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Enhancing Radiation Hardness and Granularity in HV-CMOS: The RD50-MPW4 Sensor

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The RD50-MPW4, the latest HV-CMOS pixel sensor in the series from the CERN-RD50-CMOS group, advances radiation tolerance, granularity, and timing resolution for future experiments like HL-LHC and FCC. Fabricated by LFoundry in December 2023 using a 150nm CMOS process, it features a 64 x 64 pixel matrix with a $62 \times 62 \mu m^2$ pitch and employs a column-drain readout architecture. The RD50-MPW3, its predecessor, faced noise coupling issues between the digital periphery and the pixels, limiting threshold settings to $gtrsim5ke^-$ and restricting operation to the matrix's top half.

The RD50-MPW4 solves these issues by separating the power domains for digital and analog components, enabling more sensitive threshold settings and full matrix operation. Additionally, a new backside biasing scheme and an improved guard ring structure support bias voltages up to 800V, enhancing radiation hardness.

Test with unirradiated samples showed >99.9% efficiency, ˜16μm spatial resolution, and ˜10ns timing resolution. Several samples were irradiated at JSI to fluences from 1×10^{14} up to 3×10^{16} $1MeVn_{eq}cm^{-2}$. This presentation covers IV measurements, injection scans at varying temperatures before and after annealing, and results from the latest test beam campaign, allowing the comparison of irradiated and non-irradiated samples and demonstrating the technology's suitability for high-radiation environments.

Primary experiment

Author: PILSL, Bernhard (Austrian Academy of Sciences (AT))

Presenter: PILSL, Bernhard (Austrian Academy of Sciences (AT))

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