Contribution ID: **107** Type: **not specified**

Picosecond narrow bandwidth X-ray pulses from a Laser-Thomson-Backscattering source

Thursday, 27 September 2012 16:30 (15 minutes)

Intense ultra-short hard X-ray pulses can serve as a novel tool for structural analysis of complex systems with unprecedented temporal and spatial resolution. With the simultaneous availability of a high power short-pulse laser system it provides unique opportunities for a number of subsequent research steps at the forefront of relativistic light-matter interactions. At HZDR we demonstrated the generation of such a light source (PHOENIX) by colliding picosecond electron bunches from the ELBE linear accelerator with counter-propagating femtosecond laser pulses from the 150 TW Draco Ti:Sapphire laser system. The generated narrowband X-rays are highly collimated and can be reliably adjusted from 5.5 to 23.5 keV by tuning the electron energy (24 MeV to 30 MeV) and the laser intensity. Ensuring the spatial-temporal overlap at the interaction point and suppressing the Bremsstrahlung background we have achieved a signal to noise ratio of greater than 300. Together with the use of an X-ray camera to record the spectrum (resolution of 250 eV FWHM) we were able to resolve the angular-energy correlation and to study the influence of the beam emittance on the observed bandwidth. Besides the use of the thermionic gun we also collided electron bunches generated from an SRF photo-injector. Here we detected a few orders of magnitude higher Bremsstrahlung background from the machine dark current. By carefully subtracting the background we extracted the X-ray spectrum whose peak overlaps with the one from the thermionic as expected for the same electron energy.

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Session Classification: S5.1 Nouvel sources: PXR&TR&FEL&Plasma

Track Classification: Novel sources: PXR&TR&FEL&Plasma