High Quantum-Efficiency Electron Gun Tests at SSRL

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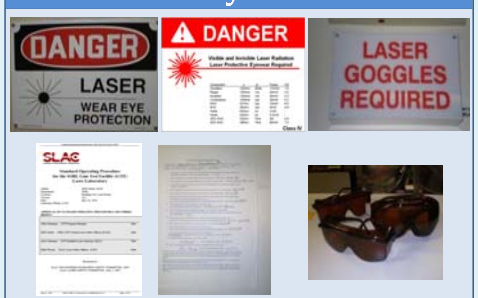
Introduction

Quantum efficiency of an electron gun can be increased by using laser-induced photo-emission. The gun cathode is normally heated to ~1000 C for electron emission and injection into the synchrotron light source. In these experiments, the cathode is cooled down and irradiated with ultra-violet laser radiation to produce emission with higher quantum efficiency. The result is an increase in shot-to-shot electron emission rate and better control over the electron beam size.

Method

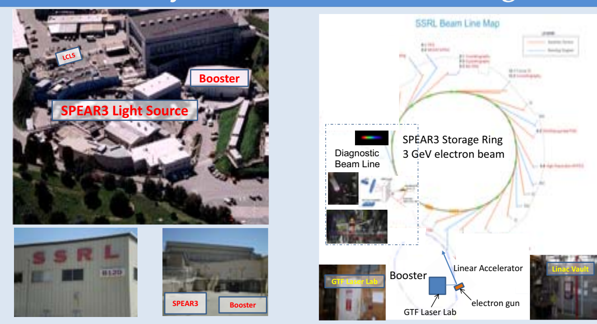
Two laser systems were commissioned to provide UV radiation in the Gun Test Facility (GTF). The first laser features an infrared Nd:glass laser frequency doubled to green light with a BBO crystal and doubled again to UV radiation. The second laser system features a 'JEDI' frequency doubled Nd:YAG laser borrowed from LCLS.

Safety First!



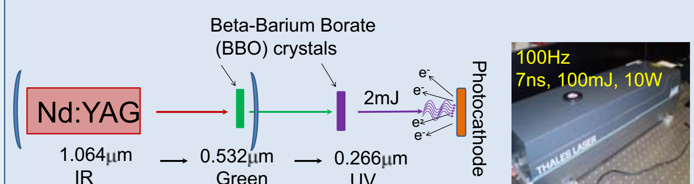
Qualified Laser Operator (QLO) for high power lasers needs extensive training

Stanford Synchrotron Radiation Lightsource



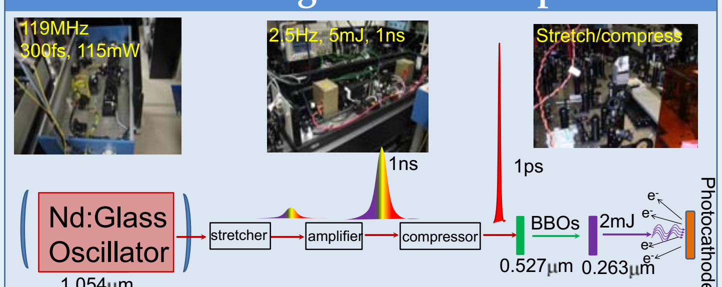
The Stanford Synchrotron Radiation Lightsource serves over 2,000 academic and commercial users annually.

JEDI Laser System



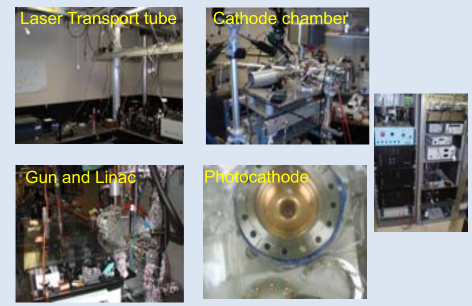
The Thales, Inc. 'JEDI' laser is used to drive the LCLS photocathode.
A second 'JEDI' laser system from LCLS is installed at the GTF to provide long-pulse durations for gun cathode tests.

Oscillator/Regenerative Amplifier



Chirped-pulse amplification (CPA) is used to produce high-power, short-pulse durations for gun cathode tests

Photocathode Test Stand



SSRL gun test facility investigates different cathode materials under laser irradiation at various photon wavelengths, pulse length and peak power.

Photocathode Emission

When photons strike the gun cathode, electrons are emitted by the photo-electric effect

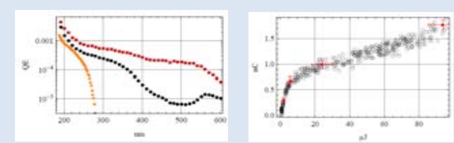


Photo-cathode quantum efficiency measurements. Photo-emitted charge vs. laser pulse energy
Black circles = cold cathode
Red squares = warm cathode
Orange diamonds = LCLS cold copper cathode.

Steve Gierman, et al, "Operating a Tungsten Dispenser Cathode in Photo-emission Mode", 23rd Particle Accelerator Conference, Vancouver, Canada, May 4-8, 2009

Discussion

During my summer internship, we commissioned two lasers to provide ultra-violet radiation on photo cathodes in the Gun Test Facility. Previous studies showed higher quantum efficiency can be obtained using UV radiation. Our work has helped to provide the necessary steps for this on-going research.
I learned a lot this summer working with top researchers at SLAC and added to my previous knowledge of laser physics. I also learned about accelerators and synchrotrons first hand and saw the value of accurate log books, effective collaboration and careful planning. I look forward to sharing this knowledge with my students in the classroom.

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