AKBP 7: Electron Accelerators

Time: Wednesday 14:00–16:15 Location: AKBPb

AKBP 7.1 Wed 14:00 AKBPb

Recent Developments at the S-DALINAC* — •M. Arnold, J. Birkhan, A. Brauch, M. Dutine, J. Enders, M. Fischer, R. Grewe, L. Jürgensen, M. Meier, J. Pforr, N. Pietralla, F. Schliessmann, D. Schneider, M. Steinhorst, L. Stobbe, and S. Weih — Institut für Kernphysik, Technische Universität Darmstadt

The superconducting Darmstadt linear accelerator S-DALINAC is a thrice-recirculating linac for electrons [1]. Besides the conventional acceleration scheme with corresponding nuclear physics experiments, the accelerator of TU Darmstadt can also be operated as an energy recovery linac (ERL) [2]. Since its establishment in 1991, the S-DALINAC was mainly developed and operated by students. Also during the past year, various projects have progressed and several measurements have been done. Among them, a new system for the measurement of beam emittance by optical transition radiation was set into operation. Additional diagnostics have been commissioned or are under construction. Further upgrades of the injector section are in preparation. Several projects are addressing the ERL operation of the S-DALINAC. Simulations and dedicated diagnostics for the twice-recirculating ERL mode are under investigation. This contribution will give an overview of the status of those projects.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).
[2] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101 (2020).
*Work supported by DFG (GRK 2128), BMBF (05H18RDRB2), State of Hesse (LOEWE Research Cluster Nuclear Photonics)

AKBP 7.2 Wed 14:15 AKBPb

A storage ring upgrade for MESA — •Christian Stoll — Institut für Kernphysik - JGU Mainz

MESA is an ERL facility currently under construction at the Johannes Gutenberg University in Mainz. With a maximum beam current of 1 mA it provides the opportunity for electron scattering experiments with a high density gas jet target at the MAGIX experiment. Increasing the beam current even further would also open up the investigation of thin polarized gas targets with sufficiently high interaction rates. Increasing the beam current to 100 mA would pose significant challenges to the existing ERL machine, thus the proposal is to use MESA in pulsed operation with a repetition rate of several kHz to fill a storage ring. The stored beam could nearly completely fill the ring, providing a quasi c.w. beam current to the thin gas target. Due to the repetition rate of several kHz the beam will not be stored for long so damping times and steady states are of no concern, rather we aim for peak brilliance at the experiment. Investigation of a suitable injection- and extraction scheme is crucial as well as understanding the beam target interaction and its effects on the beam. In the most favourable configuration the spent beam could be used for energy recovery.

AKBP 7.3 Wed 14:30 AKBPb

Investigations into MESA's Longitudinal Beam Dynamics with OPAL — •Sebastian Taubert — Institut für Kernphysik, JGU Mainz, Deutschland

The experiments at the future user facility MESA (Mainz Energy-Recovering Superconducting Accelerator) have very high demands regarding energy resolution and beam stability. Therefore, non-isochronous beam recirculation and off-crest acceleration will be used to reduce the energy spread. For the Energy Recovery (ER) mode of MESA this is not trivial and different operation schemes need to be investigated. In order to do that MESA's ER mode is being simulated using the OPAL accelerator library.

AKBP 7.4 Wed 14:45 AKBPb

Simulations and Measurements of the Emittance of the S-DALINAC's Electron Beam after its Injector Beamline* — •Lennart Stobbe, Michaela Arnold, Lars Jürgensen, Jonas Pforr, and Norbert Pietralla — IKP, TU Darmstadt, Germany

The injector section of the superconducting electron-linear-accelerator S-DALINAC has two different electron sources, a thermionic gun and a source of spin-polarized electrons [1]. The current chopper system consists of a 3 GHz normal-conducting pill-box cavity, a steering magnet and an aperture plate with a diameter of two millimeters. The injector beam-line was studied with respect to further optimizations of the resulting beam quality. Modifications of the current chopper system were investigated irrespective of constraints related to the source of polarized electrons. The results of simulations with the program Astra [2] will be presented. Also emittance measurements behind the injector beamline will be shown and compared to the simulations of the current setup.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).
[2] A Space Charge Tracking Algorithm (ASTRA)
http://www.desy.de/ mpyflo/
*Work supported by DFG through GRK 2128 and by the state of Hesse through the LOEWE Research Cluster Nuclear Photonics

AKBP 7.5 Wed 15:00 AKBPb

Status and Advancements towards Commissioning of the S-DALINAC Injector Upgrade* — •Simon Weih, Michaela Arnold, Joachim Enders, and Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany

A capture cavity for non-ultra relativistic electrons ($\beta = 0.86$) will be installed at the injector of the superconducting Darmstadt electron linear accelerator (S-DALINAC) [1] to achieve the beam quality required for the currently investigated multi-turn ERL mode and to re-enable an operation of the spin-polarized gun. After the finalization of the mechanical cavity processing, the latest completed work packages of the project include a hydrogen bake-out, field-flatness tuning, final RF surface preparation, and testing of the tuner components. In addition, a new diagnostics beamline upstream of the capture cavity was recently installed and commissioned. We will report on these latest advancements towards the commissioning of the upgraded injector.

[1] N. Pietralla, Nuclear Physics News, Vol. 28, No. 2, 4 (2018).
*Work supported by DFG through GRK 2128 and the state of Hesse through the LOEWE Research Cluster Nuclear Photonics

AKBP 7.6 Wed 15:15 AKBPb

LightHouse – A Superconducting Electron Accelerator for the Production of Medical Isotopes — Guido Blokesch, Marc Grewe, Björn Keune, Jakob Krämer, Michael Pekeler, Christian Piel, •Christoph Quitmann, Claudio Serpico, Peter vom Stein, and Thu Trang Trinh — RI Research Instruments GmbH, Friedrich-Ebert-Str. 75, 51429 Bergisch Gladbach, Germany

We are in designing the first industrial superconducting electron linear accelerator, which will be used for high-volume productionof ^{99}Mo. This isotope decays to the short-lived ^{99m}Tc, used in several ten-million diagnostic procedures worldwide, mostly with cancer patients. Customer is the Institute for Radioelements (IRE), Belgium, the world-leader in ^{99}Mo production. For decades ^{99}Mo has been produced by irradiating ^{235}U in high-flux reactors. The new LightHouse facility will be using a (γ, n) reaction driven by a high intensity 75 MeV electron beam stopped in the ^{100}Mo target. This eliminates the need for reactors and minimizes nuclear waste. The electron accelerator uses proven technology from the Cornell CBETA facility, a high brightness DC photoinjector and 1.3 GHz superconducting RF cavities. The challenges are the very high beam power of 3.0 MW (75 MeV, 40 mA) and the high uptime (23 h/day, 360 d/year) required for producing commercially relevant quantities of the short-lived ^{99}Mo ($t_{1/2} = 66$ h). At present, a Beam Test Facility is being constructed to demonstrate the performance of the photoinjector for this linear accelerator. We describe the design challenges and strategies for solution. We also present opportunities for thesis projects for students in accelerator physics.

AKBP 7.7 Wed 15:30 AKBPb

Investigation of a Thomson scattering based gamma source at MESA — •Christoph Lorey — Johannes Gutenberg Universität, Mainz, Germany

At the Johannes Gutenberg University (JGU) in Mainz, the Mainz Energy-recovering Superconducting Accelerator (MESA), designed to deliver electron beams of up to 155 MeV, is currently under construction. As it can be operated in an energy-recovery (ER) mode with high repetition rate, it is a promising candidate for a Thomson scattering based gamma source of which a low interaction cross section is one of the key features. With MESA as the exemplary subject, this presentation will give a short summary of the challenges and benefits of a Thomson scattering based gamma source and a description of future tasks as well as potential realization concepts for the future beyond.

AKBP 7.8 Wed 15:45 AKBPb

Influence of collective effects on electron bunching — •Dmitrii Samoilenko[1,2], Lucas Schaper[2], Sven Ackermann[2], Wolfgang Hillert[1,2], and Enrico Allaria[2] — [1]University of Hamburg, Institut für Experimentalphysik, Hamburg, Germany — [2]DESY, Hamburg, Germany

FLASH is a free electron laser with high repetition rate in XUV and soft X-ray regime. Currently an upgrade for this facility is under development and it includes enabling an elaborated external seeding scheme: echo-enabled harmonic generation (EEHG). This scheme provides efficient electron bunching at high harmonics of the seeding laser, which will allow generation of seeded FEL radiation at wavelengths down to 4.16nm. To a considerable part the design implies sizable use of numerical simulations that predict performance of the future machine. Since these simulations are usually quite time- and resource-consuming, extensive parameter scans are expensive. The number of core-hours spent on the simulations can be reduced by educated guess for initial parameters. Here, an analytical study providing such a guess is performed on influence of collective effects on electron bunching for EEHG seeding scheme at FLASH. First, the study focuses on how different effects depend on beamline parameters separately to gain a clearer insight on each effect as compared to simulations. Then, combined contributions of the effects are considered together in order to determine an initial working point with promising performance.

AKBP 7.9 Wed 16:00 AKBPb

High brightness beam from a photoinjector for ultrafast scattering experiments. — •Beñat Alberdi Esuain[1,2], Axel Neumann[1], Jens Voelker[1], and Thorsten Kamps[1,2] — [1]Helmholtz-Zentrum Berlin — [2]Humboldt University of Berlin

Ultrafast Electron Diffraction (UED) is a pump-probe technique used to observe dynamical changes in the structure of materials. A laser pulse excites the target structure and a subsequent electron bunch scatters in the sample producing a diffraction pattern. The time resolution of UED experiments is governed by the bunch length, while the spatial resolving power is related to the transverse phase space. Hence, high brilliance electron beams are needed. The SRF Photoinjector test facility is a high current electron source at Helmholtz-Zentrum Berlin (HZB). It offers unique possibilities to perform UED experiments as the design is flexible enough to realize the strict electron beam requirements. Two phases are foreseen to achieve operational UED capabilities. The first phase is a proof of concept experiment with a static target to prove that it is possible to attain the required beam parameters. The second phase will have the objective of implementing the time-resolved pump-probe scheme. Phase 1 is currently being developed and is the main focus of this talk. In order to accomplish the high brilliance beam, the longitudinal phase space is linearized at the target by three booster cavities, while the desired transverse phase space is achieved by using an aperture and focusing elements. We discuss the requirements for such experiment, the work that has been carried out for the first phase and the outlook of the UED project in HZB.