Electron acceleration for X-ray sources – Comparison of experiment and numerical simulations

S. Karsch,1,2 M. Gilljohann,1 J. Wenz,1 K. Khrennikov,1 M. Heigoldt,1 A. Popp,1 A. Buck,2 J. Xu,2 L. Veisz,2 R. Weingartner,1 M. Fuchs,1 S.-W. Chou,3 J. Vieira,3 L. O. Silva,3 S. Schleede,4 M. Bech,4 P. Thibault,4 F. Pfeiffer4

1Ludwig-Maximilians-Universität München, Garching, Germany
2Max-Planck-Institut für Quantenoptik, Garching, Germany
3GOLP, Instituto Superior Technico, Lisboa, Portugal
4Technische Universität München, Garching, Germany

We investigated Laser-Plasma accelerated electron beams for use as drivers for various free-electron X-ray sources, such as undulator sources, betatron X-rays and Compton backscattering sources. The beams were accelerated from gas jets or gas cells using the 60 TW ATLAS Ti:Sa laser at MPQ, and comprehensively characterized with regards to spectrum, pulse duration and transverse emittance. A good shot-to-shot stability of the electron beam parameters is evident from the data and is prerequisite for statistically accurate results. In addition, the X-ray source characteristics are presented to demonstrate their compatibility with the electron measurements.

2-D and 3-D PIC numerical modelling for LWFA acceleration under our experimental conditions was carried out to understand the details of the experimental findings. Some discrepancies, mainly in the way that PIC codes reproduce injection into a wakefield, will be discussed, as well as the sensitivity of LWFA to deviations from the ideal laser and plasma parameters. We will also present checks to the PIC method that were performed in order to understand these issues.