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Cryogenic Modeling of Open-Source Skywater 130nm Process Design Kit at 77K for High Energy Physics

Thursday 9 October 2025 17:30 (15 minutes)

We present a Berkeley Short-channel IGFET Model (BSIM4)-based cryogenic Process Design Kit (PDK) for the open-source Skywater 130nm transistor node for operation at 77 Kelvin. Reliable operation of read-out electronics at cryogenic temperatures is crucial for their use in liquid argon detectors that are ubiquitous in high energy physics (HEP) experiments. The open-source Skywater 130nm node is a viable option for large-scale detector read-out ASICs (application-specific integrated circuits) due to its cost effectiveness. However, ASIC designers require cryogenic models for HEP applications because cryogenic temperatures fall outside of the temperature range of the foundry-verified, room temperature PDK. For this reason, we sought to characterize and model the Skywater 130nm PDK at liquid nitrogen temperature (77K), a region previously unexplored. I-V curves were acquired at room temperature (300K) for model verification and at 77K for the generation of the cryogenic PDK for multiple single transistors. A physics-based parameter extraction strategy was implemented to adjust model parameters that reflect the change in transistor behavior in cold environments to achieve a better model fit. The cryogenic models can be incorporated into a SPICE-simulator framework to verify cryogenic performance of readout circuits commonly used in HEP applications using the Skywater 130nm node.

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