EIC-UK WP1
Outer Barrel Layout Options (Retrospective)

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Wednesday, 13th September 2023

Based on studies by Peter Jones

ePIC – SVT Barrel Layers

- Sensor length considerations

Current conceptual design based on ITS3 LoI

	Layer	r (mm)	l (mm)	X/X_0 (%)	Area (m^2)	theta (deg)	eta
IB	L0	36.0	270	0.05	0.06	14.93	2.03
	L1	48.0	270	0.05	0.08	19.57	1.76
	L2	120.0	270	0.05	0.20	41.63	0.97
OB	L3	270	540	0.25	0.92	45.00	0.88
	L4	420	840	0.55	2.22	45.00	0.88

Comments
- Beam pipe radius = 31.76 mm
- New L0 radius is +5.64 mm
- New (and old) IB radii assume no overlap
- IB length is fixed by maximum 12 RSUs
- Note that lengths are active lengths – do not include the endcaps (4.5 mm and 1.5 mm)
- OB Opt 1: smaller radii to keep same eta coverage
- OB Opt 2: original radii with reduced eta coverage
- OB Opt 3: original radii and eta coverage by adding an additional sensor per layer
- T6 = 1x6 RSUs, T5 = 1x5 RSUs

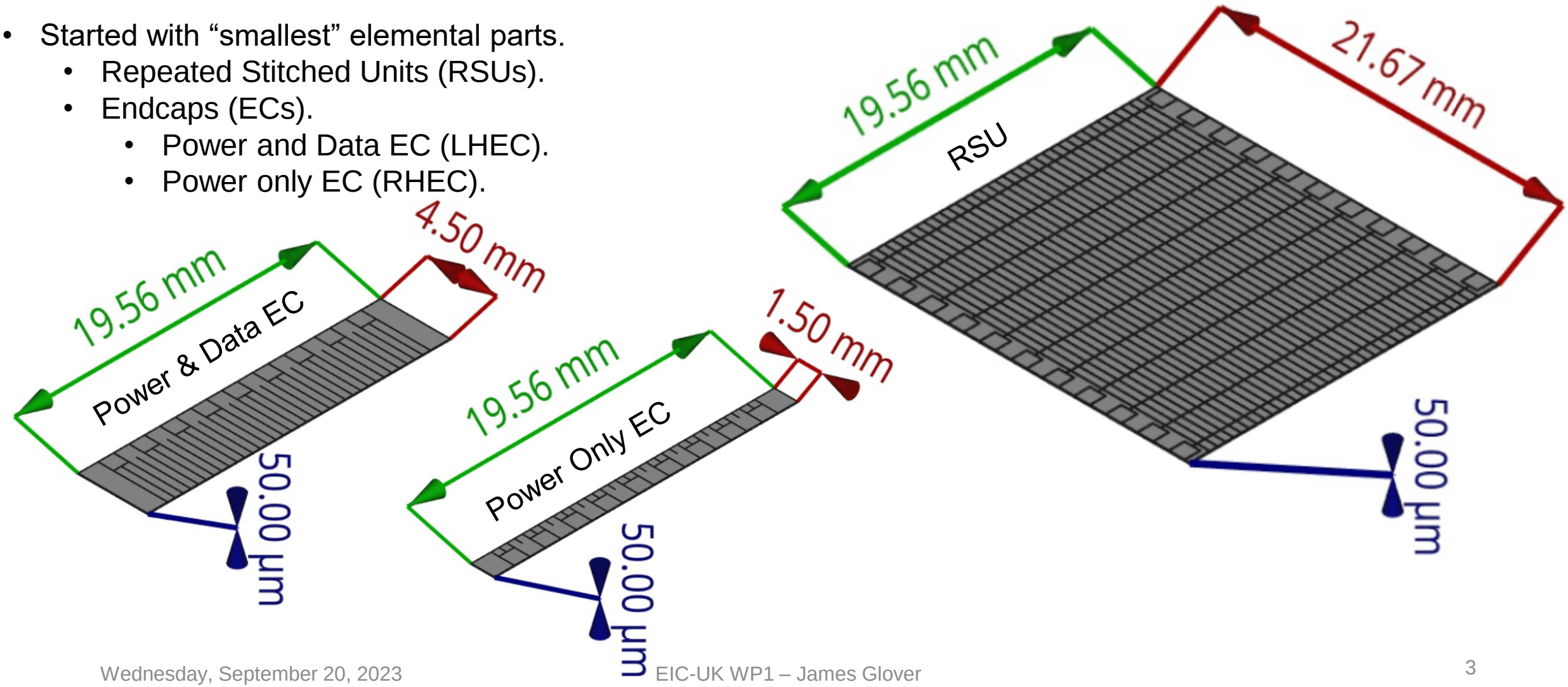
Proposed new layout based on ITS3 ER2 sensor

	Layer	r (mm)	l (mm)	X/X_0 (%)	Area (m^2)	theta (deg)	eta	n_rsu	T6	T5
IB	L0	37.4	260	0.05	0.06	16.04	1.96			
	L1	49.8	260	0.05	0.08	20.97	1.69			
	L2	124.5	260	0.05	0.20	43.77	0.91			
OB Opt 1	L3	260	520	0.25	0.85	45.00	0.88	24	4	
	L4	390	780	0.55	1.91	45.00	0.88	36	6	
OB Opt 2	L3	270	520	0.25	0.88	46.08	0.85	24	4	
	L4	420	780	0.55	2.06	47.12	0.83	36	6	
OB Opt 3	L3	271	542	0.25	0.92	45.00	0.88	25		5
	L4	422	845	0.55	2.24	45.00	0.88	39	4	3

https://indico.bnl.gov/event/20219/contributions/79348/attachments/49030/83511/EIC-SVT-08Aug23.pdf

CAD model built from smallest standard parts

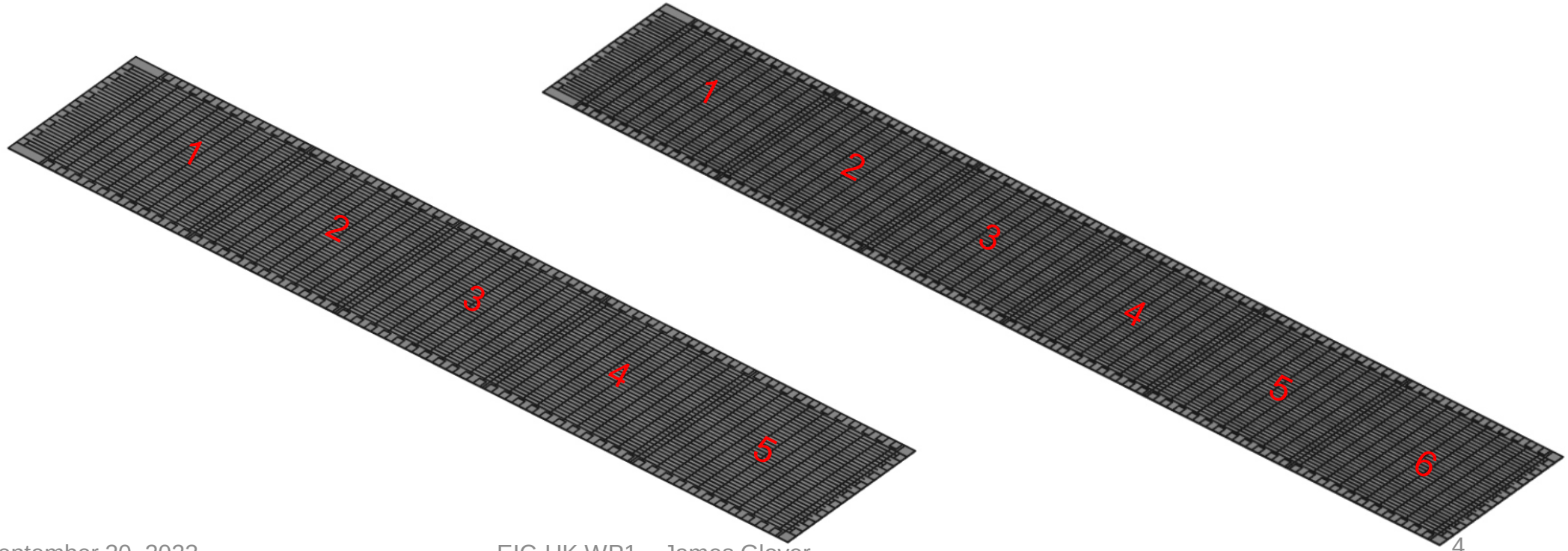
- Started with “smallest” elemental parts.
  - Repeated Stitched Units (RSUs).
  - Endcaps (ECs).
    - Power and Data EC (LHEC).
    - Power only EC (RHEC).



2 EIC-LAS (segment) lengths required

Reminder: A segment is the name for the collection for stitched RSUs both a “Power and Data” and “Power Only” endcap (to terminate the stitching plan).

- The aim is to have EIC-LAS (segments) with 6RSU (believed to be the longest we can power from just 1 EC).
- To realise the “OB Opt 3” from Peter’s slides, we would need an extra flavour of EIC-LAS:
  - 5RSUs in length (but still with both ECs).

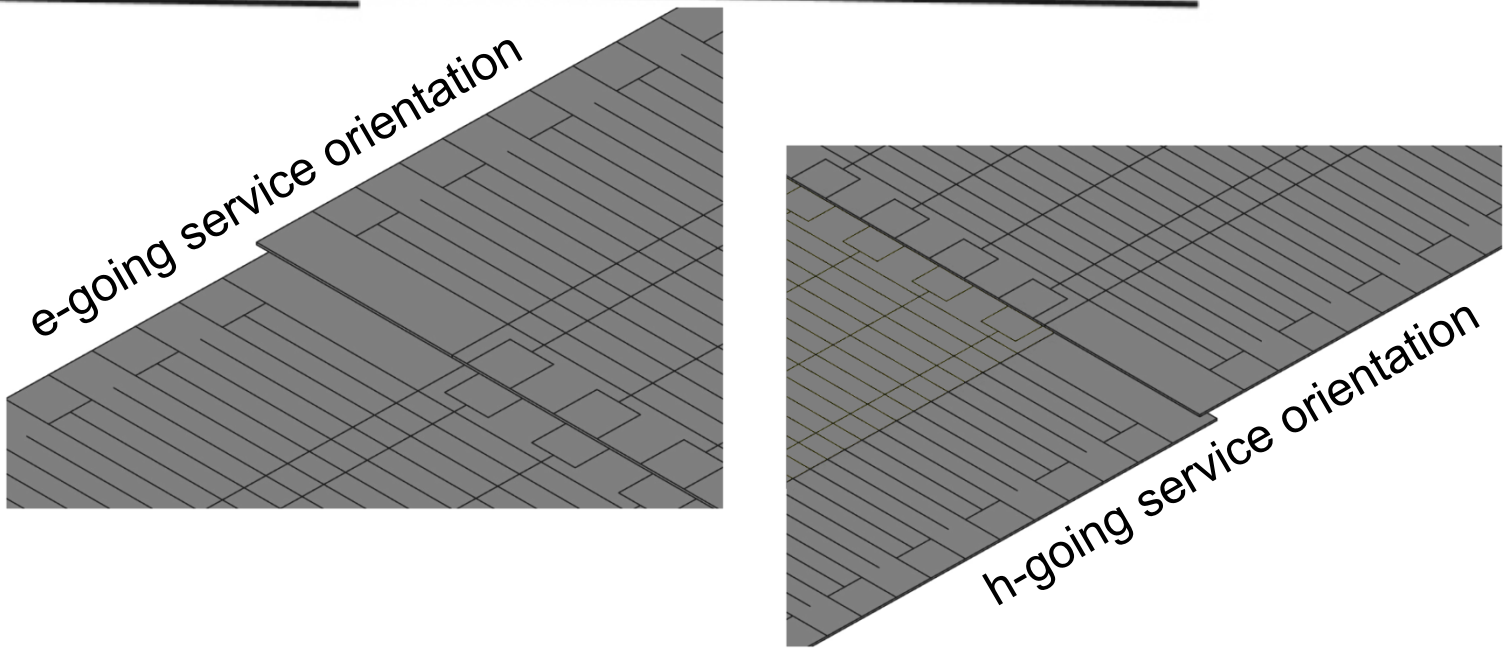


Construction of modules (Collection of EIC-LAS, here 2 side-by-side)

All EIC-LAS structures will have dead space around the edges (none active area include the ECs, and data and power buses running along the length of the segment edges*)

- To minimise the dead space in the detector, this study has applied a small overlap for each segment.
  - For now, an (arbitrary) overlap of 500 μm.
  - This has been achieved by angling the segments by 1°.

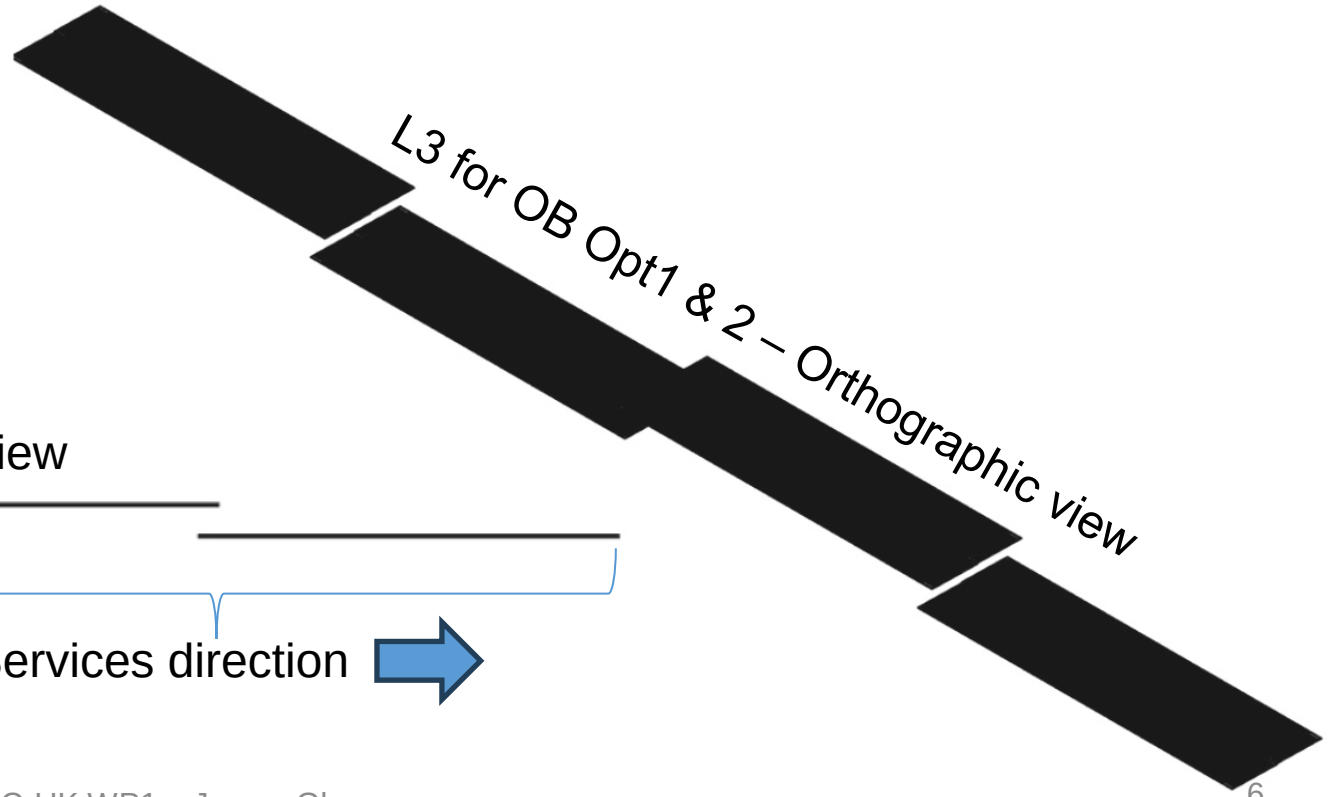
- To minimise the length of service cabling, power and data cables should be as close to the barrel ends as possible (avoid the services running over the centre of the barrel's length).
  - This requires modules with the Power&Data EC pointing in opposite directions.
    - For both services in the e-going side and in the h-going side of the barrel.



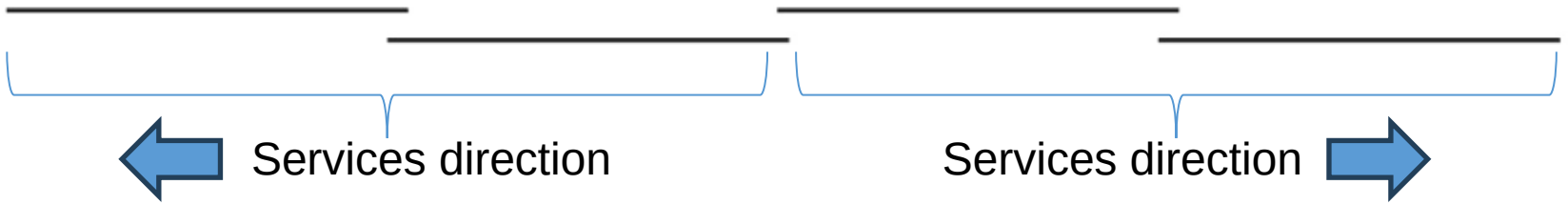
* As the RSUs are split into half-units, there is also some dead space running along the central length of the segment.

Construction of staves (Plank structure of modules to cover layer length)

- Numerous stave structures are required for the OB layers (L3 and L4).
- Peter also suggested different lengths and configurations for both L3 and L4 in his OB Opt 3.
  - Layer length and for module configuration are the same for OB Opt 1 and 2.
- To overlap the ECs of successive modules along the stave's length, it has been suggested to place them on opposite sides of the stave structure.



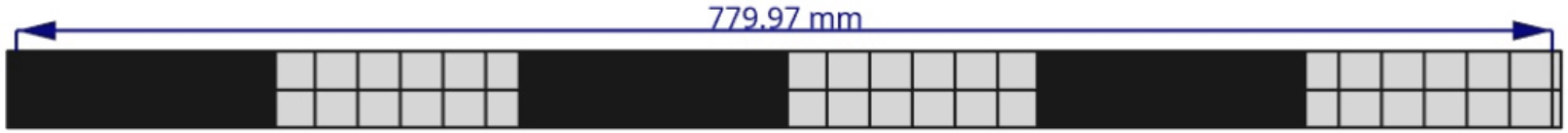
L3 for OB Opt1 & 2 – Side view



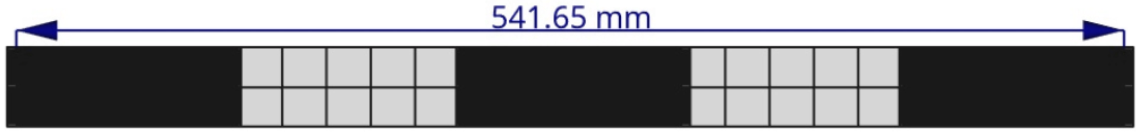
Various stave lengths

L3 for OB Opt 1 & 2 (4×6RSU modules)

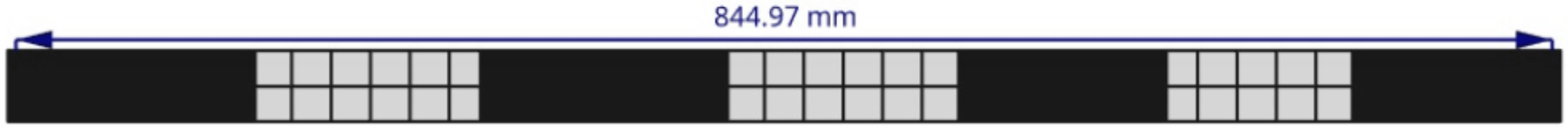
L4 for OB Opt 1 & 2 (6×6RSU modules)



L3 for OB Opt (5×5RSU modules)

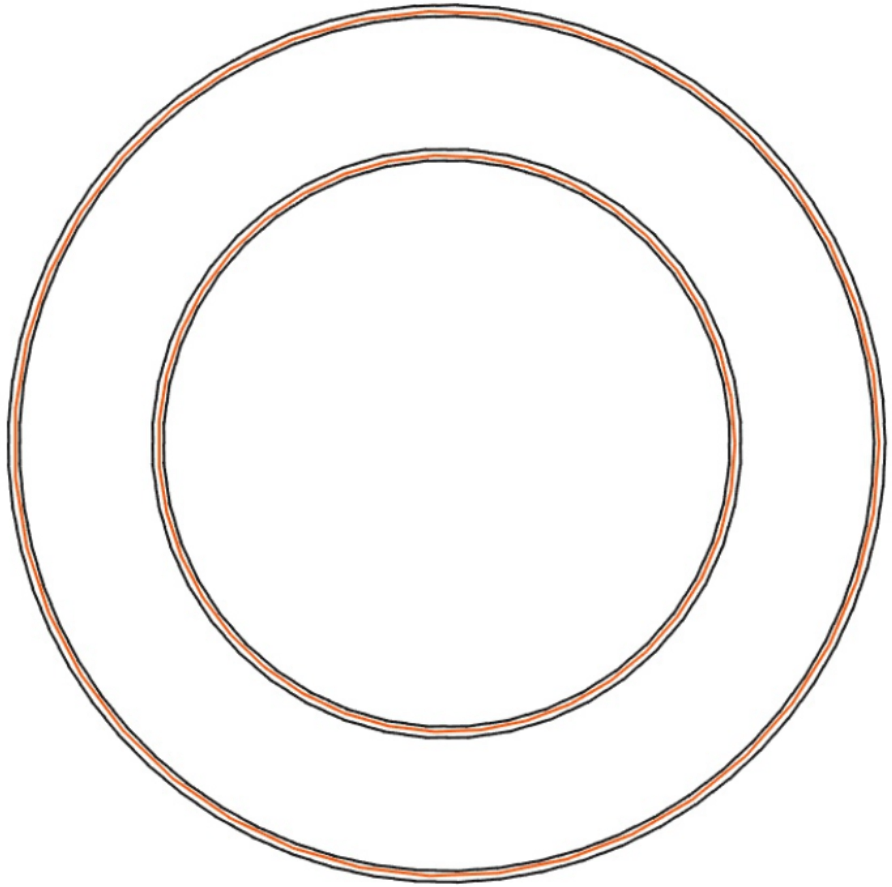


L4 for OB Opt 3 (4×6RSU + 3×5RSU modules)



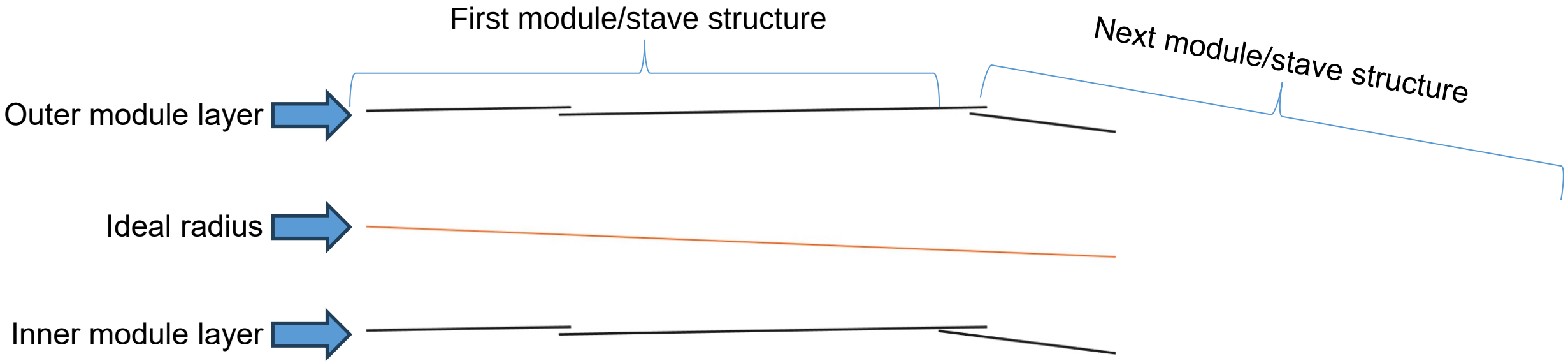
Construction of barrel options

- The modules (shown in previous slides) were rotated around an origin point (to represent the centre of the beam pipe), at the radii suggested in Peter's slides.
- This was done to get the minimum number of staves required to completely cover the circumference (with minimum module overlap).
- The structure created has inner module layer of one stave only overlapping with the inner module layer of the next stave.
  - The is not easy to physically build, but helps to see minimum numbers of staves.
  - A realistic structure would be likely to "tile" staves; this would be were an entire stave overlaps with the next (inner **and** outer module layers of one stave both overlap with the inner **and** outer module layers of the next stave).



Stave spacing for each layer radii

- As this design has modules on both the inner and outer side of the stave, the centre of the stave was positioned at the (ideal) recommended radii in Peter's slides.
- So, both the inner and outer module layers are equally spaced from the given radius.
  - Some variation along the width of a stave exists as the staves are not built with any curvature.



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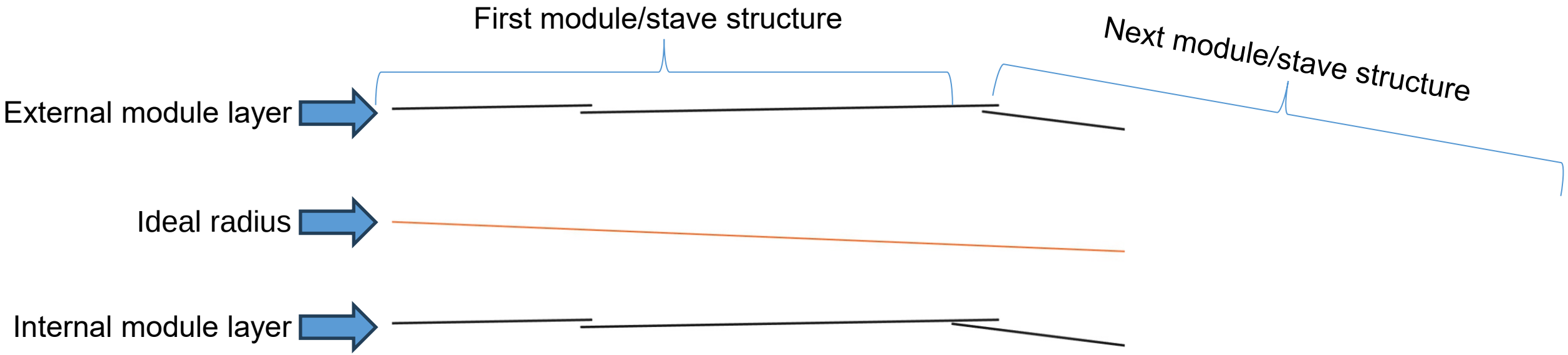

Numbers given by this study (1)

Per stave length (1 sensor/segment/RSU wide) – match Peter's numbers.

	Layer	r (mm)	L (mm)	n_rsu	T6 sensors	T5 sensors
OB Opt 1	L3	260	520	24	4	0
	L4	390	780	36	6	0
OB Opt 2	L3	270	520	24	4	0
	L4	420	780	36	6	0
OB Opt 3	L3	271	542	25	0	5
	L4	422	845	39	4	3

Numbers given by this study (2)

Per stave (2 sensor/segment/RSU wide).

	Layer	r (mm)	L (mm)	n_rsu	T6 sensors	T5 sensors	Min # of staves needed
OB Opt 1	L3	260	520	48	8	0	44
	L4	390	780	72	12	0	65
OB Opt 2	L3	270	520	48	8	0	45
	L4	420	780	72	12	0	70
OB Opt 3	L3	271	542	50	0	10	45
	L4	422	845	78	8	6	70

Numbers given by this study (3)

Per layer. As more staves are likely needed to have a constructable barrel, these number could be considered as the minimum required to assemble the ePIC Outer Barrel (OB).

	Layer	r (mm)	L (mm)	n_rsu	T6 sensors	T5 sensors	T6 wafers (16 sensors)	T5 wafers (22 sensors)
OB Opt 1	L3	260	520	2112	352	0	20	0
	L4	390	780	4680	780	0	44	0
OB Opt 2	L3	270	520	2160	360	0	20	0
	L4	420	780	5040	840	0	47	0
OB Opt 3	L3	271	542	2250	0	450	0	21
	L4	422	845	5460	560	420	32	20

An estimate for the number of sensors able to fit on a single production wafer can be found on the final of Peter's slides.

Additional slides

Reference table used for model sizes

'Segment/RSU width	=19.564 mm
'RSU length	=21.666 mm
'Power+Data Endcap Length	=4.5 mm
'PowerOnly Endacp Length	=1.5 mm
'Sensor Thickness	=50 um
'Overhange (Seg Width)	=500 um
'Module Role	=1 deg
'Stave Thickness	=10 mm