IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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X-RAY FLUORESCENCE FOR MOON EXPLORATION AND EXPLOITATION

Abstract

X-Ray Fluorescence (XRF) is a spectroscopic method that allows detection and measurements of the amount of any atoms heavier than Na. XRF spectrometers are used in wide range of application and are paramount instruments for planetary science since the beginning of space exploration. Improvements of detectors and electronics allowed to improve capabilities of such planetary instruments. Up to now, all the XRF space instruments have used radioisotopes sources as excitation sources. The only exception is the very last PIXL instrument sent on Mars by NASA onboard Perseverance which uses an X-Ray tube. We propose to use XRF for three different instruments for the exploration and exploitation of the Moon. The first instrument will be placed on a rover for geological survey; this instrument will used pyroelectric X-ray generator as an excitation source. We reached an energy resolution of 121.17 eV using a Silicon Drift Detector (SDD) and we have reduced measurement fluctuation from 25.2The second one will used by astronauts in a handheld version and will use a miniature X-Ray tube. The device will allow rapid sampling of rocks to allow the best choice of samples for earth return. The device will use machine learning and will present results on simple way to tell astronauts if a sample is worth collecting. The current TRL level of this second instrument is 4

The third one will be used to monitor the Oxygen production unit from lunar regolith. Oxygen extraction is taking place using a method called molten salt electrolysis, involving placing regolith in a metal basket with molten calcium chloride salt to serve as an electrolyte, heated to 950C. At this temperature the regolith remains solid. But passing a current through it causes the oxygen to be extracted from the regolith and migrate across the salt to be collected at an anode. As a bonus this process also converts the regolith into usable metal alloys. XRF will be used to follow the concentration of atoms involved in the process and therefore to monitor the oxygen production. The current TRL level of this third instrument is 2.