Analysis of tracking data from a Si-strip telescope

Simone Bianco, Max Becker, Kai-Thomas Brinkmann, Ralf Kliemt,
Karsten Koop, Robert Schnell, Thomas Würschig, Hans Georg Zaunick

Bundesministerium
für Bildung
und Forschung

DPG Spring Meeting 2011, Muenster 21.03.2011

Bonn-Cologne Graduate School
of Physics and Astronomy

Outline:

- Setup of the Bonn telescope

- Optimization of the setup:

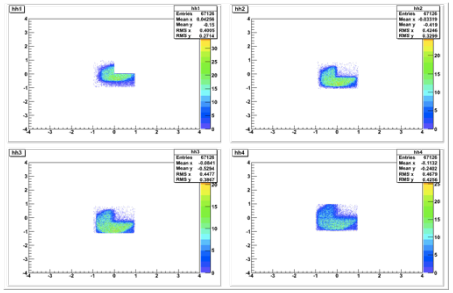
  - ✓ Rotation of one sensor
  - ✓ Longitudinal scan

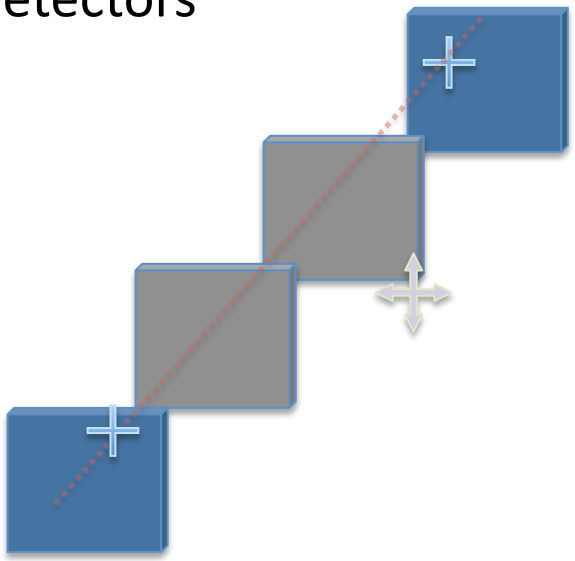
- Scattering measurements

The Bonn Si-strip telescope

Experimental Setup:

4 scintillators (mostly triggering on 3 out of 4)
2 double sided silicon strip detectors
4 single sided silicon strip detectors





Available beams:

Protons: 800 MeV/c
2.95 GeV/c
Electrons: 1 – 5 GeV

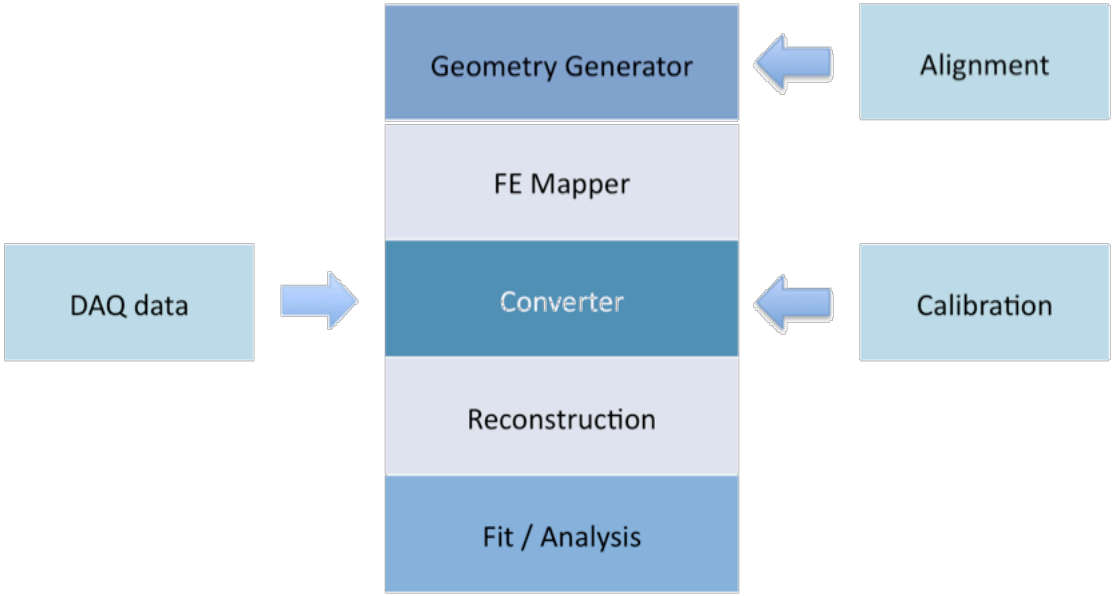
Setups:

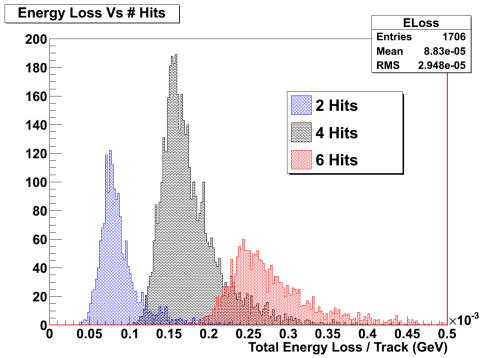
Holding structure for scatterers
Z-positioning for the 4 boxes
One rotatable box

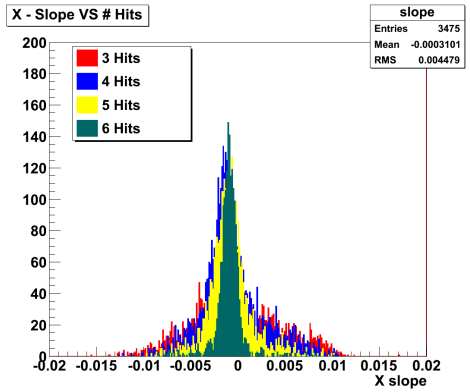
Software Tools:

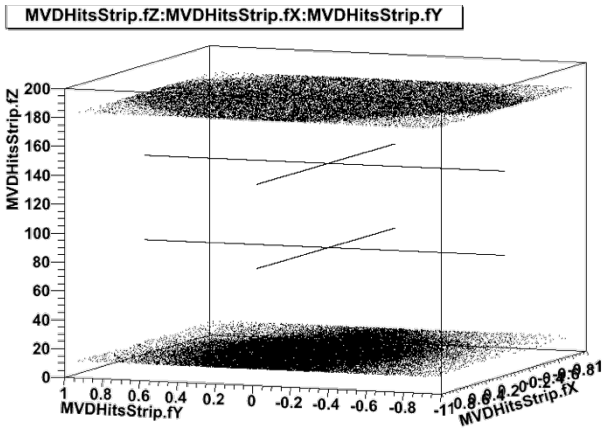
Offline alignment
Calibration
DAQ → pandaroot
Analysis tools

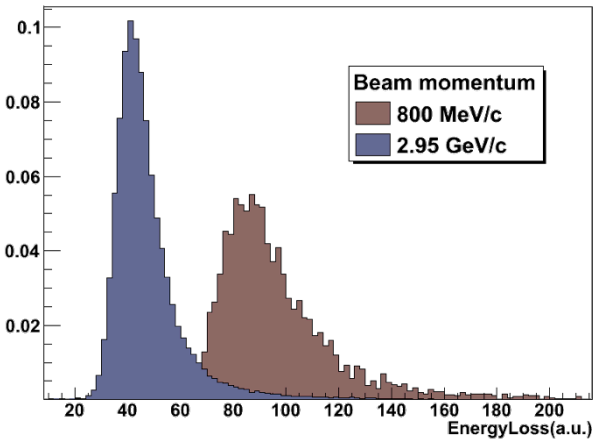
DAQ to PANDAroot

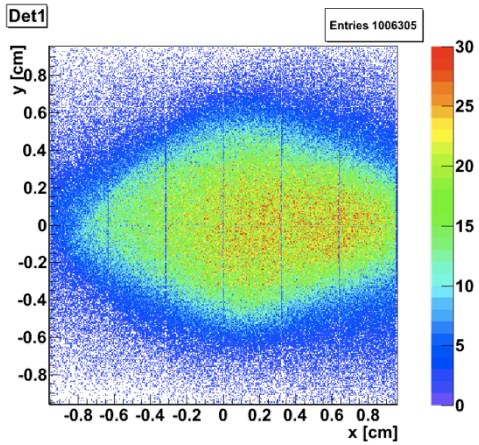




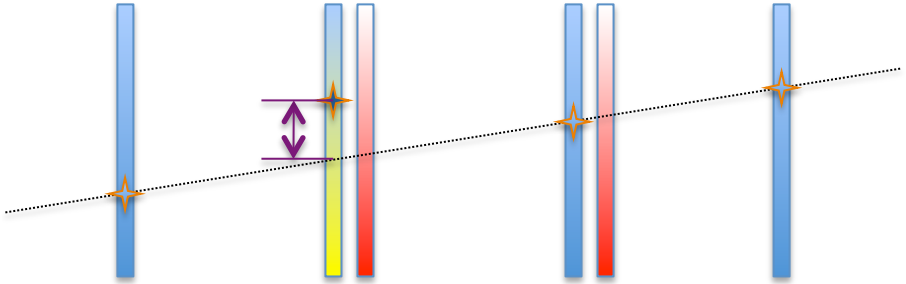








Alignment



Iterative procedure to align sensors:

1. Measure residual on the 1st sensor
2. Correct the position of the 1st sensor
3. 2nd sensor… 6th sensor
4. Reiterate the whole loop

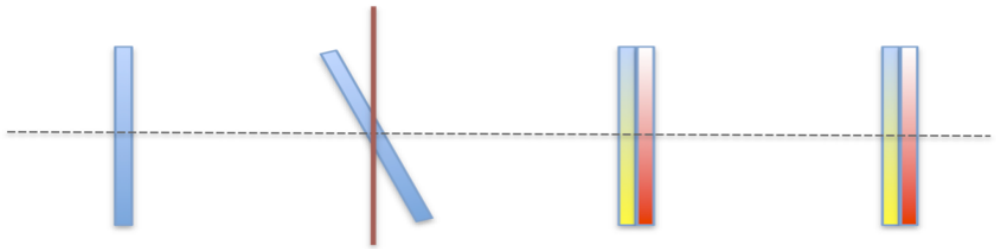
Energy Calibration

Realized in two steps:

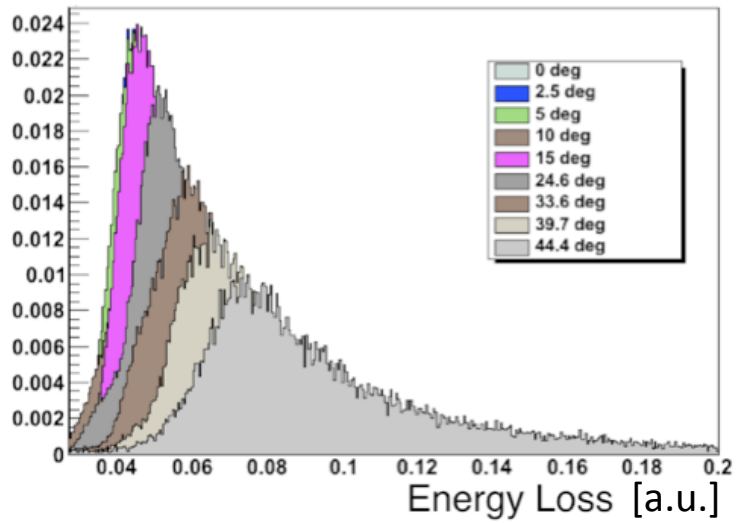
✓ Same charge injected on each of the FE channels
→ to resolve differences in the response

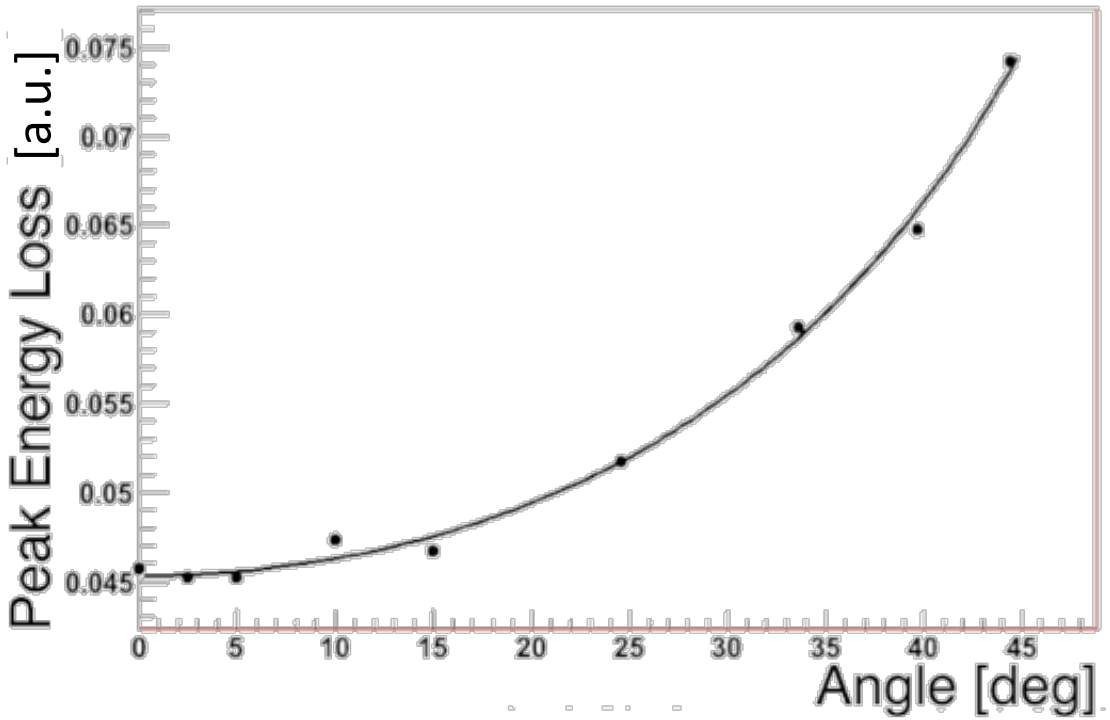
✓ MIP hypothesis
→ to set an absolute ADC counts-to-energy-loss scale

Rotation of One Sensor

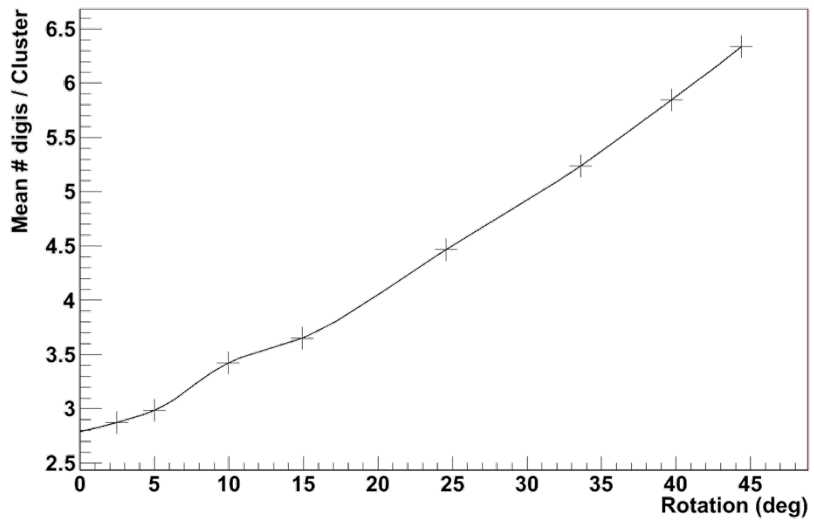


4 GeV electrons @ DESY [Hamburg]

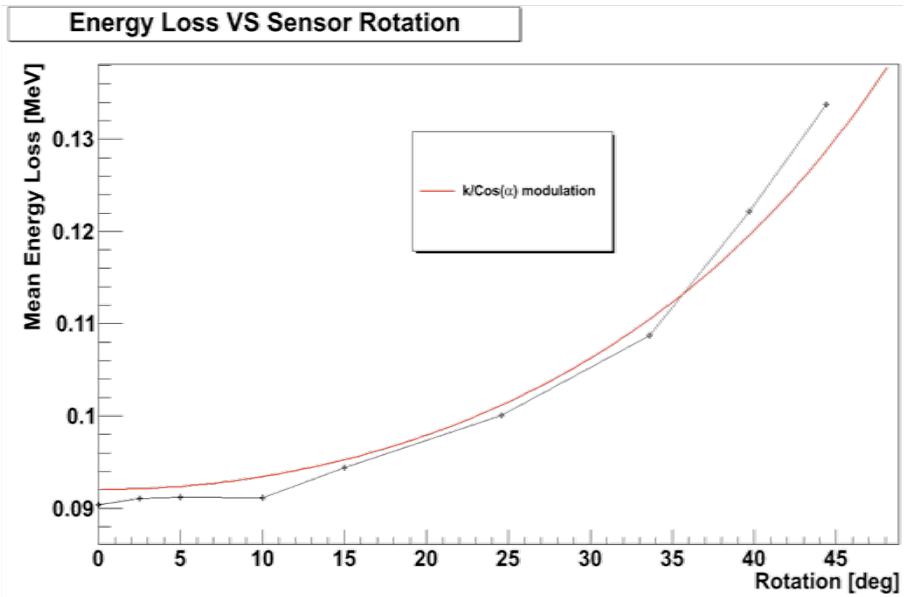


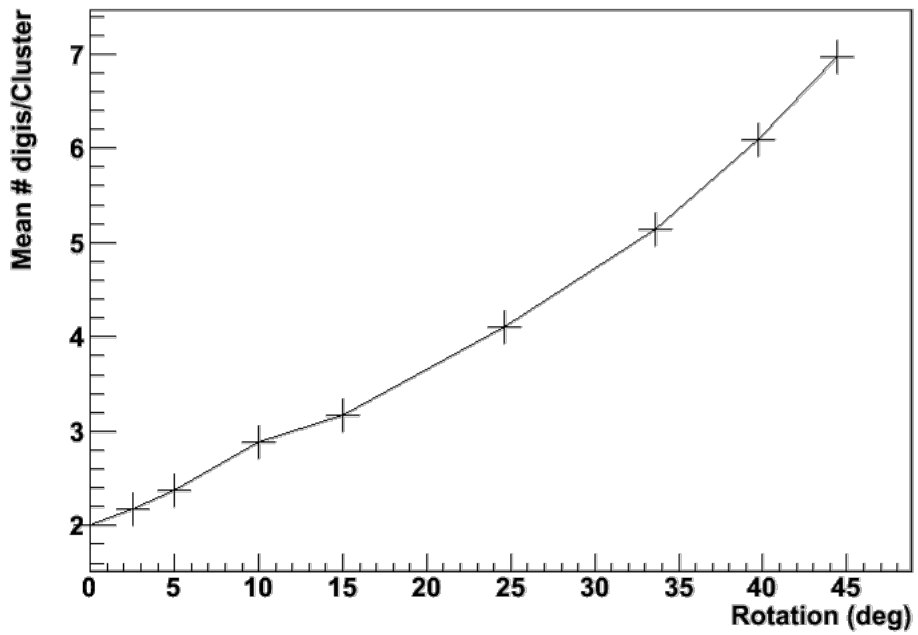


Energy loss and cluster size in the rotated sensor



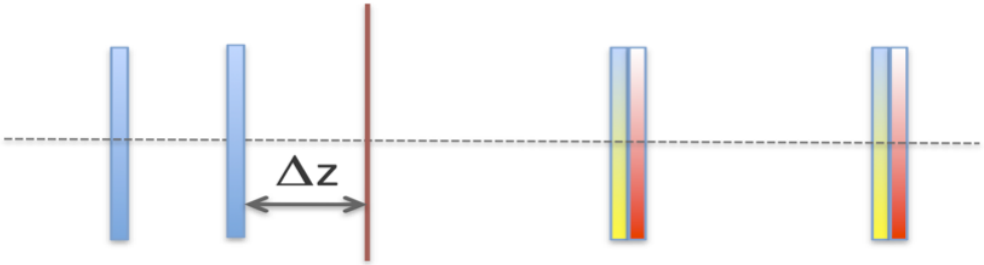
Rotation of One Sensor - Simulations





Electrons of 4 GeV, results obtained with Geant3

Translation of One Sensor

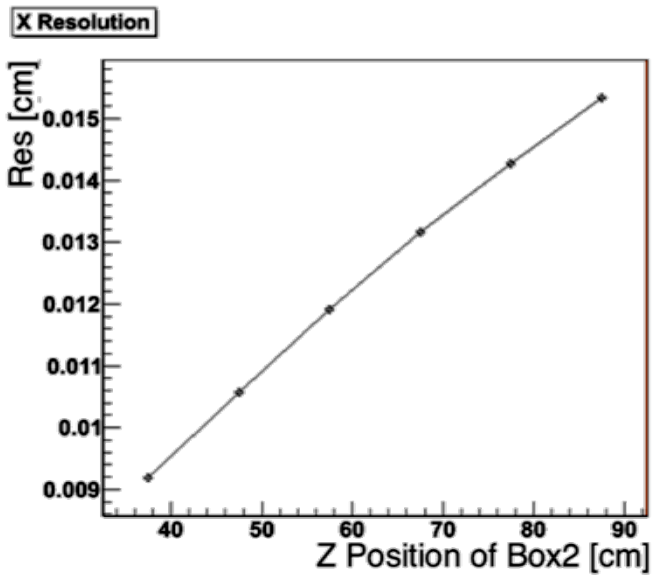


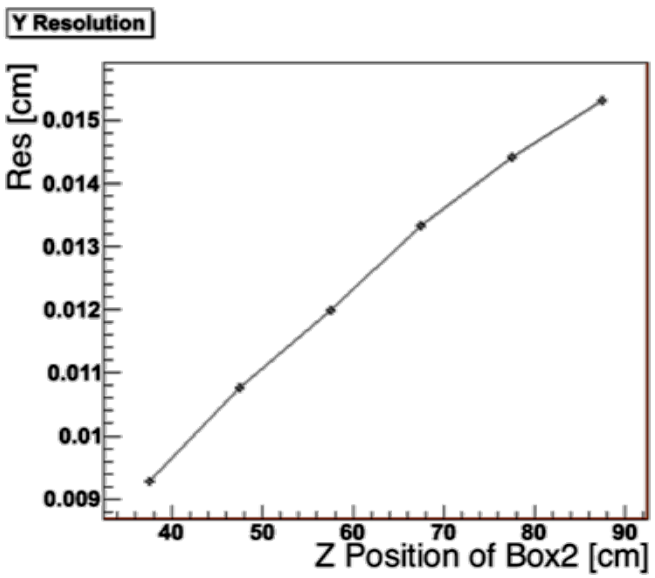
3 GeV electrons @ DESY [Hamburg]

Defining the following estimator:
"Unbiased resolution"

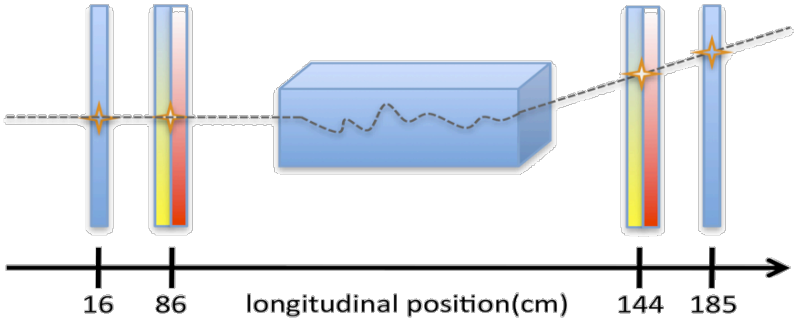
$$\mathrm{RES} = \sqrt[4]{\sigma_1 * \sigma_2 * \sigma_3 * \sigma_4}$$

RES minimal for the smallest distance between box 1 and 2





Scattering Measurements

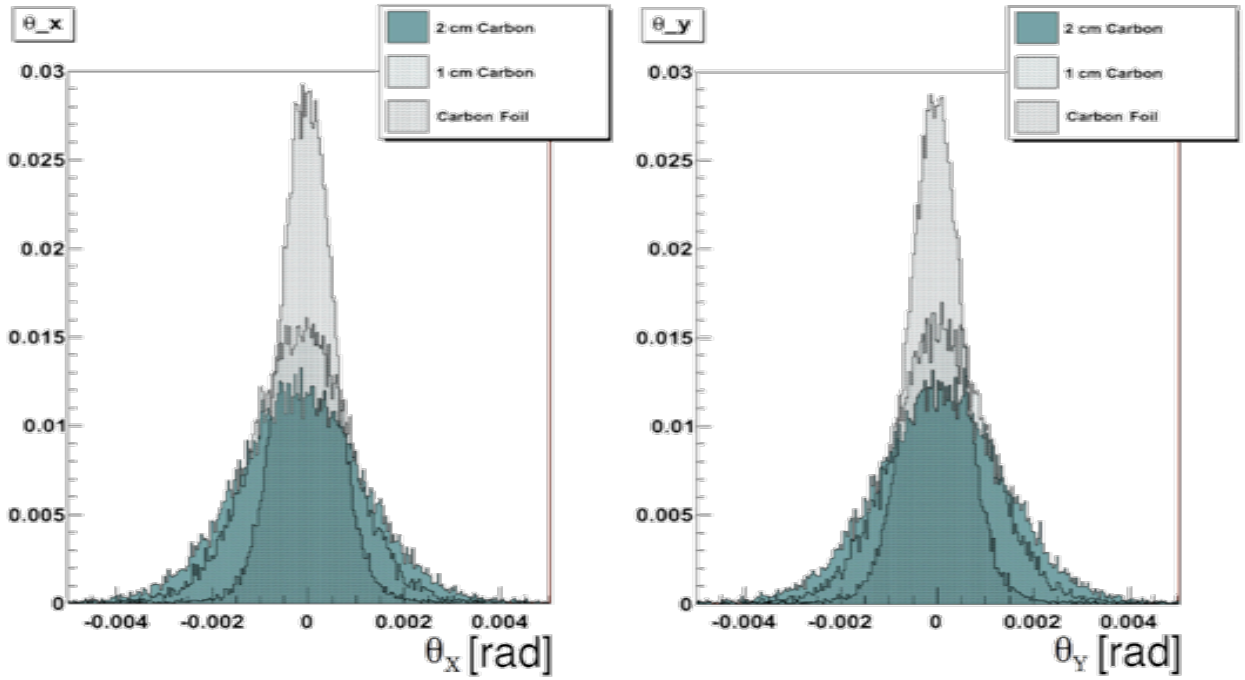


2 hits before the volume
2 hits downstream

Measurements of the scattering angle

Scatterers:

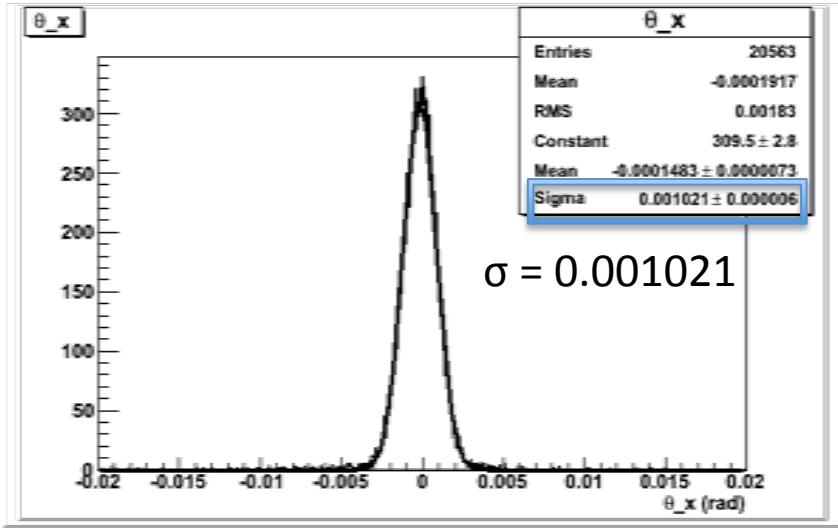
- a carbon foil (0.6 mm thick)
- 1 cm of C-like material (1.79 g/cm^3)
- 2 cm of C-like material (1.69 g/cm^3)
- 2.5 cm of carbon foam with a density of ~ 0.52 g/cm^3
- 4 mm thick carbon foam support disk with a density of ~ 1.1 g/cm^3

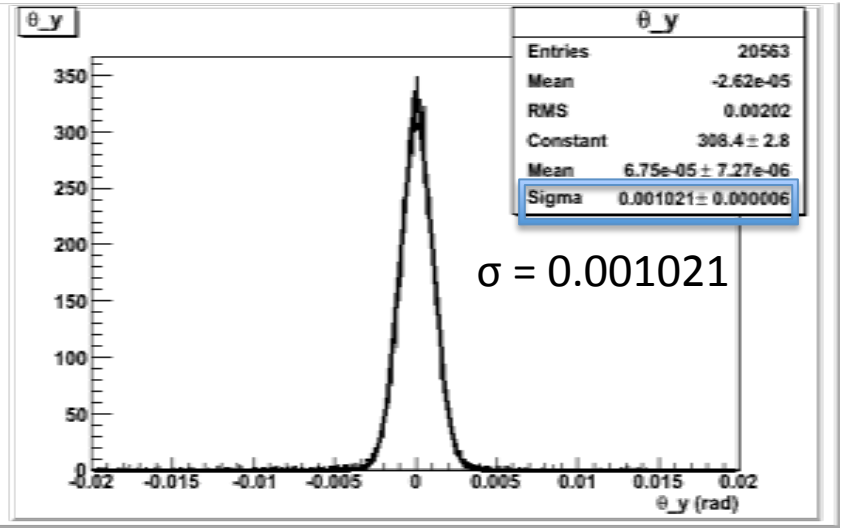


Beam: 2.95 GeV/c protons

Scattering – Measured Data

GEANT3 →Sigma 0.001011



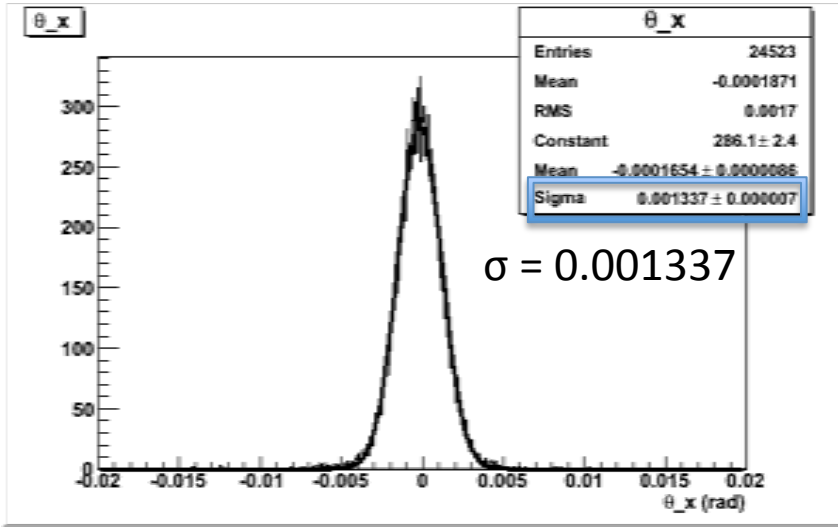


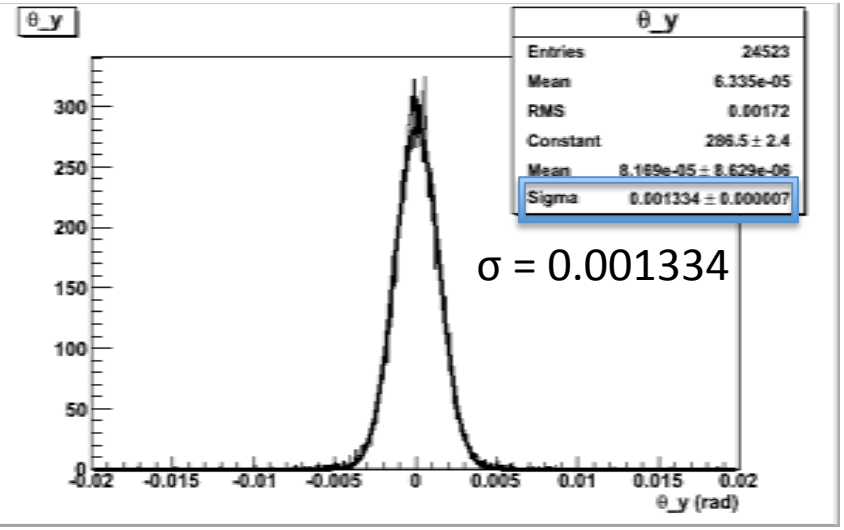
2.95 GeV/c protons scattering in:

1 cm of C-like material

2 cm of C-like material

GEANT3 →Sigma 0.001334





Scattering – Measured Data II

Measurements performed at DESY compared with Geant3 simulations

Scatterer	e^- Momentum	Sigma Meas. (rad)	Sigma Sim (rad)
air	1 GeV/c	0.00124	0.00140
air	3 GeV/c	0.000423	0.000476
air	5.4 GeV/c	0.000243	0.000284
2.5 cm C-Foam	1 GeV/c	0.002184	0.002544
2.5 cm C-Foam	3 GeV/c	0.0007455	0.0008869
2.5 cm C-Foam	4 GeV/c	0.0005876	0.0006453
1 Cm C	1 GeV/c	0.002483	0.002894
1 Cm C	5.4 GeV/c	0.0005109	0.0005986
2 Cm C	1 GeV/c	0.003145	0.003820
2 Cm C	5 GeV/c	0.0006978	0.0008071
Foam Disk	1 GeV/c	0.001758	0.001866
Foam Disk	3 GeV/c	0.0006004	0.0006105
Foam Disk	4 GeV/c	0.0004709	0.0004831

Conclusions

- The Bonn Si-telescope has been tested successfully in several beam conditions
- The effects of the rotation of one sensor are compatible with what is foreseen by simulations
- Using a high momentum electron beam the best unbiased resolution is achieved with a small distance between the first two boxes
- Scattering can be measured even in light and thin scatterers
- Materials aimed to be used for cooling or support structure (ie: for PANDA Micro Vertex Detector) can be characterized in terms of multiple scattering introduced

Thanks for your attention!