



Lunar Prospector: Managing a Very Low Cost Mission

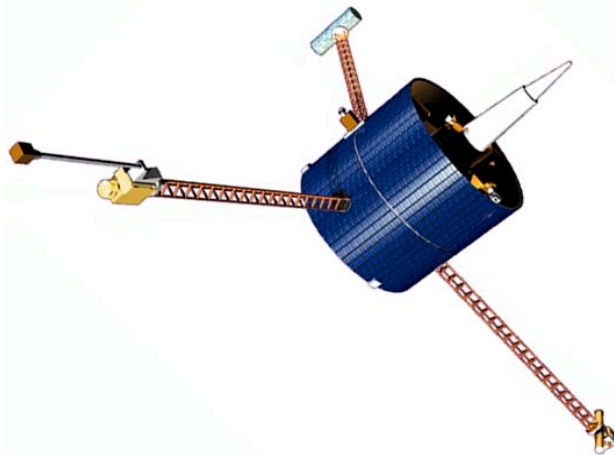
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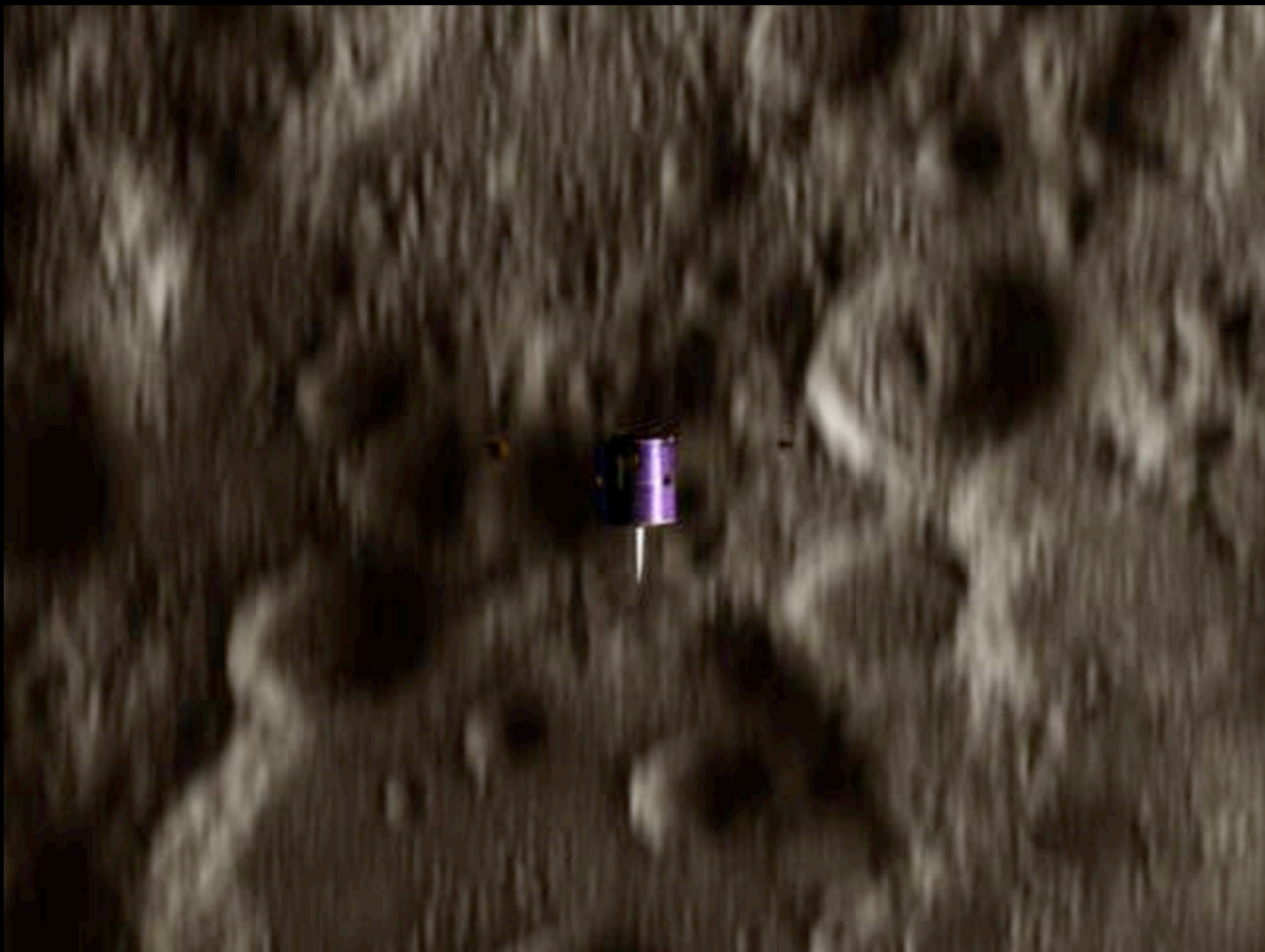
NASA Manager of LP from 1995-1998

The PI-Team Masters Forum - 2
April 27, 2010



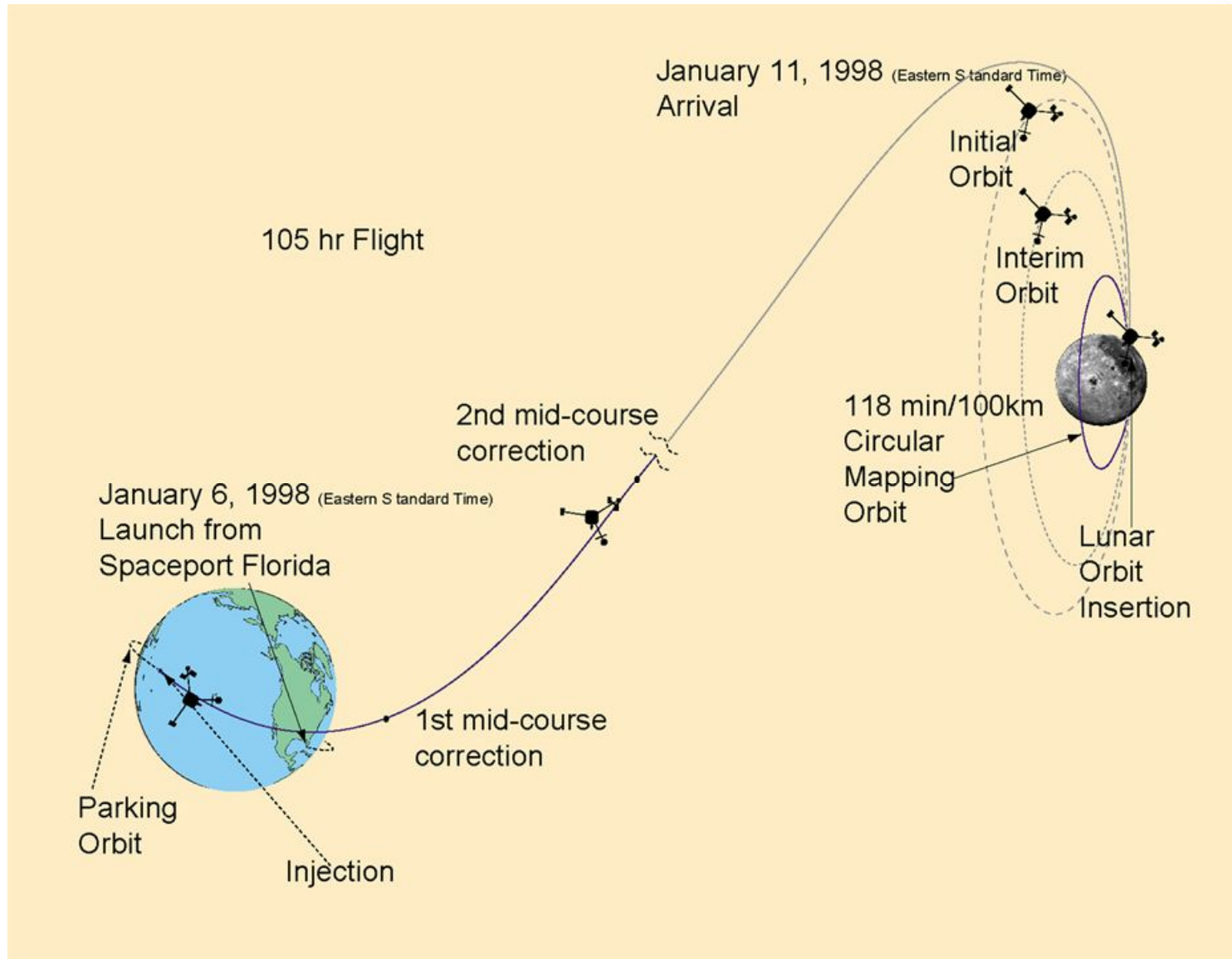
- Understand the origin, evolution and resources of the Moon
- Demonstrate “Faster, Better, Cheaper” goals of Discovery Missions
 - LP was the first competitively selected Discovery Mission
- Catalyze planetary exploration via education and outreach programs

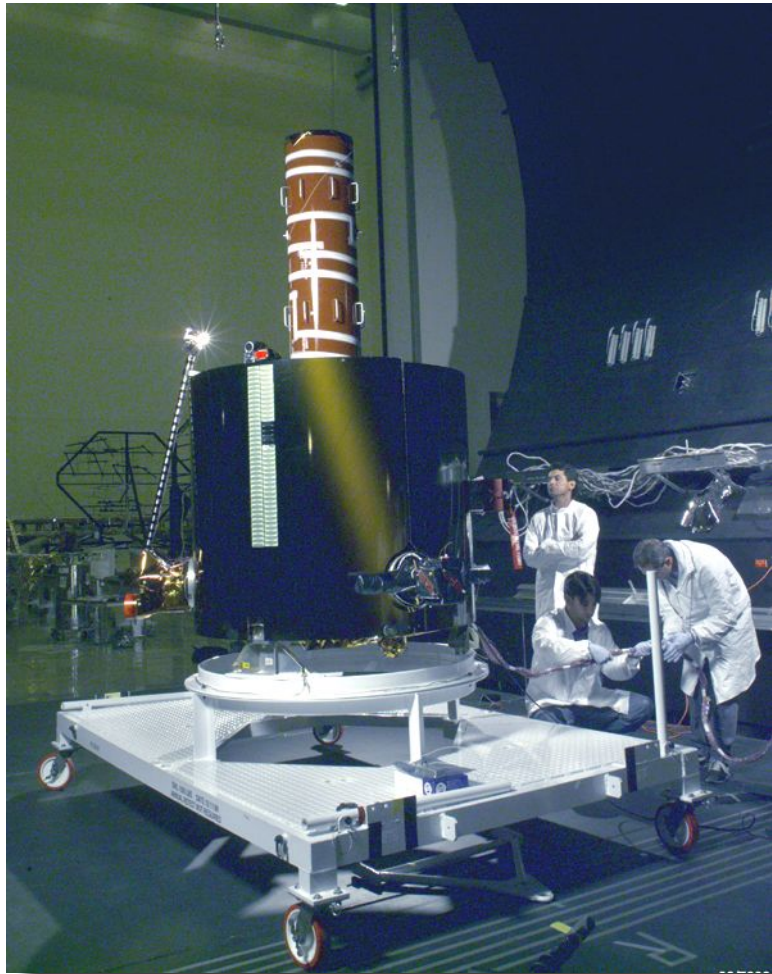






- **\$62.8M Total Mission Cost (FY96)**
 - Phase B study: \$2M
 - 5 Instruments/6 experiments: \$3.6M
 - Spacecraft and mission analysis: \$22.6
 - ELV, translunar stage and adapter: \$26M
 - Operations: \$4.2M
 - Maximum award fee: \$4.4M
- **Education and Outreach (example)**
 - Innovative Web activities using ARC information technology
- **22 Month development**
- **1 year primary mission at 100km circular polar orbit**
- **6 month extended mission at 10-30 km polar orbit**





- Spacecraft:
 - Simple, spin-stabilized, reliable
 - High heritage instruments, components & subsystems
 - Mix of subsystem and operational redundancy
- Test
 - Rigorous test-as-you-fly program
 - Addressed all spacecraft functions and risk areas
 - No normal project steps were skipped

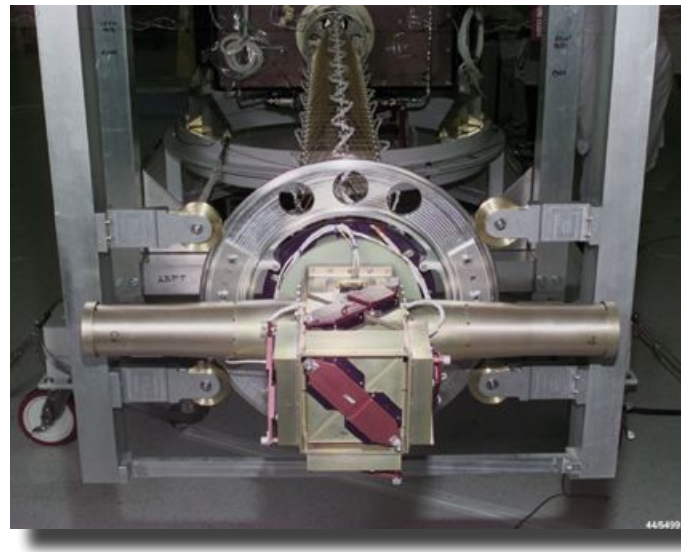


Mission Command & Control
at Ames Research Center

- **Operations:**
 - Operational simplicity combined with planning, staffing and training of all aspects of operations
 - Extensive off-nominal system and mission analysis, contingency procedures development and team training
- **ELV:**
 - Athena II launch vehicle with commercial ship & shoot processes
 - Rigorous mission success qualification process



- Manage to cost, yet maximize mission success on a short schedule
- Balance teamwork with NASA accountability
- Develop new management tools without sacrificing prudent process
- Accommodate new roles of PI and Project Manager





- Freeze project design and develop without deviation
- Minimize staff; place responsibility and accountability on front-line personnel (but maintain a mix of senior and junior staff)
- Maximize science per dollar via clear, firm objectives and metrics
 - Well-defined data return (e.g., global H maps to 50 ppm)
 - < 2 year development
 - \$62.8M Total Mission Cost
 - New Education and Outreach mechanisms



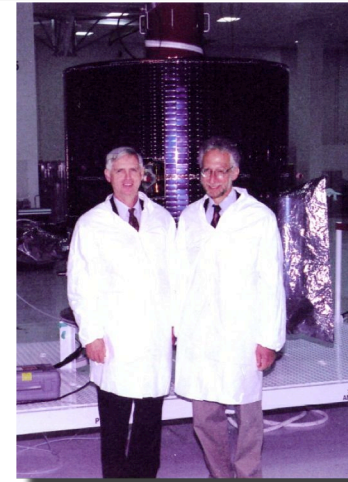
Stanford University Department of Aeronautics and Astronautics



Ames Research Ctr: Lunar Prospector Mission
Mission Manager: **Scott Hubbard**
Deputy Mission Manager: **Sylvia Cox**

← Cost Plus Award Fee
type contract

Lockheed/Martin: Lunar Prospector Project
PI: **Alan Binder***
Project Manager: **Tom Dougherty**



Co-Investigators
and Instruments

Ames LP Team
-Mission/Trajectory Analysis
-Operations/Tracking Support

Spacecraft Development
at LMMS

Launch Vehicle Development
at LMA

* Now at Lunar Research Institute



- **Balance programmatic oversight with technical insight**
 - Simplified reporting and monitoring systems
 - Modified SR & QA surveillance
- **Use performance based award fee contract with cost and science incentives**
 - Maximum award fee available (15%)
 - 1/2 award fee on Cost; fee reduced dollar for dollar by overruns
 - 1/2 on Science data, but if no science data, all award fee lost
- **Fixed price subcontracts**
- **Rapid movement of LMCO staff on and off project**



- **Oversight/ Direct Involvement**

- Proposed Science
- Top level schedule
- Total Mission Cost (TMC)
- Major Reviews (IRR)
- Athena II first use
- Tracking/DSN Ops
- SR & QA plan approval

- **Insight/Vigilance**

- Spacecraft Design Details (e.g.)
 - >Spacecraft moment of inertia
 - >C&DH breadboard FPGAs
 - >Solar cell selection
 - >Mast deployment
 - >GRS Thermal performance*
- Subcontract Selection and management
- Instrument Development
- SR & QA process monitoring

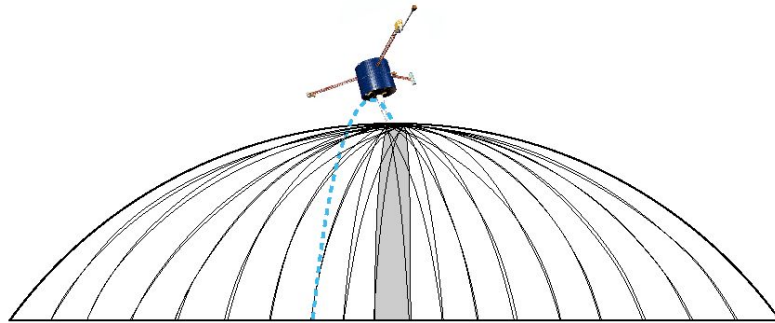
*Example of parallel analysis



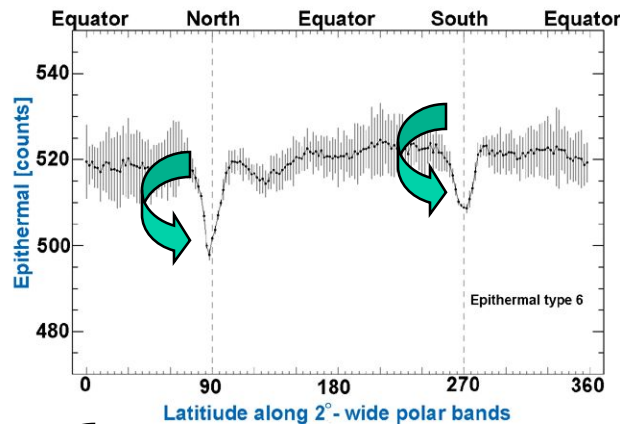
- Exploit proximity of PI/Contractor-NASA management to streamline all processes
- Minimize NASA team size but maintain continuity; restrict parallel analysis
- Combine in-depth Independent Readiness Reviews (IRR) with normal prudent project milestone reviews
- Use existing contractor systems wherever possible



- Met goal of 22 month development through spacecraft test
- Project completed inside cost box and exceeded performance goals
- Athena II low cost launch vehicle first use successful
- Innovative website received >100M hits and won numerous awards



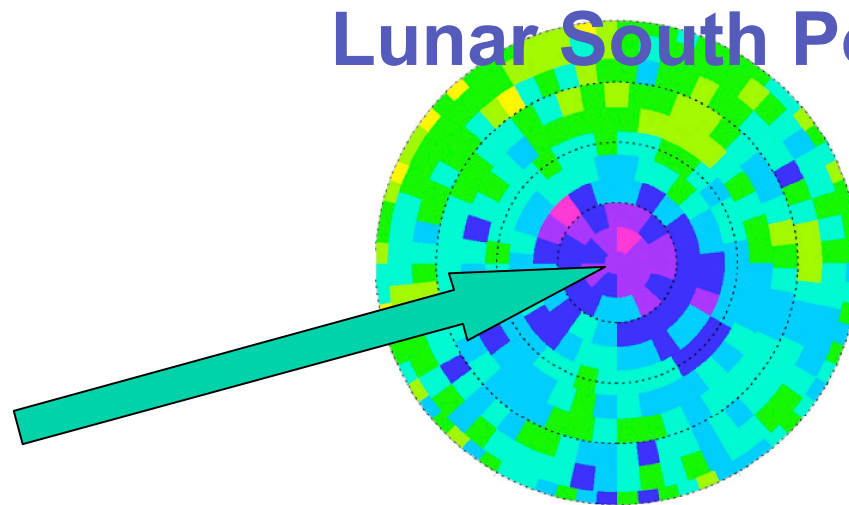
Neutron Spectrometer Data



Dips indicate presence of hydrogen = water ice

- Circular polar orbit ensured high quality data from target polar regions
- Telltale dips in the counts of epithermal neutrons indicate excess hydrogen
- Large amounts of excess hydrogen are likely deposits of cometary water ice

Lunar South Pole





- **Discovery Program experiment and FBC worked, and:**
 - Adequate reserves are key for even mature design
 - Personal “team chemistry” is important in small program
 - Risk management, including off-nominal assessment, must be considered continuously throughout program
 - Education and public outreach has become major effort
- **Balance of management insight versus oversight must be appropriate for scope of program**

