

NASA Robotic Lunar Exploration Program

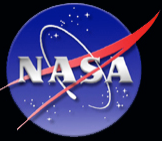
2008 Lunar Reconnaissance Orbiter (LRO)



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September 2004

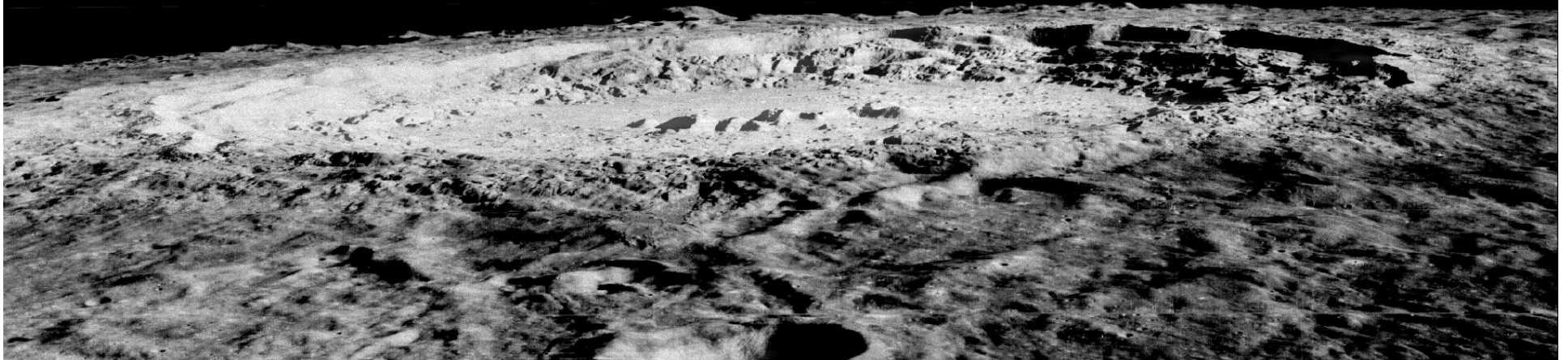
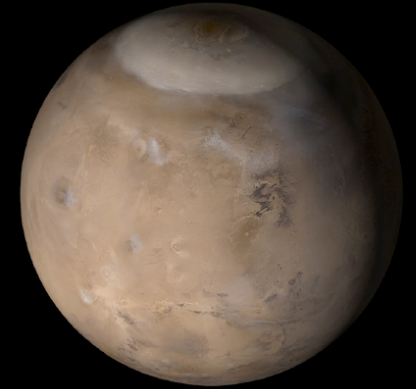




Robotic Lunar Exploration

“Starting no later than 2008, initiate a series of robotic missions to the Moon to **prepare for and support future human exploration activities**”

- *Space Exploration Policy Directive, January 2004*





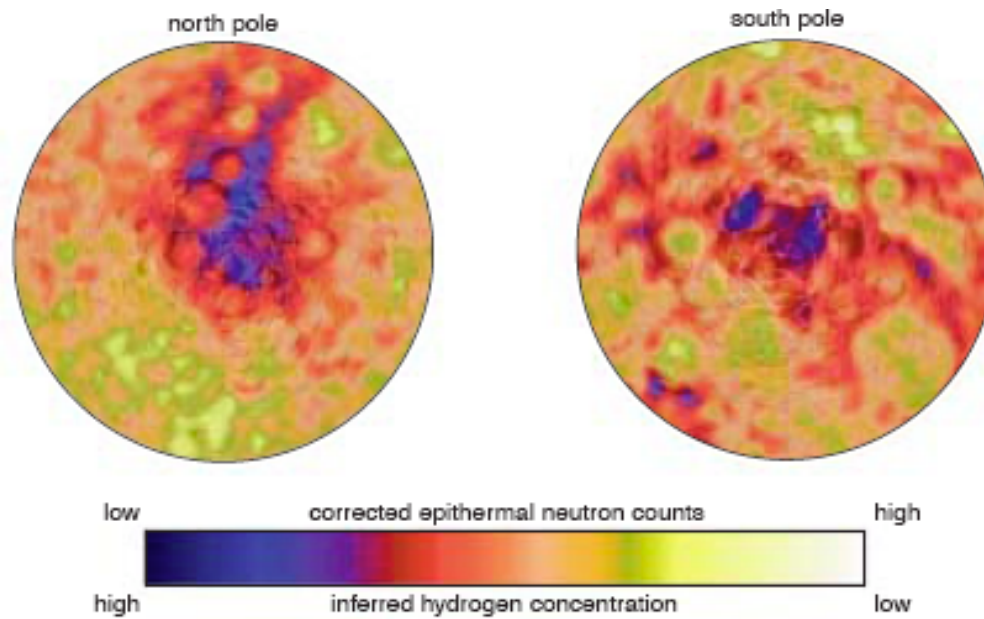
Robotic Lunar Exploration Program

- ◆ **A program-level systems approach to robotic exploration of the Moon that will reduce cost and risk for human exploration missions.**
- ◆ **First mission launch in 2008, to be followed by approximately yearly missions**
 - 2008 Lunar Reconnaissance Orbiter
 - 2009/2010 Robotic Lunar Landed Mission
 - Future Robotic Lunar Testbeds/Orbiters
- ◆ **Managed and implemented by the Robotic Lunar Exploration Program in the Solar System Division of SMD**
 - Program implementation modeled after highly successful Mars Program
 - Program implementation assigned to Goddard Space Flight Center
- ◆ **Requirements for these missions determined by Exploration Systems Mission Directorate, in cooperation with the Science Mission Directorate**
- ◆ **Funding requested to begin in FY 05 (\$70M); \$1.3B through FY 09**



RLEP Measurement Objectives

- ◆ Acquisition of a high spatial resolution, 3-dimensional, geodetic grid for the Moon at landing site scales
- ◆ Characterization of the lunar environment and its biological impacts (including radiation, dust, thermal, and partial gravity)
- ◆ Characterization of lunar regolith in preparation for ISRU activities
- ◆ Identification of possible water ice resources on the lunar surface through orbital and in-situ ground truth measurements

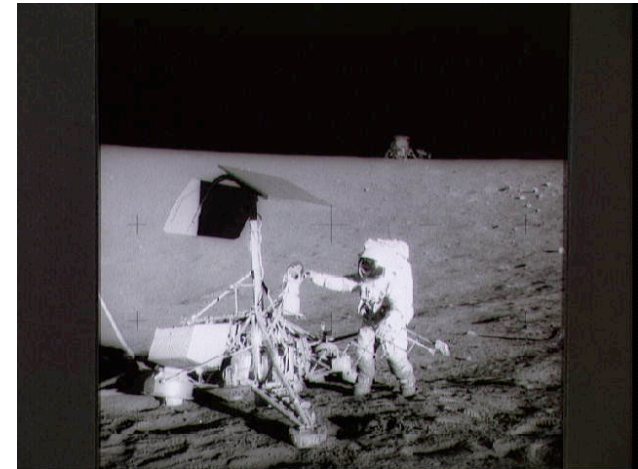


Hydrogen concentrations
in the lunar polar regions
measured by Lunar Prospector



Technology and Infrastructure Objectives

- ◆ Demonstration of precision landing on the lunar surface
- ◆ Demonstration of shielding capabilities, as well as prototype hardware and software for monitoring/mitigating space environment effects on humans
- ◆ Demonstration of ISRU package for water ice, if any is found on the lunar surface, and/or demonstration of oxygen extraction from lunar regolith
- ◆ Establishment of communications infrastructure for future robotic and human missions





Development of RLEP Architecture

- ◆ **Lunar Reconnaissance Orbiter (LRO) Requirements have been established**
 - Objectives and Requirements Definition Team (ORDT) convened in March to prioritize measurements
 - NASA Exploration Systems Review Board approved recommended payload requirements

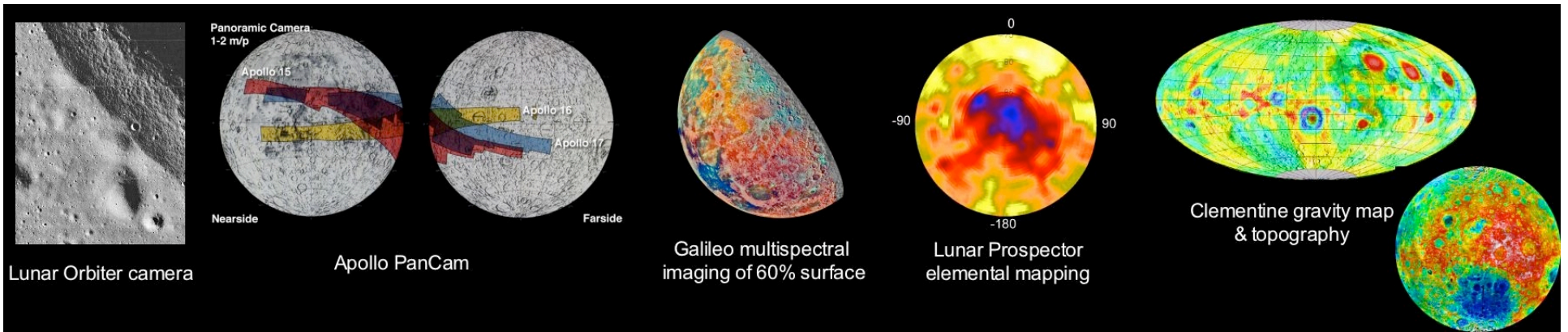
- ◆ **Architectural Trade Studies underway to aid in determining scope and frequency of missions from 2008 through 2015 - 2020 (first human landing)**
 - Pathways approach for post-LRO missions with flexibility to incorporate recent data (i.e. water ice discovery) , science findings, and technology developments into architecture
 - Anticipate that Mission #2 might be surface measurement in south polar region

- ◆ **Requests for Information (RFIs) released for:**
 - LRO mission ground system and operations
 - Surface water ice validation concepts
 - Radiation/biology surface demonstration
 - Advanced technology for space platform architectures

- ◆ **“Lunar Exploration Program Analysis Group” modeled after Mars group with an Exploration focus will have first meeting soon**
 - Analysis from this group will aid in prioritization of lunar program objectives as well as definition of program architecture
 - Plan to involve academia, industry , and NASA centers



2008 Lunar Reconnaissance Orbiter: First Step in the Lunar Exploration Program



Objective: The Lunar Reconnaissance Orbiter (LRO) mission objective is to conduct investigations that will be specifically targeted to prepare for and support future human exploration of the Moon.





LRO Mission Objectives

ORDT Recommended Objectives for the LRO Mission

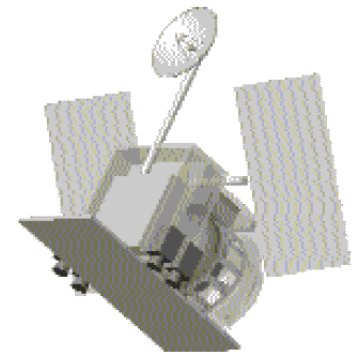
- ◆ Four primary objectives, in priority order
 1. Characterization of the lunar radiation environment, biological impacts, and potential mitigation
 - Determine global radiation environment
 - Investigate shielding capabilities of materials
 - Validate other deep space radiation prototype hardware and software
 2. Determine a high resolution global, geodetic grid of the Moon (in 3 dimensions)
 - Provide necessary topography sufficient to quantify safety of future landing sites
 3. Assess in detail the resources and environments of the Moon's polar regions, including ices (if any)
 4. Assess globally at high spatial resolution the following (for the lunar surface):
 - Elemental composition
 - Mineralogy
 - Regolith characteristics
- ◆ ORDT recognized that achieving 4th objective for 2008 LRO would be difficult



LRO Mission Overview

- **The AO solicits measurement investigations for the LRO from the eight highest priority measurement sets as follows:**
 - Characterization of the deep space radiation environment in lunar orbit
 - Geodetic global topography
 - High spatial resolution hydrogen mapping and assessment of ice (if any)
 - Temperature mapping in polar shadowed regions
 - Imaging of the lunar surface in permanently shadowed regions
 - Identification of putative deposits of appreciable near-surface water ice in the polar cold traps
 - Assessment of meter and smaller scale features for potential landing sites
 - Characterization of the changing lunar surface illumination conditions in polar regions at time scales as short as hours

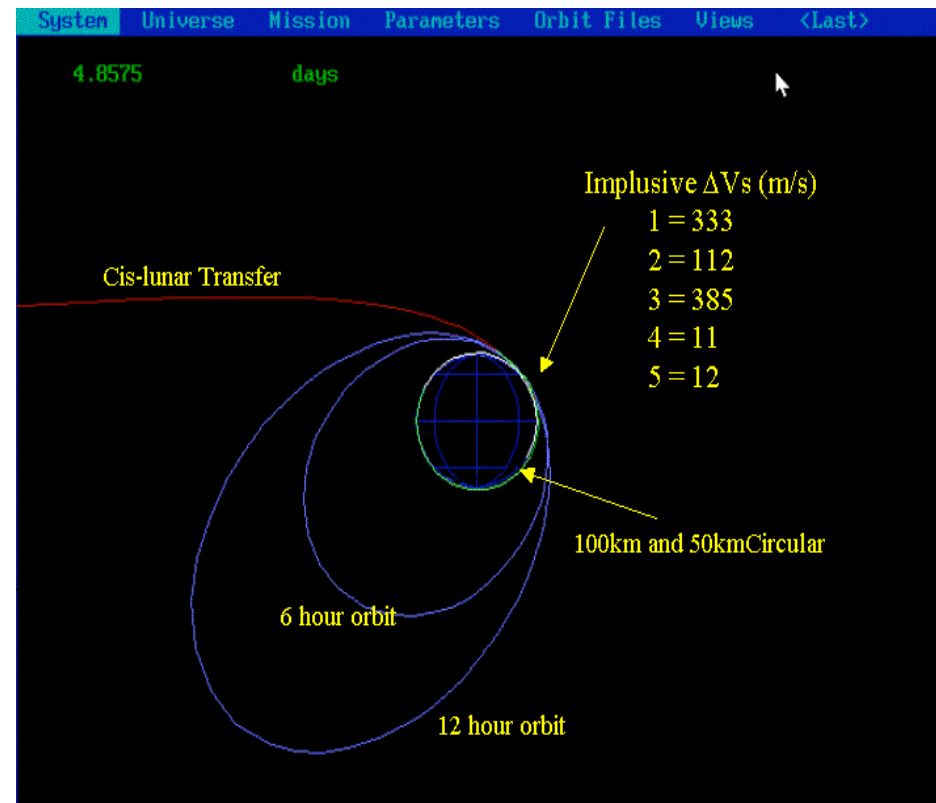
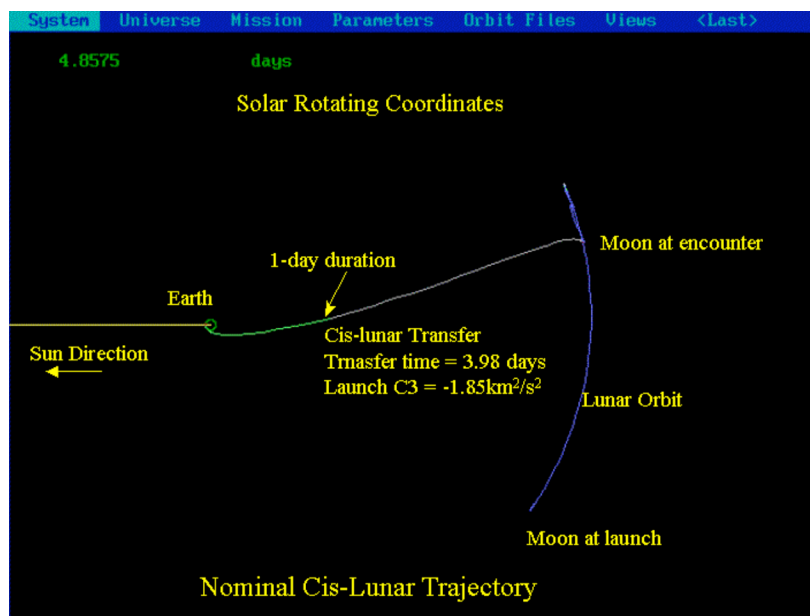
- **Mission is “Discovery Class” in Scope**
 - 1000 kg spacecraft (wet)
 - 100 kg instruments
 - One year of observations from 50 km circular polar orbit





LRO Mission Profile

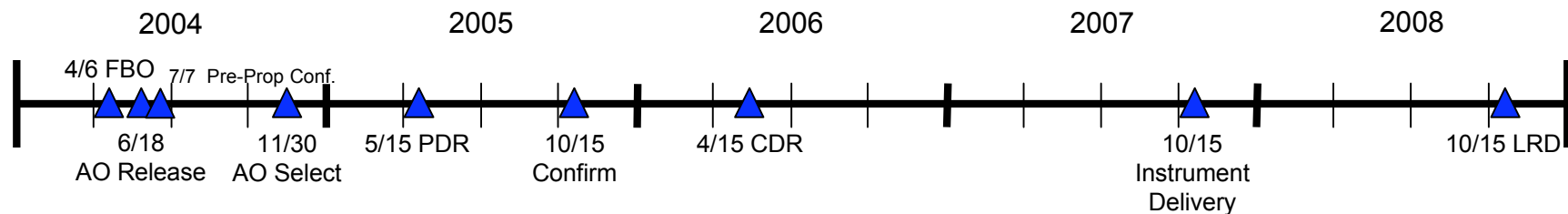
- Launch from Kennedy Space Center on Delta-II class ELV
- Primary mission of at least 1 year in circular polar mapping orbit (nominal altitude 50 km)
- Potential extended mission at low maintenance elliptical “relay” orbit (to end-of-life ~5yrs), or flown for short duration in low altitude orbit which terminates in targeted impact





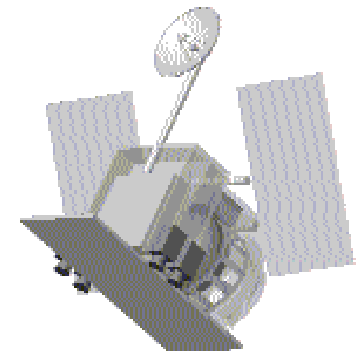
LRO Status

◆ Project schedule established for the 2008 LRO Mission



◆ LRO Measurement Investigations AO was released June 18

- Proposal Information Package posted on Web
- Proposals submitted September 15
- Selection planned for November 30



◆ Major design drivers and mission trade studies are ongoing

◆ Communications requirements for RLEP Mission #2 support defined

◆ Project infrastructure & staffing development underway at GSFC



RLEP Synergy with Science

- ◆ **RLEP will have a Research and Analysis (R&A) program**
 - Supports science-based data analysis by the broader science community
 - Results will help guide future missions and provide information beneficial to exploration
 - Results will help define science-based activities by human missions and provide basis of landing site choices

- ◆ **Science and technology gained from SMD's New Frontiers, Discovery, and Mars Scout missions could naturally enhance/extend the RLEP**
 - If SMD selects science-driven lunar missions or MoO's as part of these programs, the results can be leveraged by the RLEP