# The DEPFET prototype for the ILC: test beam measurements

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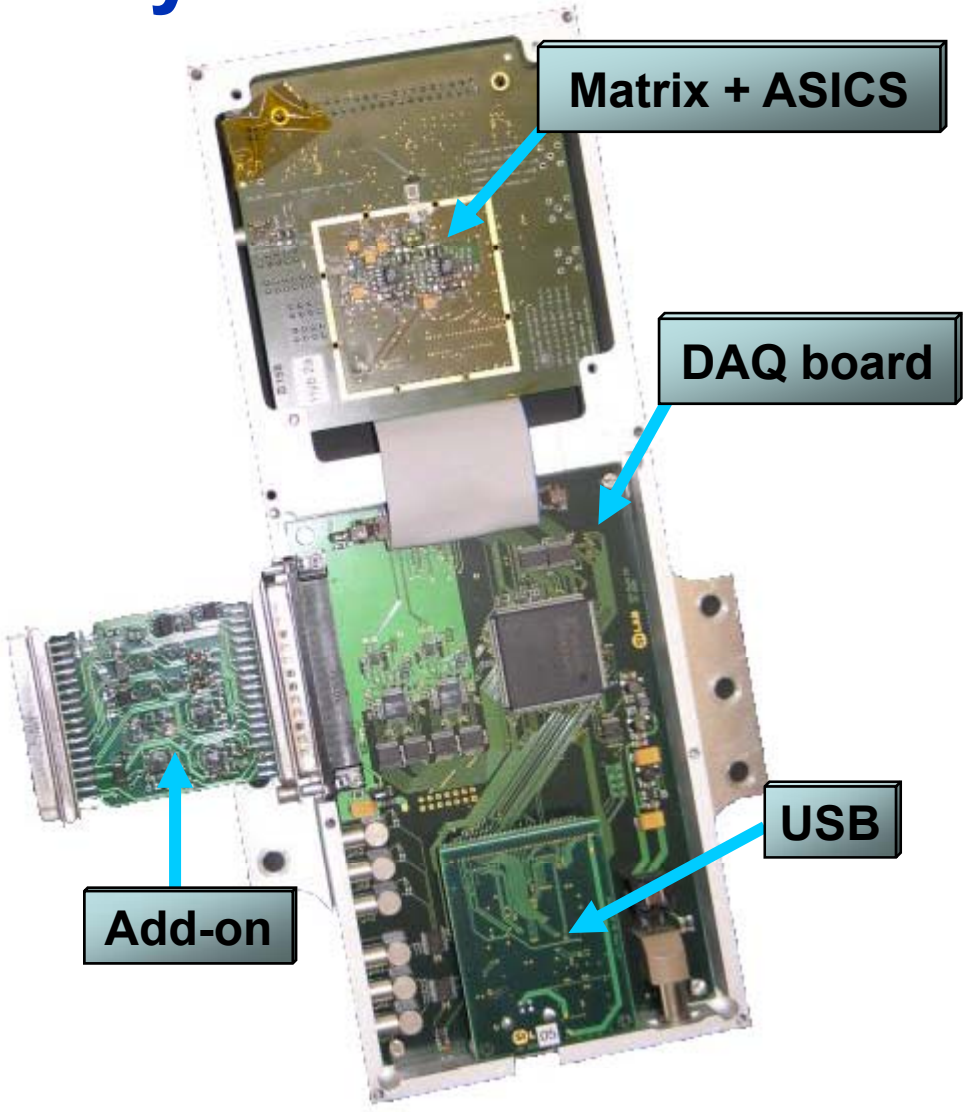
# Content

- DEPFET prototype system
- Test beam setup & DAQ
- Measurement program
- EUDET analysis software
- Preliminary results
- Issues & Summary

**All results are preliminary**

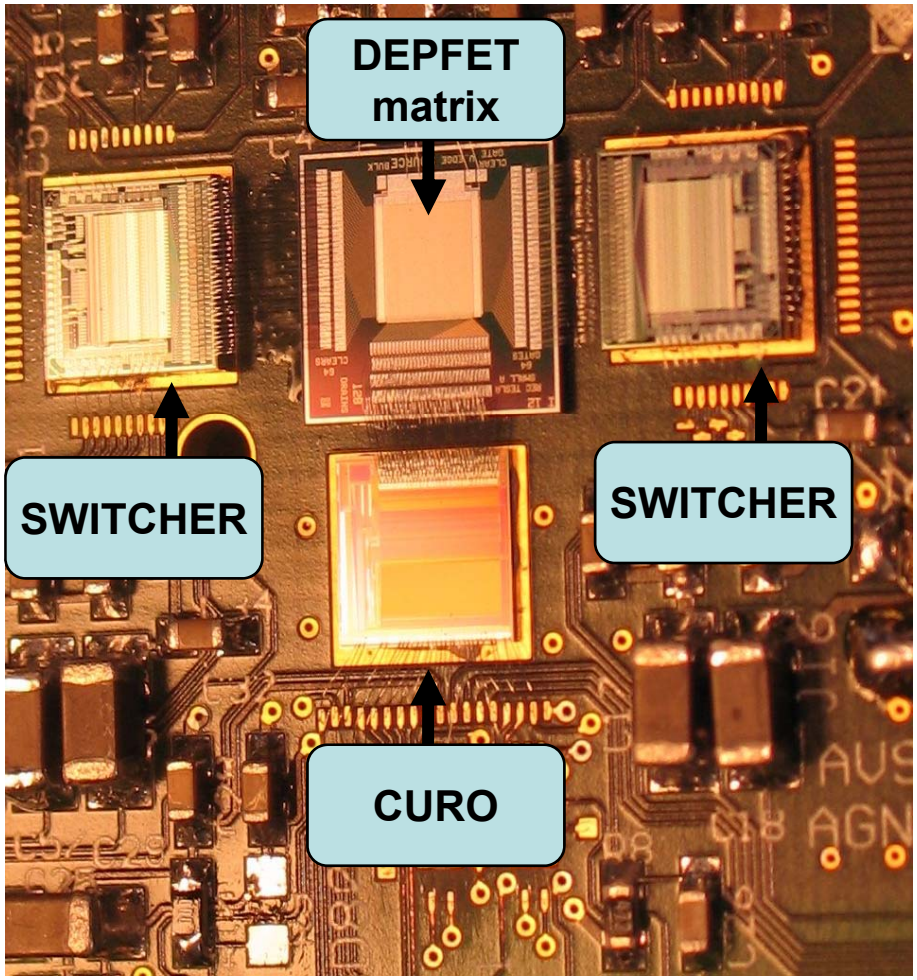
# The DEPFET prototype system for the ILC

- matrix board
  - 64x128 pixel DEPFET matrix
  - 2x SWITCHER steering ASICs
  - 1x CURO read out ASIC
- Read out board:
  - XILINX S3A FPGA
  - 128k RAM (16 frames)
  - 2x 16 bit ADCs
  - USB read out
- Voltage control add-on board
  - Over voltage protection
  - Linear regulator (voltage supply)



# The ASICS & DEFET Matrix

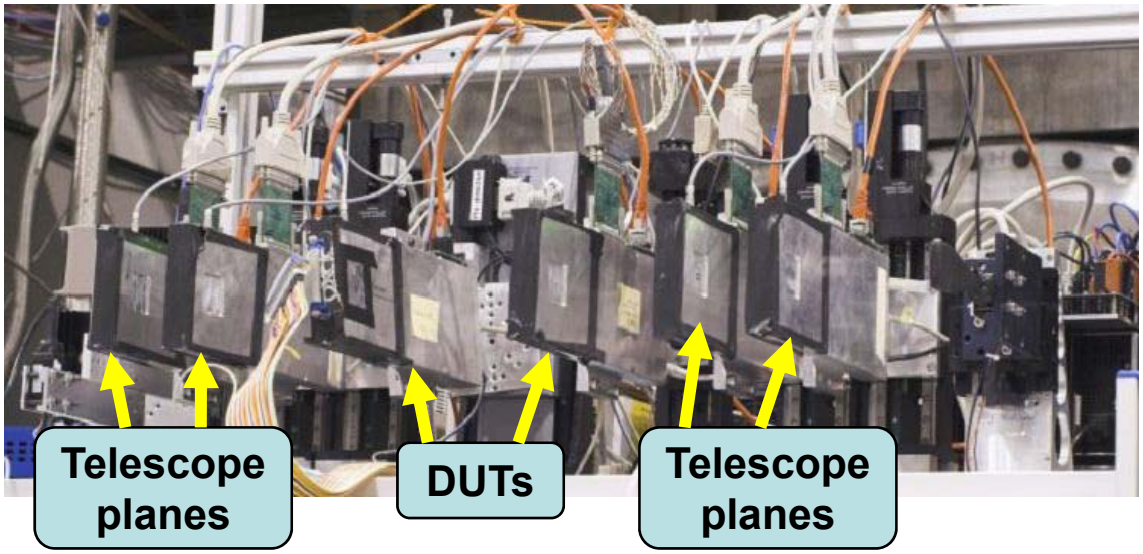
- Several DEPFET pixel types with different geometries
- Switch: steering ASICS
  - Switches up to 24 V
  - Gate Switcher
  - Clear Switcher
- CURO: read out ASIC
  - Current read out
  - Pedestal correction
- New ASIC generation
  - Produced and under test
  - Read out: current ADC
  - Switching: rad. hard tech.



# Test Beam Setup

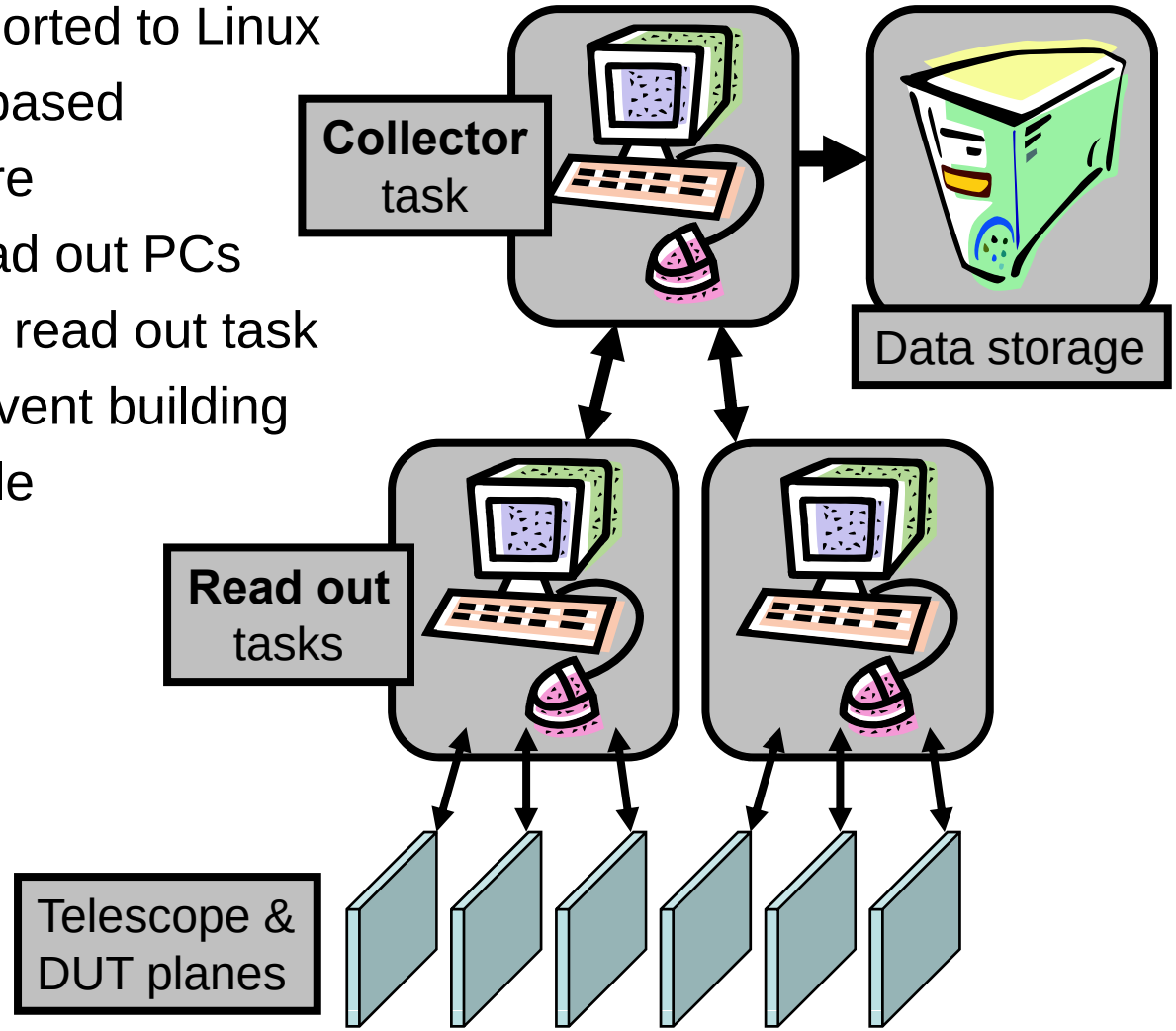
- 4 DEPFET telescope planes
  - 24 x 33 µm² sized standard type common clear gate pixel
- DEPFET matrix size trigger
  - Higher track efficiency
- 6 X-Y motor stages for optimal alignment (track efficiency)

- 2 DEPFET DUT planes
  - 24 x 24 µm² sized standard type common clear gate pixel
  - 24 x24 µm² sized pixel with four quadrants ➔ new pixel types



# Test Beam telescope DAQ

- Windows based DAQ ported to Linux
- Server-client, network based
- Very flexible architecture
- Can include several read out PCs
- Each plane has its own read out task
- One collector task ➔ event building
- EUDET DAQ compatible



# Beam test operation and program

- 2 weeks@ PS: July 2008:
  - Checking: new DAQ, new mechanics etc…
  - Beam was divergent ➔ alignment not possible
- 4 weeks@ SPS: August 2008
  - Shared beam time with other silicon users (parasitic running)
  - Thanks to EUDET & MAPS
- Three weeks of successful data taking
  - almost 20 million events
  - 3.5 TB of data
  - Analysis takes a while

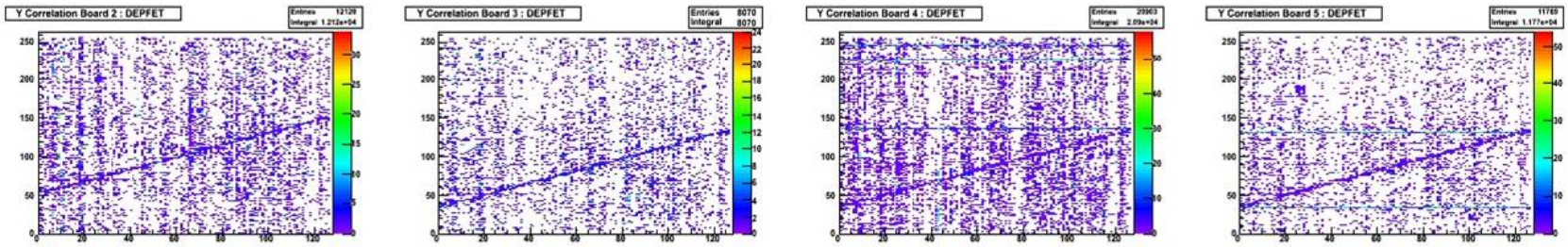
## Beam test program

- High statistics for in-pixel studies ➔ 12M events
- Angular scans
- Clear Parameter Scans
- Depletion voltage scan
- Energy scan
- Matrix edge voltage

| | |
|---|---|
| High Statistics | 11941 |
| Angular Scans | 4134 |
| CCCG scan | 1815 |
| Backplane scan | 909 |
| Rest | 389 |
| Energy Scan | 222 |
| V_Edge scan | 128 |

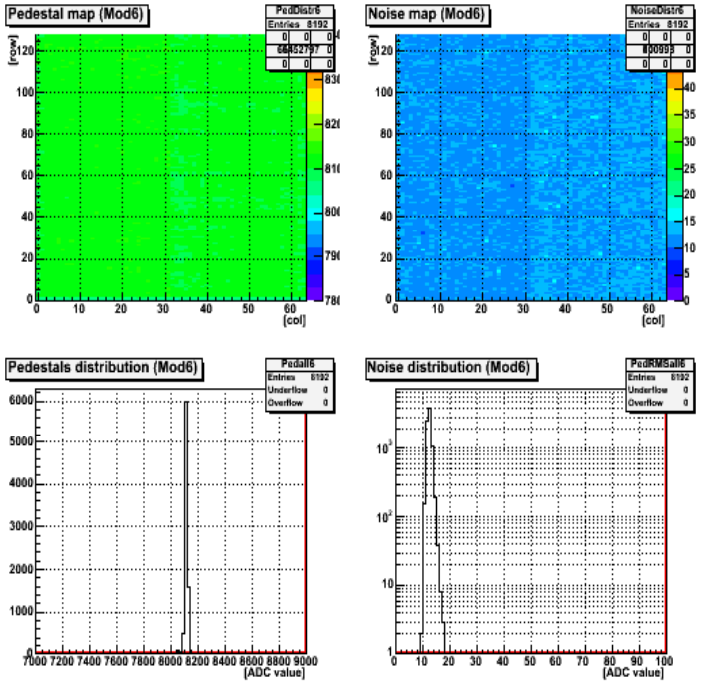
# EUDET project and analysis package

- EUDET is a EU sponsored project for detector development
- EUDET telescope and analysis package
- DEPFET is part of the EUDTE project as demonstrator DUT with complete DAQ integration
  - Successfully done in this CERN test beam period
- Moving from self made to EUDET analysis package
  - More momentum and support, longer lifetime
  - Detector (DEPFET) specific modifications necessary, e.g. Common

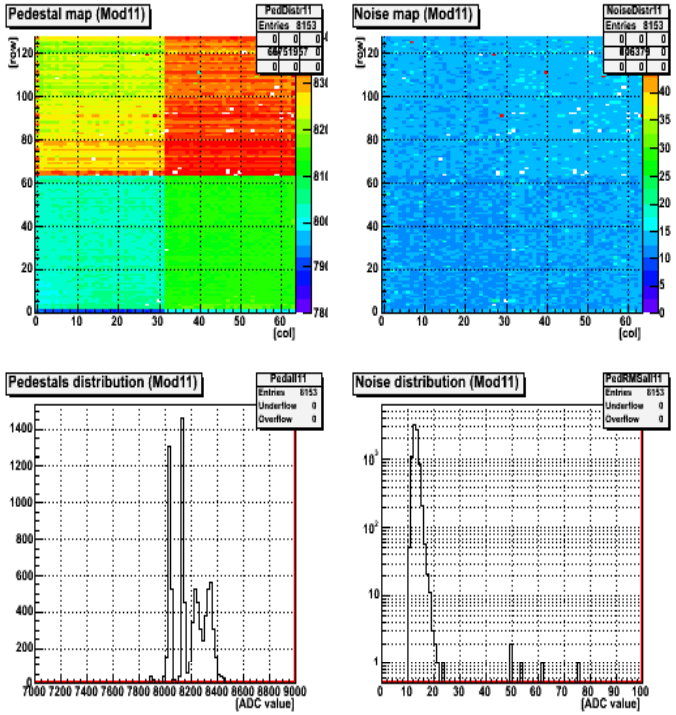


# Pedestals and Noise

- Telescope plane
  - Uniform pedestals
  - Uniform noise:
    ~13 ADUs ~ 330e-

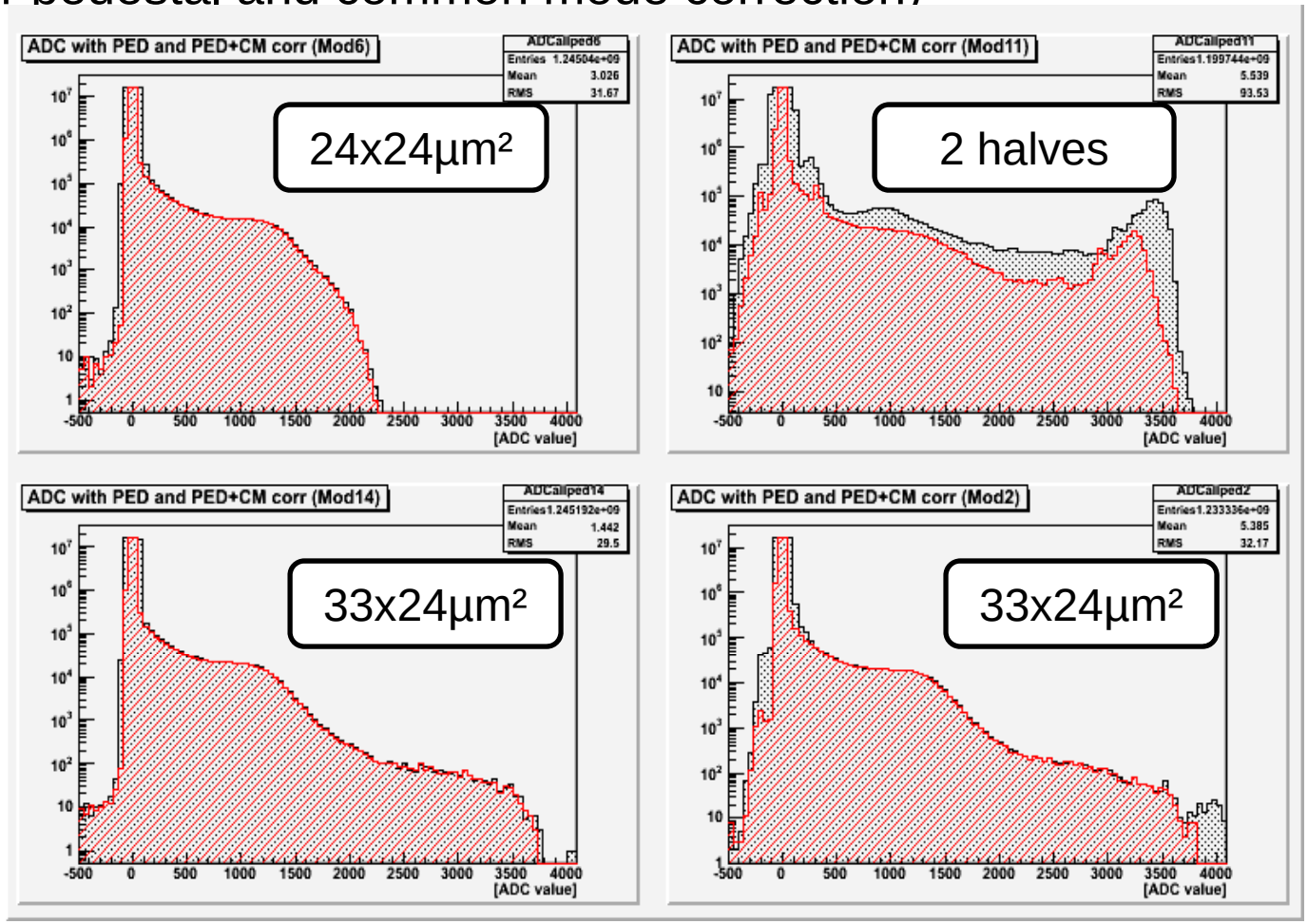



- DUT
  - Different pixel layouts
  - Pedestals different
  - Noise uniform



# Corrected pixel signals (no clustering)

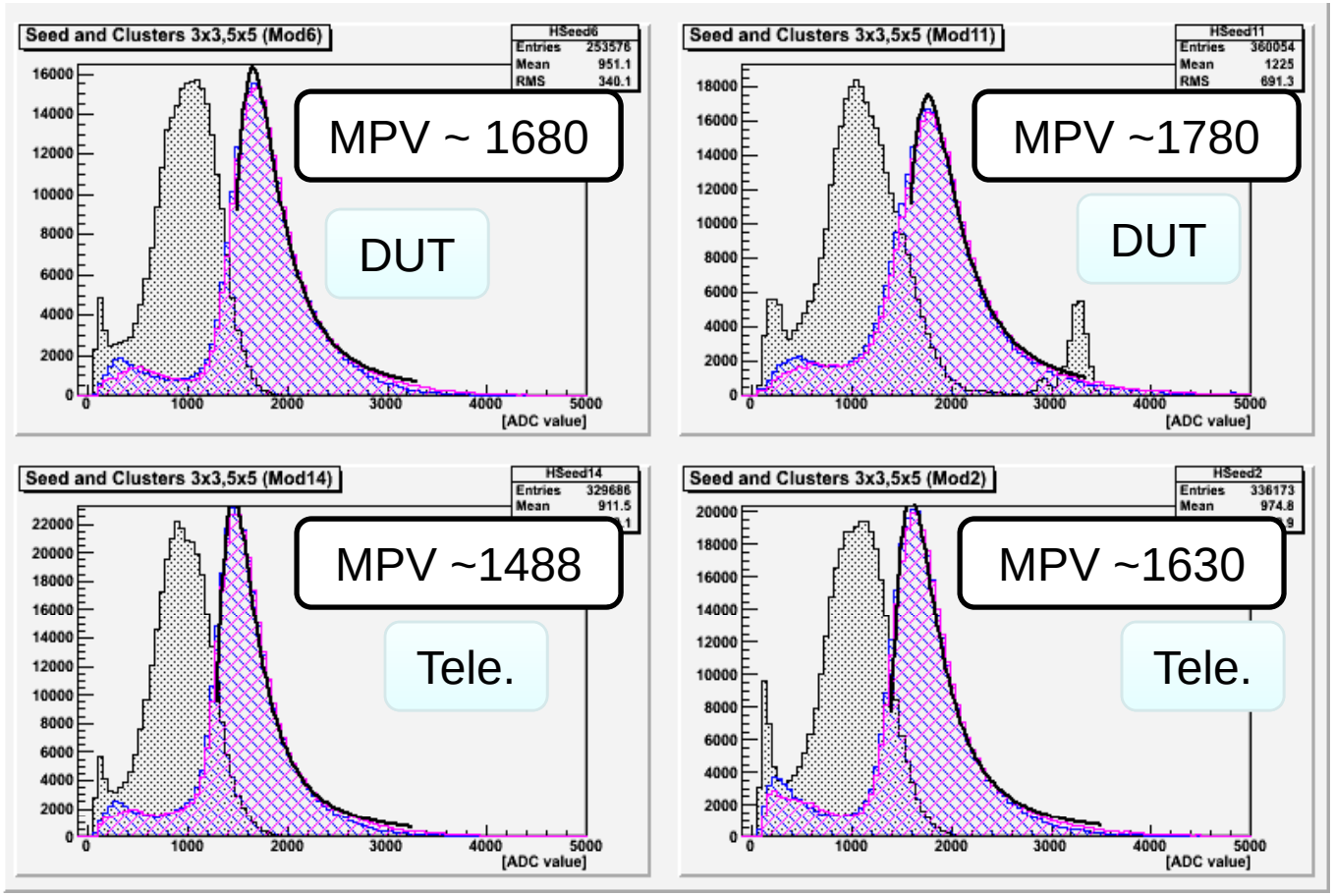
- Different pixel sizes ➔ Different charge collected per pixel
  (after pedestal and common mode correction)



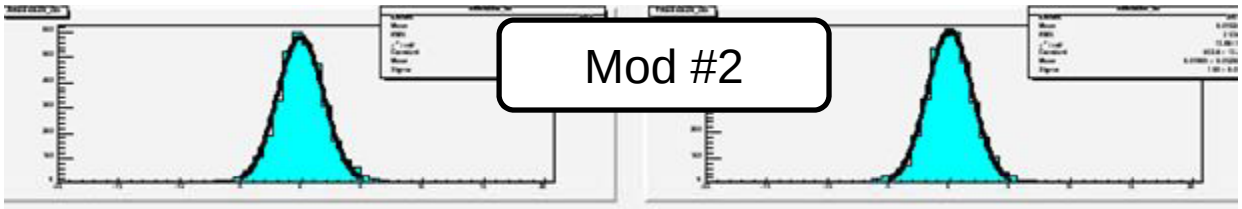
# Cluster Properties

- Cluster Signals looking good
- One telescope performing less well
  ➔ wrong operating voltages

- **S/N* ~ 100 - 150**
- * except one plane



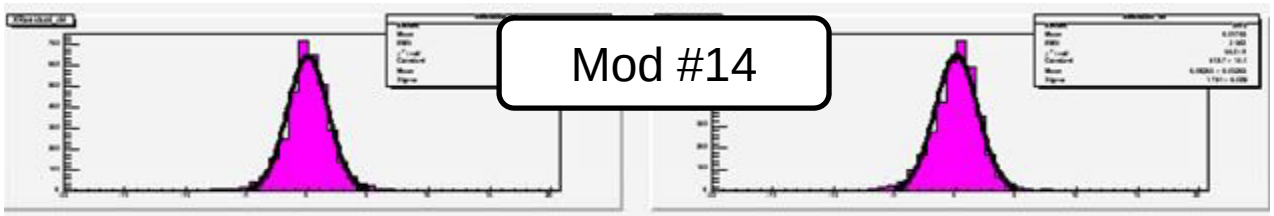
# Residuals Telescope Planes



Mod #2

X: ~1.91 µm

Y: ~1.86 µm

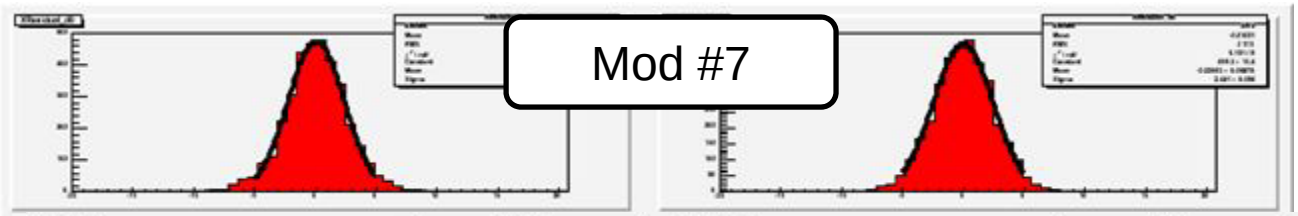


Mod #14

X: ~1.79 µm

Y: ~1.76 µm

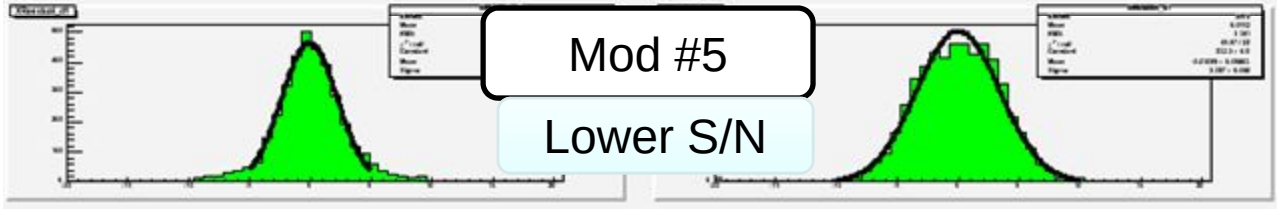
Dut Planes: Mod #6 & Mod #11



Mod #7

X: ~2.23 µm

Y: ~2.19 µm



Mod #5

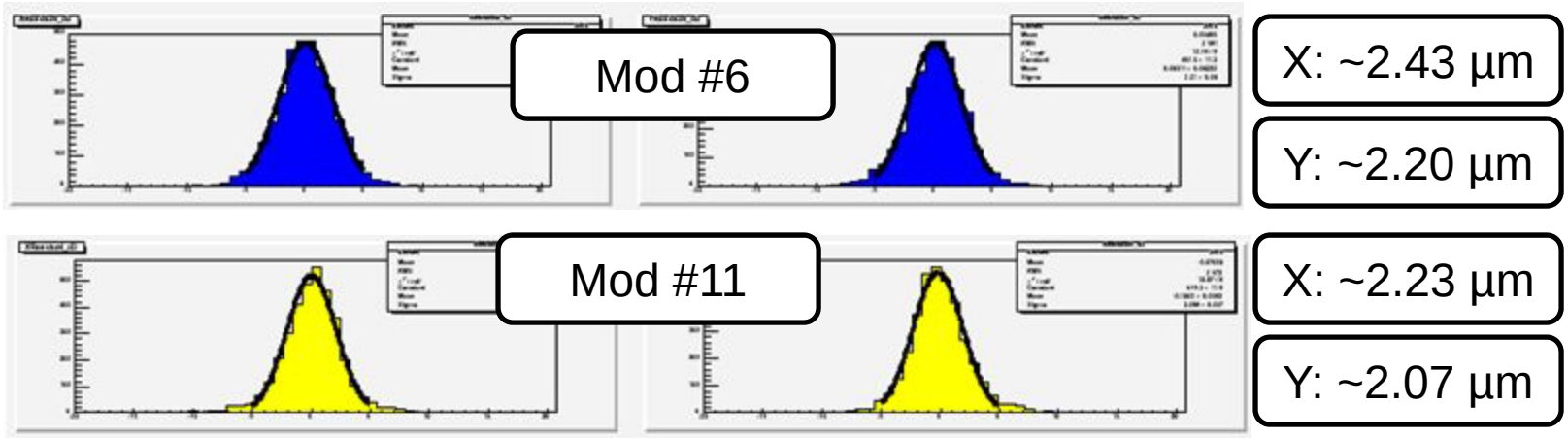
Lower S/N

X: ~2.20 µm

Y: ~3.07 µm

# Residuals DUT planes

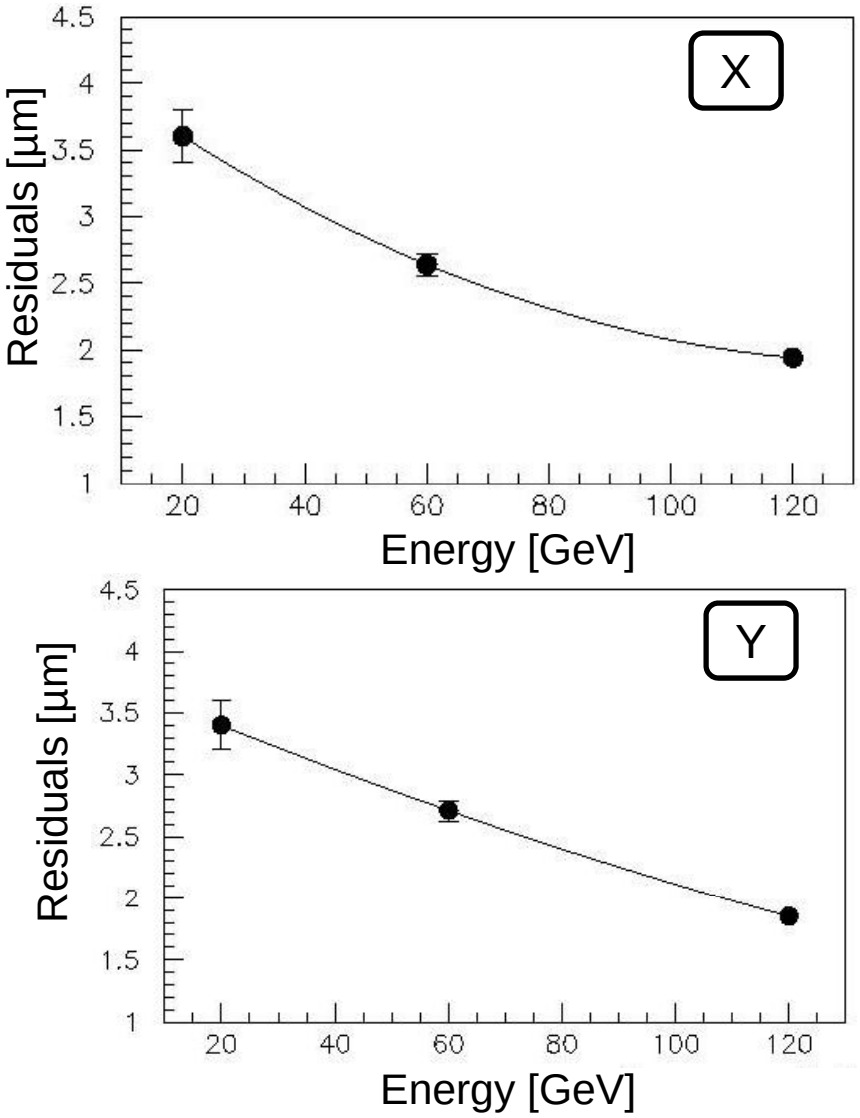
- Residuals in X between 1.79 µm and 2.43 µm
- Residuals in Y between 1.76 µm and 3.07 µm
- That includes tracking error, multiple scattering, intrinsic and telescope resolution
- Position reconstruction method (η for x and y separate) can be improved and is under investigation ➔ look-up table, etc.
- Tracking: no weighting by S/N
- Telescope resolution@DUT planes around one micron



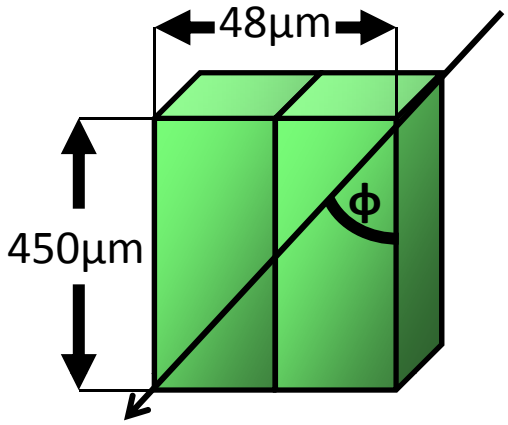
# Energy Scan

- Just a first glance at the data
- Tracking issues
- Extrapolation to ∞ energies
- Higher energies
  ➔ less multiple scattering
  ➔ smaller residuals
- Tendency is there

$\sigma_{MS}^2 \sim 1/E_{tot}^2$



# Anglar Scan

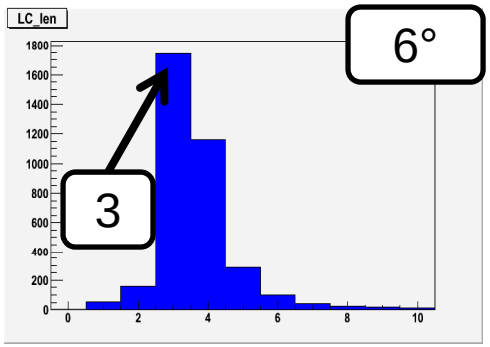


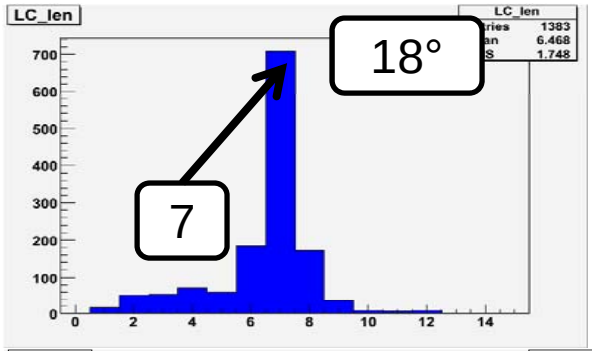

- Expected Clustersize:

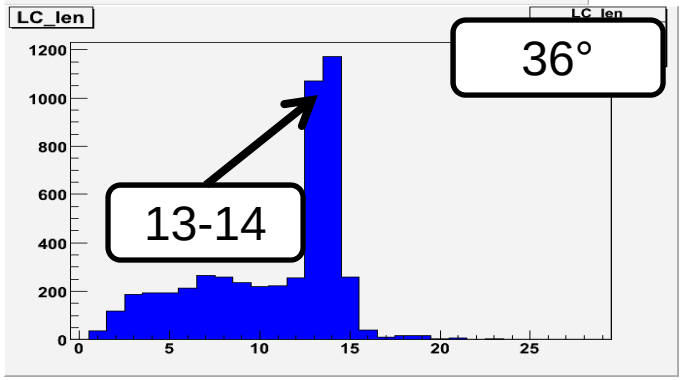
$$n = 1 + \tan(\phi) \bullet \frac{sensor\_thickness}{pixel\_pitch}$$

$$= 1 + \tan(\phi) \bullet \frac{450\mu m}{24\mu m}$$

~ real cluster size

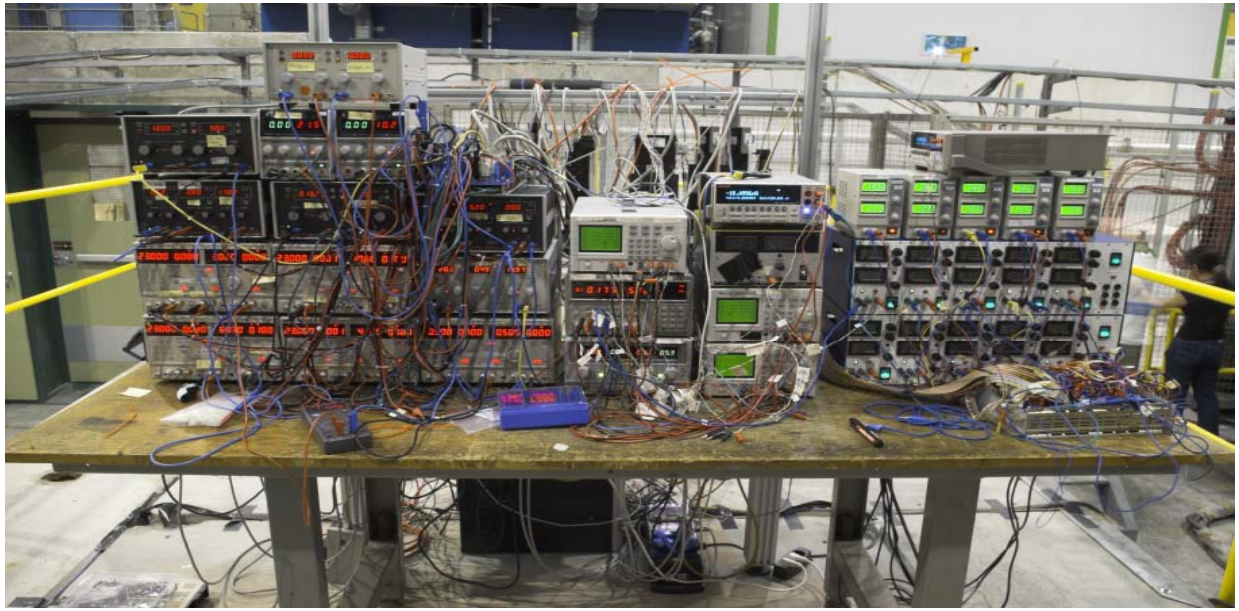


# Current Issues

- Test Beam Setup
  - Big silicon strip sensor for alignment in beam
  - **Designated power supply**
- Analysis just started
- DEPFET specific modifications of EUDET analysis software package



# Summary

- Successfully run a high energy (120 GeV) test beam at SPS/CERN with 20 million events taken
- 4 telescope planes and 2 DUTs ➔ 5 tracking planes
- New setup with improved track efficiency
- Completed measurement program
  - High statistics (14M events)
  - Energy scan (➔ multiple scattering)
  - Angular scans
  - New DEPFET generation
  - Studied influence of operation voltage parameters
- Full integration into EUDET DAQ in a parallel setup
- Making use of the EUDET analysis package