URSI AP-RASC, Sydney, Australia, 17 – 22 August 2025

SEAMS: A space mission dedicated to ultra-low frequency radio observations

Abhirup Datta*(1), Harsha A. Tanti(1), Aditee Joshi(2), Damayanti Gharpure(2), Subramaniam Ananthakrishnan(2), Narendranath Patra (1), Suman Majumdar(1), and Janardhan Padmanabhan(3),
(1) Department of Astronomy,Astrophysics and Space Engineering, IIT Indore, Indore, 453552, Madhya Pradesh, India; e-mail: abhirup.datta@iiti.ac.in
(2) Department of Electronics and Instrumentation Science, Savitribai Phule Pune University, Pune, 411007, Maharashtra, India; e-mail: dcgharpure@gmail.com; subra.anan@gmail.com
(3) Physical Research Laboratory, Ahmedabad, 380009, Gujarat, India; e-mail: janardhan.padmanabhan@gmail.com

The Space Electric and Magnetic Sensors,(SEAMS) is a mission dedicated to opening up low-frequency observations of the radio sky. This mission will offer sensitive measurements for frequencies below 20 Mhz to 300 kHz. Thereby enabling astronomers to study radio emissions from the Sun, planetary and exoplanetary magnetosphere, and the galactic spectrum at such low frequencies. With regard to the cosmological red-shifted HI 21cm line, the SEAMS frequency band targets the early universe from around 0.38 to 400 million years after the Big Bang, mainly known as the Cosmic Dark Ages. It will allow us to study a wide range of astrophysical phenomena that are not easily observed from the ground due to the Earth's ionosphere. The mission is designed in multiple phases. In the initial phase, the payload will be mounted on the fourth stage of PSLV and placed in the Low Earth orbit (LEO) around the earth to study relatively high-energy phenomena at such low-frequency bands like Auroral Kilometric wave Radiation (AKRs), CMEs, and radio bursts. The RFI from Earth in the LEO environment will be mapped in order to aid in the design of future phases. The next phase is designed to have multiple payloads orbiting at the LEO. This study will demonstrate the science achieved using LEO radio interferometry. In the final phase, the best configuration of SEAMS will be deployed in a Lunar orbit to carry out sensitive cosmological and planetary experiments.

In this work, we present the scientific scopes of this mission, different stages of prototyping of SEAMS phase I, and an initial cube satellite prototype of SEAMS phase I. The SEAMS phase I contains two electric field sensors,(Active antenna) with a Xilinx Virtex-7-based customized preprocessing system and an on-board computer to oversee the health of the satellite. Several tests were performed in a radio-quiet environment, which show that the RF and the digital system are sensitive enough to detect at least the galactic background. To further increase the sensitivity, it is observed from simulations that the antenna size has to be increased. In this study, ground test cases for the SEAMS phase I prototype are also presented. In addition, we present the use of a modified direction-of-arrival (DoA) algorithm to accommodate the mission-specific requirements of the SEAMS mission.

References

[1] Atharva, K., Aditee, N., Rasika, S., Nikhil, N., D.C., G., Abhirup, D., . . . S., A. (2021). Instrumentation for seams phase i. *In URSI GASS 2021*, Rome.

[2] Tanti, H. A., Datta, A., Biswas, T., and Tripathi, A.,(2025), "Development of a machine learning-based radio source localization algorithm for tri-axial antenna configuration: Development of a machine learning-based radio source...", *JApA*,46,1,5, doi:10.1007/s12036-024-10032-w.

[3] Tanti, H. A., Datta, A., and Ananthakrishnan, S.,(2023)"Snapshot averaged Matrix Pencil Method (SAM) for direction of arrival estimation", *Experimental Astronomy*,56,1,267–292, doi:10.1007/s10686-023-09897-6.