Genesis Solar Wind Sample Curation

Astromaterials Acquisition and Curation Office
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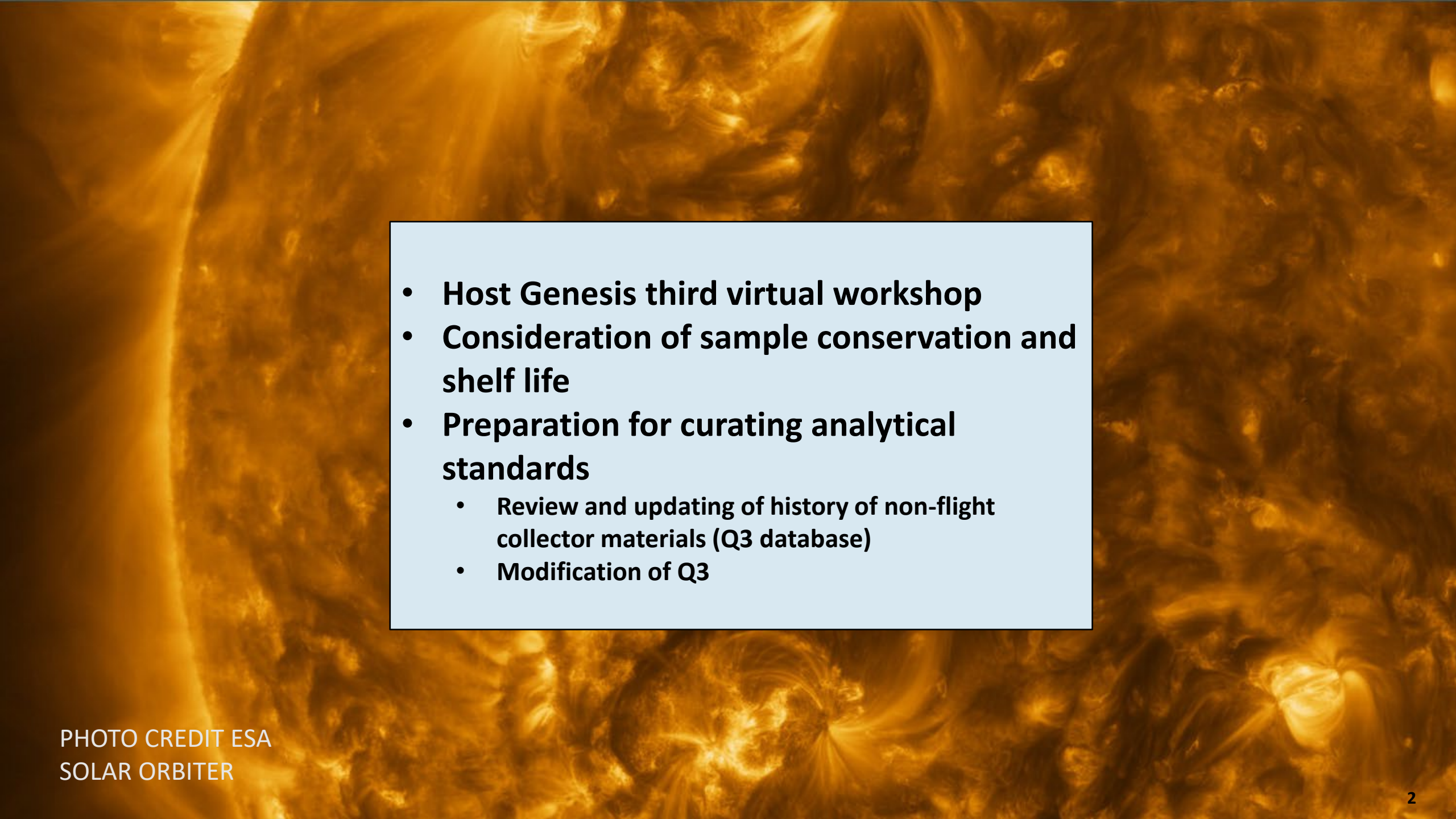


- Host Genesis third virtual workshop
- Consideration of sample conservation and shelf life
- Preparation for curating analytical standards
  - Review and updating of history of non-flight collector materials (Q3 database)
  - Modification of Q3

PHOTO CREDIT ESA SOLAR ORBITER

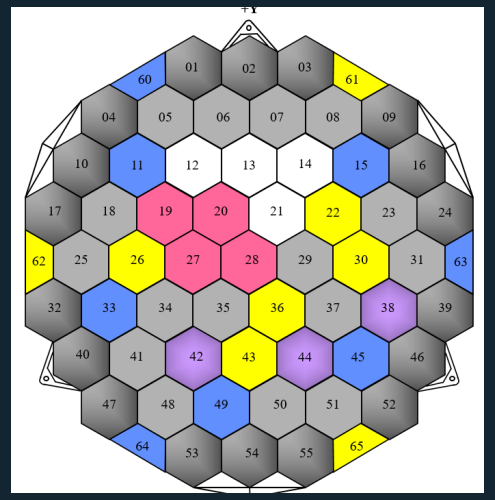
As deployed for solar wind collection

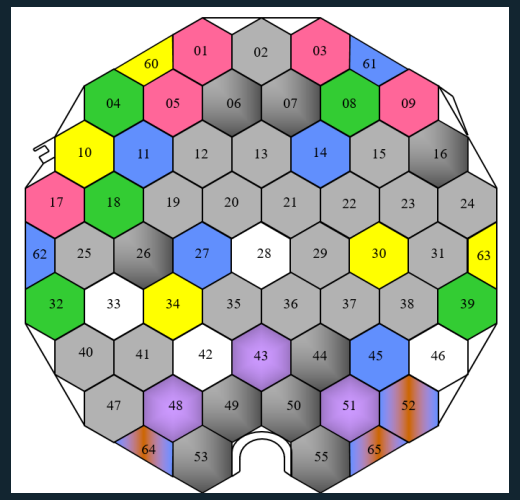
Engineering model at JPL in 2014 for Genesis 10th anniversary of Sample Return

September 8, 2024 will be 20th anniversary

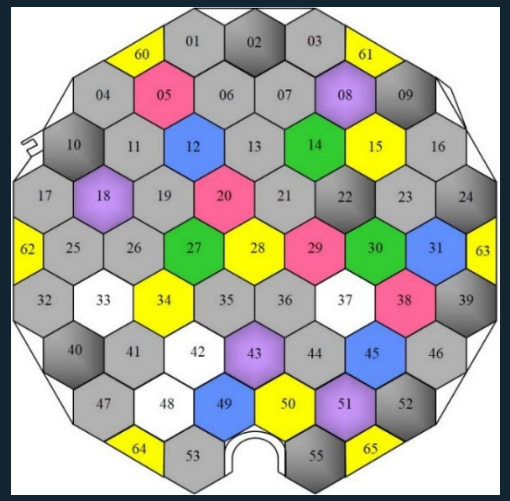
SAMPLES:
Total 4837
Characterized: 2801
Multi-fragment: 603

REFERENCE MATERIALS:
Total 2200
Allocated 350

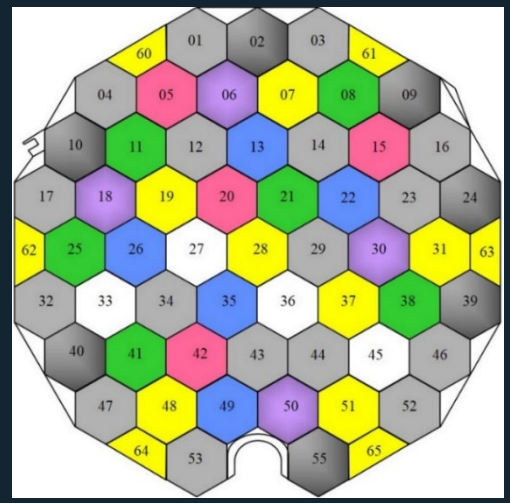




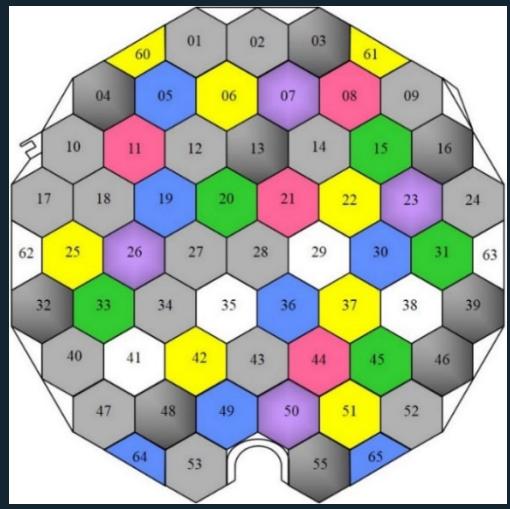
Bulk solar wind collectors



Interstream slow speed solar wind collectors



Coronal hole, high speed solar wind collectors



Coronal mass ejection solar wind collectors

FZ

CZ

AlOS

DOS (DLC on Si)

AuOS

Ge

SAP

SOS

CONSIDERATIONS FOR SAMPLE CONSERVATION AND SAMPLE SHELF LIFE

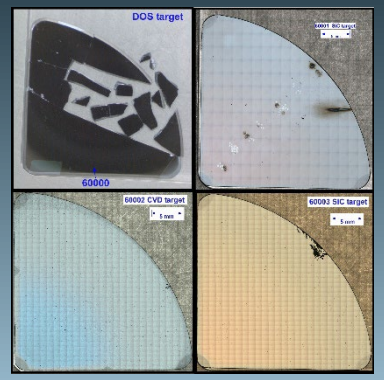
Classes of materials:
- **Solar Wind Regimes**
- **Collector composition**

Proportions of conserved materials are measured by size (area), unlike Apollo samples which are measured by weight.

Conservation is the proportion of the collectors, for each material and regime, to be retained for future studies.
Preservation is the permanent archiving of representative samples from each material and regime.

HEXAGONS – Crash created smaller fragment sizes from silicon-based hexagons than from sapphire-based hexagons

SPECIAL SAMPLES – Evaluate case-by-case.



SAPPHIRE-BASED HEXAGONS:
- Aluminum-on-sapphire
- Gold-on-sapphire
- Silicon-on-sapphire
- Sapphire
- Carbon-cobalt-gold-on-sapphire

SILICON-BASED HEXAGONS:
- Float zone silicon
- Czochralski silicon
- Diamond-like carbon on silicon

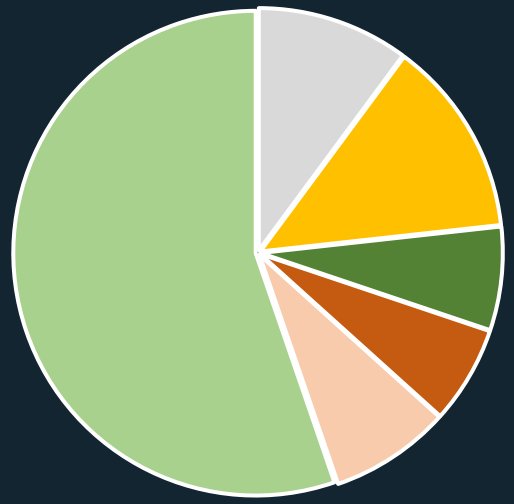
SPECIAL SAMPLES:
- Concentrator targets SiC, 13-C diamond, Diamond-like carbon on silicon
- Polished aluminum
- Gold foil

	BULK	CORONAL MASS EJECTION	CORONAL HOLE	INTERSTREAM
	B/C	E	H	L
Silicon based				
TOTAL FRAGMENTS	928	244	252	179
AREA RANGE, mm2	3 to 268	5 to 184	4 to 262	5 to 212
AVERAGE AREA, mm2	**28**	**41**	**55**	**44**
SAP based				
TOTAL FRAGMENTS	497	215	185	130
AREA RANGE, mm2	4 to 5908	18 to 2537	12 to 3115	5 to 1296
AVERAGE AREA, mm2	**279**	**395**	**344**	**240**

What survived – size of fragments

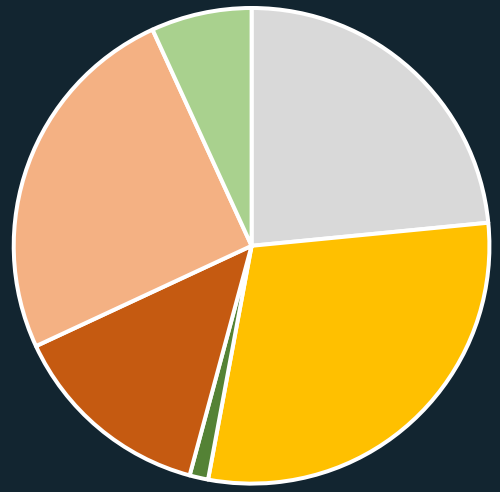
- Conserve a portion based on number of fragments for silicon-based materials, and based on area for sapphire-based materials
- Conserved portion to be periodically recalculated based on remaining samples (this allows controlled gradual usage based on shelf life)
- Shelf life has not yet been determined

Area Flown

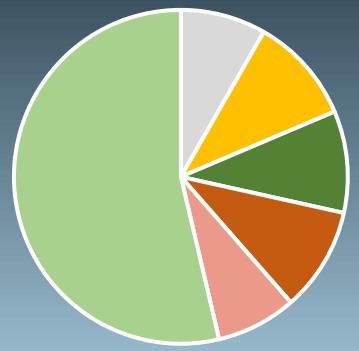


AlOS AuOS DOS SAP SOS Total Si

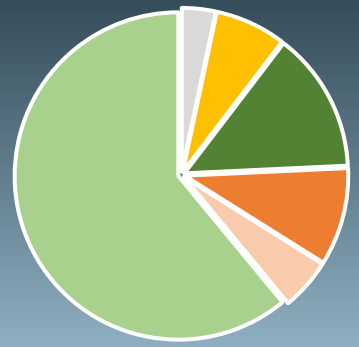
Area Catalogued



Samples Characterized



Samples Allocated



Area data from Burkett 2008.
Sample number data extracted from database July 2023.

CONSIDERATIONS FOR SAMPLE CONSERVATION

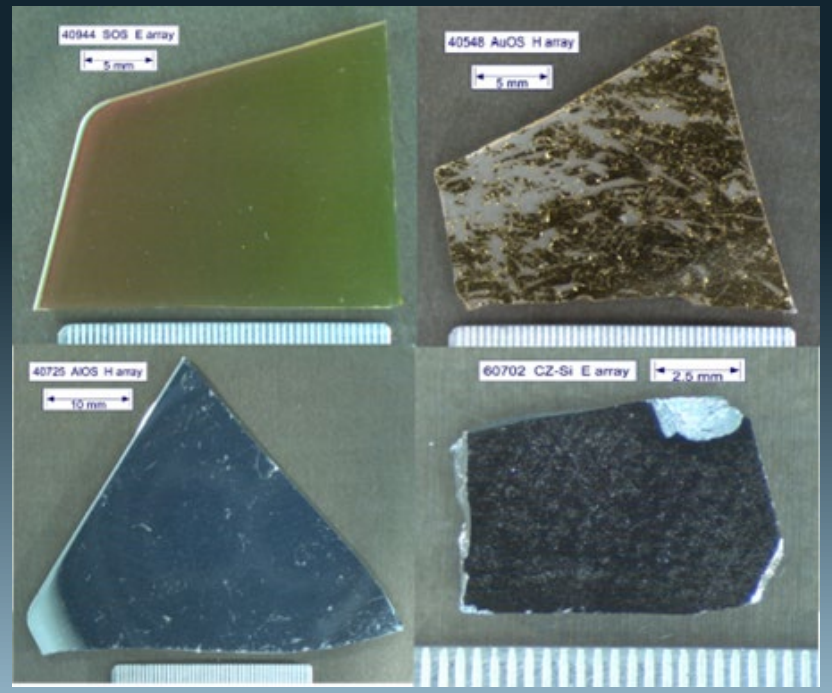
BASELINE ASSESSMENTS OF AVAILABILITY:

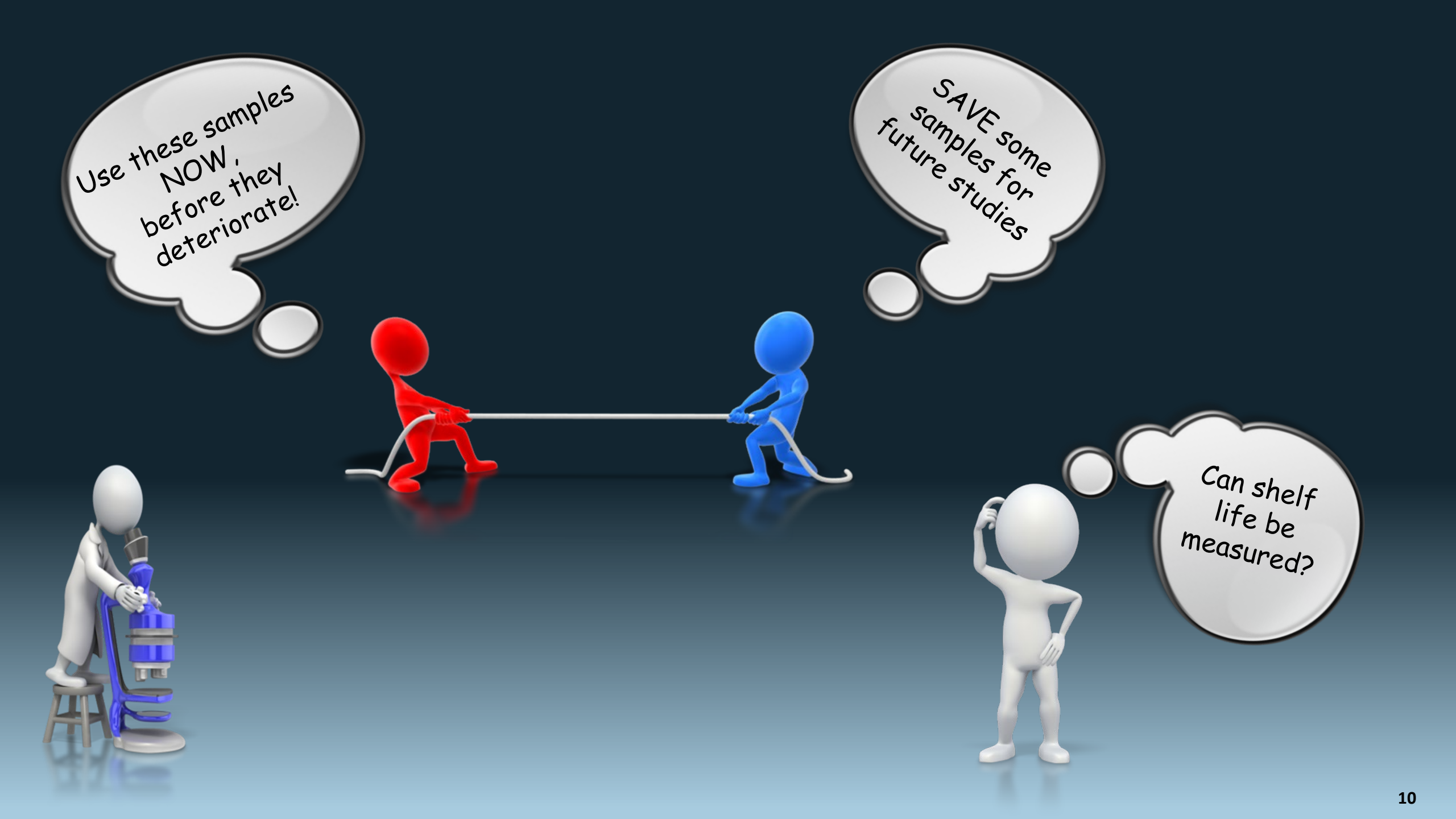
Burkett, P. J. et al . (2008) GENESIS SOLAR WIND ARRAY COLLECTOR CATALOGING STATUS. 40th LPSC, Abst. #1373.

Gonzalez, C. P. et al.(2015) GENESIS SOLAR WIND SAMPLES: UPDATE OF AVAILABILITY. 46th LPSC, Abst. #1950.

OTHER FACTORS AFFECTING SAMPLE SCIENCE VALUE:

Condition of surface
Cleanability




Use these samples NOW, before they deteriorate!
SAVE some samples for future studies
Can shelf life be measured?

CONSIDERATIONS FOR SAMPLE SHELF LIFE

ESSENTIAL TOOLS FOR MEASURING CHANGES WITH TIME

- Non-flight reference collectors
- Theoretical implantation modeling
- External and internal standards

Are rates of future chemical exchange of Genesis collectors with their surfaces accurately quantifiable?" No (not yet)*

- Effects of temperature?
- Effects of radiation damage?
- Effects of moisture or atmospheric reactivity?

Have solar wind ions migrated within collectors? Yes, in some cases (material, regime, handling dependent)

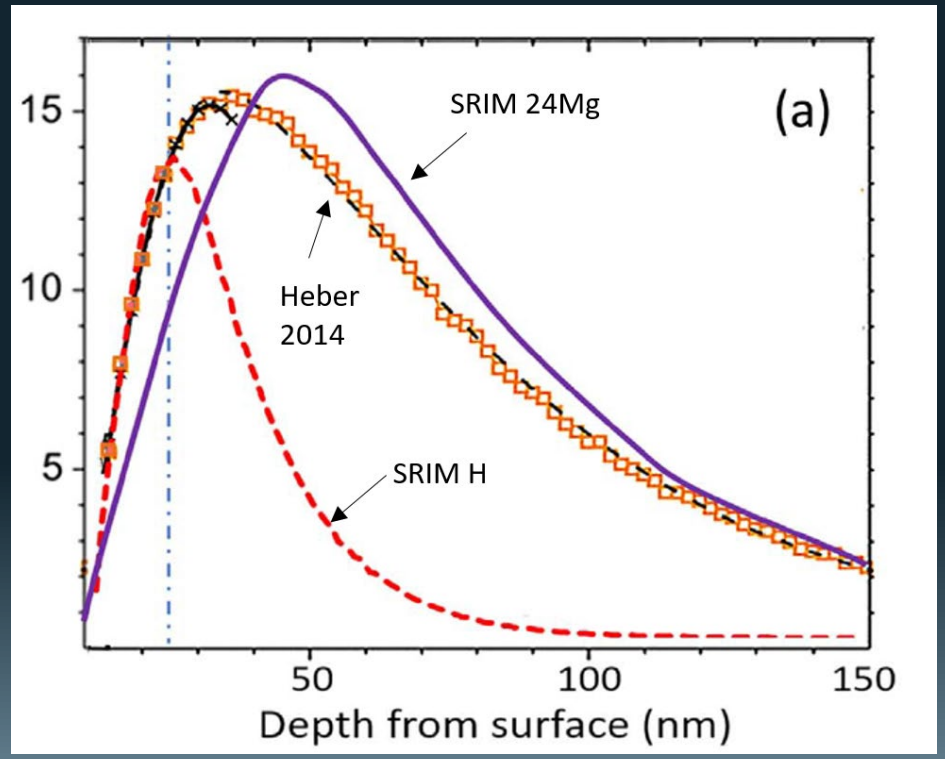
Did the hot, moist crash environment alter collector surfaces?

Does surface contamination (molecular films or nanoparticles) protect or erode implanted solar wind with time?

Cleaning processes have been monitored for effect on SW content collectors. (example- recent measurements indicate UPW cleaning has not altered sapphire collectors**)

***lack of matrix appropriate diffusion coefficients**

**** Keller, L. P. (2023) Genesis workshop**



Example of comparison of the measured near-surface shape of the SW 24-Mg implant with SRIM models for SW H and 24-Mg into silicon.

Heber, V. S. et al. (2014) Accurate analysis of shallowly implanted solar wind ions by SIMS backside depth profiling. *Chem Geol*. 390 18.
Jurewicz, A. J. G. et al. (2023) Space Weathering of Genesis Mission Solar-wind Collectors with Inferences for Weathering on Airless Bodies. *The Planetary Sci. J.* 4 98.

USEFUL REFERENCES

- Burnett, D. S. et al. (2015) Ion Implants as Matrix-Appropriate Calibrators for
- Geochemical Ion Probe Analyses. *Geostd. & Geoanalytical Res.* doi: 10.1111/j.1751-908X.2014.00318.x
- Rieck, K. D. et al. (2022) Depth profiling and standardization from the back side of a sample for accurate analyses: Emphasis on quantifying low-fluence, shallow implants in diamond-like carbon. *Rapid Comm. In Mass Spec.* **https://doi.org/10.1002/rcm.9454**
- Mabry, J. C. et al. (2009) Light Noble Gas Diffusion in Genesis Samples. 39th LPSC, Abstract. #2255
- King, B. V. et al. (2008) Investigation of radiation enhanced diffusion of magnesium in substrates flown on the NASA genesis mission. *Applied Surface Science .* doi:10.1016/j.apsusc.2008.05.158.
- Jurewicz, A. J. G. et al. (2020) Quantifying low fluence ion implants in diamondlike carbon film by secondary ion mass spectrometry by understanding matrix effects. J. of Analytical Atomic Spectroscopy, v. 36. 194-209.
- Ziegler J.F., Biersack J.P. and Ziegler M.D. (2008) SRIM: The stopping and range of ions in matter. SRIM Co. (Chester, USA), 398pp.

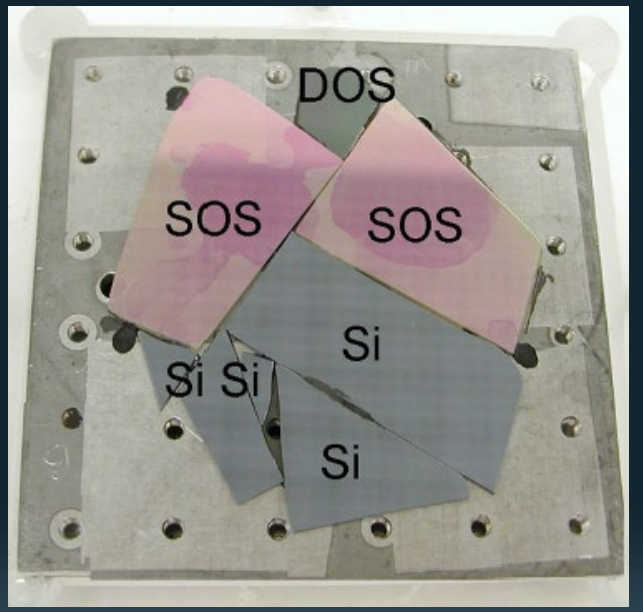
40Ca
44Ca
52Cr
64Zn
O
N
H
He
18O
15N
20Ne
25Mg
34S
16O
13C
36Ar
38Ar
22Ne
40Ar
28Si
29Si
56Fe
54Fe
23Na
41K
24Mg
26Mg
27Al
Mn
Ni
Li

History and Scope of Artificially Implanted Collector Materials

Post launch implantation of reference materials managed by Burnett and Jurewicz under mission funding and grants to support Genesis sample analysis, resulting in estimated 1000 samples during >100 implant sessions performed by multiple vendors.

Some implanted *flight spare* materials have been calibrated; and therefore, of higher priority to document and make available.

Implanted collector *flight spare* and reference materials: **silicon (FZ, CZ), sapphire**, **diamond on silicon**, silicon on sapphire, aluminum on sapphire, gold on sapphire, silicon carbide, CVD, germanium.



Typical implant plate

7.6 cm

Enabling Genesis Science …

Implementing Archive of Standards, Implants, and Flight-like Materials

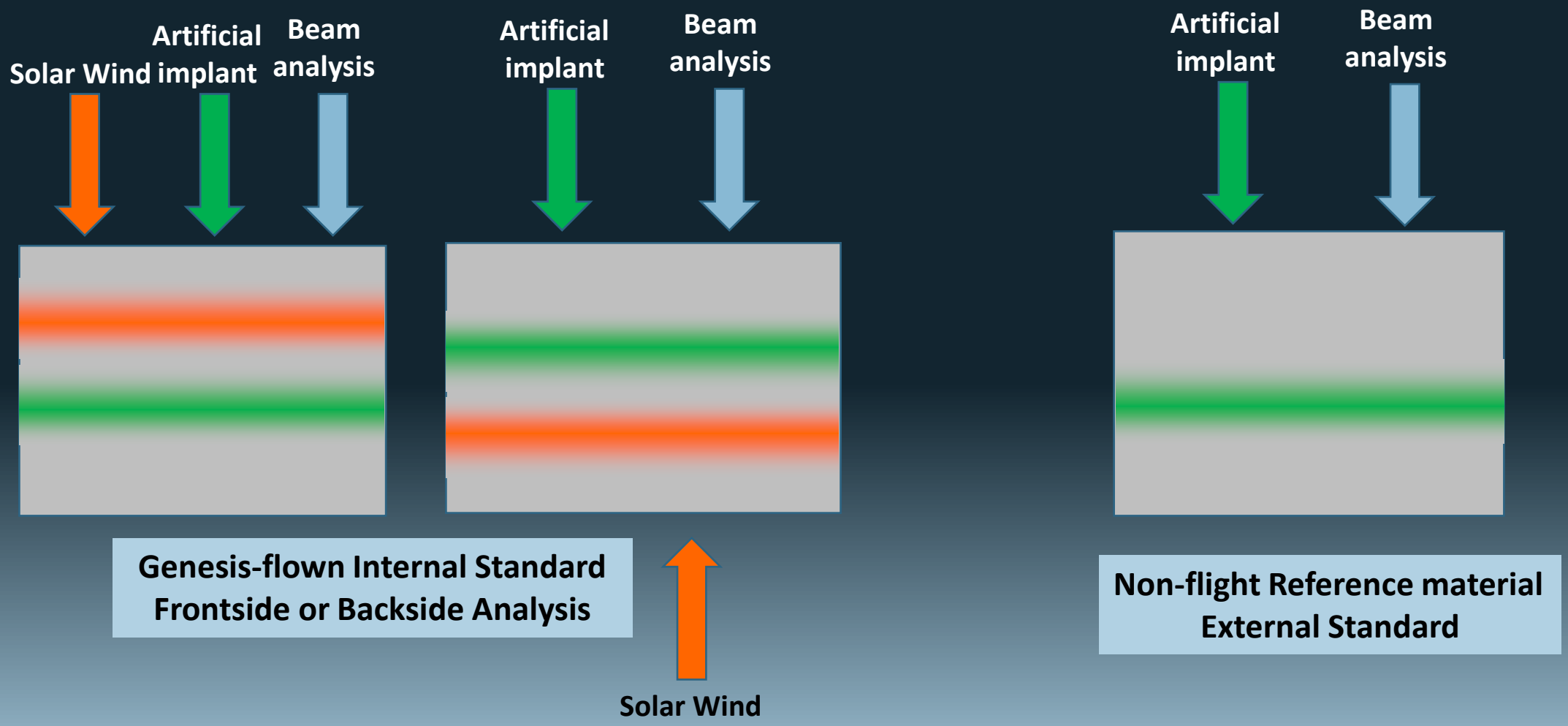


Image Credit K. D. RIECK 2015, adapted

Enabling Genesis Science …

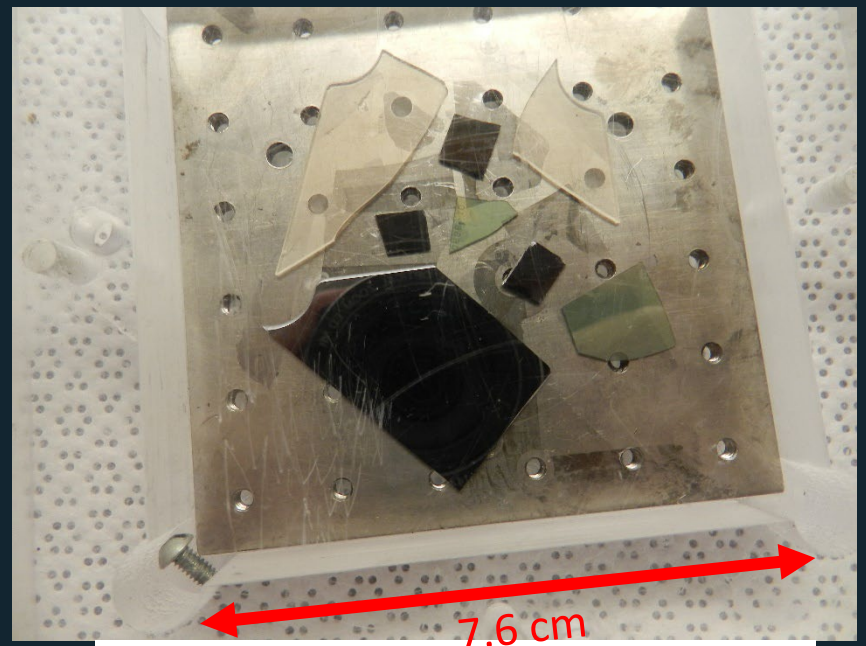
Implementing Archive of Standards, Implants, and Flight-like Materials

PROGRESS REPORT-
J. H. Allton, C. P. Gonzalez, K. K. Allums-Spencer, C. D. Calva, NASA JSC Genesis Curation
A. J. G. Jurewicz, Arizona State University, Buseck Center for Meteorite Studies

Pilot Project-
Received 26 samples with documentation
Database modification initiated – in design review
Selected physical storage space

Separate physical storage for non-flight implanted samples. Under nitrogen, ISO 4 room.

Example of first implant receipt



NAME: A000x
Nickname: 35Cl implant

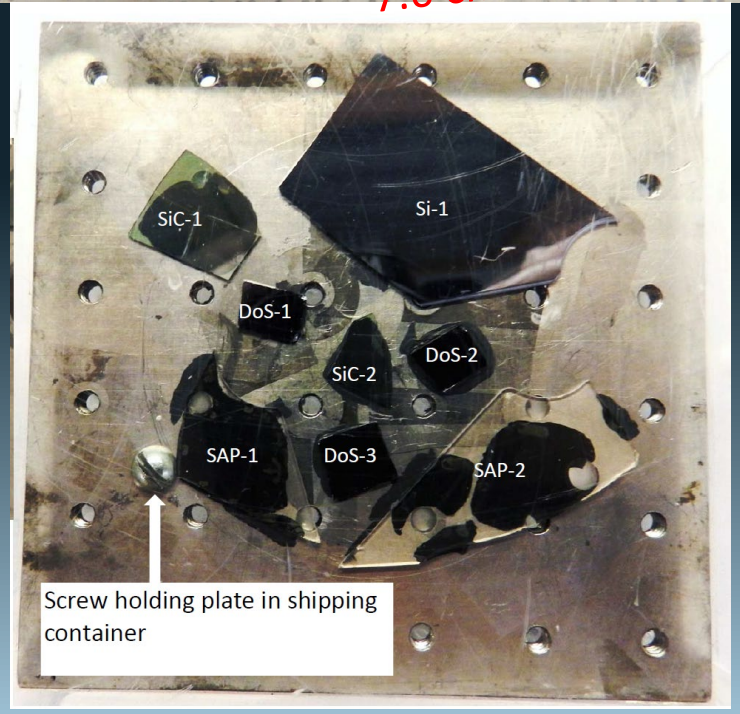
Implant ion:	Dose (ion/cm2):	Energy (keV):	Date/Name:	Vendor:	Calibrated
^{35}Mg	5e14	180	5/20/2014	Kroko	N

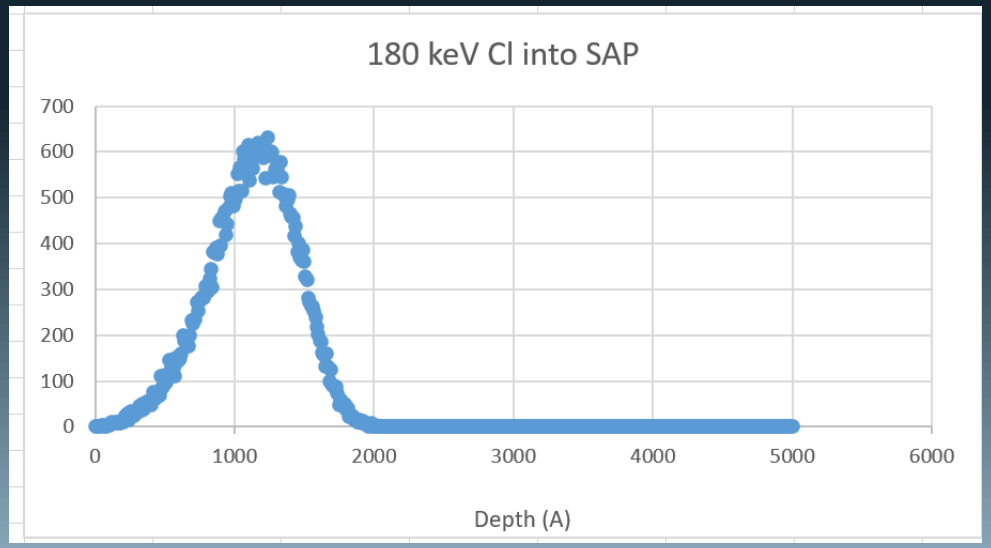
Important general information:

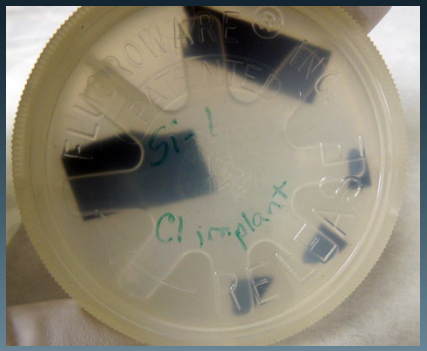
1) Have not located certificate of compliance
2) Not SW energy.

Purpose of implant (most recent if different dates of implantation):

1) Implant primarily to be used to estimate backgrounds of implanted materials







Post-implant samples as shipped

DATABASE MODIFICATION

EXISTING DATABASE
Sample Number: X900xx

Material:
- Manufacturer
- Batch, Lot

Container
Location
Sample images
Subsample numbering
Handling flags

MULTIPLE ADDITIONS
FOR EACH SAMPLE NUMBER
Date received
Implant Session ID

NEW LINKS

Implant Session: A0001

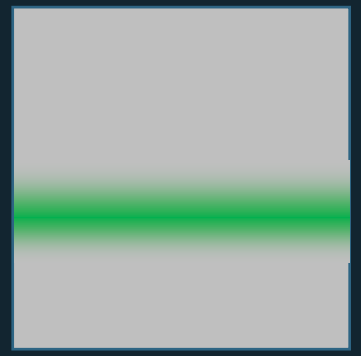
Ion: 13C
Dose: 1e13
Energy: 20 keV
Date: 2005-APR-18
Vendor: LANL
Calibrated: N
Calibration documents
Implant plate images

Implant Session: A0002

Ion: 36Ar
Dose: 1e13
Energy: 36 keV
Date: 2005-APR-18
Vendor: LANL
Calibrated: N
Calibration documents
Implant plate images

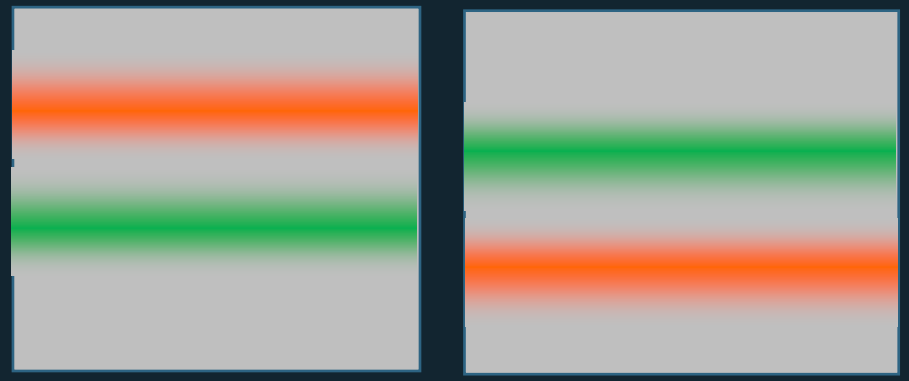
- EACH FRAGMENT NEEDS A UNIQUE NUMBER
- EACH FRAGMENT CAN OFTEN BE LINKED WITH MULTIPLE IMPLANT SESSIONS

Going forward .....



Non-flight reference material calibrated for use as an external standard will be added to our Q3 Reference Material collection.

Sun facing surface



Sun facing surface

Existing Genesis-flown Internal Standards, either frontside or backside, returned by investigators in good condition will be added to the flight collection.

We anticipate interaction with the community on how best to make these accessible and useful.

Thank you!

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Genesis Curation web site:
https://curator.jsc.nasa.gov/genesis/index.cfm

Genesis online sample catalog:
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