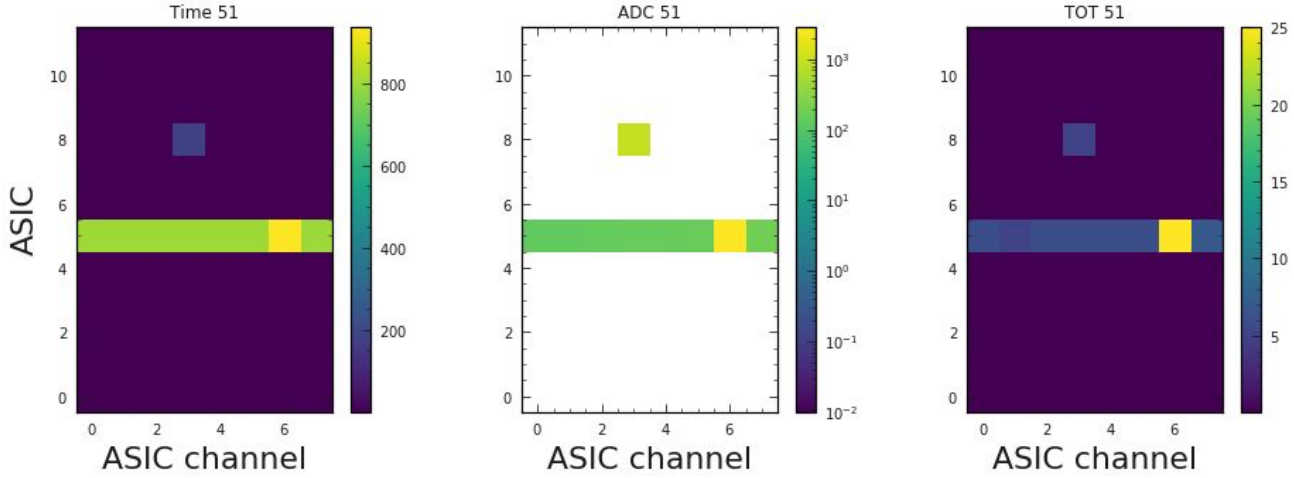
ASIC-based cross-talk filter

9 Aug 2019, S. Glazov

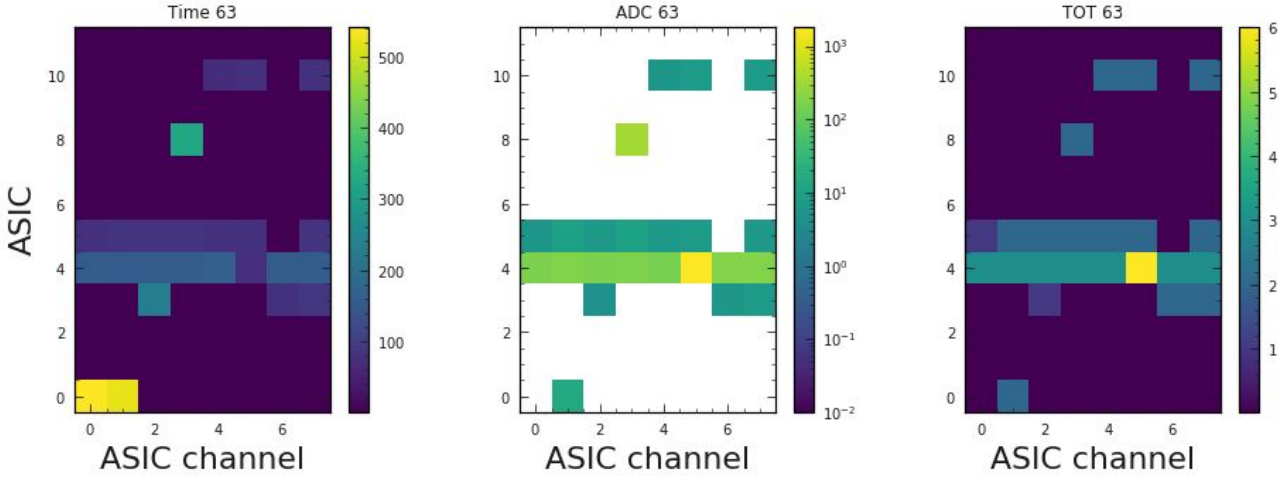
ASIC cross talk (exp 8, run 2228, after threshold update)



Group CDC hits in pairs of readout boards (96 channels = 2 boards x 6 ASICs x 8 channels per ASIC). Plot Time, ADC and TOT. Significant fraction of events with signal in all ASIC channels, most of them in-time, with larger ADC, with a single channel out-of-time, and even larger ADC value.

Suggested by Nanae Taniguchi

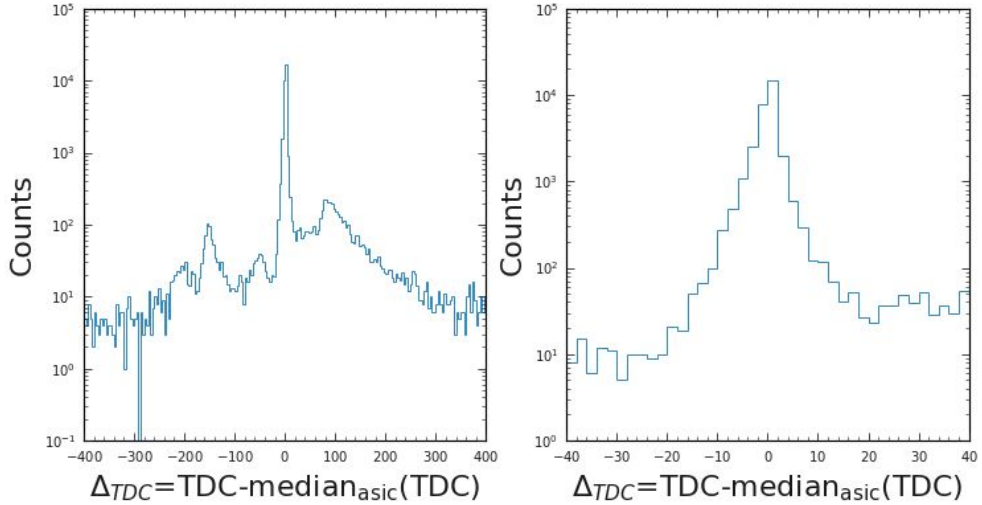
ASIC cross talk



Sometimes cross talk shows up in the neighboring ASICs, sharing a common connector. However typically the ADC values are small, can be suppressed by ADC/TOT cuts.

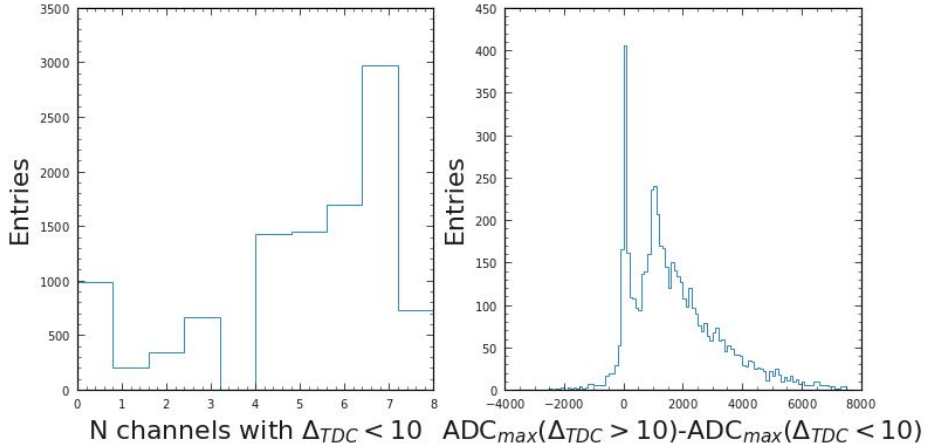
→ Introduce ASIC cross talk filter, based on 8-channel correlation.

Tuning filter: TDC-median(TDC)



Select ASICs with at least 5 hits, determine median TDC for them, and histogram the difference of the hit vs median. Most of the hits are within 10 counts window.

Tuning filter: N hits close to median TDC and ADC



Count channels within 10 TDC counts vs median. Require more than 1 and less than Ntot-1, leaving at least one channel for the “signal”. Hits off-median should have max(ADC) above hits at the median TDC.

Final set of cuts

Minimal number of hits per ASIC: NTot=5

Deviation from median TDC for cross-talk candidates: 10 TDC counts

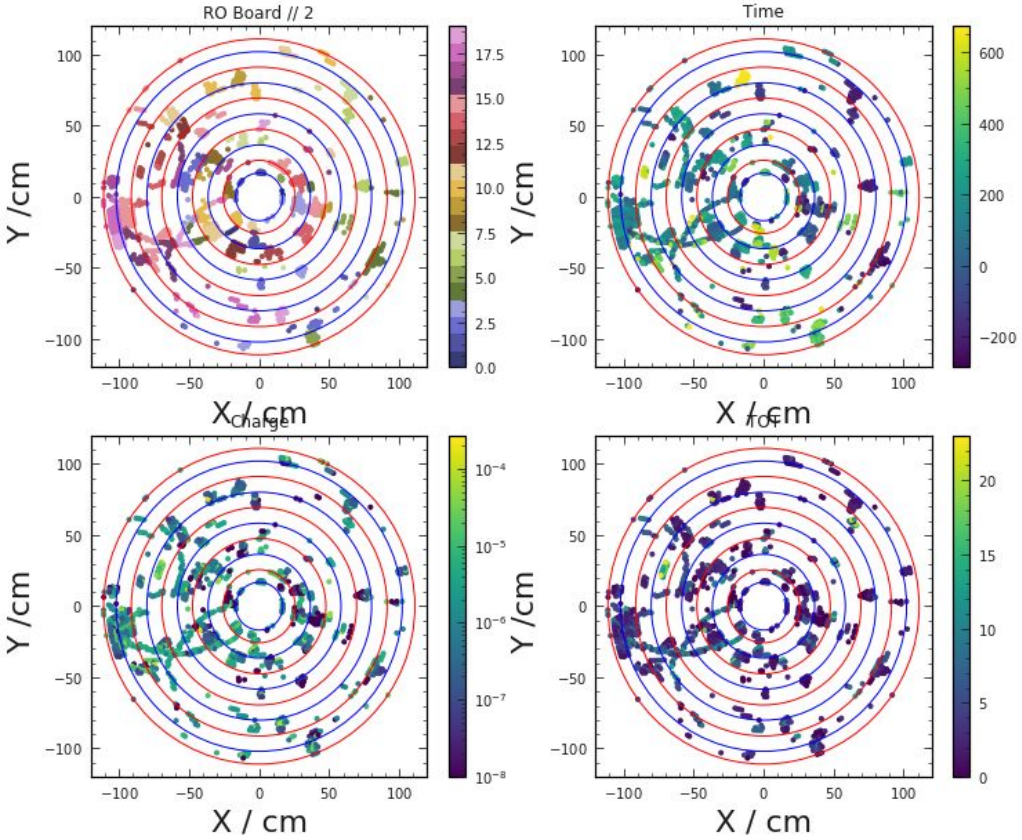
Number of cross-talk candidates: > 1

Number of “signal” (|TDC-median|>10) candidates: Nsig >0 and Nsig<4

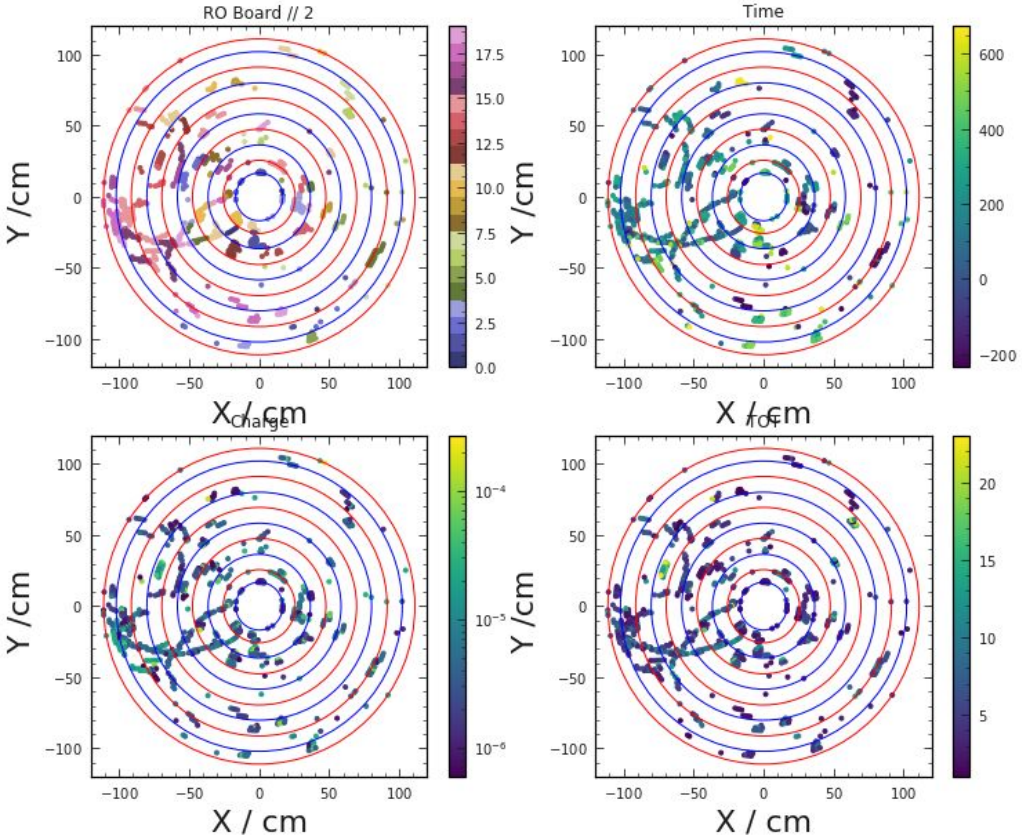
Maximal ADC of the “signal” > maximal ADC of the “cross-talk”

→ when all conditions are satisfied, raise background flag for hits with |TDC-median|<10.

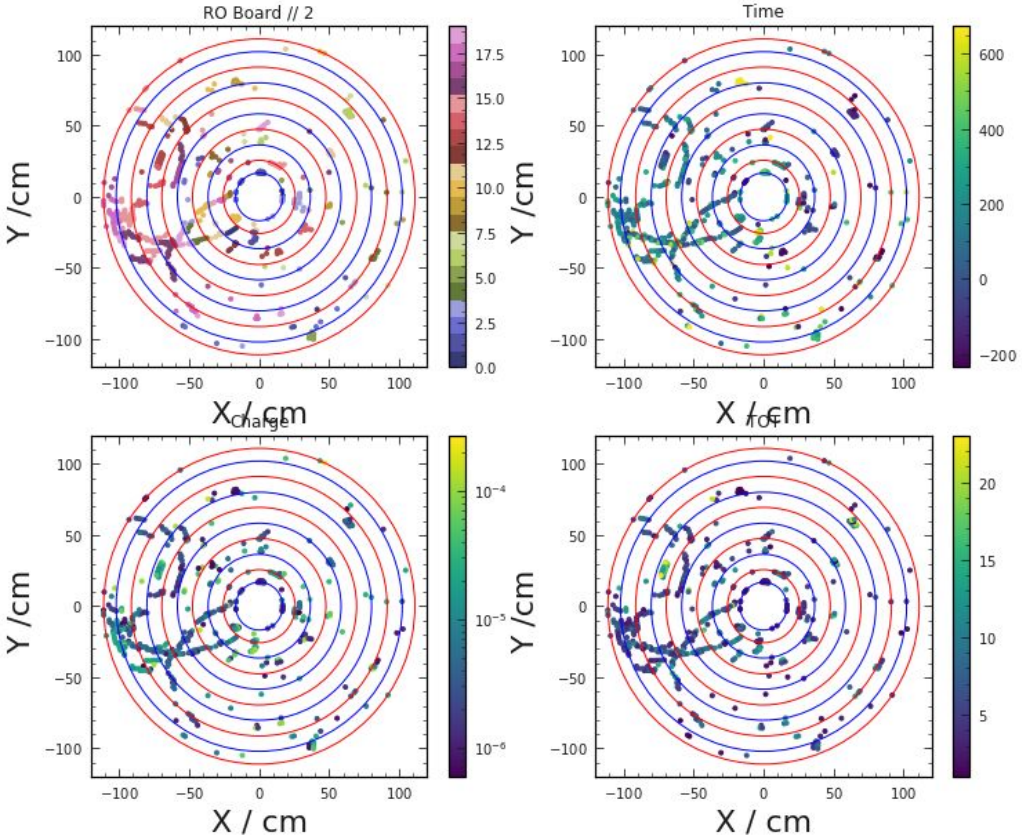
An example event display: all hits



An example event display: ADC cut



An example event display: ADC + ASIC cut



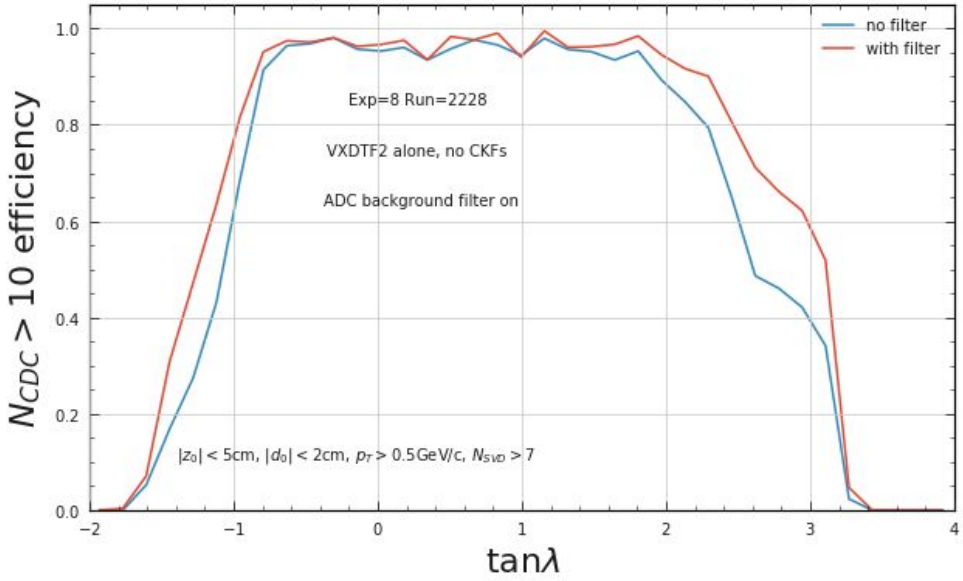
Efficiency of the filter for hits on/off track

	ADC>18	ADC>18 and ASIC	1200>ADC>18 and ASIC
On Track	95.4%	93.2%	92.5%
Off Track	54.1%	31.1%	25.8%

Check efficiency for hits on / off tracks (for tracking without bg cut). Note that combined ADC&TOT cut has slightly better performance vs single ADC cut (see studies from Cyrille).

→ ASIC cuts brings significant additional reduction of cross-talk hits with a small signal loss. Further reduction of background can be achieved by upper ADC cut (not considered in the following)

CDC efficiency



Check CDC standalone tracking efficiency using VXDTF2 tracks as a reference for all tracks from the IP and pT>0.5 GeV/c. Significant improvement with ASIC filter on

Timing

	No Filter, ms	With Filter, ms
TFCDC_WireHitPreparer	2.3	2.4
TFCDC_AxialTrackFinderLegendre	51.5	20.5
TFCDC_SegmentFinderFacetAutomaton	42.6	14.7
TrackCreator	30.3	31.9

Check timing performance using the same data run (2228, exp8). More than factor of 2 improvement for CDC standalone algorithms.

Impact on MC

Checked impact for MC events using Y(4S) sample, with nominal background using 1000 events. (Expected) minor degradation of the estimators

	No Filter	With Filter
Finding efficiency	94.7%	94.6%
Fake rate	6.2%	6.2%
Clone rate	6.5%	6.8%
Hit efficiency	79.8%	78.4%

→ pull request in review for release 4