WP3

Nb_3Sn on Cu films for 4.2K cavity operation

Steering Committee Meeting
27.01.2026

Activities Update - Points of attention

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Steering Committee Jan 2025

WP3: Nb_3Sn on Cu films for 4.2K cavity operation

INFN, CEA, HZB, UKRI
Convener: Cristian Pira (INFN), Deputy O. Malyshev (UKRI)
Main contacts with other partners:
T. Proslier (CEA), O.Kugeler (HZB), O. Malyshev (UKRI), R. Valizadeh (UKRI)

Task 3.1: Coordination of R&D on SC Cavities – M1-M48

- *General coordination by INFN.*

Task 3.2: Flux Trapping – M1-M32

- *Explore new coating parameters for planar samples and small resonators to minimize flux trapping in SC A15 films.*
- *Upgrade the STFC choke cavity and the HZB QPR to support detailed flux trapping analyses of coated SC films.*
- *Characterize trapped flux, flux viscosity and the interaction with the RF field with SC A15 films in small resonators and planar samples with the upgraded systems.*

Task 3.3: RF Tunability – M1-M32

- *Explore new coating parameters on planar samples and resonators to enhance the mechanical strength in SC A15 films.*
- *Mechanical film-stability tests with planar samples.*
- *Build cavity tuning system and perform vertical cryo-tests of coated cavities to explore RF performance limits and acceptable tuning without incurring film damage.*
- *Devise cavity tuning schemes for Nb3Sn cavities fulfilling the required tuning parameters while taking into account the constraints of Nb3Sn. The implementation of FE-FRT to assist will be considered.*

Task 3.4: Adaptative layers – M1-M40

- *Develop adaptative layers by atomic layer deposition on Cu that are stable up to 650 ±C.*
- *Compare performance Nb3Sn on Cu with and without adaptive layers on planar samples and QPR.*

Task 3.5: Working Cavity @4.2 K – M1-M48

- *Improve I.FAST 1.3-GHz superconducting coating recipe based on Tasks 3.2-3.4 results.*
- *Prepare 1.3-GHz thin film cavities with an optimized coating recipe.*

WP3 – SRF: status/evolution of Task 3.1

Coordination (**INFN**, CEA, HZB, UKRI) – *Cristian Pira*

Milestone 39 Impact risk analysis WP3 - *INFN - Presentation M24* **On track**

- **WP3 Meeting 07 – Online meeting on 24/11/2025**
  https://indico.ijclab.in2p3.fr/event/12433/
- **WP3 Meeting 08 – Online meeting on February (date to be confirmed)**

WP3 – SRF: status/evolution of Task 3.2

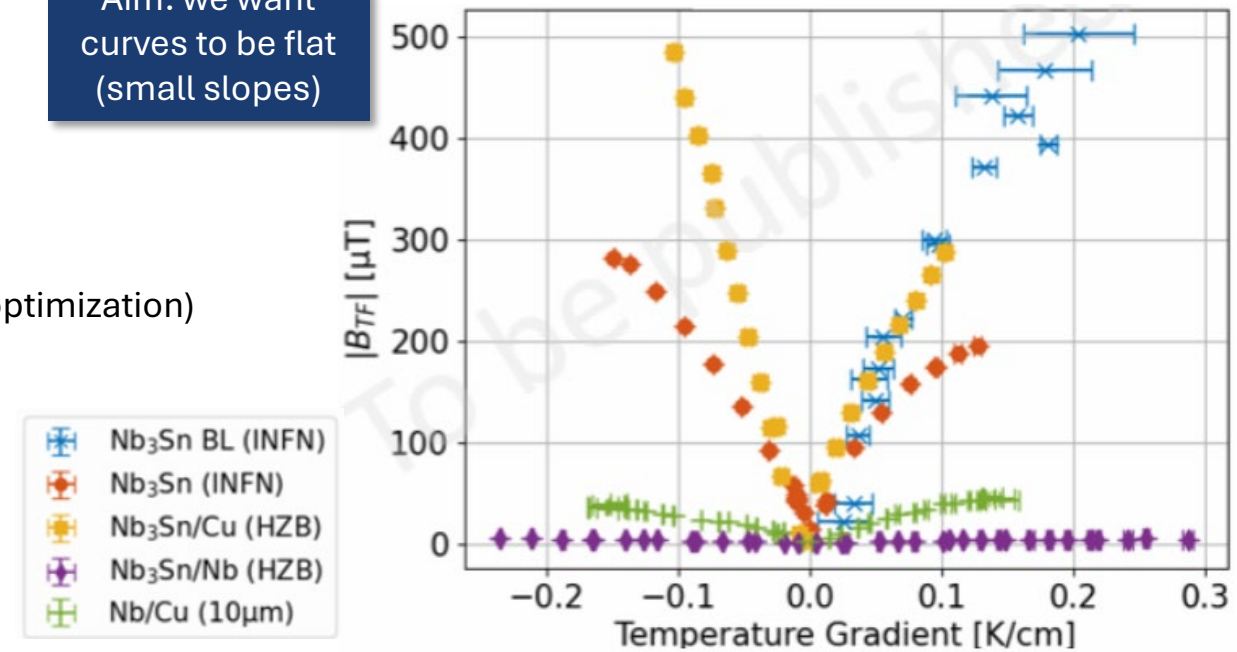
Flux Trapping (INFN, CEA, HZB, **UKRI**) – *Oleg Malyshev*

Milestone 3.1 Modification of choke cavity for flux trapping study - *Engineering report M12* **Completed in time**

Deliverable 3.2 Flux trapping Report on flux dynamics study in Nb3Sn on Cu samples - *HZB - Report M30* **On track**

- ***New flux expulsion measurements***
  - Trapped flux was measured as a function of temperature gradient for different coated samples
  - Large thermo-current induced trapped flux observed
  - Fields vary by several oorders of magnitude
  - Buffer layer (BL) did not improve expulsion behavior (needs optimization)
  - Further improvement needed

Aim: we want curves to be flat (small slopes)



F. Kramer: Invited talk at SRF 2025

Paper for SST in preparation

WP3 – SRF: status/evolution of Task 3.3

Tunability (INFN, CEA, **HZB**, UKRI) – *Oliver Kugeler*

Deliverable 3.1 Cavity tuning Report on implementation of cavity Q vs F tuning tool
HZB - Report M24

On track

- **Adapter for blade tuner ready in HZB**
- **Tuner flange under production at INFN**
- **The cavity will be sent to HZB by the end of January**
- **Testing at HZB is scheduled for the first half of February**

Milestone 3.3 Report on mechanical strength test of SC coatings - *Test report M30*

Started but slightly delayed

CEA: New task responsable identified
UKRI and INFN: Coating systems ready for first planar samples deposition

WP3 – SRF: status/evolution of Task 3.4

Adaptive Layers (INFN, **CEA**, HZB, UKRI) – *Thomas Proslier*

Milestone 3.2 Developed ALD adaptive layers on Cu - *Test report M24* **Completed – Report ready for submission**

- **At CEA: Al_2O_3, ZrO_2 and $AlZrO_x$ oxides successfully coated by ALD and stable up to 750 °C**
- Adaptive layers tested successfully with Nb films deposited by HIPIMS (100-200°C) at CERN
- 2 Cu 1.3 GHz cavities coated at CERN with Nb films
- **HPR tests successfull (no Nb film delamination). Sucessfull mitigation of thermo-electric currents even in high thermal gradient cool down.**
- Tunneling spectroscopy measurements in progress

Deliverable 3.3 Adapt. Layer Report on QPR study of Nb3Sn on Cu & adaptive layers - CEA - *Report M38* **On track**

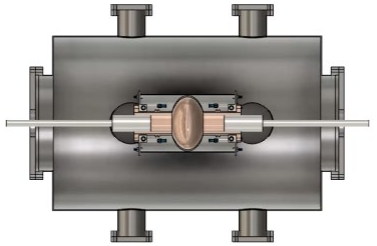
- **Nb_3Sn coated successfully on different adaptive layers at INFN. Test ongoing**
- **Other coating in progress (Oxide ALD adaptive layer + Nb PVD adaptive layer)**
- Tunneling spectroscopy measurements in progress

WP3 – SRF: status/evolution of Task 3.5

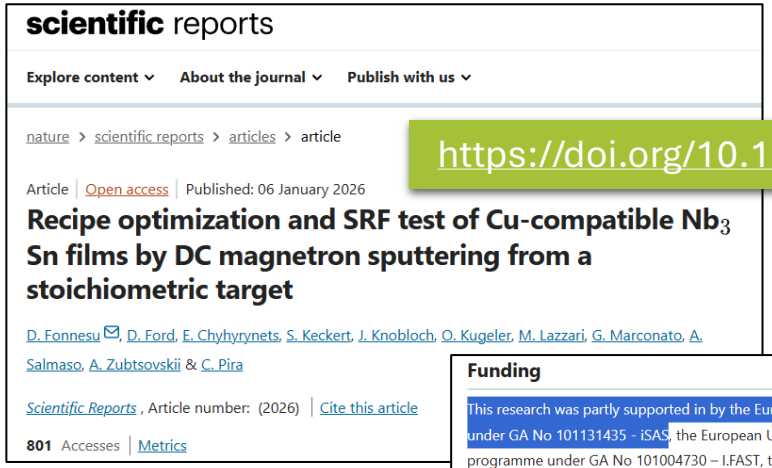
Working Cavity (INFN, CEA, HZB, **UKRI**) – *Reza Valizadeh*

Milestone 3.4 Characterization of Nb3Sn reference cavity - *Test report M34* **On track**

- 1.3 GHz Nb cavity successfully coated with Nb_3Sn at UKRI
- **Tested at HZB in November**
- **Cu contamination killed the RF performances**
- **New coating tests ongoing**



Deliverable 3.4 4.5-K Cavity Report on 4.5-K Cavity performance & tunability tests - INFN - *Report M46* **On track**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Recipe optimization and SRF test of Cu-compatible Nb_3Sn films by DC magnetron sputtering from a stoichiometric target

D. Fonnesu, D. Ford, E. Chyhyrynets, S. Keckert, J. Knobloch, O. Kugeler, M. Lazzari, G. Marconato, A. Salmaso, A. Zubtsovskii & C. Pira

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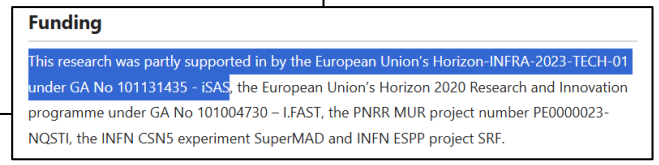
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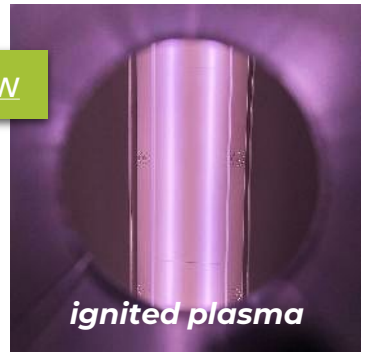
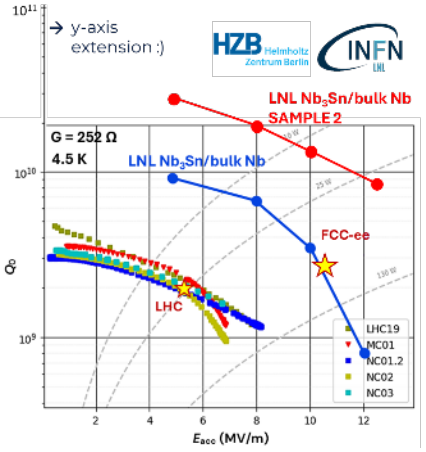


First plasma on 1.3 GHz rectangular magnetron



Q 10 times better than LHC!

WP3 – SRF: points of attention

- ***EPITA** (I.FAST-2) **proposal submitted** in September*
  - ***Further progress on TRL** expected by Nb3Sn on Cu technology: production of a 4 K conduction cooling cryomodule*
  - ***Zanon and RI are industrial partner in the proposal***
  - ***EU response expected in February***

WP3 – SRF: Tasks Status

Timeline in project months (M)				M/D	#	Related task	Description	Status	Risk level
Y1	M12	Feb	2025	M	3.1	3.2 Flux Trapping	Modification of choke cavity for flux trapping study	Done submitted	On track
Y2	M24	Feb	2026	M	3.2	3.4 Adaptive Layers	Developed ALD adaptive layers on Cu	Done (to be submitted)	On track
Y2	M24	Feb	2026	D	3.1	3.3 RF Tunability	Cavity tuning Report on implementation of cavity Q vs F tuning tool	In progress	On track
Y2	M24	Feb	2026	M	39	3.1 Coordination of R&D on SC Cavities	Impact risk analysis WP3	In progress	On track
Y3	M30	Aug	2026	M	3.3	3.3 RF Tunability	Report on mechanical strength test of SC coatings	In progress	Risk to mitigate
Y3	M30	Aug	2026	D	3.2	3.2 Flux Trapping	Flux trapping Report on flux dynamics study in Nb3Sn on Cu samples	In progress	On track
Y3	M34	Dec	2026	M	3.4	3.5 Working Cavity @4.2K	M3.4 Characterization of Nb3Sn reference cavity	In progress	On track
Y4	M38	Apr	2027	D	3.3	3.4 Adaptive Layers	Adapt. Layer Report on QPR study of Nb3Sn on Cu & adaptive layers	In progress	On track
Y4	M46	Dec	2027	D	3.4	3.5 Working Cavity @4.2K	4.5-K Cavity Report on 4.5-K Cavity performance & tunability tests	In progress	On track

- All tasks are on track except M3.3
- The delay of M3.3 is not critical, we expect to be able to meet the original deadline