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# OPTICAL FIBRES IN THE RADIATION ENVIRONMENT OF CERN)

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ABSTRACT

CERN, the European Organization for Nuclear Research (in Geneva, Switzerland), is home to a complex scientific instrument: the 27-kilometre Large Hadron Collider (LHC) collides beams of high-energy particles at close to the speed of light. Optical fibres are widely used at CERN, both in surface areas (e.g. for inter-building IT networks) and in the accelerator complex underground (e.g. for cryogenics, vacuum, safety systems). Optical fibres in the accelerator are exposed to mixed radiation fields (mainly composed of protons, pions, neutrons and other hadrons, gamma rays and electrons), with dose rates depending on the particular installation zone, and with radiation levels often significantly higher than those encountered in space. In the LHC and its injector chain radiation levels range from relatively low annual doses of a few Gy up to hundreds of kGy.

Optical fibres suffer from Radiation Induced Attenuation (RIA, expressed in dB per unit length) that affect light transmission and which depends on the irradiation conditions (e.g. dose rate, total dose, temperature). In the CERN accelerator complex, the failure of an optical link can affect the proper functionality of control or monitoring systems and induce the interruption of the accelerator operation. The qualification of optical fibres for installation in critical radiation areas is therefore crucial. Thus, all optical fibre types installed in radiation areas at CERN are subject to laboratory irradiation tests, in order to evaluate their RIA at different total dose and dose rates. This allows the selection of the appropriate optical fibre type (conventional or radiation resistant) compliant with the requirements of each installation. Irradiation tests are performed in collaboration with Fraunhofer INT (irradiation facilities and expert team in Euskirchen, Germany).

Conventional off-the-shelf optical fibres can be installed for optical links exposed to low radiation levels (i.e. annual dose typically below few kGy). Nevertheless, the conventional optical fibres must be carefully qualified as a spread in RIA of factor 10 is observed among optical fibres of different types and dopants. In higher radiation areas, special radiation resistant optical fibres are installed. For total dose above 1 kGy, the RIA of these special optical fibres is at least 10 times lower than the conventional optical fibres RIA at same irradiation conditions. 2400 km of these special radiation resistant optical fibres were recently procured at CERN. As part of this procurement process, a quality assurance plan including the irradiation testing of all 65 produced batches was set up.

This presentation will review the selection process of the appropriate optical fibre types to be installed in the radiation environment of CERN. The methodology for choosing the irradiation parameters for the laboratory tests will be discussed together with an overview of the RIA of different optical fibre types under several irradiation conditions.