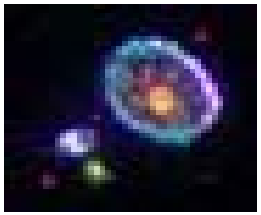
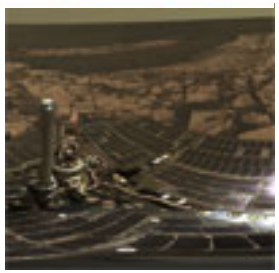
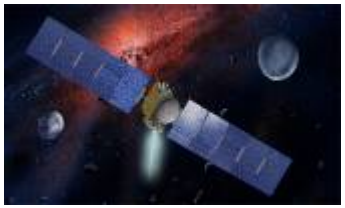
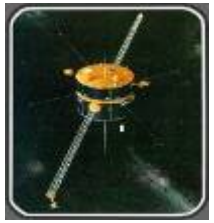
INTERPLANETARY NETWORK CUSTOMER FORUM

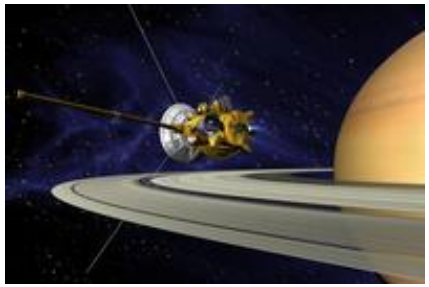


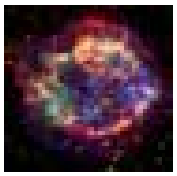






February 14, 2006





AGENDA

February 14, 2006

• Introduction	B. Weber	8:30
• Role Call and Overview	D. Morris	8:40
• NASA Headquarters Perspective – Science Mission Directorate	C. Holmes	8:50
• DSMS Commitments Office	E. Luers	9:10
• JPL DSMS Development Operations and Services Office	A. Bhanji / W. Sible	9:30
– DSN Implementation Plans FY06 – 07	J. Berner / S. Kurtik	9:40
– DSN Operations – Mini ACP	A. Berman	10:00
• New Or Modified Project Requirements		
– Venus Express Science Mission	D. Holmes	10:20
– Phoenix	J. Guinn	10:40
• Resource Allocation Review 2007-2009		
– Analysis & Recommendations	E. Hampton	11:00
– Responses	Projects	
– Discussion / Decisions	All	
• New Action Items & Summary	D. Morris	

CUSTOMER FORUM REPRESENTATIVES

Bill Weber	JPL	Director for Interplanetary Network Directorate
Claudia Alexander	JPL	Rosetta U.S. Project Manager
Cynthia Abramo	GSFC	STEREO, Kepler Project Representative
Al Bhanji	JPL	DSMS Development, Operations and Services Office
Pat Carr	ITT	ITT DSN O&M Program Manager
Albert Chang	JPL	Lunar-A and Hayabusa Project Representative
Pat Crouse	GSFC	Space Science Mission Operations Deputy Project Manager (ACE, Cluster II, Geotail, IMAGE, INTEGRAL, Polar, SOHO, Wind, WMAP)
Chad Edwards	JPL	IND Mars Network Office Manager
Jim Erickson	JPL	Mars Exploration Rover (Spirit & Opportunity) Project Manager
Donald Gates	Boeing	GOES Project Representative
Joe Guinn	JPL	Phoenix Project Representative
Mark Holdridge	APL	MESSENGER, New Horizons Project Representative
Dwight Holmes	JPL	Venus Express Project Representative
Chris Jacobs	JPL	Reference Frame Calibration Project Representative
Ben Jai	JPL	Mars Reconnaissance Orbiter Project Representative
Ed Luers	JPL	DSMS Commitments Office Manager

CUSTOMER FORUM REPRESENTATIVES (cont'd)

Bob Mase	JPL	2001 Mars Odyssey Mission Project Representative
Ed Massey	JPL	Ulysses/Voyager Project Manager
Bob Mitchell	JPL	Cassini Program Manager
Sophia No	JPL	Mars Express Orbiter Project Representative
Steve Ostro	JPL	GSSR Project Scientist
Marc Rayman	JPL	Dawn Project Representative
Maria Schellpfeffer	JPL	Mars Global Surveyor Project Manager
Bob Shendock	GSFC	ST-5 Project Representative
Martin Slade	JPL	GSSR Project Manager
Bob Wilson	JPL	Spitzer Space Telescope Project Manager
Pam Wolken	JPL	Radio Astronomy & Advanced Tracking and Observational Techniques Project Representative
Greg Wright	MSFC	Chandra Project Representative

Introduction

W. Weber

Roll Call and Overview

D. Morris

Why the Name Change?

- **Why Interplanetary Network Customer Forum?**
  - Focus on the Customers of the DSN
    - Provide a Setting that DSN Managers and Users Communicate Plans and Share Concerns
  - Deemphasize Scheduling as the Main Purpose
    - What About the Resource Allocation Review?
    - Now an Agenda Item of this Forum

Resource Allocation Review Status

- **Status of August 2005 RARB**
  - Utilized the Monthly Joint Users Resource Allocation Planning (JURAP) Meeting in July to Introduce the Material
    - Same Format as Today's Resource Allocation Review
    - Contention in 9 of 24 Months – 7 Approved; 1 Action Item
    - Presented Action Item at September JURAP
      - Approved the Remaining 2 Months Recommendations
- **August 2006 Resource Allocation Review**
  - Will Use JURAP Meetings As Necessary

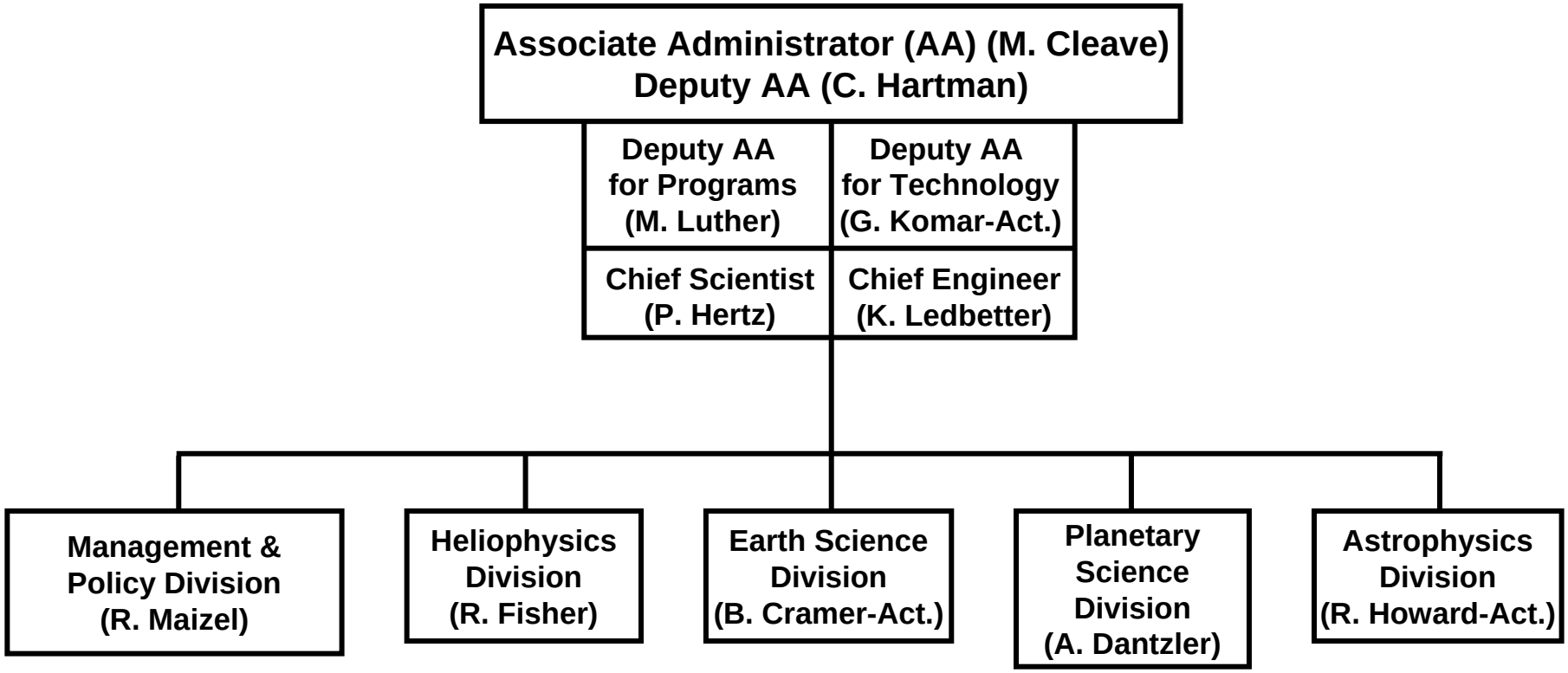
Views from Washington

Charles P. Holmes
Heliophysics Division
Science Mission Directorate

TOPICS

- New HQ organization
- New budget
- Senior Reviews
  - Results from the 2005 Heliophysics SR
- Status of IMAGE

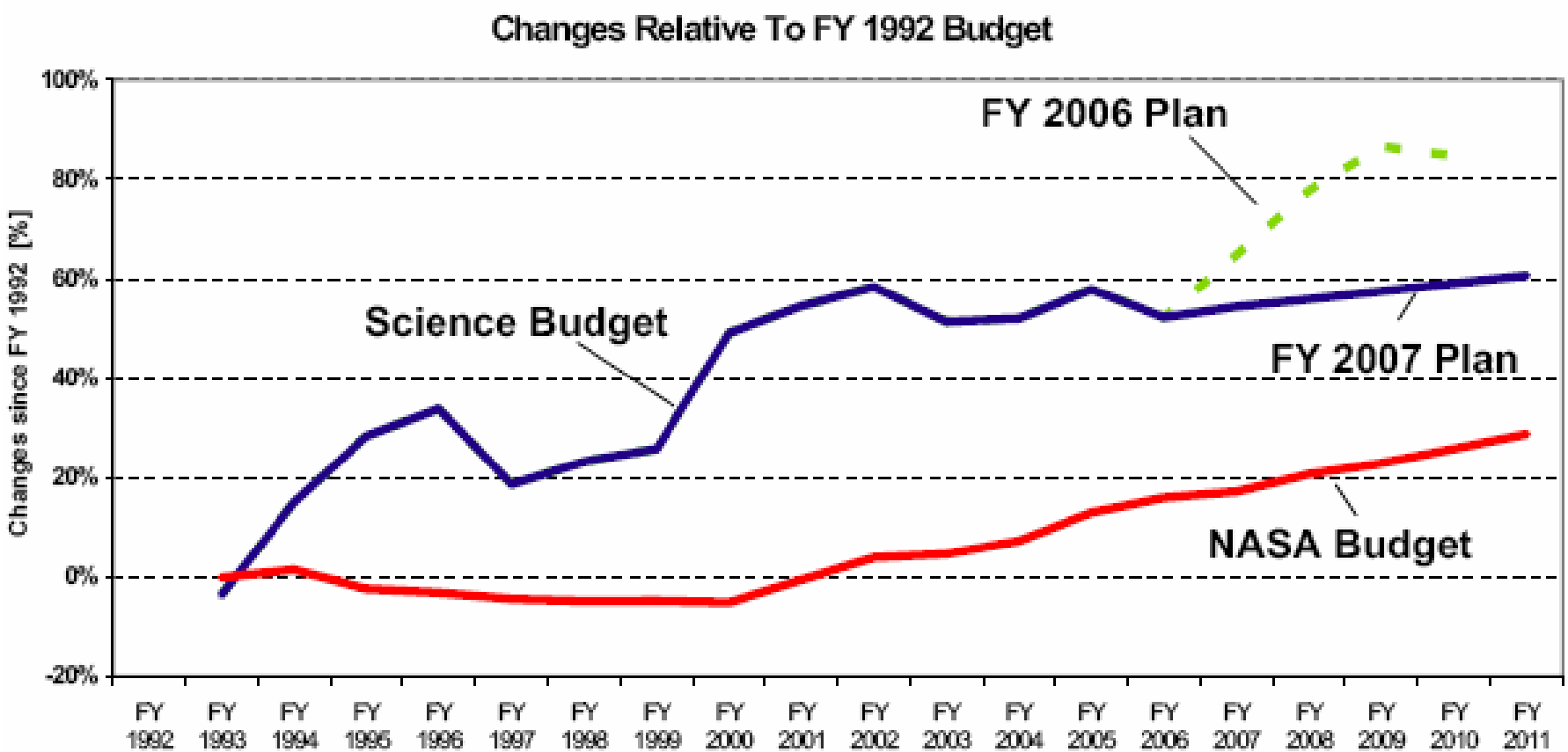
Science Mission Directorate Organization Chart



DSMS missions by SMD Division

- Planetary Science
  - Mars, Cassini, Messenger, Rosetta, Hayabusa, Venus Express, New Horizons
  - More Mars, Dawn, Selene, Juno, future Discovery and New Frontiers [next AO NET FY 08]
- Astrophysics
  - Chandra, WMAP, Spitzer, INTEGRAL
  - Kepler, JWST, SIM, Con-X, LISA
- Heliophysics
  - Voyager, Ulysses, SOHO, ACE, Polar, Cluster, Wind, Geotail
  - ST-5, STEREO, Sentinels, future MidEX [next AO NET FY 07]

Science Budget Growth History



- The rate of growth for Science previously planned for the five year runout from the FY2006 budget is not sustainable, given the priority to safely complete ISS assembly to fulfill International Partner agreements and retire the Shuttle, within the resources provided.
- Science growth is therefore moderated to 1.5% in FY 2007 and 1% thereafter.

NASA Authorization Act of 2005

- SEC. 304. ASSESSMENT OF SCIENCE MISSION EXTENSIONS.
  - (a) ASSESSMENT.–The Administrator shall carry out biennial reviews within each of the Science divisions to assess the cost and benefits of extending the date of the termination of data collection for those missions that have exceeded their planned mission lifetime.

Senior Reviews

- A "Senior Review" is a science program review within a science discipline:
  - 9th Astrophysics in April 2006.
  - 5th Heliophysics in November 2005.
  - 1st Earth Science in April 2005.
  - Planetary/Mars is under discussion within SMD.
    - In 2001, we held a "comparative science review" for Galileo, MGS, DS-1 & NEAR.
- Conducted as a science peer review and considers future science value / cost.
  - Operational values are considered independently.

Results of Heliophysics Senior Review

Mission	Launch	Termination resulting from SR	Programmatic Action
IMAGE	3/25/00	Dec 2005	Closing out mission
Polar	2/24/96	~ 2007	Ramp down with a focus on radiation belt measurements while s/c runs out of fuel.
Geotail	7/24/92	Sept 2008	Come back to next Senior Review.
Ulysses	10/06/90	Mar 2008	Terminate mission operations at end of 3rd solar pass.
Cluster	7/16/00	~ 2010	The 4 satelites re-enter ~2010.
ACE	8/27/97	> 2011	
SOHO	12/02/95	> 2011	Aggressively ramp down the mission to the "Coronagraph only" version. Terminate MDI after sufficient overlap with SDO/HMI.
Voyager	8/20/77	> 2011	Voyager 2 is approaching termination shock ~ 8 AU earlier than Voyager 1
Wind	11/01/94	> 2011	

Status of IMAGE

- IMAGE went silent on Dec 18, and no RF signal from it has been received since.
  - A Failure Review Board is underway to investigate the cause.
  - One failure/recovery scenario has been identified. It is possible that an SEU opened an SSPC, but that it is erroneously reading as closed, preventing onboard FDC s/w from restoring power to the transponder.
  - IMAGEs apogee will precess into extended eclipse in October 2007. IMAGE will suffer a power-reset, which may close the SSPC and restore power to transponder.
- It is expected that we will cease efforts to contact IMAGE when the FRB concludes it's investigation, and will resume efforts in mid-October 2007.

DSMS Commitments Office

E. Luers

INTERPLANETARY NETWORK CUSTOMER FORUM

DRAFT

911
DEEP SPACE MISSION SYSTEMS
Commitments Office

Edward B. Luers, Manager

Staff

Roger Bartoo, Staff Engineer(317)
David Morris, Staff Engineer
V. Rose Nadjarian, Secretary
Ronald A. Slusser, Staff Engineer
E. Diane von Delden, Secretary
Ellen M. Walsh, Program Resource Admin.(252J)
Eve M. Zimmerle, Secretary

Telecommunication & Mission Systems Managers (TMS)

Richard D. Benson	DEEP IMPACT, NEW HORIZONS, STEREO A/B
Eugene S. Burke	ACE, ACRIMSAT, GOES, HST, IMAGE, JASON, LANDSAT-5, MARS GLOBAL SURVEYOR, NOAA, TDRSS, WMAP
Albert F. Chang	ASTRO-E2, CLUSTER-II, GEOTAIL, HAYABUSA, LUNAR-A, POLAR, SELENE, SOHO, WIND
Daniel F. Finnerty	DAWN, MESSENGER, MSL, SPACE INTERFEROMETRY MISSION (SIM)
Ronald L. Gillette	CASSINI, CHANDRA/AXAF, JUNO
Dwight P. Holmes	INTEGRAL, MARS EXPRESS, ROSETTA, VENUS EXPRESS
Katherine I. Moyd	MRO, KEPLER
Peter T. Poon	ATOT, EVN and GLOBAL VLBI, GROUND BASED RADIO ASTRONOMY (GBRA), GOLDSTONE APPLE VALLEY RADIO TELESCOPE, GODR, GRAVITY PROBE-B, GSSR, ODYSSEY, REFERENCE FRAME CALIB., SPACE GEODESY, ULYSSES, VOYAGER INTERSTELLAR MISSION
Stefan Waldherr, Jr.	RADARSAT-S/X BAND, SPITZER, ST-5, STARDUST
Byron G. Yetter	OPPORTUNITY ROVER, PHOENIX, SPIRIT ROVER

Future Missions Planning

Warren L. Martin, Manager

Andrew Kwok
Katherine I. Moyd (Add'l Duty)

Edward B. Luers, Manager
DSMS Commitments Office

Michael J. Rodrigues, Manager
DSMS Program Office

William J. Weber, Director
Interplanetary Network Directorate

DSMS Commitments Office

- **Challenge of the Office**
  - Improve and simplify the commitments process
  - Over the next 6 months I plan to meet with every Commitments Office customer
- **Customer Forum**
  - This forum will be continued on a yearly basis
  - Its imperative that our customers and the DSMS Management get together so we can keep each other updated and air our concerns if necessary

JPL

DSMS

Development Operations and Services Office

W. Sible

Agenda

- Organization Overview
- Challenges & Progress

DDOSO Organization Concept

- **Operations and Engineering integrated together**
  - Vertical integration (requirements, design, deployment, operations, and retirement)
  - DSCC operations and maintenance, and JPL Central operations, will be involved in the ground floor of developments, both new and follow-on
    - Ensures operations needs are addressed (e.g., operations requirements, desired real-time metrics, system maintainability and ease of operations are included in designs)
    - Have a direct input into the decisions on resolving problems
- **Four main offices organized to provide a "cradle-to-grave" process flow**
  - Each office is responsible for the development, implementation and delivery, operations, and maintenance of their areas of concern
  - Each office can determine how a problem should be corrected (updates, operational procedures, training, etc.)
  - Offices work together on issues that span multiple offices

DDOSO Organization Concept (cont.)

- **Additionally, there are two key support groups**
  - Development and Operations Engineering Staff
    - Responsible for technical coordination across the offices
    - Lead for cross office problem investigation
    - Across the board interface for operations and maintenance
  - Resource Manager
- **All offices have the following functions:**
  - Requirements analysis
  - Low level requirements generation
  - Development of trade-offs and cost estimating
  - Selection of program work content in response to SE requirements
  - Implementation and delivery
  - Equipment operations and maintenance
  - Monitoring of performance via DR (Discrepancy Report) analysis and mission feedback
- **ITT (main O & M contractor) engineers are integrated into this structure**

DSMS Development, Operations and Services

Office 920

DSMS Development, Operations and Services Office

Alaudin Bhanji, Mgr
Wayne Sible, Deputy Mgr

ITT Program Manager, P. Carr
Goldstone (ITT) Site Mgr., S. Giroux
Canberra Director, P. Churchill
Madrid Director, J. Gimeno

Admin & Secretarial Support

M. Romejko, Sr. Administrator
L. Avila, 920 Office Secretary

Division Representatives

Division 31	B. Vargo
Division 33	J. Patterson
Division 34	E. Maize
Division 37	D. Horgan

Business Office Manager

M. Hansen, Mgr (2x)

Development & Operations Engineering Staff

J. Berner, Dev & Ops Chief Engr
M. Levesque, Chief S/W Engr (313)
J. Wackley, Chief Reliability Engr
S. Kurtik, Mission Support Mgr
J. Osman, DSN O&M CTM
A. Salazar, DSN TMR
K. Kimball, Process Eng (912)

921
Service Management

Allen Berman, Mgr
Pat Beyer, Deputy Mgr
Jim Hodder, Asst. Mgr, Ops

922
TT&C E2E Data Services

Ana Guerrero, Mgr
Miguel Marina,Deputy Mgr

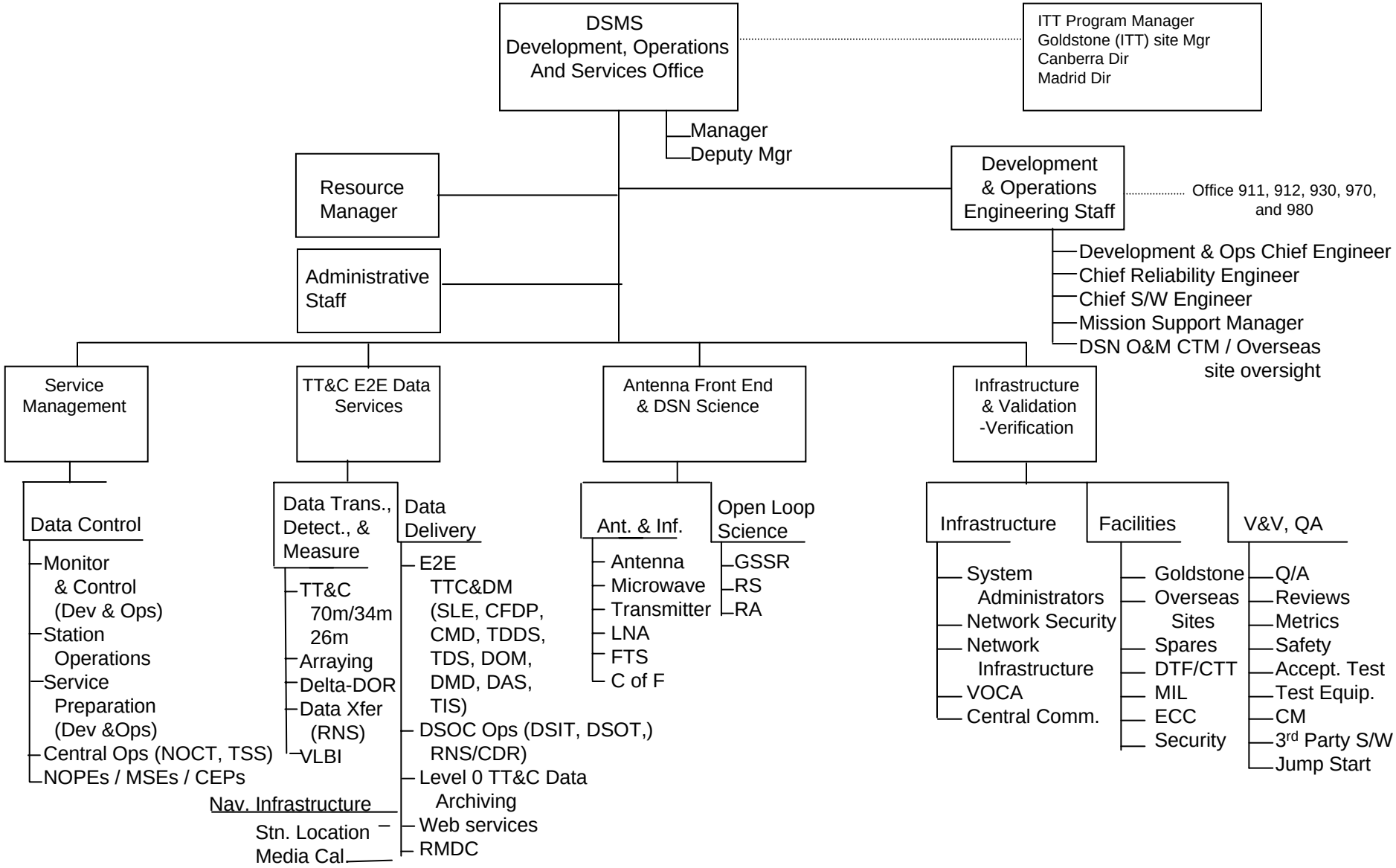
923
Antenna Front End & DSN Science Support

Dennis Buck, Mgr
Wendy Hodgin, Deputy Mgr

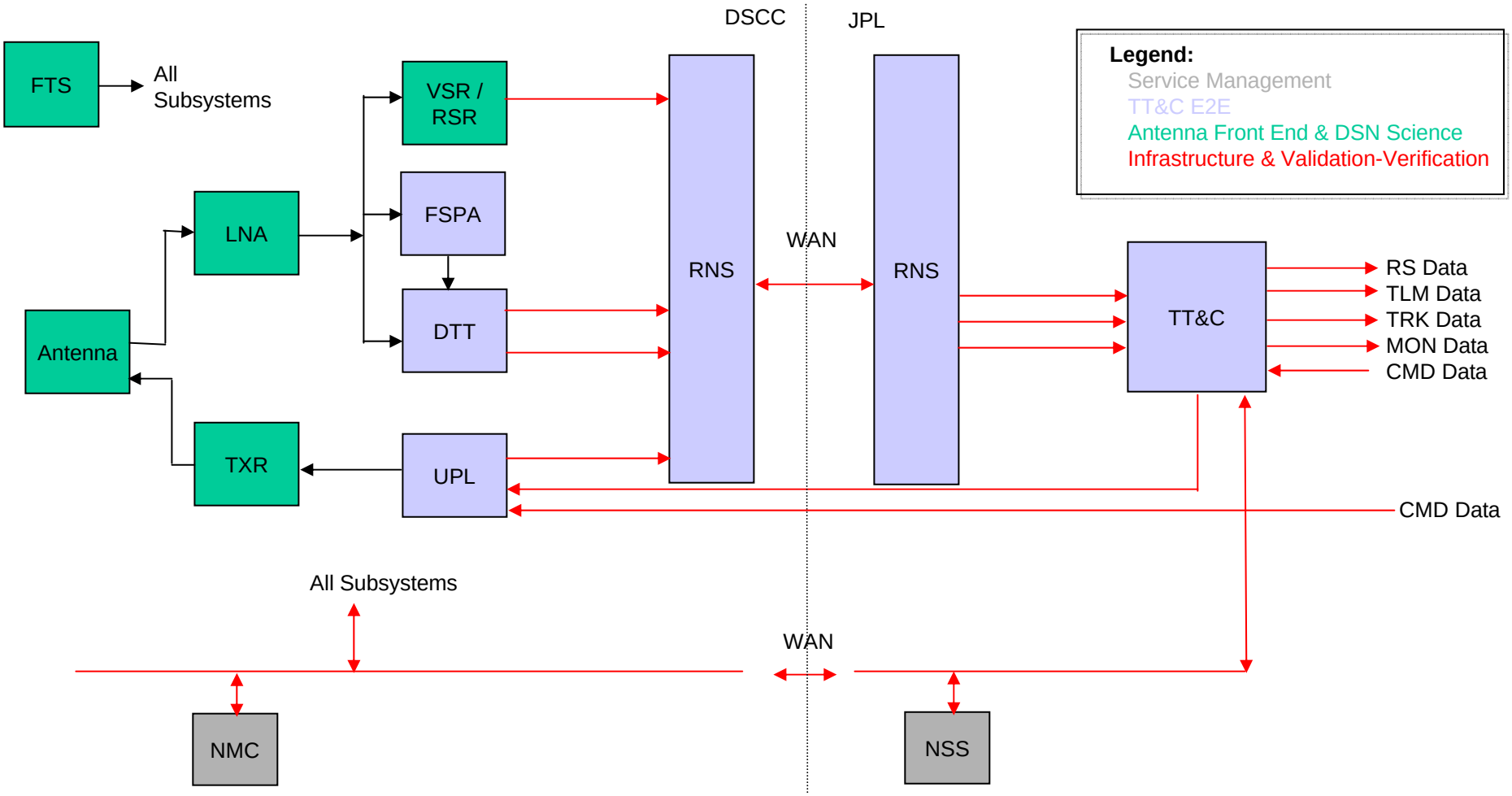
924
Infrastructure - Verification & Validation

Chuck Klose, Mgr
Dave Recce, Deputy Mgr

INTERPLANETARY NETWORK CUSTOMER FORUM



Office Mapping to DSN High Level Diagram



Challenges

- **Keeping the DSN "green" within the current budget allocation while meeting:**
  - Project commitments
  - Health, Safety, and Environment regulations
  - New or updated NASA Policies (S/W, IT Security, System Engineering, etc.)

Approach

- **Station Electronics**
  - Engineering / Implementation reprioritized to focus on obsolescence avoidance and fixing of current equipment
- **Antenna**
  - 70m / 34m antennas to be refurbished to extend life time
  - 26m network to be decommissioned – no refurbishment
- **Facilities**
  - Infrastructure (water, roads, power) response changed to reactive mode from proactive mode
    - New plan will fix critical infrastructure elements as they fail
      - Use RCM methodologies to determine cost efficient maintenance and equipment disposition (repair, replace, upgrade) for appropriate elements
    - Will spread out funding (and fixes) over number of years

Approach (cont.)

- **Power Generation**
  - Developing options for addressing aging and environmental issues
  - Generators will primarily be used when commercial power fails
    - May not automatically use generators for all Level 1 events
    - Decreased use of generators will extend their lifetime, helping with the aging issue, and meet environmental requirements
- **Power Distribution**
  - Power system studies by outside consultant are underway at all complexes

Approach (cont.)

- **Infuse Reliability**
  - Per NASA policy, the DSN is transitioning to follow Reliability Centered Maintenance (RCM) concepts.
    - The implementation of RCM to the DSN is incomplete at this time; however, full implementation of RCM will result in economic and reliability improvements to the DSN. The elements of RCM include Corrective (i.e. reactive) and Preventive (i.e. proactive, preventive and predictive) maintenance.
  - A Reliability Modeling task is underway by the Aerospace Corporation. Once the model is developed, it will be kept current with evolving DSN upgrades and asset improvements, and will be used to support the RCM program.

DSN Implementation Plans FY06 - 07

Jeff Berner / Susan Kurtik

Agenda

- Downtimes
- Key upgrades
- 26m subnet plans
- New maintenance plan

Downtimes

- Goldstone
  - DSS-15, Antenna Drive Cabinet Replacement
    - 9/4/06 to 10/8/06
- Canberra
  - DSS-45, Antenna Controller Replacement
    - 10/8/06 to 12/10/06
  - DSS-45, Antenna Drive Cabinet Replacement
    - 8/27/06 to 9/30/06
- Madrid
  - DSS-63, Antenna Controller Replacement
    - 5/22/06 to 10/1/06
  - DSS-63, Hydrostatic Bearing Replacement
    - July-Sept, 2007
  - DSS-65, Antenna Drive Cabinet Replacement + 200w Uplink
    - 2/26/07 to 5/1/07

Key Upgrades

- These are upgrades that may require project participation in the form of PITs or may require downtime for installation
  - Dates provided represent start of operations
  - Project testing would need to be scheduled for dates prior to operational usage

Key Upgrades (Cont.)

- Service Preparation Subsystem
  - Replaces existing NSS
  - NSS will be prime with SPS backup on 7/20/06
  - SPS prime (with NSS as backup) 9/25/06
- DSN TT&C Subsystems (Uplink and Downlink)
  - Anomaly corrections
  - Consolidates three Receiver CPUs to one Power PC
  - Adds PN Ranging for demonstration
  - Delivery review 9/15/06
- Ground Data Delivery Subsystem, Phase 1B
  - Upgrades to existing RNS and CDR
  - Provides capability to support MRO Primary Science Phase
  - Operational May - July, 2006 (depends on STEREO launch schedule)

Key Upgrades (Cont.)

- AMMOS TTC Subsystems
  - Following versions are planned:
    - V30.0, operational May – June, 2006
      - Phoenix, MSAP, & Kepler adaptations
      - CFDP/FDM operability improvements
      - Gateway SLE RAF/RCF Service adaptations
      - Initial Linux support
    - V30.1, operational November – December, 2006
      - Features TBD
    - V30.2, operational May – June, 2007
      - Features TBD
- 200W S-band Transmitter HEF
  - Adds 200 W S-band uplink to DSS-45 & -65
  - DSS-65 operational May, 2007
  - DSS-45 operational October, 2007

26m Subnet Plans

- The 26m subnet is planned on being decommissioned
  - Acquisition aid antennas will either be moved to the HEF antennas or be provided as stand alone antennas
  - DSS-27 has been upgraded to support SLE and offload DSS-16
  - 200 W S-band transmitters will be added to DSS-45 & -65 to help offload DSS-46 & -66, respectively
- DSS-16 is not schedulable anymore
  - Exception for initial acquisition support (until acquisition aid antenna is moved or replaced)
  - Special support for GOES-N launch plus first 3 weeks has been negotiated
- DSS-46 & -66 are planned to go down in late FY08
  - Dates still to be determined

New Maintenance Plan

- A new approach to maintenance of the DSN will be put into effect in FY07
- Key points:
  - Maintenance will have priority over Level 3 events
  - Antennas will undergo periodic “depot” level maintenance
    - Over an approximate 3 to 4 year period, each antenna will be taken down for 1 month for maintenance, spares checkout, etc.
  - Complexes will have periodic complex-wide downtimes for maintenance of facilities infrastructure, such as power systems

The 2006 "Mini-ACP"

A. Berman

The 2006 "Mini-ACP"

- **The 2003/2004 Activity Contention Period [ACP] was by far the most intense period of Mission Critical Events in the 41-year-history of the DSN.**

- **In mid-2005, we realized that early 2006 was shaping up as a very busy period for the DSN, not nearly on the level of the ACP, but very, very busy in its own right.**
  - Hence, we coined the short-hand term "Mini-ACP"

The 2006 "Mini-ACP" (cont'd)

- **Originally, the Mini-ACP had 6 Major Mission Critical Event Phases in a three-month period:**
  - New Horizons Launch
  - Stardust Return to Earth
  - ST-5 (Triple Nanosatellite) Launches
  - MRO Mars Orbit Insertion [MOI]
  - Venus Express [VEX] Venus Orbit Insertion [VOI]
  - STEREO A&B (dual) Launches

The 2006 "Mini-ACP" (cont'd)

- **Subsequently, the STEREO Launches have slipped from April to June, providing some relief at the tail end of the Mini-ACP**

Mini-ACP (Originally Jan – Apr 2006)

MISSION	UTC Start	Jan	Feb	Mar	Apr	May	Jun
New Horizons	Jan ~~11~~ 19	Launch					
Stardust	Jan 13	Trajectory Correction Maneuver 19 [TCM-19]					
Stardust	Jan 14	Sample Return Capsule [SRC] Release					
ST-5 (3 S/Cs)	Feb 28		Launch				
MRO	Mar 9 -10			TCM–5A & 5B			
MRO	Mar 10			Mars Orbit Insertion [MOI]			
VEX	Apr 11				Venus Orbit Insertion [VOI]		
STEREO A&B	~~April~~ Jun 23						Launch

February 14

New Horizons

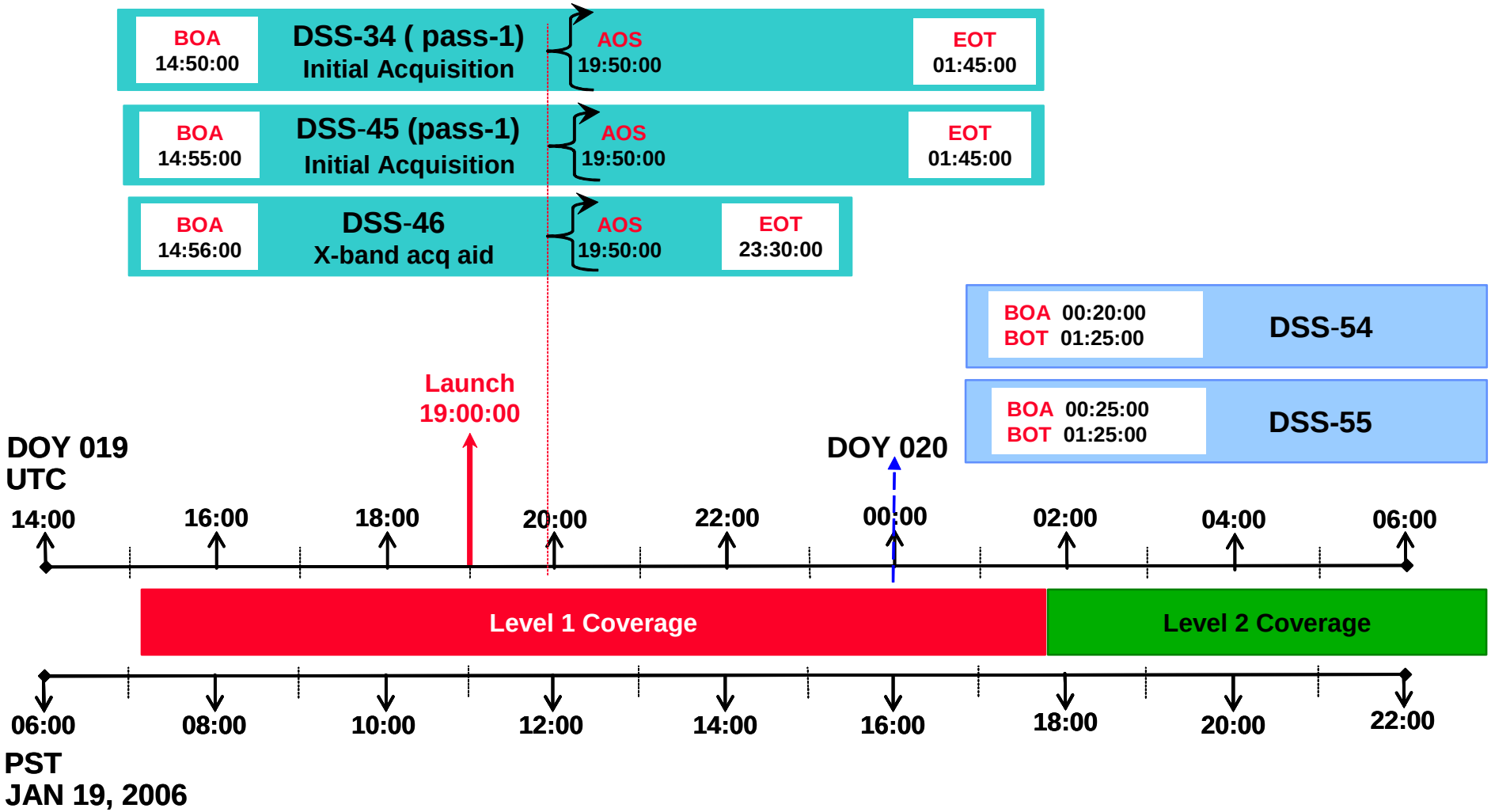
- **Launch**
  - Original Open Window—January 11
  - First Attempt: January 17—Scrubbed due to high wind
  - Second Attempt: January 18—Scrubbed due to APL power failure
  - Third Attempt: January 19—Successful!

New Horizons (cont'd)

- **DSN Challenges**
  - Very rapid initial acquisition and establishment of two-way communications; of particular concern because of the nuclear payload

√ Challenge met—rapid and routine initial acquisition and establishment of two-way communications at Canberra

New Horizons Timeline



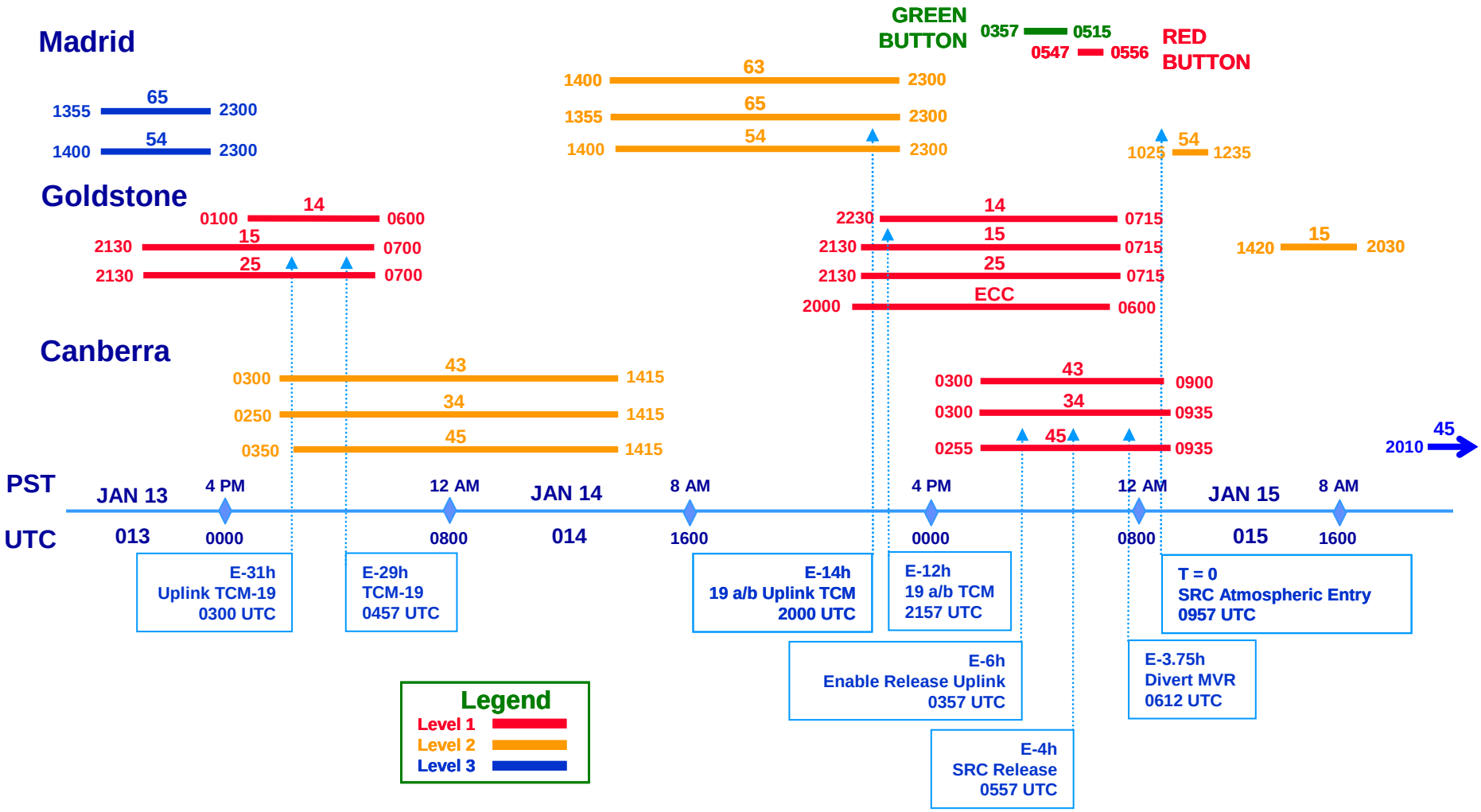
Stardust

- **Final TCM and SRC Release Phase—January 13-15**

- **DSN Challenges**
  - Ultra-reliable command capability during "Green" and "Red" Button Events just prior to Release

√ Challenge met—Command capability provided by and/or available via multiple antennas at both Goldstone and Canberra

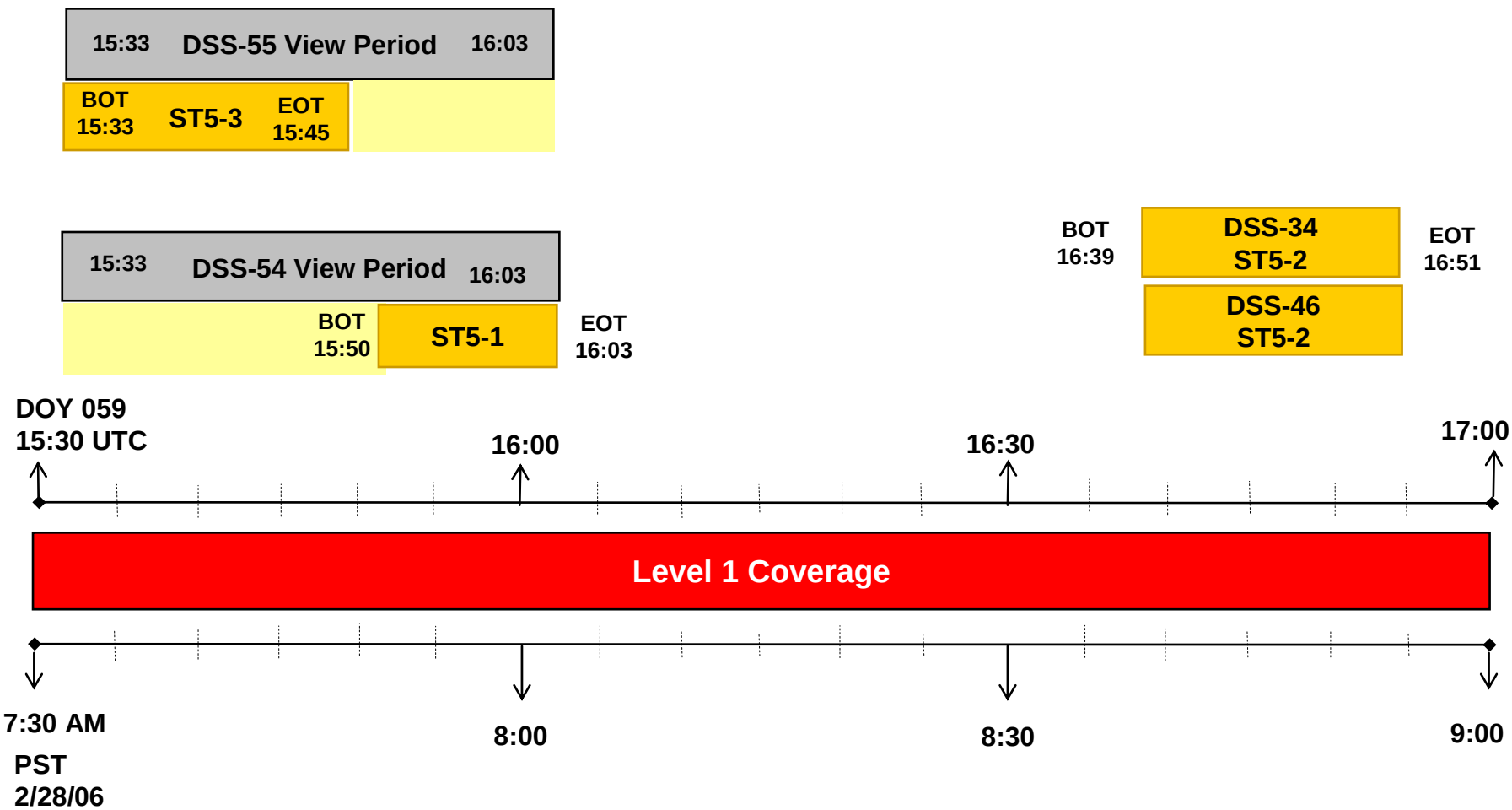
Stardust Timeline



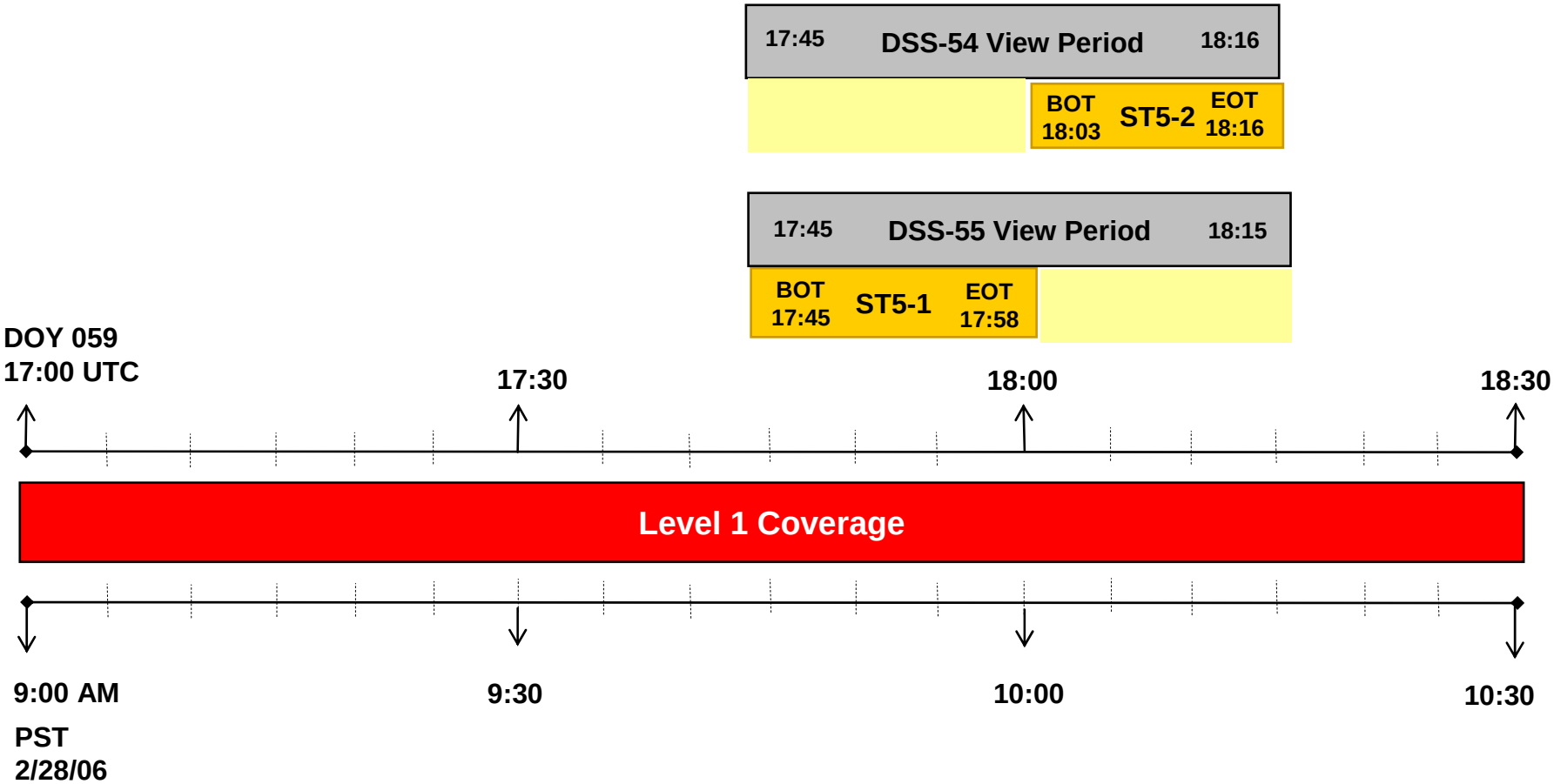
Space Technology 5 (ST-5)

- **Launch—February 28**
  - 3 Nanosatellites in Low Earth Orbit
- **DSN Challenges**
  - Pegasus Launch—Possible large injection uncertainties
  - Low Earth Orbit not optimum for large DSN antennas [High Angle Rates and very short Viewperiods]
  - Near Earth X-Band Frequency—Excludes 34m HEF Subnet Uplink

ST-5 Timeline



ST-5 Timeline (cont'd)

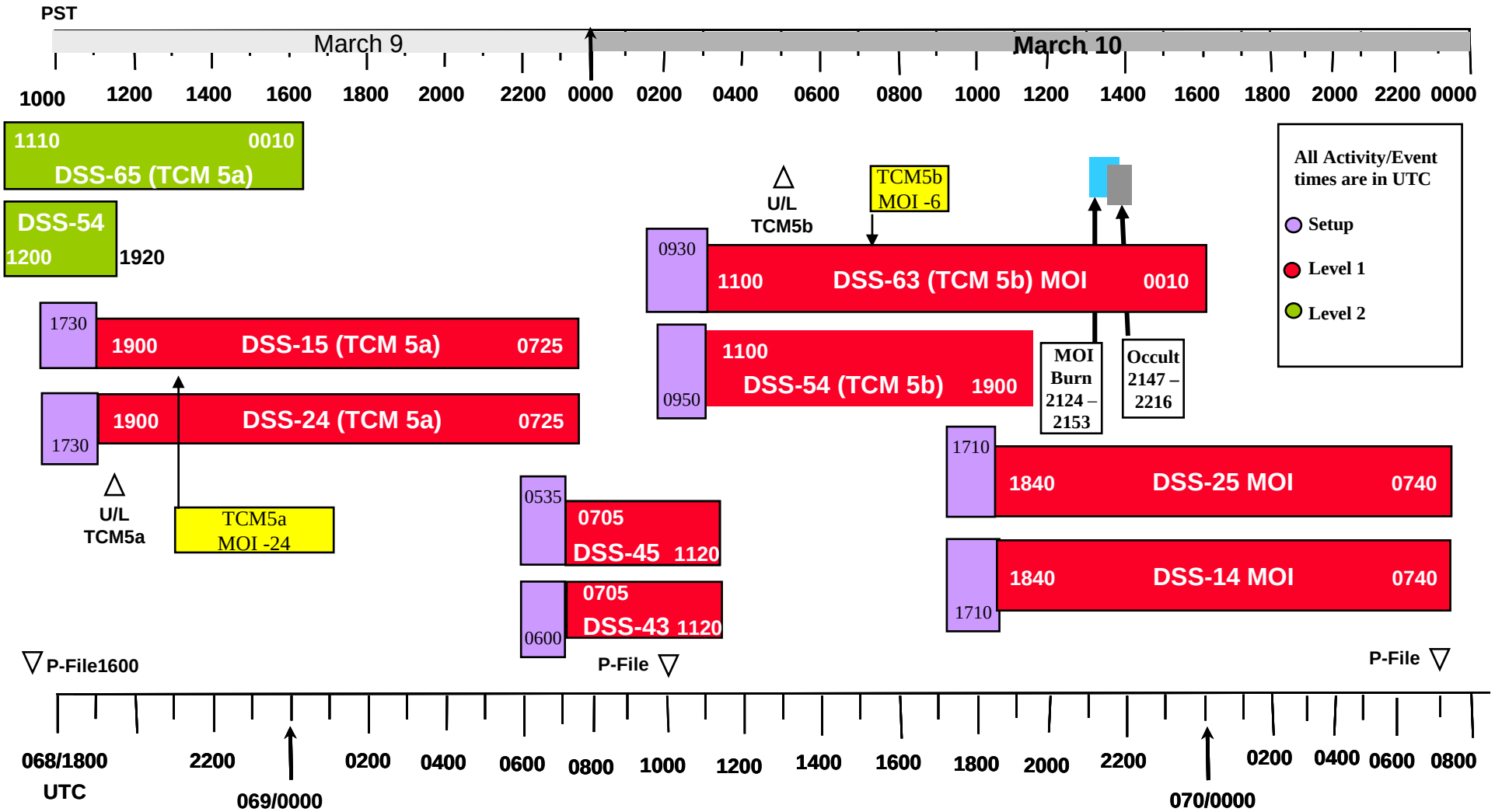


Mars Reconnaissance Orbiter

- **Final TCMs and MOI—March 9-11**

- **DSN Challenges**
  - Provide very high accuracy radio metric data prior to MOI
  - Provide ultra-reliable command service for TCM-5A & TCM-5B (collision avoidance) Opportunities

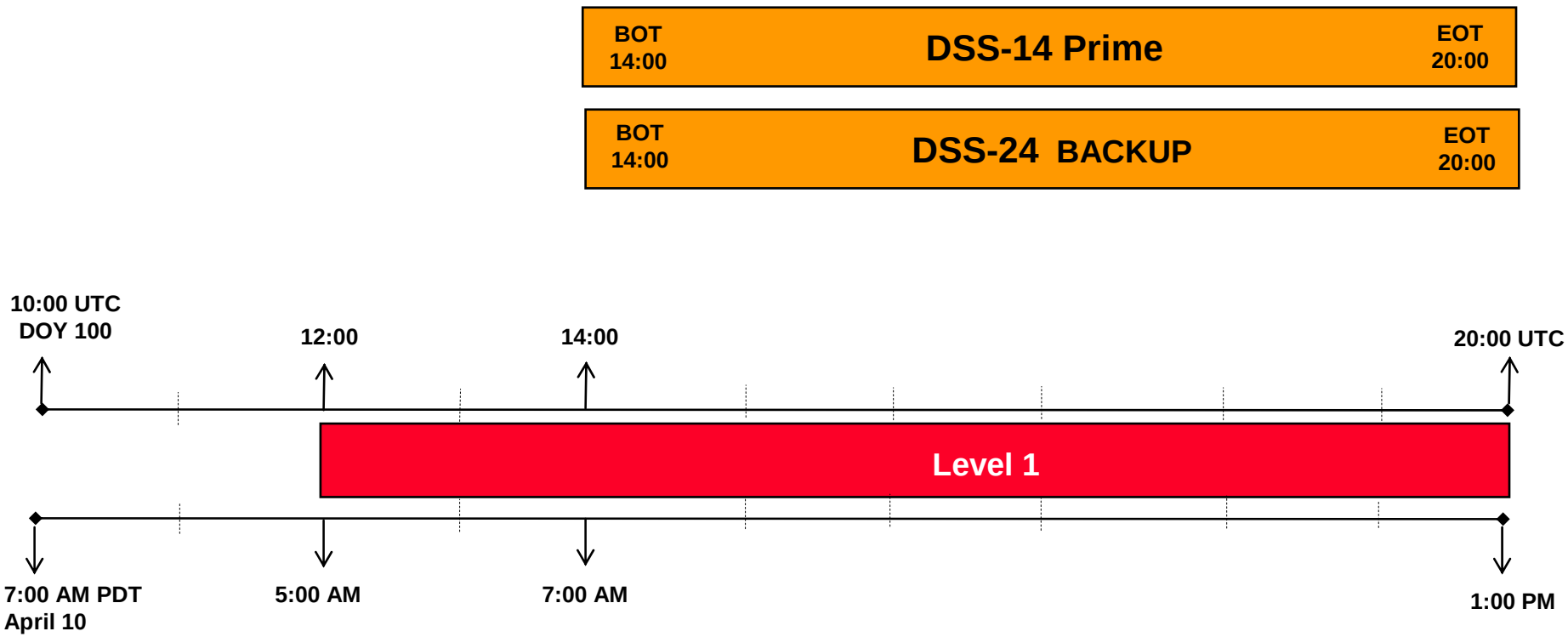
MRO Timeline



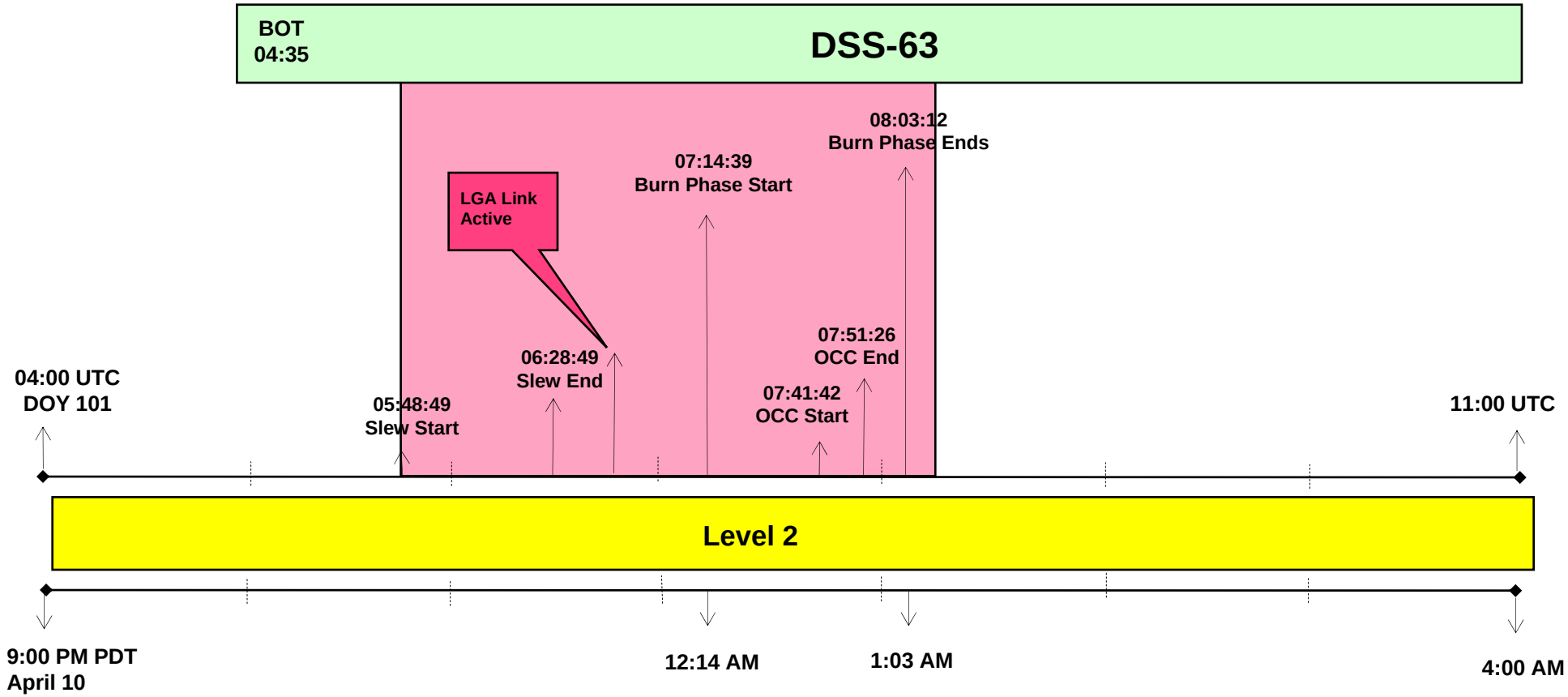
Venus Express

- **VOI—April 11**
- **DSN Challenges**
  - Weak signal [Spacecraft on Low Gain Antenna]—only a single 70m in view; therefore, dependent on a single antenna
  - S-Band—Therefore, no 34m Antenna Arraying as a possible backup

Venus Express Timeline



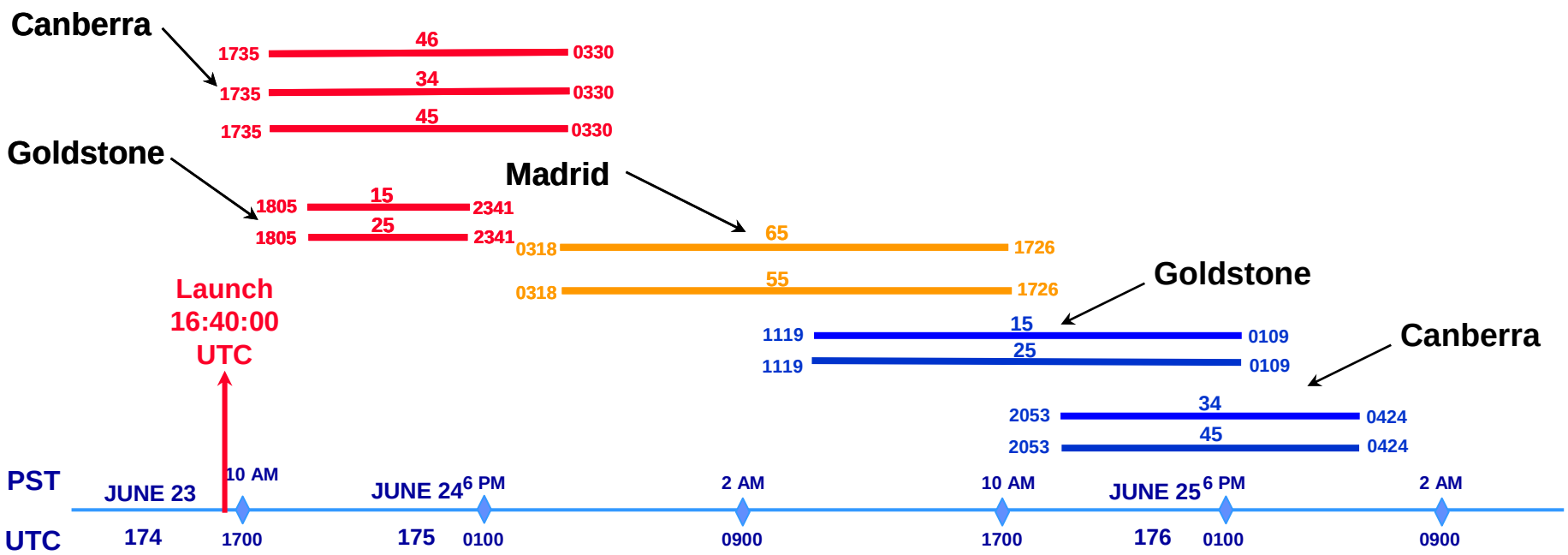
Venus Express Timeline (cont'd)



STEREO

- **A&B Spacecraft Launches—June 23**
- **DSN Challenges**
  - Simultaneous Initial Acquisitions for two Spacecrafts at a single complex [Canberra]
  - Only two 34m antennas in Canberra; no backup antennas!

STEREO Timeline



Legend
Level 1
Level 2
Level 3

Venus Express

D. Holmes / T. Thompson

Agenda

- Mission Overview
- Science Instruments
- Science Goals
- DSN Support

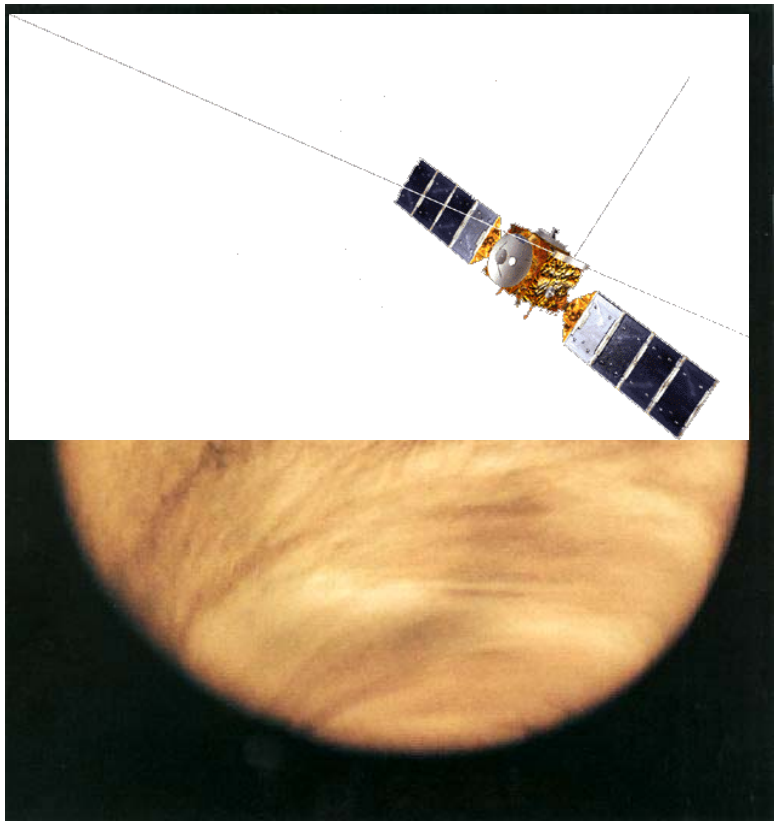
Mission Overview

- **ESA's Venus Express Mission will revolutionize our understanding of the evolution of the Venusian atmosphere.**
- **ESA's Venus Express Mission satisfies many of the objectives identified in the Next Decadal Study**
- **Its synergistic set of experiments measure key aspects of Venus encompassing:**
  - The surface,
  - The middle and upper portions of the Venusian atmosphere,
  - The interaction between the Venusian atmosphere and the solar wind.
  - Venus Express is an important pathfinder for Venus Sample Return Mission

Mission Overview

THE VENUS EXPRESS MISSION

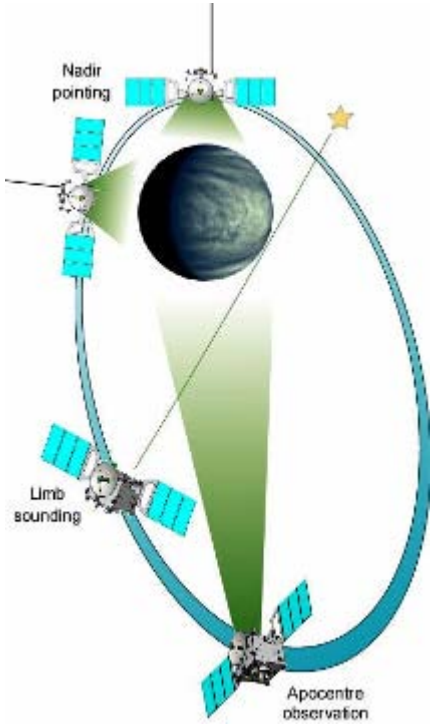
LAUNCH - 11/05
DONE



ARRIVAL - 04/06
Coming up

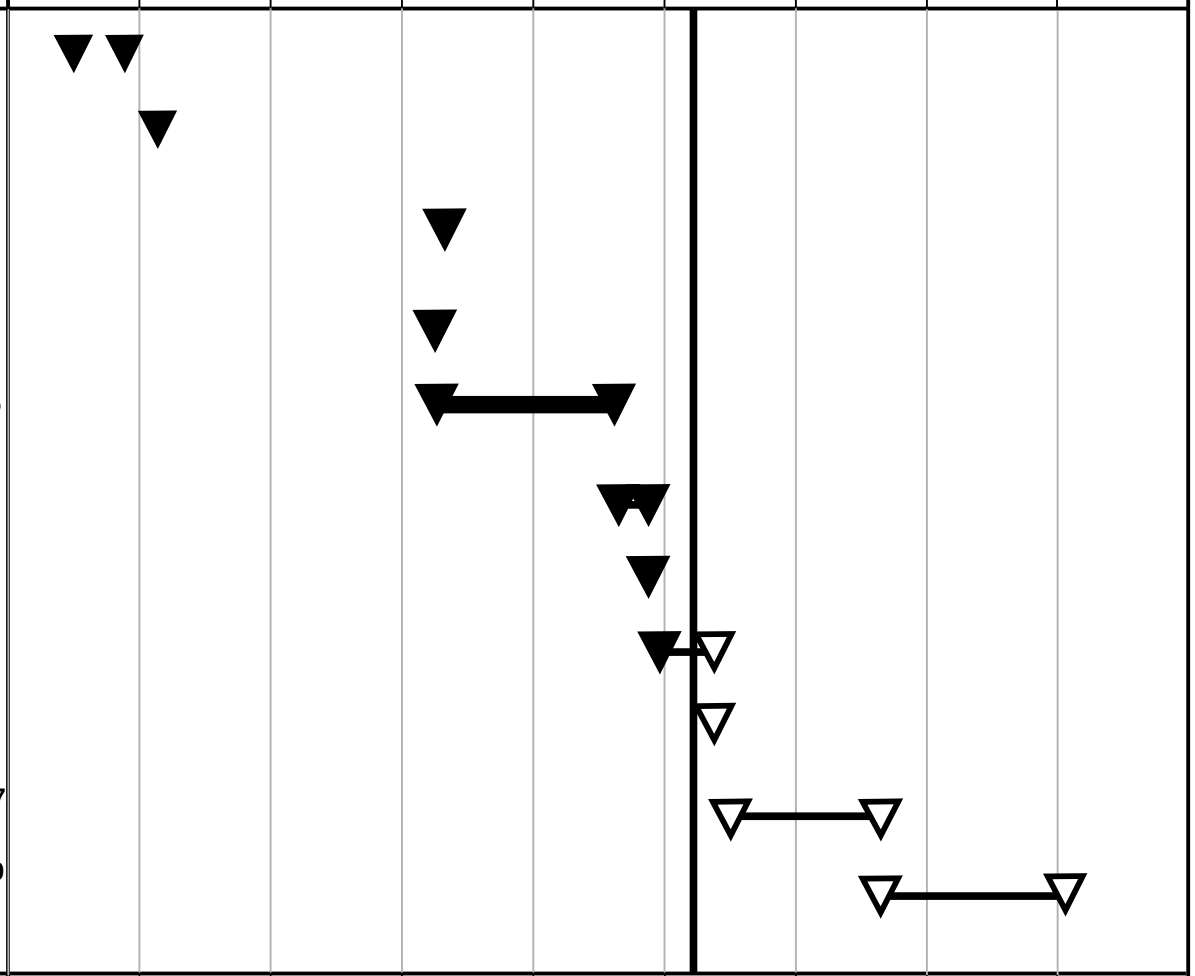
1 Venusian year = Earth 224 days

Prime Mission =
2 Venusian Years



Mission Overview

ACTIVITY	DATES
ESA Selection	Jul – Nov 2001
Preliminary Design Review	Jan 2002
Critical Design Review	Mar/Apr 2004
Payload Delivery	Mar 2004
Spacecraft integration	Mar '04 – July '05
Launch Campaign	Aug – Nov 2005
Launch (Nov 2005)	Nov 2005
Earth Venus Cruise	Nov '05 – Apr '06
Venus Orbit Insertion	Apr 2006
Prime Mission	Jun '06 – Sept '07
	Sept '07 – Jan '09



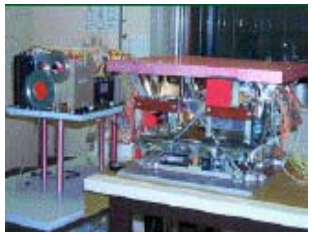
Extended Mission	DATES	2001	2002	2003	2004	2005	2006	2007	2008	2009

Mission Overview

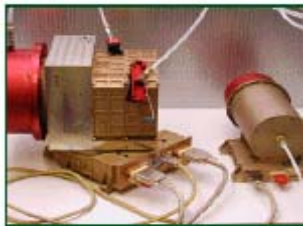
- **Current Status**
  - Venus Express Launch, although delayed from late October to November 9th was flawless.
  - All spacecraft operational systems have successfully been commissioned.
  - All Science Instruments except PFS were successfully commissioned in late 2005. The PFS anomaly is attributed to a thermal problem (too cold) that is expected to disappear at Venus.
  - Spacecraft operations have been basically flawless, no safe-modes. Main engine calibration to be conducted this week.
  - Arrival/VOI will be Tuesday, April 11, 2006 (about 8 AM in Europe, which translates to midnight local)

Science Instruments

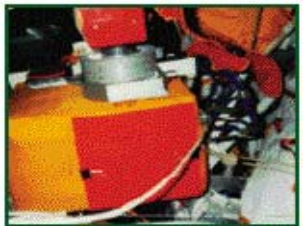
VENUS EXPRESS INSTRUMENTS



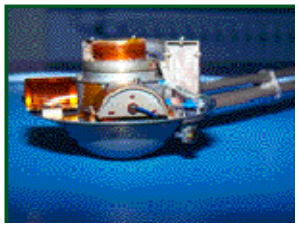
VIRTIS
P. Drossart, Obs. Meudon (FR)



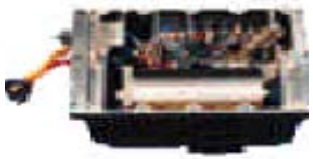
ASPERA
S. Barabash, IRF Kiruna (SE)



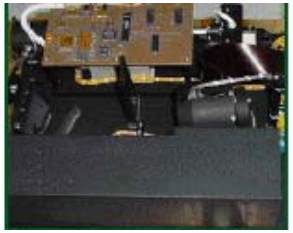
PFS
V. Formisano, CNR Rome (IT)



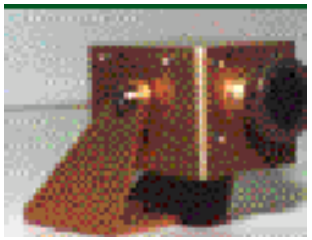
MAG
T. Zhang, OAW Graz (AT)



VeRA
B. Häusler, Univ.BW München (DE)



SPICAV
J-L.Bertaux, CNRS Verrières (FR)



VMC
W. Markiewicz, MPAe Lindau (DE)

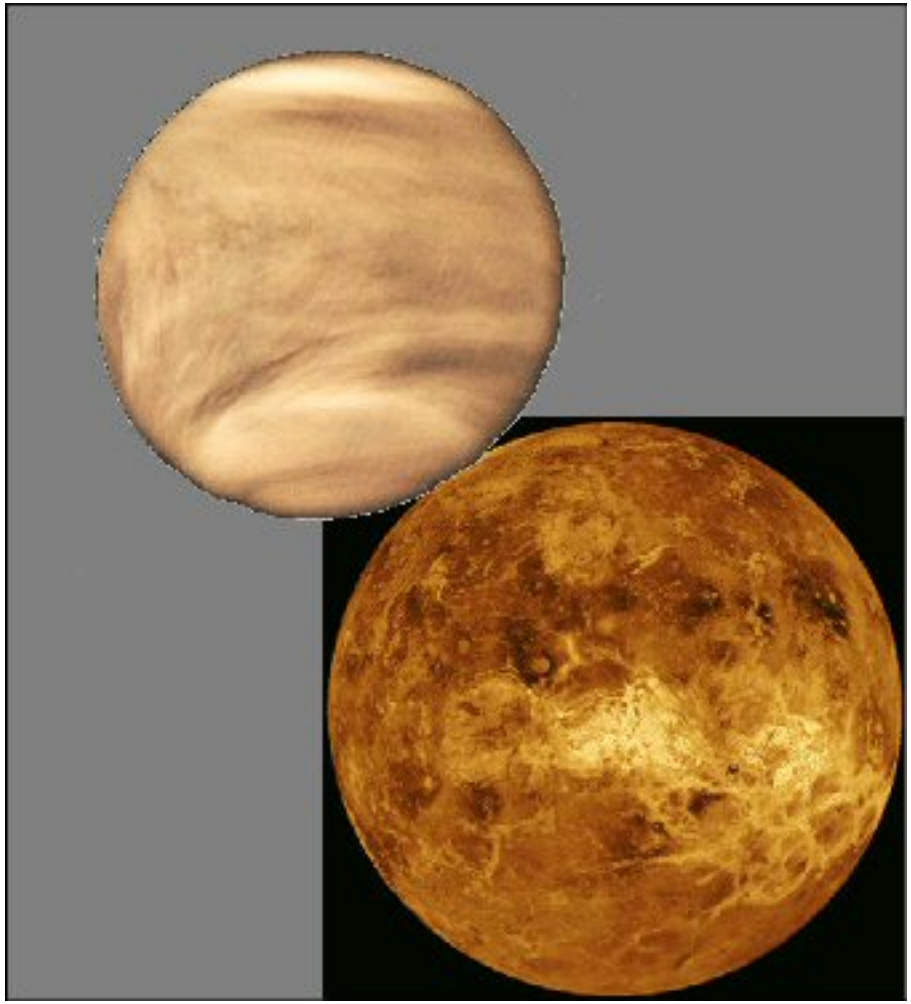
Science Instruments

Mars Express Payload		Venus Express Payload	
Acronyms	Instruments	Acronyms	Instruments
Obiter			
HRSC	High-resolution stereo imager		
OMEGA	IR mineralogical mapper		
MARSIS	Subsurface sounding RADAR		
PFS	Planetary Fourier Spectrometer	PFS	Identical instrument
SPICAM	UV and IR atmospheric spectrometer	SPICAV	Improved IR channel
ASPERA	Energetic neutral atom analyser	ASPERA	Identical instrument
MaRS	Radio Science	VeRA	Upgraded with USA
		VIRTIS	VNIR-SWIR special imager (Rosetta)
		VMC	UV-VIS global imager (new)
		MAG	Magnetometer (new)
Lander			
Beagle-2	Suite of imagers, chemical analysers, robotic devices, & meteo sensors	(H) Potentail replacement by descent probe under evaluation as a collaboration with Russia	
TOTAL MASS(kg)	175	104	

Science Goals

MAJOR SCIENCE GOALS

- Space environment:
  - Ionised plasma environment
  - Interaction with solar wind
- Atmosphere:
  - Mechanisms of general atmospheric circulation
  - Greenhouse effect
  - Physics & chemistry of cloud layer
  - Composition & chemistry of lower atmosphere
  - Atmosphere-surface interaction
- Solid planet:
  - Surface IR topography



DSN Support

- **DSN support to the Venus Express Mission**
  - Post Launch Tracking (assure round-the-clock coverage)
  - Cruise and Approach Navigation Tracking
    (Delta-DOR, VLBI technique for location in plane of sky)
  - VOI Support
  - Radio Science Bistatic Radar Observations
    (provides S-Band and larger aperture, stronger echoes)
  - Conduct Solar Corona Observations
    (Use 34-m and 70-m)
  - Radio Science Occultation Observations
    (2 wavelengths, S- and X-band, to separate ionosphere from neutral atmosphere)
  - Augment Data Downlink during Science Campaigns
    (Venus Movies - Use 70-m)

Phoenix Mars Lander Mission Overview

Interplanetary Network Customer Forum

Joe Guinn, Mission System Manager

14 February 2006

Why is it called Phoenix?

The Phoenix bird symbolizes rebirth, the Phoenix mission reuses the existing spacecraft and instruments intended for the Mars Surveyor Program 2001 lander

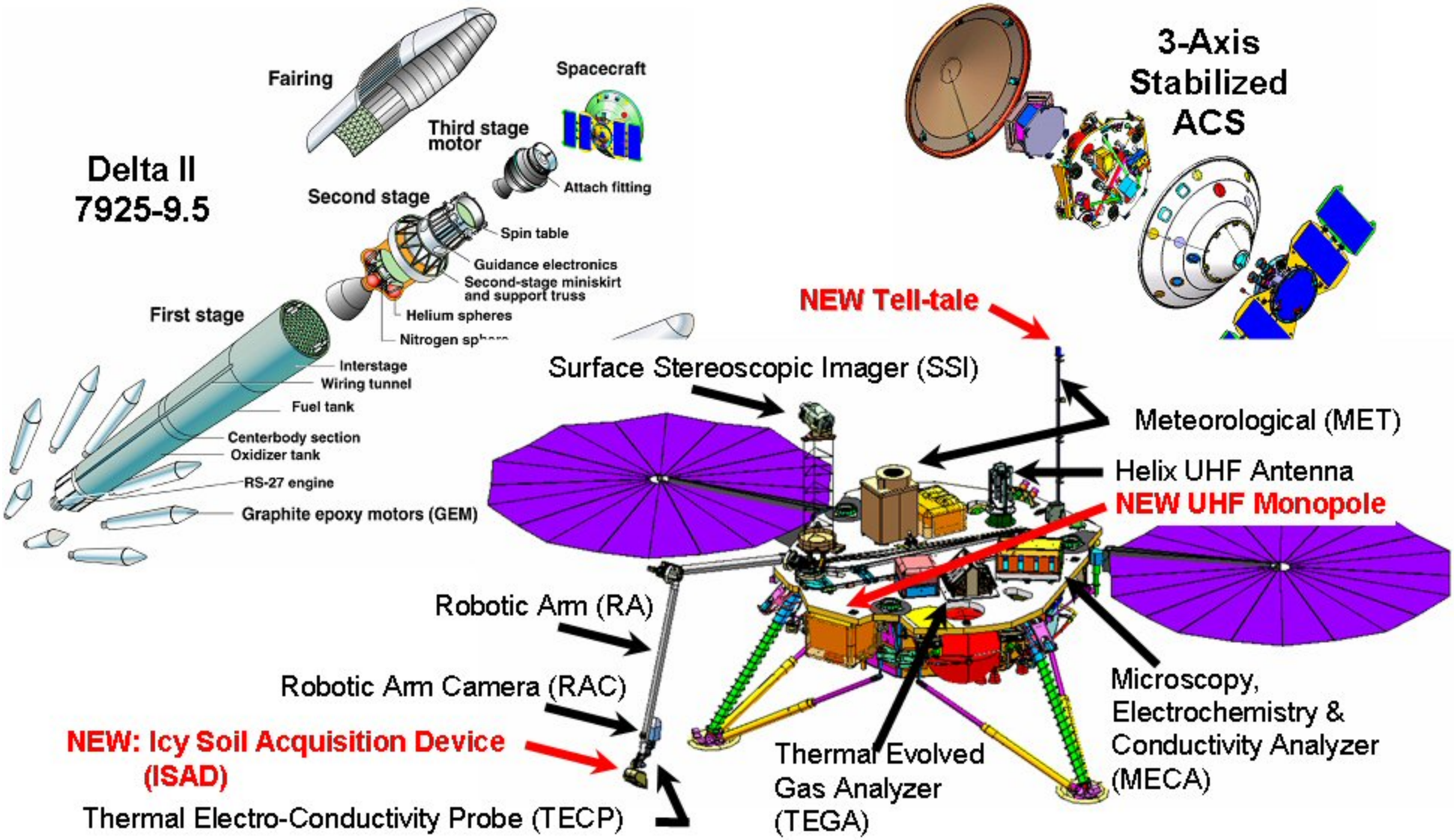
PI is from University of Arizona in Tucson (90 miles south of Phoenix)

Phoenix follows the water by landing and digging beneath the surface in an ice-rich region discovered by the Odyssey mission near the north pole of Mars

Mission Overview

- KSC Launch: August 2007 (22 day launch period, open:2AM/PT, close:10PM/PT)
- Mars Arrival: May/June 2008 (region B, open:12AM/PT, close:4PM/PT)
- 90 Sol Surface Mission
- Communications:
  - Cruise: X-band DSN
  - EDL: UHF-band ODY/MRO, UHF-band Direct-to-Earth (best effort)
  - Surface: UHF-band ODY/MRO Relay (60 Mbit/Sol Data Return)
- Distributed Operations (JPL, LM, UA)
- Mars Time Operations
- Overnight Command Generation Every Sol during Surface Phase
- Mission Success Criteria Achieved:
  - Minimum: 32 sols
  - Full: 50 sols
  - Expected: 80 sols

Flight Hardware



Phoenix Operations

Phoenix uses a Distributed Organization
For Operations, and multiple Projects
For Relay support

Surface Phase Overview

Landed Init

Sol 0

Touch Down

Release Arrays

Deploy Arrays

Deploy MET

Release BioBarrier

Deploy SSI Eng Images

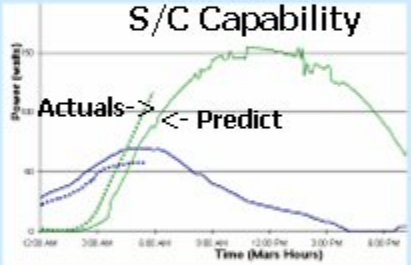
Trans. To LANDED
Start Sol 0 Master
Start Sol 0 Science
MET P/T
*SSI Imaging Shutdown
Sol 0 PM UHF Shutdown

*Duration TBD

Characterization

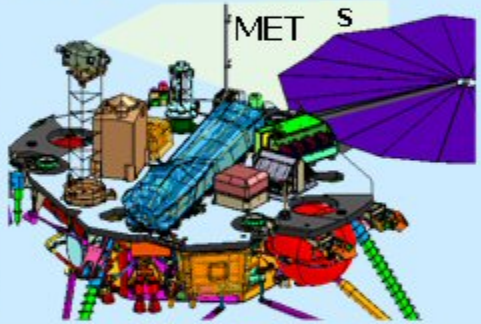
Sol 1-7

Determine S/C Capability



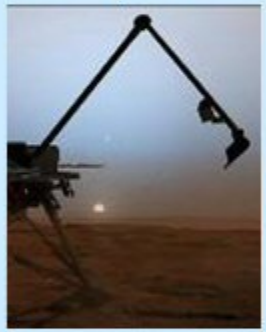
Take SSI Pan

Checkout Instrument



Deploy & Checkout RA

Test Soil Properties

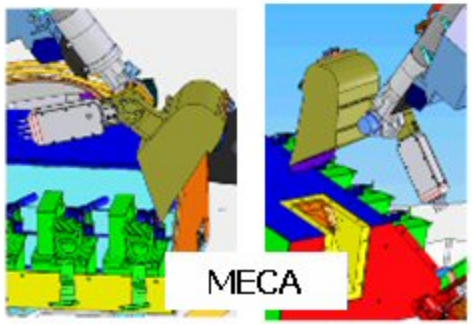


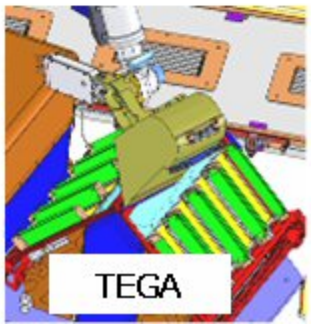
Normal Surface

Sol 8-90

Acquire Samples

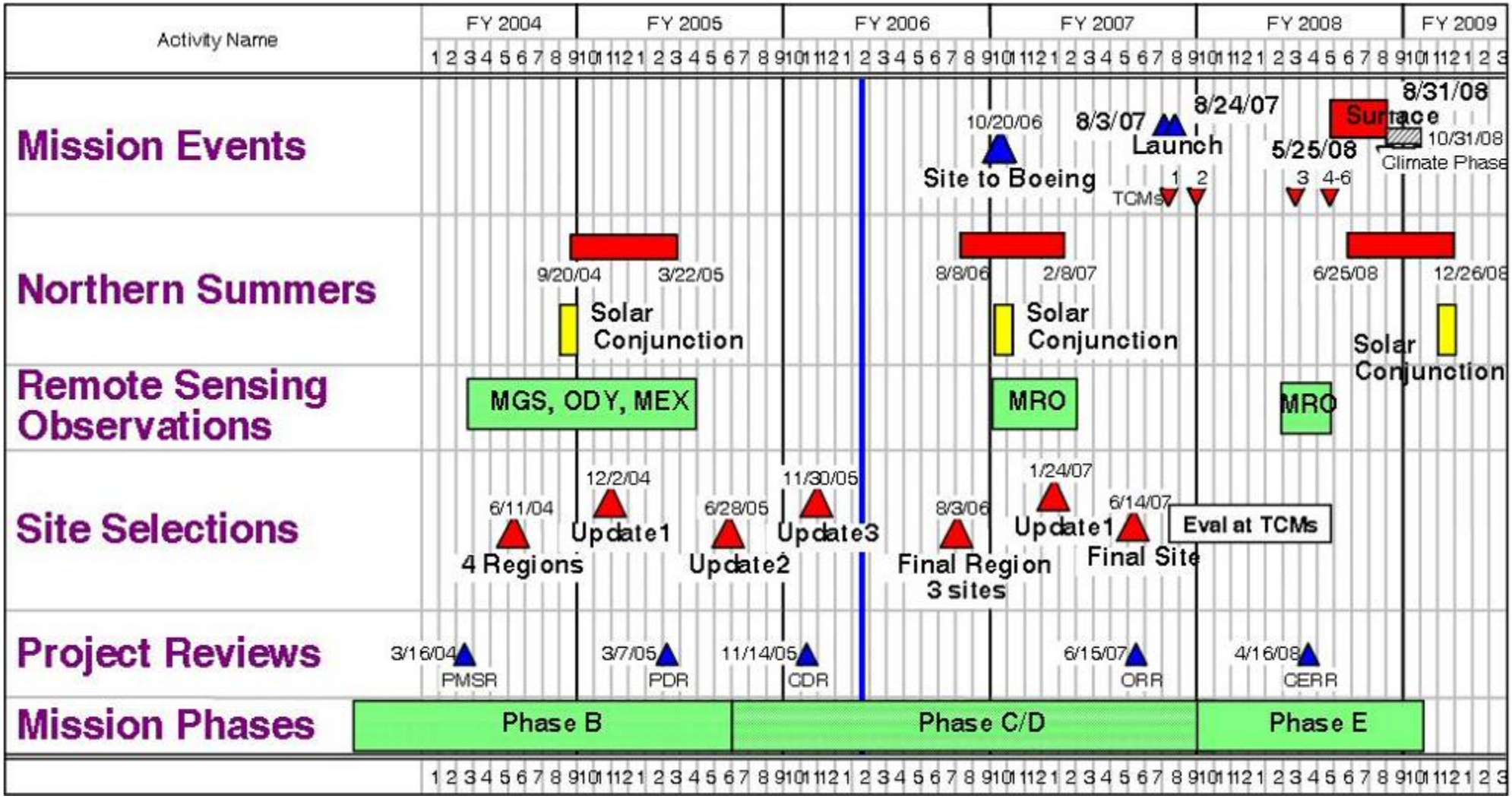
Transfer and Analyze Samples



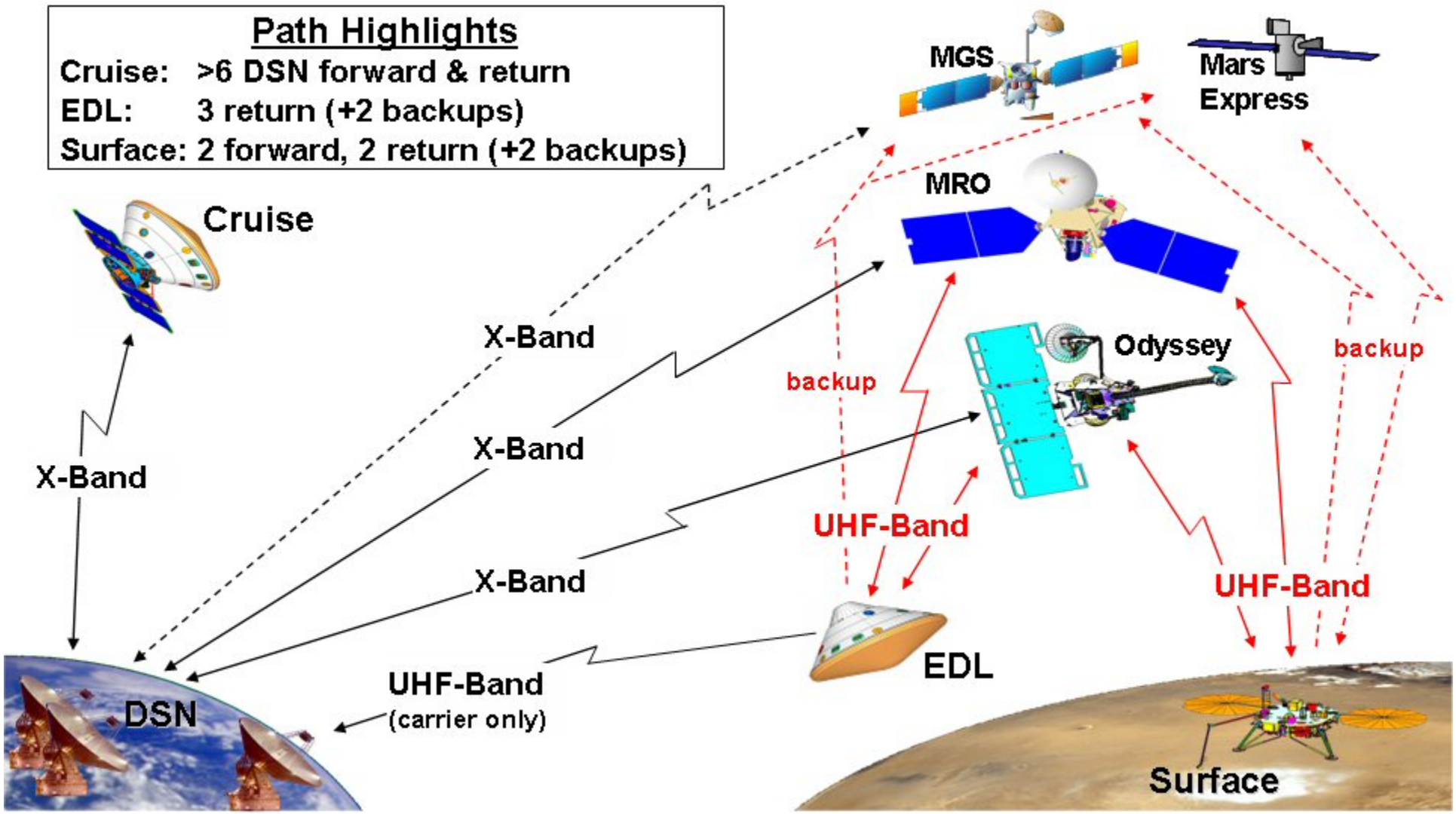


MET LIDAR

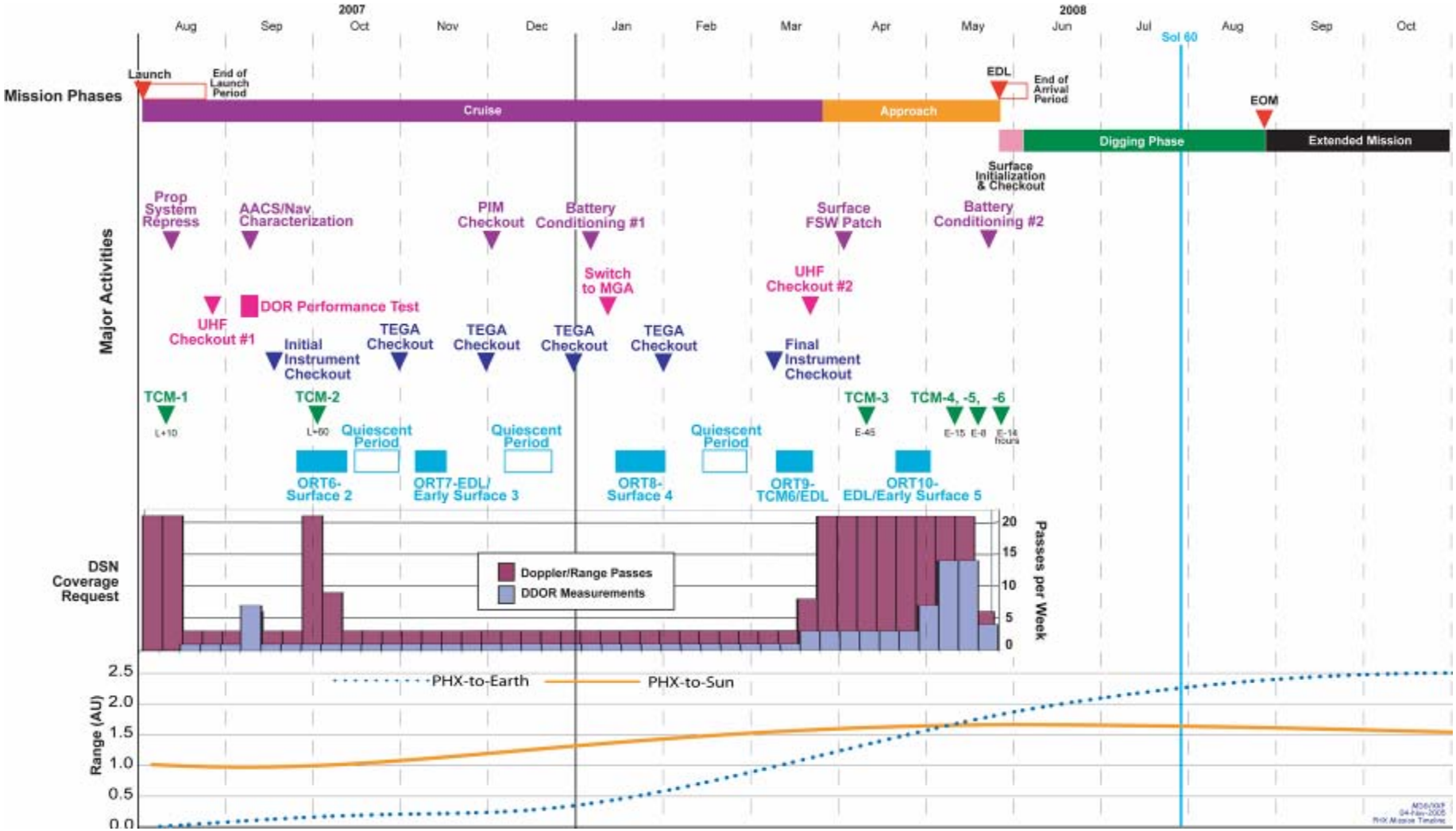
Top Level Schedule



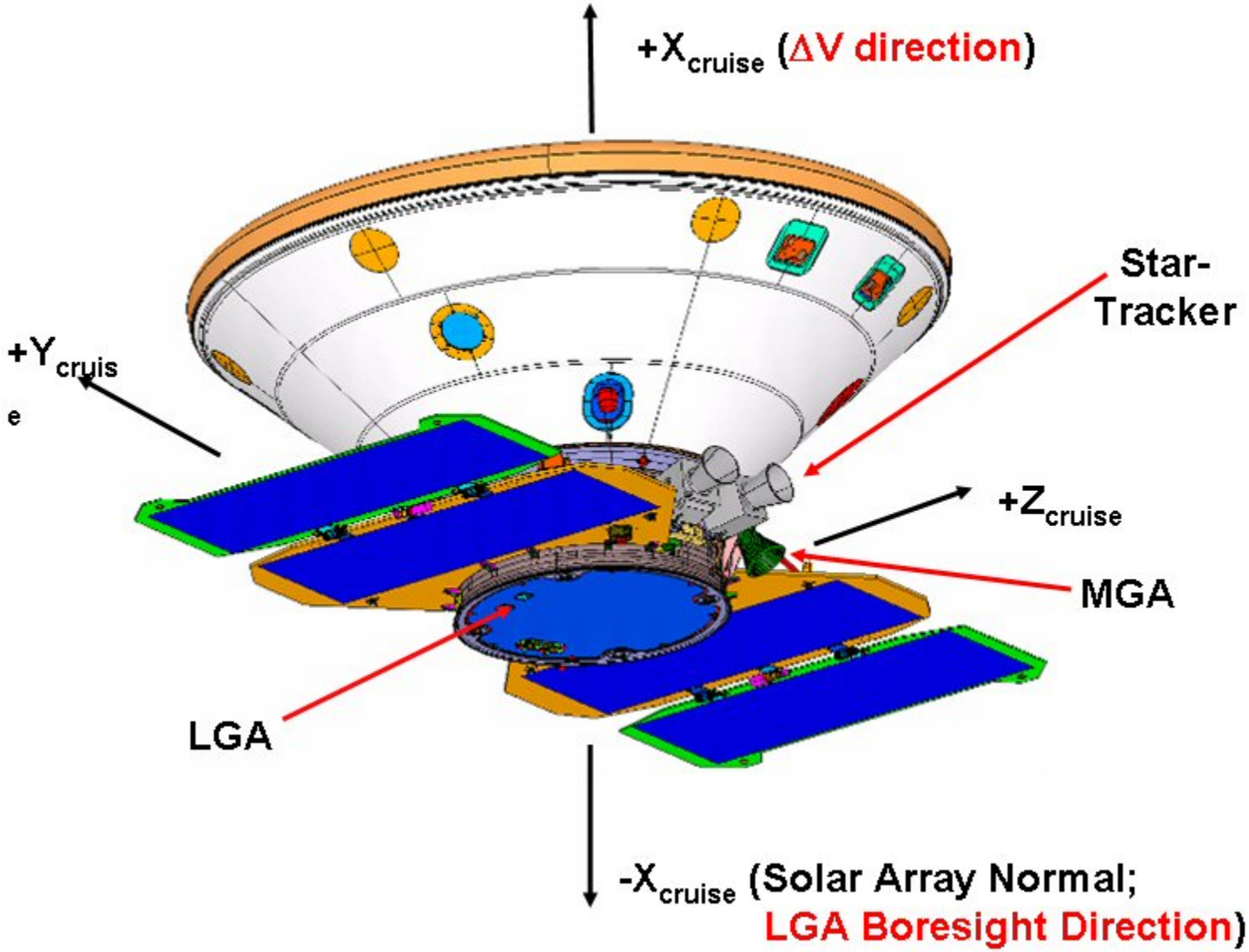
Communication Paths



Mission Timeline

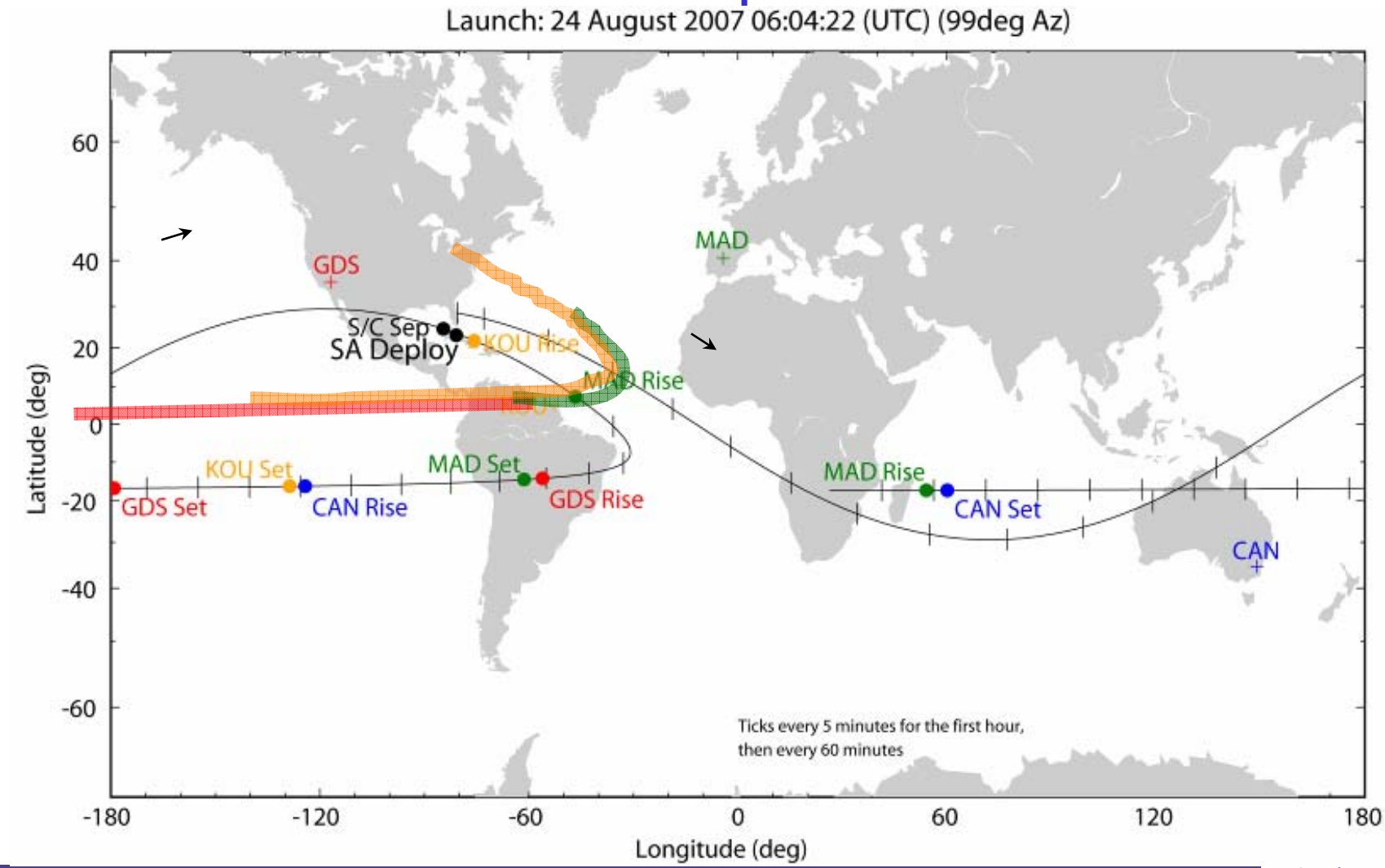


Communication & Propulsion



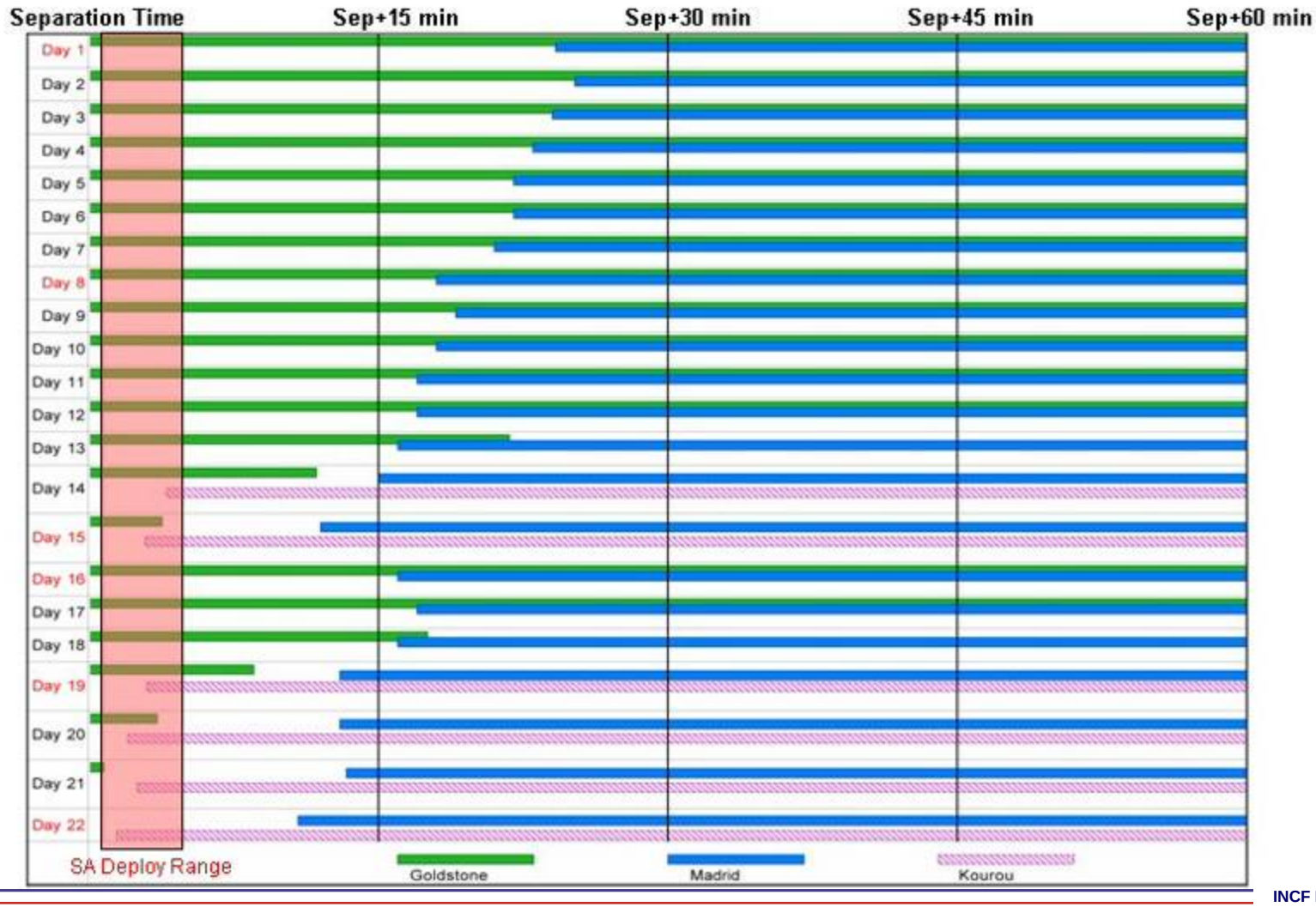
Critical Event Communication

Initial Acquisition



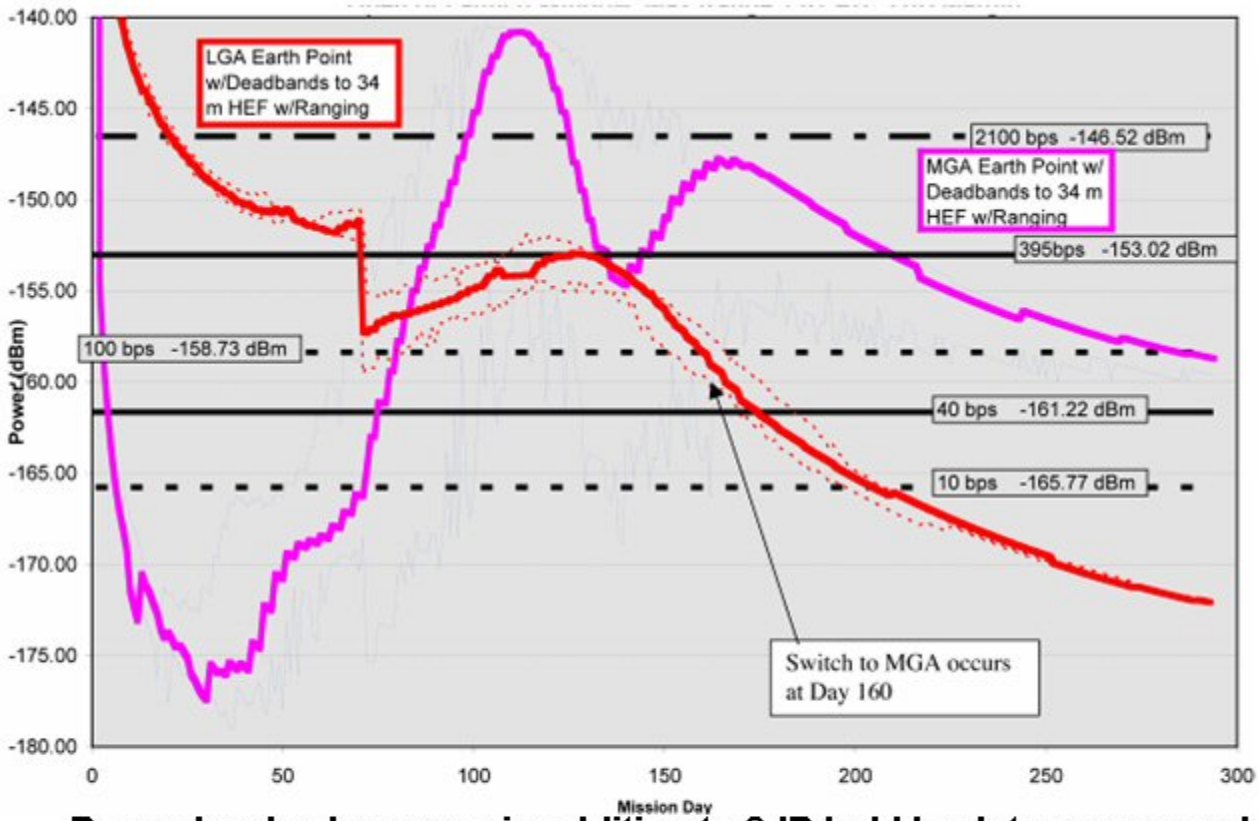
Critical Event Communication

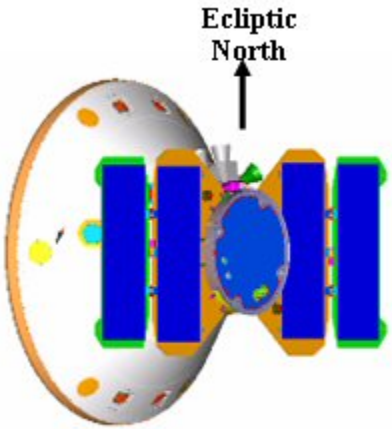
Kourou Fills DSN Gaps



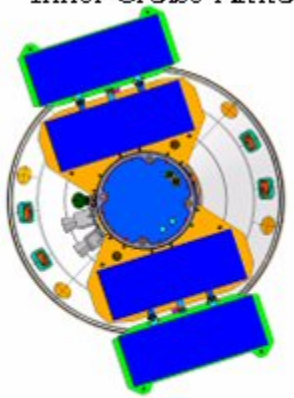
Downlink Performance and Spacecraft

Cruise/Approach Configurations





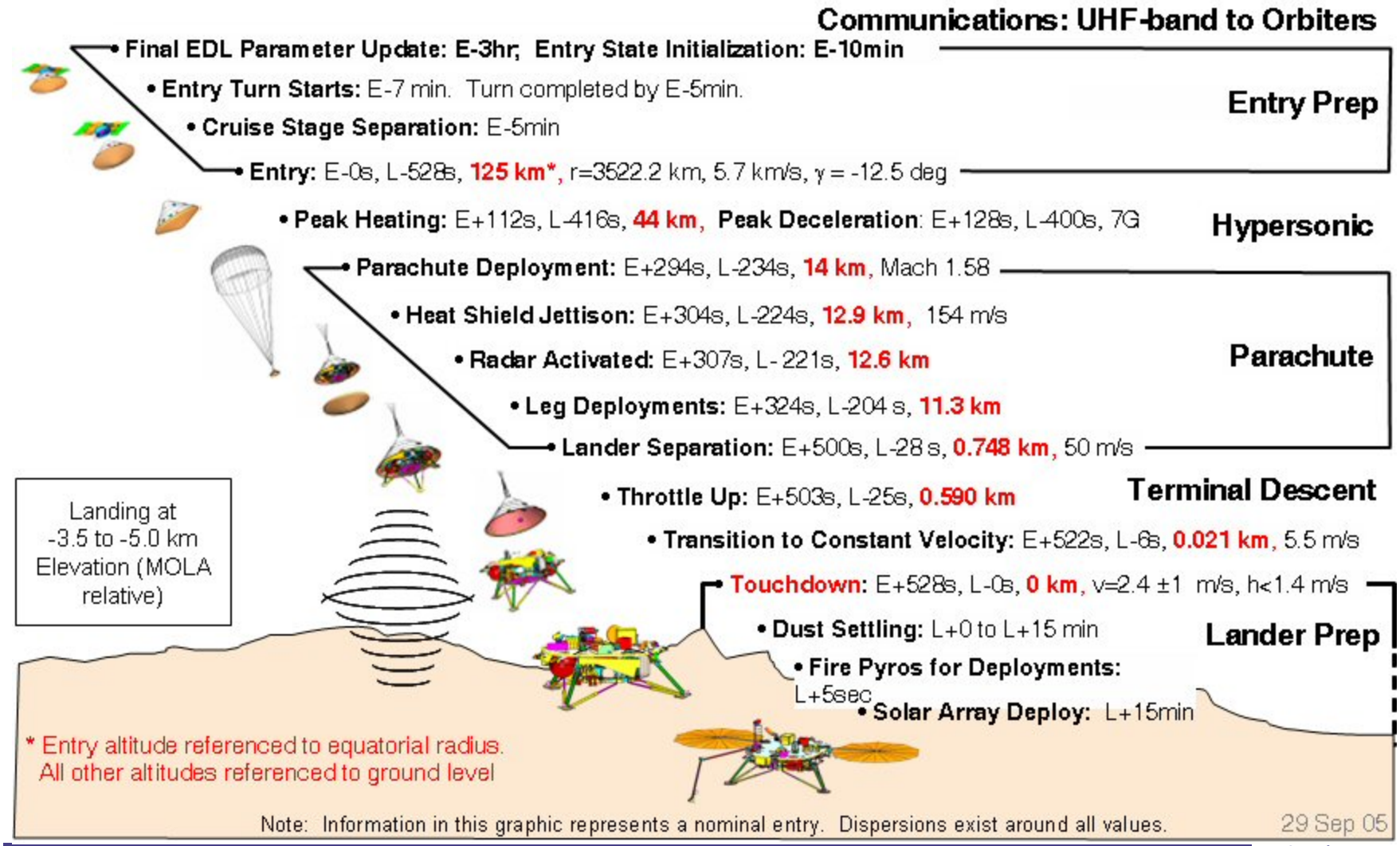
View from Sun
Inner Cruise Attitude



View from Sun
Outer Cruise Attitude

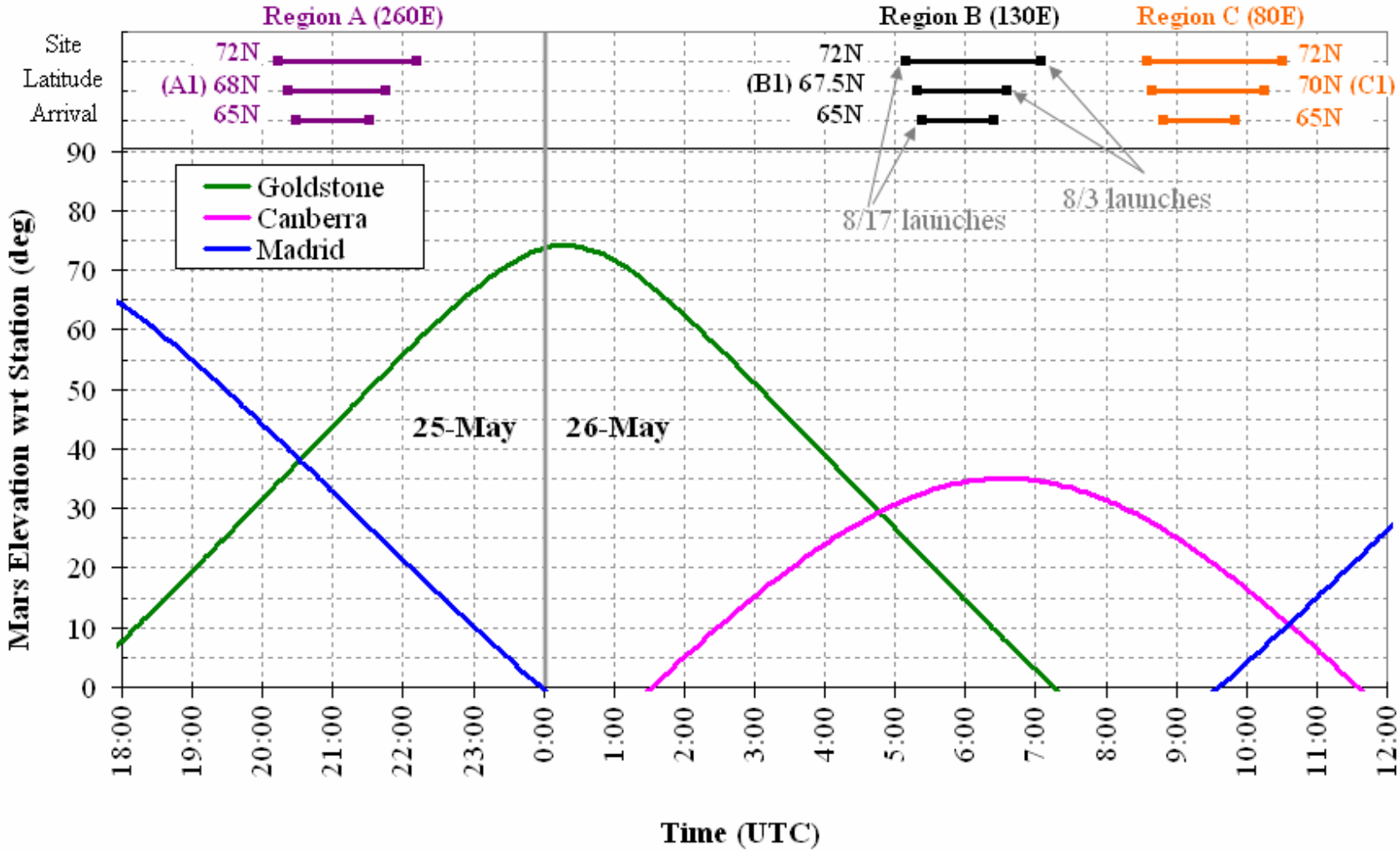
Power levels shown are in addition to 3dB held back to accommodate Design Principle. Link calculation also assumes the use of a 34M HEF & that Ranging is turned on. Spacecraft orientation maintains solar array @ Sun during Approach. Offpoint & deadbanding scheme does NOT require reorientation for transmit/receive.

EDL Timeline Overview



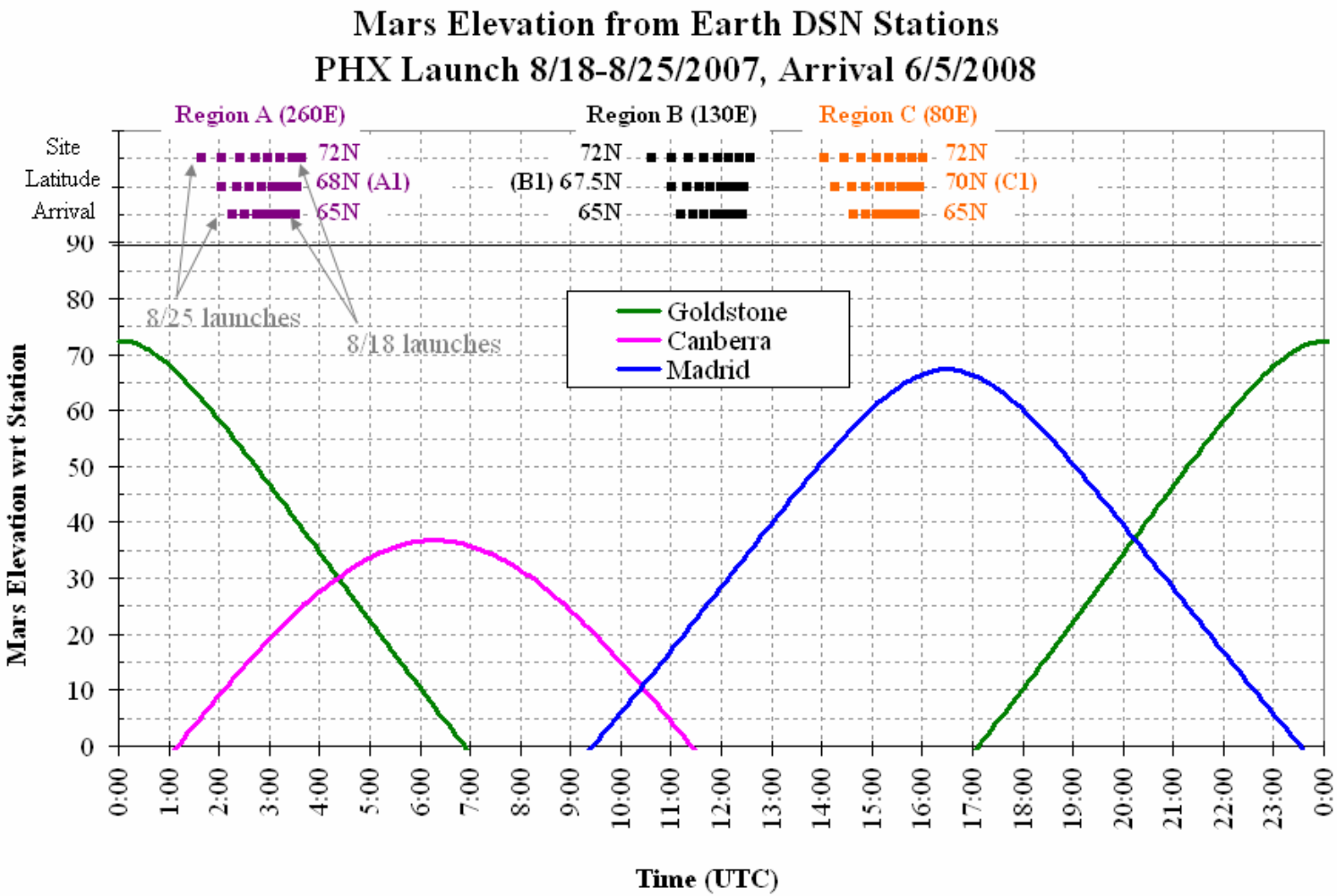
DSN EDL Coverage

For Launches Early in Period

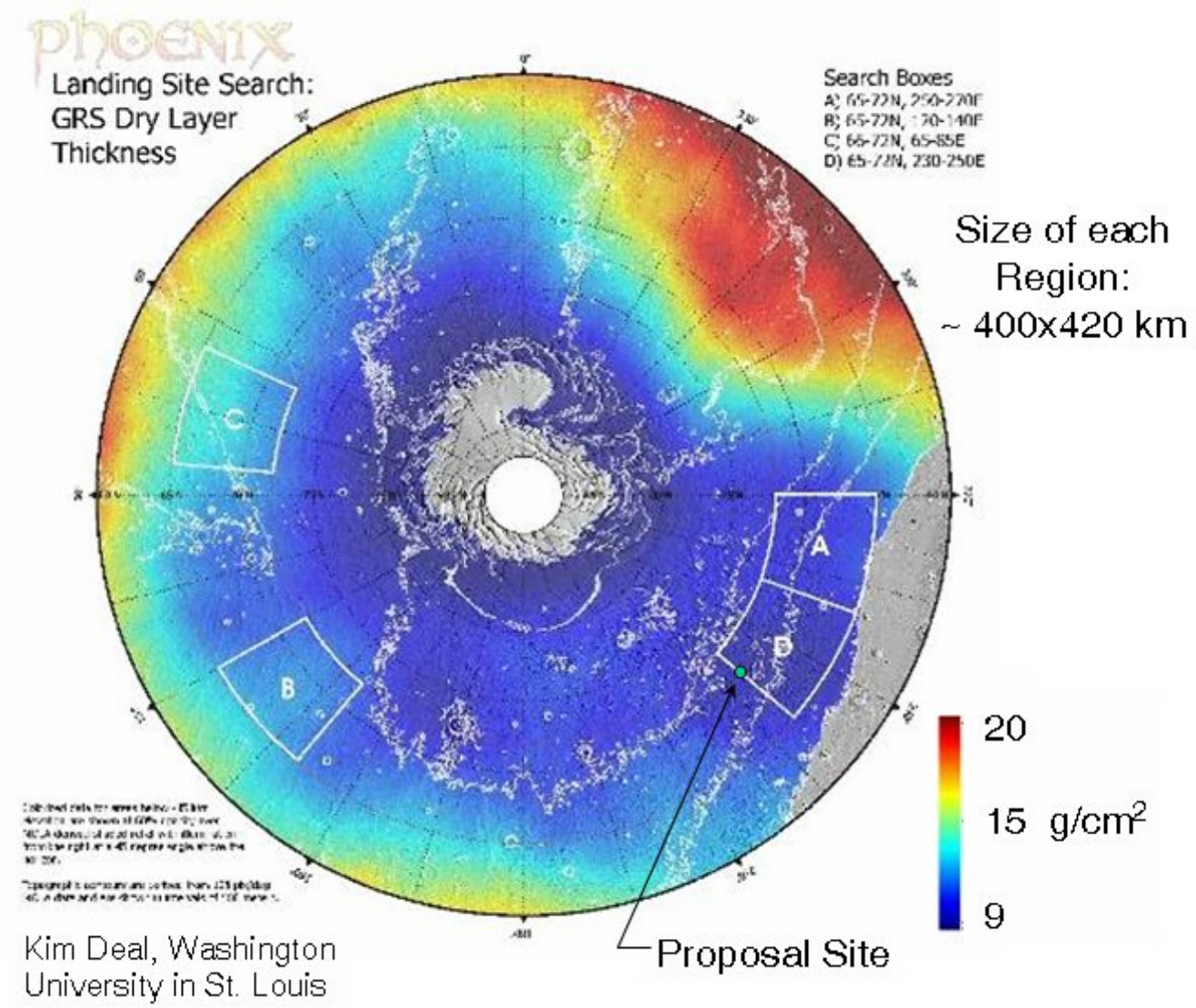


DSN EDL Coverage

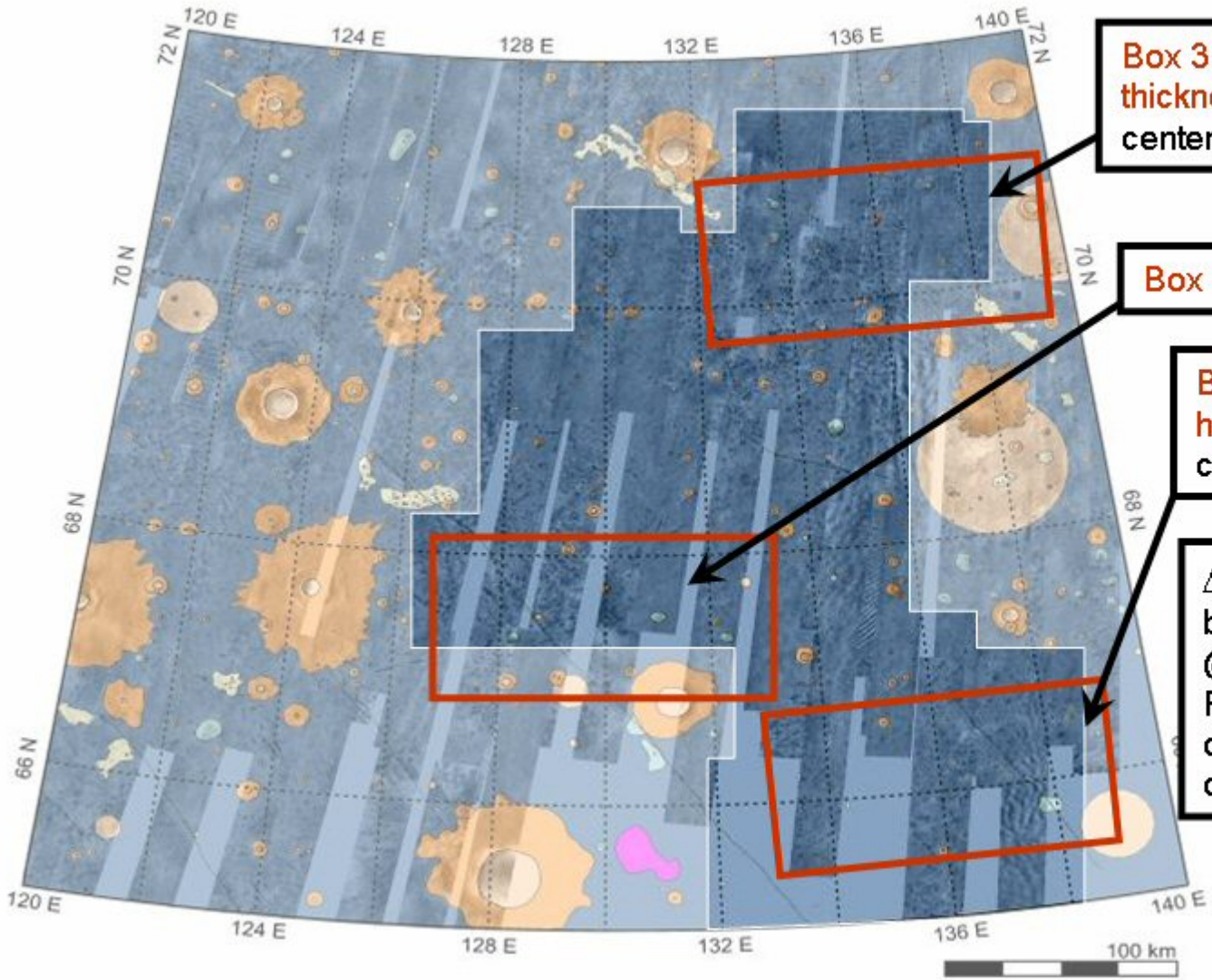
For Launches Late in Period



Landing Regions



Landing Sites within Region B



Box 3: High latitude, lower soil thickness, better comm: centered at 70.5N, 136E

Box 1: centered at 67.5N,130E

Box 2: Low latitude, higher soil thickness centered at 66N, 136E

ΔV_{99} cost for retargetting between boxes is ~1.5 m/s @ TCM-3 (E-45 days). Final MRO/ODY EDL comm phasing due by E-56 days.