STATUS OF GENESIS Mo-Pt FOILS. K. Nishiizumi[1], J. H. Allton[2], D. S. Burnett[3], A. L. Butterworth[1], M. W. Caffee[4], B. Clark[5], A. J. G. Jurewicz[3], K. Komura[6], A. J. Westphal[1], K. C. Welten[1], and D. S. Woolum[7], [1]Space Sciences Laboratory, Univ. of California, Berkeley, CA 94720-7450 (kuni@ssl.berkeley.edu), [2]Johnson Space Center, Houston, TX 77058, [3]California Institute of Technology, Pasadena, CA 91125, [4]Dept. of Physics, Purdue Univ., West Lafayette, IN 47907, [5]Lockheed Martin, Littleton, CO 80127, [6]Low Level Radioactivity Lab., Kanazawa Univ., Ishikawa, Japan, [7]Dept. of Physics, California State Univ., Fullerton, CA 92834.

Introduction: A total of 8,000 cm^2 of Mo-coated Pt foils were exposed to solar wind for 884 days by the Genesis mission. Solar wind ions were captured in the surface of the Mo. Our objective is the measurement of long-lived radionuclides, such as ^{10}Be, ^{26}Al, ^{36}Cl, and ^{53}Mn, and short-lived radionuclides, such as ^{22}Na and ^{54}Mn, in the captured sample of solar wind. The expected flux of these nuclides in the solar wind is 100 atom/cm^2·yr or less. The hard landing of the SRC (Sample Return Capsule) at UTTR (Utah Test and Training Range) has resulted in contaminated and crumpled foils. Here we present a status report and revised plan for processing the foils.

Original Plan: The collector foils consist of a Mo coating (~300 nm in thickness) on a Pt substrate (~48 μm in thickness)[1]. We originally planed to (1) to remove dust from contamination by UTTR soil, which was expected to attach to the SRC, and carbon composite contamination from heat shield materials on the Pt foils, leaving no more than 1 mg of terrestrial contamination on the entire collector, while leaving the Mo coating intact; (2) to identify and remove micrometeorite (MM) impacts, leaving no more than 1 μg of residual meteoritic contamination on the entire collector; (3) to dissolve the Mo and separate all radionuclides from the Mo without introducing contaminants; and (4) to measure the concentration of these extremely low abundance radionuclides. The events of September 8, 2004 have made the original scope of work more challenging since the Pt foils must first be unfolded to allow for cleaning of the unexpected terrestrial contamination.

Foils After Hard Landing: Over 90% of the Mo-Pt foils were recovered. All recovered foils were transferred from UTTR to Berkeley on September 20. We have examined the foils using optical microscopy and backscatter SEM and found the following features: (1) all foils were heavily crumpled by the impact; (2) in general, the Mo coatings were in good shape and looked better than the Mo on the non-flight foils; (3) portions of Mo coatings have flaked off or been lost by scratching; (4) the Mo-Pt foils were much stiffer than our archived non-flight foils, possibly due to solar wind hydrogen implantation and the 2 yrs heating by the Sun; (5) all foils had Utah dirt contamination on the surface, but the amount is highly variable.

Present Status: The major task at present is the development of the best methods for unfolding the foils, removal of Utah dirt contamination without damage to the Mo surface, and verification of cleanliness, before we can start our original proposed plan. The foils will also have to be uncrumpled and smoothed in order to provide a flat sample suitable for automated microscopic scanning for identification of MM impacts (a 200 μm deviation in a single field of view can be tolerated). Another difficulty is that the chemical and physical properties of the recovered Mo surface on Pt foils look different from that of non-flight foils. The Mo on the non-flight Pt foils appears to have oxidized during 3 years storage at JSC, while the Mo on the flight foils was reduced by solar wind hydrogen. This difference prevents us using non-flight Mo-Pt foils for various chemical and physical tests for removing dirt.

Unwrinkling the foils. The stiffness of the foils makes unwrinkling them a challenge. We observed that less crumpled annular foils had the greatest contamination and surface damage. We have been able to manually unwrinkle a few small foils by exerting pressure, using our fingers, from the backside of the Pt.

During 884 days of solar wind collection, about $2x10^{16}$ H atoms/cm^2 were implanted on the Mo-Pt foils. If all of this hydrogen remained in the Mo layer, the concentration would be ~10^{21} H atoms/cm^3. This hydrogen could be the cause of the hardening of the foils. We are testing the effect of long-term annealing (200° C) under vacuum on a piece of flight foil to remove any implanted hydrogen.

Dirt contamination. We received surface soils collected from the SRC landing site at the UTTR. Based on preliminary work, we found $2x10^7$ atom ^{36}Cl/g and $4x10^8$ atom ^{10}Be/g in the soil. 1 mg of the soil contains more ^{36}Cl (half-life = $3.0x10^5$ yr) and ^{10}Be ($1.5x10^6$ yr) than 1 μg of MM and more than 10% of the expected SW ^{10}Be and ^{36}Cl on the entire Mo-Pt foil. The soil contains 3.7% Cl, as NaCl. The most contaminated foil (40391) was used for cleaning tests. A large portion of bulky dirt was removed from the foil by light shaking or using very gentle

brushing. However, thin-coated dirt, that was wet when it splashed on the Mo surface, was hard to remove. (a) We applied the CO_2-snow method for removing dirt from the Mo surface with limited success. Weak CO_2-snow application blew out large chunks of dirt without visual damage to the Mo surface. Strong CO_2-snow application removed slightly more contamination than the weak application did, but the CO_2 didn't remove thin layers of dry soil and did damage to creased portions of the Mo surface. (b) Replication methods were applied for removing dirt from the Mo surface by coating and then removing a thin film. This method is widely used for cleaning optical surfaces and making thin film grids. We applied 1-10% solution of Collodion (nitrocellulose), 0.25-1% of Formvar resin (in ethylene dichloride), and 2-4% of polyvinyl alcohol on surface of non-flight Mo-Pt foils or Mo coated stainless steel foils. Lightly attached contamination was removed by peeling off the thin film but the thin-coated contamination was not. Furthermore, some Mo was flaked off with the films. (c) Preliminary tests using ultrasonic cleaning (40 kHz) removed a few percent of the Mo coat, as measured in the washing solutions (ethanol, isopropanol, and water). The Mo coat was likely removed by ultrasonic erosion. We will continue to test more gentle washing methods such as a high frequency megasonic cleaning.

Cosmogenic Radionuclides in Monitor Target: The Mo-Pt foils were also exposed to solar cosmic rays (SCR) and galactic cosmic rays (GCR) for 1,125 days in space. In order to correct for the contribution of cosmogenic radionuclides in the collectors, we exposed a synthetic SiO_2 (Spectrosil quartz) disk (50x50x5 mm) at the side of the Mo-Pt foils deployed on the SRC Lid blanket. Although the disk was broken by the impact, we recovered all of the pieces since it was covered by a plastic sheet. Most of the broken pieces were reassembled to an original block shape. Cosmogenic ^{7}Be (half-life = 53 d) and ^{22}Na (2.60 yr) in the 23.6 g of SiO_2 block were measured by high-sensitivity Ge detector at Low Level Radioactivity Laboratory, Kanazawa University. Long-lived ^{10}Be in the small broken pieces (2.49 g) was measured by AMS. The results are shown in Table 1. The ^{10}Be/^{7}Be ratio of 0.36±0.10 is in the same range as that found in meteorite falls. Nearly all ^{7}Be and more than 95% of ^{10}Be were produced by GCR. Based on the measured ^{10}Be in the SiO_2 plate, ^{10}Be production in Mo by cosmic rays for the entire flight period is less than 2 atom/cm^2 which is equivalent to 1% of expected ^{10}Be from the Sun [2].

Table 1. Cosmogenic radionuclides in SiO_2 plate.

	atom/g[#]	dpm/g[#]	dpm/kg[*]
^{7}Be	$(8.6\pm2.1)\times10^{3}$	$(7.8\pm1.9)\times10^{-2}$	78±19
^{10}Be	$(4.5\pm0.7)\times10^{4}$	$(4.0\pm0.6)\times10^{-8}$	28±4
^{22}Na	$(9.5\pm0.5)\times10^{4}$	$(4.8\pm0.2)\times10^{-2}$	86±4

#: at September 8, 2004; *: at saturation

Acknowledgement. We thank Eco-Snow Systems, PCT Systems, and T. Teague for initial tests.

References: [1] Jurewicz A. J. G. et al. (2003) *Space Sci. Rev.*, 105, 535-560. [2] Nishiizumi K. and Caffee M. W. (2001) *Science,* 294, 352-354.

Fig. 1. 80 cm diameter of circular foil before launch.

Fig. 2. Circular foil after landing.

Fig. 3. One of the most contaminated foils (40391,1).