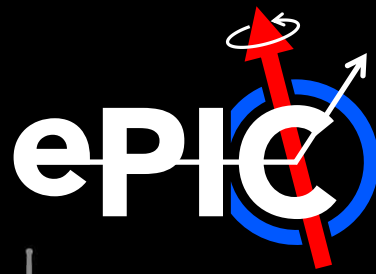




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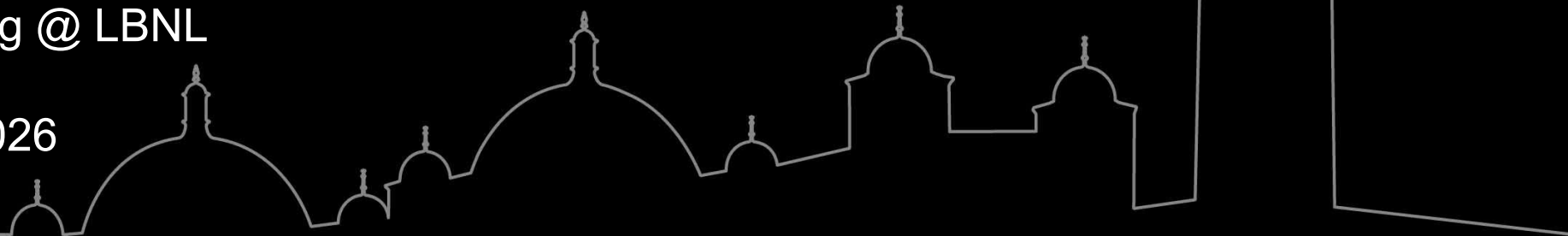


ePIC SVT Outer Barrel (The UK contribution thus far)

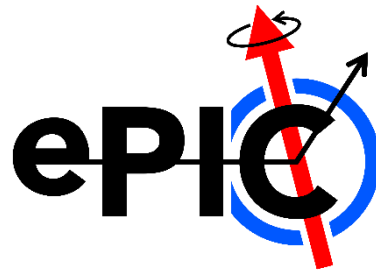
James Glover

ePIC SVT working meeting @ LBNL

Thu, 8th and Fri, 9th Oct 2026

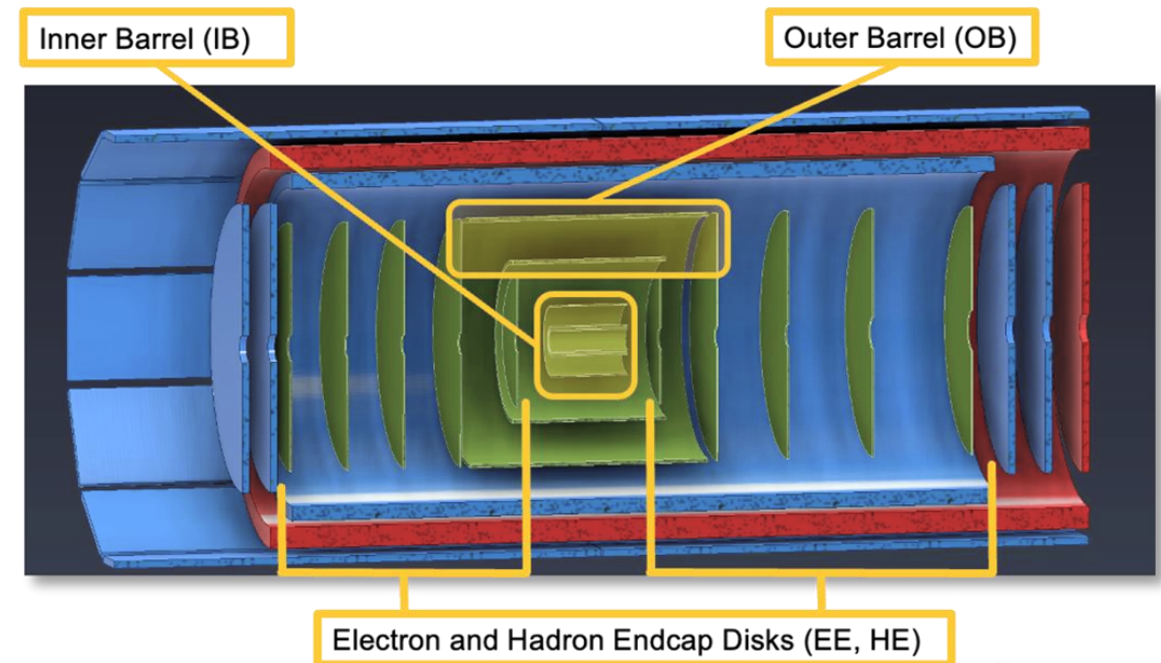


Outer Barrel Overview

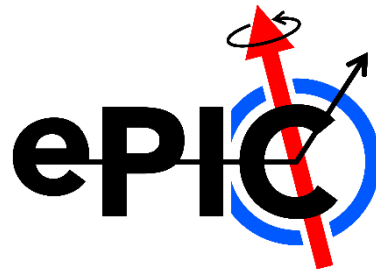


- OB is last 2 last layers of the SVT barrel.
- Physics requirements (from the [YR](#)), led to early simulations with active layers of 540 mm @ $r=270$ mm (0.25% x/X_0) and 840 mm @ $r=420$ mm (0.55% x/X_0) for L3 and L4 respectively.
- This set the targets for the physical designs.

OB	r (mm)	L (mm)	x/X_0 (%)
L3	270	540	0.25
L4	420	840	0.55



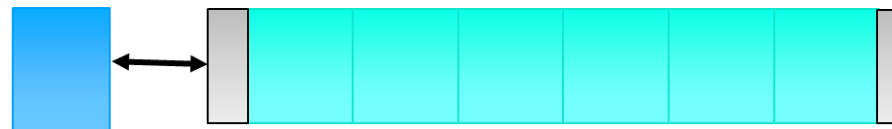
OB sensor and infrastructure



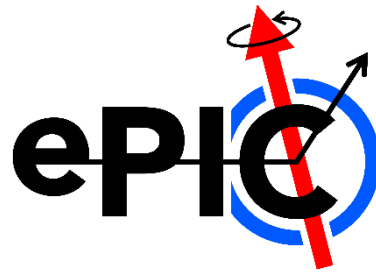
The same building blocks as used for the Endcap Disks.

- Sensor: **EIC-LAS**
Shorter (5 or 6 RSU) version of the IB MOSAIX chip w. one readout channel
- Ancillary ASIC: aka **AncASIC** (enables the below)
- Power segmentation: **per Flexible Printed Circuit**
- Readout connections: **one per EIC-LAS**
- Powering scheme: **serial power**
- Slow Control scheme: **daisy chained ePIC_SC interface per FPC**

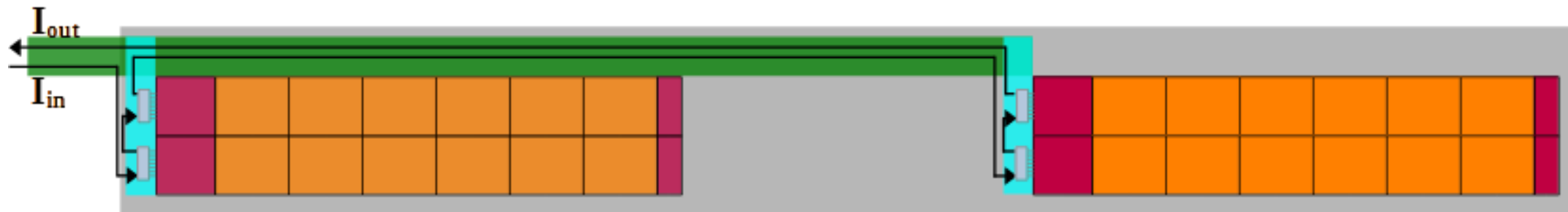
EIC-LAS and ancillary chip



SP and EIC-LAS groupings



- Serial Powering (SP) was base-lined early in the development of SVT, to help minimise service material.
 - One current supply for many EIC-LAS.
- # EIC-LAS per SP chain was matched to # readout channels per VTRx+ - a board (FIB) with $1 \times \text{VTRx+}^*$ also serves $1 \times \text{SP chain!}$
- Maximising EIC-LAS/FIB and FIB/stave dictates multiples of $4 \times \text{EIC-LAS per stave.}$



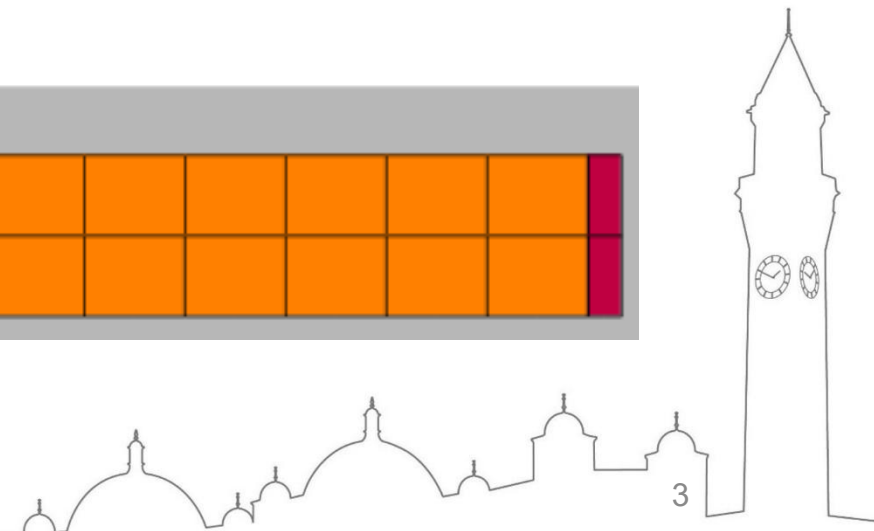
* 4 readout channels per VTRx+.



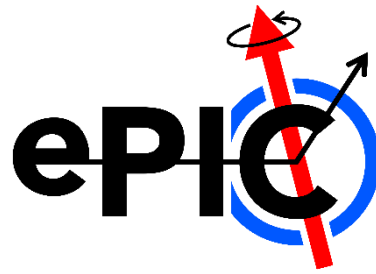
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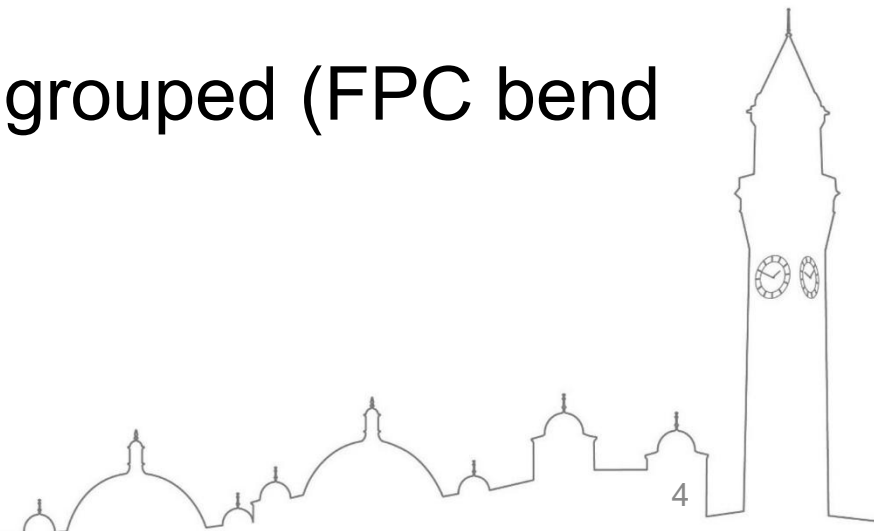
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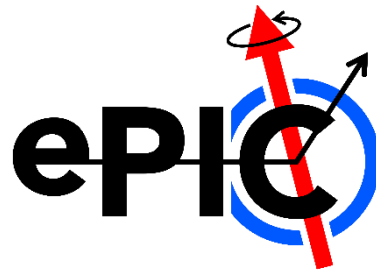
Mapping EIC-LAS to staves



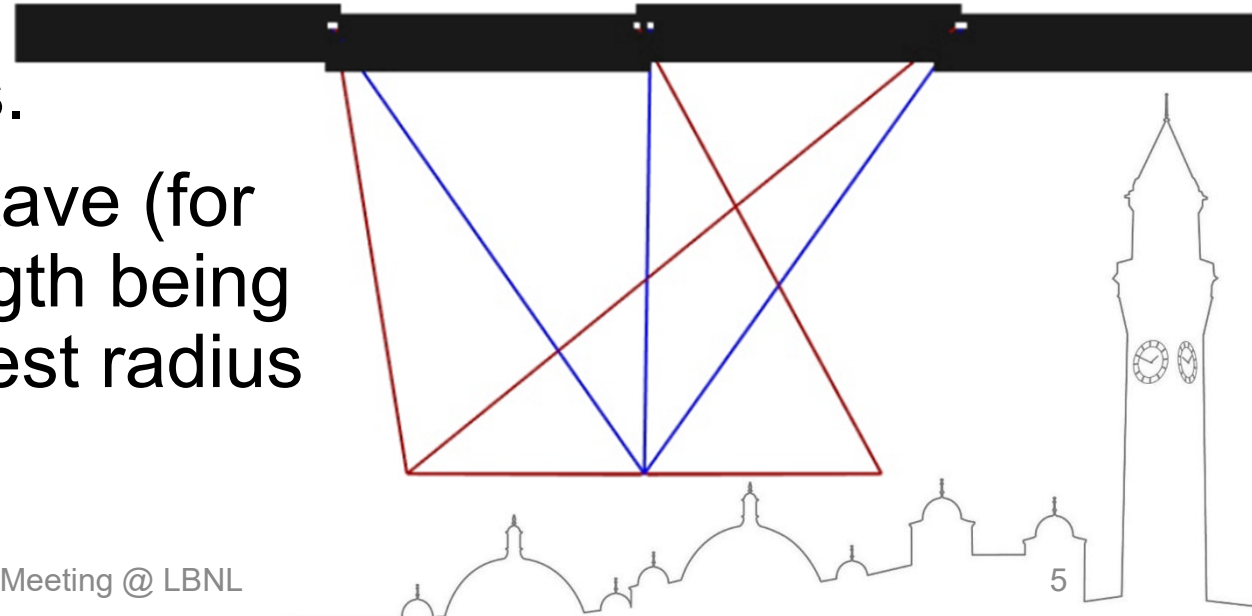
- Originally discussed back in [2023](#).
- Closest matches to the reference (simulation) layout was:
 - 4×EIC-LAS(w. 6 RSUs) in length for L3.
 - 8×EIC-LAS(w. 5 RSUs) in length for L4.
 - Both staves are 2×EIC-LAS wide.
- Double-sided staves to enable overlap of inactive sensor peripheries (LEC & REC).
- EIC-LAS on opposite stave sides can not be grouped (FPC bend radius would make stave too thick).



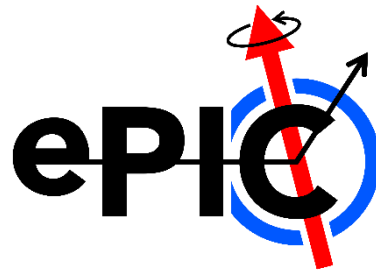
Ensuring full coverage along a stave



- Discussed back in [2024](#).
- Overlapping the active area of EIC-LAS on opposing stave sides.
- Considerations need to be made for the variation in the interaction point (± 10 cm in Z).
- Not a problem for L4, 8×EIC-LAS(w. 5 RSUs. Sensor overlap likely to be determined by length limitations, not minimum overlaps.
- However, for L3 shortening the stave (for full coverage) risks the active length being too small, consideration for the best radius needed to be made.

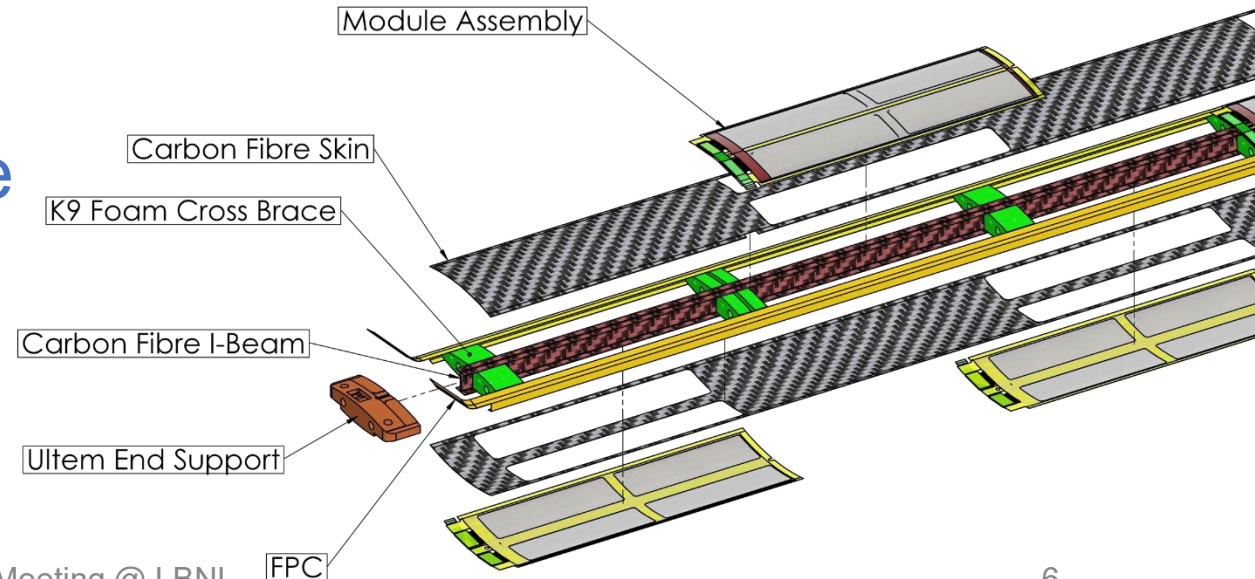
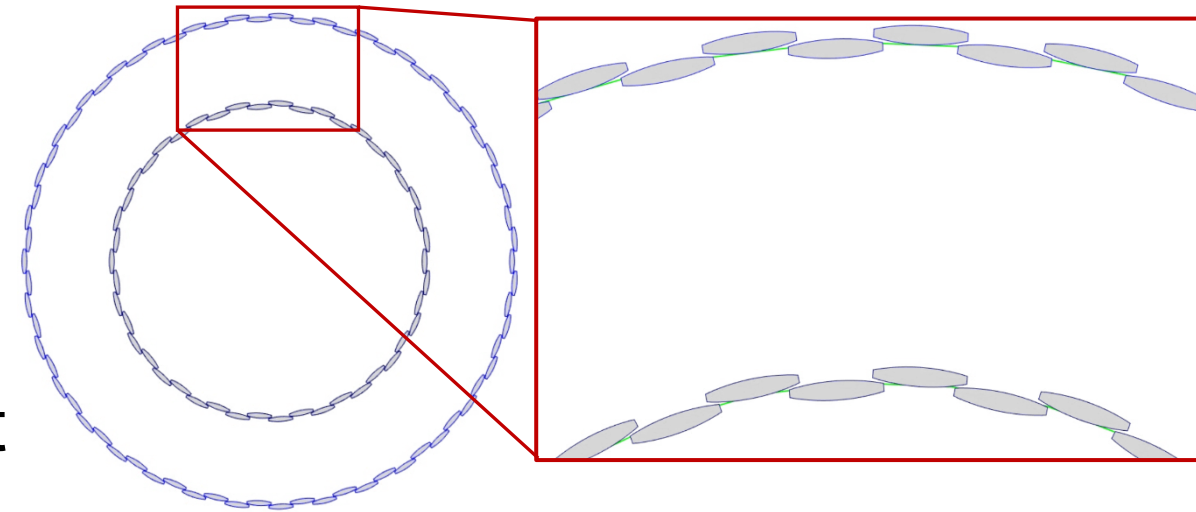


Stave structure & barrel layout

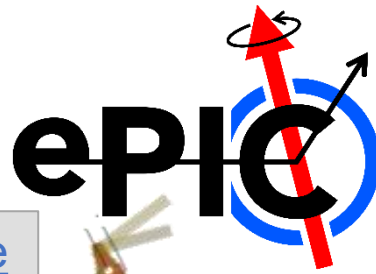


Trialling curved stave surfaces and castellated barrel layout.

- Curved silicon can add to the structural support of the stave, as it will be stiffer than flat silicon.
- A curved stave surface benefits the castellation but **minimising the radius variation** between the inner and outer staves.

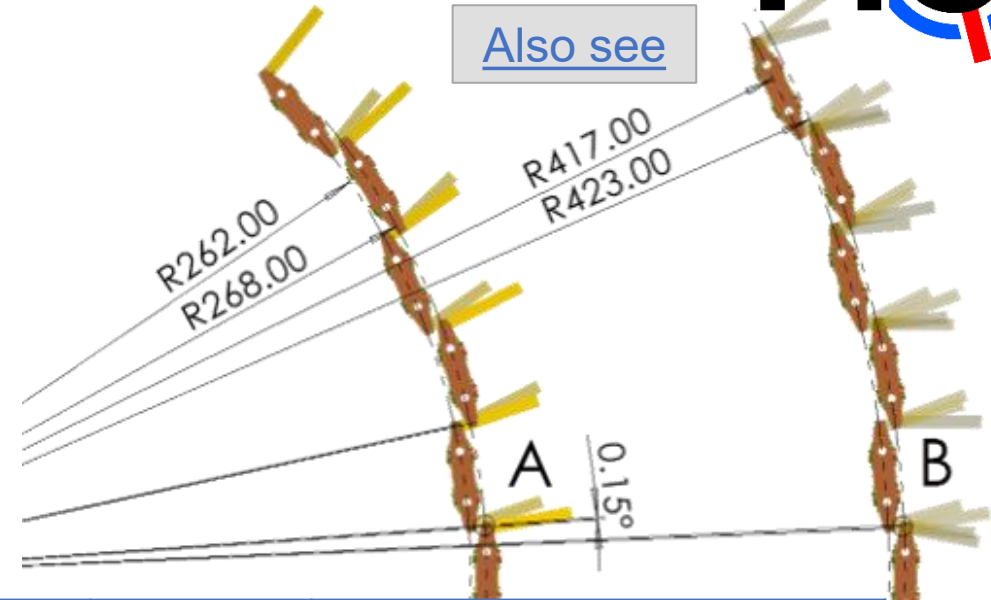


Balancing stave positions & coverage



Positioning staves to **maximise coverage** requires balancing:

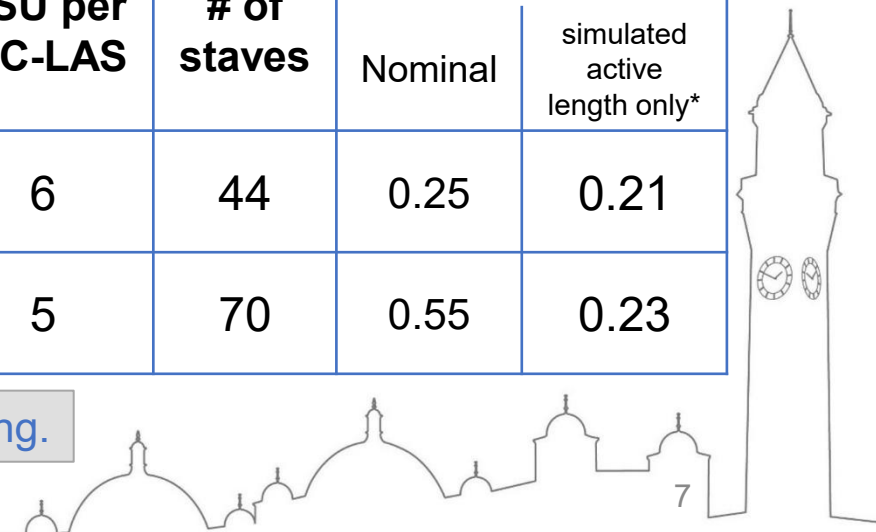
- Layer radii (**η coverage**)
- Castellations spacing (**Φ & η coverage**)
- Number of staves (**Φ coverage**)



[Also see](#)

Layer	Radius (mm)			Stave Length (mm)			Modules per stave	RSU per EIC-LAS	# of staves	x/X ₀ (%)	
	Nominal	Design CoM (Inner/Outer)	Design Range	Nominal	Design Overall	Design Active				Nominal	simulated active length only*
L3	270	265 (262/268)	257-273	540	550	503	4	6	44	0.25	0.21
L4	420	420 (417/423)	412-428	840	840	793	8	5	70	0.55	0.23

* slight underestimate, some materials will be missing.

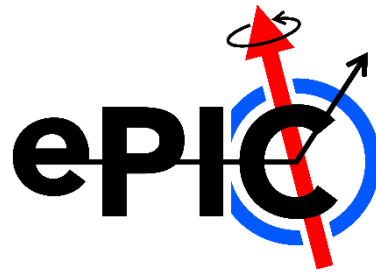


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OB modules

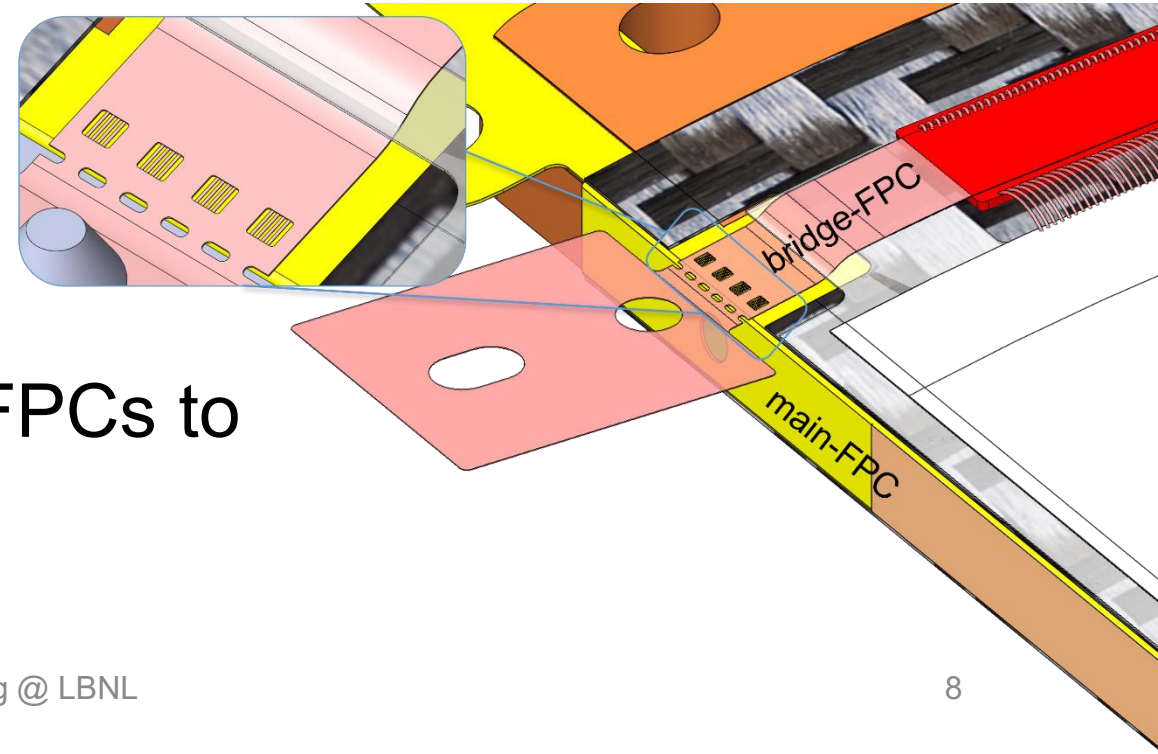


An OB module consists of:

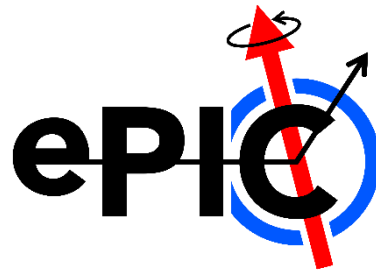
- 2 EIC-LAS
- 2 AncASIC (1 per EIC-LAS)
- Module carrier/bridge-FPC

These are to be built and tested as prior to mounting onto staves.

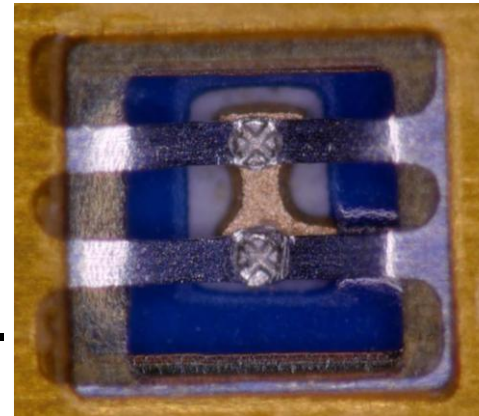
Modules are interconnected via main-FPCs to build groups of 4 EIC-LAS.



OB interconnections



- The OB plan was to use wire bonding to connect both the AncASIC and EIC-LAS to the bridge-FPC.
- Interconnections between bridge- and main-FPCs was to use spTAB (single-point Tape Automated Bonding).
- Bond parameter trials have occurred in the UK.
 - Wire bonding on FPC-like foils.
 - FPC-to-FPC spTAB connections.
 - FPC-to-PCB spTAB connections.
- Suitable bonds have been achieved.
 - In terms of pull strength and data integrity.



[Also see](#)

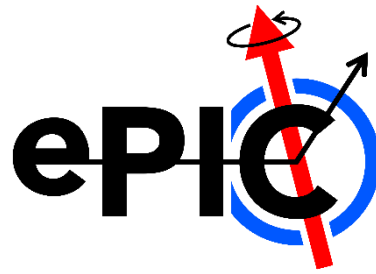


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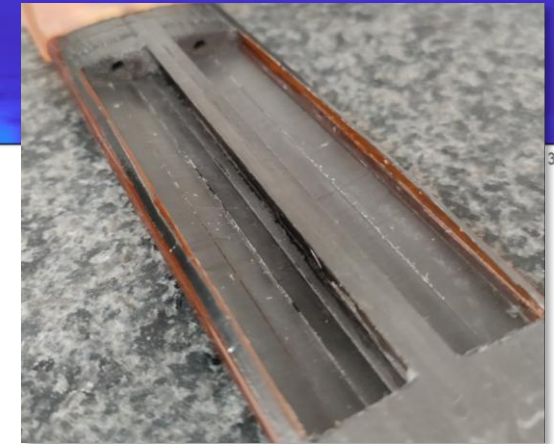
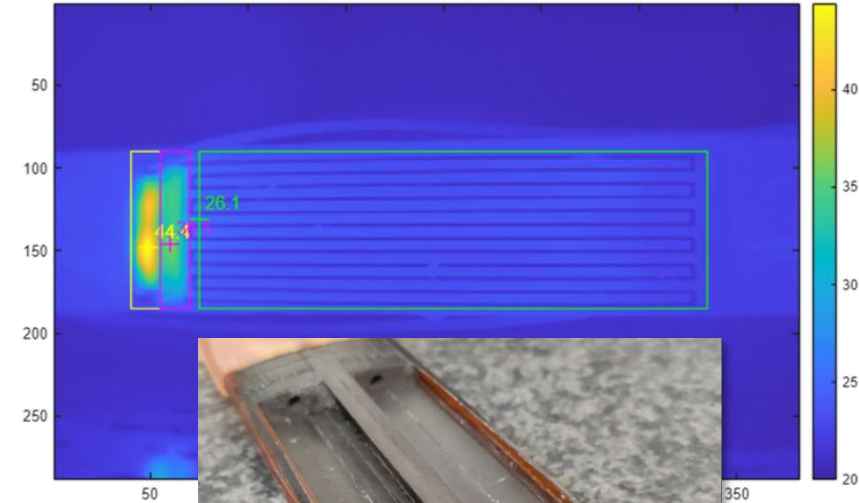
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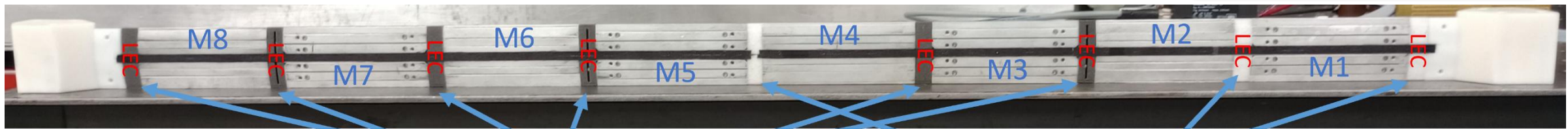
Stave prototyping



- Mechanical stave prototypes have been built and tested.
 - Numerous $\frac{1}{4}$ length L4 staves and one full length L4 stave.
- Vibrations testing showed good alignment with simulations
- Thermal module plates included for thermal tests.
 - Cooling performance characterised against air flow.



[Also see](#)



K9 cross-ribs

Non-conductive cross-ribs



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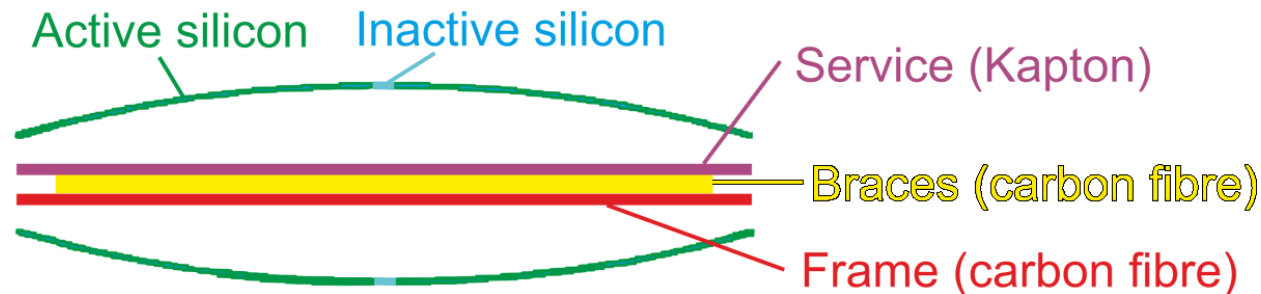
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10

Realistic staves in simulations

Work has progressed over a couple of years:

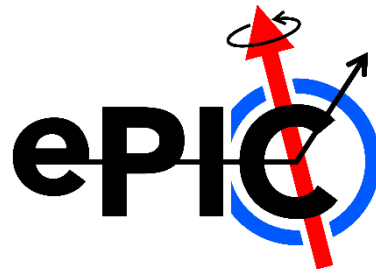
- Converting full CAD models for use with dd4hep.
- Building (simulation) native geometries to match the (CAD-based) material maps.
- Implementing staves with active surface alternating between the top and bottom surface.
- Implementing curved active surfaces.



[Also see](#)

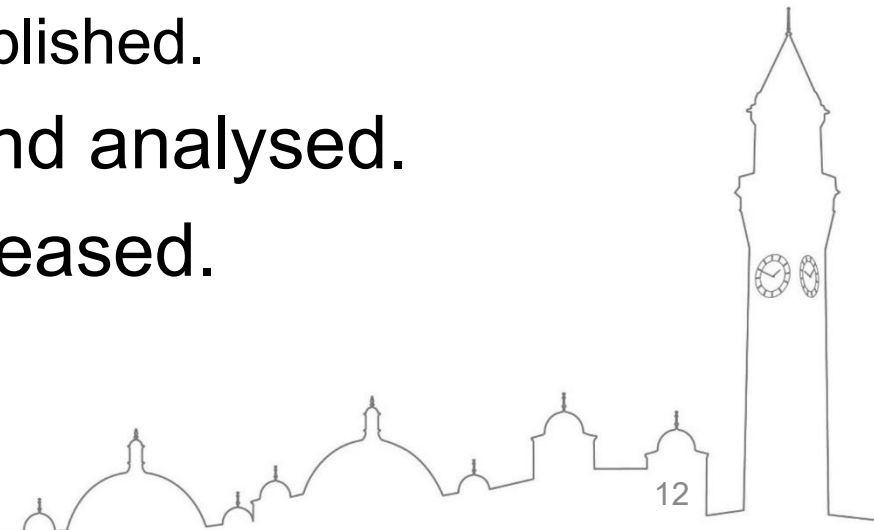


OB Summary

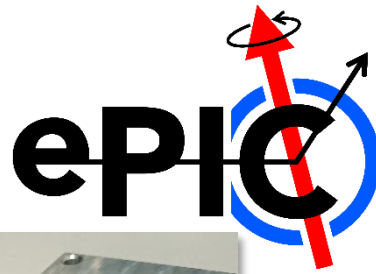


Designs for the OB layers have been put together over the last 4 years. This includes:

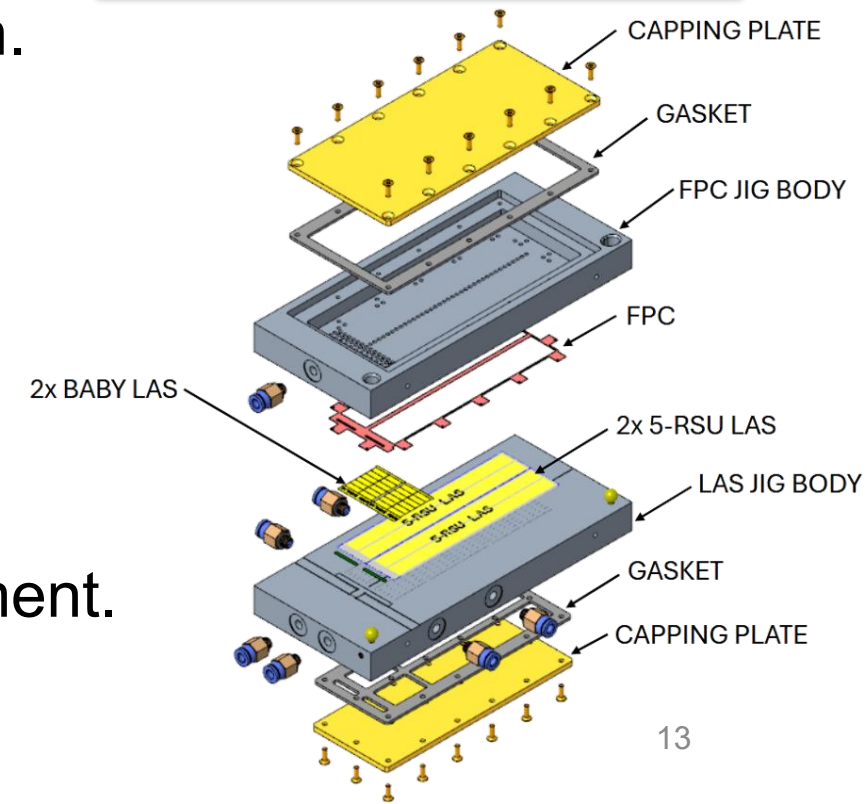
- Sensors dimensions (# of RSUs needed).
- Full η coverage along a stave.
- Full Φ coverage with a castellated stave layout.
- OB modules have been developed.
 - Interconnection procedures have also been established.
- Thermomechanical staves have been built and analysed.
- Simulation geometry realism has greatly increased.



The UK situation

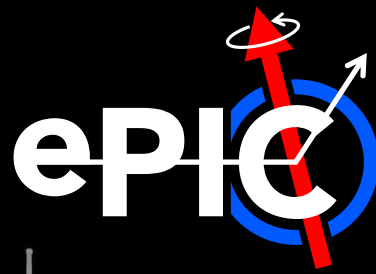


- The UK situation has been a stumbling block.
- Despite that the UK-community are eager to assist where they can:
 - Module assembly tooling is in-hand, trials of assembly procedures can and will be undertaken.
 - Bonding and interconnection trials can continue, as can supporting other sites on their own bonding set-ups.
 - Be that wire bonding or spTAB.
- Current prospects enable some support for the next 12 months.
 - Looking for options to maintain a longer involvement.



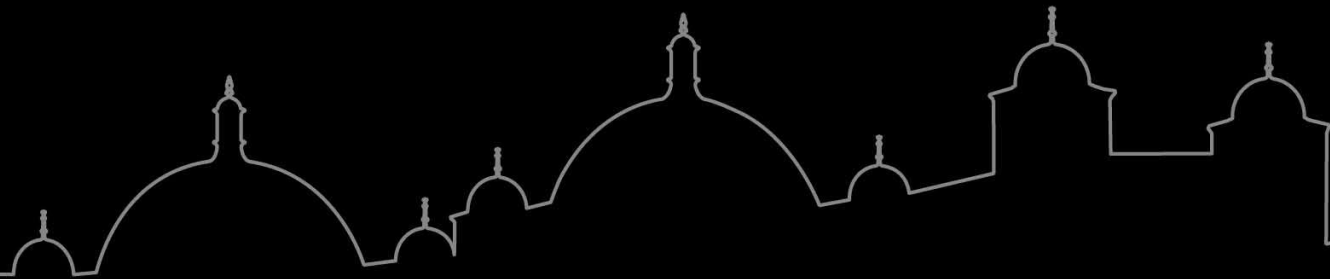


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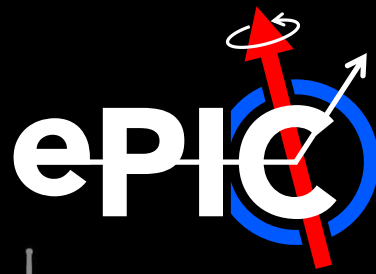
Thank you very much!

Any questions?





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Additional (support) slides

