DRIFT CHAMBER DETECTORS IN FOOT

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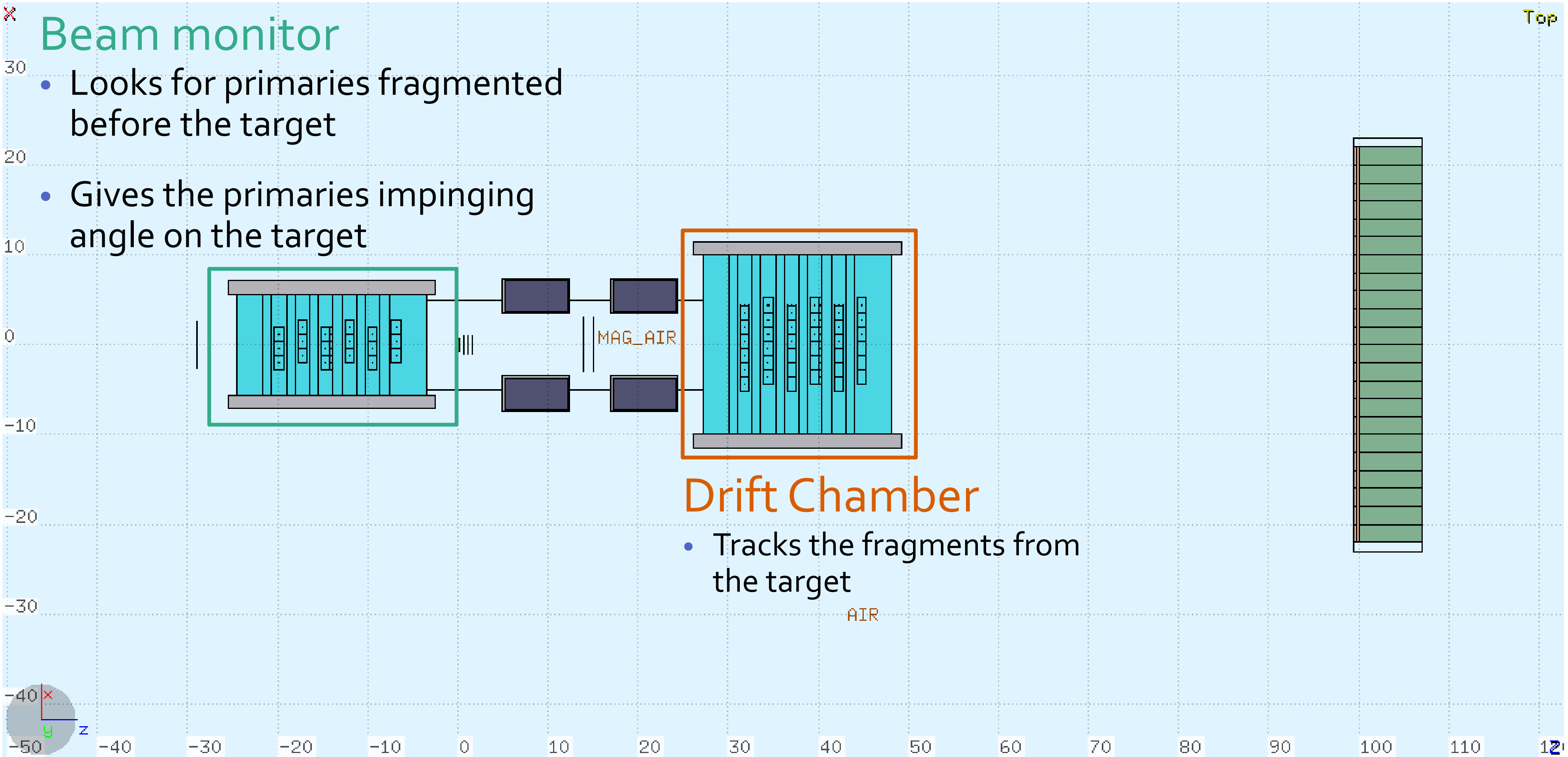
FOOT meeting

Drift chamber detectors in FOOT



Beam monitor

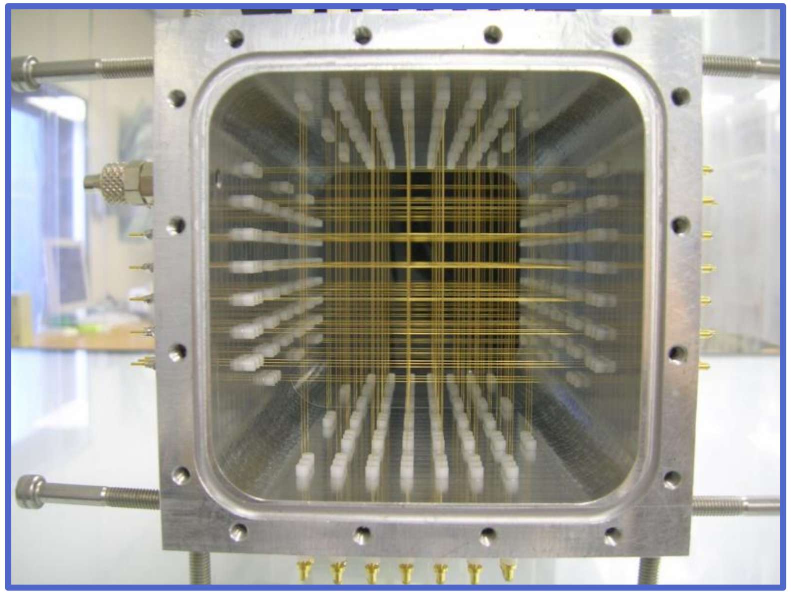
- Looks for primaries fragmented before the target
- Gives the primaries impinging angle on the target

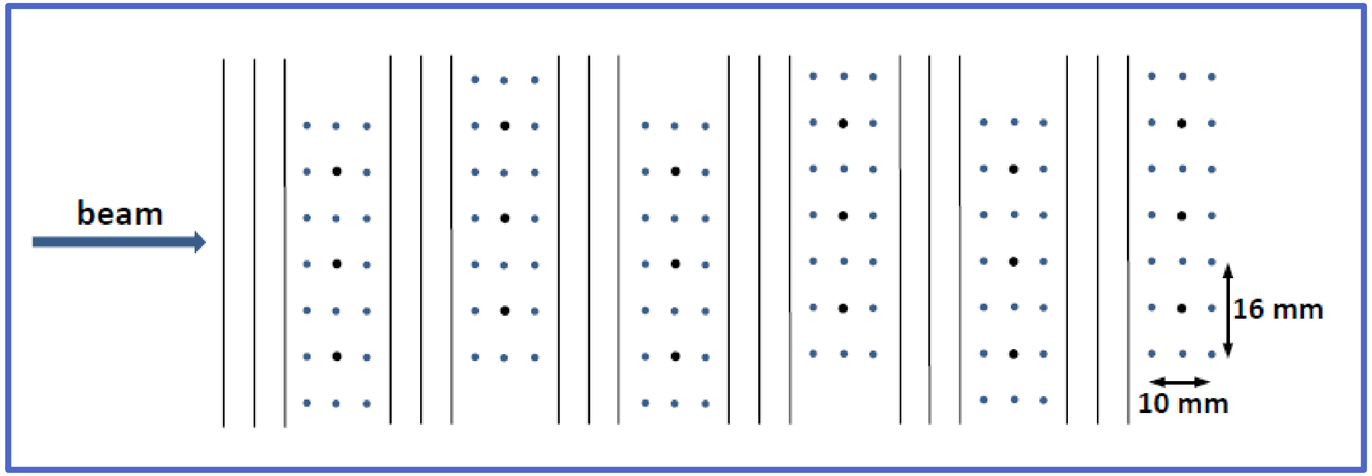
Drift Chamber

- Tracks the fragments from the target

What we have

- Drift chamber beam monitor (FIRST, HIT and GSI test beam experiment)
- Alternated horizontal and vertical wire layers
- Three rectangular cells per layer (16mm x 10mm)
- Consecutive layers of each view staggered by half a cell to minimize tracking ambiguities
- Not optimized for multitrack detection
- Needed an accurate calibration test





Requirements & issues

- ✔ Spatial resolution ~ 100-150 μm
- ~ Low density material to minimize inelastic interaction probability
- ✘ Multi-track detection capability

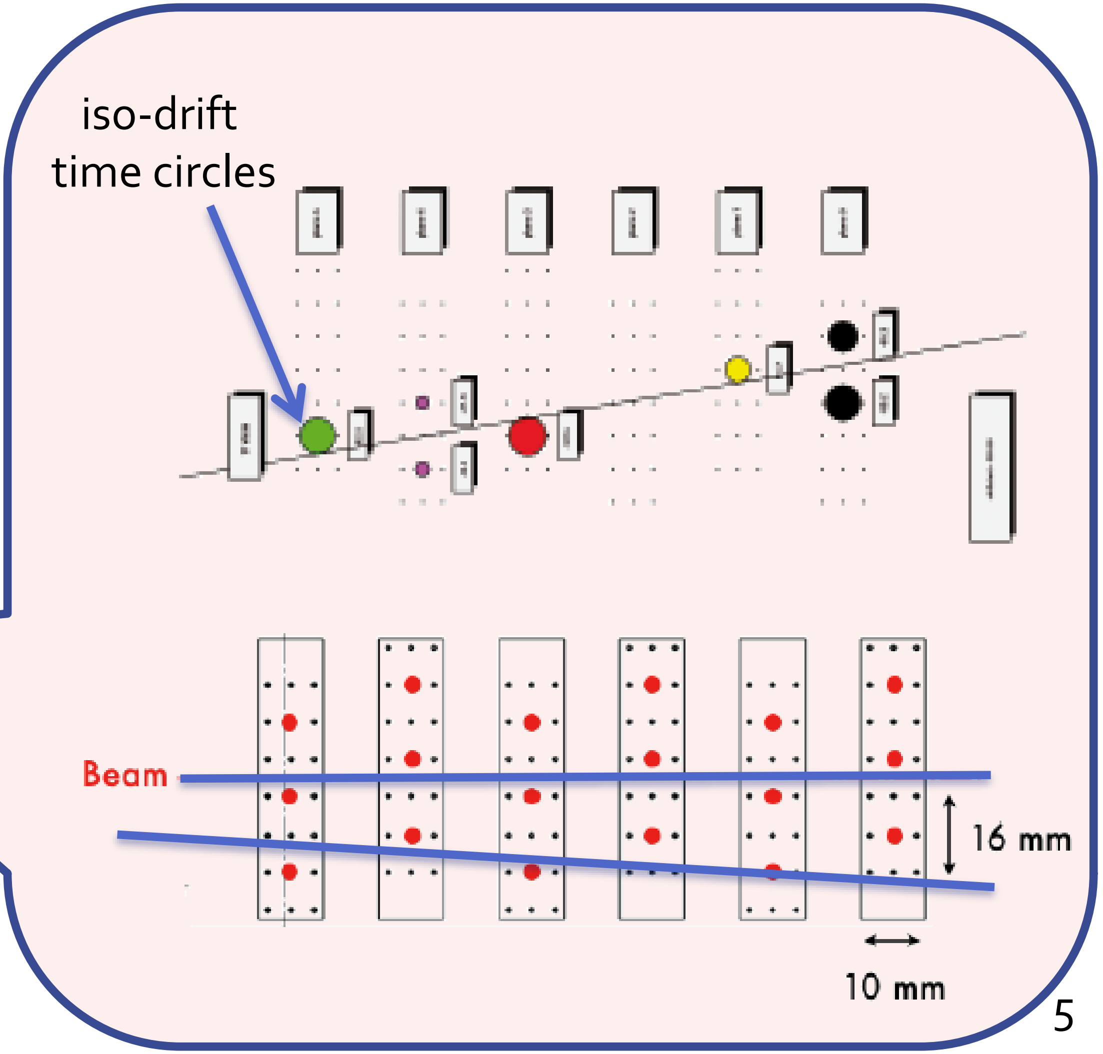
Requirements & issues

- Spatial resolution ~ 100-150 μm
- Low density material to minimize inelastic interaction probability
- Multi-track detection capability

- Total dimension (number of cells per layer and number of layers)
- Gas type

Requirements & issues

- ✓ Spatial resolution ~ 100-150 μm
- ~ Low density material to minimize inelastic interaction probability
- ✗ Multi-track detection capability



Multi-track detection

- Cell dimensions
- Low drift velocity
- TDC multihit
- Reconstruction algorithm

Multi-track detection

Cell dimensions

Low drift velocity

TDC multihit

Reconstruction algorithm

Increase cell dimensions

→ many tracks could cross the same cell

→ minimum separation angle?

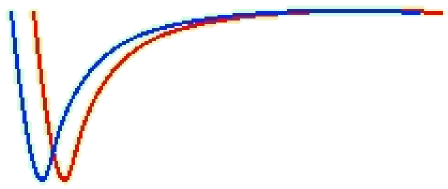
Decrease cell dimensions

→ number of channels increases

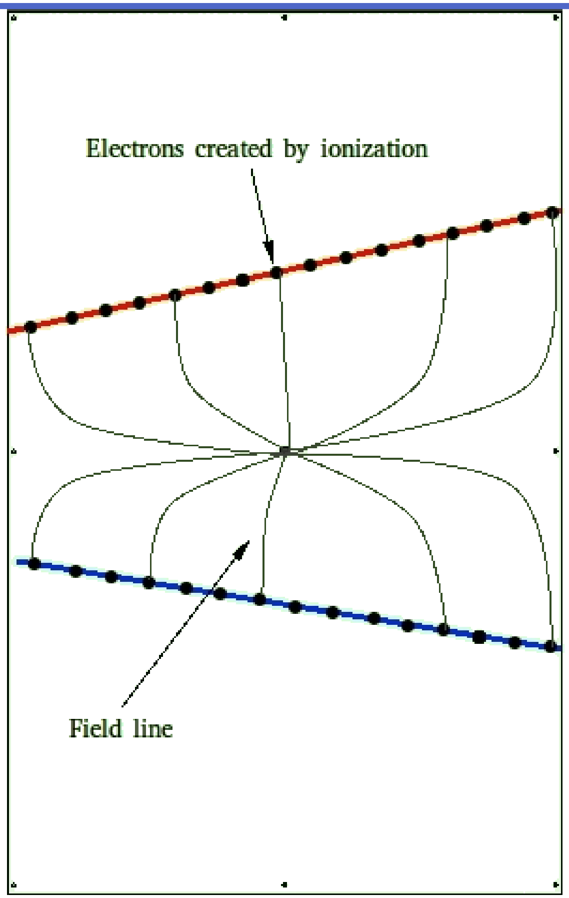
→ inelastic interaction in wires increases

Multi-track detection

- Cell dimensions
- **Low drift velocity**
- TDC multihit
- Reconstruction algorithm



Needed low drift velocity to better separate the tracks in time



Multi-track detection

Cell dimensions

Low drift velocity

TDC multihit

Reconstruction algorithm

Increase pressure?

- atmospheric pressure is easier to handle (thinner mylar layers required)

Decrease the electric field?

- minor wires displacement due to electrostatic forces
- also efficiency decreases

Multi-track detection

- Cell dimensions
- **Low drift velocity**
- TDC multihit
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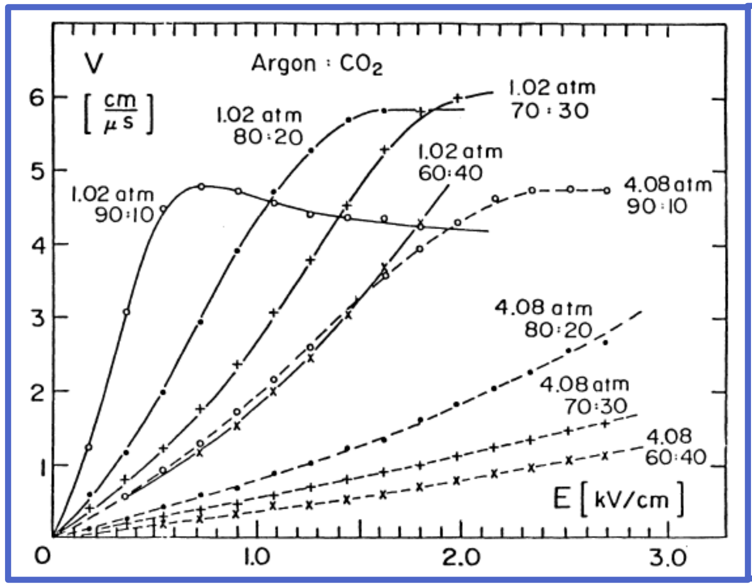
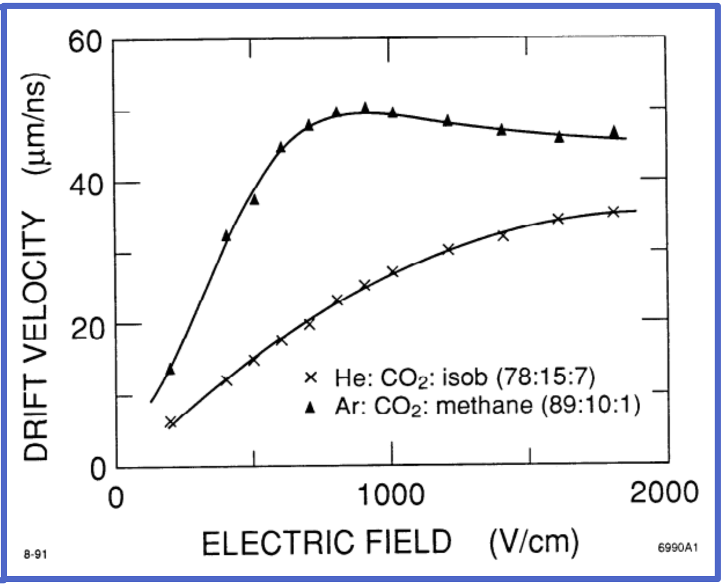




Explore different gas mixtures

➢ Ar-CO_2 or He-CO_2? Does He minimize fragmentation probability?

Multi-track detection

Cell dimensions

Low drift velocity

TDC multihit

Reconstruction algorithm

Garfield

- Toolkit for detailed simulation of particle detectors which use a gas mixture as sensitive
- With the input of medium and geometry, can interface with different programs to calculate material properties, fields and transportation of particles
- Will be used for MC simulation of the beam monitor and drift chamber, to estimate the drift parameters (drift velocity, space-time relationship…) and to optimize the geometry

Multi-track detection

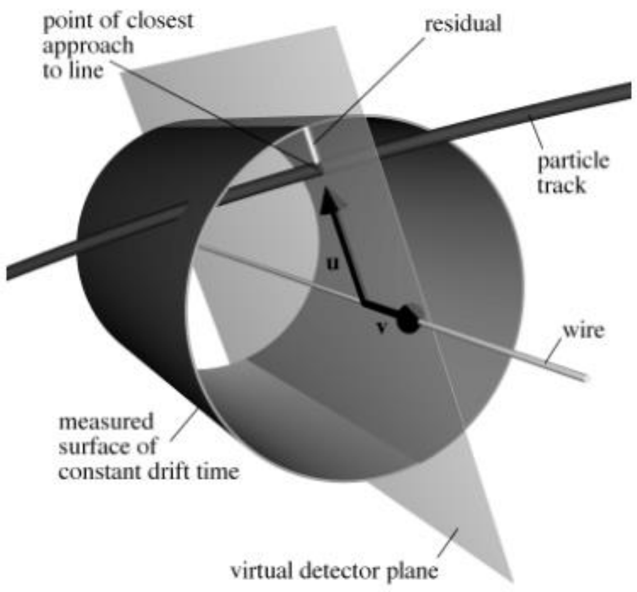
- Cell dimensions
- Low drift velocity
- **TDC multihit**
- Reconstruction algorithm

Example of TDC multihit

- 64 channels
- 3 programmable ranges: 100 ps LSB (19 bit resolution), 200 ps LSB (19bit) and 800 ps LSB (17 bit)
- ECL/LVDS inputs automatically detected
- 5 ns Double Hit Resolution
- Leading and Trailing Edge detection
- Trigger Matching and Continuous Storage acquisition modes
- 32 k x 32 bit output buffer
- Cost: approximately €6200 (VAT included)

Multi-track detection

- Cell dimensions
- Low drift velocity
- TDC multihit
- Reconstruction algorithm



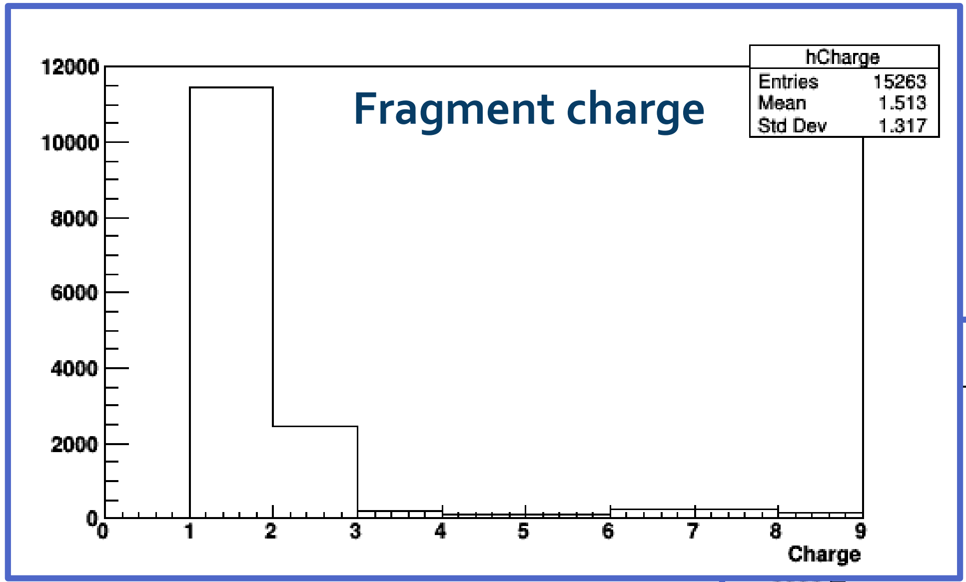
Wire measurement
(e.g. from drift-chamber or STT).

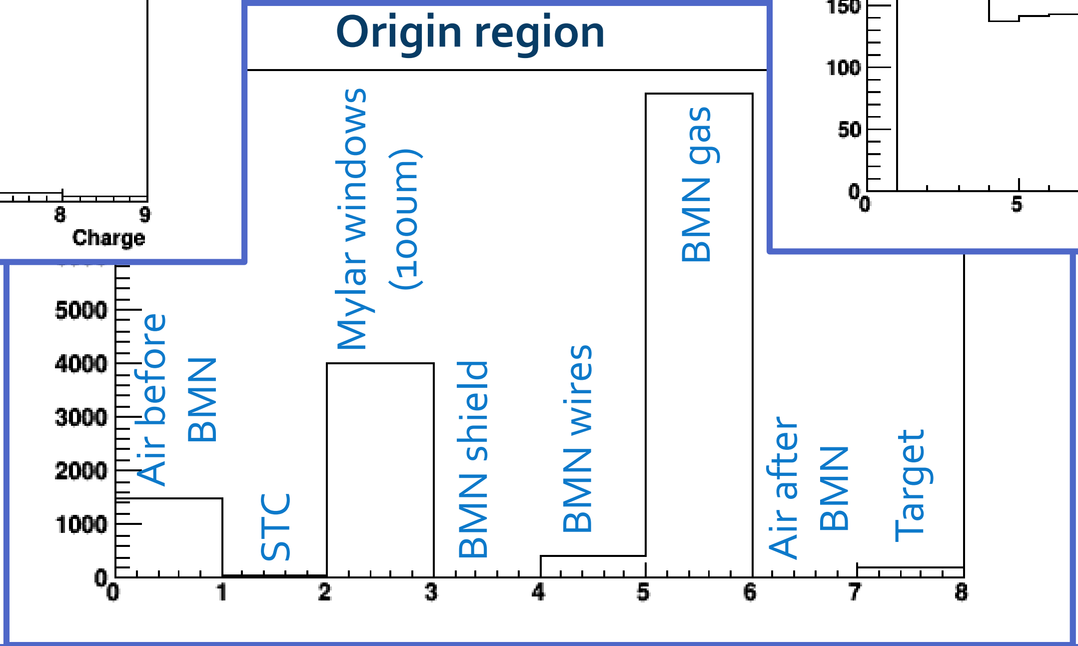
Genfit

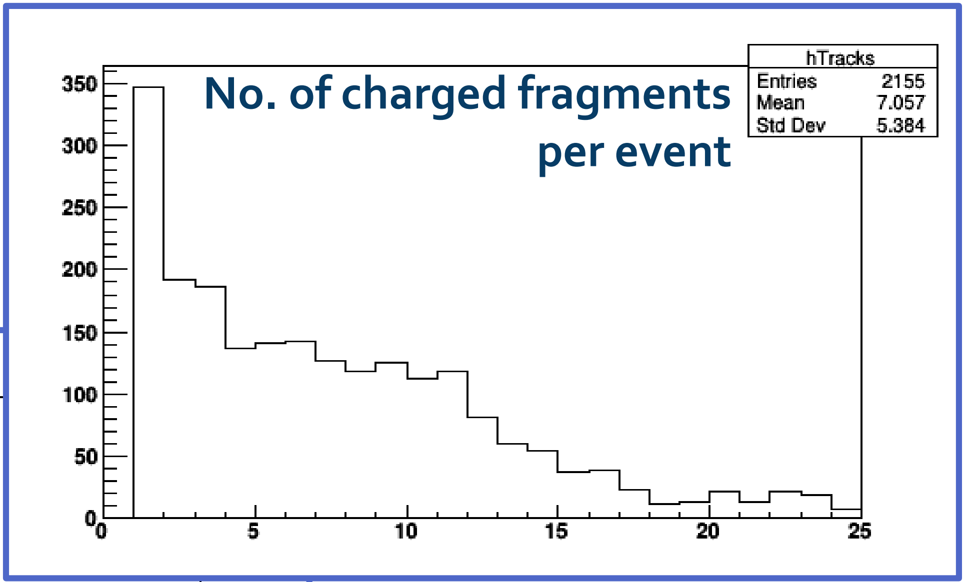
- Open source track-fitting toolkit suitable for a wide variety of experiments and detectors
- Will be used as tracking algorithm for the beam monitor and the drift chamber
- Provides different fitting algorithms:
  - Kalman filter which linearizes the transport around the state predictions
  - Kalman filter which linearizes around a reference track
  - Deterministic annealing filter (DAF)

Beam Monitor Simulation

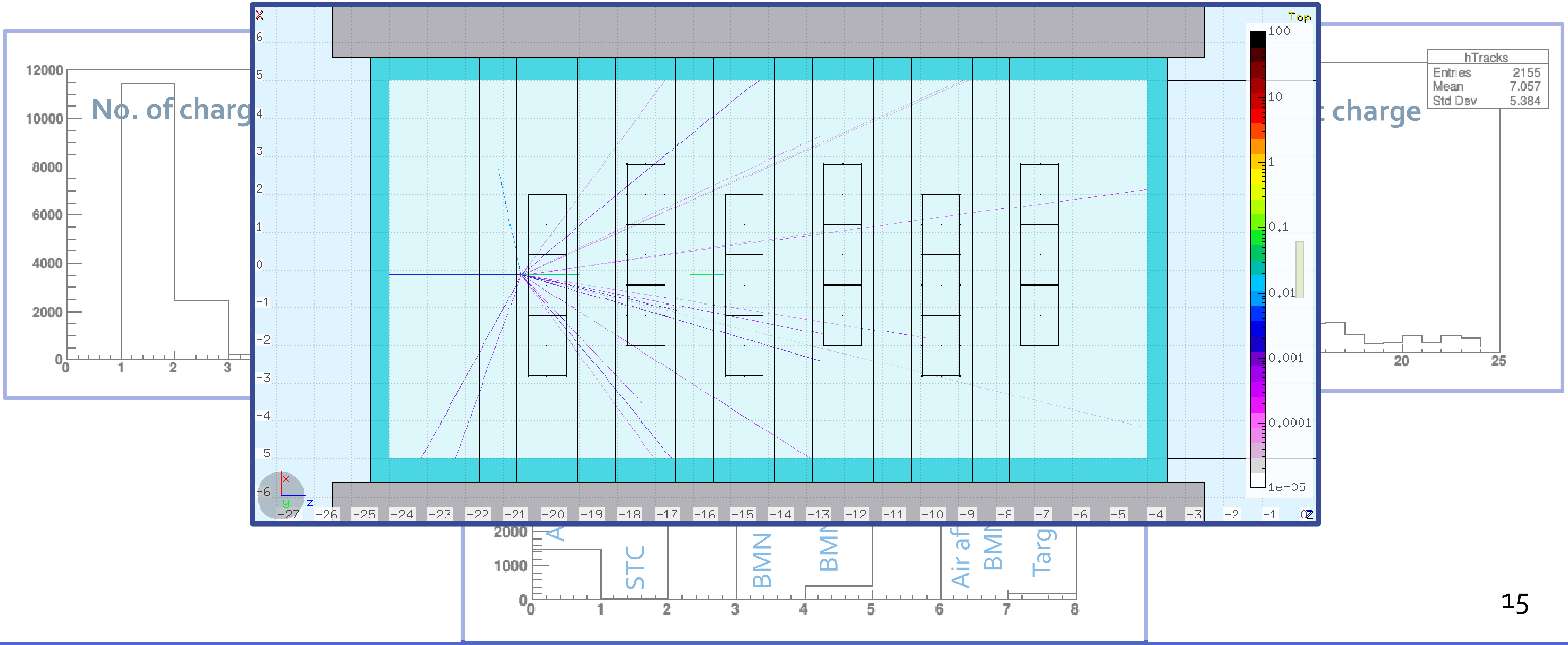
1 million events
O@200MeV/u
2mm C_2H_4 target







Beam Monitor Simulation



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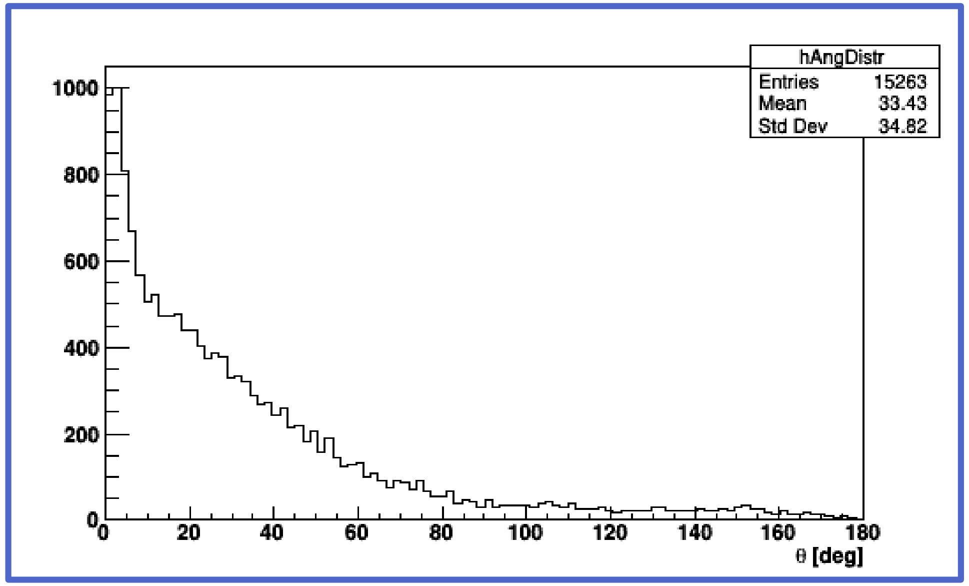
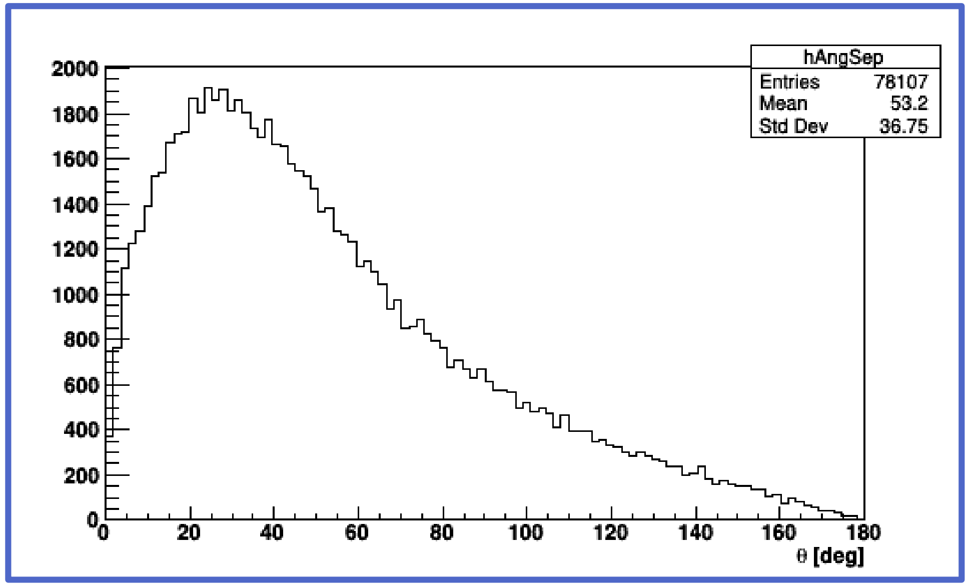
2mm C_2H_4 target

Fragments angular distribution

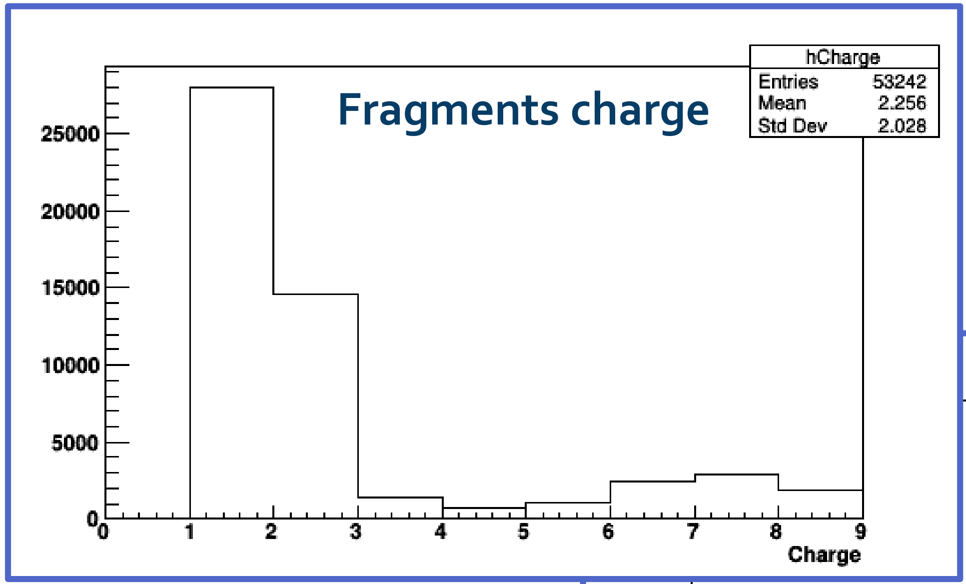


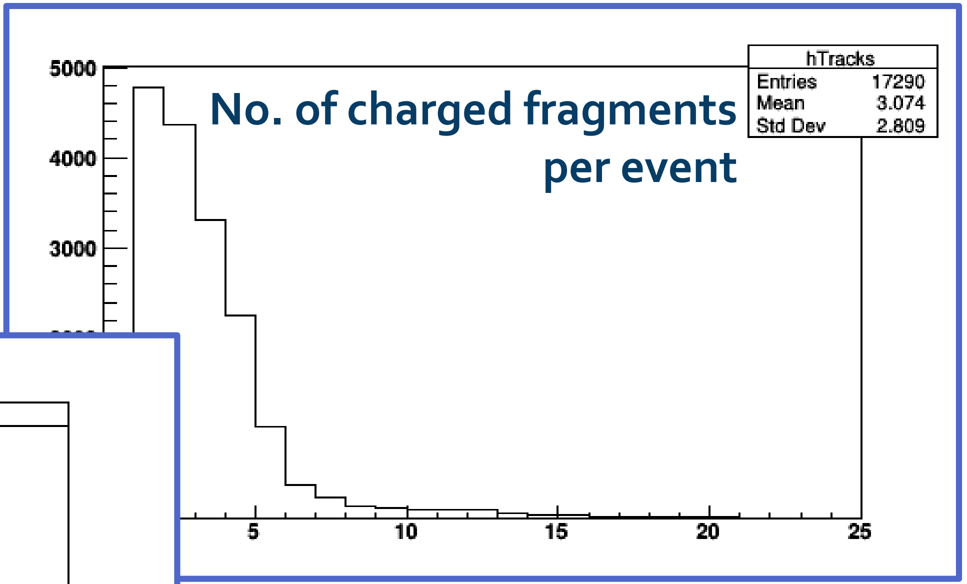
Fragments angular separation distribution

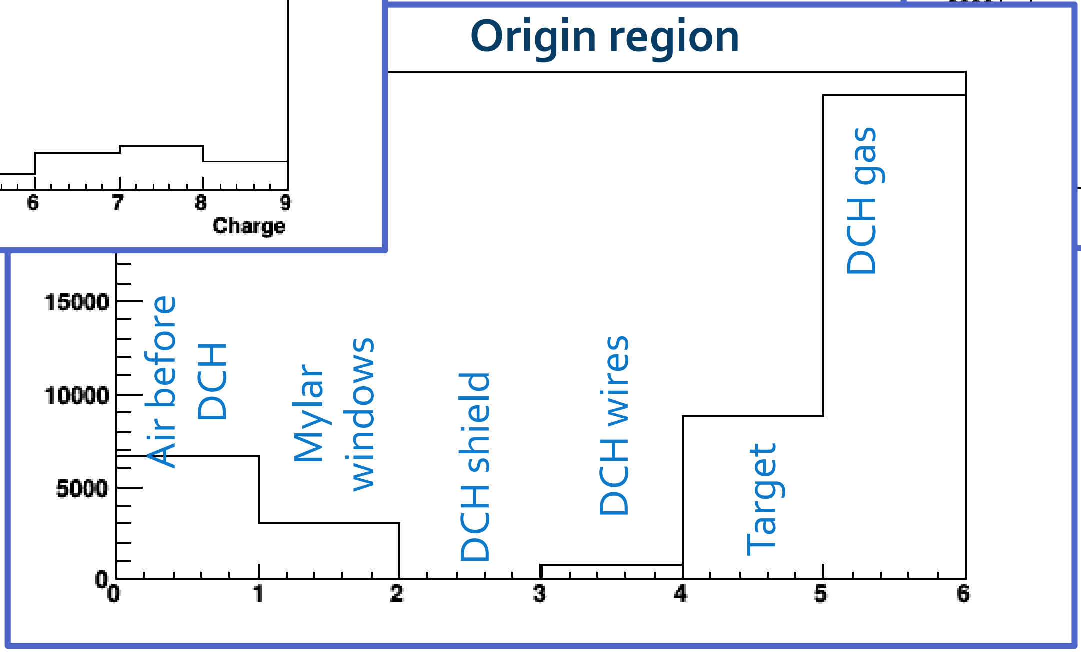


Drift Chamber Simulation

1 million events
O@200MeV/u
2mm C_2H_4 target







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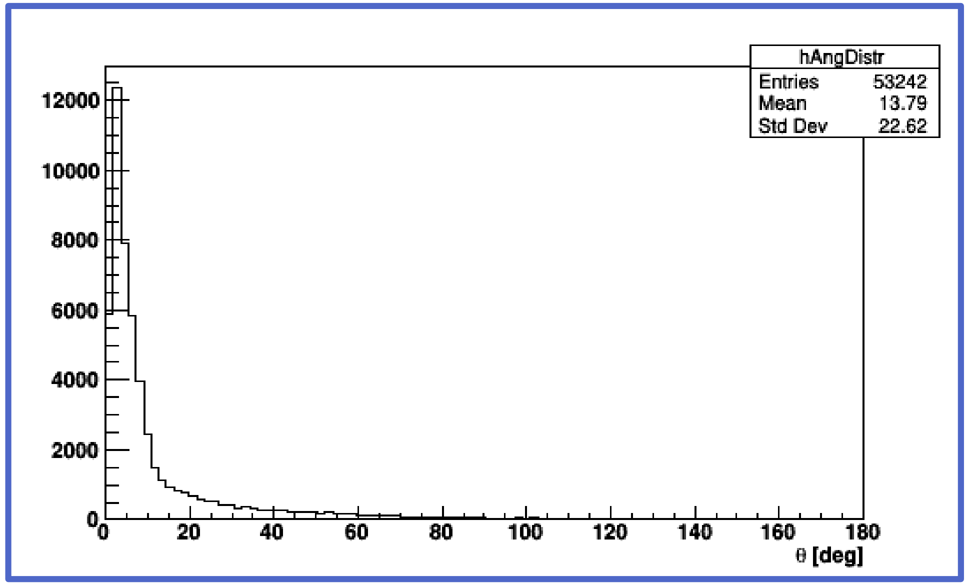

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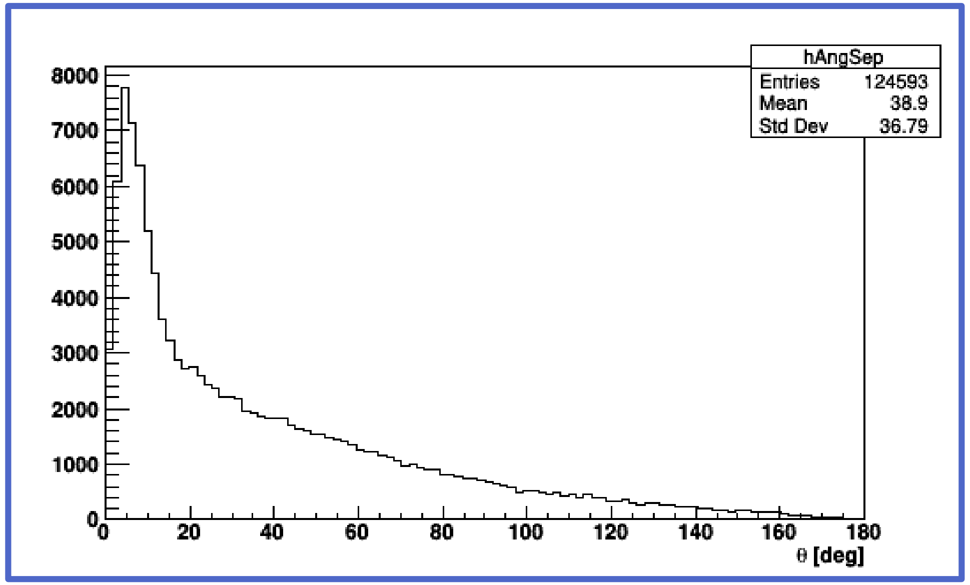
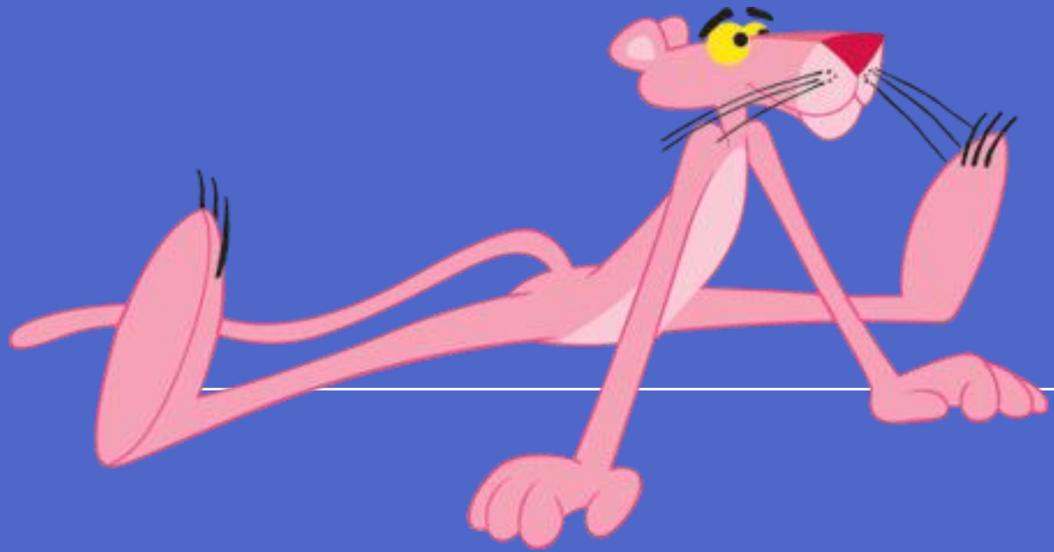


Conclusions & take home messages

- The existing beam monitor requires to be optimized for multitrack detection:
  - Gas mixture, electric field, cell and total dimension
- An accurate calibration test is strongly needed (next year?)
- Parameters optimisation will be performed by means of the MC code FLUKA and Garfield
- We need to learn how to use the reconstruction algorithm (Genfit)



THANK YOU