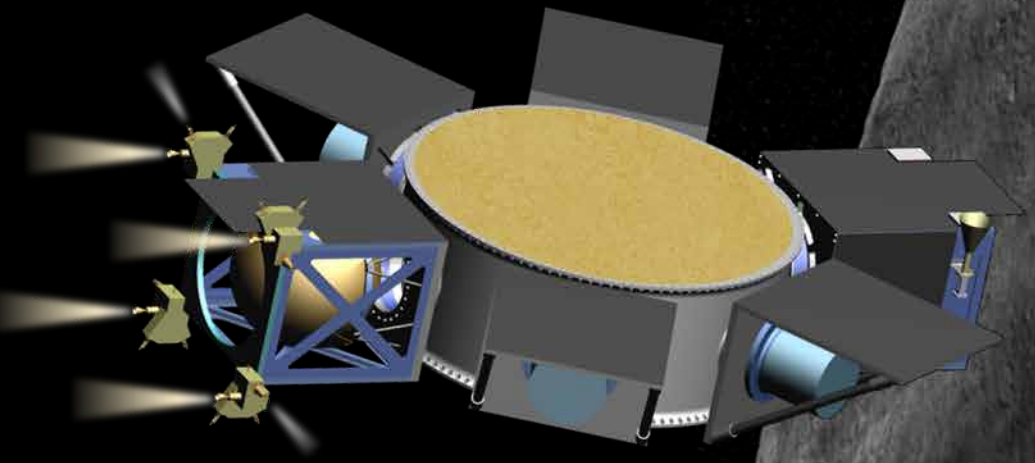
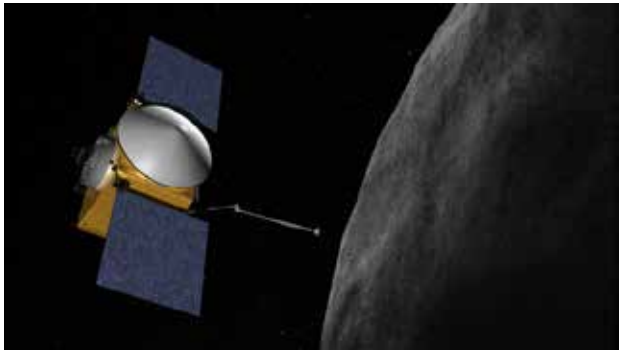
ISIS

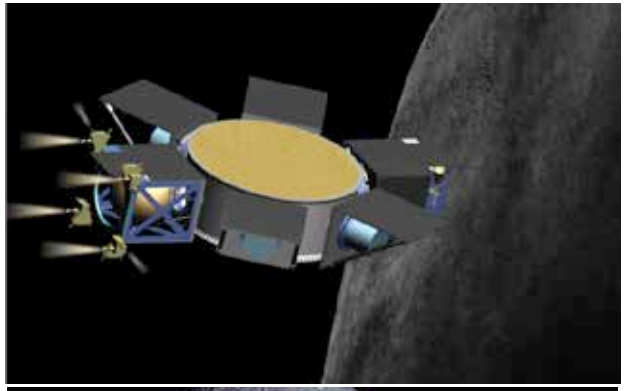
Impactor for Surface and Interior Science



ISIS Mission Concept

- Send an independent, autonomous impactor spacecraft, to the asteroid target of the OSIRIS-REx mission
  - Co-manifest impactor with InSight launch
  - Arrive after OSIRIS-REx has completed its science objectives (i.e., sample collection)
- ISIS creates crater tens of meters in diameter
  - OSIRIS-REx images the impact from a safe vantage point (~1-meter resolution)
- Seismic reverberations throughout the asteroid cause global modifications
  - After debris clears, approach asteroid for imagery of crater and previously mapped terrain (~2 cm resolution). Also collect spectra of pristine material exposed by impact
- Deflection experiment
  - Measure asteroid delta-V due to impactor

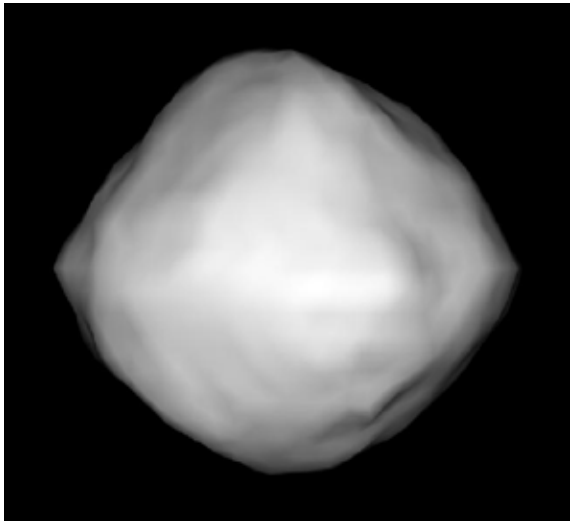




Cross-cutting Exploration & Science Benefits

ISIS delivers Discovery-level Science, closes Exploration SKGs and demonstrates NEO Mitigation Technology, all for a small fraction of the cost of a Discovery mission.

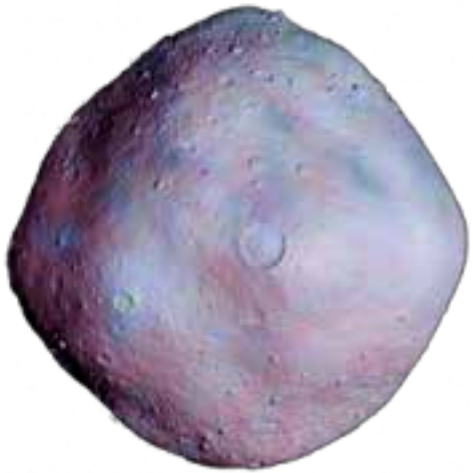
- Cratering experiment – regolith properties and geophysics
- Seismic experiment – global alterations (toppled rocks, landslides) due to shock wave/reverberations, lofting of material far from impact site
- Ejecta – size distribution of regolith, understanding meteorite formation process
- Imaging of crater – formation processes, morphology and subsurface geology
- Spectroscopy of pristine material from depth provides context to OREx sample
- Characterization of any volatiles released from impact site
- Thermal properties of disturbed & undisturbed areas
- Topographic mapping before and after to reveal exhumed volume and material mobility
- Particulate environment following impact over a wide range of disturbance energies
- Rotational excitation can constrain the interior mass distribution.
- Measure delta-V imparted by impact – determine momentum enhancement due to ejecta



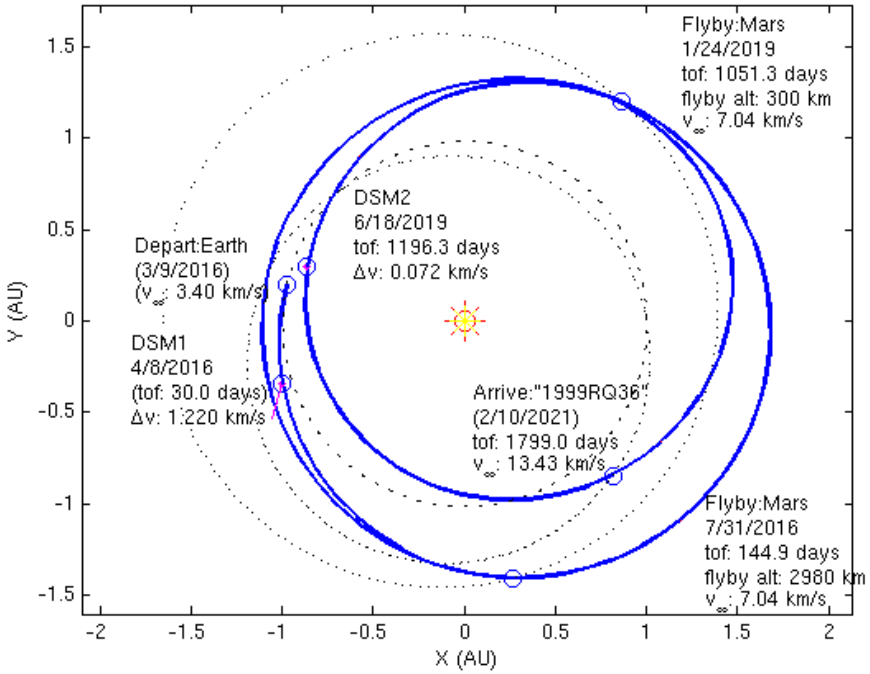
The Planetary Defense aspects of a deflection experiment will generate significant public interest.

ISIS/ORIRIS-REx Operations Concept

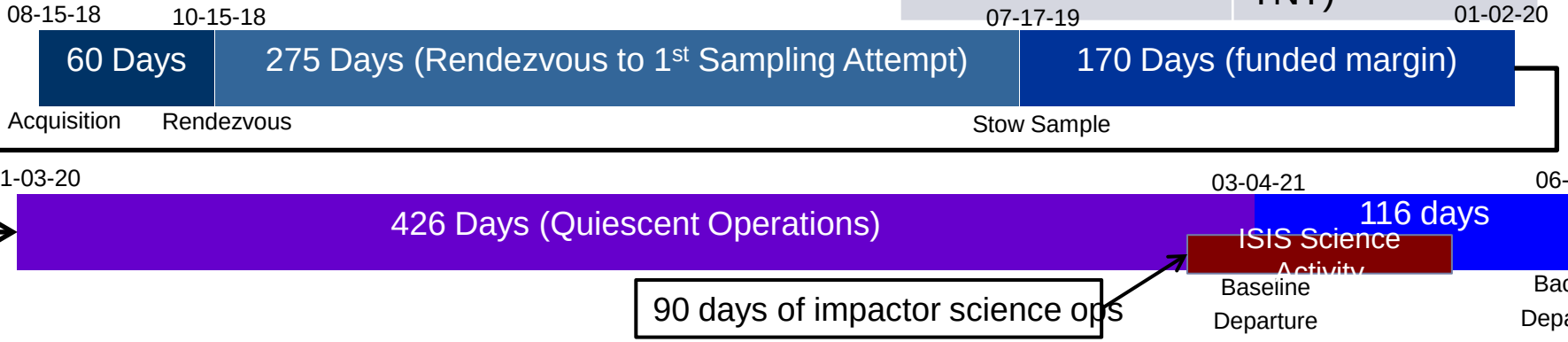
- Pre-impact characterization of asteroid ephemeris
- Move to safe observing location and image ejecta cone as it expands over a period of several minutes.
  - 50 km gives 0.7 m/pixel with Polycam
- Monitor ejecta as it dissipates (15-20 days)
- Perform slow flyby(s) for imaging and spectra (15-20 days)
- Enter radio science mode
  - Few km terminator orbit for 15-20 days
- Total time from impact 45-60 days
  - Assume **90 days** science operations from impact to departure, including margin



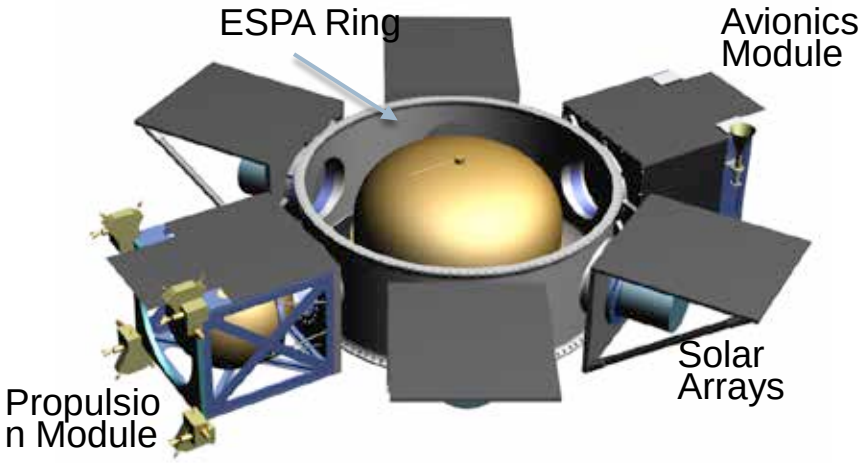
ISIS Schedule Compatible with OSIRIS-REX

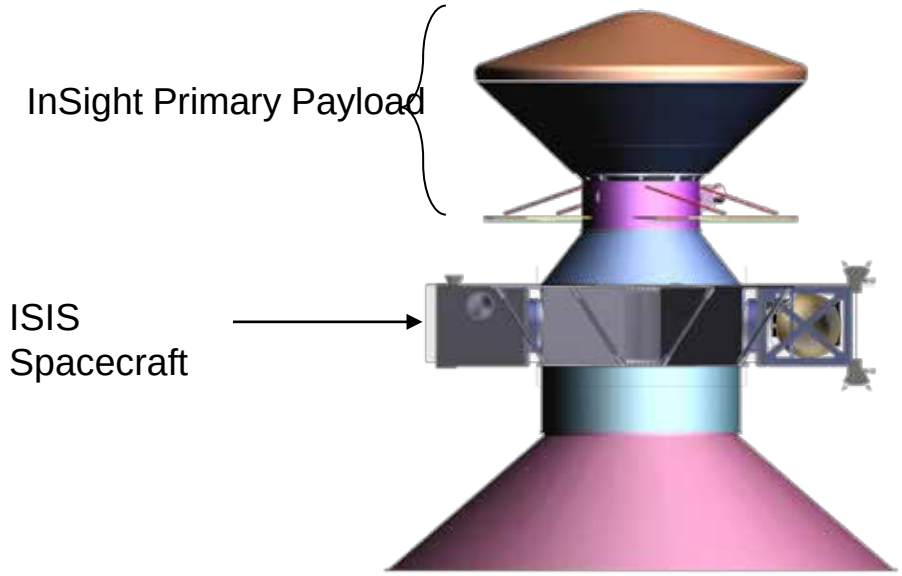


ISIS Baseline Mission	
Launch	9-Mar-2016
Mission ΔV	1.29 km/s
Arrival & Impact	10-Feb-2021
Arrival Phase Angle	9°
Impact Velocity	13.4 km/s
Impact Mass	440 kg
Impact Energy	50 GJ (~9t TNT)



ISIS Flight System Overview

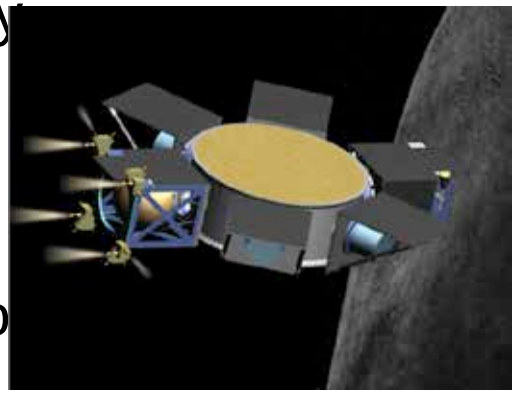


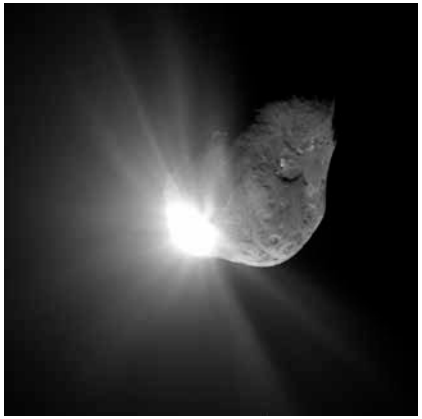


- System designed around flight-qualified ESPA
  - Imposes no impact on host SC/LV interface
- Modular Flight System
- Spacecraft Architecture emphasizes simplicity and reliability
  - No Comm. Crosslink (to observer s/c)
  - No Pyrotechnics
  - No Deployments
  - No Mechanisms

Potential Stakeholders

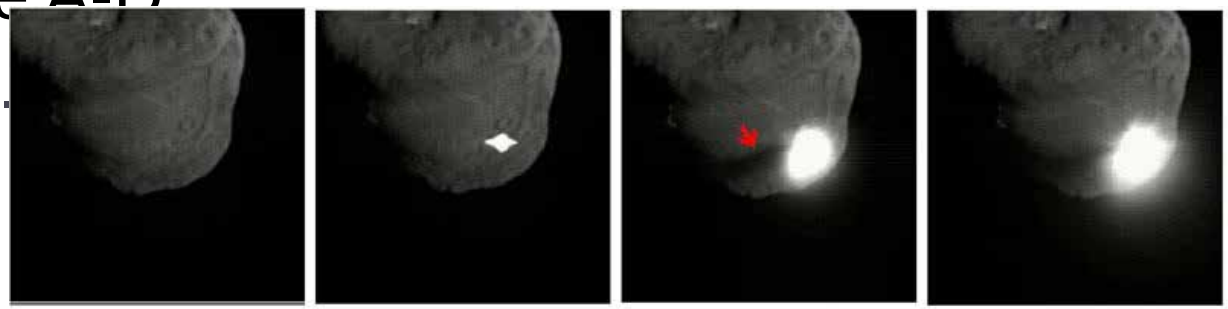
- Science – This mission scheme is extraordinarily cost effective and aligned with NASA Science Mission Directorate objectives
  - Planetary Decadal Report, “The first and most important [criterion] was science return per dollar.”
- Technology – NEO Mitigation is a Space Technology Grand Challenge
  - Terminal guidance demonstration
  - Earth impactor deflection demonstration
- Exploration
  - ISIS squarely addresses numerous “Critical” Strategic Knowledge Gaps (SKGs) for human exploration of NEAs
  - Characterize geotechnical properties, particulate environment, mechanical response, structural integrity and local stability of sub-km NEAs





ISIS is a natural candidate for joint funding. In the current climate, this may be imperative in order to take advantage of the InSight secondary payload opportunity.

Schedule

- Time is short!
  - The InSight launch provides a critical constraint on the viability of the ISIS mission concept
- Starting 3-month pre-phase A study
  - High concept maturity crucial for short development schedule
  - Leading to a mid-2013 Decision Point
- ISIS development schedule assumes ~30 month Phase A-D
  - Aug.  ht launch

Conclusions

- ISIS is a low-cost mission that addresses NASA strategic goals and provides Discovery-class science returns across a wide range of small body science disciplines.
  - The mission leverages NASA's investment in the OSIRIS-REx mission and takes full advantage of the New Frontiers-class instrumentation on the observer spacecraft.
  - Co-manifesting with InSight further improves the cost-effectiveness.
- NEAR-Shoemaker is NASA's only NEA rendezvous mission so far. The second will be OSIRIS-REx, twenty years later.
  - The convergence of OSIRIS-REx schedule and Insight launch opportunity is an extraordinary alignment that will not be repeated again soon.
- ISIS represents a once-in-a-generation opportunity to fly a low-cost asteroid cratering experiment