5th Joint HiLumi LHC-LARP Annual Meeting

Oct 26-30,2015 CERN

High Luminosity LHC

LHC VAX Displacement and impact on experiments

Francisco Sanchez Galan on behalf of WP8

*Vincent Baglin, Austin Ball, Enrico Bravin, **Helmut Burkhardt**, Kevin Einsweiler, Jean-Pierre Corso, Beniamino Di Girolamo, **Ilias Efthymiopoulos**, Bruno Feral, Roberto Kersevan, Helene Mainaud Durand, Yvon Muttoni, Ludovico Pontecorvo, Michel Raymond, Stefan Roesler, Francisco Sanchez Galan, Oliver Aberle, Paolo Fessia, Christian Boccard, Stephane Maridor, Stephane Bally, Ramon Folch, Andrea Gaddi, Dirk Mergelkuhl, Luigi Salvatore Esposito, Sebastien Evrard, Catherine Magnier, Cristina Adorisio, Joel Albertone, Francesco Cerutti, Riccardo De Maria, Michael Lazzaroni, Giuseppe Bregliozzi, Andrea Santamaria Garcia, Antonio Sbrizzi, Sune Jakobsen, Lukasz Piotr Krzempek, Jaime Perez Espinos, Blanca Vazquez De Prada*

The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

Motivation (s)

TAS will be replaced for HL-LHC operation to increase the aperture for the beam.

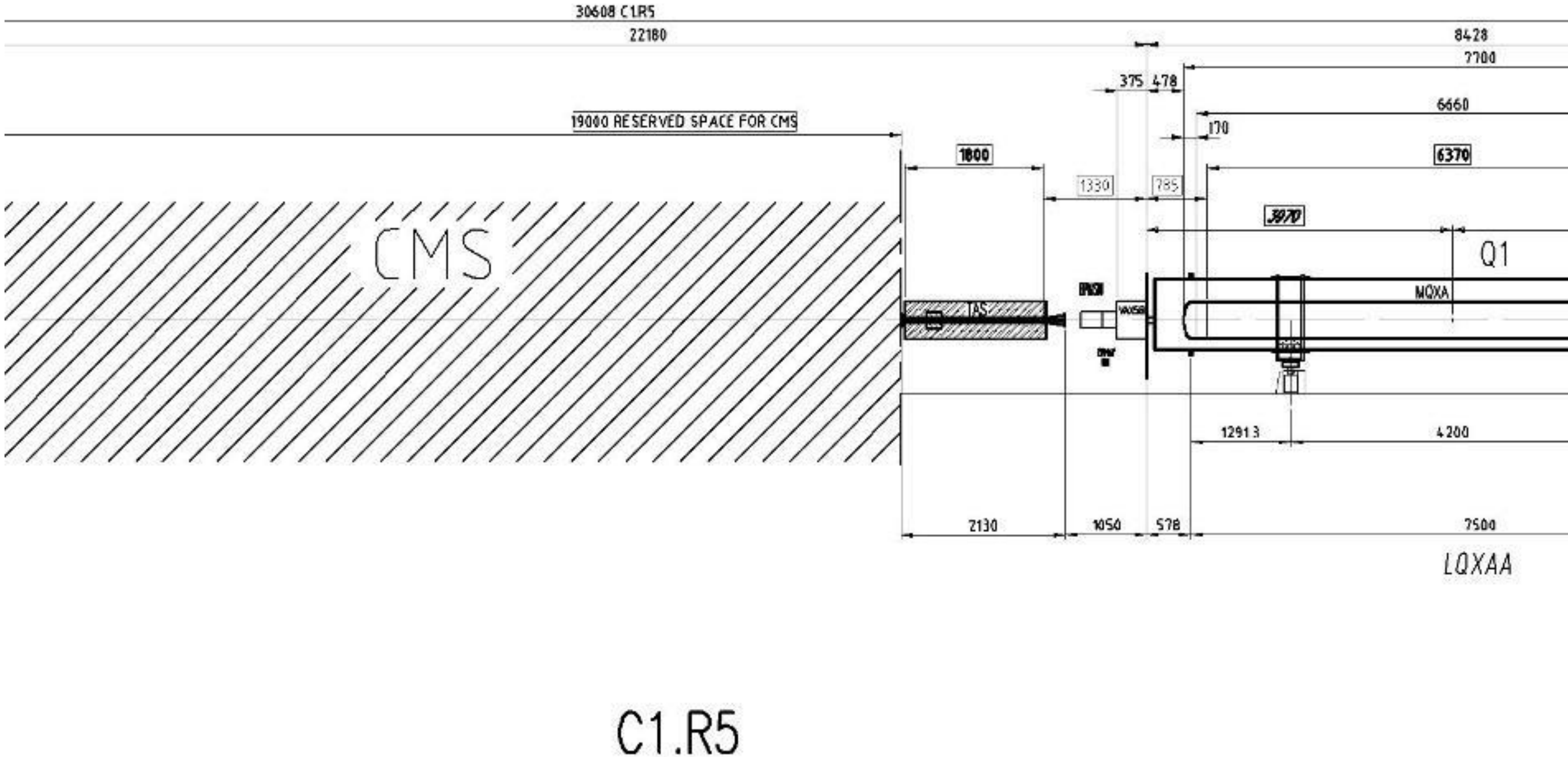
Q1-TAS is a very difficult access area, space is very limited and subject to high radiation doses.

(ALARA)

Reduce and improve interventions in view of HL-LHC, having a safe and quick access to vacuum components.

Furthermore, the presently installed warm BPM is not optimal in terms of operation, new position & fixing it to Q1 could improve situation.

LHC LAY-OUT



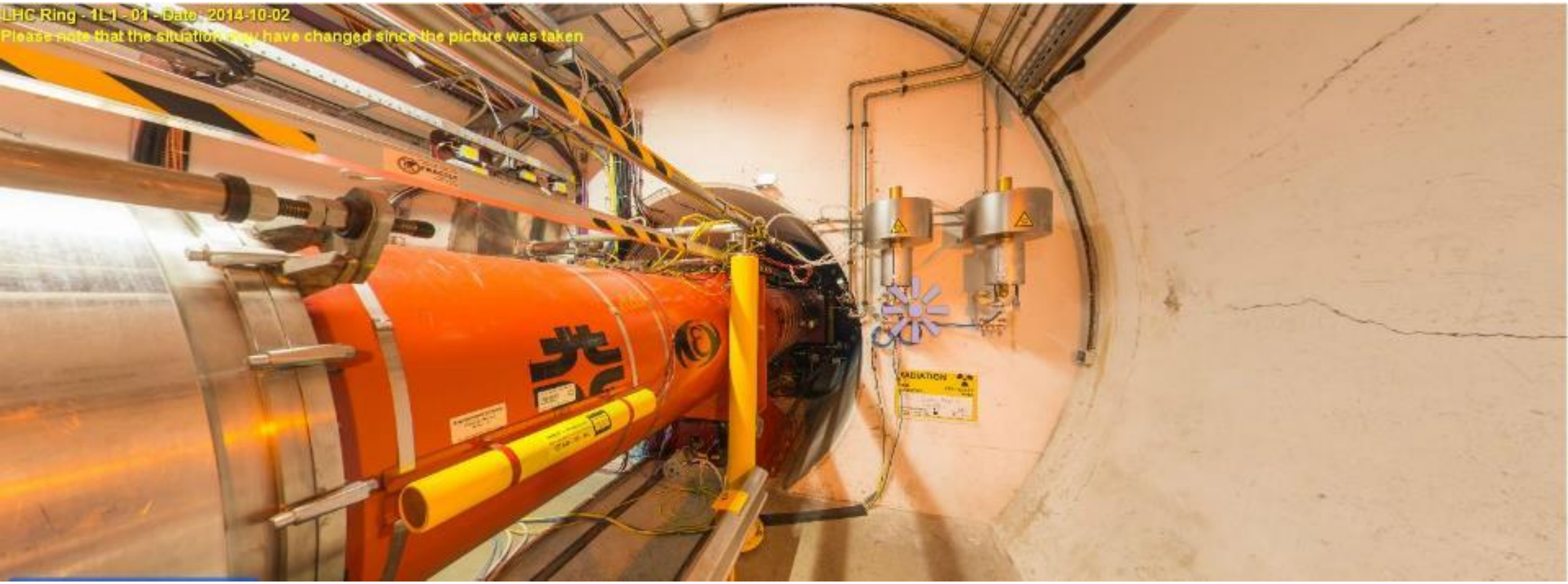
Presently ~ 1.3 m of space. Equipment installed: warm BPM, 2 vacuum valves, bellows, bake-out equipment.

Constraints for Interventions @ TAS/Q1 region

- Physical barriers
  - Equipment situation. Very difficult access to the region.
  - Limited available space around equipment.

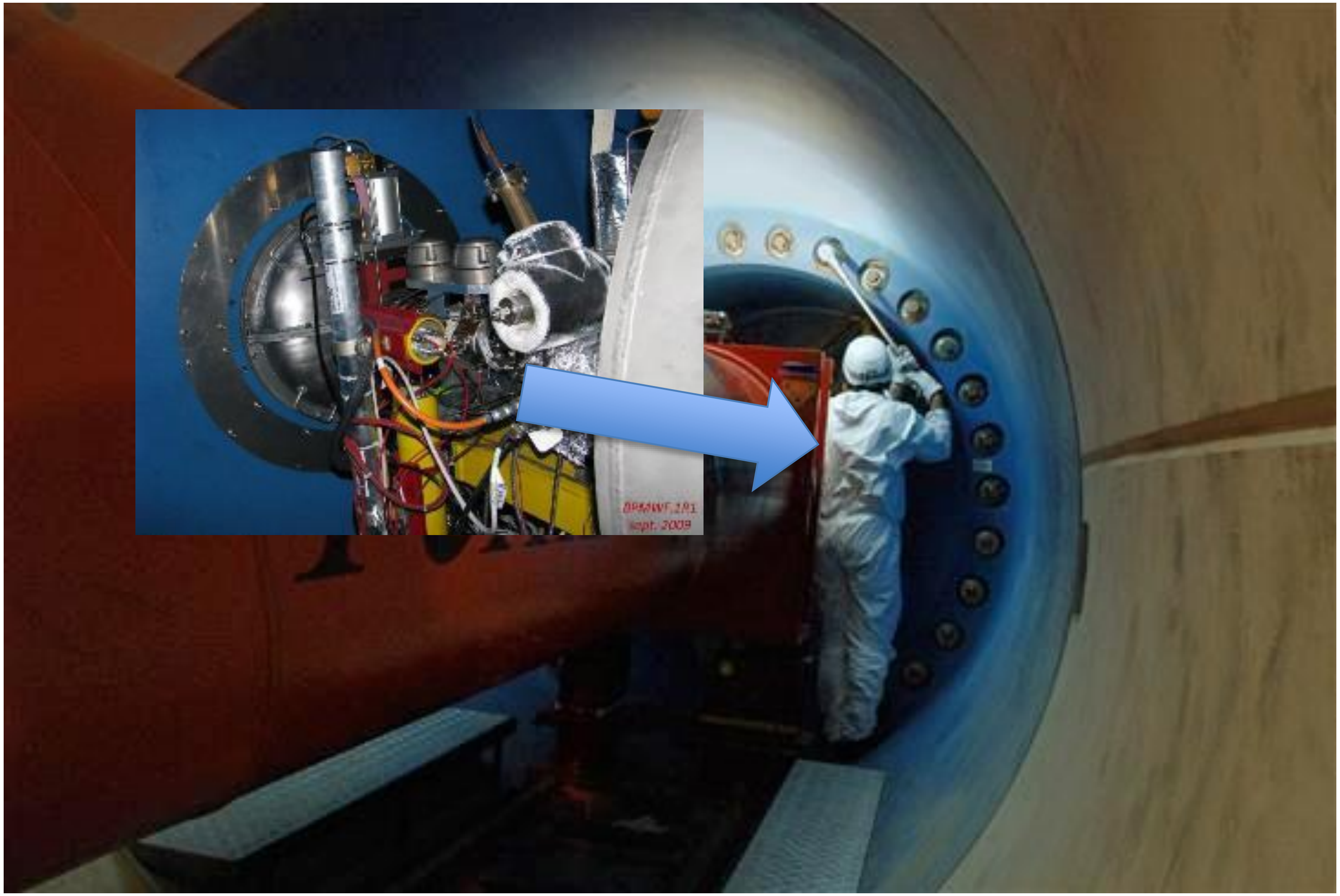
- Radiation barriers
  - Limited time access.
  - Working conditions

Access Q1 to TAS region (ATLAS)



Access Q1 to TAS region (ATLAS)

Access Q1 to TAS region (ATLAS)

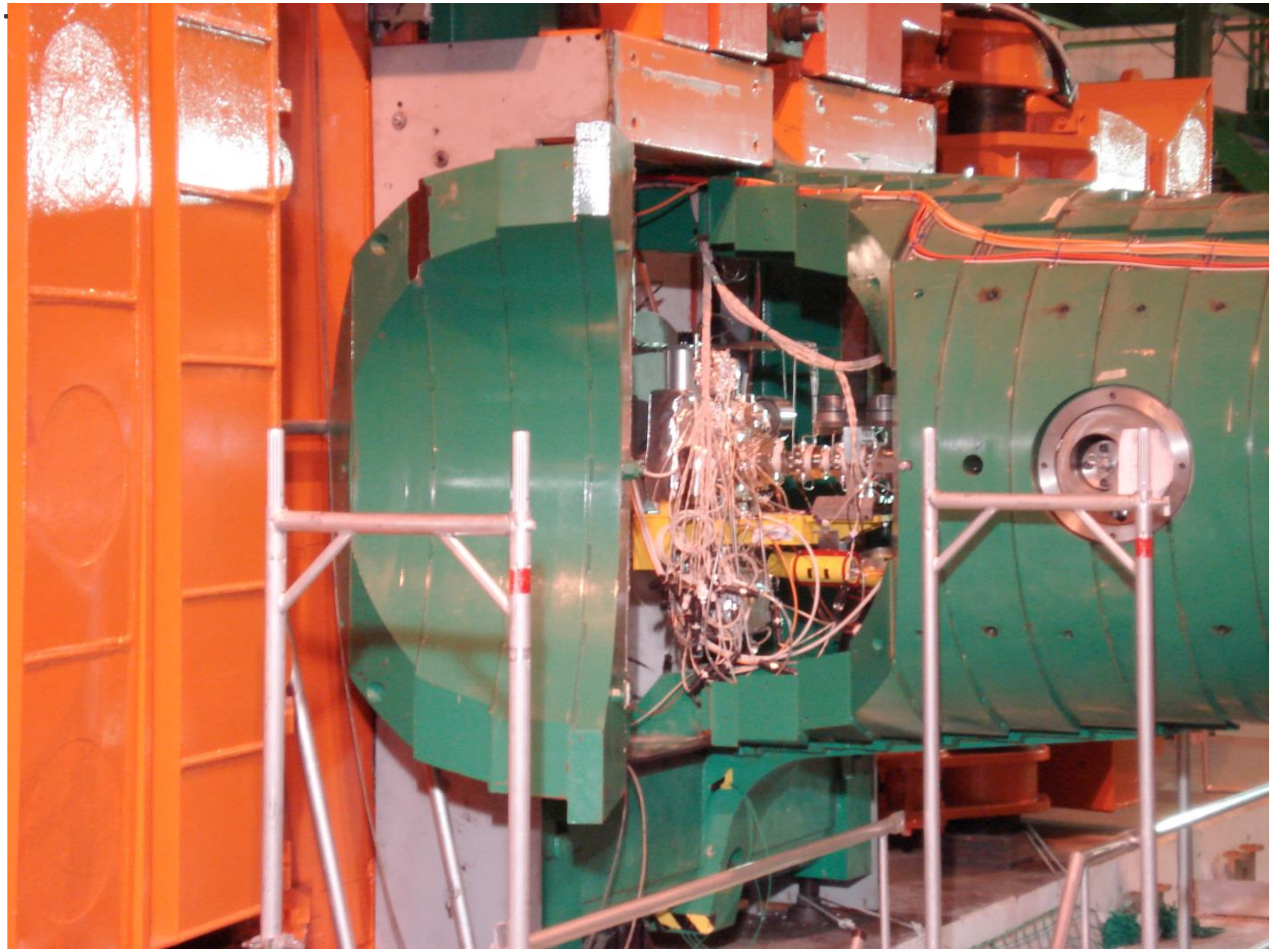


Access Q1 to TAS region (CMS)

Access Q1 to TAS region (CMS)

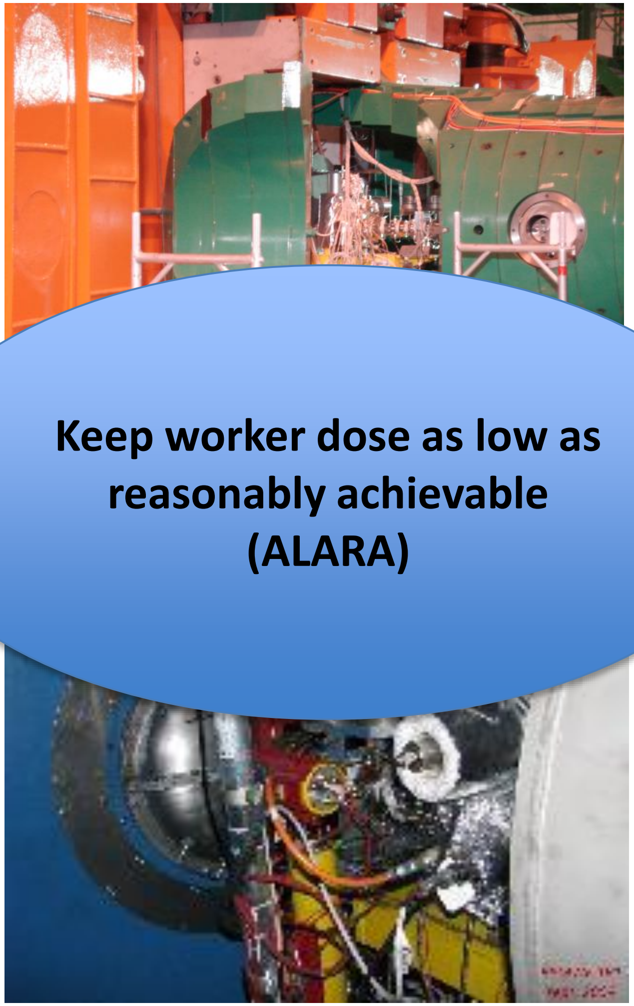
Access - CMS/IR5

- Possibility of side access through special openings in the FIN shielding, after opening the large rotating shielding.



Interventions @ TAS/Q1 region

- Preventive (Routine)
  - Alignment, survey (TAS, BPM)
  - Beam instrumentation
  - Bake-out
- Corrective (Failure of equipment)
  - BPM
  - All metal gate valves.
  - Pumps.
  - Gas Injection
  - Bellows
  - Connections
  - Ancillaries (cabling, piping)



Keep worker dose as low as reasonably achievable (ALARA)

Overview of Radiation (EDMS 1434476)

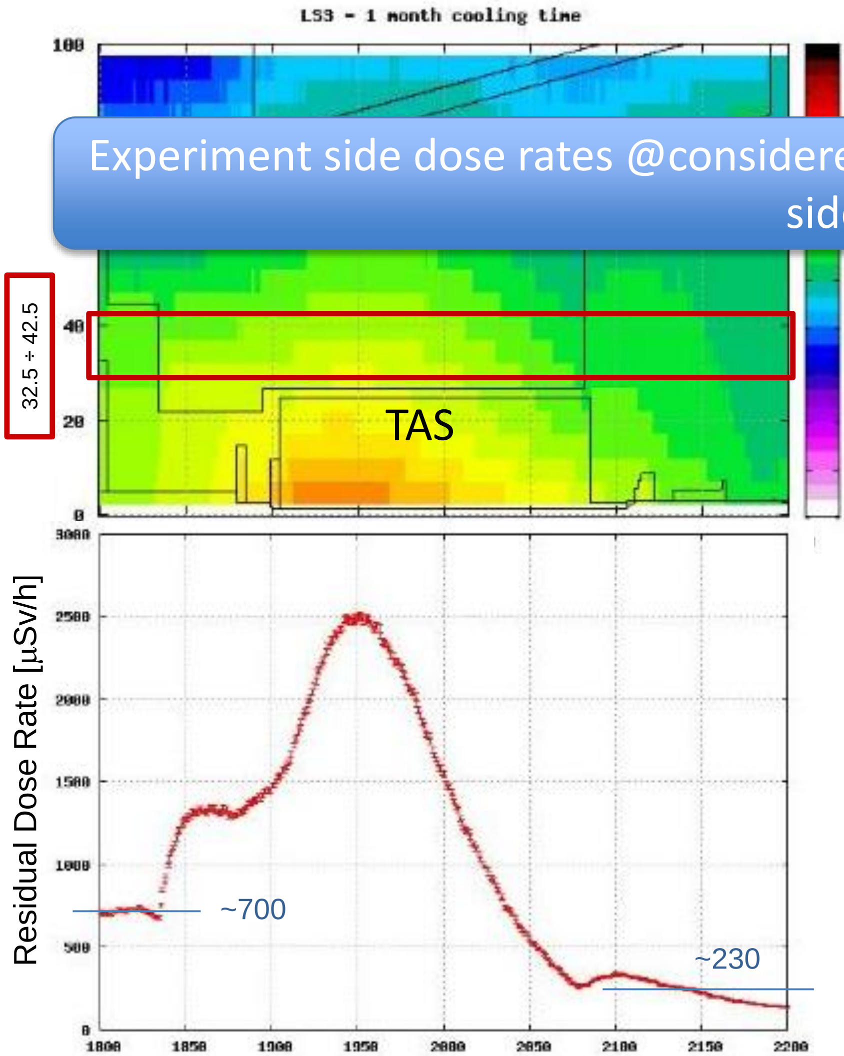
- The residual dose rate increase until LS3 depends on operational scenario, cooling time and material and is about a factor of 4 to 6
- The residual dose rate increase until HL-LHC era depends on operational scenario, cooling time and material and is about a factor of 15 to 30
  - Short cooling times: no differences among the LSs after LS3
  - Longer cooling time: slightly increasing (but not evident along the triplet)
  - HL vs LS3: a factor 4 to 6 higher
  - HL vs LS1: a factor 15 to 30 higher
- HL-LHC Ultimate vs Nominal: a factor 1.2 to 1.5 higher, depending on the cooling time (mainly driven by the instantaneous luminosity)

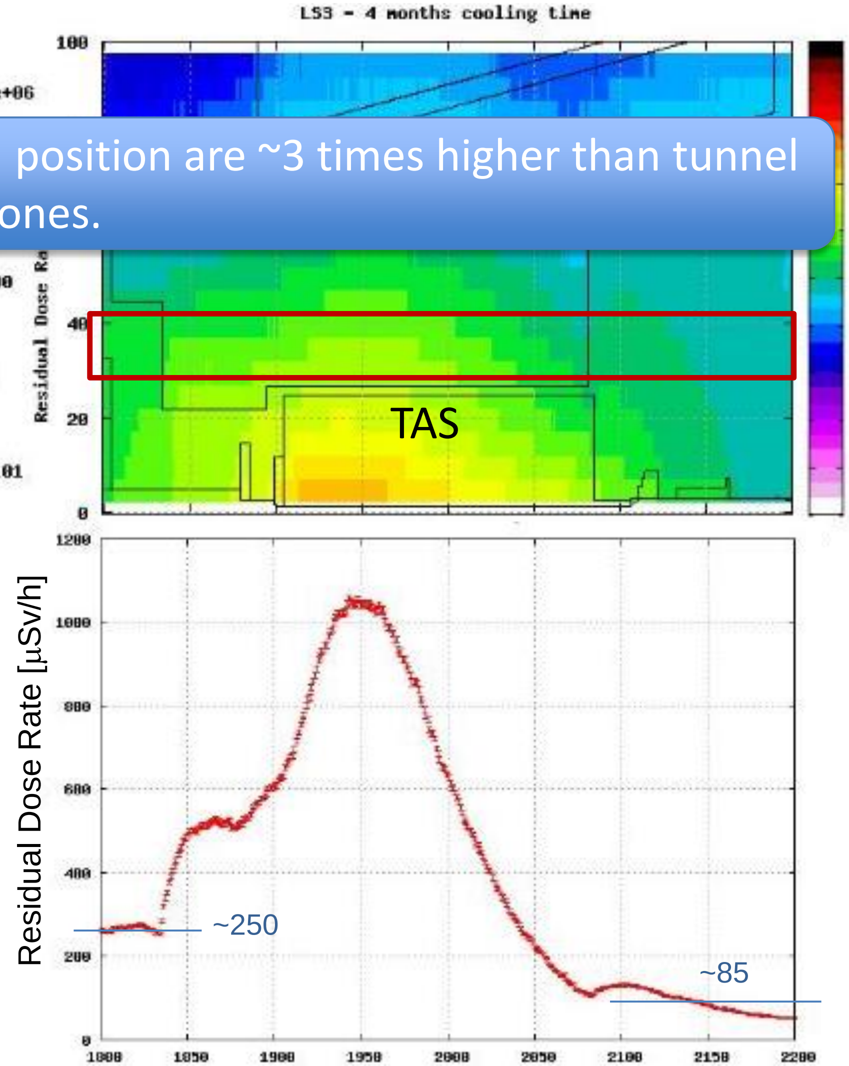
C. Adorisio - 4th Joint HiLumi LHC-LARP Annual Meeting

22

LS3 estimation

CERN HSE Occupational Health & Safety and Environmental Protection Unit





Experiment side dose rates @considered position are ~3 times higher than tunnel side ones.

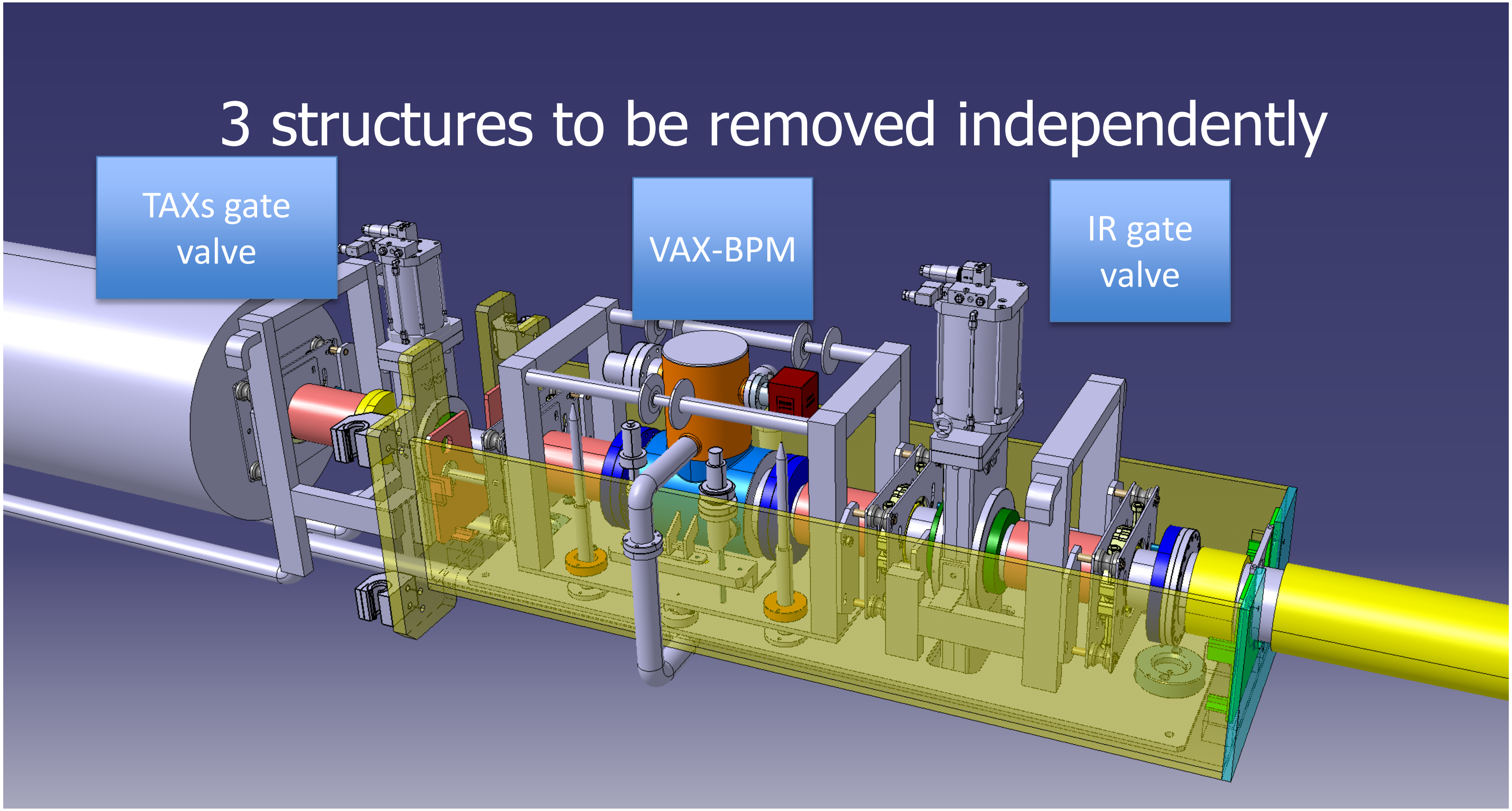
TAXS Experiments region lay-out proposal.

- TAXS designed with C-coated vacuum chamber, no bake-out required.

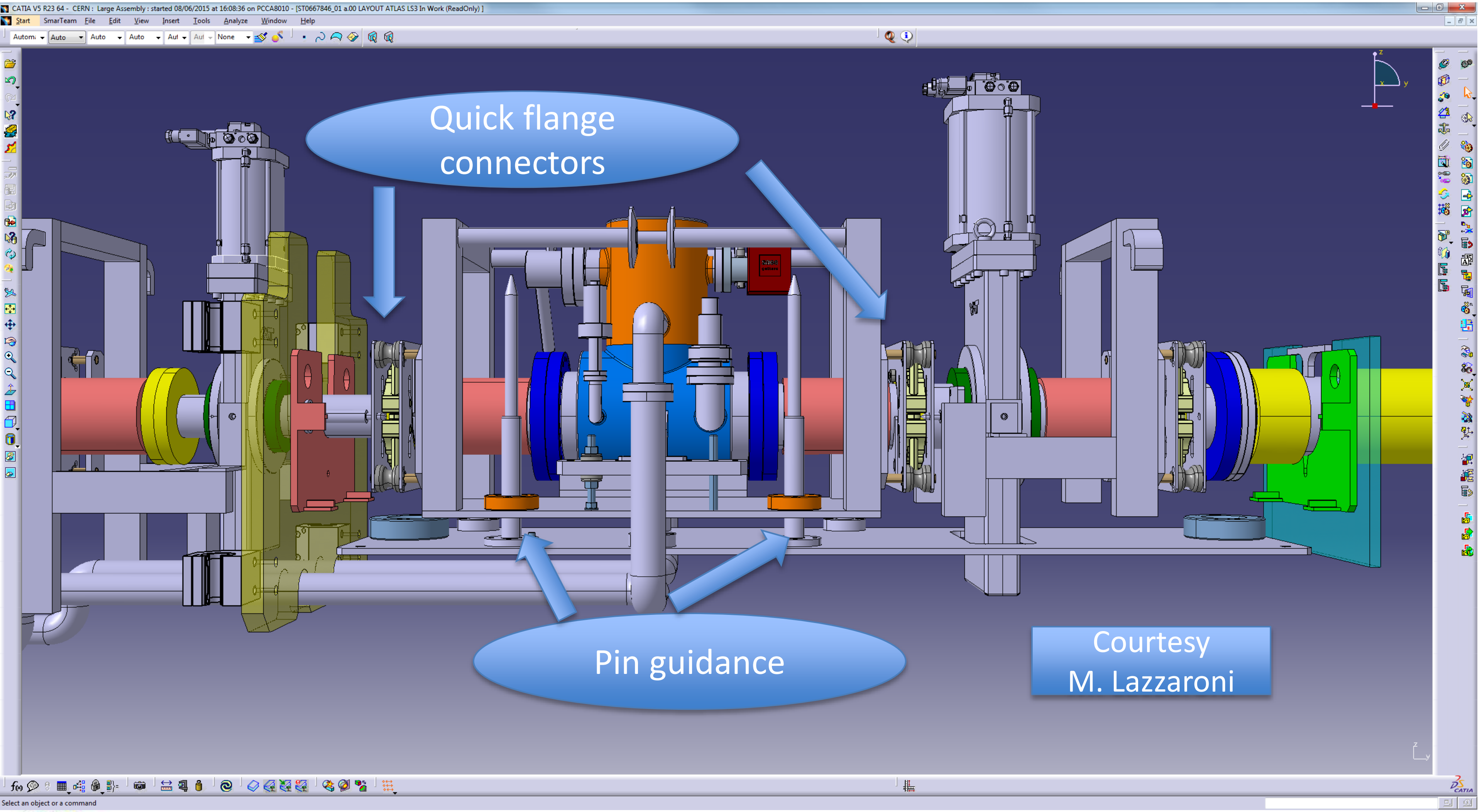
- Move equipment and services from Q1-TAXS region to experiment's cavern.
  - Modular Design for fast exchange (remote handling) of equipment based on existing solutions.
  - Common lay-out for ATLAS and CMS.

- Include a new warm BPM that would be located in a good region to allow optimised beam steering and luminosity optimization during operation.

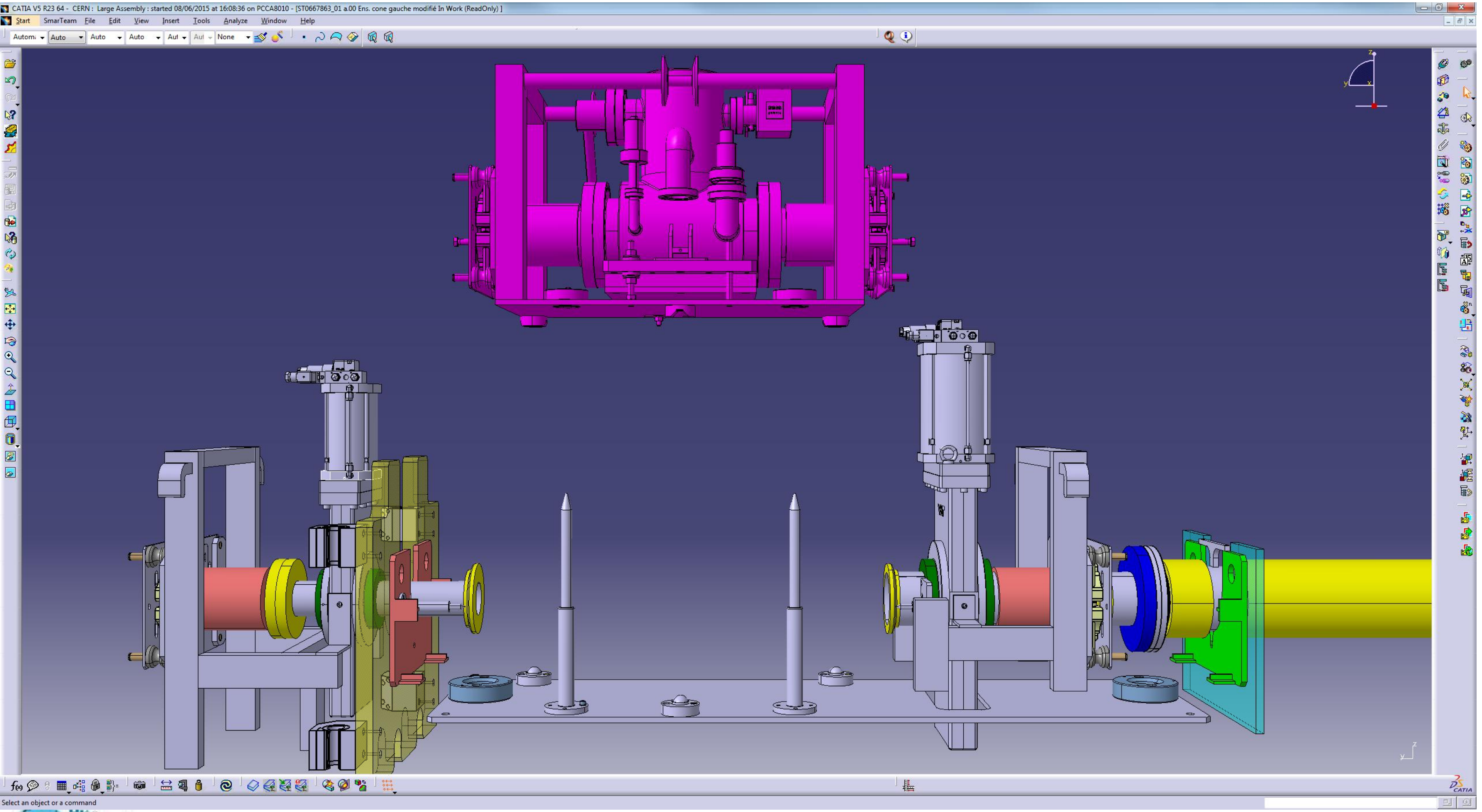
New VAX-BPM module



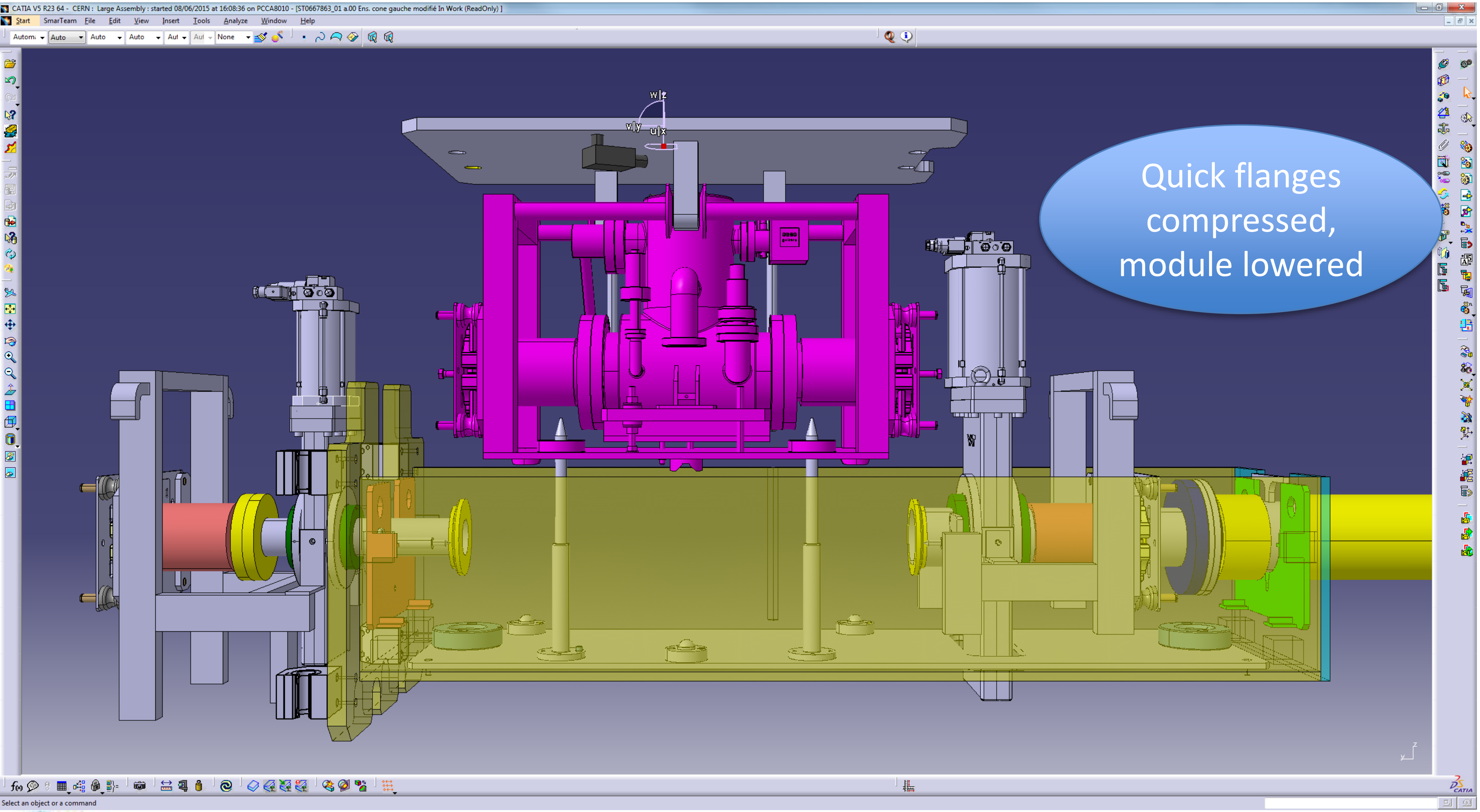
Modular approach, vertical operations



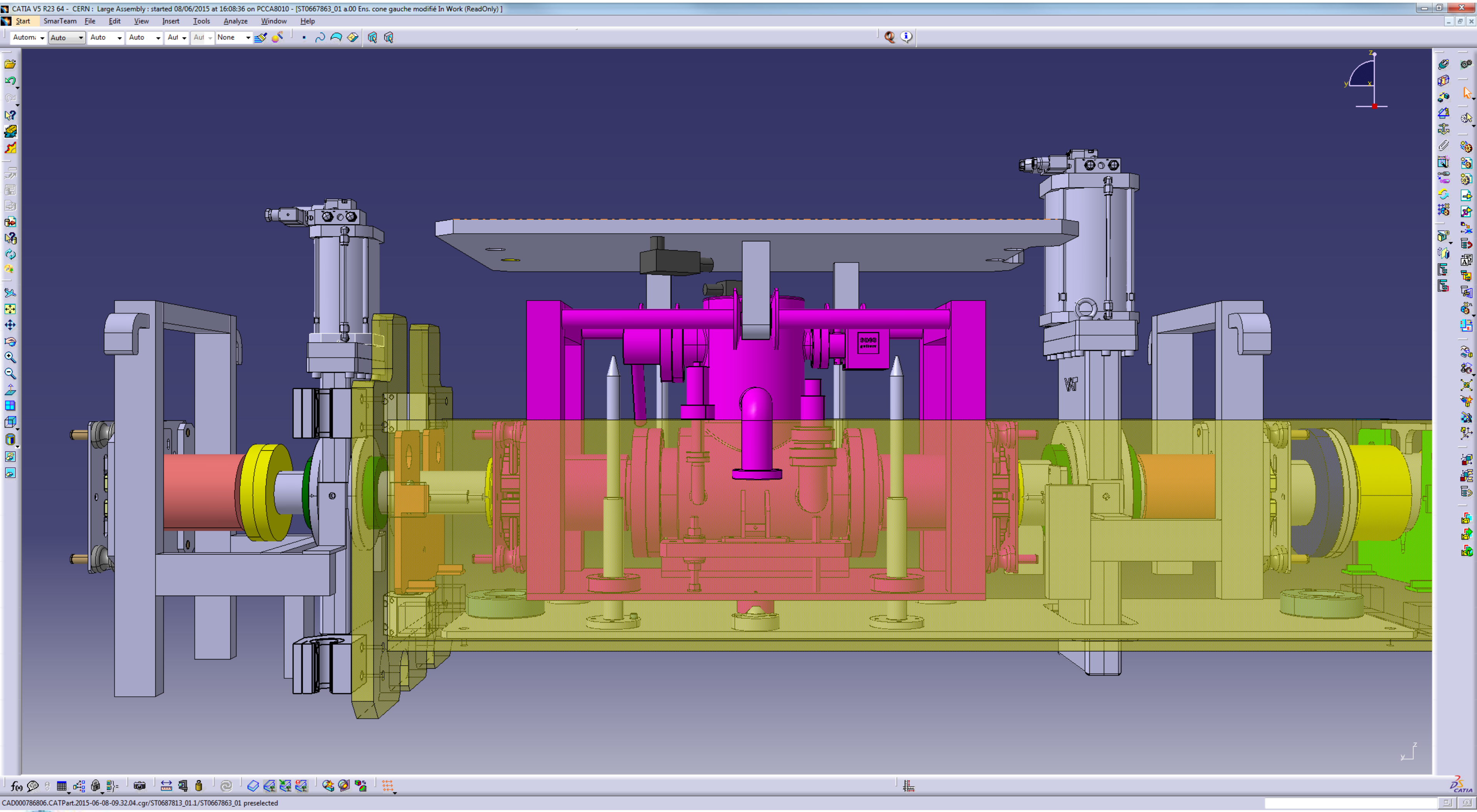
VAX-BPM Installation sequence



VAX-BPM Installation sequence



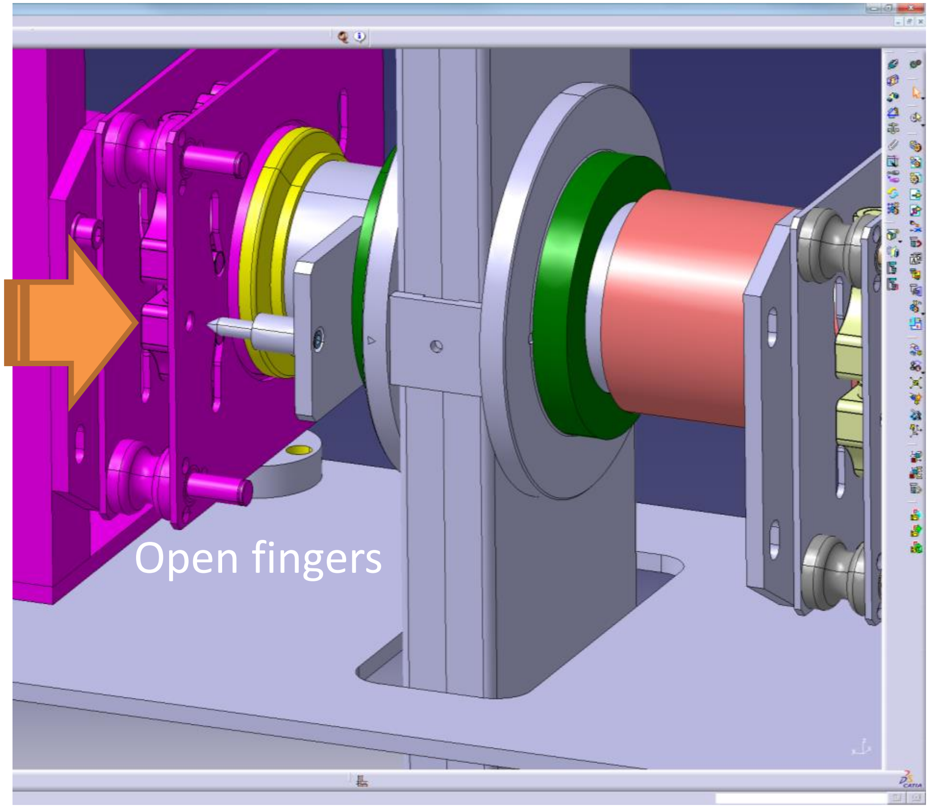
VAX-BPM Installation sequence

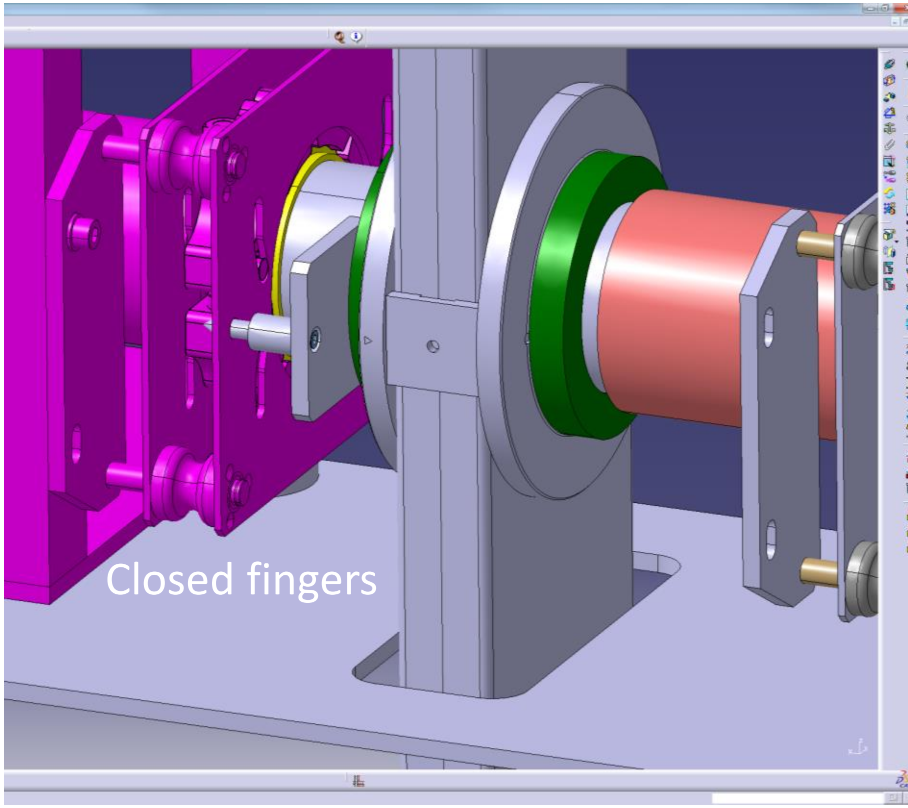


VAX-BPM Installation sequence

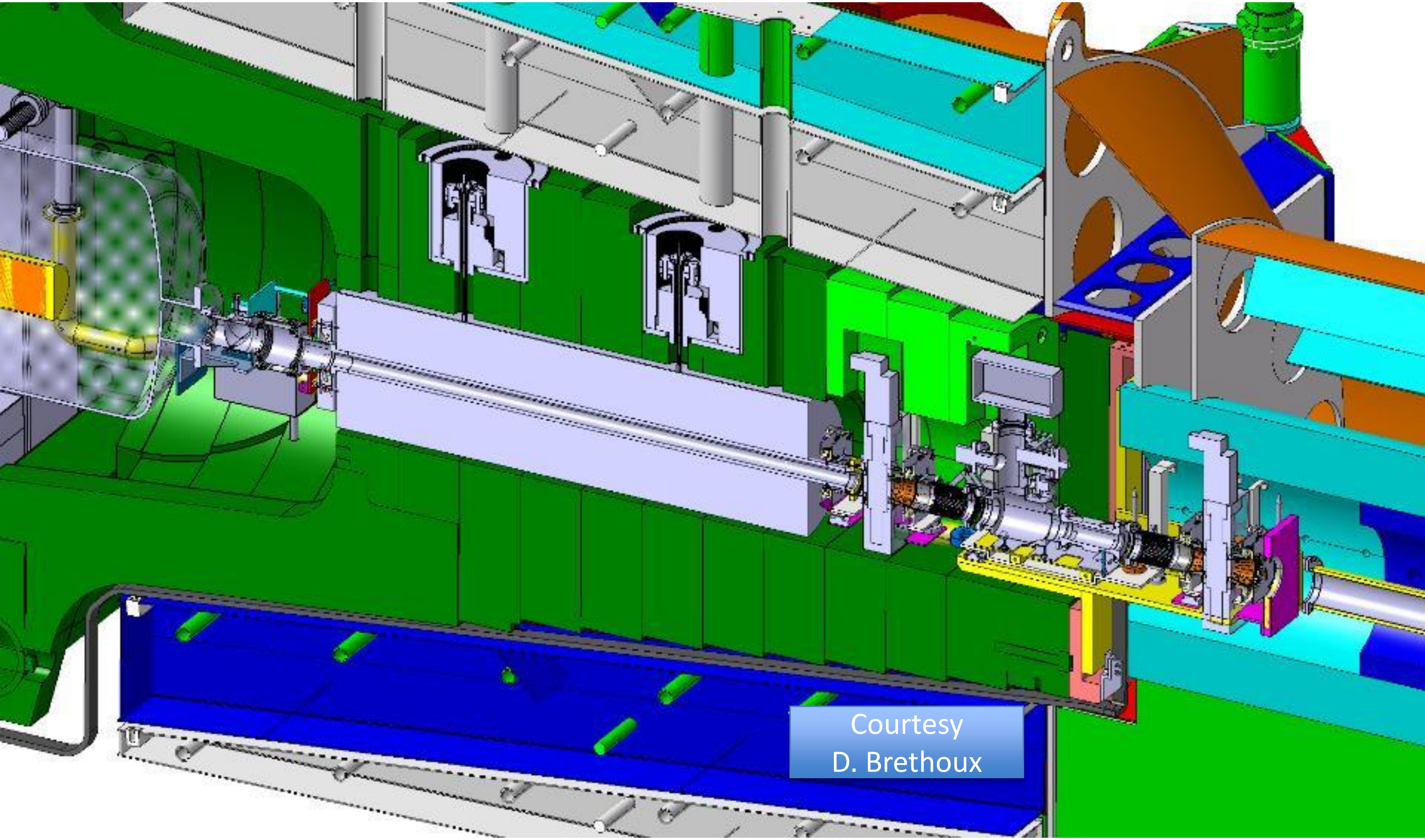
Flange connection

(Quick flange centering based on current collimator's approach)



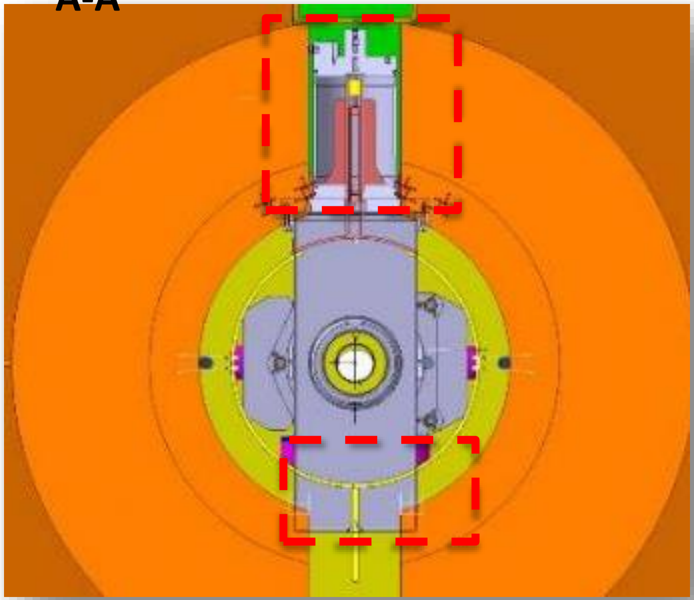


HL-LHC TAXS VAX Lay-out CMS

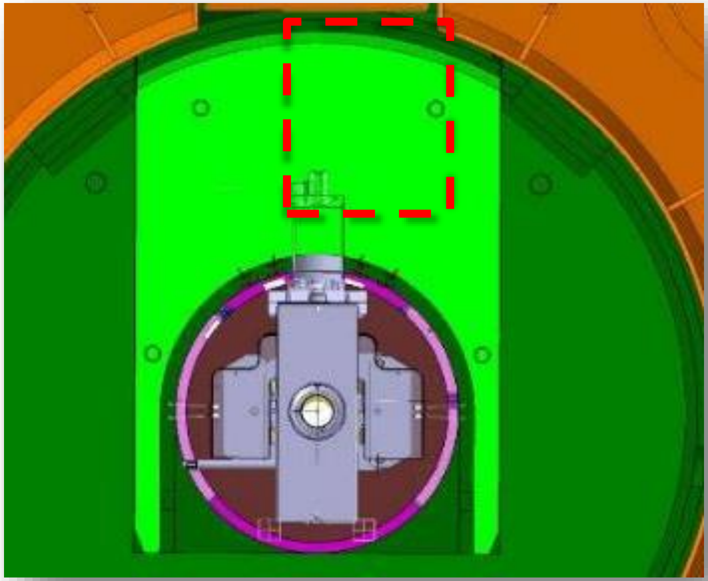


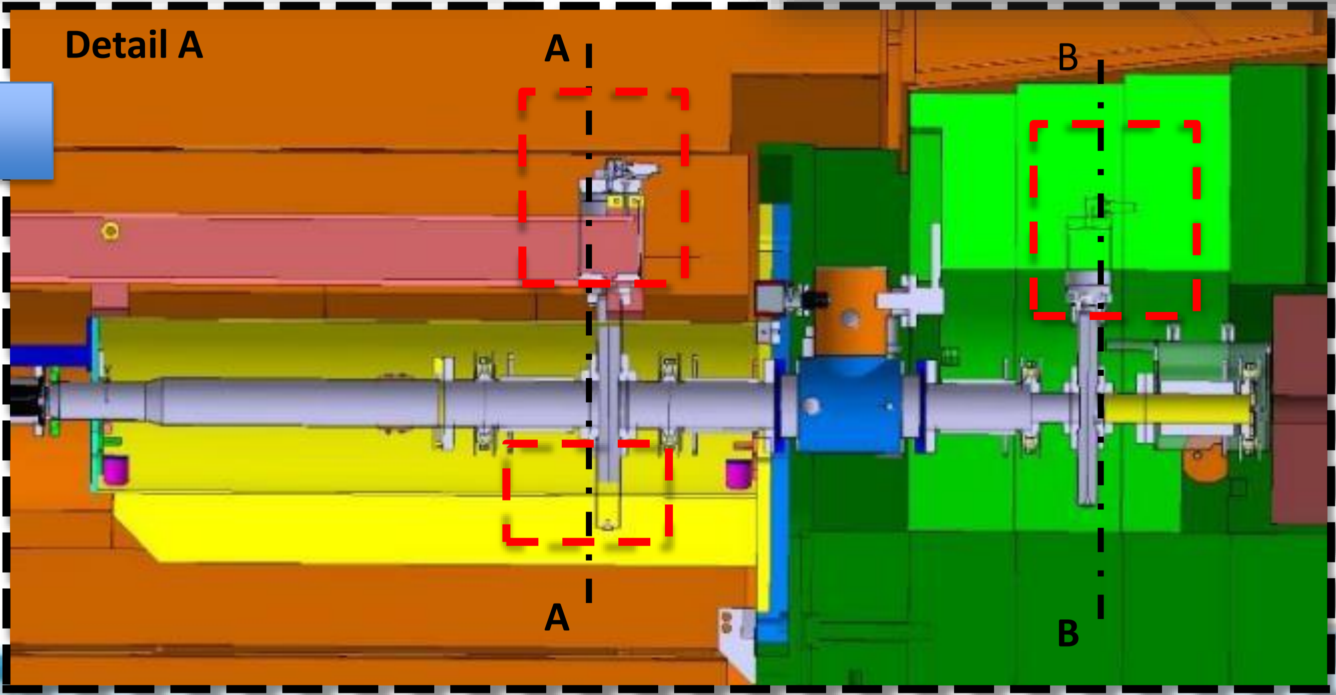
Conflicts with CMS shielding

A-A



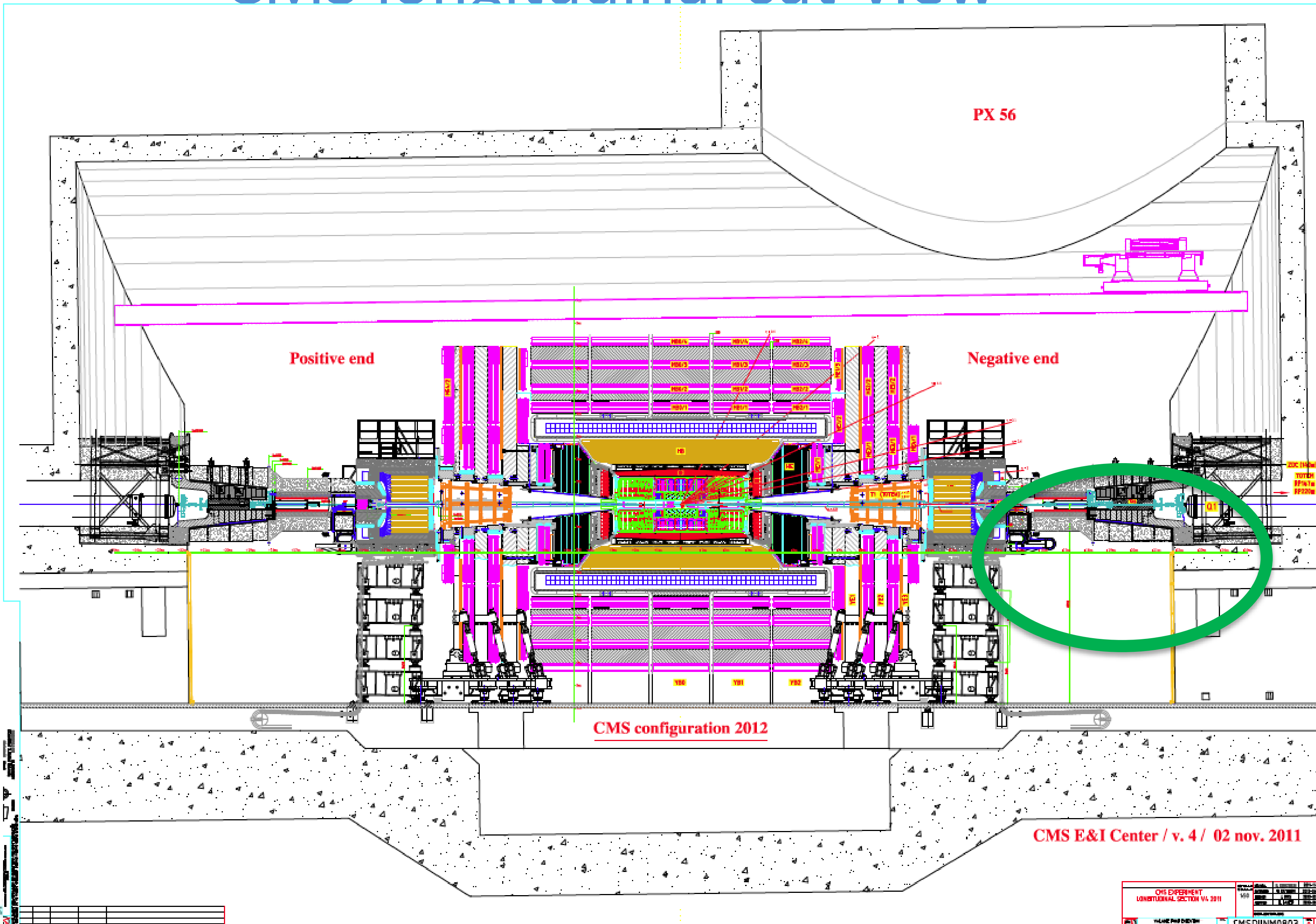
B-B



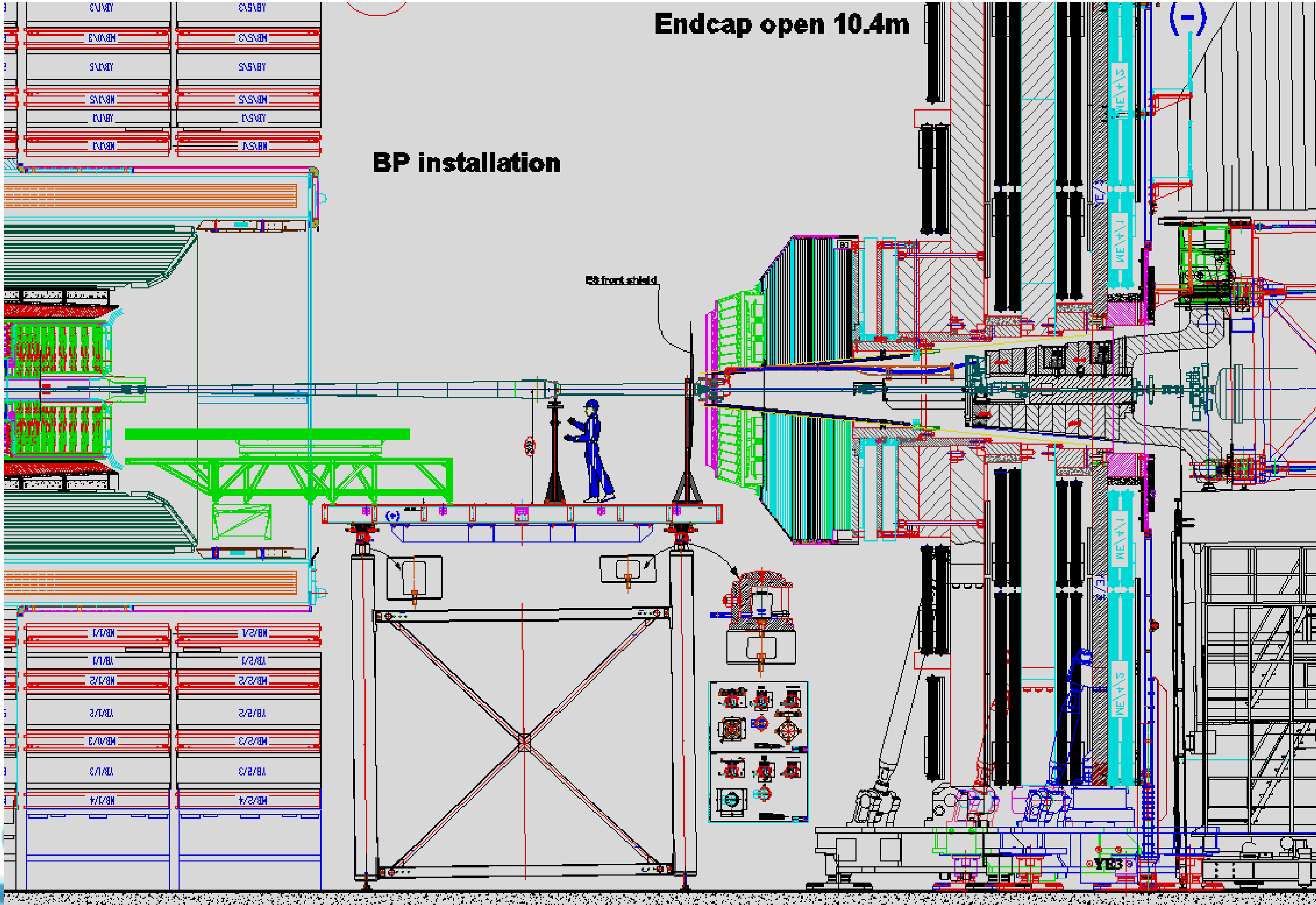


Courtesy
A. Gaddi

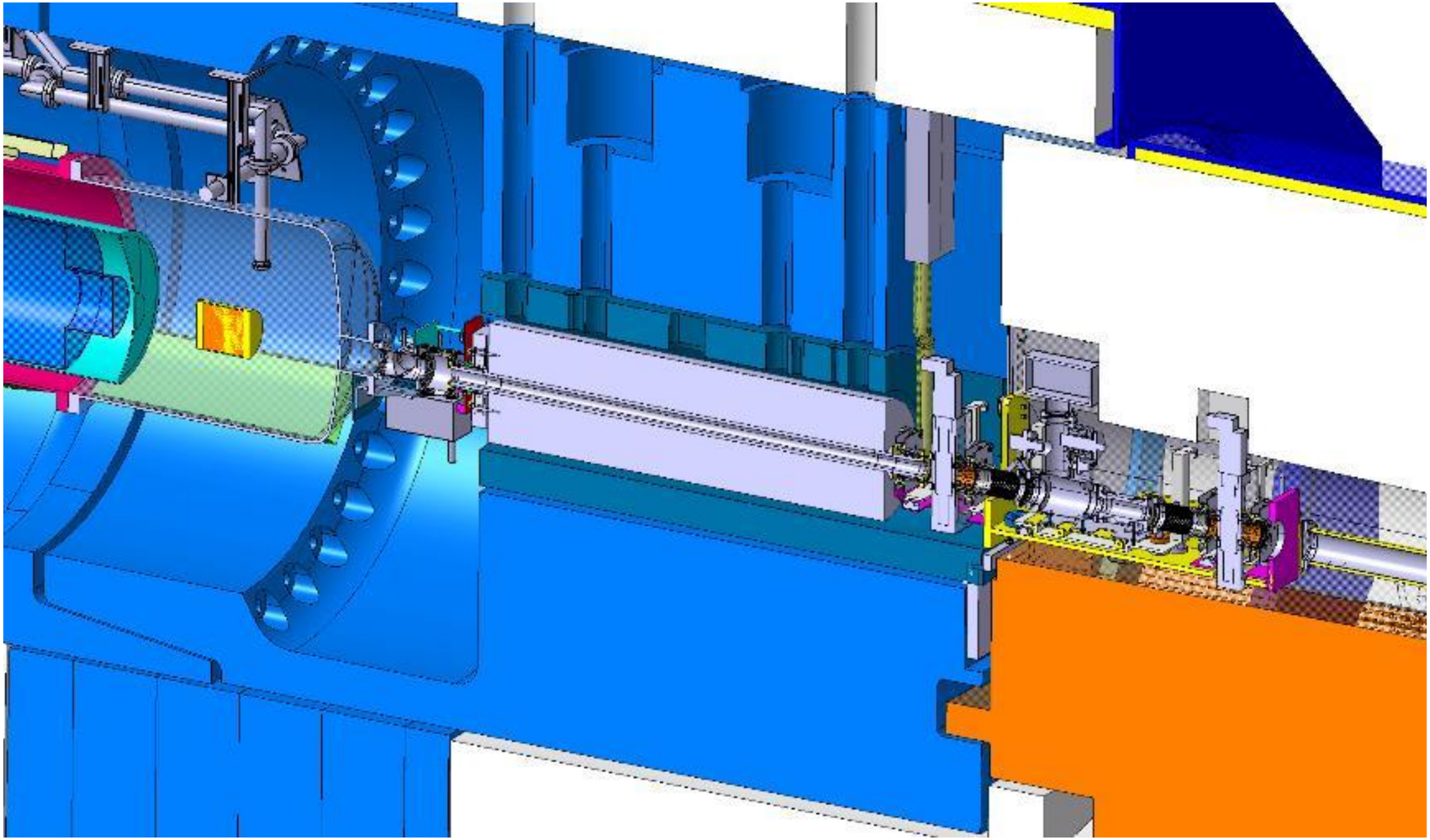
CMS longitudinal cut-view



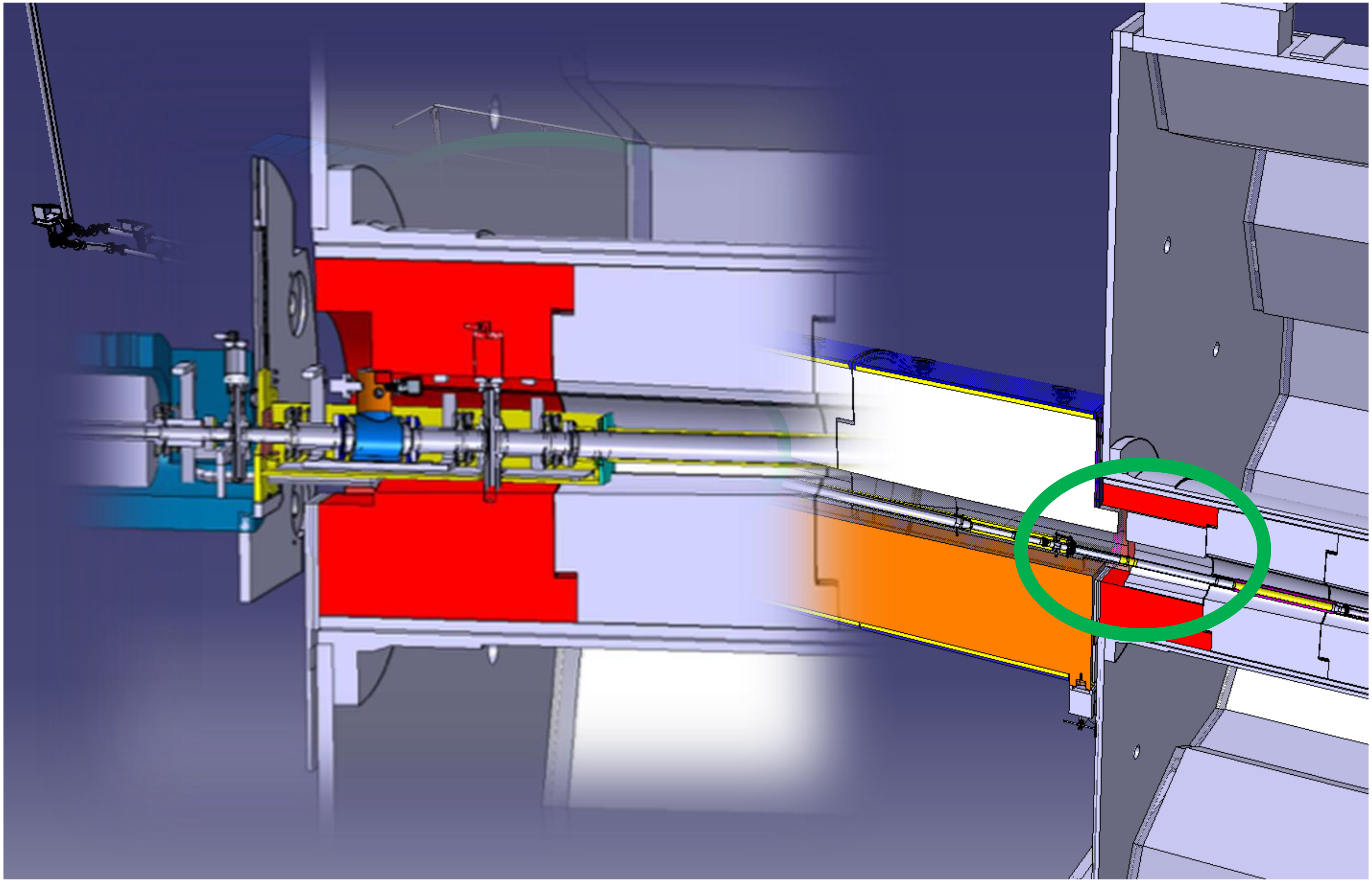
Endcap opening onto the FIN



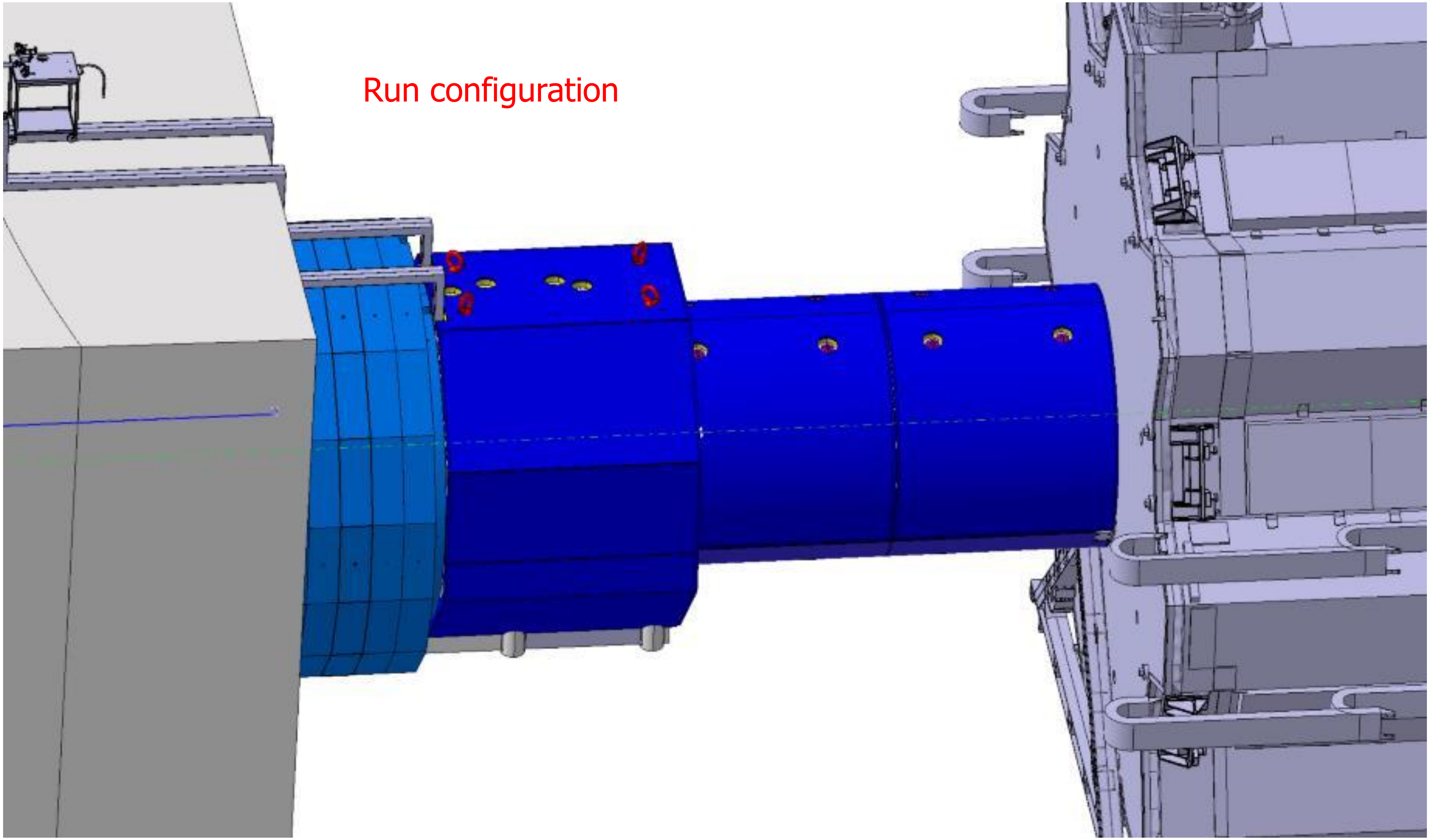
HL-LHC TAXS VAX Lay-out ATLAS



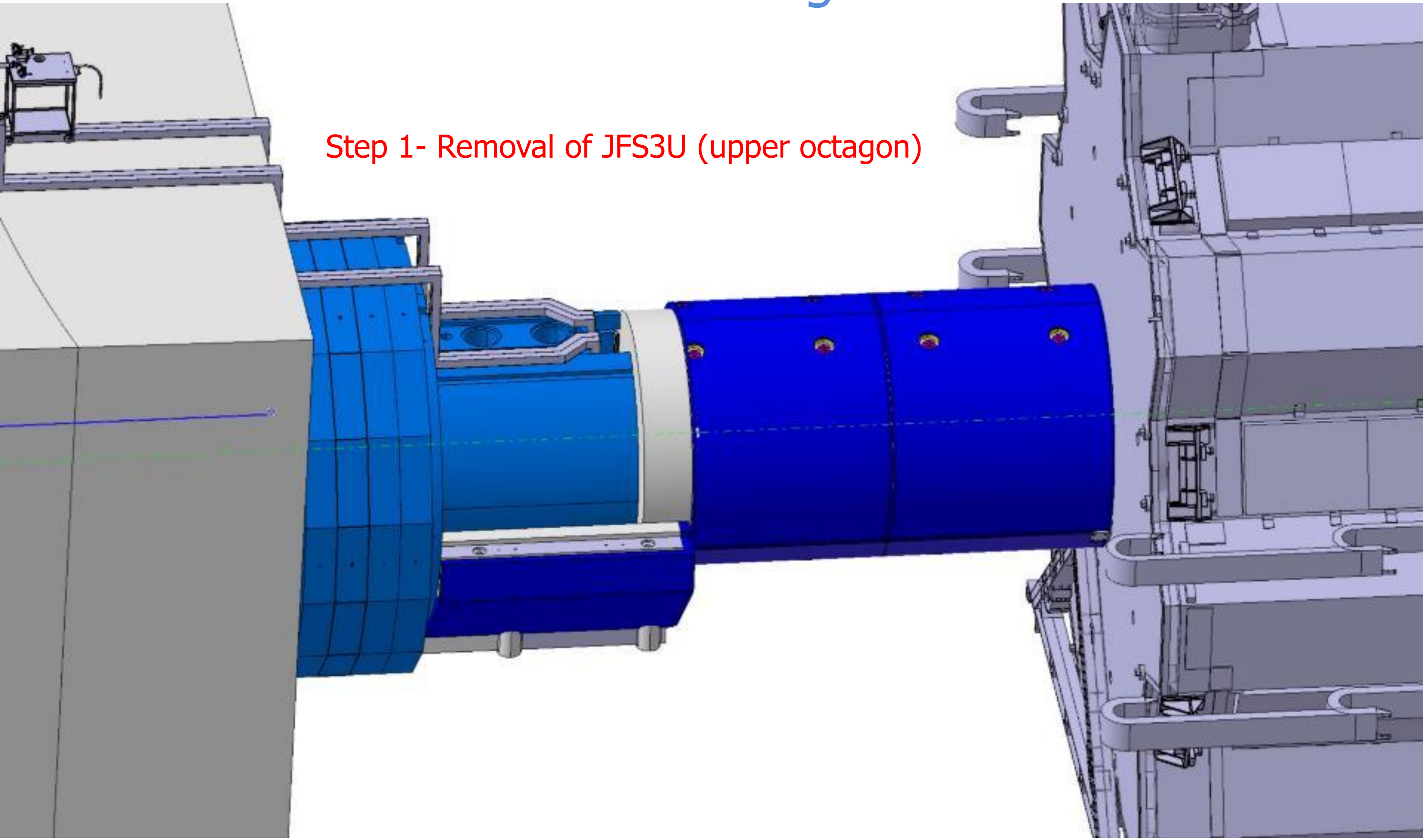
ATLAS. Conflicts with existing shielding structures



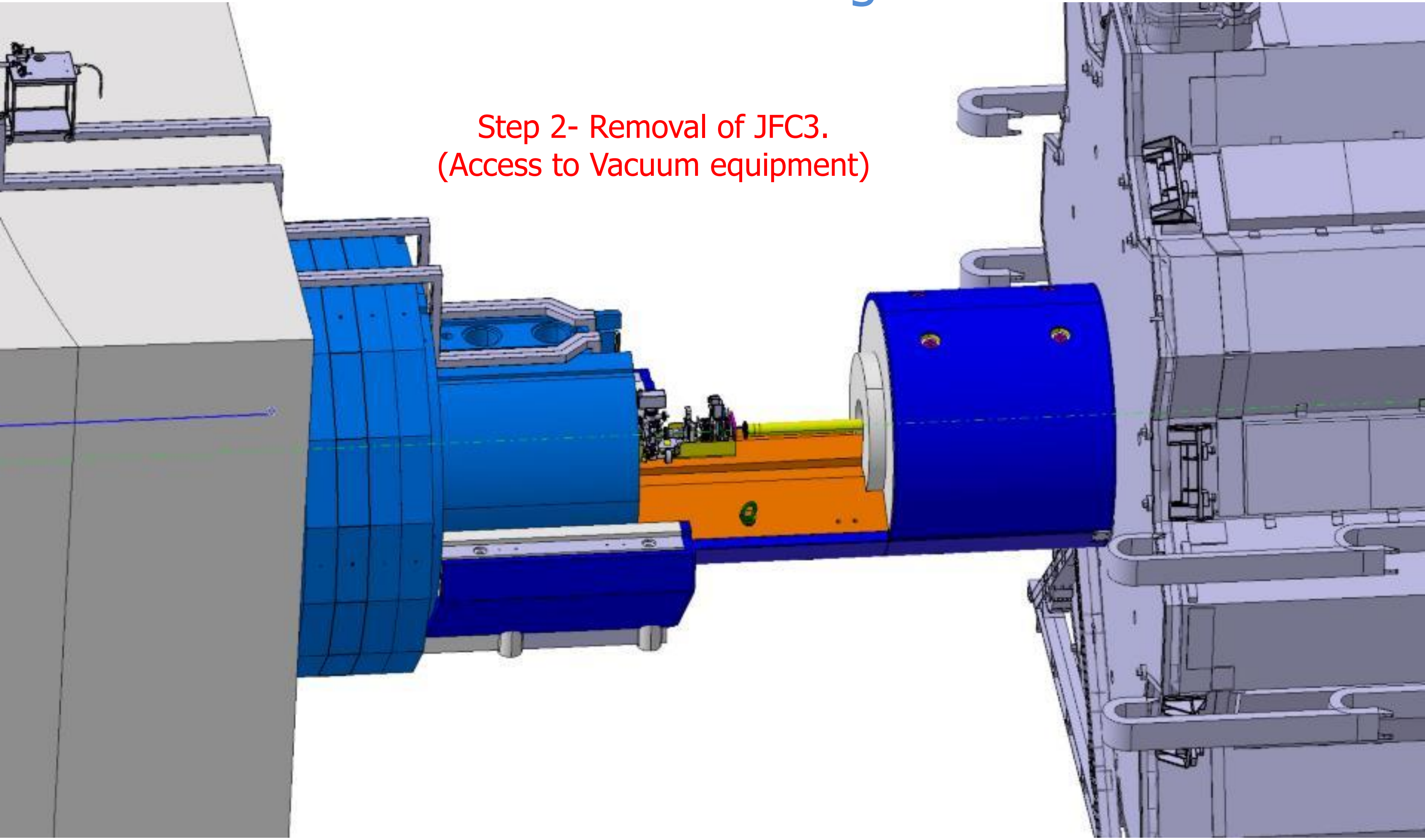
ATLAS Forward shielding removal



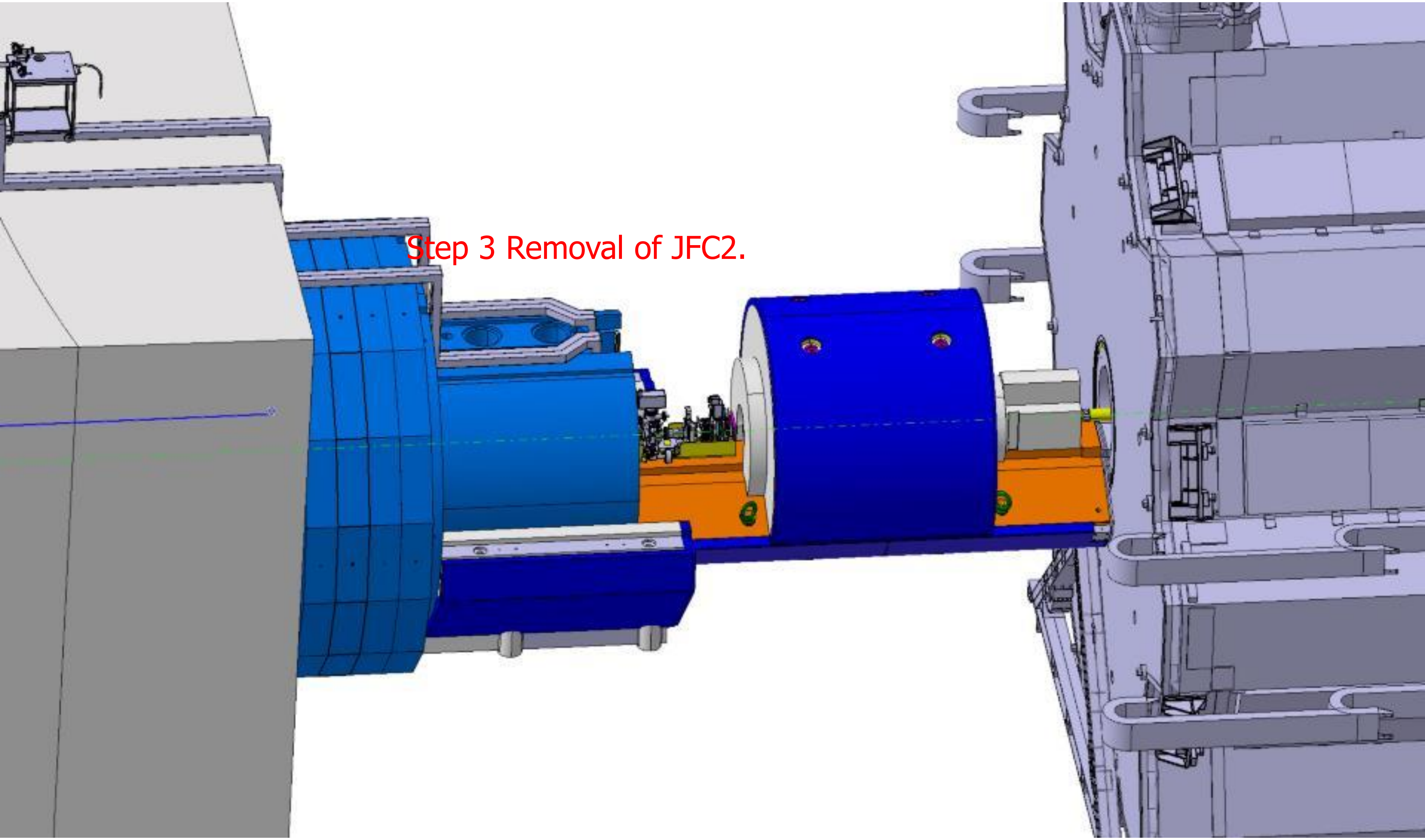
ATLAS Forward shielding removal



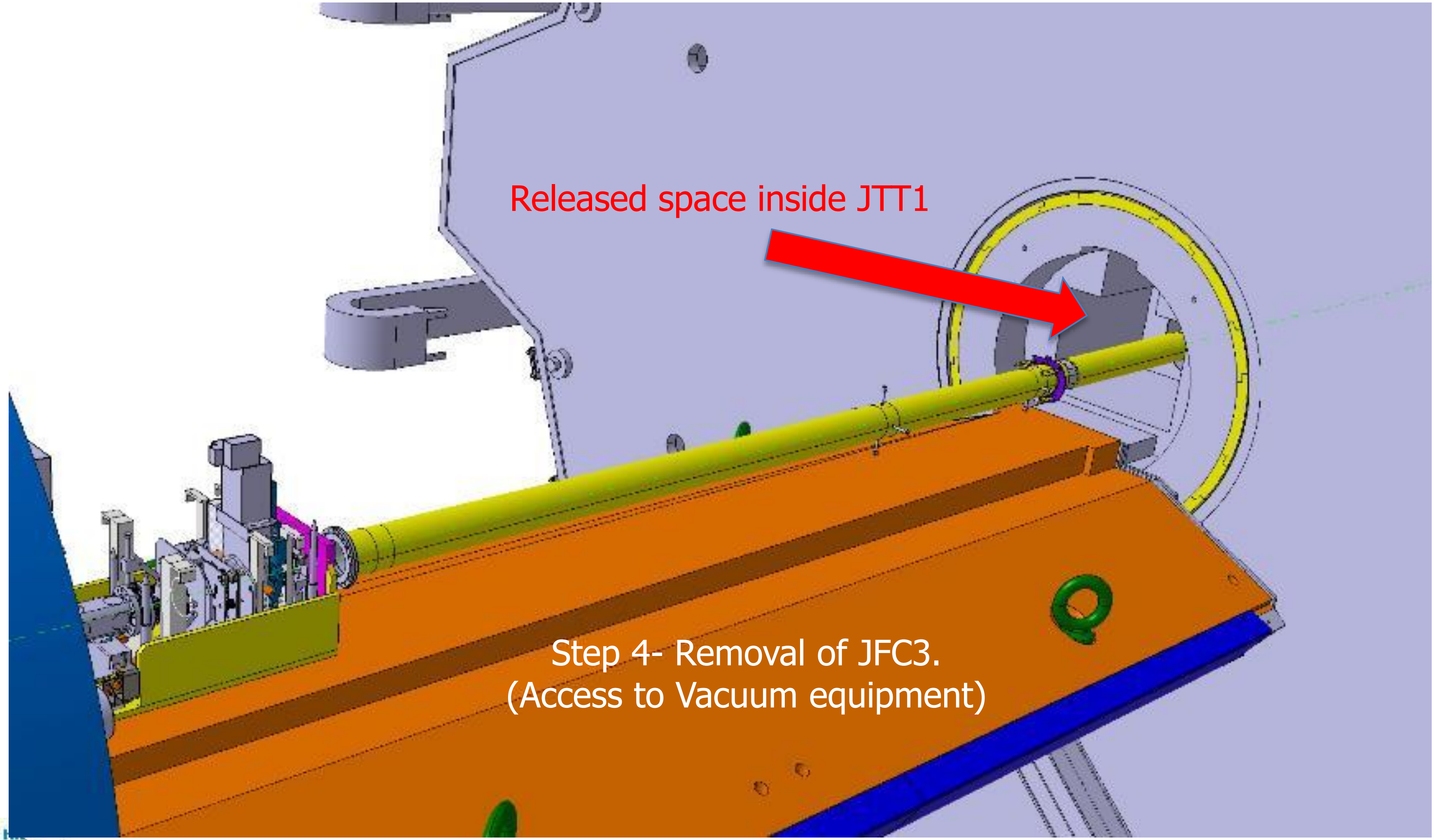
ATLAS Forward shielding removal



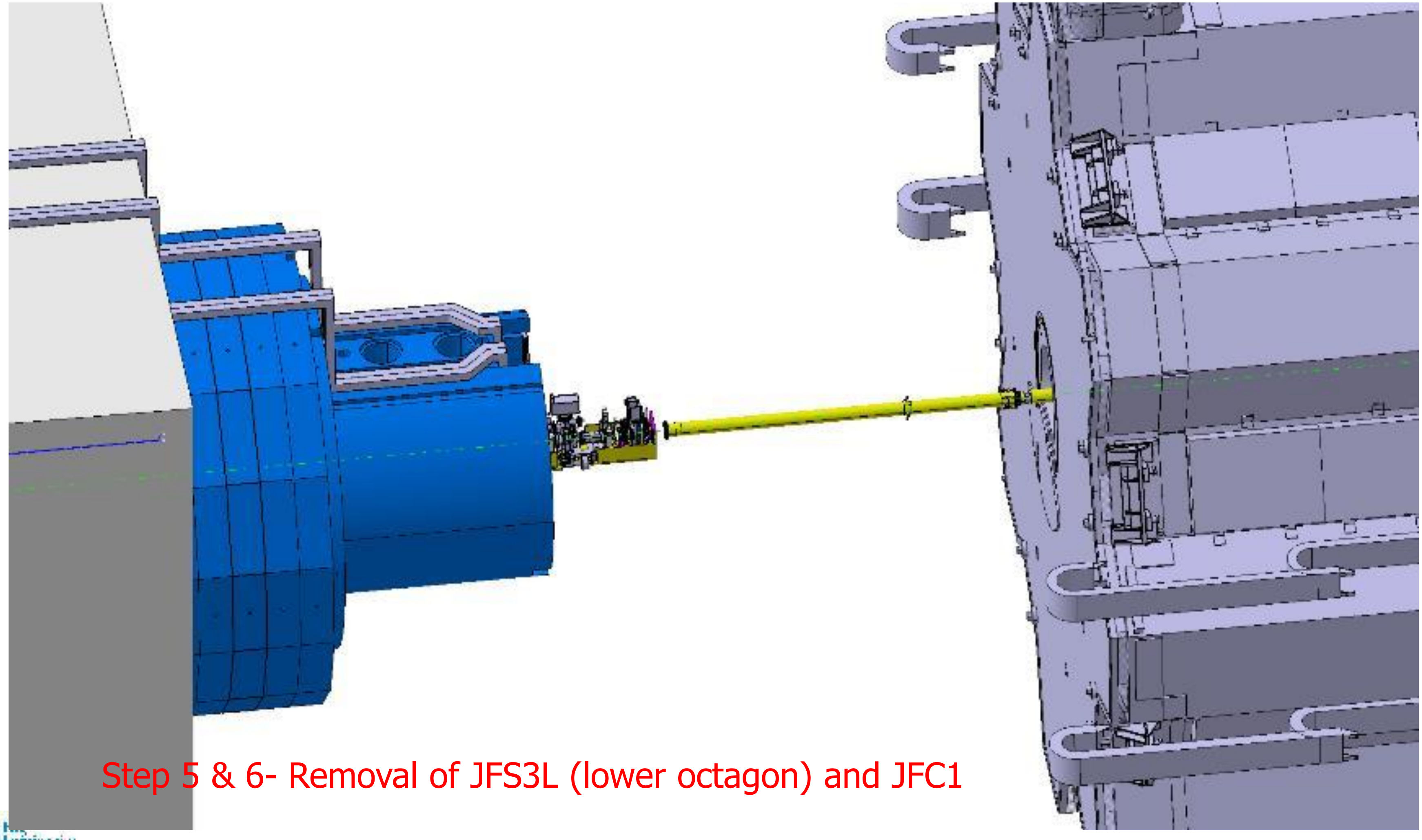
ATLAS Forward shielding removal



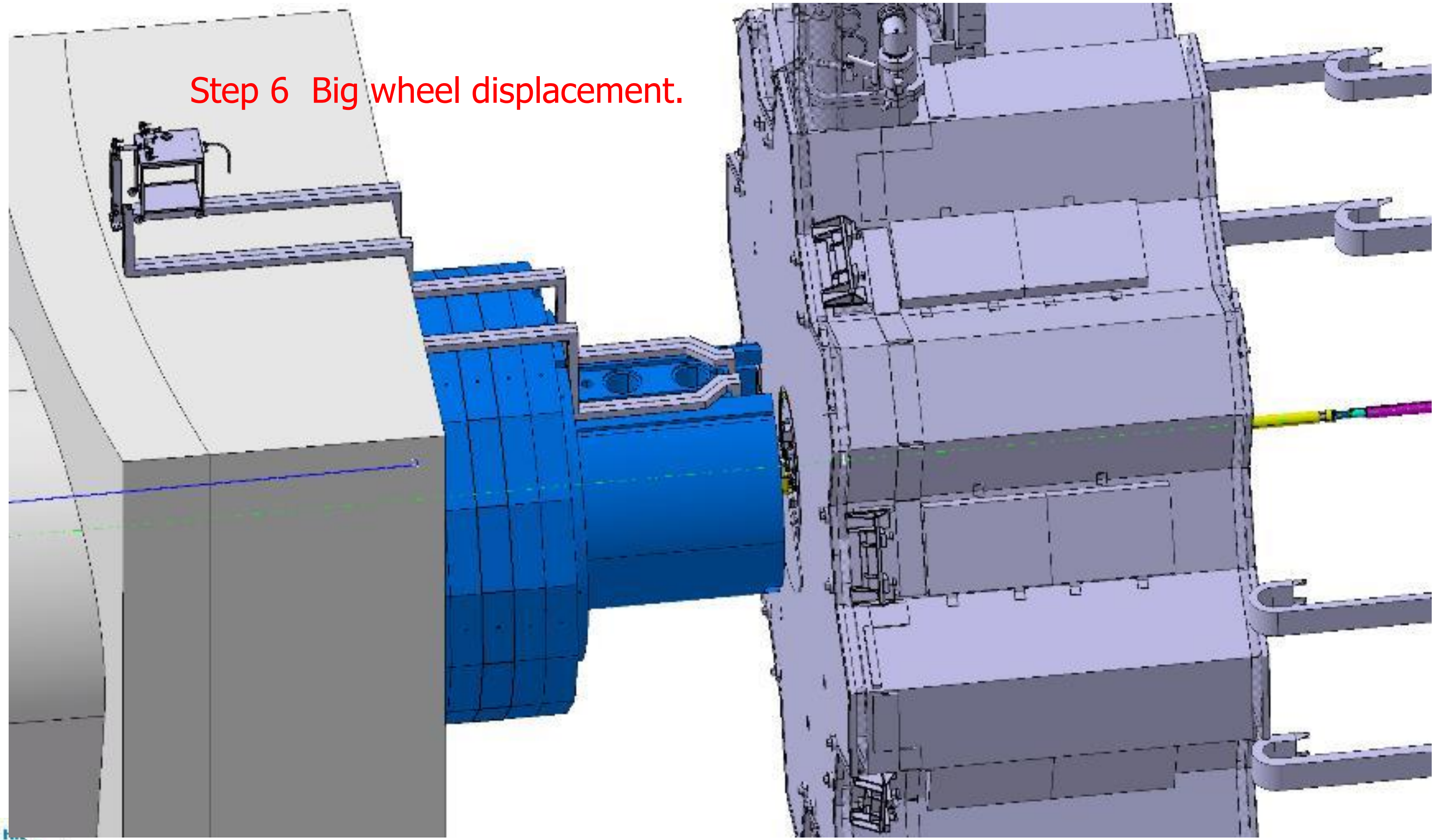
ATLAS Forward shielding removal



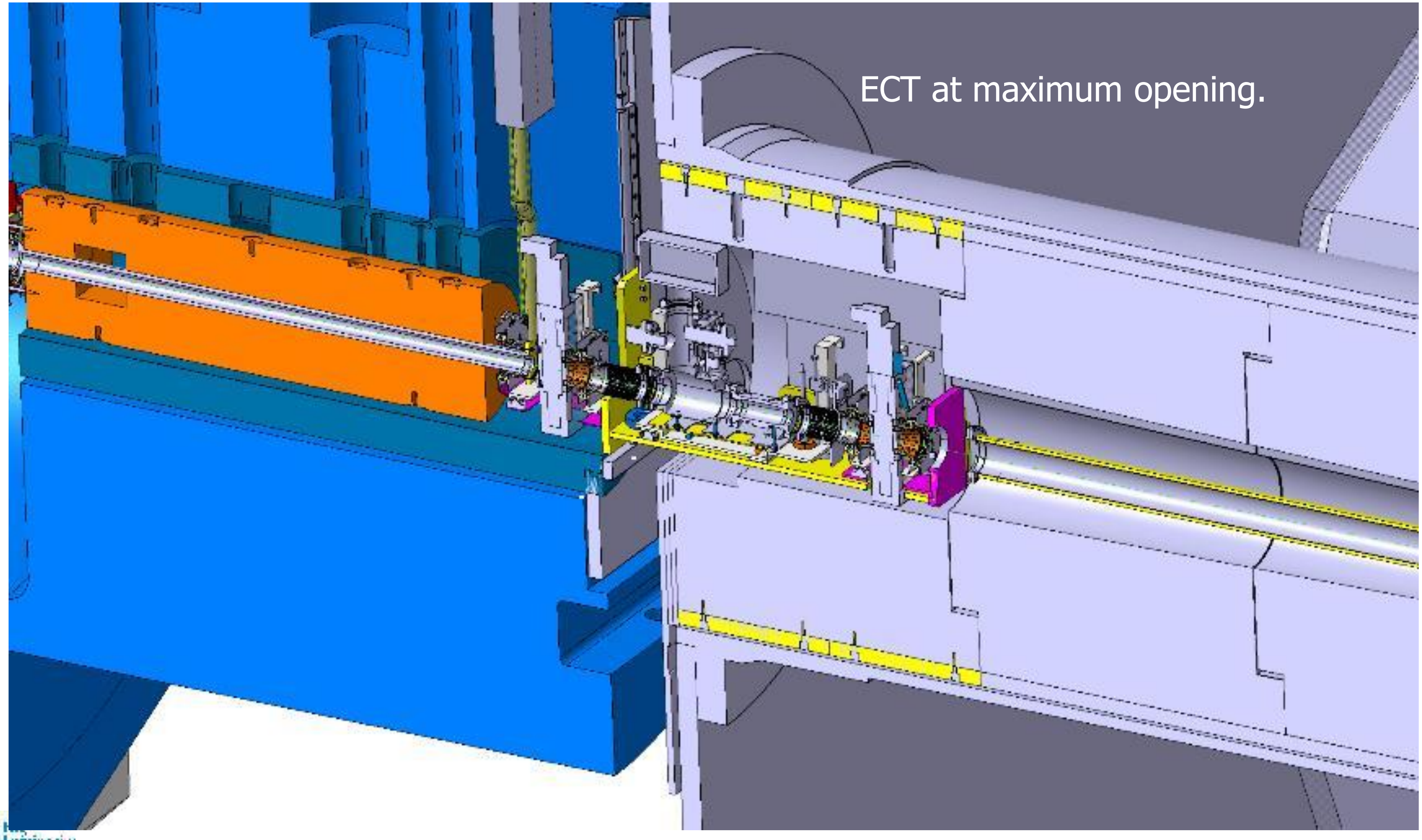
ATLAS Forward shielding removal



ATLAS Forward shielding removal



ATLAS Forward shielding removal



Required modifications in Forward Shieldings…

❑ATLAS

- JFS3Octogone
- JFC2
- JFC3.
- Toroid shielding (JTT1).

❑CMS

- FIN Top insert
- Rotating Shielding removable shielding inserts ("chicane")

… and to auxiliary equipment

❑ATLAS

- Beam pipe support (both at JN mono-block and JTT).
- Beam pipe alignment rails inside JTT shortened (from JTT2 instead of JTT1).
- Lucid position.

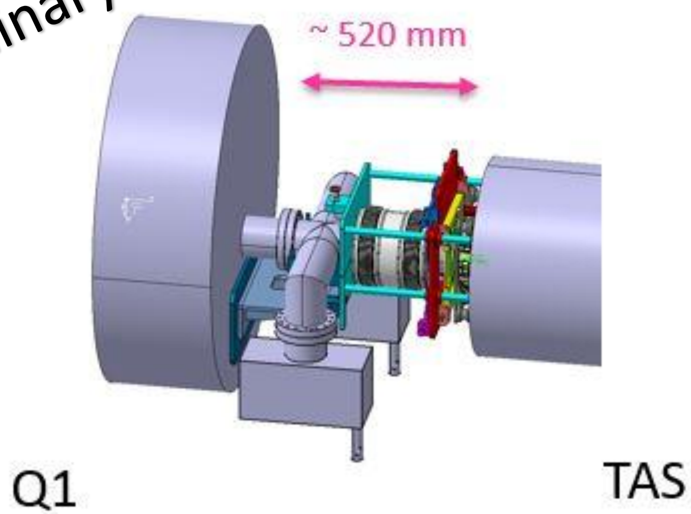
❑CMS

- Beam pipe support at FIN.
- Services routing to 13 m vacuum pump.

Q1 to TAS

Pumping and bellow to decouple room temperature TAS from cryogenic temperature triplet

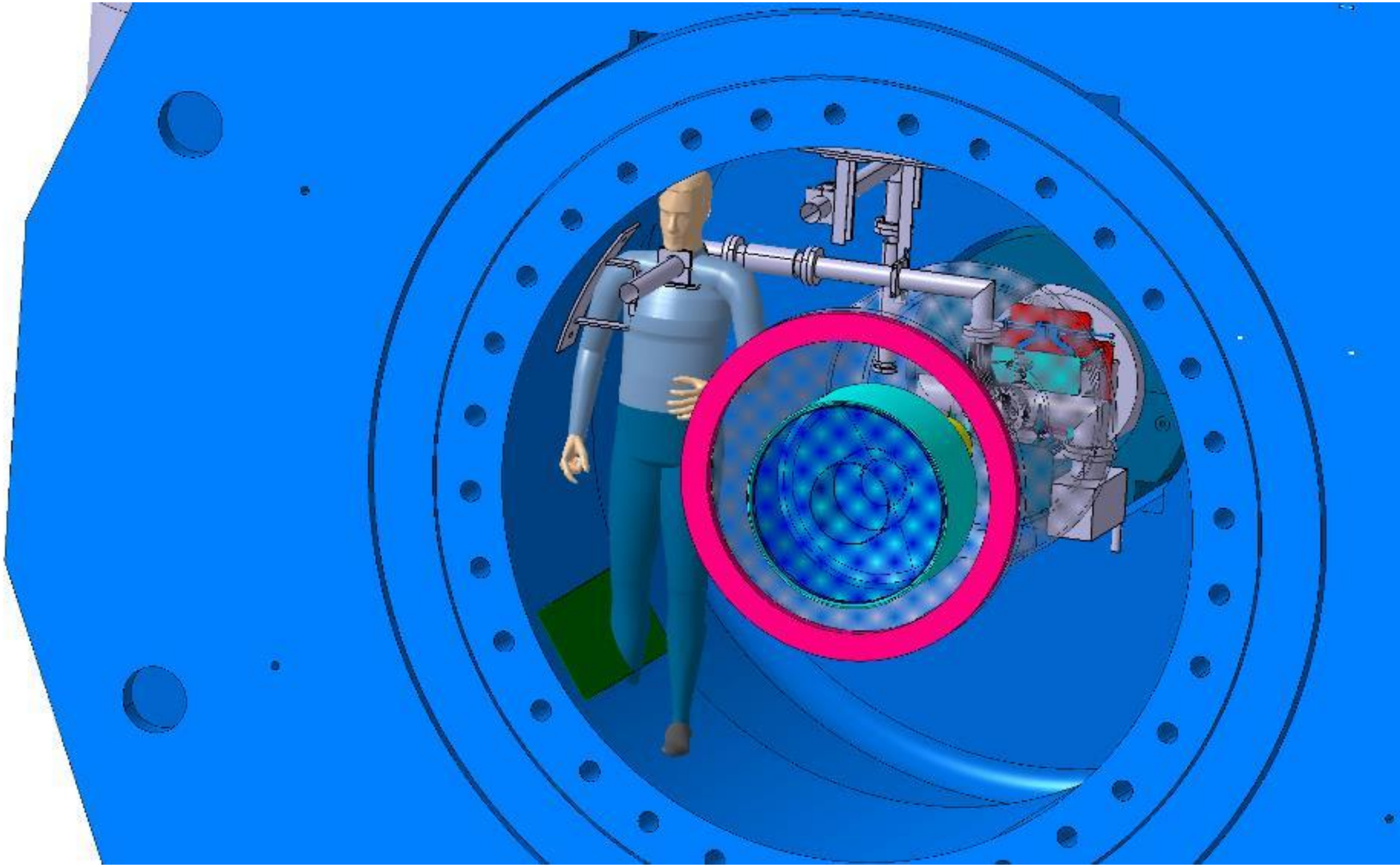
Preliminary work



Courtesy L. Krzempek

No access during operations required.

Q1 to TAS



CONCLUSIONS

- Very good collaboration & support from experiments (Thanks!)
- Relocation of vacuum equipment from the tunnel to the experimental area (from 22-21m to 19 to 17m) seems feasible, but has implications on experiments:
  - Modifications in experiment shielding.
  - Modifications in auxiliary systems.
- Radiation levels 3x on the experiment side, remote operations and alignment compulsory.
- Q1-TAS remains one of the most difficult access areas to access in the accelerator.

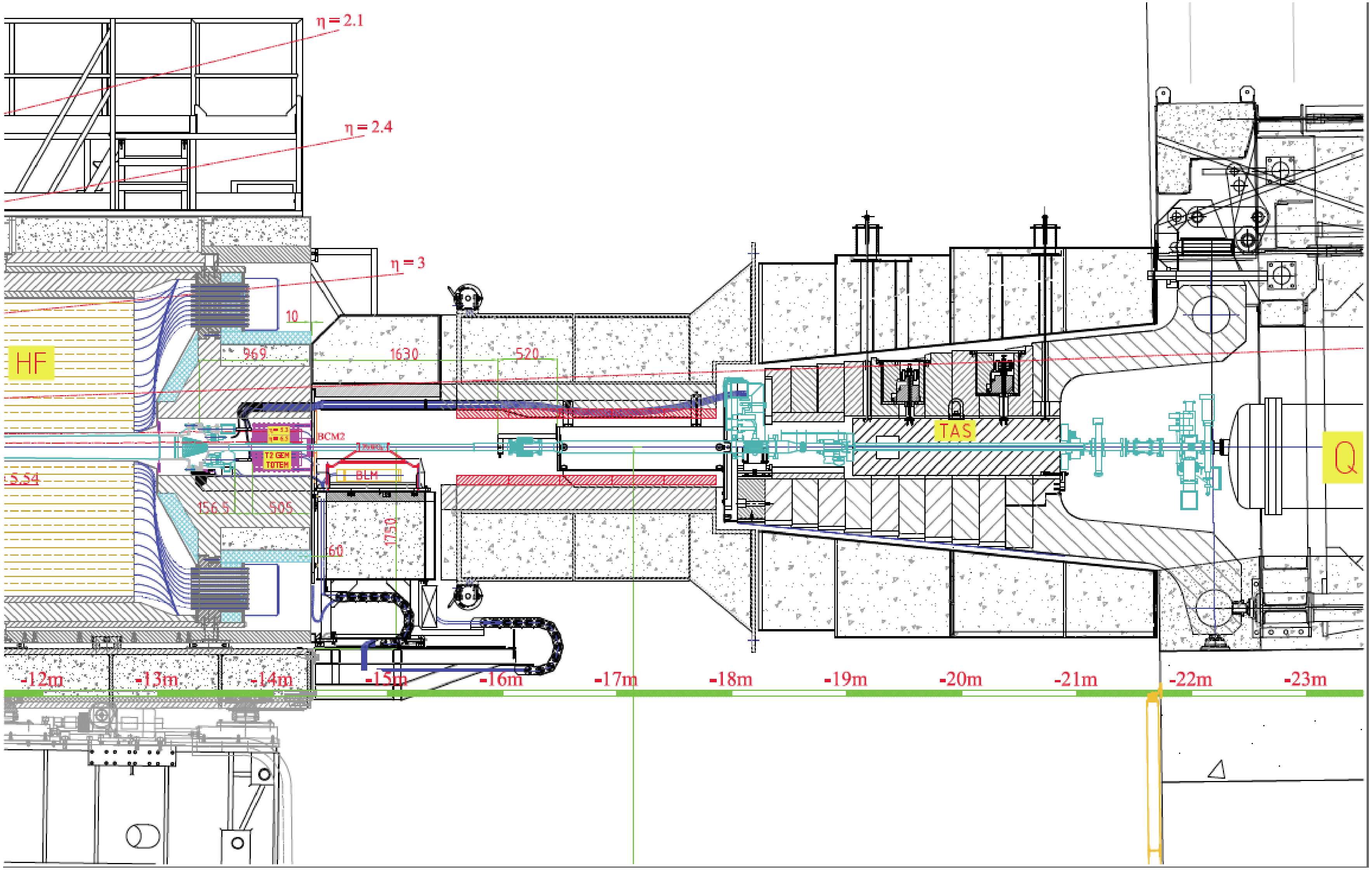
High Luminosity LHC

Thanks to all colleagues of WP8!!!

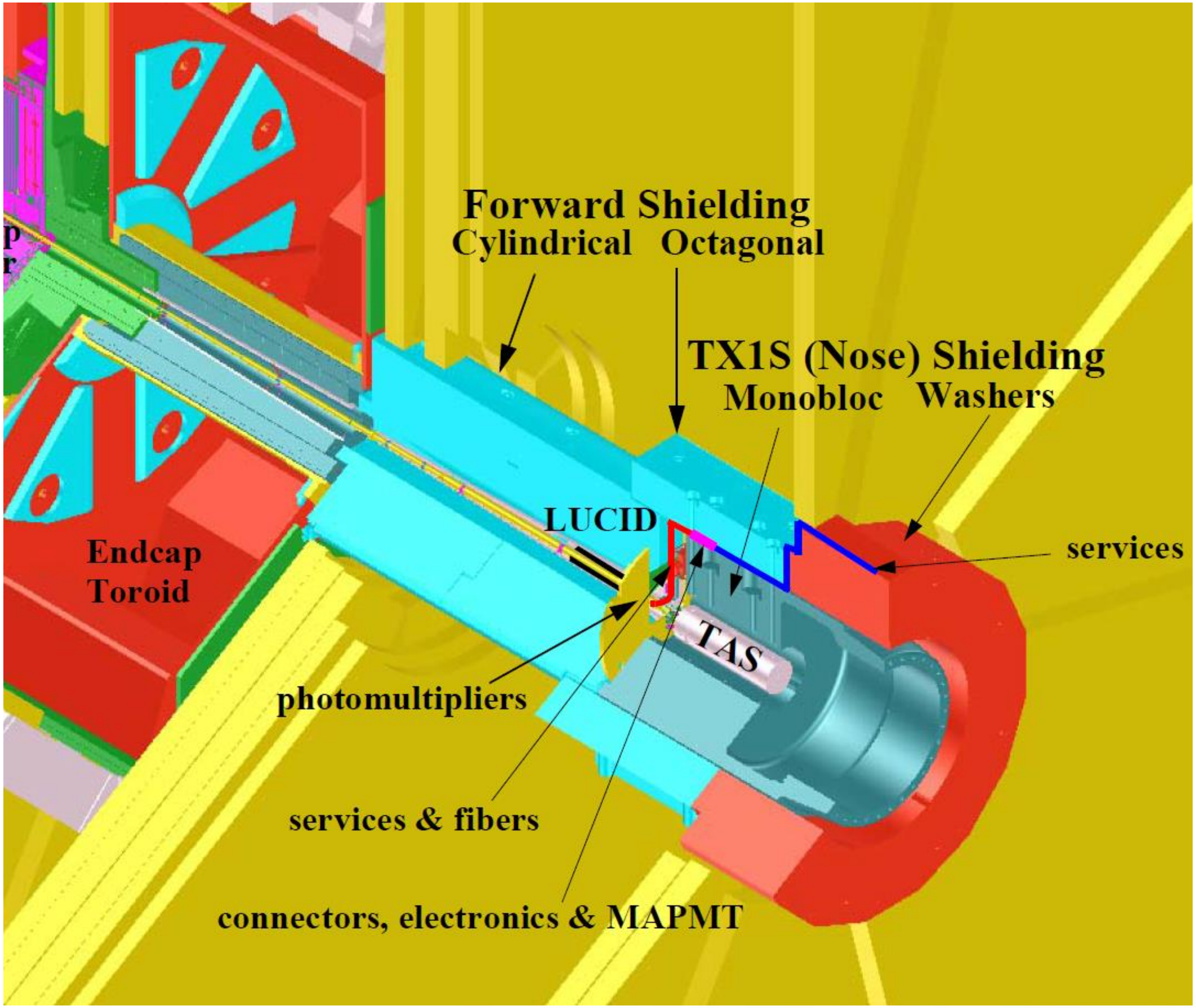
Vincent Baglin, Austin Ball, Enrico Bravin, Helmut Burkhardt, Kevin Einsweiler, Jean-Pierre Corso, Beniamino Di Girolamo, Ilias Efthymiopoulos, Bruno Feral, Roberto Kersevan, Helene Mainaud Durand, Yvon Muttoni, Ludovico Pontecorvo, Michel Raymond, Stefan Roesler, Francisco Sanchez Galan, Oliver Aberle, Paolo Fessia, Christian Boccard,Stephane Maridor, Stephane Bally, Ramon Folch, Andrea Gaddi, Dirk Mergelkuhl, Luigi Salvatore Esposito, Sebastien Evrard, Catherine Magnier, Cristina Adorisio, Joel Albertone, Francesco Cerutti, Riccardo De Maria, Michael Lazzaroni, Giuseppe Bregliozzi, Andrea Santamaria Garcia, Antonio Sbrizzi, Sune Jakobsen, Lukasz Piotr Krzempek, Jaime Perez Espinos, Blanca Vazquez De Prada

The HiLumi LHC Design Study is included in the High Luminosity LHC project and is partly funded by the European Commission within the Framework Programme 7 Capacities Specific Programme, Grant Agreement 284404.

CMS Forward Shielding Zone



ATLAS Forward region



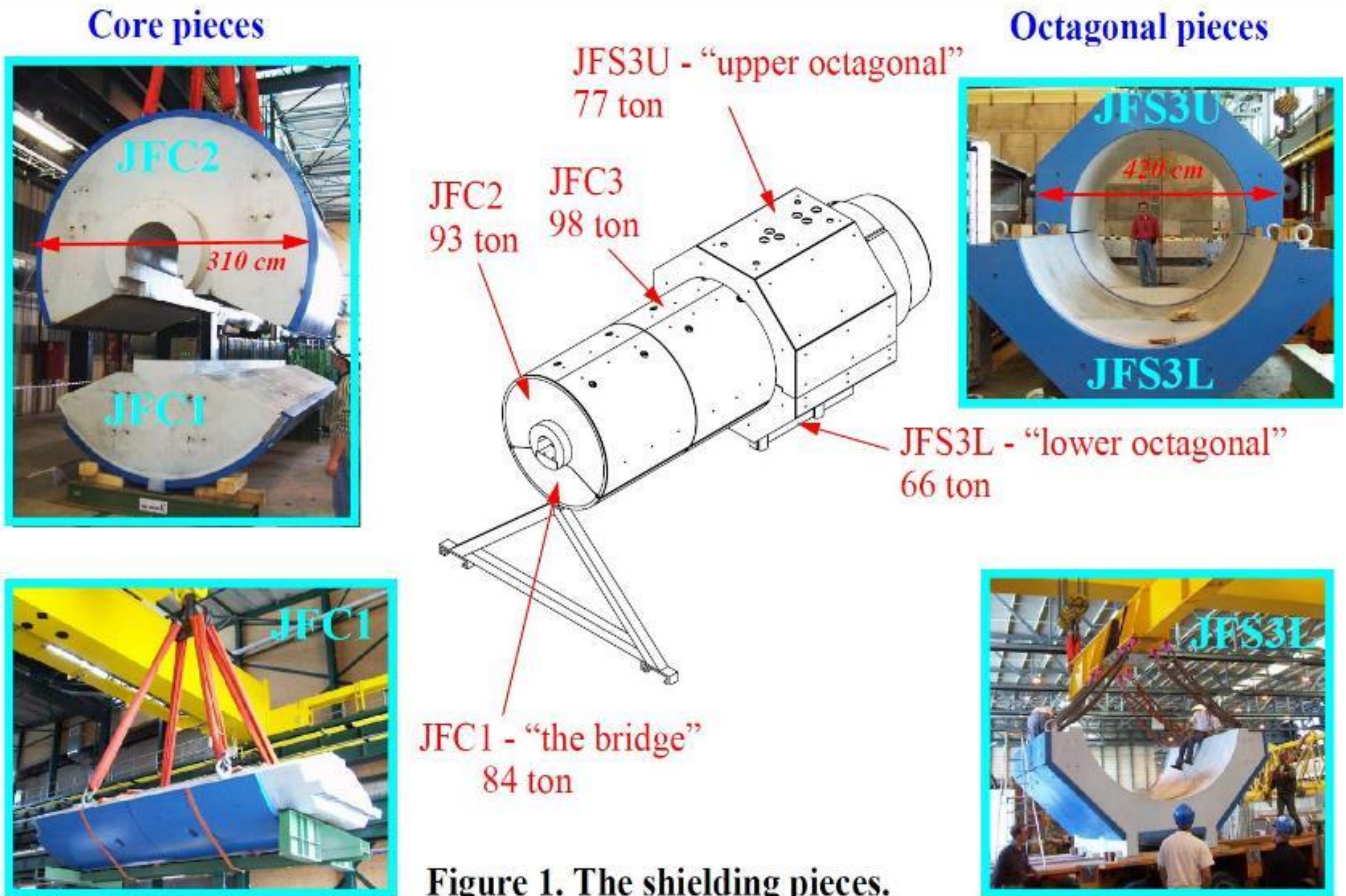
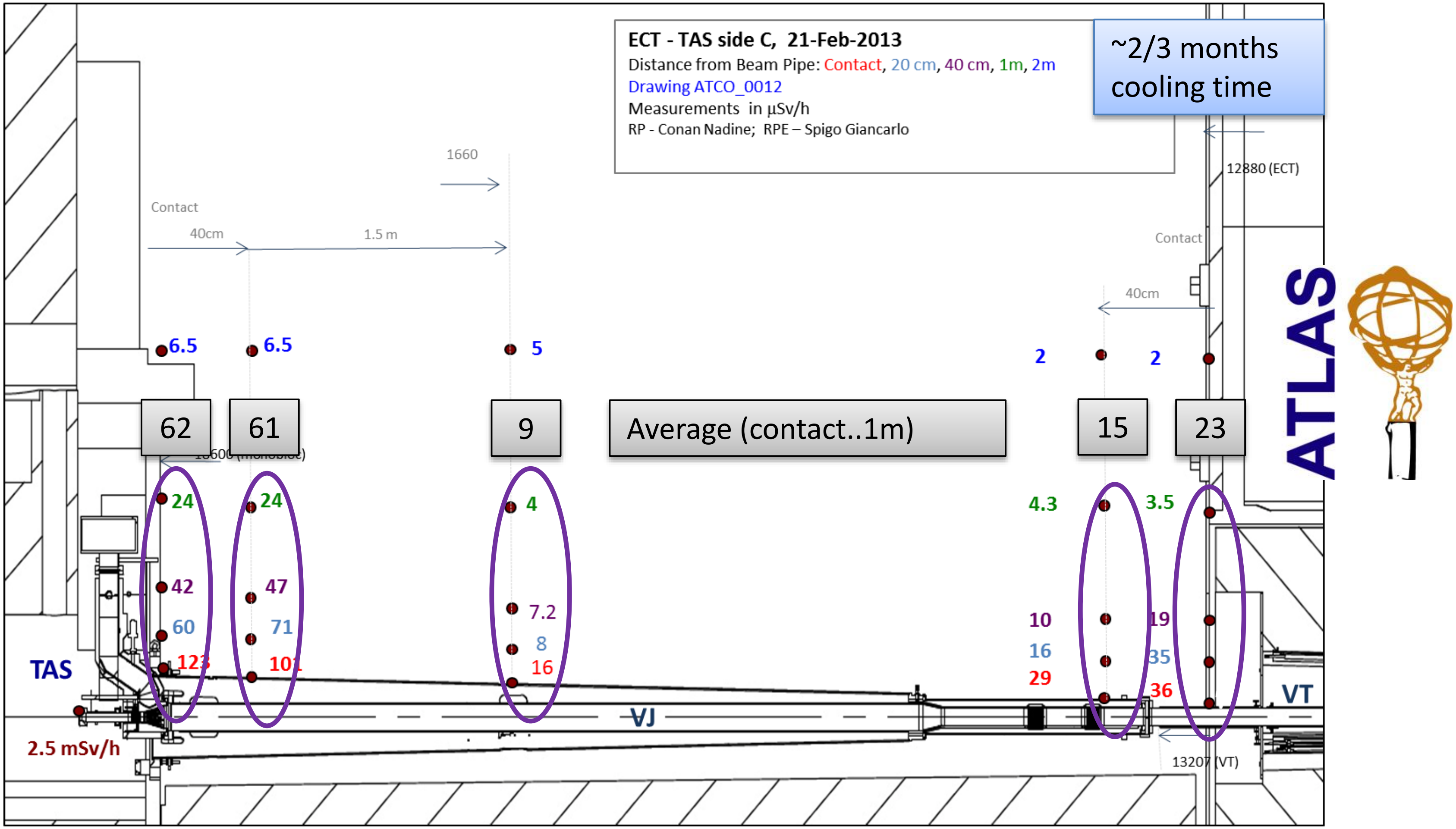


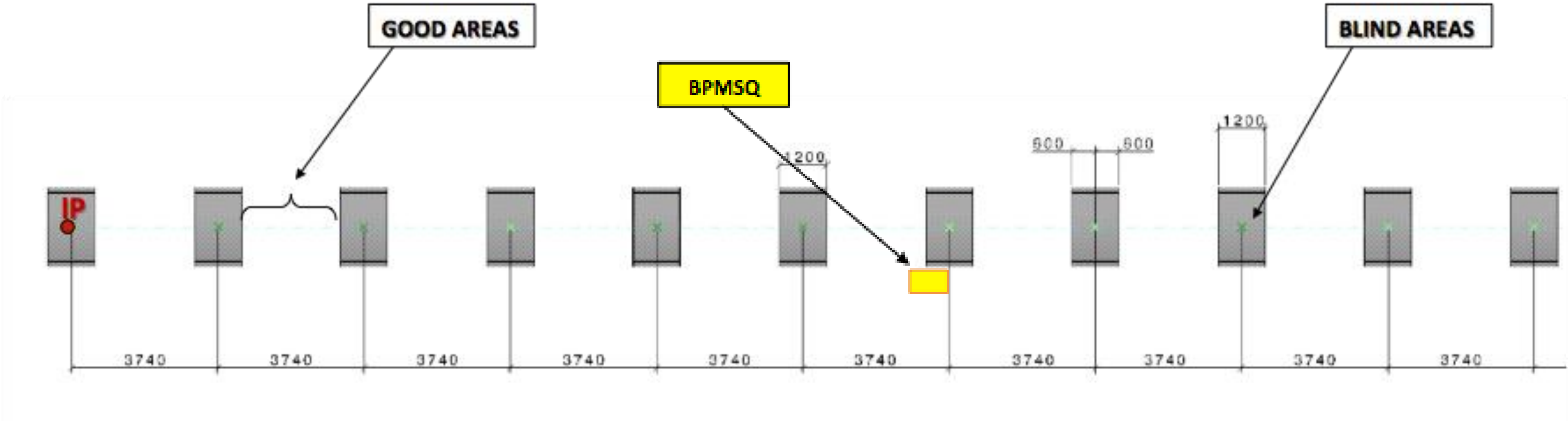
Figure 1. The shielding pieces.

LS1 measurement



BPM Position

- For optimal use during operations, the location of the BPMs should be positioned at least ±60 cm away of the beam crossing points, defined every 3.74m from the IP ⟶ the “blind areas”



- Having an BPM that works with collision optics would be important for HL-LHC operation and in particular for luminosity levelling

Courtesy P. Fessia

TAS-Q1 Layout proposal for HL-LHC operation

- **A. Maintain the same location of Q1 (L*=23m) and include the Q1-BPM into the cryostat**
  - Allows for fixed mechanical connection between the BPM and the magnet cold mass therefore improved alignment and position monitoring during operations
  - Mitigates the risk of vacuum leak from the warm BPM of today

- We also investigated the option to move Q1 further away from the TAS by ~1m (L*=24m) but doesn't seem to work
  - penalty for luminosity (small ~5% loss), doesnt' really solve the access problems, and as all IT magnets would have to move accordingly, puts almost all BPMs of the SS to "blind" positions

baseline → L*23m

? ⇢ L*22.7m

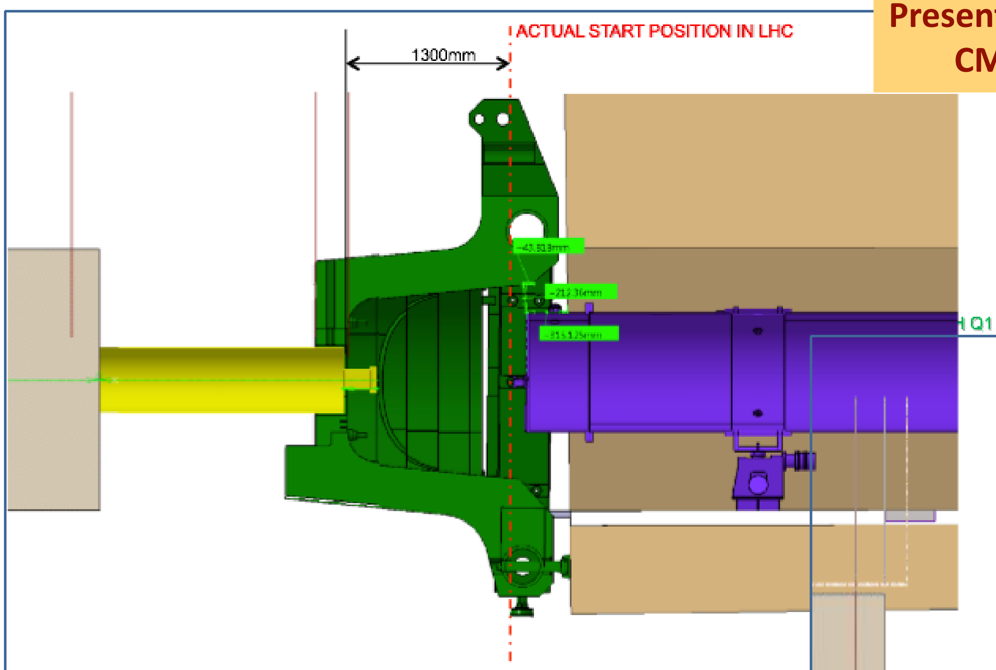
C	Q1	Q2A	Q2B	Q3A	Q3B	D1	DFXJ
NAME	BPMSQ	BPMSQ	BPMSQT	BPMSQT	BPMSQT	BPMSQ	BPMSQ
L*23m	BLIND	BLIND	OK	OK	OK	OK	BLIND
DISTANCE TO THE BLIND AREA	-92	-12	181	616	696	360	-288
L*22.7m	OK	OK	OK	OK	OK	OK	HALF
L*24m	HALF	HALF	BLIND	BLIND	BLIND	BLIND	OK

High Luminosity LHC

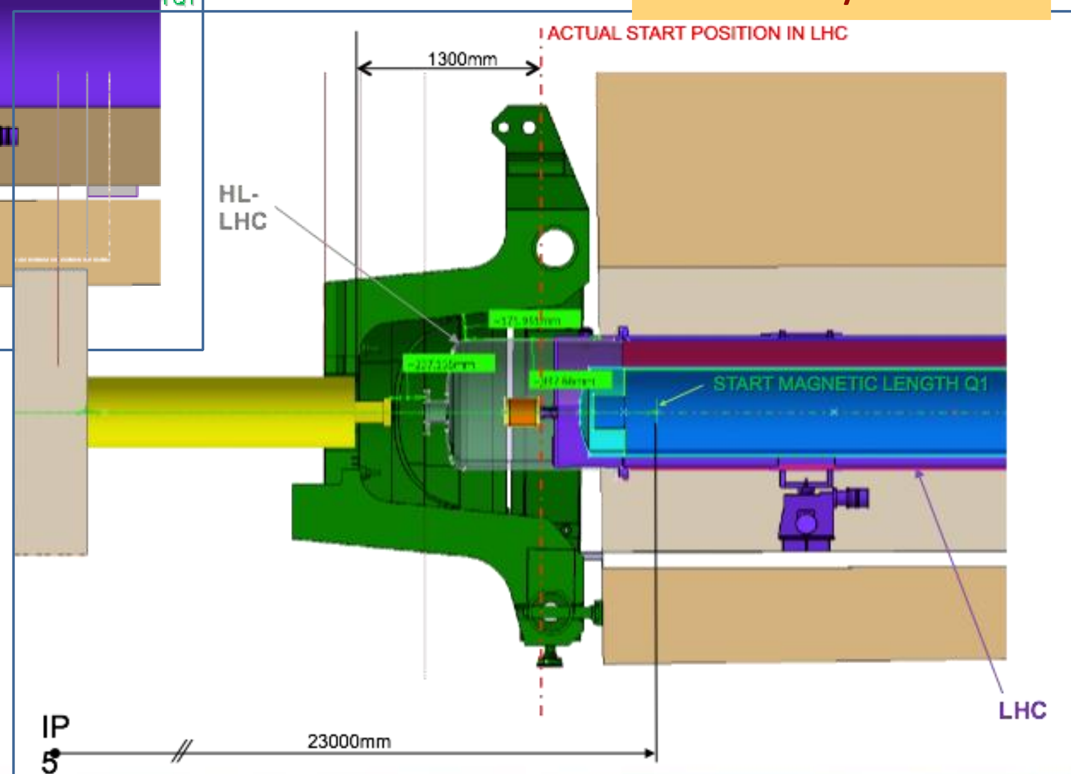

OPEN

TAS-Q1 Layout proposal for HL-LHC operation

Present Situation
CMS/IR5

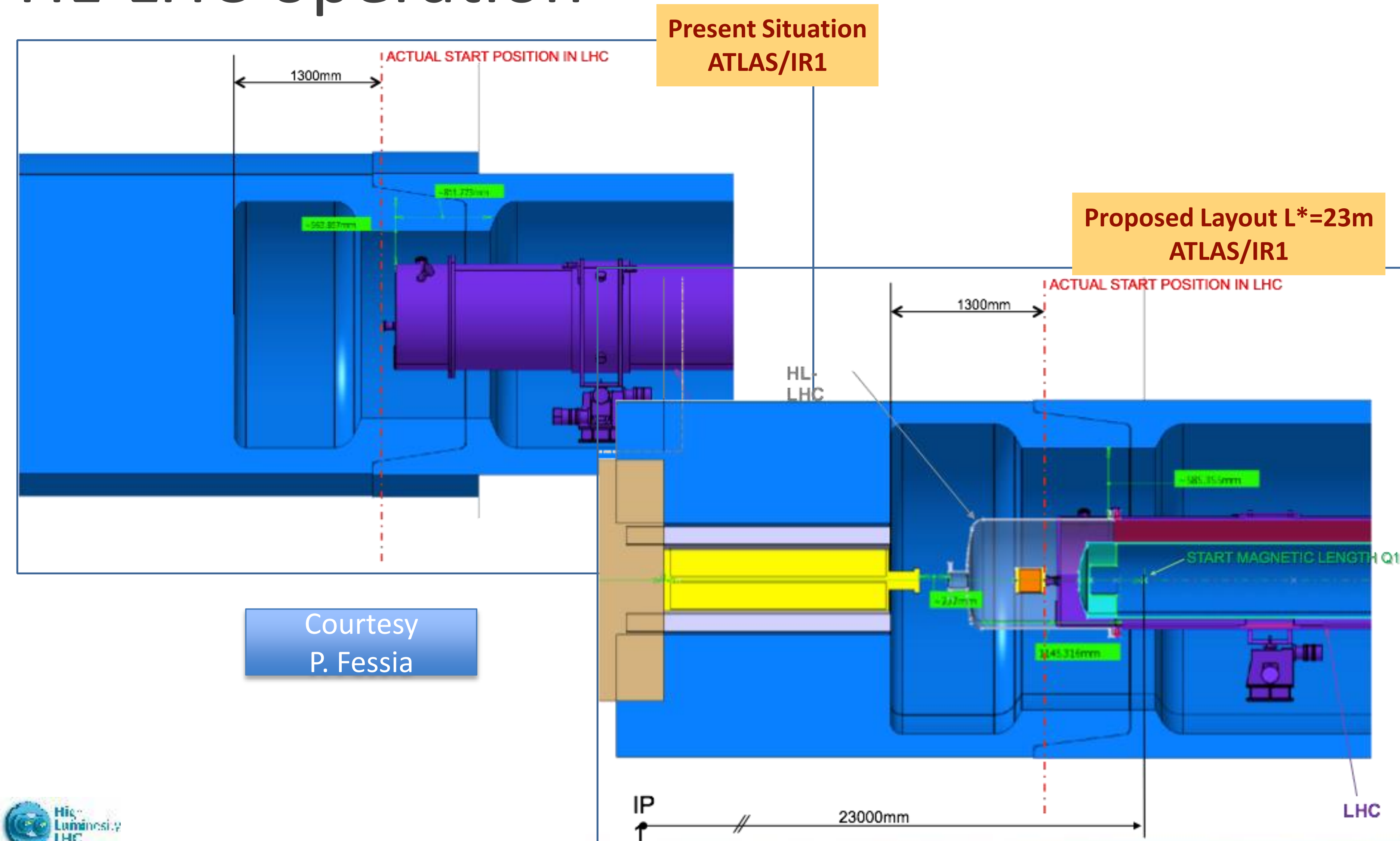


Proposed Layout L*=23m
CMS/IR5



Courtesy
P. Fessia

TAS-Q1 Layout proposal for HL-LHC operation



Courtesy
P. Fessia