FACILITY UPGRADE AT PITZ AND FIRST OPERATION RESULTS.

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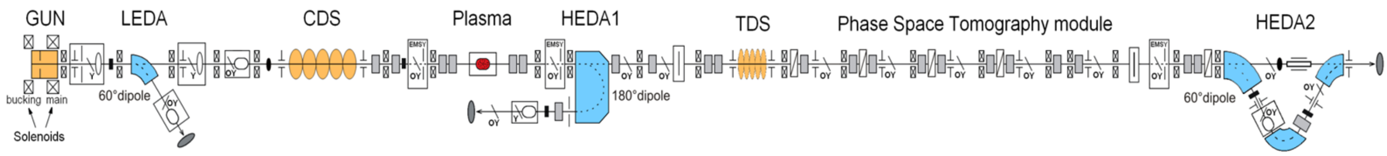
Facility upgrade goals

In the past, record low emittances at different charge levels were obtained at PITZ [1]. During the last two years, the PITZ facility was then mainly devoted to the preparation of RF guns for their later operation at FLASH and the European XFEL, with the main focus on operation stability, which is a critical issue for single-pass FELs.

In view of improving both, beam quality and operation reliability, the PITZ facility was significantly upgraded in the summer shutdown 2014.

The upgrade was realized with three main aspects:

- preparations for the installation of an additional, new laser system capable of producing 3D ellipsoidal laser pulses;
- installation of a new normal conducting RF gun cavity together with its new waveguide system for the RF feed, improving the stability and reliability of the gun operation, as required for the European XFEL;
- modifications of the PITZ beamline for improving the electron beam transport through the PITZ accelerator, extending the beam-based measurement capabilities, and preparing the installation of a plasma cell.

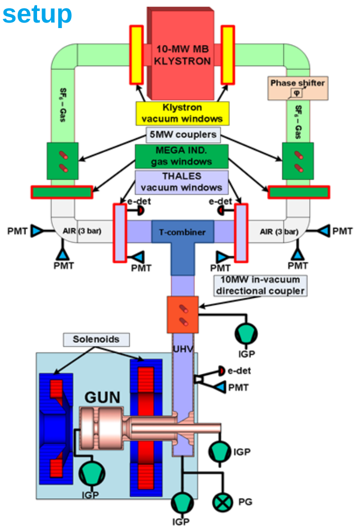


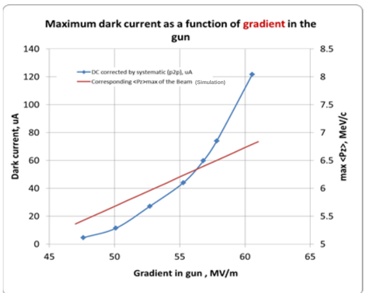
Layout of the current PITZ setup with the plasma chamber installed.

Gun 4.2 and the two-window setup

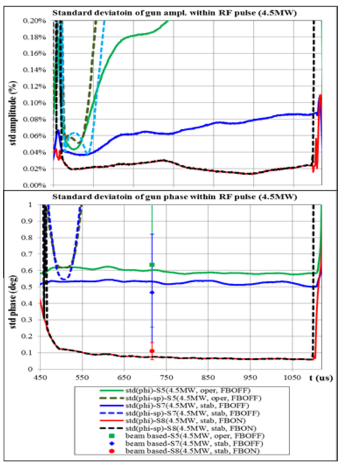
Gun 4.2, already used at PITZ and FLASH in the years 2008 to 2012 was mounted on a new setup together with two Thales RF windows. The use of two windows has the advantage that each window gets only half of the total RF power in the gun, which should help to avoid the destruction of this sensitive component observed in 2014 during the operation of different gun setups with a single Thales RF window, and increase the operation reliability.

The gun is in operation at PITZ since September 2014. After conditioning, long-term stability tests of the two-window gun setup and a dense beam measurement program including studies for the European XFEL have started.





Dark current studies for the European XFEL: depending on the performance of the dark current kicker which protects the super conducting modules, the transmitted dark current can limit the allowed max. gun gradient at the injector, e.g. 60 MV/m → 110 µA from the gun; 50 MV/m → 11 µA from the gun



Top: Gun IL and RF distribution scheme. Left: Amplitude and phase stability measurements with the new, µTCA based LLRF system

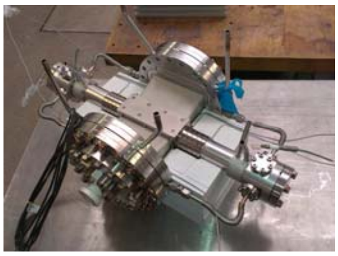
Preparations for the 3D ellipsoidal laser system

In order to further improve the electron beam quality delivered by the PITZ photo injector, a new laser system was taken into operation at PITZ (see contribution TUPWA47). In order to house this additional laser system, the laser hutch was completely re-arranged in the summer shutdown 2014.

Furthermore, since simulations [2] suggested a different optimum position of the post-accelerating cavity (CDS booster), the booster was moved towards the gun cavity. The position shift allows reaching lower emittance values due to a better envelope matching. In addition, some space is gained for the installation of a set of new quadrupole magnets needed for beam focusing into the plasma cell.

Plasma cell integration

As a proof-of-principle experiment for the AWAKE experiment at CERN, a plasma cell will be installed in the PITZ beamline with the goal to measure the energy modulation of an electron beam passing through the plasma [3]. During the year 2014, a plasma cell - basically a Lithium heat pipe oven with Helium buffers – was built. Coupling of the ionization laser happens through the side ports. In the summer shutdown, this ArF laser was installed and commissioned in a new lab. The plasma cell will be inserted into the PITZ beam line in May 2015 for the first experiments with electron bunches. At the same time, a transverse deflecting structure (TDS), which is the basic diagnostics tool for the plasma self-modulation studies, will be taken into operation.



The completed plasma cell. The big side ports allow the coupling of the ionization laser which generates the plasma channel at the center of the Lithium column and leave additional space for plasma diagnostics.

References:
[1] M.Krasilnikov et al., Experimentally minimized beam emittance from an L-band photoinjector, PRST AB 15, 100701 (2012).
[2] M.Khojoyan et al., Proc. IPAC'14, Dresden, Germany (2014).
[3] M.Gross et al., Preparations for a plasma wakefield acceleration (PWA) experiment at PITZ, NIM A740 (2014), pp. 74-80.

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