UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

Disk Material Studies for B-1.0, P-1.0, N-1.0

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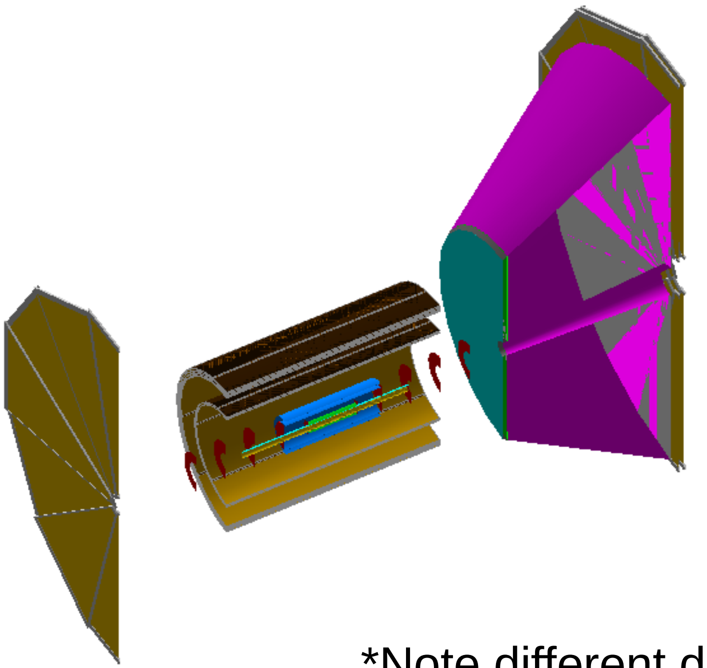
Overview

- Work is ongoing to define services and mechanics for the disks
- Disk material changes according to design
  - Looked at effect of changing disk material in forward and backwards regions ($2.5 < |\eta| < 3.5$) of B-1.0, P-1.0, N-1.0 design
  - Disks of thickness 0.24%, 0.29%, 0.40%, 0.53% X/X_0 investigated

B-1.0, P-1.0*, N-1.0*

- Silicon
  - 3 Vertex layers 0.05% X/X0
  - 2 Barrel layers 0.55% X/X0
  - 5 disks 0.24% X/X0
  - 10 μm pixel pitch
- Barrel Micromegas
  - 2+3 layers
  - 150 μm in z and Rphi
  - 0.4% X/X0
- GEM Endcaps
  - 1 N side, 2 P side
  - 0.4% X/X0
  - 250 μm R, 50 μm Rphi



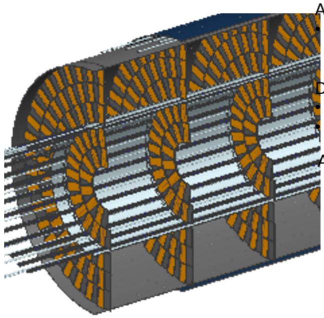
*Note different disk placement with respect to P-1.0 N-1.0

Disk	z position (mm)	Inner radius (mm)	Outer radius (mm)
Disk 1	220	36.4	71.3
Disk 2	430	36.4	139.4
Disk 3	690	57.4	190.0
Disk 4	950	78.3	190.0
Disk 5	1210	99.3	190.0

Disks material

* See L. Greiner slides
https://indico.bnl.gov/event/12512/

Double Sided half disc plates with radial sensor distribution



Advantages:
- Close to full spatial coverage along the beam pipe edge.

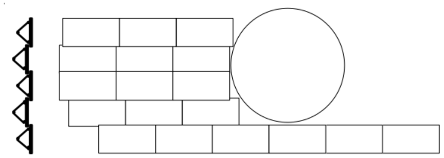
Disadvantages:
- High mass – significant sensor overlap
- Manufacture is more difficult

Assume Silicon sensor and FPC at 80% fill both sides

component	% X/X0
plate	0.15
Si	(1.6)*(0.05)= 0.08
FPC	(1.6)*(0.13)=0.21
Water + tube	0.03
Glue + other	(1.5)*0.04=0.06
total	~0.53%

2021_07_26_EICSC_discs_detector_model - LG 5

Half-discs composed of overlapping staves running parallel



Advantages:
- Low mass, can be as low as 0.3 %/layer or less.
- Uses understood fabrication techniques

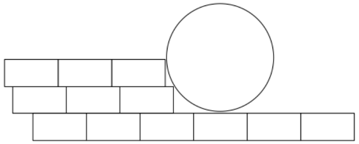
Disadvantages:
- Coverage gaps along the beam pipe edge.
- Mechanically more complex for offset overlapping stave support

Comments:
- The next half disc could be rotated by 30 or 45 degrees to keep the gaps along the beam pipe from aligning. In principle this would result in the vast majority of high eta particles only missing one disc. This makes the mechanics harder and may not be necessary.
- A support ring that terminates the staves at high eta around the beam pipe will be necessary. As low mass as possible. It is also possible that spars may be necessary to hold the inner ring. This is pending FEA analysis. This is not included in the estimate.

X/X0 is the same as ITS-2 staves minus ITS-3 adjustments = ~0.29% X/X0

2021_07_26_EICSC_discs_detector_model - LG 6

Single sided half-disc plates with sensors in linear array



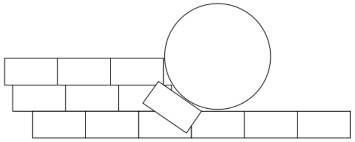
Advantages:
- Lower mass.
- One sided construction is simpler
- No overlap of sensors needed.

Disadvantages:
- Coverage gaps along the beam pipe edge.

component	% X/X0
plate	0.15
Si	0.05
FPC	0.13
Water + tube	0.03
Glue + other	0.04
total	~0.4%

2021_07_26_EICSC_discs_detector_model - LG 7

Combo - Single sided half-disc plates with sensors in linear array + sensors on back to plug high eta gaps



Advantages:
- Lower mass than double sided
- Minimized gaps at high eta

Disadvantages:
- Minimal gaps still exist along the beam pipe edge.

There will be additional mass in the high eta edge of beam pipe sensor overlap regions. This is neglected for this estimate.

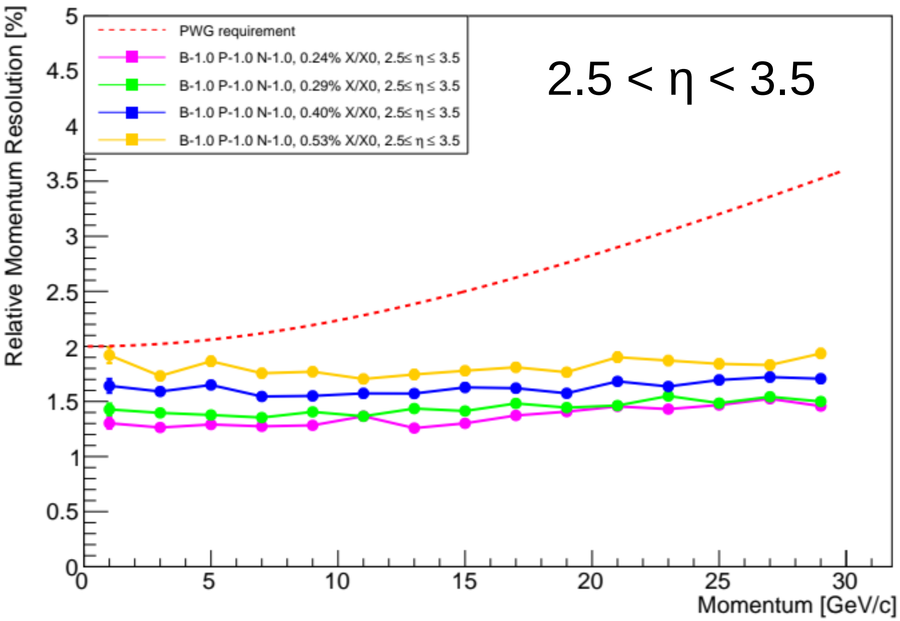
component	% X/X0
plate	0.15
Si	0.05
FPC	0.13
Water + tube	0.03
Glue + other	0.04
total	~0.4%

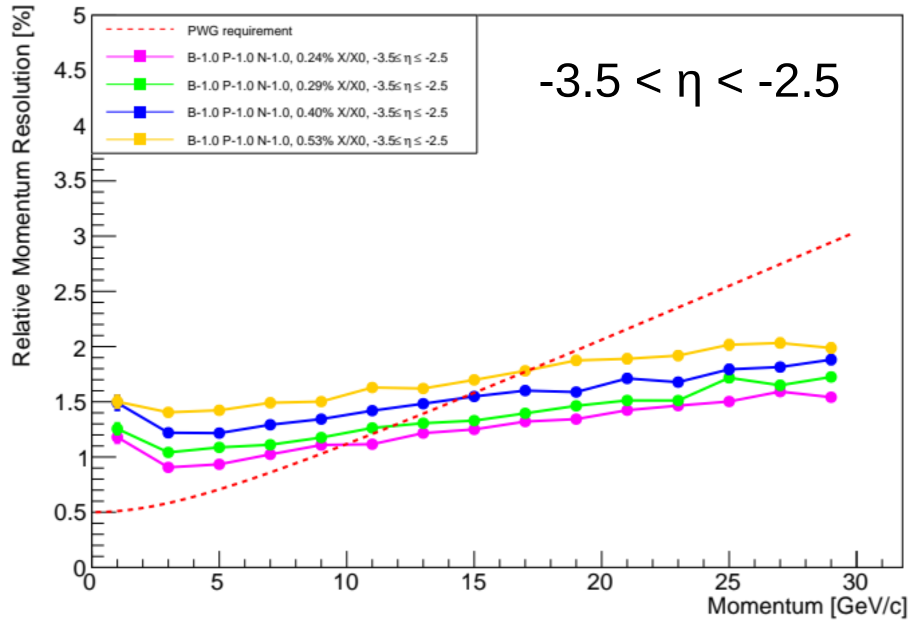
2021_07_26_EICSC_discs_detector_model - LG 8

Simulation

- Simulated particles uniformly in p_T range $0 < p_T < 30$ GeV/c
  - **$-3.5 < \eta < -2.5$** : 1.5M electrons
  - **$2.5 < \eta < 3.5$** : 1.5M negative pions
- 2021-05-07 B Field Map used
- Disk Material budget {0.24, 0.29, 0.40, 0.53}% X/X0
- Inner radii are perfect circles → Best case scenario

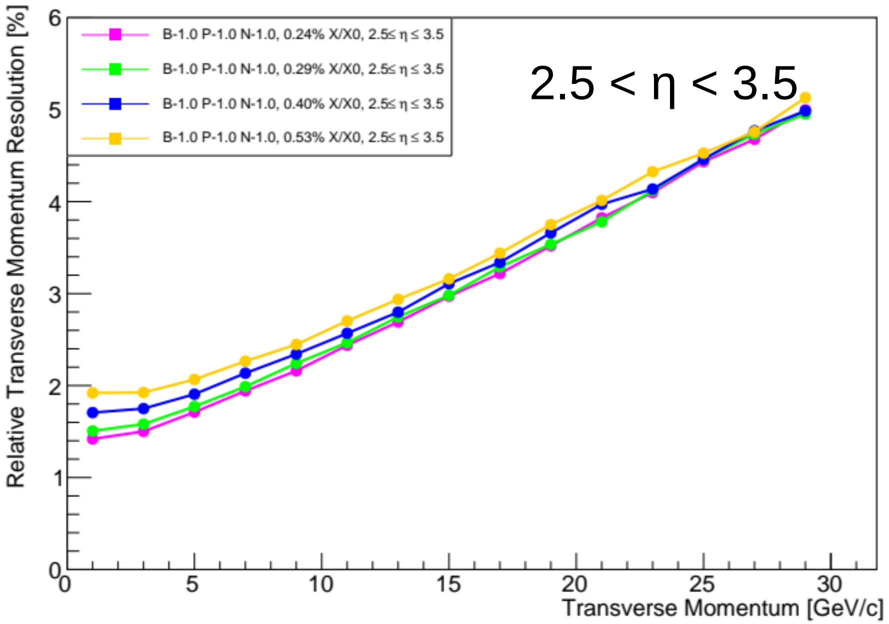
Relative Momentum Resolution

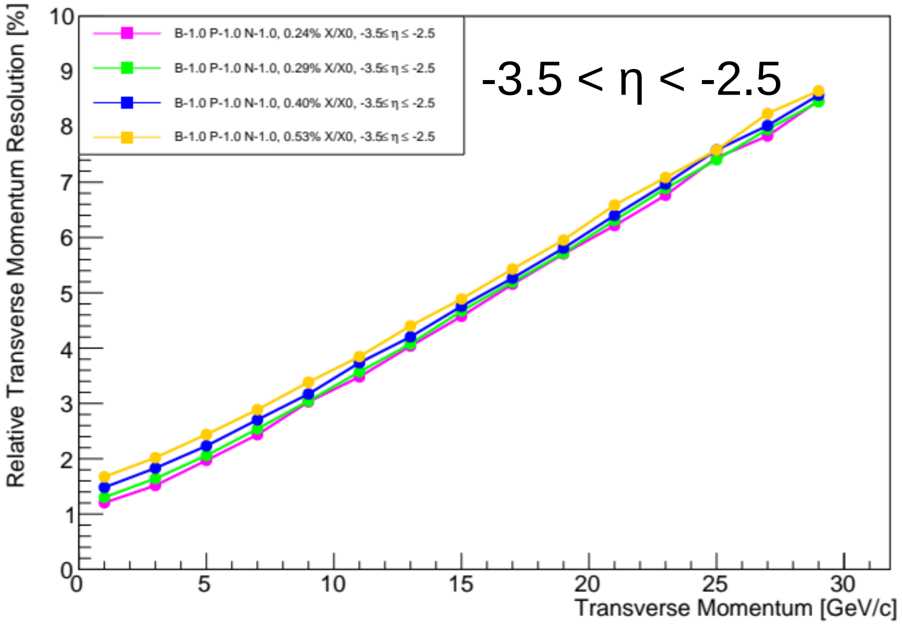




- 0.24% X/X0
- 0.29% X/X0
- 0.40% X/X0
- 0.53% X/X0

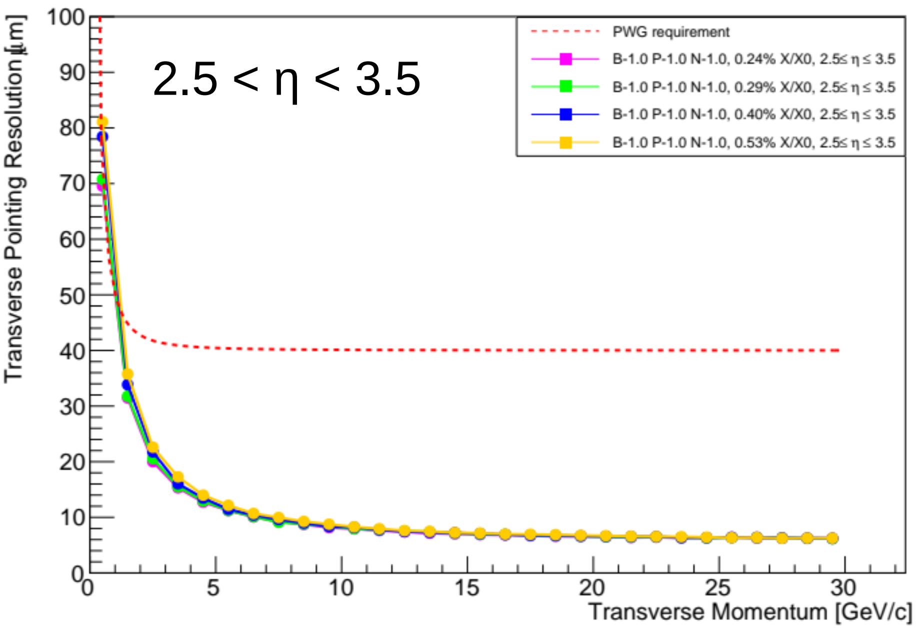
Relative Transverse Momentum Resolution

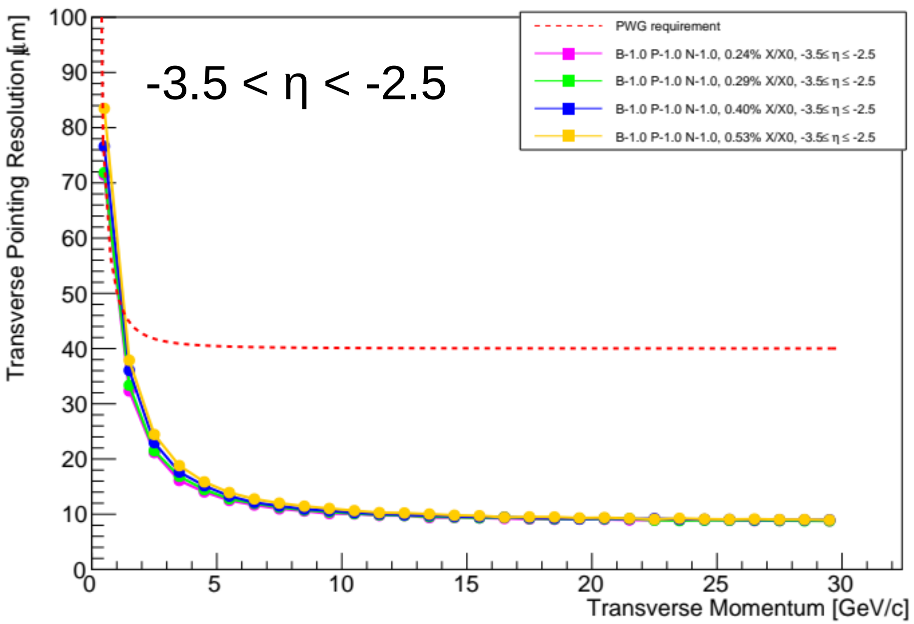




- 0.24% X/X0
- 0.29% X/X0
- 0.40% X/X0
- 0.53% X/X0

Transverse Pointing Resolution





- 0.24% X/X0
- 0.29% X/X0
- 0.40% X/X0
- 0.53% X/X0

Summary

- First look at effect of disk material on B-1.0, P-1.0, N-1.0 design (with alternative disk positions) → See expected deterioration in resolutions with material

Next Steps

- Simulate for central and intermediate pseudorapidity
- Make plots for resolutions as a function of η