Experience with the Superradiant THz User Facility Driven by Quasi-CW SRF Accelerator at ELBE

M. Bawatna[1], B. Green[2]

[1] Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany
[2] Magnet Science & Technology, Tallahassee , FL, USA

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Motivation

Instabilities in beam and bunch parameters, such as bunch charge, beam energy or changes in the phase or amplitude of the accelerating field in the RF cavities can be the source of noise in the various secondary sources driven by the electron beam. Bunch charge fluctuations lead to intensity instabilities in the superradiant THz sources [1]. The primary electron beam driving the light sources has a maximum energy of 40 MeV and a maximum current of 1.6 mA [2]. Depending on the mode of operation required there are two available injectors in use at the ELBE. The first is the thermionic injector, which is used for regular operating modes and supports repetition rates up to 13 MHz and bunch charges up to 100 pC. The second is the SRF photocathode injector, which is used for experiments that may require lower emittance or higher bunch charges of up to 1 nC [3]. It has a maximum repetition rate of 13 MHz which can be adjusted to lower rates if desired, also including different macro pulse modes of operation. In this contribution, we will present our work in the pulse-resolved intensity measurement that allows for correction of intensity instabilities..

Pulse-resolved intensity monitor @ TELBE

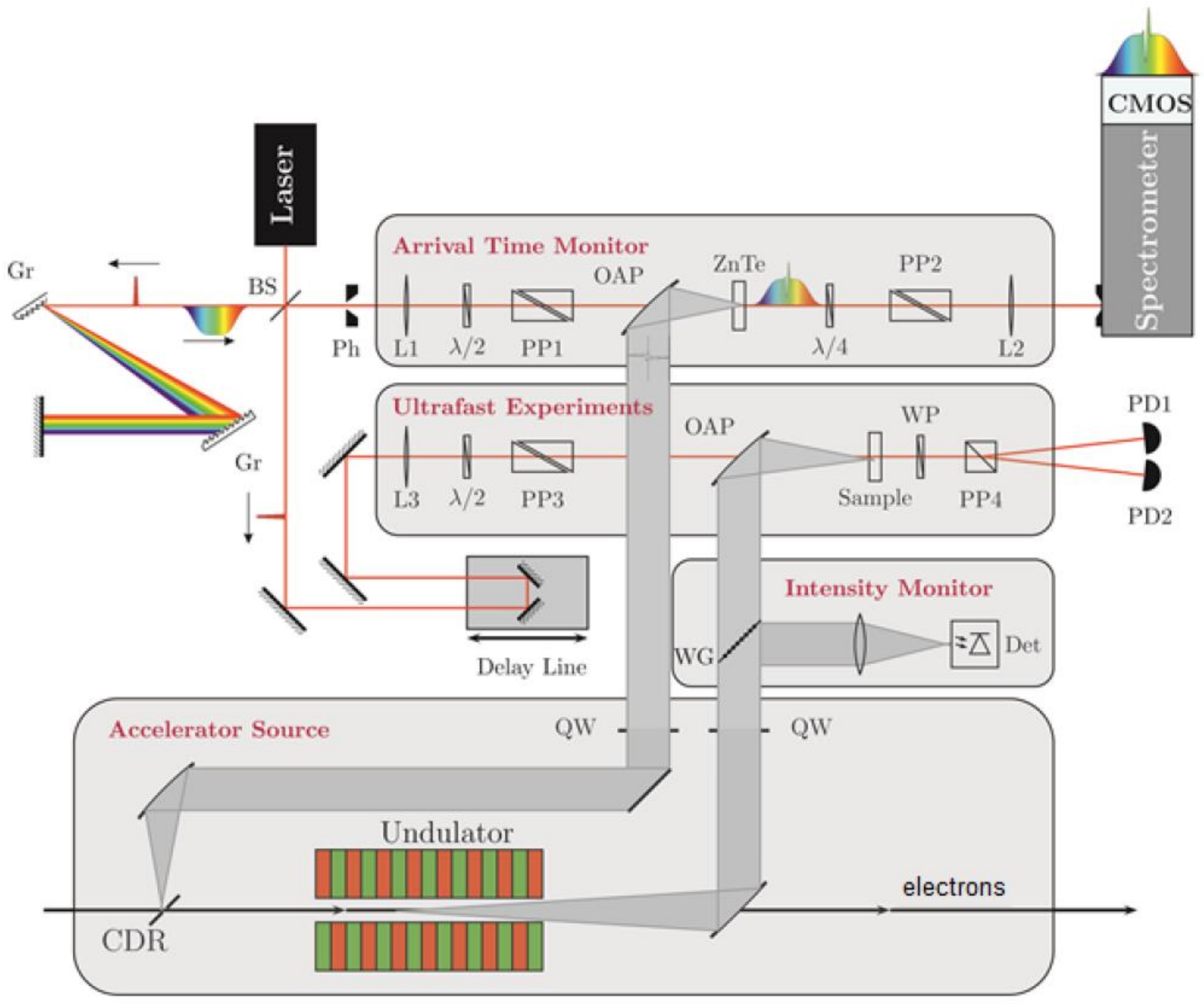


Fig 1. Schematic diagram of the developed pulse-resolved diagnostic at the TELBE facility, combining a 30 fs (FWHM) resolution arrival-time monitor with a pulse intensity monitor

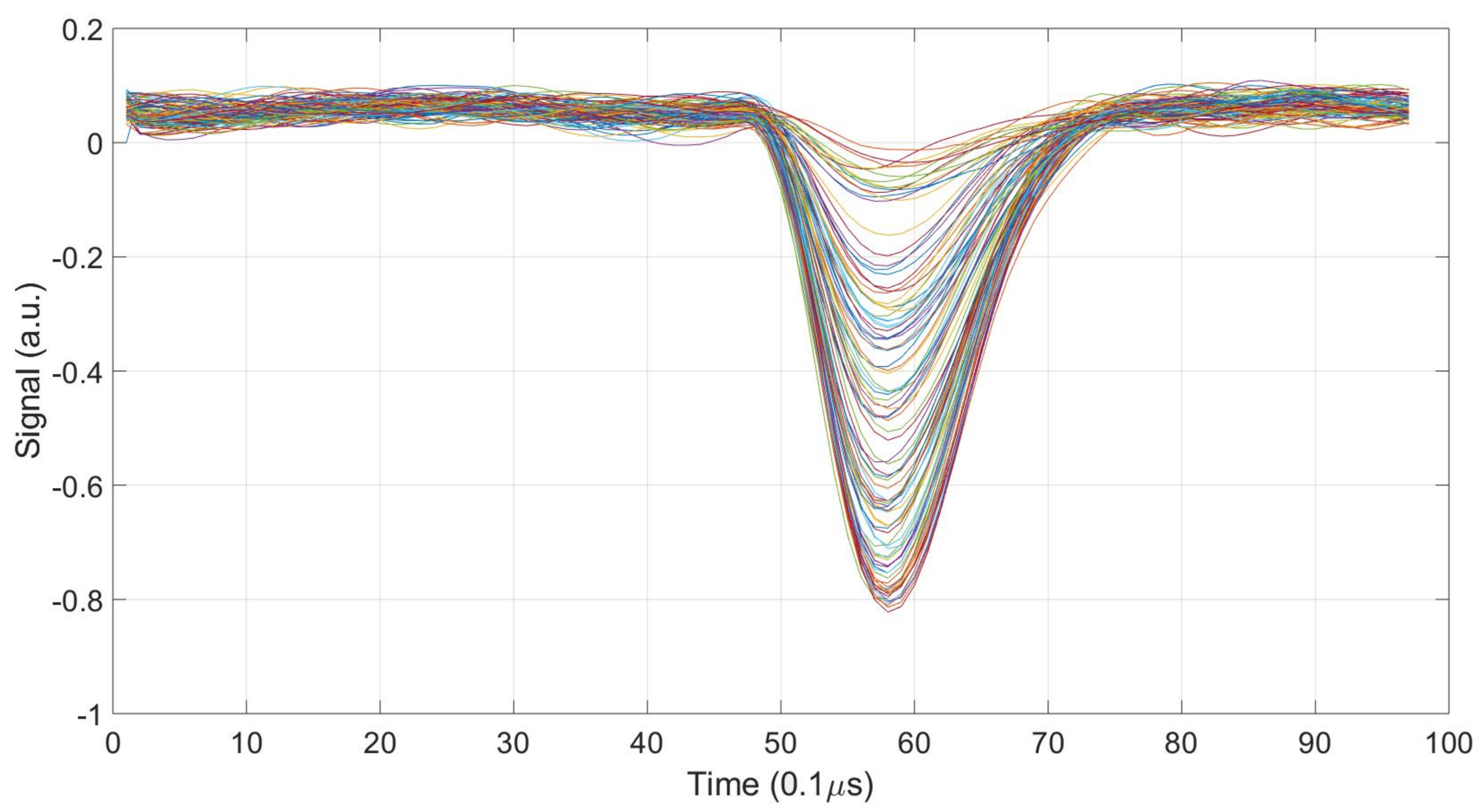


Fig 2. Signal measured by the pyroelectric detector that shows the intensity fluctuation for 10000 THz pulses.

Intensity fluctuation Measurements

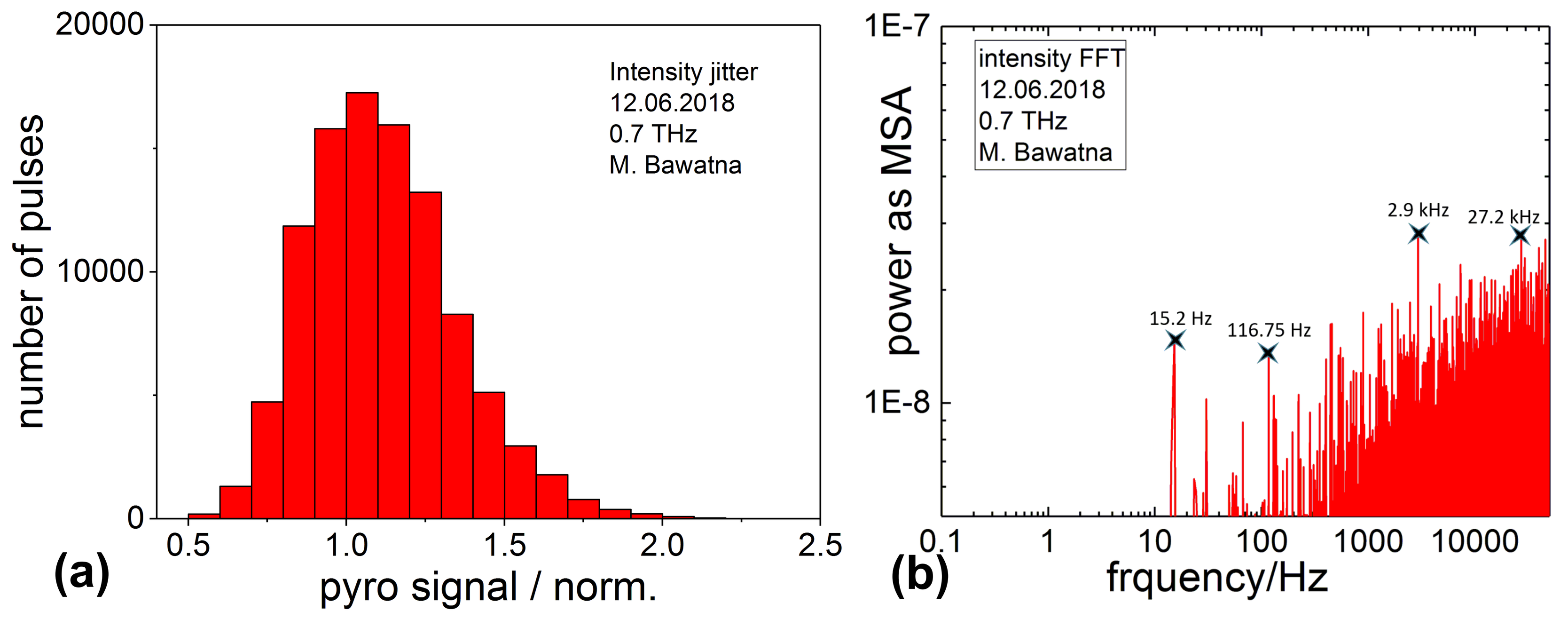


Fig 3. THz pulses Intensity fluctuation measurements at TELBE by the pyroelectric detector, taken over 1 second: (a) Histogram of the change in intensity of pulses from the TELBE undulator source. (b) Spectrum of the fluctuations in the beam intensity of the undulator pulses at a 700 GHz tune.

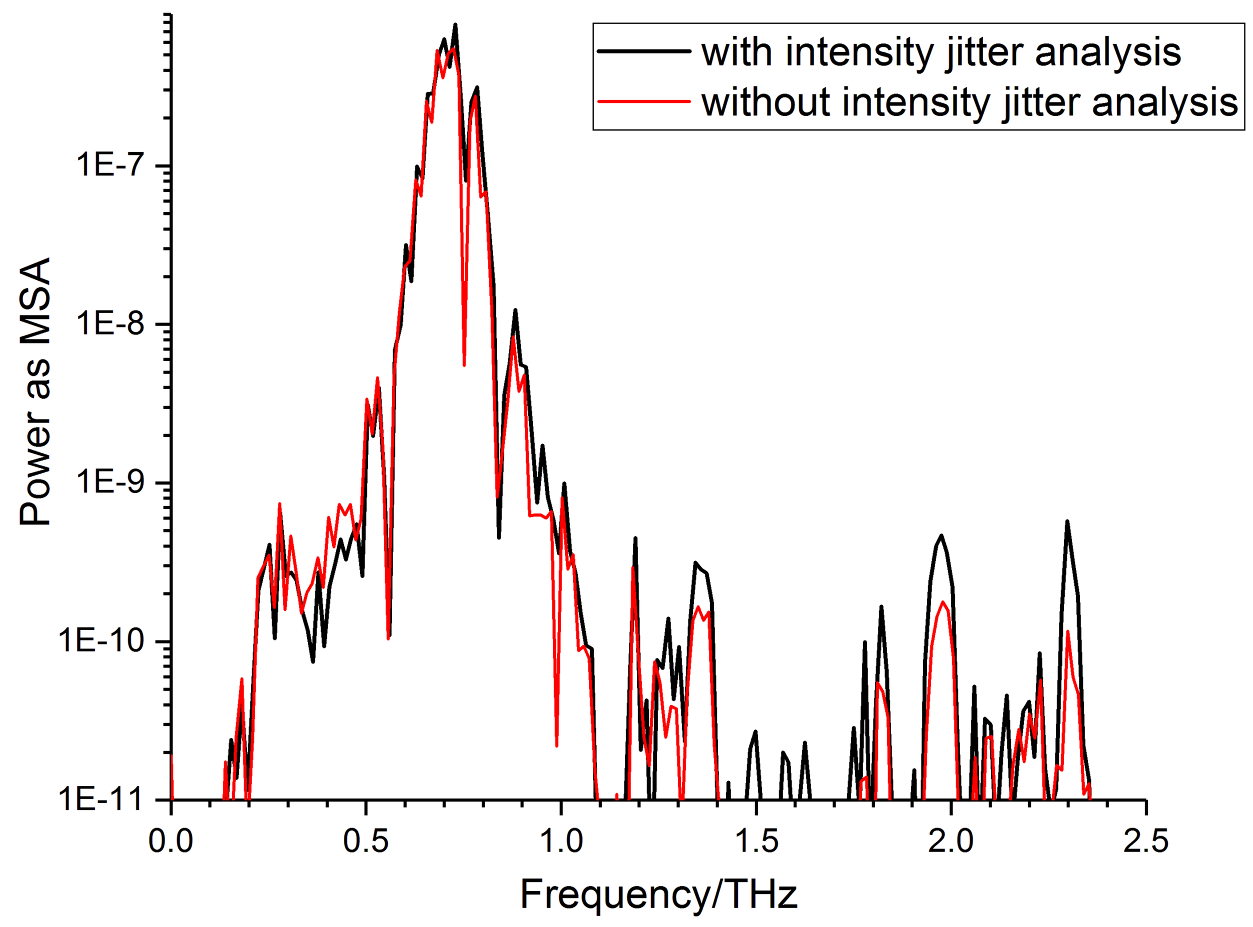
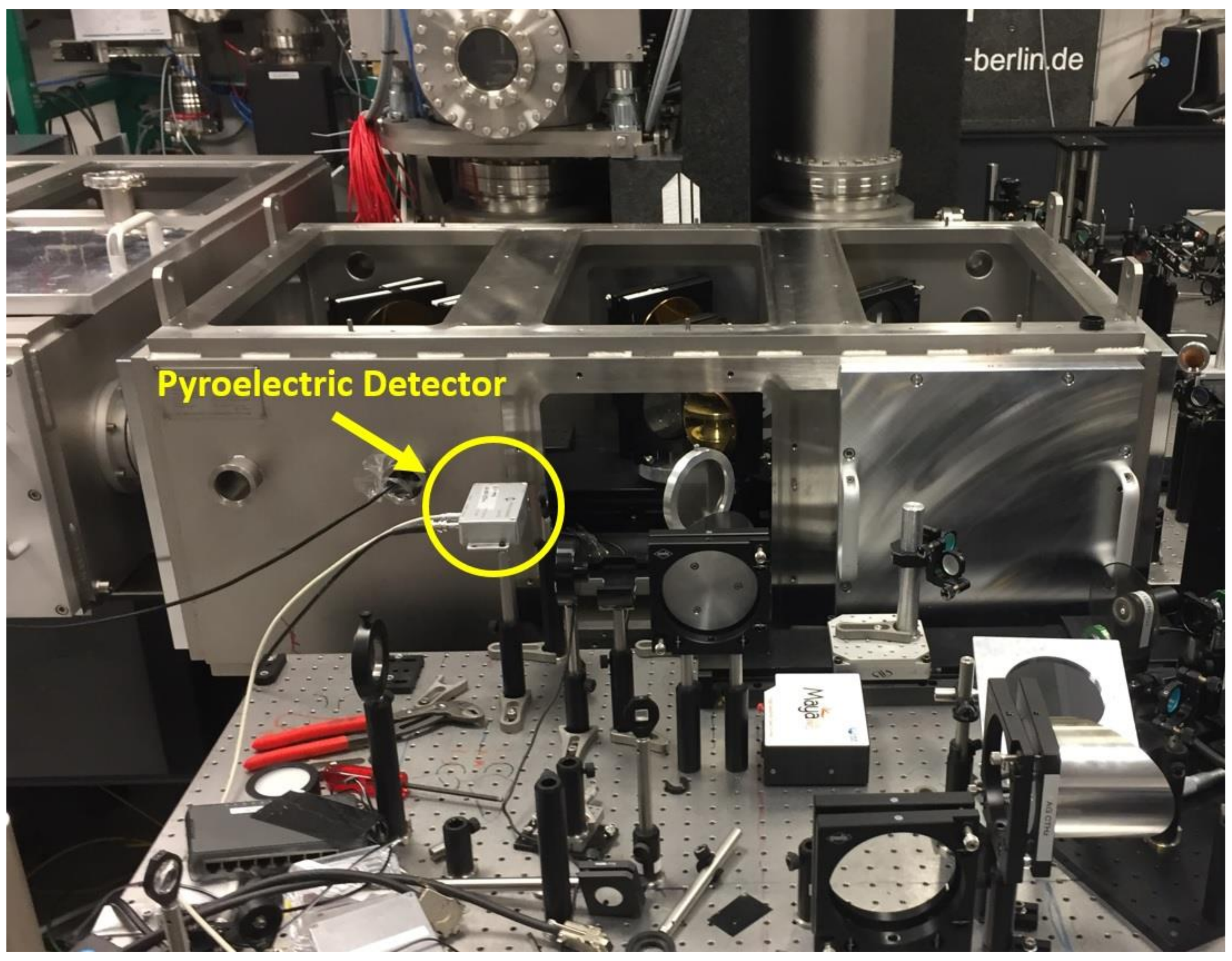


Fig. 4 Fourier transform of the signal measured by electro-optic sampling at 700 GHz tune with including the pulse-resolved intensity measurement into the data analysis.



OUTLOOK & next steps

- In this poster the determination of the pulse-resolved intensity fluctuations serves to correct for them in experimental data. Moreover, these instabilities in pulse energy can be harnessed to provide a pulse-energy-resolved measurement utilizing the intensity fluctuations as fast modulation of the pulse intensity.

References:

[1] B. Green et al., Sci. Rep., 6:22256, 2016.
[2] ELBE. Pulsed injector, 2016. URL https://www.hzdr.de/db/Cms?pNid=971.
[3] J. Teichert et al., Nucl. Instr. Meth. Phys. Res. A, 507:354, 2003.