

UK Cryomodules Procurements, Schedule & Challenges

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

9th Oct '24

focaccia
Gotta catch 'em all!



UK Procurements, Schedule & Challenges

- Cryomodule Procurements (Recap)
- Planning (Recap)
- Risks, Existing Controls, & Mitigations Options

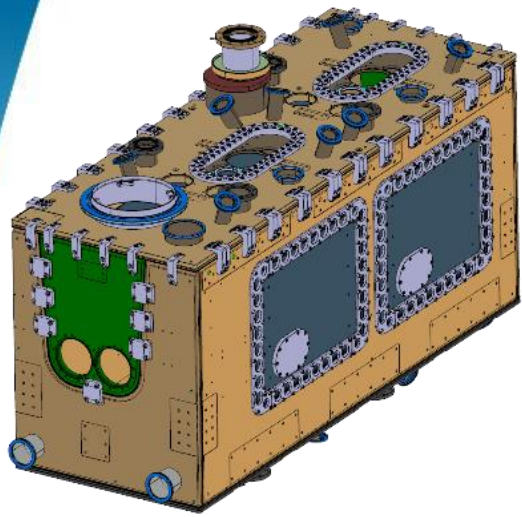
Cryomodule Procurements

OVCs, Bi Phase & Cryolines, Mag Shields, Thermal Screens,
Thermal Intercepts, MLI, Cavity Supports, Cryo Supports...

Outer Vacuum Chambers

Ollie Poynton

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Plenary Talk

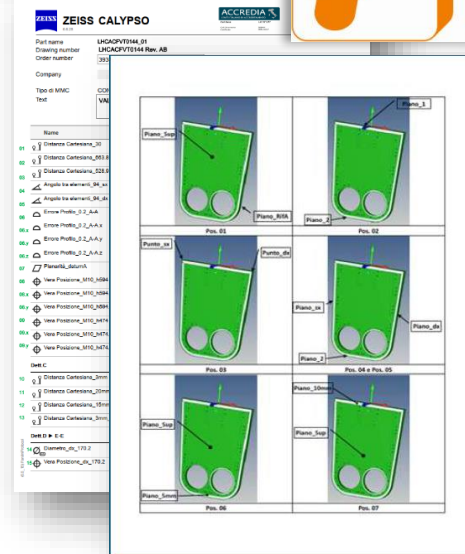
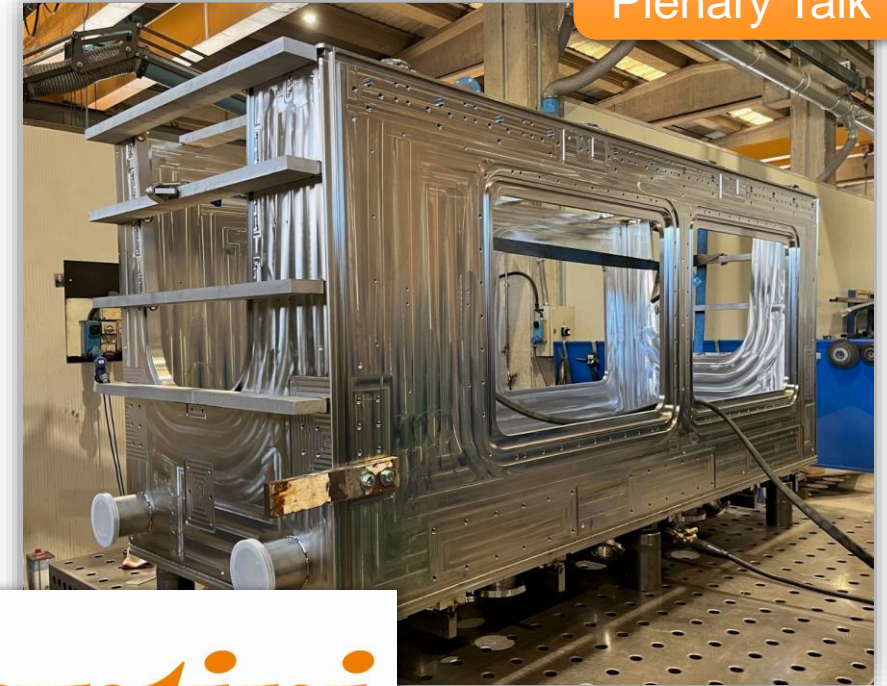


Design: CERN

Procurement: Lancaster

Manufacture: Fantini

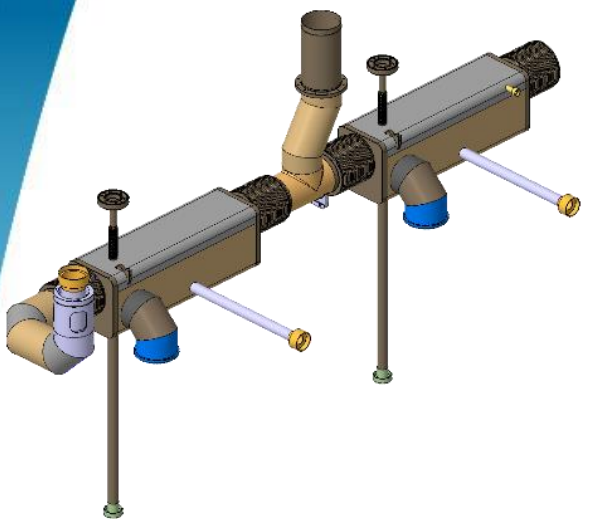
- MIP ✓
- material traceability ✓
- welding qualifications ✓
- machining & metrology ✓
- welding – *on-going*
- leak tests – *next*



Bi Phase Cryoline

Andy Blackett-May & Carlos Granjeiro

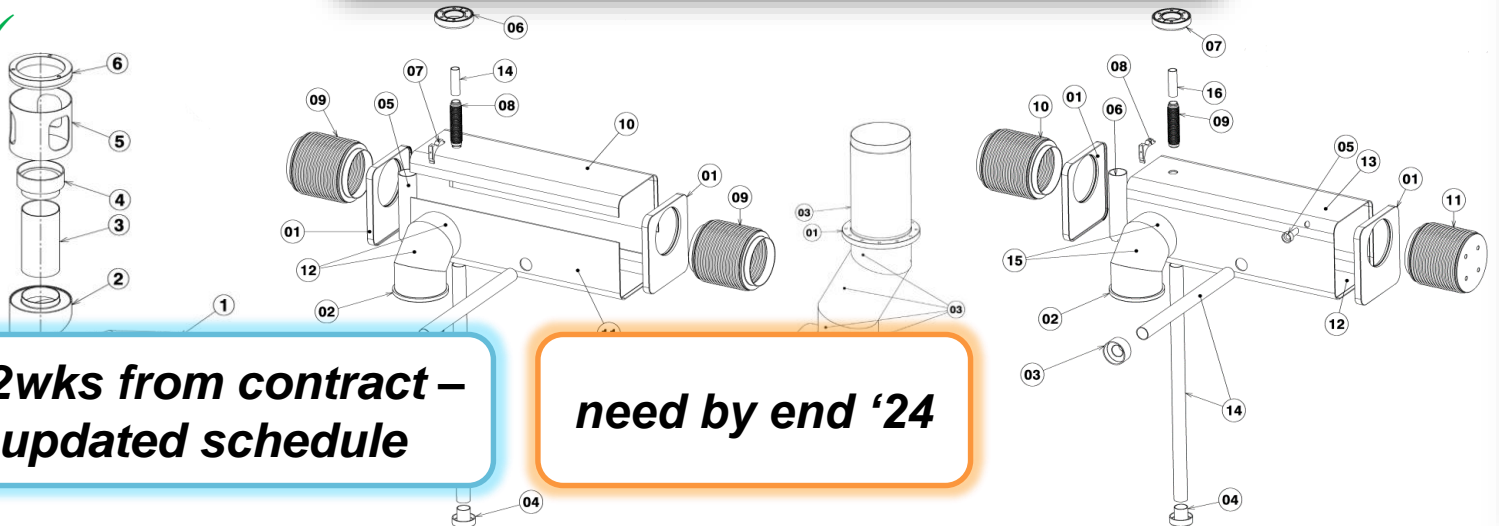
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Design: CERN
 Procurement: STFC
 Manufacture: Hyde

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

CM2 critical path



lead-time 12wks from contract – awaiting updated schedule

need by end '24

MIP v0.9

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

MIP v0.9

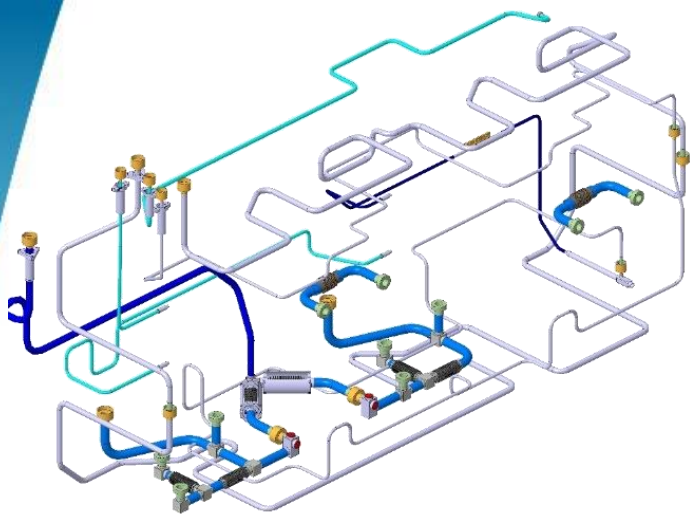
Item No.	Description	Quantity	Unit	Material	Spec	Notes
01
02
03
04
05
06
07
08
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11
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13
14
15
16



Other Cryolines

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Plenary Talk

Andy Blackett-May & Carlos Granjeiro



Design: CERN

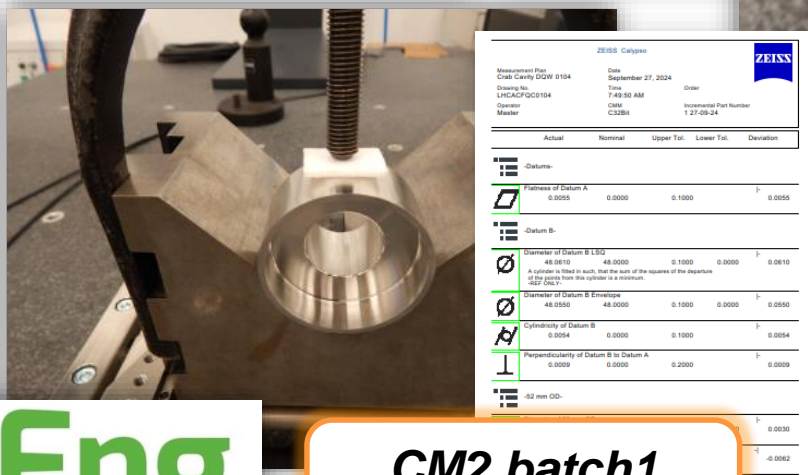
Procurement: STFC

Manufacture: Fieldhouse Engineering

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

upper lines - CM2 critical path

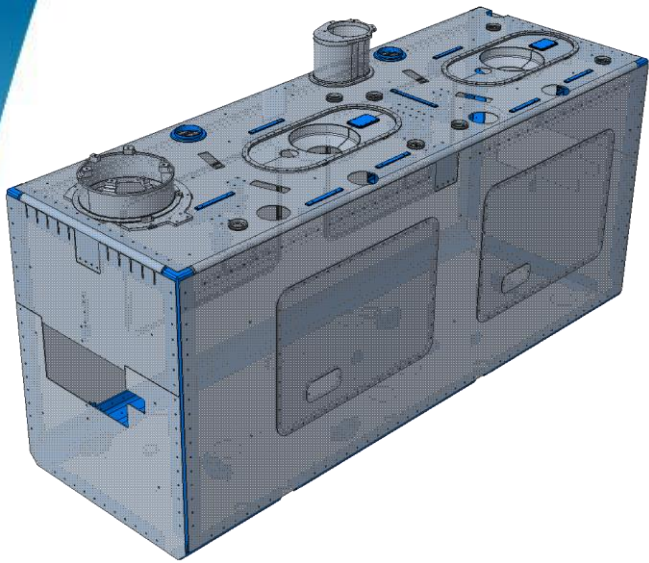
**lead-time CM2 Batch1 –
6wks from 'green light'**



**CM2 batch1
need by end '24**

FEng
Ltd

Thermal Screens



Design: CERN & STFC

Procurement: STFC

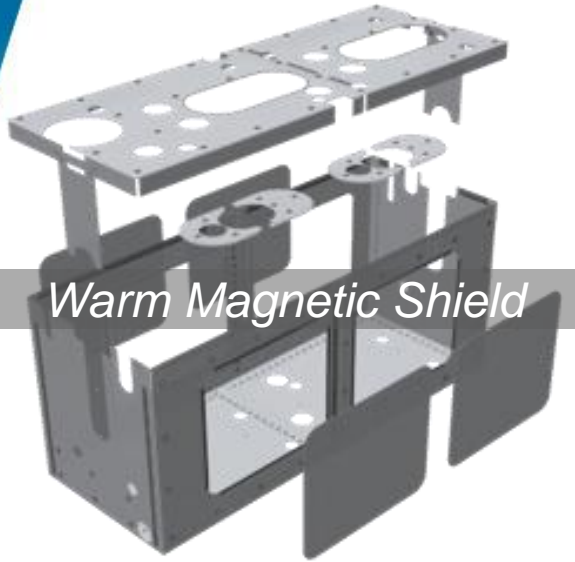
Manufacture: EGKENN

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



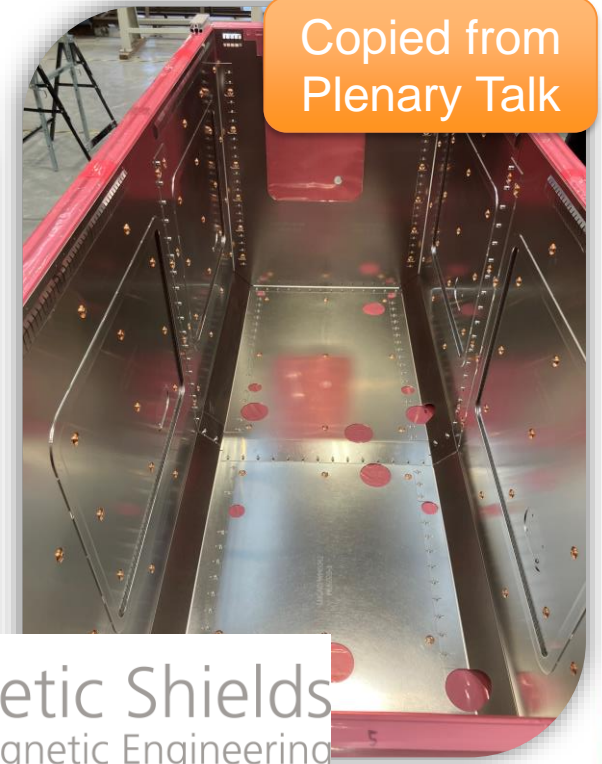
Magnetic Shields

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Warm Magnetic Shield

Item No.	Part No.	Description	QTY	UOM	Material	Spec	Notes
1	MS-001	SHIELD PLATE	10	EA	ALUMINUM	6061-T6	
2	MS-002	SUPPORT BRACKET	5	EA	ALUMINUM	6061-T6	
3	MS-003	FASTENER	100	EA	ALUMINUM	6061-T6	
4	MS-004	WASHER	100	EA	ALUMINUM	6061-T6	
5	MS-005	SPACER	5	EA	ALUMINUM	6061-T6	
6	MS-006	PLATE	10	EA	ALUMINUM	6061-T6	
7	MS-007	BRACKET	5	EA	ALUMINUM	6061-T6	
8	MS-008	FASTENER	100	EA	ALUMINUM	6061-T6	
9	MS-009	WASHER	100	EA	ALUMINUM	6061-T6	
10	MS-010	SPACER	5	EA	ALUMINUM	6061-T6	

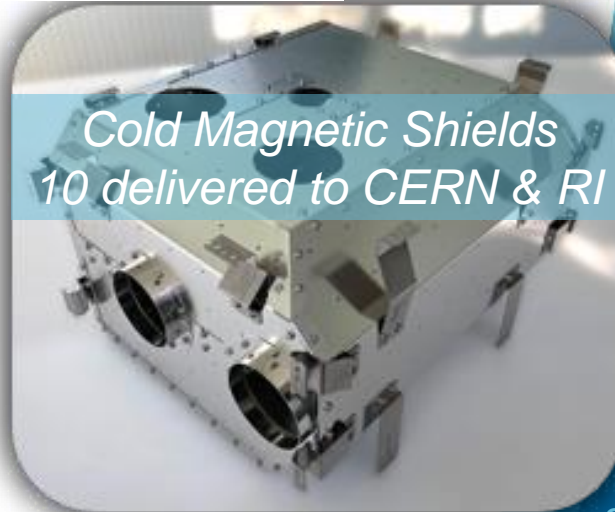
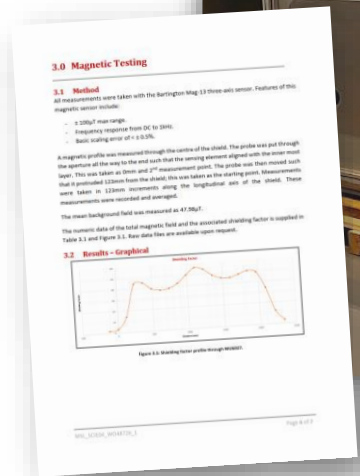


Design: CERN & STFC

Procurement: STFC

Manufacture: Magnetic Shields LTD

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

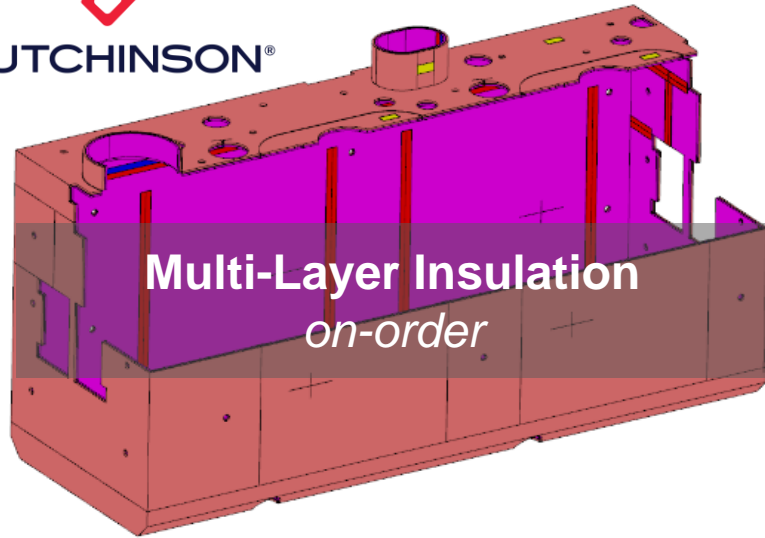


Cold Magnetic Shields
10 delivered to CERN & RI

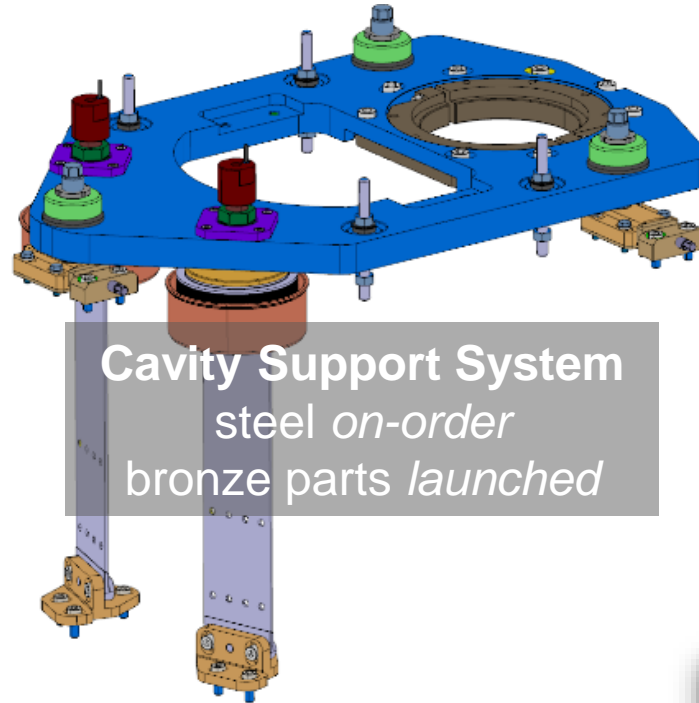


Other CM Procurements

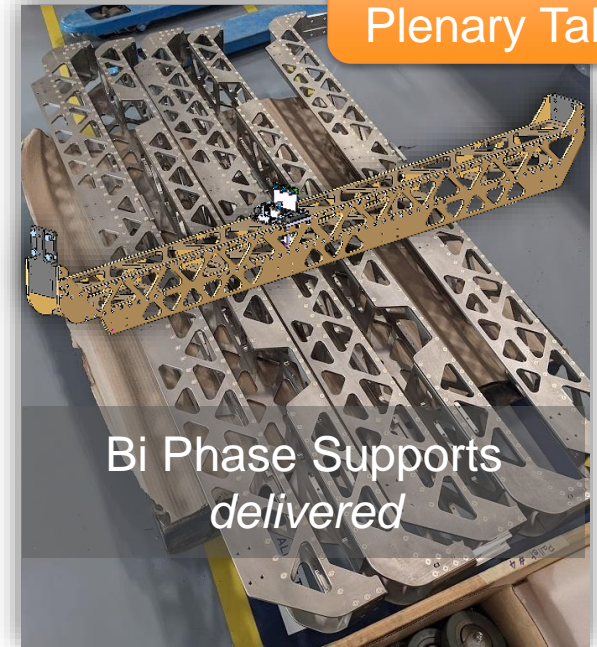
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Multi-Layer Insulation
on-order



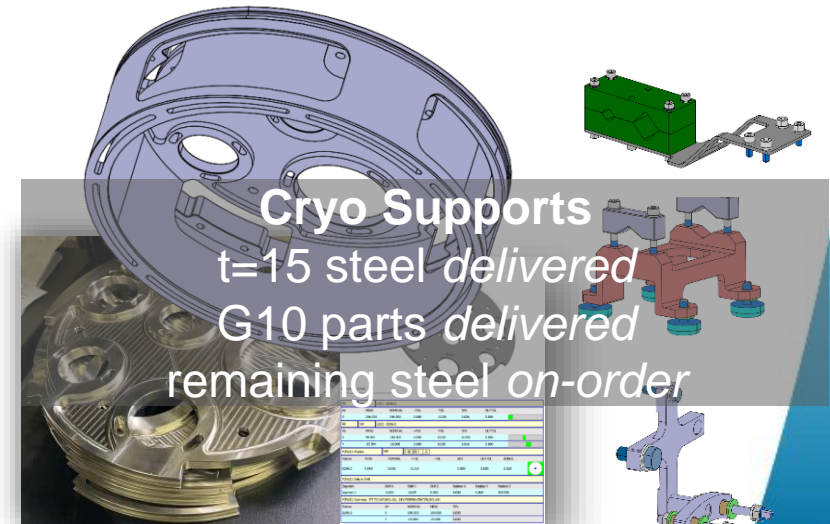
Cavity Support System
steel *on-order*
bronze parts *launched*



Bi Phase Supports
delivered



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



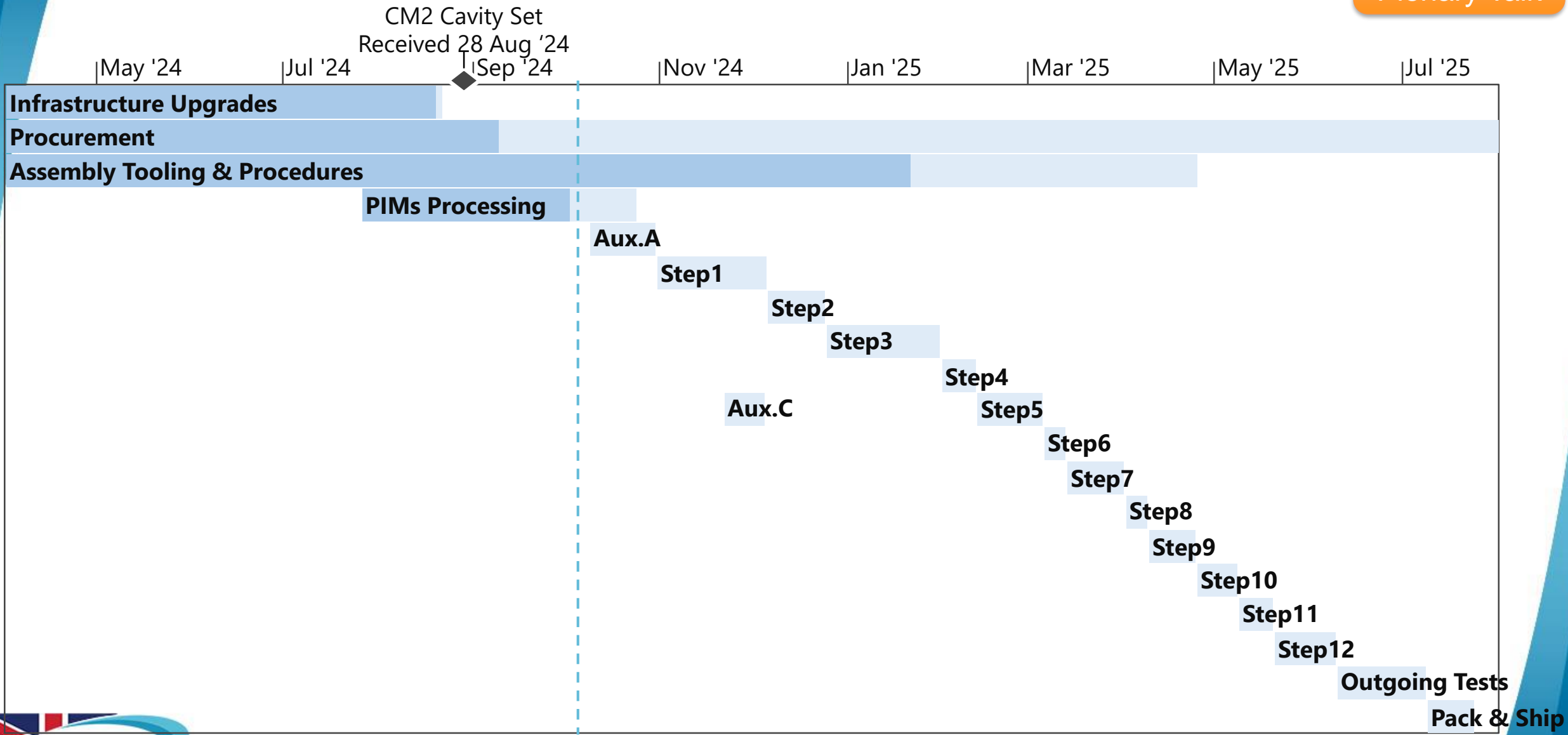
Cryo Supports
t=15 steel *delivered*
G10 parts *delivered*
remaining steel *on-order*



Planning

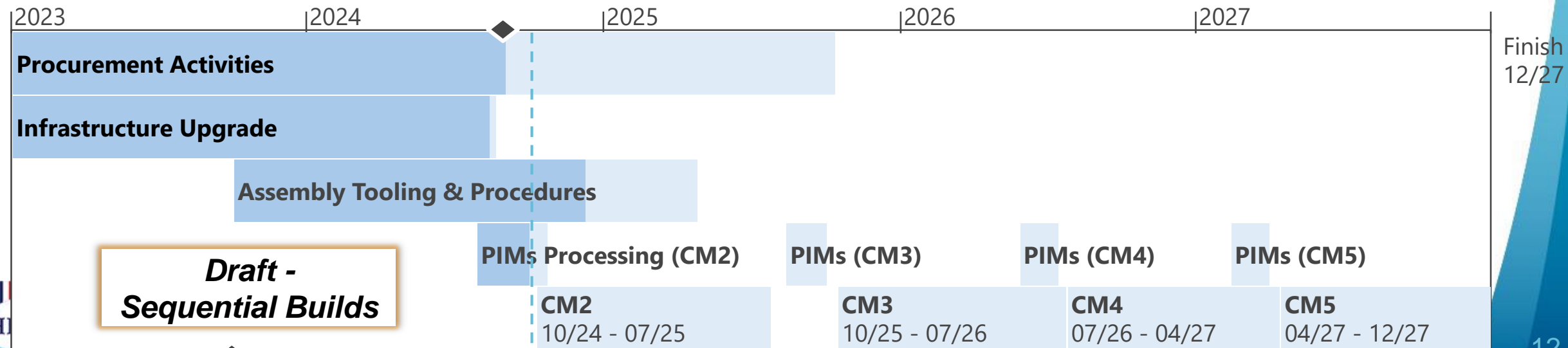
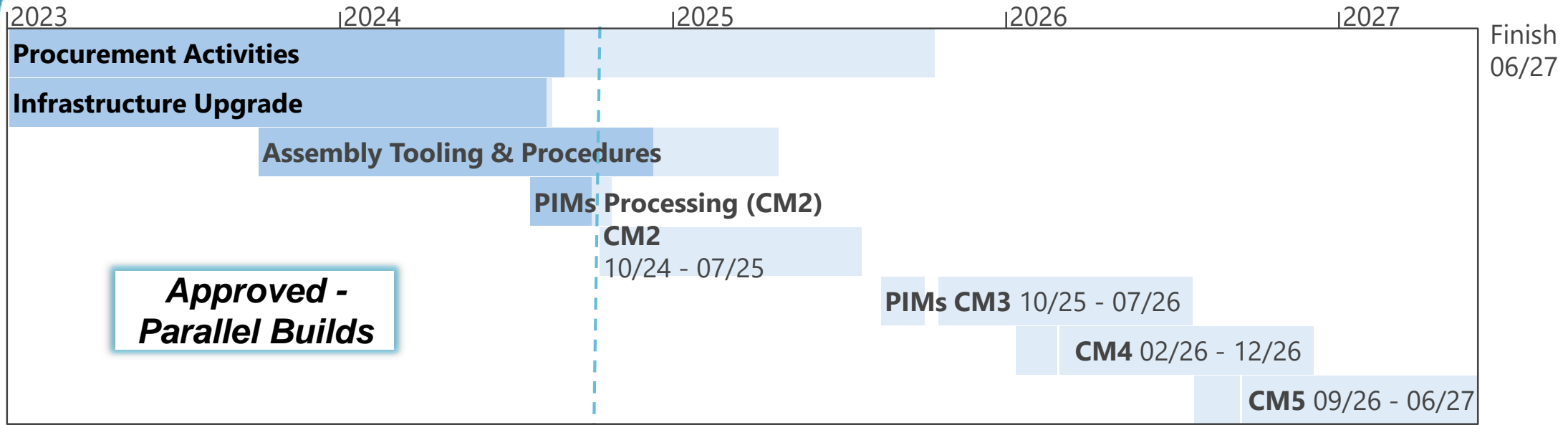
CM2 Schedule

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CM2-5 Planning

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Co-ordination Challenge

- 60 specialist activities planned for CM2
 - 40 internal support; riggers, metrology, welding, vacuum, cryo
 - 20 **CERN support**; RF, metrology, tuner, integration, HSE, mech inst., transport, (welding)
 - **Min. 10 visits**
- **'specialist resource planning' shall be updated and shared monthly**

Step ID	Task Name	Start	Finish	Resource
2.02	Install FPCs	18-Nov-24	21-Nov-24	CERN RF
F.02	Install FSI heads	30-Jan-25	03-Oct-24	CERN Metrology
F.03	Fiducialization of top plate	30-Jan-25	04-Oct-24	CERN Metrology
G.02	Install FSI heads	30-Jan-25	02-Oct-24	CERN Metrology
G.03	Fiducialization of lower OVC	30-Jan-25	04-Oct-24	CERN Metrology
3.04	Installation of Mechanical instrum on FPC pipe	12-Dec-24	17-Dec-24	CERN MME
3.11	Assemble tuner frame	19-Dec-24	06-Jan-25	CERN Tuner
4.05	Install tuner double pipe with braids	17-Jan-25	22-Jan-25	CERN Tuner
5.03	Connect V-HOMs and H-HOMs Coax to cavity & inst	24-Jan-25	30-Jan-25	CERN RF
5.04	Alignment of top plate WRT string	30-Jan-25	31-Jan-25	CERN Metrology
5.05	Lower top plate onto cavity string	30-Jan-25	31-Jan-25	CERN
6.02	Install and adjust cavity supports	13-Feb-25	14-Feb-25	CERN
6.04	Install FSI targets on cavity flanges	30-Jan-25	13-Feb-25	CERN Metrology
6.06	Connect coaxial lines to top plate	12-Feb-25	13-Feb-25	CERN RF
7.05	Install cryogenic instr 3/6 & feedthrough +Mech Instrumentation Check	20-Feb-25	28-Feb-25	Cryo, CERN MME
8.02	Install Pick Up RF Cable	11-Mar-25	12-Mar-25	CERN RF
10.01	Install lower RF coaxial lines and thermal intercept	01-Apr-25	03-Apr-25	CERN RF
10.05	Connect lower RF coaxial lines to lower vessel port	24-Jan-25	04-Apr-25	CERN RF
13.01	Pressure Tests	15-May-25	22-May-25	Vacuum, Cryo, CERN HSE

~~Risks, Existing Controls, & Mitigation Options~~

Top 13 Scary List



Top Risks (13 – 10)

RANK	RISK	EXISTING CONTROLS	MITIGATION OPTIONS	Likelih'd (/5)	Impact (/5)	Score (/25)
13	integration issues / clashes	procedure development CAD checks RFD Experience	rework / repair overtime	1	2	2
12	NC CM welds	weld procedure specifications sample qualification & testing CERN oversight & coaching	rework / repair overtime	1	2	2
11	cleanroom staff shortage	training back-up CL technician	contract collaborators	3	1	3
10	late SM18 deliveries	planning overtime	CERN planning CERN overtime	1	3	3

Top Risks (9 – 6)

RANK	RISK	EXISTING CONTROLS	MITIGATION OPTIONS	Likelih'd Impact Score		
				(/5)	(/5)	(/25)
9	string mis-alignment	procedures hold-points responsibility matrix	rework / repair overtime	2	2	4
8	forgotten torques or tooling	procedures hold-points internal audits / cross-checks	more oversight more reporting 3rd party checks	2	2	4
7	Cavity-Beamline contamination	procedures training best practice	spares rework / repair overtime	1	5	5
6	FPC damage	procedures design improvements oversight	more hold & check points collaborator involvement	1	5	5

Top Risks (5 – 2)

RANK RISK		EXISTING CONTROLS	MITIGATION OPTIONS	Likelih'd Impact Score		
				(/5)	(/5)	(/25)
5	NC & late CM equipment	pre-procurement & production quality management spares	rework / repair spares CERN manufacture	3	2	6
4	late cavity deliveries	planning 'spares' staff re-deployment	HPR & ISO4 R&D(?)	2	3	6
3	loss of key staff	succession planning quality management contract staff	overtime contract collaborators	3	2	6
2	major bellows damage	covers & tooling design procedures responsibilities matrix	spares repairs damage qualification	2	4	8

#1 Risk...

RANK	RISK	EXISTING CONTROLS	MITIGATION OPTIONS	Likelih'd Impact Score		
				(/5)	(/5)	(/25)
1	unknown-unknowns	?	?	?	?	?

"There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say, we know there are some things we do not know.

But there are also unknown unknowns — the ones we don't know we don't know."

- Donald Rumsfeld (via ChatGPT)





What have we missed?



Daresbury Laboratory



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



Ed Jordan
DAPT Lead



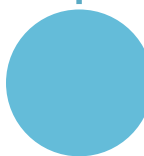
Marco
Contract Engineer



Kavi Grad
Engineer




Dan
Design Apprentice



David
Undergrad Engineer

Quality Assurance, Welding & Logistics




Carlos Granjeiro
QAWL Lead



John
Welder

Instrumentation, Qualification & Testing




Andy Blackett-May
IQT Lead



Ivan
Cryo Engineer




Stuart
Vac Engineer



Ollie
Vac Engineer

Technical Engineering



Luke Bladen
TE Lead



Abi
Technician



Susan
Technician



Apprentice
Technicians



Matty
Technician

Shared Resources

Outside
Manufacture

In-House
Manufacture

Vacuum
Processing

Riggers

Metrology

Logistics