

---

# **Design study for the forward trackers**

PANDA meeting, Torino, June 2009

**Ola Wrońska**

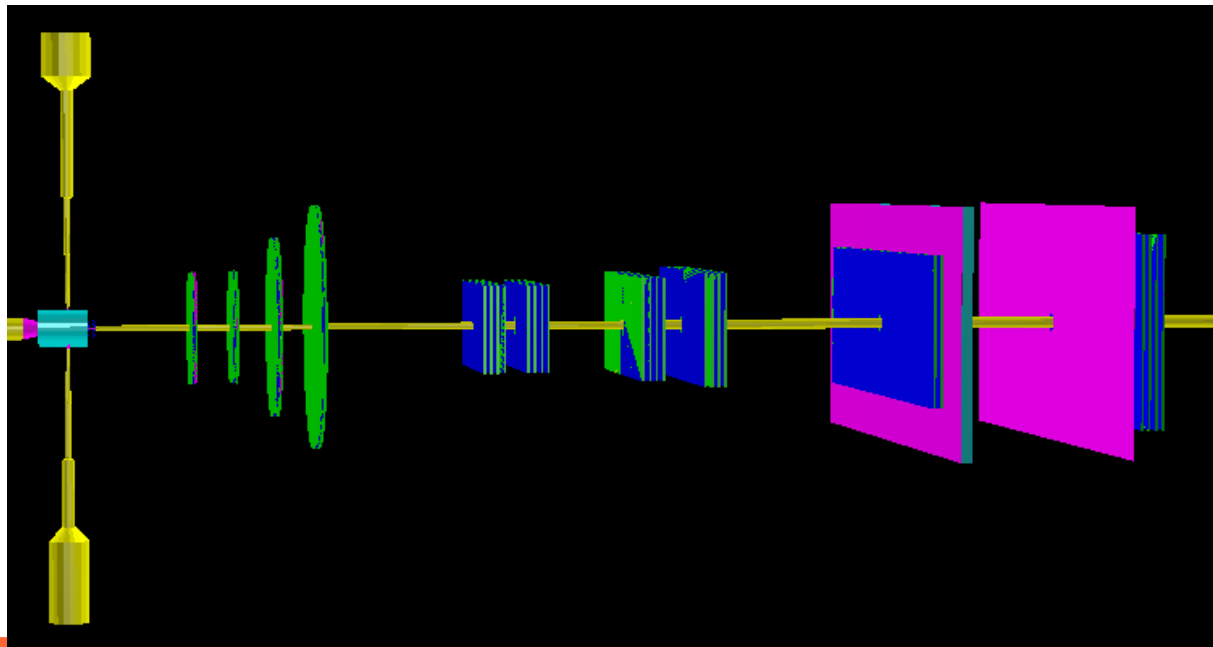
# Basics

---

- Forward tracking is realised by a set of **6 straw tube detectors**, each consisting of 8 sensitive planes. First 4 planes in each pack have vertical wires (measure horizontal position), next two are inclined by 10 deg., further two by -10 deg.
- Detectors ordered in pairs: one pair upstream, one pair inside and one pair downstream of the dipole magnet
- They should register particles emitted at horizontal angle  $\theta_x < 10 \text{ deg}$  and vertical angle  $\theta_y < 5 \text{ deg}$ .
- We should assume in the simulation that we have particles with momentum 0.5-15 GeV/c

# Geometry

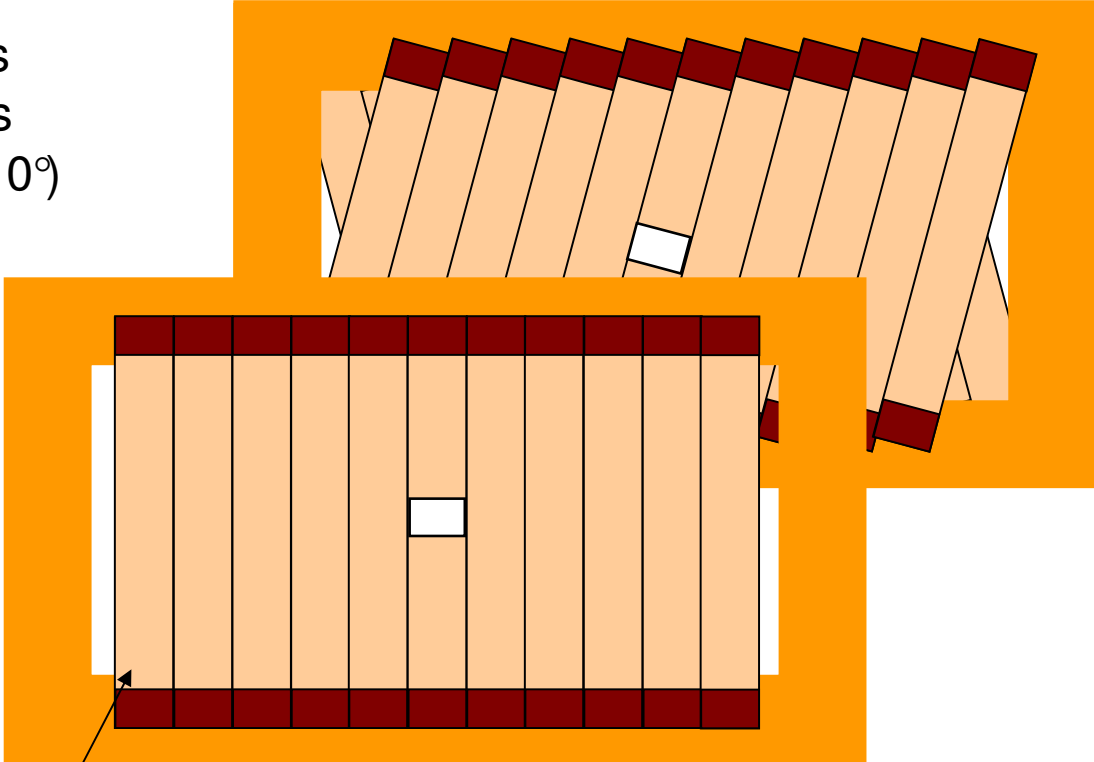
- Geometry of forward trackers is stored in [pandaroot/geometry/dch.root](#)
- It is easy to create **two slightly different setups**:
  - default one: there is a dummy RICH detector inserted between two last packs of detectors, which is currently a valid solution
  - the other option: last two chambers are standing close to each other, RICH is moved behind the last tracking detector



# Layout of a single detector

Two double layers  
with inclined wires  
e.g. (+10°) and (-10°)

Two double layers  
with vertical wires



Module: 2x 16 straws

# Design: open question

---

- What should be the optimal positions and sizes of the trackers?
- Is momentum resolution deteriorated when RICH moved behind the last tracker?
- How sensitive is reconstruction of various channels to momentum resolution in forward?
- **What is the reasonable compromise for the angle of inclined planes?**
  - **perform simulations showing quality of reconstruction for various inclination angles**
    - in view of detector construction the smaller inclination angle, the easier to build
    - deciding criterion has to be that quality of reconstruction of vertical angle is not worse than quality of reconstruction of horizontal angle

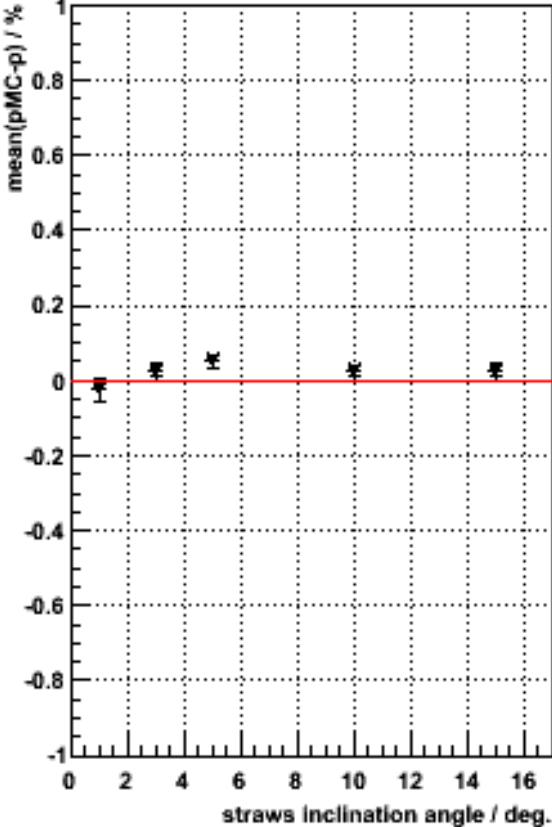
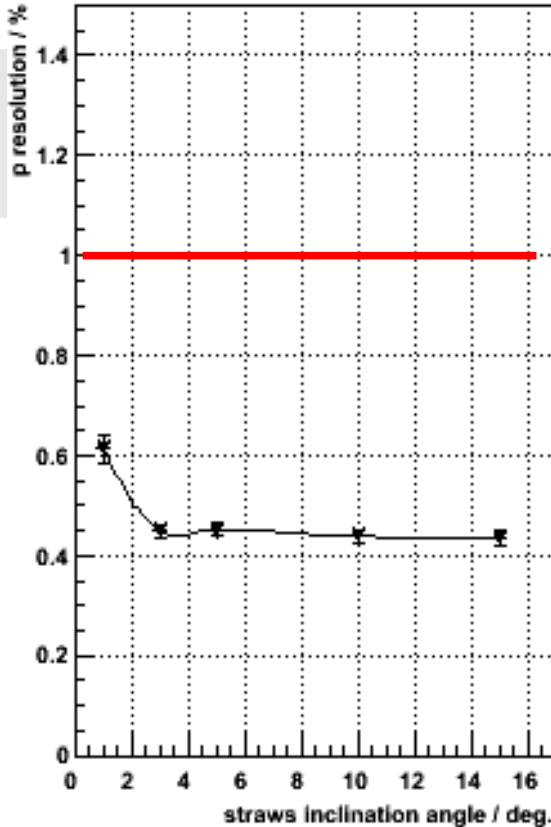
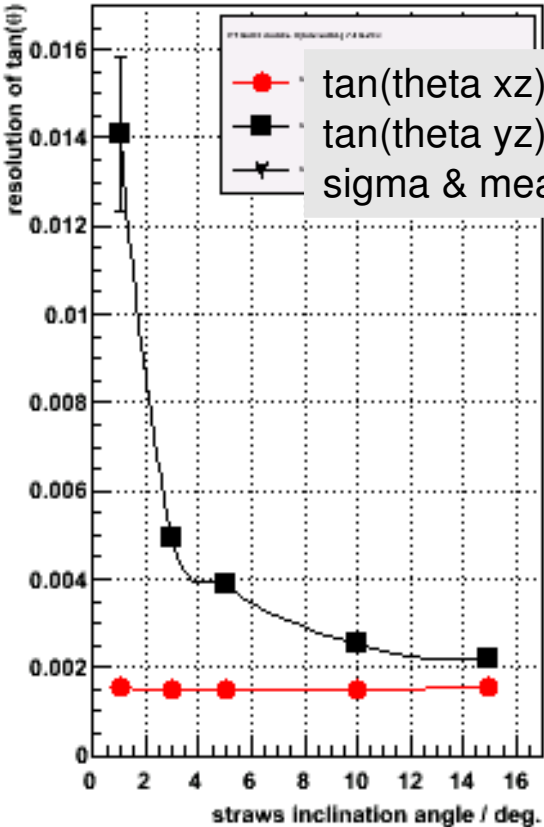
# Wires inclination angle – simulation

---

- A series of simulations performed to study effect of different inclination angles:
  - 1000 muons shot at  $\theta=(3-5)$  deg.,  $\phi=(0-360)$  deg.,  $p=\{0.5, 1, 5, 10\}$  GeV/c
  - dipole field setting for  $p_{beam}=7.8$  GeV/c
  - inclination angle  $\alpha=\{1, 3, 5, 10, 15\}$  deg.
  - all material budget upstream the fwd trackers included (beam pipe, mvd, gem)
  - look at resolutions in  $\tan\theta_{xz}=px/pz$  and  $\tan\theta_{yz}=py/pz$  and compare them for different inclination angles, as reconstructed on the first hit plane

# Inclination angle study: $p=0.5 \text{ GeV}/c$

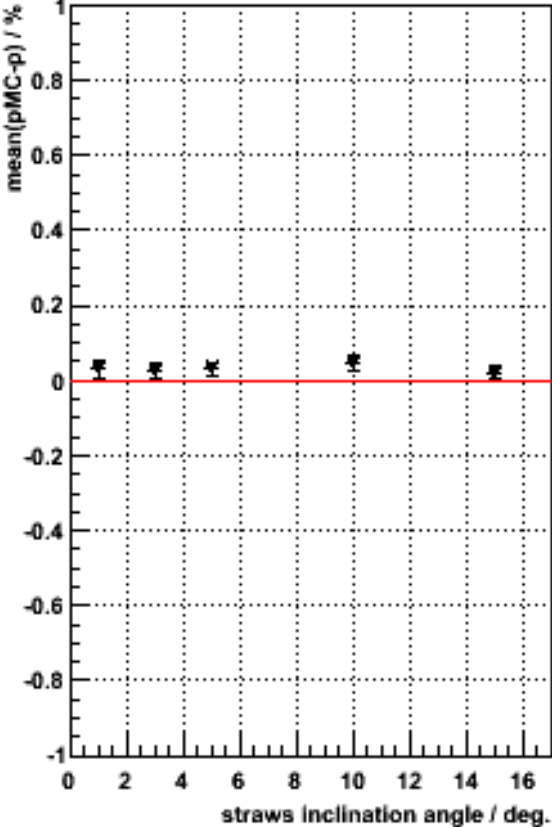
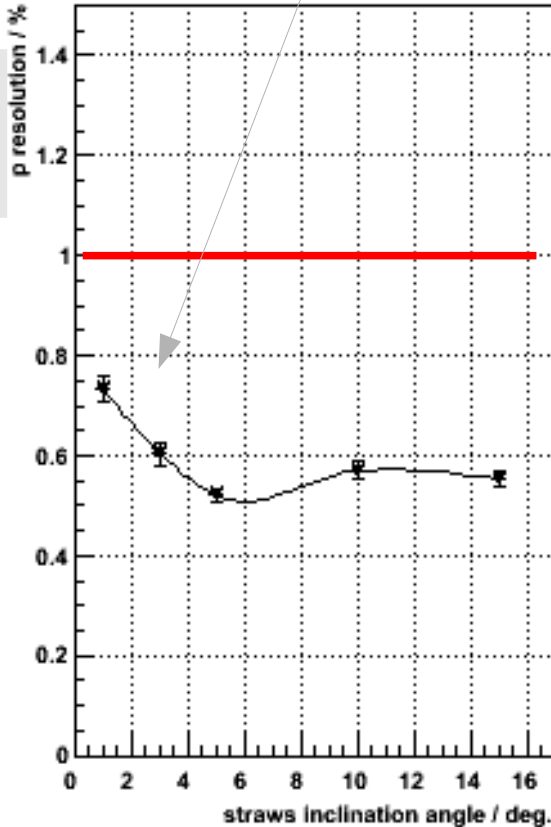
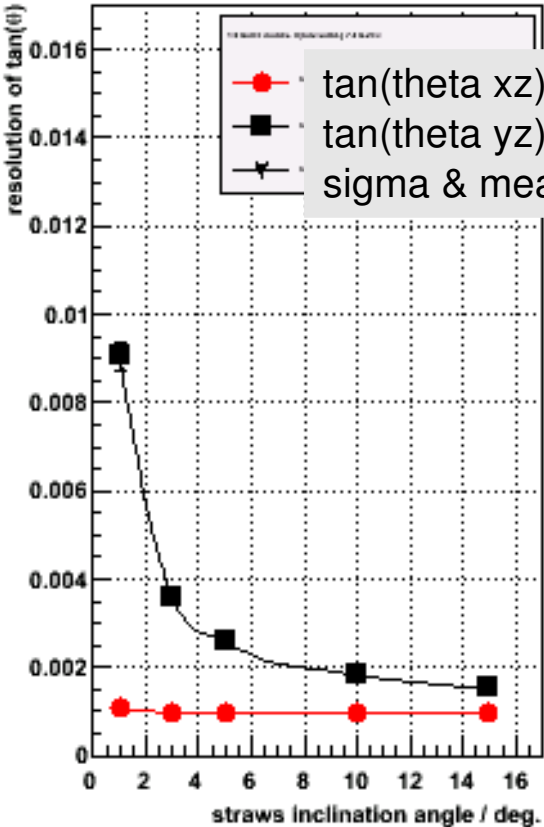
Range of  $\tan(\theta)$  in this simulation:  $(5.2-8.7)e-2$



# Inclination angle study: $p=1$ GeV/c

Range of  $\tan(\theta)$  in this simulation:  $(5.2-8.7)e-2$

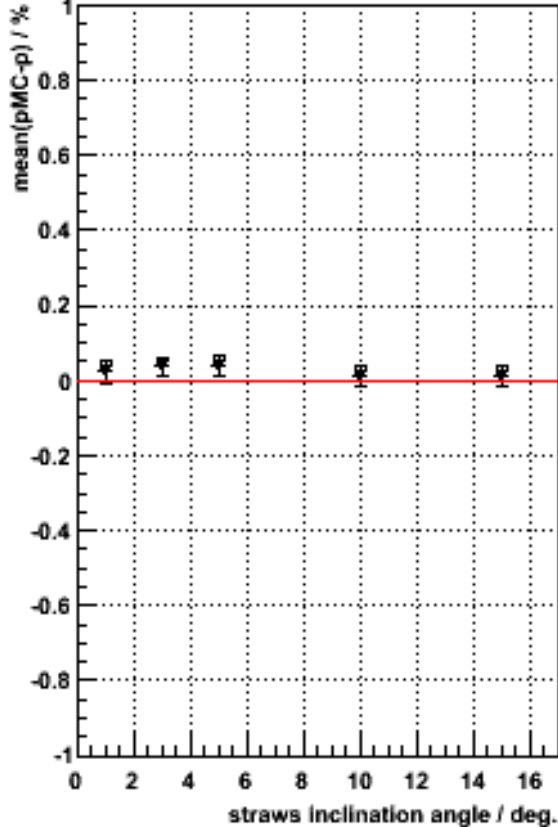
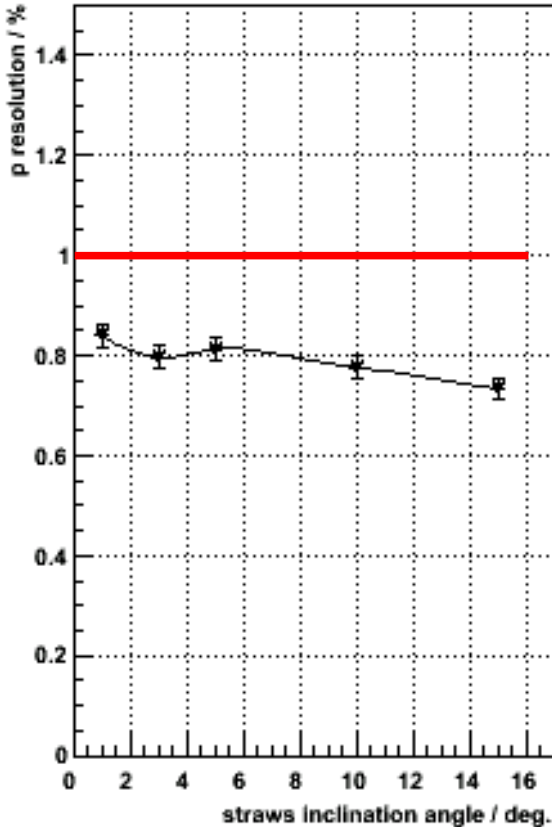
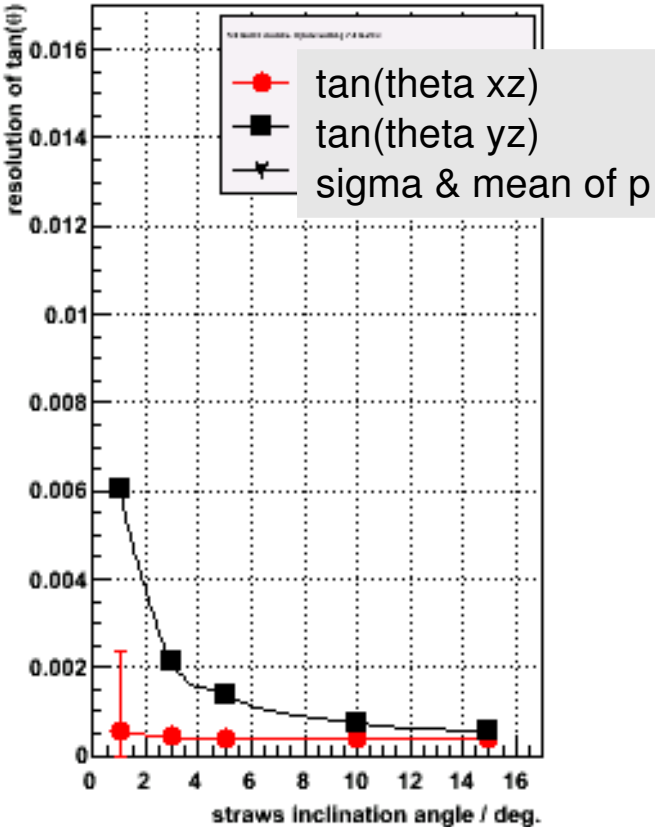
Why?





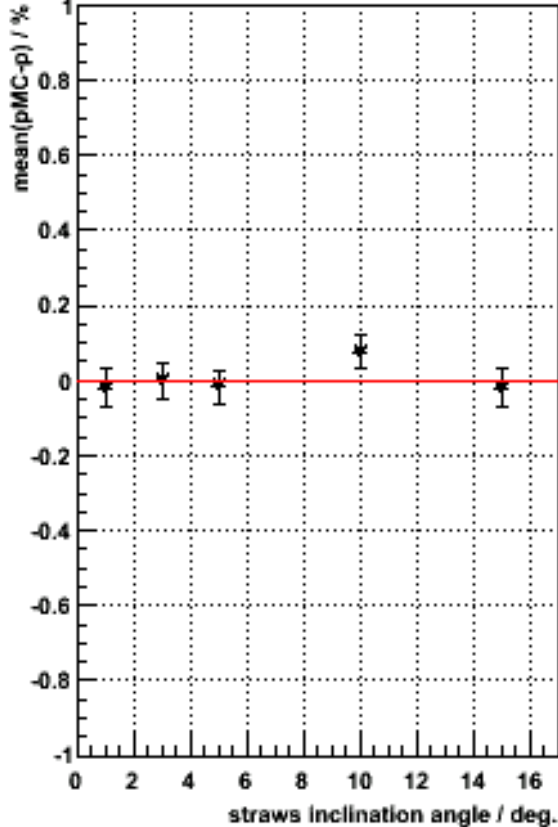
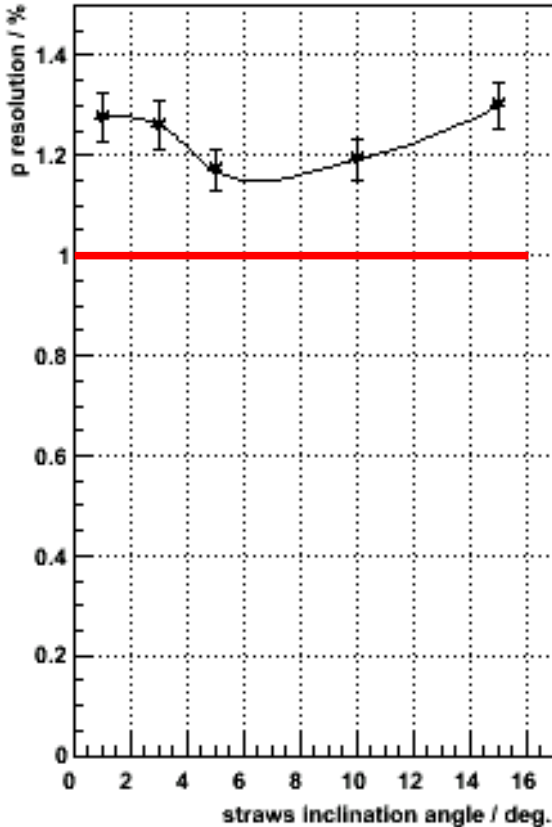
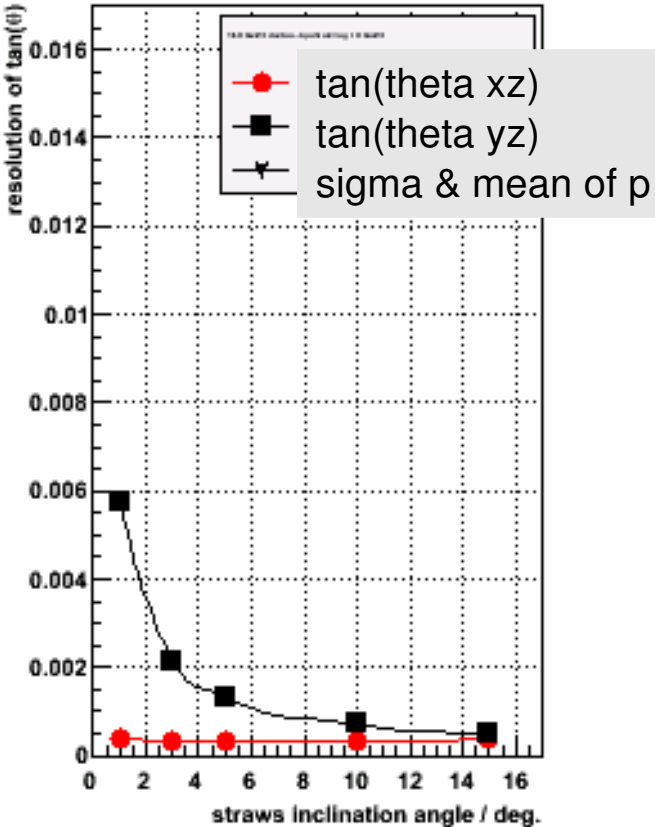
# Inclination angle study: $p=5 \text{ GeV}/c$

Range of  $\tan(\theta)$  in this simulation:  $(5.2-8.7)e-2$



# Inclination angle study: $p=10$ GeV/c

Range of  $\tan(\theta)$  in this simulation:  $(5.2-8.7)e-2$



# Inclination angle study: observations

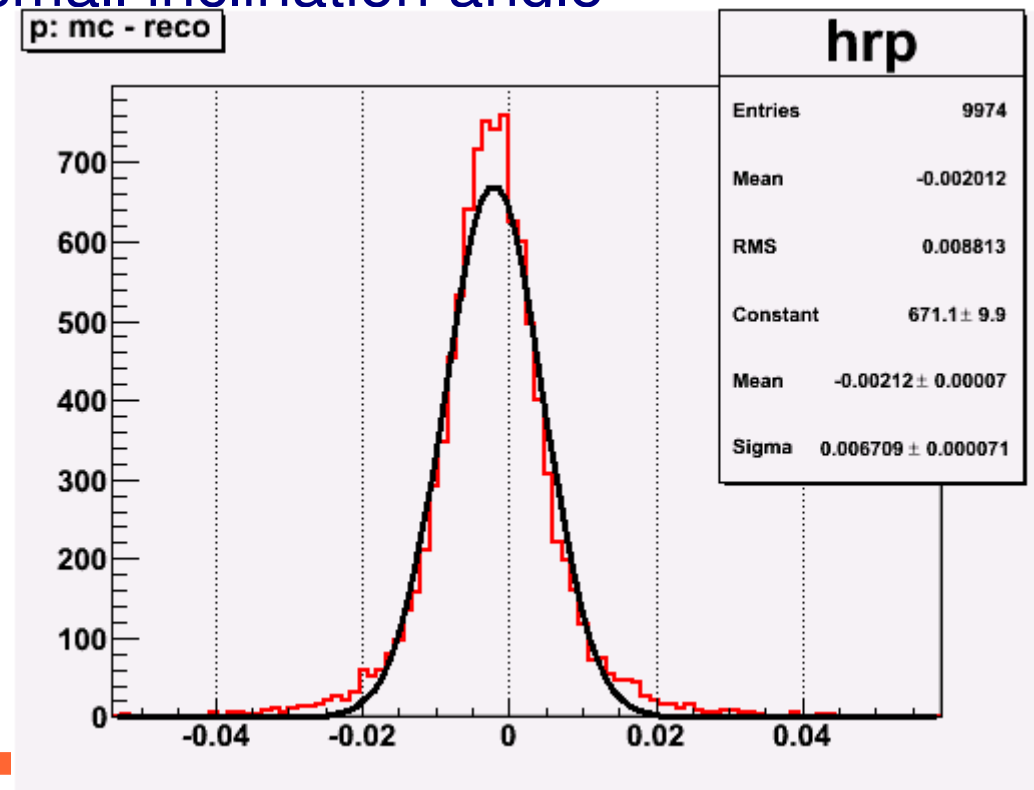
---

- Vertical and horizontal angle resolutions (for angles reconstructed on first hit plane) are getting equal for  $\alpha \approx 15$  deg.
- However, when one draws residuals and determines resolutions after extrapolating to IP, these two are getting equal for  $\alpha \approx 5$  deg! (material budget on the way determines final resolution)
- How will this change when we include information from TS trackers in the common fit?
- As expected, momentum resolution increases with p due to smaller curvature of trajectory
- But why is the momentum resolution worse for very small inclination angles?
  - Not due to poor  $p_y/p_z$  resolution – too small effect to observe!
  - Is it due to different field integral over wrongly reconstructed path?  
**Check!**

# Momentum resolution “puzzle”

- Test: all simulation conditions as before, but for each MCPoint  $y\text{-position} \pm 1\text{ cm}$  – tracks are parallel to MC tracks
  - box-field approximation momentum should be reconstructed properly, only vertex shifted.
  - Well, it is not!  $\Rightarrow$  *indication* that this can be the origin of worse resolution for small inclination angle

**Mean  $|p(\text{mc}) - p(\text{reco})| > 30 \sigma$**   
(2 MeV/c for 1 GeV/c muons)



# Summary

---

- Design study oriented simulation for forward trackers ongoing.
  - First results - based on the pure FS tracker info - indicate that the inclination angle between 5-10 deg. will be the optimal choice.
  - These results need verification with TS detectors included in the Kalman fit.
  - We need to study effect of swapping of RICH and the last tracker pack.