Contribution ID: **90** Type: **Oral**

Fast Single-Quantum Measurement with a Multi-Amplifier Sensing Charge-Coupled Device

Thursday, 9 November 2023 13:50 (20 minutes)

Non-destructive readout capability of the Skipper Charge Coupled Device (CCD) has been proven to be a powerful technique to reduce the noise limitation of conventional silicon devices even to levels that allow single-photon or single-electron counting. The noise reduction is achieved by spending extra time taking several measurements of the same pixel charge. This extra time has been a limitation for the broader use of the technology in particle physics and astronomy applications beyond its successful use for dark matter searches. In this talk, I will present recent results of a novel sensor architecture that uses multiple non-destructive floating-gate amplifiers to achieve sub-electron readout noise in a thick, fully-depleted silicon detector as a solution to the readout time limitation with an order of magnitude increase in readout speed.
This Multi-Amplifier Sensing Charge-Coupled Device (MAS-CCD) can perform multiple independent charge measurements with each amplifier. These measurements from the multiple amplifiers can then be combined to reduce the readout noise without the penalty of the extra readout time of the repetitive sampling scheme of the Skipper CCD.
The readout speed of this detector scales roughly linearly with the number of amplifiers without requiring segmentation of the active area. We will show the results obtained for sensors with 8 and 16 amplifiers per readout stage. The noise reduction capability of the new technique will be demonstrated emphasizing the ability to resolve individual quanta, low energy particle detection, optical properties, and the ability to combine measurements across amplifiers to reduce readout noise.
The unprecedented low noise and fast readout of the MAS-CCD have been already identified as a candidate technology for the next large spectroscopic survey of galaxies, it provides a faster sensor alternative for background reduction in single-electron energy depositions searches from dark matter and other dark sector candidates and provides a suitable solution for fast readout in high-precision and quantum imaging systems.

Early Career

Yes

Primary authors: LAPI, Agustin (CONICET); DRLICA-WAGNER, Alex (Fermilab); BOTTI, Ana Martina (FNAL); IRIGOYEN GIMENEZ, Blas Junior (Fermi National Accelerator Laboratory); CERVANTES VERGARA, Brenda Aurea (Fermilab); CHAVEZ, CLAUDIO (Fermilab); MARRUFO VILLALPANDO, Edgard (University of Chicago); Dr CHIERCHIE, Fernando (Universidad Nacional del Sur); FERNANDEZ MORONI, Guillermo (Fermilab); Dr TIFFENBERG, Javier (Fermilab); ESTRADA, Juan (Fermilab); LIN, Kenneth (University of California, Berkeley); Dr SOFO HARO, Miguel (Universidad Nacional de Cordoba); Dr UEMURA, Sho (Fermilab); HOLLAND, Stephen (Lawrence Berkeley National Laboratory)

Presenter: IRIGOYEN GIMENEZ, Blas Junior (Fermi National Accelerator Laboratory)

Session Classification: RDC1+2+7

Track Classification: RDC Parallel Sessions: Cross-Cutting: RDCs 1, 2, and 7