Early Approach Kickoff: FDS Overview

22 May 2018
**Early Approach Phase Overview**

- **First 3 days (Aug 17-19) not shown**
- **Notional DDOR schedule placement shown with changes from ULP**
- **Notional OD2 delivery every Monday**
- **Reference trajectory delivered in mid-July to include actual performance of DSM-2**
  - Science planning begins with current reference trajectory
Ephemeris Deliveries

• Refod030, delivered on Feb 12, 2018, is applicable at start of planning for Early Approach
  • orx_171006_190608_180125_od030-R-DSM2-P-M28D_v1.bsp

• Next Reference OD deliveries:
  • orx_yymmdd_200101_180710_od0xx-R-AM1-P-M3B_v1.bsp expected July 13, 2018 (DSM-2 reconstruction)
  • orx_yymmdd_190228_181114_od0xx-R-M0P-P-M3A_v1.bsp expected Nov 14, 2018 (AAM4 reconstruction)

• Transition to nadir-pointing (based on onboard ephemeris) is expected to occur during week 33 (prior to Aug 17th observations)
Approach DSN & DDOR Tracking Guidelines

- “Continuous” tracking assumed to start after Early Approach around AAM1
  - Sparse tracking in weeks 33-36, one pass per day in weeks 37-39
  - Mission phase templates allows for 12-14 hours of Doppler if stations are available

- DDOR assumptions in Early Approach
  - N-S baseline measurements 2x/week – including during weeks 38, 39 (=change to ULP)
  - N-S (Goldstone-Canberra) Baseline Only (No E-W Opportunities)
**View Periods and Spacecraft Template**

- Combination of HGA/LGA tracking assumed between 1200-0400 UTC
- 5-7 hour HGA passes constrained to 9 hour window (primarily Madrid)
  - Early Approach HGA pass spans gap between Canberra & Madrid
- LGA DDORs: Constrained to three-hour window on GDS/CAN track
- Nav analysis assumes 8 hours per day of Doppler
Mission Geometry

OREX Mission Geometry

Sun Range

Earth Range

SPE

Range (AU)

(2018/08/17 00:00:00.00) (abs day)

---Earth OREX Range AU ---SUN OREX Range AU o-SPE Angle
OpNav Narrative Overview

- OpNav visits occur 3 times per week, on Mondays, Wednesdays, and Fridays.
- Assumption: Transition to nadir-based pointing based on onboard ephemeris occurs prior to start of first OpNav on Aug 17
- Each visit will use the PolyCam OpNav block
  - 4 light image pairs and 1 dark image pair, resulting in a total of 10 images per day.
  - Although the block allows for two different exposure time inputs, it is not needed until the asteroid becomes much brighter than the background stars.
  - We will command the same value for both exposure time inputs.
- On 8/17/2018, Bennu's apparent magnitude is 13.
  - A 4000 millisecond exposure will record ~216 DN of signal from Bennu, with a signal-to-noise ratio (SNR) of ~11.9.
- On 9/19/2018, the apparent magnitude of Bennu is approximately 11.39.
  - A 2000 millisecond exposure will record ~481 DN of signal from Bennu, with a signal-to-noise ratio (SNR) of ~24.4.
  - A 2000 millisecond PolyCam exposure will provide an SNR of 14.8 on a 12th magnitude star. The density of the background star field down to 12th magnitude is sufficient to guarantee enough stars in the PolyCam FOV for OpNav.
  - Thus, on this day we will transition from 4000 millisecond to 2000 millisecond exposures through Week 39.
- KXIMP processing details
  - Asteroid treated as unresolved point source
  - Stars brighter than 8th magnitude will saturate (> 16000 DN) and be ignored in the pointing solution
    - Very few epochs where a magnitude 8 or brighter star will be in the PolyCam FOV.
- Work to go: Identify if Bennu is near any bright stars during opnav epochs that may impact the ability to perform centerfinding. There may be times in the SOW that are better opportunities for imaging.
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