Stability of the CAL Calibrations

- Online script “suites” acquire charge injection and muon data.
- Offline, *calibGenCAL* package processes that data for 3 clients:
  1. fle, fhe, lac settings for online (that online can also make itself)
  2. “calib”.xml files for offline reconstruction, via the rdb metadata database.
  3. The “calib”.xml files to be used for Monte Carlo detector simulation (see Julie McEnery’s talk at Monday’s analysis meeting).
- Test the whole chain via the final single crystal energy & positions.

- This talk: test the stability of the results for different data-taking configurations.

The Method

- Extrapolate TKR track to CAL and predict which crystals get hit.

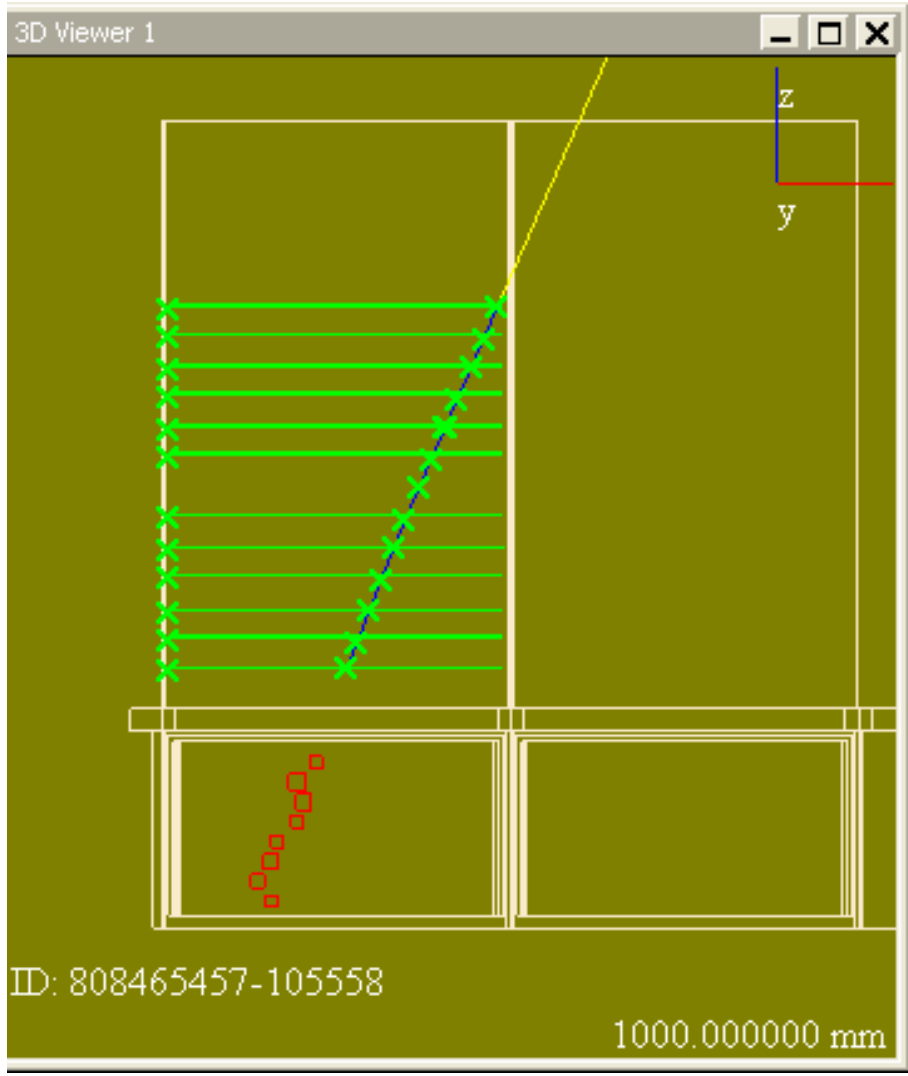
- Compare energy deposits, position resolution with Monte Carlo.

- Use Tkr1EndPos, Dir

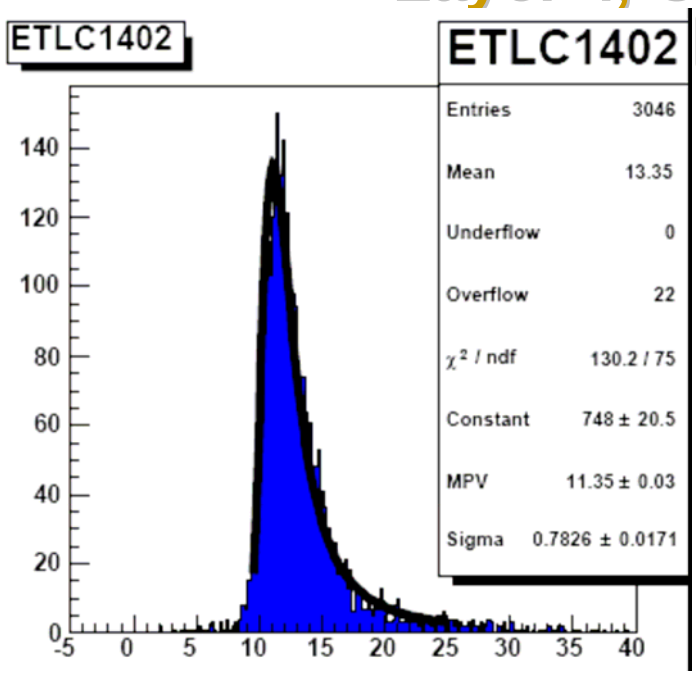
- Require:
TkrNumTracks == 1
Tkr1KalThetaMs < 0.03
Tkr1NumHits > 15

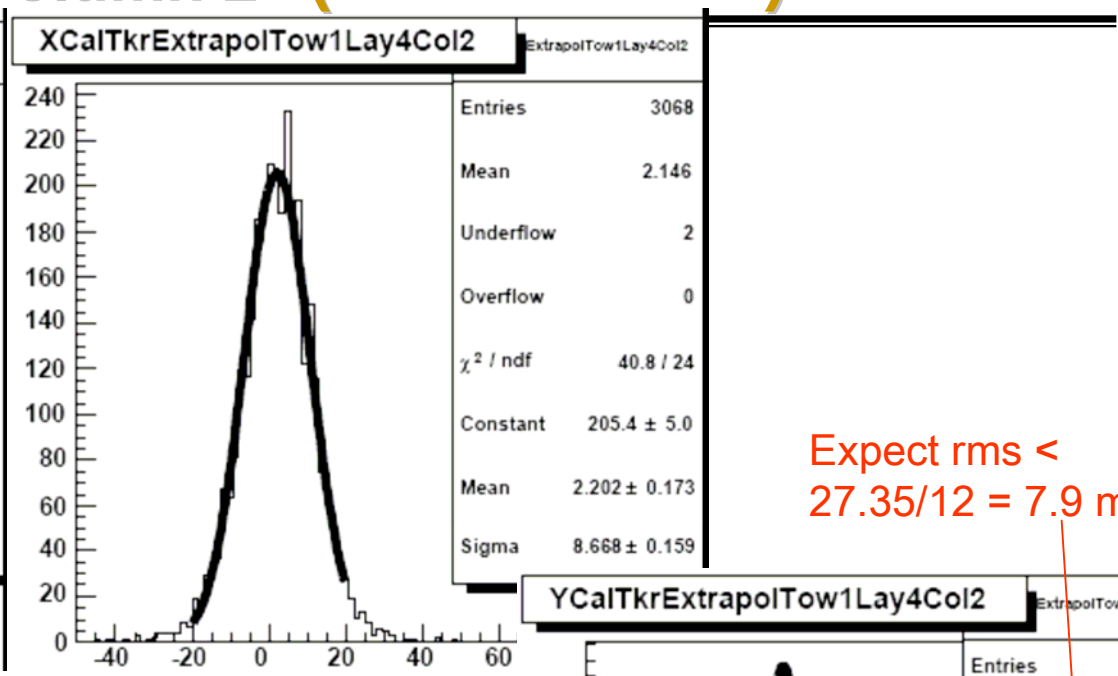
<2 MeV in adjacent crystals
Track must traverse top & bottom of crystal ("V == 1")

- Correct energy for cosθ.

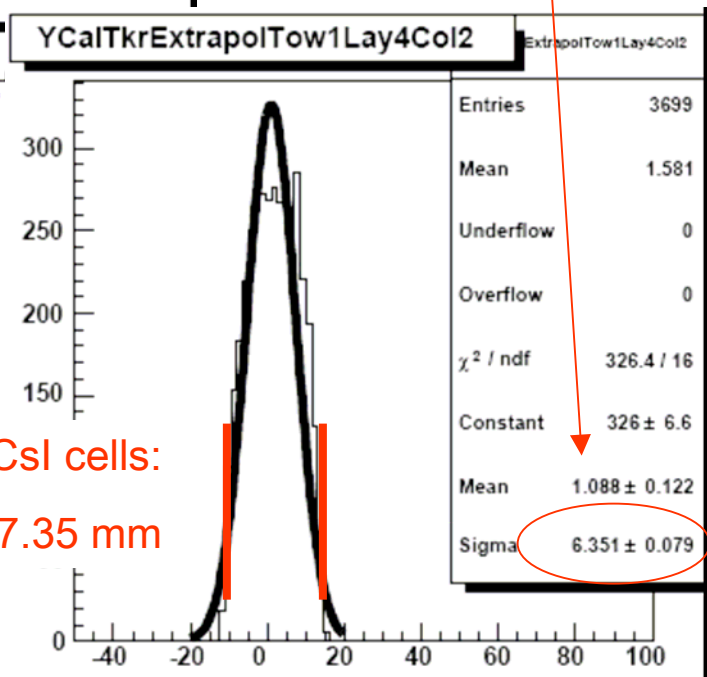


Example: Bay 1 (=FM103) Layer 4, Column 2 (All 2 tower B/2 data)





Expect rms < 27.35/12 = 7.9 mm



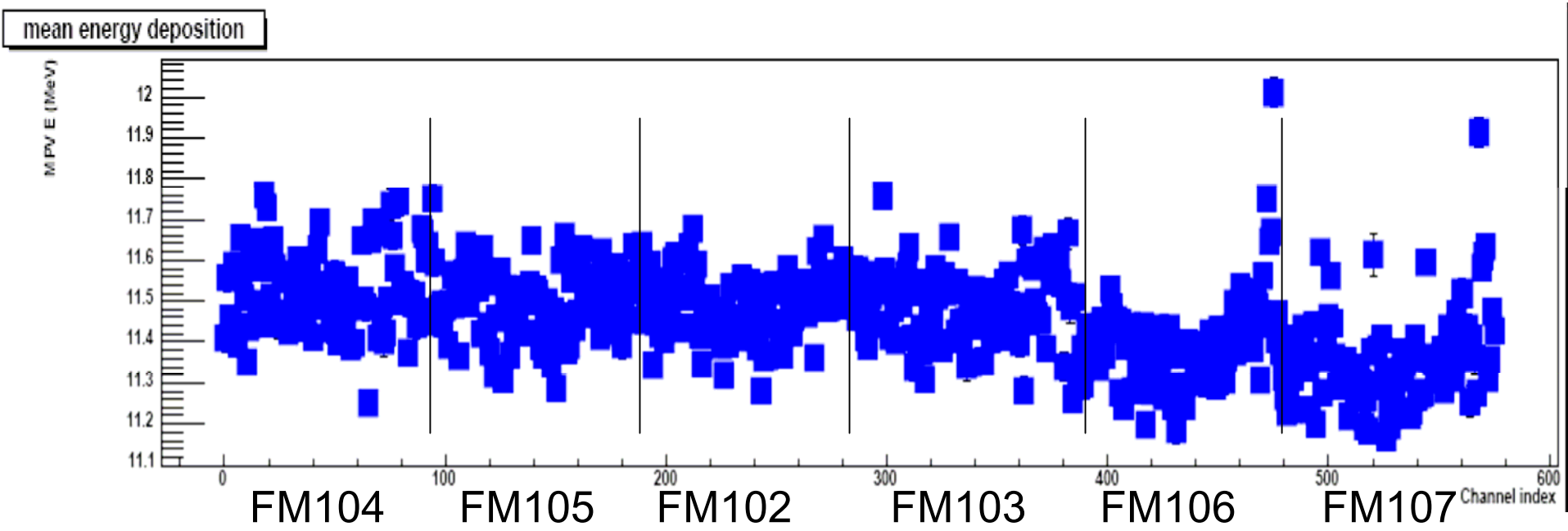
For *even* layers, CAL asymmetry gives position along the X direction. Y position is center of crystal face.

(Have cut 30 mm away from ends.)

Width of CsI cells: 27.35 mm

Six towers -- energy

(FIFO configuration goof for 5th, 6th towers -- after these 2 slides, show only 2 tower data.)

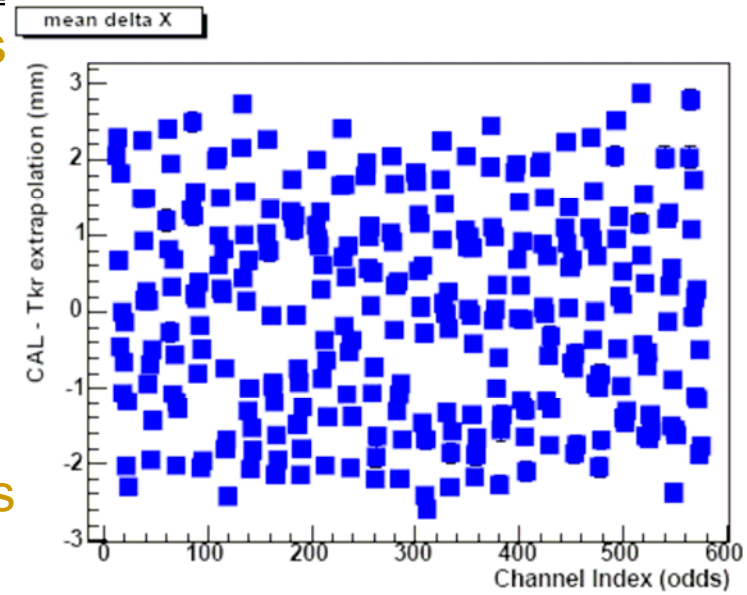


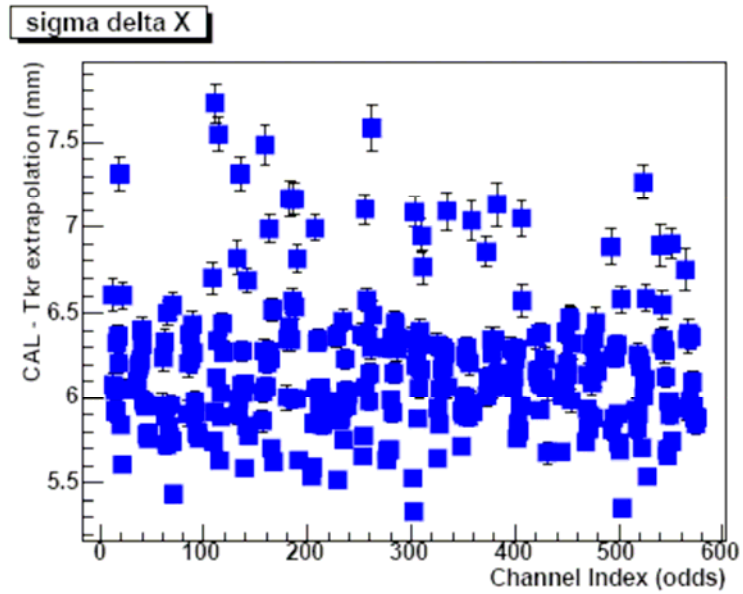
Six towers -- position (Δx,y) for odd layers

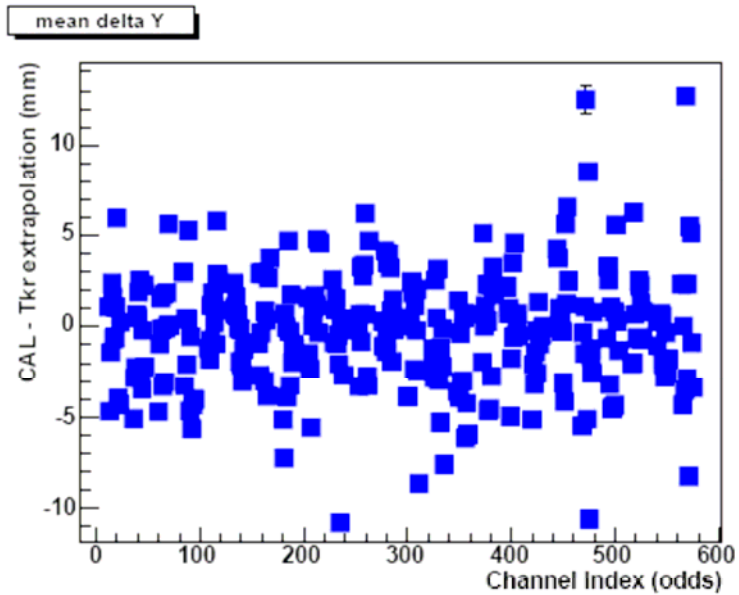
calibrations stable across 3/8 of LAT.

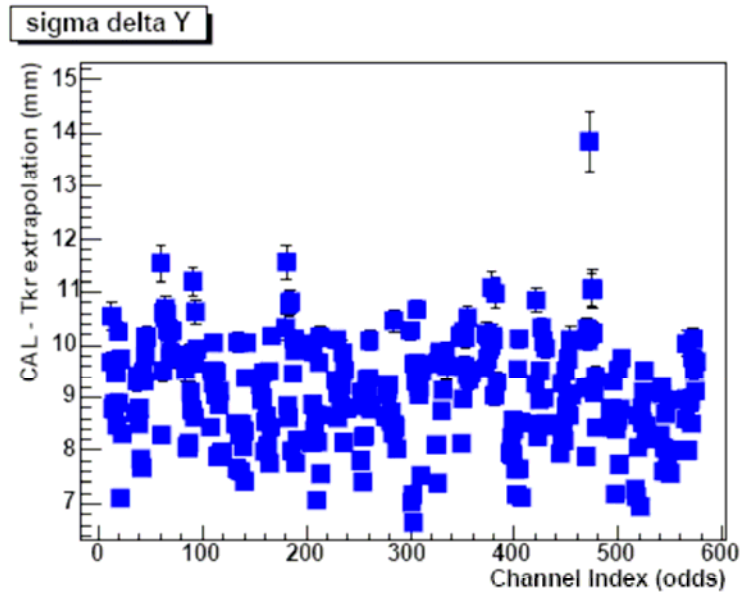
No glaring issues of *e.g.* even vs odd bays.

Bigger, better calibration data samples needed.



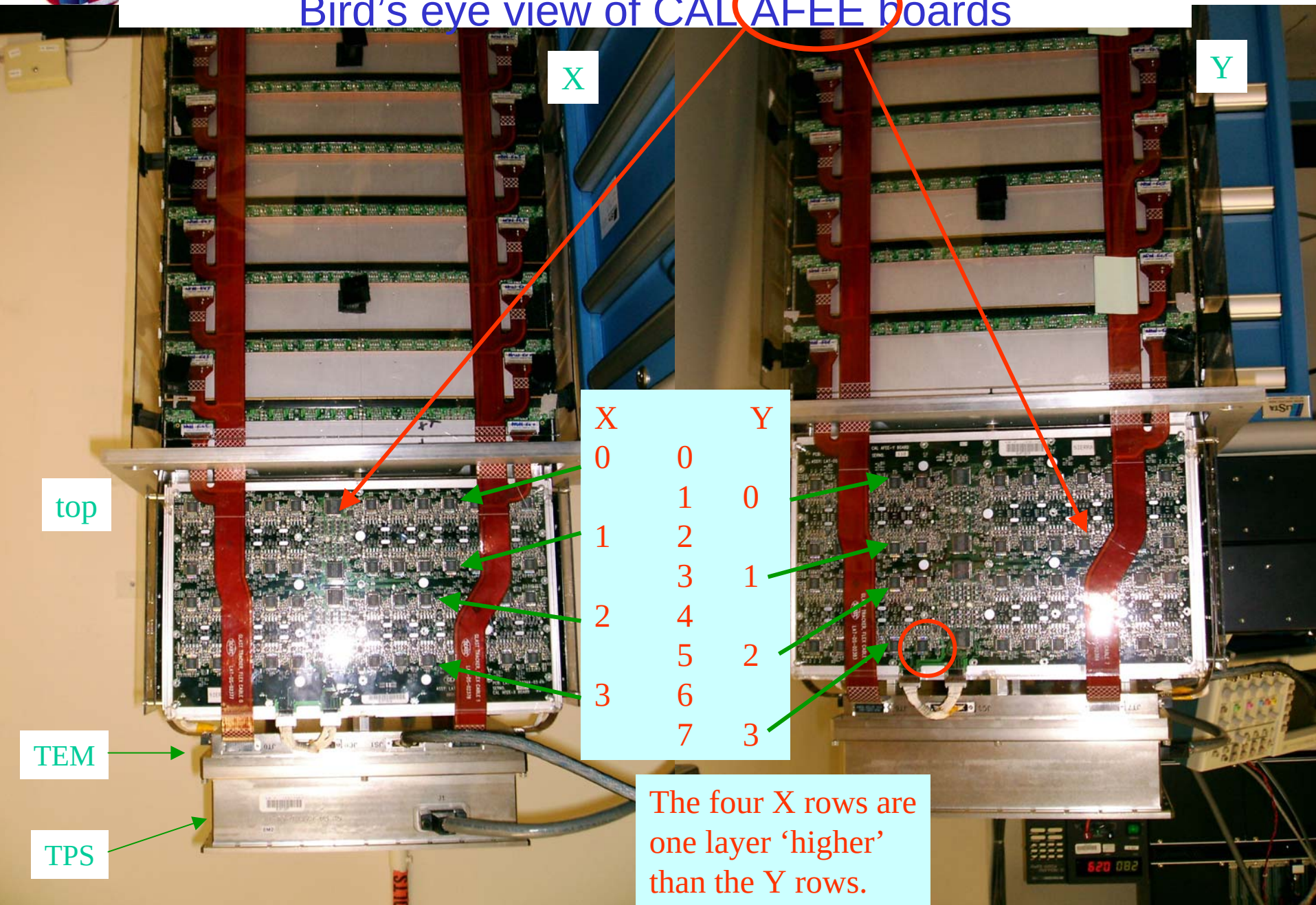




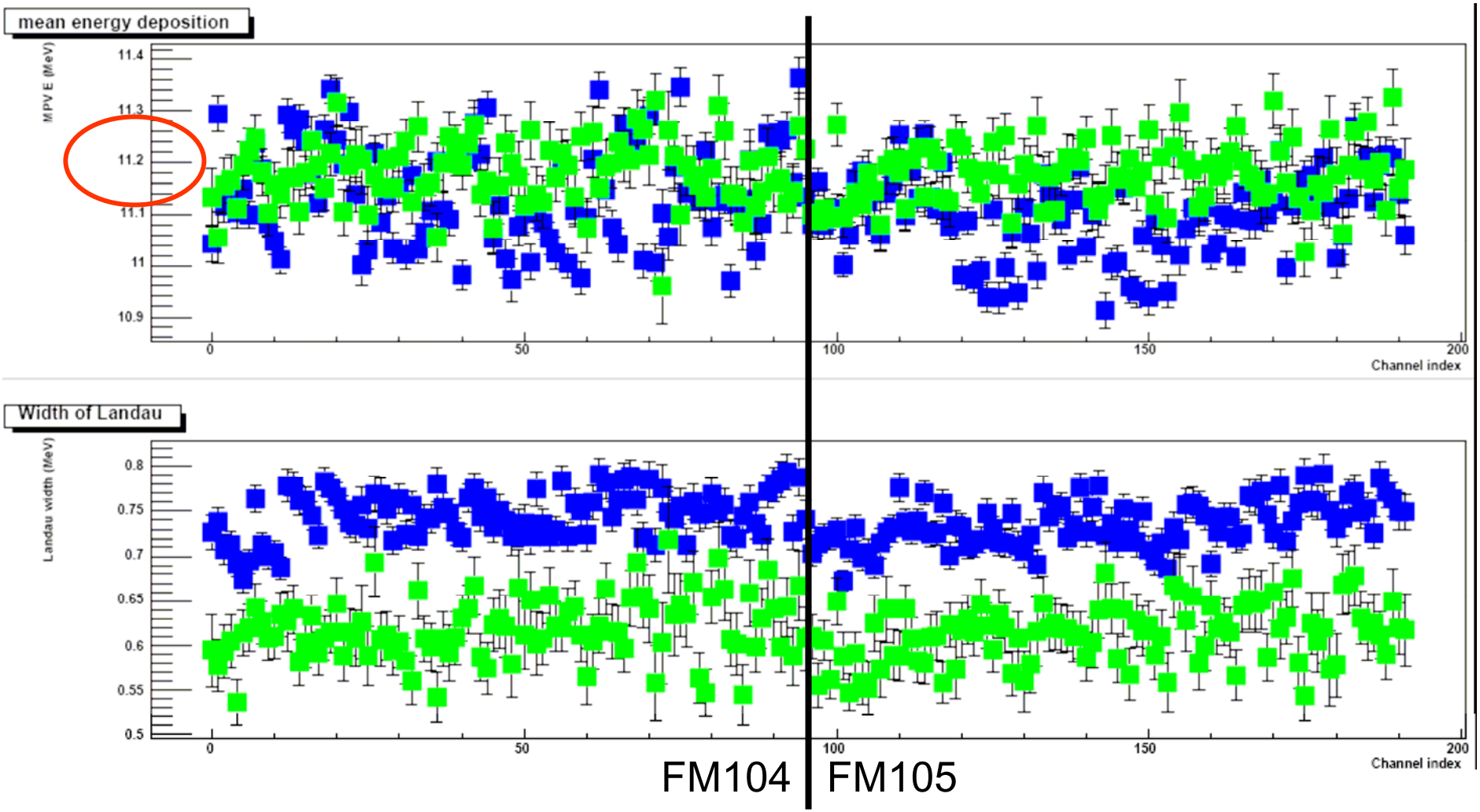


How odd & even layers differ

Bird's eye view of CAL AFEE boards

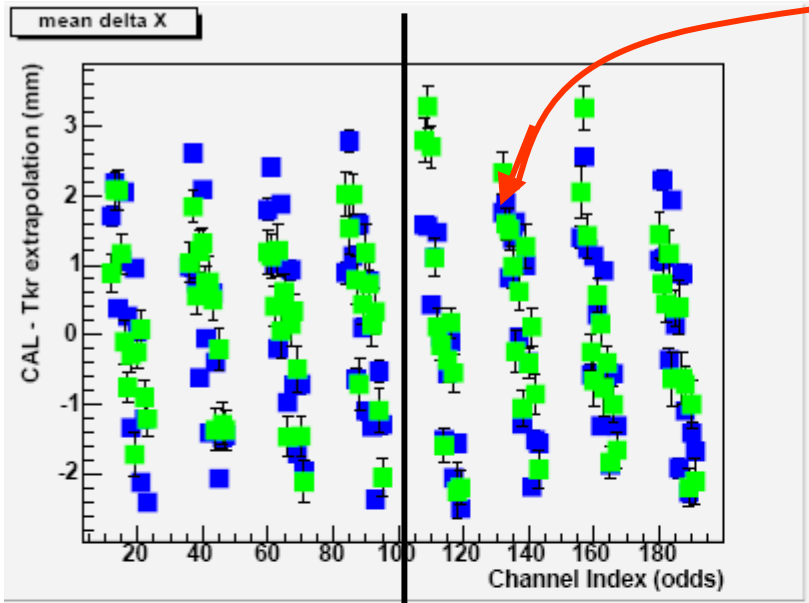


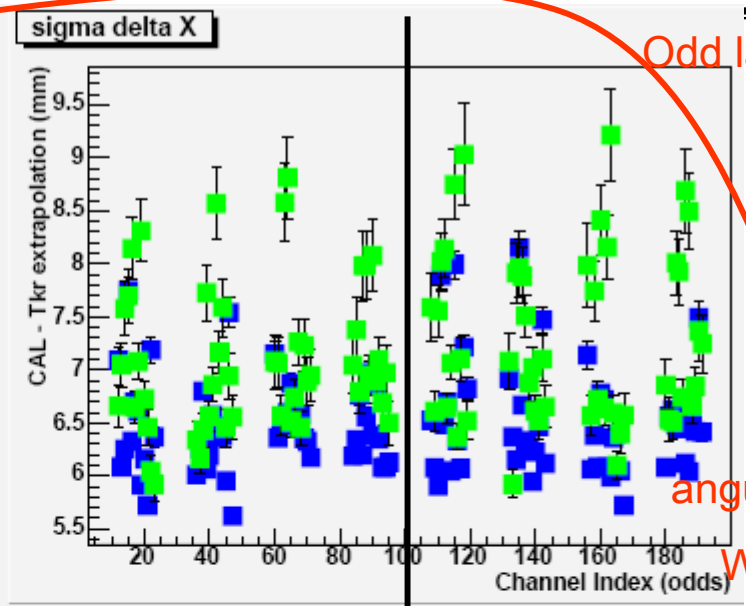
2 Towers -- zoom on energy. Blue=data, Green=MC



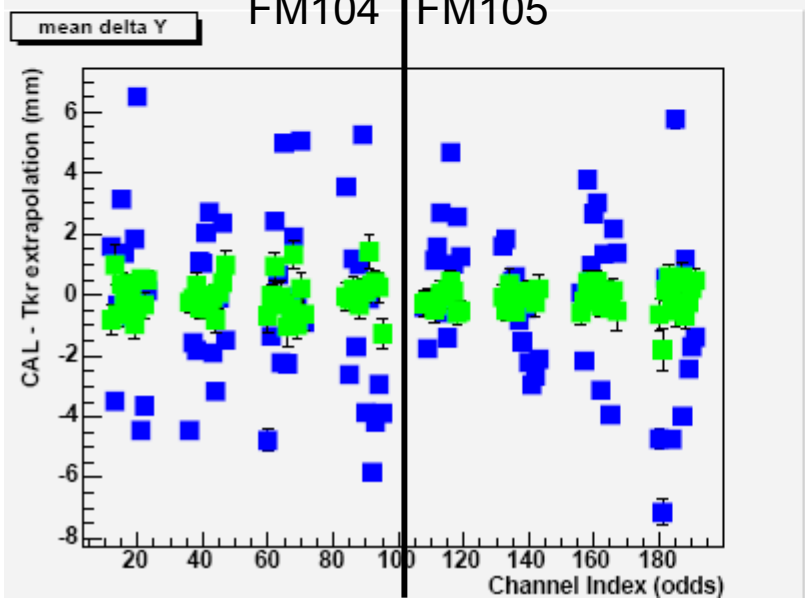
Monte Carlo width is ~150 keV narrower than for real data.
Reflects a known misunderstanding of light yield in CsI.
See e.g. Benoit Lott's "quenching" studies.

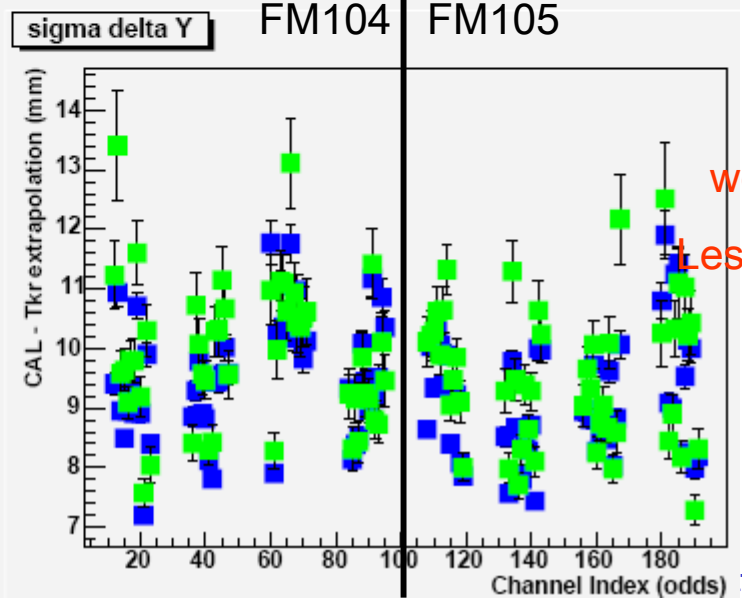
2 Towers -- zoom on Δx,y and compare with MC





FM104 FM105





FM104 FM105

Odd layers: "Y" is the longitudinal measurement.

"X" structure an artifact of muon angular distribution.

Widths as in MC.

"Y" means:

work-in-progress.

Less striking in "X".

Glasnost…

• The preceding slides make it look like our <11.2 MeV> energy comes out perfectly.

• But… after the 2 tower data, a minor geometry bug was found and fixed in calibGenCAL.

• the bug fix raises reconstructed energy to ~11.4 MeV.

• We may have a CAL trigger induced shift in muon energy peak for the CAL-trigger calibration data, absent in the TKR-triggered data we are analysing.

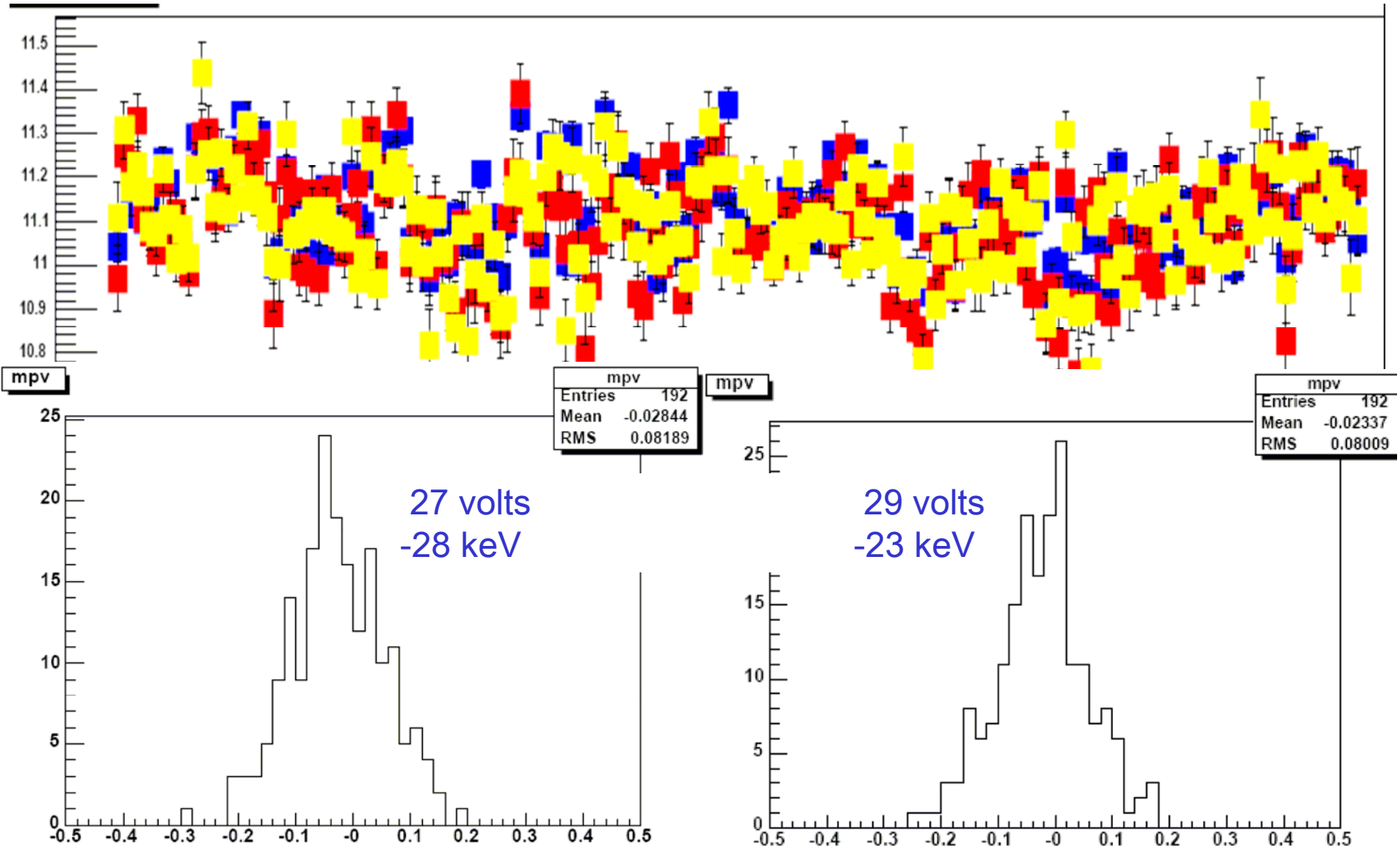
• Several valiant attempts to confirm that were foiled by various technical hitches… we're working on it … it's only a 2% effect and will get straightened out.

2 Towers -- some data sets

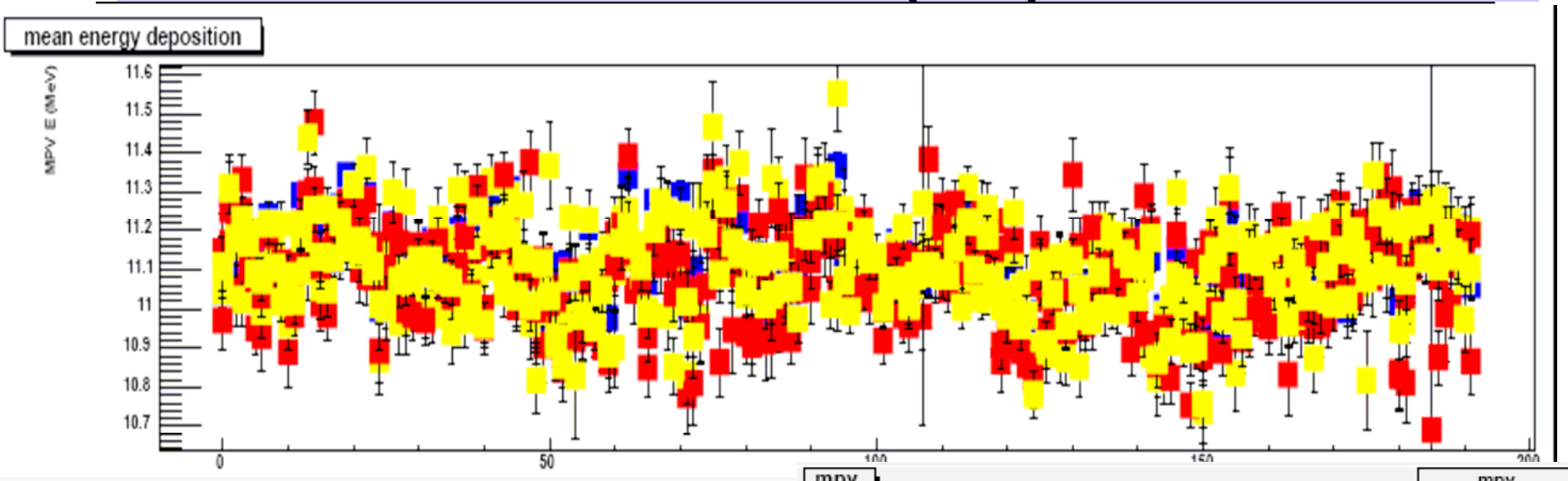
(from Eduardo's May 13 "End to end" slides)

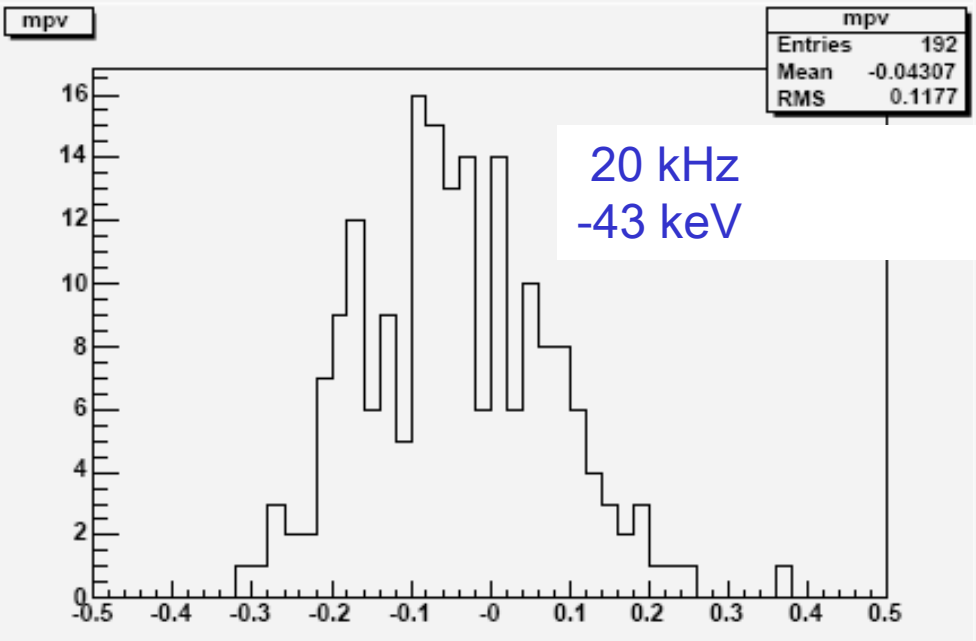
- B/2 -- (baseline) (preceding slides)
- 2/1 and 2/2 -- 27 and 29 volts, (nominal spacecraft supply is 28 volt).
- 4/4 -- overlay rate of 20 kHz.
- 8/6 -- overlay rate of 1kHz, non-zero suppressed 4-range readout.

27 (red), 29 (yellow) versus 28 volts (B/2, blue)

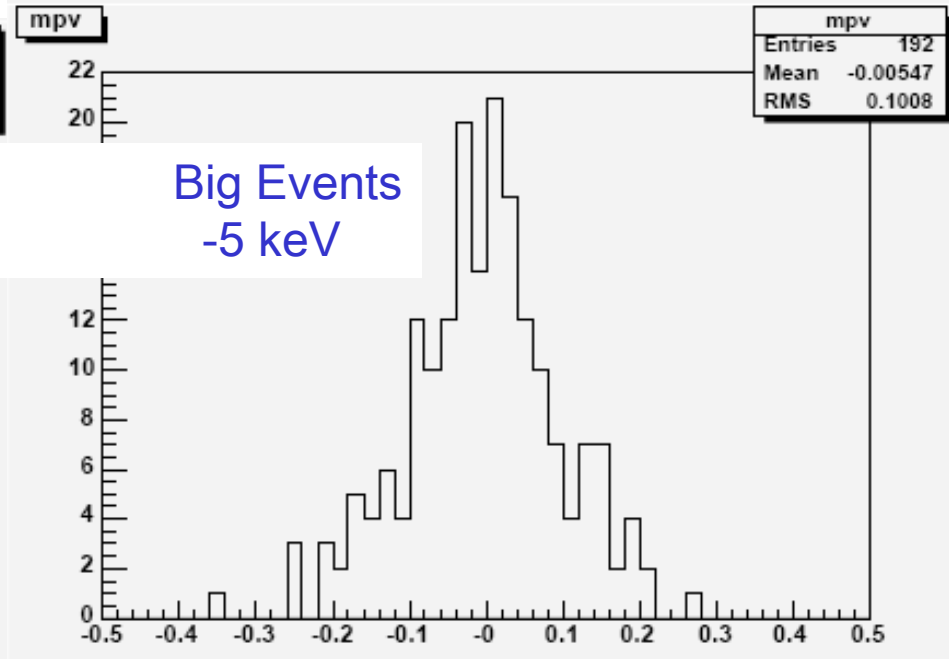


Hi rate (20 kHz, red), Big events (yellow) versus B/2 (blue)





20 kHz
-43 keV



Big Events
-5 keV

Direct Illumination from Bordeaux

- Denis Dumora, Marie-Helene Grondin, and Benoit Lott used digi and svac files to study direct illumination. (After an original study by Andrey & Sasha, available in the Instr. Ana. Meeting archives)

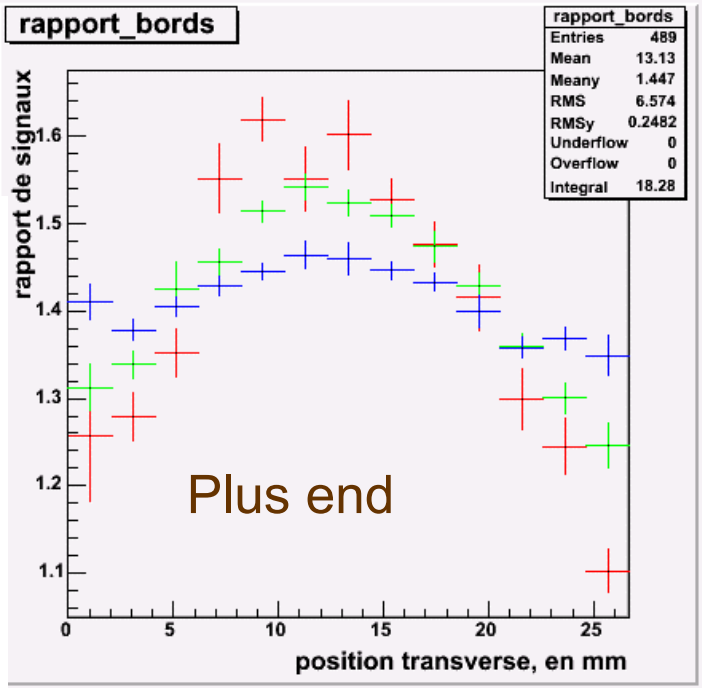
- Calculated pedestals by hand by waiting for the *CalTuple* to really get up to speed.

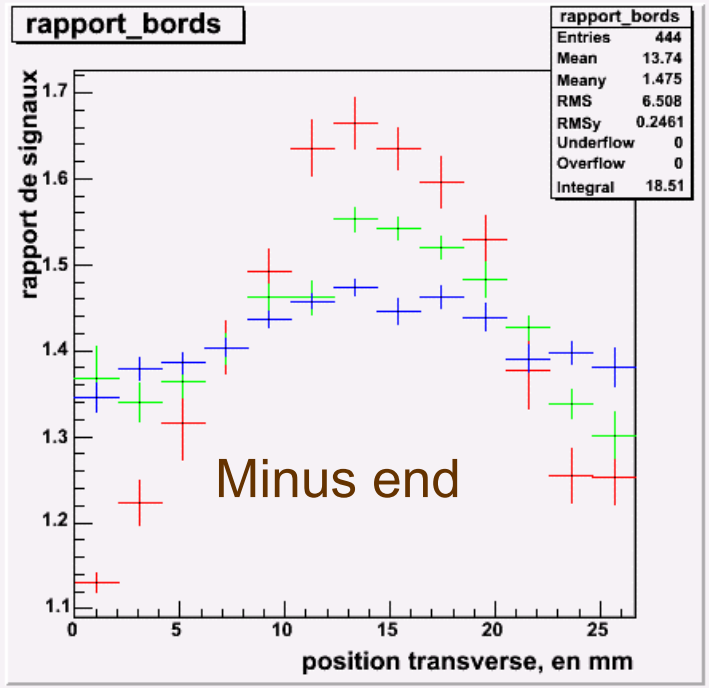
- Use TKR extrapolation to select tracks near the crystal ends, then study the (Near end/Far end) ratio as a function of *transverse* position.

- They have mapped the large photodiode!

Distance of track from crystal end:

Red: <5mm
Green: <10 mm
Blue: < 15 mm

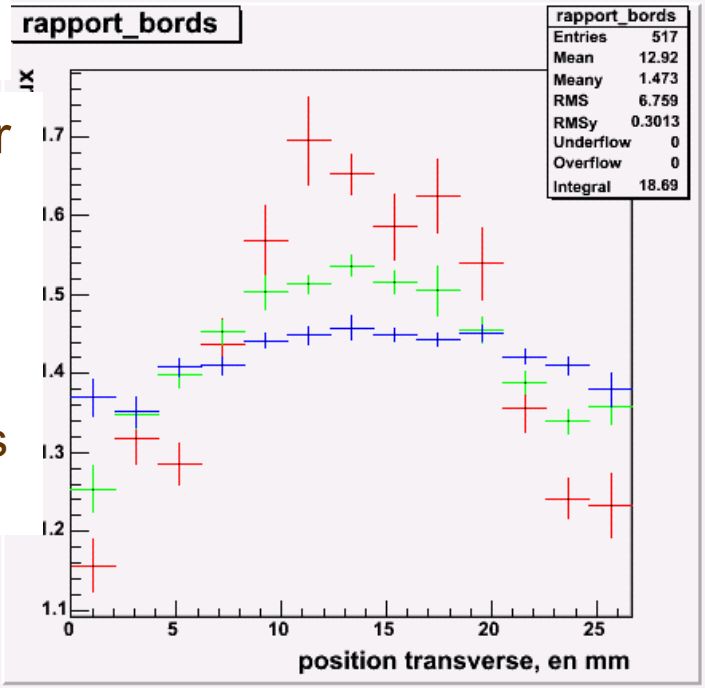


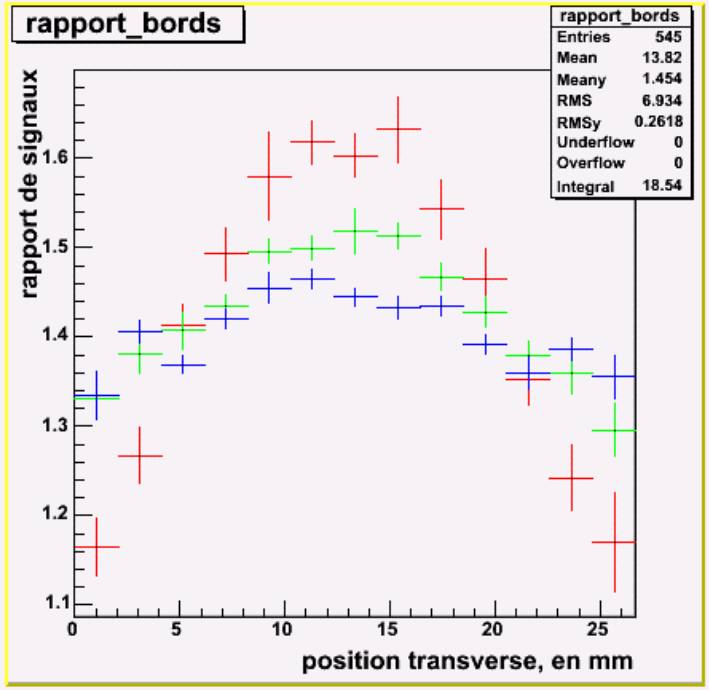


Large diode center 11 mm from edge.

900 k events used.

Top two: even layers
Bottom: odds





Conclusions

• First look at 3/8 of LAT CAL suggests uniformity across towers.
No glaring issues of *e.g.* even vs odd bays.

• A 2% shift between calibration muons and reconstructed muons exists, and is being tracked down.

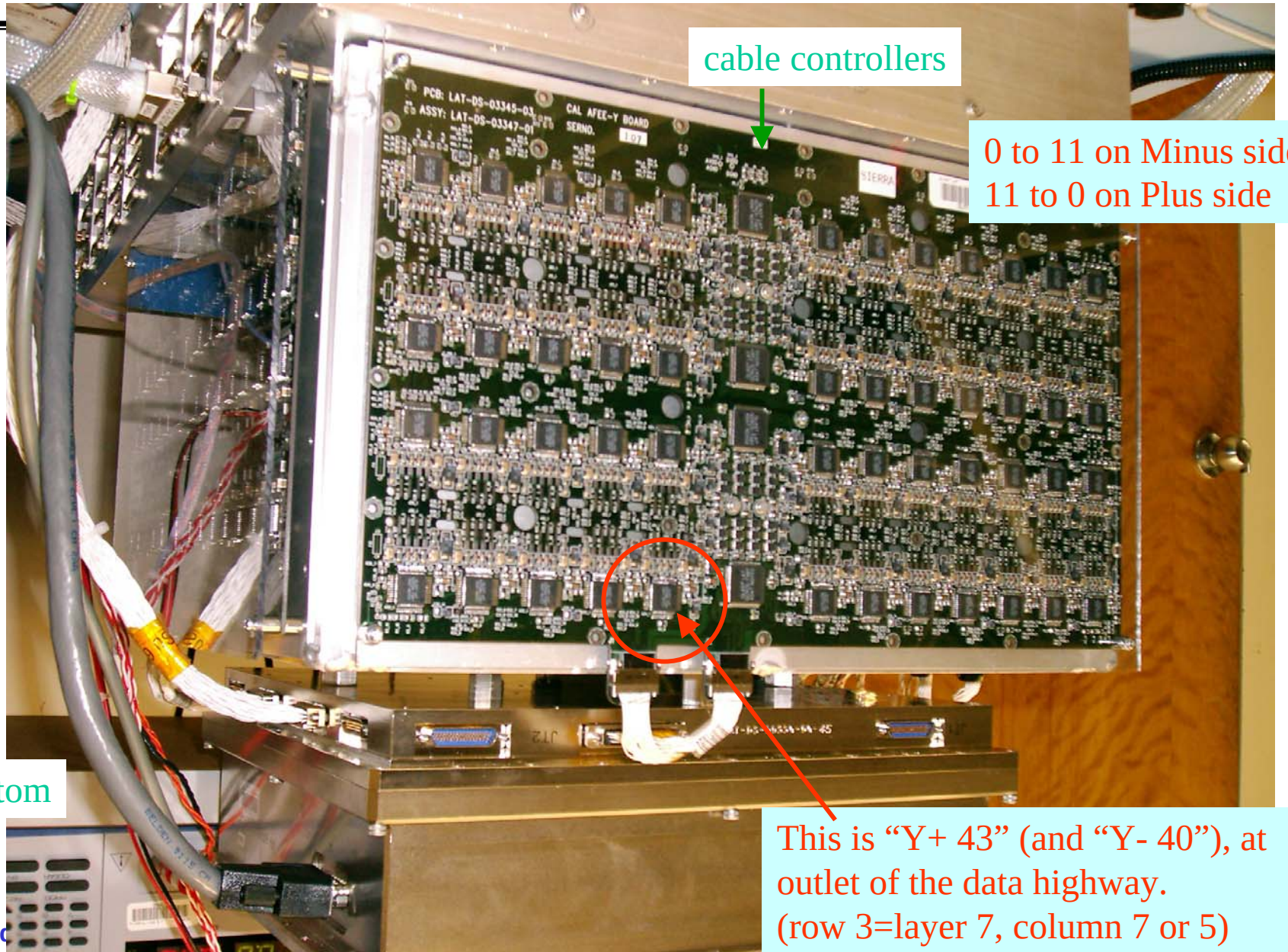
• Spacecraft supply voltage ; data rate ; event size have no obvious effect on measured muon energy (or landau width, or Δx,y either)

• Recent v3 “parallelized” online acquisition, combined with forthcoming v4 “parallelized & streamlined” calibGenCAL are simplifying the calibration process.

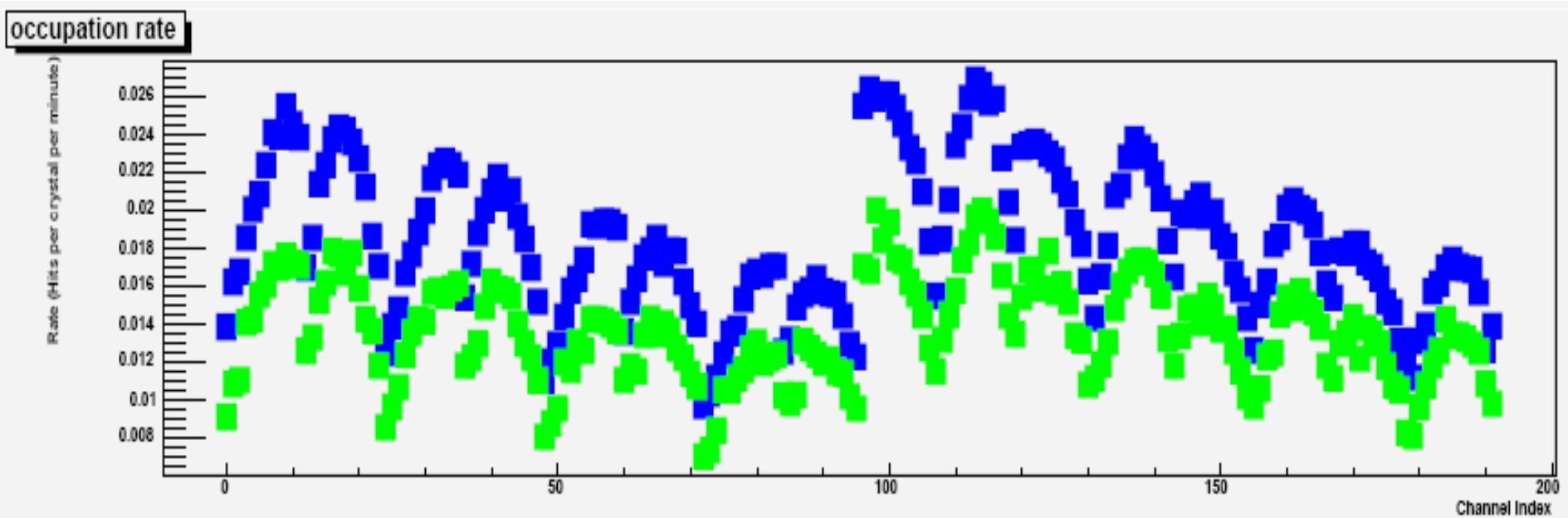
• v3 also corrected ancient “badcalibGen” that made HE range continuity study harder to do.

• We’re in fairly good shape, and steadily getting better.

AFEE = Analog Front End Electronics



MC cosmic muons have good angular distribution



Blue: muons per crystal per minute

Green: Monte carlo, arbitrary units