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Electro-optical characterisation and radiation hardness of a CMOS image sensor optimised for soft X-ray astronomy

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CIS221-X is a prototype CMOS image sensor, optimised for soft X-ray astronomy and developed for the proposed ESA THESEUS mission. The sensor features 40 μm pixels built on a 35 μm thick, high-resistivity epitaxial silicon that is fully depleted by reverse substrate bias. A comprehensive electro-optical characterisation of CIS221-X has been completed. When cooled to -40 ℃, the image sensor reports a readout noise of 3.3 e- RMS and 12.4 $\pm$ 0.06 e-/pixel/s of dark current. Following per-pixel gain correction, an energy resolution of 126 $\pm$ 2 eV FWHM has been measured at 5.9 keV. In the 310 - 1900 eV energy range, the sensor achieves a quantum efficiency of above 80%. These results strongly support the consideration of CMOS technology for soft X-ray astronomy. To better understand how the CIS221-X would perform over the course of the THESEUS mission, it is necessary to test the radiation hardness of the image sensor. Using the ESTEC ^{60}Co facility, the CIS221-X sensitivity to total ionising dose (TID) has been measured. At increasing dose levels, readout noise, dark current and image lag were assessed. The results show the expected deterioration of CIS221-X performance due to TID over the course of the THESEUS mission.

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