

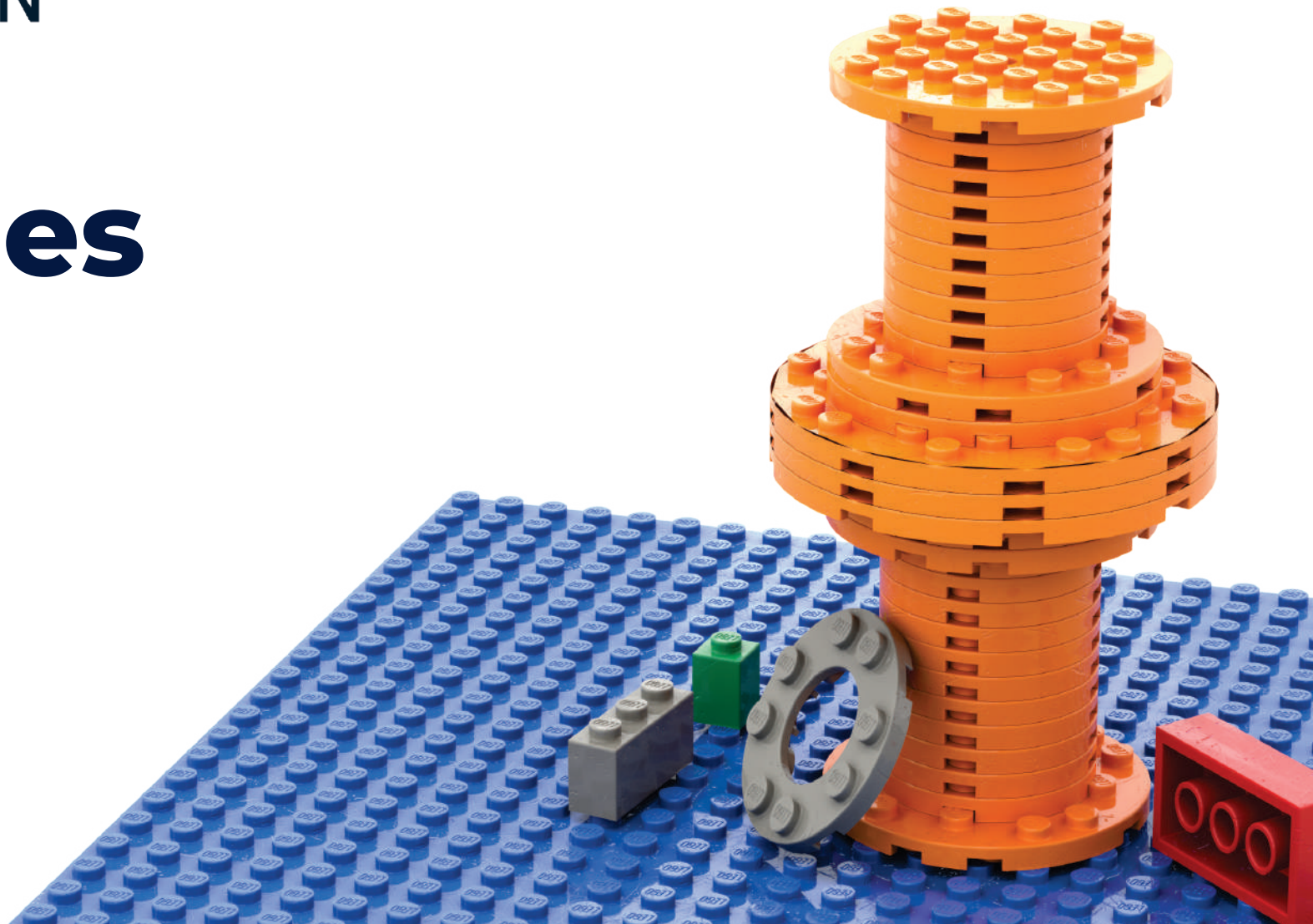
Cristian Pira 

Presented by  
**Eduard Chyhyrynets**

# SRF cavities R&D for FCC-ee

ESPP 2026-2033

17<sup>th</sup> September 2024



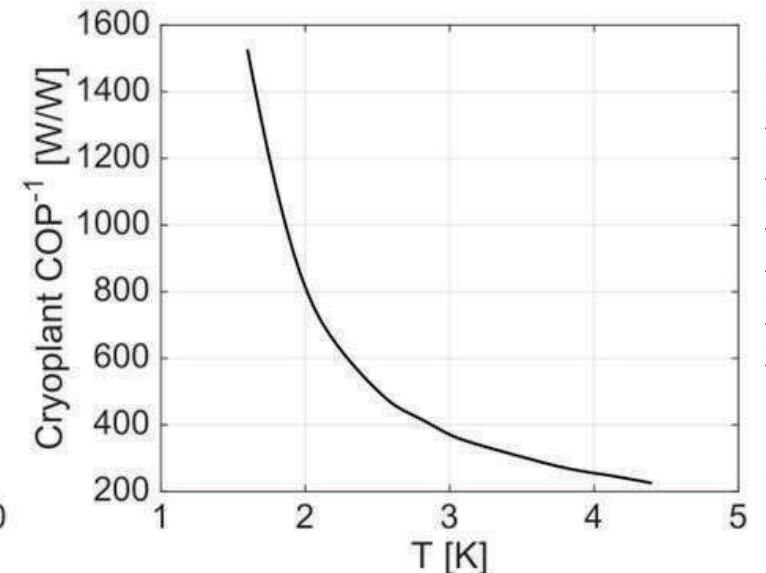
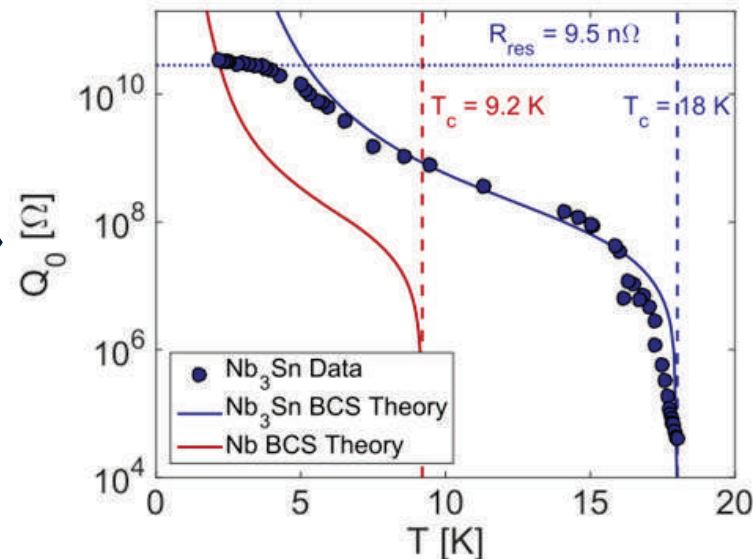
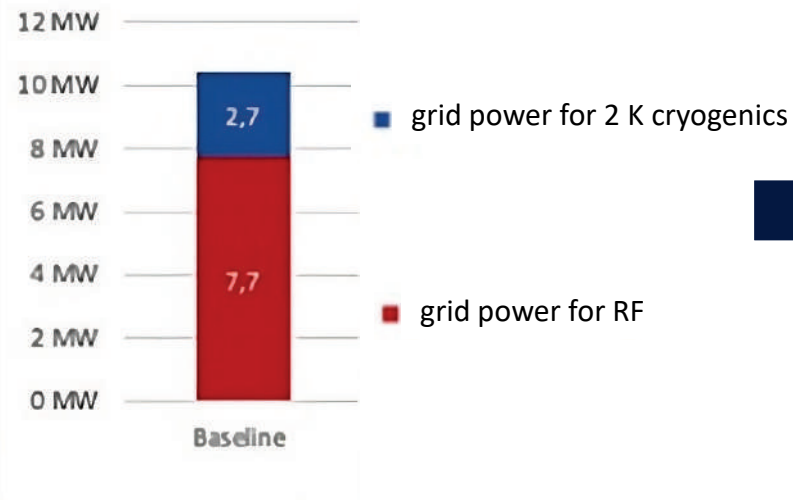
# Nb<sub>3</sub>Sn motivation

**Energy saving** is mandatory for the **next generation accelerators**

**Cryogenics** is one of the **larger energy cost** in modern SRF accelerators

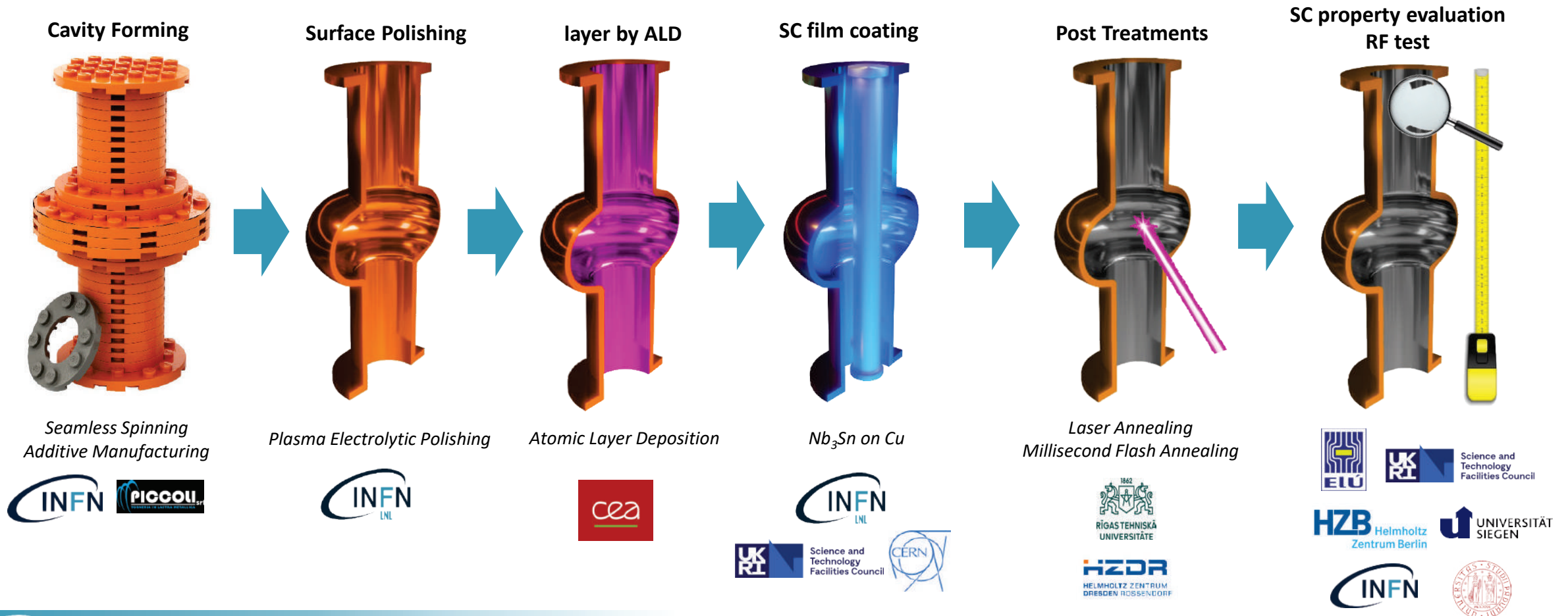
➔ Move from **bulk Nb @2K** to **Nb<sub>3</sub>Sn @4.5 K**  
reduces cryogenic power by a factor of 3

7.5 GeV LINAC new construction

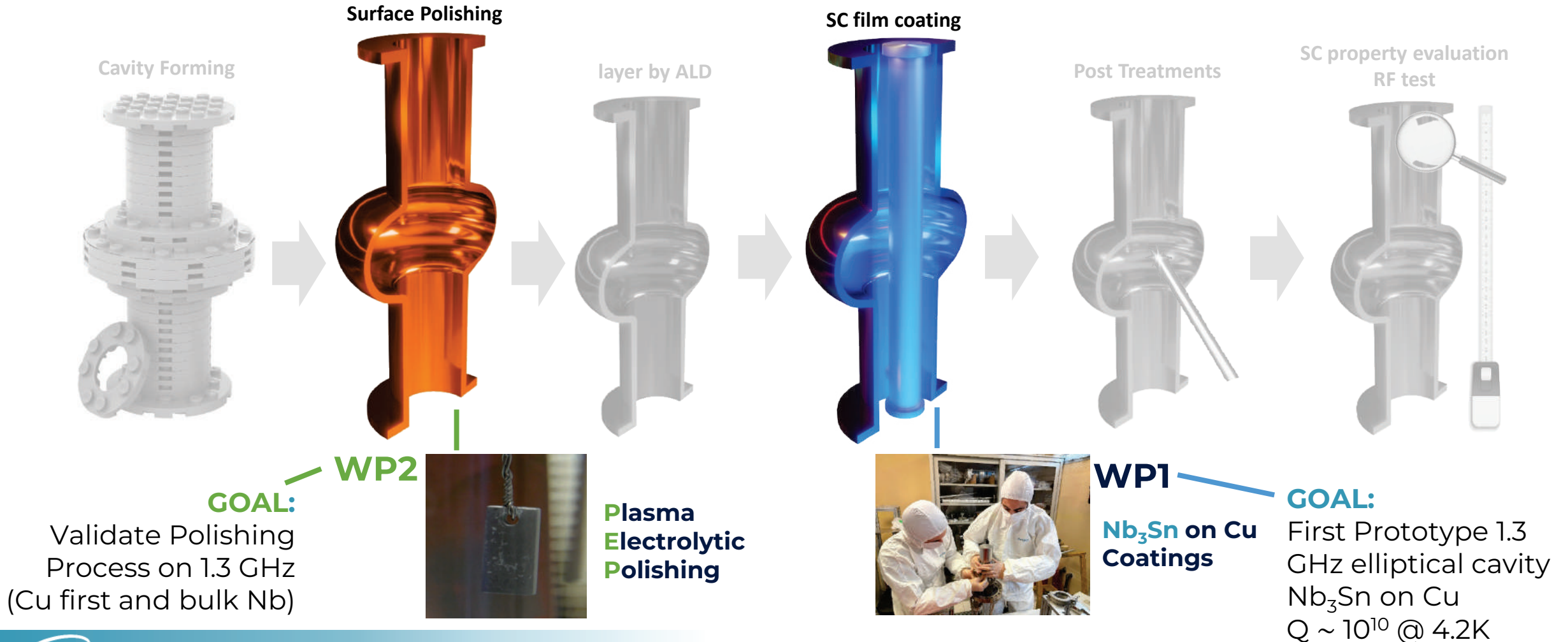


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# Nb<sub>3</sub>Sn on Cu R&D activity covers all cavity production chain



# In SRF project 2 technologies are currently developed in prospective of FCC



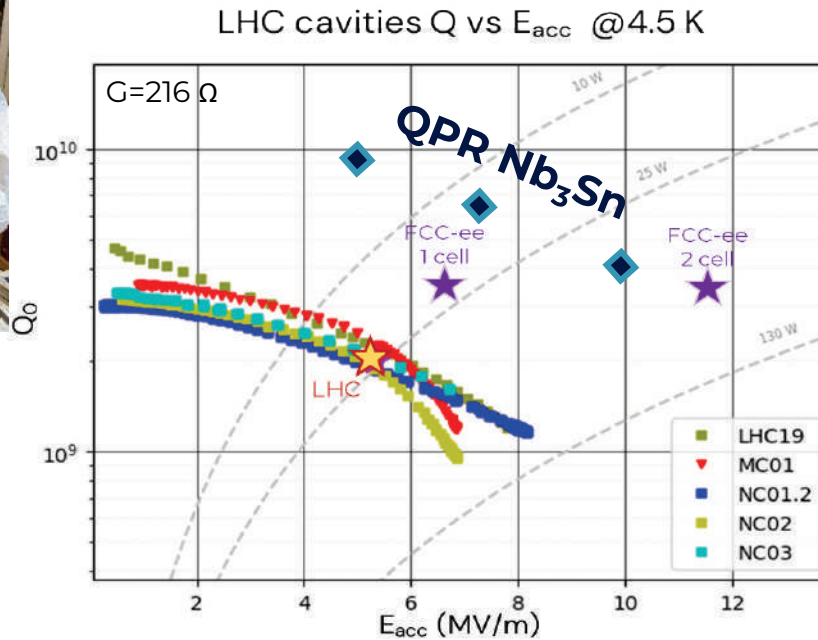


# Preliminary Result



**$R_s$  of 23 n $\Omega$**   
@ 4.5 K, 20 mT

**Quench >70 mT**  
@ 4.5 K



**First Nb<sub>3</sub>Sn RF Results** (on a small Nb planar resonator)

**Equivalent to a Q of  $9 \cdot 10^9$  @5 MV/m @4.5 K**

**5 times better than LHC → FCC-ee compatible**

*Room for improvement*



## PEP on 1.3 GHz

- 10 times faster than standard EP
- Very low roughness finishing
- Greener Process

**Feasibility Test Successfully Passed on Cu 1.3 GHz elliptical cavity**  
*Optimization in progress*

# Plan for next 5-10 years

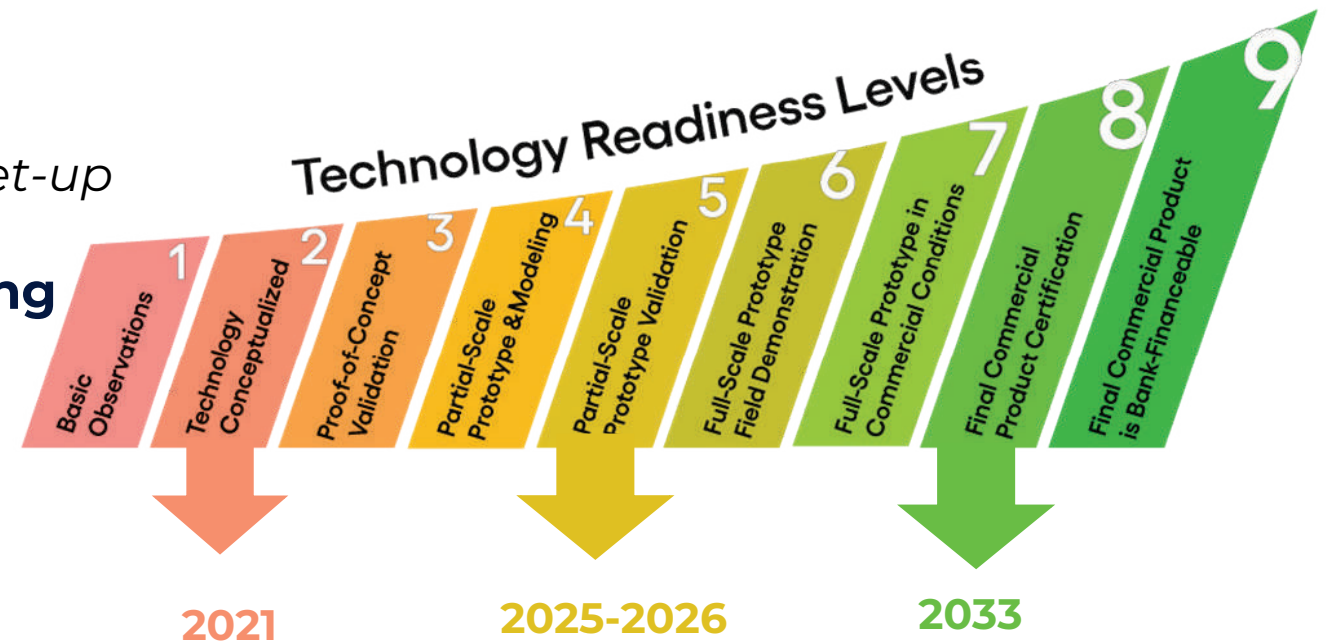
Push TRL from prototype level to large scale production readiness

## WP1 - Nb<sub>3</sub>Sn on Cu Coatings

- Reproducibility
- Scalability to 800 MHz and 400 MHz (FCC)
- Multicell cavity
- Industrial Protocol Definition
- Study on new SCs (A15/Tc>Nb)  
*compatible with Nb<sub>3</sub>Sn coating set-up*

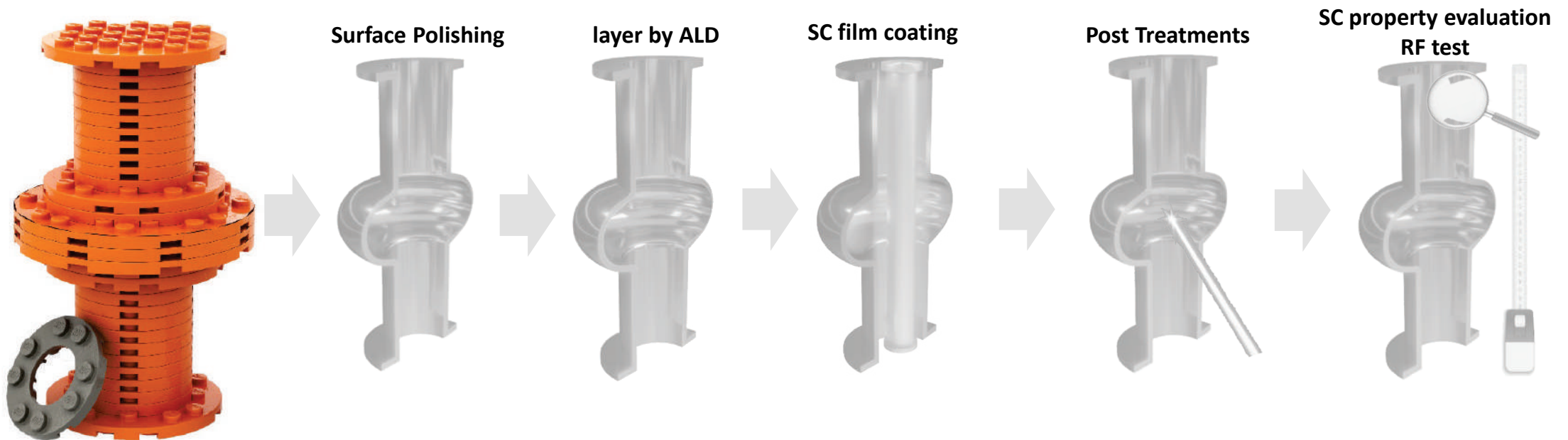
## WP2 - Plasma Electrolytic Polishing

- Reproducibility
- Scalability to 800 MHz and 400 MHz (FCC)
- Multicell cavity
- Industrial Protocol Definition



# Plan for next 5-10 years

Add a third WP on Cavity Forming by **Additive Manufacturing**



Cavity Forming by Additive Manufacturing

## WP3 – Cavity Forming via Additive Manufacturing

- Surface roughness optimization via PEP
- Innovative Cavity Design (Integrated Cooling Channels)

# Partnerships

## WP1 - Nb<sub>3</sub>Sn on Cu Coatings

- LNL (project leader)
- LASA: RF test
- CERN: co-developing coating / characterizations / (*strong interest in FCC*)
- STFC: co-developing coating / characterizations
- CEA: interlayer R&D, RF test
- HZB: RF test / characterizations

## WP2 - Plasma Electrolytic Polishing

- LNL (project leader)
- CERN: characterizations, RF test
- ZANON/RI: process industrialization

## WP3 – Cavity Forming via AM

- PD: substrate production via AM
- LNL: polishing / surface treatments
- LNL, LASA, LNF: innovative cavity design



# Resources @LNL

## BUDGET

- **150-200 k€/year** equipment, consumable, mechanical workshop, maintenance
- **Extra budget for scaling** processes to 800, 400 MHz, multicell cavities **(from 200 k€ up to 1000s k€)**

## PERSONELL

- Permanent Staff: **2 technologist** (C. Pira WP1, O. Azzolini WP3)
- Staff TD: **1 Technologist** (E. Chyhyrynets WP2), **1 Technician** (D. Ford WP1)
- Temporary Positions for all the project duration:
  - **2 Post doc positions** (1 WP1 + 1 WP2+WP3)
  - **1 mechanic technician** (WP1+WP2+WP3)
  - **1 PhD Student** (WP1)



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**Thank you!**

