Analytical Techniques in Double Walled Isolator and BLS4+ Sample Return Facilities

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Restricted, Category V Earth Return planetary protection protocols [1] impose a number of procedural requirements on the handling of material returned from target bodies like Mars and Phobos. Double Wall Isolation (DWI) will address these concerns and is a crucial component in the containment system for samples delivered to a specialist curation facility. The advantage of this system is that it maintains both containment and ultra-cleanliness of the samples. Management of sample quarantine is critical and the DWI approach protects the samples from terrestrial contamination ingress, cross contamination, and provides mitigation of risk to our biosphere, from intrinsic sample pathogens. A key to the effectiveness of this system is development of a set of standard interfaces between the DWI and the scientific instruments that are necessary to analyse the samples.

Using martian meteorites as analogues, the full range of techniques required to characterise samples usually follows a chain from optical microscopy, polished section preparation, electron microscopy and mass spectrometry. However, the DWI and/or BLS4+ environment required to satisfy planetary protection constraints [1] mean that this chain of analyses is challenging for returned samples where planetary protection is a constraint. One example is the loss of material and use of resins during polished section preparation for meteorites. Other analyses may necessitate the use of a high resolution optical microscope and relatively complex remote manipulation of a microscopic sample, all self-contained within the DWI. Such interfaces (e.g. power or light conduit & data) may be straightforward. However, other decisive instruments will probably include X-Ray Tomography, to investigate the sample interior, and electron microscopy to characterise the surface topography and composition. These instruments require extensive ancillary interfaces to high power (high tension supplies), active or passive cooling/heating, focused electron (or ion) beams, high energy X-rays, three dimensional sample articulation, high vacuum containment and specialist gases. Such interfaces present a number of complex technical challenges and will be assessed as part of an ESA study [2] for their compatibility with the unique functional requirements of the DWI system.

References: [1] Debus, A. (2006) The European standard on planetary protection requirements. Research in Microbiology 157(1): 13-18 [2] ESA Work Plan ref. Work Plan ref. E914-005MM.

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