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# The Radiation Hardness of Specific Mulit-mode and Single-mode Optical Fibres at -25 deg. C. to full SLHC doses.

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The Versatile Link project is a joint effort between CERN and several experiments to develop a high-speed optical link for use in the LHC upgrades. Of concern to the project is the fact that optical fibres experience higher levels of attenuation at low temperatures for the same integrated dose. This paper describes a CO2 cooling system which was used in a radiation environment for exposures of optical fibres exceeding 500kGy(Si) of 60Co gamma radiation exposed at a rate greater than 20kGy/hr while at the same time maintaining a temperature less than -20oC. The optical fibres under test were both single mode fibres and graded index multimode optical fibres (GRIN fibres). The multimode (single mode) fibres all operate at 850nm (1310 nm) and use VCSEL's (EELs) as a source. Estimates are given of an upper bound on the effect of radiation on these cold fibres. Because of the harsh environment near radiation sources, there are difficulties making in-situ radiation damage measurements of optical fibres. The implications of these results for the readout of tracking detectors for SLHC are critical, as they will determine how close to the beam region the optoelectronics can be located.

## Summary

The luminosity upgrade for the LHC (SLHC), requires new inner detectors capable of operating in the harsher SLHC environment. The expected SLHC doses are a factor of four times higher than those assumed for the LHC detectors. The higher luminosity at the SLHC will require more granular tracking detectors and imply that a higher data transmission rate will be required. An optical readout system is planned for which the consequences will be that higher speed digital links will be required to read out the increased number of channels and all on-detector components must be significantly more radiation tolerant than was required for the current LHC detectors. A joint project between members of CERN, and the CMS and ATLAS collaborations have formed the Versatile Link project to develop such links for LHC upgrades.[1]

Optical fibres are known to be more susceptible to damage if the environment is cold. Previous results have shown this and also indicated that the damage level may be serious when extrapolated up to SLHC doses.[2] However there is limited information available in the literature. Our first tests at low dose rates for fibres proposed for the SLHC indicated that the radiation damage is indeed significantly worse at low temperatures.

This paper will present first results on radiation tests to the full SLHC dose, at cold temperatures of optical fibres that might be required inside the SLHC tracking detectors and calorimeters. An in-situ measurement of the attenuation as the radiation exposure takes place will be shown. The details of this procedure are also outlined in [3] below.

This paper will explain a CO2 cooling system which was used in a radiation environment for exposures of optical fibres exceeding 500 kGy(Si) of Cobalt-60 gamma radiation exposed at a rate greater than 20 kGy/hr while at the same time maintaining a temperature less than -20oC throughout the exposure period. The optical fibres under test will be both single mode fibres (from Corning, Draka and Fujikura) ,and several different types of Graded index multimode optical fibres (GRIN fibres) The multimode (single mode) fibres all operate at 850nm (1310 nm) and use VCSEL's (EELs) as a source. Among the GRIN candidates will be InfinicorSX+ and the Draka radiation hard candidate which were tested in [1 and 2]. Estimates will be given of an upper bound on the effect of radiation on these cold fibres.. Because of the harsh environment and the presence of radiation sources, it is difficult to make in-situ measurements of optical fibre damage to radiation and these will be the only tests performed to these dose levels at this temperature. The implications of these results for the readout of tracking detectors for SLHC will be critical, as they will determine how close to the beam region the optoelectronics can be located

[1] "The versatile link, a common project for super-LHC ", L. Amaral, et. al., 2009 JINST 4 P12003
[2] "The Radiation Hardness of Certain Optical fibres for the LHC upgrades at −250C", C. Issever, J. Hanzlik, B.T. Huffman, A. Weidberg; Proceedings TWEPP-09, CERN-2009-009.
[3] B Arvidsson , K Dunn , C Issever , B T Huffman , M Jones , J Kierstead , G Kuyt , T Liu , A Povey , E Regnier , A R Weidberg , A Xiang and J Ye ; 2009 JINST 4 P07010.

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