

Prototyping and data analysis of SPARC, A CMOS based sensor with asynchronous readout

CMOS (Complementary Metal-Oxide Semiconductor) sensors are widely used as trackers in particle physics experiments due to their high granularity and low material budget. Nowadays, they are considered as favourite candidates for the trackers of future Higgs factories (FCC/ILC) as well as sensors for various medical and societal applications.

Their tiny pixel size enables to reach spatial resolution of the order of few micrometers. Moreover, the fabrication technology of CMOS sensors is still progressing by pushing the limit of the circuits printing resolution, which reduces the pixel size and enables improving the detection performances in terms of spatial resolution, efficiency, as well as readout rate.

PicSel group and C4PI platform have a very good expertise in the R&D of CMOS sensors and their characterization in the laboratory as well as on irradiation facilities.

The SPARC sensor was developed as part of an asynchronous readout architecture for CMOS pixel sensors. It is a prototype that includes a pixel matrix, an asynchronous readout system, timestamping, internal memory, and so on.

Asynchronous readout architectures offer several important advantages for pixel sensors—especially in high-rate or sparse-hit environments (typical in particle physics, imaging, and neuromorphic detectors): zero-suppression at the pixel level, fast response, low power consumption, fine time resolution.

Objective: Process, visualize, and interpret the data produced by the SPARC sensor to evaluate its performance (readout time, false trigger rate, position of activated pixels, etc.) and propose avenues for optimization.

Desired profile

- **Level:** Master's student (ideally M2), but strong M1 candidates may be considered depending on autonomy.
- **Skills:**
 - Python, MATLAB, or R for data processing.
 - Knowledge of electronics (basics) / CMOS pixel sensors.
 - Knowledge of particle-matter interaction and detection.
 - Knowledge of statistics and data visualization.
- **Assets:**
 - Experience in instrumentation or electronic readout.
 - Knowledge of asynchronous architectures is a plus.

References: Jean Soudier. Study of asynchronous readout architectures for CMOS pixels sensors. Micro and nanotechnologies/Microelectronics. Université de Strasbourg, 2024. English. {NNT : 2024STRAE047}. {tel-05111831}

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