



*Vicky Hamilton, Ph.D.
Southwest Research Institute*

OSIRIS-REx Defined

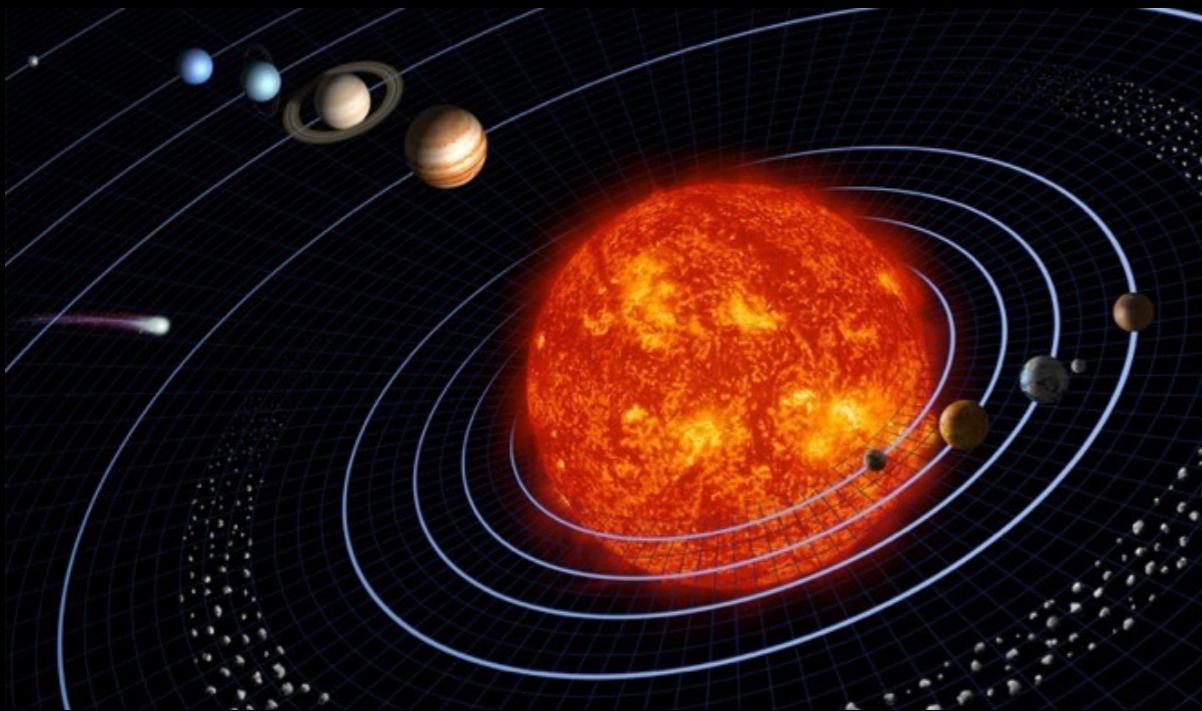
Osiris is the Egyptian god of the afterlife, the dead, transition, resurrection, and regeneration



- **Origins**
 - Return and analyze a sample of pristine carbonaceous asteroid regolith
- **Spectral Interpretation**
 - Provide ground truth for telescopic data of the entire asteroid population
- **Resource Identification**
 - Map the chemistry and mineralogy of a primitive carbonaceous asteroid
- **Security**
 - Measure the Yarkovsky effect on a potentially hazardous asteroid
- **Regolith Explorer**
 - Document the regolith at the sampling site at scales down to the sub-cm

Exploring our Past, Securing our Future

Revealing Solar System History



Mitigating Impact Hazards



Enabling Human Exploration

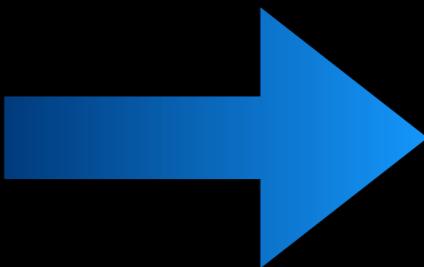


Developing a Space Economy



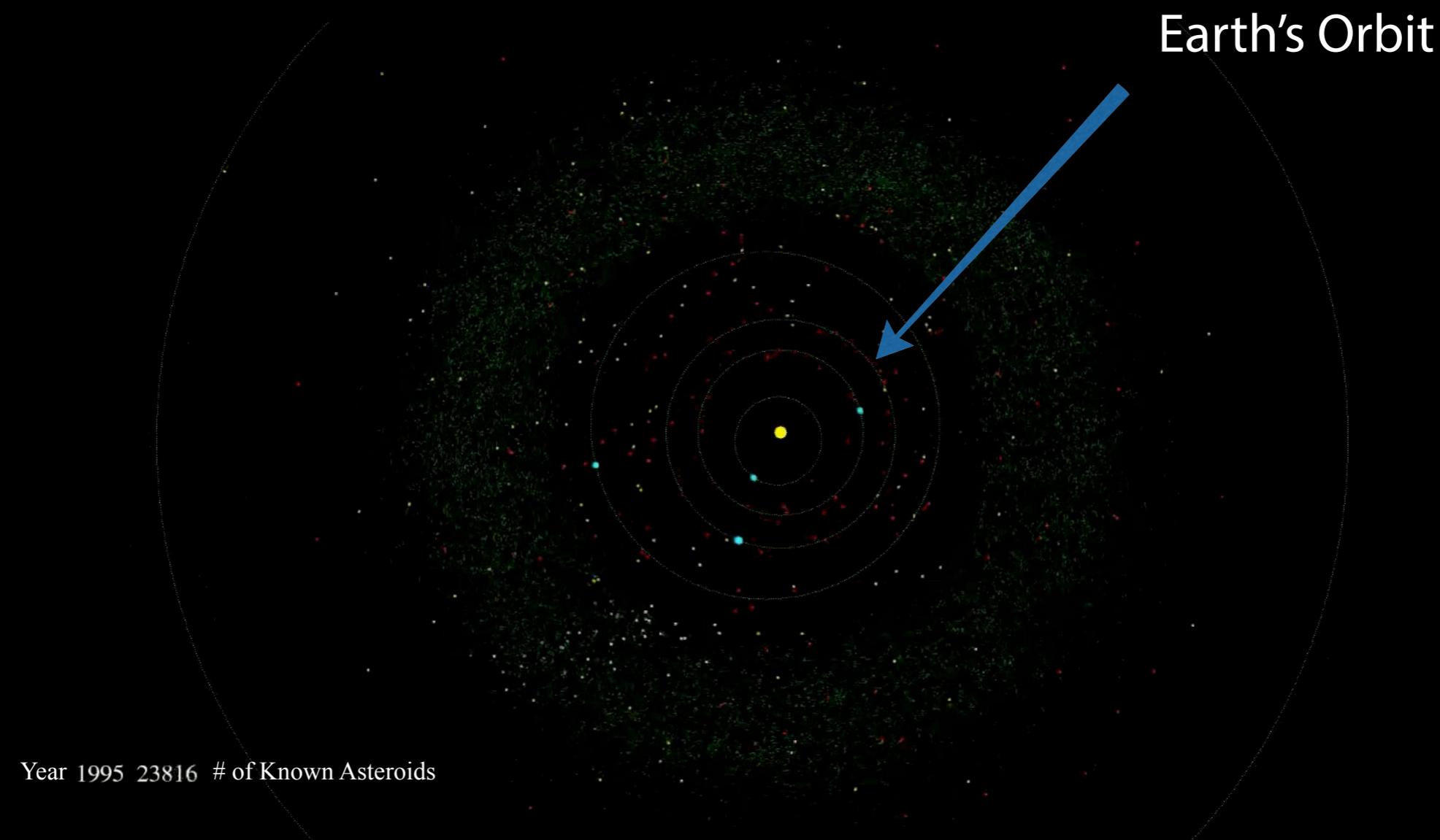
What is the Mission?

OSIRIS-REx will return a sample from the early Solar System to help us understand where we came from



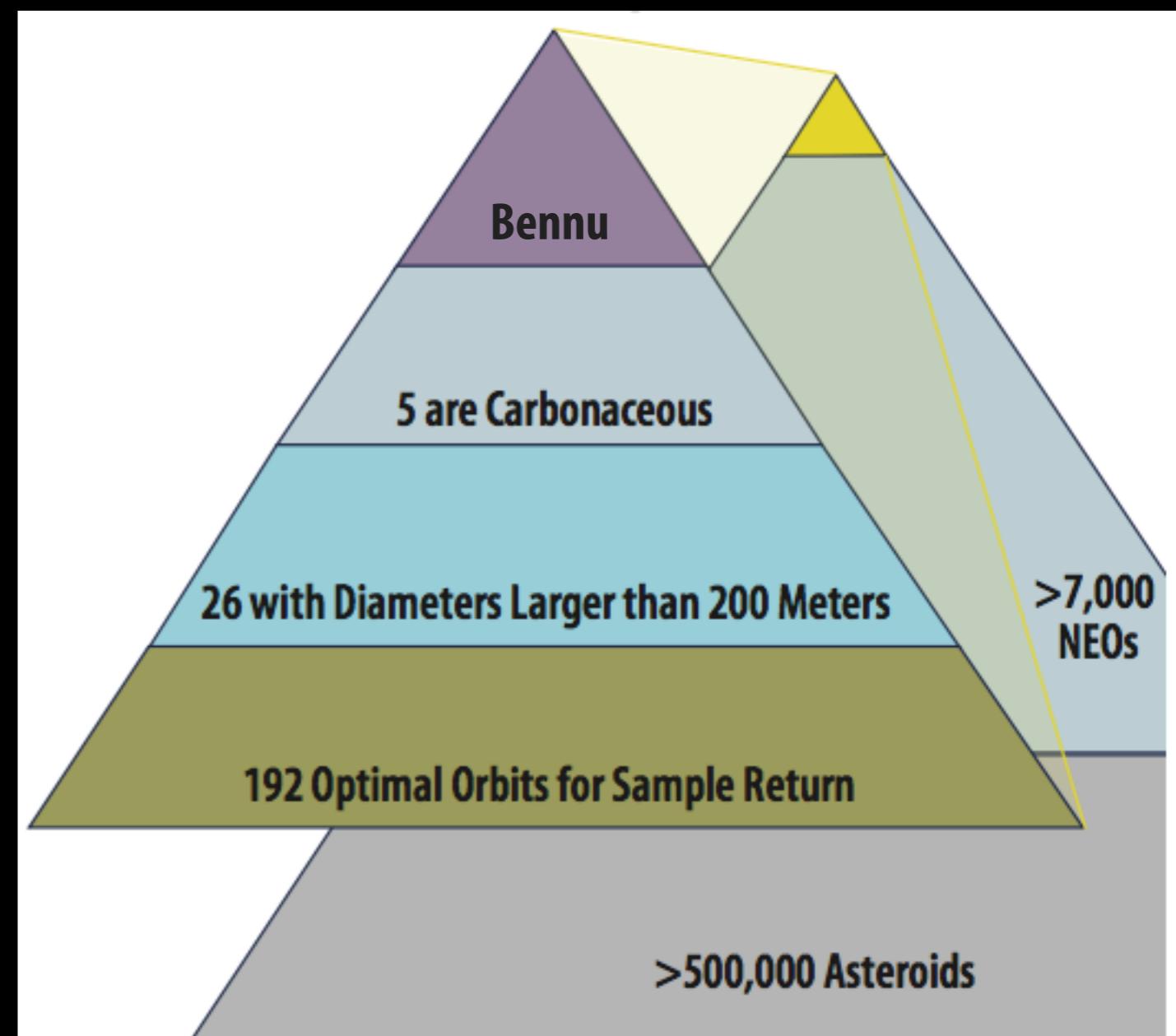
Dante Lauretta, Principal Investigator
University of Arizona, Goddard Spaceflight Center, Lockheed Martin Space Systems

Which Asteroid? Lots of Choices...



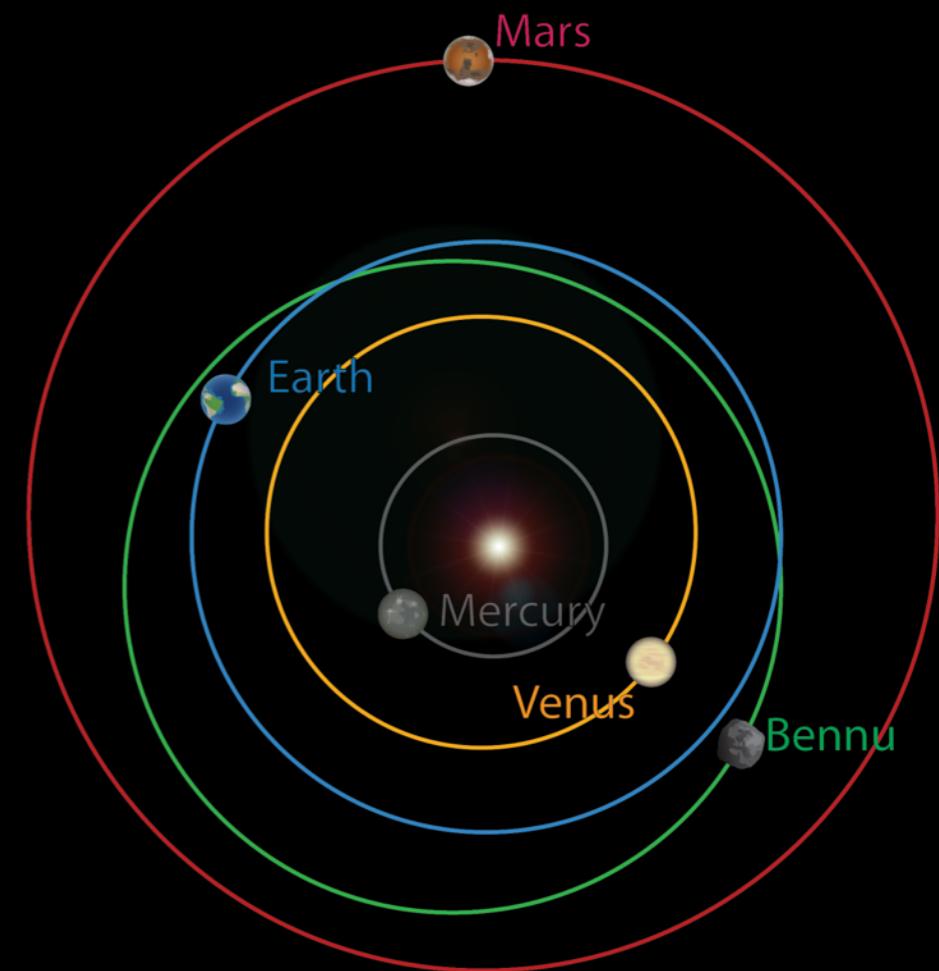
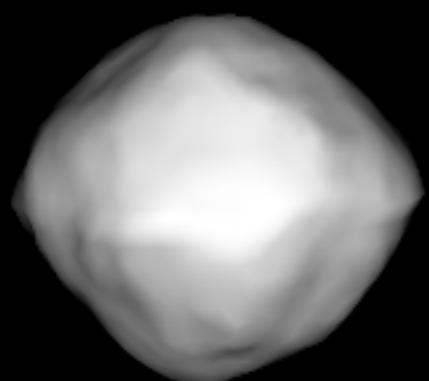
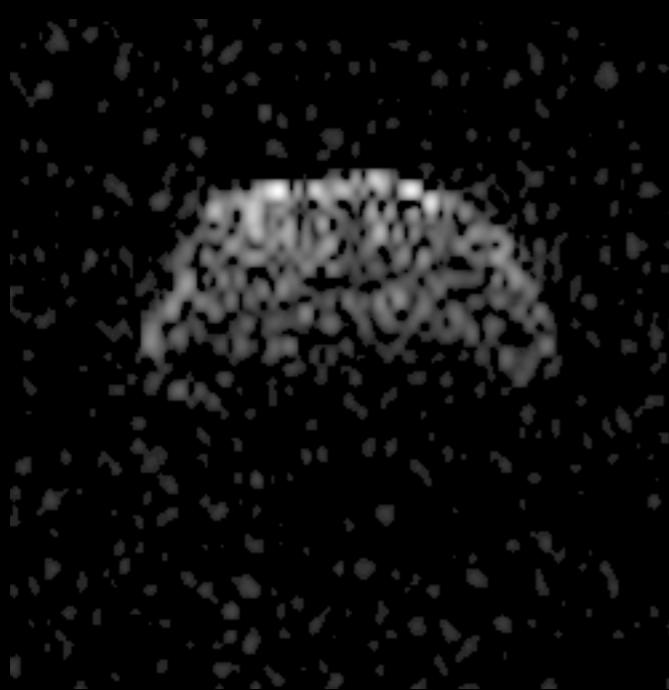
...But Not Really

- Want asteroid crossing Earth's orbit
- Distance to Sun is "just right" for return
- Big enough to rotate slowly and not eject all surface particles
- Want organics and water in minerals



Where Are We Going?

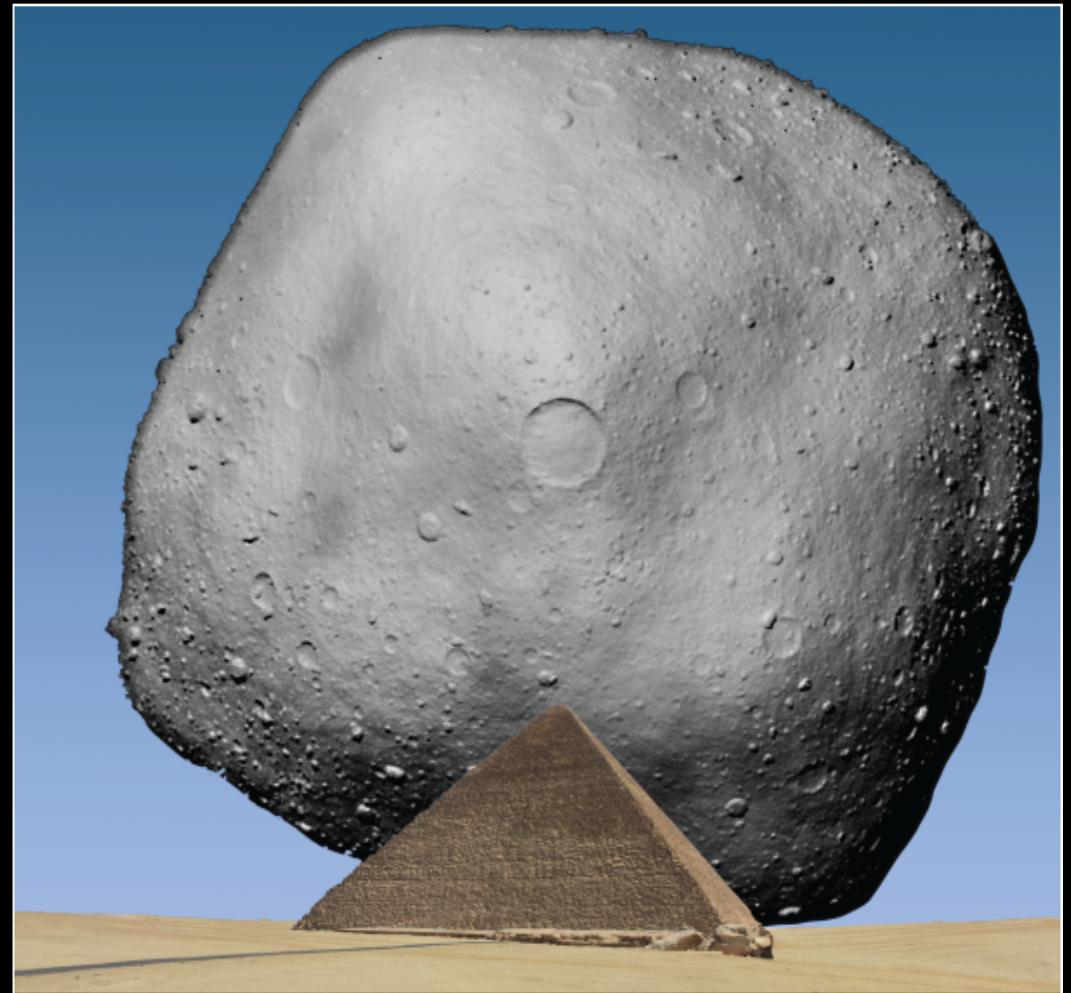
- Near-Earth Asteroid (101955) Bennu
- NC 3rd-grader Michael Puzio proposed the name in reference to the Egyptian mythological bird Bennu, a heron associated with rebirth & Osiris



Bennu Fast Facts

- Near-Earth asteroid
- About 500 meters ($\frac{1}{3}$ mile) diameter
- 4.3-hour rotation period
- 436.6-day orbit of Sun
- Collection of materials into a rubble pile
- Ancient carbon and volatiles such as water
- Potential hazard to Earth (0.037% between 2175 - 2196)

A time capsule from the early Solar System!



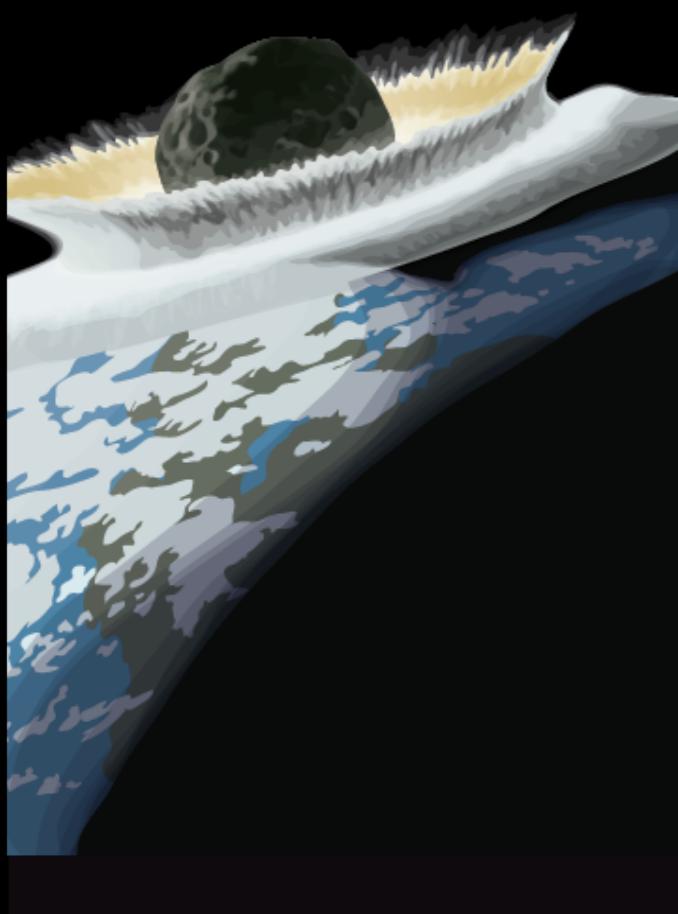
We will return at least 60 grams (2.1 ounces) and possibly as much as 2 kg (4.4 pounds)

Defining the Mission



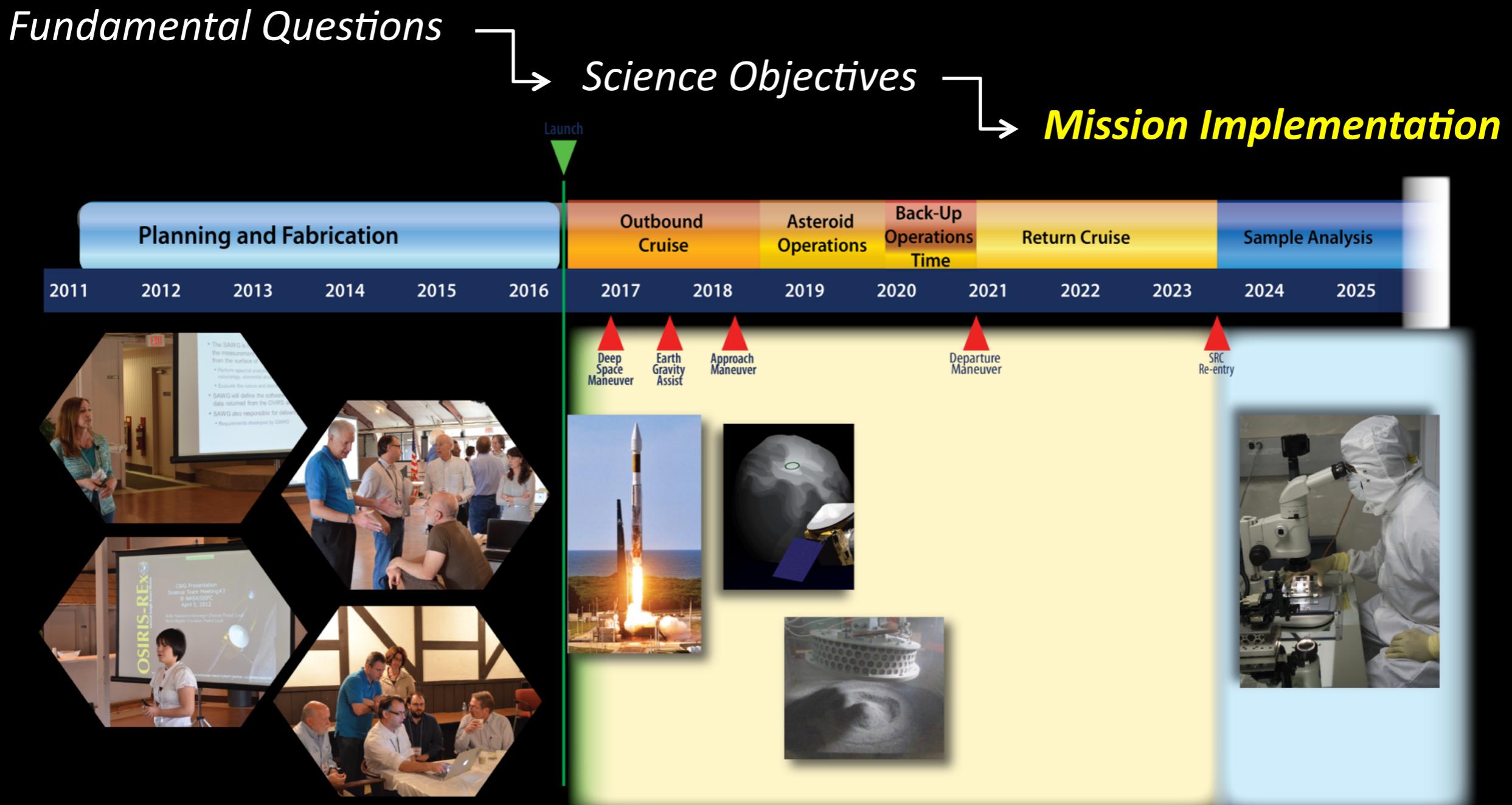
1. How did the Solar System form?
2. What kinds of materials exist in the Solar System?
3. How did life evolve in the Solar System?
4. Are asteroids bringers of life or death - or both?

Defining the Mission



- Map the asteroid & pick sample site
- Document the sample site and obtain the sample
- Return the sample and analyze
- Ground-truth observations
- Refine orbital deviations

Defining the Mission



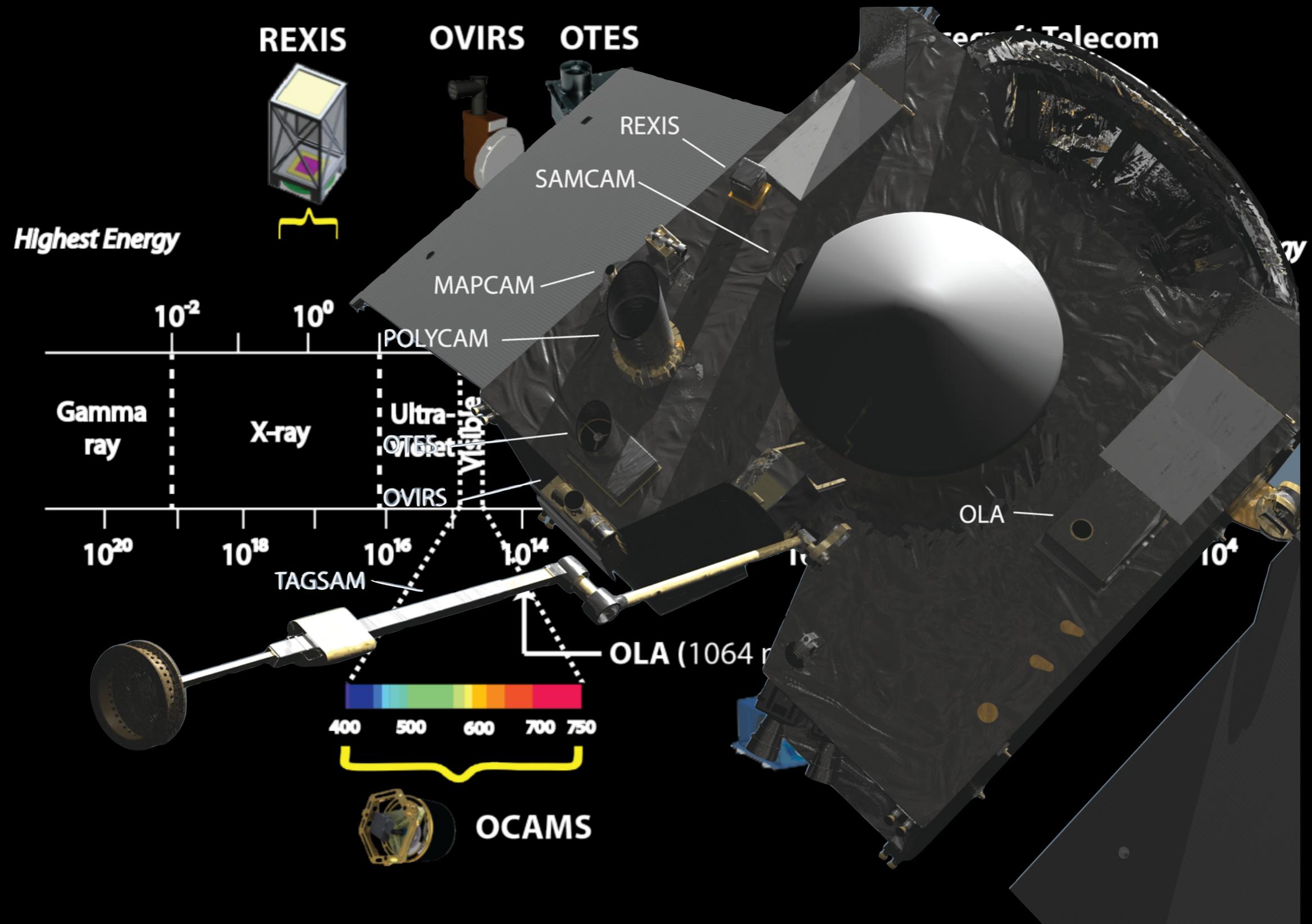
Students in this audience could be on teams analyzing OSIRIS-REx samples!

The Spacecraft

- 2 meters (6.6 feet) per side
- 8.5 m² (91 sq. ft.) of solar panels
- 5 science instruments
- Touch-and-Go Sample Acquisition Mechanism (TAGSAM)
- Sample Return Capsule (SRC)

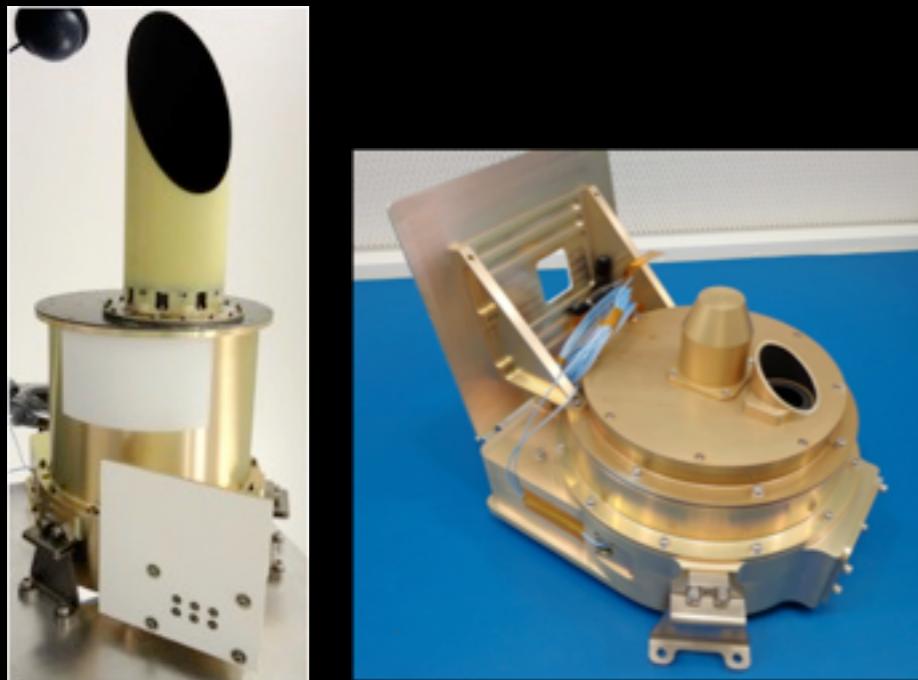
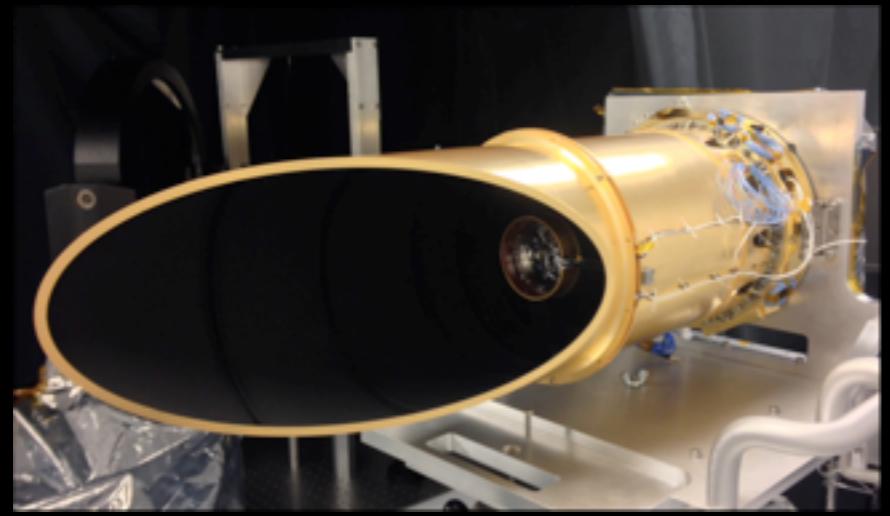


How We Will Study Bennu



The Payload

- OSIRIS-REx Camera Suite (OCAMS)
 - *PolyCam* is first to see Bennu from >500,000-km range, performs star-field OpNav, and performs high-resolution surface imaging
 - *MapCam* performs filter photometry, maps the surface, and images the sample site
 - *SamCam* images the sample site, documents sample acquisition, and images TAGSAM to evaluate sampling success



University of Arizona
Bashar Rizk, Instrument Scientist

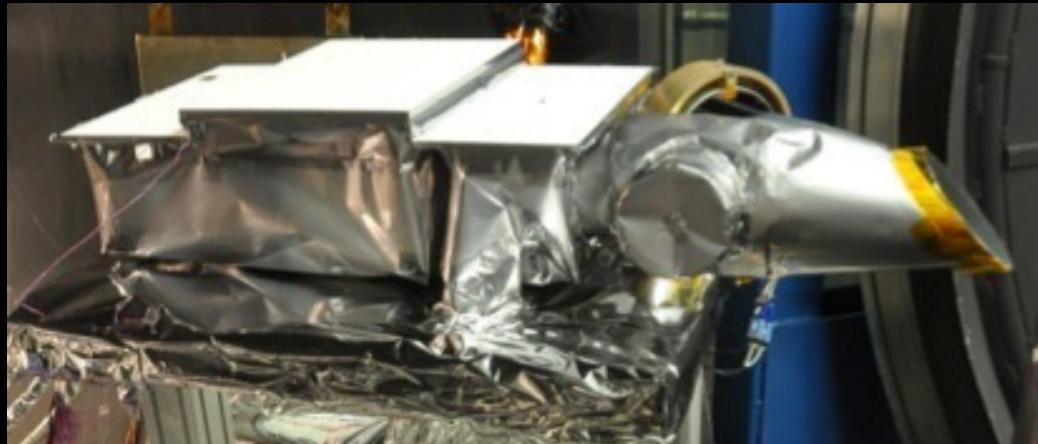
The Payload



Contribution of the
Canadian Space Agency
Mike Daly, Instrument Scientist

- **OSIRIS-REx Laser Altimeter (OLA)**
- Provides ranging data out to 7 km and maps the asteroid shape & surface topography

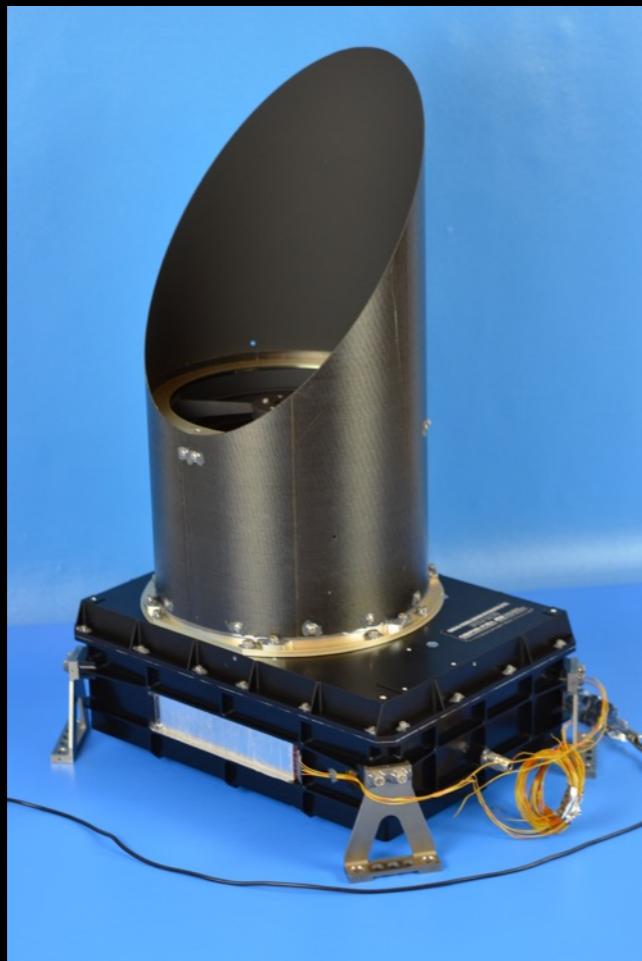
The Payload



Goddard Space Flight Center
Dennis Reuter, Instrument Scientist

- **OSIRIS-REx Visible and Infrared Spectrometer (OVIRS)**
 - Maps spectral properties from 0.4 – 4.3 μm
 - Measures albedo

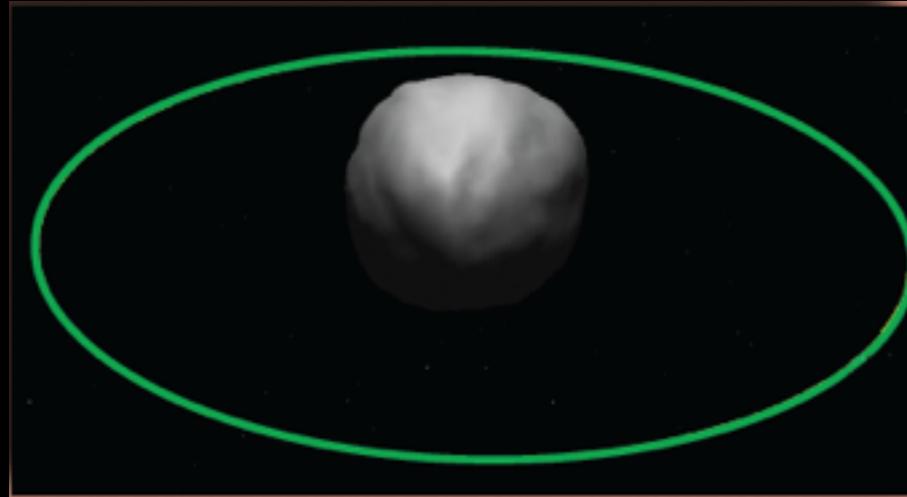
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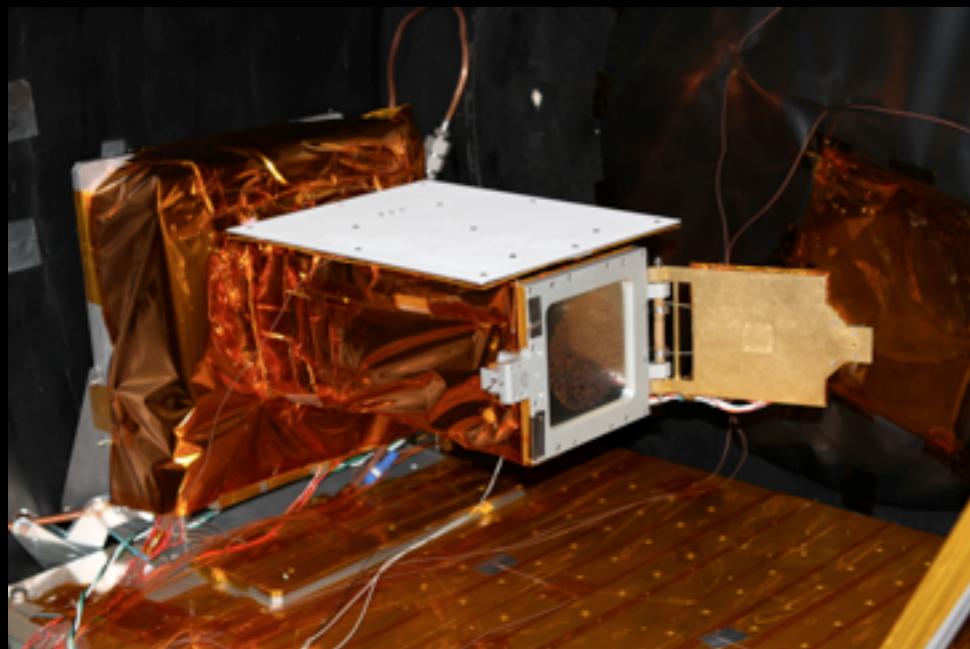
- **OSIRIS-REx Thermal Emission Spectrometer (OTES)**
 - Maps spectral properties from 5.5 – 50 μm
 - Measures thermal flux

Arizona State University
Phil Christensen, Instrument Scientist

The Payload



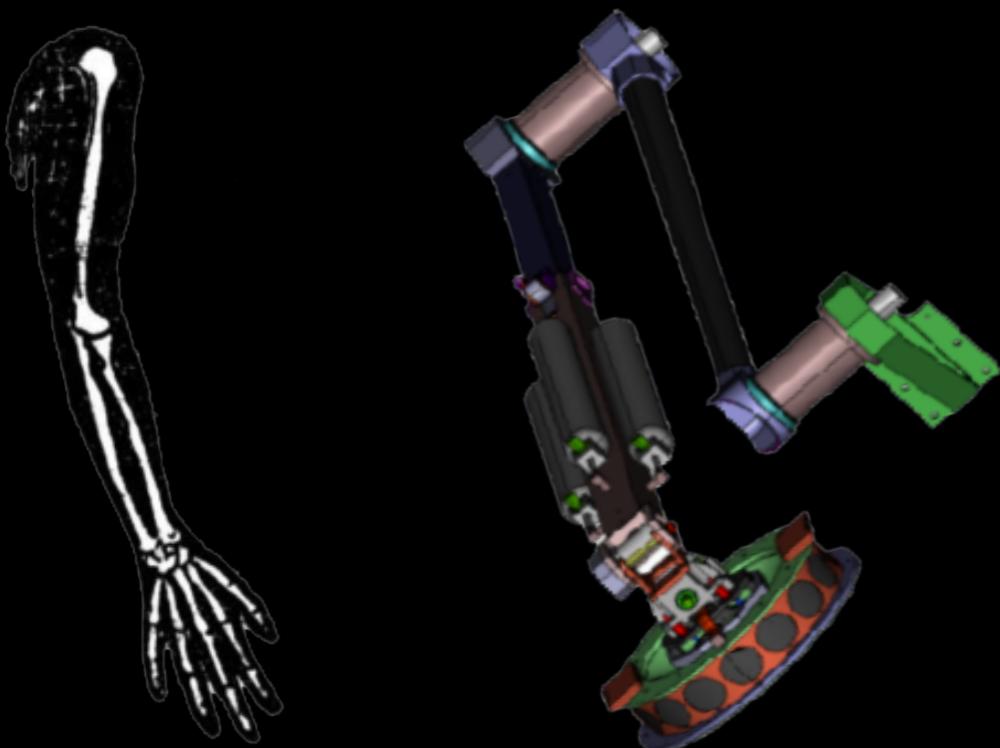
University of Colorado, Boulder
Dan Scheeres, Radio Science Lead



Massachusetts Institute of Technology
Rick Binzel, Instrument Scientist

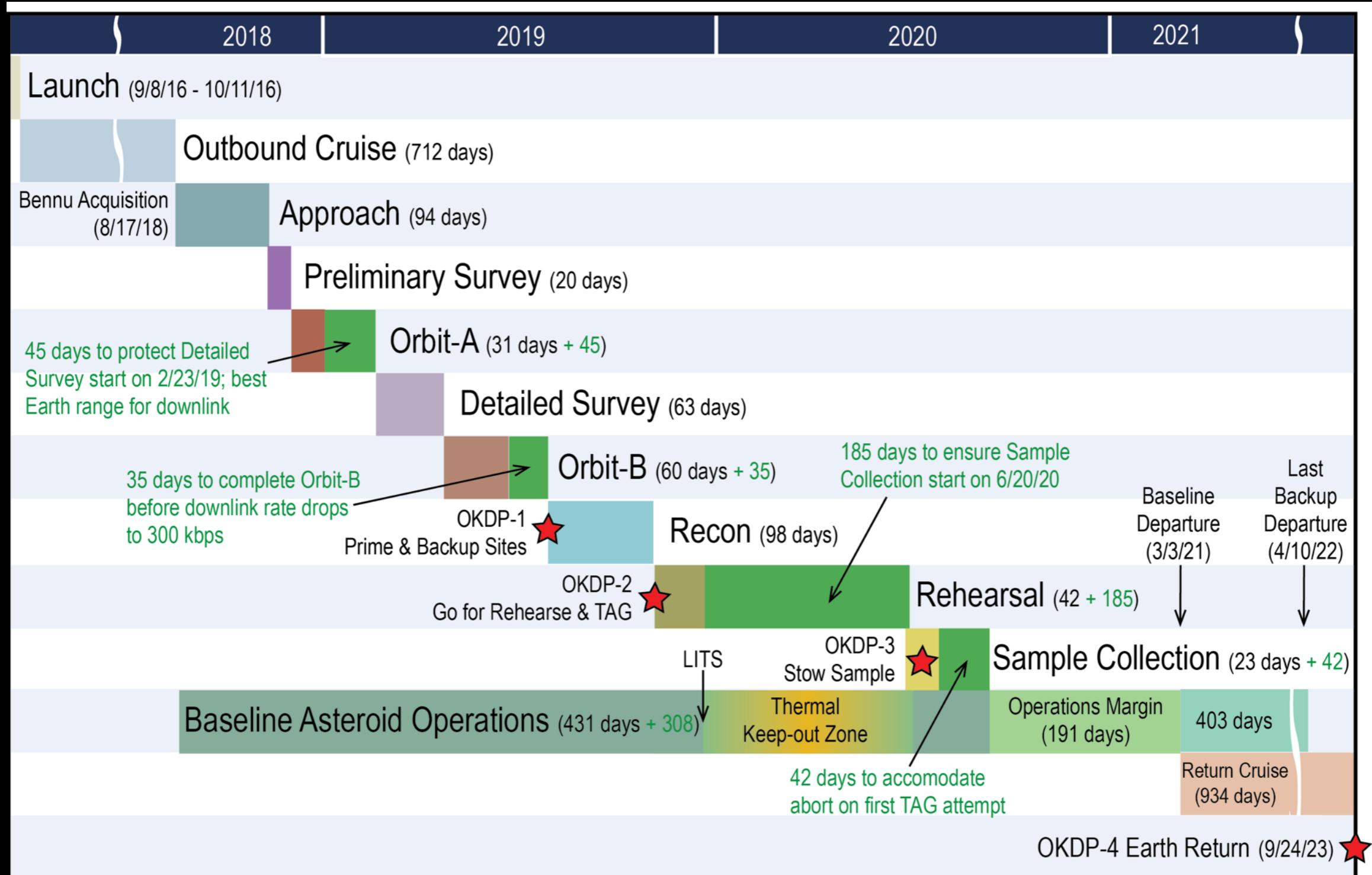
- **Radio Science** reveals the mass, gravity field, internal structure, and surface acceleration distribution
- The **Regolith X-ray Imaging Spectrometer (REXIS)** student experiment maps the elemental abundances of the asteroid surface

The Payload

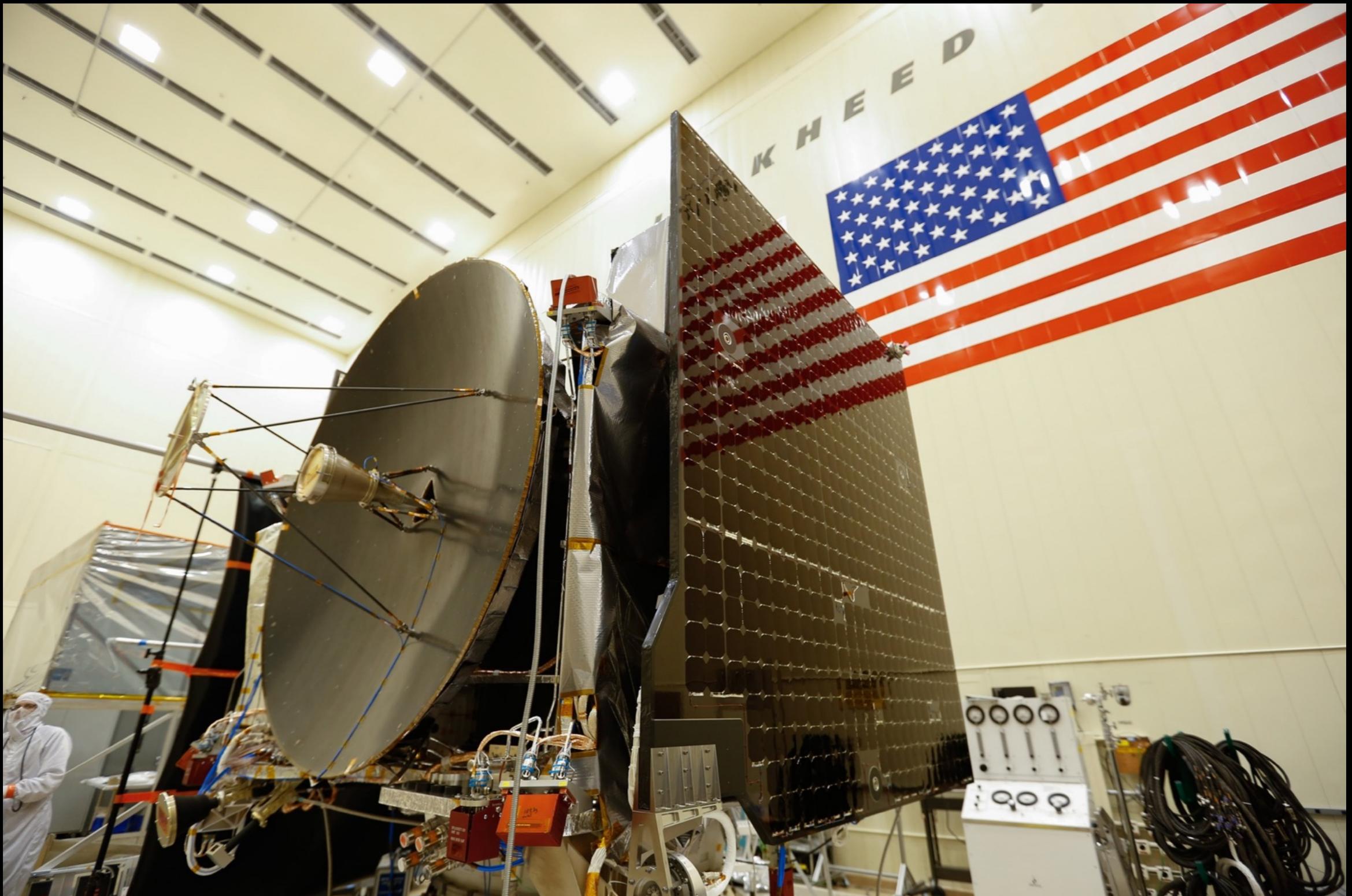


- The Touch-and-Go Sample Acquisition Mechanism (TAGSAM) collects the sample
- Equipped for three tries

Mission Timeline



OSIRIS-REx Spacecraft After Assembly and Testing Operations



Arriving at NASA's Kennedy Space Center























OSIRIS-REx Launched!

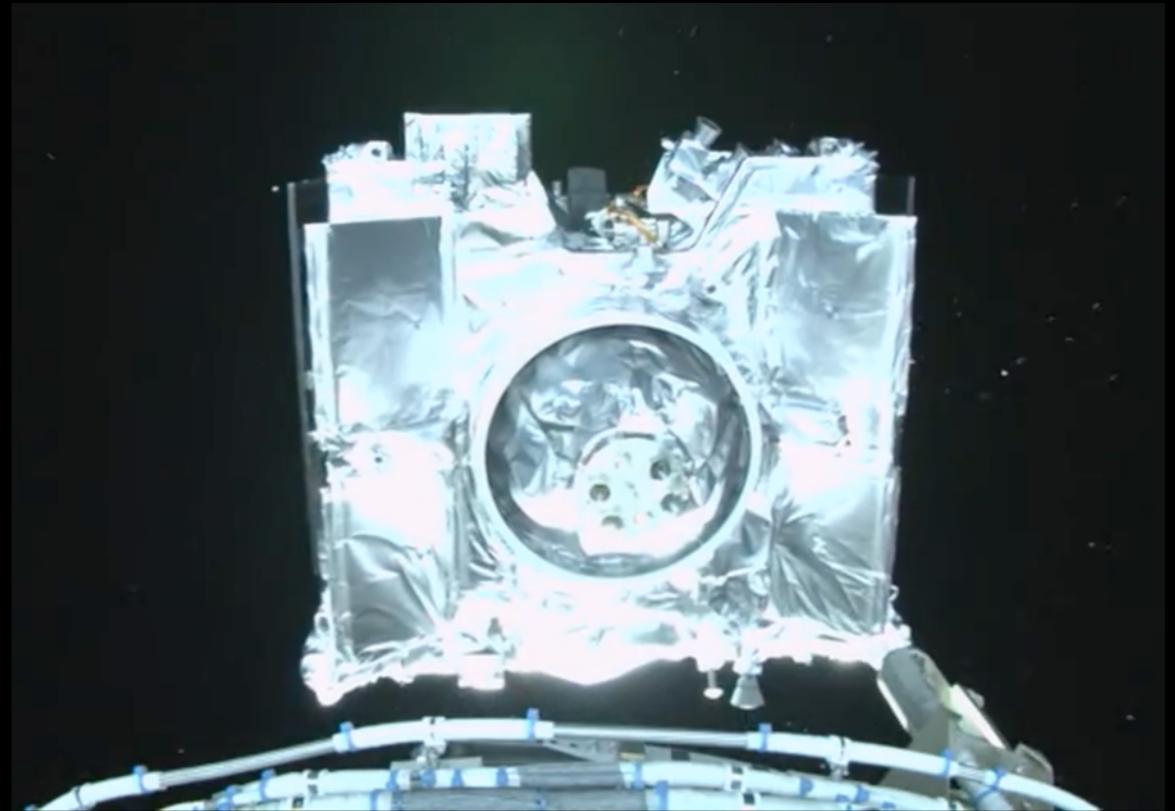
- OSIRIS-REx launched 8 September 2016 at 7:05 pm EDT on an Atlas V 411
- Liftoff occurred 180 ms into the opening of our window
- Vehicle performance was near-perfect



J.D. SEKORA / SEKORAPHOTO

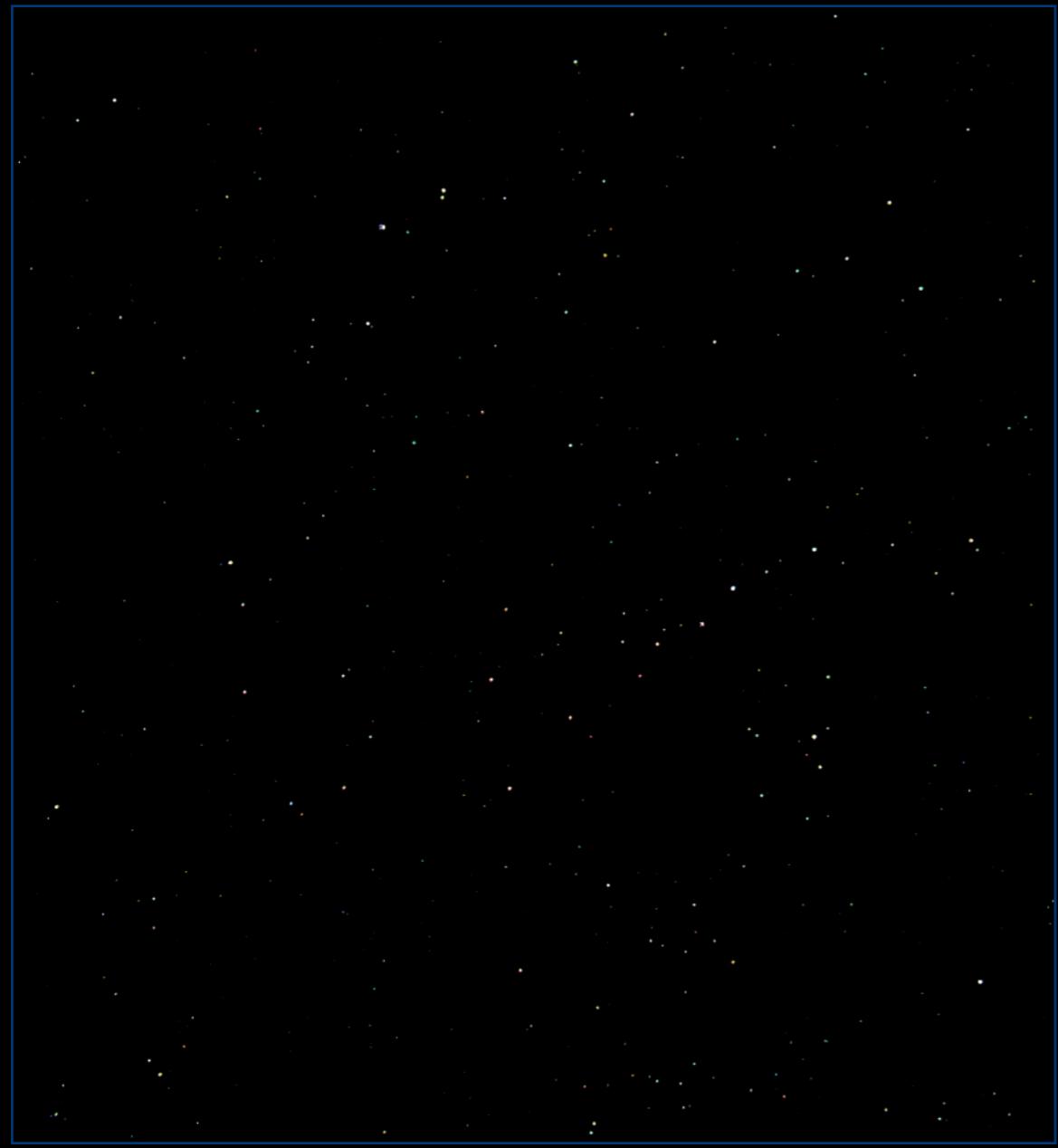
Spacecraft Status

- Spacecraft operations have been “nominal”
- Post-launch instrument aliveness checkouts occurred in late September and all are operating as expected



OSIRIS-REx spacecraft at separation

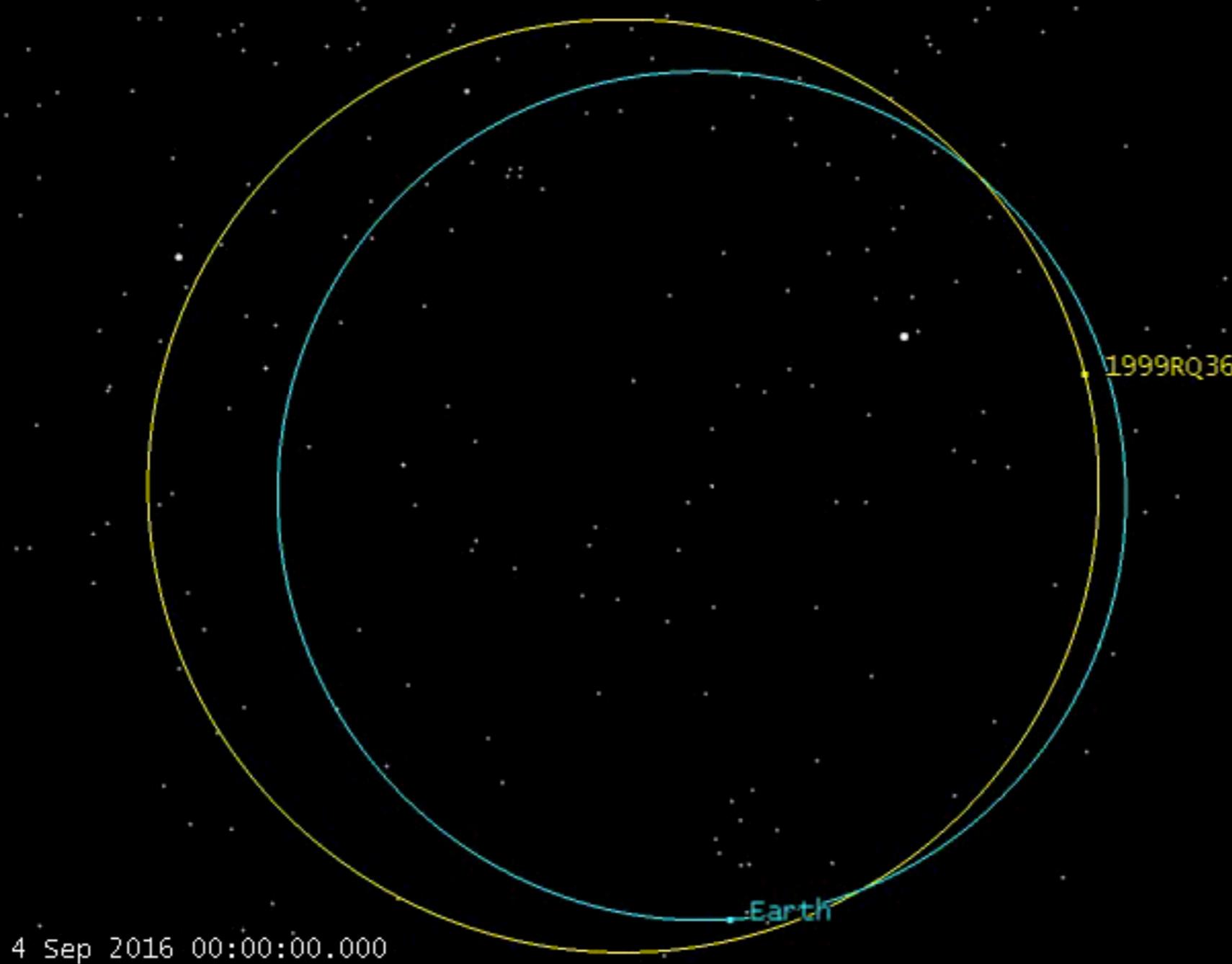
First Image from MapCam



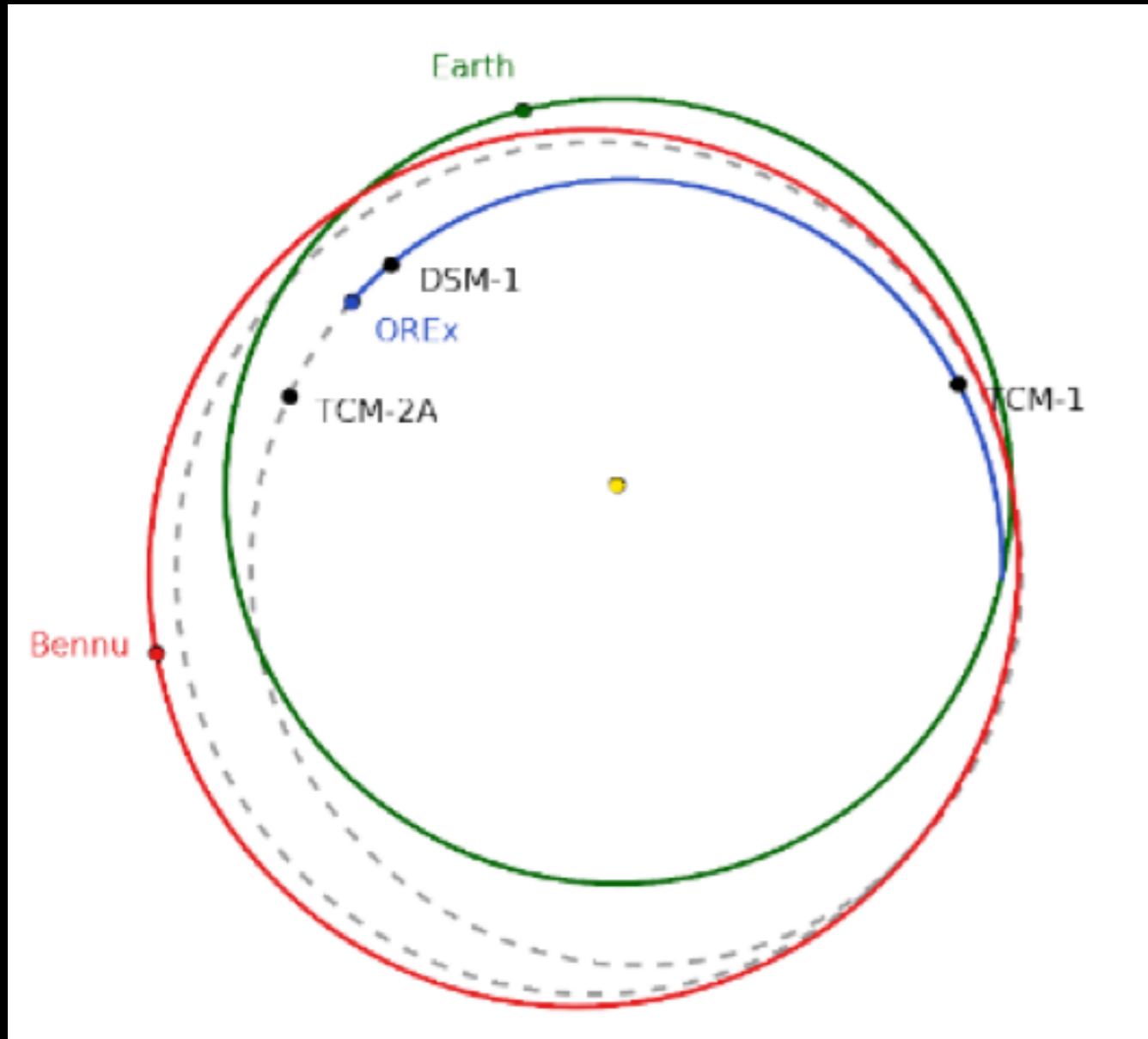
- First image from MapCam taken on September 19
- Star field in Taurus, north of the top of the constellation Orion
- Composite of three of its four color filters, roughly corresponding to blue, green, and red wavelengths

Credit: NASA/GSFC/University of Arizona

How Does OSIRIS-REx Travel to Bennu?



Current Orbit Configuration



Statistics as of Jan 04, 2017, L+118 days

Earth Range = 97,000,000 km (0.65 AU)

Sun Range = 122,000,000 km (0.82 AU)

Sun-Probe-Earth Angle = 83 deg

One Way Light Time = 00:05:27 hh:mm:ss

Round Trip Light Time = 00:10:54 hh:mm:ss

Upcoming Activities

- Earth Trojan asteroid search (mid-February)
- Instrument L+6 mo. calibrations (mid-March)
- Earth gravity assist (end of September)

The Mission Movie

It Takes A Big Team!



Join the Mission on the Web!



- *Website:* asteroidmission.org
- *PI blog:* dslauretta.com
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- youtube/osirisrex
- instagram.com/osiris_rex