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PROGRESS OF THE EU-XFEL LASER HEATER*

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Abstract

We describe the technical layout and report the status of the installation of the undulator, optical and vacuum systems of the laser heater for the EUXFEL. The laser heater is a device to increase the overall X-ray brightness stability. This is achieved by an optical laser system which induce an additional momentum spread in the electron bunches to reduce micro-bunching instabilities.

INTRODUCTION

The momentum spread of the electron beam coming from the photo cathode in the EUXFEL accelerator is so small (cold beam) that the beam is prone to micro bunching instabilities. A proven way to overcome this is to increase the momentum spread with a laser heater.

In this device the cold electron beam is overlapped by a laser beam while travelling through an undulator magnet. The transversely oscillating electrons will then obtain additional momentum spread which subsequently is smeared out in a chicane [1-2].

The laser heater for EUXFEL is built up as an in kind contribution from Sweden. Technical details have been described in greater detail elsewhere [3]. Therefore only recent progresses regarding several key parts are discussed. These key parts include the IR-laser system generating the photons, vacuum routing system for transporting the photons down to the vicinity of the interaction region, undulator magnet (being the actual interaction region), electron beam vacuum system and support systems.

IR LASER SYSTEM

The laser system used for generating the IR photons has been delivered from the Max-Born institute during spring 2014 and is currently optimized for the photo-cathode gun by the DESY laser group. For the additional necessary IR amplifier, amplifying the pulses up to 50 µJ implementation is foreseen earliest January 2015.

LASER TRANSPORT VACUUM SYSTEM

The vacuum routing system is used for transporting the IR photons down to the interaction point ~40 m in an environment free from disturbing atmosphere. It consists of pipes, specially designed corners with mirror mounts, bellows, viewports, valves and pumps. The major fraction is ordered and partly delivered except for details where clearance from DESY is still awaited. Installation of the vacuum parts is foreseen in throughout the summer of 2014.

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UNDULATOR MAGNET

The laser and the electron beam interact within the 0.8 m long undulator where the resonant exchange of energy takes place. The magnet, which was ordered and designed by Kyma Technologia, is of Halbach type using NeBFe magnets. It has 10 periods of 74 mm length of which end periods are special in order to roughly compensate the field integrals. The peak field of the undulator of 0.3 T can be reached at a gap setting of 32 mm. The gap is adjusted by servo motors using a Beckhoff PLC controller that also handles the interlock system.

Figure 1: The undulator on the Hasylab magnetic test bench.

The magnet was delivered to XFEL in summer 2013 and went through acceptance tests in the Hasylab magnetic measurement laboratory. The field profile was measured using a Hall probe at different gap settings and both on and off-axis. The field integrals were measured with a stretched wire. Fig.1 shows the undulator on the test bench with the Hall probe scanning the magnetic field in the gap between the upper and lower yoke of the undulator. The box on the lower right contains the undulator control PLC system. The measurements verified those performed at the vendor prior to shipment, as can be seen from the field measurements in Fig.2. The magnet is waiting for installation in the XFEL injector building in storage.

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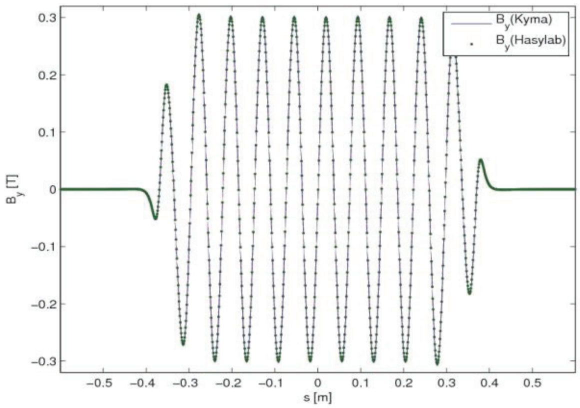

Figure 2: The vertical field in the undulator for a gap of 32 mm. Both the measurements at Hasylab and at Kyma are shown superimposed.

ELECTRON BEAM VACUUM SYSTEM

The vacuum chamber for the ~3 m, UHV accelerator beam line section is located in a magnetic chicane made up of four dipole magnets. It starts upstream just before the first dipole and ends just after the fourth dipole downstream (see Fig. 3-4). All the vacuum chambers are manufactured. The specified requirements regarding magnetic permeability <1.01, surface roughness and oxide layer thickness are challenging and final tests are currently in progress. The cleaning procedure includes reaching ISO5 level and doing mass spectrum analysis. Once approved by DESY the installation will be undertaken by the MVS group.

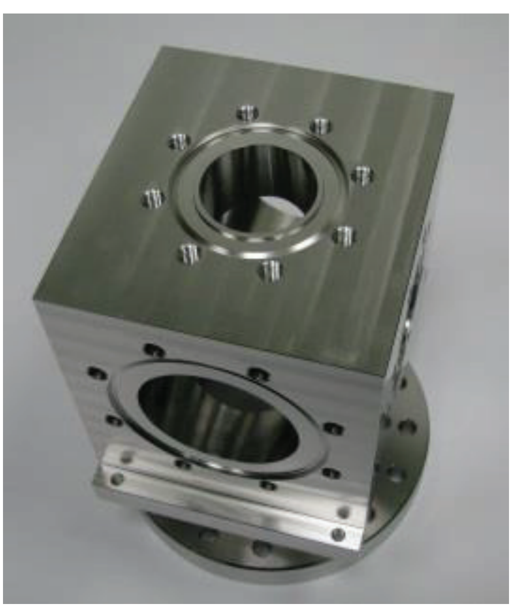

Figure 3: OTR-cross for electron beam vacuum system.

Figure 4: Inlet/outlet chamber for electron beam vacuum system.

STATUS AND OUTLOOK

Currently most structural hardware has arrived to DESY and await installation. The current strategy by the installation manager is to orient the installation of most hardware parts in September 2014. This will be followed by installation of PLC system and optics system, implementation and interfacing to the control system.

Commissioning follows in two stages:

1) Commissioning of optical components with the laser amplifier is foreseen from autumn 2015.
2) Full commissioning with SASE feedback during 2017.

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