

IHEP cosmics in up-down coincidence

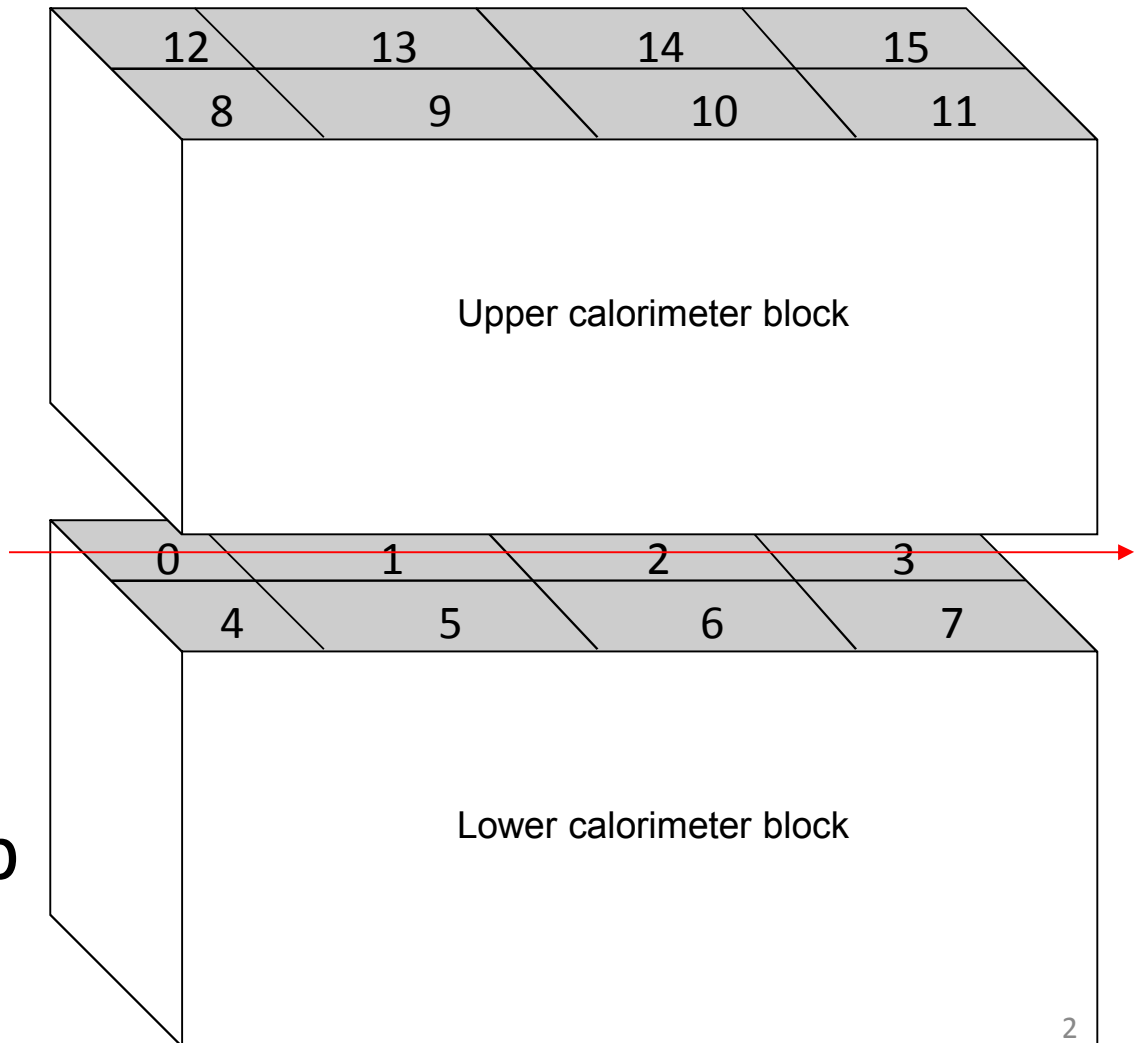
Looking for cosmic ray signals

“Normal” configuration

- FADC 0:
chs.0,1,2,3 dn
chs.4,5,6,7 up

- FADC 1:
chs.8,9,10,11 up
chs.12,13,14,15 up

Photons from BESIII

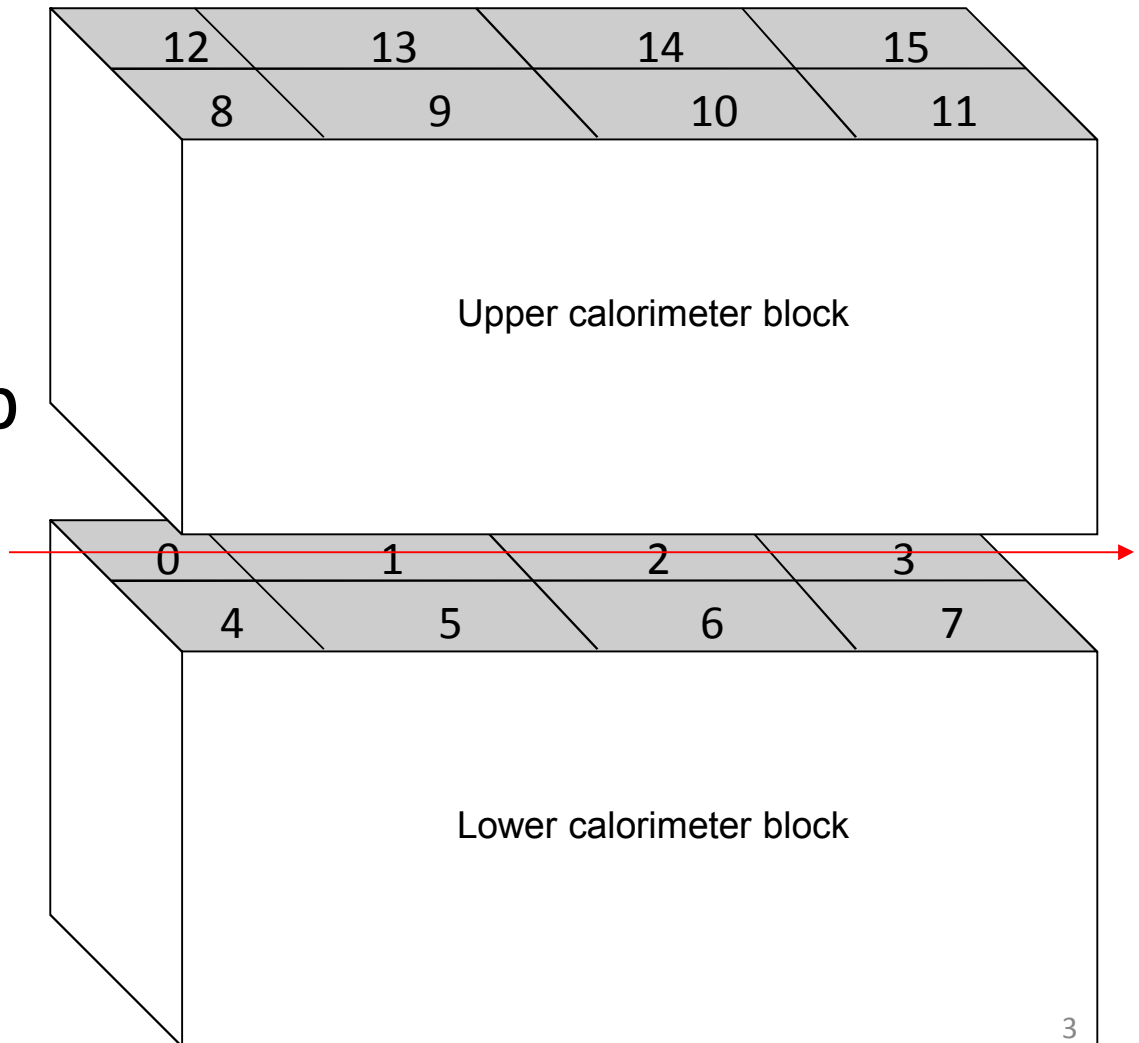


“Coincidence” configuration

- FADC 0:
chs.0,1,2,3 dn
chs.12,13,14,15 up

- FADC 1:
chs.8,9,10,11 up
chs.4,5,6,7 dn

Photons from BESIII



Running conditions

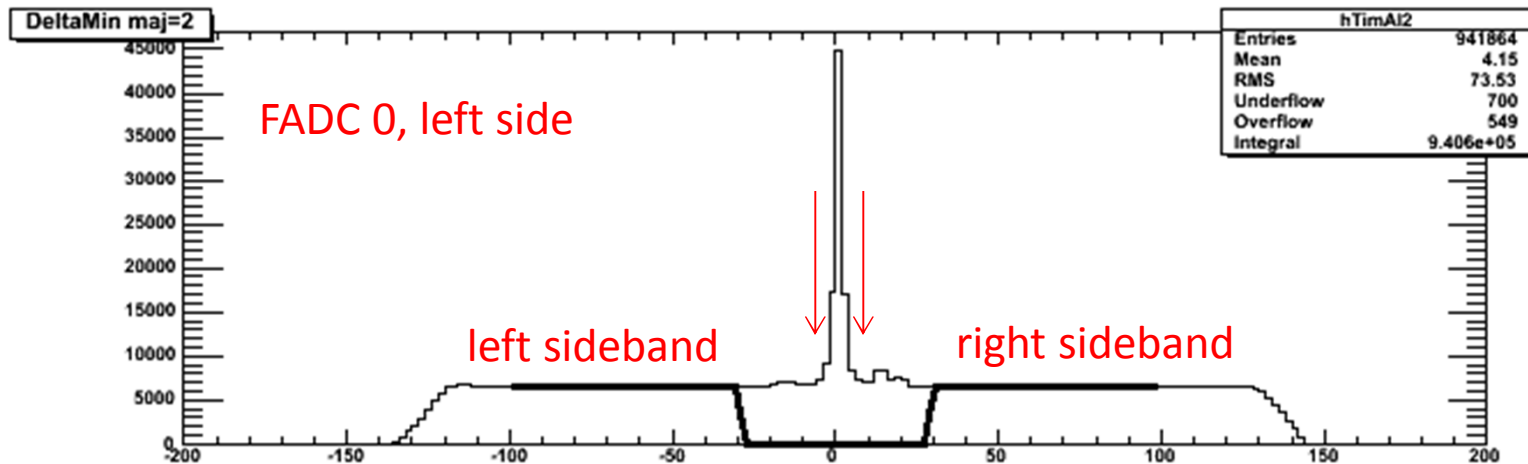
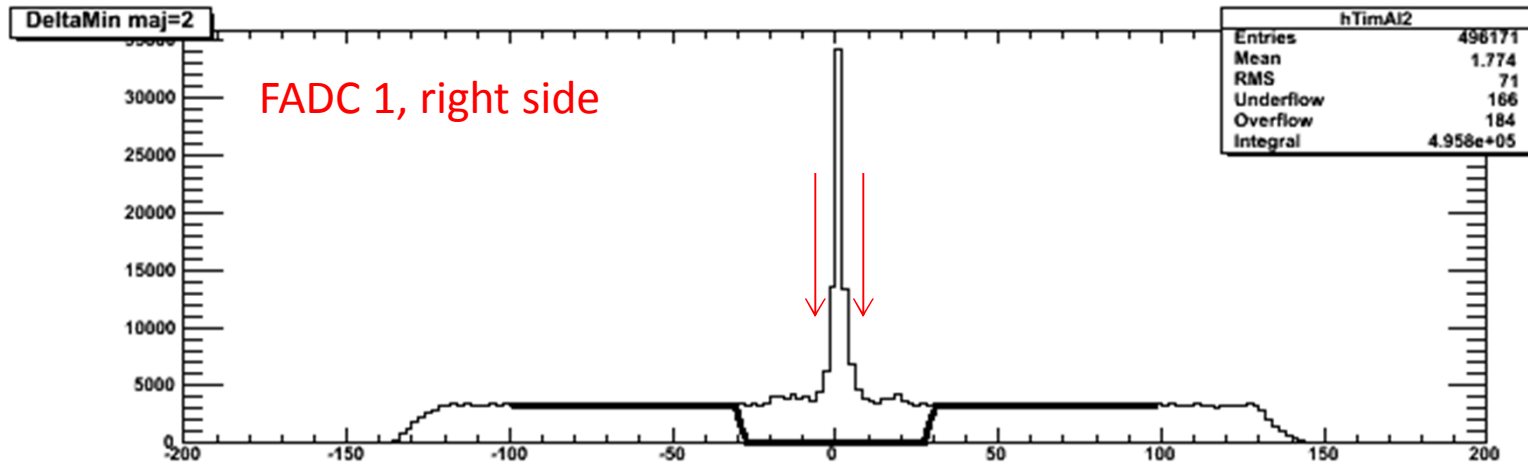
- HV: “Frascati” 1.4 kV points, gain $\approx 1.2 \cdot 10^6$, Happy Box present
- Autotriggered, majority 2 channels
- One-channel trigger: baseline-4cts (16 mV after x4 amplification)
- Independent trigger and DAQ on each FADC; each FADC represents a half of the East ZDD: left and right, wrt photon line of flight

Data sample

Selection cuts

- First 80 ns data (40 samples) used to find the 8 baselines and baseline standard deviations on a per-event, per-waveform basis
- **Bad event, rejected if one σ is > 0.5 cts (2 mV)**
- Samples 41 to 196 (82 to 384 ns) used to find the signal peak, and time of peak
- **If majority = 2, $|t(\text{peak}_{\text{up}}) - t(\text{peak}_{\text{dn}})| < 100$ ns (very wide)**
- Majorities 3 and up pass w/o time cuts

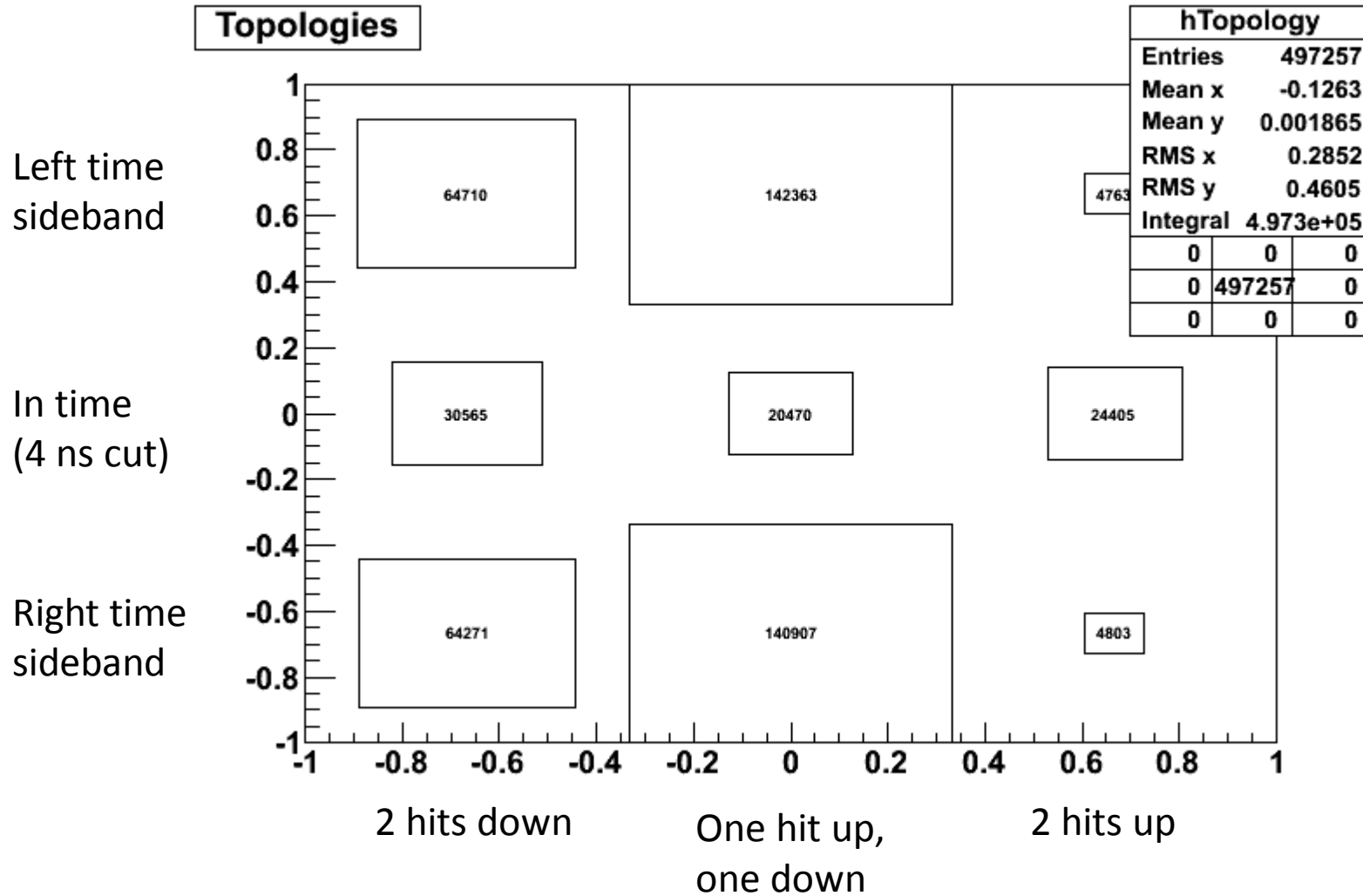
RUN 30, majority 2



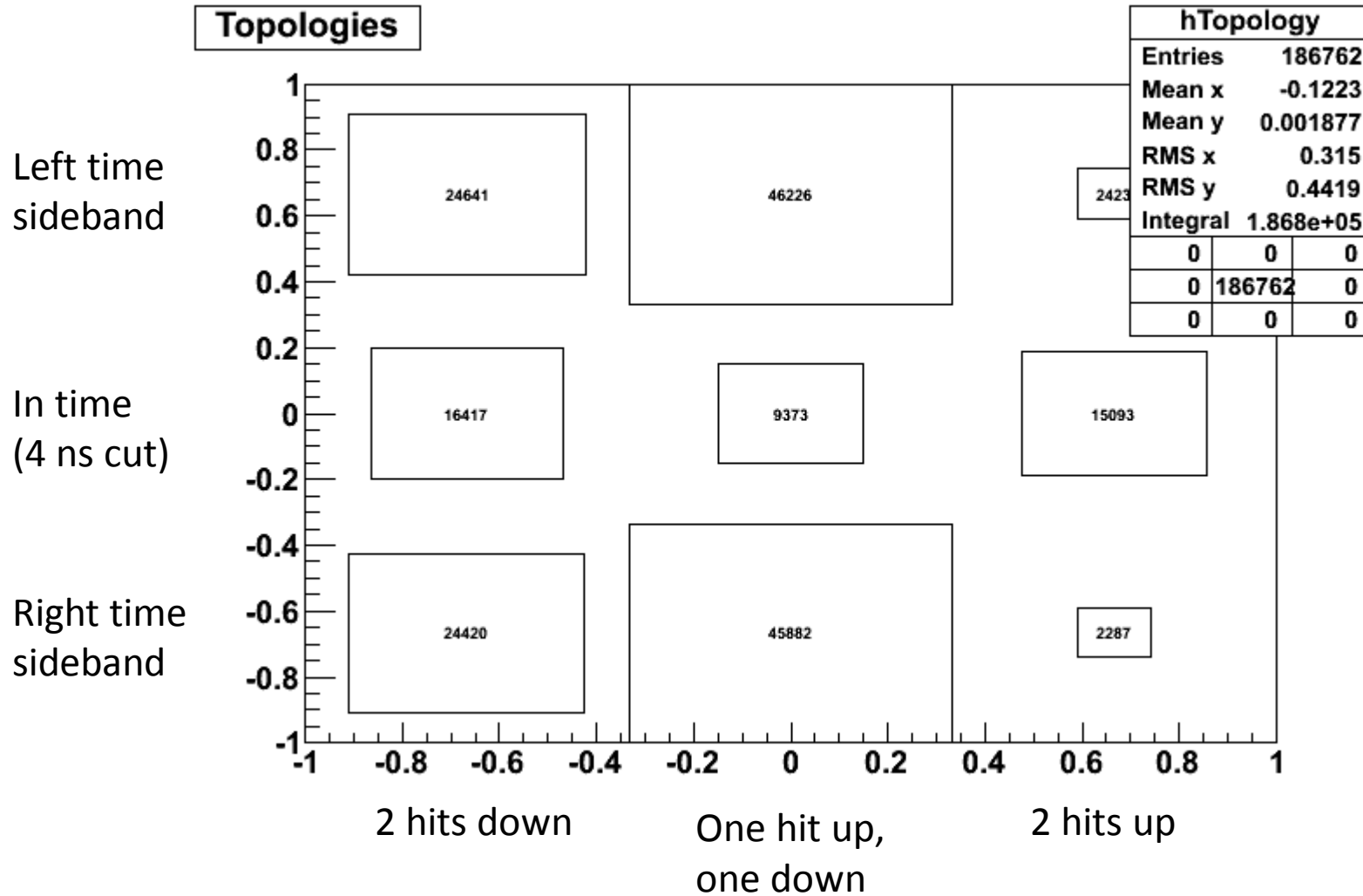
Noise for majority 2

- Uncorrelated noise is higher in the left side than in the right side
- This appears also in the total number of triggers, almost double for the same time
- In a 6 ns central time window $S/N=1.7$ on the left side, 3.1 on the right side
- Define a central region ($|\Delta t| < 6\text{ns}$), and left/right sidebands (see prev.slide)

Stats for majority 2, left



Stats for majority 2, right



Noise is asymmetric

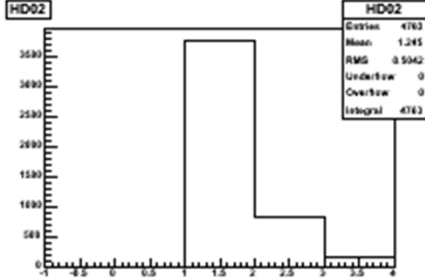
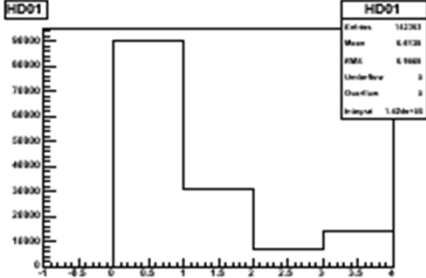
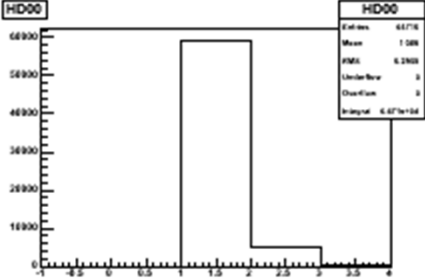
- Not only more noise in left side than in right side, also more noise in the 4 channels “down” than “up”, both on left and right.
- Possibly due to less perfect light shielding for bottom minicalorimeter
- On the next slides, we plot **differences in channel number**: what do they mean?

Delta-channel number

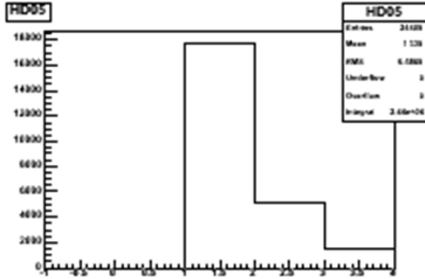
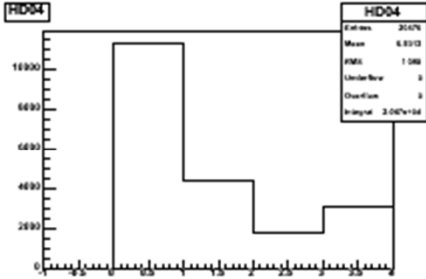
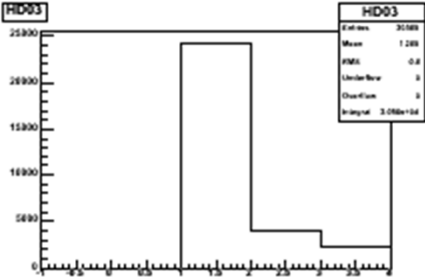
- If both hits are “up” or “down”
 - Delta=1: adjacent hits (3 possible ways)
 - Delta=2: one “hole” in between (2 ways)
 - Delta=3: 2 “holes” in between (1 way only)
- If one hit “up”, one “down”
 - Delta=0: one hit directly above another (4 ways)
 - Delta=1: one hit on a side (6 ways)
 - Delta=2: “hole” (4 ways)
 - Delta=3: 2 “holes” (2 ways)

Configurations for majority 2, left

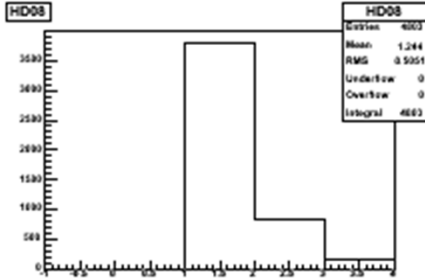
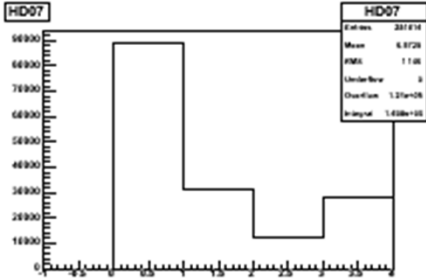
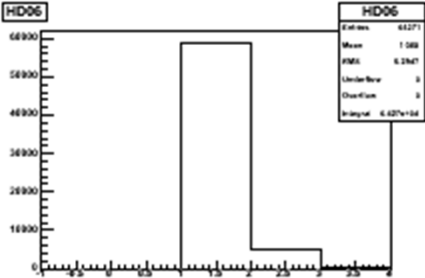
Left time sideband



In time (4 ns cut)



Right time sideband



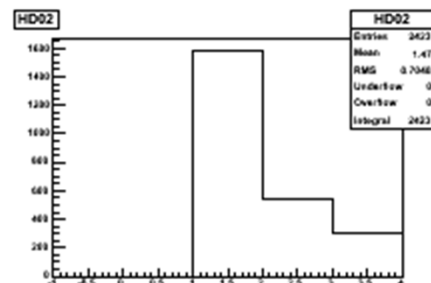
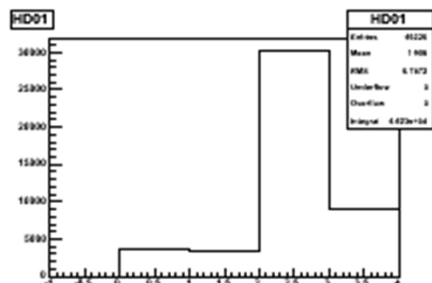
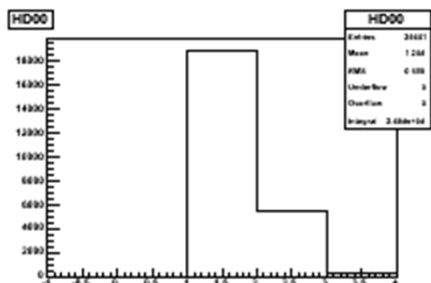
2 hits down

One hit up,
one down

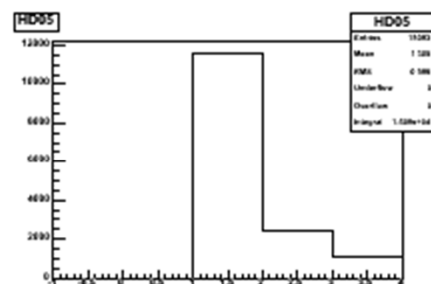
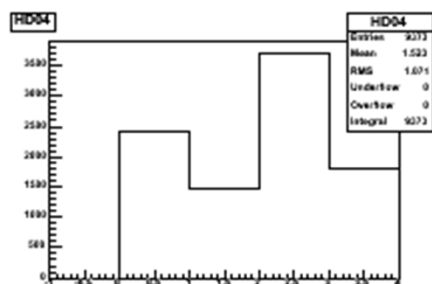
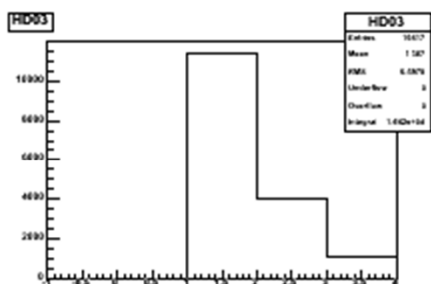
2 hits up

Configurations for majority 2, right

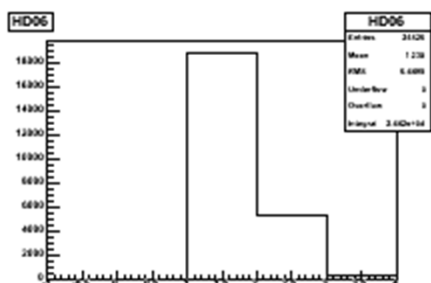
Left time sideband



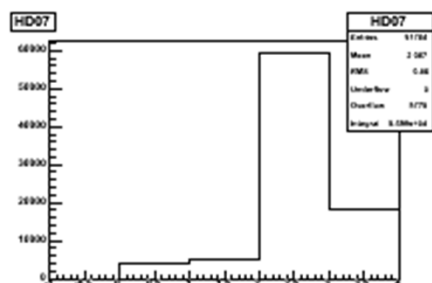
In time
(4 ns cut)



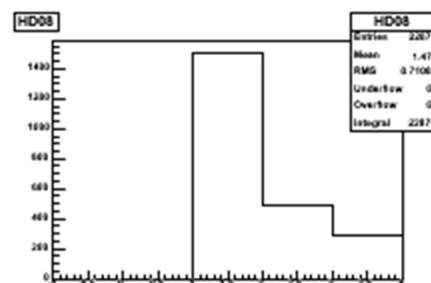
Right time sideband



2 hits down



One hit up,
one down

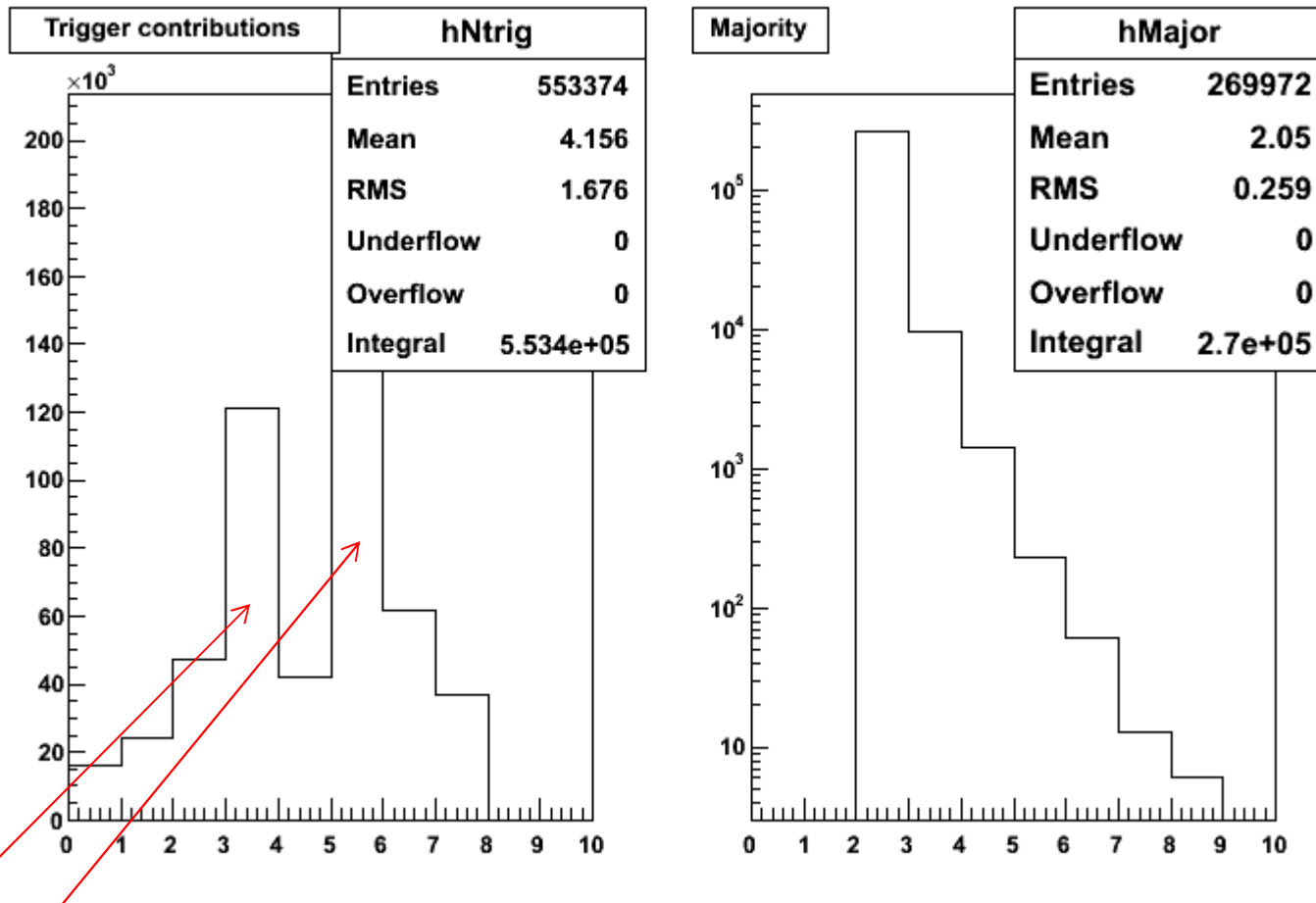


2 hits up

Probability laws not followed!

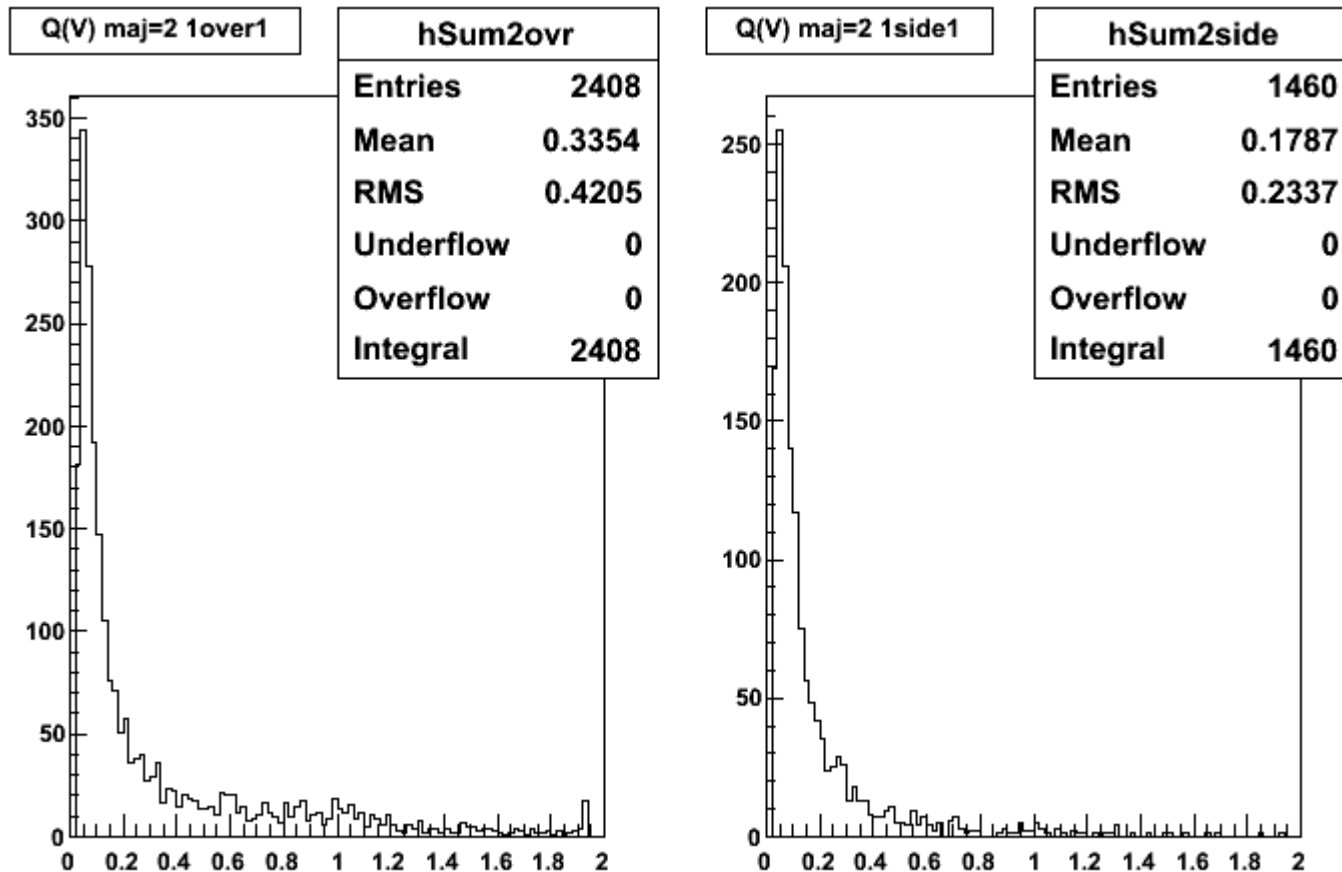
- When “2 hits up” or “2 down” the stats are not too wrong: adjacent hits more frequent than “holes”, only too much so
- When “one up, one down”, left and right differ
 - On the left, stats are the same in time and out of time: no visible signal. Too much noise
 - On the right, there *is* a difference: bin 0 (also 1?) more prominent when “in time”. Bin 2 is due to noisier PM’s

Stats for majority 2, right



PM's 3 and 5 much more frequent than the others

Majority 2 “signal”, right



Conclusions for majority 2: 😞

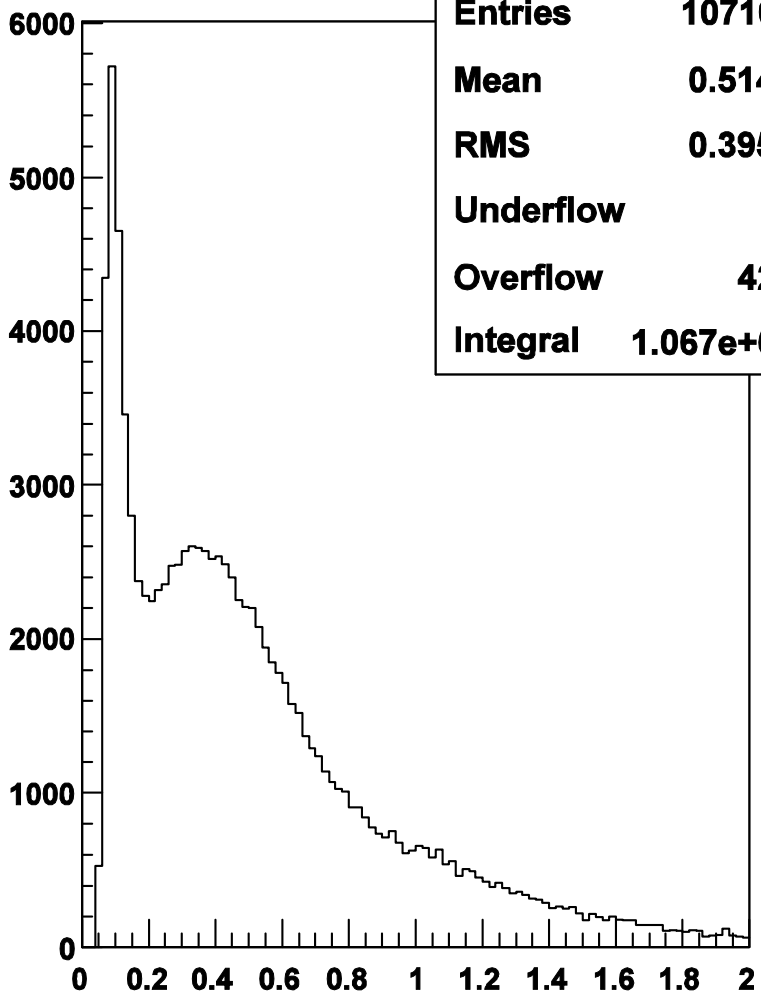
- Noise problems and varying PM singles rates make the left side unusable
- The abundance of “down” hits on the right makes also the right side suspicious
- On the right side, there is a slight difference in the charge spectra for “1up 1 down” hits
- Even so, disadvantageous geometry makes the charge spectra not useful

Majority > 2

- Should be cleaner than majority=2
- Majority 3 may be:
 - Validated if all 3 hits in time
 - Downgraded to majority 2 if 2 hits are in time, suppressing the hit out of time
- Majorities ≥ 4 only a handful....forget.

Q, time cuts: maj. 3, minical 0

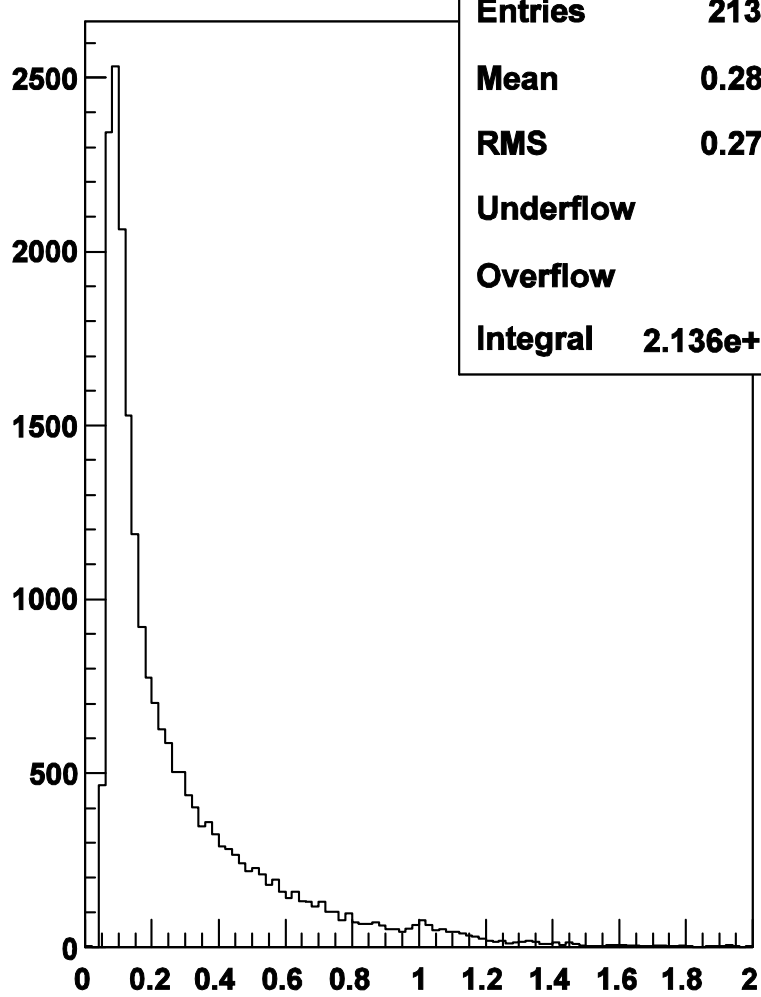
Q(V) maj=3 in time



hSum3

Entries	107109
Mean	0.5145
RMS	0.3959
Underflow	0
Overflow	423
Integral	1.067e+05

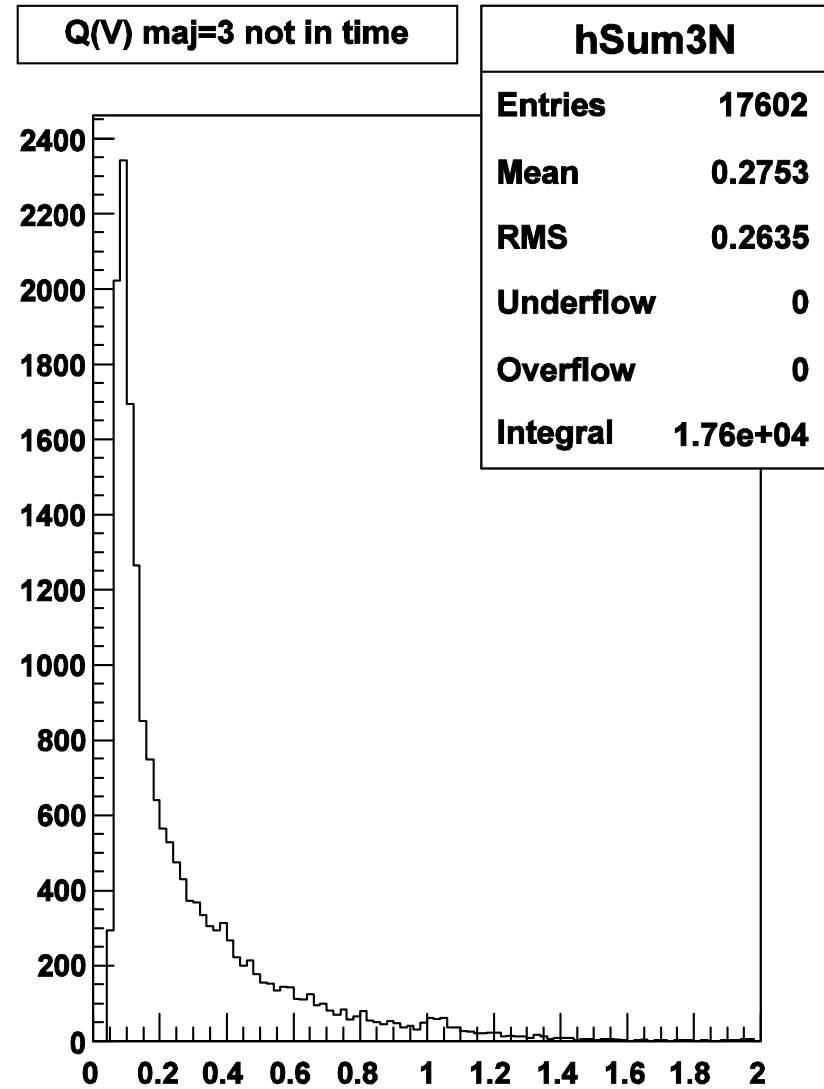
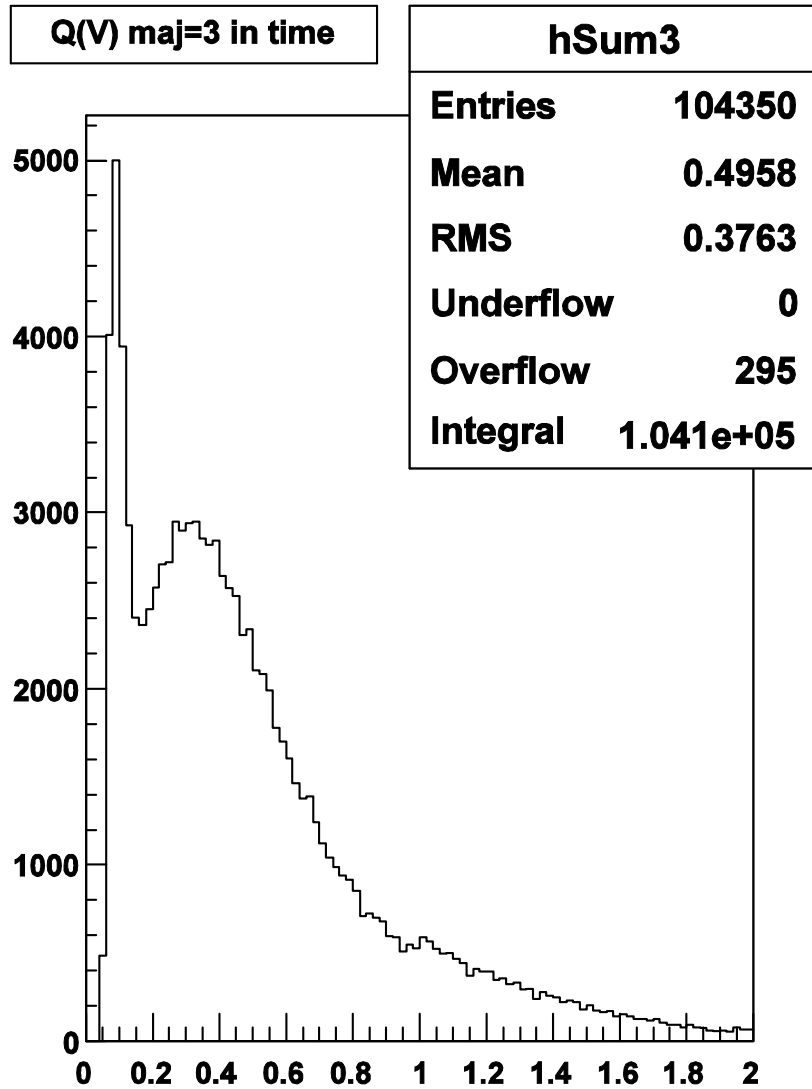
Q(V) maj=3 not in time



hSum3N

Entries	21363
Mean	0.2818
RMS	0.2705
Underflow	0
Overflow	2
Integral	2.136e+04

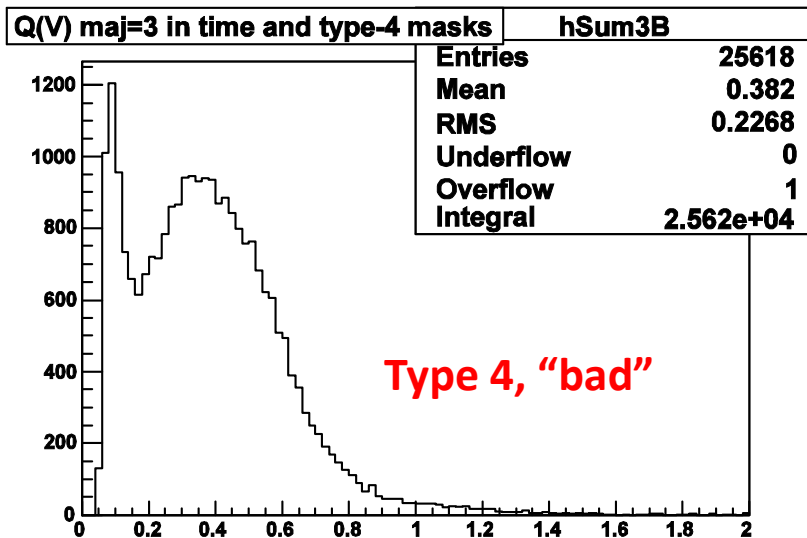
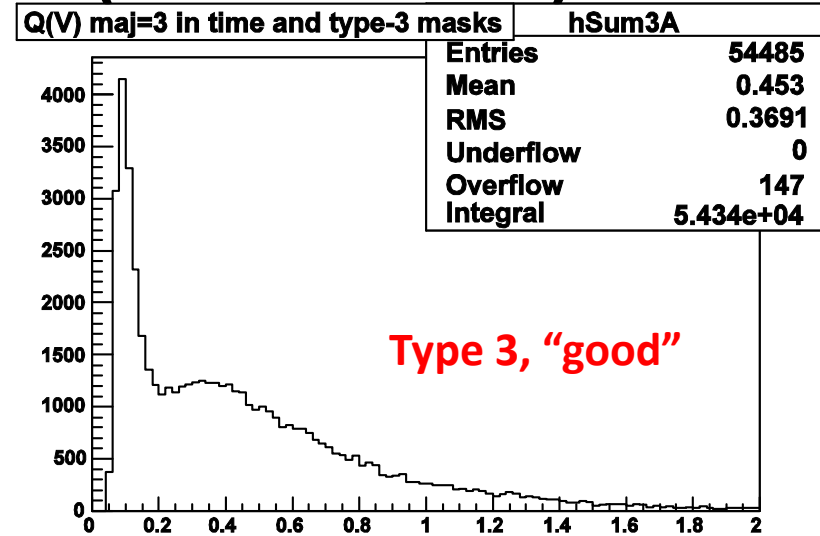
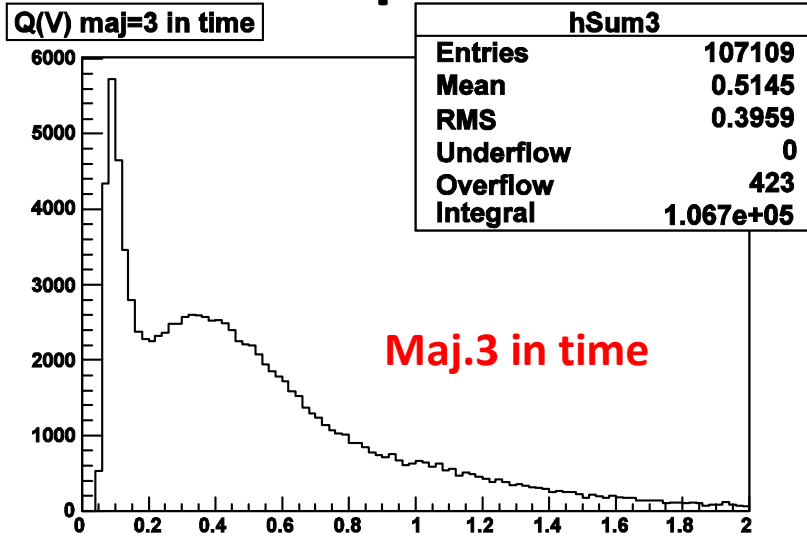
Q, time cuts: maj. 3, minical 1



Masks for majority 3: 56

- Type 0: one hit up(down), two down(up) directly below: 12
- Type 1: one hit up(down), two hit down(up) on a side: 8
- Type 2: one hit up(down), two hit down(up), disjoint: 28
- Type 3: 3 hits up(down) close together: 4
- Type 4: 3 hits up(down) separated: 4

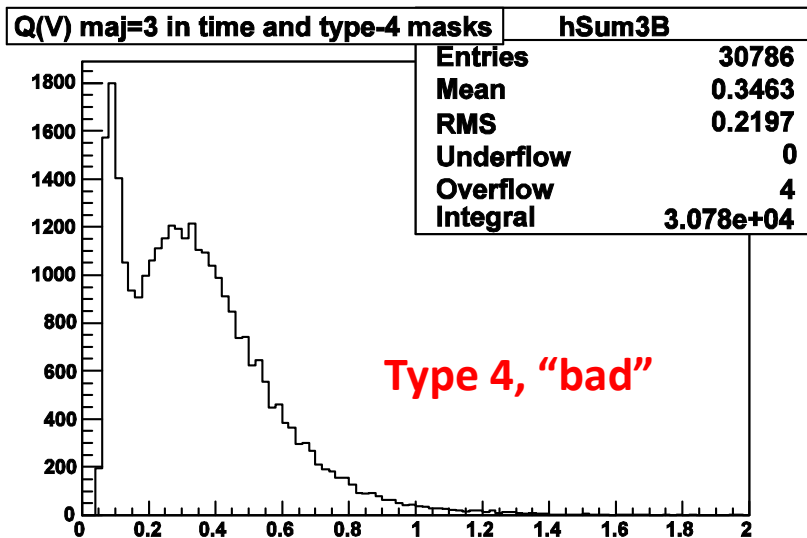
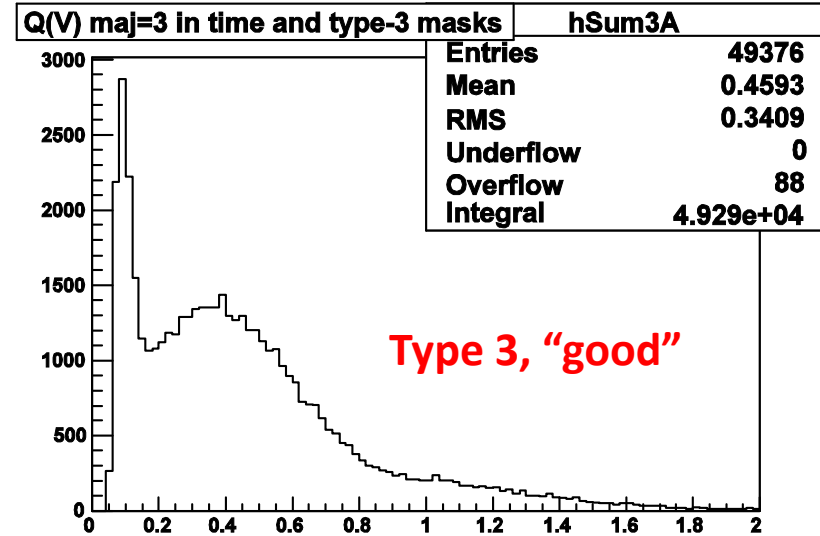
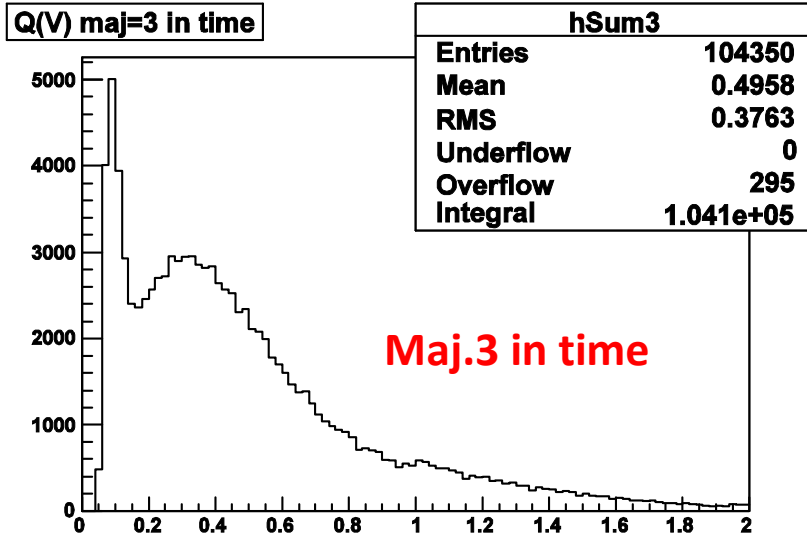
3up or 3down (minical 0)



Surprisingly:

- 1) Most triggers are 3-up or 3-down!
- 2) Their shapes look the same!

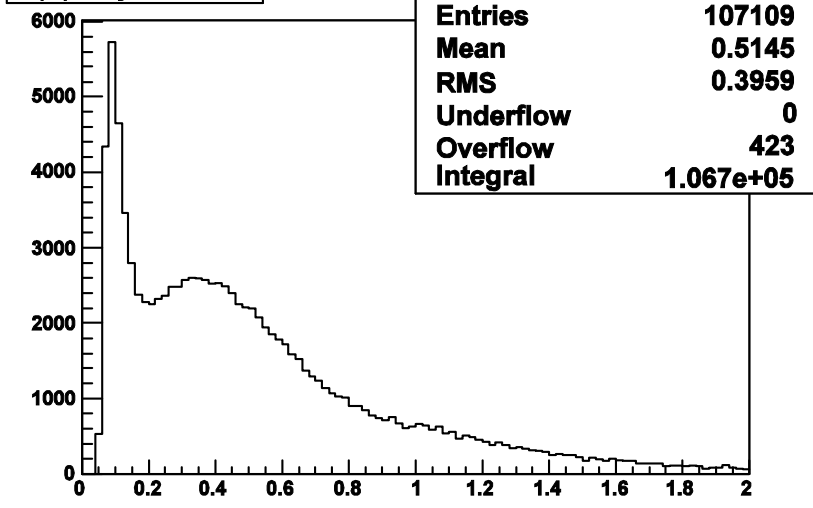
3up or 3down (minical 1)



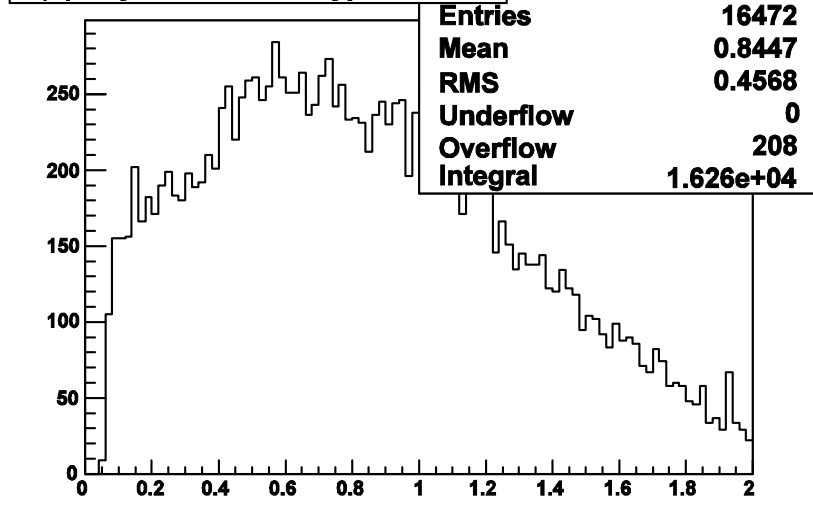
- Surprisingly:
- 1) Most triggers are 3-up or 3-down!
 - 2) Their shapes look the same!

Up-down types (minical 0)

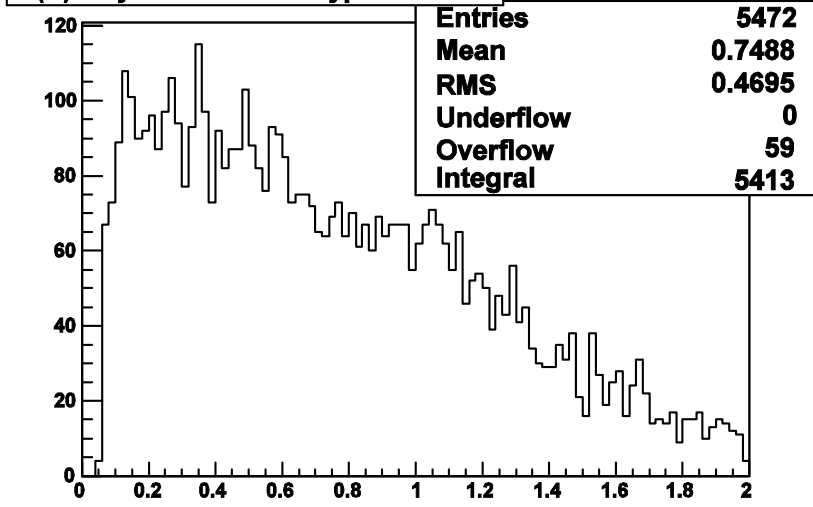
Q(V) maj=3 in time



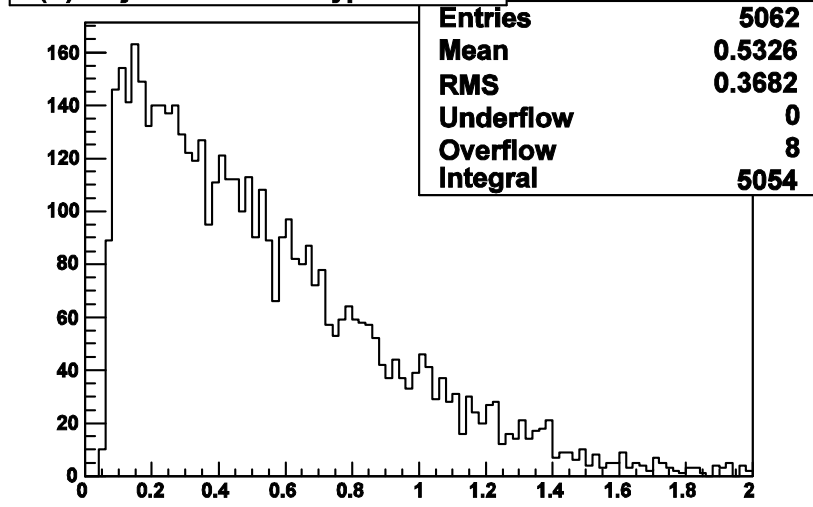
Q(V) maj=3 in time and type-0 masks



Q(V) maj=3 in time and type-1 masks

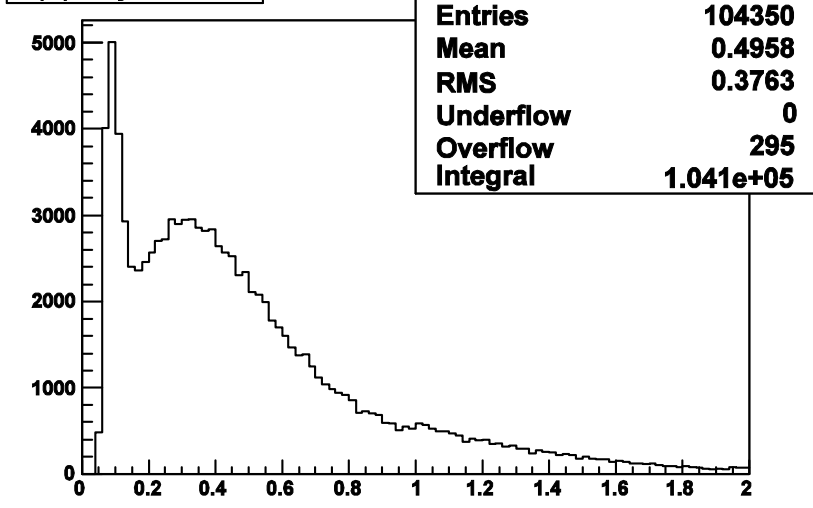


Q(V) maj=3 in time and type-2 masks

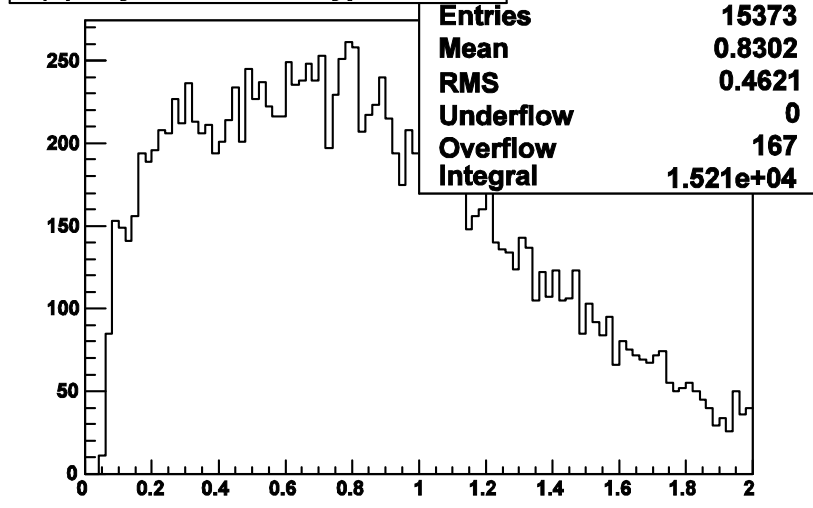


Up-down types (minical 1)

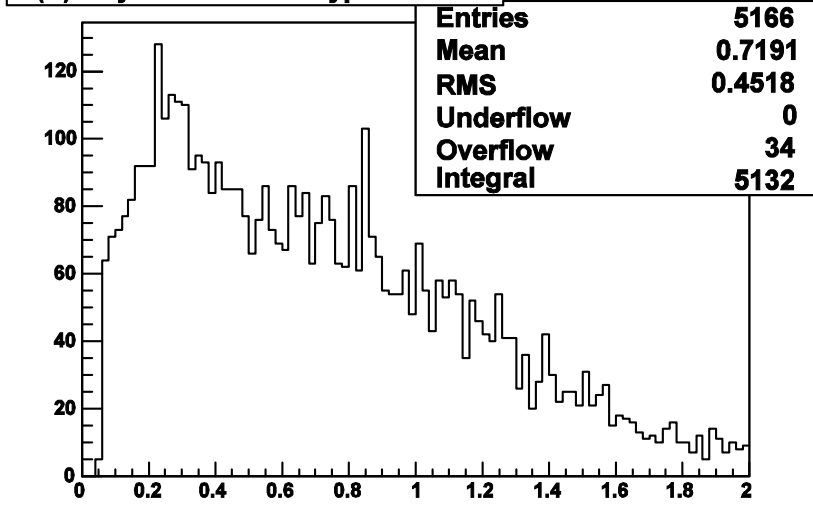
Q(V) maj=3 in time



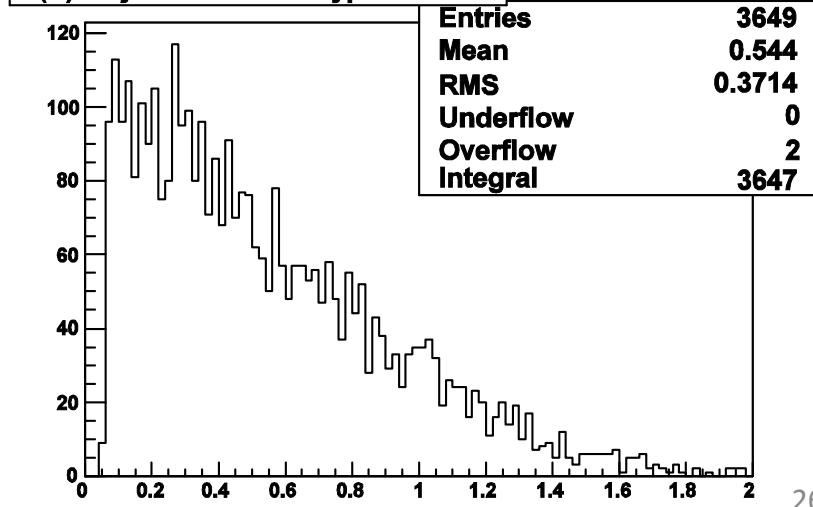
Q(V) maj=3 in time and type-0 masks



Q(V) maj=3 in time and type-1 masks



Q(V) maj=3 in time and type-2 masks



Majority-3 facts and questions

- Is the lower peak correlated noise?
- Why it appears only when all 3 hits are in a same calorimeter?
- Is it bundle-to-bundle crosstalk? Was it already there in LNF data?
- Are all other events legitimate cosmics?

“Conclusions”

- Timing cuts and mask cuts help to isolate real cosmic tracks from background
- Nevertheless, the angle of incidence of cosmics on fibers is very small and cosmic tracks deposit very little charge, compared to the situation in the Frascati cosmic setup
- Isolate cosmic tracks is very difficult
- A comparison with LNF data does not (yet) appear possible

To do

- Reanalyze data before up-down coincidence, adding the timing cuts