IAF SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SPACE PHYSICS MISSIONS (A7)
Technology Needs for Future Missions, Systems, and Instruments (3)

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TECHNOLOGY ROADMAP OF MANUFACTURING AND ROBOTIC ASSEMBLY OF A LUNAR RADIO TELESCOPE ON THE FAR SIDE OF THE MOON

Abstract

This paper presents a 15-year technology roadmap detailing the in-situ manufacturing and robotic assembly of a low frequency radio telescope on the far side of the moon. Frequencies below 30 MHz are undetectable by telescopes on the surface of Earth or in low earth orbit (LEO). The Earth's ionosphere reflects these frequencies, distorting the waves as they travel through it. The far side of the moon has long been a proposed location to observe frequencies below 30 MHz as this is the most viable approach for natural radio wave shielding. Data collected by a low frequency array on the far side of the moon would be invaluable to the astrophysics community, enabling observation of emissions from the first stars and galaxies due to the red-shifting of these sources.

The proposed roadmap is based off of the LOFAR (Low-Frequency Array) Superterp design and was selected as a template because it was designed for 30 MHz and can be modified to look at lower frequencies. Superterp can also be combined with similar stations to create a larger telescope array enabled by manufacturing and assembly for future mission concepts. Superterp is comprised of an array of low band antennas (LBA) and high band antennas (HBA). The roadmap focuses on the construction of the LBA's optimized for 10 MHz to 80 MHz and not the HBA's optimized for above 80 MHz.

The paper describes the in-situ lunar manufacturing and robotic assembly of a LOFAR on the far side of the moon. Robotic assembly is preferable due to the increased complexity and cost of a crewed mission. Modern rover technologies, such as the VIPER (Volatiles Investigating Polar Exploration Rover), are assessed for use during large area construction. Additionally, new technology development such as OSAM (On-Orbit Servicing, Assembly, and Manufacturing) technologies and In-Situ Resource Utilization (ISRU) regolith 3D printing, are examined with respect to the overall technology roadmap. Qualitative and quantitative analysis are performed on these emerging technologies with respect to current Technology

Readiness Level (TRL), required TRL, price for this transition, timeline, complexity, and total value when considering this mission. This paper concludes with a 15-year road map including the above categories for executing this mission.