AKBP 5: Hadron Accelerators

Time: Tuesday 16:30–18:00 Location: CHE/0184

AKBP 5.1 Tue 16:30 CHE/0184

Broadband laser cooling of stored relativistic bunched ion beams at the ESR — •Sebastian Klammes[1], Lars Bozyk[1], Michael Bussmann[2,3], Noah Eizenhöfer[4], Volker Hannen[5], Max Horst[4], Daniel Kiefer[4], Nils Kiefer[6], Thomas Kühl[1,7], Benedikt Langfeld[4,9], Xinwen Ma[8], Wilfried Nörtershäuser[4,9], Rodolfo Sánchez[1], Ulrich Schramm[3,10], Mathias Siebold[2], Peter Spiller[1], Markus Steck[1], Thomas Stöhlker[1,7,11], Ken Ueberholz[5], Thomas Walther[4,9], Hanbing Wang[8], Weiqiang Wen[8], Daniel Winzen[5], and Danyal Winters[1] — [1]GSI Darmstadt — [2]HZDR Dresden — [3]Casus Görlitz — [4]TU Darmstadt — [5]Uni Münster — [6]Uni Kassel — [7]HI Jena — [8]IMP Lanzhou — [9]HFHF Darmstadt — [10]TU Dresden — [11]Uni-Jena

High-precision experiments at heavy-ion storage rings strongly benefit from cold ion beams, i.e. beams with a small relative longitudinal momentum spread (Δp/p) and a small emittance (ϵ). Especially for the higher ion intensities and Lorentz factors (γ) at FAIR (SIS100), laser cooling has proven to be a powerful tool for cooling of relativistic bunched ion beams. The principle is based on resonant absorption (photon momentum & energy) in the longitudinal direction and subsequent spontaneous random emission (fluorescence & ion recoil) by the ions, combined with a moderate bunching of the ion beam. We will report on results from a 2021 laser cooling beamtime at the ESR, where we could demonstrate for the first time broadband laser cooling of relativistic bunched C^{3+} ions using a new pulsed UV laser system with a very high repetition rate, tunable pulse duration, and high power.

AKBP 5.2 Tue 16:45 CHE/0184

Tumor irradiation in mice with a laser-accelerated proton beam — •Florian Kroll[1], Florian-Emanuel Brack[1], Elke Beyreuther[1,2], Thomas Cowan[1,3], Leonhard Karsch[1,2], Josefine Metzkes-Ng[1], Jörg Pawelke[1,2], Marvin Reimold[1,3], Ulrich Schramm[1,3], Tim Ziegler[1,3], and Karl Zeil[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]OncoRay - National Center for Radiation Research in Oncology, Dresden, Germany — [3]Technische Universität Dresden, Dresden, Germany

Oncological studies identified beneficial properties of radiation applied at dose rates considerably exceeding the clinical standard of 1 Gy/min. At the Draco PW laser of Helmholtz-Zentrum Dresden-Rossendorf, a laser-driven proton research platform enables research on ultra-high dose rate effects for diverse user-specific small animal models.

Tunable single-shot doses are applied to mm-scale volumes on ns time scales, resulting in instantaneous dose rates around 10^9 Gy/s. Dose distributions that uniformly cover the sample volume were generated from individual broad-band proton bunches provided by our laser-driven source with unprecedented stability and long-term reliability. Maximum proton energies regularly exceeded 60 MeV.

We conducted the first radiobiological in vivo study with laser-driven protons using human tumors in a mouse model. We show the concerted preparation of mice and laser accelerator, the dose-controlled, tumor-conform irradiation using a laser-driven as well as a clinical reference proton source, and the radiobiological evaluation of irradiated and unirradiated mice for radiation-induced tumor growth delay.

AKBP 5.3 Tue 17:00 CHE/0184

Update on the Future Neutron Beam Line at the Bonn Isochronous Cyclotron — •Maximilian Loepke, Reinhard Beck, Dieter Eversheim, and Dennis Sauerland — Helmholtz-Institut für Strahlen- und Kernphysik Bonn

The Bonn Isochronous Cyclotron provides a beam of protons, deuterons, α-particles or other light ions with a mass-to-charge ratio $\geq 1/2$ with a kinetic energy ranging from 7 to 14 MeV per nucleon. Since 2019, a proton beam is utilized for irradiation of e.g. silicon pixel detectors for radiation hardness studies.

It is planned to extend the facility's irradiation and experimentation capabilities by providing a neutron beam in the near future. The neutrons are produced by splitting-up deuterons into protons and neutrons in a thick carbon or beryllium converter. Protons are stopped in the converter whereas the neutrons' flux and angular energy distribution is optimized by a subsequent copper/tungsten collimator. After collimation, the neutron beam can be utilized to irradiate a target.

The transversal dimension, yield and energy distribution of the neutron beam has been estimated for different collimator geometries using simulations with *Geant4* to optimize for radiation hardness tests.

This talk gives a conceptual overview of the future experimental area and results of the simulations are presented.

AKBP 5.4 Tue 17:15 CHE/0184

Standalone Readout for Mimosis-Sensors of the MVD. — •Benedikt Gutsche for the CBM-Collaboration — Goethe University Frankfurt

The Micro-Vertex-Detector (MVD) is a four-layer layer pixel detector and the first detector stage of the CBM experiment. Besides dedicated sensors (MIMOSIS), a fast and robust readout is necessary in order to handle the data in a proper way. In the prototyping phase of the detector and for sensor evaluation, a test system with smaller capabilities regarding the number of read-out sensors has been developed. This enables the use of a much simpler FPGA-based system. We chose the TRB platform and existing software framework, originally developed for HADES at GSI. We are going to show how automated tests of sensors can be implemented, in order to provide important information like the dead pixel count or the behaviour of DACs, using TRB-Software and root-based analysis applications (DABC, Go4) . This work has been supported by BMBF (05P21RFFC2) and GSI.

AKBP 5.5 Tue 17:30 CHE/0184

Upgrade of the Beam Preparation System of the Bonn Isochronous Cyclotron — •Béla Daniel Knopp[1], Reinhard Beck[1], Paul-Dieter Eversheim[1], Dennis Sauerland[1], and Pascal Wolf[2] — [1]Helmholtz-Institut für Strahlen- und Kernphysik — [2]SiLab, Physikalisches Institut, Universität Bonn

With the Bonn Isochronous Cyclotron either protons, deuterons, alpha particles or other light ions with a charge-to-mass ratio $\geq 1/2$ are accelerated to a kinetic energy ranging from 7 to 14 MeV per nucleon. The extracted beam is guided to one of five experimental sites via a high-energy beamline.

To ensure a controlled beam transport via this beamline, the beam is stabilized in angle and position by the beam preparation system after extraction from the cyclotron. This is achieved by fixating the beam position in two consecutive locations. Using pairs of adjustable scrapers which are symmetrically aligned horizontally and vertically around the design orbit one can deduce the relative beam position in the transversal plane. This is done by comparing the beam scrape-off current at the scrapers when the beam is passing between them. Using the relative beam position as feedback for a control loop, the respective beam deviation from the design orbit can be minimized by using dedicated corrector magnets.

In this talk, the design and development of a new digital readout and control of the beam preparation system, which replaces the current analog one, will be presented.

AKBP 5.6 Tue 17:45 CHE/0184

Kaon beam studies employing coventional hadron beam concepts at the CERN M2 beam line for the future AMBER experiment — •Fabian Metzger[1,2], Dipanwita Banerjee[2], Johannes Bernhard[2], Lau Gatignon[3], Alexander Gerbershagen[4], Bernhard Ketzer[1], Laurence James Nevay[2], and Silvia Schuh[2] — [1]Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany — [2]CERN, Geneva, Switzerland — [3]Lancaster University, Lancaster, United Kingdom — [4]University of Groningen, Particle Therapy Research Center, Netherlands

As a part of its rich proposed future physics programme, the AMBER (NA66) experiment aims to measure the inner structure and the excitation spectra of mesons with open strangeness with a high-intensity kaon beam at the CERN secondary beam line M2. One way to identify the small fraction of kaons in the available beam is tagging with the help of differential Cherenkov detectors (CEDARs), which are blind to other particles and whose detection efficiency depends critically on the beam parallelism.

In this contribution, we discuss possible improvements of the conventional beam optics to achieve a better performance of the CEDARs for the AMBER programme with hadron beams, in particular for the planned Drell-Yan and diffractive measurements. We focus on the investigation of multiple scattering in the present setup in the regions where the beam runs through vacuum windows and air at atmospheric pressure, and on the optimization of the beam optics.