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Laser systems for the low emittance injector of the future SwissFEL X-ray source

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Future free-electron laser (FEL) light sources based on LINAC are demanding high quality electron beams for X-ray production. The SwissFEL laser group at Paul Scherrer Institute at PSI is working on the development of photo-injector laser systems and cathode studies to achieve the lowest possible emittance both in transverse and longitudinal planes and to meet the requirements for the future SwissFEL electron source [1,2]. The group is also responsible for delivering THz sources and pump lasers for the experimental stations of SwissFEL.
The currently operating SwissFEL Test Injector Facility is delivering 250MeV electron bunches with up to 200pC charge at 10Hz repetition rate, with a compression scheme downstream the booster cavities. The requirements for the laser, in order to achieve low emittance, include wavelength tuneability of the source to lower the intrinsic (thermal) emittance from the copper cathodes used [3], as well as transverse and longitudinal shaping of the laser beam to reduce space charge induced emittance degradation. For the production of ultrashort X-ray pulses stability of the laser system is crucial [4]. Synchronization of the laser pulses to the machine RF system with extreme high accuracy of 40fs is required. A terawatt class Ti:Sapphire oscillator followed by chirped pulse amplifier system provides the primary synchronized source and allows for ˜25nm tuneability range at the 3rd harmonic (˜260nm) [5]. An optical parametric amplifier together with frequency mixing stages added to the system enables larger tuning range for thermal emittance studies. The broad bandwidth of the Ti:Sapphire amplifier system also supports the temporal shaping requirements for the injector and with a stacking scheme based on birefringent crystals, delivers 4 and 10 ps nearly flat-top temporal profile in the deep-UV with sub-ps rise- and falltime. A second, directly diode pumped Nd:YLF laser system provides the backup for operation, and is limited to Gaussian pulse shapes. In the future a hybrid fiber-solid-state system is considered.
The presentation will give a general overview of the group's work on the gun lasers with a focus on recent studies of emittance optimization via laser wavelength tuning. Laser and electron-beam based measurements of timing jitter will also be discussed.

[1] SwissFEL, http://www.psi.ch/swissfel/
[2] B. D. Patterson et al., New J Phys. 12, 035012 (2010)
[3] C.P. Hauri et al., Wavelength-tuneable UV laser for electron beam generation with low intrinsic emittance Proc. IPAC10 WEPD052, Kyoto, Japan (2010)
[4] B. Beutner, S. Reiche Sensitivity and tolerance study for the SwissFEL Proc FEL2010 WEPB17, Malmö, Sweden (2010)
[5] A. Trisorio et al. Ultrabroadband TW-class Ti:sapphire laser system with adjustable central wavelength, bandwidth and multi-color operation
Opt. Exp. 19, 21, pp. 20128-20140 (2011)

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