Development of the I-BEAT: Ionoacoustic diagnostic for laser-driven ion sources

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The properties of laser accelerated ion bunches demand for the development of suitable equipment for beam diagnostics. Especially the short and intense particle pulses with a broad energy spectrum emitted in conjunction with a strong electromagnetic pulse (EMP) are an unmet challenge to well established monitoring systems. A new approach based on measuring the acoustic signals of particles depositing their energy in water, referred to as Ion-Bunch Energy Acoustic Tracing (I-BEAT), allows online detection of single, focused proton bunches while being cost effective and EMP resistent.

The I-BEAT set-up is based on a single transducer detecting the ionoacoustic signal of the particles. The measured signal contains information about the particles energy distribution, intensity and spot size. Making use of the iterative reconstruction algorithm simulated annealing, complex energy spectra typical for laser accelerated ions can be resolved [1]. To enable the complete three dimensional reconstruction of the Bragg peak, an extension of the I-BEAT set-up equipped with four transducer, referred to as I-BEAT 3D, is presented. A quick evaluation algorithm allows for the online evaluation of spatial and spectral parameters. First experiments show improvements in calculation time and promising results in terms of beam size and position.

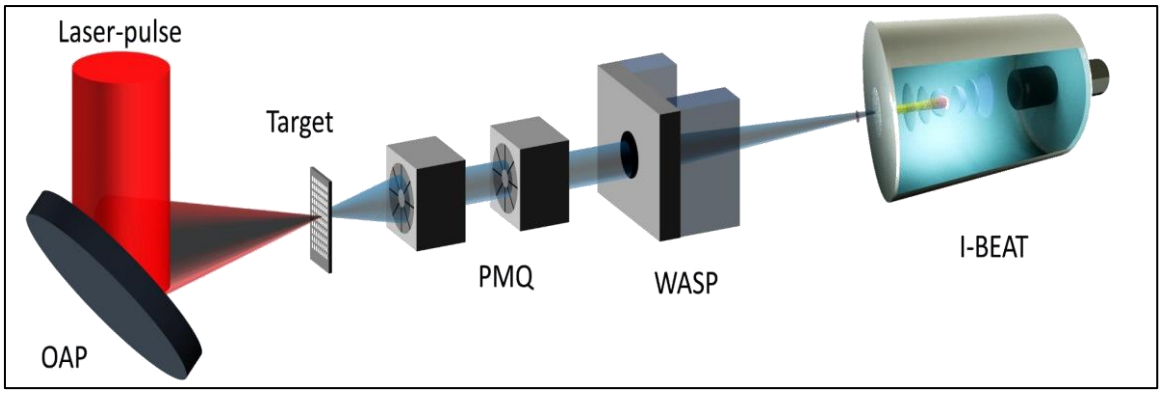

Figure 1: Schematic drawing of the I-BEAT integrated in a beamline for laser accelerated ions. The laser pulse is focused via an off-axis parabolic mirror (OAP) onto a target, from which the ions are accelerated. Two permanent magnet (PMQ) are installed to focus the ions and and a wide angle spectrometer (WASP) filters out electrons and low energy particles. The ionoacoustic signal of the particles in the I-BEAT detector is recorded with a transducer (visible in black).

[1] Haffa D, *et al.*, I-BEAT: Ultrasonic method for online measurement of the energy distribution of a single ion bunch, Sci. Rep., **9** (2019), p. 6714.