ATLAS-Pixel modules with FE-I4

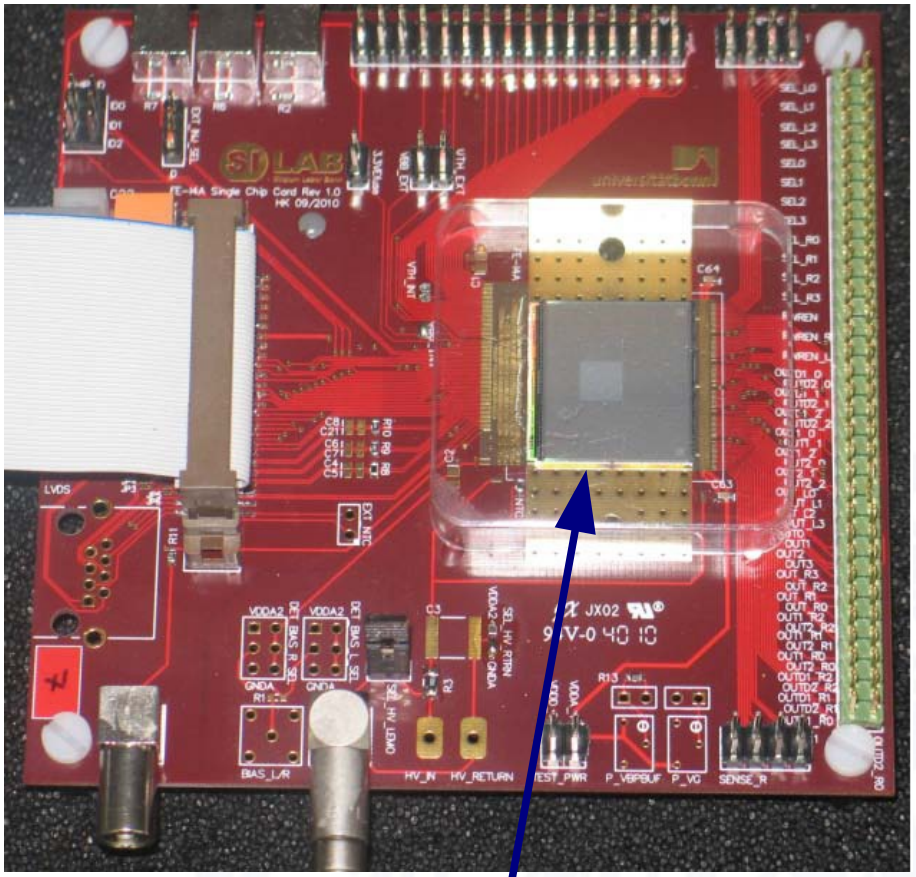
Jörn Grosse-Knetter
University of Göttingen

Overview

- Module overview
- Selection of lab measurements
  - Threshold measurement, tuning
  - Charge measurement, tuning
  - Source measurement
- First test beam results

Sensor-FE-Assemblies

- FE-I4 bump-bonded to planar n-in-n sensor of similar size (~2x2 cm)
- Sensor pixels 50x250 μm, as in FE-I4
- Bump bonding done at IZM
- Mounted on support board for lab, test beam and irrad. tests

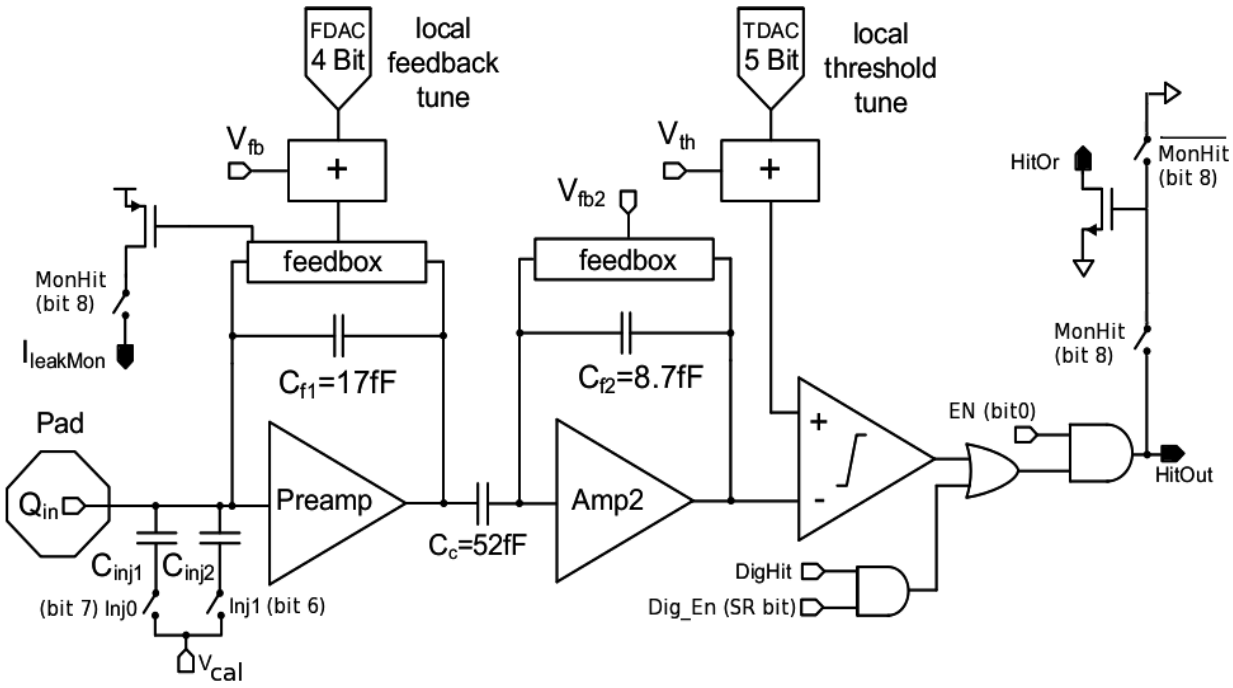


FE-sensor assembly

Lab measurements

FE analogue cell

- Using on-chip charge injection mechanism
- Diagnostics via hit counting and ToT measurement

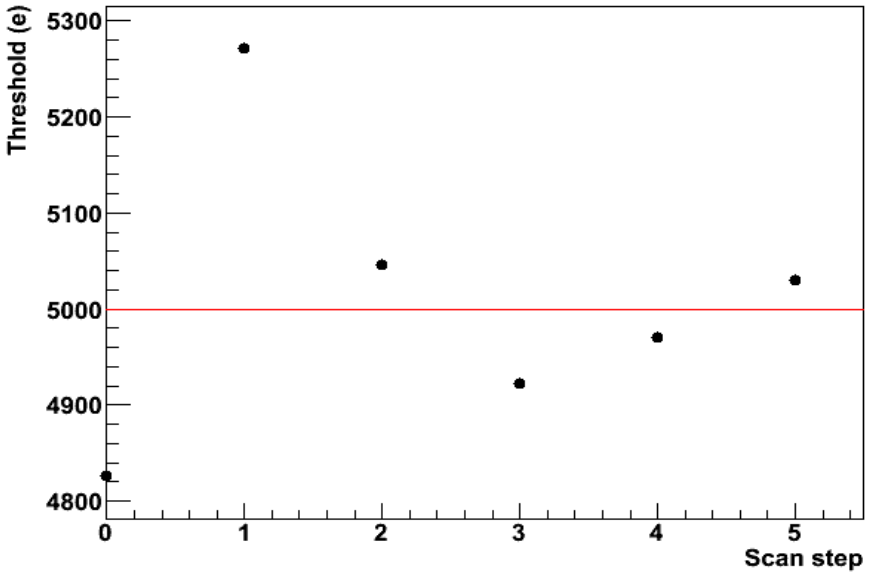


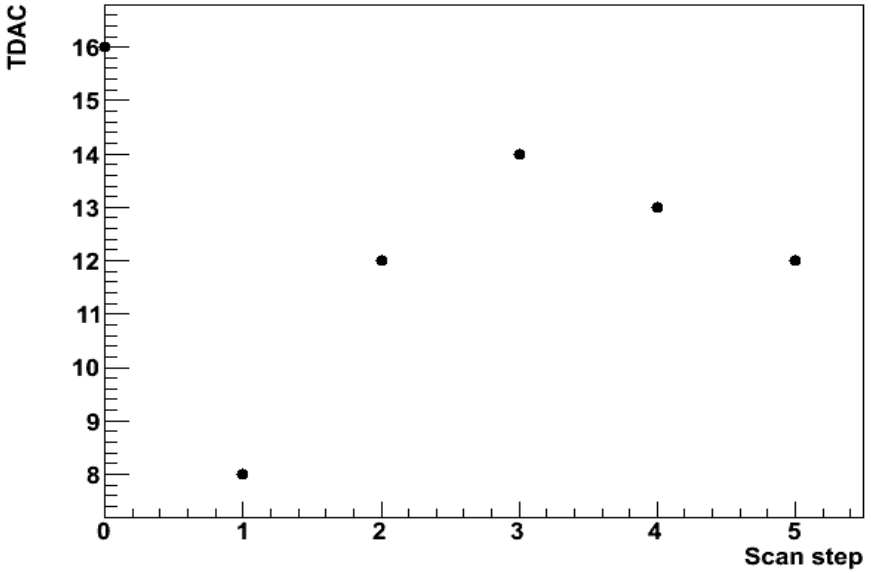
- Used to measure threshold, tune threshold and feed-back current (→ ToT) pixel by pixel
- Use a mask to inject into every 6th pixel to avoid cross talk

Thresh. tuning mechanism

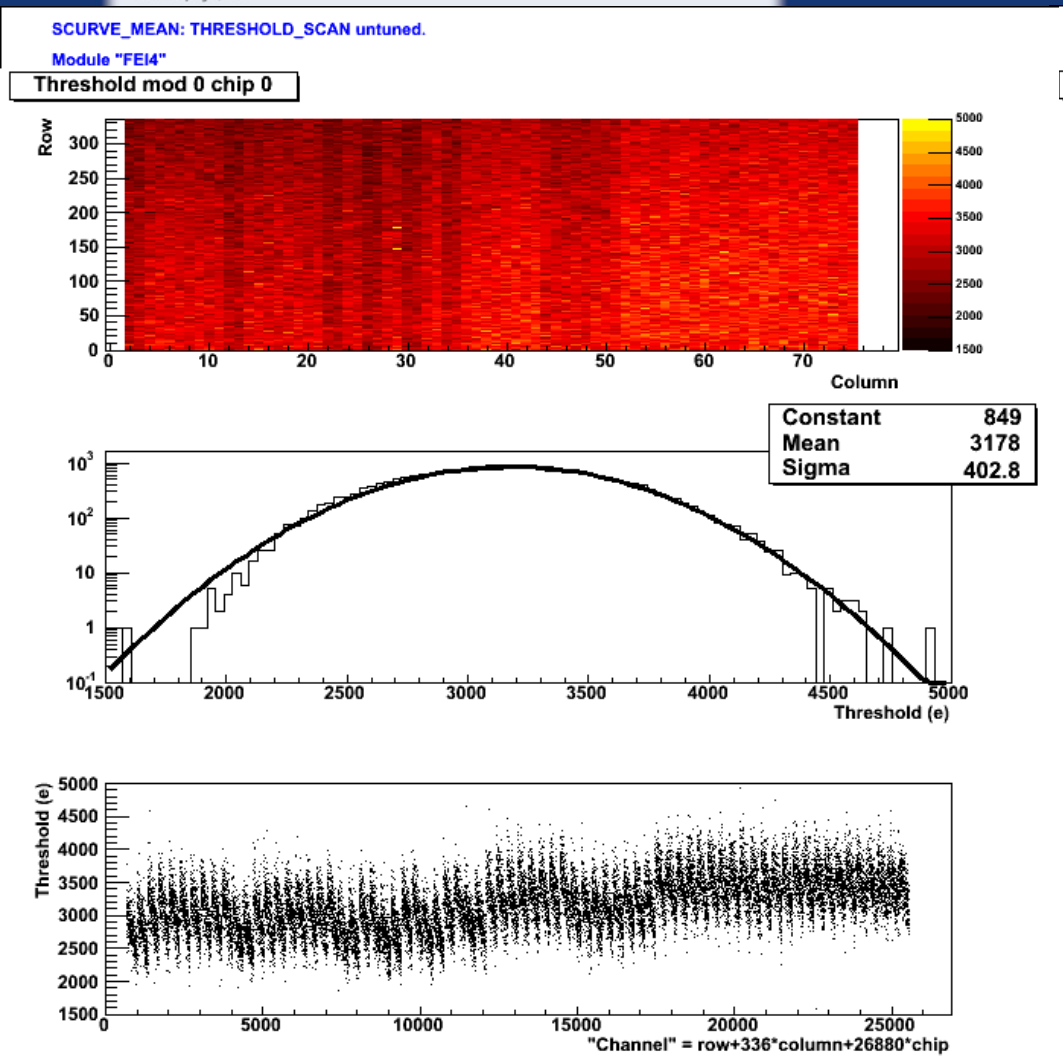
Threshold tuning procedure:

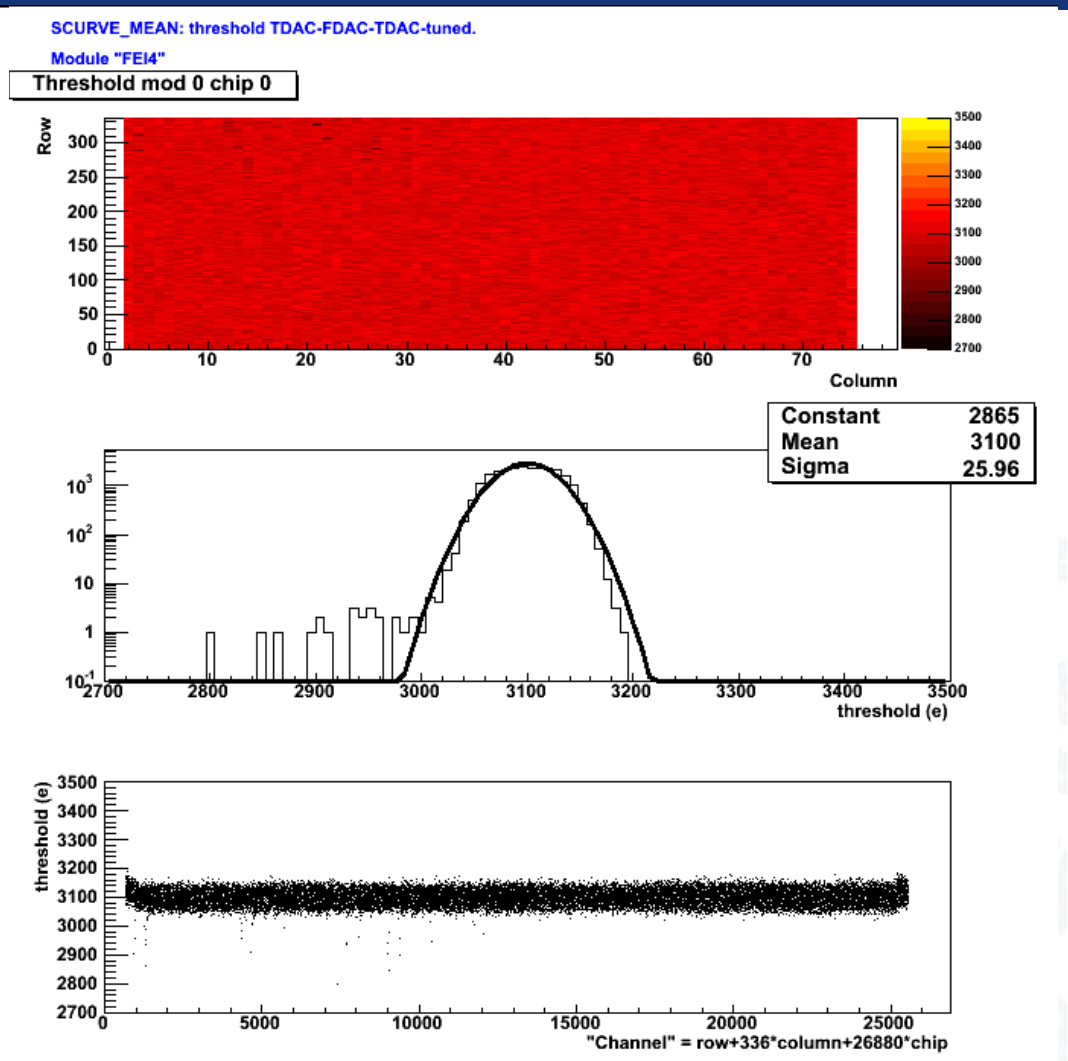
- Start with central TDAC value, measure threshold
- If threshold above/below target, add/subtract 8 (4,2,...) from TDAC
- TDAC with threshold closest to target is chosen





Threshold scan and tuning





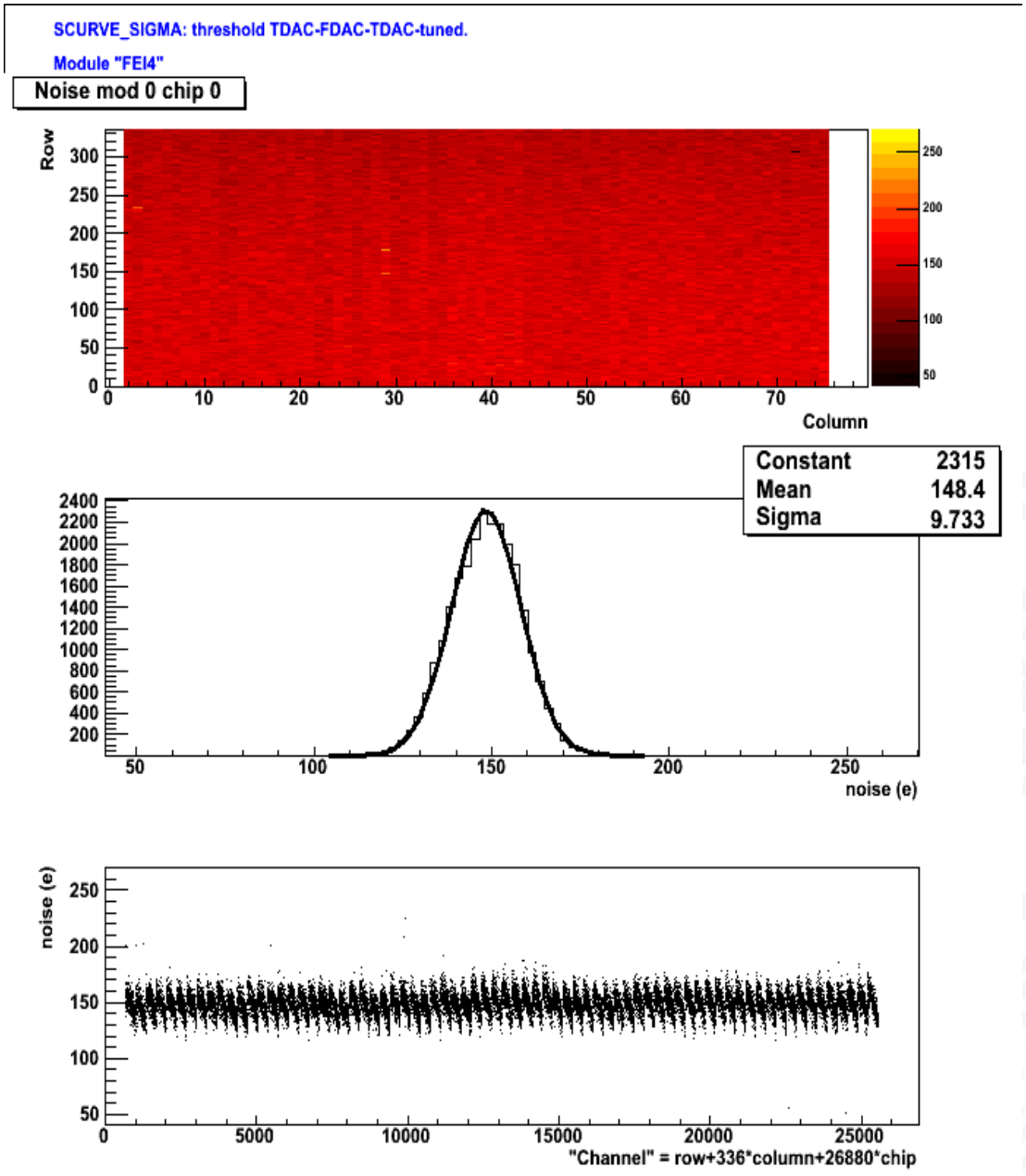
before

after

tuning

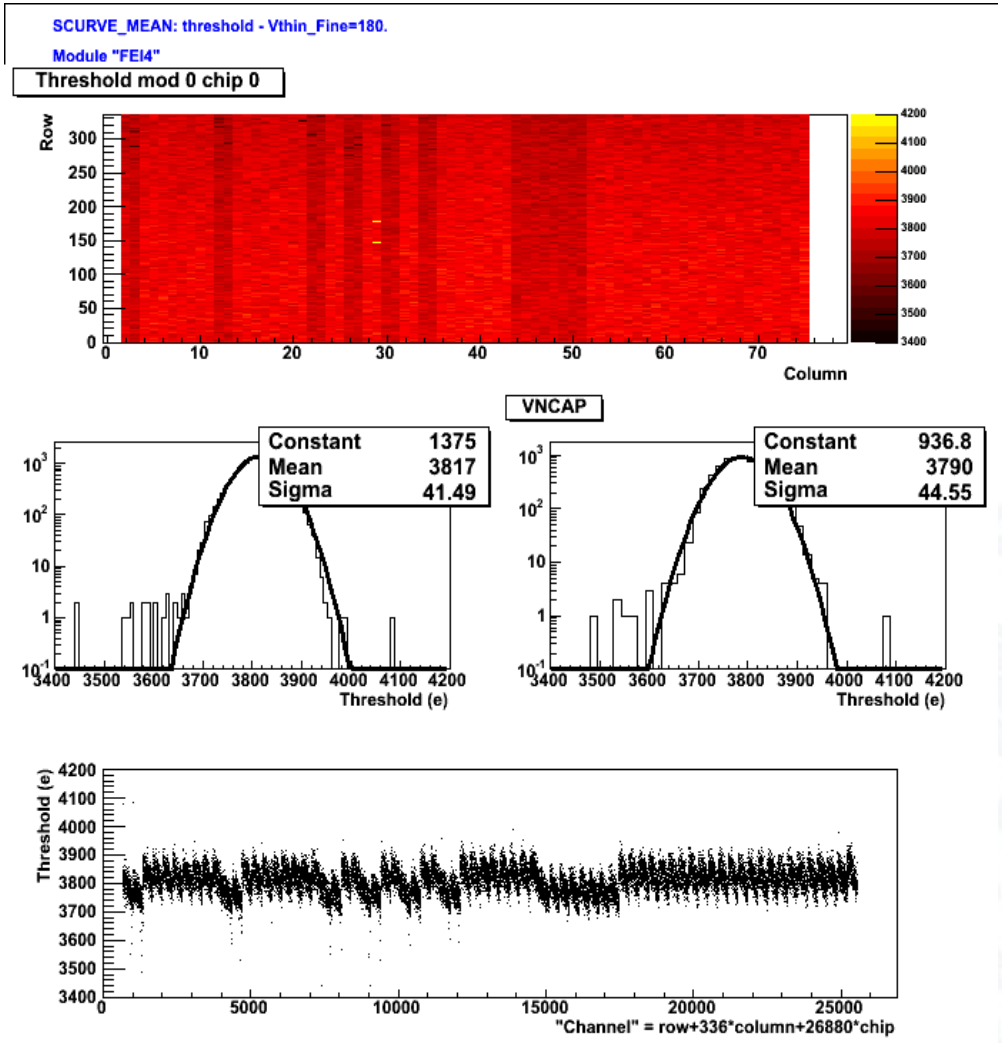
Threshold tuning: noise

- Threshold tuning: threshold dispersion from ~400e → few 10e
- Only very few outliers
- Noise after tuning: ~150e (prelim. Calibration!)
- Some variation with row-no. visible



Global threshold setting

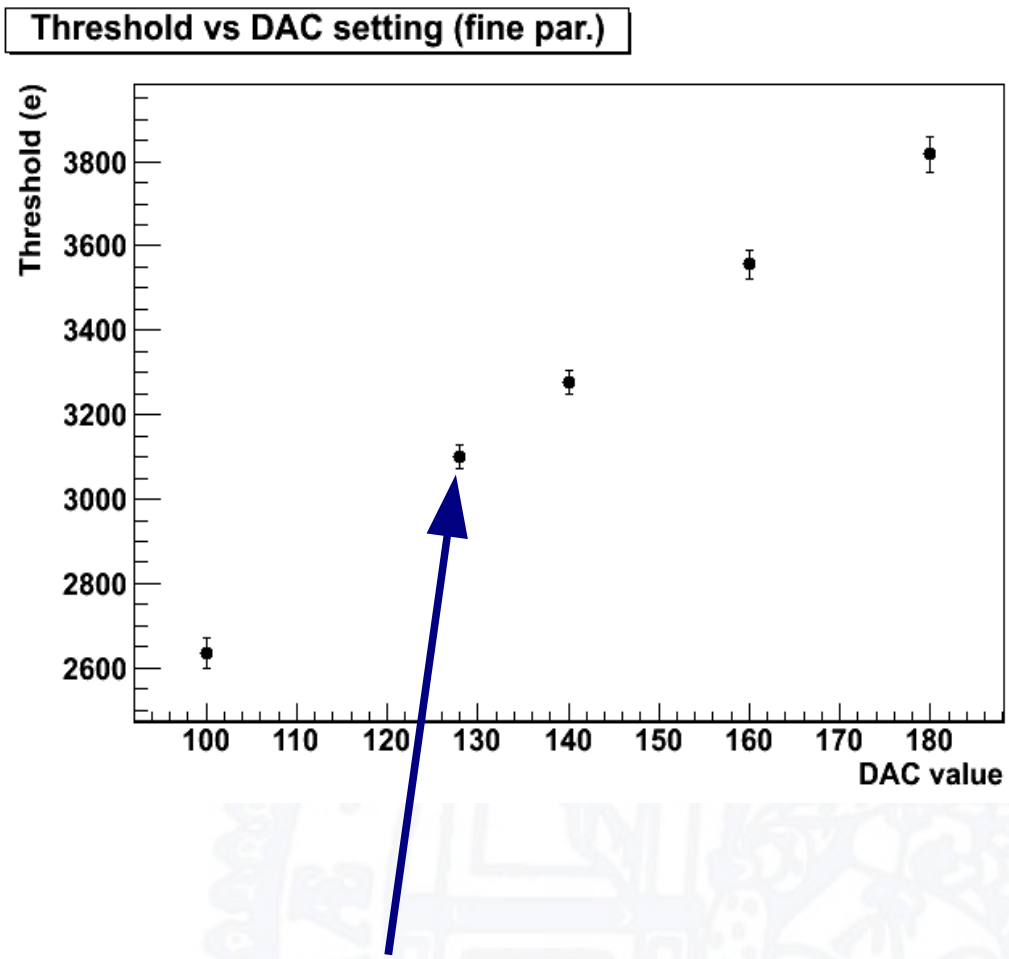
- 8bit coarse and 8bit fine parameter to set threshold globally on FE
- Largely preserves tuning done at different settings
- “Stripes” due to different amplification in analogue cells



Tuned to 3100e threshold

Global threshold setting

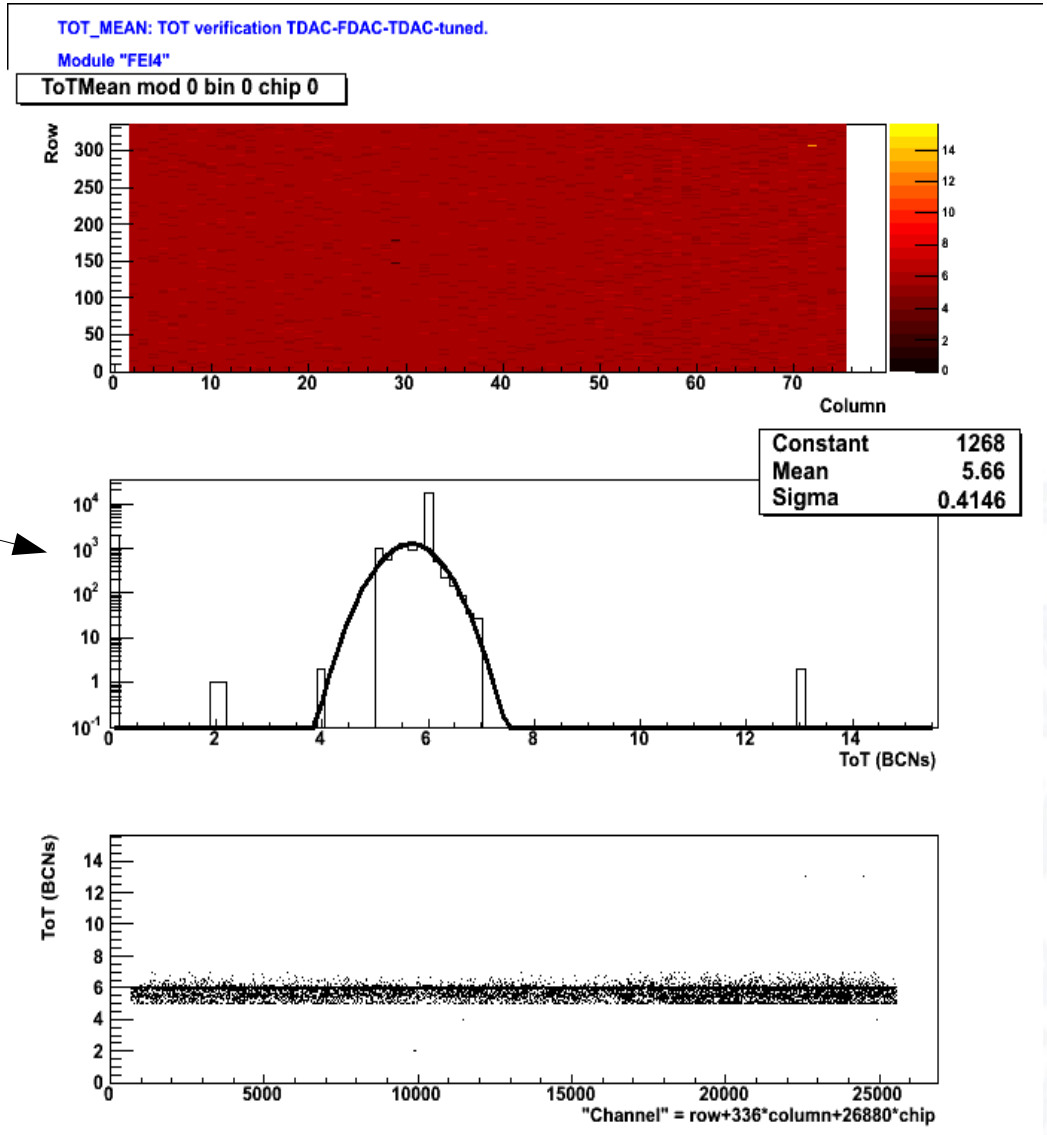
- 8bit coarse and 8bit fine parameter to set threshold globally on FE
- Largely preserves tuning done at different settings
- “Stripes” due to different amplification in analogue cells

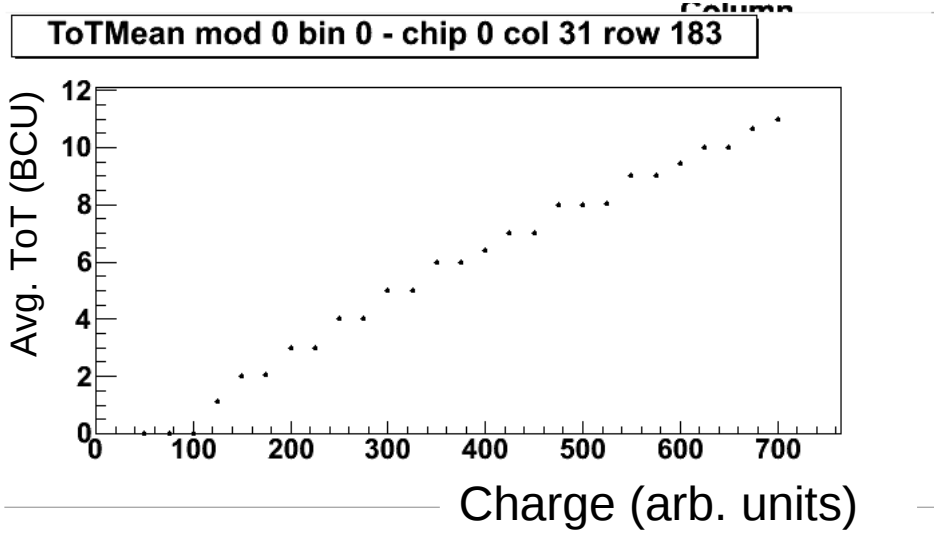


Tuned to 3100e threshold
Error bars: dispersion

Charge measurement

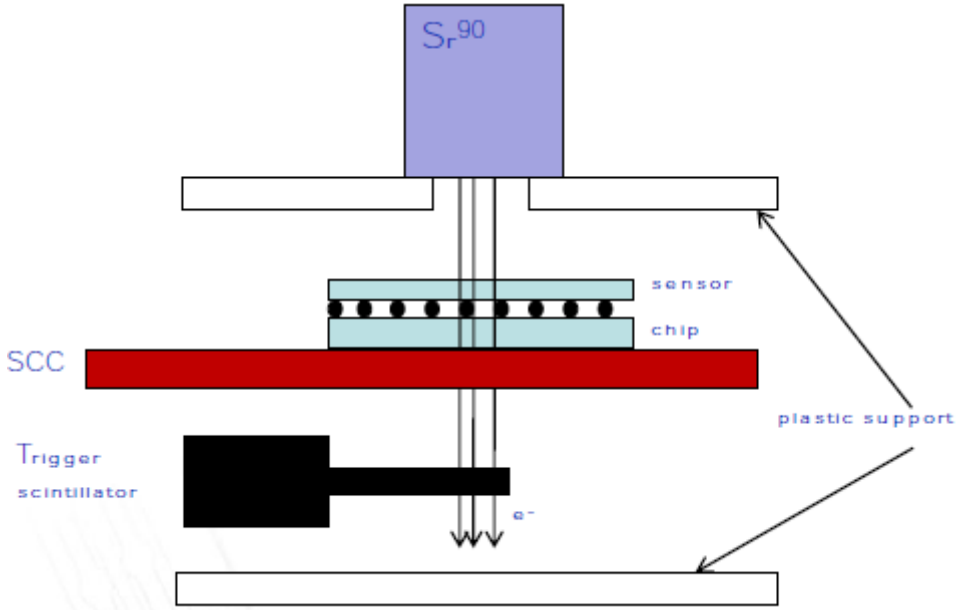
- Use ToT to measure charge of hit
  - Adjust feedback-current to desired charge target
  - Only coarse resultion available





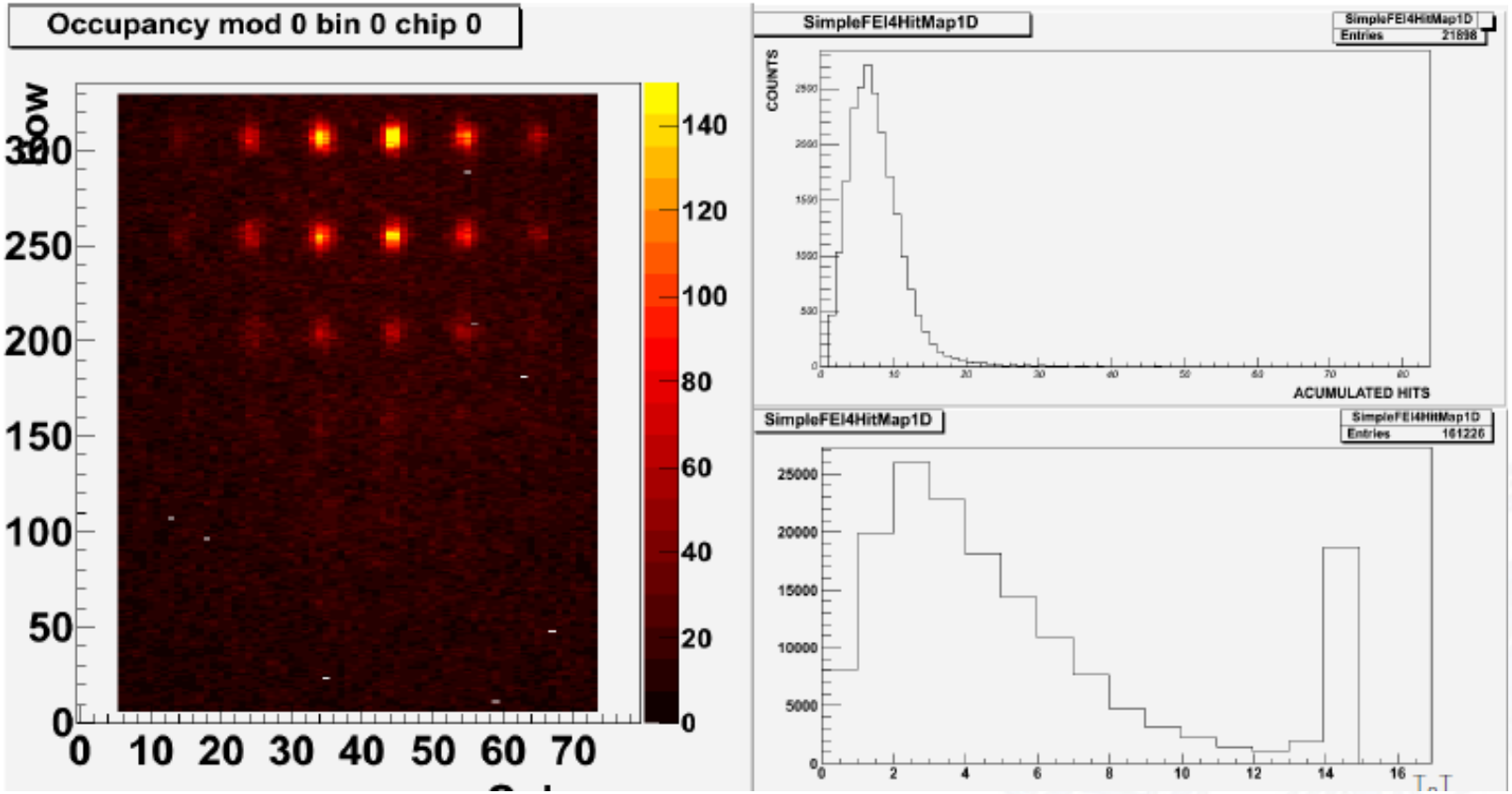
Source measurement (1)

- Use Sr90-β-source with scintillator trigger to collect real data
- Will mostly see hits at PCB holes, β's do not reach scint. otherwise



Backside of SCC

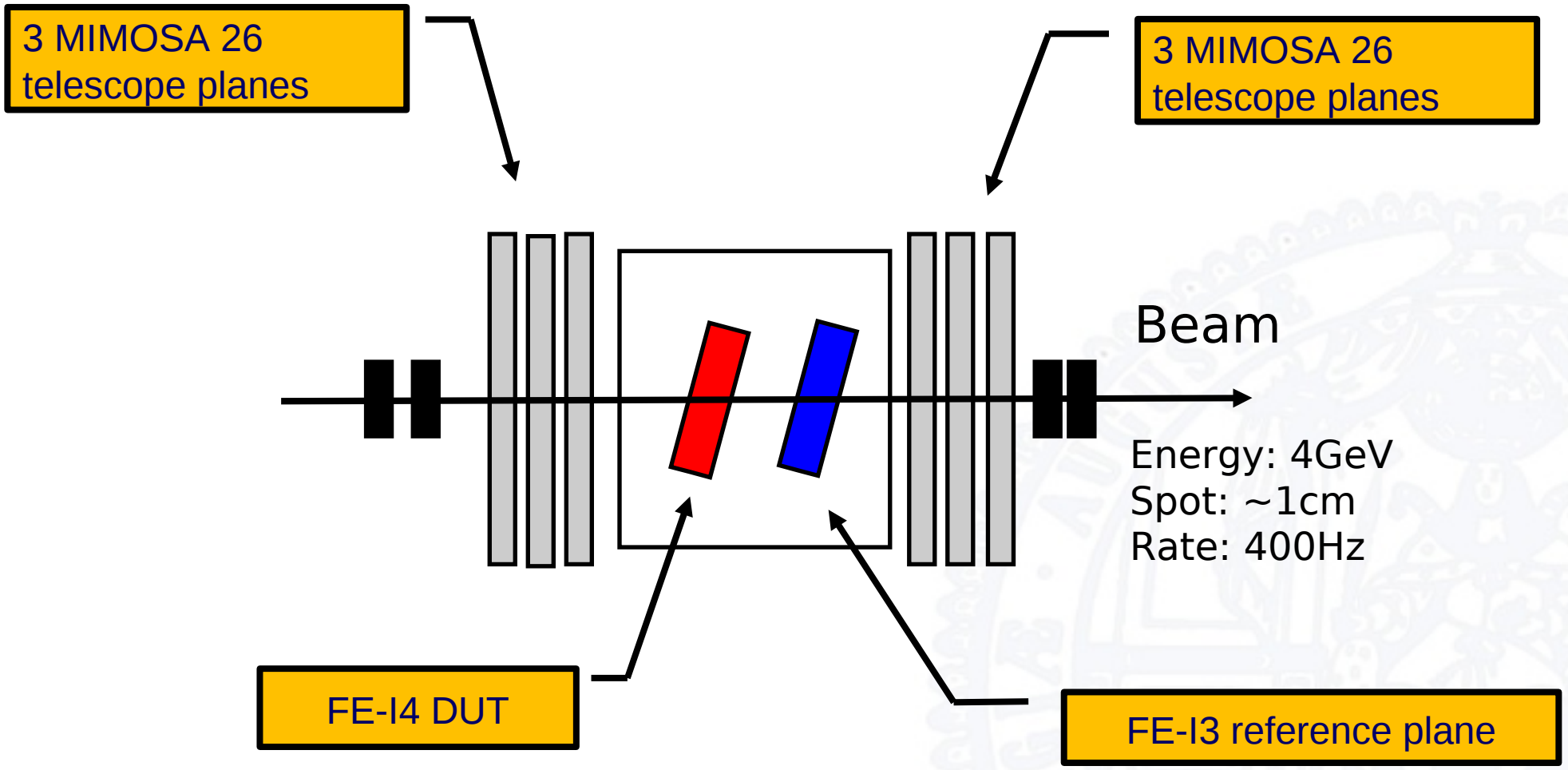
Source measurement (2)



- Landau spectrum visible
- Special ToT codes:
  - 13: ToT was 14 or 15 BCU
  - 14: ToT was >15 BCU

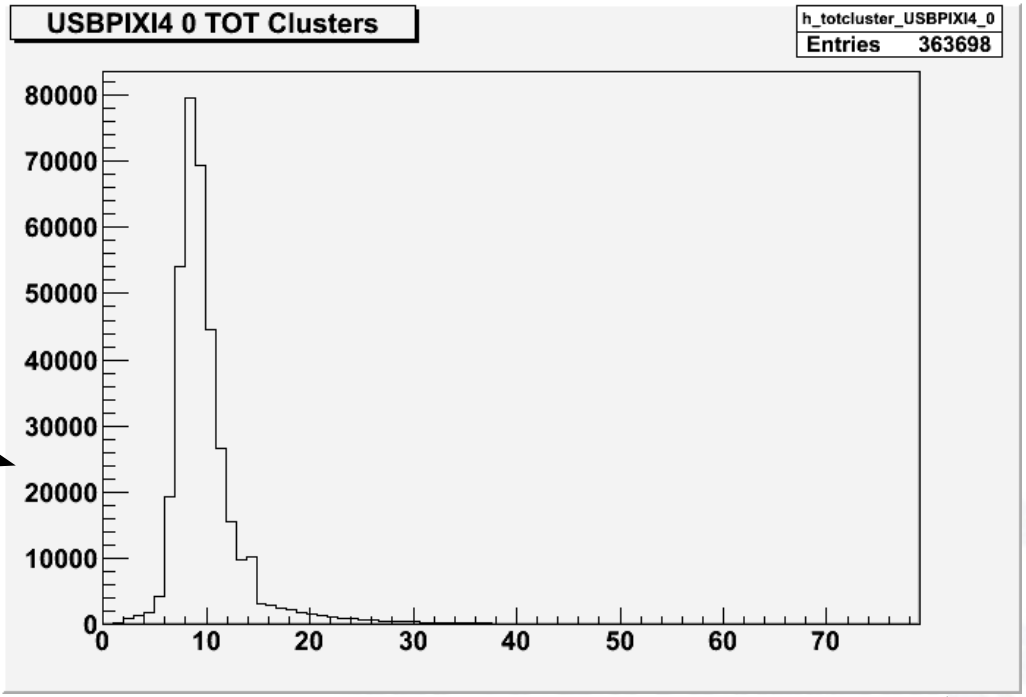
Test beam measurements (1)

- First measurements in DESY 4GeV-e test beam in Feb.

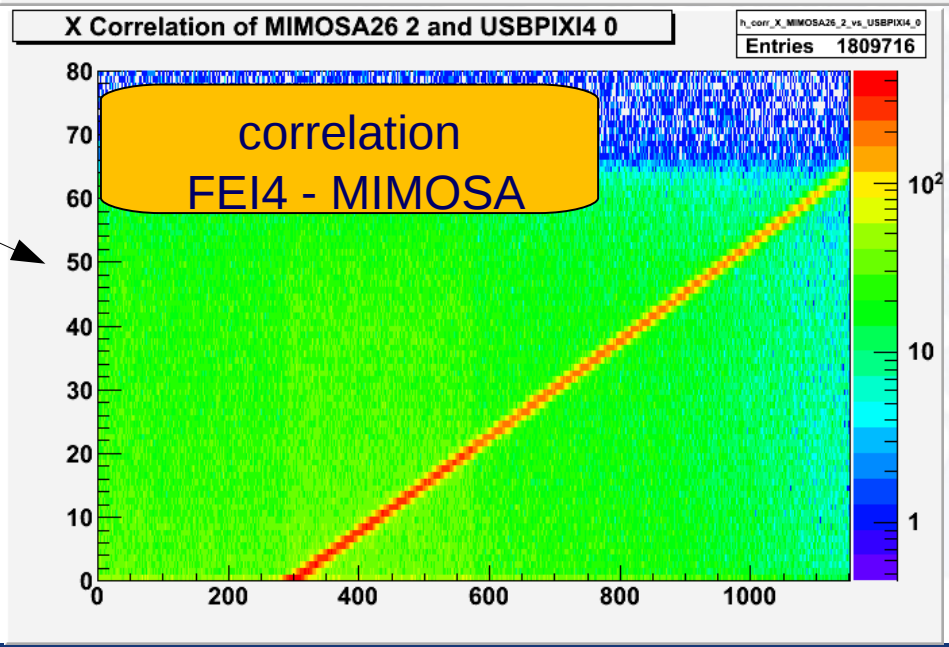


Test beam measurements (2)

- First results look very promising:
  - Charge of clusters in ToT as expected



  - Clear correlation between telescope and FE-I4-module position – prelim. residuals look OK

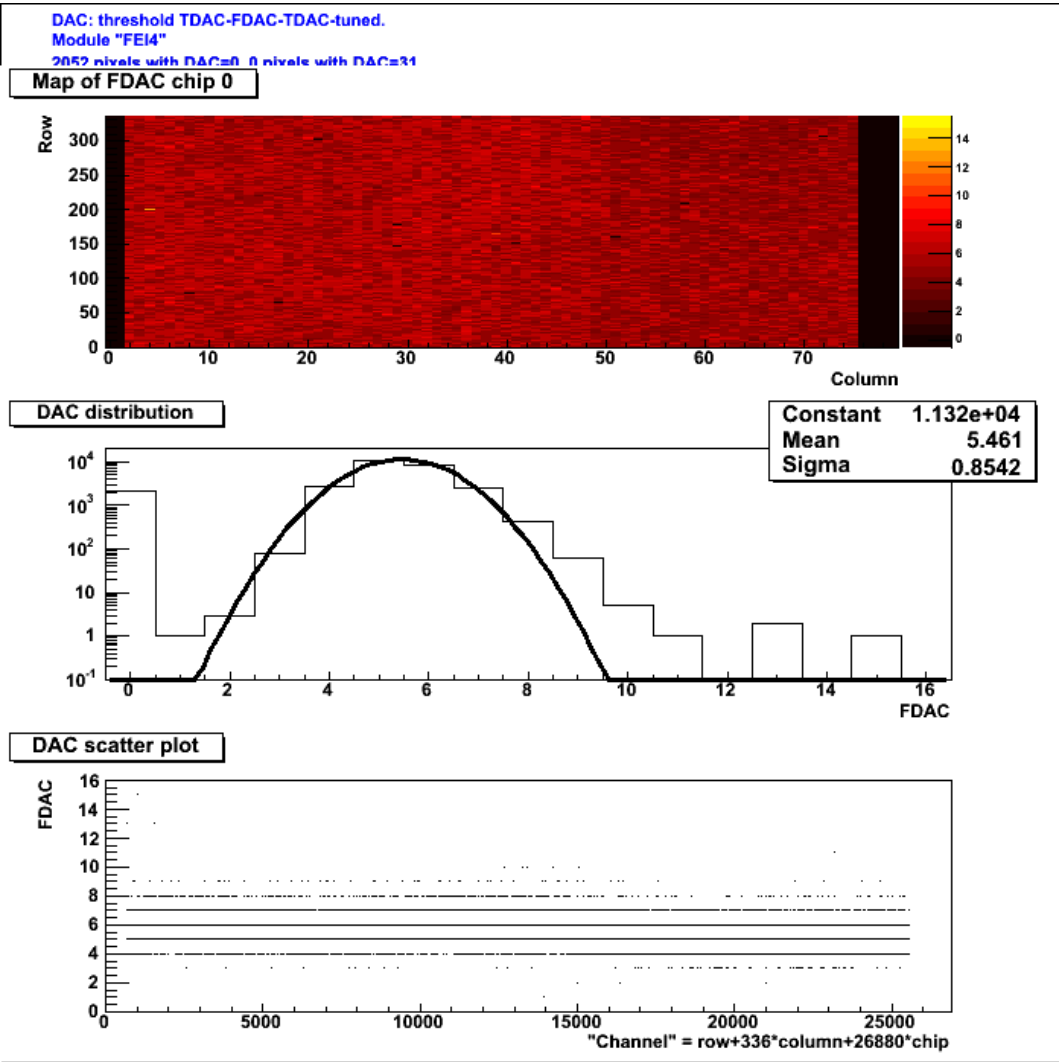


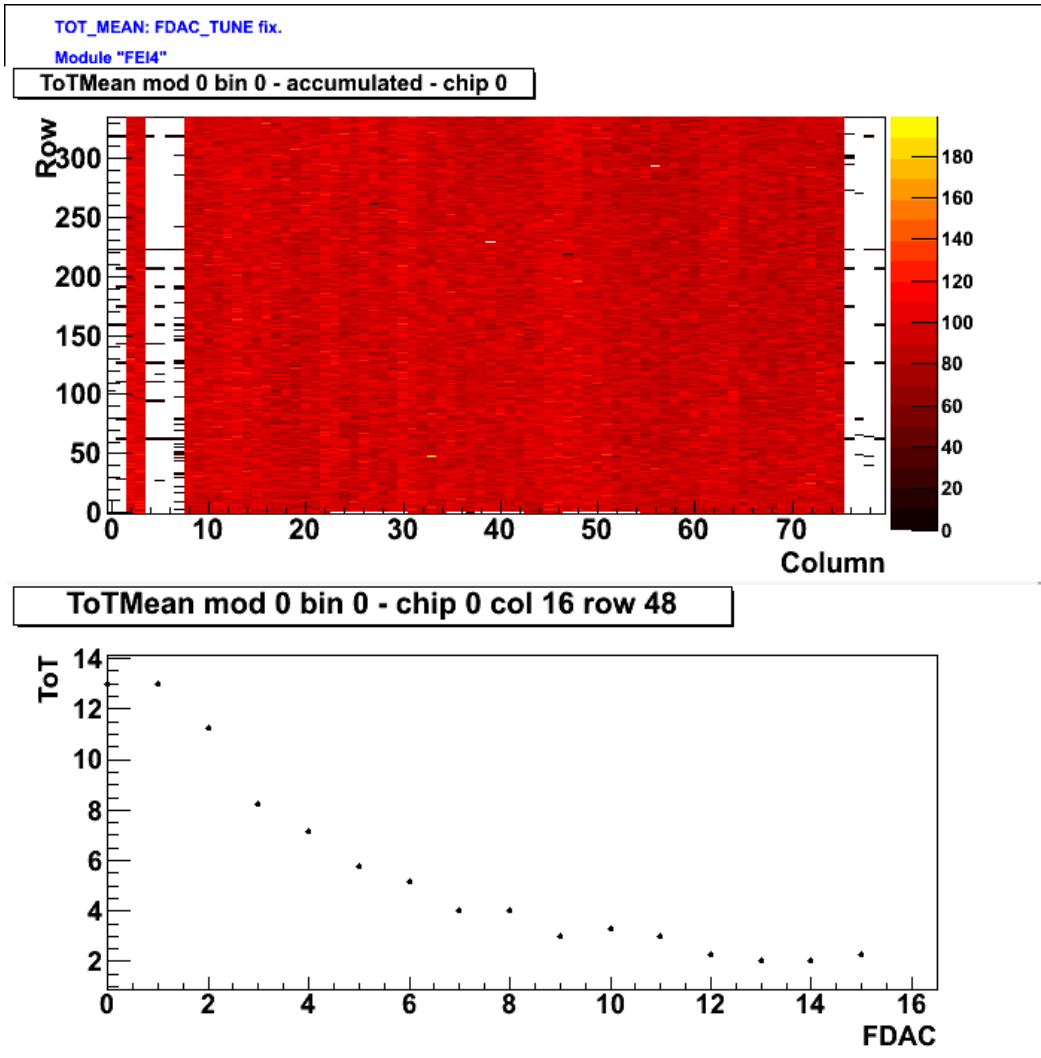
Summary

- First measurements with FE-I4 modules look very promising:
  - Data taking (test beam, sources) works
  - FE parameters act essentially as expected, tuning works
- So far only looked at most important functionality, still many things to be checked/measured
- Irradiation tests to start soon, more test beam measurements to follow

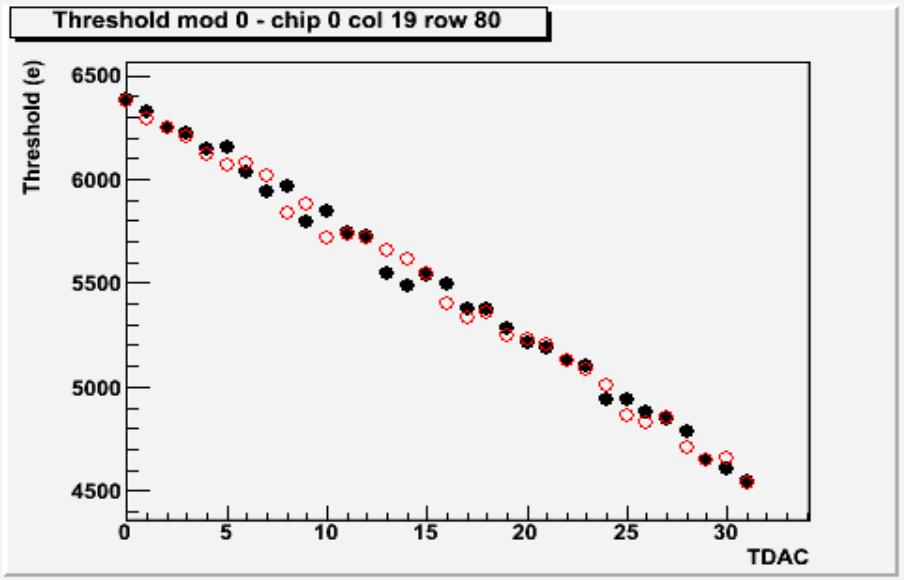
Backup

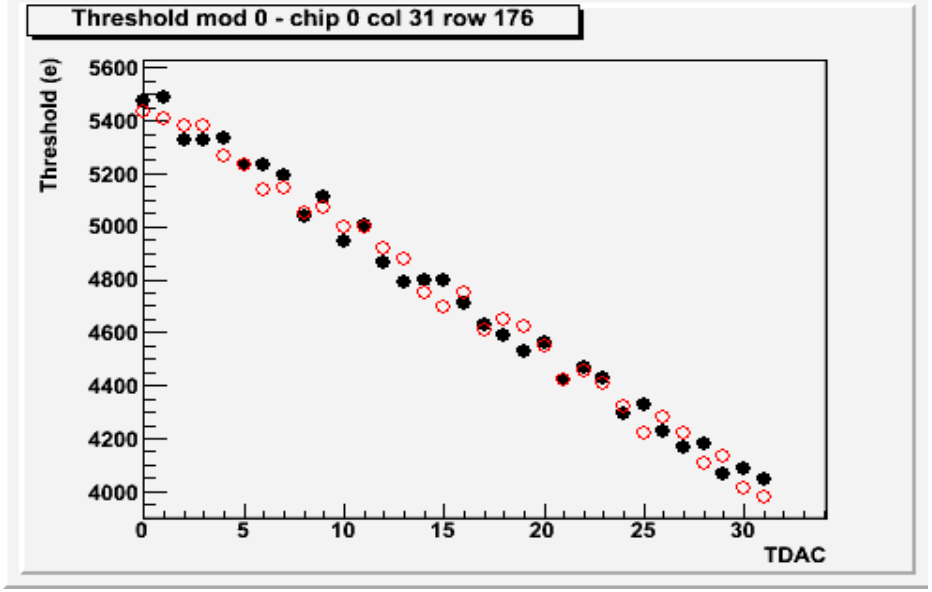
FDAC tuning

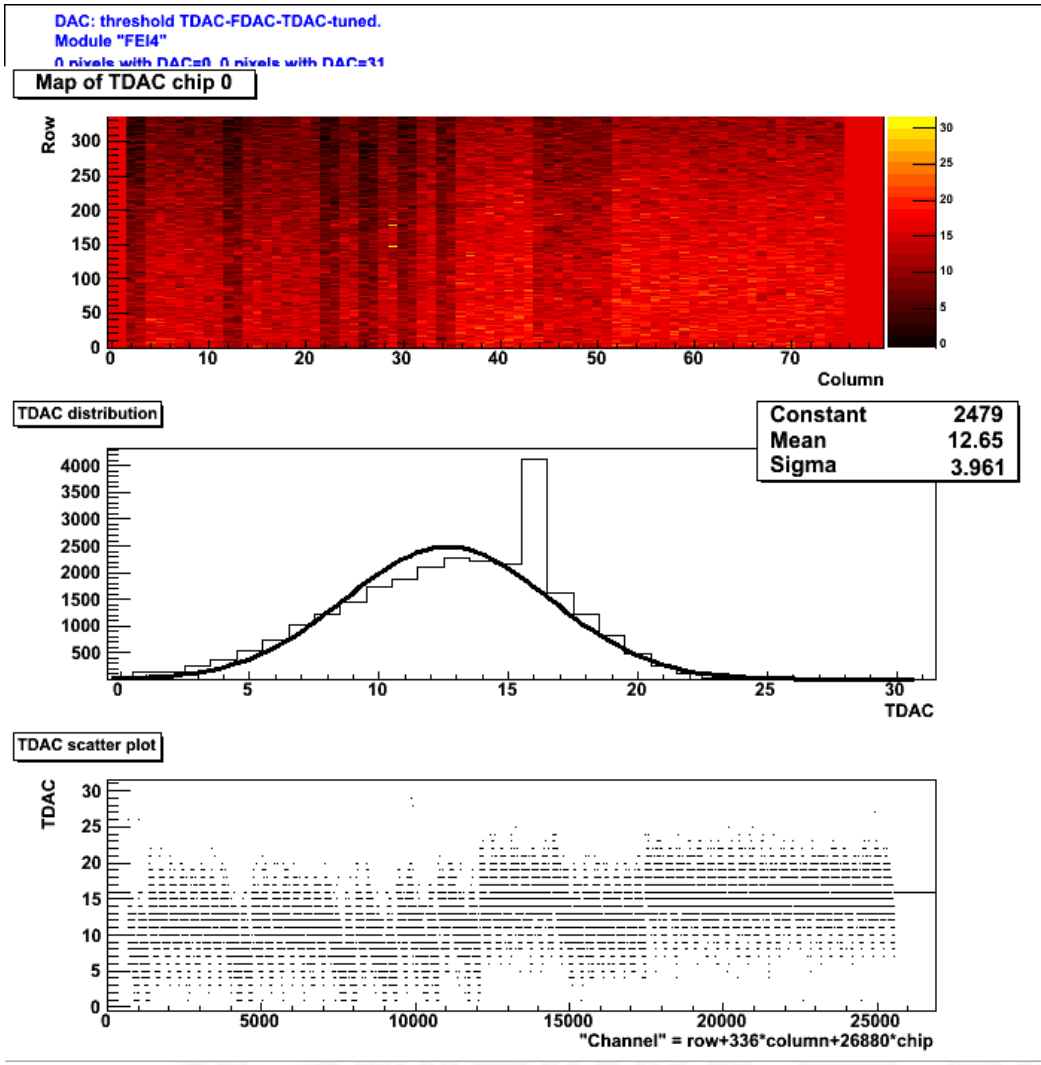
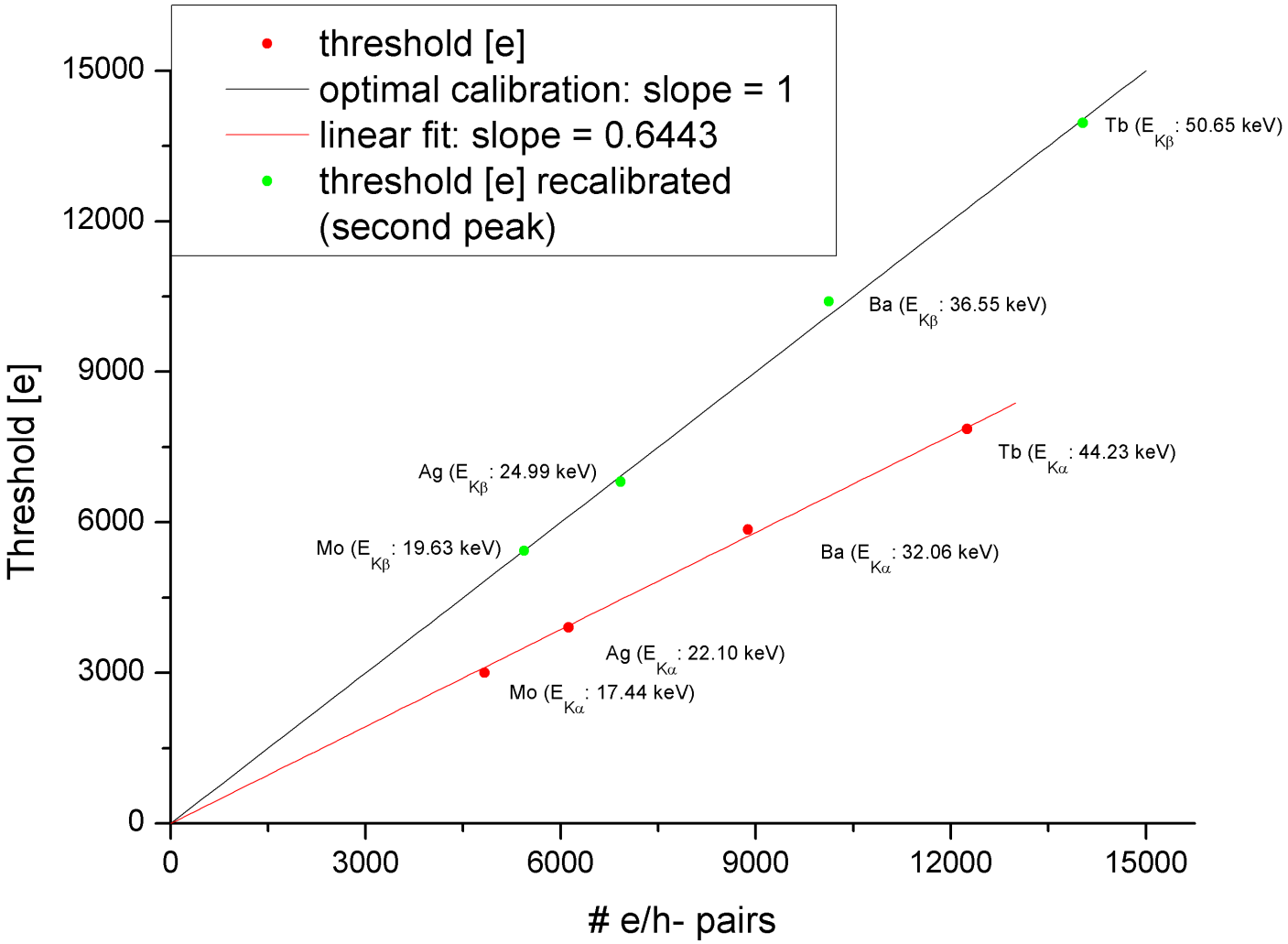

DAC: threshold TDAC-FDAC-TDAC-tuned.
Module "FEI4"
Map of FDAC chip 0
Row
Column
DAC distribution
Constant 1.132e+04
Mean 5.461
Sigma 0.8542
FDAC
DAC scatter plot
FDAC
"Channel" = row+336*column+26880*chip


TOT_MEAN: FDAC_TUNE fix.
Module "FEI4"
ToTMean mod 0 bin 0 - accumulated - chip 0
Row
Column
ToTMean mod 0 bin 0 - chip 0 col 16 row 48
ToT
FDAC

TDAC tuning


Threshold mod 0 - chip 0 col 19 row 80
Threshold (e)
6500
6000
5500
5000
4500
0
5
10
15
20
25
30
TDAC


Threshold mod 0 - chip 0 col 31 row 176
Threshold (e)
5600
5400
5200
5000
4800
4600
4400
4200
4000
0
5
10
15
20
25
30
TDAC


DAC: threshold TDAC-FDAC-TDAC-tuned.
Module "FEI4"
Map of TDAC chip 0
Row
Column
TDAC distribution
Constant 2479
Mean 12.65
Sigma 3.961
TDAC
TDAC scatter plot
TDAC
"Channel" = row+336*column+26880*chip

Calibration of charge injection