

International Workshop on Linear Colliders



Test Beam Studies for GaAs Sensor for the Beam Calorimeter at ILC



DESY, Germany

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On behalf of FCAL Collaboration

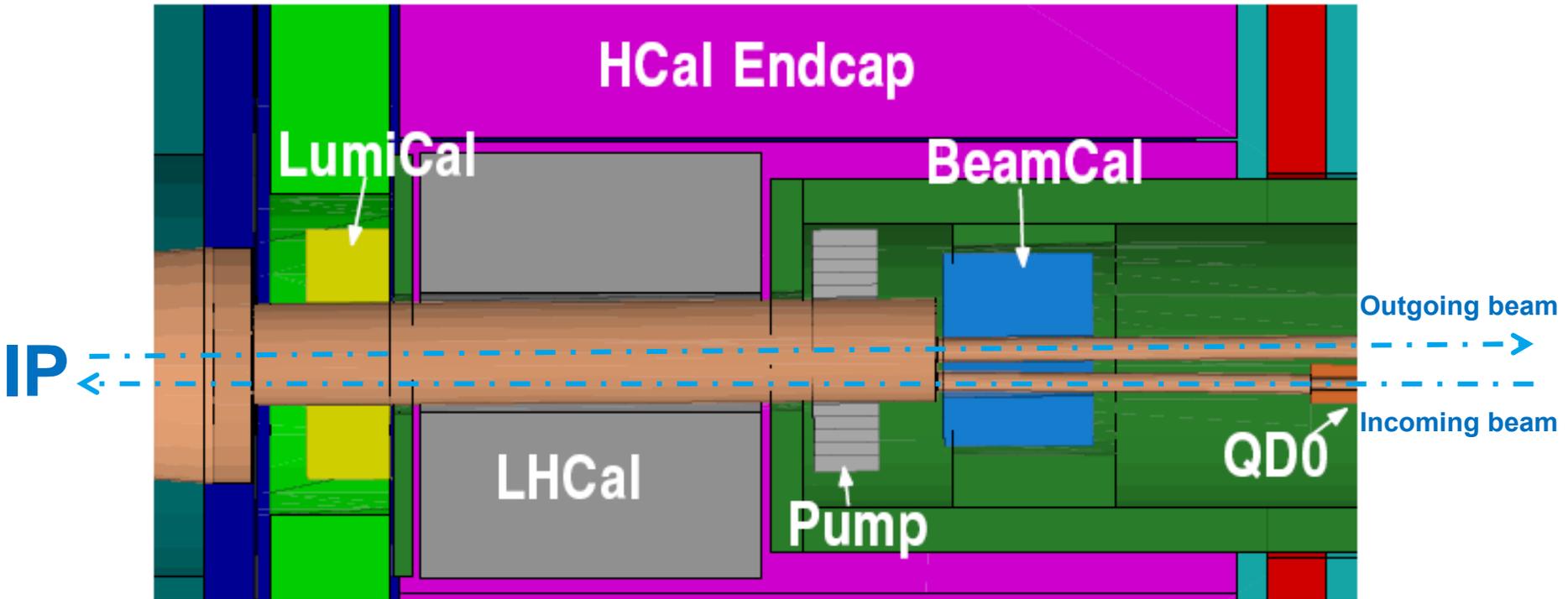


Plan:

- > Introduction
- > Beam Calorimeter
- > Sector Prototype for BeamCal
- > Test Beam DESYII (Summer 2010)
- > Measurements
- > Analysis
- > Conclusions



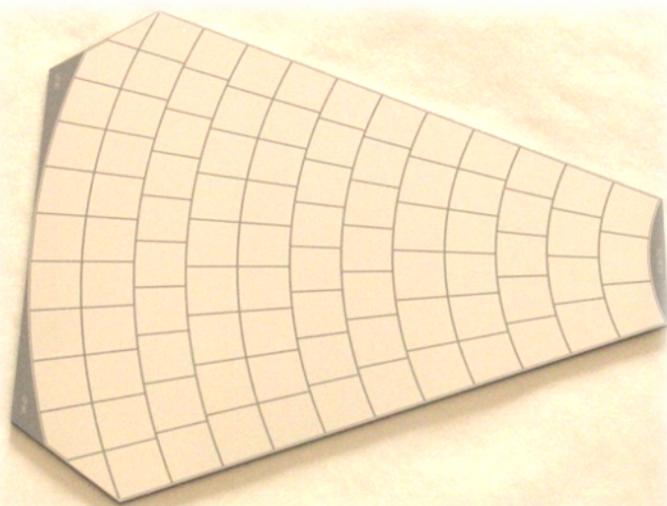
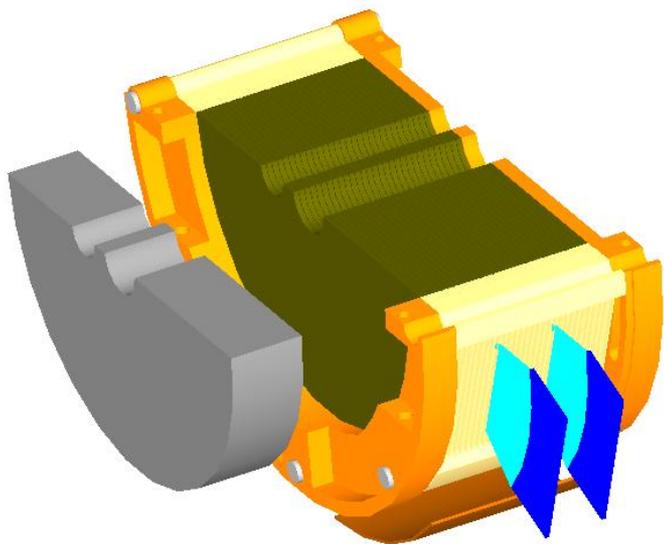
Forward Region



Precise luminosity measurement,
Hermeticity (electron detection at low polar angles),
Assisting beam tuning (fast feedback of BeamCal data to machine)

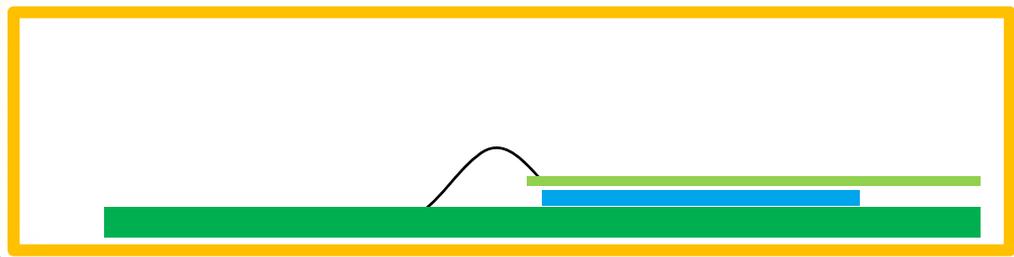
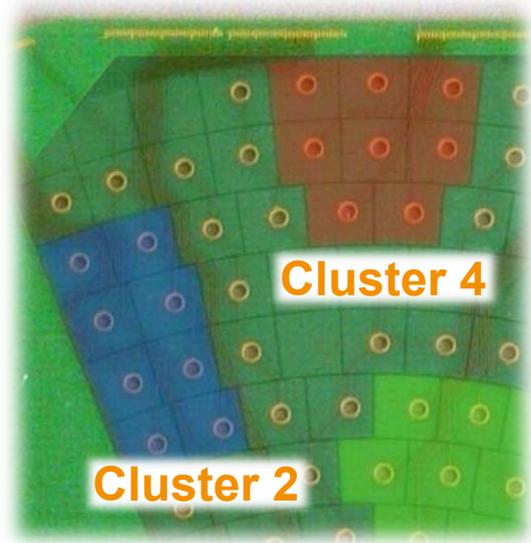
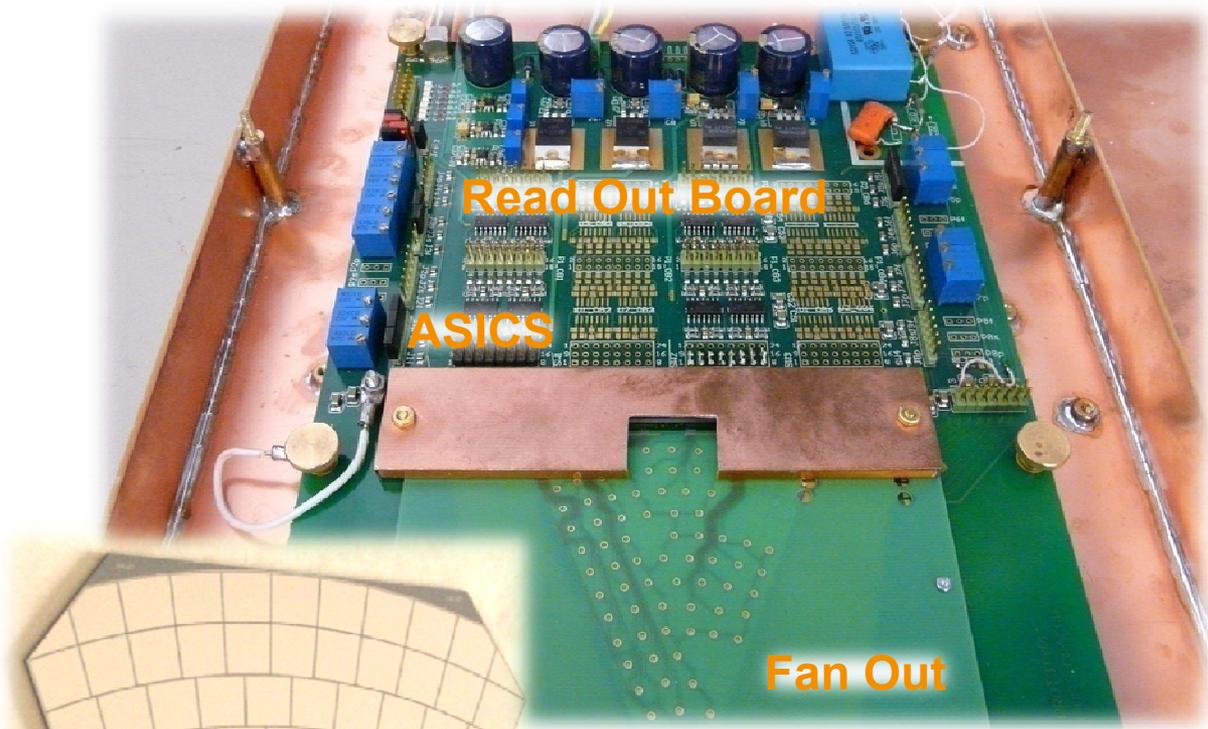
Challenges: radiation hardness (BeamCal), high precision (LumiCal)
and fast readout (both)

Beam Calorimeter



30 Layers	Tungsten - Sensor layers - GaAs or Di
Radii	2-15 cm
Depth	~12 cm
GaAs Prototype	
Radii	2-8.5 cm
Segmentation	5x5 mm²
Thickness	500 μm
Metallization	Al
provided by RID Tomsk through JINR Dubna	
Leakage Current	~100nA, 50V

First Prototype for GaAs

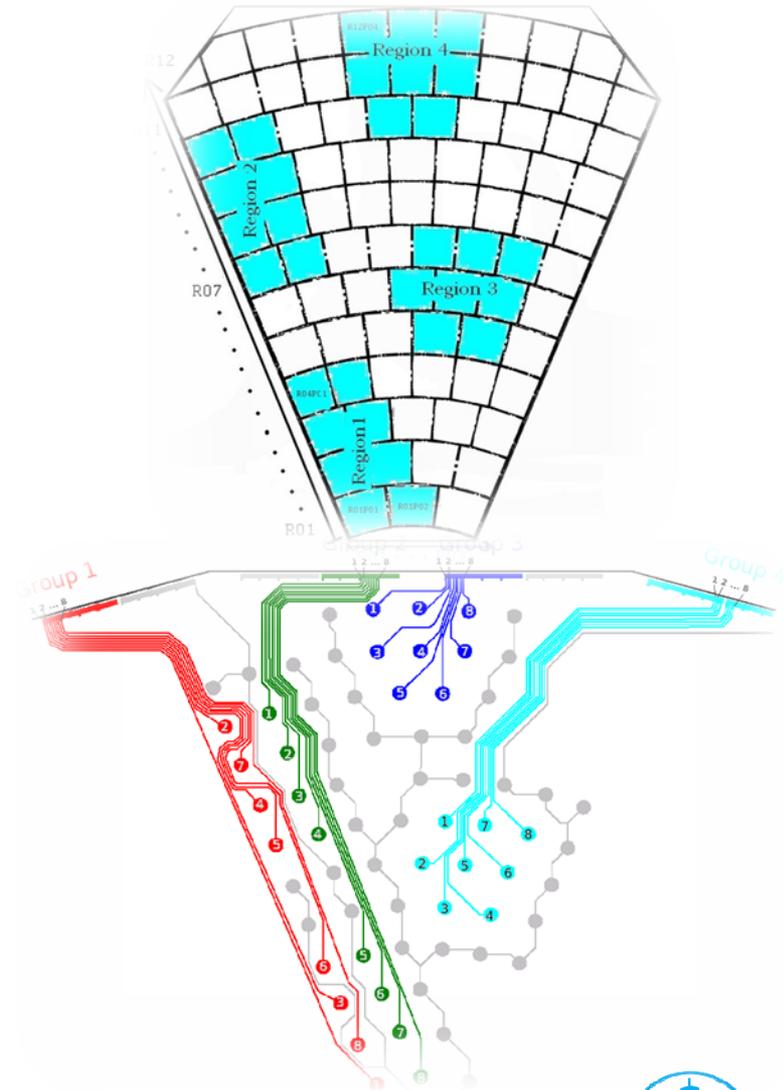


AI window
Fan Out
Sensor
R/O Board
AI window

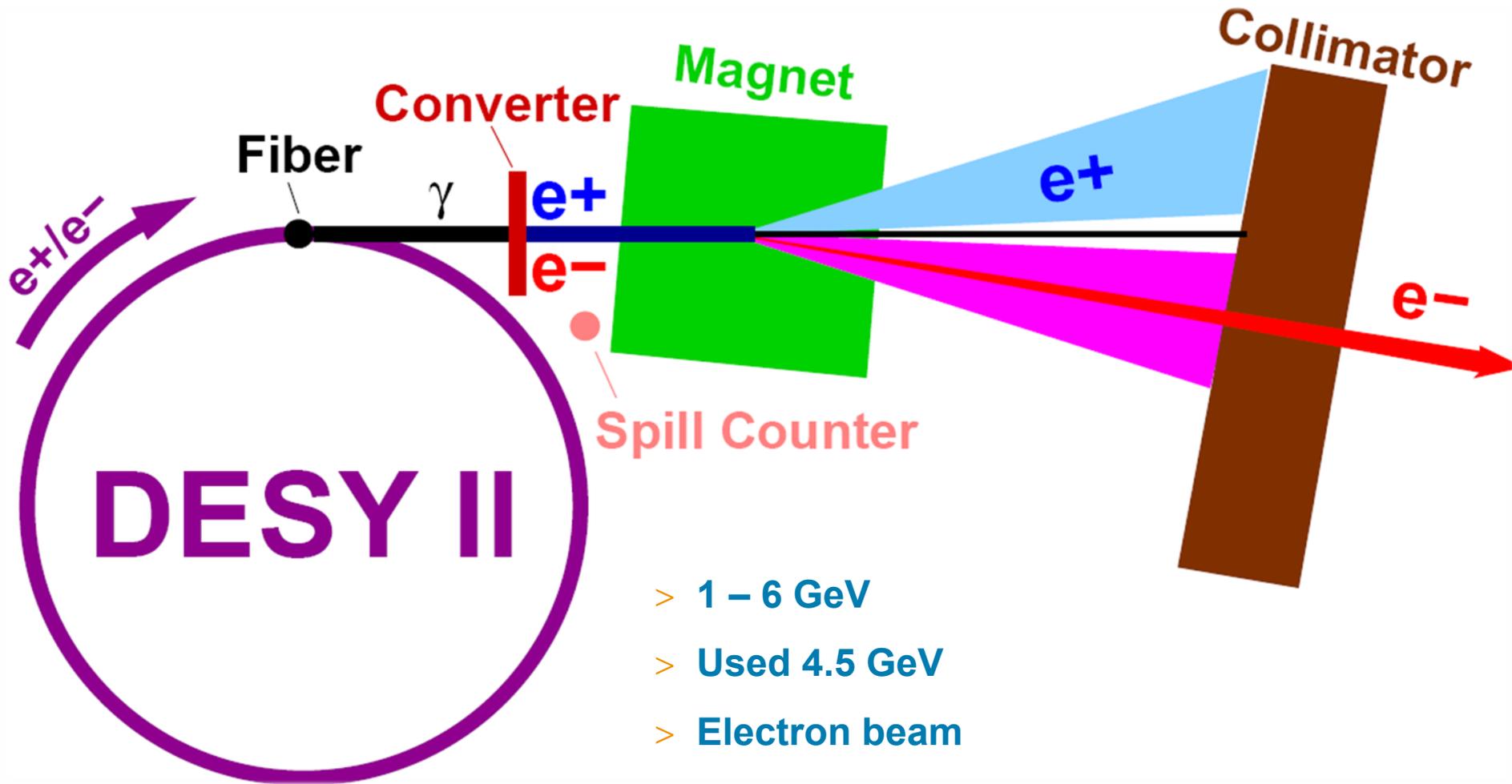


Preparation work

- > **GaAs detectors**
 - IV-measurements ($\sim 100\text{nA}$ at 50V)
 - CV-measurements ($\sim 10\text{pF}$)
- > **Fan out**
 - Capacitance measurements
- > **Readout chips**
 - linearity test
 - signal size
 - signal to noise
 - calibration

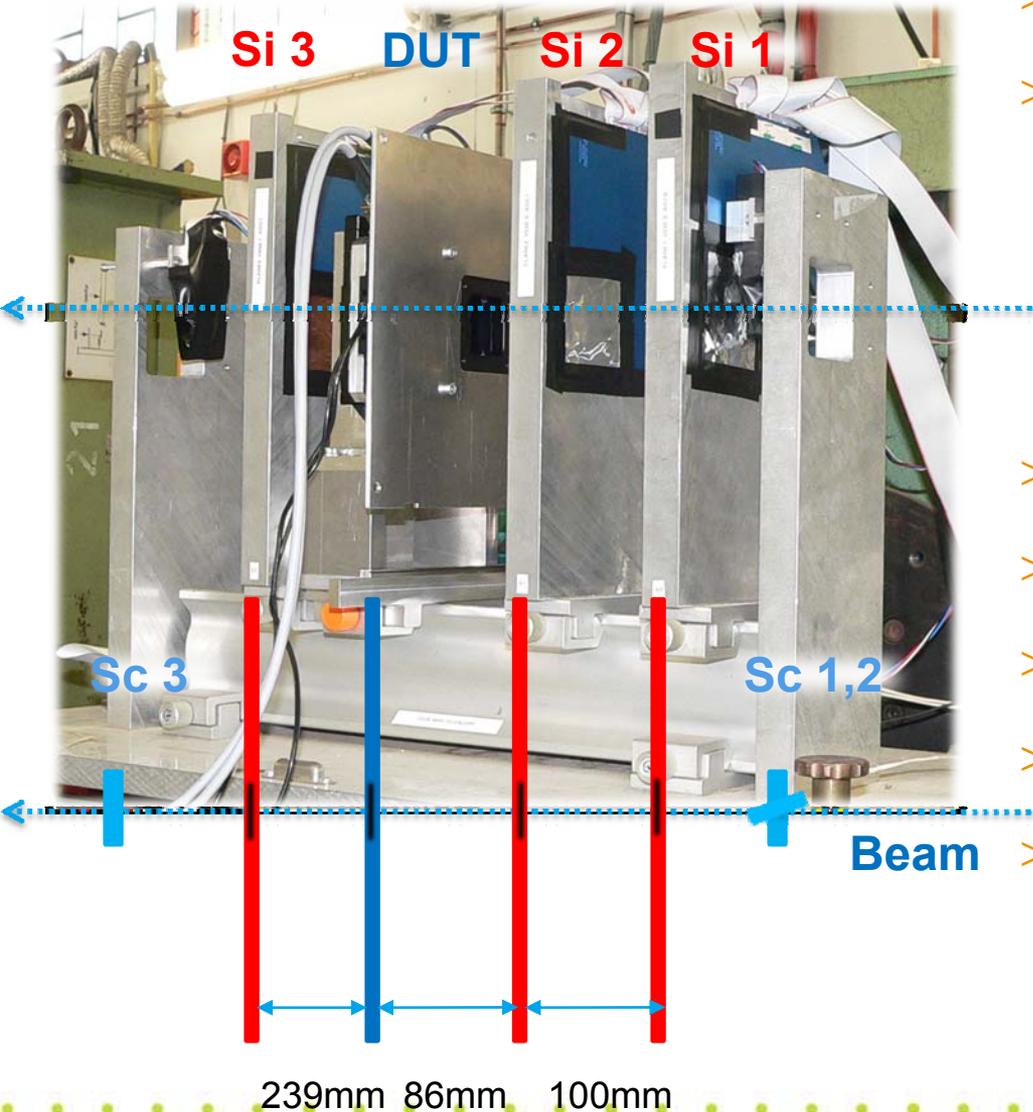


TestBeam DESY II



- > 1 – 6 GeV
- > Used 4.5 GeV
- > Electron beam

Test Beam Set Up



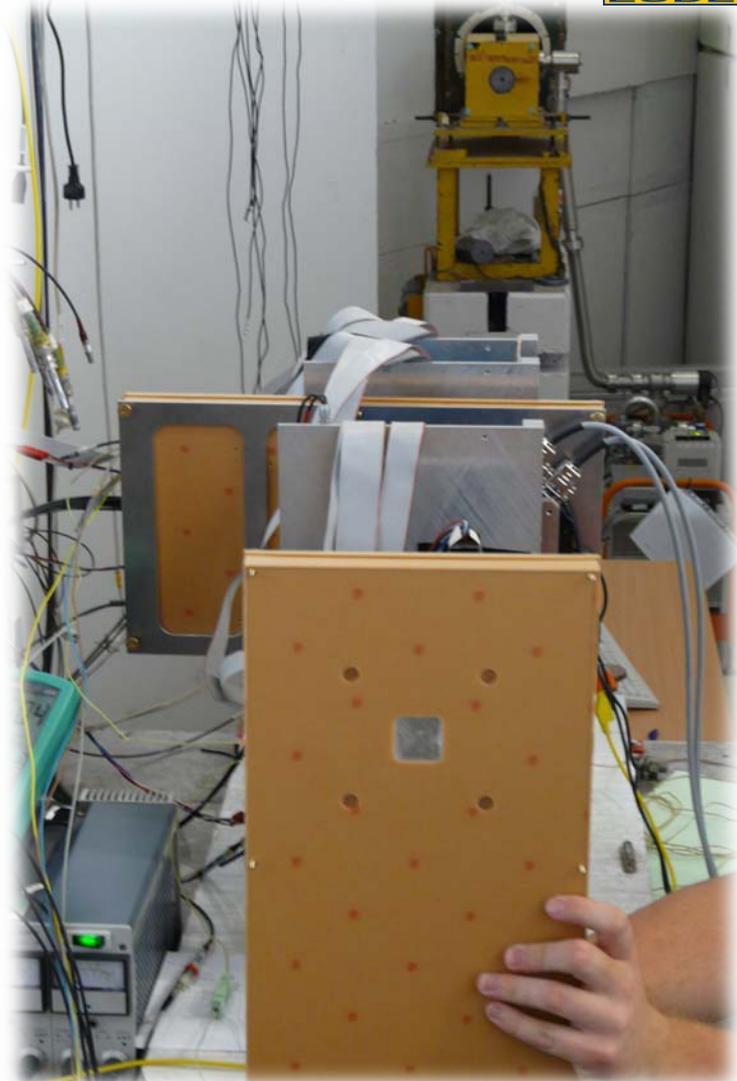
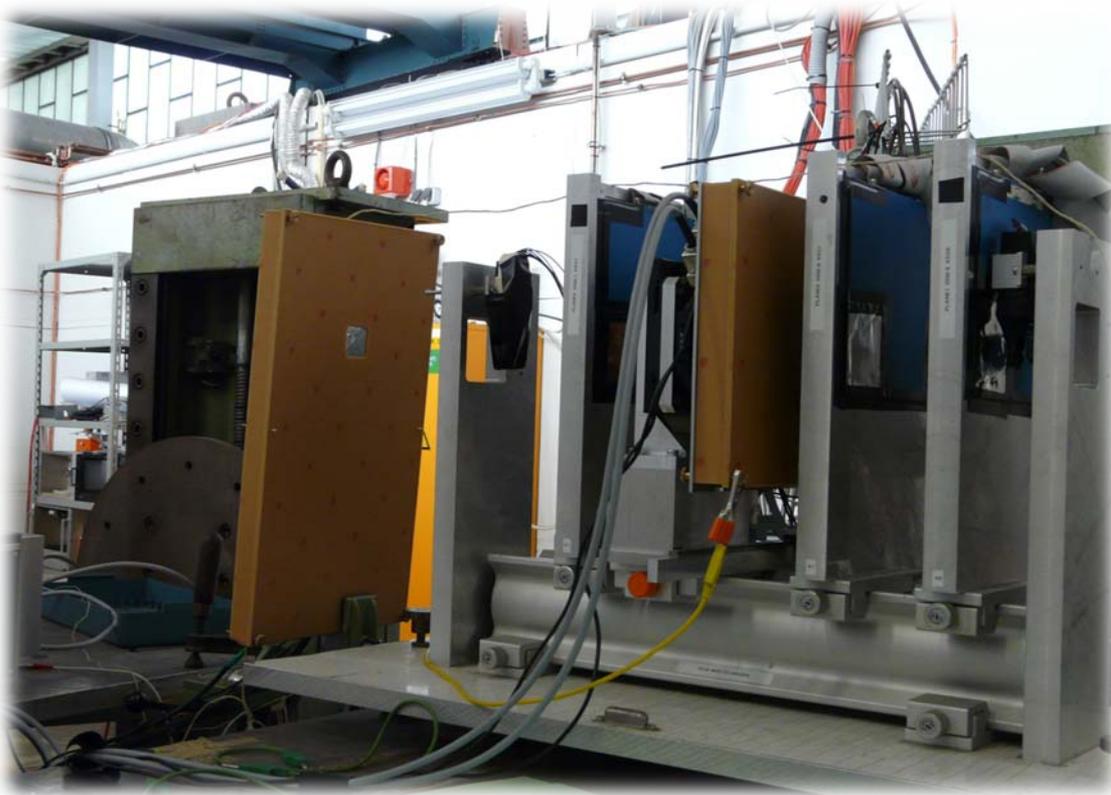
- > 7mm scintillator fingers
- > Zeus Telescope
 - > 3 Si planes
 - > Double perpendicular layers
 - > 640 strip channels (50 μ m)
- > Precise XY Table
- > Sensor Box
- > ADC v1721 as for BCM1F
- > Veto scheme
- > DAQ systems
 - > Telescope
 - > BCM1F



Test Beam Area 22

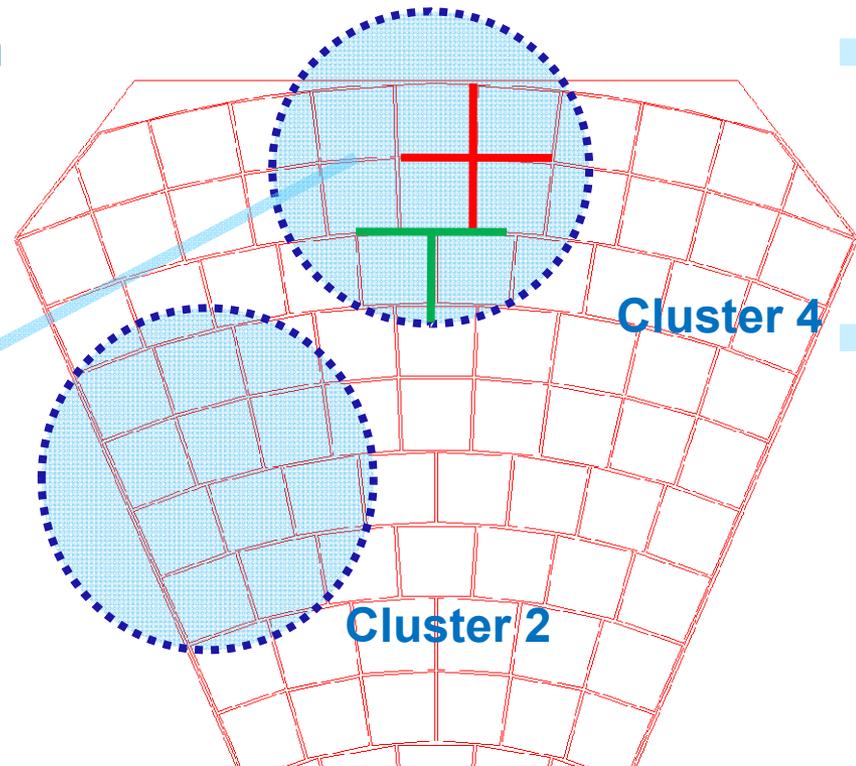
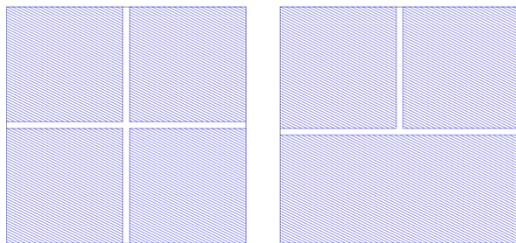


> Set Up with two boxes



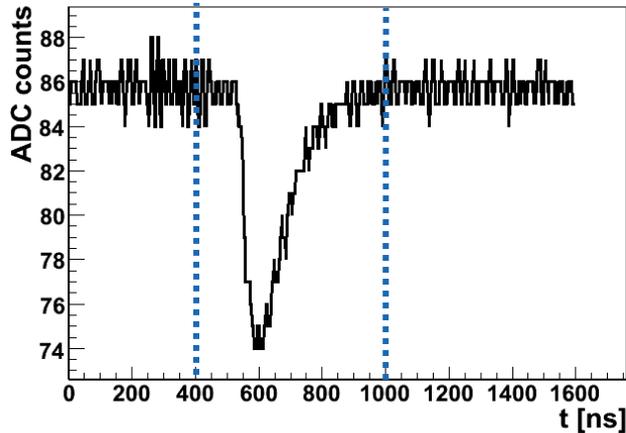
Test Beam Measurements

- > To prove front end electronics operation together with sensor and automated readout
 - > Measure every pad (~200.000 events)
 - > Edges between pads irradiation
- Green and red regions
~2.000.000 events
- > Cross talk measurements

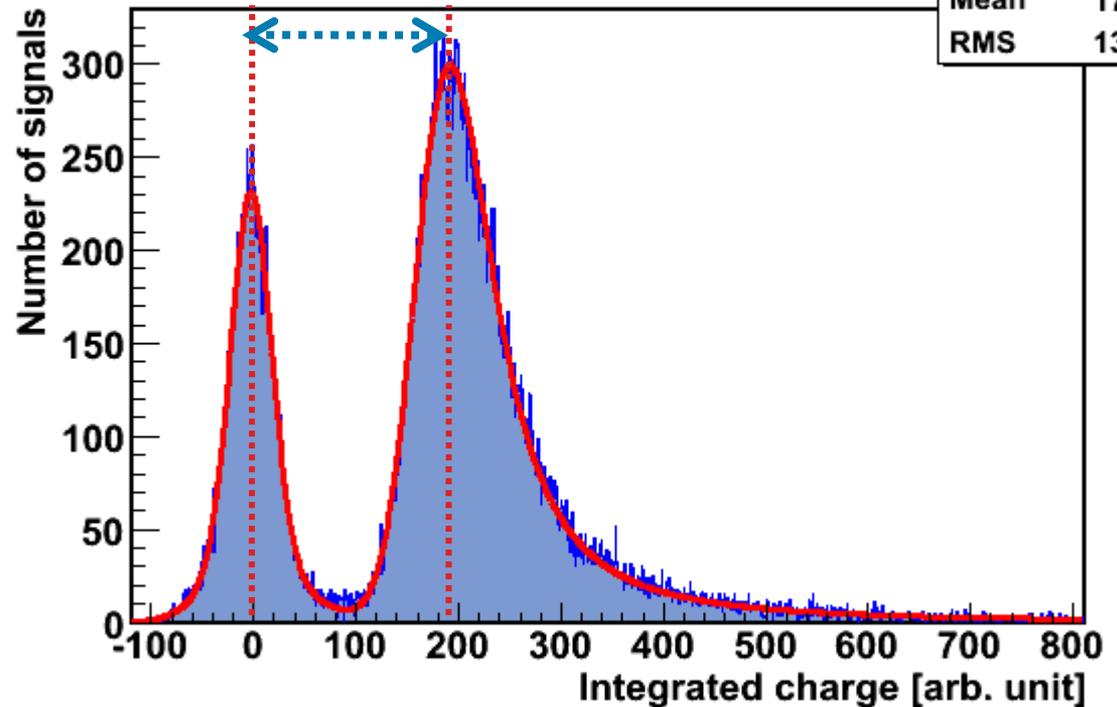


Charge Collection Efficiency (CCE)

Event no. 112 on 01 Aug 2010, 13:17 -- channel 1



Signal Size Spectrum (pedestal not scaled)



$$CCE = \frac{Q_{\text{collected}}}{Q_{\text{induced}}}$$

$$CCD = CCE \cdot d_{\text{thickness}}$$

$$S/N = \frac{MPV_{\text{Signal}}}{\text{Sigma}_{\text{Pedestal}}}$$

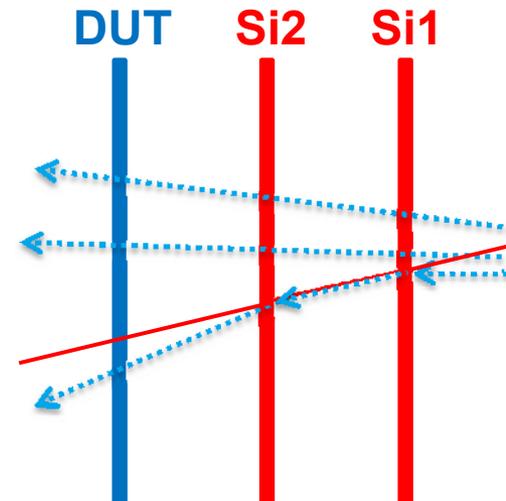
	All Channels
CCE	23-34%
S/N	6-12
HV	60V



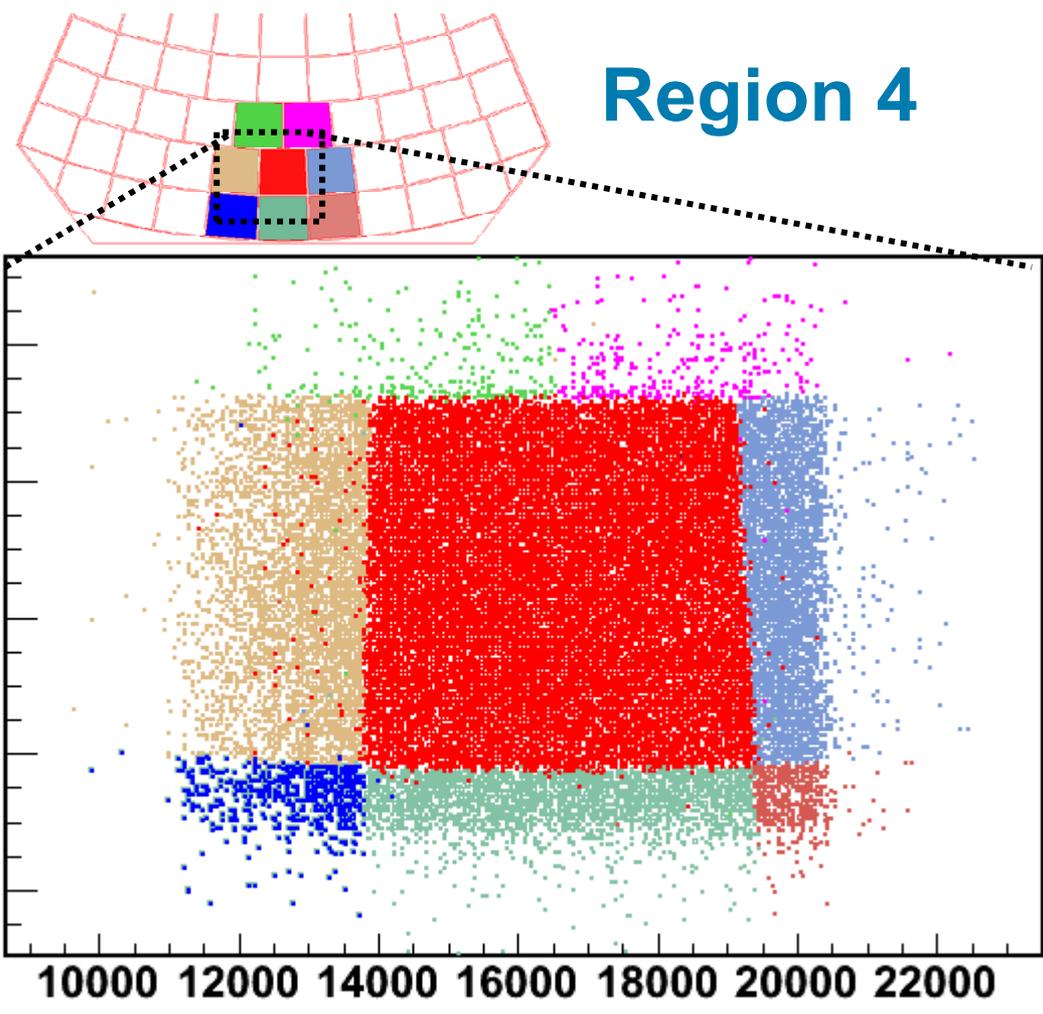
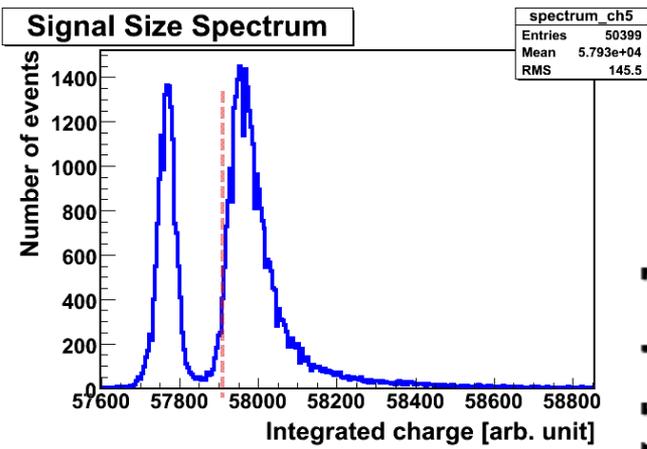
Telescope Analysis



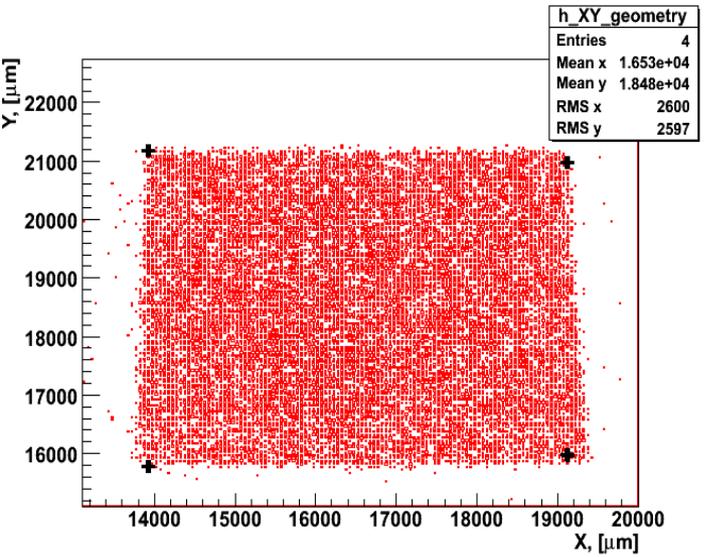
- > TelAna provides information about hits (two algorithms of hit calculations + alignment between Si planes)
 - DIG – digital → seed signal
 - COG – center of gravity
- > Tracks are reconstructed:
 - 3 hits per telescope
 - 1 hit in every plane
 - 62% of tracks
- > 2 telescope planes are used for linear fit for prediction of the position in the sensor



Preliminary Tracking



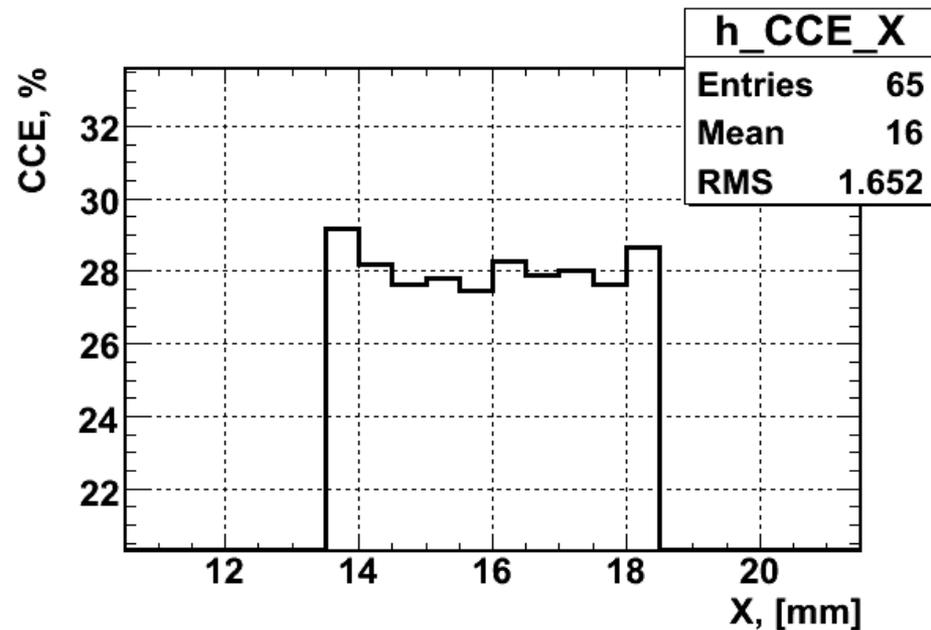
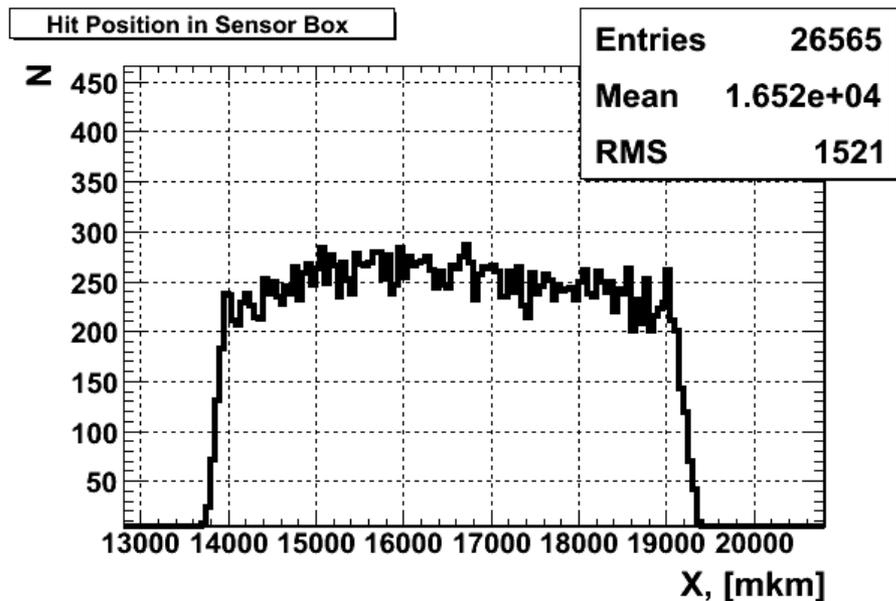
- No connection between Telescope and Sensor Box
- Alignment is made for Telescope itself



Reconstruction of position in the Sensor Box X, [mkm]



CCE vs Position

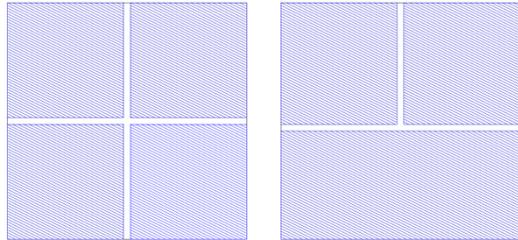


> Number of hits as a function of reconstructed x position in sensor box.

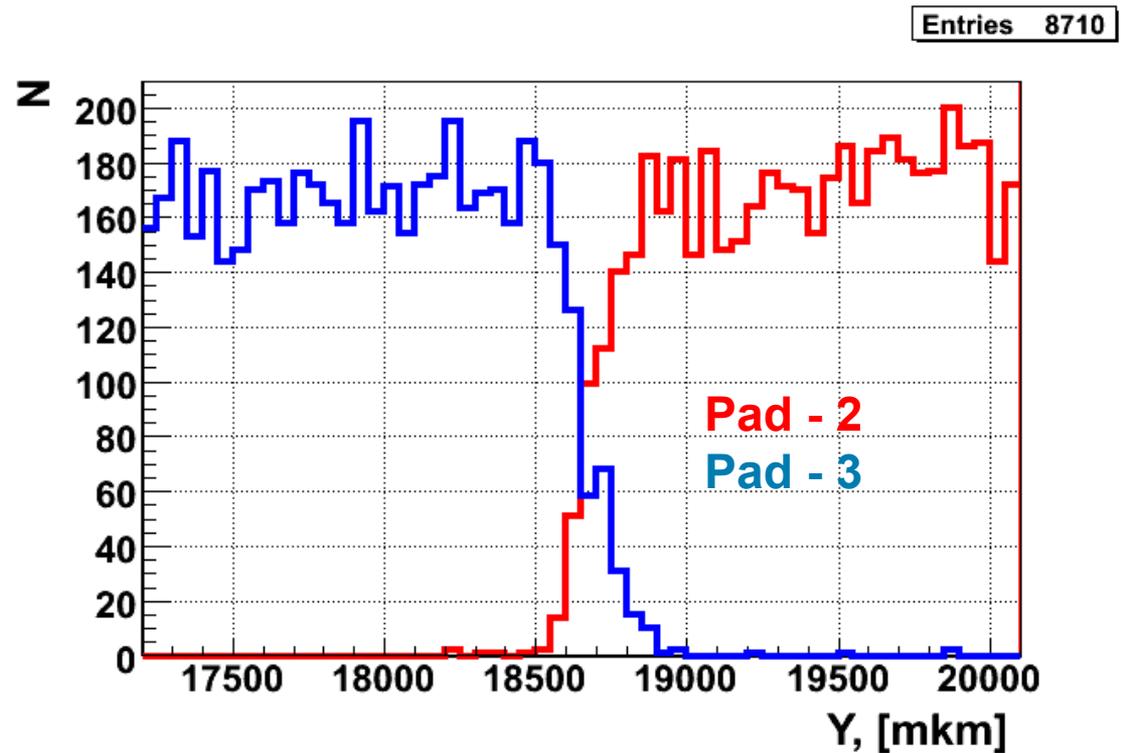
> CCE as a function of reconstructed x position in sensor box.



Charge Sharing - Preliminary



- > Pad's gaps 0.2 mm
- > 50 μm bin
- > Charge Sharing in 4 Edge case



Conclusions

- > In the summer 2010 a first measurement combining a sensor with a front-end ASIC was made on the TestBeam DESYII (Hamburg).
- > Detectors were characterized with IV ($\sim 100\text{nA}$), CV ($\sim 10\text{pF}$), CCE ($\sim 30\%$), S/N (~ 10)
- > Full chain of Sensor-Readout-Fanout-ADC-Telescope

- > Under investigations:
 - Analysis of edges
 - Tracking and alignment
 - CCE vs Voltage



> **Thank You for Your Attention!**

