



HFM
High Field Magnets

Infrastructure Needs for Conductors

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Introduction

For HFM program, there is a strong need to upgrade the B163/103 facilities to cope with characterization and cabling requirements, in particular:

1. Critical current station with solenoid magnet of 20 T (vertical field):

In order to develop high-field accelerator magnets in 14-20 T range, need to have adequate test stations for characterizing potential superconductors for use in such magnets (current capacity up to 15 T).

2. Critical current station with 10 T split-pair magnet (horizontal field):

Test stations with vertical solenoidal field only enable characterization of MgB_2 and HTS wires and tapes in most favorable orientation (i.e., with field parallel to sample axis) due to bending requirements (e.g., 100 mm minimum curvature radius for MgB_2). This new station will allow to characterize transport current properties of HTS materials, very sensitive on field orientation, as function of temperature, field and field orientation.

3. New Rutherford cabling machine (up to 60 strands):

Current cabling machine in B103 can manufacture Rutherford cables with up to 40 strands. For HFM, on-going block-coil designs require larger cable widths, 44-56 strands appear to be necessary.



Technical contents of WP5.2 (1)

RD5	WP5.2	WP5.2	Infrastructure needs for conductors - CERN	Fri 30/09/22	Sat 01/07/28
RD5	WP5.2	WP5.2-T1	Infrastructure for Cabling and Characterisation	Fri 30/09/22	Mon 30/11/26
RD5	WP5.2	WP5.2-T1-D1	Procurement and installation of new critical current stations (B \geq 18T and 10T split magnet)	Fri 30/09/22	Sun 01/11/26
RD5	WP5.2	WP5.2-T1-D1-M1	Conceptual design including integration in B163 and ancillaries (e.g. current leads, sample power supply, cryogenics...)	Fri 30/09/22	Wed 01/03/23
RD5	WP5.2	WP5.2-T1-D1-M2	Elaboration of specifications including interfaces and drawings of components manufactured by CERN	Fri 31/03/23	Fri 01/12/23
RD5	WP5.2	WP5.2-T1-D1-M3	Tender process, procurement and fabrication of magnets and test station ancillaries	Thu 28/09/23	Tue 31/03/26
RD5	WP5.2	WP5.2-T1-D1-M4	Assembly of the critical current stations including Data Acquisition software	Sat 31/01/26	Mon 01/06/26
RD5	WP5.2	WP5.2-T1-D1-M5	Commissioning of the stations	Thu 30/04/26	Mon 30/11/26
RD5	WP5.2	WP5.2-T1-D2	Procurement and installation of new cabling machine (up to about 60 strands)	Sat 01/10/22	Mon 30/11/26
RD5	WP5.2	WP5.2-T1-D2-M1	Elaboration of Technical Specification of cabling machine	Sun 01/01/23	Sat 01/06/24
RD5	WP5.2	WP5.2-T1-D2-M2	Tender process	Sat 01/06/24	Mon 30/09/24
RD5	WP5.2	WP5.2-T1-D2-M3	Electronics and software for cabling and QA/QC	Sat 30/09/23	Sun 30/11/25
RD5	WP5.2	WP5.2-T1-D2-M4	Study for installation of potential insulation/braiding machines	Sat 01/10/22	Thu 30/10/25
RD5	WP5.2	WP5.2-T1-D2-M5	Procurement and fabrication of the cabling machine	Mon 30/09/24	Tue 31/03/26
RD5	WP5.2	WP5.2-T1-D2-M6	Installation and commissioning of cabling machine	Wed 01/04/26	Mon 30/11/26



Technical contents of WP5.2 (2)

RD5	WP5.2	WP5.2-T1-D3	Upgrade of FRESCA stations	Fri 31/01/25	Sun 30/05/27
RD5	WP5.2	WP5.2-T1-D3-M1	Sample insert design and fabrication for 60-strand cables and including transverse pressure (FRESCA 2)	Fri 31/10/25	Sat 30/01/27
RD5	WP5.2	WP5.2-T1-D3-M2	FRESCA 2 testing of 60-strand cable sample	Wed 31/03/27	Sun 30/05/27
RD5	WP5.2	WP5.2-T1-D3-M3	Conceptual study for potential FRESCA 3 station with $B \geq 15T$ (size, requirements and cost)	Fri 31/01/25	Sun 31/01/27
RD5	WP5.2	WP5.2-T1-D4	Procurement and installation of additional infrastructure	Sun 01/01/23	Sat 01/07/28
RD5	WP5.2	WP5.2-T1-D4-M1	Supply of spare solenoid for existing Ic stations ($B=15-17 T$), upgrade VSM and magnetization measurements of cables and consolidation of interstrand/intertape contact resistance station	Sun 01/01/23	Sat 01/07/28
RD5	WP5.2	WP5.2-T1-D4-M1a	Supply of spare solenoid for existing Ic stations ($B=15-17 T$), upgrade VSM and magnetization measurements of cables and consolidation of interstrand/intertape contact resistance station: equipment for station upgrade (1)	Sun 01/01/23	Sun 01/06/25
RD5	WP5.2	WP5.2-T1-D4-M1b	Supply of spare solenoid for existing Ic stations ($B=15-17 T$), upgrade VSM and magnetization measurements of cables and consolidation of interstrand/intertape contact resistance station: equipment for station upgrade (2)	Sun 01/06/25	Tue 01/12/26
RD5	WP5.2	WP5.2-T1-D4-M1c	Supply of spare solenoid for existing Ic stations ($B=15-17 T$), upgrade VSM and magnetization measurements of cables and consolidation of interstrand/intertape contact resistance station: spare solenoid (3)	Tue 01/12/26	Sat 01/07/28
RD5	WP5.2	WP5.2-T1-D4-M2	Design and fabrication of adapted sample insert and sample holder for HTS and special measurements	Mon 01/09/25	Mon 01/03/27
RD5	WP5.2	WP5.2-T1-D4-M3	Study of infrastructure requirements for HTS conductors	Wed 01/01/25	Fri 01/01/27
RD5	WP5.2	WP5.2-T1-D4-M4	Supply of a furnace for thermal expansion measurement during heat treatment including commissioning	Wed 01/04/26	Thu 01/04/27
RD5	WP5.2	WP5.2-T1-D4-M5	Supply of a reaction oven for strand/cable samples	Wed 01/01/25	Wed 01/07/26
RD5	WP5.2	WP5.2-T1-D4-M6	Supply of a tensile/twisting machine for cable check	Tue 01/10/24	Sat 01/11/25
RD5	WP5.2	WP5.2-T1-D4-M7	Design and construction of a test facility for current leads, cables and splices	Thu 01/05/25	Tue 01/09/26
RD5	WP5.2	WP5.2-T1-D4-M8	Inserts for split coil (10 T) and solenoid (20 T)	Mon 01/06/26	Thu 30/09/27



Progress update: 20 T solenoid station (1)

- Procurement and installation of upgraded I_c station (up to **20 T vertical field**).
- **Full magnet system** including **magnet, cryostat, magnet PS/current leads, protection systems** and ancillaries to be procured from industry.
- **CERN** will cope for station upgrade/construction for **civil engineering, cryogenic/electrical** connections and racks...

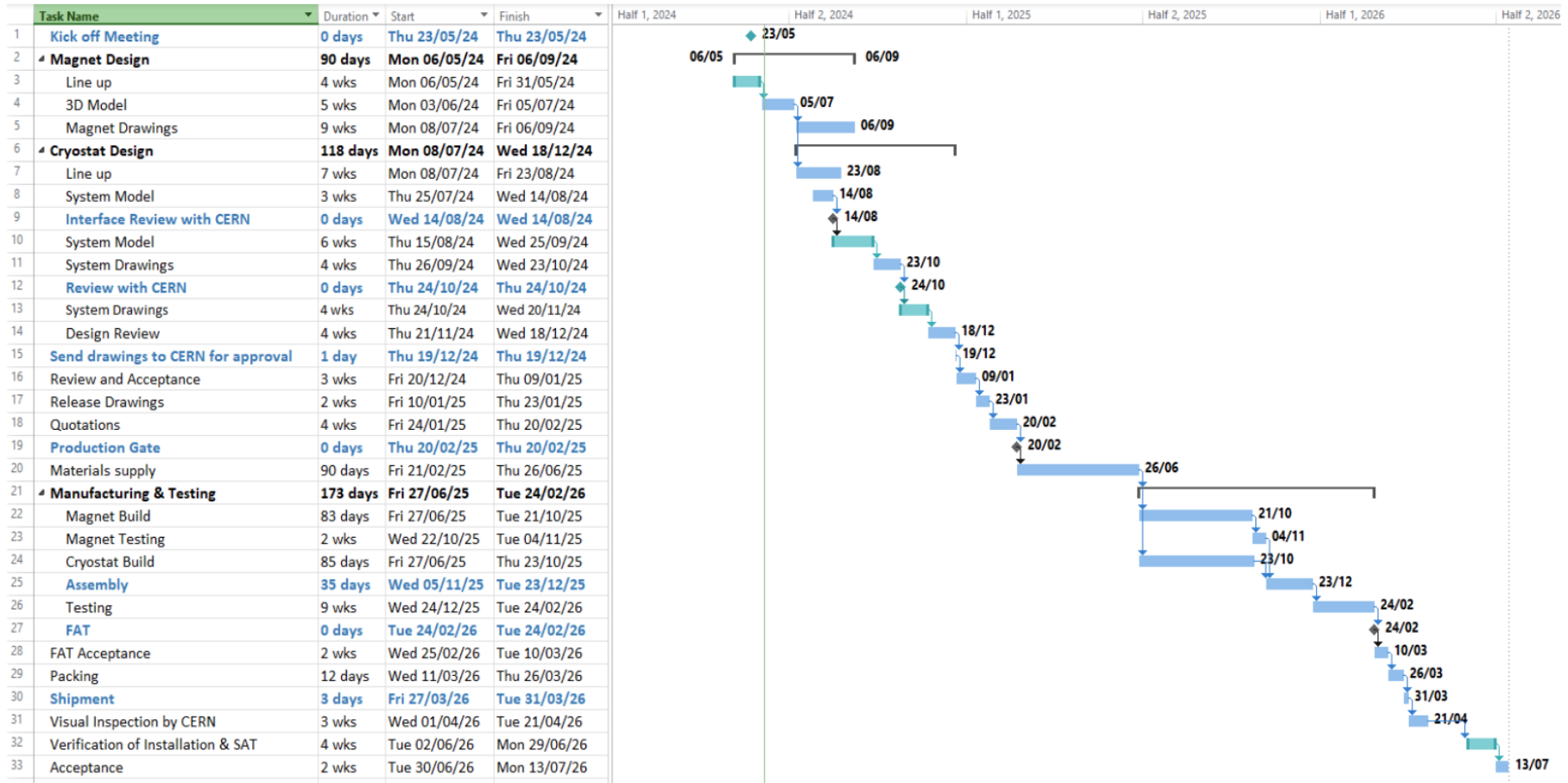
- **Combined Market Survey** for both **20 T solenoid** and **10 T split-pair** magnet systems launched in **June 2023**.
- **Individual invitation to tender** issued for **20 T** system on September 28th, 2023. **Contract F809** awarded to **OXFORD INSTRUMENTS** and signed on **26th of March 2024**.
- **Contract** includes **commissioning** of the magnet system.

- **OXFORD INSTRUMENTS** currently **designs** magnet system (expected to be completed by **end of 2024**).
- **Solenoid** magnet expected to be **manufactured and tested** in **Q4 2025**, delivered in **Q1 2026**.
- **20 T station** planned to be **commissioned Mid-2026** (see planning next slide).



Progress update: 20 T solenoid station (2)

053S000620 / BOUTBOUL / CERN 20T – PROJECT PLAN



Progress update: 10 T split-pair station (1)

- Procurement and installation of new I_c station (up to **10 T horizontal field**).
- **Full magnet system** including **magnet, cryostat, magnet PS/current leads, protection systems** and ancillaries to be procured from industry.
- **CERN** will cope to station upgrade/construction for **civil engineering, cryogenic/electrical** connections and racks...

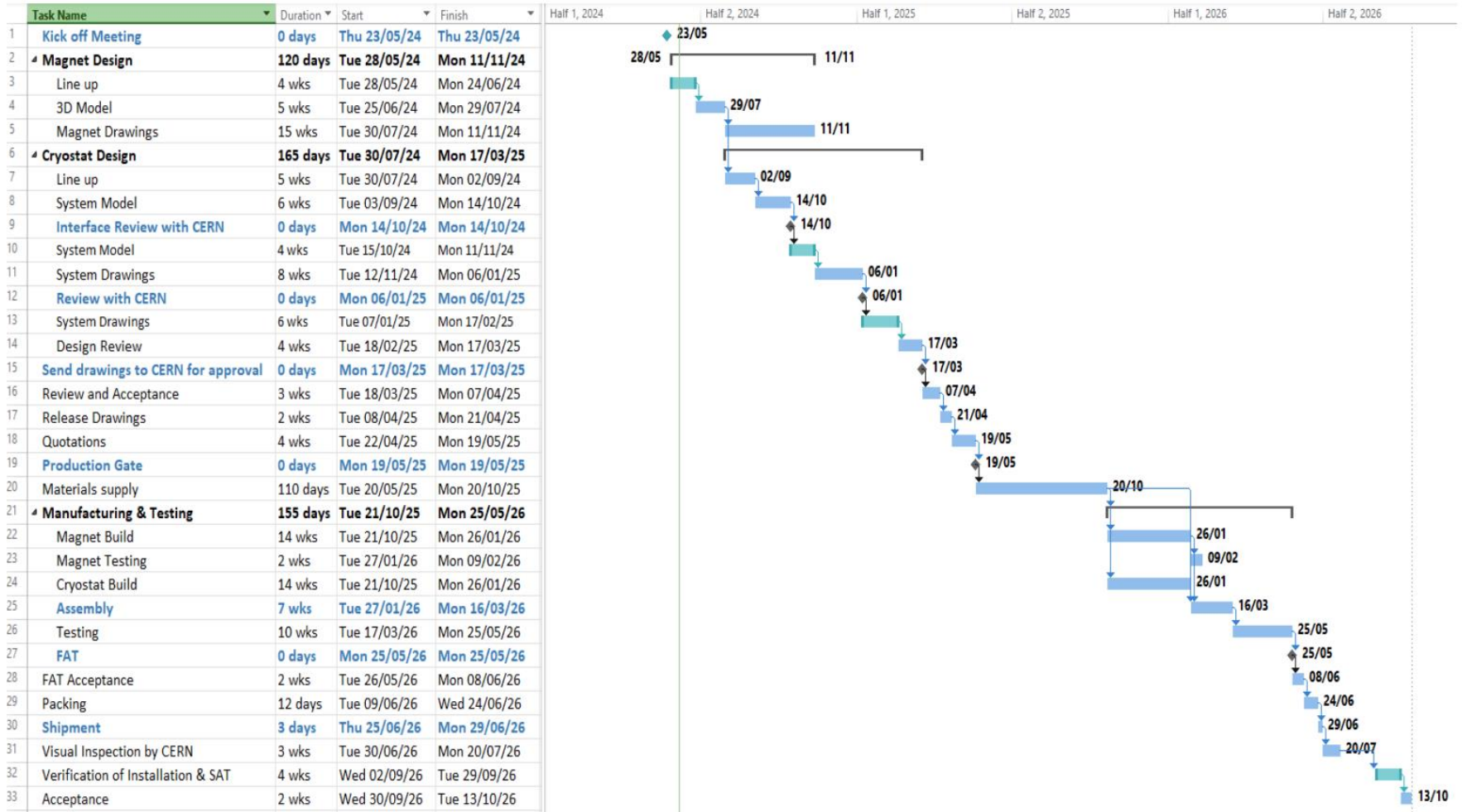
- **Combined Market Survey** for both magnet systems launched in **June 2023**.
- **Invitation to tender** issued for **10 T** system on December 8th, 2023. **Contract F810** awarded to **OXFORD INSTRUMENTS** and signed on **26th of March 2024**.
- **Contract** includes **commissioning** of the magnet system.

- **OXFORD INSTRUMENTS** currently **designs** magnet system with a lower priority than 20 T (expected to be completed by **March 2025**).
- **10 T** magnet expected to be **manufactured and tested** in **Q1 2026**, delivered in **Q3 2026**.
- **10 T station** expected to be **commissioned Sept 2026** (see planning next slide).



Progress update: 10 T split-pair station (2)

053S000619 / FLEITER / CERN 10T – PROJECT PLAN



Progress update: New Cabling Machine

- Procurement and installation by the industry of a **new cabling machine** for the manufacturing of Rutherford-type cables of up to **60 strands**.
- **Market Survey** launched on September 15th, 2023; feedback received so far from 4 companies (MS not yet closed).
- **Invitation to Tender**: tender documentation currently under elaboration and IT expected to be **launched by end of 2024 or Q1 2025**.
- **Contract** expected to be **signed** in **Q3 2025**.
- Cabling machine expected to be **installed** and **commissioned** by the supplier in **B927** in **Q2 2027**.



Progress update: Consolidation of the VSM station

- The **Vibrating Sample Magnetometer (VSM)** facility of B163 has been **consolidated in 2024**:
- The **magnetic field** has been **calibrated** by means of an **NMR probe**.
- The temperature calibration and regulation have been investigated to ensure that the sample temperature is under control. Then the **temperature calibration** has been **confirmed** based on pure **Indium and Niobium samples** for which the critical temperature is well known.
- Afterwards, the **magnetic moment calibration** was **performed** by means of two reference spheres provided by NIST.
- Finally, both **Nb₃Sn and HTS samples** were measured and **benchmarked** against measurements performed at **UNIGE**, with a good agreement.
- The **VSM test station** of B163 is now **more reliable**.
- **Work on data acquisition, software and mechanical components** is planned for **2025**



Conclusions

- The main tasks of the WP5.2 are to **upgrade the infrastructure needs for conductors.**
- **The procurement of new high field test station was launched:**
 - **Contract** for magnet systems and cryostat **awarded in Q1 2024**
 - **20 T solenoid** to be **commissioned** in **Q3 2026**
 - **10 T split pair** to be **commissioned** in **Q4 2026**
- **The Procurement and installation of new cabling machine (up to about 60 strands) was started:**
 - **MS issued in Sept 2023, IT** expected to be **launched by Q4 2024.**
 - **Contract** expected to be **signed** in **Q1 2025.**
 - Cabling machine expected to be **installed** and **commissioned** by the supplier in **B927** in **Q2 2027.**
- **The VSM test station has been consolidated in 2024. Work on data acquisition, software and mechanical components is planned for 2025.**

