

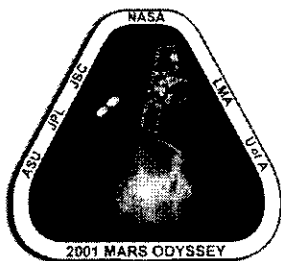


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HEND Workshop

Mars Odyssey Mission Status

Robert A. Mase
Odyssey Mission Manager



June 6, 2005





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Mission Statistics

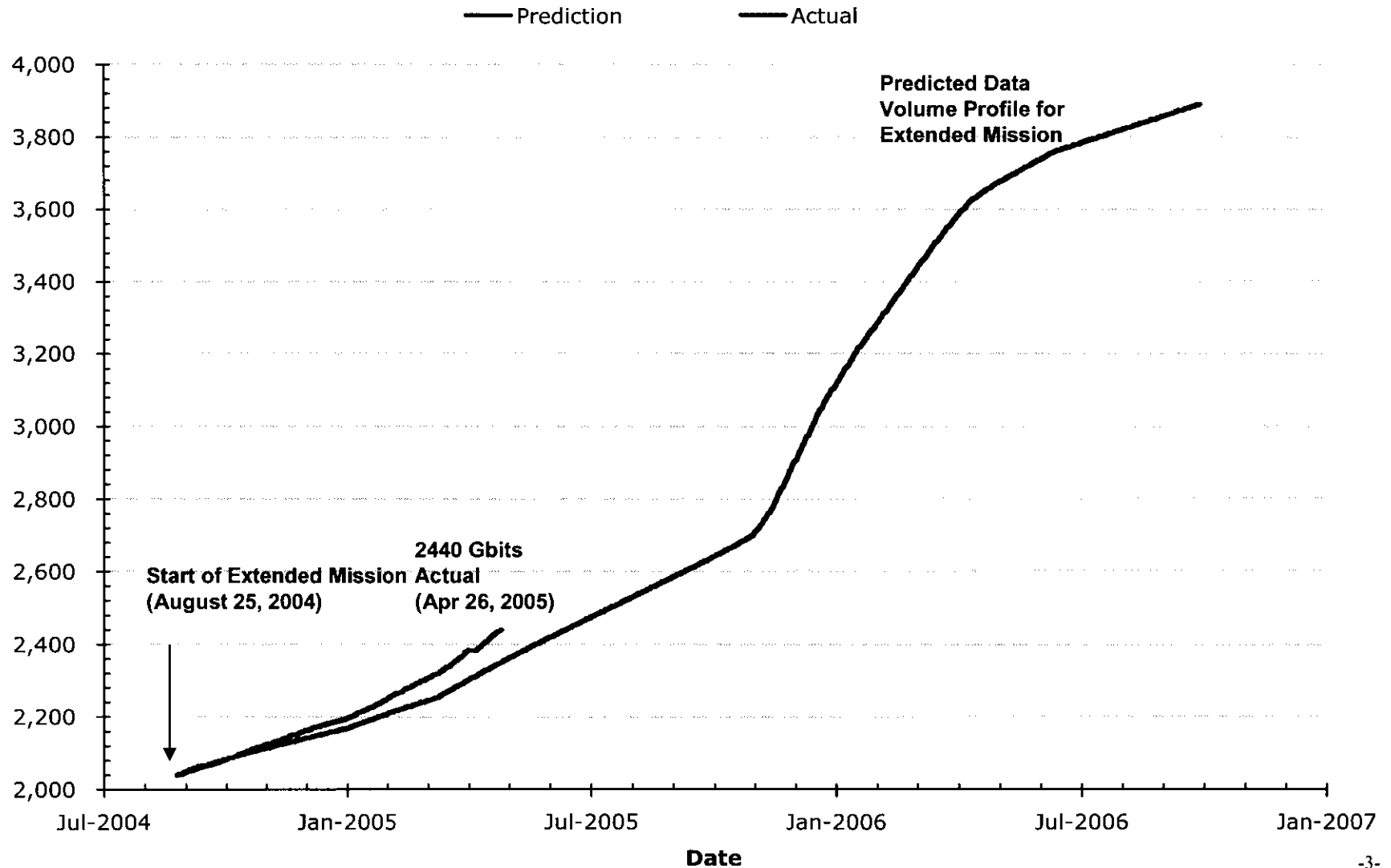
Mission Milestone	Primary Mission	Current (May 3, 2005)
Days of Science Mapping Operations (since Feb 19, 2002)	917	1169
Mars-Years of Science Mapping Operations	1.33	1.70
Earth-Years of Science Mapping Operations	2.5	3.20
Total Number of Science Mapping Orbits (since Feb 19, 2002)	11,142	14,200
Total Number of Orbits around Mars (since Oct 23, 2001)	11,958	15,016
Days in Orbit around Mars (since Oct 23, 2001)	1035	1287
Days Since Launch (since April 7, 2001)	1235	1487
Total MER UHF Data Returned	56 Gbits	105 Gbits
Total Science Data Returned	2038 Gbits	2440 Gbits



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Science Data Return





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UHF Relay Support

UHF Relay campaign is back to normal

- 4 day interruption during Odyssey safe-mode
- **Total Data Return: (as of April 27, 2004)**

<u>Return Data Path</u>	<u>Total Data Return</u>	<u>Percentage</u>
Mars Odyssey	104,475 Mbits	91%
Mars Global Surveyor	6,231 Mbits	6%
Direct-To-Earth	3,688 Mbits	3%

- Working with PHX to coordinate future UHF relay support
 - Preliminary MOA with PHX is signed
 - ODY agreed to fully support PHX EDL Communications



Consumables and Expected Lifetime

As of Apr 1, 2005:

- Propellant Remaining: 37.4 kg \pm 3 kg
 - Nominal usage is ~1 kg per year for momentum management
- TCM Valve Thermostats
 - 4.3 years of formal lifetime remaining
 - Expect to last indefinitely, no qual data exists beyond 100,000 cycles
- IMU
 - 6.4 years of lifetime remaining
 - B-side available, could develop all-stellar attitude determination, LIMs provide 2000 hours of advance warning
- HGA Gimbals: 13 years of life remaining
- Battery: 23 years of life remaining
- SSPA: 23 years of life remaining
- Solar Array Gimbals: 25 years of life remaining



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Mars Odyssey Spacecraft Activity

- Mar 15, 2004 10,000 Orbits around Mars
- Aug 24, 2004 End of Primary Mission
- Aug 25, 2004 Start of E1 Extended Mission
- Sept 10, 2004 Solar Conjunction

- Apr 2, 2005 Safe-Mode Entry
- May 2, 2005 15,000 Orbits around Mars
- June 22, 2005 5° Yaw Attitude
- July 6, 2005 12° Yaw Attitude
- Aug 25, 2005 5° Yaw Attitude
- Sept 7, 2005 Return to Nadir Attitude
- Sept 30, 2006 End of E1 Extended Mission



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Safe-Mode

- **Anomaly Description - Saturday Apr 2, 2005 at 20:33 UTC**
 - Software performance monitor (SWPM) regularly interrogates all software tasks
 - High-rate ACS task did not respond for 4 consecutive interrogations (~ 3 seconds)
 - High Level Fault Protection responded as designed - requested heartbeat termination
 - Spacecraft gracefully safed itself (takes ~2 minutes) and warm rebooted
 - Spacecraft came back up in safe-mode, on A-side hardware

- **Analysis of Fault**
 - No indication of any hardware failure - all A-side hardware appears healthy
 - ACS task was actually running the whole time, right up until the warm reboot
 - No trace in telemetry or flight software dumps of any fault or SEU

- **Actions Taken to Date**
 - Opened Criticality 2 ISA Z86144
 - Followed established Safe-Mode Recovery Procedure
 - Downlinked all available FSW diagnostic information
 - Recovered spacecraft back to nadir-point attitude on Tuesday Apr 5
 - Resumed MER UHF operations on Wednesday Apr 6
 - Science instruments turned back on Thursday Apr 7
 - GRS successfully annealed Apr 12-20
 - Spacecraft has been functioning nominally ever since



Mars Odyssey

Safe-Mode (cont)

- Ongoing Analysis
 - LMSS anomaly investigation team developed a fault tree
 - Continuing to investigate available telemetry, and analyzing flight code
 - Have not yet exhausted all possible avenues
 - Analyzing environmental effects - does not appear to be an SEU
 - Investigating a method to reproduce anomaly in the testbed
 - Searching for evidence of similar behavior on other spacecraft
 - Engaging JPL assistance to aid in root cause investigation
- Current Theory
 - ACS task task may have been in partial deadlock with another task
- Corrective Action
 - Root cause not yet uncovered, so no corrective action to take at this point
 - Pursuing an increase to the task trace buffer to preserve longer history during a fault response
 - Held lesson-learned to improve safe-mode recovery procedure for future
- Residual Risk
 - Should this anomaly reoccur, we would end up in safe-mode again
 - Although safe-mode is undesirable, it has proven to be safe for the spacecraft
 - Safe-mode implies interruption to science data collection and MER UHF relay support



Mars Odyssey

“Rendezvous” with Mars Express

- ODY Navigation Team regularly monitors ODY close approaches with MGS and MEX
 - MEX orbit rotates through ODY and MGS orbits - provides regular “opportunities”
 - We rely on MEX to provide updates on their orbit evolution
 - ODY orbit specifically designed to never intersect with MGS orbit

- Nav Team discovered a close approach on May 7 of less than 10 km
 - Followed up with MEX project at JPL and later ESA
 - Discovered that MARSIS deployment (May 4) will slightly alter the MEX orbit
 - Introduced another close-approach opportunity on May 5
 - Thruster-based attitude control during deploy will introduce significant trajectory uncertainty
 - Trajectory perturbation cannot be entirely modeled a-priori, will not know until after the fact
 - MEX orbit “cloud of uncertainty” will definitely intersect with ODY orbit

- Mitigation Options Considered
 - Do nothing - analyze probability of impact and convince ourselves that it is sufficiently low
 - MEX perform a collision avoidance maneuver (implemented)
 - MEX delay MARSIS deployment
 - ODY perform a collision avoidance maneuver

- Actions Taken
 - MEX successfully performed an orbit phasing maneuver on Apr 28
 - ODY prepared a contingency maneuver just in case
 - MEX agreed to jointly monitor these opportunities in the future



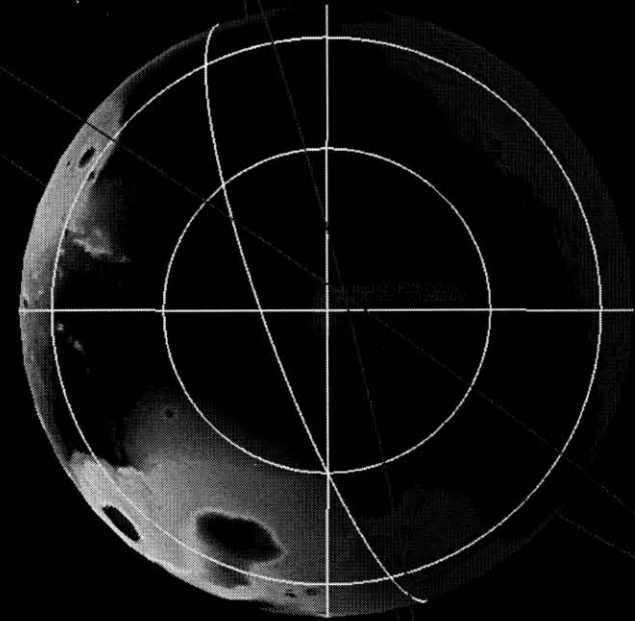
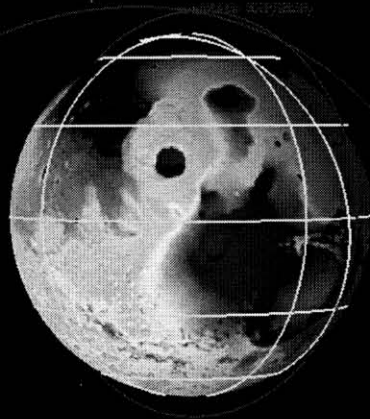
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“Rendezvous” with Mars Express

Mars CI Observer View
2005 MAY 07 01:44:30.00 UTC

Mars CI Observer View
2005 MAY 07 01:44:30.00 UTC





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Restricted HGA Pointing Issue

- Range of motion of High-Gain Antenna gimbals will preclude the High-Gain Antenna from pointing at the Earth throughout the entire orbit
 - Earth at maximum elongation from Sun as viewed from ODY orbit
 - Period lasts from mid-June through mid-September 2005
 - This is a new geometry we did not experience in the Prime Mission

- Impact without mitigation
 - In worst case downlink data volume would drop by a factor of 3-4
 - In worst case contact times too short to perform an uplink, lasts for several weeks

- Mitigation Strategy
 - Yaw the spacecraft by 5-12 degrees to enable HGA to point towards Earth

- Impacts
 - Primary science impact to THEMIS IR, smears the images or effectively lowers the resolution

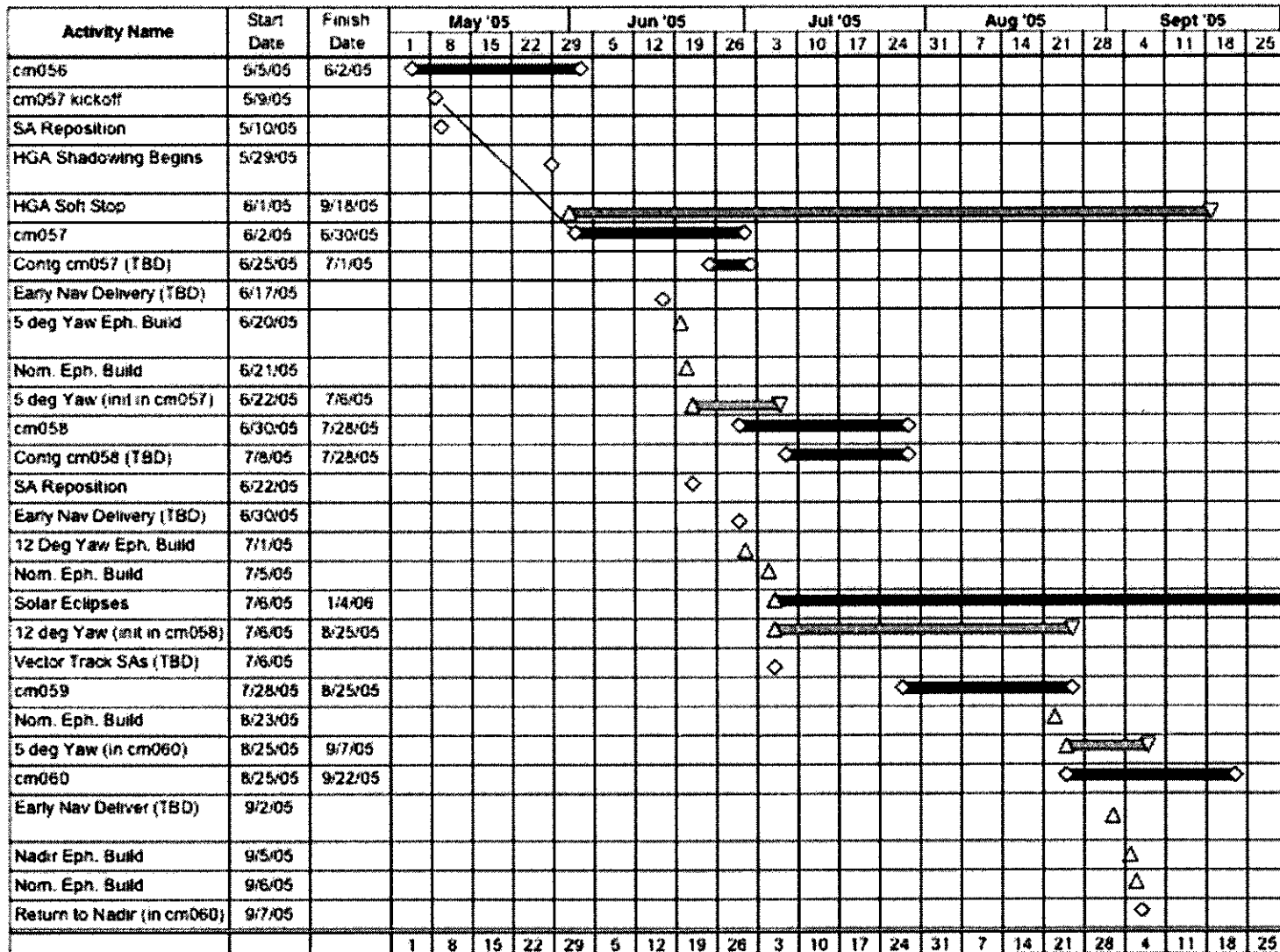
- Schedule
 - Strategy and schedule complete (see backup material)
 - Flight product build and test in May
 - Implement Yaw attitude on the spacecraft in mid-June



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Schedule for Yaw Attitude Implementation

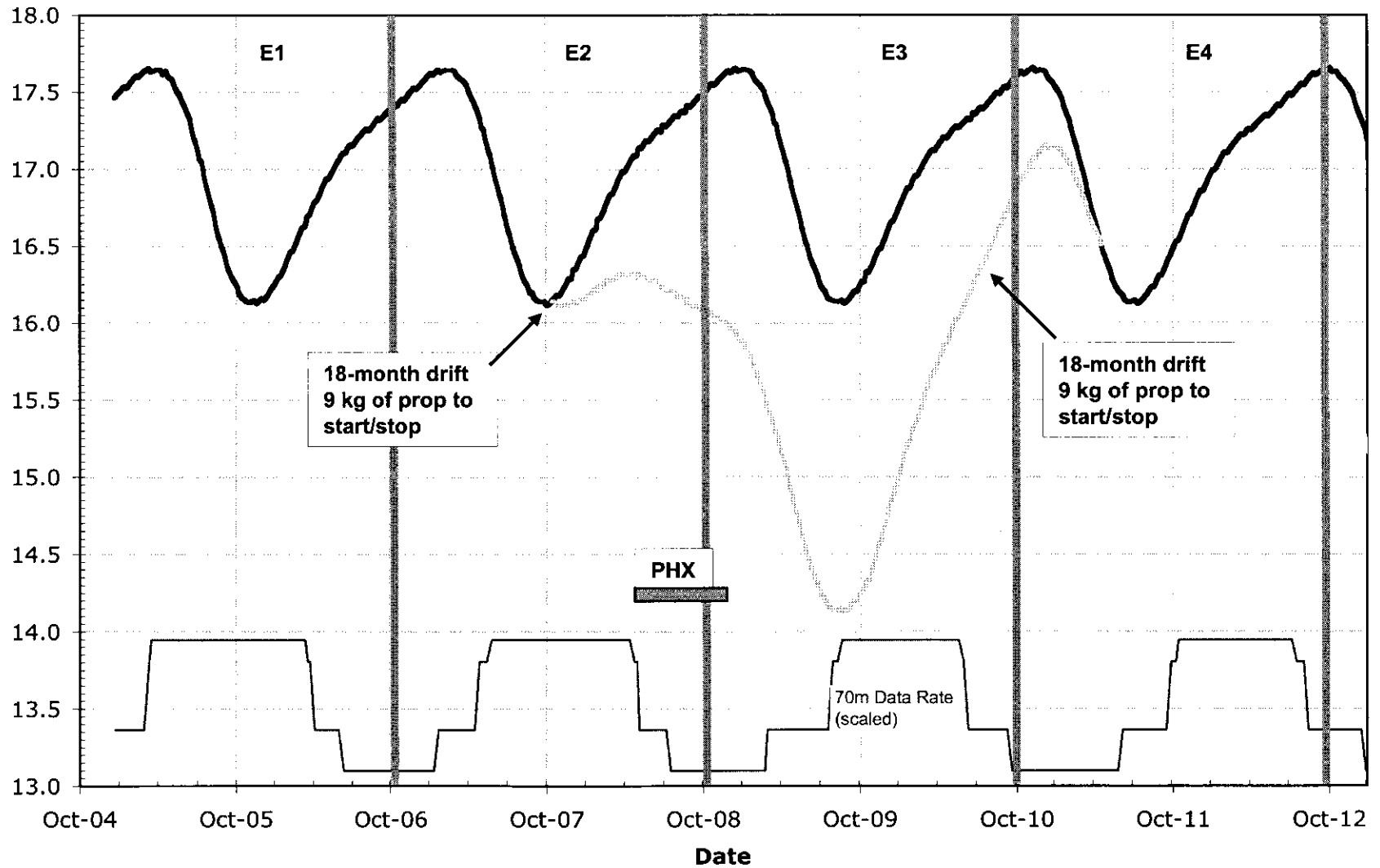




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E3 Example - Early LST

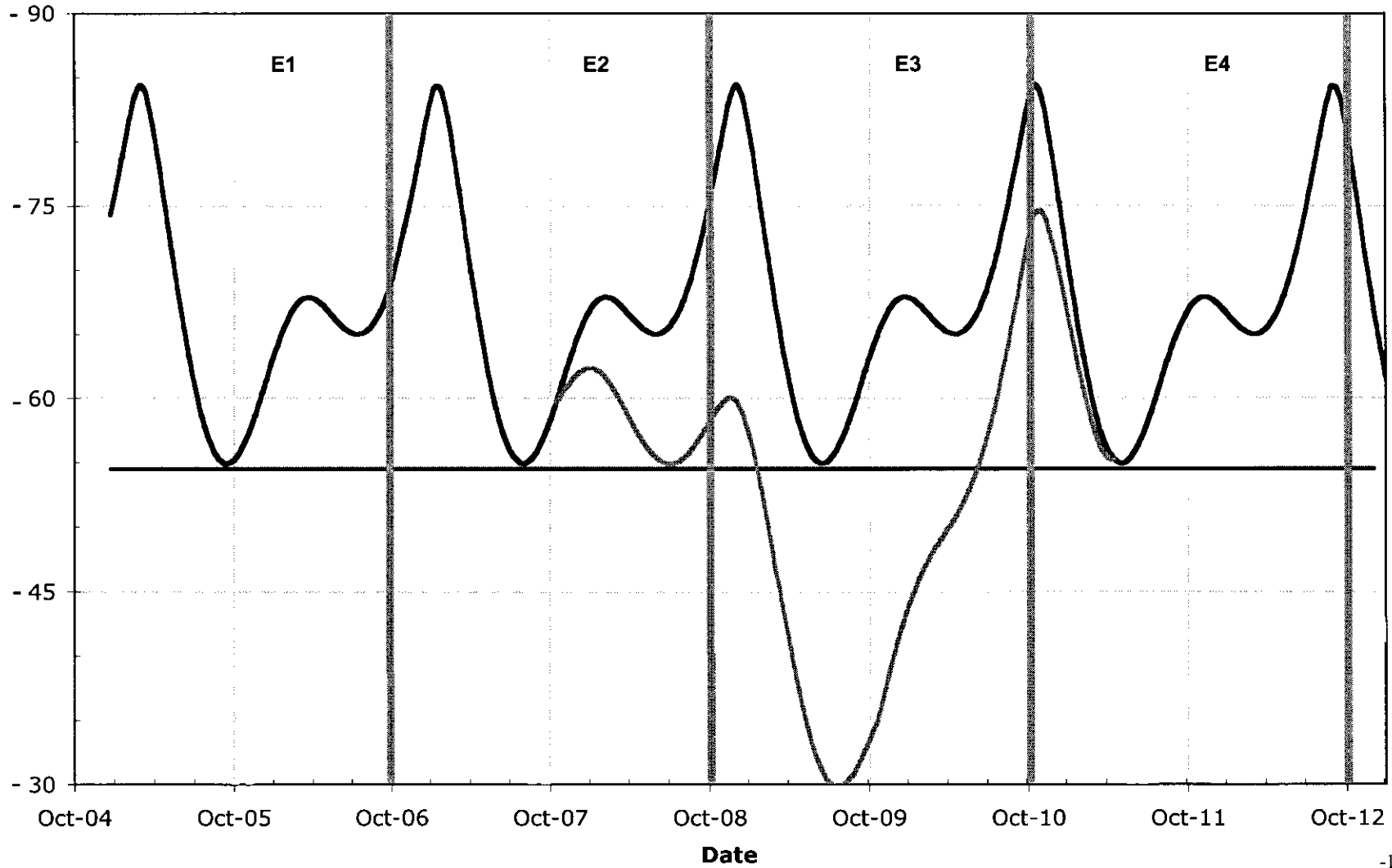




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E3 Example - Solar Beta Angle

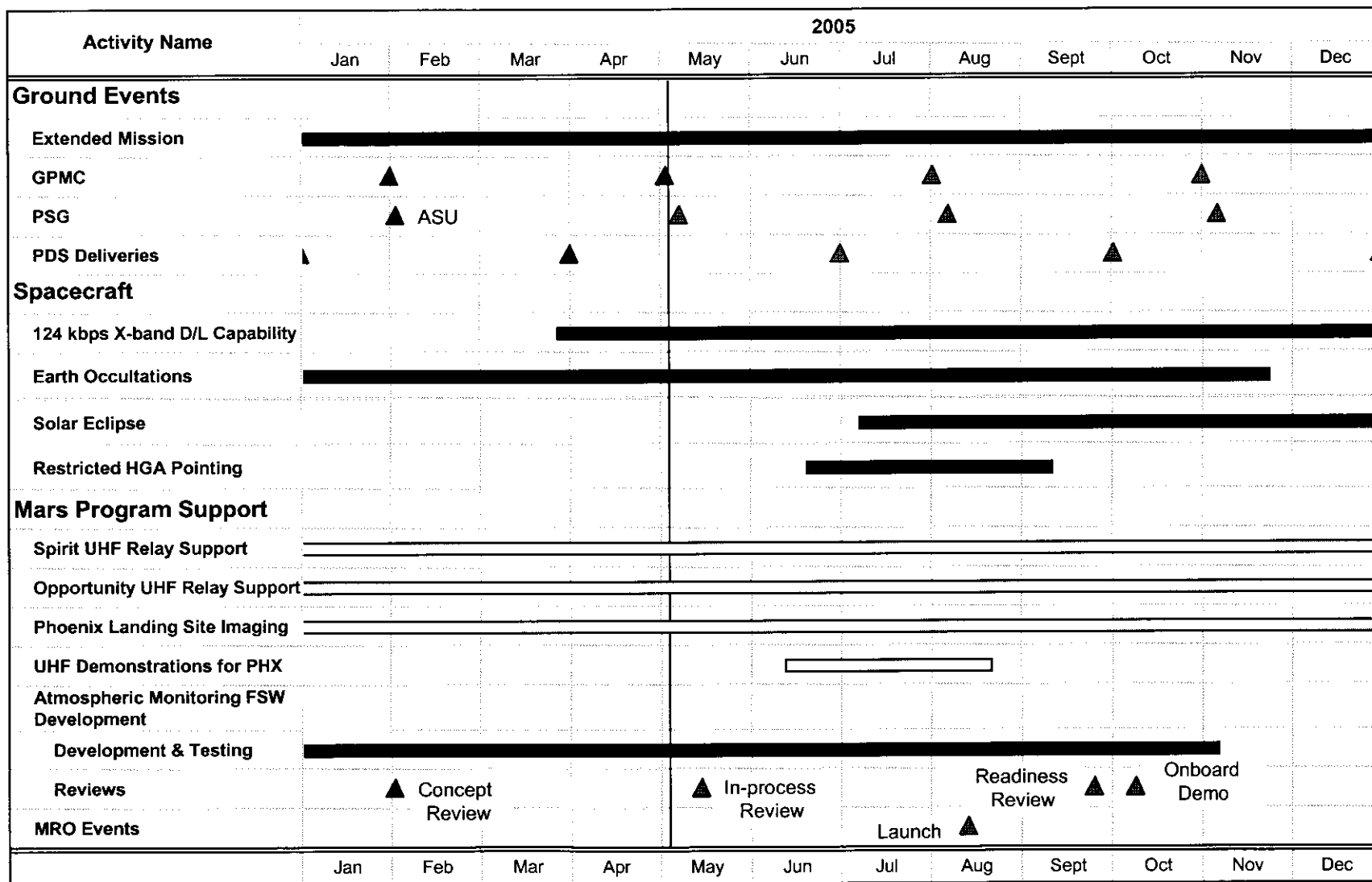




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One Year Rolling Schedule





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Mars Odyssey Long-Range Schedule

