

# Session 4 Summary

## Small NEA Mission Design Challenges

Damon Landau (JPL): *End-to-End Mission Design – Trajectory Optimization and Realization*

Steve Broschart (JPL): *Proximity Operations and Characterization /Navigation/Control*

Carlos Roithmayr (LaRC): *Docking, Grappling, Capture, Control, and Alternative Approaches*

Dave Folta (GSFC): *Maintaining a Safe, Stable and Human Accessible Parking Orbit*

John Dankanich (MSFC): *Defining Key Technology Requirements*

Session chairs: Brent Barbee (GSFC) and Steve Chesley (JPL)

# Session 4 Summary

## Key points from presentations

- **Mission Design (Landau)**
  - Given a suitable target, it appears feasible to rendezvous with and return an entire near- Earth asteroid using technology that is or can be available in this decade.
    - 6 years, 8 t of propellant, & 40 kW SEP system can return a 500 t asteroid to Earth/Moon capture orbit
- **Proximity Ops (Broschart)**
  - Solar radiation pressure (SRP) would dominate the dynamics during most ARM phases
    - A station-keeping strategy more practical than orbiting
  - Operations require a careful balance of OD/maneuver turnover time and execution errors
    - Autonomy can be used to minimize turnover time, which allows for larger maneuver/model errors
- **Capture (Roithmayr)**
  - Capture/despun of principal axis rotators appears feasible
  - Hovering at low latitudes appears impractical for fast rotators (suggesting that matching rates with a fast tumbler is also infeasible)
- **Parking Orbit (Folta)**
  - Distant Retrograde Orbits provide suitable stability without station-keeping
  - Dynamical Systems Theory and associated flight experience should be leveraged
  - Human accessibility of DRO is comparable to other alternatives, e.g., Lagrange point orbits
- **Driving Technology (Dankanich)**
  - Key technology development needs: Propulsion, Power, ProxOps, Capture Mechanism
  - Mission requirements not fully formulated making technological targets poorly defined
  - Unclear if these technologies can be “ready” in time for 2018 launch

# Session 4 Summary (Continued)

## Issues from Q&A Discussion

- Tumbling rotation requires careful study: flexible structure dynamics, shearing inside capture mechanism
- Target mass uncertainty creates challenges/risks
- Boulder vs. Asteroid trade discussed
- Xenon production question will be asked often
- Schedule is aggressive in terms of technology and target set
- Should ARRM get a pass on standard TRL and development oversight applied to other missions?

## Questions from the co-chairs

- Quantify value to ARM of
  - Enlarging the pool of suitable targets to afford more flexibility
  - Small robotic precursor to close characterization risks