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Simulations with the new MVD geometry and data measurements with the Bonn Tracking Station

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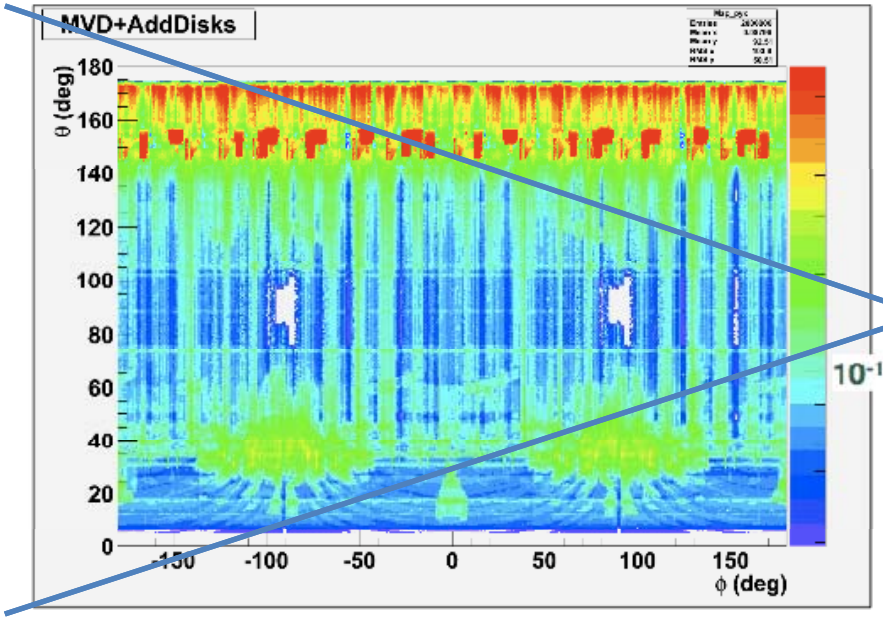
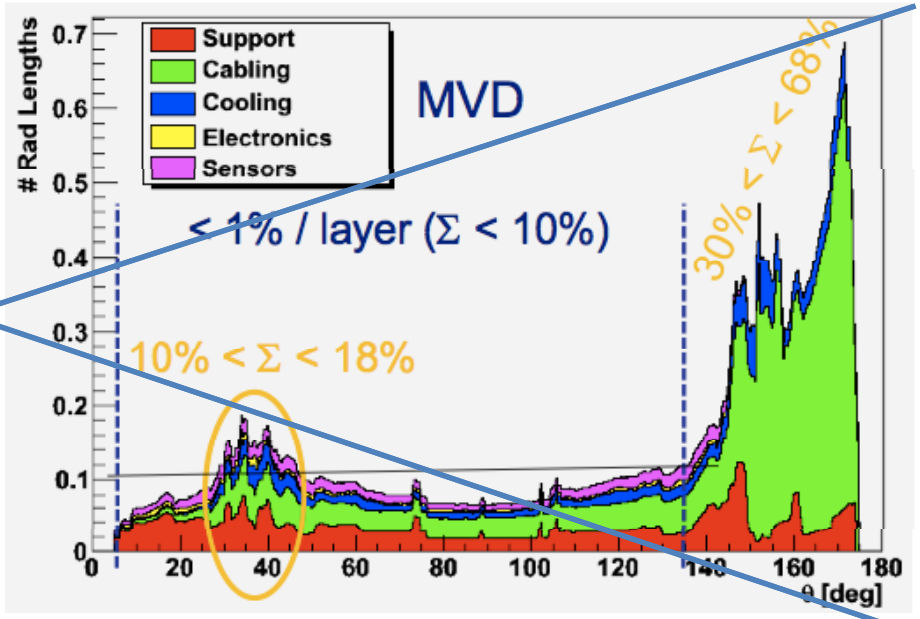
Summary

- Updated MVD geometry
- New material budget evaluations
- Momentum resolution with the “full geometry”
- Pile up probability in the MVD pixels
- Report on data measured with the Bonn Tracking Station

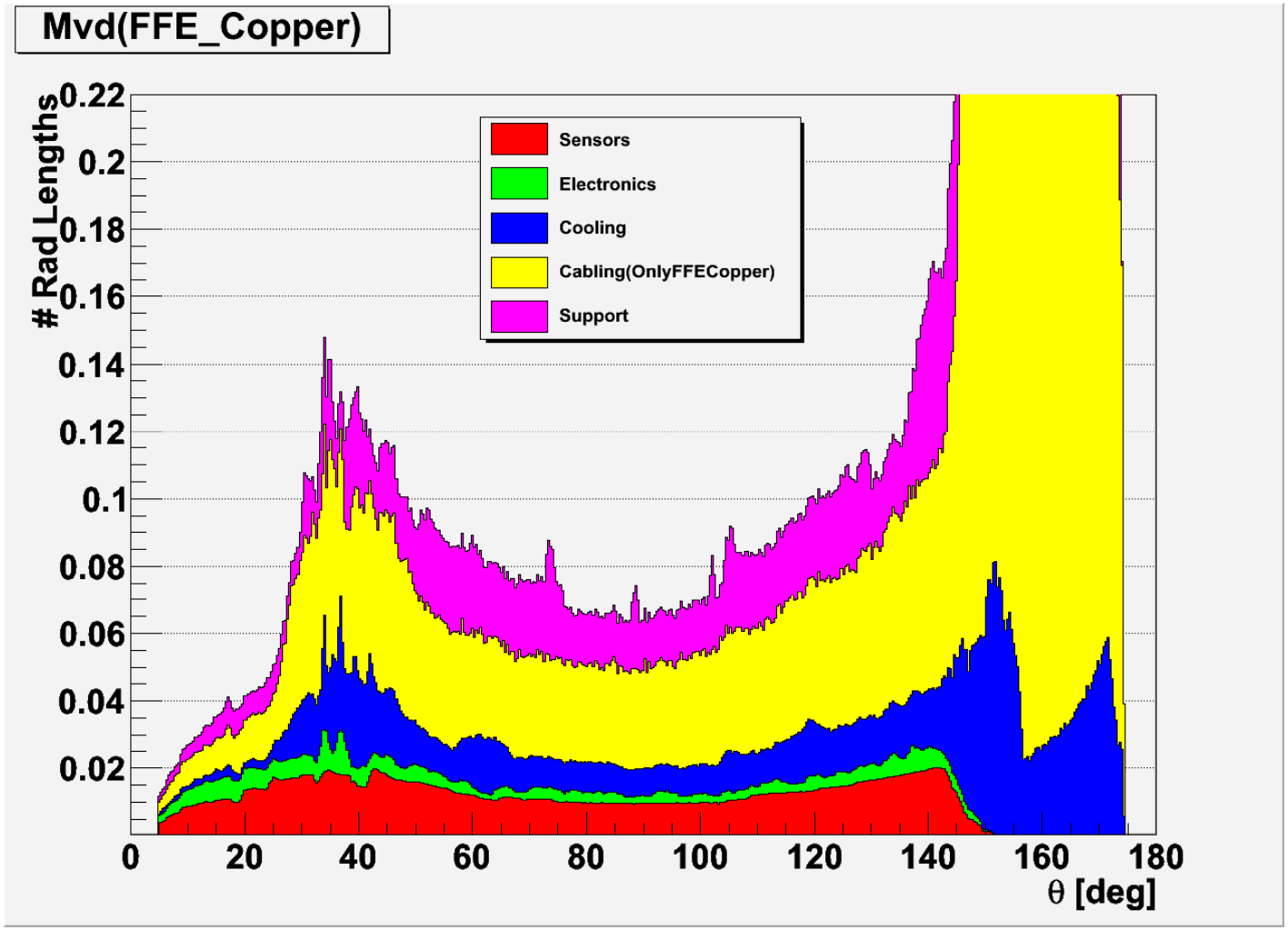
MVD Geometry

- New detailed full model implemented and presented during the previous CM
- Some overestimations in term of material budget emerged in the support structure
  → New definition of the support structure
- Pixel bus thickness has been corrected





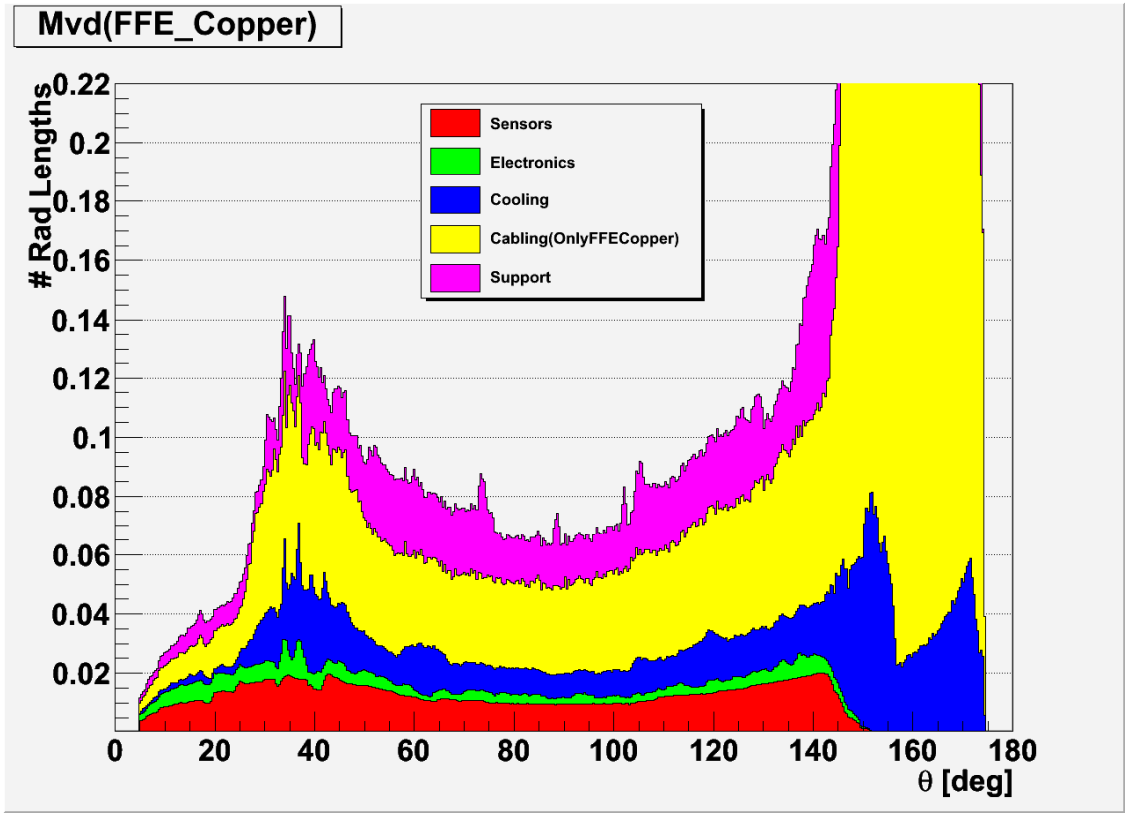
MVD Geometry



MVD Geometry

No more bumps due to the forward support structure

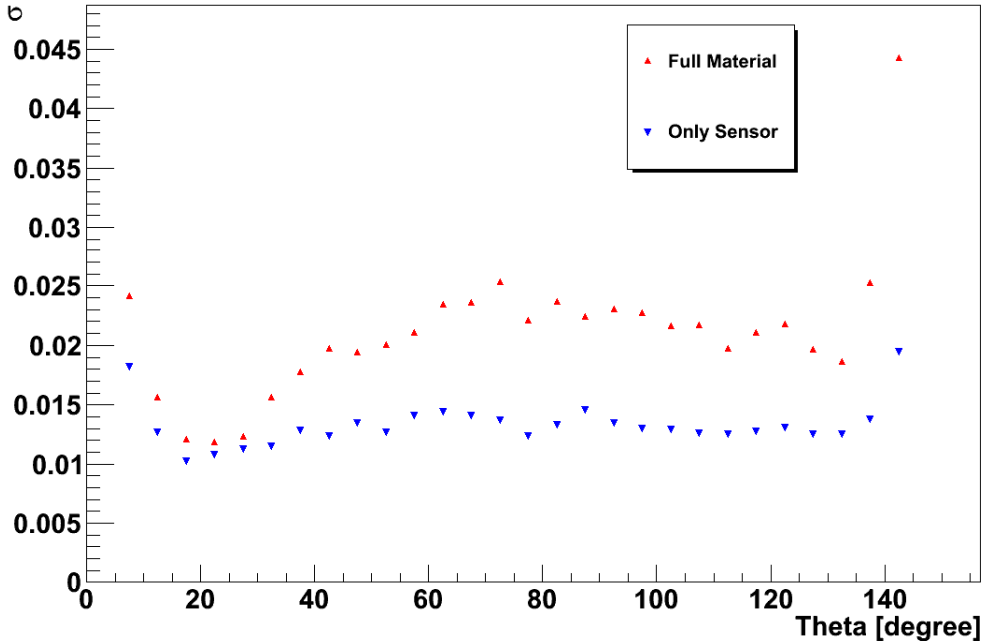
Forward enhancement less important: max 15% X_0 (cfr. 18% of the previous definition)



Momentum Reconstruction

The “Full-Version” geometry includes passive materials. It is interesting to study their influence on the momentum resolution.
A scan along θ has been performed shooting particles in a chosen direction and comparing the MC truth with the reconstructed momenta.

π+ with a momentum of 1 GeV/c

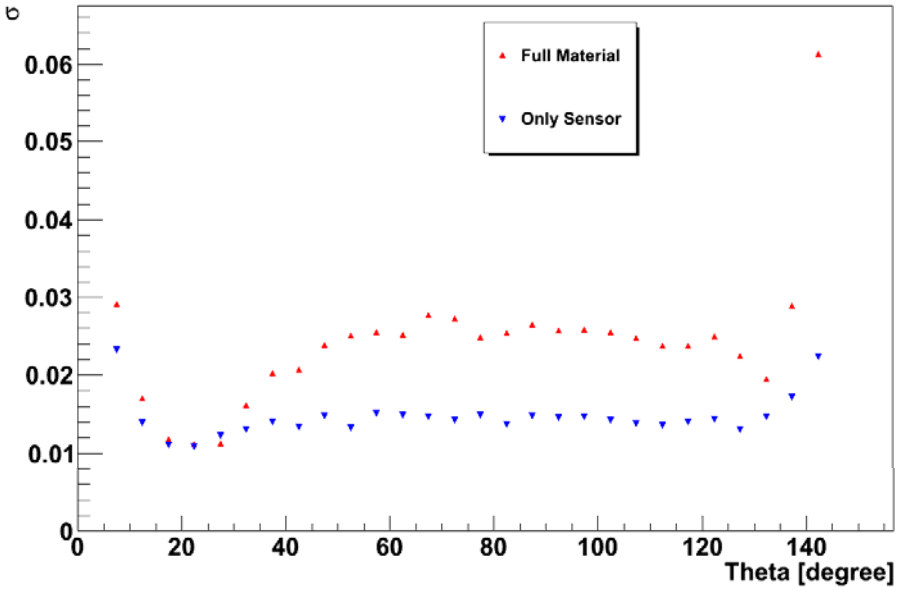


Full chain simulation including digitization, clustering and reconstruction.

1000 events for each point

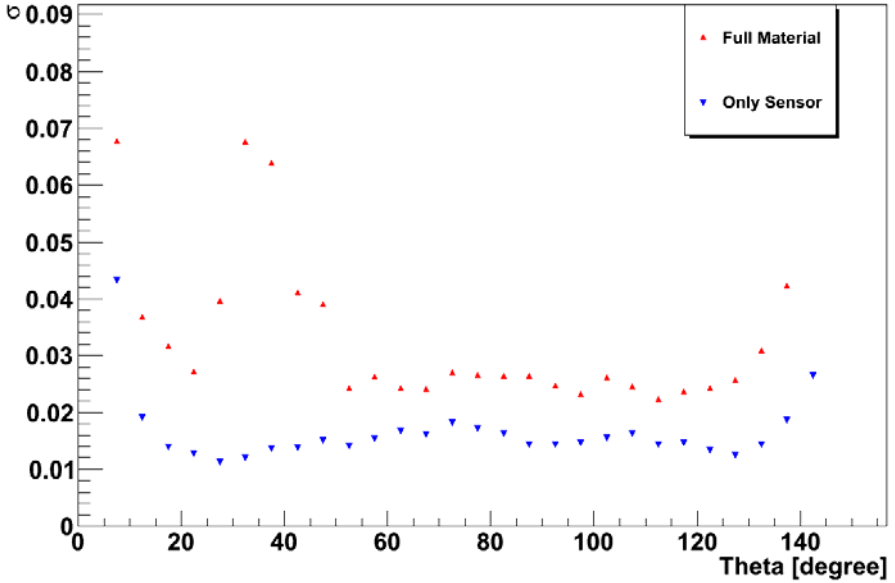
σ of $\frac{p_{MC} - p_{RECO}}{p_{MC}}$

Momentum Reconstruction



protons with a momentum of 1 GeV/c

protons with a momentum of 0.5 GeV/c

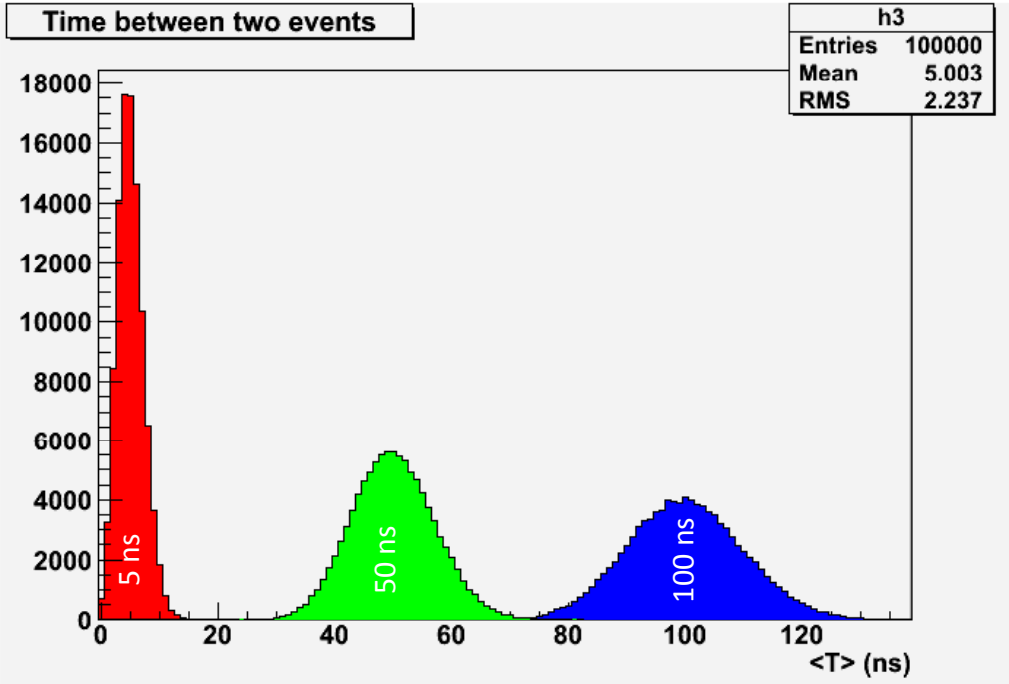


Pile-up probability for the MVD Pixels

When a pixel is hit it will need a time T before being able to process another hit (avoiding pile-ups). This time can be expressed as:

$$T = T_{TOT} + T_{READ} \qquad \text{where} \qquad T_{TOT} = 152ns / fC$$

$$T_{READ} = 10 * (\text{internal clock cycles @ } 155\text{MHz})$$



Assuming a stochastic behavior a Poissonian distribution is used to generate the time step between two events.

Different mean values to represent luminosity fluctuations.

Pile-up probability for the MVD Pixels

Simulation of DPM events at 15 GeV/c with elastic and inelastic interactions. According to L. Zotti's estimation this is the situation with highest density of hits:

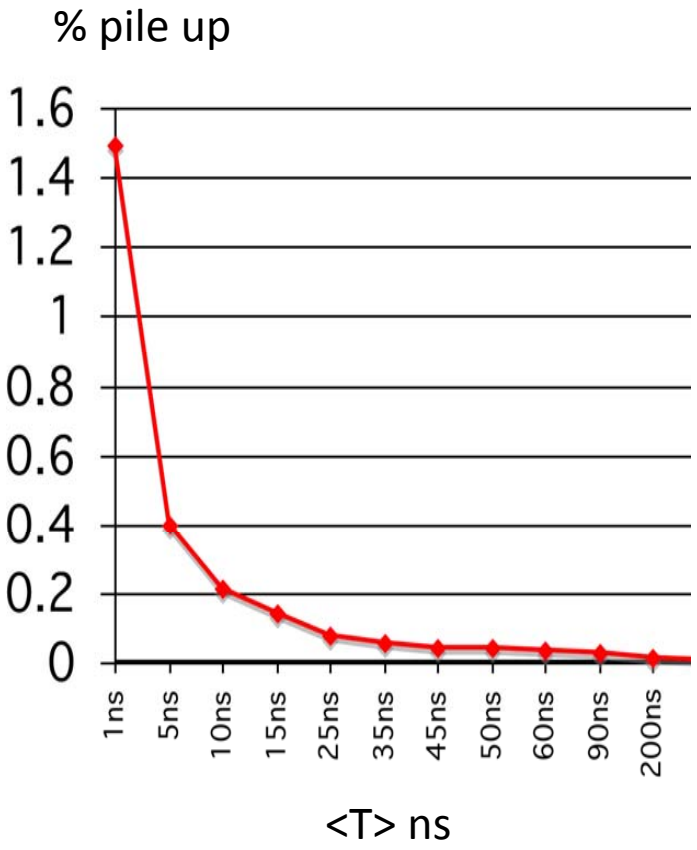
Annihilations	Simulated Events	Average Rate [$cm^2\ s^{-1}$]	Maximum Rate [$cm^2\ s^{-1}$]	Where?
$\bar{p} - p$	$8.5\ 10^6$	$8.24\ 10^5$	$6.10\ 10^6$	Disk Part
$\bar{p} - N$	$2.5\ 10^6$	$1.85\ 10^6$ /3	$3.70\ 10^6$	Disk Part
$\bar{p} - Ar$	$2.5\ 10^6$	$3.30\ 10^6$ /10	$6.80\ 10^6$	Disk Part
$\bar{p} - Au$	$2.5\ 10^6$	$1.03\ 10^7$ /100	$1.60\ 10^7$	Barrel Part

In the simulations:

- Using the new geometry definition with full material + beam pipe;
- Summing the event-based time-of-flight MC information to the event start time (from the Poissonian distributions);
- Checking for each new hit whether the hit pixels are still "busy" due to previous events;
- Counting the number of pile-up occurrences.

Pile-up probability for the MVD Pixels

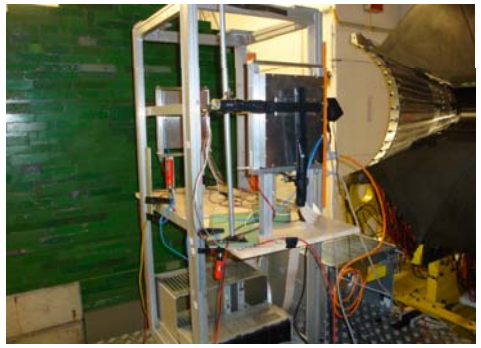
<T> (ns)	"Pile up"s	Regular hits	%
1	2820	189133	1.4910
5	759	191194	0.3970
10	407	191546	0.2125
15	268	191685	0.1398
25	154	191799	0.0803
35	114	191839	0.0594
45	85	191868	0.0443
50	84	191869	0.0438
60	71	191882	0.0370
90	49	191904	0.0255
200	22	191931	0.0115
500	9	191944	0.0047

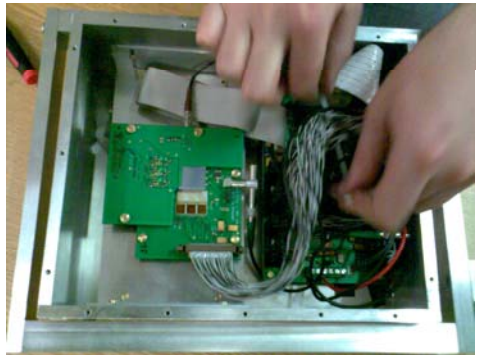


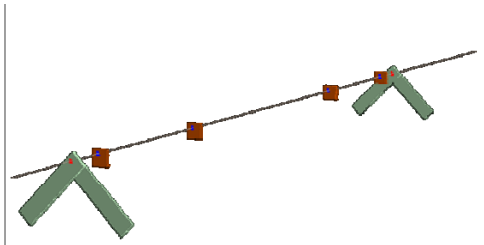
The Bonn Tracking Station

New Beam Times:

- protons @ COSY (Juelich) with different momenta [800 MeV/c and 2.95 GeV/c] and scattering volumes
- Bremsstrahlung photons @ ELSA (Bonn) looking for pair production
- electrons @ DESY (Hamburg)with momenta between 1 and 5 GeV/c and several different setups



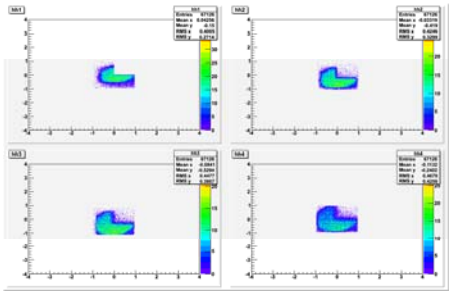




Protons @ COSY

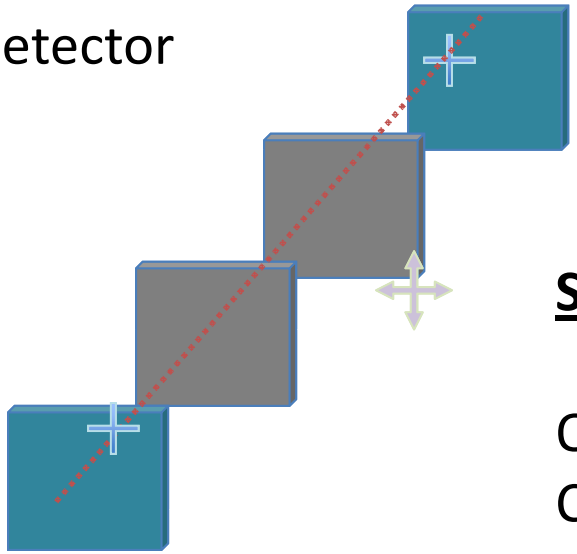
Experimental Setup:

4 scintillators (for the trigger 3 out of 4)
2 double sided silicon strip detectors
4 single sided silicon strip detector



Available momenta:

800 MeV/c
2.95 GeV/c



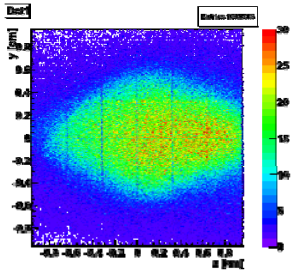
Scattering Volumes:

Carbon foil
Carbon Boxes (1 cm, 2 cm)

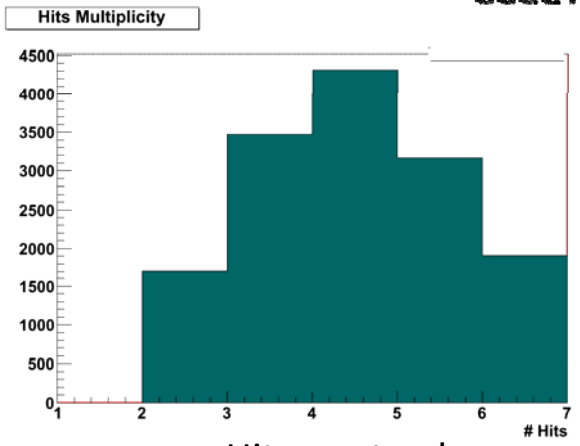
Software Tools:

Offline alignment
Calibration
DAQ → pandaroot
Analysis tools

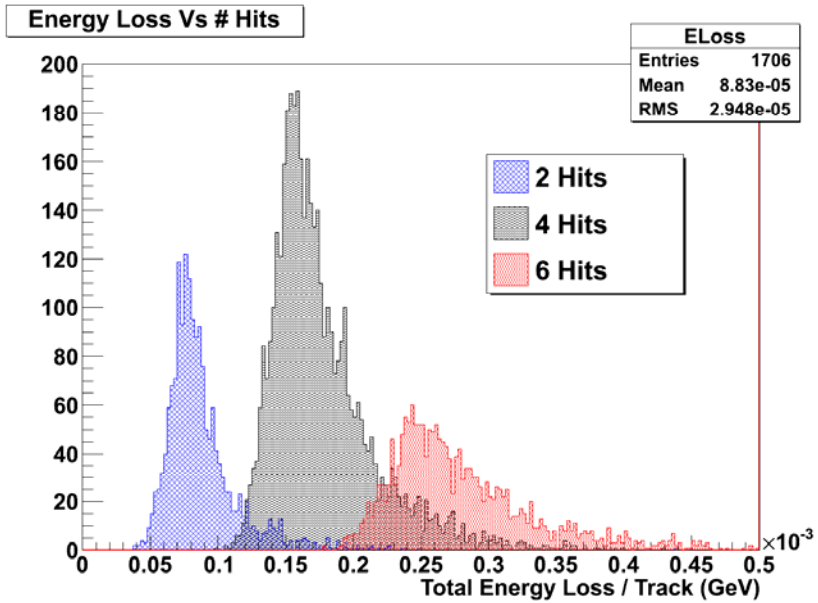
Protons @ COSY



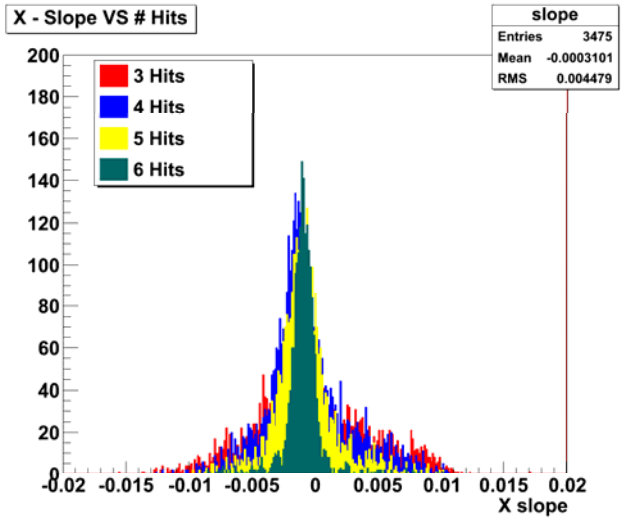
First analysis on data measured in Juelich without scattering volumes.
These are the results of straight line fits made on data acquired with 2.95 GeV/c protons.



Hits per track



Total energy loss along one track



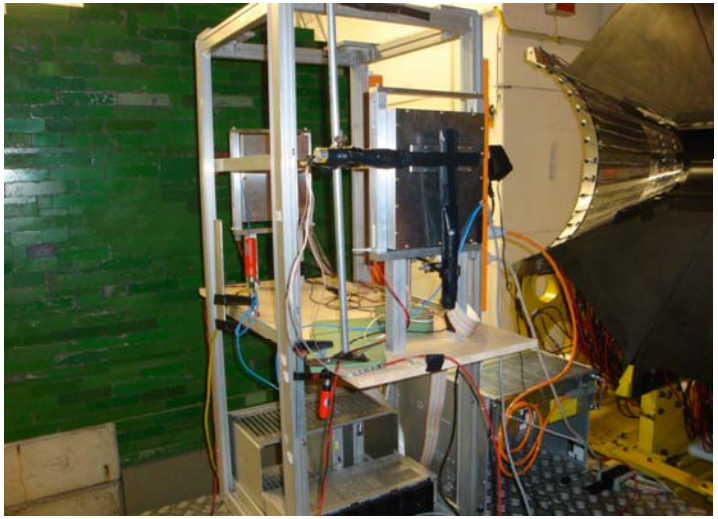
Slope depending on the # of hits

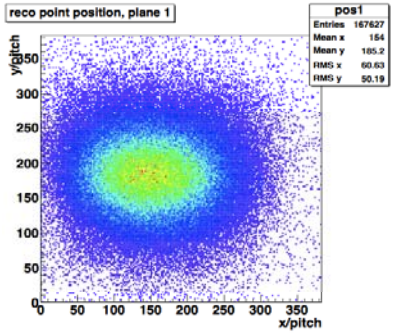
Photons @ B1-ELSA

Electron ring → Bremsstrahlung photons (up to 3 GeV) → pair production in a converter

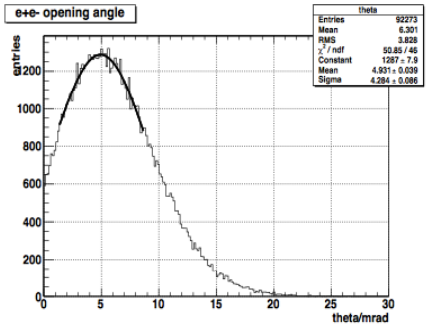
2 Boxes equipped with double sided sensors

Using a scintillator in front of the sensors as a converter to create e- e+ pairs





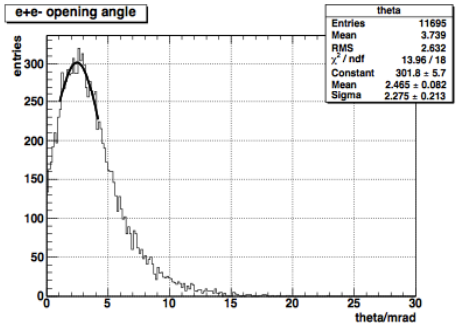
Hits on the first sensor in events with two hits per sensor



Distribution of the opening angle of the e+ e- pair

←Low energies (~400 MeV)

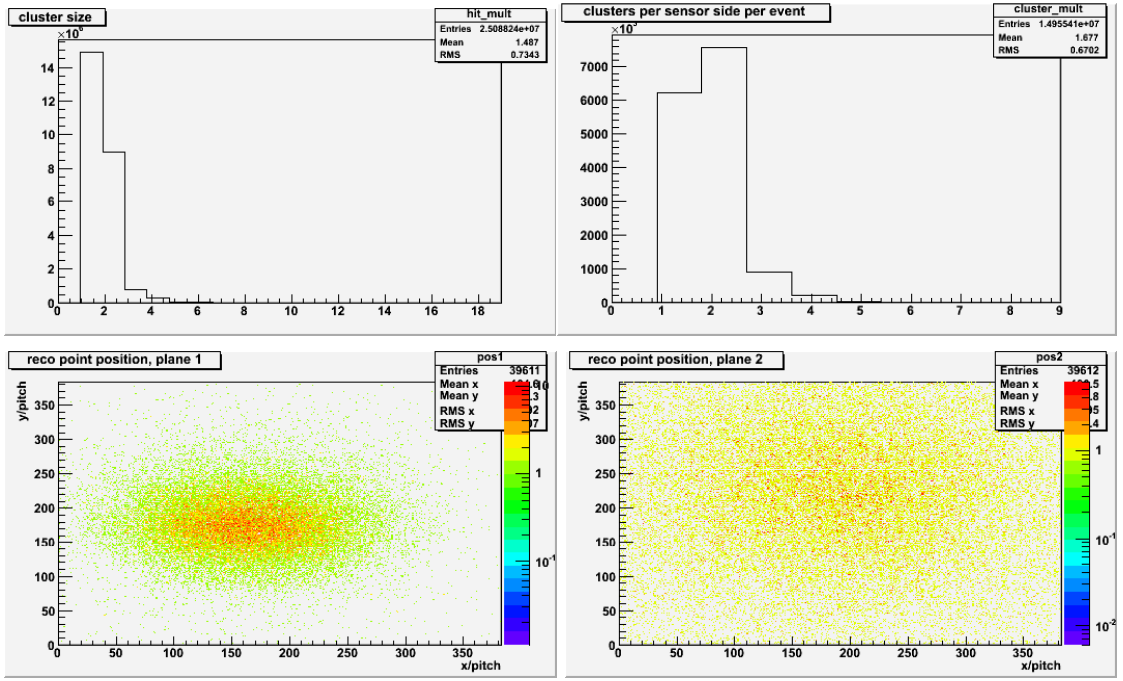
Higher energies →

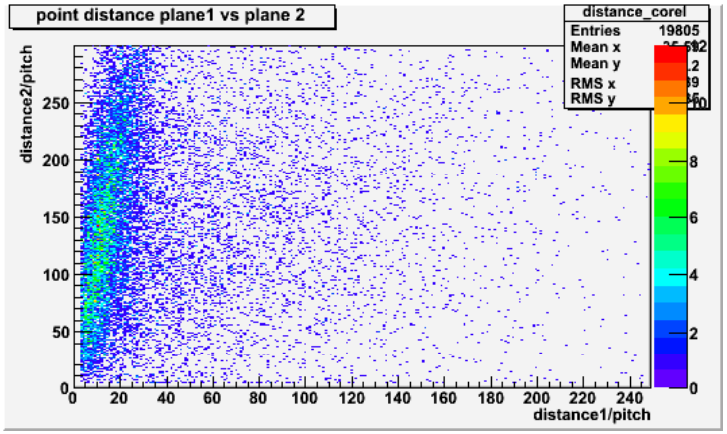


Photons @ B1-ELSA

Setup with one scintillator in front of the boxes.

Looking for e+ e- pair selecting events with two hits per sensor.





The correlation between distances on the two sensors suggests a main site for pair production.

Electrons @ DESY

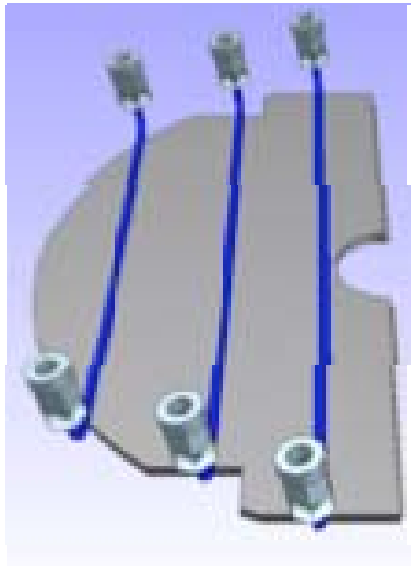
Electrons available in the momentum range 1-5 GeV/c.

Tracking station equipped with the same setup used in Juelich.

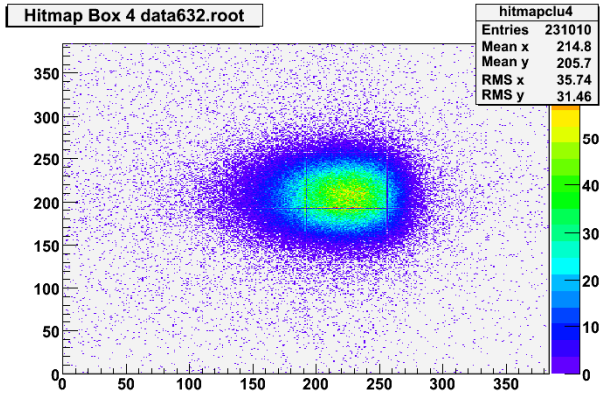
Scintillating slabs (bigger than the used in Juelich) in front and at the end of the station used to trigger (3 out of 4, 4 out of 4, 2 out of 4)

Different scattering volumes were placed in the mid of the station:

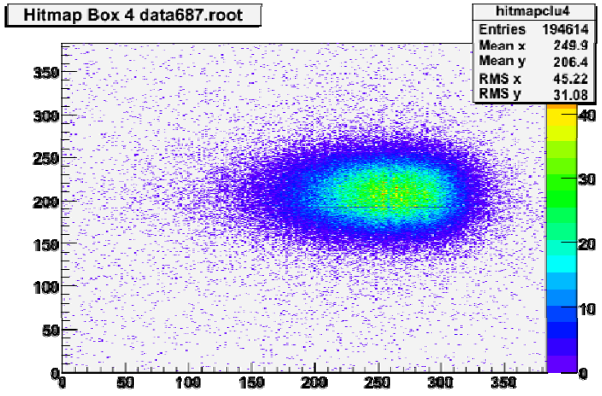
Thin Carbon Foil	**0.375 mm thick**
Thick Carbon Foil	**0.650 mm thick**
Carbon I	**1 cm thick**
Carbon II	**2 cm thick**
Carbon Foam Cube	**(25.0x25.0x28.0) mm**
Carbon Foam Cube	**(25.0x28.0x50.0) mm**
Torino Pixel Stave *	**4 mm thick**



Electrons @ DESY

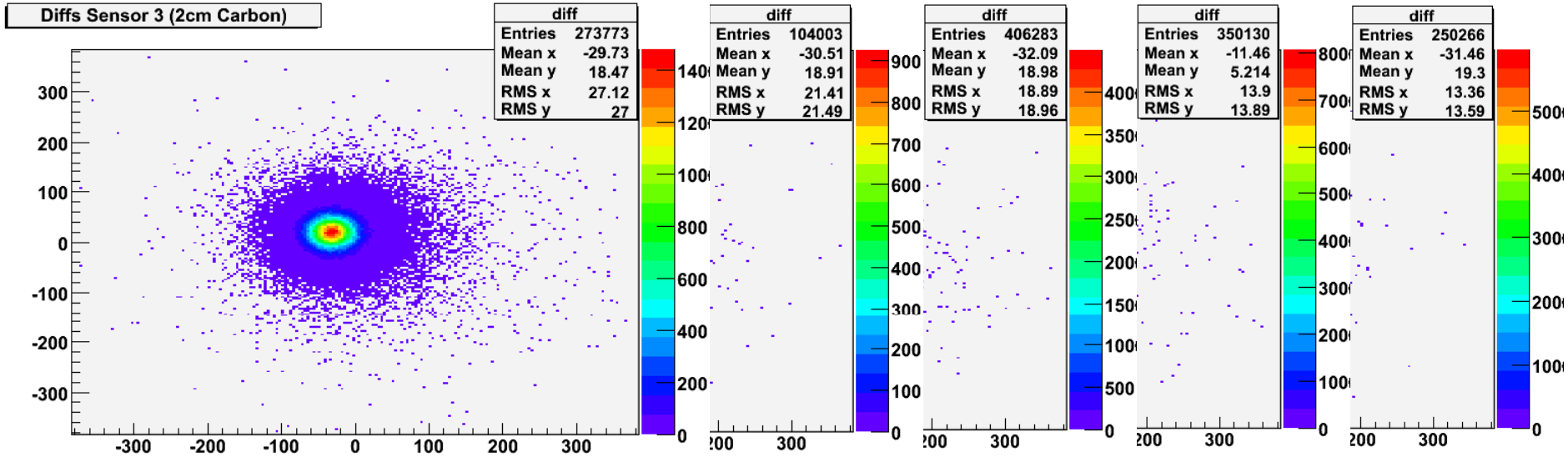


Normal position



Box rotated of 40°

Hit distribution on the fourth box



Difference between hits on the second box and the straight lines connecting box 1 and 3

Future plans

Detailed analysis of the data collected so far:

→ Scattering of protons in carbon and carbon foam (from the data measured in Juelich)

→ Pair production @ ELSA

→ Scattering of electrons with different material configuration and momenta @ DESY

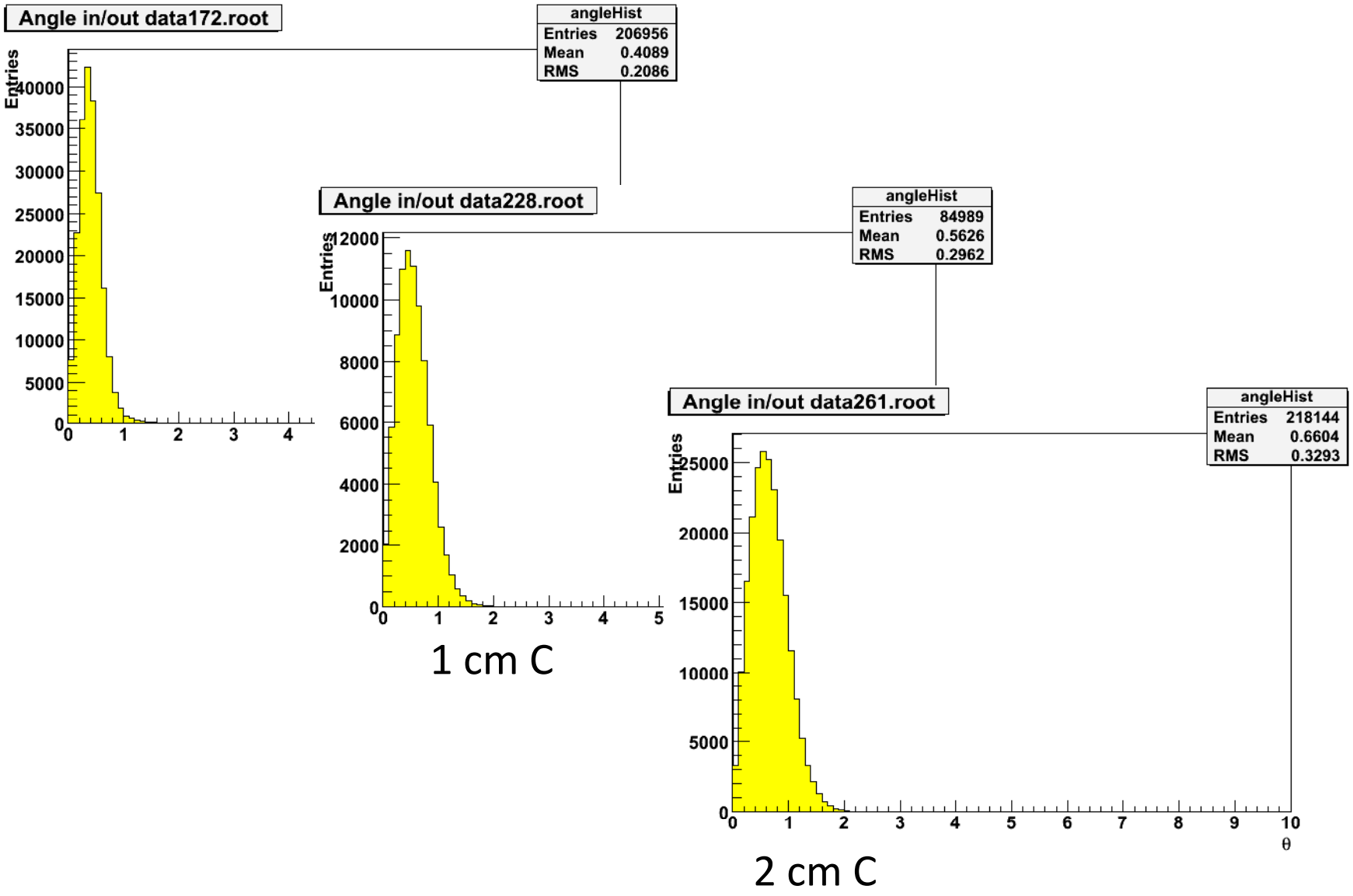
→ Effect of a 45° rotation of one module on reconstruction performances

→ Comparison of setups with different z-distances between modules

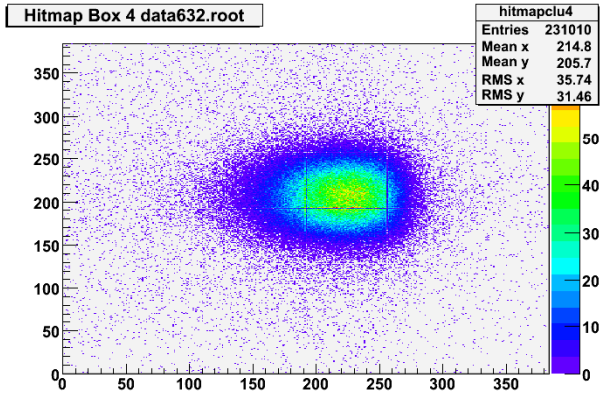
THANKS FOR YOUR ATTENTION!

FORZA AZZURRI!

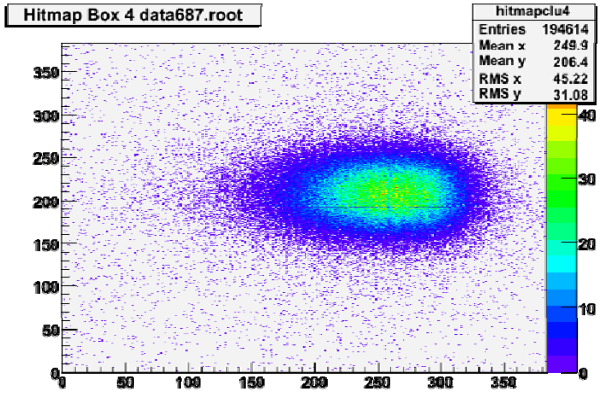
Electrons @ DESY



Electrons @ DESY



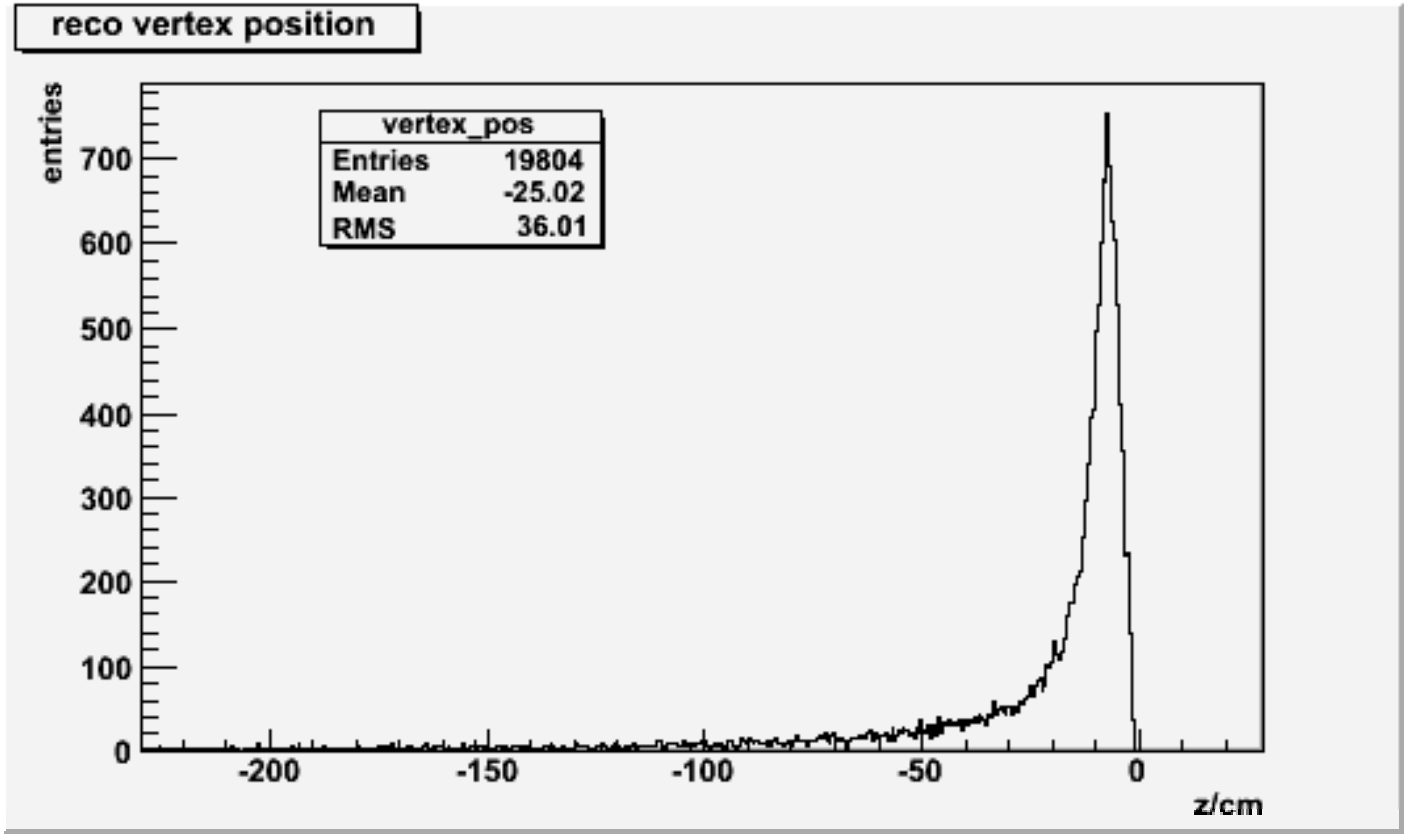
Normal position



Box rotated of 40°

Hit distribution on the fourth box

RMSx/RMSx_40° = 0.77777
cos(40°) = 7.6627


reco vertex position
vertex_pos
Entries 19804
Mean -25.02
RMS 36.01
entries
700
600
500
400
300
200
100
0
-200
-150
-100
-50
0
z/cm