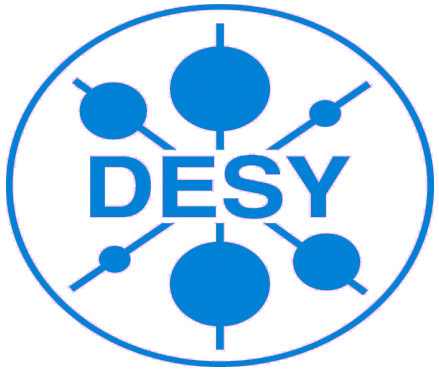

ATLAS Planar Sensors Preliminary Report

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On behalf of PPS Testbeam Group

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EUDET Annual Meeting 2010, JRA1 Users Session

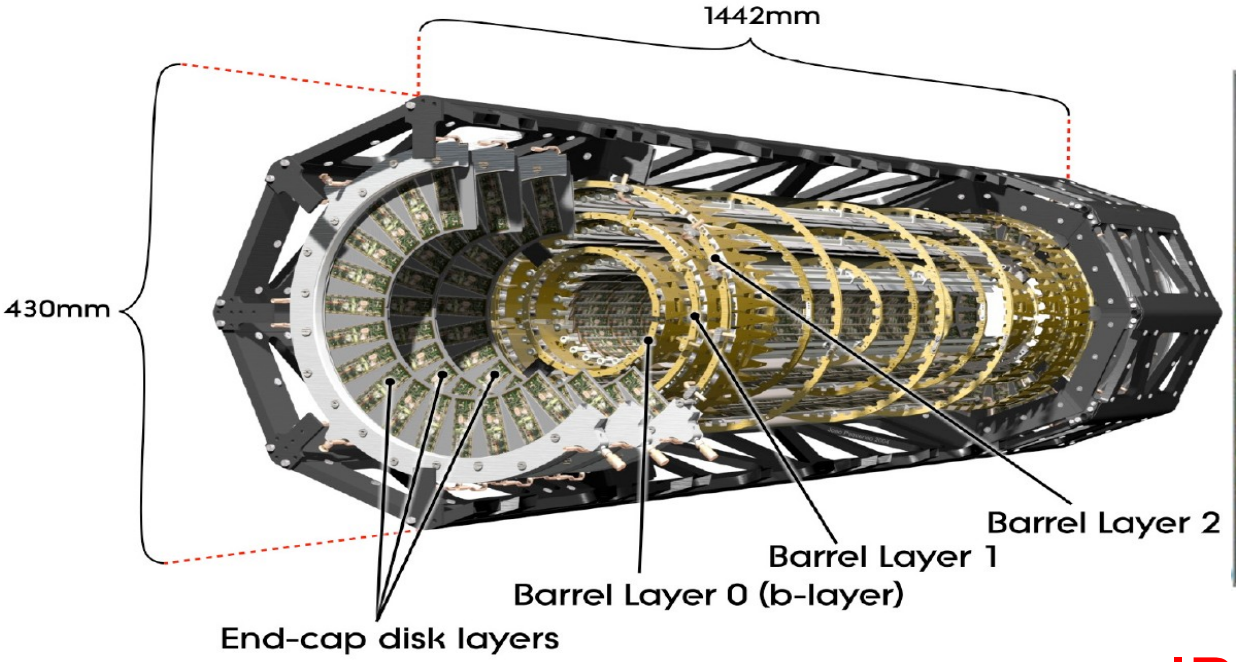
29 September 2010

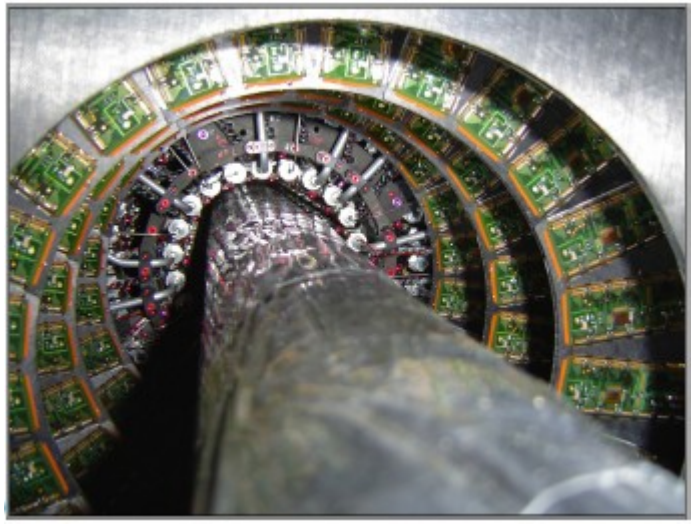
Outline

- ATLAS Inner Detector & Insertable B-layer project
- ATLAS Planar Pixel Sensors
- July 2010 Testbeam @ CERN SPS
- Data reconstruction
- *Preliminary* results
- Summary & Outlook

ATLAS Pixel Detector & Insertable B-Layer

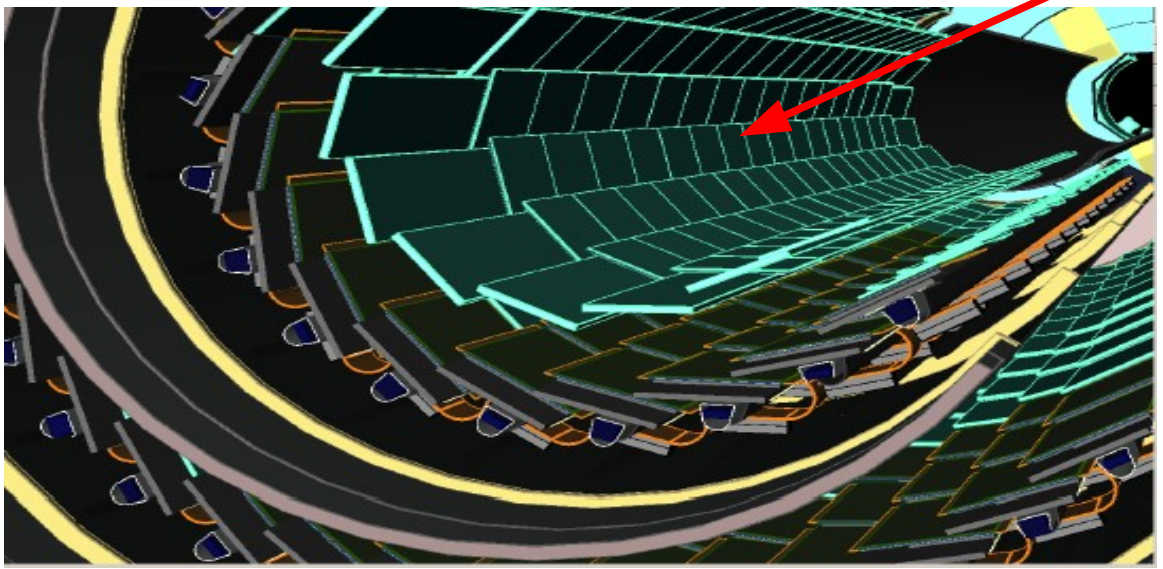
Current Pixel Detector

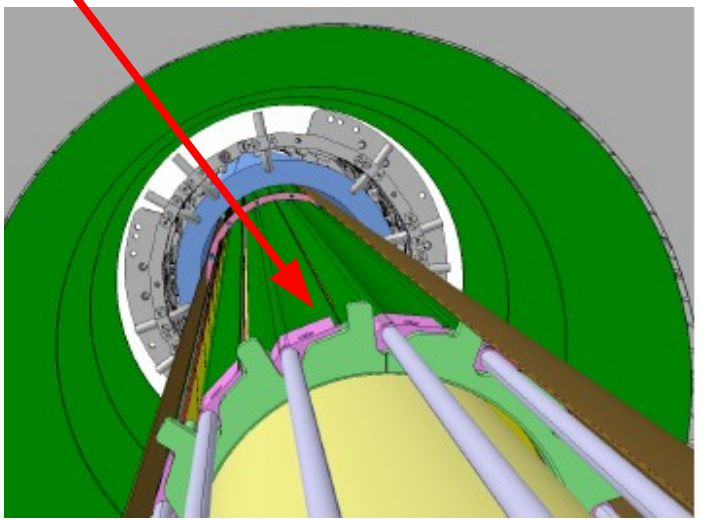




+ IBL

IBL





Why IBL?

- Tracking robustness
  - Restores efficiency in case of Pixel layers failure
- Luminosity effects
- Tracking precision
  - Improves sensitivity for signals involving b-jets, e.g. low mass SM Higgs in $WH \rightarrow b\,\bar{b}$
- Beam Pipe replacement
- Large Radiation Doses

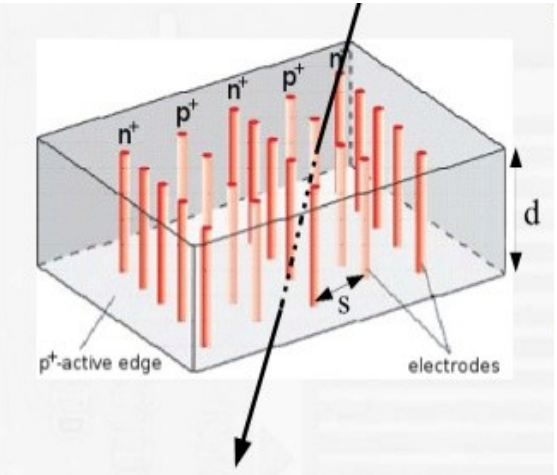
Three technologies are considered for IBL *(no decision yet)*

Planar Sensor

- current design is an n-in-n planar sensor
- silicon diode
- different designs under study (n-in-n; n-in-p ....)
- radiation hardness proven up to 2.4 . 10^{16} p/cm^2
- problem: HV might need to exceed 1000V

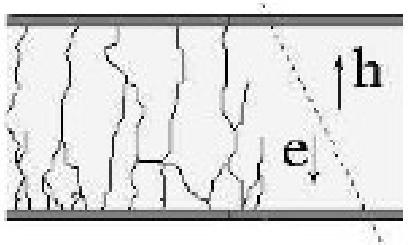
3D Silicon

- Both electrode types are processed inside the detector bulk instead of being implanted on the wafer's surface.
- Max. drift and depletion distance set by electrode spacing
- Reduced collection time and depletion voltage
- Low charge sharing



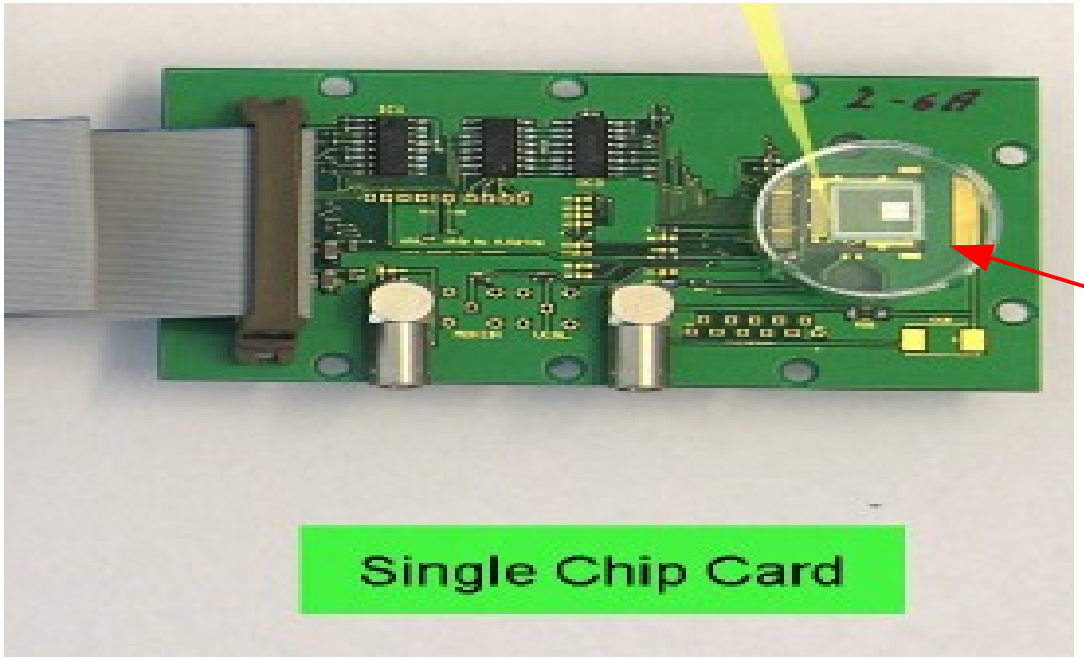
CVD (Diamond)

- Poly crystalline and single crystal
- Low leakage current, low noise, low capacitance
- Radiation hard material
- Operation at room temperature possible
- Drawback: 50% signal compared to silicon for same X_0, but better S/N ratio (no dark current)



Principle aim: study performance of three technologies in the same way and compare

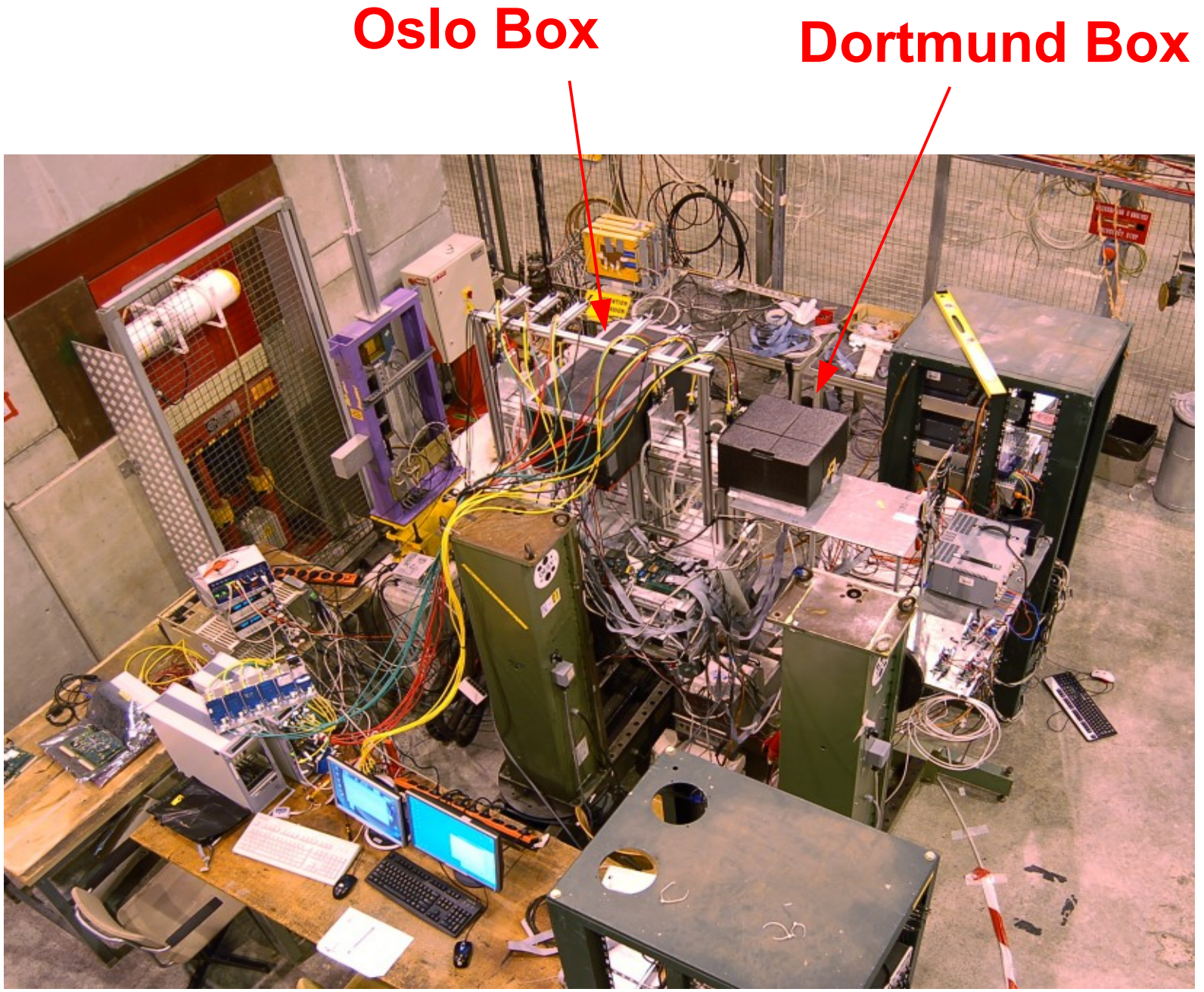
FE-I3 Planar Pixel Sensors



- Pixel size: 50 x 400 µm
- Sensor consists of 18 * 160 pixels
- Pixel at column 0 and 17:

  50 x 600 µm

July 2010 Testbeam @ CERN SPS

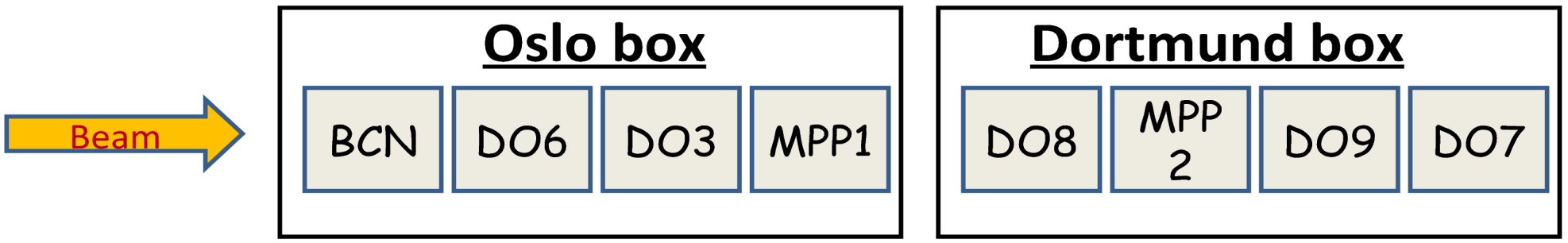


~30M events taken

July 2010 Testbeam @ CERN SPS

Batch 2

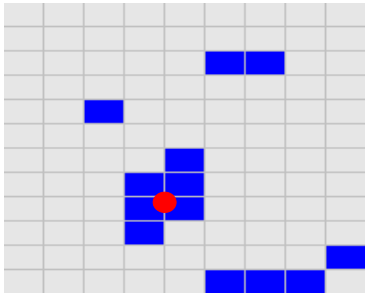
DUT	BCN	DO6	DO3	MPP1	DO5	MPP2	DO8	DO9	DO7
GA	3	C	A	5	B	6	E	F	D
type	Trench etched	Gr shifted	Pxl shifted	Red. gr	Pxl segm.	Std gr	1E15 neutrons	5E15 neutrons	1E15 protons

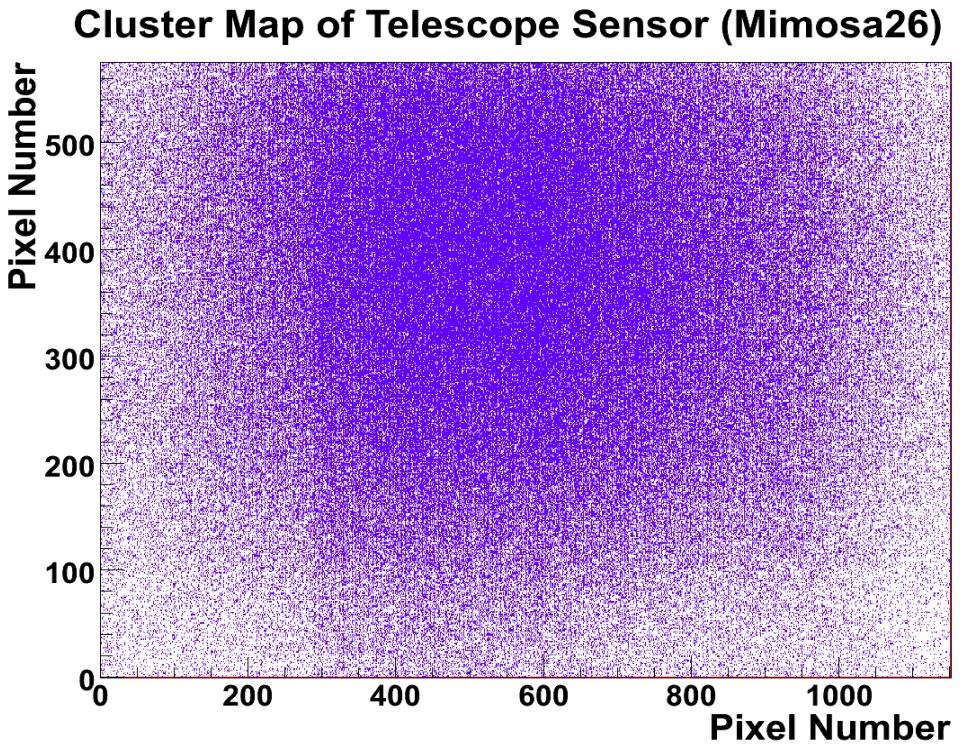


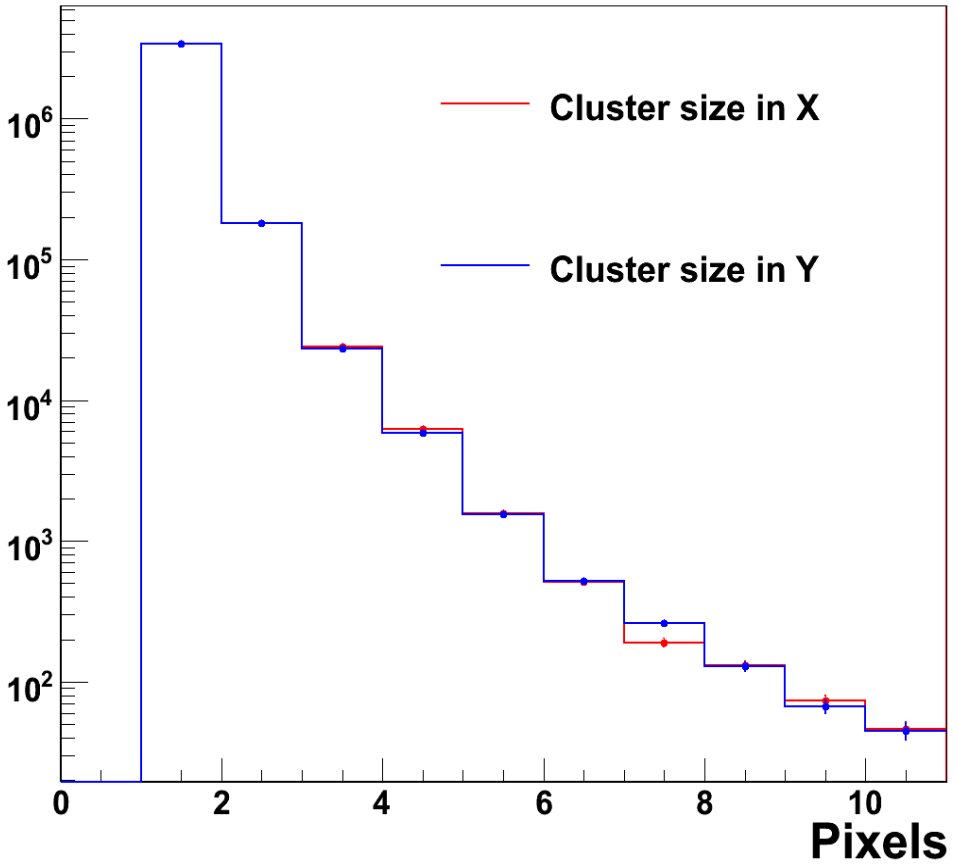
Version: 15/07/2010 09:00

Data reconstruction - clustering

- Sparse Clustering Algorithm - vicinity criterion
- Hit position – (Charge-weighted) Center of Gravity

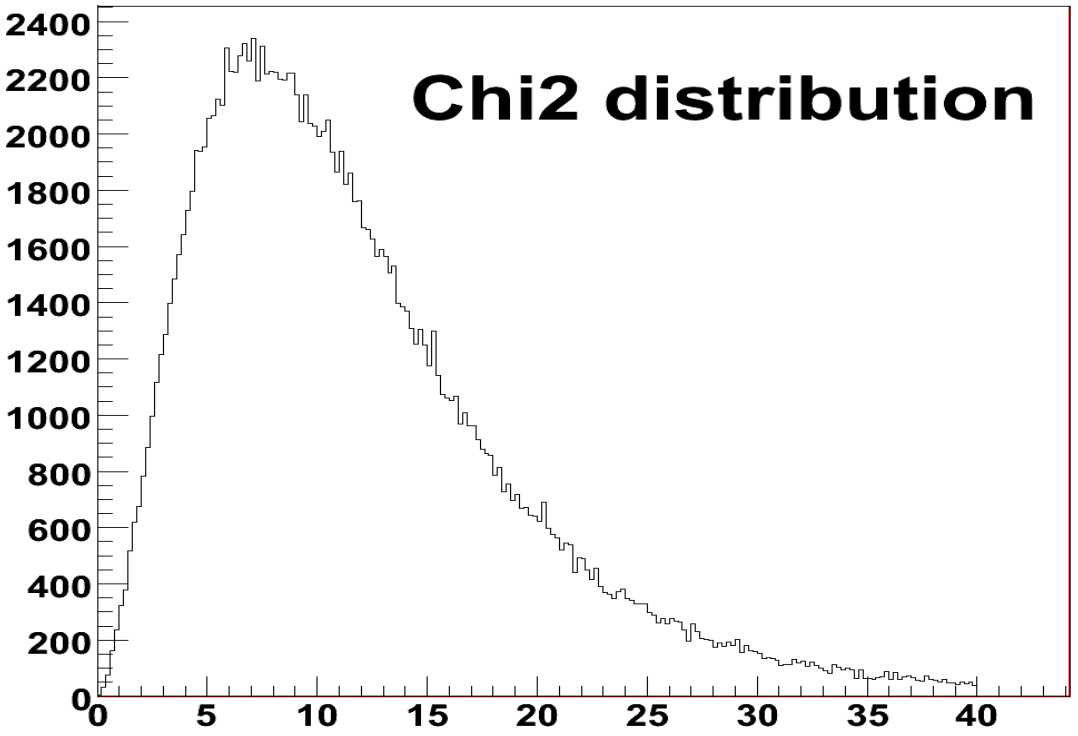


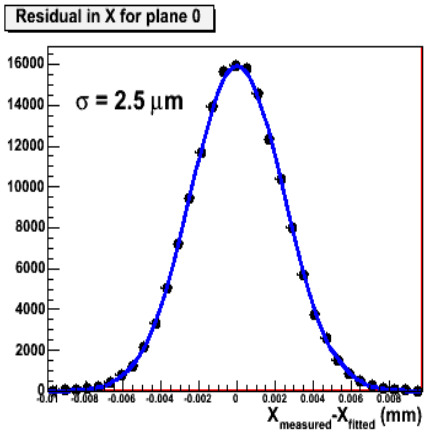


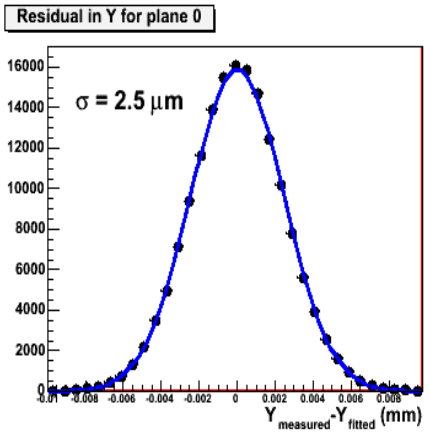


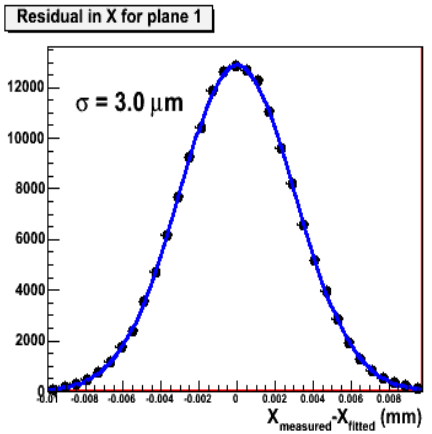
Data reconstruction - tracking

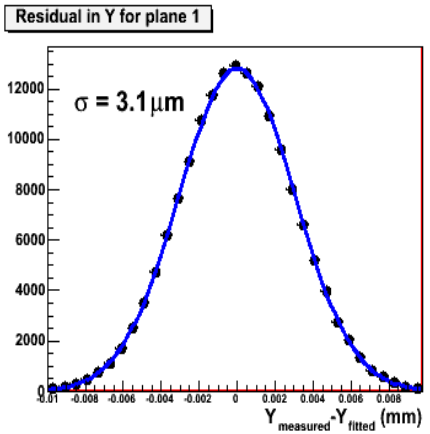
- Track selection for alignment using correlation bands, no need to choose residuals
- Trackfit – “analytical fitter”
- Nice gaussian residuals, $\sigma \sim 3\mu m$

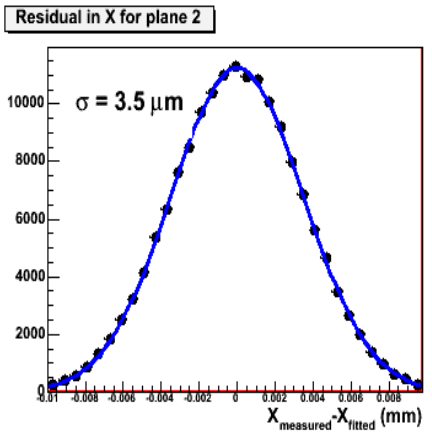


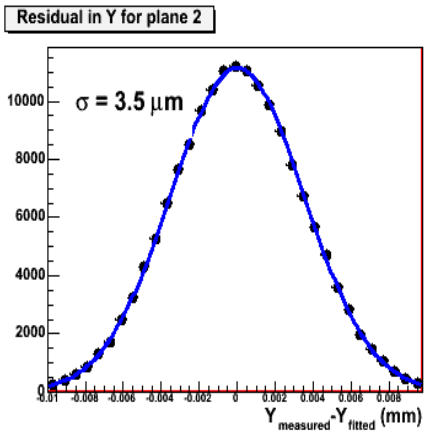






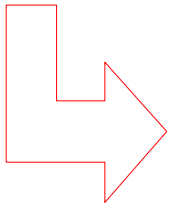


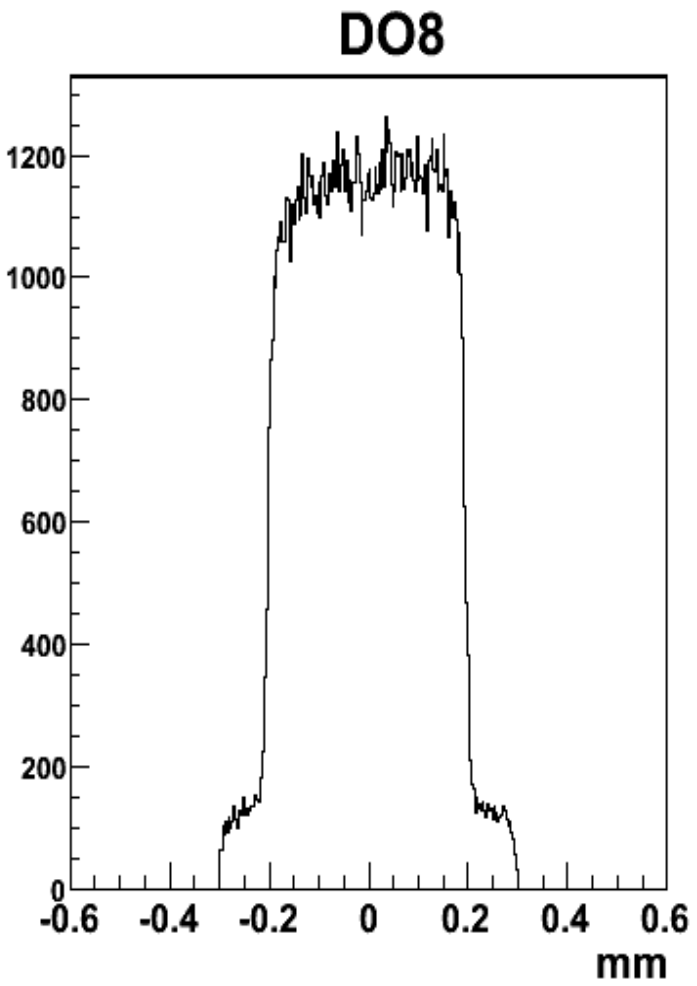


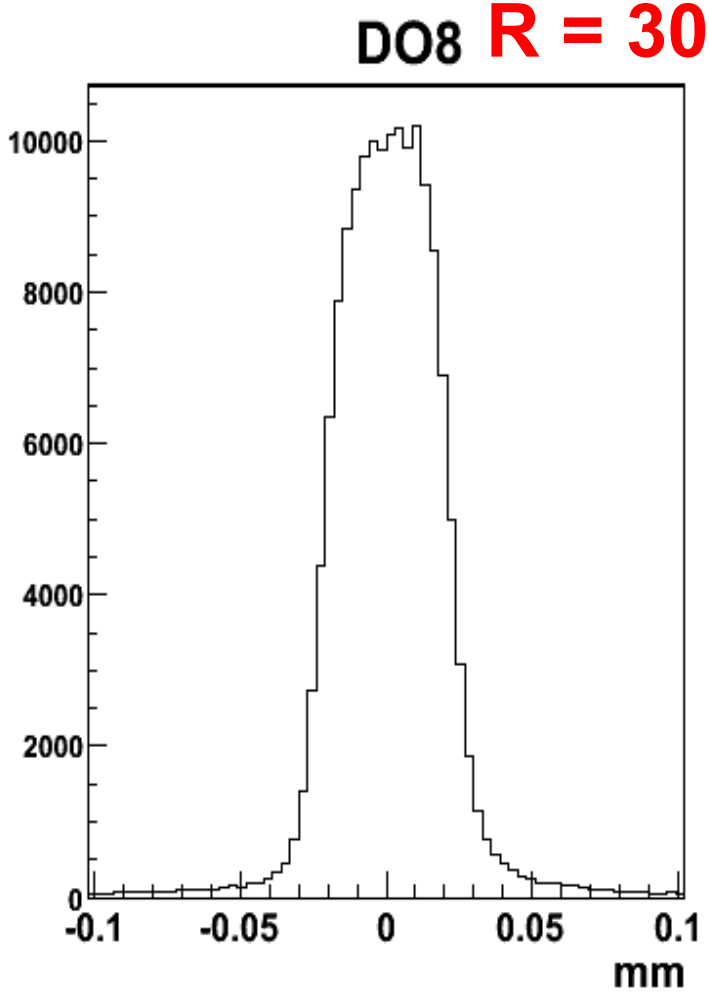


“Unbiased” DUT residuals

- Tracks are extrapolated to DUT
- If there is a hit inside a radius of R, it's considered as matched



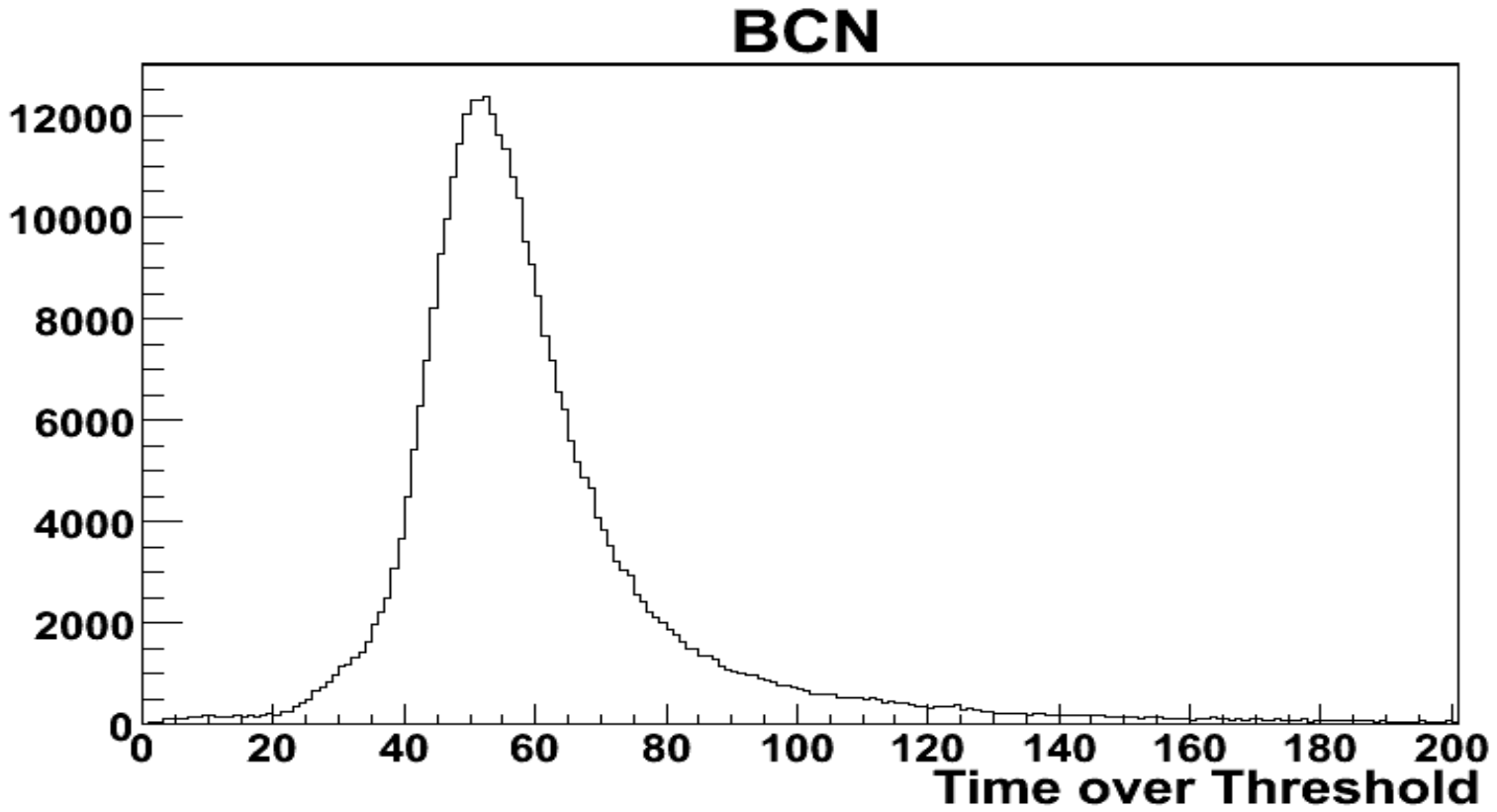




- Long pixel are visible (600μ instead of 400μ)

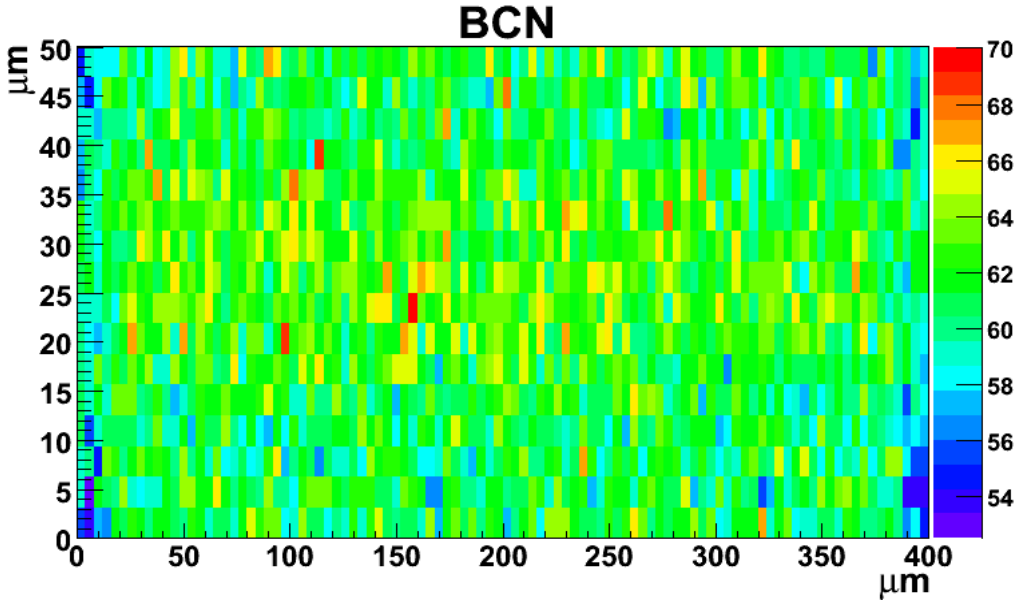
ToT spectra

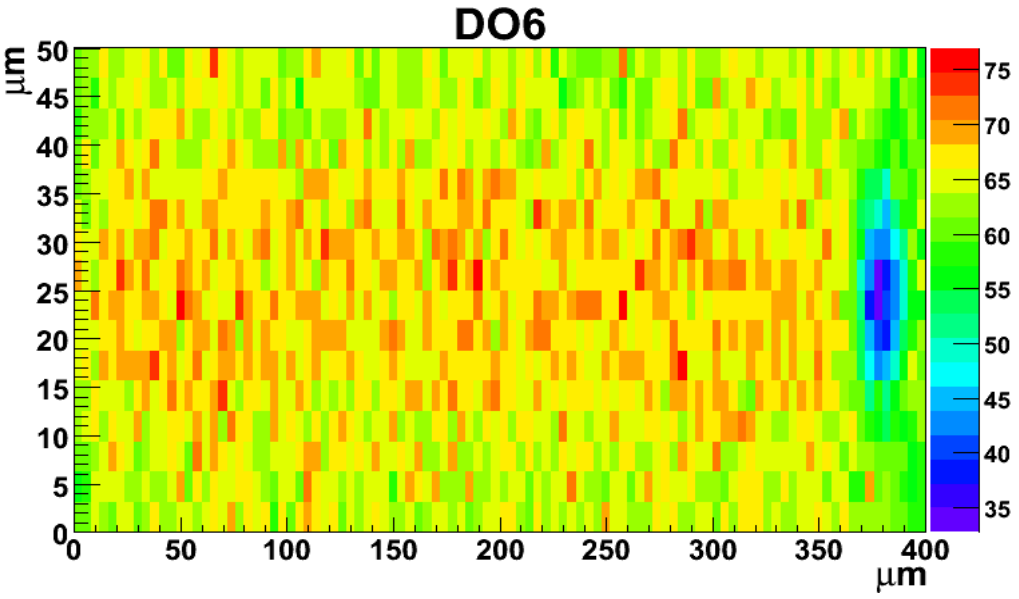
- ToT = Time over Threshold, corresponds to charge collected from the pixel

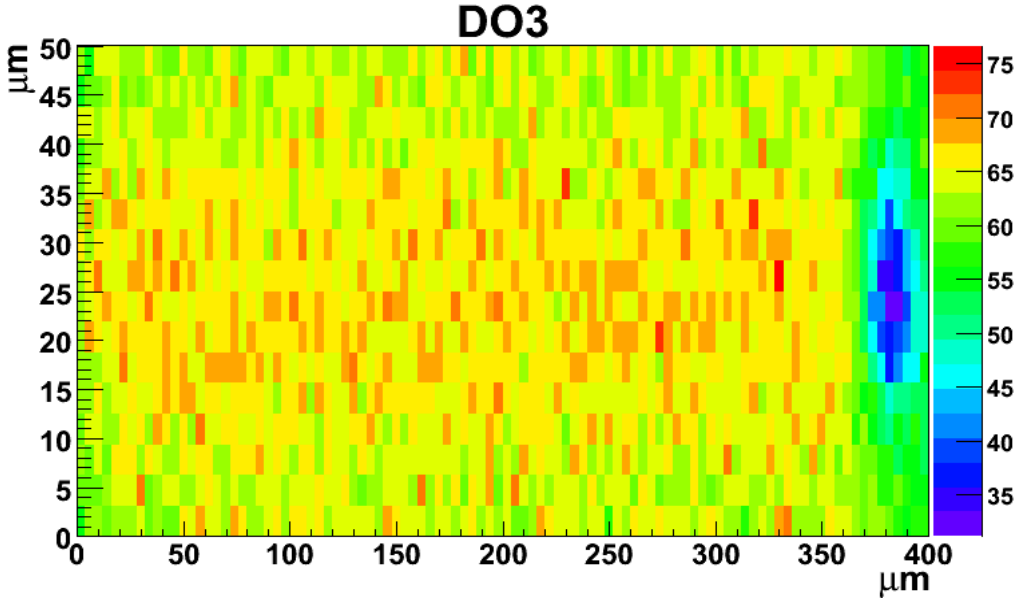


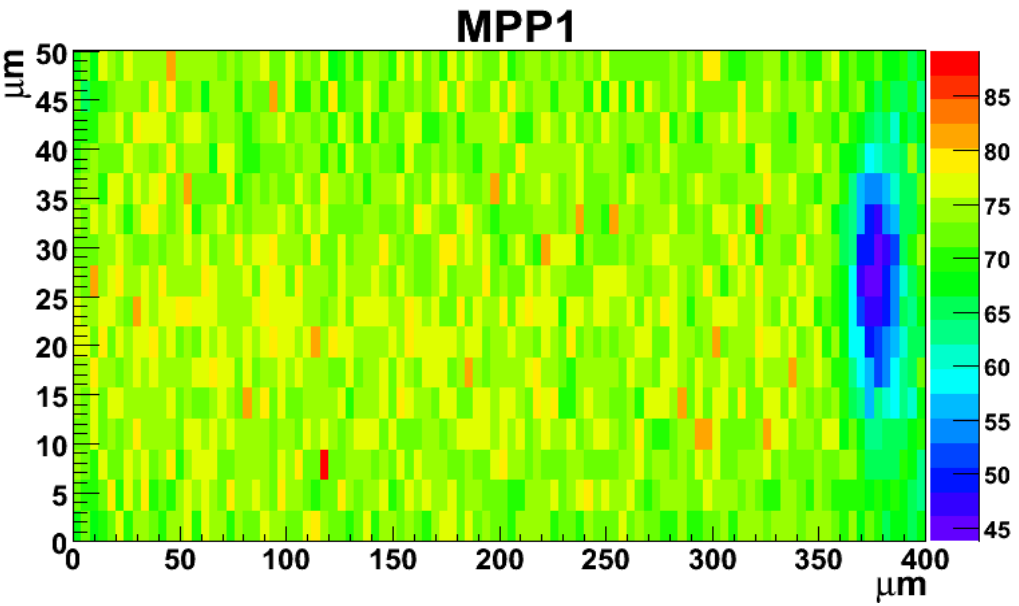
- Follows landau distribution as expected

ToT vs track position inside pixel



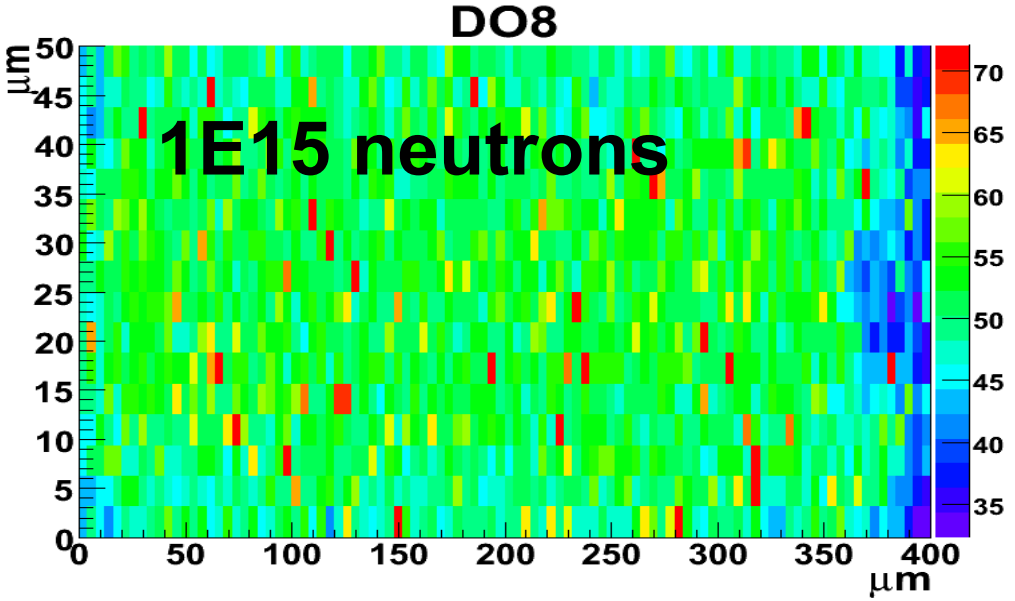


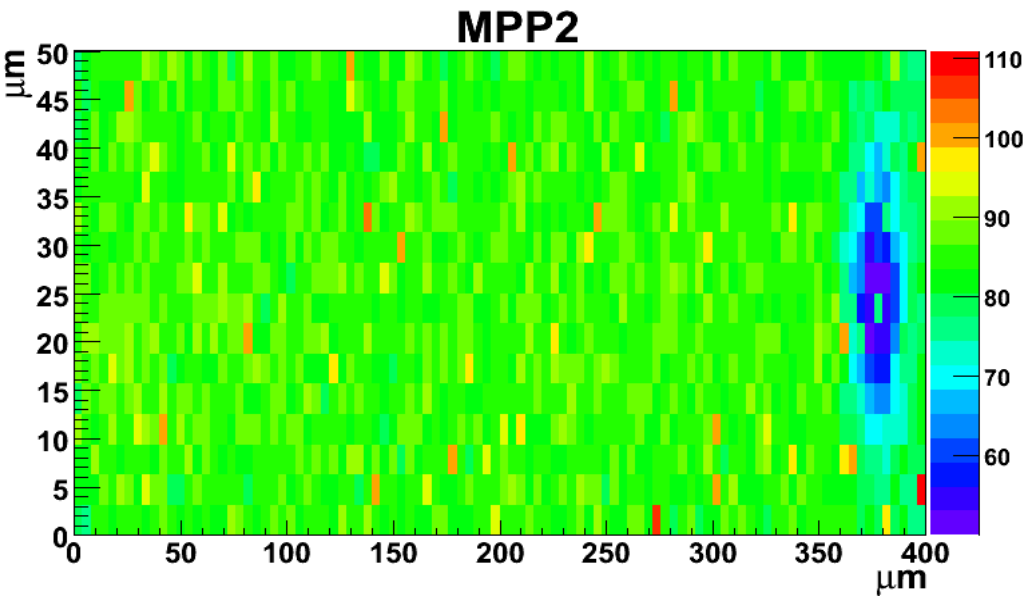


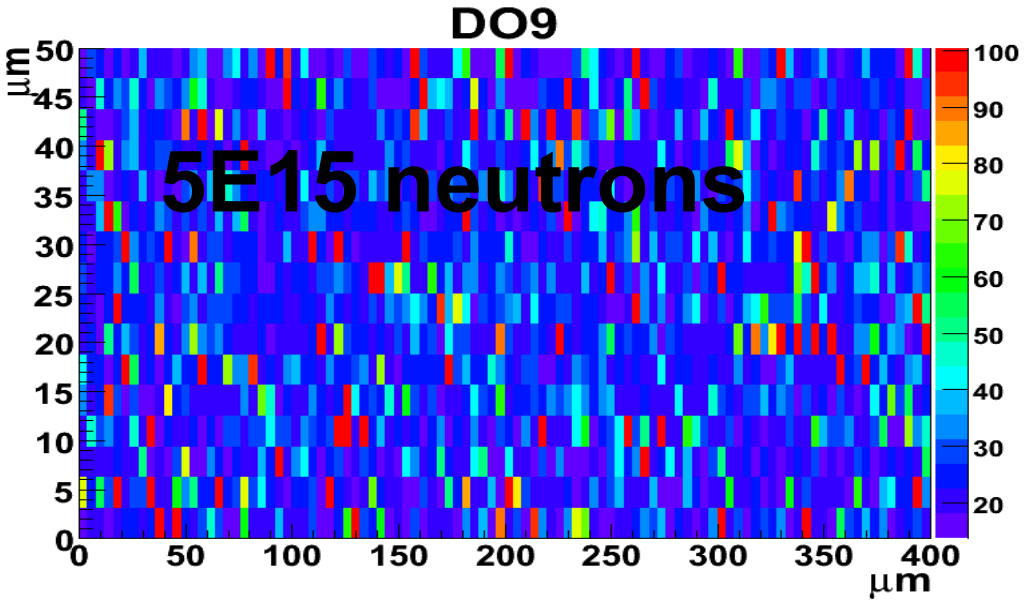


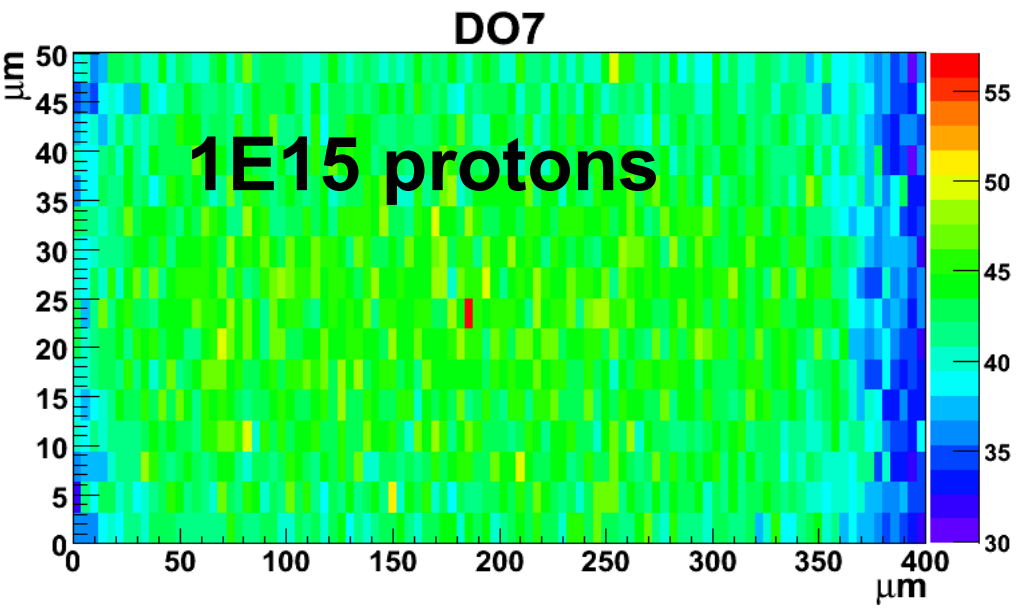
- *"Bias dots"* clearly visible (not in BCN – as expected!)

ToT vs track position inside pixel



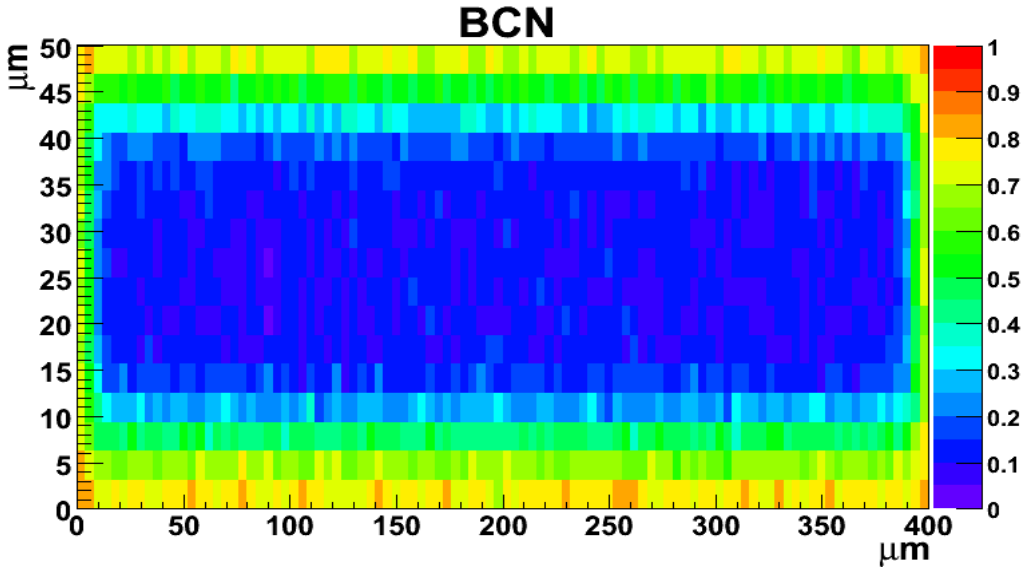


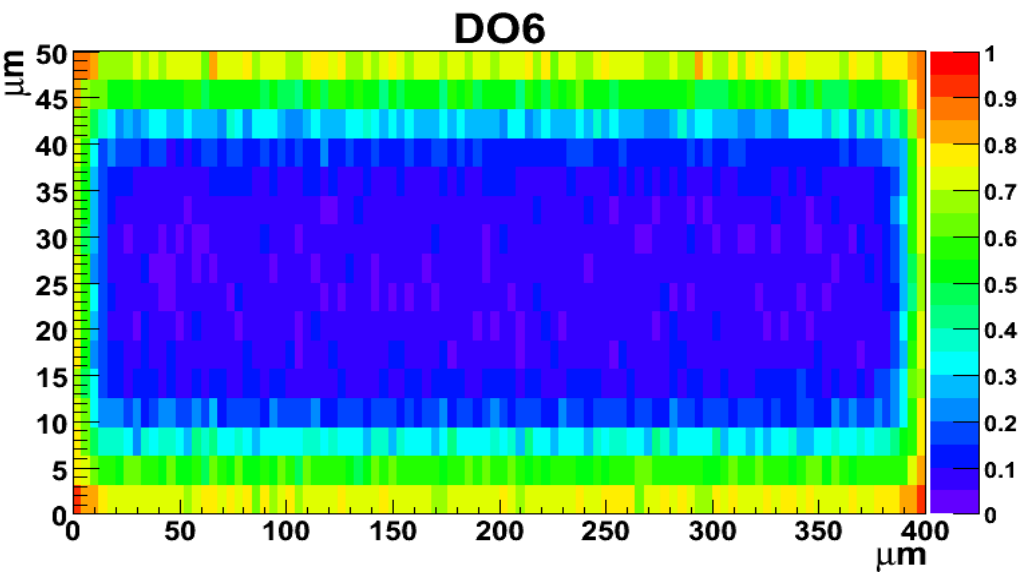


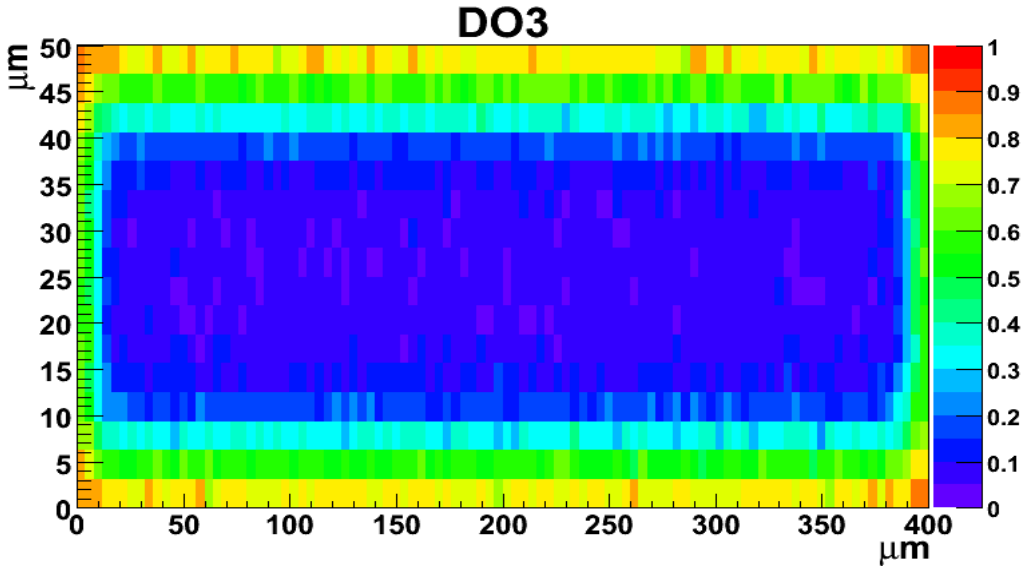


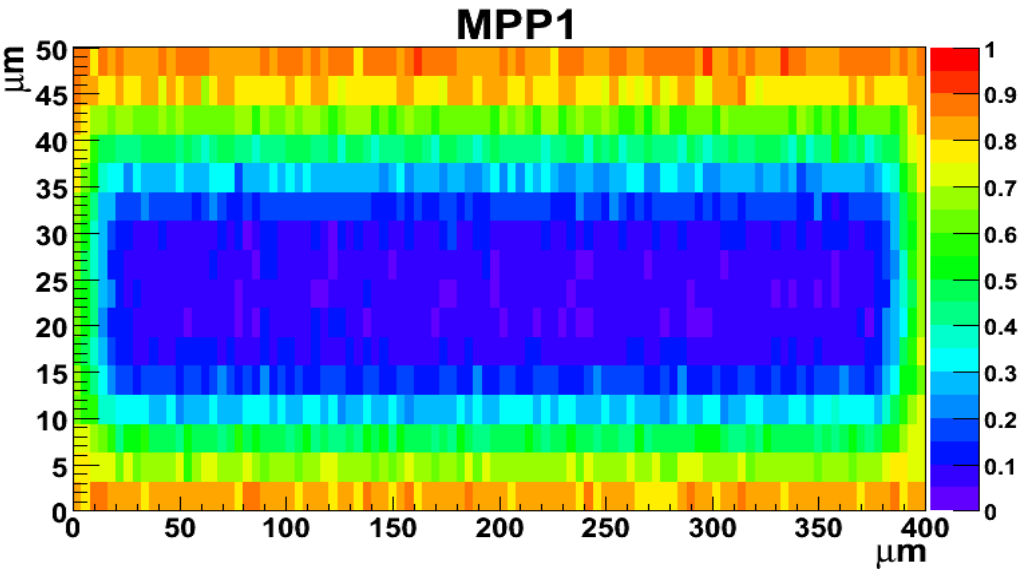
- Irradiated samples behave differently

Charge Sharing Probability



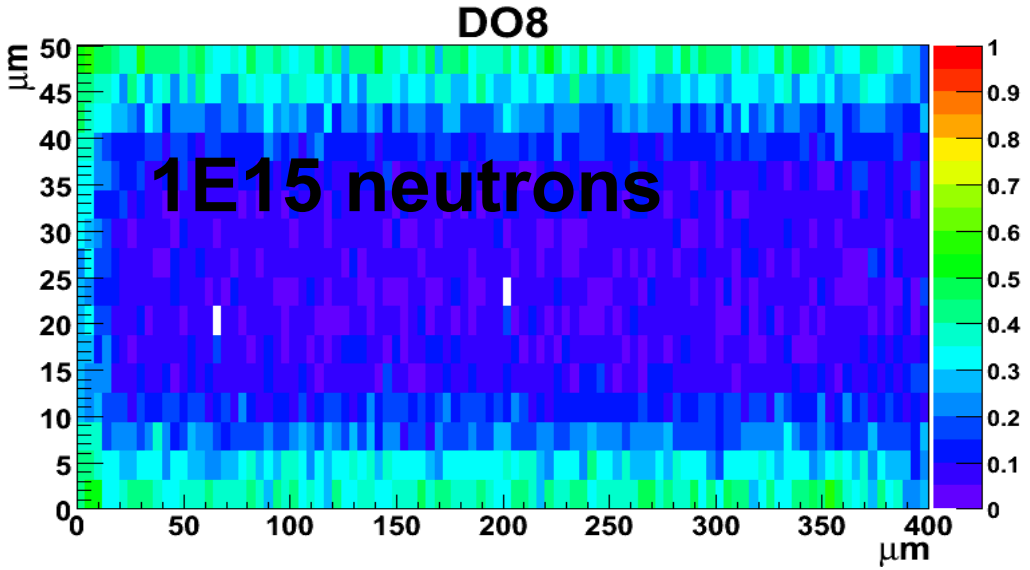


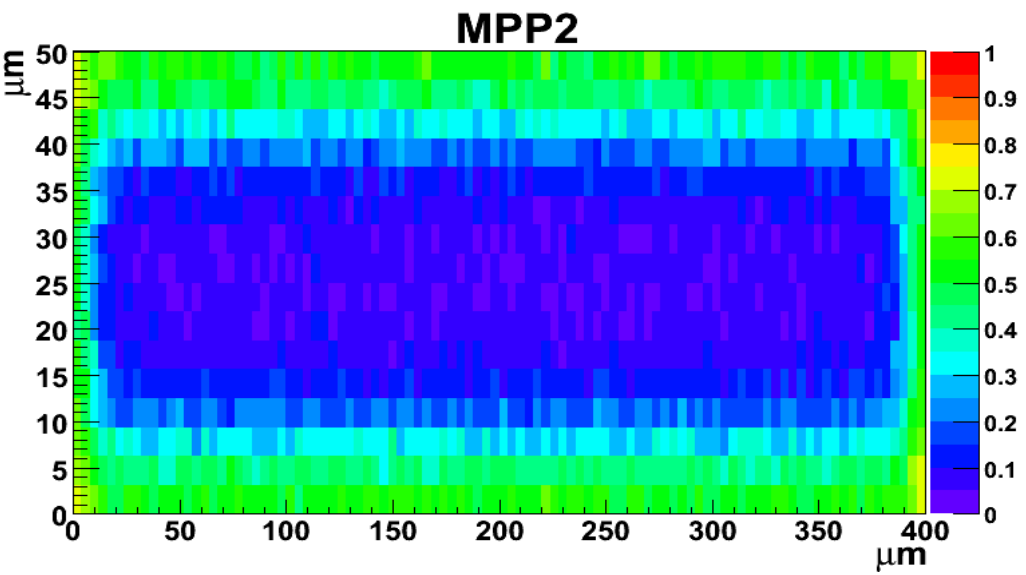


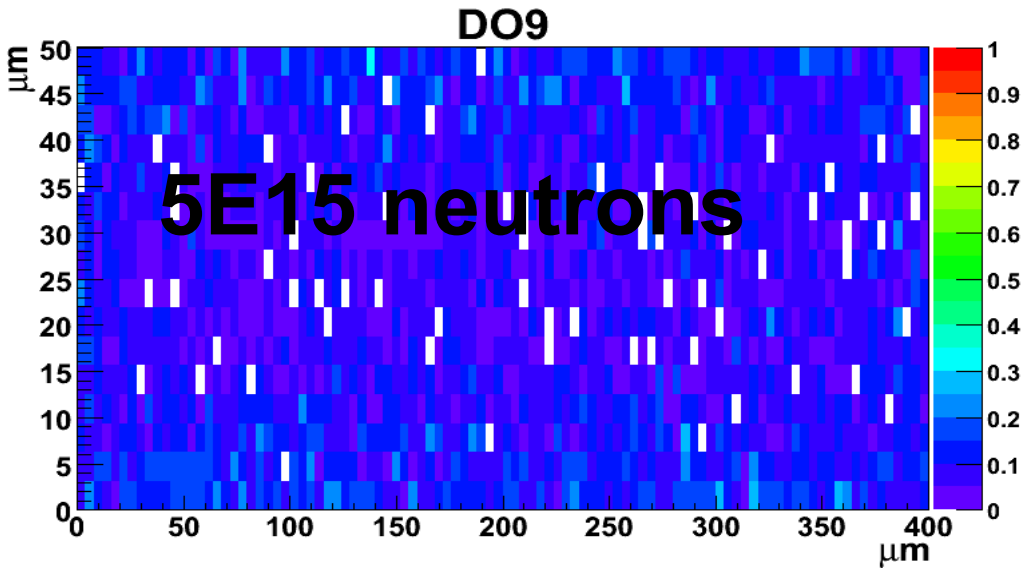


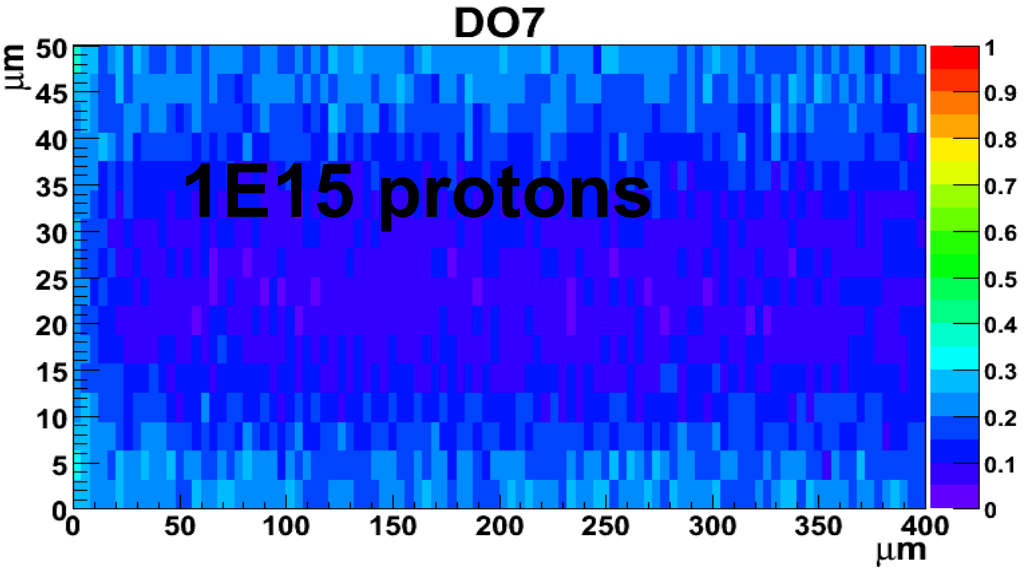
- Charge sharing higher at the edges as expected

Charge Sharing Probability





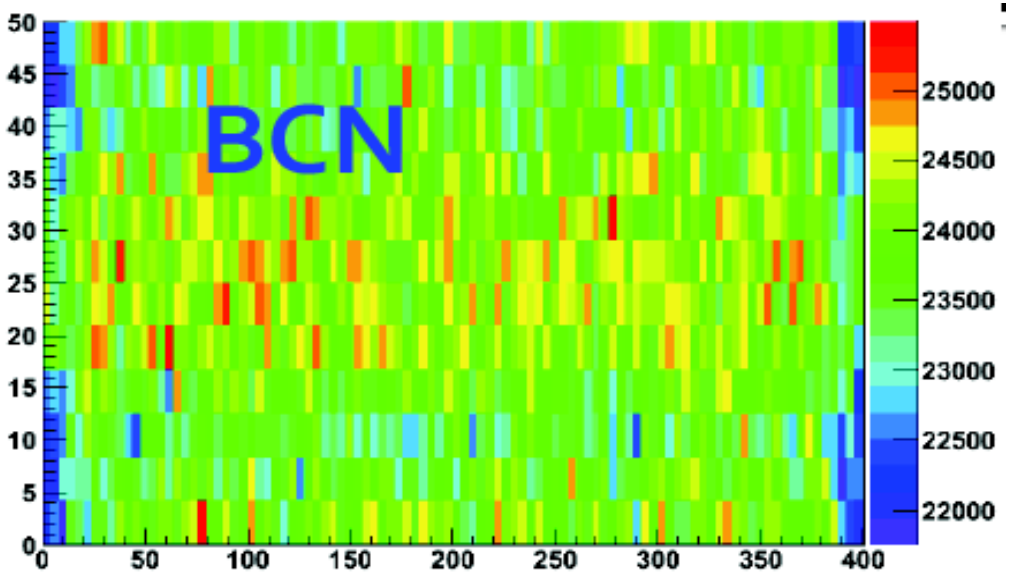


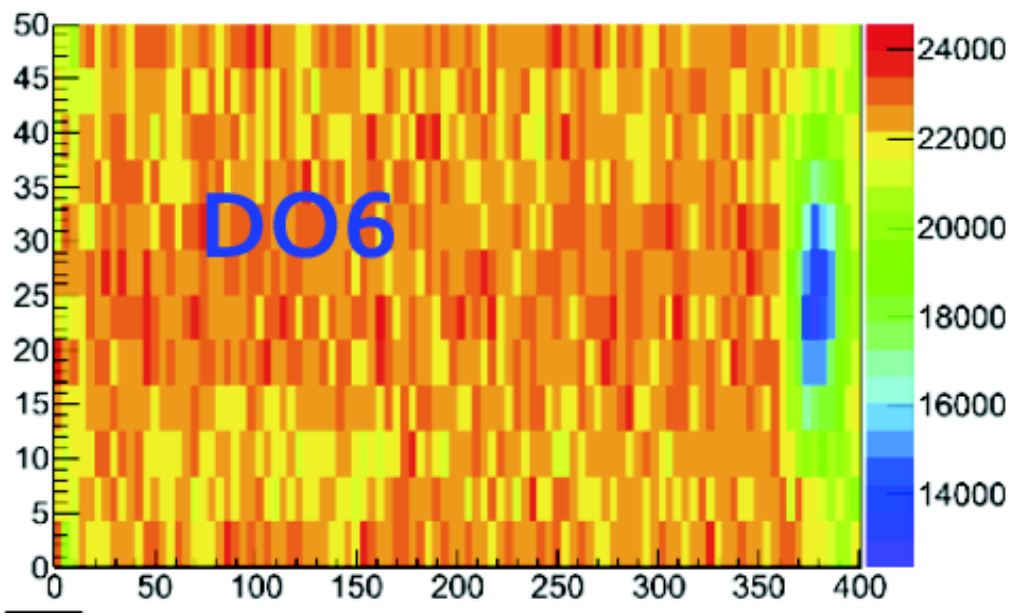


- Irradiated samples show less charge sharing

Analysis with tbmon

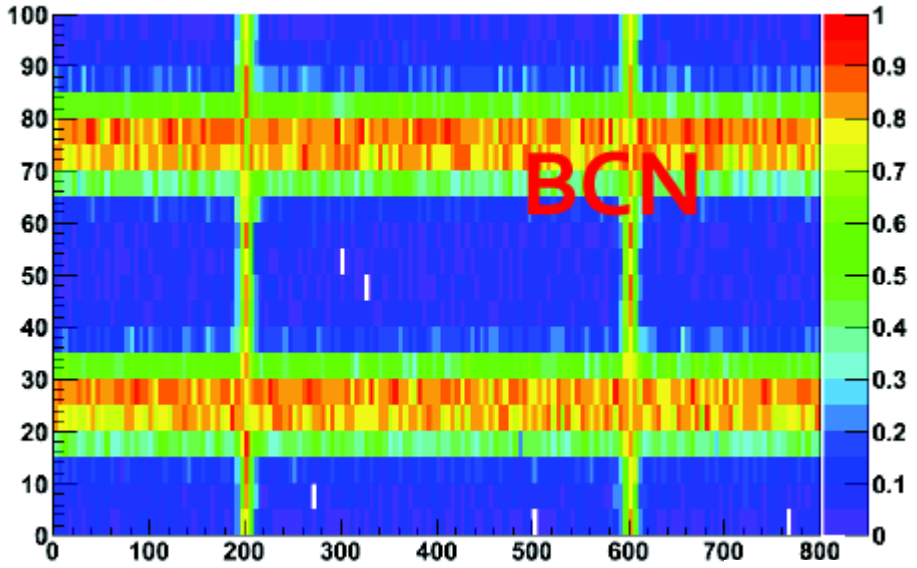
- Charge collection plots
- Look similar to ones from EUTelescope (compare slide 13)

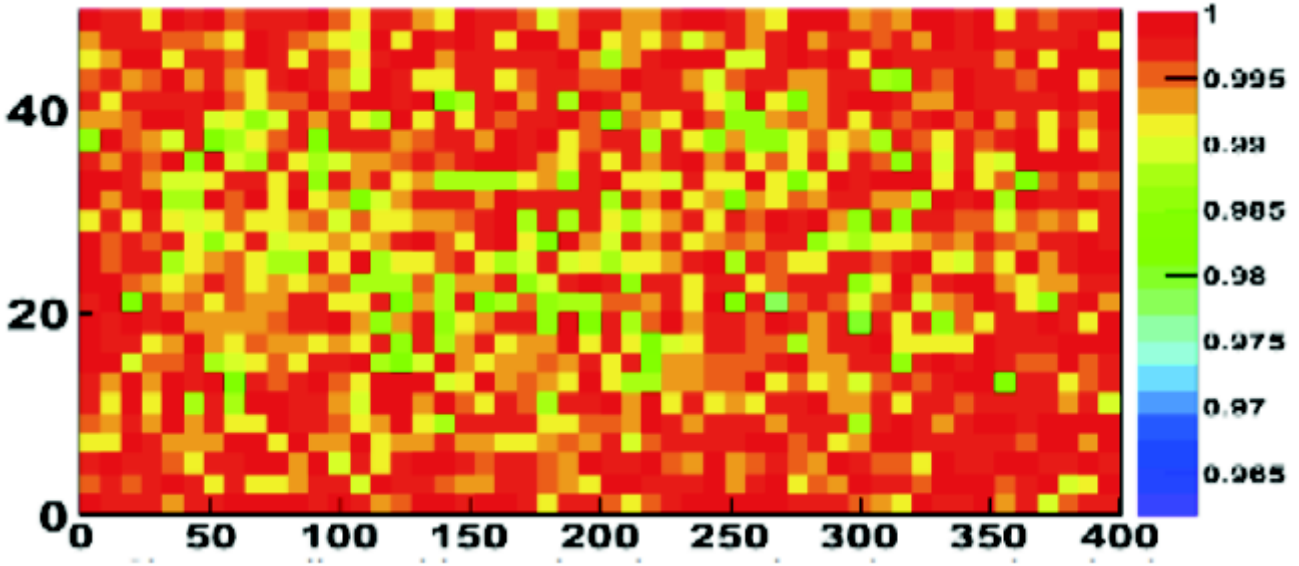




Plots: M. Benoit @ Planar Pixel Sensor Meeting, Munich, 16-17 September 2010

Analysis with tbmon – charge sharing, efficiency





Plots: M. Benoit @ Planar Pixel Sensor Meeting, Munich, 16-17 September 2010

Summary and Outlook

- Analysis of July 2010 testbeam data is in progress
- This talk: analysis entirely within EUTelescope
- Results agree to tbmon
- Next – finish reconstruction of all data, prepare final plots
- Get ready for IBL testbeam in October 2010

Thanks a lot for Your attention!