

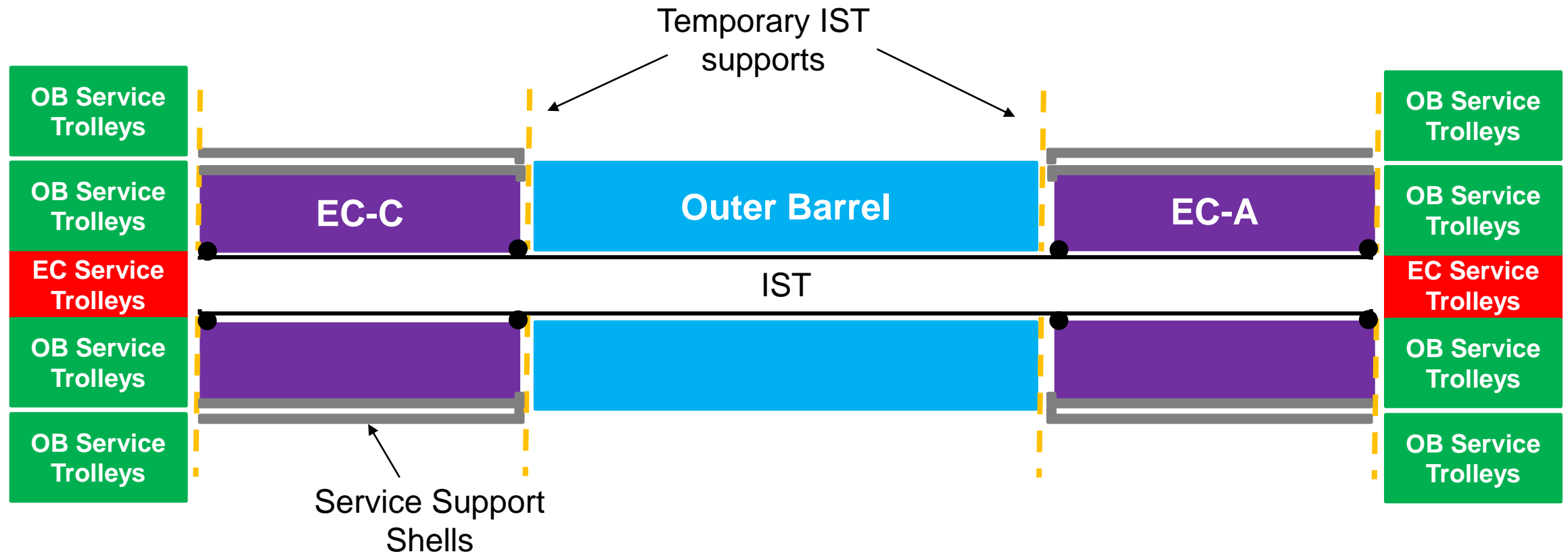
# Outer System Integration and Testing

Endcap Integration workshop  
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# Introduction OS Integration

- OB, ECs & IST assembled together in SR1 on the OS Integration Tool

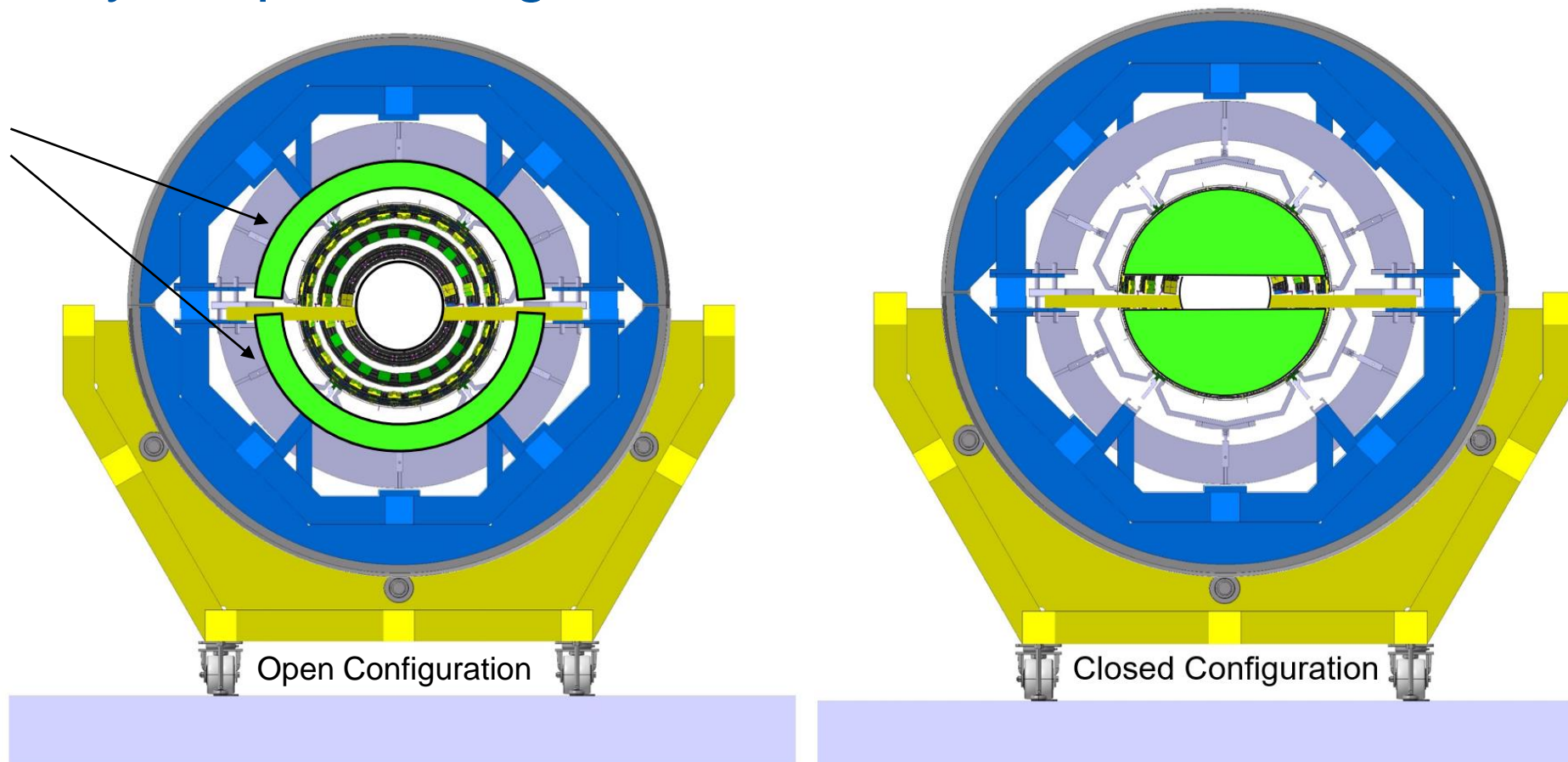


- Material from Diego's slides: <https://indico.cern.ch/event/1315511/>

# Outer Barrel Preparation for OS Integration

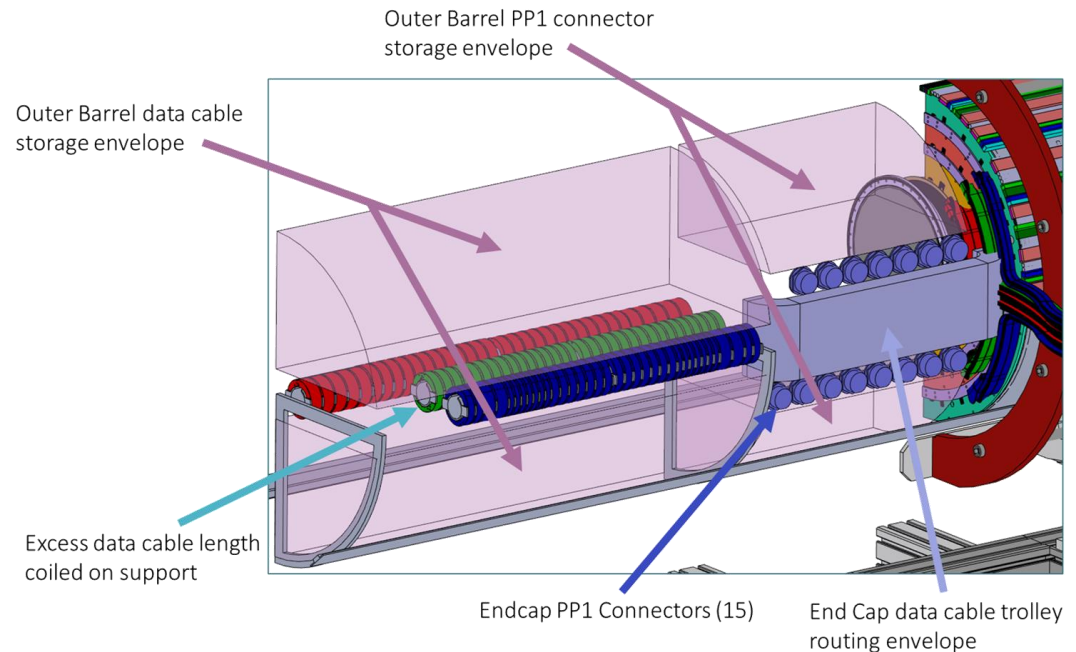
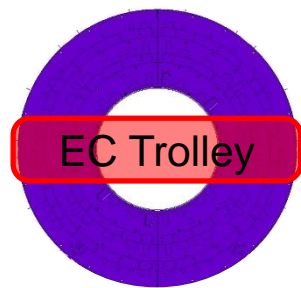
- Outer Barrel already installed in the Outer System tool
- Service support shells in open configuration (3-4mm radial gap)
- OB service trolley in open configuration to clear the way for ECs

“Open” OB  
Service Trolleys



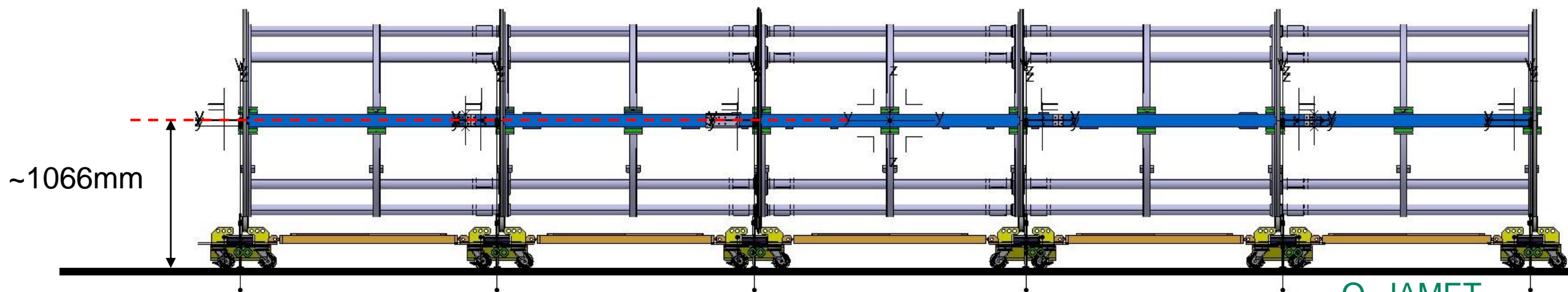
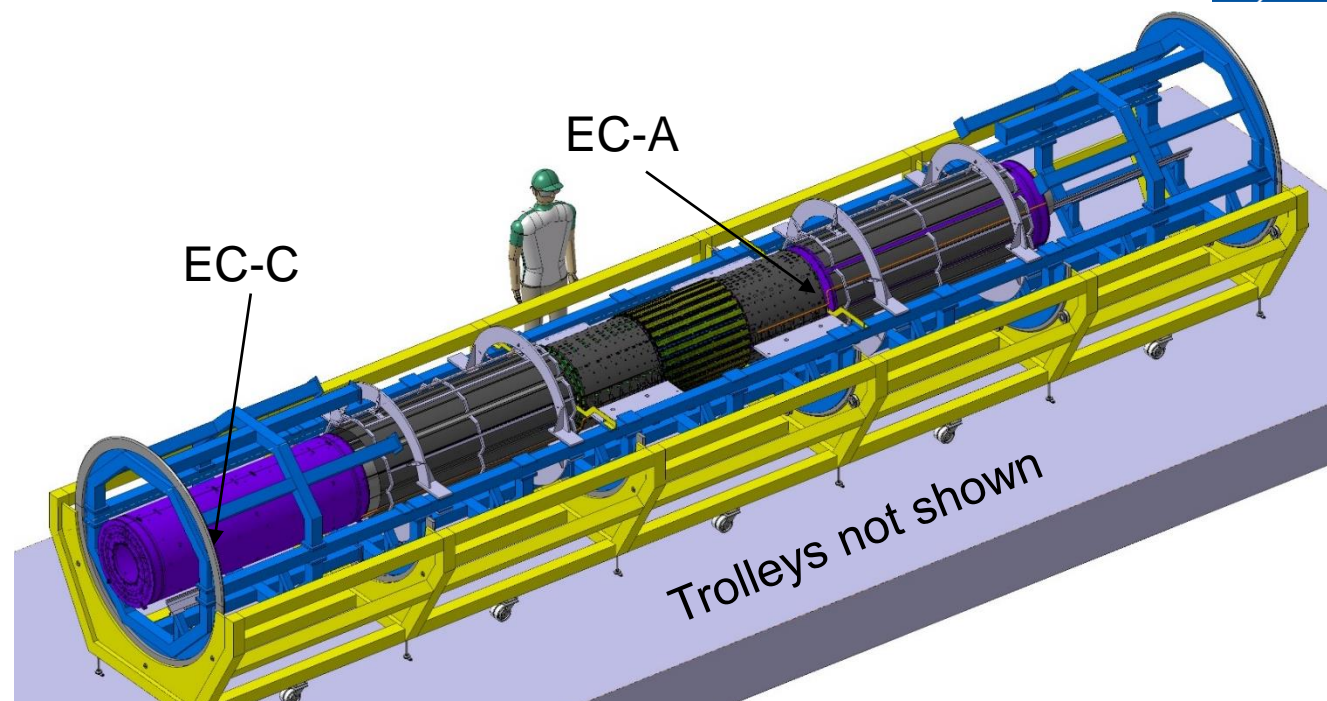
# Endcap Preparation for OS Integration

- Reception test after transport to SR1
- Disconnection of off-detector services and trolley with type-1 services in configuration for insertion
- Compact trolley configuration for insertion into OS Integration tool



# Endcap insertion

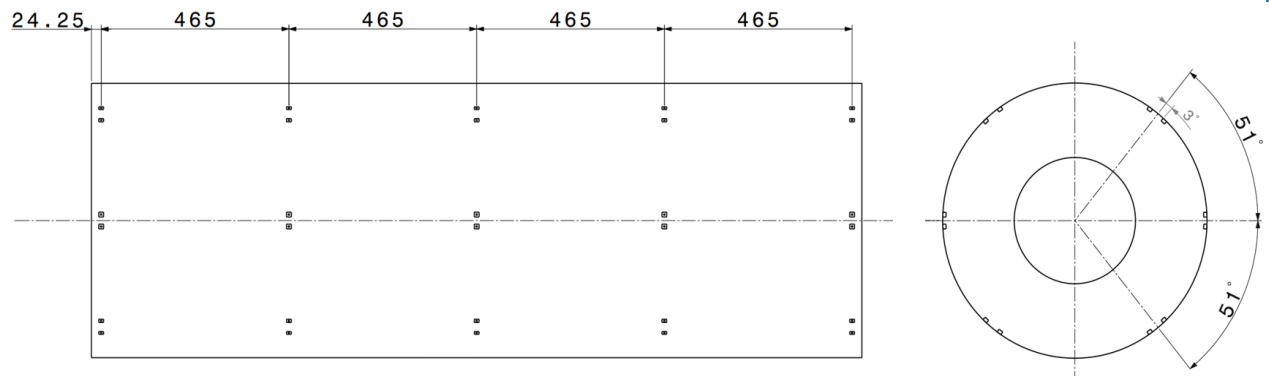
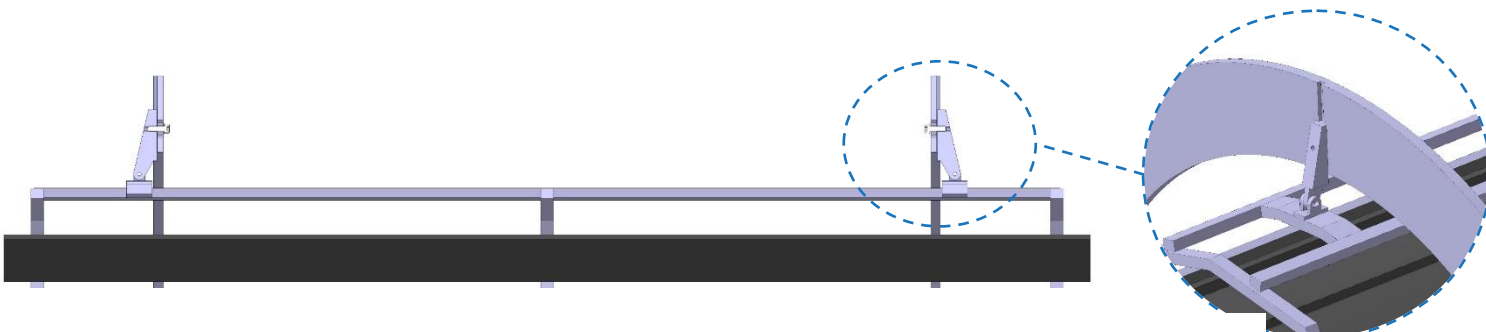
- Alignment of EC and OB tools; Install rail extensions
- EC-A inserted first; EC-C after
- Transfer IST from temporary brackets to final supports on EC flanges
- Connection to OB via OB-EC interlinks (2 interlinks with ball joints for z-coupling)



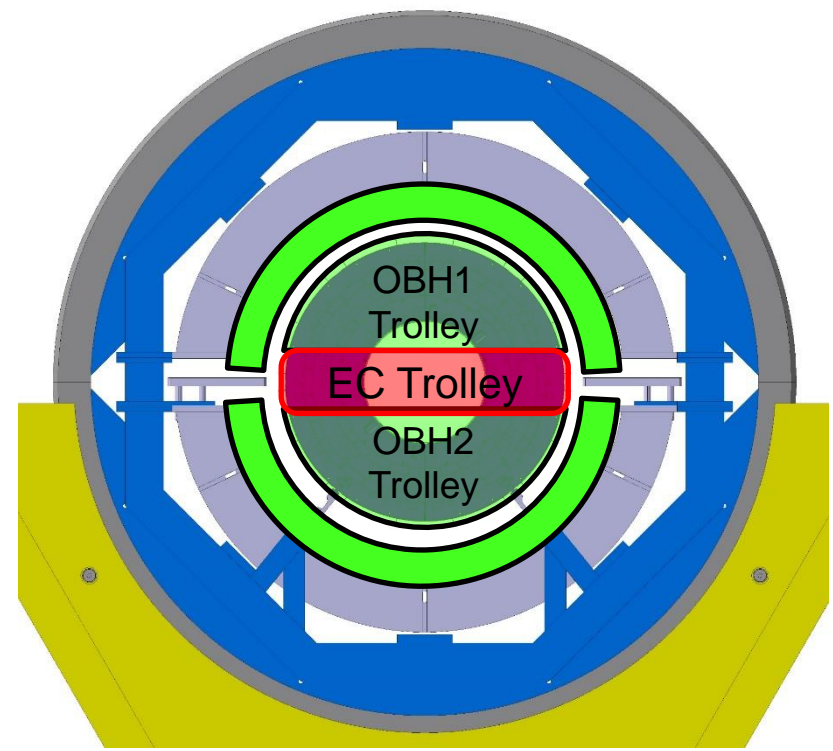
O. JAMET

# Outer Barrel closure after Endcap insertion

- Closure of OB Service support shells and weight transfer to ECs
  - Closing system with guiding slots for handling frames
  - Service support shells bolted to ECs via threaded inserts bonded to the EC shells
- Closure of OB trolleys around EC trolleys and weight transfer to rails
- Fine adjustment of OB & EC support points if needed (pre-alignment & load distribution)

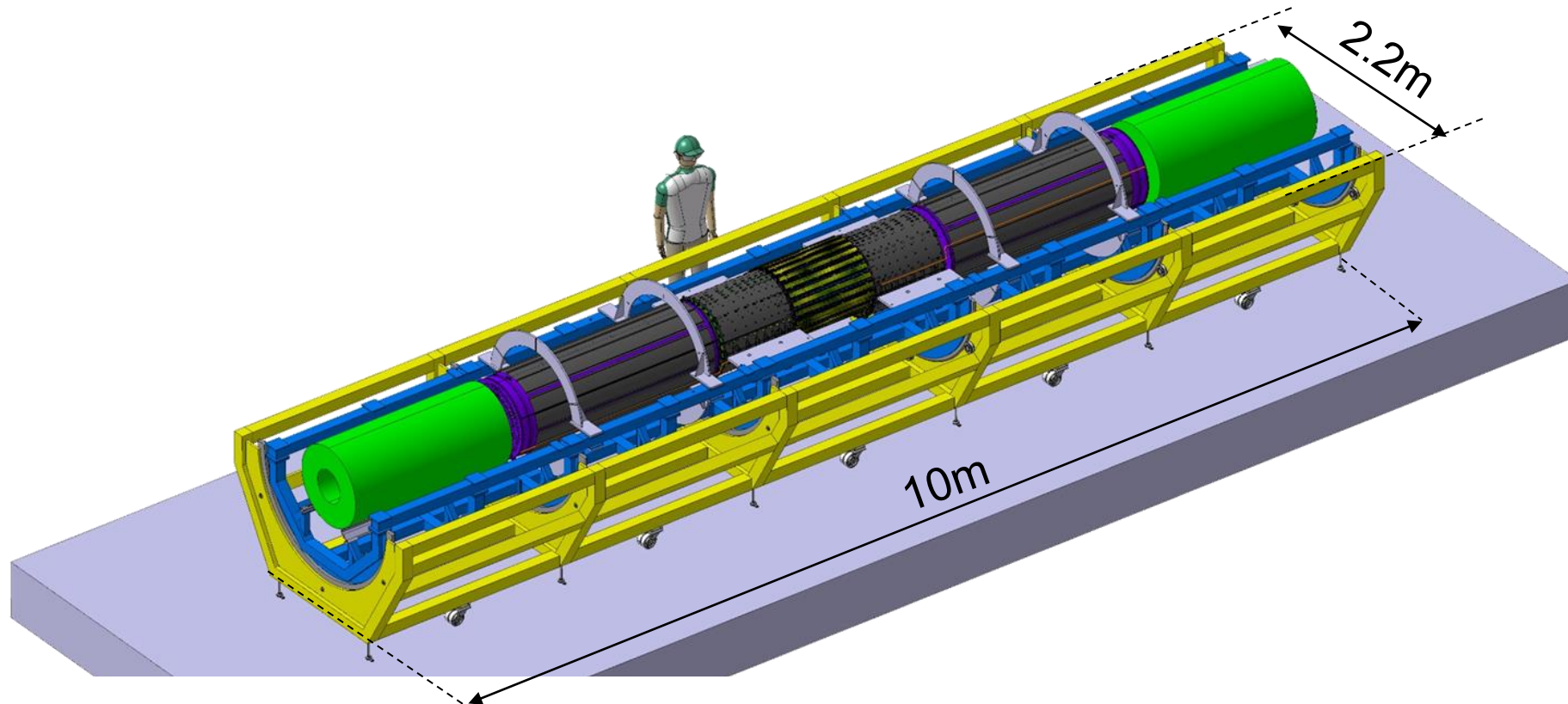


Threaded inserts bonded to the EC to fix the service support shells



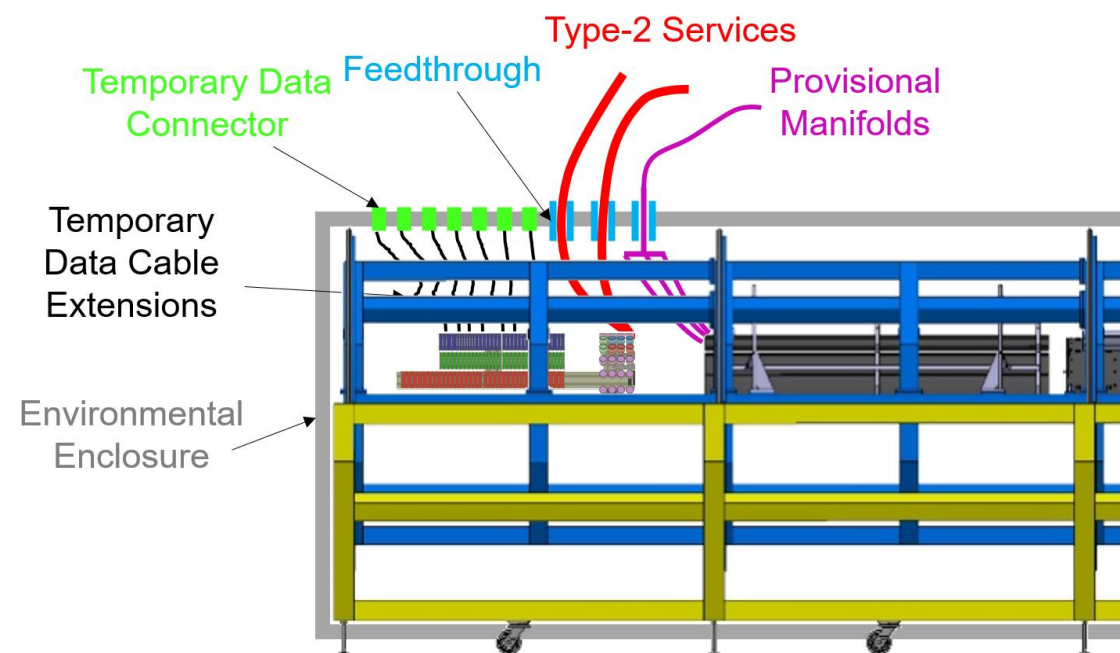
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# Testing of Outer System

- Envelope check to verify that the 5 wagons are within R343.7mm for PST insertion
- Electrical tests to verify installation of EC and OB in OS didn't degrade the units
- Tests inside of temporary environmental enclosure for the electrical tests of the OB/EC/OS
  - Removable panels for the integration/work on the detector
  - Light, modular structure with seals for light and gas-tightness (Very large dry volume, ~20-30m<sup>3</sup>)
- Patch panels at the extremities for temporary cooling and electrical connections
  - Constraints from the temporary services (e.g. length of data extensions)
  - Constraints in the position of the opto-panels
- Design effort needed





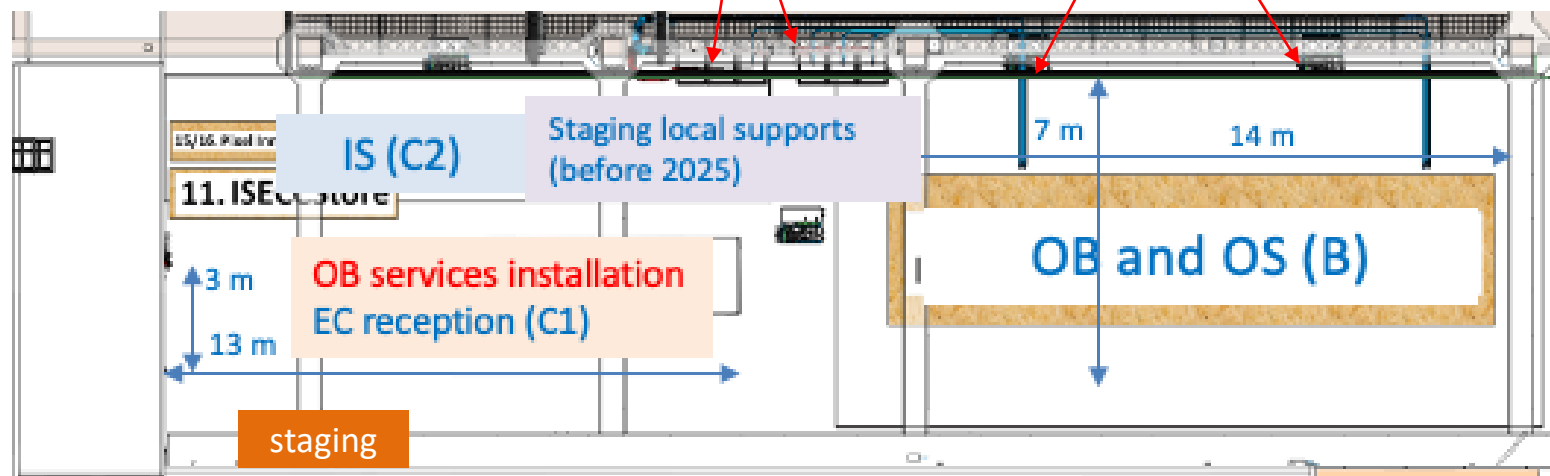
# Electrical Test of Outer System

- Electrical tests to verify connectivity inside of environmental enclosure
  - Same testing steps as before during integration, re-use of connectivity files
  - Connectivity test: min health test, IV, SP-LV
  - OB: 504 LINKS, 56 SP-chains, EC: 528 LINKS, 16 SP-chains
  - Warm temperature of modules (around 20°C)

Same 2 blue racks and piping, cables now to route to OS

Cooling racks for OS: piping for EC outlet to setup to be provided by EC team

- 2 Cooling FT on A- and 2 FT on C-side with power and flow equivalent to 1 PP1 CFT (1 loop for OB and 1 for EC (in OS))
- In rack room: using same racks as before



- Hand-over to ITk Common Mechanics for insertion into ITk

# SPARE



# Test sequence

- Final set of electrical tests to verify connectivity: SP-chain powering and configuration of FEs
- Same sequence as ran during OB and EC integration individually → Usage of same connectivity files

Test Step	Endcaps			Outer Barrel		
	Detector Tested Section	# SP Chains	#Data (up/down) Links	Detector Tested Section	# SP Chains	#Data (up/down) Links
1	6xHRs (A&C) L2 left	24	768/192	OBH2-IU2-A & OBH2-IU2-C	24	384/192
2	6xHR (A&C) L2 right	24	768/192	OBH1-IU2-A & OBH1-IU2-C	24	384/192
3	5xHR L2 (A&C) left	20	320/160	OBH2-BH2	32	576/288
4	5xHR L2 (A&C) right	20	320/160	OBH1-BH2	32	576/288
5	8xHR L3 (A&C) left	32	704/352	OBH2-IU3-A & OBH2-IU3-C	32	352/352
6	8xHR L3(A&C) right	32	704/352	OBH1-IU3-A & OBH1-IU3-C	32	352/352
7	5xHR L4 (A&C) left	20	260/260	OBH2-BH3	44	396/396
8	5xHR L4 (A&C) right	20	260/260	OBH1-BH3	44	396/396
9	4xHR L4 (A&C) left	16	312/208	OBH2-IU4-A & OBH2-IU4-C	36	504/504
10	4xHR L4 (A&C) right	16	312/208	OBH1-IU4-A & OBH1-IU4-C	36	504/504
11				OBH2-BH4	56	504/504
12				OBH1-BH4	56	504/504

# Information to store in the PDB

- Results of the reception tests for each component
- Results of the metrology survey
- Results of the module calibration test
- Results of the leak and pressure tests
- Results of the electrical tests
  - Comparison to electrical (readout, IV) results and configs from previous assembly steps for comparison
  - Mass