L.6: Development of PCI controlled Gated grid S-20 optical streak camera

Streak cameras are among the fastest detectors of light pulses. They are especially used in studies of laser plasma interaction and in measurement of electron bunch length in synchrotron radiation sources due to very fast response of ns and sub ns time resolution. Normally, the streak camera is used for measurement of single shot events where accelerating grid is biased with DC voltage. However, for repetitive events, activating the accelerating grid with pulsed voltage is necessary for the selection of a single pulse to acquire proper streak images without integrating. Figure L.6.1 shows the PCI controlled gated grid streak camera assembly.

Fig.L.6.1: Photograph of the PCI controlled gated grid optical streak camera

This report briefly describes the development of a PCI controlled gated grid S-20 optical streak camera. The key control electronics required for the streak camera includes high voltage power supplies for biasing various electrodes of the system like streak tube and image intensifier tube, a MOSFET based programmable slope integrator unit for getting variable ramp speeds, an adjustable beam biasing unit to select linear part from the ramp voltages and to adjust the streak image at the desired location of the screen.

For gating of the accelerating grid, a MOSFET based pulser unit has been introduced in the high voltage section of the streak camera, superimposed on the grid through a coupling capacitor in synchronization with a trigger. This in turn allows the streak camera to be transparent to the optical input for the selected duration only. To synchronize the operation of the streak camera with the event to be captured, ECL logic based single pulse selector unit has also been developed. Main application of gated grid technique is for capturing streak images of the optical pulse train without getting integrated on the phosphor screen as well as to improve signal to noise ratio.

A PCI control card and interface unit along with a LABVIEW based image capturing and image processing software have also been developed and tested using indigenous components.

Characterization of the streak camera has been carried out using a commercial laser head from pico-quant, GmBH (Model No.:PDL800-D) with diode driver from the same company (Model No.: LDH-P-670) has been used which delivers, 40 ps, 20 pJ, 670 nm laser pulse at a rate selectable from single shot to 80 MHz. Figure L.6.2 shows a typical 80 MHz laser pulse train at ramp speed of 62 ns/25 mm.

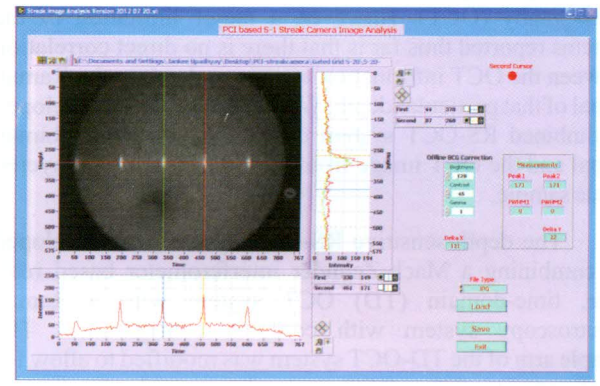

Fig.L.6.2: Streak image of 80 MHz laser pulse train at 62 ns/25 mm ramp speed

The calibrated streak camera has also been used in the Indus-1 synchrotron radiation source for the electron bunch length measurement. Typical streak images of the electron bunch and their corresponding profile are shown in Fig.L.6.3.

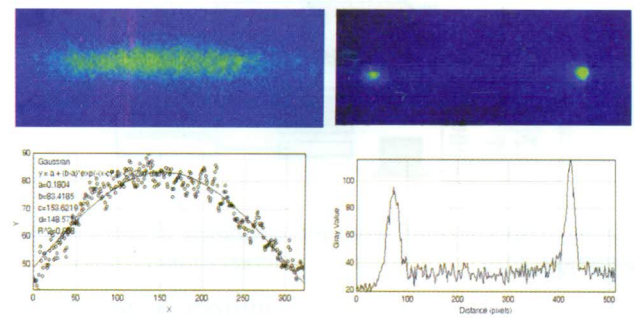

Fig.L.6.3: Picture shown at the left is a typical streak image and its Gaussian profile of an electron bunch at 100 mA beam current in Indus-1 which measures typical bunch length of ~1.34 ns (FWHM)/~585 ps (rms) at the ramp speed of 6.8ns/25 mm, and the picture at the right shows the streak image of two electron bunches and its intensity profile at the ramp speed of 58 ns/25 mm, which measures a typical bunch separation of ~ 31.6 ns.

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