ESCAPADE
Escape and Plasma Acceleration and Dynamics Explorers Mission

Presenter: Mitchell Rosen
The ESCAPEADE Team

- Advanced Space
  - Trajectory and maneuver design

- UC Berkeley Space Sciences Lab – PI and PM
  - Led by Dr. Robert Lillis

- RocketLab – Satellite Bus

Jeff Parker, CTO
Mitch Rosen, ASN Engineer
Andrew Koehler, ASN Engineer
Evolution of ESCAPADE

• 2016-17 – NASA requested study to understand Planetary Science capabilities with $110M budget
  • Converged on 3 low-thrust satellites of 120kg each
• 2018 – SIMPLEx budget announced to be $55M
  • Cut to 2 larger satellites of 165kg each
  • Intended rideshare with Psyche
• 2019 – ESCAPADE selected and funded under Heliophysics
  • The satellites evolved to current wet mass of 530kg each
• 2020 – Psyche launch target change necessitates mission redesign
  • NASA gave nearly 100% chance of going over budget
  • De-manifested from Psyche, switched to high-thrust, significant mass increase
• 2023 – New Glenn selected for launch
• 2024 – Launching later this year!
Science

• Investigations:
  • Structure, composition and variability of Mars’ magnetosphere
  • Atmospheric Escape Processes
• Dual measurement platforms
  • Distinguishes spatial and temporal variations

<table>
<thead>
<tr>
<th>Observation type</th>
</tr>
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<tbody>
<tr>
<td>Time-separated boundary crossings between two regions (N of crossings) can reveal boundary dynamics.</td>
</tr>
<tr>
<td>Time-separated passages through the same spatial volume (N of hours) can probe temporal variability within each region.</td>
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<tr>
<td>Simultaneous, spatially-separated measurements (N of hours) can probe spatial variability within each region.</td>
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<tr>
<td>Simultaneous, spatially-separated measurements (N of hours) can probe correlations between plasma regions.</td>
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BC  TV  SV  CR
Mission Timeline

- **Phase I – Launch**
  - Both spacecraft inserted to hyperbolic departure from Earth
  - Launch targets are identical across every launch window (one window per day)

- **Phase II – Interplanetary Cruise**
  - TCMs to clean up launch, target Mars, navigate to Orbit Insertion Corridors, maintain Multi-Spacecraft Per Aperture

- **Phase III – Orbit Reduction and Transition to Science**
  - Move from initial insertion orbit (~60 hour period) to science formation (~6.5 hour period)

- **Phase IV – Science**
  - Campaign A – string of pearls formation
  - Campaign B – separate orbits
Orbit Reduction and Transition to Science Formation

Delivering Innovation to Orbit.
Orbit Reduction and Transition to Science Formation
Eclipses

• Maximum eclipse duration allowed – 75 minutes
  • Necessitated redesign of orbit reduction phase in early 2022
  • Reduced size of orbits during conjunction to reduce eclipse durations

• Changed ConOp to shorten duration had waterfall effect that necessitated complex TSF targeting scheme
## Close Approaches

<table>
<thead>
<tr>
<th>Pair</th>
<th>Closest Approach Distance (km)</th>
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<tbody>
<tr>
<td>Blue – Gold</td>
<td>204.59</td>
</tr>
<tr>
<td>Blue – Phobos</td>
<td>80.73</td>
</tr>
<tr>
<td>Blue – Deimos</td>
<td>12,088.06</td>
</tr>
<tr>
<td>Gold – Phobos</td>
<td>73.90</td>
</tr>
<tr>
<td>Gold – Deimos</td>
<td>12,750.23</td>
</tr>
</tbody>
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Science Campaign
ESCAPADE and Humans on Mars

• Paving the way for low-cost robotic support missions
  • $55M for two support satellites
  • Lessons learned for mission cost reduction

• Improved understanding of Martian environment

• Connecting heliophysics to Mars
Thank you!