



SPS-RFD and Series DQW Cryomodule Production in the UK

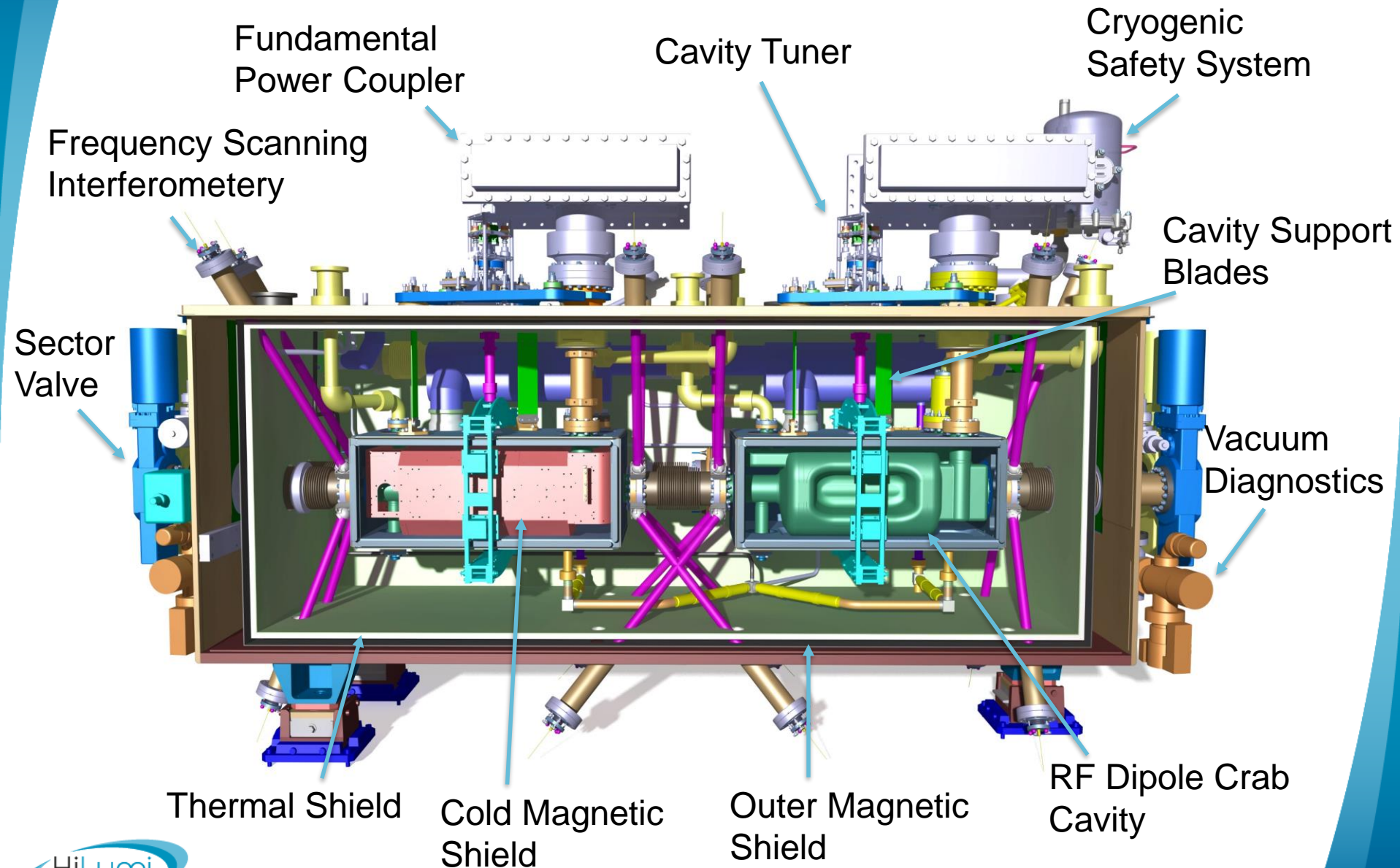
Thomas Jones (STFC) on behalf of the UK team

International Review of the Crab Cavity system design
and production plan for the HL-LHC

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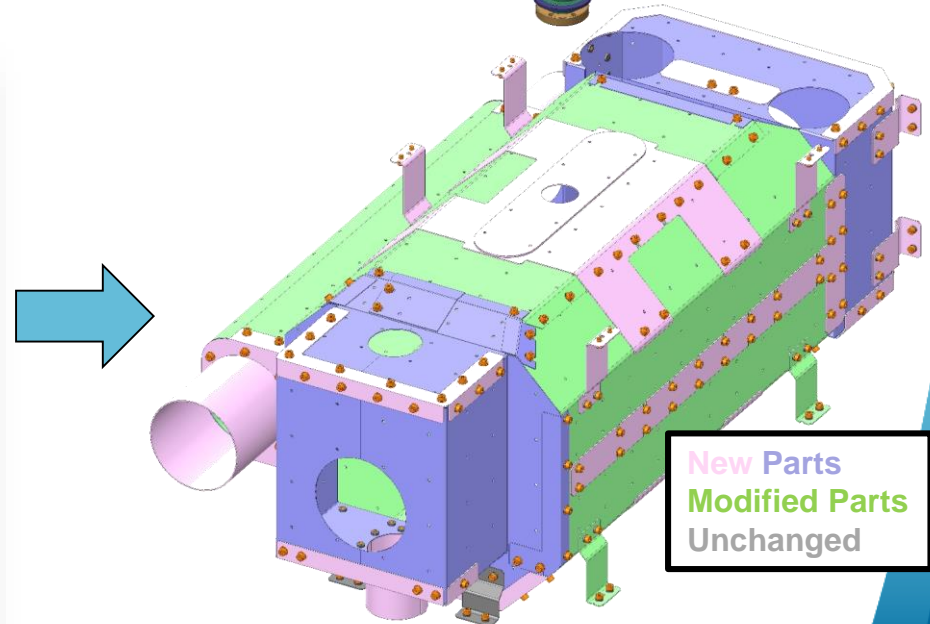
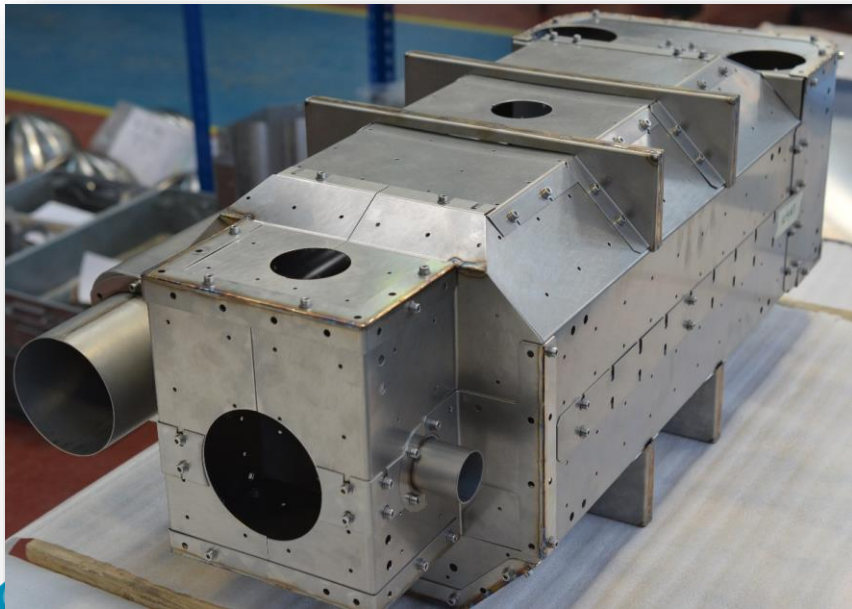
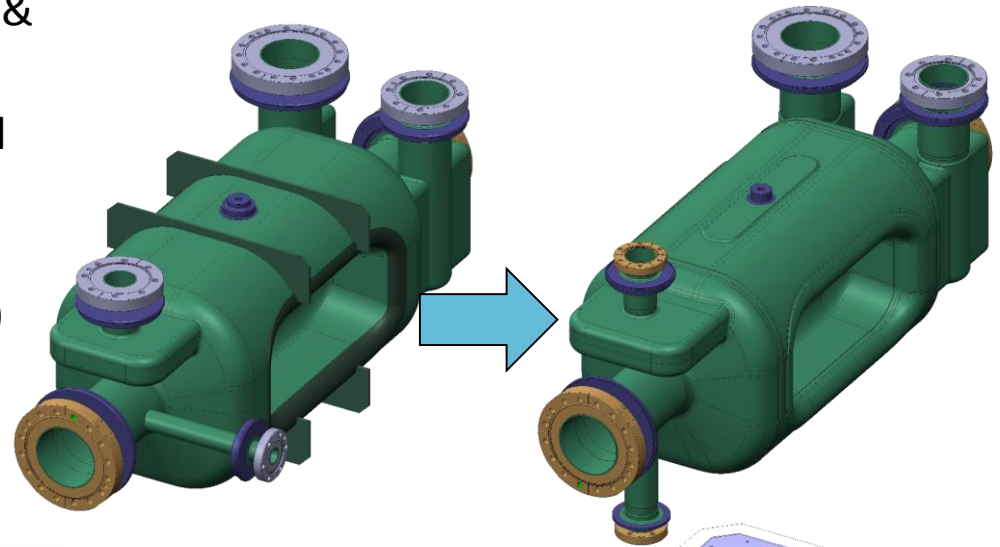
- UK Design Contribution to SPS-RFD Cryomodule
 - Magnetic Shielding
 - Thermal Shield
 - DL Infrastructure upgrades
 - Transportation Frame
- Schedule for SPS-RFD Cryomodule build in UK
- HL-LHC-UK2
- Scope of WP2, Series Crab Cavity Cryomodule Build in UK
- Schedule for Series Crab Cryomodule Build

SPS-RFD Cryomodule

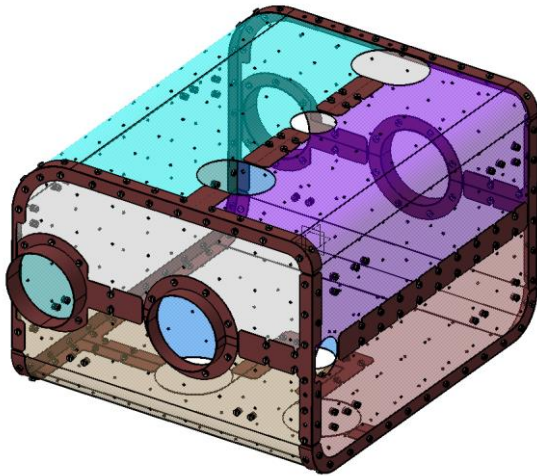


SPS-RFD Cold Magnetic Shield

- RFD Cold Magnetic Shields designed & delivered to CERN in Apr '16
- Changes in cavity design mean shield designs require revision
- Approach taken to modify & reuse existing shields (as much as possible)
- Detailed design: Complete
- Integration checks: On-going
- Specification & Tender: On-hold



DQW Series Cold Magnetic Shield

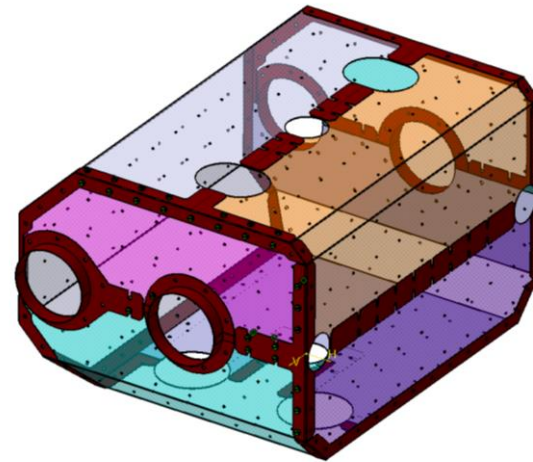


Prototype Design

(Modelled in CREO)

Modifications:

- Add Pick-Up Port (Mandatory)
- Radius Elimination (Highly desirable)
- Brackets review (Highly desirable)



New Design

(Modelled in CATIA V5)

Modifications STATUS:

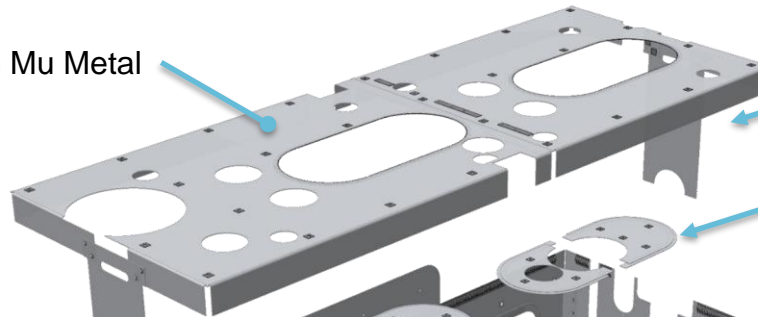
- Add Pick-Up Port **(DONE)**
- Radius Elimination **(DONE)**
- Brackets review **(On-going)**

SPS-RFD Warm Magnetic Shield

Top Joint EM Gasket



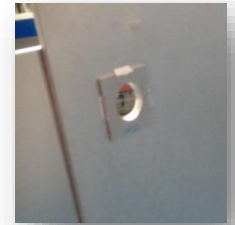
2mm Mu Metal



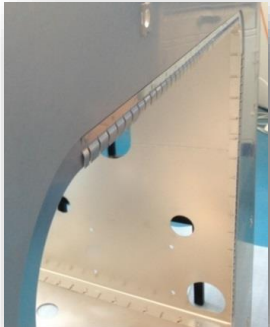
Top Assembly

FPC Cover

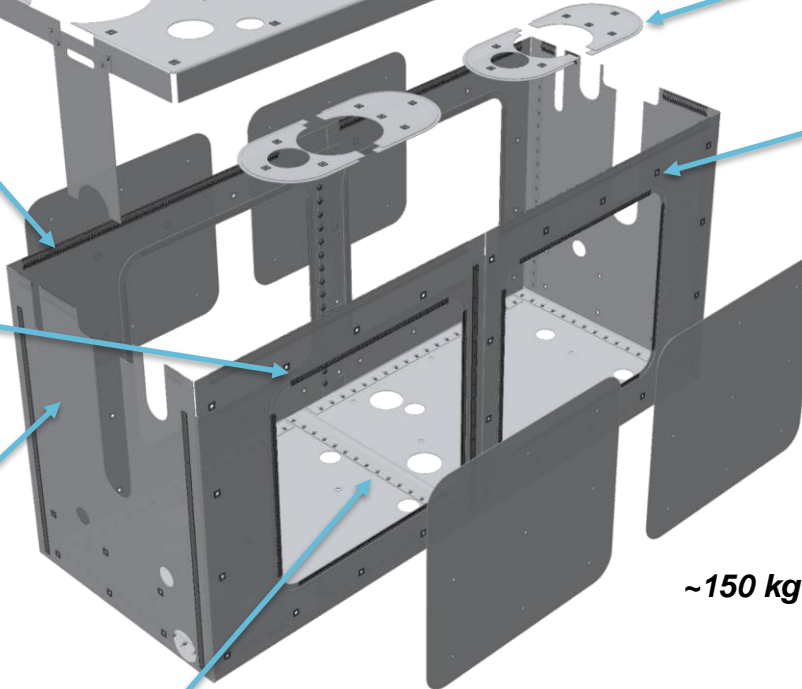
Tapped OVC Spacers



Window Joint Spring Fingers



Lower Assembly

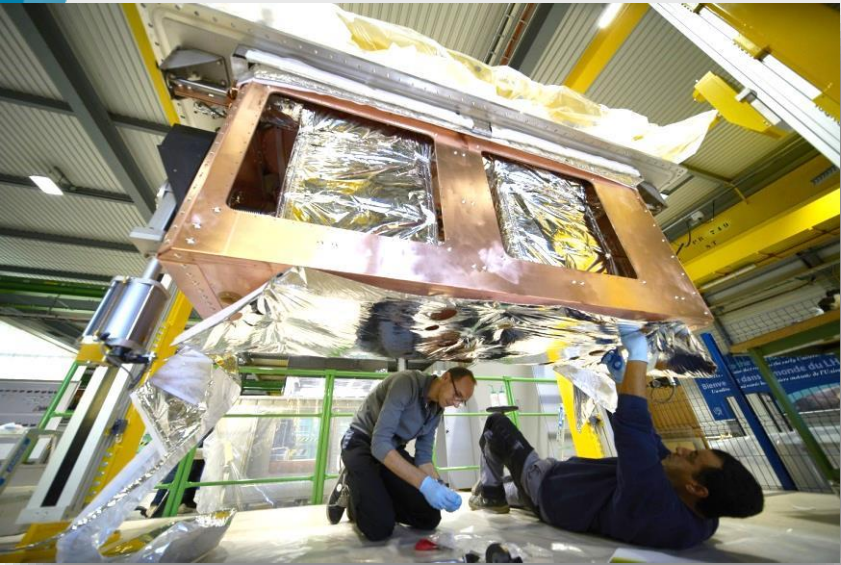


Windows

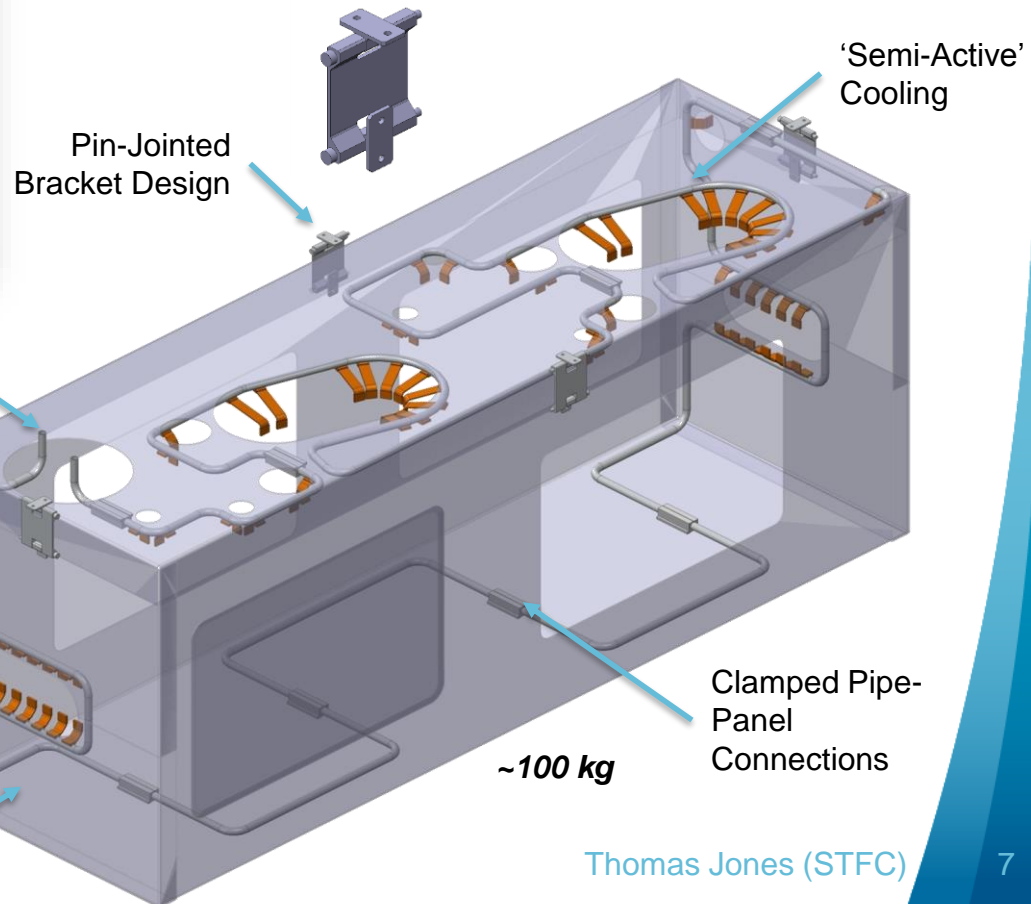
~150 kg

Sliding Joints for OVC Tolerance

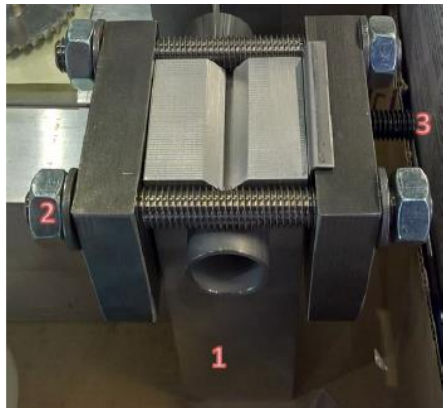
Thermal Shield



- Al1100 panels give significant cost and weight savings for series production
- SS316 Cooling circuit for cryoline integration and pressure safety



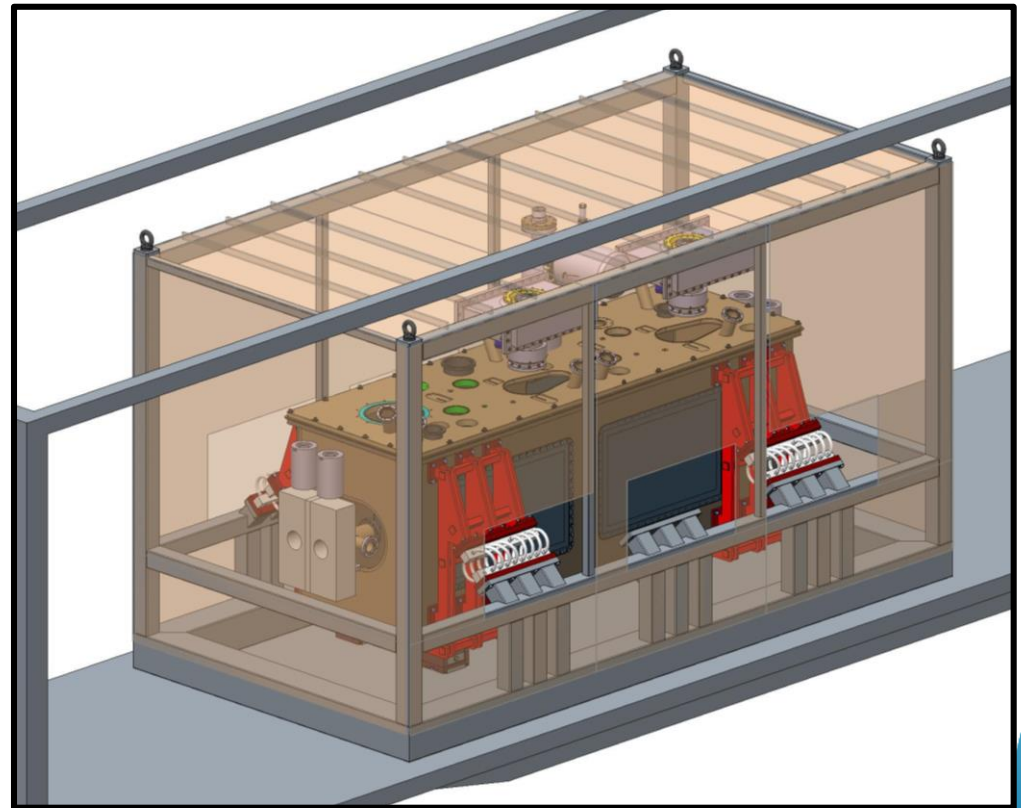
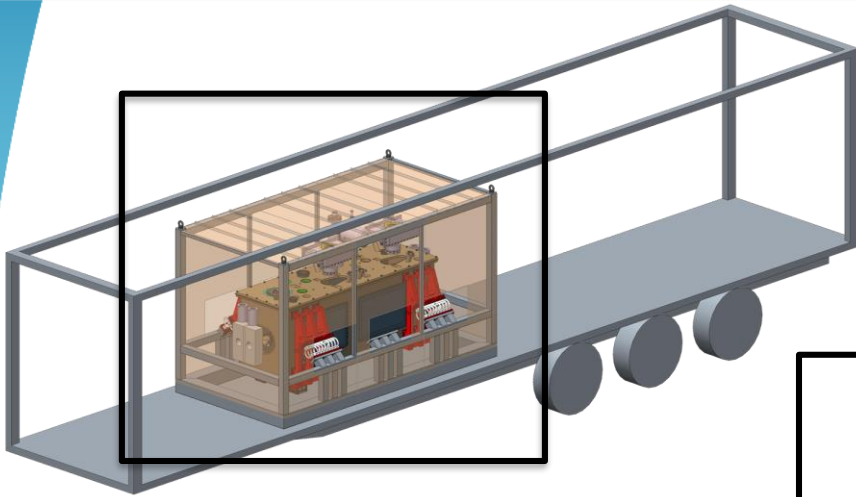
Cooling Circuit Ø15/19 316LN



3mm Al1100 Panels

Transport Tooling

See talk on 'Transport Aspects'
by Kurt and Ed later today.



Cryomodule Integration



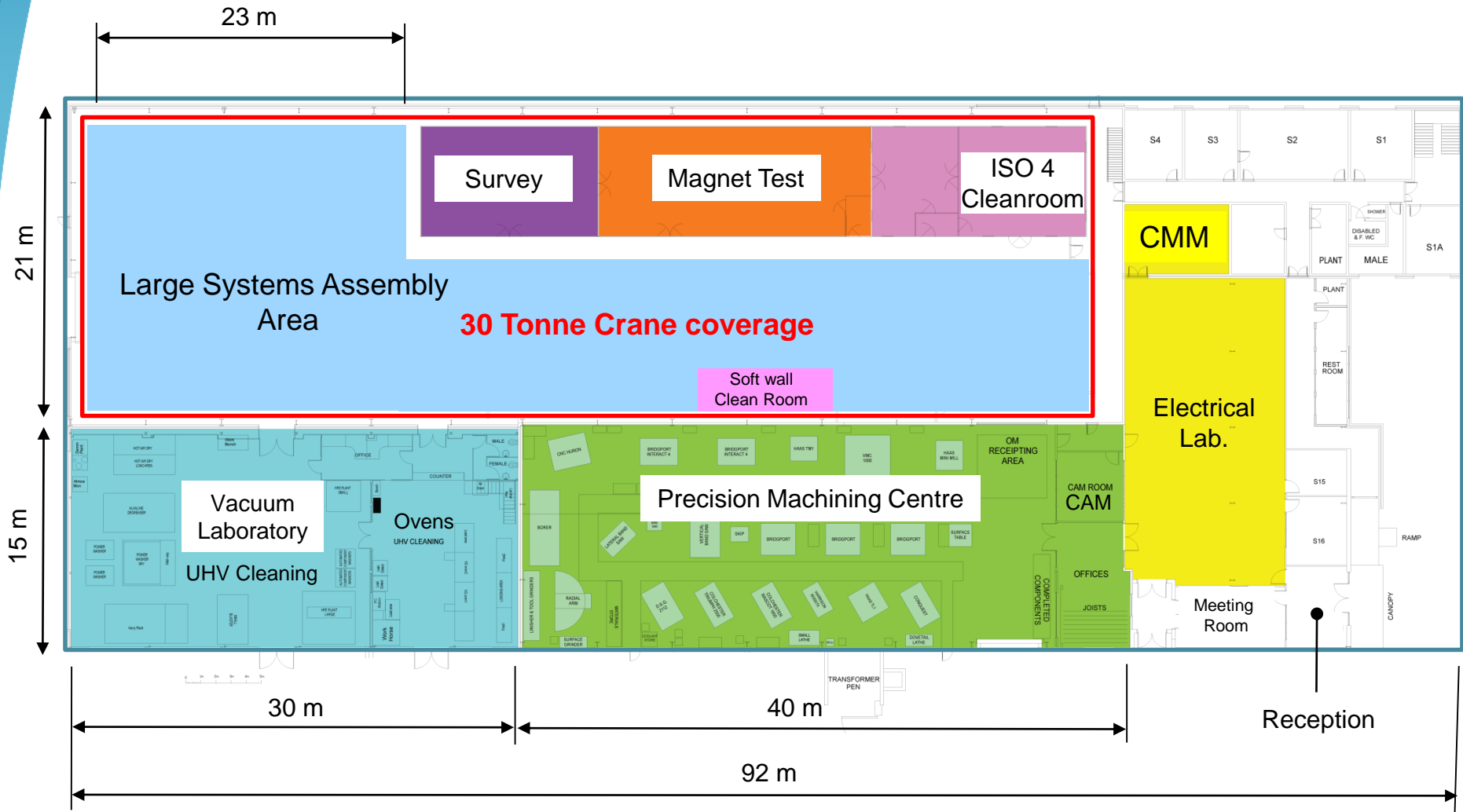
bsi.

Certificate of Registration

QUALITY MANAGEMENT SYSTEM – ISO 9001 : 2008



Daresbury Engineering Technology Centre Floor Plan

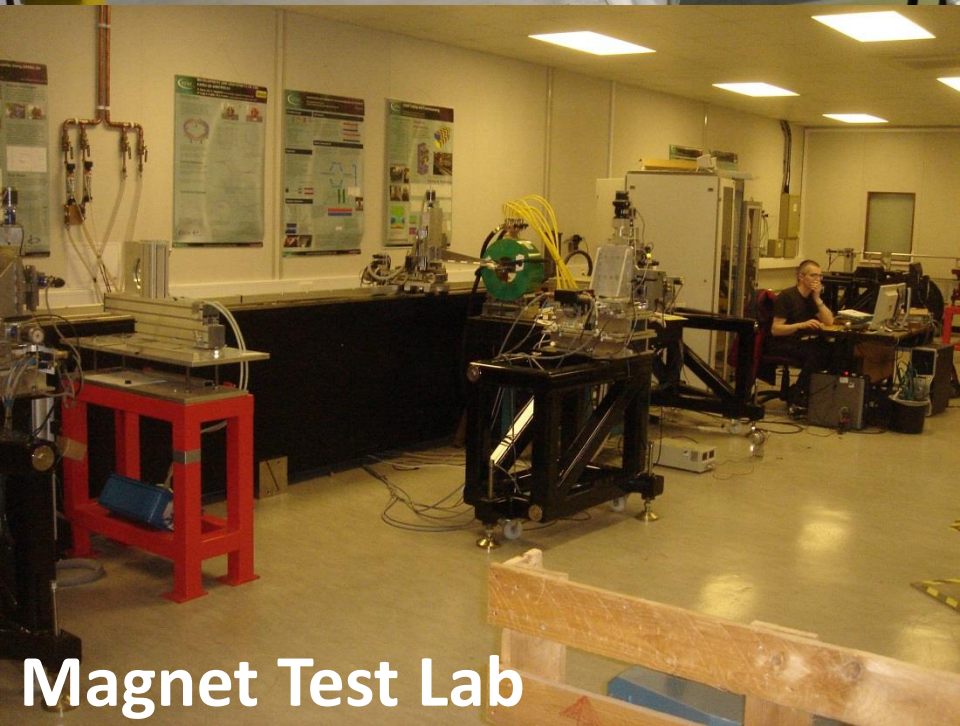




Machine Centre



Cleaning in Vacuum Lab



Magnet Test Lab



Ovens in Vacuum Lab



30 Tonne Crane

Assembly Hall



Softwall cleanroom



Magnet Test Room

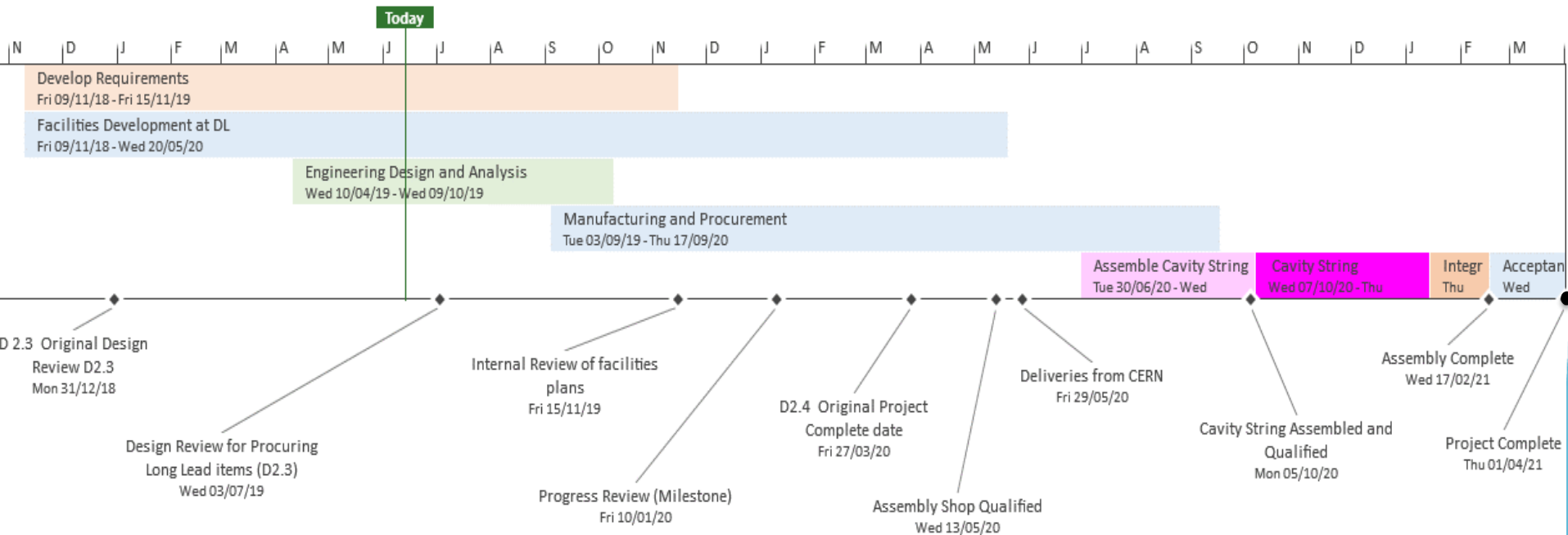
ISO 4 Cleanroom

Assembly Hall



ISO 4 Cleanroom

SPS-RFD Schedule



HL-LHC-UK2

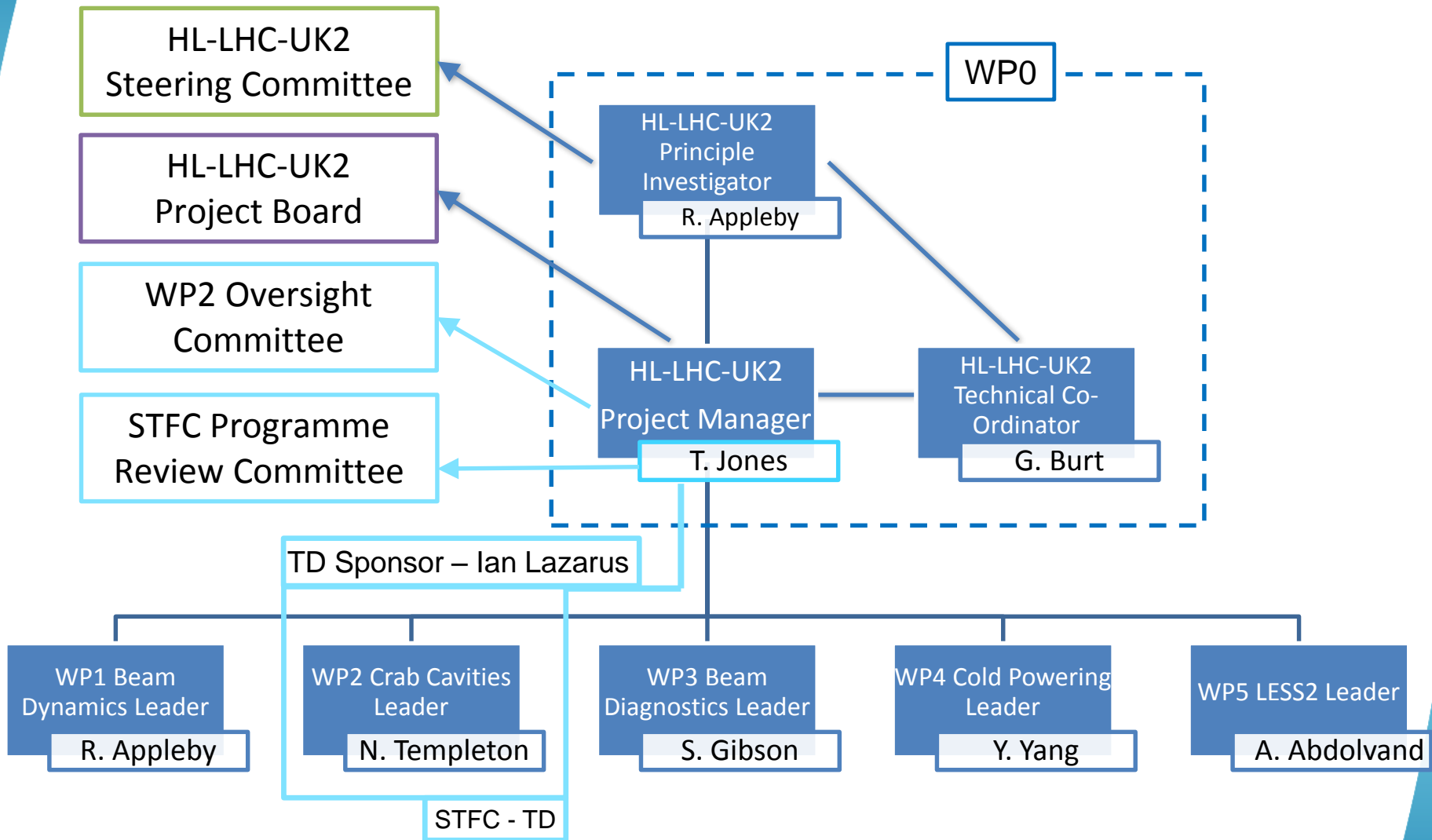
- HL-LHC-UK is a collaboration of UK institutes and Universities delivering hardware for the High Luminosity Upgrade of the Large Hadron Collider at CERN.
- The current collaboration, funded by STFC, has been successful in providing Research and Development into several key areas of the upgrade including;
 - Work Package 1 - Beam Dynamics (led by Manchester University)
 - Work Package 2 - Crab Cavities (STFC-Lancaster)
 - Work Package 3 - Beam Diagnostics (RHUL and Liverpool University)
 - Work Package 4 - Cold Powering (Southampton University).
- In parallel the Laser Engineered Surface Structures (LESS) project has positioned the UK (Dundee University) as a leader in LESS technology for the mitigation of Secondary Electron Yield issues in the LHC.
- LESS will join the HL-LHC-UK collaboration as WP5 for the next phase of the project known as HL-LHC-UK2.
- The project will officially commence on the 1st April 2020, with some pre-work ongoing in 19/20.

HL-LHC-UK2 Key Dates

Project subject to review through STFC Projects Peer Review Panel (PPRP).

- 13th September 2018 – Statement of Interest (Sol) reviewed by STFC Accelerator Strategy Board (ASB)
- 16th October 2018 – Feedback received from ASB
- 4th June 2019 – PPRP Documentation Submission
- 4th September 2019 – PPRP Review Meeting
- Date TBD (October 2019) – STFC PPRP Visiting Panel meeting
- Date TBD (December 2019) - STFC Science board
- 1st January 2020 – WP5 project start
- 1st April 2020 – WP1 to WP4 Start.
- Start Q1 2024 to end Q2 2026 – Long Shutdown 3

HL-LHC-UK2 Project Organisation



WP2 Scope of Work

Goal: Design and procure necessary components and then to assemble **4 Double Quarter Wave Crab Cavity Cryomodules**

Included;

- Review the design of pre-series cryomodule and undertake any design modifications.
- The procurement from industry of the required components to produce 4 cryomodules.
- Assembly of 4 x Double Quarter Wave cavity strings and associated ancillaries in ISO-4 clean room.
- Assembly of the cryomodules (cryostating).
- Undertake vacuum leak tests after thermal cycling with liquid nitrogen.
- Design and fabrication of the transport frame.
- Organise shipment of Cryomodules to CERN (CERN to fund).
- QA management for all the above.

WP2 Scope of Work

Excluded

- Design and procurement of cavities, tuners, HOMs, RF Couplers, RF Probes, beam line components and Cryogenic Safety equipment.
- Conducting Cryogenic and/or RF performance tests at 4K and 2K.
- The conditioning and testing of the RF input couplers (It is assumed that the conditioning and testing of the RF input couplers will be performed at and by CERN).
- Any-reprocessing of the cavities or RF Couplers in case of contamination at any stage between arrival, assembly and transport.
- Transportation costs from DL to CERN.

Facilities

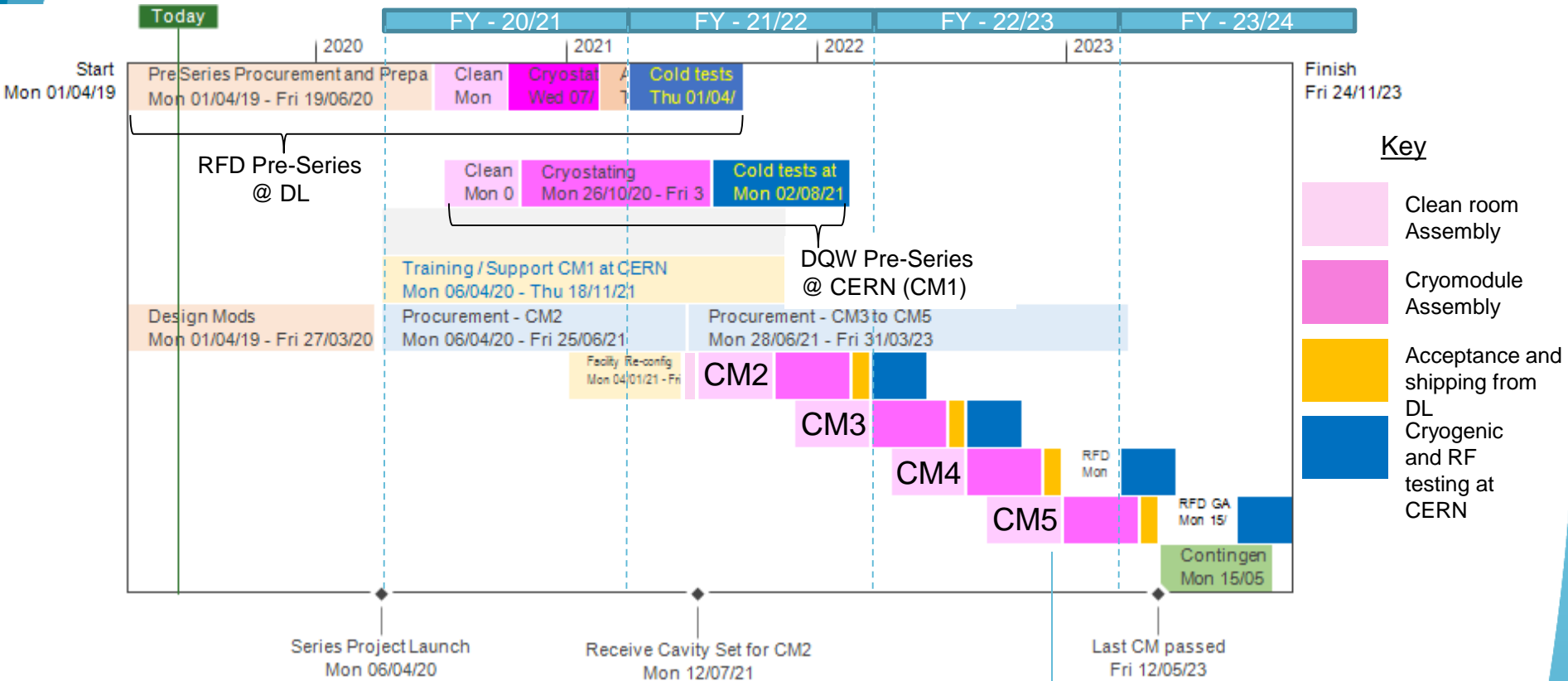
The project will utilise the infrastructure developed for the RFD-prototype cryomodule located within ETC at Daresbury Laboratory.

WP2 Scope of Work

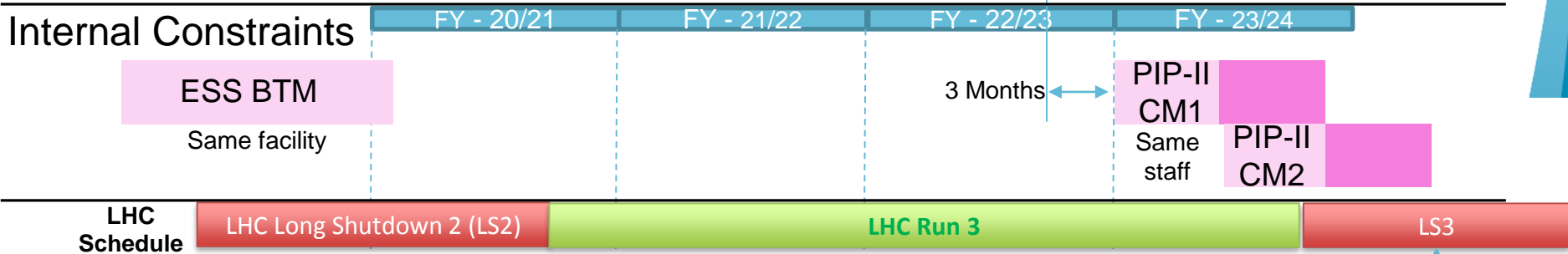
Assumptions

- STFC will share the efforts for design with CERN and University of Lancaster. The details of responsibilities have been agreed with CERN.
- Procurement responsibility will also be shared with the collaborators depending upon respective funding allocations.
- All required cryomodule drawings and CAD will be delivered by CERN to STFC upon project initiation.
- Assembly procedures for the cryomodule will be shared by CERN at timescales appropriate for the STFC project delivery.
- Drawings and/or CAD models for cryomodule assembly tooling will be made available to STFC by CERN at timescales appropriate for the STFC project delivery.
- Periodical review/progress meetings will be held with the collaborators.

Series Crab Cavities High Level Schedule



Internal Constraints



LHC Schedule



Modules installed in LHC

Conclusions and further work

- Progress is on schedule for RFD SPS Prototype assembly at Daresbury from Summer 2020.
- UK design responsibilities progressing well. Cold Shield designs complete, lessons learned from DQW SPS tests have been incorporated into Outer Magnetic Shield and thermal shield.
- Good progress on the transportation frame and internal transportation restraints working with CERN.
- CERN-UK need to finalise designs and begin negotiations with suppliers for Long Lead items (OVC and Cryogenic lines)
- Orders to be placed for long lead items by end of September 2019.
- HL-LHC-UK2 proposal was submitted, to be reviewed in September 2019.



Thank you for your attention

Any Questions?