# Future plans at the Photo Injector Test Facility at DESY Zeuthen

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**Abstract**

The Photo Injector Test facility PITZ will be upgraded in 2004. Its main research goals are studies on the production and the conservation of low transverse emittance electron beams. The installation of an additional accelerating cavity is planned, which increases the beam energy from ~ 5 MeV after the gun to about 30 MeV after the booster. The goal is to produce and conserve a normalized transverse emittance of about 1 π mm mrad at 1 nC charge. For the characterization of the low emittance beam at higher beam energy, new diagnostics tools need to be installed. In this article, an overview about the layout of the upgraded facility and the planned physics activities is given.

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## 1. Introduction

The Photo Injector Test facility at DESY Zeuthen (PITZ) was built in order to test and optimize sources of high brightness electron beams for future free electron lasers and linear colliders. The focus is on the production of intense electron beams with small transverse and longitudinal emittance using the most advanced techniques in combination with key parameters of projects based on TESLA technology like TTF2, TESLA-XFEL and BESSY III.

The first photo electrons were produced at PITZ in January 2002. In the meanwhile, the existing electron source has been fully characterized and beam measurements have been presented at different conferences, see e.g. [1].

The second stage of PITZ (PITZ2) will start in 2004. It is a large extension of the facility and its research program. The concept of PITZ2 is to basically resemble TTF2 up to that critical beam energy where emittance becomes a constant of motion for the rest of acceleration. Thus, the PITZ studies on improvement of electron beam quality can readily be transferred to TTF2 and other facilities. In addition, PITZ will be able to study injector schemes beyond TTF2 demands, e.g. for TESLA-XFEL and BESSY III.

## 2. Emittance conservation and booster cavity

One of the main objectives of PITZ2 is the proof of the emittance compensation technique and its experimental optimization, since many future FEL proposals rely on this technique [2].

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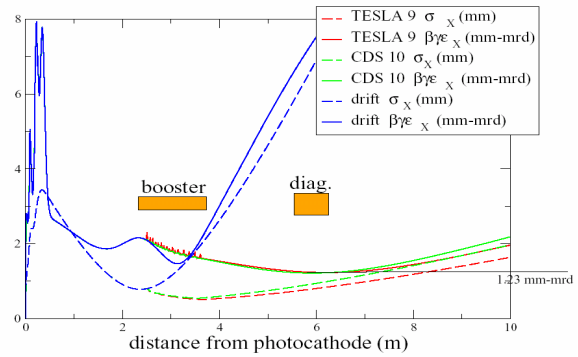


Fig. 1. Emittance conservation at PITZ2 with two different normal conducting booster cavities: TESLA-booster (red) and CDS-booster (green). The drift case (without booster) is shown in blue.

According to simulations, the minimum normalized transverse beam emittance can be conserved by locating a booster cavity at the position of the beam envelope waist, together with a proper choice of rf-gun and solenoid parameters (Fig. 1).

Since the booster plays such a significant role in the emittance compensation technique, it will be the key technical element of PITZ2. The experimental study will be done in two stages: first, a preliminary TESLA booster will be used. Later, it will be replaced by the CDS booster, being actually under development for PITZ, which will reach the final beam energy of up to 30 MeV.

## 3. Diagnostics Beamline

In order to provide a most complete characterization of the electron source at higher beam energies, a new diagnostics beamline will be needed. A number of new diagnostics elements have to be developed and installed, including devices that allow efficient and precise measurements of transverse and longitudinal phase space parameters as well as slice parameters for the full range of beam energies, see Fig.2.

## 4. Further plans

In order to obtain optimum electron beam parameters, a stable and reliable photo cathode laser system with flat-top temporal and transverse laser pulse shape has to be developed and installed. Further optimization of all subsystems requires extensive beam dynamics studies. It is foreseen to design and test a high duty cycle rf-gun, which is important for the operation of high repetition rate FELs and energy recovery linacs. The delivery of improved guns for the VUV FEL at TTF is also envisaged. In addition, studies on the improvement of photocathodes are planned.

PITZ2 will be realized by DESY in collaboration with BESSY Berlin, MBI Berlin and TU Darmstadt. Contributions from INFN Milan (cathodes), INR Troitsk (CDS booster), INRNE Sofia, and LAL Orsay (both diagnostics) are also included. First attempts to extend the collaboration have been started.

## 5. References

[1] M.Krasilnikov et al., "Characterization of the Electron Source at the Photo Injector Test Facility at DESY Zeuthen", paper to be published at FEL 2003.

[2] M.Ferrario et al. "HOMODYN study for the LCLS rf photo-injector", NLNF-00/004(P) and SLAC-PUB 9400, Contribution to the 2nd ICFA Advanced Accelerator Workshop, Los Angeles, November 1999. M.Ferrario et al., "Conceptual Design of the TESLA XFEL Photoinjector", TESLA-FEL 2001-3. L.Serafini "New perspectives and programs in Italy for advanced applications of high brightness beams", ICFA AABD Workshop, Chia Laguna, Sardenia, July 2002.

Fig. 2. Preliminary layout of PITZ2.