

DQW Crab Cavity Cryomodules – UK Collaboration

Niklas Templeton – STFC Daresbury Laboratory
14th HL-LHC Collaboration Meeting, Genoa, ITA

7th Oct '24

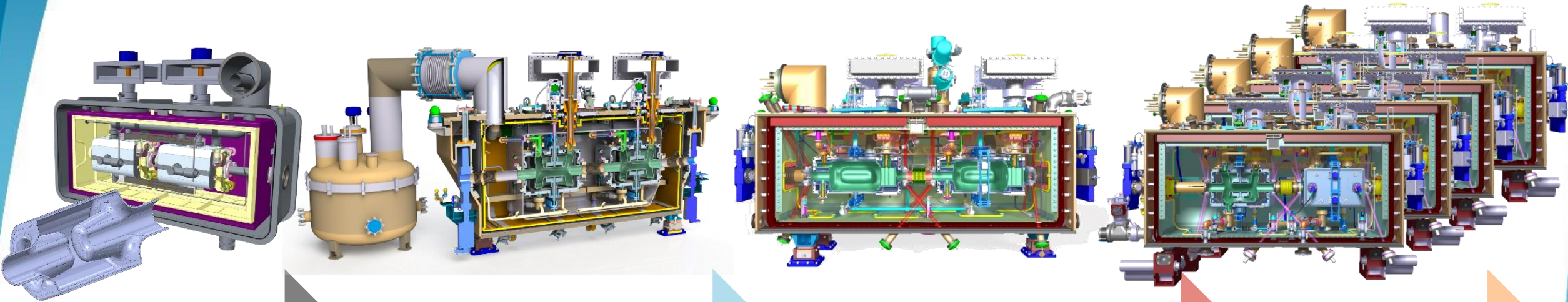


DQW-LHC Cryomodules UK



- CM2 Status & Schedule
- Build Area Upgrades & Improvements
- Assembly Tooling & Procedures
- Cryomodule Procurements
- Staff & Planning

Hi Lumi Crab Cavities – UK Collaboration

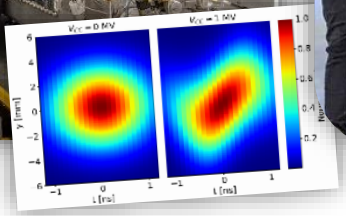
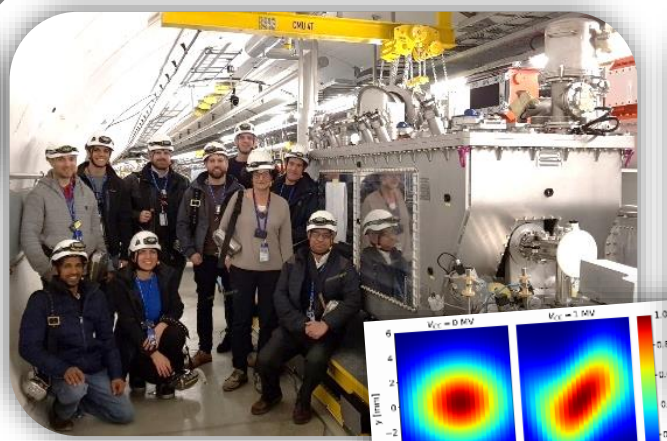


2011 UK 4-Rod Crab Cavity

DQW Prototype CM

RFD-SPS CM

DQW-LHC CMs 2027



RFD Build Poster by Teddy Capelli

Step 1 Step 2 Step 3 Step 4 Step 5 Step 6 Step 7 Step 8 Step 9 Step 10 Step 11 Step 12

ISO4

LOAD TRANSFER

LOAD TRANSFER

Trolley Assy

Gantry Assy

Welds, Tests & Transport Loading

pipe & bellows
UHV shielded bellows
Extremely vacuum inst.
STEP 1 - Assembly files
Auxiliary STEP A, B & C
Assembly files

2K filling line
Upper cryogenic support
4.20K cooling line
HOMS cooling line
Tuner frame
Thermal intercept

4K upper line
50K upper line
Thermalization braids 1/2

Cryo instrumentation 2/6
HOMS thermal links
HOMS - RF lines
Jumper support
Cryostat upper plate

Cavity support
FSI flanges
FSI targets
Thermal intercept
HOMS - RF lines
External clamp
Beam screen cooling line

STEP 2 - Assembly files

STEP 3 - Assembly files

STEP 4 - Assembly files

STEP 5 - Assembly files

STEP 6 - Assembly files

Antenna - RF lines & Cable installation
STEP 8 - Assembly files

Magnetic sensors

Thermalization intercept
Thermal screen
Thermal screen preparation
Cryogenic extensions

Internal intrum.

STEP 7 - Assembly files

STEP 8 - Assembly files

STEP 9 - Assembly files

STEP 10 - Assembly files

STEP 11 - Assembly files

STEP 12 - Assembly files

Rigid line
Cryo instrumentation 5/6
FSI flanges
Vacuum vessel
Extremely vacuum inst.
Vacuum blow off valve
STEP 11 - Assembly files

Level gauge and Helium guard
Cryo instrumentation 6/6
External heaters and sensors
STEP 12 - Assembly files

WELDING ACTIVITY

STEP 1 - Assembly files

STEP 2 - Assembly files

STEP 3 - Assembly files

STEP 4 - Assembly files

STEP 5 - Assembly files

STEP 6 - Assembly files

STEP 7 - Assembly files

STEP 8 - Assembly files

STEP 9 - Assembly files

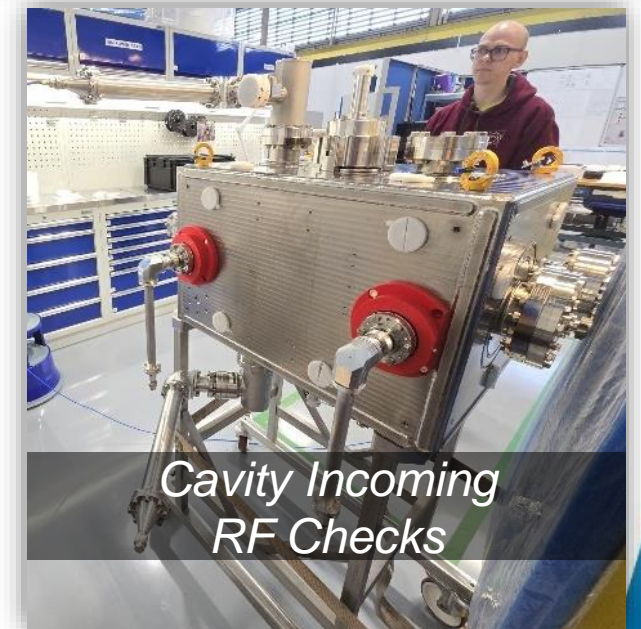
STEP 10 - Assembly files

STEP 11 - Assembly files

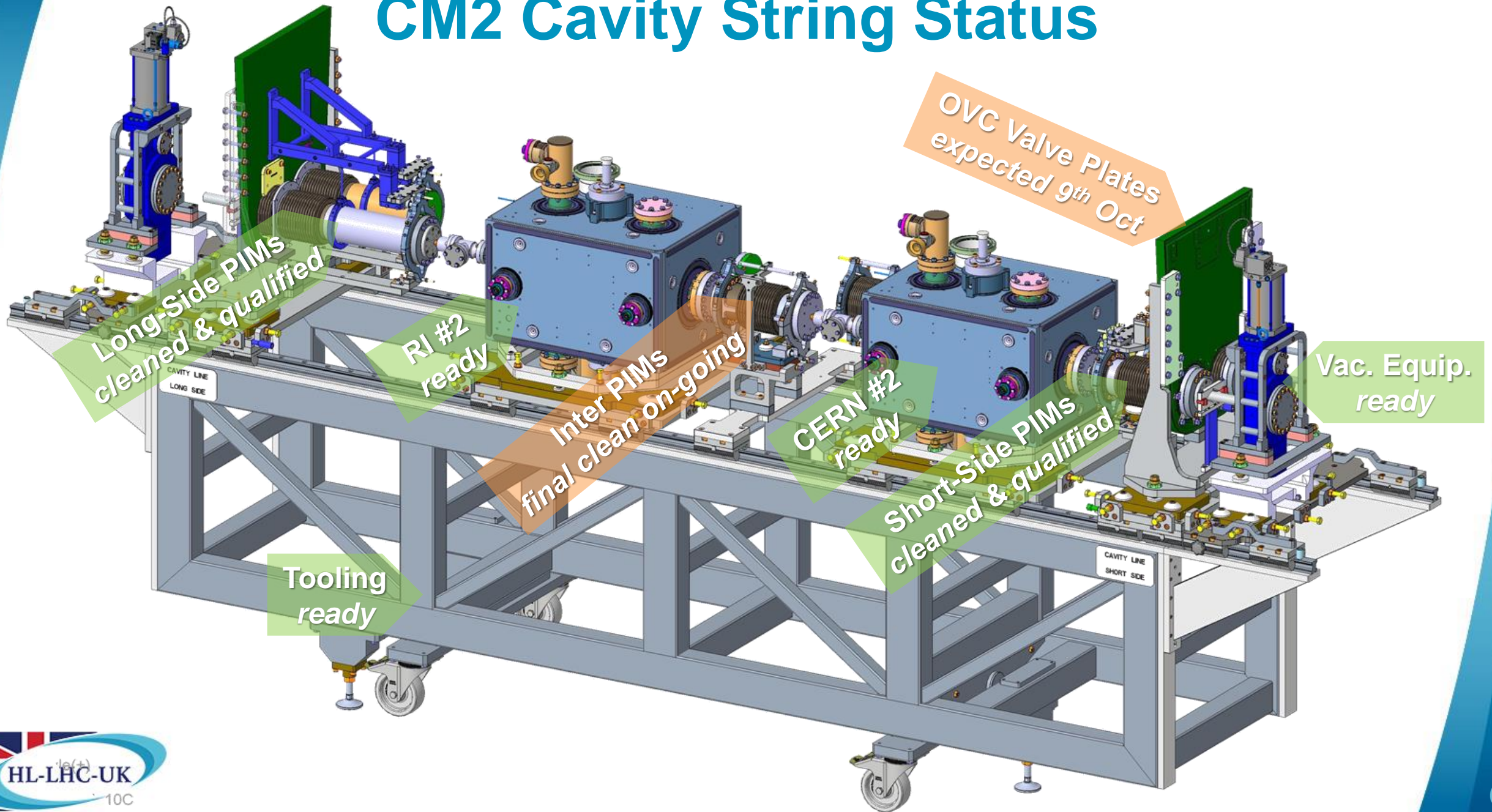
STEP 12 - Assembly files

1st DQW-LHC Cryomodule Build

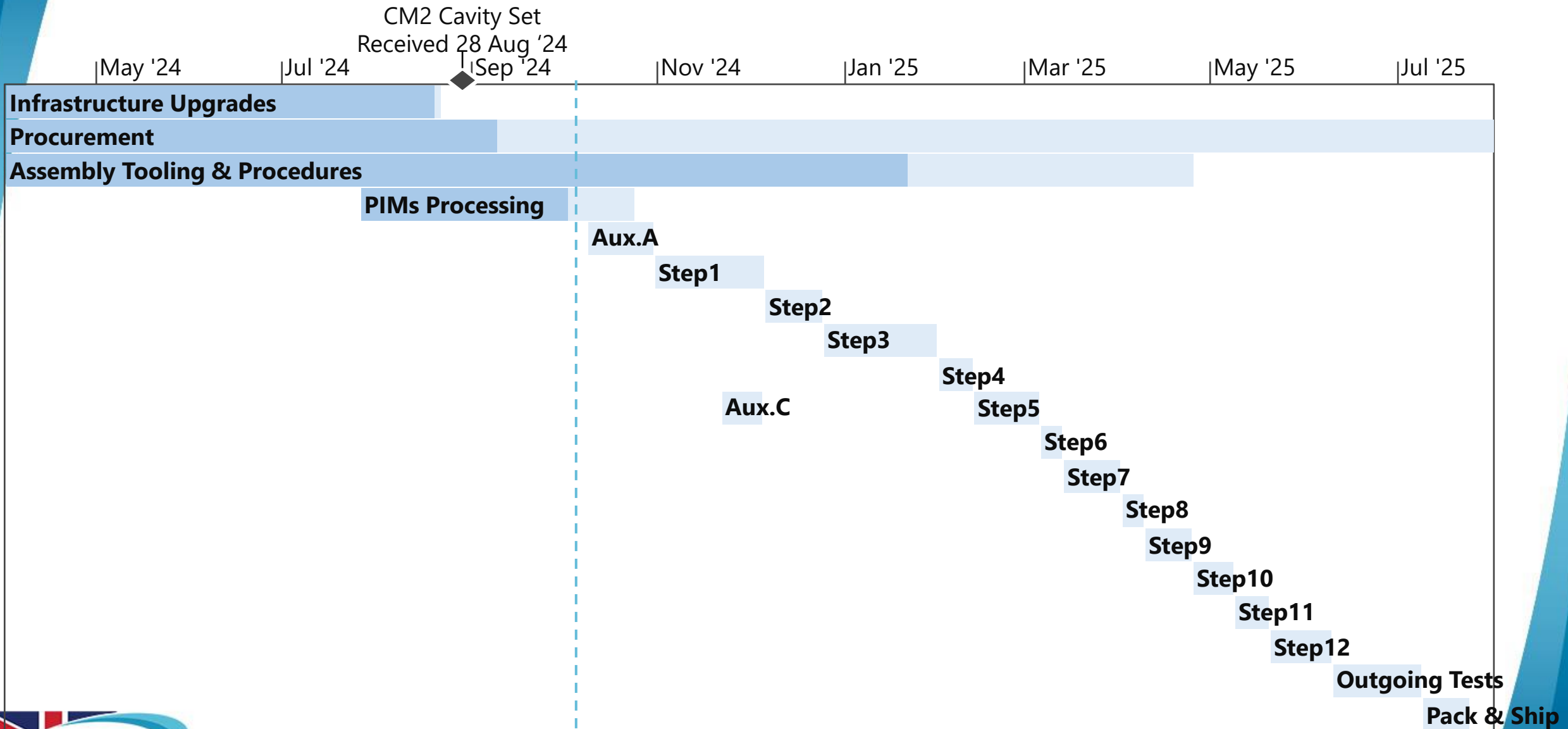
- Received 28th Aug '24
 - 2x DQW cavities
 - 2x Fundamental Power Couplers
 - 6x Beamscreen Bellows
 - Vacuum Equipment & Fasteners
- UHV cleaning & qualification of beamscreen assemblies *on-going*
- Incoming RF checks performed
- Assembly tooling cleaned & ready
- Awaiting OVC Valve Plates to start build



CM2 Cavity String Status



CM2 Schedule



Infrastructure Upgrades

Overhead
Electrical Boom

Gantry
Modifications

Cryo, Vacuum, Weld
& QA workstations

More Storage

+ Far
Storage

New Floor

5S Markings



Continuous Improvement

Luke Bladen & Carlos Granjeiro



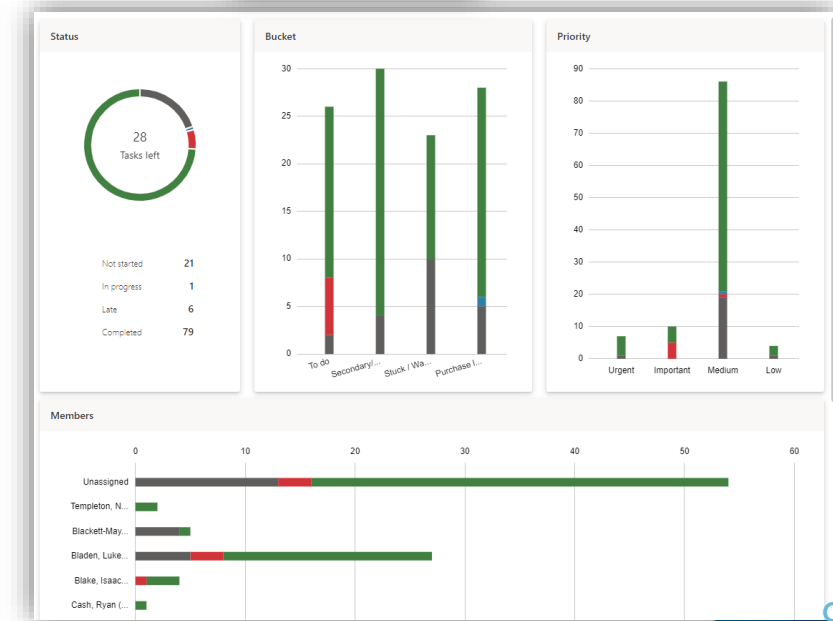
- Build Area 5S Methodology
- New Parts Management System
 - + Processes & Local Instructions
- Quality Control Workstation
- Digital Technician Job-Board

PartID	ST Num.	CERN Num.	DL Number	ISO Num.	Description	Cleanline
18	ST119193	LHCACHC3230	300-10081-00018		DQW FEEDTHROUGH 25 Ohm INNER ROD BRAZING	UHV
19	ST1441029	LHCACHC3428	300-10081-00019		DQW HOM COUPLER - WELDING ASSEMBLY	UHV
20	ST1439442	LHCACHC3414	300-10081-00020		DQW HOM COUPLER DN63 BRAZING ASSEMBLY - MACHINING	UHV
21	ST1440991	LHCACHC3425	300-10081-00021		DQW HOM COUPLER HOOK+NB ROUND - MACHINING	UHV
22	ST1580392	LHCACHC3468	300-10081-00022		HOM COUPLER BODY ELECTRON-BEAM WELDING ASSEMBLY	UHV
23	ST1440016	LHCACHC3421	300-10081-00023		HOM COUPLER TEE SECTION - MACHINING	UHV
24	ST1028565	LHCACHC3187	300-10081-00024		HOM COUPLER BELLOWS - ASSEMBLY	UHV
25	ST1440229	LHCACHC3417	300-10081-00025		DQW HOM COUPLER DN40 BRAZING ASSEMBLY - MACHINING	UHV
26			300-10081-00026			UHV



The screenshot shows a digital technician job-board interface with several task lists:

- To do:** PIMS PROCESSING SECONDARY, PIMS PROCESSING, Floor Holes, Critical Path, Dusty Jobs Day, FLOOR HOLES TO BE MARKED, FLOOR DRILLED FOR PUSHER PLATES, ORDER HITS FOR FLOOR.
- Secondary/Apprentice Tasks: To do:** 5S FLOOR MARKINGS, Swap Q2 and Q3 (outgoing parts), new areas, Cable Management.
- Completed tasks:** 26
- Stuck / Waiting on info from others:** cold-test trolley assembly, Move FATKIT and Server, WAITING ON: Final test by andy and ian ea, WALLS, matrix corner.
- Purchase list:** spill kit, Cotton swab, Hits for floor, mag-perm, CR - filter, UHV FOIL.



Assembly Procedures & Tooling *Ed Jordan*



String Assembly Tooling



Steps 0-6 Tooling & Procedures ✓



Clean Glovebox



Cold Test Trolley

Metrics	Procedures	DWGs
RFD-SPS	892p	675
DQW-LHC	554p	254

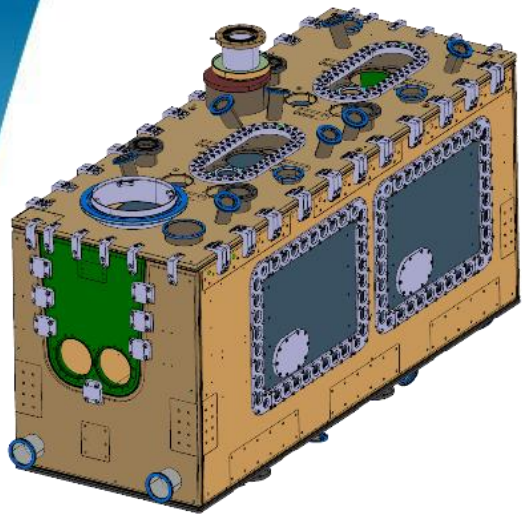


Anti-shock Transport Frame & Arms



Outer Vacuum Chambers

Ollie Poynton

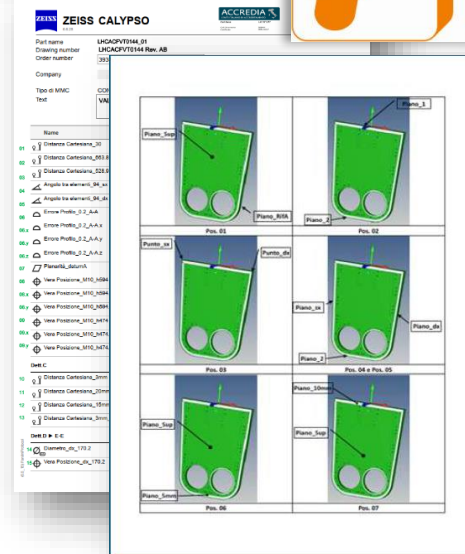


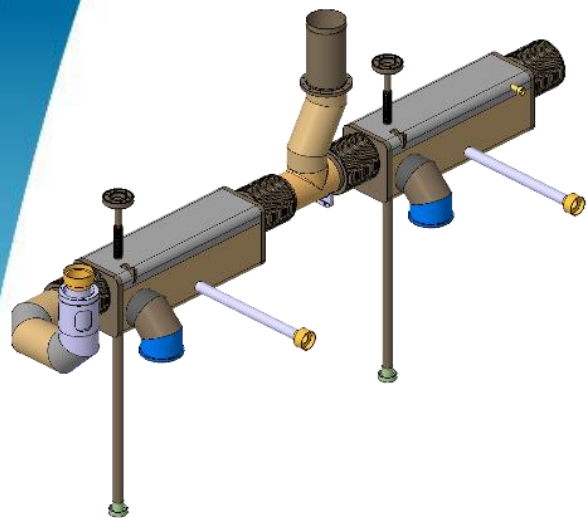
Design: CERN

Procurement: Lancaster

Manufacture: Fantini

- MIP ✓
- material traceability ✓
- welding qualifications ✓
- machining & metrology ✓
- welding – *on-going*
- leak tests – *next*





Bi Phase Cryoline

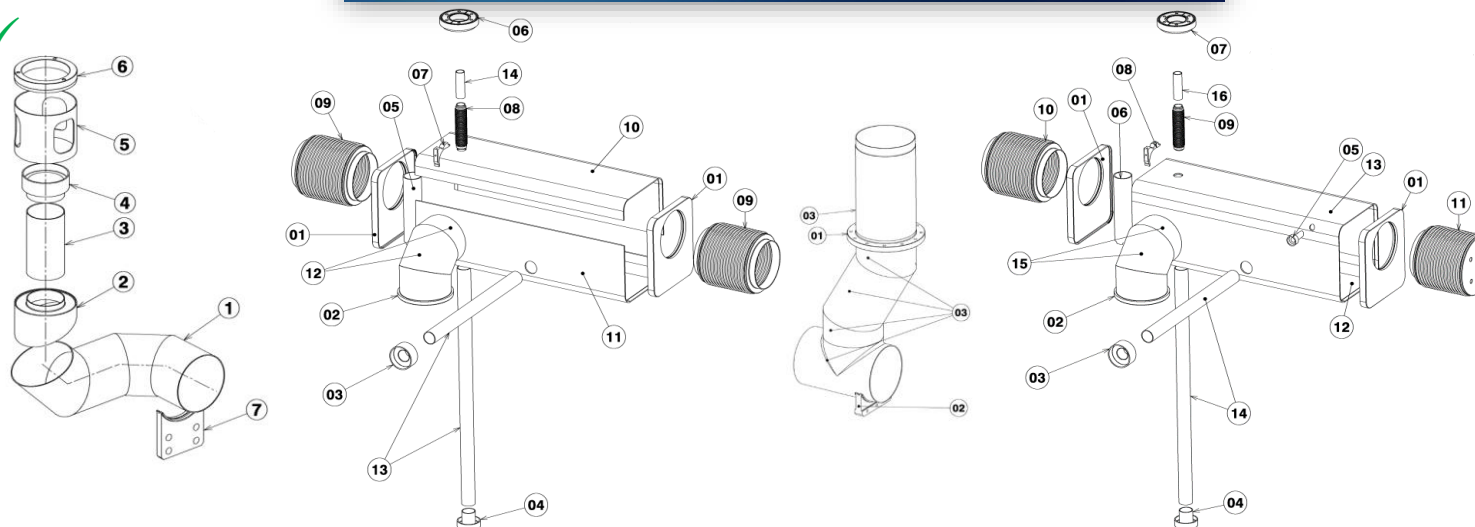
Andy Blackett-May & Carlos Granjeiro



Design: CERN
 Procurement: STFC
 Manufacture: Hyde

- free-issue sub-parts ✓
- material traceability ✓
- MIP v0.9 - *in-review*
- fabrication – *next*

CM2 critical path



CMM Dimensional Metrology Report

DL LHCFC0208 v AB
 Date: September 27, 2024
 Title: Test Fixture for Cryo Support DB3
 Operator: 101834 ABP
 Machine: 127-05-24

Feature	Actual	Nominal	Upper Tol.	Lower Tol.	Description
Feature: Dia 8	8.0000	8.0000	0.0000	0.0000	
Feature: Dia 10	10.0000	10.0000	0.0000	0.0000	
Feature: Dia 12	12.0000	12.0000	0.0000	0.0000	

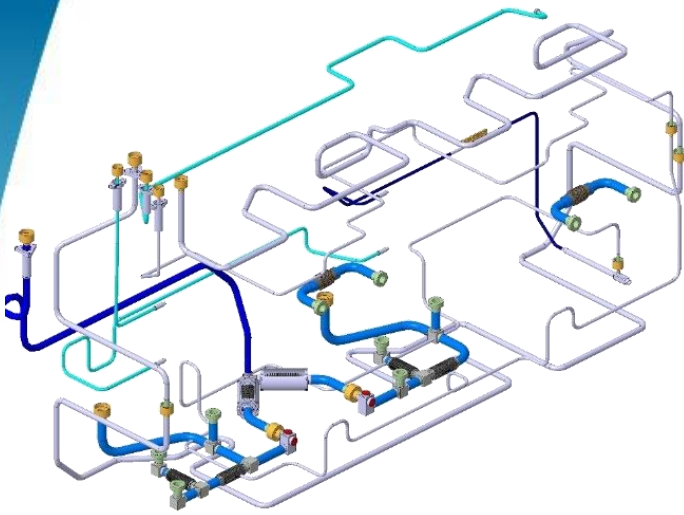
MIP v0.9

Item No.	Description	Material	Quantity	Unit	Drawn	Checked	Released
01
02
03
04
05
06
07
08
09
10
11
12
13
14
15
16



Other Cryolines

Andy Blackett-May & Carlos Granjeiro



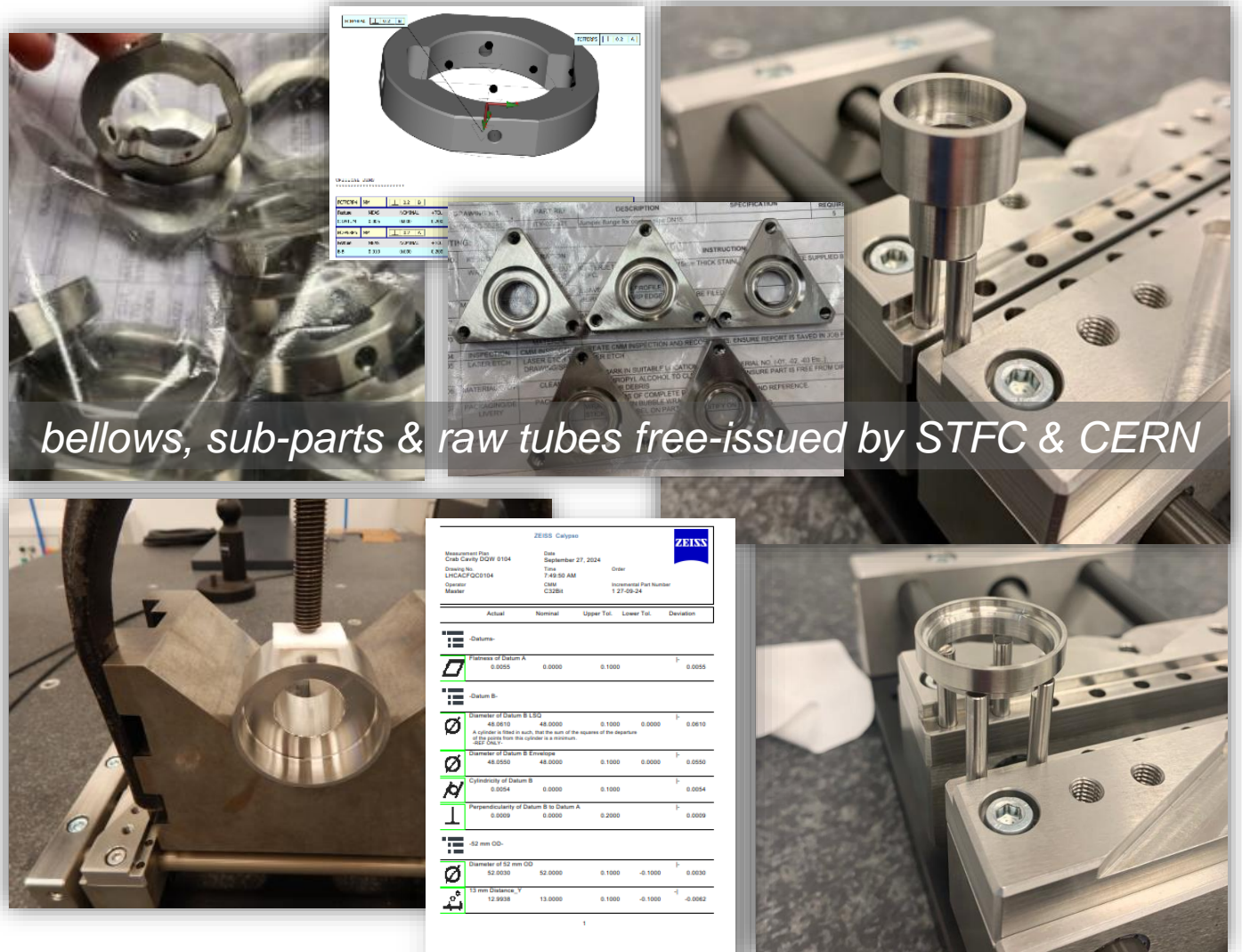
Design: CERN

Procurement: STFC

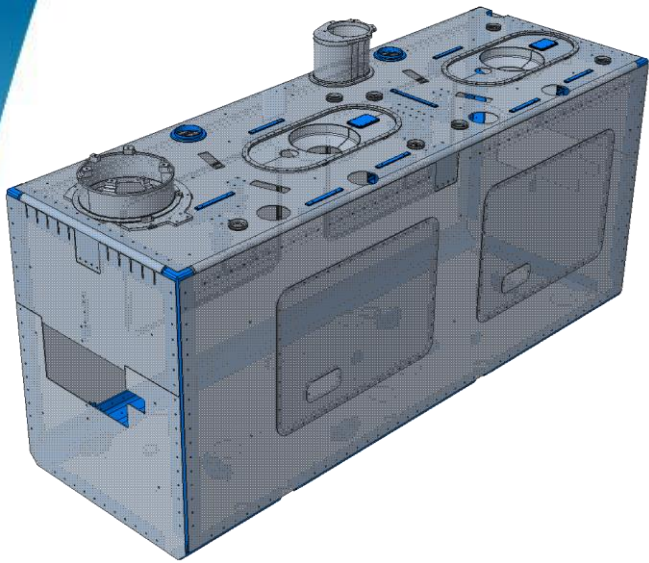
Manufacture: Fieldhouse Engineering

- free-issue sub-parts ✓
- material traceability ✓
- MIP v0.3 - *in-review*
- tube bending – *next*

upper lines - CM2 critical path



Thermal Screens

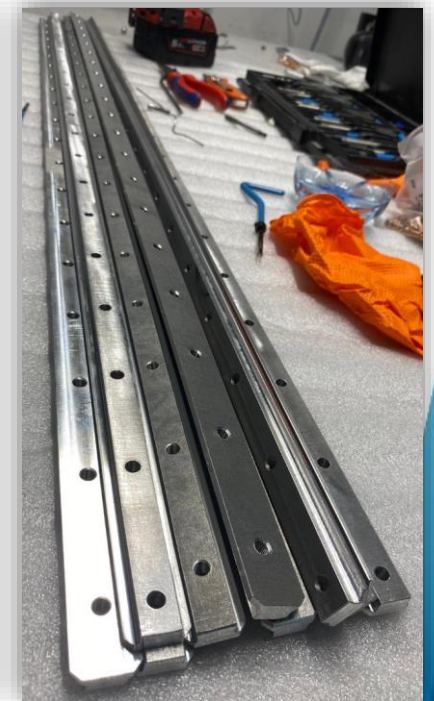


Design: CERN & STFC

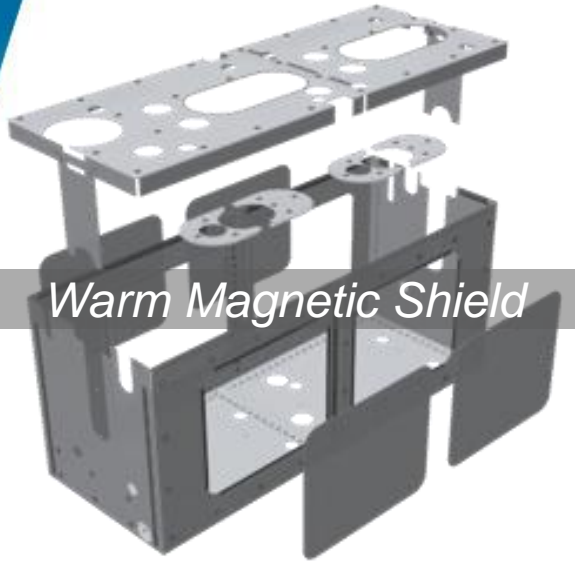
Procurement: STFC

Manufacture: EGKENN

- MIP ✓
- material traceability ✓
- fabricartion & metrology – *ongoing*
- mock assembly – *next*



Magnetic Shields



Warm Magnetic Shield

Design: CERN & STFC

Procurement: STFC

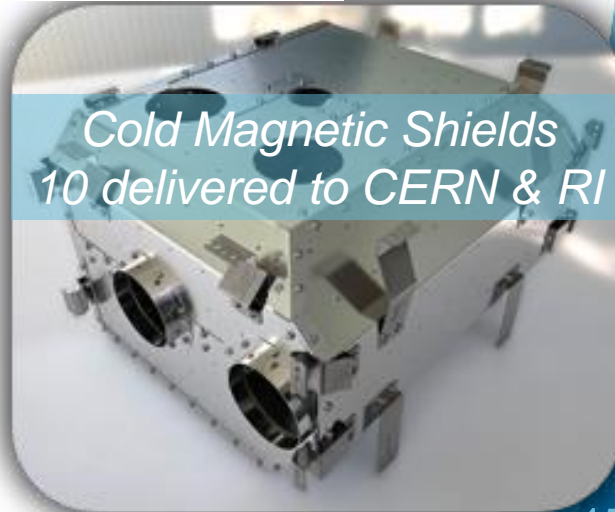
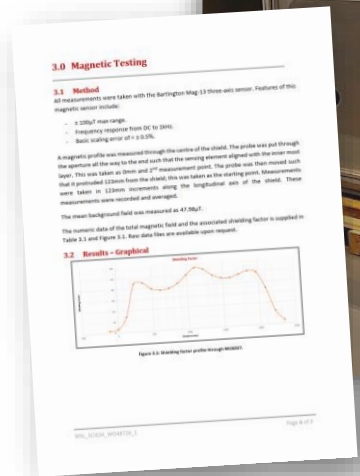
Manufacture: Magnetic Shields LTD

- MIP ✓
- material traceability ✓
- fabrication, metrology & tests ✓
 - 3 of 5 delivered

Item No.	Part No.	Description	QTY	UNIT	PRICE	TOTAL
1	MS-001	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
2	MS-002	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
3	MS-003	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
4	MS-004	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
5	MS-005	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
6	MS-006	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
7	MS-007	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
8	MS-008	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
9	MS-009	Warm Magnetic Shield Plate	100	EA	120.00	12000.00
10	MS-010	Warm Magnetic Shield Plate	100	EA	120.00	12000.00



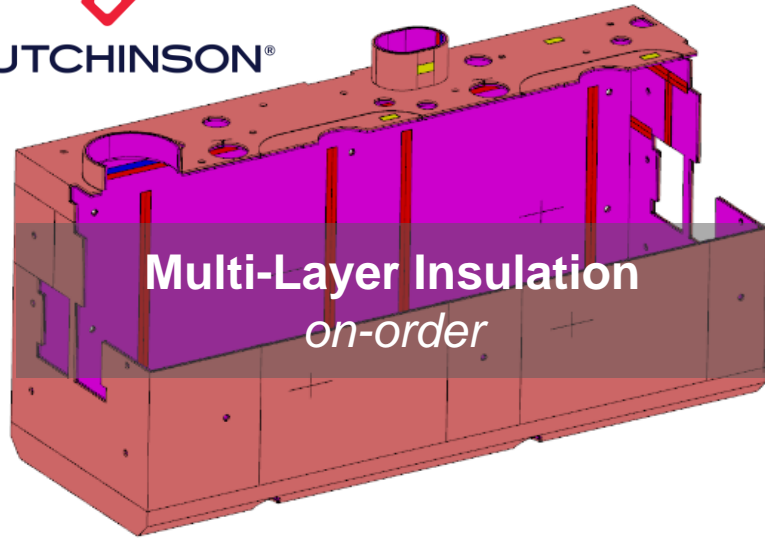
Magnetic Shields
Electromagnetic Engineering



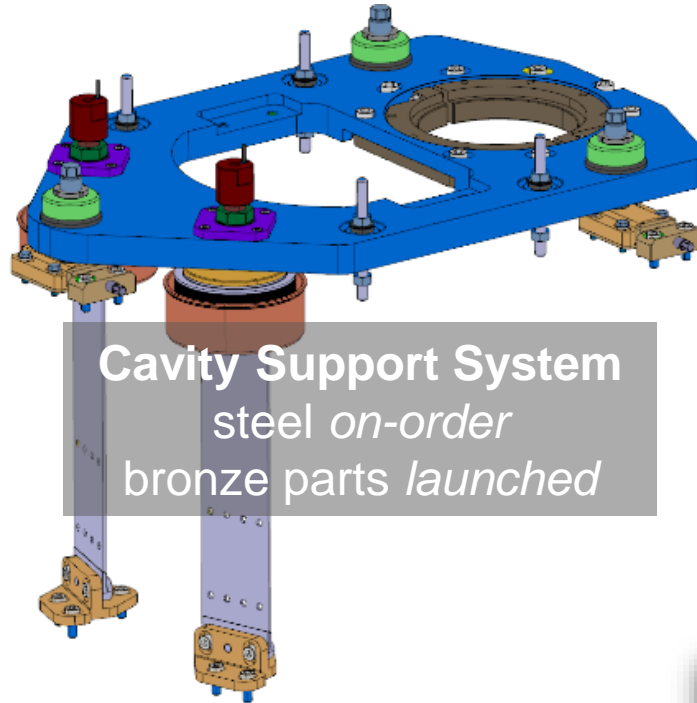
Cold Magnetic Shields
10 delivered to CERN & RI



Other CM Procurements



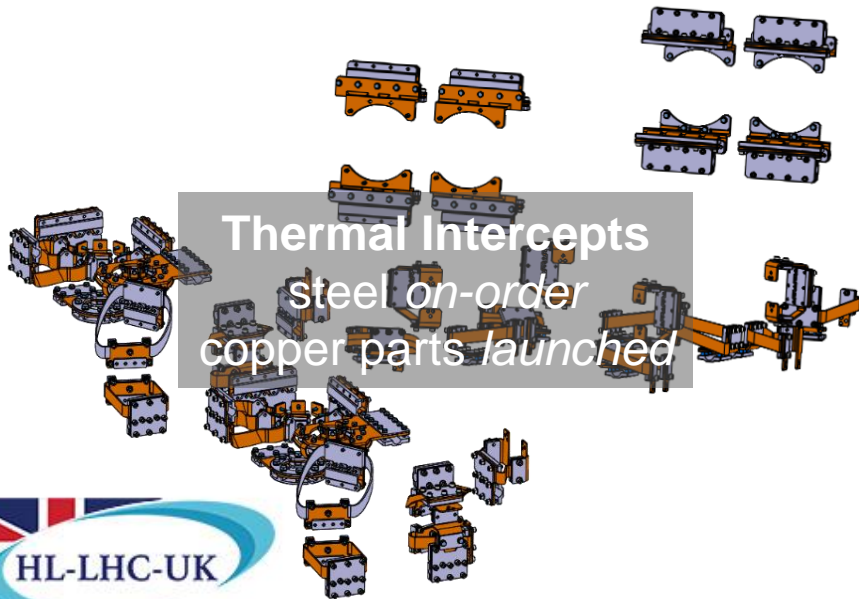
Multi-Layer Insulation
on-order



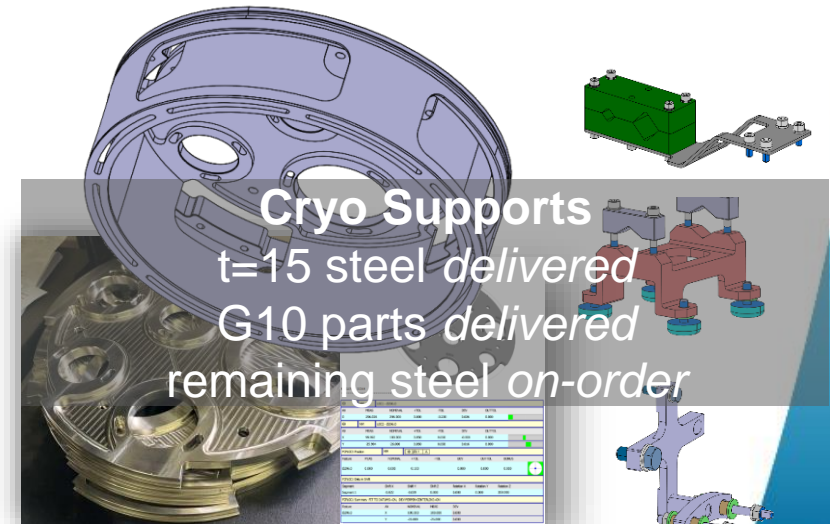
Cavity Support System
steel *on-order*
bronze parts *launched*



Bi Phase Supports
delivered



Thermal Intercepts
steel *on-order*
copper parts *launched*



Cryo Supports
t=15 steel *delivered*
G10 parts *delivered*
remaining steel *on-order*



Staff

Arriving Oct'24
Luke Farley
Lancaster Grad.



Graeme Burt
HL-LHC-UK PM



Ian Lazarus
STFC Sponsor



Phil Atkinson
Technical Oversight



Anna Vikhoreva
Project Support



WP2 Lead
Nik Templeton



Paul Hindley
Technician Manager

Departed Sep'24
Tom Hanley
Senior Technician


Management & Oversight

Design, Assembly Procedures & Tooling


Quality Assurance, Welding & Logistics

Instrumentation, Qualification & Testing


Technical Engineering




Ed Jordan
DAPT Lead




Carlos Granjeiro
QAWL Lead



Andy Blackett-May
IQT Lead



Luke Bladen
TE Lead




Marco
Contract Engineer



John
Welder




Ivan
Cryo Engineer




Stuart
Vac Engineer



Abi
Technician



Kavi
Grad Engineer



Ollie
Vac Engineer



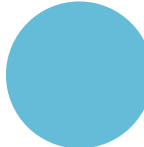
Susan
Technician



Matty
Technician



Dan
Design Apprentice



David
Undergrad Engineer



Apprentice
Technicians

Shared Resources

Outside
Manufacture

In-House
Manufacture

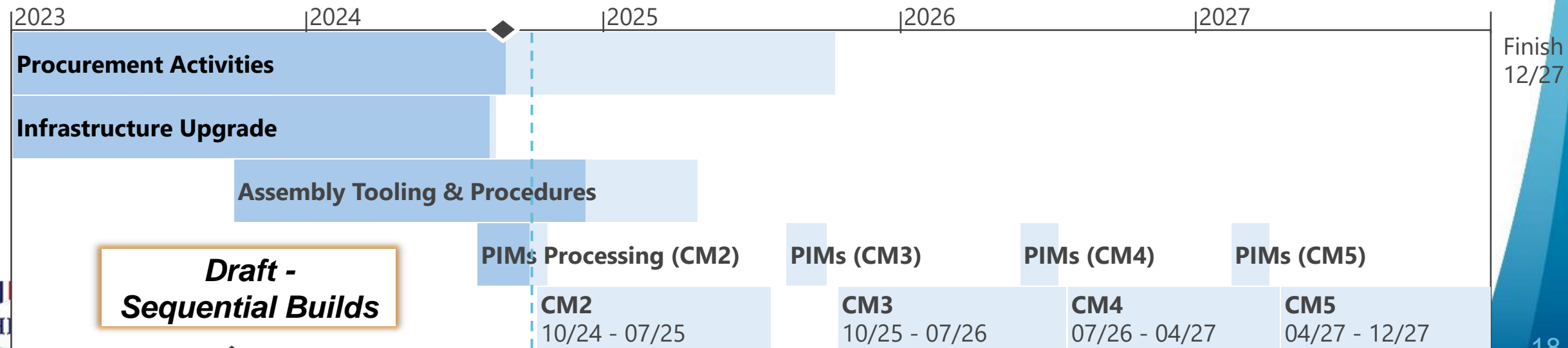
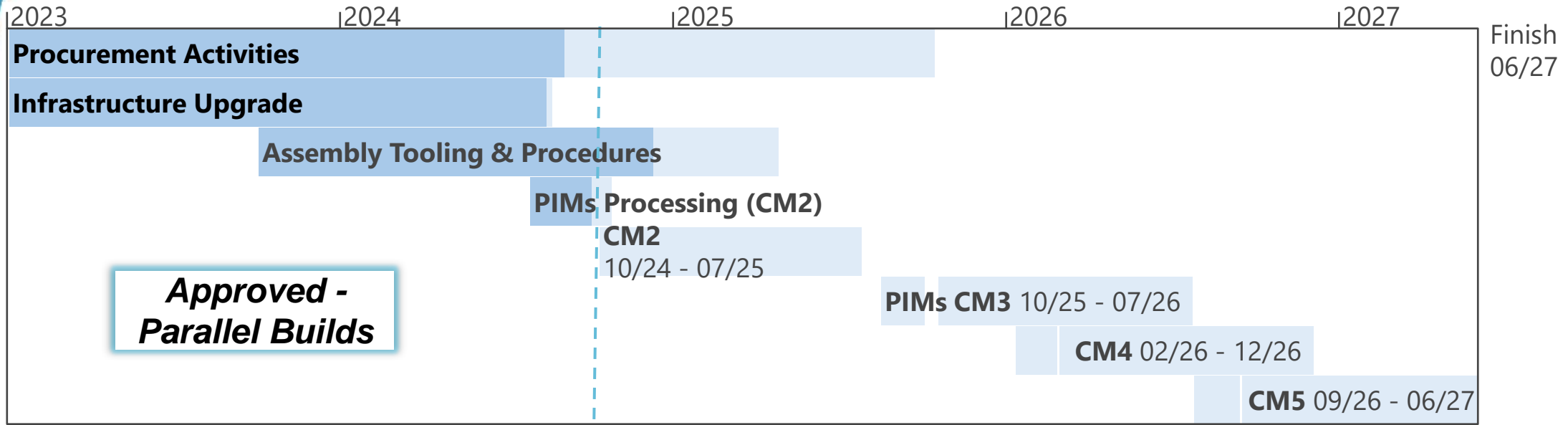
Vacuum
Processing

Riggers

Metrology

Logistics

Planning





Related Talks

Nuria's Cavities Wed 08:50

Ed's RFD Tue 16:10

Teddy's Cryomodules Wed 14:00

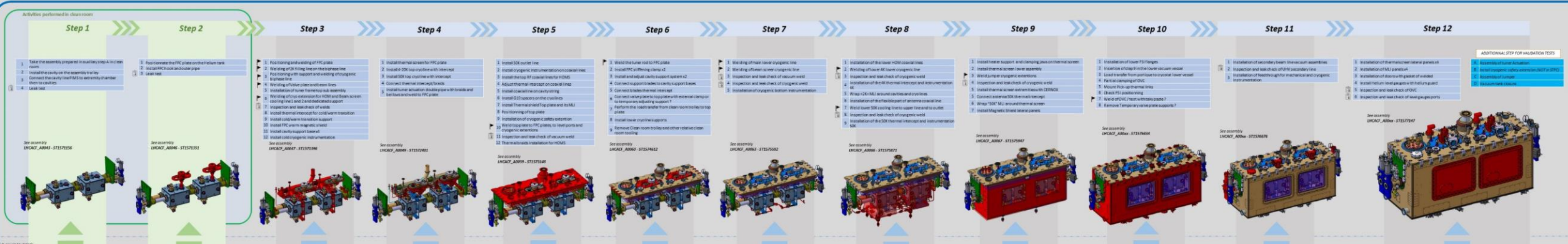
Thanks!

Questions?



Daresbury Laboratory





Cavity equipped UHVC02008 - 1001 - Preparation steps UHVC02008 - 0200 - Drilled cavity 	FPC Assembly with outer pipe & bellows UHVC02008 	Upper cryoline UHVC02037 	FPC screen + MU UHVC02041 - 2K filling line UHVC02042 - 2K filling line UHVC02043 - 4K upper line 	SOK outlet line UHVC02045 - Line SOK with intercept 	FPC plate clamp UHVC02052 - FPC plate clamp 	Beam screen cooling lines UHVC02086 - 4-20K heat exchanger line UHVC02087 - 4-20K heat exchanger line 	MU 2K UHVC02088 - MU 2K 	Internal cryo supports UHVC02090 - Heater support UHVC02091 - Cabling lines 	FSI Flanges UHVC02092 - FSI device on flange 	Extremity vacuum inst. UHVC02094 - Extremity module type 1 UHVC02095 - Extremity module type 2 	Doors UHVC02096 - Door clamping UHVC02097 - Corner flange UHVC02098 - Cover for transport UHVC02099 - Thermal screen doors UHVC02100 - Thermal screen covers 	Tuner activation UHVC02101 - Tuner activation 														
UHV shielded bellows UHVC02004 - Inner bellows screen PM UHVC02005 - Inner cavity PM UHVC02006 - Short trans. Sec. Line UHVC02007 - Short trans. Cas. Line UHVC02008 - Long trans. Sec. Line UHVC02009 - Long trans. Cas. Line 	FPC plate for OVC UHVC02011 	2K filling line UHVC02037 - 2K filling line 	4K upper line UHVC02041 - 4K upper line 	HOMS thermal links UHVC02045 - Line SOK with intercept 	Thermal intercept UHVC02052 - Thermal intercept 	Main lower cryogenic line UHVC02086 - Lower cryogenic line UHVC02087 - Lower cryogenic line 	Antennas - RF lines Cable installation UHVC02088 - Antennas - RF lines Cable installation 	Lower HOMs - RF lines UHVC02088 - Lower HOMs - RF lines 	Thermal screen preparation UHVC02090 - Thermal screen preparation 	Vacuum vessel UHVC02092 - Vacuum vessel 	Internal instrum. feedthroughs UHVC02094 - Internal instrum. feedthroughs 	Cryo instrumentation 2/6 UHVC02096 - Cryo instrumentation 2/6 	Beam screen cooling lines UHVC02086 - Beam screen cooling lines 	External damp UHVC02053 - External damp 	External cryo supports UHVC02090 - External cryo supports 	4K lower line UHVC02041 - 4K lower line 	50K lower line UHVC02045 - 50K lower line 	Thermal screen UHVC02090 - Thermal screen 	Valve plate clamp UHVC02092 - Valve plate clamp 	Blow-up Valve UHVC02095 - Blow-up Valve 	Cryo instrumentation 3/6 UHVC02096 - Cryo instrumentation 3/6 	STEP 7 - Assembly files 	Thermal screen end panels UHVC02090 - Thermal screen end panels 	External heaters and sensors UHVC02096 - External heaters and sensors 	STEP 12 - Assembly files 	
Valve plate UHVC02044 - Valve plate 	STEP 2 - Assembly files 	4-20K cooling line UHVC02038 - 4-20K cooling line 	SOK upper line UHVC02045 - SOK upper line 	G10 spacers UHVC02088 - G10 spacers 	External damp UHVC02053 - External damp 	Cryo instrumentation 4/6 UHVC02096 - Cryo instrumentation 4/6 	Transport pod UHVC02101 - Transport pod 	STEP 8 - Assembly files 	Thermal screen UHVC02090 - Thermal screen 	External clamp UHVC02092 - External clamp 	STEP 11 - Assembly files 	Level gauge and Helium guard UHVC02096 - Level gauge and Helium guard 	Beam screen cooling lines UHVC02086 - Beam screen cooling lines 	Beam screen cooling support UHVC02053 - Beam screen cooling support 	50K lower line UHVC02045 - 50K lower line 	HOMS thermal links UHVC02045 - HOMS thermal links 	Cryo instrumentation 5/6 UHVC02096 - Cryo instrumentation 5/6 	Thermal screen end panels UHVC02090 - Thermal screen end panels 	Valve plate clamp UHVC02092 - Valve plate clamp 	Lower vessel preparation UHVC02092 - Lower vessel preparation 	Cryo instrumentation 6/6 UHVC02096 - Cryo instrumentation 6/6 	STEP 9 - Assembly files 	MU 50K UHVC02088 - MU 50K 	STEP 10 - Assembly files 	Magnetic shield UHVC02096 - Magnetic shield 	STEP 9 - Assembly files
Extremity vacuum inst. UHVC02094 - Extremity vacuum inst. 	STEP 1 - Assembly files 	HOMS cooling line UHVC02038 - HOMS cooling line 	Tuner frame UHVC02041 - Tuner frame 	Thermal screen UHVC02090 - Thermal screen 	Beam screen cooling support UHVC02053 - Beam screen cooling support 	Transport pod UHVC02101 - Transport pod 	STEP 8 - Assembly files 	Thermal screen UHVC02090 - Thermal screen 	External clamp UHVC02092 - External clamp 	Valve plate clamp UHVC02092 - Valve plate clamp 	STEP 10 - Assembly files 	Internal support UHVC02090 - Internal support 	Magnetic shield UHVC02096 - Magnetic shield 	STEP 9 - Assembly files 	Partial support UHVC02041 - Partial support 	Cryo instrumentation 1/6 UHVC02096 - Cryo instrumentation 1/6 	STEP 3 - Assembly files 	WELDING ACTIVITY 	WELD INSPECTION - LEAK TEST 	STEP 11 - Assembly files 	STEP 12 - Assembly files 					