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U.S. DEPARTMENT OF ENERGY

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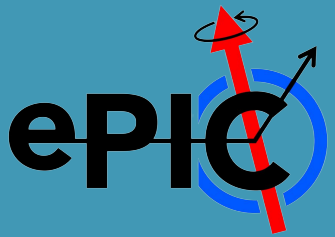
Cone design and interfaces

SVT Working Meeting at Oxford

2025-12-17

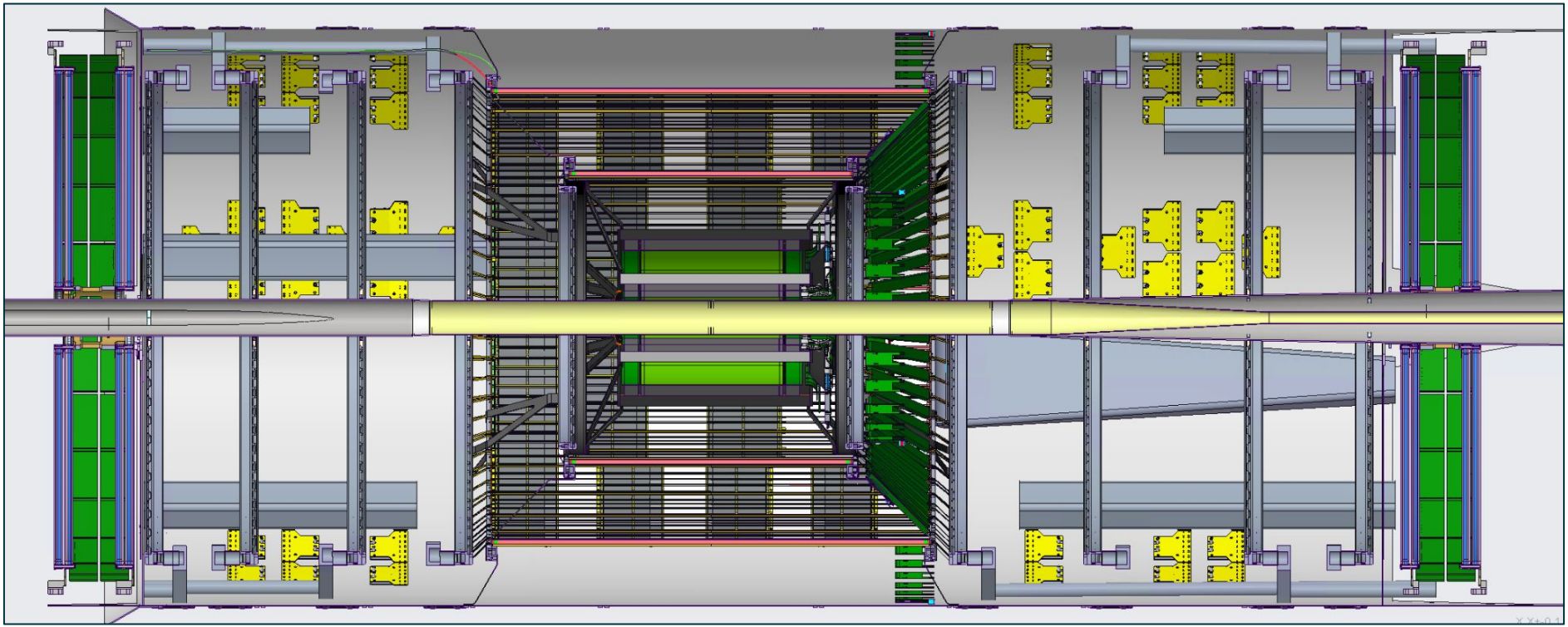
Joe Silber (LBNL) - mechanical engineer, presenting

Elaine Buron (LBNL) - CAD design



Current CAD model

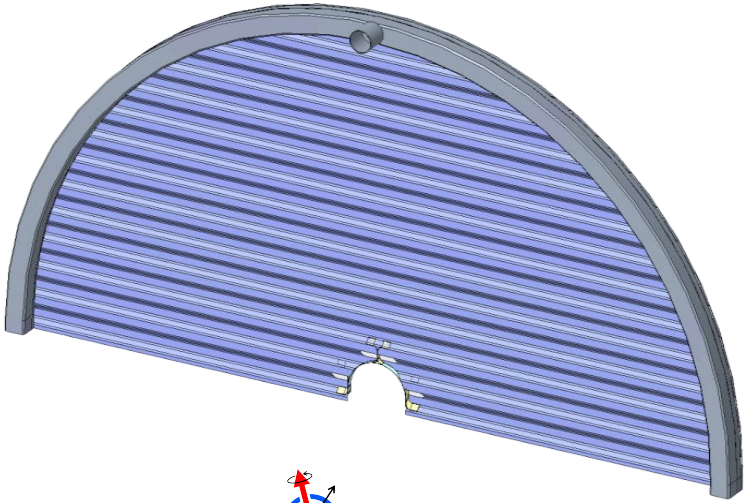
(SVT team's Nov 2025 snapshot + some new LBNL stuff for Dec)

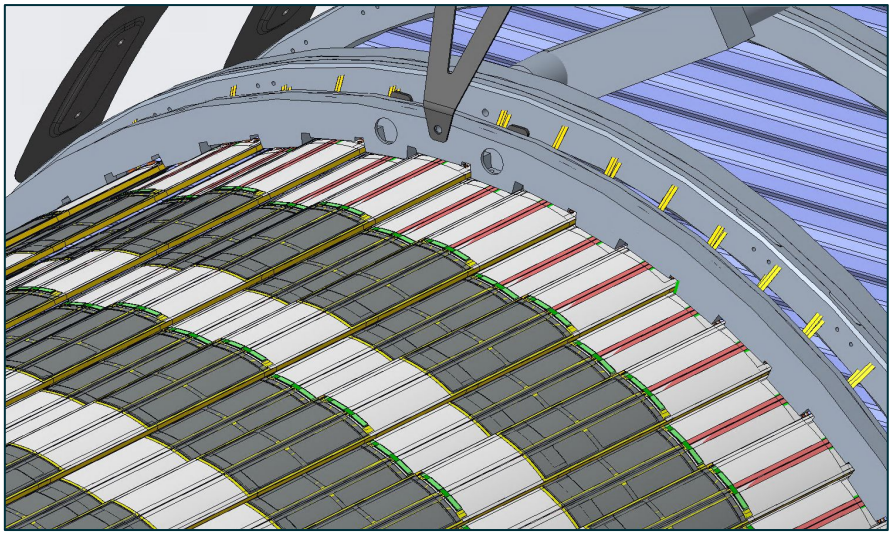


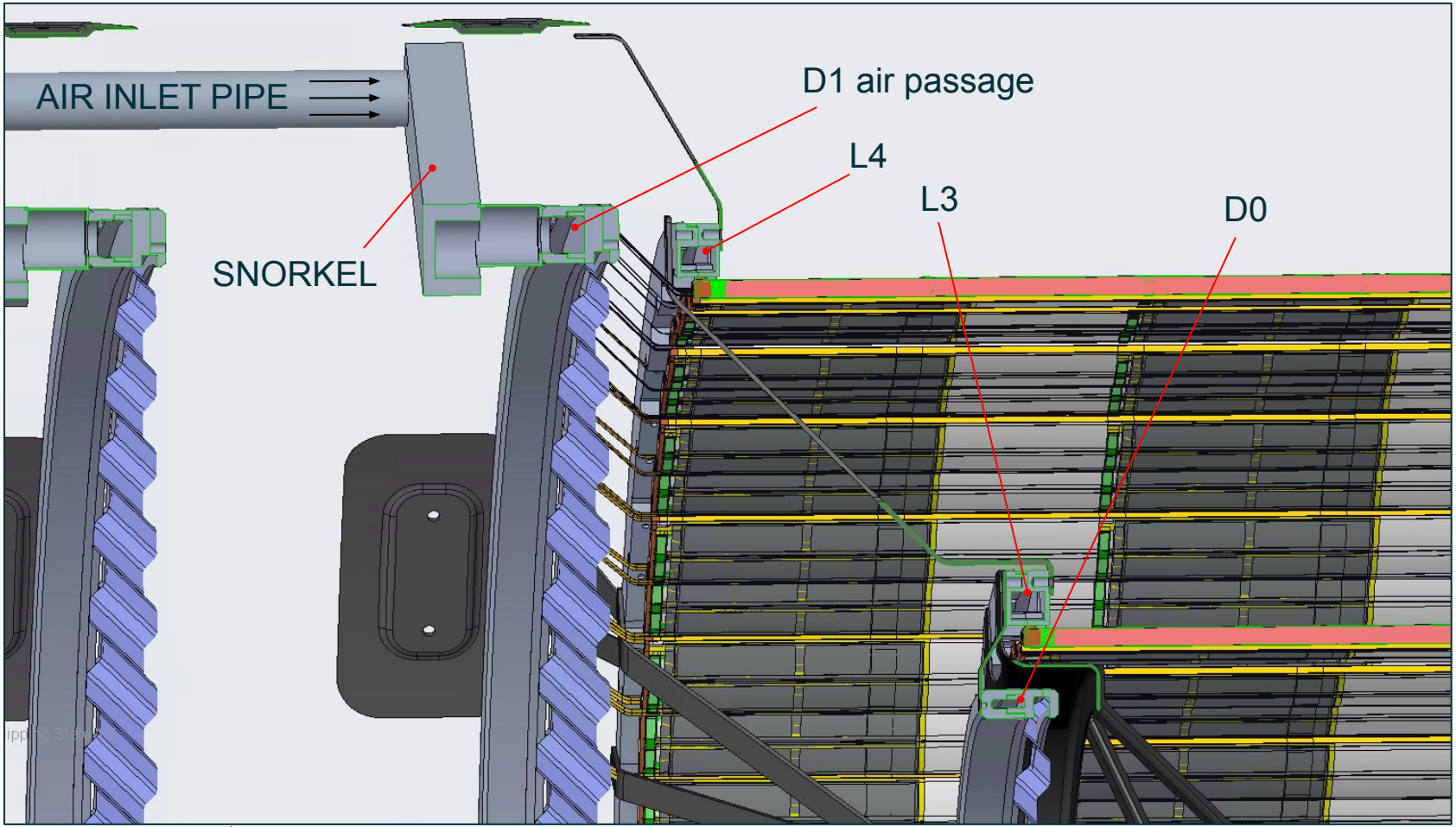
Rims support each disk or outer barrel layer

Rims are:

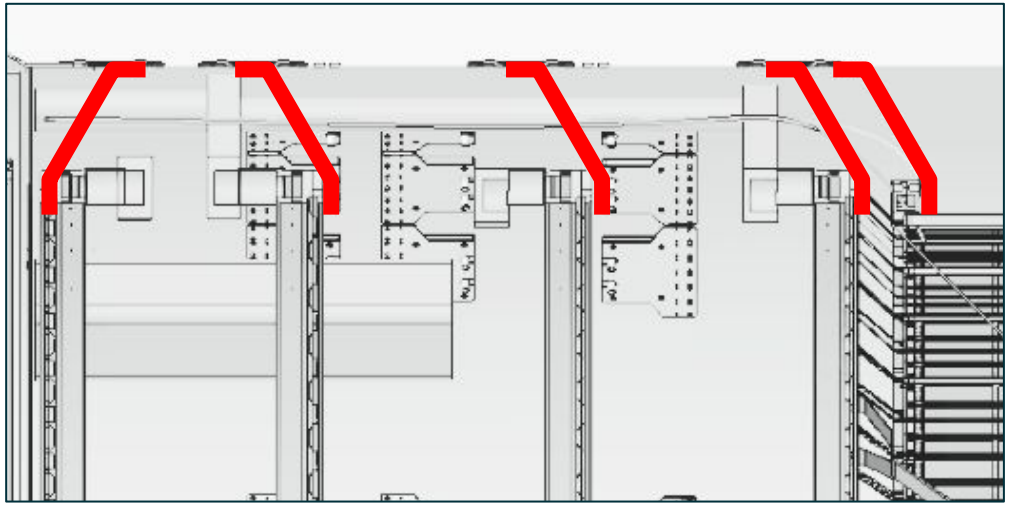
- Stiff
- Held at 3 points
- Air manifold for many corrugations or staves
- Always a half circle

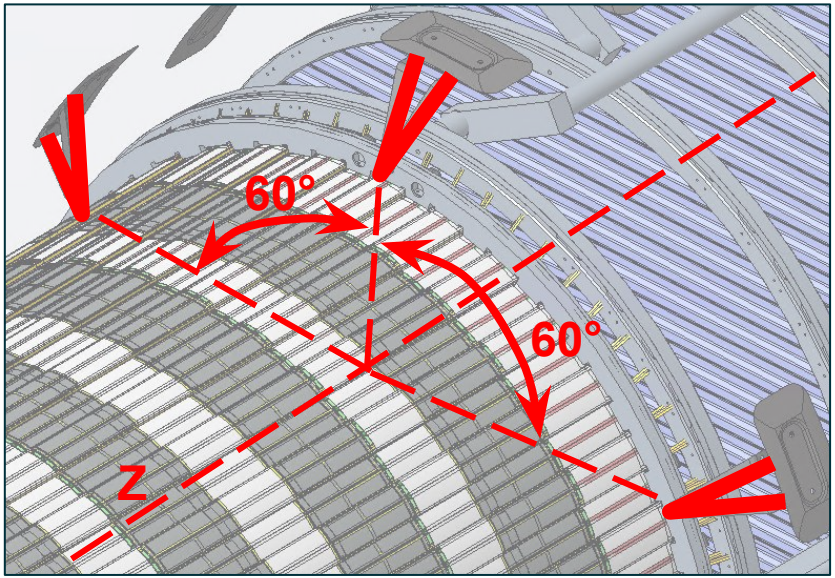




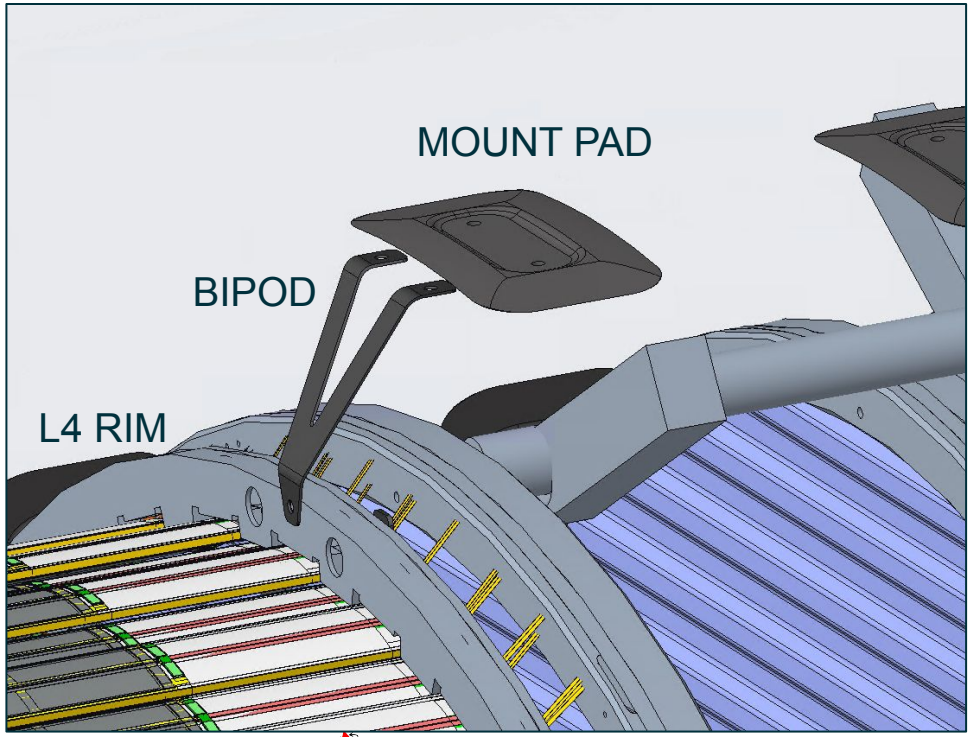

AIR INLET PIPE
D1 air passage
L4
L3
D0
SNORKEL

Bipods support large disks and L4

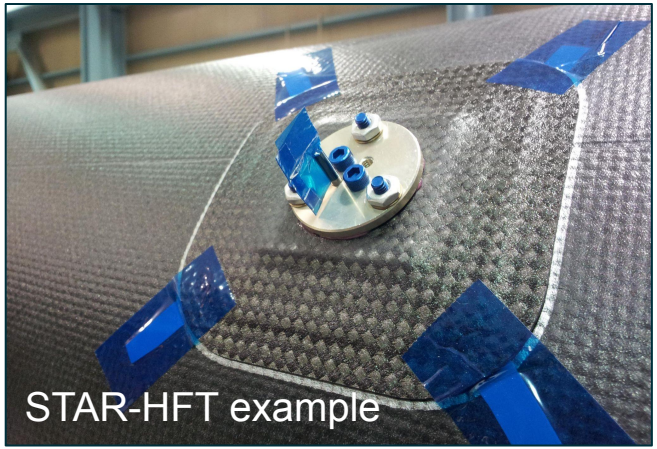




Mount pads are glued to outer surface of PST

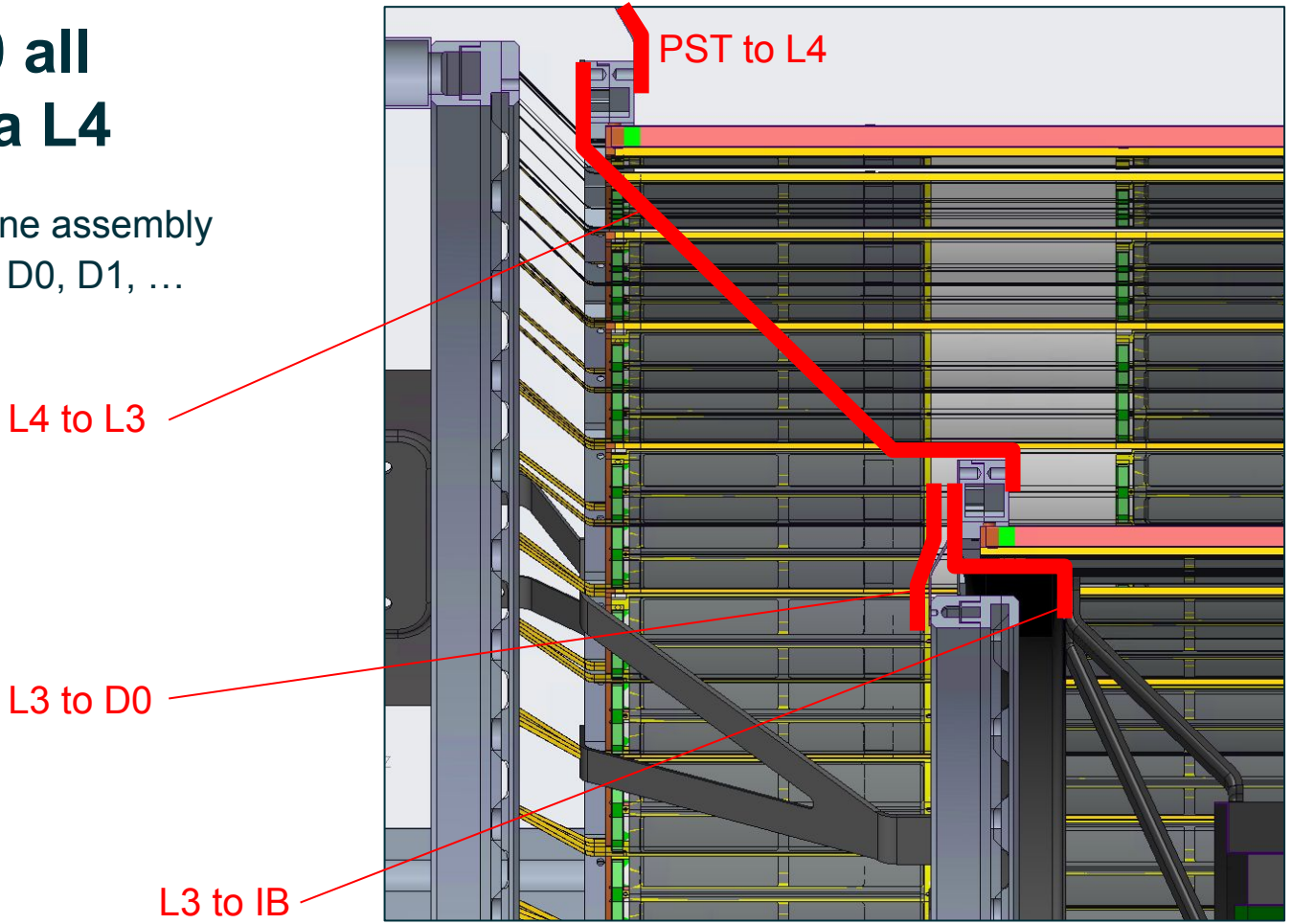


- Mount pads based on heritage designs from STAR-HFT, ATLAS
- 3 bipods per half-rim approximates kinematic support, while allowing some Z flexure
- No structural analysis done yet, just laying out the concept in CAD

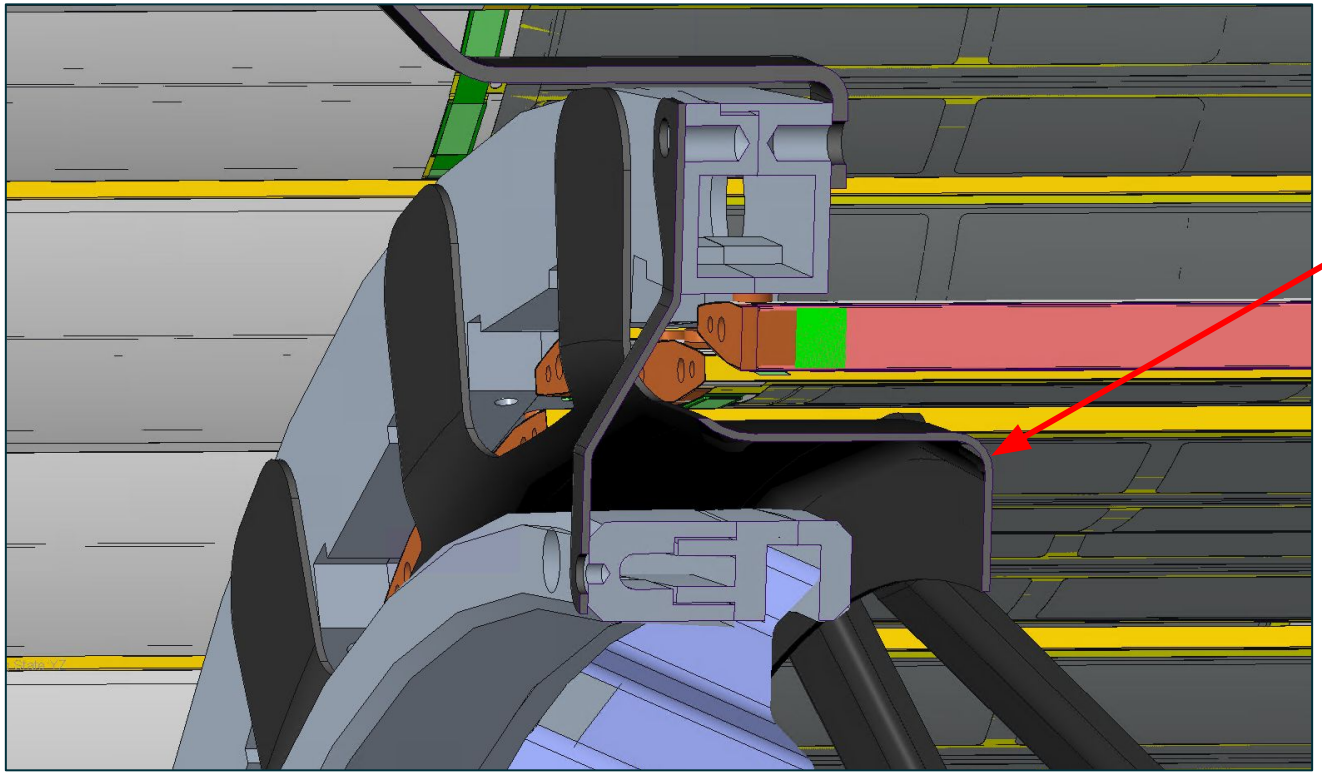


L0-L3 and D0 all supported via L4

This allows the baseline assembly sequence: L4, L3, IB, D0, D1, …

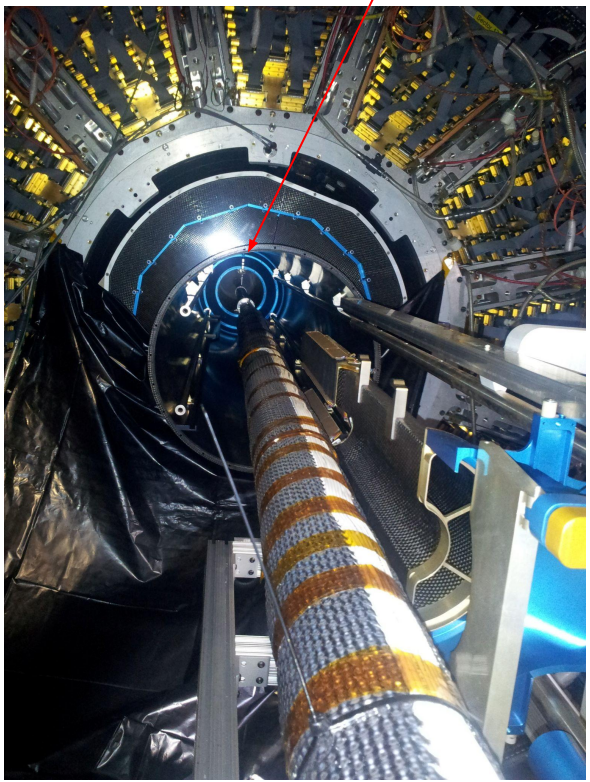


IB-L3 Support protects L3 staves when installing Inner Barrel services



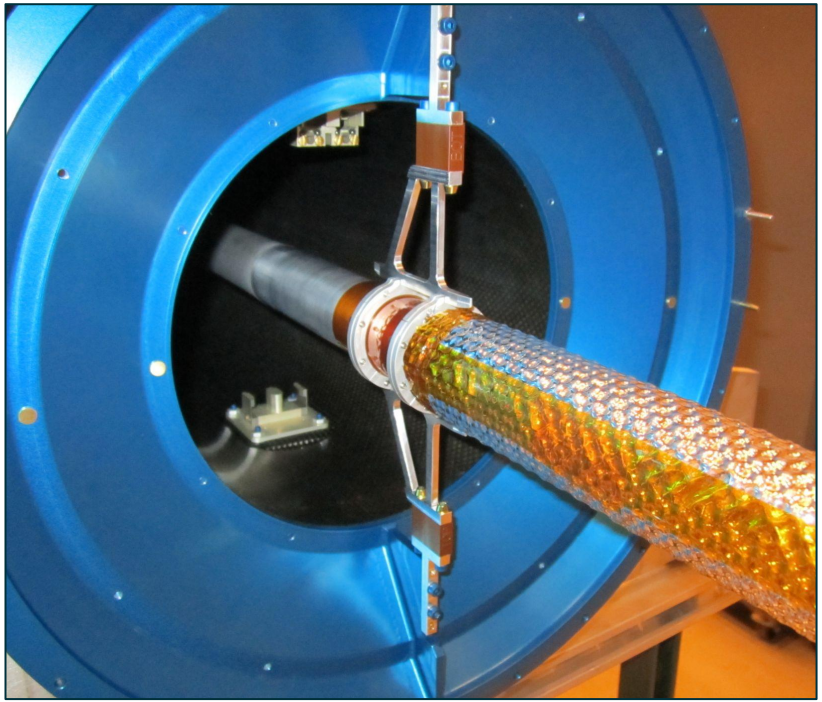
Structural support - Beampipe @ low |Z|

- Not yet provided at low |Z|
- Experience with STAR HFT and similar systems suggests we will likely need it
- Beampipes and detector structures are relatively long and compliant
- Presume they will each deflect something like ~3-4 mm
  - SVT nominal radial gap between BP and L0 is only 5.65 mm
  - That gap also must fit bakeout insulation
- Deflected shapes will be different, as well as orientation-dependent
  - SVT assembly sequence includes a 90° rotation about Z
- Therefore
  - I think we should baseline mechanically coupling BP to the small disks
  - Simple support (radial forces, not axial, not bending moments)
  - Possibly the large disks, too
- Whose scope to design?
  - Purdue - already designing BP supports at high |Z|
  - LBNL - naturally fits with cone supports design task

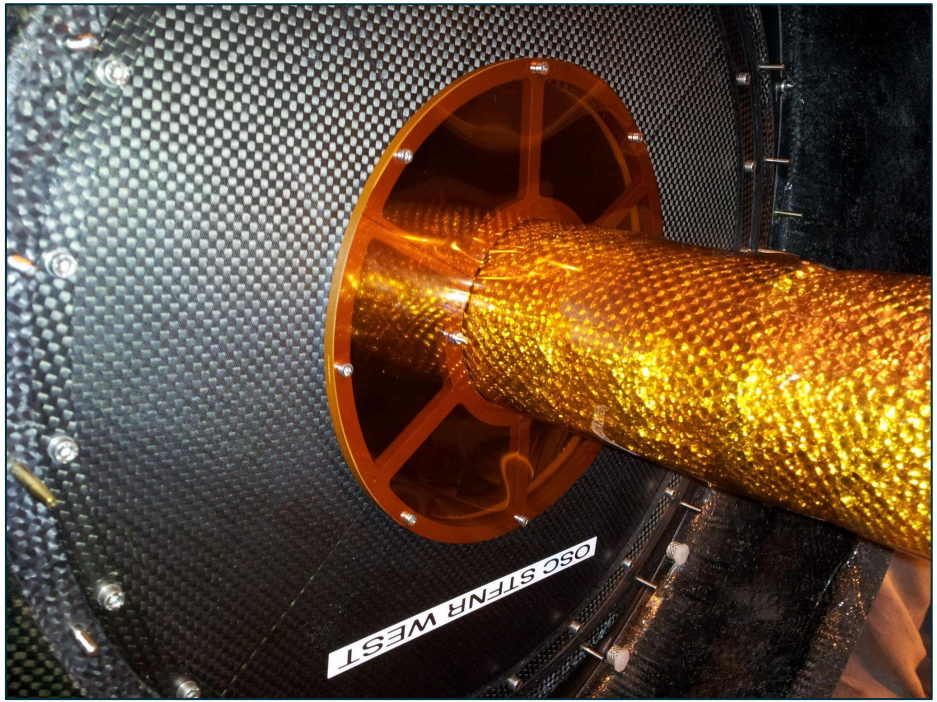


STAR-HFT beampipe supports

inner

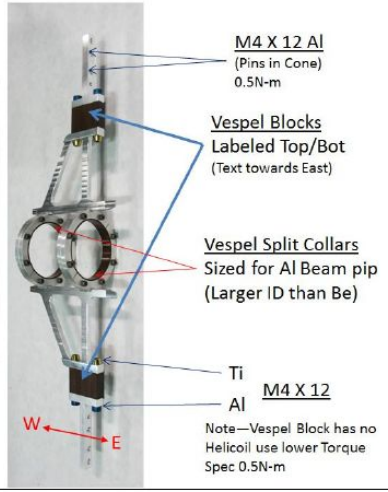


outer



From STAR-HFT's IDS assembly procedure doc (v1.0, 2012)

Step	0	Attach BP collars to BP



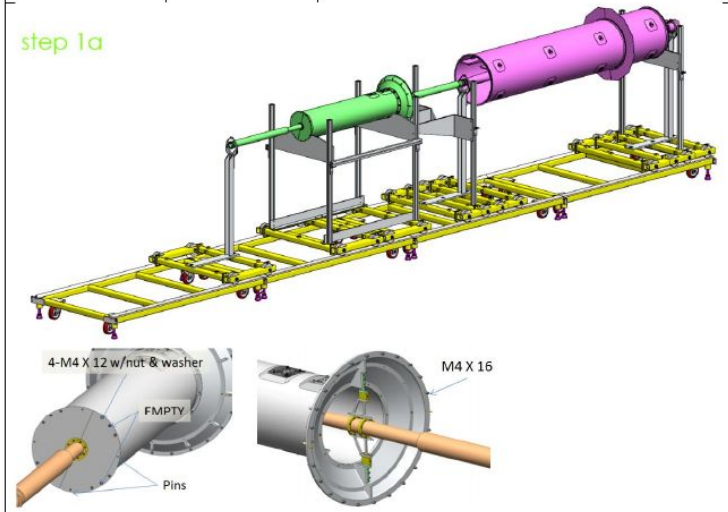
Description

Collar Assembly on Beam Pipe

Procedure

Collars assembled on Beam pipe—split rings sized for either Be or Al (two for Al are larger in diameter). May need to shim with Kapton film to get to size—can refabricate split rings with better measurement (record diameter on build). Note bolt heads face away from IP
Torque for these Ti fasteners is 0.5N-m

Step	1a	Berylium Beampipe Mounted in PST



Description

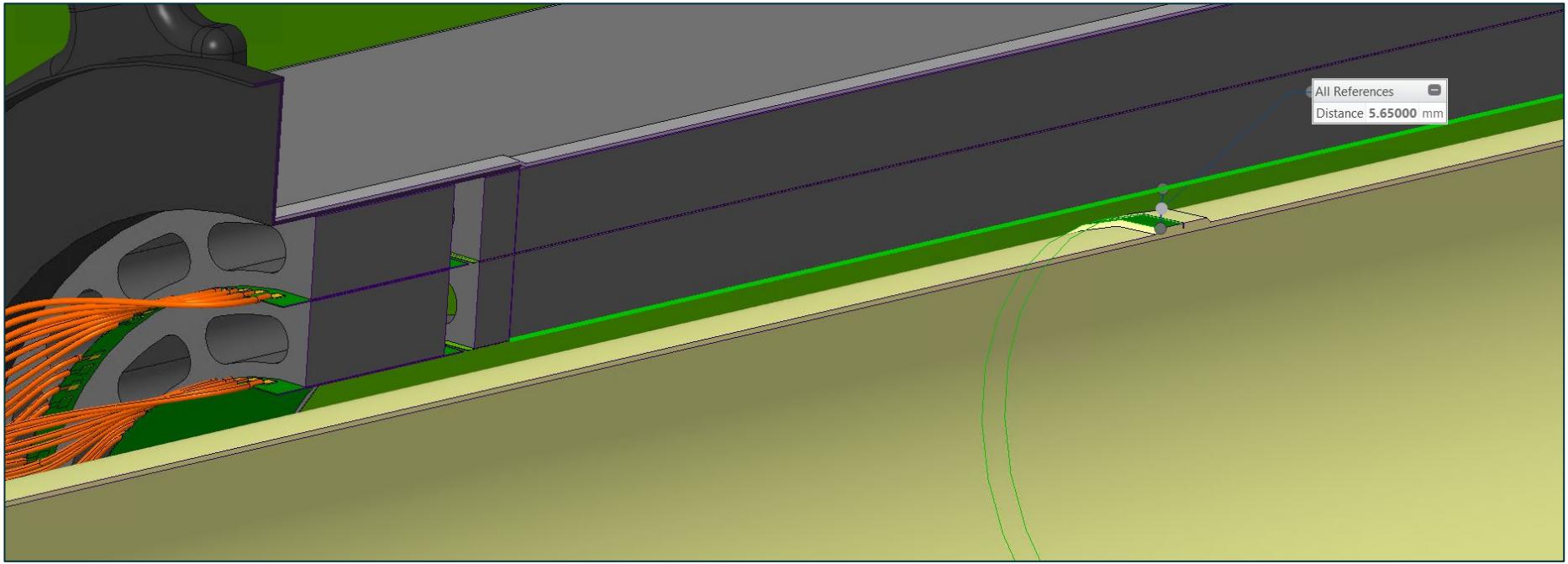
PST and inner beampipe pre-asembled. Introduce PIT and east BP extension.

Procedure

Fastener lengths indicated. Install with nut and washer. On West BP Support Plate, note skipped holes; nut and washer installed on flange side, with bolt head on plate. On Cone, to PST, install M4 X 12 with washer. Outer radius will use M4 X 16. Washer on Nut side, opposite Al part (washer on composite PIT flange)

Beampipe / Inner Barrel gap questions

1. Do we need to flow air to this gap for beampipe bakeout?
2. Do we have a definition yet how thick the insulation on the pipe will be?



ePIC SVT - cooling system diagram

Rev	Date	Author	Description
v1	2025-12-11	Joe Silber (LBNL)	initial release
v2	2025-12-12	Joe Silber (LBNL)	add liquid system
v3	2025-12-16	Joe Silber (LBNL)	space out e-/hadron & top/bottom

Nomenclature

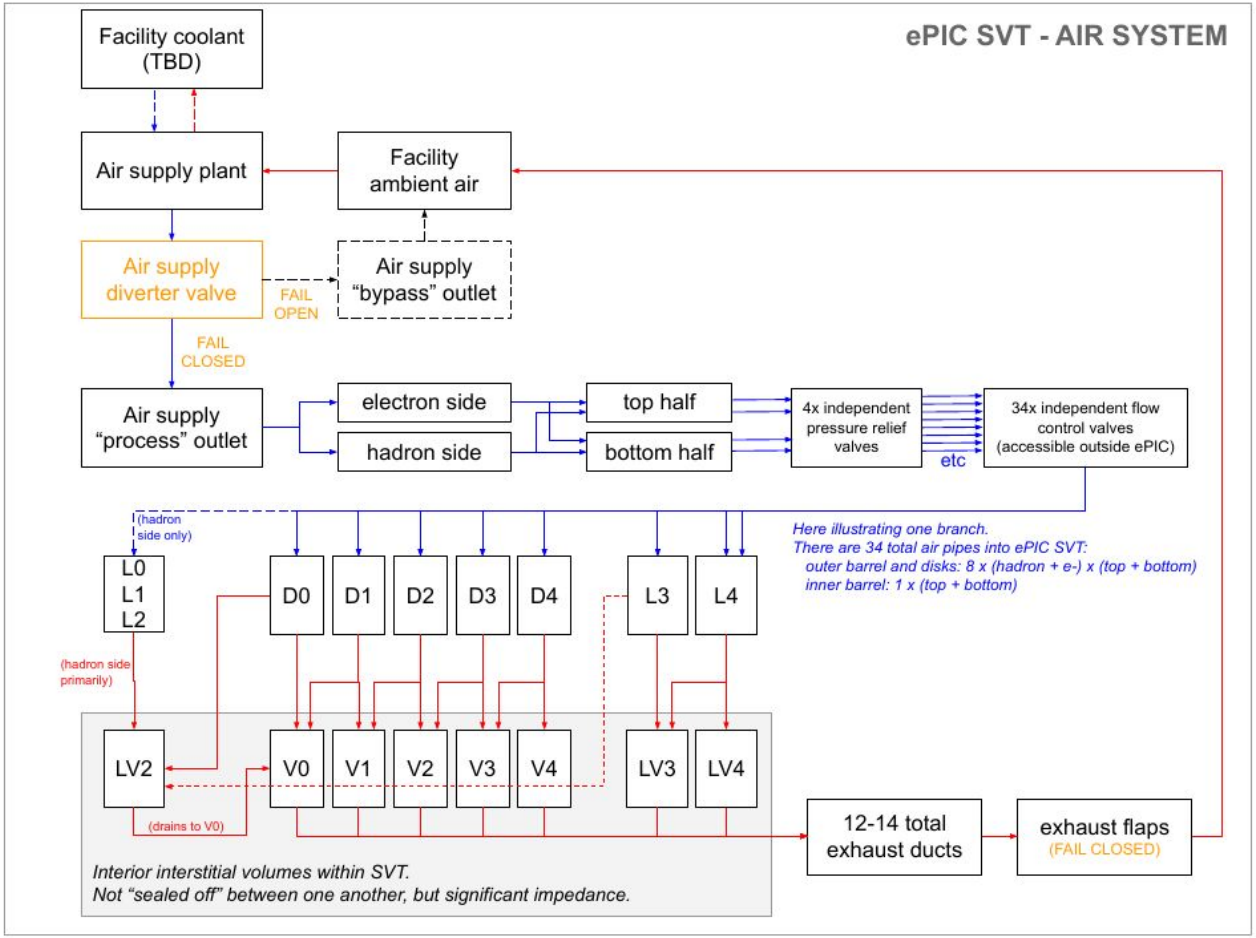
SVT … Silicon Vertex Tracker
TBD … To Be Determined
L# … Barrel layer IDs
D# … Disk IDs
V# … Disk interstitial volume IDs
LV# … Barrel layer interstitial volume IDs
SCB … Segment Control Board
CB … Control Board

Notes

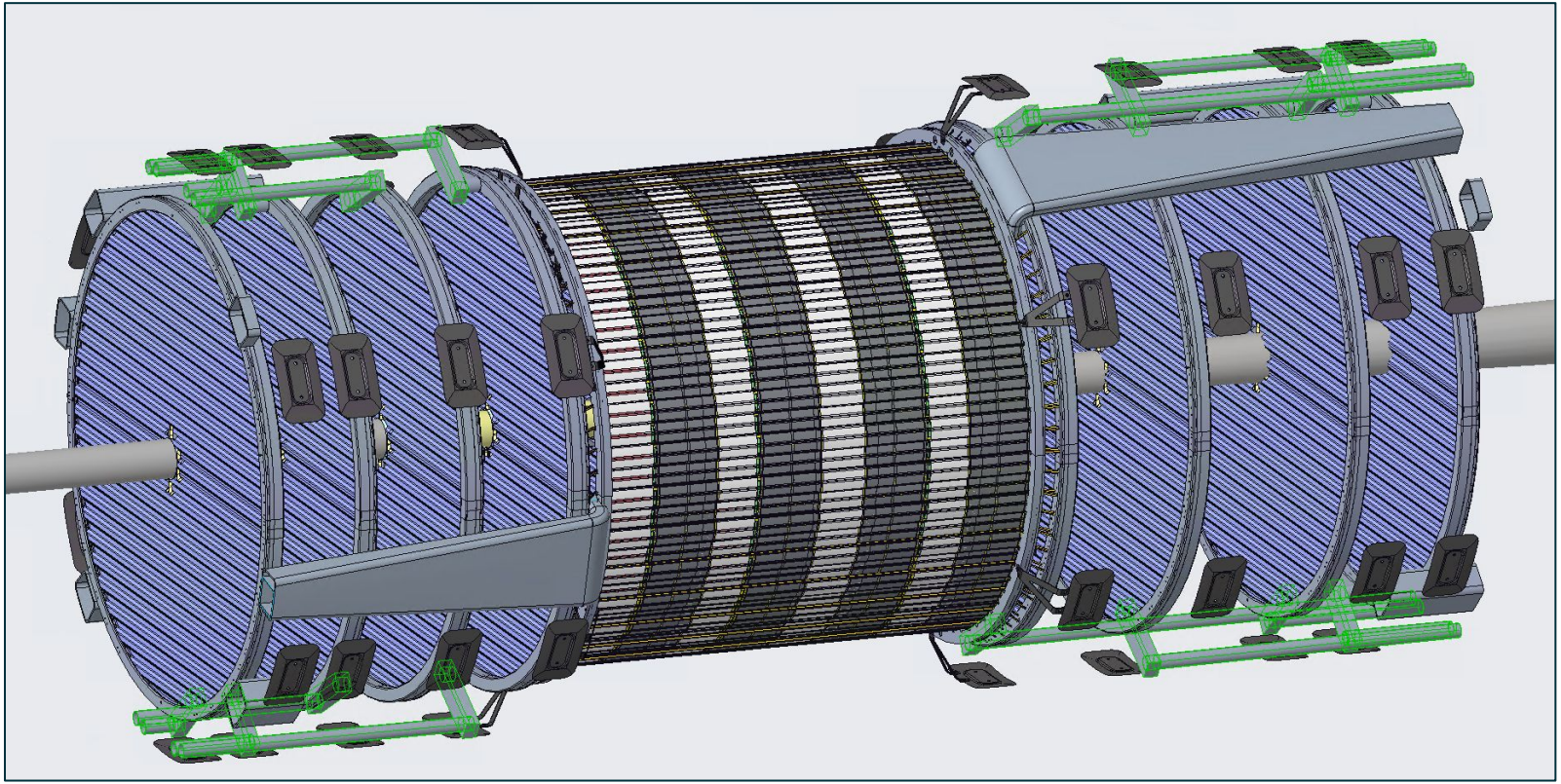
1. Graphical elements not intended to follow any standard.
2. Color-coding consistency not guaranteed.

References

1. Live editable version of this document
2. ePIC SVT interior air volumes diagram
3. ePIC SVT cooling air flow stages



Air supply pipes



Air exhaust

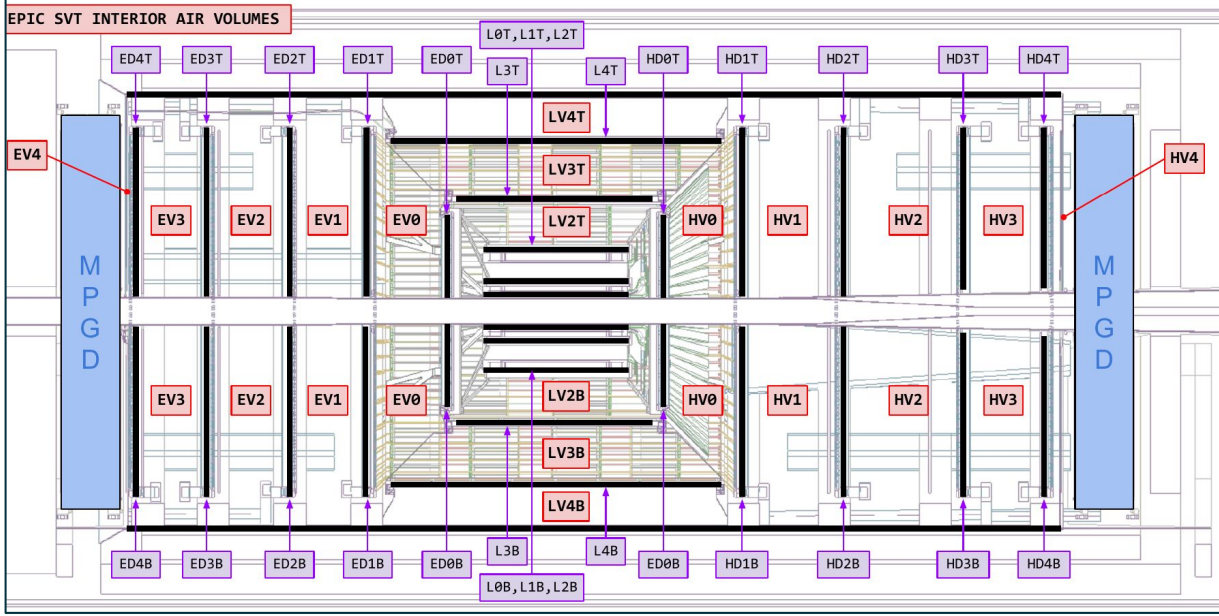
- Exhaust via 12-14 ducts
- Duct hydraulic ∅62 mm
  - I.e. much greater cross-section than input pipes (4 x ∅50 mm)
- Ducts draw from interior volumes (see diagram)
- These volumes aren't "sealed" from each other, but significant impedance
- Suction could be done but prob not necessary
- Flapper valves at outlets to prevent ingress when flow off

ePIC SVT - interior air volumes diagram

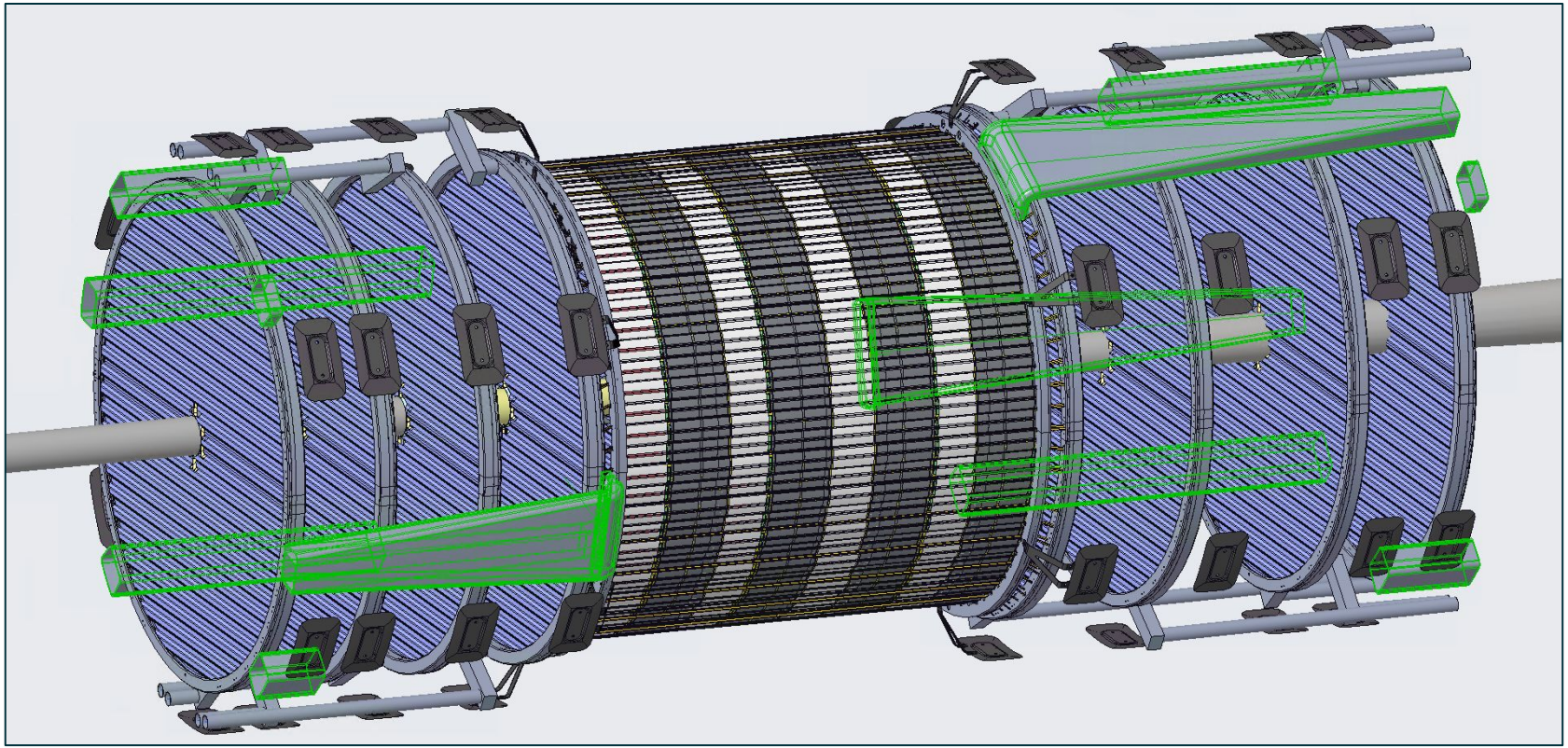
Rev	Date	Author	Description
v1	2025-12-11	Joe Silber (LBNL)	initial release

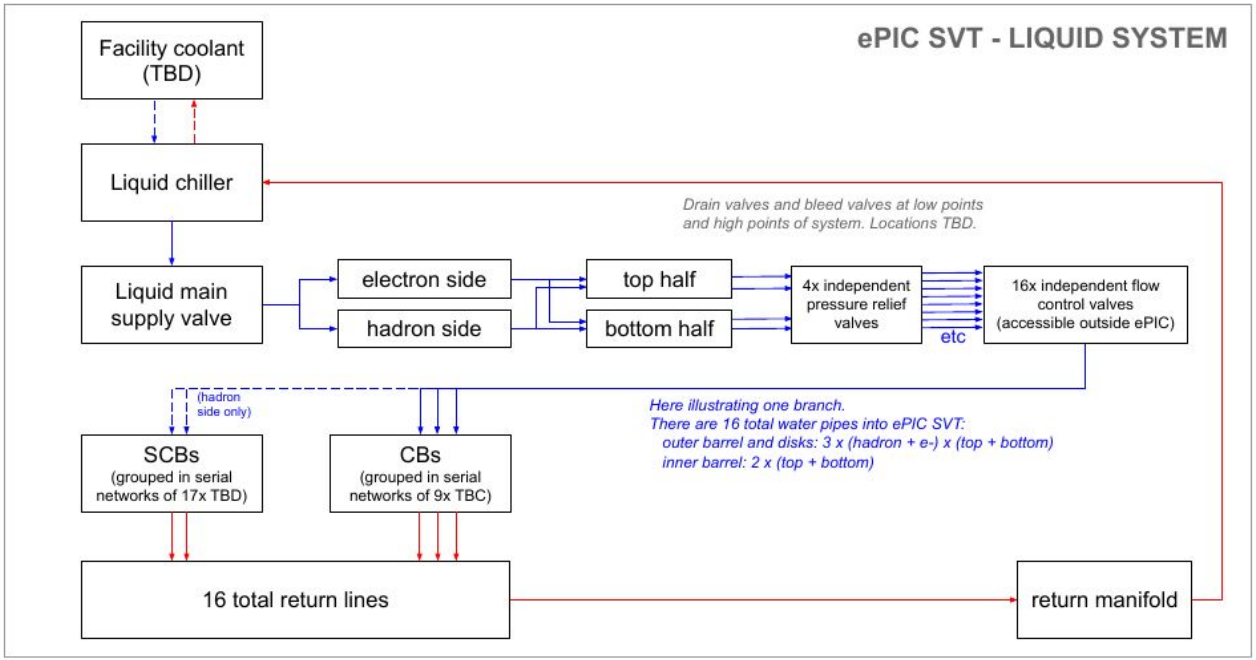
Notes
1.

References
1. Live editable version of this document
2. ePIC SVT cooling system diagram
3. ePIC SVT cooling air flow stages



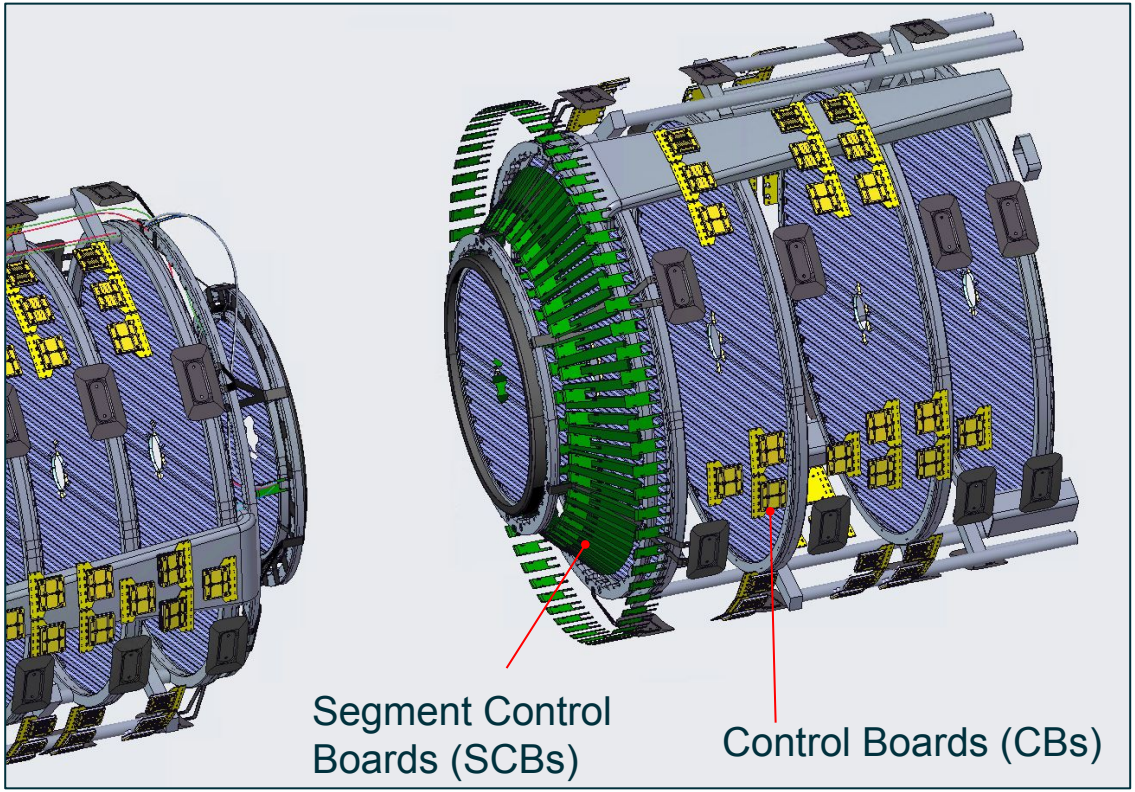
Air exhaust ducts




ePIC SVT - LIQUID SYSTEM
Facility coolant (TBD)
Liquid chiller
Drain valves and bleed valves at low points and high points of system. Locations TBD.
Liquid main supply valve
electron side
hadron side
top half
bottom half
4x independent pressure relief valves
etc
16x independent flow control valves (accessible outside ePIC)
(hadron side only)
Here illustrating one branch.
There are 16 total water pipes into ePIC SVT:
outer barrel and disks: 3 x (hadron + e-) x (top + bottom)
inner barrel: 2 x (top + bottom)
SCBs (grouped in serial networks of 17x TBD)
CBs (grouped in serial networks of 9x TBC)
16 total return lines
return manifold

Liquid cooling of CBs and SCBs

- Current thought is to group CBs into serial cooling chains of ~9x
  - i.e. 12x such networks
  - assemble and test a network outside detector, prior to assembly
  - still working on patterning
  - might make sense to unify multiple CBs into fewer cold plates
- And group SCBs into networks of 17x
- Very much a work in progress



Power and readout architecture for disks and outer barrel

ePIC SVT - disk and barrel power and readout architecture
Sichtermann, Glover, Silber

Rev	Date	Author	Description
v1	2025-10-09	Joe Silber (LBNL)	imported original diagram from Ernst, added details on sizes, counts, and connection interfaces
v2	2025-10-15	Joe Silber (LBNL)	visual cleanup, approx dims on furcation tubes, power wire pairs, and CB-FIB ribbon
v3	2025-10-16	Joe Silber (LBNL)	incorporated comments from Nikki on barrel vs disk variations; made MFPC and bridge connections more visually clear
v4	2025-12-16	Joe Silber (LBNL)	Added ref links

Nomenclature

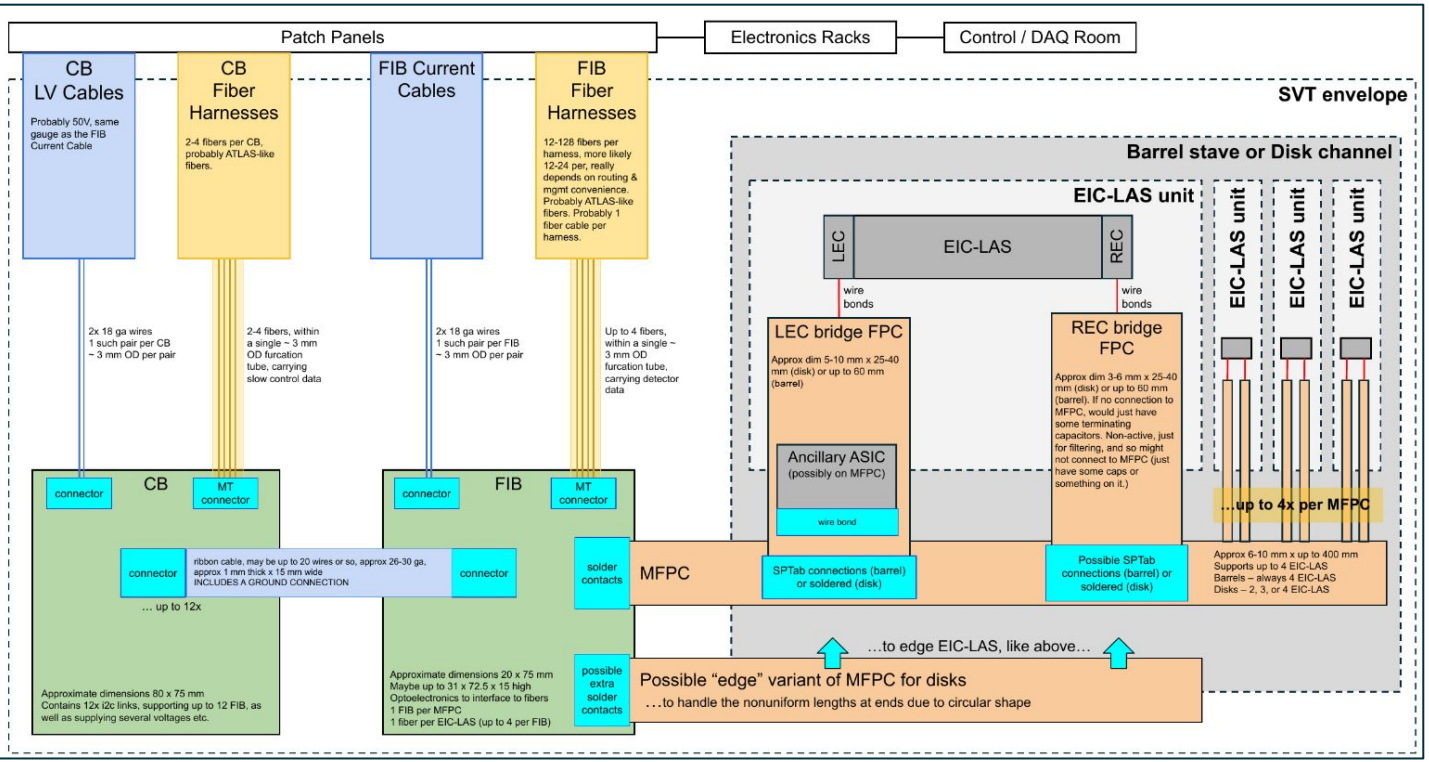
FPC … Flexible Printed Circuit
CB … Control Board
FIB … FPC Interface Board
LV … Low Voltage
MFPC … Main FPC
BFPC … Bridge FPC
SPTab … bonded overlapping Al/Kapton

Notes

1. Not to scale.
2. Color-coding consistency not guaranteed.

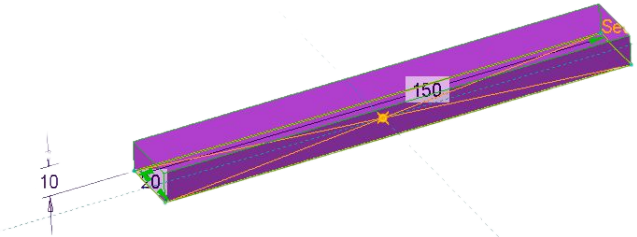
References

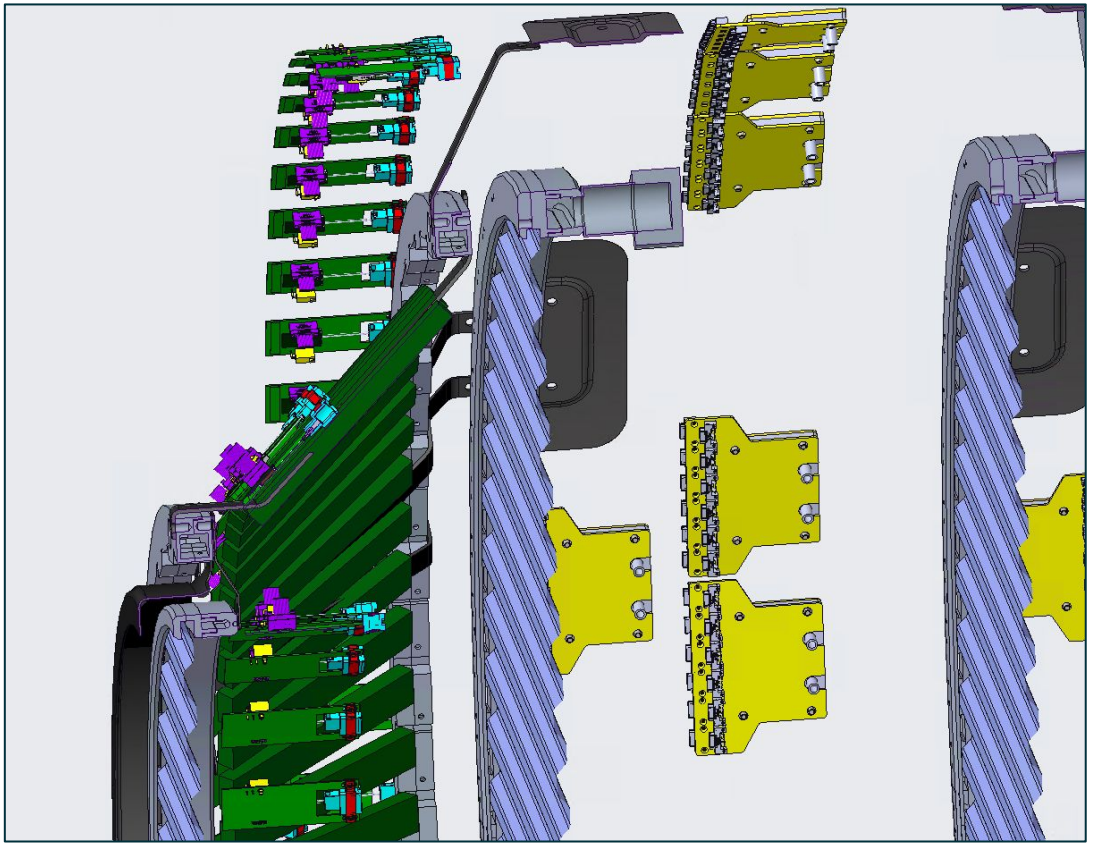
1. Live editable version of this document
2. module drawing from Nikki 2025-08-22



FIBs, CBs and SCBs

- Very much a work in progress
- Don’t take anything in the CAD screenshot at right too seriously
- L4/L3 bipod interlinks may become more cone-like to support boards, TBD
- Except for the SCB envelopes
- We think the following SCB envelope can fit within the cone
  - Yep: L 150 x W 20 x H 10 mm
  - Nope: 220 x 28
- Q: How long could the SCB cables remote from the SIBs?





Interface Control Documents (ICDs)

- We have not been provided a clear mandate or framework for ICDs from the project
- But they will be helpful for us the SVT team to ensure clear understandings between institutions
- Let us be practical and minimally bureaucratic
- Let us focus them internal to SVT only
- I suggest the high value ICDs to develop are:

1. Outer Barrel (UK) / Cones & Services (LBNL)
2. Inner Barrel (INFN) / Cones & Services (LBNL)
3. Global Supports (Purdue) / Cones & Services (LBNL)

These ICDs should state clearly:

- mounting concept
- air connection
- inlet air pressure, velocity, and temperature
- expected pressure drop at nominal velocity
- power dissipated
- where the exhaust air goes
- maximum cable distances to FIB, CB, SCB
- mass estimate
- grounding of…
  - structure
  - cooling pipes
  - active components
- module, stave, segment, and cable counts
- conceptual assembly sequence

And not much more than that.