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Multi-Amplifier Sensing Charge-Coupled Device as a solution for a fast single quanta CCD

Tuesday, 12 March 2024 10:30 (25 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, we will show the recent results of a new 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. The results show that the readout noise decreases as expected with the square root of the number of amplifiers providing a suitable solution for the construction of fast single quanta devices based on non-destructive readout sense nodes.

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This Multi-Amplifier Sensing Charge-Coupled Device (MAS-CCD) can perform 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.

During the talk we will show the measurements obtained with devices of 8 and 16 amplifiers per readout stage showing the improved performance compared to the Skipper CCD. The readout time of this detector decreases roughly linearly with the number of amplifiers without requiring segmentation of the active area as in the case of a distributed amplifier scheme. 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 low noise and fast readout of the MAS-CCD have been already identified as a candidate technology for spectroscopy experiments in terrestrial and space missions, and other lab applications such as quantum imaging.

contribution subject matter

CCD sensors

Keywords for your contribution subject matter (this will assist SOC in accurately characterizing your contribution)

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