SOLAR WIND KRYPTON IN POLISHED ALUMINUM GENESIS COLLECTOR: CURRENT STATUS.

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Introduction: One of the major Genesis Mission goals is to verify solar wind composition previously estimated from analysis of solar-wind-rich lunar and meteoritic materials [e. g., 1, 2, 3]. The difference, if observed, may constrain a temporal variation of solar wind isotopic composition. The heavy noble gases, Kr and Xe, are special because they have multiple isotopes spanning over ten mass units, so they can be used as indicators of nonlinear fractionation. Here we present isotopic composition of krypton extracted from Polished Aluminum Genesis solar wind collector.

Experimental: Presently our major difficulty measuring the heavy noble gas in the solar wind is impurities in the Genesis collectors which constitutes up to a half of the amount of collected solar wind. To solve this problem we first attempted to separate surface blank from deeply implanted solar wind noble gases using stepped power UV-laser extraction. Although this approach was very productive for light noble gases, it was not for Xe and Kr. Our Xe, Kr blanks turned out to be neither sufficiently reproducible nor linearly proportional to the raster area. Therefore, in this work we extracted all of the solar wind noble gases in one single step, with surface correlated gases being removed by 3-week 150°C baking followed by several low power defocused UV rastering of the entire collector.

Our latest design of the extraction cell solves our earlier problem of sputtered Al condensation on the vacuum viewport. The collector is placed at 45° relative to incident laser beam and an additional 45° dichroic mirror is installed outside of the extraction cell to keep working distance constant (Fig. 1a,b). The long-focusing laser objective required for this arrangement has the benefit of a larger "depth of field", which solves our earlier focus problems on the slightly curved polished aluminum collector (PAC).
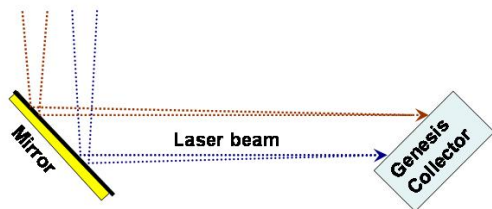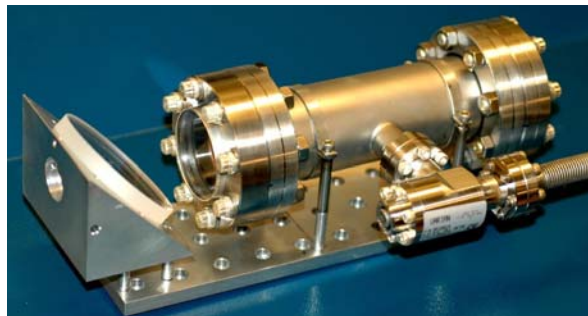

Fig 1a. Optics of the new extraction cell.

Fig. 1b. Optimized cell for UV-extraction of heavy noble gases from polished aluminum collector.

In this work we chose PAC rather than AloS. Although PAC has somewhat higher surface blank than Aluminum on Sapphire (AloS), the bulk material blank of PAC is extremely low. In contrast, AloS, in addition to surface blank, has significant blank from the Sapphire-Al interface, which behavior is not completely understood at this time.

Mass spectrometry: For the analyses of heavy noble gases we used a "special edition" of Nu-Instruments Noblesse equipped with eight Burle channeltrons. Krypton was analyzed in three steps of the magnetic field. In the first step ion beams with m/e = 86, 85, 84, 83, 82 81, 80 and 79 were measured simultaneously. Next, the magnet setting was downshifted by 2 mass units: m/e = 84, 83, 82, 81, 80, 79, 78, 77. The third step was for measuring baseline (zeros) between the ion peaks. The zoom lens setting for the second step was adjusted in order to measure ^{78}Kr off-center to avoid interference from $C_6H_6^+$ (benzene), a small but ubiquitously present hydrocarbon contamination. Another way to correct for benzene is to use neigbouring ion beams with m/e = 77 and 79, collected in the second step anyway. However, it seems that the peaks with m/e = 77, 78 and 79 may not related in a simple linear manner, and more work is needed to understand and quantify this relationship. While ^{78}Kr and benzene can be partially resolved by Noblesse, a ~10K resolution is required to resolve ^{80}Kr$^+$ from ^{40}Ar^{++}. Luckily ^{40}Ar is virtually absent in the solar wind, so doubly charged argon does not contribute significantly to ^{80}Kr.
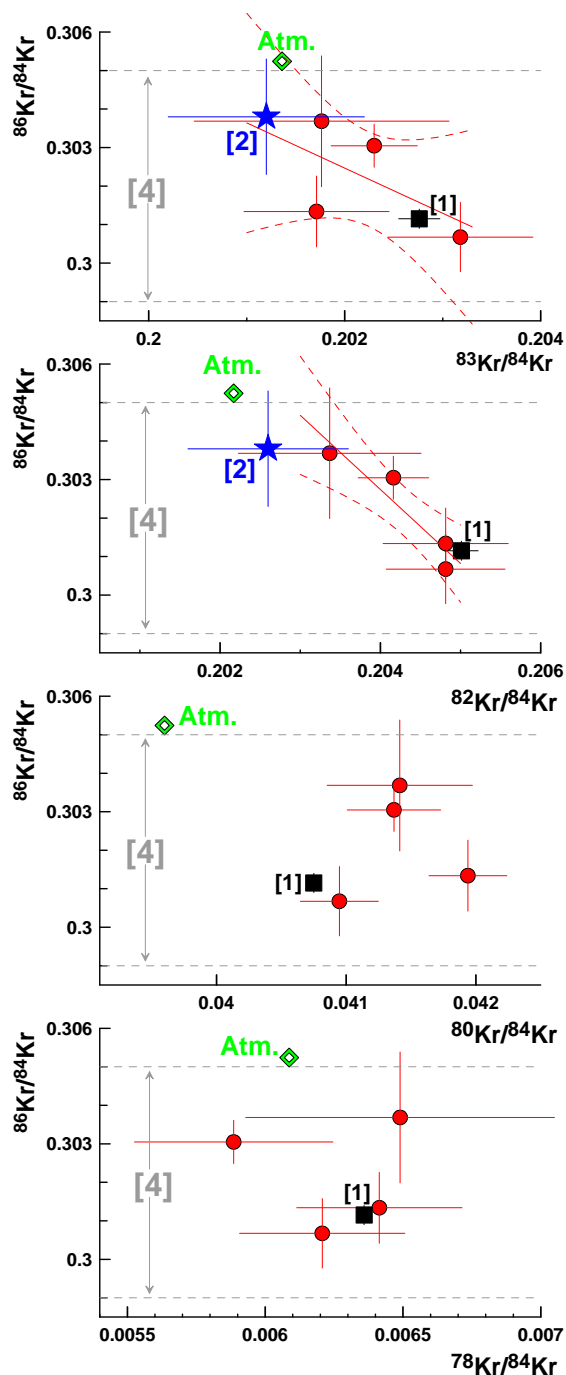
Fig.2. Red circles are Kr from total UV-laser extraction (this work). These data are not corrected for blank contribution and for doubly charges ^{40}Ar. Black squares [1] are most accurate regolith data by Pepin, Becker and Rider, 1995. Blue stars [2] are data by Pederoni and Begemann, 1994. Grey [4] is the only published ^{86}Kr/^{84}Kr ratio recently measured in Genesis collectors by Heber at al, 2006. All error bars are 2σ. Confidence intervals for correlation lines are 90%.

Results: Four independent isotopic analyses of Kr extracted from different PAC fragments (from ~0.3 to ~3.5 cm^2) are plotted in Fig. 2. Within analytical precision all Kr isotope ratios, except ^{80}Kr are consistent with mixtures of solar wind Kr from lunar soils [1] and atmospheric Kr. The correction for ^{40}Ar^{++} (to be done soon) should hopefully shift the data points to the same mixing line. Atmospheric blank corrections (we are still looking for the best way to apply them) will shift the data points along the mixing line toward the regolith point [1].

We believe that the spread of the experimental points reflects different atmospheric blank contributions, rather than representing isotopic fractionation during implantation [5] because solar wind gases were extracted in one single step summing up both isotopically light (former SW) and deeper implanted isotopicaly heavy gases (former SEP). Although tempting, it would be inappropriate to average our four points to improve statistics until these points are individually blank corrected.

Discussion: It is difficult to unambiguously distinguish between Kr isotope fractionation and various contributions of atmospheric Kr (and even the former SEP Kr, which unfortunately lies on the same line). Nevertheless, we can conclude that solar wind krypton captured by Genesis is in a reasonable agreement with solar Kr deduced from analysis of lunar soils [1] and fractionated with respect to the terrestrial atmosphere. Proper corrections for atmospheric blank may make this agreement even better.

Conclusion: The time and effort we spent to make Nu-Instrument suitable for Genesis analysis finally begins to pay off. Kr data obtained in this work apparently agree with Kr solar composition reported by [1] better than it does with [2]. However, it is too early to draw more precise compositions, or any conclusions concerning speed or temporal variations in composition of solar wind krypton.

References: [1] Pepin R. O., Becker R. H., and Rider P. E. (1995) *GCA 59*, No.23, 4997-5022. [2] Pederoni A. and Begemann F. (1994) *Meteoritics 29*, No.5, 632-642., [3] Wieler R and Baur H. (1994) 570-580. [4] Heber V. S., Wieler R., Baur H. et al (2009) *CGA 73*, 7414-7432. [5] Grimberg A. et al (2006) Science 314 1133-1135.