THE OSIRIS-REX CAMERA SUITE (OCAMS). Peter H. Smith[1], Bashar Rizk[1], Ellyne Kinney-Spano[1], Charles Fellows[1], Christian d'Aubigny[1] and Catherine Merrill[1], [1]Lunar and Planetary Lab, University of Arizona, Tucson, AZ 85721, psmith@lpl.arizona.edu.

Introduction: OSIRIS-REx is a New Frontiers mission that will launch in September 2016 and rendezvous with asteroid 1999RQ36 in 2018. The goal of the mission is to retrieve a surface sample and return it to Earth. To futher this goal, the asteroid must be mapped to find a sampling site that is both safe and scientifically interesting. Once the site is identified, the spacecraft slowly approaches and retrieves a surface sample lingering in the near-surface environment for only a few seconds. After verifying that a sample of sufficient mass (>60 g) has been collected, the spacecraft returns to Earth and ejects the sample return capsule on the proper trajectory to land by parachute in Utah. The pristine sample is archived and analyzed from its curation facility at the Johnson Spaceflight Center in Houston.

OCAMS is a set of three cameras designed to support the mission through all its phases from approach to sample collection (Fig. 1). The asteroid is first acquired through the PolyCam, an 8" Richey-Chretien telescope capable of detecting up to 12^{th} mag objects limited by spacecraft jitter . As features on the asteroid become resolvable, this telescope is used for preliminary mapping at a surface resolution of <25 cm. Four-color filter mapping (half of the ECAS filter set [1] used by groundbased astronomers) is then conducted by MapCam at a suite of phase angles. The final sampling sequence is documented by the wide-field SamCam and gives the context for the recovered sample. All cameras use identical detector arrays but are characterized by focal lengths separated by a factor of 5.

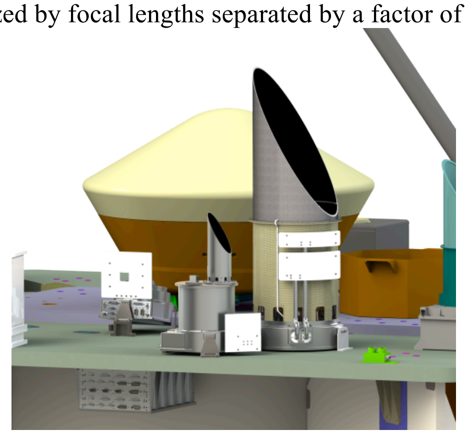

Figure 1. The 3 cameras are seen on the instrument deck with the Sample Return Capsule in the background. In the center from left to right: SamCam, MapCam, and PolyCam. Notice the electronics control module underneath the deck.

Cruise and Approach: Post-launch calibration of the cameras is performed during the 2-year cruise that includes an Earth flyby. Five sources are used for calibration: stellar clusters (geometric distortion); solar-type stars (radiometric calibration); blocking filter (dark current evolution in the radiation environment); illumination lamps (pixel-to-pixel fixed pattern noise); and the Earth-Moon system (operational preparation).

Within 500,000 km of RQ36, PolyCam aides the navigation team by locating the asteroid against background stars. The approach affords an opportunity to verify the phase curve, the rotation rate, and other properties that have been measured using groundbased telescopes. A search for potentially hazardous secondaries will assure a safe approach (an example of a MapCam image is shown in Fig. 2). In addition, PolyCam collects images for a preliminary shape model.

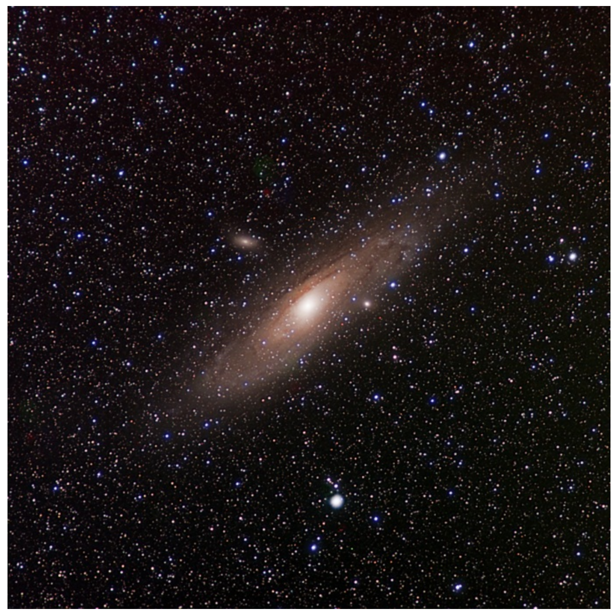

Figure 2. An image of the Andromeda Gallaxy[2] taken by a prototype of the MapCam.

Survey: After approaching the asteroid and accomplishing flybys of the polar regions, a series of observing positions allows the mapping of RQ36 from various phase angles and latitudes throughout its 4.5 hour rotation. Both high resolution and color-ratio maps are generated over at least 80% of the surface. The data sets are combined to make a solid model of the asteroid shape forming the basis for detailed mapping. These maps are used to delineate craters, large boulders, and linear features. The maps will also be examined to determine 12 potential sampling sites of diameter 25 m.

Orbital Phase: The navigation team guides the spacecraft to a polar orbit above the terminator where the gravitational attraction is balanced by radiation pressure from the Sun. The 1-km orbit puts the cameras several hundred meters above the surface of the 275-m radius object. From this vantage point the 12-sites are more closely examined (>5cm objects resolved by PolyCam) and the top 4 sites are selected for further investigation.

Reconnaissance: Fly-overs from the safe home orbit allow sub-cm imaging for the 4 finalists. The high resolution is accomplished by refocusing the Poly-Cam, effectively converting a telescope to a microscope. These reconnaissance fly-overs permit final assurance that the surface materials are neither hazardous to sample collection (>21 cm) nor devoid of small regolith particles that can be collected by the sampling arm (<2 cm).

Sampling: Using all information, a final site is selected and a series of rehearsals takes place to practice each step of the sampling process. At each rehearsal the MapCam monitors the surface motions with images at a range of 30 m from the surface,a distance that allows the rotational velocity to be matched.

From this matchpoint the final sampling event is initiated. Slowly descending toward the surface with its arm extended, the OSIRIS-REx spacecraft prepares to collect a sample of RQ36. The SamCam records the event at about a frame/sec, its wide field encompassing the sampling head near the center of the frame.

These images document the context of the undisturbed surface, then the post-collection morphology, that help the team decide if a sufficiently large sample has been taken. It is important to be certain that the sample is in the collection chamber before returning to Earth. The SamCam images the sample head when the spacecraft has reached a safe distance away from the asteroid to provide visual confirmation of the sample within the sample head. With these final images the mission for the cameras is completed. An overview of OCAMS resolution vs range for the mission phases is shown in Fig. 3.

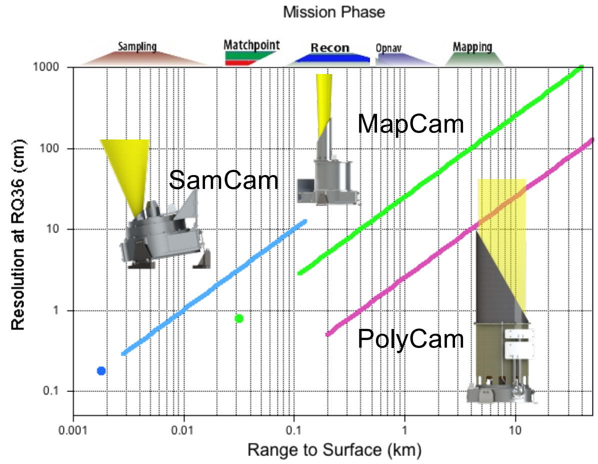

Figure 3. The 3 cameras have overlapping capabilities and can accommodate the loss of a camera. Notice the dots for SamCam and MapCam at their closest approaches, these are modifications of the focal length using a diopter lens in the filter wheel.

References: [1] Tholen, D. J. (1989) *Asteroids II*, Tucson, UA Press, 1139-1150. [2] Thanks to Steve Peterson for providing this image.