The XGIS instrument on board the THESEUS mission: Detector Principle and Read-out electronics

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The **Transient High-Energy Sky and Early Universe Surveyor** (THESEUS) is a multi-instrument space mission concept proposed in response to the European Space Agency (ESA)'s M7 call for the medium size missions within the Cosmic Vision Program 2021 with an intended launch in 2037. With the past heritage derived as one of the successful candidates from M5 Phase-Assessment (Phase-A) study conducted by ESA in 2018, THESEUS successfully qualified the M7 Phase-0 in 2022 and is currently one of the candidates for M7 Phase-A selection 2023.

The combination of three state-of-art scientific payloads and instruments onboard along with its rapid spacecraft slewing capability, equip THESEUS with the potential of achieving its scientific goals to explore the early universe through identification, localization of Gamma Ray Bursts (GRBs) at higher redshifts (up to redshift of 10 and even beyond) and contribute to the multimessenger, time domain astrophysics through extensive monitoring of X-ray transient universe.

Good transient detection capability is achieved through very wide and deep sky monitoring in a broad energy band (0.3 keV – 10 MeV) through **XGIS (X/Gamma-ray Imaging Spectrometer)** in addition to good focusing capabilities in the soft X-ray band (0.3–5 keV) with high positional accuracy (≤ 2 arcmin) through SXI (Soft X-ray Imager) while immediate transient identification, arcsecond localization, and redshift determination of these transients with very high location accuracy is achieved with the onboard InfraRed Telescope (IRT).

The XGIS is a set of two coded-mask monitor cameras using monolithic SDD (Silicon Drift Detector) and CsI(Tl) scintillator-based X-ray and gamma-ray detectors while SXI is a set of two lobster-eye monitors dedicated to the follow-up in soft X-ray and imaging. The IRT is an infrared telescope with imaging and spectroscopy capabilities dedicated to the follow-up in the infrared waveband and the measure of the redshift of the GRBs.

XGIS is capable of covering an unprecedented wide energy band (2 keV – 10 MeV), with imaging capabilities and location accuracy <15 arcmin up to 150 keV over a Field of View of 2 sr, a few hundreds eV energy resolution in the X-ray band (<30 keV) and timing resolution down to a few μs by exploiting the coupling between Silicon Drift Detectors (SDD) with crystal scintillator bars. The design, working principle and the expected performances of the XGIS are presented. Furthermore, performance characterization of ORION, a very low noise multichip read out and processor electronics designed specifically for the XGIS instrument is also presented. This includes characterization of ORION I, a single channel version of this Application Specific Integrated Circuit (ASIC) both at room temperature and under a thermal cycle along with a second version of this ASIC (4 channel ORION IV) with both performance and functionality tests.