Plans for testing during EC assembly

Marianna Testa LNF-INFN

ITK OEC Integration Workshop in Otranto (LECCE)

With many contributions from

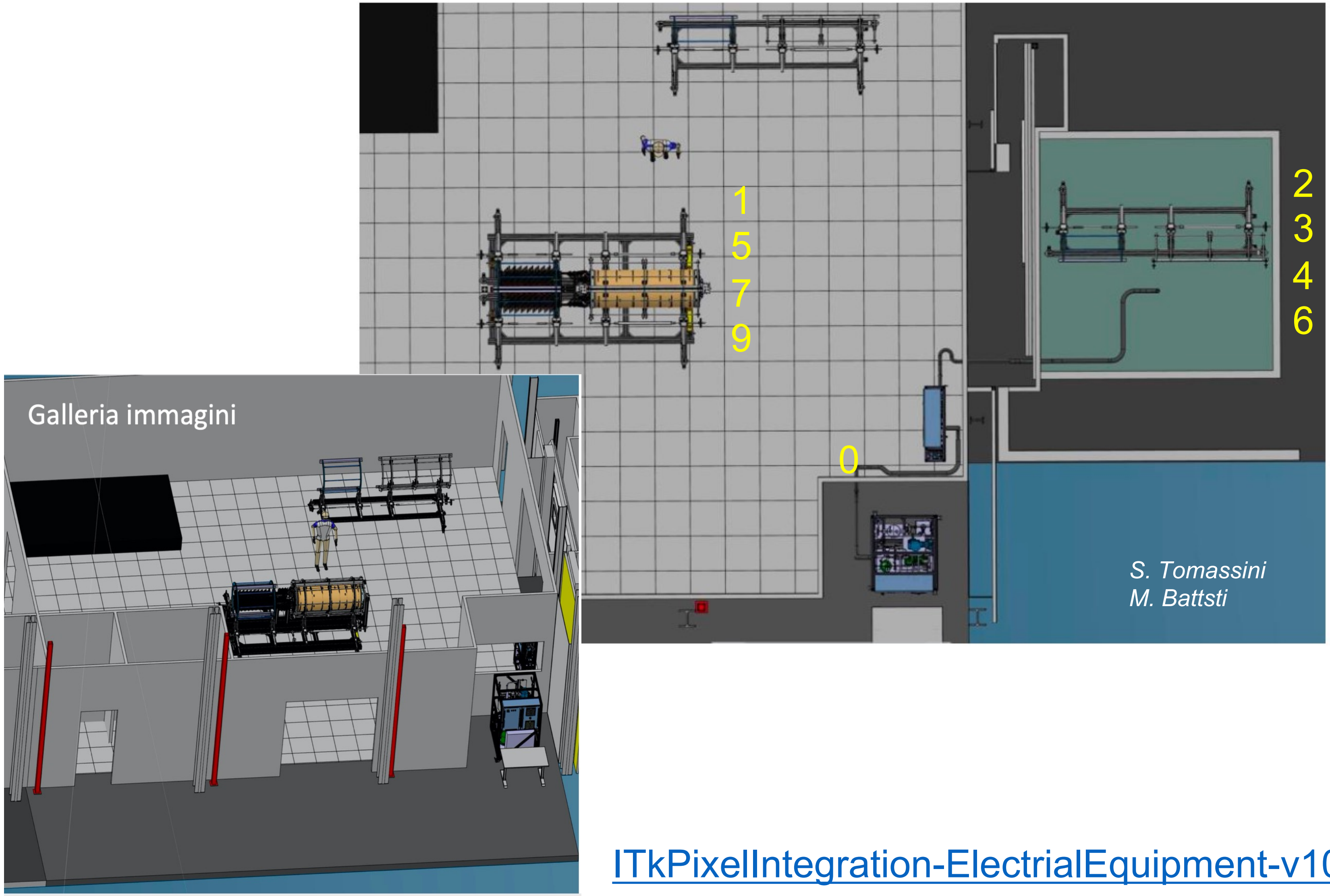
Z. Chubinidze, B.Buadze, L.Vannoli,

G. Cesarini, E. Dane’, P. Albicocco, M. Beretta

Overview of EC Testing during Integration

	Power mode	Cooling	Granularity
Insertion of individual HR	LP	Convective	After each HR insertion
Fully populated HS	Normale	CO_2 “cold”	2 (1) steps for HS of L2-L4 (L3)
Thermal Cycle HS	off	Climate chamber	
Complete layer	LP	CO_2 “warm” and/or climate chamber	2 (1) steps per HS of L2-L4 (L3)
Complete layer after manifold welding	LP	Reduced flux CO_2 “warm” and/or climate chamber	2 (1) steps per HS of L2-L4 (L3)
Full EndCap	LP	Reduced flux CO_2 “warm” and/or climate chamber	2 (1) steps per HS of L2-L4 (L3)

EC Testing during Integration



S. Tomassini
M. Battsti

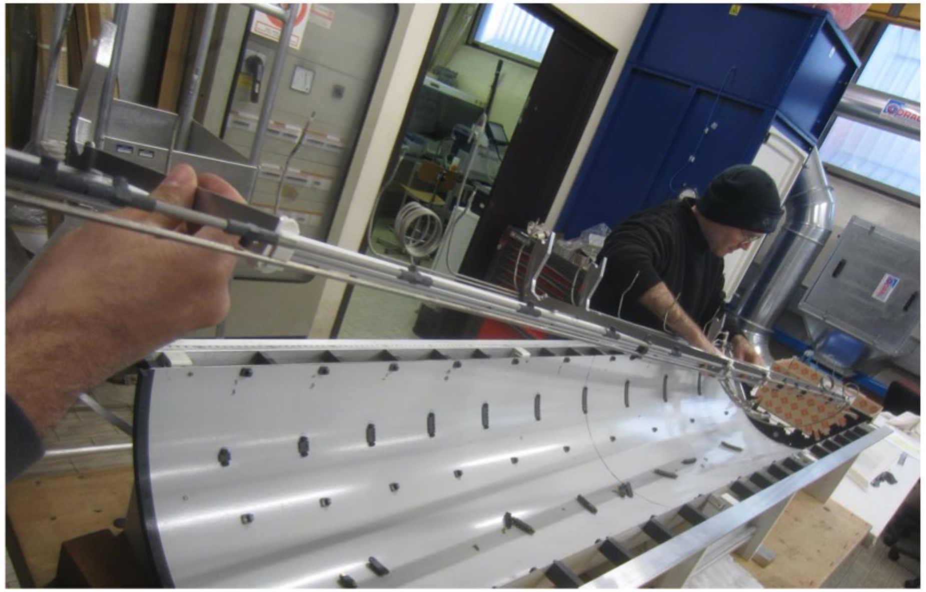
0. Half-ring reception test
1.insertion of services – cooling lines, data/pwr cable - and test
2.Insertion of half-ring with silicon modules
3.Low Power mode connectivity test
4.Testing connectivity with cold CO_2.
5.Thermo-cycles test with detector Off
6.Testing again connectivity with cold CO_2
7. Mating couple of half-shells to form a layer
8.Testing connectivity of complete layer cooling with Lp mode /warm CO2
9.Bring layer on platform
10.Repeat for the three layers
11.Final test on transport box

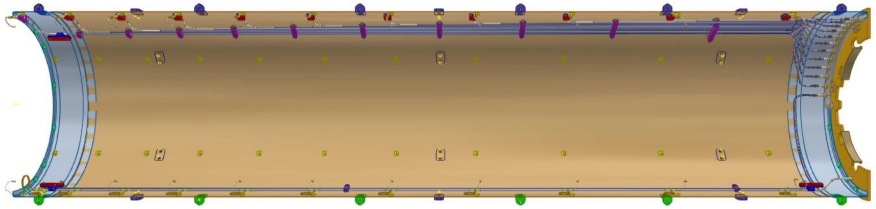
ITkPixelIntegration-ElectrialEquipment-v10_docx_cpdf.pdf

Insertion of cooling type-1 services

S. Coelli
A. Capsoni

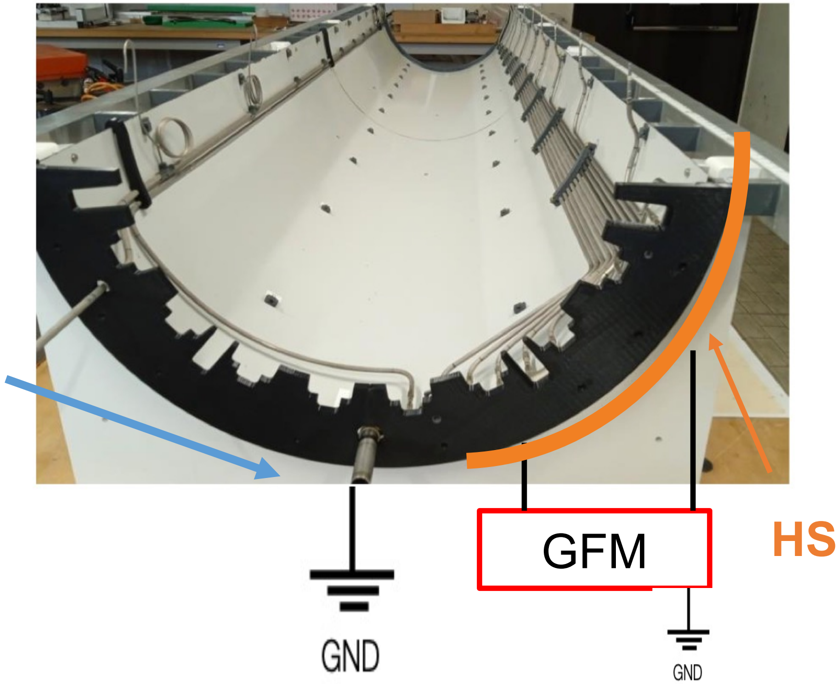
Simone Slides





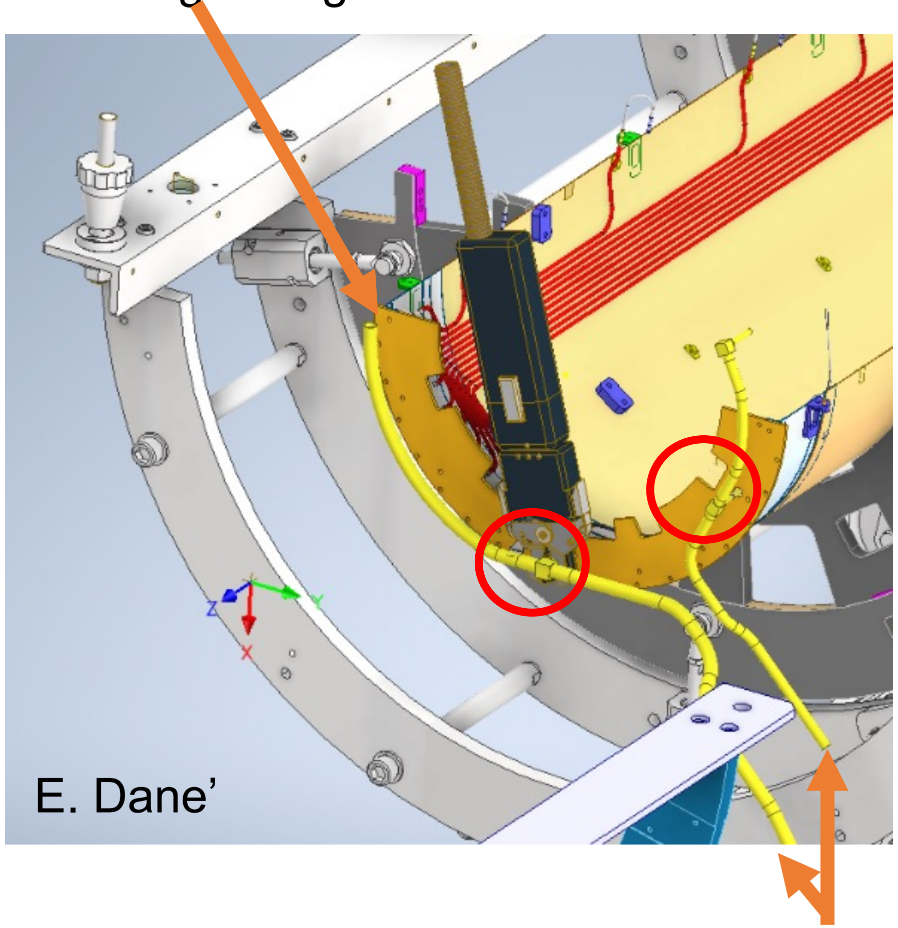
- Type 1 pipes and capillaries will be isolated from half-shells or any other conductive surface using ULTEM clip
- The resistance to the support structure will be measured and recorded to ensure compliance with the grounding and shielding including ground fault monitors specifications
- See L. Vannoli talk for baseline proposal and functionality

- If pipes are grounded, GFM can spot unwanted connections
- TBD: Do we want to keep it during all integration tests?



Cooling system in PP1 Volume

Closing Fitting



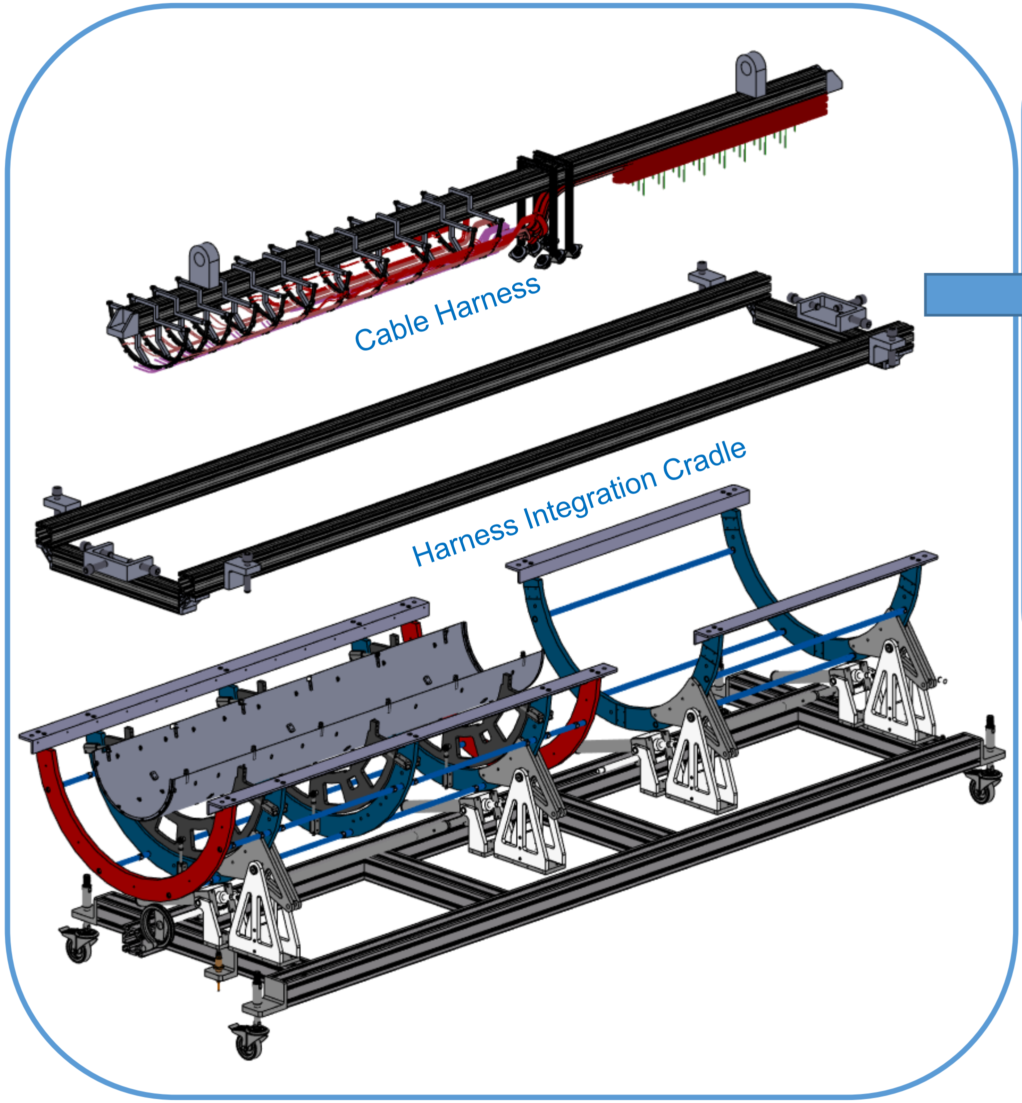
E. Dane’

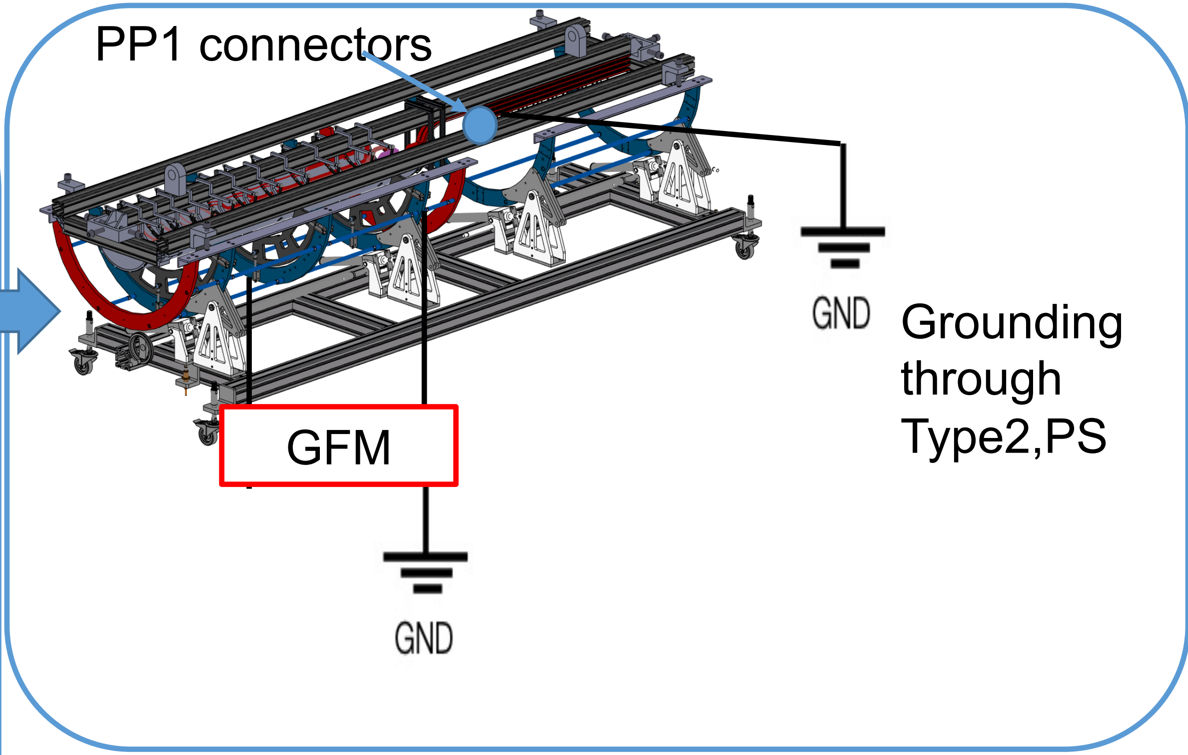
Connection to CO_2 plant

- PP1 EC cooling manifold installed during EC integration
- Two welds after piping installation on HS
- Other welds after HS mating
- Leak test, pressure test @ 162 Bar, leak test
- In case of failure, remove remove the entire piping, rework in workshop and restart the process or we can use another brand new one set of pipings

Type-1 services insertion

O. Shea, S. Eisenhardt





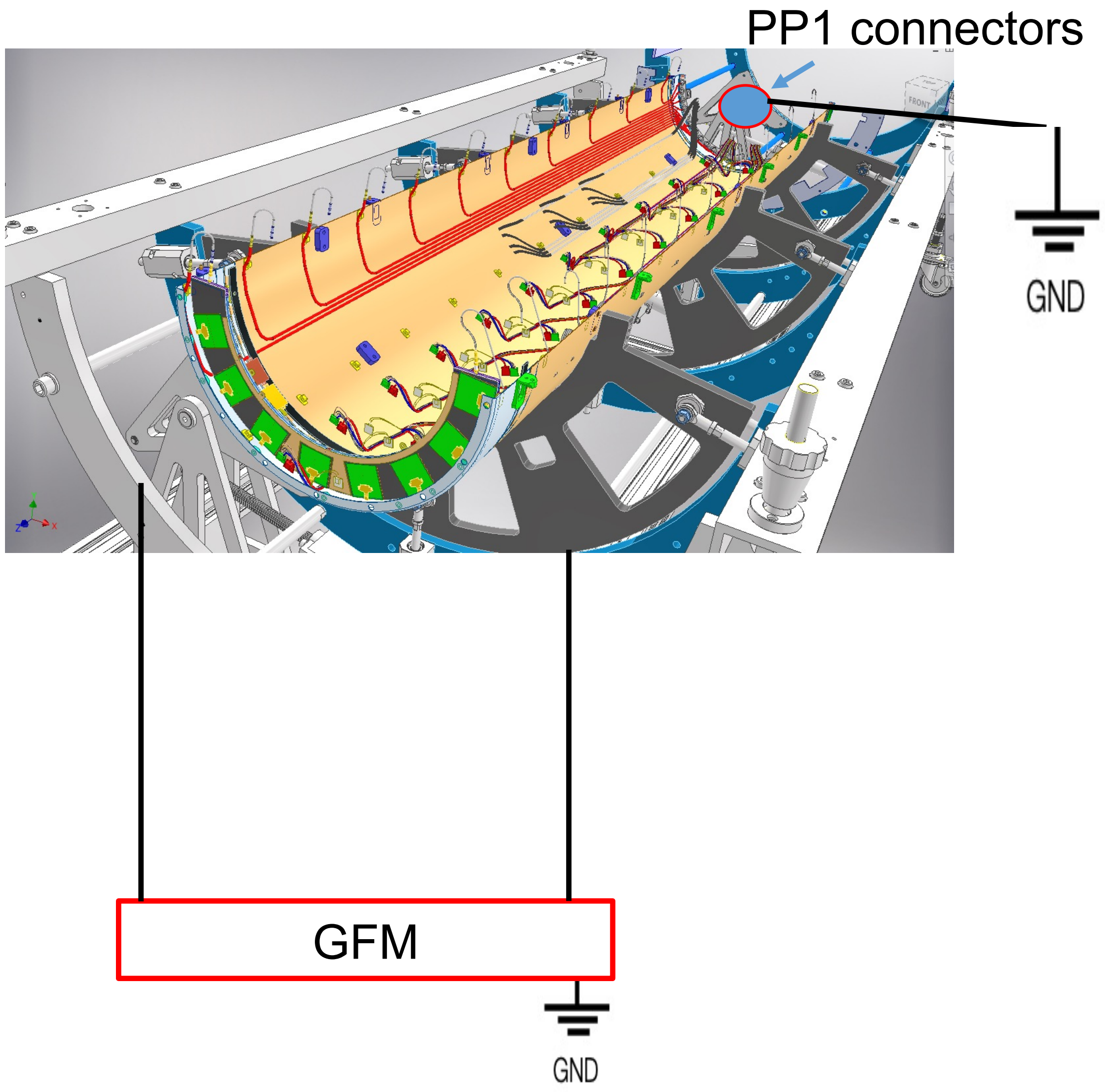
- GFM connected between HS and ground will spot unwanted connection between services and HS
- Grounding through Type2,PS,.. ?

Test after Insertion of data/pwr and env type-1 services

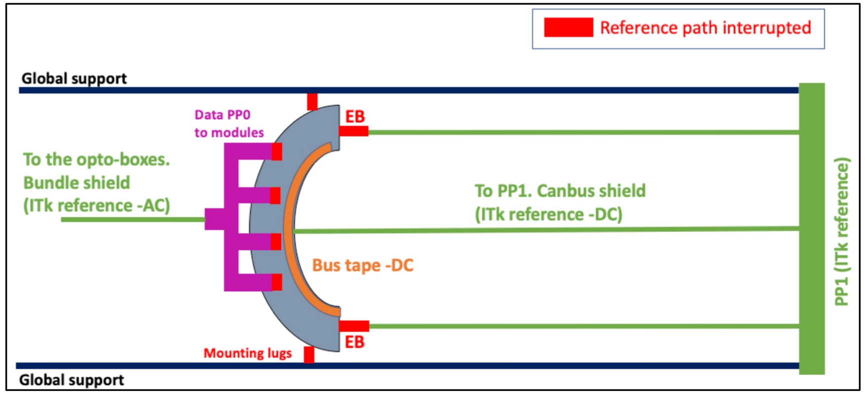
Data Connectivity	
Already Tested	**To be tested after insertion**
Twinax bundle and terminations on insertion tools before installation	Eletr. Continuity between Twinax bundle terminations
Fibers & their connectors	
Twinax Extensions	
Mapping extensions-optoboards-felix	

Electrical Connectivity	
Already Tested	**To be Tested after insertion**
Type-1 pwr and env. bundles and termination on insertion tools before installation	Electr. continuity from PP1 connectors to PCB termination
PP1 connectors, Type2, Type3 cables (all off-detector cables)	Mapping of pwr and env bundles - PP2/PP3 - PSU
	Env. Sensors respone with Localized heat input / ‘cold-spray’ (check on humidity sensors TBD).

Test after insertion of Half-Rings & connection to Electrical services



- After insertion, before connecting the services, the HR should be electrically isolated from HS through mounting lugs
- After services are connected, the HR are grounded through PP1 connectors
- Grounding through Type2,PS,.. ?
- GFM can spot unwanted connection
- See L. Vannoli presentation for baseline proposal



Connectivity Test on each HR before and after welding with Low Power Mode

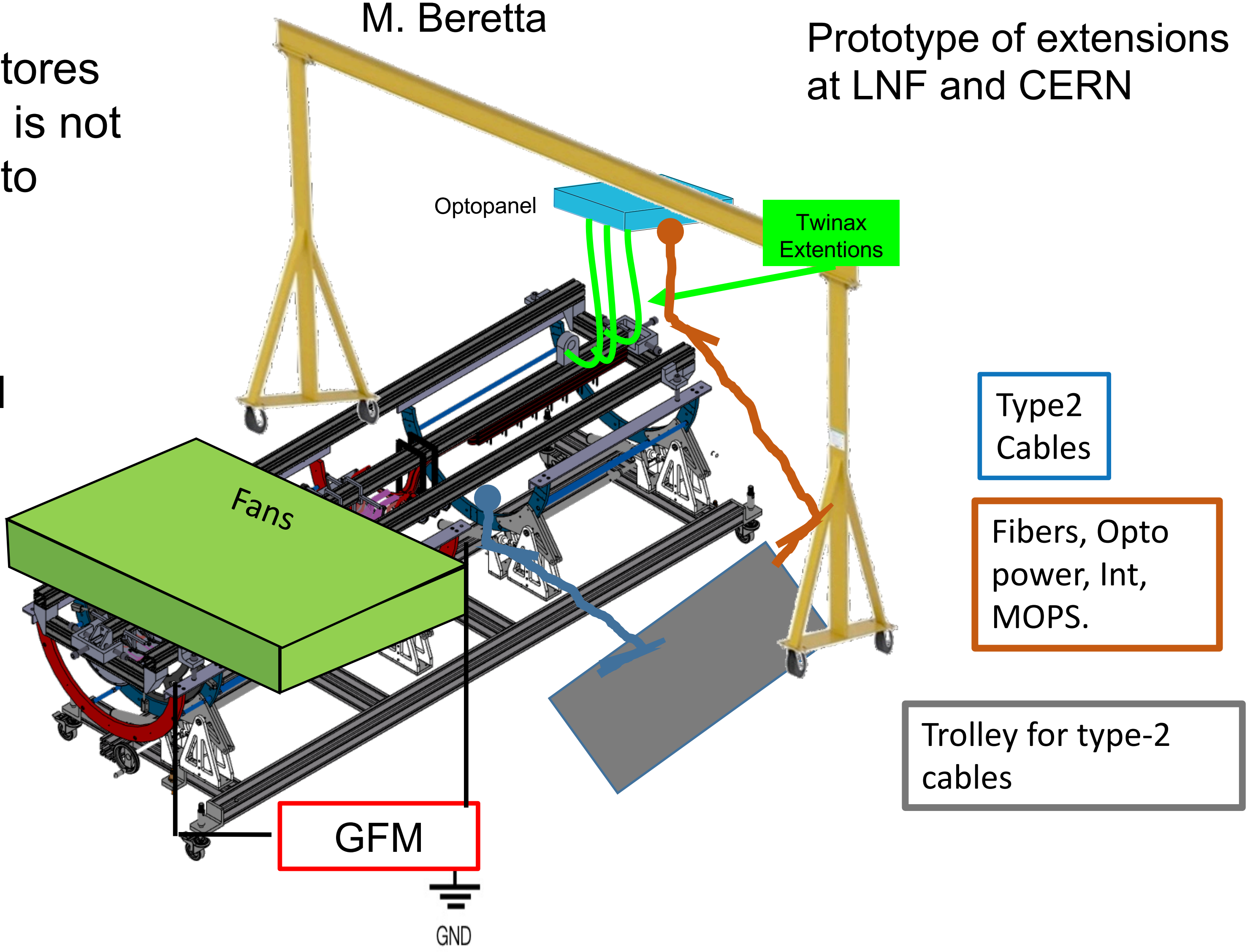
Test after HR insertion: Setup

- Connect the type-2 cable to PP1 connectores
    - If structure holding PP1 connectores is not stiff enough need an external trolley to support type-2 cables

- Optopanel installation on the cradle
    - Connections between extenders and twinax bundles

- Fans installation

- Convective cooling demonostrated with HR prototype (Z. Chubinidze, B. Buadze, backup)

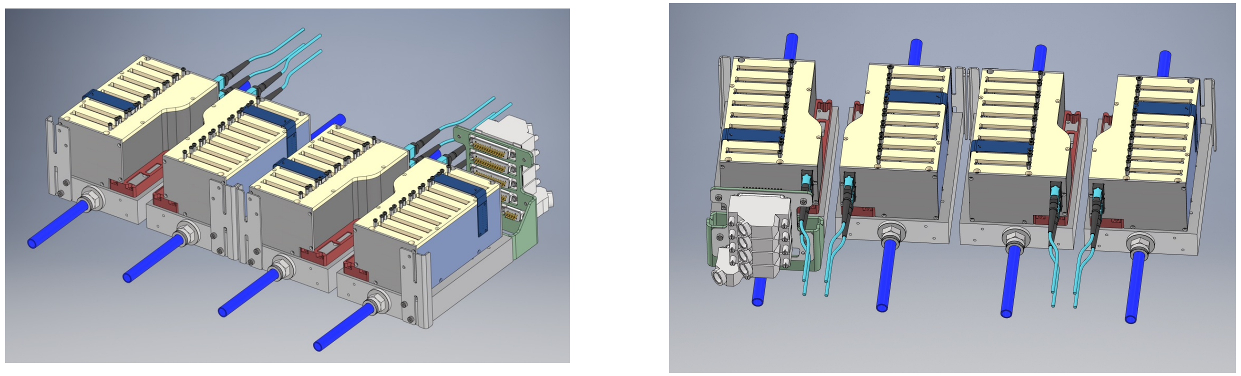

M. Beretta

Prototype of extensions at LNF and CERN

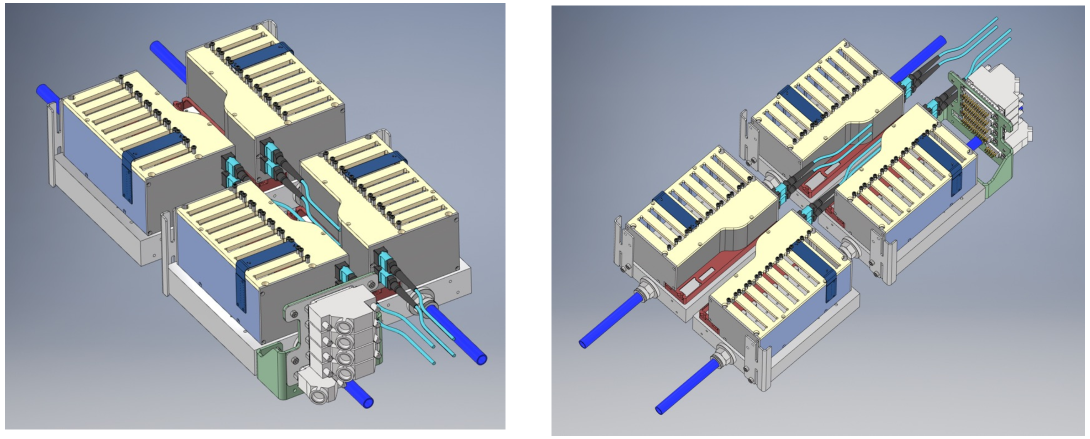
Test after HR insertion: Setup II

- To test EC we would need 4 M and 3 N type optoboxes
- But during EC integration we may use only 4 M optoboxes, if we change SW configuration
- First proposal from Bern group: Optopanel should contains 4 optoboxes
- The optoboxes can then be screwed on mounting plates, to bed designed by ourselves

Option 4x1

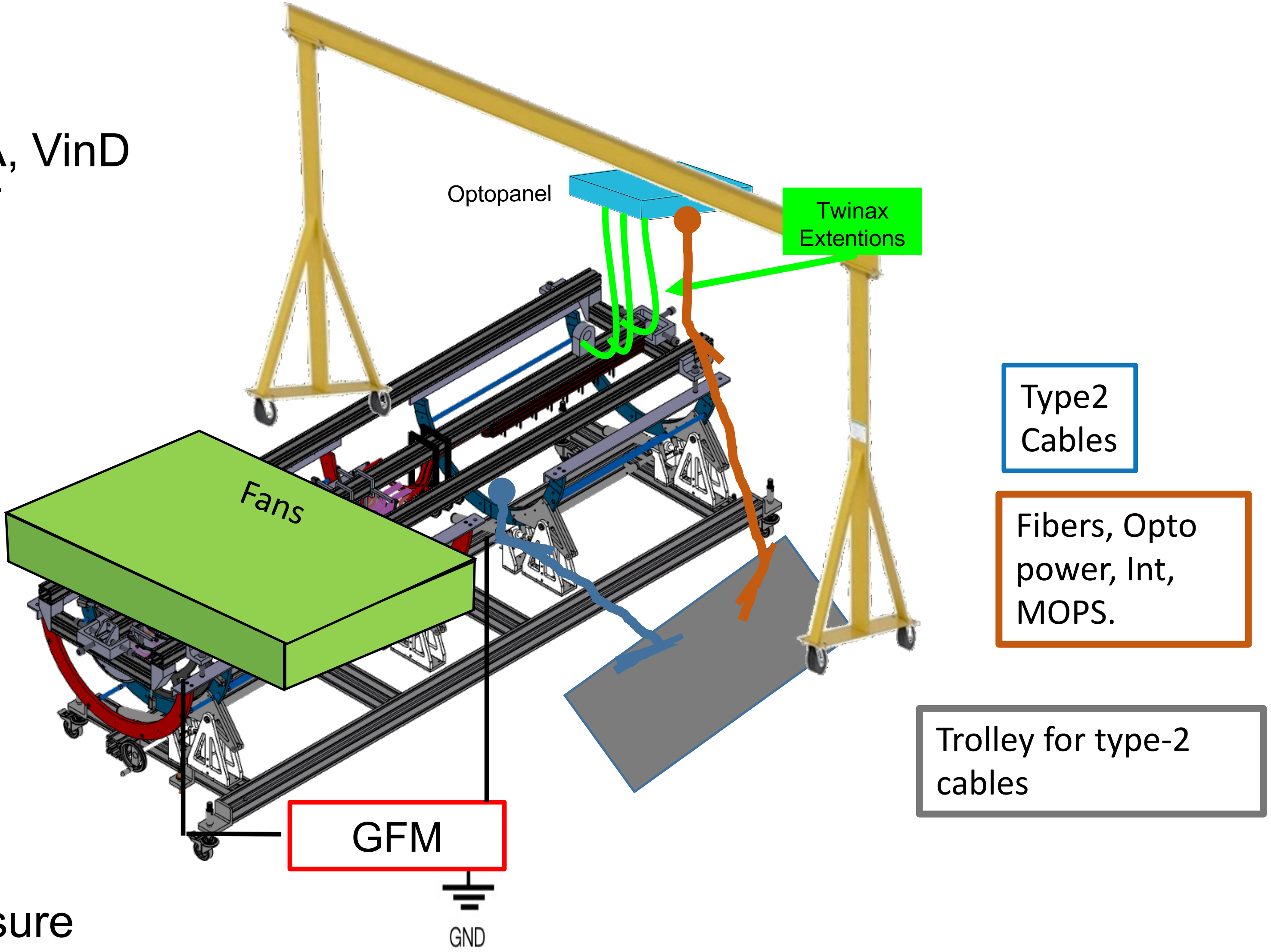


Option 2x2 preferred



Test after HR insertion: LP mode

- Connectivity Test on one HR at the time
  - LV lines:
    - chip register reading: NTC T, VinA, VinD
    - MOPS reading of module V and T
  - data transmission:
    - Uplink: digital scan and BERT
    - Downlink: Configure a FE in each module
  - Tilock
  - HV lines: work in progres
    - PS accuracy ~50 nA not to spot individual modules
    - Option: small bias and light from LED as studied in OB
    - Preferably do not use dark enclosure



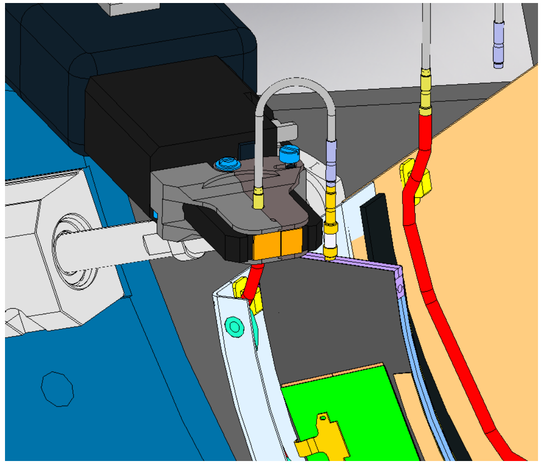
Type2 Cables

Fibers, Opto power, Int, MOPS.

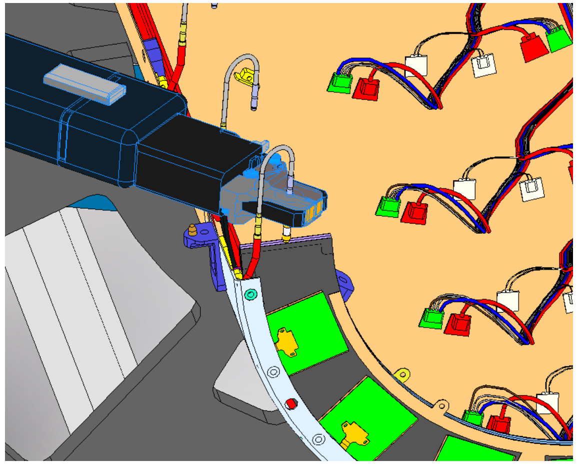
Trolley for type-2 cables

Welding

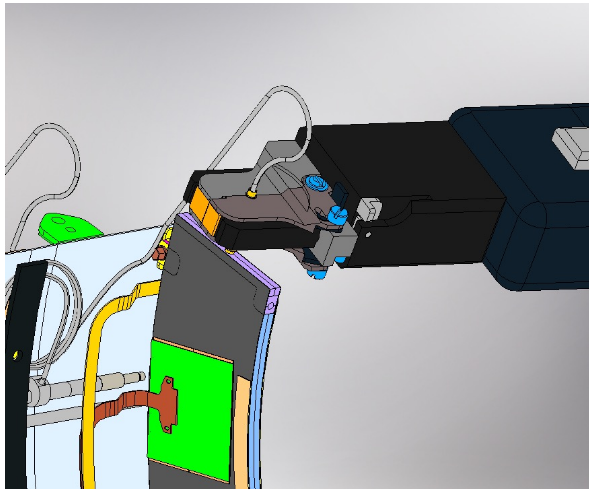
1° exhaust welding



2° exhaust welding



1° inlet welding



- Leak test
- Pressure test 162 bar
- Leak test

- Re-test connectivity one HR at the time after welding to check no damage to module or services

- Repeat until Half-shell is populated
- Choice about gas (Ar in SR1) to be made by the responsible of the welding

Functional and Connectivity test on populated HS with cold CO_2

Functional test on populated Half-Shell

Previous Step: connectivity of individual HRs with LP mode	Current Step: populated HS
Electrical and Data connectivity for each HR	• CO_2 Cooling • GS cooling • Overall connectivity at low T • Thermal cycles • Post-thermal cicle connectivity at low T

Equipment

Full equipment for EC integration in ITkPixelIntegration-ElectrialEquipment-v10_docx_cpdf.pdf

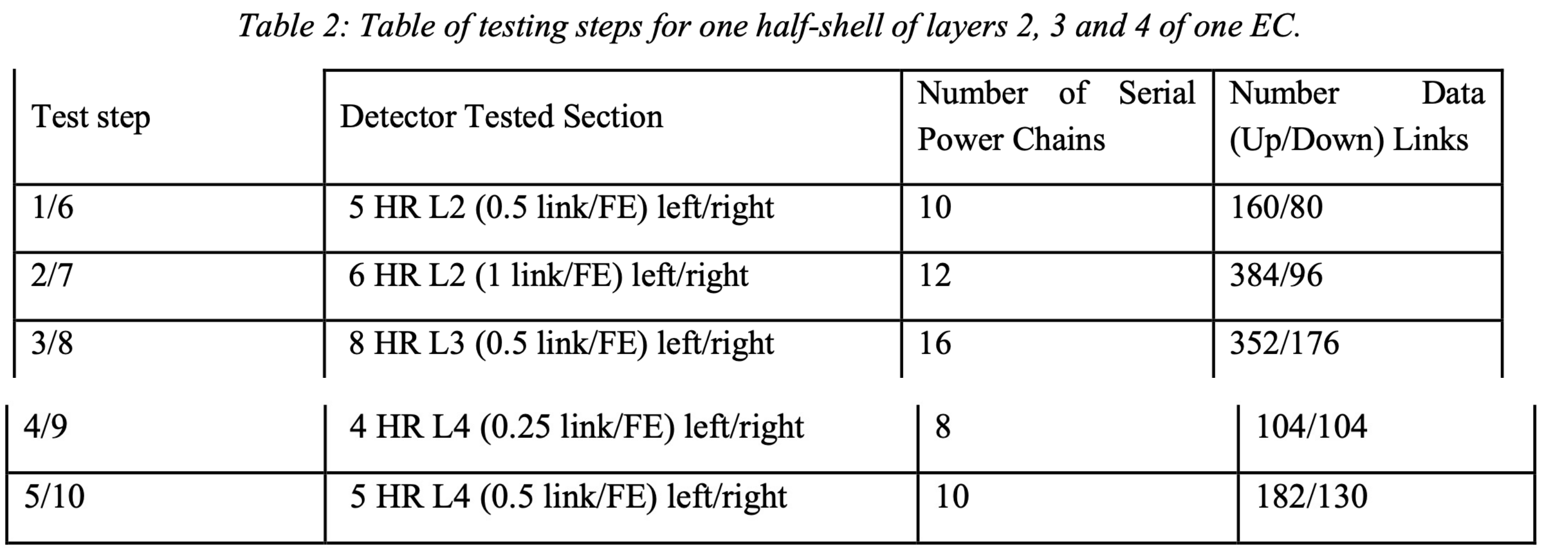


Table 2: Table of testing steps for one half-shell of layers 2, 3 and 4 of one EC.

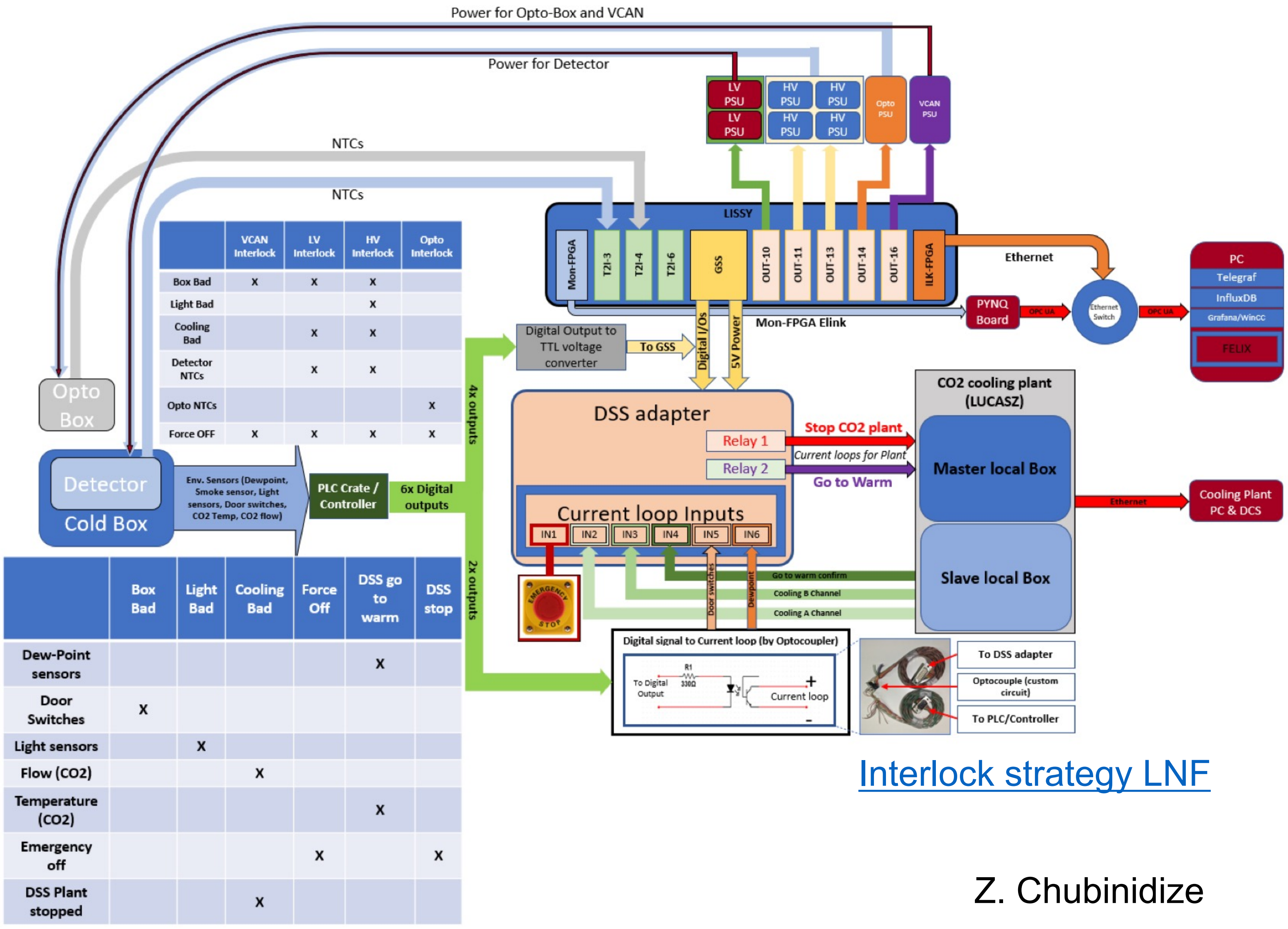
Test step	Detector Tested Section	Number of Serial Power Chains	Number Data (Up/Down) Links
1/6	5 HR L2 (0.5 link/FE) left/right	10	160/80
2/7	6 HR L2 (1 link/FE) left/right	12	384/96
3/8	8 HR L3 (0.5 link/FE) left/right	16	352/176
4/9	4 HR L4 (0.25 link/FE) left/right	8	104/104
5/10	5 HR L4 (0.5 link/FE) left/right	10	182/130

The largest testing step and thus required equipment is step 3.

- 4 PP1 connector, 4 type-2 cables,
- 1 Env-terminal PP1 connector (2 wire T-sensor), 1 Extra Env PP1 connector, 2 Env. Type-2 cable
- 2(4) LV(HV) PSU
- 32 twinax bundles, 3 trunk fibers
- …

Interlock

- PLC handles environmental sensors insides test box
- PLC provides outputs for LISSY interlock matrix
- Need to define number of sensor to proceed with order, common to OB



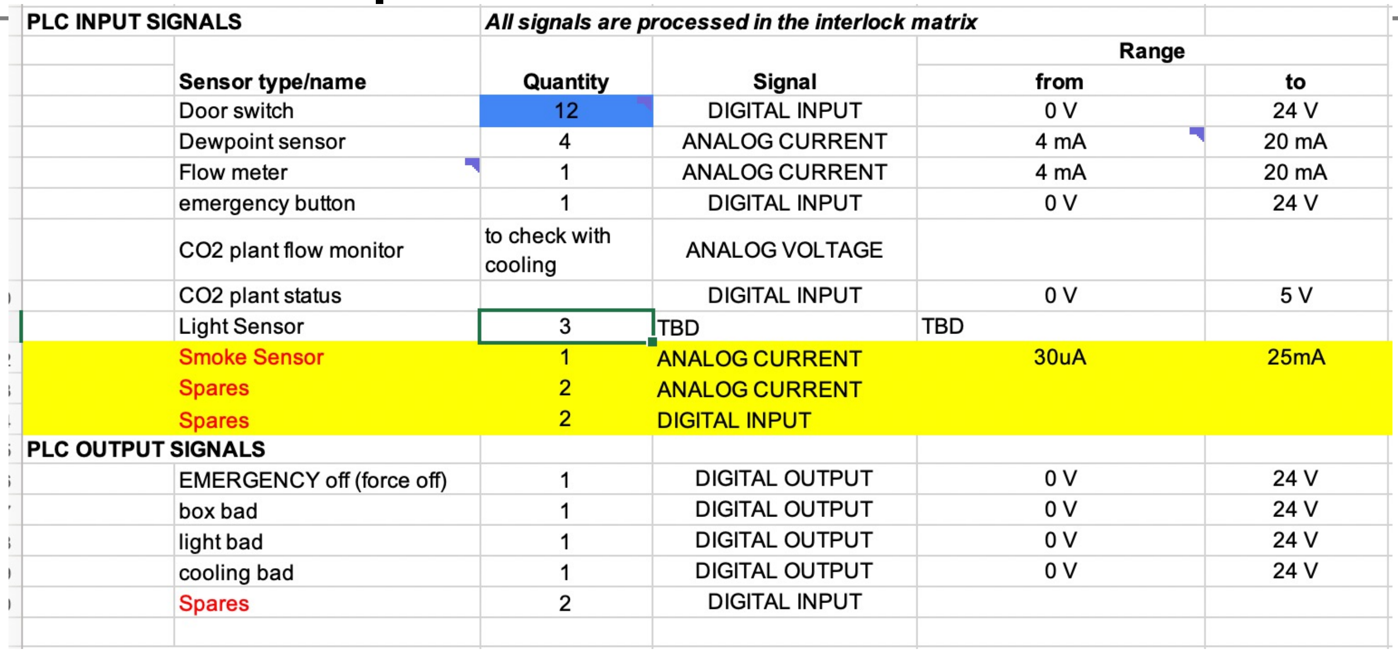
	VCAN Interlock	LV Interlock	HV Interlock	Opto Interlock
Box Bad	x	x	x	
Light Bad			x	
Cooling Bad		x	x	
Detector NTCs		x	x	
Opto NTCs				x
Force OFF	x	x	x	x

	Box Bad	Light Bad	Cooling Bad	Force Off	DSS go to warm	DSS stop
Dew-Point sensors					X	
Door Switches	X					
Light sensors		X				
Flow (CO2)			X			
Temperature (CO2)					X	
Emergency off				X		X
DSS Plant stopped			X			

Interlock strategy LNF

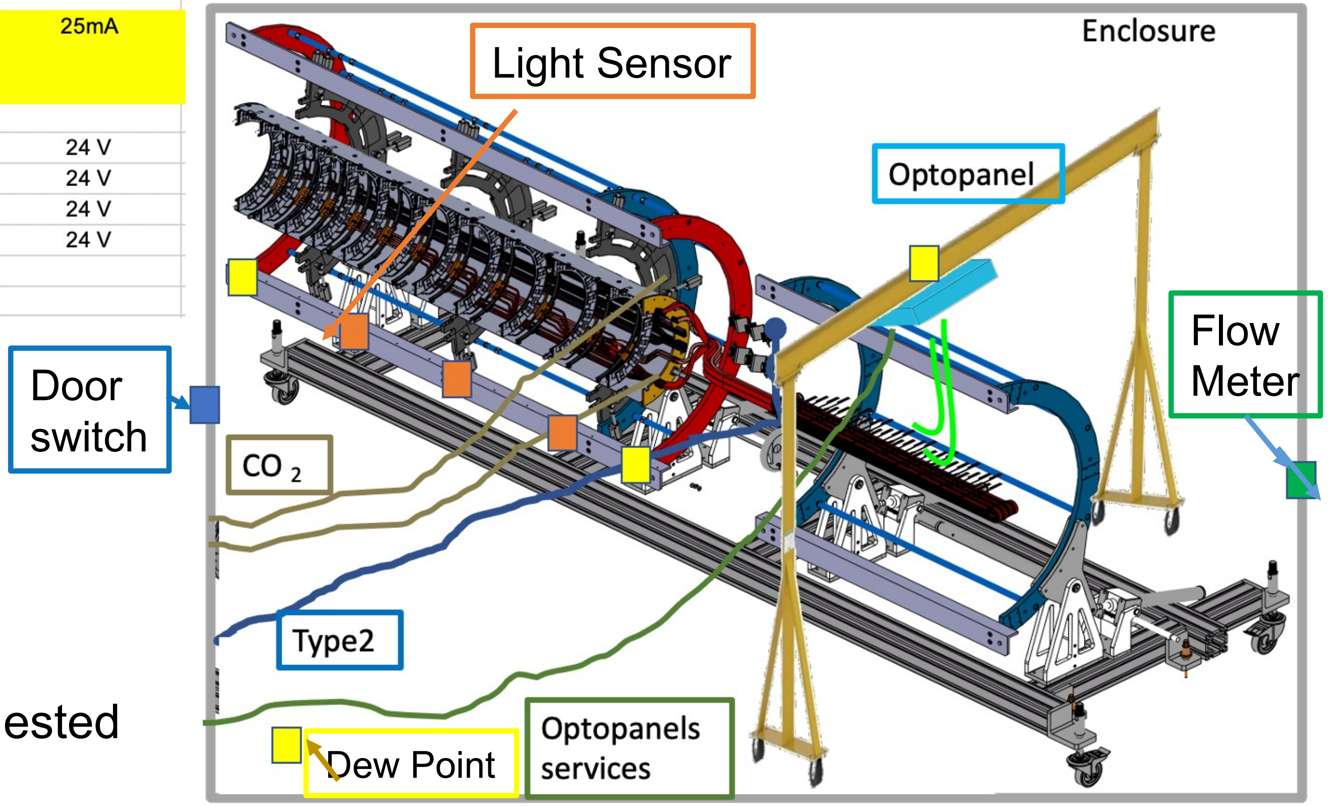
Z. Chubinidize

PLC inputs

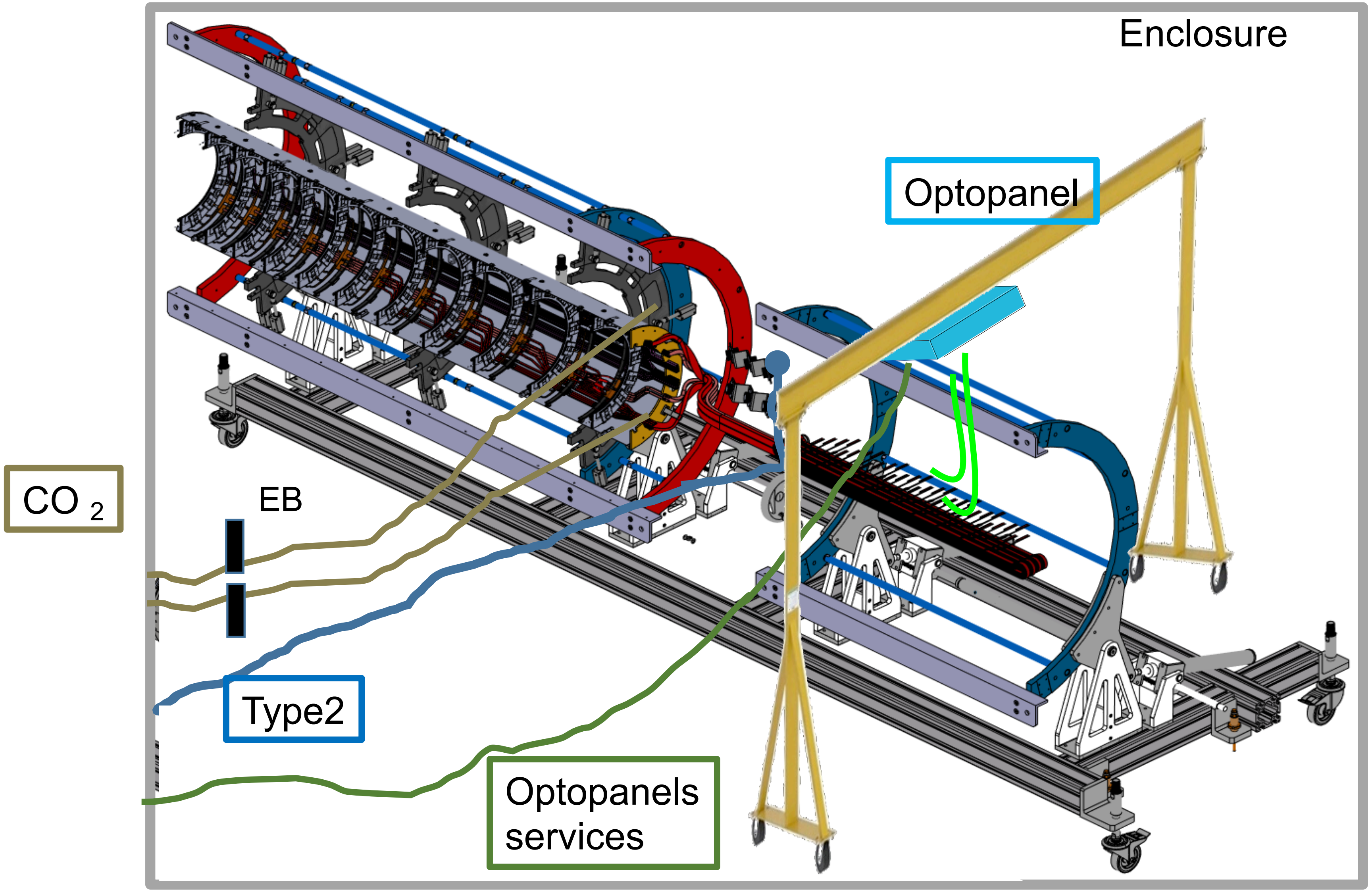


PLC INPUT SIGNALS		***All signals are processed in the interlock matrix***			
				Range	
	Sensor type/name	**Quantity**	**Signal**	**from**	**to**
	Door switch	12	DIGITAL INPUT	0 V	24 V
	Dewpoint sensor	4	ANALOG CURRENT	4 mA	20 mA
	Flow meter	1	ANALOG CURRENT	4 mA	20 mA
	emergency button	1	DIGITAL INPUT	0 V	24 V
	CO2 plant flow monitor	to check with cooling	ANALOG VOLTAGE		
	CO2 plant status		DIGITAL INPUT	0 V	5 V
	Light Sensor	3	TBD	TBD	
	Smoke Sensor	1	ANALOG CURRENT	30uA	25mA
	Spares	2	ANALOG CURRENT		
	Spares	2	DIGITAL INPUT		
PLC OUTPUT SIGNALS					
	EMERGENCY off (force off)	1	DIGITAL OUTPUT	0 V	24 V
	box bad	1	DIGITAL OUTPUT	0 V	24 V
	light bad	1	DIGITAL OUTPUT	0 V	24 V
	cooling bad	1	DIGITAL OUTPUT	0 V	24 V
	Spares	2	DIGITAL INPUT		

- Starting list from Outer Barrel edms doc
- In red proposal modification for Endcap
- Note: the PLC will be same for EC and OB. The requested channels will be the sum of the two.



Test on populated Half-Shell: Setup



- Move HS into climate chamber which serve also as test box
- Connect type 2 cables
- Connect twinax extensions
- Need EB between cooling transfer lines from lucasz plant and on-detector cooling pipes to reduce noise fr
- GFM is connected

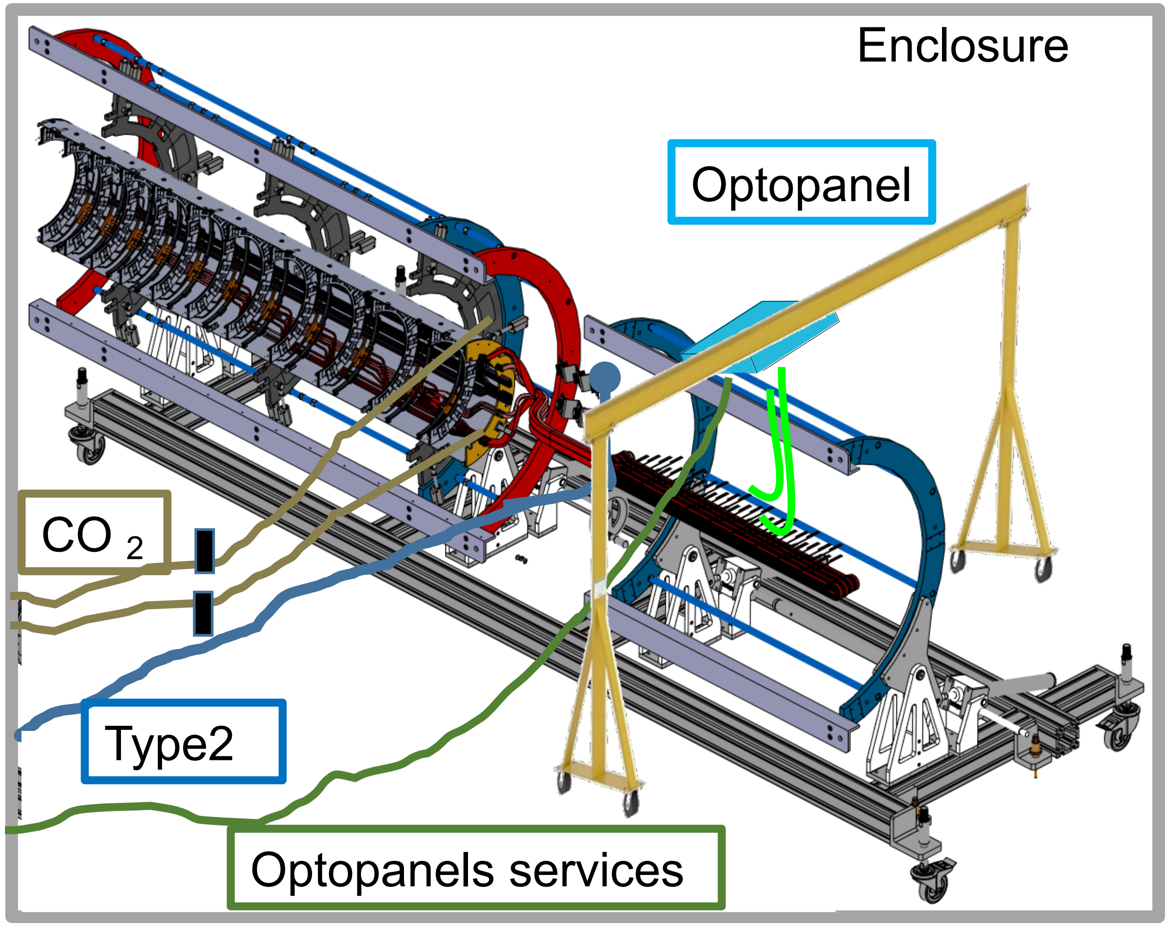
OEC Half-cylinder integration & test

- Move HS into climate chamber which serve also as test box

- Function cold test
  - Dew Point < -60 C
  - $T_{ev\ CO2}$ ~ -15 C
  - Normal powering mode
  - Digital, Analog, Threshold scan, Disconnected bump-bond scan

- Thermal cycle [+40 – 45C]
  - Detector Off
  - All service can be kept inside (TBC)

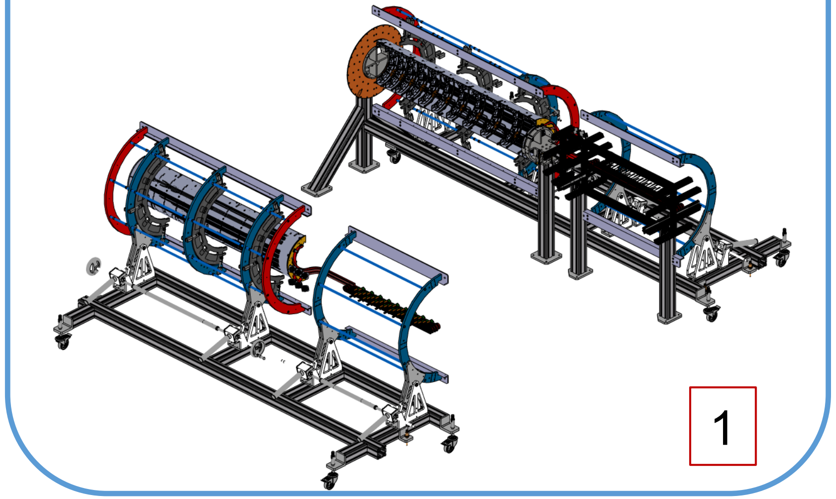
- Repeat cold test



Connectivity test on Complete layer

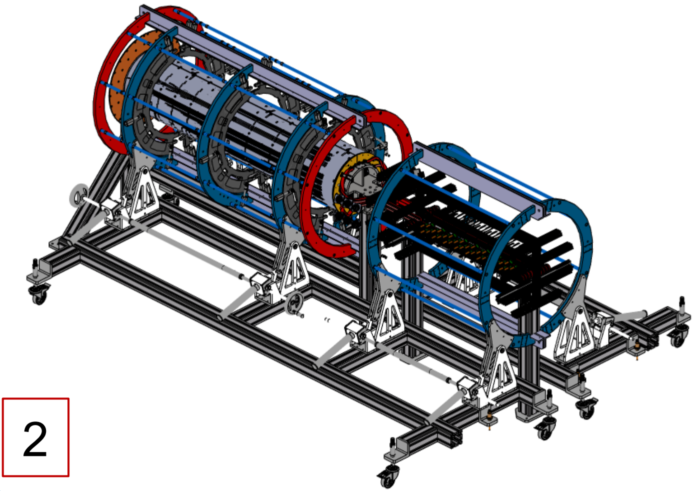
HS mating

L2 Half Cylinders are brought into the central support tool on floor rail system (not shown)



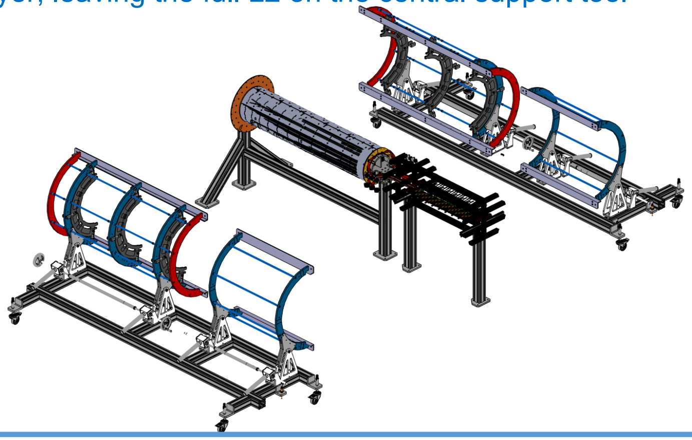
1

L2 Services are transferred onto the



2

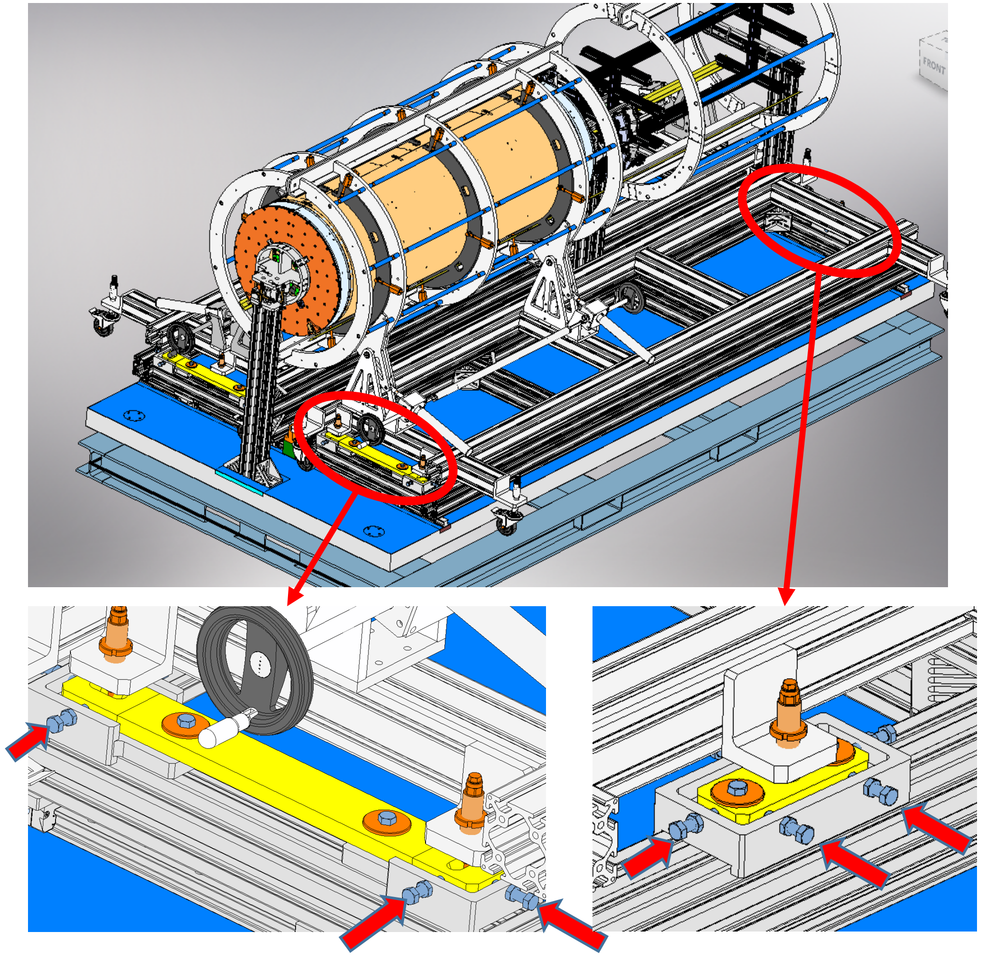
Rotating tools are slid away to be used for another layer, leaving the full L2 on the central support tool



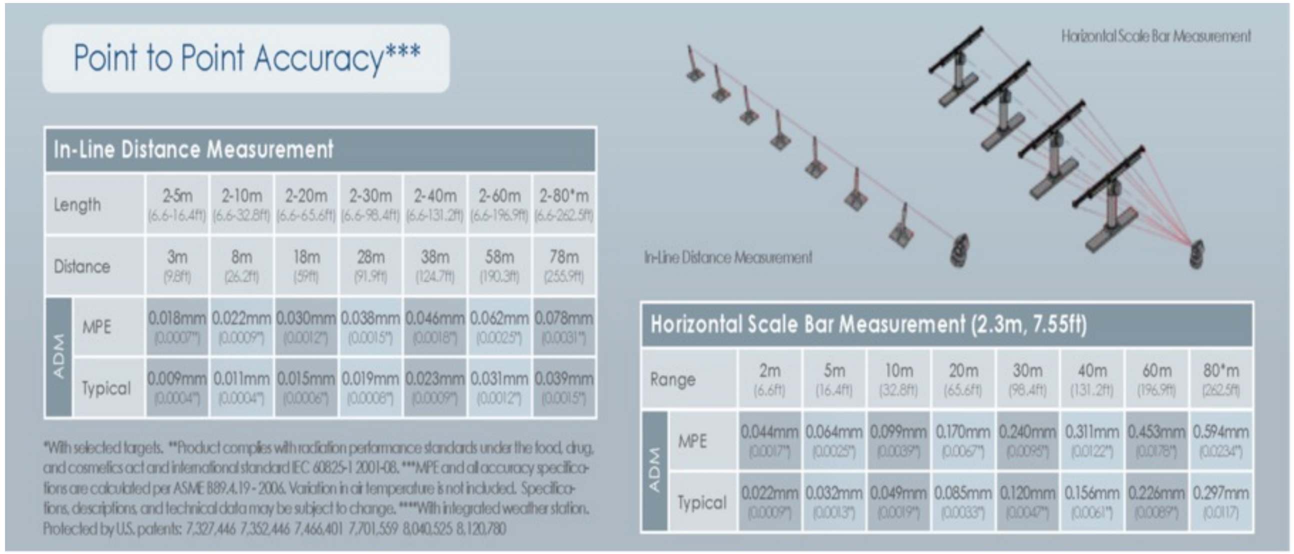
3

- The layer on the central tool is ready to be tested.
- Two options for the enclosure:
  - In Climate chamber (baseline)
    - Need to move for some meters
  - Using external box made of removable panel
- Cooling with climate chamber only using halved flux of CO_2, both using LP mode: feasibility demonstrated with HR prototype

HS mating (continue): alignment



- Tool is sitting on 3 points allowing vertical,horizontal and angolar movements
- The empty HS are pre-aligned (SL 5)
- After HS loading, re-adjust alignment if needed
- An optical survey of the tool and of the detector foreseen with a laser tracker.



Point to Point Accuracy***

In-Line Distance Measurement

Length		2-5m (6.6-16.4ft)	2-10m (6.6-32.8ft)	2-20m (6.6-65.6ft)	2-30m (6.6-98.4ft)	2-40m (6.6-131.2ft)	2-60m (6.6-196.9ft)	2-80*m (6.6-262.5ft)
Distance		3m (9.8ft)	8m (26.2ft)	18m (59ft)	28m (91.9ft)	38m (124.7ft)	58m (190.3ft)	78m (255.9ft)
ADM	MPE	0.018mm (0.0007")	0.022mm (0.0009")	0.030mm (0.0012")	0.038mm (0.0015")	0.046mm (0.0018")	0.062mm (0.0025")	0.078mm (0.0031")
	Typical	0.009mm (0.0004")	0.011mm (0.0004")	0.015mm (0.0006")	0.019mm (0.0008")	0.023mm (0.0009")	0.031mm (0.0012")	0.039mm (0.0015")

*With selected targets. **Product complies with radiation performance standards under the food, drug, and cosmetics act and international standard IEC 60825-1 2001-08. ***MPE and all accuracy specifications are calculated per ASME B89.4.19 - 2006. Variation in air temperature is not included. Specifications, descriptions, and technical data may be subject to change. ****With integrated weather station. Protected by U.S. patents: 7,327,446 7,352,446 7,466,401 7,701,559 8,040,525 8,120,780

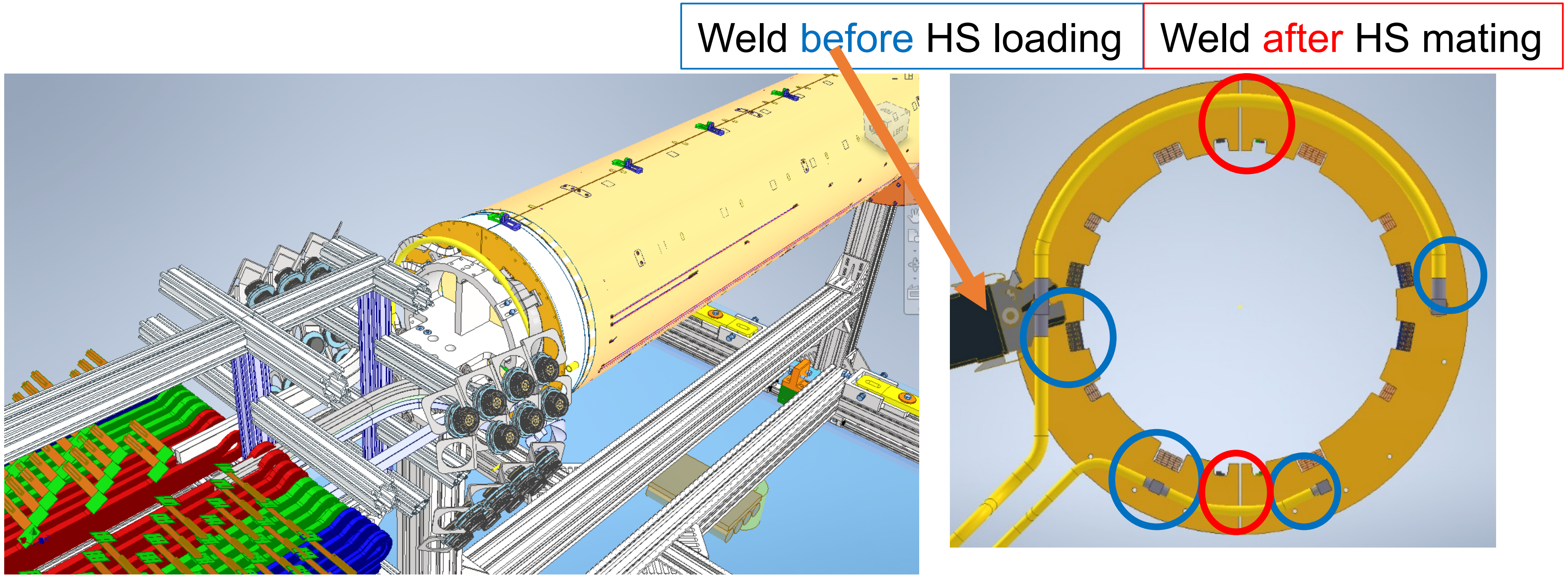
Horizontal Scale Bar Measurement

In-Line Distance Measurement

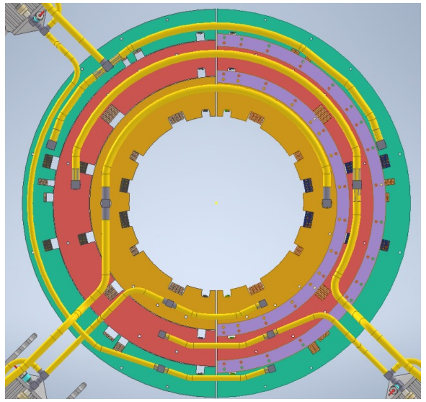
Horizontal Scale Bar Measurement (2.3m, 7.55ft)

Range		2m (6.6ft)	5m (16.4ft)	10m (32.8ft)	20m (65.6ft)	30m (98.4ft)	40m (131.2ft)	60m (196.9ft)	80*m (262.5ft)
ADM	MPE	0.044mm (0.0017")	0.064mm (0.0025")	0.099mm (0.0039")	0.170mm (0.0067")	0.240mm (0.0095")	0.311mm (0.0122")	0.453mm (0.0178")	0.594mm (0.0234")
	Typical	0.022mm (0.0009")	0.032mm (0.0013")	0.049mm (0.0019")	0.085mm (0.0033")	0.120mm (0.0047")	0.156mm (0.0061")	0.226mm (0.0089")	0.297mm (0.0117)

Manifold weldings in PP1 volume

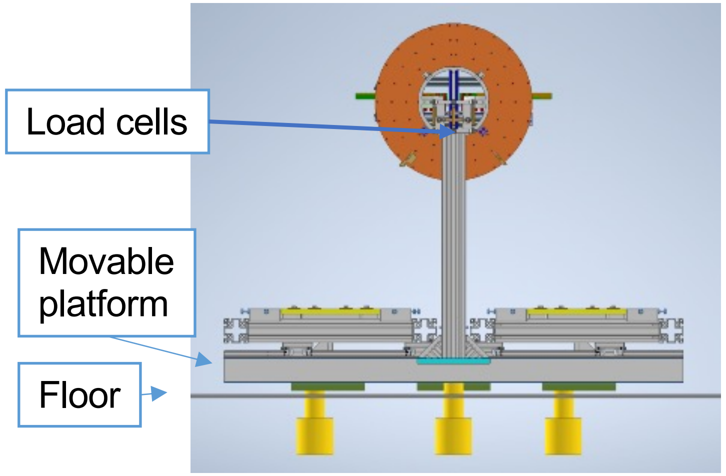

Weld before HS loading

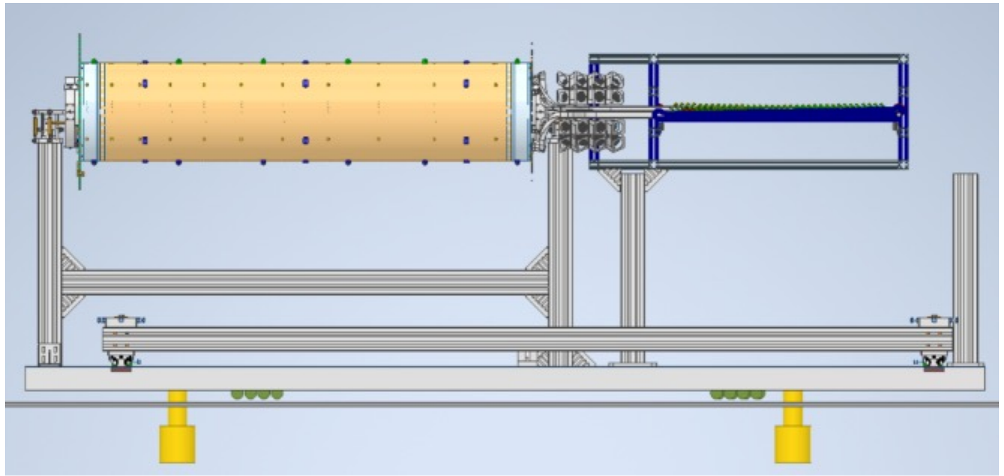
Weld after HS mating



To be decided: electrical test before and after manifold welding?

Tool to move Layer

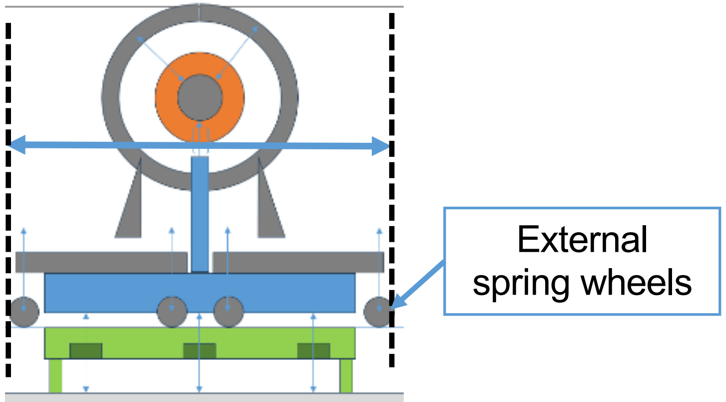




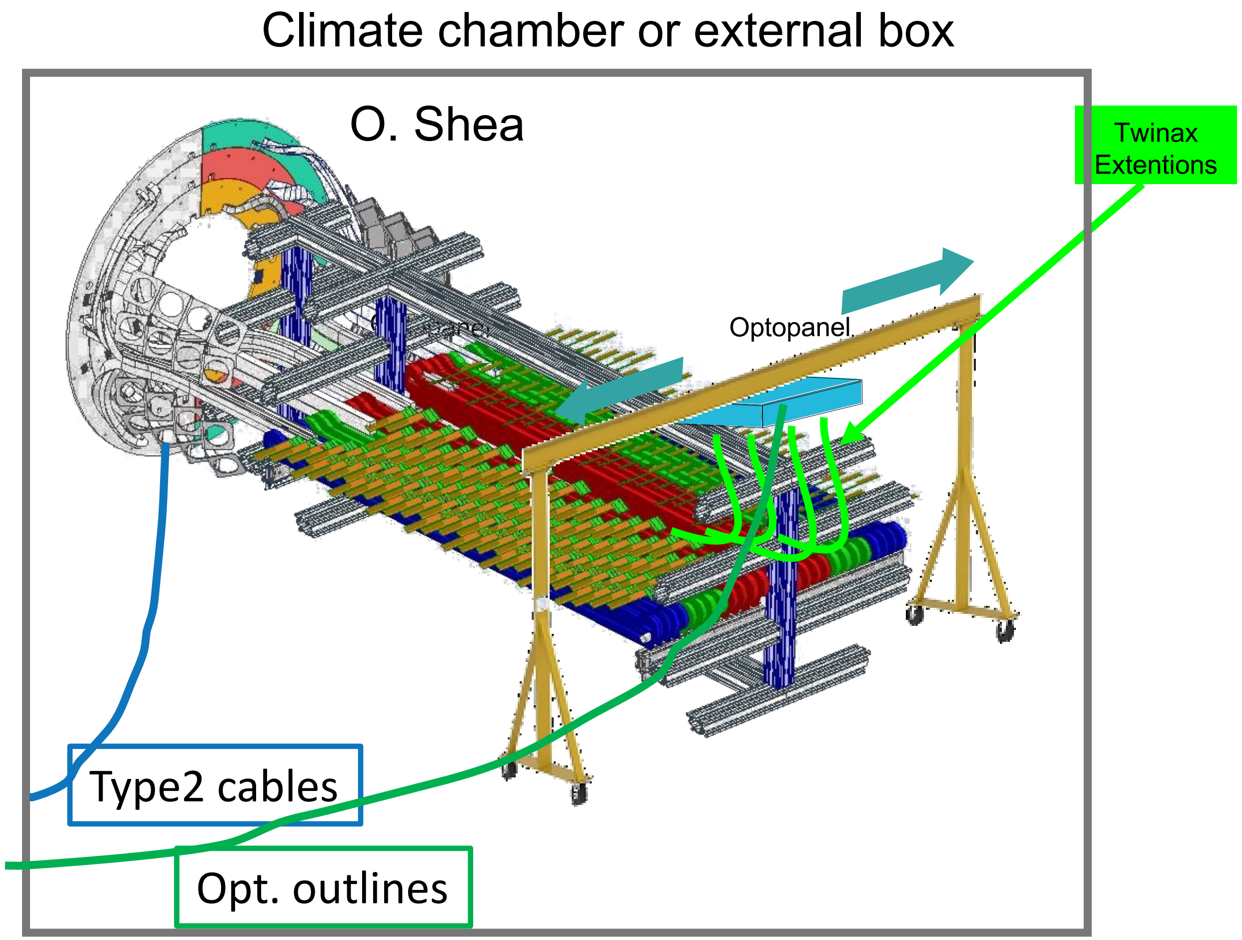
- Under design a movable platform which supports the central tool

- Passive and active pillars (only active shown in the pictures) passing through the fixed platform at the floor level

- Embedded wheels or external spring wheels

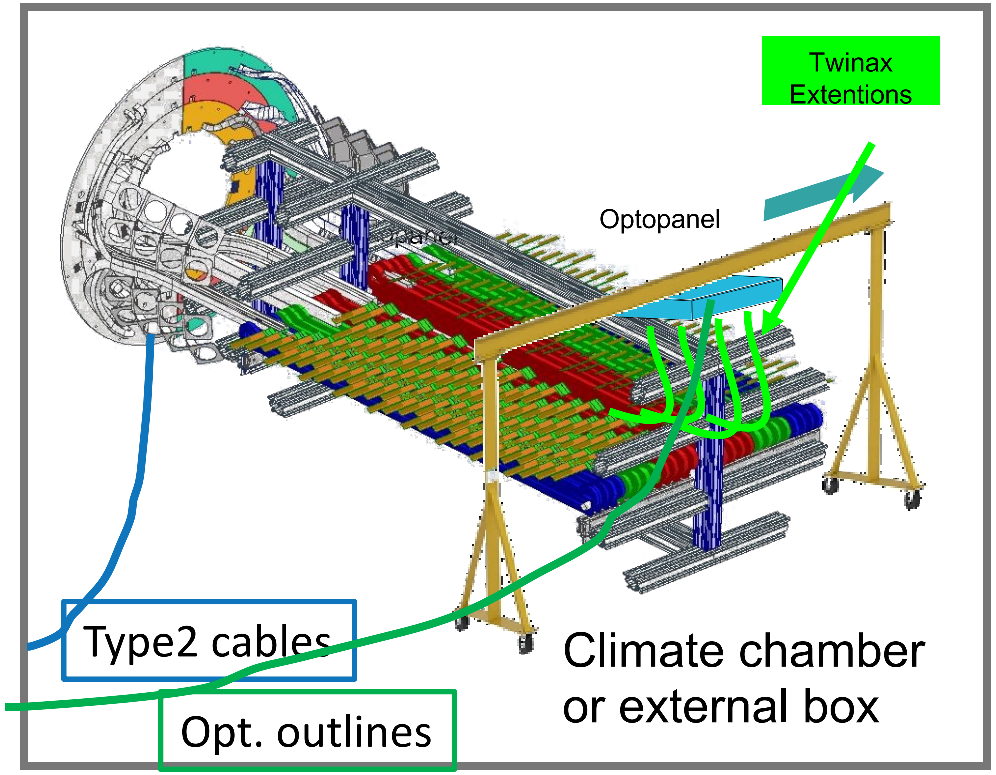


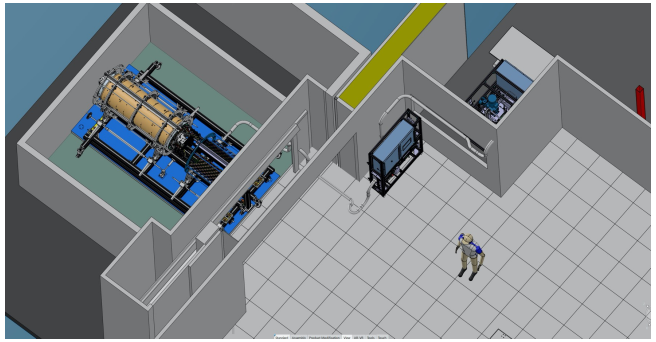
Test on full layers: Setup



- Connect type 2 cables
- Connect twinax extensions
- Plug and un-plug type-2 cables from PP1 connectors and twinax extension from termination board, to test all detector regions

Test on complete Layer: LP test





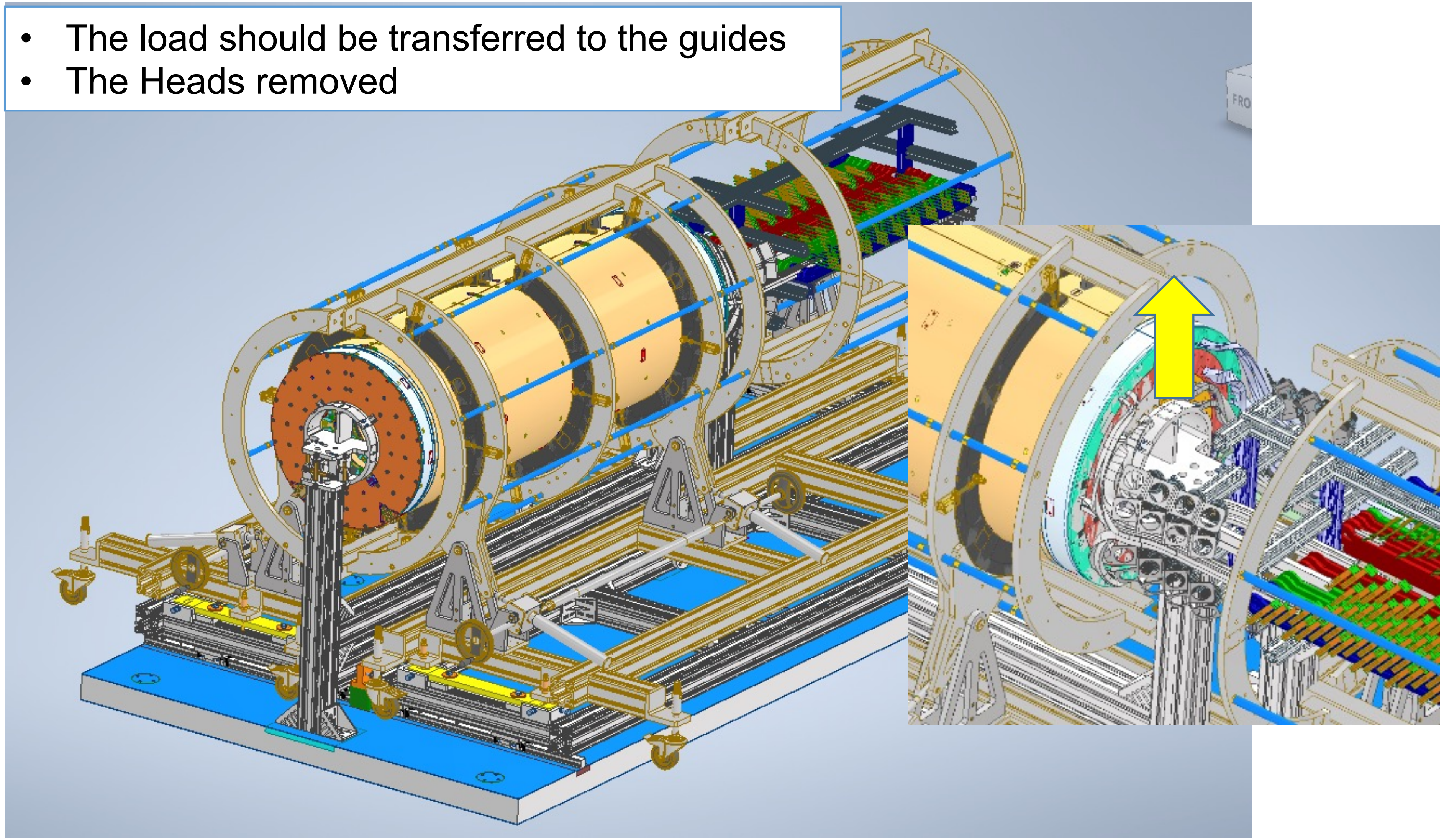
- Connectivity Test for complete layer
  - Use Lowe Power mode
  - Cooling through climate chamber
    - Demonstrated with prototype with. T_{air} ~ - 35 C (Z. Chubinidze, B. Buadze)
  - CO_2 cooling is still possible

- LV lines:
  - chip register reading: NTC T, VinA, VinD
  - MOPS reading of module V and T
- Data transmission:
  - Uplink: digital scan and BERT
  - Downlink: Configure a FE in each module

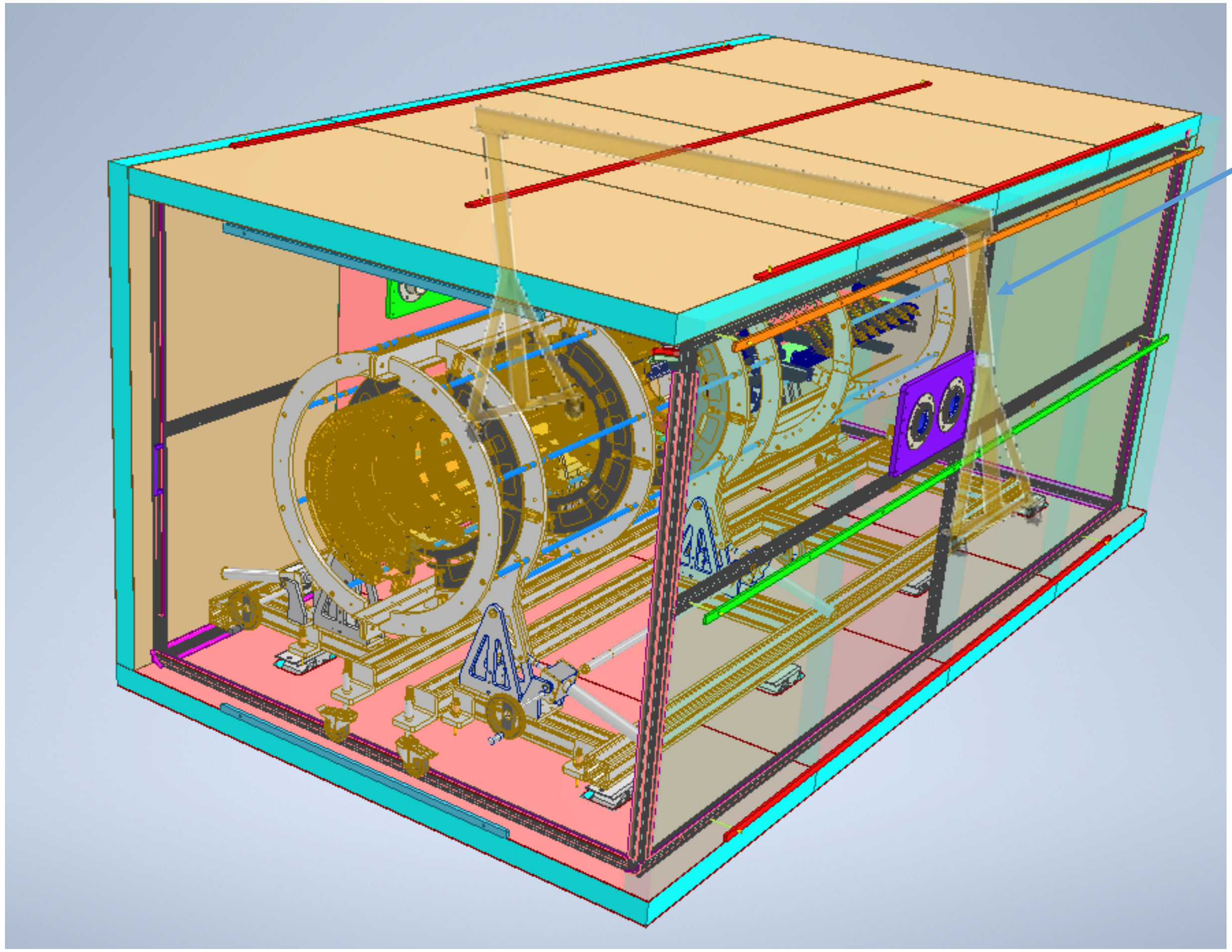
- HV lines: Under Investigation. Can not use light because structure is closed
- Tilock and MOPS readback

Complete Endpcap

- The load should be transferred to the guides
- The Heads removed



Endcap test in Transport Box: Setup

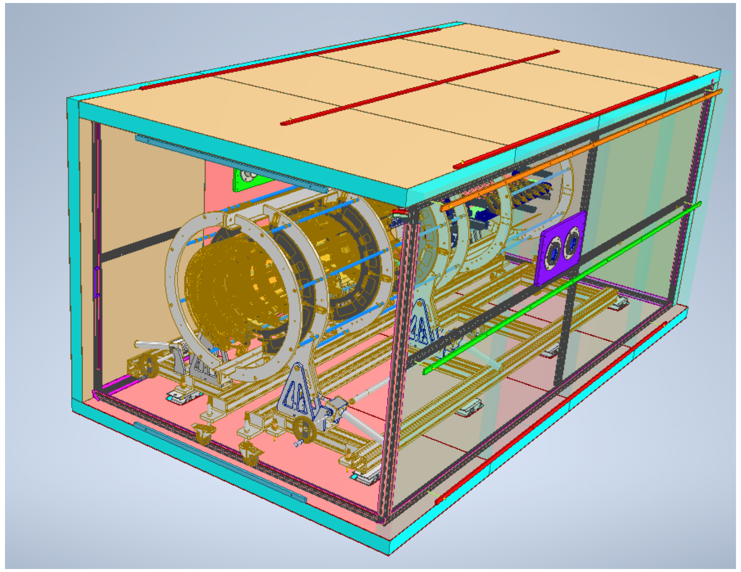


- Support structure for Optopanel insed

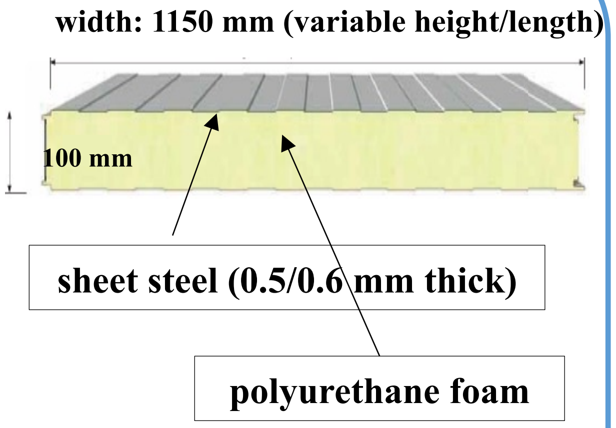
- Connect type 2 cables

- Connect twinax extensions
- Connect CO_2 lines
  - Cooling with halved Flux in LP mode demonstrted with HR prototype (backup)
- Plug and un-plug type-2 cables from PP1 connectors and twinax extension from termination board, to test all detector region

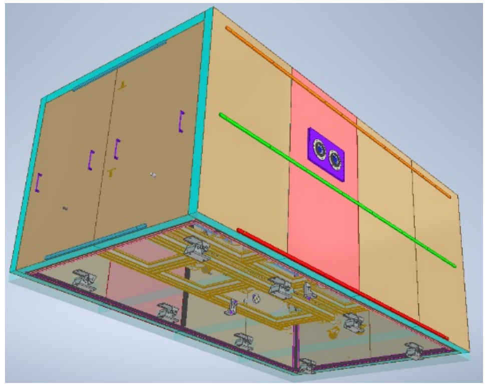
Transport Box



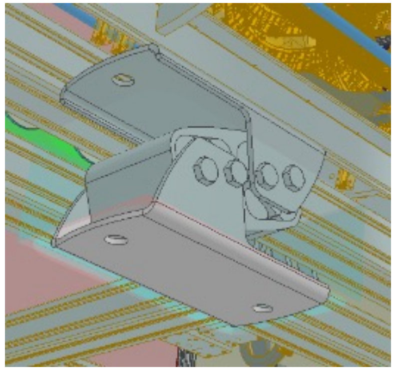
Every wall is composed by panels, inserted one by one using sliders and fixed by pins and aluminum rods.



Nominal Panel Thickness mm	100
Thermal Transmittance U (W/m^2K)	0.22
Annex A.10 of the European standard EN 14509	



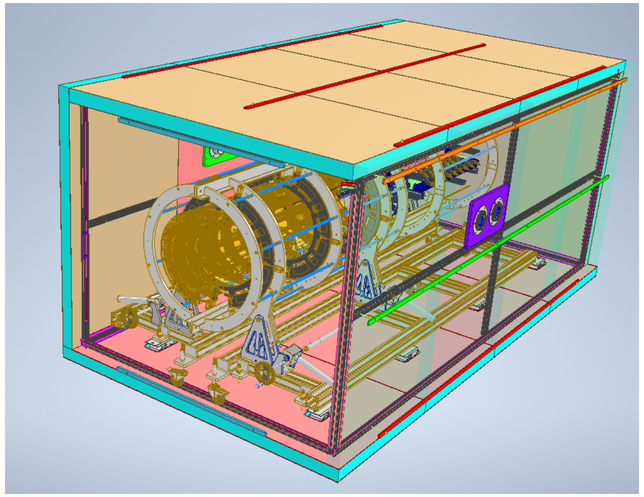
S. Tomassini



Design of Dumping System on going

Reception Test at SR1

- Use Transport Box as Enclosure
- Feedthoughs for services and CO_2 pipes
- Same testing steps as in integratino sites
- Same equipment used in Integration site
- At SR1 no cooling limitation
    - Test with CO_2 there instead of a LP mode for the final tests in integration site



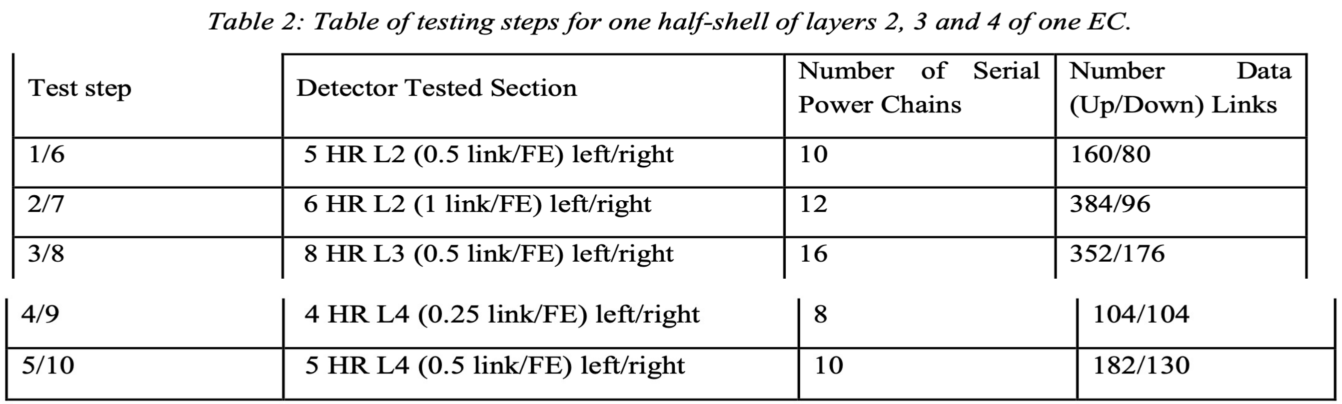


Table 2: Table of testing steps for one half-shell of layers 2, 3 and 4 of one EC.

Test step	Detector Tested Section	Number of Serial Power Chains	Number Data (Up/Down) Links
1/6	5 HR L2 (0.5 link/FE) left/right	10	160/80
2/7	6 HR L2 (1 link/FE) left/right	12	384/96
3/8	8 HR L3 (0.5 link/FE) left/right	16	352/176
4/9	4 HR L4 (0.25 link/FE) left/right	8	104/104
5/10	5 HR L4 (0.5 link/FE) left/right	10	182/130

ITkPixelIntegration-ElectrialEquipment-v10_docx_cpdf.pdf

Connectivity test on completed layers

Previous Step: tests on HS	To be tested	How?

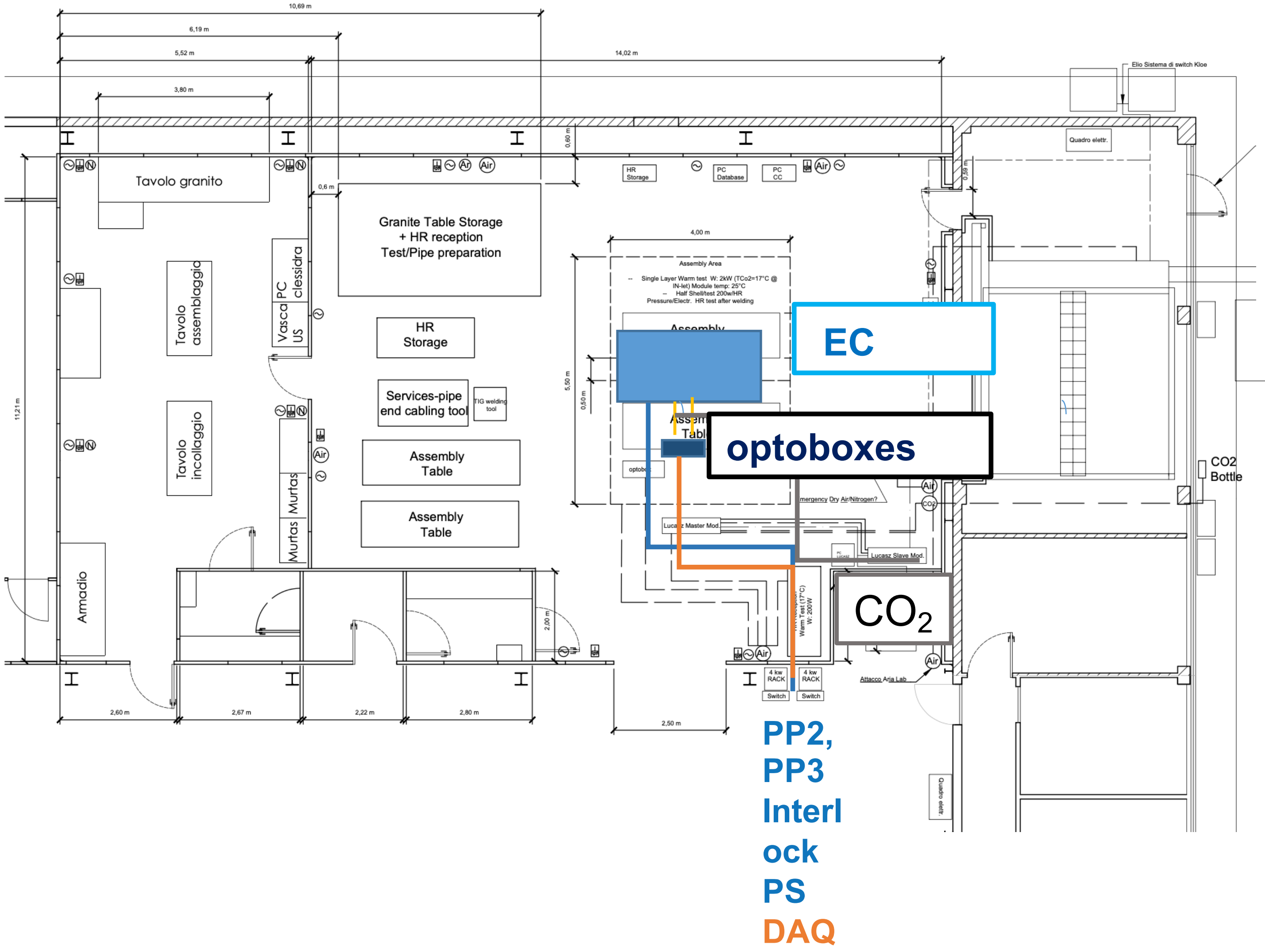
• Overall connectivity at low T pre and after thermal cycle on individual HS
• CO_2 Cooling
	Connectivity of complete layer after mating	**Pending:**
		• tests before or after (preferred) welding of manifolds
		• **Granularity** same as for individual HS
		• **Cooling options**
		  • Low pow mode in climate chamber
		  • Nominal (Small) flux CO_2 + low power mode if manifolds are not (are) welded
		  • Nominal (Small) flux CO_2 + low power mode in climate chamber if manifolds are not (are) welded
		Test:
		• Short connectivity test: configure one module per SP chain all return data lines with digital scan or electrical&optical alignment

Connectivity test on complete endcap

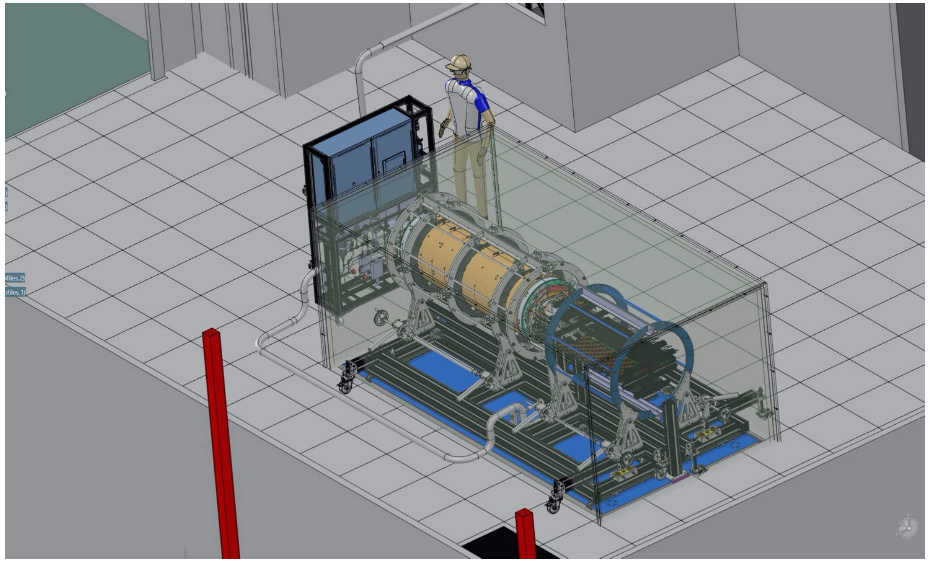
Connecivity test on complete endcap

Already checked in previous steps	To be tested	How
Overall connectivity • For HS at low T CO_2 • For completed layer at high T CO_2 and/or LP mode	• Full endcap connectivity • Final Comissioning Test • Reference for SR1 post-shipment test	**Granularity** same as for individual HS **Where**: TBD in shipping box or climate chamber **Cooling options** • Low pow mode in climate chamber • Small flux CO_2 + low power mode • Small flux CO_2 + low power mode in climate chamber **Test:** • Short connectivity test: configure one module per SP chain all return data lines with digital scan or electrical&optical alignment

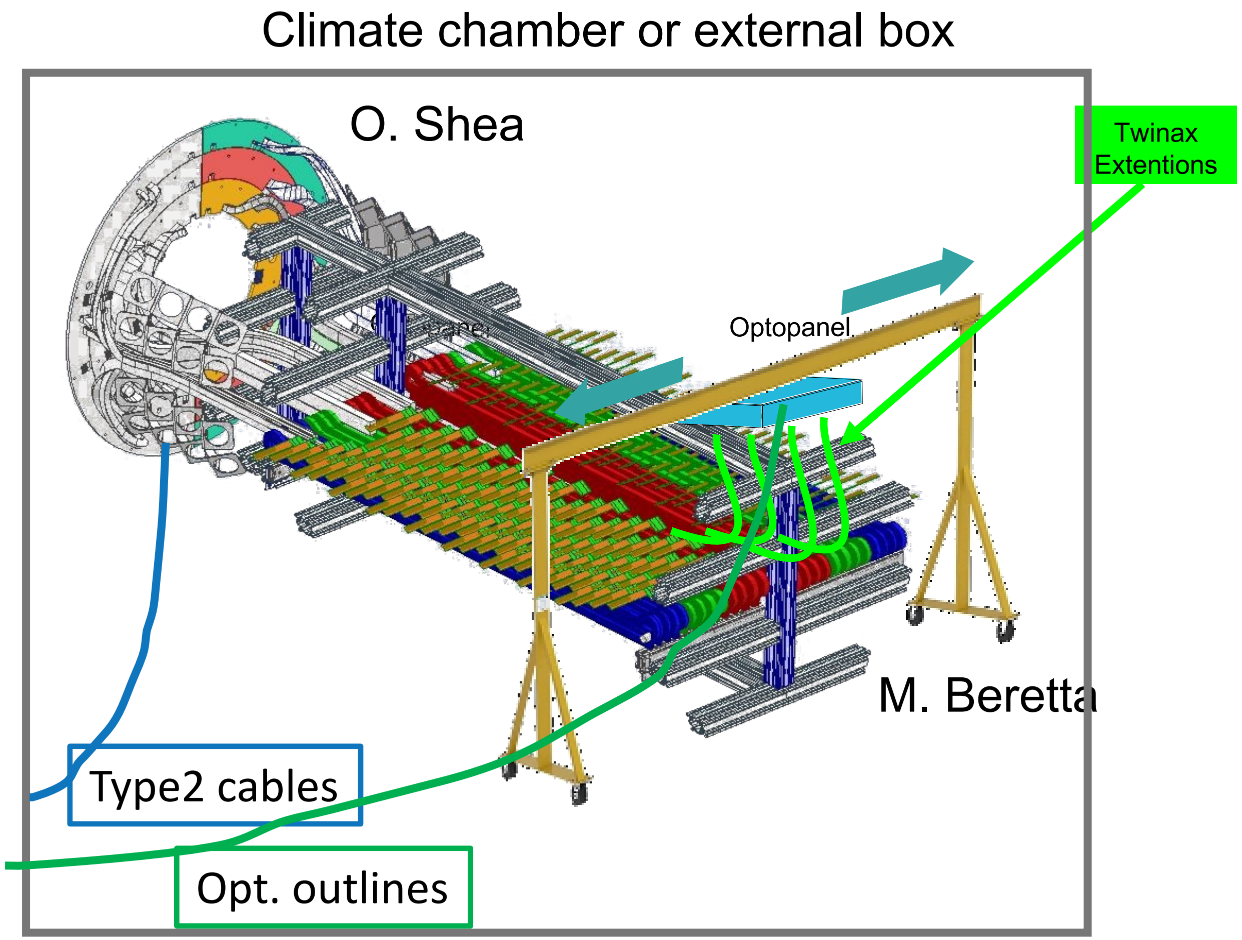
Completed Endcap



- All mainfolds are welded →CO2 flux reduced by 2
- Final reference warm test to be comparated with reception test at SR1
- **Cooling Options**
  - Low pow mode in climate chamber
  - Small flux CO_2 + low power mode
  - Small flux CO_2 + low power mode in climate chamber



Services handling during test on full layers



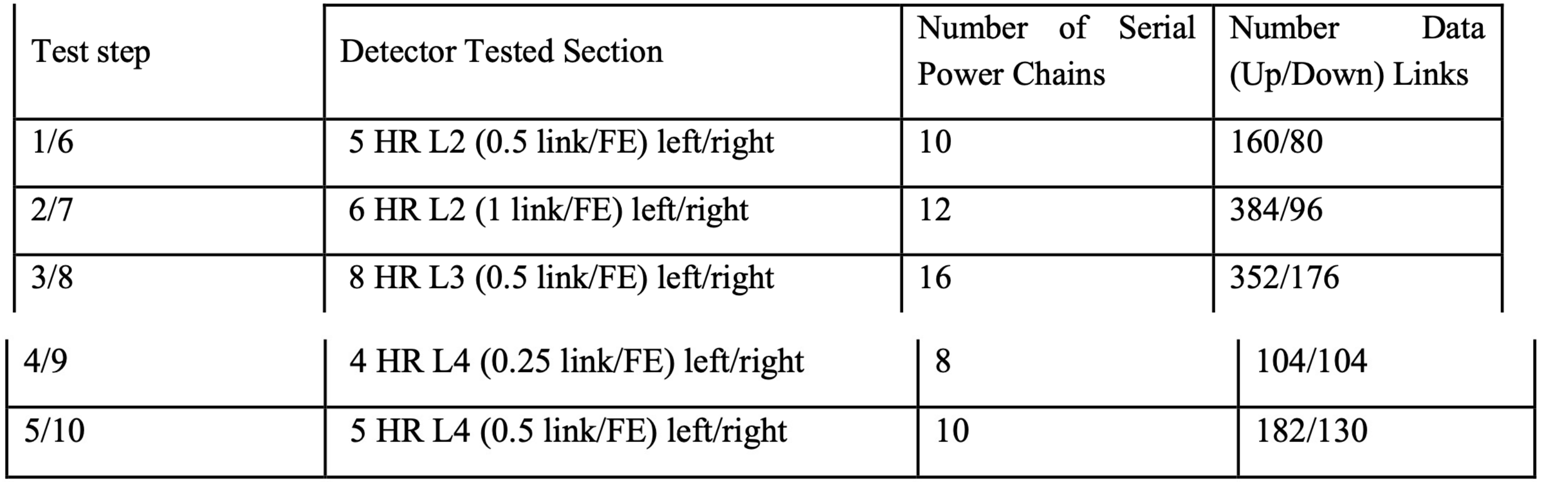
- Connect type 2 cables
- Connect twinax extensions
- Plug and un-plug type-2 cables from PP1 connectors and twinax extension from termination board, to test all detector region
- No need to change Outlines from Optopanels

Reception Test at SR1

ITkPixelIntegration-ElectrialEquipment-v10_docx_cpdf.pdf

- Same Testing step and
- Same Equipment used in Integration site

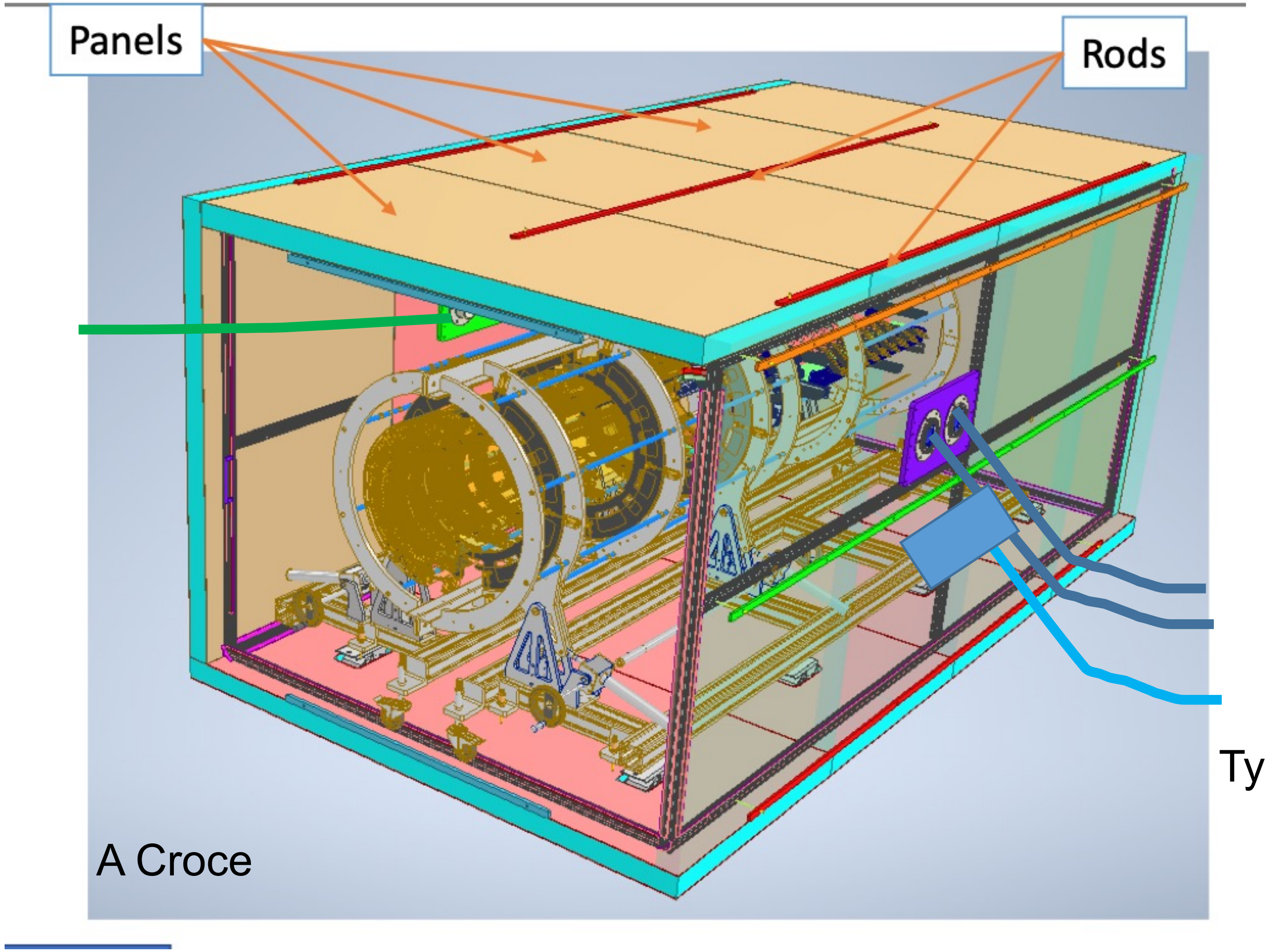
Table 2: Table of testing steps for one half-shell of layers 2, 3 and 4 of one EC.



Test step	Detector Tested Section	Number of Serial Power Chains	Number Data (Up/Down) Links
1/6	5 HR L2 (0.5 link/FE) left/right	10	160/80
2/7	6 HR L2 (1 link/FE) left/right	12	384/96
3/8	8 HR L3 (0.5 link/FE) left/right	16	352/176
4/9	4 HR L4 (0.25 link/FE) left/right	8	104/104
5/10	5 HR L4 (0.5 link/FE) left/right	10	182/130

- At SR1 no cooling limitation
- We may have a test with CO2 there instead of a LP mode for the final tests in integration site

Reception Test at SR1



- Feedtough still to be designed
- Support for Optopanel i(not shown) is inside

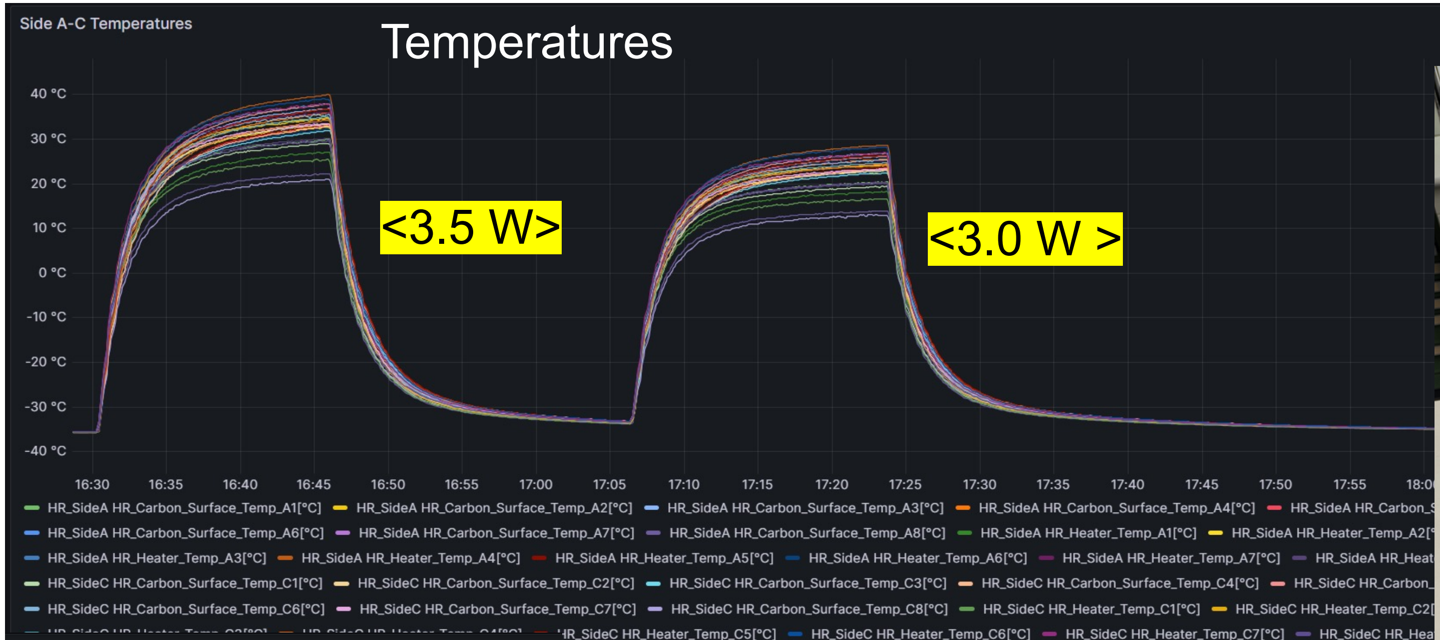
Optoboard services

Type-2 cables

Backup

Test on Thermal HR in small climate chamber

- Preliminary, work in progress
- Rough enclosure to emulate low air conduction regime; less volume wrt to LNF WS slides

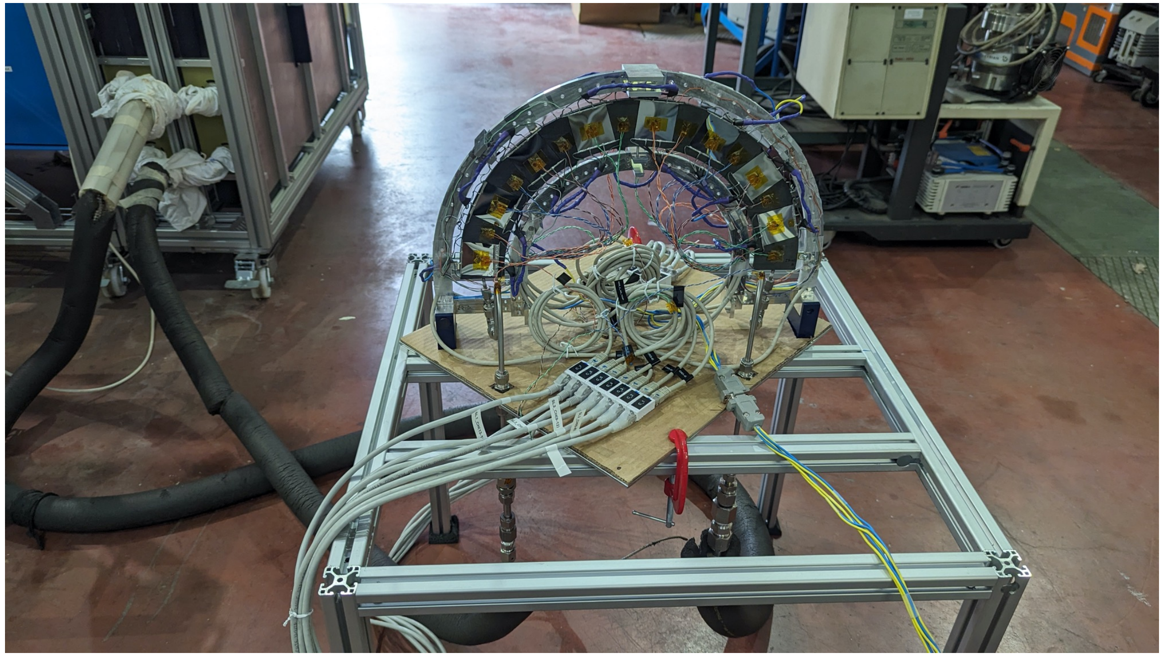


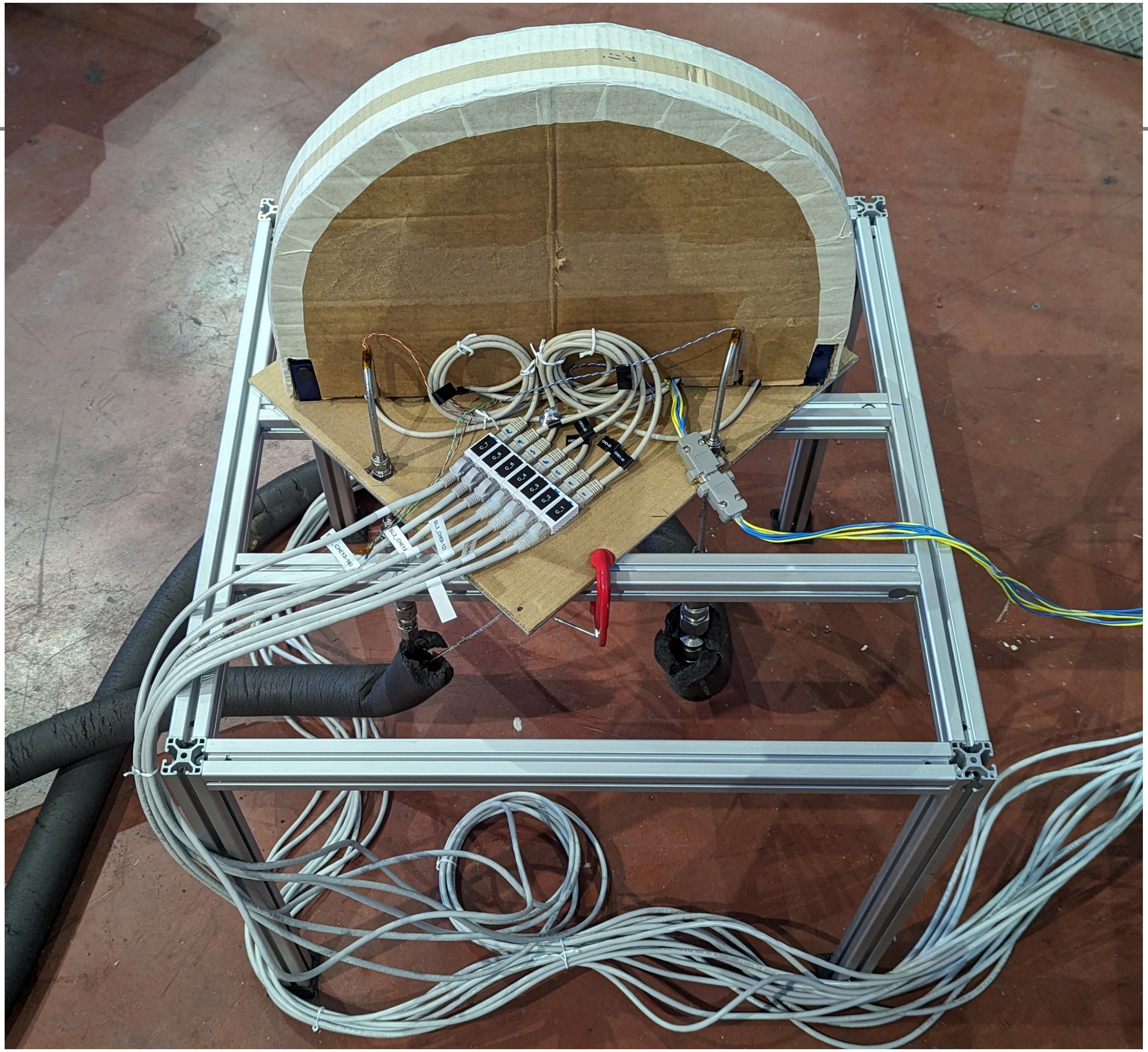
Next steps:

- Aluminium HRs with heaters to emulate neibourgh HRs

Z. Chubinidze, B. Buadze

Test on Thermal HR with CO2





Thanks to Ian, Jo, Alex, Paki for providing us the Fred-fittings!

Z. Chubinidze, B. Buadze
C. Ligi, M. Beatrici, G. Cesarini

Test on Thermal HR with CO2

Goal:

- Study T distribution of heater in Low Power mode in **nominal** and *halved* CO2 flux, **before** and *after* manifold welding
- Study Dry Out condition

Limitation:

- Heater Resistance inhomogenity of ~%30
- Only L2 HR available

Methodology:

- Configurations with
  < 3 W >and < 3.5 W > and < 10 W >

average power among heaters

  - <10 W > Max power with current PS
  - Cover the L4 case
- Configurations with 2.0, 1.0 and 0.5 g/s
- Configurations with set T CO_2 = 5, 13 C

Flux per HR [g/s] from plant	**L2**	**L3**	**L4**
Before Manifold Welding	1.7	2.2	2.0
After Manifold Welding	0.8	1.1	1.0

Power per HR (W)(*)	**L2**	**L3**	**L4**
Low Power Mode	~48	~66	~ 78
Nominal Power (SF 1.2)	224.8	309.0	365.2

(*) Assume 3W per module in Low power mode; neglecting other power contributions

Raw Measurements

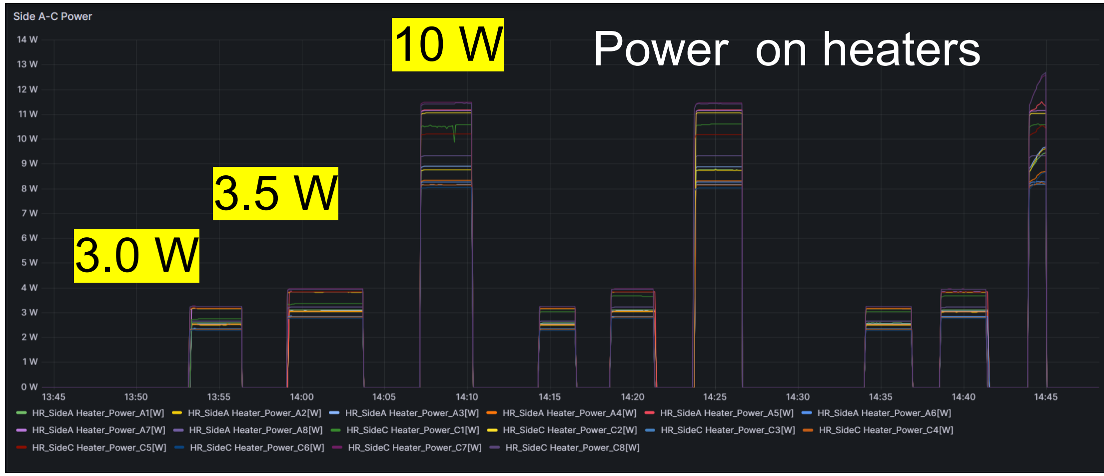
Temperatures on heaters

Set TCO$_2$ 13 C

2 g/s

1.0 g/s

0.5 g/s

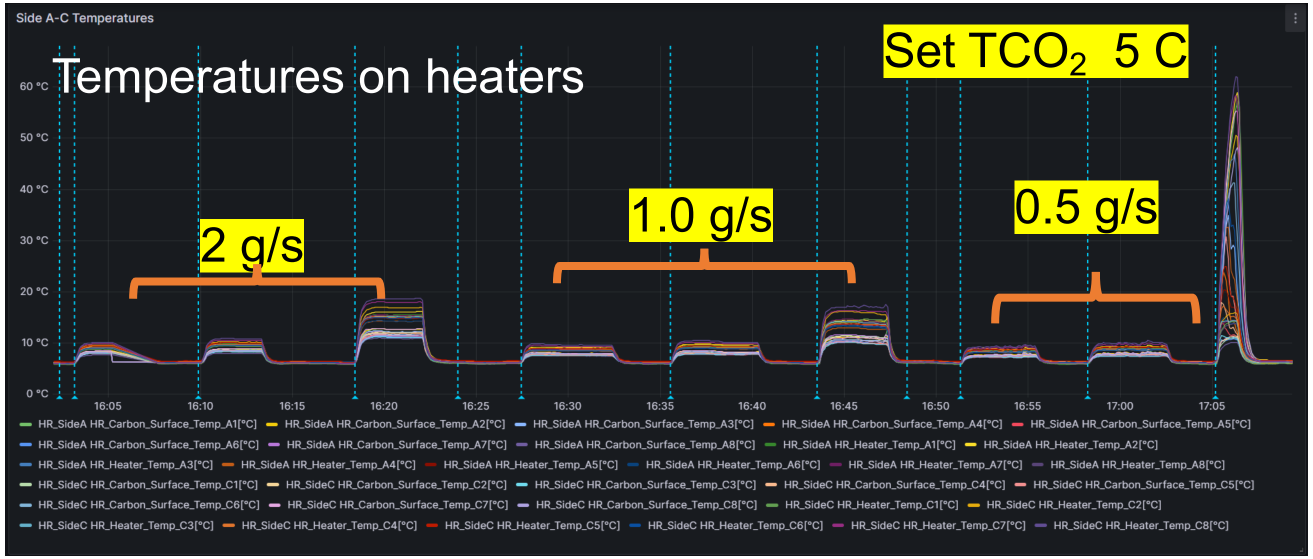


10 W

Power on heaters

3.5 W

3.0 W



Temperatures on heaters

Set TCO$_2$ 5 C

2 g/s

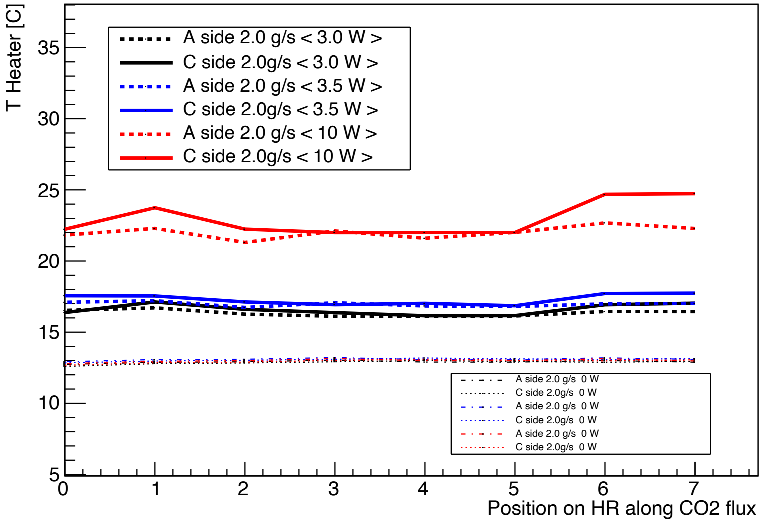
1.0 g/s

0.5 g/s

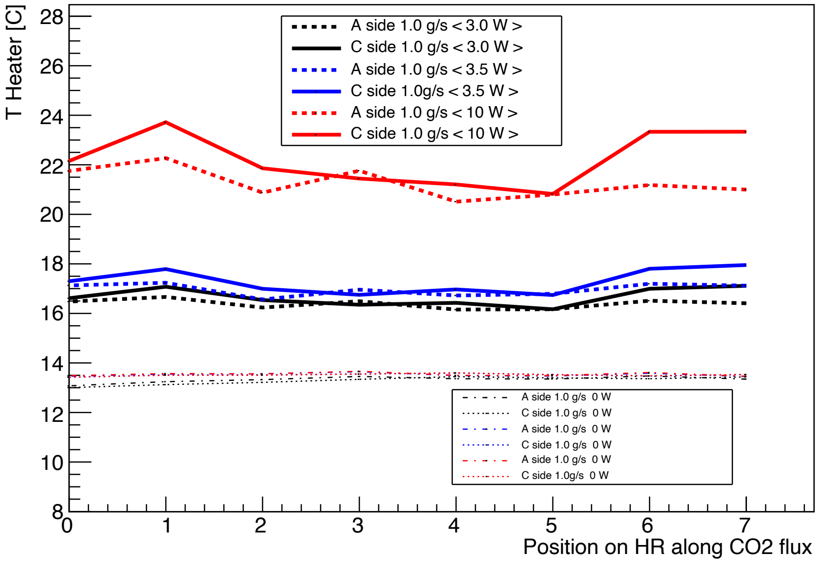
G. Cesarini, Z. Chubinidze, C. Ligi, B. Buadze

T on heaters along HR with CO$_2$ set T = 13 C

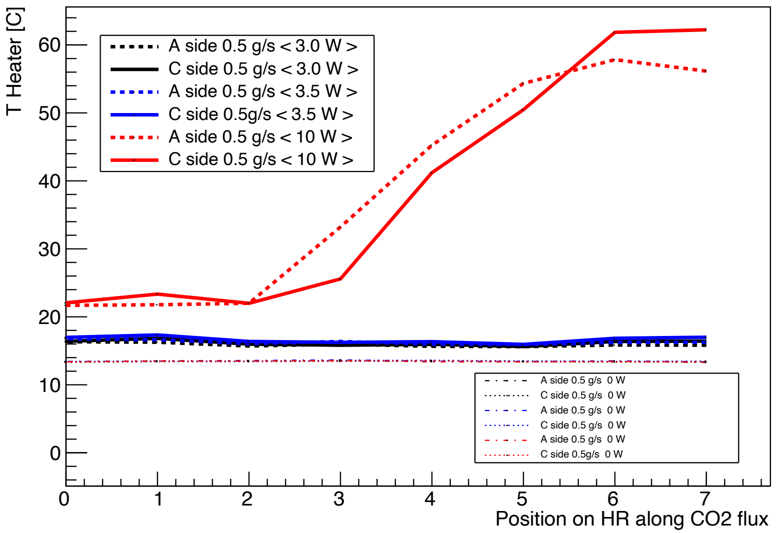
2 g/s



1 g/s



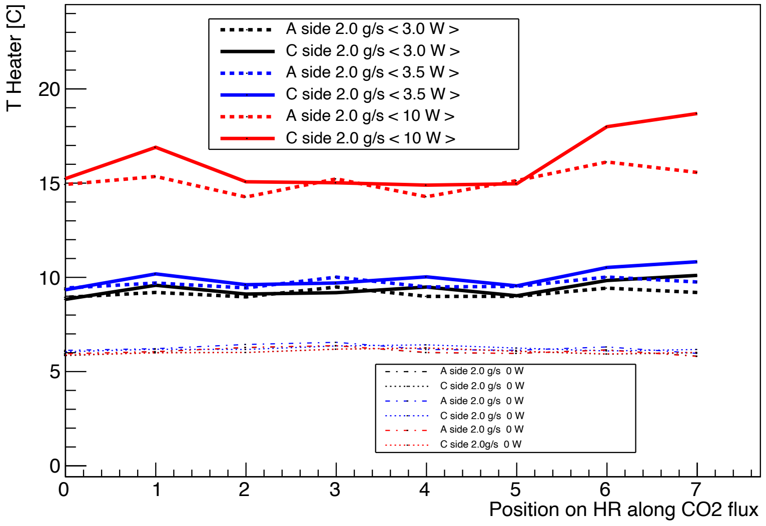
0.5 g/s



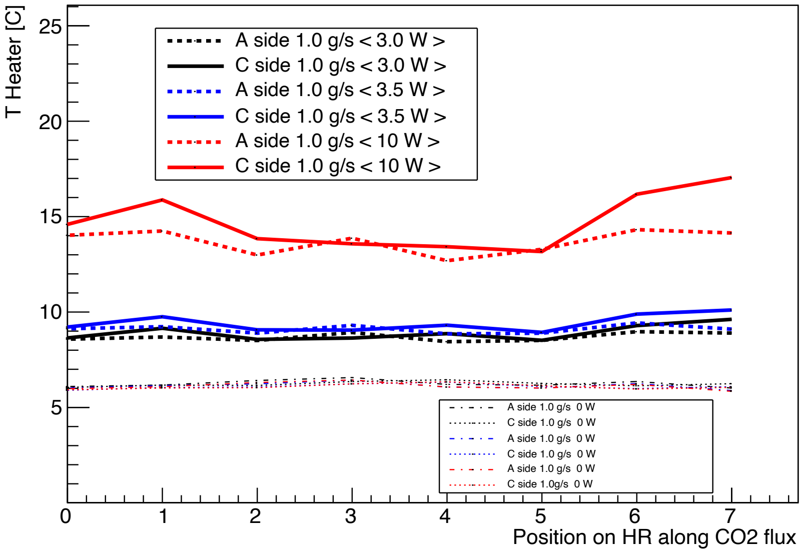
- Stable T on HR in direction of CO2 flux with 2 g/s and 1 g/s
- Increasing T with 0.5 g/s and 10 W
- Further test will be performomed to study the effects of dependence on enclosoure thermal conducibility
- Do we expect effects from nearby HR ?

T on heaters along HR with CO_2 set T = 5 C

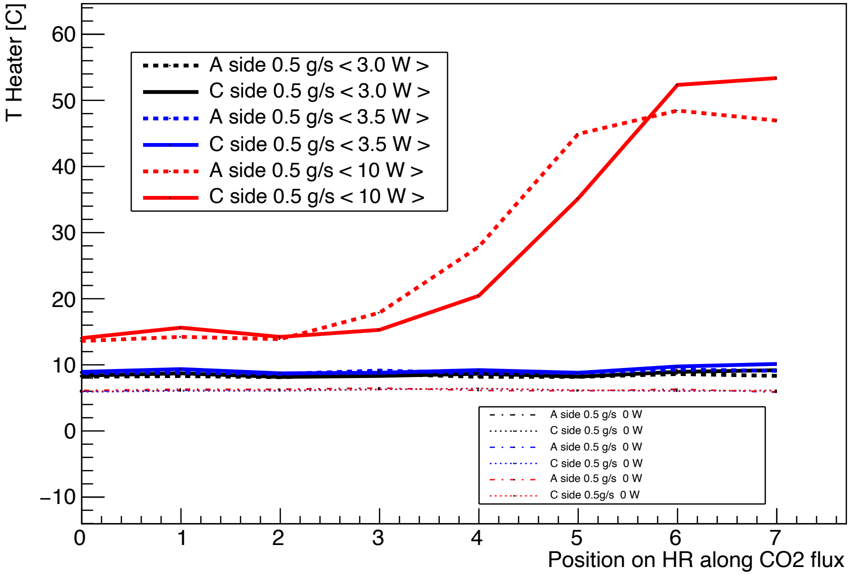
2 g/s



1 g/s



0.5 g/s

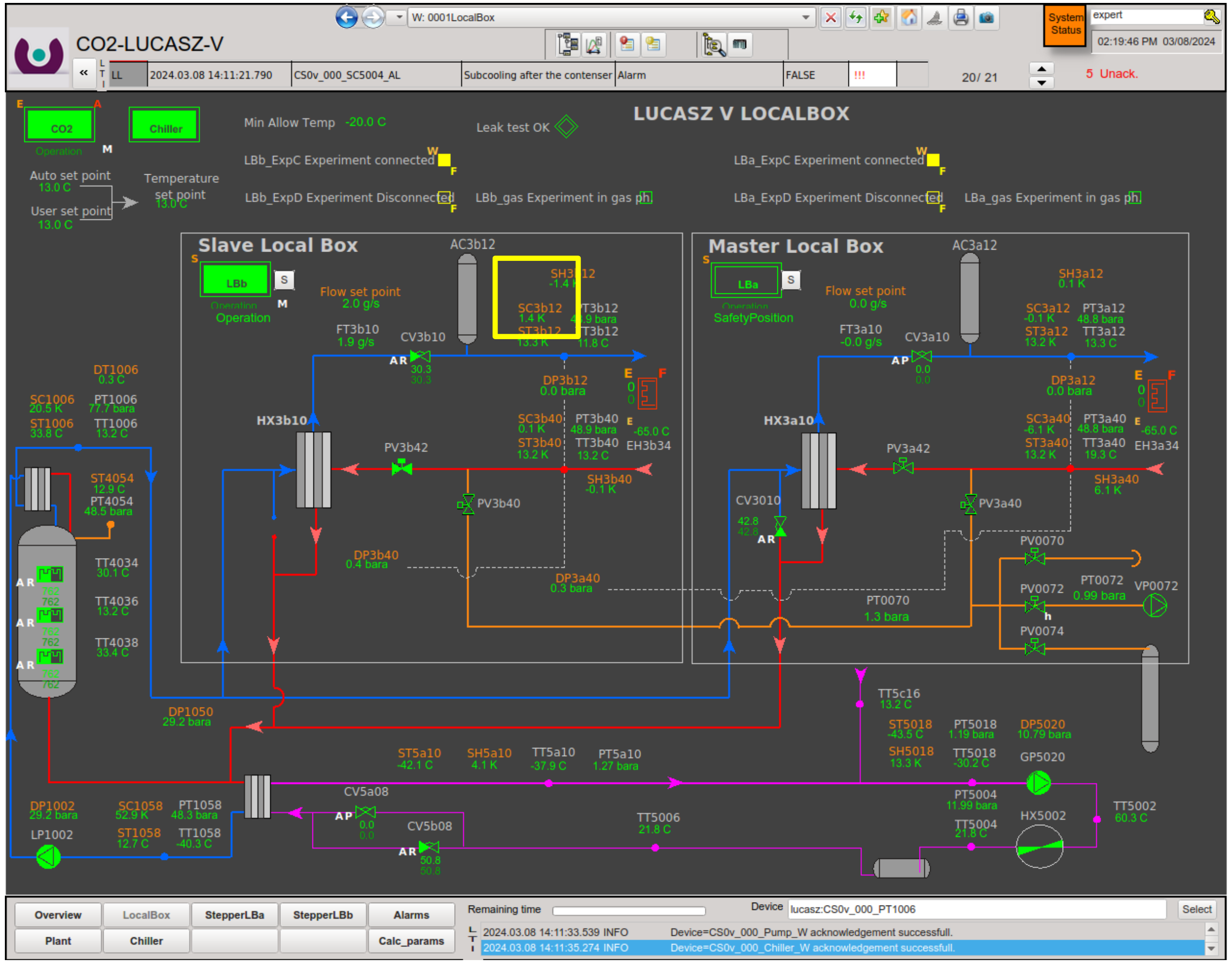


- Stable T on HR in direction of CO2 flux with 2 g/s and 1 g/s
- Increasing T with 0.5 g/s and 10 W
- Further test will be performnd to study the effects of dependence on enclosoure thermal conducibility
- Do we expect effects from nearby HR ?

Lucasz plant configuration

2 g/s 3 W 13 C

1 g/s 3 W 5 C

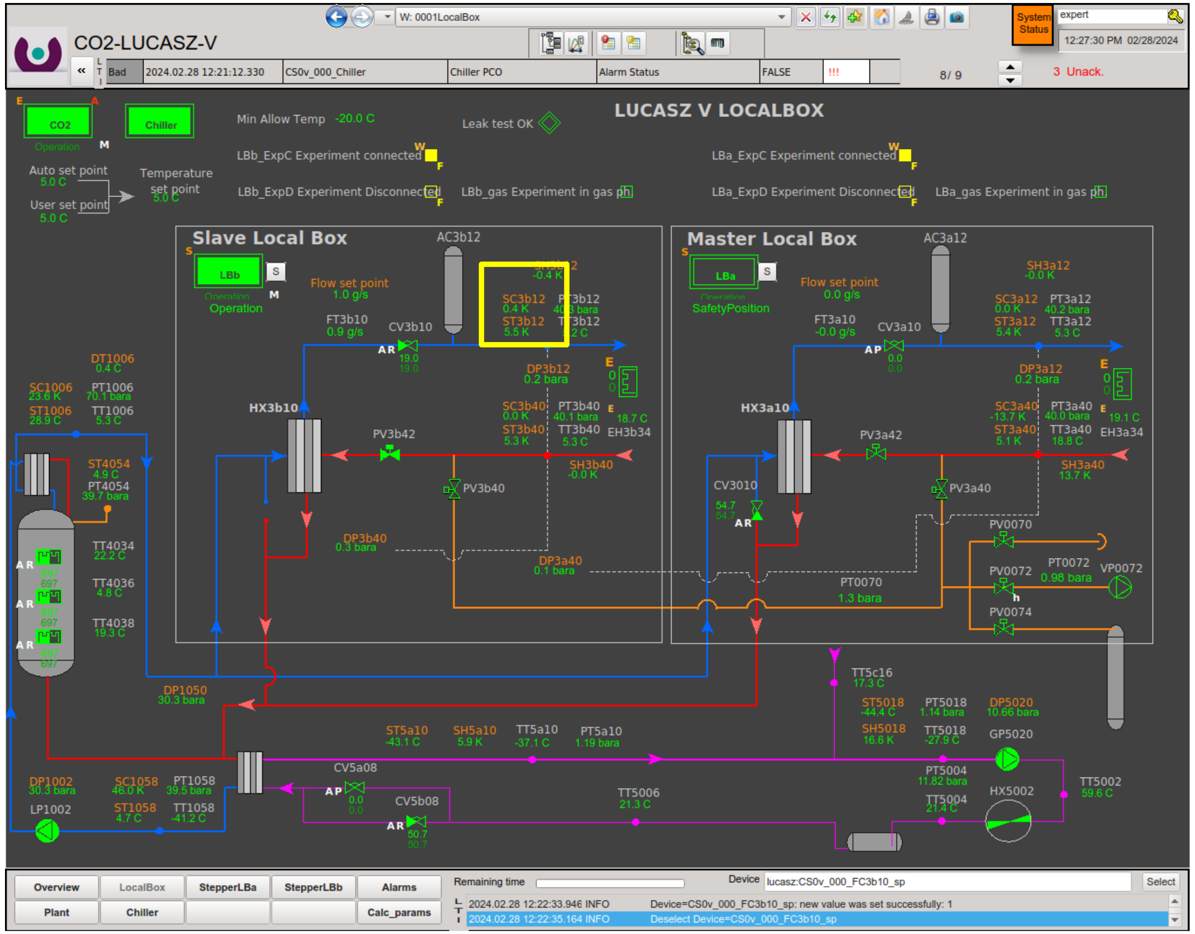


LL 2024.03.08 14:11:21.790 CS0v_000_SC5004_AL Subcooling after the contenser Alarm FALSE !!! 20/ 21 5 Unack.

Device lucasz:CS0v_000_PT1006

2024.03.08 14:11:33.539 INFO Device=CS0v_000_Pump_W acknowledgement successfull.

2024.03.08 14:11:35.274 INFO Device=CS0v_000_Chiller_W acknowledgement successfull.



Bad 2024.02.28 12:21:12.330 CS0v_000_Chiller Chiller PCO Alarm Status FALSE !!! 8/ 9 3 Unack.

Device lucasz:CS0v_000_FC3b10_sp

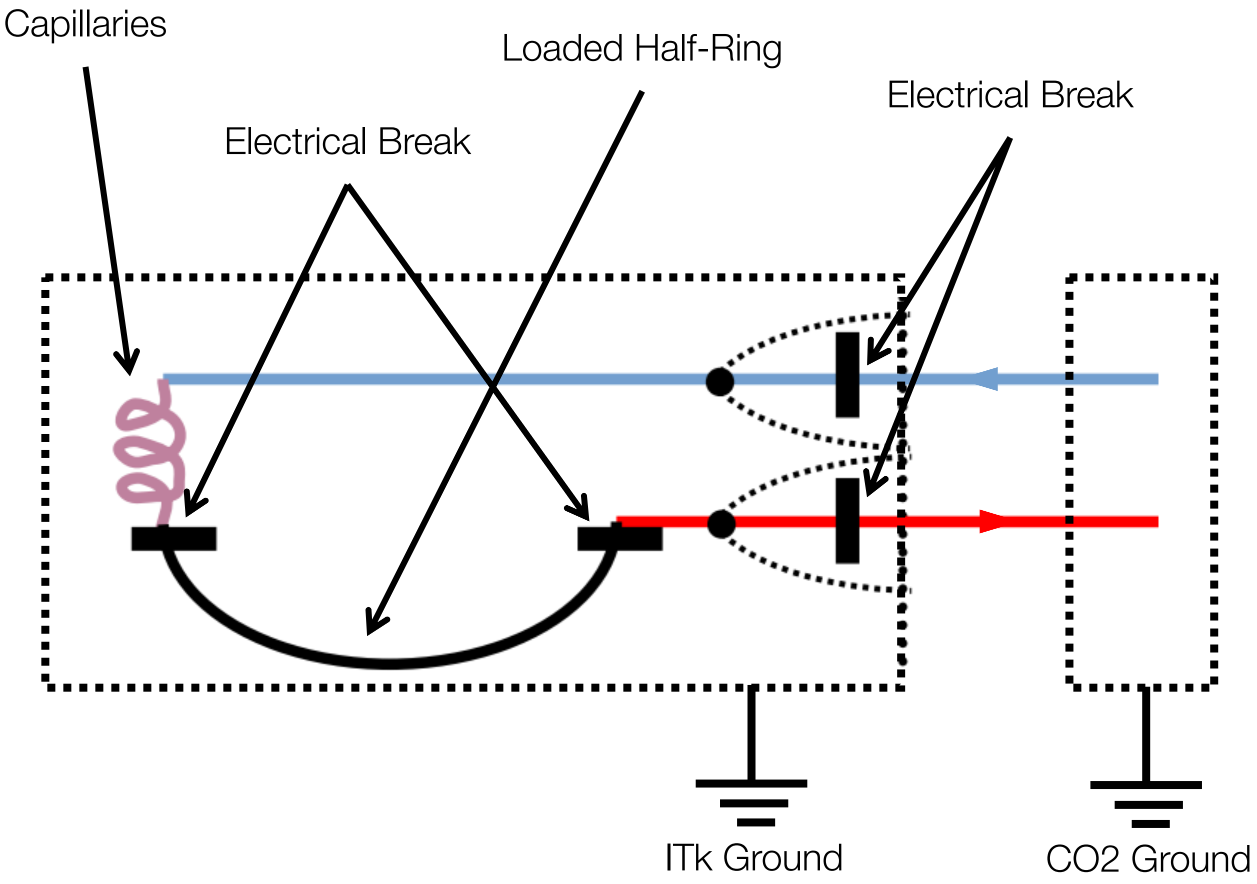
2024.02.28 12:22:33.946 INFO Device=CS0v_000_FC3b10_sp: new value was set successfully: 1

2024.02.28 12:22:35.164 INFO Deselect Device=CS0v_000_FC3b10_sp

Are this sub-cooling conditions expected?
Do we need in general needle valve?

Functional test on populated HS: G&S. Cooling scheme

- When testing with CO2 , proper G&S scheme should be adopted



- Need EB between cooling transfer lines from lucasz plant and on-detector cooling pipes to reduce noise fr

From Slice Test in SR1

Connectivity Test with Low Power Mode

Work in progress

Data Connectivity		
Already Tested on the HR	**Already tested after twinax harness installation**	**To be Tested**
Module-PP0	Electrical continuitiy of twinax cables	Twinax – PP0 connectivity
		Mapping twinax-extensions-optoboard-felix

- **Granularity:** one PP0-twinax-extension per time
- Switch on modules in LP mode.
- **DAQ Felix-Module** basic connectivity :
  - Optical and electrical alignment
- **Downlink** checks from Felix to Modules:
  - Configure a FE in each module
- **Uplink** check: digital scans / BERT

Connectivity Test with Low Power Mode

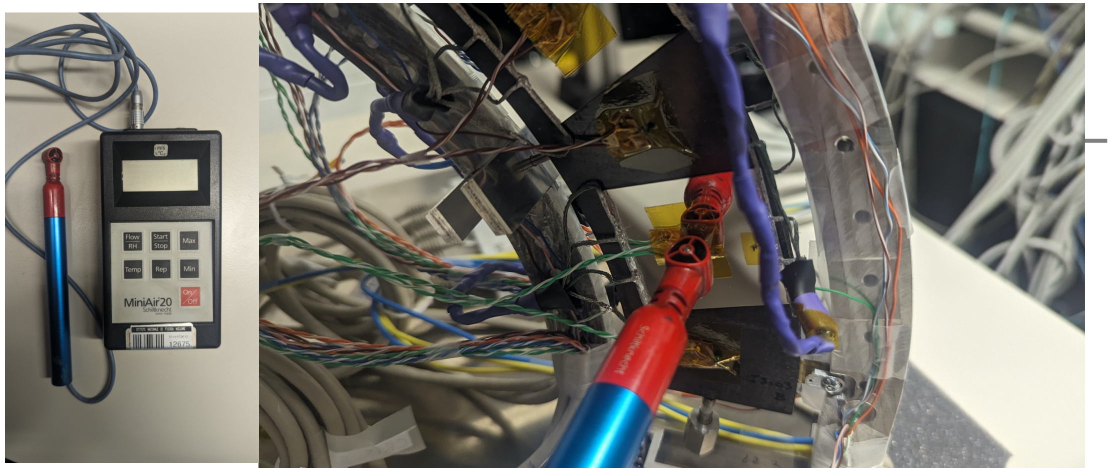
Work in progress

Electrical Connectivity		
Already Tested on HR side	**Already tested on type-1 cable side after insertion**	**To be Tested**
Bus Tape-EoS (HV,LV, Vcan,Canbus, T-ilock)	Electrical continuity between type-1 cable termination	Type1 bundle - EoS connection
	Mapping of pwr and env bundles - PP2/PP3 - PSU	

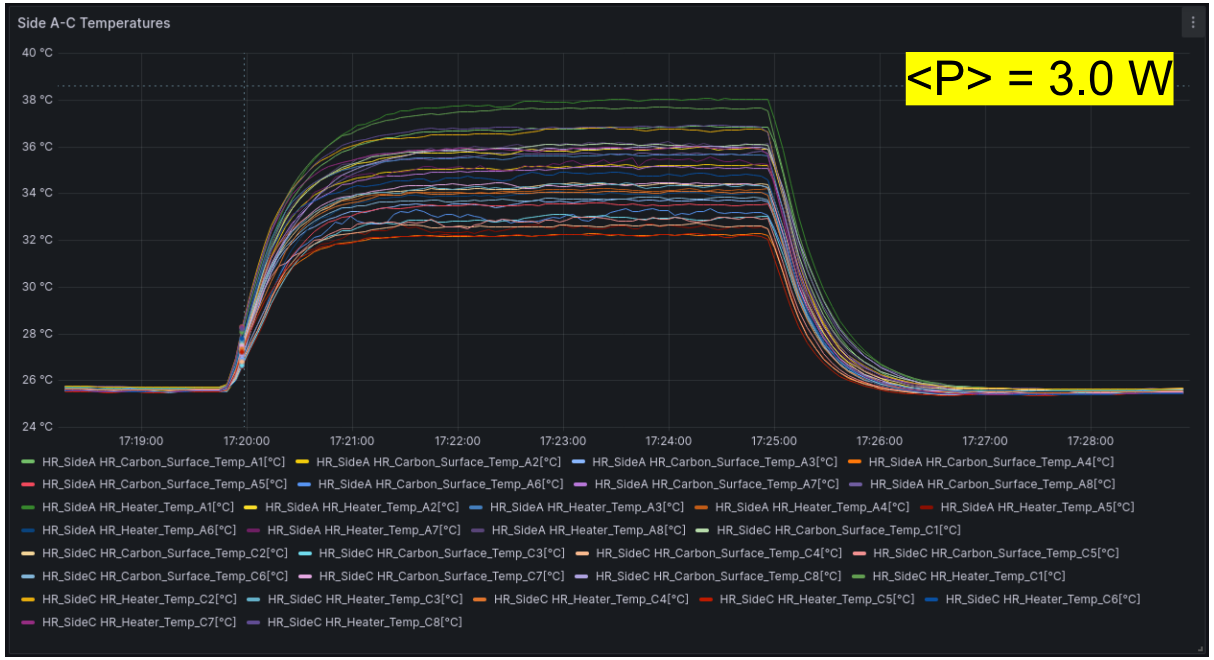
- **Granularity:** one Type1 bundle per time
- **Connectivity of HV/LV/Canbus/Vcan/ T-lock lines**
  - Switch on modules in LP mode.
  - LV lines:: Register Reading
  - HV lines: PS not enough sensitivity. Alternatives under investigation.
  - Canbus Line: MOPS reading with PP3
  - T-lock lines: NTC reading

Low Power Mode on Thermal Half Rings using Fans

Heaters with P>3W	**C7**	**C8**	**A7**	**C2**	**C5**	**C6**
Air velocity m/s	3.3	3.2	3.6	5.3	4.2	4.3



More details in [LNF WS]



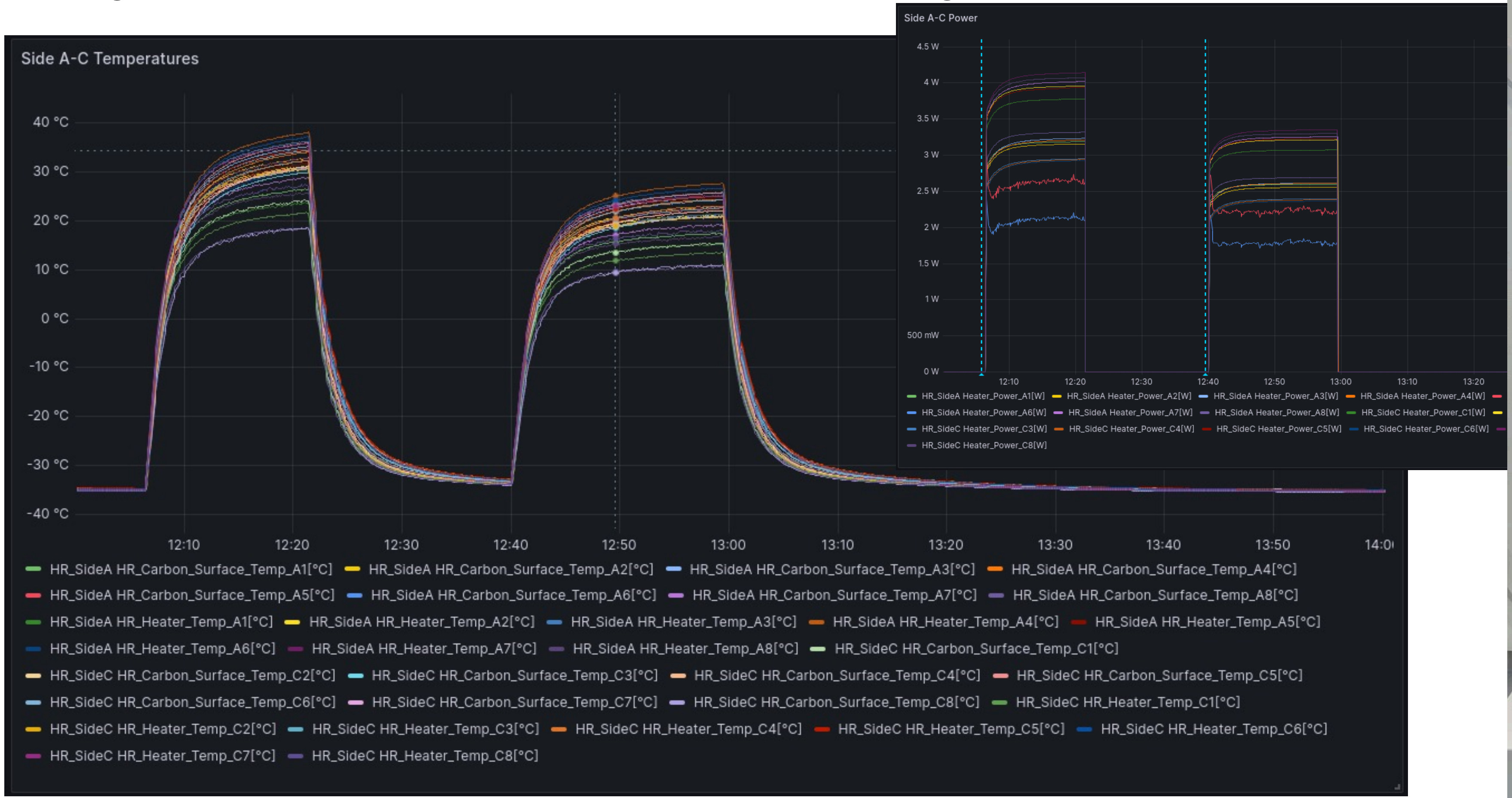
<P> = 3.0 W

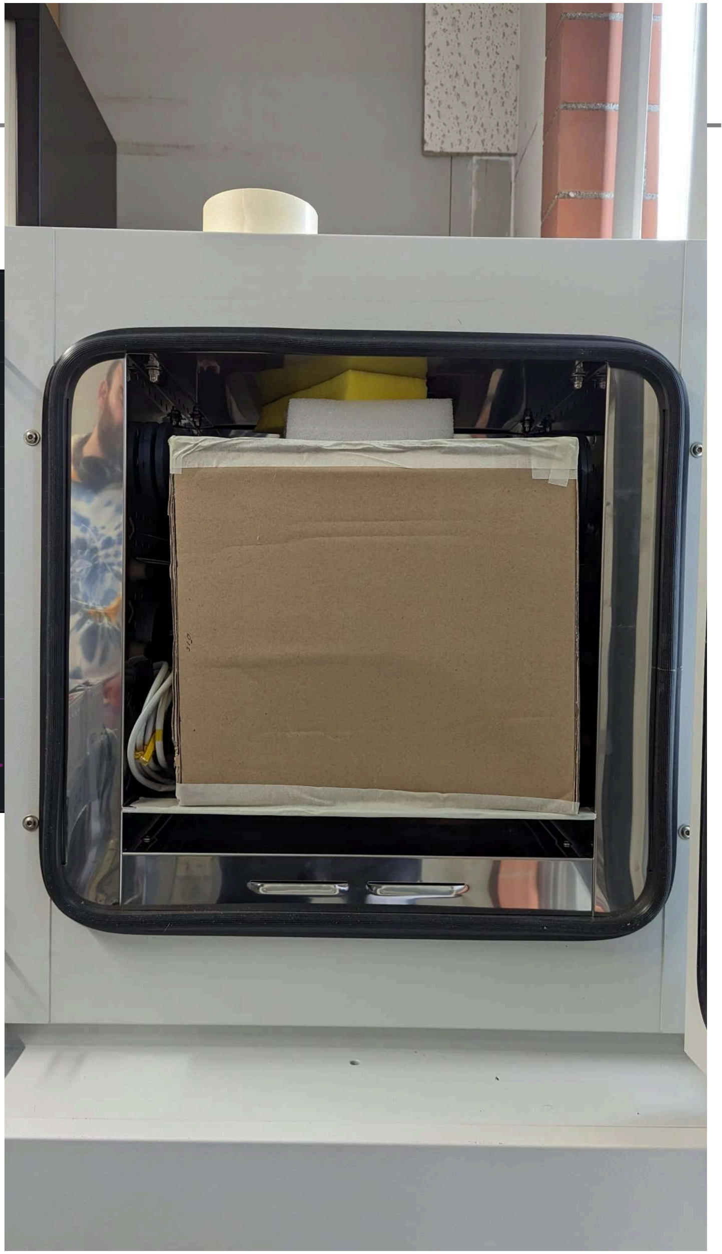
air velocity >= 3.2 m is enough to maintain T<40 C

Z. Chubinidze

Test on Thermal HR in small climate chamber

- Preliminary, work in progress
- Rough enclosure to emulate low air conduction regime



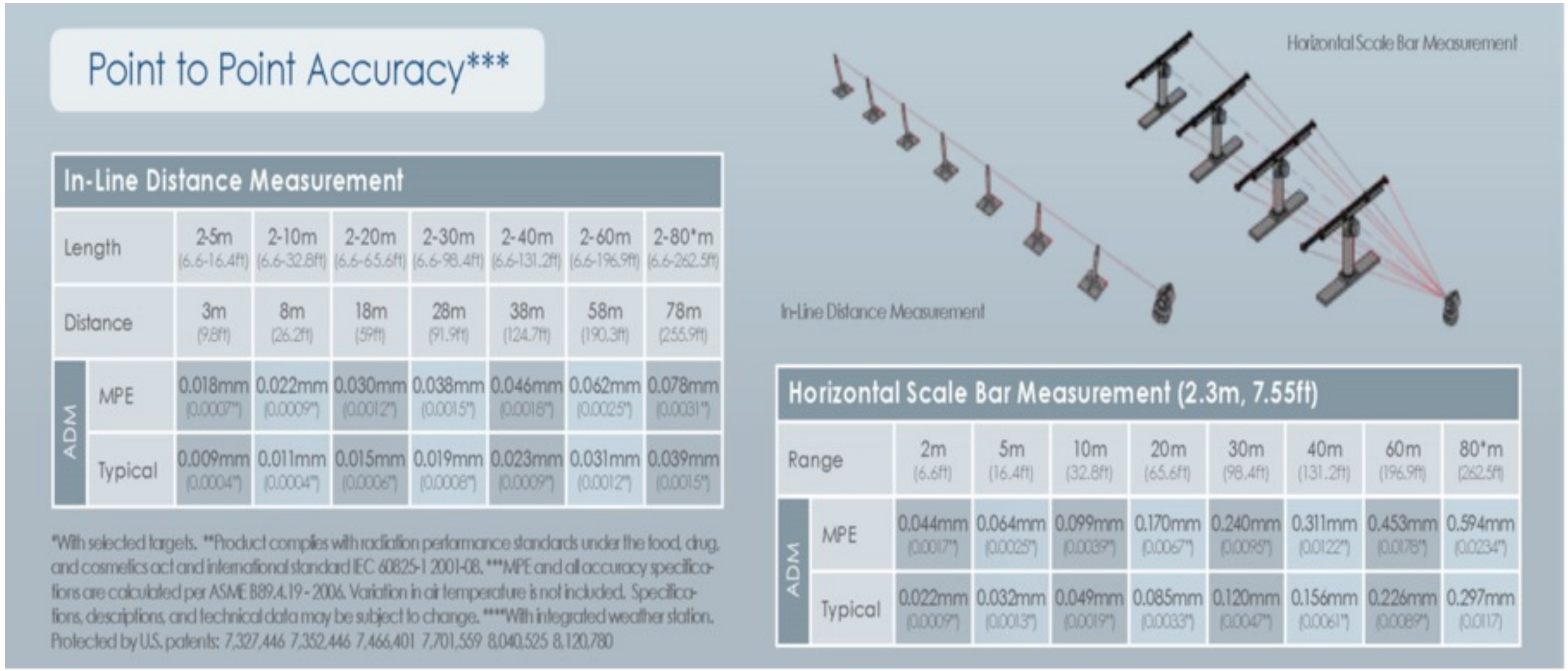


Further tests will come with CO2 flux

Z. Chubinidze, B. Buadze

Mating of Half-shell

FARO Laser Tracker Vantage:
Measurement of the target position (contact measurement)



Point to Point Accuracy***

In-Line Distance Measurement								
Length		2-5m (6.6-16.4ft)	2-10m (6.6-32.8ft)	2-20m (6.6-65.6ft)	2-30m (6.6-98.4ft)	2-40m (6.6-131.2ft)	2-60m (6.6-196.9ft)	2-80*m (6.6-262.5ft)
Distance		3m (9.8ft)	8m (26.2ft)	18m (59ft)	28m (91.9ft)	38m (124.7ft)	58m (190.3ft)	78m (255.9ft)
ADM	MPE	0.018mm (0.0007")	0.022mm (0.0009")	0.030mm (0.0012")	0.038mm (0.0015")	0.046mm (0.0018")	0.062mm (0.0025")	0.078mm (0.0031")
	Typical	0.009mm (0.0004")	0.011mm (0.0004")	0.015mm (0.0006")	0.019mm (0.0008")	0.023mm (0.0009")	0.031mm (0.0012")	0.039mm (0.0015")

*With selected targets. **Product complies with radiation performance standards under the food, drug, and cosmetics act and international standard IEC 60825-1 2001-08. ***MPE and all accuracy specifications are calculated per ASME B89.4.19 - 2006. Variation in air temperature is not included. Specifications, descriptions, and technical data may be subject to change. ****With integrated weather station. Protected by U.S. patents: 7,327,446 7,352,446 7,466,401 7,701,559 8,040,525 8,120,780

Horizontal Scale Bar Measurement (2.3m, 7.55ft)									
Range		2m (6.6ft)	5m (16.4ft)	10m (32.8ft)	20m (65.6ft)	30m (98.4ft)	40m (131.2ft)	60m (196.9ft)	80*m (262.5ft)
ADM	MPE	0.044mm (0.0017")	0.064mm (0.0025")	0.099mm (0.0039")	0.170mm (0.0067")	0.240mm (0.0095")	0.311mm (0.0122")	0.453mm (0.0178")	0.594mm (0.0234")
	Typical	0.022mm (0.0009")	0.032mm (0.0013")	0.049mm (0.0019")	0.085mm (0.0033")	0.120mm (0.0047")	0.156mm (0.0061")	0.226mm (0.0089")	0.297mm (0.0117)

Status of datase extenders extension

- Ordered 6x data extender prototypes for electrical test
  - 3x 2m, 3x 3m

- Prototypes expected in ~2months

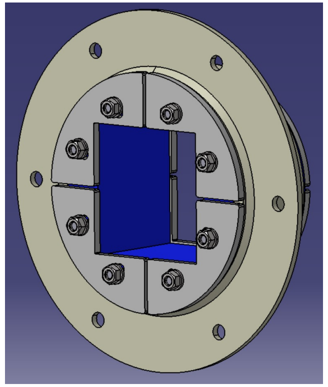
- Mechanical aspects are still to be evaluated:
  - the definition of the termination boards position and orientation on trolley are not available

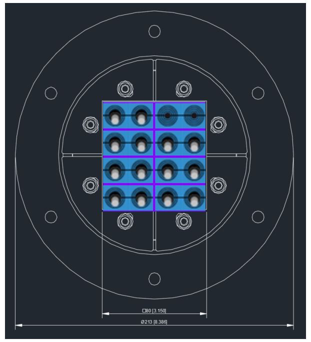
  - Tehcnical design and mapping in backup slides

G. Cesarini

Feedthrough Options

(1)

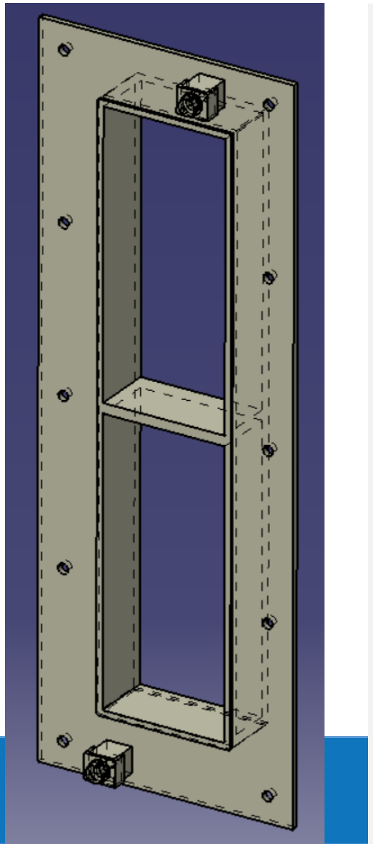


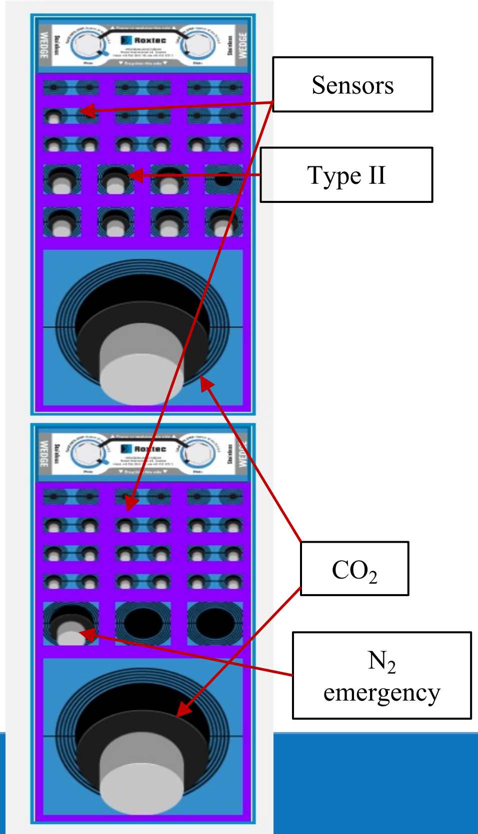


Optoboxes

- AISI316
- Packing space (mm) 80 x 80
- Aperture dimension Ø (mm) 144 - 144
- Weight (kg) 3.4

- AISI316
- Frame openings 2
- Packing space (mm) 120 x 240
- External dimensions
- WxHxD (mm) 252.5 x 698 x 93
- Aperture dimensions WxH (mm) 148(+5/-5) x 595(+5/-5)
- Weight (kg) 9.8





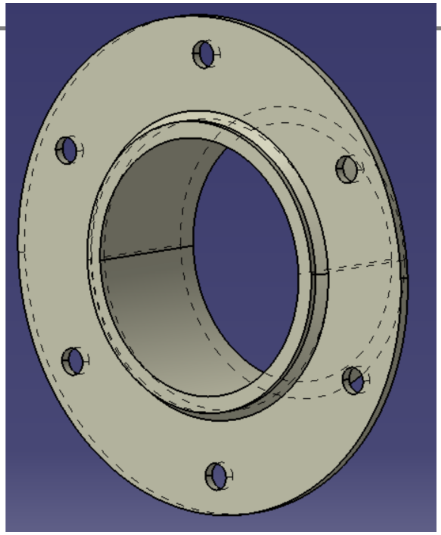
Sensors

Type II

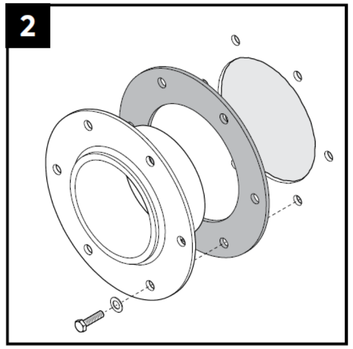
CO_2

N_2 emergency

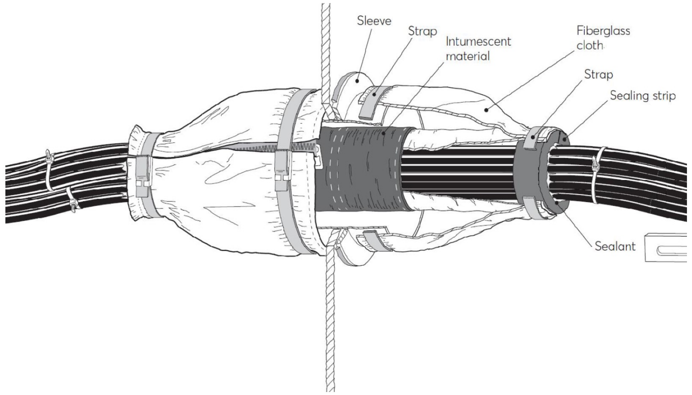
(2)



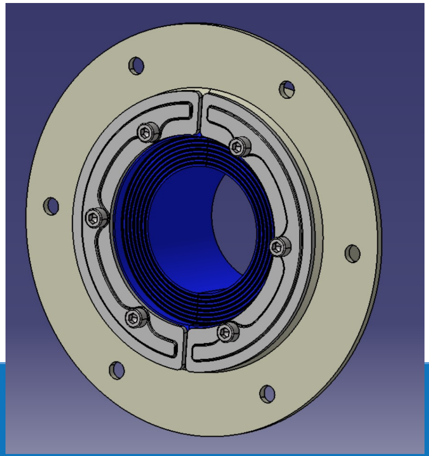
Sleeve gasket



Round sleeve with pre-punched gasket.



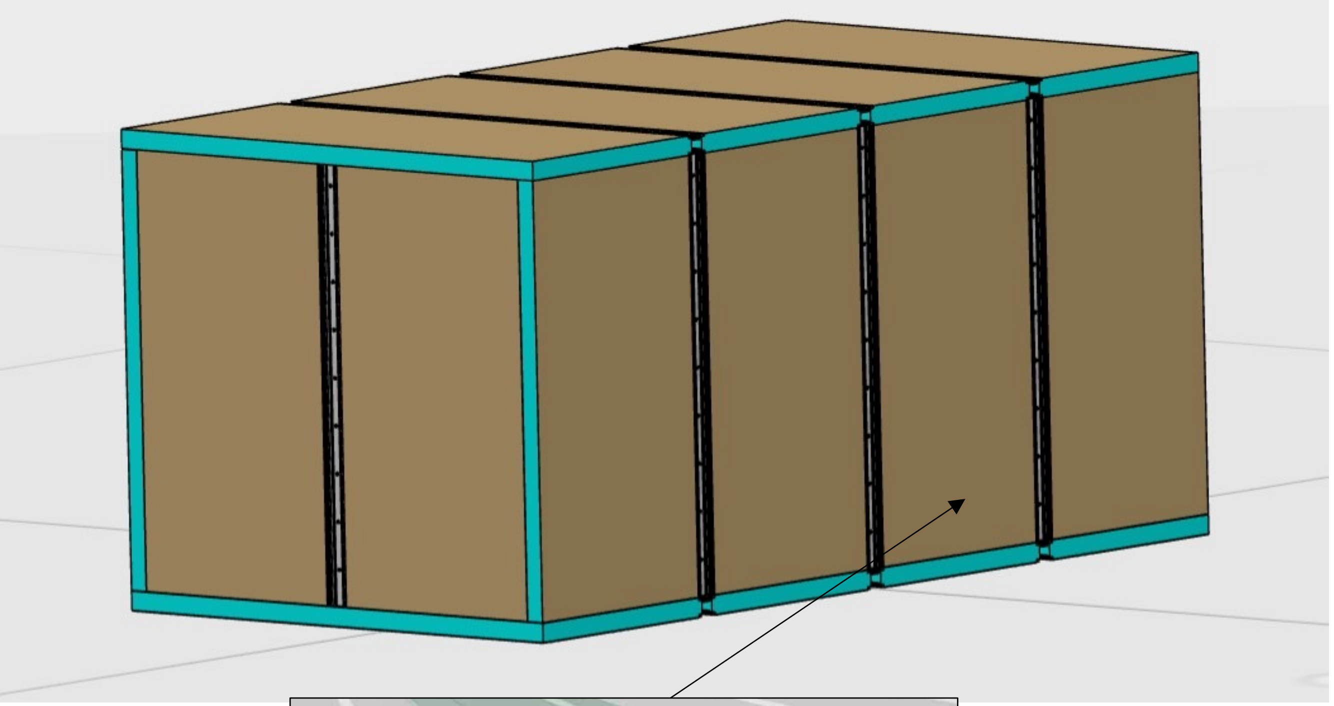
Lighter (AISI316 1.6 kg)- to be used for sensor cables, for Type II ones and for those of the optoboxes (multiplicity to be defined)

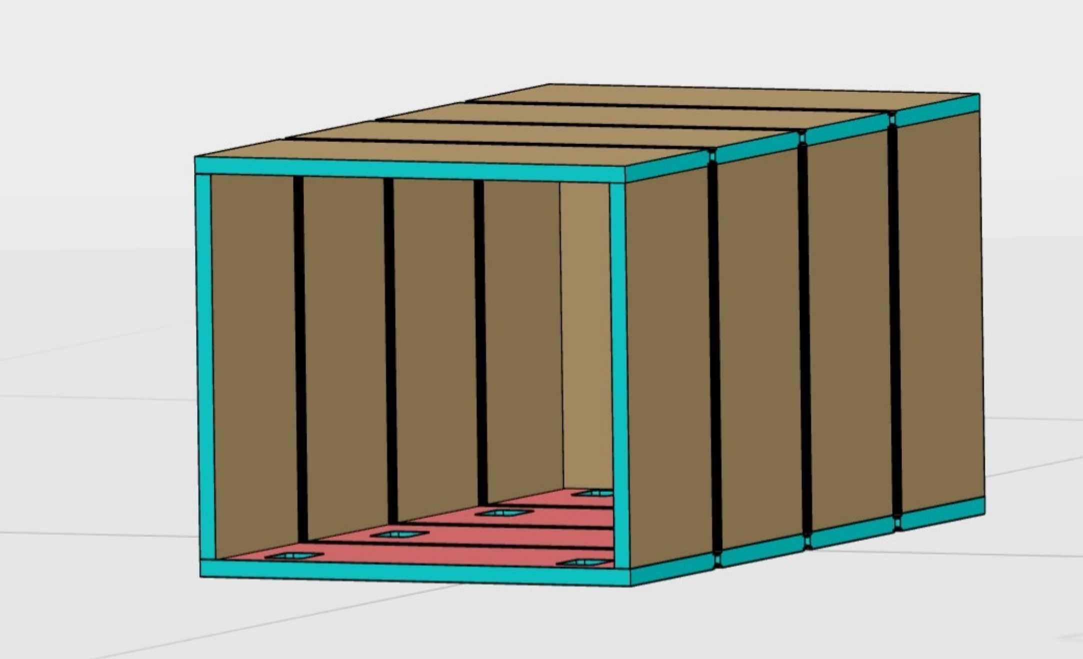


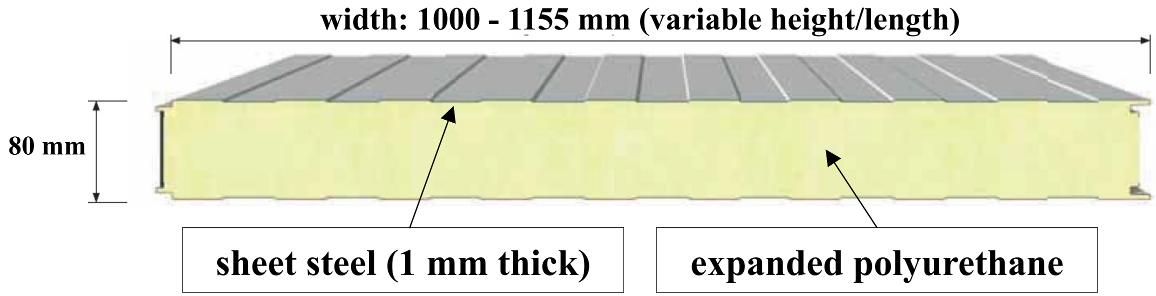
Feedthrough for single CO_2 line (AISI316 – Φ 66-98 mm – 3.6 kg)

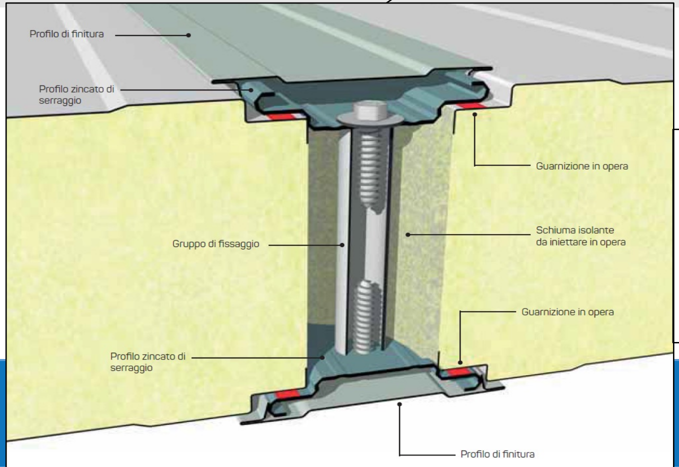
Reception Test and Transport Box

- Preliminary design: L x W x H = 4250 mm x 2200 mm x 2000 mm
- To be checked: space for optopanel trolley
- Note: The width of the door in SR1 is slightly more than 3000mm









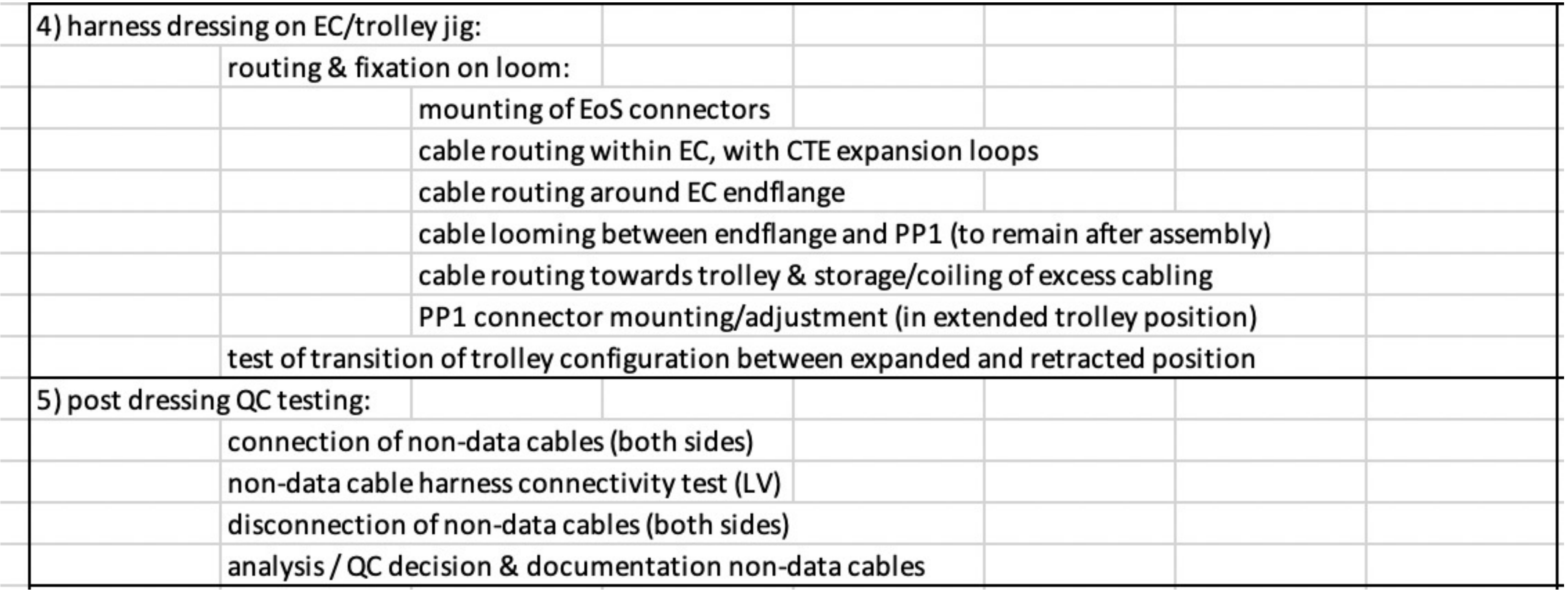
Injected joint with insulating foam to be injected on site (Average Thermal Transmittance $U = 0.119\ W/m^2K$)

A. Croce,
G. Cesarini

Nominal Panel Thickness mm	100	120	150	200
Thermal Transmittance U (W/m^2K)	0.22	0.18	0.15	0.11
Annex A.10 of the European standard EN 14509				

Panel supplier company

Test of pwr bundles on trolley

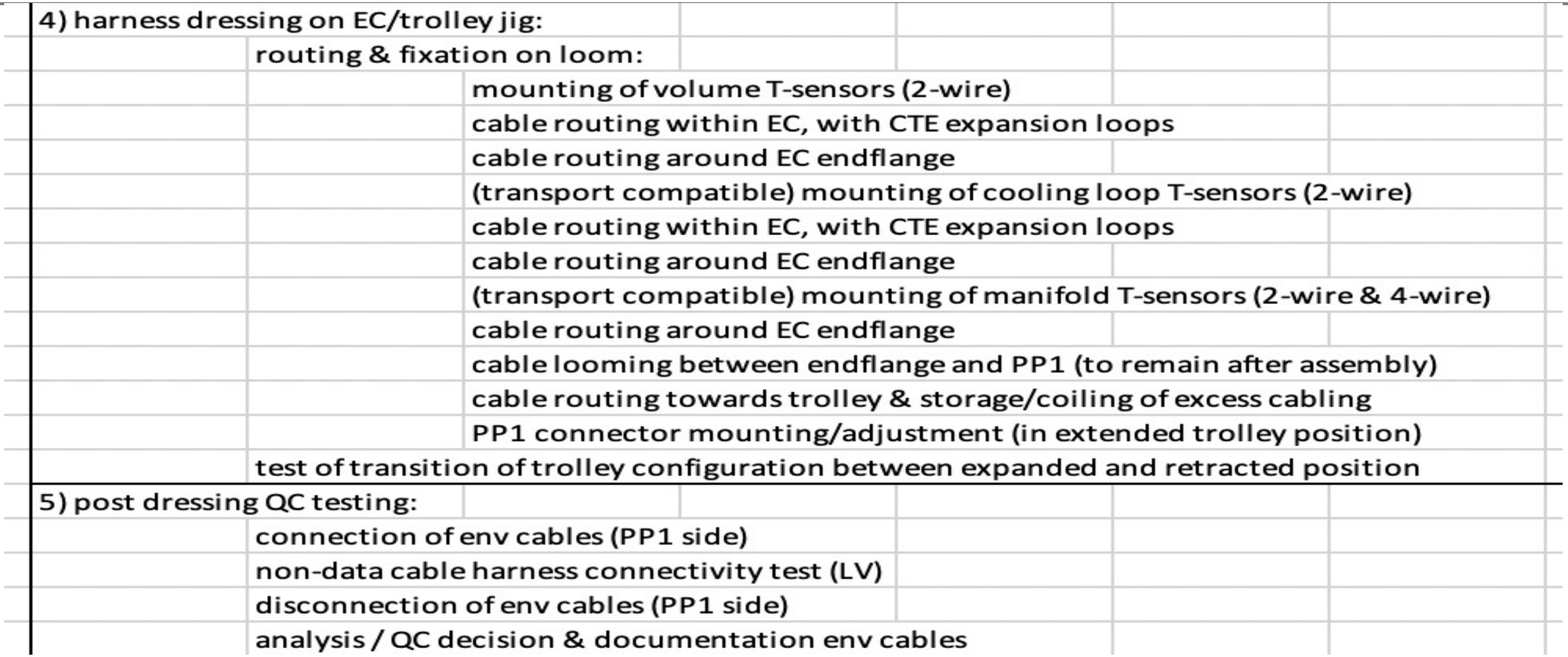


- 4) harness dressing on EC/trolley jig:
  - routing & fixation on loom:
    - mounting of EoS connectors
    - cable routing within EC, with CTE expansion loops
    - cable routing around EC endflange
    - cable looming between endflange and PP1 (to remain after assembly)
    - cable routing towards trolley & storage/coiling of excess cabling
    - PP1 connector mounting/adjustment (in extended trolley position)
  - test of transition of trolley configuration between expanded and retracted position
- 5) post dressing QC testing:
  - connection of non-data cables (both sides)
  - non-data cable harness connectivity test (LV)
  - disconnection of non-data cables (both sides)
  - analysis / QC decision & documentation non-data cables

Stolen from S. Eisenhardt harnesses timeline

Test of env. bundles on trolley

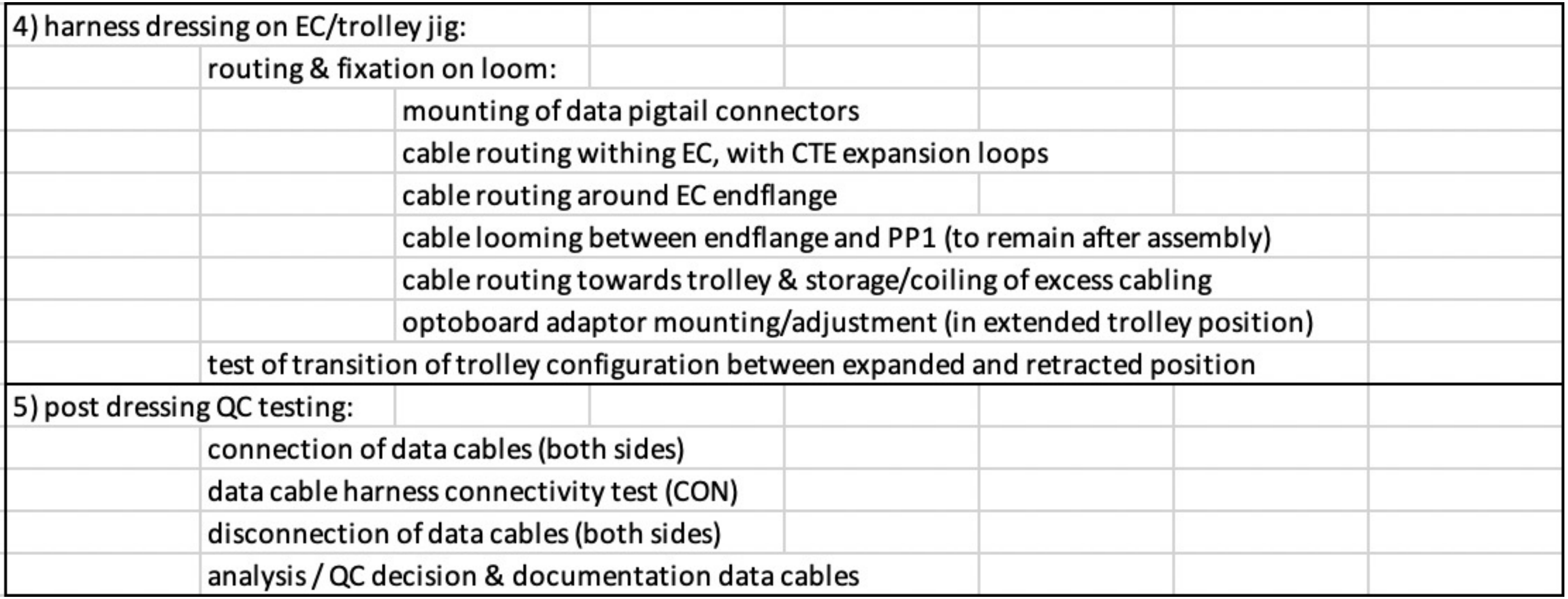
Stolen from S. Eisenhardt harnesses timeline



- 4) harness dressing on EC/trolley jig:
  - routing & fixation on loom:
    - mounting of volume T-sensors (2-wire)
    - cable routing within EC, with CTE expansion loops
    - cable routing around EC endflange
    - (transport compatible) mounting of cooling loop T-sensors (2-wire)
    - cable routing within EC, with CTE expansion loops
    - cable routing around EC endflange
    - (transport compatible) mounting of manifold T-sensors (2-wire & 4-wire)
    - cable routing around EC endflange
    - cable looming between endflange and PP1 (to remain after assembly)
    - cable routing towards trolley & storage/coiling of excess cabling
    - PP1 connector mounting/adjustment (in extended trolley position)
  - test of transition of trolley configuration between expanded and retracted position
- 5) post dressing QC testing:
  - connection of env cables (PP1 side)
  - non-data cable harness connectivity test (LV)
  - disconnection of env cables (PP1 side)
  - analysis / QC decision & documentation env cables

Cooling temperature and environmental sensors are installed. Electrical connectivity tests will be made to ensure that those sensors and their associated cabling are free from damage. Localized heat input / ‘cold-spray’ will be used to make sure the sensors respond appropriately (need to understand how best to check humidity sensors).

Test of data bundles on trolley

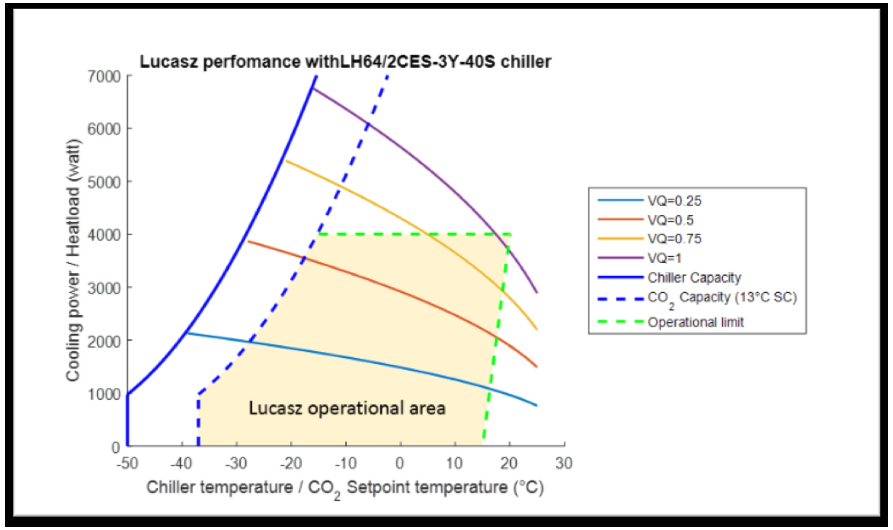


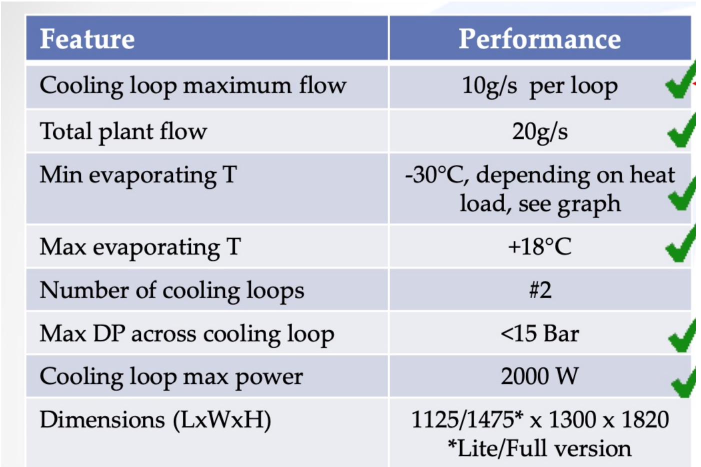
4) harness dressing on EC/trolley jig:		
	routing & fixation on loom:	
		mounting of data pigtail connectors
		cable routing withing EC, with CTE expansion loops
		cable routing around EC endflange
		cable looming between endflange and PP1 (to remain after assembly)
		cable routing towards trolley & storage/coiling of excess cabling
		optoboard adaptor mounting/adjustment (in extended trolley position)
	test of transition of trolley configuration between expanded and retracted position	
5) post dressing QC testing:		
	connection of data cables (both sides)	
	data cable harness connectivity test (CON)	
	disconnection of data cables (both sides)	
	analysis / QC decision & documentation data cables	

Stolen from S. Eisenhardt harnesses timeline

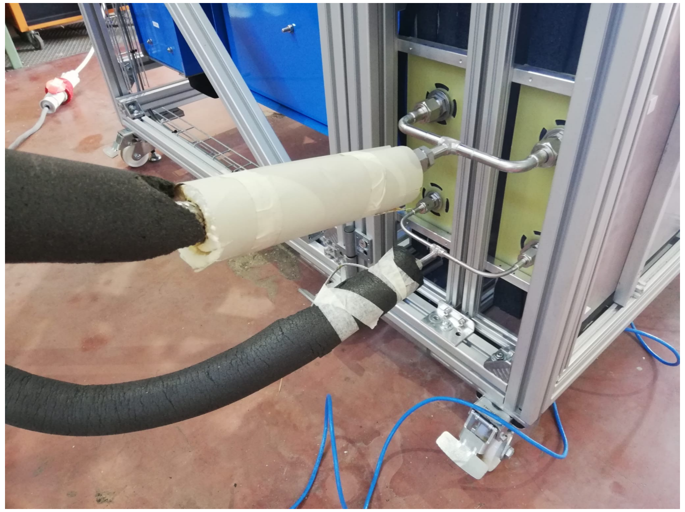
Status Infrastrucure: Lucasz Plant at LNF

C. Ligi, G. Cesarini





Feature	Performance
Cooling loop maximum flow	10g/s per loop ✓
Total plant flow	20g/s ✓
Min evaporating T	-30°C, depending on heat load, see graph ✓
Max evaporating T	+18°C ✓
Number of cooling loops	#2
Max DP across cooling loop	<15 Bar ✓
Cooling loop max power	2000 W ✓
Dimensions (LxWxH)	1125/1475* x 1300 x 1820 *Lite/Full version



- Merging of lines to reach 20 g/s

- With VP = 0.5 proposal:
    - $T_{C02\ evap}$ -15 C for cold test
    - $T_{C02\ evap}$ +15 C for warm test