NEAR ULTRAVIOLET ASTRONOMICAL OBSERVATIONS FROM THE LUNAR SURFACE USING LUNAR ULTRAVIOLET COSMIC IMAGER (LUCI). Joice Mathew[1], Binu Kumar[1], Mayuresh Sarpotdar[1], Ambily Suresh[1], Nirmal K[1], A.G Sreejith[2], Margarita Safonova[3], Jayant Murthy[1] and Noah Brosch.[4] , [1]Indian Institute of Astrophysics, Bangalore, India (joice@iiap.res.in). [2]Space Research Institute, Austrian Academy of Sciences, Schmiedlstrasse 6, Graz, Austria. [3]M. P. Birla Institute of Fundamental Research, Bangalore, India. [4]The Wise Observatory and the Dept. Of Physics and Astronomy, Tel Aviv University, Israel.

Introduction: Observations from the Moon provide a unique opportunity to observe the sky from a stable platform far above the Earth atmosphere [1, 2]. This is especially relevant in the ultraviolet (UV) field. Hence we have explored the prospects for UV observations from the lunar surface, mainly the feasibility, scientific outcomes and possible configuration of UV telescopes [3]. To realize this, we have been in collaboration with TeamIndus, (an entry to the Google Lunar X prize competition), to put a UV telescope (LUCI-Lunar Ultraviolet Cosmic Imager) on the Moon as a piggyback payload. LUCI is an all spherical near UV (passband: 200-320 nm) telescope with a field of view of 0.46° x 0.34° [4].

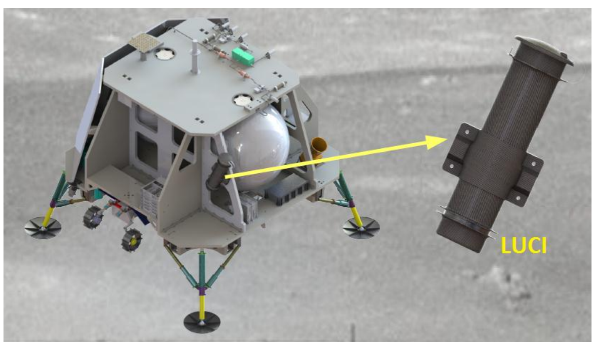

Figure. 1. LUCI on the TeamIndus lunar lander

LUCI will be mounted on the lunar lander (Fig. 1) as a transit telescope and will perform the survey of the available sky from the surface of the Moon. It has potential capability of delivering unique science - perform a survey of the available sky in the NUV domain from the surface of the Moon, with the aim to detect bright UV transients such as SNe, novae, TDE etc.

Here we will describe the various science cases of LUCI and will present the design and development of the instrument. We will also briefly explain the assembly, integration, and calibration of LUCI.

Science Objectives: A UV/optical transit telescope that uses the slow lunar sidereal rate was by Nein and Hilchey [5]. It was suggested that a large 20-m liquid mirror telescope [6] with UV imaging capability has the potential to surpass the sensitivity of HST and even JWST by orders of magnitude [7].

The primary science goal of LUCI is the detection of transients such as, for example, Tidal Disruption Events (TDEs), or SNe in distant galaxies as a probe for cosmological distant scale. As we perform survey of the sky, we will also pick up other transients such as near-Earth asteroids, as well as produce an NUV catalog of the sky. A majority of short-scale UV transients are stellar flares from late-type stars, for example, *K* and *M* dwarfs [8]. The M dwarf flare 100 pc away will produce UV flux at Earth of $10–10^2$ photons/cm^2, detectable by LUCI in 100 sec [4]. In Fig. 2 we show the black body flux curves for a solar type star (G8V, τ Ceti taken as an example), a cooler star (K2V, ε Eri as an example) and an *M* dwarf (M6V, Proxima Cen as an example) as seen from the same distances, along with UV sensitivity of LUCI for several exposure times with $SNR = 5$.

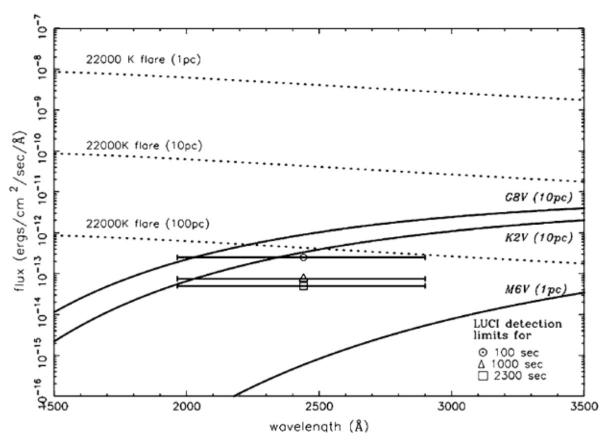

Fig. 2. LUCI detection limits for different integrated exposures

Instrument Overview: The instrument is an all-spherical UV telescope, with a weight of 1.2 kg. It will be used to study the variability and environment of bright UV sources by acquiring photometric time-series in the 200–320 nm wavelength range. The events will be processed and stored on-board, and send back to Earth whenever the radio link is available. The cross-section of the instrument is shown in Fig. 3, and technical specifications are given in Table. 1.

Table. 1. Instrument Specifications

Instrument	UV Imager
Telescope	Cassegrain
Field of View	0.46° x 0.34°
Aperture	80 mm
Focal length	800.69 mm
Detector	UV-sensitive CCD
Sensor format	1360 x1024 (HxV)
Pixel Scale	1.2”/pixel
Resolution	5”
Band of operation	200-320 nm
Weight	1.2 kg
Dimension	450 mm x150 mm
Power	< 5 W
Sun Avoidance	45°
Sensitivity	12 with S/N: 3

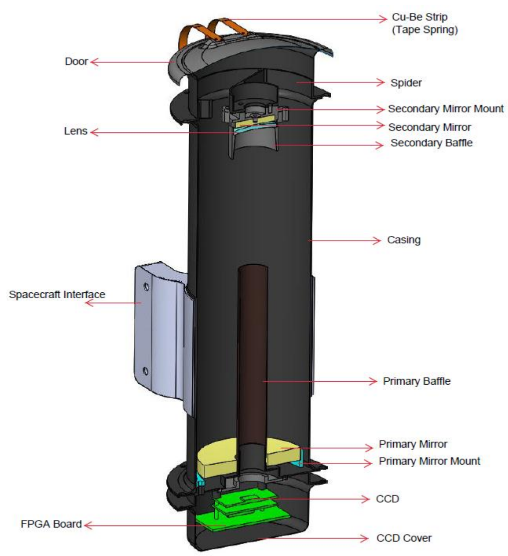

Fig. 3. LUCI Cross-section

Assembly and Calibration: The payload has been assembled in the class 1000 clean room in the M.G.K. Menon Laboratory for Space Sciences; this facility was used for the assembly, integration, and calibration of the UVIT instrument [9]. Opto-mechanical alignment of the instrument was carried out by using alignment telescope cum auto collimator (for coarse alignment) and ZYGO interferometer (fine alignment). We will also discuss the various ground calibration tests performed on the assembled telescope. The various calibrations tests involve, the determination of PSF, WFE, FOV, distortion, QE of detector, linearity, and uniformity of the detector, filter transmission, effective area of the telescope, sensitivity limits. The primary space photometric calibration of LUCI will be made with reference to a set of well-studied hot, young and/or massive stars, including bright O,B, and bright white dwarfs as was done for the UV instruments onboard the HST.

Observation Strategy: LUCI will be mounted as a transit telescope, where it will look at zenith to scan the sky in the NUV domain. The apparent motion of the celestial objects will allow the telescope scan a portion of the sky, and the observation will continue until the object moves out of the available sky region of the telescope. The required power for the detector will be provided by the lander, where solar panels are the primary source of electrical energy during the lunar day surface operations, therefore LUCI will only operate in the daytime.

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