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Single event effect in HCC ASICs for ITk strip upgrade

Special considerations have been made in the design to reduce digital state changes and ensure reliable operation, we tested the effectiveness of the protection by running separate chips inside the proton beam, and layout is that all chips concurrently fit into a 20 mm beam spot. The
study of corrected bit flips in registers and actual SEEs in LCB and LP path is carried out under different energies. The preliminary estimate there will be approximately O(10) corrected bit flips per HCC bit per year at the HL-LHC. The total ionizing dose effect is monitored as well during the experiment.

Summary (500 words)

This paper will present results from proton irradiations of the HCCStar at the China Spallation Neutron Source (CSNS) during November 2023.The irradiation tests have been performed before at TRIUMF in May 2022, for correctable bit flips per bit per year, the value we calculated in CSNS is consistent with the result of TRIUMF, they are both O(10), and register resets also happen in CSNS, which is consistent.The irradiation tests have been performed before at TRIUMF in May 2022, for correctable bit flips per bit per year, the value we calculated in CSNS is consistent with the result of TRIUMF,
they are both O(10), and register resets also happen in CSNS, which is consistent.In addition, we observed the occurrence of actual SEUs in CSNS, which is not observed
previously before with proton beam, and we also study the dependency of bit flips on energy by applying several different beam energy, which haven't been done before.The significance of this work lies in the systematic study of SEE under various energy levels,
which aids in a deeper understanding the performance of SEE in HCC. Additionally, this work evaluates the bit flip situation of HCC on the HL-LHC based on data from CSNS.The challenge of this work is to minimize the impact of secondary particles on the equipment, which can lead to device failure or erroneous bit flips, because our focus is on the SEEs caused by proton beam. To address this, we placed the relevant FPGA boards and low voltage power supplies under the protection of lead bricks and within a bunker, respectively.Certainly, there are some uncertainties encountered during this experiment, such as the issue of LP/LCB signals not being in sync. Currently, we suspect that this may be related to a poor connection in the long two twisted cable (˜1.5m), but the answer to this problem depends on our future experiments.

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