DEVELOPING THE NEW HAYABUSA CURATION FACILITY AT JOHNSON SPACE CENTER.

B. T. De Gregorio[1], M. E. Zolensky[2], R. Bastien[1], B. McCann[1], D. R. Frank[1], J. L. Warren[1], and C. C. Allen[2], [1]ESCG/NASA Johnson Space Center (e-mail: bradley.t.degregorio@nasa.gov), [2]NASA Johnson Space Center (e-mail: michael.e.zolensky@nasa.gov).

Introduction: On 25 November 2005 the Japan Aerospace Exploration Agency (JAXA) Hayabusa spacecraft made contact with the asteroid 25143 Itokawa and collected a small amount of regolith dust from Muses Sea region of smooth terrain [1]. Even though optimal sample collection did not occur, the spacecraft returned to Earth with more than 10,000 grains ranging in the size from 300 μm to less than 10 μm [2, 3]. These grains represent the only collection of material returned from an asteroid by a spacecraft. As part of the joint agreement between JAXA and NASA for the mission, 10% of the Hayabusa grains will be transferred to NASA for parallel curation and allocation, the first 15 of which arrived in December 2011. In order to properly receive and process these samples, a new curation facility was developed at Johnson Space Center (JSC).

Creating a Pristine Curation Environment: Since the Hayabusa samples within the JAXA curation facility have been stored and processed in specially-designed cabinets, free from exposure to terrestrial atmosphere and contamination [4], one of the goals of the new NASA curation facility was to continue this requirement. An existing lab space at JSC was transformed into a 120 sq.ft. ISO class 4 (equivalent to the original class 10 standard) clean room. Hayabusa samples will be stored, observed, processed, and packaged for allocation inside a stainless steel glove box under dry N_2 (Figure 1). Construction of the clean laboratory was completed in December 2011 and an internal readiness inspection is underway in order to confirm that the lab meets the NASA cleanliness and contamination control requirements for sample curation. Currently, the first batch of 15 Hayabusa particles transferred to NASA are being stored in their original transfer packaging within a clean-room cabinet in the Cosmic Dust Laboratory until the Hayabusa Lab is fully operational.

Special care has been taken during lab construction to remove or contain materials that may contribute contaminant particles in the same size range as the Hayabusa grains, some of which are up to 300 μm but are predominantly less than 10 μm in diameter. Several witness plates of various materials will be installed around the clean lab and within the glove box to identify local contaminants at regular intervals by SEM and mass spectrometry, and particle counts of the lab environment will be acquired frequently. Of particular interest is anodized aluminum, which contains copious sub-mm grains of a multitude of different materials embedded in its upper surface. Unfortunately the use of anodized aluminum was necessary in the construction of the clean room frame (visible in Figure 1) to strengthen it and eliminate corrosion and wear over time. All anodized aluminum interior to the lab will be covered or replaced by minimally-contaminating materials.

Manipulating Sub-mm Asteroid Grains: Although NASA already curates other collections containing sub-mm extraterrestrial particles, these collections include terrestrial materials that significantly aid in their manipulation by sharp glass needles. For example, Cosmic Dust particles and aggregates contain a

FIGURE 1. The new Hayabusa clean lab and sample cabinet at JSC, after construction has been completed but before readiness clearance. A new glass front for the glove box will be fabricated, and any anodized aluminum parts will be replaced with new stainless steel parts.

thin layer of silicone oil that helps them attach to the needle tip, while Stardust cometary grains are surrounded by silica aerogel. In contrast, the Hayabusa asteroid grains are "naked", and some other form of assistance is required.

JAXA/ISAS and researchers at Kyushu University and Sendai University, under the direction of Tomoki Nakamura and Akio Fujimura, have developed a electrostatic particle manipulator system, which we are now adapting to our lab (Figure 2). In general, this system operates by establishing a constant residual charge on the probe needle, which attracts the particle to be transported. Removing or neutralizing the charge allows the particle to be set down. A prototype system has been successfully tested with sub-mm grains of San Carlos olivine. The electrostatic manipulator system will be incorporated with an optical microscope and micro-manipulator controls similar to the setups used in the Cosmic Dust and Stardust curation facilities. The entire microscope/micro-manipulator setup will be placed inside the glove box and controlled by a curator in the clean lab through the glove ports. It will be non-trivial to adapt this system for such use. Alternatively, we are testing the efficacy of a "vacuum tweezer" system using quartz glass needles with an open tip diameter less than 5 μm. However, such a vacuum system would necessarily be located outside of the glove box.

Allocation of NASA's Hayabusa Samples: The first JAXA international Announcement of Opportunity (AO) for Hayabusa samples is scheduled for early 2012, and NASA intends to synchronize its AO announcement with it. The first sample allocations of Hayabusa samples should occur sometime during Summer 2012. The entirety of NASA's allotment of Hayabusa grains will be available to both domestic and international researchers. The first 15 Hayabusa particles will be allocated "as is", without processing. However, future grains can be allocated in a variety of processed states, as requested by researchers. Preliminary examination of the first 15 Hayabusa particles by low voltage SEM/EDS has been performed at the JAXA curation facility, and many of the future grains transferred to NASA will also be characterized in this way, either at JAXA or at JSC. However, a subset of future NASA curated grains will likely remain pristine and uncharacterized. It should be noted, however, that many of these uncharacterized grains will be composed of aluminum from the walls of the sample catcher. Additional information about NASA's Hayabusa collection, curation, and allocation is available at http://curator.jsc.nasa.gov/hayabusa/.

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References: [1] Yano H. et al. (2006) *Science, 312*, 1350. [2] Nakamura T. et al. (2011) *Science*, *333*, 1113. [3] Abe M. (2011) personal communication. [4] Yada T. et al. (2011) *Meteoritics & Planetary Science, 74 (suppl.)*, abstract 5386.

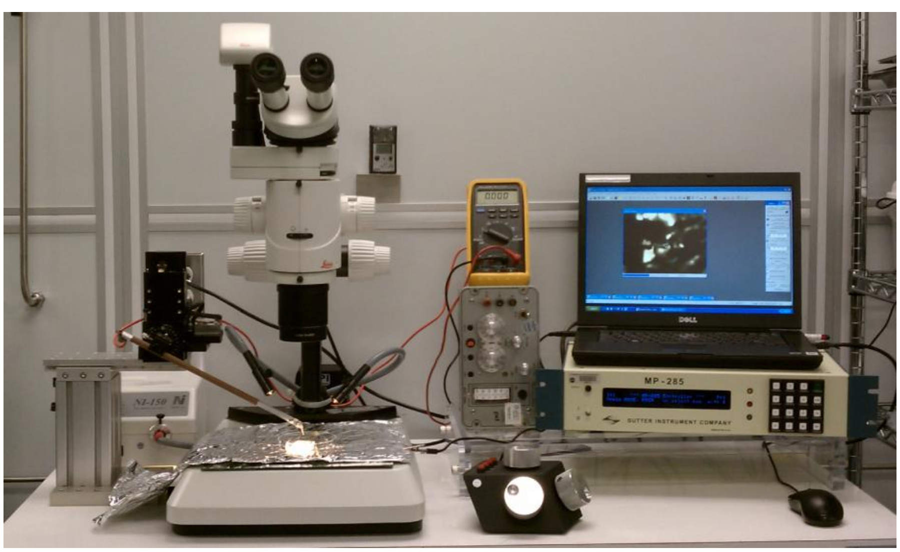

FIGURE 2. Prototype of the electrostatic micro-manipulator system to be used to handle and transfer sub-mm asteroid grains. It has been operated successfully to manipulate olivine test grains in this size range.