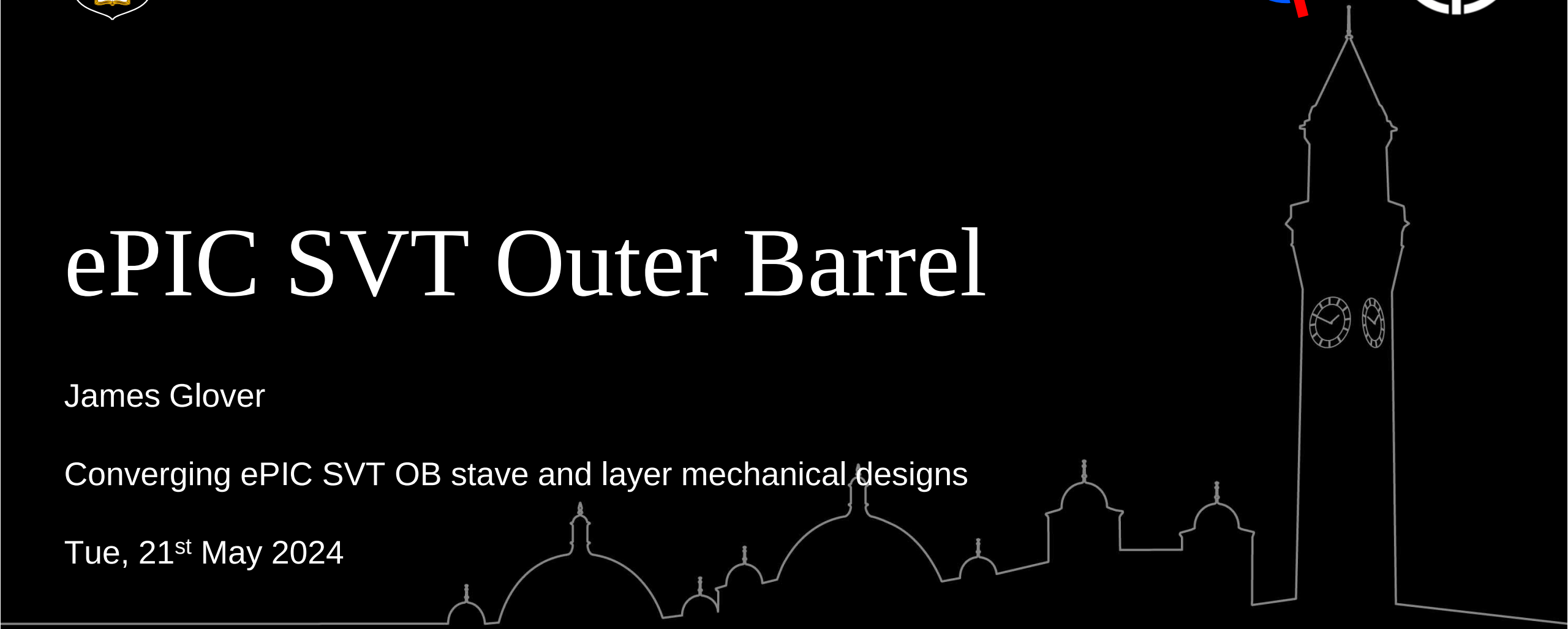


ePIC SVT Outer Barrel

James Glover

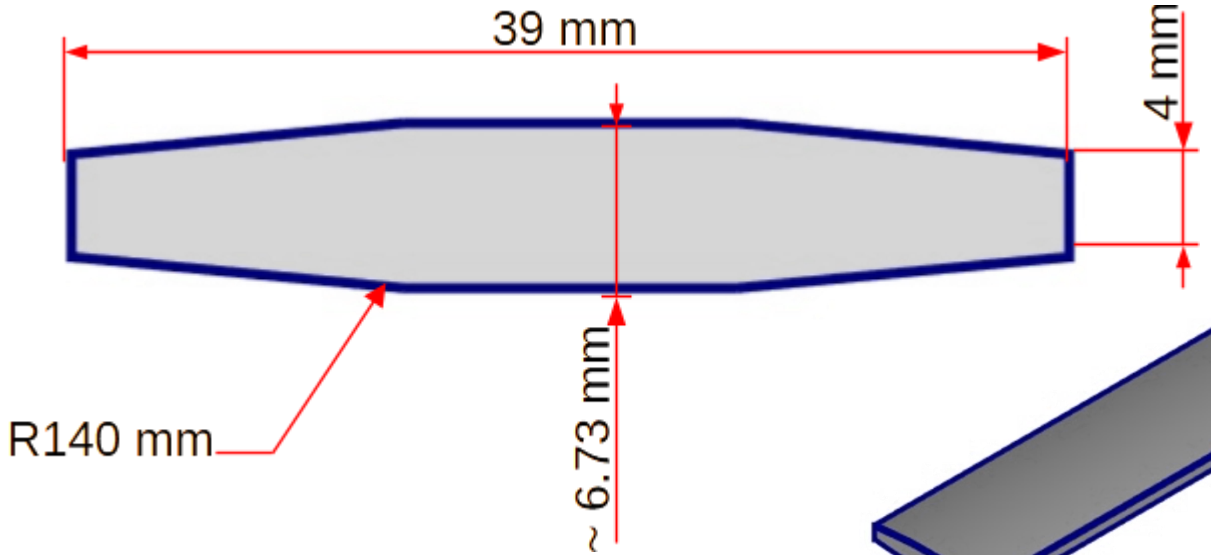
Converging ePIC SVT OB stave and layer mechanical designs

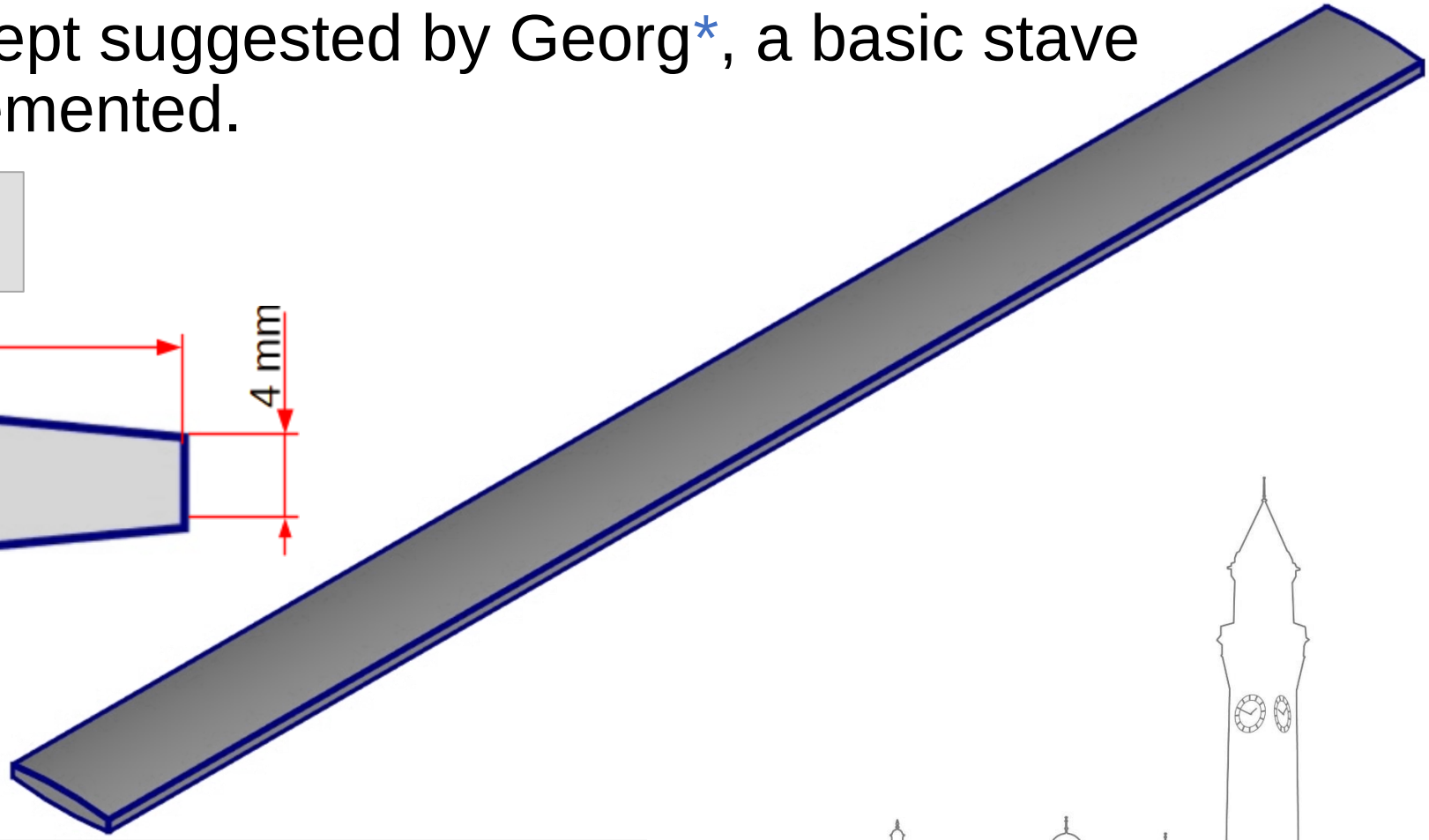
Tue, 21st May 2024

Conceptual stave structure

Based on a curved concept suggested by Georg*, a basic stave structure has been implemented.

Curved surface width = 39.127 mm
2 segment width = 2 × 19.56 = 39.12 mm

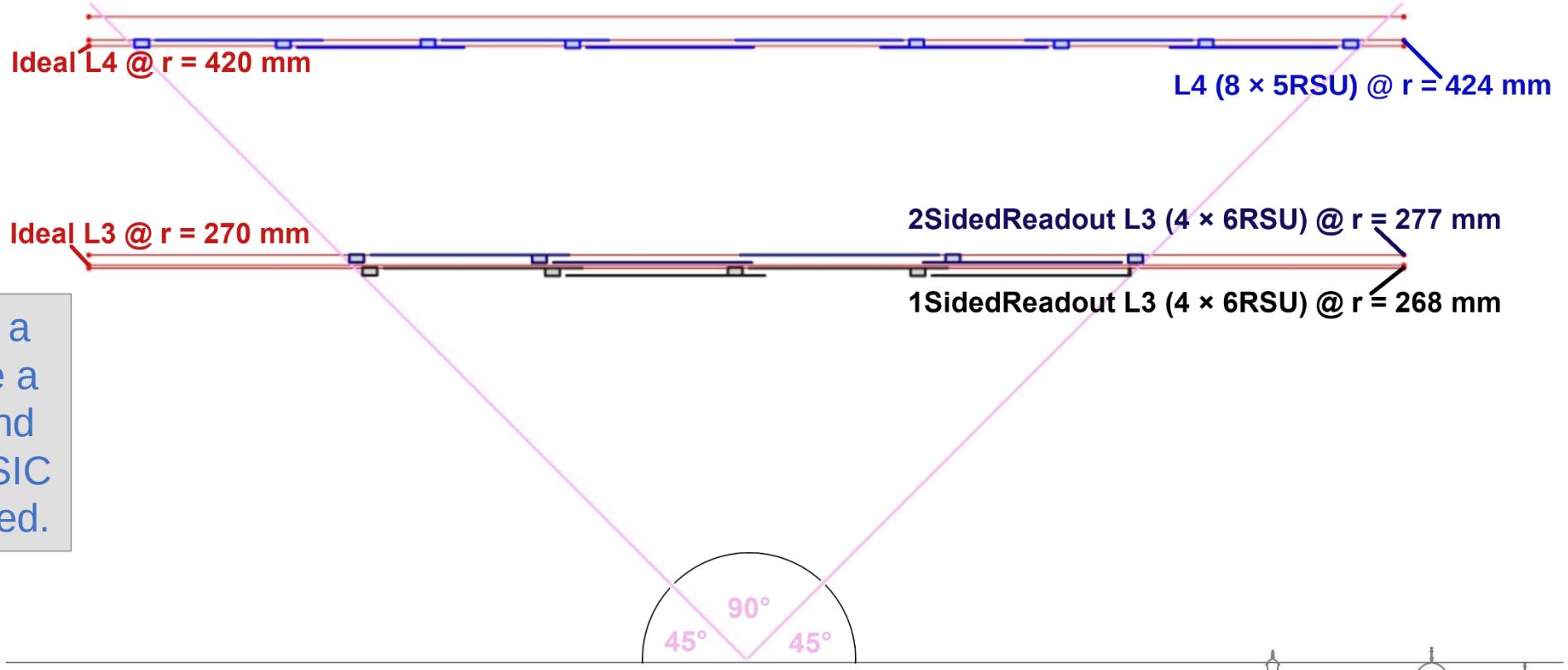




* https://indico.bnl.gov/event/20473/contributions/85002/

Fitting staves into the support cone

Adjusted L3 for both scenarios (keeping the same Active length). The longer (by 17.5 mm) stave, with 2-sided readout, needs a 9 mm larger radius to fit.

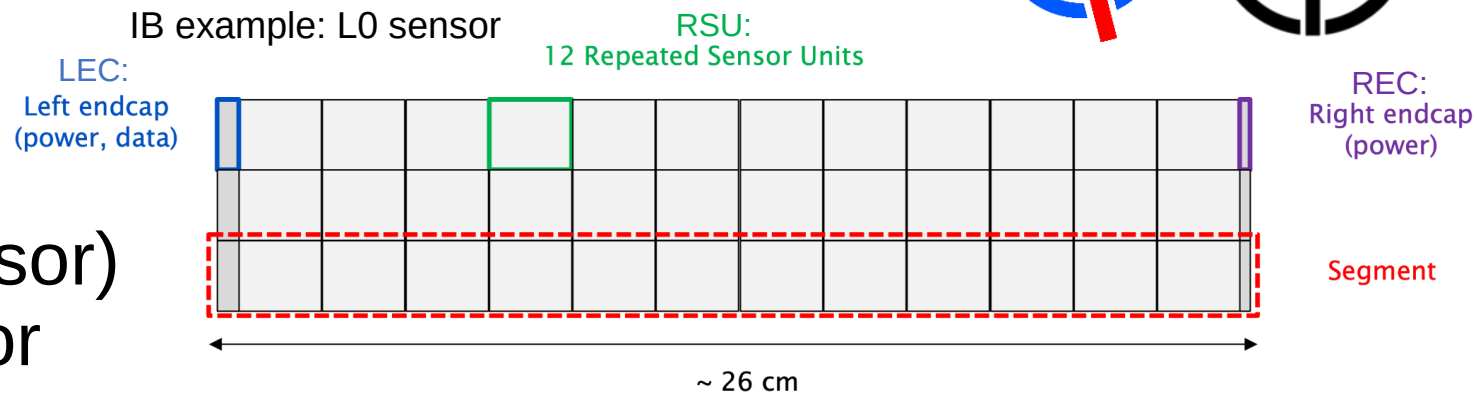


All modules on a stave now have a fixed overlap and space for AncASIC has been included.

Additional (support) slides

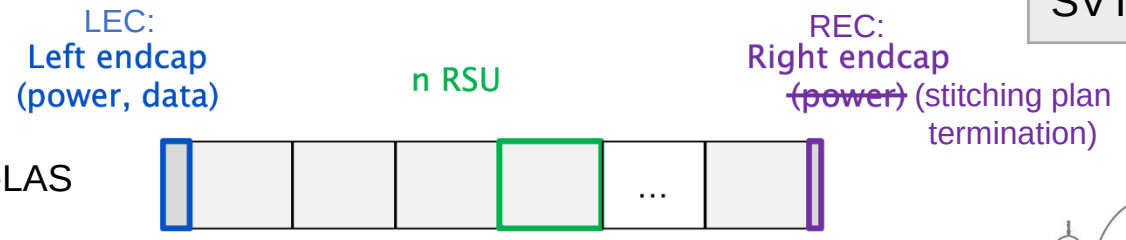
MAPS for EIC

- Wafer-scale sensor used in IB.
- EIC-LAS (Large Area Sensor) is the EIC optimised sensor variant to help minimise the material required due to service (data/power/control) connections and improve yield for large area coverage.
  - For OB, EE, and HE of SVT.



From: https://wiki.bnl.gov/EPIC/index.php?title=Si_Vertex_Tracker

IB	–	Inner Barrel
OB	–	Outer Barrel
EE	–	Electron (going) Endcap
HE	–	Hadron (going) Endcap
SVT	–	Silicon Vertex Tracker



Outer barrel

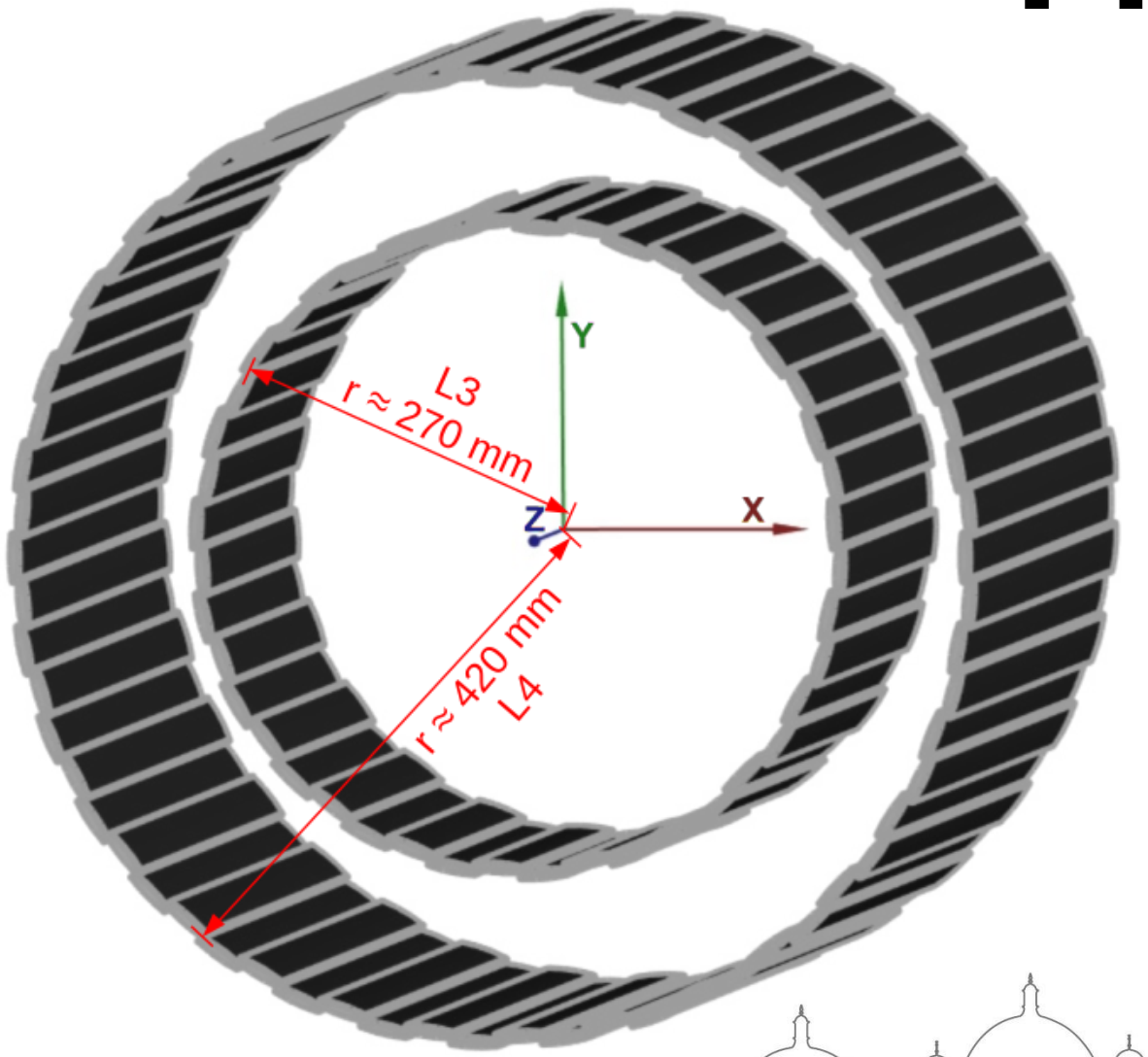
2 stave-based layers (L3 and L4) of stitched MAPS.

L3 (ideals):

- r = 270 mm
- L = 520 mm

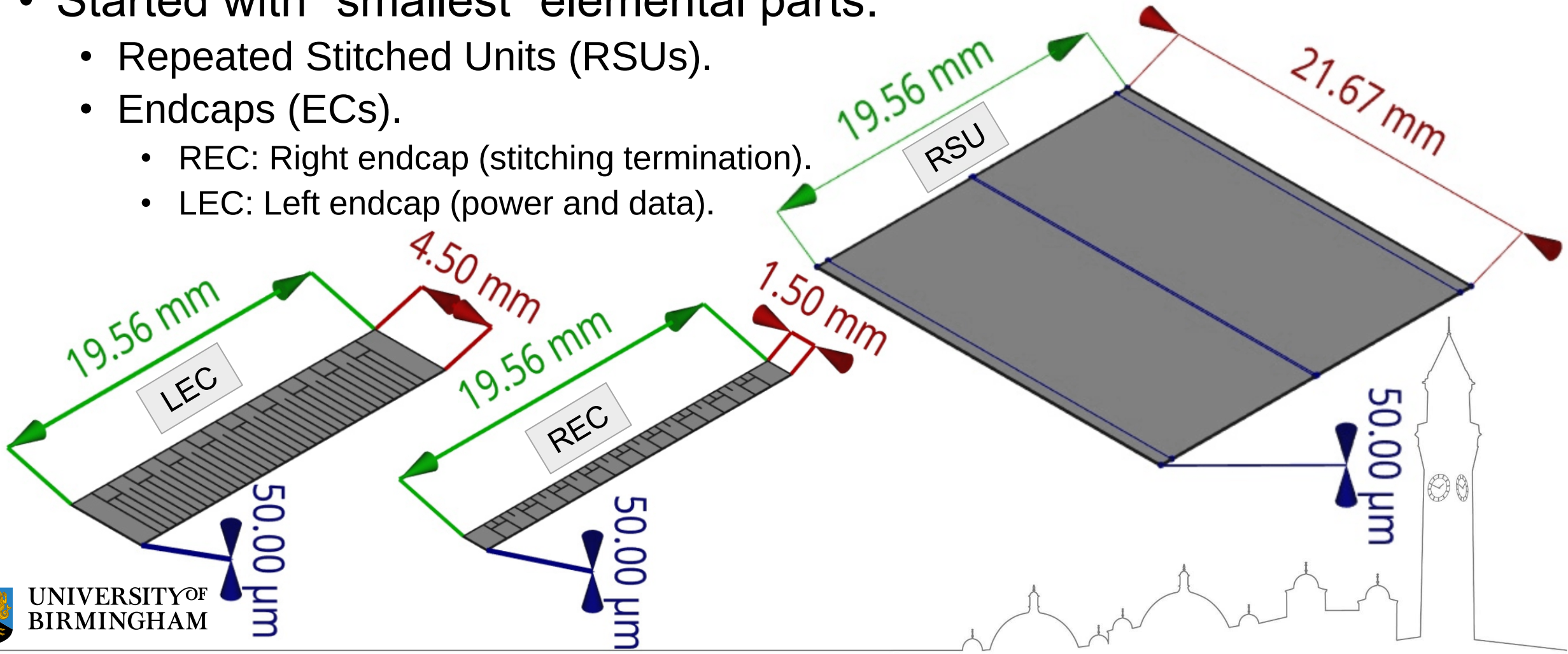
L4 (ideals):

- r = 420 mm
- L = 780 mm



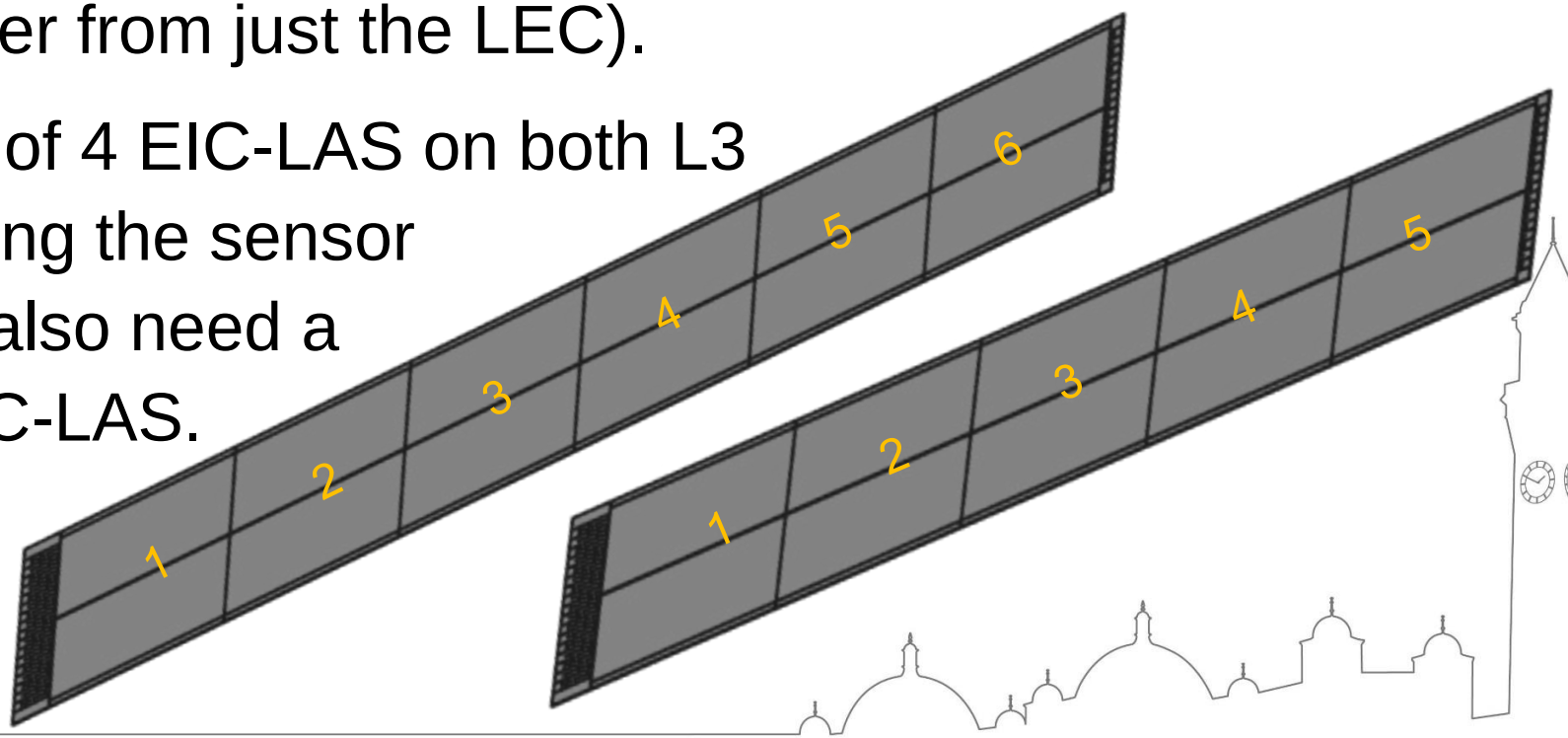
Elements of an EIC-LAS

- Started with “smallest” elemental parts.
  - Repeated Stitched Units (RSUs).
  - Endcaps (ECs).
    - REC: Right endcap (stitching termination).
    - LEC: Left endcap (power and data).

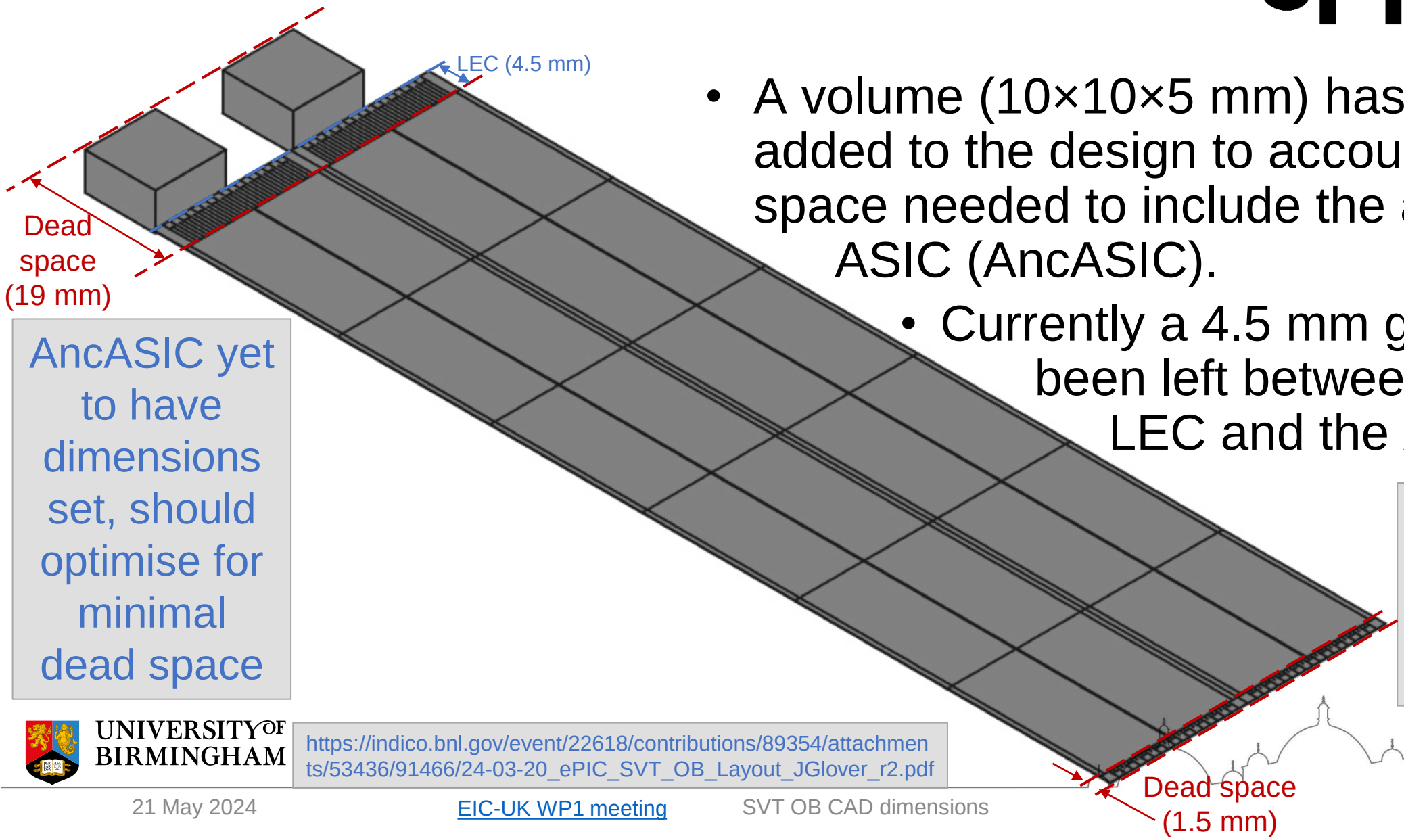


2 EIC-LAS lengths required

- A segment is the name for the collection for stitched RSUs with both a left and right.
- The aim is to have EIC-LAS (segments) with 6 RSU (believed to be the longest we can power from just the LEC).
- To realise multiples of 4 EIC-LAS on both L3 & L4 (while minimising the sensor overlap), we would also need a 5 RSU flavour of EIC-LAS.



1 Module



- A volume (10×10×5 mm) has been added to the design to account for the space needed to include the ancillary ASIC (AncASIC).
  - Currently a 4.5 mm gap has been left between the LEC and the AncASIC.

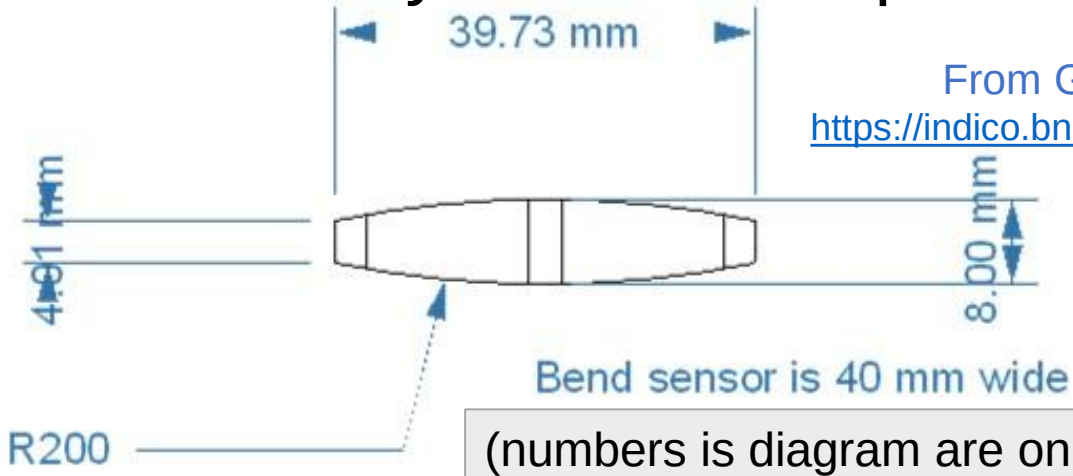
AncASIC yet to have dimensions set, should optimise for minimal dead space

2 EIC-LAS (side-by-side), each with an AncASIC.

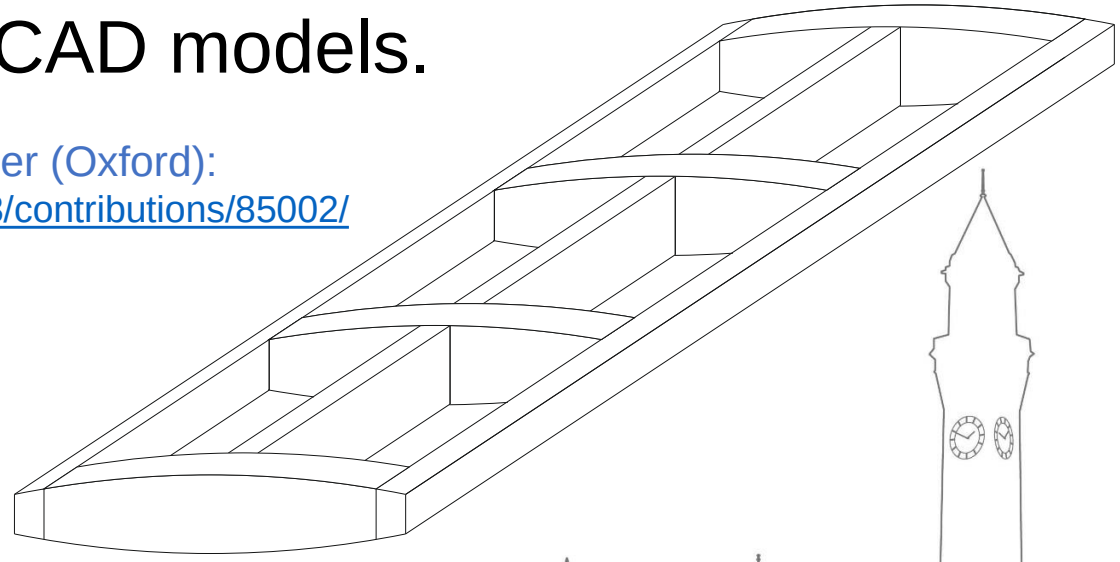
https://indico.bnl.gov/event/22618/contributions/89354/attachments/53436/91466/24-03-20_ePIC_SVT_OB_Layout_JGlover_r2.pdf

Conceptual stave structure

- Following these barrel layout studies, wider mechanical meetings have been held to look at the how the stave could be built and supported from only the extreme ends.
- Current plan is to thin and bend the sensor for increased rigidity.
- This is yet to be incorporated in the CAD models.



From Georg Viehhauser (Oxford):
https://indico.bnl.gov/event/20473/contributions/85002/



(numbers is diagram are only approximate, not set to current sensor size)

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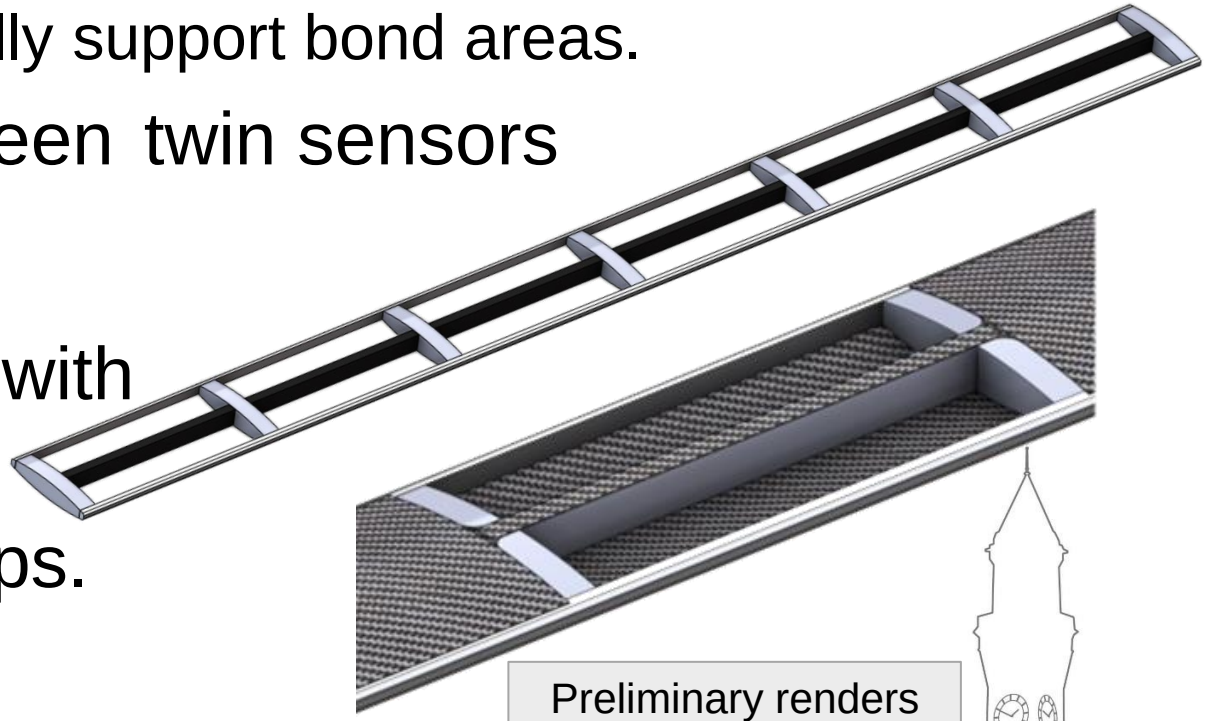
Curved staves

- LEC areas backed by carbon foam ribs.
  - Help heat dissipation and mechanically support bond areas.
- Central spar will support joint between twin sensors and maintain curvature of sensors.
- Surface between sensors covered with carbon fiber skin.
- Sensors are placed over empty gaps.
- Sensor edges to be sealed.
  - Creating an air-tight tube for air cooling.

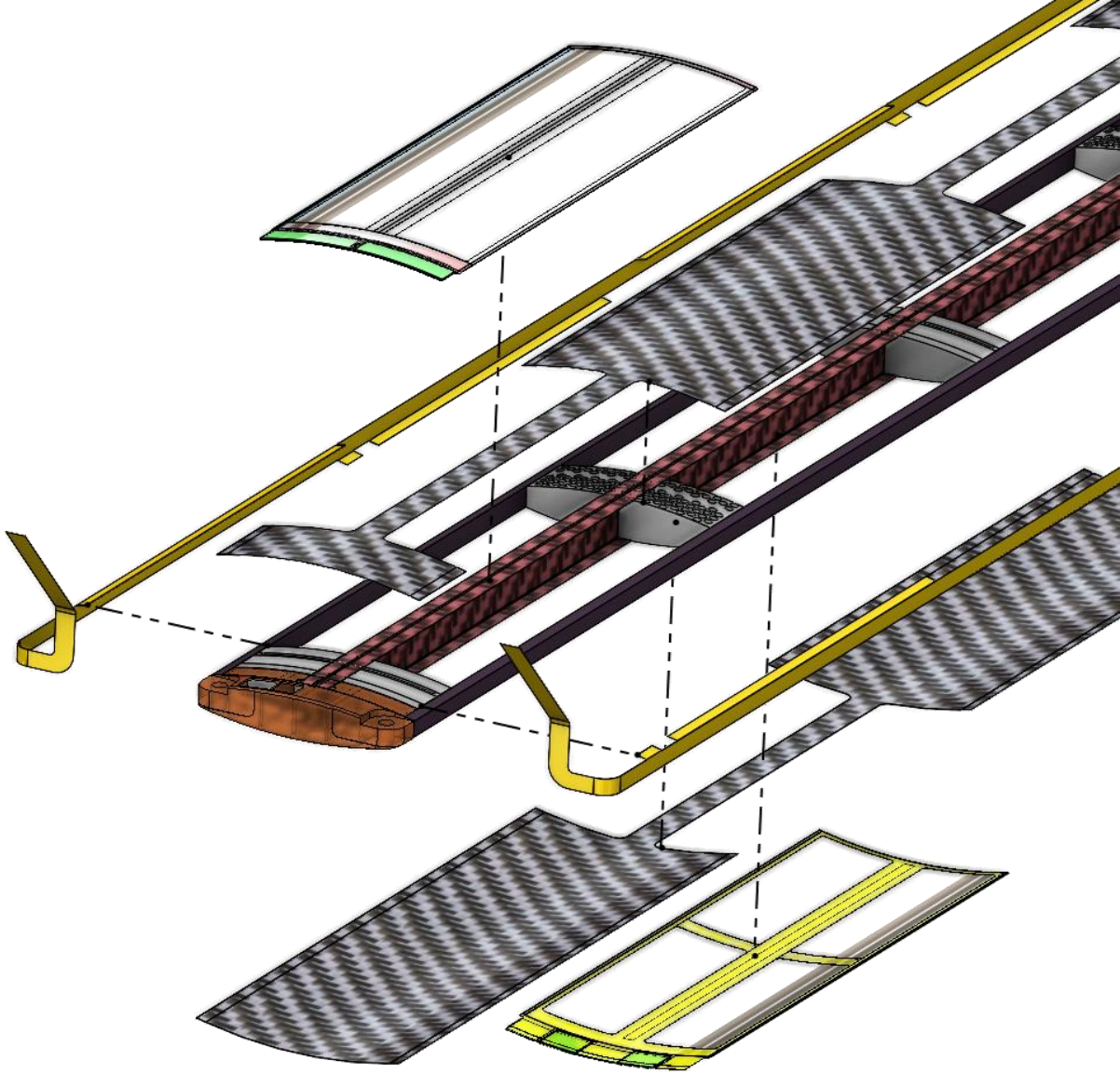


Preliminary renders
(subject to change)

From Georg Viehhauser (Oxford):
https://indico.bnl.gov/event/20473/contributions/85002/

Reminder of Stave Structure Geometry

- Skeleton will be assembled/bonded prior to curing of composite laminates & FPC
  - Central carbon fibre I-beam divides left and right air channels
  - K9 Cross Braces for ASIC & LEC heat dissipation
  - 3% RVC foam longerons for structural support
- FPCs run along the longerons



From Adam Huddart (STFC):
https://indico.bnl.gov/event/23179/contributions/91299/attachments/54470/93215/ePIC%20WP1%20-%20Stave%20Assembly%20Tooling%20-%20Adam%20Huddart.pptx

End Goal

Alternating top/bottom open sides

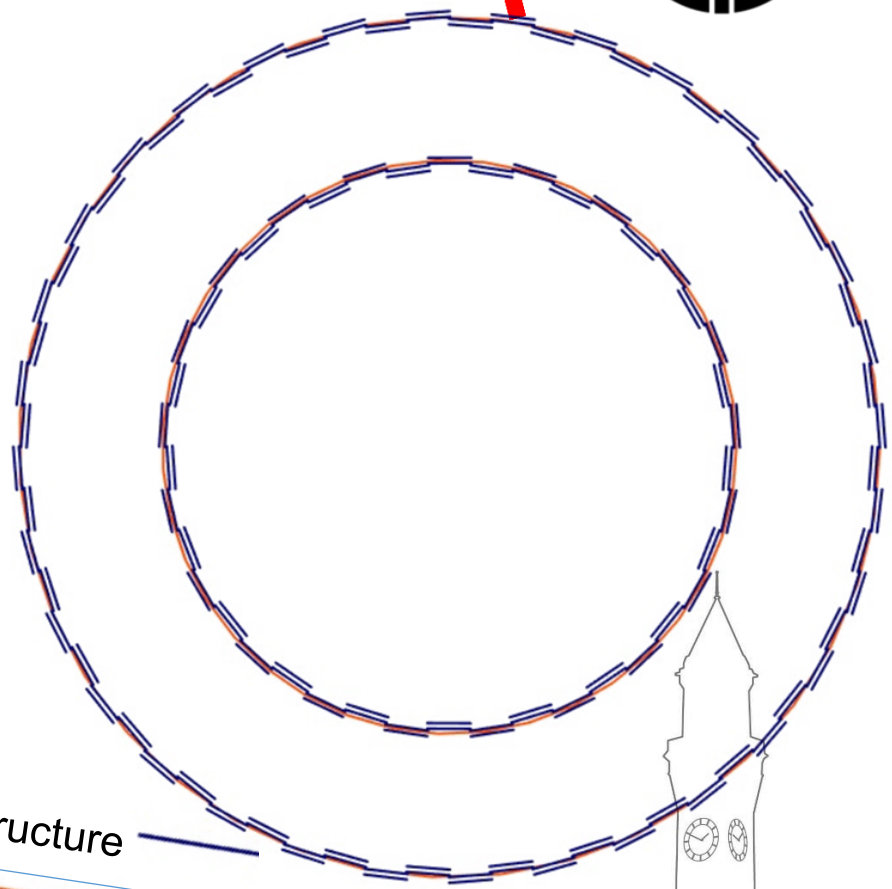
From Adam Huddart (STFC):
https://indico.bnl.gov/event/23179/contributions/91299/attachments/54470/93215/ePIC%20WP1%20-%20Stave%20Assembly%20Tooling%20-%20Adam%20Huddart.pptx

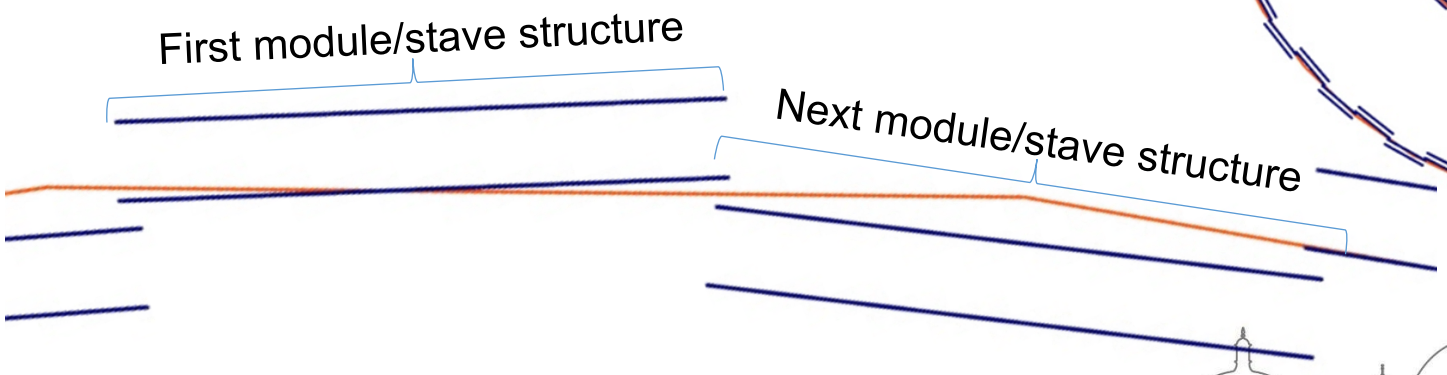
Bottom

Top

Castellated layout

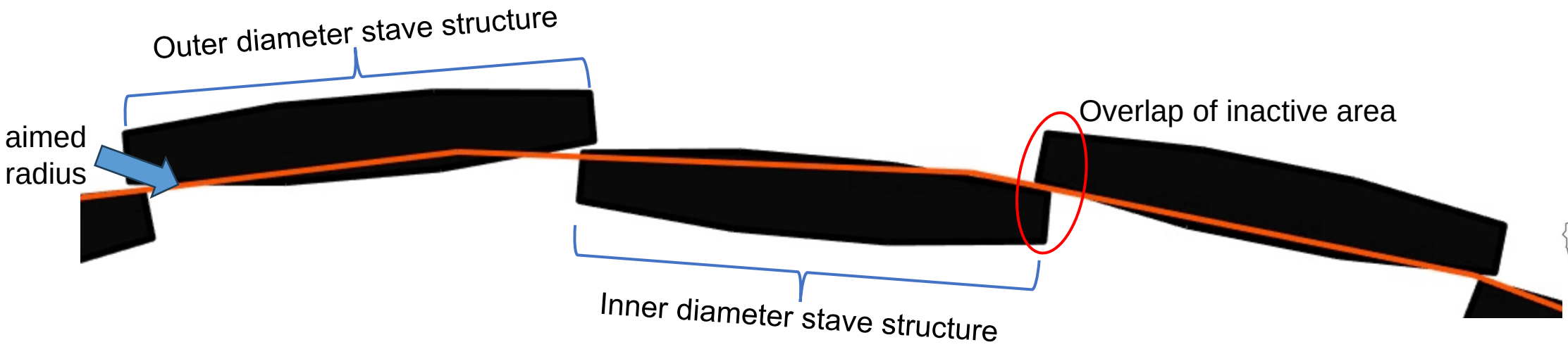
- Alternating inner/outer structure.
  - Easy mounting/replacing (at most 3 staves removed to replace 1).
  - Preferred (over tiled option) for its “easier” mounting/replacing of staves.
- A realistic number of staves accounted for.
- Number of staves must be even.
- Some overlap of staves (in both designs).
  - To account to dead area at the sensor’s edge.





Constructing the barrel layers

- From the radii shown previously, repeated a structure of castellated pairs to obtain maximum (azimuthal) coverage.
- Observe how well pairs of staves fit at each radii.



Structural findings

Layer	Radial Aim	Inner Radii	Outer Radii	#RSU per EIC-LAS	#Staves per layer	#EIC-LAS per layer
L3	268 mm	261 mm	274 mm	6RSU-LAS	44	176
L4	424 mm	417 mm	430 mm	5RSU-LAS	70	560

Azimuthal overlap between neighbouring staves is 200-400 μm.
(200 μm of dead-space runs along the edge of the silicon)

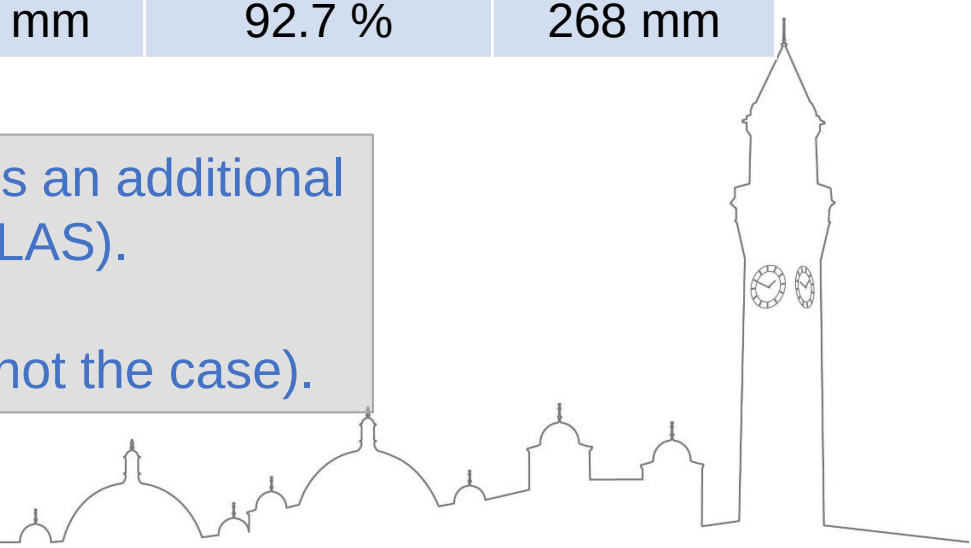
Reducing L4 radius to 420 mm, overlaps become (O)600 μm.

Structural findings

Layout	Active length	Stave length	% of Active Stave length†	Required radii
1 sided readout	505.0345 mm	525.53 mm	96.1 %	268 mm
2 sided readout (same Active length)	505.0345 mm	543.0345 mm	93.0 %	277 mm
2 sided readout (same Stave length)*	487.0345 mm	525.53 mm	92.7 %	268 mm

* Bringing the Active length down requires an additional 6 mm of RSU overlap (per EIC-LAS).

† Assuming 100% active area on RSU (not the case).



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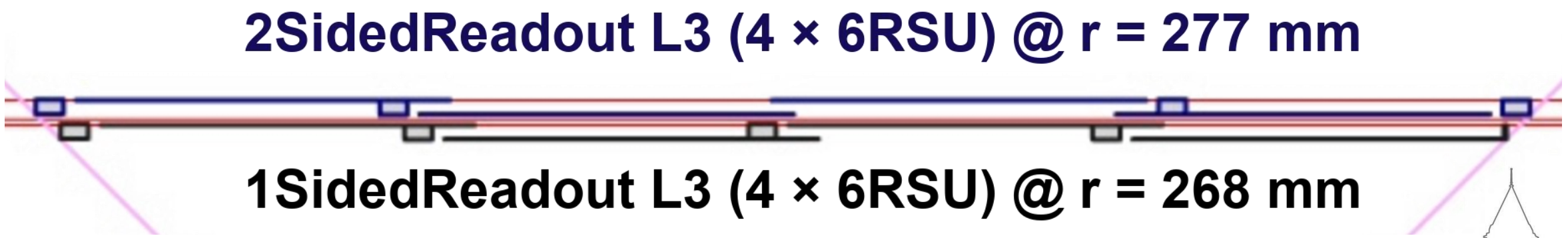

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