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P2.30: Exploring coded aperture imaging with the MiniPIX EDU for high-resolution radiation belt electron pitch angle observations

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This work explores coded aperture imaging methods using the MiniPIX system for high-resolution angular observations of energetic electrons (100s of keV to several MeV) in Earth's radiation belts. Observing energetic electron pitch angle is critical to understanding energetic particle dynamics, and in particular, particle precipitation into the upper atmosphere.

We present a simulation study in Geant4 of the instrument design space, including coded aperture pattern, aperture thickness, and instrument geometry. Performance characteristics evaluated include angular resolution and field-of-view. We present the results of a proof-of-concept experiment using Advacam's MiniPIX EDU and a photochemical-etched Tungsten coded aperture mask to validate our simulation work.

We find that coded aperture imaging can achieve an angular resolution better than 1° across a narrow field-of-view ($<10^\circ$), or resolution better than 10° across a larger field-of-view ($>25^\circ$) but with losses in sensitivity and resolution across the field-of-view due to aperture collimation. Previous radiation belt electron observations typically provide no better than 10° resolution. We find that the MiniPIX EDU is a suitable high-resolution low-noise platform to validate our simulation work wherein we image sealed gamma emitters. We further explore the viability of the Timepix for high-resolution pitch angle observations of radiation belt electrons. The authors acknowledge funding from the National Aeronautics and Space Administration (NASA) (Award #80NSSC21K1394).

Primary author: REID, Riley (University of Colorado Boulder)

Co-authors: Prof. MARSHALL, Robert (University of Colorado Boulder); Mr BERLAND, Grant (University of Colorado Boulder); Prof. BLUM, Lauren (University of Colorado Boulder)

Presenter: REID, Riley (University of Colorado Boulder)

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