

# 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  $40\ \mu\text{m}$  pixels built on a  $35\ \mu\text{m}$  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  $-40\ ^\circ\text{C}$ , the image sensor reports a readout noise of  $3.3\ \text{e}^- \text{RMS}$  and  $12.4 \pm 0.06\ \text{e}^-/\text{pixel/s}$  of dark current. Following per-pixel gain correction, an energy resolution of  $126 \pm 2\ \text{eV FWHM}$  has been measured at  $5.9\ \text{keV}$ . In the  $310 - 1900\ \text{eV}$  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  $^{60}\text{Co}$  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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