

TIRI: a multi-purpose Thermal InfraRed payload for asteroid observation

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TIRI is a multi-purpose Thermal InfraRed (TIR) Imager, initially designed for the Asteroid Impact Mission. It is conceived to pursue scientific goals such as retrieving temperature, thermal inertia, chemical composition and rock shape of the Didymos surface, and to aid the spacecraft navigation. A European consortium, formed by cosine measurement systems and GMV, has designed TIRI within the ESA General Studies Programme. TIRI takes advantage of the recent developments in TIR sensors, optical manufacturing, electronics and navigation algorithms. The result is a medium sized payload (ca. 11 kg mass and 18 litre volume). TIRI integrates two optical systems. The first is an imaging spectrometer, exhibiting a spatial resolution of few metres and a spectral resolution of tens of nanometres. It allows determining the asteroid surface temperature with an accuracy better than 5 K, to quantitatively evaluate its thermal inertia, and to sample its spectrum with more than 20 bands in the 8-14 micron range. The second TIRI optical head is NavIR, a miniaturised navigation camera (less than 1.5 litre volume), based on the HyperScout design, developed by cosine under an ESA GSTP contract. NavIR exhibits a fully reflective telescope with a large 2D field of view (up to 24x16 deg). The navigation system uses the NavIR images to determine the spacecraft position and velocity relative to the asteroid. A position error of tens of metres and a velocity error of centimetres per second are expected in the line-of-sight direction. Both optical instruments are integrated in the same mechanical structure and employ uncooled micro-bolometer arrays as detectors. The TIRI electronic system controls both detectors, it processes the acquired frames to enhance radiometric performance and it runs the navigation algorithms. Due to its high performance and versatility, TIRI can be effectively used in a wide range of small and medium size missions targeting near Earth small celestial bodies.