



Superconducting link & feedbox status and tests

Amalia Ballarino for the WP6a

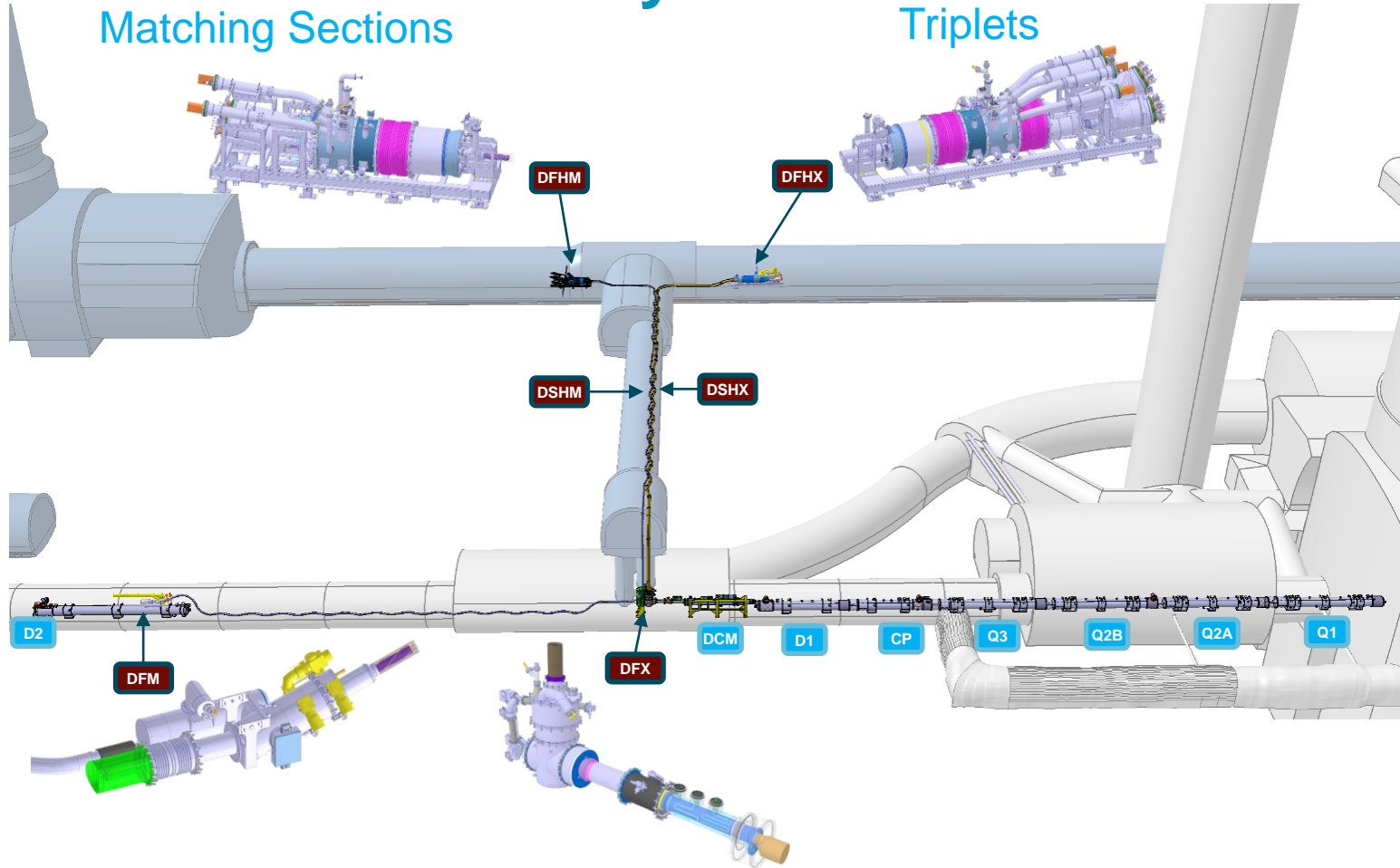


12th HL-LHC Collaboration Meeting, Uppsala - Sweden
19-22 September 2022

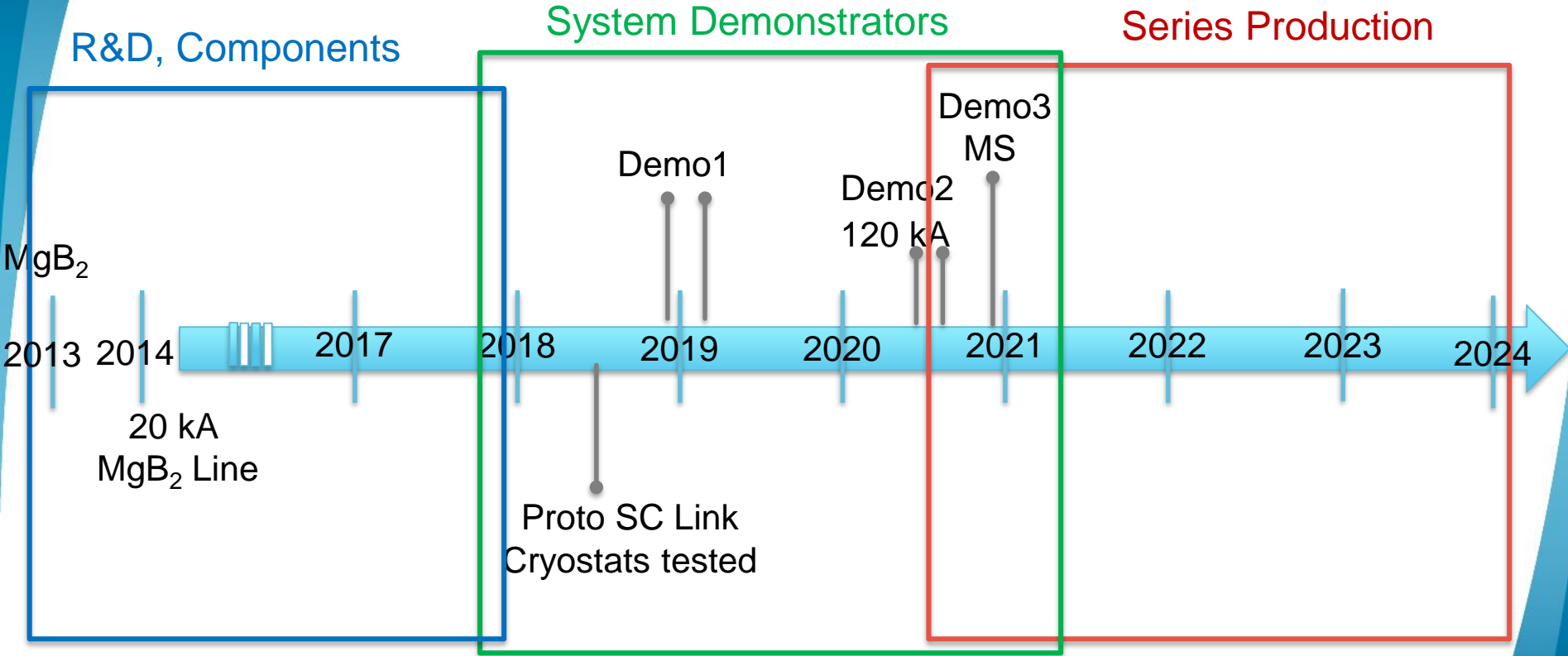
The Systems

Matching Sections

Triplets



WP6a Timeline



Progress from the last HL-LHC Annual Meeting

- SC MgB₂ Cables
- SC Link cryostats
- DFX/DFM (4.5 K)
- DFHX/DFHM (20 K)
- Current Leads (20 K to RT)
- Prototype System
- Clusters F2/Cluster G
- WP6a System for the String
- Master Plan
- Conclusions

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The MgB₂ cables series production

Received from ICAS five series cables (four delivered in 2022)

MgB₂ wire:
850 km +
100 km
delivered

Strict QC
@ CERN



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SC Link cryostats

Completed at Cryoworld two series units (one for IT, one for MS)

Leak and pressure tests at Cryoworld

Delivery to CERN



Triplets: 74.5 m
MSs: 120.5 m



- Defined leak test procedures.
- Performed endoscopic inspections, visual and dimensional controls

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DFX Pre-Series Cryostat

- Collaboration agreement with **University of Southampton** for pre-series and series production
- First **pre-series DFX** unit UK marked and **delivered to CERN in March 2022** (deliverable of UK1, Addendum 4)
- **UK2** agreement for **series production** (4 DHX and 5 DFM) signed in **July 2022**. Deliveries as from Q1 2023 till Q4 2024



DFX Series Production

Activity at the University of Southampton

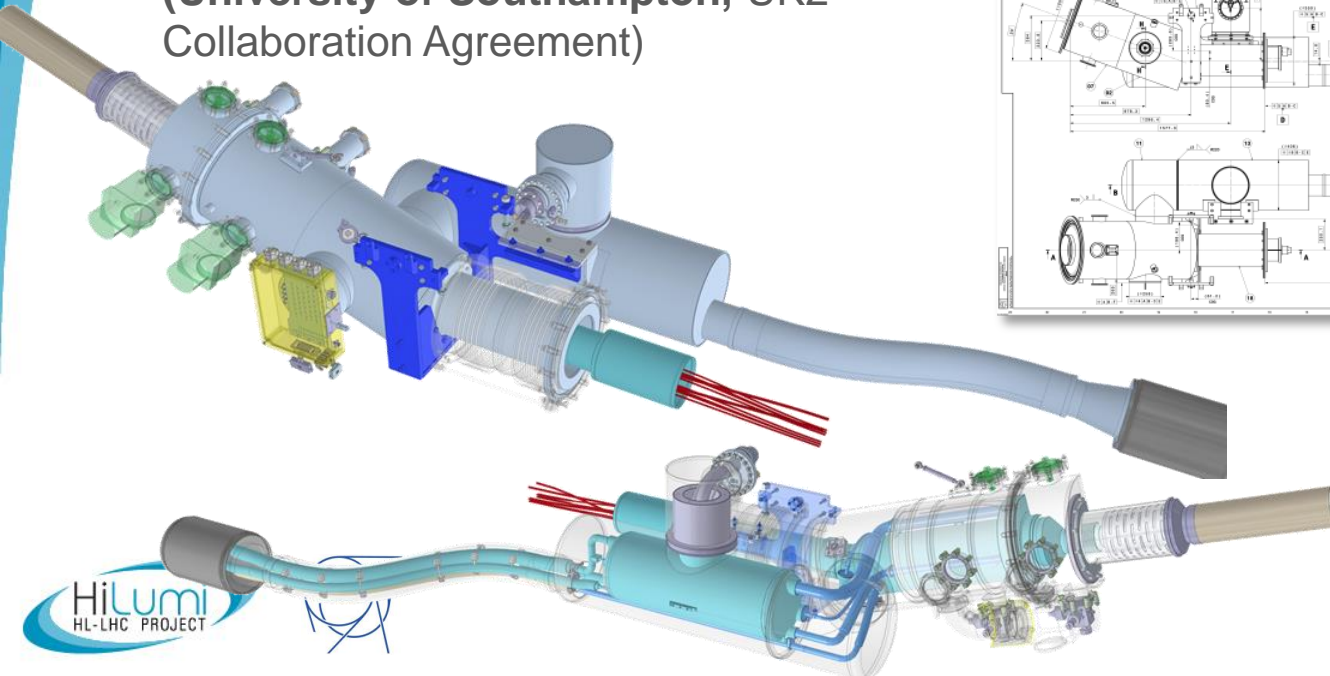
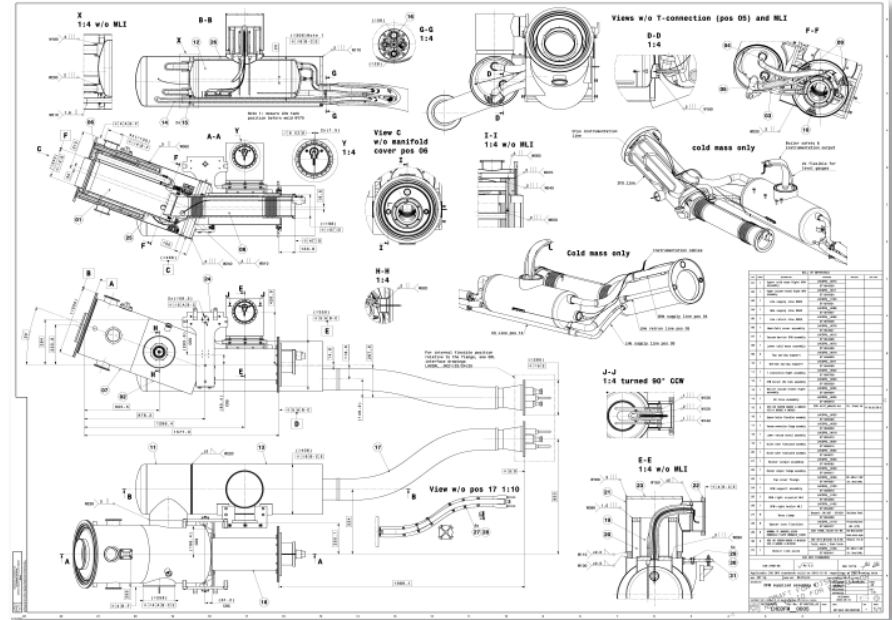
- **Series procurement has been in progress since May 2022**

- **Materials** are mostly sourced and **ready for being ordered**
- **Series production partners** are being shortlisted and narrowed down.

Several companies have been sought in parallel with preference for on-site or sole subcontract machinist, an engaging engineering team, proven track record for complex cryogenic pressure vessels, capability of producing within budget and on schedule

DFM Cryostat

- Detailed Design Review at CERN in January 2022
- Manufacturing drawings completed (Sept 2022)
- Production consists of 5 series units (University of Southampton, UK2 Collaboration Agreement)



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The DFHX

H I G H L U M I N O S I T Y L H C

12th HL-LHC Collaboration Meeting UPPSALA - Sweden 19 - 22 September 2022

The 12th HL-LHC Collaboration Meeting will take place in Uppsala, Sweden, from 19th to 22nd September 2022, as an in-person meeting.

Based on the traditional programme with plenary and work package parallel sessions, this meeting will serve as a technical update forum for the 6th Cost and Schedule Review, planned at CERN in November 2022, and provides the framework for additional collaborative meetings between the project partners.

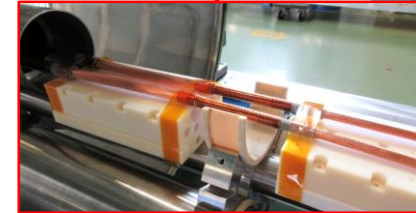
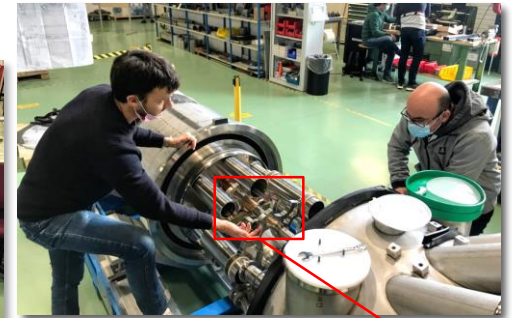
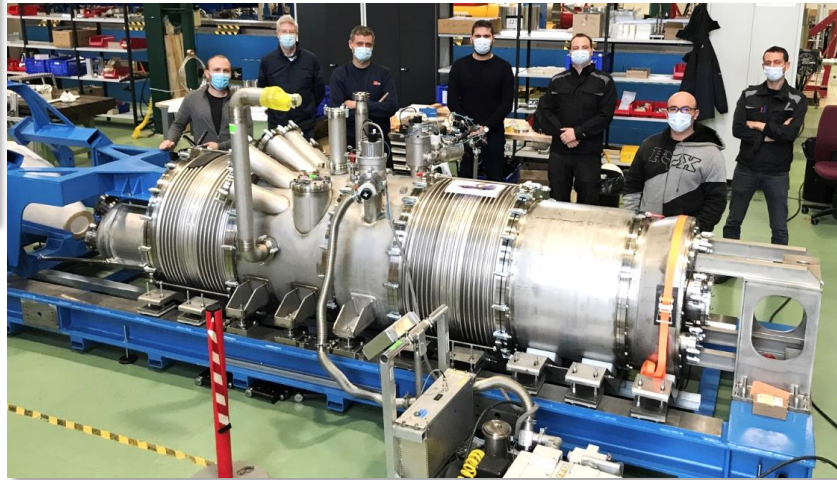
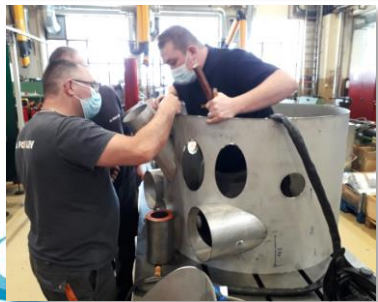
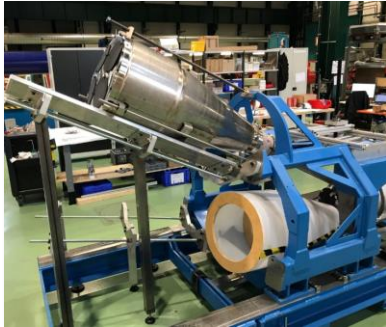
This year, the main objectives will be to update all HiLumi collaborators on the results of key HL-LHC prototypes tests, to highlight the progress made in the transition from prototype validation to series production, and to update all collaborators on the latest schedule changes.



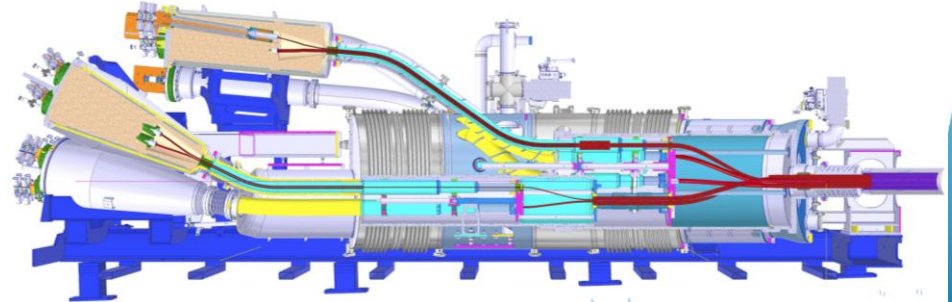
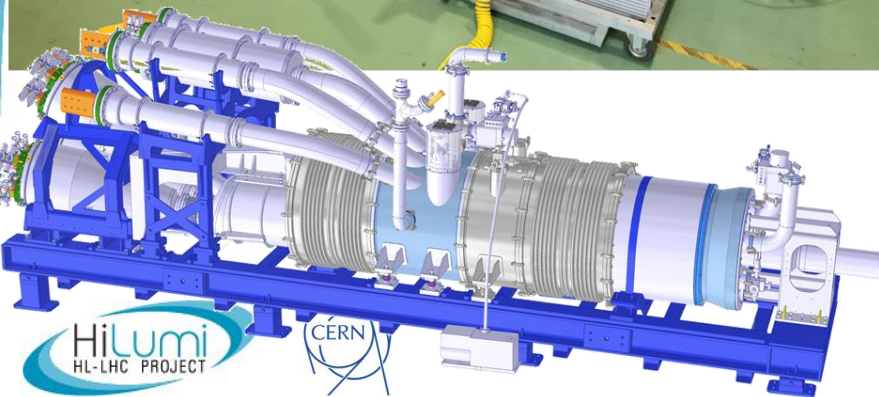
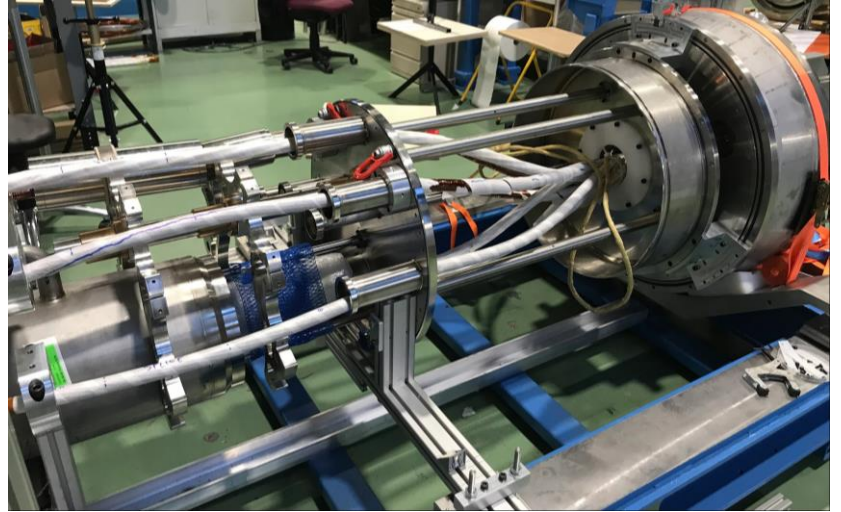
DFHX Pre-series unit (1/2)

- **Manufactured at CERN** in 2021 with **6 components contracted to RFR solutions**. Interactions with Uppsala University and RFR – technology transfer. Vacuum vessels blank assembly **completed Q4-2021**
- **Integration studies** of superconducting components in **2022** (current leads, HTS and MgB₂ routing and connections, splices, tooling, processes...)

Pre-series DFHX at CERN
120 kA @ ~ 20 K



DFHX Pre-series unit (2/2)



DFH Series Production – Uppsala University

Collaboration Agreement with Uppsala University signed in January 2022

Series: 9 DFH (4 DFHX + 5 DFHM)

First delivery: November 2022

*On-going production at **Uppsala University workshop**
Courtesy Uppsala University*

*On-going production **in CERN workshop**. Visit of RFR technicians at CERN*

*On-going manufacturing at **RFR solutions**
Courtesy RFR Solutions*



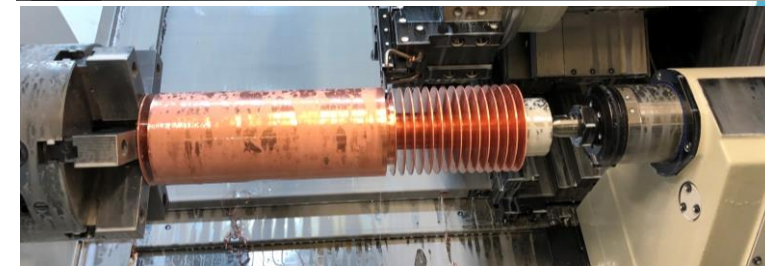
Six complex DFX sub-components manufactured at CERN

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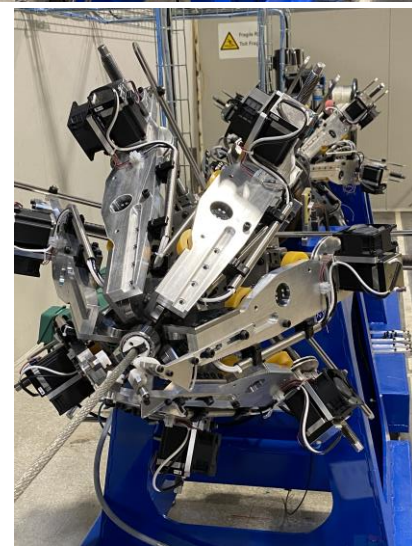
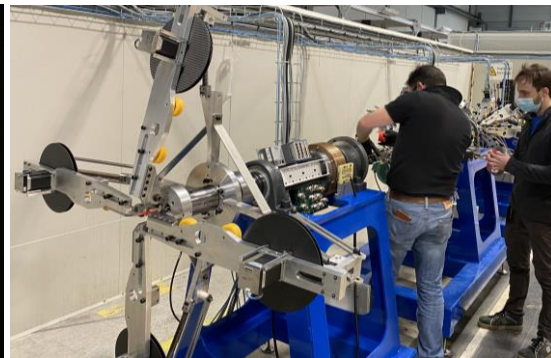
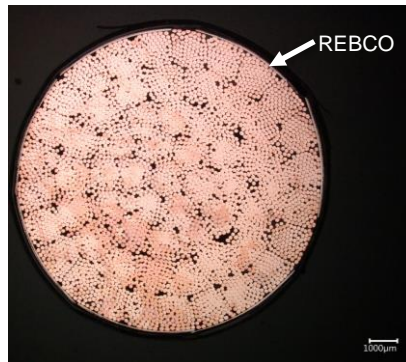
HTS Current leads (1/2)

- **Current Leads for Prototype System** (4×18 kA, 12×2 kA and 3×7 kA): **manufactured in the CERN Main Workshop**. Production of HTS parts ongoing (see next slide)
- **Decided in March 2022 to internalize the series production of the resistive parts of the HL-LHC current leads (170 units)**. Manufacturing/assembly both at CERN and in industry – via EN-MME. Procurement of raw material launched and almost completed. Started manufacturing of components



HTS Current leads (2/2)

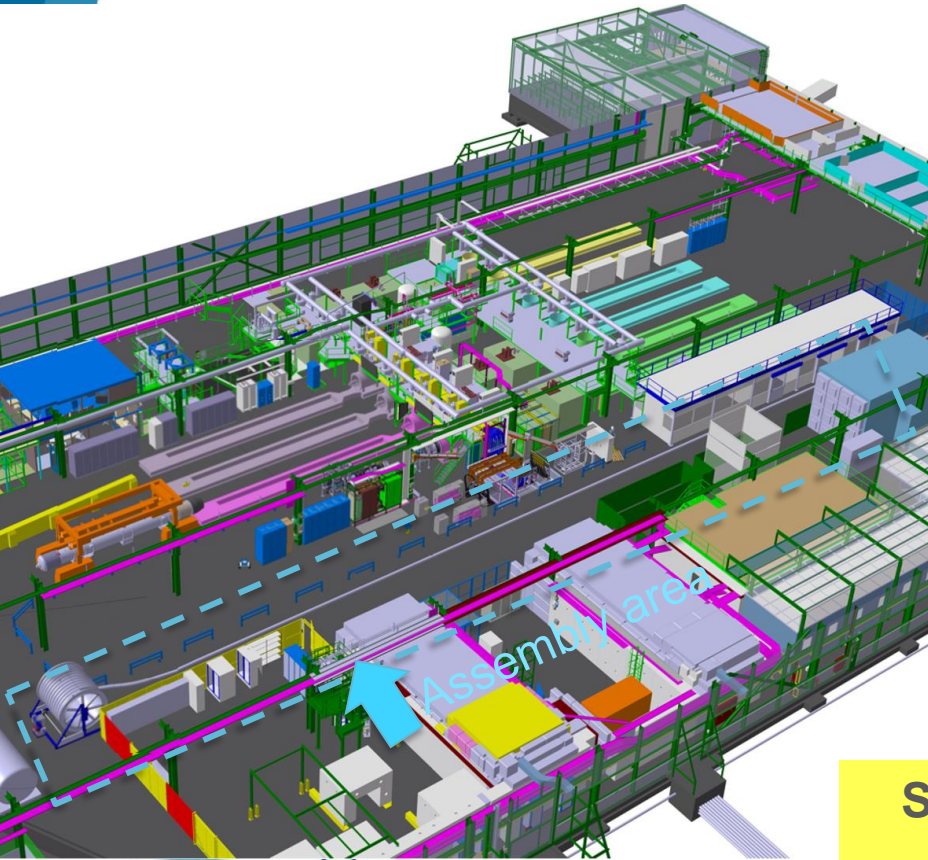
- **REBCO High Temperature Superconducting tape** ($4 \times 0.1 \text{ mm}^2$)
- Operating temperature: **20 K to 50 K**
– inside the DFH, in GHe environment
- Design, construction and commissioning at CERN (Q1 2022) of a dedicated **cabling machine**. Optimization of: **cabling process**, soldering processes for low-resistance high-current splices; electrical insulation



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Prototype System Test – SM18



Prototype System assembly and test (SCR edms 2747986):

Start system assembly	– Oct 2022
Ready for cooldown	– March 2023
Cold tests	– April to June 2023
Disassembly & delivery to String	– July 2023

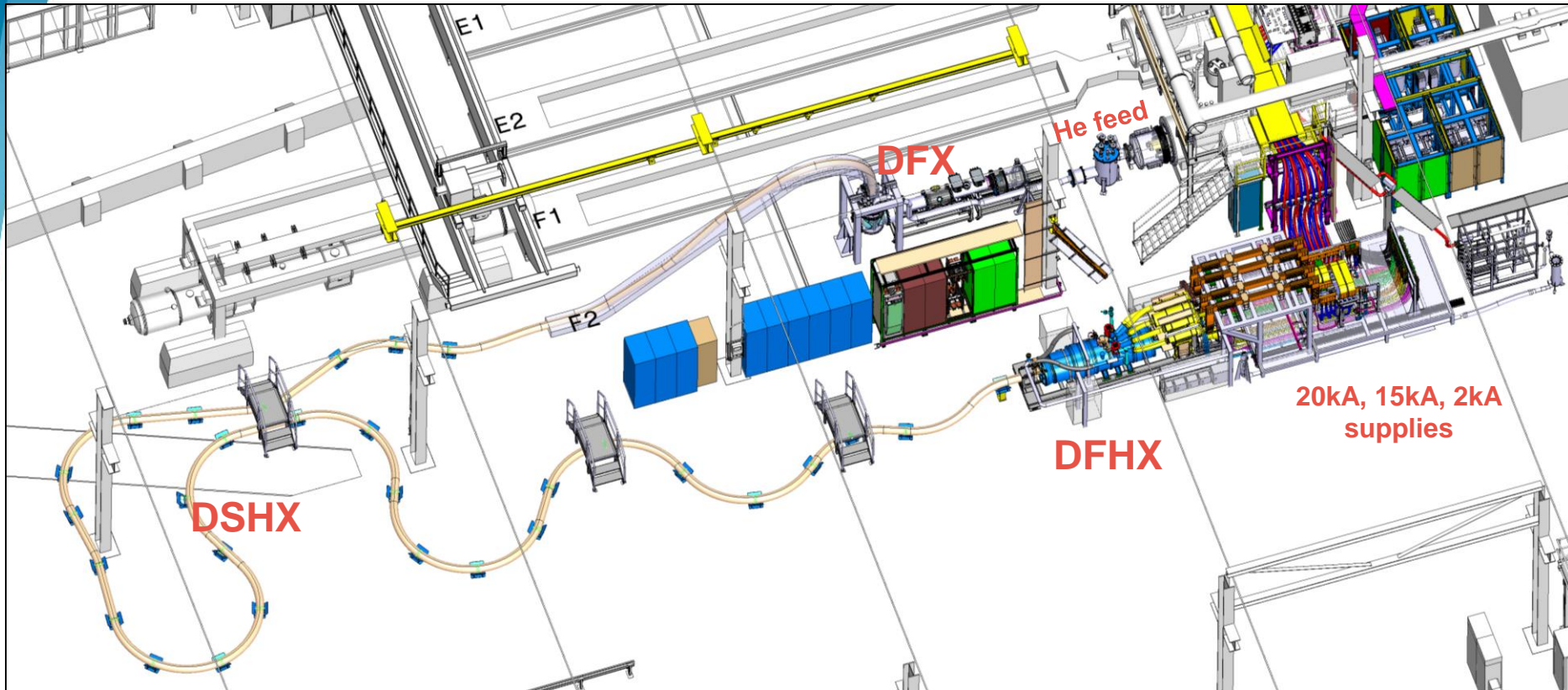
Action	Duration
Spooler transportation	(1w)
Cryostat spool transportation	(3d)
Cryostat spool installation	0.5d
Cryostat unspooling	1d
Cryostat straightening+fixing	1d
DFHx frame positioning	0.5d
Cryostat spool removal	0.5d



**Spare System for
HL-LHC**

Cluster F2

Cluster F2: Prototype System (delivered to the String after test) + series systems

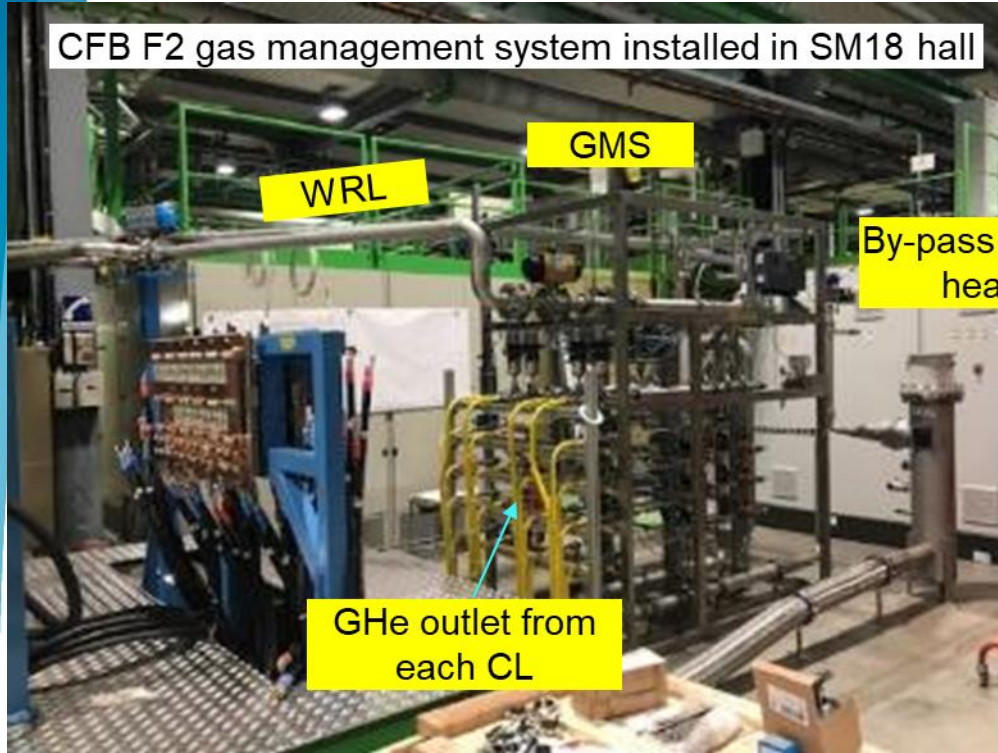


Readiness of Cluster F2

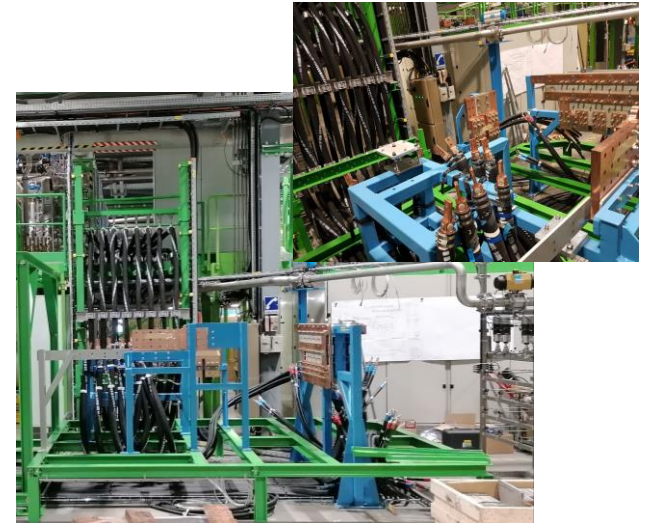
Cryogenic system ready

Electrical system close to completion

CFB F2 gas management system installed in SM18 hall

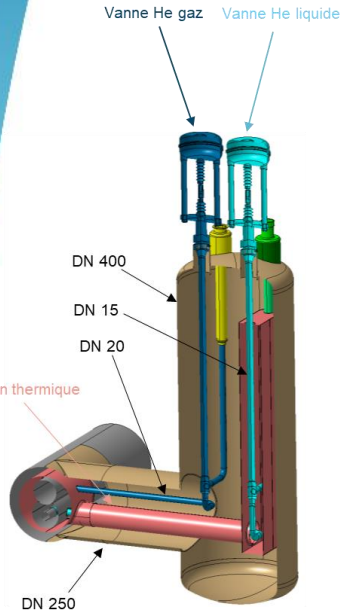


G.Rolando, O.Pirotte, V.Gahier



Operation in Cluster F2 as in the tunnel. Cold tests planned to start in April 2023

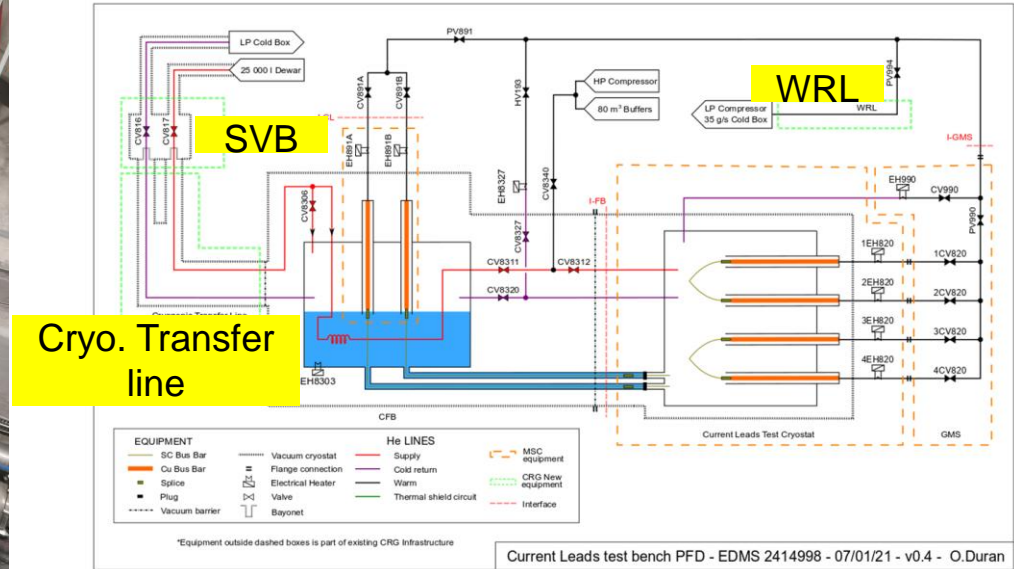
Cluster G – Current Leads individual tests



SVB 3D model



SVB Connected to SM18 Infrastructure



G.Rolando, O.Pirotte

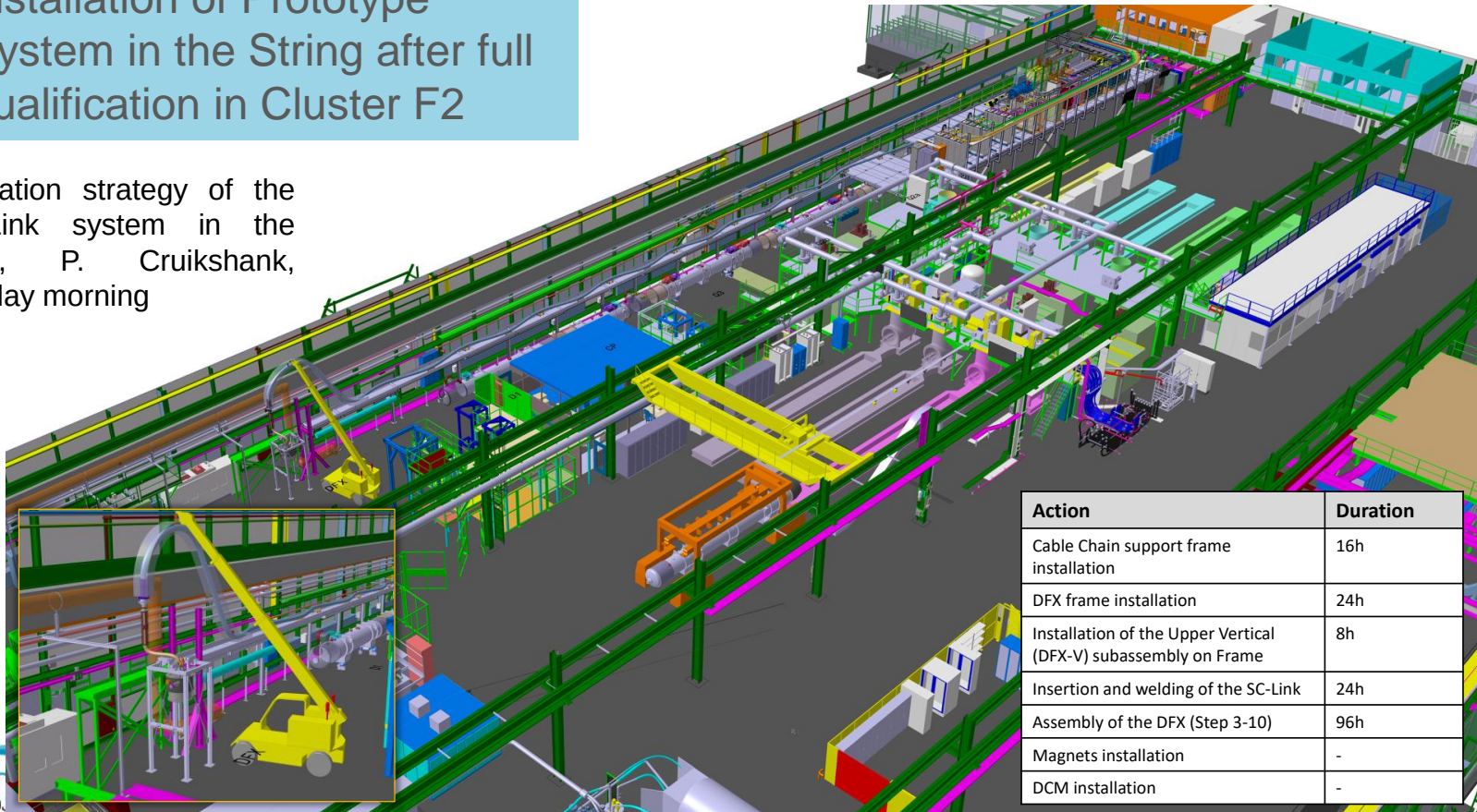
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Installation of Cold Powering System in the String

Installation of Prototype System in the String after full qualification in Cluster F2

“Installation strategy of the SC Link system in the String”, P. Cruikshank, Thursday morning



Action	Duration
Cable Chain support frame installation	16h
DFX frame installation	24h
Installation of the Upper Vertical (DFX-V) subassembly on Frame	8h
Insertion and welding of the SC-Link	24h
Assembly of the DFX (Step 3-10)	96h
Magnets installation	-
DCM installation	-

Conclusions

- **Industrialization** has been **completed**. Series production is progressing well: **MgB₂ wire** (950 km) delivered to CERN; **MgB₂ cables**: five out ten units produced; **SC Link cryostats**: first two units produced
- Important contributions by collaborators: pre-series **DFX** via UK1 (University of Southampton) delivered in March 2022; first series **DFHX** (University of Uppsala) scheduled to be delivered in Q4 2022
- Next coming important milestone: assembly of **Prototype Cold Powering System** for the Triplets and test, in SM-18, in Q3 2023



Thanks for your attention !

