Joint DESY and University of Hamburg Accelerator Physics Seminar

Wednesday, 27.09.2017

(16:00 in Room 459/30b)

Stability and Performance Studies of the PITZ Photoelectron Gun

(PhD Defense)

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Abstract

The invention of free electron lasers (FELs) opened new opportunities for the investigation of natural phenomena. However, the operation of a FEL requires high energy, high peak current electron beams with very small transverse emittance which causes extreme requirements for the corresponding electron sources. Besides the high beam quality, the electron sources must have very high operational stability and reliability. One of the electron source types which satisfy FEL requirements is a photoelectron gun. Photoelectron guns combine photoemissive electron generation and direct acceleration in a Radio Frequency (RF) cavity. The Photo Injector Test facility at DESY, Zeuthen site (PITZ), was established as a test stand of the electron source for FELs like FLASH and the European XFEL in Hamburg.

The studies of the beam emittance at PITZ showed that the gun is able to produce electron beams with emittance even smaller than it is required by XFEL specifications. But the experiments on the emittance revealed discrepancies between expected gun behavior and observation, such as the difference in optimal parameters for the smallest emittance value, asymmetry of the transverse beam profile and the phase spaces. The work performed at PITZ includes preparation of several RF guns for their subsequent operation at FLASH and the European XFEL. RF conditioning of a gun cavity is one of the major steps of the preparation of a high brightness electron source required for modern FELs. A thorough procedure is applied to increase the peak and average RF power in the gun cavity, including an increase of the repetition rate and RF pulse length combined with a gun solenoid current sweep.

The main goals of this thesis are: (1) an attempt of deep understanding of physical processes taking place during operation of a photoelectron gun (conditioning process, parameters adjustments); (2) definition of operational problems sources and explanation of the experimentally obtained results in the gun behavior; (3) understanding of the differences between models used to describe the gun operation and the real device. Furthermore, this thesis considers a few key problems of the photoelectron gun implementation at European XFEL: the beam quality improvement, understanding of the beam production behavior and beam features that can have an effect on the output radiation and the gun performance stability at the nominal parameters for XFEL.

NOTE THE UNUSUAL DATE

W.Hillert, (Univ. HH), I.Agapov (MPY) and M.Vogt (MFL).

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