Single-Event Upset testing of the Versatile Transceiver
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ABSTRACT
The Versatile Transceiver (VTRX) will be deployed on detectors that will be operated at the upgraded HL-LHC where the instantaneous luminosity will be increased by a factor of 5-10 with respect to the nominal LHC. All components housed at the front-ends must thus be immune to single-event upsets (SEUs) to a level compatible with the correct operation of the detector systems. We report the results of SEU testing of the full VTRX in a proton beamline.

VERSATILE LINK
The Versatile Link project aims to propose a 54 Gb/s bi-directional optical data transmission link that bridge the 50-150 m from the front-ends of upgraded detectors at the HL-LHC with the back-ends located in the shielded counting rooms. The front-end components will have to withstand significant radiation levels: 10^7 particles/cm^2 fluence and 500 krad total dose for future tracking detectors. Optical link systems operating at 1310 nm over single-mode fibre as well as those operating at 850 nm over multi-mode fibre will be supported.

SEU TESTING USING A MONO-ENERGETIC PROTON BEAM
Several full VTRX modules were exposed to a 70 MeV proton beam at the PSI facility at PSI, Villigen, CH. The flux used was 1x10^10 protons/cm^2, which is approximately a factor of two higher than the highest fluxes expected in the HL-LHC trackers. Devices were exposed to the beam at gridding incidences in order to maximise the path length through the DUT and thus the energy deposition within the DUT.

The receiver exhibit the typical SEU behaviour due to the deposition of charge in the photodiode due to the passage of particles through the material. These results confirm our previous measurements that show no additional SEUs due to the GBTIA. All errors are fully corrected by the GBT FEC protocol. We observe that the GaAs photodiode on VTRX 401 shows the same angular dependence as previously measured for InGaAs devices.

CONCLUSIONS
A first SEU test of a complete VTRX has been carried out by exposing a number of VTRX modules to a 70 MeV proton beam at the PSI facility at PSI. The four VTRX tested represent a broad spectrum of uses in single-mode and multi-mode Versatile Link systems. This was the first time the ONET 1180L commercial laser driver from Texas Instruments was exposed to a proton beam. The same is also true of the currently employed GBDL laser drivers that have previously been shown to be sufficiently robust to total fluence effects. All receivers use the GBTIA mounted directly with the photodiode in a ROSA package.

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The transmitter did not show any single-event effects during our testing, since the beam on BER curves perfectly overlap those taken with the beam off. In addition, we did not observe any configuration changes via our continuous monitoring via the I2C interface. There were also no changes in the optical output signal measured using the oscilloscope. The transmit side of the VTRX is thus SEU immune.

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