OSIRIS-REx AMINO ACID CONTAMINTION RESULTS. J.P. Dworkin[1*], C.C. Lorentson[1], C.A. Reigle[2], J. Moore[2], G. O. Jayne[1,3], L.L. Matthias[4], H.L. McLain[1,5], J.E. Elsila[1] [1]NASA Goddard Space Flight Center, Greenbelt, MD 20771, [2]Lockheed Lockheed Martin Space Systems Co., Littleton, CO 80125 [3]SGT, Inc, Greenbelt, MD 20770 [4]Analex Corporation, NASA Launch Services Program, Kennedy Space Center, FL 32899, [5]Catholic University of America, Washington DC 20064. [*]Jason.P.Dworkin@nasa.gov

OSIRIS-REx: The OSIRIS-REx mission (Origins, Spectral Interpretation, Resource Identification, and Security Regolith Explorer) is the third NASA New Frontiers mission. It launched September 8, 2016. The primary objective of the mission is to return at least 60 g of "pristine" material from the B-type near-Earth asteroid (101955) Bennu, which is spectrally similar to organic-rich CI or CM meteorites [1, 2]. The study of these samples will advance our understanding of materials available for the origin of life on Earth or elsewhere. The spacecraft will rendezvous with Bennu in 2018 and spend at least a year characterizing the asteroid before executing a maneuver to recover a sample of regolith in the touch-and-go sample acquisition mechanism (TAGSAM). The TAGSAM head and sample are stowed in the sample return capsule (SRC) and returned to Earth in 2023.

Contamination Control: To collect and maintain a pristine sample, OSIRIS-REx implemented a contamination control requirement for critical surfaces (Fig. 1) of 100 A/2 for particles and films, a 180 ng/cm^2 requirement for amino acids, and a campaign called contamination knowledge to collect and analyze the contamination present and their sources during assembly, test, and launch operations (ATLO) [3, 4].

The amino acid cleanliness with respect to the requirement was exceptional without the use of extravagant cleaning procedures. Instead, *careful* implementaiton of industry-standard techniques produced peformace 10-200 times lower than the 180 ng/cm^2 amino acid requirement on the sampling hardware and as on witnesses in the spacecraft highbay cleanrooms.

Table 1 shows the final amino acid contamination on OSIRIS-REx sampling hardware. The amino acids measured on witness plates in the various cleanrooms where OSIRIS-REx was assembled, tested and prepared for launch were added to indicate the likely maximum amino acid contamination on the non-sampling surfaces. This is the first amino acid monitoring through the full ATLO lifecycle, including the interior of an Atlas V 4-m fairing between spacecraft encapsulation and launch.

Planetary Protection: OSIRIS-REx has a planetary protection designation of Category II outbound and Category V unrestricted inbound, thus it has no bioload requirement. Though there is no biological requirement or assessment, the amino acid results suggest that it may be biologically very clean. The biological cleanliness can be assessed by examining archived witness plates for spores or DNA. An amino acid requirement has been proposed to be used to verify bioburden for planetary protection performance, including for missions to icy or ocean worlds [4].

To our knowledge OSIRIS-REx is the first mission which has successfully implemented an amino acid requirement. The methods and lessons learned in preparing OSIRIS-REx for launch can serve as a pathfinder for future astrobiology missions sensitive to organics and planetary protection.

Table 1. The amino acid load at component encapsulation of the three OSIRIS-REx critical sampling surfaces and the total of all amino acids after a total of 310 days of ATLO exposure.

Location	Amino Acid (ng/cm^2)
TAGSAM Head	0.96
SRC	13.1
Launch Container	2.32
Environment (310 days total)	21.3

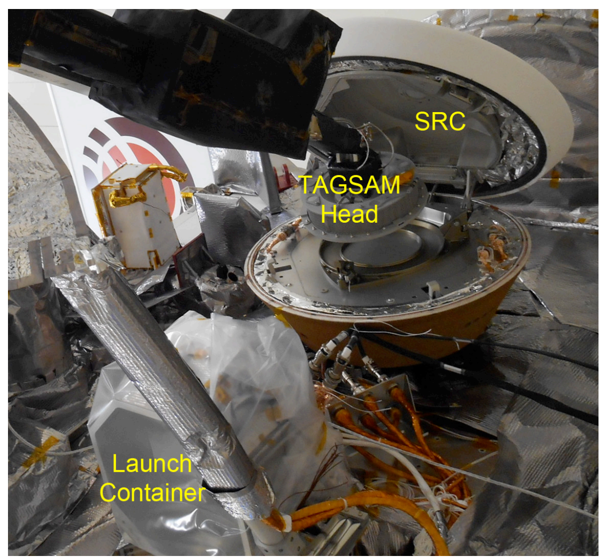

Fig 1. The critical sampling surfaces of OSIRIS-REx are the TAGSAM head, SRC, and launch container (which houses the TAGSAM head prior to sampling operations).

References: [1] Lauretta D. S. et al. (2015) Meteoritcs & Planet. Sci., 50, 834-849 [2] Clark et al. (2011) Icarus *216*, 462-475. [2] Dworkin et al. (2015) LPSC 1147 [3] Dworkin et al. (2017) in preparation. [4] Committee on Planetary Protection Standards for Icy Bodies in the Outer Solar System (2012) National Academies Press, p.56.