



Snowmass 2021



# SRF technology at Snowmass 2021

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ILC ITD WG2 SRF Group meeting

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# Introduction: Snowmass

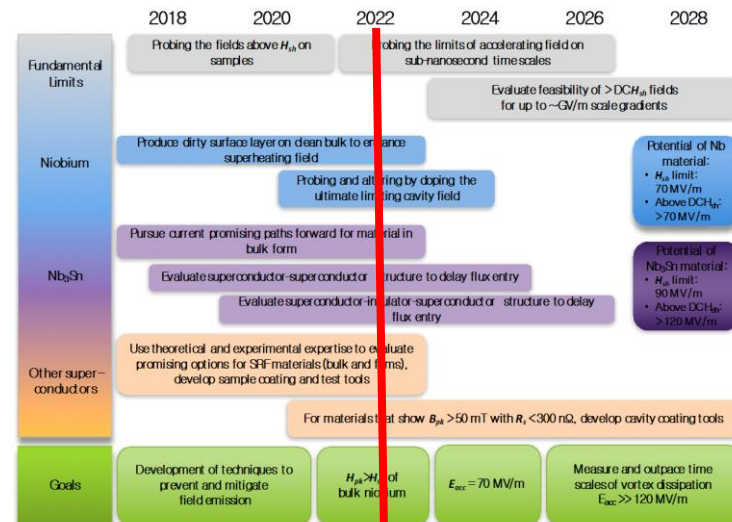
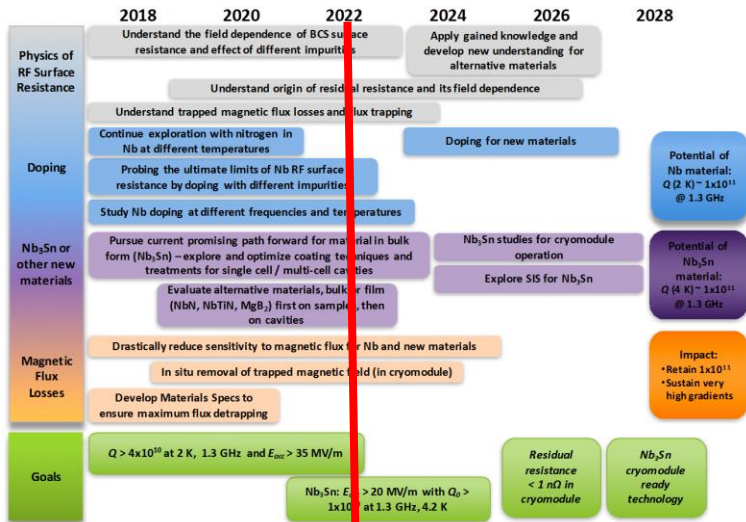
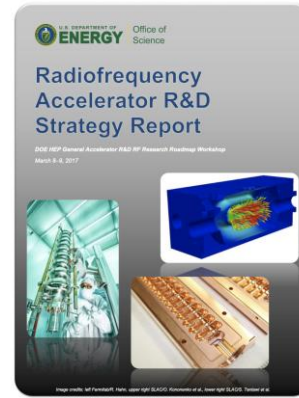
- The **Particle Physics Community Planning Exercise** (a.k.a. “Snowmass”) is organized by the Division of Particles and Fields (DPF) of the American Physical Society.
- Snowmass is a **scientific study**. It provides an opportunity for the entire particle physics community to come together to identify and document a scientific vision for the future of particle physics in the U.S. and its international partners.
- Snowmass goal is to **define the most important questions** for the field of particle physics and **identify promising opportunities** to address them.
- The P5, **Particle Physics Project Prioritization Panel**, will take the scientific input from Snowmass and develop a strategic plan for U.S. particle physics that can be executed over a 10-year timescale, in the context of a 20-year global vision for the field.

## Introduction: AF7-rf

- Snowmass 2021 was **divided into frontiers**, e.g., Energy Frontier, Neutrino Physics Frontier, etc.
- The community was encouraged to submit **Letters Of Interest (LOIs)** and then **White Papers** based on those LOIs
- The Snowmass **Accelerator Frontier (AF)** consisted of several topical groups including **AF7-rf**, which covered **RF Systems and Sources, Innovative Design and Modeling**, and **Cavity Performance Frontier**
- The AF7-rf co-conveners were Emilio Nanni (SLAC), Hans Weise (DESY), and Sergey Belomestnykh (FNAL)
- **SRF technology** was discussed under the Cavity Performance Frontier topic
- To facilitate the process, AF7-rf held miniWorkshops and seminars

# GARD RF Accelerator R&D Roadmap

- AF7-rf discussion were structured around DOE RF Accelerator Roadmap (developed in 2017)
- In addition, we explored new or overlooked topics and concepts
- All White Papers are submitted to arXiv as part of Snowmass Proceedings



# SRF-related White Papers

## Improve SRF cavity performance (gradient and Q), study new superconductors

- Key Directions for Research and Development of Superconducting Radiofrequency (SRF) Cavities <http://arxiv.org/abs/2204.01178>
- Challenges and opportunities of SRF theory for next generation particle accelerators <https://arxiv.org/abs/2203.08315>
- Medium-Grain Niobium SRF Cavity Production Technology for Science Frontiers and Accelerator Applications <https://arxiv.org/abs/2203.07371>
- Next-Generation Superconducting RF Technology based on Advanced Thin Film Technologies and Innovative Materials for Accelerator Enhanced Performance & Energy Reach <https://arxiv.org/abs/2204.02536>
- Nb<sub>3</sub>Sn Superconducting Radiofrequency Cavities: a Maturing Technology for Particle Accelerators and Detectors <https://arxiv.org/abs/2203.06752>
- An Impartial Perspective for Superconducting Nb<sub>3</sub>Sn coated Copper RF Cavities for Future Linear Accelerators <https://arxiv.org/abs/2203.09718>
- Plasma Processing for In-Situ Field Emission Mitigation of Superconducting Radiofrequency (SRF) Cryomodules <https://arxiv.org/abs/2203.12442>

## High-gradient / High-Q SRF for future accelerators and dark matter searches

- The **International Linear Collider**: Report to Snowmass 2021 <https://arxiv.org/abs/2203.07622>
- **Higgs-Energy LEptoN (HELEN) Collider** based on advanced superconducting radio frequency technology <https://arxiv.org/abs/2203.08211>
- An **8 GeV Linac as the Booster Replacement in the Fermilab Power Upgrade**: a Snowmass 2021 White Paper <https://arxiv.org/abs/2203.05052>
- The **Future Circular Collider**: a Summary for the US 2021 Snowmass Process <https://arxiv.org/abs/2203.06520>
- Snowmass2021 White Paper AF3-**CEPC** <https://arxiv.org/abs/2203.09451>
- A **Muon Collider** Facility for Physics Discovery <https://arxiv.org/abs/2203.08033>
- **CERC** – Circular e+e- Collider using Energy-Recovery Linac <https://arxiv.org/abs/2203.07358>
- The **ReLiC** – Recycling Linear e+e- Collider <https://arxiv.org/abs/2203.06476>
- Searches for **new particles, dark matter, and gravitational waves** with SRF cavities <https://arxiv.org/abs/2204.01178>

# AF7-rf draft report (will become final on 9/16)

- The AF7-rf efforts culminated in topical group report, which was discussed at the **Snowmass Community Summer Study Workshop in Seattle**

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August 29, 2022

**RF Accelerator Technology R&D**  
Report of AF7-rf Topical Group to Snowmass 2021

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# SRF key directions

Based on the discussions and submitted White Papers, the following **SRF key directions** are highlighted to be pursued during the next decade

- Studies to **push performance of niobium** and improve our understanding of SRF losses and ultimate quench fields via experimental and theoretical investigations;
- Developing **methods for nano-engineering the niobium surface** layer and tailoring SRF cavity performance to a specific application, e.g., a linear collider, a circular collider, or a high-intensity proton linac;
- Investigations of **new SRF materials beyond niobium** via advanced deposition techniques and bringing these materials to practical applications;
- Developing **advanced SRF cavity geometries** to push accelerating gradients of bulk niobium cavities to  $\sim 70$  MV/m for either upgrade of the ILC or compact SRF linear collider;
- Research on application of **SRF technology to dark sector searches**;
- Pursuing R&D on **companion RF technologies** to mitigate field emission, provide precise resonance control, enable robust low level RF systems for high gradient and high Q accelerators, etc.;
- Developing **high efficiency, low-cost RF sources** that would benefit many operating and practically every future intensity or energy frontier machine.