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The SMILE Soft X-ray Imager (SXI) CCD design and development

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SMILE, the Solar wind Magnetosphere Ionosphere Link Explorer, is a joint science mission between the European Space Agency and the Chinese Academy of Sciences. The spacecraft will be uniquely equipped to study the interaction between the Earth's magnetosphere-ionosphere system and the solar wind on a global scale. SMILE's instruments will explore this science through imaging of the solar wind charge exchange soft X-ray emission from the dayside magnetosheath, simultaneous imaging of the UV northern aurora and in situ monitoring of the solar wind and magnetosheath plasma and magnetic field conditions.

The Soft X-ray Imager (SXI) is the instrument being designed to observe X-ray photons emitted by the solar wind charge exchange process at photon energies between 200 eV and 2000 eV, using a lobster-eye micropore optic to observe over an ultra-wide field of view around $16^\circ \times 25^\circ$. X-rays will be collected using a focal plane array of two custom-designed CCDs, each consisting of $18 \mu\text{m}$ square pixels in a 4510 by 4510 array. The pixel array is asymmetrically split into image and store regions with a ratio of approximately 6:1 such that areas of 6×6 native pixels are binned on-chip before readout, thus creating super-pixels of $108 \mu\text{m}$ square in the image area.

SMILE will be placed in a highly elliptical polar orbit, passing in and out of the Earth's radiation belts every 48 hours. Proton damage accumulated in the CCDs during the mission's nominal 3-year lifetime will degrade their performance (such as through decreases in Charge Transfer Efficiency), negatively impacting the instrument's ability to detect low energy X-rays incident on the regions of the CCD image area furthest from the detector outputs. The design for the SMILE-SXI CCDs will be presented here, including discussion of proposed operating schemes, event detection algorithms, expected end of life CCD performance and results obtained from representative devices.

Primary authors: SOMAN, Matthew (Open University); HALL, David (Open University); Prof. HOLLAND, Andrew (The Open University); BURGON, Ross (Open University); BUGGEY, Thomas (Open University); SKOTTFELT, Jesper; SEMBAY, Steven (University of Leicester); DRUMM, Paul (University of Leicester); THORNHILL, Julian (University of Leicester); READ, Andrew (University of Leicester); WALTON, Dave (University College London - MSSL); BRANDUARDI-RAYMONT, Graziella (University College London - MSSL); RAAB, Walfried (European Space Agency); VERHOEVE, Peter (European Space Agency); AGNOLON, David (European Space Agency); GREIG, Tom (Teledyne e2v)

Presenter: SOMAN, Matthew (Open University)

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