HFM

High Field Magnets Programme

High Field Magnets programme update on structure

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A big thanks to our predecessors

D. Tommasini, leading
Eurocircle studies 2014-2020

Luca Bottura, leading
HFM program 2020-2021

Andrzej Siemko, leading
HFM program 2022-2023

Programme or project ?

- High Field Magnets is an R&D programme
  - In the past, the term project has been sometimes used
  - Programme is more appropriate (as used for instance in LARP: LHC Accelerator R&D Programme)
    - Project has deliverables to be installed (e.g. HL-LHC): baseline changes are tracked with engineering change request
    - Programme has targets, that can evolve in time
  - We encourage to use the term programme

Mandate of programme leaders

Dear Ezio and Bernhard,

I am very happy to confirm your nominations respectively as Leader and Co-Leader of the High Field Magnets (HFM) Programme.

Please find attached Annex 1, outlining your mandate as Leader and Co-Leader of the HFM Programme. This mandate provides the framework for guiding the strategic direction, operational management, and collaborative efforts of the Programme.

The HFM Programme is a critical endeavor for CERN and the wider community, and I am confident that your leadership will be instrumental in achieving its ambitious goals.

Warm regards,

Mike

R&D targets

- In the mandate the target for the R&D is set:
  - A ~14 T operational field Nb_3Sn magnet for an FCC-hh at ≥80 TeV
  - A ~20 T operational field HTS magnet for an FCC-hh at ~120 TeV

The HFM Programme's principle goals are:

- Develop a Nb_3Sn accelerator dipole with ~14 T operational field, compatible with the FCC-hh minimum target of 80 TeV center of mass energy;
- Explore the use of HTS magnet technologies for an up to ~20 T operational field, compatible with FCC-hh target of order of 120 TeV center of mass; the dipole shall be either based on a Nb_3Sn-HTS hybrid coil, or on an HTS-only coil to open the possibility of operating at higher temperatures (above 10 K);
- Promote the required developments for the associated superconductors (both Nb_3Sn and HTS);
- Highlight the innovative nature of high-field magnets development and its implications for the broader scientific community and societal applications.

R&D targets

- For the Nb_3Sn option:
  - Establish the operational margins
  - Select the magnet design among the variants that are in the baseline
  - Scale to 14-m-long magnets
- For HTS, prove the viability for accelerator dipoles

- Refine the roadmap to achieve the programme goals, in particular (i) establish the adequate operational margins for the ~14 T dipole magnet, (ii) select the ~14 T magnet design among the options presently pursued, (iii) scaling the selected design of Nb3Sn technology to long magnets and (iv) proving the viability of the HTS technology for accelerator dipoles, intensifying the R&D on HTS accelerator magnets to close the gap with LTS technology;
- Update the roadmap according to the programme achievements;
- The Programme Leader shares responsibility with a Programme Co-Leader, whose specific roles are summarized below.

Sharing tasks between programme leader and programme co-leader

- Budget → Ezio
- Timeline (Schedule) → Bernhard
- For reporting to Steering Board:
  - Monitoring CERN activities → Ezio
  - Monitoring collaborations → Bernhard
- Collaborating and networking → Bernhard

Role of the Programme Co-Leader

- The Co-Leader shall assume the specific responsibility for the programme timeline; the Programme Leader shall hold final responsibility of budget allocation and monitoring;
- The Co-Leader shall have the specific responsibility for the monitoring and coordinating of the activities specified in collaboration agreements; the Programme Leader shall hold the responsibility for the monitoring of HFM activities performed at CERN;
- The Co-Leader shall establish the most effective strategies to ensure effective collaboration and networking between cooperating institutes;
- Should circumstances dictate, the Co-Leader may assume the Programme Leader role *pro tempore*.

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Update of structure

- The structure is unchanged
  - Activities are organized in workpackages (WPs), steered by the workpackage leader (WPL)
  - WP activities are either at CERN or in a collaborating institute
  - In case of WP in a collaborating institute, a CERN liason is defined
  - New collaboration agreements, continuing previous activities, are assigned to new WPs – this creates an optical effect showing many WPs, but allows better follow-up
  - Some WPs are completed, so keep an eye on active WPs
  - WPs are organized in RD lines, with coordinators for each RD line
  - See https://hfm.web.cern.ch/hfm-programme-structure

Update of structure

- Few changes from January 2024
  - 12 T CERN WPL is A. Foussat, replacing D. Perini
  - CERN liason for 12 T INFN (FalconD) is A. Foussat, replacing D. Perini
  - Technological development program WPL is A. Haziot
  - CERN liason for PSI stress managed common coil is A. Haziot, replacing A. Milanese
  - 12 T long and infrastructures for long magnets WPL is S. Izquierdo Bermudez, replacing A. Milanese
  - RD line 3 coordinators from CERN are A. Foussat, A. Haziot, replacing D. Perini
    - A. Foussat special task: ensure delivery of insulated cable to collaborations
    - A. Haziot special task: collect the cross-sections of Nb3Sn magnets, make them available to the collaborators, and ensure coherent use of superconductor properties
  - We still have vacancy for RD line coordinators 5 (infrastructures) – to be decided soon

HFM programme steering board
M. Lamont (chair)
P. Vedrine (co-chair)

HFM programme collaboration board
C. Senatore (chair)
P. Campana (deputy)

High Field Magnet Programme

E. Todesco (Leader), B. Auchmann (Co-leader)

Programme office
G. Riddone

RD1: Nb_3Sn conductor

- 1.1 **Nb_3Sn procurement** — T. Boutboul (CERN)
- 1.3 **Nb_3Sn development** — C. Senatore (UniGe)
- 1.15 **Nb_3Sn development** — T. Nakamoto (KEK)
- 1.17 **Nb_3Sn characterization** — A. Kario (U. Twente)
- 1.18 **Studies on oxidation** — A. Leineweber (BAF)
- 1.19 **Nb_3Sn characterization** — C. Senatore (UniGe)

RD1 line coordinators:
T. Boutboul (CERN)
C. Senatore (UniGe)

Note: completed WPs not shown

RD2:HTS conductor and magnets

- 2.1 **REBCO development** — B. Holzapfel (KIT)
- 2.2 **REBCO tapes** — A. Ballarino (CERN)
- 2.5 **Demonstrator DI coil** — A. Ballarino (CERN)
- 2.6 **Solenoids and MuC** — L. Bottura (CERN)
- 2.7, 2.14 **HTS characterization** — A. Kario (Twente)
- 2.11 **Demonstrator MI coil** — T. Lecrevisse (CEA)
- 2.15 **IBS development** — A. Malagoli (CNR-SPIN)
- 2.16 **HTS procurement** — A. Ballarino (CERN)
- 2.17 **AC losses and solenoids** — Y. Yang (SOTON)

RD2 line coordinators:
A. Ballarino (CERN)
A. Kario (Twente)

RD3: Nb_3Sn magnets

- 3.1 **12 T cosθ CERN** — A. Foussat (CERN)
- 3.2 **12 T cosθ FalconD** — S. Farinon (INFN)
- 3.4 **Technology development** — A. Haziot (CERN)
- 3.5 **14 T block dipole** — J. C. Perez (CERN)
- 3.6, 3.12 **14 T R2D2** — E. Rochepault (CEA)
- 3.7 **14 T common coil** — F. Toral (CIEMAT)
- 3.8, 3.14 **14 T stress managed** — D. M. Araujo (PSI)

RD3 line coordinators:
F. Toral (CIEMAT)
A. Haziot, A. Foussat (CERN)

RD4: Modeling

- 4.1 **Model and software** — S. Russenschuck (CERN)
- 4.2 **Structural material** — C. Garion (CERN)
- 4.3 **Insulation materials** — R. Piccin (CERN)
- 4.4 **Impregnation R&D** — T. Tervoort (ETHZ)
- 4.5 **Quench D+P** — M. Wozniak (CERN)
- 4.6 **Cryogenics and thermal studies** — P. Borges de Sousa (CERN)

RD4 line coordinators:
S. Farinon (INFN)
C. Garion (CERN)

RD5: Infrastructures

- 5.1 **Test** — F. Mangiarotti (CERN)
- 5.2 **Conductors** — T. Boutboul (CERN)
- 5.3 **Short model** — J. C. Perez (CERN)
- 5.4 **Full scale** — S. I. Bermudez (CERN)
- 5.5 **Instrumentation** — L. Fiscarelli (CERN)

RD6: Scientific and societal impact forum
E. Chesta (CERN)
L. Kretzschmar

HFM governing bodies

- Steering Board (SB)
  - The HFM SB assesses the progress achieved by the HFM Programme and provides guidance and direction. The HFM SB makes high-level strategic decisions related to the changes of the HFM Programme scope and the scope of major collaborations. The HFM SB provides organisational and technical oversight. The Steering Board reports to the LDG.

M. Lamont (Chair) (CERN)

B. Auchmann (PSI/CHART)
B. Holzapfel (KIT)
J. M. Perez (CIEMAT)
L. Rossi (INFN)
C. Senatore (UNIGE, ex officio)
P. Vedrine (CEA)

M. Benedikt (CERN, FCC)
J. M. Jimenez (CERN, TE Dept. Head)
G. Riddone (CERN, HFM Program Office)
E. Todesco (CERN, HFM Program Leader)

HFM program is reporting three times a year to the Steering Board (see https://hfm.web.cern.ch/hfm-programme-governance-structure

HFM governing bodies

- Collaboration Board (CB)
  - HFM program is reporting once a year to the Collaboration Board (see also https://hfm.web.cern.ch/hfm-programme-governance-structure)
- The HFM CB brings together high-level representatives of all national institutions taking part in the HFM R&D Programme.
- The HFM CB mandate is to discuss the strategy and the scope of participation to the HFM Programme. Specifically, the HFM CB shall:
  - Be informed of the technical and scientific progress of the Programme;
  - Be informed of the on-going and perspective collaborations among participants within the scope of the HFM R&D Programme;
  - Review the work and resource sharing among the participating institutes;
  - Identify, within national and European funding agencies, resources for the implementation of the execution of the ongoing HFM R&D Programme and future stages;
  - Discuss the overall HFM R&D Programme strategy and provide advice and guidance to the HFM Steering Board and HFM Programme Leader on the technical progress and collaboration matters.

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HFM forum

- HFM fora started in February 2023 (one per RD line), with positive feedback from the HFM collaborators
  - Indeed, separation between RD lines is somewhat artificial
- We will merge the fora of RD lines in one HFM forum
  - Everybody shall be invited and have access to materials
  - Meeting 'a la carte' – you join if you are interested and if you have time
  - There will be a fixed slot, Thursday 9.30-11.00
  - Same structure used for HL-LHC WP3 meetings (https://indico.cern.ch/category/7762/) and for US-MDP meetings (https://conferences.lbl.gov/category/84/)
  - Tentative format: 3 presentations of 30 minutes
  - Scope: present the advancement of the work and share the results, including the timeline
    - Budget aspects are dealt offline with PL and PO
  - Meeting shall be called when needed (i.e. when new results or issues arrive) and not on the ground of periodical slot
  - Programme leader (Ezio) will take care of organization

HFM working groups

- Several colleagues expressed an interest in having working groups to treat specific topics, that are transverse to workpackages and research development lines
  - HFM WG will be the place to «make» the work and have in depth technical discussions
  - They will use the same time slot of HFM forum, alternating twice a month
  - Program co-leader (Bernhard) will take care of organizing the WG – see next presentation

HFM web site

- https://hfm.web.cern.ch/
- Main tool to distribute information, access materials of meetings, etc.
  - One page with the forum, including previous Fora, and links to meetings
  - One page with all the detail of workpackages, including past, and links to collaboration agreements
    - The collaboration agreements will not be public
  - One page with goals (to be updated)
  - One page with information on the governing bodies
- Please help us make it more effective

HFM

High Field Magnets Programme