INTRODUCTION: Long-lived radionuclides, $^{10}$Be, $^{26}$Al, and $^{51}$Mn, produced on the surface of the Sun are entrained into the solar wind (SW). Expected fluxes of these nuclides in the SW are <200 atom/cm$^2$/yr at 1 AU, but are highly uncertain. One of the objectives of the Genesis mission was to capture measurable quantities of these radionuclides in large (~8000 cm$^2$) Mo-coated Pt foils deployed in the lid of the sample return capsule (SRC). The Genesis mission exposed these foils to the Sun for ~2.4 yr. Our original plan to analyze the captured SW radionuclides included the following steps:

1. remove loosely attached terrestrial dust without damaging the Mo coating;
2. identify and remove micrometeorite (MM) impacts, which contain high levels of cosmogenic $^{10}$Be, $^{26}$Al, and $^{51}$Mn, leaving <1 µg of MM material on the entire foil;
3. dissolve the Mo layer and separate all SW radionuclides from the Mo;
4. measure the low concentrations of SW radionuclides by accelerator mass spectrometry (AMS).

Main challenges: Upon return to Earth, the SRC crashed in the Utah desert, crushing the foils and contaminating them with Utah dirt and debris from SRC/collector materials [2]. This unexpected crash has presented us several difficult additional challenges, which we have to solve before continuing with step 2-4.

- Stretching foils (5): All of the crumpled Mo-Pt foils have been stretched to their original size (or close to it) using the guitar tuner method (Fig. 2) with minimal damage to the Mo surface.
- Mapping contamination (6): All foil pieces were scanned by SEM, in backscattered electron (BSE) mode. BSE images were used to identify surface contamination, delaminating of Mo layer (revealing the underlying Pt), and locate impact craters. We determined an average contamination level of ~15 µg/cm$^2$ for foil 50053 (~5000 cm$^2$), a factor of ~150 above our upper limit of 0.1 µg/cm$^2$ (Fig. 3).
- $H_2$-reduction (7): We developed a $H_2$ reduction method to convert the MoO$_x$ layer to a less oxidized form of Mo by exposing the foil for 3-4 weeks in a Parr vessel with a $H_2$ pressure of 10-30 MPa, at 140 °C (Fig. 4). $H_2$-treated test foils show much lower Mo losses in cleaning tests compared to the untreated foils.
- Identifying MM impacts (2): We expected that ~150 µg of MM material would impact the foil during exposure in space. After scanning SEM images of >3000 cm$^2$ of foil, we found only ~20 hypervelocity impacts, ranging in size from 20-120 µm (Fig. 5). No detectable amounts (<10 pg) of MM material were found on the foil!!

Completed challenges:

Progress on remaining challenges:

- Removing contamination (8): After many tests, mixtures of methanol and glacial acetic/formic acid are most efficient in removing Utah salt/dirt without removing Mo layer. Application of this method on a ~90 cm$^2$ Mo-SS foil with ~1 mg of Utah salt/dirt applied (Fig. 6) shows that ~98% of the salt/dirt is removed, while <2 nm of the Mo surface is lost. Similar tests are now being performed on a ~270 g/cm$^2$ piece of dirty Mo-Pt flight foil.
- AMS analysis (4). Recent upgrades of the AMS facility at PRIME Lab have lowered the detection limits of $^{10}$Be and $^{26}$Al by a factor of 2-10, respectively. This higher sensitivity implies that we don’t necessarily have to dissolve the entire foil to perform successful SW radionuclide measurements, but can dissolve “only” ~1000 cm$^2$.

CONCLUSION

We have made tremendous progress in development of new techniques to clean the Mo-Pt foils, after stretching them and analyzing surface contamination by SEM. In the next few years we will apply these techniques to several large portions (1000-2000 cm$^2$) of the Genesis Mo-Pt foils to analyze SW radionuclides.