



## WP3: Nb<sub>3</sub>Sn on Cu films for 4.2K cavity operation

INFN, CEA, HZB, UKRI

Convener: Cristian Pira (INFN)

Main contacts with other partners:

T. Proslie (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 Nb<sub>3</sub>Sn cavities fulfilling the required tuning parameters while taking into account the constraints of Nb<sub>3</sub>Sn. The implementation of FE-FRT to assist will be considered.

### **Task 3.4: Adaptive layers – M1-M40**

- Develop adaptive layers by atomic layer deposition on Cu that are stable up to 650 °C.
- Compare performance Nb<sub>3</sub>Sn 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*

### **Status:**

**WP3 Meeting 01 - Task leaders Pre-Kick-Off remote meeting on 21/02/2024**

<https://agenda.infn.it/event/40107/>

**WP3 Meeting 02 - Kick-Off meeting in presence (in collaboration with I.FAST WP9) on 16/04/2024**

**WP3 Meeting 03 - Task Leaders – remote meeting on 17/07/2024**

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

**Deliverable 3.2** Flux trapping Report on flux dynamics study in Nb<sub>3</sub>Sn on Cu samples - *HZB - Report M30*

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

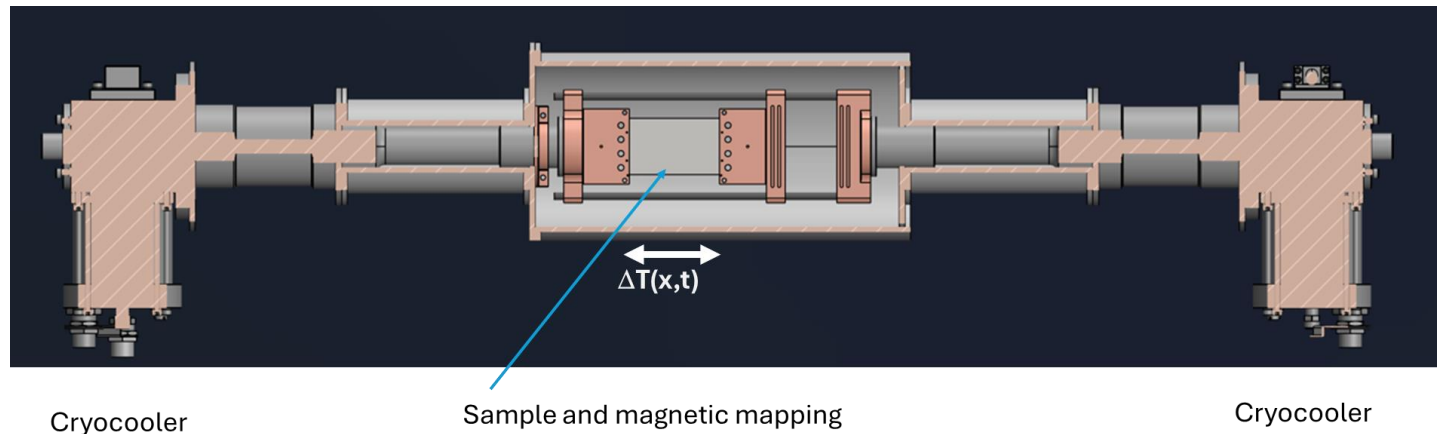
### Status:

#### At UKRI:

- A measurement facility is being moved to a new bunker to enable the measurements at higher RF power.
- New magnet shield procured and delivered to UKRI.
- New set of Hall probes and a 4-channel controller procured at Paragraf. All items arrived to UKRI. A design of a new sample holder that will accommodate Hall probes is ongoing.

#### At HZB:

- Production and procurement of apparatus to measure temperature-gradient driven flux trapping ongoing. Commissioning expected in October 2024.







## WP3 – SRF: status/evolution of Task 3.4

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

**Deliverable 3.3** Adapt. Layer Report on QPR study of Nb<sub>3</sub>Sn on Cu & adaptive layers - *CEA - Report M38*

**Milestone 3.2** Developed ALD adaptive layers on Cu - *Test report M24*

#### Status:

##### CEA:

Al<sub>2</sub>O<sub>3</sub> coatings on EP Cu substrate and subsequent low temperature Nb deposition by HIPIMS(100-200°C) successful.

- Crystalline ALD oxide layer by ALD for high temperature Nb<sub>3</sub>Sn HIPIMS growth. Layer Stable up to 750°C. Work in progress.

**UKRI and INFN:** Coating systems ready for first planar sample deposition. Substrate polishing in progress



## WP3 – SRF: status/evolution of Task 3.5

no changes to the program planned

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

**Deliverable 3.4** 4.5-K Cavity Report on 4.5-K Cavity performance & tunability tests - INFN - *Report M46*

**Milestone 3.4** Characterization of Nb<sub>3</sub>Sn reference cavity - *Test report M34*

### Status:

**UKRI and INFN:** 1.3 GHz Coating systems in the commissioning phase (part of the I.FAST program)

Two potential target manufacturing companies Osaka Asahi Metal and Photon Export has been identified and enquiry for NbTi, Nb<sub>3</sub>Sn target made as tubes is been made.

Received several halfshell 1.3 GHz copper cavity

Deposition from cylindrical mixed Nb rod and Ti mesh.



## WP3 – SRF: points of attention

- **Synergy with I.FAST partners** at least until 31/04/2025 (I.FAST extension requested up to )
- Nb<sub>3</sub>Sn R&D on I.FAST showed the need for an adaptive layer on top of the copper substrate to optimize the lattice parameter of the superconductive Nb<sub>3</sub>Sn film that is growing on the substrate in order to maximize the T<sub>c</sub> value. Currently, an Nb layer thicker than 30 microns is used for this purpose.
- **ISAS Task 3.4 gains more importance** because, in addition to looking for an adaptive layer via ALD that optimizes the mechanical properties, we will also look for the possibility of replacing the thick Nb layer with an ALD layer that optimizes the lattice parameter of the Nb<sub>3</sub>Sn coating and thus maximizes the T<sub>c</sub>.
- **In the grant agreement encountered an error in assigning deliverables** (probably occurred during the task numbering change):
  - *Deliverable 3.4 is in charge of CEA and not UKRI*
- ***New Point of Attention?***

## WP3 – SRF: plans to achieve milestones & deliverables

**D3.1** Cavity tuning Report on implementation of cavity Q vs F tuning tool - *Report M24- HZB*

**D3.2** Flux trapping Report on flux dynamics study in Nb<sub>3</sub>Sn on Cu samples - *Report M30 – HZB*

**D3.3** Adapt. Layer Report on QPR study of Nb<sub>3</sub>Sn on Cu & adaptive layers - *Report M38 – CEA*

**D3.4** 4.5-K Cavity Report on 4.5-K Cavity performance & tunability tests - *Report M46 - INFN*

**M3.1** Modification of choke cavity for flux trapping study - *Engineering report M12*

**M3.2** Developed ALD adaptive layers on Cu - *Engineering report M24*

**M3.3** Report on mechanical strength test of SC coatings - *Test report M30*

**M3.4** Characterization of Nb<sub>3</sub>Sn reference cavity - *Test report M34*

