Kick-off Meeting of HFM RD Line 1 Forum on Nb_3Sn Conductors

Introduction

Outline

- HFM R&D consortium and its structure
- Where do we stand on the LTS High Field Magnet development?
  - State-of-the-art LTS superconductors and magnet technology
  - Main challenges facing the development of LTS conductors and high-field accelerator magnets

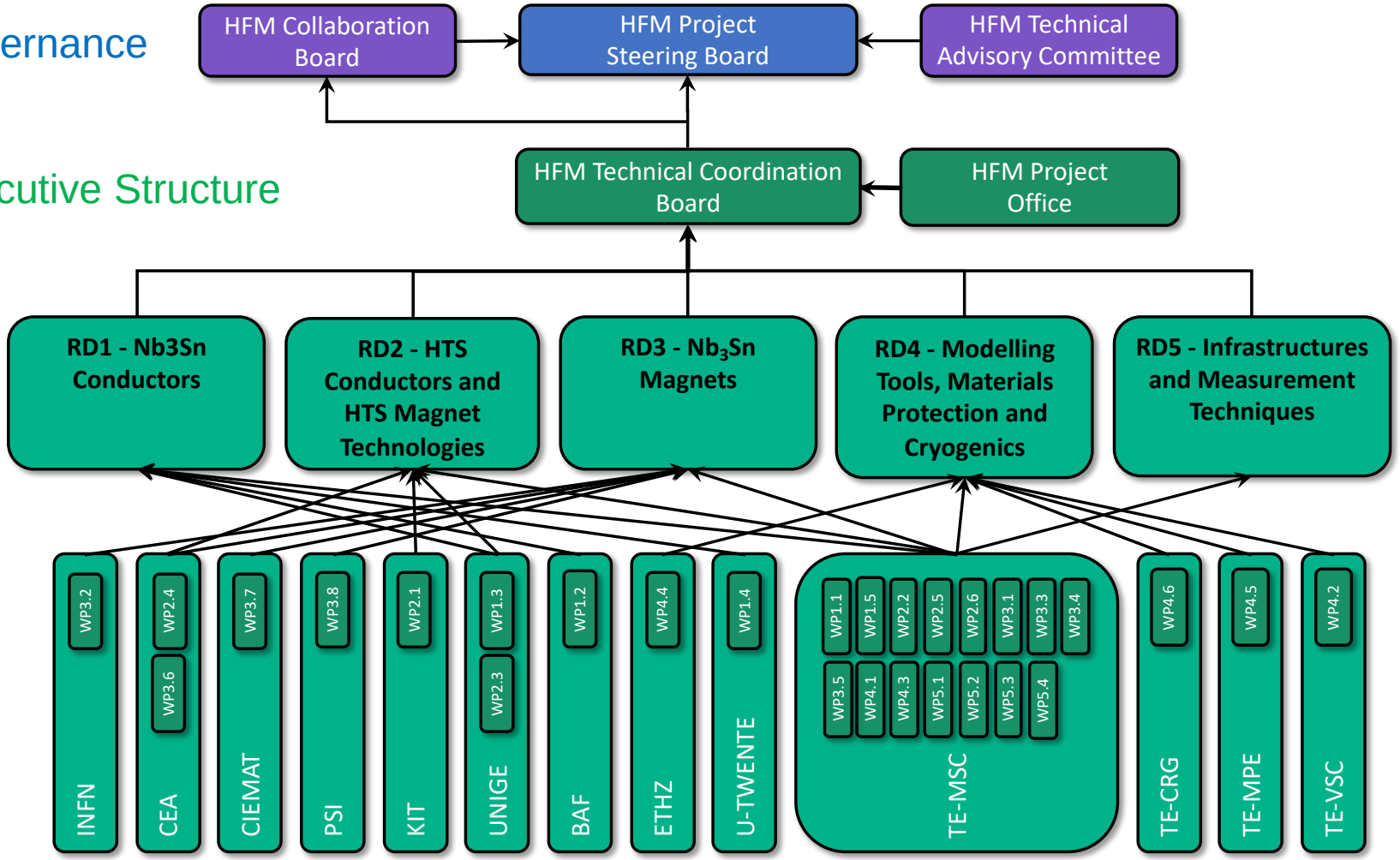
R&D Programme at CERN for the Next Generation of High-Field Accelerator Magnets

Present main contributors - **HFM R&D consortium**

HFM Programme Executive Structure

Governance

Executive Structure



R&D Lines and Technical Coordination Board

- All established Work Packages shall coordinate their activities with other contributors in their respective R&D Lines at R&D-Line Fora.
- The R&D Line Coordinators keep an updated version of the integrated R&D Line Deliverable Plan.
- Any changes to the Deliverable Plan are discussed in the Fora and presented and decided in the Technical Coordination Board in a timely fashion.
  - Changes may occur, for example, as a consequence of R&D insights, new cooperations among HFM partners, or the required re-allocation of resources as a function of programme needs.

HFM Programme – broad goals

- The EU Accelerator R&D Roadmap identifies main objectives for the High Field Magnet Programme:

  - OBJECTIVE 1:

  Design and demonstrate a full-size Nb_3Sn accelerator magnet to demonstrate the maturity of the most advanced technologies today, based on the HL-LHC design, i.e. 12 T magnets, and applying all the lessons learned from the US LHC Accelerator Research programme (LARP), the US High-Luminosity LHC Accelerator Upgrade project (AUP) and the HL-LHC project. The full-size demonstrator also aims to investigate at an early R&D stage the physical and technological effects associated with magnet length.

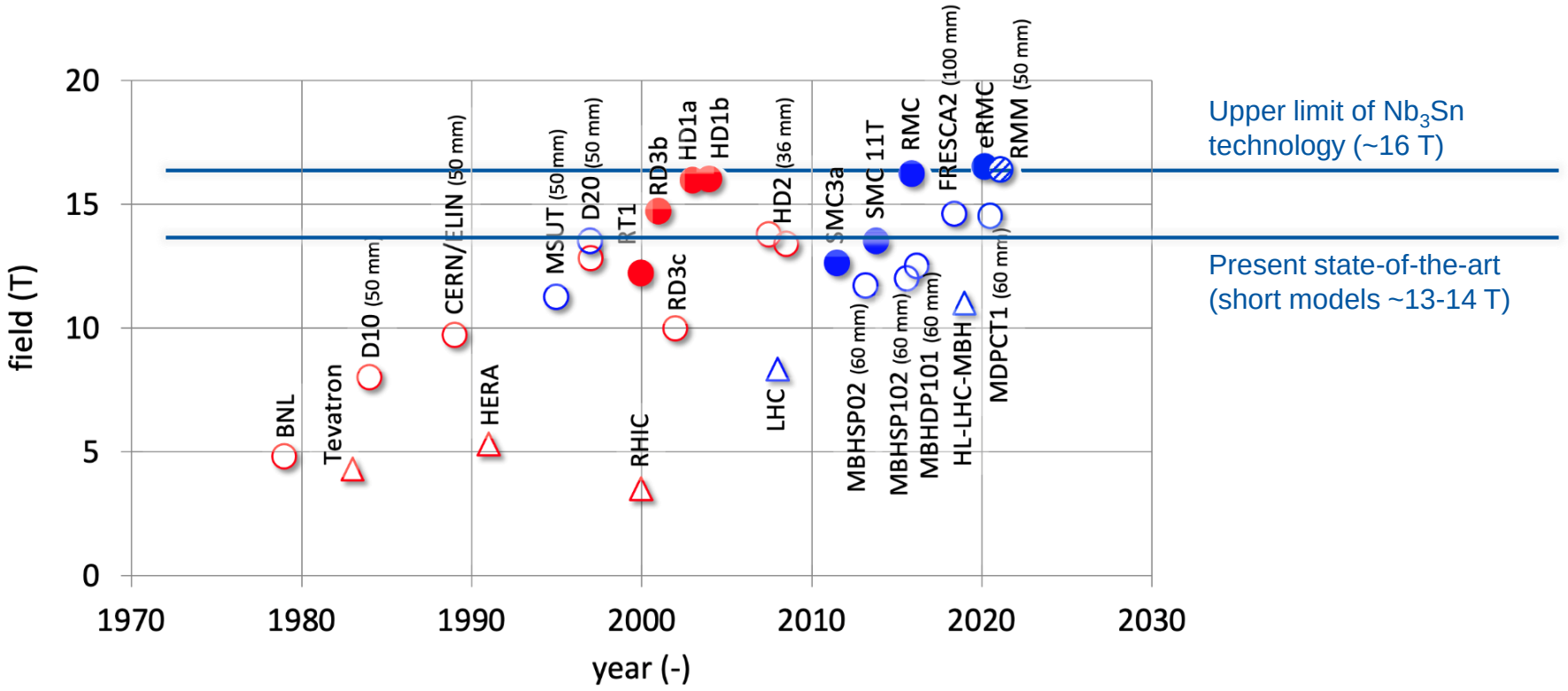
  - OBJECTIVE 2:

  Explore the limitations of the LTS state-of-the-art technology and push Nb_3Sn magnet technology to its practical limits in terms of ultimate performance, towards the 16 T target targeted by the FCC-hh.

  - OBJECTIVE 3:

  Explore the capabilities and limitations of state-of-the-art HTS and magnet technology based on these superconductors. Demonstrate the suitability of HTS superconductors for accelerator magnet applications by providing evidence of the use of HTS technology beyond the Nb3Sn range, with a target in excess of 20 T.

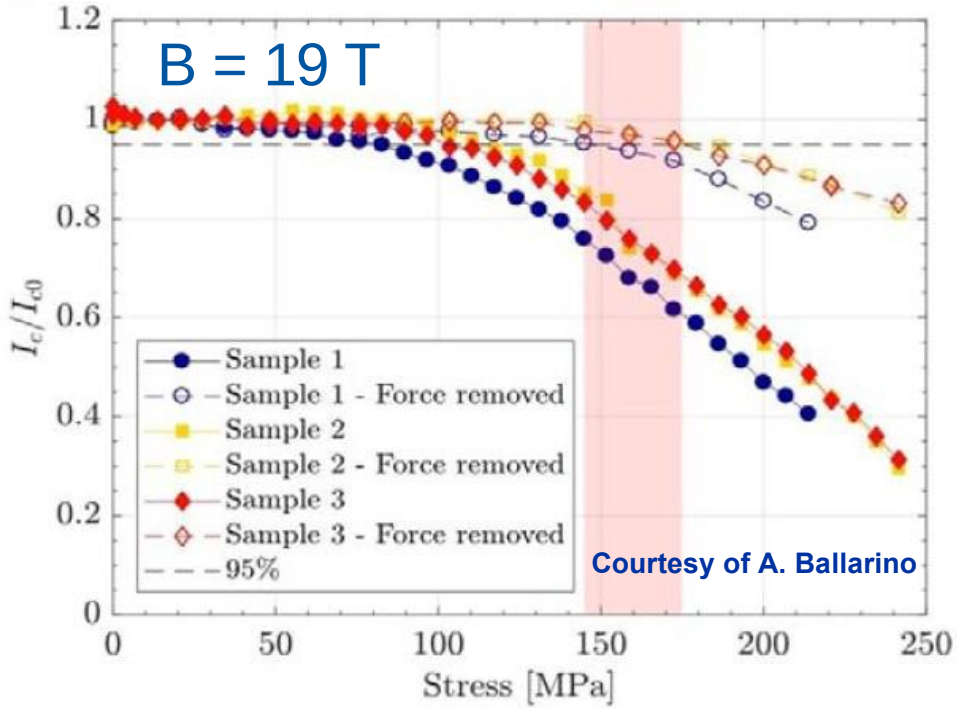
State-of-the-art LTS superconductors and magnet technology



Main challenges facing the development of future LTS high-field magnets

Nb_3Sn Conductors

- Present limitations of Nb_3Sn technology are linked to:
  - conductor stress/strain sensitivity and degradation
  - thermomechanical behaviour and degradation of magnet performance

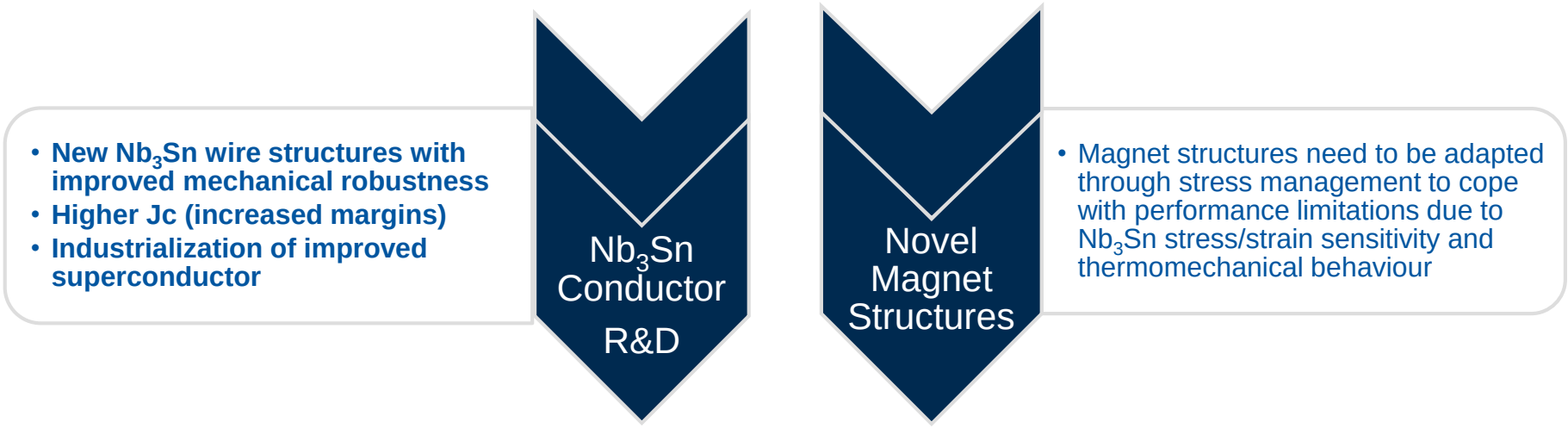


- σ_{irr} = 145–175 MPa
- I_c/I_{c0} @ 150 MPa
  → 16 % - 28 %

R&D Strategy and Focus Areas for the LTS high-field magnets

Nb_3Sn Conductors and magnets: pushing towards ultimate performance

- **Stress/strain sensitivity** and degradation of Nb_3Sn conductors **to be overcome** by one of the two development paths:



R&D Strategy and Focus Areas for the LTS high-field magnets

Nb_3Sn Magnets: 14+T Feasibility Studies

- Exploratory phase, multiple magnet-development of various magnet structures at CERN and national laboratories
- Approaches range from evolutionary, based on LARP/HL-LHC technology to departures from evolutionary to beyond state-od-the-art magnet structures

- 1st priority: performance and (sufficient) robustness.
- 2nd priority: maximum robustness and reduced cost.

- **Exploratory phase of magnet structure R&D**
  - cos theta (see 12 T Robust);
  - block coil;
  - common coil

Evolutionary technology R&D

Beyond state-of-the-art

- **Magnet structures adapted to stress/strain sensitivity limitations**
  - stress managed version of either coil variant aimed at reduced coil stresses, at cost of lower efficiency

HFM

High Field Magnets

Current Work Packages in HFM RD1

RD Line Name	RD Line	WP	WP Name
RD1 - Nb3Sn Conductors			
	RD1	WP1.1	Nb3Sn conductors for high field magnets - CERN
	RD1	WP1.2	R&D on optimisation of Nb3Sn microstructure and pinning - BAF (**KE5074**)
	RD1	WP1.3	Nb3Sn conductor Jc performance and electro-mechanical properties beyond state-of-the-art. - UNIGE (**KE4663**)
	RD1	WP1.5	R&D on mechanical properties of NB3SN wires and cables- U-Twente (agreement in preparation)
			RD Line Coordinators: C. Senatore, Th. Boutboul