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Thermal Annealing Response following Total Ionizing Dose of a CMOS Imager for the JUICE JANUS Instrument

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ESA's JUICE (JUpiter ICy moon Explorer) spacecraft is an L-class mission destined for the Jovian system in 2030. Its primary goals are to 'investigate the conditions for planet formation and the emergence of life' and 'how does the solar system work'. The JANUS camera, an instrument on JUICE, is using a 4T Back Illuminated CMOS image sensor, the CIS115 constructed by Teledyne e2v.

JANUS imager test campaigns are studying the CIS115 following exposure to gammas, protons, electrons and heavy ions, simulating the harsh radiation environment present in the Jovian system The degradation in 4T CMOS device performance following Total Ionizing Dose (TID) is being studied, as well as the effectiveness of thermal annealing to reverse radiation damage. One key parameter for the JANUS mission is the Dark Current (DC) of the CIS115, which has been shown to degrade in previous radiation campaigns. A thermal anneal of the CIS115 has been used to accelerate any ageing or annealing following the irradiation as well as to study the recovery of any performance characteristics.

CIS115s have been irradiated to double expected End of Life levels of both displacement damage radiation (2×10^{10} protons, 10 MeV equivalent) and TID levels (up to 200 krad(Si)). Following this, some devices have undergone a thermal anneal cycle at 100℃ for 168 hours to reveal the extent to which the CIS115 recovers the pre irradiation performance. DC activation energy analysis following TID gives information of trap species present in the device that contribute to the DC and how effective anneal is at removing these trap species. Extensive recovery of this parameter could prove important in improving the device performance toward the end of the lifetime of the CIS115 on JUICE and other future missions.

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