GEM TRACKER SIMULATIONS STATUS

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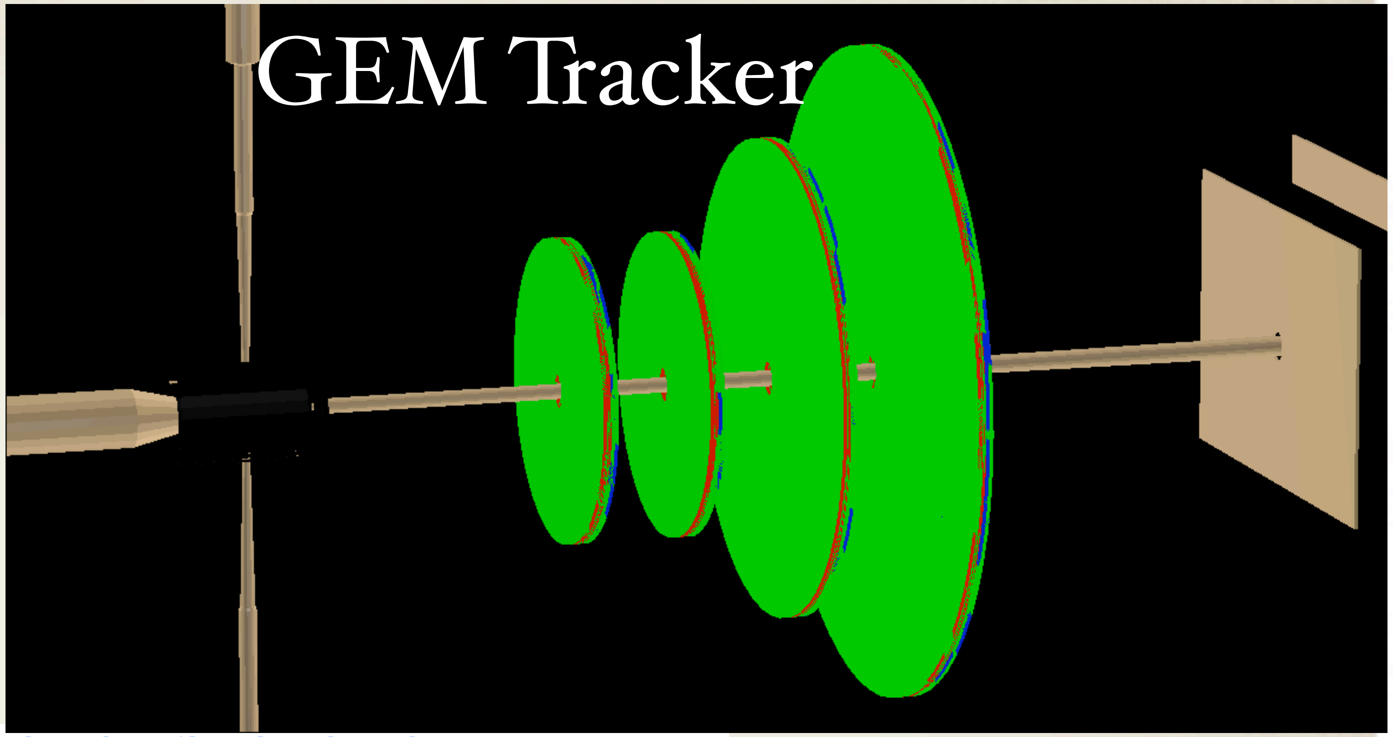
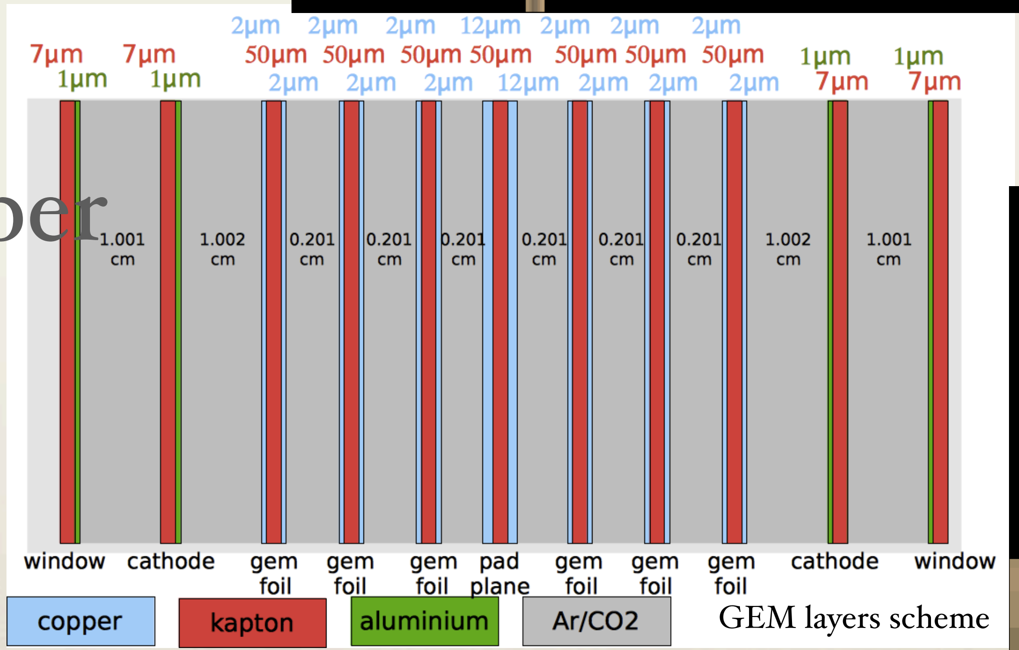
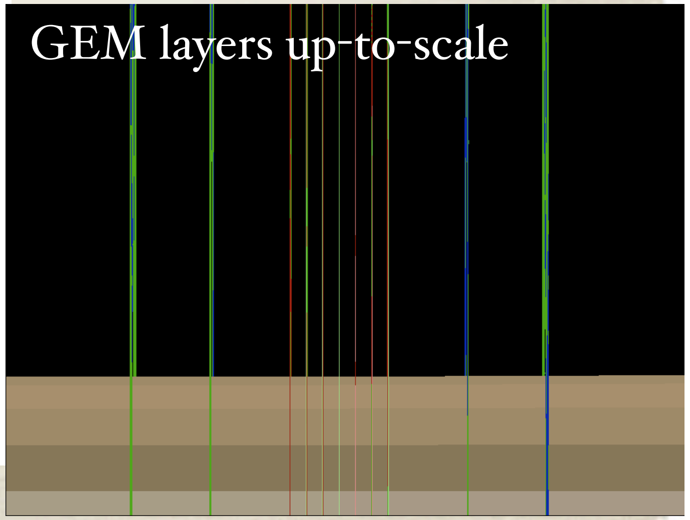
GEM layout

* 3(4) stations positioned at (84), 117, 153, 180 cm from the target
* VMC geometry mimics the geometry provided by Bernd Voss
* 2 sensitive layers per station
* 4 projections per station

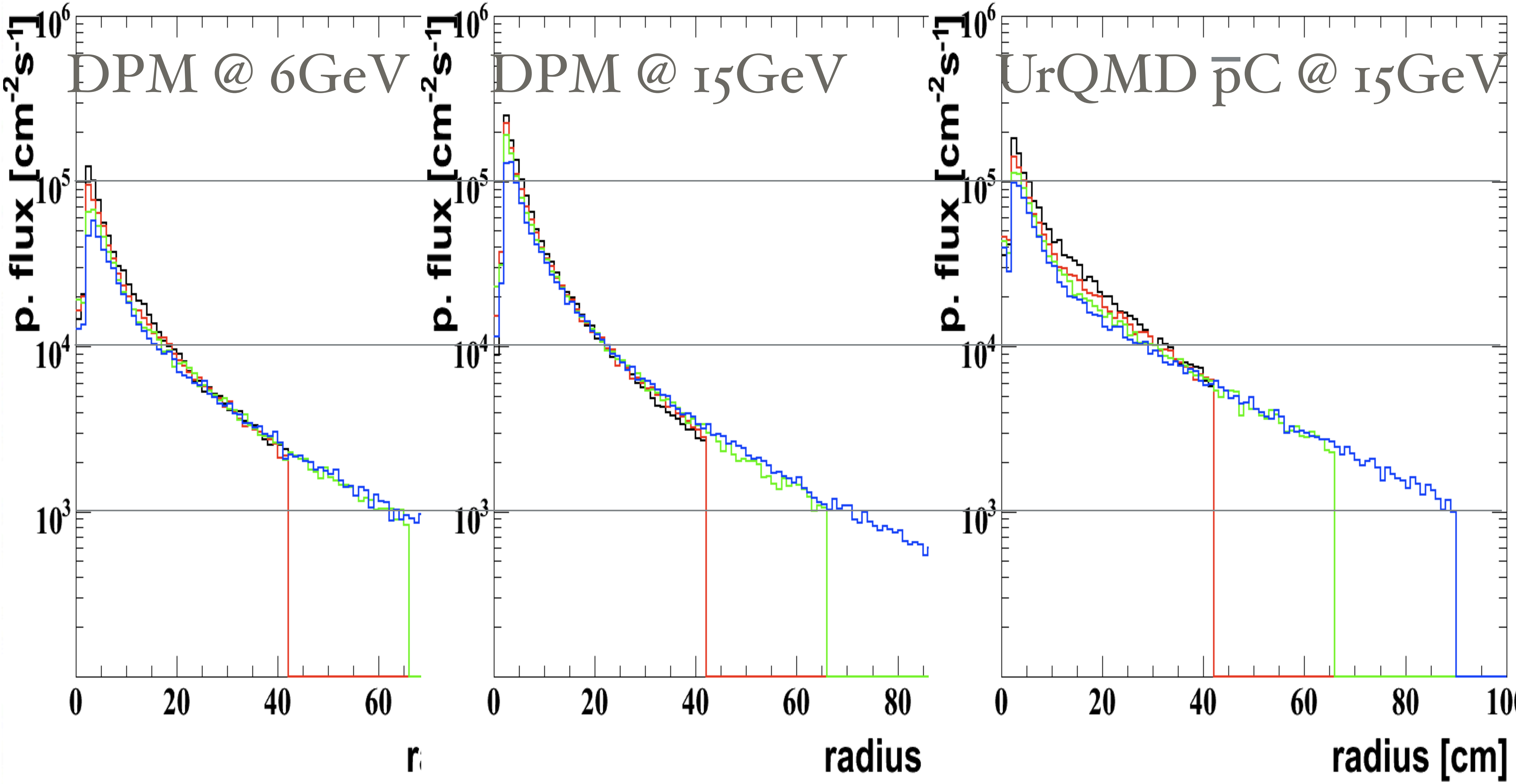




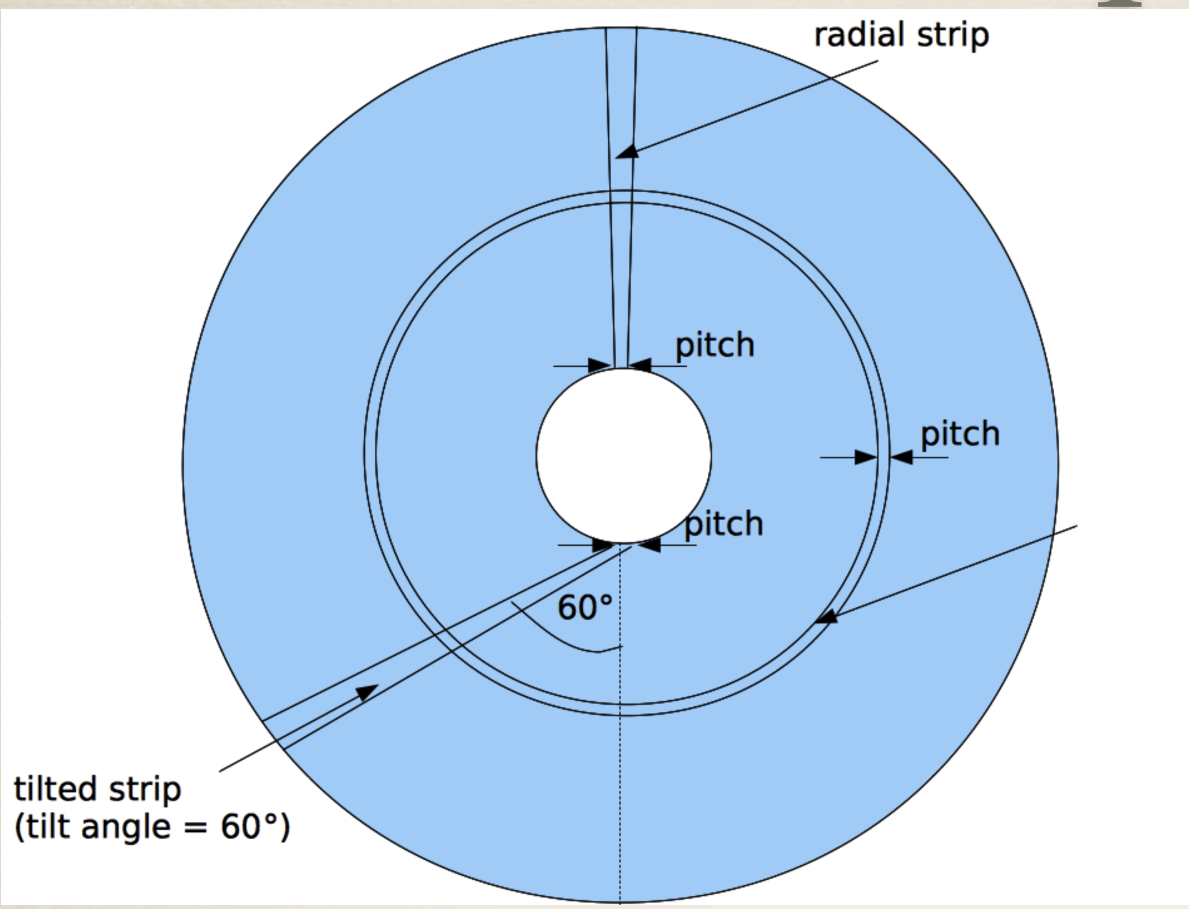
GEM layers scheme

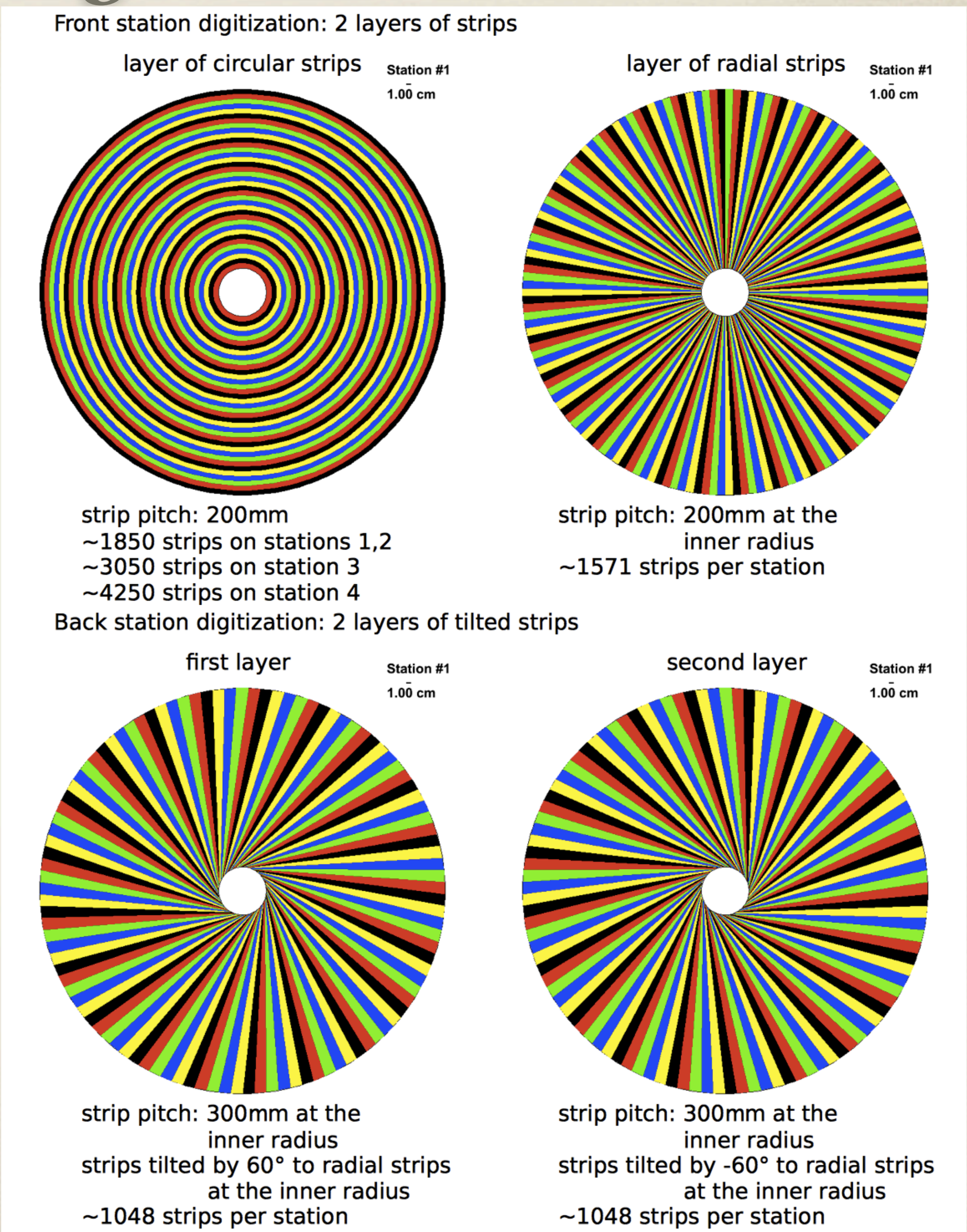

GEM layers up-to-scale

Particle flux



GEM projections





Design from early 2009

Proposition now:

circular, radial, X, Y

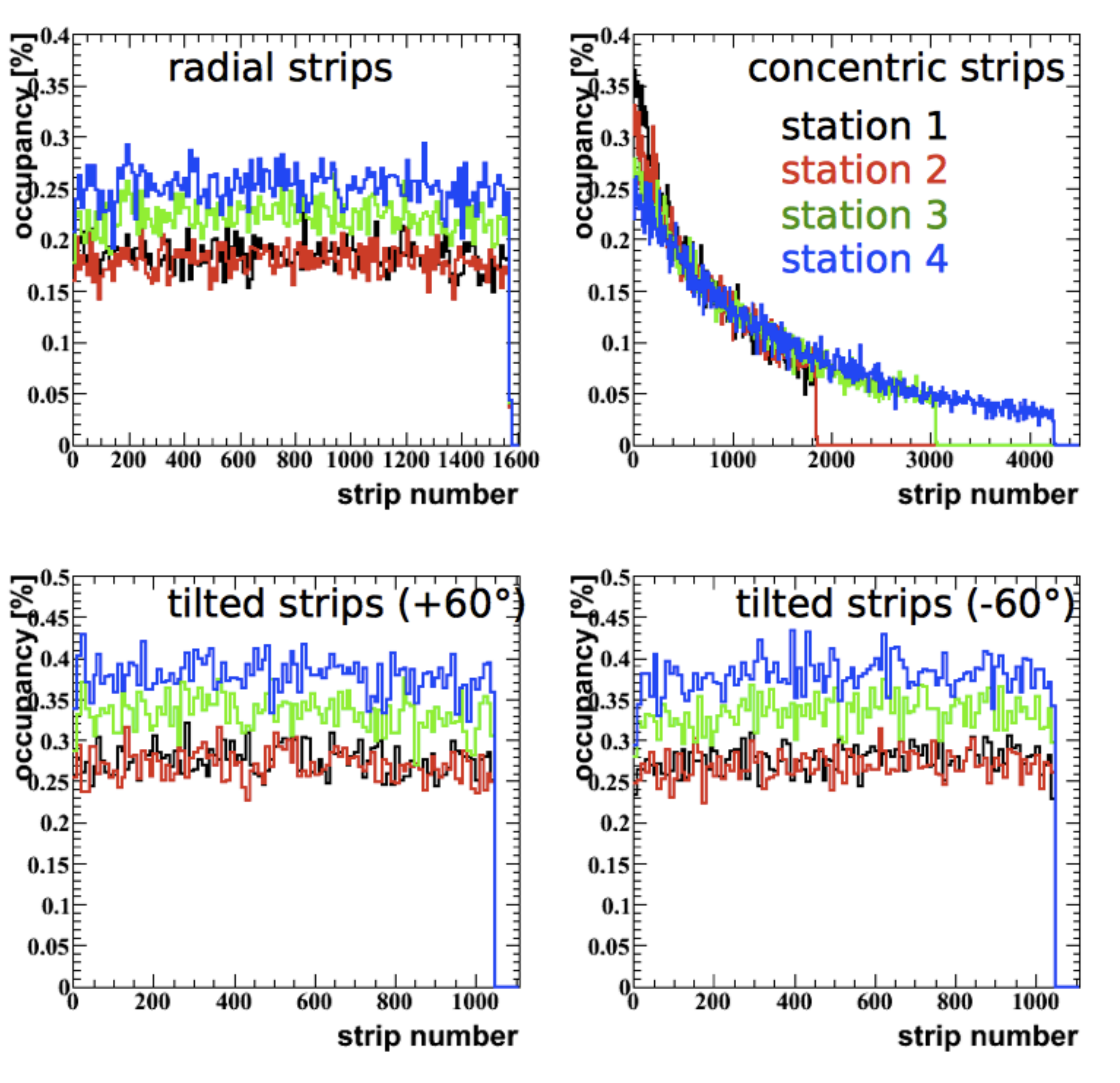
Not implemented yet

GEM occupancy

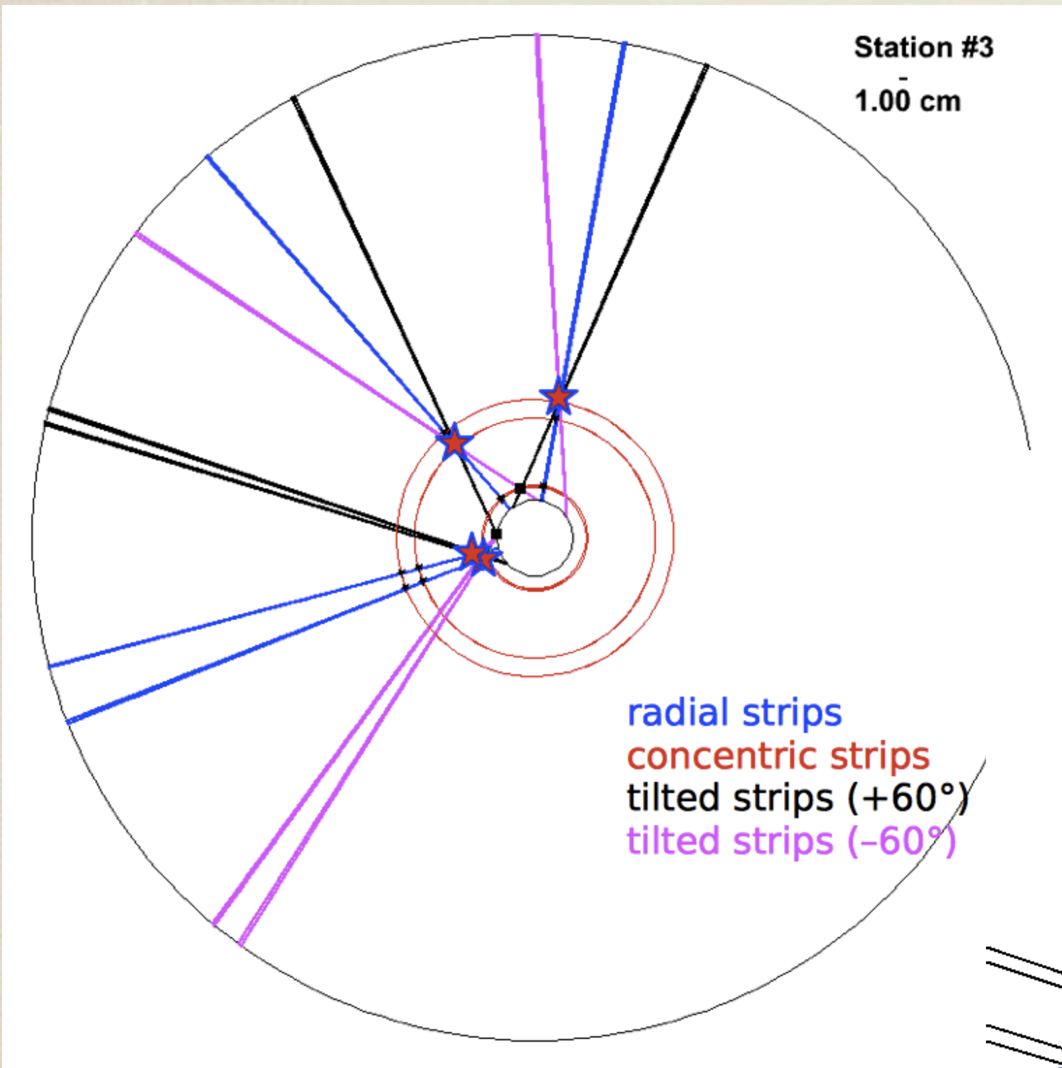
Number of fired strips per 15 GeV/c DPM event

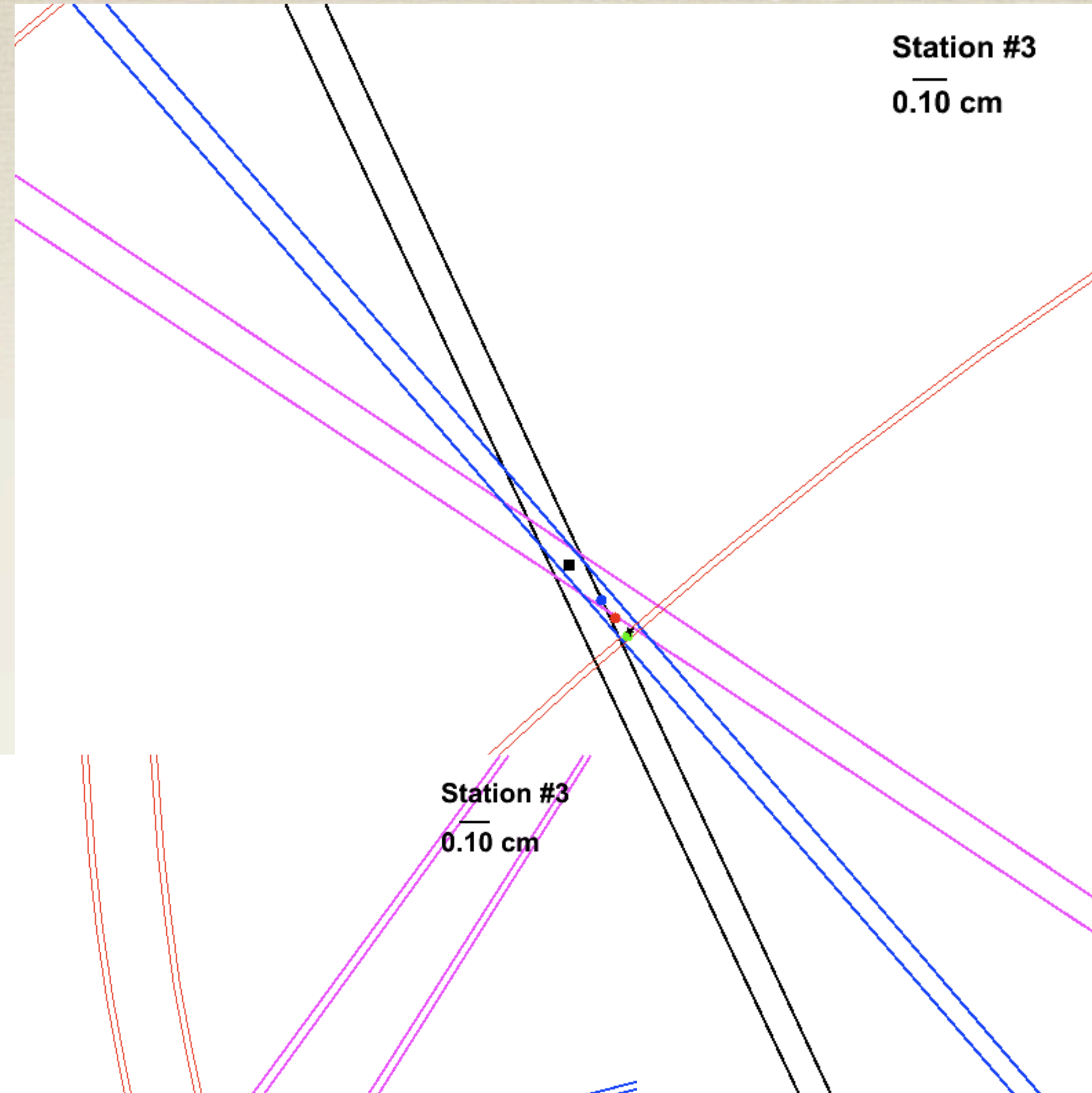
No strip sharing – only one fired strip per view per MC hit

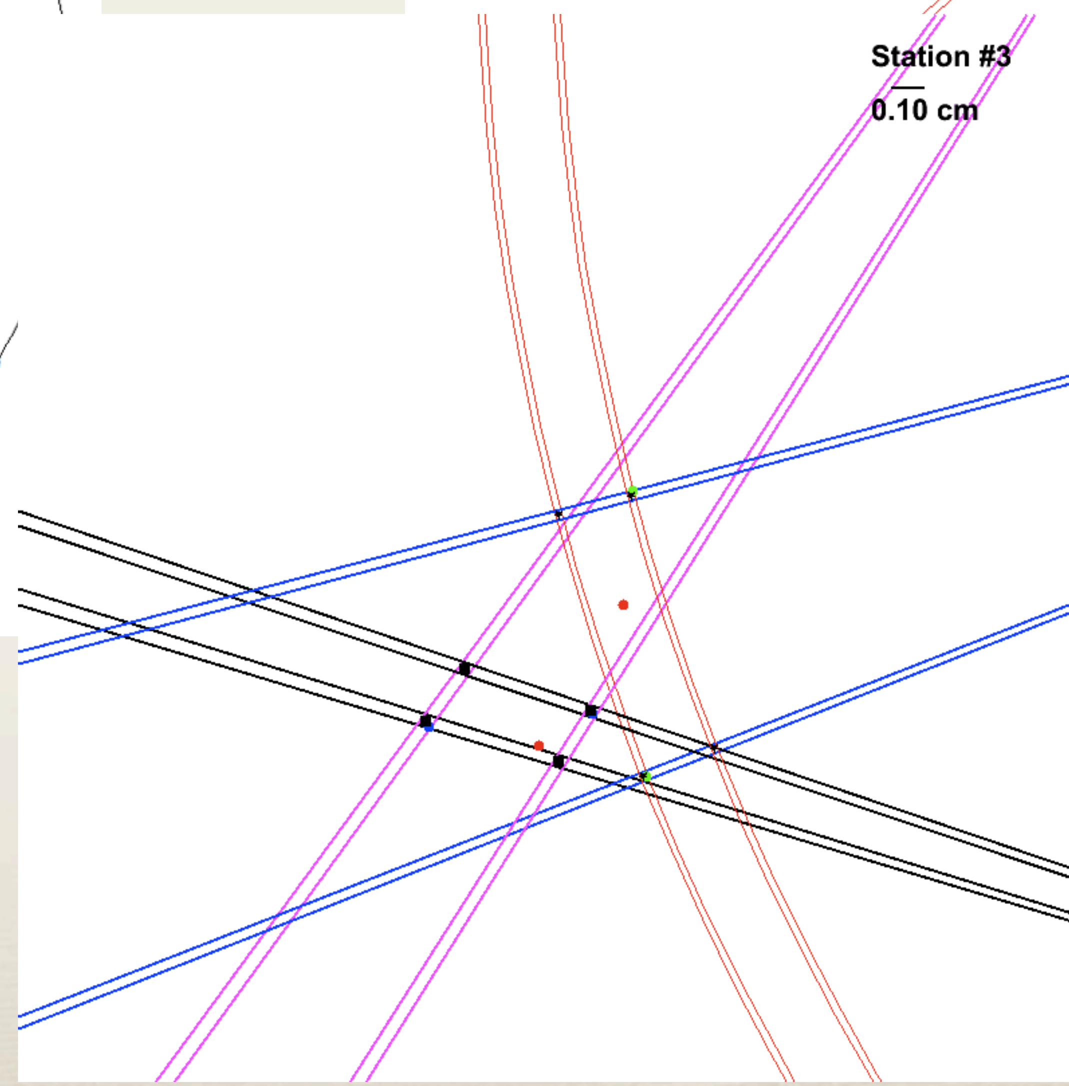
Realistically, a charge spread is up to 1.2 mm which results in ~6 times larger strip occupancy



GEM fired strips







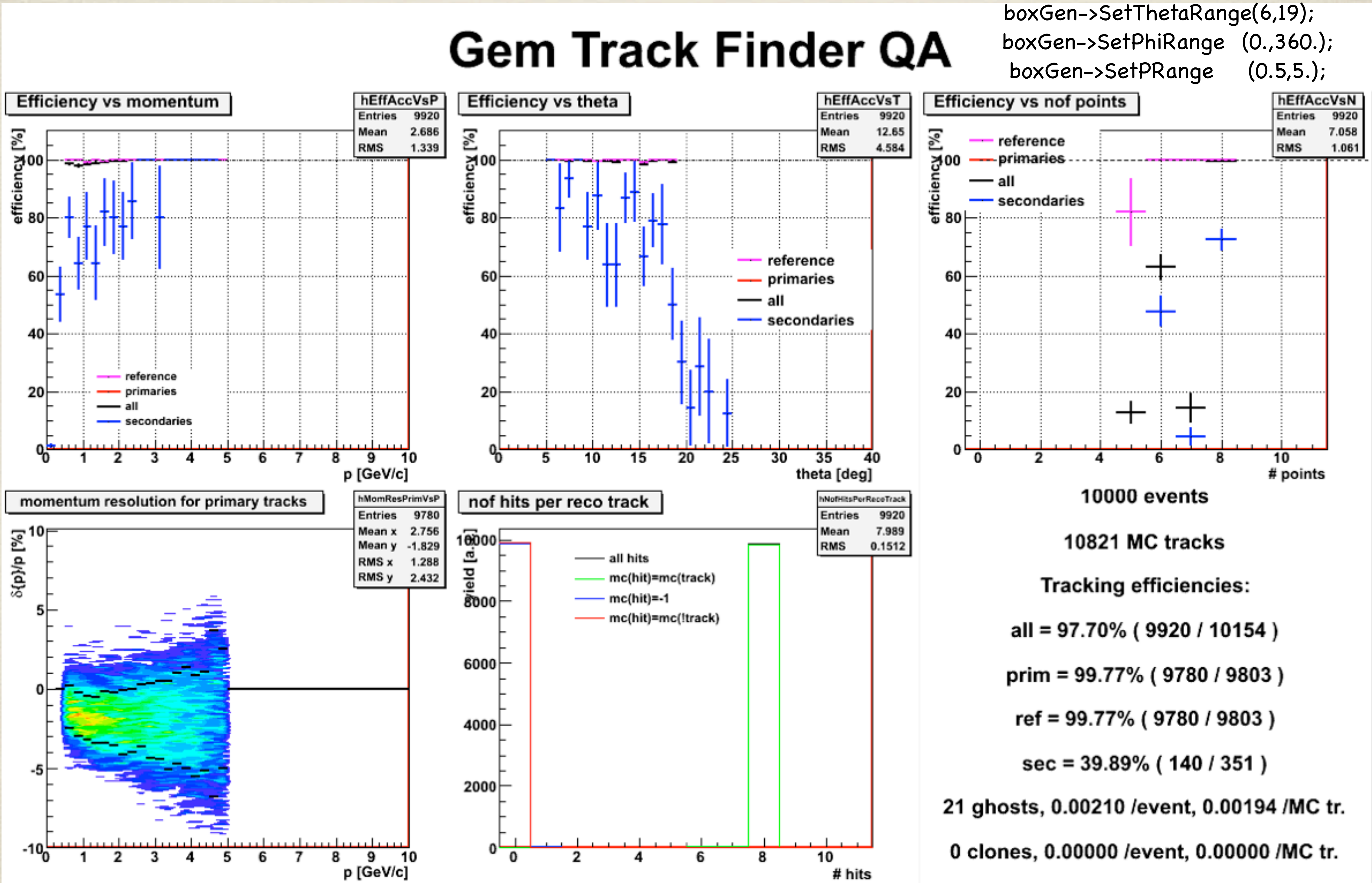
GEM track finding

- Pattern recognition + look-up table
- Find hits in front (radial+concentric) and back (tilted) layers
- Combine front and back hits from each station into "true hits"
- Combine hits from each pair of stations forming tracklets
- Get tracklets' momenta from the look-up table
- Look for hit-sharing trackles with comparable momenta

GEM tracking results

4 GEM stations, 1 pion per event

```
boxGen->SetThetaRange(6,19);
boxGen->SetPhiRange   (0.,360.);
boxGen->SetPRange     (0.5,5.);
```



GEM tracking results

3 GEM stations, 1 pion per event
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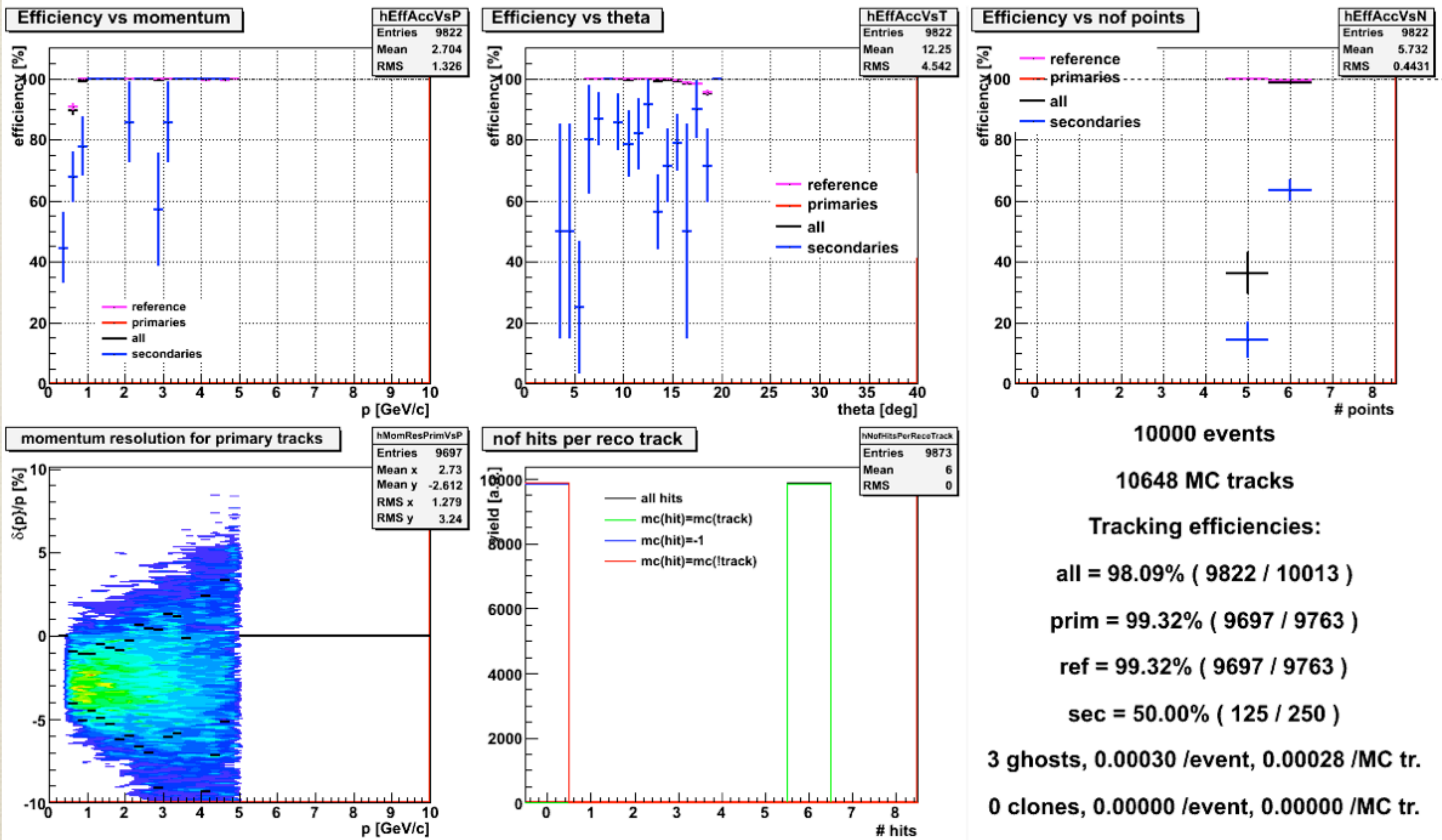
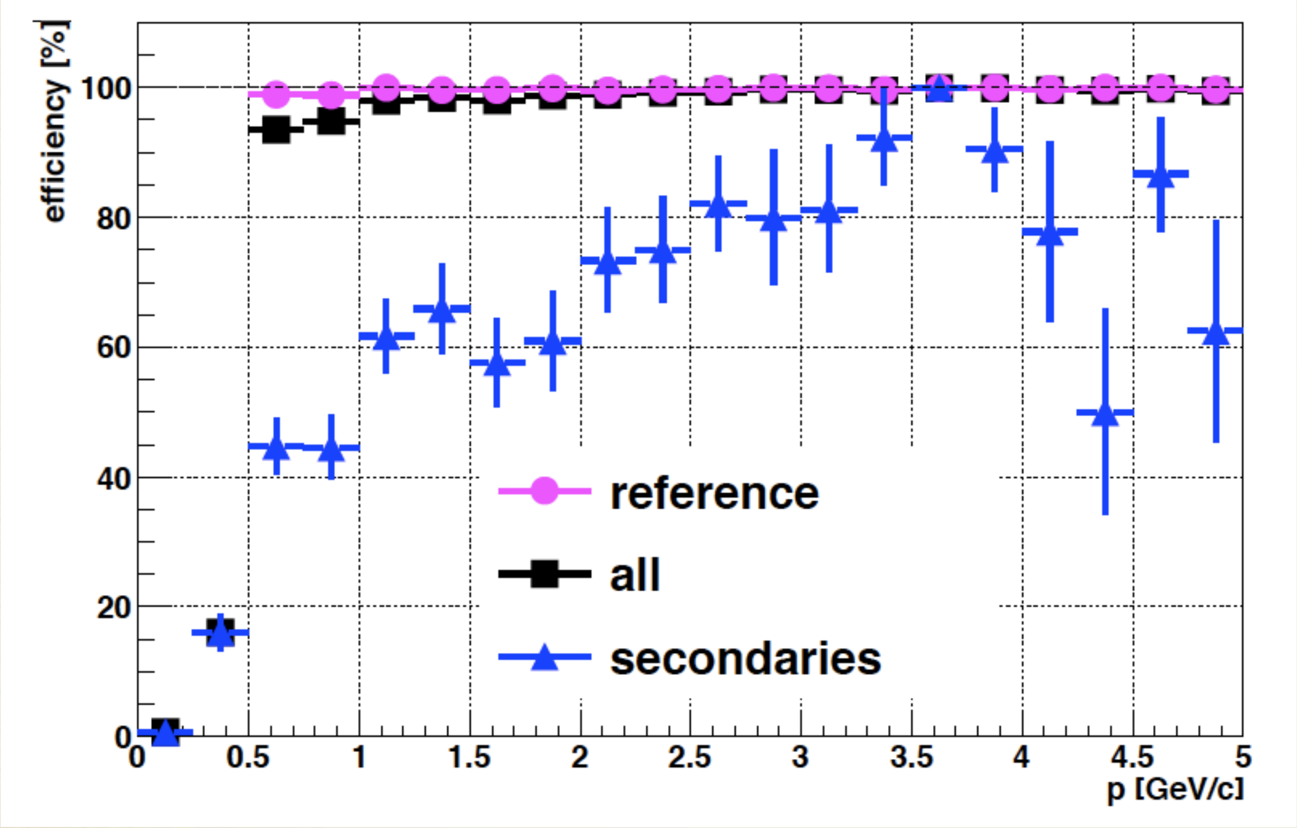
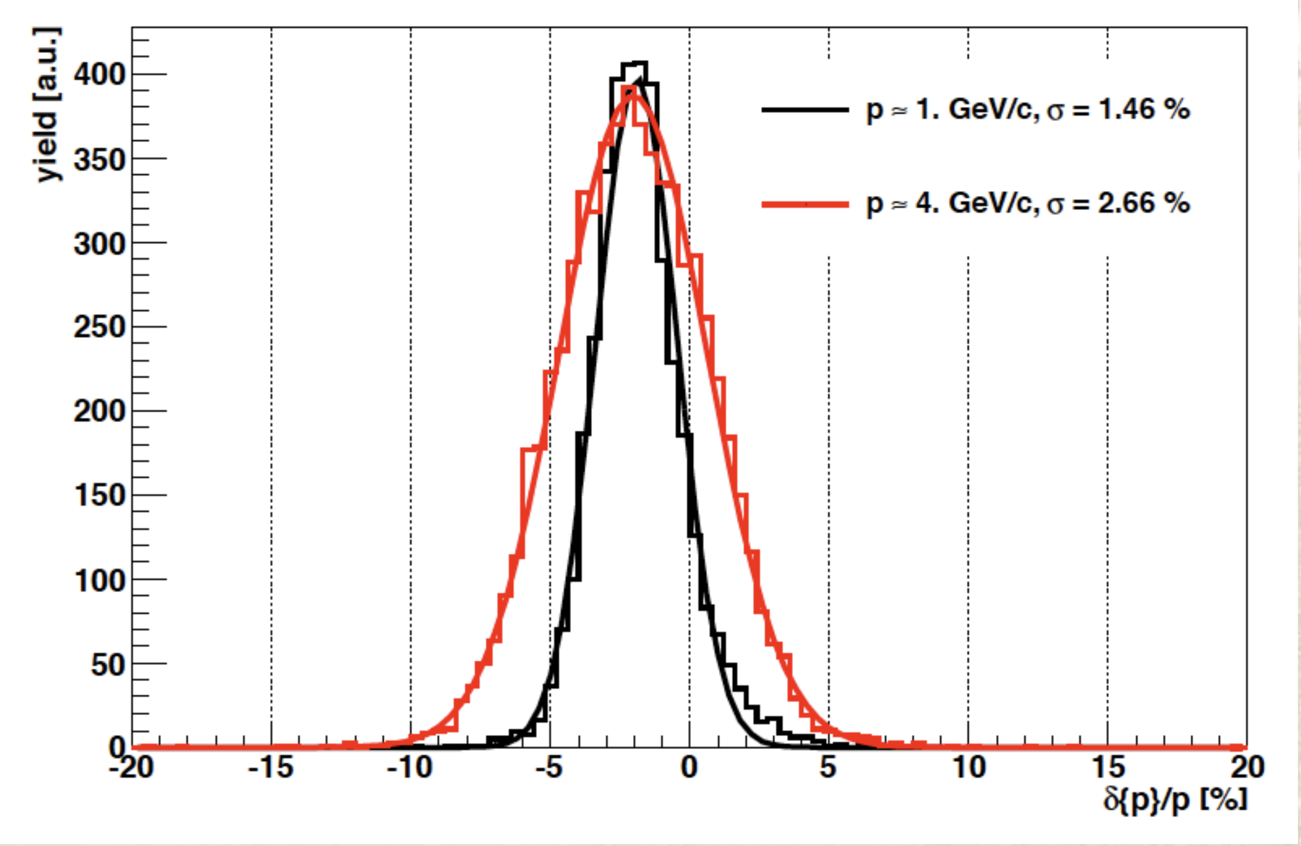
Gem Track Finder QA

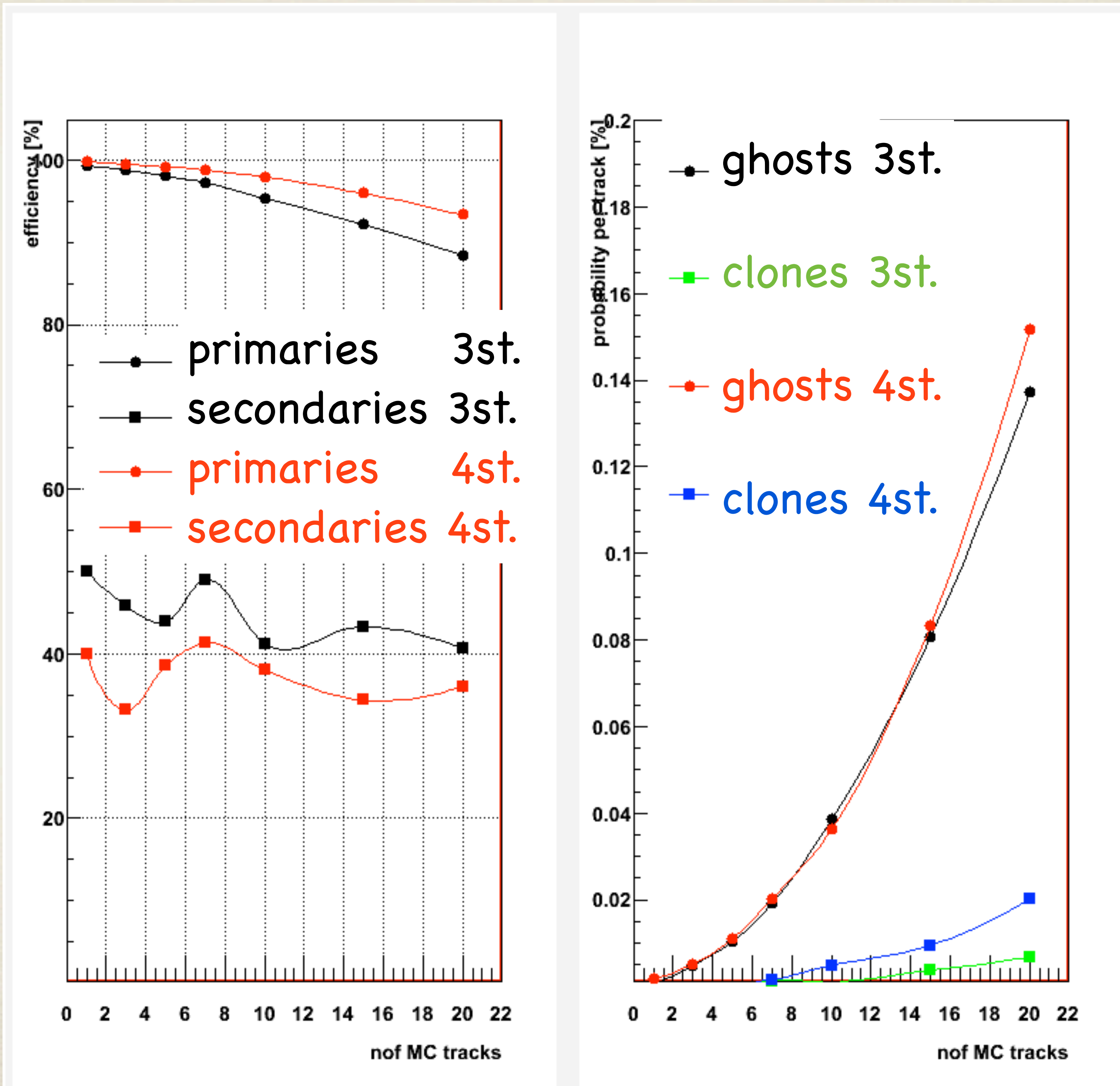


GEM results cont'd





Tracking results vs number of tracks



Time performance

The bad news is that it strongly depends on the number of track to reconstruct.
The more tracks, the slower the code.

The good news is that still it fast:

with 2 tracks per event:

```
------------------- PndGemFindTracks : Summary -----------------
 Events:        10000
 Tracks:        22760      ( 2.276 per event )
 Time:          2.72827s  ( 0.000272827s per event )
                          ( 0.000119871s per track )
-----------------------------------------------------------------
```

with 10 tracks per event:

```
------------------- PndGemFindTracks : Summary -----------------
 Events:        1000
 Tracks:        9735        ( 9.735 per event )
 Time:          9.09496s   ( 0.00909496s per event )
                           ( 0.000934254s per track )
-----------------------------------------------------------------
```

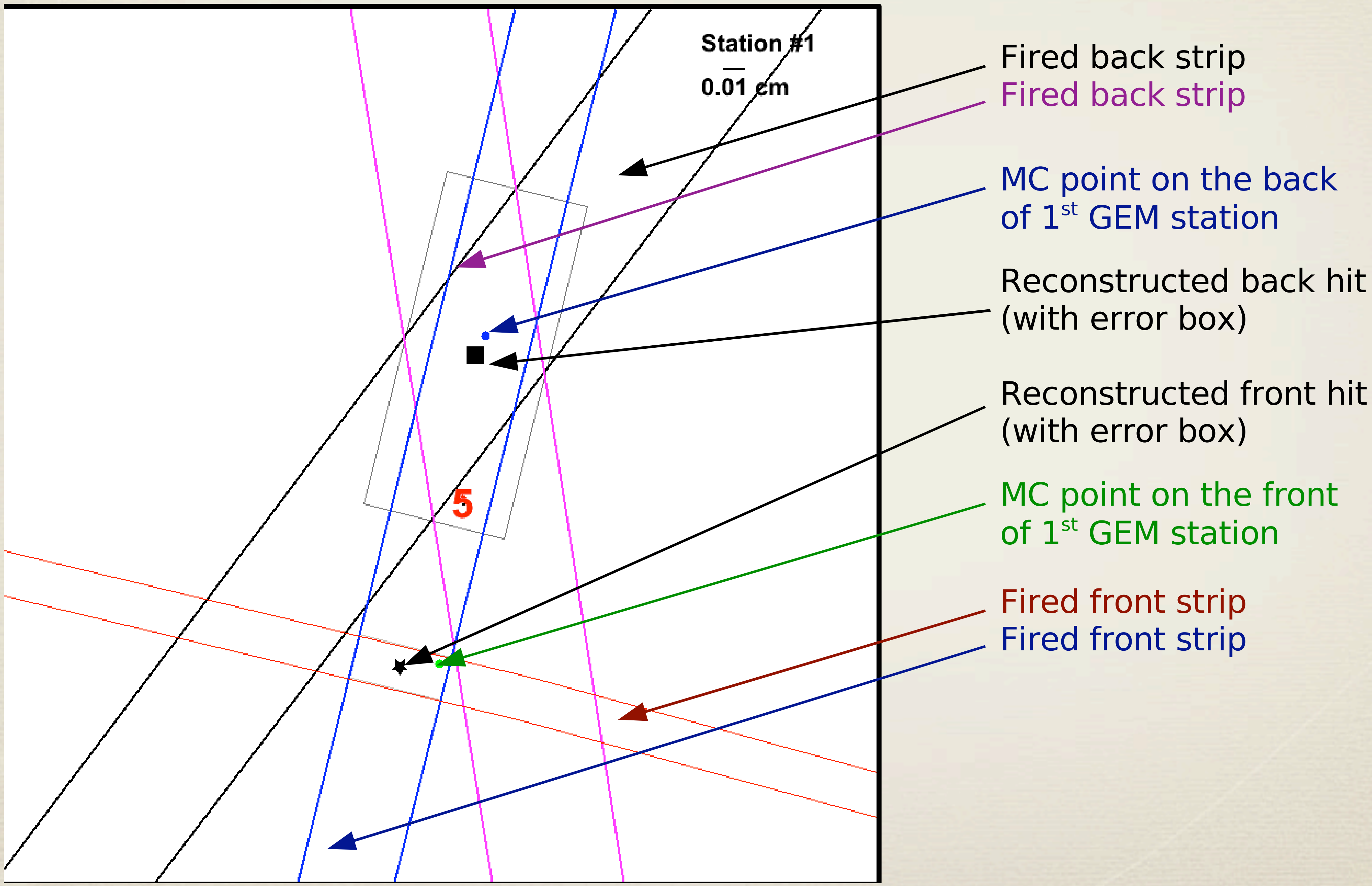
Summary

- GEM Tracker geometry implemented in pandaroot
- Simple digitizer and hit finder implemented (ideal hit producer also available)
- Standalone track finder implemented, with efficiency of about 95% and momentum resolution of 2-4%

Back-up slides

Hit finding

Digitizer + hit finder for comparison



Back-up slides

GEM-Detectors — FEE General requests

- Standard physics run $2 \cdot 10^7$ annihilations / s
- TPC:
  - L=1500, $R_{i=}$150, $R_{o=}$420mm around target position
  - ~100.000 pads 4 mm^2
  - 5 charged tracks / event
  - HIT-rate > 200kHz/pad
  - Ne/CO_2 v_D=2,8 cm/μs ⇨ t_D^{max}=50 μs
  - ⇨ 5000 tracks superimposed in one TPC “picture”, mixed in time
- Tracker:
  - 4 GEM stations, equally spaced ≈810,1170,1530,1890 mm from target
  - Outer Ø ≈900,900,1120,1480 mm (1st Trackers area similar to TPC but less pads)
  - 4 projections per station
  - Hybrid readout structures (under investigation)
    - Central: Ø60..140 mm, ~30000 pixels 1 mm^2
    - Peripheral: Ø40 - 900 mm, ~10000 radial+concentric (or similar) strips 80..220 mm^2
  - Ar/CO_2 t_{coll}=nx10ns
  - HIT-rate 5..40k particles/cm^2/s (r), 4..11kHz/pad
  - Track length radial 1..4 mm (mean 2,2..2,4 mm), angular 0..0,8° (mean 0,2°)

Back-up slides

GEM-Tracker — General FEE arrangement ideas

- Four projections / detector
  - 'State-of-the-art' solution:
    Single-sided 2x12µm 'thick' Cu on 50µm Kapton® + 125µm FR4
  - ➔ (#7) Minimize material budget, e.g.:
    Double-sided multilayer 5µm 'thin' Cu on Kapton®
- High-Density area at circumference (40 µm/signal path)
  - 'State-of-the-art' solution:
    'thick' 6-fold multi-layer
  - ➔ (#7,12) Minimize material budget & costs, e.g.
    bonded micro-cables (Aluminium strips ≈10 µm width on Kapton®)
- FEE system
  - 24 circularly arranged packages of 5 n-XYTER-based FEB cards
    (2 ASICs à 128 channels each)
  - ≈ 7..11% of total detector area,
  - ➔ Shadow region not sufficient nor feasible, Circumferential arrangement FEE-Ring width ≤ 50 mm
  - ➔ Axial cooling structure
  - ➔ ≈ 30% of weight
  - ➔ ≈ 3 kW power/cooling requirements

Back-up slides

Front-End Electronic Gas-XYTER requirements

- TPC:
  - Signal polarity negative
  - Noise @ 5pF input capacity < 500 e-
  - Programmable shaper
    with peaking time 50 – 400 ns
  - Dynamic range 200k e-
  - Analog zero suppression
  - Time resolution 2..5 ns
  - Amplitude resolution 8 bits
  - Autonomous hit detection, data driven readout
  - Hit rate 200 kHz/pad
  - Multi-event buffering
  - Analog/digital multiplexer 16:1 (32:1)
  - Differential I/O
  - Radiation tolerant up to 100 krad
- Trackers:
  - Capacity 2pF / 100..300pF
  - Hit rate 4..11 kHz/pad
- General:
  - Lower the power consumption
    20 mW/ch → < 5 mW/ch
  - Be reasonable compact (1/2 actual size)
  - ? (4)6..8 Bit resolution on linear amplification
  - ? Dynamic range: 1×10^5 .. $n \times 10^6$
  - ? Baseline restoration
  - ? Tail cancellation
  - Input protection
  - ? Minimize 'noise' → only read low amplitudes in neighborhood of big ones