Performance improvements to the UCSD mirror test facility using an Oscillator - Amplifier Kr laser configuration

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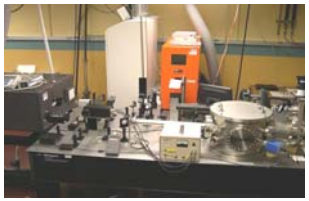
Objective

- To increase the energy available for UCSD Optics Damage Facility (200 mJ, 5ns (FWHM) and Smooth profile)

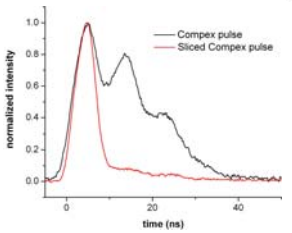


Present Laser Features

- Two KrF lasers available for mirror testing
  - a) Compex, 350 mJ, 10 Hz
  - b) LPX PRO, 600 mJ, 100 Hz
- Both the lasers produce un-polarized ~25 ns (FWHM) beams
- Nonuniformities in the laser spatial profiles

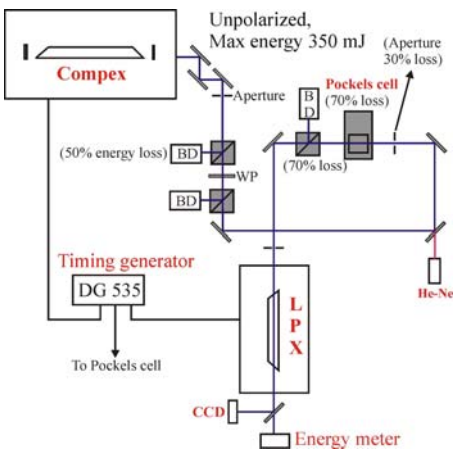
A Pockels cell provides 5 ns pulse width capability

- A Pockels cell is used for slicing a portion of laser Compex pulse.
- Pockels cell specifications:
  FastPulse Tech. Model 5046E
  Crystal material: DKDP (KD_2PO_4; >95% D_2)
  Aperture: 16 mm
- The slicing the pulse reduces the available energy to less than 1/3. The transmission of crystal used in the Pockels cell is found to be only 30% for 248 nm.
- With polarization optics, the available energy for mirror testing facility is again limited.
- An oscillator- amplifier configuration is necessary for obtaining high energy



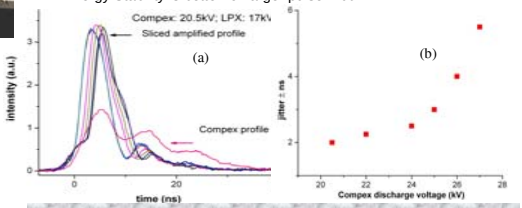
Compex pulse and sliced pulse using Pockels cell

Experimental Scheme for Oscillator-Amplifier KrF

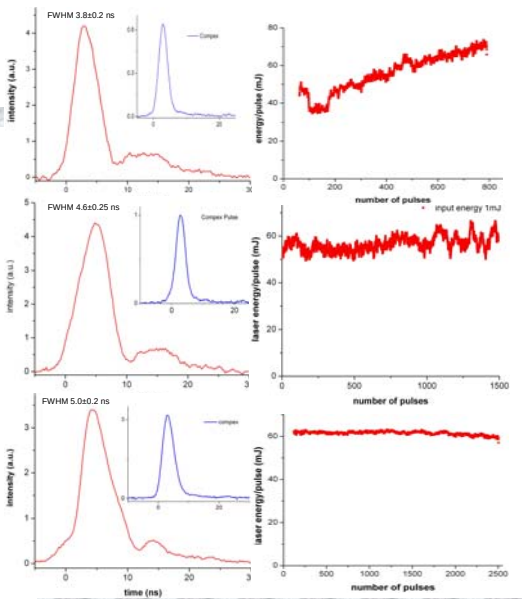


Timing and jitter

- The timing of Compex, LPX lasers and Pockels cell were controlled using SRS DG535 timing generator (50ps jitter).
- For stable amplified output, the jitter of the Compex laser should be minimum. The jitter of the Compex laser increases with increasing discharge voltage.
- The energy stability of the amplified output also depends on the part of the Compex pulse sliced and pulse width.
- Energy Stability is better for larger pulse width.



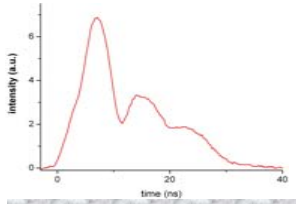
(a) Changes in the amplified temporal profiles with jitter of the input laser energy and (b) jitter of Compex laser for different discharge voltages.



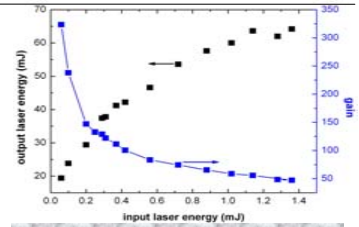
The stability of the amplified output energy is given for three different runs (Compex discharge voltage 20.5kV; LPX discharge voltage 17kV, PC voltage 4.5kV)

Gain and Saturation analysis

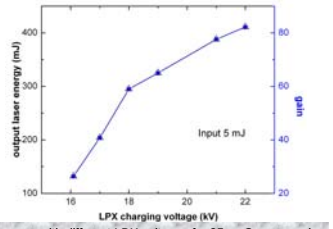
- Highest gain is obtained with smallest input energies.
- At high input laser energy levels the gain saturates.
- The maximum stable output energy obtained with FWHM 5 ns pulse is ~ 62 mJ (20.5 kV Compex & 17 kV LPX).
- More energy can be extracted from LPX by increasing discharge voltage. But ASE from the amplifier is a problem.
- ASE is found to be very strong at higher LPX voltages.
- Temporal profiles showed drastic variation at high LPX voltages.
- Obtained ~500 mJ without pulse slicing (22 kV LPX). Scope for increasing the energy with pulse slicing.



Amplified signal with 24kV Compex and 19kV LPX. The measured amplified laser energy was 120mJ

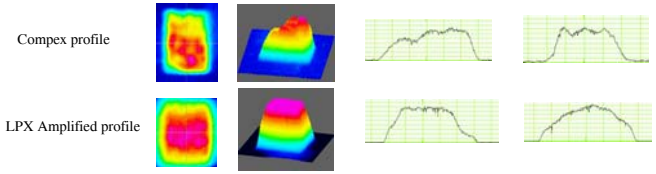


The output energy and estimated gain for sliced pulse with 20.5kVCompex and 17kV LPX discharge voltages



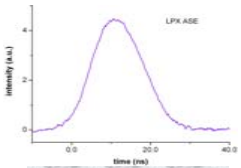
Gain curve with different LPX voltages for 25 ns Compex pulse

Smoothed beam profiles were obtained with Oscillator-amplifier configuration

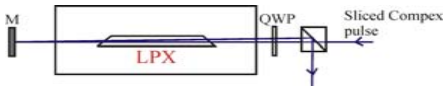


Conclusions and directions of further research

- **The usage of Pockels cell provides ~ 5 ns KrF laser beam.**
- **The absorption of the Pockels cell crystal along with slicing initiate output laser energy limitations.**
- **An oscillator – amplifier configuration provides more energy – but not high enough.**
- **Smoother spatial profiles were obtained with oscillator-amplifier configuration.**
- **Further investigations are needed for obtaining more amplified laser energy – Target : 200 mJ, 5 ns pulses.**
- **The LPX ASE lifetime is ~ 16 ns (FWHM). Scope for double passing through the LPX for extracting more energy.**



Temporal profile of ASE from LPX



LPX double pass scheme for obtaining more output energy