Beam Monitor for Scanning-TCT

Introduction

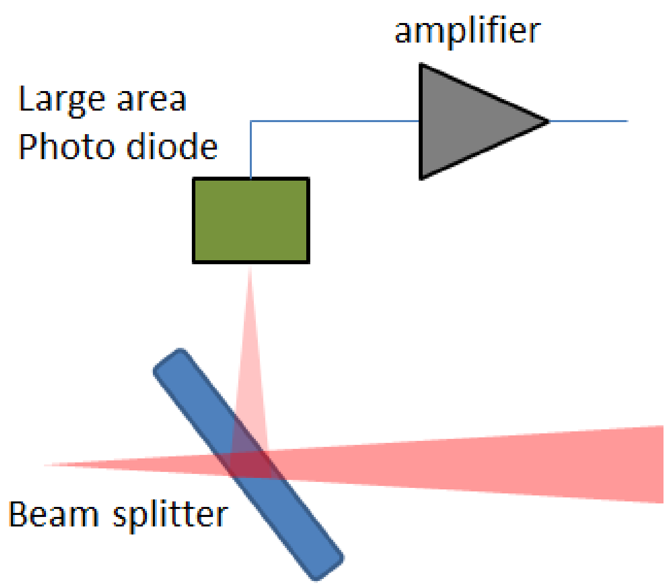
Beam monitoring is used to monitor the beam intensity of the laser illuminating the DUT. In such a way it is possible to correct for variations of beam intensity (due to e.g. temperature changes ...) over the long scans and also to set the absolute scale of the measured signal.

In-beam monitor BM-01A

The inbeam scheme of the in-beam monitor is shown in figure below.

The beam monitor consists of three parts:

- Beam splitter
- A dedicated large area photo diode
- Electronics (amplifier and shaping circuitry)



Beam monitor doesn't degrade the focusing performance of the Scanning-TCT.

Mounting

The BM-01 monitor is shown in Figure 1. The aluminum frame holding the beam monitor is fixed to the beam expander as shown in Figure 2. Beam splitter is mounted in the way of the beam under the angle of 45^{o} and splits the beam in different ratios (70:30 or 50:50). A large area photo diode is mounted on top the beam splitter and connected to the beam splitter electronics also mounted on top of the beam expander in order to shorten the connection distance and reduce the noise.

Several adjustment screws can be used to precisely set the position of large area photodiode to ensure that the beam is illuminating the sensitive surface for lasers of different wavelengths which have different focal lengths (red, infrared). Large area diode also ensures that the distance between splitter and the diode can be fixed, which makes a more compact assembly possible.

Figure 1: Beam monitor parts

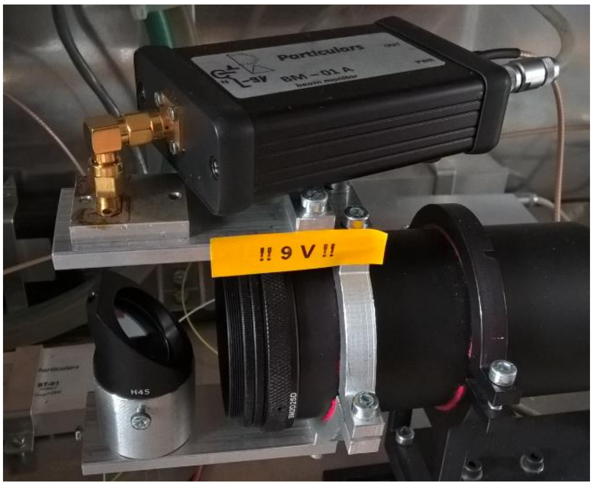


Figure 2: Beam monitor mounted in the system.

Connections

Beam monitor electronics uses +/- 9V which can be provided also from the laser power-supply. Later power supplies (PS-02 L, PS-03 L) have already connection for beam monitor while for the older the cable can be split or a separate power supply can be used. The beam monitor uses 9V also to reverse bias the photo-diode, where the bias is brought to the chassis of the diode and the whole frame is biased, hence the user should make sure that the structure is kept isolated from the ground of experimental box.

The output of the beam monitor is fed the oscilloscope/digitizer. The data acquisition software (PSTCT) has features which can be used to handle the data from the beam monitor on event/single acquisition basis.

Performance

Correction for intensity variation

An example of long term beam monitoring is shown in Figure 3. Over a period of three days the variation of laser intensity was monitored with a test device (DUT, fully depleted silicon pad detector) and beam monitor (BM) in two modes: amplitude and response integral (BM amplitude – peak amplitude of the response puse, BM integral – integral of the response pulse). Both DUT and BM recorded the same pattern which reflects the change in laboratory temperature with a period of 24 h.

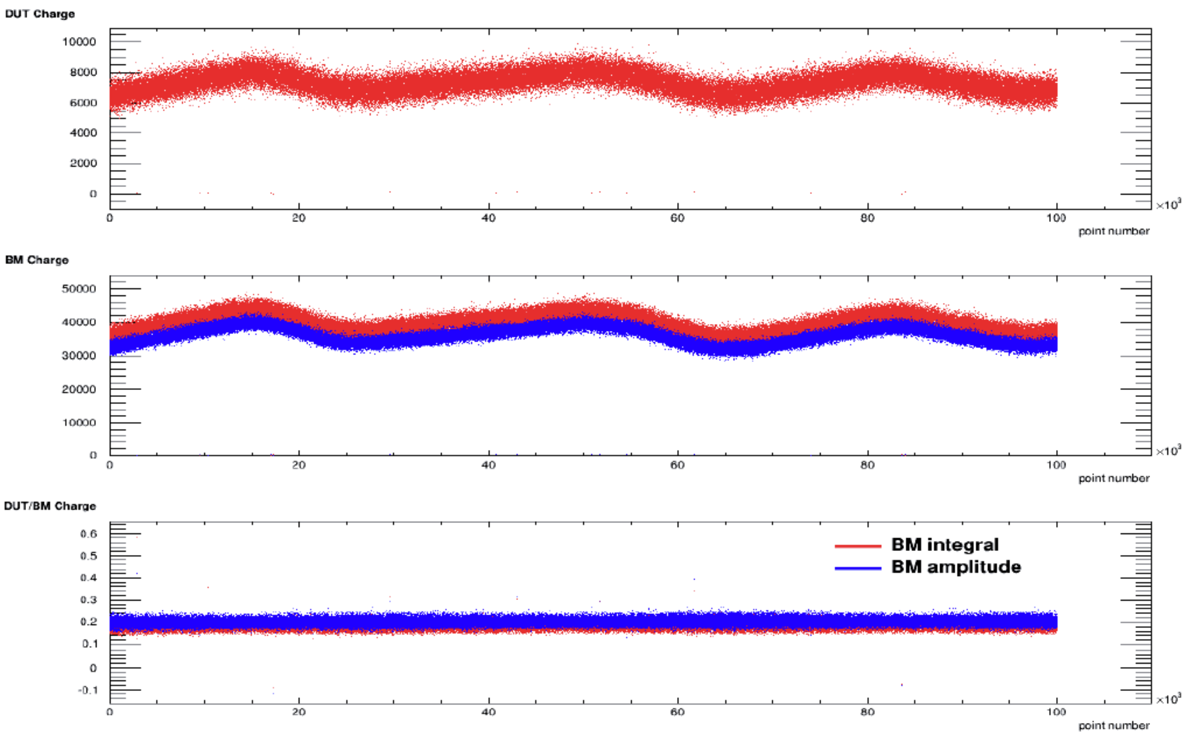


Figure 3: Long term stability monitoring with a large fully depleted silicon pad detector (DUT) compared with beam monitor (BM).

Using the data from BM, the DUT charge can be corrected for the changes of intensity. The uncertainty of the corrected intensity in per single point in DUT was found to be around 3% for the infra-red laser (1064 nm).

Absolute determination of the charge

The beam monitor is useable for the broad range of wavelengths from 405 nm – 1064 nm. For non-polarization maintaining laser fibers (lasers from Particulars) the position of the fiber before entering the beam expander should be always kept the same as different bending of the fibre before entering the beam expander changes the ratio of polarizations, which is then reflected in different beam intensities after the split (beam splitter is sensitive to different polarizations). This is not a problem for monitoring the relative long term stability of the beam. However for monitoring the absolute light intensity illuminating DUT (absolute calibration of the charge) this is a far more challenging task and requires a very careful and reproducible positioning of the fibre when samples are changed.

Beam-split monitor BM-02 A

The beam split monitor uses a differnt concept then in-beam monitor. It uses a beam splitter to separate the laser beam in two beams in 50:50 ratio. One beam is fed to the photodiode connected to the same electronics readout as the large area diode of the BM-02 A.

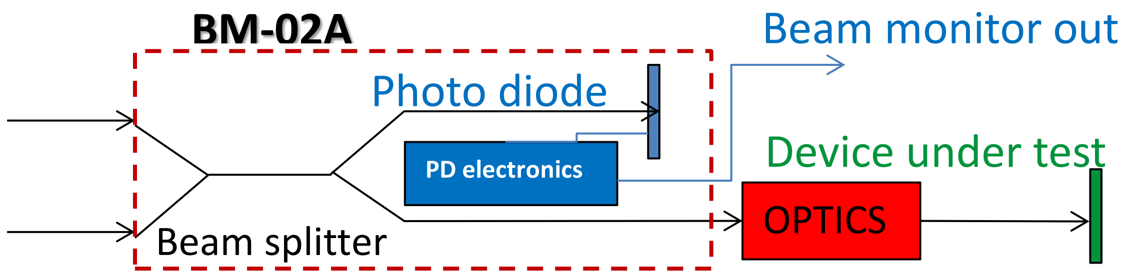


Figure 4: Schematic view of Beam-split monitor.

Unlike In-Beam monitor beam-split monitor is wavelength specific (separate for e.g red and infra-red lasers). On the other side it is not sensitive to positioning of fibers and does allow easier absolute charge measurements. The beam splitter has two separate inputs which allow several measurements that are difficult to realize without it, such as :

- Studies of response to two very close laser pulses (requires two lasers)
- Studies of response of the detector in presence of e.g. CW (DC) illumination

Beam monitor doesn't degrade the focusing performance of the Scanning-TCT and uses the same data acquisition interface as BM-01A.

Mounting

The BM-02A has two inputs for optical fibres In-A and In-B, power input for electronics and output opticial fibre and output to the digitizer board/oscilloscope. The same power supply as for laser and BM-01 A can be used.

Figure 5: Beam-split monitor BM -02A

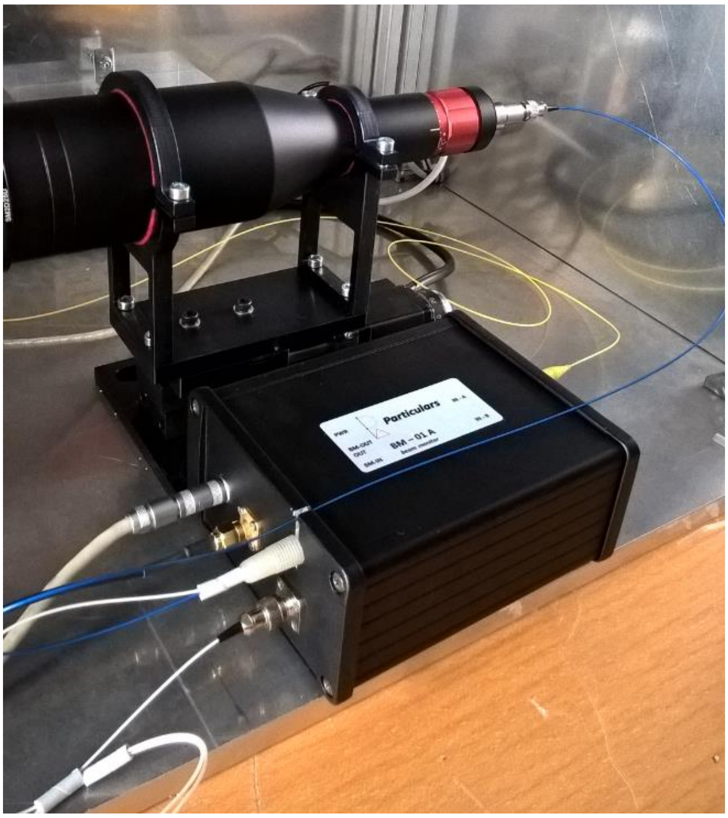


Figure 6: Example of BM-02 A use. The optical fibre comes in (yellow), the optical fibre goes out (blue). The white fibre is connected to the electronics, however it is routed outside the box for test purposes. The output from electronics is done with SMA connector.

Absolute determination of the charge

The beam split monitor is more appropriate for absolute measurements as the fibre position does not influence the light intensity. However the split is done before the optics, hence any changes in iris or use of neutral density filter changes the calibration. The insertion loss at fibre-fibre connectors demand larger intensity of laser and recalibration each time the fibre is disconnected from the beam monitor.

Information in the data file

The information from the beam monitor is stored at each step, either in x, y, z, U1 or U2. The information is stored in the variable of the PSTCT class

PSTCT.xyz[7][*index*]

For any given combination of x, y, z, U1, U2 there is a function

PSTCT.indx(x,y,z,U1,U2) which returns *index* .

Any dependence of BM data on other variables x,y,z,U1,I1,U2,I2 and time can be realized by using PSTCT.DrawArray function. See also examples od TCTAnalyse for more details.