PDC2013
Flagstaff, AZ, USA

Please send your abstract to iaapdc@iaamail.org
Before December 21, 2012

(please choose one box to be checked)
☐ **Planetary Defense – Recent Progress & Plans**
☐ **NEO Discovery**
☐ **NEO Characterization**
☒ **Mitigation Techniques & Missions**
☐ **Impact Effects that Inform Warning, Mitigation & Costs**
☐ **Consequence Management & Education**

TRAJECTORY AND MISSION DESIGN FOR THE ORIGINS SPECTRAL INTERPRETATION RESOURCE IDENTIFICATION SECURITY REGOLITH EXPLORER (OSIRIS-REx) ASTEROID SAMPLE RETURN MISSION

Mark Beckman[(1)], Brent W. Barbee[(2)], Bobby Williams[(3)], Ken Williams[(4)], Brian Sutter[(5)], Kevin Berry[(6)]

[(1)]*NASA/GSFC, 8800 Greenbelt Road, Greenbelt, MD, 20771, USA, 301-614-6742, mark.beckman@nasa.gov*
[(2)]*NASA/GSFC, 8800 Greenbelt Road, Greenbelt, MD, 20771, USA, 301-286-1837, brent.w.barbee@nasa.gov*
[(3)]*KinetX, Inc., 21 W. Easy St., Suite 108, Simi Valley, CA 93065, USA, 805-527-5890, bobby.williams@kinetx.com*
[(4)]*KinetX, Inc., 21 W. Easy St., Suite 108, Simi Valley, CA 93065, USA, 805-520-8540, kenneth.williams@kinetx.com*
[(5)]*Lockheed Martin, PO Box 179, Denver CO, 80201, MS S8110, USA, 303-971-7731, brian.mspc.sutter@lmco.com*
[(6)]*NASA/GSFC, 6416 Lakewind Cir., Parker, CO 80134, USA, 720-515-0532, kevin.e.berry@nasa.gov*

Keywords: *Mission design, sample return, proximity operations, asteroid*

ABSTRACT

The Origins Spectral Interpretation Resource Identification Security Regolith Explorer (OSIRIS-REx) mission is a NASA New Frontiers mission launching in 2016. It will rendezvous with near-Earth asteroid (NEA) (101955) 1999 RQ_{36} in 2018, study and map the NEA, determine the effect of the Yarkovsky force on its heliocentric orbit, and return a pristine carbonaceous regolith sample in 2023. (101955) 1999 RQ_{36} is an approximately 550-m diameter NEA and is one the most potentially hazardous asteroids (PHAs), based on its size and probability of future impacts with Earth. This NEA is also a member of the rare B-type subgroup of the carbonaceous C-type asteroids. Its primitive nature (here meaning relatively unprocessed since formation)

makes it an attractive science target. Its low-inclination, Earth-like orbit makes it relatively accessible in terms of spacecraft delta-V requirements.

OSIRIS-REx is the third mission to a NEA. It presents a variety of flight dynamics and mission design challenges, such as designing safe and effective captured orbits and other ballistic proximity operations trajectory sequences about the NEA for surface mapping activities. It is especially challenging in the area of designing combined ground-based and onboard guidance algorithms to execute the demanding Touch and Go (TAG) maneuver sequence for regolith sample collection using on board ephemeris knowledge, optical navigation, and laser ranging. The OSIRIS-REx Flight Dynamics System (FDS) team has developed a number of innovative techniques for addressing these design issues. Other challenging aspects of the overall mission design include optimization of the outbound cruise trajectory, which includes an Earth gravity assist bracketed by optimized Deep Space Maneuvers (DSMs). The Approach Phase culminates in a specially designed set of asteroid approach maneuvers to ensure a safe rendezvous as the mission team uses the spacecraft cameras to search for and acquire the NEA, ascertain whether any natural satellites are present in the vicinity of the NEA, and perform initial mass determination for the NEA.

This paper describes the current results produced by the OSIRIS-REx FDS team in designing and optimizing trajectories for the various phases of the mission, including the launch window for outbound cruise to the NEA, proximity operations about the NEA, the TAG maneuver sequence for regolith sample collection, and the NEA departure opportunities for inbound cruise culminating in entry, descent, and landing to return the pristine sample to Earth. Current mission design results are presented, along with overviews of the algorithms and techniques utilized.