



UNIVERSITY OF
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SCHOOL OF
PHYSICS AND
ASTRONOMY

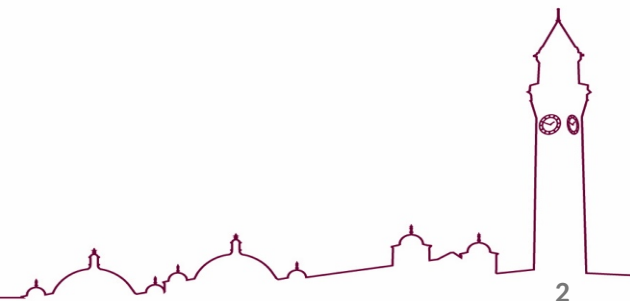
Silicon layer configuration studies in Fun4All

L. Gonella, P. G. Jones, S. Maple, P. R. Newman



Overview

- Reference detector radii for vertex layers cannot be achieved with current ITS3 reticule size
 - Present studies of detector performance in the central ($-1 < \eta < 1$) region for vertex configurations based on ITS3 reticule
- Need to modify barrel silicon if we want to avoid having services on the staves
 - Compare 3 configurations of Si Sagitta layers

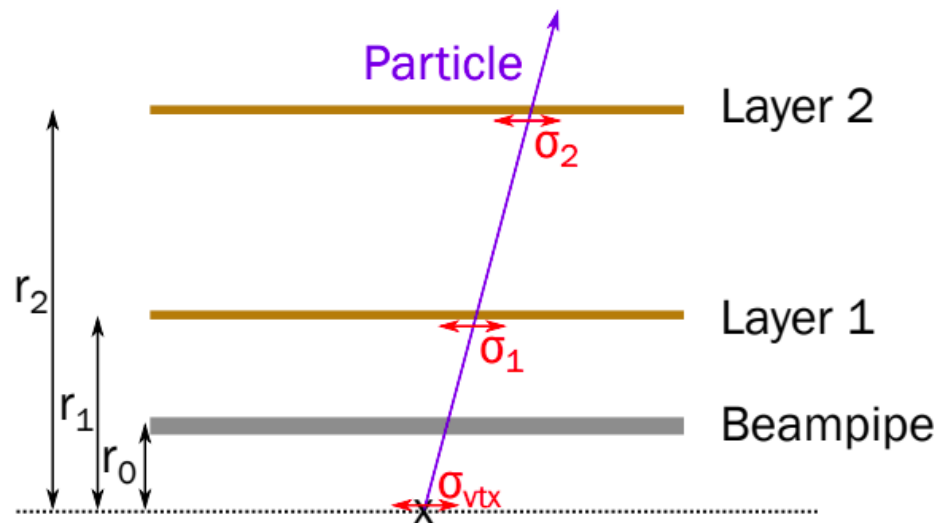


Recap of vertex resolution

- Vertexing performance determined by

- Pixel pitch d
- Material thickness x/X_0
- Radius of 1st hit r_1
- Distance between r_1 and r_2

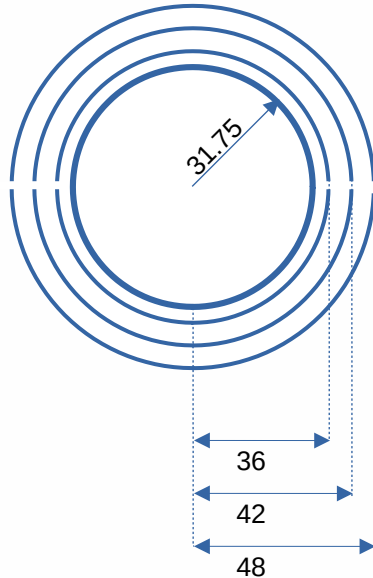
- Desire small inner radius and large distance between first and second layer



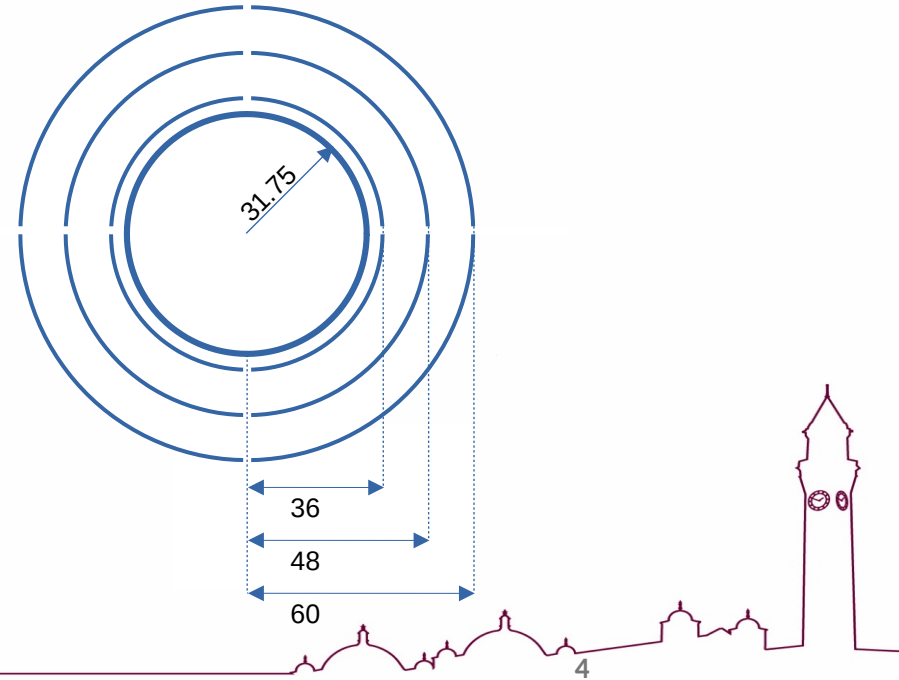
$$\sigma_{\text{vtx}} \simeq \sqrt{\left(\frac{r_1^2}{(r_2 - r_1)^2} + 1 \right) \cdot \frac{d^2}{12} + (2r_1 - r_0)^2 \cdot \frac{(13.6 \text{ MeV}/c)^2}{p^2 \cdot \beta^2} \frac{x}{X_0}}.$$

Vertex configurations

- Can opt for 2 sensors per layer:
 - Active length 24cm
 - Would need to modify stitching plan
 - $r = 36/42/48$ mm



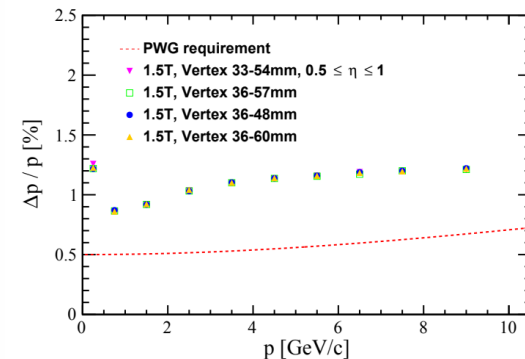
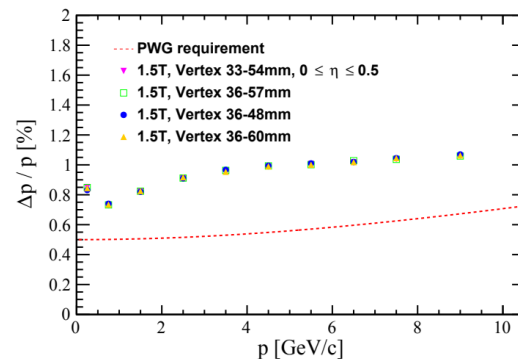
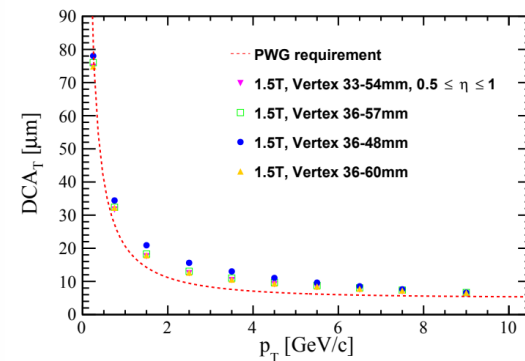
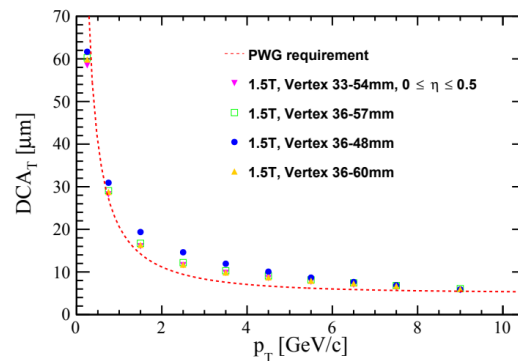
- Alternatively can preserve 27cm active length with 4 sensors per layer
 - $r = 36/48/60$ mm



Vertex performance comparisons

■ Simulations for 4 vertex configurations:

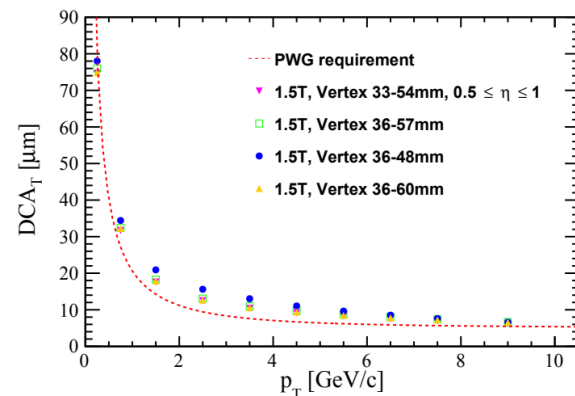
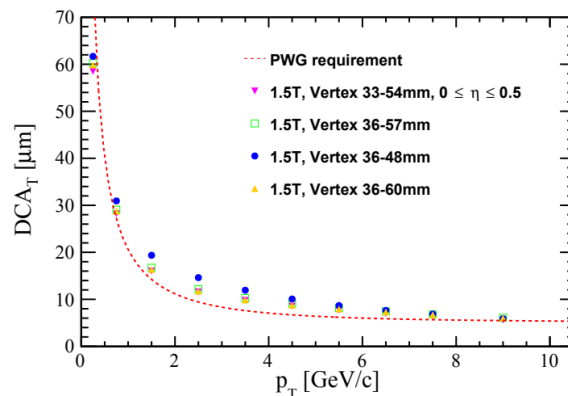
- Proposal config:
- $r = 33/43.5/54$ mm
- Proposal config moved at 5 mm from beam pipe
- $r = 36/46.5/57$ mm
- ITS3 reticule, 2 half layers
- $r = 36/42/48$ mm
- ITS3 reticule, 4 quarter layers:
- $r = 36/48/60$ mm



Can't achieve these radii with ITS3 reticule

Vertex performance comparisons

- Simulations for 4 vertex configurations:
 - ITS3 reticule, 2 half layers
 - $r = 36/42/48$ mm
 - Active length = 24cm
 - ITS3 reticule, 4 quarter layers:
 - $r = 36/48/60$ mm
 - Active length = 27cm



Some difference in DCA_T

- depends distance between r_1 and r_2
- $(r_2 - r_1)$ is an important parameter

Barrel performance comparisons

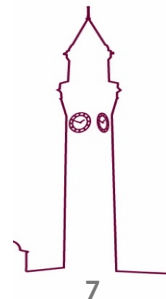
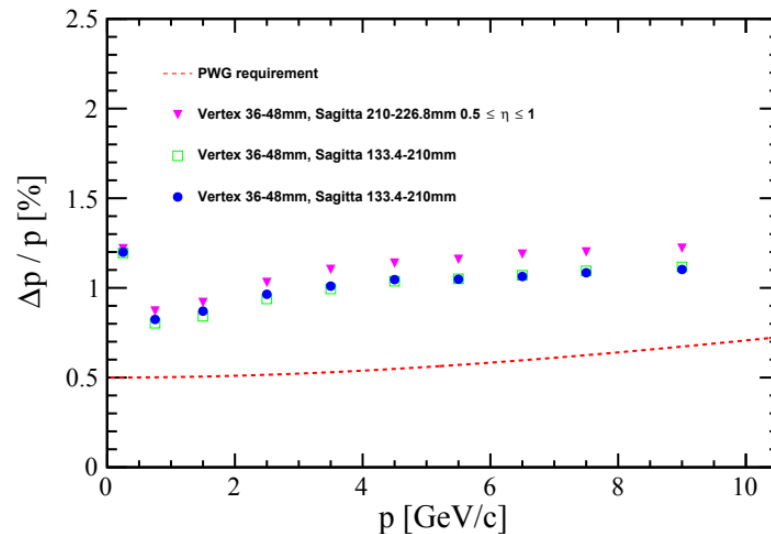
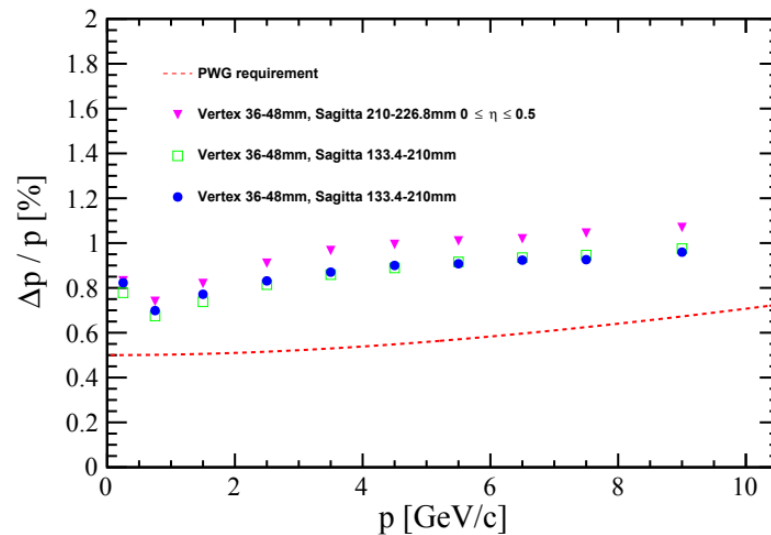
Vertex 36-48mm

- Simulations for 3 barrel configurations:
 - ECCE proposal config:
 - $r = 21.0/22.68$ cm
 - ATHENA proposal config:
 - $r = 13.34/17.96$ cm
 - Config 3:
 - $r = 13.34/21.0$ cm

* If length < 54cm → don't need services on the staves

* Note: μ RWELL resolutions in simulation are unrealistic
→ Expect these resolutions to change

* Note 2: simulations include Si vertex + barrel + disks,
 μ RWELL, AC-LGADS. Single pion events.



Barrel performance comparisons

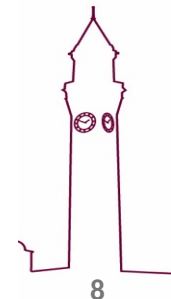
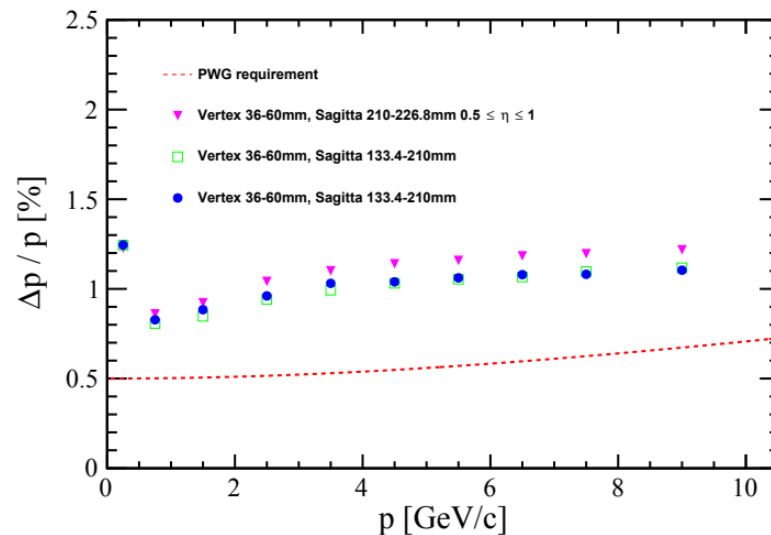
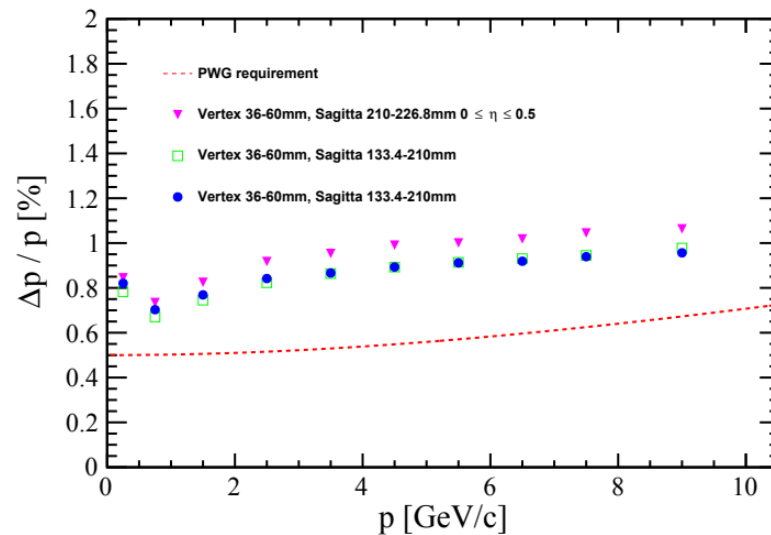
Vertex 36-60mm

- Simulations for 3 barrel configurations:
 - ECCE proposal config:
 - $r = 21.0/22.68$ cm
 - ATHENA proposal config:
 - $r = 13.34/17.96$ cm
 - Config 3:
 - $r = 13.34/21.0$ cm

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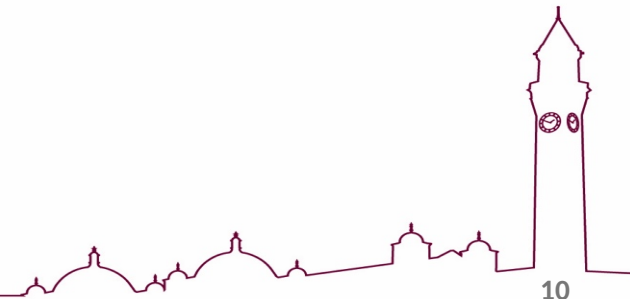


Summary

- Benchmarked performance of ITS3 inspired vertex configurations
 - See that $r_2 - r_1$ is an important parameter
 - Better performance seen for config with layers consisting of 4 sensors
 - → Does not require modification of stitching plan
- Barrel layers can't be longer than 54cm if we want to avoid services on the staves
 - Compared performance of 3 setups
 - Improved performance with a layer at $r \sim 13.34\text{cm}$ (better sagitta measurement)

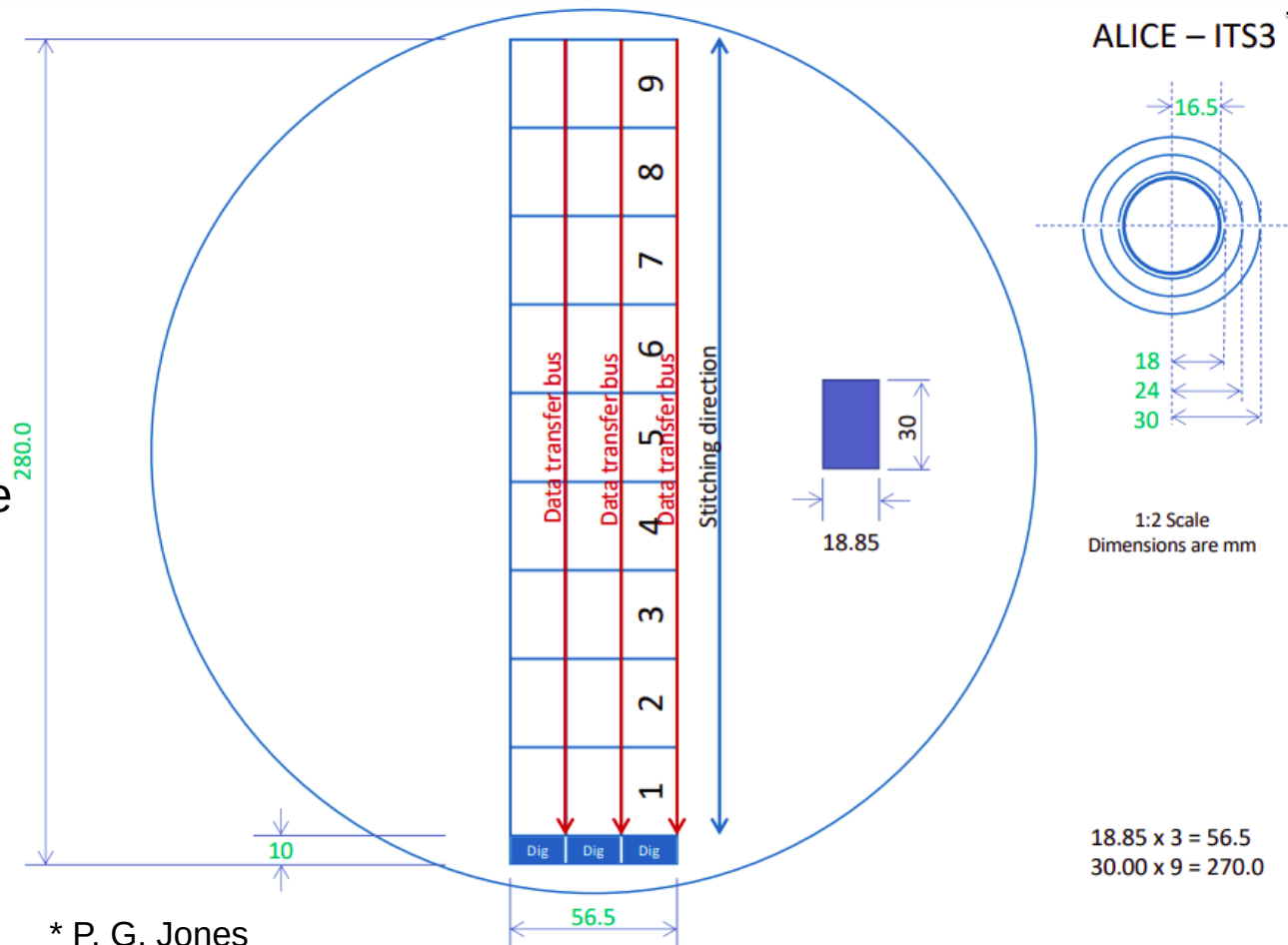


Backup



Reticule Size

- Ideal reticule size for ITS3 is $18.85 \times 30 \text{ mm}^2$
- EIC will use same reticule size as ITS3

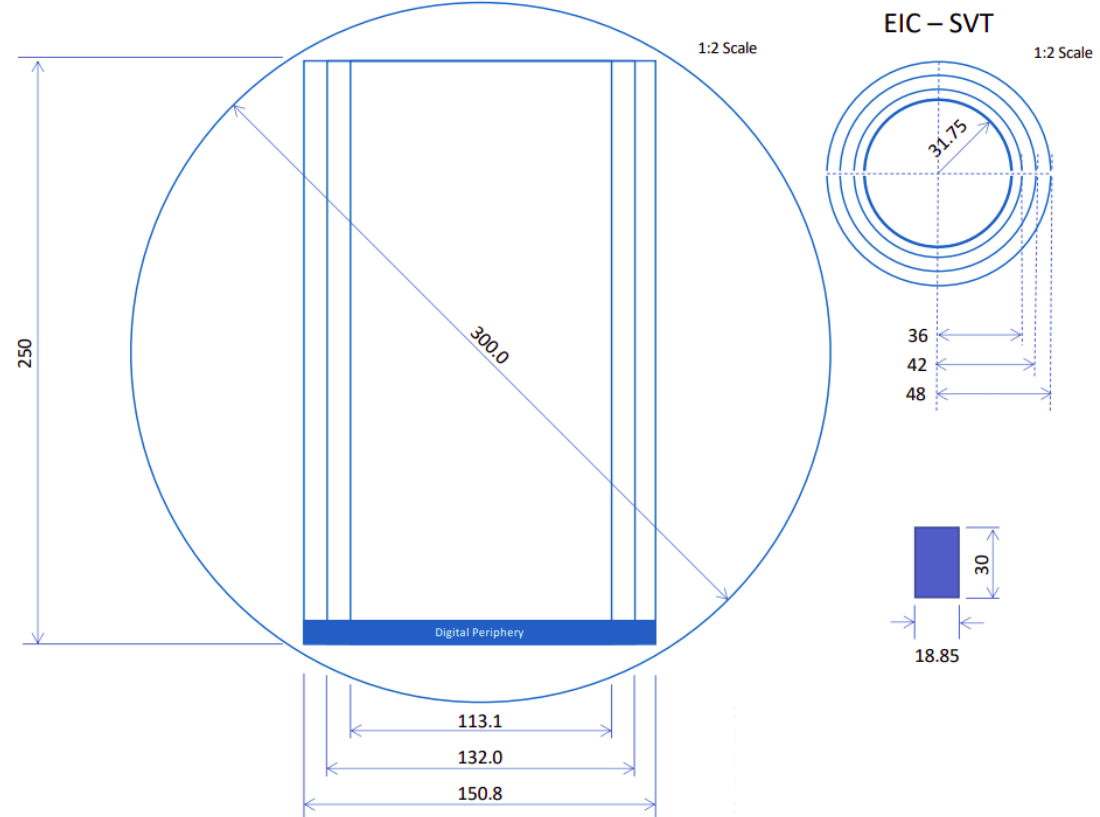


* P. G. Jones

<https://indico.bnl.gov/event/15486/contributions/62590/attachments/40656/67919/EIC-Sensors-Jones.pdf>

Vertex configuration: 2 half layers

- Layers consisting of 2 sensors:
 - Active length = 24cm
 - 25cm with periphery
 - $r = 36/42/48$ mm



* P. G. Jones

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