Task 9.2 Innovative SC Accelerating Cavity Prototype

Beneficiarie

INFN (Task Leader)

STFC

University of Siegen

CEA

HZB

IEE

Piccoli (industrial partner)

Associated Partners

Physical-Technical Institute, Belarus

Moscow Engineering Physics

Institute

Jefferson Lab JLab

Strong correlation between tasks 9.2 - 9.3 and 9.6

9.1 - Coordination and Strategy for Innovative Superconducting Accelerating Cavities *(**CEA**, LNL, HZB, STFC, USI)*

9.2 - Innovative Superconducting Accelerating Cavity Prototype *(LNL, LASA, PICCOLI, STFC, USI, CEA, IEE, HZB)*

9.3 - Optimisation of process parameters and target development for SRF cavity coating with A15 material *(STFC, LNL, USI, HZB)*

9.4 - Surface engineering by Atomic Layer Deposition (ALD) *(**CEA**, CNRS)*

9.5 Improvement of mechanical and superconducting properties of RF resonator by laser radiation *(**RTU**, STFC, LNL, IEE, HZB)*

9.6 Optimization of flat SRF thin films production procedure *(HZB, LNL, STFC, USI, CEA)*

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Objectives

- Optimize and industrialize the manufacturing of seamless elliptical copper cavities.
- Demonstrate the possibility to replace the current Nb bulk technology with an innovative SRF cavity coated with a superconducting film.

Description of work

This Task will demonstrate the possibility to replace the current Niobium bulk technology with an innovative SRF cavity coated with a SC film. The goal is to realize a thin film cavity prototype at 1.3 GHz (TRL 5) with a surface resistance at 4.2 K close to Nb bulk surface resistance at 2 K (Q0 ~ 10^{10} at 1.3 GHz). Different materials with Tc higher than Niobium will be explored for the deposition of the final prototype, as for example Nb3Sn and SIS multilayer, building on the results obtained by the ARIES project and other I.FAST Tasks. The prototype will consist of a single-cell elliptical Cu cavity coated with a SC film and tested in a vertical cryostat. Different aspects of the cavity production will be addressed, in particular, cavity manufacturing and preparation, film deposition and cavity testing. A pre-prototype cavity at 6 GHz will allow the complete exploration of all deposition parameters at lower cost before upscaling to the larger 1.3 GHz cavity.

INFN and PICCOLI will optimize the seamless production of the elliptical cavities; PICCOLI will provide EB welded elliptical cavities to test the substrate effect on SC coating. INFN will be in charge of preparing the internal copper surface of the cavities prior to the coating with Centrifugal Barrel Polishing (CBP) and chemical/electrochemical polishing. The coating and morphological characterization of SC films involve four institutes (INFN, UKRI, USI and CEA) that will develop different coating set-ups. CEA, IEE and UKRI will be in charge of the SC characterization (HC1, Tc, Tunneling Spectroscopy). Cross-checked SRF tests will be done at HZB, INFN and STFC.

Deliverable

Month 46: Resonant cavity coated and tested with an alternative material to Nb with a $Q_0 > 1*10^9$ at 4.2 K and 1.3 GHz

Sub tasks

- Copper cavity production — Seamless — EBW
- Copper cavity preparation — Chemical Polishing — Centrifugal Barrel Polishing
- Coating on coupons/cavity + characterization — Nb_3Sn — Nb_3Sn? NbN? On 1.3 GHz? — SIS?
- SC characterization — Magnetomery — Tunneling? — AC/DC characterization
- Cavity Test — 4,2 and 2 K RF test with T map