The Lyman-Alpha Mapping Project
(LAMP)

Project Overview

LAMP is a low-risk, high-heritage investigation based on a rebuild of an existing instrument. LAMP offers to enhance the exploration and science value of LRO by (i) addressing LRO-AO measurement objectives, (ii) testing a novel polar/night vision system for future robotic and human landed missions, and (iii) collecting lunar atmospheric science datasets that LRO would not otherwise obtain.
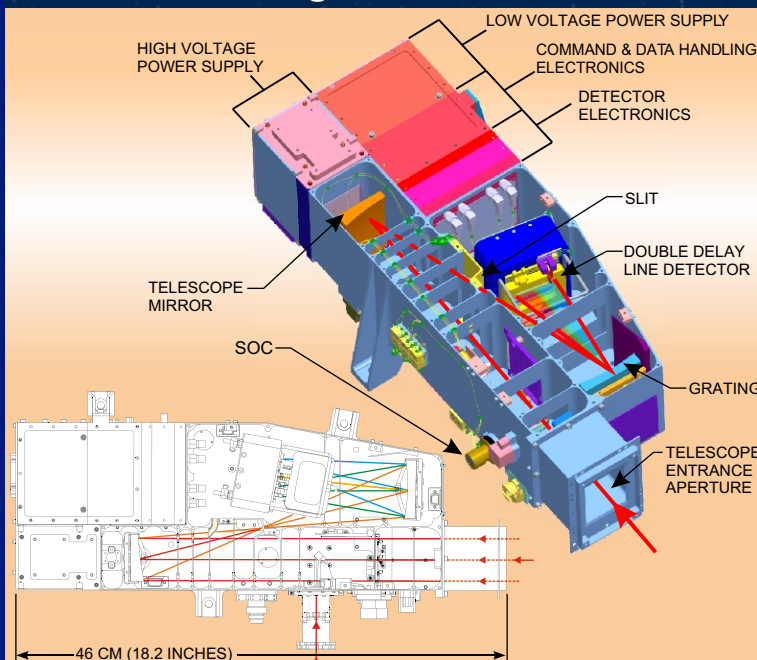
Measurement Objectives

Group 1: Required Performance Floor:
A. Identify and localize exposed water frost in Permanently Shadowed Regions (PSRs).
B. Collect landform-scale mapping in all of PSRs.
C. Demonstrate the feasibility of natural starlight and sky-glow illumination for future lunar surface mission applications.
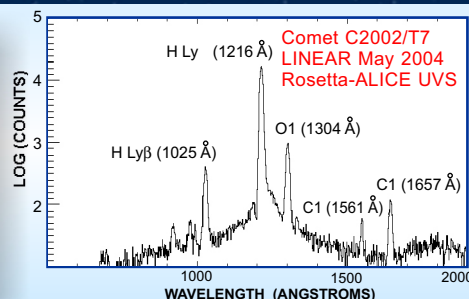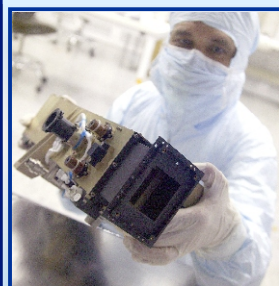
Group 2: Supplemental:
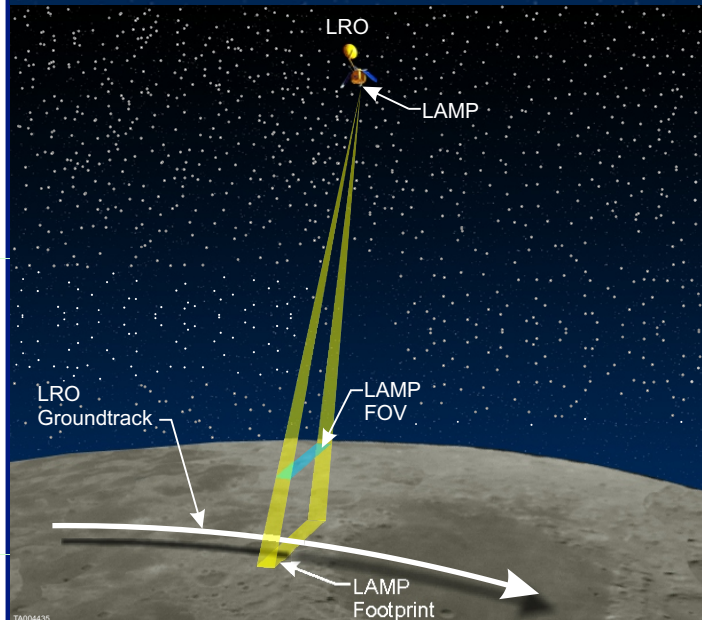A. Assay the lunar atmosphere and its variability.

Instrument Design

HIGH VOLTAGE POWER SUPPLY

LOW VOLTAGE POWER SUPPLY

COMMAND & DATA HANDLING ELECTRONICS

DETECTOR ELECTRONICS

SLIT

DOUBLE DELAY LINE DETECTOR

TELESCOPE MIRROR

SOC

GRATING

TELESCOPE ENTRANCE APERTURE

46 CM (18.2 INCHES)

LAMP: A High-Heritage UVS

Comet C2002/T7 LINEAR May 2004 Rosetta-ALICE UVS

H Ly (1216 Å)

H Lyβ (1025 Å)

O1 (1304 Å)

C1 (1561 Å)

C1 (1657 Å)

LOG (COUNTS)

WAVELENGTH (ANGSTROMS)

Investigation Concept

LRO

LAMP

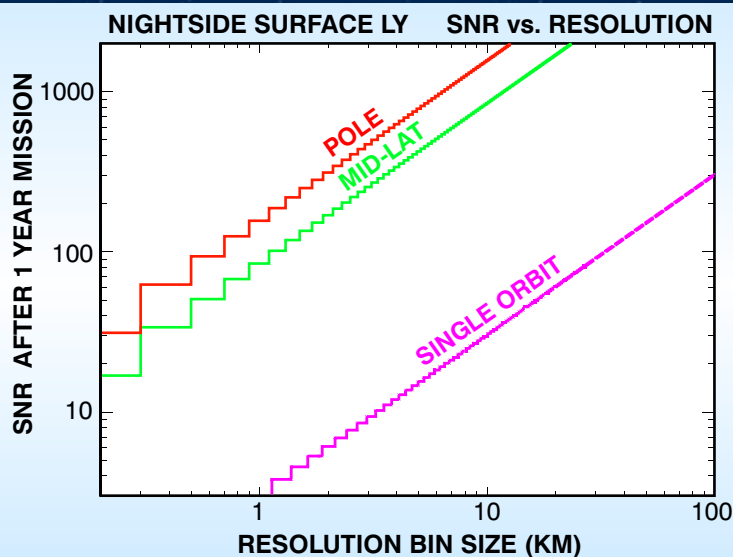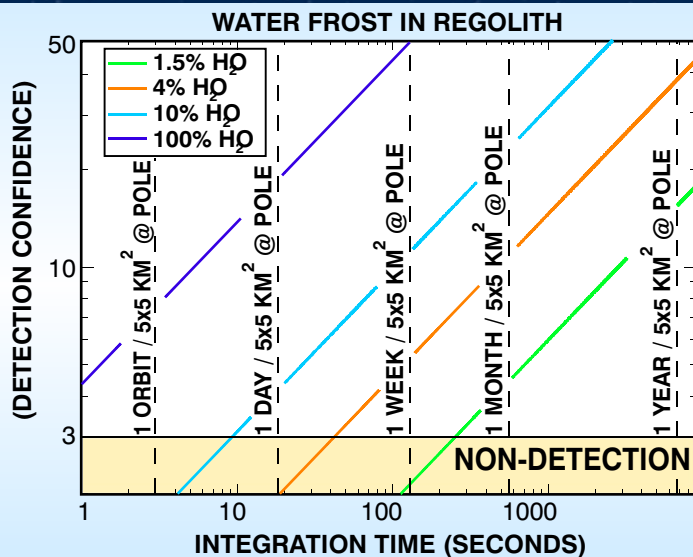LRO Groundtrack

LAMP FOV

LAMP Footprint

- Viewing in the nadir direction from LRO, LAMP measures the signal reflected from the nightside lunar surface and Permanently Shadowed Regions (PSRs) using Lyα sky-glow and UV starlight as a light source.
- LAMP data are taken entirely in pixel list (i.e., time-tagged) mode, allowing mapping at a variety of resolutions.
- Reflectance data yield albedo maps of PSRs, spectra of PSRs yield exposed water frost abundances, and atmospheric spectra yield species abundances and variability.

LAMP Instrument Summary

Attribute	Minimum Perf. Requirement (Table 1.6-5 shows Expected Perf.)
Mass, Power	5.0 kg, 4.3W (each with reserves)
Heritage	Pluto-ALICE UV Spectrograph No New Technologies
Lifetime	2 yr (required), 5 yr (goal)
Passband	1200-1800 Å
Effective Area	0.4 cm^2 @ 1216 Å (Lyα)
IFOV (Slit FOV)	0.2 x 6 deg^2
Spectral Resolution	<20 Å FWHM across passband
Spatial Resolution	≤1deg (Nyquist sampled, PSF)
Filled Slit Spectral Resolution	≤40 Å FWHM average across passband
Stray Light	$<10^{-5}$ at 7 deg off-axis
Max Count Rate	>15 kHz (~50% deadtime loss)
Dark Count Rate	<50 counts/sec (total array)
Detector Output	Continuous Pixel List

Expected Results

WATER FROST IN REGOLITH

Legend: 1.5% H₂O (H_2O), 4% H₂O (H_2O), 10% H₂O (H_2O), 100% H₂O (H_2O)

Y-axis: (DETECTION CONFIDENCE) — 50, 10, 3
X-axis: INTEGRATION TIME (SECONDS) — 1, 10, 100, 1000

Labels: 1 ORBIT / 5x5 KM² @ POLE, 1 DAY / 5x5 KM² @ POLE, 1 WEEK / 5x5 KM² @ POLE, 1 MONTH / 5x5 KM² @ POLE, 1 YEAR / 5x5 KM² @ POLE

NON-DETECTION

NIGHTSIDE SURFACE LY   SNR vs. RESOLUTION

Y-axis: SNR AFTER 1 YEAR MISSION — 10, 100, 1000
X-axis: RESOLUTION BIN SIZE (KM) — 1, 10, 100

Curves: POLE, MID-LAT, SINGLE ORBIT

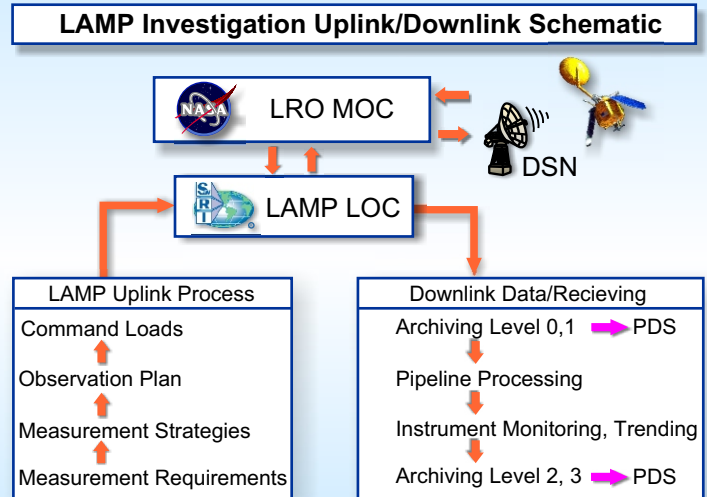## Phase A-D Organization

- LRO Project Office
  - Principal Investigator — **A. Stern (SwRI)**
    - EPO — **P. Andrews (DMNS)**
    - LAMP Investigation Cols — **D. Crider (Cath. U.)**, **P. Feldman (JHU)**, **R. Gladstone (SwRI)**
    - Project Manager — **J. Scherrer (SwRI)**
      - SwRI Project Support — **Contracts: D. Vera**, **Sched/Cost: A. Rodriguez**, **Parts Engineering: J. Stack**, **QA: B. Gupta**
      - Inst. Sys. Engineer — **J. Stone (SwRI)**
      - Project Scientist — **D. Slater (SwRI)**

- Electrical Systems — **J. Stone (SwRI)**
  - Mech/Thermal System — **G. Dirks (SwRI)**
- Optics, Detector & Cal — **D. Slater (SwRI)**
- Software — **M. Versteeg (SwRI)**
- Data Analysis & Archiving Coord. — **J. Parker (SwRI)**
- LAMP Data Scientist — **K. Retherford (SwRI)**

Blue = ALICE Project Veteran, Same Role on LAMP
Green = New to ALICE/LAMP

Operations and Data Flow

LAMP Investigation Uplink/Downlink Schematic

LRO MOC — DSN
LAMP LOC

LAMP Uplink Process
- Command Loads
- Observation Plan
- Measurement Strategies
- Measurement Requirements

Downlink Data/Recieving
- Archiving Level 0,1 → PDS
- Pipeline Processing
- Instrument Monitoring, Trending
- Archiving Level 2, 3 → PDS

Education and Public Outreach

Our EPO activities are designed to communicate the value of lunar science and exploration via the experienced outreach arm of the Denver Museum of Nature and Science (DMNS). Our project will develop a new museum exhibit and web site about LRO, LAMP, and prospects for future lunar exploration.

LAMP Resources and Reserves

	Measured Pluto-ALICE	LAMP CBE	Reserve	LAMP Request
Mass (kg)	4.4	4.5	0.5	5.0
Max. Power (W)	3.9	3.9	0.4	4.3
Daily Data (Mb)	N/A	107	25	132

NASA Funding

Phase	Total FY05 $K	Reserve FY05 $K
A	180	36 (25%)
B	364	64 (21%)
C/D	4,445	597 (16%)
E	1,001	115 (13%)
Total	**5,990**	**812 (16%)**

Schedule Summary

- Design Verification — Dec 04-Dec 05
- Fabrication — Dec 05-Jun 06
- Subsystem Test — Jun 06-Oct 06
- Integration — Oct 06-Feb 07
- Environmental Test & Calibration — Feb 07-Apr 07
- 6-Month Slack — Apr 07-Oct 07
- FM Delivered — Oct 07