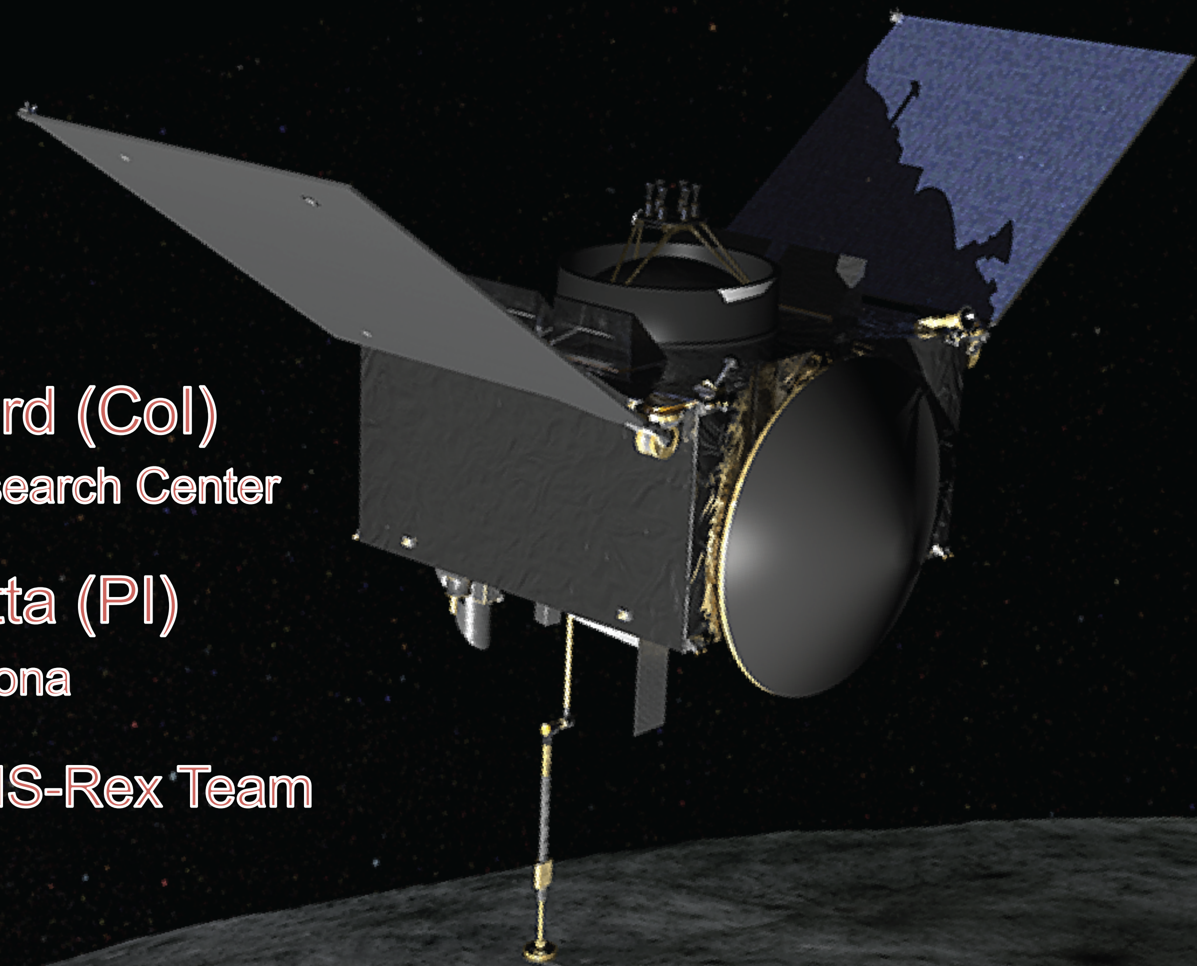
An Overview of the OSIRIS-REx Asteroid Sample Return Mission

SSERVI Exploration Science Forum, NASA Ames Research Center, 21 July 2015

OSIRIS-REx™
ASTEROID SAMPLE RETURN MISSION



Scott Sandford (CoI)
NASA-Ames Research Center

Dante Lauretta (PI)
University of Arizona

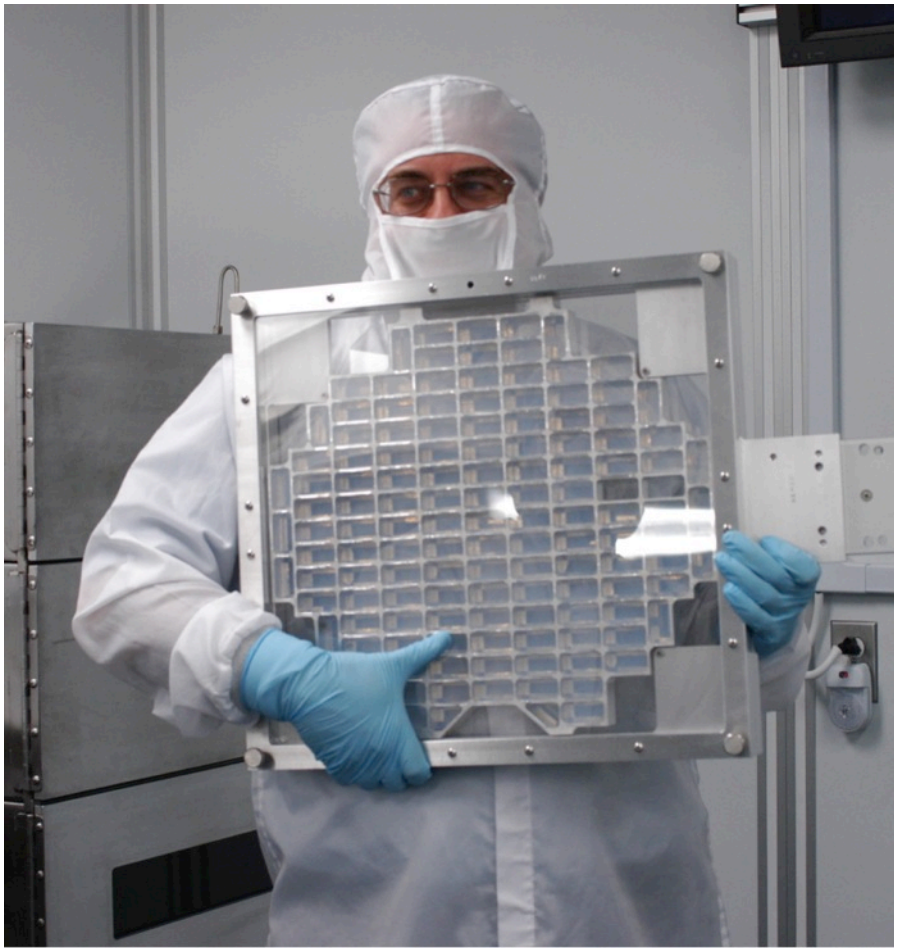
and The OSIRIS-Rex Team

THE UNIVERSITY OF ARIZONA – NASA GODDARD SPACE FLIGHT CENTER – LOCKHEED MARTIN

OSIRIS-REx Defined

- **O**rigins
  - Return and analyze a sample of pristine carbonaceous asteroid regolith
- **S**pectral **I**nterpretation
  - Provide ground truth for telescopic data of the entire asteroid population
- **R**esource **I**dentification
  - Map the chemistry and mineralogy of a primitive carbonaceous asteroid
- **S**ecurity
  - Measure the Yarkovsky effect on a potentially hazardous asteroid
- **R**egolith **Ex**plorer
  - Document the regolith at the sampling site at scales down to the sub-cm

The Advantages of Sample Return Missions



The Stardust aerogel comet dust collector

Allows for use of state-of-the-art analytical techniques and equipment, providing for the ultimate current precision, sensitivity, resolution, and reliability

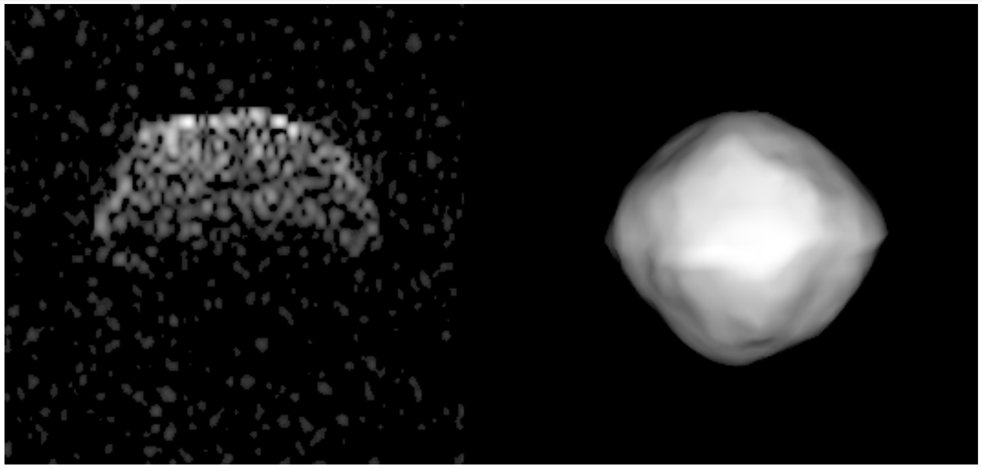
The returned samples are a resource for current and *future* studies by a broad international community

Analyses are iterative and fully adaptive - results are not limited by “instrument’ design or current ideas

Avoids limitations associated with cost, power, mass, and reliability

Analyses can be replicated, verified, done with multiple techniques and instruments, fully calibrated, and contamination can be fully evaluated

OUR TARGET ASTEROID - 101955 Bennu
(provisional designation 1999 RQ36)



Radar generated shape model

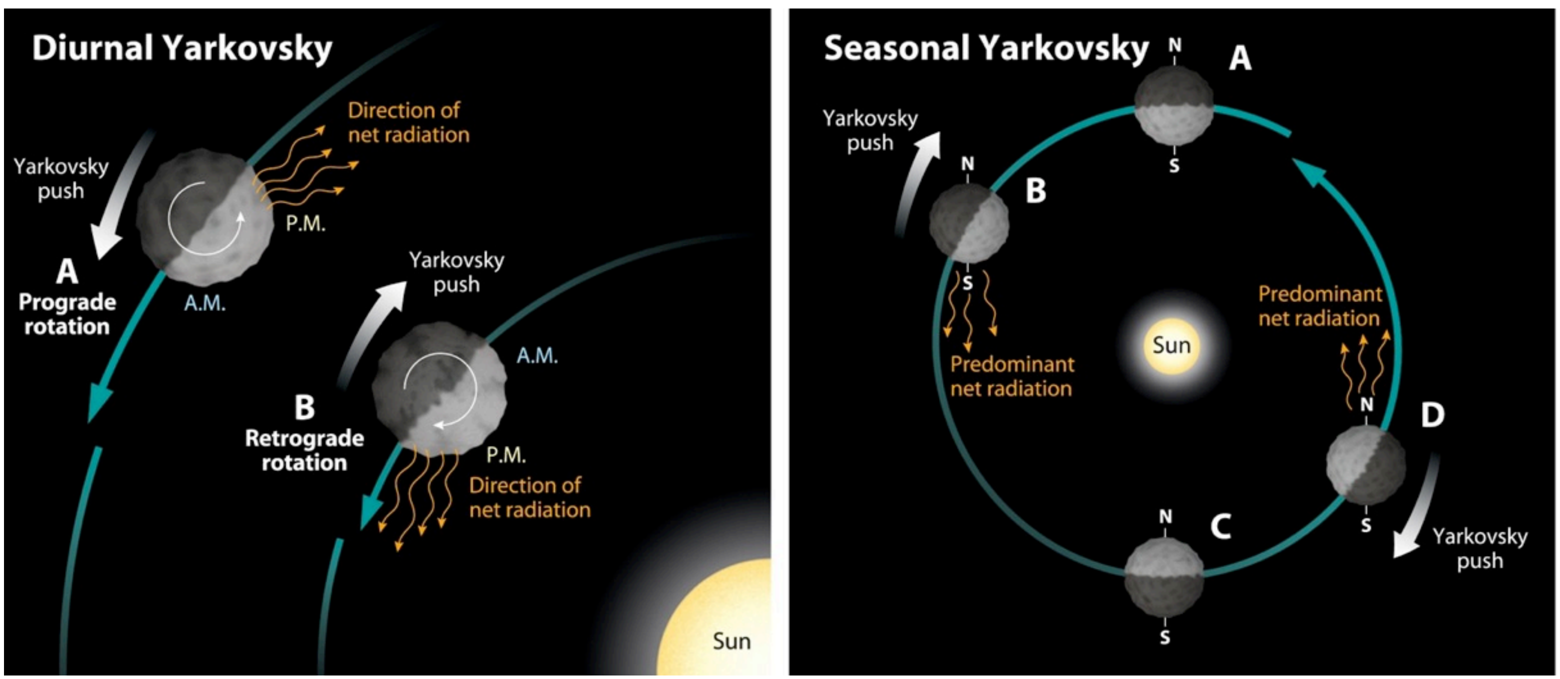
- Asteroid Bennu was discovered in 1999 and is a B-type, Apollo NEO
  - Orbital semi-major axis = 1.126 AU
  - Mean diameter = 492-m (±20 m)
  - Spheroidal with an equatorial ‘belt’
  - Rotation state = 4.2968 ± 0.0018 hr, 180 ± 5^{o} obliquity
  - Low albedo (0.035 ± 0.015)
  - Infrared spectra suggest the most likely meteorite analogs are CI or CM chondrites
  - Current best estimate of bulk density is 1260 ± 70 kg/m^3
- Observations support the presence of abundant regolith ideal for sampling (4-8 mm)
- Bennu comes within 0.003 AU of the Earth and has the highest impact probability of any known asteroid

101955 Bennu is small (but not *that* small)

- Bennu scaled (approximately) to the Golden Gate Bridge

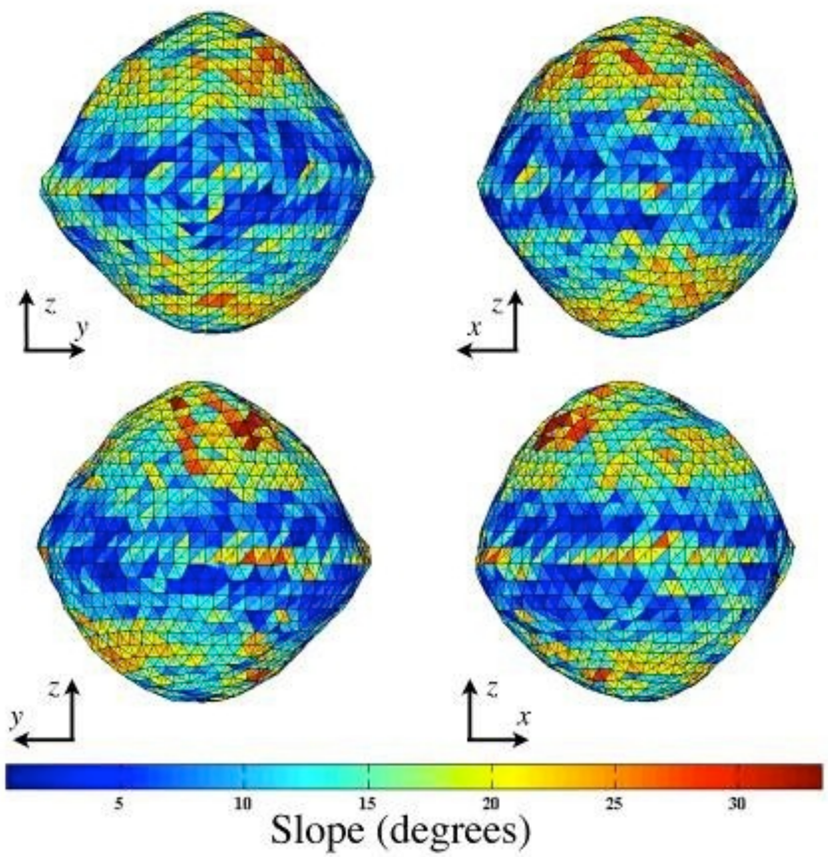
AN OSIRIS-REX FIRST: MEASURING A PLANETARY MASS USING RADAR AND INFRARED ASTRONOMY

- Three precise series of radar ranging position measurements over two synodic periods allowed us to measure Bennu’s Yarkovsky acceleration
- The asteroid has deviated from its Keplerian gravity-ruled orbit by 160 kilometers in just 12 years
- This result, when combined with the thermal inertia and the shape model, constrains the mass to 6.278 (-0.942/+1.883) x 10^{10} kg



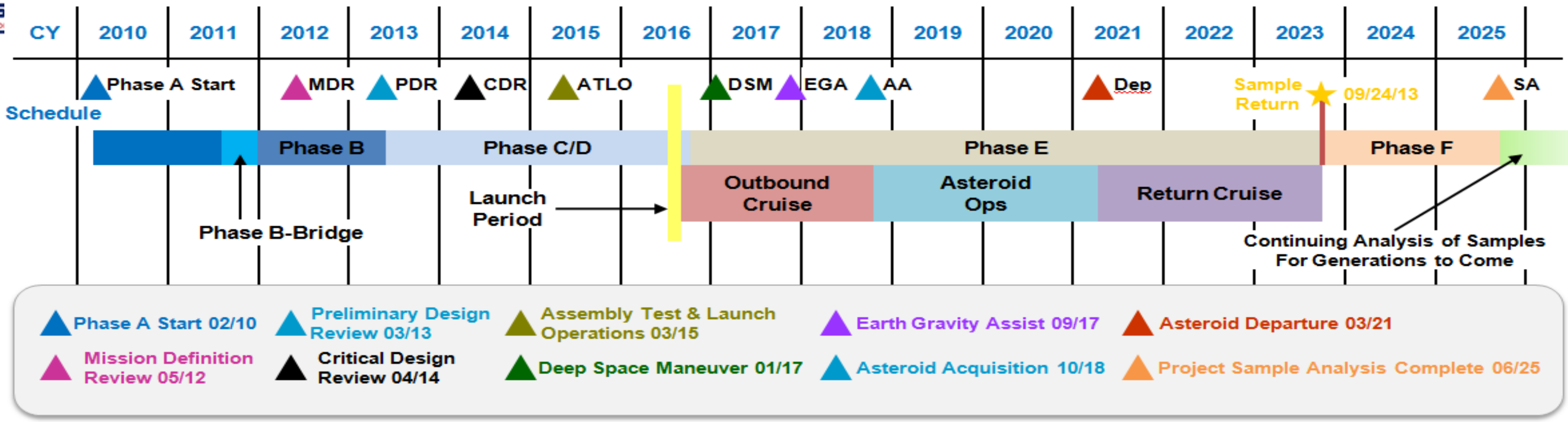
S&T ILLUSTRATION (SOURCE: RICHARD P. BINZEL)

Knowledge of Asteroid Mass and Shape Substantially Enhances Mission Planning



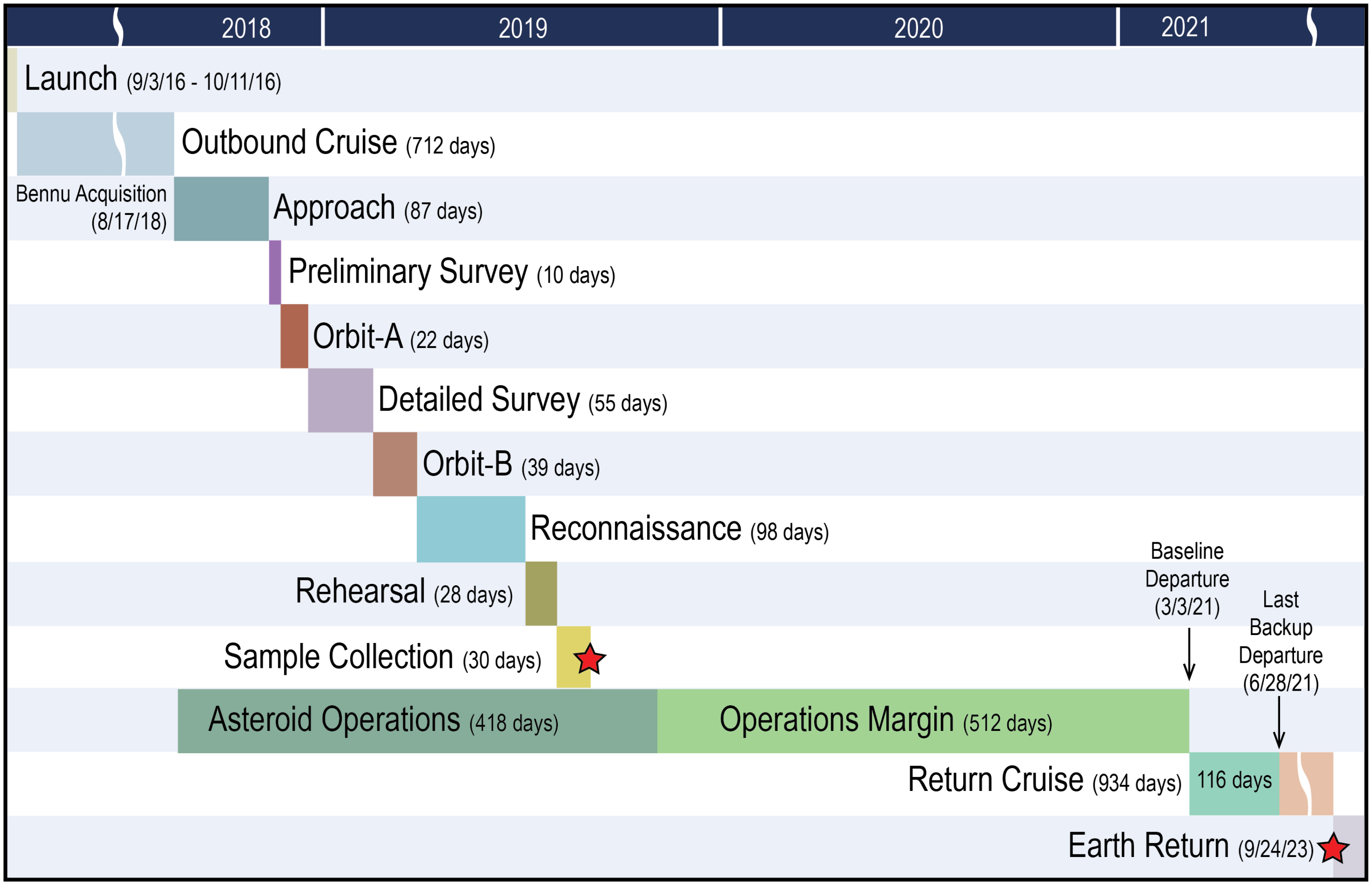
- Combined mass and shape knowledge yield a global gravity-field model that facilitates orbital stability analysis
- Combining the gravity-field model and rotation state yields global surface-slope distributions and accelerations
- All this information is critical to evaluating our ability to safely deliver the spacecraft to the asteroid surface and maintain nominal attitude during sampling

Mission Timeline



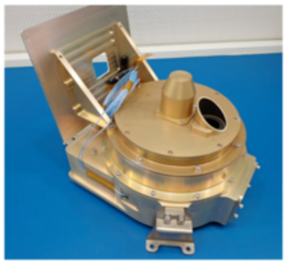
- Selection: May 25, 2011
- Preliminary Design Review (PDR): March, 2013
- Critical Design Review (CDR): April, 2014
- System Integration Review (ATLO): February, 2015
- Launch: September, 2016
- Earth Gravity Assist (EGA): September, 2017
- Asteroid Arrival (AA): August, 2018
- Asteroid Departure (Dep): March, 2021
- Sample Return: 24 September 2023
- End of Mission (Sample Analysis): September 2025

Mission Operations Timeline

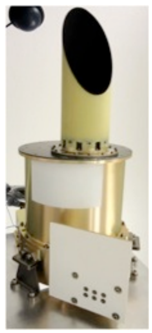


Our Payload Performs Extensive Characterization at Global and Sample-site-specific Scales

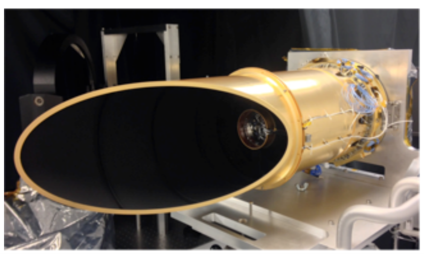
OCAMS (UA)



SamCam images the sample site, documents sample acquisition, and images TAGSAM to evaluate sampling success



MapCam performs filter photometry, maps the surface, and images the sample site



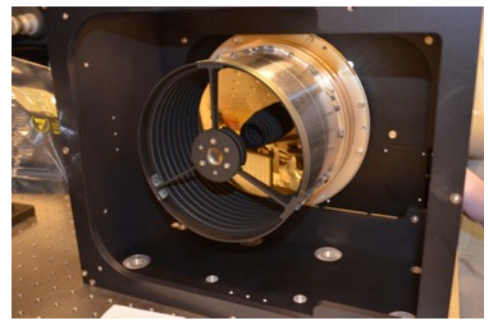
PolyCam acquires Bennu from >500K-km range, performs star-field OpNav, and performs high-resolution imaging of the surface

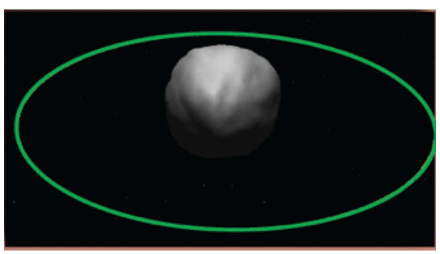
OLA (CSA) provides ranging data out to 7 km and maps the asteroid shape and surface topography

SPACECRAFT-BASED REMOTE SENSING PROVIDES GROUND TRUTH FOR OUR ASTRONOMICAL DATA

OVIRS (GSFC) maps the reflectance albedo and spectral properties from 0.4 – 4.3 μm

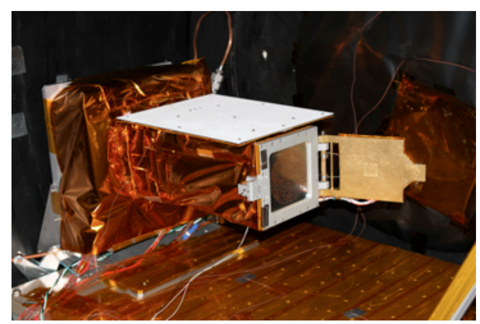
OTES (ASU) maps the thermal flux and spectral properties from 5 – 50 μm





Radio Science (CU) reveals the mass, gravity field, internal structure, and surface acceleration distribution

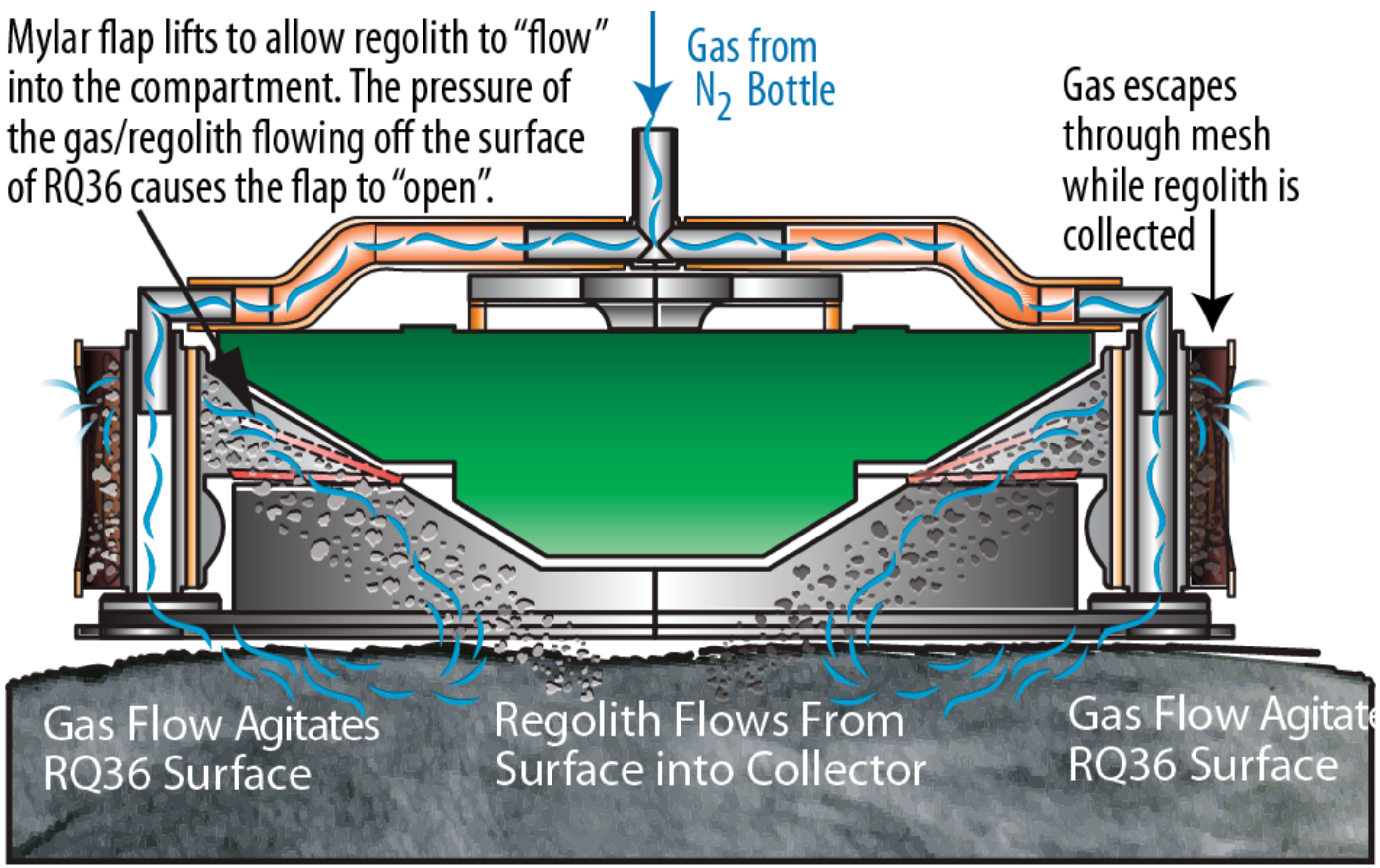
REXIS (MIT) trains the next generation of scientists and engineers and maps the elemental abundances of the asteroid surface



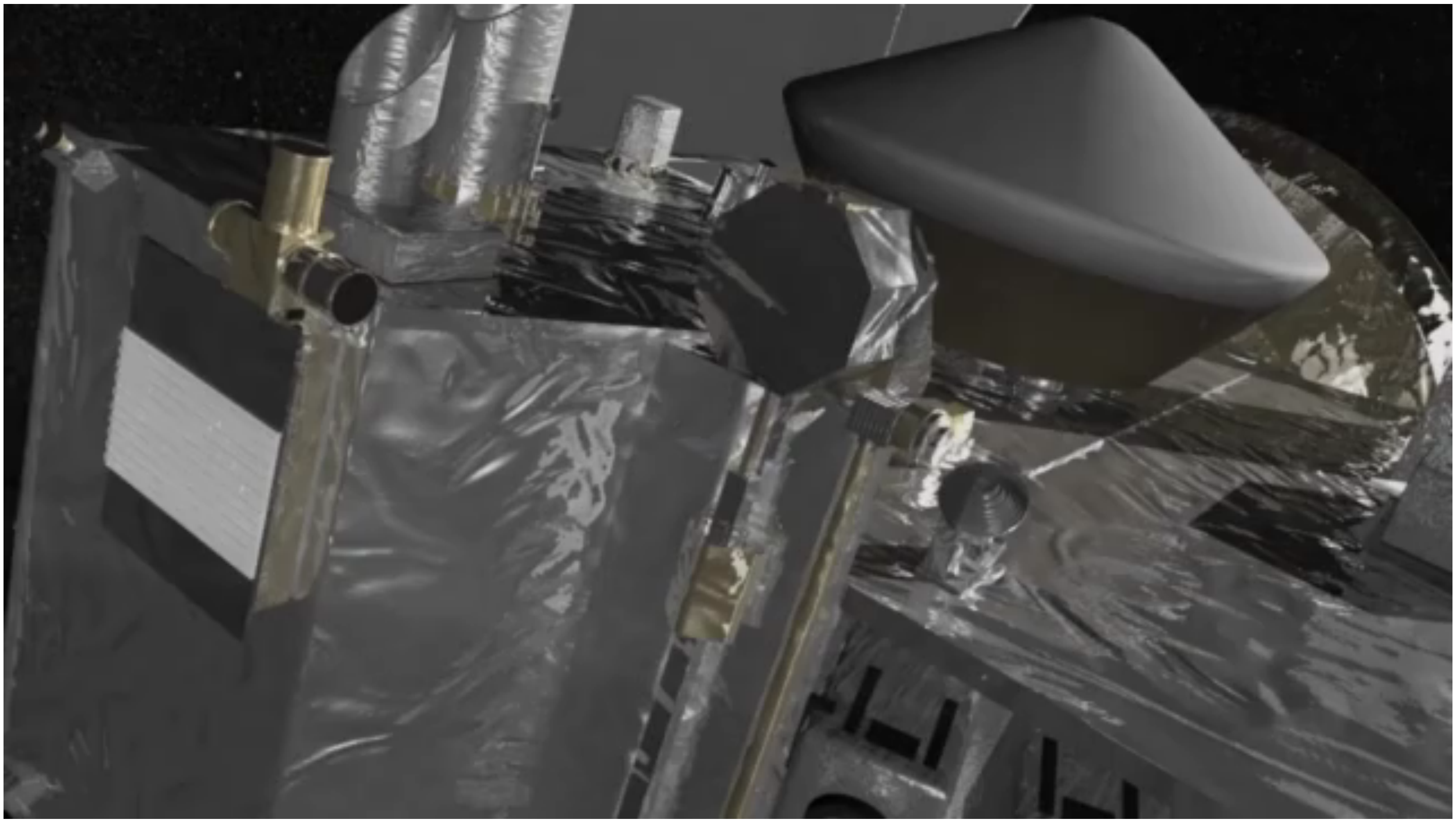
TOUCH-AND-GO SAMPLE ACQUISITION SYSTEM (TAGSAM)

TAGSAM – The OSIRIS-REx Sampling Strategy is Designed to Collect Abundant Pristine Regolith

TAGSAM acquires samples using a jet of high-purity N_2 gas that "fluidizes" the regolith into a collection chamber.

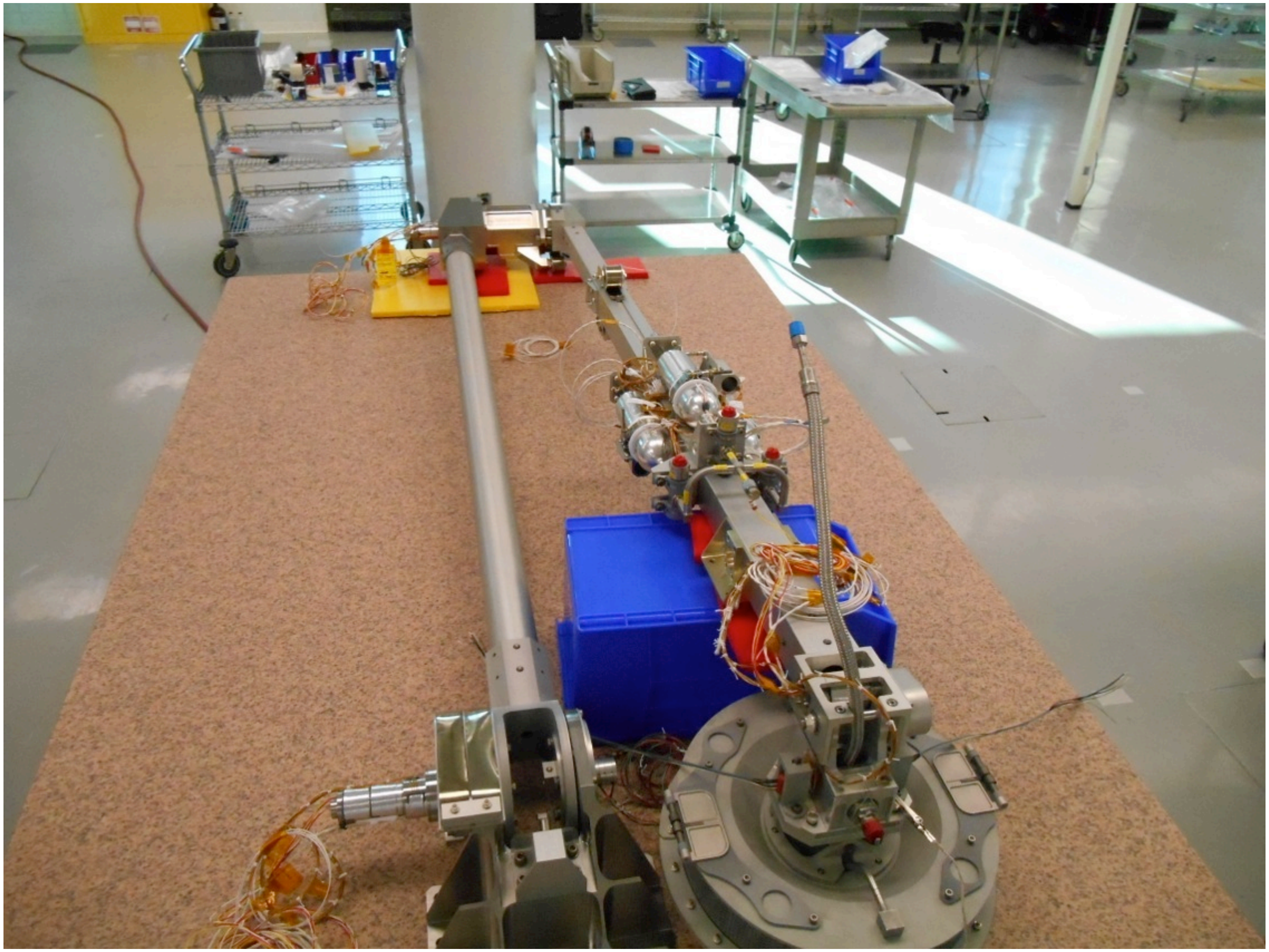


TAGSAM and Sample Return Capsule Operation



OSIRIS-REx Spacecraft Under Construction

TAGSAM – the Touch-and-Go Sample Acquisition Mechanism



OSIRIS-REx Team Members

JOIN THE MISSION ON THE WEB!

Merchandise at:
www.osirisrexstore.com

Social Media Activities

- Website: asteroidmission.org
- PI blog: dslauretta.com
- facebook.com/OSIRISREx
- twitter.com/OSIRISREx
- YouTube/osirisrex
- instagram.com/osiris_rex