HFM

High Field Magnets

RD Line 3 third forum meeting – Nb_3Sn magnets

Activities of the WP3.4 at CERN

Technology development program

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on behalf of the 12T team 20.12.2023

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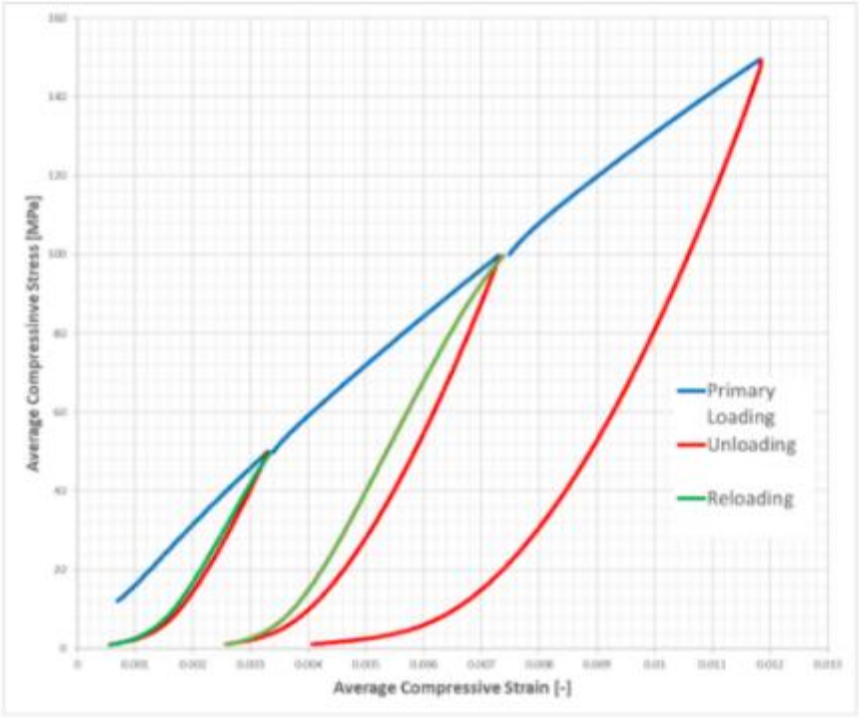
Scope of the Work Package 3.4

- Cables and coil properties
  - Material properties
  - Systematic winding tests
  - End spacers parametric studies coupled with Roxie
- Mirror coil testing device
- Splices
  - Internal - inside the pole (plan A)
  - External - outside the pole (plan B)
- Preparation studies for long coils

Cable and coil properties

- Ten stacks and coil mock-ups to measure mechanical and thermal properties.
- Refurbishing of existing E modulus press. Systematic measurements of stress – strain curve of coils



Nonlinear coil stress-strain curve used in FEM computations.

Systematic winding tests based on quantifiable parameters

- Torque (T)
- Soft bending (SB)
- Hard bending (HB)

} Parameters defined and computed in Roxie

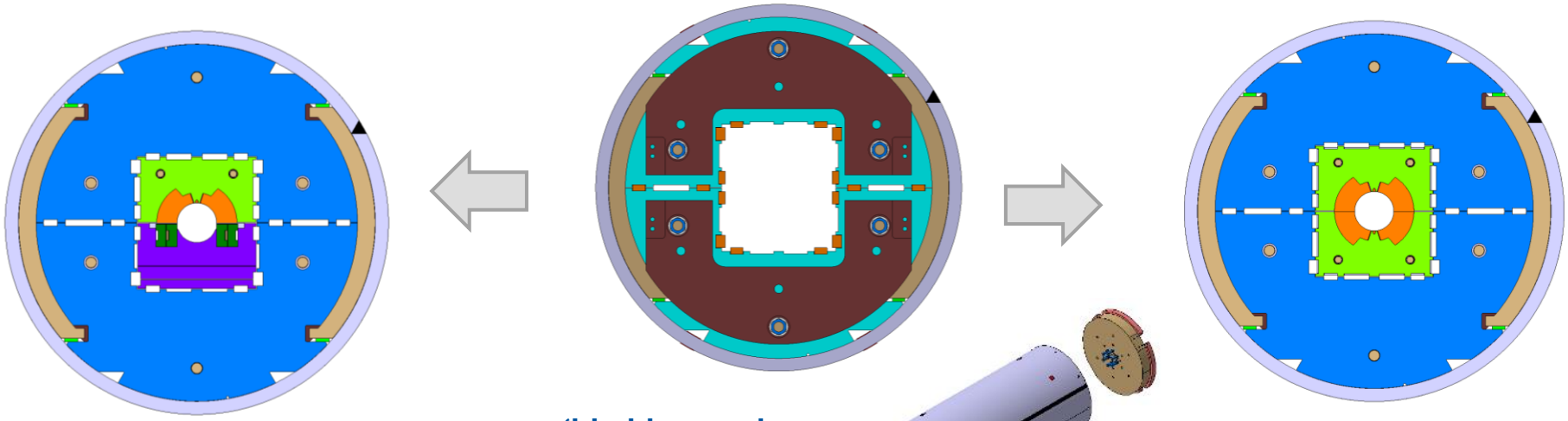
- Cable and strand characteristics

- 3D rapid prototyping allows us a quick and low-cost way to compute and test end spacers. **Variants characterized by parameters (T, SB, HB).**
- Tests for both HFM magnets and other projects using NbTi cables as well.
- Construction of a **documented and traceable database. Feedback to design code(s).**

Mirror – test coil structure

- **Design completed**
- **Assembly tools under study (re-use of many existing devices**
- **Components for external structure under procurement (price enquires)**

External structure independently assembled



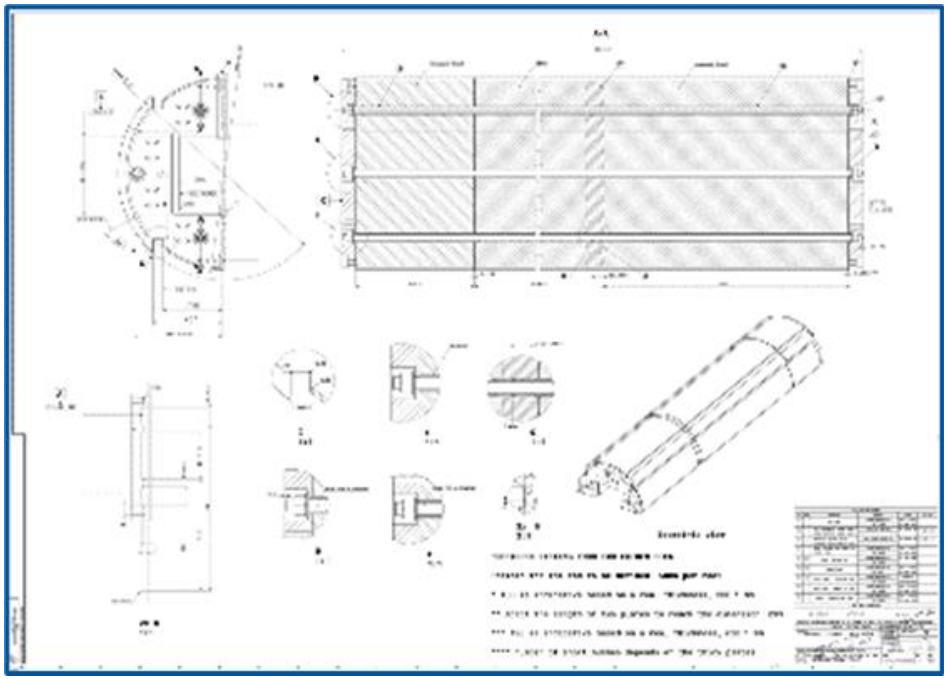
Single aperture half (mirrored)

‘bladders and keys’ type

Single aperture full

Design review 14.12.2023

There is the possibility of having Instrumentation to read the coil prestress at the midplane and better calibrate the strain gages in the collars.



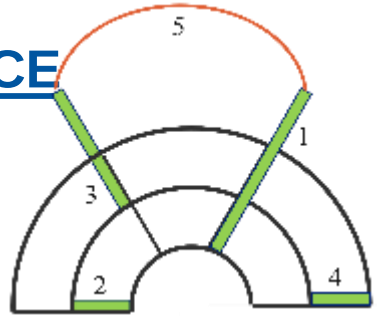
Component	Drawings	Status
External cylinder	Approved	Under construction
Iron yoke - stoppers	Ready	Price enquiries of components
Central coil support	Ready	Price enquires
End plates	Ready	Price enquiry
Pads for 11 T coil	Almost ready	
Pads for 12 T coils	Almost ready	

Splices

Splice conceptual designs

Nb_3Sn – Nb-Ti splice Nb-Ti – Nb-Ti splice Nb_3Sn – Nb_3Sn splice

EXTERNAL SPLICE

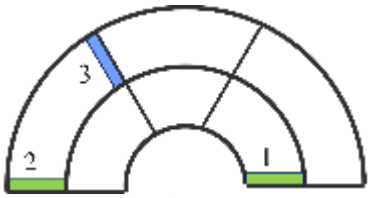


The cable ends are spliced to Nb-Ti outside the coil, before impregnation.

The two layers are then spliced through a Nb-Ti – Nb-Ti joint, during the magnet assembly.

- **Support the brittle Nb_3Sn cable**
- **Two layer-jumps** of different shapes to be accommodated into the coil pack
- **Double-layer jump** for the inner layer cable

INTERNAL SPLICE

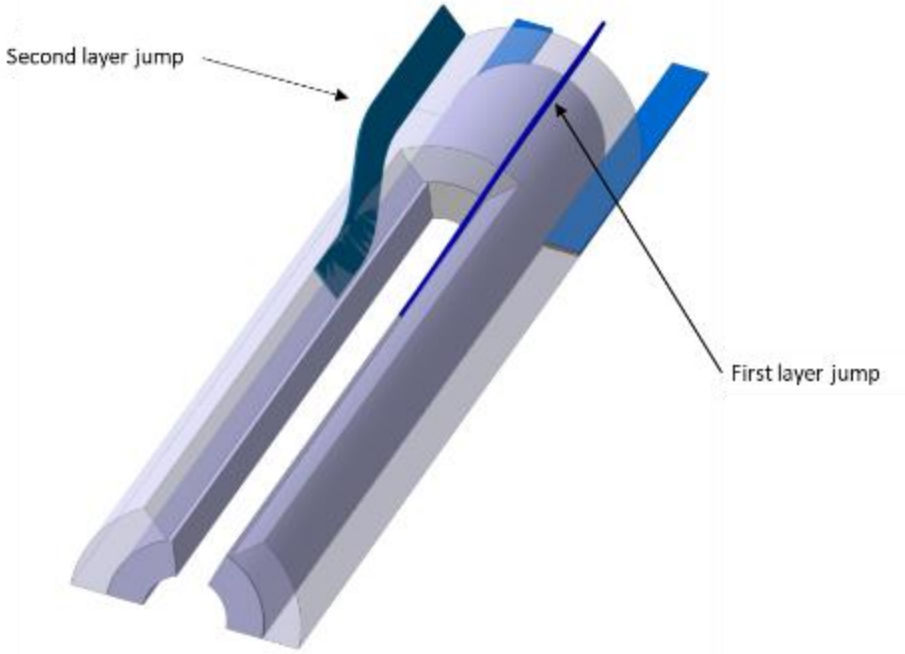


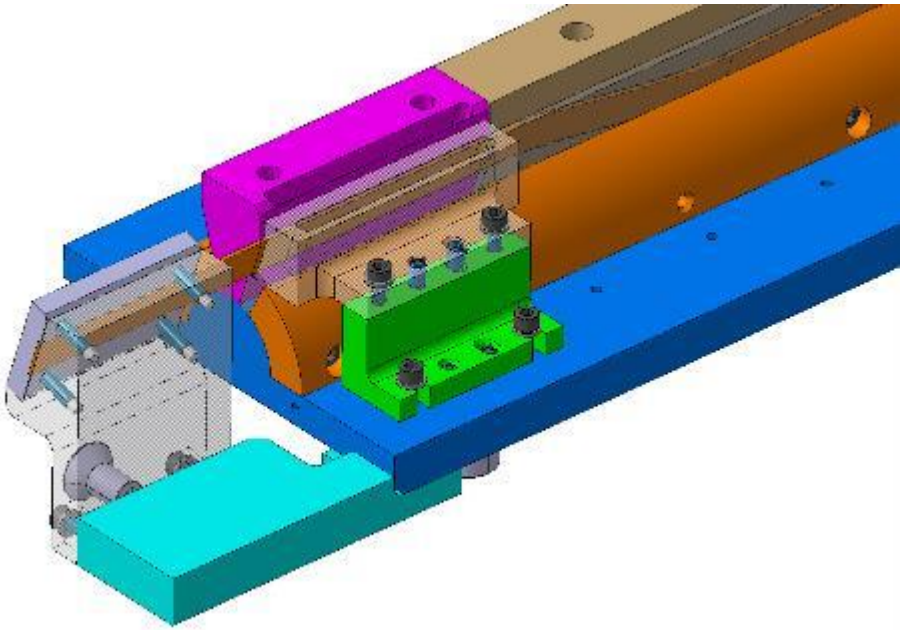
A Nb_3Sn – Nb_3Sn joint connects the two layers within the coil at the pole turn level. It is performed after impregnation.

- **Support the brittle Nb_3Sn cable**
- Splicing in the **limited space** of the pole region
- Splice in the **high field region**

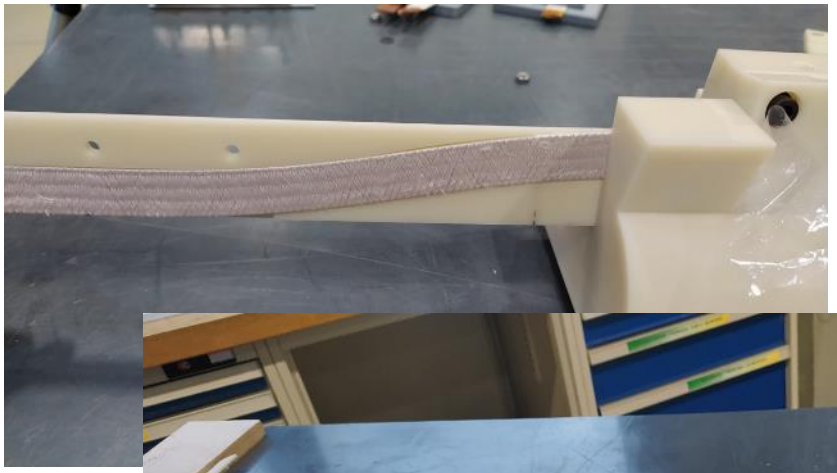
Courtesy V. Ilardi

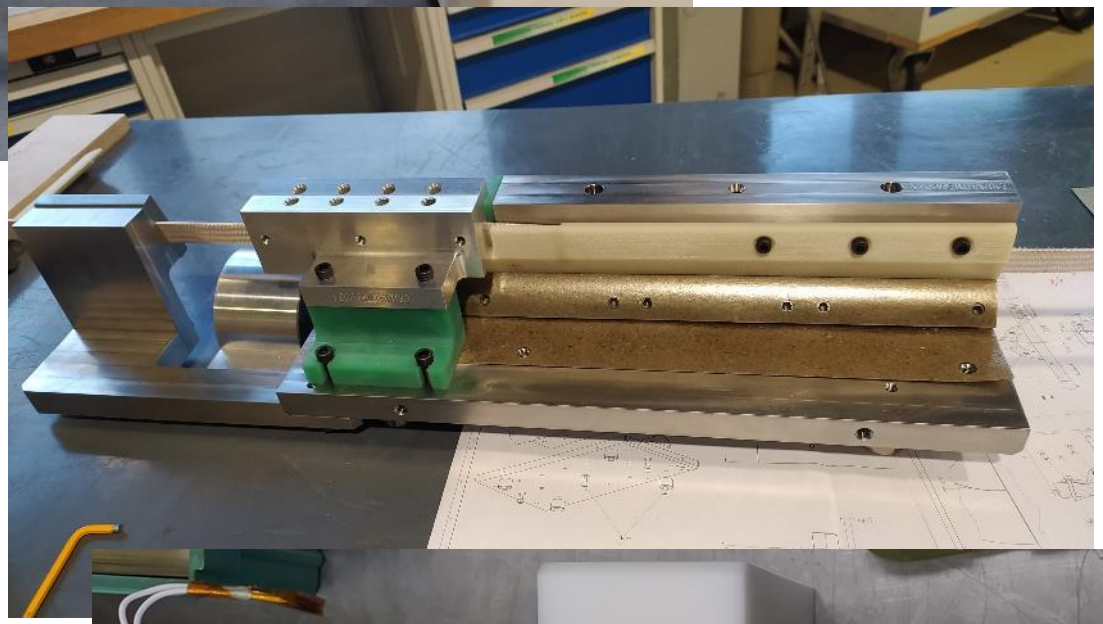
Study of possible layer jump and splice configurations in view of manufacturing separate first layer and second layer





Modular moulds to realize the two different splices or a 11 T type pole (which is not our baseline).



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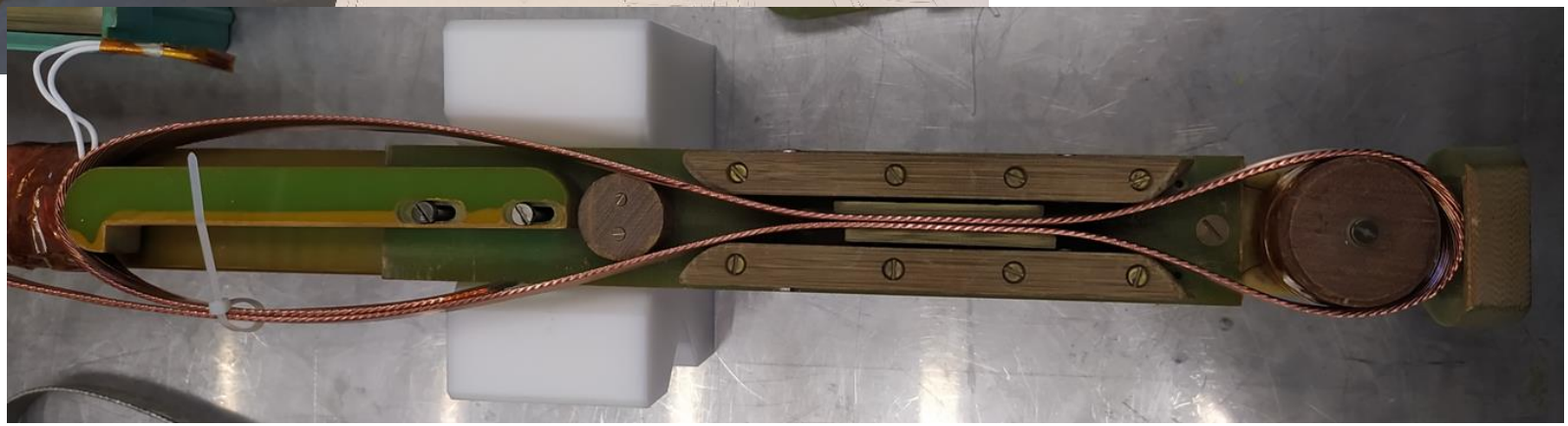

Conclusions

- We introduced the nonlinear behaviour of the cable in all our computations. Systematic measurement program and a data base for different cables and coils.
- Winding tests on going and further tests planned. Parameters to quantify the results and give feedback to the design.
- A test structure to validate the coil design choices is under construction.
- Splice design, characterization and validation tests on going.