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CMS HGCAL ECON-D ASIC : Impact of CMOS fabrication process tuning on performance and radiation tolerance

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The CMS experiment's High Granularity Calorimeter (HGCAL) upgrade will replace CMS's existing endcap calorimeters in preparation for the High Luminosity LHC. To effectively use over 6 million channels of this "imaging"calorimeter, CMS has developed two novel Endcap Concentrator (ECON) ASICs to perform data compression/selection on detector. The ECON-D ASIC operates on the 750kHz data path, and the ECON-T ASIC on the 40MHz trigger path. These 65 nm CMOS ASICs are radiation tolerant to 200 Mrad and low power, operating at less than 2.5 mW/channel.

The first full-functionality prototype ECONs were produced and characterized in 2021-23, and an initial engineering run was performed in 2024. ECON-D radiation testing for the engineering run revealed that the chip' s internal SRAMs produce intermittent read errors for a non-negligible fraction of chips. Further investigation indicated that the SRAM performance is highly sensitive to the exact parameters of the CMOS fabrication process. To both study this process sensitivity and mitigate SRAM performance issues, twenty ECON wafers were produced in 2025 with a range of doping concentrations designed to tune the underlying transistor threshold voltage by 0%, 5%, 10%, and 15% from nominal. This talk will present first measurements of ECON-D performance, power consumption, and radiation tolerance for these four variations of CMOS process.

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