PLATFORM FOR CONDUCTING EXPERIMENTS TO STUDY THE LONG-TERM EXPOSURE EFFECTS OF SPACECRAFT COATING, MATERIALS AND COMPONENTS IN A DEEP-SPACE ENVIRONMENT. J. F. Rosenqvist[1], A. Bhardwaj[1], M. I. Nazarious[1], J. Martín-Torres[1,3,4], M.-P. Zorzano[1,2], D. Fernandez-Remolar[1], J. A. Ramirez-Luque[1], A. Soria-Salinas[1], T. Mathanlal[1], S. Konatham[1] and A. Ramachandran[1]. [1]Luleå University of Technology (LTU), Luleå, Sweden, joaros-6@student.ltu.se. [2]Centro de Astrobiología (INTA-CSIC), Torrejon de Ardoz, Spain. [3]Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Granada, Spain. [4]UK Centre for Astrobiology, The University of Edinburgh, Edinburgh, U.K.

Scientific Domain: Physical Sciences, Materials, Coating, Technical Readiness Level (TRL), Aging.

Introduction: The rapid growth in research and development of spacecraft capable of deep-space travel results in an increasing demand for technology capable of enduring the conditions that come with this kind of longterm exposure. Space travel to potential destinations like Moon, Mars and others involve demanding technological challenges to overcome long term exposure to bombarding space radiation, huge temperature fluxes, possible attack of micro-meteorites etc. that degrades the health of spacecraft in several ways. This calls for technology and materials capable of sustaining outer space for long periods at a time. Materials exposure testing has been conducted previously, with the MISSE experiments on the ISS [1], but the limitations of those experiments are their large testing platforms, and lack of exposure to a deep space environment. Other exposure experiments, such as the biological EXPOSE-R [2], has also been performed on the ISS previously, but suffers the same limitations as mentioned above. Therefore, improved designs on existing concepts will be required for materials that can endure the above mentioned environment, which requires a simple, reliable, versatile and adaptable method for testing new technologies being brought forward to meet the challenges mentioned above. The Deep Space Gateway will be of a small size, an expected pressurized volume of 2,684 cu ft, compared to the ISS which is has a pressurized volume of 32,898 cu ft, which will result in less options in terms of exterior space and number of attachment points. Therefore a more compact and centralized testing platform, capable of holding any type of exposure experiment adjusted to fit, on the outer hull of the space station would allow for solving this issue.

Idea description: The idea of this experiment is to provide a platform for testing various kinds of coating, paint, materials, components etc. to determine that the experiment being tested is suitable/viable to be applied on future spacecraft/space stations used for deep-space travel. The platform can also be used to test anything designed to be placed on the outside of a spacecraft, for example solar panels, protective alloys and many other currently existing, and upcoming concepts.

The platform (Fig. 1) would be designed as a 11 sq ft plate (plate size is subject of change), which has a grid-shape designed placement to fit in 8 smaller plates, which would hold the experiment that is of interest in testing in a deep-space environment. The centre of the central plate would leave room for attachment of sensors, which can be interchanged based on what is of interest to measure. This plate would be attached to the outside of the space station. The smaller plates would be attached via a detachable method to the main plate. The smaller plates would have different kinds of coating applied, to be tested over a long-term period. Most of the coatings that would be tested might already have a TRL of 9, but what hasn't been possible before is long term monitoring of these coatings, as well as possible sample return for closer examination. Other components can be tested on the same central plate, having been modified to fit to the central plates' attachment mechanism. Several sensors will be mounted to the central plate to check important variables such as radiation, temperature gradients, light-levels etc, but there will also be room to add other sensors that are relevant for a specific experiment, and these, too, can be interchanged. A monitoring camera would be attached next to the central plate, and connected to a live network which can be accessed and checked by onboard crew as well as researchers on ground. The camera would be able to monitor micro-meteorite impacts on the experiments, and provide a visual result of this event.

A few examples of experiments (fig. 2) that could be performed on this platform would be to test a new type of Multi-Layer Insulation (MLI) material designed to be used in spacesuits with a current TRL of 6 and associated sensors of relevance, experiments that could lead to further development in spacecraft coating for deep-space travel, testing protective alloys to protect from different elements, such as micro-impacts. Many components/materials of existing and upcoming concepts would allow for possible increase in TRL and development of better versions more suited to the long-term exposure, as well as improving the sustainability and protection of human passengers on board a spacecraft located in deep space. The long term-exposure effects could be quantified and new improvements for existing spacecraft can be formulated from this, resulting in less degradation over time.

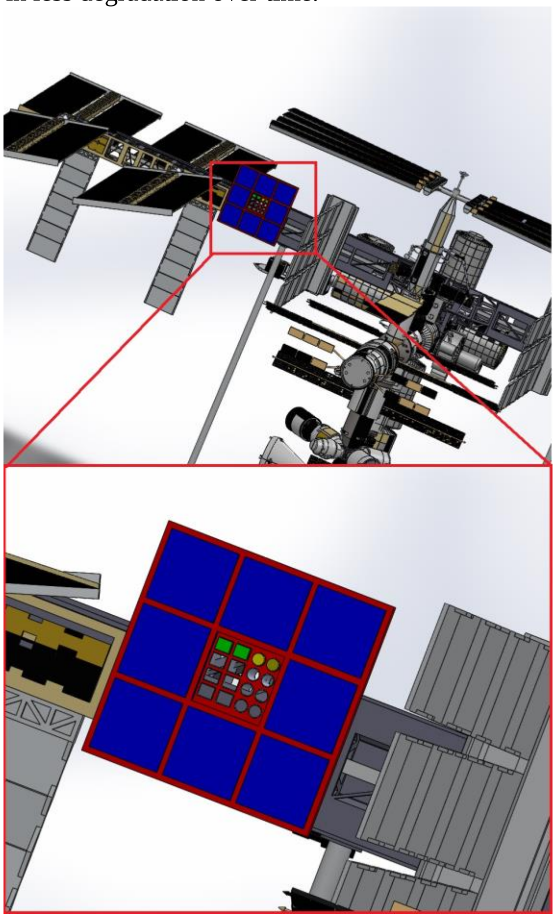

Fig.1: The images above illustrates a simple model of the platform attached to a space station, NOT to scale.

This testing platform offers the possibility of raising the TRL of many upcoming concepts with a simple, inexpensive testing method, opening access for more companies, research groups etc. to improve the TRL for their concept ideas, that involves deep-space exposure. There will likely be interest from research groups, companies, agencies etc. to bring back the experiments to Earth for closer examination of the long-term exposure test. This will be easily achieved, as the experiments would be of a fairly small size to fit on the main plate, which allows for easy and lightweight transport on a spacecraft heading back to earth.

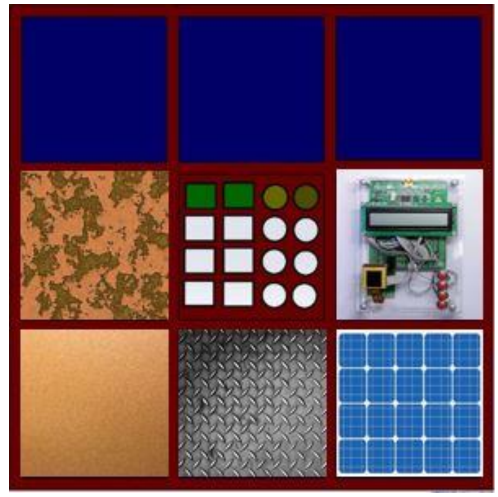

Fig.2: The above image illustrates the platform with attached examples of experiments such as coatings, materials and components.

On-board crew would have to be available to attach the main plate to the exterior hull of the space station. They would also have to be available to detach experiments and attach new ones on to the main plate. A simple attachment mechanism would allow for experiments and sensors to be easily interchanged by the crew. Should robotic manipulation, such as a Canadarm [3] be available, the central plate and the attachment mechanism could be modified to attaching experiments via this method. Ability to survey the experiments from the station would be recommended, possibly through a window, or a live-feed from the monitoring camera connected to a monitor inside the station. At some of the proposed lunar orbits, continuous live-feed would not be a possibility, so an option of recording during the blackout-periods would have to be available.

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