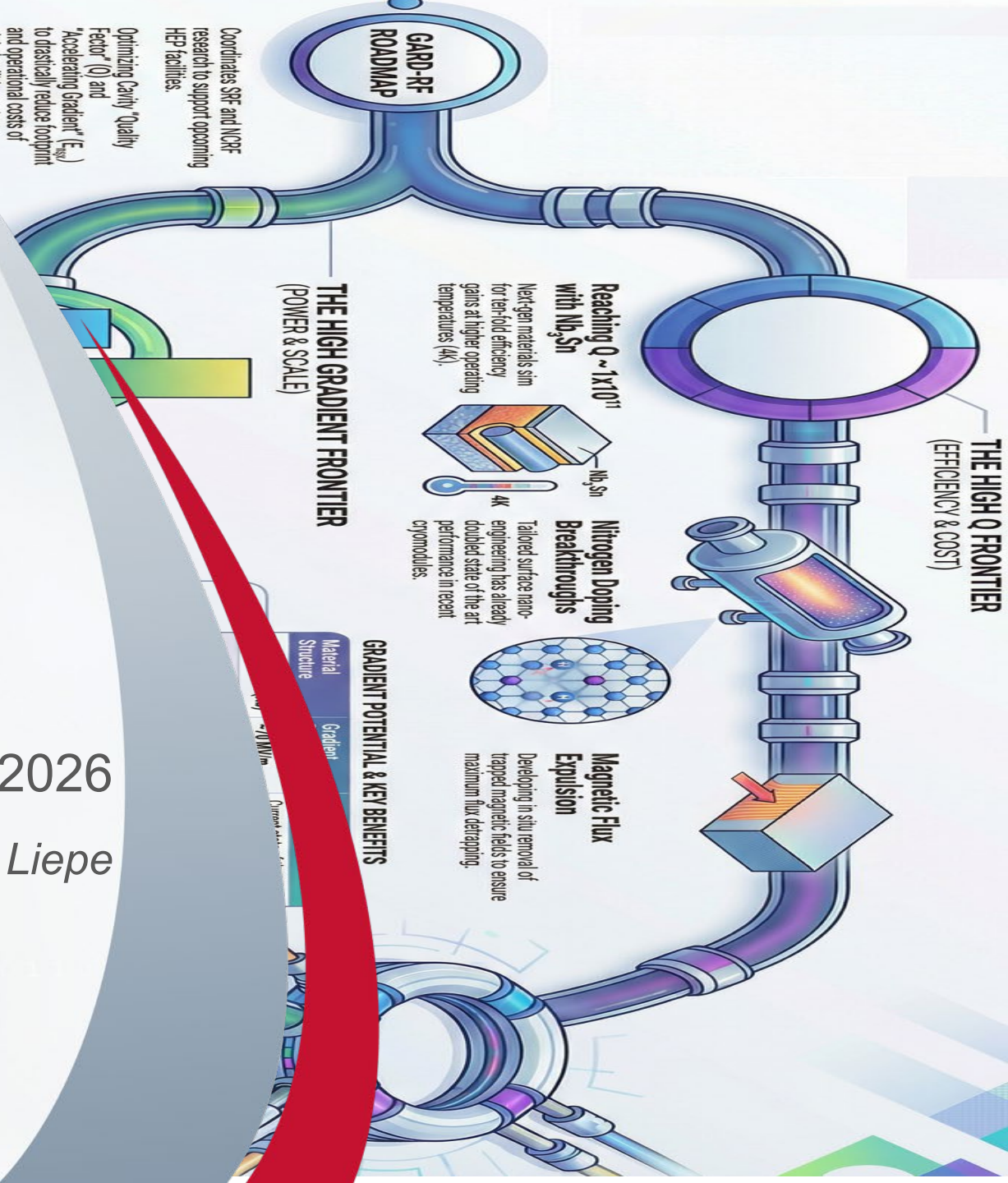
DOE RF Roadmap Update

SRF Virtual Workshop

02/05/2026

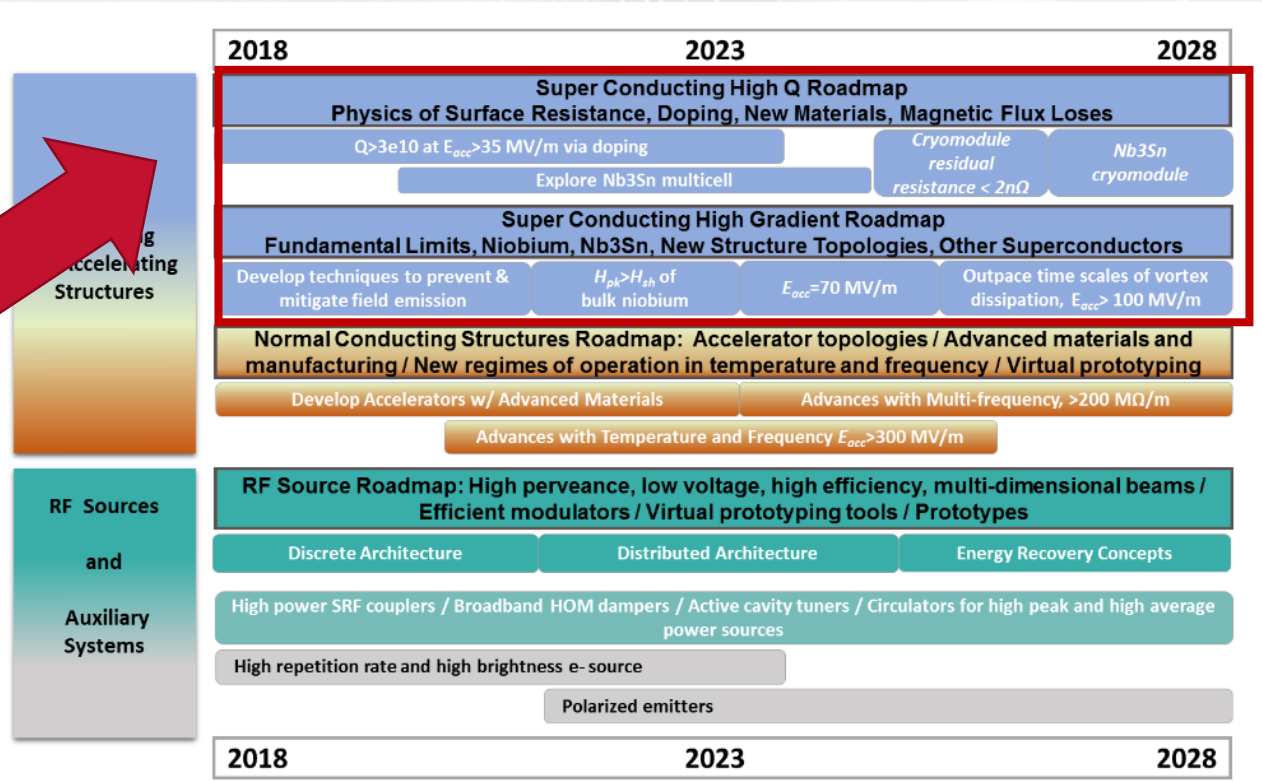
Anne-Marie Valente-Feliciano & Matthias Liepe



Jefferson Lab

U.S. Department of ENERGY

DOE GARD RF Roadmap - circa 2017



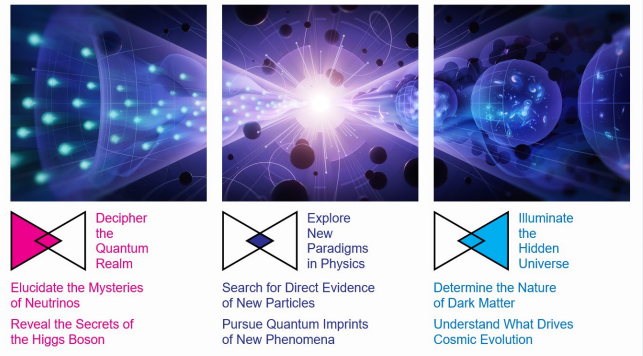
GARD RF Roadmap Refresh initiative- CHARGE

There has been a lot of research progress since 2017, and the landscape of needs has continued to evolve

The GARD program manager Derun Li launched an initiative to update the GARD RF Roadmap with specific goals to:

- ❑ Identify high impact R&D topics
- ❑ Define near, mid, and far term goals
- ❑ Ascertain the community's most urgent priorities
- ❑ Evaluate workforce development needs

Recent releases: P5 report in 2023, Pathways to Innovation and Discovery in Particle Physics
The European Strategy for Particle Physics: 2026 Update



Your input and feedback is welcome

Process Timeline

Spring-Fall 2025

- ✓ Virtual an dinformal meetings during workshops/conferences

Nov 2025 – Jan 2026

- ✓ schedule meetings, develop agendas, and solicit speakers

Jan/Feb 2026

- ○ Subtopic virtual group meetings

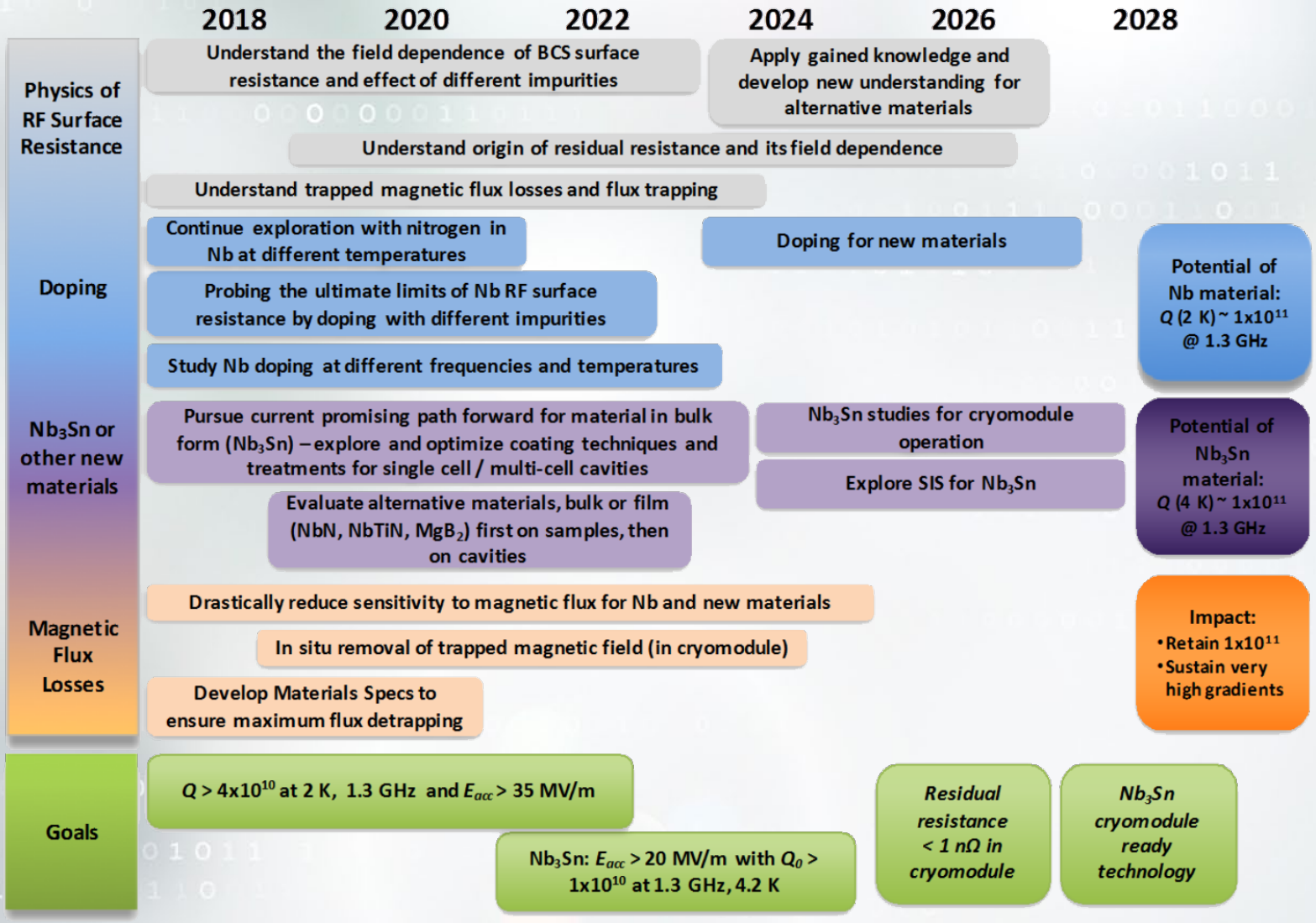
March 3 & 4 , 2026

- ▪ large in person meeting in March with summaries of virtual meetings by subtopic leaders

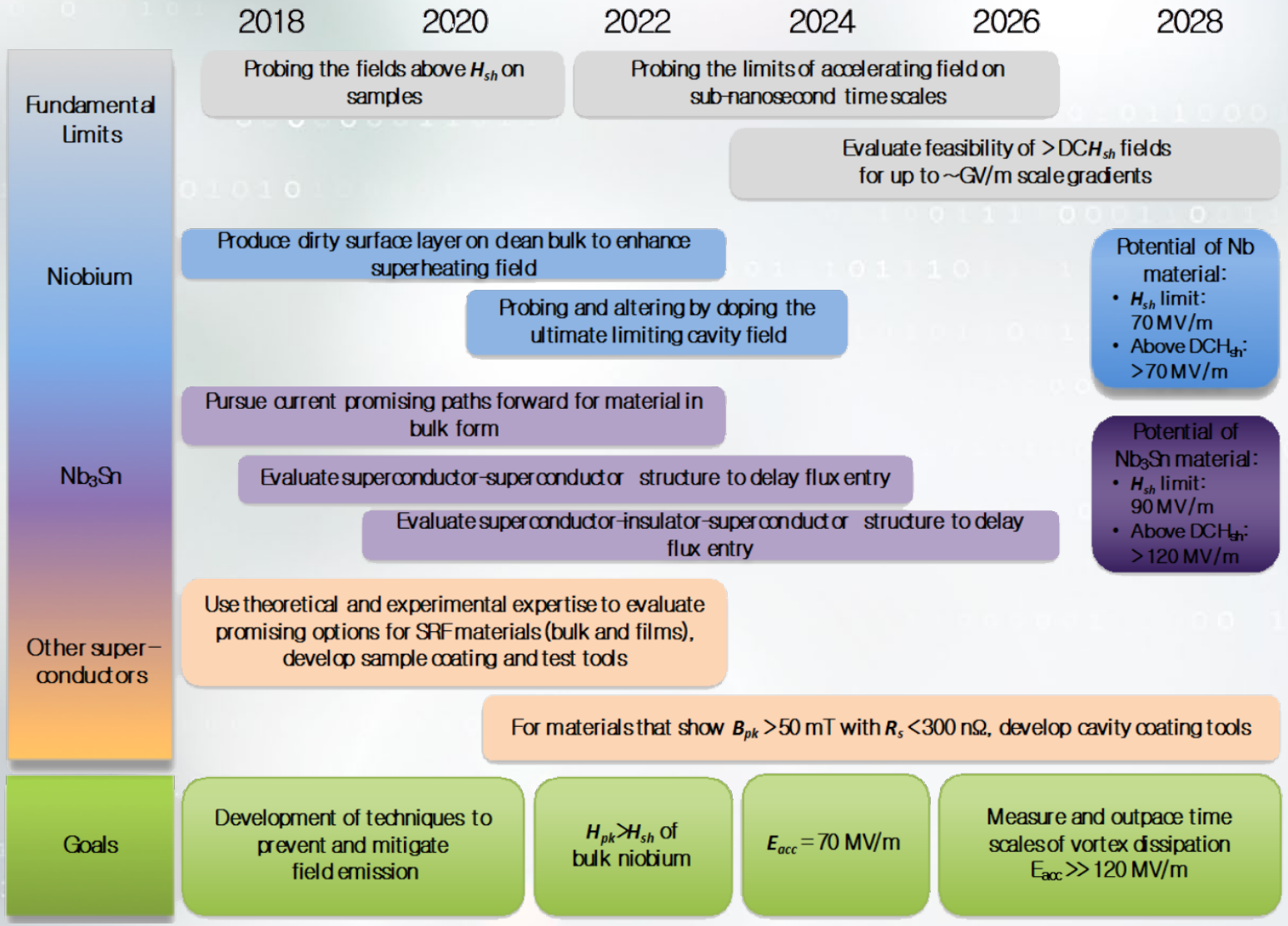
Spring/early Summer 2026

- ▪ Report writing
- ▪ Calibration step with DOE

Decadal roadmap and milestones for the high Q SRF frontier



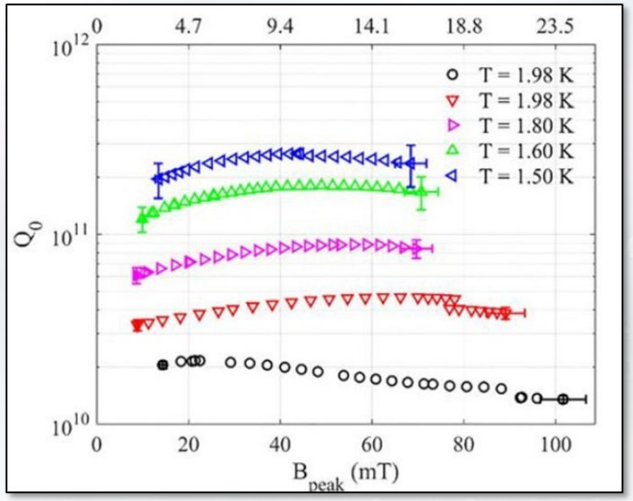
Decadal roadmap and milestones for the high Gradient SRF frontier

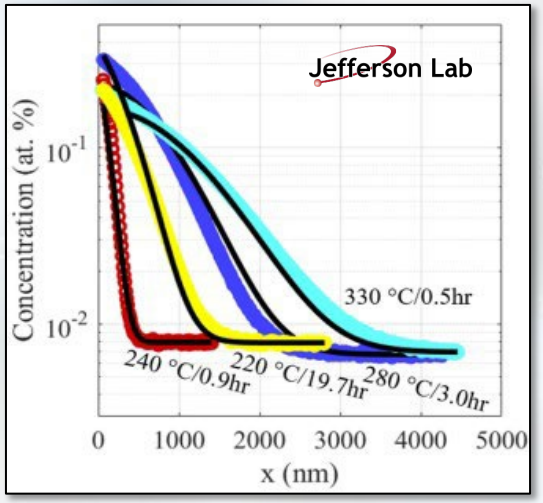


Progress since 2017
Pushing the limits for bulk Nb

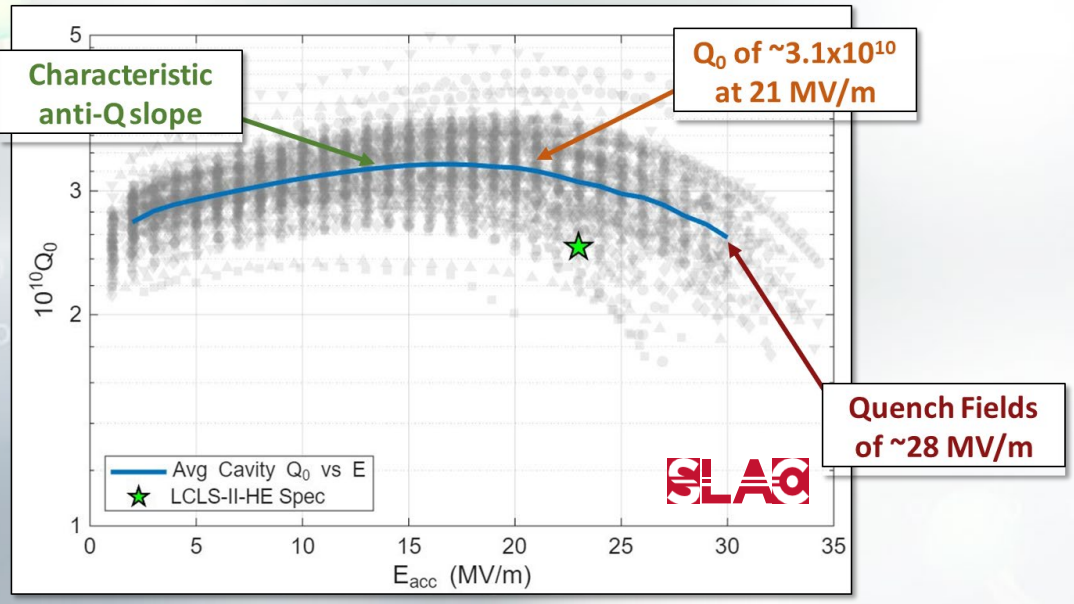
High Q developments

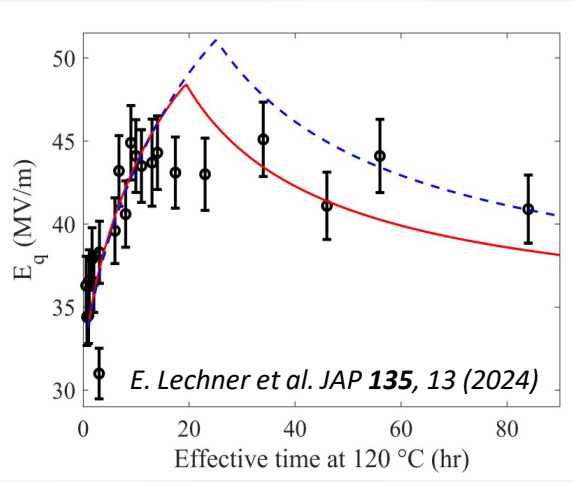
- ❑ Low and mid T-bake
- ❑ Further understanding of Nb oxide layer





*E. Lechner et al APL **119**, 082601 (2021)*



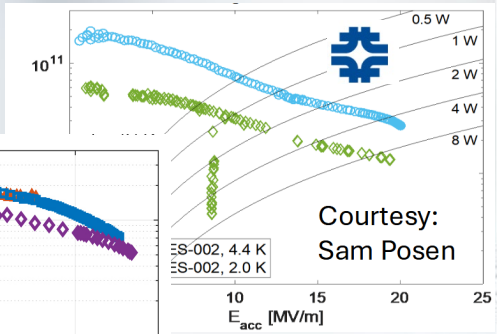


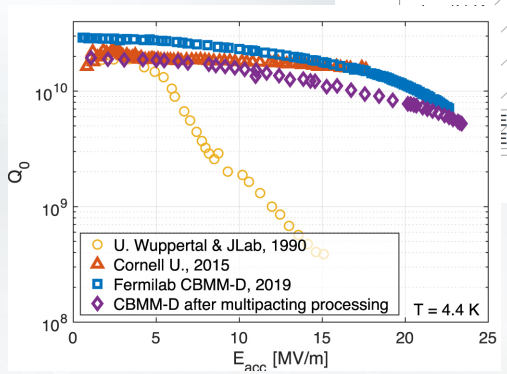
*E. Lechner et al. JAP **135**, 13 (2024)*

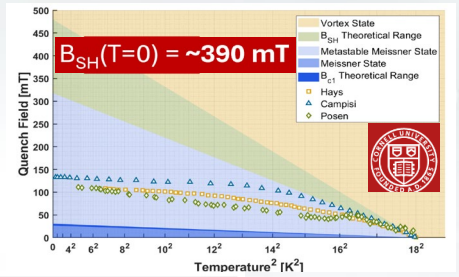
- ❑ N doping deployed at large scale – completion of LCLS-II and HE

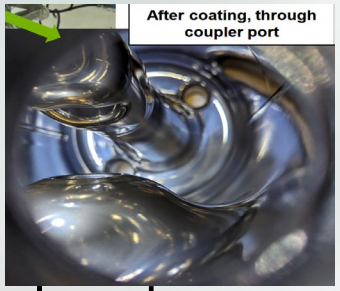
Progress since 2017
Development of Nb_3Sn as Practical SRF Material

- Sn vapor diffusion technology refinements progressively leading to improved performance
- Demonstration of achievable field for Nb_3Sn
- Deployment to lower frequencies and QWR
- Deployment of technology in cryomodule and for industrial applications



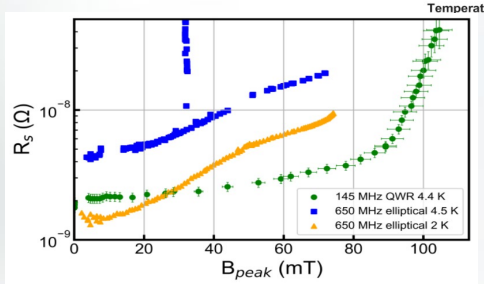


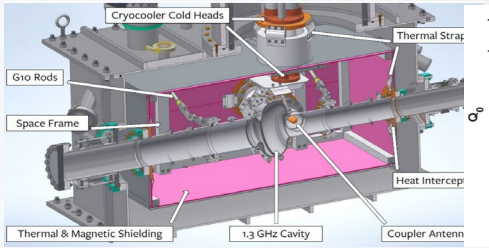


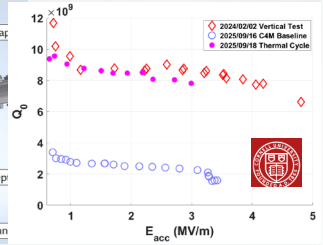


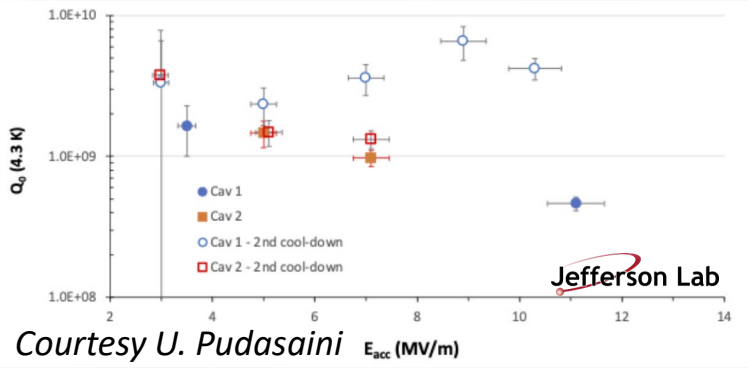
Courtesy T. Petersen

RadiaBeam Fermilab Argonne NATIONAL LABORATORY



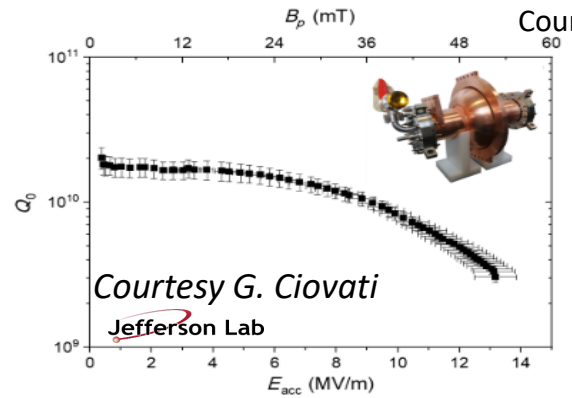






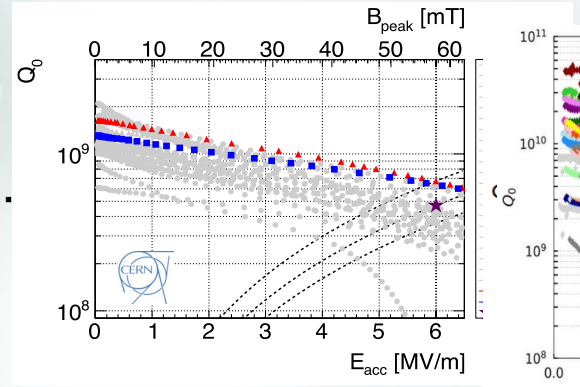
Courtesy U. Pudasaini

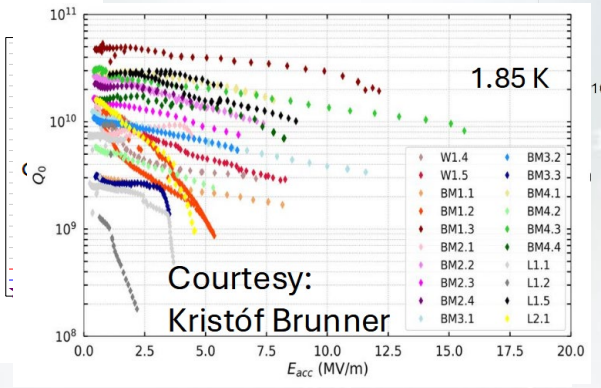
Courtesy N. Steilin

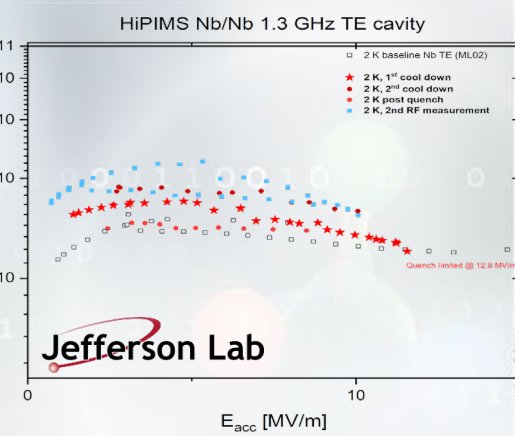


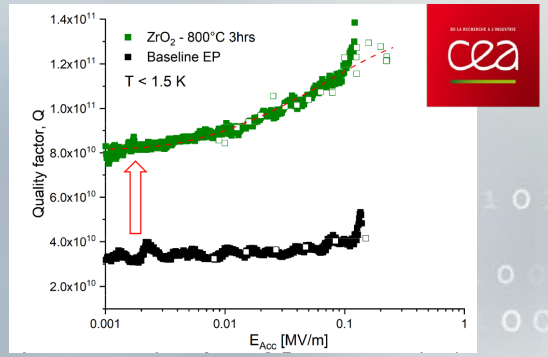
Progress since 2017
New Materials, Films, and Multilayers

- Nb/Cu (HiPIMS, ECR)
- Nb_3Sn on Cu (DCMS, HiPIMS…
- Other materials - NbTiN, MgB_2
- SIS Multilayers NbTiN/AlN/Nb, Nb_3Sn /AlN/Nb(PE-ALD, DCMS, HiPIMS)
- Capping Layers: Al_2O_3,ZrO_2. Ta_2O_5, Au

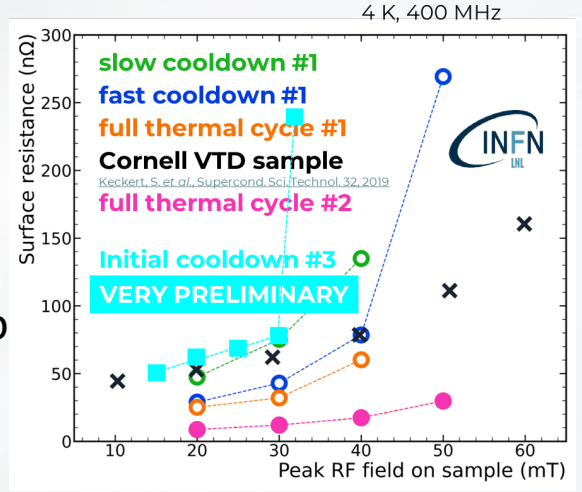


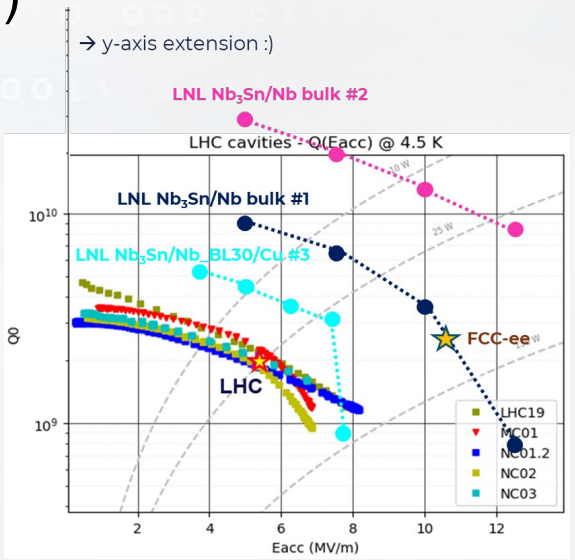






Various levels of maturity, efforts to deploy on cavities in parallel with material/technique developments

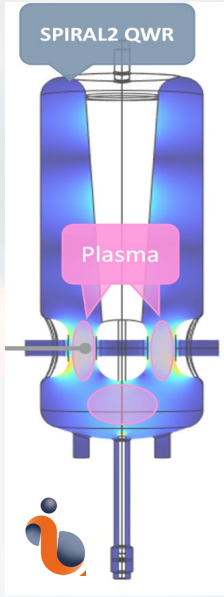




Full Cu QPR sample / NbBL30/ Nb_3Sn film, courtesy C. Pira

Progress since 2017
Field Emission Mitigation

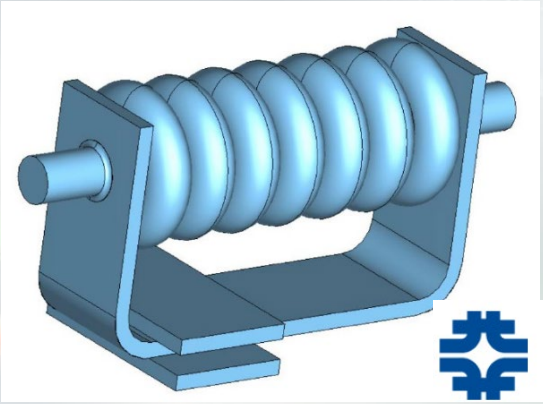
- In-situ plasma cleaning
- Deployment to other frequencies and geometries
- Deployment in cryomodules (ORNL, FNAL, Cornell, SLAC, JLab…) and beam lines (ORNL, JLab)

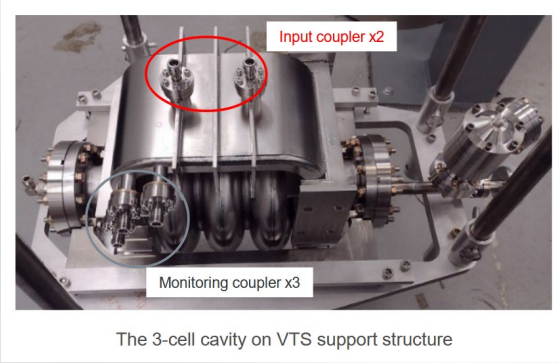


- Robotics
- Cleanroom assembly and handling, precision component installation, automated cleaning (HPR)

Progress since 2017
Novel SRF Cavity Shapes

Travelling waves

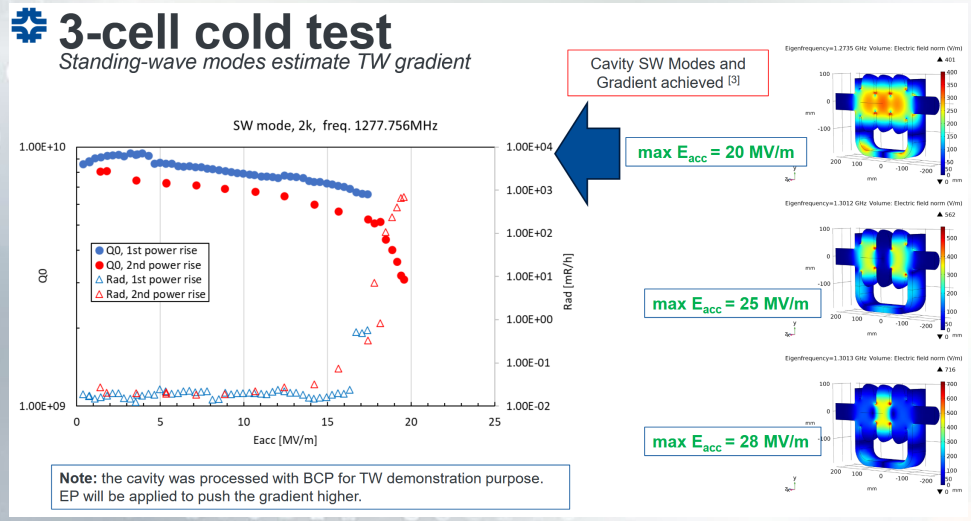




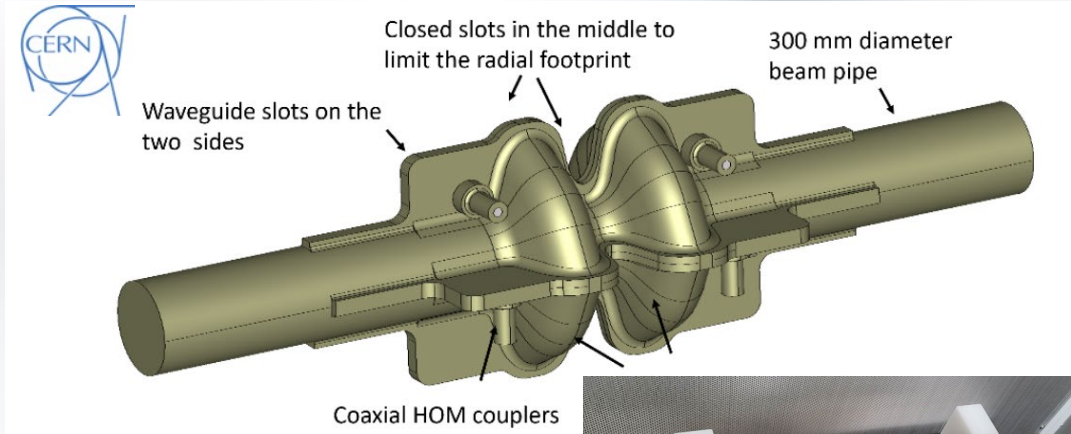
The 3-cell cavity on VTS support structure

3-cell cold test

Standing-wave modes estimate TW gradient

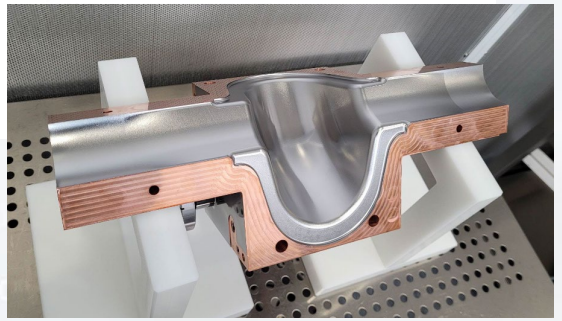


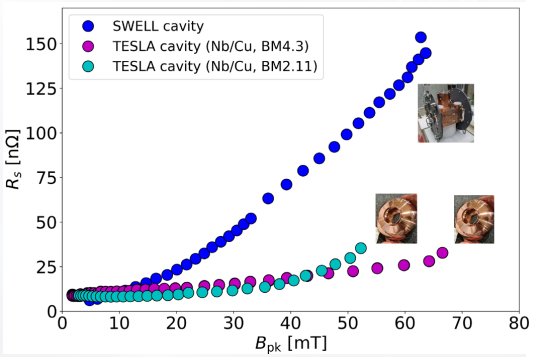
Courtesy K. McGee

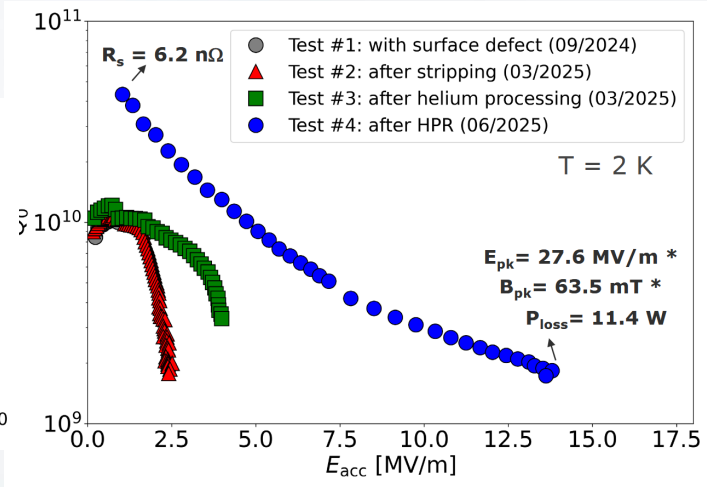


400 MHz 2-cell SWELL

Courtesy F. Peauger







Today's Program & Organization

- Facilities: SRF needs for the next decade
- Niobium
- SRF thin films
- AI/ML for SRF R&D and Operations
- SRF Technology
- Short Talks

Each session has a 10-15' allocated slot for discussion.
The program is dense, so please respect the allotted time.
Please upload your presentations to the Indico site.