SRF2025 - 22nd International Conference on RF Superconductivity

22ND INTERNATIONAL CONFERENCE ON RF SUPERCONDUCTIVITY

September 21-26, 2025

Report of Contributions

Contribution ID: **2** Contribution code: **MOA01** Type: **Invited Oral Presentation**

5 year operation of RIKEN super-conducting linac

Monday, September 22, 2025 8:30 AM (20 minutes)

The RIKEN superconducting heavy-ion linac, so-called SRILAC, has been successfully operating for almost five years, and continuously deliver a heavy ion beam for a super-heavy-element synthesis experiment by fixing minor and major hardware troubles. The effects of a broken coupler in the early days and four years of operation have resulted in increased X-ray emission levels in several superconducting cavities, which have been successfully corrected by High Power Processing (HPP). Owing to the fine tunings of the control system of LLRF and cryogenic system the availablity more than 99 % has been achieved. This talk will share the experiences and lessons learned from five-year operation with low beta SC-cavities.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: SAKAMOTO, Naruhiko (Nishina Center)

Co-authors: IMAO, Hiroshi (RIKEN Nishina Center); KAMIGAITO, Osamu (RIKEN Nishina Center); NAGATOMO, Takashi (RIKEN Nishina Center); NISHI, Takahiro (RIKEN Nishina Center); OZEKI, Kazutaka (RIKEN Nishina Center); SUDA, Kenji (RIKEN Nishina Center); UCHIYAMA, Akito (RIKEN Nishina Center); WATANABE, Tamaki (RIKEN Nishina Center); WATANABE, Yutaka (RIKEN Nishina Center); YAMADA, Kazunari (RIKEN Nishina Center)

Presenter: SAKAMOTO, Naruhiko (Nishina Center)

Session Classification: Monday Oral Session: A

Track Classification: MC1: SRF Facilities

Contribution ID: **3** Contribution code: **MOP09** Type: **Poster Presentation**

Dynamics issues and challenges of superconducting triple RF systems in future-synchrotron light sources

Monday, September 22, 2025 2:30 PM (3 hours)

In new-generation synchrotron light sources, triple-radio-frequency (triple-RF) systems are proposed to meet larger bunch lengthening requirements and enable specific longitudinal injection conditions. In this talk, we will present beam dynamics analysis for the superconducting triple-RF system designed for the Hefei Advanced Light Facility (HALF) storage ring. We will demonstrate that a particular beam instability imposes stringent requirements on the R/Q values of the triple-RF system, mainly for the higher harmonic cavities. For HALF, our findings reveal that the R/Q values of the two higher harmonic cavities need to be reduced to approximately 10 or below to achieve the optimal bunch lengthening. Such exceptionally low R/Q values pose new issues and challenges for the design of higher harmonic cavities.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: HE, Tianlong (University of Science and Technology of China)

Co-authors: XIAO, Jincheng (University of Science and Technology of China); LI, Weimin (University of Science and Technology of China)

Presenter: HE, Tianlong (University of Science and Technology of China)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **4** Contribution code: **TUP09** Type: **Poster Presentation**

Point contact tunneling spectroscopy for SRF applications

Tuesday, September 23, 2025 2:30 PM (3 hours)

Point Contact Tunneling Spectroscopy (PCTS) is a powerful technique ideal for investigating the surface superconducting properties of materials. Since it utilizes the oxides present on the sample' s surface to probe the superconducting density of states, this tool is valuable for studying superconducting devices such as qubits and SRF cavities, where a native or engineered oxide layer is present on the surface. PCTS can uncover various phenomena at the oxide/superconductor interface, such as the presence of magnetic impurities or the proximity effect, which might play a significant role in the performance limitations of superconducting devices. Therefore, PCTS is highly useful for understanding the mechanisms that limit the capabilities of these devices, potentially leading to technological solutions. I will present our latest PCTS results obtained on Nb, Nb3Sn and NbTiN samples for RF applications.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: CURCI, Ivana (Université Paris-Saclay)

Presenter: CURCI, Ivana (Université Paris-Saclay)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **5** Contribution code: **WEB03** Type: **Invited Oral Presentation**

Oxygen vacancies in niobium pentoxide as a source of two-level system losses in superconducting niobium

Wednesday, September 24, 2025 11:40 AM (20 minutes)

Two-level systems (TLS) have long been a catch-all explanation for RF loss and quantum decoherence in superconducting devices. In our study, the first to directly link TLS losses to a specific physical mechanism, we demonstrate that oxygen vacancies in the naturally formed Nb_2O_5 on oxidized niobium are a major driver of such dissipation. We performed sequential in situ vacuum-baking treatments on niobium superconducting radio-frequency (SRF) cavities and used time-of-flight secondary ion mass spectrometry (TOF-SIMS) to reveal a nonmonotonic evolution in cavity quality factor (Q_0). This behavior correlates with the interplay of Nb_2O_5 vacancy generation and oxide-thickness dissolution. We localize this effect to the oxide itself and present the insignificant role of diffused interstitial oxygen in the underlying Nb by regrowing the oxide via wet oxidation, revealing a mitigation of aggravated TLS losses. We hypothesize that such vacancies in the pentoxide serve as magnetic impurities and are a source of TLS-driven rf loss. Although our measurements center on 3-D SRF cavities, the insights gained here have significant implications for mitigating decoherence in 2-D superconducting qubits.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

U.S. Department of Energy, Office of Science, National Quantum Information Science Research Centers, Superconducting Quantum Materials and Systems Center (SQMS) under Contract No. DE-AC02-07CH11359.

Author: BAFIA, Daniel (Fermi National Accelerator Laboratory)

Co-authors: MURTHY, Akshay (Fermi National Accelerator Laboratory); ROMANENKO, Alexander (Fermi National Accelerator Laboratory); GRASSELLINO, Anna (Fermi National Accelerator Laboratory)

Presenter: BAFIA, Daniel (Fermi National Accelerator Laboratory)

Session Classification: Wednesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **6** Contribution code: **THP25** Type: **Poster Presentation**

Cold spray additive manufactured copper as substrate for thin film-SRF cavities

Thursday, September 25, 2025 2:30 PM (3 hours)

Recent advances in additive manufacturing promise interesting possibilities for the design and fabrication of superconducting radio frequency (SRF) cavities. Cold Spray Additive Manufacturing (CSAM) is one candidate that would allow for rapid built times, realization of integral cooling structures, deposition of different materials and an easy upscaling with available equipment. As it is the case for any present AM-method, we need to address limitations and challenges regarding microstructure and surface quality of the built material towards an actual application. This work focuses on the experimental analysis of pure copper manufactured by CSAM regarding their mechanical, microstructural and physical properties that are key for the operation of SRF-cavities. The present state of the art cold sprayed copper demonstrates a dense microstructure with a low defect density. Residual resistance ratios and mechanical properties in the range of the specifications of conventionally used oxygen-free copper can be obtained with adequate post-heat treatments. Special attention is also paid to the condition and possible improvement routes for the RF-facing surface of CSAMed copper cavities.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: MOTSCHMANN, Fritz (Commissariat à l'Energie Atomique)

Co-authors: BAUDOUY, Bertrand (Commissariat à l'Energie Atomique); VERDY, Christophe (Université de technologie de belfort-montbéliard); EOZÉNOU, Fabien (Commissariat à l'Energie Atomique); PROSLIER, Thomas (Université Paris-Saclay)

Presenter: MOTSCHMANN, Fritz (Commissariat à l'Energie Atomique)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **7** Contribution code: **MOB06** Type: **Invited Oral Presentation**

5 years of SPIRAL2 LINAC operation: cryogenic and superconducting RF aspects

Monday, September 22, 2025 12:40 PM (20 minutes)

The superconductor linear accelerator LINAC of SPIRAL2 at the GANIL facility is in operation since October 2019. The 26 superconducting quarter wave resonators (QWR) of the LINAC are integrated into 19 cryostats and cooled down at 4 K by a dedicated refrigeration system. These superconducting cavities are operated at a nominal gradient of 6.5 MV/m but most of the cavities can be operated up to 8 MV/m. One of the 26 cavities shows abnormal energy dissipation at medium and high RF gradient. In this paper, we will present the evolution of the superconducting cavities and the main issues that happened to the superconducting LINAC and its cryogenic system during the last six years and their effects on the beam schedule.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: ABURAS, Muhammad (Grand Accélérateur Nat. d'Ions Lourds)

Co-authors: Dr GHRIBI, Adnan (Grand Accélérateur Nat. d'Ions Lourds); Mr DI GIACOMO, Marco (Grand Accélérateur Nat. d'Ions Lourds); BERNAUDIN, Pierre-Emmanuel (Grand Accélérateur Nat. d'Ions Lourds); LASSALLE, Charly (GANIL; Université de Caen Normandie)

Presenter: ABURAS, Muhammad (Grand Accélérateur Nat. d'Ions Lourds)

Session Classification: Monday Oral Session: B

Track Classification: MC1: SRF Facilities

Contribution ID: **8** Contribution code: **MOB05** Type: **Invited Oral Presentation**

Commissioning of the first HElmholtz LInear ACcelerators (HELIAC) cryomodule with heavy ion beam

Monday, September 22, 2025 12:20 PM (20 minutes)

The superconducting heavy ion HELmholtz LInear ACcelerator (HELIAC) is designed to meet the needs of the Super Heavy Element (SHE) research and material sciences user programs at GSI in Darmstadt. The HELIAC is planned for construction at GSI in Darmstadt. The beam energy can be varied smoothly between 3.5 and 7.3 MeV/u, with an average current of up to 1 emA and a duty cycle of 100 %. Recently, the first cryomodule CM1, was fully commissioned and tested w/o beam. CM1 comprises three Crossbar H-mode (CH)-type accelerator cavities, a CH-rebuncher, and two superconducting solenoid lenses. Following the commissioning of the cryogenic supply and the RF-systems, successful beam tests were conducted at the end of 2023 and mid of 2024. A helium as well as an argon ion beam was successfully accelerated to the design energy. The beam energy could be varied continuously between 1.3 and 3.1 MeV/u without any significant particle losses being measured in the cryomodule. This contribution covers the construction and commissioning of the first HELIAC cryomodule and the results of the beam test campaign.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: MISKI-OGLU, Maksym (GSI Helmholtz Centre for Heavy Ion Research)

Co-authors: DZIUBA, Florian Dirk (Helmholtz Institute Mainz); LIST, Julian (Helmholtz Institute Mainz); LAUBER, Simon (Helmholtz Institute Mainz); KUERZEDER, Thorsten (GSI Helmholtz Centre for Heavy Ion Research); BARTH, Winfried (GSI Helmholtz Centre for Heavy Ion Research); YARAMYSHEV, Stepan (GSI Helmholtz Centre for Heavy Ion Research); GETTMANN, Viktor (GSI Helmholtz Centre for Heavy Ion Research); SCHEELER, Uwe (GSI Helmholtz Centre for Heavy Ion Research); VORMANN, Hartmut (GSI Helmholtz Centre for Heavy Ion Research)

Presenter: MISKI-OGLU, Maksym (GSI Helmholtz Centre for Heavy Ion Research)

Session Classification: Monday Oral Session: B

Track Classification: MC1: SRF Facilities

Contribution ID: **9** Contribution code: **TUA02** Type: **Invited Oral Presentation**

The path to high duty cycle at European XFEL: cryomodule developments

Tuesday, September 23, 2025 8:50 AM (20 minutes)

The European XFEL is in operation since 2017 with a maximum energy of 17.5 GeV in short-pulse (SP) mode, consisting of 0.65 ms-long bunch trains at 10 Hz repetition rate. The accelerator can deliver up to 2700 electron bunches every 100 ms, with a spacing between bunches of 220 ns. After eight years of successful operation the accelerator team, with strong support from the XFEL strategy process, is working to define an accelerator upgrade scenario for possible implementation in the next decade. The main goal of the upgrade is to facilitate more bunches per second with larger bunch spacing while maintaining the high energy of the beam, a world record amongst FEL machines. Possible scenarios include continuous-wave (CW) and long-pulse operating modes, collectively referred to as high duty cycle (HDC). This paper describes the different operating modes under investigation and the R&D activities ongoing at DESY to support the upgrade. The main focus of the paper is on the cryomodule and cavity design modifications, while also giving a brief introduction of the other challenging aspects connected to the upgrade.

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Yes

Footnotes

Funding Agency

Author: BARBANOTTI, Serena (Deutsches Elektronen-Synchrotron DESY)

Co-authors: BRANLARD, Julien (Deutsches Elektronen-Synchrotron DESY); JENSCH, Kay (Deutsches Elektronen-Synchrotron DESY); KOSTIN, Denis (Deutsches Elektronen-Synchrotron DESY); RESCHKE, Detlef (Deutsches Elektronen-Synchrotron DESY); SCHNAUTZ, Tobias (Deutsches Elektronen-Synchrotron DESY); STEDER, Lea (Deutsches Elektronen-Synchrotron DESY); WALKER, Nicholas (Deutsches Elektronen-Synchrotron DESY); WEISE, Hans (Deutsches Elektronen-Synchrotron DESY)

Presenter: BARBANOTTI, Serena (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Tuesday Oral Session: A

Track Classification: MC1: SRF Facilities

Contribution ID: **10** Contribution code: **TUB04** Type: **Invited Oral Presentation**

Plasma electrolytic polishing of 1.3 GHz cavities

Tuesday, September 23, 2025 12:00 PM (20 minutes)

The performance of superconducting radio frequency (SRF) cavities is critically influenced by surface preparation. Traditionally, electropolishing (EP) has been employed to achieve a clean, low-roughness surface on both niobium (Nb) and copper (Cu) substrates, despite requiring harsh and corrosive acids. Since 2019, our research at LNL has focused on an alternative approach: Plasma Electrolytic Polishing (PEP). This method uses only diluted salt solutions, presenting several advantages over EP, including a superior removal rate (2-8 µm/min for Nb and 3-30 µm/min for Cu) and achieving a surface roughness (Ra) lower than tens of nm. Additionally, the set-up has been optimized and simplified using external cathodes (no cathodes placed inside the elliptical cavity are necessary). In 2022, we established the initial recipes for PEP, and four of them were subsequently patented in 2023. First successful applications included a Cu 6 GHz elliptical cavities, QPRs and 3D-printed devices. In august 2024 the process scaling to 1.3 GHz Cu elliptical cavity has been done successfully. A collaboration with CERN and KEK is ongoing to validate the RF performances of PEP on a hydroformed seamless cavity produced by KEK and coated with a Nb thin film at CERN. On this talk PEP scaling to 1.3 GHz geometry and first RF results will be reported.

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Yes

Footnotes

Funding Agency

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Author: CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Co-authors: EZEABA, Tochukwu Emmanuel (University of Padua); CARLOS, Carlota (European Organization for Nuclear Research); FORD, Davide (Istituto Nazionale di Fisica Nucleare); FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare); STIVANELLO, Fabrizio (Istituto Nazionale di Fisica Nucleare); KEPPEL, Giorgio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); ROSAZ, Guillaume (European Organization for Nuclear Research); ARAKI, Hayato (High Energy Accelerator Research Organization); YAMANAKA, Masashi (High Energy Accelerator Research Organization); Dr LAZZARI, Matteo (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); AZZOLINI, Oscar (Istituto Nazionale di Fisica Nucleare); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare)

Presenter: CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Session Classification: Tuesday Oral Session: B

Track Classification: MC3: Cavities

Contribution ID: **11** Contribution code: **FRB05** Type: **Invited Oral Presentation**

Detection of high-f gravitational waves using SRF cavities

Friday, September 26, 2025 12:20 PM (20 minutes)

Today, apart from some isolated R&D efforts, there are no GW experiments, yet which explore a large part of the vast frequency range above the LIGO/Virgo band. It is planned to establish an experiment at DESY and FNAL to search for high-frequency GWs in the frequency range of 10 kHz to 100 MHz. The basic idea is to use superconducting radiofrequency (SRF) cavities to detect tiny harmonic deformations induced by GWs which change the boundary conditions of the oscillating electromagnetic field.

This talk deals with a brief motivation of this search, which dictates the challenging environmental boundary requirements, and the R&D to operate a cavity using a LLRF system which pushes beyond state-of-the-art accuracy and resolutions and a seismic noise mitigated cryostat at 1.8 K.

A focus of the presentation will be the warm and cold commissioning of a prototype cavity, built 20 years ago during the MAGO collaboration, and its first measurement in our collaborative research project. We will address the questions "What can we learn from this prototype?"and "how to design and build an optimized cavity for high-f GW search?"and the preparations for a first physics run in 2026 to explore an uncharted phase space in GW physics."

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Authors: WENSKAT, Marc (Universität Hamburg); GIACCONE, Bianca (Fermi National Accelerator Laboratory)

Co-authors: BRANLARD, Julien (Deutsches Elektronen-Synchrotron DESY); CHOUHAN, Vijay (Fermi National Accelerator Laboratory); DOKUYUCU, Can (Deutsches Elektronen-Synchrotron DESY); FISCHER, Lars (Universität Hamburg); GONIN, Ivan (Fermi National Accelerator Laboratory); GRASSELLINO, Anna (Fermi National Accelerator Laboratory); HILLERT, Wolfgang (Universität Hamburg); KHABIBOULLINE, Timergali (Fermi National Accelerator Laboratory); KROKOTSCH, Tom (Universität Hamburg); Dr LUDWIG, Frank (Deutsches Elektronen-Synchrotron DESY); MARCONATO, Giovanni (Universität Hamburg); MELNYCHUK, Alex (Fermi National Accelerator Laboratory); MOORTGAT-PICK, Gudrid (Universität Hamburg); MUHS, Andrea (Deutsches Elektronen-Synchrotron DESY); NETEPENKO, Alex (Fermi National Accelerator Laboratory); ORLOV, Yuriy (Fermi National Accelerator

Laboratory); Mr PAULSEN, Michel (Universität Hamburg); PETERS, Krisztian (Deutsches Elektronen-Synchrotron DESY); Mr PFEIFFER, Linus (Universität Hamburg); POSEN, Sam (Fermi National Accelerator Laboratory); PRONITCHEV, Oleg (Fermi National Accelerator Laboratory); SCHLARB, Holger (Deutsches Elektronen-Synchrotron DESY)

Presenters: WENSKAT, Marc (Universität Hamburg); GIACCONE, Bianca (Fermi National Accelerator Laboratory)

Session Classification: Friday Oral Session: B

Track Classification: MC5: SRF Applications

Contribution ID: **12** Contribution code: **THA02** Type: **Invited Oral Presentation**

Development of Nb3Sn coatings on copper at INFN-LNL

Thursday, September 25, 2025 8:50 AM (20 minutes)

The successful development of Nb3Sn/Cu coatings for the SRF cavities of next generation particle accelerators would result in the reduction of the needed cryogenic power by a factor 3 with respect to what normally needed for bulk Nb cavities, while maintaining operation at 4.5 K. In the framework of the I.FAST and ISAS collaborations, research activities are carried out at INFN-LNL to develop new technologies for the application of Nb3Sn on Cu, including seamless spinning of cavity prototypes, surface chemical preparation, cavity coating and testing. At the same time, an optimized recipe for Nb3Sn films deposited via DCMS has been established on small samples and is discussed in this work. The recipe delivers films showing a Tc ≈ 17 K, at deposition temperatures ≤ 650 ℃, on a Cu substrate pre-coated with a 30-micron thick buffer layer of Nb. The deposition recipe is validated on bulk Nb by measuring the RF properties on a QPR sample, with the results being also discussed in this work. A surface resistance of 23 nΩ at 4.5 K (at 20 mT, 417 MHz, with quench field ~ 70 mT) is measured, which is about 5 times larger than the baseline specifications for the LHC Nb/Cu cavities and already fulfills the requirements for the FCC-ee. Finally, the expected challenges toward the scalability of the coating recipe to an elliptical cavity prototype, and the perspectives for further recipe refinement are discussed.

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Yes

Footnotes

Funding Agency

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Author: FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare)

Co-authors: CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); FORD, Davide (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); Dr KECKERT, Sebastian (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen); KRAMER, Felix (Helmholtz-Zentrum Berlin für Materialien und Energie); KUGELER, Oliver (Helmholtz-Zentrum Berlin für Materialien und Energie); Dr LAZZARI, Matteo (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); MARCONATO, Giovanni (Universität Hamburg); PROSLIER, Thomas (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); WENSKAT, Marc (Universität Hamburg; Deutsches Elektronen-Synchrotron DESY); ZUBTSOVSKII, Aleksandr (University of Siegen); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare)

Presenter: FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare)

Session Classification: Thursday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **13** Contribution code: **FRA06** Type: **Invited Oral Presentation**

RF DIPOLE CRYOMODULE TESTS

Friday, September 26, 2025 10:10 AM (20 minutes)

The first RF Dipole crab cavity cryomodule, jointly developed by CERN and UK-STFC under the HL-LHC project, was built for proton beam tests in the SPS machine. In 2024, the cryomodule was tested in the CERN horizontal test facility prior to its installation in the SPS. During acceptance tests, two critical non-conformities related to the fundamental power couplers were identified. This paper presents the mitigation of these non-conformities and the subsequent validation tests that led to successful continuous wave (CW) operation. Key aspects of RF performance, cryogenics, alignment, and frequency tuning are also discussed.

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Yes

Footnotes

Funding Agency

This research is supported by the HL-LHC project and UK Science and Technology Council through HL-LHC-UK.

Author: VALVERDE ALONSO, Nuria (European Organization for Nuclear Research)

Co-authors: EDWARDS, Amelia (European Organization for Nuclear Research); MONTESINOS, Eric (European Organization for Nuclear Research); Mr CIPOLLA, Gino (European Organization for Nuclear Research); BREGLIOZZI, Giuseppe (European Organization for Nuclear Research); BURT, Graeme (Lancaster University); HAGMANN, Gregoire (European Organization for Nuclear Research); SWIESZEK, Joanna (Kraftanlagen (Germany)); TURAJ, Katarzyna (European Organization for Nuclear Research); ARTOOS, Kurt (European Organization for Nuclear Research); Mr DELPRAT, Laurent (European Organization for Nuclear Research); DASSA, Luca (European Organization for Nuclear Research); GARLASCHÈ, Marco (European Organization for Nuclear Research); GUINCHARD, Michael (European Organization for Nuclear Research); Mr JAUSSI, Michael (European Organization for Nuclear Research); Mr STAPLEY, Niall (European Organization for Nuclear Research); TEMPLETON, Niklas (Science and Technology Facilities Council); CAPATINA, Ofelia (European Organization for Nuclear Research); Mr MINGINETTE, Pierre (European Organization for Nuclear Research); CALAGA, Rama (European Organization for Nuclear Research); DOMINGO GOMEZ, Sara (European Organization for Nuclear Research); CALVO, Sebastien Jerome (European Organization for Nuclear Research); BARRIERE, Simon (European Organization for Nuclear Research); Mr CAPELLI, Teddy (European Organization for Nuclear Research); GUILLEN HERNANDEZ, Teresa (European Organization for Nuclear Research); RUDE, Vivien (European Organization for Nuclear Research); Mr BRODZINSKI, krzysztof (European Organization for Nuclear Research)

Presenter: VALVERDE ALONSO, Nuria (European Organization for Nuclear Research)

Session Classification: Friday Oral Session: A

Track Classification: MC3: Cavities

Contribution ID: **14** Contribution code: **WEB01** Type: **Invited Oral Presentation**

Insights on the effect of N and O impurities towards optimizing SRF cavity performance

Wednesday, September 24, 2025 11:00 AM (20 minutes)

Recent developments in the high Q and high gradient frontier of SRF cavities have focused on altering the surface impurity profile through *in-situ* baking, furnace baking, and doping to introduce and diffuse impurities such as O, N and C. However, the precise role of each impurity in improving performance is not fully understood. We take a materials-focused approach to identifying the efficiency of O and N impurities. Niobium cavity cutouts are baked at temperatures from 120-800°C with and without nitrogen injection as well as subjected to varying amounts of EP removal. Time-of-flight secondary ion mass spectrometry is used to quantify the absolute concentration of each impurity, and these material studies are correlated to the BCS surface resistance measured through cavity tests. These results are compared with BCS theory as well as with first principle calculations. We find that the same reduction in BCS resistance can be realized with either O or N. Furthermore, the concentration of N required is ten times less than that of O to achieve the same improvement in performance.

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Yes

Footnotes

Funding Agency

Author: HU, Hannah (University of Chicago)

Co-authors: BAFIA, Daniel (Fermi National Accelerator Laboratory); KIM, Young-Kee (University of Chicago)

Presenter: HU, Hannah (University of Chicago)

Session Classification: Wednesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **16** Contribution code: **TUB05** Type: **Invited Oral Presentation**

Plasma processing of FRIB low-beta cryomodules using higher-order modes

Tuesday, September 23, 2025 12:20 PM (20 minutes)

Improvement in SRF accelerator performance after in-tunnel plasma processing has been seen at SNS and CEBAF. Plasma processing development for FRIB quarter-wave and half-wave resonators (QWRs, HWRs) was initiated in 2020. Plasma processing on individual QWRs (beta = 0.085) and HWRs (beta = 0.53) has been found to significantly reduce field emission. A challenge for the FRIB cavities is the relatively weak fundamental power coupler (FPC) coupling strength (chosen for efficient continuous-wave acceleration), which produces a lot of mismatch during plasma processing at room temperature. For FRIB QWRs, driving the plasma with higher-order modes (HOMs) is beneficial to reduce the FPC mismatch and increase the plasma density. The first plasma processing trial on a spare FRIB QWR cryomodule was done in January 2024; before-and-after bunker tests showed a significant increase in the average accelerating gradient for field emission onset after plasma processing. The plasma-processed cryomodule was installed into the FRIB linac in August 2024; the in-situ performance was similar to that of the post-plasma-processing bunker test. Additional development work is ongoing, with the goal of a first in-tunnel plasma processing trial during the summer 2025 linac maintenance period.

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Yes

Footnotes

Funding Agency

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Author: TUTT, Patrick (Facility for Rare Isotope Beams)

Co-authors: SAITO, Kenji (Facility for Rare Isotope Beams); ELLIOTT, Kyle (Facility for Rare Isotope Beams); KIM, Sang-Hoon (Facility for Rare Isotope Beams); XU, Ting (Facility for Rare Isotope Beams); HARTUNG, Walter (Facility for Rare Isotope Beams); CHANG, Wei (Facility for Rare Isotope Beams)

Presenter: TUTT, Patrick (Facility for Rare Isotope Beams)

Session Classification: Tuesday Oral Session: B

Track Classification: MC3: Cavities

Contribution ID: **17** Contribution code: **THA06** Type: **Invited Oral Presentation**

Nonequilibrium corrections and Higgs mode in superconducting devices: unraveling the pronounced Anti-Q slope in high-frequency regime and current-dependent kinetic inductance

Thursday, September 25, 2025 10:10 AM (20 minutes)

The anti-Q-slope observed in superconducting RF (SRF) cavities has been a longstanding puzzle. Previous studies by Gurevich [1] and Kubo-Gurevich [2] linked this phenomenon to the smearing of the density of states under high RF current. However, the experimentally observed trend of a more pronounced anti-Q-slope with increasing frequency remains unexplained. Recent theoretical investigations using the Keldysh formalism of nonequilibrium superconductivity have provided new insights [3,4]. They revealed that in superconductors exposed to a perturbative RF field on a bias dc, nonequilibrium corrections to the current-carrying state, including the Higgs mode—previously overlooked—significantly influence Q-values and kinetic inductance, even in the RF region. Notably, over 40 % of the current dependence of kinetic inductance is attributed to the Higgs mode. Moreover, the anti-Q-slope as a function of dc bias becomes more pronounced at higher frequencies. These findings suggest that the anti-Q-slope under strong RF fields arises from these nonequilibrium corrections in addition to DOS smearing. Such corrections, including the Higgs mode, are crucial in superconducting devices under strong currents, whether dc or RF, affecting not only SRF cavities but also devices like single photon detectors and kinetic inductance detectors. This presentation highlights key physical mechanisms and their impact on superconducting devices, including SRF cavities.

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Yes

Funding Agency

JSPS KAKENHI Grants No. JP17KK0100, Toray Science Foundation Grants No. 19-6004

Footnotes

[1] A. Gurevich, Phys. Rev. Lett. 113, 087001 (2014).
[2] T. Kubo and A. Gurevich, Phys. Rev. B 100, 064522 (2019).
[3] T. Kubo, Phys. Rev. Applied 22, 044042 (2024).
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Author: KUBO, Takayuki (High Energy Accelerator Research Organization)

Presenter: KUBO, Takayuki (High Energy Accelerator Research Organization)

Session Classification: Thursday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **19** Contribution code: **THA01** Type: **Invited Oral Presentation**

Production of Nb3Sn film on copper substrate by the bronze route and the RF characterization of samples with the quadrupole resonator

Thursday, September 25, 2025 8:30 AM (20 minutes)

Copper-based Nb3Sn cavity is a promising candidate for next generation accelerator applications in the field of superconducting radio frequency (SRF). It combines the excellent thermal conductivity of copper and the superior superconducting properties of Nb3Sn, and has the potential to greatly improve the performance of the SRF cavity. The electrochemical and thermal synthesis (ETS) bronze route is one of the proven methods to achieve Nb3Sn coating on copper. Its advantages are low cost, simple operation, suitable for complex cavity types and mass production. In this report, we have prepared a copper-based Nb3Sn sample specifically for Quadrupole Resonator (QPR) testing. We provide a complete set of QPR sample preparation processes from copper electropolishing, Nb sputtering, electrodeposition and heat treatment to synthesize Nb3Sn. By optimizing the entire preparation process and key parameters, a new Cu-based Nb3Sn QPR sample was successfully prepared and its RF properties have been characterized by QPR testing system at HZB.

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Yes

Footnotes

Funding Agency

Author: LU, Ming (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: KECKERT, Sebastian (Helmholtz-Zentrum Berlin für Materialien und Energie); KRAMER, Felix (Helmholtz-Zentrum Berlin für Materialien und Energie); ZUBTSOVSKII, Aleksandr (University of Siegen); Dr PRUDNIKAVA, Alena (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen); KUGELER, Oliver (Helmholtz-Zentrum Berlin für Materialien und Energie)

Presenter: LU, Ming (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Thursday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **20** Contribution code: **THA05** Type: **Invited Oral Presentation**

Investigation of anti-Q-slope and Q-slope effects in SRF cavities: a unified theoretical framework

Thursday, September 25, 2025 9:50 AM (20 minutes)

In the SRF community, the origin of the anti-Q-slope in bulk niobium cavities and the Q-slope in niobium-coated copper cavities remains an open question. In this contribution, we propose a theoretical framework explaining both phenomena through a unified approach. The distribution function of quasiparticles may play a crucial role in the response of a superconductor exposed to radio-frequency (RF) fields. In SRF applications, the non-equilibrium dynamics of quasiparticles is traditionally considered independently of phonon dynamics. However, under certain conditions, quasiparticle-phonon scattering in niobium could dominate the dynamic process, making phonon decoupling unfeasible. Unlike previous models, our approach considers the dynamics of quasiparticles and phonons together. For bulk niobium with doped impurities, we show that the non-equilibrium quasiparticle distribution deviates significantly from the Fermi-Dirac distribution and effectively reduces the surface resistance. In niobium-coated cavities, the niobium/copper interface increases the phonon density near the RF surface, leading to a reduction of the order parameter and an increase in surface resistance. In this contribution, we present calculations of the coupled kinetic equations describing the non-equilibrium distributions of quasiparticles and phonons under RF fields and compare our theoretical predictions with experimental data, offering new insights into the optimization of SRF cavity performance.

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Yes

Footnotes

Funding Agency

Author: BIANCHI, Antonio (Istituto Nazionale di Fisica Nucleare)

Presenter: BIANCHI, Antonio (Istituto Nazionale di Fisica Nucleare)

Session Classification: Thursday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **21** Contribution code: **MOP31** Type: **Student Poster Presentation**

Electromagnetic design of a quadrupole resonator for SRF materials at IMP

Monday, September 22, 2025 2:30 PM (3 hours)

Comprehensive RF characterization of superconducting materials in a large range of multiparameters plays a pivotal role in research both on exploring material limits and understanding RF loss mechanism. This is particularly critical for emerging thin-film superconductors such as Nb_3Sn and superconducting-insulator-superconducting (SIS) heterostructures (e.g., NbTiN-AlN-Nb). The Quadrupole Resonator (QPR), originally developed at CERN, employing RF-DC compensation technique to measure surface resistance in a high resolution. A QPR operating at a fundamental frequency of 325MHz is under development at Institute of Modern Physics, CAS, the lower frequency means higher residual resistance sensitivity compared to existing systems at CERN and HZB. In this paper, the electromagnetic optimization following some crucial figure of merits will be showed, including avoiding (Δf = f_QPR −f_dipole >5 MHz), multipacting suppression (SEY > 1), and field emission control (B_pk/E_pk). Designs for P_in (input) and P_t (pick-up) couplers are detailed, alongside the cavity fabrication process.

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Yes

Footnotes

Funding Agency

Author: ZHAO, Yong (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: HUANG, Shichun (Institute of Modern Physics, Chinese Academy of Sciences); YU, MIngming (Sichuan University); PENG, Long (Lanzhou University); GU, Xiangcheng (Institute of Modern Physics, Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: ZHAO, Yong (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **22** Contribution code: **MOP61** Type: **Student Poster Presentation**

Design and testing of high power test bench for CiADS elliptical superconducting cavity input coupler

Monday, September 22, 2025 2:30 PM (3 hours)

The Chinese initiative Accelerator Driven Subcritical System (CiADS) proposed by the Insitute of Modern Physics (IMP) will use 58 650 MHz input power couplers for low β and high β elliptical superconducting cavities, for continuous wave power up to 130 kW. Pre-design of 650 MHz couplers has been completed. In order to validate the performance of these couplers and effectively eliminate soft Multipacting through high power testing. A high power test bench was designed, machined and commissioned for 650 MHz elliptical superconducting cavity couplers. Due to the different coupling antenna lengths of the two types of superconducting cavity couplers, transmission performance of up to -35 dB was achieved by optimizing the structure of the test cavities of the high power test bench. The high power test bench utilizes forced air cooling to effectively reduce excessive temperature rise during high power testing. The high power test procedure for this coupler is also presented to be effective in reducing the conditioning time of the couplers.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: LIU, Guochang (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: JIANG, Tiancai (Institute of Modern Physics, Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: LIU, Guochang (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **23** Contribution code: **TUP70** Type: **Student Poster Presentation**

A low-level radio frequency (LLRF) control system for multiple superconducting cavities based on MicroTCA.4

Tuesday, September 23, 2025 2:30 PM (3 hours)

In modern particle accelerators, multiple superconducting cavities are often driven simultaneously by one high-power klystron, thereby reducing the cost of the power supplies. The CEPC TDR specifies 96 cryomodules for 650 MHz 2-cell cavities, with each cryomodule originally housing two cavities. During the horizontal testing phase, however, we plan to simultaneously drive six superconducting cavities per klystron to verify the RF system's reliability. This approach significantly reduces the cost of the power supply but introduces several challenges for high-precision control of superconducting cavities, such as gradient differences due to individual cavity variations, frequency offsets caused by Lorentz force detuning, and the calibration of vector sum of amplitudes and phases for multiple cavities. This paper introduces the design of China's first LLRF control system for multi-superconducting cavity control, based on a fully domestic MicroTCA.4 platform with self-developed hardware and software capable of supporting both pulsed and continuous wave operation modes. Based on the vector-sum control principle, the system utilizes IQ sampling, feedforward-feedback control, and other techniques, eventually achieving high-precision amplitude and phase control and frequency tuning of six superconducting cavities through comprehensive domestic innovation in critical components and control algorithms.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: GAO, Wenbin (Institute of High Energy Physics)

Co-authors: GAN, Nan (Institute of High Energy Physics); ZHOU, Zusheng (Institute of High Energy Physics); Prof. ZHAI, Jiyuan (Institute of High Energy Physics); MA, Xinpeng (Key Laboratory of Particle Acceleration Physics and Technology)

Presenter: GAO, Wenbin (Institute of High Energy Physics)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **24** Contribution code: **WEA02** Type: **Invited Oral Presentation**

Nb3Sn development for low-beta cavities

Wednesday, September 24, 2025 8:50 AM (20 minutes)

Nb3Sn has been identified as the most promising next-generation superconducting material for accelerator cavities. This is due to the higher critical temperature of Nb3Sn (Tc = 18 K) compared to niobium (Tc = 9.2 K), which leads to greatly reduced RF losses in the cavity during 4.5 K operation. This allows two important changes during cavity and cryomodule design. First, the higher Tc leads to negligible BCS losses when operated at 4.5 K, which allows for a higher frequency to be used, translating to significantly smaller cavities and cryomodules. Second, the reduced dissipated power lowers the required cryogenic cooling capacity, meaning that cavities can feasibly be operated on 5-10 W cryocoolers instead of a centralized helium refrigeration plant. These plants and distribution systems are costly and complex, requiring skilled technicians for operation and maintenance. These fundamental changes present an opportunity for a paradigm shift in how low-beta linacs are de-signed and operated. Fabrication and testing results of first prototypes are discussed.

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Yes

Footnotes

Funding Agency

Author: PETERSEN, Troy (Argonne National Laboratory)

Co-authors: AGUSTSSON, Ronald (RadiaBeam Technologies (United States)); EREMEEV, Grigory (Fermi National Accelerator Laboratory); GUILFOYLE, Ben (Argonne National Laboratory); KEDZIE, Mark (Argonne National Laboratory); KELLY, Michael (Argonne National Laboratory); KUTSAEV, Sergey (RadiaBeam Technologies (United States)); POSEN, Sam (Fermi National Accelerator Laboratory); REID, Thomas (Argonne National Laboratory); SPRANZA, Edward (RadiaBeam Technologies (United States)); TAGDULANG, Nikki (Fermi National Accelerator Laboratory); TENNIS, Brad (Fermi National Accelerator Laboratory); XU, Shifu (Argonne National Laboratory); ZHOU, Yang (Argonne National Laboratory)

Presenter: PETERSEN, Troy (Argonne National Laboratory)

Session Classification: Wednesday Oral Session: A

Track Classification: MC3: Cavities

Contribution ID: **25** Contribution code: **THA04** Type: **Invited Oral Presentation**

Studies as a function of different ALD capping layers on cavity losses for QIS and accelerators

Thursday, September 25, 2025 9:30 AM (20 minutes)

Niobium-based bulk SRF cavities have demonstrated exceptional performance. To further improve niobium cavity performance, we present studies involving a novel surface engineering process designed to prevent the formation of amorphous niobium oxides on the surface. This is achieved by encapsulating the niobium surface using thermal Atomic-Layer-Deposition (ALD). This technique has been shown to enhance the properties of niobium cavities and 2D resonators. This study not only aims to improve SRF performance at high fields but also has the potential to enhance the quality factor in low-field regimes, particularly for quantum applications. For the method to be effective, it is essential to have a clean interface between the encapsulating layer and the bulk niobium. Achieving this requires a uniform coating across the entire cavity surface and efficient removal of the underlying niobium oxides. To optimize the process, a variety of material characterization tools have been utilized to refine parameters such as thin film thickness and annealing conditions. Cavity RF measurements were performed at the vertical test facilities at FNAL to assess the Q vs. Eacc curves for accelerator applications, as well as at the SQMS dilution refrigerators to investigate the full two-level system (TLS) losses at milliKelvin and single-photon levels. Based on the results, we characterized the loss of different oxides in various regimes and applications, comparing them to natural niobium pentoxide.

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Yes

Footnotes

Funding Agency

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Author: GRASSELLINO, Laura (Fermi National Accelerator Laboratory)

Co-authors: MURTHY, Akshay (Fermi National Accelerator Laboratory); ROMANENKO, Alexander (Fermi National Accelerator Laboratory); GRASSELLINO, Anna (Fermi National Accelerator Laboratory); BAFIA, Daniel (Fermi National Accelerator Laboratory); EREMEEV, Grigory (Fermi National Accelerator Laboratory); POSEN, Sam (Fermi National Accelerator Laboratory); BELOMESTNYKH, Sergey (Fermi National Accelerator Laboratory); PROSLIER, Thomas (Université Paris-Saclay); KALBOUSSI, Yasmine (Commissariat à l'Energie Atomique)

Presenter: GRASSELLINO, Laura (Fermi National Accelerator Laboratory)

Session Classification: Thursday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **26** Contribution code: **TUA04** Type: **Invited Oral Presentation**

Studies of in-situ baking of SRF niobium cavities without a furnace at HZB

Tuesday, September 23, 2025 9:30 AM (20 minutes)

A specialized setup was designed to carry on a mid-T baking of SRF niobium cavities. It utilizes resistive heaters installed on the outer cavity walls, with a cryostat serving as a vacuum vessel. Based on our material studies with the real-time in-situ synchrotron XPS, a single-cell 1.3 GHz cavity was thermally treated in the regime providing contamination-free oxygen doping of niobium. RF tests of the cavity showed a significant reduction in surface resistance, primarily due to a decrease in residual resistance, with no field emission or degradation of the maximum accelerating field. This developed procedure can be potentially applied to bake "dressed"cavities prior to cryomodule assembly without breaking the cavity vacuum, thereby preventing surface re-oxidation and allowing the full benefits of mid-T baking to be realized in a real accelerator environment.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Dr PRUDNIKAVA, Alena (Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-authors: TAMASHEVICH, Yegor (Helmholtz-Zentrum Berlin für Materialien und Energie); MATVEENKO, Alexander (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen); KUGELER, Oliver (Helmholtz-Zentrum Berlin für Materialien und Energie); NEUMANN, Axel (Helmholtz-Zentrum Berlin für Materialien und Energie)

Presenter: Dr PRUDNIKAVA, Alena (Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Tuesday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **27** Contribution code: **MOA02** Type: **Invited Oral Presentation**

Crystallinity in niobium oxides: a pathway for mitigation of two-level system defects in niobium 3D resonator for quantum applications

Monday, September 22, 2025 8:50 AM (20 minutes)

Materials imperfections in Nb-based superconducting quantum circuits—in particular, two-level-system (TLS) defects—are a major source of decoherence, ultimately limiting the performance of quantum computation and sensing. Thus, identifying and understanding the microscopic origin of possible TLS defects in these devices will help developing strategies to eliminate them and is key to superconducting qubit performance improvement. We will report in this presentation, an order of magnitude reduction in two-level system losses in three-dimensional superconducting radio frequency (SRF) niobium resonators by a 10 hour high vacuum (HV) heat treatment at 650 ℃, even after exposure to air and high pressure rinsing (HPR). X-ray photoelectron spectroscopy (XPS) and high-resolution scanning transmission electron microscopy (STEM) reveal an alteration of the native oxide composition re-grown after air exposure and HPR and the creation of nano-scale crystalline oxide regions, which correlates with the measured tenfold quality factor enhancement at low fields of the 1.3 GHz niobium resonator. Tunneling spectroscopy measurements show a pronounced proximity effect that further confirms the presence of metallic layers on the niobium surface.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: PROSLIER, Thomas (Université Paris-Saclay)

Co-authors: EOZÉNOU, Fabien (Commissariat à l'Energie Atomique); JULLIEN, Grégoire (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); CURCI, Ivana (Université Paris-Saclay); MAURICE, Luc (Commissariat à l'Energie Atomique); SAHUQUET, Patrick (Commissariat à l'Energie Atomique); KALBOUSSI, Yasmine (Commissariat à l'Energie Atomique)

Presenter: PROSLIER, Thomas (Université Paris-Saclay)

Session Classification: Monday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **28** Contribution code: **FRB04** Type: **Invited Oral Presentation**

Perspectives of superconducting materials in SRF at high fields for large physics experiments

Friday, September 26, 2025 12:00 PM (20 minutes)

Large experiments in fundamental physics such as the detection of dark matter axions [1] or new particle accelerators like the CERN FCC [2], can greatly benefit from the low surface impedance Zs of superconductors (SC) in high magnetic fields H. In the pursuit of high-Q SC cavities (haloscopes), the understanding and control of high frequency vortex motion, the main dissipative channel acting in the mixed state, is of paramount importance. We propose a microwave (ν=8-27 GHz) study at high H, ≤12 T, of Zs in Nb3Sn samples grown by different techniques: high isostatic pressure sintering (HIP), vapor diffusion (VD), and DC magnetron sputtering (DCMS). Using a dual frequency dielectric loaded resonator, vortex dynamics parameters are extracted. Several results are deduced for the various Nb3Sn samples: the HIP sample presents effective, albeit collective, pinning; the VD sample exhibits a weak collective pinning overcome already at a few T; the DCMS sample shows a marked signature of Josephson coupled network of grain boundaries, sites for the effective pinning observed. Secondly, we present a broad comparison of the potential performances of several SC, evaluated in a large (T, H, ν) parameter space [3]. It is inferred that, althoughvortex pinning plays obviously a major role, the often-disregarded flexibility of vortex lines and the penetration depth strongly affect haloscopes Q, so that the choice of the material is not obvious.

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Yes

Funding Agency

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Footnotes

[1] D Alesini et al, Phys. Rev. D 99, 101101(R) (2019)
[2] S Calatroni, IEEE Trans. Appl. Supercond. 26, 3500204 (2016)
[3] A Alimenti et al, Instruments 6, 1 (2022)

Author: POMPEO, Nicola (Università degli Studi Roma Tre)

Co-authors: MAGALOTTI, Alessandro (Roma Tre University; Istituto Nazionale di Fisica Nucleare, Sezione di Roma Tre); ALIMENTI, Andrea (Roma Tre University; Istituto Nazionale di Fisica Nucleare, Sezione di Roma Tre); SILVA, Enrico (Roma Tre University; Istituto Nazionale di Fisica Nucleare, Sezione di Roma Tre); TOROKHTII, Kostiantyn (Roma Tre University); VIDAL GARCÍA, Pablo (Roma Tre University; Istituto Nazionale di Fisica Nucleare, Sezione di Roma Tre)

Presenter: POMPEO, Nicola (Università degli Studi Roma Tre)

Session Classification: Friday Oral Session: B

Track Classification: MC5: SRF Applications

Contribution ID: **29** Contribution code: **WEA05** Type: **Invited Oral Presentation**

Beam acceleration with a Nb3Sn cryomodule at JLAB

Wednesday, September 24, 2025 9:50 AM (20 minutes)

A CEBAF-style quarter cryomodule with two Nb3Sn coated 5-cell CEBAF-style SRF cavities was tested successfully in the cryomodule test facility (CMTF) at JLab in 2024. Efforts continued since then toward a beam test of that cryomodule in the upgraded injector test facility (UITF) at JLab. In this talk, we will report on the beam test results and the planned future steps in further developing the Nb3Sn cryomodule technology in support of CEBAF accelerator upgrade scenarios and other application beyond nuclear physics.

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Yes

Footnotes

Funding Agency

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Author: GENG, Rong-Li (Thomas Jefferson National Accelerator Facility)

Co-authors: BACHIMANCHI, Ramakrishna (Thomas Jefferson National Accelerator Facility); CIOVATI, Gianluigi (Thomas Jefferson National Accelerator Facility); CREEL, Jonathan (Thomas Jefferson National Accelerator Facility); DRURY, Michael (Thomas Jefferson National Accelerator Facility); DUTTON, Stephen (Thomas Jefferson National Accelerator Facility); FISCHER, John (Thomas Jefferson National Accelerator Facility); GALE, Natalie (Thomas Jefferson National Accelerator Facility); HESSE, Kyle (Thomas Jefferson National Accelerator Facility); KING, Larry (Thomas Jefferson National Accelerator Facility); Dr KUZIKOV, Sergey (Thomas Jefferson National Accelerator Facility); LATSHAW, James (Thomas Jefferson National Accelerator Facility); MARBLE, Gregory (Thomas Jefferson National Accelerator Facility); MUSSON, John (Thomas Jefferson National Accelerator Facility); OWEN, Peter (Thomas Jefferson National Accelerator Facility); PLAWSKI, Tomasz (Thomas Jefferson National Accelerator Facility); POELKER, Matt (Thomas Jefferson National Accelerator Facility); PUDASAINI, Uttar (Thomas Jefferson National Accelerator Facility); WANG, Haipeng (Thomas Jefferson National Accelerator Facility); WANG, Shaoheng (Thomas Jefferson National Accelerator Facility); WANG, Yan (Thomas Jefferson National Accelerator Facility); WEAKS, Matt (Thomas Jefferson National Accelerator Facility); GOMEZ, Xavier (Thomas Jefferson National Accelerator Facility)

Presenter: GENG, Rong-Li (Thomas Jefferson National Accelerator Facility)

Session Classification: Wednesday Oral Session: A

Track Classification: MC4: SRF Technologies

Contribution ID: **31** Contribution code: **MOB01** Type: **Invited Oral Presentation**

Commissioning experience of ESS superconducting linac

Monday, September 22, 2025 11:00 AM (20 minutes)

The SCL is an in kind contribution to ESS by IJCLAB (spoke cavities and cryomodules), INFN (Medium Beta Cavities), STFC (High Beta cavities) and CEA (all elliptical cryomodule assembly). Spoke cryomodules have been tested at FREIA facility in Uppsala (Sweden) and elliptical cryomodules have been tested at the ESS Test Stand 2 in Lund. The installation of 27 cryomodules (13 spokes, 9 medium beta and 5 high beta elliptical) was completed in summer 2024, providing a 2 MW beam power capability on a neutron production target for the first operation phase of the facility. The ESS superconducting linac cool down to 4 K started in December 2024, followed by the non-on resonance cold coupler conditioning of all 82 superconducting cavity couplers (26 spoke, 36 medium beta and 20 high beta elliptical). Stable 2 K conditions were reached in January 2025, followed by the tuning to resonance and the start of cavity conditioning process to nominal operation parameters. The preparation of cavities for stable beam operation is currently ongoing, after recovering from infrastructure outages that resulted in cryoplant failure and full unintentional warmup cycle. Beam operation, first in the normalconductiong front end and then to the temporary beam dump will start on March 19th. In the talk we summarize the experience of cryomodules commissioning in the ESS linac and compare tot the site acceptance test of the cryomodules and the factory acceptance tests of the cavities at the in kind partners.

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Footnotes

Funding Agency

Author: MAIANO, Cecilia (European Spallation Source)

Co-authors: BHATTACHARYYA, Anirban (European Spallation Source); ELIAS, Nuno (European Spallation Source); GOUDKET, Philippe (European Spallation Source); JENSEN, Morten (European Spallation Source); Mr KRAWCZYK, Artur (European Spallation Source); Mr NABYWANIEC, Mateusz (European Spallation Source); PIERINI, Paolo (European Spallation Source); PRZYBILSKI, Henry (European Spallation Source); SKIBA, Marek (European Spallation Source); SVENSSON, Anders (European Spallation Source); VAN VELZE, Peter (European Spallation Source); WANG, Muyuan (European Spallation Source); Ms ZWOZNIAK, Agnieszka (European Spallation Source)

Presenter: MAIANO, Cecilia (European Spallation Source)

Session Classification: Monday Oral Session: B

Track Classification: MC1: SRF Facilities

Contribution ID: **32** Contribution code: **TUP38** Type: **Poster Presentation**

The plasma processing development for CSNS-II superconducting Linac

Tuesday, September 23, 2025 2:30 PM (3 hours)

As a practical technique to mitigate field emission effect of superconducting cavities on-line, plasma processing has been developed for CSNS-II superconducting Linac. Experimental platform has been set up and experiments of plasma ignited in various cavities with different frequencies have been conducted. The details of the research will be presented in the paper.

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Yes

Footnotes

Funding Agency

Guangdong Basic and Applied Basic Research Foundation(Grant No.2022B1515120027)

Author: ZHANG, Cong (Institute of High Energy Physics)

Co-authors: LIU, Huachang (Dongguan Neutron Science Center); GE, Rui (Institute of High Energy Physics); ZHOU, Wenzhong (Institute of High Energy Physics); LI, Ahong (Institute of High Energy Physics); CHEN, Qiang (Institute of High Energy Physics); LI, Bo (Institute of High Energy Physics); WU, Xiaolei (Dongguan Neutron Science Center); Dr FAN, Mengxu (Institute of High Energy Physics); QU, Peihua (Institute of High Energy Physics); KONG, Qiyu (Institute of High Energy Physics)

Presenter: ZHANG, Cong (Institute of High Energy Physics)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **33** Contribution code: **MOP72** Type: **Poster Presentation**

The horizontal testing of CSNS-II elliptical cryomodule

Monday, September 22, 2025 2:30 PM (3 hours)

The China Spallation Neutron Source II (CSNS - II) necessitates 10 cryomodules equipped with double - spoke cavities and 8 cryomodules equipped with elliptical cavities to achieve the acceleration of H^- ions from 80 MeV to 300 MeV. Prior to their installation into the tunnel, each cryomodule must undergo horizontal testing and obtain certification. This paper will elaborate on the results of the horizontal tests.

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Yes

Footnotes

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Guangdong Basic and Applied Basic Research Foundation(Grant No.2022B1515120027)

Author: ZHANG, Cong (Institute of High Energy Physics)

Co-authors: LI, Ahong (Institute of High Energy Physics); LI, Bo (Institute of High Energy Physics); HE, Feisi (Institute of High Energy Physics); LIU, Huachang (Dongguan Neutron Science Center); DAI, Jin (Institute of High Energy Physics); Dr FAN, Mengxu (Institute of High Energy Physics); QU, Peihua (Institute of High Energy Physics); CHEN, Qiang (Institute of High Energy Physics); KONG, Qiyu (Institute of High Energy Physics); GE, Rui (Institute of High Energy Physics); ZHOU, Wenzhong (Institute of High Energy Physics); WU, Xiaolei (Dongguan Neutron Science Center)

Presenter: ZHANG, Cong (Institute of High Energy Physics)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **34** Contribution code: **THB05** Type: **Invited Oral Presentation**

Cold Integration of the DESY CW L-band SRF Injector Cavity with Copper Photocathode

Thursday, September 25, 2025 12:20 PM (20 minutes)

A future upgrade of the European XFEL foresees High-Duty-Cycle (HDC) operation which requires a new electron beam injector. The centerpiece of such a photoinjector is a continuous wave (CW) L-band superconducting radio frequency (SRF) cavity developed at DESY. This cavity demonstrated world record peak axial electric field values of up to 50 MV/m with a copper (Cu) cathode, thread mounted to the cavity backwall. In this contribution, we report on the present status of the cavity design, describe the cold integration of the cavity including the cryostat, tuner and solenoid magnet, and show the plans for a test facility being built to verify the beam quality produced by this SRF injector.

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Yes

Footnotes

Funding Agency

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Author: JASTER-MERZ, Sonja (Deutsches Elektronen-Synchrotron DESY)

Co-authors: NANDAWADEKAR, Ajit (European X-Ray Free-Electron Laser); HECK, Artur (Deutsches Elektronen-Synchrotron DESY); ENGLING, Claudia (Deutsches Elektronen-Synchrotron DESY); KLINKE, Daniel (Deutsches Elektronen-Synchrotron DESY); BAZYL, Dmitry (Deutsches Elektronen-Synchrotron DESY); VOGEL, Elmar (Deutsches Elektronen-Synchrotron DESY); THIE, Jan-Hendrik (Deutsches Elektronen-Synchrotron DESY); BRANLARD, Julien (Deutsches Elektronen-Synchrotron DESY); Dr KASPRZAK, Karol (Deutsches Elektronen-Synchrotron DESY); JENSCH, Kay (Deutsches Elektronen-Synchrotron DESY); MISIURA, Konrad (Deutsches Elektronen-Synchrotron DESY); TRELLE, Lennart (Deutsches Elektronen-Synchrotron DESY); SCHMOEKEL, Manuela (Deutsches Elektronen-Synchrotron DESY); SPRUZZOLA, Paolo (Istituto Nazionale di Fisica Nucleare, Sezione di Milano); PAPARELLA, Rocco (Istituto Nazionale di Fisica Nucleare); MASOUDI, Schagayeg (Deutsches Elektronen-Synchrotron DESY); BARBANOTTI, Serena (Deutsches Elektronen-Synchrotron DESY); MOGK, Silke (Deutsches Elektronen-Synchrotron DESY)

Presenter: JASTER-MERZ, Sonja (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **35** Contribution code: **FRB03** Type: **Invited Oral Presentation**

Overview on current activities of conduction-cooled SRF accelerators and their applications

Friday, September 26, 2025 11:40 AM (20 minutes)

When Nb_3Sn was reintroduced to the SRF community as an alternative to pure niobium, one key motivation has been to reduce the cryogenic requirements of new and existing accelerators by shifting from 2 K to 4 K operation. Meanwhile, a variety of implementations beyond research machines are being explored. The combination of Nb_3Sn with conventional cryocoolers, enabling cryogen-free operation, has paved the way for the development of compact, standalone systems suitable for applications far beyond research, such as enhancing the durability of synthetics via crosslinking or sterilizing food and medical equipment, as well as environmental cleanup when it comes to decontaminating liquid and solid waste material. So, while fundamental R&D continues to refine Nb_3Sn resonators, exploring improvements such as replacing the niobium substrate with copper, parallel research efforts are investigating how the increased beam power provided by SRF could expand the commercial use of electron beams. This presentation aims to deliver a comprehensive overview of ongoing research efforts to harness the benefits of SRF through Nb3Sn and conduction cooling.

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Yes

Footnotes

Funding Agency

Author: VENNEKATE, John (Thomas Jefferson National Accelerator Facility)

Presenter: VENNEKATE, John (Thomas Jefferson National Accelerator Facility)

Session Classification: Friday Oral Session: B

Track Classification: MC5: SRF Applications

Contribution ID: **36** Contribution code: **MOP59** Type: **Poster Presentation**

Conduction-cooled operation of an SRF multi-cell cavity

Monday, September 22, 2025 2:30 PM (3 hours)

The development of compact, SRF-based accelerators for applications beyond research is experiencing notable advancements due to the use of cryocoolers for conduction cooling instead of traditional liquid cryogens. Following the successful demonstration of a single-cell cavity operated through conduction cooling with three two-stage cryocoolers, Jefferson Lab has made strides in the operation of a multi-cell resonator. This milestone paves the way for high-energy applications of compact, conduction-cooled SRF machines. The demonstration, carried out in collaboration with General Atomics, will take place in a dedicated horizontal test cryostat (HTC) at their San Diego facility. This presentation will highlight the technological developments, the latest results, and valuable lessons learned.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: VENNEKATE, John (Thomas Jefferson National Accelerator Facility)

Co-authors: CASTILLA, Alejandro (Thomas Jefferson National Accelerator Facility); CHENG, Gary (Thomas Jefferson National Accelerator Facility); CIOVATI, Gianluigi (Thomas Jefferson National Accelerator Facility); HARDING, Keith (Thomas Jefferson National Accelerator Facility); O'BRIEN, Adam (Thomas Jefferson National Accelerator Facility); PUDASAINI, Uttar (Thomas Jefferson National Accelerator Facility); RIMMER, Robert (Thomas Jefferson National Accelerator Facility); Dr HANNON, Fay (Phase Space Tech); PACKARD, Drew (General Atomics (United States)); RATHKE, John (Advanced Energy Systems (United States); JW Rathke Engineering Services); SCHULTHEISS, Tom (TJS Technologies)

Presenter: VENNEKATE, John (Thomas Jefferson National Accelerator Facility)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **37** Contribution code: **TUA01** Type: **Invited Oral Presentation**

Recent progress of SRF linac projects, HIAF and CiADS, at IMP

Tuesday, September 23, 2025 8:30 AM (20 minutes)

IMP is currently constructing three major SRF linacs: the High Intensity Heavy Ion Accelerator (HIAF), the China Initiative Accelerator Driven System (CiADS), and the Isotope Platform based on a high current superconducting linac (IP-SAFE), and operating one superconducting linac for Super Heavy Elements (CAFE2). This talk will report recent progress of these projects with emphasis on SRF equipment, operation stability, and discuss lessons learned. R&D activities to meet high demands on mass production and testing will also be presented, which includes robot-assisted clean assembly, RF testing, cryomodule design and testing, performance analysis, as well as new methods and innovative structures.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: HUANG, Shichun (Institute of Modern Physics); JIANG, TIANCAI (Institute of Modern Physics)

Presenter: HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Tuesday Oral Session: A

Track Classification: MC1: SRF Facilities

Contribution ID: **38** Contribution code: **MOP73** Type: **Poster Presentation**

The higher order mode study of CSNS-II superconducting Linac

Monday, September 22, 2025 2:30 PM (3 hours)

The study of higher order modes (HOM) excited in the pulse mode superconducting Linac of CSNS-II is presented in this paper. The effects of cryogenic losses and influences on beam dynamics caused by the HOMs have been investigated.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Guangdong Basic and Applied Basic Research Foundation(Grant No.2022B1515120027)

Author: ZHANG, Cong (Institute of High Energy Physics)

Co-authors: LIU, Huachang (Dongguan Neutron Science Center); GE, Rui (Institute of High Energy Physics); ZHOU, Wenzhong (Institute of High Energy Physics); LI, Ahong (Institute of High Energy Physics); CHEN, Qiang (Institute of High Energy Physics); LI, Bo (Institute of High Energy Physics); Dr FAN, Mengxu (Institute of High Energy Physics); QU, Peihua (Institute of High Energy Physics); KONG, Qiyu (Institute of High Energy Physics)

Presenter: ZHANG, Cong (Institute of High Energy Physics)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **39** Contribution code: **FRA05** Type: **Invited Oral Presentation**

SRF Cavity Development for the FCC-ee at 400/800 MHz

Friday, September 26, 2025 9:50 AM (20 minutes)

FCC-ee is the baseline for future lepton collider projects at CERN. To meet specific physics objectives, CERN is developing two types of accelerating cavities in collaboration with international partners. For low-energy applications, namely the Z pole, W, and H physics cases, CERN is working on 400 MHz seamless cavities with Nb-coating technology, in partnership with KEK. Prototype cavity development is ongoing at CERN using HiPIMS technology. In parallel, a novel bulky Nb-coated cavity design, known as SWELL, is undergoing testing at CERN. For higher-gradient applications required for tt-bar operation and the booster, 800 MHz bulk niobium cavities are being developed in collaboration with Fermilab, Cornell, and IJCLab. This paper will cover the SRF cavity development for FCC-ee.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: GORGI ZADEH, Shahnam (European Organization for Nuclear Research)

Co-authors: PEAUGER, Franck (European Organization for Nuclear Research); ROSAZ, Guillaume (European Organization for Nuclear Research); BRUNNER, Kristof (European Organization for Nuclear Research); VENTURINI DELSOLARO, Walter (European Organization for Nuclear Research); ARAKI, Hayato (High Energy Accelerator Research Organization); MCGEE, Kellen (Fermi National Accelerator Laboratory); MIYAZAKI, Akira (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Presenter: GORGI ZADEH, Shahnam (European Organization for Nuclear Research)

Session Classification: Friday Oral Session: A

Track Classification: MC3: Cavities

Contribution ID: **40** Contribution code: **FRA02** Type: **Invited Oral Presentation**

SRF technology challenges for the electron ion collider

Friday, September 26, 2025 8:50 AM (20 minutes)

The Electron Ion Collider (EIC) pushes the limits of superconducting radio frequency systems to fulfil a variety of accelerator physics requirements. Thomas Jefferson National Accelerator Facility (TJNAF) and Brookhaven National Laboratory (BNL) in partnership are leading an international collaboration designing and building 46 independent superconducting cavity resonators comprised of 4 unique cavity types. The 4 systems all operate at 2.0 K and separately provide a range of capabilities such as compensating a 25 mrad collision crossing angle with > 11 MV of 197 MHz and 3 MV of 394 MHz deflecting voltage per crab cavity, coupling up to 800 kW of power per SRF cavity compensating the 10 MW of beam losses in the 2.5 A electron storage ring, storing and ramping the energy of the 1 A hadron storage ring, and providing the high voltage necessary to rapidly accelerate single 28 nC bunches to variable energies between 5 and 18 GeV for injection into the electron storage ring. This presentation will overview the challenges and proposed solutions for these systems and outline our future plans for the high-power superconducting cavities, 500 kW fundamental power couplers, and >60 kW beam line absorbers

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Yes

Footnotes

Funding Agency

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Author: CONWAY, Zachary (Thomas Jefferson National Accelerator Facility)

Co-authors: LI, Zenghai (SLAC National Accelerator Laboratory); WANG, Shaoheng (Thomas Jefferson National Accelerator Facility); DENNY, Philip (Thomas Jefferson National Accelerator Facility); Dr KUZIKOV, Sergey (Thomas Jefferson National Accelerator Facility); CASTILLA, Alejandro (Thomas Jefferson National Accelerator Facility); ZALTSMAN, Alex (Brookhaven National Laboratory); XIAO, Binping (Brookhaven National Laboratory); SAVRANSKY, David (Thomas Jefferson National Accelerator Facility); SEVERINO, Freddy (Brookhaven National Laboratory); CHENG, Gary (Thomas Jefferson National Accelerator Facility); NARAYAN, Geetha (Brookhaven National Laboratory); BURT, Graeme (Lancaster University); WANG, Haipeng (Thomas Jefferson National Accelerator Facility); BRUTUS, Jean Clifford (Brookhaven National Laboratory); DELAYEN, Jean (Thomas

Jefferson National Accelerator Facility); FITE, Jesse (Brookhaven National Laboratory); GUO, Jiquan (Thomas Jefferson National Accelerator Facility); BUTTLES, John (Bailey Tool & Manufacturing (United States)); MATALEVICH, Joseph (Thomas Jefferson National Accelerator Facility); WILSON, Katherine (Thomas Jefferson National Accelerator Facility); MERNICK, Kevin (Brookhaven National Laboratory); SMITH, Kevin (Brookhaven National Laboratory); RAUT, Nabin (Thomas Jefferson National Accelerator Facility); HUQUE, Naeem (Thomas Jefferson National Accelerator Facility); TEMPLETON, Niklas (Science and Technology Facilities Council); DHAKAL, Pashupati (Thomas Jefferson National Accelerator Facility); RIMMER, Robert (Thomas Jefferson National Accelerator Facility); BIRA, Sarra (Thomas Jefferson National Accelerator Facility); VERDU-ANDRES, Silvia (Brookhaven National Laboratory); DE SILVA, Subashini (Old Dominion University); XU, Wencan (Brookhaven National Laboratory)

Presenter: CONWAY, Zachary (Thomas Jefferson National Accelerator Facility)

Session Classification: Friday Oral Session: A

Track Classification: MC4: SRF Technologies

Contribution ID: **41** Contribution code: **FRA04** Type: **Invited Oral Presentation**

Cryogenics for SRF accelerator facilities: recent developments and challenges

Friday, September 26, 2025 9:30 AM (20 minutes)

Large-scale 4.5 K and 2.0 K helium cryogenic systems are a foundational support system for modern superconducting accelerator facilities. These are highly energy intensive systems. Large-scale efficient helium systems presently require approx. 800 W/W of cooling at 2 Kelvin (30 mbar) and 250 W/W at 4.5K. Due to the nature of the application, these systems require very high reliability (24/7/365 operation). Over the last few decades, progressive and synergistic advancements in cryogenic system operating efficiency and reliability have been made –starting from development of warm compressor skids with wide range operation, to development and implementation of the Ganni floating pressure process for efficient and high turn-down of the refrigeration systems (NASA-JSC, 12 GeV-JLab, FRIB etc.). These design and developments are successfully utilized with high turn-down capacity and substantial energy savings for large-scale helium cryogenic systems at many US Labs. The design and successful implementation of superconducting magnet quench recovery and management helped preservation of helium inventory and improved beam availability. There are still several challenges, e.g. efficient and reliable operation of small-scale 2.0 K cryogenic systems, helium recovery and purification systems that can affect reliable cryogenic system operation. In this talk, the operational experience, progress made to date, recent challenges, and the path forward are discussed.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HASAN, Nusair (Facility for Rare Isotope Beams)

Co-authors: GANNI, Venkatarao (Facility for Rare Isotope Beams); HOWARD, Jonathon (Facility for Rare Isotope Beams); CASAGRANDE, Fabio (Facility for Rare Isotope Beams)

Presenter: HASAN, Nusair (Facility for Rare Isotope Beams)

Session Classification: Friday Oral Session: A

Track Classification: MC4: SRF Technologies

Contribution ID: **42** Contribution code: **MOA04** Type: **Invited Oral Presentation**

Specification, design, production and test schedule of cryomodule for SRF 5-year plan (MEXT-ATD) at KEK by global collaboration for ILC technology network

Monday, September 22, 2025 9:30 AM (20 minutes)

A five-year project (MEXT advanced Accelerator element Technology Development (MEXT-ATD)) funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) began at KEK in FY2023. The goal is to manufacture, construct and test a cryomodule (CM) that satisfies the ILC (International Linear Collider Project) specifications and conduct cooling tests. The MEXT-ATD program is closely related to the ILC Technology Network (ITN). Many SRF experts from Europe and Korea are already joining to contribute to 9-cell cavity production in each region. The 3D model of the cryomodule will be based on the Type-4 CM adopted in the Technical Design Report (TDR) published in 2013, moreover will also reflect the latest technology and experience obtained from the construction and operation of the European XFEL in Europe and LCLS-II in the United States since the TDR. In addition, in anticipation of future prospects, it has been decided that the design and production of every cavity and CM will be based on the refrigeration regulations of the High Pressure Gas Safety (HPGS) Act in Japan. In this presentation, the basic specifications and design of the cryomodule as well as the overall manufacturing/test schedule and recent progress will be reported in detailed.

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Yes

Footnotes

Funding Agency

This work was supported by 【MEXT Development of key element technologies to improve the performance of future accelerators Program】Japan Grant Number JPMXP1423812204.

Author: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Presenter: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Session Classification: Monday Oral Session: A

Track Classification: MC4: SRF Technologies

Contribution ID: **44** Contribution code: **MOB04** Type: **Invited Oral Presentation**

Status of SRF activities for the SHINE project

Monday, September 22, 2025 12:00 PM (20 minutes)

Recently, the SHINE Linac layout has been modified to use fewer cryomodules (CMs) to reach 8 GeV, bene-fiting from the higher performance of high-Q cavities and CMs. The mass production of SHINE cavities and CMs is currently underway. To date, more than 100 mid-T baked cavities and 100 N-doped cavities have been vertically tested. Most of them have been assem-bled into cryomodules, achieving high Q and quite high gradient in horizontal test. These high-Q CMs are being gradually installed into the Linac section. Two 3.9 GHz CMs have been assembled and tested, demonstrating excellent RF performance. This paper will report the progress in the production and performance of the cavities and CMs.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: CHEN, Jinfang (Shanghai Advanced Research Institute)

Co-authors: CAO, Shanshan (Shanghai Advanced Research Institute); Dr GONG, Lingling (Shanghai Advanced Research Institute, Chinese Academy of Sciences); Dr HE, Yongzhou (Shanghai Advanced Research Institute, Chinese Academy of Sciences); LI, Zheng (Shanghai Advanced Research Institute, Chinese Academy of Sciences); LIU, Xuming (Shanghai Advanced Research Institute, Chinese Academy of Sciences); PU, xiaoyun (Shanghai Advanced Research Institute, Chinese Academy of Sciences); XING, Shuai (Shanghai Advanced Research Institute, Chinese Academy of Sciences); XIANG, Shengwang (Shanghai Advanced Research Institute); ZHAI, Yanfei (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZONG, Yue (Shanghai Advanced Research Institute); GU, Duan (Shanghai Advanced Research Institute); HOU, Hongtao (Shanghai Advanced Research Institute); LU, Lijun (Shanghai Advanced Research Institute, Chinese Academy of Sciences); MA, Zhenyu (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, Yeliang (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, ShenJie (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHENG, Xiang (Shanghai Advanced Research Institute, Chinese Academy of Sciences); JIANG, Zhiqiang (Shanghai Advanced Research Institute, Chinese Academy of Sciences); YAN, Yingbing (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, Yubin (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHANG, Meng (Shanghai Advanced Research Institute); SUN, Sen (Shanghai Advanced Research Institute, Chinese Academy of Sciences); LIU, Yiyong (Shanghai Advanced Research Institute, Chinese Academy of

Sciences); GU, Qiang (Shanghai Advanced Research Institute, Chinese Academy of Sciences); YIN, Lixin (Shanghai Advanced Research Institute, Chinese Academy of Sciences); LIU, Bo (Shanghai Advanced Research Institute); ZHAO, Zhentang (Shanghai Advanced Research Institute); HUANG, Yawei (ShanghaiTech University); SUN, Jiuce (ShanghaiTech University); OUYANG, Zhengrong (ShanghaiTech University); WANG, Dong (ShanghaiTech University); WU, Xiaowei (Shanghai Optoelectronics Science and Technology Innovation Center)

Presenter: CHEN, Jinfang (Shanghai Advanced Research Institute)

Session Classification: Monday Oral Session: B

Track Classification: MC1: SRF Facilities

Contribution ID: **45** Contribution code: **WEB02** Type: **Invited Oral Presentation**

Flux ratcheting: enhanced magnetic flux expulsion in SIS multilayer structures

Wednesday, September 24, 2025 11:20 AM (20 minutes)

A program of quantitative measurements of magnetic flux expulsion on flat macroscopic samples has been used to assess and categorise magnetic expulsion efficiency. The measurement setup is a magnetic flux lens based on closed-topological heating/cooling through the material's superconducting transition. This offers systematic and repeatable expulsion measurements for bulk, thin film and multilayer samples. Of particular interest is the magnetic response of superconductor-insulator-superconductor (SIS) multilayer structures, which can exhibit a response that is characteristically different to that of bulk Niobium, if thermally manipulated in a specific way - this process we term "flux ratcheting".

Flux ratcheting is the incremental expulsion of trapped magnetic flux with repeated, controlled thermal cycles on a SIS sample, such that the trapped flux is incrementally moved ("ratcheted") out, with limited magnetic relaxation. Measurements indicate flux ratcheting is particular to the SIS structure, and requires the Tc of the surface thin film to be greater than that of the substrate.

To assess the impact of flux ratcheting on cavity performance, the application of an SIS structure to a 1.3 GHz bulk Nb cavity has been prepared, and referenced to the baseline performance of the bare Nb cavity. The RF performance with and without flux ratcheting is compared, and first implications of magnetic flux ratcheting to RF cavity performance are discussed.

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Yes

Footnotes

Funding Agency

Author: TURNER, Daniel (European Organization for Nuclear Research)

Co-authors: MACPHERSON, Alick (European Organization for Nuclear Research); GONZÁLEZ DÍAZ-PALACIO, Isabel (Universität Hamburg); PREECE, Lea (Universität Hamburg); WENSKAT, Marc (Universität Hamburg)

Presenter: TURNER, Daniel (European Organization for Nuclear Research)

Session Classification: Wednesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **46** Contribution code: **THB03** Type: **Invited Oral Presentation**

Cavity surface inspection: automated defect detection using a short focus imaging system

Thursday, September 25, 2025 11:40 AM (20 minutes)

The performance of SRF cavities is critically dependent on the integrity of their inner surfaces. However, traditional inspection methods are limited by the geometry of these cavities. To overcome this challenge, a novel automated defect detection system has been developed at CERN. This system utilizes a short-focus imaging system mounted on a scanning robotic arm, enabling comprehensive and high-resolution inspection of the entire cavity surface. By combining overlapping image coverage with optical anomaly analysis, surface irregularities can be precisely identified and cataloged. Advanced algorithms, including both rule-based and machine learning models, are employed to classify defects such as scratches, inclusions, pits, and weld artifacts. This approach has been successfully tested on 1.3 GHz and 400 MHz cavities fabricated from both bare niobium and copper substrates, as well as niobium-coated cavities. Full cavity scans typically require between 3 to 20 hours, depending on cavity size, and are performed by acquiring a series of overlapping images each 10 x 15 mm. Subsequent defect detection and analysis are carried out offline as part of the automated image processing chain. This facilitates the creation of a standardized catalogue of surface defects, with images taken under consistent imaging conditions. The systematic analysis of defects can be used to develop predictive insights into defect impact on cavity performance, ultimately advancing SRF technology.

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Yes

Footnotes

Funding Agency

Author: MATHEWS, Sonia (European Organization for Nuclear Research)

Co-authors: MACPHERSON, Alick (European Organization for Nuclear Research); STAPLEY, Niall (European Organization for Nuclear Research)

Presenter: MATHEWS, Sonia (European Organization for Nuclear Research)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **47** Contribution code: **TUB03** Type: **Invited Oral Presentation**

Advancements in HF-free bipolar pulsed electropolishing for next-generation superconducting cavities

Tuesday, September 23, 2025 11:40 AM (20 minutes)

Hydrofluoric acid (HF)-free bipolar pulsed electropolishing (BPEP) offers an environmentally sustainable alternative to conventional Buffered Chemical Polishing (BCP) and Electropolishing (EP) techniques for superconducting radiofrequency (SRF) cavities. Recent studies at Jefferson Lab have demonstrated that a single-cell 1.3 GHz niobium cavity processed using HF-free BPEP achieved an accelerating gradient Eacc of 35 MV/m with a quality factor Q0 of 1E10 at 2 K, following extensive research and optimization. This talk will highlight the challenges encountered in developing this technique, key insights gained from experimental studies, and ongoing efforts to enhance its capabilities. In particular, we will explore its potential for refining Nb3Sn-coated niobium cavities via vapor diffusion techniques and for electroplating Nb3Sn films onto various cavity substrates, contributing to the advancement of high-performance SRF systems.

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Yes

Footnotes

Funding Agency

Authors: TIAN, Hui (Thomas Jefferson National Accelerator Facility); GENG, Rong-Li (Thomas Jefferson National Accelerator Facility)

Co-author: Dr GE, Mingqi (Thomas Jefferson National Accelerator Facility)

Presenter: GENG, Rong-Li (Thomas Jefferson National Accelerator Facility)

Session Classification: Tuesday Oral Session: B

Track Classification: MC3: Cavities

Contribution ID: **49** Contribution code: **THB04** Type: **Invited Oral Presentation**

Status of the CW SRF gun development at FRIB for LCLS-II-HE

Thursday, September 25, 2025 12:00 PM (20 minutes)

A superconducting radio-frequency photo-injector (SRF-PI) can in principle operate in continuous-wave (CW) mode at high gradients with ultra-high vacuum. Using low mean-transverse-energy photocathodes, SRF-PIs could provide high-brightness, high- repetition-rate beams with long cathode lifetimes. For these reasons, an SRF-PI has been adopted for the proposed Low Emittance Injector addition to the SLAC Linac Coherent Light Source II High-Energy (LCLS-II-HE) Upgrade, which would operate in CW with bunch rates of up to 1 MHz. This new injector is a critical part of the effort to extend the photon energy range of this new x-ray laser. A 185.7 MHz quarter-wave gun cavity and cryomodule have been developed by the Facility for Rare Isotope Beam at Michigan State University (FRIB/MSU) in collaboration with HZDR, ANL, and SLAC. A cryomodule test of the first prototype gun cavity and cold tests of a second cavity are underway at FRIB/MSU. The cavities have met the goal of 30 MV/m photocathode field in cold tests in which a photocathode was not installed. All critical cavity parameters fit very well with the simulations and a fully integrated module test with normal conducting cathodes (both metal and semiconductor) are underway.

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Yes

Footnotes

Funding Agency

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Author: SMEDLEY, John (SLAC National Accelerator Laboratory)

Co-authors: MANISCALCO, James (SLAC National Accelerator Laboratory); ADOLPHSEN, Chris (SLAC National Accelerator Laboratory); JI, Fuhao (SLAC National Accelerator Laboratory); XU, Ting (Facility for Rare Isotope Beams); CHOI, Yoonhyuck (Facility for Rare Isotope Beams); ELLIOTT, Kyle (Facility for Rare Isotope Beams); GOWER, Blake (Facility for Rare Isotope Beams); TOUSIGNANT, Bryan (Facility for Rare Isotope Beams); WENSTROM, John (Facility for Rare Isotope Beams); TAYLOR, Alex (Facility for Rare Isotope Beams); COMPTON, Chris (Facility for Rare Isotope Beams); CHANG, Wei (Facility for Rare Isotope Beams); DU, Xiaoji (Facility for Rare Isotope Beams); HARTUNG, Walter (Facility for Rare Isotope Beams); KIM, Sang-Hoon (Facility for Rare Isotope Beams); KONOMI, Taro (Facility for Rare Isotope Beams); MILLER, Samuel (Facility for Rare Isotope Beams); MORRIS, Dan (Facility for Rare Isotope Beams); PATIL, Mohit (Facility for Rare Isotope Beams); POPIELARSKI, Laura (Facility for Rare Isotope Beams); WEI, Jie (Facility for Rare Isotope Beams); YIN, Ziye (Facility for Rare Isotope Beams); KELLY, Michael (Argonne National Laboratory); PETERSEN, Troy (Argonne National Laboratory); ARNOLD, Andre (Helmholtz-Zentrum Dresden-Rossendorf); GATZMAGA, Stefan (Helmholtz-Zentrum Dresden-Rossendorf); STEINBRÜCK, Reinhard (Helmholtz-Zentrum Dresden-Rossendorf); MURCEK, Petr (Helmholtz-Zentrum Dresden-Rossendorf); XIANG, Rong (Helmholtz-Zentrum Dresden-Rossendorf); TEICHERT, Jochen (Helmholtz-Zentrum Dresden-Rossendorf); Dr LEWELLEN, John (Los Alamos National Laboratory); Mr SIMS, Benjamin (Los Alamos National Laboratory)

Presenter: SMEDLEY, John (SLAC National Accelerator Laboratory)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **50** Contribution code: **MOP80** Type: **Poster Presentation**

Enhancing niobium films for SRF and quantum applications

Monday, September 22, 2025 2:30 PM (3 hours)

Niobium films are crucial for superconducting radiofrequency cavities and two-dimensional superconducting transmon qubits. However, performance issues such as the medium-field Q-slope in Nb film cavities and microwave dissipation in qubits persist. To identify the limiting factors in Nb film performance, we used DC biased high-power impulse magnetron sputtering to deposit niobium films onto a 1.3 GHz single-cell elliptical bulk niobium cavity. By systematically modifying the material properties and microstructure through annealing, we identified the key limiting parameters. Annealing at 340℃ raised the quench field from 10.0 to 12.5 MV/m, while treatments at 600 ℃ and 800 ℃ for 3 hours increased it to 15.3 MV/m. Extending to 6 hours at 800 ℃ further improved the quench field to 17.5 MV/m. Reduced field-dependent losses were linked to the mitigation of hydrides, local misorientation, and defects. Using the same cavity to isolate Nb film losses from other materials in the qubit allowed us to pinpoint losses due to the Nb film and the metal-air interface. Operating the cavity in the quantum regime, we correlated RF losses to material parameters. The microwave dissipation mimicked the high intrinsic Q0 of bulk Nb cavities, with lifetimes extending into seconds. Nb film microstructure and impurity levels had minimal impact, with the oxide layer being the primary limitation in qubit performance. These findings advance efficient SRF technologies and extend qubit coherence times.

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Yes

Footnotes

Funding Agency

Author: ABDISATAROV, Bektur (Fermi National Accelerator Laboratory)

Co-authors: EREMEEV, Grigory (Fermi National Accelerator Laboratory); Prof. HANI, Elsayed Ali (Old Dominion University); BAFIA, Daniel (Fermi National Accelerator Laboratory); MURTHY, Akshay (Fermi National Accelerator Laboratory); ROMANENKO, Alexander (Fermi National Accelerator Laboratory); GRASSELLINO, Anna (Fermi National Accelerator Laboratory); CARLOS, Carlota (European Organization for Nuclear Research); ROSAZ, Guillaume (European Organization for Nuclear Research); CALATRONI, Sergio (European Organization for Nuclear Research)

Presenter: ABDISATAROV, Bektur (Fermi National Accelerator Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC5: SRF Applications

Contribution ID: **51** Contribution code: **WEB04** Type: **Invited Oral Presentation**

Direct measurement of magnetic fields generated in Nb3Sn samples during cooldown

Wednesday, September 24, 2025 12:00 PM (20 minutes)

We present trapped flux data of Nb3Sn samples prepared with sputtering and via bronze route. The data shows that during cooldown magnetic fields with magnitudes several times that of the earth's magnetic field can be generated. As the sample becomes superconducting the fields are trapped and can be directly measured by our setup. In the data a correlation between field magnitude and the temperature gradient during cooldown is evident, where higher gradients lead to more generated magnetic field. These results can have an important impact on the production and operation of Nb3Sn cavities.

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Yes

Footnotes

Funding Agency

Author: KRAMER, Felix (Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-authors: Mr CIERPKA, Alexander (Helmholtz-Zentrum Berlin für Materialien und Energie); KUGELER, Oliver (Helmholtz-Zentrum Berlin für Materialien und Energie); LU, Ming (Helmholtz-Zentrum Berlin für Materialien und Energie); FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare); FORD, Davide (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); KNOBLOCH, Jens (Helmholtz-Zentrum Berlin für Materialien und Energie; University of Siegen)

Presenter: KRAMER, Felix (Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Wednesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **52** Contribution code: **THP12** Type: **Poster Presentation**

Unveiling the interplay: cold work, recrystallization, and flux expulsion in SRF cavities

Thursday, September 25, 2025 2:30 PM (3 hours)

The fabrication of SRF cavities from sheet materials includes deep-drawing, electron beam welding, chemical and mechanical polishing, high-temperature heat treatment, and material diffusion. The performance of these cavities is frequently constrained by magnetic flux trapping. In this presentation, we thoroughly examine how recrystallization influences flux expulsion in SRF cavities, using cold-worked niobium sheets from various suppliers. Our findings reveal that cold-worked sheets enhance flux expulsion, especially at lower heat treatment temperatures, by promoting improved recrystallization. In particular, a traditionally fabricated Nb cavity half-cell from an annealed polycrystalline Nb sheet after an 800 C heat treatment leads to a bi-modal microstructure that ties in with flux trapping and inefficient flux expulsion. This non-uniform microstructure is related to varying strain profiles along the cavity shape. A novel approach to prevent this non-uniform microstructure is presented by fabricating a 1.3 GHz single cell Nb cavities with a cold-worked sheet and subsequent heat treatment leading to better flux expulsion after 800 C/3 h.

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Yes

Footnotes

Funding Agency

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Author: DHAKAL, Pashupati (Thomas Jefferson National Accelerator Facility)

Co-authors: KHANAL, Bashu (Old Dominion University); Dr BALACHANDRAN, Shreyas (Florida State University); Dr CHETRI, Santosh (Florida State University; Applied Superconductivity Center); Dr LEE, Peter (Florida State University; Applied Superconductivity Center); CIOVATI, Gianluigi (Thomas Jefferson National Accelerator Facility)

Presenter: Dr CHETRI, Santosh (Florida State University; Applied Superconductivity Center)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **53** Contribution code: **TUP36** Type: **Student Poster Presentation**

Preparation and test of Nb3Sn cavities by tin vapor diffusion method at Peking University

Tuesday, September 23, 2025 2:30 PM (3 hours)

Researches on preparation of Nb3Sn superconducting cavities has been carried at Peking University. Nb3Sn films were prepared by tin vapor method with a high vacuum furnace. We proposed a coating scheme of 1.3 GHz single cell Nb3Sn cavity with three tin sources inside. Nb3Sn films with a tin content of more than 25 % were obtained. The vertical tests show the Q of the prepared Nb3Sn cavities reaches 3.2E10 at low accelerating gradient and larger than 1.0E10@10 MV/m after optimization of the annealing procedure.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: WANG, Ziyu (Peking University)

Co-authors: HAO, Jiankui (Peking University); HUANG, Senlin (Peking University); JIAO, Fei (Peking University); LIN, Lin (Peking University); QVAN, Shengwen (Peking University); REN, Manqian (Peking University); WANG, Fang (Peking University); WANG, Gai (Peking University); ZHU, Feng (Peking University)

Presenter: WANG, Ziyu (Peking University)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **54** Contribution code: **TUB06C** Type: **Contributed Oral Presentation**

Plasma processing under the microscope: a multi-diagnostic investigation from langmuir probes to cryogenic RF tests in low-beta SRF cavities

Tuesday, September 23, 2025 12:40 PM (15 minutes)

Plasma processing has emerged as a powerful tool for restoring and sustaining the performance of SRF cavities over long-term operation. While well-established for elliptical cavities, its application to low-beta structures presents new challenges due to their complex geometries. To address this, we developed optimized plasma processing techniques for a quarter-wave resonator (SPIRAL2 QWR) and a single-spoke resonator (PIP-II SSR1), precisely targeting critical regions such as accelerating gaps and multipacting-prone areas.

Despite the increasing adoption of plasma processing, the underlying plasma parameters remain poorly known. At IJCLab, we conducted advanced numerical simulations alongside direct Langmuir probe diagnostics, marking one of the first in-depth characterizations of the plasma parameters in these cavities. In addition, in-situ quartz crystal microbalance (QCM) measurements quantified the cleaning rate, revealing a strong correlation between plasma parameters and carbon-based surface contamination removal efficiency. To validate our approach, vertical cryostat RF tests were performed on an SSR1 cavity before and after processing.

Our findings provide valuable insights into the effectiveness of our plasma processing approach, representing a major step toward fully optimizing this technique for next-generation SRF systems, both in long-term operation and cavity preparation protocols.

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Yes

Footnotes

Funding Agency

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Author: CHENEY, Camille (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie)

Co-author: LONGUEVERGNE, David (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie)

Presenter: CHENEY, Camille (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie)

Session Classification: Tuesday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **55** Contribution code: **TUB02** Type: **Invited Oral Presentation**

Nb3Sn coating and conduction cooling R&D at KEK

Tuesday, September 23, 2025 11:20 AM (20 minutes)

KEK has performed R&D toward Nb3Sn accelerator. Investigation is carried out to optimize coating parameters, such as amount of Sn, process of nucleation, coating and annealing, toward realize higher performance of cavity. Simultaneously study on conduction cooling by cryo-cooler and design of Nb3Sn cryomodule are ongoing. Currently horizontal cryostat for Nb3Sn cavity is under construction and test is planned on 2025 spring.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: YAMADA, Tomohiro (High Energy Accelerator Research Organization)

Presenter: YAMADA, Tomohiro (High Energy Accelerator Research Organization)

Session Classification: Tuesday Oral Session: B

Track Classification: MC3: Cavities

Contribution ID: **56** Contribution code: **FRA03** Type: **Invited Oral Presentation**

Production of 1.3 GHz cavities for SHINE project

Friday, September 26, 2025 9:10 AM (20 minutes)

The production of over hundreds of 1.3 GHz high-Q superconducting cavities for the Shanghai High repetition rate XFEL and extreme light facility (SHINE) has now been successfully carried out. Both high temperature nitrogen doping (N-doping) recipe and mild temperature (Mid-T) baking recipe have been adopted to achieve high-Q performance. The main challenge for SHINE mass production is to promise high quality from niobium materials to cavities production. SHINE provided high purity niobium and NbTi materials to each supplier. The production was shared by five companies to provide cavities at different stages. In the talk, experience with the 1.3 GHz high-Q cavities for SHINE will be present and main performance including mechanical properties and Q0-Eacc curve will be reported. The lessons we learned during production will be discussed. Cavities performance from vertical test to horizontal test will be reported, too.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HOU, Hongtao (Shanghai Advanced Research Institute)

Presenter: HOU, Hongtao (Shanghai Advanced Research Institute)

Session Classification: Friday Oral Session: A

Track Classification: MC3: Cavities

Contribution ID: **58** Contribution code: **TUP19** Type: **Student Poster Presentation**

Development of a 1.3 GHz RF research cavity for use in testing of superconducting thin films

Tuesday, September 23, 2025 2:30 PM (3 hours)

RF testing is a key element in the development of superconducting thin film coated cavities. In order to optimize the deposition process, tests initially focussed on flat samples, before moving on to RF cavity tests, however the jump from flat samples to cavities is large and often requires significant changes to the deposition process. In order to develop a multi-step approach to cavity testing, a new 1.3 GHz test cavity has been designed as an intermediary between depositing on flat samples and research cavities. The cavity is split longitudinally, giving it an open-faced design, that enables planar thin film deposition techniques, as well as facilitating easy access for quality control of the deposited surfaces. In addition it has been designed to have a low surface electric field, which allows us to test the superconducting properties due only to the magnetic field, without it being perturbed by field emissions. This paper discusses the design of this novel cavity geometry for use in thin film testing.

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Yes

Footnotes

Funding Agency

Author: LEICESTER, Nathan (Cockcroft Institute)

Co-authors: BURT, Graeme (Science and Technology Facilities Council); MALYSHEV, Oleg (Science and Technology Facilities Council); SEAL, Daniel (Science and Technology Facilities Council); VALIZADEH, Reza (Science and Technology Facilities Council); BENJAMIN, Christopher (Science and Technology Facilities Council); MOGHEYSEH, Amir (Science and Technology Facilities Council); SIAN, Bhagat-Taaj (Science and Technology Facilities Council); DISSANAYAKE MUDIYANSELAGE, Maleesh (Lancaster University); CONLON, James (Science and Technology Facilities Council); PIRA, Cristian

(Istituto Nazionale di Fisica Nucleare); CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Presenter: LEICESTER, Nathan (Cockcroft Institute)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **60** Contribution code: **THP45** Type: **Student Poster Presentation**

HOM antenna upgrades and cavity refurbishment for MESA ER-Mode

Thursday, September 25, 2025 2:30 PM (3 hours)

The Mainz Energy-Recovering Superconducting Accelerator is currently under construction at the Institute for Nuclear Physics on the campus of the Johannes Gutenberg University Mainz. A future upgrade is planned for the multi-turn Energy Recovery (ER) mode, increasing the beam current from 1 mA to 10 mA in continuous wave at 1.3 GHz. Simulations have calculated an increased power deposition of 3 W in the Higher Order Modes (HOMs) of the TESLA cavities. The power, which is deposited by the passing electron beams through the cavity, is reduced in the cavity through the HOM dampers, but the power at the HOM antenna will increase up to 1 W. This will exceed the current limits and lead to a quench of the antenna. The quench limit could be increased by using an alternative superconducting material with a higher critical temperature than Niobium. Two candidates like Nb3Sn on Cu and NbTiN on Nb will be coated as a thin film on the antenna. Simulations have shown that the limit can be increased up to 1.1 W for NbTiN on Nb and 4.7 W for Nb_3Sn on Cu. Two TESLA cavities, from a cryomodule (CM) of the decommissioned ALICE(*) project, are refurbished in the clean room infrastructure of the Helmholtz Institute Mainz (HIM). The performance of the cavities will be tested in several configurations: after refurbishment, with the original antenna design, with coated antennas, and in the fully assembled cryomodule with an electron beam.

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Yes

Footnotes

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Funding Agency

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Author: PLATTNER, Paul (Johannes Gutenberg University Mainz)

Co-authors: HUG, Florian (Johannes Gutenberg University Mainz); STENGLER, Timo (Institut für Kernphysik)

Presenter: PLATTNER, Paul (Johannes Gutenberg University Mainz)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **61** Contribution code: **WEB05** Type: **Invited Oral Presentation**

Measurements of RF magnetic field limits of Nb and Nb3Sn

Wednesday, September 24, 2025 12:20 PM (20 minutes)

Measuring fundamental RF field limits of candidate superconductors for SRF cavities is challenging as local defects and thermal heating can lead to premature quench at field well below the ultimate limit of a superconducting material. Cornell has developed, fabricated, and commissioned a unique sample host cavity that allows for exposing superconducting material samples to very high RF fields (>0.5 T) in very short RF pulse operation. Using high pulsed RF power, these high field are reached at the sample within a few microseconds. This very short pulse operation diminishes the effects of localized defects and thermal heating, thereby allows exploring fundamental field limits as function of temperature. In this talk we will present details form the design and commissioning of this system. We will show detailed measurement results of the (fundamental) RF field limit vs T for electropolished niobium and for Nb3Sn. For Nb, our results demonstrate that the high-field Q slope induced quench observed in SRF cavities is not fundamental but a result of thermal instability; the material itself is cable of supporting fields well above 200 mT, in agreement with the predicted superheating field of clean niobium.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: VERBONCOEUR, Nicole (Cornell University (CLASSE))

Co-authors: HOLIC, Adam (Cornell University); SEARS, James (Cornell University); SHPANI, Liana (Cornell University); LIEPE, Matthias (Cornell University); Dr PORTER, Ryan (SLAC National Accelerator Laboratory); OSEROFF, Thomas (Cornell University)

Presenter: VERBONCOEUR, Nicole (Cornell University (CLASSE))

Session Classification: Wednesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **62** Contribution code: **WEA04** Type: **Invited Oral Presentation**

First beam acceleration using cryo-cooled Nb3Sn coated cavity at IMP

Wednesday, September 24, 2025 9:30 AM (20 minutes)

Operational experience of the LHe-Free (LHe-free) Nb3Sn demo SRF electron linac over the past year will be reported. A statistical analysis was conducted on beam loss-induced irradiation effects on the Nb3Sn thin film of the superconducting cavity inner surfaces, with subsequent assessment of their impact. An irradiation terminal facility was constructed to conduct experiments on electron beam irradiation for wastewater treatment. A 650 MHz 5-cell Nb3Sn cavity coated by the tin vapor diffusion method has been vertically tested to verify its RF performance.

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Yes

Footnotes

Funding Agency

Advanced Energy Science and Technology Guangdong Laboratory (HND22PTDZCD)
National Natural Science Foundation of China (No.12175283, No.U24A2019)

Author: YANG, Ziqin (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: HE, Yuan (Institute of Modern Physics); WANG, Zhijun (Institute of Modern Physics)

Presenter: YANG, Ziqin (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Wednesday Oral Session: A

Track Classification: MC4: SRF Technologies

Contribution ID: **63** Contribution code: **MOP53** Type: **Student Poster Presentation**

RF and Mechanical Design of a 1.3 GHz 7-cell High-current Superconducting Cavity

Monday, September 22, 2025 2:30 PM (3 hours)

To meet the stringent requirements of high-current energy recovery linacs (ERLs), a 1.3 GHz 7-cell superconducting cavity was designed and optimized. The RF design employed multi-objective optimization to balance accelerating mode performance with higher-order mode (HOM) damping, achieving effective HOM suppression without compromising the fundamental mode performance. Key RF components, including the fundamental power coupler antenna and HOM absorbers, were optimized. Based on the optimized geometry, mechanical analysis was conducted to evaluate structural strength, pressure and tuning sensitivities, and modal behavior. Optimization of the stiffening ring radius further enhanced mechanical stability and reduced frequency variation. The integrated RF and mechanical studies demonstrate that the proposed cavity fulfills the performance and reliability demands of high-current ERL applications.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: GUO, Xinghao (Shanghai Advanced Research Institute)

Co-authors: WU, Xiaowei (Shanghai Zhangjiang Laboratory); DENG, Haixiao (Shanghai Advanced Research Institute); CHEN, Jinfang (Shanghai Advanced Research Institute); Ms ZHAO, Xinning (ShanghaiTech University); Mr YAN, Xia (ShanghaiTech University); WANG, Dong (Shanghai Advanced Research Institute); HUANG, Xuan (Shanghai Institute of Applied Physics); HUANG, Yawei (ShanghaiTech University); ZHAI, Yanfei (Shanghai Advanced Research Institute, Chinese Academy of Sciences)

Presenter: GUO, Xinghao (Shanghai Advanced Research Institute)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **64** Contribution code: **TUB07C** Type: **Contributed Oral Presentation**

Study of niobium surface under ultra hight vacuum after heat treatment for SRF cavities

Tuesday, September 23, 2025 12:55 PM (15 minutes)

Specific heat treatments applied to superconducting radio-frequency (SRF) cavities, such as nitrogen infusion or Mid-T baking, aim to improve the quality factor (Qo) at medium accelerating fields (˜10–20 MV/m). These treatments reduce the BCS surface resistance by tuning the mean free path of niobium over a few hundred nanometers, either by diffusing oxygen from the native oxide layer or by diffusing nitrogen after the dissolution of the oxide layer. However, these treatments preclude the usual chemical polishing, as it would reverse the beneficial effects of the heat treatments, making the cavities highly sensitive to surface contamination. In particular, the formation of niobium carbides, which can mask the expected benefits, strongly depends on the annealing conditions, surface preparation, and the material's history. Several hypotheses are considered regarding the origin of carbon: vacuum contamination, surface pollution, or internal migration from the niobium itself, potentially enriched with carbon during previous chemical treatments (BCP, EP).

This work aims to identify the primary source of carbon responsible for niobium carbide growth, using techniques such as X-ray photoelectron spectroscopy (XPS), scanning electron microscopy (SEM), and secondary ion mass spectrometry (SIMS). This study will also help identify the key influencing parameters, in order to better understand and reduce their impact on SRF cavity performance.

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Yes

Footnotes

Funding Agency

Author: BOUTELAA, Chahinez (Centre National de la Recherche Scientifique)

Co-authors: LONGUEVERGNE, David (Institut National de Physique Nucléaire et de Physique des Particules); SATTONNAY, Gaël (Institut National de Physique Nucléaire et de Physique des Particules); KOLB, Philipp (TRIUMF); LAXDAL, Robert (TRIUMF)

Presenter: BOUTELAA, Chahinez (Centre National de la Recherche Scientifique)

Session Classification: Tuesday Oral Session: B

Track Classification: MC3: Cavities

Contribution ID: **65** Contribution code: **MOB03** Type: **Invited Oral Presentation**

FRIB operation, status of power ramp up, and R&D for energy upgrade

Monday, September 22, 2025 11:40 AM (20 minutes)

FRIB is the first heavy-ion accelerator facility to deploy a large number of Half-Wave Resonators (220 HWRs) and operate at 2 K in its superconducting drive linac. As of today, FRIB delivered the world's highest uranium beam power (>18 kW) on target and will continue its power ramp-up in the next few years in parallel to support user science program. The technologies that have sustained the establishment of the FRIB facility and beam power ramp-up include large-scale superconducting RF, superconducting magnets, liquid metal charge stripping, and high-power targetry. This talk summarizes the current operational experience with these technologies, the plan to ramp up power to the full design power of 200 kW, and the R&D activities preparing for a 400 MeV energy upgrade in the near future.

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Yes

Footnotes

Funding Agency

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Author: XU, Ting (Facility for Rare Isotope Beams)

Co-authors: AO, Hiroyuki (Michigan State University); Mr BULTMAN, Nathan (Facility for Rare Isotope Beams); Dr CASAGRANDE, Fabio (Michigan State University); CHANG, Wei (Michigan State University); Dr CHEON, Yoo Lim (Facility for Rare Isotope Beams); CHOI, Yoonhyuck (Michigan State University); COMPTON, Chris (Facility for Rare Isotope Beams); Mr CURTIN, John (Facility for Rare Isotope Beams); ELLIOTT, Kyle (Facility for Rare Isotope Beams); HOLLAND, Kent (Michigan State University); Dr GANNI, Venkatarao (Michigan State University); GANSHYN, Andrei (Facility for Rare Isotope Beams); GUO, Junwei (Michigan State University); HARTUNG, Walter (Michigan State University); HASAN, Nusair (Michigan State University); KANEMURA, Takuji (Michigan State University); KIM, Sang-hoon (Michigan State University); KONOMI, Taro (Michigan State University); IKEGAMI, Masanori (Facility for Rare Isotope Beams); LIDIA, Steven (Michigan State University); MACHICOANE, Guillaume (Michigan State University); MARUTA, Tomofumi (Michigan State University); METZGAR, Ethan (Facility for Rare Isotope Beams); MILLER, Samuel (Facility for Rare Isotope Beams); MORRIS, Dan (Facility for Rare Isotope Beams); OSTROUMOV, Peter (Michigan State University); PLASTUN, Alexander (Michigan State University); POPIELARSKI, Laura (Michigan State

University); RAO, Xing (Michigan State University); SAITO, Kenji (Michigan State University); TOUSIGNANT, Bryan (Facility for Rare Isotope Beams); STOLZ, Andreas (Michigan State University); WEI, Jie (Michigan State University); WENSTROM, John (Facility for Rare Isotope Beams); Dr WU, Yuting (Facility for Rare Isotope Beams); ZHAO, Qiang (Michigan State University); ZHAO, Shen (Michigan State University)

Presenter: XU, Ting (Facility for Rare Isotope Beams)

Session Classification: Monday Oral Session: B

Track Classification: MC1: SRF Facilities

Contribution ID: **66** Contribution code: **FRB01** Type: **Invited Oral Presentation**

Experimental demonstration of the slotted waveguide elliptical SWELL cavity for high intensity SRF accelerators

Friday, September 26, 2025 11:00 AM (20 minutes)

In the context of the FCC study where strongly damped RF structures are required to accelerate high beam currents, a new slotted waveguide cavity called SWELL has been proposed. The design is based on an elliptical cavity shape split into four quadrants making it compatible with Niobium-on-Copper coatings. A first prototype at 1.3 GHz has been fabricated at CERN to demonstrate the feasibility of this new cavity topology. This paper reports on the manufacturing steps of the individual quadrants, the surface preparation including chemical electropolishing and thin film coating, and the assembly process of the cavity in clean environment. First RF tests results of this prototype at cryogenic temperature are presented and compared with standard tesla cavity performances. The measurement of the trapped flux surface resistance is also reported and discussed. Finally, we highlight advances in the design and development plan of such cavity concept for future high intensity SRF accelerators.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: PEAUGER, Franck (European Organization for Nuclear Research)

Co-authors: BRUNNER, Olivier (European Organization for Nuclear Research); GARLASCHÈ, Marco (European Organization for Nuclear Research); GORGI ZADEH, Shahnam (European Organization for Nuclear Research); KARPOV, Ivan (European Organization for Nuclear Research); KOETTIG, Torsten (European Organization for Nuclear Research); THERASSE, Mathieu (European Organization for Nuclear Research); TIMMINS, Marc (European Organization for Nuclear Research); Dr ROSAZ, Guillaume (European Organization for Nuclear Research); Mr SYRATCHEV, Igor (European Organization for Nuclear Research)

Presenter: PEAUGER, Franck (European Organization for Nuclear Research)

Session Classification: Friday Oral Session: B

Track Classification: MC3: Cavities

Contribution ID: **67** Contribution code: **TUP78** Type: **Student Poster Presentation**

Coming closer to high frequency gravitational wave detection with MAGO

Tuesday, September 23, 2025 2:30 PM (3 hours)

In the last years, low frequency gravitational waves (GWs) have been consistently measured by the LIGO-Virgo collaboration, but little to no attention has been paid to higher frequencies GWs in the range of 10 kHz to 100 MHz, at which confirmation for current theories or even new physics could be hidden. The MAGO 2.0 project aims at filling this gap in the parameters space using superconducting radio-frequency (SRF) cavities. Exploiting the excellent Q-factors of these resonators, we plan to detect tiny harmonic deformations induced by GWs which change the boundary conditions of the oscillating electromagnetic field. We present the results of the first cold tests ran at DESY and FNAL using the cavity prototype built 20 years ago at the end of the MAGO collaboration, characterizing the RF spectrum, Q-factor and surface resistance. In particular we present the mechanical vibration spectrum characterization and the RF response of the cavity with the injection of a "fake GW"signal using piezoelectric actuators.

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Yes

Footnotes

Funding Agency

Author: MARCONATO, Giovanni (Universität Hamburg)

Co-authors: BRANLARD, Julien (Deutsches Elektronen-Synchrotron DESY); Dr BUTKOWSKI, Lukasz (Deutsches Elektronen-Synchrotron DESY); CHOUHAN, Vijay (Fermi National Accelerator Laboratory); DOKUYUCU, Can (Deutsches Elektronen-Synchrotron DESY); Dr EBERENZ, Mona (Deutsches Elektronen-Synchrotron DESY); Mr FISCHER, Lars (Universität Hamburg); GIACCONE, Bianca (Fermi National Accelerator Laboratory); GONIN, Ivan (Fermi National Accelerator Laboratory); GRASSELLINO, Anna (Fermi National Accelerator Laboratory); Dr HIERHOLZER, Martin (Deutsches Elektronen-Synchrotron DESY); Prof. HILLERT, Wolfgang (Universität Hamburg); Dr HOFFMANN, Matthias (Deutsches Elektronen-Synchrotron DESY); KHABIBOULLINE, Timergali (Fermi National Accelerator Laboratory); Mr KROKOTSCH, Tom (Universität Hamburg); Dr MELNYCHUK, Alex (Fermi National Accelerator Laboratory); Prof. MOORTGAT-PICK, Gudrid (Universität Hamburg); Dr MUHS, Andrea (Deutsches Elektronen-Synchrotron DESY); Dr NETEPENKO, Alex (Fermi National Accelerator Laboratory); Dr ORLOV, Yuriy (Fermi National Accelerator Laboratory); Dr PETERS, Krisztian (Deutsches Elektronen-Synchrotron DESY); POSEN, Sam (Fermi National Accelerator Laboratory); Dr PRONITCHEV, Oleg (Fermi National Accelerator Laboratory); WENSKAT, Marc (Deutsches Elektronen-Synchrotron DESY; Universität Hamburg)

Presenter: MARCONATO, Giovanni (Universität Hamburg)

Session Classification: Tuesday Poster Session

Track Classification: MC5: SRF Applications

Contribution ID: **68** Contribution code: **MOP15** Type: **Student Poster Presentation**

Suppressing Nb oxidation via noble-metal caps and oxide replacement: ab initio guidance

Monday, September 22, 2025 2:30 PM (3 hours)

Niobium-based superconducting radio-frequency (SRF) cavities are crucial for particle accelerators, yet their performance is limited by native niobium oxide formation, which contributes significantly to increased residual surface resistance. This oxidation challenge is similarly critical in superconducting quantum circuits, where niobium oxide layers adversely impact coherence times and device stability. To address these issues, we present a first-principles density functional theory (DFT) study exploring surface passivation strategies using noble metals (Au, Pt, Pd) and stable oxide coatings (Al_2O_3, ZrO_2) on Nb substrates. Our calculations systematically assess the thermodynamic stability, interface energies, and electronic interactions at Nb–coating interfaces. Results identify several candidate materials exhibiting superior stability compared to native niobium oxide, potentially suppressing its formation. By effectively passivating the Nb surface, these coatings promise significant reductions in residual resistance for SRF cavities and enhanced coherence for superconducting qubits. These insights offer theoretical guidance for experimental implementation, contributing to improved performance across superconducting technologies.

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Yes

Footnotes

Funding Agency

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Author: MENDEZ, Cristobal (Cornell University)

Co-authors: SITARAMAN, Nathan (Cornell University); SEDDON-STETTLER, Sadie (Cornell University); LIEPE, Matthias (Cornell University); Prof. ARIAS, Tomás (Cornell University)

Presenter: MENDEZ, Cristobal (Cornell University)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **69** Contribution code: **TUP68** Type: **Student Poster Presentation**

Development of fault identification pipeline for SPIRAL2 LLRF data

Tuesday, September 23, 2025 2:30 PM (3 hours)

SPIRAL2 is a state-of-the-art superconducting linear accelerator for heavy ions. The radiofrequency operation of the linac can be disrupted by anomalies that affect its reliability. This work leverages fast, multivariate time series postmortem data from the Low-Level Radio Frequency (LLRF) systems to differentiate anomaly groups. However, interpreting these anomalies traditionally relies on expert analysis, with certain behaviours remaining obscure even to experienced observers. By adopting the Time2Feat pipeline, this study explores the interpretability of anomalies through feature selection, paving the way for real-time state observers. Clustering dashboards are presented, allowing the use of multiple clustering algorithms easily configurable and tools to help for visualizing results. A case study on distinguishing electronic quenches and false quench alarms in postmortem data is highlighted. Thereby, a fast and reliable K-Nearest Neighbours (KNN) classifier is proposed.

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Yes

Footnotes

Funding Agency

Author: LASSALLE, Charly (Université de Caen Normandie; GANIL)

Co-authors: Dr GHRIBI, Adnan (GANIL); BOULY, Frédéric (Laboratoire de Physique Subatomique et de Cosmologie); Mr DI GIACOMO, Marco (GANIL); BONNAY, Patrick (Université Grenoble Alpes; CEA Grenoble; Institut de Recherche Interdisciplinaire de Grenoble; Département des Systèmes Basses Températures)

Presenter: LASSALLE, Charly (Université de Caen Normandie; GANIL)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **70** Contribution code: **WEA03** Type: **Invited Oral Presentation**

Towards high power tests of an FE-FRT for transient detuning

Wednesday, September 24, 2025 9:10 AM (20 minutes)

The design, fabrication, and validation progress towards a ferroelectric fast reactive tuner (FE-FRT) as a demonstrator of a high-power tuner for beam loading compensation at LHC injection settings is presented. Such compensation is referred to as transient detuning compensation and involves discrete frequency switching of an LHC cavity configuration on sub-microsecond time scales. The FE-FRT is operated in a two-state mode with a 7 kV bias applied across a BaTiO3/SrTiO3-Mg ferroelectric material in the tuner stub to provide the required cavity frequency shift. To achieve this, the device has been designed to operate as a coupled resonant tuner that provides an ˜8 kHz cavity tuning range. As an FE-FRT design, the tuner must tolerate a reactive power load of ±226 kW and ˜3 kW of dissipated power. The key design decisions taken are presented, along with the specific optimisation of the tuner in terms of the expected performance. Finally, measurements and first results for the tuner demonstrator validation process are discussed.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: SMITH, Samuel (European Organization for Nuclear Research)

Co-authors: MACPHERSON, Alick (European Organization for Nuclear Research); STAPLEY, Niall (European Organization for Nuclear Research); Mr BASTARD, Jeremy (European Organization for Nuclear Research); Mr SCHNEIDER, Paul (European Organization for Nuclear Research); Dr BEN-ZVI, Ilan (Stony Brook University); BARRIÈRE, Simon (European Organization for Nuclear Research)

Presenter: SMITH, Samuel (European Organization for Nuclear Research)

Session Classification: Wednesday Oral Session: A

Track Classification: MC4: SRF Technologies

Contribution ID: **71** Contribution code: **WEB07C** Type: **Contributed Oral Presentation**

Effects of thin gold layers on performance of 2.6 GHz SRF cavity

Wednesday, September 24, 2025 12:55 PM (15 minutes)

SRF cavities are a critical technology both for particle accelerators, where they enable high energies and efficient operation, and superconducting quantum circuits, where they enable large coherence times for qubits. In both applications, the need for better performing cavities with higher quality factors is clear. The native oxide that forms on the surface of niobium may be the source of conductive losses in high-energy accelerator applications and of two level system losses in low-energy quantum applications. Previous work from Cornell University studied the effect of passivating the niobium oxide on an RF sample plate with a thin layer of gold, selected for its properties as a non-oxidizing normal conductor. At sub-nanometer thicknesses, the sample showed an increased quality factor. In this paper, we report first RF results scaling up the treatment for full-scale cavity testing using electrochemical deposition of gold on a 2.6 GHz niobium SRF cavity. We also report sample imaging characterizing the growth of thin gold films on niobium, and DFT calculations on the effect of gold on the presence of oxygen impurities in niobium.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

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Author: SEDDON-STETTLER, Sadie (Cornell University (CLASSE))

Co-authors: ARIAS, Tomás (Cornell University); LIEPE, Matthias (Cornell University); MENDEZ, Cristobal (Cornell University); OSEROFF, Thomas (Cornell University); SITARAMAN, Nathan (Cornell University); Ms DO, Van (University of Chicago); Prof. SIBENER, Steven (University of Chicago)

Presenter: SEDDON-STETTLER, Sadie (Cornell University (CLASSE))

Session Classification: Wednesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **72** Contribution code: **TUA06** Type: **Invited Oral Presentation**

SIS multilayer studies and status of the new cavity-coating system at University of Hamburg

Tuesday, September 23, 2025 10:10 AM (20 minutes)

Theories predict that Superconducting-Insulating-Superconducting (SIS) multilayers delay vortex penetration allowing for operation gradients more than twice of bulk Nb cavities and significantly higher Q-values [1]. The University of Hamburg focuses on Atomic Layer Deposition (ALD) as the most promising technique to coat SIS multilayers. A proof-of-principle experiment to coat cavities with an insulator has been successfully carried out, and the complex coating process was numerically modelled, which resulted in a further process time reduction while maintaining the high film quality [2,3]. For SIS multilayer deposition, plasma-enhanced ALD (PEALD) is used to deposit AlN and NbTiN as dielectric and superconducting material, respectively. The deposition process and post-deposition treatments have been optimized by studying the superconducting properties of the NbTiN thin film [4]. Moreover, properties such as flux-trapping behaviour and thermal transmittance of SIS multilayers have been measured. Furthermore, various material characterization techniques were applied to investigate the contribution of vacancy densities, recrystallization eVects due to the annealing past the deposition and the impact of the insulating layer on the properties of SIS multilayers. This talk will show the aggregated results of all those measurements and present the status of the PEALD single-cell cavity coating device at the University of Hamburg.

I have read and accept the Privacy Policy Statement

Yes

Funding Agency

Footnotes

[1] A. Gurevich, Applied Physics Letters 88, 12511 (2006).
[2] Wenskat. M, Deyu. G. et al., Superconductor Science and Technology 36.1 (2022): 015010.E.
[3] Deyu, G., et al., Chemistry of Materials 36.6 (2024): 2846-2856.
[4] I. Gonzalez Diaz-Palacio et al., Journal of Applied Physics, vol. 134, no. 3, p. 035301, 2023.

Author: PREECE, Lea (Universität Hamburg)

Co-authors: MACPHERSON, Alick (European Organization for Nuclear Research); TURNER, Daniel (European Organization for Nuclear Research); Dr DEYU, Getnet Kacha (Universität Hamburg); GONZÁLEZ DÍAZ-PALACIO, Isabel (Universität Hamburg); LIEDKE, Maciej Oskar (Helmholtz-Zentrum Dresden-Rossendorf); WENSKAT, Marc (Universität Hamburg); KLUG, Sebastian (Helmholtz-Zentrum Dresden-Rossendorf); HILLERT, Wolfgang (Universität Hamburg)

Presenter: PREECE, Lea (Universität Hamburg)

Session Classification: Tuesday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **73** Contribution code: **MOP21** Type: **Student Poster Presentation**

Commissioning of chemical vapor deposition system for superconducting thin films

Monday, September 22, 2025 2:30 PM (3 hours)

Next-generation, thin-film surfaces employing Nb3Sn, NbN, NbTiN, or other compound superconductors are essential for reaching enhanced RF performance levels in SRF cavities. However, optimized, advanced deposition processes are required to enable high-quality films of such materials on large and complex-shaped cavities. For this purpose, Cornell University developed and commissioned a chemical vapor deposition (CVD) system that facilitates coating on complicated geometries with a high deposition rate. This system is based on a high-temperature tube furnace with a high-vacuum, gas, and precursor delivery system. Here, we present the commissioned system with the control aspects and safety considerations addressed and the materials we are interested in growing.

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Yes

Footnotes

Both G. Gaitan and A. Grassl are primary authors of this contribution.

Funding Agency

This work was supported by the U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams.

Author: GAITAN, Gabriel (Cornell University)

Co-authors: GRASSL, Alexis (Cornell University); HOLIC, Adam (Cornell University); HOWES, Will (Cornell University); KULINA, Greg (Cornell University); LIEPE, Matthias (Cornell University); MIDDLETON, Caleb (Cornell University); QUIGLEY, Peter (Cornell University); SEARS, James (Cornell University); SITARAMAN, Nathan (Cornell University)

Presenter: GRASSL, Alexis (Cornell University)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **74** Contribution code: **MOP11** Type: **Student Poster Presentation**

Early exploration of zirconium doping SRF cavities with chemical vapor deposition

Monday, September 22, 2025 2:30 PM (3 hours)

The introduction of zirconium to niobium SRF cavities suggests a promising alloy with lower RF losses, higher critical magnetic fields, and a higher endurance to gradients. However, difficulties in fabrication of a ZrNb alloy, especially on the irregular surface of SRF cavities, have slowed the applicatory study of this potential improvement. We utilize a newly commissioned chemical vapor deposition system to fabricate this alloy with minimal surface defects on irregular surfaces. We present the initial results of this method's effectiveness with surface characterization methods.

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Yes

Footnotes

Funding Agency

Author: GRASSL, Alexis (Cornell University)

Co-authors: SITARAMAN, Nathan (Cornell University); LIEPE, Matthias (Cornell University)

Presenter: GRASSL, Alexis (Cornell University)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **75** Contribution code: **TUP13** Type: **Student Poster Presentation**

Mechanically polishing electroplated Nb3Sn for higher accelerating gradients

Tuesday, September 23, 2025 2:30 PM (3 hours)

As the demand for more efficient SRF technology continues to rise, so does the need to improve the performance of Nb3Sn, the most promising alternative to niobium. Leveraging recent breakthroughs in Nb3Sn research from Cornell University and Fermilab, namely the electrochemical synthesis-based growth of Nb3Sn and the centrifugal barrel polishing (CBP) technique to smoothen the final Nb3Sn film, our primary goal is to reduce surface roughness while preserving the film's quality. We present promising RF results from an electroplated cavity that underwent mechanical polishing using the CBP technique, which showed an increase in the maximum accelerating gradient compared to the baseline test.

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Yes

Footnotes

Funding Agency

Author: SHPANI, Liana (Cornell University (CLASSE))

Co-authors: LIEPE, Matthias (Cornell University); OSEROFF, Thomas (Cornell University); EREMEEV, Grigory (Fermi National Accelerator Laboratory); POSEN, Sam (Fermi National Accelerator Laboratory)

Presenter: SHPANI, Liana (Cornell University (CLASSE))

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **76** Contribution code: **MOP20** Type: **Student Poster Presentation**

Initial results for CVD based growth of Nb_3Sn

Monday, September 22, 2025 2:30 PM (3 hours)

Niobium-3 tin Nb3Sn is a promising material for next-generation superconducting RF cavities due to its high critical temperature and high theoretical field limit. There is currently significant world-wide effort aiming to improve Nb3Sn growth to push this material to its ultimate performance limits. In this paper, we present the first results of deposition of Sn on different Nb samples in different orientations in our Chemical Vapor Deposition (CVD) system. We discuss imaging results for Sn on Nb substrates. We discuss CFD flow simulations and how they may be relevant to formulating a recipe for coating cavities. We describe the parameters used in the film deposition and future steps towards coating a 2.6 GHz cavity in our CVD system. We also discuss potential alternative tin precursors to improve coating uniformity and stoichiometry.

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Yes

Footnotes

Funding Agency

This work was supported by the U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams and by the U.S. Department of Energy under award DE-SC0024137.

Author: GAITAN, Gabriel (Cornell University)

Co-authors: GRASSL, Alexis (Cornell University); MIDDLETON, Caleb (Cornell University); LIEPE, Matthias (Cornell University); SITARAMAN, Nathan (Cornell University); QUIGLEY, Peter (Cornell University); HOWES, Will (Cornell University)

Presenter: GAITAN, Gabriel (Cornell University)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **77** Contribution code: **TUP64** Type: **Student Poster Presentation**

Field emission and particulate contamination in TRIUMF's superconducting accelerators

Tuesday, September 23, 2025 2:30 PM (3 hours)

Particulate contamination in SRF cavities is known to trigger field emission, a phenomenon where electrons tunnel out from the surface of the cavities due to high electric fields. These rogue electrons limit the achievable accelerating gradient, affecting the final beam energy delivered by the accelerator. The TRIUMF e-Linac and ISAC-II heavy ion accelerators see a progressive onset of field emission in their SRF cavities during operation, despite stringent cleaning and testing procedures prior to installation. One hypothesis is that particulates migrate back into cavities after installation, leading to the renewed onset of field emission. The dynamics of micron scale particulates in vacuum is influenced by their electrostatic charge, and the environment of a particle accelerator is ideal for them to gain such charge. However, fundamental parameters such as composition and charge-to-mass ratio of particulates remain largely unknown. I will present an analysis of particulates collected from TRIUMF accelerators, detailing size, composition and possible sources, and subsequently describe a series of experiments studying the charging and migration mechanisms of particulates in vacuum.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: MAHON, Aveen (TRIUMF)

Co-author: PLANCHE, Thomas (TRIUMF; University of Victoria)

Presenter: MAHON, Aveen (TRIUMF)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **78** Contribution code: **WEA06** Type: **Invited Oral Presentation**

Performance of the Cornell conduction-cooled Nb3Sn cavity cryomodule

Wednesday, September 24, 2025 10:10 AM (20 minutes)

Recent improvements in Nb3Sn cavity and commercial cryocooler performance have made the fabrication of conduction-cooled cryomodules for SRF cavities feasible, which drastically expands SRF applications to medical imaging, water purification, and security. Cornell has developed a turn-key, conduction-cooled cryomodule to operate a 1.3 GHz Nb3Sn SRF cavity by optimizing the cooling output of two commercial cryocoolers. The cryomodule, cavity, and RF input coupler have been designed for very high CW beam current operation (>100 mA) and high RF power (100 –200 kW CW RF). We present the design, optimization, and assembly process of this conduction-cooled cryomodule as well as performance during initial cooldown tests and low power RF testing.

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Yes

Footnotes

Funding Agency

Author: PARSONS, Jake (Cornell University)

Co-authors: HOLIC, Adam (Cornell University); KULINA, Greg (Cornell University); CONKLIN, Holly (Cornell University); SEARS, James (Cornell University); TURCO, Jessica (Cornell University); LIEPE, Matthias (Cornell University); QUIGLEY, Peter (Cornell University); GRUBER-HINE, Terri (Cornell University); SHEMELIN, Valery (Cornell University)

Presenter: PARSONS, Jake (Cornell University)

Session Classification: Wednesday Oral Session: A

Track Classification: MC4: SRF Technologies

Contribution ID: **79** Contribution code: **TUP10** Type: **Student Poster Presentation**

Identifying the connections between grain growth and flux expulsion in low RRR niobium SRF cavities

Tuesday, September 23, 2025 2:30 PM (3 hours)

The SRF community has shown that high temperature annealing can improve the flux expulsion of niobium cavities during cooldown. The required temperature will vary between cavities and different batches of material, typically around 800 C and up to 1000 C. However, for niobium with a low residual resistance ratio (RRR), even 1000 C is not enough to improve its poor flux expulsion. The purpose of this study is to observe the grain growth behavior of low RRR niobium coupons subjected to high temperature annealing to identify the mechanism for improving flux expulsion. We observe that low RRR material experiences less grain growth than high RRR when annealed at the same temperature. We search for the limitations to grain growth in low RRR material and develop a diagnostic based on grain structure to determine the appropriate recipe for good flux expulsion. The results of this study have the potential to unlock a new understanding on SRF materials and enable the next generation of high Q/high gradient surface treatments.

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Yes

Footnotes

Funding Agency

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Author: HOWARD, Katrina (University of Chicago)

Co-authors: BAFIA, Daniel (Fermi National Accelerator Laboratory); SUNG, Zuhawn (Fermi National Accelerator Laboratory); DZIEDZIC-MISIEWICZ, Wieslawa (Fermi National Accelerator Laboratory); KIM, Young-Kee (University of Chicago; Fermi National Accelerator Laboratory)

Presenter: HOWARD, Katrina (University of Chicago)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **80** Contribution code: **THA03** Type: **Invited Oral Presentation**

Improving quench fields of enhanced-Tc surfaces

Thursday, September 25, 2025 9:10 AM (20 minutes)

The sensitivity of compound superconductors to gradient-limiting defects is well established. To overcome this challenge and develop recipes for enhanced-Tc surfaces that approach their fundamental limits, we take a multi-pronged theoretical approach: we identify material systems where low-Tc or normal-conducting defects are less likely to occur, where bulk superconducting properties favor proximity coupling of defects, and where clean interfaces with the niobium substrate allow for thinner films and better thermal stability. We present progress toward growing ultra-thin-film Nb-Zr and Nb3Al superconductors on niobium with the goal of achieving high quality factors at unprecedented fields.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

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Author: SITARAMAN, Nathan (Cornell University)

Co-authors: BARAISSOV, Zhaslan (Cornell University); OSEROFF, Thomas (Cornell University); MULLER, David Anthony (Cornell University); LIEPE, Matthias (Cornell University)

Presenter: SITARAMAN, Nathan (Cornell University)

Session Classification: Thursday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **81** Contribution code: **TUP37** Type: **Student Poster Presentation**

An Update of the Plasma Processing Developments at TRIUMF

Tuesday, September 23, 2025 2:30 PM (3 hours)

Superconducting Radio Frequency (SRF) technology is a key component in many particle accelerators operating in a continuous wave, or high duty cycle, mode. The on-line performance of SRF cavities can be negatively impacted by the gradual reduction in the accelerating gradient that can be attained within a reasonable field emission level. Conventional cleaning procedures are both time- and resource-exhaustive as they are done ex-situ. Plasma processing is an emerging in-situ method of cleaning which chemically removes hydrocarbon-based field emitters through plasma. An R&D program is underway at TRIUMF with the goal to develop fundamental power coupler (FPC) driven plasma processing of the installed 1.3 GHz nine-cell cavities in the ARIEL 30 MeV SRF e-LINAC. Processing recipes have been systematically studied in single-cell and multi-cell cavities off-line. The single-cell studies involved varying the input parameters and testing the effectiveness of the treatment through RGA analysis, while the multi-cell tests focused on understanding ignition behaviors when using the TM_{010} passband. The progress on these developments will be reported.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HEDJI, Daniel (TRIUMF)

Co-authors: LAXDAL, Robert (TRIUMF; University of Victoria); KOLB, Philipp (TRIUMF); YAO, Zhongyuan (TRIUMF); ZVYAGINTSEV, Vladimir (TRIUMF); JUNGINGER, Tobias (University of Victoria; TRIUMF)

Presenter: HEDJI, Daniel (TRIUMF)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **82** Contribution code: **TUP20** Type: **Poster Presentation**

Density-functional theory study of novel recipes to reduce Nb3Sn grain boundary dissipation

Tuesday, September 23, 2025 2:30 PM (3 hours)

Previous research has shown that Nb3Sn cavities with tin-rich grain boundaries tend to show significant Q-slope behavior, while cavities with grain boundaries of the "ideal"25 %-tin composition have higher quality factors and reach higher quench fields. In this paper, we make the case that it is possible to improve the properties of Nb3Sn grain boundaries even further. We use density-functional theory (DFT) to show that the addition of some ternary elements creates Nb3Sn grain boundaries with more bulk-like electronic structure, potentially making them more resistant to magnetic flux entry and dissipation. We discuss next steps toward introducing ternary elements in a post-processing step compatible with existing state-of-the-art Nb3Sn cavity recipes.

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Yes

Footnotes

Funding Agency

This work was supported by the U.S. National Science Foundation under Award PHY-1549132, the Center for Bright Beams

Author: SITARAMAN, Nathan (Cornell University)

Co-author: LIEPE, Matthias (Cornell University)

Presenter: SITARAMAN, Nathan (Cornell University)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **85** Contribution code: **MOA03** Type: **Invited Oral Presentation**

EIC crab cavity RF systems

Monday, September 22, 2025 9:10 AM (20 minutes)

The Electron-Ion Collider (EIC) is being implemented at Brookhaven National Laboratory (BNL) in a special partnership with Thomas Jefferson National Accelerator Facility. EIC is designed to collide electrons and protons/Heavy Ions with energies of 5-18 GeV, 2.5 A in the Electron Storage Ring (ESR) and 41-275 GeV/u, 1 A in the Hadron Storage Ring (HSR). The interaction region with a crossing angle of 25 mrad requires several Crabbing Cavity RF Systems operating at 197 MHz and 394 MHz. All the crabbing systems are designed with superconducting RF-dipole type cavities, where the HSR will include both 197 MHz and 394 MHz crabbing cavities, while ESR will include only 394 MHz crabbing cavities. In this paper, we will review the EIC crabbing system design, its complexities, and the challenges it presents.

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Yes

Footnotes

Funding Agency

Author: DE SILVA, Subashini (Old Dominion University)

Co-authors: XIAO, Binping (Brookhaven National Laboratory); LI, Zenghai (SLAC National Accelerator Laboratory); HUQUE, Naeem (Thomas Jefferson National Accelerator Facility); ANDHARE, Chinmay (Thomas Jefferson National Accelerator Facility); CHENG, Gary (Thomas Jefferson National Accelerator Facility); Prof. DELAYEN, Jean (Old Dominion University); LI, Guangjiang (Brookhaven National Laboratory); WU, Qiong (Brookhaven National Laboratory); CASTILLA, Alejandro (Thomas Jefferson National Accelerator Facility); GUO, Jiquan (Thomas Jefferson National Accelerator Facility); COX, Justine (Thomas Jefferson National Accelerator Facility); DRACHUK, Eduard (Thomas Jefferson National Accelerator Facility); CARRIERE, Paul (Thomas Jefferson National Accelerator Facility); BUTTLES, John (Thomas Jefferson National Accelerator Facility); SENECAL, Ethan (Thomas Jefferson National Accelerator Facility); OAST, Michelle (Thomas Jefferson National Accelerator Facility); O'BRIEN, Adam (Thomas Jefferson National Accelerator Facility); GROSE, Gregory (Thomas Jefferson National Accelerator Facility); RATH, Damon (Thomas Jefferson National Accelerator Facility); ARMSTRONG, Joshua (Thomas Jefferson National Accelerator Facility); VERDU-ANDRES, Silvia (Brookhaven National Laboratory); CONWAY, Zachary (Thomas Jefferson National Accelerator Facility)

Presenter: DE SILVA, Subashini (Old Dominion University)

Session Classification: Monday Oral Session: A

Track Classification: MC3: Cavities

Contribution ID: **86** Contribution code: **MOB02** Type: **Invited Oral Presentation**

LCLS-SC Operations Status and the LCLS-II-HE Upgrade

Monday, September 22, 2025 11:20 AM (20 minutes)

The Linac Coherent Light Source superconducting linac (LCLS-SC) at SLAC National Accelerator Laboratory, built during the LCLS-II project, has now been in operation for the past three years, with user experimental delivery commencing in 2024. In 2026, the LCLS-II-HE project will add 23 additional 1.3 GHz cryomodules, bringing the LCLS-SC maximum electron beam energy from 4 GeV to 8 GeV. This talk will provide an overview of operational experiences, challenges, and performance analysis of the SRF cavities and associated systems during the first few years of LCLS-SC operation, performance improvements in preparation for LCLS-II-HE, as well as the LCLS-II-HE cryomodule performance test results.

Footnotes

Funding Agency

U.S. Department of Energy, contract DE-AC02-76SF00515

I have read and accept the Privacy Policy Statement

Yes

Author: ALSBERG, Lauren (SLAC National Accelerator Laboratory)

Co-authors: GRABOWSKI, Adam (Thomas Jefferson National Accelerator Facility); CRAVATTA, Andrew (Fermi National Accelerator Laboratory); BAFIA, Daniel (Fermi National Accelerator Laboratory); GONNELLA, Daniel (SLAC National Accelerator Laboratory); WHITE, Dominique (SLAC National Accelerator Laboratory); WU, Genfa (Fermi National Accelerator Laboratory); CIOVATI, Gianluigi (Thomas Jefferson National Accelerator Facility); MARTS, Haley (SLAC National Accelerator Laboratory); MANISCALCO, James (SLAC National Accelerator Laboratory); NELSON, Janice (SLAC National Accelerator Laboratory); VENNEKATE, John (Thomas Jefferson National Accelerator Facility); ZACARIAS, Lisa (SLAC National Accelerator Laboratory); CHECCHIN, Mattia (SLAC National Accelerator Laboratory); BEVINS, Michael (Thomas Jefferson National Accelerator Facility); DRURY, Michael (Thomas Jefferson National Accelerator Facility); MCCAUGHAN, Michael (Thomas Jefferson National Accelerator Facility); NEVEU, Nicole (SLAC National Accelerator Laboratory); ADERHOLD, Sebastian (SLAC National Accelerator Laboratory); ARKAN, Tug (SLAC National Accelerator Laboratory)

Presenter: ALSBERG, Lauren (SLAC National Accelerator Laboratory)

Session Classification: Monday Oral Session: B

Track Classification: MC1: SRF Facilities

Contribution ID: **87** Contribution code: **FRB02** Type: **Invited Oral Presentation**

Development of a traveling-wave (TW) structure for high gradients

Friday, September 26, 2025 11:20 AM (20 minutes)

High-gradient superconducting RF structures are of keen interest to next-generation linear colliders because they offer substantial savings in terms of reduced construction cost by shortening the machine, and reduced operating costs. The gradient of bulk niobium superconducting RF structures is fundamentally limited by the maximum surface magnetic field these structures can sustain before quenching. While a history of sophisticated and complex niobium surface processing techniques has aimed to increase the niobium critical surface field, it is also possible to increase the accelerating gradient by altering the cavity geometry and accelerating mode in order to improve the ratio of the accelerating gradient to peak surface magnetic field. Traveling wave structures do just this by using geometric means to operate in the traveling-wave mode to increase the structure's transit time factor. With increased transit-time factor, higher gradients such as ~70 MV/m can be achieved under the same peak surface fields that otherwise limit 1.3 GHz cavities to below ~50 MV/m. These structures use proven Nb fabrication and processing techniques. Prototype development activities for a 3-cell structure, and a proof-of-principle waveguide loop are under development at FNAL. This talk shall provide an update of activities at FNAL, and worldwide collaboration on traveling wave structure development.

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Yes

Footnotes

Funding Agency

Author: MCGEE, Kellen (Fermi National Accelerator Laboratory)

Co-authors: NETEPENKO, Alex (Fermi National Accelerator Laboratory); CONTRERAS-MARTINEZ, Crispin (Fermi National Accelerator Laboratory); FURUTA, Fumio (Fermi National Accelerator Laboratory); UMEMORI, Kensei (High Energy Accelerator Research Organization); SOLYAK, Nikolay (Fermi National Accelerator Laboratory); AVRAKHOV, Pavel (Euclid Techlabs (United States)); KOSTIN, Roman (Euclid Techlabs (United States)); KAZAKOV, Sergey (Fermi National Accelerator Laboratory); KHABIBOULLINE, Timergali (Fermi National Accelerator Laboratory); YAKOVLEV, Vyacheslav (Fermi National Accelerator Laboratory)

Presenter: MCGEE, Kellen (Fermi National Accelerator Laboratory)

Session Classification: Friday Oral Session: B

Track Classification: MC3: Cavities

Contribution ID: **88** Contribution code: **TUP14** Type: **Student Poster Presentation**

Measurements of the DC field of first vortex penetration on modern SRF materials using a vibrating sample magnetometer

Tuesday, September 23, 2025 2:30 PM (3 hours)

A vibrating sample magnetometer (VSM) is being developed with the capability to measure field penetration on ellipsoidal superconducting samples intended for use in superconducting radio frequency cavities. The explicit goal of this machine is to perform field penetration measurements on atomic layer deposition (ALD) coated niobium ellipsoids (ie., thin film MgB2, Nb3Sn on Nb), as well as on electropolished (EP) bare/low-temp baked Nb, and pair these measurements with beta detected nuclear magnetic resonance (bNMR) measurements on identical samples. The machine is capable of performing field penetration measurements at temperatures as low as ~2 kelvin, and for magnetic fields up to ~450 mT. Additionally, the test stand is based around a 1.5 watt SHI cryocooler, and is thus helium free. To accompany the VSM, an in-house EP setup for both flat and ellipsoidal Nb samples has begun development. This EP test stand, along with the vacuum furnace located at TRIUMF, will allow production of highly polished bare/baked Nb ellipsoids for field penetration measurements. The flat samples then provide a witness to the EP process in order to characterize the post-EP surface roughness. These combined facilities are well suited to measure field penetration on a wide range of modern SRF materials, encompassing ALD thin films, multilayers, and low-temperature baked niobium samples.

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Yes

Footnotes

Funding Agency

Author: WALLACE, Lucas (University of Victoria)

Co-author: JUNGINGER, Tobias (TRIUMF)

Presenter: WALLACE, Lucas (University of Victoria)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **89** Contribution code: **TUP17** Type: **Student Poster Presentation**

Characterization of multilayer SRF cavity materials using radioactive beam based techniques for gradient enhancement

Tuesday, September 23, 2025 2:30 PM (3 hours)

Coating Nb with thin superconducting layers (with or without insulating layers, i.e., SS or SIS) with longer penetration depth λ can enhance the accelerating gradient by maintaining the Meissner state above each layer's superheating field Bsh, due to reduced surface screening currents and interfacial energy barriers. We review previously published studies using radioactive beam-based techniques to investigate SS and SIS for increasing accelerating gradient. Muon spin rotation (μSR) measurements of Nb3Sn(2 μm)/Nb samples revealed interfacial energy barriers through depth profiling of the first-flux-penetration field Bvp, consistent with Nb's metastable Bsh. Low-energy μSR study at depths <=˜ 150 nm in SS Nb1-xTixN/Nb samples confirmed nanoscale current suppression and a bipartite Meissner screening profile, supporting the "counter-current" model and identifying optimal coating thickness for maximizing Bvp. For vortex penetration study in SIS, β-detected nuclear magnetic resonance (βNMR) study optimizes the superconducting and normal-state properties of Nb0.75Ti0.25N in Nb0.75Ti0.25N(91 nm)/AlN(4 nm)/Nb. Resonance measurements in the vortex state showed broadening below Tc ˜ 15 K, yielding λ near the intrinsic limit, while spin-lattice relaxation exhibited a metallic Korringa response modified below Tc by a Hebel-Slichter coherence peak.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: ASADUZZAMAN, Md (University of Victoria)

Co-authors: Dr MCFADDEN, Ryan M. L. (TRIUMF; University of Victoria); Mr THOENG, Edward (TRIUMF; University of British Columbia); VALENTE-FELICIANO, Anne-Marie (Thomas Jefferson National Accelerator Facility); Mr BEVERSTOCK, David R. (Thomas Jefferson National Accelerator Facility); Dr SUTER, Andreas (Paul Scherrer Institute); Dr SALMAN, Zaher (Paul Scherrer Institute); Dr PROKSCHA, Thomas (Paul Scherrer Institute); KALBOUSSI, Yasmine (Commissariat à l'Energie Atomique); PROSLIER, Thomas (Université Paris-Saclay); Dr LI, Ruohong (TRIUMF); Dr MORRIS, Gerald D. (TRIUMF); Dr DUNSIGER, Sarah R. (TRIUMF); MACFARLANE, W. Andrew (TRIUMF; University of British Columbia); LAXDAL, Robert (TRIUMF); JUNGINGER, Tobias (TRIUMF; University of Victoria)

Presenter: ASADUZZAMAN, Md (University of Victoria)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **90** Contribution code: **WEB06C** Type: **Contributed Oral Presentation**

Dynamics of few-trapped vortices in niobium at microwave frequencies

Wednesday, September 24, 2025 12:40 PM (15 minutes)

Trapped vortices in superconductors introduce residual resistance in superconducting radio-frequency (SRF) cavities and disrupt the operation of superconducting quantum and digital electronic circuits. Understanding the detailed dynamics of trapped vortices under oscillating magnetic fields is essential for advancing these technologies. We have developed a near-field magnetic microwave microscope to study the dynamics of a limited number of trapped vortices under the probe when stimulated by a localized rf magnetic field.† By measuring the local second-harmonic response (P_2f) at sub-femto-Watt levels, we isolate signals exclusively arising from trapped vortices, excluding contributions from surface defects and Meissner screening currents. Toy models of Niobium superconductor hosting vortex pinning sites are introduced and studied with Time-Dependent Ginzburg-Landau (TDGL) simulations‡ of probe/sample interaction to better understand the measured second-harmonic response. The simulation results demonstrate that the second-harmonic response of trapped vortex motion under a localized rf magnetic field shares key features with the experimental data. This measurement technique provides access to vortex dynamics at the micron scale, such as depinning events and spatially-resolved pinning properties, as demonstrated in measurements on a Niobium film with an antidot flux pinning array.

I have read and accept the Privacy Policy Statement

Yes

Funding Agency

This work is funded by US Department of Energy / High Energy Physics through grant # DE-SC0017931 and the Maryland Quantum Materials Center.

Footnotes

† C.-Y. Wang, S. M. Anlage, "Microwave Microscope Studies of Trapped Vortex Dynamics in Superconductors,"https://arxiv.org/abs/2503.02811.
‡ B. Oripov, S. M. Anlage, Phys. Rev. E 101, 033306 (2020).

Author: Dr WANG, Chung-Yang (University of Maryland, College Park)

Co-author: Prof. ANLAGE, Steven (University of Maryland, College Park)

Presenter: Prof. ANLAGE, Steven (University of Maryland, College Park)

Session Classification: Wednesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **91** Contribution code: **THP19** Type: **Poster Presentation**

RF and DC vortices in superconductors studied with time-dependent Ginzburg-Landau theory

Thursday, September 25, 2025 2:30 PM (3 hours)

Time-dependent Ginzburg-Landau (TDGL) numerical simulations can capture vortex nucleation and motion, as well as proximity effects, at high frequencies in superconductors.† We use TDGL to study the nucleation of RF semi-loop vortices in Niobium in the presence of surface defects when the material is subjected to an intense RF magnetic field arising from a near-field microwave frequency dipole source.‡ We also simulate the case of trapped dc magnetic vortices near the surface of a superconductor being stimulated by the nearby microwave magnetic dipole.§ These simulations also yield the second- and third-harmonic signal responses produced by the superconductor and captured by the near-field microwave probe. The results of such simulations are in good agreement with data and provide an excellent "digital twin"of our near-field microwave microscope. This combined simulation and measurement technique provides access to vortex dynamics at the micron scale, such as depinning events and spatially-resolved pinning properties, as demonstrated in measurements on a Niobium film with an antidot flux pinning array. We use these validated TDGL simulations to address "what-if"questions about the response of superconducting surfaces and vortices to intense RF magnetic fields under a variety of conditions, and some of these results will be presented.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

† B. Oripov, S. M. Anlage, Phys. Rev. E 101, 033306 (2020).
‡ C.-Y. Wang, C. Pereira, S. Leith, G. Rosaz, S. M. Anlage, Phys. Rev. Applied 22, 054010 (2024).
§ C.-Y. Wang, S. M. Anlage, arxiv:2503.02811.

Funding Agency

This work is funded by US Department of Energy / High Energy Physics through grant # DE-SC0017931 and the Maryland Quantum Materials Center.

Author: WANG, Chung-Yang (University of Maryland, College Park)

Co-author: Prof. ANLAGE, Steven (University of Maryland, College Park)

Presenter: Prof. ANLAGE, Steven (University of Maryland, College Park)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **92** Contribution code: **FRA01** Type: **Invited Oral Presentation**

PIP-II SRF cavities performance and field emission mitigation strategy

Friday, September 26, 2025 8:30 AM (20 minutes)

PIP-II project is based on 5 types of SRF cavities. Developing the linac includes several advances in the SRF cavity processing and cryomodule design and assembly. This talk will summarize these advances, report recent results, and plans for further developments.

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Footnotes

Funding Agency

Author: HOLZBAUER, Jeremiah (Fermi National Accelerator Laboratory)

Presenter: HOLZBAUER, Jeremiah (Fermi National Accelerator Laboratory)

Session Classification: Friday Oral Session: A

Track Classification: MC3: Cavities

Contribution ID: **93** Contribution code: **MOA05** Type: **Invited Oral Presentation**

Recent advances in 3D SRF cavity-based quantum computing facility at the Fermilab SQMS Center

Monday, September 22, 2025 9:50 AM (20 minutes)

This talk will describe the most recent advances and progress in building an SRF cavity-based quantum computing facility at the Fermilab SQMS center. Several technical challenges had been successfully overcome to preserve the highest quality factors of SRF cavities in the presence of the sapphire chip holding the transmon qubit inside the cavity. The record values of the attained multicell cavity (2-cell, 9-cell)-qubit systems will be presented, as well as a variety of quantum operations realized with such systems, including the generation of large Fock states, coherent states, entangled mode-mode states etc. The quantum algorithms and computational problems being implemented on this 3D SQMS QPUs will be discussed as well.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: ROMANENKO, Alexander (Fermi National Accelerator Laboratory)

Presenter: ROMANENKO, Alexander (Fermi National Accelerator Laboratory)

Session Classification: Monday Oral Session: A

Track Classification: MC5: SRF Applications

Contribution ID: **94** Contribution code: **THB02** Type: **Invited Oral Presentation**

Status of robotics and automation in the SRF community and real applications

Thursday, September 25, 2025 11:20 AM (20 minutes)

The performance of superconducting RF (SRF) cavities is extremely sensitive to contamination by particles on the SRF surface. To mitigate this, high-pressure rinsing (HPR) with ultra-pure water is performed after surface treatment, and cavity assembly is conducted in a cleanroom environment. However, even when cleanroom suits are worn, human involvement in these processes can still introduce particle contamination.

In recent years, significant advancements have been made in the development of work robots across industries such as automotive manufacturing, semiconductor technology, and medical care, leading to increased automation. The SRF community has also embraced this trend. For example, FRIB has implemented robots for HPR, and institutions like FNAL, KEK, and Saclay are exploring robotic solutions for cavity assembly. Looking ahead, the integration of artificial intelligence (AI) is expected to enable cavity assembly that is entirely free from particle contamination while also eliminating the risk of human error. This talk will provide an overview of robotic and automated technologies related to superconducting cavities, along with examples of their practical applications.

Footnotes

Funding Agency

Work supported by the U.S. Department of Energy, Office of Science,
Office of Nuclear Physics under award number DE-SC0025531.

I have read and accept the Privacy Policy Statement

Yes

Author: POPIELARSKI, Laura (Facility for Rare Isotope Beams)

Co-authors: PASSARELLI, Donato (Fermi National Accelerator Laboratory); GUO, Hao (Institute of Modern Physics, Chinese Academy of Sciences); RUBER, Roger (Thomas Jefferson National Accelerator Facility); Dr BERRY, Stéphane (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); YAMADA, Tomohiro (High Energy Accelerator Research Organization)

Presenter: POPIELARSKI, Laura (Facility for Rare Isotope Beams)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **95** Contribution code: **THB01** Type: **Invited Oral Presentation**

Semi-automatic robot assisted, clean assembly of PIP-II LB650 cavity string at CEA

Thursday, September 25, 2025 11:00 AM (20 minutes)

Achieving optimal performance in SRF (Superconducting Radio Frequency) cavity assembly relies heavily on precise cleanroom processing, where contamination poses significant risks. Human activities, a major source of particle emissions in cleanrooms, not only threaten cavity cleanliness but also contribute to labor intensity and noise exposure. To mitigate these challenges, recent advancements in robotics offer promising solutions for automating critical steps in cavity assembly. In particular, a collaborative robot (cobot) implemented by CEA introduces automated processes such as coupler to cavity assembly, flange and bellows cleaning, and repetitive handling. The cobot, a FANUC CRX-25 6-axis arm mounted on a support frame, can operate independently and at night, significantly reducing assembly duration while ensuring consistent, reproducible results. By eliminating the need for manual operation in noisy, repetitive tasks, this cobot enhances both efficiency and technician safety, supporting higher cleanroom standards. This paper presents an overview of these automated processes, the cobot's implementation, the cavity RF cold test and the technical decisions shaping future developments in SRF cavity assembly.

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Footnotes

Funding Agency

Author: BERRY, Stéphane (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Co-author: BAZIN, Nicolas (Commissariat à l'Energie Atomique)

Presenter: BERRY, Stéphane (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **98** Contribution code: **TUB01** Type: **Invited Oral Presentation**

Systematic study of annealing effects on RF properties of HiPIMS Nb film

Tuesday, September 23, 2025 11:00 AM (20 minutes)

This talk will make a report on investigating performance of Nb thin films and in particular: effect of sequential heat treatments on mid field Q-slope and quench of Nb thin films effect of film vs bulk vs the Nb oxide in losses of the films in the quantum regime. This innovative study investigates a thin film of HiPIMS niobium deposited on a bulk niobium cavity. Measurements at FNAL investigated the performance of the film as compared to the bulk cavity it was coated on, and after subjecting the cavity to multiple and sequential heat treatment ranging from low temperature to mid temperature, to high temperature. Interestingly heat treatments in the range of 800 C demonstrate a significant improvement in mid-field Q slope and quench field. Studies have been performed with T-map to study the evolving character of the film losses for both slope and quench. Investigation into performance in the quantum regime demonstrate unequivocally that the leading role of low field Q-slope and TLS losses stems from the surface oxide and not from the Nb film or niobium bulk.

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: ABDISATAROV, Bektur (Fermi National Accelerator Laboratory)

Presenter: ABDISATAROV, Bektur (Fermi National Accelerator Laboratory)

Session Classification: Tuesday Oral Session: B

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **100** Contribution code: **WEA01** Type: **Invited Oral Presentation**

RF characterization of 1.3 GHz single-cell Nb/Cu full-seamless cavity manufactured by hydroforming

Wednesday, September 24, 2025 8:30 AM (20 minutes)

The Future Circular Collider (FCC) will employ 400 MHz elliptical cavities with niobium coating on copper substrates. Since the performance requirements of the FCC are higher than those of the Large Hadron Collider, which has similar operating conditions, a "seamless"substrate without welding seams is being investigated to achieve these requirements. Hydroforming is one of the methods to fabricate seamless-cavities for mass production, and the first prototype series of 1.3 GHz single-cell cavities for R&D was completed in 2023 through a collaboration between CERN and KEK. The cavities were hydroformed by KEK, niobium thin film was coated on them by CERN with HiPIMS, and their performance was measured by both KEK and CERN. Although the surface resistance was not small enough in high field, the target accelerating gradient 12 MV/m was achieved.

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Yes

Footnotes

Funding Agency

Amada Foundation

Author: ARAKI, Hayato (High Energy Accelerator Research Organization)

Presenter: ARAKI, Hayato (High Energy Accelerator Research Organization)

Session Classification: Wednesday Oral Session: A

Track Classification: MC3: Cavities

Contribution ID: **101** Contribution code: **TUA03** Type: **Invited Oral Presentation**

Progress of CSNS-II SRF system

Tuesday, September 23, 2025 9:10 AM (20 minutes)

The China Spallation Neutron Source (CSNS) is the fourth pulsed accelerator-driven neutron source in the world. Meanwhile, it is one of the core large-scale scientific facilities of the Guangdong-Hong Kong-Macao Greater Bay Area Comprehensive National Science Center. The planned China Spallation Neutron Source Phase II (CSNS-II) started construction in 2024 and is scheduled to be completed in July 2029. To achieve a beam power of 500 kW for target station, the beam energy of the linear accelerator needs to be increased to 300 MeV. Therefore, a superconducting linear accelerator composed of two types of superconducting cavities, namely 324 MHz double-spoke cavities with β0 is 0.5 and 648 MHz 6-cell elliptical cavities with βg is 0.62, will be added after the Drift Tube Linac (DTL). We have completed the R&D of a prototype double-spoke cavity cryomodule and two prototype elliptical cavities. The test results showed that the maximum gradients of the two double spoke cavities at a pulse width of 4 ms and a repetition frequency of 25 Hz was 15.2 MV/m during horizontal test, while the maximum gradient of the elliptical cavity reaches 25.7 MV/m during vertical test. Both type cavities test results indicate that the design and post processing are very reliable， the mass production of superconducting cavities, couplers, tuners, and cryostats has been initiated, with plans to complete the manufacturing of all cryomodules by early 2027.

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Yes

Footnotes

Funding Agency

Author: GE, Rui (Institute of High Energy Physics)

Co-authors: ZHANG, Cong (Institute of High Energy Physics); HE, Feisi (Institute of High Energy Physics); ZHOU, Wenzhong (Institute of High Energy Physics)

Presenter: GE, Rui (Institute of High Energy Physics)

Session Classification: Tuesday Oral Session: A

Track Classification: MC1: SRF Facilities

Contribution ID: **102** Contribution code: **TUA05** Type: **Invited Oral Presentation**

Enhancement of medium-temperature heat-treated SRF cavities for high quality and high gradient

Tuesday, September 23, 2025 9:50 AM (20 minutes)

The heat treatment of SRF cavities at medium temperature (250 ℃ to 350 ℃), also known as "mid-T heat treatment", is one of the R&D activities at DESY towards a high-duty-cycle (HDC) upgrade of the European XFEL. Such treated cavities exhibit an improvement in the quality factor Q0 (3E10 to 5E10) at a moderate accelerating electric field strength Eacc (10 MV/m to 20 MV/m) compared to EuXFEL cavities. In fact, cavities treated in this way do experience quenching at Eacc in the range of 20–30 MV/m, i.e. they cannot be operated at gradients above 30 MV/m. However, in this work, we have found that a heat treatment consisting of a combination of mid-T and low-T not only favorable high Q0-values were measured, but additionally high gradients of up to 40 MV/m could be achieved. This offers great potential for upgrading modern LINACs with new high usable performance. The results of 1.3 GHz TESLA-type single- and nine-cell cavities as well as the influence of the effective oxygen diffusion length l will be presented. Further insights into the surface of Nb are provided by supporting sample analyses.

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Yes

Footnotes

Funding Agency

This work was funded by the Helmholtz Association within the MT ARD and the European XFEL R&D Program

Author: GOEDECKE, Julia (Deutsches Elektronen-Synchrotron DESY)

Co-authors: STEDER, Lea (Deutsches Elektronen-Synchrotron DESY); BATE, Christopher (Deutsches Elektronen-Synchrotron DESY); KASPRZAK, Karol (Deutsches Elektronen-Synchrotron DESY); RESCHKE, Detlef (Deutsches Elektronen-Synchrotron DESY); TRELLE, Lennart (Deutsches Elektronen-Synchrotron DESY); WEISE, Hans (Deutsches Elektronen-Synchrotron DESY); WIENCEK, Mateusz (Deutsches Elektronen-Synchrotron DESY)

Presenter: GOEDECKE, Julia (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Tuesday Oral Session: A

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **105** Contribution code: **THP53** Type: **Poster Presentation**

Development of 1.3 GHz 3-cell superconducting cavities for high-current application

Thursday, September 25, 2025 2:30 PM (3 hours)

1.3 GHz 3-cell superconducting cavities were proposed for the injector of the high-brightness free electron laser based on energy recovery linac scheme. The average beam current is 10 mA and injector energy is 10 MeV. The beam tube of the cavity is enlarged to damp higher-order modes (HOMs) and to keep beam stability. Three cavities have been fabricated. An intrinsic quality factor of 2.0×10^{10} at 12.0 MV/m and a maximum accelerating gradient of 25.6 MV/m were achieved in the vertical test of the first bare cavity. Design, fabrication, surface treatment, and rf test results will be presented in this paper.

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Yes

Footnotes

Funding Agency

Author: WU, Xiaowei (Zhangjiang Laboratory)

Co-authors: HUANG, Xuan (Shanghai Institute of Applied Physics); CHEN, Jinfang (Shanghai Advanced Research Institute); DENG, Haixiao (Shanghai Advanced Research Institute); DONG, Pengcheng (Shanghai Advanced Research Institute, Chinese Academy of Sciences); WANG, Zheng (Shanghai Institute of Applied Physics); ZONG, Yue (Shanghai Advanced Research Institute); XING, Shuai (Shanghai Advanced Research Institute, Chinese Academy of Sciences); WU, Jiani (Shanghai Advanced Research Institute, Chinese Academy of Sciences); LIU, Xuming (Shanghai Advanced Research Institute, Chinese Academy of Sciences); OUYANG, Xiaohan (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, ShenJie (Shanghai Advanced Research Institute); ZHAI, Yanfei (Shanghai Advanced Research Institute, Chinese Academy of Sciences); PU, xiaoyun (Shanghai Advanced Research Institute, Chinese Academy of Sciences); WANG, Dong (Shanghai Advanced Research Institute); ZHAO, Yeliang (Shanghai Advanced Research Institute, Chinese Academy of Sciences); GUO, Xinghao (Shanghai Advanced Research Institute); HUANG, Yawei (ShanghaiTech University); YAN, Xia (ShanghaiTech University)

Presenter: WU, Xiaowei (Zhangjiang Laboratory)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **106** Contribution code: **MOP52** Type: **Student Poster Presentation**

Electromagnetic-thermal coupling study of the SHINE injector cavity

Monday, September 22, 2025 2:30 PM (3 hours)

The SHINE project is a high-repetition-rate hard X-ray Free Electron Laser (XFEL) facility driven by a superconducting RF linear accelerator with an energy exceeding 8.0 GeV. The linear accelerator (LINAC) of SHINE consists of six hundred 1.3 GHz 9-cell cavities for acceleration, producing photons with energies ranging from 0.4 to 25 keV. This study focuses on the first single-cavity cryomodule of the LINAC which follows the electron gun. The injector cavity is a 1.3 GHz axisymmetric superconducting cavity with two fundamental power couplers. The accelerating gradient of the cavity reached 28 MV/m in the vertical test, but was limited below 8.1 MV/m in the horizontal test by thermal runaway. This did not meet the specification of 12 MV/m. Experiments revealed that the cause of thermal quench was insufficient cooling. Electromagnetic-thermal coupling simulation was performed to analyze this phenomenon and optimize the cooling conditions. The original cooling setup was enhanced and several new cooling configurations were proposed in the simulations. The optimization schemes showed a significant increase in the accelerating gradient. The injector cavity met the specification in horizontal test after applying the enhanced cooling scheme.

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Yes

Footnotes

Funding Agency

Author: GUO, Xinghao (Shanghai Advanced Research Institute)

Co-authors: DENG, Haixiao (Shanghai Advanced Research Institute); CHEN, Jinfang (Shanghai Advanced Research Institute); ZHAO, ShenJie (Shanghai Advanced Research Institute, Chinese Academy of Sciences); WU, Xiaowei (Shanghai Zhangjiang Laboratory); HUANG, Xuan (Shanghai Institute of Applied Physics)

Presenter: GUO, Xinghao (Shanghai Advanced Research Institute)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **107** Contribution code: **THP10** Type: **Poster Presentation**

Thermal and magnetic flux dynamics in superconducting niobium cavities: implications for the threshold field limit

Thursday, September 25, 2025 2:30 PM (3 hours)

While the fabrication technology superconducting Niobium cavities is advanced, a wide gap exist between the theoretical threshold field H_{sh} and the observed values. The reasons behind this discrepancy continue to pose intriguing questions, highlighting the need for further investigation. While material properties undoubtedly influence performance, we believe that the intricate dynamics of thermal and magnetic flux diffusion play a crucial role in limiting H_{sh}.

A notable peculiarity arises from the boundary conditions imposed on the niobium sheet used to fabricate accelerator cavities. The magnetic field is applied at the inner surface, while the outer surface is maintained at a constant temperature. Near the inner surface, the magnetic field can be formally expressed as: $B_a exp(-x/\lambda_e)$, where λ_e, the effective complex penetration depth, is derived using the two-fluid model: $\lambda_e = \lambda_L(1 - in_n\omega\tau_n/n_s)^{-1/2}$, where, $n_n(n_s)$ is normal (superconducting) carrier density, ω and τ_n are field frequency and scattering time of normal carriers, respectively. To further explore this phenomenon, we will present our calculations by self-consistently solving the steady-state heat diffusion equation: $\nabla^2 T(\vec{r}) = -Q(\vec{r})/k$. $T(\vec{r})$ is fixed at the outer surface of the cavity, $Q(\vec{r})$ - the local heat generated by the RF fields, k - thermal conductivity of niobium in its superconducting state.

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Yes

Footnotes

Funding Agency

Government of India, Department of Science and Technology, DST-PURSE Grant No. SR/PURSE/2023/169(G) Dated 13/12/2023

Author: GURAZADA, Ravikumar (GITAM University)

Co-authors: Dr ANGANI, Chandrasekhar (GITAM University); Prof. ROY, Sindhunil B. (Ramakrishna Mission Vivekananda Educational and Research Institute); YAMAMOTO, Akira (KEK Applied Research Laboratory); Prof. MYNENI, Ganapati (GITAM University)

Presenter: GURAZADA, Ravikumar (GITAM University)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **108** Contribution code: **TUP11** Type: **Student Poster Presentation**

Development of in situ thickness sensor for vapor diffused Nb3Sn films

Tuesday, September 23, 2025 2:30 PM (3 hours)

Fermilab is one of the leaders in development of vapor diffused Nb3Sn films inside niobium cavities. This material has a higher critical temperature (Tc) than niobium, enabling cavity operation at 4.2 K. This higher operational temperature significantly reduces the infrastructure required for cooling compared to 2 K systems, making superconducting radio-frequency (SRF) technology more accessible. Current deposition methods have relied on iterative testing to determine nominal film thickness, a process that can be time-consuming and imprecise. To address this, we are developing a sensor to measure the thickness of Nb3Sn thin film in situ during vapor diffusion. Our design involves the resistance measurement of a thin film of niobium. During coating, the change in resistance reflects the conversion of the film to Nb3Sn, which allows simple integration with the current furnace infrastructure. This sensor would allow real time measurement of the thickness, allowing for increased precision in future depositions.

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Yes

Footnotes

Funding Agency

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Author: HOWARD, Katrina (University of Chicago)

Co-authors: EREMEEV, Grigory (Fermi National Accelerator Laboratory); POSEN, Sam (Fermi National Accelerator Laboratory); TENNIS, Brad (Fermi National Accelerator Laboratory); BAFIA, Daniel (Fermi National Accelerator Laboratory); KIM, Young-Kee (University of Chicago; Fermi National Accelerator Laboratory)

Presenter: HOWARD, Katrina (University of Chicago)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **109** Contribution code: **MOP77** Type: **Poster Presentation**

First ESS LINAC cooldown using the master automatic control sequence

Monday, September 22, 2025 2:30 PM (3 hours)

This paper presents the key aspects of the cryogenic integrated control system for the ESS superconducting linear accelerator and its importance during the first operational experience in a LINAC configuration, enabling 2 MW beam power and beyond. This unified system is controlled by a master PLC managing the full CMDS (Cryomodules and Cryogenic distribution System) consisting of 43 cells, each comprising a Cryomodule with 352.21 MHz Double-Spoke or 704.42 MHz elliptical SRF cavities, and a valve box, which in turn are controlled by their own dedicated PLC. A key aspect of this integrated control system is the Master Automatic Control Sequence (MACS), which allows for the simultaneous cryogenic operation of the entire LINAC, managing and coordinating the different phases required for cryogenic operation, while handling failure response protocols and operator interface requirements. The paper also highlights lessons learned during the operation, identifies areas for improvement, and proposes strategies for optimizing SRF cryogenic controls in the upcoming phases of the ESS project.

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Yes

Footnotes

Funding Agency

Author: Mr ASENSI, Emilio (European Spallation Source)

Co-authors: FONTOURA, Adalberto (European Spallation Source); CARDONA, Horus (European Spallation Source); ZHANG, Jianqin (European Spallation Source); SKIBA, Marek (European Spallation Source); BASKAR, Nishanthi (European Spallation Source); ELIAS, Nuno (European Spallation Source); HALCZYNSKI, Pawel (Institute of Nuclear Physics, Polish Academy of Sciences); NILSSON, Per (European Spallation Source); ARNOLD, Philipp (European Spallation Source); GAJ, Wawrzyniec (Institute of Nuclear Physics, Polish Academy of Sciences)

Presenter: Mr ASENSI, Emilio (European Spallation Source)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **110** Contribution code: **THP26** Type: **Poster Presentation**

European thin film roadmap

Thursday, September 25, 2025 2:30 PM (3 hours)

Superconducting thin film (TF) technology for Superconducting readio-frequency(SRF) applications is under intense development in many research centres around the world. TF SRF technology can not only drastically reduce cryogenic costs but also opens the door to simplified alternative cooling schemes with reduced helium inventory. Up to today, TF development have been considered within two High Energy Roadmaps (CERN and Snowmass), without taking into account other possible applications. Within the framework of the European H2020 project IFAST, an "European TF-SRF Roadmap"has been developed that also covers all applications aspects including high-intensity hadron/neutron sources, light sources, cavity detectors, quantum computing or emerging fields like compact accelerators poised to revolutionize industrial processes and medical diagnostics, and commercial applications. This work proposes a comprehensive approach focused on the expertise and collaborative network that has been built in Europe and in the entire world over the past years. Ten priority topics have been identified on TF development. This talk will briefly describe the main feature of the roadmap and expecting for returns from the international community to improve our initial document and disseminate it on a larger scale.

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Yes

Footnotes

Thin Film SRF

Funding Agency

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Author: MALYSHEV, Oleg (Science and Technology Facilities Council)

Co-authors: Dr ANTOINE, Claire (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); KUGELER, Oliver (Helmholtz-Zentrum Berlin für Materialien und Energie); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); PROSLIER, Thomas (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); VALIZADEH, Reza (Daresbury Laboratory)

Presenter: MALYSHEV, Oleg (Science and Technology Facilities Council)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **114** Contribution code: **THB07C** Type: **Contributed Oral Presentation**

Progress of assembly and installation of LIPAc SRF cryomodule under the EU–JA collaborative framework

Thursday, September 25, 2025 12:55 PM (15 minutes)

The commissioning of LIPAc (Linear IFMIF Prototype Accelerator) is ongoing at QST Rokkasho Institute for Fusion Energy within the engineering validation of the accelerator system up to 9 MeV/125 mA in continuous wave under international collaboration between Japan and Europe. Several SRF cryomodules will be required for IFMIF to accelerate deuterons from 5 MeV to 40 MeV. The prototype of the first of these cryomodules has been manufactured and will be installed and tested on the LIPAc. It holds the eight Half Wave Resonator and RF couplers to accelerate the beam and the eight superconducting solenoids to focus it. During the cryomodule assembly, several non-conformities were identified, including vacuum leaks and cryogenic pipe issues. These challenges were addressed through a coordinated effort involving Japanese and European partners. Solutions included the refabrication and repair in Japan of critical components, adhering to Japan' s High Pressure Gas Safety Act and international standards. Material selection, thermal cycling treatments, magnetization assessments, and regulated welding with non-destructive tests (pressure and penetration) were jointly implemented. This poster outlines the technical approaches taken, highlights the collective efforts of the LIPAc team in resolving the encountered issues, and reports on the progress toward the successful assembly and validation of the LIPAc SRF cryomodule.

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Yes

Footnotes

Funding Agency

Author: EBISAWA, Takashi (National Institutes for Quantum Science and Technology)

Co-authors: CHAMBRILLON, Janic (Fusion for Energy); CARIN, Yann (Fusion for Energy); DZITKO, Herve (Fusion for Energy); GEX, Dominique (Fusion for Energy); HASEGAWA, Kazuo (National Institutes for Quantum Science and Technology); Mr KASUGAI, Atsushi (National Institutes for Quantum Science and Technology); KONDO, Keitaro (National Institutes for Quantum Science and Technology); Mr MASUDA, Kai (National Institutes for Quantum Science and Technology); ADAM, Jean-Pierre (Fusion for Energy); BAZIN, Nicolas (Centre Antoine Lacassagne); JIMENEZ, David (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas); KAKO, Eiji (High Energy Accelerator

Research Organization); SAKAI, Hiroshi (High Energy Accelerator Research Organization)

Presenter: EBISAWA, Takashi (National Institutes for Quantum Science and Technology)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **115** Contribution code: **TUP58** Type: **Poster Presentation**

Status of the SRF cavity tuner for the MEXT-ATD / ITN cryomodule being built at KEK

Tuesday, September 23, 2025 2:30 PM (3 hours)

Currently a prototype cryomodule for the International Linear Collider featuring eight 1.3 GHz TESLA-type superconducting radio frequency cavities is being designed and built at KEK. In this contribution we report on the status of the development and production of the cavity frequency tuner. The design of the tuner body was finalized and the procurement of the first four series units is underway. The first test of the slow actuator cold test setup is discussed. It is prepared for the upcoming qualification of a newly developed slow actuator. Results of the qualification tests of a new fast actuator prototype are presented. The concept of the fast actuator control system is described.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: OMET, Mathieu (High Energy Accelerator Research Organization)

Co-authors: KUMAR, Ashish (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization); Dr BAJPAI, Rishabh (High Energy Accelerator Research Organization); DOHMAE, Takeshi (High Energy Accelerator Research Organization); YAMADA, Tomohiro (High Energy Accelerator Research Organization); MATSUMOTO, Toshihiro (High Energy Accelerator Research Organization); YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Presenter: OMET, Mathieu (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **116** Contribution code: **THP20** Type: **Poster Presentation**

Molecular dynamics study on the mechanical behavior of pure and alloyed niobium for superconducting RF cavity applications

Thursday, September 25, 2025 2:30 PM (3 hours)

Niobium (Nb) has long been recognized as the primary material for superconducting radio-frequency (SRF) cavities due to its excellent superconducting properties and mechanical formability. However, improving its structural stability under cryogenic operating conditions and high electromagnetic loads remains a key challenge. In this study, we employ molecular dynamics (MD) simulations to investigate the mechanical behavior of three candidate materials: single-crystalline niobium, low-alloyed Nb-Zr, and Nb-Mo systems. Each system is modeled as a cubic specimen subjected to 20 % uniaxial compression, and their mechanical responses are analyzed through stress-strain curves, dislocation evolution, and local atomic structure classification via Common Neighbor Analysis (CNA). Alloying effects on yield strength, plastic deformation mechanisms, and microstructural stability are systematically evaluated. The simulation results provide atomistic insights into how minor alloying additions influence defect formation and dislocation motion, which are critical factors in maintaining cavity performance under thermal and mechanical stress. This study aims to propose a guideline for alloy composition optimization in SRF cavity design by identifying compositions that enhance mechanical resilience while preserving favorable superconducting characteristics. The findings are expected to support the development of next-generation SRF cavity materials with improved durability and performance.

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Yes

Footnotes

Funding Agency

Author: YOON, Taeyoung (Changwon National University)

Presenter: YOON, Taeyoung (Changwon National University)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **117** Contribution code: **TUP60** Type: **Poster Presentation**

Real-time cavity simulator and tuner control system for the ITN cryomodule at KEK

Tuesday, September 23, 2025 2:30 PM (3 hours)

At KEK, an International Linear Collider prototype cryomodule containing eight TESLA-type cavities is currently under development and is scheduled for testing in 2028. To evaluate the performance of the low-level RF (LLRF) system, a Red Pitaya-based cavity simulator is being developed. The simulator will also be used at the STF VT stand to support the development of the digital LLRF system, which is necessary for preparation of the Vertical Tests for the ITN CM cavities. Additionally, we are considering utilizing the Red Pitaya hardware platform to control the piezo of the cavity tuners for Lorentz force detuning (LFD) compensation. In this contribution the progress of the cavity simulator and tuner control are reported.

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Yes

Footnotes

Funding Agency

Author: Dr BAJPAI, Rishabh (High Energy Accelerator Research Organization)

Co-authors: Dr MATSUMOTO, Toshihiro (High Energy Accelerator Research Organization); OMET, Mathieu (High Energy Accelerator Research Organization)

Presenter: Dr BAJPAI, Rishabh (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **118** Contribution code: **THP61** Type: **Poster Presentation**

Assembly of the LIPAc SRF LINAC cryomodule

Thursday, September 25, 2025 2:30 PM (3 hours)

In complement to the development activities for fusion reactors (JT-60SA & ITER), Fusion for Energy contributes to the R&D for material characterisation facilities. The LIPAc, technical demonstrator for the production and acceleration of a D+ beam, will be used for neutron production by nuclear stripping reaction on a liquid Li target. Since its first beam in 2014, the LIPAc construction and commissioning continues and will be concluded with the cryomodule installation aiming for beam validation at nominal power. The cryomodule assembly, started in March 2019, was paused for two and half years, devoted to improve the pumping, repair, cold tests and high pressure rinse the solenoids. In August 2022, the cleanroom activities resumed with the cavity/coupler assembly but had to be paused again to fix a leaking bellows on a solenoid. In September 2024, the beam line left the cleanroom to start the cold mass assembly phase which was concluded in January 2025 with the cold mass insertion. In March 2025, the cryomodule was transported to the accelerator vault for the last assembly steps before its integration. The team is working on the connection of the super-conducting solenoids. The final leak tests of the cryomodule, conclusion of its assembly, are expected in the second half of 2025. This paper presents the technical challenges encountered and their solutions, highlighting continuous progress in overcoming complex integration issues across a synergic international collaboration.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: CHAMBRILLON, Janic (Fusion for Energy)

Co-authors: ADAM, Jean-Pierre (Fusion for Energy; Commissariat à l'Énergie Atomique et aux Énergies Alternatives); BAZIN, Nicolas (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); CARIN, Yann (Fusion for Energy); DEVANZ, Guillaume (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); Mr DUGLUÉ, Daniel (Fusion for Energy); DZITKO, Herve (Fusion for Energy); EBISAWA, Takashi (National Institutes for Quantum Science and Technology); Mr GEX, Dominique (Fusion for Energy); HASEGAWA, Kazuo (National Institutes for Quantum Science and Technology); JENHANI, Hassen (CEA Paris-Saclay); Dr JIMENEZ, David (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas); KASUGAI, Atsushi (National Institutes for Quantum Science and Technology); KONDO, Keitaro (National Institutes for Quantum Science and Technology); Mr KUMAGAI, Kohki (National Institutes for Quantum Science and Technology); MASUDA, Kai (National Institutes for Quantum Science and Technology); MOLLA, Joaquin (Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas); Mr PHILLIPS, Guy (Fusion for Energy); PIQUET, Olivier (CEA Paris-Saclay); PLAISANT, Thomas (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); SCANTAMBURLO, Francesco (Fusion for Energy)

Presenter: CHAMBRILLON, Janic (Fusion for Energy)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **119** Contribution code: **TUP74** Type: **Poster Presentation**

The RF design of a fast reactive tuner for UK-XFEL superconductor cavities

Tuesday, September 23, 2025 2:30 PM (3 hours)

A Ferro Electric Fast Reactive Tuner(FE-FRT) for UK-XFEL superconducting Tesla Cavities is under development, which is used to suppress the microphonics of the superconducting cavities, a fast dynamic detuning. The EF-FRT tuner doesn't have moving parts and so has an extremely fast tuning process to compensate the microphonics. The RF design of the FRT includes the optimization of the Figure of Merit by changing the geometry of the tuner using the CST eigenmode solver. With a higher FoM that means there is a larger tuning range with fixed power dissipated in the FE-FRT. An overview of the approximation calculation theory and automatic optimization of FoM will be discussed in detail.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: JIANG, Hongping (Lancaster University)

Presenter: JIANG, Hongping (Lancaster University)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **120** Contribution code: **THP52** Type: **Poster Presentation**

The development of 648 MHz elliptical proto cavity for CSNS-II

Thursday, September 25, 2025 2:30 PM (3 hours)

Since the second half of 2022, the design of the CSNS-II elliptical cavities was completed and their manufacturing was initiated. After nearly three years of research, we have successfully developed three prototype elliptical cavities. Vertical tests demonstrated a maximum gradient of 25.7 MV/m, significantly surpassing the operational requirement of 14 MV/m. This achievement has laid a solid foundation for the construction of CSNS-II.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: ZHOU, Wenzhong (Institute of High Energy Physics)

Co-authors: GE, Rui (Institute of High Energy Physics); HE, Feisi (Institute of High Energy Physics); DAI, Jin (Institute of High Energy Physics); DONG, Chao (Institute of High Energy Physics); ZHANG, Cong (Institute of High Energy Physics); JIN, Song (Institute of High Energy Physics); LI, Bo (Institute of High Energy Physics); MI, Zhenghui (Institute of High Energy Physics); XU, Miaofu (Institute of High Energy Physics); CHEN, Xu (Institute of High Energy Physics); Mr LIU, Baiqi (Institute of High Energy Physics); Dr FAN, Mengxu (Institute of High Energy Physics); WU, Xiaolei (Dongguan Neutron Science Center); LI, Ahong (Institute of High Energy Physics); CHEN, Qiang (Institute of High Energy Physics); QU, Peihua (Institute of High Energy Physics)

Presenter: ZHOU, Wenzhong (Institute of High Energy Physics)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **121** Contribution code: **THP50** Type: **Poster Presentation**

Considerations on using SQUID metamaterials for tuning SRF cavities in accelerator applications

Thursday, September 25, 2025 2:30 PM (3 hours)

Superconducting QUantum Interference Devices (SQUID)s are superconducting loops broken by one or more Josephson junctions and act as RLC circuits with a resonant frequency that can be tuned by an applied magnetic field. A microwave metamaterial can be created by positioning many of these SQUIDs in an array such that such that their spacing is much less than that of the microwave wavelength. In this work, the extent the resonant frequency of an accelerator cavity can be shifted for a given coupling with a SQUID metamaterial is obtained with two models. From this, it is considered if the cavity resonance shift is sufficient for weak enough couplings that such a cavity tuning scheme could be relevant for accelerator applications.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: OSEROFF, Thomas (Cornell University)

Co-author: LIEPE, Matthias (Cornell University)

Presenter: OSEROFF, Thomas (Cornell University)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **122** Contribution code: **THP51** Type: **Poster Presentation**

Attempt to include beam loading effects in finite element method RF simulations for B-cell cryomodules

Thursday, September 25, 2025 2:30 PM (3 hours)

In this work a method to include the effects of beam loading in FEM solvers for electromagnetic problems, such as CST and HFSS, is considered. The method involves using transmission line models of a beam-loaded and beamless resonant cavity to determine an effective surface resistance and tuning angle for the beamless cavity to produce the same reflection as the beam-loaded case. The cavity, its coupler, and the relevant waveguide sections are then simulated with the desired surface resistance and shift from resonance. This allows for detailed understanding of the fields in regions of interest, such as transformers and RF windows, as a function of relevant parameters, such as beam current, cavity voltage, and tuning angle.

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Yes

Footnotes

Funding Agency

Author: OSEROFF, Thomas (Cornell University)

Co-author: LIEPE, Matthias (Cornell University)

Presenter: OSEROFF, Thomas (Cornell University)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **123** Contribution code: **TUP67** Type: **Poster Presentation**

Implementation and initial deployment of embedded EPICS for MELSEC iQ-R in the SRILAC LLRF system

Tuesday, September 23, 2025 2:30 PM (3 hours)

At the Superconducting RIKEN Linear Accelerator (SRILAC), auxiliary control and monitoring tasks for the RF system, such as RF voltage and power readout, feeder control, and tuner adjustments, are managed using a Mitsubishi MELSEC iQ-R series programmable logic controller (PLC). This PLC is directly connected to the FPGA-based LLRF controller, forming an integrated system for low-level RF operations. In the conventional configuration, the PLC communicated with EPICS via an external Linux computer using the MC protocol over TCP/IP, which often suffered from limited reliability compared with fieldbus-based solutions. To overcome this limitation, we implemented EPICS support directly on the C-language intelligent function module of the iQ-R series. By embedding the IOC in the PLC module itself, the need for an external Linux interface was eliminated, and communication stability was significantly improved. The new system has been deployed and tested in the SRILAC LLRF environment. This paper describes the system architecture, details of the embedded implementation, and operational results obtained during beam operation.

I have read and accept the Privacy Policy Statement

Yes

Funding Agency

Footnotes

Author: UCHIYAMA, Akito (RIKEN Nishina Center)

Co-authors: KOMIYAMA, Misaki (RIKEN Nishina Center); YAMADA, Kazunari (RIKEN Nishina Center); FUKUNISHI, Nobuhisa (RIKEN Nishina Center)

Presenter: UCHIYAMA, Akito (RIKEN Nishina Center)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **124** Contribution code: **MOP14** Type: **Poster Presentation**

High Q –high G study on single cell medium grain niobium cavities

Monday, September 22, 2025 2:30 PM (3 hours)

Medium Grain Niobium (MG Nb) is a cost-effective material compared to Fine grain Nb (FG Nb) that has isotropic mechanical properties and can clear the high-pressure gas safety criteria for a 1.3 GHz 9-Cell jacketed Tesla cavity. At KEK, various high Q –high G surface treatments have been applied to the 1-Cell MG Nb cavities and its performance has been measured via vertical tests, with and without trapped flux. It has been observed that the performance of these cavities are on par with FG Nb cavities for standard, 2-step and Mid-T furnace baking. Moreover, the flux expulsion of the single cell MG Nb cavity has been studied at 800 and 900 ℃ annealing, and the subsequent performance improvement has been confirmed with 900 ℃ annealing.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: KUMAR, Ashish (High Energy Accelerator Research Organization)

Co-authors: ITO, Hayato (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization)

Presenter: KUMAR, Ashish (High Energy Accelerator Research Organization)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **125** Contribution code: **THP35** Type: **Poster Presentation**

Microstructural characterization of Nb3Sn thin films using 3D FIB tomography

Thursday, September 25, 2025 2:30 PM (3 hours)

The accelerating gradient of Nb_3Sn superconducting radiofrequency (SRF) cavities is currently limited, and the underlying cause remains an open question in the field. One leading hypothesis attributes this limitation to the presence of tin-deficient regions within the Nb_3Sn coating, which can suppress the superheating field. Due to the relatively large coherence length of Nb_3Sn, defects near the surface may significantly interact with the RF field. However, these subsurface defects have proven difficult to characterize. In this contribution, we present an unprecedented level of detail into the structure and distribution of subsurface tin-deficient regions to better understand their influence on cavity performance. We employ 3D focused ion beam (FIB) tomography to analyze the subsurface microstructure of Nb_3Sn thin films. This technique enables three-dimensional reconstruction of both the tin distribution and the grain structure within the film. By correlating compositional variations with grain morphology, we gain insights into the formation mechanisms of tin-deficient regions and their potential role in limiting SRF cavity performance.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: VIKLUND, Eric (High Energy Accelerator Research Organization)

Co-authors: Prof. SEIDMAN, David N. (Northwestern University); POSEN, Sam (Fermi National Accelerator Laboratory)

Presenter: VIKLUND, Eric (High Energy Accelerator Research Organization)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **128** Contribution code: **THB06C** Type: **Contributed Oral Presentation**

First beam commissioning of the bERLinPro superconducting radio-frequency (SRF) photoelectron gun

Thursday, September 25, 2025 12:40 PM (15 minutes)

After about a decade of research, development and construction work, the bERLinPro Energy Recovery Linac project at HZB changed over into the commissioning phase and started the operation of the SRF photo-injector with the injection line of the accelerator. This system had already produced beam from a metal photo-cathode in 2018 [1] in a dedicated test environment and was assembled in the accelerator hall after a required refurbishment and repair program [2]. The 1.3 GHz SRF gun successfully generated first photoemission beam from a high quantum efficiency (QE) Na-based multi-alkali photocathode. In this contribution, the results of the first two measurement campaigns will be shown, including a review of the SRF design, the RF commissioning, the cavity performance, especially with respect to dark current, the cathode quantum efficiency and lifetime, as well as the measured beam parameters.

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Yes

Footnotes

[1] A. Neumann et al., "The BERLinPro SRF Photoinjector System - From First RF Commissioning to First Beam", in Proc. 9th Int. Particle Accelerator Conf. (IPAC'18), Vancouver, BC, Canada, Apr. 4,, pp. 1660-1663, doi:10.18429/JACoW-IPAC2018-TUPML053
[2] Yegor Tamashevich et al 2024 Eng. Res. Express 6 025009

Funding Agency

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Author: NEUMANN, Axel (Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-authors: GALDI, Alice (University of Salerno); Mr HEUGEL, Andreas (Helmholtz-Zentrum Berlin für Materialien und Energie); USHAKOV, Andriy (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr FRAHM, André (Helmholtz-Zentrum Berlin für Materialien und Energie); ALBERDI-ESUAIN, Benat (Helmholtz-Zentrum Berlin für Materialien und Energie); WANG, Chen (Helmholtz-Zentrum Berlin für Materialien und Energie); WANG, Chen (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr EICHEL, Dan (Helmholtz-Zentrum Berlin für Materialien und Energie); BROOKES, Emily Jayne (Helmholtz-Zentrum Berlin für Materialien und Energie); ERGENLIK, Ezgi (Helmholtz-Zentrum Berlin für Materialien und Energie); PFLOCKSCH, Fabian (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr HOFFMANN, Falk (Helmholtz-Zentrum Berlin für Materialien und Energie); Dr

REHM, Guenther (Helmholtz-Zentrum Berlin für Materialien und Energie); KLEMZ, Guido (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr STEIN, Hannes (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr PLÖTZ, Henry (Helmholtz-Zentrum Berlin für Materialien und Energie); HUCK, Holger (Deutsches Elektronen-Synchrotron DESY); WILL, Ingo (Max-Born-Institute for Nonlinear Optics and Short Pulse Spectroscopy); Mr ULLRICH, Jan (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen); VOELKER, Jens (Helmholtz-Zentrum Berlin für Materialien und Energie); DUBE, Jonas (Helmholtz-Zentrum Berlin für Materialien und Energie); KUEHN, Julius (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr KOLBE, Jörg (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr JANKE, Karsten (Helmholtz-Zentrum Berlin für Materialien und Energie); Ms OHM, Nina (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr SCHAPPEIT, Oliver (Helmholtz-Zentrum Berlin für Materialien und Energie); ECHEVARRIA, Pablo (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr FLEISCHHAUER, Roland (Helmholtz-Zentrum Berlin für Materialien und Energie); Dr MISTRY, Sonal (Helmholtz-Zentrum Berlin für Materialien und Energie); Mr ROTTERDAM, Stefan (Helmholtz-Zentrum Berlin für Materialien und Energie); LEDERER, Sven (Helmholtz-Zentrum Berlin für Materialien und Energie); BIRKE, Thomas (Helmholtz-Zentrum Berlin für Materialien und Energie); KAMPS, Thorsten (Helmholtz-Zentrum Berlin für Materialien und Energie)

Presenter: NEUMANN, Axel (Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Thursday Oral Session: B

Track Classification: MC4: SRF Technologies

Contribution ID: **129** Contribution code: **MOP16** Type: **Poster Presentation**

Magnetic flux expulsion lens: concept and measurements

Monday, September 22, 2025 2:30 PM (3 hours)

The trapping of magnetic flux during the transition of a superconducting radio frequency (SRF) cavity can substantially increase RF dissipation in the cavity walls, leading to a reduction in Q0, that in turn can increase cryogenic costs. The impact of trapped magnetic flux can be reduced by either suppressing the ambient magnetic field or by limiting/removing the influence of pinning sites in the material. The former involves custom engineering solutions, the latter requires an understanding of the magnetic response of the cavity material. To quantify magnetic trapping of cavity material, a magnetic flux lens (MFL) has been developed at CERN. This device is based on topological conduction cooling for small samples, allowing repeatable cooling dynamics to analyse the spatial thermal gradients and velocity of the superconducting wavefront. Each thermal cycle investigates the magnetic flux trapping on a macroscopic scale. A program of quantitative measurements of magnetic flux expulsion on flat samples has been used to assess the expulsion efficiency of bulk Nb, cold worked bulk Nb with and without heat treatments, sputtered Nb on Cu, sputtered Nb3Sn on Cu and SIS multilayer structures. An overview of the results are reported. Our concept offers a stand alone means to control the dynamics of the Meissner effect, and the MFL can be used both for material qualification and for investigation of the magneto-thermal behaviour of the RF layer.

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Yes

Footnotes

Funding Agency

Author: TURNER, Daniel (European Organization for Nuclear Research)

Co-author: MACPHERSON, Alick (European Organization for Nuclear Research)

Presenter: TURNER, Daniel (European Organization for Nuclear Research)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **130** Contribution code: **MOP29** Type: **Poster Presentation**

RF performance results of RF double quarter wave resonators for the high luminosity LHC project

Monday, September 22, 2025 2:30 PM (3 hours)

Double Quarter Wave (DQW) superconducting crab cavities will be employed to compensate for the vertical crossing angle in the High-Luminosity LHC (HL-LHC). Four DQW series cavities were manufactured and tested at the CERN vertical test facility. Each cavity undergoes a sequence of cold tests, starting from the bare cavity and progressing to the cavity in its final configuration, with all higher-order mode (HOM) couplers and the field antenna installed. This document presents the experience gained from RF cold test measurements of the first batch of DQW series cavities, with particular emphasis on measurements involving the HOM couplers. Challenges encountered during testing, such as limited field reach and the onset of field emission in two cavities equipped with HOM couplers, are also discussed.

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Yes

Footnotes

Funding Agency

Author: Mrs TURAJ, Katarzyna (European Organization for Nuclear Research)

Co-authors: BARRIERE, Simon (European Organization for Nuclear Research); BREGLIOZZI, Giuseppe (European Organization for Nuclear Research); CALAGA, Rama (European Organization for Nuclear Research); CALVO, Sebastien Jerome (European Organization for Nuclear Research); CAPATINA, Ofelia (European Organization for Nuclear Research); CHIODINI, Marco (European Organization for Nuclear Research); EDWARDS, Amelia (European Organization for Nuclear Research); MARQUES ANTUNES FERREIRA, Leonel (European Organization for Nuclear Research); DOMINGO GOMEZ, Sara (European Organization for Nuclear Research); MONTESINOS, Eric (European Organization for Nuclear Research); PECHAUD, Gabriel (European Organization for Nuclear Research); ROSAZ, Guillaume (European Organization for Nuclear Research); Mr STAPLEY, Niall (European Organization for Nuclear Research); VALVERDE ALONSO, Nuria (European Organization for Nuclear Research)

Presenter: EDWARDS, Amelia (European Organization for Nuclear Research)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **131** Contribution code: **MOP30** Type: **Poster Presentation**

RFD crab cavity HOM evolution: dressed cavities through to cryomodule testing at 2 K

Monday, September 22, 2025 2:30 PM (3 hours)

As part of the High Luminosity LHC (HL-LHC) project, crab cavities will be installed around CMS and ATLAS experiments of the LHC. To accommodate the different crossing angle planes, two cavity designs have been selected: the RF Dipole (RFD) and the Double Quarter Wave resonator (DQW).

Two prototype RFD cavities were fabricated and successfully tested at CERN. Subsequently, the cavities were integrated into a dedicated cryomodule at STFC Daresbury in the UK. At CERN's SM18 test facility the cryomodule was tested at 2 K, validating RF, mechanical, and cryogenic performance. Very strong damping along with potentially high HOM power (~1 kW) is specified as a requirement for both crab cavity designs. This study presents the evolution of Higher Order Mode (HOM) measurements for the two RFD cavities, including measurement results from vertical tests and cryomodule tests at 2 K. The measured results are compared simulation data and used to qualify the prototype HOM couplers and their performance across test environments.

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Yes

Footnotes

Funding Agency

Author: EDWARDS, Amelia (European Organization for Nuclear Research)

Co-authors: CALAGA, Rama (European Organization for Nuclear Research); CALVO, Sebastien Jerome (European Organization for Nuclear Research); CAPATINA, Ofelia (European Organization for Nuclear Research); MONTESINOS, Eric (European Organization for Nuclear Research); TURAJ, Katarzyna (European Organization for Nuclear Research); VALVERDE ALONSO, Nuria (European Organization for Nuclear Research)

Presenter: EDWARDS, Amelia (European Organization for Nuclear Research)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **132** Contribution code: **THP72** Type: **Poster Presentation**

New cleanroom nitrogen purge system to be used for superconducting radio frequency cavity string build at STFC

Thursday, September 25, 2025 2:30 PM (3 hours)

STFC has built new infrastructure to enable particulate control whilst building superconducting radio frequency cavity string and beam line assemblies that can be used in high beta cryomodule applications. The new facility includes an ISO4 cleanroom, low particulate high pressure rinse, and most recently, a nitrogen purge system that can allow varying and controlled purge of nitrogen through vacuum vessels as they are built. The nitrogen purge ensures that particulate ingress onto sensitive surfaces, such as within high beta RF cavities, is minimised. This paper describes the new purge system, its capabilities, and results from thorough validation testing to ensure that it operates within the required specification.

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Yes

Footnotes

Funding Agency

Author: WILDE, Stuart (Daresbury Laboratory)

Co-authors: Mr OATES, Adrian (Daresbury Laboratory); MASON, David (Daresbury Laboratory); MILLER, George (Daresbury Laboratory); HASSALL, John (Daresbury Laboratory); Mr STOWELL, John (Daresbury Laboratory); Dr MIDDLEMAN, Keith (Daresbury Laboratory); PENDLETON, Mark (Daresbury Laboratory); Dr KANE, Mitchell (Daresbury Laboratory); Mr POYNTON, Oliver (Daresbury Laboratory); Mr WARBURTON, Phil (Daresbury Laboratory)

Presenter: WILDE, Stuart (Daresbury Laboratory)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **133** Contribution code: **THP80** Type: **Poster Presentation**

Searching for axions: a new SRF cavity-based programme at CERN

Thursday, September 25, 2025 2:30 PM (3 hours)

As part of the Quantum Technology Initiative (QTI) at CERN, a programme to develop a novel SRF cavity for axion searches has been launched. This Axion Detector Demonstrator (QTI_ADD) is based on the heterodyne approach to axion detection, and uses a dedicated SRF cavity design with overlapping, quasi-degenerate modes to search for axion-induced photon conversion from a driven, resonant cavity mode (pump mode) to a second, distinct mode (signal mode), with the frequency spacing between them being proportional to the prospective axion mass.

Whilst the programme is its initial stages, the conceptual design of a suitable cavity and signal acquisition system has been outlined. Of particular interest are the constraints which arise from the anticipated measurement setup, with a sub-Kelvin cryogenic detector volume now foreseen, and axion mass scans to be performed using a non-mechanical tuning system. Key design choices and implications for the expected axion search reach are discussed, and the envisioned timeline for this QTI_ ADD facility and its first measurement programme are addressed.

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Yes

Footnotes

Funding Agency

Author: MILLAR, Lee (European Organization for Nuclear Research)

Co-authors: MACPHERSON, Alick (European Organization for Nuclear Research); GRUDIEV, Alexej (European Organization for Nuclear Research); Ms KOSS, Natalia (European Organization for Nuclear Research); Dr BARRIENTOS, Diego (European Organization for Nuclear Research); Mr BALOCCHI, Leonardo (European Organization for Nuclear Research); CALATRONI, Sergio (European Organization for Nuclear Research); Dr ELLIS, Sebastian (University of Geneva; King's College London); Dr KOETTIG, Torsten (European Organization for Nuclear Research); Dr VALLECORSA, Sofia (European Organization for Nuclear Research); Dr D'AGNOLO, Raffaele-Tito (Université Paris-Saclay; Laboratoire de Physique de l'ENS)

Presenter: MILLAR, Lee (European Organization for Nuclear Research)

Session Classification: Thursday Poster Session

Track Classification: MC5: SRF Applications

Contribution ID: **134** Contribution code: **THP59** Type: **Poster Presentation**

PIP-II LB650 cryomodules test bench at CEA

Thursday, September 25, 2025 2:30 PM (3 hours)

The Proton Improvement Plan - II (PIP-II) project at Fermi National Accelerator Laboratory (Fermilab) is the first U.S. accelerator initiative to include major in-kind contributions (IKC) from international partners. As part of the French contribution, the French Alternative Energies and Atomic Energy Commission (CEA) will deliver ten 650 MHz low-beta (LB650) cryomodules. These cryomodules incorporate superconducting cavities provided by INFN-LASA (Italy), Fermilab (USA), and DAE-VECC (India), as well as RF power couplers and tuning systems from Fermilab. The scope of work carried out by CEA includes the design, manufacturing, integration, and performance testing of the cryomodules. This paper focuses on recent progress related to the Site Acceptance Tests (SAT) for the main equipment of cryogenic and RF systems and the preparation of the test stand for the LB650 cryomodules. It highlights the ongoing efforts and progress made in preparing the infrastructure, as well as the steps being taken to ensure readiness for the upcoming cryogenic and high-power RF testing phases of the LB650 cryomodules.

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Yes

Footnotes

Funding Agency

Author: JENHANI, Hassen (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Co-authors: CHRISTIAN, ARCAMBAL (CEA Paris-Saclay); BAZIN, Nicolas (Commissariat à l'Energie Atomique); QUENTIN, Bertrand (CEA Paris-Saclay); MEHDI, Bounou (CEA Paris-Saclay); PHILIPPE, Bredy (CEA Paris-Saclay); DEVANZ, Guillaume (Commissariat à l'Energie Atomique); FLORIAN, Hassane (CEA Paris-Saclay); CHARLES, MAILLERET (CEA Paris-Saclay); MAURICE, Luc (Commissariat à l'Energie Atomique); PIQUET, Olivier (CEA Paris-Saclay); PATRICK, Sahuquet (CEA Paris-Saclay); SIMON, Claire (Commissariat à l'Energie Atomique)

Presenter: JENHANI, Hassen (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **138** Contribution code: **THP05** Type: **Poster Presentation**

Beam envelope measurements using beam position monitors for low-beta superconducting linear accelerator

Thursday, September 25, 2025 2:30 PM (3 hours)

Accurate monitoring of beam dynamics in superconducting linear accelerators (linacs) is important for minimizing beam losses and maintaining stable operation. In superconducting sections, however, destructive diagnostics must be avoided to prevent issues such as particulate contamination and outgassing, which makes direct beam envelope measurements particularly difficult. This work introduces a non-destructive approach that leverages beam position monitors (BPMs) to infer the transverse beam envelope by measuring the quadrupole moment of the beam profile. Although the principle was initially proposed in the 1980s, its adoption—especially for hadron beams—has remained limited due to insufficient signal sensitivity and the geometric limitations of conventional BPM designs. To address these challenges, we utilized BPMs with a cos(2θ) electrode structure, which provide enhanced sensitivity to quadrupole components and are particularly effective for low-β heavy ion beams. This technique was implemented in the superconducting RIKEN linac (SRILAC), where data from eight BPMs were combined with transfer matrix modeling and supplementary wire scanner measurements. The estimated beam envelopes showed good agreement with results from standard quadrupole scans, validating the proposed method as a practical tool for non-destructive, routine beam diagnostics in superconducting accelerator systems.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: NISHI, Takahiro (RIKEN Nishina Center)

Co-authors: YAMADA, Kazunari (RIKEN Nishina Center); SAKAMOTO, Naruhiko (RIKEN Nishina Center); KAMIGAITO, Osamu (RIKEN Nishina Center); KOYAMA, Ryo (SHI Accelrator Service Ltd.); ADACHI, Taihei (RIKEN Nishina Center); WATANABE, Tamaki (RIKEN Nishina Center)

Presenter: NISHI, Takahiro (RIKEN Nishina Center)

Session Classification: Thursday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **139** Contribution code: **TUP27** Type: **Poster Presentation**

Design, simulation and test of 975 MHz superconducting radio frequency cavity

Tuesday, September 23, 2025 2:30 PM (3 hours)

The superconducting linac is proposed for effective acceleration of proton beam in a new project of China Institute of Atomic Energy. A 975MHz superconducting radio frequency cavity is designed to accelerate the H+ ion beam in the energy range from 500 MeV to 1000 MeV. This paper will present the design and simulation, including the multi-parameter electromagnetic design and optimization, high-order modes analyses, multipacting simulations, mechanical and engineering analyses. A prototype cavities were fabricated and vertical tested to verify the electromagnetic properties, the fabrication and post-processing technologies.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: FAN, Yuxuan (China Institute of Atomic Energy)

Co-authors: YANG, Jinghe (China Institute of Atomic Energy); Mr WANG, Bo (China Institute of Atomic Energy)

Presenter: Mr WANG, Bo (China Institute of Atomic Energy)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **140** Contribution code: **MOP04** Type: **Poster Presentation**

Commissioning plans for the CSNS-II superconducting linac

Monday, September 22, 2025 2:30 PM (3 hours)

The power upgrade project of the China Spallation Neutron Source(CSNS-II) was officially launched in 2024. It will upgrade the accelerator complex five times its current beam power capability, from 100 kW to 500 kW. A key component of the project is the superconducting linac(SCL), designed to accelerate an H- beam of 43 mA peak current from 80 MeV to 300 MeV. The SCL is composed of two families of cavities: 324 MHz double-spoke cavities and 648MHz elliptical cavities. This article describes the commissioning strategy plans for the SCL, with a focus on techniques for establishing RF setpoints and implementing rapid fault recovery in the event of cavity or subsystem failures. Additionally, other critical requirements, such as beam matching and steering approaches are discussed as well.

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Yes

Footnotes

Funding Agency

Author: PENG, Jun (Institute of High Energy Physics)

Co-authors: HAN, Yanliang (China Spallation Neutron Source; Institute of High Energy Physics); LIU, Huachang (China Spallation Neutron Source; Institute of High Energy Physics); FENG, Xinyuan (China Spallation Neutron Source; Institute of High Energy Physics); LI, Zhiping (China Spallation Neutron Source; Institute of High Energy Physics)

Presenter: PENG, Jun (Institute of High Energy Physics)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **141** Contribution code: **MOP08** Type: **Poster Presentation**

Optimization of several operating parameters to increase the beam delivery time at the European XFEL

Monday, September 22, 2025 2:30 PM (3 hours)

The pulsed linac at EuXFEL, operated by DESY, is de-signed to deliver up to 2700 electron bunches during a beam delivery time of 600 µs within an RF flat-top time of 650 µs. The user community would like to have more photon pulses. This can be done only by increasing RF flat-top length. The whole RF pulse length at the linac is limited by several factors, primarily the RF pulse length in the existing photoinjector. The new RF photoinjector, currently under development and testing, will enable beam pulses of up to 800 µs. The second limiting factor could be the stability of the RF power sources, the klys-trons, which must handle longer high-voltage and RF pulses. Other very important parts are the accelerating cavities and RF fundamental couplers, which must handle higher power during cavity filling and a longer RF flat-top time. Initial investigations into extending the RF flat-top length began in 2022. Recently, various measures have been developed and implemented to increase the RF flat-top length while keeping power consumption low without compromising linac performance. These include optimizing the klystron high-voltage (HV) waveform, the high-power RF pulse shape, and the coupling factors of the accelerating cavities. The latest results from the tests of several RF stations with a beam delivery time of 800 µs are presented

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: VOGEL (FOGEL), Vladimir (Deutsches Elektronen-Synchrotron DESY)

Co-authors: AYVAZYAN, Valeri (Deutsches Elektronen-Synchrotron DESY); BRANLARD, Julien (Deutsches Elektronen-Synchrotron DESY); CHRISTOU, Chris (Deutsches Elektronen-Synchrotron DESY); Dr DIOMEDE, Marco (Deutsches Elektronen-Synchrotron DESY); KOSTIN, Denis (Deutsches Elektronen-Synchrotron DESY); Dr SCHMIDT, Christian (Deutsches Elektronen-Synchrotron DESY); Dr WALKER, Nicholas (Deutsches Elektronen-Synchrotron DESY)

Presenter: VOGEL (FOGEL), Vladimir (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **142** Contribution code: **THP24** Type: **Poster Presentation**

A LHe-free test facility for thin film SRF cavity testing

Thursday, September 25, 2025 2:30 PM (3 hours)

A new cryogenic facility for the RF testing of thin film coated SRF cavities has been designed and built at Daresbury Laboratory. This facility uses a pulse-tube cryocooler providing 2.7 W of cooling power at 4.2 K and enables cavity tests at: 1.3, 3 and 6 GHz. The cryostat has been constructed and has successfully passed initial vacuum and cryogenic tests. The primary focus of this facility is on testing 1.3 GHz single-cell TESLA cavities. For this, a bespoke conduction cooling system has been engineered to ensure optimal thermal contact to account for slight geometric variations between cavities. A new RF system has also been built that can be used for low power continuous wave and pulsed testing across the full range of test frequencies. With a throughput of at least one cavity per week, the facility provides an efficient platform to pre select cavities before high-power liquid helium testing at 2 and 4.2 K. Details of the design, commissioning and early performance of the facility are reported.

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Yes

Footnotes

Funding Agency

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Author: SEAL, Daniel (Science and Technology Facilities Council)

Co-authors: BURT, Graeme (Lancaster University; Cockcroft Institute); LEICESTER, Nathan (Cockcroft Institute); MALYSHEV, Oleg (Science and Technology Facilities Council; Cockcroft Institute); Dr MARKS, Harry (Lancaster University; Cockcroft Institute); MOGHEYSEH, Amir (Lancaster University; Cockcroft Institute); Ms RIGBY, Jordan (Science and Technology Facilities Council; Cockcroft Institute); POYNTON, Oliver (Science and Technology Facilities Council; Cockcroft Institute); SMITH, Liam (Science and Technology Facilities Council; Cockcroft Institute); Dr JOURI, Walid (University of Salford)

Presenter: SEAL, Daniel (Science and Technology Facilities Council)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **143** Contribution code: **TUP33** Type: **Poster Presentation**

Results of 1.3 GHz Nb cavity coated with Nb3Sn thin film deposition by PVD magnetron sputtering

Tuesday, September 23, 2025 2:30 PM (3 hours)

Nb3Sn thin film cavities are new generation of superconducting cavities, which have the potential to replace traditional pure niobium cavities owing to their superior theoretical radio frequency (RF) performance. Higher theoretical acceleration gradient and quality factor give Nb3Sn cavities more possibilities in the future. There have been relatively high success in producing such cavities by Sn diffusion method. The production of such cavities through thin film deposition on copper cavity foresees lower cost of material and at the same time profiting from higher thermal conductance of copper.

At Daresbury Laboratory, we have commissioned a new Nb3Sn deposition facility for depositing a Nb cavity with Nb3Sn. The system is based on using planar magnetron where the optimised parameters for Nb3Sn on flat surfaces had been well stablished. The Cavity was deposited at 580 ℃ using two special designed 2 inch magnetrons travelling inside cavity simultaneously from each end of the cavity. The deposition was done at 50 W DC power with a bias of -75 V. We further report on the RF performance of the cavity at 4 K in liquid He, demonstrating quality factor Q0 of 3x1010 comparable to Nb cavity at 2 K and extending to accelerating gradient of up to 16 MV/m.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

STFC

Author: VALIZADEH, Reza (Science and Technology Facilities Council)

Co-authors: BENJAMIN, Christopher (Science and Technology Facilities Council); Dr SEAL, Daniel (Science and Technology Facilities Council); Dr MALYSHEV, Oleg (Science and Technology Facilities Council); Dr SIMON, Stephane (Science and Technology Facilities Council)

Presenter: VALIZADEH, Reza (Science and Technology Facilities Council)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **144** Contribution code: **TUP28** Type: **Poster Presentation**

Optimisation of Nb3Sn Thin Films for SRF Applications at Daresbury Laboratory

Tuesday, September 23, 2025 2:30 PM (3 hours)

Nb3Sn is a promising alternative to bulk niobium (Nb) for superconducting radio-frequency (SRF) cavities due to its higher critical temperature and superheating field. In this study, Nb3Sn thin films were deposited via DC magnetron sputtering from a stoichiometric Nb:Sn alloy target onto various substrates, including diamond-turned Cu, bulk Nb, and Cu with a Nb bilayer. The influence of magnetron power, film thickness and substrate on the surface resistance (Rs) at 7.8 GHz was systematically investigated.

Films deposited at lower magnetron powers (50 W) demonstrated significantly lower Rs values, reaching $0.38\mu\Omega$ at 4.2 K, whereas higher power led to increased residual resistance, likely due to Cu diffusion and surface defects. Thinner Nb3Sn films exhibited elevated Rs while Nb3Sn films on bulk Nb showed variable performance depending on surface preparation, a film with a Nb bilayer on Cu unexpectedly underperformed relative to direct deposition on Cu.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

STFC

Author: BENJAMIN, Christopher (Science and Technology Facilities Council)

Co-authors: PIRA, Cristian (Istituto Nazionale di Fisica Nucleare); Dr SEAL, Daniel (Science and Technology Facilities Council); CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); BURT, Graeme (Lancaster University); CONLON, James (Science and Technology Facilities Council); SMITH, Liam (Science and Technology Facilities Council); VALIZADEH, Reza (Science and Technology Facilities Council); SIMON, Stephane (University of Liverpool); Dr MALYSHEV, oleg (Science and Technology Facilities Council)

Presenter: BENJAMIN, Christopher (Science and Technology Facilities Council)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **146** Contribution code: **TUP53** Type: **Poster Presentation**

First elliptic cavity fabricated with metallographic polishing

Tuesday, September 23, 2025 2:30 PM (3 hours)

The development of an easy and inexpensive Nb sheet preparation process, based on metallographic polishing has been presented earlier [1,2]. The aim is to remove the damage layer issued from the rolling process on the sheet in order to reduce the length of surface treatment on completed cavities. The process has been applied on a QPR sample and tested in RF, without any surface chemistry. Its surface resistance is about 4 times lower that the EP baseline at 414 MHz, 2 K [3]. The first elliptical cavity based on this principle has been produced at KEK, starting with large polished sheets developed in collaboration between IJCLAB, and the company LAMPLAN. We present its 1rst RF test at CEA, with a HF rinsing and a recrystallization treatment at 600 ℃ 10 h, without any chemical etching at first.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

[1] C. Z. Antoine and R. Crooks, "Reducing Electropolishing Time with Chemical-Mechanical Polishing", in Proc. SRF'09, Berlin, Germany, Sep. 2009, pp. 405-405.
[2] O. Hryhorenko et al., "An innovative approach of surface polishing for SRF cavity applications" , Journal of Manufacturing and Materials Processing, 2023. 7(2): p. 62.
[3] O. Hryhorenko et al., "Recent Advances in Metallographic Polishing for SRF Application", in Proc. SRF'23, Grand Rapids, MI, USA, Jun. 2023, pp. 646-650.

Funding Agency

Author: DOHMAE, Takeshi (High Energy Accelerator Research Organization)

Co-authors: Dr ANTOINE, Claire (Université Paris-Saclay); LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab); CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); EOZÉNOU, Fabien (Commissariat à l'Energie Atomique); JULIEN, Gregoire (Université Paris-Saclay); MAURICE, Luc (Commissariat à l'Energie Atomique); VANNSON, Mael (Université Paris-Saclay, CNRS/IN2P3, IJCLab); GANDOLFO, Nicolas (Université Paris-Saclay, CNRS/IN2P3, IJCLab); HRYHORENKO, Oleksandr (Thomas Jefferson National Accelerator Facility); RENARD, Sebastien (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Presenter: DOHMAE, Takeshi (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **147** Contribution code: **THP39** Type: **Poster Presentation**

Fabrication of the prototype spoke cavity for the JAEA-ADS linac

Thursday, September 25, 2025 2:30 PM (3 hours)

Japan Atomic Energy Agency (JAEA) has been proposing an accelerator-driven nuclear transmutation system (ADS) as a future nuclear system to efficiently reduce high-level radioactive waste generated at nuclear power plants. As the first step toward the full-scale CW proton linac for the JAEA-ADS, we are currently prototyping a low-beta (around 0.2) single-spoke cavity. Because there is no experience in manufacturing superconducting spoke cavities in Japan, prototyping and performance evaluation of the cavity are essential to ensure the feasibility of the JAEA-ADS. The actual cavity fabrication started in 2020, and the cavity assembly by electron-beam welding was finally completed in fiscal year 2024. The fabrication of the prototype spoke cavity is presented.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: TAMURA, Jun (Japan Atomic Energy Agency)

Co-authors: KONDO, Yasuhiro (Japan Atomic Energy Agency); YEE-RENDON, Bruce (Japan Atomic Energy Agency); MEIGO, Shin-ichiro (Japan Atomic Energy Agency); MAEKAWA, Fujio (Japan Atomic Energy Agency); KAKO, Eiji (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization); SAKAI, Hiroshi (High Energy Accelerator Research Organization); DOHMAE, Takeshi (High Energy Accelerator Research Organization)

Presenter: TAMURA, Jun (Japan Atomic Energy Agency)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **148** Contribution code: **MOP78** Type: **Poster Presentation**

Gamma-based diagnostics of field emission in SRF cavities and cryomodules using plastic scintillators: a joint study at ESS TS2

Monday, September 22, 2025 2:30 PM (3 hours)

Field emission is a major parasitic phenomenon that limits the performance of superconducting RF (SRF) cavities. It leads to the generation of dark currents and bremsstrahlung gamma rays, which in turn cause increased cryogenic load, local heating, and in severe cases, cavity quench. Moreover, the high dose rates produced in the proximity of the cavity can result in material damage and activation, posing additional challenges for maintenance and safe operation. The maturity of plastic scintillator technology, combined with recent advances in fast digital acquisition systems, enables the development of compact and sensitive diagnostics for these emissions. We present a modular gamma detection system based on plastic scintillators with various geometries, designed for temporally and spatially resolved measurements. Different prototypes have been deployed at the TS2 facility of the European Spallation Source (ESS) to monitor gamma radiation during RF tests. Preliminary results confirm its ability to detect field emission onset and localize emission regions, offering a promising tool for understanding emission mechanisms and improving SRF cavity performance and reliability.

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Yes

Footnotes

Funding Agency

Author: CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Co-authors: DEVANZ, Guillaume (Commissariat à l'Energie Atomique); Mr PIQUET, Olivier (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); MAURICE, Luc (Commissariat à l'Energie Atomique); MAIANO, Cecilia (European Spallation Source)

Presenter: CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **149** Contribution code: **THP43** Type: **Poster Presentation**

Strain gauge-based position monitoring of spaceframe-suspended SRF cavities

Thursday, September 25, 2025 2:30 PM (3 hours)

The VSR cavities, featuring protruding waveguides and HOM absorbers, are designed to be installed as part of the cold string in a spaceframe within a cryogenic vessel. Precise alignment of the cavities during installation and continuous position monitoring during operation are required to prevent damage of other cold string components such as bellows. To achieve this, strain gauges are installed on the rods suspending the cavity within the spaceframe, measuring the superimposed bending and normal forces. To validate this approach, assembly tests were conducted, comparing strain gauge measurements with laser tracker data. The results demonstrate that strain gauge-based monitoring enables continuous position tracking of the cavity. Operation within a vacuum vessel at low temperature still needs to be tested.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Ms OHM, Nina (Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-authors: Prof. VELEZ, Adolfo (TU Dortmund University); PFLOCKSCH, Fabian (Helmholtz-Zentrum Berlin für Materialien und Energie); GLÖCKNER, Felix (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen); SCHEMMEL, Kevin (Helmholtz-Zentrum Berlin für Materialien und Energie); WUNDERER, Nora (Helmholtz-Zentrum Berlin für Materialien und Energie); WIESE, Stefan (Helmholtz-Zentrum Berlin für Materialien und Energie); DÜRR, Volker (Helmholtz-Zentrum Berlin für Materialien und Energie)

Presenter: Ms OHM, Nina (Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **152** Contribution code: **THP11** Type: **Poster Presentation**

Role of niobium purity and thermal parameters in SRF cavity optimization

Thursday, September 25, 2025 2:30 PM (3 hours)

In continuous mode operation, performance of normal-conducting copper RF cavities is limited by high power dissipation around 100 kW/m, needed there for achieving a modest 2 MV/m gradient. In contrast, superconducting RF (SRF) cavities can easily exceed 15 MV/m under similar conditions due to nominal Ohmic losses, thus making them ideal for high-duty accelerators like SNS and ADSS.

We are pursuing a study*, in which a magneto-thermal analysis of niobium (Nb)-based SRF cavities, examines how the intrinsic properties like BCS resistance, thermal conductivity, and Kapitza resistance affect the performance of these cavities. These parameters are evaluated as functions of temperature, RF magnetic field, and material purity, better represented by normal-state conductivity than by residual resistivity ratio (RRR).

Our initial results show that cavities of RRR 100 grade niobium can provide high threshold magnetic field values and quality factors. Besides, a reduced wall thickness there, viable because of enhanced material strength, can result in an increase in thermal efficiency. Our study also indicates that defining material specifications for Nb-cavities in terms of normal-state conductivity and thermal diffusivity, might be a more accurate framework than RRR alone.

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Yes

Funding Agency

Footnotes

*Jana A R, Kumar A, Kumar V and Roy S B.. Pramana-J Phys 93, 51 (2019). https://doi.org/10.1007/s12043-019-1813-4

Author: Dr JANA, Arup Ratan (Variable Energy Cyclotron Centre)

Co-authors: Mr KUMAR, Abhay (Raja Ramanna Centre for Advanced Technology); KUMAR, Vinit (Raja Ramanna Centre for Advanced Technology); GURAZADA, Ravikumar (GITAM University); MYNENI, Ganapati (GITAM University); BARMAN ROY, Sindhunil (Ramakrishna Mission Vivekananda Educational and Research Institute)

Presenter: GURAZADA, Ravikumar (GITAM University)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **153** Contribution code: **TUP24** Type: **Poster Presentation**

Field emission analysis in SRF cavities for PIP-II using GEANT4

Tuesday, September 23, 2025 2:30 PM (3 hours)

Field emission (FE) remains a significant hurdle for achieving optimal performance and reliability in superconducting radiofrequency (SRF) cavities used in accelerator cryomodules. A thorough understanding of the generation and propagation of FE-induced radiation is therefore essential to mitigate this problem. The absence of standardized measurement protocols further complicates the comparison of radiation data across different testing phases and facilities. This highlights the need for a precise quantitative method to diagnose and analyze FE-induced radiation. Such efforts could prove beneficial for improving cavity preparation and cleanroom assembly techniques during the prototype and production stages of Fermilab's upcoming PIP-II project. In this study, we combine radiation diagnostics with detailed Geant4 simulations to analyze FE-induced radiation, enhance diagnostic accuracy, and optimize detector positioning. This integrated approach ultimately aims at optimizing the preparation, assembly, and testing procedures for PIP-II SRF cavities to achieve FE-free cryomodules.

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Yes

Footnotes

Funding Agency

Author: WIJETHUNGA, Sajini (Fermi National Accelerator Laboratory)

Co-authors: SUKHANOV, Alexander (Fermi National Accelerator Laboratory); Dr NAPOLY, Olivier (Fermi National Accelerator Laboratory); MCGEE, Kellen (Fermi National Accelerator Laboratory)

Presenter: MCGEE, Kellen (Fermi National Accelerator Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **154** Contribution code: **MOP57** Type: **Poster Presentation**

The design of a compact conduction-cooling system for SRF characterization

Monday, September 22, 2025 2:30 PM (3 hours)

The precise and efficient testing of the RF performance of superconducting radio frequency (SRF) samples under superconducting conditions serves as the fundamental support for developing new SRF materials. The traditional SRF material RF performance testing systems have technical bottlenecks such as strong dependence on liquid helium, long testing cycles, and high operating costs. In this paper, a conduction-cooling RF performance testing system for SRF materials is presented. This system has the ability to achieve high-field and high-resolution measurement of the surface resistance without liquid helium cooling. The system is designed based on an optimized mushroom-type sample host cavity, which mainly works at 3.9 GHz TE011 mode. The radius of the sample is 33 mm. The microwave surface loss of the cavity can be reduced by coating niobium-tin on the inner surface and the conduction-cooling structure is well designed. The resolution and range of Rs measurement are analyzed by Multiphysics simulation in this work.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: WANG, Gai (Anhui University)

Co-authors: Mr QUAN, Shengwen (Peking University); WANG, Fang (Peking University); REN, Manqian (Peking University); WANG, Ziyu (Peking University); YAO, Zeqin (Peking University); ZHANG, Xiang (Peking University); ZHANG, Yue (Anhui University); XU, Zhongxiang (Anhui University)

Presenter: WANG, Gai (Anhui University)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **155** Contribution code: **TUP04** Type: **Poster Presentation**

Cavity compensation studies in the JAEA-ADS superconducting linac using LightWin

Tuesday, September 23, 2025 2:30 PM (3 hours)

High-intensity accelerators, particularly Accelerator-Driven Systems (ADS), require high availability and reliability for proper operation. For superconducting linear accelerators, the ability to continue operating even when one of the RF cavities fails is key to achieving the required availability, known as cavity compensation. Beam dynamics studies of the JAEA-ADS linear accelerator have demonstrated the possibility of operating with multiple RF cavities disabled with acceptable beam quality. Several other superconducting linear accelerator laboratories have adopted similar methods and developed their procedures. Among these efforts, the LightWin tool has proven to be an effective tool for automatically and systematically identifying compensation settings for each cavity failure in any linear accelerator. This software has been successfully utilized on the MINERVA linac, as well as on the high-energy part of the JAEA-ADS linac. It has currently been tested and improved to ease SPIRAL2 operation. This work presents an analysis of cavity compensation in the JAEA-ADS superconducting linear accelerator using the LightWin tool and compares the results with previous studies.

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Yes

Footnotes

Funding Agency

Author: YEE-RENDON, Bruce (Japan Atomic Energy Agency)

Co-authors: Dr PLAÇAIS, Adrien (Laboratoire de Physique Subatomique et de Cosmologie); BOULY, Frédéric (Laboratoire de Physique Subatomique et de Cosmologie); MAEKAWA, Fujio (Japan Atomic Energy Agency); TAMURA, Jun (Japan Atomic Energy Agency); MEIGO, Shin-ichiro (Japan Atomic Energy Agency); KONDO, Yasuhiro (Japan Atomic Energy Agency)

Presenter: YEE-RENDON, Bruce (Japan Atomic Energy Agency)

Session Classification: Tuesday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **156** Contribution code: **MOP07** Type: **Poster Presentation**

Beam dynamics studies of cavity failures for the initial operation phase of the ESS superconducting linac

Monday, September 22, 2025 2:30 PM (3 hours)

The European Spallation Source (ESS) superconducting proton linac is currently undergoing commissioning. During the initial operation phase, the final beam energy will be about 800 MeV, reaching a 2 MW power. High reliability and availability are crucial for the success of the ESS science programs and thus operations will be maintained even with failures of main linac components such as cavities and quadrupoles, as long as ˜50 % of the intended power can be achieved. To this end, we developed beam optics strategies to address failures in the cavities of the superconducting linac. Due to the constraints in the RF cavity amplitudes, we implemented a modified version of standard cavity compensation techniques. The results indicated that this strategy enables beam recovery that meets the beam quality specifications, thereby enhancing the availability of the ESS linac.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: YEE-RENDON, Bruce (Japan Atomic Energy Agency)

Co-authors: KONDO, Yasuhiro (Japan Atomic Energy Agency); TAMURA, Jun (Japan Atomic Energy Agency); MEIGO, Shin-ichiro (Japan Atomic Energy Agency); MAEKAWA, Fujio (Japan Atomic Energy Agency); MIYAMOTO, Ryoichi (European Spallation Source); MILAS, Natalia (European Spallation Source); ESHRAQI, Mamad (European Spallation Source)

Presenter: YEE-RENDON, Bruce (Japan Atomic Energy Agency)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **157** Contribution code: **TUP65** Type: **Poster Presentation**

Overview of metal cathode R&D for the CW L-band SRF photoinjector at DESY

Tuesday, September 23, 2025 2:30 PM (3 hours)

Thread-mounted cathode installation directly at the backwall of the gun cavity allows cavity cleaning following cathode installation and thus beneficial for RF performance of the injector. Recent vertical tests of the CW L-band SRF gun cavity with a copper cathode installed demonstrated world-record high axial electric fields (up to 50 MV/m). While beneficial for RF performance, photoemissive performance of copper degrades quickly following air and water exposure (high pressure water rinsing followed by 90 degree bake out). In this work, we provide an overview of metal photocathode R&D activities aimed at addressing a challenging set of requirements with the goal of meeting top-level parameters of the future CW / high-duty-cycle upgrade of the European XFEL: 100 pC at 1 MHz in CW regime.

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Yes

Footnotes

Funding Agency

Work performed in the framework of R&D for future accelerator operation modes at the European XFEL and financed by the European XFEL GmbH.

Author: BAZYL, Dmitry (Deutsches Elektronen-Synchrotron DESY)

Co-author: VOGEL, Elmar (Deutsches Elektronen-Synchrotron DESY)

Presenter: VOGEL, Elmar (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **158** Contribution code: **MOP63** Type: **Poster Presentation**

Status of the power coupler for the half wave resonator in Institute for Rare Isotope Science

Monday, September 22, 2025 2:30 PM (3 hours)

A heavy-ion accelerator facility was constructed for the Rare Isotope Science Project (RISP) at the Institute for Rare Isotope Science (IRIS) in Daejeon, Korea. The cryomodule with quarter-wave resonators (QWRs) and half-wave resonators (HWRs) was installed in the SCL (Superconducting Linac) 3 tunnel, and the beam commissioning (Beam energy = 16.4 MeV/u, 40Ar8+) has been completed. The geometry of the power coupler for the HWRs is a coaxial capacitive type based on a conventional 1-5/8 inch electronic industries alliance (EIA) 50 Ω coaxial transmission line with a single ceramic window. The multi-physics analysis, which includes electromagnetic, thermal, and mechanical analysis, was performed by ANSYS to evaluate the thermal expansion of the power couplers. In this paper, we present the analysis results and revised design of the power coupler for HWRs.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Prof. YOON, Junyoung (Cheongju University)

Co-authors: KAKO, Eiji (High Energy Accelerator Research Organization); Mr CHA, Daeboo (Vitzro Tech (South Korea)); Mr LEE, Dongkeun (Vitzro Tech (South Korea)); JEON, Sungmin (Kyungpook National University); CHUNG, Yeonsei (Institute for Basic Science); Mr JO, Yong Woo (Institute for Basic Science); Dr JUNG, Yoochul (Institute for Basic Science); CHO, Yong-Sub (Korea Atomic Energy Research Institute); Dr KIM, Youngkwon (Institute for Basic Science)

Presenter: JEON, Sungmin (Kyungpook National University)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **159** Contribution code: **MOP32** Type: **Poster Presentation**

RF testing and performance analysis of low beta superconducting cavities for HIAF and CiADS facilities

Monday, September 22, 2025 2:30 PM (3 hours)

RF testing and performance analysis of low beta superconducting cavity cryomodules are in progress for the two facilities: High Intensity Heavy Ion Accelerator (HIAF) and Chinese initiative Accelerator Driven System (CiADS). This poster describes the status and progress of RF conditioning, plasma cleaning, key cavity parameter identification, cavity operation limits testing, and stability testing of cavities and cryomodules during horizontal and integration testing. Advanced measurement techniques are introduced, such as online measurement of key cavity parameters (loaded Q and cavity frequency) during cryomodule cooling-down process, as well as dynamic detuning and dynamic loaded Q identificatoin in SEL and GDR loops. In addition, cavity quench strong textbehaviors under pulsed and CW RF operations are also discussed.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: WEI, Shihui (Institute of Modern Physics)

Co-authors: QIU, Feng (Institute of Modern Physics, Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences); WANG, Zhijun (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **160** Contribution code: **THP23** Type: **Poster Presentation**

Fabrication of 1.3 GHz MgB2 superconductor-on-copper cavity using hybrid physical-chemical vapor deposition

Thursday, September 25, 2025 2:30 PM (3 hours)

Superconductor MgB2 has a Tc of 40 K, and its materials parameters suggest that SRF cavities with higher Q, higher gradient, and higher operation temperatures than Nb cavities can potentially be made from MgB2. We present our ongoing efforts towards the development of MgB2-coated SRF cavities. Thick MgB2 films, up to 5 um in thickness, were deposited onto 1.3 GHz Tesla-type copper RF cavities using a hybrid physical-chemical vapor deposition (HPCVD) process. The mock cavities were fabricated through deep drawing. A pair of clamshell resistive heaters was employed for heating the cavity during the coating. MgB2 films grown on 1 cm × 1 cm copper substrates attached to the inner wall of the cavities exhibited a critical temperature of up to 38 K, as determined by AC susceptibility measurements. Uniform MgB2 film coatings were achieved by moving the Mg and B source in tandem with computerized control of deposition parameters, including cavity temperatures and gas flow rates. The MgB2 films were also characterized by RF surface resistance measurements.

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Yes

Footnotes

Funding Agency

This work was supported by the U.S. Department of Energy, Office of Science under Grant DE-SC0022330.

Author: Prof. XI, Xiaoxing (Temple University)

Co-authors: Dr CHEN, Ke (Temple University); Dr XU, Xiaojun (Temple University)

Presenter: Prof. XI, Xiaoxing (Temple University)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **161** Contribution code: **TUP32** Type: **Poster Presentation**

Research and development of Nb3Sn SRF cavity at IHEP

Tuesday, September 23, 2025 2:30 PM (3 hours)

Research of Nb3Sn superconducting radio-frequency (SRF) cavities was conducted at the Institute of High Energy Physics Chinese Academy of Sciences (IHEP), in order to improve the intrinsic quality factor (Q0) and accelerating gradient (Eacc). Various recipes of coating were attempted at SRF cavities and samples made of Nb, which resulted in different Sn content. It was found that the Sn content, namely the ratio of Nb/Sn, had great influences on the performance of Nb3Sn SRF cavities. When the ratio of Nb/Sn was slightly higher than 3, the Nb3Sn SRF cavities showed the best performance during the vertical test. Q0 of 1.3 GHz 1-cell Nb3Sn SRF cavity (the ratio of Nb/Sn ≈ 3.16) reached 3.0 × 1010 (@ 4.2 K) and 1.0 × 1011 (@ 2.0 K) at low RF field. Besides, conduction cooling of Nb3Sn SRF cavity has also been carried out at IHEP.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: SHA, Peng (Institute of High Energy Physics)

Co-authors: PAN, Weimin (Chinese Academy of Sciences); LIU, Baiqi (Institute of High Energy Physics); HE, Feisi (Institute of High Energy Physics); JIN, Song (Institute of High Energy Physics); Mr YU, Jinxin (Institute of High Energy Physics); Ms DONG, Chao (Institute of High Energy Physics); MI, Zhenghui (Institute of High Energy Physics); ZHAI, Jiyuan (Institute of High Energy Physics)

Presenter: SHA, Peng (Institute of High Energy Physics)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **162** Contribution code: **MOP60** Type: **Poster Presentation**

Initial conditioning of the 1.5 GHz prototype couplers for VSR demo

Monday, September 22, 2025 2:30 PM (3 hours)

Two Prototype 1.5 GHz fundamental power couplers for the VSR (Variable pulse length Storage Ring) DEMO project at Helmholtz Zentrum Berlin (HZB), were produced by Research Instruments (RI) and Thales, with the aim to reach 16 KW CW. To allow for conditioning of the couplers in cold a dedicated coupler test stand was designed, installed and commissioned, creating a testing environment that mimics the module conditions. The couplers were initially delivered in March 2023 after substantial reworking, however due to leak tightness issues further reworking was required and were finally installed on the dedicated test stand in June 2024. Such significant levels of rework dictated the more cautious testing plan detailed in this paper. After a 120C baking, an initial short run of conditioning was performed August 2024, followed by a longer conditioning run in May of 2025. Here, we will present the first conditioning results for the VSR Demo prototype fundamental power couplers.

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Yes

Footnotes

Funding Agency

Author: SHARPLES-MILNE, Emmy (Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-authors: Prof. VELEZ, Adolfo (TU Dortmund University); NEUMANN, Axel (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen); WUNDERER, Nora (Helmholtz-Zentrum Berlin für Materialien und Energie); Dr ECHEVARRIA, Pablo (Helmholtz-Zentrum Berlin für Materialien und Energie); DÜRR, Volker (Helmholtz-Zentrum Berlin für Materialien und Energie)

Presenter: SHARPLES-MILNE, Emmy (Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **163** Contribution code: **TUP05** Type: **Poster Presentation**

Three years of operating the superconducting linac for the Linac Coherent Light Source (LCLS)

Tuesday, September 23, 2025 2:30 PM (3 hours)

The LCLS-II project has installed a new superconducting linac at SLAC National Accelerator Laboratory to enable free electron laser science at repetition rates up to 1 MHz. The installed 35 1.3 GHz cryomodules produce an electron beam with energy of up to 4 GeV. Commissioning of the superconducting linac began in mid-2022, leading to the achievement of first light in 2023 and subsequent user experiment deliveries in 2024.

This poster will provide an overview of the operational experience gained during the three years of operations, focusing on the performance of the superconducting radiofrequency (SRF) cavities and associated systems in the linac. Highlighted topics include beam stability, cavity availability and failure modes, as well as performance improvements in preparation for the installation of the LCLS-II High Energy (HE) Upgrade. Additionally, we will discuss challenges faced, such as power outages, and address degradation mechanisms, including field emission.

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Yes

Footnotes

Funding Agency

Author: ADERHOLD, Sebastian (SLAC National Accelerator Laboratory)

Presenter: ADERHOLD, Sebastian (SLAC National Accelerator Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **164** Contribution code: **TUP57** Type: **Poster Presentation**

Preliminary results of electromagnetic simulation for optimizing an SRF gun cavity

Tuesday, September 23, 2025 2:30 PM (3 hours)

A high beam brightness is an important requirement for an electron linear accelerator, with the electron source setting the lower limit for the achievable brightness. A superconducting radio-frequency photoelectron injector (SRF gun)) stands out as an advanced electron source capable of delivering beams with superior properties compared to other continuous-wave injectors. Currently, SRF guns are being reliably operated at various accelerators. However, the gun cavities are operated below its design gradient due to the field emission. This lower gradient reduces particle energy gain per cell and adversely affects beam quality by deviating from theoretical optima.

To overcome these limitations, a new cavity design is being explored, with the peak surface electric field restricted to 30 MV/m, corresponding to the fields that have typically been achieved so far. In the first step, the first half-cell geometry will be optimized to maximize the ratio of the cathode's electric field to the resonator's surface field (Ecath/Epk) which guarantees the maximum possible acceleration of the electrons from their generation. Following this, additional optimized cells are included to maximize the beam energy gain. Subsequent to the electromagnetic optimization, beam dynamics study will provide the operating point of the SRF gun to maximize the beam brightness. This contribution will discuss the initial findings from the electromagnetic and beam dynamics study.

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Yes

Footnotes

Funding Agency

Author: HALLILINGAIAH, Gowrishankar (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: ARNOLD, Andre (Helmholtz-Zentrum Dresden-Rossendorf); TEICHERT, Jochen (Helmholtz-Zentrum Dresden-Rossendorf); XIANG, Rong (Helmholtz-Zentrum Dresden-Rossendorf); MURCEK, Petr (Helmholtz-Zentrum Dresden-Rossendorf); GATZMAGA, Stefan (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: HALLILINGAIAH, Gowrishankar (Helmholtz-Zentrum Dresden-Rossendorf)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **165** Contribution code: **TUP44** Type: **Student Poster Presentation**

In-situ plasma processing on low-beta cavities at the Argonne Tandem Linac Accelerator System (ATLAS)

Tuesday, September 23, 2025 2:30 PM (3 hours)

A method to enhance ATLAS low-beta superconducting cavities has been developed at Argonne National Laboratory in collaboration with MSU/FRIB, Fermilab, IJCLab, JLab, and BNL. At the center of the accelerator, a cryostat containing seven 72 MHz QWR installed in 2014 has world-leading performance for ion linacs at v/c˜0.1, though performance has been reduced by ˜20 % over the past decade due to contaminants. ATLAS operates over 6000 hours annually with a winter maintenance period, during which we aim to recover cavity performance through in-situ plasma processing. Cold testing on a spare 72 MHz QWR before and after fundamental mode plasma processing, using the real ATLAS coupler and an 80:20 Ar/O2 gas mixture, demonstrates remarkable improvements. We present experimental results of plasma processing on the spare cavity in both bench-top test and realistic test-cryostat environments. We include a system developed to prevent plasma formation in the coupler port.

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Yes

Footnotes

Funding Agency

Author: MCINTYRE, Megan (Argonne National Laboratory)

Co-authors: SINHA, Deeksha (Northern Illinois University); ZINKANN, Gary (Argonne National Laboratory); KELLY, Michael (Argonne National Laboratory); SAMARDZIC, Milica (Georgia Institute of Technology); PETERSEN, Troy (Argonne National Laboratory)

Presenters: MCINTYRE, Megan (Argonne National Laboratory); KELLY, Michael (Argonne National Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **166** Contribution code: **MOP33** Type: **Poster Presentation**

Status of the 650 MHz elliptical cavities in IMP

Monday, September 22, 2025 2:30 PM (3 hours)

650 MHz multicell superconducting radio frequency (SRF) elliptical cavities are developed for stable acceleration of proton beam in the Chinese initiative Accelerator Driven Subcritical System (CiADS). Two families of such cavities with optimum beta equal to 0.62 and 0.82, respectively, were proposed to boost the beam energy from 175 MeV to 500 MeV, with the capabilities to upgrade the energy to higher level with additional Ellip.082 cryomodule. Electromagnetic design, mechanical Design and Multiphysics analysis of the cavities were performed, two prototype cavities were fabricated, post-processed and vertical tested. Overview status of the elliptical cavities will be discussed in the paper.

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Yes

Footnotes

Funding Agency

Author: HUANG, Yulu (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: JIANG, TIANCAI (Institute of Modern Physics); WANG, Zhijun (Institute of Modern Physics, Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: HUANG, Yulu (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **167** Contribution code: **MOP70** Type: **Poster Presentation**

Status of the 650 MHz high power couplers in IMP

Monday, September 22, 2025 2:30 PM (3 hours)

The 650 MHz high power coupler has been designed and developed by IMP for medium-high beta elliptical superconducting cavities in the Chinese Initiative for Accelerator Driven Subcritical Systems (CiADS) project, delivering an average power of 130 kW. The coupler incorporates a door knob conversion structure, 75 ohm coaxial structure and dual warm window structure to achieve long term stable operation at high power. The electromagnetic design, multi-physical field analysis and mechanical design of the coupler have been completed, and prototype production of the coupler has been completed. The traveling and standing wave conditioning results of the coupler are discussed in this paper.

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Yes

Footnotes

Funding Agency

Author: JIANG, TIANCAI (Institute of Modern Physics)

Co-authors: LIU, Guochang (Institute of Modern Physics, Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences); WANG, Zhijun (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: JIANG, TIANCAI (Institute of Modern Physics)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **169** Contribution code: **MOP37** Type: **Poster Presentation**

Strength evaluation of large-grain niobium sheets and derivation of allowable stress

Monday, September 22, 2025 2:30 PM (3 hours)

The high-purity niobium material used in the superconducting cavities is an ingot produced by electron beam melting, and is a polycrystalline with a grain size of 10 to 200 mm. Niobium sheets sliced from ingots contain large grains and called as large grain (LG). Superconducting cavities made from LG niobium have the advantages of a high maximum acceleration gradient, Q value, and low manufacturing cost. Large-numbered tensile testing at room temperature using two kinds of LG niobium sheets with RRR392 and RRR189 was performed. The tensile strengths are 79.2 MPa and 83.3 MPa, respectively, about half that of ordinary fine grain (FG) niobium. The variation of strength is significant due to crystal orientation. The minimum tensile strength was estimated based on material strength studies to apply the LG cavity to the High-Pressure Gas Safety Act, and the allowable stress for vessel design was derived. These are 12 MPa and 15 MPa, respectively, which are less than half that of FG niobium. The strength estimation method shown here can be applied with approximately 50 tensile testing results. It is also simple and versatile and does not require crystal orientation measurement.

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Yes

Footnotes

Funding Agency

Author: UMEZAWA, Hiroaki (Tokyo Denkai Co., Ltd.; The Graduate University for Advanced Studies, SOKENDAI)

Co-authors: YAMANAKA, Masashi (High Energy Accelerator Research Organization); Mr NISHIDA, Naoshi (Tokyo Denkai Co., Ltd.)

Presenter: UMEZAWA, Hiroaki (Tokyo Denkai Co., Ltd.; The Graduate University for Advanced Studies, SOKENDAI)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **170** Contribution code: **THP36** Type: **Poster Presentation**

RF measurements and performance tests at 4 K of cryomodule 1 cavities for HELIAC

Thursday, September 25, 2025 2:30 PM (3 hours)

A new superconducting (sc) continuous-wave (cw) linear accelerator (linac) is currently being built at GSI to meet the future requirements in research on superheavy elements (SHE) synthesis and material science with a particular focus on fusion studies. The HElmholtz LInear Accelerator (HELIAC) will provide ion beams in the energy range from 1.4 MeV/u to 7.3 MeV/u with a mass-to-charge ratio (A/z) of up to 6. For acceleration, superconducting multi-cell crossbar-H-mode (CH) cavities operating at a resonance frequency of 217 MHz are used. Additionally, superconducting single-spoke buncher cavities are employed for longitudinal beam matching within the CH sections. In 2023/2024, the first cryomodule, CM1, consisting of three CH cavities, one buncher, and two sc solenoids, was commissioned with beam at the GSI test stand. This paper presents RF measurements and performance tests of the cavities conducted during initial operation of CM1.

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Yes

Footnotes

Funding Agency

Author: DZIUBA, Florian Dirk (GSI Helmholtz Centre for Heavy Ion Research)

Co-authors: BARTH, Winfried (GSI Helmholtz Centre for Heavy Ion Research); GETTMANN, Viktor (GSI Helmholtz Centre for Heavy Ion Research); KUERZEDER, Thorsten (Helmholtz Institute Mainz); LIST, Julian (Helmholtz Institute Mainz); MISKI-OGLU, Maksym (GSI Helmholtz Centre for Heavy Ion Research); PODLECH, Holger (Goethe University Frankfurt); YARAMYSHEV, Stepan (GSI Helmholtz Centre for Heavy Ion Research)

Presenter: DZIUBA, Florian Dirk (GSI Helmholtz Centre for Heavy Ion Research)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **171** Contribution code: **THP34** Type: **Poster Presentation**

Characterizing and controlling recovery and recrystallization in niobium for improved SRF cavity performance

Thursday, September 25, 2025 2:30 PM (3 hours)

Crystal defects, such as dislocations and low-angle boundaries, provide sources of magnetic flux trapping in the Nb materials used for superconducting radio frequency (SRF) resonating cavities. Improving the performance of SRF cavities, as measured through the quality factor, requires reducing these defects. SRF cavity production involves deformation processing, such as rolling and forming, and strategic annealing heat treatments. The resulting microstructures can be recovered, recrystallized, or both. Because recovery leaves many defects that can trap flux, recrystallization should improve cavity performance. Thus, processing schedules that produce complete recrystallization without excessive grain growth need to be designed. Solutions to this problem require understanding physical metallurgy and differentiating between recovered and recrystallized regions of microstructure. Backscattered electron microscopy techniques are applied to this end. We demonstrate that the conditions required to produce fully recrystallized microstructures depend on Nb impurity content, suggesting that processing schedules may need to be adjusted by material heat or lot. We also demonstrate that processing can be used to control recrystallized grain growth to maintain mechanical strength in fully recrystallized materials. Forming cavities from cold-rolled Nb sheet material may provide strategic new routes to obtain microstructures that improve SRF cavity performance.

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Yes

Footnotes

Funding Agency

U.S. Department of Energy, Office of High Energy Physics under Grant DE-SC0009960

Author: TALEFF, Eric (The University of Texas at Austin)

Co-authors: Ms BANERJEE, Sucharita (The University of Texas at Austin); Dr BENNETT, Thomas (Sandia National Laboratories); BALACHANDRAN, Shreyas (Florida State University; National High Magnetic Field Laboratory); CHETRI, Santosh (Florida State University; National High Magnetic Field Laboratory); Mr BORITZ, Trent (Florida State University; National High Magnetic Field Laboratory); DHAKAL, Pashupati (Thomas Jefferson National Accelerator Facility); Mr THUNE, Zack (Michigan State University); Prof. EISENLOHR, Philip (Michigan State University); LEE, Peter (National High Magnetic Field Laboratory); Prof. BIELER, Thomas (Michigan State University)

Presenter: TALEFF, Eric (The University of Texas at Austin)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **172** Contribution code: **MOP36** Type: **Poster Presentation**

The fabrication of the 1.3 GHz single-cell cavities by niobium materials with fine and medium grain sizes

Monday, September 22, 2025 2:30 PM (3 hours)

The collaboration research is conducted according to the ITN (ILC Technology Network). As a part of research into the manufacturing methods for SRF cavities used in ILC (International Linear Collider), two 1.3 GHz single-cell cavities were fabricated by utilizing fine and medium grain size niobium materials, respectively. Those cavities are manufactured by KAT Co., Ltd. in Korea under the research collaboration for ILC SRF cavity between KEK and KU (Korea University). Both cavities are fabricated with the same process and toolings including the pressing dies, machining jigs, and welding jigs. They have been tested in KEK and satisfied the required specification in the vertical test. This presentation shows lesson learn during the fabrication process of both cavities.

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Yes

Footnotes

Funding Agency

Author: PARK, HeeSu (Kiswire Advanced Technology Ltd.)

Co-authors: HAN, Junho (Kiswire Advanced Technology Ltd.); HWANG, Jongmo (Korea University Sejong Campus); KIM, Eun-San (Korea University Sejong Campus); DOHMAE, Takeshi (High Energy Accelerator Research Organization); SAEKI, Takayuki (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization)

Presenter: PARK, HeeSu (Kiswire Advanced Technology Ltd.)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **173** Contribution code: **TUP56** Type: **Poster Presentation**

Development of organic solvent electropolishing method for Nb cavity

Tuesday, September 23, 2025 2:30 PM (3 hours)

Electropolishing (EP) is used for the surface treatment of Nb cavities used in superconducting accelerators. The electrolyte for Nb material EP is a mixture of hydrofluoric acid and sulfuric acid, which makes EP work in Nb cavities very expensive. In this study, the development of a new EP method for Nb cavity using fluoride salts and organic solvents will be reported. The organic solvents with high flash point and high relative permittivity, such as ethylene glycol and formamide were chosen. It was found that an electrolyte solution of ammonium fluoride dissolved in ethylene glycol (2 M) could be used for mirror finish

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Yes

Footnotes

Funding Agency

Author: GOTO, Takeyoshi (High Energy Accelerator Research Organization)

Presenter: GOTO, Takeyoshi (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **175** Contribution code: **TUP48** Type: **Poster Presentation**

Improvement of performance for Nb/Cu hydroformed full-seamless cavity

Tuesday, September 23, 2025 2:30 PM (3 hours)

In order to reduce the cost of superconducting cavities, research has been actively conducted in recent years to realize inexpensive cavities by making the cavity body out of copper and coating the inside with niobium to induce superconductivity. The inner surface of the accelerating cavity must be smooth, and a seamless cavity is ideal as a base for the coating. We came up with the idea of manufacturing a seamless cavity from a single copper pipe, and succeeded in prototyping it by hydroforming. At CERN, a niobium coating with a film thickness of about 5 μm was applied by magnetron sputtering. Electric field performance tests were conducted at KEK, and the accelerating gradient reached 12 MV/m at 4 K and 16 MV/m at 1.85 K. We are currently working on further improvements to improve performance. After hydroforming, the inner surface of the cell becomes rough. We report our efforts to improve the roughness by polishing and to design a new mold to improve the accuracy of the cell shape, and the results of hydroforming.

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Yes

Footnotes

Funding Agency

Author: YAMANAKA, Masashi (High Energy Accelerator Research Organization)

Co-authors: ROSAZ, Guillaume (European Organization for Nuclear Research); ARAKI, Hayato (High Energy Accelerator Research Organization)

Presenter: YAMANAKA, Masashi (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **176** Contribution code: **MOP24** Type: **Poster Presentation**

Design, fabrication and concept for the surface treatment of the SRF cavity prototype for the CLIC damping rings

Monday, September 22, 2025 2:30 PM (3 hours)

The Compact Linear Collider (CLIC) Damping Rings (DRs) must generate ultra-low emittance bunches to achieve high luminosity. This requires many wigglers with high energy loss, compensated by the RF system. The resulting strong beam loading transients pose a major challenge for RF system design. A novel 2 GHz SRF cavity with an ultra-low R/Q below 1 Ω is proposed to minimize these transients. Design and fabrication of a bulk Nb prototype, turned from a single piece and EB welded, are presented. A conceptual study of surface treatment to achieve the highest surface magnetic field—the goal of the prototype cold test—is also described. To enable excellent performance, we plan to apply a 75/120℃ modified low-temp bake with cold electropolishing. This approach consistently delivers high gradients and quality factors in TESLA-shaped 1.3 GHz SRF cavities. Adapting this for the 2 GHz ultra-low R/Q design aims to maximize surface magnetic field while minimizing residual resistance and field emission—critical to meeting CLIC DR RF performance requirements under high beam loading.

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Yes

Footnotes

Funding Agency

Author: BAFIA, Daniel (Fermi National Accelerator Laboratory)

Co-authors: GRUDIEV, Alexej (European Organization for Nuclear Research); SMITH, Davida (Fermi National Accelerator Laboratory); EREMEEV, Grigory (Fermi National Accelerator Laboratory); HU, Hannah (University of Chicago); SCIBOR, Karol (European Organization for Nuclear Research); BETEMPS, Robin (European Organization for Nuclear Research); BARRIERE, Simon (European Organization for Nuclear Research); DEMAZIERE, Thomas (European Organization for Nuclear Research); RING, Tim (Fermi National Accelerator Laboratory)

Presenter: BAFIA, Daniel (Fermi National Accelerator Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **177** Contribution code: **THP62** Type: **Poster Presentation**

Improved calorimetric cavity measurement techniques for the HB650 prototype cryomodule for PIP-II

Thursday, September 25, 2025 2:30 PM (3 hours)

Measuring cavity quality factors in a cryomodule requires calorimetric techniques because of the heavy input overcoupling. This involves using physical parameters of the cryogenic system such as mass flow, bath pressure, helium liquid level to estimate dynamic heat load of SRF cavities, often calibrated with heaters. The main challenges of these techniques are reducing sources of variation and error in the system to below the precision level required for the low dynamic heat levels added by the cavities and identifying and incorporating all of the important parameters into the analysis. For testing of the prototype HB650 cryomodule for PIP-II, we've developed a completely data-driven fitting technique that significantly reduces the error of the resulting qualify factor measurements which reducing the overall length of the measurement. This technique with example analyses and error analysis will be presented.

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Yes

Footnotes

Funding Agency

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Author: HOLZBAUER, Jeremiah (Fermi National Accelerator Laboratory)

Co-authors: OZELIS, Joseph (Fermi National Accelerator Laboratory); Mr WIXSON, Adam (Fermi National Accelerator Laboratory)

Presenter: HOLZBAUER, Jeremiah (Fermi National Accelerator Laboratory)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **178** Contribution code: **TUP69** Type: **Poster Presentation**

Design of an MTCA.4-Based LLRF tuning controller for cryomodules at S3FEL

Tuesday, September 23, 2025 2:30 PM (3 hours)

This report presents the design of an MTCA.4-based low-level radio frequency (LLRF) tuning controller for the Shenzhen Superconducting Soft X-ray Free Electron Laser (S3FEL). A standard 1.3 GHz cryomodule at S3FEL comprises eight superconducting cavities, each requiring one slow tuner motor control, two fast piezoelectric actuator (PZT) controls, and an additional motor control for high-power coupler antenna depth adjustment. To manage these requirements, two pairs of MTCA.4 control boards (each pair consisting of an AMC and an RTM connected via MTCA Zone3 D1.0 interface) are implemented per cryomodule. The controller's core processing utilizes a Kintex UltraScale KU040 FPGA on the AMC, which acquires cavity detuning data from four cavities through backplane peer-to-peer high-speed communication. An FMC mezzanine card interfacing with the AMC provides eight optically isolated motor control channels. The RTM board delivers eight channels of 16-bit high-precision DAC output for PZT control. Preliminary testing confirms that the developed tuning controller meets the operational requirements for S3FEL's standard superconducting cryomodules.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: ZHU, Jinfu (Institute of Advanced Science Facilities, Shenzhen)

Co-authors: DING, Hongli (Dalian Institute of Chemical Physics); Mr ZHANG, Zhiyuan (Institute of Advanced Science Facilities, Shenzhen); LIU, Gangyang (Institute of Advanced Light Source Facilities Shenzhen); YANG, Jiayue (Dalian Institute of Chemical Physics); Prof. ZHANG, Weiqing (Dalian Institute of Chemical Physics)

Presenter: ZHU, Jinfu (Institute of Advanced Science Facilities, Shenzhen)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **179** Contribution code: **THP78** Type: **Poster Presentation**

Preliminary design of continuous wave low-level RF systems for S3FEL

Thursday, September 25, 2025 2:30 PM (3 hours)

In the Shenzhen Superconducting Soft X-ray Free Electron Laser (S3FEL), Continuous Wave (CW) Low-Level Radio Frequency (LLRF) systems perform critical functions including adjusting the power coupling of accelerator cavities, regulating the amplitude and phase of the RF field, and maintaining the resonance frequency and phase of the cavities. These functions are essential to ensure the electron beam operates at the accelerating phase. Within S3FEL, each superconducting cavity is driven by a solid-state amplifier (SSA), with each SSA paired with a dedicated LLRF system. Based on the distinct acceleration cavities employed, the CW LLRF systems for S3FEL are categorized into four types: 1. Primary accelerator LLRF systems (superconducting, 1.3 GHz; quantity: 168), 2. Harmonic cavity LLRF systems (superconducting, 3.9 GHz; quantity: 16), 3. VHF electron gun LLRF systems (room temperature, 216 MHz; quantity: 4), 4. Buncher LLRF systems (room temperature, 1.3 GHz; quantity: 2). These four LLRF system categories exhibit differing requirements for RF field and acceleration cavity control. This report presents the preliminary design schemes for these four types of CW LLRF systems.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: ZHANG, Zhiyuan (Institute of Advanced Science Facilities, Shenzhen)

Co-authors: ZHU, Jinfu (Institute of Advanced Science Facilities, Shenzhen); DING, Hongli (Dalian Institute of Chemical Physics); HAN, Jiawei (Institute of Advanced Light Source Facilities Shenzhen); YANG, Jiayue (Dalian Institute of Chemical Physics); ZHANG, Weiqing (Dalian Institute of Chemical Physics)

Presenter: ZHANG, Zhiyuan (Institute of Advanced Science Facilities, Shenzhen)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **180** Contribution code: **MOP23** Type: **Poster Presentation**

Strength evaluation of high-purity niobium single crystals considering crystal orientation

Monday, September 22, 2025 2:30 PM (3 hours)

The relationship between crystal orientation and the strength of single-crystal niobium was evaluated. First, several single-crystal blocks were cut from a niobium ingot, and bar tensile testing specimens were taken from each block. In previous studies, a niobium ingot was sliced to produce a disk, from which a small single-crystal flat specimen was cut; however, this time, round bar specimens were used. This distinction is one of the features of this study. The longitudinal orientation of each test specimen was measured using EBSD, after which tensile tests were performed. The Schmidt factor was calculated, assuming a {110} slip system, revealing a correlation with the 0.2 % proof stress that satisfies Schmidt's law. The CRSS was 36.5 MPa. Next, a method was developed to extract test specimens with orientations that maximized and minimized the Schmidt factor. Test specimens targeting (1 1 1) and (9 2 20) were successfully produced. As anticipated, the 0.2 % proof stress was maximized and minimized during tensile tests. Based on these findings, we examined the derivation of the minimum strength required for designing LG niobium cavities.

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Yes

Footnotes

Funding Agency

Author: YAMANAKA, Masashi (High Energy Accelerator Research Organization)

Co-authors: Mr UMEZAWA, Hiroaki (The Graduate University for Advanced Studies, SOKENDAI); NISHIDA, Naoshi (Tokyo Denkai Co., Ltd.)

Presenter: YAMANAKA, Masashi (High Energy Accelerator Research Organization)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **181** Contribution code: **TUP50** Type: **Poster Presentation**

Fabrication of seamless single-cell copper elliptical cavities through bulk-machining

Tuesday, September 23, 2025 2:30 PM (3 hours)

In the context of future accelerator studies, niobium coating of copper-based cavities plays a key role in achieving an optimal balance between radio-frequency performance and cost-effectiveness.

Recent advancements have focused on the development of bulk-machined elliptical cavities, featuring a seamless, weld-free equator. By optimizing the design of machining tools, the machining strategy and processing parameters, Fabrication of high-quality cavities with excellent shape accuracy and surface finish has been achieved, along with improved repeatability.

This contribution presents the current status of fabrication for such seamless cavities, including the design of the specialized cutting tools. It also explores the relationship between cutting tool parameters, machining conditions and surface integrity, providing a deeper insight into the factors that may influence the future success of niobium coatings.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: SAILLET, Alan (European Organization for Nuclear Research)

Co-authors: Mr ATIEH, Said (European Organization for Nuclear Research); Mr GARLASCHÈ, Marco (European Organization for Nuclear Research); Mr GEISSER, Jean-Marie (European Organization for Nuclear Research); Mr KOLENIC, Michal (European Organization for Nuclear Research); Dr MOROS, Alice (European Organization for Nuclear Research); Mr NINET, Romain (European Organization for Nuclear Research); PEREZ FONTENLA, Ana Teresa (European Organization for Nuclear Research); SCIBOR, Karol (European Organization for Nuclear Research); Mr SIDOROWICZ, Grzegorz (European Organization for Nuclear Research)

Presenter: SAILLET, Alan (European Organization for Nuclear Research)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **182** Contribution code: **TUP03** Type: **Poster Presentation**

Design, fabrication, assembling and testing of QWR/HWR cryomodules for HIAF project

Tuesday, September 23, 2025 2:30 PM (3 hours)

The QWR/HWR cavity cryomodules have been designed for High Intensity heavy-ion Accelerator Facility (HIAF) at the Institute of Modern Physics (IMP) of the Chinese Academy of Science (CAS). There are 17 cryomodules operating at 2 K&3130 Pa of HIAF linac, which consist of 6 QWR007 cryomodules and 11 HWR015 cryomodules, respectively. These cryomodules are being processed in the vendor currently. And the first cryomodule has completed horizontal testing in July 2024. This paper will report the design, fabrication, assembling and testing of the cryomodule for HIAF project.

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Yes

Footnotes

Funding Agency

Author: BAI, Feng (Institute of Modern Physics)

Co-authors: NIU, Xiaofei (Institute of Modern Physics, Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences); WANG, Zhijun (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: BAI, Feng (Institute of Modern Physics)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **183** Contribution code: **TUP59** Type: **Poster Presentation**

Developments for the RF transmission system of the ITN cryomodule

Tuesday, September 23, 2025 2:30 PM (3 hours)

The International Linear Collider (ILC) is a future linear collider that uses superconducting accelerating cavities. In the scope of the ILC Technology Network (ITN), an ILC prototype cryomodule featuring 8 cavities is being developed and built at KEK. The cavities will be driven by a 10 MW multibeam klystron located about 200 m away from the test stand. The WR650 and WR770 are commonly used waveguides for RF transmission at 1.3 GHz. The klystron delivers its power through two WR650 ports, which are combined. The waveguides at the cavity input couplers are also of the type WR650. For efficient transmission of the required RF power over most of the distance, a WR770 type waveguide will be used. An adapter was designed for the interconnection between the WR650 and WR770. WR770 H and E corners were also designed for the transmission line.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

MEXT Development of key element technologies to improve the performance of future accelerators program (JPMXP1423812204)

Author: JOSHI, Prakash (The Graduate University for Advanced Studies, SOKENDAI)

Co-authors: MATSUMOTO, Toshihiro (High Energy Accelerator Research Organization; The Graduate University for Advanced Studies, SOKENDAI); MICHIZONO, Shinichiro (High Energy Accelerator Research Organization; The Graduate University for Advanced Studies, SOKENDAI); OMET, Mathieu (High Energy Accelerator Research Organization; The Graduate University for Advanced Studies, SOKENDAI)

Presenter: JOSHI, Prakash (The Graduate University for Advanced Studies, SOKENDAI)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **184** Contribution code: **THP77** Type: **Poster Presentation**

Development of 1.5 GHz harmonic superconducting cavity and cryomodule

Thursday, September 25, 2025 2:30 PM (3 hours)

The Institute of High Energy Physics (IHEP) developed the 1.5 GHz high -order harmonic cavity system for the Hefei Advanced Light Facility (HALF) project. This paper primarily introduces the design and development of the 1.5 GHz high-order harmonic superconducting cavity and cryomodule. The structure of the harmonic cavity has been simplified, and an integral welding method for the cavity with helium vessel has been adopted to enhance operational reliability. This not only reduces the complexity of the cavity but also minimizes potential failure points, thereby significantly improving the stability and performance of the 1.5 GHz high-order harmonic cavity system during operation. The design and development strategies presented here provide valuable references for similar high-frequency superconducting cavity projects in the future.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: MI, Zhenghui (Institute of High Energy Physics)

Co-authors: LIU, Baiqi (Institute of High Energy Physics); HE, Feisi (Institute of High Energy Physics); ZHENG, Hongjuan (Institute of High Energy Physics); ZHAI, Jiyuan (Institute of High Energy Physics); GE, Rui (Institute of High Energy Physics); JIN, Song (Institute of High Energy Physics); PAN, Weimin (Chinese Academy of Sciences); YANG, Xiaochen (University of Science and Technology of China); WEI, Yelong (University of Science and Technology of China)

Presenter: MI, Zhenghui (Institute of High Energy Physics)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **185** Contribution code: **THP64** Type: **Poster Presentation**

The development and application of expansion joints

Thursday, September 25, 2025 2:30 PM (3 hours)

FLEXTAI LTD is located in Shenyang Economic and Technological Development Zone, Liaoning Province, China. It is the first Sino-foreign joint venture in China specializing in the production of metal corrugated pipe series products. The company mainly engages in the design, development and manufacture of metal bellows, metal bellows expansion joints, metal hoses, precision bellows and pipeline systems. Relying on advanced technology and equipment, the company has become one of the important manufacturers of metal bellows expansion joints in both domestic and international markets. The various types of metal bellows produced by the company have been widely used in industries such as aviation and aerospace, power (thermal power, nuclear power, hydropower, etc.), steam turbines, gas turbines, ultra-high voltage power transmission and transformation, instruments and meters, metallurgy, petrochemicals, oil storage and transportation, urban centralized heating, light industry, electronics, and pharmaceuticals.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HUANG, Kai (FLEXTAI LTD)

Presenter: HUANG, Kai (FLEXTAI LTD)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **187** Contribution code: **THP30** Type: **Poster Presentation**

Enhancing superconducting radio-frequency performance with high-throughput method-assisted FeSe1-xTex coated Nb films

Thursday, September 25, 2025 2:30 PM (3 hours)

Bulk Nb superconducting radio-frequency (SRF) cavities are widely utilized in particle accelerators, however, their accelerating gradient and overall performance are limited by the superheating field (Bs). To overcome this theoretical limit, we aim to develop innovative multilayer structures. Iron-based superconductors are considered promising coating materials for such multilayer structures, however, detailed studies on this topic remain scarce. In this research, we fabricated FeSe1-xTex-coated Nb planar films and characterized their structural, electrical transport and magnetic properties to explore the feasibility of this superconductor-superconductor bilayer. To efficiently identify the optimal Te doping level, advanced high-throughput film synthesis techniques were employed to fabricate composition-spread FeSe1-xTex film (x = 0 - 1) on a piece of Nb film, followed by micro-region structural and transport characterizations. The results demonstrate that under optimal doping, the Bc1 of FeSe1-xTex coated Nb films is significantly enhanced, while its Tc is comparable to that of bulk Nb. Through high-throughput methods, this work provides valuable technical parameters and insights into vortex penetration behavior, laying the foundation for the development of future SRF cavities based on iron-based superconducting films.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: DONG, Chao (Institute of High Energy Physics)

Co-author: SHA, Peng (Institute of High Energy Physics)

Presenter: DONG, Chao (Institute of High Energy Physics)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **188** Contribution code: **THP28** Type: **Poster Presentation**

The Non-dusting Vacuum system for the Beam line of 1.3GHz-9cell CryoModule

Thursday, September 25, 2025 2:30 PM (3 hours)

A high-Q, high-gradient 1.3 GHz cryomodule containing eight 9-cell SRF cavities has been designed, manufactured, and assembled at IHEP-CAS. The eight cavities achieve an average unloaded quality factor (Q_0) of 3.8×1010 at 16 MV/m and 3.6×1010 at 18 MV/m. After horizontal testing, the cryomodule was transported approximately 1,000 km to Dalian.
To achieve such exceptional performance, the beamline vacuum system must be kept extremely clean. However, an ultra-high vacuum is not required at room temperature, as long as the high-frequency aging process is adequately performed. Therefore, cleanliness must be maintained throughout the entire process, including component cleaning, assembly, rough pumping, nitrogen purging, and transport.
In addition, vacuum pressure fluctuations were continuously monitored during cavity cooldown, operation, warmup and coupler aging to prevent vacuum degradation. Furthermore, during the long-distance transport of the cryomodule, the beamline vacuum pressure was recorded continuously to confirm the absence of any leaks.

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Yes

Footnotes

Funding Agency

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Author: LIU, Baiqi (Institute of High Energy Physics)

Co-authors: PAN, Weimin (Chinese Academy of Sciences); HE, Feisi (Institute of High Energy Physics); ZHAI, Jiyuan (Institute of High Energy Physics); JIN, Song (Institute of High Energy Physics); GE, Rui (Institute of High Energy Physics); MI, Zhenghui (Institute of High Energy Physics); HE, Ping (Institute of High Energy Physics)

Presenter: LIU, Baiqi (Institute of High Energy Physics)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **190** Contribution code: **THP07** Type: **Poster Presentation**

Q degradation in operation in ISAC-II SC linac

Thursday, September 25, 2025 2:30 PM (3 hours)

Quality factor (Q) of SRF cavities is one of the essential parameters in continuous wave accelerator operation. Q degradation has been observed in the operation of ISAC-II superconducting heavy ion linac. Other than the well-known mechanisms, such as field emission and trapped magnetic flux, the past eight years statistics reveals gas molecules in the beam line caused measurable Q drops after a few months'operation. This paper will describe the observations on ISAC-II linac, analyze data from operation and accidents, and discuss the results of the proof of principle tests.

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Yes

Footnotes

Funding Agency

Author: YAO, Zhongyuan (TRIUMF)

Co-authors: BJARNASON, Rowan (TRIUMF); CHEUNG, Johnson (TRIUMF); KEIR, James (TRIUMF); KISHI, David (TRIUMF); KIY, Spencer (TRIUMF); KOLB, Philipp (TRIUMF); LANG, Devon (TRIUMF); LAXDAL, Robert (TRIUMF)

Presenter: YAO, Zhongyuan (TRIUMF)

Session Classification: Thursday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **191** Contribution code: **THP06** Type: **Poster Presentation**

The operation of ARIEL e-LINAC RF system

Thursday, September 25, 2025 2:30 PM (3 hours)

The 30 MeV section of the Advanced Rare Isotope Laboratory (ARIEL) electron linear accelerator (e-Linac), a 1.3 GHz superconducting SRF system, currently includes the injector cryomodule (EINJ), housing a single nine-cell cavity, and the first accelerator cryomodule (EACA), configured with two cavities. This paper reports recent progress of high-power RF system operation. In 2025, the system achieved stable continuous operation for three consecutive days with a 30 MeV, 1 mA beam, reaching a reliability of approximately 97.9%. EACA, operating in vector sum mode, has demonstrated stable operation for up to eight days.

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Yes

Footnotes

Funding Agency

Author: MA, Yanyun (TRIUMF)

Co-authors: KOLB, Philipp (TRIUMF); LAXDAL, Robert (TRIUMF); Mr PILETSKIY, Konstantin (TRIUMF); Mr FU, Xiaoliang (TRIUMF); ZVYAGINTSEV, Vladimir (TRIUMF)

Presenter: MA, Yanyun (TRIUMF)

Session Classification: Thursday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **192** Contribution code: **THP08** Type: **Poster Presentation**

Progress of prototype RFD crab cavity string assembly for HL-LHC at TRIUMF

Thursday, September 25, 2025 2:30 PM (3 hours)

The High-Luminosity Large Hadron Collider (HL-LHC) project is to increase the integrated luminosity by a factor of 10 beyond the LHC's design value. TRIUMF is collaborating with CERN, UK and US-AUP to provide five RF dipole (RFD) crab cavity cryomodules to HL-LHC as Canadian contribution. A prototype cryomodule (TCM0) is being assembled to qualify TRIUMF's infrastructure, procedure and tooling. The experience and lessons learned on TCM0 will be applied to the series production cryomodules. This paper will give updates of the progress of TCM0 string assembly, including infrastructure readiness, tooling and fixture readiness, prototype cavity acceptance, and the status of the string assembly.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: YAO, Zhongyuan (TRIUMF)

Co-authors: MATHESON, Ben (TRIUMF); WARAICH, Bhalwinder (TRIUMF); LANG, Devon (TRIUMF); KEIR, James (TRIUMF); LAW, Oliver (TRIUMF); KOLB, Philipp (TRIUMF); LAXDAL, Robert (TRIUMF); SEKHON, Ruminder (TRIUMF)

Presenter: YAO, Zhongyuan (TRIUMF)

Session Classification: Thursday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **193** Contribution code: **TUP79**	Type: **Poster Presentation**

Photon frequency conversion in high-Q superconducting resonators: axion electrodynamics, QED, and nonlinear meissner radiation

Tuesday, September 23, 2025 2:30 PM (3 hours)

Bogorad et al. proposed Superconducting Radio-Frequency (SRF) cavities with high quality factors as a platform for detecting axions, which are a dark matter candidate, as well as low-energy QED corrections that give rise to photon-photon scattering [1]. The idea is to use the cubic nonlinearity of axion-electrodynamics to detect the axion field by measuring photons at a signal frequency ω3 = 2 ω1 - ω2 in an SRF cavity simultaneously pumped with photons at two resonant frequencies ω1 and ω2. Signal photons are sourced by axion-mediated currents, or by virtual electron-positron pairs in the vacuum of the cavity [1,2]. However, the Meissner screening current is a nonlinear function (nonlinear Meissner effect [NLM]) of the field at the surface, and thus sources photons at the signal frequency ω3 [3]. We report calculations of the number of NLM photons, leakage noise photons, and the resulting impact on the sensitivity of SRF cavities to axion and QED mediated photon conversion [4]. For SRF cavities with ultra-high-Q we show that the NLM effect parametrically shifts the frequency of surface generated photons sufficiently away from the signal frequency to allow for detection of nonlinear QED frequency conversion. We also show that dual-cavity setup for source and detector [5] and the single-cavity setup proposed for heterodyne detection of galactic axion dark matter [6] can suppress the NLM and leakage backgrounds.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

[1] Z. Bogorad et al., Phys. Rev. Lett. 123, 021801 (2019).
[2] W. Heisenberg and H. Euler, Z. Phys. 98, 714 (1936).
[3] J. A. Sauls, Prog. Theor. Exp. Phys. 2022, 033I03 (2022).
[4] H. Ueki and J. A. Sauls, Prog. Theor. Exp. Phys. 2024, 123I01 (2024).
[5] C. Gao, and R. Harnik, J. High Energ. Phys. 2021, 53 (2021).
[6] A. Berlin et al., J. High Energ. Phys. 2020, 88 (2020).

Funding Agency

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Author: UEKI, Hikaru (Louisiana State University)

Co-author: SAULS, James (Louisiana State University)

Presenter: UEKI, Hikaru (Louisiana State University)

Session Classification: Tuesday Poster Session

Track Classification: MC5: SRF Applications

Contribution ID: **194** Contribution code: **MOP58** Type: **Poster Presentation**

Design of a 915 MHz conduction-cooled cryomodule

Monday, September 22, 2025 2:30 PM (3 hours)

High-power, compact, continuous-wave (CW) linear electron accelerators with beam energies of up to 10 MeV are being considered for possible industrial applications. Conduction-cooled, superconducting radio-frequency (SRF) technology allows operating such machines at high electrical efficiency, thereby reducing the operating cost significantly. A prototype conduction-cooled SRF cryomodule has been designed and components are currently being manufactured. The cryomodule features a two-cell, 915 MHz SRF cavity, two cryocoolers, a fundamental power coupler, two magnetic shields, a thermal shield and warm-to-cold transitions. The cryomodule has been designed to be able to provide an energy gain of 3.5 MeV to a CW electron beam with a current of 5 mA. This contribution focusses on thermal and mechanical design aspects of the cryomodule.

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Yes

Footnotes

Funding Agency

Author: CIOVATI, Gianluigi (Thomas Jefferson National Accelerator Facility)

Co-authors: ARMSTRONG, Joshua (Thomas Jefferson National Accelerator Facility); CASTILLA, Alejandro (Thomas Jefferson National Accelerator Facility); CHENG, Gary (Thomas Jefferson National Accelerator Facility); COLLEY, Jason (Thomas Jefferson National Accelerator Facility); HARDING, Keith (Thomas Jefferson National Accelerator Facility); HAYS, Gary (Thomas Jefferson National Accelerator Facility); VENNEKATE, Hannes (Thomas Jefferson National Accelerator Facility); LEWIS, Jacob (Old Dominion University); RATHKE, John (TechSource (United States)); SCHULTHEISS, Thomas (TJS Technologies LLC)

Presenter: VENNEKATE, Hannes (Thomas Jefferson National Accelerator Facility)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **195** Contribution code: **MOP62** Type: **Student Poster Presentation**

Design and conditioning of a low thermal load coupler for conduction-cooled accelerators

Monday, September 22, 2025 2:30 PM (3 hours)

Thermal management of high-power input couplers is a critical challenge in conduction-cooled superconducting accelerators. This work presents a low thermal load input coupler design featuring a detachable electromagnetic shield, effectively directing microwave-induced heat toward the 50K region. RF and thermal simulations confirm its efficient power transmission and reduced heat load at cryogenic temperatures around 4K. Experimental tests validate the electromagnetic shielding performance. High-power conditioning demonstrates stable 70kW CW power transmission, meeting the dual requirements of low thermal load and high RF power handling for conduction-cooled accelerators.

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Yes

Footnotes

Funding Agency

Author: SHEN, Haoyu (Peking University)

Co-authors: YAO, Zeqin (Peking University); Ms WANG, Xiaoxiao (Peking University); LIN, Lin (Peking University); WANG, Fang (Peking University); HAO, Jiankui (Peking University); Mr QUAN, Shengwen (Peking University); HUANG, Senlin (Peking University)

Presenter: SHEN, Haoyu (Peking University)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **196** Contribution code: **TUP72** Type: **Poster Presentation**

Progress and challenges on SRF technology development for PERLE

Tuesday, September 23, 2025 2:30 PM (3 hours)

Powerful Energy Recovery Linac for Experiments (PERLE) is a compact three-pass ERL project based on SRF technology, being as a new generation machine targeting the 5 MW beam power regime. PERLE will serve as a hub for the validation and exploration of a broad range of accelerator phenomena in an unexplored operational power regime serving for the development of ERL technology for future energy and intensity frontier machines. The SRF cavities have been designed and prototyped to be similar or virtually identically to the ttbar option of FCCee, namely, 800 MHz bulk niobium cavities with Q_0>3×10ˆ10 around 22 MV/m. This ambitious performance will be enabled by state-of-the-art medium temperature baking. In this contribution, we discuss progress and challenges in cavity fabrication, higher order mode couplers and beam line absorbers, and the cryomodule with a special focus on magnetic shield and potential flux expulsion scheme.

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Yes

Footnotes

Funding Agency

Author: MIYAZAKI, Akira (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Presenter: MIYAZAKI, Akira (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **197** Contribution code: **MOP10** Type: **Poster Presentation**

France-Japan collaboration for high-Q / high-G SRF cavities

Monday, September 22, 2025 2:30 PM (3 hours)

High-performance SRF cavities are of central importance for many future projects and can only be realized through international collaboration. A key challenge is the standardization of parameters for chemical etching, heat treatment, and vertical testing. We have observed small but significant differences in the parameters defined locally across laboratories. In parallel with collaborative initiatives within European laboratories and between American and French institutions, we are consolidating the partnership between France and Japan. At present, we are developing a 1-cell 1.3 GHz cavity to systematically compare the vacuum furnaces at IJCLab and KEK, as well as the vertical testing procedures at CEA and KEK. Our investigations include mid-T baking, high-temperature annealing, low-temperature baking, and studies of magnetic field sensitivity. In this contribution, we present the global scope of the collabora- tion, the comparative analysis of furnaces, and the results of vertical tests.

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Yes

Footnotes

Funding Agency

Author: MIYAZAKI, Akira (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Co-authors: FOUAIDY, Mohammed (Université Paris-Saclay, CNRS/IN2P3, IJCLab); GANDOLFO, Nicolas (Université Paris-Saclay, CNRS/IN2P3, IJCLab); LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab); Dr OLRY, Guillaume (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); VANNSON, Mael (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); VOGT, Lê My (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Mr BAUDRIER, Matthieu (CEA Paris-Saclay); CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); EOZÉNOU, Fabien (Commissariat à l'Energie Atomique); JULLIEN, Grégoire (CEA Paris-Saclay); MAURICE, Luc (Commissariat à l'Energie Atomique); HARA, Takafumi (High Energy Accelerator Research Organization); OMET, Mathieu (High Energy Accelerator Research Organization); ITO, Hayato (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization)

Presenter: MIYAZAKI, Akira (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **199** Contribution code: **THP40** Type: **Poster Presentation**

Measurement of low accelerating gradients in 1.3 GHz cavities at DESY

Thursday, September 25, 2025 2:30 PM (3 hours)

During last few years, an extensive efforts for obtaining Q0 vs Eacc characteristic of SRF cavities at very low accelerating gradients have been conducted in several laboratories around the world. In the Accelerator Module Test Facility (AMTF) at DESY, several attempts of such measurements were performed, mainly focused on the comparison between the widely used decay measurements technique and the standard vertical test. To ensure good quality of the signals at very low gradients, several hardware adaptations of the existing test - stand were introduced. In this paper, compliance between two measurement ideas is presented, as well as some cross-checking ideas, which could give an overview of the measurement quality at very low RF amplitudes.

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Yes

Footnotes

Funding Agency

Author: WIENCEK, Mateusz (Deutsches Elektronen-Synchrotron DESY)

Co-authors: BÜTTNER, Thorsten (Deutsches Elektronen-Synchrotron DESY); KASPRZAK, Karol (Deutsches Elektronen-Synchrotron DESY)

Presenter: WIENCEK, Mateusz (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **200** Contribution code: **THP37** Type: **Poster Presentation**

Interface studies of Nb-AlN-NbTiN multilayers grown by PEALD

Thursday, September 25, 2025 2:30 PM (3 hours)

Superconducting–Insulating–Superconducting (SIS) multilayers offer a promising approach to surpass the accelerating gradients and quality factors of standard bulk-Nb SRF cavities†. Plasma-enhanced atomic layer deposition (PEALD) stands out as a key technique for the next-generation thin-film-based SRF cavities, providing conformal coatings on highly structured, three-dimensional substrates without shadowing effects and with sub-nm thickness precision. This poster contributes to thin-film SRF R&D through dedicated material studies. The results presented correspond to Nb–AlN–NbTiN multilayers grown by PEALD, focusing on the S–I and I–S interfaces. Depth-resolved X-ray photoelectron spectroscopy (XPS) and cross-sectional energy-dispersive X-ray spectroscopy (EDX) are employed to assess the film stoichiometry and detect any interdiffusion or deposition residues. Side effects induced by high-temperature post-deposition annealing–required to obtain high-Tc NbTiN‡–are systematically investigated. Lastly, complementary studies on Superconducting–Superconducting (SS) Nb–NbTiN bilayers–grown without the AlN interlayer–underscore the crucial role of AlN as an effective diffusion barrier.

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Yes

Footnotes

†A. Gurevich, "Enhancement of rf breakdown field of superconductors by multilayer coating", Applied Physics Letters 88, 12511 (2006)

‡I. González Díaz-Palacio, M.Wenskat, G. K. Deyu, W. Hillert, R. H. Blick, and R. Zierold, "Thermal annealing of superconducting niobium titanium nitride thin films deposited by plasma-enhanced atomic layer deposition", Journal of Applied Physics 134, 035301 (2023)

Funding Agency

Author: GONZÁLEZ DÍAZ-PALACIO, Isabel (Universität Hamburg)

Co-authors: MOROS, Alice (European Organization for Nuclear Research); MACPHERSON, Alick (European Organization for Nuclear Research); STIERLE, Andreas (Universität Hamburg; Deutsches Elektronen-Synchrotron DESY); TURNER, Daniel (European Organization for Nuclear Research); REYES, David (École Polytechnique Fédérale de Lausanne); Dr DEYU, Getnet Kacha (Universität Hamburg); NOEI, Heshmat (Deutsches Elektronen-Synchrotron DESY); PREECE, Lea (Universität Hamburg); WENSKAT, Marc (Universität Hamburg); GARCÍA BLANCO, Miguel (Deutsches Elektronen-Synchrotron DESY; Universität Hamburg); HILLERT, Wolfgang (Universität Hamburg)

Presenter: GONZÁLEZ DÍAZ-PALACIO, Isabel (Universität Hamburg)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **201** Contribution code: **MOP22** Type: **Poster Presentation**

Progress in Nb3Sn vapor diffusion method for single-cell cavities at KEK

Monday, September 22, 2025 2:30 PM (3 hours)

Nb3Sn SRF cavities have attracted increasing attention as a candidate for next-generation accelerators due to their potential to achieve high Q-values even at 4.2 K, enabling operation with conduction cooling. Since 2019, KEK has been developing Nb3Sn single-cell cavities via the vapor diffusion method using Sn and SnCl2 sources. In parallel, a dedicated small-scale coating system was constructed to promote systematic investigations using planar samples. This contribution presents recent progress in both single-cell cavity coatings and sample-based investigations. Notably, our best-performing cavity achieved an accelerating gradient of 17.5 MV/m with a Q-value of 1.2×10^{10} at 5 MV/m and 4.2 K. Through systematic trials, we are beginning to clarify how coating parameters—such as source amount and heating duration—under our furnace environment relate to cavity performance. In addition, sample studies have provided intriguing insights into how variations in coating conditions affect the resulting film quality. These insights are being used to refine the coating protocol in the large cavity furnace.

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Footnotes

Funding Agency

This work was supported by 【MEXT Development of key element technologies to improve the performance of future accelerators Program】Japan Grant Number JPMXP1423812204.

Author: ITO, Hayato (High Energy Accelerator Research Organization)

Co-authors: YAMADA, Tomohiro (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization); SAKAI, Hiroshi (High Energy Accelerator Research Organization)

Presenter: ITO, Hayato (High Energy Accelerator Research Organization)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **202** Contribution code: **MOP01** Type: **Poster Presentation**

HOM study for CEPC cavities: HOM damping and recent developments

Monday, September 22, 2025 2:30 PM (3 hours)

CEPC is engineered to function in four distinct operational modes (Higgs, W, Z-pole, and t-tbar), supporting a broad spectrum of beam parameters. The collider's beam energy ranges from 45.5 to 180 GeV, with a beam current varying from 5.6 mA to 1.4 A, and a synchrotron radiation (SR) power output ranging from 30 to 50 MW. The collider is a double-ring with shared cavities for Higgs operation and separate cavities for W and Z operations. The higher order modes (HOM) excited by the intense beam bunches must be damped to avoid additional cryogenic loss and multi-bunch instabilities. In this paper, the impedance, HOM damping and HOM power requirements for the CEPC collider ring are given. This HOM power limit and the fast-growing longitudinal coupled-bunch instabilities (CBI) driven by both the fundamental and higher order modes impedance of the RF cavities determine to a large extent the highest beam current and luminosity obtainable in the Z mode. The prototypes of HOM coupler have been fabricated and tested on the 650 MHz 2-cell cavity. The mechanical, RF, and cryogenic performance of the higher-order mode coupler has been verified. A full-size cryomodule with 6 cavities and 12 HOM couplers is currently under development. Finally, the deep suppression of HOMs with high-power extraction, and the associated technical challenges were discussed.

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Yes

Footnotes

Funding Agency

Author: ZHENG, Hongjuan (Institute of High Energy Physics)

Co-authors: GAO, Jie (Chinese Academy of Sciences); ZHAI, Jiyuan (Institute of High Energy Physics)

Presenter: ZHENG, Hongjuan (Institute of High Energy Physics)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **203** Contribution code: **TUP29** Type: **Student Poster Presentation**

Experimental study on deposition of Nb3Sn thin films on 6 GHz copper half-cell using Co-sputtering

Tuesday, September 23, 2025 2:30 PM (3 hours)

As the application of superconducting cavities becomes increasingly widespread, the development of cost-effective coatings with enhanced performance has become a focal point for researchers. This study primarily focuses on depositing niobium-niobium-tin (Nb3Sn) multilayer thin films on the inner surface of a 6 GHz copper half-cell via the co-sputtering method. The emphasis is on preparing coated superconducting cavities with excellent surface morphology, high quality factor (Q), and high accelerating gradient (Eacc). The copper half-cell is split along its axis, and superior superconducting films are prepared by controlling various co-sputtering conditions, followed by electron beam welding to reassemble the cavity. To date, through sample experiments, we have successfully prepared copper samples coated with Nb3Sn that exhibit a dense surface and a critical temperature (Tc) as high as 17.2 K.

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Yes

Footnotes

Funding Agency

IHEP

Author: KAN, Jiawen (Institute of High Energy Physics)

Co-authors: ZHANG, Pei (Institute of High Energy Physics); XIN, Tianmu (Institute of High Energy Physics)

Presenter: KAN, Jiawen (Institute of High Energy Physics)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **204** Contribution code: **TUP30** Type: **Poster Presentation**

Towards Nb3Sn coated copper cavities for energy efficient SRF applications

Tuesday, September 23, 2025 2:30 PM (3 hours)

Superconducting radio frequency (SRF) cavities which are made from bulk niobium and operated at cryogenic temperatures around 2 K, are essential components in modern particle accelerators. Due to the sustainability issues related to niobium, which is considered a critical metal, and the huge power consumption of accelerator facilities, the community has discussed alternative high(er)-temperature superconductors for many years. Recent advances in Nb_3Sn thin film technology have revitalized this discussion. In particular, the ability to coat copper with high-quality Nb_3Sn surface layers has sparked hope that we can finally move beyond conventional niobium technology. We have demonstrated that a specific magnetron co-sputtering process enables the synthesis of fully superconducting Nb_3Sn, even at low temperatures, where copper diffusion can be disregarded. When coating sapphire substrates, we achieve critical temperatures (Tc) of 17.9 K. The same process (i.e. without post-annealing) on copper yields Tc values of around 15 K and lower critical fields of approximately 200 mT at 4 K. Moving beyond flat substrates, we coated a higher order mode (HOM) antenna —a three-dimensional, mushroom-like object —with Nb_3Sn, achieving similar Tc values at all positions on its surface. We anticipate that, by 2030, Nb_3Sn-coated copper cavities will surpass the quality factor of standard Nb bulk cavities.

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Yes

Footnotes

Funding Agency

German Research Foundation (DFG), project ID 264883531.
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Author: ALFF, Lambert (Technical University of Darmstadt)

Co-authors: Dr ARZUMANOV, Alexey (Technical University of Darmstadt); Mr FARHOOD, Amir (Technical University of Darmstadt); MAJOR, Marton (Technical University of Darmstadt)

Presenter: ALFF, Lambert (Technical University of Darmstadt)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **205** Contribution code: **THP63** Type: **Poster Presentation**

RF in-situ heating of a single and nine-cell 1.3 GHz cavity

Thursday, September 25, 2025 2:30 PM (3 hours)

High acceleration gradients Eacc and high quality factors Q0 can be achieved by heat treatments of the cavity [1]. However, the heating processes are carried out in furnaces where the cavity is forcibly exposed to air afterwards, which can lead to contamination. For moderate temperatures (T < 350 ℃), this issue could be overcome by in-situ heating. A few studies on in-situ heating have already been published, showing promising results [2]. But, the heating was achieved using heating strips, which are not applicable in an accelerator cryomodule. By applying a radio frequency electromagnetic field at RT to the cavity (here called RF-heating), the cavity can be heated under UHV conditions without being exposed to air. Furthermore, this setup could be implemented in the module, which is beneficial for accelerators that don't have the option of gas processing. A first study reporting on RF heating, still in its early stages, was published recently [3]. In the work presented here, we will further investigate RF heating and explain the experimental setup. In addition, first heating results for a 1.3 GHz nine-cell and a single-cell cavity will be presented, whereby temperatures in the mid-T range (approx. 240 ℃) have already been achieved for a single cell with the current setup.

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Yes

Footnotes

[1] L. Steder et al.,2024 , https://doi.org/10.48550/arXiv.2407.12570
[2] S. Posen et al.,2020 , Phys. Rev. Applied 13, 014024
[3] H.-W. Glock et al.,2024, https://doi.org/10.48550/arXiv.2412.13628

Funding Agency

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Author: GOEDECKE, Julia (Deutsches Elektronen-Synchrotron DESY)

Co-authors: BÜTTNER, Thorsten (Deutsches Elektronen-Synchrotron DESY); KASPRZAK, Karol (Deutsches Elektronen-Synchrotron DESY); MARCONATO, Giovanni (Universität Hamburg); RESCHKE, Detlef (Deutsches Elektronen-Synchrotron DESY); WIENCEK, Mateusz (Deutsches Elektronen-Synchrotron DESY); SULIMOV, Alexey (Deutsches Elektronen-Synchrotron DESY); WEISE, Hans (Deutsches Elektronen-Synchrotron DESY)

Presenter: GOEDECKE, Julia (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **206** Contribution code: **THP32** Type: **Poster Presentation**

Activities on medium grain niobium at DESY

Thursday, September 25, 2025 2:30 PM (3 hours)

Within the ITN (ILC Technology Network) activity led by KEK, the so-called "Medium Grain Niobium" is investigated with respect to its possible application for a large-scale SRF cavity production for the International Linear Collider ILC [1-3]. In the framework of the KEK-DESY collaboration, the niobium material for two 1.3 GHz single-cell cavities was supplied by KEK. After fabrication and initial surface treatment by electropolishing in industry, the cavities have been tested successfully at DESY with gradients above 40 MV/m. Subsequently, a heat treatment at medium temperatures around 350 °C (Mid-T heat treatment) in the DESY furnace was applied. The vertical test results of these treatments will be reported. In addition, the effect of UHV heat treatments on state-of-the-art fine grain niobium at temperatures between 800 °C and 1100 °C has been studied on samples with respect to grain growth, mechanical and thermal properties.

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Yes

Footnotes

[1] doi:10.18429/JACoW-SRF2021-MOPCAV004
[2] doi:10.18429/JACoW-SRF2021-MOPCAV012
[3] doi:10.18429/JACoW-SRF2023-WEIXA04

Funding Agency

This work was supported by the Helmholtz Association within the topic Accelerator research and Development (ARD) of the Matter and Technologies (MT) Program.

Author: RESCHKE, Detlef (Deutsches Elektronen-Synchrotron DESY)

Co-authors: ARNOLD, Svenja (Deutsches Elektronen-Synchrotron DESY); BATE, Christopher (Deutsches Elektronen-Synchrotron DESY); ERMAKOV, Alexey (Deutsches Elektronen-Synchrotron DESY); ERMAKOVA, Elena (Deutsches Elektronen-Synchrotron DESY); GOEDECKE, Julia (Deutsches Elektronen-Synchrotron DESY); IVERSEN, Jens (Deutsches Elektronen-Synchrotron DESY); KASPRZAK, Karol (Deutsches Elektronen-Synchrotron DESY); KLINKE, Daniel (Deutsches Elektronen-Synchrotron DESY); MUHS, Andrea (Deutsches Elektronen-Synchrotron DESY); STEDER, Lea (Deutsches Elektronen-Synchrotron DESY); THIE, Jan-Hendrik (Deutsches Elektronen-Synchrotron DESY); TRELLE, Lennart (Deutsches Elektronen-Synchrotron DESY); WIENCEK, Mateusz (Deutsches Elektronen-Synchrotron DESY)

Presenter: RESCHKE, Detlef (Deutsches Elektronen-Synchrotron DESY)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **207** Contribution code: **THP09** Type: **Poster Presentation**

Magnetic field sensitivity of a QWR under different cooldown dynamics

Thursday, September 25, 2025 2:30 PM (3 hours)

The sensitivity of the surface resistance of SRF cavities depends on several aspects, such as the specific surface and heat treatment of the cavity. The the cooldown dynamics as the cavity transitions into the superconducting (sc) state also influence the performance if there is an external magnetic field. Both temperature gradient across the cavity and speed of the superconducting front have been shown to be impacting the performance. But also the direction of movement of the superconducting front impacts the performance as magnetic fields are pushed by the superconducting front. Quarterwave resonators (QWR) have a complex geometry with their closed inner conductor. Depending on the cooldown dynamics, the magnetic flux could be pushed to either the tip of the inner conductor with low rf surface currents, or to the short plate of the cavity with high rf surface currents. In previous measurements of the TRIUMF multimode QWR the SC front moves from outer conductor to the inner conductor. In the presented paper, the direction has been reversed to show the effects of the direction of movement of the sc front on the cavity performance.

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Footnotes

Funding Agency

Author: KOLB, Philipp (TRIUMF)

Co-authors: YAO, Zhongyuan (TRIUMF); Mr STOKES, Will (TRIUMF; University of Victoria); LAXDAL, Robert (TRIUMF)

Presenter: KOLB, Philipp (TRIUMF)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **208** Contribution code: **THP67** Type: **Poster Presentation**

Feature of NC25 material and impact on flux trapping when used them for SRF cavity assembly

Thursday, September 25, 2025 2:30 PM (3 hours)

FRIB has developed a high Q 0.53HWRs within a DOE R&D program titled Development of Transformative Preparation Methods to Push up High Q&G Performance of FRIB Spare HWR Cryomodule Cavities. In this study, we found that flux trapping produces 80 % of the residual surface resistance (Rres). The main contribution is that from thermoelectric current produced by Seebeck effect (Dynamical magnetic contamination) at the dissimilar metal join nearby cavity. Other contributions are DC magnetic contaminations: insufficient earth magnetic field and magnetic contamination from the magnetized components used nearby cavity. Uniform cool-down reduces the dynamic magnetic flux, the ambient field is reduced to ˜ 6 mG, and the resultant Rres is ˜ 3 nW. Active field cancellation reduces the DC ambient field more to 3 mG and decreases Rres to ˜ 2 nW. FRIB 0.53HWR is operated at 322 MHz at 2 K. RBCS is ˜ 0.5 nW, and Rres dominates to Qo. If reduce the Rres less than 0.5 nW, Qo could reach ˜1x10ˆ11. To enhance Qo, we tried to use NC25 bolts and nuts instead SUS ones, which are perfectly none magnetized material even after work unlike SUS. We investigated the impact on the cavity performance. In this paper, report about this result.

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Funding Agency

Footnotes

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† Retired MSU/FRIB and moved to Aoi Kogyo Co. Ltd.,
email address: k-saito@aoi-k.co.jp or saito@frib.msu.edu

Author: SAITO, Kenji (Facility for Rare Isotope Beams)

Co-authors: GANSHYN, Andrei (Facility for Rare Isotope Beams); CHANG, Wei (Facility for Rare Isotope Beams); Dr CHEON, Yoo Lim (Facility for Rare Isotope Beams); COMPTON, Chris (Facility for Rare Isotope Beams); COMBS, Spencer (Facility for Rare Isotope Beams); ELLIOTT, Kyle (Facility for Rare Isotope Beams); HARTUNG, Walter (Facility for Rare Isotope Beams); KIM, Sang-hoon (Facility for Rare Isotope Beams); KONOMI, Taro (Facility for Rare Isotope Beams); POPIELARSKI, Laura (Facility for Rare Isotope Beams); Dr WU, Yuting (Facility for Rare Isotope Beams); XU, Ting (Facility for Rare Isotope Beams)

Presenter: SAITO, Kenji (Facility for Rare Isotope Beams)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **209** Contribution code: **TUP42** Type: **Poster Presentation**

RF measurement of plasma electrolytic polished 1.3 GHz full-seamless Nb/Cu cavities

Tuesday, September 23, 2025 2:30 PM (3 hours)

From the production and testing of Nb/Cu elliptical cavities by hydroforming, it was found that there is a problem of poor surface roughness due to the large plastic deformation of the copper substrate. To improve this problem, we are trying to apply Plasma Electrolytic Polishing (PEP), which has been developed by INFN-LNL. PEP has the features of extremely high polishing speed compared to conventional electrolytic polishing and simplicity of equipment structure since the cathode does not need to be inserted into the cavity. We plan to perform PEP at INFN-LNL and niobium thin film coating at CERN on the 1.3 GHz copper hydroformed cavities provided by KEK, and to measure the RF performance at KEK by September 2025. In this poster presentation, the preparation status and results of the cavity measurements will be reported.

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Footnotes

Funding Agency

Amada Foundation

Author: ARAKI, Hayato (High Energy Accelerator Research Organization)

Co-authors: CARLOS, Carlota (European Organization for Nuclear Research); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare); CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); ROSAZ, Guillaume (European Organization for Nuclear Research); YAMANAKA, Masashi (High Energy Accelerator Research Organization)

Presenter: ARAKI, Hayato (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **210** Contribution code: **THP60** Type: **Poster Presentation**

Mitigating residual magnetization in coldmass components via superconducting focusing lenses

Thursday, September 25, 2025 2:30 PM (3 hours)

Residual magnetization of ferromagnetic coldmass components located near superconducting RF (SRF) cavities poses a significant threat to cavity performance, especially when a magnetic source, such as a focusing lens, is in close proximity. Previous work evaluated several passive mitigation techniques, including the use of local magnetic shields, and quantified both the residual fields induced by the focusing lenses and their detrimental impact on SRF cavity performance. Building on those findings, this paper presents the development and preliminary validation of an active demagnetization procedure to mitigate such effects. Using a dedicated magnet test stand equipped with a superconducting magnet, comprising a solenoid and four dipole correctors, and multiple fluxgate sensors, we explored demagnetization cycles with varying amplitudes and polarities. Initial results demonstrate a measurable reduction in remanent magnetic fields after the application of bidirectional ramp cycles. These findings pave the way for implementing robust in-situ demagnetization procedures as a complementary approach to passive magnetic hygiene and material selection strategies.

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Footnotes

Funding Agency

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Author: BERNARDINI, Jacopo (Fermi National Accelerator Laboratory)

Co-authors: PASSARELLI, Donato (Fermi National Accelerator Laboratory); PARISE, Mattia (Fermi National Accelerator Laboratory)

Presenter: BERNARDINI, Jacopo (Fermi National Accelerator Laboratory)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **211** Contribution code: **THP21** Type: **Student Poster Presentation**

Study of multilayer thin-film structures in superconducting acceleration cavities

Thursday, September 25, 2025 2:30 PM (3 hours)

Currently, 1.3 GHz Nb superconducting elliptical cavities have achieved accelerating gradients of Eacc ≈ 40 MV/m. In contrast, theoretical predictions suggest that accelerating cavities with multilayer thin-film structures on their inner surfaces might reach gradients of Eacc ≈ 100 MV/m. Such significant performance improvements would represent a major advancement not only in high-energy physics experiments, but also in industrial applications. Previous studies have confirmed the feasibility and effectiveness of forming multilayer thin films on flat samples. The next step is to develop film-deposition techniques suitable for the inner surfaces of cavities. In particular, developing specialized cathodes for sputtering alloy films is a key challenge. Therefore, simulations of sputtering are conducted to analyze the distribution and thickness of the resulting films for the cathode design. Furthermore, by exploring various experimental conditions, thin-film deposition tests will be carried out efficiently for evaluating the performance of multilayer structures. This presentation reports in detail on studies related to thin-film depositions inside superconducting accelerator cavities.

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Yes

Footnotes

Funding Agency

Author: SASAKI, Taisei (Tohoku University)

Co-authors: SAEKI, Takayuki (High Energy Accelerator Research Organization); KUBO, Takayuki (High Energy Accelerator Research Organization); KATAYAMA, Ryo (High Energy Accelerator Research Organization); Dr IWASHITA, Yoshihisa (Osaka University); FUWA, Yasuhiro (Japan Atomic Energy Agency); SANUKI, Tomoyuki (Jikei University School of Medicine)

Presenter: SASAKI, Taisei (Tohoku University)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **212** Contribution code: **MOP03** Type: **Poster Presentation**

Operational status and experience of the TLS CESR-B type SRF module

Monday, September 22, 2025 2:30 PM (3 hours)

Taiwan Light Source (TLS) is a third-generation synchrotron light source located at NSRRC in Taiwan, operating at an electron energy of 1.5 GeV. The original RF system of TLS utilized two normal-conducting Doris cavities. In 2005, these were replaced with a single CESR-B type superconducting RF (SRF) module, which significantly improved the system's stability and enabled an increase in the operating beam current to 360 mA. This report describes the operational performance of the SRF module over more than 20 years, including statistical records, performance monitoring, and major operational issues along with their solutions. The status of the spare SRF module is also discussed in this report.

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Yes

Footnotes

Funding Agency

Author: LO, Chih-Hung (National Synchrotron Radiation Research Center)

Co-authors: LIU, Zong-Kai (National Synchrotron Radiation Research Center); CHANG, Mei-Hsia (National Synchrotron Radiation Research Center); CHUNG, Fu-Tsai (National Synchrotron Radiation Research Center); CHEN, Ling-Jhen (National Synchrotron Radiation Research Center); LIN, Ming-Chyuan (National Synchrotron Radiation Research Center); YEH, Meng-Shu (National Synchrotron Radiation Research Center); WANG, Chaoen (National Synchrotron Radiation Research Center); LI, Yi-Ta (National Synchrotron Radiation Research Center); CHANG, Shian-Wen (National Synchrotron Radiation Research Center); HUANG, Chao-Hui (National Synchrotron Radiation Research Center)

Presenter: LO, Chih-Hung (National Synchrotron Radiation Research Center)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **213** Contribution code: **TUP80** Type: **Poster Presentation**

Search for dark matter with superconducting cavities and qubits

Tuesday, September 23, 2025 2:30 PM (3 hours)

Dark matter with masses much less than 1 eV/c² is treated as a classical field, commonly referred to as wavelike dark matter. Among the leading candidates is the axion, which may have a mass on the order of μeV and can be converted into ordinary microwave photons of minuscule amplitude under a strong magnetic field. Leading wavelike dark matter searches often employ SRF cavities as detectors for enhancing tiny signals. Therefore, the sensitivity of detection is proportion to the quality factor of the cavity.

Our research explores a broad range of cavity-based technologies for particle physics applications. For example, we aim to realize high-Q superconducting cavities at the single-photon regime at millikelvin temperatures to maximize sensitivity in dark matter detection. We also investigate the development of SRF cavities with high magnetic-field tolerance for axion searches. Additionally, we couple cavities to superconducting qubits to assess their potential for versatile quantum sensing technologies, such as single-photon counting or direct excitation of transmon qubits.

In this poster, we present our approach to dark matter detection using SRF cavities and report on the progress of each application.

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Yes

Footnotes

Funding Agency

Author: NITTA, Tatsumi (High Energy Accelerator Research Organization)

Presenter: NITTA, Tatsumi (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC5: SRF Applications

Contribution ID: **214** Contribution code: **THP33** Type: **Poster Presentation**

Sideband excitation phenomena study in SRF vertical testing

Thursday, September 25, 2025 2:30 PM (3 hours)

Sideband excitations observed in superconducting radio-frequency (SRF) cavities during vertical tests are indicative of complex underlying phenomena that can impact cavity performance and their measurements. This work presents an analysis combining experimental data and numerical simulations to investigate the origins and contributions of multipactor and field emission to sideband generation. RF measurements and radiation monitoring were employed during vertical tests of several niobium cavities to characterize the temporal and spectral features of the side bands under varying field levels. Complementary particle tracking and electromagnetic simulations were performed to model electron trajectories, secondary emission, and RF power deposition in the cavity. This study provides new insight into the interplay between surface phenomena and RF field dynamics in SRF cavities and offers guidelines for improved interpretation of vertical test data and enhanced cavity processing strategies.

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Yes

Footnotes

Funding Agency

Author: CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Co-authors: Mr BOSOTTI, Angelo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); DEL CORE, Elisa (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Presenter: CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **215** Contribution code: **THP79** Type: **Student Poster Presentation**

CFD simulation of micron-scale dust particle transport and deposition in superconducting accelerator vacuum lines

Thursday, September 25, 2025 2:30 PM (3 hours)

During vacuum commissioning and operation of large superconducting accelerators, gas flow may induce the dust particle within pipelines, causing intolerable particulate contamination in superconducting radio frequency (SRF) cavities. Investigating the transport behavior of microscale solid particles within accelerator pipelines is critical for understanding and solving particulate contamination problems in superconducting accelerators.

Computational fluid dynamics (CFD) methods with proper conditions can accurately predict particle behavior in gas flows. We developed our own OpenFOAM solver and case setup to systematically investigate the transport and deposition behavior of micron- and submicron-scale particles in long straight pipelines. Initially, we simulated gas flows in a sufficiently long straight circular pipe with different inlet velocity for an extended duration to obtain fully developed velocity profiles. These velocity profile were then applied as boundary conditions at both the inlet and outlet to maintain fully developed flow conditions within the computational domain during the simulation. Building upon this foundation, we thoroughly investigated the influence of three key operational parameters—gas flow rate, pressure, and particle size on the behavior of the test particle in pipelines. These findings can offer valuable insights and references for controlling particle contamination issues in SRF cavities.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

National Natural Science Foundation of China under Grant 12375161, Youth innovation promotion association CAS under Grant 2023017

Author: LUO, Zhizhen (Institute of High Energy Physics)

Co-authors: ZHAI, Jiyuan (Institute of High Energy Physics); HE, Feisi (Institute of High Energy Physics); LIU, Baiqi (Institute of High Energy Physics)

Presenter: LUO, Zhizhen (Institute of High Energy Physics)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **216** Contribution code: **TUP08** Type: **Poster Presentation**

Beam characterization and lessons learned from beam commissioning prior to SRF linac integration

Tuesday, September 23, 2025 2:30 PM (3 hours)

The Linear IFMIF Prototype Accelerator (LIPAc) is a deuteron linear accelerator (linac) designed to validate the acceleration of a 125-mA beam up to 9 MeV in continuous wave (CW) operation, contributing to the realization of the IFMIF project. The 125-mA deuteron beam is initially accelerated to 5 MeV by a radio-frequency quadrupole (RFQ) and subsequently to 9 MeV by a superconducting radio-frequency (SRF) linac. In LIPAc, even slight particle losses can lead to SRF linac quenching, component damage, and radioactivation. Therefore, ensuring stable beam transport with minimal particle losses is crucial to the success of this project. LIPAc is assembled and commissioned in phases, and the installation of the SRF linac into the beamline is underway. The validation of the functionality of the beam diagnostic devices and the characterization of the beam properties were conducted during phase B+ beam commissioning prior to operating with the SRF linac. Particle losses and discrepancies were observed between the measured and simulated beam sizes. However, through iterative optimization, these particle losses were minimized achieving a matched beam. In this conference, the details of the beam characterization and lessons learned from Phase-B+ will be presented, as well as the beam optics for commissioning with the SRF linac.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HYUN, Jibong (National Institutes for Quantum Science and Technology)

Co-authors: Dr MIZUNO, Akihiko (Japan Synchrotron Radiation Research Institute; National Institutes for Quantum Science and Technology); Dr TAKAYAMA, Ken (High Energy Accelerator Research Organization); MASUDA, Kai (National Institutes for Quantum Science and Technology); KONDO, Keitaro (National Institutes for Quantum Science and Technology); SCANTAMBURLO, Francesco (IFMIF/EVEDA Project Team); Dr CARIN, Yann (Fusion for Energy); Dr DZITKO, Herve (Fusion for Energy); INTEGRATED PROJECT TEAM, IFMIF/EVEDA (IFMIF/EVEDA Integrated Project Team)

Presenter: HYUN, Jibong (National Institutes for Quantum Science and Technology)

Session Classification: Tuesday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **217** Contribution code: **MOP49** Type: **Poster Presentation**

Update on INFN LASA in-kind contribution to ESS ERIC superconducting linac

Monday, September 22, 2025 2:30 PM (3 hours)

INFN-LASA has successfully completed its in-kind contribution to the European Spallation Source Eric, delivering 36 superconducting medium beta cavities for the ESS Linac. These cavities are designed to increase the energy of the proton beam from 216 MeV to 571 MeV. In addition, four spare cavities are being fabricated. This article outlines the performance of the cavities delivered so far and updates on the production status of the latest cavities.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Co-authors: BERTUCCI, Michele (Istituto Nazionale di Fisica Nucleare); BOSOTTI, Angelo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); DEL CORE, Elisa (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); Mr FIORINA, Fabrizio (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PAPARELLA, Rocco (Istituto Nazionale di Fisica Nucleare); Dr SPRUZZOLA, Paolo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); VITALI, Bastiano (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); Prof. PAGANI, Carlo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata; University of Milan)

Presenter: SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **218** Contribution code: **MOP39** Type: **Poster Presentation**

ITN in Europe: a coordinated effort for ILC technology development

Monday, September 22, 2025 2:30 PM (3 hours)

The ILC Technology Network (ITN) in Europe, in close collaboration with KEK and key institutions including CEA, CERN, INFN, is actively driving the development of advanced superconducting radiofrequency (SRF) technologies to support the realization of the International Linear Collider (ILC). The ITN-EU initiative focuses on developing and validating cost-effective, high-performance cavity production processes, transitioning from single-cell R&D to the industrialization of 9-cell cavities. Activities include optimizing surface treatment protocols, rigorous quality control of niobium materials, harmonization with Japanese High Pressure Gas Safety (HPGS) regulations, and preparing technical specifications for cavity jacketing and testing. As part of this program, Europe will contribute fully qualified SRF cavities to a globally designed ILC-type cryomodule for testing at KEK. The collaboration fosters knowledge exchange across laboratories and industry, supports advanced diagnostics development, and benefits from wider initiatives such as the Marie Skłodowska-Curie EAJADE network. These collective efforts not only support ILC realization but also reinforce Europe's strategic capabilities in SRF technology for future accelerators.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

This work was partially supported by the European Union's Horizon Europe Marie Sklodowska-Curie Staff Exchanges programme under EAJADE (Europe-America-Japan Accelerator Development Exchange) grant agreement no. 101086276.

Funding Agency

This work was partially supported by the European Union's Horizon Europe Marie Sklodowska-Curie Staff Exchanges programme under EAJADE (Europe-America-Japan Accelerator Development Exchange) grant agr

Author: MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Co-authors: CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); YAMAMOTO, Akira (High Energy Accelerator Research Organization); SAKAI, Hiroshi (High Energy Accelerator Research Organization); Mr SCHIRM, Karl-Martin (European Organization for Nuclear Research); UMEMORI, Kensei (High Energy Accelerator Research Organization); MICHIZONO, Shinichiro (High Energy Accelerator Research Organization; The Graduate University for Advanced Studies, SOKENDAI); STAPNES, Steinar (European Organization for Nuclear Research); SAEKI, Takayuki (High

Energy Accelerator Research Organization); DOHMAE, Takeshi (High Energy Accelerator Research Organization); YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Presenter: MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **219** Contribution code: **THP38** Type: **Poster Presentation**

Virtual cavity probe for the real-time identification of cavity burst-noise type in superconducting radio-frequency systems

Thursday, September 25, 2025 2:30 PM (3 hours)

Burst-noise events are primary trip sources at the China Accelerator Facility for superheavy Elements (CAFE2), characterized by a rapid burst noise in the cavity pick-up signal categorizable into three distinct types: flashover, electronic quench (E-quench), and partial E-quench. Herein, we design an algorithm identifying the burst-noise event types in real time to realize a real-time discrimination of the three types of burst-noise events. This algorithm is based on a virtual cavity probe constructed with the forward and reflected signals of the cavity and integrated into a field-programmable gate array (FPGA). Moreover, we introduce an innovative method for calibrating the transmission delay in channels. This FPGA-based low-level radio-frequency algorithm identifies the burst-noise event type in real time. Its effectiveness has been validated in the CAFE2 facility, offering valuable data support for future advancements in machine learning-based fault classification and dark-current characterization.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: MA, Jin (Institute of Modern Physics, Chinese Academy of Sciences)

Co-author: QIU, Feng (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: MA, Jin (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **220** Contribution code: **TUP40** Type: **Poster Presentation**

Plasma electrolytic polishing (PEP) at INFN: A versatile surface treatment technology for additively manufactured accelerator components

Tuesday, September 23, 2025 2:30 PM (3 hours)

Plasma Electrolytic Polishing (PEP) is under active development at INFN-LNL as a flexible, environmentally friendly alternative to conventional electropolishing (EP). Since 2019, our research has focused on optimizing PEP for a variety of accelerator-relevant materials and geometries, ranging from standard planar samples to complex components, including parts fabricated via Additive Manufacturing (AM). Unlike EP, PEP uses diluted salt-based electrolytes, avoiding hazardous acids, and allows for high removal rates (up to 30 µm/min for Cu) with low surface roughness (Ra<50 nm). These properties make it highly suitable for applications requiring excellent surface finish and minimal contamination, such as RF structures and vacuum components. This contribution presents an overview of the various developments achieved with PEP at LNL. These include treatments of AM stainless steel and copper structures, inner copper conductors, and Cu drift tubes for LINACs. The synergy between PEP and AM surfaces has also been explored, with promising results indicating the potential for replacing multi-step post-processing chains with a single PEP step. Furthermore, custom electrolytes and process parameters have been developed and patented for multiple metals including Cu, Nb, Al, and stainless steels. The contribution highlights the versatility of PEP across multiple materials and geometries, its scalability, and its prospects for integration into accelerator component manufacturing workflows.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

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3. Weal 3T System S.r.l. Torino, Italy

Author: EZEABA, Tochukwu Emmanuel (University of Padua)

Co-authors: CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare); FORD, Davide (Istituto Nazionale di Fisica Nucleare); FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare); STIVANELLO, Fabrizio (Istituto Nazionale di Fisica Nucleare); KEPPEL, Giorgio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); AZZOLINI, Oscar (Istituto Nazionale di Fisica Nucleare); MAYER-HOFER, Michael (Universität der Bundeswehr München); Dr HÄHNEL, Hendrik (Goethe University Frankfurt)

Presenter: CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **222** Contribution code: **TUP45** Type: **Poster Presentation**

Performance analysis of the ESS SRF cavities from qualification to first operation run

Tuesday, September 23, 2025 2:30 PM (3 hours)

The 82 SRF cavities of the present 2 MW configuration of the ESS Linac have been operated up to their specification during the first technical commissioning run on the temporary beam dump. Operational experience and comparison of cavity performances between vertical tests at the project in kind members and those measured at the cryomodule test stands and in the tunnel is described.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: PIERINI, Paolo (European Spallation Source)

Co-authors: ELIAS, Nuno (European Spallation Source); GOUDKET, Philippe (European Spallation Source); Mr KRAWCZYK, Artur (European Spallation Source); LAFACE, Emanuele (European Spallation Source); MAIANO, Cecilia (European Spallation Source); PRZYBILSKI, Henry (European Spallation Source); SKIBA, Marek (European Spallation Source); WANG, Muyuan (European Spallation Source); Ms ZWOZNIAK, Agnieszka (European Spallation Source)

Presenter: PIERINI, Paolo (European Spallation Source)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **223** Contribution code: **TUP46** Type: **Poster Presentation**

Beam-based measurements on ESS SRF cavities

Tuesday, September 23, 2025 2:30 PM (3 hours)

During the present technical commissioning run of the ESS linac several measurements were taken to extract beam properties (e.g. phase and current) on the base of beam transient induced voltage and comparing with beam diagnostic based measurements.

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Yes

Footnotes

Funding Agency

Author: PIERINI, Paolo (European Spallation Source)

Co-authors: Ms ZWOZNIAK, Agnieszka (European Spallation Source); Mr KRAWCZYK, Artur (European Spallation Source); MAIANO, Cecilia (European Spallation Source); LAFACE, Emanuele (European Spallation Source); PRZYBILSKI, Henry (European Spallation Source); SKIBA, Marek (European Spallation Source); WANG, Muyuan (European Spallation Source); ELIAS, Nuno (European Spallation Source); GOUDKET, Philippe (European Spallation Source)

Presenter: PIERINI, Paolo (European Spallation Source)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **224** Contribution code: **TUP47** Type: **Poster Presentation**

Status of the qualification campaign of the ESS elliptical cryomodules

Tuesday, September 23, 2025 2:30 PM (3 hours)

All elliptical cryomodules are tested at the ESS Test Stand in Lund before their installation in the linac. In June 2024 21 of the 30 cryomodules have been tested, 8 more are being prepared for test. This contribution presents a review of the testing experience, success rate, non-conformities encountered, and their resolution.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: PIERINI, Paolo (European Spallation Source)

Co-authors: Ms ZWOZNIAK, Agnieszka (European Spallation Source); Mr KRAWCZYK, Artur (Institute of Nuclear Physics, Polish Academy of Sciences); MAIANO, Cecilia (European Spallation Source); PRZYBILSKI, Henry (European Spallation Source); SKIBA, Marek (European Spallation Source); WANG, Muyuan (European Spallation Source); ELIAS, Nuno (European Spallation Source); GOUDKET, Philippe (European Spallation Source)

Presenter: PIERINI, Paolo (European Spallation Source)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **225** Contribution code: **MOP44** Type: **Poster Presentation**

CNRS contribution to PIP-II project: overview and lessons learned from SSR2 cavities prototyping phase

Monday, September 22, 2025 2:30 PM (3 hours)

Since 2018, IJCLab is involved in PIP-II project on the design, development and qualification of accelerator components for the SSR2 (Single Spoke Resonator type 2) section of the superconducting linac. All pre-production components (cavity, coupler and tuner) have been fabricated and qualified either at IJCLab (tuner and cavity) and/or at FNAL (coupler and cavity). This paper will summarize all tests done during this prototyping phase at IJCLab.

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Yes

Footnotes

Funding Agency

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Author: LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Co-authors: Mr LE DRÉAN, David (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); PASSARELLI, Donato (Fermi National Accelerator Laboratory); Mr MAVILLA, Guillaume (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Ms VOGT, Lê My (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); VANNSON, Mael (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Mr PIERENS, Matthieu (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); PARISE, Mattia (Fermi National Accelerator Laboratory); GANDOLFO, Nicolas (Université Paris-Saclay, CNRS/IN2P3, IJCLab); Ms DUCHESNE, Patricia (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Dr DUTHIL, Patxi (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Dr WALLON, Sandry (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); KAZAKOV, Sergey (Fermi National Accelerator Laboratory); Mrs GUEDDANI, Soukaina (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); POUX, Véronique (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie)

Presenter: LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **226** Contribution code: **MOP18** Type: **Poster Presentation**

Nb3Sn coatings on copper at INFN-LNL

Monday, September 22, 2025 2:30 PM (3 hours)

The successful development of Nb3Sn/Cu coatings for the SRF cavities of next generation particle accelerators would allow for the operation of the SRF system at 4.5 K, resulting in a reduction of the needed cryogenic power by a factor 3 with respect to what normally needed for bulk Nb cavities, operated at 2 K. In the framework of I.FAST and ISAS collaborations, an optimized recipe for Nb3Sn films deposited via DCMS has been established on small samples at INFN-LNL and is discussed in this work. Films with a Tc ≥ 17 K at deposition temperatures ≤ 650 °C on Cu substrate pre-coated with a 30-micron thick buffer layer of Nb have been successfully produced. The same deposition recipe is RF validated on bulk Nb QPR sample, with the results being also discussed in this work. A surface resistance of 23 nΩ at 4.5 K (at 20 mT, 417 MHz, with quench field ˜ 70 mT) is measured, which is about 5 times larger than the baseline specifications for the LHC Nb/Cu cavities and already fulfills the requirements for the FCC-ee. Finally, the expected challenges toward the scalability of the coating recipe to an elliptical cavity prototype are discussed.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare)

Co-authors: BATTISTELLO, Alex (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare); FORD, Davide (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); STIVANELLO, Fabrizio (Istituto Nazionale di Fisica Nucleare); PASQUATO, Flavio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); KEPPEL, Giorgio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); Dr LAZZARI, Matteo (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); LOLLO, Michele (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); AZZOLINI, Oscar (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); BORTOLAMI, Thomas (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Presenter: FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **227** Contribution code: **MOP43** Type: **Poster Presentation**

First results on plasma cleaning tests in a SSR1-type spoke resonator for PIP-II project at IJCLab

Monday, September 22, 2025 2:30 PM (3 hours)

Plasma ignition studies have been initiated at IJCLab since 2022. These are focusing on "in situ" plasma decontamination of SRF cavities with complex geometries as Quarter Wave Resonator (QWR) and Single Spoke Resonators (SSR). IJCLab being strongly involved in PIP-II project and in particular in the qualification test of SSR1- and SSR2-type resonators, the vertical cryostat has been upgraded to implement plasma decontamination capabilities. With the support of Fermilab and Eurolabs project, the impact of plasma ignition on the performance of a prototype SSR1 cavity has been assessed. This paper will give an overview on the upgrade work done on the cryostat, on the plasma decontamination process and on the comparative analysis of the 2 vertical tests (before and after plasma process).

I have read and accept the Privacy Policy Statement

Yes

Footnotes

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Author: LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Co-authors: GIACCONE, Bianca (Fermi National Accelerator Laboratory); CHENEY, Camille (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); LE DRÉAN, David (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); PASSARELLI, Donato (Fermi National Accelerator Laboratory); MAVILLA, Guillaume (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); VOGT, Lê My (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); VANNSON, Mael (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); PARISE, Mattia (Fermi National Accelerator Laboratory); GANDOLFO, Nicolas (Université Paris-Saclay, CNRS/IN2P3, IJCLab); DUCHESNE, Patricia (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); DUTHIL, Patxi (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); AIAZZI, Tommaso (Fermi National Accelerator Laboratory)

Presenter: LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **228** Contribution code: **THP31** Type: **Poster Presentation**

Additive manufacturing for seamless 6 GHz Nb/Cu cavities

Thursday, September 25, 2025 2:30 PM (3 hours)

Additive Manufacturing (AM) offers a unique way of fabricating components with intricate geometries and enables the use of materials that are otherwise difficult to machine or process due to high melting points. Within this context, recent work at INFN-LNL and INFN-Padova focused on the fabrication of a seamless 6 GHz copper cavity using AM techniques. This study investigates the feasibility of fabricating a geometrically complex structure (such as an elliptical RF cavity) without internal supports, while demonstrating compatibility with ultra-high vacuum (UHV), superconducting coating, and cryogenic operation. The cavity underwent successful internal polishing via Plasma Electrolytic Polishing (PEP) and passed standard leak tests. After polishing, a thin niobium (Nb) coating (˜ 3 µm) was deposited at low temperature (˜ 300 ℃). The film delaminated during the post-coating High Pressure Rinsing (HPR), therefore the RF test of the cavity could not be performed at this round. A new deposition run will be carried out at a higher deposition temperature and increased film thickness, with the goal of improving adhesion and mechanical stability of the film.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

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Author: FORD, Davide (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Co-authors: CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare); KEPPEL, Giorgio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare); STIVANELLO, Fabrizio (Istituto Nazionale di Fisica Nucleare); CANDELA, Valentina (INFN- Sez. di Padova); CANDELA, Silvia (INFN- Sez. di Padova); PEPATO, Adriano (Univ. degli Studi di Padova); REBESAN, Pietro (INFN- Sez. di Padova)

Presenter: FORD, Davide (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **229** Contribution code: **TUP31** Type: **Poster Presentation**

Development of a new system for Nb_3Sn thin film deposition on 1.3 GHz cavities

Tuesday, September 23, 2025 2:30 PM (3 hours)

Nb_3Sn in the form of thin film on copper is one of the most promising routes in the field of superconducting radio-frequency accelerating cavities for future colliders. At INFN –Legnaro National Laboratories, thin films of Nb_3Sn have been successfully deposited on small copper samples via DC magnetron sputtering the process enabled the production of films with critical temperature > 17 K, at deposition temperatures of 600 ℃ - 650 ℃ and with the implementation of a Nb buffer layer of 30 um thickness. The design and development of a dedicated system to scale this deposition recipe from small samples to a full-size 1.3 GHz copper cavity are presented in this work. The main challenges involve both the high substrate temperatures—requiring careful thermal management and mechanical design—and the need to ensure uniform thin film deposition over a large and curved internal surface. Since a planar magnetron is employed, a rotational motion must be maintained during the process, achieved in this case by rotating the cavity itself. The system's core features include substrate heating using four infrared lamps, the insertion of a custom planar magnetron inside the cavity, and a ferrofluidic rotation mechanism compatible with ultra-high vacuum conditions. To this day, the system has been successfully built and tested.

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Yes

Footnotes

Funding Agency

Author: LAZZARI, Matteo (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Co-authors: AZZOLINI, Oscar (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); Mr BATTISTELLO, Alex (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); Mr BORTOLANI, Thomas (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); Dr FETAJ, Anita (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); FONNESU, Dorothea (Istituto Nazionale di Fisica Nucleare); FORD, Davide (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); KEPPEL, Giorgio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); Mr PASQUATO, Flavio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare); Dr SALMASO, Alessandro (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); STIVANELLO, Fabrizio (Istituto Nazionale di Fisica Nucleare)

Presenter: LAZZARI, Matteo (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **230** Contribution code: **THP65** Type: **Poster Presentation**

Utilization of remote monitoring tools in the long-term operation of the superconducting linac at RIKEN

Thursday, September 25, 2025 2:30 PM (3 hours)

Compared to normal-conducting accelerators, superconducting linacs require a dramatically larger number of parameters to be monitored, including not only RF power and beam-related signals, but also cryogenic conditions such as helium tank pressure, vacuum levels, and cavity temperatures. This increased complexity demands robust and flexible monitoring systems, especially during extended operation over several consecutive months.

At RIKEN superconducting heavy-ion linac (SRILAC), EPICS (Experimental Physics and Industrial Control System) serves as the main control framework, providing standard GUI tools such as control panels and archive viewers. However, as the scale and duration of operation have grown, the need for more accessible and responsive monitoring solutions has become apparent.

To meet this need, we have developed web-based applications using Ajax, React, and D3.js. These tools provide real-time access to trend graphs, Machine Protection System (MPS) alarm status, and control screen streaming—all through a standard web browser. This setup enables accelerator staff to monitor system conditions not only from the control room, but also from offices, labs, or even from home. We report on how these tools have proven useful in maintaining effective monitoring during the long-term operation of SRILAC.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: KANEKO, Kenta (SHI Accelrator Service Ltd.)

Co-author: UCHIYAMA, Akito (RIKEN Nishina Center)

Presenter: KANEKO, Kenta (SHI Accelrator Service Ltd.)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **231** Contribution code: **TUP43** Type: **Poster Presentation**

Development of wet nitrogen doping to improve the performance of half-wave resonators

Tuesday, September 23, 2025 2:30 PM (3 hours)

A new surface treatment method is being developed, wet nitrogen doping, in which nitric acid is added during electro-polishing (EP). In the first trial on a FRIB beta = 0.53 half-wave resonator (HWR), a high quality factor (Q0 = 8E10) was observed at 2 K at low field (accelerating gradient ≤ 0.5 MV/m) without an anti-Q slope. It is known that the Q0 can be increased by shortening the mean free path via surface contamination by oxygen. Low-temperature baking (LTB) can allow oxygen to diffuse into the surface to a depth similar to the RF penetration depth. However, nitrogen cannot diffuse via LTB. Therefore, the mechanism for increasing Q0 with N-doping has not been clearly understood. Moreover, by comparing the behavior of buffered chemical polishing (BCP) processed cavities, it was found that BCP also dopes nitrogen on the SRF surface, and the doped nitrogen hinders the diffusion of oxygen under LTB, making LTB unable to mitigate the high field Q-slope (HFQS).

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Yes

Footnotes

Funding Agency

U.S. Department of Energy, Office of Science, Office of Nuclear Physics and used resources of the Facility for Rare Isotope Beams (FRIB) Operations under Award Number RC114424

Author: Dr WU, Yuting (Facility for Rare Isotope Beams)

Co-authors: GANSHYN, Andrei (Facility for Rare Isotope Beams); COMPTON, Chris (Facility for Rare Isotope Beams); METZGAR, Ethan (Facility for Rare Isotope Beams); SAITO, Kenji (Facility for Rare Isotope Beams); ELLIOTT, Kyle (Facility for Rare Isotope Beams); POPIELARSKI, Laura (Facility for Rare Isotope Beams); MILLER, Samuel (Facility for Rare Isotope Beams); KIM, Sang-hoon (Facility for Rare Isotope Beams); COMBS, Spencer (Facility for Rare Isotope Beams); KONOMI, Taro (Facility for Rare Isotope Beams); XU, Ting (Facility for Rare Isotope Beams); HARTUNG, Walter (Facility for Rare Isotope Beams); CHANG, Wei (Facility for Rare Isotope Beams); CHEON, Yoo-lim (Facility for Rare Isotope Beams)

Presenter: SAITO, Kenji (Facility for Rare Isotope Beams)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **232** Contribution code: **MOP45** Type: **Poster Presentation**

Preparation and qualification of pre-production SSR2 jacketed cavities for PIP-II

Monday, September 22, 2025 2:30 PM (3 hours)

The qualification of 325 MHz Single Spoke Resonators type 2 (SSR2) jacketed cavities to meet technical requirements represents a significant milestone in the development of the SSR2 cryomodules for the PIP-II Project at Fermilab. This poster reports the procedures and lessons learned in processing and preparing these cavities for horizontal cold testing prior to integration into a cavity string assembly, with a focus on addressing the field emission issues observed during the cold testing. A comprehensive root cause analysis identified critical fabrication, processing, and handling factors impacting field emission onset. New techniques were successfully developed and implemented to achieve field emission-free SSR2 cavities, and efforts were made to correlate radiation levels measured at the test stand with expected levels in the LINAC tunnel. Additionally, the evolution of field emission through assembly steps was thoroughly investigated, leading to a reassessment of design choices and enhancing our understanding of their effects on cavity performance.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: GRASSELLINO, Laura (Fermi National Accelerator Laboratory)

Co-authors: SUKHANOV, Alexander (Fermi National Accelerator Laboratory); Mr BICE, Damon (Fermi National Accelerator Laboratory); LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab); PASSARELLI, Donato (Fermi National Accelerator Laboratory); Mr SANG-HOON, Kim (Facility for Rare Isotope Beams); ELLIOTT, Kyle (Facility for Rare Isotope Beams); PARISE, Mattia (Fermi National Accelerator Laboratory); XU, Ting (Facility for Rare Isotope Beams); AIAZZI, Tommaso (Fermi National Accelerator Laboratory)

Presenter: GRASSELLINO, Laura (Fermi National Accelerator Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **233** Contribution code: **MOP46** Type: **Poster Presentation**

Grinding studies for improvement of cavity sub-components manufacturing defects

Monday, September 22, 2025 2:30 PM (3 hours)

The grinding process plays a crucial role in the fabrication of sub-components for 325 MHz spoke SRF cavities. During the forming and manufacturing stages, various defects can occur, which are addressed through grinding. This study aims to examine the effect of different grit sizes and explore how these sizes correlate with defect measurements. Optical microscopy and scanning electron microscopy (SEM) were employed to characterize the defects both before and after chemical treatment.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: GRASSELLINO, Laura (Fermi National Accelerator Laboratory)

Co-author: PARISE, Mattia (Fermi National Accelerator Laboratory)

Presenter: GRASSELLINO, Laura (Fermi National Accelerator Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **235** Contribution code: **TUP07** Type: **Poster Presentation**

LCLS-II-HE cavity and cryomodule test performance

Tuesday, September 23, 2025 2:30 PM (3 hours)

The LCLS-II-HE project has completed qualification testing of the 9-cell 1.3 GHz cavities and has completed construction and testing of 22 out of 24 new cryomodules. All but 9 cavities out of over 200 tested have met the qualification requirements in vertical test. The cryomodules have met specifications, exceeding the required accelerating voltage by an average of 25 MV per module. Here we present details of these results and an outlook to the final testing stages and installation plans.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: MANISCALCO, James (SLAC National Accelerator Laboratory)

Presenter: MANISCALCO, James (SLAC National Accelerator Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **238** Contribution code: **THP73** Type: **Poster Presentation**

String assembly for the first HELIAC cryomodule

Thursday, September 25, 2025 2:30 PM (3 hours)

The Helmholtz Linear Accelerator HELIAC is a superconducting (sc) continuous wave linear accelerator for heavy ions currently under development at GSI in Darmstadt. However, single cavity tests and the majority of cleanroom activities took and still take place at the designated facilities of the Helmholtz Institute Mainz (HIM). Each of the sc cryomodules of the HELIAC houses 3 cross-bar acceleration cavities, a sc rebuncher cavity and 2 sc solenoid lenses. Such a string is about 5 m long and has a mass of roughly 600 kg. Therefore for the cleanroom assembly in ISO-class 4 a heavy duty rail and girder system was used. The first cryomodule was successfully tested in Dezember 2023. We will report on the cleaning procedures and assembly steps as well as the finale integration into cryomodule at HIM.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: KUERZEDER, Thorsten (Helmholtz Institute Mainz)

Co-authors: Mr BURANDT, Christoph (GSI Helmholtz Centre for Heavy Ion Research); DZIUBA, Florian Dirk (GSI Helmholtz Centre for Heavy Ion Research); LIST, Julian (Helmholtz Institute Mainz); MISKI-OGLU, Maksym (GSI Helmholtz Centre for Heavy Ion Research); YARAMYSHEV, Stepan (GSI Helmholtz Centre for Heavy Ion Research); Mr KOWINA, Szymon (GSI Helmholtz Centre for Heavy Ion Research); GETTMANN, Viktor (GSI Helmholtz Centre for Heavy Ion Research); BARTH, Winfried (GSI Helmholtz Centre for Heavy Ion Research)

Presenter: KUERZEDER, Thorsten (Helmholtz Institute Mainz)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **239** Contribution code: **TUP01** Type: **Poster Presentation**

Test stand for HELIAC cryomodules at GSI

Tuesday, September 23, 2025 2:30 PM (3 hours)

The Helmholtz Linear Accelerator HELIAC is a superconducting (sc) continuous wave linear accelerator for heavy ions currently under development at GSI in Darmstadt. In order to fully test the new cryomodules a new area was set up. The construction started already in 2018 by clearing the necessary space for a radiation protection bunker near the existing pre-accelerator HLI at GSI. Because of a separate beam line from HLI, HELIAC cryomodules can already be tested with beam, which is crucial as the beam dynamics have to be checked, too. The bunker houses now the first 5 m long HELIAC cryomodule, the differential vacuum pumping chambers and the beam diagnostics. In 2021 the set-up of the cryogenic supply was finished. A 80 m long transferline between the cryogenic plant of GSI and a coldbox next to the bunker were installed for the supply with 4 K and 50 K helium. In the same year a first cryogenic test with the cryomodule was done, using dummy cavities. In 2023 the same module was operated, fully equipped with all srf cavities and sc solenoids, with beam. We will report on the details of the set-up and its installation.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: KUERZEDER, Thorsten (Helmholtz Institute Mainz)

Co-authors: BURANDT, Christoph (GSI Helmholtz Centre for Heavy Ion Research); DZIUBA, Florian Dirk (GSI Helmholtz Centre for Heavy Ion Research); LIST, Julian (Helmholtz Institute Mainz); MISKI-OGLU, Maksym (GSI Helmholtz Centre for Heavy Ion Research); YARAMYSHEV, Stepan (GSI Helmholtz Centre for Heavy Ion Research); KOWINA, Szymon (GSI Helmholtz Centre for Heavy Ion Research); GETTMANN, Viktor (GSI Helmholtz Centre for Heavy Ion Research); BARTH, Winfried (GSI Helmholtz Centre for Heavy Ion Research)

Presenter: KUERZEDER, Thorsten (Helmholtz Institute Mainz)

Session Classification: Tuesday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **240** Contribution code: **MOP06** Type: **Poster Presentation**

Upgrade of the ELETTRA 2.0 cryogenic plant

Monday, September 22, 2025 2:30 PM (3 hours)

As part of the upgrade of the Elettra synchrotron ring to Elettra 2.0, an upgrade and expansion of the helium liquefaction plant is also planned. The current cryogenic system is based on a Kaeser He compressor and a Helial 1000 cold box liquefier/refrigerator, with a Siemens S7-00 PLC-based control system, currently connected exclusively to the superconducting third harmonic cavity (S3HC).

The upgraded system will continue to provide cooling for the S3HC, but will also supply liquid helium to users and provide cryogenic support for the superconducting wiggler (SCW). A complete renewal of the control system is underway, transitioning from the obsolete and unsupported Siemens S7-00 PLC to the S7-1500 series.

A helium recovery and re-liquefaction system is planned both for the SCW and for the beamlines that require liquid helium for experimental activities.

This paper presents the current status of the cryogenic plant upgrade project, along with its economic and environmental impact.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Dr MODICA, Marco (Elettra-Sincrotrone Trieste S.C.p.A.)

Co-authors: Mr CARNIEL, Alessandro (Elettra-Sincrotrone Trieste S.C.p.A.); DI MITRI, Simone (Elettra-Sincrotrone Trieste S.C.p.A.); KRECIC, Stefano (Elettra-Sincrotrone Trieste S.C.p.A.); TREVI, Massimo (Elettra-Sincrotrone Trieste S.C.p.A.); Mr ZUPANCICH, Pietro (Elettra-Sincrotrone Trieste S.C.p.A.); FABRIS, Alessandro (Elettra-Sincrotrone Trieste S.C.p.A.); KARANTZOULIS, Emanuel (Elettra-Sincrotrone Trieste S.C.p.A.)

Presenter: Dr MODICA, Marco (Elettra-Sincrotrone Trieste S.C.p.A.)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **241** Contribution code: **THP68** Type: **Poster Presentation**

Preliminary thermal load calculations of superconducting deflecting cavities for ELETTRA 2.0

Thursday, September 25, 2025 2:30 PM (3 hours)

Picosecond-long X-ray pulses of moderate intensity and high repetition rate are highly sought after by the light source community, especially for time-resolved fine spectroscopic analysis of matter in the linear response regime. We investigate the upgrade of the Elettra 2.0 diffraction-limited storage ring light source to radiofrequency transverse deflecting superconducting cavities generating a steady-state vertical deflection of selected electron bunches. In this paper, a preliminary design of the cryomodule of the deflecting superconducting cavities is reported, both static and dynamic thermal loads are calculated using an analytical approach. The dynamic loads are calculated assuming both bulk Nb and Nb3Sn thin film cavities. The two different solutions involve different cryogenic plants, which will be reported.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Dr MODICA, Marco (Elettra-Sincrotrone Trieste S.C.p.A.)

Co-authors: SHAFQAT, Nuaman (Elettra-Sincrotrone Trieste S.C.p.A.); DI MITRI, Simone (Elettra-Sincrotrone Trieste S.C.p.A.); MANUKYAN, Koryun (Elettra-Sincrotrone Trieste S.C.p.A.); CLEVA, Stefano (Elettra-Sincrotrone Trieste S.C.p.A.); DASTAN, Sara (Elettra-Sincrotrone Trieste S.C.p.A.); FABRIS, Alessandro (Elettra-Sincrotrone Trieste S.C.p.A.); KARANTZOULIS, Emanuel (Elettra-Sincrotrone Trieste S.C.p.A.)

Presenter: Dr MODICA, Marco (Elettra-Sincrotrone Trieste S.C.p.A.)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **243** Contribution code: **TUP62** Type: **Poster Presentation**

Specification, design, production including quality check and preparation for high-power test of input power couplers for SRF 5-year plan (MEXT-ATD) at KEK by global collaboration for ILC Technology Network (ITN)

Tuesday, September 23, 2025 2:30 PM (3 hours)

A five-year project (MEXT advanced Accelerator element Technology Development (MEXT-ATD)) funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) began at KEK in FY2023. The goal is to manufacture, construct and test a cryomodule (CM) that satisfies the ILC (International Linear Collider Project) specifications and conduct cooling tests. The MEXT-ATD program is closely related to the ILC Technology Network (ITN). Based on the KEK-DESY license agreement, a 3D model of E-XFEL power coupler was submitted from IJCLAB, and RF simulations of the power coupler were conducted by KEK and FNAL through the US-Japan science and technology cooperation. In KEK, simulations on static/dynamic heat load was also done. From FY2024, production of four sets of input power couplers began (another four sets to be produced in FY2025). At the same time, quality checks were conducted on brazing, TiN coating, and copper plating. The production of four sets of power couplers were completed by the end of Mar/2025. Currently, preparation for high power test at resonant ring system in STF is under progress. In this presentation, the basic specifications and design of the input power coupler as well as the overall manufacturing/test schedule and recent progress will be reported in detailed.

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Yes

Footnotes

Funding Agency

This work was supported by 【MEXT Development of key element technologies to improve the performance of future accelerators Program】Japan Grant Number JPMXP1423812204.

Author: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Co-authors: SAKAI, Hiroshi (High Energy Accelerator Research Organization); OMET, Mathieu (High Energy Accelerator Research Organization); DOHMAE, Takeshi (High Energy Accelerator Research Organization); YAMADA, Tomohiro (High Energy Accelerator Research Organization); KATAYAMA, Ryo (High Energy Accelerator Research Organization); KUMAR, Ashish (High Energy Accelerator Research Organization); HARA, Takafumi (High Energy Accelerator Research Organization); KAZAKOV, Sergey (Fermi National Accelerator Laboratory)

Presenter: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **244** Contribution code: **TUP63** Type: **Poster Presentation**

Recent progress of robotic R&D for SRF at KEK

Tuesday, September 23, 2025 2:30 PM (3 hours)

Robotic R&D for SRF started from FY2022 at KEK. Some works related to auto-cleaning and assembly in clean room have been done in FY2023. In FY2024, a simulator 'ROBOGUIDE'was introduced, enabling precise orbit development and positioning, moreover, any 3D models developed by CAD became available on ROBOGUIDE. In FY2025, assembly between mock-up cavity and mock-up coupler will be demonstrated, 2D vision system will be also tested, and the effectiveness of clean work performed by robot will be verified through vertical test of SRF cavities. The third task will be collaboratively done between KEK and FNAL through the US-Japan science and technology cooperation. This robotic technology will be used for the on-going five-year project (MEXT advanced Accelerator element Technology Development (MEXT-ATD)) funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The goal is to manufacture, construct and test a cryomodule (CM) that satisfies the ILC (International Linear Collider Project) specifications and conduct cooling tests. The MEXT-ATD program is closely related to the ILC Technology Network (ITN). In this presentation, the recent progress of robotic R&D for SRF at KEK will be reported in detailed.

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Yes

Footnotes

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Author: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Co-authors: ITO, Hayato (High Energy Accelerator Research Organization); SAKAI, Hiroshi (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization); Prof. HIRAKI, Masahiko (High Energy Accelerator Research Organization); DOHMAE, Takeshi (High Energy Accelerator Research Organization); YAMADA, Tomohiro (High Energy Accelerator Research Organization)

Presenter: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **245** Contribution code: **TUP39** Type: **Poster Presentation**

Design and simulation of conductive cooling for radio frequency superconducting cavity

Tuesday, September 23, 2025 2:30 PM (3 hours)

The RF accelerating module is crucial for imparting kinetic energy to particle beams in accelerators. Superconducting RF (SRF) technology offers key advantages over conventional room-temperature RF systems, including lower operational costs, reduced beam loss, and higher accelerating power. The superconducting cavity, SRF's core component, requires ultra-low temperatures. While liquid helium cooling meets this need, its complex and expensive infrastructure hinders SRF's widespread adoption. Recent advances in cavity manufacturing have improved quality factors (Q-values) and reduced heat loads to watt levels, enabling alternative cooling methods. This study investigates conduction cooling using compact cryocoolers for a 648 MHz superconducting cavity. Numerical simulations analyzed two cooling structures, focusing on configuration, material choice, and thermal contact resistance. Results show conduction cooling effectively maintains operational temperatures, with high-purity aluminum outperforming oxygen-free copper as a thermal bridge material. Maintaining thermal contact resistance below 10 $K\cdot cm^2/W$ is critical. These findings offer valuable guidance for designing more efficient SRF cooling systems.

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Yes

Footnotes

Funding Agency

Guangdong Basic and Applied Basic Research Foundation(Grant No.2022B1515120027)

Author: ZHANG, Cong (Institute of High Energy Physics)

Co-authors: CHEN, Zhifan (China Spallation Neutron Source); WEN, Jian (Xi'an Jiaotong University)

Presenter: ZHANG, Cong (Institute of High Energy Physics)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **246** Contribution code: **THP01** Type: **Poster Presentation**

Status of the Mainz Energy-Recovering Accelerator (MESA)

Thursday, September 25, 2025 2:30 PM (3 hours)

This contribution provides an updated overview of the Mainz Energy-Recovering Accelerator (MESA), a continuous-wave superconducting electron linac currently under construction at the Institute for Nuclear Physics at Johannes Gutenberg University Mainz. Designed to deliver high-current, highly polarized beams with energy recovery, MESA aims to support a diverse experimental program. The current status of the accelerator, with a focus on the installation of key components of the SRF infrastructure, will be presented.

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Yes

Footnotes

Funding Agency

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Author: STENGLER, Timo (Institut für Kernphysik)

Co-authors: HUG, Florian (Johannes Gutenberg University Mainz); AULENBACHER, Kurt (Helmholtz Institute Mainz)

Presenter: STENGLER, Timo (Institut für Kernphysik)

Session Classification: Thursday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **250** Contribution code: **THP42** Type: **Poster Presentation**

Development of a cobot-assisted high pressure rinsing solution for SRF cavities

Thursday, September 25, 2025 2:30 PM (3 hours)

IJCLab has been contributing to several SRF accelerators in the world (SPIRAL2, ESS, PIP-II) and in particular was in charge of the design, surface preparation and qualification in vertical cryostat of low beta (i.e. complex 3D shape) resonators as Quarter-Wave Resonators (QWR) and Spoke Resonators. One of the main challenges of these complex geometries is the final surface cleaning by High Pressure Rinsing (HPR) to limit or in the best case suppress the Field Emission (FE) at nominal gradient. While standard HPR methods have effectively reduced FE, they could not eliminate it in these geometries. Since 2024, triggered and motivated by PIP-II prototyping phase, IJCLab is investing in COBOT technology (COllaborative roBOT) in an effort to improve HPR capabilities, leveraging the flexibility and precision of cobots to perform complex trajectories for optimal surface coverage. This paper will summarize the on-going R&D activities at IJCLab.

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Yes

Footnotes

Funding Agency

Author: GANDOLFO, Nicolas (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Co-authors: Mr DELHAYE, Bastien (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); DUCHESNE, Patricia (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); LONGUEVERGNE, David (Université Paris-Saclay, CNRS/IN2P3, IJCLab); VANNSON, Mael (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); VOGT, Lê My (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); WALLON, Sandry (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie)

Presenter: GANDOLFO, Nicolas (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **251** Contribution code: **THP55** Type: **Student Poster Presentation**

The influence of rolling direction and surface pinning of deformed grain boundaries during recrystallization in high-RRR niobium sheet

Thursday, September 25, 2025 2:30 PM (3 hours)

The ability to accurately and consistently quantify the recrystallized (Rx) microstructure of heat-treated high-purity Nb used in superconducting radiofrequency (SRF) applications is critical for the improvement of material processing and cavity production. The production of SRF cavity half-cells by deep-drawing Nb sheets into the half-cell geometry results in different stain paths in different locations of the cavity (which includes prior rolling history). Cavity production typically removes the damaged surface layer followed by a vacuum anneal at 800℃ for 3-hours. Dislocation substructures that develop during the anneal are known to be sources of magnetic flux trapping, and higher temperature anneals between 900 and 1000℃ have shown cavity performance improvement through the reduction of these defects. As the microstructure within each lot of Nb varies, it is possible that rolling coupons in different directions could identify differences in Rx response with respect to the rolling direction and provide guidance for the optimal anneal for a given lot. The significance of the strain path effect is exaggerated on the surface due to pinning of deformed grain boundaries during the anneal. Removal of surface grains reveals a more homogeneous Rx with larger grain sizes. Hence, it is critical for the SRF community to understand where measurements are taken (surface vs. interior) to accurately quantify the extent of Rx present in the material.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

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Author: THUNE, Zackery (Michigan State University)

Co-author: BIELER, Thomas (Michigan State University)

Presenter: THUNE, Zackery (Michigan State University)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **252** Contribution code: **THP66** Type: **Poster Presentation**

Mock-up waveguide loop development towards a half-meter scale traveling-wave (TW) SRF cavity

Thursday, September 25, 2025 2:30 PM (3 hours)

Traveling-Wave (TW) technology can push the accelerator field gradient of niobium SRF cavity to 70 MV/m or higher beyond the fundamental limit of 50˜60 MV/m in Standing-Wave regime. The success of TW resonance excitation in a proof-of-principle 3-cell SRF cavity in 2 K liquid helium encouraged to advance TW technologies necessary more for future accelerator-scale one. Fermilab has proposed a preliminary RF design of a half-meter scale cavity by considering the physical dimensions of existing SRF facilities and the lessons learned from the 3-cell. It consists of a 7-cell structure and a power feedback waveguide (WG) loop with new TW excitation and control schemes such as, double directional coupler and two WG tuners. Mock-up waveguide loop development was launched under Fermilab LDRD program to demonstrate those new RF schemes at a room temperature. Fabrication drawings of a mock-up loop were completed. More details and plans of the development will be presented.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: FURUTA, Fumio (Fermi National Accelerator Laboratory)

Co-authors: MCGEE, Kellen (Fermi National Accelerator Laboratory); KAZAKOV, Sergey (Fermi National Accelerator Laboratory); KHABIBOULLINE, Timergali (Fermi National Accelerator Laboratory); NG, Man-Kwan (Fermi National Accelerator Laboratory); YAKOVLEV, Vyacheslav (Fermi National Accelerator Laboratory)

Presenter: MCGEE, Kellen (Fermi National Accelerator Laboratory)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **253** Contribution code: **THP56** Type: **Student Poster Presentation**

The effects of strain path and strain magnitude on the uniformity of recrystallization in high-RRR niobium 1.3 GHz half-cells

Thursday, September 25, 2025 2:30 PM (3 hours)

The consistent production of high-RRR Nb cavities for superconducting radiofrequency applications is critical to advancements in accelerator performance and technology. Despite standard guidelines for material and cavity production, the properties and performance of these cavities can vary significantly. Improvements in cavity performance due to better flux expulsion are observed after heat treatment temperatures in the range of 900-1000℃. This can be attributed to more recrystallization (Rx) and grain growth that removes geometrically necessary dislocations (GNDs) that act as magnetic flux pinning centers. Recent work has shown that the observed Rx fraction via electron backscatter diffraction (EBSD) analysis of GNDs in cold-rolled high-RRR Nb to be strain path dependent. A high-RRR deep-drawn Nb half-cell was sliced with section edges aligned 0°, 45°, and 90° from the final rolling direction of the Nb sheets. The effects of heating rate (5 and 250℃/min), annealing temperature (800 and 900℃), strain path, and strain magnitude on the Rx fraction and uniformity were quantitatively assessed in samples from the iris, equator, and a lesser-strained region in between. The insights gained from these microstructural observations can guide novel heat treatment strategies that enable consistent higher-performance cavity production.

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Yes

Footnotes

Funding Agency

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Author: THUNE, Zackery (Michigan State University)

Co-authors: BALACHANDRAN, Shreyas (Florida State University); BIELER, Thomas (Michigan State University)

Presenter: THUNE, Zackery (Michigan State University)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **254** Contribution code: **MOP81** Type: **Poster Presentation**

High-Q 3D niobium λ/4 coaxial cavities for quantum applications inspired by SRF technologies

Monday, September 22, 2025 2:30 PM (3 hours)

High-Q three-dimensional (3D) superconducting cavities are often used for quantum application including dielectric constant measurement, quantum memory[1], and dark matter detection[2]. In these experiments, a high-Q cavity is integrated with a superconducting qubit, which yields circuit-based Quantum Electrodynamics (cQED) architecture. The cavity geometry employed for quantum applications is radically different from that used for particle accelerators like a TESLA cavity. Most recently 3D cQED platforms are composed of a λ/4 coaxial cavity[1] which permits strong enough coupling between the superconducting qubit and the coaxial cavity to manipulate the quantum state of the cavity whilst sustaining internal Q factors of 1e9[3]. However, the best internal Q factor for these types of cavities is still an order of magnitude smaller than TESLA cavities. The origin of the reduced internal Q factor for λ/4 coaxial cavities has still not been clarified. One prominent candidate for the source of loss stems from the fact that 3D cQED devices for quantum applications are operated in the low-power limit, which is insufficient to saturate oxide defects on the cavity surface. In this study, various surface treatments are investigated with the aim to improve the lifetimes of 5.5 GHz λ/4 coaxial cavities. The internal Q factor after each treatment will be reported in this study and the most effective methods to fabricate a high-Q cavity for quantum applications will be discussed.

I have read and accept the Privacy Policy Statement

Yes

Funding Agency

JST Moonshot R&D, Grant Number JPMJMS2067.

Footnotes

[1] M. Reagor, et al., PRB 94, 014506 (2016).
[2] K. Nakazono, et al., arXiv:2505.15619 (2025).
[3] A. Oriani, et al., arXiv:2403.00286 (2024).

Author: TAKENAKA, Takaaki (NTT Basic Research Laboratories)

Co-authors: Dr MAHBOOB, Imran (NTT Basic Research Laboratories); Dr SAITO, Shiro (NTT Basic Research Laboratories); KUBO, Takayuki (High Energy Accelerator Research Organization); SAEKI, Takayuki (High Energy Accelerator Research Organization)

Presenter: TAKENAKA, Takaaki (NTT Basic Research Laboratories)

Session Classification: Monday Poster Session

Track Classification: MC5: SRF Applications

Contribution ID: **255** Contribution code: **TUP61** Type: **Poster Presentation**

Design of ILC prototype cryomodule under ITN activities at KEK

Tuesday, September 23, 2025 2:30 PM (3 hours)

A 5-year project called MEXT Advanced Accelerator element Technology Development began in FY2023 at KEK. The goal of this project is to manufacture one cryomodule (CM) that meets the requirements of International Linear Collider (ILC) and to test completed CM at cryogenic temperature. ILC model CM consists of nine cell superconducting cavities, magnetic shields, power couplers, tuners, cooling piping to cool the cavities to 2 K, two layers of thermal shields cooled to 80 K and 5 K respectively, a superconducting magnet and a beam position monitor. In this development, we are also aiming to reduce the manufacturing costs of the CM. Two layers of thermal shield in ILC model CM were changed to single layer thermal shield in the KEK design to reduce costs and to simplify the structure. Pipes which are compliant with JIS (Japanese Industrial Standard) and easy to procure in Japan will be used in this CM. For the cooling test, the placement of temperature sensors on each component was considered. The feedthroughs were newly designed for various sensors, monitors and power supplies. This development will contribute to establish technologies of superconducting accelerator and is a step toward the realization of the ILC. This presentation will report on the status of designing and manufacturing of the CM.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Acknowledgement: This work was supported by 【MEXT Development of key element technologies to improve the performance of future accelerators Program】Japan Grant Number JP-MXP1423812204.

Author: HARA, Takafumi (High Energy Accelerator Research Organization)

Co-authors: UMEMORI, Kensei (High Energy Accelerator Research Organization); DOHMAE, Takeshi (High Energy Accelerator Research Organization); YAMADA, Tomohiro (High Energy Accelerator Research Organization); YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Presenter: HARA, Takafumi (High Energy Accelerator Research Organization)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **256** Contribution code: **TUP66** Type: **Poster Presentation**

Commissioning status of the RF power source for the LIPAc SRF linac

Tuesday, September 23, 2025 2:30 PM (3 hours)

The Linear IFMIF Prototype Accelerator (LIPAc) is designed as a high-current deuteron linear accelerator (linac) capable of accelerating a 125-mA beam up to 9 MeV in continuous wave (CW) mode. The RFQ linac and subsequent beam transport lines equipped with several diagnostics successfully commissioned a 119-mA deuteron beam with an 8.75% duty cycle. The superconducting RF (SRF) linac is the remaining critical component to be commissioned in CW to reach the final acceleration target of 9MeV. The installation of the SRF linac into the beamline is currently underway. In preparation for the integrated commissioning of the SRF linac, the RF station has been commissioned in stand-alone mode. Unlike the synchronized RF control of the RFQ (where 8 RF chains inject in one resonant cavity), the SRF-RF control can be fine-tuned individually and new functionalities peculiar to the SRF environment, such as quench detection, have been implemented. This report summarizes the features of the LIPAc SRF-RF system and its current commissioning status.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HIROSAWA, Kouki (National Institutes for Quantum Science and Technology)

Co-authors: Mr KUBO, Naoya (National Institutes for Quantum Science and Technology); SCANTAMBURLO, Francesco (IFMIF/EVEDA Project Team); Dr MOYA, Ivan (Fusion for Energy); ADAM, Jean-Pierre (Fusion for Energy); GONZALEZ GALLEGO SANCHEZ CAMACHO, Luis (Consorcio IFMIF--DONES España); PIQUET, Olivier (CEA Paris-Saclay)

Presenter: HIROSAWA, Kouki (National Institutes for Quantum Science and Technology)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **258** Contribution code: **TUP15** Type: **Student Poster Presentation**

Predicting the critical fields of the vortex state in impure superconductors

Tuesday, September 23, 2025 2:30 PM (3 hours)

Here we investigate the magnetic phase behaviour of an impure superconductor, and predict the critical fields of the Meissner/vortex state in the presence of impurities. To do this, we derive the Gibbs free energy of an impure superconductor immersed in an external magnetic field. We then use this Gibbs free energy to derive modified Ginzberg-Landau equations, which if solved describe the equilibrium state of the superconductor. We go on to solve these modified Ginzberg-Landau equations numerically, and use these solutions to predict the energy barrier for transition between the Meissner and vortex states. We perform this calculation in the case of a superconductor-insulator boundary, which has practical applications in superconducting radio frequency cavities. Operating in the Meissner state is critical for superconducting radio frequency cavities, thus calculating this state's stability is an important practical problem. Additionally, it has been theorized that some of the most promising surface treatments for cavities work due to diffusion of oxygen impurities into the superconductor, which "dirty" the material. Understanding the action of some general impurity distribution on the stability of the Meissner state could then lead to higher critical fields and more efficient superconducting radio frequency cavities.

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Yes

Footnotes

Funding Agency

Author: WALLACE, Lucas (University of Victoria)

Presenter: WALLACE, Lucas (University of Victoria)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **260** Contribution code: **THP15** Type: **Poster Presentation**

Development of niobium 3 GHz single-cell cavity for superconducting thin film research

Thursday, September 25, 2025 2:30 PM (3 hours)

The introduction of thin film structures into superconducting cavities is theoretically predicted to improve performance, and experimental verification is now required. In this study, we are developing a relatively small and easy-to-handle niobium-made 3 GHz single-cell cavity to verify the effects of introducing thin film structures. We performed vertical measurements on the 3 GHz single-cell cavity after applying standard BCP and EP treatments, and obtained baseline data prior to the introduction of thin film structures. In this presentation, we report on the longitudinal measurement setup and results for the 3 GHz cavity, as well as our future research plans.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: FUWA, Yasuhiro (Japan Atomic Energy Agency)

Co-authors: HATTORI, Ayaka (National Institute of Technology); ITO, Hayato (High Energy Accelerator Research Organization); Dr IWASHITA, Yoshihisa (Osaka University); Dr KATAYAMA, Ryo (High Energy Accelerator Research Organization); KUBO, Takayuki (High Energy Accelerator Research Organization); SAEKI, Takayuki (High Energy Accelerator Research Organization)

Presenter: Dr KATAYAMA, Ryo (High Energy Accelerator Research Organization)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **261** Contribution code: **THP75** Type: **Poster Presentation**

Expansion of the line-up of high capacity 4 K GM-JT cryocooler system

Thursday, September 25, 2025 2:30 PM (3 hours)

Recent advancements in Nb_3Sn cavity development have enabled the design of SRF accelerators utilizing compact mechanical cryocoolers instead of helium liquefiers, simplifying system architecture and reducing costs. In this background, our company has released a high-efficiency, high-capacity 4 K GM-JT (Gifford-McMahon-Joule-Thomson) cryocooler system with 10 W-class cooling capacity at 4.2 K. This system provides higher efficiency and superior cooling performance in comparison to GM or PT (Pulse-Tube) cryocooler systems. So, it contributes to reducing power consumption, installation footprint, and maintenance costs for customer systems. To further promote the adoption of GM-JT cryocooler systems, ongoing development efforts focus on expanding low-vibration line-up, shortening cooldown times, and broadening operational temperature ranges. The progress of these developments will be presented at this conference.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: IINO, Yuki (Sumitomo Heavy Industries (Japan))

Co-author: IKEDA, Taiki (Sumitomo Heavy Industries (Japan))

Presenter: IINO, Yuki (Sumitomo Heavy Industries (Japan))

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **262** Contribution code: **THP16** Type: **Poster Presentation**

Impact of initial cold work on the bulk microstructure and flux expulsion performance of SRF Nb cavities

Thursday, September 25, 2025 2:30 PM (3 hours)

Recent advances in understanding the subsurface microstructure and microchemistry of niobium (Nb) have led to significant improvements in the quality factor (Q0) of superconducting radiofrequency (SRF) cavities. Beyond traditional surface treatments, emerging evidence highlights the critical role of the bulk microstructure, particularly in influencing the trapping and expulsion of residual magnetic flux during cooldown. We explore the possibilities to change the bulk microstructure by deep-drawing high-purity, cold-rolled Nb sheets into half-cells and fabricating cavities. Notably, forming half-cells starting with a cold-worked Nb sheet prior to heat treatment yields a more uniform and homogeneous microstructure, which correlates with enhanced flux expulsion and improved Q0. In this work, we systematically investigated the effects of varying degrees of cold work followed by heat treatment, on the microstructural evolution of SRF-grade Nb. We also demonstrate the feasibility of fabricating cavities from these cold-worked Nb sheets and assess their flux expulsion behavior. The results demonstrate that tailoring the initial deformation state of Nb offers a promising pathway to consistently optimize SRF cavity performance.

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Yes

Footnotes

Funding Agency

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Author: CHETRI, Santosh (Florida State University)

Co-authors: KHANAL, Bashu (Old Dominion University); CARL, Matthew (ATI Specialty Alloys & Components); LANNOY, Nathan (ATI Specialty Alloys & Components); DHAKAL, Pashupati (Thomas Jefferson National Accelerator Facility); LEE, Peter (Florida State University); BALACHANDRAN, Shreyas (Florida State University); BORITZ, Trent (Florida State University)

Presenter: CHETRI, Santosh (Florida State University)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **263** Contribution code: **MOP34** Type: **Poster Presentation**

Vertical test results for ITN single cell cavities

Monday, September 22, 2025 2:30 PM (3 hours)

To support the ILC Technology Network (ITN) Cryomodule project at KEK, we have constructed and assembled six single cell cavities, four fine grain (FG) and two medium grain (MG) for vertical testing (VT). A series of surface treatment were applied to the cavities using the proposed recipe for the construction of the International Linear Collider (ILC). This recipe consists of four steps: bulk electropolishing (EP), annealing, cold EP, and finally two step baking. Using this recipe, we can consistently exceed the ILC specifications. We analyze the performance and characteristics of these cavities using Q vs E and temperature mapping measurements. One of the cavities was treated with a special recipe which skips the cold EP step to simplify the cavity preparation process. We find that this modified recipe is also able to exceed the ILC specification, however the quality factor was negatively affected.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: VIKLUND, Eric (High Energy Accelerator Research Organization)

Co-authors: UMEMORI, Kensei (High Energy Accelerator Research Organization); OMET, Mathieu (High Energy Accelerator Research Organization); KATAYAMA, Ryo (High Energy Accelerator Research Organization); HARA, Takafumi (High Energy Accelerator Research Organization)

Presenter: VIKLUND, Eric (High Energy Accelerator Research Organization)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **264** Contribution code: **THP03** Type: **Poster Presentation**

Beam diagnostics and RF cavity operation during SCL3 beam commissioning at RAON

Thursday, September 25, 2025 2:30 PM (3 hours)

RAON is a heavy ion accelerator consisting of a cryomodule containing a superconducting cavity in the SCL3 section and a warm section with a quadrupole magnet and a diagnostic chamber. Two types of superconducting RF cavities are utilized, arranged in three types of cryomodules: the 81.25 MHz quarter-wave resonator (QWR) and the 162.5 MHz half-wave resonator (HWR). In 2024, beam commissioning was carried out with the entire SCL3 section in operation. RF cavity tuning was successfully achieved using a systematic phase scan procedure. During this period, an argon beam with a current of 40 μA and a sodium beam with a rate of ˜10,000 particles per second were delivered to the experimental area. The accelerator was operated at an RF power of 4 W and a maximum duty cycle of 10%. The beam diagnostic system included beam position monitors (BPM), wire scanners (WS), Faraday cups (FC), beam loss monitors (BLM), and beam loss collectors (BLC). All current-based diagnostic signals, including BLC and Faraday cup signals, were processed through the mTCA standard-based data acquisition system. This poster describes the integrated operation of the diagnostic and RF systems and summarizes key observations made during the commissioning of the SCL3 linear accelerator.

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Yes

Footnotes

Funding Agency

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Author: KWON, Jangwon (Institute for Basic Science)

Presenter: KWON, Jangwon (Institute for Basic Science)

Session Classification: Thursday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **265** Contribution code: **THP22** Type: **Poster Presentation**

Thermo-mechanical testing results for IC-DX ultra-low thermal expansion alloy at cryogenic temperature

Thursday, September 25, 2025 2:30 PM (3 hours)

Thermal shrink of materials is always an obstacle when designing cryogenic systems. In superconducting cavity cryomodules, some adopt reference bars, which are made by Invar, to keep cavities' position same at cryogenic temperature from room temperature. Linear expansion of Invar from 300 K to 2 K is about 0.04 %, resulting in approximately 5 mm of thermal shrink for the 12.6 m ILC cryomodule, for example. Since the less the reference bar shrinks, the better, our search for a new material led us to a material called IC-DX. It has 3˜4 times smaller thermal shrink than Invar and has about 180 GPa of Young's modulus at room temperature, which is 1.5 times larger than that of conventional Invar. It was known that IC-DX did not change to martensitic structure when cooled to cryogenic temperatures, but tensile tests, thermal conductivity measurements, and Charpy impact tests at liquid helium temperatures had not been conducted. In this study, tensile and Charpy impact tests were conducted at room temperature, liquid nitrogen temperature, and liquid helium temperature, and thermal conductivity measurements were conducted at 4-50 K. In this presentation, we report on these results.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: YAMADA, Tomohiro (High Energy Accelerator Research Organization)

Co-authors: KUMAR, Ashish (High Energy Accelerator Research Organization); YAMANAKA, Masashi (High Energy Accelerator Research Organization)

Presenter: YAMADA, Tomohiro (High Energy Accelerator Research Organization)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **266** Contribution code: **MOP48** Type: **Poster Presentation**

INFN LASA activities toward the PIP-II LB650 cavity production

Monday, September 22, 2025 2:30 PM (3 hours)

This contribution outlines the current status and recent progresses of INFN LASA's in-kind contribution to the PIP-II project at Fermilab. It focuses on key manufacturing activities, on preliminary inspection results on sub-components and on upgrades to cavity testing infrastructures. The production of the 38, 5-cell, $\beta = 0.61$ SRF cavities designed by INFN LASA for the LB650 section of the linac is underway, starting with two pre-series units aimed at validating the full manufacturing and processing workflow. The series production is being carried out by industry, with cavities also undergoing most of surface treatments as well as final cleaning and preparation at vendor's premises. Final experimental qualification, to verify that cavities meet the challenging performance specifications required by the project, will be conducted through vertical cold tests at the DESY AMTF (Germany) facility before being delivered at CEA Saclay (France) as ready for string-assembly.

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Yes

Footnotes

Funding Agency

Author: PAPARELLA, Rocco (Istituto Nazionale di Fisica Nucleare)

Co-authors: BERTUCCI, Michele (Istituto Nazionale di Fisica Nucleare); BONEZZI, Massimo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); BOSOTTI, Angelo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); DEL CORE, Elisa (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); FIORINA, Fabrizio (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PAGANI, Carlo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); SPRUZZOLA, Paolo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); Dr VITALI, Bastiano (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); GRASSELLINO, Laura (Fermi National Accelerator Laboratory); PASSARELLI, Donato (Fermi National Accelerator Laboratory); OZELIS, Joseph (Fermi National Accelerator Laboratory)

Presenter: SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **267** Contribution code: **MOP51** Type: **Poster Presentation**

Development of High-Pressure Rinsing (HPR) simulation for SSR cavities at RAON

Monday, September 22, 2025 2:30 PM (3 hours)

High-Pressure Rinsing (HPR) is one of the most im-portant processes in achieving high performance of SRF cavities. The geometry of SSR cavities differs significant-ly from that of HWR and QWR cavities. To upgrade the HPR process of SSR cavities, it is important to under-stand how much of the inner surface area can be effective-ly reached by the waterjet from HPR nozzles. HPR simu-lation software was developed to evaluate waterjet cover-age based on parameters such as nozzle hole orientation, rotation speed, and translation speed of the nozzle rod. Two types of nozzles were fabricated for SSR1 and SSR2 cavities to improve rinsing performance. Prototype test-ing of SSR1 and SSR2 cavities using these new nozzles is currently underway at IRIS. The nozzle design is being optimized based on simulation and experimental results.

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Yes

Footnotes

Funding Agency

Author: KIM, Juwan (Institute for Basic Science)

Co-authors: JUNG, Yoochul (Institute for Basic Science); CHOI, Jongwan (Institute for Basic Science); KIM, Heetae (Institute for Basic Science); KIM, Youngkwon (Institute for Basic Science)

Presenter: KIM, Juwan (Institute for Basic Science)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **268** Contribution code: **MOP69** Type: **Student Poster Presentation**

Design and CW RF transmission test up to 100 kW of L-band high-power input coupler

Monday, September 22, 2025 2:30 PM (3 hours)

A high-power input coupler was developed to transmit 100 kW-class RF power in continuous wave (CW) mode to a 1.3 GHz conduction-cooled superconducting accelerator. Both RF and thermal design optimizations were carried out to ensure efficient performance and compatibility with cryogenic constraints. Results of RF simulations showed a reflection coefficient of S1,1 = −44 dB at 1.3 GHz and a bandwidth of 24.6 MHz at the −20 dB level. Thermal simulations estimated the total static heat load to be approximately 1.2 W at the 4 K stage and 11.3 W at the 35 K stage, which is well within the cooling capacity of the available cryocoolers. To suppress the temperature increase under high RF power transmission, active water cooling was integrated into critical components, including the warm inner conductor, warm outer conductor antenna, and RF window. The newly developed coupler was successfully tested at a test stand under RF power up to CW 100 kW at room temperature conditions. A temperature rise at the inner conductor, which is the most critical component, was 15 ℃. A maximum temperature rise of 19 ℃ was recorded at the doorknob. The high-power test results demonstrated the coupler's capability to handle the target power level reliably while effectively mitigating thermal load during CW operation.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: NAMA, Pragya (The Graduate University for Advanced Studies, SOKENDAI)

Co-authors: KUMAR, Ashish (High Energy Accelerator Research Organization); Dr ARAKAWA, Dai (High Energy Accelerator Research Organization); KAKO, Eiji (High Energy Accelerator Research Organization); SAKAI, Hiroshi (High Energy Accelerator Research Organization); UMEMORI, Kensei (High Energy Accelerator Research Organization); MIURA, Takako (High Energy Accelerator Research Organization)

Presenter: NAMA, Pragya (The Graduate University for Advanced Studies, SOKENDAI)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **269** Contribution code: **THP41** Type: **Poster Presentation**

Magnetic environment optimization in SRF testing at INFN-LASA

Thursday, September 25, 2025 2:30 PM (3 hours)

Minimizing residual magnetic fields during SRF cavity cooldown is essential for reducing surface resistance and improving the quality factor. At LASA-INFN, we implemented an active compensation system using Helmholtz-like coils in vertical test cryostats. The setup is optimized to reduce the average magnetic flux through the cavity surface by accounting for the spatial inhomogeneity of the residual field. Experimental studies on PIP-II prototype cavities confirm the critical role of magnetic field conditions during cooldown. Observations suggest that, if a quench occurs in the presence of such external fields, trapped flux can cause a lasting degradation of the quality factor.

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Yes

Footnotes

Funding Agency

Author: BERTUCCI, Michele (Istituto Nazionale di Fisica Nucleare)

Co-authors: BOSOTTI, Angelo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); DEL CORE, Elisa (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); FIORINA, Fabrizio (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PAGANI, Carlo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PAPARELLA, Rocco (Istituto Nazionale di Fisica Nucleare); SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); SPRUZZOLA, Paolo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); VITALI, Bastiano (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Presenter: BERTUCCI, Michele (Istituto Nazionale di Fisica Nucleare)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **270** Contribution code: **MOP54** Type: **Poster Presentation**

Cavities mass production for SHINE at HERT

Monday, September 22, 2025 2:30 PM (3 hours)

The main accelerator of Shanghai High Repetition Rate X-ray FEL and Extreme Light Facility (SHINE) is an 8 GeV CW superconducting RF linac, which constructed by superconducting modules (8 X 9-cell 1.3 GHz TESLA type cavities). This article introduces the cavities progress that Beijing HE-Racing Technology Co., Ltd. (HERT) fabricated for SHINE.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: ZHAO, Jianbing (Institute of High Energy Physics)

Co-authors: ZHAO, Hui (Institute of High Energy Physics); HOU, Hongtao (Shanghai Advanced Research Institute); ZHANG, Zhanjun (Institute of High Energy Physics); ZHENG, Xiaobin (Institute of High Energy Physics); YANG, Conglai (Institute of High Energy Physics); MU, Zhihui (Institute of High Energy Physics)

Presenter: ZHAO, Jianbing (Institute of High Energy Physics)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **271** Contribution code: **MOP02** Type: **Poster Presentation**

CEPC superconducting RF system EDR design and R&D

Monday, September 22, 2025 2:30 PM (3 hours)

The CEPC (Circular Electron-Positron Collider) is a 100-kilometer circular collider designed to operate at center-of-mass energies ranging from 90 GeV to 360 GeV, with the primary physics program targeting Z and W bosons, Higgs bosons, and top-quark pair (ttbar) production. Following the publication of its Technical Design Report (TDR) in 2024, the project has now entered the Engineering Design Report (EDR) phase. This contribution outlines the EDR design of the CEPC' s Superconducting Radiofrequency (SRF) system, along with the associated R&D challenges and recent progress. During the EDR phase, the SRF system's primary objective is to develop SRF cryomodules for the first operational stage of the CEPC. A key milestone will be a full-scale 650 MHz cryomodule prototype for the collider ring to validate the stable operation using an 800 kW continuous-wave (CW) klystron and the Low-Level Radio Frequency (LLRF) control system. Additionally, preparations for mass-production of 650 MHz and 1.3 GHz cavities and cryomodules are underway aligned with China's ongoing large-scale SRF projects.

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Yes

Footnotes

Funding Agency

Author: ZHAI, Jiyuan (Institute of High Energy Physics)

Co-authors: SHA, Peng (Institute of High Energy Physics); ZHENG, Hongjuan (Institute of High Energy Physics); HUANG, Tongming (Institute of High Energy Physics); MA, Qiang (Institute of High Energy Physics); CHEN, Xu (Institute of High Energy Physics); MENG, Fanbo (Institute of High Energy Physics); MI, Zhenghui (Institute of High Energy Physics); JIN, Song (Institute of High Energy Physics); ZHANG, Xinying (Institute of High Energy Physics); DONG, Chao (Institute of High Energy Physics); GE, Rui (Institute of High Energy Physics); HAN, Ruixiong (Institute of High Energy Physics); XU, Miaofu (Institute of High Energy Physics); LI, Mei (Institute of High Energy Physics); LIU, Baiqi (Institute of High Energy Physics)

Presenter: ZHAI, Jiyuan (Institute of High Energy Physics)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **273** Contribution code: **MOP76** Type: **Poster Presentation**

Status of the cryomodule tests as a part of Polish in-kind contribution to the European Spallation Source (ESS) realized by IFJ PAN

Monday, September 22, 2025 2:30 PM (3 hours)

The European Spallation Source (ESS), as one of the complex accelerators require installation and commissioning of many systems and components. One of them is the accelerator line which is composed with the cryomodules uses to accelerate of the particles. Taking into account that ESS is one of the most technological advanced accelerators in Europe we can expect also that accelerator line is very complex and advanced part of the machine. Among others things three types of the cryomodules spokes, medium and high beta are used to assembly accelerator line. In 2017 first group of engineers from the Henryk Niewodniczanski Institute of Nuclear Physics Polish Academy of Science (IFJ PAN) arrived to Lund in order to start execution of IFJ PAN contribution to this project. In total 31 cryomodules have to be tested and prepared for assembly in the tunnel as a part of the accelerator line. In this paper the current status of the tests as well as early stage of the optimization process regarding test program for cryomodules tests is showed. The main focus is done on the procedures and quality aspects, required skills and challenges occurring during the tests work; inter alia: incoming inspection, tests before installation in the bunker, preparation of the cryomodules for the test, test in the bunker, outgoing inspection. A very expensive RF cryomodules and systems required the special skills and the right approach to quality which is provided by engineers and technicians from IFJ PAN.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: SWIERBLEWSKI, Jacek (Institute of Nuclear Physics, Polish Academy of Sciences)

Co-author: BOCIAN, Dariusz (Institute of Nuclear Physics, Polish Academy of Sciences)

Presenter: BOCIAN, Dariusz (Institute of Nuclear Physics, Polish Academy of Sciences)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **274** Contribution code: **TUP25** Type: **Student Poster Presentation**

Localization of field emission emitters in RAON HWRs using quality factor

Tuesday, September 23, 2025 2:30 PM (3 hours)

Field emission (FE) is one of the main issues limiting the performance of superconducting cavities. Various studies have been conducted to mitigate FE using methods such as computer simulations, microscopic surface analysis, plasma processing, and X-ray or temperature mapping. Among these, X-ray and temperature mapping are the most direct methods for localizing FE emitters. However, due to limitations such as cavity geometry and construction schedules, installing X-ray or temperature mapping system in the RAON Half-Wave Resonators (HWRs) was limited. To address these challenges, this study investigates the FE characteristics of superconducting cavities by primarily utilizing quality factor measurements, without relying on mapping systems. A new parameter was introduced, derived from the field enhancement factor and onset accelerating field, by processing quality factor data to identify the emitter locations. As a result, several FE-related characteristics in RAON HWRs were identified, including changes in emitter behavior due to FE conditioning and the predominant regions where emitters are likely to be located. Surface regions that require focused treatment to reduce FE were identified as well.

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Yes

Footnotes

Funding Agency

Author: JEON, Sungmin (Kyungpook National University)

Co-authors: KIM, Heetae (Institute for Basic Science); HAN, JangMin (Institute for Basic Science); KIM, Juwan (Institute for Basic Science); JUNG, Yoochul (Institute for Basic Science); KIM, Youngkwon (Institute for Basic Science)

Presenter: JEON, Sungmin (Kyungpook National University)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **275** Contribution code: **THP44** Type: **Poster Presentation**

Hybrid Wire Laser Additive Manufacturing and CNC machining for advanced SRF cavity fabrication

Thursday, September 25, 2025 2:30 PM (3 hours)

The fabrication of Superconducting Radio Frequency (SRF) cavities traditionally relies on forming and welding high-purity metal sheets, resulting in a local surface discontinuity that degrades the final SRF performance. In this work, we propose and explore a novel hybrid approach combining Wire Laser Additive Manufacturing (WLAM), with in situ CNC machining for the fabrication of mono-cell 1.3 GHz SRF cavity. This technique enables the layer-by-layer deposition of high-purity metals with precise dimensional control, while simultaneously integrating subtractive steps to maintain tolerances and surface quality crucial for RF performance. The hybrid WLAM and CNC machining stands as a candidate for next-generation SRF cavity production minimizing material waste, eliminating the need for electron beam welding, through the direct creation of complex geometries, and enhancing the surface finishing in the as-built condition. Results on stainless steel 1.3 GHz prototype are presented.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: AZZOLINI, Oscar (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Co-authors: CHYHYRYNETS, Eduard (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); KEPPEL, Giorgio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro); OLIVIERI, Giorgio (MELTIO); PIRA, Cristian (Istituto Nazionale di Fisica Nucleare); STIVANELLO, Fabrizio (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Presenter: AZZOLINI, Oscar (Istituto Nazionale di Fisica Nucleare, Laboratori Nazionali di Legnaro)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **276** Contribution code: **MOP27** Type: **Poster Presentation**

Testing and delivery of high beta cavities for the European Spallation Source by UKRI-STFC Daresbury Laboratory

Monday, September 22, 2025 2:30 PM (3 hours)

The testing and delivery of 86 704 MHz high-beta superconducting RF (SRF) cavities as part of an In-Kind-Contribution (IKC) by Accelerator Science and Technology Centre (ASTeC) for the European Spallation Source (ESS) facility in Lund, Sweden has just been completed. The cavities have been manufactured by industry, Research Instruments in Germany, and have been tested at Daresbury Laboratory and Deutsches Elektronen-Synchrotron (DESY). The requirement for the cavities was to achieve an accelerating gradient of 18.9 MV/m at a Q0 of 5e10. A review of the test results is described.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

UKRI-STFC

Author: Mr WHEELHOUSE, Alan (ASTeC, STFC Daresbury Laboratory)

Co-authors: BLACKETT-MAY, Andrew (ASTeC, STFC Daresbury Laboratory); Mr AKINTOLA, Ayo (ASTeC, STFC Daresbury Laboratory); JENKINS, Conor (Science and Technology Facilities Council); Mr MASON, David (Science and Technology Facilities Council); RESCHKE, Detlef (Deutsches Elektronen-Synchrotron DESY); Mr MILLER, George (Science and Technology Facilities Council); Dr SKACHKO, Ivan (ASTeC, STFC Daresbury Laboratory); Ms MUTCH, Jennifer (Science and Technology Facilities Council); STEDER, Lea (Deutsches Elektronen-Synchrotron DESY); Mr PENDLETON, Mark (Science and Technology Facilities Council); WIENCEK, Mateusz (Deutsches Elektronen-Synchrotron DESY); Mr ELLIS, Michael (ASTeC, STFC Daresbury Laboratory); POYNTON, Oliver (Science and Technology Facilities Council); Dr SMITH, Paul (ASTeC, STFC Daresbury Laboratory); MCINTOSH, Peter (Science and Technology Facilities Council); HORNICKEL, Philip (Science and Technology Facilities Council); Mr PATTALWAR, Shrikant (ASTeC, STFC Daresbury Laboratory); WILDE, Stuart (Daresbury Laboratory); Ms BILQUES, Zakia (Science and Technology Facilities Council)

Presenter: Mr WHEELHOUSE, Alan (ASTeC, STFC Daresbury Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **278** Contribution code: **TUP16** Type: **Poster Presentation**

Quality factor analysis of surface-passivated cavities at low gradients applying two level system models

Tuesday, September 23, 2025 2:30 PM (3 hours)

The native oxides of niobium cause surface losses during cavity operation arising from two-level systems/defects (TLS). These losses dominate the quality factor at low accelerating gradients (Eacc < 0.1 MV/m). In particular, the amorphous Nb_2O_5 is identified as a prominent host for the TLS. Nb_2O_5 dissociates when the material is baked above 200 ℃ for several hours in vacuum (the so-called Mid-T Bake), allowing for the modification or reduction of these losses. However, due to the inevitable exposure to air after the annealing, the surface reoxidizes and Nb_2O_5 regrows. When the cavity is already coated with Al_2O_3 or Ta_2O_5 and then subjected to the Mid-T Bake, this subsequent reoxidation of the niobium is inhibited.

It is still unclear how the TLS losses are modified when the surface undergoes a passivating coating, and this study aims at possibly finding a correlation between the different passivating layers.

Herein, we studied the quality factor of several superconducting radio frequency cavities in the low gradient range (Eacc < 0.1 MV/m) at 1.5 K and analyzed the data using TLS models like the standard TLS model and the non-interacting TLS (one species and two species). Specifically, we used cavities that had undergone the standard "European XFEL"treatment, followed by an atomic layer depositing coating with a passivating layer and the subsequent Mid-T Bake.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: VENUGOPAL, Rakshith (Deutsches Elektronen-Synchrotron DESY)

Co-authors: KASPRZAK, Karol (Deutsches Elektronen-Synchrotron DESY); WIENCEK, Mateusz (Deutsches Elektronen-Synchrotron DESY); Dr DEYU, Getnet Kacha (Universität Hamburg); Mr VOIGE, Marco (Universität Hamburg; Deutsches Elektronen-Synchrotron DESY); Dr ZIEROLD, Robert (Center for Hybrid Nanostructures); Prof. H. BLICK, Robert (Center for Hybrid Nanostructures); HILLERT, Wolfgang (Universität Hamburg); WEISE, Hans (Deutsches Elektronen-Synchrotron DESY); WENSKAT, Marc (Universität Hamburg; Deutsches Elektronen-Synchrotron DESY)

Presenter: WENSKAT, Marc (Universität Hamburg; Deutsches Elektronen-Synchrotron DESY)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **279** Contribution code: **MOP41** Type: **Poster Presentation**

Upgrades to the Daresbury Laboratory Vertical Test Facility and testing of PIP-II HB650 cavities

Monday, September 22, 2025 2:30 PM (3 hours)

A novel vertical test facility (VTF) has been in operation at the UKRI-STFC Daresbury Laboratory since 2019. This VTF tests jacketed SRF cavities in a horizontal configuration at 2 K. Originally designed and operated for 704 MHz high-beta cavities for ESS, the facility has now been upgraded and expanded to test 650 MHz high-beta cavities for PIP-II, including fast cooldown capability (>20 K/min) for magnetic flux expulsion. This paper reports on the new design, commissioning, and operation of the facility.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

UKRI-STFC

Author: BLACKETT-MAY, Andrew (ASTeC, STFC Daresbury Laboratory)

Co-authors: AKINTOLA, Ayo (ASTeC, STFC Daresbury Laboratory); Ms BILQUES, Zakia (Science and Technology Facilities Council); Mr CAVANAGH, Edward (ASTeC, STFC Daresbury Laboratory); Mr HASSALL, John (Science and Technology Facilities Council); HORNICKEL, Philip (Science and Technology Facilities Council); JENKINS, Conor (Science and Technology Facilities Council); Mr JONES, Matthew (ASTeC, STFC Daresbury Laboratory); MASON, David (Science and Technology Facilities Council); MCINTOSH, Peter (Science and Technology Facilities Council); MUTCH, Jennifer (Science and Technology Facilities Council); PATTALWAR, Shrikant (ASTeC, STFC Daresbury Laboratory); PENDLETON, Mark (Science and Technology Facilities Council); POYNTON, Oliver (Science and Technology Facilities Council); SHABALINA, Anna (Science and Technology Facilities Council); SKACHKO, Ivan (ASTeC, STFC Daresbury Laboratory); SMITH, Paul (ASTeC, STFC Daresbury Laboratory); WHEELHOUSE, Alan (ASTeC, STFC Daresbury Laboratory); WILDE, Stuart (Daresbury Laboratory); CHOUHAN, Vijay (Fermi National Accelerator Laboratory); GRASSELLINO, Laura (Fermi National Accelerator Laboratory); OZELIS, Joseph (Fermi National Accelerator Laboratory); PARK, HyeKyoung (Fermi National Accelerator Laboratory); Dr WU, Genfa (Fermi National Accelerator Laboratory)

Presenter: SHABALINA, Anna (Science and Technology Facilities Council)

Session Classification: Monday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **280** Contribution code: **MOP40** Type: **Poster Presentation**

Status of PIP-II HB650 cavities production

Monday, September 22, 2025 2:30 PM (3 hours)

STFC is responsible for delivering 20 high-beta 650 MHz cavities for the PIP-II project, with industry partners now producing series cavities. Both pre-series cavities have set world records in performance and cleanliness, meeting the project's stringent requirement for field emission-free operation, accelerating gradient, and Quality factor. Achieving this milestone required an industrialization of advanced processing techniques, including cold electropolishing and nitrogen doping, and a major effort to optimize cleanroom operations at the vendor's facility.
We will present the journey from prototyping to industrial production, highlighting the technology transfer, cleanroom upgrades, and QA/QC procedures that enabled these record-breaking results. Early performance data from the first series cavities will also be shared, demonstrating progress toward full-scale production.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: SHABALINA, Anna (Science and Technology Facilities Council)

Co-authors: WHEELHOUSE, Alan (Daresbury Laboratory); NETEPENKO, Alex (Fermi National Accelerator Laboratory); GRESELE, Ambra (Zanon Research & Innovation); BLACKETT-MAY, Andrew (ASTeC, STFC Daresbury Laboratory); TSYMBALIUK, Andrii (Zanon Research & Innovation); AKINTOLA, Ayo (Daresbury Laboratory); STONE, Brent (Fermi National Accelerator Laboratory); JENKINS, Conor (Science and Technology Facilities Council); MASON, David (Daresbury Laboratory); CAVANAGH, Edward (Daresbury Laboratory); WU, Genfa (Fermi National Accelerator Laboratory); PARK, HyeKyoung (Fermi National Accelerator Laboratory); SKACHKO, Ivan (Daresbury Laboratory); MUTCH, Jennifer (Daresbury Laboratory); OZELIS, Joseph (Fermi National Accelerator Laboratory); Dr CHEETHAM, K.J. (Daresbury Laboratory); GRASSELLINO, Laura (Fermi National Accelerator Laboratory); JONES, Matthew (Daresbury Laboratory); ELLIS, Michael (Daresbury Laboratory); KANE, Mitchell (Daresbury Laboratory); POYNTON, Oliver (Science and Technology Facilities Council); BARBERO, Paolo (Zanon Research & Innovation); SMITH, Paul (Daresbury Laboratory); MCINTOSH, Peter (Science and Technology Facilities Council); WILDE, Stuart (Daresbury Laboratory); CHOUHAN, Vijay (Fermi National Accelerator Laboratory); Ms BILQUES, Zakia (Science and Technology Facilities Council)

Presenter: SHABALINA, Anna (Science and Technology Facilities Council)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **281** Contribution code: **THP17** Type: **Poster Presentation**

RaSTA 2.0 - development of a compact sample test cavity for surface resistance measurements

Thursday, September 25, 2025 2:30 PM (3 hours)

RaSTA, the Rapid Superconductor Test Apparatus, is a sample test cavity project at HZB. It shares the sample geometry and the calorimetric measurement principle with the QPR but is targeted at quicker turnaround times and a more compact footprint at higher operating frequency. RaSTA 2.0 features a niobium coated copper cavity allowing for higher RF field levels and better thermal stability. The outer dimensions have been reduced to fit the system inside a compact cryostat; sample handling and tooling have been revised for reduced overall complexity. RaSTA can be operated without radiation shielding and the entire system is intended to be transferable to labs without extensive SRF infrastructure. We present the design and construction of RaSTA 2.0 together with operating considerations and first data obtained with the new cavity.

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Yes

Footnotes

Funding Agency

Author: Dr KECKERT, Sebastian (Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-authors: KRAMER, Felix (Helmholtz-Zentrum Berlin für Materialien und Energie); KUGELER, Oliver (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen)

Presenter: Dr KECKERT, Sebastian (Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **282** Contribution code: **THP54** Type: **Student Poster Presentation**

Preliminary physics design of 1.3 GHz superconducting electron gun

Thursday, September 25, 2025 2:30 PM (3 hours)

High gradient CW electron guns are essential for high-repetition-rate, high-brightness electron beams, key to advanced light sources and other applications. Compared to DC guns and normal conducting VHF guns, SRF guns are considered the next-generation solution for further boosting CW gun acceleration capabilities and electron source brightness. This paper presents the initial physics design of an SRF gun aiming for a 30 MV/m cathode field. It covers RF design optimizations, beam dynamics simulations, and frequency stability analyses. Results demonstrate the feasibility of the SRF gun design, and paves the way for the next phase of engineering development.

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Yes

Footnotes

Funding Agency

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Author: YUAN, XiongHao (Shanghai Institute of Applied Physics)

Co-authors: DENG, Haixiao (Shanghai Institute of Applied Physics); QIAN, Houjun (Shanghai Zhangjiang Laboratory); SHU, Guan (Shanghai Zhangjiang Laboratory); CHEN, Jinfang (Shanghai Advanced Research Institute); HOU, Hongtao (Shanghai Advanced Research Institute); PU, Xiaoyun (Shanghai Advanced Research Institute, Chinese Academy of Sciences)

Presenter: YUAN, XiongHao (Shanghai Institute of Applied Physics)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **284** Contribution code: **TUP26**　　Type: **Poster Presentation**

Statistical analysis of field emission for SHINE project

Tuesday, September 23, 2025 2:30 PM (3 hours)

Field emission is one of the main problems that is difficult to completely avoid in superconducting accelerator project, and it is usually considered to be caused by particles or chemical residuals. Although careful assembly and cleaning can minimize or eliminate this issue, field emission may still occur to some extent. This report focuses on the field emission problem faced in the SHINE project, including the field emission of bare cavities and of cryomodules. Through statistical analysis, possible correlations between processing and the occurrence of field emission were identified, allowing targeted countermeasures to be implemented and resulting in a noticeable reduction in field emission probability. Ongoing monitoring will be maintained to keep the field emission occurrence rate low in SRF cavities and to further toward field emission-free cryomodules.

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Yes

Footnotes

Funding Agency

Author: ZONG, Yue (Shanghai Advanced Research Institute)

Co-authors: Mr XING, Shuai (Shanghai Advanced Research Institute, Chinese Academy of Sciences); CHEN, Jinfang (Shanghai Advanced Research Institute); Mr LU, Lijun (Shanghai Advanced Research Institute, Chinese Academy of Sciences); WANG, Zheng (Shanghai Institute of Applied Physics); Ms WU, Jiani (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, ShenJie (Shanghai Advanced Research Institute, Chinese Academy of Sciences); Dr ZHAO, Yeliang (Shanghai Advanced Research Institute); ZHANG, Jiale (Shanghai Advanced Research Institute); XUE, Wentian (Shanghai Institute of Applied Physics); WANG, Xiaohu (ShanghaiTech University); Mr TAO, Yinji (ShanghaiTech University)

Presenter: ZONG, Yue (Shanghai Advanced Research Institute)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **285** Contribution code: **TUP41** Type: **Poster Presentation**

Plasma processing on low beta SRF elliptical cavities

Tuesday, September 23, 2025 2:30 PM (3 hours)

Plasma treatment has emerged as an effective method for mitigating field emission and recovering the performance of superconducting radiofrequency (SRF) cavities. A collaborative effort involving CEA, ESS, FNAL, and INFN is currently focused on applying this technique to low-beta elliptical cavities for both the ESS and PIP-II linacs. This paper reports on the ongoing work aimed at developing plasma processing for cavities both installed in cryomodules and assembled for the vertical test. For the ESS cavities, a bead-pull setup has been developed, enabling validation of experimental results against electromagnetic simulations. In parallel, FNAL has conducted simulation studies to identify effective modes for plasma ignition in PIP-II cavities, with experimental work expected to start in the coming months.

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Yes

Funding Agency

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Author: DEL CORE, Elisa (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Co-authors: BOSOTTI, Angelo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PAPARELLA, Rocco (Istituto Nazionale di Fisica Nucleare); SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PIERINI, Paolo (European Spallation Source); CENNI, Enrico (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); GIACCONE, Bianca (Fermi National Accelerator Laboratory); POSOS, Taha (Fermi National Accelerator Laboratory); KAZAKOV, Sergey (Fermi National Accelerator Laboratory)

Presenter: DEL CORE, Elisa (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **287** Contribution code: **THP57** Type: **Poster Presentation**

High intensity proton cryomodule parasitic radiation analysis

Thursday, September 25, 2025 2:30 PM (3 hours)

Experimental evidence of parasitic radiation originating from cavity field emission or beam losses and interacting with cryomodule diagnostics has been collected.
We focus on the case of spurious triggering of power coupler interlock system which is based on the light detection of arcs and its transmission in optical fibers. Scenario of radiation interaction are modeled using Geant4, aiming at reproducing several experimental observations, in the case of ESS high beta cryomodules and investigate possible mitigation techniques.

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Yes

Footnotes

Funding Agency

Author: DEVANZ, Guillaume (Commissariat à l'Energie Atomique)

Co-authors: CENNI, Enrico (CEA Paris-Saclay); MAIANO, Cecilia (European Spallation Source); PIQUET, Olivier (CEA Paris-Saclay)

Presenter: DEVANZ, Guillaume (Commissariat à l'Energie Atomique)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **288** Contribution code: **MOP42** Type: **Poster Presentation**

Experimental investigation of plasma processing for PIP-II SSR2 cavities

Monday, September 22, 2025 2:30 PM (3 hours)

Field emission and multipacting are critical factors that limit the achievable operational gradient of superconducting radio frequency (SRF) cavities. Plasma processing has been demonstrated as an effective in-situ technique for mitigating hydrocarbon-induced field emission and multipacting across a range of cavity geometries. In this work, we present the initial development and subsequent application of plasma processing for PIP-II type II spoke resonators (SSR2). The process was carried out at room temperature on an SSR2 cavity equipped with the CM-style high-power coupler and installed in the cryostat. Cavity performance was evaluated through comparative cold tests conducted before and after plasma processing.

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Yes

Footnotes

Funding Agency

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Author: GIACCONE, Bianca (Fermi National Accelerator Laboratory)

Co-authors: PASSARELLI, Donato (Fermi National Accelerator Laboratory); PARISE, Mattia (Fermi National Accelerator Laboratory); AIAZZI, Tommaso (Fermi National Accelerator Laboratory); ROGER, Vincent (Fermi National Accelerator Laboratory)

Presenter: GIACCONE, Bianca (Fermi National Accelerator Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **291** Contribution code: **THP18** Type: **Student Poster Presentation**

Point defects in Nb-based superconducting films probed by positron annihilation spectroscopy

Thursday, September 25, 2025 2:30 PM (3 hours)

Positron annihilation spectroscopy (PAS) is a powerful and precise tool to study atomic-scale defects in a wide range of materials, especially superconductors. The PAS methods available at the user facility radiation source ELBE (HZDR, Germany) enable analysis of point defects and their agglomerations including within the range of micro- and mesopores. The extended defects and their complexes with vacancies as well as point defect - impurity associates are detectable and sensitivity of positrons to these shallow traps is enhanced by cryogenic temperature measurements. Positrons quantify defect microstructure characteristics as density, type, and local atomic chemistry. PAS has proven to be highly effective in characterizing vacancy-hydrogen complexes during low temperature baking * as well as for vacancy kinematics and evolution of point defects and native Nb oxides for baking at larger temperatures **.

In this contribution, defect microstructure of DC magnetron sputtered Nb and Nb3Sn thin films will be discussed, supplemented with conventional characterization methods such as XRD and vibrating sample magnetometry (VSM). The combination of these complementary techniques will provide correlations between sputter deposition parameters, e.g., deposition pressure, gas flows, etc., defects, crystal phases, and superconducting characteristics (Tc, Hc). Our long-term goal is to enable in-situ PAS during sample processing to study defect formation and their evolution.

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Yes

Footnotes

*M. Wenskat et al., Sci. Rep. 10 (2020) 8300.**M. Wenskat et al., Phys. Rev. B. 106 (2022) 094516.

Funding Agency

BMFTR (Federal Ministry of Research, Technology and Space).
HZDR (Helmholtz-Zentrum Dresden-Rossendorf e.V.).

Author: KLUG, Sebastian (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: Dr BUTTERLING, Maik (Delft University of Technology); Dr WAGNER, Andreas (Helmholtz-Zentrum Dresden-Rossendorf); Dr LIEDKE, Maciej Oskar (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: KLUG, Sebastian (Helmholtz-Zentrum Dresden-Rossendorf)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **292** Contribution code: **MOP79** Type: **Poster Presentation**

Insights into the cryogenic operation of the ESS superconducting cryomodules during the first commissioning phase

Monday, September 22, 2025 2:30 PM (3 hours)

The first commissioning run of the superconducting cryomodules at the European Spallation Source (ESS) provided important insights into the performance of the cryogenic systems. This paper reviews the cryogenic operations, with a focus on cooldown processes, pressure control, temperature stability, and overall system reliability. The effectiveness of individual helium bath pressure regulation in managing pressure transients during cavity quenches and RF trips is demonstrated. The response of the system to cryoplant trip events is also analyzed. In addition, results from automated heat load measurements are presented, confirming that the thermal performance meets expectations. These findings demonstrate the robustness of the ESS cryogenic systems.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: SKIBA, Marek (European Spallation Source)

Co-authors: ELIAS, Nuno (European Spallation Source); GOUDKET, Philippe (European Spallation Source); Mr KRAWCZYK, Artur (European Spallation Source); MAIANO, Cecilia (European Spallation Source); PIERINI, Paolo (European Spallation Source); PRZYBILSKI, Henry (European Spallation Source); Mr VAN VELZE, Peter (European Spallation Source); WANG, Muyuan (European Spallation Source); Ms ZWOZNIAK, Agnieszka (European Spallation Source)

Presenter: SKIBA, Marek (European Spallation Source)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **293** Contribution code: **MOP68** Type: **Poster Presentation**

High-Power RF Conditioning of MYRRHA Prototype Power Couplers AT IJCLAB

Monday, September 22, 2025 2:30 PM (3 hours)

Multi-purpose hYbrid Research Reactor for High-tech Applications (MYRRHA) is an experimental accelerator-driven system in development at SCK-CEN. It will allow fuel developments, material developments for GEN IV systems, material developments for fusion reactors and radioisotope production for medical and industrial applications. First phase of the project called MINERVA currently in construction at Mol in Belgium will deliver a 100 MeV-4 mA protons beams dedicated for applications and detailed studies of the reliability of the installation. IJCLab is engaged with the industrial monitoring, quality control, and RF conditioning of power couplers up to 60 kW at 352 MHz. The initial phase, which involved the conditioning of three pairs of prototype couplers, was completed in 2024. This phase enabled the identification of various areas for improvement in both the couplers, procedures and test bench [1]. In this paper, we will present and discuss the results of the conditioning of the couplers in full reflection mode. The conditioning results in full transmission mode have already been presented [1]. Additionally, we will outline the various enhancements made to the conditioning processes based on the findings from the prototype phase. These modifications are expected to improve the efficiency of the test bench and facilitate better conditioning of the series.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

[1] N. Elkamchi, C. Joly, C. Magueur, P. Duchesne, S. Berthelot, W. Kaabi, C. Lhomme « Proceedings of SRF2023 », Grand Rapids, USA

Funding Agency

Author: ELKAMCHI, Noureddine (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Co-authors: Dr JOLY, Christophe (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Mr MAGUEUR, Christopher (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Dr OLIVIER, Gilles (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Mr BERTHELOT, Sylvain (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Ms THIEBAULT, Alice (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Dr DUCHESNE, Patricia (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Mr FROSSARD, Olivier (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Ms POUX, Véronique (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Ms TUN LANOE, Kaing Mon Mon (Laboratoire de Physique des 2 Infinis Irène Joliot-Curie); Dr PERROT, Luc (Laboratoire de Physique des 2

Infinis Irène Joliot-Curie)

Presenter: ELKAMCHI, Noureddine (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **295** Contribution code: **THP47** Type: **Poster Presentation**

Local magnetic field evolution in shielded SRF cavities during thermal cycling in a cryomodule-like configuration

Thursday, September 25, 2025 2:30 PM (3 hours)

At FREIA, Uppsala (Sweden), an investigation of the Magnetic Field (MF) evolution during cool-down / warm-up cycles of 352 MHz single spoke cavities for the MINERVA proton linac (Phase I of the MYRRHA project) has been carried out: bulk-Nb SRF cavities equipped each with a dedicated MINERVA cavity magnetic shield (MGS) made of CRYOPHY® material have been measured during their testing in the horizontal cryostat HNOSS.

The MF was monitored by multiple fluxgate sensors placed at various positions around the cavities during the cool-down and warm-up cycles. Note that HNOSS is equipped by design with a global mu-metal magnetic shield covering the inner walls of the cryostat vessel (at room temperature) to provide a reduction of the Earth's magnetic field to around 2 uT at lateral cavity test positions (otherwise higher). Together with the cavity-individual shields, this allowed to perform precise measurements of the remnant field.

Upon cool down, a change in the surrounding MF was observed due to the interplay of the Seebeck and Meissner effects, which directly correlates to the cavity's temperature profile.

The estimated influence of these MF dynamics on SRF cavity performance are discussed, while proposing optimized cool-down sequences aimed at minimizing trapped flux and enhancing the performance and reliability of SRF cavities for future accelerator applications.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Dr SALÉN, Peter (Uppsala University)

Co-authors: Dr OLVEGÅRD, Maja (Uppsala University); SANTIAGO KERN, Rocío (Uppsala University); SVANBERG, Carl (Uppsala University); ZHOVNER, Mykhailo (Uppsala University); MARHAUSER, Frank (Belgian Nuclear Research Centre)

Presenter: SANTIAGO KERN, Rocío (Uppsala University)

Session Classification: Thursday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **296** Contribution code: **MOP67** Type: **Poster Presentation**

Coupler installations on cavities at CEA followed by high power test in horizontal cryostat at Fermilab prior to the assembly of the PIP-II LB650 pre-production cryomodule

Monday, September 22, 2025 2:30 PM (3 hours)

The Proton Improvement Plan II (PIP-II) that will be installed at Fermilab is the first U.S. accelerator project that will have significant contributions from international partners. CEA joined the international collaboration in 2018 and will deliver 10 low-beta cryomodules as In-Kind Contributions to the PIP-II project, with cavities supplied by LASA-INFN (Italy) and VECC-DAE (India), and power couplers and tuning systems supplied by Fermilab. Before the start of the assembly of the LB650 preproduction cryomodule in the second half of 2025, the project decided to proceed with coupler installations on cavities at CEA followed by high power test in horizontal cryostat at Fermilab in order to validate the assembly process and infrastructure. This paper will present the results, including the one of a power coupler installed on a cavity using a robot.

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Yes

Footnotes

Funding Agency

Author: BAZIN, Nicolas (Commissariat à l'Energie Atomique)

Co-author: OZELIS, Joseph (Fermi National Accelerator Laboratory)

Presenter: BAZIN, Nicolas (Commissariat à l'Energie Atomique)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **297** Contribution code: **THP69** Type: **Poster Presentation**

Construction of the LB650 pre-production cryomodule for the PIP-II linear accelerator

Thursday, September 25, 2025 2:30 PM (3 hours)

The Proton Improvement Plan II (PIP-II) that will be installed at Fermilab is the first U.S. accelerator project that will have significant contributions from international partners. CEA joined the international collaboration in 2018 and will deliver 10 low-beta cryomodules as In-Kind Contributions to the PIP-II project, with cavities supplied by LASA-INFN (Italy) and VECC-DAE (India), and power couplers and tuning systems supplied by Fermilab. This paper will detail the activities at CEA on the construction of the LB650 pre-production cryomodule.

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Yes

Footnotes

Funding Agency

Author: BAZIN, Nicolas (Commissariat à l'Energie Atomique)

Co-authors: SIMON, Claire (Commissariat à l'Energie Atomique); DEVANZ, Guillaume (Commissariat à l'Energie Atomique); JENHANI, Hassen (CEA Paris-Saclay); Mr CUBIZOLLES, Robin (Commissariat à l'Énergie Atomique et aux Énergies Alternatives); Dr BERRY, Stéphane (Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Presenter: DEVANZ, Guillaume (Commissariat à l'Energie Atomique)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **298** Contribution code: **MOP38** Type: **Poster Presentation**

SRF R&D activities at INFN-LASA

Monday, September 22, 2025 2:30 PM (3 hours)

Sustainability and cost reduction are key factors for the development of future large particle accelerators. This has led INFN LASA to start an INFN-funded R&D program dedicated to studying and improving the performance of SRF Nb cavities in terms of quality factor (High-Q) and accelerating gradient (High-G). Moreover, the R&D program is also pushed by the INFN LASA contribution to international projects such as PIP-II and by the participation on the international collaboration ILC Technology Network (ITN). The strategy of the R&D program consists of studying and optimizing different surface treatments on 1.3 GHz single-cell cavities that will later be applied to 9-cell cavities in view of the industrialization process needed for large scale production. A key activity of this program is the upgrade of our experimental vertical cold test facility needed to enable the qualification of such high-performance cavities. Ongoing activities include a new dedicated cryostat designed to minimize the liquid helium inventory consumption, the implementation of an active magnetic field compensation for the reduction of trapped magnetic flux, and the usage of a wide range of diagnostics for quench, field emission, etc. This paper presents the current status of the facility and its key features, an overview of cavities currently in production, and the experimental results obtained to date.

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Yes

Footnotes

Funding Agency

This work was partially supported by the European Union's Horizon Europe Marie Sklodowska-Curie Staff Exchanges programme under EAJADE grant agreement no. 101086276.

Author: MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Co-authors: BERTUCCI, Michele (Istituto Nazionale di Fisica Nucleare); BOSOTTI, Angelo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); DEL CORE, Elisa (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); FIORINA, Fabrizio (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PAPARELLA, Rocco (Istituto Nazionale di Fisica Nucleare); SERTORE, Daniele (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); SPRUZZOLA, Paolo (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); VITALI, Bastiano (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata); PAGANI, Carlo (Istituto Nazionale di Fisica Nucleare, Laboratorio Acceleratori e Superconduttività Applicata; University of Milan)

Presenter: MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **299** Contribution code: **MOP17** Type: **Poster Presentation**

In-situ HRTEM monitoring of oxide layer decomposition and lattice defect evolution on Nb during Medium-T Baking

Monday, September 22, 2025 2:30 PM (3 hours)

Medium-temperature baking (Medium-T Baking) has emerged as a key technique for enhancing SRF cavity performance, with multiple studies attributing its efficacy to oxide decomposition and oxygen diffusion. In-situ high-resolution transmission electron microscopy (HRTEM) enables real-time, atomic-scale visualization of dynamic structural changes, providing an ideal platform for probing Nb oxide layer dynamics during baking.

Our previous in-situ HRTEM measurements at 350 ℃ heating showed emergent 'white dots' and local contrast variations that revealed nanoscale lattice transformations. Recently, we utilized on-site vacuum storage to avoid cross-section sample oxidation post-FIB processing, which enabled us to single out the oxide layer for both HRTEM and energy-dispersive X-ray spectroscopy (EDS) to obtain definitive evidence of its decomposition during heating. We also detected interstitial oxygen diffusion-induced lattice defects via HRTEM.

Preliminary results showed that the observed defects may enhance cavity performance, and further vertical tests are underway to fully elucidate the underlying mechanisms.

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Yes

Footnotes

Funding Agency

Author: HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: LUO, Didi (Institute of Modern Physics, Chinese Academy of Sciences); TAN, Teng (Institute of Modern Physics); CHEN, Shantong (Institute of Modern Physics)

Presenter: HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **300** Contribution code: **TUP75** Type: **Poster Presentation**

Damping microphonics in SRF cavities using boron nitride nanotubes

Tuesday, September 23, 2025 2:30 PM (3 hours)

The design of the ten additional CEBAF Upgrade Cryomodules leads to significantly higher fault rates than the 40 original cryomodules, due to sensitivity to microphonics. Cartridges that compress pellets of boron nitride nanotubes (BNNT) are mounted in parallel to the SRF cavities of two refurbished Upgrade Cryomodules. Now substituted into CEBAF, these cryomodules exhibit significant microphonics reduction such that their fault rates are the lowest of all cryomodules in CEBAF. The boron nitride nanotube pellets are developed and manufactured by BNNT LLC of Newport News, Virginia and the cartridge design, testing and installation was sponsored by a Small Business Innovative Research Grant from the US DOE Office of Science, Office of Nuclear Research. The cartridge design, its testing in a two-SRF cavity, Horizontal Test Bed, the details of incorporation into the CEBAF Upgrade Cryomodule and operational data are presented.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

US DOE Office of Science, Office of Nuclear Research, SBIR Grant #DE-SC0018489

Author: JORDAN, Kevin (Thomas Jefferson National Accelerator Facility)

Co-authors: BIALLAS, George (Hyperboloid LLC); Dr SCAMMELL, Lyndsey (BNNT LLC); Mr WEAKS, Matt (Thomas Jefferson National Accelerator Facility); OWEN, Peter (Thomas Jefferson National Accelerator Facility); POWERS, Tom (Thomas Jefferson National Accelerator Facility)

Presenter: JORDAN, Kevin (Thomas Jefferson National Accelerator Facility)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **301** Contribution code: **TUP76** Type: **Poster Presentation**

Results from a helium flowmeter that measures SRF cavity Q0s in situ

Tuesday, September 23, 2025 2:30 PM (3 hours)

We report on the easily accomplished, in situ measurement of individual SRF Cavity dissipation in CEBAF cryomodules at the Thomas Jefferson National Accelerator Facility (JLab). Calculated Q0s from the data allows assessing the health of cryomodules over time. A 2022 SBIR Grant from the Office of Nuclear Physics, DOE Office of Science, to Hyperboloid LLC enabled development. JLab provided the test bed environment and development of electronics through a cooperative agreement. Use of the flowmeter for determining the Q0s of LCLS-II-HE cryomodules built at JLab as well as results from other installations are also reported. The meter measures the helium vapor evaporating from the 2 K helium bath at 1/30 atm, resolving 0.05 g/s = 1 W. As a power meter, it has a broad range, measuring from 10 W to 200 W. The meter's sensitivity uses voltage signal change when the superconductor (SC) sensor (Tc = 9.2 K) changes to normal conducing. Cooling from helium vapor is bucked against resistive heat from an adjacent resistive wire until the sensor' s temperature is non-SC. An electronics chassis interfaced to an AtoD/DtoA LabJack T7 couples to Linux-based EPICS, providing control and data processing of the signals. The Hyperboloid flowmeter is now a commercial instrument, available to the SRF community.

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Yes

Footnotes

Funding Agency

US DOE Office of Science, Office of Nuclear Physics, SBIR Grant #DE-SC0022380

Author: Mr CHRISTIAN, Dakota (Thomas Jefferson National Accelerator Facility)

Co-authors: BIALLAS, George (Hyperboloid LLC); CONWAY, Zachary (Thomas Jefferson National Accelerator Facility); Mr CROKE, Gary (Thomas Jefferson National Accelerator Facility); Ms JONES, Claire (Thomas Jefferson National Accelerator Facility); JORDAN, Kevin (Thomas Jefferson National Accelerator Facility); MCCAUGHAN, Michael (Thomas Jefferson National Accelerator Facility); OWEN, Peter (Thomas Jefferson National Accelerator Facility); Mr SAMARI, Jerone (Thomas Jefferson National Accelerator Facility); Dr TIEFENBACK, Michael (Thomas Jefferson National Accelerator Facility)

Presenter: JORDAN, Kevin (Thomas Jefferson National Accelerator Facility)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **304** Contribution code: **TUP21** Type: **Poster Presentation**

Progress on theory of nanohydride dissipation

Tuesday, September 23, 2025 2:30 PM (3 hours)

We present further progress on a theoretical model linking nanohydride formation to mid- and high-field Q-slope in SRF cavities. Using time-dependent Ginzburg-Landau theory, we calculate Q-vs-E curves for cavities with a range of hydride distributions corresponding to different global hydrogen concentrations and different distributions of hydride nucleation sites. We show that hydrides smaller than one coherence length in radius have a minor effect on dissipation, even at high fields and high overall hydrogen concentrations. In contrast, hydrides significantly in excess of one coherence length in radius tend to invite flux vortex nucleation and significantly reduce quality factor even at modest fields and lower overall hydrogen concentrations. We conclude that disorder induced by other dissolved impurities may serve to increase the number of hydride nucleation sites, reducing the typical size of nanohydrides beneath the critical coherence length threshold and improving high-field quality factor.

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Yes

Footnotes

Funding Agency

Author: HARBICK, Aiden (Brigham Young University)

Co-authors: Dr TRANSTRUM, Mark (Brigham Young University); LIEPE, Matthias (Cornell University (CLASSE)); SITARAMAN, Nathan (Cornell University)

Presenter: SITARAMAN, Nathan (Cornell University)

Session Classification: Tuesday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **307** Contribution code: **MOP55** Type: **Poster Presentation**

HOM analysis of the 1.3 GHz 3-cell cavity for high-current beam acceleration

Monday, September 22, 2025 2:30 PM (3 hours)

Recently, 1.3 GHz 3-cell superconducting cavities were proposed for the injector of the high-brightness free electron laser based on the energy recovery linac scheme. In the injector section, three cavities are required to accelerate a 10 mA electron beam to 10 MeV. The diameter of the beam pipe is increased to 100 mm to damp higher order modes (HOMs), which may lead to beam quality degradation or beam instability. The results of HOM simulations and measurements will be presented in this paper.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: HUANG, Xuan (Shanghai Institute of Applied Physics)

Co-authors: WU, Xiaowei (Zhangjiang Laboratory); CHEN, Jinfang (Shanghai Advanced Research Institute); WANG, Dong (Shanghai Advanced Research Institute); DENG, Haixiao (Shanghai Institute of Applied Physics)

Presenter: HUANG, Xuan (Shanghai Institute of Applied Physics)

Session Classification: Monday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **308** Contribution code: **MOP65** Type: **Poster Presentation**

Development of a 197 MHz crab cavity cryomodule for the electron-ion collider

Monday, September 22, 2025 2:30 PM (3 hours)

Thomas Jefferson National Accelerator Facility (JLab) is leading the design and fabrication of all superconducting radiofrequency (SRF) cryomodules for the Electron-Ion Collider (EIC), to be built at Brookhaven National Laboratory (BNL). To achieve head-on luminosity at the interaction point, the EIC will employ SRF Radiofrequency Dipole (RFD) crab cavity cryomodules to compensate for the 25 mrad crossing angle. The hadron and electron storage rings (HSR and ESR) will utilize RFD cavities operating at 197 MHz and 394 MHz, respectively, with both frequencies used in the Hadron Storage Ring (HSR) and 394 MHz in the Electron Storage Ring (ESR). JLab is presently developing the 197 MHz cavity and associated cryomodule design. Each cavity is required to deliver a deflecting voltage of 11 MV, pushing the current limits of deflecting cavity performance and fabrication. This paper presents the key challenges in achieving these performance targets and highlights the innovative design solutions implemented for both the cavity and cryomodule systems.

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Yes

Footnotes

Funding Agency

Author: HUQUE, Naeem (Thomas Jefferson National Accelerator Facility)

Co-authors: ANDHARE, Chinmay (Thomas Jefferson National Accelerator Facility); CHENG, Gary (Thomas Jefferson National Accelerator Facility); COX, Justine (Thomas Jefferson National Accelerator Facility); DE SILVA, Subashini (Old Dominion University); CONWAY, Zachary (Thomas Jefferson National Accelerator Facility)

Presenter: HUQUE, Naeem (Thomas Jefferson National Accelerator Facility)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **310** Contribution code: **MOP64** Type: **Poster Presentation**

Fabrication of higher-order mode couplers for HL-LHC crab cavities at JLab

Monday, September 22, 2025 2:30 PM (3 hours)

The superconducting Radiofrequency Dipole (RFD) crab cavities for the Large Hadron Collider's High-Luminosity upgrade (HL-LHC) incorporate hook-style Horizontal Higher-Order Mode (HHOM) couplers to extract and damp HOMs, minimizing beam-cavity interactions. These couplers, fabricated from high-purity niobium, must maintain superconductivity under operational conditions at 2 K. As part of the U.S. contribution to the Accelerator Upgrade Project (AUP), Thomas Jefferson National Accelerator Facility (JLab) is responsible for the full fabrication and qualification of HHOM couplers for series-production cryomodules. The process includes vacuum brazing, electron-beam welding (EBW), precision metrology, and RF qualification. Couplers are first tested in a dedicated RF test box before integration with dressed RFD cavities, followed by qualification at 2 K in JLab's Vertical Test Area (VTA). Prototype HHOMs were fabricated and tested to validate design tolerances, assess performance on prototype cavities, and establish repeatable fabrication protocols. This paper presents key fabrication challenges, RF test results, and the current status of series production.

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Yes

Footnotes

Funding Agency

Author: HUQUE, Naeem (Thomas Jefferson National Accelerator Facility)

Co-authors: O'BRIEN, Adam (Thomas Jefferson National Accelerator Facility); GROSE, Gregory (Thomas Jefferson National Accelerator Facility); DE SILVA, Subashini (Old Dominion University)

Presenter: HUQUE, Naeem (Thomas Jefferson National Accelerator Facility)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **312** Contribution code: **TUP71** Type: **Poster Presentation**

Initial results of the ESS cavities parameters identification at the TS2 towards future LLRF operation

Tuesday, September 23, 2025 2:30 PM (3 hours)

A dedicated series of tests on the superconducting Medium-Beta and High-Beta cavities has been proposed to determine various parameters critical for future LINAC and LLRF system operation. These studies include measurement of the cavity stiffness coefficient (expressed as the Lorentz Force Detuning factor), evaluation of piezo tuner range and polarity, investigation of piezo capacitance as a function of temperature, and identification of resonator pi-mode frequencies. Additionally, the detection of the main mechanical longitudinal mode and assessment of field regulation performance are also of interest.

This contribution presents the results from several measurement campaigns conducted at the ESS Test Stand 2 (TS2). The development and evaluation of the testing tools, along with the obtained characterization results and plans for future implementation in the ESS LINAC environment, are also discussed.

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Yes

Footnotes

Funding Agency

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Authors: Mr KLYS, Kacper (Lodz University of Technology); CICHALEWSKI, Wojciech (Lodz University of Technology)

Co-authors: MAIANO, Cecilia (European Spallation Source); Dr JABLONSKI, Grzegorz (Lodz University of Technology); Mr NABYWANIEC, Mateusz (European Spallation Source); PIERINI, Paolo (European Spallation Source); Dr KIELBIK, Rafal (Lodz University of Technology); Dr JALMUZNA, Wojciech (Lodz University of Technology); Dr TYLMAN, Wojciech (Lodz University of Technology)

Presenter: CICHALEWSKI, Wojciech (Lodz University of Technology)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **313** Contribution code: **TUP77** Type: **Poster Presentation**

Nb3Sn thin films for dark matter detection

Tuesday, September 23, 2025 2:30 PM (3 hours)

Nb3Sn has great potential to be the next generation superconducting material on the inside of Cu superconducting radiofrequency cavities (SRF) due to its relatively high critical temperature Tc ≈ 18 K compared to other low temperature superconductors e.g., Nb with Tc ≈ 9 K. For Axion detection, cavities might operate below 100 mK, and copper bodies are preferred. Here, we report methods to make Nb3Sn films on copper substrates that could be scaled to microwave detectors. We develop bronze routes to facilitate a Nb-Sn reaction at ˜700 ℃, well below the melting point of Cu. We use Ta as a diffusion barrier and possible mitigation of thermal contraction mismatch. High Sn activity is obtained by using Cu25at.%Sn (epsilon phase) instead of alpha-bronze as our Sn source. We then explored formation of Nb3Sn via reaction of the multilayer Cu substrate/barrier/Nb/bronze at >700 ℃. Cross-sectional SEM/FIB analyses were performed to see the differences in morphology and composition of the films. Since copper was the dominant material, thermal contraction applied stress to the resulting Nb3Sn films reducing Tc to ˜15 K. We also designed, modeled, and machined a cavity to test the RF properties of our thin films.

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Yes

Footnotes

Funding Agency

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Author: JULIAO, Andre (National High Magnetic Field Laboratory)

Co-authors: Prof. COOLEY, Lance (National High Magnetic Field Laboratory); Mr CADAVID, Nikolya (Florida State University); Dr CAROSI, Gianpaolo (Lawrence Livermore National Laboratory)

Presenter: JULIAO, Andre (National High Magnetic Field Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC5: SRF Applications

Contribution ID: **314** Contribution code: **THP14** Type: **Poster Presentation**

Depth-resolved characterization of the magnetic field screening in superconducting RF materials near the critical field

Thursday, September 25, 2025 2:30 PM (3 hours)

The new "β-SRF" facility at TRIUMF allows for the near surface characterizations of materials with β-radiation-detected nuclear magnetic resonance (β-NMR) in applied magnetic fields up to 200 mT parallel to the sample surface. The unique facility can probe the local magnetic field within the first 100 nm of the surface and allows , for example, to measure the evolution of the Meissner screening profile as a function of applied parallel field right up to the critical field of niobium. It is the only place in the world where such a direct measurement of the local magnetic field is possible near the critical field and is ideal for the characterization of new doping treatments or layered systems. First measurements on two Nb samples one with a standard baseline treatment and with an O-doped treatment have been measured. The samples show contrasting evolution in their magnetic field screening as the applied field is increased up to 200 mT. The method and results will be summarized and the interpretation discussed utilizing recent theories.

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Yes

Footnotes

Thoeng, E., Asaduzzaman, M., Kolb, P. et al. Depth-resolved characterization of Meissner screening breakdown in surface treated niobium. Sci Rep 14, 21487 (2024). https://doi.org/10.1038/s41598-024-71724-5

Funding Agency

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and Discovery Grants from the Natural Sciences and Engineering Research Council

Author: LAXDAL, Robert (TRIUMF)

Co-authors: THOENG, Edward (TRIUMF; University of British Columbia); ASADUZZAMAN, Md (University of Victoria); KOLB, Philipp (TRIUMF); MCFADDEN, Ryan M. L. (University of Victoria; TRIUMF); JUNGINGER, Tobias (TRIUMF); MACFARLANE, W. Andrew (TRIUMF; University of British Columbia)

Presenter: LAXDAL, Robert (TRIUMF)

Session Classification: Thursday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **315** Contribution code: **HT1** Type: **Hot Topics**

Hot Topic 1: sustainability of accelerator facilities

Monday, September 22, 2025 5:30 PM (1 hour)

There is increasing awareness within the global community of the need for meaningful actions on energy consumption and sustainability. High energy physics installations consume large quantities of energy and non-recoverable resources. Existing operation is being challenged to reduce consumption and new projects are being scrutinized for a full life cycle impact. Future developments of accelerator science and technology will be required with increasing urgency to improve efficiency of operation, promote more sustainable accelerator concepts and reduce environmental impact of our facilities. While noting that SRF is an intrinsically efficient technology there are steps that our community can contribute to support the cause. The hot topic session will host panelists from each of the three global regions to discuss on-going efforts to enable big science to proceed in a more sustainable way and the role that superconducting rf can play in that initiative.

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Yes

Footnotes

Funding Agency

Author: LAXDAL, Robert (TRIUMF)

Co-authors: MADUR, Arnaud (CEA Paris-Saclay); GAO, Jie (Chinese Academy of Sciences); BELOMESTNYKH, Sergey (Fermi National Accelerator Laboratory)

Presenters: MADUR, Arnaud (CEA Paris-Saclay); GAO, Jie (Chinese Academy of Sciences); LAXDAL, Robert (TRIUMF); BELOMESTNYKH, Sergey (Fermi National Accelerator Laboratory)

Session Classification: Hot Topic Session: 1

Track Classification: MC1: SRF Facilities

Contribution ID: **316** Contribution code: **HT2** Type: **Hot Topics**

Hot Topic 2: development toward extremely high performance superconducting cavities

Tuesday, September 23, 2025 5:30 PM (1 hour)

For the sustainable accelerators in the future, we need to develop extremely high performance superconducting cavities. This would require collaboration between physicists and engineers towards the same goal. In this hot topic, the internationally distinguished panel members and the audience will discuss state-of-the-art of superconducting cavities and overview the perspective of research directions beyond the state-of-the-art. The session will be coordinated by a few provocative questions on the screen and then will trigger exciting debate among the participants.

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Yes

Footnotes

Funding Agency

Author: MIYAZAKI, Akira (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Presenter: MIYAZAKI, Akira (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Session Classification: Hot Topic Session: 2

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **317** Contribution code: **MOP82** Type: **Poster Presentation**

591 MHz single-cell cavity optimization using evolutionary algorithms

Monday, September 22, 2025 2:30 PM (3 hours)

A 591 MHz superconducting RF cavity is designed for the Electron Storage Ring (ESR) of the Electron-Ion Collider (EIC), providing an accelerating voltage of up to 4 MV. Based on the requirements for Robinson stability and suppression of multipacting effects, four key physical parameters are specified: the fundamental mode frequency should be 591 MHz ± 0.1 MHz; the R/Q of the fundamental mode (591 MHz) must be less than 80 Ω; the peak electric field should be less than 40 MV/m; and the peak magnetic field should be less than 80 mT. To meet these goals with minimal computation time, we propose using the multi-objective optimization algorithm NSGA-III (Non-dominated Sorting Genetic Algorithm III) for cavity geometry design. We combined the Poisson Superfish electromagnetic simulation with the genetic algorithm in a Python environment. A Pareto-optimal front was obtained after about 50,000 iterations. The peak electric field was successfully reduced by 20% without deteriorating the other three objectives. In the future, these datasets can be analyzed using machine learning algorithms to identify patterns relevant to various axisymmetric cavities for different beam manipulation applications.

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Yes

Footnotes

Funding Agency

Author: LI, Guangjiang (Brookhaven National Laboratory)

Co-authors: XU, Wencan (Brookhaven National Laboratory); VERDU-ANDRES, Silvia (Brookhaven National Laboratory); XIAO, Binping (Brookhaven National Laboratory); ZALTSMAN, Alexander (Brookhaven National Laboratory)

Presenter: LI, Guangjiang (Brookhaven National Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC2: Fundamental SRF research and development

Contribution ID: **318** Contribution code: **MOP83** Type: **Poster Presentation**

Trapped mode and wakefield evaluation of bellows for 197 MHz superconducting crab cavities

Monday, September 22, 2025 2:30 PM (3 hours)

Stainless steel bellows are used to connect the 197 MHz superconducting crab cavities, to compensate for the cavity displacement due to cryogenic temperature changes. The impedance of the bellows should be evaluated for both wakefield effects and the potential high order trapped modes. In the nominal bellows one longitudinal trapped mode was found at 2252 MHz, located between two nearby harmonic frequency lines in the beam spectrum for the 0.7 A average current with 290 proton bunches. Mechanical simulations were performed to evaluate the compressed, extended, and transversely deformed states of the bellows. The trapped modes in all configurations remained well confined within the two harmonic frequencies. The ohmic losses of the trapped modes are calculated accounting for the mechanical and electrical conductivity at both 4 K and room temperature. The differences were found to be negligible, indicating that the bellows can also be used in the cold-to-warm transition between the crab cavity and the beam pipe. A preliminary short-range wakefield was calculated as a basis for subsequent long-range wakefield analysis.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: LI, Guangjiang (Brookhaven National Laboratory)

Co-authors: XIAO, Binping (Brookhaven National Laboratory); HUQUE, Naeem (Thomas Jefferson National Accelerator Facility); COX, Justine (Thomas Jefferson National Accelerator Facility); WANG, Gang (Brookhaven National Laboratory); XU, Wencan (Brookhaven National Laboratory); VERDU-ANDRES, Silvia (Brookhaven National Laboratory); ZALTSMAN, Alexander (Brookhaven National Laboratory); BLEDNYKH, Alexei (Brookhaven National Laboratory)

Presenter: LI, Guangjiang (Brookhaven National Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **319** Contribution code: **TUP82** Type: **Poster Presentation**

591 MHz SRF cavity design for the EIC ESR

Tuesday, September 23, 2025 2:30 PM (3 hours)

Electron-Ion Collider (EIC) is a next generation particle accelerator to be built at Brookhaven National Laboratory, in partnership with Thomas Jefferson National Accelerator Facility. In Electron Storage Ring (ESR), 18 single-cell 591 MHz SRF cavities are required to compensate for energy loss from synchronic radiation. Effective damping of higher-order-modes (HOMs) is also critical to ensure beam stability. This paper presents the design of the single-cell 591 MHz cavity, including cavity geometry optimization, multipacting evaluation, HOM damping analysis.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

The work is supported by Brookhaven Science Associates, LLC under Contract No. DE-AC02-98CH10886 with the U.S. DOE.

Author: XU, Wencan (Brookhaven National Laboratory)

Co-authors: BLEDNYKH, Alexei (Brookhaven National Laboratory); CONWAY, Zachary (Thomas Jefferson National Accelerator Facility); GUO, Lin (Brookhaven National Laboratory); GUO, Jiquan (Thomas Jefferson National Accelerator Facility); HOLMES, Douglas (Brookhaven National Laboratory); LI, Guangjiang (Brookhaven National Laboratory); LI, Zenghai (SLAC National Accelerator Laboratory); MATALEVICH, Joseph (Thomas Jefferson National Accelerator Facility); RIMMER, Robert (Thomas Jefferson National Accelerator Facility); SMITH, Kevin (Brookhaven National Laboratory); WANG, Gang (Brookhaven National Laboratory); VERDU-ANDRES, Silvia (Brookhaven National Laboratory); ZALTSMAN, Alex (Brookhaven National Laboratory)

Presenter: XU, Wencan (Brookhaven National Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **320** Contribution code: **THP82** Type: **Poster Presentation**

LCLS-II-HE cryomodule test results after an uncontrolled vacuum event

Thursday, September 25, 2025 2:30 PM (3 hours)

During the preparation for the installation of the LCLS-II HE cryomodules, one previously qualified cryomodule experienced an uncontrolled vacuum event. The cavity string vacuum unexpectedly increased to 2 × 10ˆ (-3) Torr. Simulation showed the vacuum incident may have introduced 0.1 µm sized particulates into the cavity RF volume. Careful analysis of the particulates' path and migration indicated that the particle migration was negligible except for finer particles smaller than 0.1 µm. A repeat test of the cryomodule verified the initial analysis. The cryomodule's performance was intact. All cavities experienced no detectable x-ray as in its previous test. Particles of the smaller size may not cause harm to the cryomodule at the admin limit of the HE cavity gradients. This article describes the vacuum event, analysis, and cryomodule test results before and after the event.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

The work was supported by DOE contract 89243024CSC000002 for FNAL and DE-AC02-76SF00515 for SLAC

Author: CRAVATTA, Andrew (Fermi National Accelerator Laboratory)

Co-authors: Mr ARKAN, Tug (SLAC National Accelerator Laboratory); MANISCALCO, James (SLAC National Accelerator Laboratory); WHITE, Dominique (SLAC National Accelerator Laboratory); WU, Genfa (Fermi National Accelerator Laboratory)

Presenter: WU, Genfa (Fermi National Accelerator Laboratory)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **321** Contribution code: **TUP83** Type: **Poster Presentation**

High power FPC progress for EIC ESR SRF cavities

Tuesday, September 23, 2025 2:30 PM (3 hours)

In EIC Electron Storage Ring (ESR), 18 single-cell 591 MHz SRF cavities are required to compensate for up to 10 MW energy loss from synchronic radiation. There are two FPCs to deliver 800 kW RF power to each cavity. The FPC was design and under prototyping. This paper presents the FPC design and manufacture progress of FPC.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

The work is supported by Brookhaven Science Associates, LLC under Contract No. DE-AC02-98CH10886 with the U.S. DOE.

Author: XU, Wencan (Brookhaven National Laboratory)

Co-authors: FITE, Jesse (Brookhaven National Laboratory); VERDU-ANDRES, Silvia (Brookhaven National Laboratory); CONWAY, Zachary (Thomas Jefferson National Accelerator Facility)

Presenter: XU, Wencan (Brookhaven National Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **322** Contribution code: **THP83** Type: **Poster Presentation**

Improving the performance of mid-T baked niobium cavities through post-bake surface treatment

Thursday, September 25, 2025 2:30 PM (3 hours)

Medium temperature (mid-T) baking of niobium superconducting radio-frequency cavities at 300–350 ℃ in a vacuum furnace is known to enhance the quality factor (Q_0). However, despite this improvement, cavities treated with this process often prematurely quench at relatively low accelerating fields. This limitation is suspected to arise from the formation of surface contaminants, such as niobium carbides, during the furnace bake. To investigate the influence of potential surface contamination, this study applied an ultralight chemical removal to 1.3 GHz and 650 MHz single-cell cavities that had undergone medium-temperature baking. The removal of the top RF surface layer led to a notable improvement in the quench field and Q_0, indicating a beneficial effect of eliminating possible surface residues introduced during the bake.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: CHOUHAN, Vijay (Fermi National Accelerator Laboratory)

Co-authors: BICE, Damon (Fermi National Accelerator Laboratory); CRAVATTA, Andrew (Fermi National Accelerator Laboratory); Mr GUILFOYLE, Ben (Argonne National Laboratory); MURTHY, Akshay (Fermi National Accelerator Laboratory); Dr NETEPENKO, Alexandr (Fermi National Accelerator Laboratory); Mr REID, Thomas (Argonne National Laboratory); RING, Tim (Fermi National Accelerator Laboratory); Ms SMITH, Davida (Fermi National Accelerator Laboratory); WU, Genfa (Fermi National Accelerator Laboratory)

Presenter: WU, Genfa (Fermi National Accelerator Laboratory)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **323** Contribution code: **MOP66** Type: **Poster Presentation**

Higher order modes couplers tuning optimization of 1.3 GHz 9 cell SRF cavities for SHINE project

Monday, September 22, 2025 2:30 PM (3 hours)

The Shanghai HIgh repetition rate XFEL aNd Extreme light facility (SHINE) project has entered its construction phase. This state-of-the-art facility includes an 8 GeV electron linear accelerator, which utilizes superconducting radio frequency (SRF) cavities. Each cryomodule within the accelerator comprises eight standard TESLA 1.3 GHz 9-cell superconducting cavities with two Higher Order Modes (HOM) couplers. Effective suppression of HOM is crucial to maintain beam quality and stability. This paper discusses the performance and adjustment experiences related to the HOM couplers integrated within SHINE's 1.3 GHz cryomodules. We present detailed results from vertical and horizontal tests, emphasizing the successful HOM notch filter tuning to maintain the fundamental mode HOM Qext above 3×10^{11} at 2K. Optimization strategies and revised specifications for HOM tuning have been established and formally approved.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: PU, Xiaoyun (Shanghai Advanced Research Institute, Chinese Academy of Sciences)

Co-authors: HOU, Hongtao (Shanghai Advanced Research Institute); CHENG, Changhao (Shanghai Advanced Research Institute, Chinese Academy of Sciences); Mr SHI, Jing (Shanghai Advanced Research Institute, Chinese Academy of Sciences); CHEN, Jinfang (Shanghai Advanced Research Institute); SUN, Sen (Shanghai Advanced Research Institute, Chinese Academy of Sciences); LIU, Xuming (Shanghai Advanced Research Institute, Chinese Academy of Sciences); Mr OUYANG, Xiaohan (Shanghai Advanced Research Institute, Chinese Academy of Sciences); Mr LI, Zheng (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, ShenJie (Shanghai Advanced Research Institute, Chinese Academy of Sciences); HUANG, Yawei (ShanghaiTech University); LU, Lijun (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, Yeliang (Shanghai Advanced Research Institute, Chinese Academy of Sciences); ZHAO, Yubin (Shanghai Advanced Research Institute, Chinese Academy of Sciences)

Presenter: PU, Xiaoyun (Shanghai Advanced Research Institute, Chinese Academy of Sciences)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **324** Contribution code: **KEY1** Type: **Keynote**

Dawn of new era for nuclear physics prevailed by the 2nd generation RI beam accelerator facilities in the world

Thursday, September 25, 2025 5:30 PM (1 hour)

The mission of the RIKEN Radioactive Isotope Beam Factory (RIBF) is to improve our understanding of the mechanism of synthesis of elements in the universe via experiments using intense heavy-ion beams. The RIBF accelerator complex consists of booster ring cyclotrons and three injectors of AVF cyclotron, RIKEN Linear ACcelerator (RILAC), and RILAC2. Beams of ion species ranging from hydrogen to uranium are accelerated in accordance with experimental requirements. The RIBF has started providing intense heavy-ion beams for RI beam production and achieved the beam power of 10 kW for the uranium beams. Recently the projects of the second generation heavy-ion facilities are on-going all over the world, FAIR in Germany, SPIRAL2 in France, FRIB in the USA, RAON in Korea, and HIAF in China. Most of them are based on superconducting linac aiming at higher beam power. Obviously the field of nuclear physics is going into a new era. This talk will share the new coming prospects of nuclear physics explored with these 2nd generation facilities.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Dr SAKURAI, Hiroyoshi (RIKEN Nishina Center)

Presenter: Dr SAKURAI, Hiroyoshi (RIKEN Nishina Center)

Session Classification: Keynote

Track Classification: General

Contribution ID: **325** Contribution code: **TUP81** Type: **Poster Presentation**

Current status of the high current 1.5 GHz SRF cavity prototypes for VSR Demo

Tuesday, September 23, 2025 2:30 PM (3 hours)

The BESSY Variable pulse-length Storage Ring (VSR) Demo project aimed to provide short and long pulses simultaneously in the BESSY II storage Ring. To achieve this goal HZB has developed high current Continuous Wave (CW) Superconducting Radio Frequency (SRF) cavities operating at 1.5 GHz for 300 mA beams with large damping capabilities to cope with the HOM powers expected. This paper presents the current status, fabrication and lessons learned as results from the delivered prototype by Reseach Instruments and tests carried on at SupraLab HZB.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: Prof. VELEZ, Adolfo (TU Dortmund University; Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-authors: Dr TSAKANIAN, Andranik (Helmholtz-Zentrum Berlin für Materialien und Energie); SHARPLES-MILNE, Emmy (Helmholtz-Zentrum Berlin für Materialien und Energie); GLÖCKNER, Felix (Helmholtz-Zentrum Berlin für Materialien und Energie); Dr GLOCK, Hans Walter (Helmholtz-Zentrum Berlin für Materialien und Energie); KNOBLOCH, Jens (University of Siegen); WUNDERER, Nora (Helmholtz-Zentrum Berlin für Materialien und Energie)

Presenter: Prof. VELEZ, Adolfo (TU Dortmund University; Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Tuesday Poster Session

Track Classification: MC3: Cavities

Contribution ID: **326** Contribution code: **MOP26** Type: **Poster Presentation**

Impedance measurement setup design of a silicon carbide beamline higher-order-mode absorber

Monday, September 22, 2025 2:30 PM (3 hours)

Cylindrical shell silicon carbide (SiC) higher-order-mode (HOM) beamline absorbers (BLA) were developed and high-power tested for the 591 MHz single-cell superconducting radio frequency (SRF) cavities in the Electron Storage Ring of the Electron-Ion Collider. The material properties of the BLA are crucial for HOM damping and wakefield performance. However, discrepancies were observed between the material parameters measured from small SiC samples and those of the full SiC cylinder used in the BLA, which has a radius of 137 mm. To address this, a coaxial-type test setup was designed to measure the transmission characteristics and extract the material parameters of SiC. These parameters can be used for accurate HOM analysis in the 591 MHz SRF cavity string design.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: GUO, Lin (Brookhaven National Laboratory)

Co-authors: XU, Wencan (Brookhaven National Laboratory); LINK, Eric (Brookhaven National Laboratory); BLASKIEWICZ, Michael (Brookhaven National Laboratory); ZALTSMAN, Alex (Brookhaven National Laboratory); VERDU-ANDRES, Silvia (Brookhaven National Laboratory); CONWAY, Zachary (Thomas Jefferson National Accelerator Facility); GUO, Jiquan (Thomas Jefferson National Accelerator Facility); RIMMER, Robert (Thomas Jefferson National Accelerator Facility)

Presenter: XU, Wencan (Brookhaven National Laboratory)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **327** Contribution code: **TUP55** Type: **Poster Presentation**

Multipacting analysis of the conditioning box of the 591 MHz SRF cavity fundamental-mode power coupler in EIC

Tuesday, September 23, 2025 2:30 PM (3 hours)

A fundamental-mode power coupler (FPC) for the 591 MHz superconducting RF (SRF) cavities is currently being designed and prototyped for use in the Electron Storage Ring of the Electron-Ion Collider. Due to limitations in power source availability and in consideration of the FPC fabrication schedule, the initial high-power tests of the prototyped FPCs are planned to be conducted using a 704 MHz power source. The conditioning box to be used has been structurally modified based on the existing design. Multipacting simulations have been carried out for both the FPC and the conditioning box under high-power conditions. The simulation results will be compared with subsequent experimental tests to provide references for future high-power testing at 591 MHz.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: GUO, Lin (Brookhaven National Laboratory)

Co-authors: XU, Wencan (Brookhaven National Laboratory); HOLMES, Douglas (Brookhaven National Laboratory); MALENDELE, Prince-David (Brookhaven National Laboratory); Mr LUKACH, Daniel (Brookhaven National Laboratory); ZALTSMAN, Alex (Brookhaven National Laboratory); VERDU-ANDRES, Silvia (Brookhaven National Laboratory)

Presenter: XU, Wencan (Brookhaven National Laboratory)

Session Classification: Tuesday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **328** Contribution code: **THP81** Type: **Poster Presentation**

Design of a fast reactive tuner for 1.3 GHz TESLA cavities at MESA

Thursday, September 25, 2025 2:30 PM (3 hours)

This work presents a state-of-the-art design of a Ferroelectric Fast-Reactive Tuner (FE-FRT), capable of modulating high reactive power in TESLA type cavities on a microsecond time scale. The Mainz Energy-Recovering Superconducting Accelerator employs superconducting radio frequency cavities operating at 1.3 GHz, achieving quality factors on the order of 10ˆ10. However, detuning of +/-25 Hz induced by microphonics have led to the use of strong coupling for the fundamental power coupler, requiring high-power amplifiers, orders of magnitude above the intrinsic dissipation. Current solutions to mitigate microphonics rely on piezoelectric tuners, which are not fast enough for the spectral range of the microphonics. A novel alternative is the FE-FRT, a technology made possible by the development of low-loss ferroelectric materials, which offer sub-microsecond response times. Analytical results are provided along with their validation through finite-element simulations. The FE-FRT is expected to handle substantial reactive power while offering a tuning range of 50 Hz in these types of cavities, resulting in a reduction in peak forward RF power by about an order of magnitude.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

This work is supported by the BMBF under the research grants 05H24UM1.

Author: MONROY-VILLA, Ricardo (Johannes Gutenberg University Mainz)

Co-authors: HUG, Florian (Johannes Gutenberg University Mainz); BEN-ZVI, Ilan (Brookhaven National Laboratory; Stony Brook University); STENGLER, Timo (Institut für Kernphysik)

Presenter: MONROY-VILLA, Ricardo (Johannes Gutenberg University Mainz)

Session Classification: Thursday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **329** Contribution code: **THP58** Type: **Poster Presentation**

Progress of superconducting quarter-wave resonators for HIAF at IMP

Thursday, September 25, 2025 2:30 PM (3 hours)

Three superconducting linear accelerators are under construction at the Institute of Modern Physics (IMP) of the Chinese Academy of Sciences (CAS). 96 superconducting radio frequency (SRF) cavities housed in 17 cryomodules were fabricated, preparation and installed in the accelerator tunnel in 14 months. The cold test of the SRF cavity and cryomodule is skipped due to our excellent full-process quality control. The mass production of SRF cavity shows good performance, a higher accelerating gradient than the operation specification is achieved. In this paper, an overview of the cavity design, production fabrication, string and cryomodule assembly, efforts for SRF cavity performance recovery and operation status are introduced.

I have read and accept the Privacy Policy Statement

Yes

Footnotes

Funding Agency

Author: WANG, Zhijun (Institute of Modern Physics, Chinese Academy of Sciences)

Co-authors: Mr ZHANG, Shengxue (Institute of Modern Physics; University of Chinese Academy of Sciences); HUANG, Shichun (Institute of Modern Physics; University of Chinese Academy of Sciences); JIANG, TIANCAI (Institute of Modern Physics; University of Chinese Academy of Sciences); HE, Yuan (Institute of Modern Physics, Chinese Academy of Sciences); ZENG, Rihua (European Spallation Source); BAI, Feng (Institute of Modern Physics; University of Chinese Academy of Sciences); QIU, Feng (Institute of Modern Physics, Chinese Academy of Sciences); NIU, Xiaofei (Institute of Modern Physics, Chinese Academy of Sciences)

Presenter: WANG, Zhijun (Institute of Modern Physics, Chinese Academy of Sciences)

Session Classification: Thursday Poster Session

Track Classification: MC1: SRF Facilities

Contribution ID: **330** Type: **Tutorials**

Tutorial 1: SRF Basics

Thursday, September 18, 2025 9:00 AM (1h 30m)

SRF Basics

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: Dr ANTOINE, Claire (Université Paris-Saclay)

Presenter: Dr ANTOINE, Claire (Université Paris-Saclay)

Session Classification: Tutorials (Day 1)

Track Classification: General

Contribution ID: **331** Type: **Tutorials**

Tutorial 2: TM Cavities

Thursday, September 18, 2025 11:00 AM (1h 30m)

TM Cavities

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: UMEMORI, Kensei (High Energy Accelerator Research Organization)

Presenter: UMEMORI, Kensei (High Energy Accelerator Research Organization)

Session Classification: Tutorials (Day 1)

Track Classification: General

Contribution ID: **332** Type: **Tutorials**

Tutorial 3: TEM Cavities

Thursday, September 18, 2025 1:30 PM (1h 30m)

TEM Cavities

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: LAXDAL, Robert (TRIUMF)

Presenter: LAXDAL, Robert (TRIUMF)

Session Classification: Tutorials (Day 1)

Track Classification: General

Contribution ID: **333** Type: **Tutorials**

Tutorial 4: Fundamental and HOM Couplers

Thursday, September 18, 2025 3:30 PM (1h 30m)

Fundamental and HOM Couplers

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: XU, Wencan (Brookhaven National Laboratory)

Presenter: XU, Wencan (Brookhaven National Laboratory)

Session Classification: Tutorials (Day 1)

Track Classification: General

Contribution ID: **334** Type: **Tutorials**

Tutorial 5: Cavity Fabrication and Surface Preparation

Friday, September 19, 2025 9:00 AM (1h 30m)

Cavity Fabrication and Surface Preparation

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Presenter: MONACO, Laura (Istituto Nazionale di Fisica Nucleare, Laboratori Acceleratori e Superconduttività Applicata)

Session Classification: Tutorials (Day 2)

Track Classification: General

Contribution ID: **335** Type: **Tutorials**

Tutorial 6: Cavity Clean Assembly and Testing

Friday, September 19, 2025 11:00 AM (1h 30m)

Cavity Clean Assembly and Testing

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: WU, Genfa (Fermi National Accelerator Laboratory)

Presenter: WU, Genfa (Fermi National Accelerator Laboratory)

Session Classification: Tutorials (Day 2)

Track Classification: General

Contribution ID: **336** Type: **Tutorials**

Tutorial 7: Cryomodule Design and Testing

Friday, September 19, 2025 1:30 PM (1h 30m)

Cryomodule Design and Testing

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Presenter: YAMAMOTO, Yasuchika (High Energy Accelerator Research Organization)

Session Classification: Tutorials (Day 2)

Track Classification: General

Contribution ID: **337** Type: **Tutorials**

Tutorial 8: High Q, High Gradient

Friday, September 19, 2025 3:30 PM (1h 30m)

High Q, High Gradient

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: GONNELLA, Daniel (SLAC National Accelerator Laboratory)

Presenter: GONNELLA, Daniel (SLAC National Accelerator Laboratory)

Session Classification: Tutorials (Day 2)

Track Classification: General

Contribution ID: **338** Type: **Tutorials**

Tutorial 9: New Materials

Saturday, September 20, 2025 9:00 AM (1h 30m)

New Materials

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: PIRA, Cristian (Istituto Nazionale di Fisica Nucleare)

Presenter: PIRA, Cristian (Istituto Nazionale di Fisica Nucleare)

Session Classification: Tutorials (Day 3)

Track Classification: General

Contribution ID: **339** Type: **Tutorials**

Tutorial 10: LLRF

Saturday, September 20, 2025 11:00 AM (1h 30m)

In this tutorial an introduction to Low Level Radio Frequency (LLRF) is given. The tutorial is divided into two parts. First, after explaining the purpose of LLRF, an introduction to the theoretical background is given. This covers the modeling of accelerating RF cavities, the deduction of fundamental equations, and short peaks into signal processing and controller theory. This part also includes a demo with a cavity simulator, to give the listener a better feeling, on how a basic system behaves. The second part of the lecture focuses on the architecture of LLRF systems, actual applications, and real-world examples. At the end of the tutorial, the listener should have a good idea what LLRF is about and what path to follow, if the listener wants to get involved with this topic.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: OMET, Mathieu (High Energy Accelerator Research Organization)

Presenter: OMET, Mathieu (High Energy Accelerator Research Organization)

Session Classification: Tutorials (Day 3)

Track Classification: General

Contribution ID: **340** Type: **Tutorials**

Tutorial 11: Beam Loading

Saturday, September 20, 2025 1:30 PM (1h 30m)

Beam Loading

I have read and accept the Privacy Policy Statement

Footnotes

Funding Agency

Author: NISHIWAKI, Michiru (High Energy Accelerator Research Organization)

Presenter: NISHIWAKI, Michiru (High Energy Accelerator Research Organization)

Session Classification: Tutorials (Day 3)

Track Classification: General

Contribution ID: **341** Type: **Tutorials**

Tutorial 12: Cryogenics

Saturday, September 20, 2025 3:30 PM (1h 30m)

Superconducting Radio Frequency (SRF) technology relies on cryogenics to achieve and maintain the ultra-low temperatures required for efficient accelerator operation. This tutorial introduces the essential principles of cryogenics for SRF applications, aimed at providing participants with a foundation to support their work in the field. Topics include the role of cryogenics in SRF technology, the basic laws of thermodynamics, and an overview of refrigeration and liquefaction cycles. Special emphasis will be placed on the unique properties of helium and its importance for SRF systems. The lecture will also address how heat transfer is managed in cryogenic environments, drawing on examples from cryogenic systems at the European Spallation Source (ESS). In addition, operational aspects such as: safety considerations, system control, and monitoring will be highlighted.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: ELIAS, Nuno (European Spallation Source)

Presenter: ELIAS, Nuno (European Spallation Source)

Session Classification: Tutorials (Day 3)

Track Classification: General

Contribution ID: **342** Contribution code: **MOP19** Type: **Poster Presentation**

ELBE SRF gun –the most advanced source of its kind

Monday, September 22, 2025 2:30 PM (3 hours)

At the electron accelerator for beams with high brilliance and low emittance (ELBE), the second version of a superconducting radio-frequency (SRF) photoinjector was brought into operation in 2014. After a period of commissioning, a gradual transfer to routine operation took place in 2017, so that now up to 1800h of user beam are generated every year. In addition to this standard mode with a few tens of microamperes, another important milestone was achieved recently. An average current of 1 mA at a repetition rate of 13 MHz was generated and further accelerated to almost 30 MeV by the ELBE LINAC. After guiding the beam to one of the IR-FELs, lasing was easily achieved and even a very sensitive user experiment was conducted. This is particularly important with regard to the successor of the ELBE accelerator called DALI, which is planned to be fed by an SRF gun with a high average current as well. The contribution presents the most important steps for achieving the full beam current and summarizes related measurement results and findings. No fundamental difficulties were identified.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: ARNOLD, Andre (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: CIOVATI, Gianluigi (Thomas Jefferson National Accelerator Facility); Mr HOFFMANN, Adrian (Helmholtz-Zentrum Dresden-Rossendorf); KLOPF, J. Michael (Helmholtz-Zentrum Dresden-Rossendorf); KNEISEL, Peter (Thomas Jefferson National Accelerator Facility); MURCEK, Petr (Helmholtz-Zentrum Dresden-Rossendorf); Dr RYZHOV, Anton (Helmholtz-Zentrum Dresden-Rossendorf); Mr SCHURIG, Rico (Helmholtz-Zentrum Dresden-Rossendorf); TEICHERT, Jochen (Helmholtz-Zentrum Dresden-Rossendorf); VENNEKATE, Hannes (Thomas Jefferson National Accelerator Facility); Dr WILL, Ingo (Max-Born-Institute for Non-linear Optics and Short Pulse Spectroscopy); XIANG, Rong (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: ARNOLD, Andre (Helmholtz-Zentrum Dresden-Rossendorf)

Session Classification: Monday Poster Session

Track Classification: MC4: SRF Technologies

Contribution ID: **343** Contribution code: **TUP02** Type: **Poster Presentation**

Application of the plasma processing technique to the ELBE SRF gun

Tuesday, September 23, 2025 2:30 PM (3 hours)

As for all superconducting radio-frequency (SRF) cavities preserving the performance during accelerator operation is even more essential for an SRF gun, because the accelerating field is typically very high and cannot be compensated by a neighboring cavity. One of the main limiting factors remains field emission, that is originating either from particulates or hydrocarbon contaminants on the niobium surface. To remove the latter, plasma cleaning was developed for the Spallation Neutron Source (SNS) at the Oak Ridge National Laboratory as an effective method for mitigating field emitters and increasing the work function of Nb. For elliptical cavities, the method was then adapted by Thomas Jefferson National Accelerator Facility for their 1.5 GHz CEBAF cavities and later further developed by Fermi National Accelerator Laboratory for the 1.3 GHz TESLA design. Since the ELBE SRF gun cavity is also based on an elliptical design with the same resonant frequency, a similar experimental setup was built to adapt the published results to a 3.5-cell test cavity made from reactor grade Nb (RRR40). The contribution will present a detailed description of the plasma processing setup as well as RF simulations and measurements of the 1st and 2nd dipol passband. First plasma ignition was achieved using 100 mbar helium and up to 100 W of RF power but further optimization of the parameter space is needed.

Footnotes

Funding Agency

I have read and accept the Privacy Policy Statement

Yes

Author: ARNOLD, Andre (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: HOFFMANN, Adrian (Helmholtz-Zentrum Dresden-Rossendorf); Mr BERNDT, Max Henryk (Helmholtz-Zentrum Dresden-Rossendorf); MURCEK, Petr (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: ARNOLD, Andre (Helmholtz-Zentrum Dresden-Rossendorf)

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Evolution of the ELBE SRF gun - improvements towards the 3rd generation

Tuesday, September 23, 2025 2:30 PM (3 hours)

HZDR has done pioneering work in the field of the superconducting photoelectron source (SRF gun). The development began more than 20 years ago with the first proof of concept experiment. This was the first time worldwide that electrons were generated from a normal-conducting semiconductor photocathode within a superconducting half-cell resonator [1]. Convinced by this success the work was continued by developing a 3½-cell prototype SRF gun (referred to as ELBE SRF gun I). During an operating time of about 5 years, various problems were solved and different routines were implemented, which finally made it possible to drive the free-electron laser of the ELBE accelerator by the SRF gun [2]. In order to take full advantage of the electron source an improved niobium cavity was built and together with a superconducting solenoid integrated in a new gun module (referred to as ELBE SRF gun II). Since 8 years this gun is in routine user operation, delivering bunches with 200 pC and a repetition rate of 100 kHz to generate THz radiation in a very stable and reliable manner [3]. The development of the third generation of this electron source is now concentrating on the cathode cooler, the cathode transfer system and the superconducting solenoid, while the cavity was refurbished with the help of HZB in Berlin. The contribution will present the lessons learned and the main technical changes of ELBE SRF gun III compared to its predecessors.

Funding Agency

Footnotes

[1] D. Janssen et al., Nucl. Instr. Meth. A 507 (2003) 314 - 317
[2] J. Teichert, et al., Nucl. Instr. Meth. A 743 (2014) 114 - 120
[3] J. Teichert, et al., Phys. Rev. Accel. Beams 24, 033401 (2021)

I have read and accept the Privacy Policy Statement

Yes

Author: MURCEK, Petr (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: HOFFMANN, Adrian (Helmholtz-Zentrum Dresden-Rossendorf); ARNOLD, Andre (Helmholtz-Zentrum Dresden-Rossendorf); RYZHOV, Anton (Helmholtz-Zentrum Dresden-Rossendorf); HALLILINGAIAH, Gowrishankar (Helmholtz-Zentrum Dresden-Rossendorf); TEICHERT, Jochen (Helmholtz-Zentrum Dresden-Rossendorf); VENNEKATE, John (Thomas Jefferson National Accelerator Facility); BERNDT, Max Henryk (Helmholtz-Zentrum Dresden-Rossendorf); XIANG, Rong (Helmholtz-Zentrum Dresden-Rossendorf); MA, Shuai (China Academy of Engineering Physics, Institute of Applied electronics); GATZMAGA, Stefan (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: MURCEK, Petr (Helmholtz-Zentrum Dresden-Rossendorf)

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