SOLAR WIND SAMPLE COLLECTION AT THE DEEP SPACE GATEWAY. R. C. Wiens[1], D. S. Burnett[2], A. Jurewicz[3], K. Rieck[1], D. Reisenfeld[4] J. Kasper[5], and B. Clark[6] [1]Los Alamos National Laboratory (rwiens@lanl.gov), [2]Caltech, [3]ASU, [4]U. Montana, [5]CLaSP, U. Michigan, [6]Space Science Institute.

Introduction: Returned samples of the solar wind have greatly increased our understanding of the solar system and its formation, as well as understanding of the acceleration of the solar wind. A number of important science objectives can be attained if new, longer-duration collections are performed. Solar-wind collection must be done outside of the Earth's magnetosphere, and hence requires deep space missions that return to Earth. We propose to use the Deep Space Gateway to perform long-term collections of solar wind for return to Earth and subsequent analysis.

History: Not much was known about the composition of the solar wind prior to the Apollo missions. On several of the lunar missions, foils were deployed to collect solar wind for periods of about an hour to nearly two days [1]. These experiments revealed, among other things, that solar neon is isotopically much lighter than terrestrial neon, providing strong evidence for the loss of the Earth's primary atmosphere due to hydrodynamic escape (e.g., [2]).

The success of these short-exposure experiments prompted the development of the Genesis mission, which collected solar wind for 2.4 years at the Earth's L1 point [3] from 2001-2004. Successful analyses of these samples yielded the isotopic composition of solar oxygen [4] and nitrogen [5], resolving a long-held mystery surrounding the origin of oxygen isotopic heterogeneities in solar-system materials (e.g., [6]) by pointing to carbon monoxide self-shielding [7] and similar likely effects with nitrogen (e.g. [8]), providing a unique window into the environment of the solar nebula. Elemental abundances determined from the Genesis samples has led to ongoing work in understanding the acceleration of the solar wind from the solar surface (e.g., [9]).

While the Genesis mission was a success, a number of important objectives of solar-wind sample analyses have not yet been realized. Analyses requiring relatively large surface areas (e.g., 20 cm^2 or larger), such as to use radiochemistry with neutron activation analysis to determine solar abundances of rare-earth elements, could not be carried out with the relatively small samples from Genesis. Other tests, such as determining the solar carbon isotopic composition, or the ratio of volatile to dust-forming elements in the sun (e.g., [10]) have not been possible. Observation of the lithium and beryllium isotope ratios [11], indicative of the history of the mass of the solar convection zone, would also be desirable.

Deep Space Gateway Solar Wind Collection Concept: A follow-on solar-wind collection experiment on the Deep Space Gateway would be required to be sun-pointed. Collector materials would be exposed for significantly longer than on the Genesis mission, to enable maximum science return. We envision two identical experiments, one which would be exposed for five years, and another to be exposed for ten years. The redundancy and the earlier return of the first samples reduces risk, and if the ten-year experiment is successful, it would provide more than four times the solar wind fluence compared to Genesis. Each experiment would cover approximately one square meter of sun-facing surface with ultra-high purity collector materials such as silicon wafers (e.g., Fig. 2). The materials should be shielded by line of sight from contaminants that may be emitted by the spacecraft. The collector materials could be folded up for return to Earth. Each passive experiment would require no power and would have a mass of approximately 5 kg.

In addition to the passive collectors, each of the two (5- and 10-year) experiments might optionally include a solar-wind concentrator. The Genesis instrument provided a 40x boost in solar-wind fluence for key isotopes. The Deep Space Gateway solar-wind concentrator could be tuned for isotopes of Li, Be, and B, or for other important isotopes. The design used for the Genesis mission [12] measured 46 cm diameter by 21 cm (Fig. 1), had a mass of 7.6 kg, and used very little power (~ 2 W). Its sun-pointing requirements are more stringent, within a couple of degrees of the average solar-wind direction, and a monitor, providing solar-wind speed in real time would be required. A careful study might help determine the value of adding the concentrator to the passive experiments.

Summary: Collection of solar wind at the Deep Space Gateway represents a simple experiment with the potential to return important fundamental science to enhance our understanding of Sun, the solar wind, and the evolution of the solar system. This collection requires deep space.

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Figure 1. Genesis Concentrator, a reflecting ion telescope. Solar wind is collected in the underside of the center circle (target).

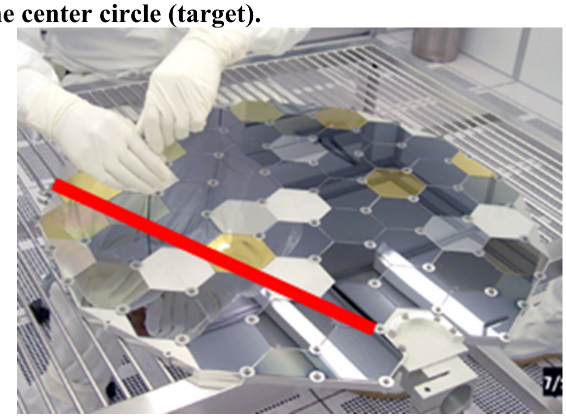

Figure 2. Example of a Genesis-mission solar-wind collector array. Red line is approximately 60 cm.