Potential for Characterization of the Dust Threat for In-Situ Resource Utilization. W. T. Pike and J. B. McClean, Department of Electrical and Electronic Engineering, Imperial College London, South Kensington Campus, SW7 2AZ, United Kingdom, w.t.pike@imperial.ac.uk, j.mcclean15@imperial.ac.uk.

In-Situ Resource Utilization (ISRU) offers the opportunity to reduce the launch mass of planetary exploration missions. One application is the manufacture of O_2 from Mars' atmospheric CO_2. Mars 2020 will carry the Mars Oxygen ISRU Experiment (MOXIE), a 1% scale ISRU plant technology demonstrator which compresses CO_2 using a scroll pump and generates up to 20g/hr of O_2 via solid oxide electrolysis (SOXE) [1].

One of the requirements is that the O_2 produced must be of high (>99.6%) purity. To prevent dust ingestion, MOXIE's intake is protected by a High-Efficiency Particulate Arrestance (HEPA) filter. For the short operational time of MOXIE (50 sols), this is likely to be sufficient. However, for a continuously operating full-scale ISRU plant, such a filter may clog, preventing the production of the required amount of O_2. Unlike solar panels, it is not certain that dust devils can be relied upon to clean such a filter.

Sources of dust include long- and short-term suspension, saltation, reptation, and creep. The dust flux will increase during dust devils and storms, and will be influenced by the local topography as well as the presence of the rover itself. The main threat to an ISRU plant inlet is likely to be saltated particles. Saltation is the transport of particles by the combination of wind and repeated impacts with the surface. Typically, saltated particles on Mars are expected to be in the size range 50 to several hundred microns, with a typical saltation height and length of 10 cm and 1 m respectively [2]. There are several uncertainties in the dust characteristics, and as a result, there is a need to improve understanding of the likely Particle Size Distribution (PSD) and flux at the inlet of a full-scale ISRU plant.

One concept for a dust characterization instrument is a MEMS device which requires little or no power and is very low mass. Several designs are being studied which use structures micromachined in silicon to ingest, filter, and store dust particles in the size range 2 to 400 μm. Due to their small (centimeter scale) size and low mass, these devices could be mounted in a variety of locations and orientations. The dust PSD and flux can then be estimated from repeated viewing of the dust hoppers with the robotic arm, or active measurement capability may be added.

Sieving is an obvious and familiar technique for particle size analysis, and one initial design uses arrays of microsieves. An example is shown in Fig. 1, below.

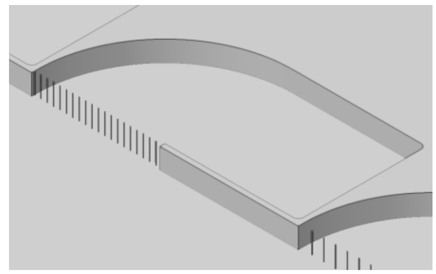

Figure 1 Example of geometry. Particles enter from the bottom left, and size selection is achieved by the microsieve.

Sieve cut-off sizes can be selected to study the relative fluxes of particles with sizes relevant to the MOXIE design, such as those that would affect sealing or scroll pump clearances. However, despite the familiarity of this technique it has several limitations [3]. Firstly, for dry sieving the minimum particle size is in the range 20 to 50 μm; below this size range, the effects of mechanical and electrostatic blockage become problematic. For finer sieves, the particles need to be set in motion either by an air jet or liquid, both of which would be impractical for the current application. Secondly, blockages of apertures, or 'blinding', produces a size cut-off that varies with time. Thirdly, although the expected size range of saltated particles overlaps well with the applicability of the technique, the typical saltation height presents a challenge in accessing the dust.

It is likely that any final instrument will require a combination of passive and active techniques. Beyond the initial, purely mechanical concept, other options are being studied, from more complex arrangements of sieves to the use of entrained flows in a cascade impactor arrangement. It is planned to develop and test these designs in a representative environment to investigate their potential to characterize the likely dust threat to MOXIE and any future full-scale ISRU plant.

References: [1] Hecht, M. H. and Hoffman, J. A. (2015) *LPS XLVI,* Abstract #2774 [2] Kok, J. F. et al. (2012) *Rep. Prog. Phys.*, *75*, 10, 106901 [3] Leschonski, K. (1979) *Powder Tech., 24,* 2, 115-124.