AKBP 2: Electron Sources and Cathodes

The session deals with new developmetns for electron sources

Time: Monday 11:30–13:30 Location: E 020

Group Report AKBP 2.1 Mon 11:30 E 020

Photo-electron Source Research at Photo-CATCH* — •Maximilian Herbert, Joachim Enders, Markus Engart, Maximilian Meier, Julian Schulze, Vincent Wende, and Victor Winter — Institut für Kernphysik, Fachbereich Physik, Technische Universität Darmstadt, Darmstadt, Germany

The institute for nuclear physics at TU Darmstadt houses the test stand for Photo-Cathode Activation, Testing and Cleaning using atomic-Hydrogen Photo-CATCH. It enables dedicated research on GaAs photocathodes as well as DC photo-gun design for future use at the in-house Superconducting Darmstadt Linear Accelerator S-DALINAC. This contribution will give an overview of recent, ongoing and planned projects at Photo-CATCH.

*Work supported by DFG (GRK 2128 „AccelencE “, project number 264883531)

AKBP 2.2 Mon 12:00 E 020

Exploring the untapped potential of the next-generation SRF gun cavity — •Gowrishankar Thalagavadi Hallilingaiah and André Arnold — Helmholtz-Zentrum Rossendorf-Dresden, Dresden, Germany

A high beam brightness is a fundamental requirement for an electron linear accelerator, with the injector setting the lower limit for the achievable brightness. Over the past fifteen years at the ELBE accelerator in Dresden, the superconducting radio-frequency photoelectron injector (SRF gun) has been consistently delivering a high-brightness continuous wave electron beam, supporting the FEL, THz, and neutron experiments. Throughout this period, the gun cavity was operated below its design gradient due to the field emission from intricate cleaning and assembly processes, as well as contamination during cathode handling. A lower accelerating 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, aiming to restrict the peak surface electric field to practically achievable levels. Additionally, the investigation includes the utilization of secondary TM and TE modes for improving the beam quality. Simultaneously, enhancements to the choke cell, cathode shape, and the transition from cell to beam pipe are being implemented to maximize the beam brightness and improve cavity cleaning. This contribution will discuss the initial findings obtained from the electromagnetic and beam dynamics simulations conducted on the new gun cavity.

AKBP 2.3 Mon 12:15 E 020

Development of a Hybrid Thermionic and Photoemission Electron Gun and Dedicated Test Stand for ELSA — •Samuel Kronenberg, Klaus Desch, Dennis Proft, and Philipp Hänisch — Physikalisches Institut der Universität Bonn

A new electron gun is currently being designed for the S-band Linac injector for ELSA. The objective of this development is to realise a new single bunch injection mode in addition to the standard long pulse (multi bunch) mode along with an improvement of the current beam parameters (e.g. emission current & transverse emittance) achieved by the existing gun. A dual mode design is being developed that utilises a caesium dispenser cathode both as a thermionic and a photo-cathode using thermally assisted photoemission. In addition to the novel electron gun, a dedicated test stand is currently being designed to allow detailed characterisation of both operating modes. The refined design of the gun and the current status of the test stand including beam parameter simulations are presented.

AKBP 2.4 Mon 12:30 E 020

Quantum efficiency scan setup for the activation chamber of Photo-CATCH* — •Julian Schulze, Joachim Enders, Markus Engart, Maximilian Herbert, Maximilian Meier, and Victor Winter — Institut für Kernphysik, Fachbereich Physik, Technische Universität Darmstadt, Darmstadt, Germany

GaAs photocathodes are used to generate spin-polarized electron beams for a variety of applications. The quantum efficiency (QE) of a photocathode is defined as the ratio of extracted electrons to incident photons. GaAs cathodes are activated to negative electron affinity (NEA) by applying a thin layer of an alkali metal (esp. Cs) and an oxidant (eg. O_2). The activation layer may be inhomogeneous and/or deteriorate during operation due to interaction with residual-gas atoms or ion back-bombardment. The QE thus is position-dependent. A map of the QE can be measured by raster scanning the cathode surface with a laser to find the region with maximum QE which is best suited for beam extraction. A QE scan setup based on a piezoelectric mirror mount and a position sensitive feedback detector has been designed and installed. This contribution presents the design and characterization of the QE scan setup as well as results of the first performed QE scans at the activation chamber of Photo-CATCH.

*Work supported by DFG (GRK 2128 „AccelencE“, project number 264883531)

AKBP 2.5 Mon 12:45 E 020

High quantum efficiency magnesium photocathode for photoinjectors — •Rong Xiang, Jana Schaber, Jochen Teichert, Andre Arnold, Petr Murcek, Raffael Niemczyk, and Anton Ryzhov — Helmholtz Zentrum Dresden Rossendorf

To improve the quality of photocathodes is one of the critical issues in enhancing the stability and reliability of photo-injector systems. Magnesium has a low work function (3.6 eV) and shows high quantum efficiency (QE) after proper surface cleaning. This paper presents the investigation of alternative surface cleaning procedures, such as ps-laser cleaning, thermal cleaning and ion beam cleaning. The QE is able to be improved two magnitudes after the treatment.

AKBP 2.6 Mon 13:00 E 020

Na-K-Sb photocathodes for high brilliant electron beams — •Chen Wang[1,2], Sonal Mistry[1], Julius Kühn[1], and Thorsten Kamps[1,3] — [1]HZB, Berlin, Germany — [2]University of Siegen, Siegen, Germany — [3]Humboldt University of Berlin, Berlin, Germany

My PhD project aims to develop Na-K-Sb photocathodes for the Superconducting RF Electron Accelerator LABorotory (Sealab/bERLinPro) at HZB. The photocathode requires high quantum efficiency (QE) and long operational and dark lifetimes. To achieve these requirements, the QE as well as the thermal/ chemical stability of Na-K-Sb photocathode is being studied in the photocathode lab at HZB with spectral response and X-ray Photoelectron Spectroscopy (XPS). In this contribution, we will present the initial correlation between the chemical composition of Na-K-Sb and its QE and stability, as well as its failure mechanism during thermal degradation and oxidation.

AKBP 2.7 Mon 13:15 E 020

Development of a metal photocathode for the DESY SRF gun — •Chirag Banjare[1], Dmitry Bazyl[1], Klaus Floettmann[1], and Wolfgang Hillert[2] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]Universität Hamburg, Hamburg, Germany

DESY and its collaborators are working on future continuous wave (CW) operations of a superconducting radio-frequency (SRF) photoinjector for the European X-ray-free electron laser (EuXFEL). CW-mode operation in a photoinjector requires a sufficiently high quantum efficiency (QE) photocathode. Currently, semiconductor photocathodes are operated in pulsed mode for the Eu-XFEL. However, installing a semiconductor photocathode in the SRF gun cavity can increase the risk of contamination of the SRF cavity. Therefore, metal photocathodes such as copper, gold, or niobium, which are durable, air-stable, and have a lesser risk of contamination in the cavity, are preferable to semiconductor photocathodes. However, metallic photocathodes have a lower QE (10^{-5}) than semiconductor photocathodes. Thus, the engineering of metallic photocathode design from the backside and front side illumination for light absorption is studied. A subwavelength-sized rectangular nanohole array on the gold surface is modeled to excite surface plasmons. Using CST Studio and FDTD software, the attenuated total reflection (ATR) phenomenon in a thin metal prism and several other techniques are simulated to perfectly absorb the light in the ultraviolet to green spectrums. This phenomenon contributes to obtaining the high QE of metal photocathodes.