Detector alignment for CERN 2007 testbeam runs

CALICE Collaboration meeting
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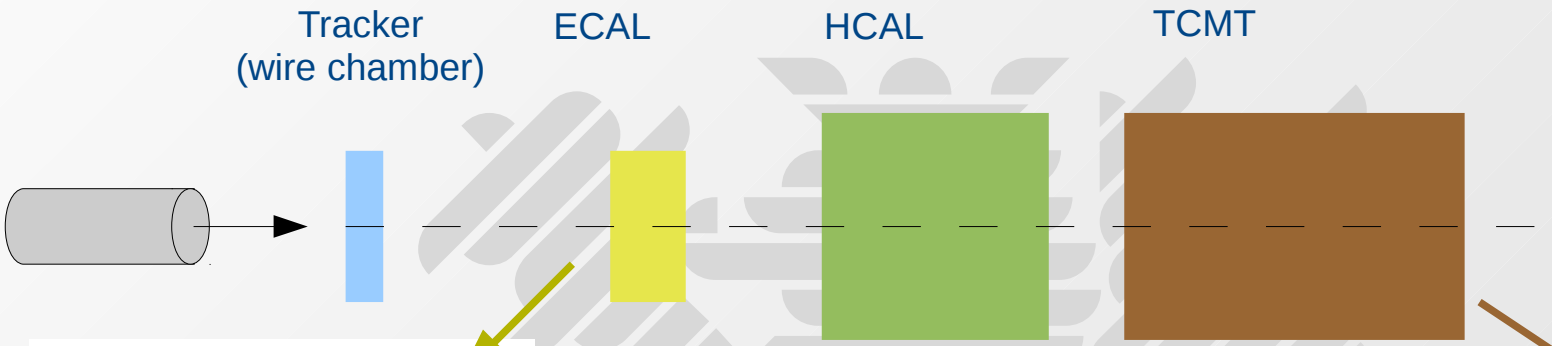
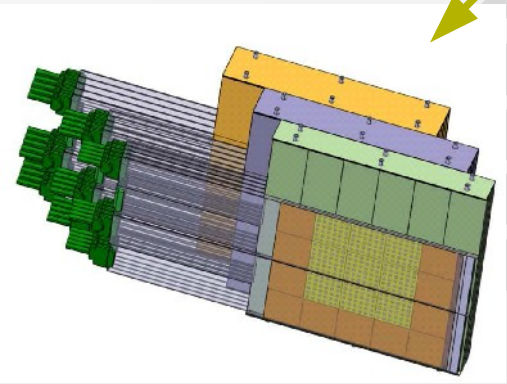
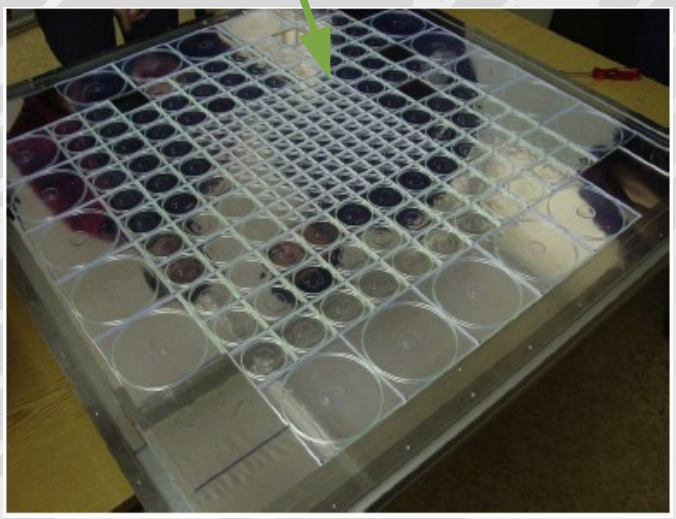
CALICE Prototype: testbeam CERN'07





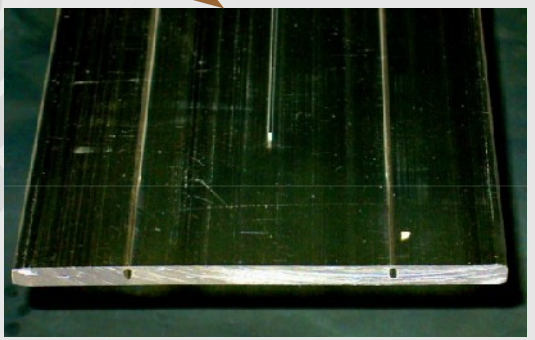
ECAL

- Si/Tungsten
- 30 layers
- 18x18 „Pads“ of 1cm²
- XY-stage
- rotary



HCAL (38 Lagen)

- Steel / Scintillator
- 38 layers
- „tiles“ of 3x3 to 12x12cm²
- XY-stage
- Rotary (layer wise)

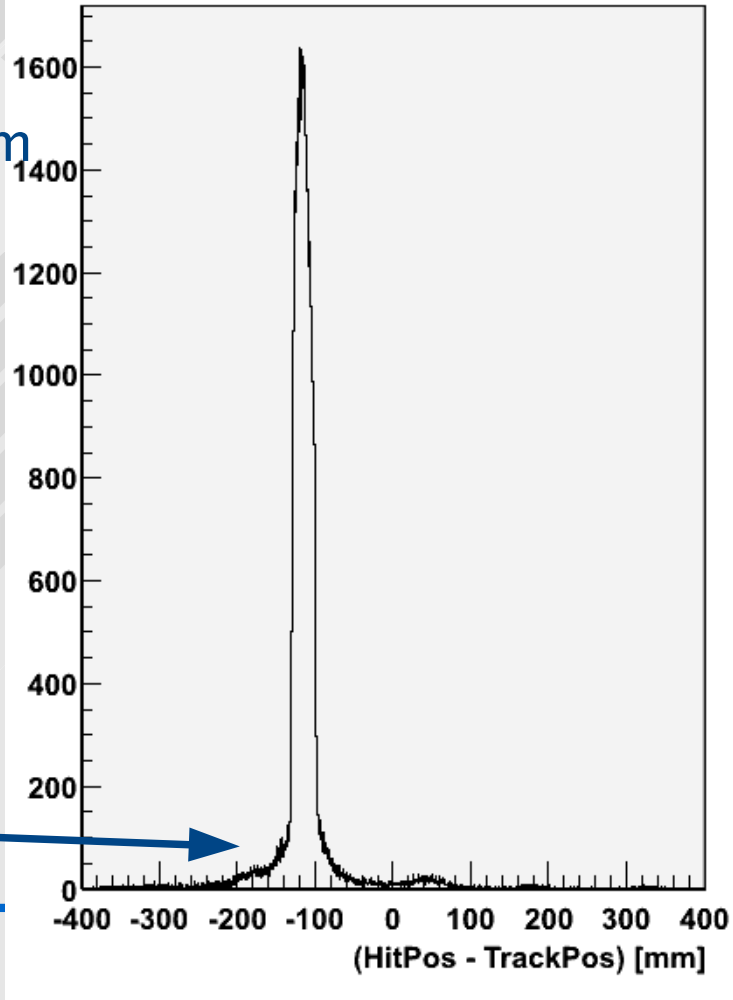


TCMT (16 Lagen)

- **T**ail**C**atcher**M**uon**T**racker
- „coarse resolution“ HCAL
- Stripes instead of tiles

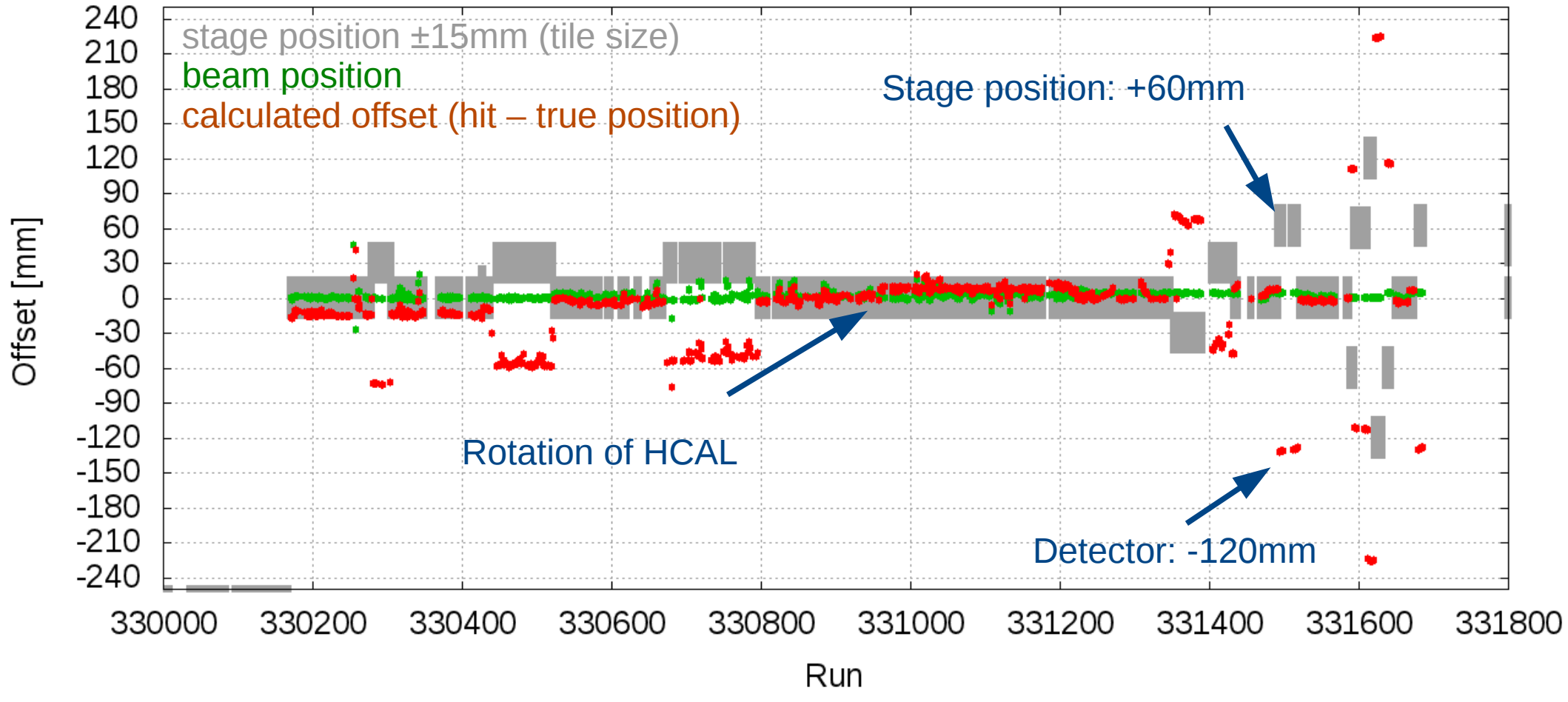
Global alignment

- Detectors
  - Slight shift against reference coordinate system
  - XY-stage to change impact point
  - Hit coordinates should maintain coordinate system
- Tracker
  - Here: defines reference coordinate system
  - Gives „true position“ of tracks
  - Beam is roughly located at z-axis (x, y=0)
- First idea:
  - Histogram (Hit – true position) for each direction (x,y)
  - Just first 5 layers (HCAL) before shower start
  - **Offset directly visible!**
    - ***-110mm → something is wrong***



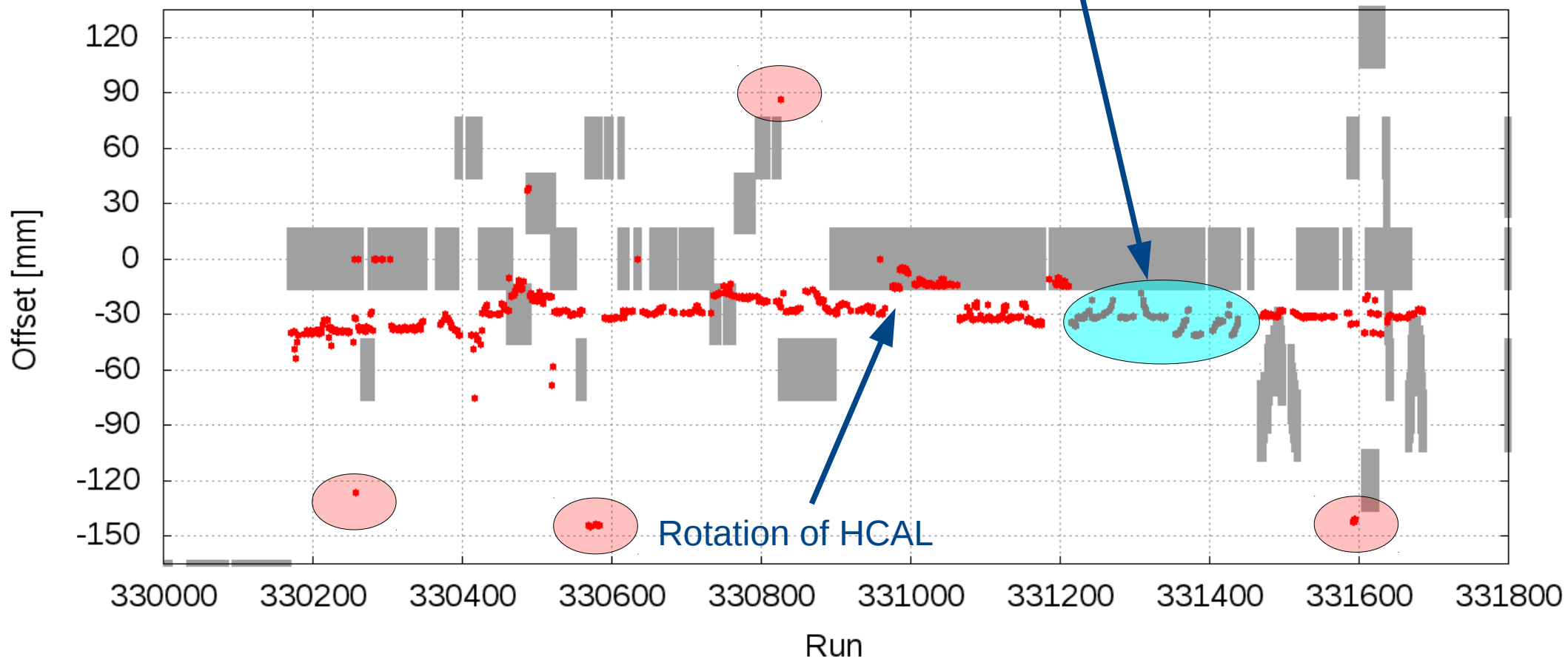
Global alignment – first look at HCAL (y)

- In general low offset (~10-15mm)
- Sign error in handling of stage (y-)position
  - This is why alignment is done
- Changes in detector position visible
- **Allows definition of run ranges without change of detector position**



Global alignment – first look at HCAL (x)

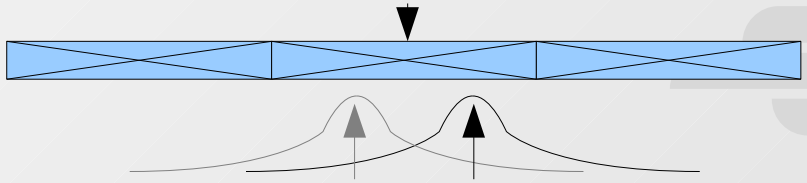
- In general larger offset (~30-40mm)
- No systematic sign errors
- Still some errors, usually when stage position changed
- **Variation** in offset of adjacent runs visible

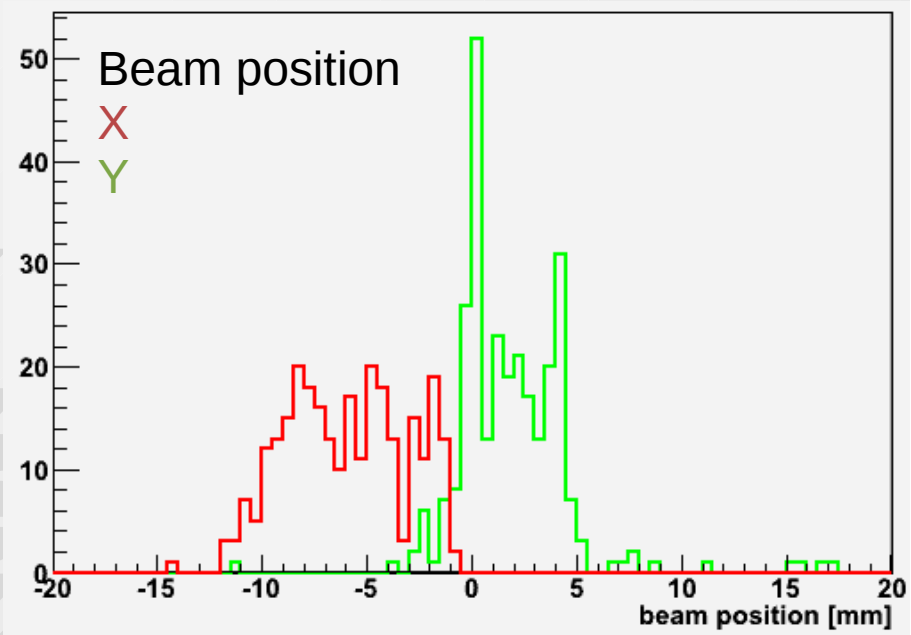


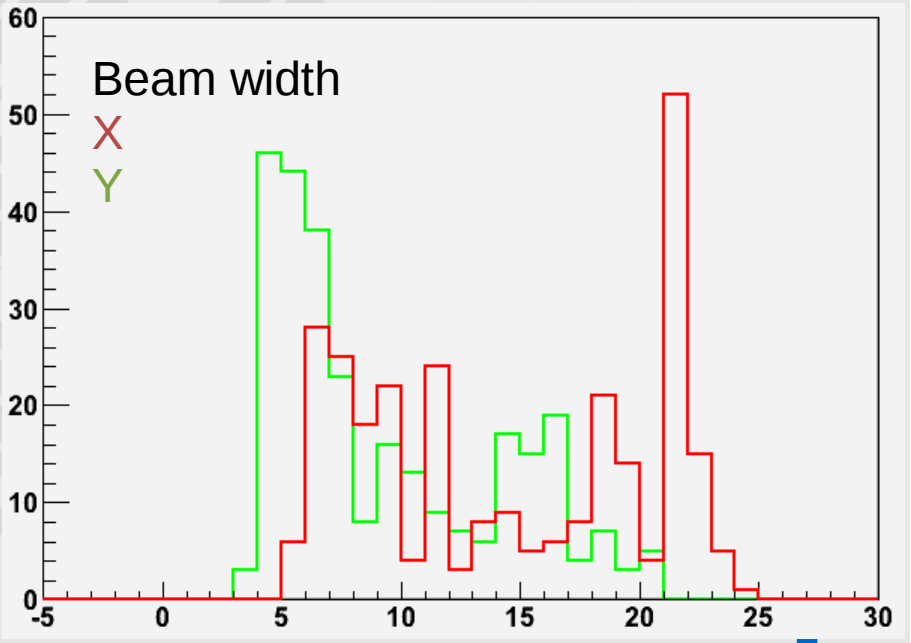
Variations

- **Effect 1**: Particle types
- Mainly electron runs:
  - shower in ECAL
  - only tail in HCAL
  - Fades to HCAL center for lower Energies as signal vanishes in noise

- **Effect 2**: Beam properties
  - beam sweeping ~10mm over tile gives offset sweeping the same magnitude
  - Dependency on beam width / showers

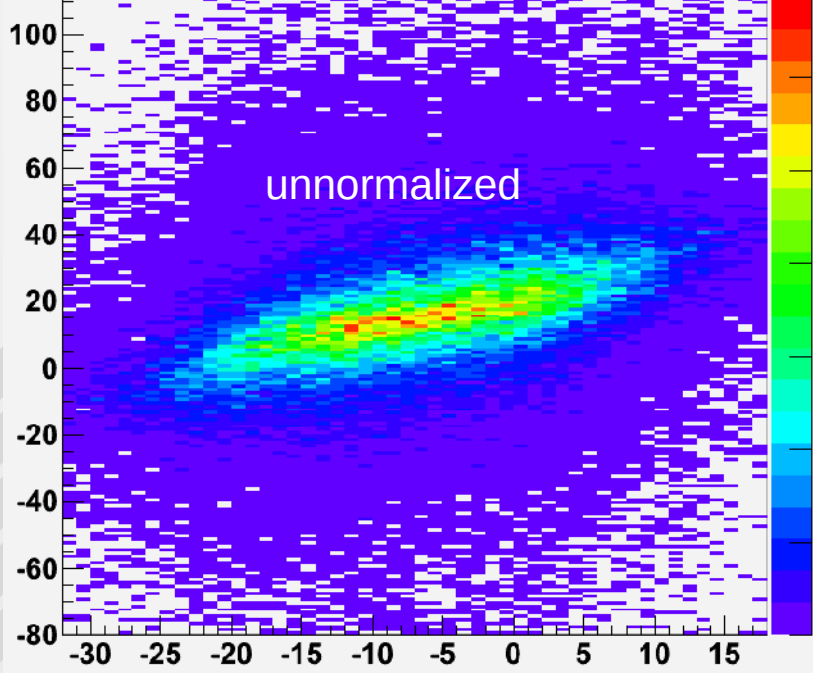




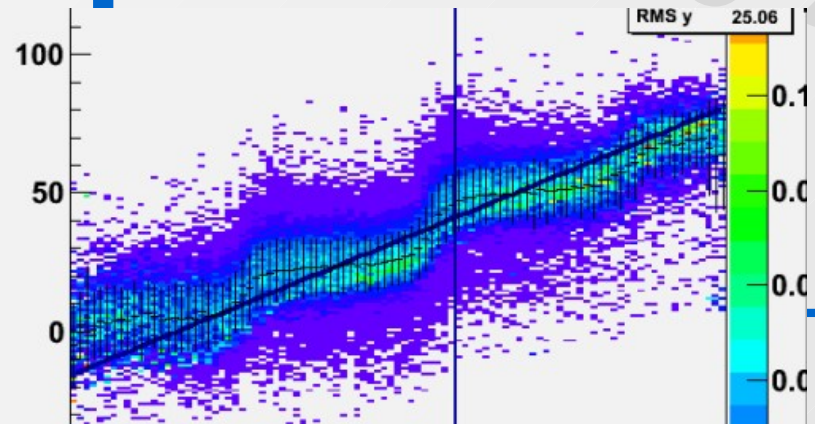


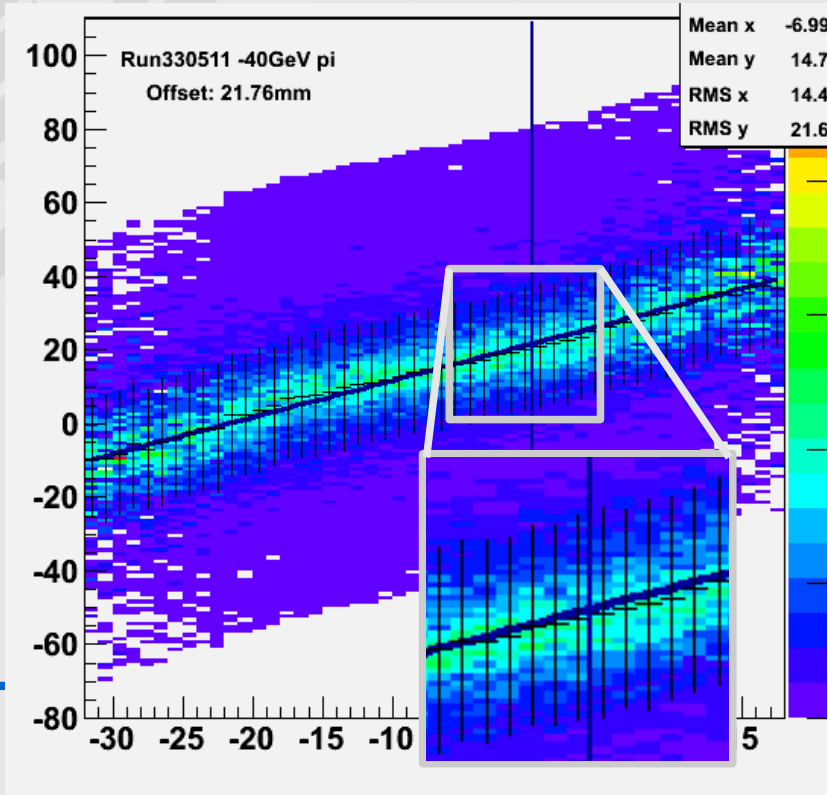
Improvement:

- Correlation of COG and true position
- Normalized to beam profile
- Almost linear distribution
- Fit with slope 1 to get offset
- Slight effect of discrete tiles (steps) still visible but neglible



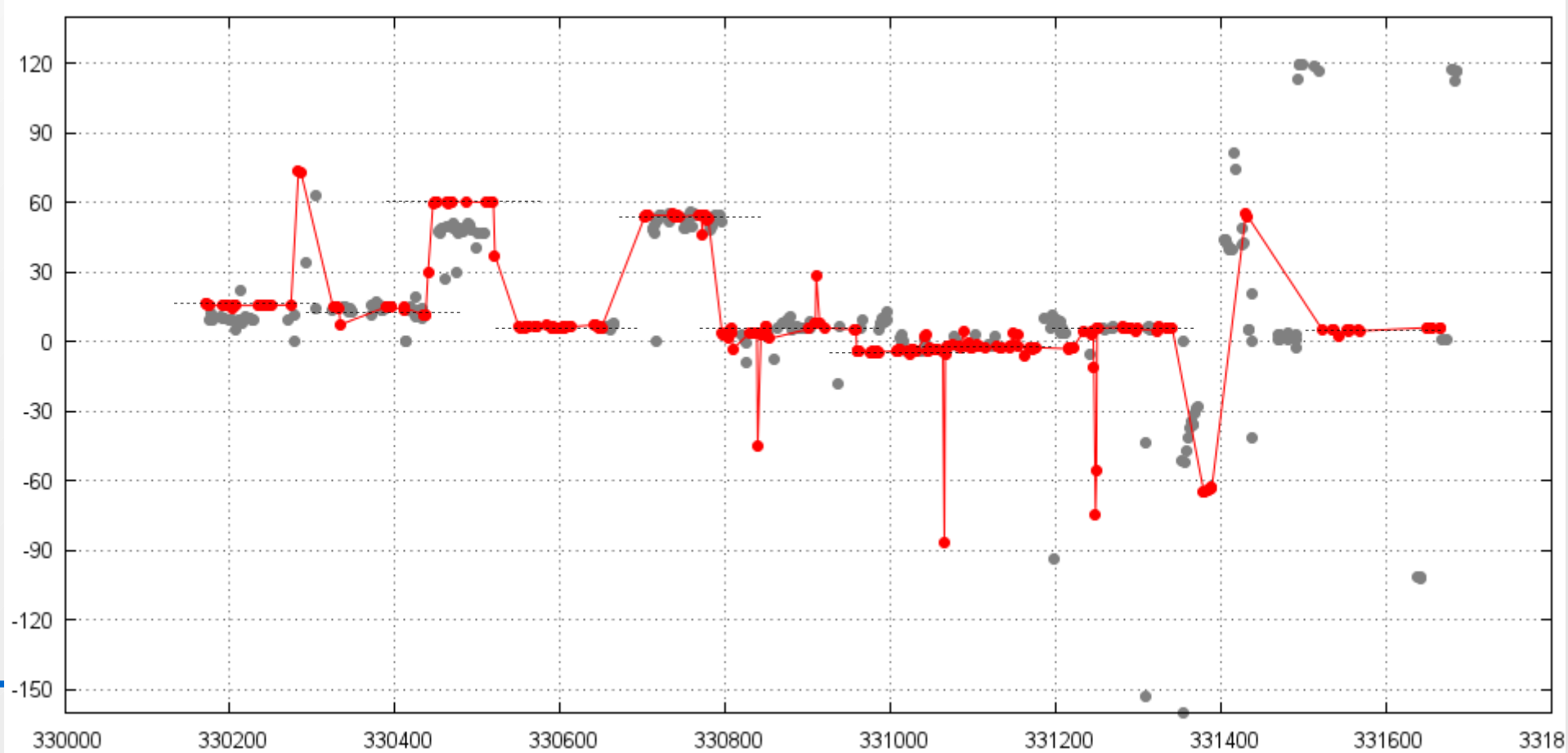
- Not satisfying for muons:





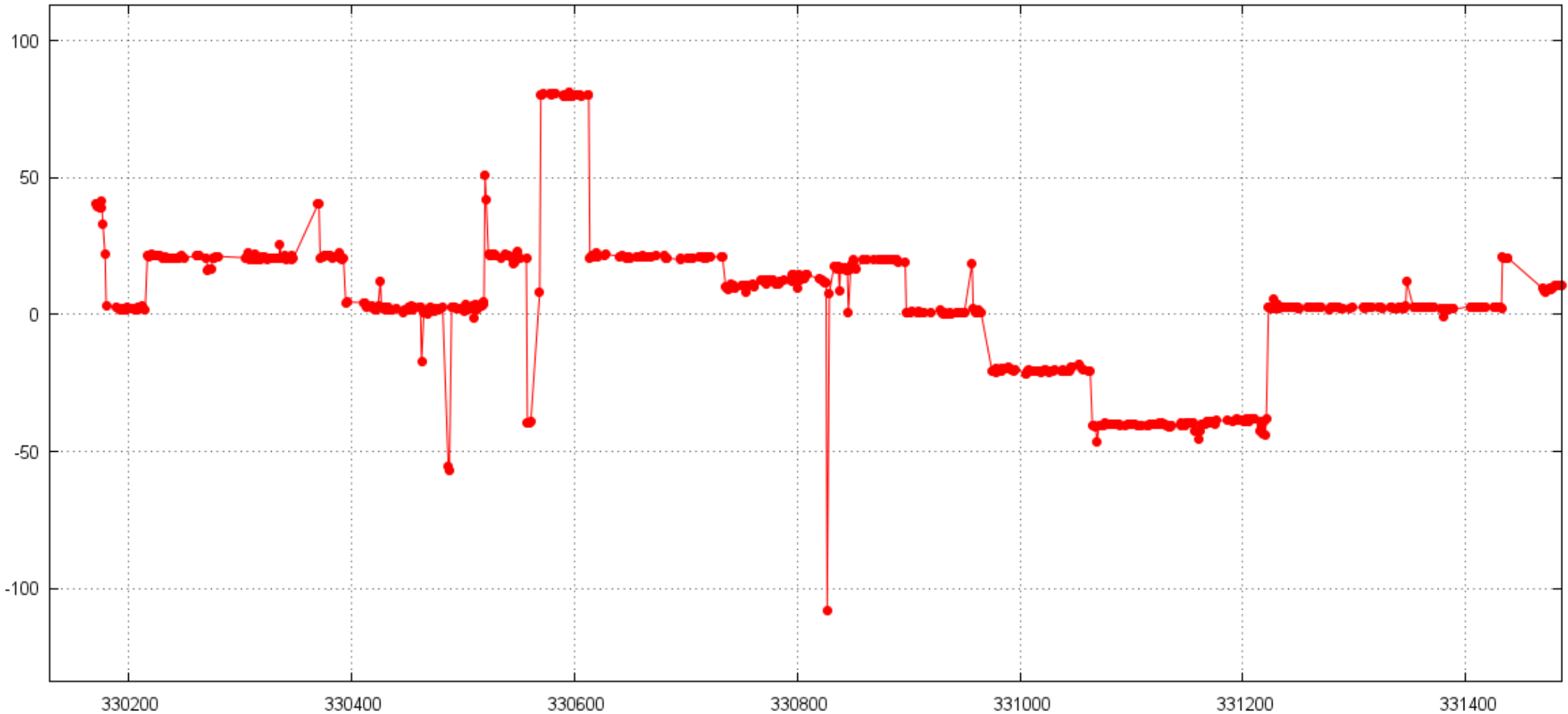
Global alignment (HCAL)

- Pions show distribution without large variations
- Sort out garbage runs
- Concatenate runs with same offset to increase statistics
- For comparison: electrons



Global alignment (ECAL)

- Process transferable to ECAL
- Situation relaxed: Can use all types of particles
- Pad size < beam width
- By now, stage position not taken into account...



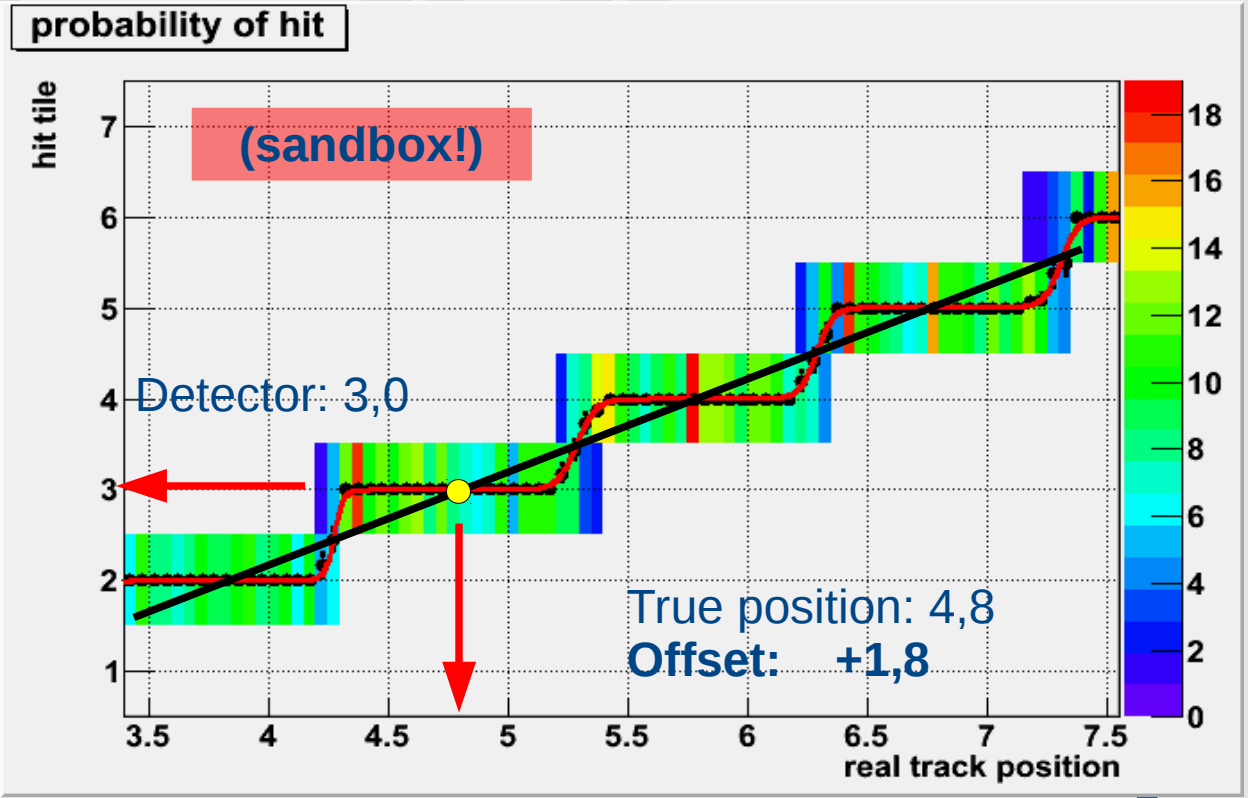
Status of global alignment

- Analysis has been done for CERN 2007 runs 330xxx-331xxx (ECAL + HCAL)
- Runs 335xxx (HCAL only) still need review

- Todo:
- Concatenate runs with same offsets
- Fix offsets and write to database

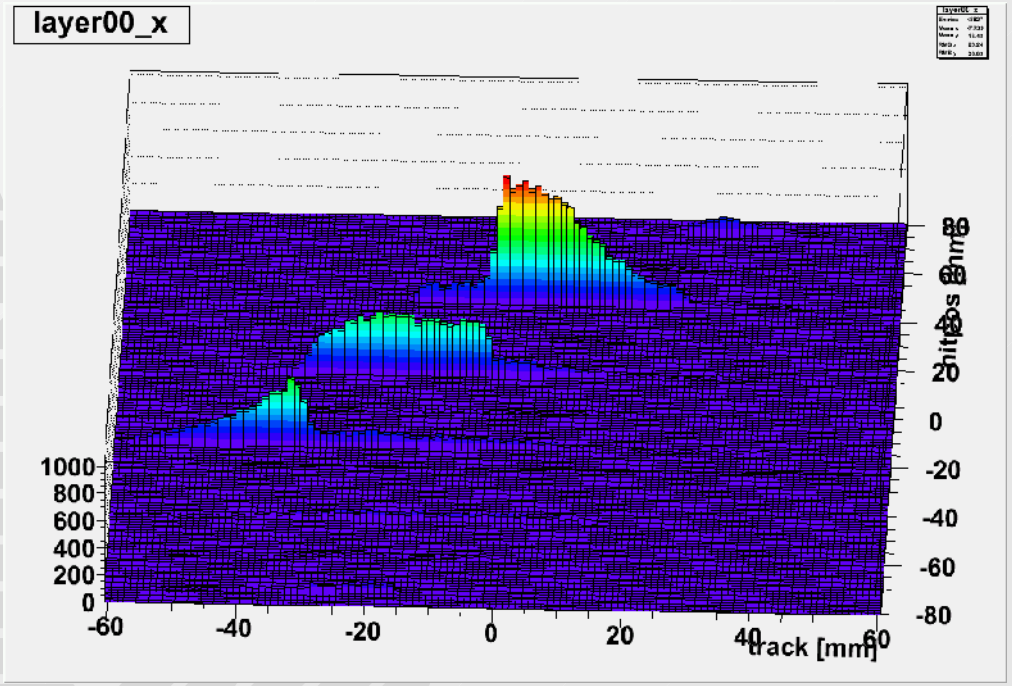
Muon alignment

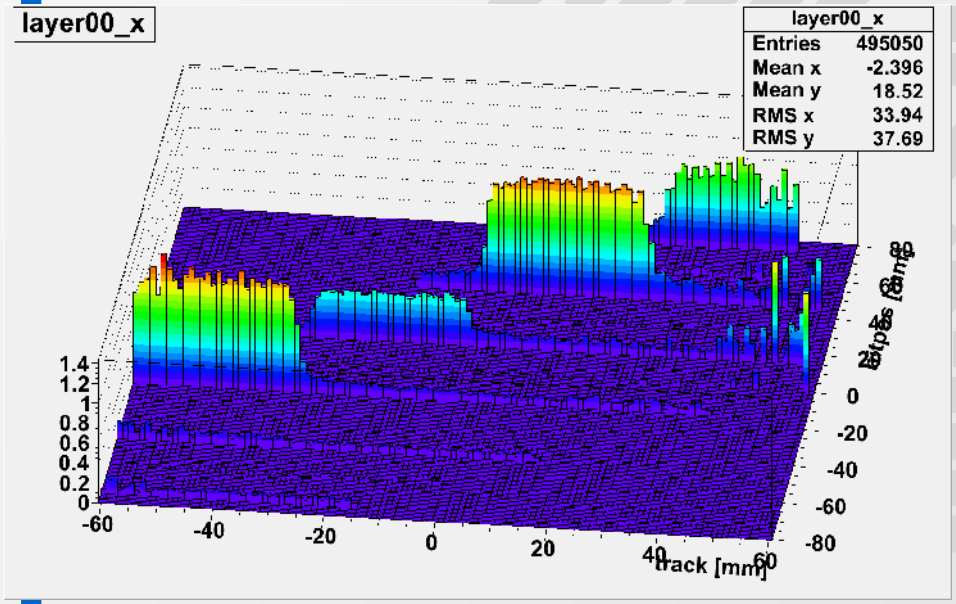
- **Offsets of single layers in HCAL and ECAL**
- Use muons due to their clean tracks
  - Correlation true position ↔Hits in Detector for each direction (x and y)
  - Step function due to discrete cell positions
  - Fit of s-curves
  - Center of cells in between

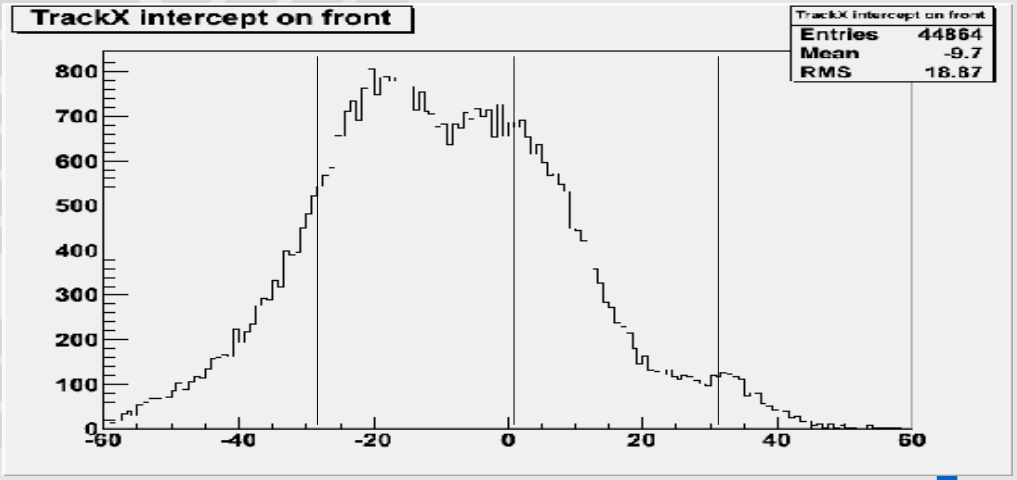


Testbeam data

- Few steps due to beam profile
- Normalize to beam profile
- … and to hits per cell

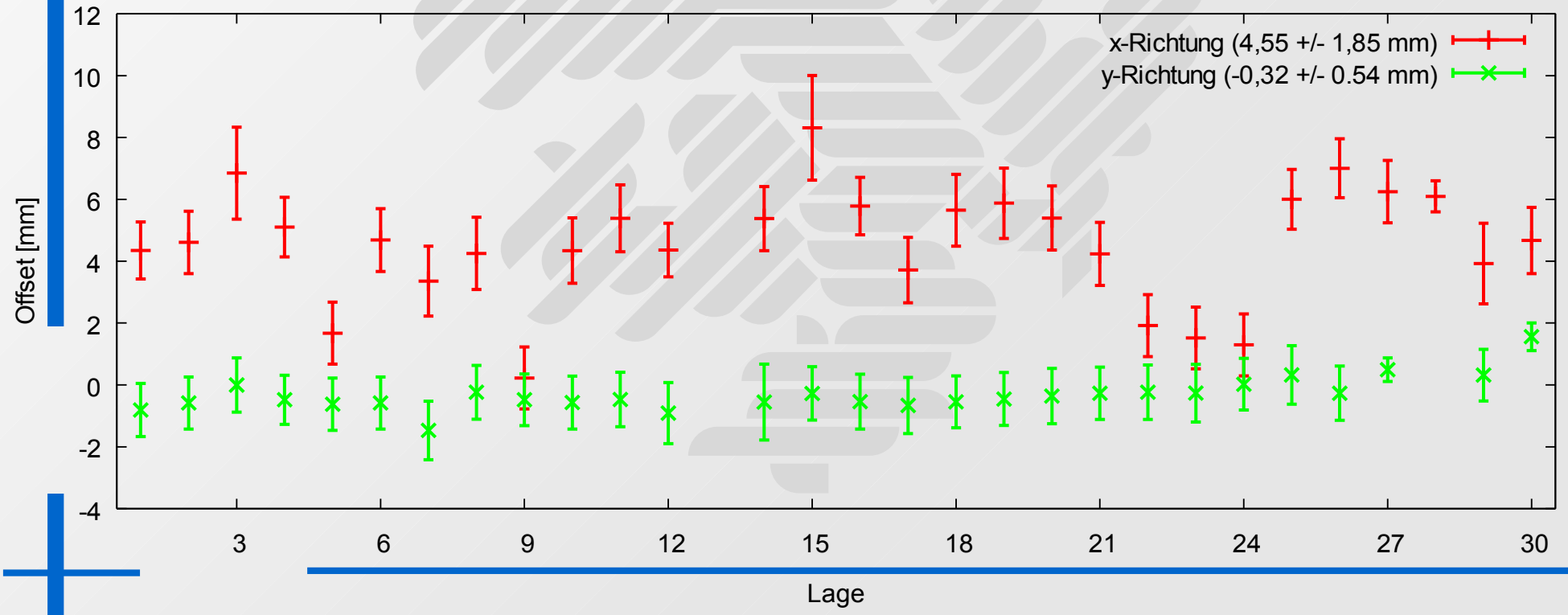






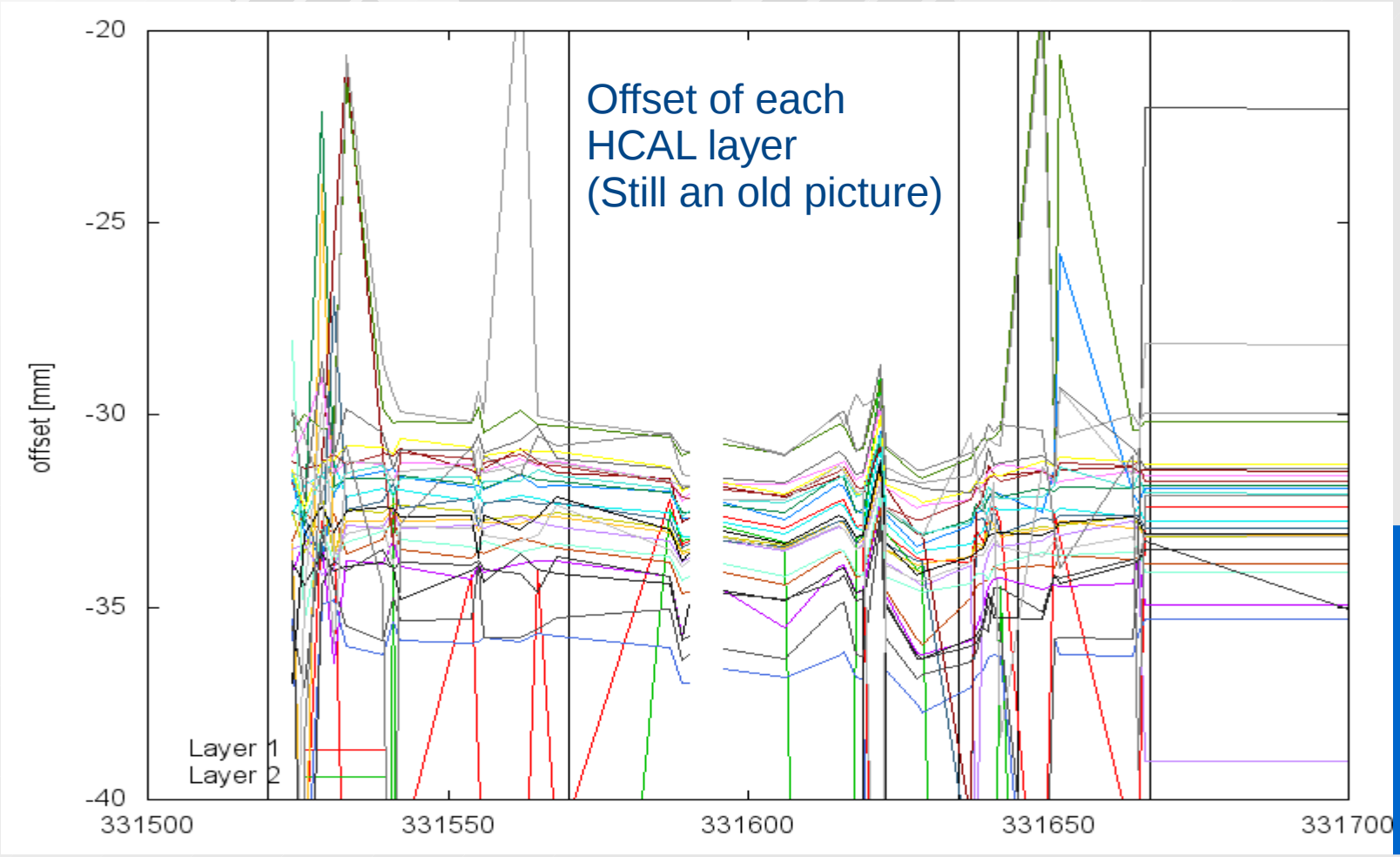
Muon alignment (HCAL)

- Horizontal Offset
  - Spread: 8,1mm (RMS: 4,6mm)
  - Assembly issue?
- Vertical Offset
  - Spread: 1,4 mm (RMS: 0,54mm)



Muon alignment (HCAL)

- Muon alignment works for many runs – also pion runs!
- Inter-layer-offset almost stable – visible as ribbon
- Still some tuning needed for muon selection



Status of Muon alignment

- Alignment is working fine for muon runs so far
- Also applicable to pion runs
  - Still needs some tuning
  - Lower statistics
- Identify and concatenate runs with same offsets
- Fix and write to database

Outlook

- Muon alignment also possible for TCMT

- So far, only ECAL&HCAL of CERN'07 used
  - No track information for FNAL
  - Should be possible to roughly check data
    - *Consider beam at (0,0)*
    - *Compare ECAL ↔ HCAL*