SLAC-PUB-11373
July 2005

LASER DEVELOPMENT FOR FUTURE PHOTOCATHODE RESEARCH AT SLAC [1]

A. Brachmann, K. Cone, J. E. Clendenin, E. L. Garwin, R. E. Kirby, D.-A. Luh, T. Maruyama, R. Prepost, and C. Y. Prescott

Stanford Linear Accelerator Center
2575 Sand Hill Road,
Menlo Park, CA 94025, USA
E-mail: brachman@slac.stanford.edu

This report summarizes results of recent upgrades to SLAC's polarized source drive laser system. A Q-switching system has been incorporated into the flashlamppumped Ti:Sapphire laser system. The Q-switched laser provides energies up to 5 mJ for a 200 ns long pulse. Slow Q-switching provides control over length and shape of the laser pulse. A peak current of > 5.5 A has been demonstrated using a GaAs photocathode illuminated by this laser system.

1. Introduction

Since 1993 a flashlamp-pumped Ti:Sapphire laser is used at SLAC polarized electron source. Details about this system and its modifications can be found in the literature [1]. This paper describes modifications of the laser cavity and summarized results of Q-switched operation. The motivation for this work was to increase the laser pulse energy available for photocathode research. An important aspect was to develop a system that provides flexibility for future photocathode research projects.

2. Laser Cavity Modifications

Two Pockel's cells have been introduced into the Ti:Sapphire cavity and allow controlled electro-optical switching of the stimulated emission. Figure 1 shows a scheme of the cavity layout.

One Pockel's cell is operated such that the HV pulse acts as an inhibitor of stimulated emission and thereby increasing the population of the upper lasing level. The amount of

[1] Polarized Electron Sources and Polarimeters International Workshop, Institute for Nuclear Physics, Mainz, Germany 10/07/2005-10/09/2005.
This work is supported by Department of Energy contract DE- AC02-76 SF00515.

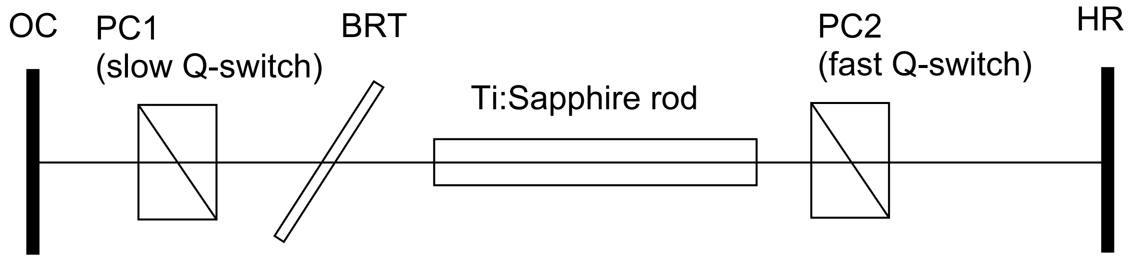

Figure 1: Scheme of Ti:Sapphire laser cavity; OC: output coupler, PC: Pockel's cell, BRT: birefringent tuner, HR: high reflector

stored energy can be controlled by HV pulse height and length and relative timing of flashlamp and Pockel's cell trigger. A second Pockel's cell is operated as a slow Q-switch by applying a ramped HV pulse. A programmable function generator determines the overall length and slope of the ramp. This allows controlled release of the stored energy. The result is a flexible system with adjustable energy, length and shape of the laser pulse. Also, concerns regarding optical damage can be addressed by controlled switching of the laser cavity. We performed a large number of experiments to determine the optimum operating conditions for the use of this laser system at our polarized source.

3. Results

Q-switched operation using only one Pockel's cell with a square switching pulse of 600 ns produced a 5 mJ pulse with a Gaussian temporal shape of ~ 200 ns FWHM. This is an increase of laser energy by one order of magnitude compared to un-Q-switched operation. Further energy increase is possible by extending the length of the `hold-off' pulse. To reduce the risk of optical damage of cavity components we decided not to explore laser energies above 5 mJ. A comparison of both operational modes is given in igure 2. The second Pockel's cell is used for slow release of the stored energy. A pulse length of ~ 1000 ns was achieved. Appropriate relative timing of the square `hold-off' and shaped `release' also allows temporal shaping of the pulse. Figure 3 illustrates the evolution of the pulse's profile when the timing of `hold-off' and `release' is varied with respect to each other. Initial experiments at our test facility result in an peak electron beam current in excess of 5.5 A. Figure 4 compares the performance of a strained GaAs cathode when used with standard and Q-switched laser system.

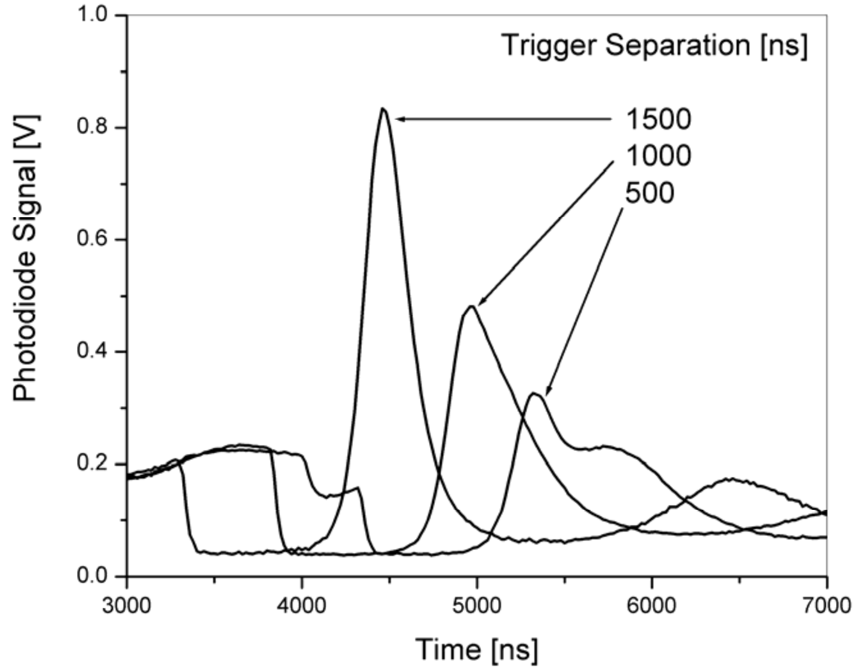

Figure 2: Temporal pulse shape comparison of Q-switched and un-Q-switched cavity.

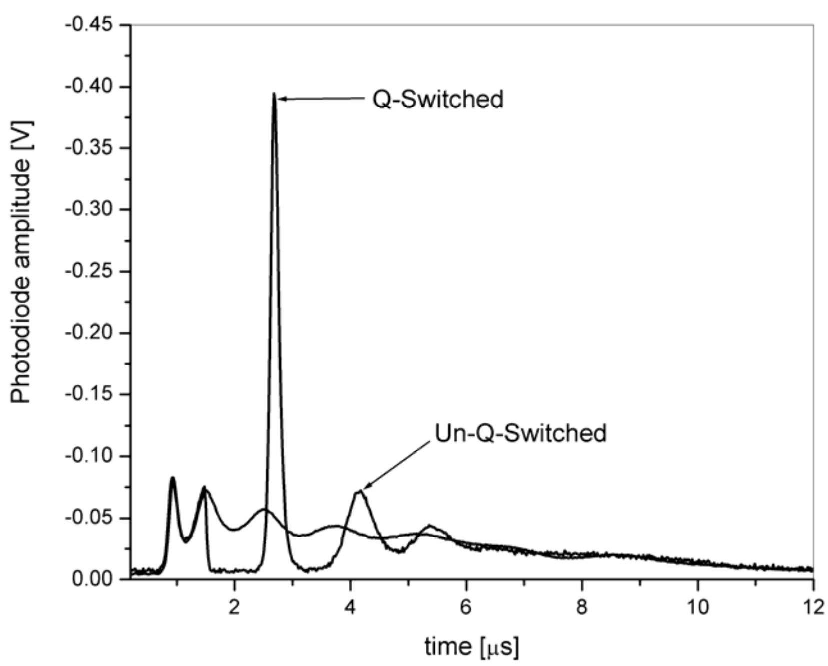

Figure 3: Illustration of temporal pulse shaping effect by separation of Pockel's cell trigger (PC1 and PC2).

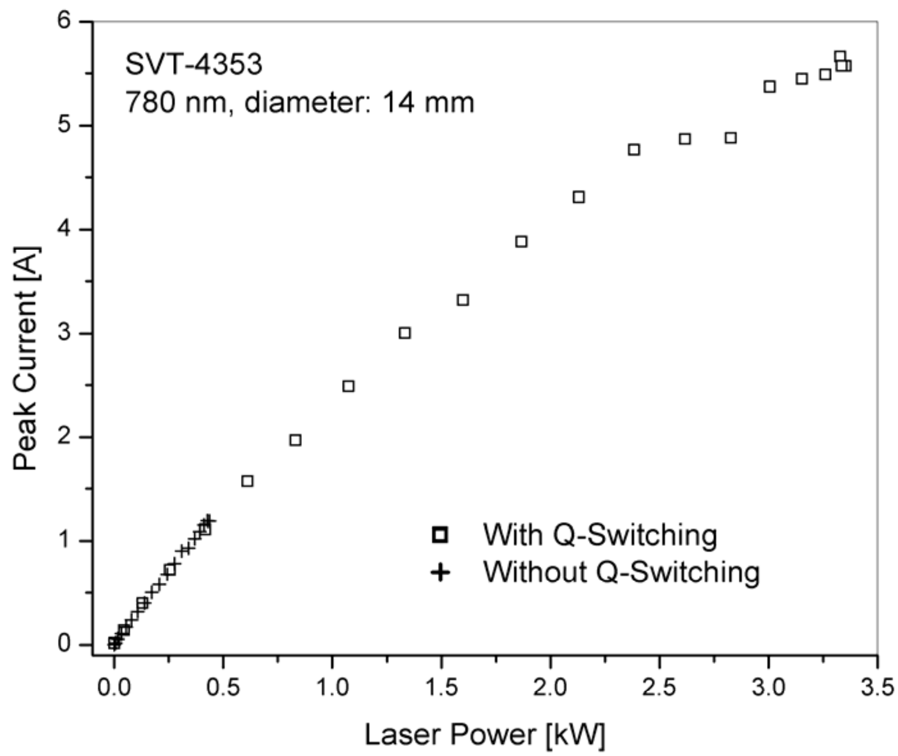

Figure 4: Cathode peak photo-current vs. laser power.

4. Summary

SLAC's flashlamp-pumped Ti:Sapphire polarized source laser has been successfully modified for Q-switched operation and provides pulse energies in excess of 5 mJ. A peak current of > 5.5 A has been extracted from a strained GaAs cathode. Appropriate timing of cavity Pockel's cells allows flexibility in pulse energy and shape.

References

[1] T. B. Humensky et al., *Nucl. Instrum. Meth.* **A521**, 261 (2004).