



## Status of CC cryomodules

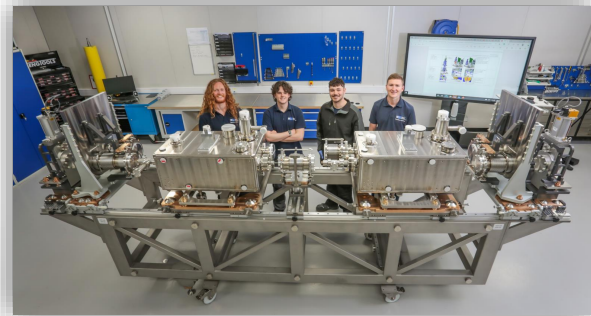
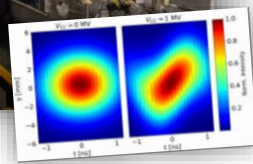
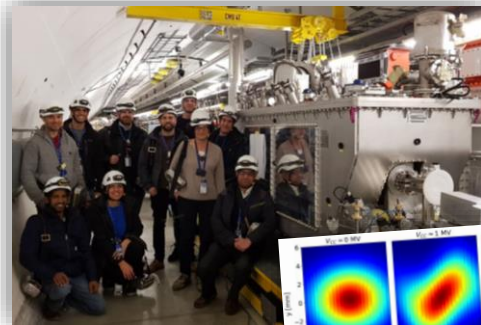
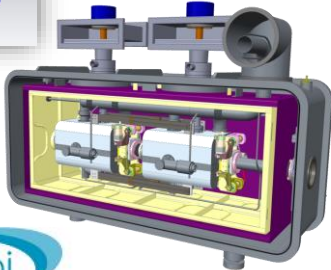
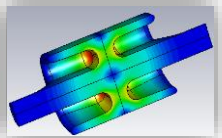
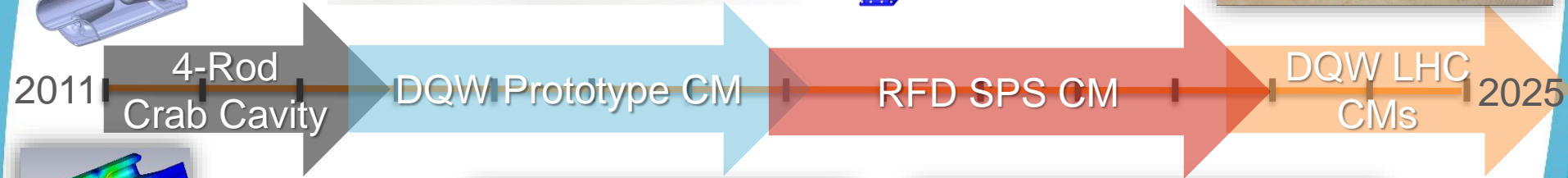
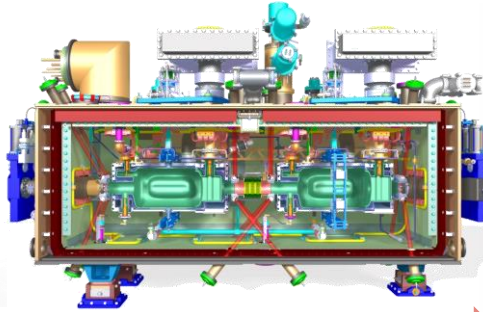
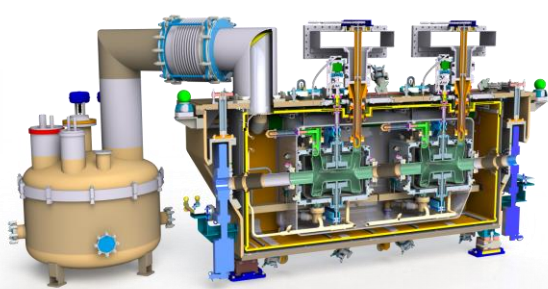
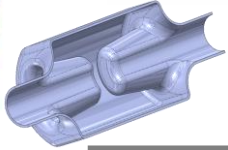
Niklas Templeton – STFC Daresbury Laboratory  
On behalf of the Crab Cavity collaboration

12th HL-LHC Collaboration Meeting – Uppsala (SE) – 19<sup>th</sup> Sep. '22

# Status of CC cryomodules

- UK involvement in HL-LHC Crab Cavities
- Pre-Series Build at Daresbury
  - Progress
  - Next Steps
- Series Cryomodules Update

# UK involvement in WP4 collaboration



# RFD SPS Cryomodule Build

**Step 1**

- 1. Assemble cryomodule support structure (SCS) to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 2**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 3**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 4**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 5**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 6**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 7**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 8**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 9**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 10**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 11**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Step 12**

- 1. Assemble the main structure to the main structure.
- 2. Assemble the main structure to the main structure.
- 3. Assemble the main structure to the main structure.
- 4. Assemble the main structure to the main structure.

**Transport**

- 1. Transport the cryomodule to the test area.
- 2. Transport the cryomodule to the test area.
- 3. Transport the cryomodule to the test area.
- 4. Transport the cryomodule to the test area.

**M7 tests**

- 1. Cryogenic safety extension
- 2. Inclinometer
- 3. Jumper
- 4. Support jack

**SPS**

- 1. Cryogenic safety extension
- 2. Inclinometer
- 3. Jumper
- 4. FSI flanges
- 5. Support jack

**Technologies and contact**

Radiology	Survey/Alignment	Cryogenic lines	Vacuum	Design	Thaw
Contact: Enrico CASALE EUGENIO ROSSI ROBERTO CASALI ANTONIO BUCCHIERE	Contact: Massimo ZAPPALÀ STEFANO FIORE	Contact: ANTONIO BUCCHIERE ANTONIO DELPINO ANTONIO CASALE ANTONIO CASALI	Contact: ANTONIO BUCCHIERE ANTONIO CASALE ANTONIO CASALI	Contact: ANTONIO BUCCHIERE ANTONIO CASALE ANTONIO CASALI	Contact: ANTONIO BUCCHIERE ANTONIO CASALE ANTONIO CASALI

**Manufacturing and contact**

CERN Manufacturing	STFC
Contact: Marco GABRIACCI STEFANO GABRIACCI	Contact: Thomas JONES (STFC) DAVID WILSON (STFC) STEFANO GABRIACCI NIKLAS TEMPLETON (STFC) JON BODDLE (STFC) GUYLE GRANGER (STFC) GEORGE CARROLL (STFC)

Overview of assembly sequence – RFD CRYOMODULE for SPS tests 2022

Poster by Teddy Capelli



# Pre-Work @ Daresbury Laboratory

## Infrastructure Upgrade

- 4 Tonne Lifting Frame
- Cleanroom Modification



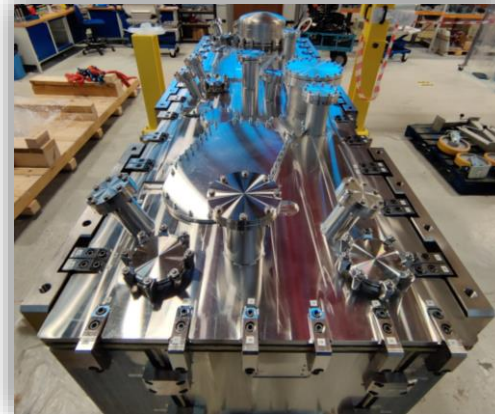
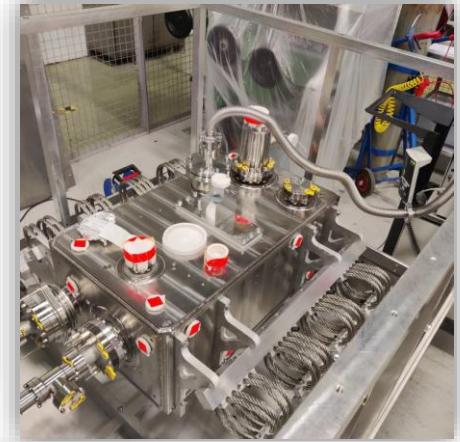
## Equipment

- Cavitystring Trolley
- Lots & lots of Assembly Tooling
- Even more documentation
  - 352p of procedures approved to date



# RFD SPS Cryomodule – Start of the build

- First cavity delivered 29<sup>th</sup> Sep 21
- Second cavity delivered 11<sup>th</sup> Nov 21
- OVC delivered 26<sup>th</sup> Nov 21

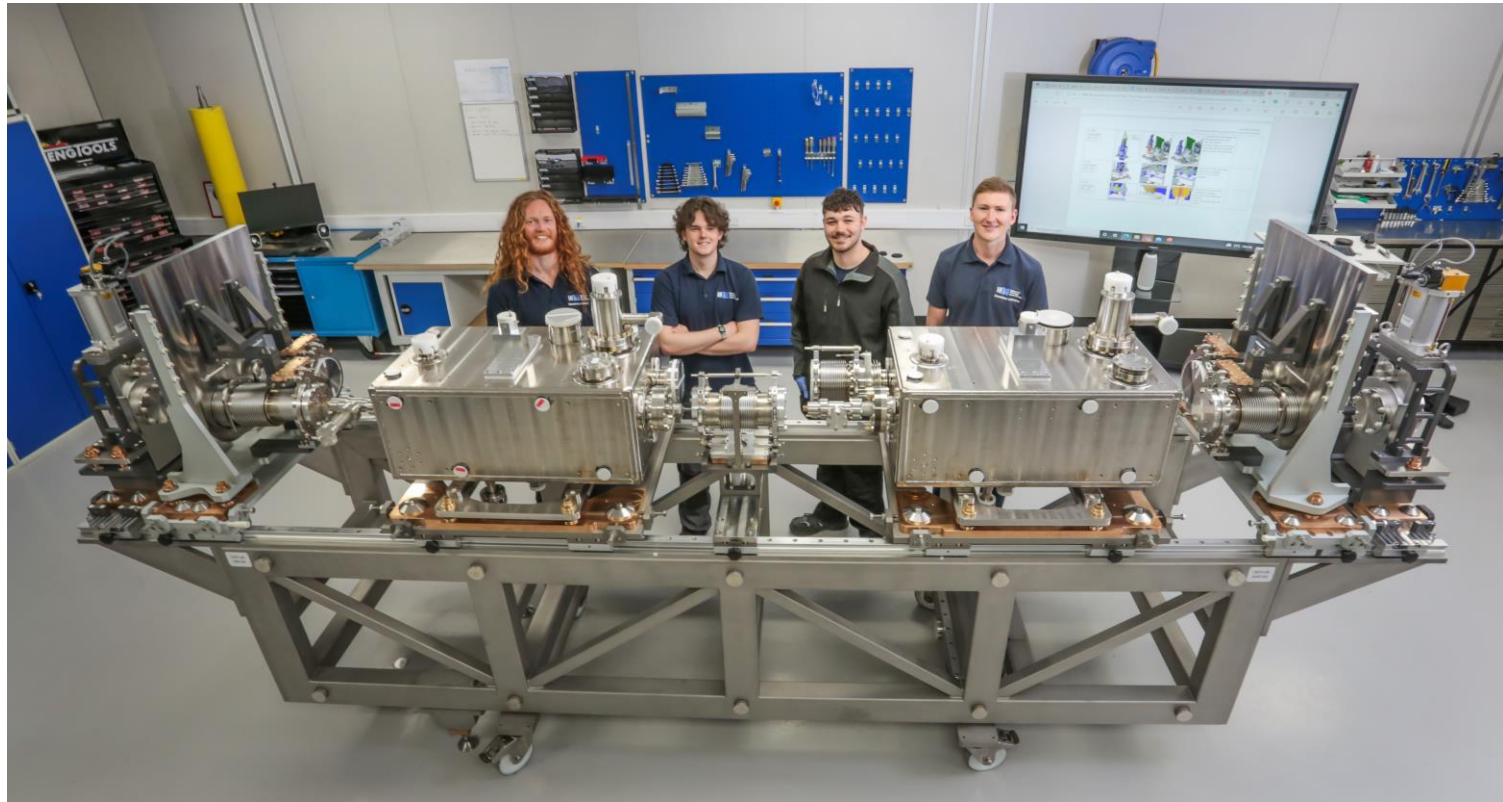


# Time-lapse - Auxiliary Steps A,B,C,D



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# Pre-cleanroom Assembly Complete – April 22



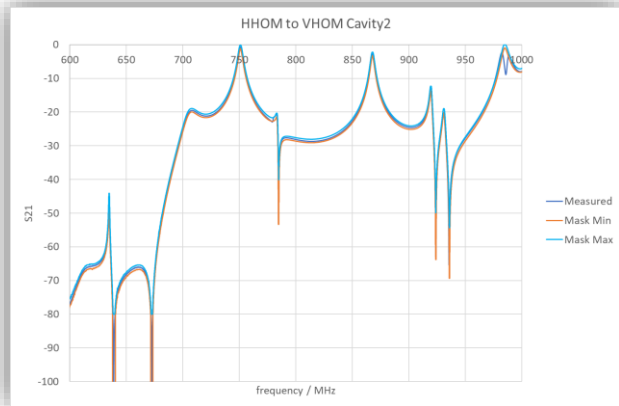


# Time-lapse – Steps 1 & 2



# RFD SPS Cryomodule – Step 2

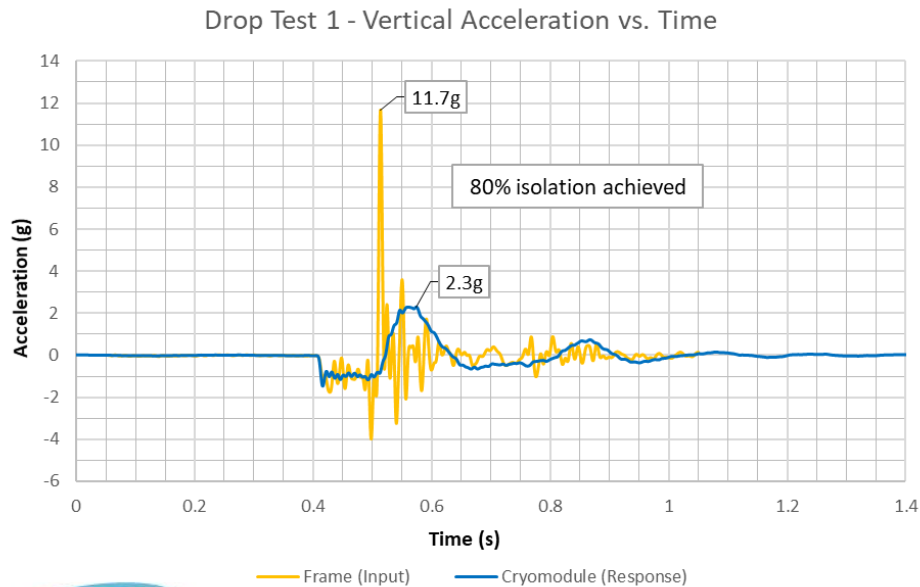
- FPC Installation complete 21<sup>st</sup> July 22
- Vacuum & RF checks successful
- Secondary line assembly complete
  - *Vacuum tests pending*





# Transport Frame Design & Test

- 1<sup>st</sup> drop test performed with a dummy CM ✓
- Results showed ~80% isolation for a 38 mm drop ✓



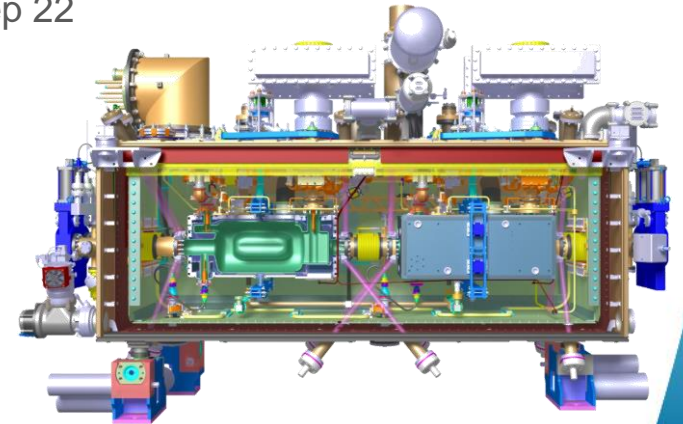
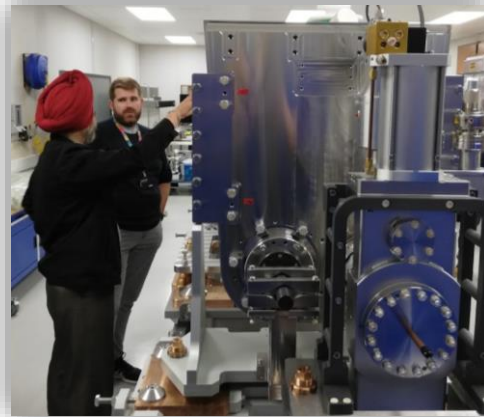
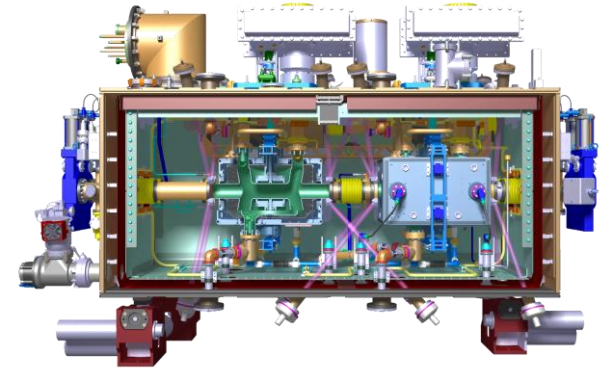
# Status & Next Steps

- Warm Magnetic Shield delivered & assembled to OVC
- Thermal Screen to be shipped from CERN shortly
  - New logistics process in place
- Upper MLI delivered
- First weld samples ready
  - Qualification & documentation work on-going
- Upper Cryo-line delays
- CM scheduled to be delivered to CERN in Feb 23

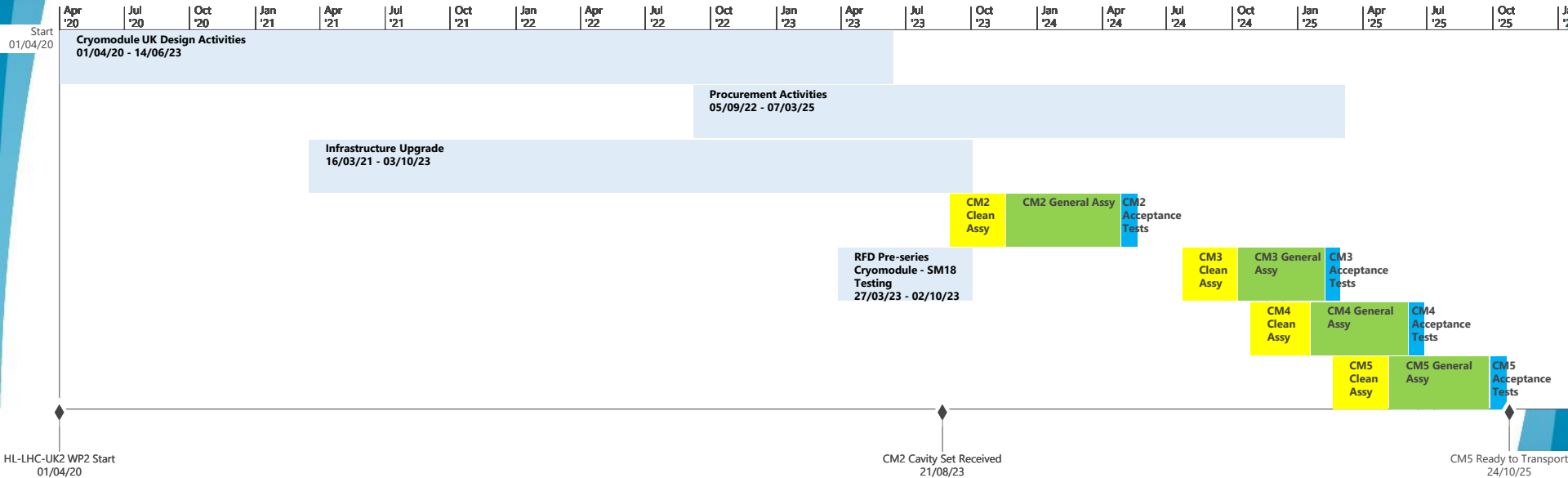


# LHC (Series) Cryomodules

- 4 x DQW at Daresbury +1 at CERN
- 5 x RFD at TRIUMF
- Detailed cryomodule designs in progress
  - Long-lead tenders to be launched soon
- Build experience & lessons learnt shared with TRIUMF Sep 22



# DQW Series Build Timeline




# Further Related Talks

- RFD / DQW cryomodule design – *Teddy Capelli*
- RFD Prototype assembly lessons learned – *Ed Jordan*
- RFD Prototype Final Test Acceptance kit design and manufacture – *Andy May*
- Cryomodule collaboration & lessons learned – *Marco Garlasche*
- *and more...*

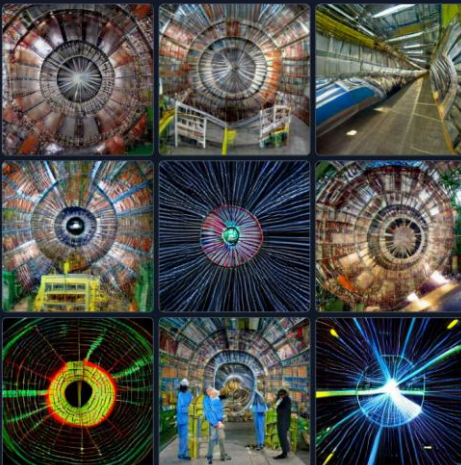


Thank You!

Questions?

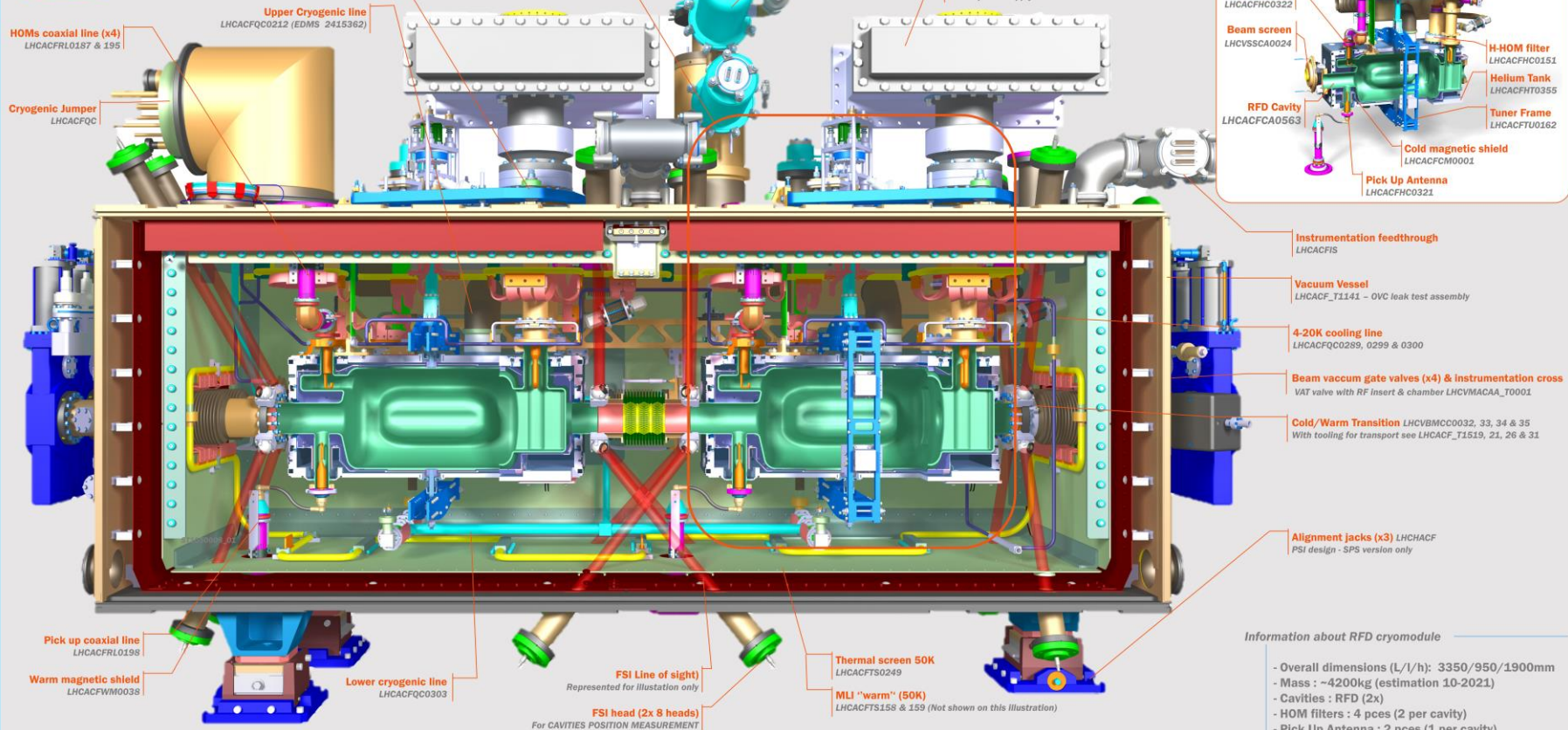
 **craiyon**  
AI model drawing images from any prompt

UK Crab Cavity Cryomodule for the High Luminosity upgrade of the Large Hadron Collider



Sci-Tech Daresbury  
Daresbury Laboratory

[niklas.templeton@stfc.ac.uk](mailto:niklas.templeton@stfc.ac.uk)



**Information about RFD cryomodule**

- Overall dimensions (L/I/H): 3350/950/1900mm
- Mass : ~4200kg (estimation 10-2021)
- Cavities : RFD (2x)
- HOM filters : 4 pces (2 per cavity)
- Pick Up Antenna : 2 pces (1 per cavity)
- Tuner : 2 unit (1 per cavity)
- RF Gate valves : 4 pces
- FSI Heads : 16 ports (8 per cavity)

# Hi Lumi LHC Crab Cavities

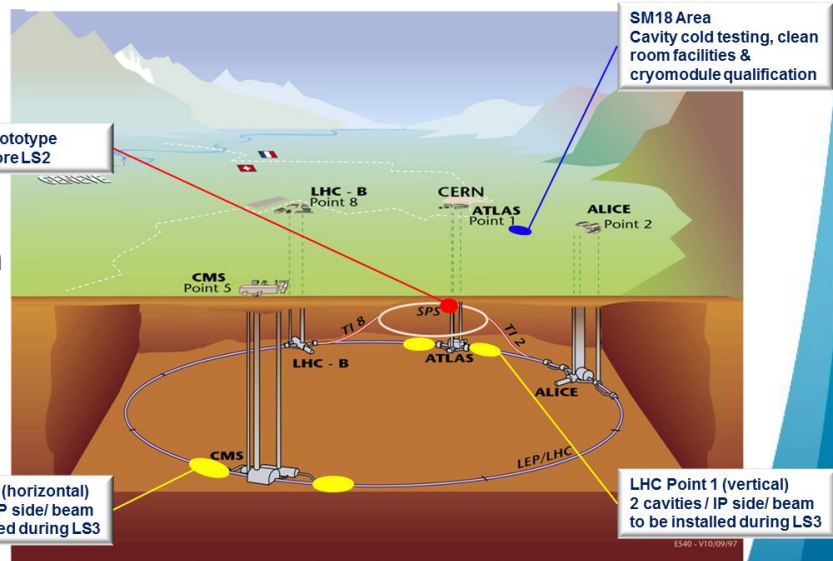


*DQW & RFD Crab Cavities*

- To maximise the discovery potential of the LHC
- Increase Luminosity (rate of collisions) x5
- Using superconducting crab cavities
  - Ultra-precise
  - Compact to fit within LHC beamlines
  - Rotate proton bunches to mimic head-on collision
- 8 CMs to be installed before/after ATLAS & CMS



*Bunches colliding without crab crossing (left) & with the crab crossing (right)*



E540 - V10.09/97

# DQW Cavity Delivery Dates (Estimates May 22)

11/05/2022, 11:27

UK2\_MilestonePlanning\_Apr2022.xlsx

Tentative planning for UK2  
06-May-22

		Pre Covid-19	Post Covid-19	Post Covid-19	C&S 2021	Estimate May 2022
		Estimate Apr 2020	Estimate Feb 2021 (already in master schedule)	Estimate Feb 2021 (already in master schedule)		
Milestone Number	Milestone Name	Complete by	Complete by	Complete by		
M2.02	Collaboration agreement signed by all parties	01/04/2020	06/07/2020	Apr-21		
M2.03	Cryomodule Acceptance Criteria Approved	01/06/2020	01/06/2020	obsolete, see M2.04		
M2.04	Series DQW All Specifications Complete and frozen	01/12/2020		Apr-21		
M2.05	Series DQW CM Conceptual Design Review	09/03/2021	Dec-21	31.03.2022		
M2.06	Pre-Series RFD CM Assembly Complete (ready for shipment)	31/08/2021	30/11/2021	31/03/2022		
M2.07	CM2 Cavity Set Received	01/04/2022	mid-Oct, 2022	05/01/2023	03/01/2023	21/08/2023
M2.08	CM3 Cavity Set Received	26/07/2022	mid-Jan 2023	10.06.2023	07/07/2023	15/07/2024
M2.09	CM4 Cavity Set Received	15/11/2022	end-Apr 2023	01.09.2023	29/09/2023	07/10/2024
M2.10	CM5 Cavity Set Received	21/03/2023	end-Jul 2023	15.12.2023	15/12/2023	13/01/2025
M2.11	CM2 Cold Test at CERN Start	13/01/2023	end-Jul 2023	Oct-23	05/10/2023	22/07/2024
M2.12	CM3 Cold Test at CERN Start	05/05/2023	end-Oct 2023	Apr-24	06/03/2024	07/04/2025
M2.13	CM4 Cold Test at CERN Start	25/08/2023	end-Feb 2024	Oct-24	08/07/2024	11/08/2025
M2.14	CM5 Cold Test at CERN Start	07/02/2025	Oct-25	Oct-25	13/04/2026	15/04/2027

RI preseries 1-2  
RI series 1-2  
RI series 3-4  
RI series 5-6  
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