CH: CHARACTERISATION OF Si DETECTORS FOR USE AT 2 K

V. Eremin, E Verbitskaya, IOFFE, St Petersburg, Russian Federation

MOTIVATION

It is expected that the luminosity of the Large Hadron Collider (LHC) will be bounded in the future by the beam loss limits of the superconducting triplet magnets (see Fig. 1).

To protect the superconducting magnets of the high luminosity insertions an optimal detection of the energy deposition by the shower of beam particles is necessary. Therefore beam loss monitors (BLM) need to be placed close to the particle impact location (see Fig. 2) in the cold mass of the magnets where they should operate in superfluid helium at 1.9 Kelvin.

INTRODUCTION

The magnets close to the Interaction Points (IP) are exposed to high irradiation from the collision debris.

Fig. 3: Simulated dose in the coil in the BLM shown for two different situations: one for the debris from the interaction region (blue) and one for a simulated dangerous loss (red). It can be seen that the signal due to the debris can mask the signal from a dangerous loss [1].

CRYOGENIC SETUP

The cryogenic system is specially adapted to match the requirements of the radiation test facility. The main elements of the cryogenic system are the cryostat, the helium storage Dewar, the transfer line that connects the two of them and the vacuum pump as can be depicted in fig. 5. Main part of the cryogenic setup installation in the T1 irradiation zone at CERN is shown in Fig. 6.

OUTLOOK

Installation of cryogenic radiation detectors on the cold mass of a LHC quadruple magnet is depicted in the Fig. 16.

SIGNAL READOUT & BEAM PROPERTIES

Fig. 7 depicts the shape of a signal from a spill for different stages of irradiation, the signal is recorded by the LeCroy Oscilloscope (WaveRunner 240MX-A). The irradiation conditions are:

- Particle momentum of 24 GeV/c.
- Beam profile of FWHM 1.2 cm at the cryostat.
- Beam intensity per spill of 1.3∙10^{12} protons/cm^{2}, corresponding to an average of about 1·10^{12} protons/on detectors.

The irradiation lasted 4 weeks and temperature of the detectors was, most of the time, 1.9 Kelvin.

Fig. 8: Detector modules mounted on plate and ready for cooling down and irradiating.

RESULTS—VOLTAGE SCAN

The voltage scans of the collected charge for the different detectors at different fluences are depicted in the figures 14 and 15. In the voltage scans positive voltage denotes a forward bias.

SUMMARY

Different Si detectors at cryogenic temperatures were tested for their radiation hardness. A total integrated fluence of 1.22·10^{10} protons/cm^{2} was reached, corresponding to an integrated dose of about 3.26 MGy for silicon. A detection effect on the silicon detectors sensitivity was observed. More experiments with different current pulse response measurements using TCT with a pulsed laser at cryogenic temperatures during irradiation are foreseen.

ACKNOWLEDGMENTS

The authors want to thank CERN RD39 collaboration (especially J. Haukolaenen), E. Gerndt, E. Guelman, CERN Crystal team, CERN BE-BL section, M. Gaiser, F. Avriti, L. Gatignon, R. Freschi and G. Burini.

REFERENCES