

Requirements Development and Management on the Psyche Mission



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Jet Propulsion Laboratory
and the Psyche Team

4 March 2019

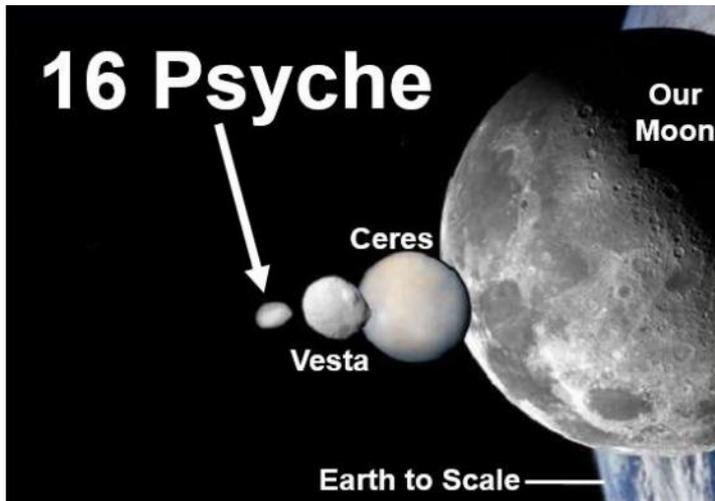
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PSYCHE

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What is (16) Psyche?



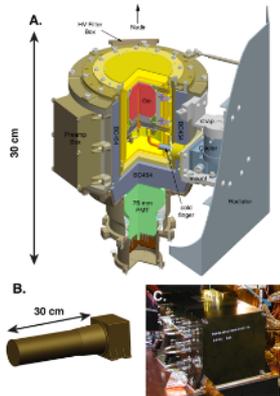
- Discovered in 1852 (Naples)
- 10th largest asteroid (largest M-type)
- $a = 2.92$ AU, $e = 0.140$, $i = 3.09$ deg
 - Relatively easy access with solar electric propulsion (SEP)
- Rotation period: 4.196 hours
- High radar albedo
- High density
- High thermal inertia (120 tiu)
- Spectra: 10% silicate, 90% metal
- Strong testable hypothesis
 - *“Is (16) Psyche the exposed core of larger differentiated body?”*
 - *“Was (16) Psyche created by a slow accretion of metal-rich material?”*



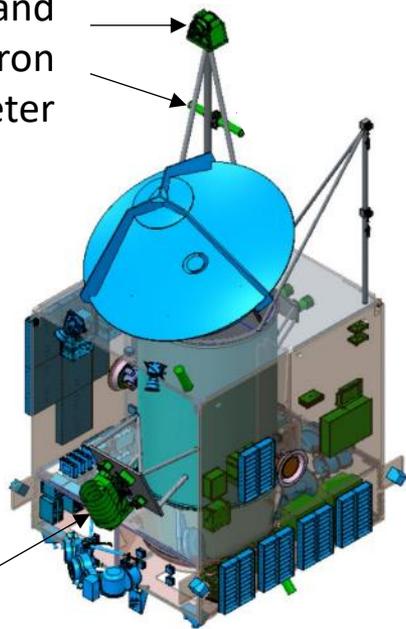
Whatever hypothesis is determined, results would be scientifically significant

Psyche Mission Concept

- Three instruments, one technology demonstration
- Spacecraft bus fusion of two partners:
 - Space Systems/Loral (SSL)
 - Jet Propulsion Laboratory (JPL)
- Leverages key strengths of each partner
 - Electric propulsion, high power S/C (SSL)
 - Deep space communications, autonomy (JPL)

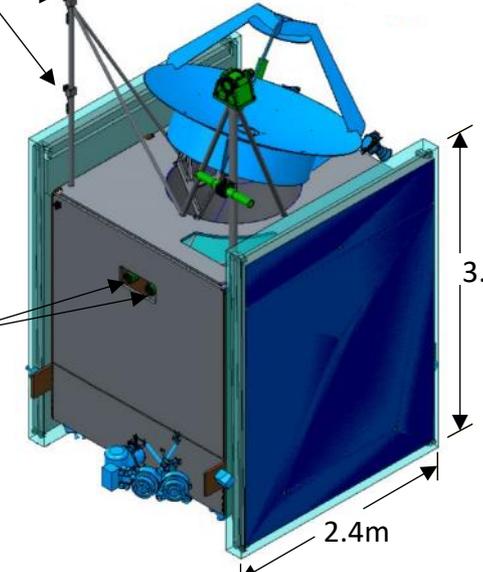
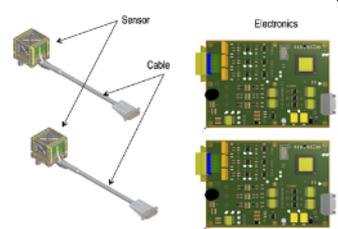


Gamma Ray and Neutron Spectrometer

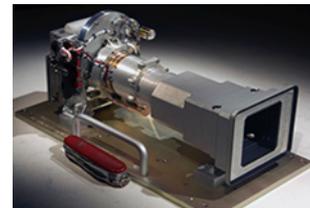


Deep Space Optical Communications

Magnetometer Sensors



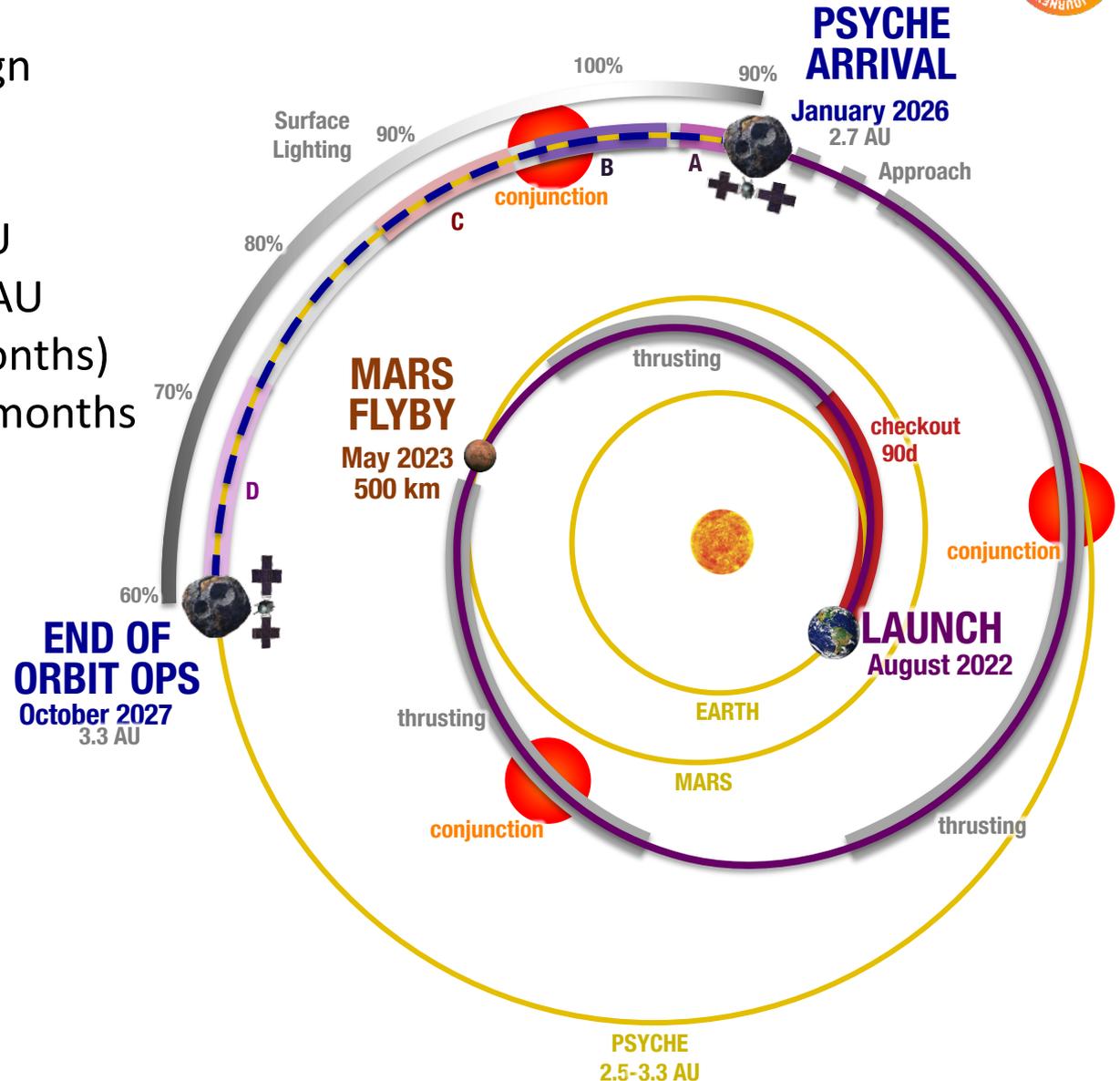
Imagers



Baseline Mission Design



- Dawn-like mission design
- Launch from KSC
- Mars Flyby (500 km)
- Min Solar Range: 1.0 AU
- Max Solar Range: 3.33 AU
- Cruise: 3.5 Years (42 months)
- Orbital Operations: 21 months



Baseline Mission Design

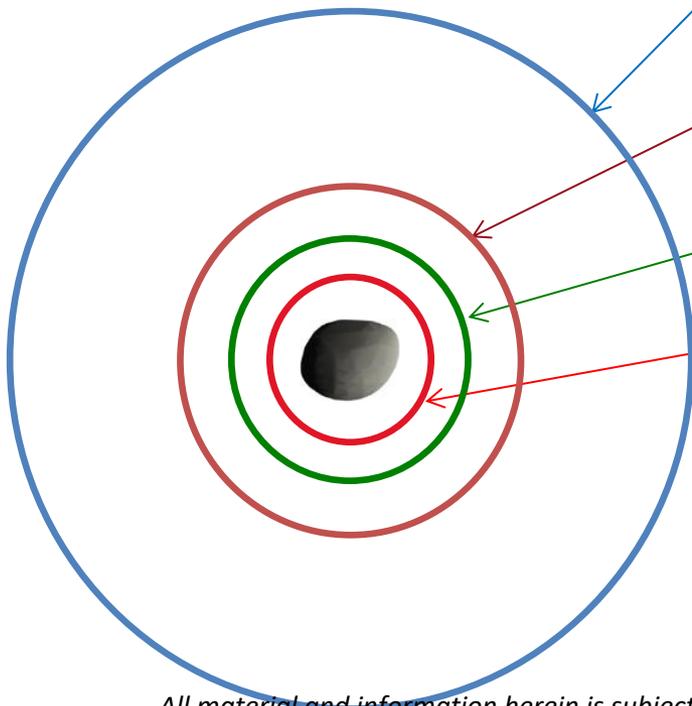
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Orbit A: 56 days (41 orbits @32.4 hrs, ~700 km alt)
Magnetic field detection L1 requirements

Orbit B: 76 days (162 orbits @11.2 hrs, ~290 km alt)
Topography L1 requirements
Spectral Imaging L1 requirements

Orbit C: 100 days (369 orbits @6.5 hrs, ~170 km alt)
Gravity Science L1 requirements

Orbit D: 100 days (585 orbits @4.1 hrs, ~85 km alt)
Elemental composition L1 requirements



Psyche Project Requirements Hierarchy

LEGEND: Approving Org

NASA	JPL
Other	SSL

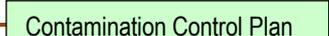
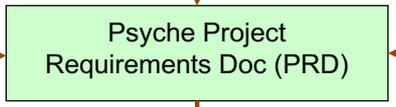


Level 1

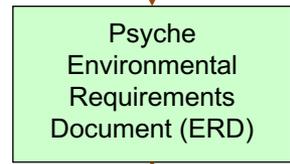
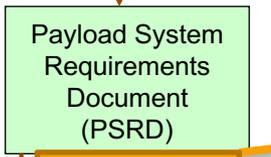


Level 2

From DSOC



Level 3



accommodation

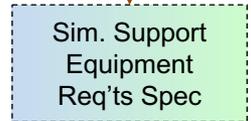
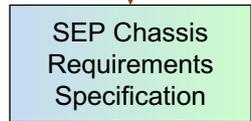
IRCDs

EICD

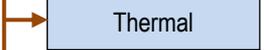
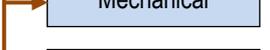
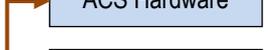
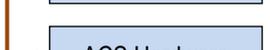
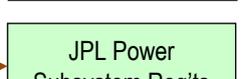
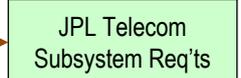
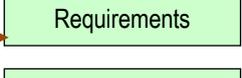
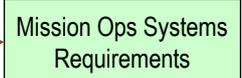
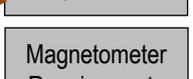
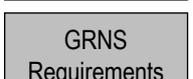
MICD

compatibility

Level 3.5



Level 4

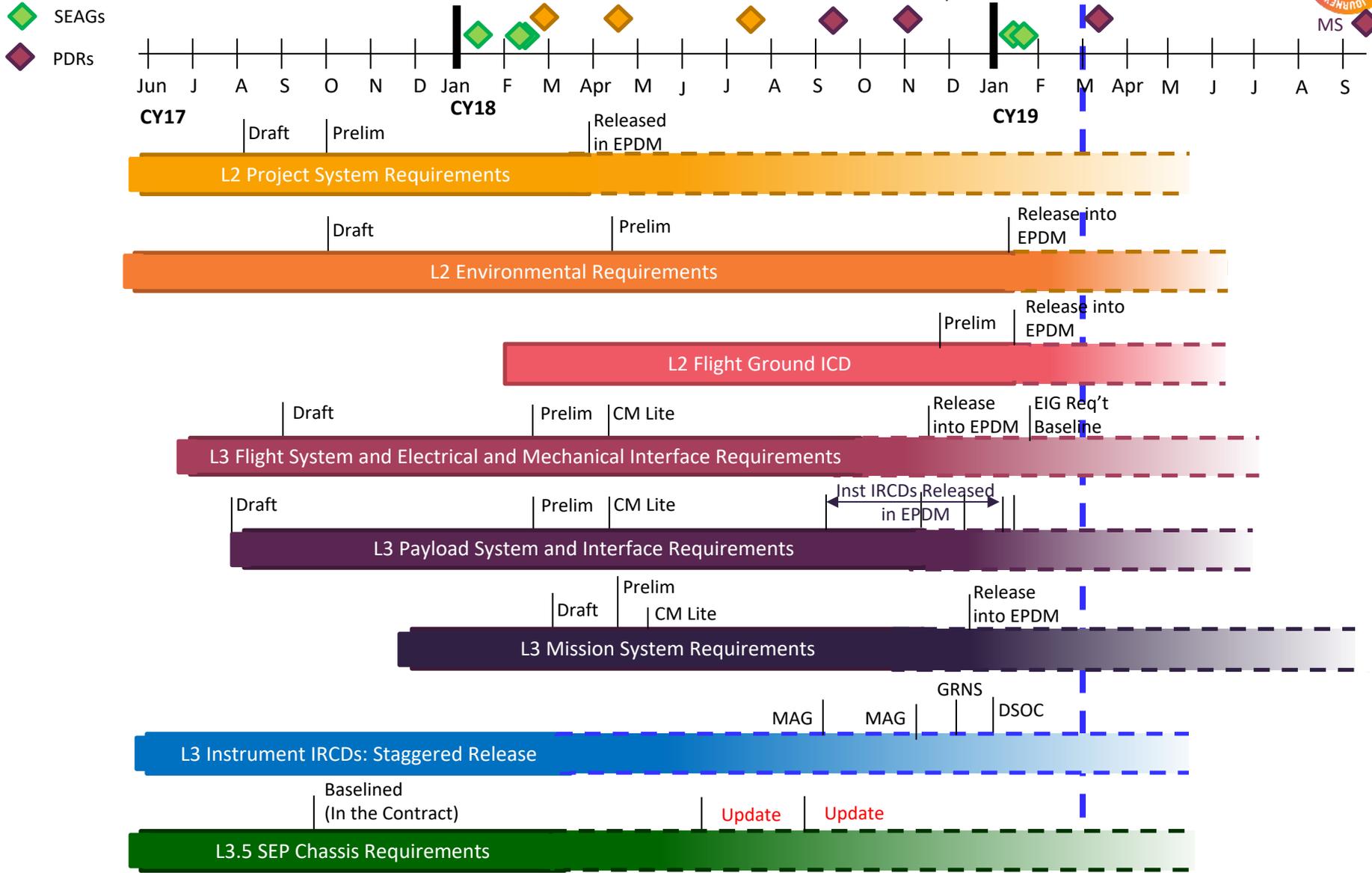


EICD = Electrical Interface Control Document

MICD = Mechanical Interface Control Document

IRCD = Interface Requirements and Control Document

Requirements Development Schedule



TODAY



Key challenges to requirements development

- New contractor: Space Systems Loral (SSL)
 - Challenges:
 - First pairing of SSL/JPL at spacecraft-level
 - First deep-space mission of SSL 1300 bus
 - Solutions:
 - “Level 3.5” SEP Chassis specification, based on SSL Platform Specification
- Technology Demonstration: DSOC
 - Challenges:
 - DSOC a separate project from Psyche
 - Project-level requirements kept in separate repositories
 - Potential for requirements to have parents from both projects
 - Solutions:
 - No L1 requirements related to DSOC
 - Have limited number of personnel with access to both DSOC and Psyche requirements databases

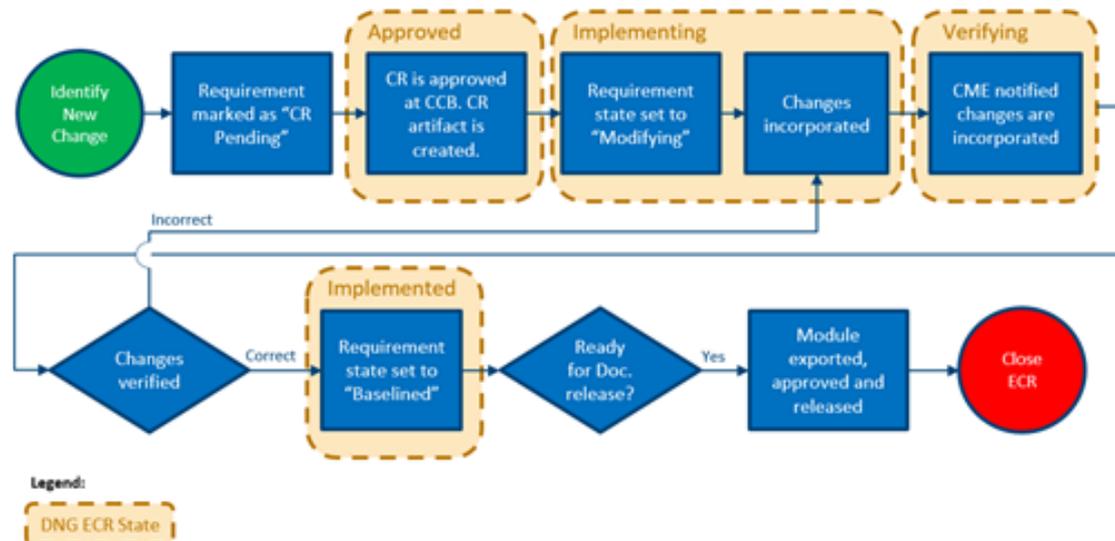
What worked



- Early definition of the Level 3.5 specification
 - Started during pre-Phase A; gave us better insight into SSL's capabilities, helped answer questions received during proposal process
 - Had to find balance between “capability” and “performance-driven” requirements
- Use of commenting features in DOORS NG
 - Helpful tool in facilitating conversations outside meetings
 - Kept requirements managers apprised of discussions through email alerts
- Use of ‘ECR-lites’ between Preliminary and Baseline stages of L3 documents
 - Level of oversight in configuration change sufficient, without being too burdensome
 - When combined with commenting, sped up change control process tremendously
 - Easy to provide progress metrics to management

What didn't work

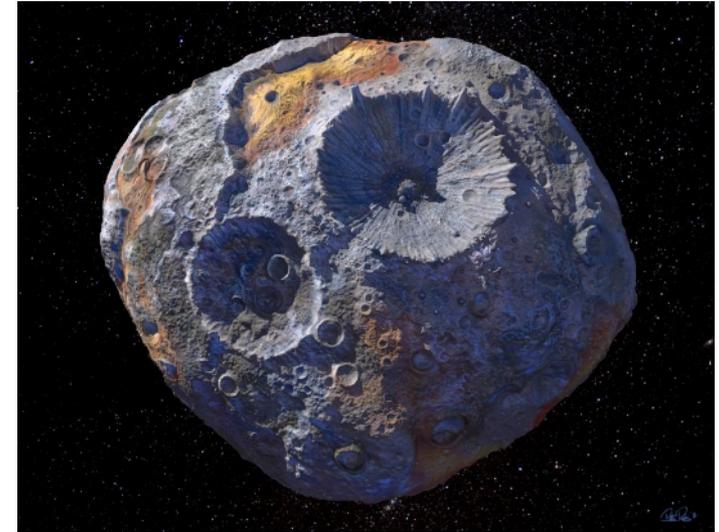
- Review process (Draft->Preliminary) at lower levels (L3+)
 - Methods used for Project-level viewed to be impractical
 - Initially used Online Review mechanic provided in DOORS NG
 - Developed 'Child System – Accept/Reject' attribute, ECR-lite process
- Establishing smooth transitions from 'ECR-lites' to ECRs
 - At baseline of L3-FS, had 20+ ECR-lites still open
 - Transition from ECR-lites to ECR resulted in substantial paperwork increase
- Obtaining quick turnarounds on ECR approvals



What's next



- Preliminary Design Review – week of March 12, 2019
 - KDP-C follows soon after
- Between PDR and CDR, concentration shifts to V&V methodology, approach
 - Test plan development started in late 2018
- CDR in mid-2020
- Launch scheduled for August 2022



Questions?



Jet Propulsion Laboratory
California Institute of Technology



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