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FERMILAB-CRADA-FRA-2016-0025

Fermilab

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Center for Applied Physics and Superconducting Technologies (CAPST)

Cooperative Research and Development Agreement Final Report

CRADA Number: FRA-2016-0025

Fermilab Technical Contact: Anna Grassellino

Report Date:
October 14, 2024

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NOTICE

In accordance with Requirements set forth in Article X of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

CRADA number: FRA-2016-0025

CRADA Title: Center for Applied Physics and Superconducting Technologies

Parties to the Agreement: Northwestern University and Fermi Research Alliance, LLC

Sponsoring DOE Program Office(s): Office of Science

DOE Funding Commitment Table:

Funding Type		FY17	FY18	FY19	FY20	FY21	Total
Fermilab	**In-Kind**	98,845.34	125,919.35	194,211.51	103,020.00	19,492.00	541,488.20

Abstract of CRADA work:

Fermi Research Alliance, LLC, as operator of Fermi National Accelerator Laboratory (Fermilab) and Northwestern University (Northwestern) have a broad overlap in scientific interests and complementary state-of-the-art facilities in the area of applied physics and technology, in particular physics of superconductivity, materials science, and detector technology.

The Center for Applied Physics and Superconducting Technology (CAPST) will provide a mechanism for cross-utilizing capabilities of the two institutions for advances in understanding key scientific problems of mutual interest and opening up broader educational opportunities for students and postdoctoral candidates (postdocs). Northwestern undergraduate students, graduate students and postdocs will be able to perform cutting edge science and technology research in accelerator and detector science and the physics of superconductivity at Fermilab and Northwestern under the joint direction of Fermilab researchers and Northwestern professors.

Research program covers three thrusts below, with subtopics detailed in the CRADA:

- Vortex dynamics in superconductors
- Superconducting devices
- New frontiers in microwave instrumentation/techniques

Summary of Research Results:

Under the guidance of scientists at Fermilab, Northwestern undergraduate students, graduate students and postdocs developed a fundamental understanding of the physics that sets the ultimate limit to the performance of superconducting radio-frequency (SRF) cavities for particle acceleration, gained greater

knowledge of the performance of SRF cavities at the single-photon detection level; and developed a world class superconducting QIS research group based at Northwestern and Fermilab.

Several collaborative proposals were submitted to NSF-DOE resulting in collaborative publications in new research in superconducting SRF accelerator physics and QIS. Researchers made new discoveries on superconducting qubits based on SRF cavities, and were invited to several international meetings.

Related Reports, Publications, and Presentations:

Publications produced as a result of this research:

- D. Bafia, J. Zasadzinski "INVESTIGATION OF FREQUENCY BEHAVIOR NEAR TC OF NIOBIUM SUPERCONUDCTING RADIO-FREQUENCYCAVITIES" *International Conference on RF Superconductivity (19th)* , 2019 https://doi.org/10.18429/JACoW-SRF2019-MOP031 Citation Details
- Checchin, M. and Martinello, M. and Grassellino, A. and Aderhold, S. and Chandrasekaran, S. K. and Melnychuk, O. S. and Posen, S. and Romanenko, A. and Sergatskov, D. A. "Frequency dependence of trapped flux sensitivity in SRF cavities" *Applied Physics Letters* , v.112 , 2018 10.1063/1.5016525 Citation Details
- Martinello, M. and Checchin, M. and Romanenko, A. and Grassellino, A. and Aderhold, S. and Chandrasekeran, S. K. and Melnychuk, O. and Posen, S. and Sergatskov, D. A. "Field-Enhanced Superconductivity in High-Frequency Niobium Accelerating Cavities" *Physical Review Letters* , v.121 , 2018 10.1103/PhysRevLett.121.224801 Citation Details
- Ngampruetikorn, Vudtiwat and Sauls, J. A. "Effect of inhomogeneous surface disorder on the superheating field of superconducting RF cavities" *Physical Review Research* , v.1 , 2019 10.1103/PhysRevResearch.1.012015 Citation Details
- Sauls, J. A. "Andreev bound states and their signatures" *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* , v.376 , 2018 10.1098/rsta.2018.0140 Citation Details
- Grassellino, A and Romanenko, A and Trenikhina, Y and Checchin, M and Martinello, M and Melnychuk, O S and Chandrasekaran, S and Sergatskov, D A and Posen, S and Crawford, A C and Aderhold, S and Bice, D "Unprecedented quality factors at accelerating gradients up to 45 MVm ^{21} in niobium superconducting resonators via low temperature nitrogen infusion" *Superconductor Science and Technology* , v.30 , 2017 10.1088/1361-6668/aa7afe Citation Details

Report Date: October 14, 2024

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