

DEPFET Technology, Test Beam Performance.

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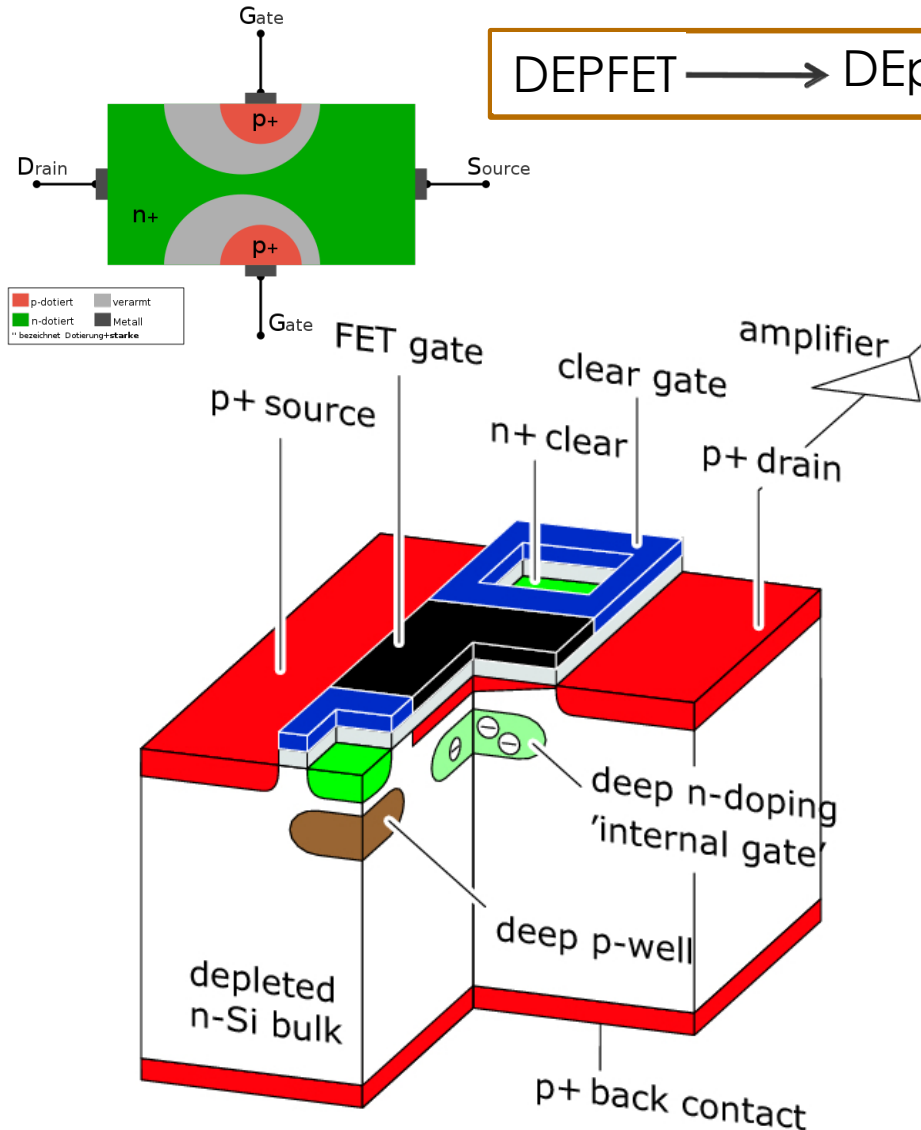
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Index

1. DEPFET Technology .
2. DEPFET Framework (Belle II, ILC).
3. Test Beam Framework.
4. Results.
 1. Maps
 2. Noise & Efficiency
 3. Charge Collection
 4. Cluster Size
 5. Sensor Resolution.

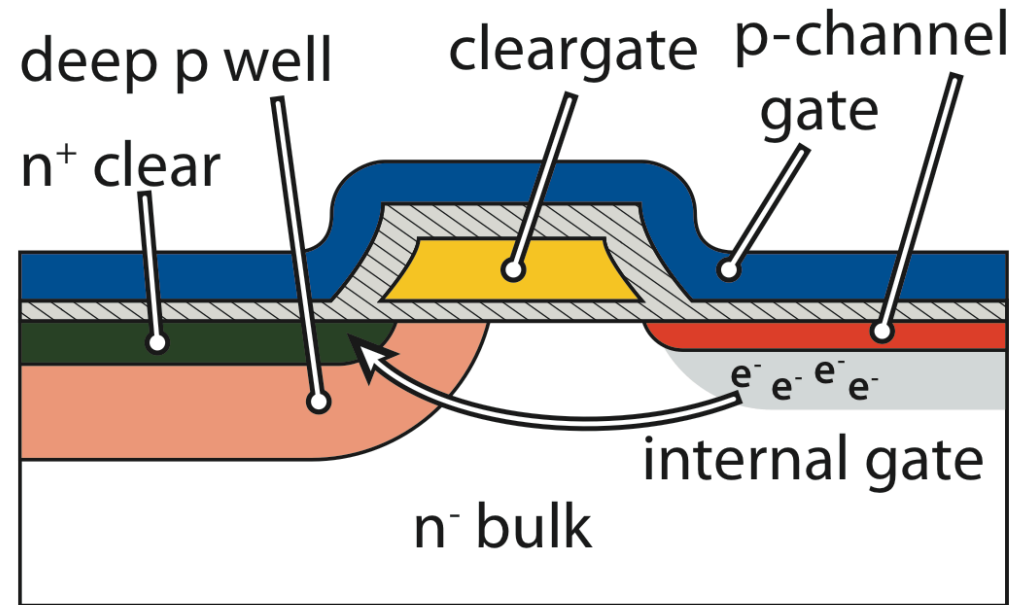
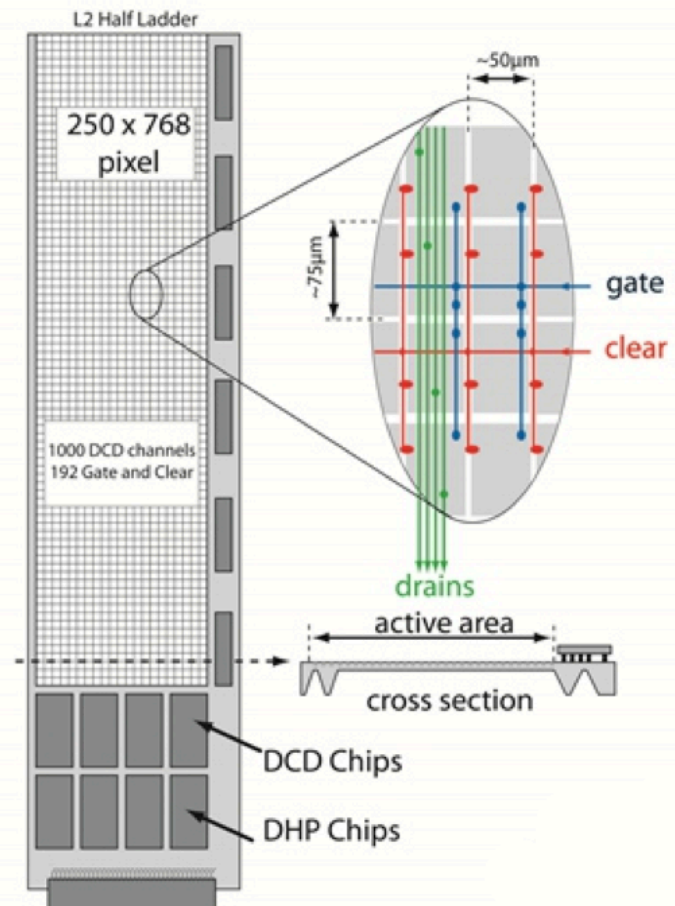
DEPFET Technology

DEPFET → DEpleted P-channel Field Effect Transistor



- It is an active pixel detector.
- A p-channel field effect transistor is integrated on completely depleted bulk.
- By means of sideward depletion a minimum of potential for electrons is created (internal gate) close the front side.
- Internal gate is capacitive coupled to the transistor channel.
- The drain current is proportional to the number of electrons collected.

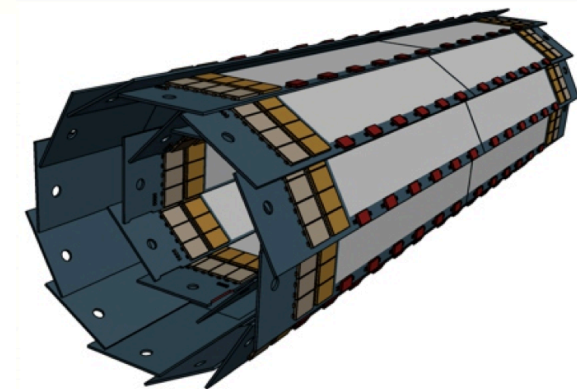
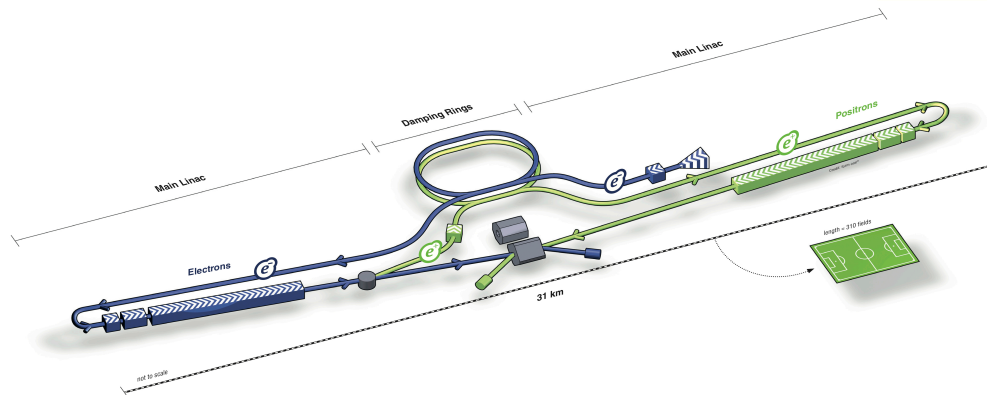
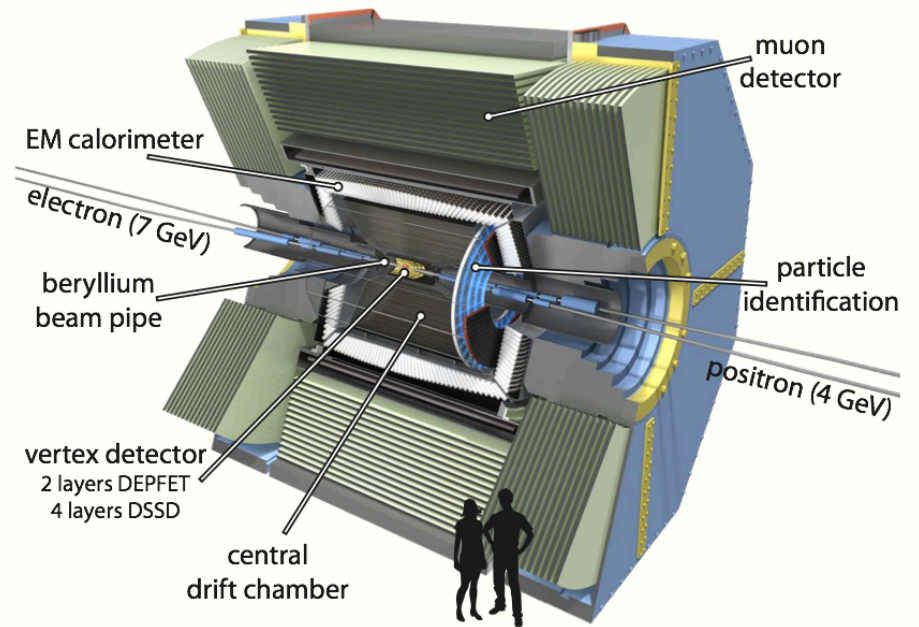
DEPFET Technology, Clear.



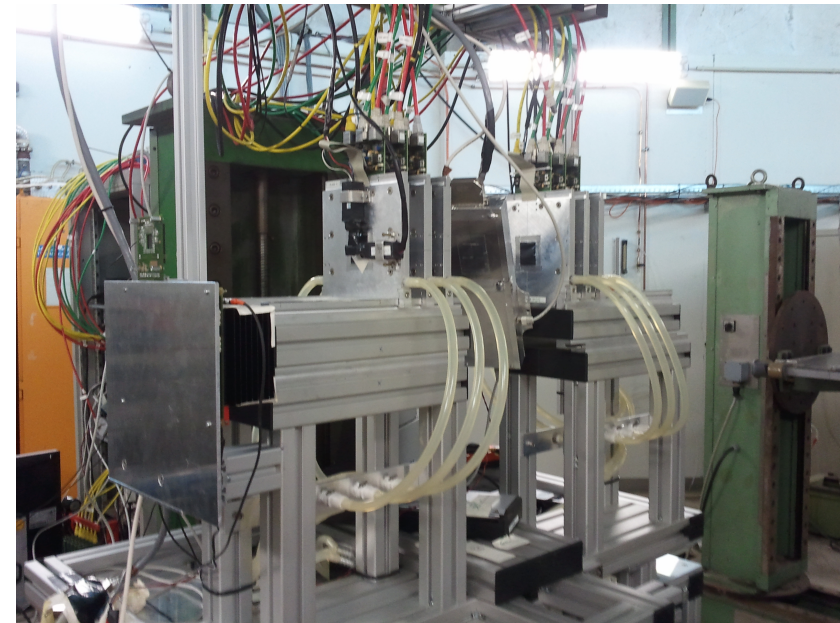
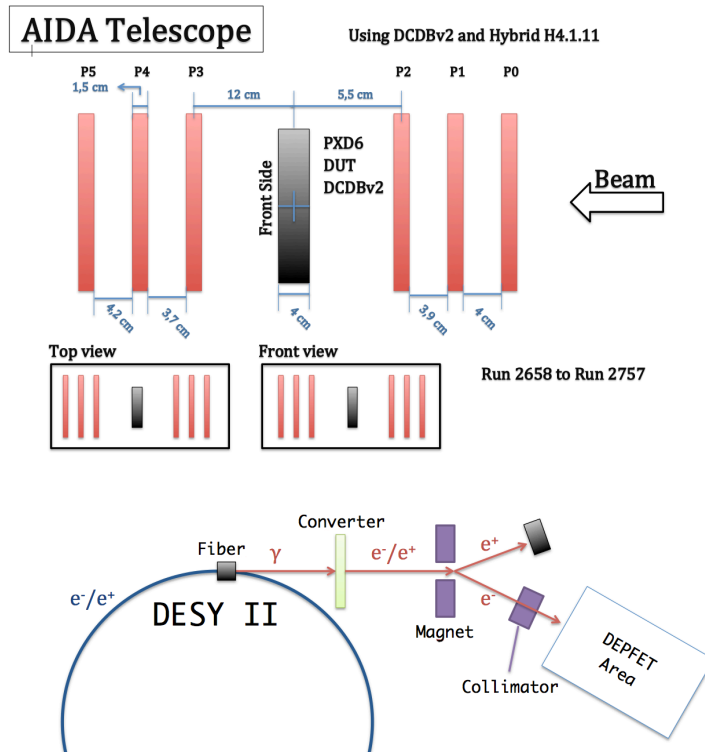
- The charge collected in the internal gate (by the impinging particles and leakage current) should be removed periodically.
- The collected charge is extracted applying a high voltage near to the internal gate (clear contact)
- (Rolling Shutter Mode).

Belle II & ILC

- DEPFET to the Belle II detector is a previous step to ILC vertex detector concept.
- DEPFET Contribution to Belle II:
 - At 14 mm of radio, 8 modules with 1536x250 pixels of $50 \times 50 \mu\text{m}^2$.
 - At 22 mm of radio, 12 modules with 1536x250 pixels of $75 \times 50 \mu\text{m}^2$.



DEPFET Test Beam, Setup

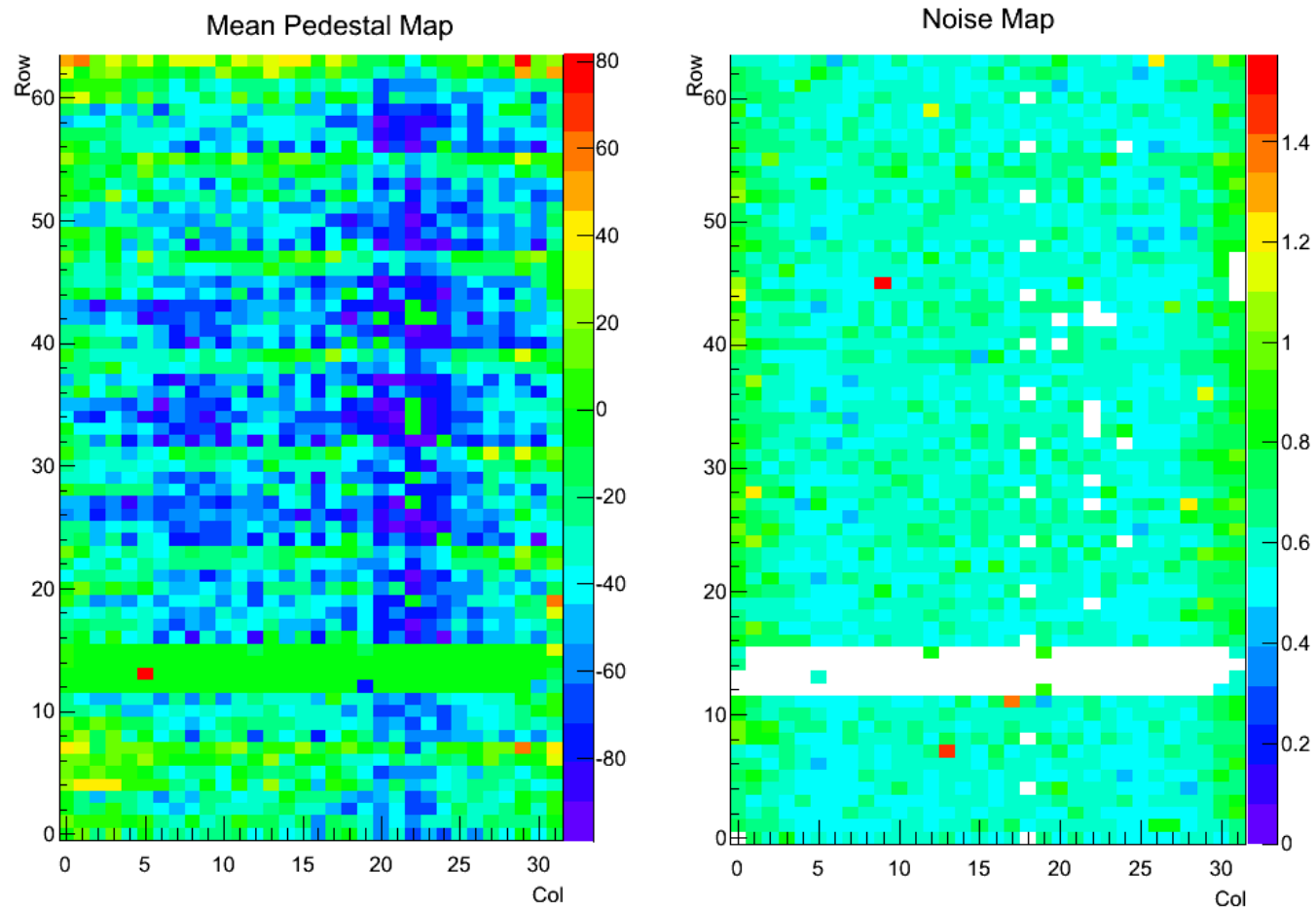


- Places: CERN - 120 GeV π and DESY – 4 GeV e^- .
- AIDA Infrastructure: Telescope with six Mimosa26 Pixel Module (pitch 18.4x18.4 μm^2) and pointing resolution $\approx 2 \mu\text{m}$.

Results From Test Beam of June at CERN:

- Module: H4.1.15 - DCDBv2, PXD6 Matrix N05, standard Belle II design, drift implantation, gate length 5 μm and thick oxide, **ASICs were operated at 100MHz.**
- **Pixel size: 50x75 μm on 50 μm thick.**

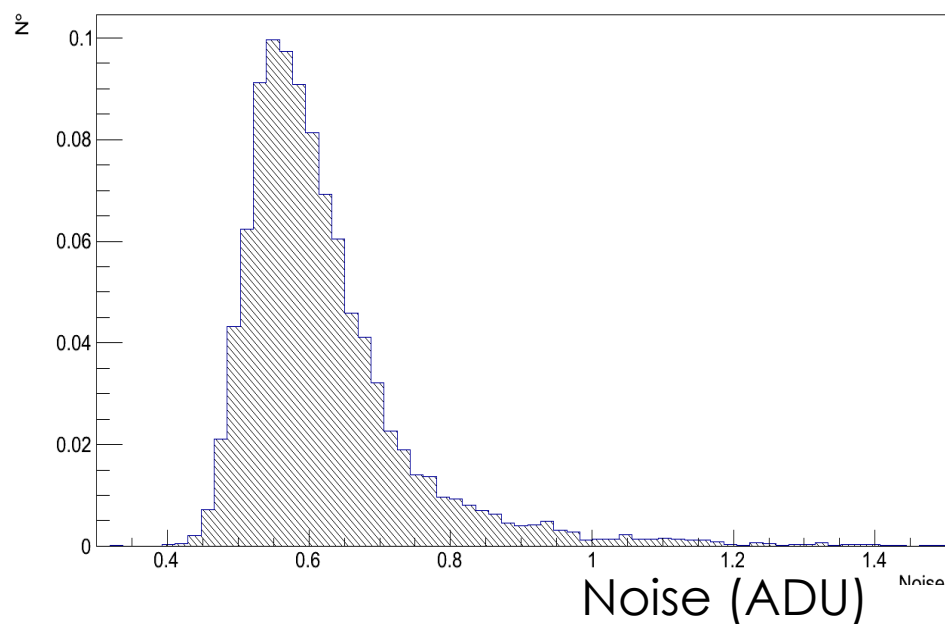
DEPFET Test Beam, Maps



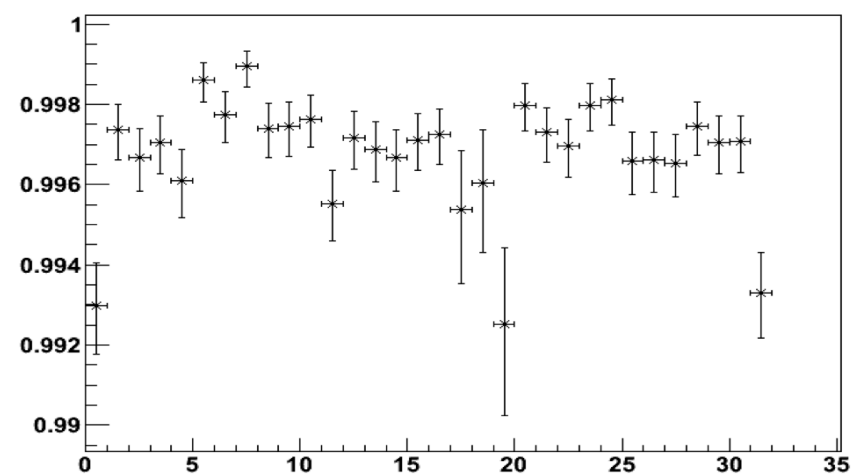
DEPFET Test Beam, Noise & Efficiency

- Noise Mean ≈ 0.6 ADU.

Noise Distribution



DUT Efficiency vs. Track X Position

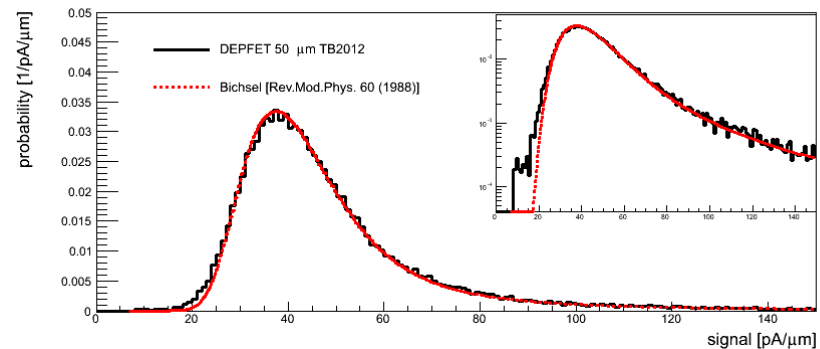
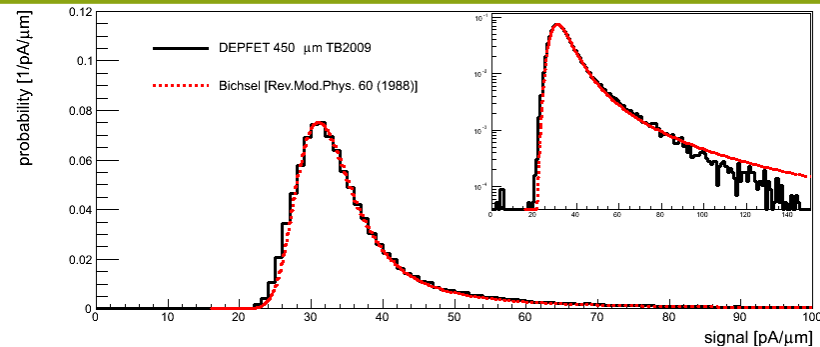
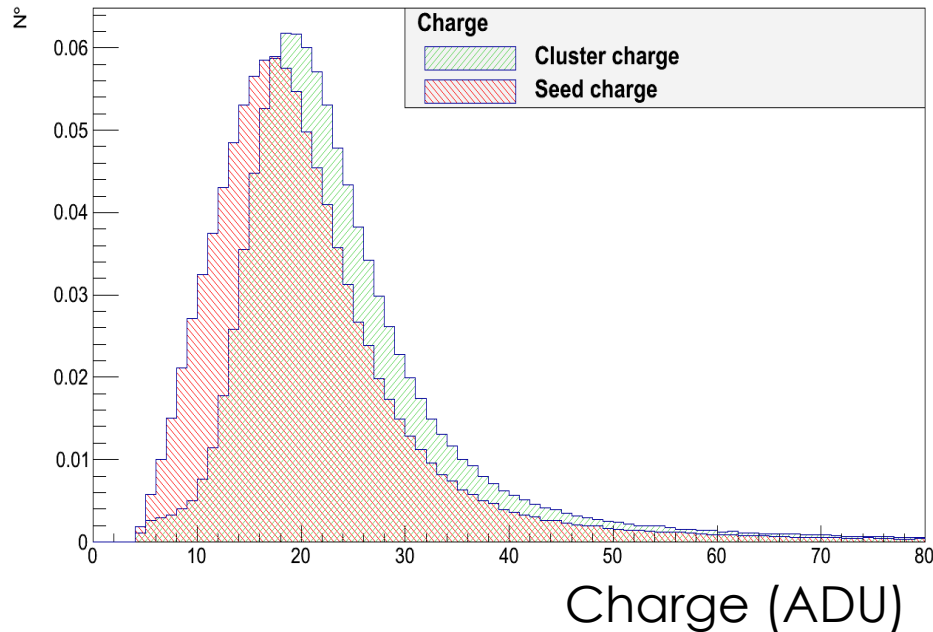


- Mean DUT efficiency $\approx 99.7\%$

DEPFET Test Beam, Charge Collection

Bichsel [Rev.Mod.Phys. 60 (1988)]

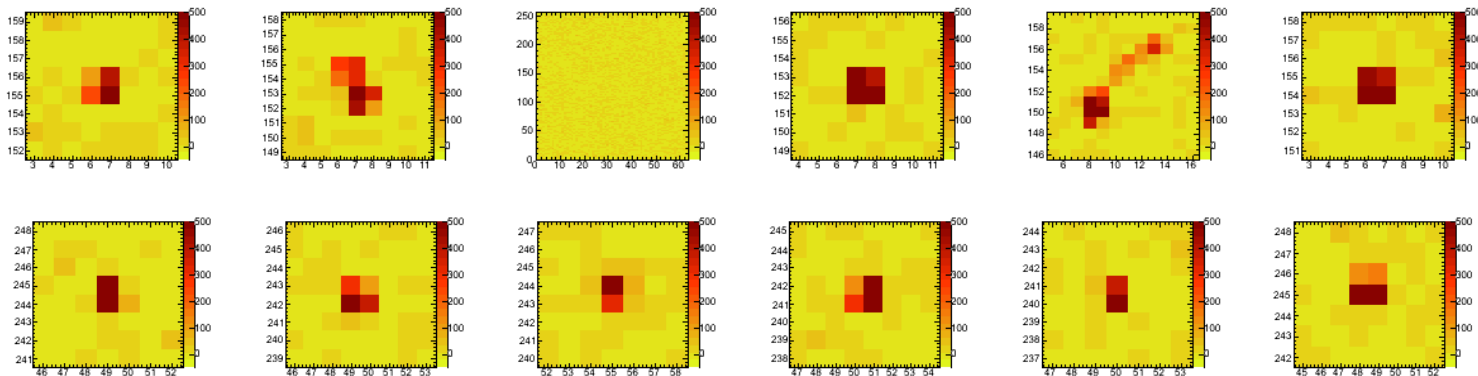
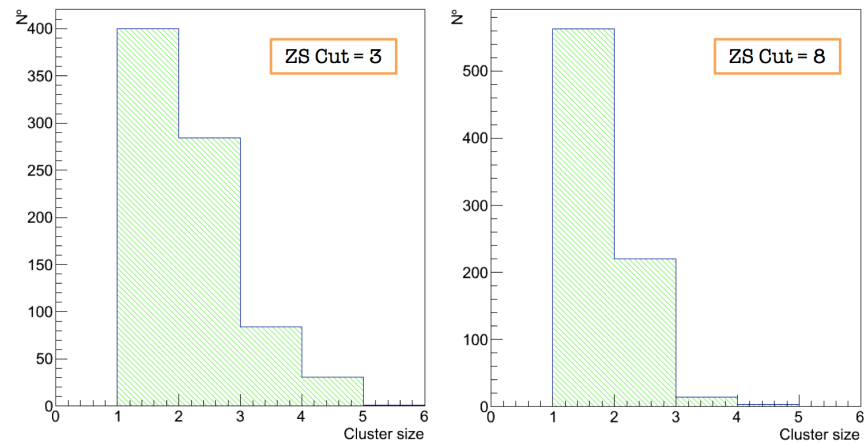
Cluster/Seed Charge Distribution



- **MPV of Cluster charge distribution ≈ 21 ADU.**
- MPV of Charge distribution of the Seed Pixel ≈ 16 ADU.
- **Signal/Noise Ratio ≈ 40 (on $50 \mu\text{m}$ thick).**
- Signal expressed in pA per micron of active Silicon, compared with the prediction for the energy deposition in thin Silicon Layers of H.Bichel.

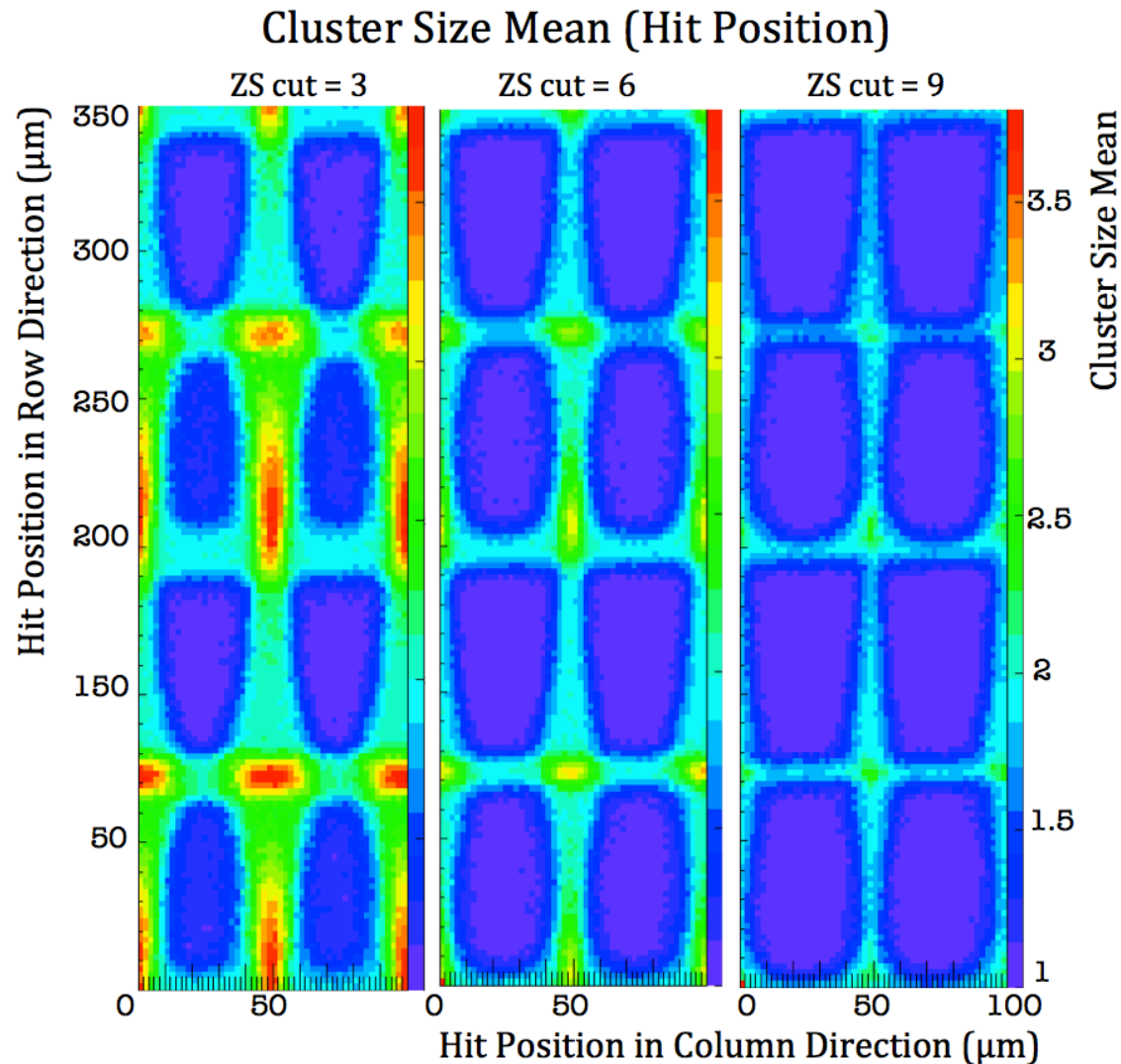
ZSCut Parameter.

Total Cluster Size



- ZS cut: Minimum required charge to consider one neighbor pixel as a part of the cluster, in units of noise of the pixel.

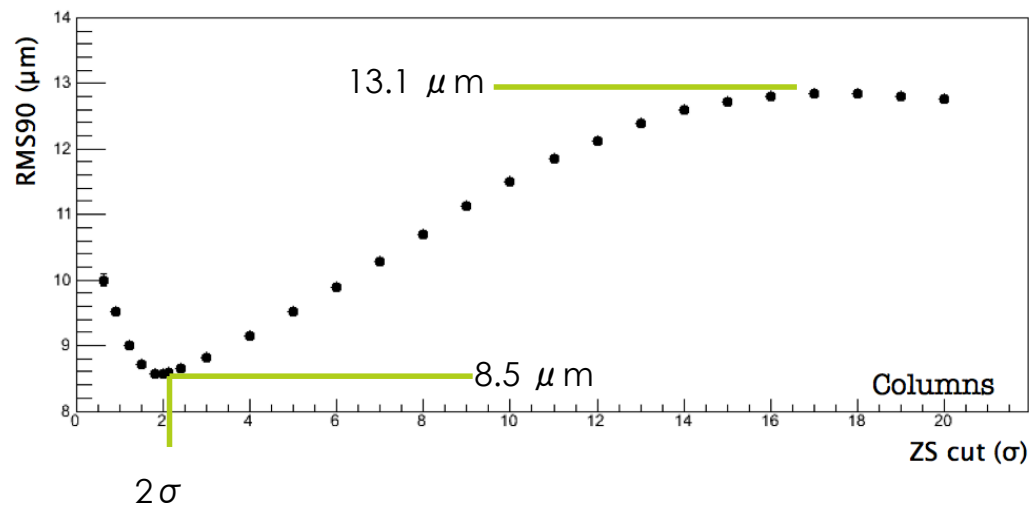
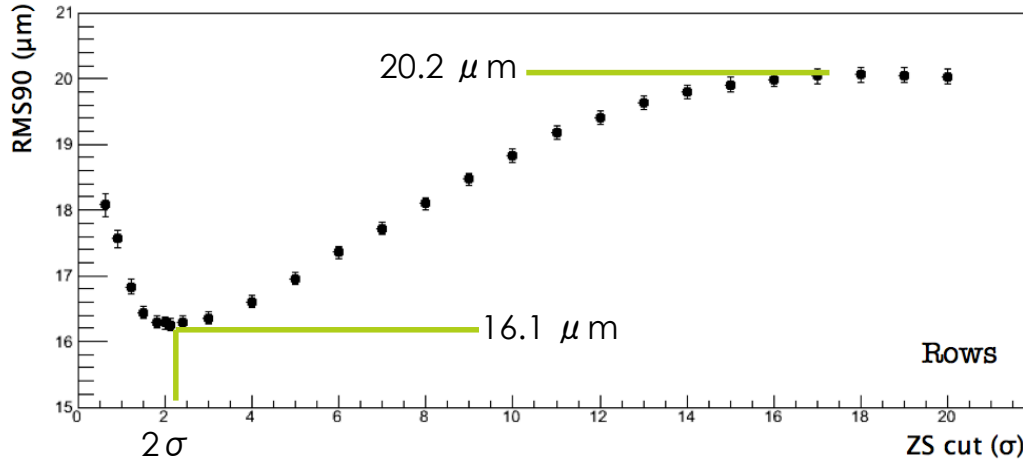
DEPFET Test Beam, Cluster Size (inpixel Map)



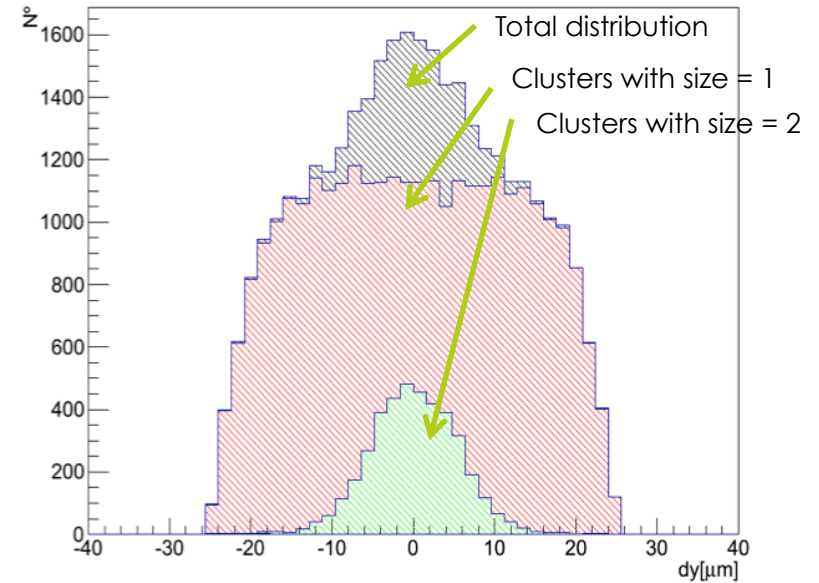
- ZS cut: Minimum required charge to consider one neighbor pixel as a part of the cluster, in units of noise of the pixel.
- Almost all clusters have size one, they are piled up on center of the. The bigger clusters are located on the pixel edges.
- ZS cut is an important parameter in the optimization of the sensor resolution.

DEPFET Test Beam, Sensor Resolution

RMS90 as a function of ZS cut



Reconstruction Method: CoG



- Resolution limit: 8.5 (16.1) μm to the side with 50 (75) μm . (Pixel size: 50x75 μm on 50 μm thick)
- Using DEPFET sensor on 450 μm tick and 20x20 μm of pitch: Resolution limit $\approx 1 \mu\text{m}$.

Summary

TESTBEAM:

- DEPFET is an active pixel detector.
- Last two years, prototypes of **50 μm thick** were tested. A full characterization of the prototypes **at 100 Mhz** was made.
- We found an **DUT efficiency of 99.7%**, a **Signal/Noise Ratio around 40** with a signal distribution **agree with the Bichsel Model**, and a limit **resolution of 8.5 μm** (CoG Method).
- Now, the collaboration are focused in the sensor characterization **at 320 MHz**, which allow a **full frame readout time of 20 μs** .

Thanks for you attention.
