L.3: Demonstration of a simple electro-optic laser pulse shaping technique

Temporal shaping of the laser pulses, particularly, generation of flat-top laser pulses, has been of interest for several decades for variety of scientific and industrial applications such as pumping optical amplifiers, laser material processing etc. Different methods have been demonstrated to generate flat-top and even arbitrary pulse shapes in femtosecond pulse regime via spectral phase or amplitude modulation, in the picosecond pulse regime via temporal stacking, and in the nanosecond regime via direct pulse intensity or phase modulation. At Laser Plasma Division, we have demonstrated a simple technique to generate temporally flat-top and some other specific pulse shapes, by taking advantages of both coherent pulse stacking and direct intensity modulation using standard commercial Pockels cell driven by single high voltage step pulse. In contrast to other reported stacking techniques, one can obtain a flat-top laser pulse shape of nearly same duration but with much smaller rise and fall times compared to the original input pulse. (For more details, please see: A.K. Sharma, R.K. Patidar, M. Raghuramaiah, P.A. Naik, and P.D. Gupta; Optics Comm. Vol 284, P 4596, 2011)

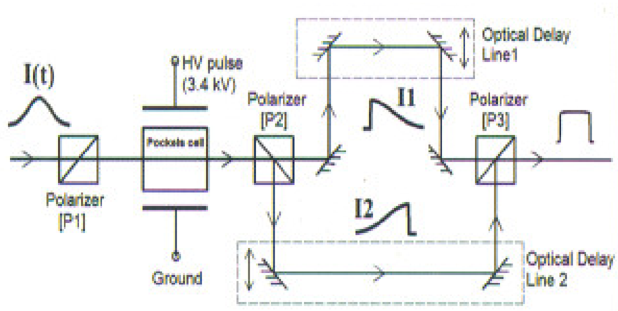

Fig.L.3.1: Experimental setup of electro -optic temporal pulse splitter and passive pulse stacker

Present pulse shaper (see Fig.L.3.1) involves temporal pulse splitting into two halves and then stacking them together with suitable polarization, intensity, delay, and phase between the two halves of the incident pulse. 7 ns duration laser pulses from a home-made Q-switched flash lamp pumped Nd:phosphate glass laser oscillator were used to demonstrate the pulse shaping. A DKDP based Pockels cell and its high voltage circuitry used in pulse shaper, were kept inside an aluminum enclosure in order to avoid electromagnetic interference. The intensity profile of the laser pulses was monitored using a fast response photodiode and 1 GHz digital storage oscilloscope (LeCroy, 6100). Theoretical and experimental results are given in Fig. L.3.2., which depicts the incident laser pulse and shaped laser pulses, at a temporal delay of ~ 6 ns between two halves of laser pulses of orthogonal polarization. To generate a flat-top laser pulse with less than 1% root mean square (r.m.s.) intensity modulation in the centre, one would require a relative temporal delay of 90% (±2%) of the FWHM duration of the incident Gaussian laser pulse. Other pulse shapes are generated for different temporal delays. For instance, a pulse shape with depressed centre is obtained for a temporal delay larger than the optimum value.

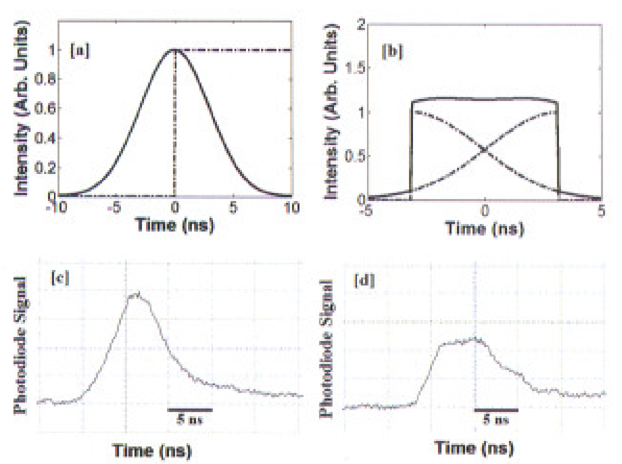

Fig. L.3.2: (a) Theoretical Gaussian pulse (solid line) of 7 ns duration and half wave step voltage (dash-dotted line); (b) Theoretical shaped pulse (solid line) for temporal delay of ~6 ns and the two halves of incident pulse (dash-dotted line); (c) Experimental incident pulse of ~7 ns duration; and (d) Experimental shaped pulse at temporal delay of 6 ns.

The present technique provides a simple way to generate a flat-top laser pulse profile. It may be extended to generate different specific pulse shapes such as convex top, concave top, half exponential etc. It is easy to implement the present method for longer duration laser pulses. A fast Pockels cell, driven by a fast high voltage transition, may be used for laser pulses of duration down to few 100 ps duration. In principle, the electro-optic switch used in the pulse splitter may be replaced by any switch capable of mimicking a fast temporal domain filter, to shape the temporal profile of the laser pulses of shorter pulse duration.

Reported by:
Avnish K. Sharma (aksharma@rrcat.gov.in)