INTERPRETING MEASURED GENESIS SOLAR WIND PROFILES THROUGH SIMULATION.

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Introduction: Simulations of ion implantation using the open source code Stopping and Range of Ions In Matter (SRIM) [1] enable corrections for backscattering of incident solar ions to isotopic and elemental ratios measured in Genesis collection materials [2,3]. Simulated depth profiles also facilitate data interpretation of Genesis measurements where surface contamination obscures the measured profile of implanted solar ions themselves.

The technique of profile matching to perform corrections for surface contamination has supported interpretation of N isotopics [4], C, N and O elemental profiles for the four regimes (Bulk, Interstream, Coronal Hole and Coronal Mass Ejection (CME)) of solar wind collected by Genesis [5], as well as He and Ne in Bulk and CME regimes [6, 7].

Background: Early in the Genesis solar wind collection mission the team realized that the determmination of solar isotopic and elemental abundances could be improved by correcting measurements of implanted ions for the small fraction of ions that get lost into space by backscatter collisions. A small campaign was initiated to model ion implantation using the open source code SRIM, accounting for elemental-specific ion flux distributions as measured by the Advanced Compositino Experiment on the SWICS spacecraft during the Genesis exposure. Preliminary solar wind simulations were performed for solar wind velocity distributions as measured by the Genesis Ion Monitor (GIM) and the Advanced Composition Explorer (ACE) [8].

New Results:

Evolution of analysis approaches and various data corrections have resulted in small but important changes in the assessed ion veloxity distributions [9]. Figure 1 shows the impact of these changes from 2006 [8] to 2013 [9] and 2017 [Reisenfeld pers. Comm] assessments of solar wind distributions. In some cases the differences in profiles are small, but we believe the new assessments will be important in peak fitting. As discussed in Heber et al. [5], a poor match between measurement and a SRIM profile may call for alterna tive methods of correcting for surface contamination.

In response to these improvements to input data, we have initiated a new campaign to simulate the implantation profiles of the most important elements and selected isotopic compositions into their key collection substrates on the Genesis spacecraft. Examples of the new simulations, in this case ^{24}Mg ions implanted into a Si substrate, are shown in Figure 2. Each of these simulation represents one million ions, and in the new assessments of solar wind, ion velocity distributions typically extend to higher velocities for coronal hole, bulk and CME regimes Even without normalization of the simulation to the relative fluences the contribution of the high energy tail of CME to the Bulk distribution is evident. After normalizing to relative fluxes, these distributions enable deconvolution of the highe-energy CME tail from other regimes [7]. Improvements in profiles associated with more representative input velocity distributions will improve fidelity of comparisons between measurement and simulation – resulting

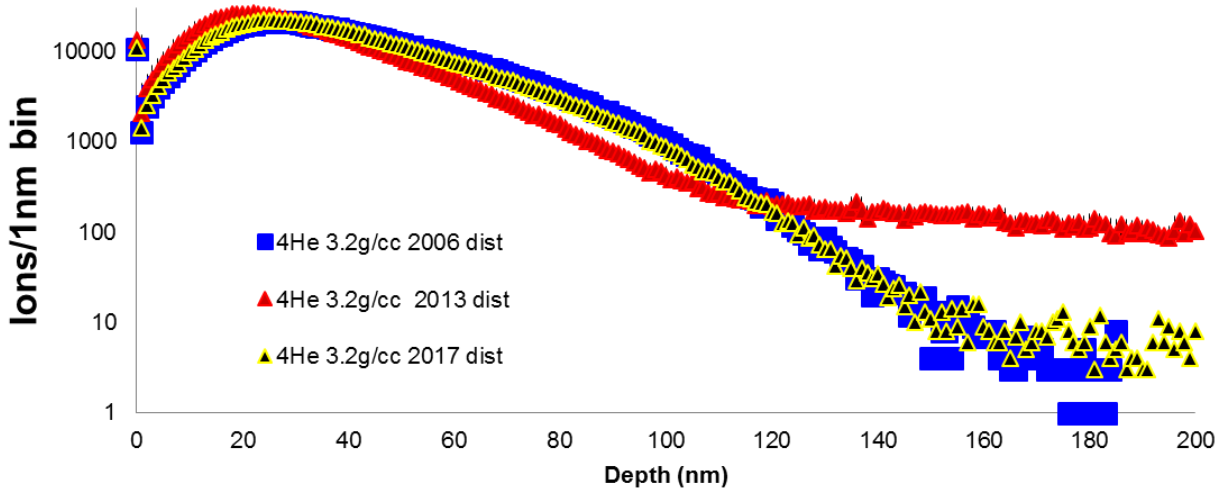

Figure 1. Changes in the assessment or solar wind velocity distributions impac the simulated implantation profile.

in improved reliability of the assessment as to whether or not the measurement – SRIM comparion is adequate.

As we proceed through these simulations, we welcome input to help prioritize which element-substrate pairs should be simulated with the new velocity disgtributions.

Disclaimer: The views expressed herein are those of the author and do not reflect the position of the United States Military Academy, the Department of the Army, or the Department of Defense.

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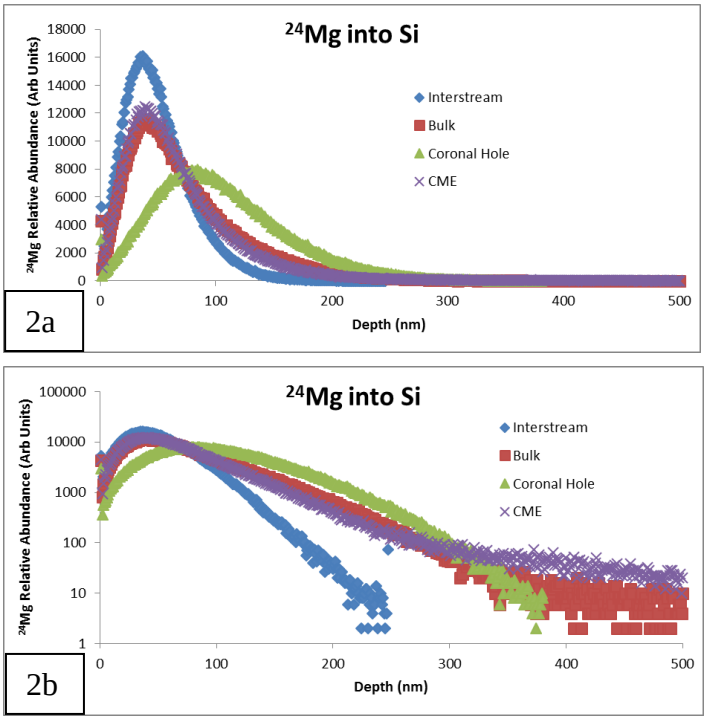

Figure 2. Simulations of the 2017 assessment of Bulk, Interstream, Coronal Hole and Coronal Mass Ejection Genesis solar wind regimes of ^{24}Mg implanted into the Si substrate. 2a is a linear plot where shifts in the relative peaks and are evident; 2b is a log-normal plot where behavior at depth is better appreciated.