UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

# University of Birmingham simulations update

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# Introduction

- EICROOT results presented two weeks ago; http://cern.ch/go/6fN8

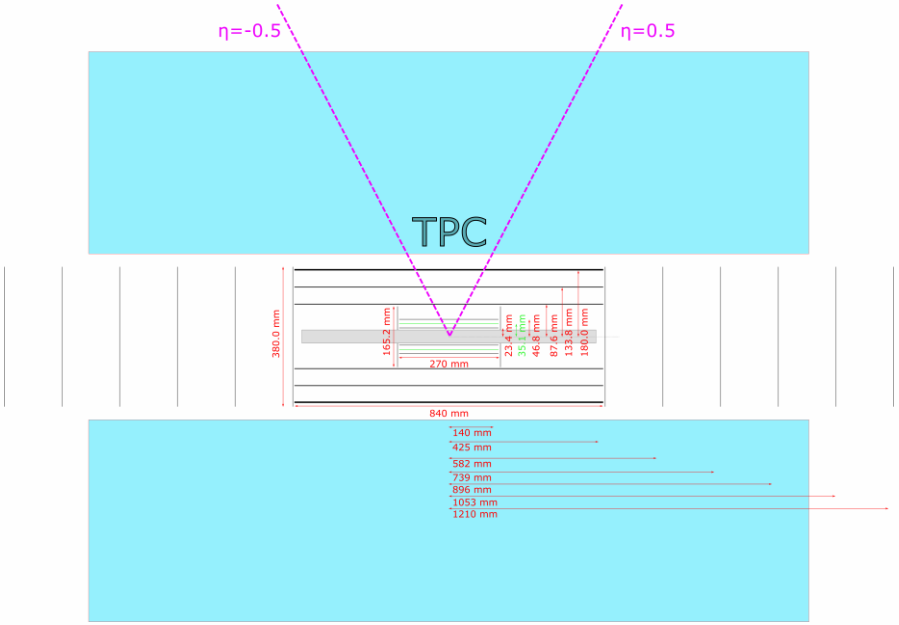
- Baseline layouts for silicon + gas TPC and all-silicon presented, and used for further studies

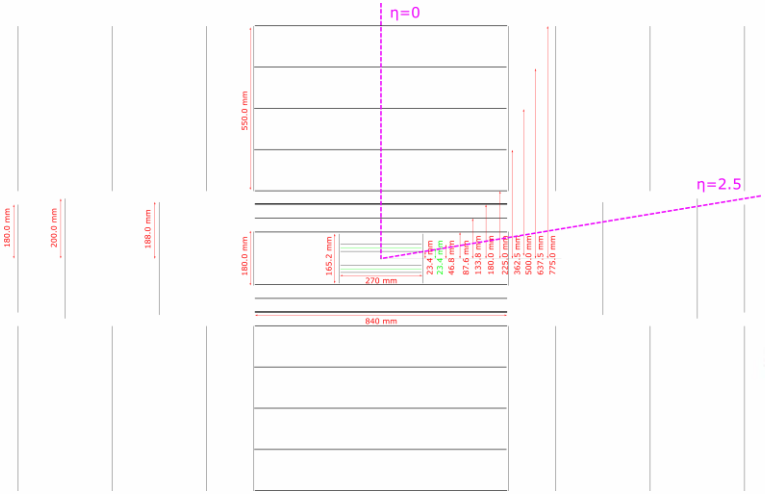
- New simulations for Pavia workshop
  - Adding a third vertex layer
  - Tests investigating new beampipe radius impact in central region
  - Studies of 1.5 T vs 3 T magnetic fields

- Simulations for tracking inputs requested by Central Detector / Integration / Magnet WG
  - Angular resolutions. Currently have them at vertex position

# Adding a third inner layer

- Parameters used:
  - Particle: π+
  - Transverse momentum range: 0 to 5 GeV/c / 0 to 50 GeV/c
  - Pseudorapidity range: -0.5 ≤ η ≤ 0.5 / 0 ≤ η ≤ 2.5
  - Default pixel size: 20x20 μm$^2$
  - Material budget: 0.3/0.8 % $X_0$ inner/outer layers, 1.6 % time-stamping layer
  - Magnetic field: uniform 1.5 T
- Comparing baseline layouts (silicon+gas and all-silicon, with old beampipe) to the same with a third inner layer added (between the two already there)

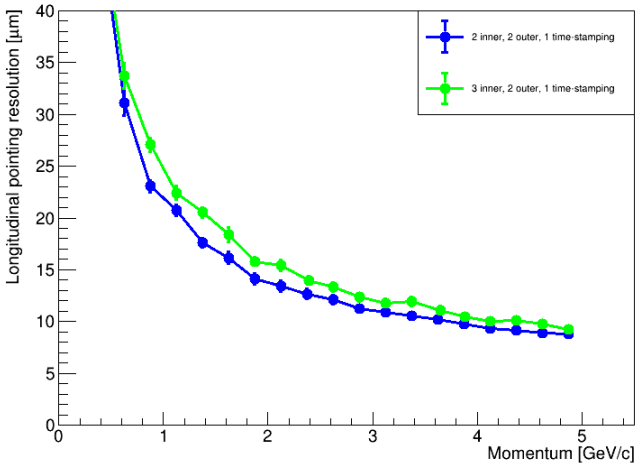


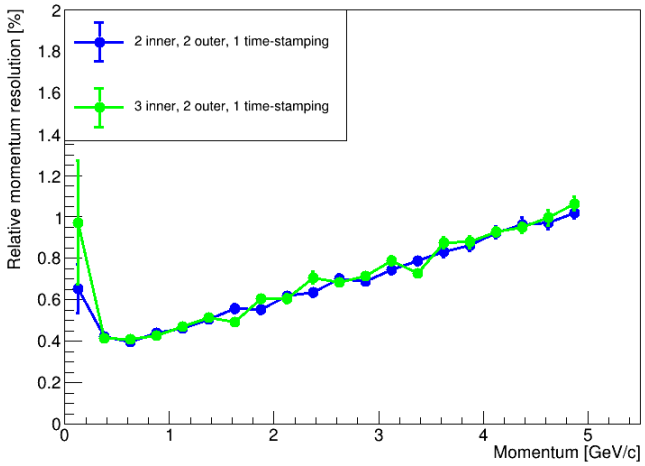
# Adding a third inner layer; silicon + gas

- In central region at momenta between 0 and 5 GeV/c:
  - No significant difference in relative momentum resolution
  - 3 layers detrimental to the pointing resolutions, especially the longitudinal at low momenta. Less so the higher the momentum

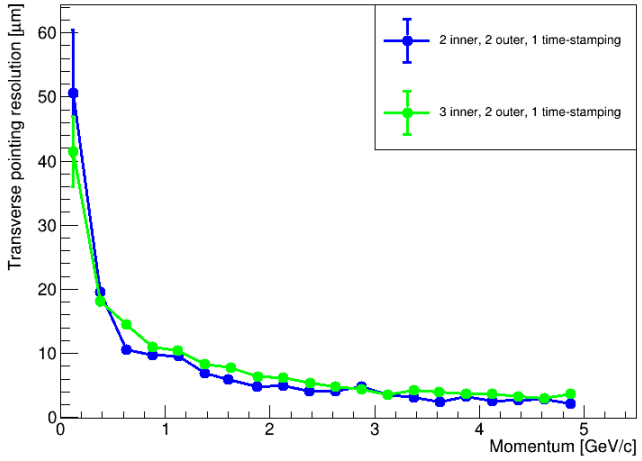
Longitudinal pointing resolution




Relative momentum resolution



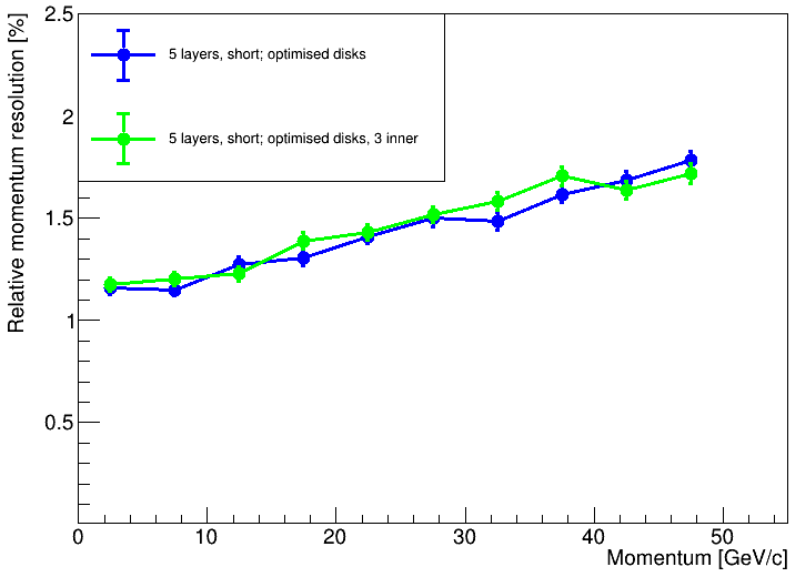

Transverse pointing resolution



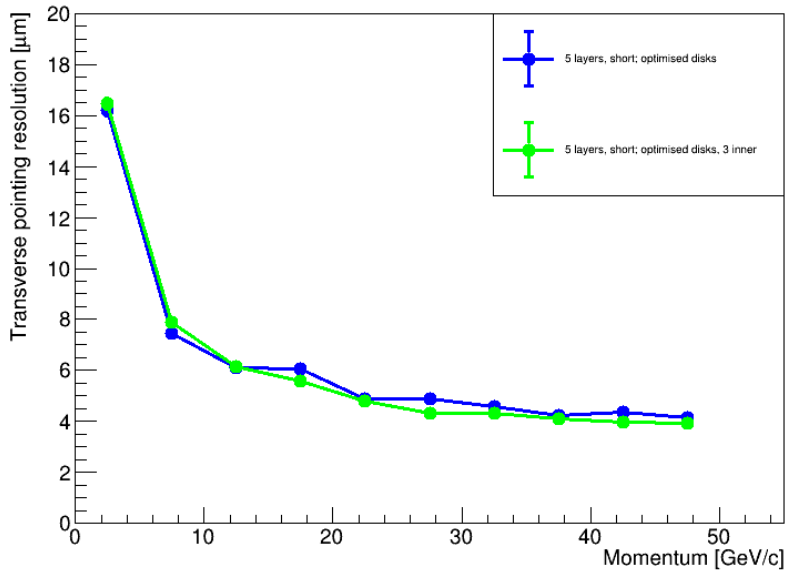
# Adding a third inner layer; all-silicon

- This study with the all-silicon optimised disk layout, in a pseudorapidity range of 0 to 2.5.

Relative momentum resolution



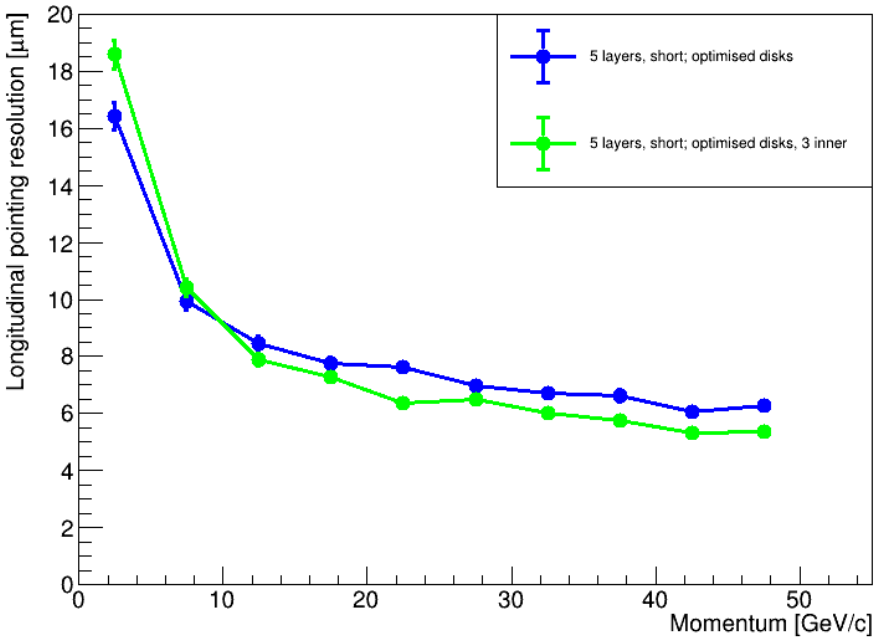

Transverse pointing resolution



# Adding a third inner layer

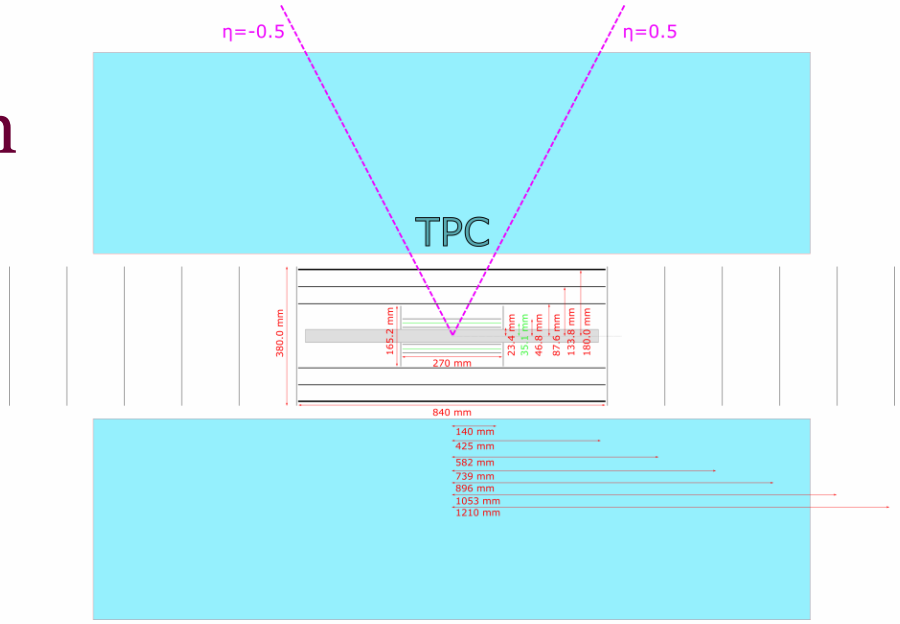
- Conclusions:
  - 3 layers is detrimental to only pointing resolutions at momenta below 5 GeV/c. Other than this, it has no effect or **improves** the resolutions.
  - Note: this is **not** considering possible dead pixels or otherwise missed layers, which is when the third layer will be very useful to have.

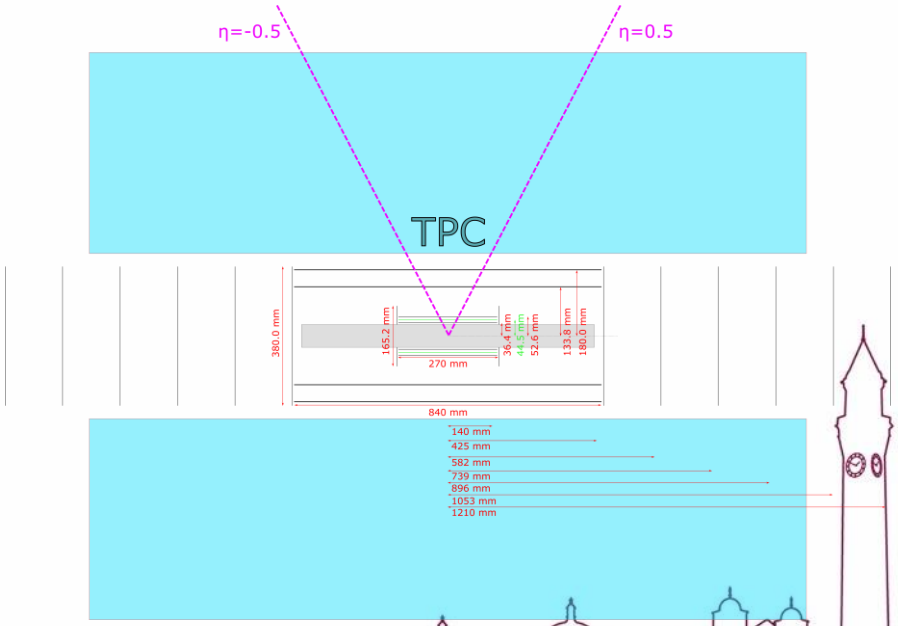
Longitudinal pointing resolution, all-silicon



# New beampipe comparison

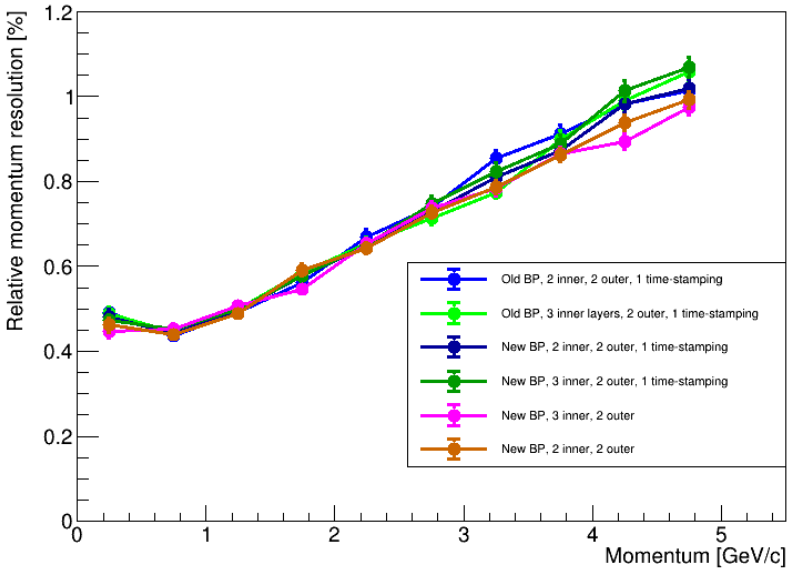
- Old beampipe radius: 18 mm
  - Tests done with 2 and 3 inner layers
- New beampipe radius: 31 mm
  - Tests done with inner layers moved out, and new layout without time-stamping layer
- Same TPC (EICROOT standard) always present
- Parameters used:
  - Particle: π+
  - Transverse momentum range: 0 to 5 GeV/c
  - Pseudorapidity range: -0.5 ≤ η ≤ 0.5
  - Default pixel size: 20x20 $\mu m^2$
  - Material budget: 0.3/0.8 % $X_0$ inner/outer layers, 1.6 % time-stamping layer
  - Magnetic field: uniform 1.5 T



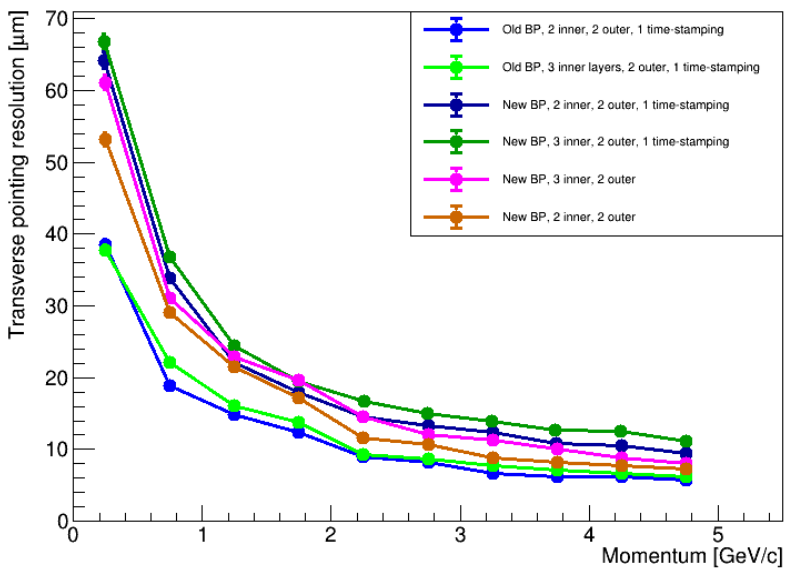



# New beampipe comparison

Relative momentum resolution




Transverse pointing resolution

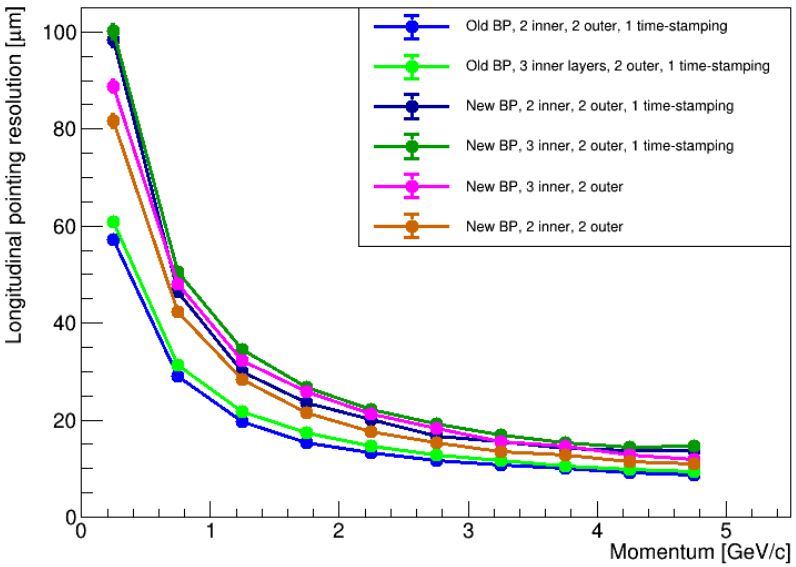



- Main comparisons:
  - Blue to darker blue
  - Green to darker green

# New beampipe comparison

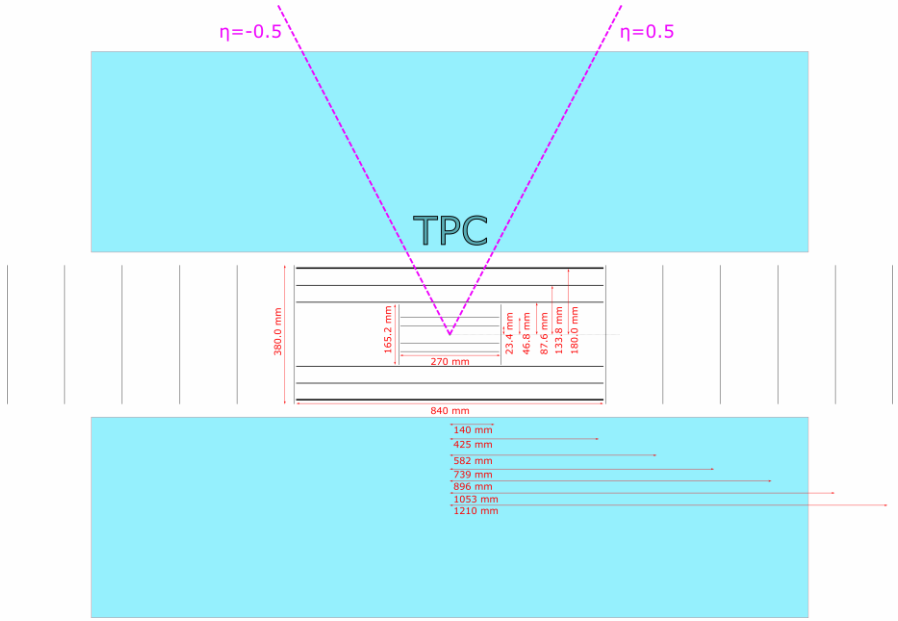
- Conclusions:
  - 3 inner layers detrimental to pointing resolutions at these low momenta
  - New beampipe makes pointing resolutions  worse, but less so as momentum increases
  - Note: smaller beampipe is not an option. Study made in order to investigate impact of more realistic beampipe

Longitudinal pointing resolution



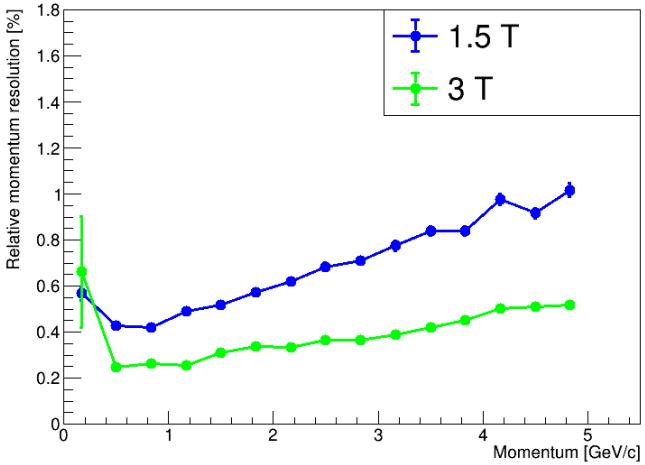
# 1.5 T and 3 T in the barrel - preliminary

- Parameters used:
  - Particle: π+
  - Transverse momentum range: 0 to 5 GeV/c
  - Pseudorapidity range: -0.5 ≤ η ≤ 0.5
  - Pixel size: 20x20 $\mu m^2$
- Magnetic field uniform. Strength varied, being either 1.5 T or 3 T
- Baseline layout used. Old beampipe, to save time in re-running comparison simulations

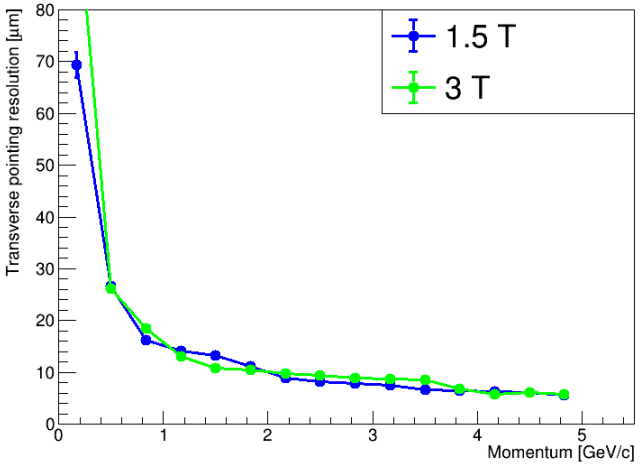


# 1.5 T and 3 T in the barrel - preliminary

Relative momentum resolution

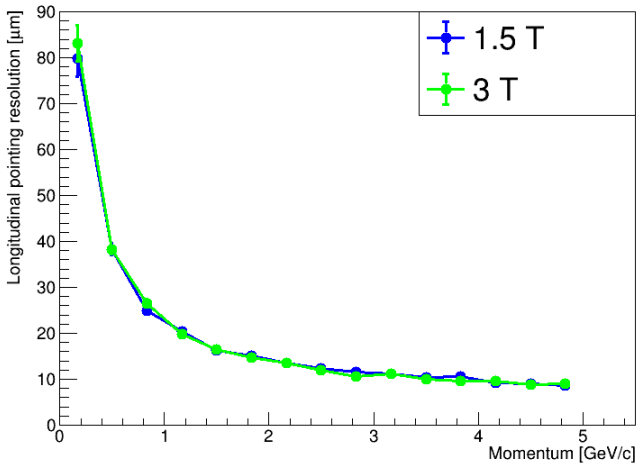



Transverse pointing resolution




- Large improvement in relative momentum resolution
- Little difference in pointing resolutions
  - Transverse pointing resolution gets worse at 3 T at the lowest momenta, due to spiralling

Longitudinal pointing resolution

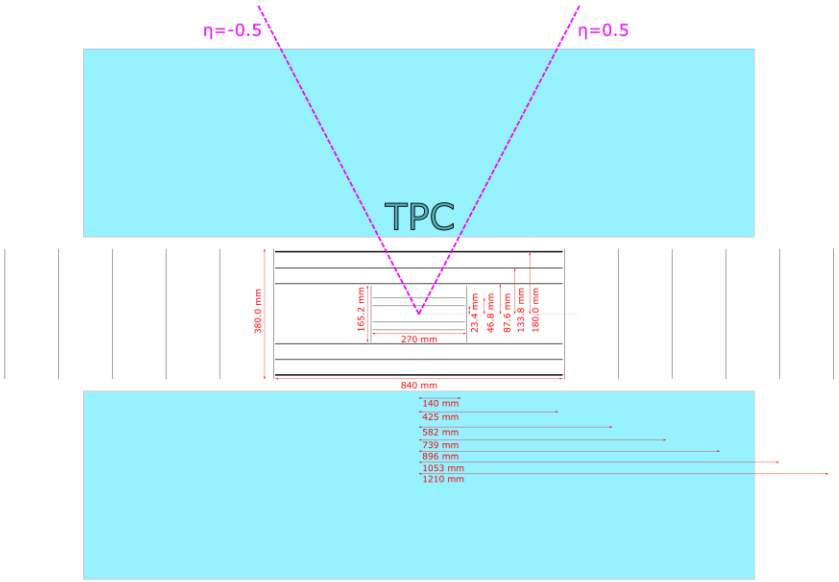


# Preliminary angular resolutions

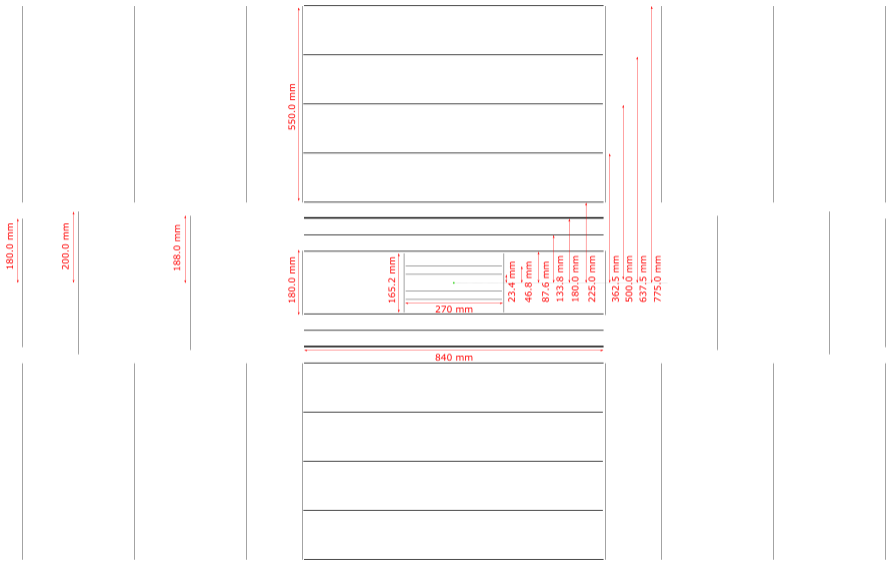
- Taken as the standard deviation of a Gaussian fit to difference between reconstructed and truth, for different momenta, **at the vertex position.**
- θ and ϕ resolutions investigated for different geometries.
- **No dedicated studies made for angular resolutions.** The resolutions presented here are all add-ons using data from simulations with different main purposes.
- Geometries shown on next slide. Results on the following.

- Pixel size used in silicon: 20x20 $\mu m^2$.
- Standard EICROOT TPC used, when present.
- Magnetic field: uniform 1.5 T.

# Geometries



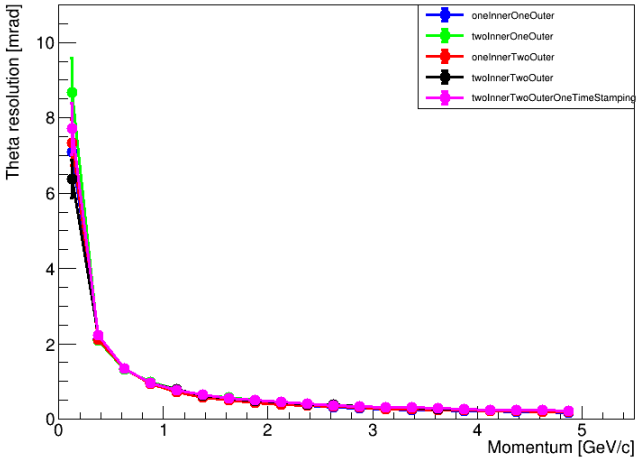

Baseline, investigated in central region. Pions, 0 to 5 GeV/c.



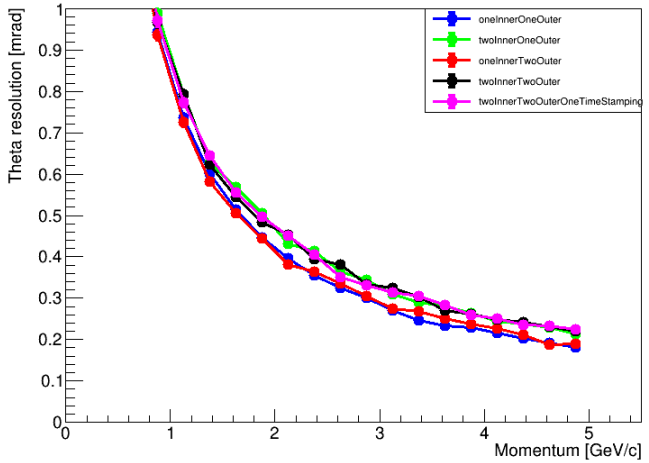

All-silicon, investigated in central regions (|η|≤1, 0 to 30 GeV/c electrons) and forward regions (1 ≤ |η|≤2.5, 0 to 50 GeV/c electrons), for different outer radii.

# Results, silicon + gas TPC, central region

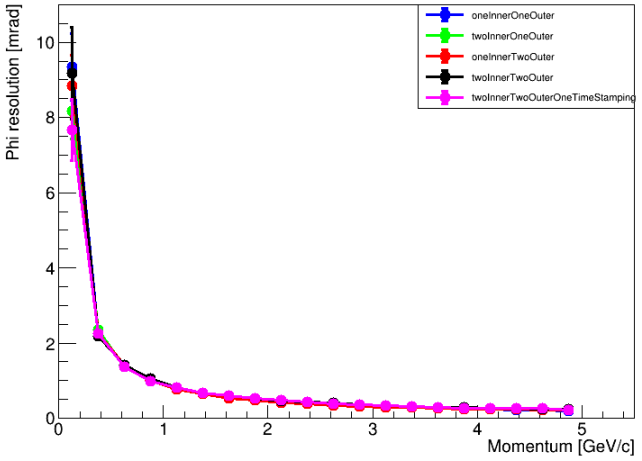
Theta resolution



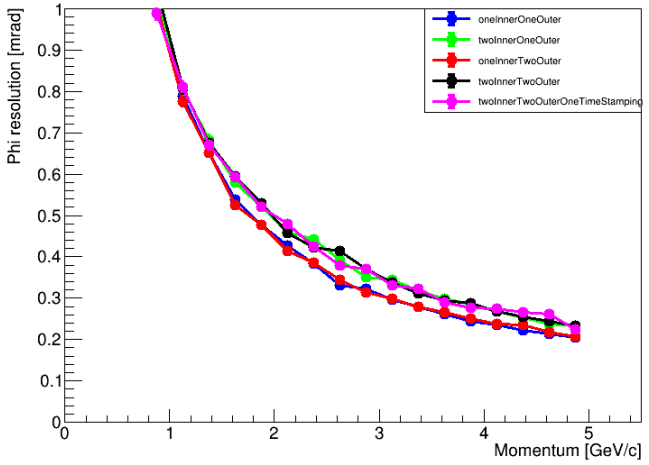

Zoomed in




Phi resolution



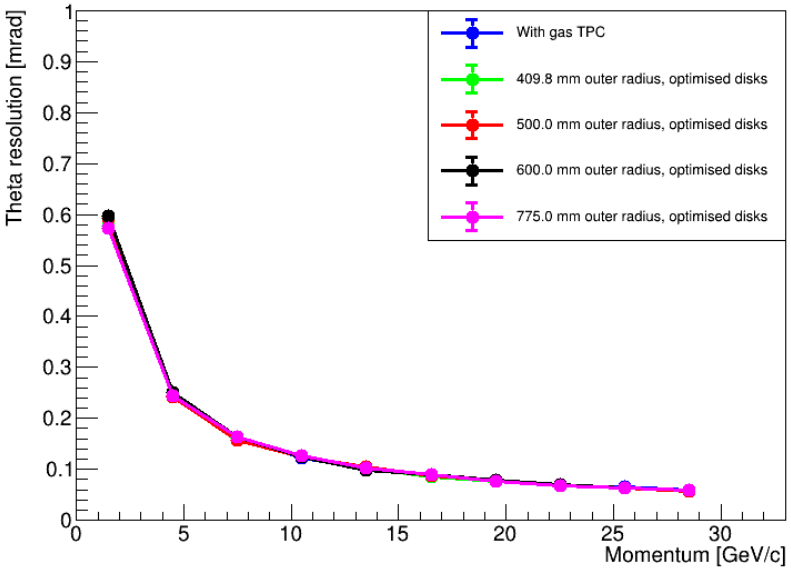

Zoomed in



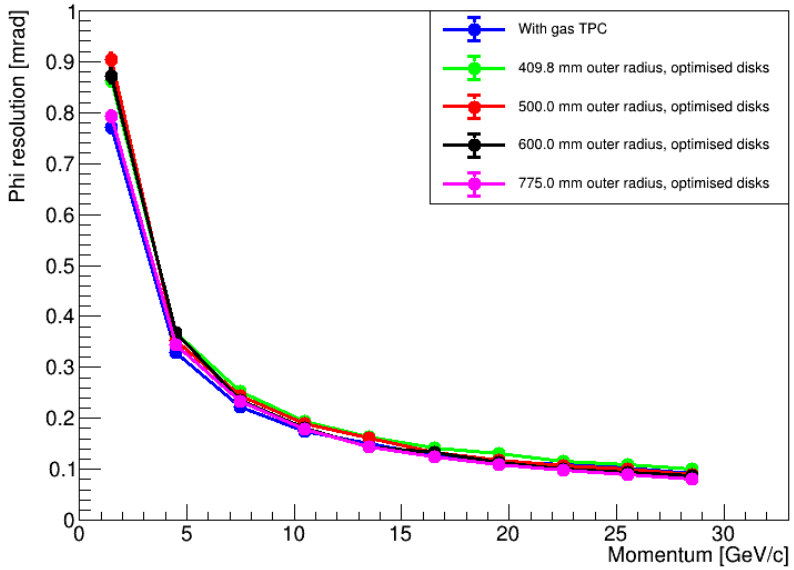

Different number of layers in central SVT tested.

# Results, all-silicon, different radii. Central

Theta resolution



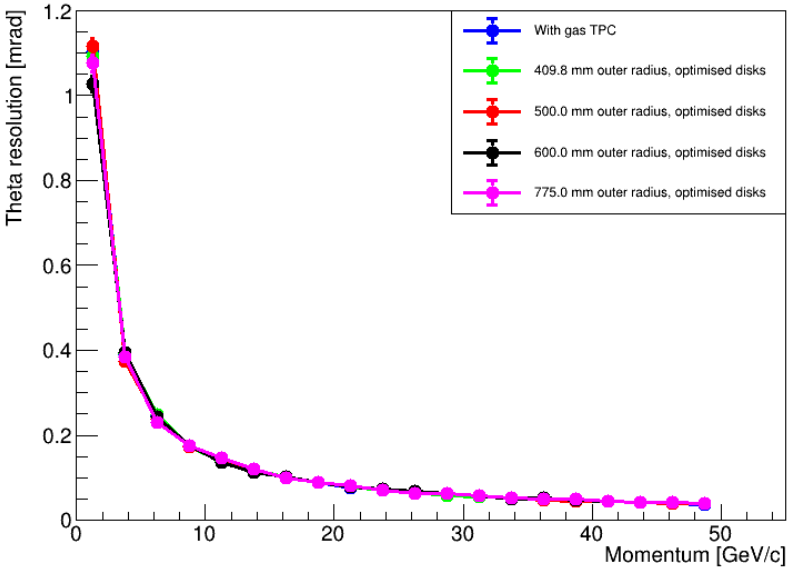

Phi resolution



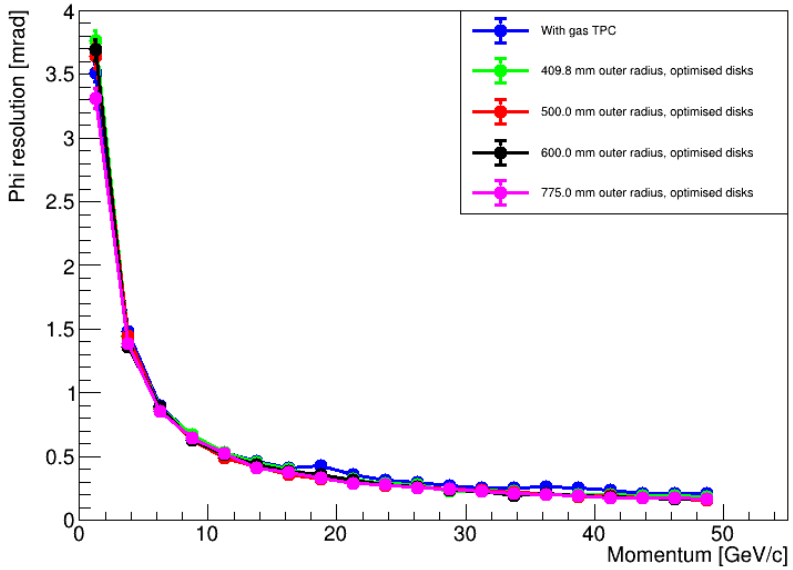

- Central regions, $|\eta| \leq 1$
- Electrons, 0 to 30 GeV/c

# Results, all-silicon, different radii. Forward

Theta resolution




Phi resolution




- Forward regions, $1 \leq \eta \leq 2.5$
- Electrons, 0 to 50 GeV/c