COMPACT EXPERIMENTAL HIGH ENERGY TELESCOPE ON DEEP SPACE GATEWAY. A.A. Gozutok [1], M.I. Gozutok [2], [1]Department of Atmospheric Science, Istanbul Technical University, agozutok@itu.edu.tr, [2] Department of Physics, Canakkale Onsekiz Mart University, inanc.gztk@gmail.com

Introduction: An advantage of high energy spectrum data collecting system with additional X-ray and Gamma ray acquisition sensors on Deep Space Gateway; a spaceship in lunar vicinity, would be a considered as a giant leap in aspects of radio astronomy and astrophysics topics using native celestial and orbital characteristics of Moon. When we consider the Earth's atmosphere which absorbs the incoming ultraviolet (UV), X-ray and Gamma spectrum, we may clearly state that it is impossible to conduct a research on UV astronomy without going outer space, so the observations at this spectrum must be performed by the spacecrafts/space telescopes or may be a remote lander/rover Infrared, UV/X-ray/Gamma telescope, robotic high energetic particle missions on Moon which would have been beneficial for the high energy research and mankind' knowledge about our solar system, our galaxy and universe.

Within this opportunity of a space gateway which will be orbiting around the Moon, the data obtained from the distant space objects will not be exposed to the atmospheric effects like pollutants, aerosols, and like any other noise generating obstacles which diminish the astronomic observations just like on the Earth's surface. The general purpose of high energy particle astronomy is that the observation and understanding the phenomena and the mysteries behind of celestial objects like energetic deep universe objects: supernovas, binary stars, black holes, our Sun, upper atmospheric research for observation of interactions between exosphere and solar activity and so on to those which emit radiation on UV and X-ray spectrum. In addition, the observation process could also be maintained continuously through communication with command and data uplink – downlink via Earth orbiting data relay satellites or direct receiving data terminals on Earth in near-real time with some signal delay in such systems, which are corrected by telemetry & tracking algorithms.

The equipments and electronic devices that are required on telescope system to work properly according to the mission are defined as initially data acquisition (telescope aperture and structure) system which includes IR, UV, X-rays & Gamma rays sensors & instruments compartment and primary telescope mirror assembly with proper RF filters and RF switches, what is more, the internal pointing, orientation and aperture alignment system including fixed star sensors for focusing proper astronomical objects is needed too for operations to avoid traditional azimuth-elevation correction by crew and not to interrupt spacecraft operations that will be hold on while the Deep Space Gateway is in operation. Also after data acquisition, a data management system is required to store and archive observation data, it may be added or programmed lately on spacecraft computers to process, generate and prepare the enhanced levels of science data from raw data acquisitions and conduct initial tests and signal processing. After the system integration procedure, the crew may calibrate the instruments on/board for general mission, do maintenance checks to achieve better scientific results and make improvements according to mission procedures. Also the telescope autonomy on the spacecraft interface which may set-up and control the instruments autonomously, which could be developed will prevent and reduce the additional crew/ground segment operations to cover times while observing variety of high energy sources across the celestial sky frame. The distant sky objects will take long time to observe since the more distant the object is the more faint signal received by the detectors.

Instruments on/board the Deep Space Gateway should be radiation resistant to protect the crew members and instruments. For the main mission phase, the thermal ranges of the electronics may vary between 210 to 350 K for minimum and maximum space environment limits for operation and non-operation constraints to work properly so that the scientific instruments & passive RF filters on/board should be cooled and/or heated accordingly for better accuracy and stability considerations, moreover, the localisation of the telescope may be considered to look forward from the dark side of the Moon where we can not see from the Earth, since the radio-free side would be the best position to prevent UV interference from the Earth's atmosphere & surface due to the Sun rays reflection, then according to this, the spacecraft attitude and orbital specifications of the mission phase would be classified. If we consider Low Lunar Orbit (LLO) station keeping, in order to maintain this configuration, it will be needed that the energy generating solar panels would be switched off to the batteries for an approximately 2 weeks for a month since the synodic period of the Moon equals 29.53059 days and half of this period will be dark while the other half will be sunlit. However, the operation orbit of the telescope can possibly be the most effectively conducted on Earth – Moon L2 Halo Orbit and Near Rectilinear Halo Orbit (NRHO) to have

continuous Earth and Moon surface communication coverage & easier for spacecraft tracking, a hundred percent Earth visibility is also provided with having less eclipse time intervals generated by the shadow of the Earth and also have lesser ΔV velocity increments for Deep Space Gateway thruster firings and to configure orbits and attitude orientation easily by low energy manoeuvres for station keeping. General operation procedures of detector compartment will include cooldown periods of the HE detectors, initialization of the system for observation period, the observation, then regeneration to cooldown to initial states of electronics & standby mode between the other mission modes. During those mission intervals, the data obtained from the observation will be calibrated in terms of orbital attitude of the Gateway and ephemeris of the target object, then modulated & encoded to achieve better signal energy per bit over noise density values, then transferred to Earth terminals via high data rate (HDR) telemetry downlink since the data obtained from the observations are stored on a limited disk space in Gbits, after these standart procedures the observation data of high energy environment will be ready to use by researchers and engineers.

We may expect the data collected from such reliable observations will contribute on the researches and technological development on upper atmospheric research, detection of deep space objects which radiates IR/UV/Gamma/X-ray radiation properties, galaxy and star systems evolution, our Sun and solar system topics and a lot more so on, in the end, the flight model will revolutionize our understanding about hot & energetic background of our universe.

Estimated experiment/mission properties

Mass of hardware

70-100 kg. for max. mass budget allocated

Volume of hardware

0.6 m3 for predicted size (using between 85-90 cm aperture diameter) 0.85 m x 0.85 m x 0.85 m

Accommodation (e.g. internal/external)

External hardware which will be operated independently from the Lunar Gateway module, spacecraft body itself

Power required

- Power drawn for tracking, focusing and communication is 75 Watts nominally.
- Power drawn for cooling/radiating the UV receiver system for reducing system noise is 20 Watts to cool down the detector sub-system. (no power requirement if passive foil shielding with thermal blankets is used)
- Power drawn for operations is 25 Watts/max.
- Total power needed 120 W max.

Data generated

- Data generation rate may rise up to Gbits/day
- An approximation for data generation: for 2000 x 2000 sensor resolution, 16 bits radiometric resolution, and 3 different channels of UV spectrum including between near UV & far UV will result in:

= (2000*2000*16*3) = 192 Mbits per image/frame

- Same calculation procedure may be considered for the X-ray and Gamma Ray radiometry

Pointing/viewing/line of sight needs

- Localisation and pointing of the telescope may be set on dark side (radio-free side) of the Moon or directed away from the Earth for better data quality for lower noise reception and performance of sensor and telescope operations

Communications needed

Optional communication links may be established between Earth/Lunar Stations or data relays/orbiters for considering further Moon missions.

Duration of experiment

May differ for properties of the target space objects (minutes-hours) or relies on better sensitive sensors.

Crew tasks (if needed)

Mounting, calibration, maintenance operations will & may be held by the crew including EVA's for these purposes.

Access and servicing by crew (if needed)

Access and servicing is needed for telescope operating tasks by relay communication.

Need for retrieval and return to Earth

Not needed, may be upgraded later for further lunar gateway terminal enhancements

Specific orbit needs (if any)

L2, NRHO (not to set constraint on the operations) or LLO (lower performance)

Operations without crew (if any)

Remote command operations from ground station, telescope orientation and programming, spacecraft payload housekeeping, data acquisition and telemetry downlink.

References

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