VAX modules

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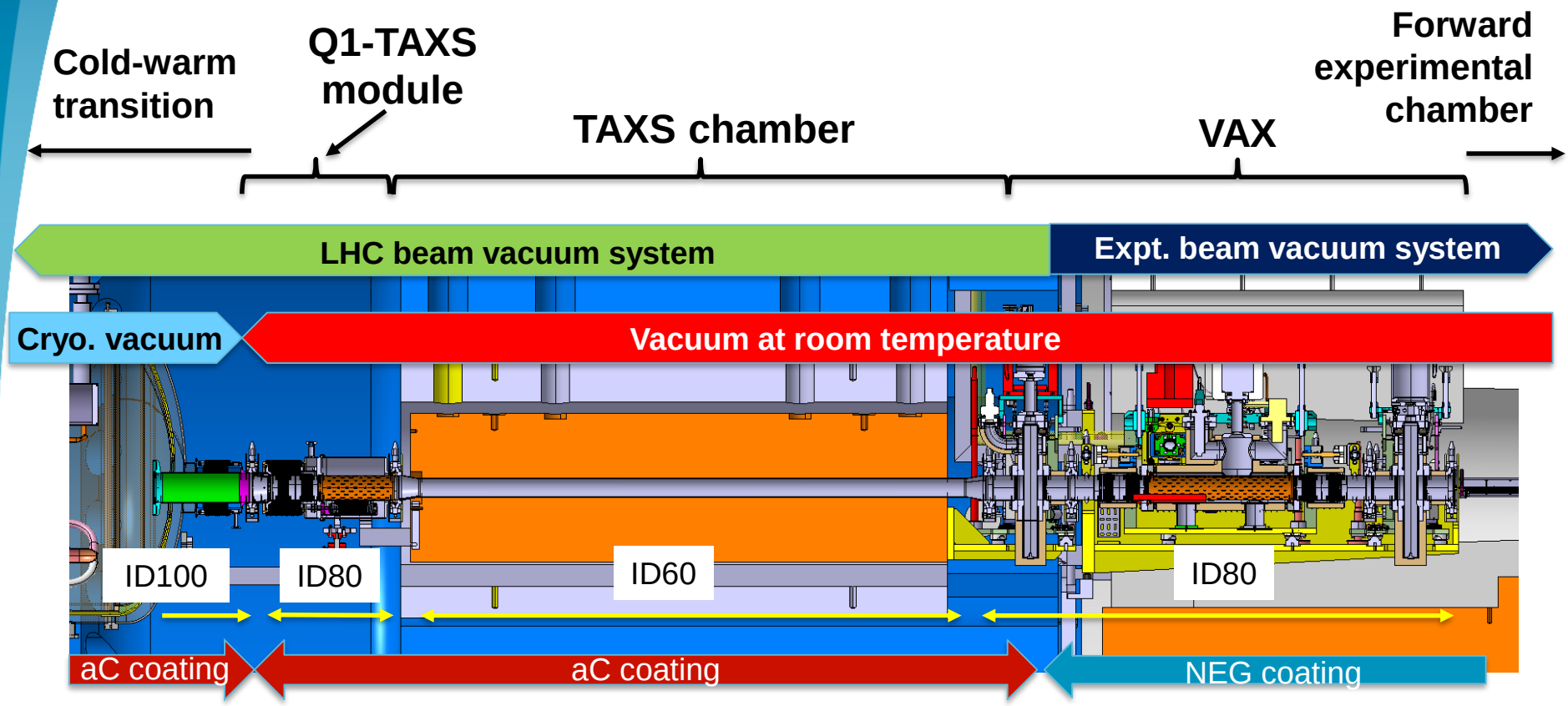
Contents

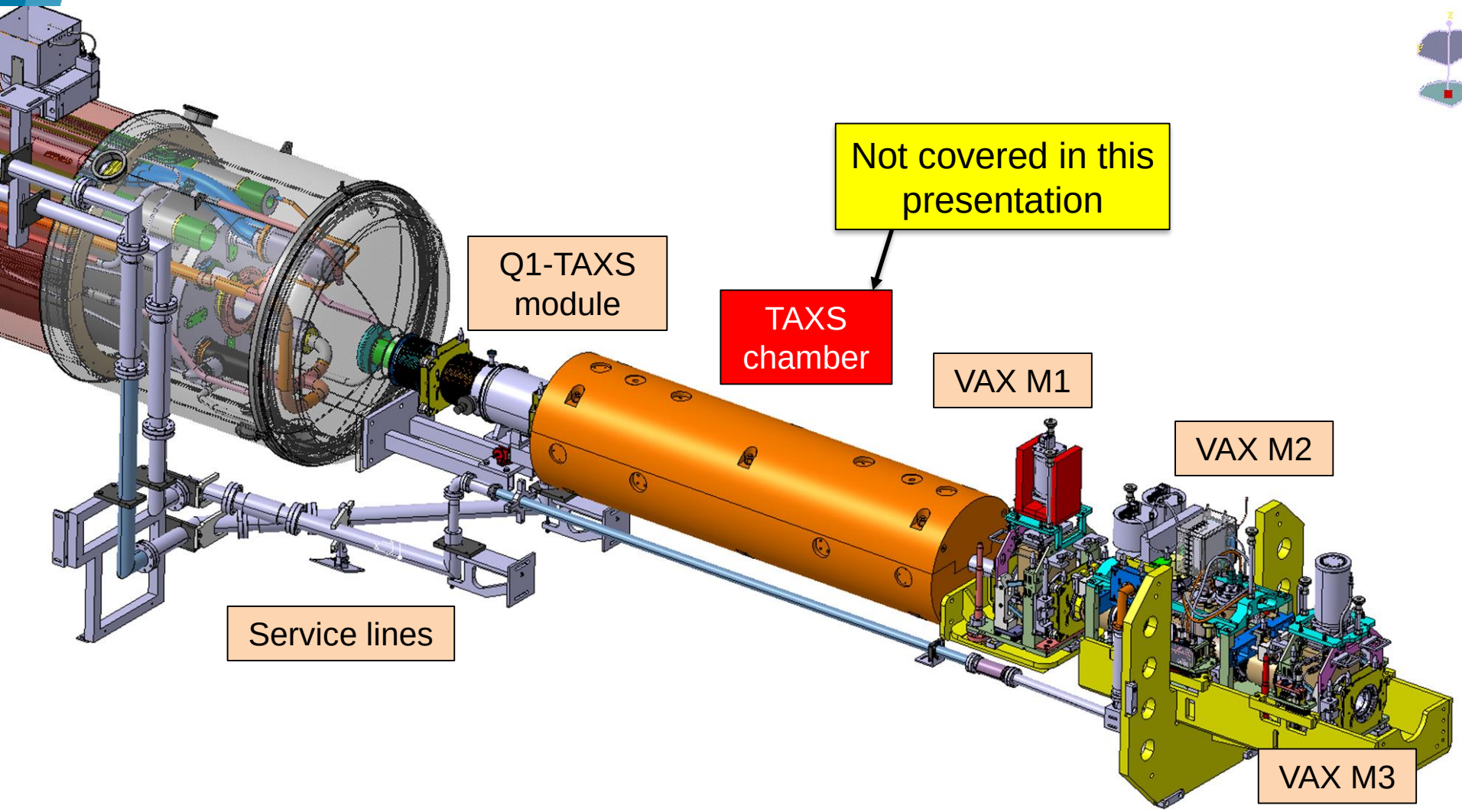
- Recall of VAX
- Planning
- Subsystem status and next steps
- Conclusions

Vacuum Assembly for eXperiments (VAX)



- For the purpose of this presentation:
  - VAX refers to **VAX area** (VAX + *TAXS chamber* + Q1-TAXS module)
  - VAX also includes service lines (pumping and/or venting lines) allowing to operate the experimental beam vacuum system

VAX area assemblies



Module configurations

SUBSYSTEM	TYPE	TOP ASSEMBLY	MAIN SUB-ASSEMBLY	VACUUM ASSEMBLY
Q1-TAXS	ATLAS-A	LHCVAP__0001		
	ATLAS-C	LHCVAP__0001		
	CMS L	LHCVAP__0001		
	CMS R	LHCVAP__0001		
	SPARE	LHCVAP__0001		
M1	ATLAS-A	LHCVAXX_0001	LHCVAXH_0001	LHCVAXH_0004
	ATLAS-C	LHCVAXX_0002	LHCVAXH_0019	LHCVAXH_0021
	CMS L	LHCVAXX_0002	LHCVAXH_0019	LHCVAXH_0021
	CMS R	LHCVAXX_0002	LHCVAXH_0019	LHCVAXH_0021
	SPARE (*)	LHCVAXX_0001 **OR** LHCVAXX_0002	LHCVAXH_0001 **OR** LHCVAXH_0019 (**)	LHCVAXH_0004 **OR** LHCVAXH_0021 (***)
M2	ATLAS-A	LHCVA1XB0001		LHCVAXH_0014
	ATLAS-C	LHCVA1XB0002		LHCVAXH_0022
	SPARE ATLAS (*)	LHCVA1XB0001 **OR** LHCVA1XB0002		LHCVAXH_0014 **OR** LHCVAXH_0022 (****)
	CMS L	LHCVA5XB0001		H_0013
	CMS R	LHCVA5XB0001		H_0013
	SPARE CMS	LHCVA5XB0001		H_0013
M3	ATLAS-A	LHCVA1XC0001		H_0006
	ATLAS-C	LHCVA1XC0002		H_0006
	CMS L	LHCVA5XC0001		H_0006
	CMS R	LHCVA5XC0001		H_0006
	SPARE (*)	LHCVA1XC0001 **OR** LHCVA1XC0002 **OR** LHCBA5XC0001	LHCVAXH_0005 (**)	LHCVAXH_0006

Potential split into right/left version

Potential merging into common version for ATLAS and CMS

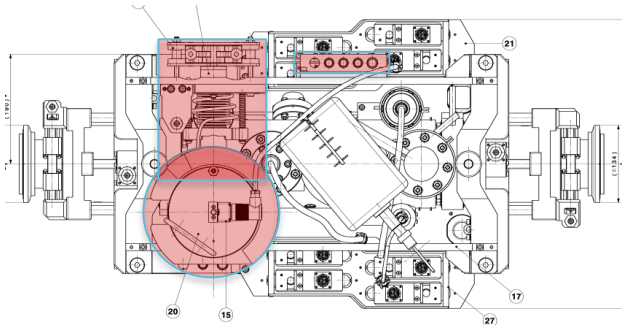
(*) SPARE is stored in a dedicated configuration (assembly code written in black); it can be optionally transformed into another configuration (assembly code/s written in red)

(**) SPARE assembly is completed with lifting points, special tooling for handling, patch panels and protection covers

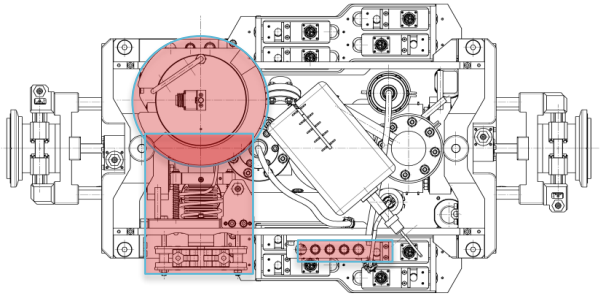
(***) SPARE requires bake-out jacket to be assembled with correct orientation

(****) SPARE requires right-angle valve to be assembled at correct configuration

M2 ATLAS-A



M2 ATLAS-C



Planning (from production to installation)

		2024				2025				2026				2027				2028				2029			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Q1-TAXS	MODULE																	P1/5							
	SUPPORT Q1 + TOOLING																	P5							
	SUPPORT TAXS + TOOLING																	P1/5							
TAXS CHAMBER											P1								P5						
VAX M1	VACUUM COMPONENTS																								
	VACUUM ASSEMBLY																		P1/5			P1			
	MECHANICS (SUPPORT)																								
	MECHANICS (MECHANISM)																								
VAX M2	VACUUM COMPONENTS																								
	VACUUM ASSEMBLY																								
	FULL VACUUM ASSEMBLY																		P5		P1	P1			
	MECHANICS (SUPPORT)																								
	MECHANICS (MECHANISM)																								
VAX M3	VACUUM COMPONENTS																								
	VACUUM ASSEMBLY																		P5		P1	P1			
	MECHANICS (SUPPORT)																								
	MECHANICS (MECHANISM)																								
PUMPING LINES	ATLAS																					P1			
	CMS																		P5						

	Conceptual design
	Final design
	Series supply and partial assembly
	Assembly, test and qualification
	Installation
	Deadline for installation

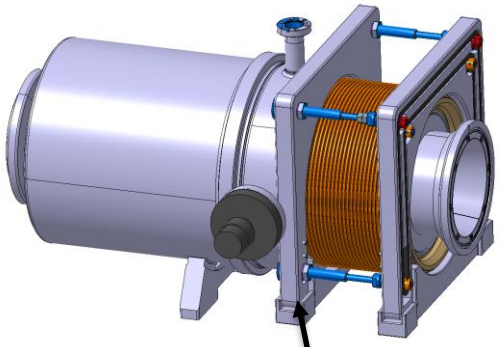
Installation dates extracted from WP8 In-work planning CSR24

Q1-TAXS module

		2024				2025				2026				2027				2028				2029			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Q1-TAXS	MODULE																	P1/5							
	SUPPORT Q1 + TOOLING																	P5							
	SUPPORT TAXS + TOOLING																	P1/5							

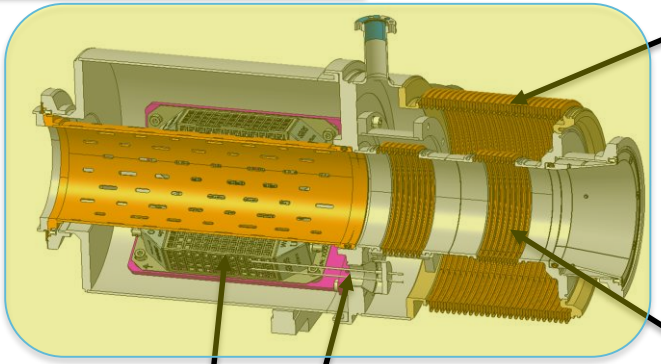
Installation

Commissioning



Drawings of compression tool, generated

JOB for manufacturing of vacuum assembly, released



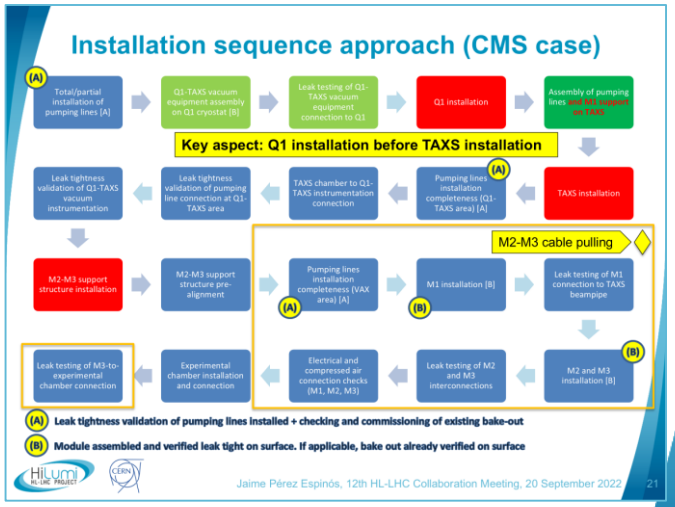
NEG wafers, internal cabling and connectors, ordered

Q1-TAXS module - next steps

- Main components:
  - Tune-up manufacturing and qualification process of Q1-TAXS module with all stakeholders involved
  - Manufacturing drawings of supports
- Tooling
  - Compression tool → launch production
  - Extension tubes for coating → launch design and production
- Open points with potential impact on design
  - Supports → installation process (MINOR)

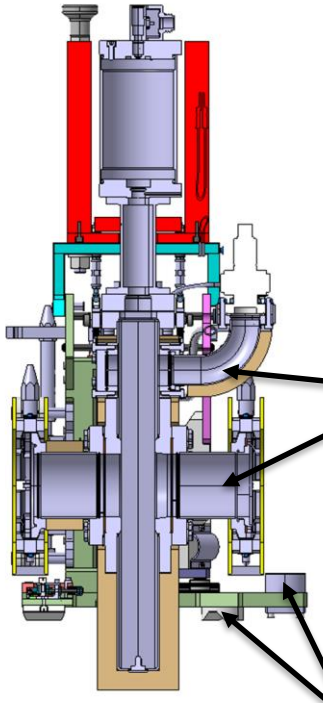
HCVAP__001		
STEP	TASK	ENTITY
10	Traceability of material	TE-VSC-DLM
20	Visual inspection	TE-VSC-DLM
30	Installation of NEG wafers and cabling	TE-VSC-BVO / ICM
40	Electrical continuity test	TE-VSC-BVO / ICM
50		
60		
70		
80		
90		

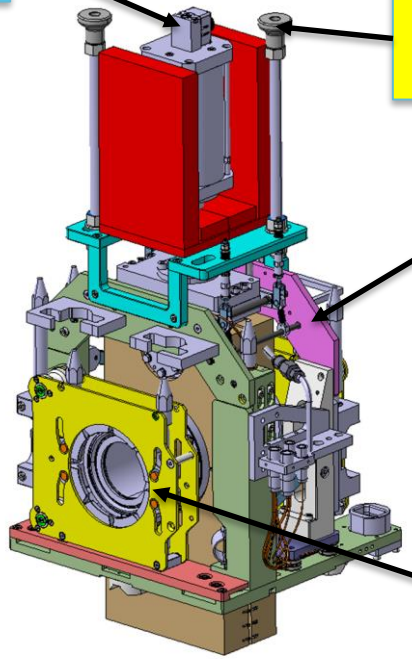
HCVAP__002		
STEP	TASK	ENTITY
10	Traceability of material	TE-VSC-DLM
20	Visual inspection	TE-VSC-DLM
30	Vacuum leak test (include tooling to block bellows)	TE-VSC-DLM
40	RGA (first 2x parts, TBC)	TE-VSC-BVO
50	Assembly to LHCVAP__0009 configuration	TE-VSC-DLM / SCC
60	aC coating	TE-VSC-SCC
70	Removal of Cu-OFE parts	TE-VSC-SCC
80	Visual inspection and adherence test on sample/s	TE-VSC-SCC
90	Installation of covers to protect beam vacuum volume	TE-VSC-SCC



VAX M1 and VAX M3

		2024				2025				2026				2027				2028				2029			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
VAX M1	VACUUM COMPONENTS																								
	VACUUM ASSEMBLY																		P1/5			P1			
	MECHANICS (SUPPORT)																								
	MECHANICS (MECHANISM)																								
VAX M3	VACUUM COMPONENTS																								
	VACUUM ASSEMBLY																		P5		P1	P1			
	MECHANICS (SUPPORT)																								
	MECHANICS (MECHANISM)																								





Installation and commissioning of M1 and M3 are decoupled

ECR for new gate valve configuration, drafted

Mushrooms for handling, delivered by EN-HE

JOB for manufacturing of vacuum components, released

Manufacturing drawings of support and mechanism, produced

Bushings of guiding system and V-seats of positioning system delivered by WP8

Manufacturing drawings for DN100 collar chains, produced

VAX M1 and M3 - next steps

- Main components:
  - Submit ECR for new gate valve configuration for approval and launch order
  - Launch order for chain collars DN100 (qualification tests almost finished)
  - Design of flange M1-to-M2 (mechanism optimization is ongoing) → JOB separated from rest of chambers
- Tooling:
  - Dedicated parts for Cu coating → launch production
  - Dedicated chambers for aC coating/NEG coating → launch design and production
- Open points with potential impact on design
  - Nominal gap M1-to-TAXS → could affect stroke of mechanism (MINOR)
  - Lifting points position (MINOR)
  - ATLAS M1 cabling integration/approach (MINOR)
  - Bake-out simplification under study → no bake-out jacket at valve body and Penning gauge; jacket retained at connection chamber (MINOR)
  - STAUBLI connectors
    - Bake-out simplification under study to minimize number of channels and cables (MINOR)
    - Design of compressed air connection to make it hard-rad compatible (TBC)
  - Impact of ATLAS integration study (TBC)
  - Outcome of ECR for gate valves (TBC)

Handling test campaign outcome

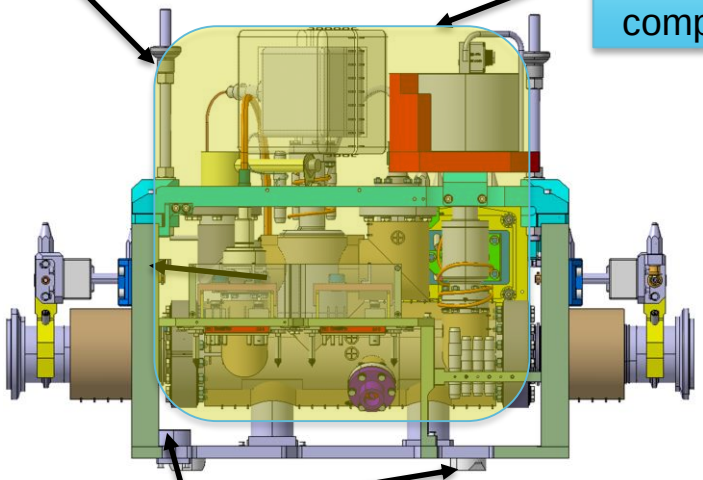
VAX M2

		2024				2025				2026				2027				2028				2029			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
VAX M2	VACUUM COMPONENTS																								
	VACUUM ASSEMBLY																								
	FULL VACUUM ASSEMBLY																		P5		P1	P1			
	MECHANICS (SUPPORT)																								
	MECHANICS (MECHANISM)																								

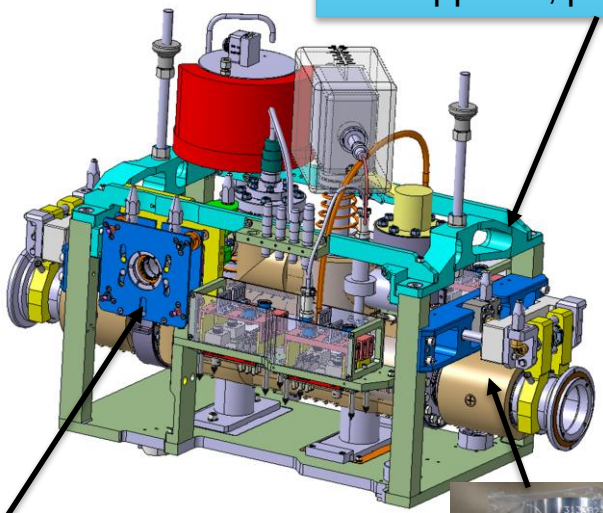
Installation and commissioning of M2 to be aligned with M3

Mushrooms for handling, delivered by EN-HE

JOB for manufacturing of vacuum components, released



Manufacturing drawings of support/s, produced



Bushings of guiding system and V-seats of positioning system delivered by WP8

Manufacturing drawings of DN40 collar chain, produced

VAX M2 - next steps

- Main components:
  - Re-design of bake-out jackets
  - Launch order for right-angle valves
  - Finalize design optimization of mechanisms (DN40 connection + DN100 connection)
  - Finalize expansion joint design (interface to mechanism) → JOB separated from rest of chambers
- Tooling:
  - Dedicated chambers for aC coating/NEG coating → launch design and production
- Open points with potential impact on design
  - Nominal gap M1-to-M2 and M2-to-M3 → could affect stroke of mechanism (MINOR)
  - Lifting points position (MINOR)
  - Re-orientation of rupture disk (TBC)
  - STAUBLI connectors
    - Bake-out simplification under study to minimize number of channels and cables (MINOR)
    - Design of compressed air connection to make it hard-rad compatible (TBC)
  - Impact of ATLAS integration study (TBC)
  - Study of reduction of number of pumping lines in CMS (MINOR)

Handling test campaign outcome

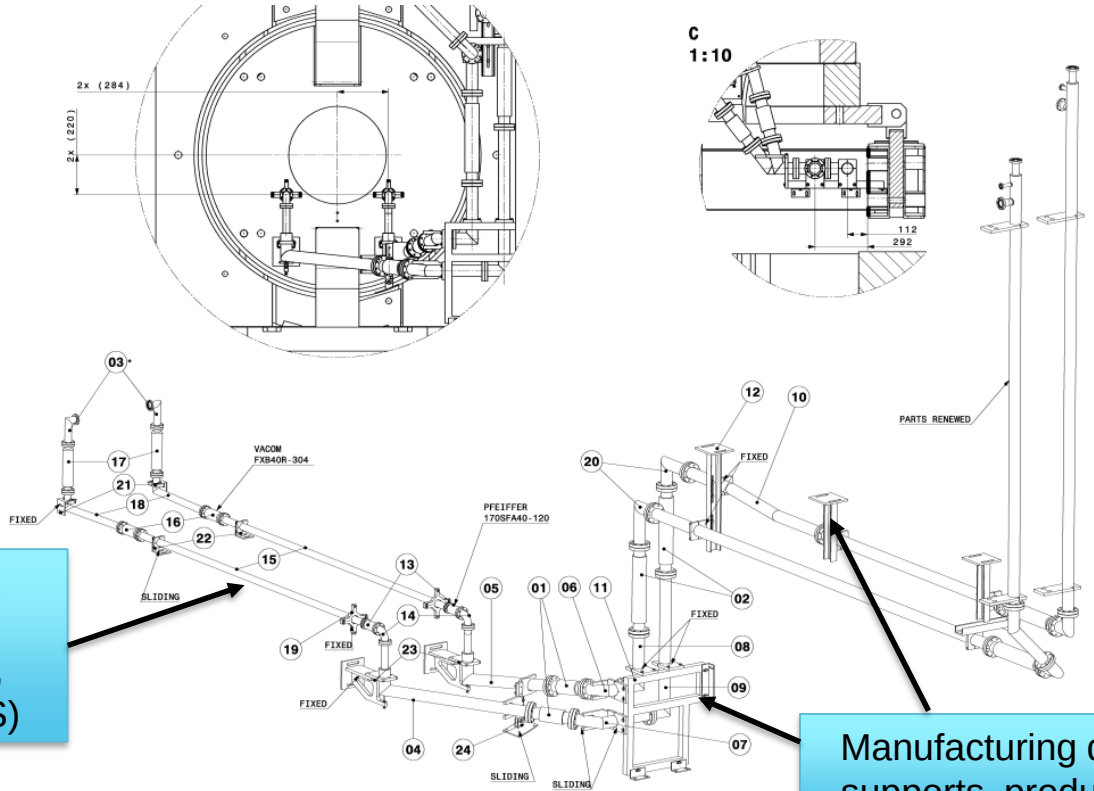
Pumping lines

		2024				2025				2026				2027				2028				2029			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
PUMPING LINES	ATLAS																					P1			
	CMS																		P5						

Integration of pumping lines up to GIS is required by end 2024

Bake-out wrapping

No time allocation for installation and commissioning



Manufacturing drawings of pumping lines, produced (CMS)

Manufacturing drawings of supports, produced (CMS)

Pumping lines - next steps

- Main components:
  - Design pumping lines of ATLAS
  - Optimize design of pumping lines of CMS in case of reduction of number of lines (study ongoing)
- Open points with potential impact on design
  - Study of reduction of number of pumping lines in CMS (MINOR)
  - Impact of ATLAS integration study
    - Vacuum line connection at top of ATLAS chimney (TBC)
    - Overall routing (MINOR)
    - Vacuum line connection to M2 (TBC)

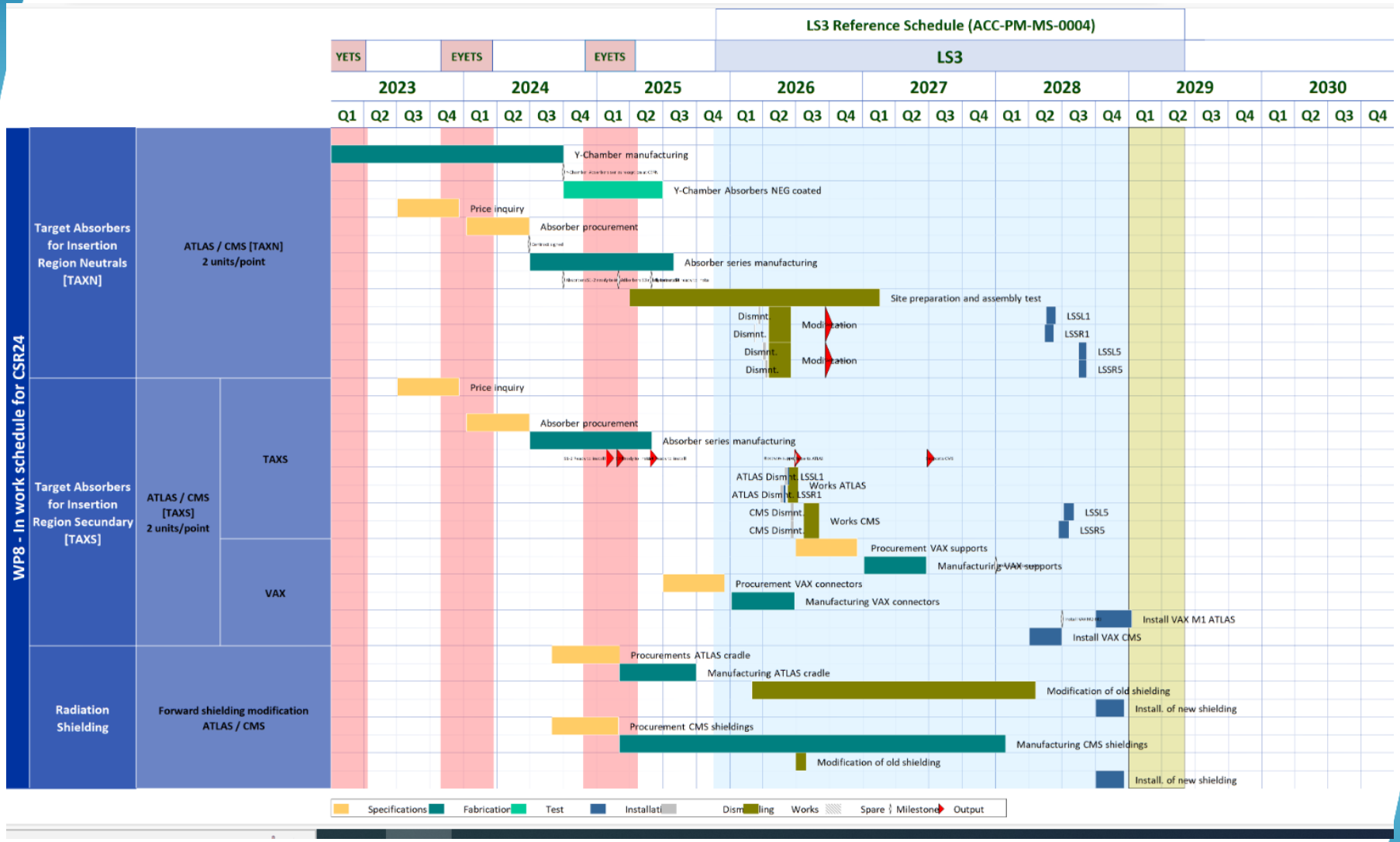
Full understanding of access condition is required ⇒ BIG WHEEL TO BE ADDED AT OPEN CONFIGURATION (TBC)

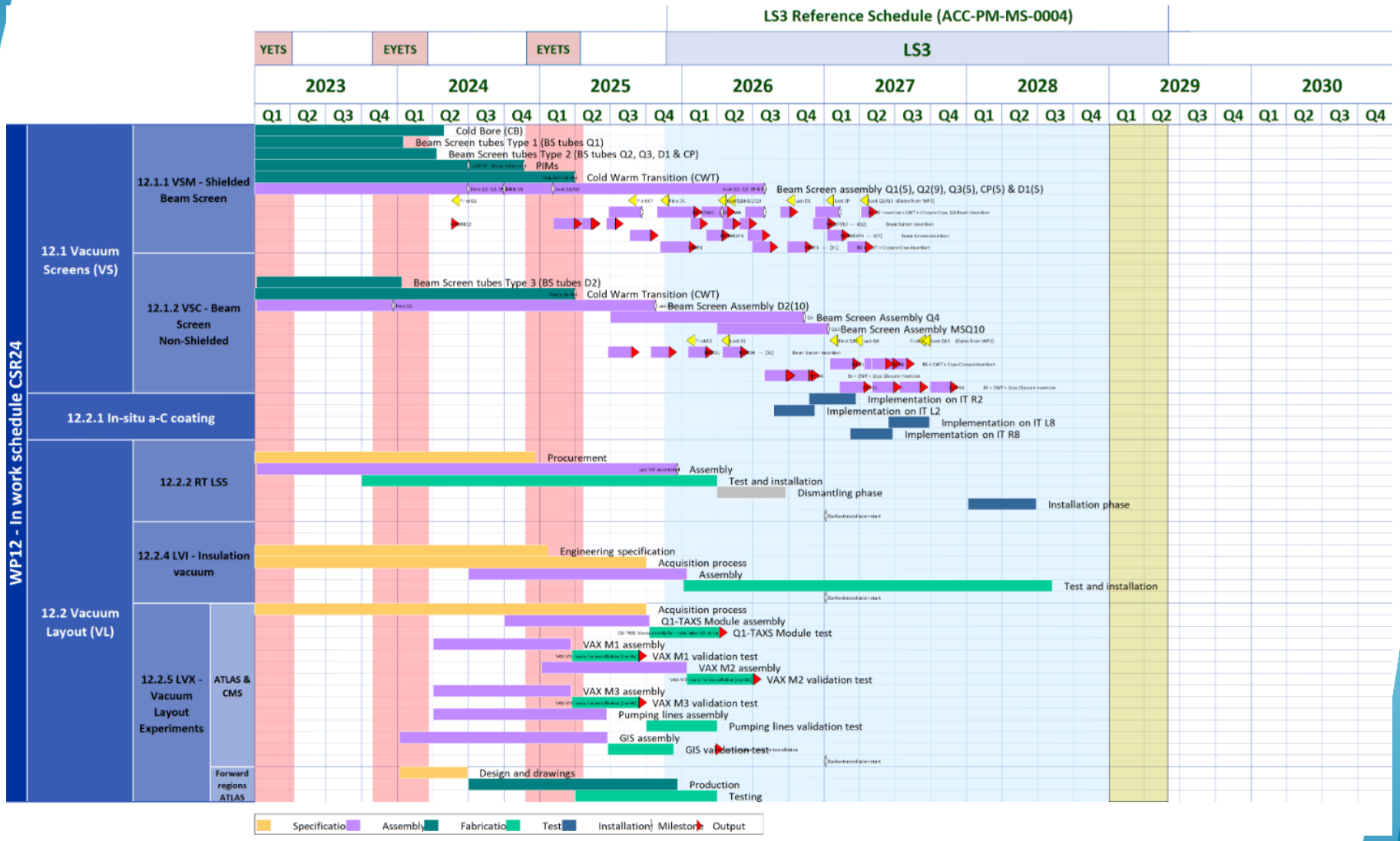
Conclusions

- Production is foreseen to be finished by Q4 2025 for Q1-TAXS and VAX modules
- Vacuum tests and qualification are foreseen to be finished by Q2 2026 for Q1-TAXS and VAX modules
- Other qualification tests linked to remote handling connection are foreseen to be finished by Q4 2026
- Production of pumping lines is foreseen by Q1 2026 (lines) by Q1 2027 (lines + heating system) $\rightarrow$ finalization of integration (ATLAS) is required by end 2024
- Following delay on start of LS3, new dates for installation are foreseen
- Installation activities require more granularity in the planning
  - Separate lines for at least, Q1-TAXS module, VAX M1, VAX M2/M3, pumping lines and services (cabling and compressed air) should be considered
- Tests and commissioning should be integrated in the planning
  - Vacuum commissioning is usually decoupled from mechanical activity and is fully dependent on vacuum sectorization $\Rightarrow$ plannings at LHC and experiment sides must be correctly synchronized
  - Tests and commissioning can be vacuum related (leak tests, B/O tests, cabling acceptance, vacuum commissioning, etc.) and non-vacuum related (handling and robotic operation tests, survey measurements, etc.)

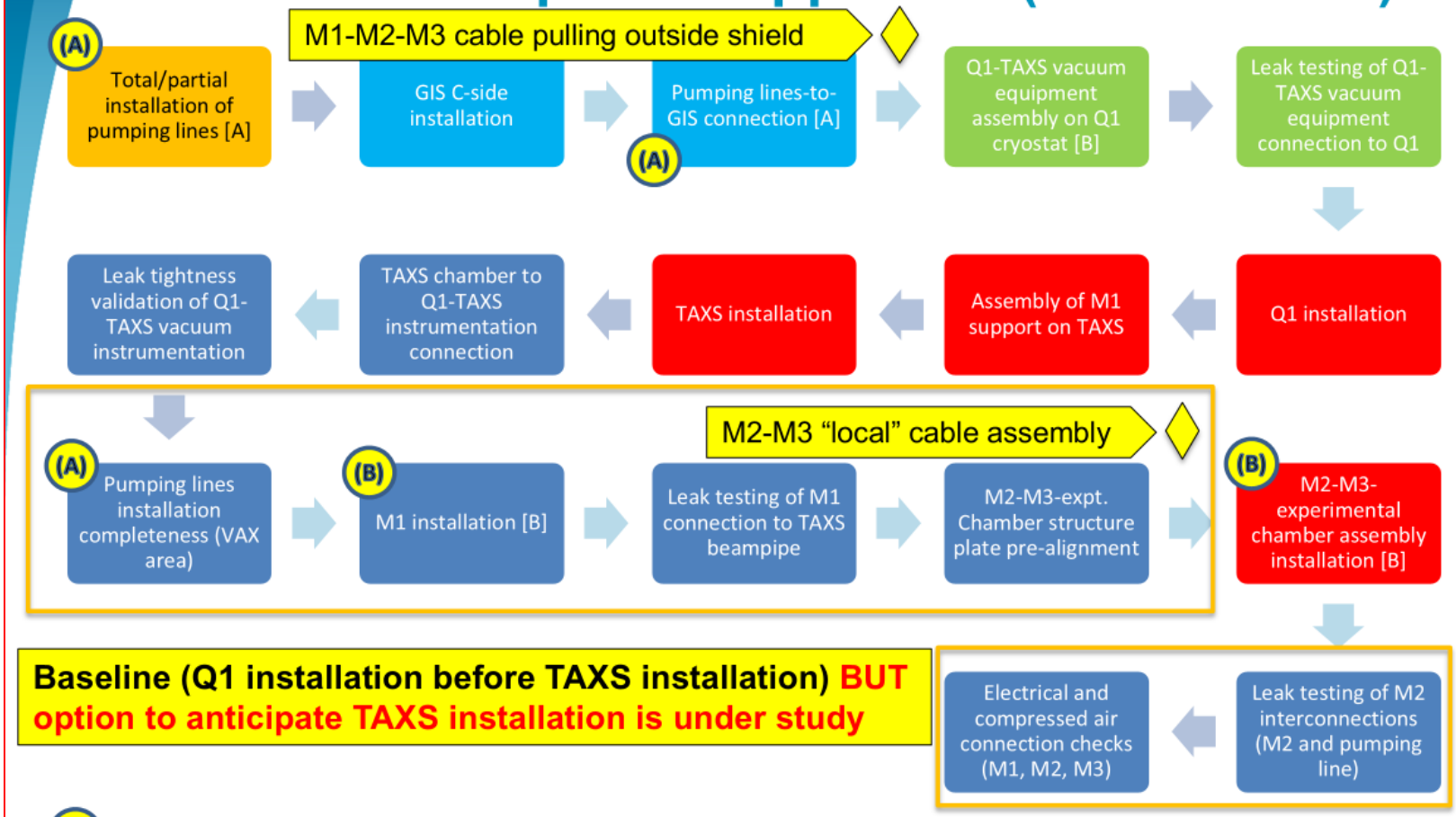
Thanks for your attention

Special thanks to WP12 members, and rest of WPs and teams involved


LS3 Reference Schedule (ACC-PM-MS-0004)
YETS
EYETS
EYETS
LS3
2023
2024
2025
2026
2027
2028
2029
2030
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
WP8 - In work schedule for CSR24
Target Absorbers for Insertion Region Neutrals [TAXN]
ATLAS / CMS [TAXN] 2 units/point
Target Absorbers for Insertion Region Secundary [TAXS]
ATLAS / CMS [TAXS] 2 units/point
TAXS
VAX
Radiation Shielding
Forward shielding modification ATLAS / CMS
Y-Chamber manufacturing
Y-Chamber Absorbers NEG coated
Price inquiry
Absorber procurement
Absorber series manufacturing
Site preparation and assembly test
Dismnt.
Dismnt.
Modification
Dismnt.
Dismnt.
Modification
LSSL1
LSSR1
LSSL5
LSSR5
Price inquiry
Absorber procurement
Absorber series manufacturing
ATLAS Dismnt. LSSL1
Works ATLAS
ATLAS Dismnt. LSSR1
CMS Dismnt.
Works CMS
CMS Dismnt.
LSSL5
LSSR5
Procurement VAX supports
Manufacturing VAX supports
Procurement VAX connectors
Manufacturing VAX connectors
Install VAX M1 ATLAS
Install VAX CMS
Procurements ATLAS cradle
Manufacturing ATLAS cradle
Modification of old shielding
Install. of new shielding
Procurement CMS shieldings
Manufacturing CMS shieldings
Modification of old shielding
Install. of new shielding
Specifications
Fabrication
Test
Installati
Dismantling
Works
Spare
Milestone
Output


LS3 Reference Schedule (ACC-PM-MS-0004)
YETS
EYETS
EYETS
LS3
2023
2024
2025
2026
2027
2028
2029
2030
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
WP12 - In work schedule CSR24
12.1 Vacuum Screens (VS)
12.1.1 VSM - Shielded Beam Screen
Cold Bore (CB)
Beam Screen tubes Type 1 (BS tubes Q1)
Beam Screen tubes Type 2 (BS tubes Q2, Q3, D1 & CP)
PIMs
Cold Warm Transition (CWT)
Beam Screen assembly Q1(5), Q2(9), Q3(5), CP(5) & D1(5)
12.1.2 VSC - Beam Screen Non-Shielded
Beam Screen tubes Type 3 (BS tubes D2)
Cold Warm Transition (CWT)
Beam Screen Assembly D2(10)
Beam Screen Assembly Q4
Beam Screen Assembly MSQ10
12.2.1 In-situ a-C coating
Implementation on IT R2
Implementation on IT L2
Implementation on IT L8
Implementation on IT R8
12.2 Vacuum Layout (VL)
12.2.2 RT LSS
Procurement
Assembly
Test and installation
Dismantling phase
Installation phase
12.2.4 LVI - Insulation vacuum
Engineering specification
Acquisition process
Assembly
Test and installation
12.2.5 LVX - Vacuum Layout Experiments
ATLAS & CMS
Acquisition process
Q1-TAXS Module assembly
Q1-TAXS Module test
VAX M1 assembly
VAX M1 validation test
VAX M2 assembly
VAX M2 validation test
VAX M3 assembly
VAX M3 validation test
Pumping lines assembly
Pumping lines validation test
GIS assembly
GIS validation test
Forward regions ATLAS
Design and drawings
Production
Testing
Specificatio
Assembly
Fabricatio
Test
Installation
Milestone
Output

Installation sequence approach (ATLAS case)

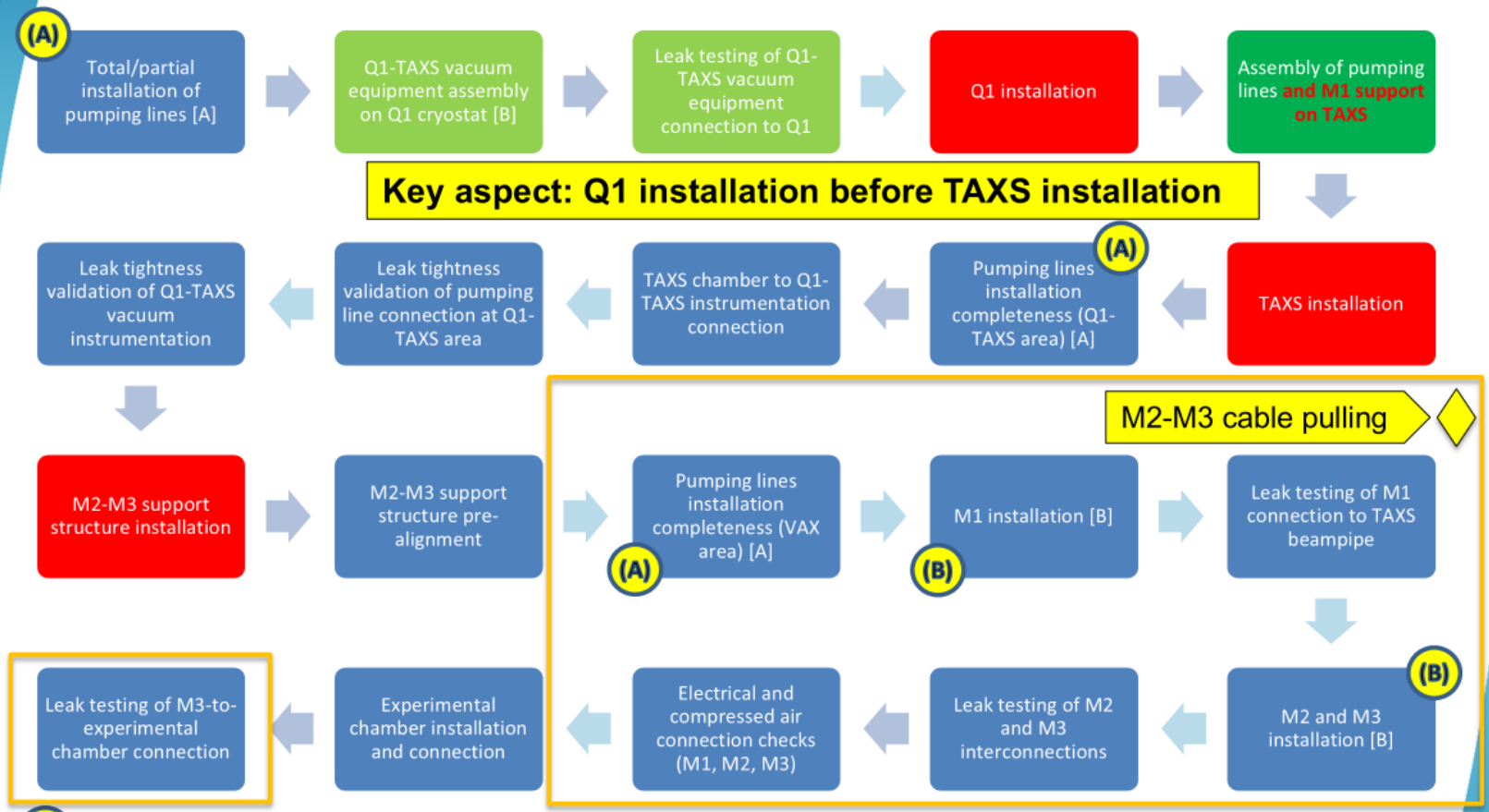


Baseline (Q1 installation before TAXS installation) BUT option to anticipate TAXS installation is under study

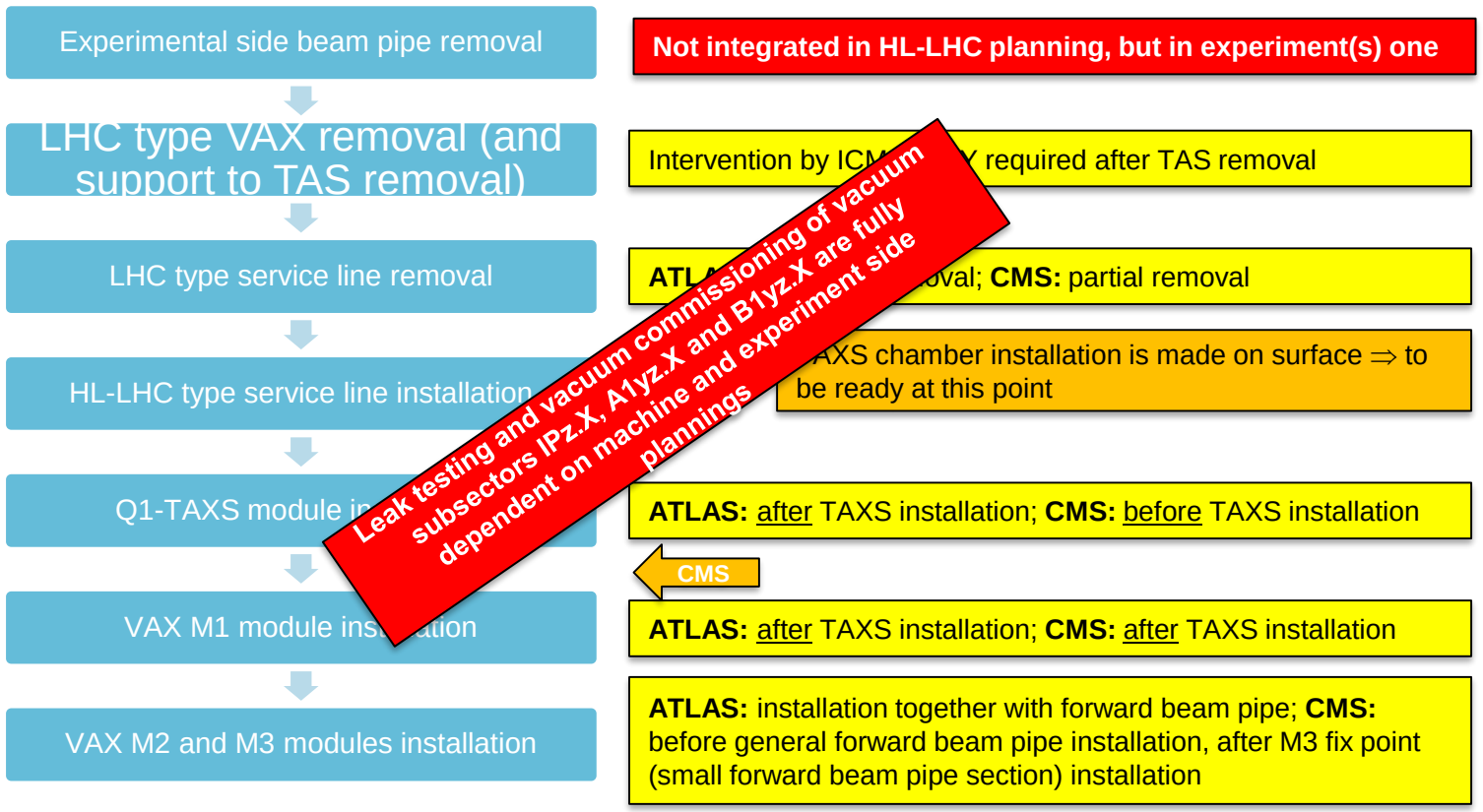
(A) Leak tightness validation of pumping lines installed + checking and commissioning of existing bake-out

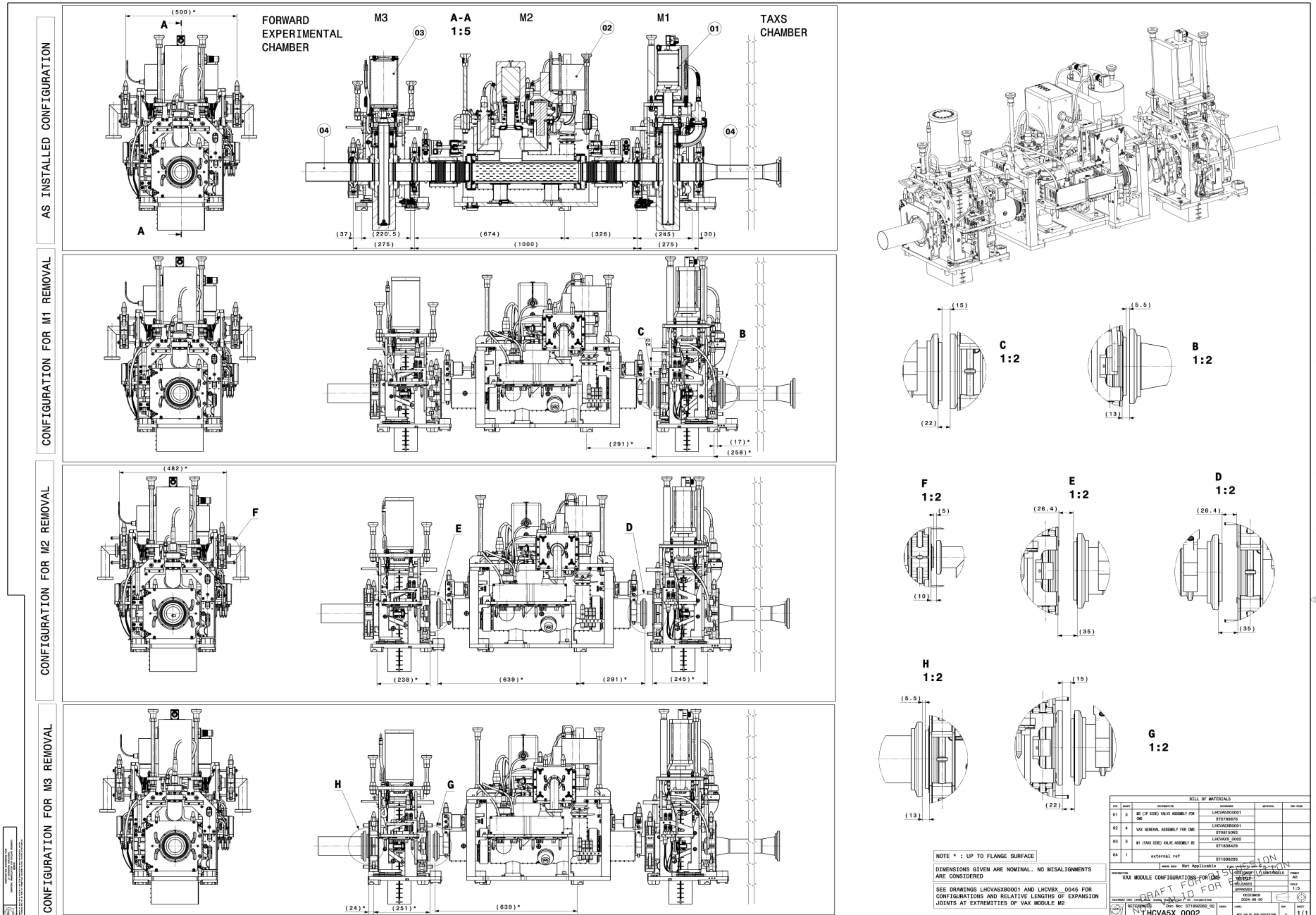
(B) Module assembled and verified leak tight on surface. If applicable, bake out already verified on surface

Installation sequence approach (CMS case)

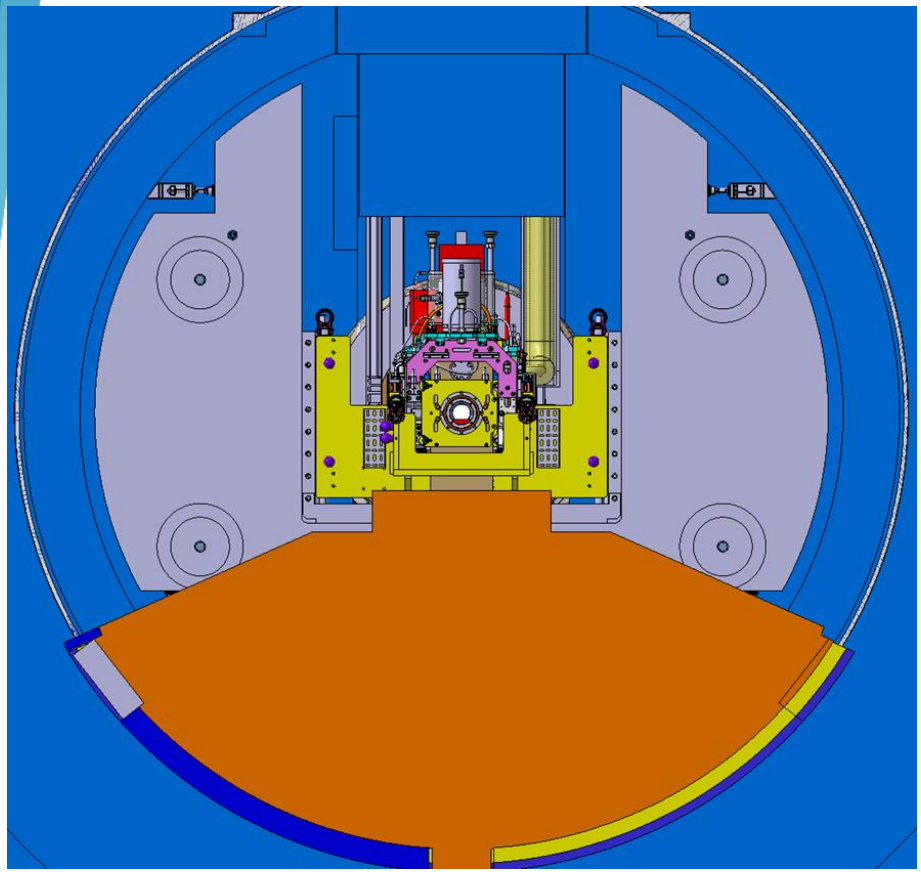


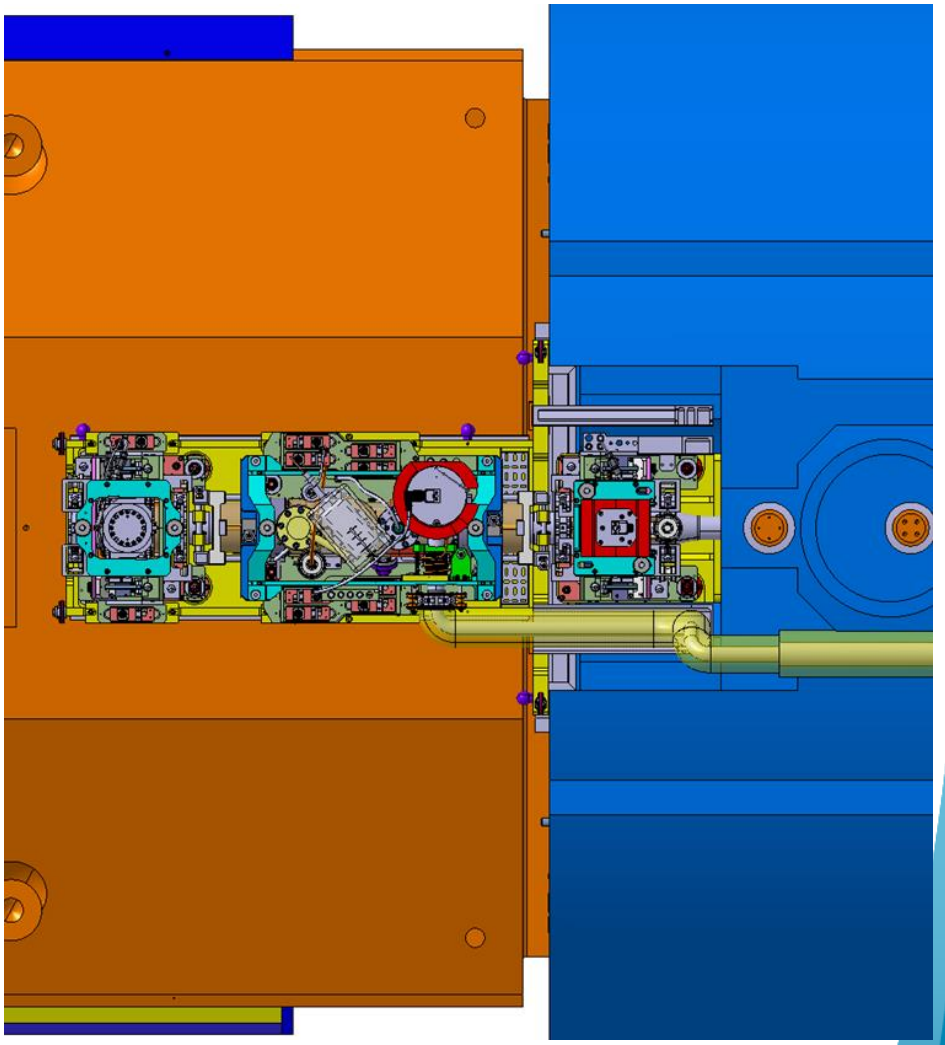
In-tunnel works sequence

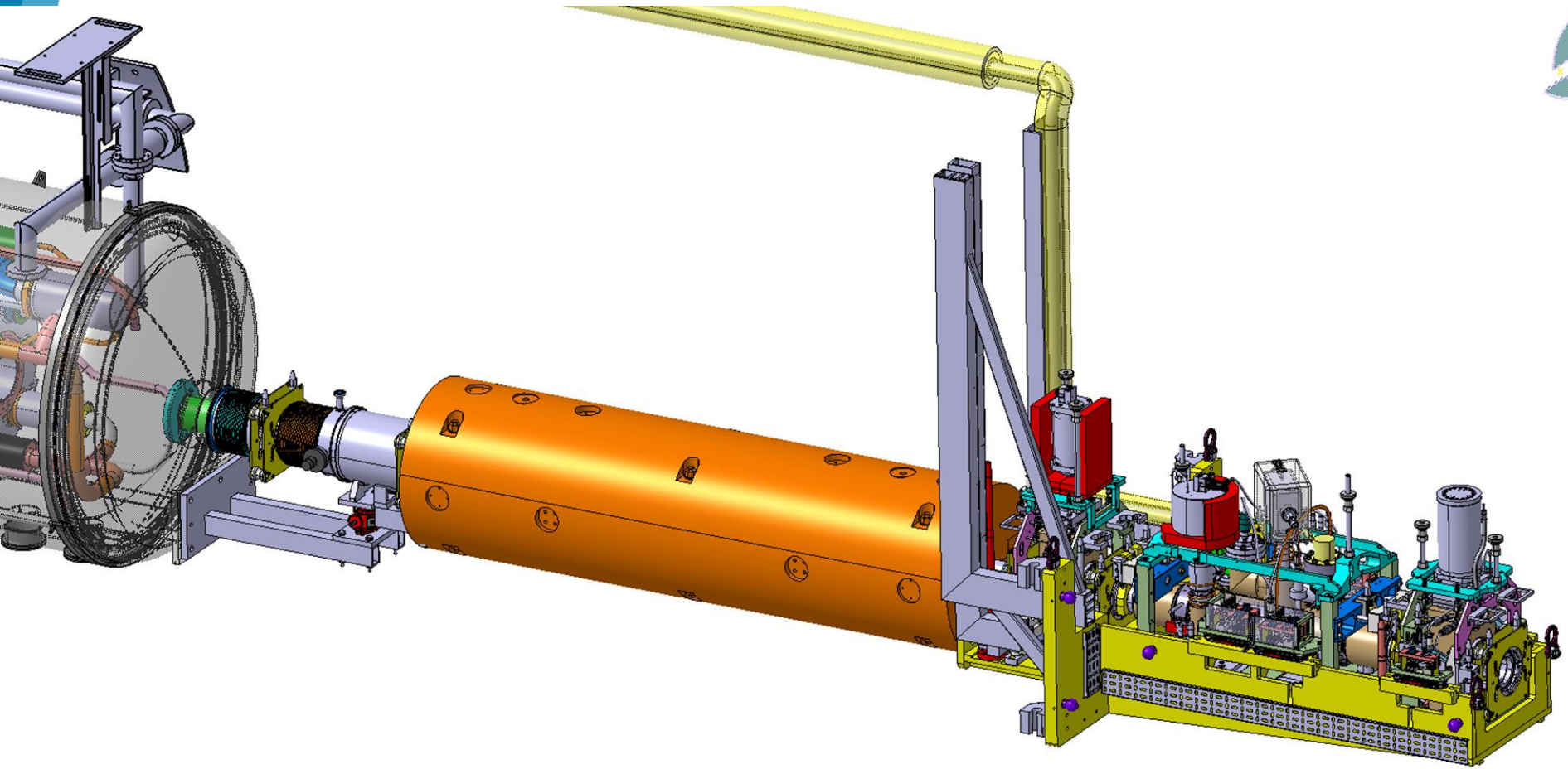



AS INSTALLED CONFIGURATION
FORWARD EXPERIMENTAL CHAMBER
M3
A-A 1:5
M2
M1
TAXS CHAMBER
01
02
03
04
CONFIGURATION FOR M1 REMOVAL
CONFIGURATION FOR M2 REMOVAL
CONFIGURATION FOR M3 REMOVAL
C 1:2
B 1:2
F 1:2
E 1:2
D 1:2
H 1:2
G 1:2
NOTE * : UP TO FLANGE SURFACE
DIMENSIONS GIVEN ARE NOMINAL. NO MISALIGNMENTS ARE CONSIDERED
SEE DRAWINGS LHCVA5XB0001 AND LHCVBX__0045 FOR CONFIGURATIONS AND RELATIVE LENGTHS OF EXPANSION JOINTS AT EXTREMITIES OF VAX MODULE M2
BILL OF MATERIALS
01 3 M3 (IP SIDE) VALVE ASSEMBLY FOR CMS LHCVA5XC0001 ST0789876
02 4 VAX GENERAL ASSEMBLY FOR CMS LHCVA5XB0001 ST0815063
03 3 M1 (TAXS SIDE) VALVE ASSEMBLY #2 LHCVAXX_0002 ST1838429
04 1 external ref ST1898293
Not Applicable
VAX MODULE CONFIGURATIONS FOR CMS
DESIGNED 2024-09-30
A0
1:5
Doc No: ST1892262_02
LHCVA5X_0002
NOT VALID FOR EXECUTION
1/1
DRAFT FOR DISCUSSION
NOT VALID FOR EXECUTION

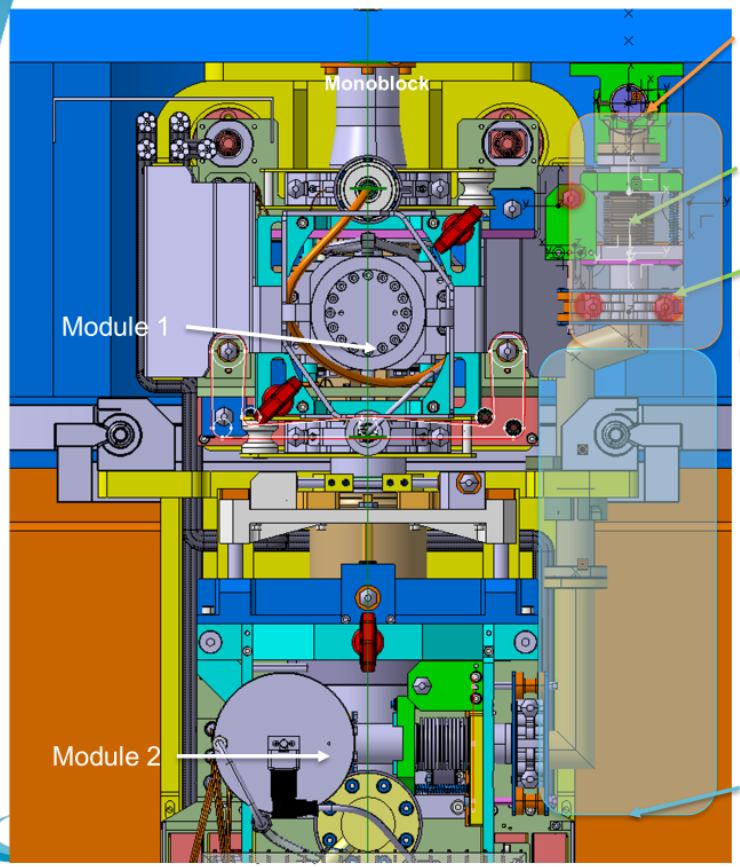

03







2. Deployment of the lines – VAX box



Service lines remaining in place

Compressible bellow and mechanism

Quick connection

Actuators

✓

Service lines anchored to the support

✓ Nothing can stay beyond the alignment plate lines during LS → dismountable last pipes

⚠ Problems identified:

- Mechanism accessible by the robot ? → actuators very close to the wall
- Mechanism does not allow removal of M1

Options:

- Design of module 1 for ATLAS without Staublis (solves the problem for the installation, not the remote actuation).
- Placing the mechanism by the level of the angle valve:
  - Solves the remote actuation problem
  - Still on the way for the removal of M1
  - Implies dismantling an ~3m long tube during LS.
- Both options above combined.

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