



Q1-TAXS vacuum system design

Jaime Pérez Espinós on behalf of WP12

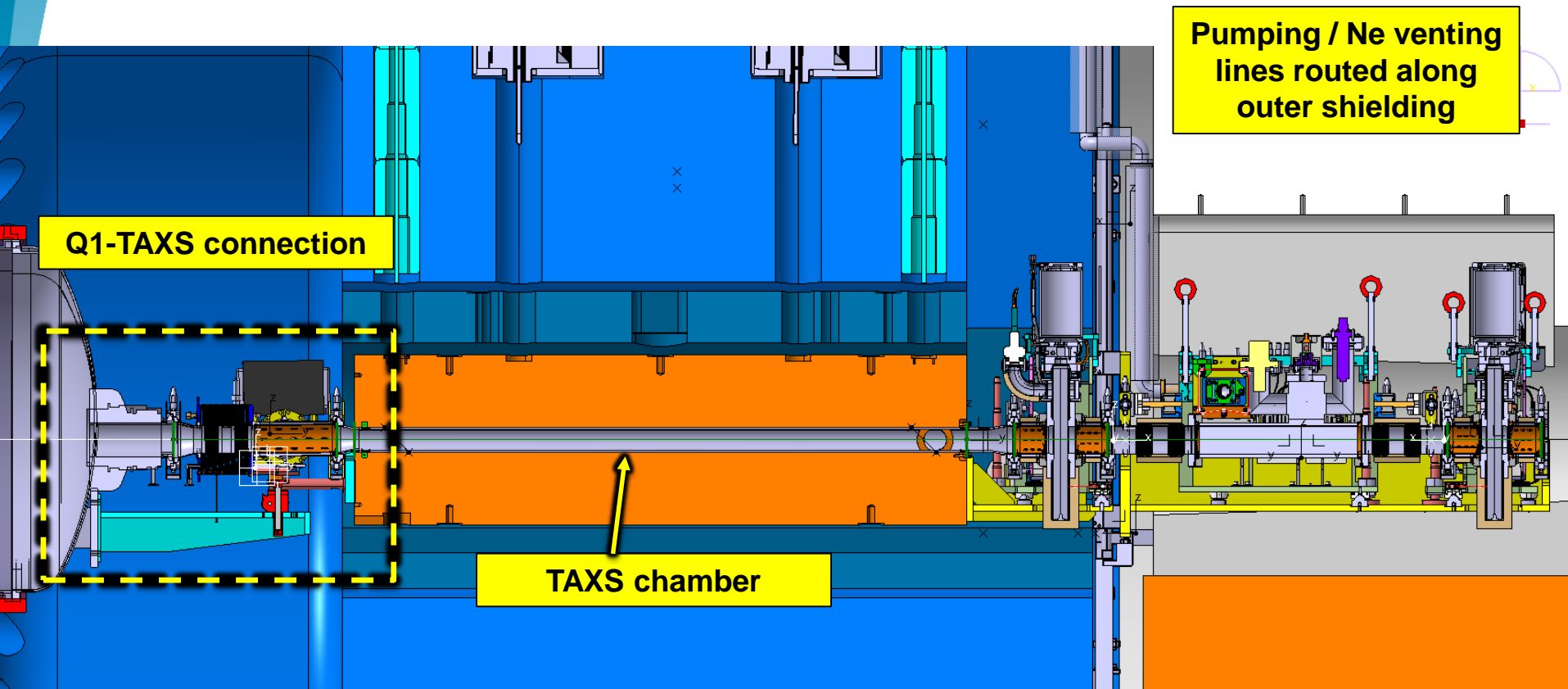


12th HL-LHC Collaboration Meeting Uppsala (Sweden), 19-22 September 2022

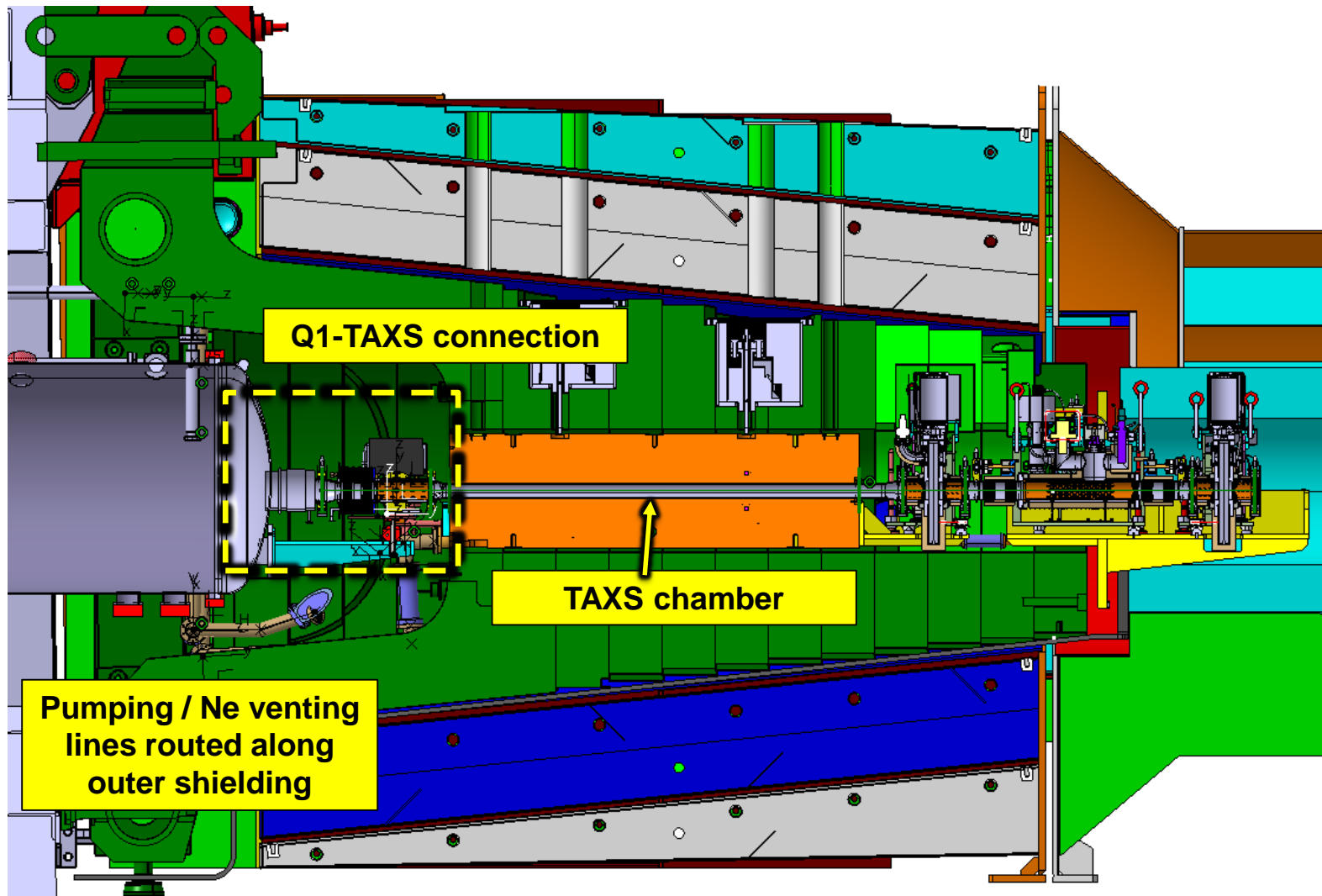
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Q1-TAXS connection - ATLAS

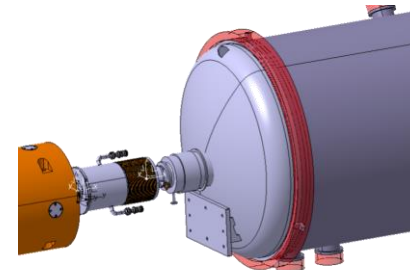
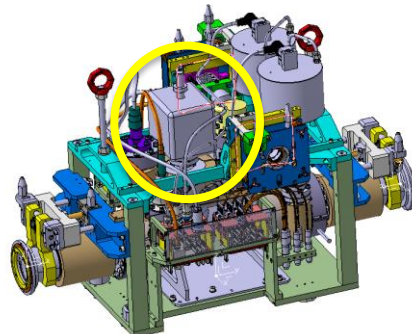
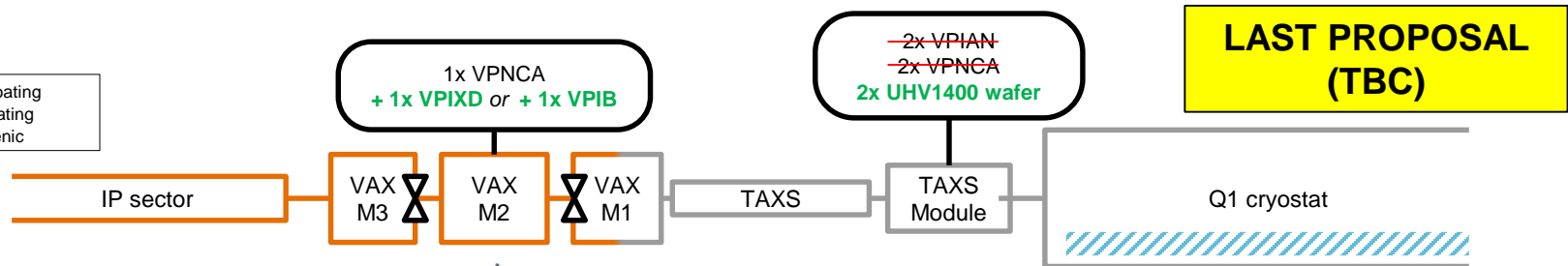
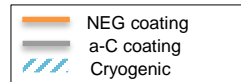
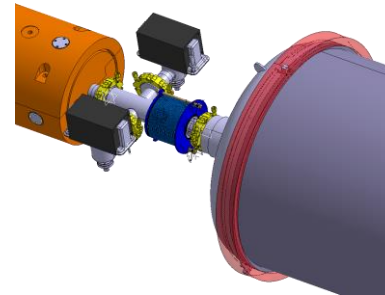
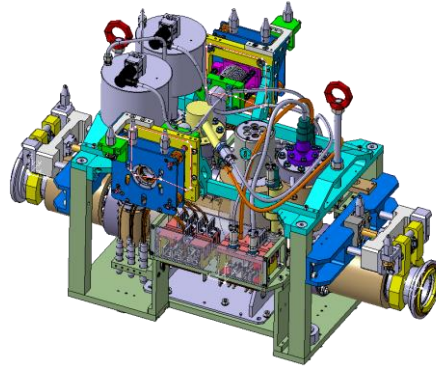
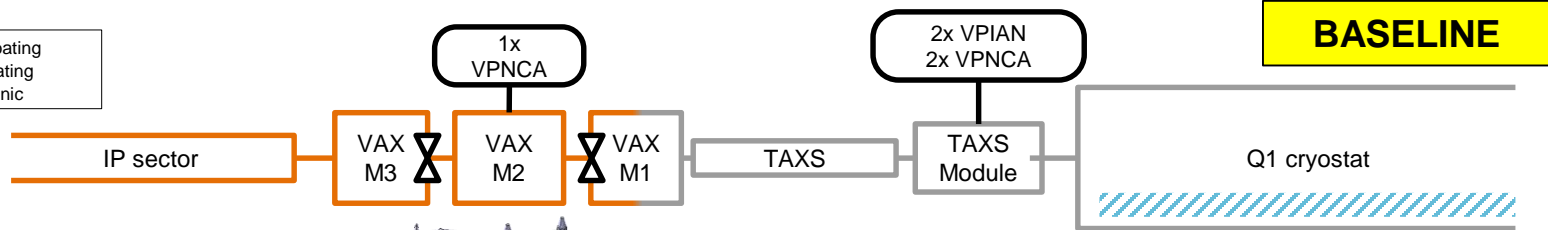
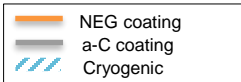


Q1-TAXS connection - CMS



1. Q1-TAXS module design

Vacuum layout alternatives



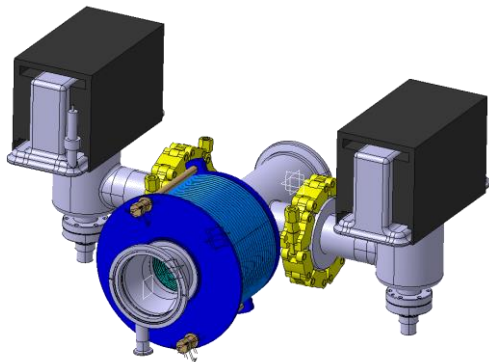
Q1-TAXS module working models

Estimated weights

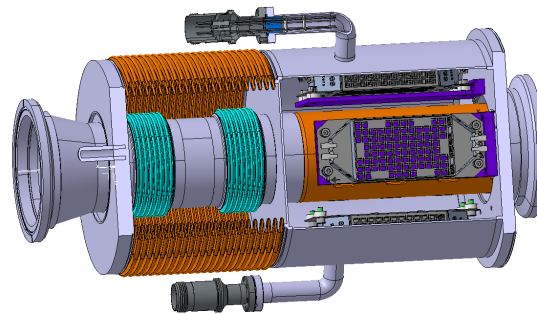
66 kg

19 kg

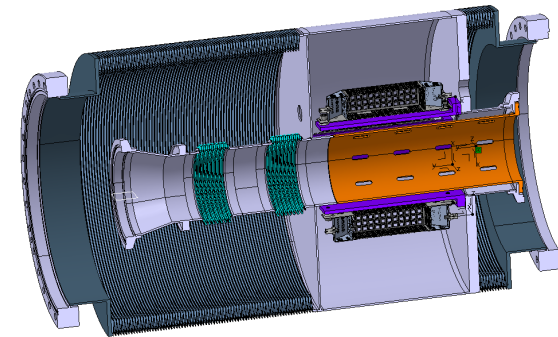
45 kg



Current baseline



**Alternative design
with NEG wafers #1**

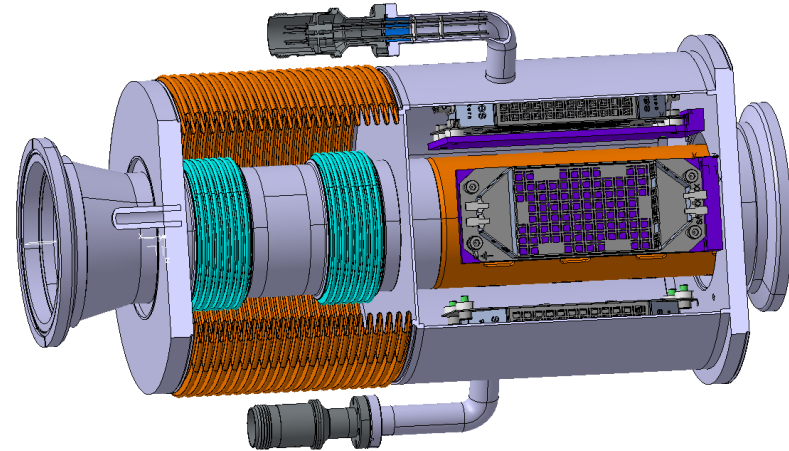


**Alternative design
with NEG wafers #2**

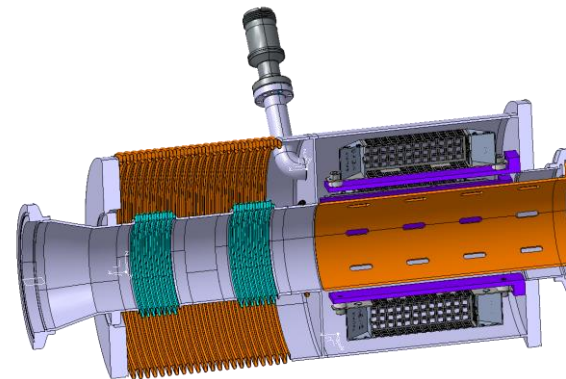
NEG wafers under qualification at CERN

Alternative design with NEG wafers #1

- Tube D204/200 (minimum diameter to fit the NEG wafers)
- 4 NEG wafers HV400 integrated
- Double bellows system enables secondary vacuum to mitigate potential future leak on internal bellows and locate intermediate feedthrough
 - Internal double bellows (same as for the VAX)
 - Outer bellows (same shape convolution as for existing solution on plug-in)
- 2 feedthrough connections (up to 2 wafers per connection)
- Distance of wafers to beam pipe is to be defined following vacuum qualification process

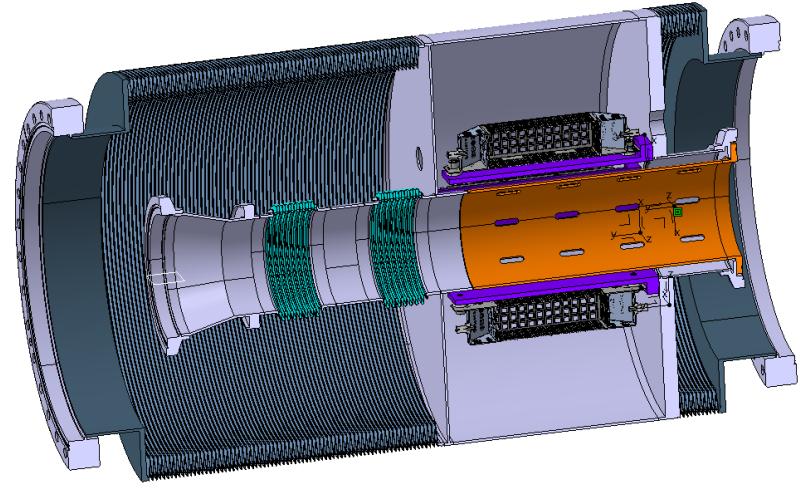


Integration of NEG wafer cabling and feedthroughs is open



Alternative design with NEG wafers #2

- Tube D340/336 used
- 4 NEG wafers HV400 integrated
- Double bellows system enables secondary vacuum to mitigate potential future leak on internal bellows, on wafer feedthrough **and on vacuum connections**
 - Internal double bellows (same as for the VAX)
 - **2x outer bellows** → **edge-welded bellows**
- 2 feedthrough connections (up to 2 wafers per connection)
- Distance of wafers to beam pipe is to be defined following vacuum qualification process



Design much more complex and difficult to implement (TBC)

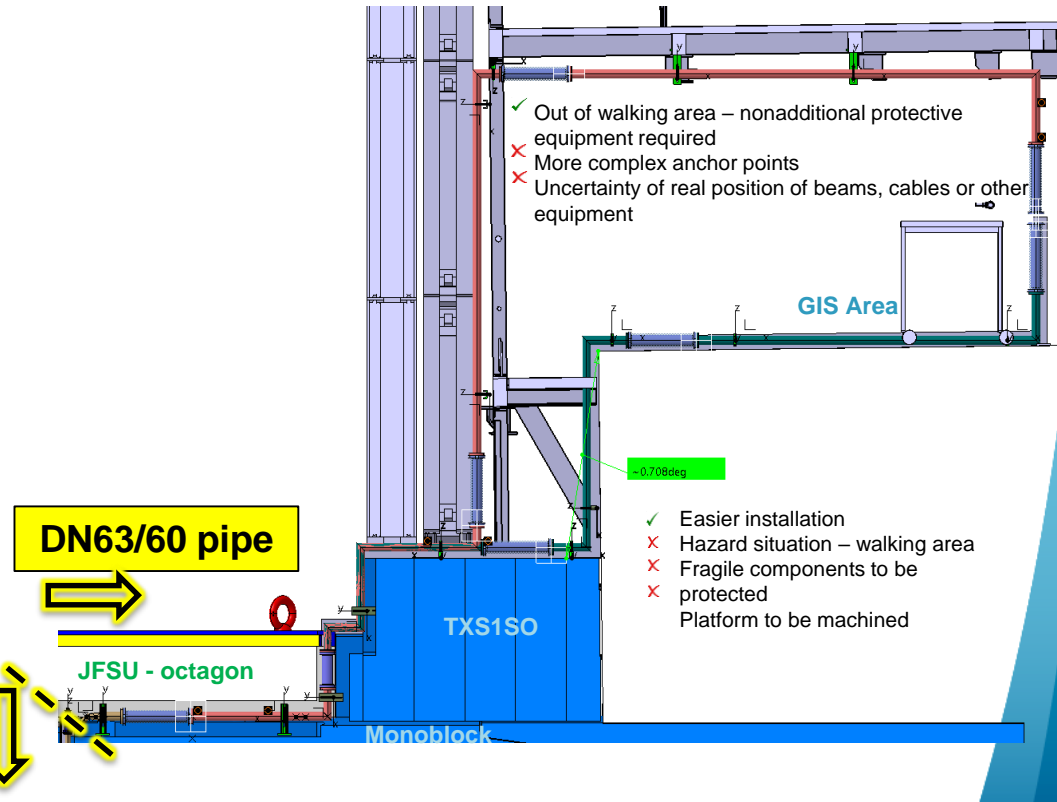
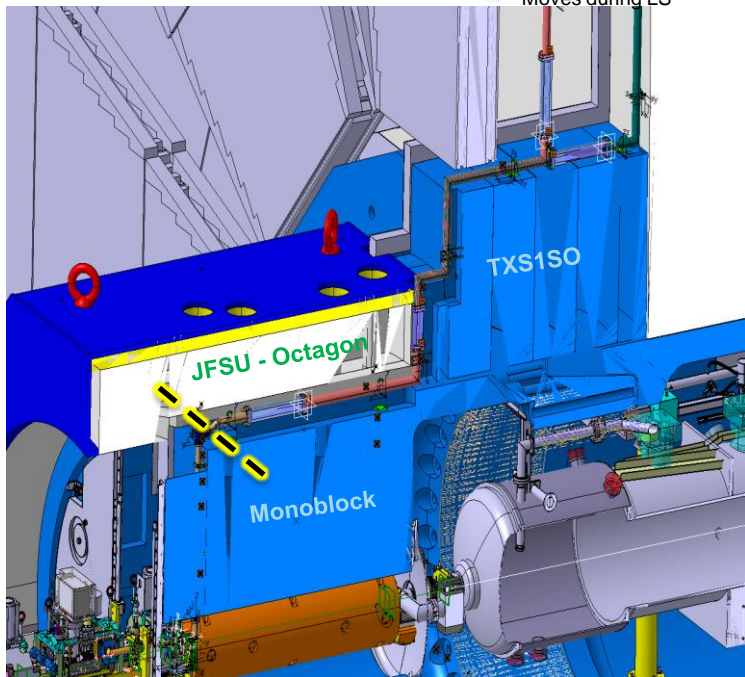
- Compression system is required
- More bulky solution to integrate quick flanges DN100
- He dome and outer sealing connection at TAXS side are blocking points

2. Pumping / Ne venting lines

Status of pumping lines - ATLAS

- Conceptual design is defined for **A-side**
- **Baseline is to retain a symmetrical solution at C-side → GIS to be installed symmetrically on similar location (reduced height wrt A-side) (TBC)**
- **Connection at VAX side is open. 2x alternatives are being analyzed** (see next slide):
 - Manual connection at JFSU octagon level → involves extending structure of M2-M3 support
 - Remotely operated connection at alignment plate level → involves making space at JFC3 or TX1SP shields (detailed analysis required)

■ Stays in place
■ Moves during LS



DN38/34 pipe

Status of pumping lines – ATLAS (VAX area)

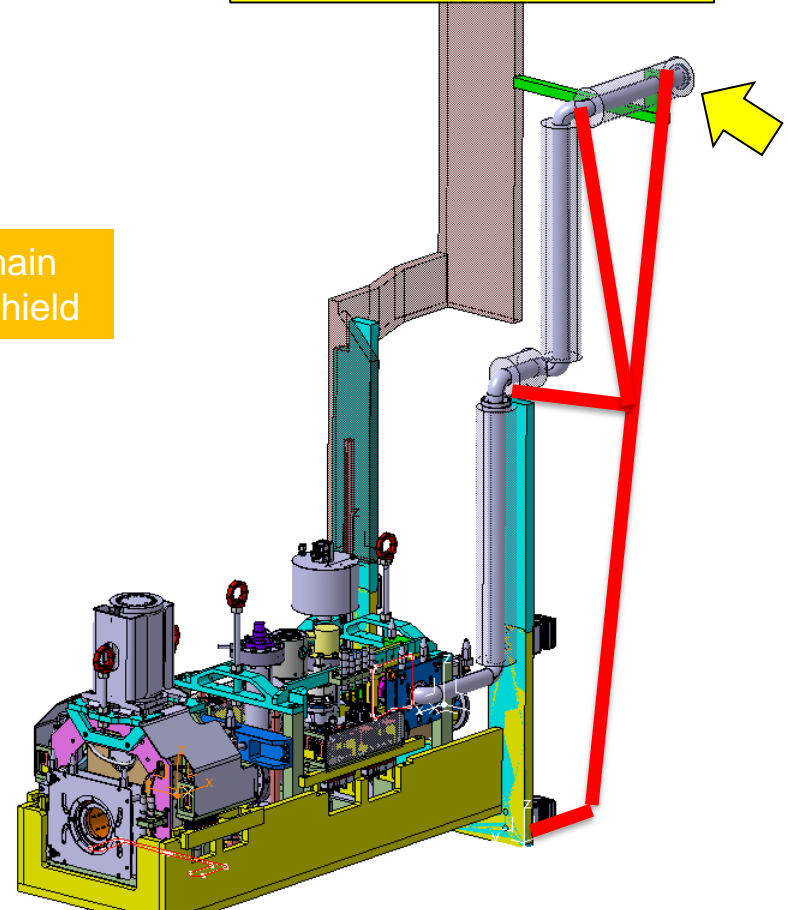
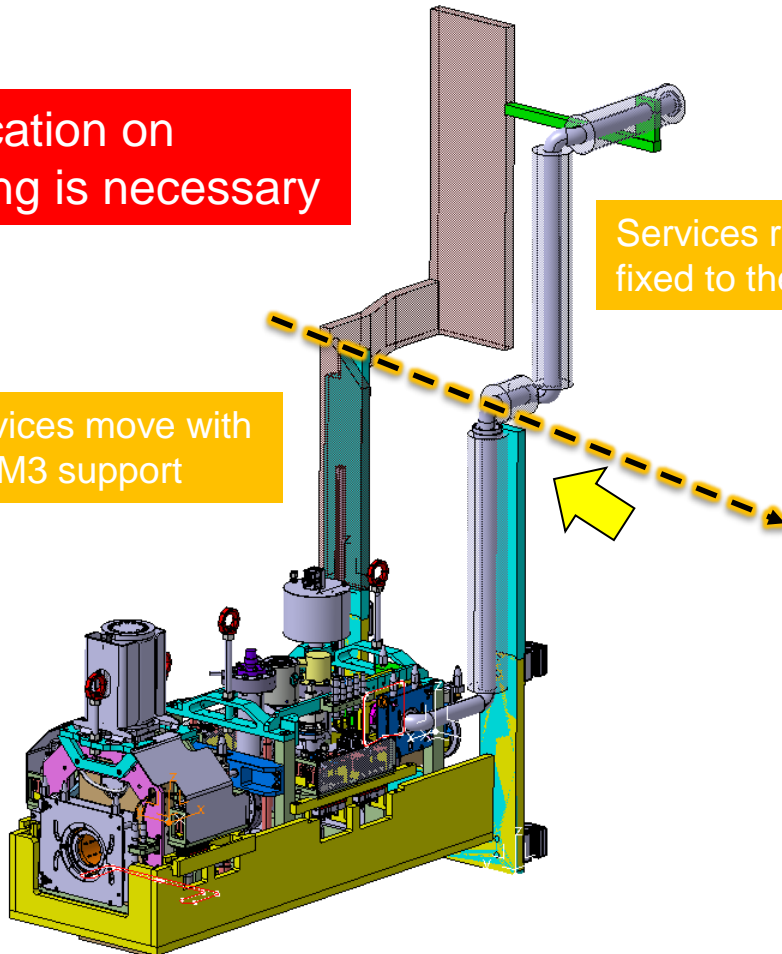
Remotely operated connection
at alignment plate level

Manual connection at
JFSU octagon level

Modification on
shielding is necessary

Services remain
fixed to the shield

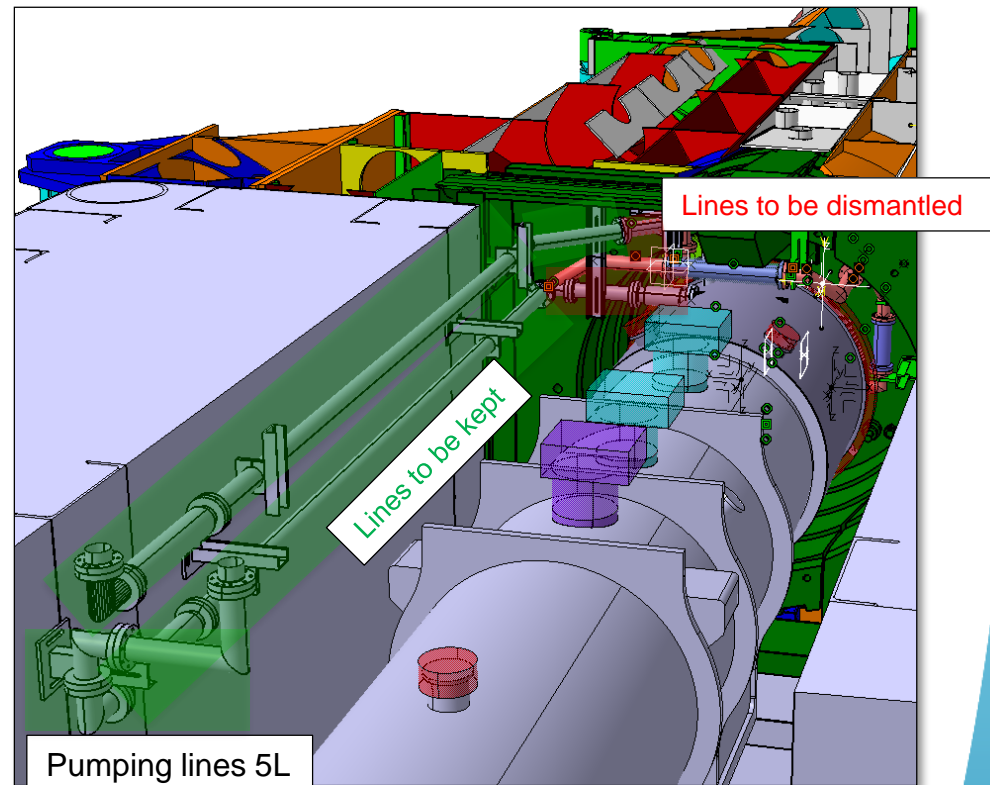
Services move with
M2-M3 support



Extending support structure is
envisaged as part of M2-M3 support

Status of pumping lines – CMS (Q1-TAXS area)

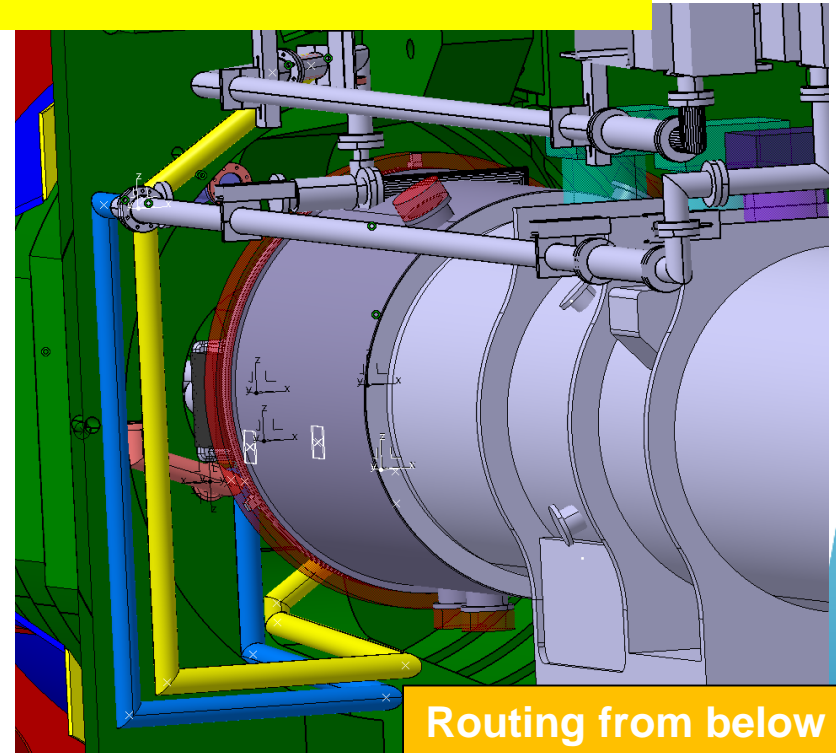
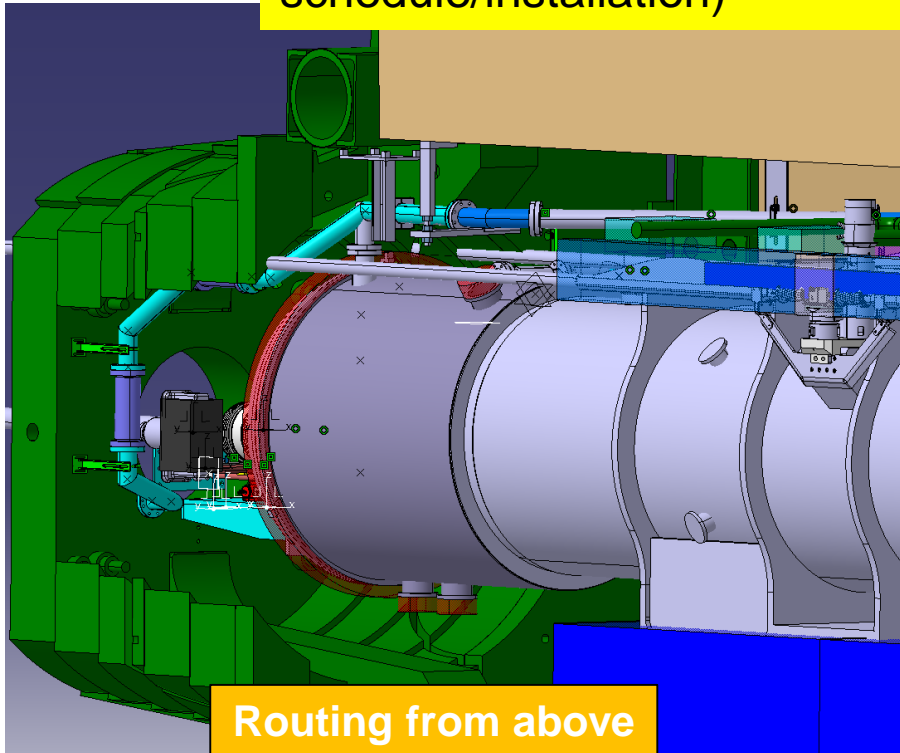
- Baseline is to retain routing of lines up to current LHC VAX
→ WP12.2.4 scope is design of new lines crossing TAXS and connection to existing pumping lines
- Conceptual studies are made for right and left sides (no symmetrical solution) with lines connecting from above and from below → current baseline is to route from below (TBC from tests on WP8 Q1-TAXS area mock-up)
- Integration studies of new routing of “existing” lines has been made following request by WP15



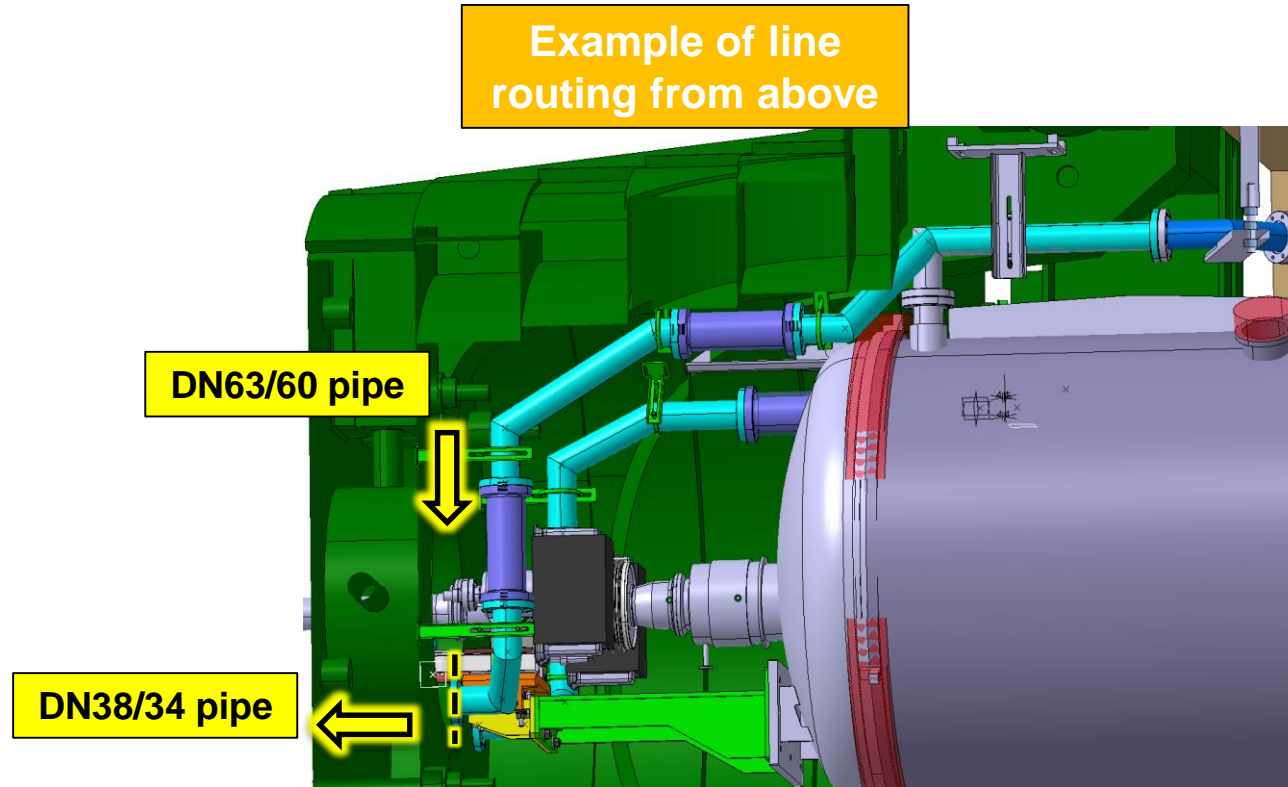
Routing of pumping lines – CMS (I)

- Design is ongoing for **left and right sides** (no symmetrical)

Multiple iterations and interfaces: WP8, WP12 (BVO), WP15 (integration + schedule/installation), CMS (integration + schedule/installation)



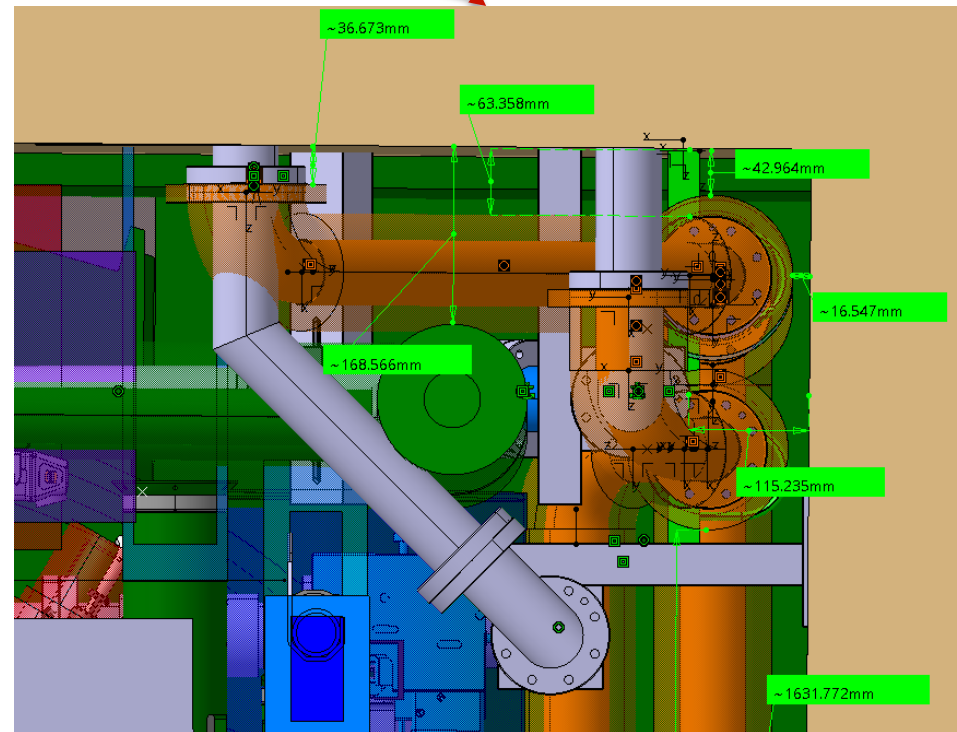
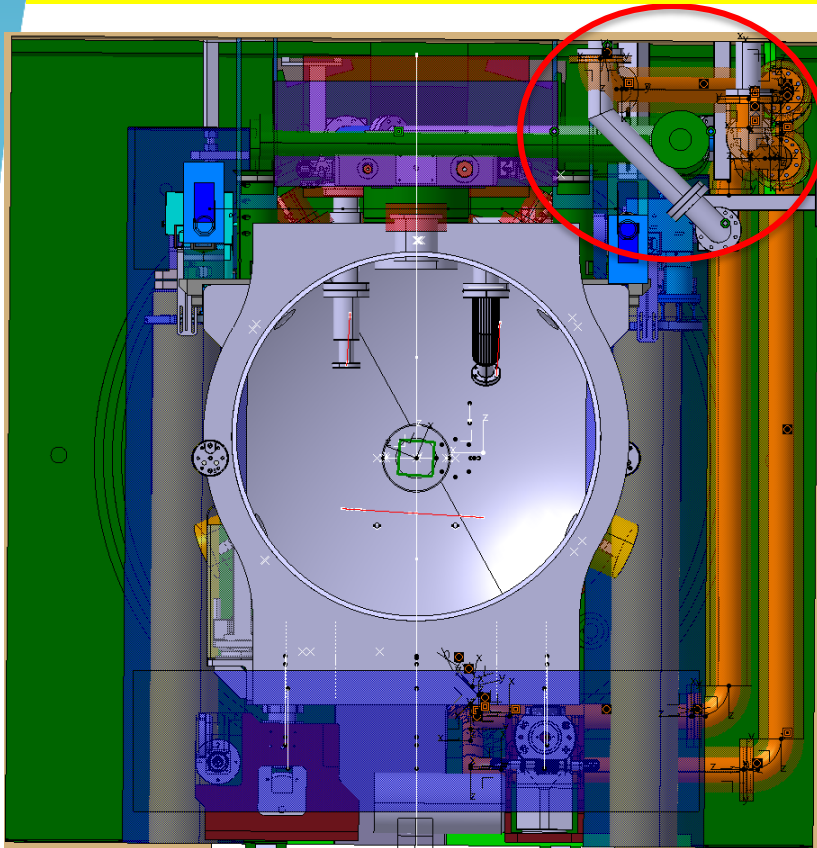
Status of pumping lines – CMS (II)



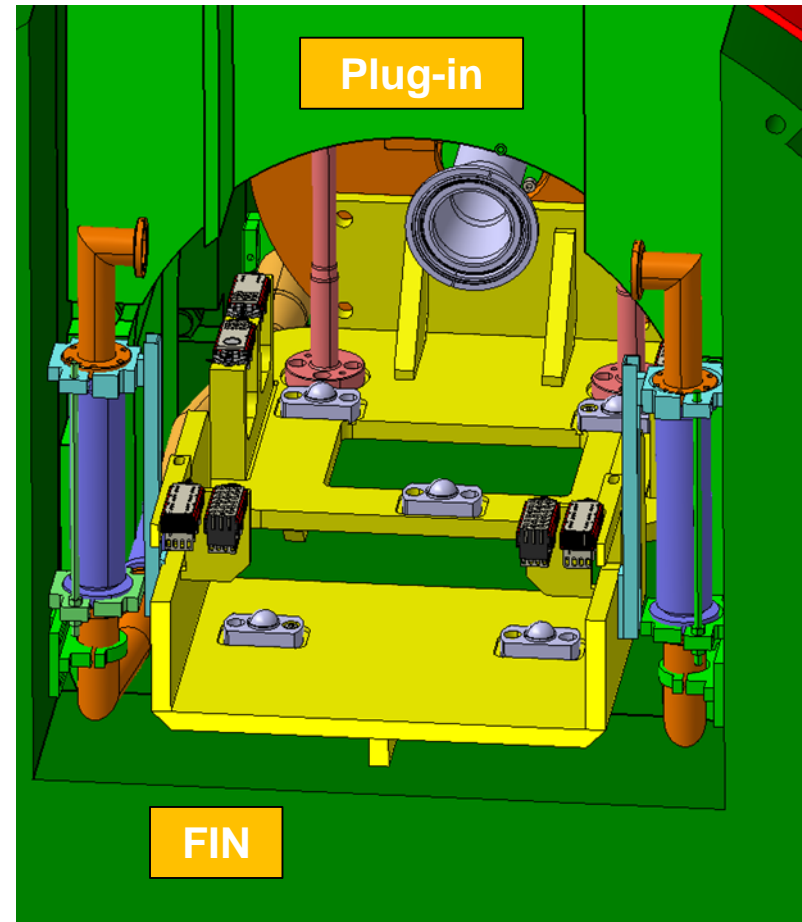
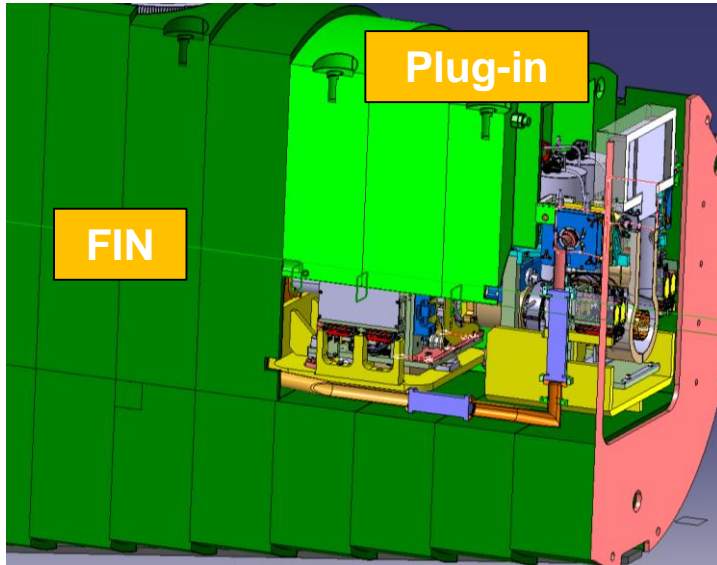
Conceptual integration studies 5R following request by WP15

Up to 3 options studied – to avoid clash with new survey device envelopes

WP15 to take a decision on next steps → possible additional scope for WP12.2.4



Status of pumping lines – CMS (VAX area)



- Routed between the VAX supports and FIN;
- Not possible to place them below the support:
 - Clearance of +/-20mm is required for alignment;
 - The envelope of heating elements is considered.

Concern:

Clearance between the VAX plug-in and the venting lines → Shielding re-design is under study

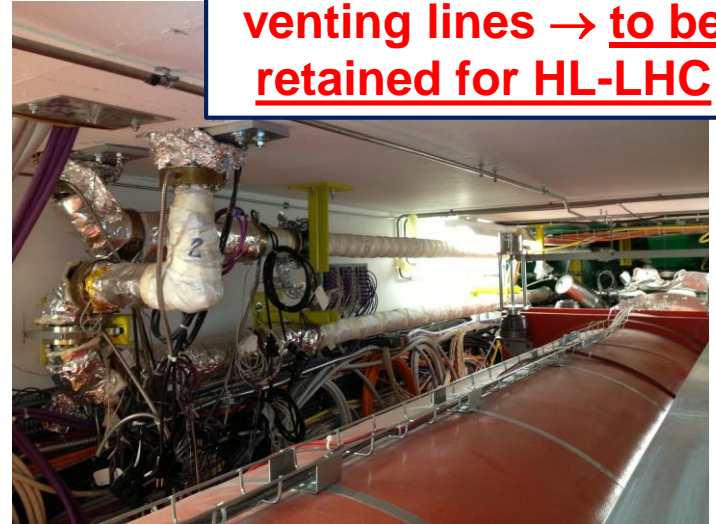
3. Integration and installation aspects with impact on the Q1-TAXS area

Access to VAX in LHC



**ATLAS
access
pathway**

CMS pumping and venting lines → to be retained for HL-LHC



CMS access pathway

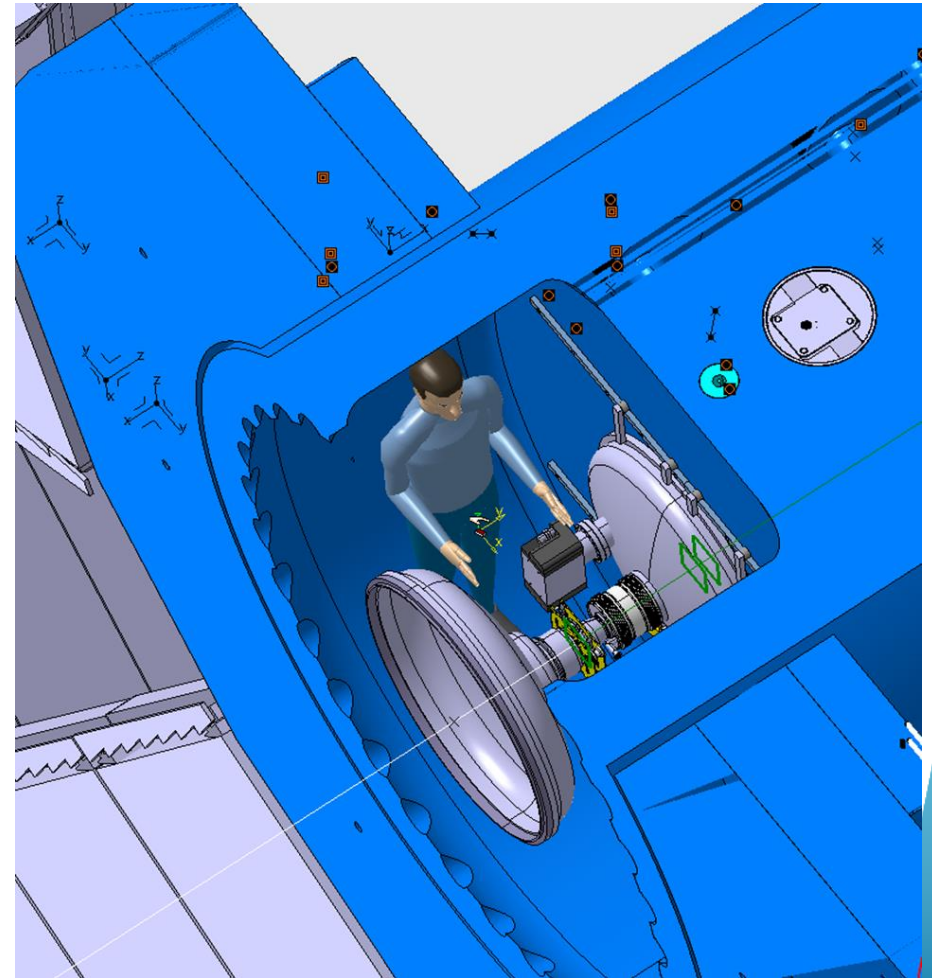
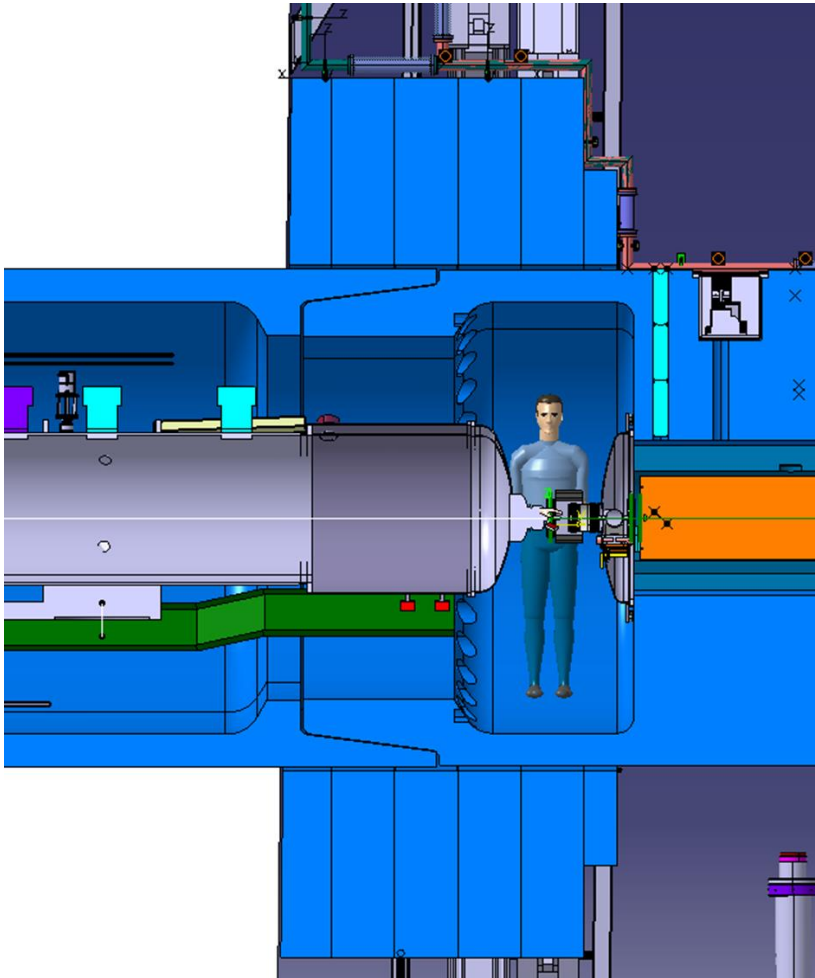


ATLAS pumping and venting lines → to be dismantled and removed for HL-LHC



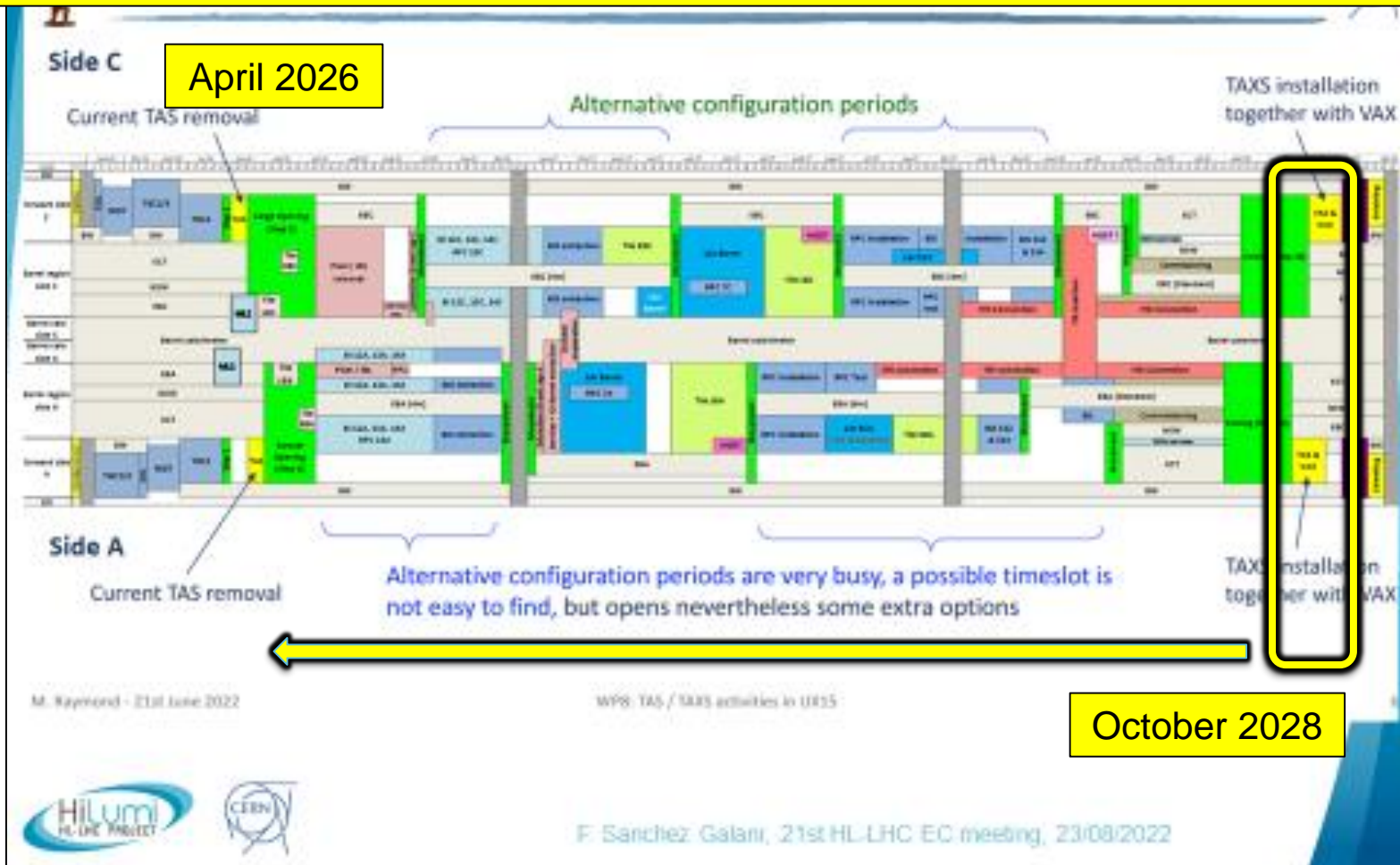
ATLAS Q1-TAXS area accessibility

Access through the LHC tunnel

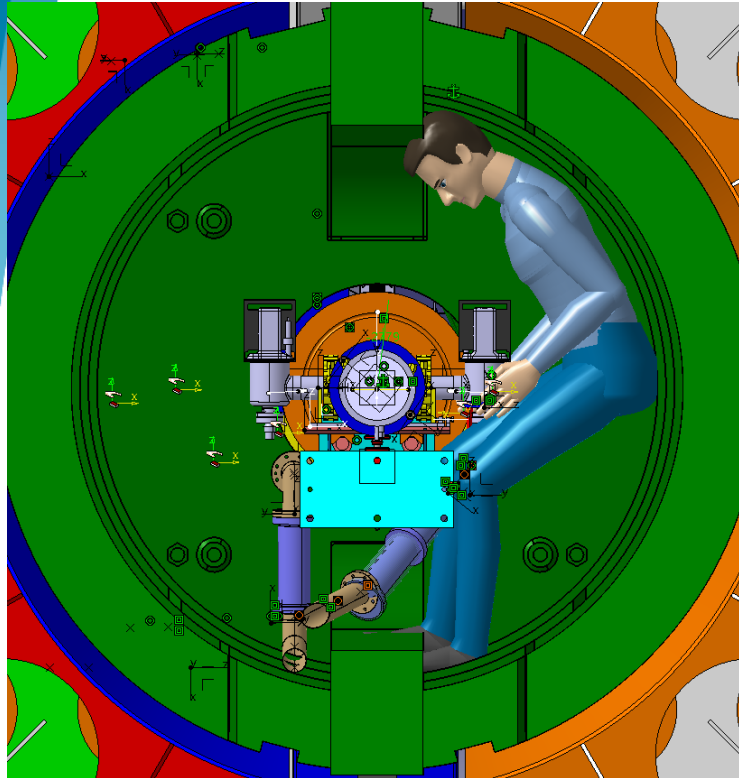


TAXS installation planning baseline in ATLAS

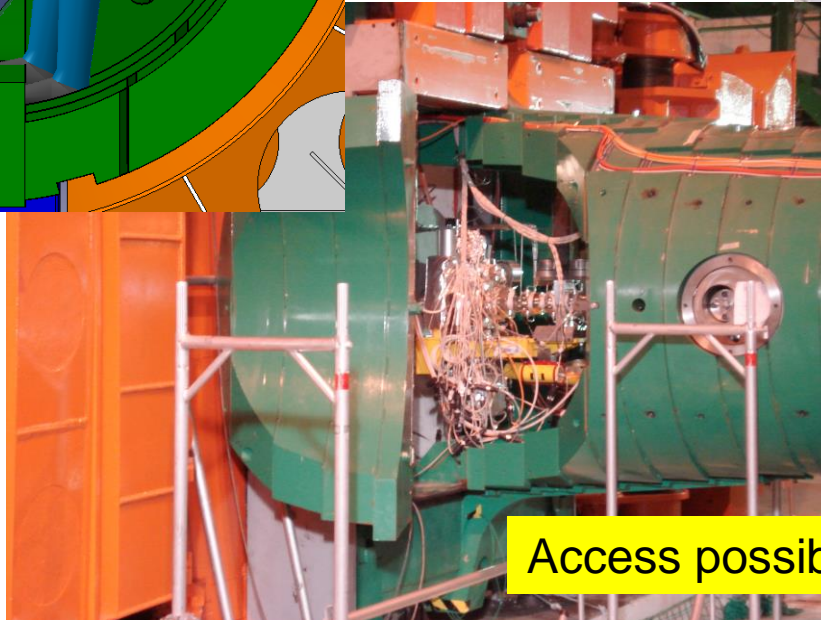
The option to anticipate the TAXS installation is under study → it would give more margin, facilitate the LHC vacuum system commissioning and enhance the installation process BUT would slightly impact the supporting configuration (see slide 26)



CMS Q1-TAXS area accessibility (I)

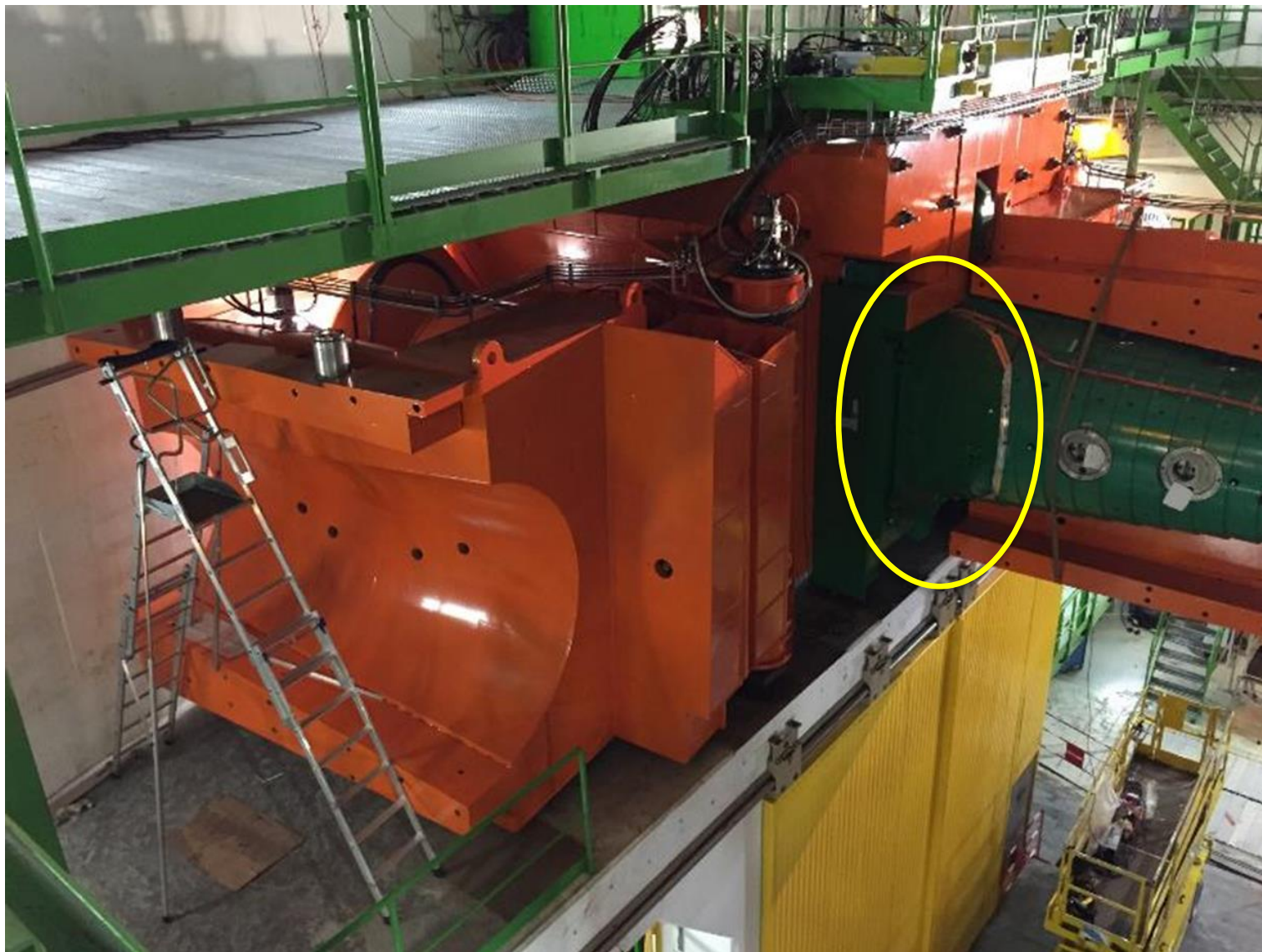


Q1-TAXS area mock-up

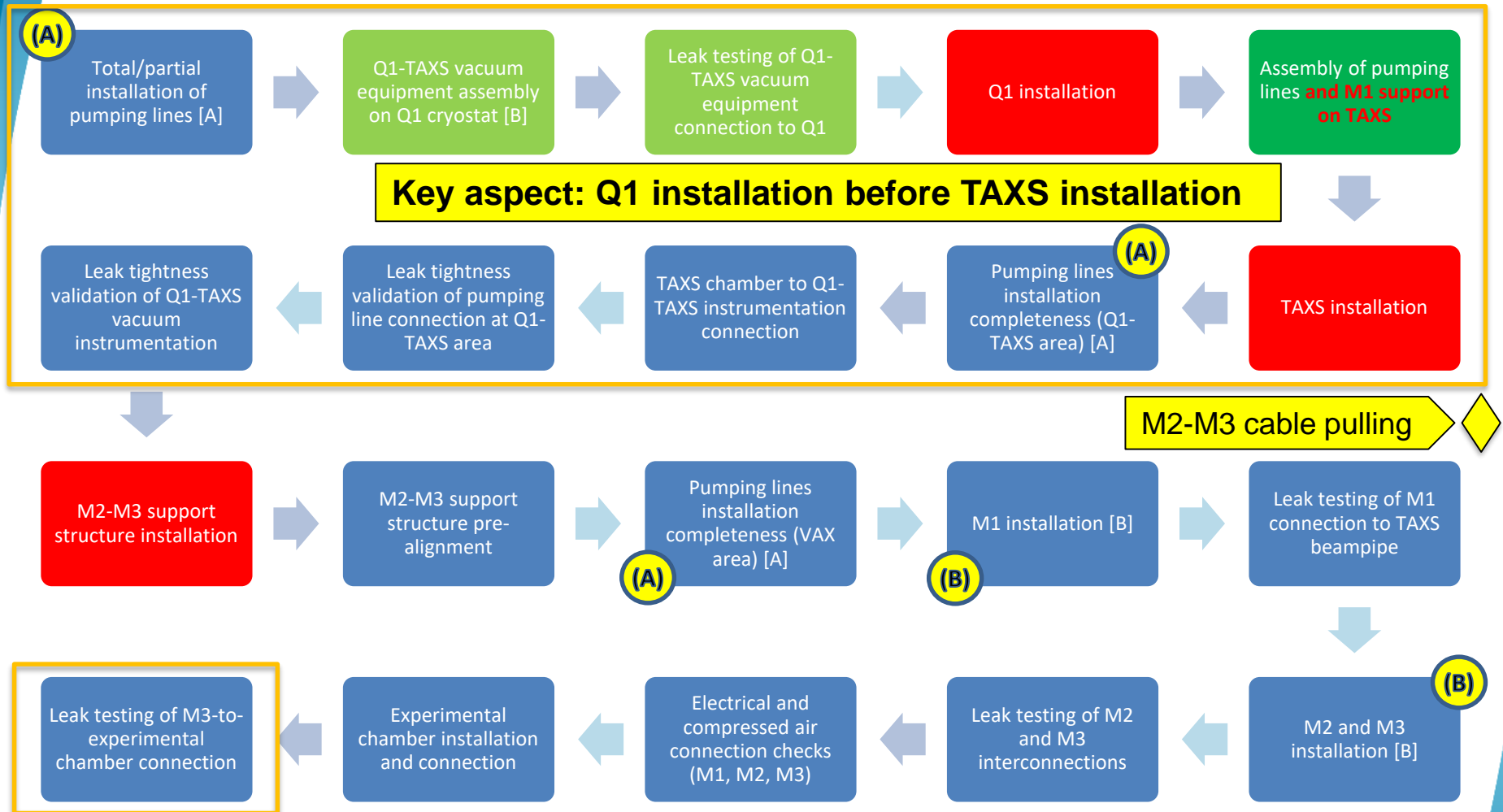


Access possible **ONLY** through cavern

CMS Q1-TAXS area accessibility (II)



Installation sequence approach (CMS case)

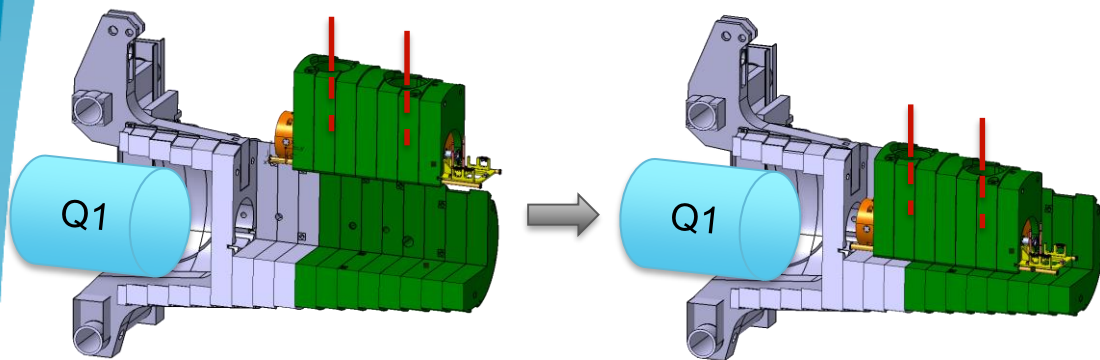


(A) Leak tightness validation of pumping lines installed + checking and commissioning of existing bake-out

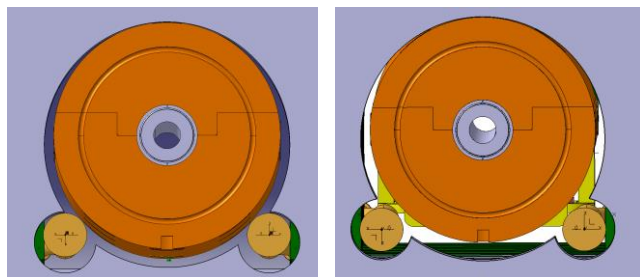
(B) Module assembled and verified leak tight on surface. If applicable, bake out already verified on surface

TAXS installation at CMS – impact on pumping line design

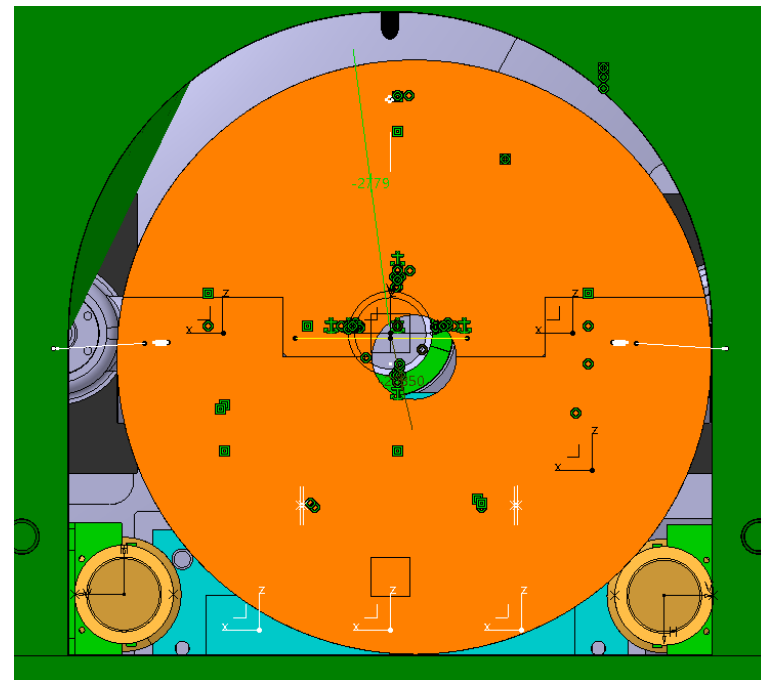
BASELINE: Q1 installation before TAXS installation



Pumping lines and TAXS chamber pre-assembled on FIN + TAXS

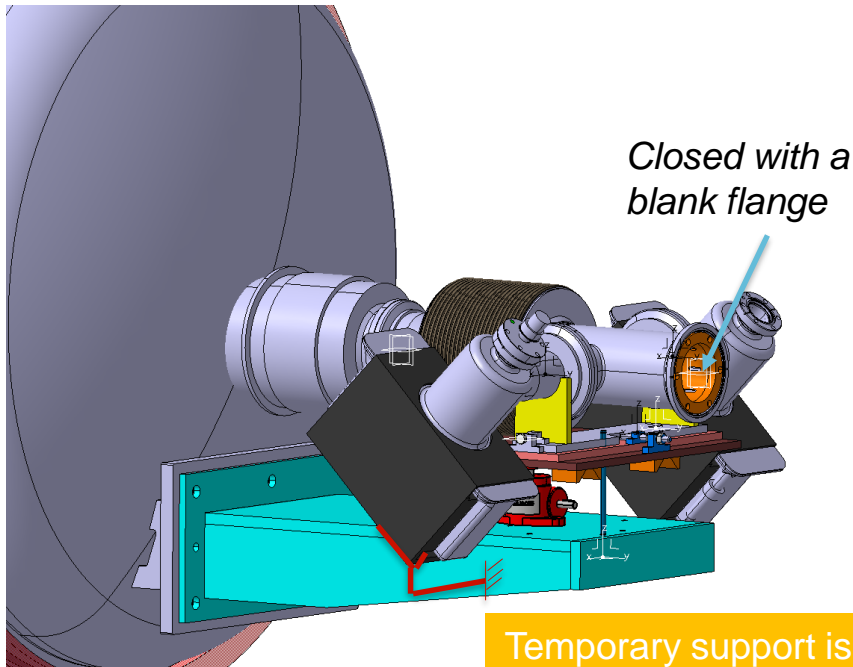


Shield hole machining must be optimized for transport configuration



Solution involves clearance of 20 mm wrt TAXS including bake-out jackets

Q1-TAXS module temporary support



Temporary support is required to facilitate installation of Q1-TAXS module and connection to TAXS chamber once the TAXS is installed

For ATLAS, no temporary support would be required if the installation of the TAXS comes before Q1. **However, depending on the relative misalignment (up to 5 mm max.) between the TAXS and Q1, it would require additional tooling to execute the connection**

4. Summary of main open points

Summary of main open points

- Freezing of vacuum layout, following NEG wafer test and qualification;
 - Choice of best design approach;
- ATLAS:
 - Confirmation of GIS location at C-side;
 - Cable and pumping line disconnection method and location in VAX area of ATLAS;
 - Action on support and/or shielding;
 - Confirmation of planning for TAXS installation;
- CMS:
 - Freezing of pumping line routing;
 - Definition of Q1-TAXS module connection process;
 - Definition of pumping line pre-installation process on plug-in (for TAXS installation) and plug-in shield modifications.

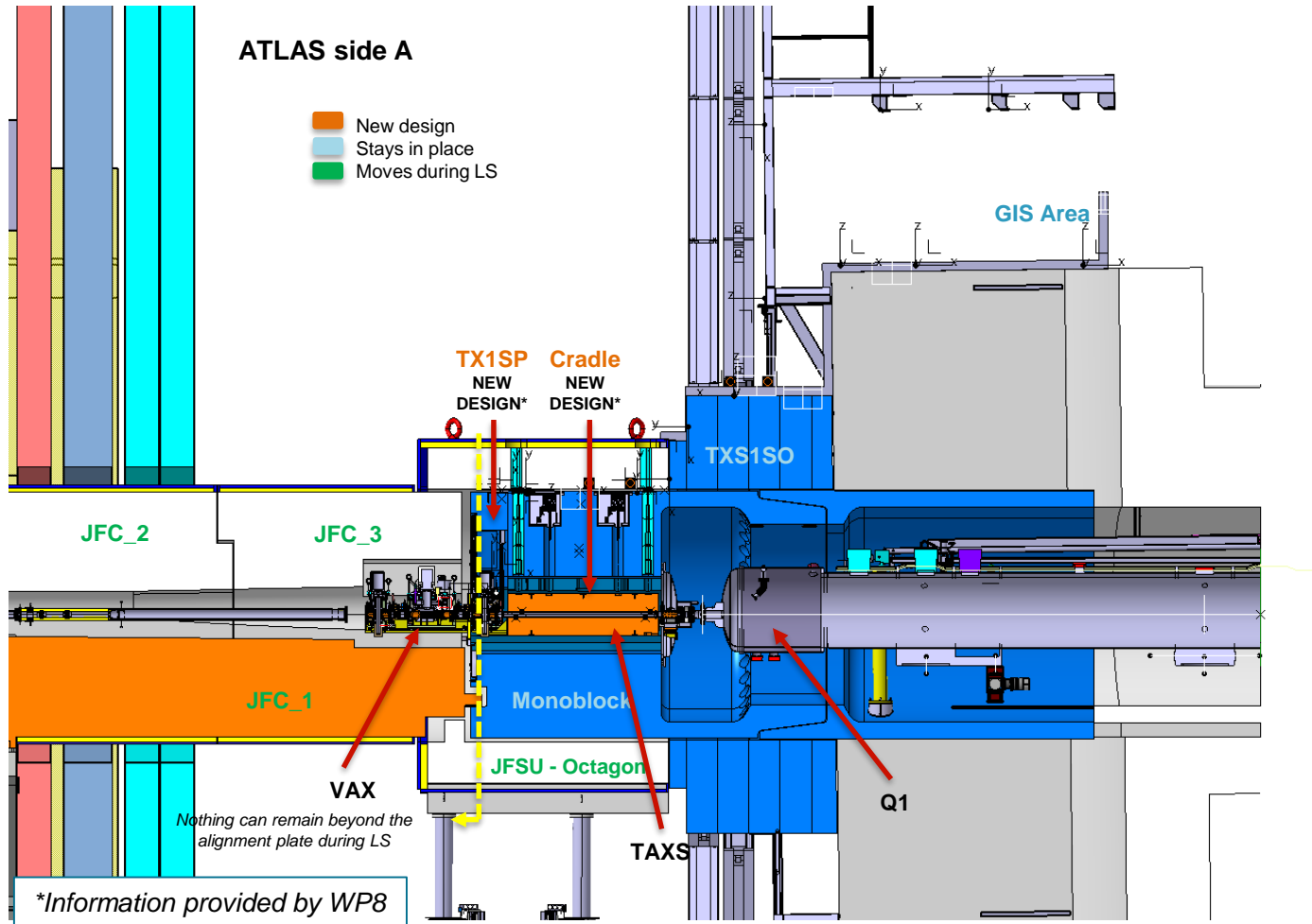


Thanks for your attention

Special thanks to Rita, Frederic, Herve, Josef, Alessio, Giuseppe, Vincent, Cedric, Oliver, Ruth, Antonio, Francisco and many others



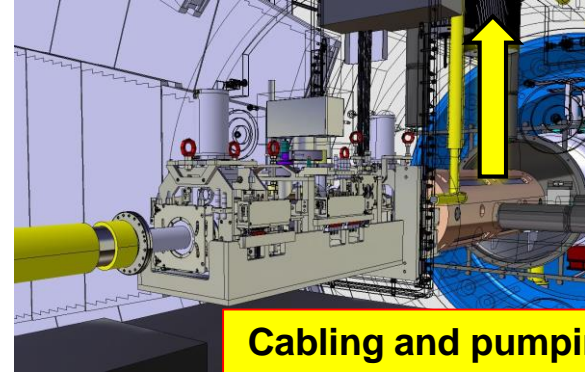
ATLAS shielding from LS3



VAX integration at pt. 1 – ATLAS



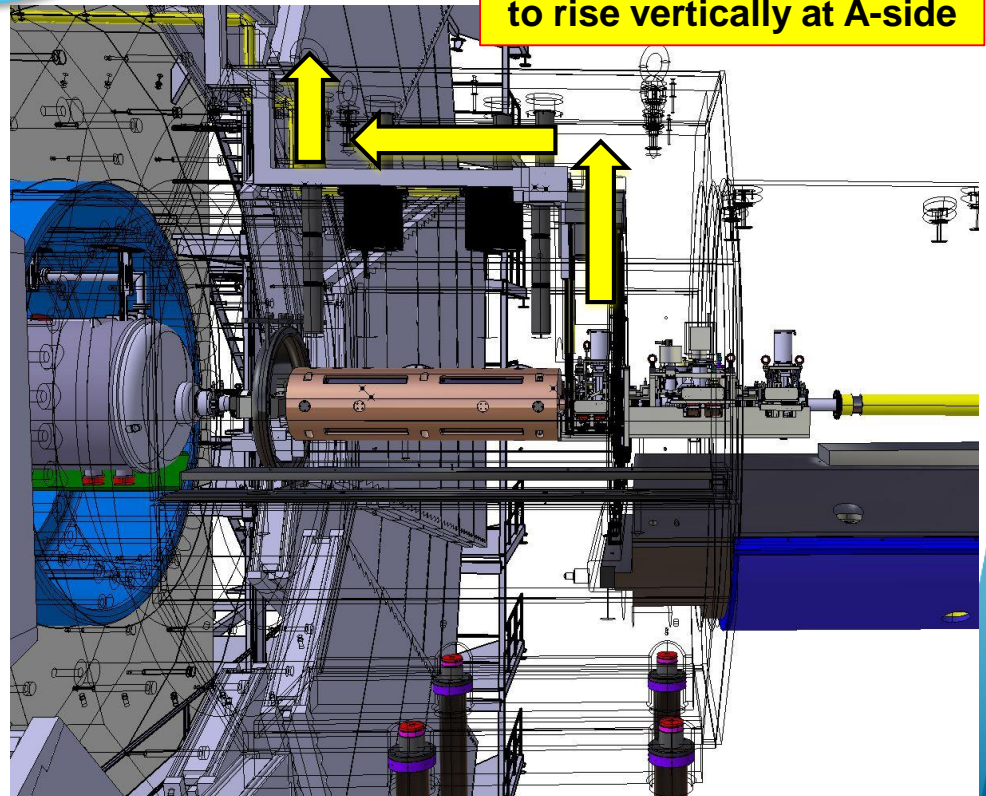
GIS A-side

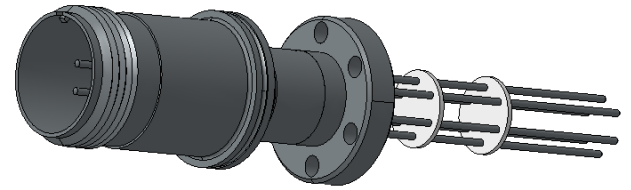
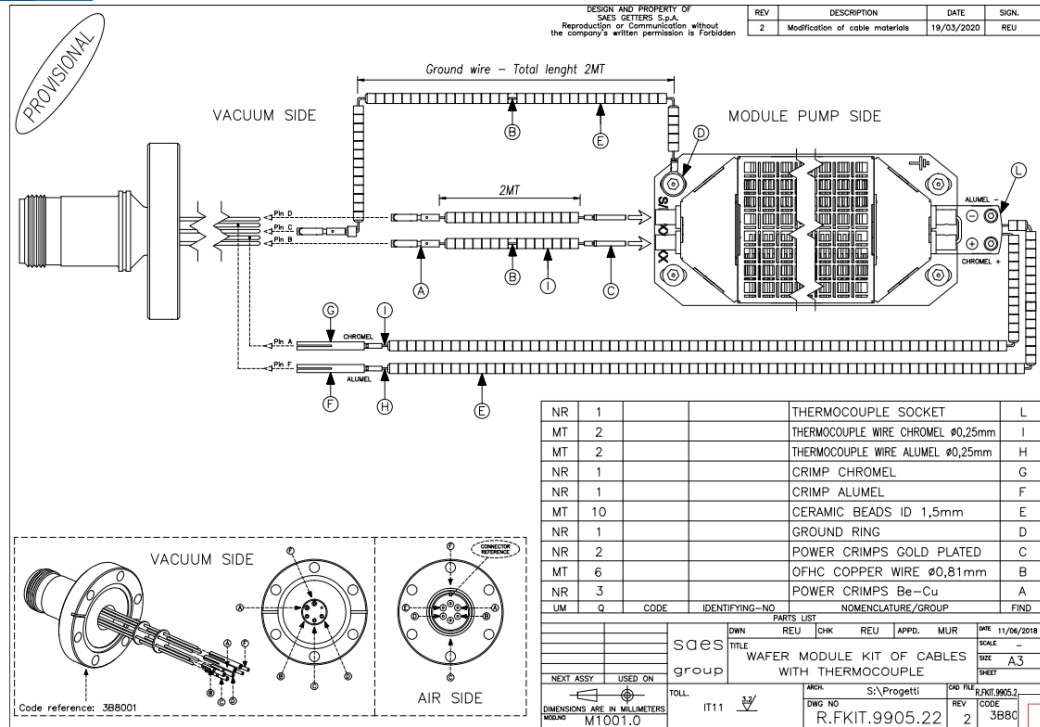


Cabling and pumping line to rise vertically at A-side



Space for GIS at C-side on symmetric solution



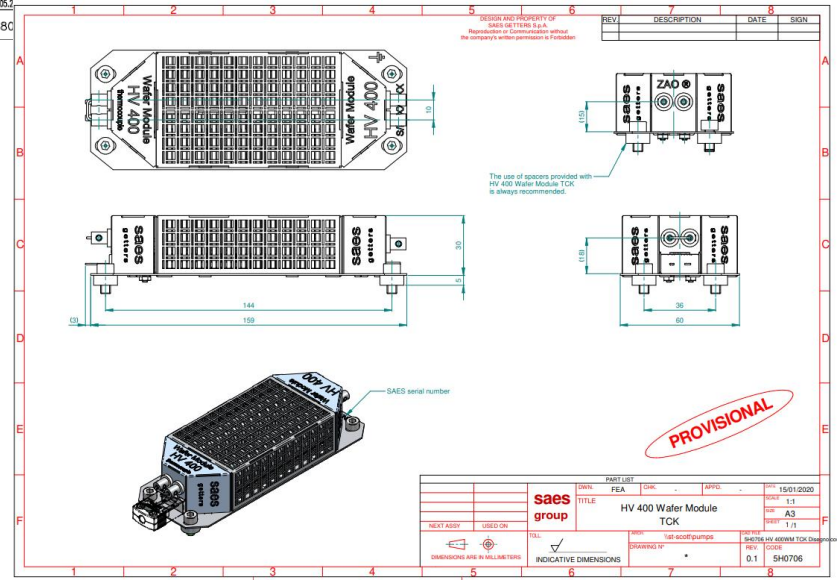


Information from the company:

- With or without thermocouple
- Standard 2m cables (needs to be discussed if we want a customized length).
- CF16 feedthrough connection: up to 2 NEG wafers in parallel or series.
- Other flanges sizes are possible for the feedthrough.
- Positioning limitations? "No problems on its positioning. The ZAO is particle free NEG sintered material. It is used in superconducting cavities."

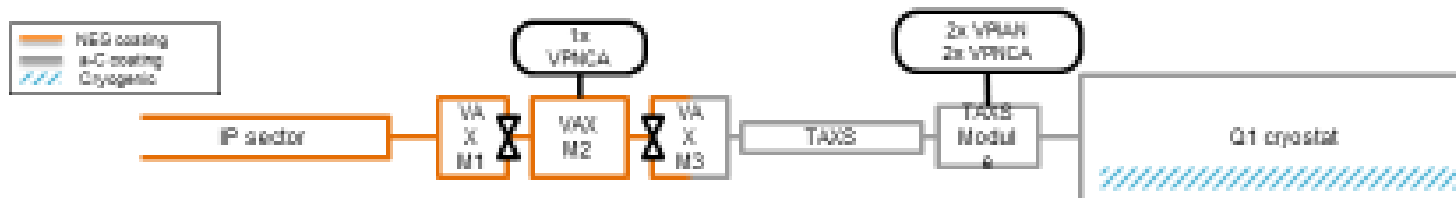
They offered to have a meeting to discuss about our specific application

REV	DESCRIPTION	DATE	SIGN.
2	Modification of cable materials	19/03/2020	REU



Current layout

- Nowadays the baseline consist in:
 - A VPNCA NEG cartridge (400L/s H_2) installed on the VAX M2 module
 - Two VPIAN ion pumps (30L/s N_2) with VPNCA NEG cartridge (400L/s H_2) installed on the module between TAXS and the cold-warm transition of the Q1 magnet



- This layout is satisfactory under the vacuum point of view, however:
 - Ion pumps are bulky in comparison to NEG cartridges
 - The reliability of ion pumps is generally lower than NEG cartridges
 - NEG based pumping does not need a continuous power supply in order to work
 - The presence of an unbaked part at room temperature is quite challenging for the activation of both NEG and ion pumps during the so called "accumulation" phase of the cooldown

Proposed changes

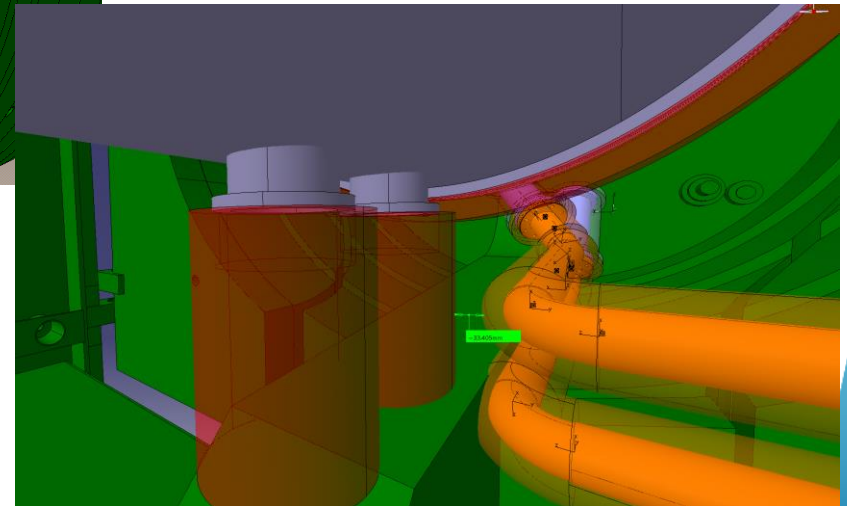
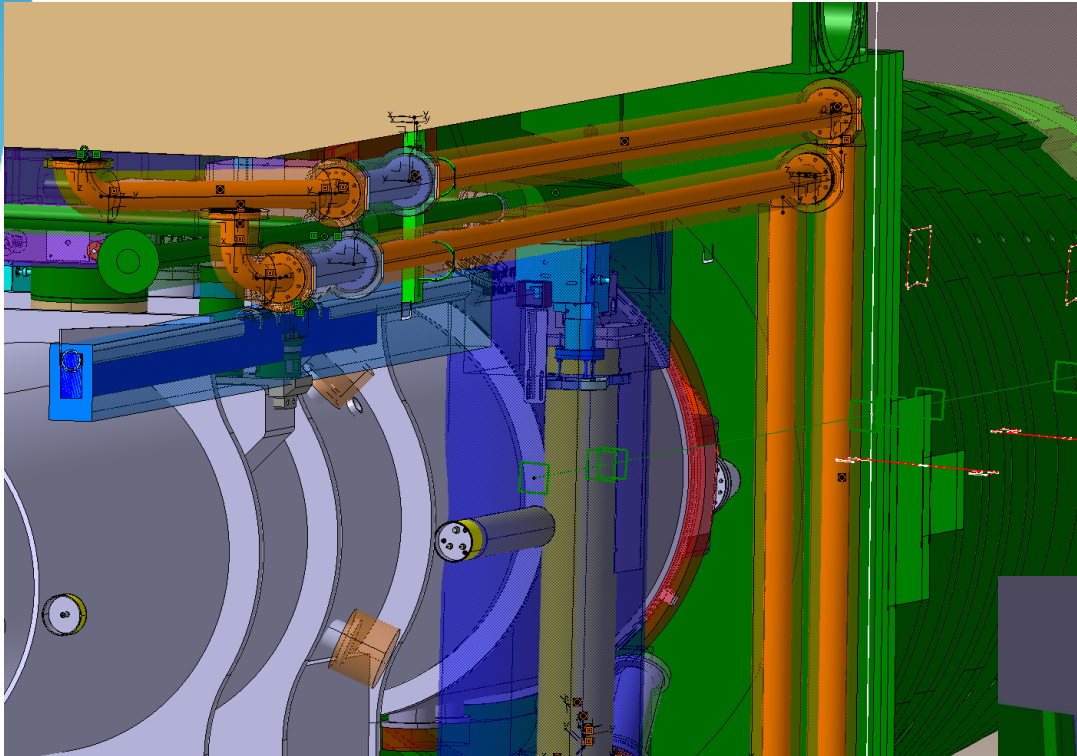
- The following changes can be implemented:
 - Integration of a 20L/s or 75L/s ion pump on the VAX



- These NEG wafers are essentially NEG cartridges with higher capacity
- Multiple units can be mounted inside the system and can share a single feedthrough
- The solution reduces the number of flanges present in the area
- It is under study the possibility to have a secondary vacuum around the module

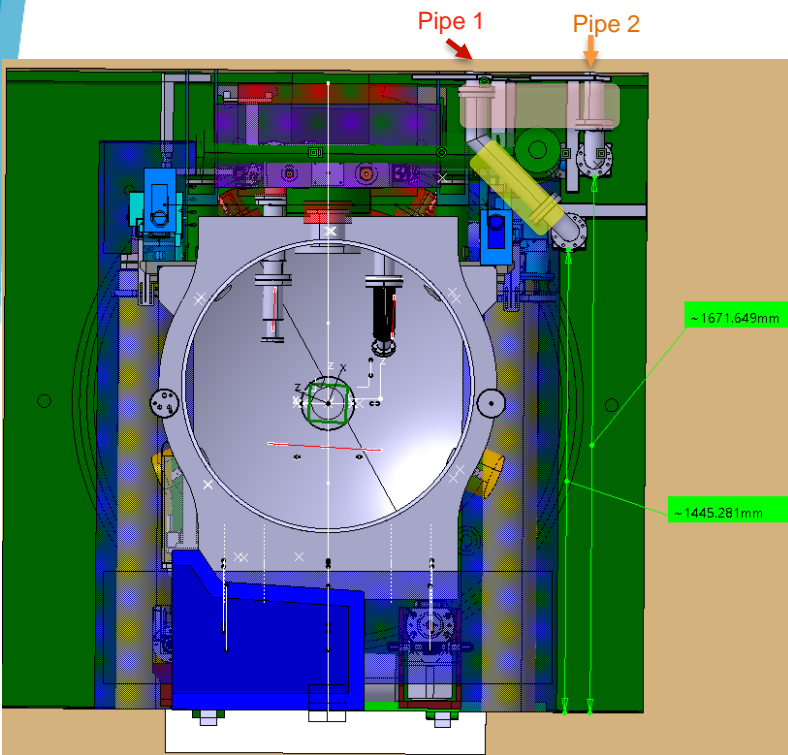


Pumping line routing in CMS

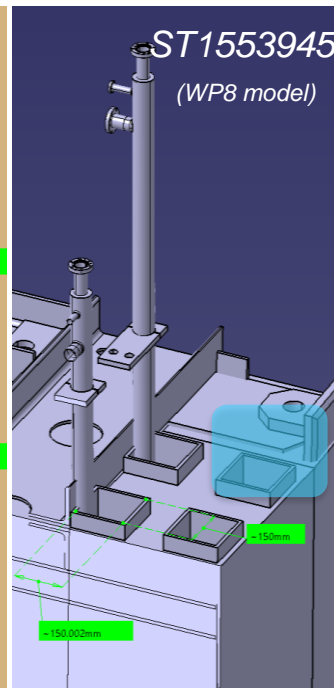


Pumping line integration studies – CMS

Existing (currently installed) lines 5R



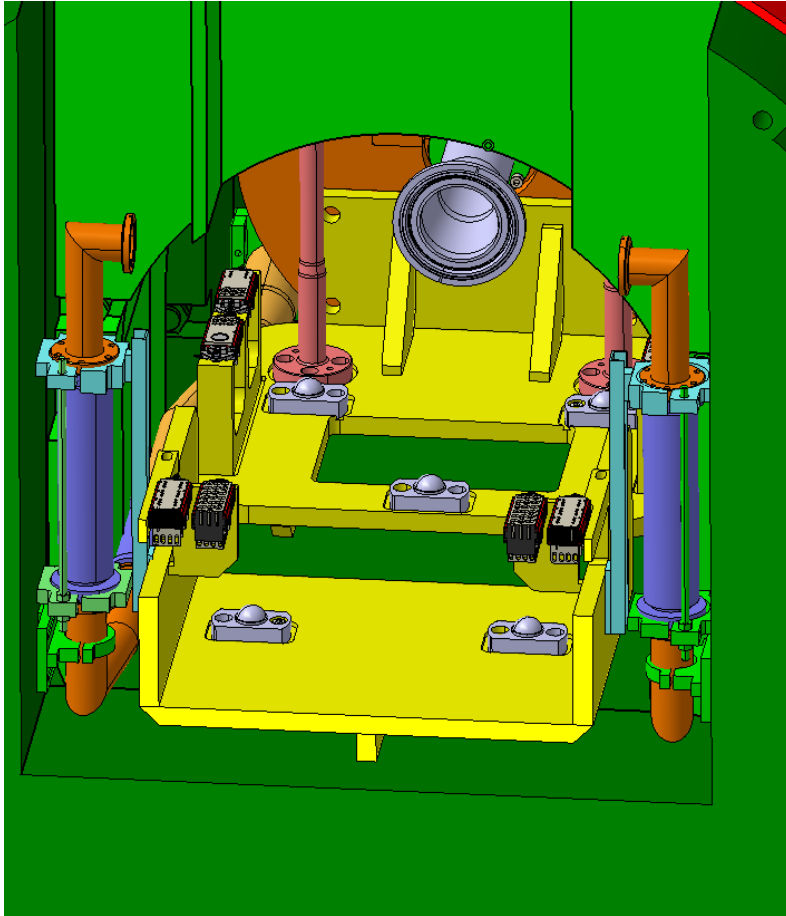
Passage for the lines
GIS - tunnel



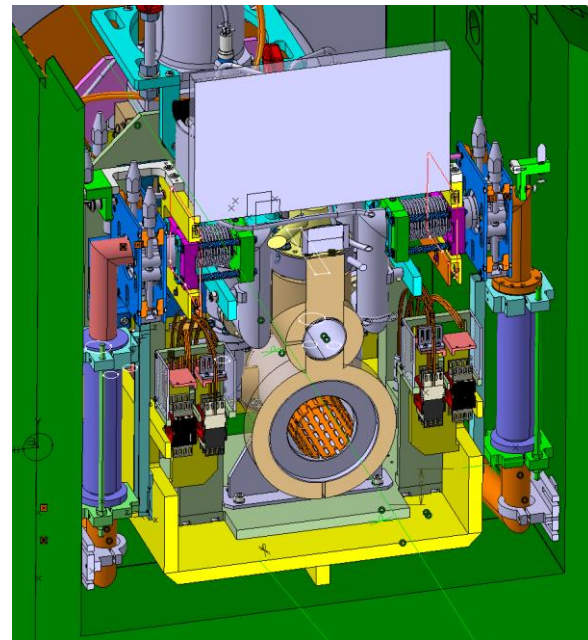
3 options considered:

- Option 1: routing pipe 1 over the water pipes; involves lowering down of pipe 2.
- Option 2: routing pipe 1 below pipe 2 (pipe 1 to cross between water pipes and wire).
- Option 3: Using another conduct for pipe 1 (available? – used for something else?) → nothing included in the 3D; involves lowering down of pipe 2? (TBC).

Pumping line integration at VAX area – CMS



- Last elbow fixed to the Module 2 support → connection with module 2 checked on surface.
- Previous rigid tube connected to FIN.
- Bellow in between to absorb the misalignments if the position of the support is adjusted (connected to alignment plate)



Q1-TAXS area mock-up - ATLAS configuration

