New Ellipsoidal Laser at the Upgraded PITZ Facility.

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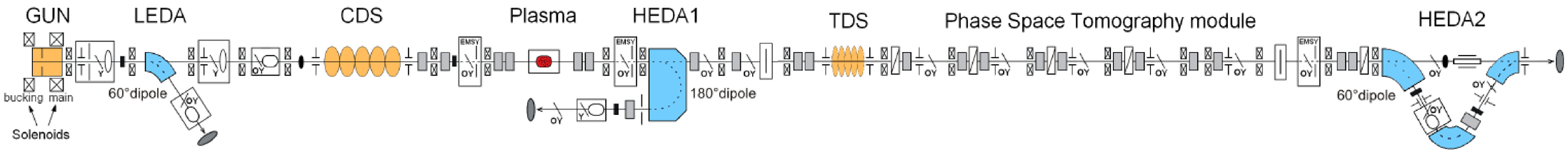
Abstract

Last year the facility was significantly upgraded with a new prototype photocathode laser capable of producing homogenous quasi-ellipsoidal pulses. Previous simulations have shown that the corresponding pulses allow the production of high brightness electron bunches with minimized emittance [1]. A laser system was developed in collaboration with the Institute of Applied Physics (Nizhny Novgorod, Russia) and the Joint Institute of Nuclear Research (Dubna, Russia).

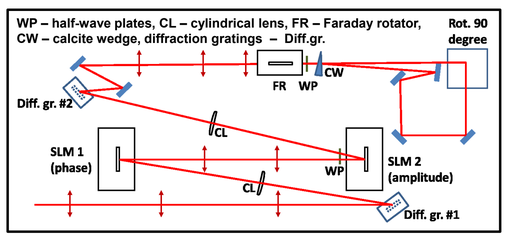
Furthermore, a new normal-conducting RF gun cavity was installed with a modified two-window pair RF feed layout for improved stability and reliability [2]. The supporting RF and water cooling systems for this gun were also improved. A detailed photoemission and emittance (see MOD04) measurement program was carried out. Finally, a new Transverse Deflecting Structure (TDS) (see MOP039) was installed and commissioned in July, and initial proof-of-principle experiments with a plasma cell for beam-drive plasma acceleration have begun.

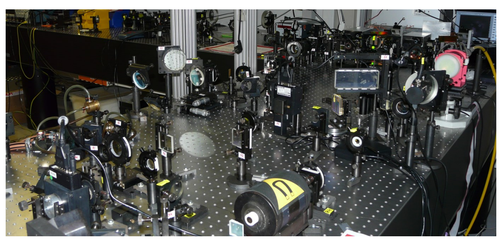


Above: Current PITZ beamline with TDS and Plasma Cell

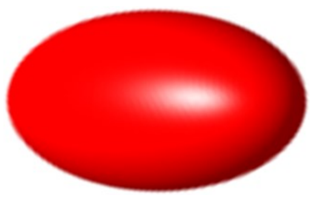
Quasi-Ellipsoidal Photocathode Laser System*

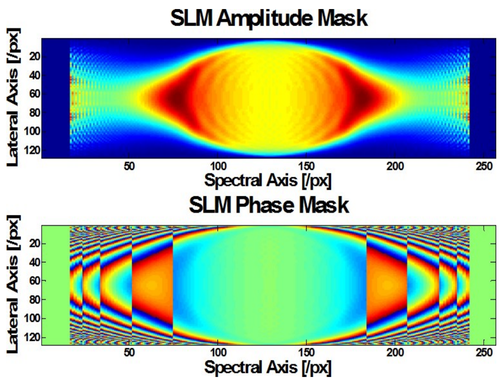
Double-pass spectral amplitude-phase masking technique





- Spectrally transformed chirped pulse imaged onto SLMs
- Frequencies modulated by separate amplitude/phase masks
- Pulse recombined, laterally rotated, and perpendicularly reshaped

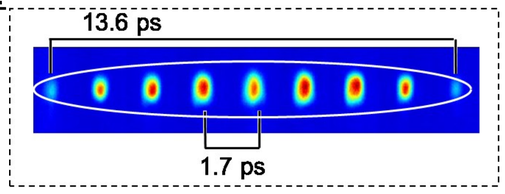




- **Frequency conversion crystals (2nd and 4th harmonics**

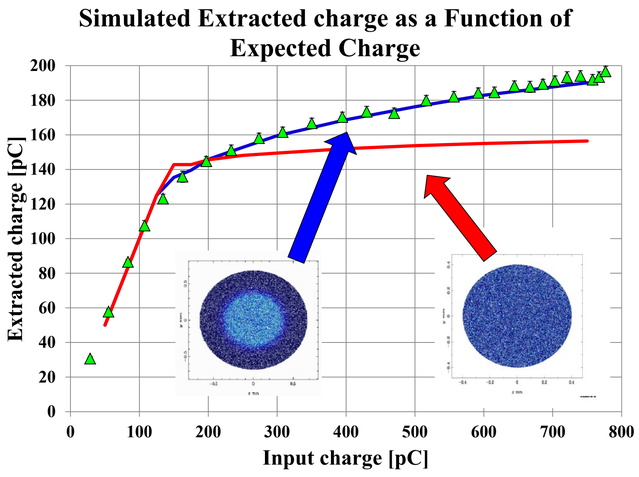
Characterization and optimization by:

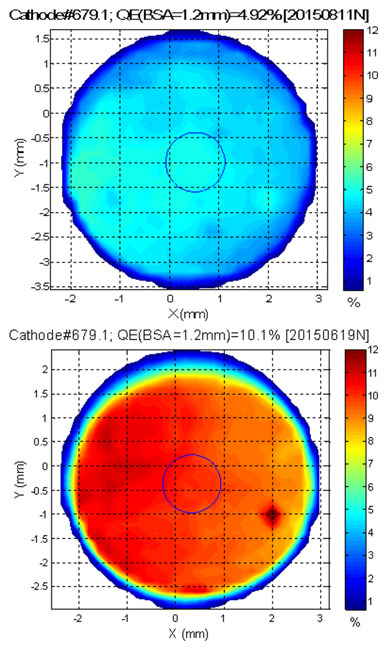
- IR cross-correlator coupled camera
- Future UV:IR cross-correlator [3]
- Electron beam diagnostics



Photoemission Studies

- Studies of quantum efficiency degradation over time
  - observable development of hot/cold spots
  - consistent across surface
- Photocathode laser core:halo investigation [4]
  - Improved radial beam profile taken from measurement
  - Full suite of comparative experimental data taken
  - Explanation for previous charge extraction behavioral discrepancies

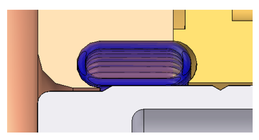




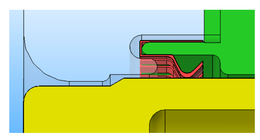
Above: QE maps taken over two months

Refurbished Gun 4.2 and RF Feed Layout

- Refurbished Gun 4.2 with re-machined backplane
  - Cathode spring updated to new contract stripe design

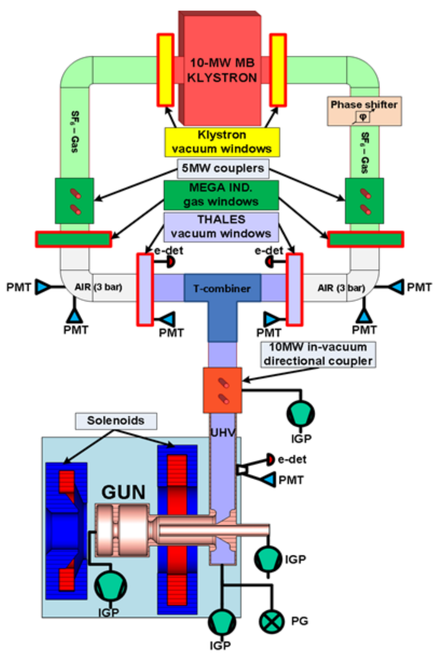


old watchband design



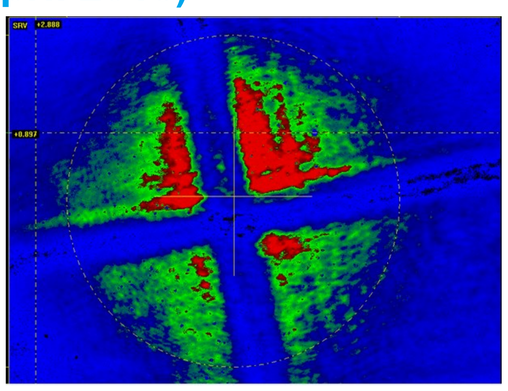
new contact stripe design

- RF feed (up to 8 MW) migrated from a single RF window layout [5] to a two-window setup [2]
- one 10 MW in-vacuum Thales window solution [5]
  - RF power now shared over two Thales RF windows
  - After conditioning, no problems anymore with the double RF window pair setup

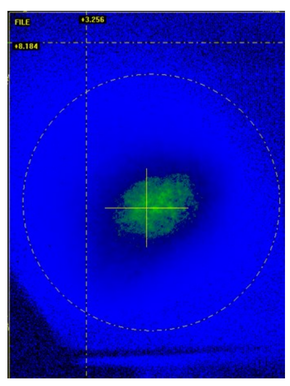


Above: PITZ two-window pair RF scheme

Experimental results (1st electrons generated in April 2015)



Top: Laser pulses imaged – by help of wire cross - onto the virtual camera (VC2)



Above: Electron bunch behind booster, imaged at camera High1Scr1 (5.74 m behind cathode)

References

[1] M.Khojoyan et al., Optimization of the PITZ photo injector towards the best achievable beam quality, Proc. FEL2014, Basel, Switzerland (2014).
[2] A. Oppelt et al., Facility Upgrade at PITZ and First Operation Results, IPAC'15, Richmond, VA, USA (2015).
[3] V V Zelenogorskii, Scanning cross-correlator for monitoring uniform 3D ellipsoidal laser beams, 2014 Quantum Electron. 44 76
[4] C. Hernandez-Garcia et al., "Studies on charge production from Cs2Te photocathodes in the PITZ L-band normal conducting radio frequency photo injector," in preparation, to be submitted to Phys. Rev. ST Accel. Beams
[5] M.Otevrel et al., Report on Gun conditioning activities at PITZ in 2013, Proc. IPAC'14, Dresden, Germany (2014).

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