Preliminary results from the Muon Tomography Station (MTS) prototype

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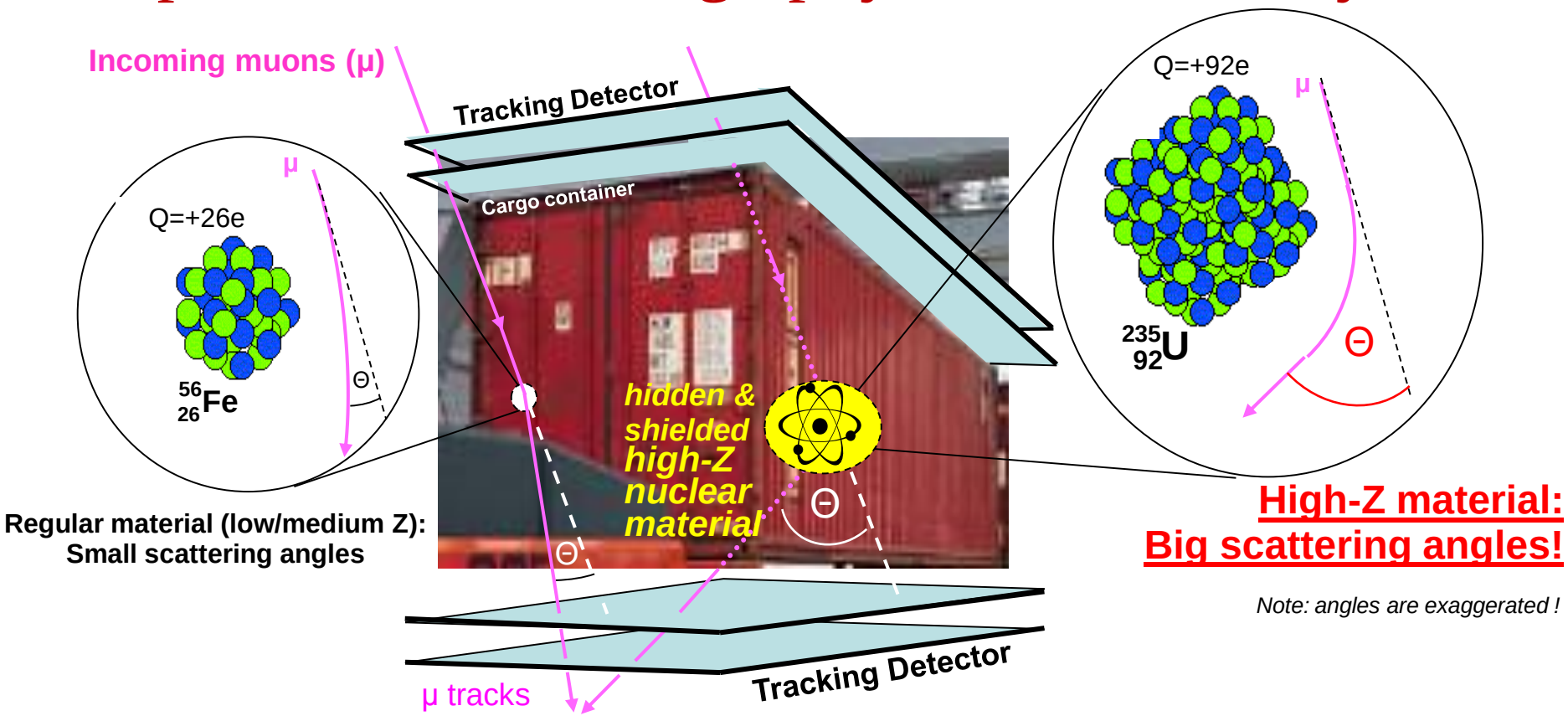
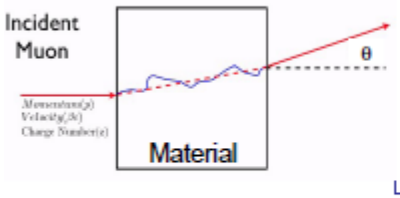
Principle of Muon Tomography with cosmic ray muons



- to 1 order produces Gaussian distribution of scattering angles θ with width σ = θ0:



$$\theta_0 = \frac{13.6\,\mathrm{MeV}}{\beta\, cp}\sqrt{\frac{x}{X_0}}\left[1 + 0.038\ln(x/X_0)\right] \quad \text{with} \quad \frac{1}{X_0} \propto Z(Z+1)$$

Radiation length X_0

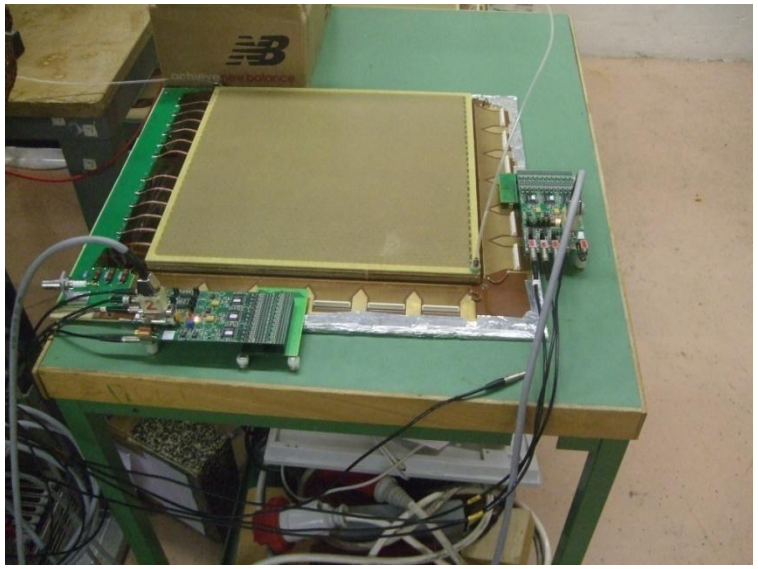
0

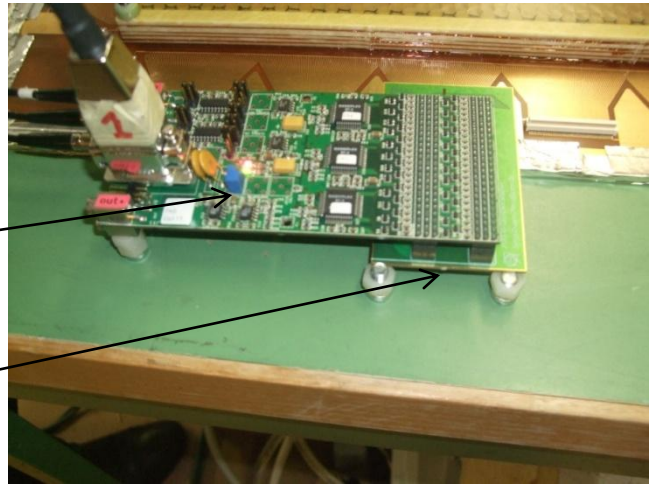
- ⇒ θ ~ proportional to Z; measuring muon scattering angles is sensitive to Z

Triple GEMs, FE cards & DAQ system

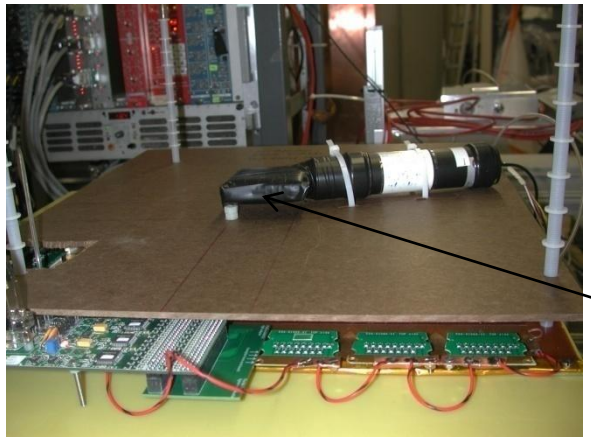
8 triple 30 cm x 30 cm GEM detectors

- Built and tested at CERN GDD lab, 1 bad detector, (do not hold HV test)
- 2 more to be built this year at Florida Tech



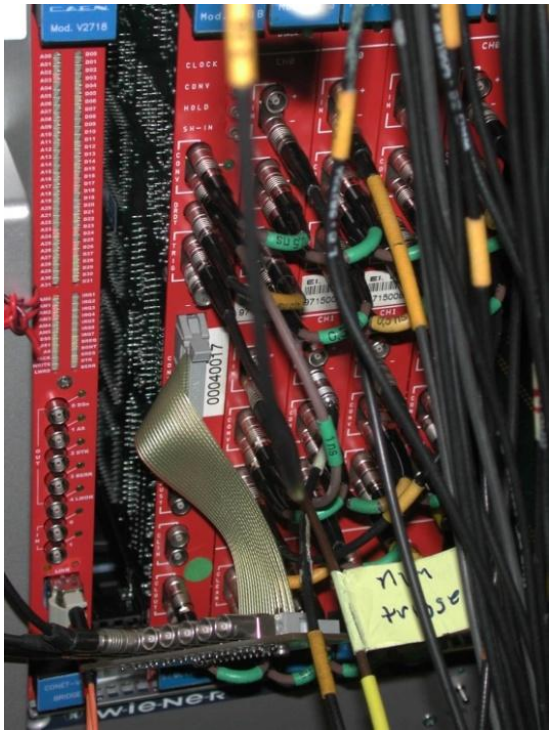


- 8 Gassiplex FE cards From Saclay
- Adapters cards
  - Adapt 96 gassiplex chan. to 128 GEM strips
  - Single/double strips & left/right cards



DAQ hardware and software

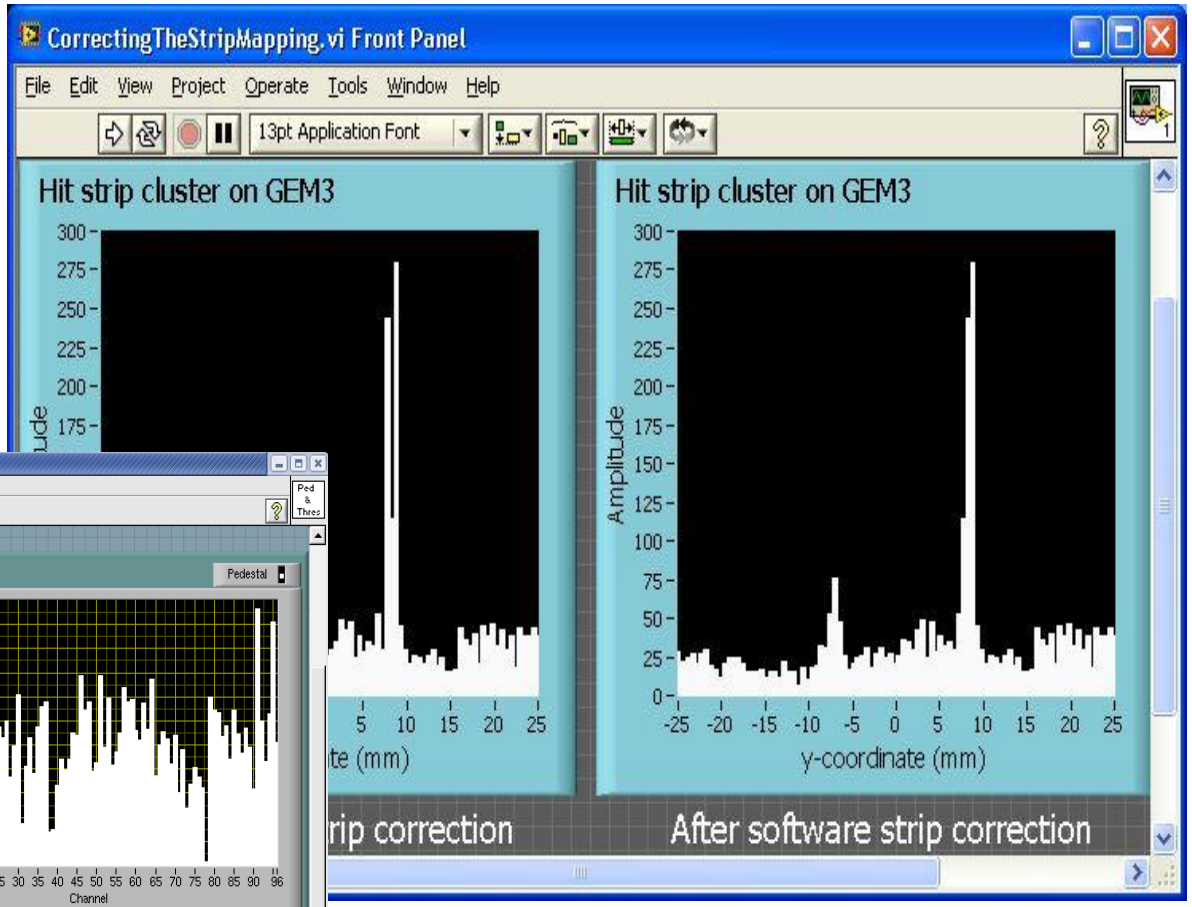
- 4 CAEN CRAMS V550 & 1 V551,
- VME crate from CERN e-pool
- Trigger with 2 PMT scintillators
- Labview DAQ software

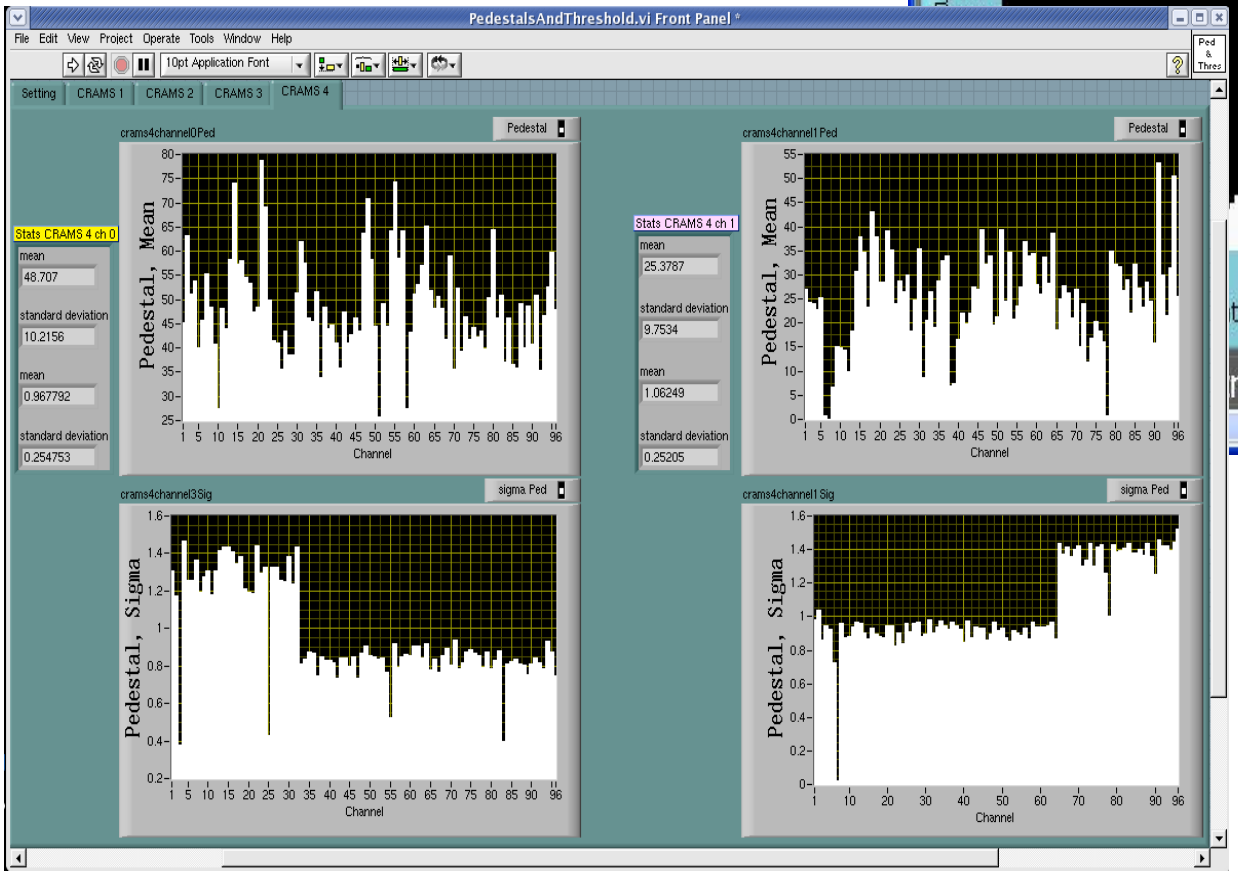


Tests & debugging

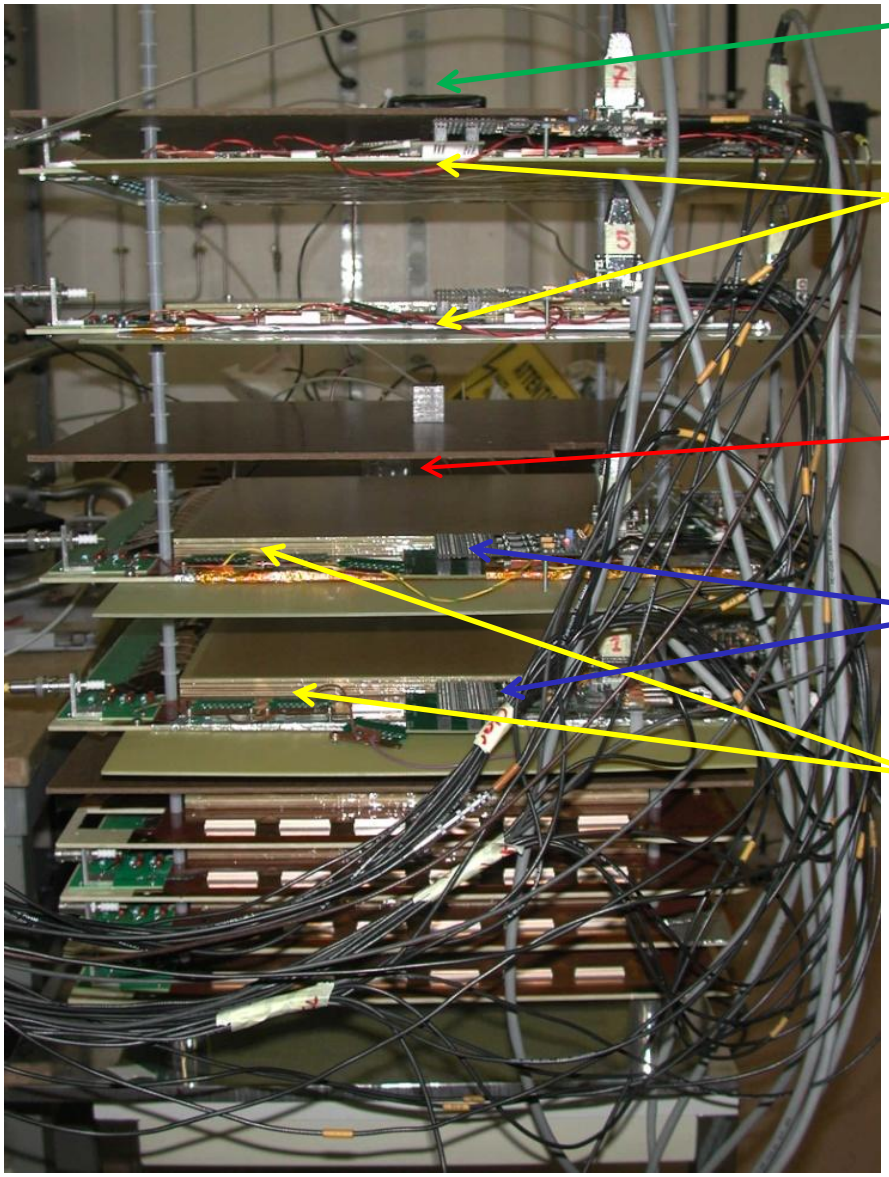
DAQ soft. debugging (Jan 2010)

- Ped. and noise of 8 Gassiplex
  - double strips effect shown on noise plots.
  - Left/right adapter cards
- Strip map correction ⟶





Muon Tomography Station (MTS) prototype



Top scintillator/PMT for the trigger

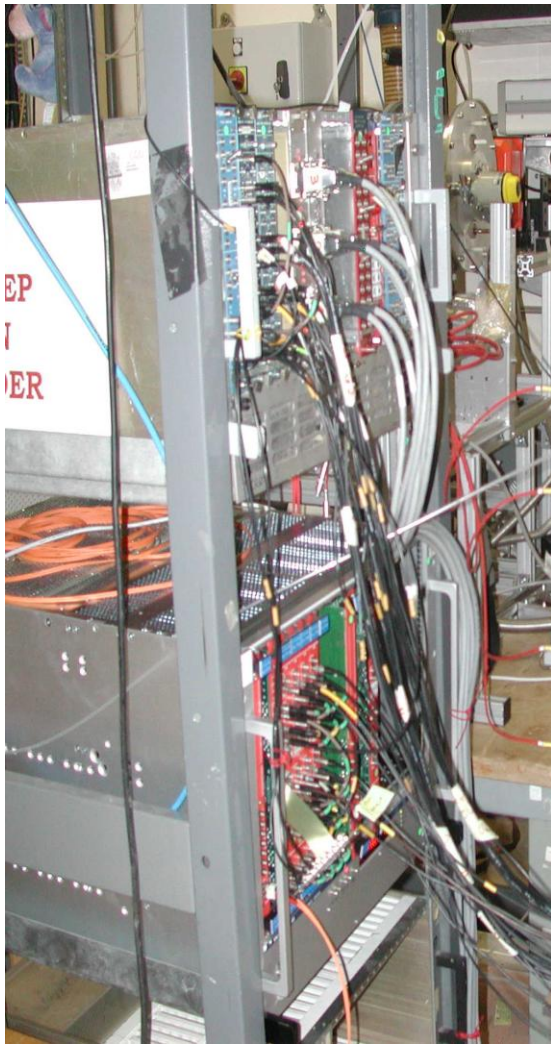
Two top station GEMs

Pb target on its support plat

Gassiplex FE cards

Two bottom station GEMs

DAQ System



Cosmic data run with targets inside the MTS

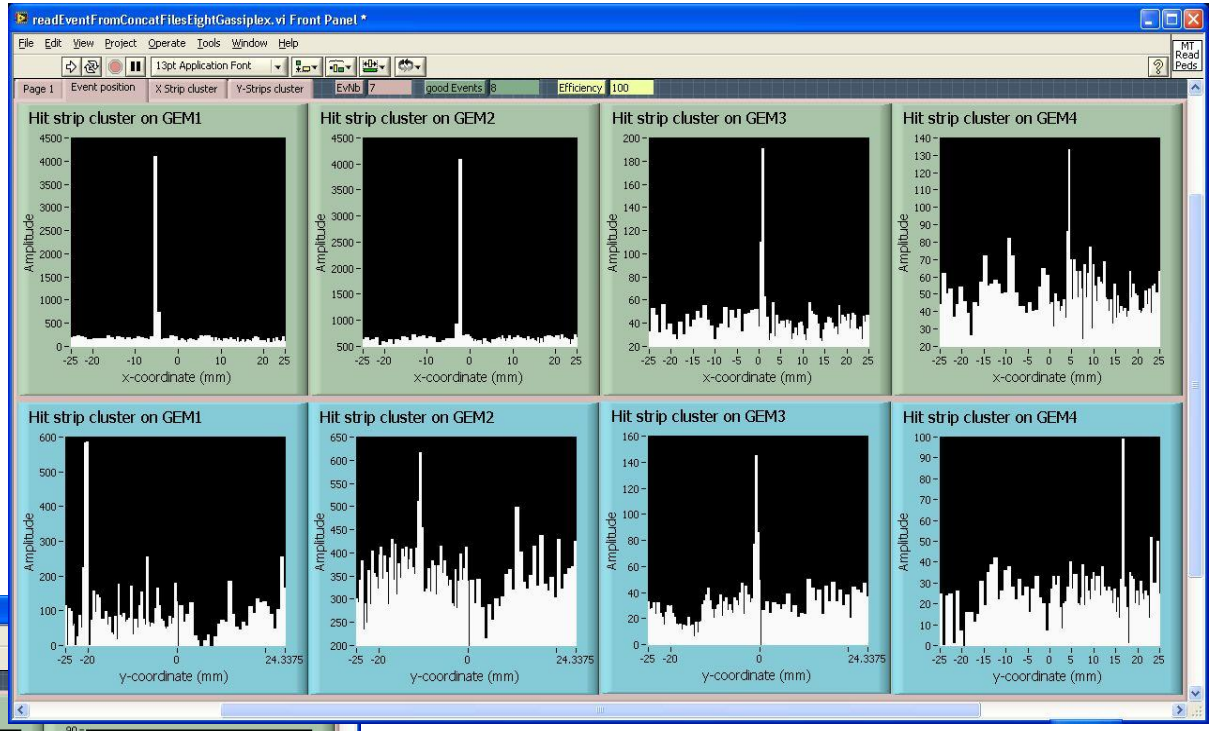
We need 3 days to collect ~ 3K events because:

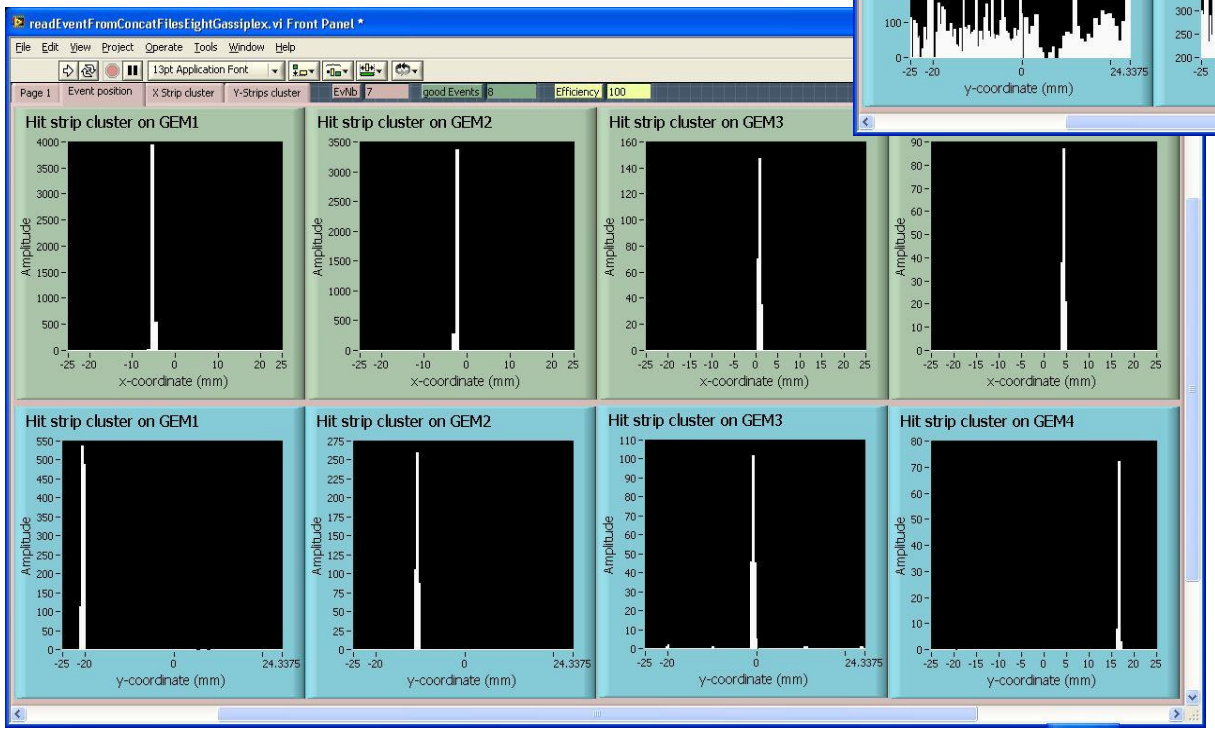
- Only 50 mm x 50 mm active area per GEM detector
  - Because we have only 8 Gassiplex FE cards
- 94.5 mm gap between the detectors
  - Mechanical constraints by the Gassiplex cards
- Acceptance volume of the MTS
  - defined by the distance between 40 cm the trigger scintillators/PMT
- About 40% are rejected for the reconstruction
  - Multi hits events
  - Missing hit in one of the 8 FE cards after pedestal subtraction

Very first results with cosmic run of the MTS

Typical good event for MTS

- Online raw data
- Offline pedestal suppression



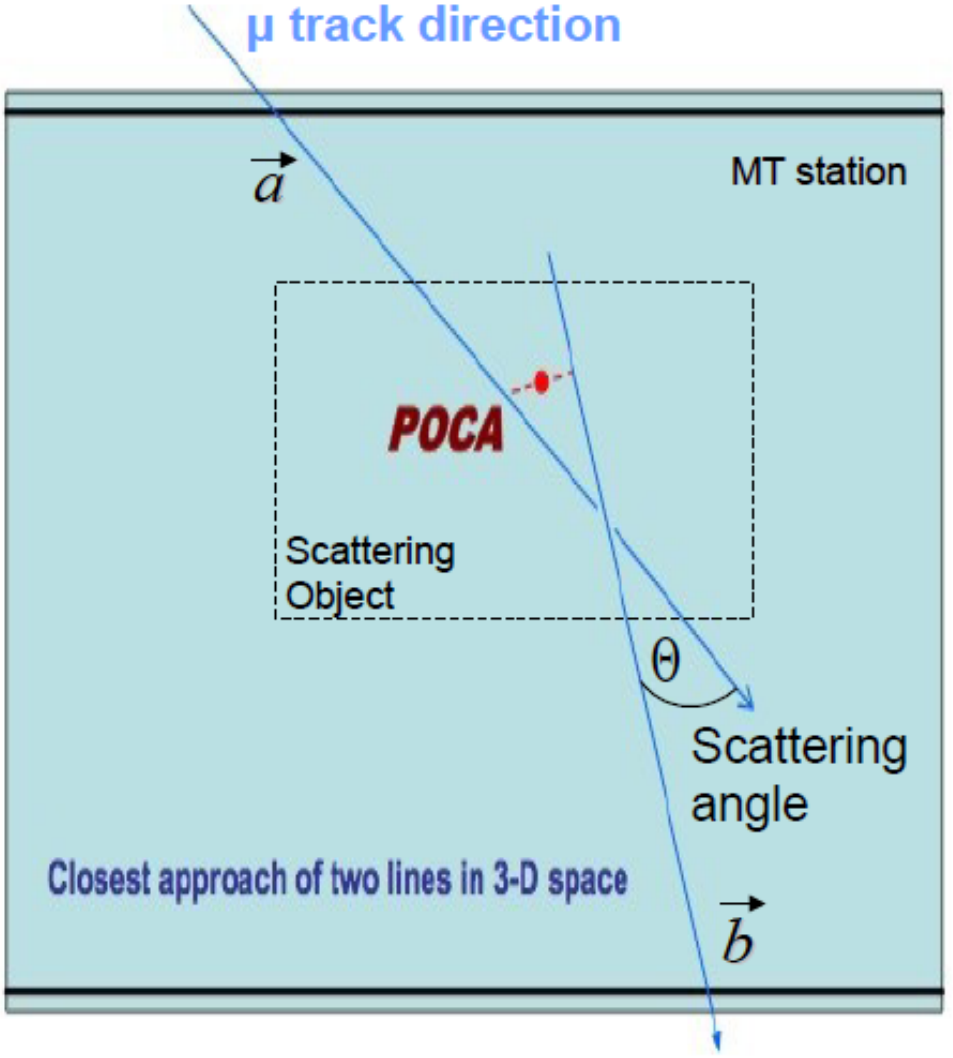


Basic scattering point reconstruction for muon tomography

- Simple reconstruction algorithm using **Point of Closest Approach** ("POCA") of incoming and exiting 3-D tracks
- Treat as **single scatter**
- Scattering angle:

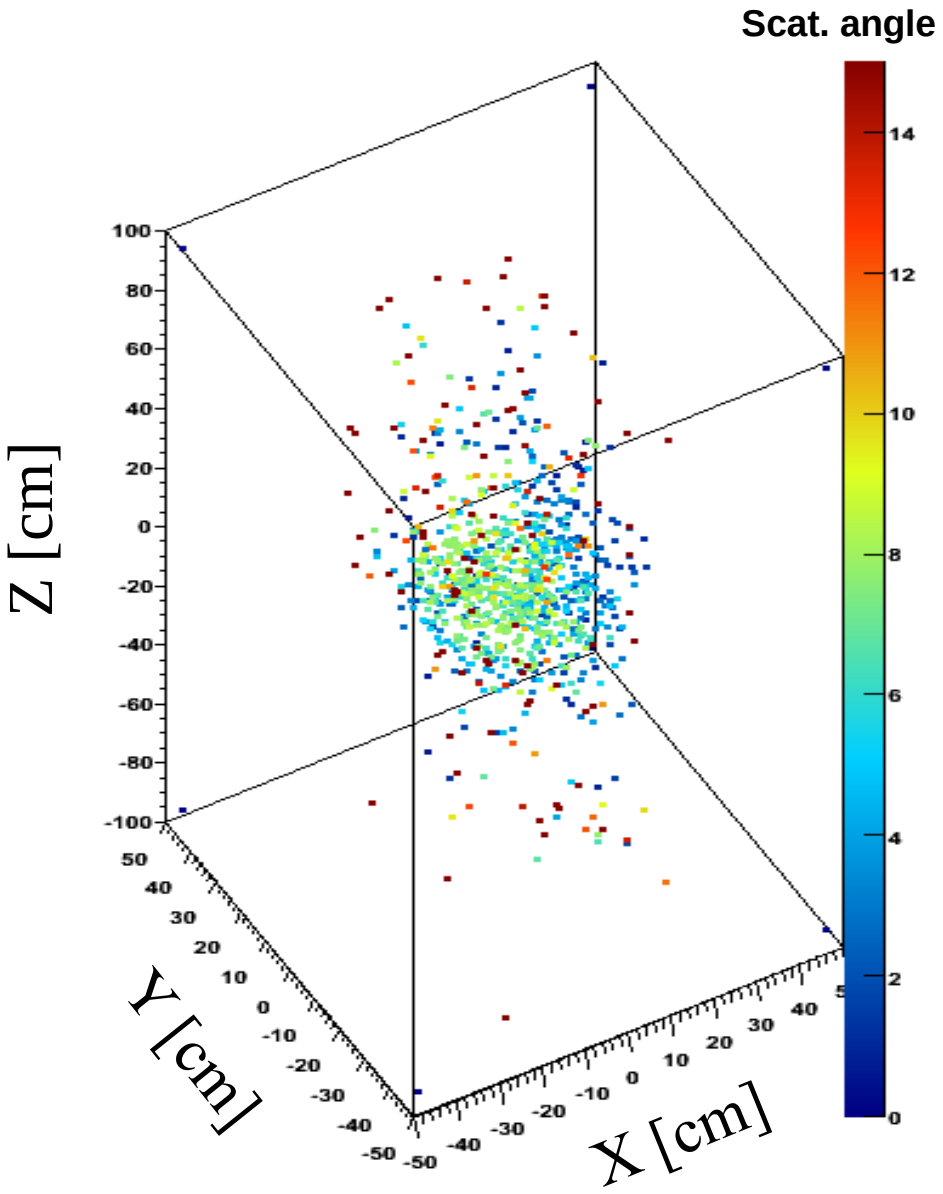
$$\theta = \cos^{-1}\left(\frac{\vec{a}\cdot\vec{b}}{|a||b|}\right)$$

(with $\theta > 0$ by definition)

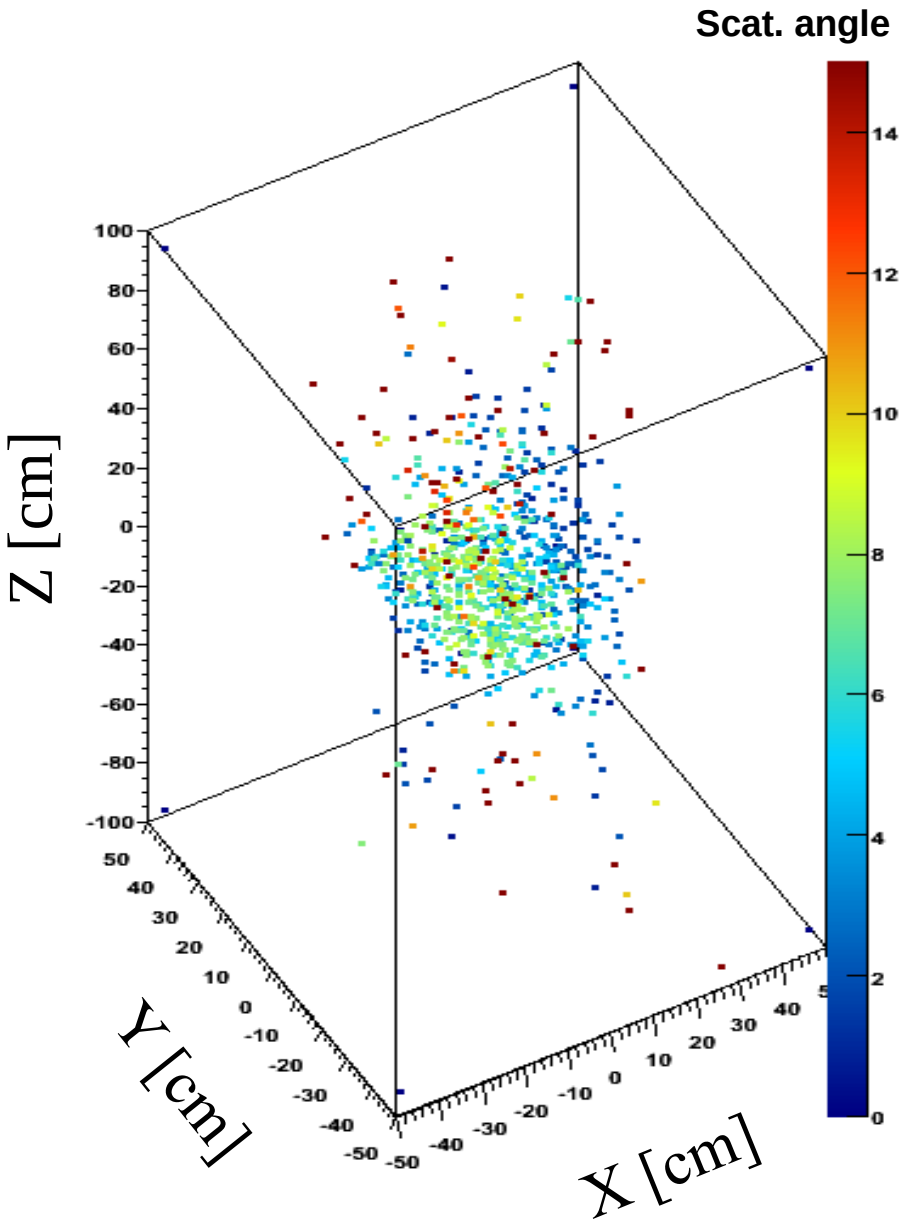


Reconstruction of targets in the MTS

Fe target (3cmx3cmx3cm)

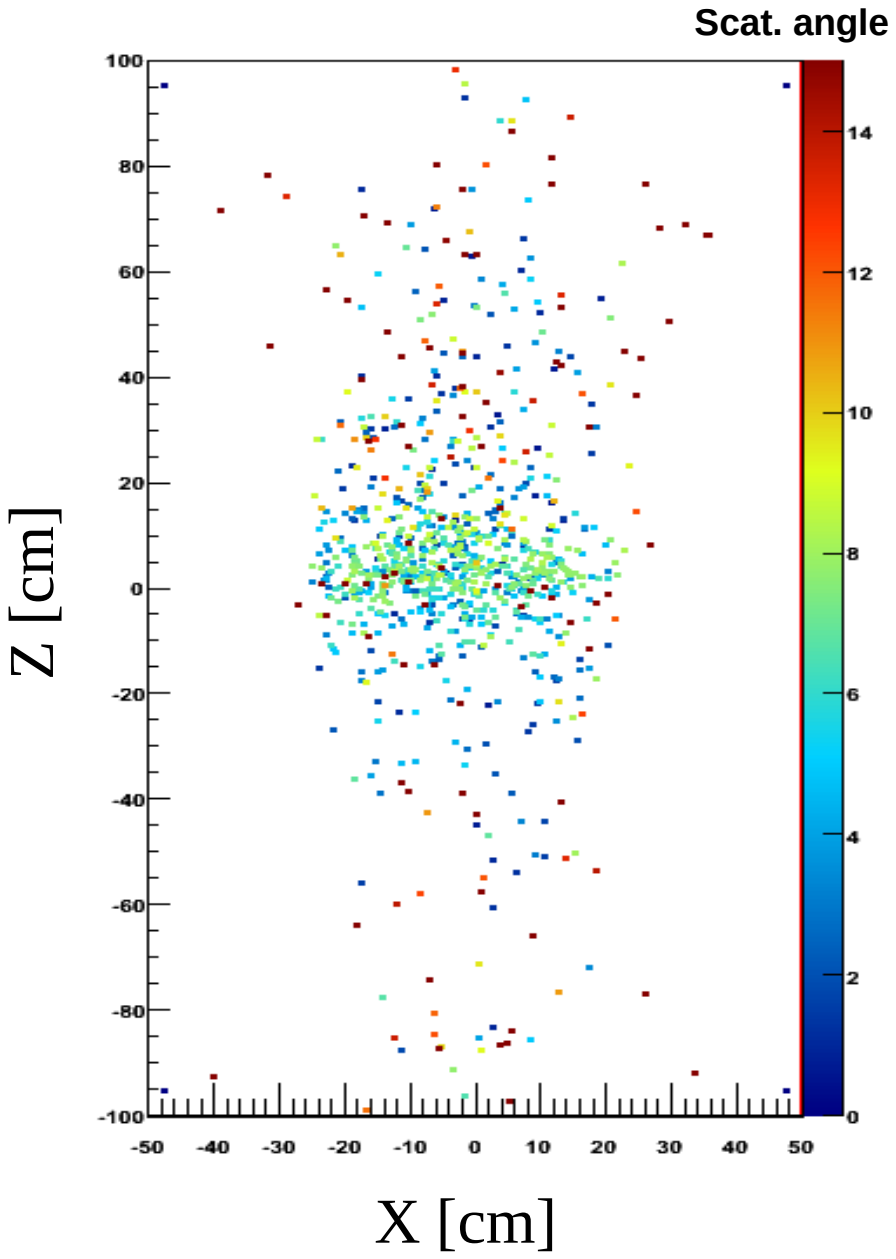


Pb target (3cmx3cmx2cm)

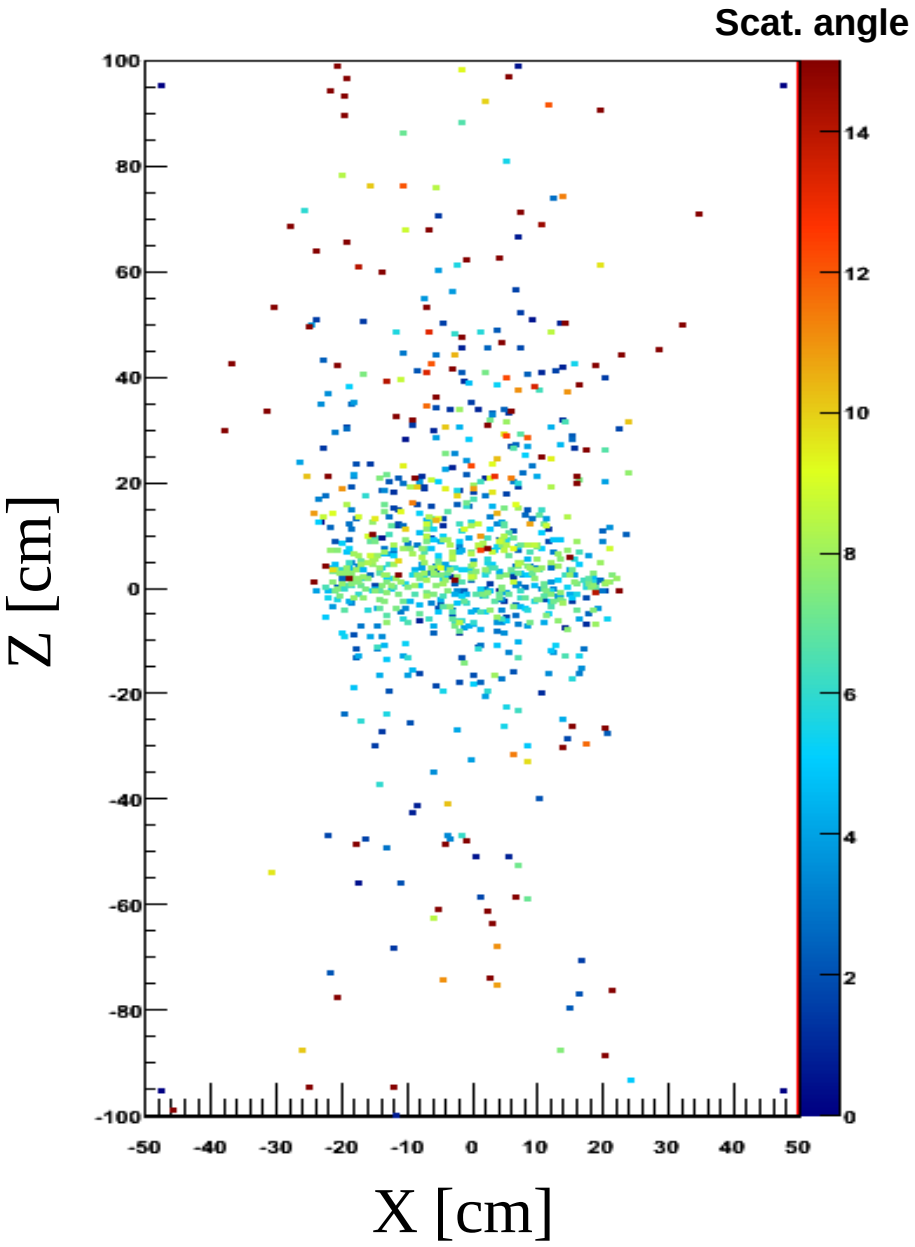


Projection on XZ plane

Fe target (3cmx3cmx3cm)



Pb target (3cmx3cmx2cm)



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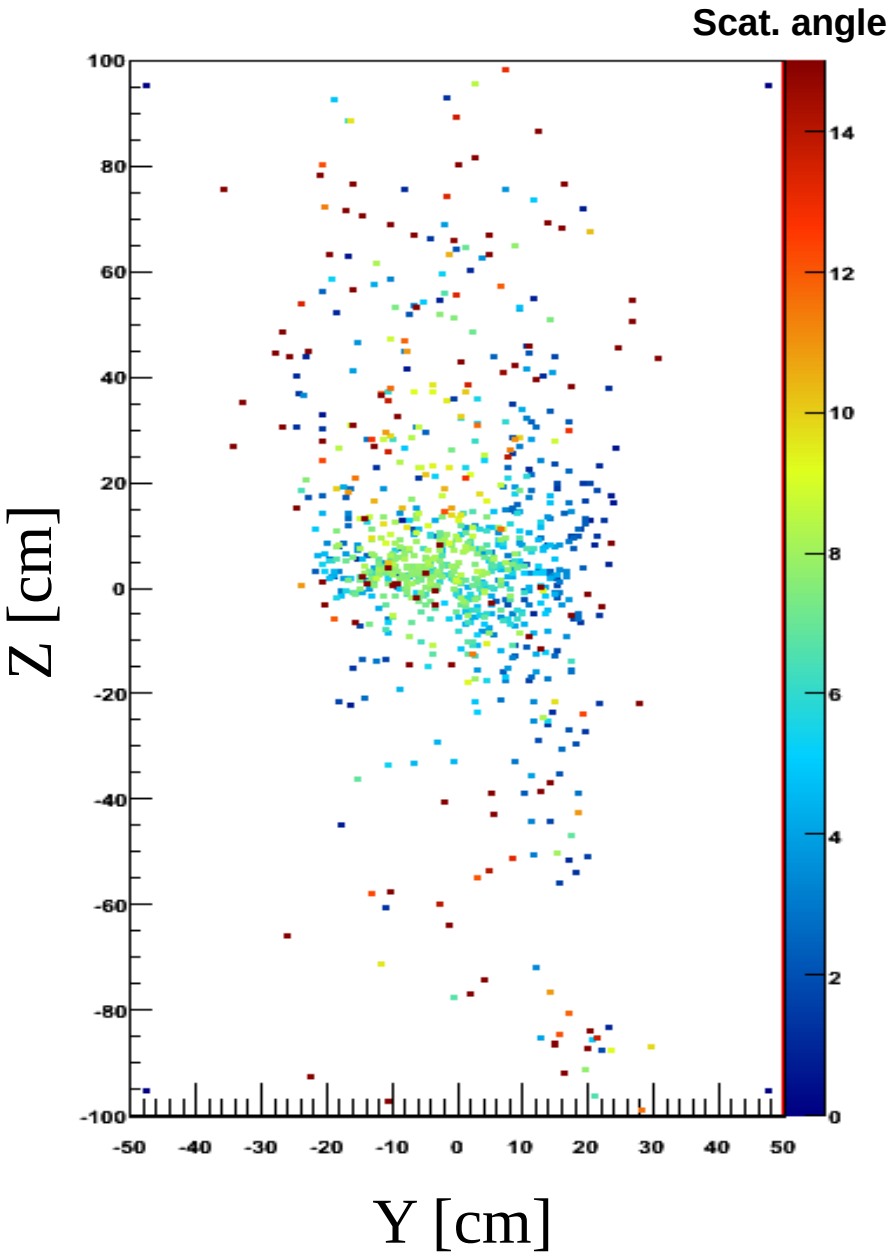

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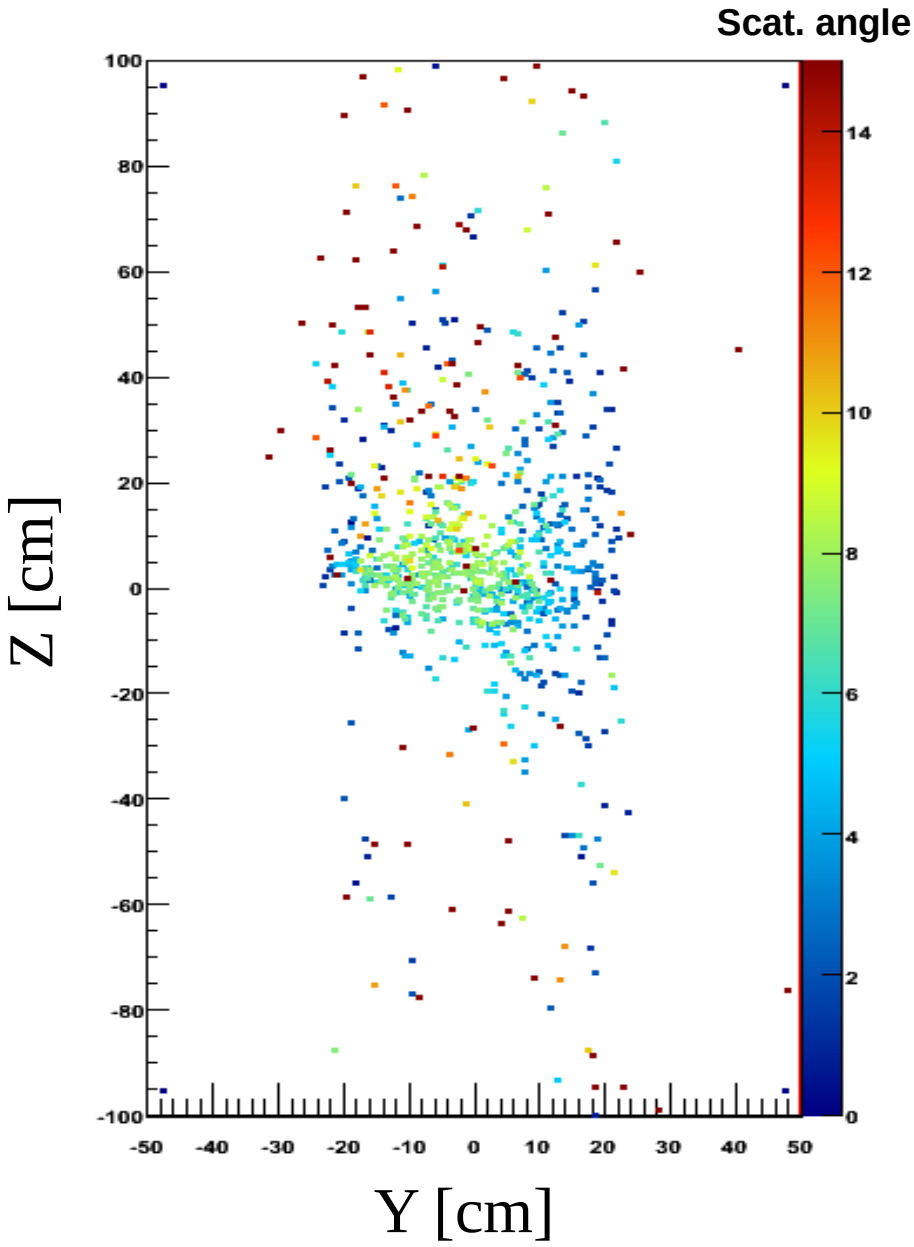
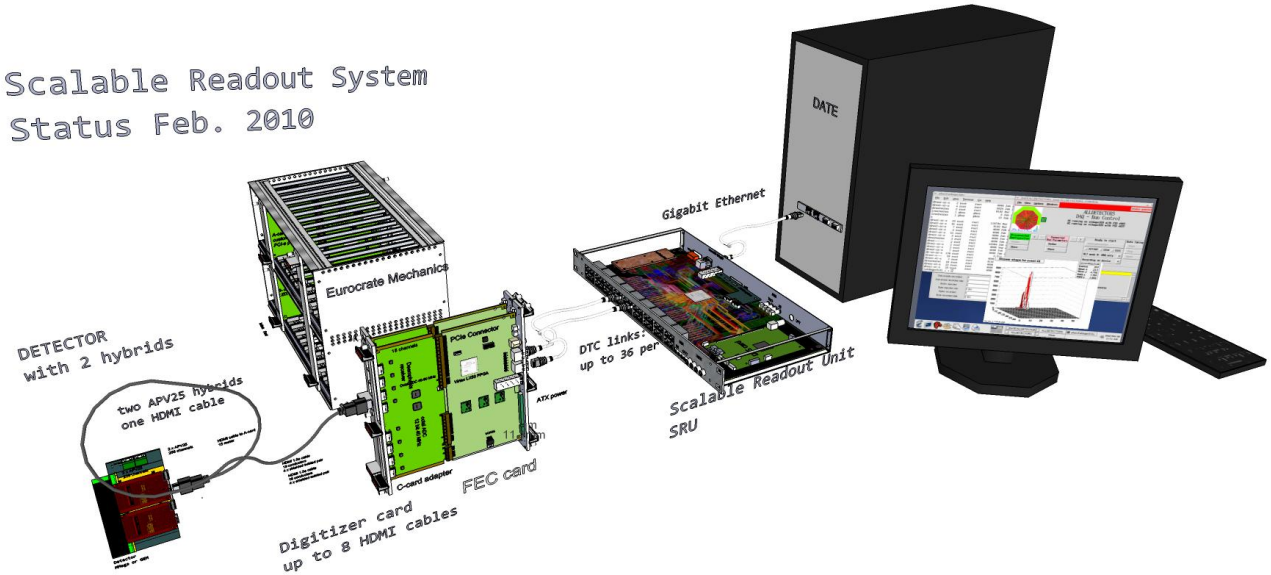


Next on GEM-based MTS !!!

Full readout of all 30 cm x 30 cm of our triple GEMs

- We are actively participating in the Scalable Readout System with RD51/WG5



http://rd51-public.web.cern.ch/RD51-Public/Activities/Documents/WG5SRS.pdf

Build the first 1m x 1m triple GEM detector as a unit for a large MTS