





LS2 Beam Gas Curtain Installation & Integration

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Contents

- Terminology
- Version 3 Phase 1 review
- Blackenings summary
- LHC Installation
- Phase 2 Updates
- Conclusions

Terminology

Phase 1 Installation (V3 BGC):

- Vacuum chamber with 3 valves that allow installation of gas injection system and dump side without breaking the LHC vacuum
- Functionally same as BGI used to measure fluorescence with a distributed gas in the chamber

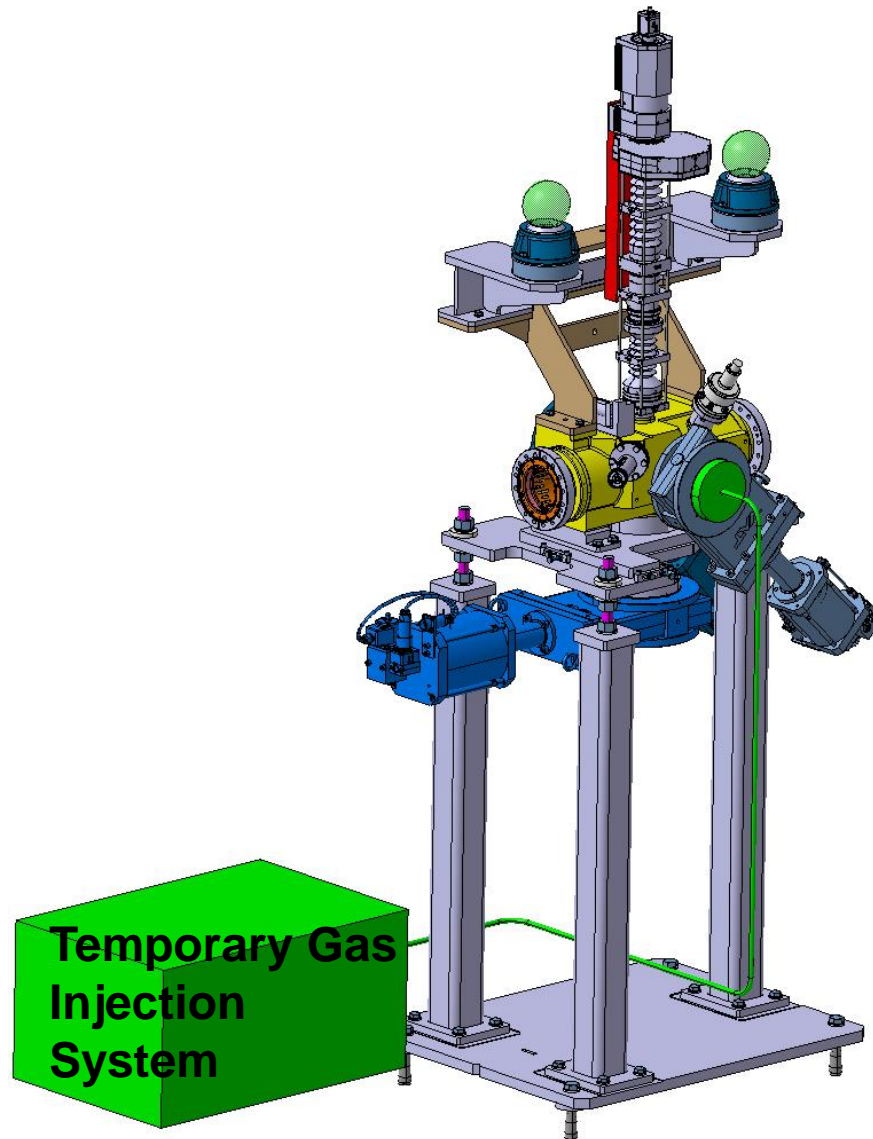
Phase 2 Installation (V3 BGC):

- Complete BGC Demonstrator in the LHC
- Addition of gas injection, gas dump, pumps and imaging system to the phase 1 installation
- Complete Gas Curtain generation – used to evaluate the instrument with 7 TeV protons

HEL test stand BGC (V3 BGC):

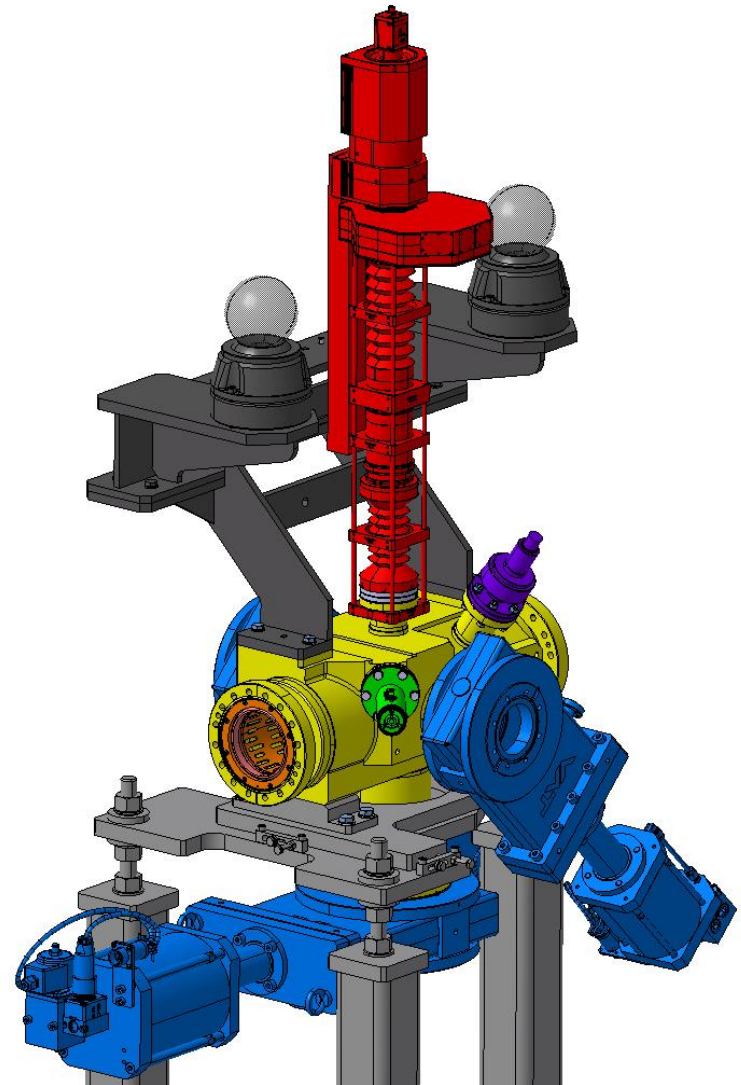
- Instrument functionally the same as V3 phase 2 but integrated for the HEL-TS
- Complete Gas Curtain generation – used to evaluate the instrument with e⁻

Version 3 Phase 1 review



Phase 1 overview

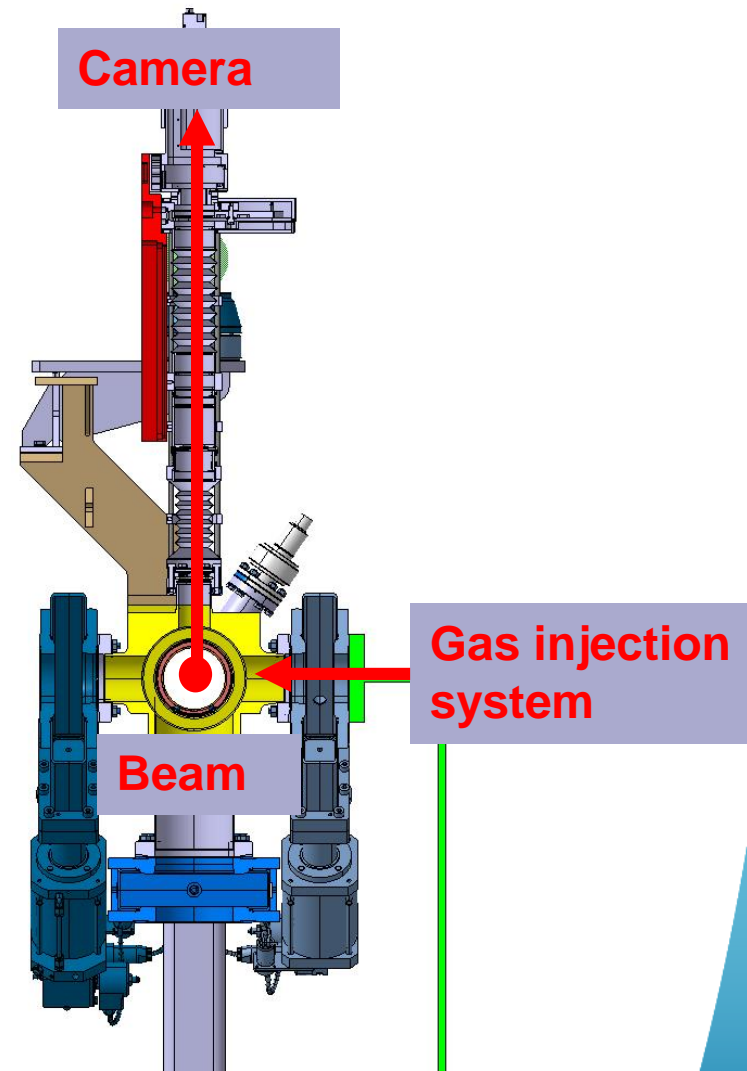
Color	Part
Grey	Support Structure
Yellow	Vacuum Chamber
Orange	Copper Liner
Blue	VAT valves
Green	LBD with camera target
Purple	Penning
Red	Camera setup
Grey	Geometer targets



Version 3 Phase 1 Working Principle

Orthogonal orientation in accordance with the other Beam Instrumentation:

- Achieved by reducing the size of the final instrument
- Allows for cross calibration with other beam instruments
- Optical system support to be finalized – optical system ex-vacua



Blackening summary



Blackenings

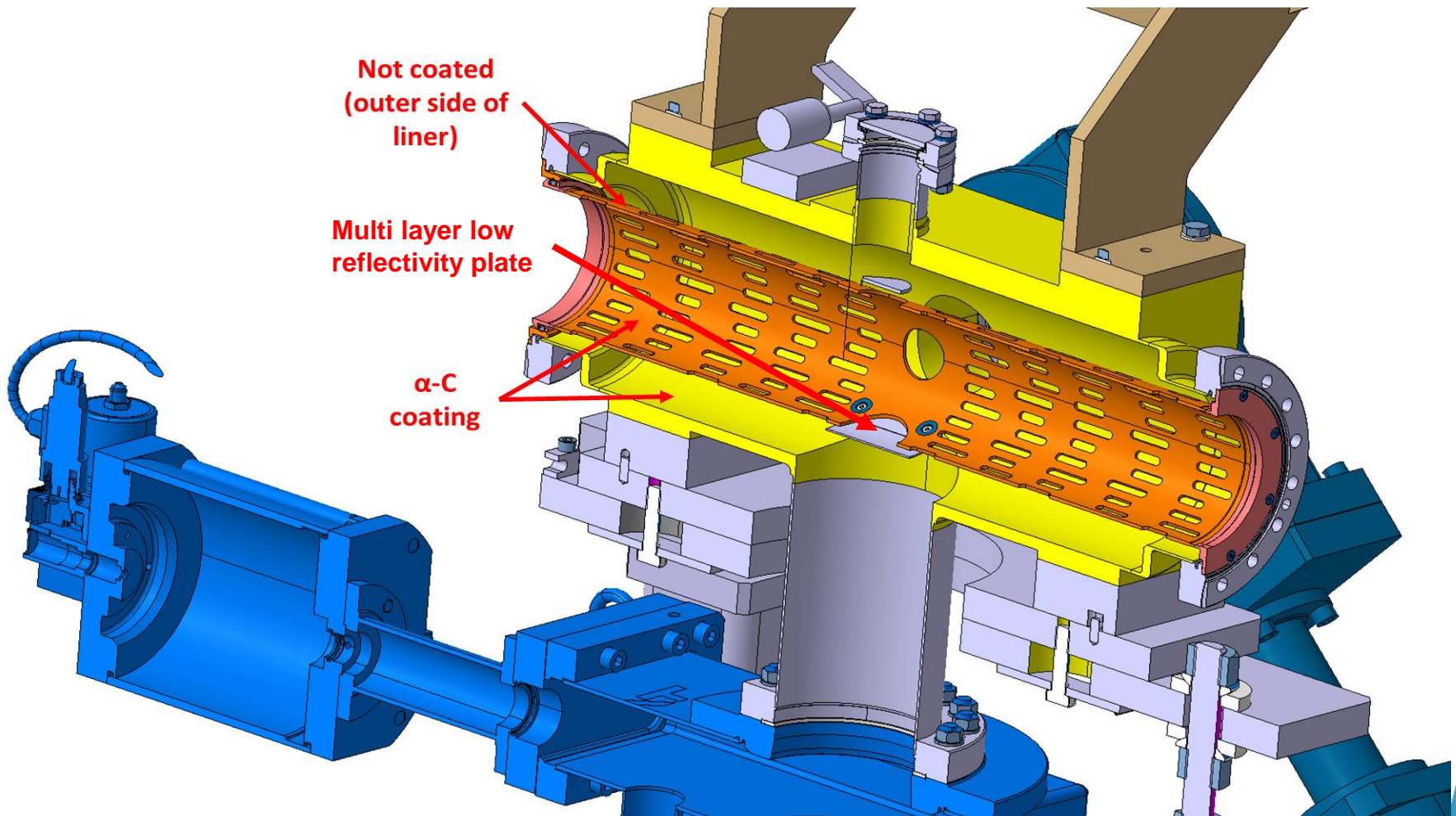
Different blackening used to minimize light reaching the sensor:

- **α -C coating** used in the copper liner and the vacuum chamber with reflection of 10-15%
- **Multi-layer optimized coating** used under the interaction point with reflection of $< 0.2\%$

Oxidized copper blackening used for camera calibration target (with gold markings)

Vantablack blackening was tested for vacuum acceptance and further use in the machine (not this phase of BGC)

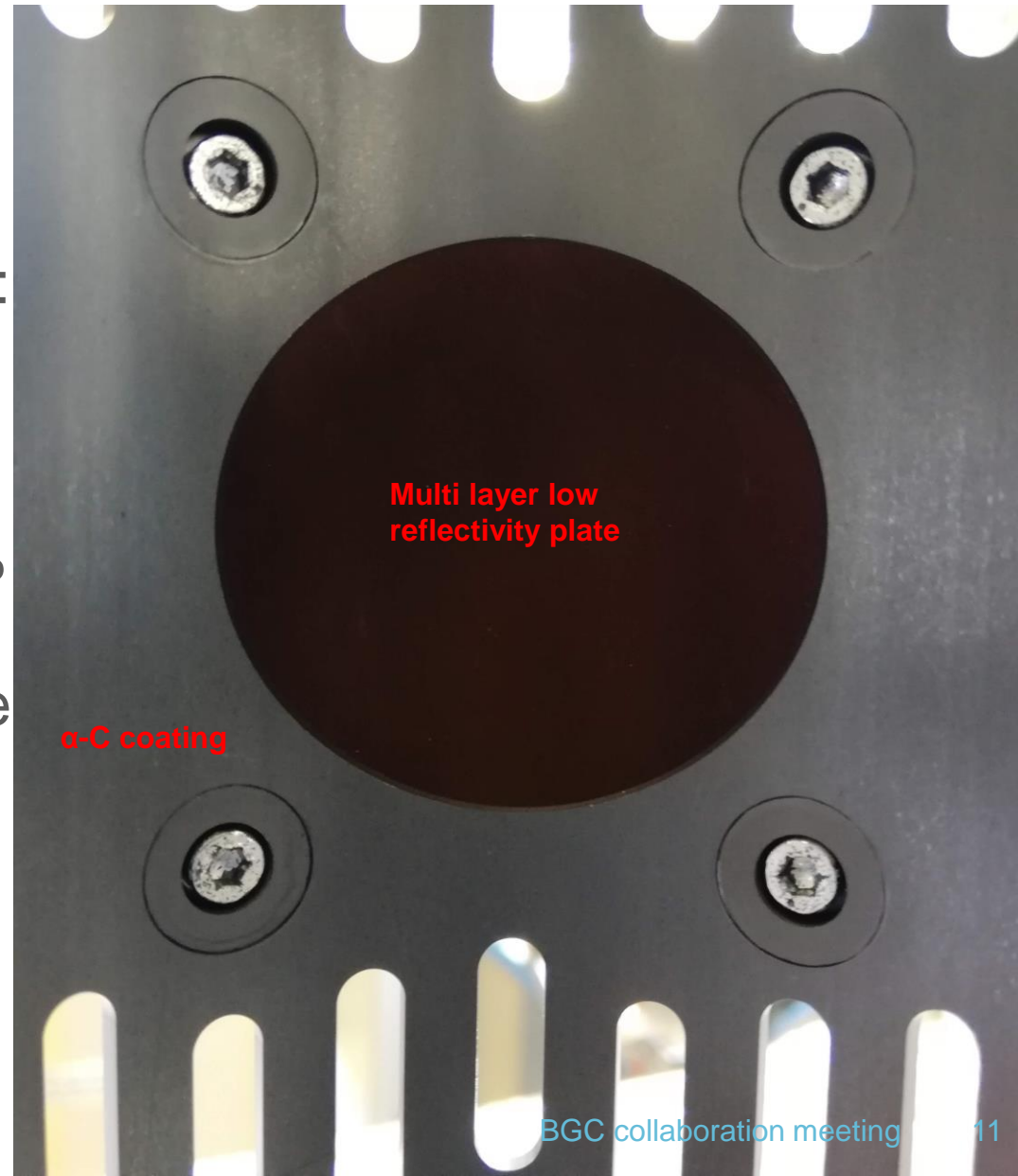
Blackenings



Multilayer and α -C coating

Different blackening used to Minimize the synchrotron radiation light reaching the sensor:

- α -C coating used in the copper liner and the vacuum chamber with reflection of $\sim 15\%$
- Multi-layer optimized coating used under the interaction point with reflection of $< 0.2\%$



Copper liner

2 complete copper liners produced:

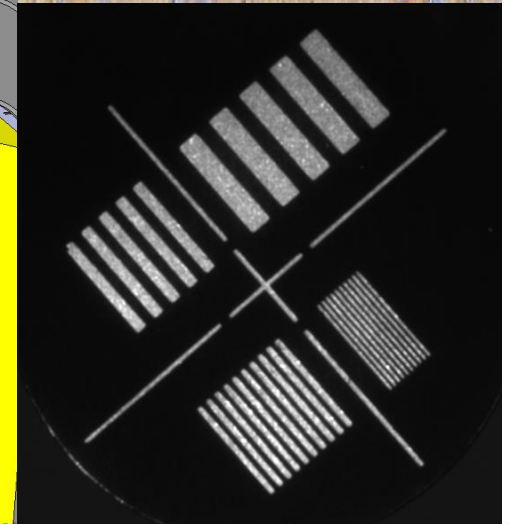
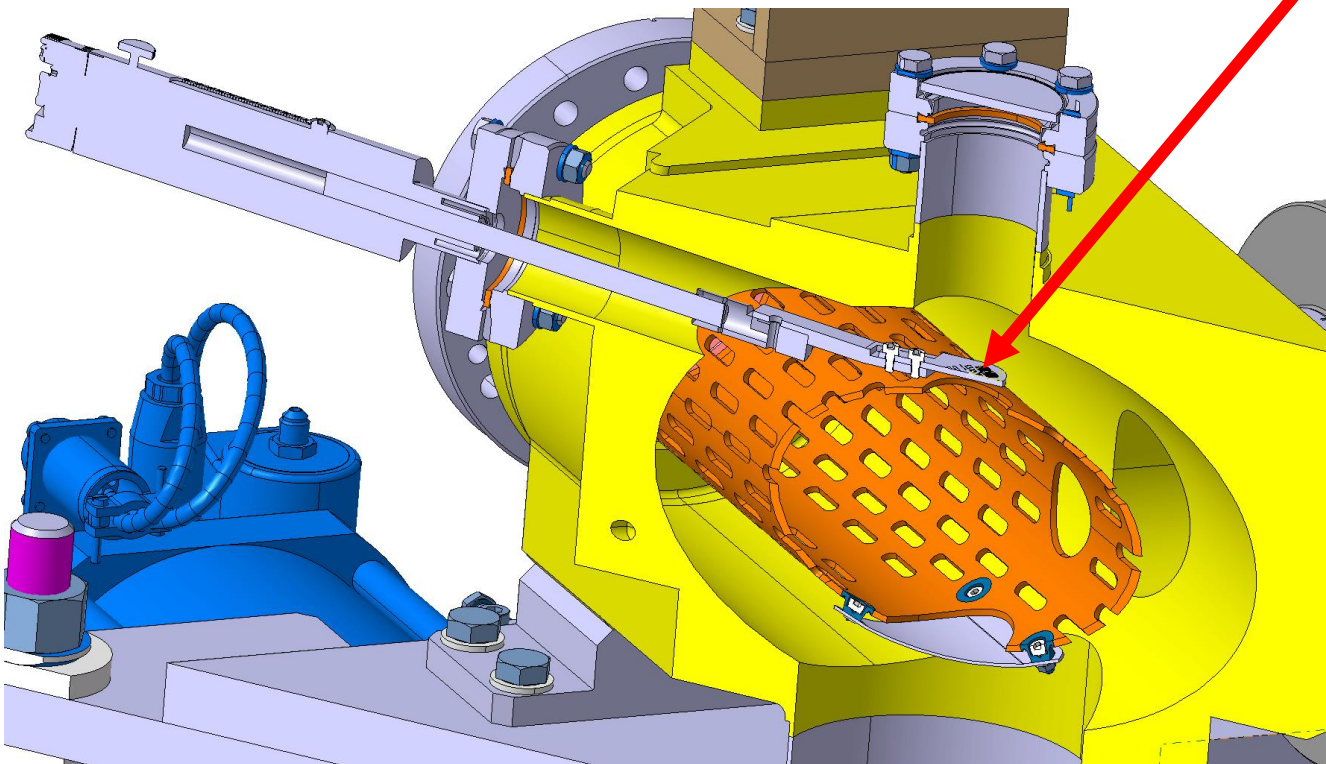
- LHC BGC
- HEL-TS BGC

**Thanks to: BE-ABP,
EN-MME, TE-VSC!**



Oxidized copper

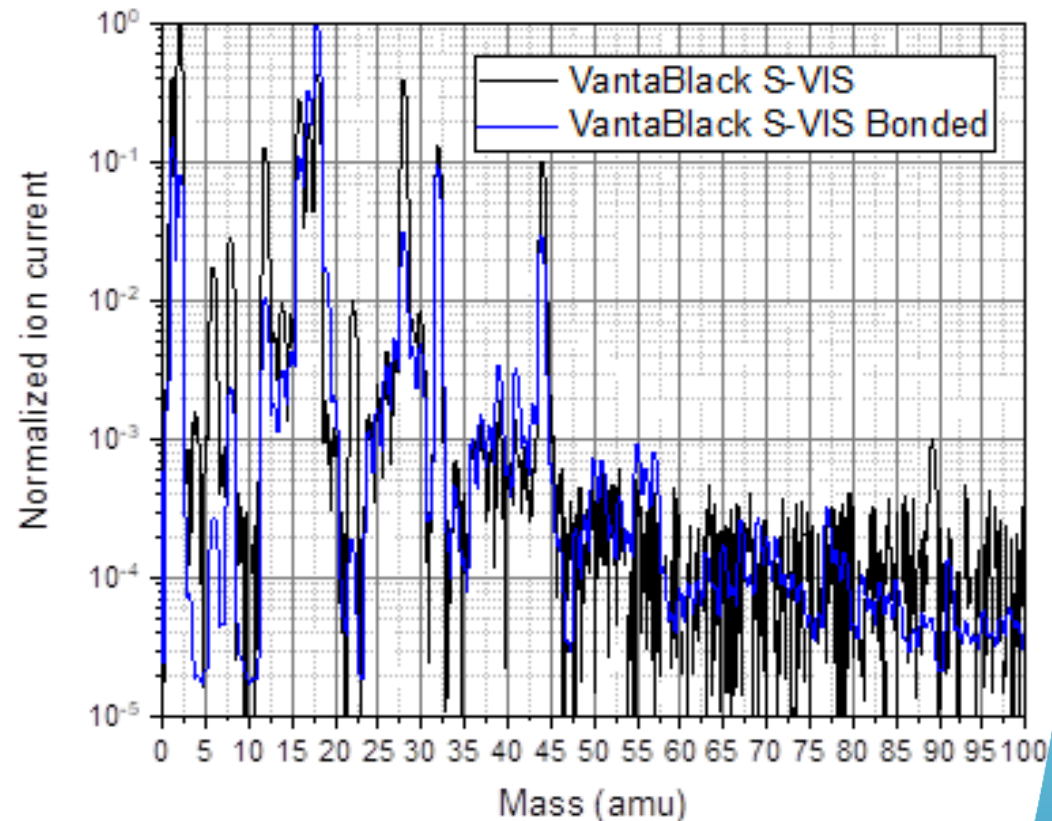
Thanks to EP-DT!



Vantablack vacuum qualification tests

- Exceptional light performance with <1% reflectivity across the visible spectrum
- Vacuum performance:
 - Ongoing approval
 - Metallic like surface outgassing
- Poor mechanical performance:
 - No abrasion resistance

Thanks to TE-VSC!



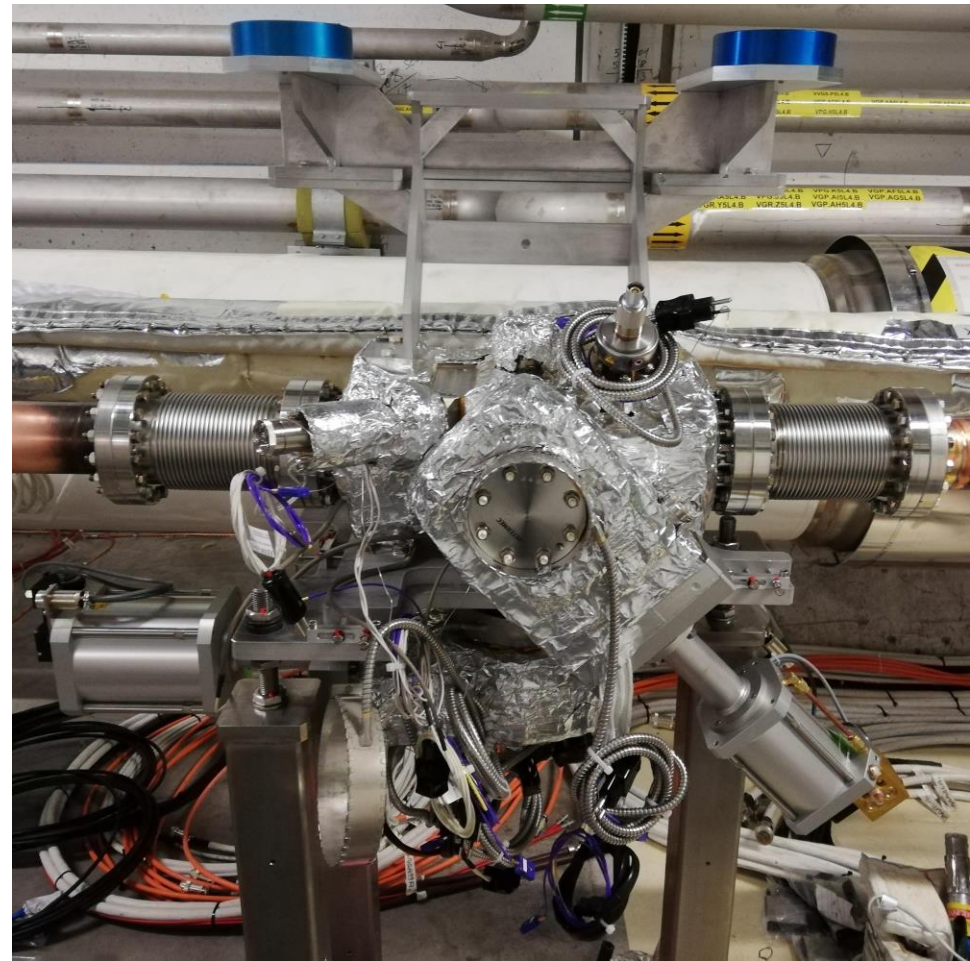
Courtesy of Chiara Pasquino

LHC Installation



Tunnel Installation (Point 4)

- Installed in the tunnel successfully!
- Connected in the vacuum sector:
 - Sector pumped down and leak tested
 - Baked out
- Alignment performed
- Electric acceptance test is done successfully



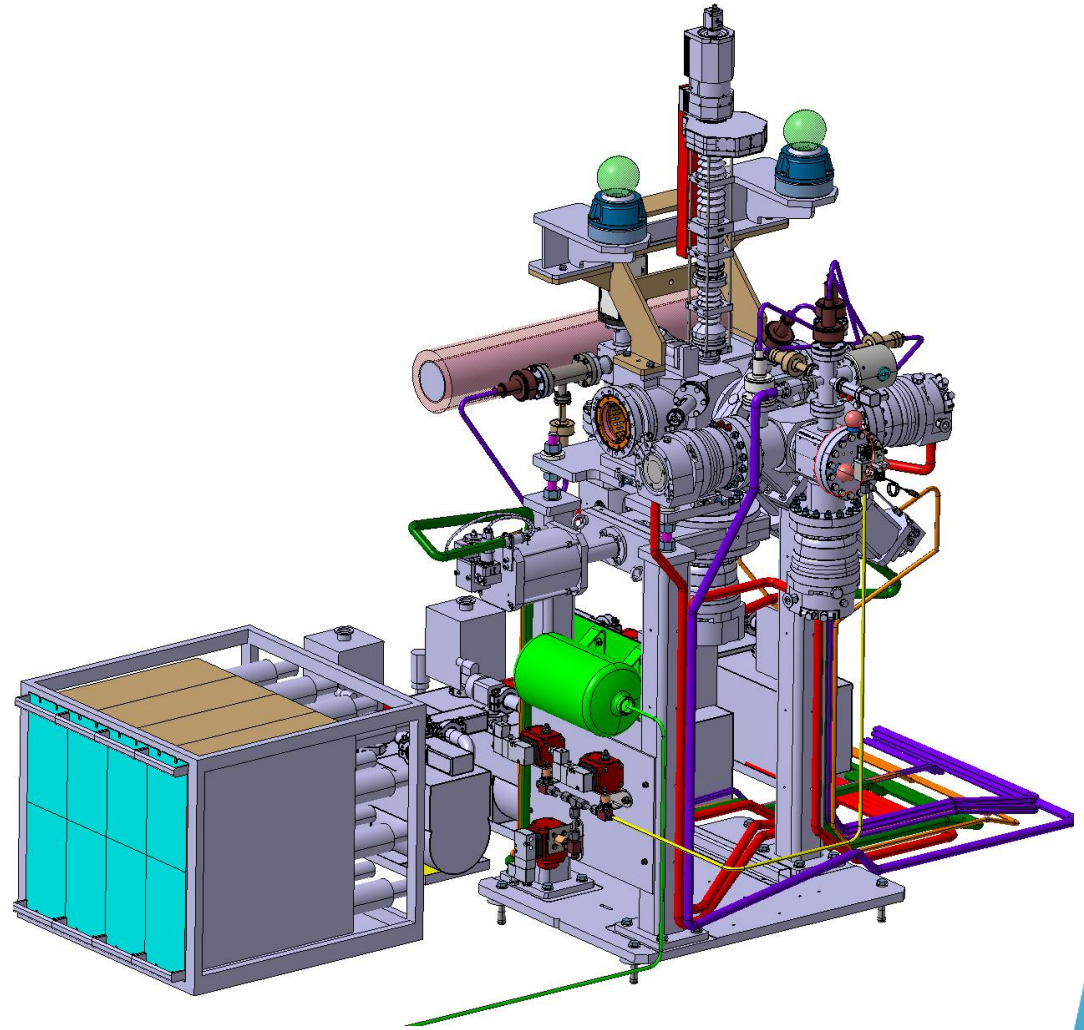
Gas injection Line (Phase 2)



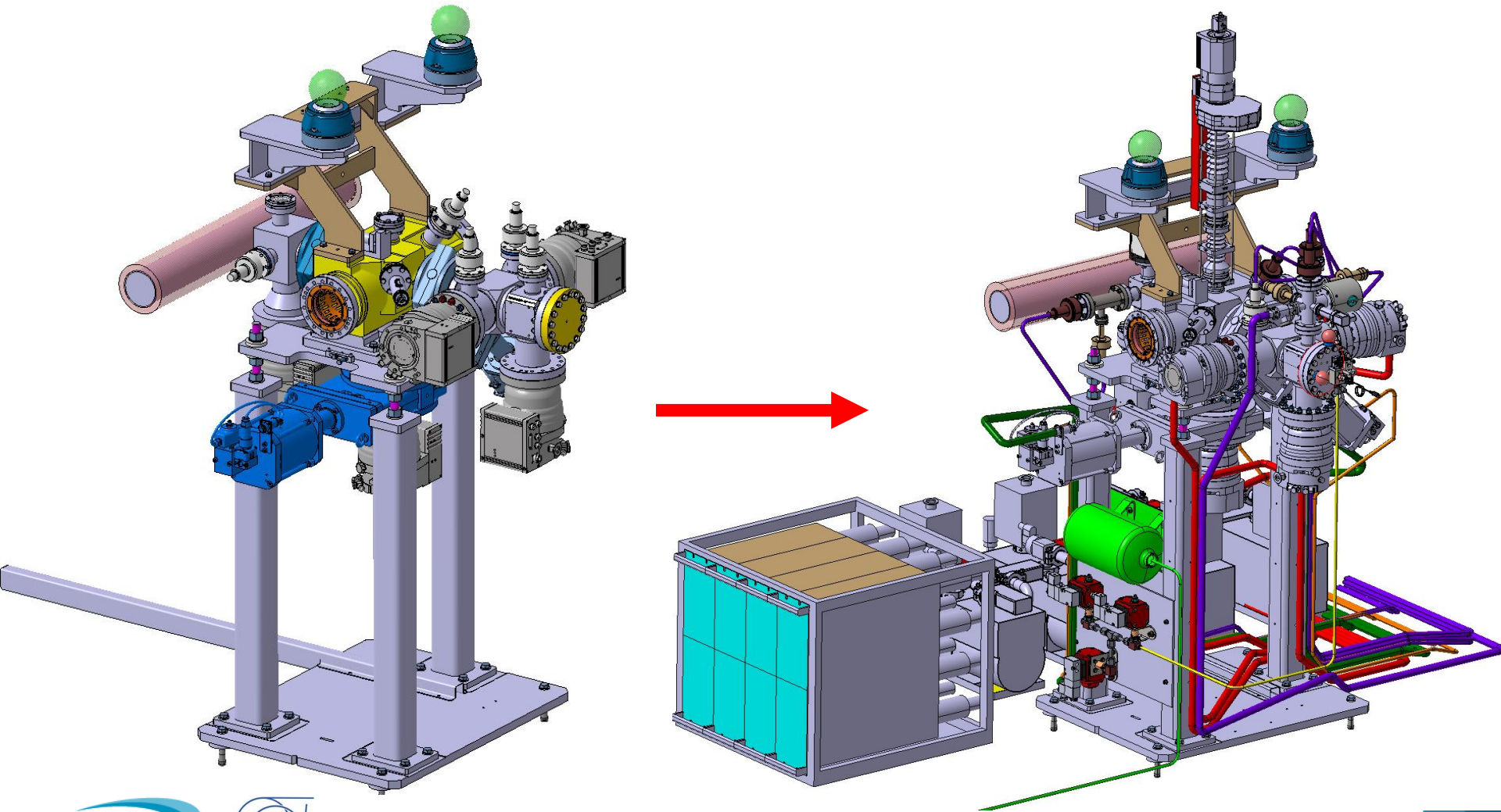
V3 Phase 1 status overview

- BGI system
 - Control rack moved to location
 - Gas injection system moved to surface for servicing
- Fiber racks rack installed in the vicinity and fibers installed and connected
- Camera system:
 - Camera system design on the way

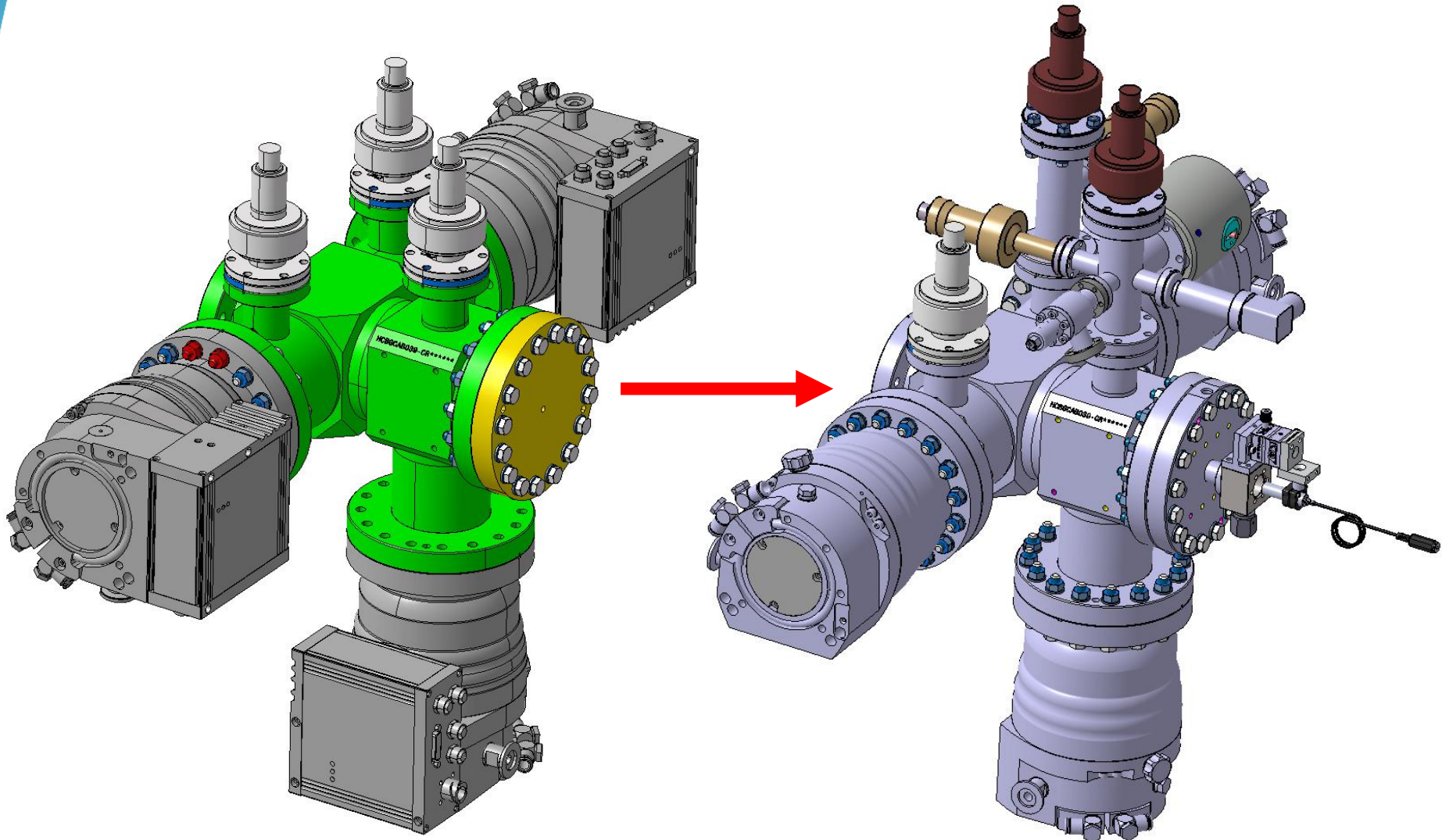
Phase 2 Updates



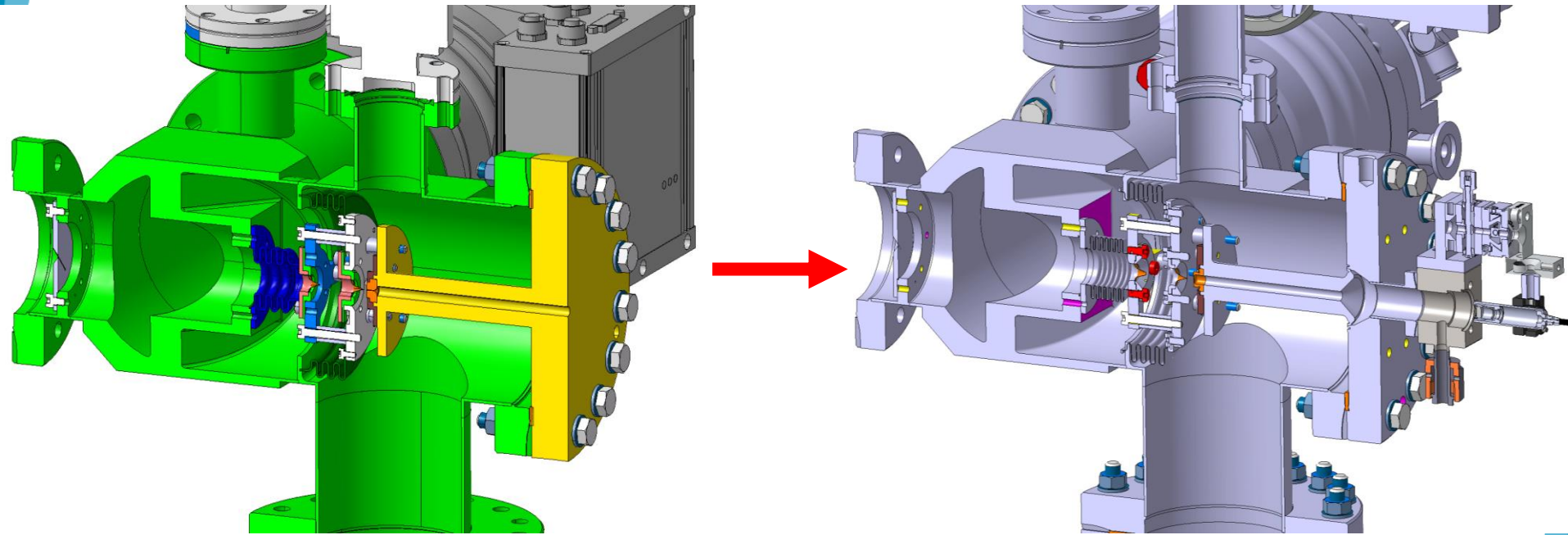
Design Evolution



Gas injection system final design

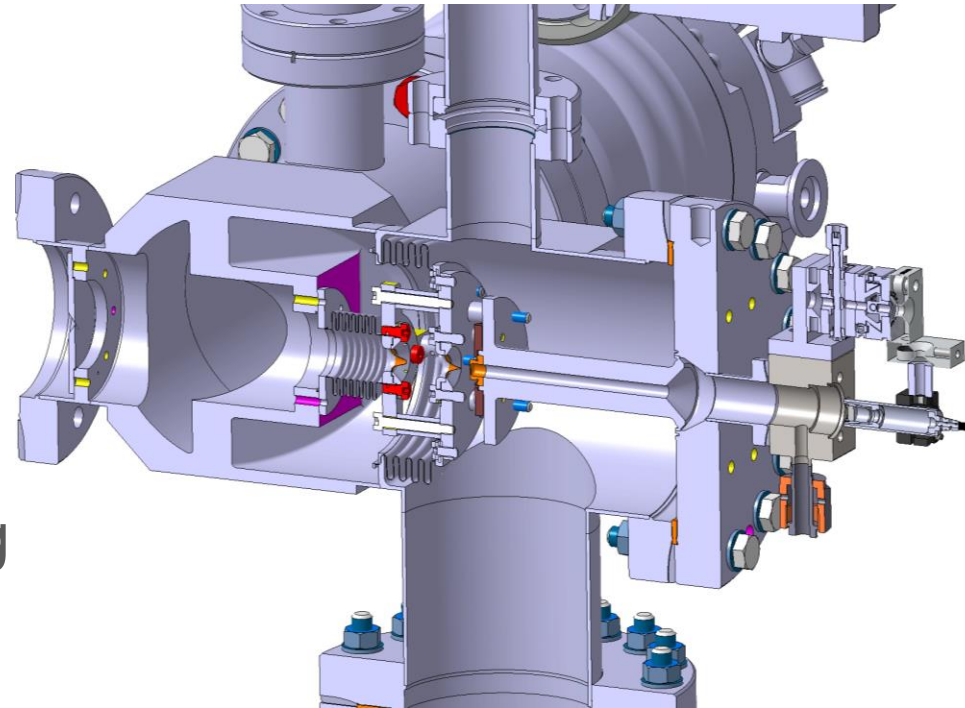


Gas injection system final design



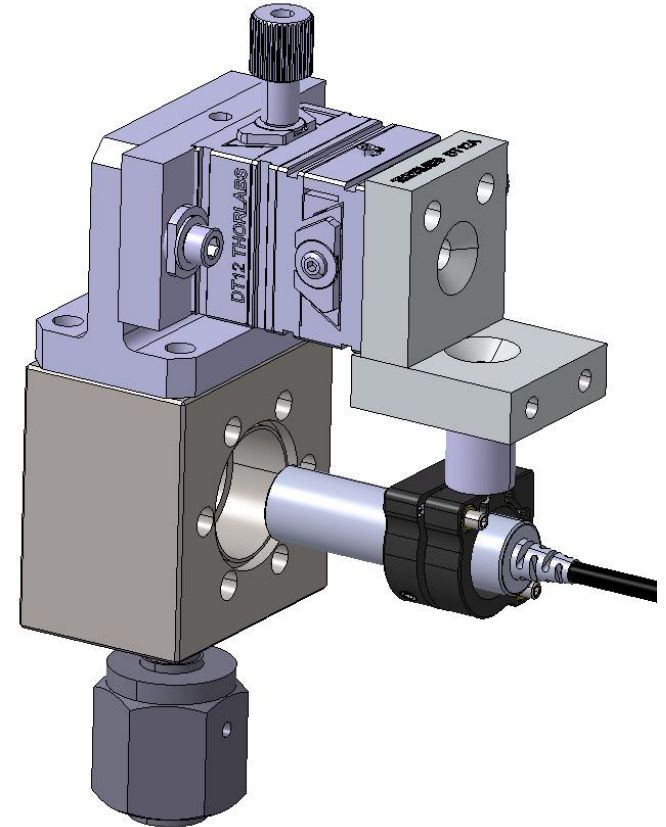
Gas injection system

- Design finalized
 - All parts manufactured or on order
- Bellows design is finalized and ordered
- Nozzle redesigned for ease of removal and ordered
- Skimmer mounts simplified
- Gas injection flange redesigned for manufacturing and function
- Custom viewport designed for gas injection and alignment

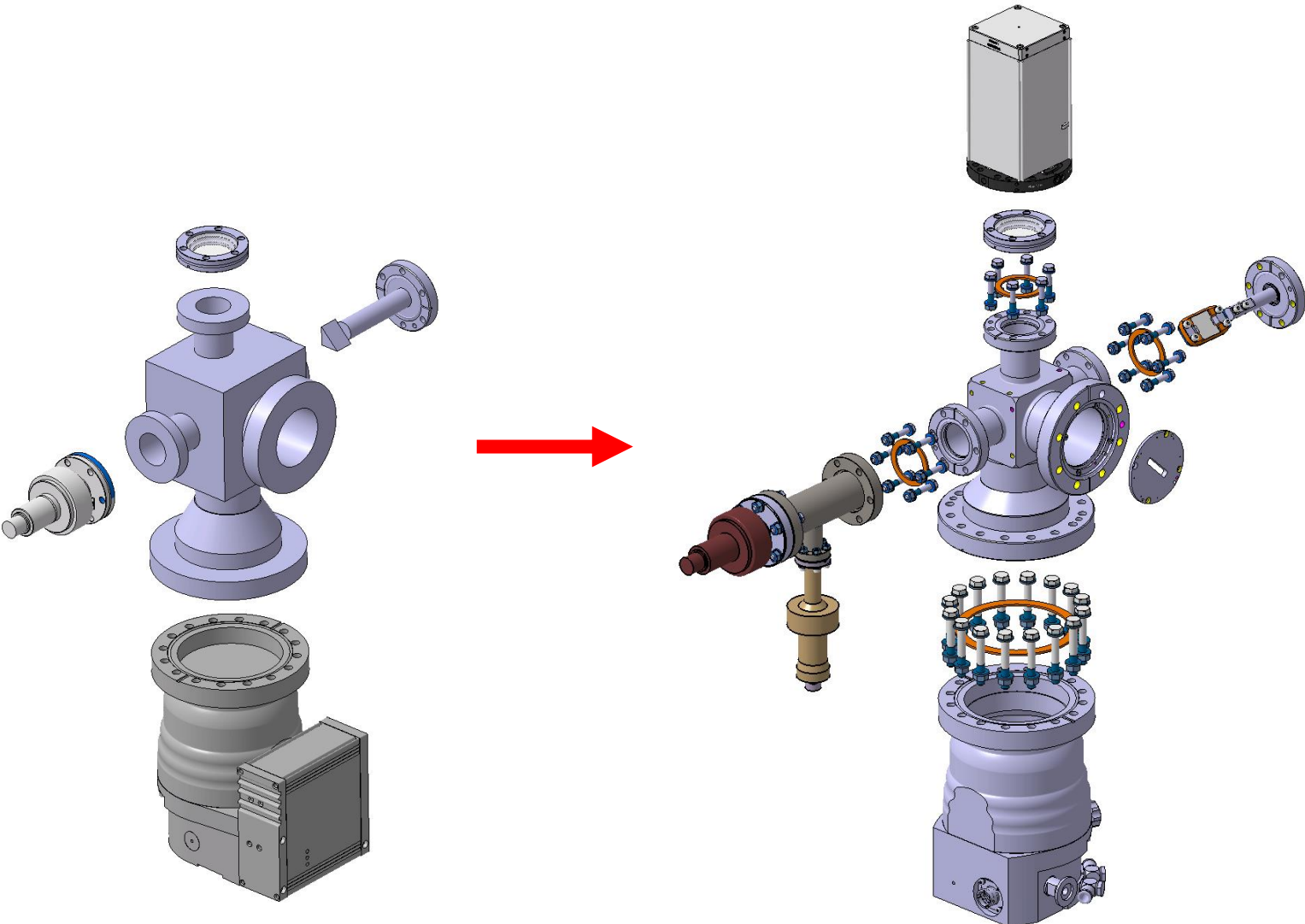


Custom Viewport

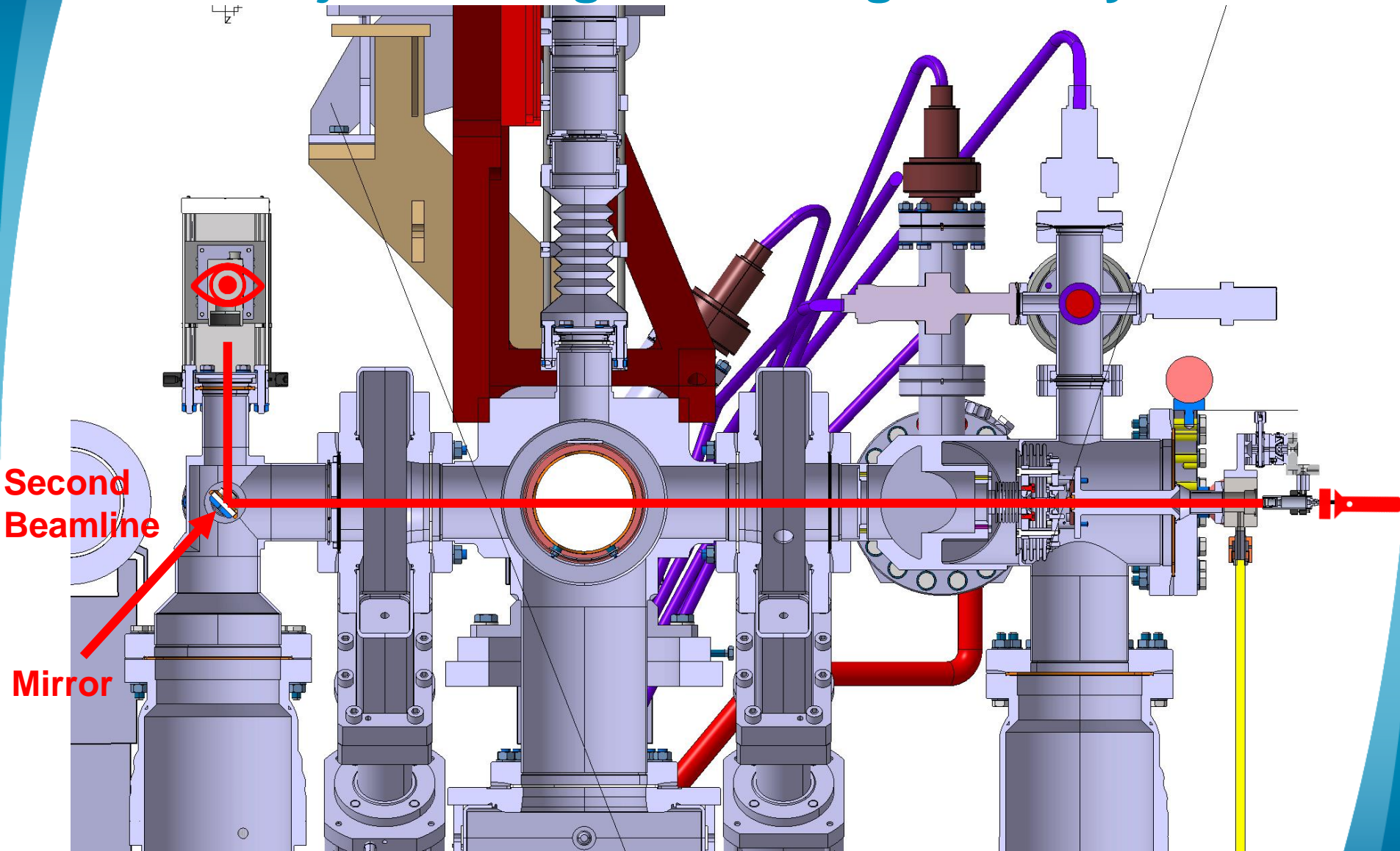
- Dual function:
 - Gas injection
 - Laser for alignment diagnostics system
- Blank designed and produced at CERN EN-MME
- Optical assembly brazed externally:
 - Pressure test
 - Leak tightness



Gas dump chamber final design

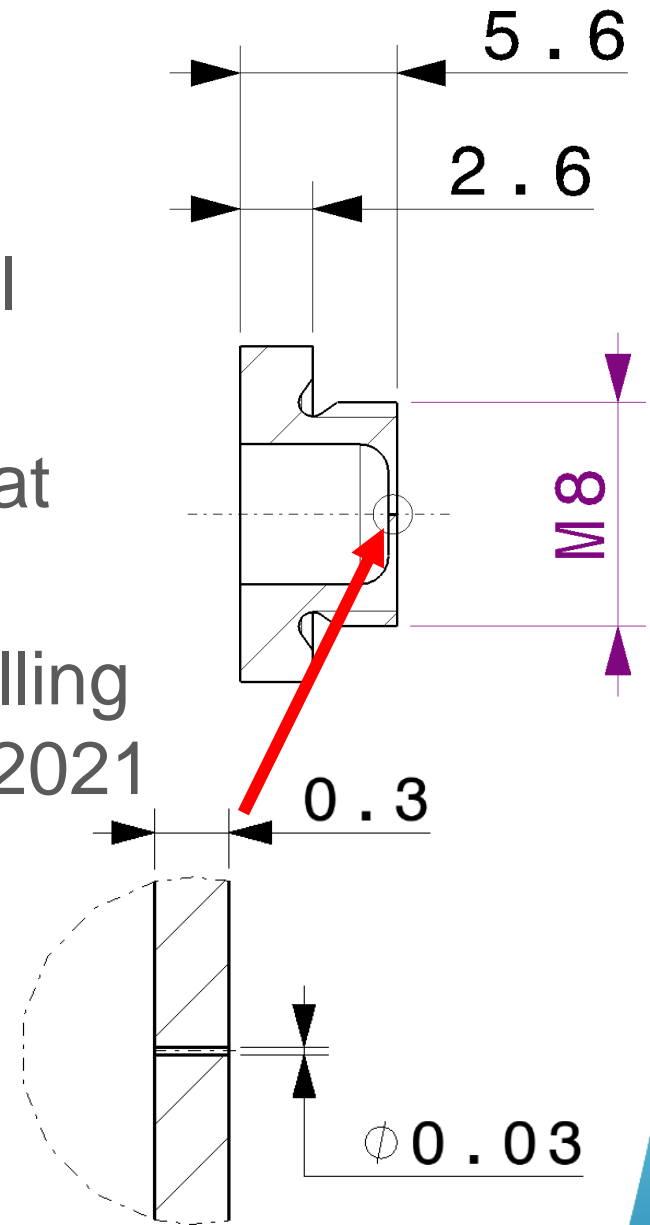


Gas injection alignment diagnostic system



Nozzles

- Redesigned for ease of removal (LHCBGCAB0066)
- Blanks manufactured in-house at **CERN – EN-MME**
- Sent to RAL for micro – hole drilling will be ready EOY – Beginning 2021



Conclusions

LHC Installation:

- BGC installed with distributed gas injection system following in 2021
- In coordination with VSC for the valves control pressure line

Phase 2 and further developments:

- Design now mostly complete
- Gas line installed and pressure tested
- Nozzles: Blanks are manufactured and drilling on the way

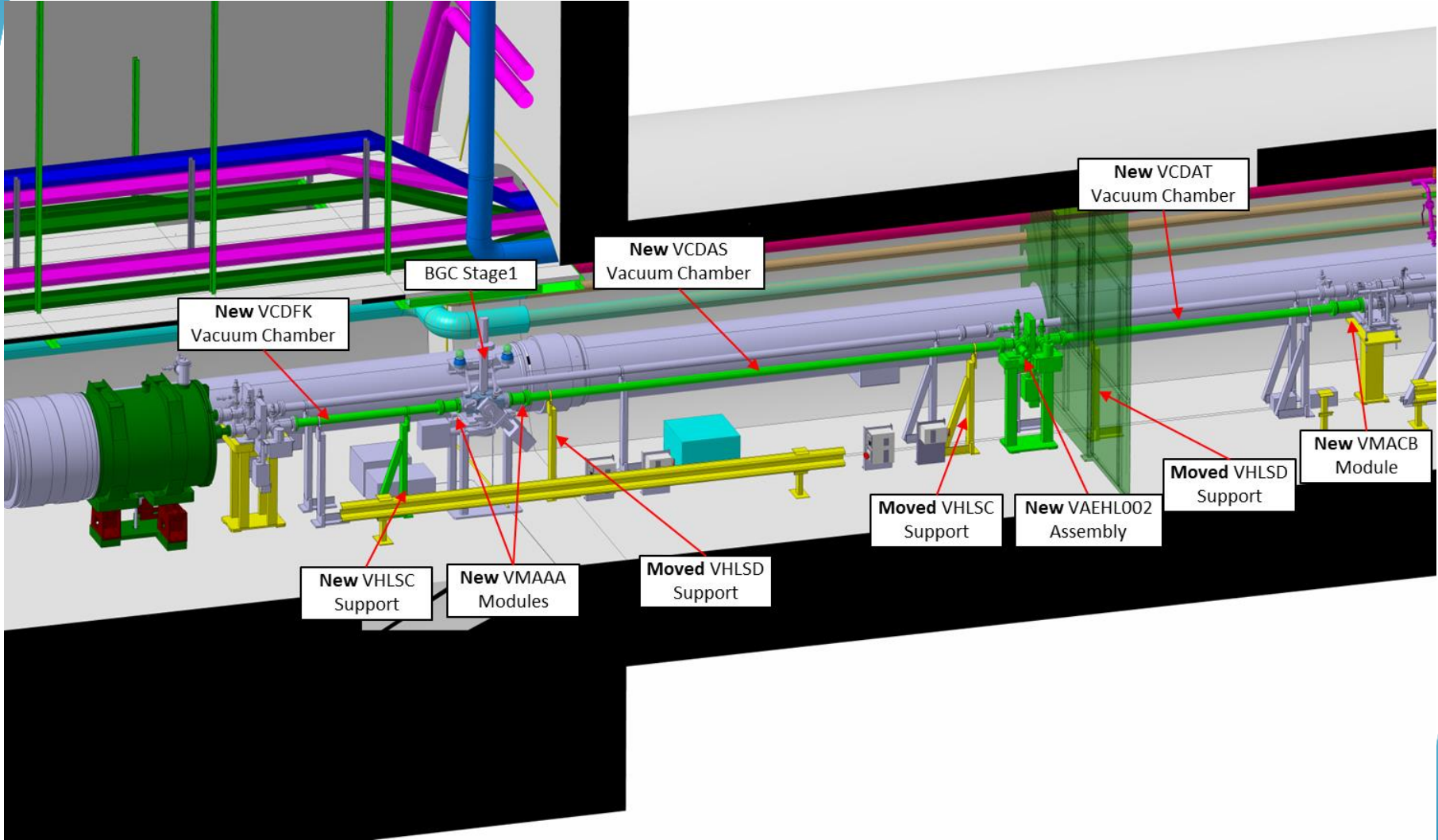


Thank you!
What questions do you have?



Backup slides

Tunnel Installation (Point 4)



Vacuum synoptics

