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Author: Ms. Molly Kirkpatrick
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

Mr. Sander Voss
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
Dr. Jack Webster
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
Mr. Lance Munday
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
Mr. Clint McNally
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
Dr. Joe Perkins
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia
Dr. Brianna Ganly
Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

VALIDATION AND VERIFICATION OF THE MINIATURE X-RAY FLUORESCENCE PAYLOAD (MINIXRF) FOR ISRU

Abstract

The manufacturing of large structures in cislunar space is currently prohibitively expensive due to the high launch cost of materials from Earth [1]. One method to increase the economic and technical viability of space-based construction is through lunar In-Situ Resource Utilisation (ISRU) to provide the required resources from lunar regolith. In conventional terrestrial mineral processing operations, monitoring and control systems are essential to maintain the efficiency and efficacy of the process. In a similar way, the success of ISRU methods in a cislunar context relies on the development of sensing technologies that can characterize and assess the properties of lunar regolith [2].

This paper presents the scientific motivation, design and testing of a miniaturised X-ray fluorescence (XRF) payload, the MiniXRF. The MiniXRF is unique in its small size, light weight and low-cost design based on terrestrially proven components. It is engineered for integration with robotic platforms in space environments to reliably determine the elemental composition of materials within the ISRU value chain including exploration, prospecting, excavation and processing. By monitoring feed, waste and value streams , MiniXRF can provide critical information during the construction of habitats, life support systems, and other infrastructure necessary to enable a sustained human presence in space.

The designed instrument weighs less than 650 grams with a volume of just over 0.5 litres. A qualification model was built and successfully passed mechanical vibration testing, electro-magnetic emissions and susceptibility testing and thermal vacuum testing. These results show that the integrated instrument can withstand expected launch and operational conditions for a lunar mission. Functional and performance verification was also conducted and demonstrated that the instrument can measure changes in the feed, value and waste streams of magnetically separated lunar regolith simulant. The test results are presented, demonstrating that the MiniXRF is a space-ready payload capable of supporting remote ISRU mineral beneficiation processes in space.

[1] Bennett, N.J. and Dempster, A.G. (2022). Lowering the barriers to lunar sourced propellant via competitive parity pricing. Acta Astronautica, 191, pp.88–98. doi:https://doi.org/10.1016/j.actaastro.2021.11.006.

[2] Hadler, K., Martin, D.J.P., Carpenter, J., Cilliers, J.J., Morse, A., Starr, S., Rasera, J.N., Seweryn, K., Reiss, P. and Meurisse, A. (2020). A universal framework for Space Resource Utilisation (SRU). Planetary and Space Science, [online] 182, p.104811. doi:https://doi.org/10.1016/j.pss.2019.104811.