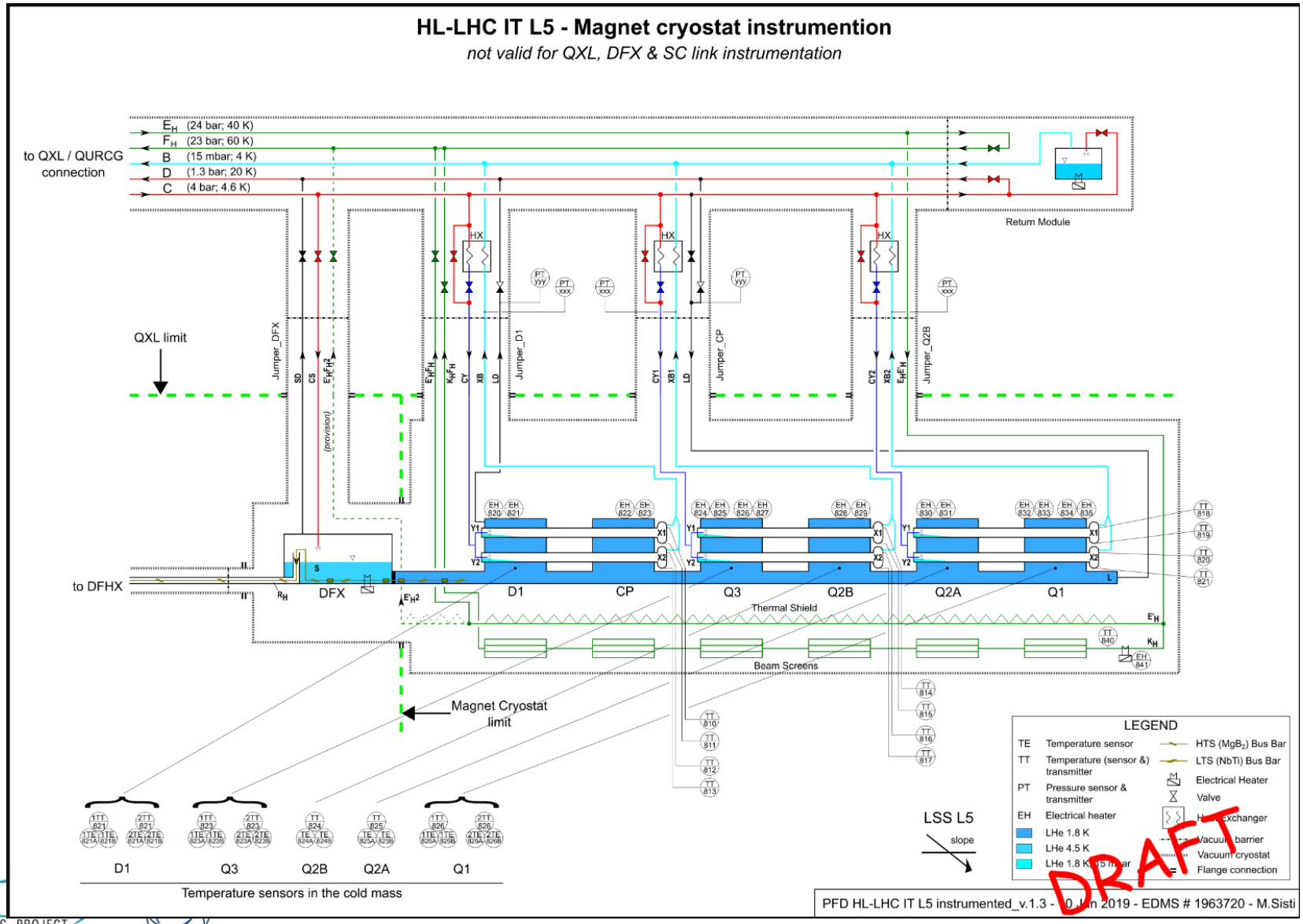
D1 integration in the cryostat

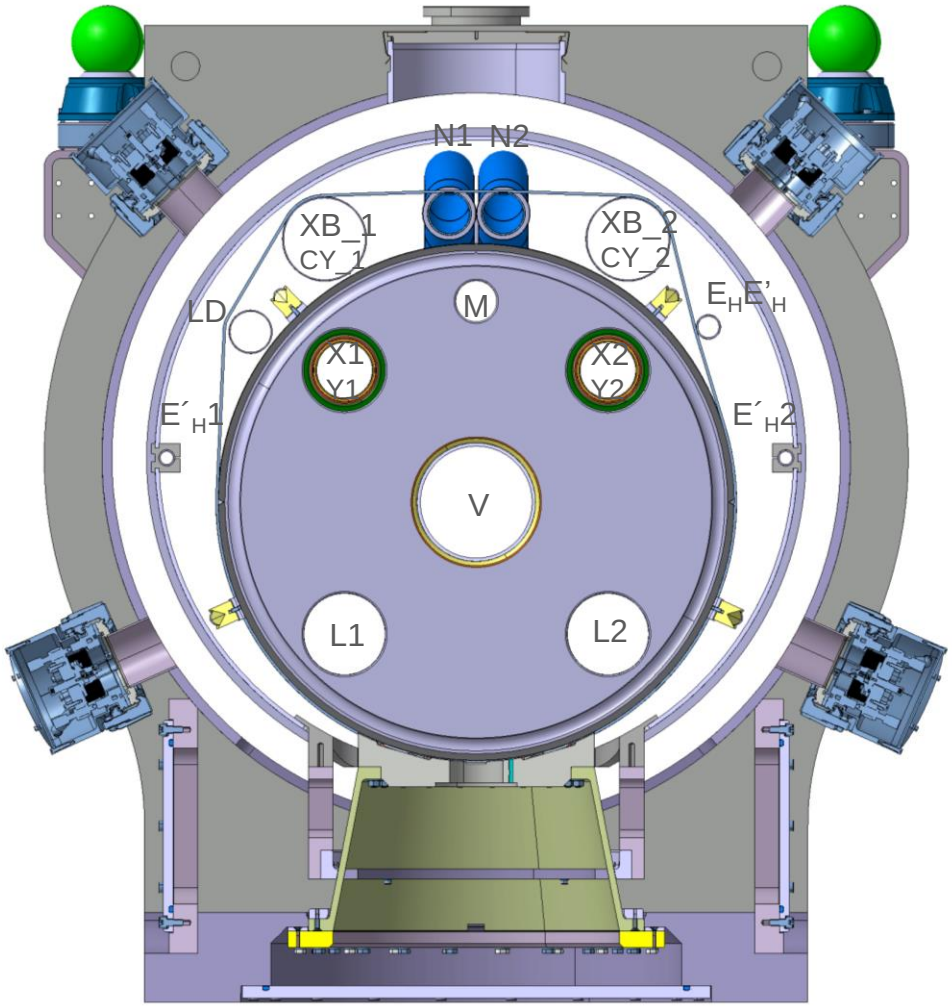
D. Ramos, A. Vande Craen,Y. Leclecq, V. Parma, C. Eymin, F. Micolon, M. Rebollo, M. Struik, G. Barlow, M. Oliver, O. Riu, H. Prin, A. Temporal

International review on D1 and D2 superconducting magnets for HL-LHC, 12.03.2019

D1 as part of a continuous cryostat



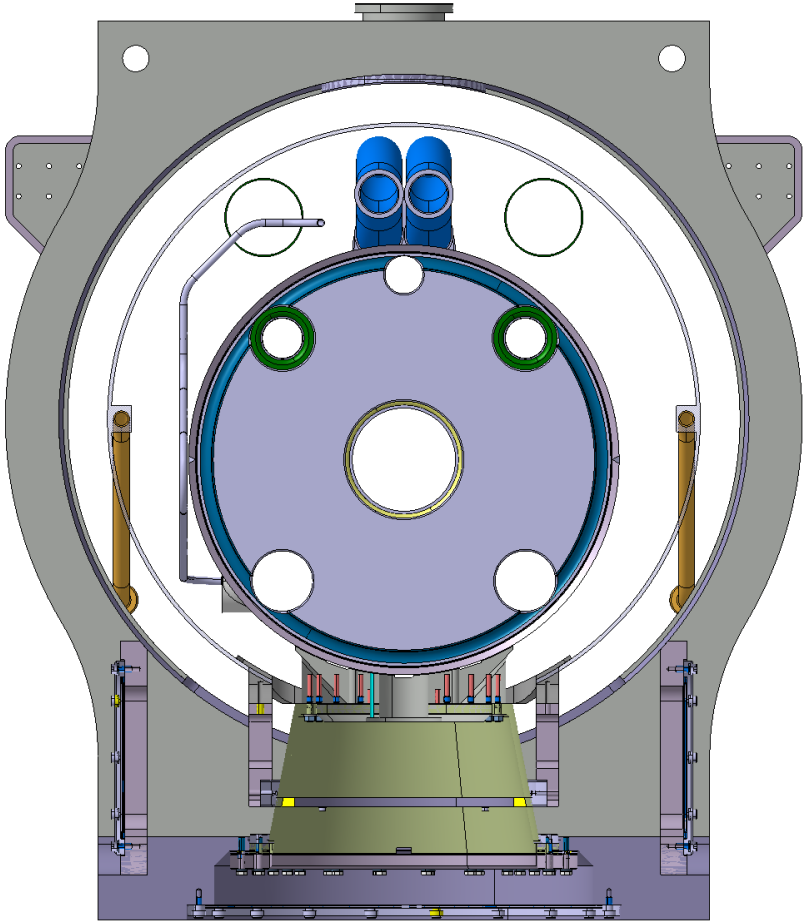
Cryostat concept for Q1-Q2-Q3CP-D1 & D2



Cross section as seen from IP

- Cold mass supported on GFRE columns:
  - Base principle of LHC arcs
  - Better return of experience than spider supports of LHC triplets
- New configuration designed for larger cold mass (Ø630 mm) plus cryogenic lines inside cryostat, but identical diameter of vacuum vessel
- Increased stiffness of supports for better alignment stability
- New assembly procedure and tooling
- Integration of cold mass position monitoring system Q1, Q2a/b, Q3 (not on D1)

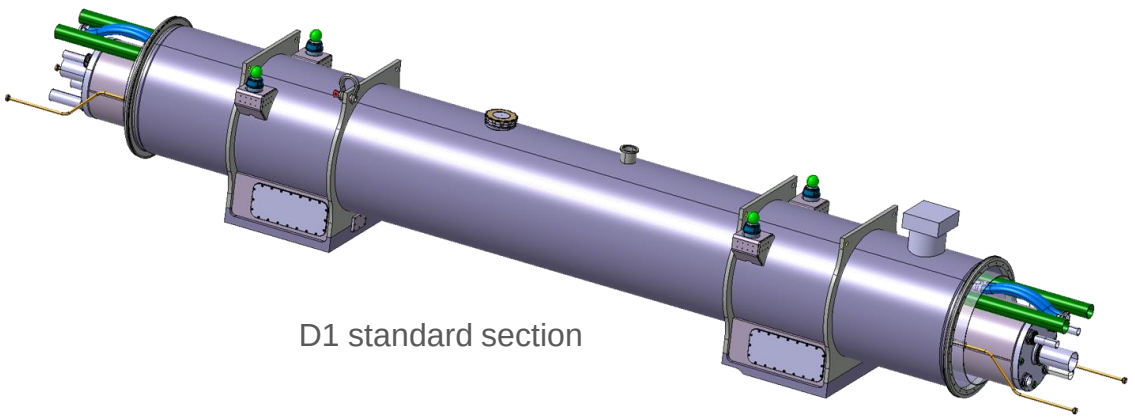
D1 cross section



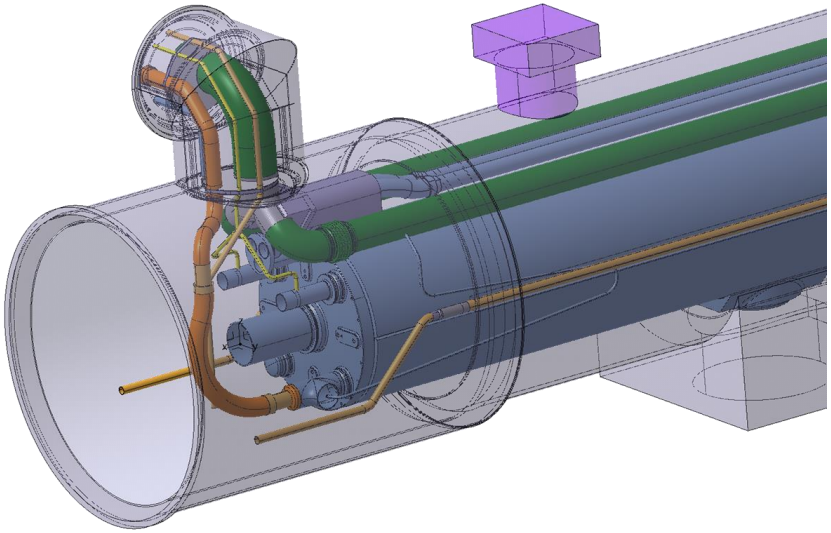
- D1 Cold mass diameter is smaller, hence higher cold mass saddles
- Common cryostating procedure and tooling
- Many components shared with other cryostats

Typical cryostat breakdown

- Standard section: the same for all IR's (assembly phase I)
  - Vacuum vessel
  - Thermal shield
  - MLI
  - Support posts
  - Piping and pipe supports
  - Cold mass
  - Feedthroughs (Instrumentation)
  - Pressure relief valve(s)
- Technical service module: slot dependent design (assembly phase II)
  - Vacuum vessel
  - Thermal shield
  - MLI
  - Phase separators
  - Piping and supports
  - Expansion joints
  - BPM and cables
  - Vacuum pumping port

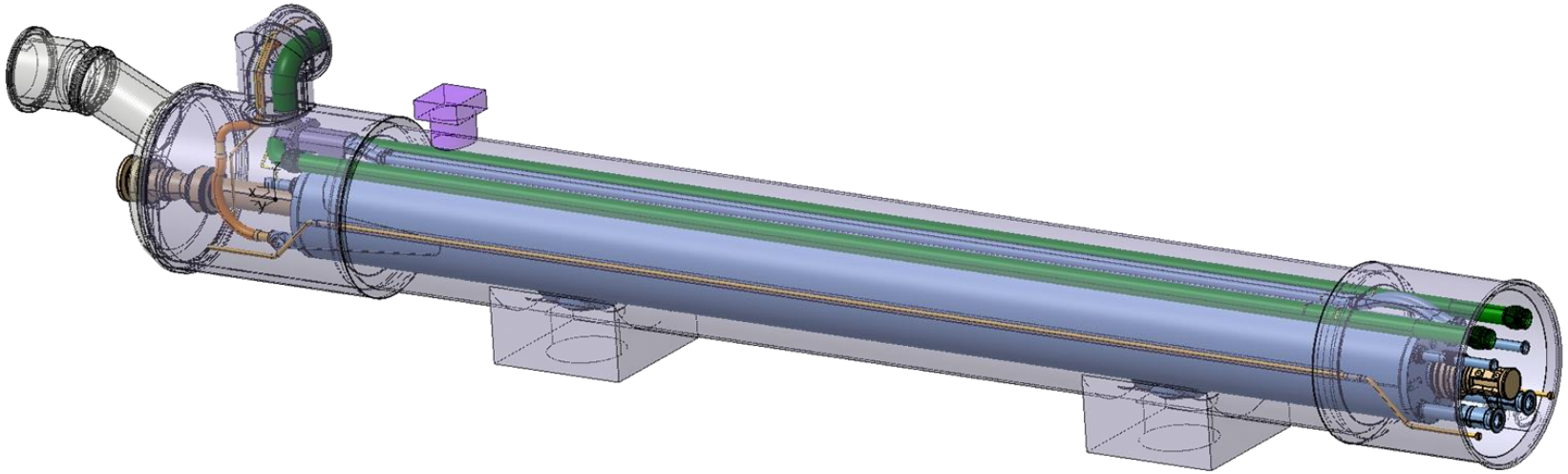


D1 standard section



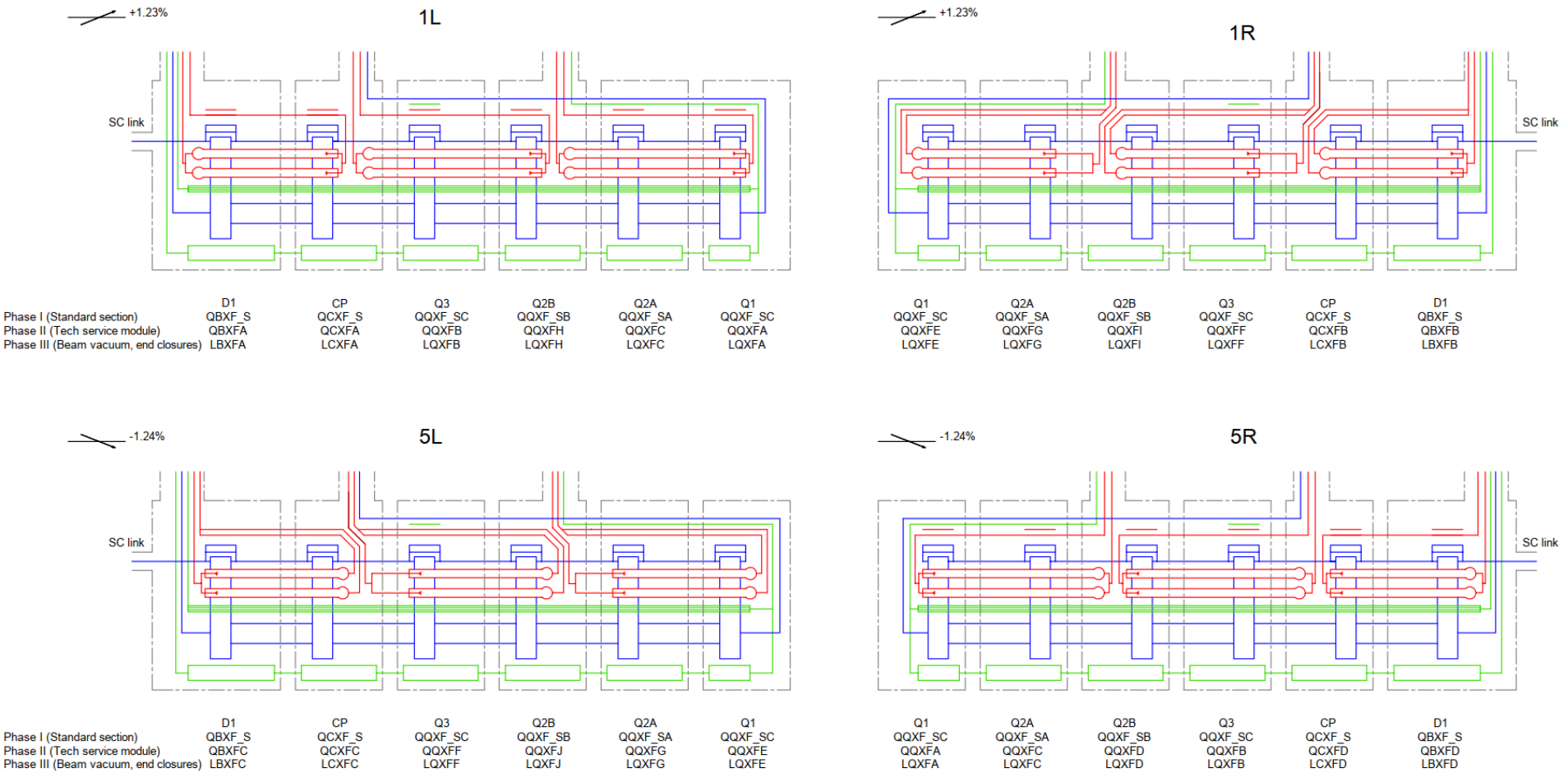
Service module: 4 variants depending on cryogenics functional requirements and installation slot. Design in work.

D1 complete cryostat



- Standard section includes instrumentation feedthrough on non-IP side
- Comprises two technical service modules:
  - Non-IP side with jumper to QXL and interface for superconducting link (to be defined)
  - IP side for interconnect components and BPM cabling
- Four variants for installation

Types of assemblies



Four different variants of D1 finished cryostat

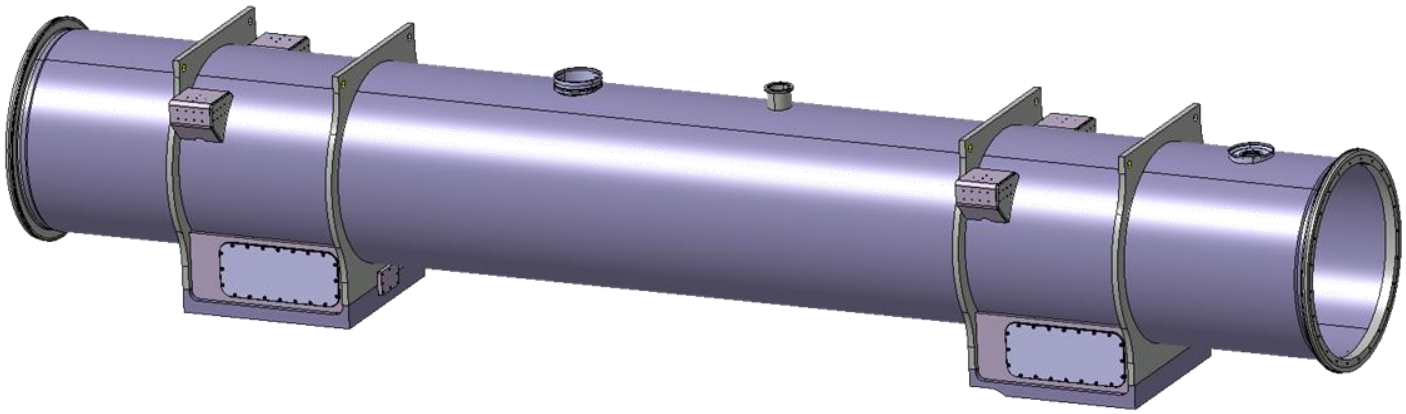
PIPING DIAGRAM AND TYPES OF ASSEMBLIES FOR THE HL-LHC INSERTION REGION CONTINUOUS CRYOSTAT Q1 TO D1		
EDMS No.: 1964233	Version: 2.0	Date: 2019-03-05
Prepared by: D. Ramos	Approved by: Cryostat Interface WG	

Cryostat assembly and cold test sequence

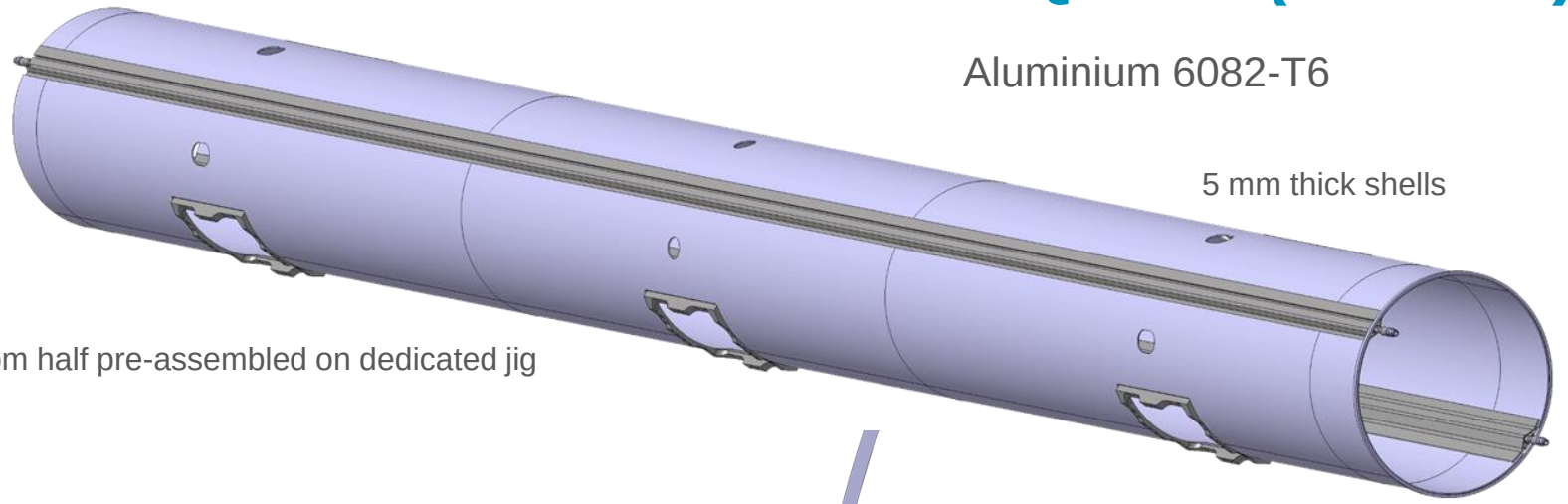
- Cryostating Phase I
  - Cold mass into standard section, with supports posts, thermal shield and MLI
  - Cold mass instrumentation (no CLIQ, K-mod in D1)
  - Straight piping with excess length for connection to test bench
- *Cold test*
  - *Connection to test bench with temporary interfaces and cryostat end cover*
- Cryostating Phase II
  - Piping, phase separators, jumpers
  - Vacuum vessel, thermal shield and MLI of service module extension
  - Cryogenic instrumentation on insulation vacuum
  - Current leads (only on CP)
- Finishing / Phase III
  - Beam screen
  - BPM
  - CWT
  - End cover

Standar section: Vacuum vessels

- Single contract for all units
- On-going invitation to tender.
- Approval by finance committe of June for purchase order issued in July



SS Thermal shields: based on Q1/2/3 (in-work)

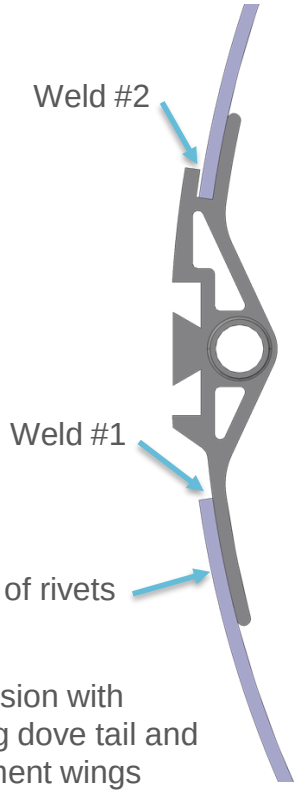


Aluminium 6082-T6

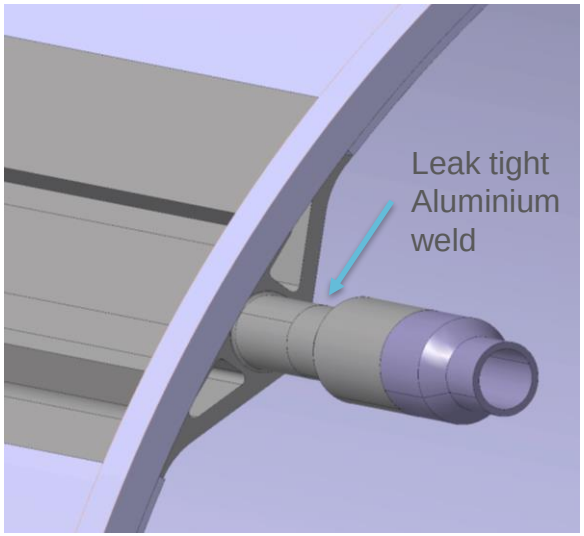
5 mm thick shells

Bottom half pre-assembled on dedicated jig

Machined structural support cradle



Pipe extrusion with positioning dove tail and reinforcement wings



Aluminium to stainless steel transition

Standard section: support posts

- On-going contract for the supply of 140 units
- Raw materials have been approved and ordered
- First part delivered at CERN for thermal shocks
- Load test rig finished
- Samples for material testing will be prepared soon
- 100% load tested and ultrasound tested
- Delivery of 10 units pre-series by April 2019
- Delivery of series in 3 batches up to January 2020

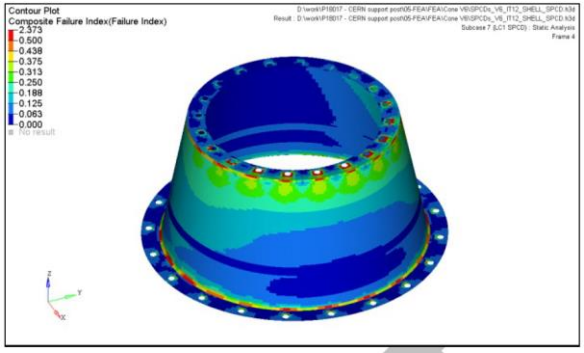
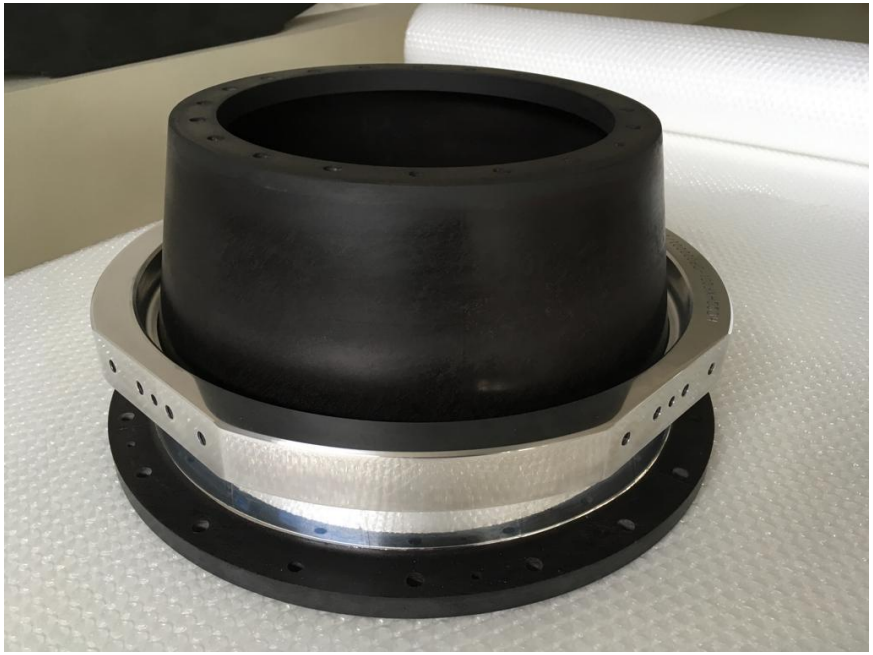
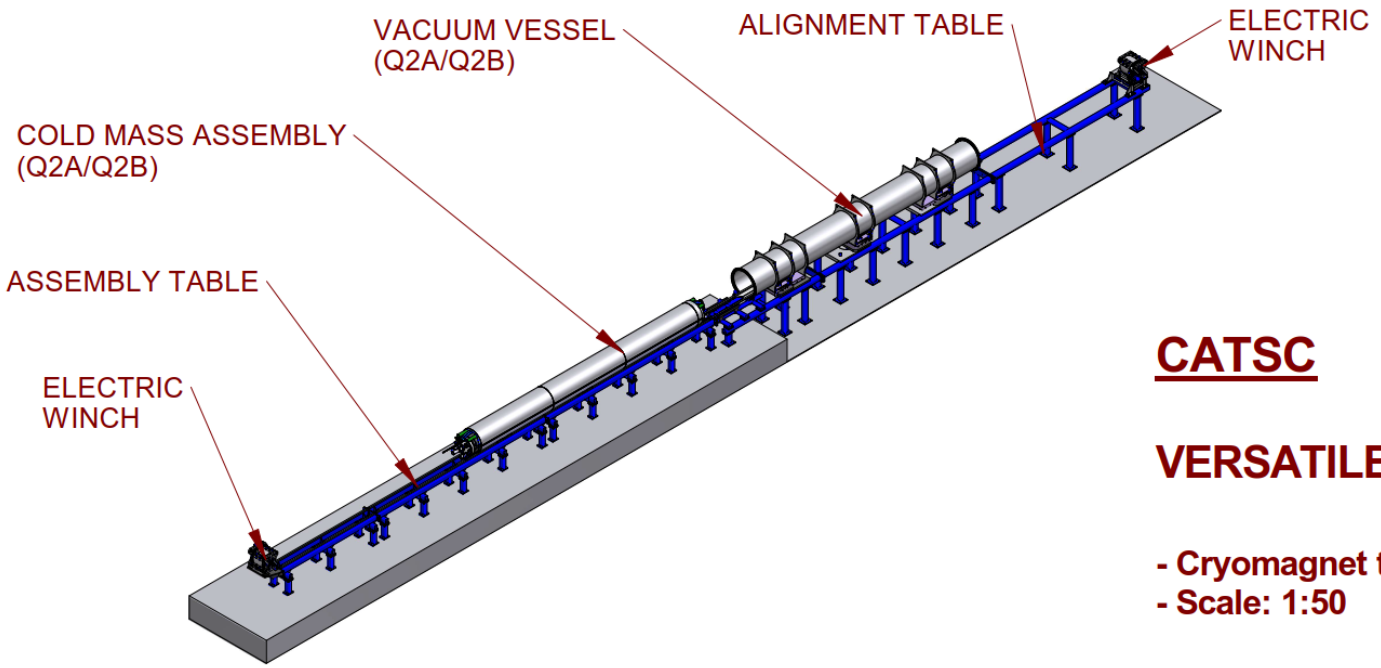


Figure 21 – Failure index – I



Cryostating tooling

- Contract running.
- The supplier is having cash flow difficulties causing manufacturing delays. The issue is being managed with IPT. **Possible delays may impact Q1/3 and Q2 schedules but not D1**.
- Contractual installation schedule:
  - at CERN: July 2019
  - at Fermilab: August 2019



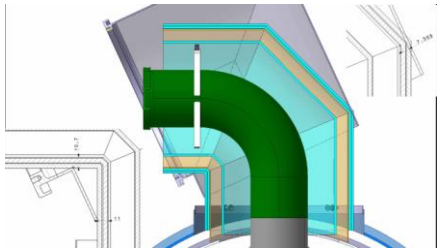
CATSC

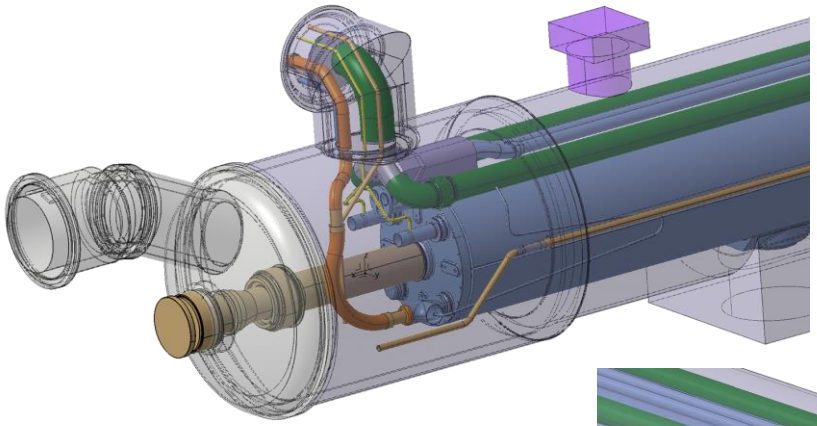
VERSATILE TOOLING SET

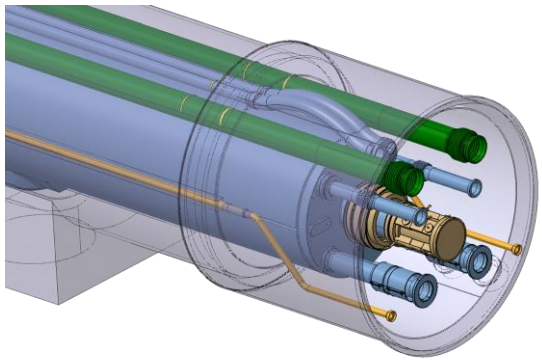
- Cryomagnet type: Q2A / Q2B
- Scale: 1:50

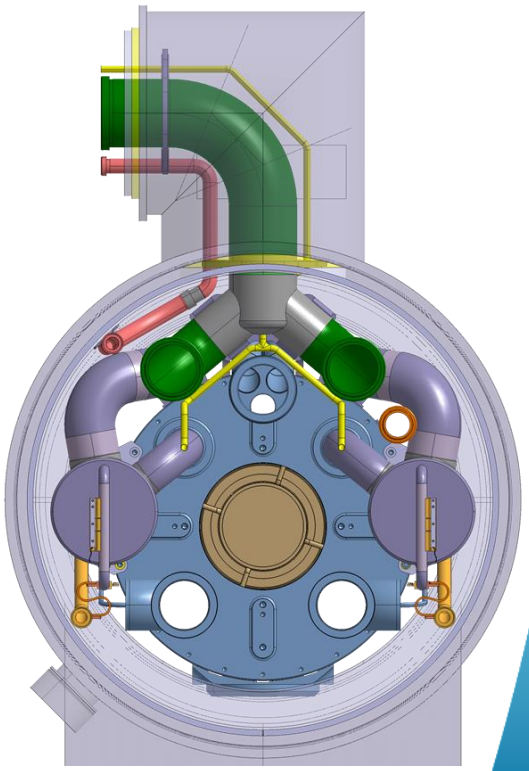
Technical service modules

- Design on-going
- Access for assembly and welding/cutting operations is challenging
- Thermal compensation at the jumper is critical. Installation offset at warm of 10 mm.
- Phase separator with liquid boiling by passive heating from thermal shield.
- Order of first components to start in July









Interconnect expansion joints

Role:

- Absorb thermal expansion/contraction during transients
- Ensure assembly and alignment flexibility

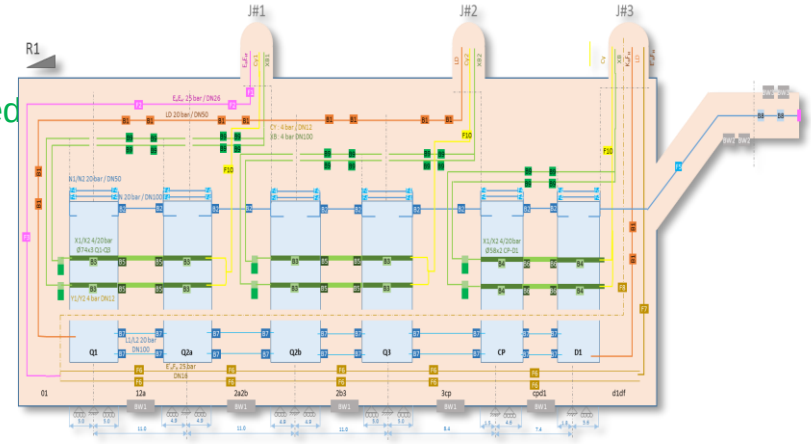
Design sequence:

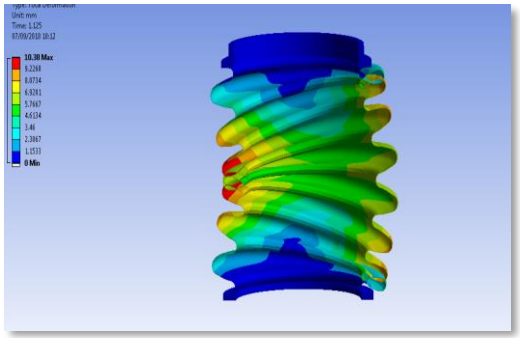
- Study cryogenic layout and transient procedures : Completed
- Define fixed points, bellows positions: Completed
- Studies for bellows operation validation: Completed
- Pre-design bellows: Completed
- Integrate pre-designed bellows : Completed

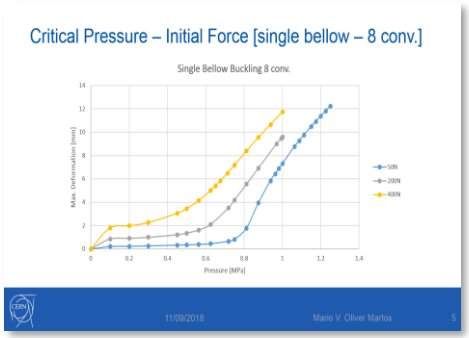
Progress status:

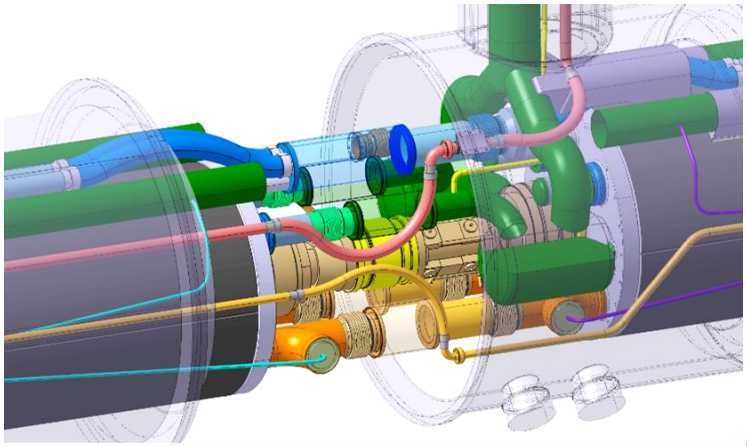
- Cold mass to HX bellows: Price enquiry opened last week
- Market Survey for 600 interconnect bellows out in Oct. 18
- IT documentation being prepared
- Contract placement 1st semester 19

5L bellows and fixed point layout





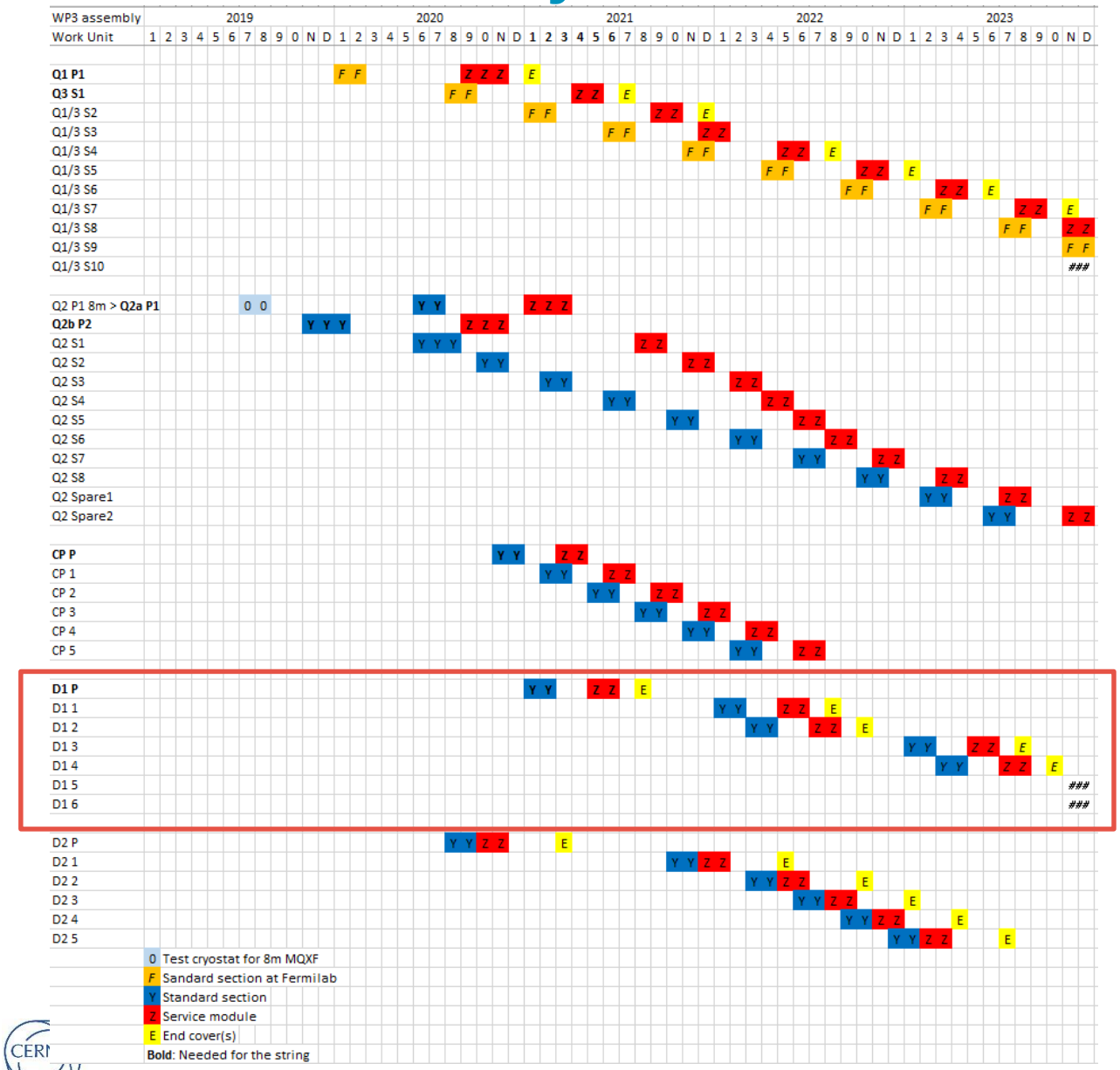




Design parameters	
Pressure	Int: 25 bar / Ext: 20 bar
Stroke	Up to 34 mm
Internal diameter	40 to 120 mm
Temperature	1.9K to 350K

Supply requirements
Standards: EN14917 / EN13445 / PED
Nb of bellows: 5L x90 / 5R x80
HL-LHC QA requirements
CE certification

Assembly schedule



Thank you.
Questions?