Cable Harness Assembly and Integration

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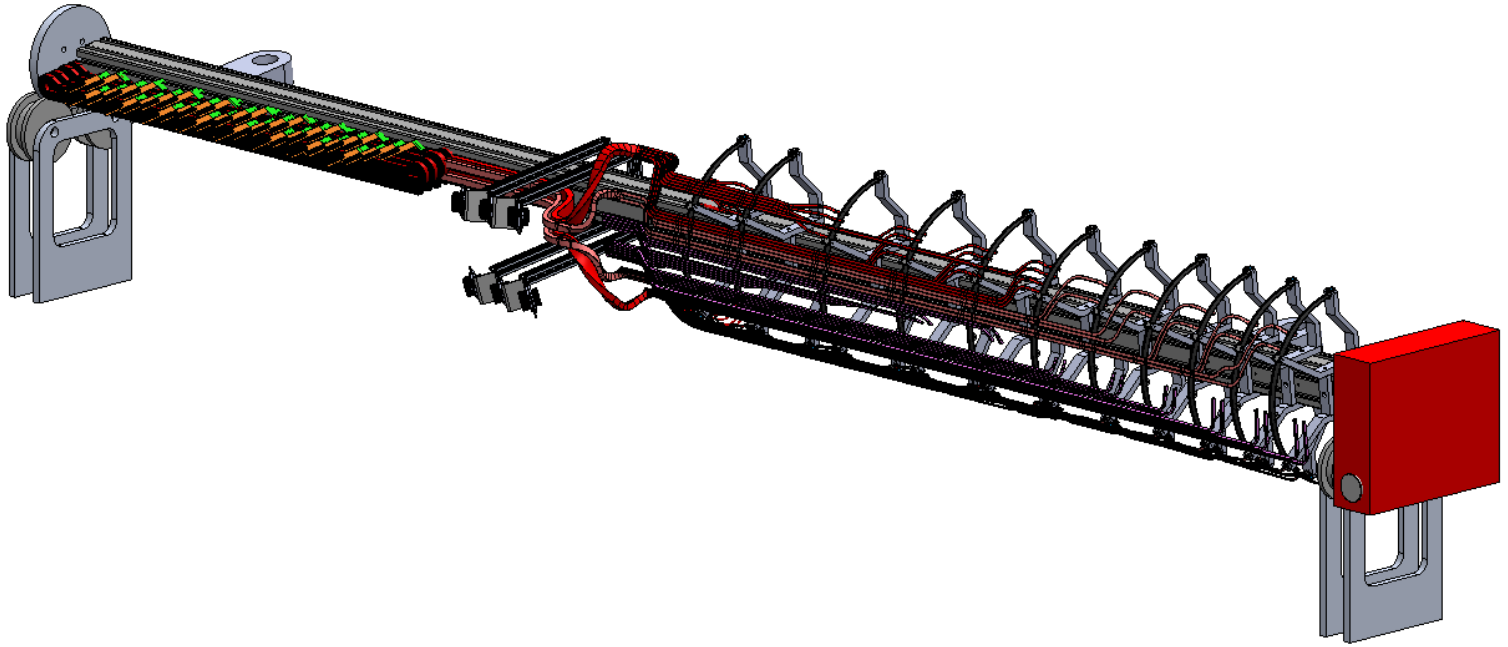
Cable Harness

- Harness construction covers the placement/support of:
  - Data cables
    - Including opto-termination boards, firefly connectors, and additional length for routing to opto-panels
  - Serial Power cables
    - Including PP1 connectors, connections to HR bus tape, and additional length for routing through PP1
  - Environmental sensor cables
    - Including additional PP1 connectors
  - Services support rings
  - Cable tensioning system (thermal expansion/contraction compensation)

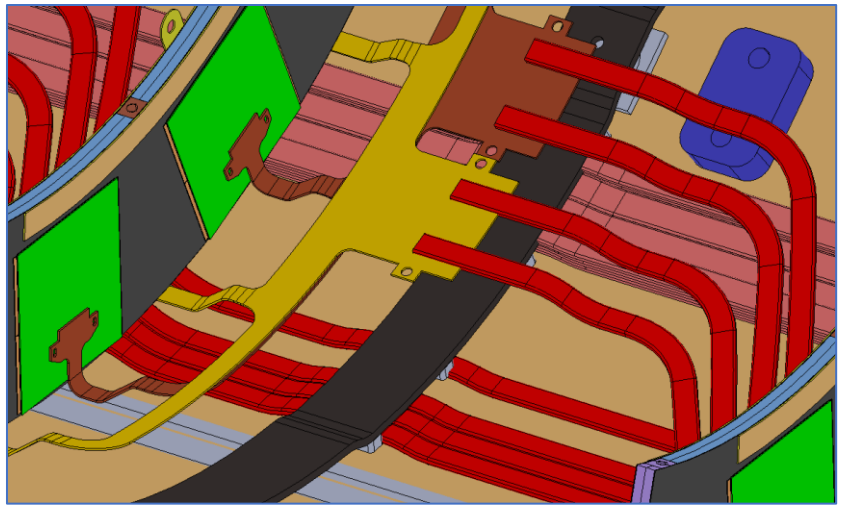
- System can be rotated so that individual components are placed in position conveniently
- Base frame will support the rotating central part and serve as base for shipping

(J. Webster)

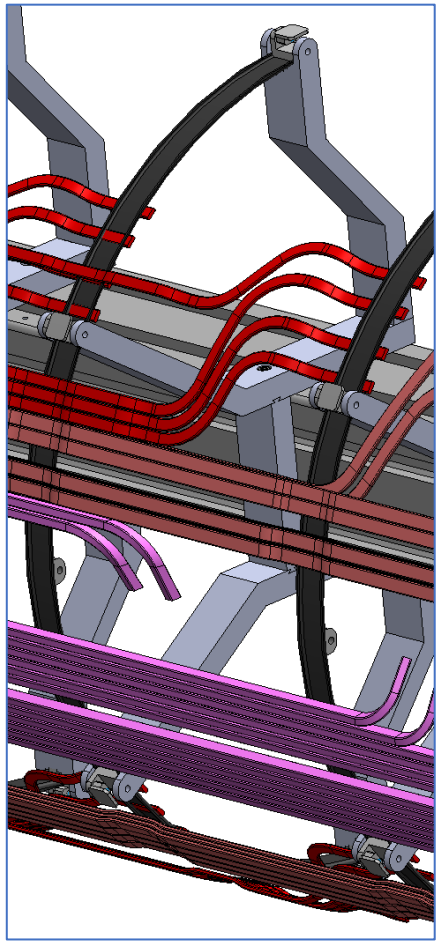


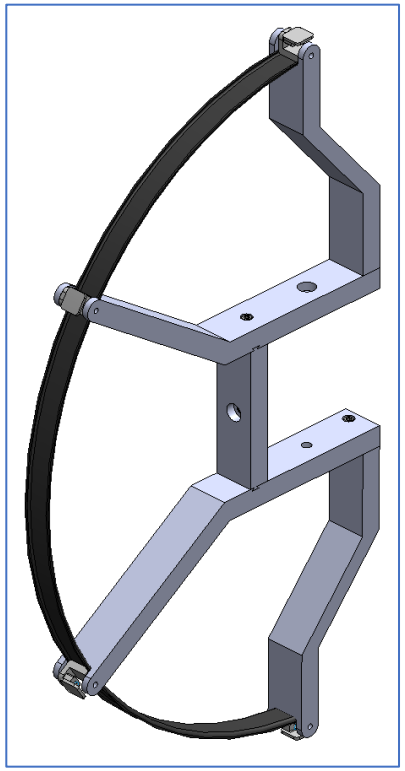
Services Support Rings

- Services support rings have the following functions:
  - Organisation of cables in the End Cap region
  - Restrict movement of cables in r
  - Provide support point for data PP0-firefly connectors
- During harness construction, the services support rings are supported from lower r
  - These also temporarily support the data and power connectors for safe storage during half ring integration
  - The support can be retained in shell during construction and removed one-by-one (without the central beam from the assembly tool)



Data PP0-Firefly connection point on support ring



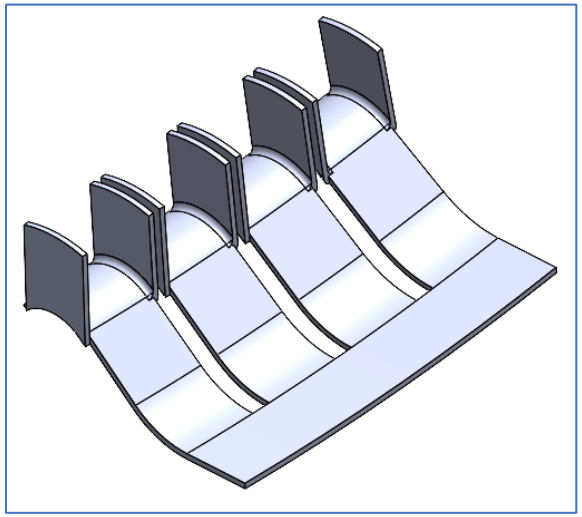


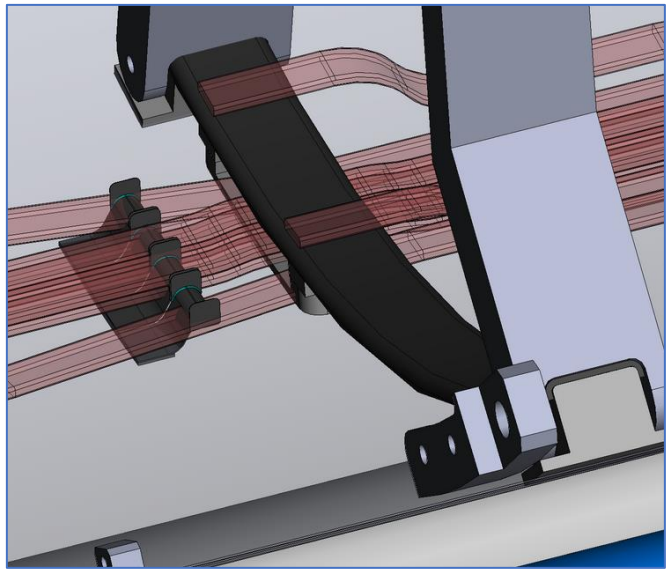
Mount for Services Support Ring (J.P. Moraga)

Thermal Expansion/Contraction Compensation

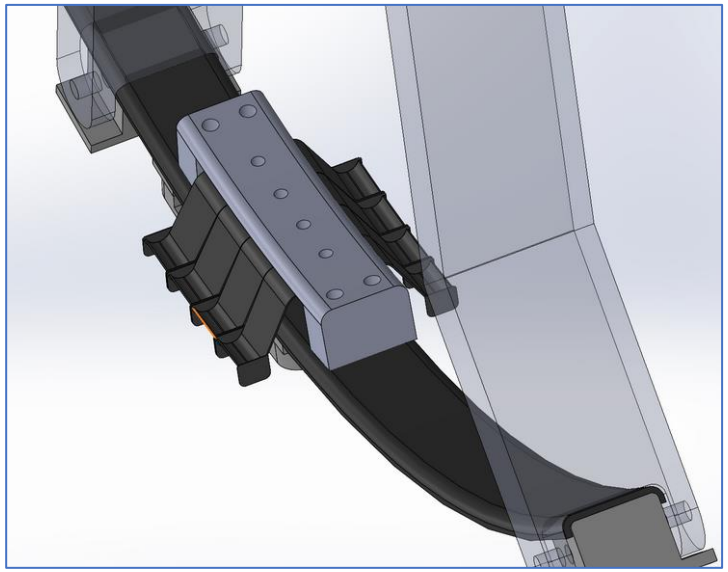
- A system is needed to control the movement of cables due to thermal expansion/contraction
  - Must be constructed with the correct length at room temperature to allow contraction down to -60
  - Must avoid the collecting excess length in one spot – we want to split the expansion into each region between half rings

- Since the Edinburgh workshop, we have been working on a flexure system which can control the motion of the cables in a repeatable way
  - Multiple possibilities being considered
    - Individual vs. combined fingers, placement along cable, whether they can be combined with the services support rings
    - If the springs are supported from the services support rings, their z position may need to be adjusted – this affects the ability of the services support rings to mount the firefly connectors
  - Need to be added to the design of the harness tooling so that they are in place during construction
    - Likewise, the transfer into the half shell needs to be devised
      - It is possible that it will require many additional glue joints





(J. P. Moraga)



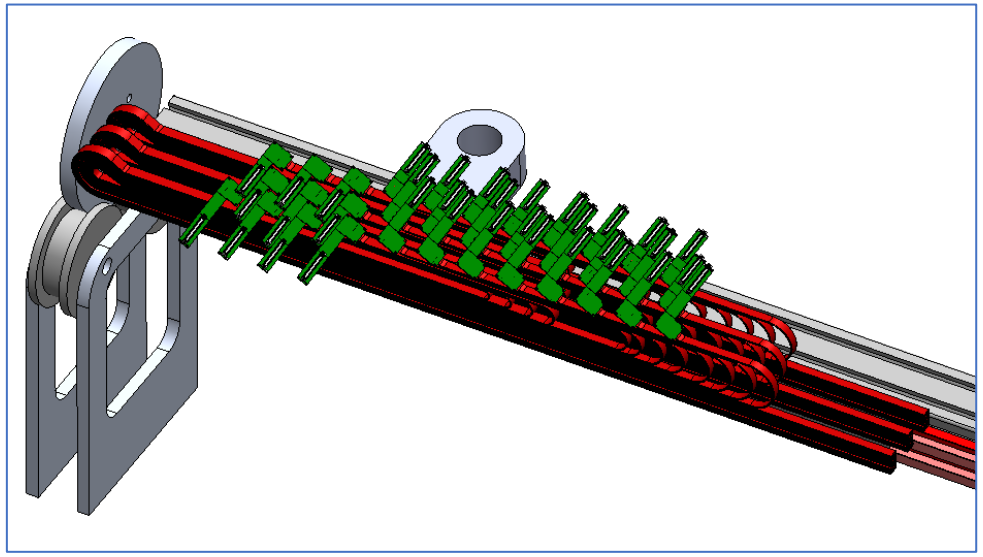
(J. P. Moraga)

Data and Power Cable Storage

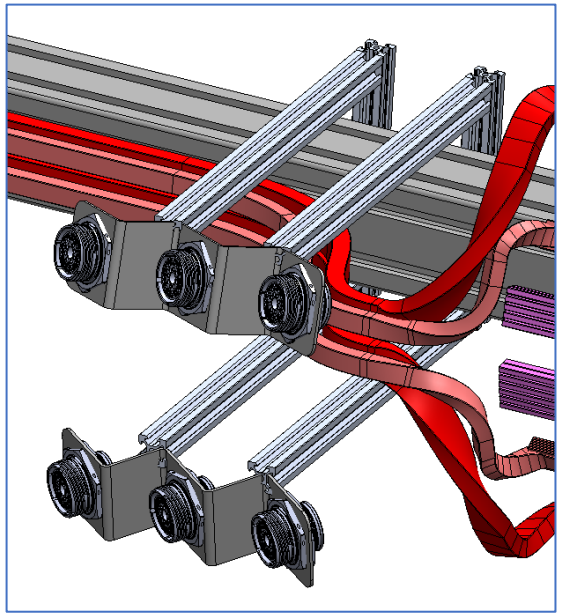
- Data Cables are folded on themselves twice
- Need guide points for cables to give correct folding point and radius
- Termination boards need mounting points
  - Must be accessible for testing
  - These are maintained as part of the services trolley throughout integration
    - Needs features to allow transfer to the trolley

- Excess power cable length is shorter than data cables (<1m)
- PP1 connectors will be held in convenient location for testing and integration
- Transfer must be made between harness assembly tool and services trolley

- Environmental monitoring cables and connectors are neglected (so far)
  - We expect an additional PP1 connector and a (relatively) small amount of cabling which needs to be included during harness assembly



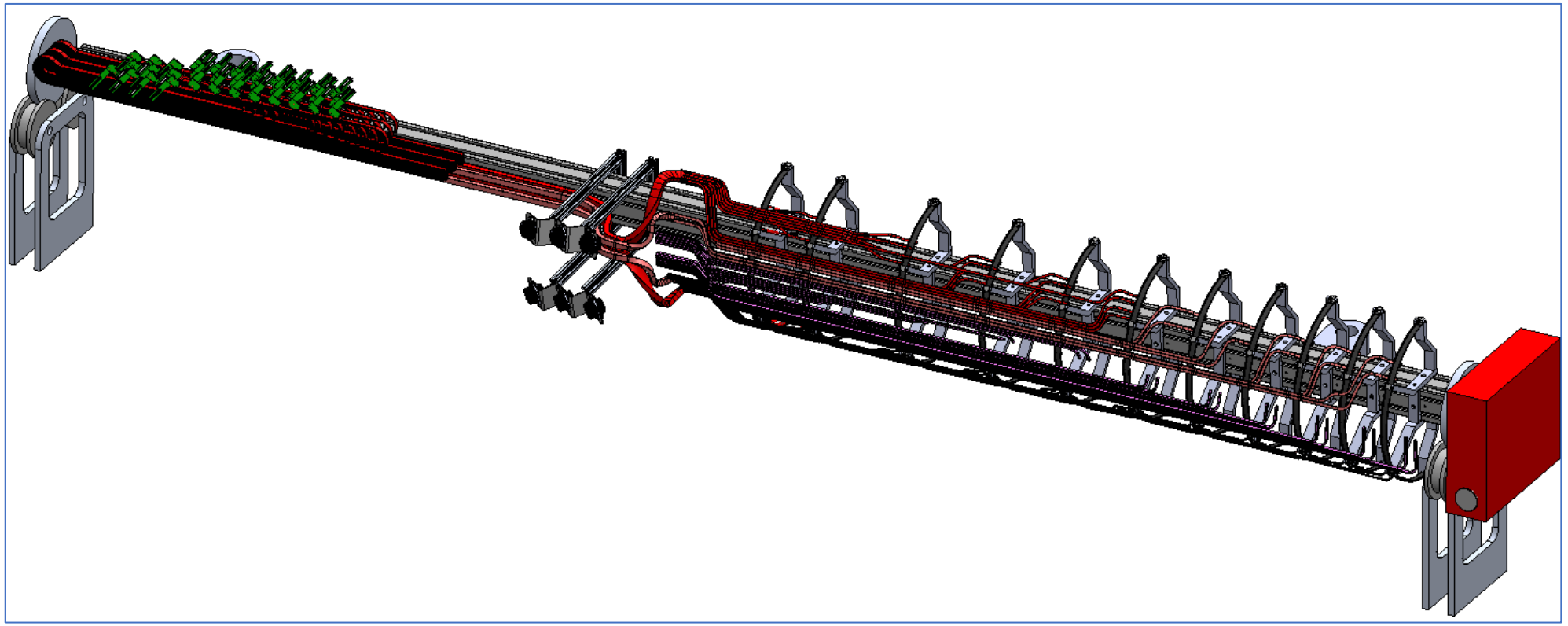
L2 Data Cable Storage with Termination Boards



L2 PP1 Connector (Cable routing between high-z support and connector not shown)

Harness Assembly Tool

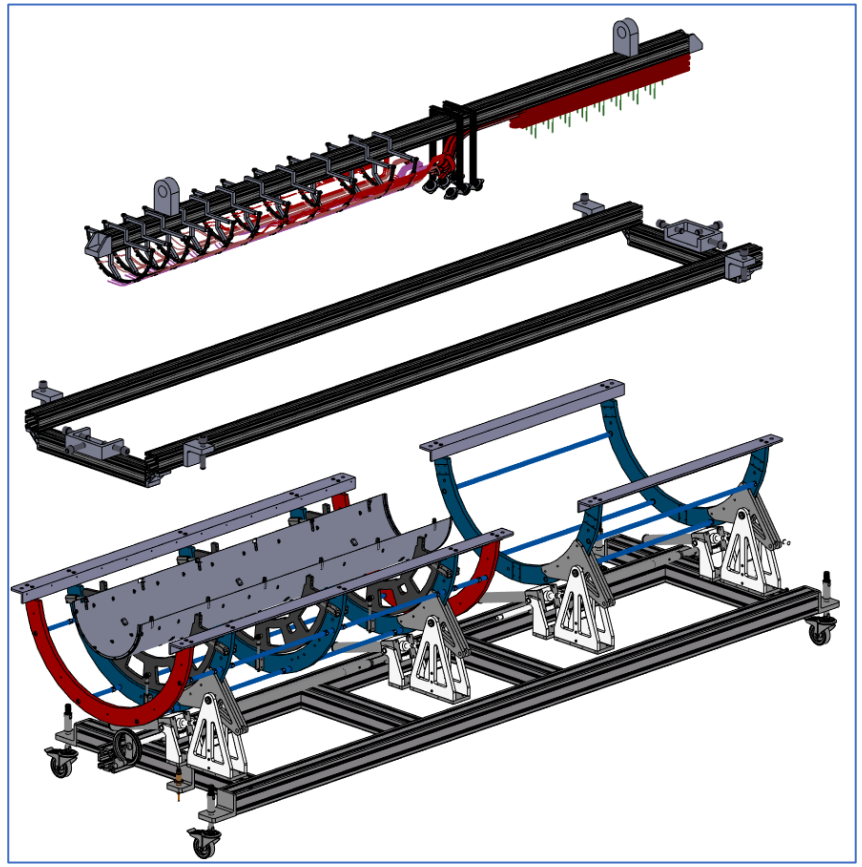
- We are taking some inspiration from other areas for the design of the rotatable assembly tool (e.g. OB IU assembly table, LHCb VELO shipping box)
- The tool will have features to account for variation in ring quantity and positions for the 3 layers and the offset between left and right half end caps
- The central beam can be separated from the support frame and added to the Frascati rotating assembly tool



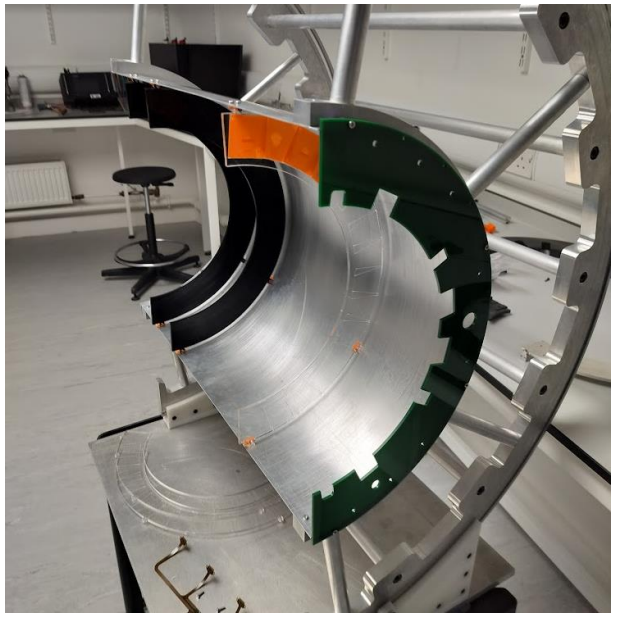
Harness Insertion in Half Shell

- Positioning cradle interfaces with Frascati rotating tool and cable harness construction tool
  - Position is adjustable (as one unit)
- Services support rings (and any CTE compensation) are glued to the shell
  - Final adjustment to mounting lugs made after testing in order to achieve proper bondline
- Connectors and excess cable length are transferred to services trolley – relative positions maintained
- Workshop in Edinburgh raised the possibility of changing this scheme to reduce the unsupported length of the central beam
  - Have not yet made any changes to this design

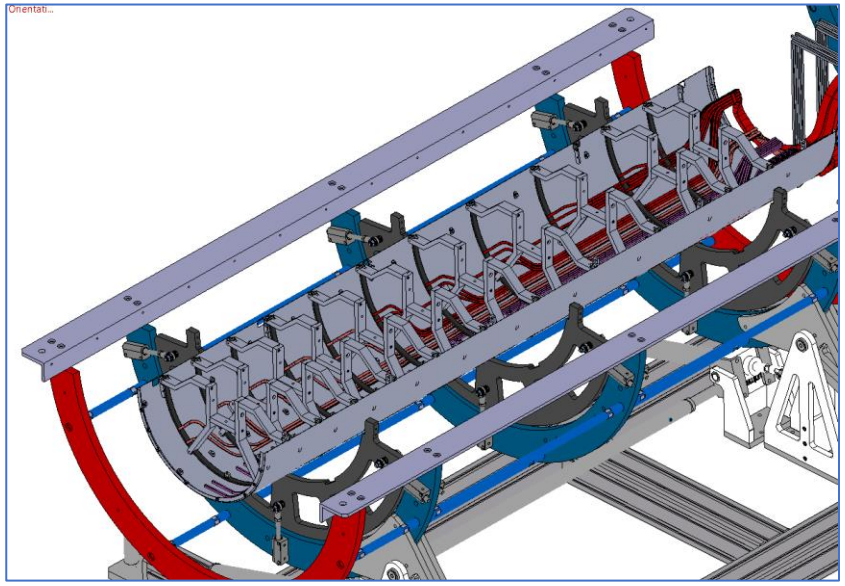
- Working on a short prototype of this tool which we can test on our 60cm long mockup



L2 Cable Harness Insertion in Half Shell



Edinburgh 60cm mockup



L2 Cables in Half Shell (incl. services support ring mounts – central beam removed)