AKBP 4: RF, Resonators and Applications II

Zeit: Montag 16:30–18:15 Raum: S1/05 24

AKBP 4.1 Mo 16:30 S1/05 24

Recommissioning of the High-Temperature UHV-Furnace at the S-DALINAC for Research on Future RF Cavitiy Materials* — •Ruben Grewe[1], Jens Conrad[1], Thorsten Kürzeder[1], Norbert Pietralla[1], Lambert Alff[2], Marton Major[2], and Florian Hug[3] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany — [2]Materialwissenschaft, TU Darmstadt, Darmstadt, Germany — [3]Institut für Kernphysik, JGU Mainz, Mainz, Germany

Current research shows an up to four times higher Q-factor for nitrogen doped superconducting niobium cavities. Those cavities are usually heat processed in an uhv-furnace with temperatures around 800°C and a short time exposed to a nitrogen atmosphere. The uhv-furnace at the S-DALINAC is able to reach temperatures of up to 1800°C, which offers the possibility of making N-doped niobium samples at temperatures between 1300°C and 1700°C. At these temperatures the so-called δ-phase of NbN forms, which is highly interesting for superconducting accelerator usage. In order to produce such samples for research on δ-phase NbN, the uhv-furnace needs technical upgrades. These include enhanced vacuum systems, temperature monitoring and residual gas analysis as well as a new, smaller niobium hot-pot for heat processing of niobium samples. In this talk first results of the furnace recommissioning will be presented. An outlook on future activities will be given.

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AKBP 4.2 Mo 16:45 S1/05 24

Suppression of field emission from Nb and Mo surfaces by insulating oxides — •Stefan Lagotzky and Günter Müller — University of Wuppertal, D-42097 Wuppertal, Germany

Parasitic field emission (FE) from particulates and surface defects is one of the main field limitations of superconducting Nb cavities and leads to dark current (DC) from the Mo substrates of semiconducting photocathodes. The activation field E_{act} of typical emitters and the emitter number density N is strongly influenced by the surface oxide thickness d_{ox}. Reduction of these oxides, e.g. by heat treatments (HT), leads to activation of new emitting sites [1-2] with $N \sim exp(-d_{ox})$. Since the achievable surface quality, however, is not yet sufficient for future ILC accelerating structures [3] and actual photoinjectors, thicker oxides are promising to reduce FE and DC, respectively. FE measurements of thermally oxidized and dry ice cleaned single crystal Nb samples ($d_{ox} \sim 100$ nm) revealed a reduction of N by a factor 20 at 70 MV/m, i.e. the intended electric peak field of future ILC cavities. The remaining FE was caused by surface defects and partially molton features with onset fields E_{on} above 90 MV/m. Furthermore, oxygen exposure of a Mo sample partially weakened or deactivated emission sites, which were previously activated by HT at 400-600°C with $E_{on} = 20$ MV/m.

[1] A. Navitski et al., Phys. Rev. ST-AB 16, 112001 (2013).
[2] S. Lagotzky et al., Eur. Phys. J. Appl. Phys. 70, 21301 (2015).
[3] S. Lagotzky u. G. Müller, Nucl. Instrum. Meth. A 806, 193 (2016).
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AKBP 4.3 Mo 17:00 S1/05 24

Influence of Eletron Beam Welding on the Surface Resistance of Bulk Niobium — •Marian Lückhof[1,2], Sarah Aull[3], Jens Knobloch[1,2], and Walter Venturini Delsolaro[3] — [1]Universität Siegen, Siegen, Deutschland — [2]Helmholtz Zentrum Berlin, Berlin, Deutschland — [3]CERN, Geneva, Switzerland

Along the production processes of SRF cavities, electron beam welding (EBW) is a production step that is predominantly used nowadays in cavity assembling. EBW changes the material properties and hence might influence the surface resistance of bulk niobium significantly.

The talk presents results from RF measurements performed on a niobium sample with an EBW on the surface as a function of temperature. The measurements were performed with CERN's Quadrupole Resonator, allowing to extract the surface resistance with high precision as a function of temperature and the applied RF fields.

AKBP 4.4 Mo 17:15 S1/05 24

Messung des Oberflächenwiderstands von supraleitenden Proben mit dem HZB Quadrupolresonator — •Sebastian Keckert, Raphael Kleindienst, Jens Knobloch und Oliver Kugeler — Helmholtz-Zentrum für Materialen und Energie GmbH, Albert-Einstein-Str. 15, 12489 Berlin

Supraleitende Beschleunigerkavitäten zeichnen sich durch ihren Oberflächenwiderstand im nOhm-Bereich aus und eröffnen dadurch Anwendungen bei hohem Beschleunigungsgradienten im cw-Betrieb. Für ein umfassendes Verständnis der Beiträge zum Oberflächenwiderstand und der Vergleich mit verschiedenen Theorien sind präzise Messungen notwendig. Der Quadrupolresonator bietet dafür ein ideales System, um flache Proben in einem großen Temperaturbereich und bei typischen Betriebsfrequenzen von 430, 860 und 1300 MHz zu charakterisieren. Mit HF-Magnetfeldstärken von bis zu 120 mT werden die Bedingungen von heutigen Beschleunigungsgradienten erreicht. Die Messung der HF-Verluste erfolgt kalorimetrisch und ermöglicht dadurch eine Auflösung von unter 1 nOhm. Nach der Inbetriebnahme des Resonators im letzten Jahr werden Messungen an Niob-Proben mit unterschiedlichen Korngrößen sowie die Entwicklung einer teilbaren Kalorimetriekammer mit dünner Probe vorgestellt.

AKBP 4.5 Mo 17:30 S1/05 24

Studies of HOMs in Chains of SRF Cavities using State-Space Concatenation Scheme — •Tomasz Galek, Johann Heller, Thomas Flisgen, Korinna Brackebusch, and Ursula van Rienen — Institut für Allgemeine Elektrotechnik, Universität Rostock

The design of modern superconducting radio frequency cavities for acceleration of charged particle bunches requires intensive numerical simulations, as they typically arise as modules of several multi-cell cavities. A wide variety of parameters vital to the proper operation of accelerating cavities must be optimized and studied. One of the most important issues concerning the SRF cavities is the influence of the higher order modes on the beam quality, in this contribution. For TESLA-like structures with 1.3 GHz accelerating mode, higher order modes are calculated up to 4 GHz, the external quality factor and the shunt/geometrical impedance spectra are analyzed. To compute properties of complete RF modules the state-space concatenation scheme is used. The aspects of the concatenation scheme and its application to the bERLinPro's chain of cavities is discussed. Work supported by Federal Ministry for Research and Education BMBF under contracts 05K13HR1 and 05H15HRRBA.

AKBP 4.6 Mo 17:45 S1/05 24

Numerical Investigation of External Losses for Superconducting Radio-Frequency Resonators — •Johann Heller, Thomas Flisgen, Tomasz Galek, and Ursula van Rienen — Institute for General Electrical Engineering, Rostock

For the thorough design of particle accelerators, the electromagnetic behavior of the accelerating resonators has to be investigated. Of special interest are the losses inside the resonators which have to be optimized such that the operation costs stay as moderate as possible and the quality of the particle beam is not diminished. In superconducting radio-frequency (SRF) cavities, the losses are dominated by energy leaving the structure through the open waveguide ports. Generally, the numerical discretization of such problems lead to large scale, non-linear, complex eigenvalue problems which are extremely hard to solve. Therefore, a standard approach is to introduce some simplifications (e.g. linearization), that allow for the fast computation of such losses. In this talk, we present an algorithm, that allows for the solution of the full non-linear eigenvalue problem by applying some model-order reduction. The usability of the approach for large-scale, real-life applications is shown on parts of the Third-Harmonic Module of the FLASH accelerator in Hamburg.

AKBP 4.7 Mo 18:00 S1/05 24

Multi-Objekt-Optimierung für Strahldynamikstudien an einem SRF Photoinjektor — •Eva Panofski, Andreas Jankowiak, Thorsten Kamps und Jens Völker — Helmholtz-Zentrum Berlin für Materialien und Energie

Viele zukünftige Anwendungen von Teilchenbeschleunigern, wie FELs oder ERLs, erfordern hochbrilliante Elektronenstrahlen. Entscheidender Bestandteil des Beschleunigers ist hierbei die Elektronenquelle, die neben einer sehr kleinen Strahlemittanz ($<$ 1 mm mrad) zeitgleich auch einen hohen mittleren Strahlstrom zur Verfügung stellen muss. Ein Photoinjektor mit supraleitender Beschleunigungskavität hat das

Potential, Elektronenstrahlen hoher Strahlbrillianz zu erzeugen. Für Design und Betrieb einer solchen Elektronenquelle stellt die Wahl geeigneter Parameter bzgl. Photoemissionslaser, Kavität und Solenoid eine Herausforderung dar. Die große Anzahl relevanter Parameter und Randbedingungen sowie die Nichtlinearität der Raumladungseffekte schließen eine exakte, rein analytische Betrachtung aus. Bei der Verwendung einer Multi-Objekt-Optimierung mit evolutionären Algorithmen kann ein optimaler Parametersatz aus Pareto-optimalen Lösungen extrahiert werden.

Es werden die Entwicklung eines Multi- Objekt Optimierungsalgorithmus sowie erste Ergebnisse eines Optimierungsproblems im Bereich der Strahldynamik für GunLab, einem SRF Photoinjektor Teststand am Helmholtz-Zentrum Berlin, präsentiert.