Status of Environmental monitoring in Pixels Outer Endcap

Dominic Howgill

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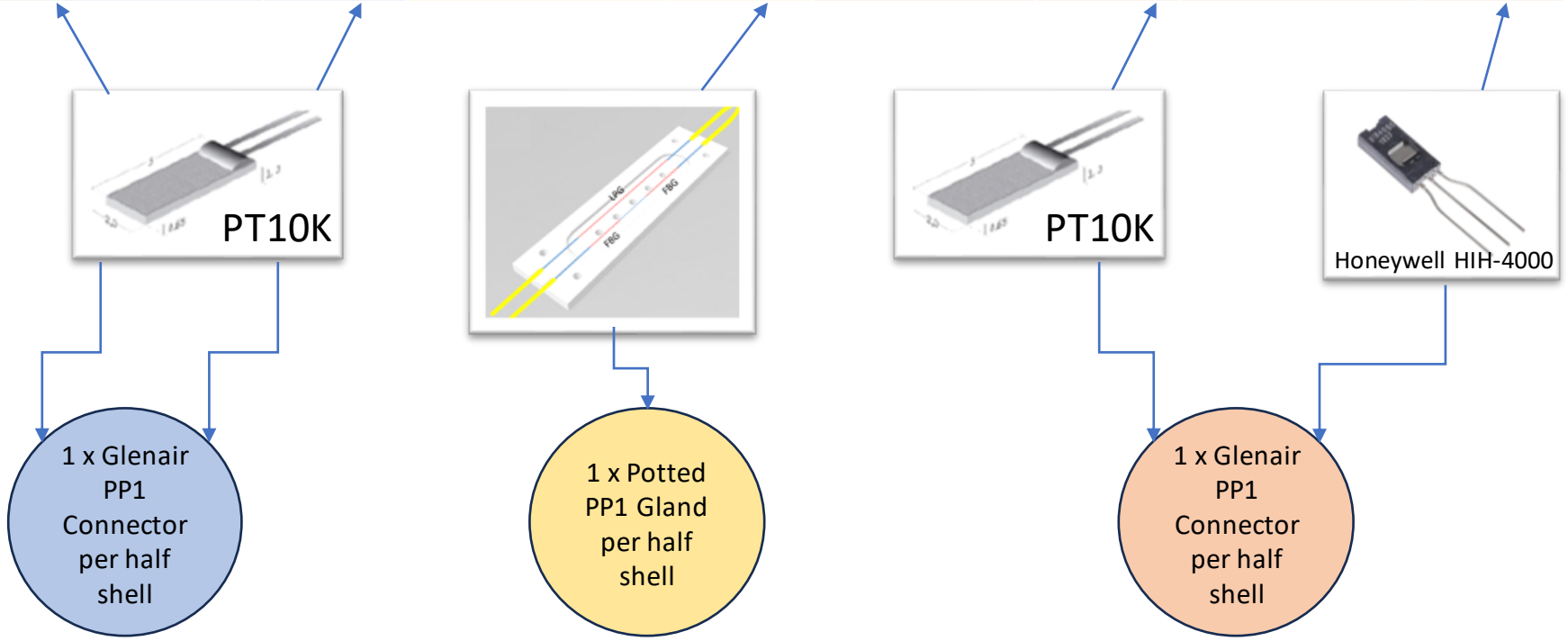
Overview

	Volume T sensors		Cooling T sensors		Humidity Optic fibres		FOS T Sensor		FOS RH sensor	
	half shell	Full shell	half shell	Full shell	half shell	Full shell	half shell	Full shell	half shell	Full shell
layer 4	8	16	9 + 1	18 + 2	0	0	0	0	0	0
layer 3	10	20	9 + 1	18 + 2	0	0	0	0	0	0
layer 2	14	28	9 + 1	18 + 2	3	6	3	6	3	6
Per Endcap		64		54 + 6		6		6		6
Total		128		108 + 12		12		12		12

Quantities

- 128 Volume Sensors
- 108 Cooling Sensors (+ 12 Supply Inlet Sensors - TBC)
- 12 FOS Humidity Sensor packages with associated T and RH sensors.

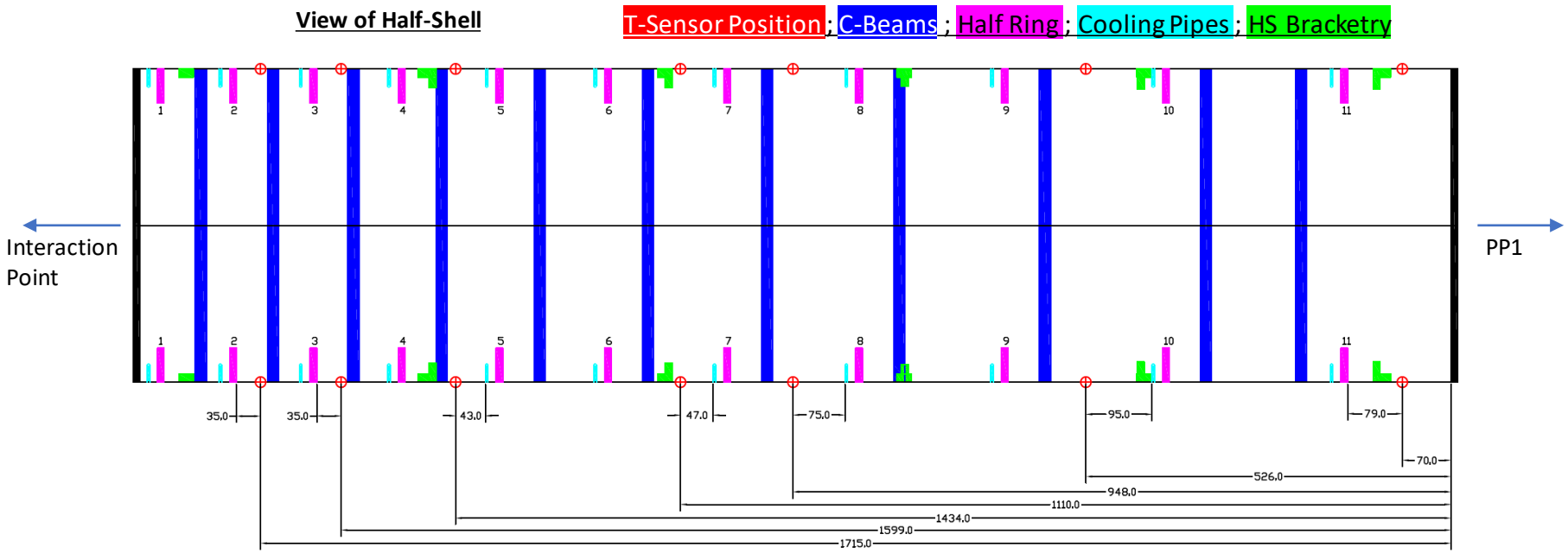


Monitoring Volume

Location

The T-Sensors monitoring the volume are located at the outside edge of each half-shell, approximately in the ϕ position of the half-ring mounting lugs.

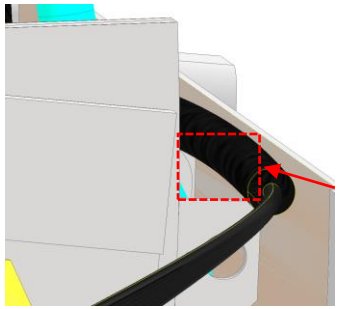
The diagram shows their positions on the layer 2 half shell and their proximity to nearest cold/heat source (Closest: 35mm)



Routing

Cables will be routed along the edge of the half shell, on the outside of the half ring mounting lugs.

The gap is small, but sufficient to allow these cables to run through (including cooling sensor cables)



Space available ~6mm x 4.3mm

View of Ring 11 on L2
From High Z

However: there has been discussion to route the spare data cables in this region as well. These will likely not fit due to very limited space:-

See my presentation detailing the routing restrictions in this region:

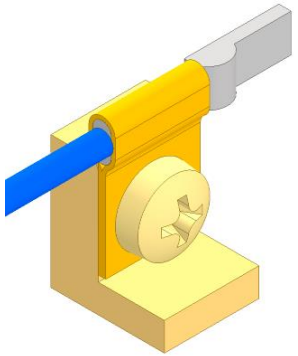
https://indico.cern.ch/event/1361408/

Monitoring Volume

Brackets

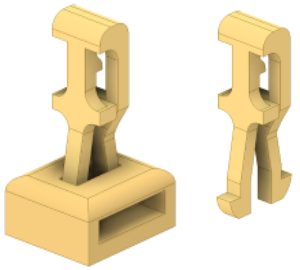
The volume sensors will be mounted on brackets adhered to the CF half shell.

The brackets will hold the sensors approximately 10mm offset from the half shell surface.



Default Option:

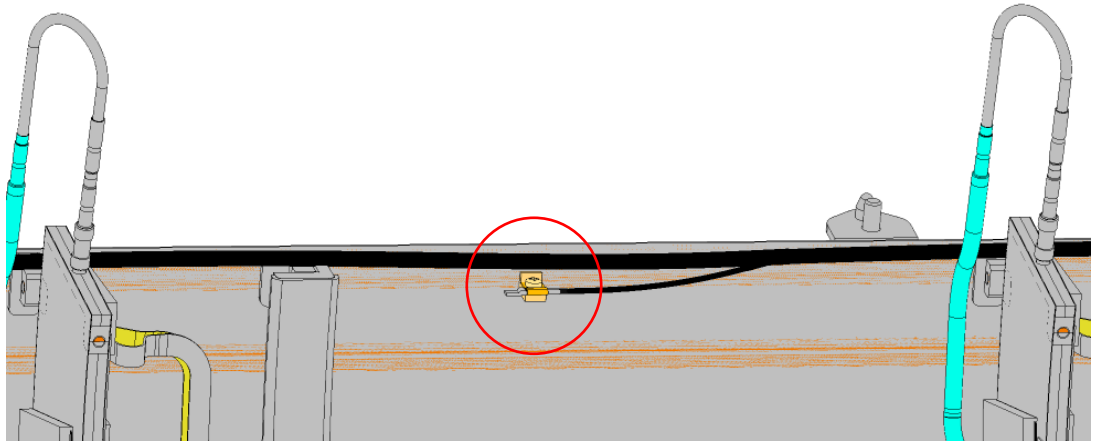
- Machined ULTEM
- Kapton tape
- PEEK screw
- Simple & low mass



Alternative solution:

- 3D Printed PEEK or ULTEM
- Sensor Mechanically held in bracket

See also presentation in this indico page:
https://indico.cern.ch/event/1346626



Progression going forwards

1. Prototyping and testing of T-sensor mounted to bracket

2. Prototyping of cable harness methods

3. Confirmation whether the T sensor will come with heatshrink or without
   - Maintain contact with D. Florez / DCS Team

4. Require updated 3D model to validate positioning (ensure no clashing)
   - Contact with John @ Liverpool / Owen @ Edinburgh

5. Look further into methods to affix the cables to strategic points (services support rings, etc) along the routed path.

Cooling Sensors

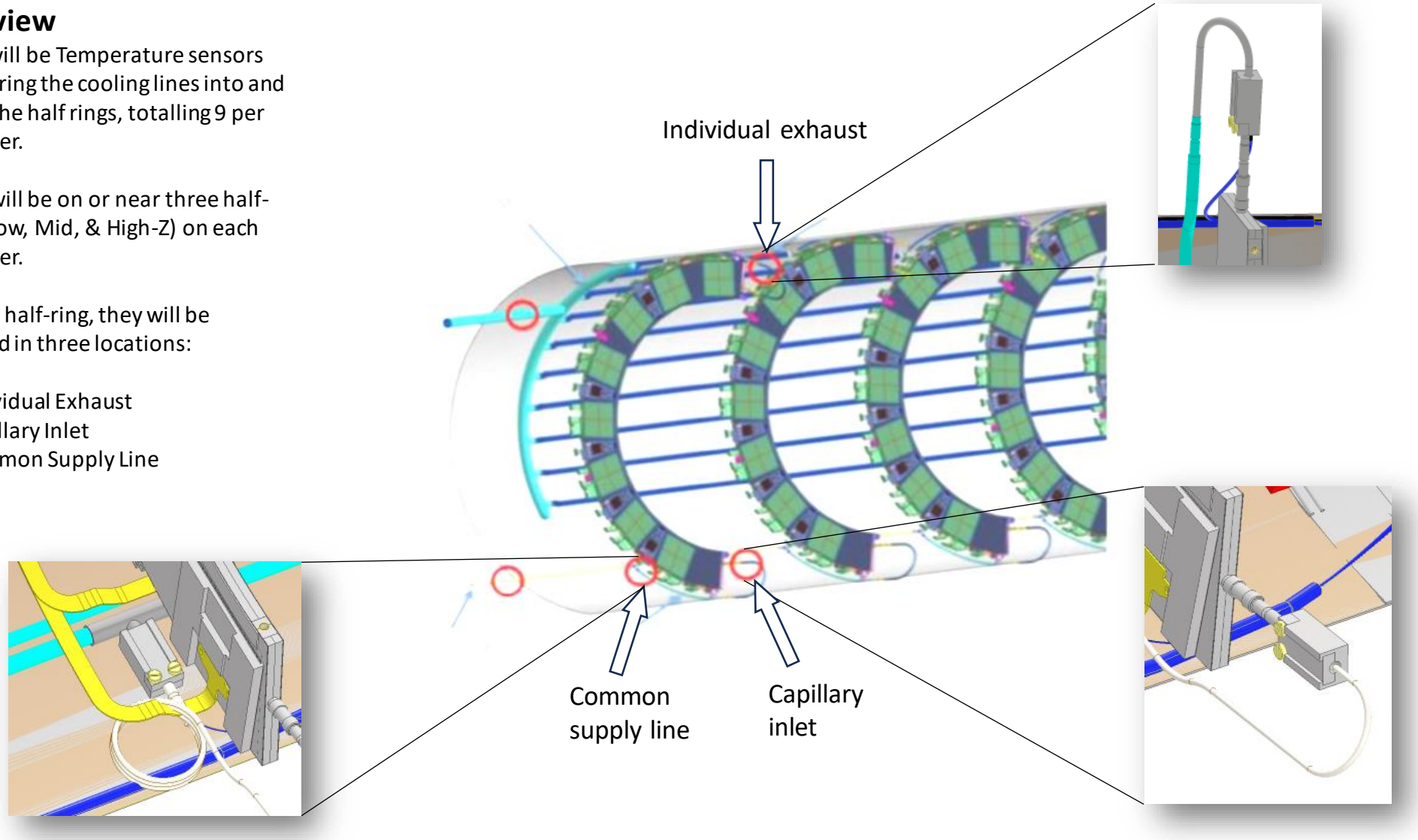
Overview

There will be Temperature sensors monitoring the cooling lines into and out of the half rings, totalling 9 per half-layer.

These will be on or near three half-rings (Low, Mid, & High-Z) on each half-layer.

At each half-ring, they will be installed in three locations:

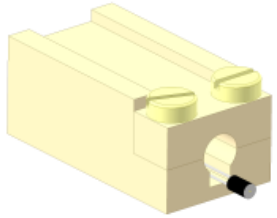
- Individual Exhaust
- Capillary Inlet
- Common Supply Line



Cooling Sensors

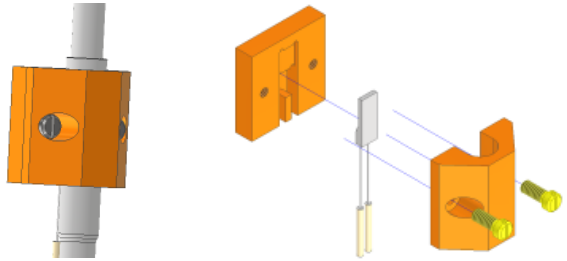
Brackets

Designs have progressed from initial concept provided by Alex @ Manchester:



More compact and added detail:

Alternative conceptualised:



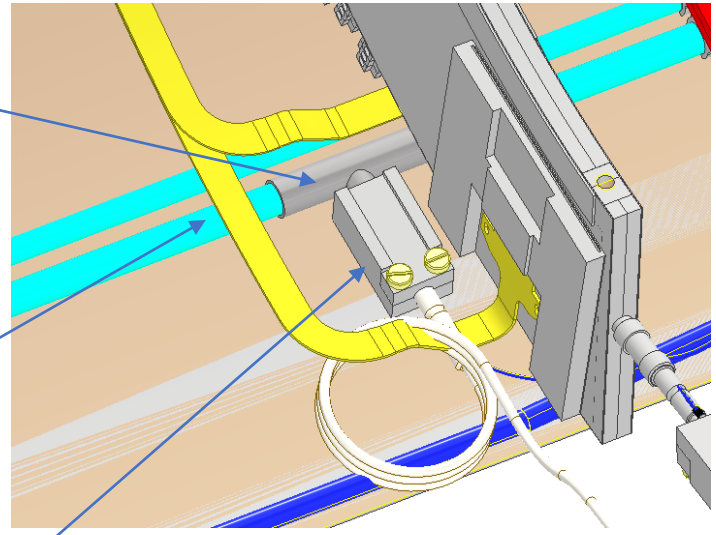
Note that DCS team are working on solving the same problems - see next slide.

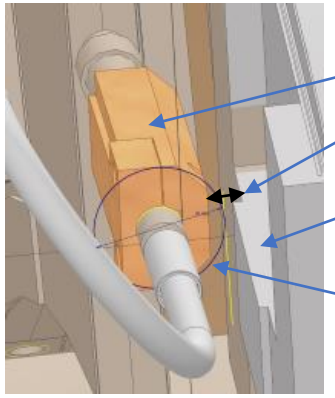
Questions on common supply line temperature monitoring:

1) Location of Capillary branching point is close to the half ring module (Ring 11, layer 2 shown)
If this position has since changed or is likely to change, please let me know as it affects the space constraints and the cable harness length.

2) Currently this is mounted on the capillary branch, the alternative is to mount on the Ø5mm main supply line nearby. Is there a preference?

Note that mounting could be difficult in this position, depending on capillary geometry.





Note the very tight clearances

Side 1 Sensor on capillary

~1mm clearance to module

Module Side 2

Clearance Envelope Ø8.94

Cooling Sensors

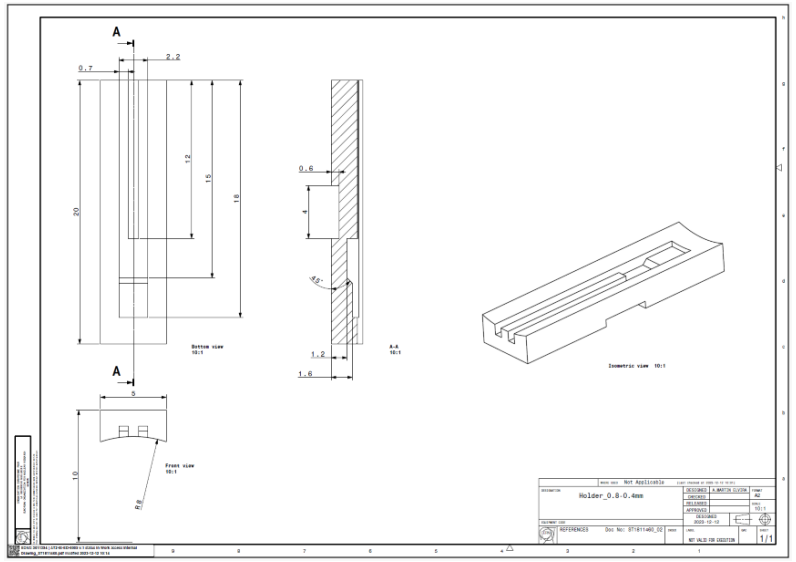
The DCS Team are developing a 3D printed solution to mount the 2-wire T-sensor to the Ø5mm supply line.

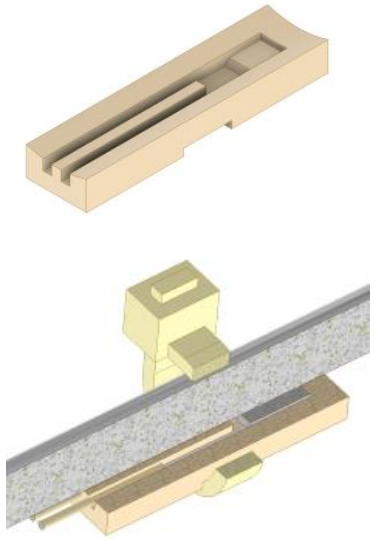
Does this offer any ideas on how to monitor the common supply line near the half rings? It looks promising though some questions could be:

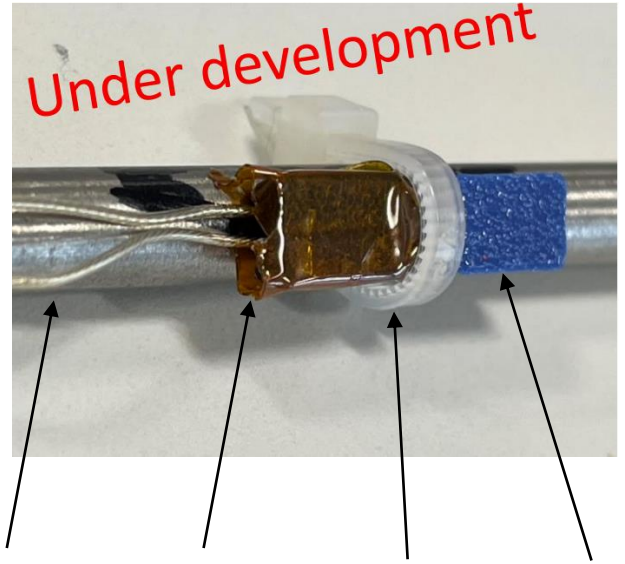
- How well does the cable tie retain the sensor over time?
- How easy is it to install on delicate pipelines/cramped locations?
- Reliability/Repeatability of the clamping force applied by cable tie
  - D. Florez comments there is a cable tie gun tool that can offer repeatable tightening forces.

Drawing:
https://edms.cern.ch/document/3011394/1

Presentation:
https://indico.cern.ch/event/1370466/contributions/5763289/attachments/2782422/4849919/ENV%20TEMP%20Update%20Jan%2017%202024.pdf



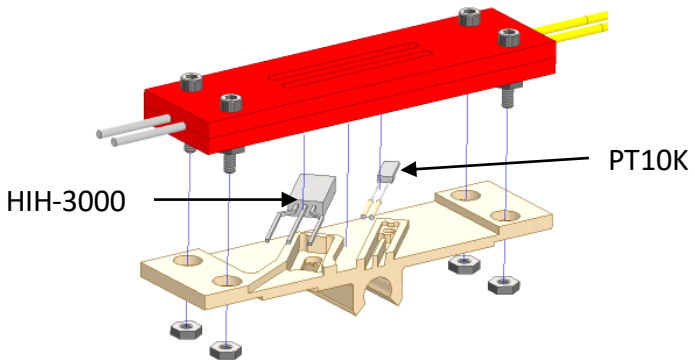


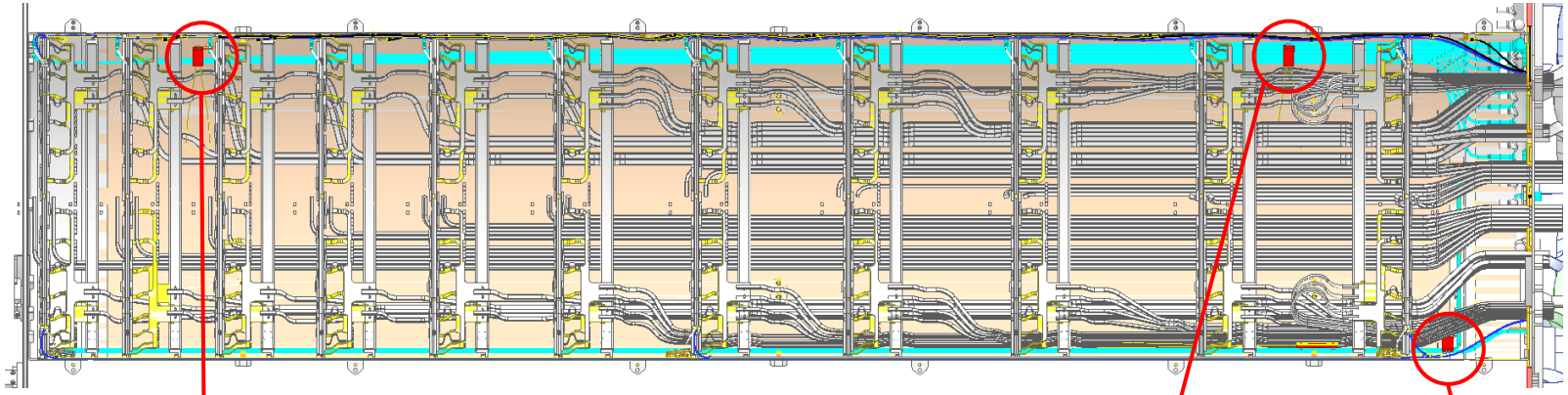


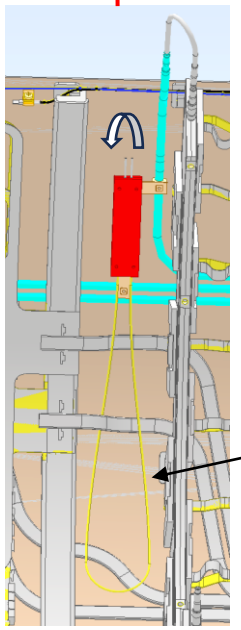
Humidity

Overview

- 3 Optical fibres per end cap half shell (6 per endcap, 12 total)
- Located in Layer 2 only
- FOS Package has a long fibre loop (Awaiting drawing of geometry)
- Sacrificial sensors in same location (1 x PT10K, 1 x HIH-4000)
- Brackets clip on to cooling pipes (In progress)

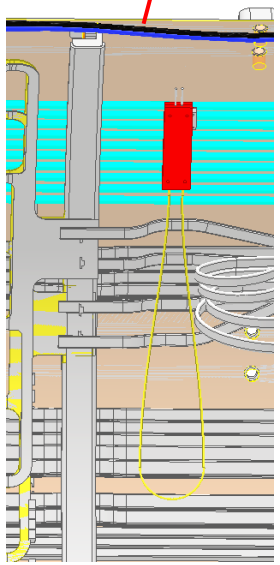


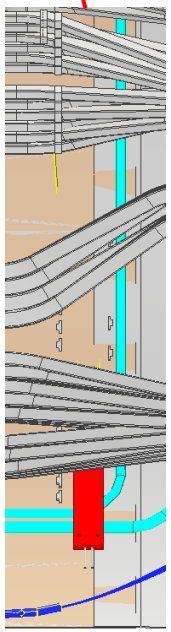




Orientation rotated 90° means package and fibre loop do not impede integration of half rings, services support rings, etc.

Ensure the fibres are routed and fixed appropriately Noting the minimum bend radius





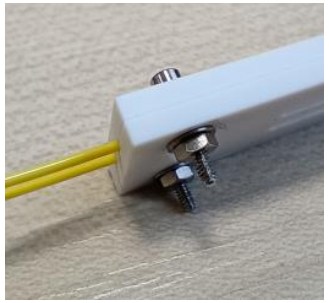
Humidity

Routing fibres into PP1 (Current understanding)

- The optical fibres from both the FOS packages and from the opto boxes will be terminated with optical fibre connectors
- Having connectors in place will assist QC testing at stages prior to full installation
- The fibres from PP2 will be routed into PP1 via a potted gland interface (DCS team are working on this)
- These fibres will finally be connected together in the PP1 volume

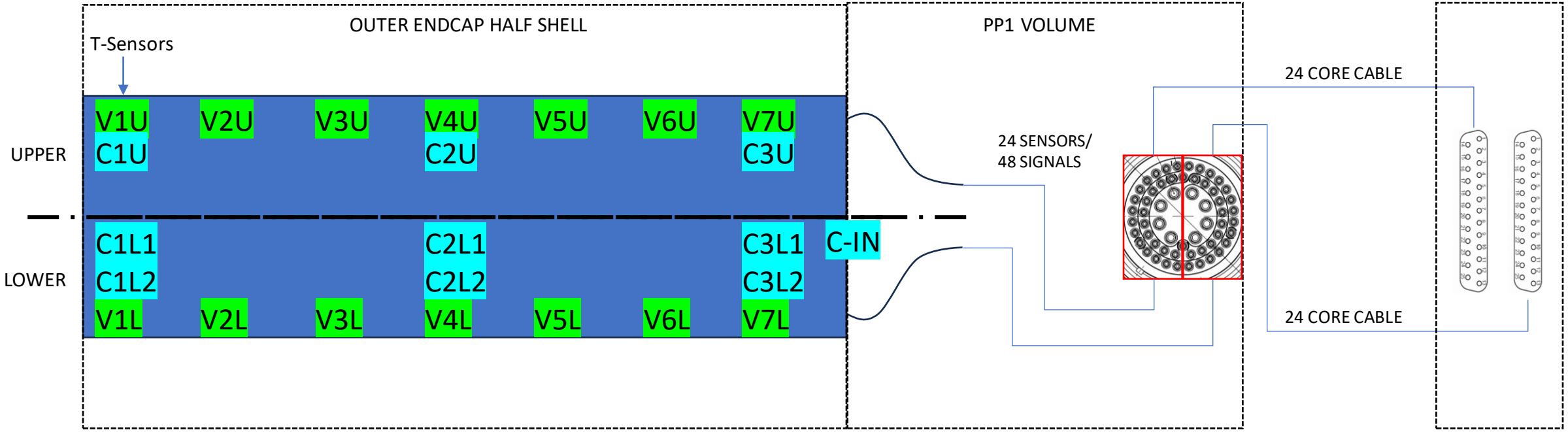
Progression going forwards:

- Obtain firm details of FOS package design, incl. geometry of fibre loop, mechanical construction, etc.
- Finalise positioning in endcap volume
- Choose optimal routing strategy considering space constraints, and preventing damage or sharp radius on fibres
- Agree upon order of integration (before or after Type 1 services)



Pin Mapping

Layer 2 OEC Block Diagram



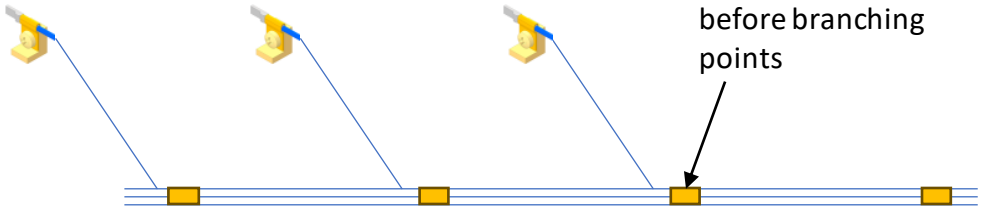
Draft has been made, need to formalise the mapping using recognised or agreed upon identifiers and references.

See also my presentation in:
https://indico.cern.ch/event/1369393/

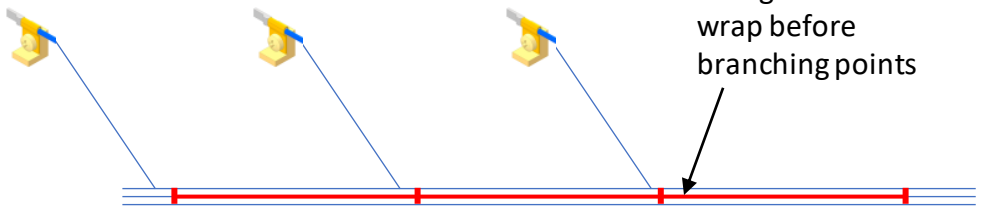
Cable Harnessing

Options for harnessing cables

1)

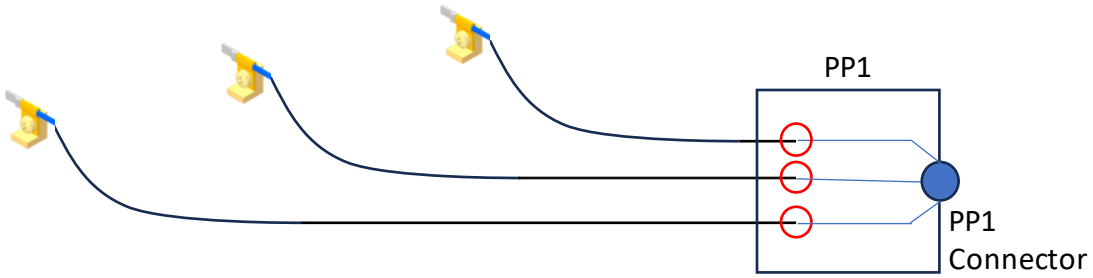


2)



Splicing

Ideally, we splice the cables in the PP1 volume



We would have two harnesses:

1. PP1 Harness with equal length twisted pairs from PP1 Connector to OEC volume

2. T-Sensor harness with various lengths to suit

Splicing would occur in PP1 whereby the PP1 harness and T-Sensor harness overlap and are both trimmed to suit the splice position.

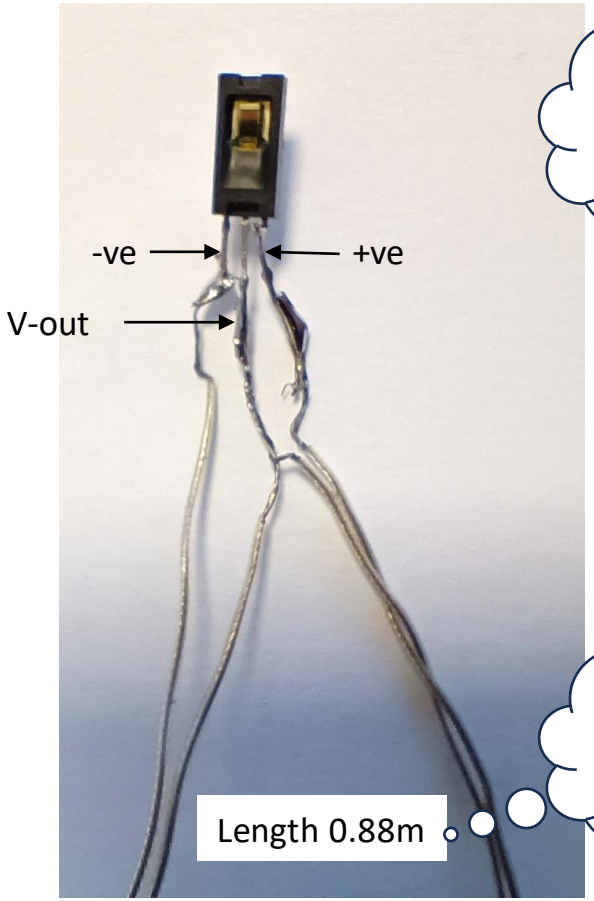
Note that 2m extension cable will not be enough to ensure that splicing occurs in PP1. Instead (at least for low-Z sensors) this would have to happen in the OEC volume.

Therefore, from OEC perspective, 3.5m T-Sensor cable is desired.

Samples

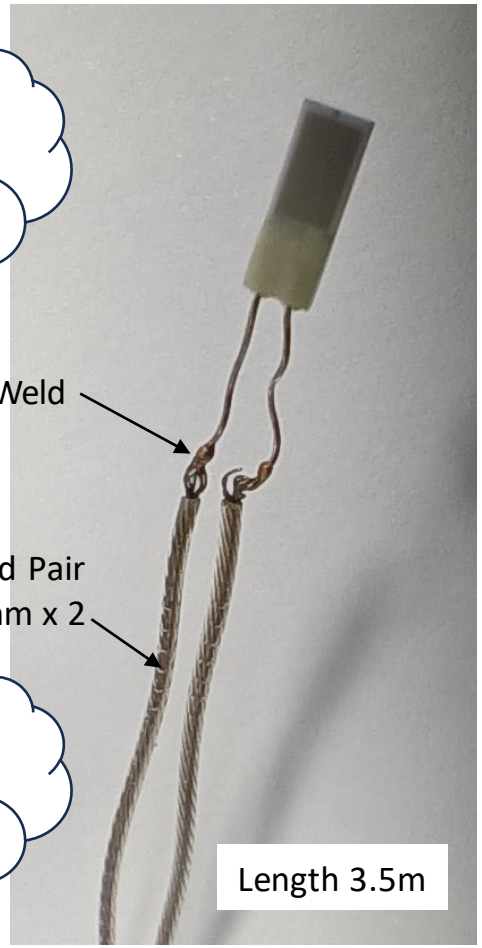
Kindly received samples from Xola Mapekula

Honeywell HIH-4000 Sacrificial Humidity Sensor



Twisted Pair 1

PT10K RTD Temperature Sensor



Twisted Pair 2

"Dummy" FOS Package Humidity Sensor