Small Bodies Assessment Group
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Washington, DC
Recent Highlights

• Dawn’s Ceres baseline mission timeline has been approved and funded by NASA
  – Mission ends in early July 2016
  – Thanks to NASA HQ and community support for the budget increase needed to execute a robust mission at Ceres

• Call for Dawn@Ceres Guest Investigator Program has been issued
  – Many thanks to SBAG and the community for their advocacy
  – Dawn team looks forward to including new team members

• Spacecraft and team are performing well and preparations for the Ceres mission are nearly complete
  – Risk review on Aug 21
  – Readiness review on Nov 20
Interplanetary Trajectory

Distance to Vesta 0.6036 AU
Distance to Earth 2.626 AU
Distance to Ceres 0.0499 AU
Distance to Sun 2.657 AU

Launch Sep 2007
Vesta arrival July 16, 2011
Vesta departure Sep 5, 2012
Ceres arrival March 2015

Dawn today
Ceres Science Orbits

- 406 days of operations are planned at Ceres
  - Primarily constrained by hydrazine
- **RC3**
  - Phase angle = varying
  - Duration 1 orbit (20 days)
  - Nadir rotation movies, high phase observations.
- **Survey Orbit:**
  - Beta angle = 10-25° drifting, Incl. = 90°
  - Duration 7 orbits (22 days)
  - Nadir mapping, limb observations
- **High Altitude Mapping Orbit (HAMO):**
  - Beta angle = 27-37° drifting, Incl. = 90°
  - Duration 70 orbits (56 days)
  - Nadir and fixed off-nadir mapping
- **Low Altitude Mapping Orbit (LAMO):**
  - Beta angle = 45-50°, Incl. = 90°
  - Duration 404 orbits (92 days)
  - Nadir pointed for GRaND
  - HGA-on-Earth for gravity (some LGA tracks)
Flight Team is performing well and the Flight System is healthy

- The spacecraft is thrusting nominally

- Recent Flight Activities:
  - Ion engine low-thrust calibration – July 21, 2014
    - Reduced a first-in-flight risk for Ceres operations, demonstrating ion thrusting stability at the lowest throttle levels expected to be used at Ceres

- Upcoming Flight Activities:
  - Final calibrations and checkouts prior to Ceres Arrival – Oct 2014
  - Solar Conjunction – Dec 2014
  - Ceres Approach Begins – Jan 2015

- Estimated Ceres arrival (capture) date is currently: 28 March 2015
  - Expect to continue to be variable on the order of a few weeks
Instruments are all healthy and performing well

Performed routine checkouts on all three instruments - June 23, 2014

- **FC2 (Framing Camera)**
  - Updated instrument software to capture and report additional diagnostics in the event of an instrument reset
  - Addresses lesson learned from Vesta experience

- **VIR (Visible and Infrared Mapping Spectrometer)**
  - Power on and functional checkout
  - Performed internal calibration
    - Supports calibration of the Vesta data in the 3 micron region (Level-1B)

- **GRaND (Gamma Ray and Neutron Detector)**
  - Power on and one week of background data collection
PDS Archiving Status

<table>
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<tr>
<th>Status</th>
<th>Pre-Vesta Data</th>
<th>Vesta Data</th>
<th>Legend</th>
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<tr>
<td></td>
<td>1A (Raw)</td>
<td>1B (Calibrated)</td>
<td>Archived, Available at PDS</td>
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<tr>
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<td>VIR</td>
<td>Correcting Liens</td>
<td>Certified</td>
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<td>GRaND</td>
<td>Archived</td>
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<td>Not yet delivered to PDS for Review</td>
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<tr>
<td>Gravity</td>
<td>N/A</td>
<td>(Level-0) Correcting Liens</td>
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1. Task force formed to address calibration artifacts in the 3-micron region for VIR Level 1-B dataset
   - Recent flight activity is being used to test and verify the reduction of artifacts in the revised calibration
   - Correction for time-dependent contamination near 3 microns is being derived

2. GRaND L-1B Vesta delivered to DSC, being prepared for PDS review
Ceres Mission Timeline

Proposed Ceres Science Mission

- 1 – Bulk Density
- 2 – Spin Axis
- 3b. – High-resolution Gravity field
- 6abc. – GRaND elemental abundance
- 7b. – VIR low-resolution
- 4b. – FC color coverage
- 5b. – FC topography
- SC2 – 1 month below 700 km
- VIR global coverage
- PI Arrival

2014
Oct Dec Jan Feb
2015
Jan Feb Mar Apr May
Jun Jul Aug Sep Oct
2016
Jan Feb Mar Apr May
Jun Jul Aug Sep Oct

Interplanetary Cruise
Cruise Margin
Ceres Approach
Survey Science Orbit (~4250 km)
High Altitude Science Orbit (~1475 km)
Low Altitude Science Orbit (~365 km)
LAMO Margin
End Prime Mission
Ops Margin
Transfer
Solar Conjunction
Transfer

FY15
FY16
FY16
FY16
Post-Vesta, ~30 kg of hydrazine available to complete the mission

4.4 kg needed to get to Ceres

Project is holding 3.5 kg as Contingency (to accommodate potential future anomalies)

Leaving 21.5 kg available to accomplish the Ceres mission
Ceres Hydrazine Estimate

Dawn has enough hydrazine to complete the baseline mission
Ceres Late Approach and Capture

RC 2

RC 3

Capture
RC3 Geometry
RC3 Plans

- Small Turn
  - Off-Nadir
  - Nadir
  - HGA to Earth for +Z Sun Avoidance
  - Nadir
  - Off-Nadir

- S/C Lat
- S/C Long
- VIR Phase
- +Z to Sun
  - +Z 60° to Sun
  - +Z 25° to Sun
- Close VIR Cover
- Open VIR Cover

Date:
- DOY 107: 2015-Apr-17
- DOY 110: 2015-Apr-19
- DOY 111: 2015-Apr-20
- DOY 112: 2015-Apr-21
- DOY 113: 2015-Apr-22
- DOY 114: 2015-Apr-23
Plume/Exosphere Detection

- The RC3 observations will be the best opportunity to see material emitted or lofted from Ceres’ surface
  - VIR team has used their simulation tools to predict the ability to detect the putative flux of 6 kg/s estimated from Herschel detection (Küppers et al., 2014)
    - By averaging many spectra together, the expected signal can be observed with SNR of 2-3
  - FC images at high phase are expected to be able to see dust

- Dawn’s payload is well suited to searching for evidence of activity on Ceres’ surface
  - Look for recent and past deposits of outgassed material (and ice)
  - Constrain the thermophysical properties
  - Link surface composition to geologic processes
Here we come!