AKBP 17: Instrumentation III

Time: Thursday 17:30–18:45 Location: CHE/0183

AKBP 17.1 Thu 17:30 CHE/0183

Tracing Ionoacoustic Modulations of Broad Energy Distributions — •Alexander Prasselsperger, Felix Balling, Hans-Peter Wieser, Julia Liese, Anna K. Schmidt, Florian Schweiger, Ina Hofrichter, Katia Parodi, and Jörg Schreiber — LMU München, Fakultät für Physik - Medizinische Physik, Am Coulombwall 1, 85748, Garching

Modern laser-plasma based ion accelerators challenge particle detectors with very high beam intensities, strong EMP emission and tens of Hz repetition rates. This calls for new detector types for characterising ion-bunch characteristics. A first step towards this ambition is the ion-bunch energy acoustic tracing (I-BEAT) detector which measures the ionoacoustic signal generated by the energy deposition of energy-selected ion bunches in a water reservoir to reconstruct the incident energy spectrum [1]. Here we propose a new detector concept which expands the I-BEAT approach to arbitrary ion spectra by tracing ionoacoustic modulations of broad energy distributions (TIMBRE). By inserting modulator foils into the water reservoir the deposited energy distribution and the ionoacoustic wave are modulated which allows to reconstruct the ion spectrum on-line by measuring these modulations. The detector is placed within centimetre range behind the laser target to collect most of the accelerated particles. It inherently is EMP and saturation resistant and allows re-usability as the water reservoir does not suffer from major radiation damage. A minimum sensitivity to ion fluences of $\approx 10^4$ $protons/mm^2/bunch$ is predicted.

[1] D. Haffa et al. Sci. Rep. 9 (2019) 6714

AKBP 17.2 Thu 17:45 CHE/0183

Acoustic Measurement of the Energy Deposition of Heavy Ions in Water at 4°C — •Anna-Katharina Schmidt, Julia Liese, Alexander Prasselsperger, Felix Balling, Sonja Gerlach, Martin Speicher, Walter Assmann, and Jörg Schreiber — LMU München, Fakultät für Physik - Medizinische Physik, Am Coulombwall 1, 85748 Garching

Energy deposition of ions in water leads to the emission of a pressure, i.e. ionoacoustic wave. It is commonly described in the thermoacoustic approximation, that is, localized heating and volume change is considered as prime cause of the wave. If this was true, no pressure wave is expected at 4°C, which was indeed observed after localized absorption of light. Contrary, when initiated by protons, this minimum is shifted to significantly higher temperatures of around 4.5°C, hinting towards an additional, non-thermal excitation mechanism that has not yet been understood and is referred to as "charge effect" in the literature [1]. We want to investigate this effect, which as of today lacks an explanation, experimentally for femto-second laser induced water plasmas and heavy ions with higher charge than protons for the first time by measuring the polarity change of the pressure wave around the water anomaly at 4°C. Understanding the non-thermal effects has potential implications for completely new measurement principles, could open up new insights into the fast, pre-thermal processes and even help classifying the relevance of mechanically induced radiation damage.This work is supported by GSI-LMU F&E cooperation LMSCH2025.

[1] R. Lahmann et al. Astroparticle Physics 65 (2015): 69-79.

AKBP 17.3 Thu 18:00 CHE/0183

Characterization of low-density gas targets for wake driven plasma field using high harmonics — •Piet Leyendecker, Marc Osenberg, Dirk Hemmers, Bastian Hagmeister, and Georg Pretzler — Institute of Laser- and Plasmaphysics, University Düsseldorf

Low-density gas jets are a crucial part for wake driven plasma accelerators. Measuring the spatial and temporal density profile is challenging with common methods. Fortunately, the used gases have high and varying absorption rates in the XUV. Using high harmonics, we can detect the absorption for different wavelengths simultaneously. This method allows to determine the gas density even for hydrogen and helium down to the $10^{17} cm^{-3}$ regime. In this talk we will discuss the setup and challenges for this rarely used method, and we show actual results.

AKBP 17.4 Thu 18:15 CHE/0183

Time-Resolved Interferometric Measurement of Ultrasound Pulses in Water — •Julia Liese, Anna-Katharina Schmidt, Alexander Prasselsperger, Jens Hartmann, and Jörg Schreiber — LMU München, Fakultät für Physik - Medizinische Physik, Am Coulombwall 1, 85748 Garching

Current development in laser-driven ion acceleration demands for reliable techniques for ion beam monitoring. The ultra-short and intense ion bunches with a broad spread in energy are a challenge for conventional beam detectors. Our group recently presented a new approach for online detection of laser-accelerated ions referred to as Ion-Bunch Energy Acoustic Tracing (I-BEAT) [1]. This method is based on measuring the pressure pulse induced by ions stopping in water with piezoelectric transducers. Here, we investigate an optical method based on measurements of the refractive index change associated with the pressure pulse by femtosecond laser pulse probing. In contrast to transducer measurements, we can thus study the volume of the pressure pulse origin directly. To this end, an interferometric setup was tested in first experiments with ultrasound pulses generated by a piezoelectric transducer. Experimental results show temporally resolved images of the ultrasound pulse and reveal characteristics of the ultrasound pulse in agreement with theory. Within an ongoing project funded by the DFG (491853809), the pressure waves originating from laser-accelerated ions will be investigated optically to facilitate new insights into the fast dynamics of ion energy deposition.

[1] D. Haffa et al., Sci. Rep. 9 (2019), 6714.

AKBP 17.5 Thu 18:30 CHE/0183

Analysis of Real Materials for the RF Window of a GHz Transition Radiation Monitor — •Stephan Klaproth[1,2], Herbert De Gersem[2], and Andreas Penirschke[1] — [1]Technische Hochschule Mittelhessen, Friedberg, Hessen — [2]TU Darmstadt, Darmstadt, Hessen

State of the art measurement devices for longitudinal beam profiles typically include Feschenko monitors, Fast Faraday Cups, and field monitors. A novel approach of a GHz diffraction radiation monitor is able to non-destructively measure the longitudinal charge distribution of each micro-bunch within a bunch-train of a heavy ion beam. In this contribution, we compare several vacuum-grade, dielectric materials for the monitor's rf window aiming at signals as strong and well distinguishable as possible with beam energies of $\beta = 0.05$ to 0.75. To achieve this, numerical field simulations were performed with CST Particle Studio® to investigate the influence of different window materials on the signal strength.