OSIRIS-REX AND HAYABUSA2 SAMPLE CLEANROOM DESIGN AND CONSTRUCTION PLANNING AT NASA-JSC. L.F. Pace[1] , K. Righter[1], K. Nakamura-Messenger[1], J. McQuillan[2] and OSIRIS-REx Curation working group. [1]NASA JSC, Astromaterials Research and Exploration Science, Mailcode XI, 2101 NASA Pkwy, Houston, TX 77058; (lisa.pace@nasa.gov).[2]NASA JETS contract, 2224 Bay Area Blvd, Houston, TX 77058.

The OSIRIS-REx asteroid sample return mission launched to asteroid Bennu September 8, 2016. The spacecraft will arrive at Bennu in late 2019, orbit and map the asteroid, and perform a touch and go (TAG) sampling maneuver in July 2020 [1]. After confirmation of successful sample stowage, the spacecraft will return to Earth, and the sample return capsule (SRC) will land in Utah in September 2023. Samples will be recovered from Utah [2] and then transported and stored in a new sample cleanroom at NASA Johnson Space Center in Houston [3]. All curation-specific examination and documentation activities related to Bennu samples will be conducted in the dedicated OSIRIS-REx sample cleanroom to be built at NASA-JSC. It is in this laboratory where the bulk and surface contact pad samples will be characterized during preliminary examination and mission (25%) and archival (75%) sample subsets will be cataloged. In addition, in 2014, NASA signed a memorandum of understanding with JAXA that designates 10% of the Hayabusa2 collected Ryugu samples be exchanged with NASA for curation at JSC. A new sample cleanroom for the NASA portion of the Hayabusa2 samples is also required and included in the new cleanroom suite at JSC.

Cleanroom location and characteristics

The asteroid sample cleanroom suite will be constructed within existing space in Building 31 at JSC (Fig. 1). The space will be entirely re-furbished, replicating what was done in support of the Genesis and Stardust mission sample curation facilities over a decade ago. Refurbishing includes demolition of all existing walls and materials, including a full asbestos abatement throughout the space. After demolition, all surfaces will be cleaned and prepared for installation of a new cleanroom floor, wall and ceiling system ranging from ISO Class 5 to 7 [3]. All electrical, mechanical, security, and IT systems will be replaced to meet the new sample collection needs. JSC Curation has been through this process for five different cleanrooms – Genesis (completed in 1999), Remote Storage Facility (completed 2002), Stardust (completed in 2006), Space Exposed Hardware (completed 2006) and Hayabusa (completed in 2012) providing a breadth of experience over the last two decades. Many lessons learned will be implemented in the construction of the asteroid sample (OSIRIS-REx and Hayabusa2) cleanroom suite, and associated curatorial procedures.

Requirements were established for the cleanroom, and associated rooms (anterooms, air showers, microtomy room) which will support the ISO 5 rating of the sample curation cleanrooms within the suite. Requirements for the new cleanroom include temperature (23°C), relative humidity 50 % ± 5 %, positive room pressure (air velocity > 0.2 m/s, 0.08 inches of H_2O relative pressure per [3]), acoustic (not to exceed NC45), and lighting (500 lux in all spaces). In addition, existing stainless steel nitrogen gas plumbing will be extended to areas where required. Fire protection, power and security (motion and door sensors) will be designed to meet new laboratory needs. A new air handling system will be installed to ensure no cross contamination within the new suite or with adjacent laboratories within Building 31. The new air handler will be tied to the center operations control system to monitor and control temperature, humidity and pressure.

Prohibited materials include compounds that would produce amino acid-like materials (because amino acids are one of the primary focal points of the science data; [2]) such as Latex, Nylon, and polyamide materials (*Polyimides*, like Kapton, are acceptable for use however); open solder; mercury-containing light bulbs (use LED lights instead); magnetic materials; silicones (are difficult to remove using either chemical or vacuum baking cleaning techniques); foams; paints (can become particle generators when improperly applied or cured and some paints contain large pigment particles); metal oxides (bare (untreated) aluminum and magnesium, iron, non-corrosion resistant steel); and materials with thin films that might erode or crack and flake.

In March 2016, RS&H was selected from a pool of pre-registered design firms available for NASA-JSC to carry out a design for the cleanroom suite. We completed 30%, 60%, 90%, and 100% design reviews, culminating with a February 2017 100% design review meeting and a completed design and specification package (Figures 2 and 3). The two sample cleanrooms will have separate entries and air showers, but will share a main entrance and staging area. Both rooms will have pass throughs into an ISO 7 microtomy room where samples can be further subdivided for preliminary examination or science PIs. Adjacent to the OSIRIS-REx cleanroom, and with separate entrance from the cleanroom suite, will be a dedicated sample preparation room where techniques such as cutting, grinding, thin sectioning, and other sample preparation approaches can be employed.

As the cleanroom facility approaches the construction phase, curation staff will identify any prob-

lematic materials that would compromise the mission science. As an example, the curation staff has already identified high off-gassing values for the flooring and wall materials selected by the design firm. In response to this information, we will identify and evaluate possible replacement materials before the construction contract is awarded. The team, together with input from the Curation Working Group, will work to choose alternative materials that will better satisfy mission and sample science requirements. Construction will begin in FY2019, with a goal of cleanrooms being completed by June 2020. For Hayabusa2, samples are collected in 2019, return to Earth in FY2021, and the NASA portion arrives at JSC in FY2022. For OSIRIS-REx, samples are collected in 2020, and return to Earth in 2023. The cleanroom suite's completion date in June 2020 allows ample time for cleanroom commissioning, outfitting, sample receiving and preparation rehearsals, and sample handling practice.

References: [1] Lauretta, D.S. et al. (2017) Space Science Reviews 212, 925-984. [2] Dworkin, J.P et al. (2018) Space Science Reviews 214, article id. #19, 53 pp.; 10.1007/s11214-017-0439-4. [3] ISO 14644, Cleanrooms and associated controlled environments - Part 4: Design, construction and start-up.

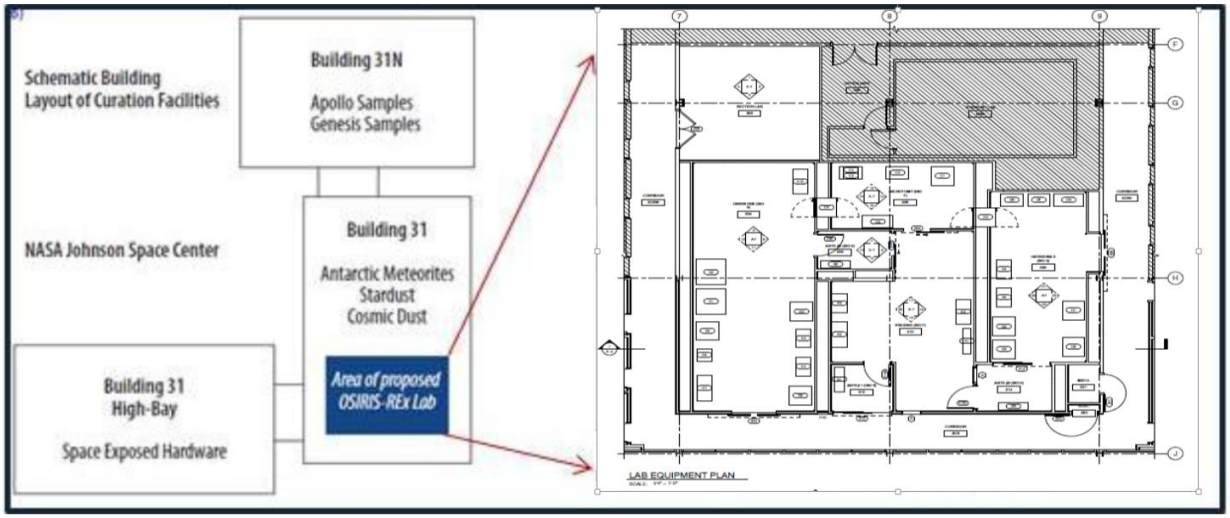
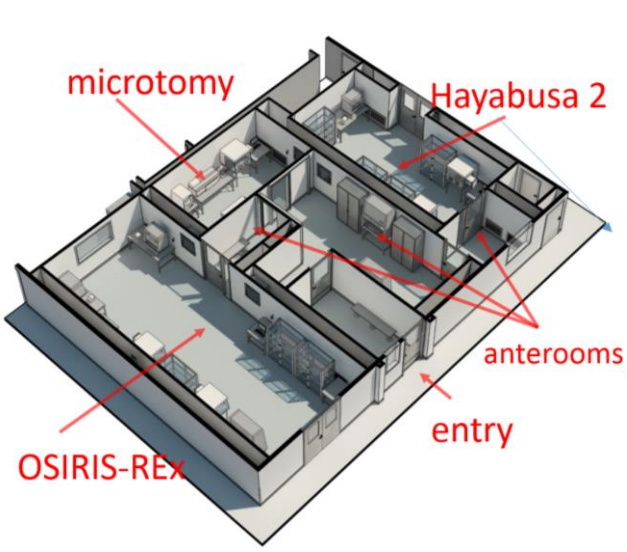


Figure 1: *Schematic diagram by design firm RS&H of OSIRIS-REx – Hayabusa2 laboratory suite at NASA-JSC, B31.*



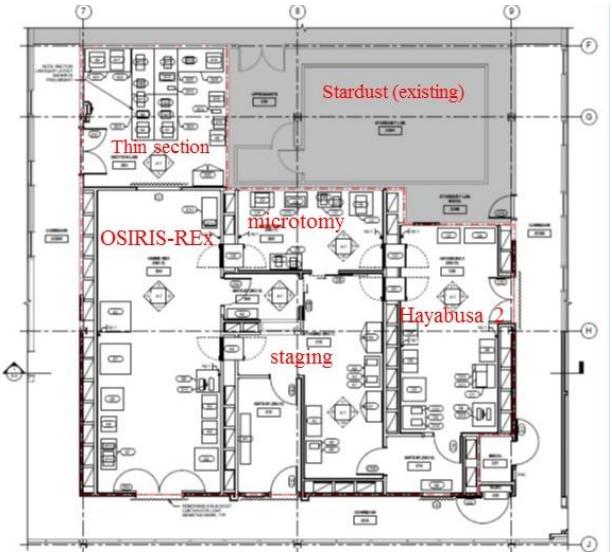


Figure 2 (above, left). *Model/design view by RS&H of OSIRIS-REx – Hayabusa2 cleanroom suite at NASA-JSC, B31.* ***Figure 3 (above right):*** *floor plan for new design.*