

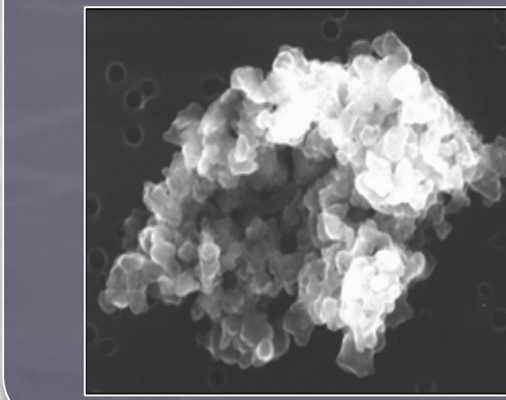


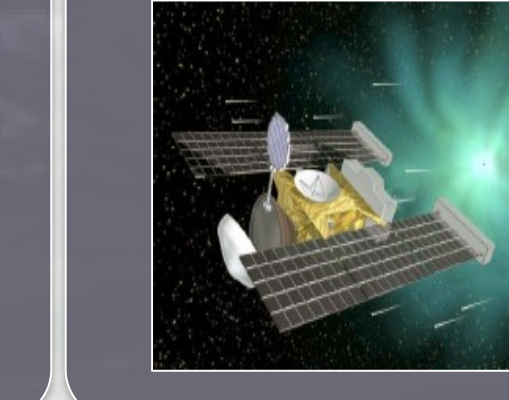


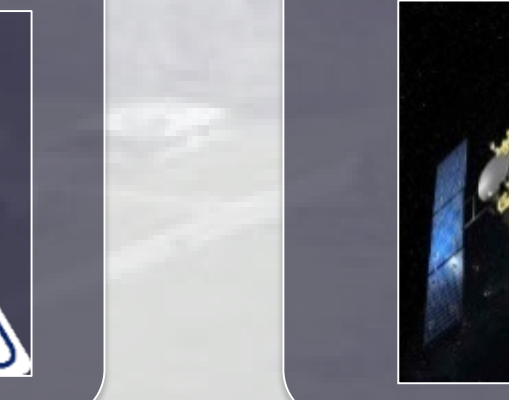
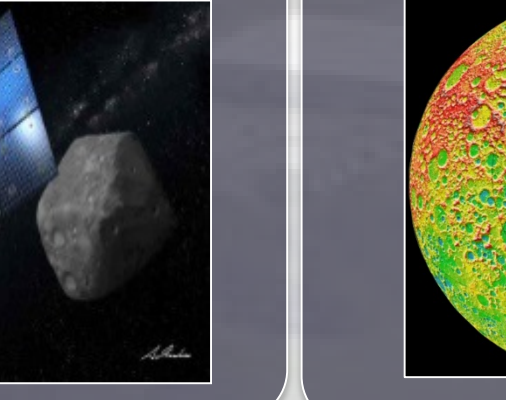
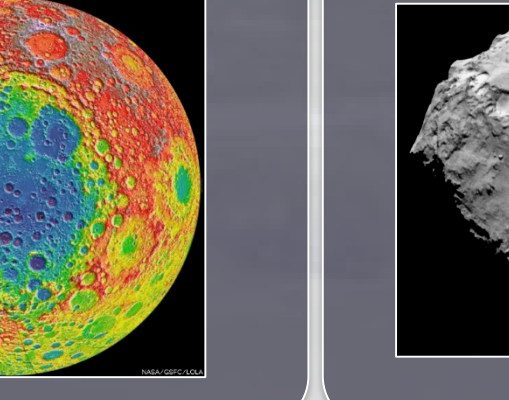
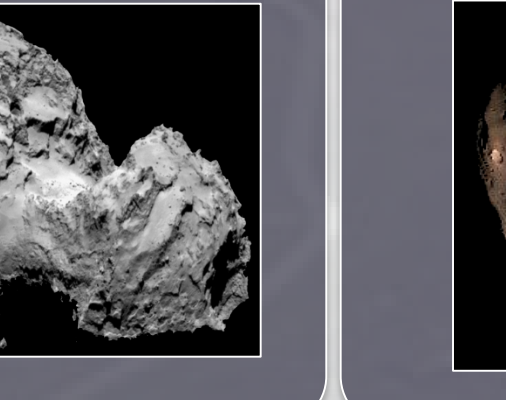
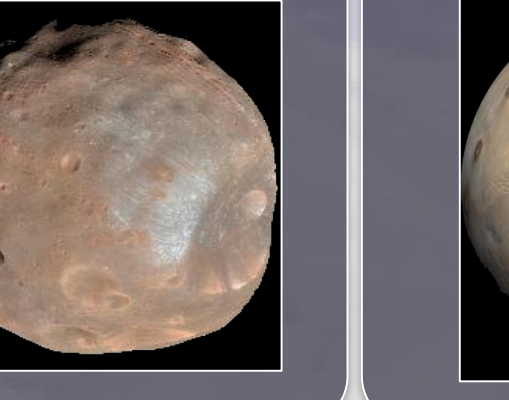


ADVANCED CURATION ACTIVITIES AT NASA: PREPARING FOR THE NEXT WAVES OF ASTROMATERIALS SAMPLE RETURN



Ryan Zeigler, Judy Allton, Cindy Evans, Marc Fries, Francis McCubbin, Keiko Nakamura-Messenger, Kevin Righter, Mike Zolensky, and Eileen Stansbery, NASA – Johnson Space Center, Astromaterials Acquisition and Curation Office

Astromaterials Acquisition and Curation Office at JSC: The Past, Present, and Future Home of all of NASA's Astromaterial Collections

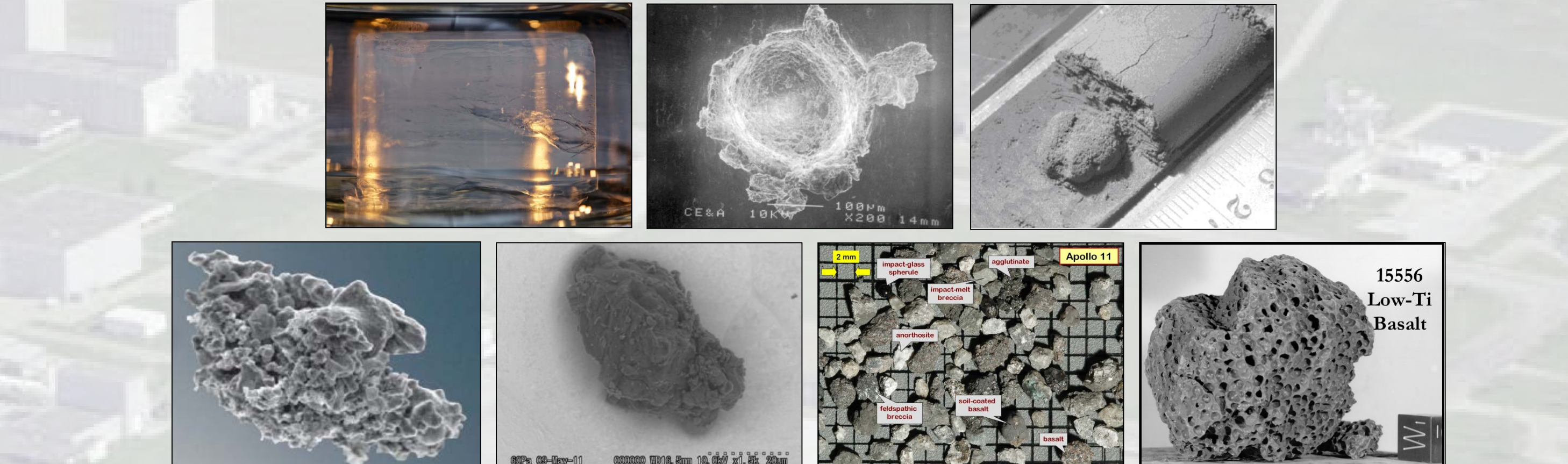
Lunar (1969) Apollo program rocks, soils; Subset of USSR Luna samples 	Meteorites (1977) Antarctic Search for Meteorites program: asteroids, Mars, Moon 	Cosmic Dust (1981) Cosmic dust grains collected from Earth's stratosphere by aircraft 	Microparticle Impact (1985) Space exposed hardware from science missions 	Genesis (2004) Genesis mission solar wind samples from Earth-Sun L1 point 	Stardust (2006) Two collections: interstellar grains and Comet Wild 2 grains 	Hayabusa (2012) Subset of samples collected from asteroid Itokawa By JAXA 	OSIRIS-REx (2015) Contamination Knowledge; samples from asteroid 101955 Bennu in 2023 	Hayabusa2 (2021) Subset of samples collected from asteroid Ryugu by JAXA 	Lunar South Pole Sampler (2020s) Volatile or Non-volatile-rich farside/polar sample return 	Comet Surface Sample Return (2020s) Cold curated surface sample return from a comet 	Phobos (2020s) Possible participation in a JAXA mission to bring back Phobos samples 	Mars (2030s) Various Mars Sample Return incl. Mars 2020, HAMSR, SCIM, etc. 
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Current Facilities

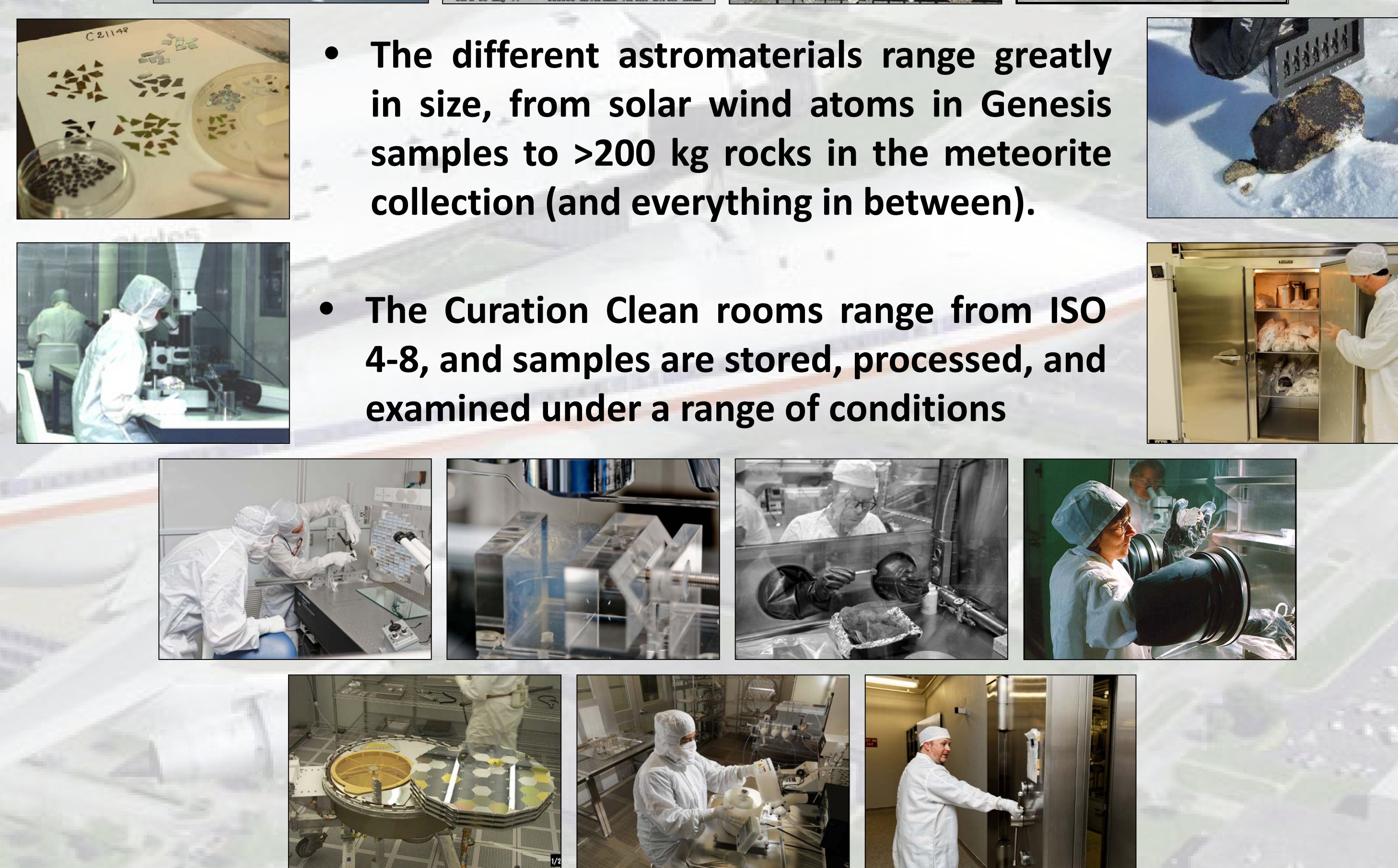
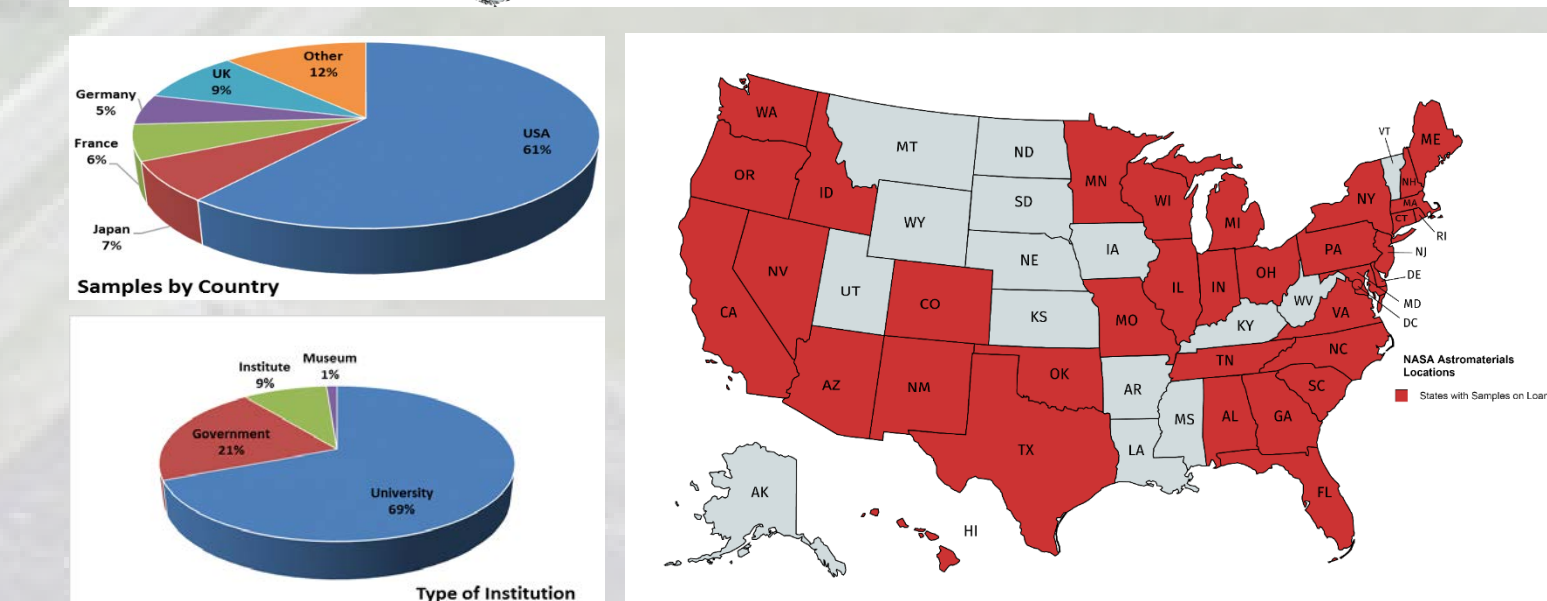
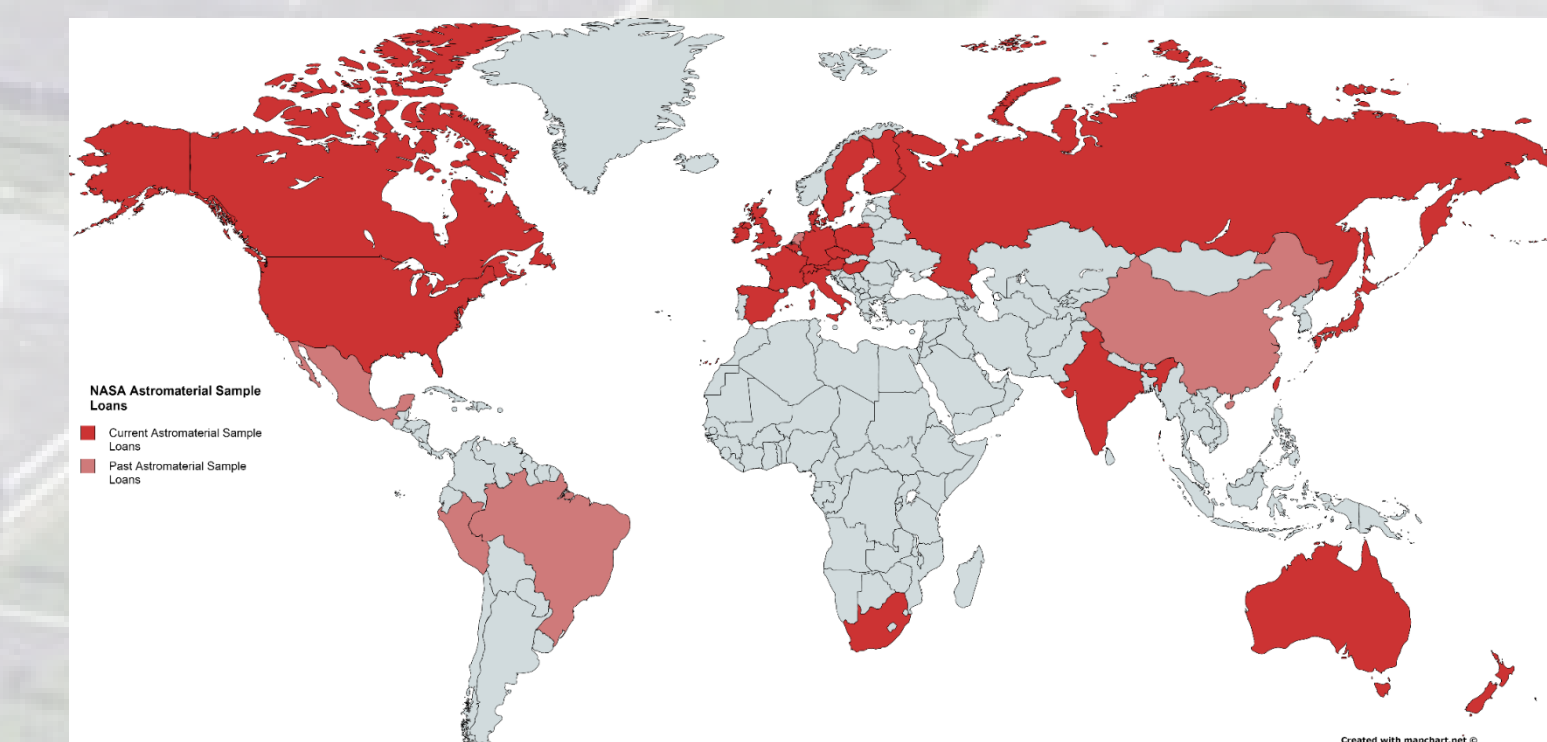
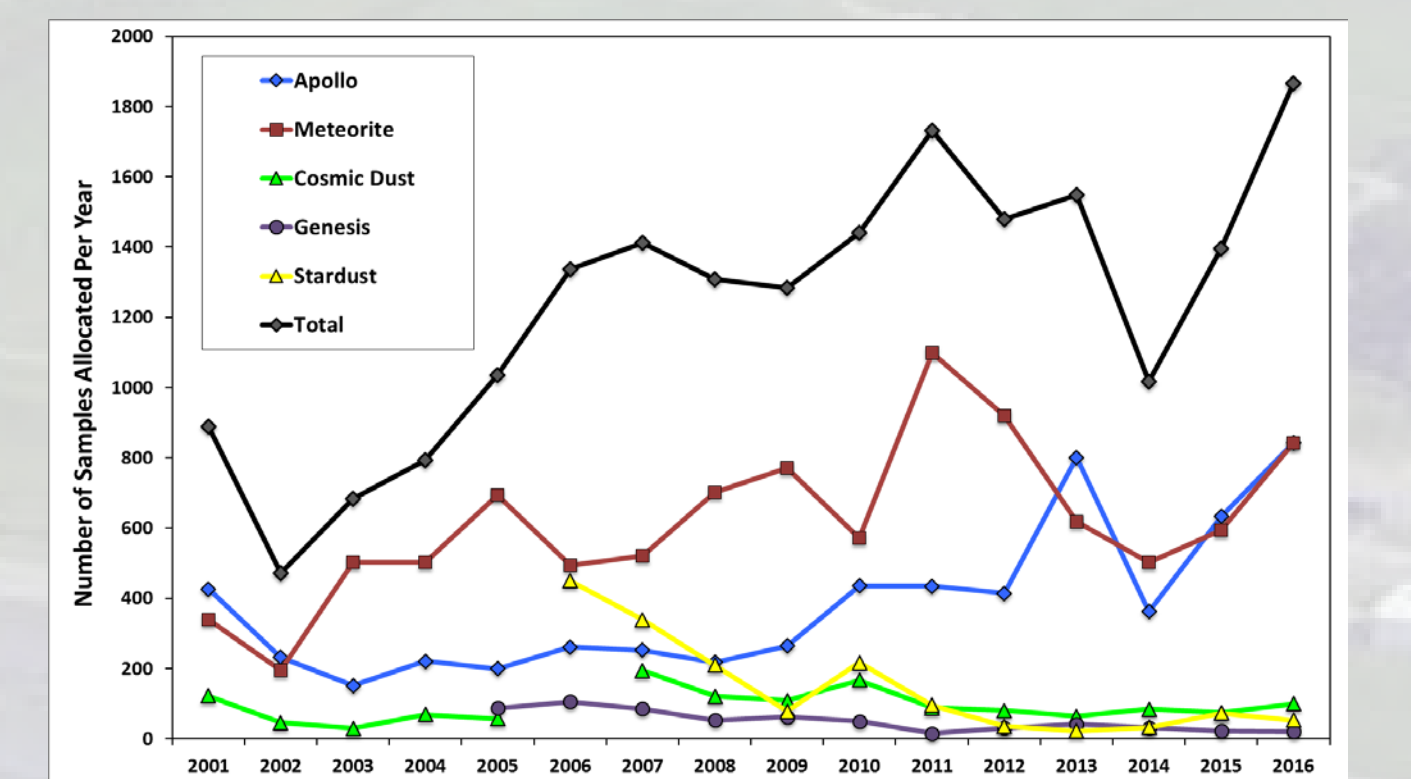
- Currently NASA's astromaterials samples are curated in 8 clean room suites at JSC and a remote storage facility at White Sands Complex.
- A variety of facilities and infrastructure are required to support the clean rooms including 10 different HEPA-filtered HVAC systems, an ultrapure gaseous N₂ system, an ultrapure water (UPW) system, and cleaning facilities to provide clean tools and equipment for the labs.
- We also have sample preparation facilities for making thin sections, microtome sections, and even focused ion-beam (FIB) sections to meet the research requirements of scientists across the globe.



Current Samples and Allocations

- The different astromaterials range greatly in size, from solar wind atoms in Genesis samples to >200 kg rocks in the meteorite collection (and everything in between).
- The Curation Clean rooms range from ISO 4-8, and samples are stored, processed, and examined under a range of conditions

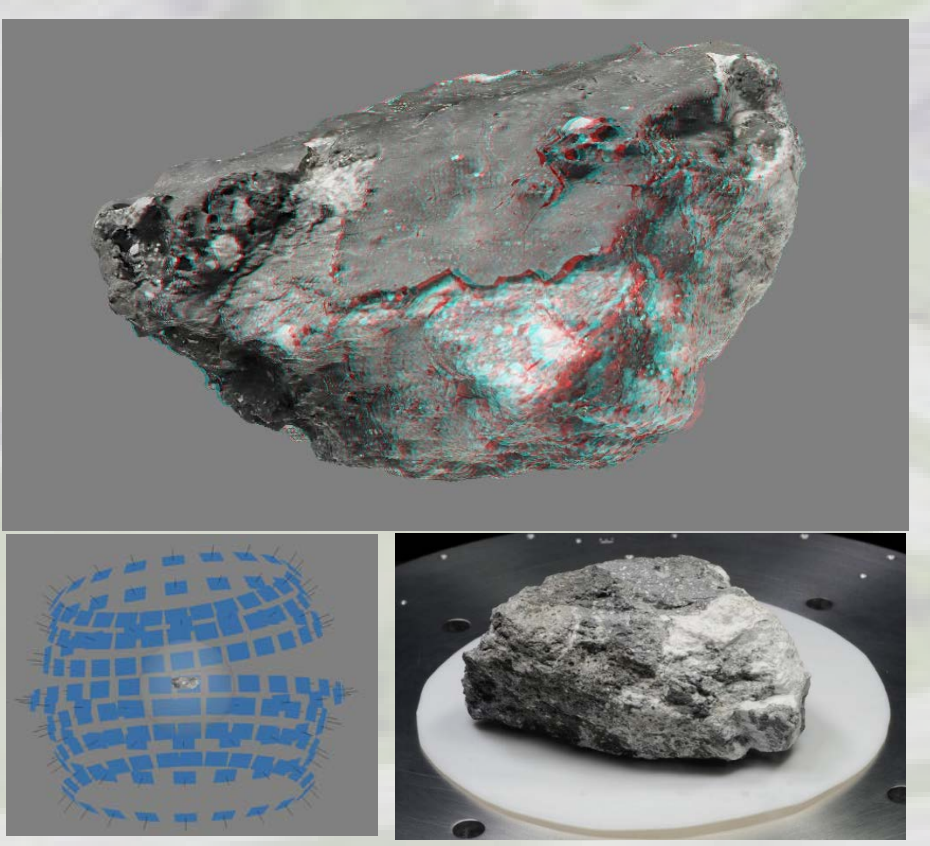



- An average of >1,400 samples have been loaned annually since 2006.
- There are currently >19,000 samples loaned to 433 Principal Investigators in 24 countries.

Advanced instrumentation

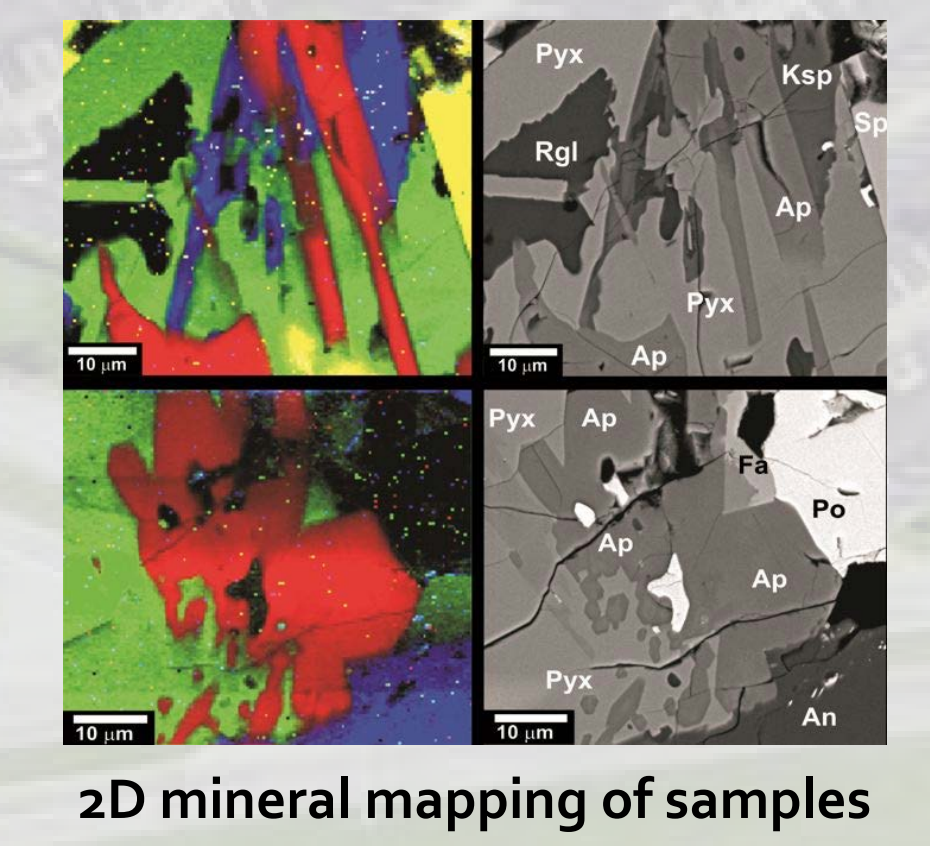
We are augmenting our analytical facilities to enable non- or minimally-destructive characterization, handling, and analyses of astromaterials. This will enable: (1) next gen sample handling, (2) PET for future sample return missions, (3) retroactive PET-style on existing collections, and (4) periodic assessments of the existing sample collections.

3D imaging



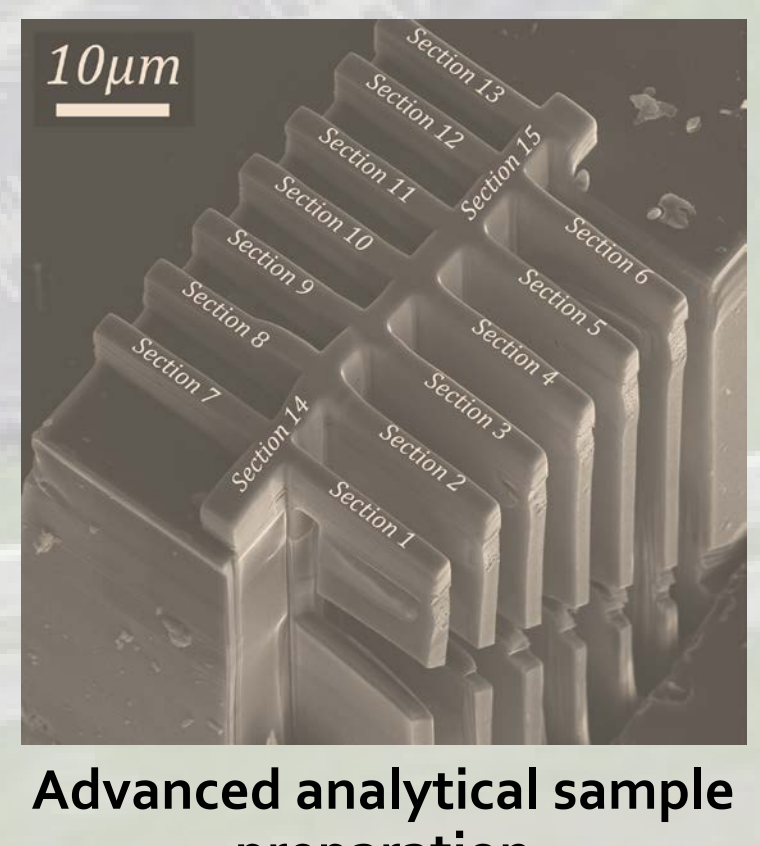
State of the art imaging and characterization

Micro-Raman



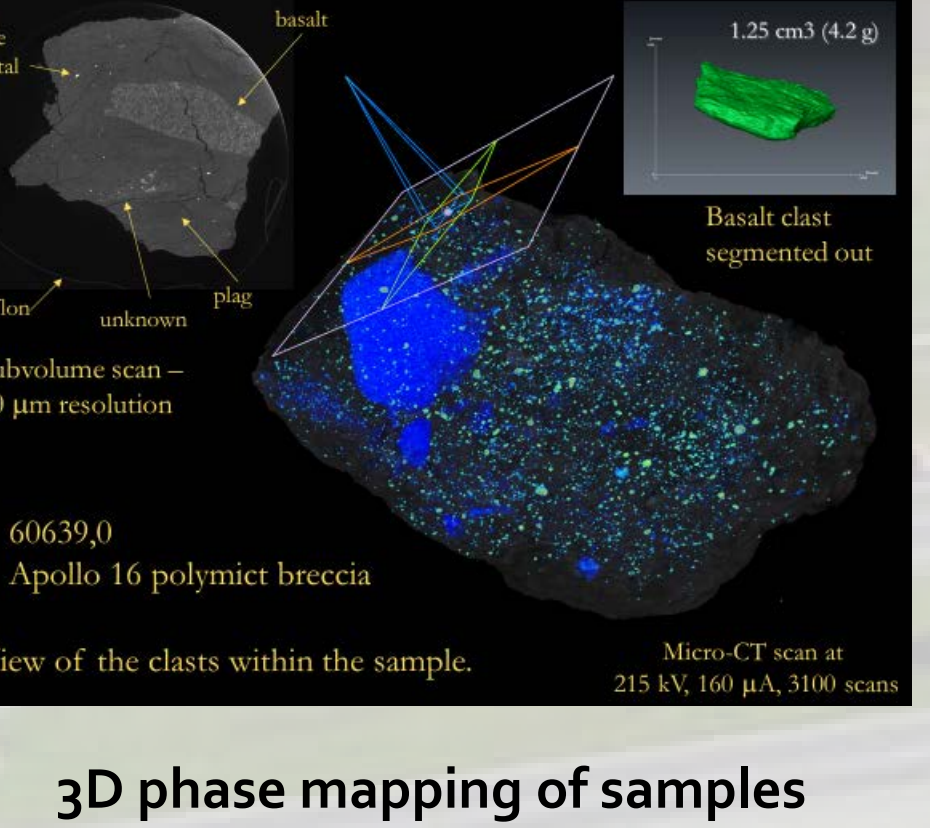
2D mineral mapping of samples

FIB



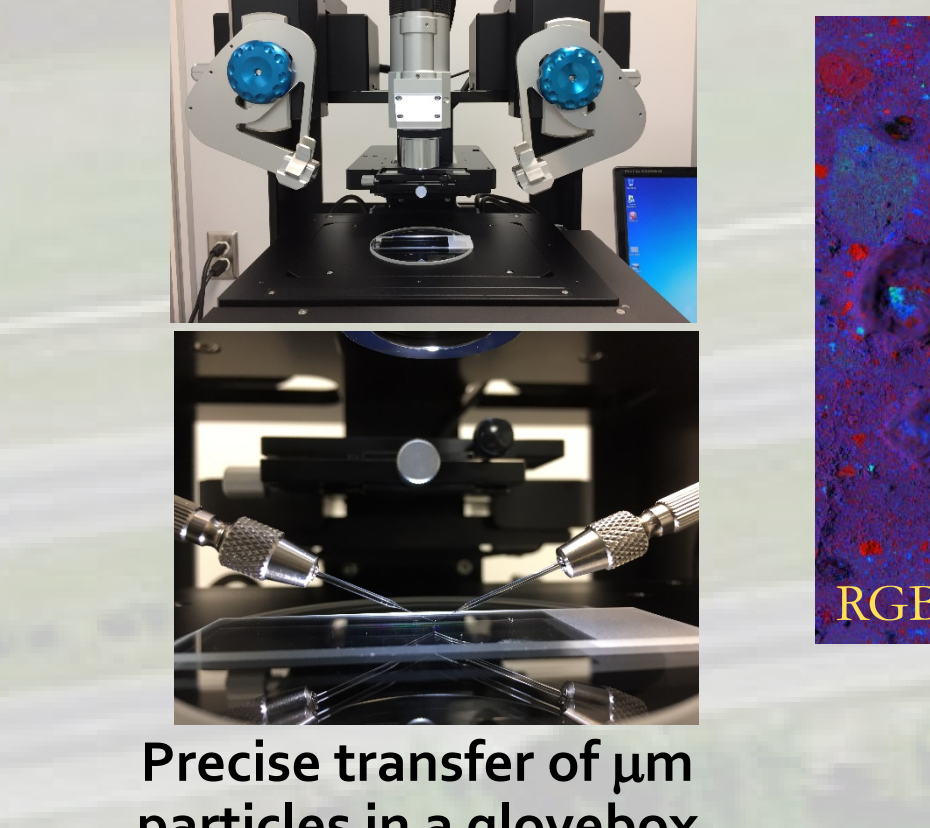
Advanced analytical sample preparation

Micro-XCT



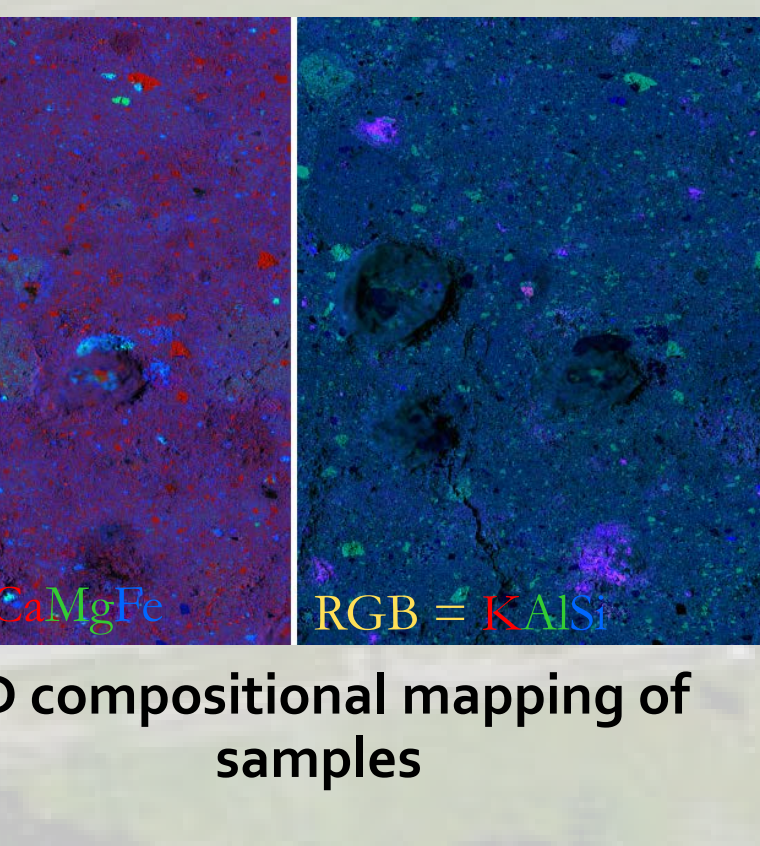
3D phase mapping of samples

Micromanipulator



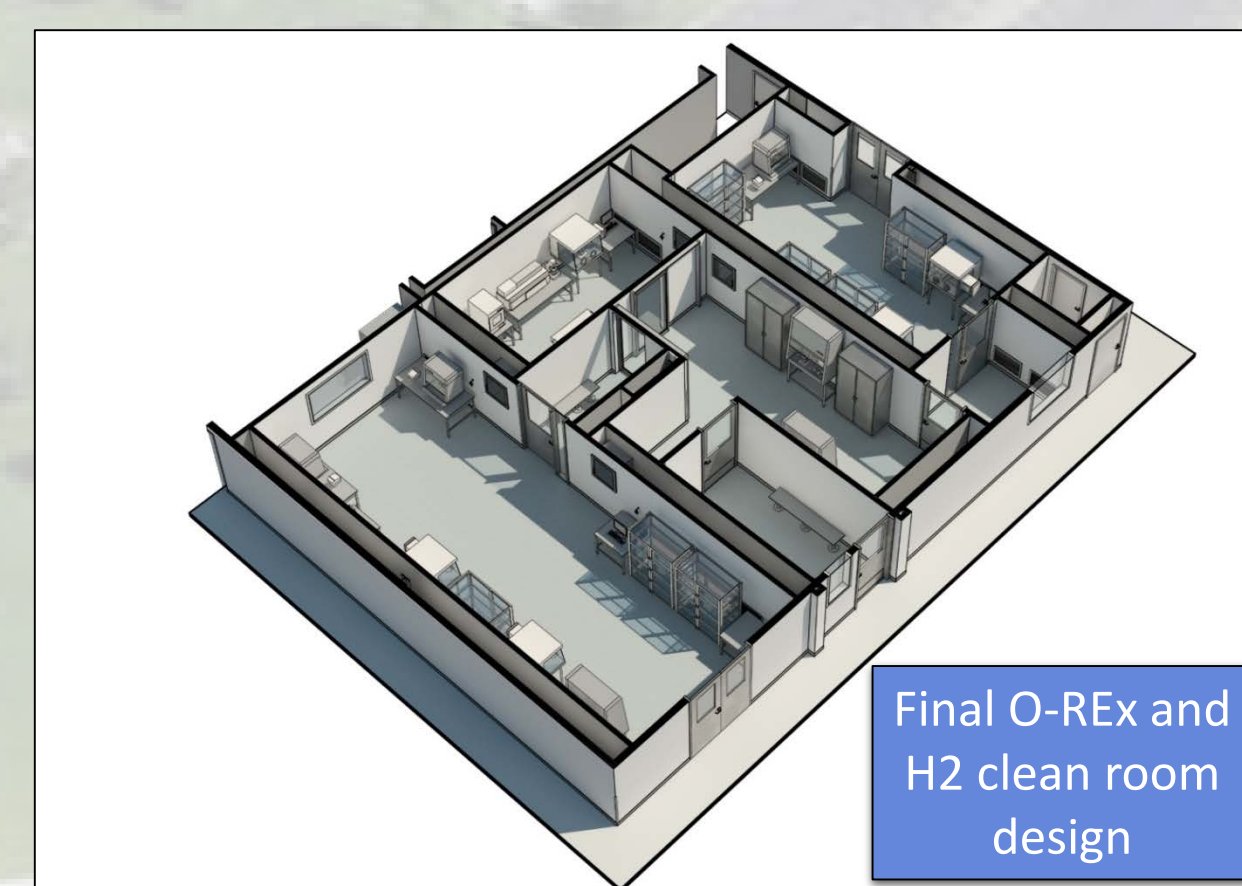
Precise transfer of μm particles in a glovebox

Micro-XRF



2D compositional mapping of samples

Future Facility Planning



As new collections are added, custom clean rooms are designed, e.g. the O-REx and H2 labs.

Additionally, we have initiated plans for a new curation facility, including BSL-4 capabilities to be able to handle restricted sample return missions (e.g., Mars)



Advanced Curation Research Efforts

Advanced Curation is tasked with developing procedures, technology, and data sets necessary for curating new types of collections as envisioned by NASA exploration goals.

Current Areas of research include:

- Storage and processing of samples under cold conditions (<-20° C)
- Extended curation of ices and volatiles
- Curation of samples with special chemical considerations such as perchlorate-rich samples
- Curation of Samples Requiring extremes of redox state
- Curation of organically- and biologically-sensitive samples.

Future Areas of Research include:

- Curation of samples requiring extremes of temperature and pressure
- Cryogenic curation and processing of samples (< -150° C)

