L.9: Development of micro-controller based S-20 optical streak camera

Streak camera is an instrument for studying very fast (sub-nanosecond) optical events in a single-shot mode. Laser Electronics Support Division has developed a micro-controller based S-20 optical streak camera. The optical imaging system, mechanical housings and mountings, as well as all the electronic circuits were fabricated at RRCAT using indigenous components. Fig.L.9.1 shows a view of internal assembly of this streak camera.

The streak camera consists of a Streak tube, a de-magnifier tube, and an image intensifier tube, (procured from General Physics Institute, Moscow) whose optical output is coupled to PC through a CCD camera and a frame grabber card. High voltage biasing network for the camera was designed using a programmable DC-DC converter of 15KV output and suitable divider network. Various controls signals are generated for gain and gate width control of micro channel plate (MCP) of intensifier unit, beam position control (to move beam position on the screen), operation mode selection (static mode/ gate mode/dynamic mode), programming delay of ramp trigger, speed selection (fastest/ slower), etc. The details of this work can be found in *Review of Scientific Instruments, Vol 79, 05470 ,2008.*

The microcontroller generates necessary analog and digital signals as per the mode selected. It is connected to a PC through a serial port. A LABVIEW based graphical user interface (GUI) has been developed for controlling all the above operations. Fig.L.9.2 shows the typical GUI to capture and analyze streak images.

The streak speed calibration of the streak camera was first carried out using a Nd-YLF laser oscillator with fundamental wavelength of 1.053 μm, with pulse duration ranging from 400 ps to 1.5 ns. Since the S-20 photocathode (300nm to 800 nm) has peak response in the green region of the visible spectrum, this output was converted in second harmonics (527 nm). The calibration of the streak camera was performed by introducing an optical delay in the beam path by using two different lengths of fiber cables. This laser system was used for calibrating all the speeds viz. 700 ps, 8 ns, 16 ns, 24 ns, and 32 ns. For each speed, images of streaks were taken on different parts of screen by adjusting the beam position, to verify linearity and repeatability. Optical delay in various parts was measured. A piece wise linearization technique was employed to recreate the calibrated streak image and determine the effective ramp speed. For verifying the fastest

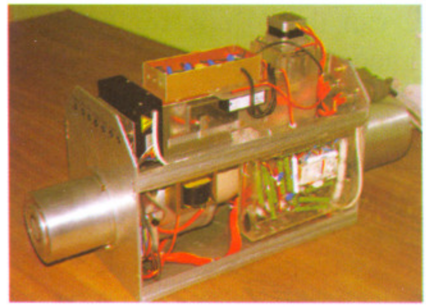

Fig. L.9.1: Photograph of the micro-controller based S-20 optical streak camera

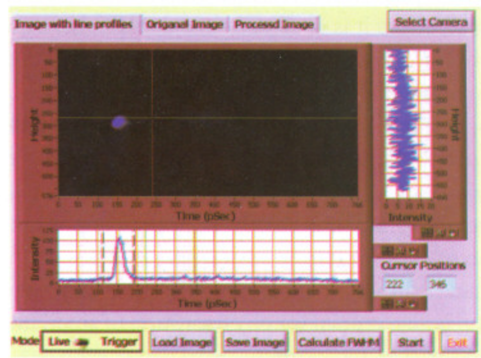

Fig.L.9.2: GUI to capture and analyze streak image

speed of 700 ps, and to determine temporal resolution, Ti:Sapphire laser system was used which provides 50 fs duration laser pulses at 790 nm. Fig.L.9.3 shows the temporal profile of the streak image monitored for 50 fs laser pulse at the fastest speed setting.

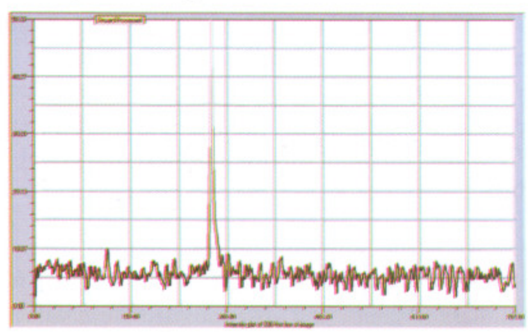

Fig.L.9.3: Shows the temporal profile of a 50 fs laser pulse

The average fastest streak speed of the streak camera was found as 3.51 cm/ns. The temporal and spatial resolution the camera was measured as 4.5 ps and 175 μm respectively.

Reported by:
J. Upadhyay (janky@rrcat.gov.in), M. J. Joshi
and C. P. Navathe