

Cosmic Ray Telescope for the Effects of Radiation (CRaTER)

Harlan E. Spence, PI

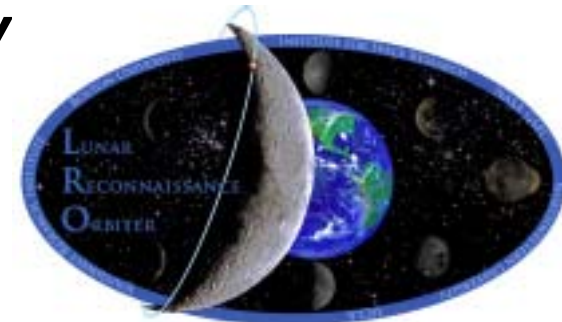
Boston University

Center for Space Physics and

Department of Astronomy

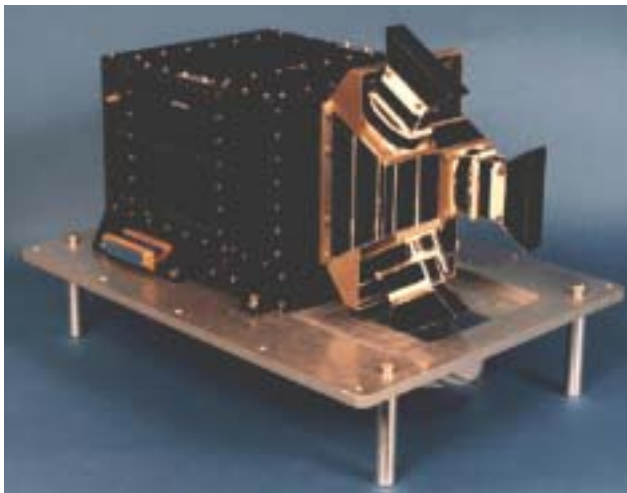


LRO CRaTER TIM
MIT, 14 April 2005

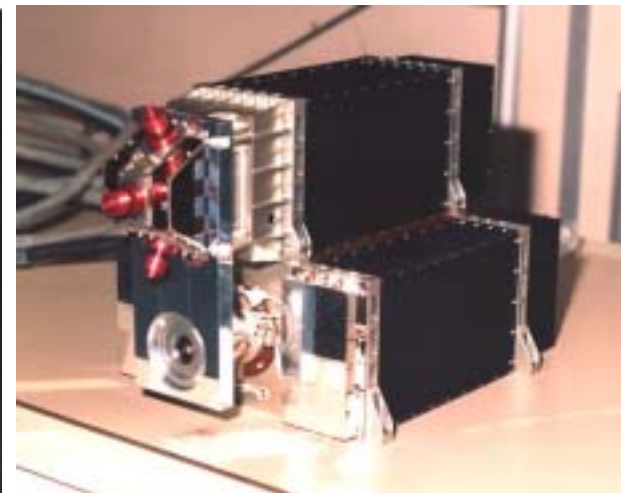
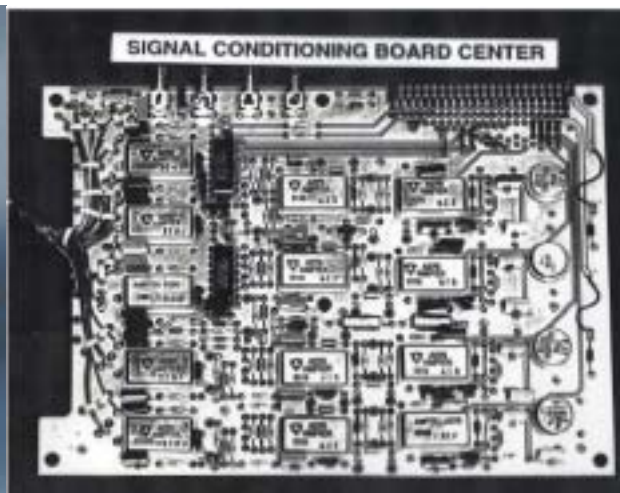


Background

- PhD, Earth and Space Science, UCLA, 1989
- Senior Member of the Technical Staff, The Aerospace Corporation, 1989-1994 (“casual status” now)
- Professor of Astronomy, Boston University, 1994-present
- Lead instrument scientist of Imaging Proton Spectrometer on NASA/POLAR s/c (led design, development, testing, and calibration)
- Co-investigator on CEPPAD and CAMMICE energetic particle instruments on POLAR
- Co-investigator on energetic particle instrument suite on SMART consortium for NASA/MMS Mission (in Phase A downselect)



NASA POLAR IPS instrument and analog board



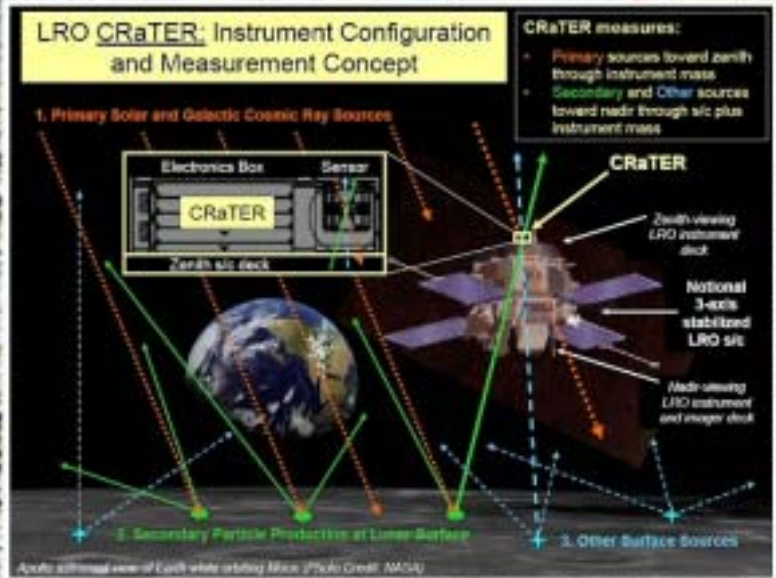
POLAR CEPPAD

Science/Measurement Overview

CRaTER Objective:

“To characterize the global lunar radiation environment and its biological impacts.”

“...to address the prime LRO objective and to answer key questions required for enabling the next phase of human exploration in our solar system.”



CRATER
COSMIC RAY TELESCOPE FOR THE EFFECTS OF RADIATION

A proposal submitted by Boston University to NASA in response to the AO for Lunar Reconnaissance Orbiter Measurement Investigations

Principal Investigator: Prof. Harlan E. Spence, Boston University
Co-Investigators: Dr. J. Bernard Blake, The Aerospace Corporation
Dr. Justin Kasper, MIT
Dr. Larry Kepko, Boston University
Dr. Joseph Mazur, The Aerospace Corporation
Prof. Lawrence Townsend, Univ. of Tennessee, Knoxville

Collaborators: Dr. Michael Golightly, Air Force Research Laboratory
Dr. Terrance Onsager, NOAA/SEC

LRO CRaTER: Instrument Configuration and Measurement Concept

CRaTER measures:

- Primary sources toward zenith through instrument mass
- Secondary and Other sources toward nadir through sic plus instrument mass

CRaTER

- Zenith-viewing LRO instrument deck
- Nadir-viewing LRO instrument and imager deck
- National 3-axis stabilized LRO sic

1. Primary Solar and Galactic Cosmic Ray Sources

2. Secondary Particle Production at Lunar Surface

3. Other Surface Sources

Small inset diagram showing the instrument configuration: Electronics Box, Sensor, CRaTER, and Zenith sic deck.

Graphic: National Science Foundation/Courtesy of NASA/JPL/ASU/CRaTER

Relationship of CRaTER Measurement Goals to LRO Mission Objectives

Highest-priority
LRO Objective

Characterization of the global lunar radiation environment and its biological impacts and potential mitigation, as well as investigation of shielding capabilities and validation of other deep space radiation mitigation strategies involving materials.

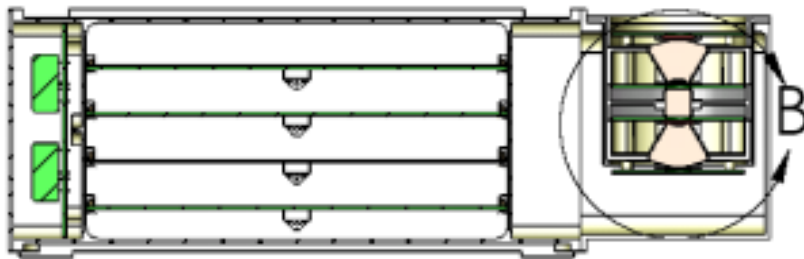
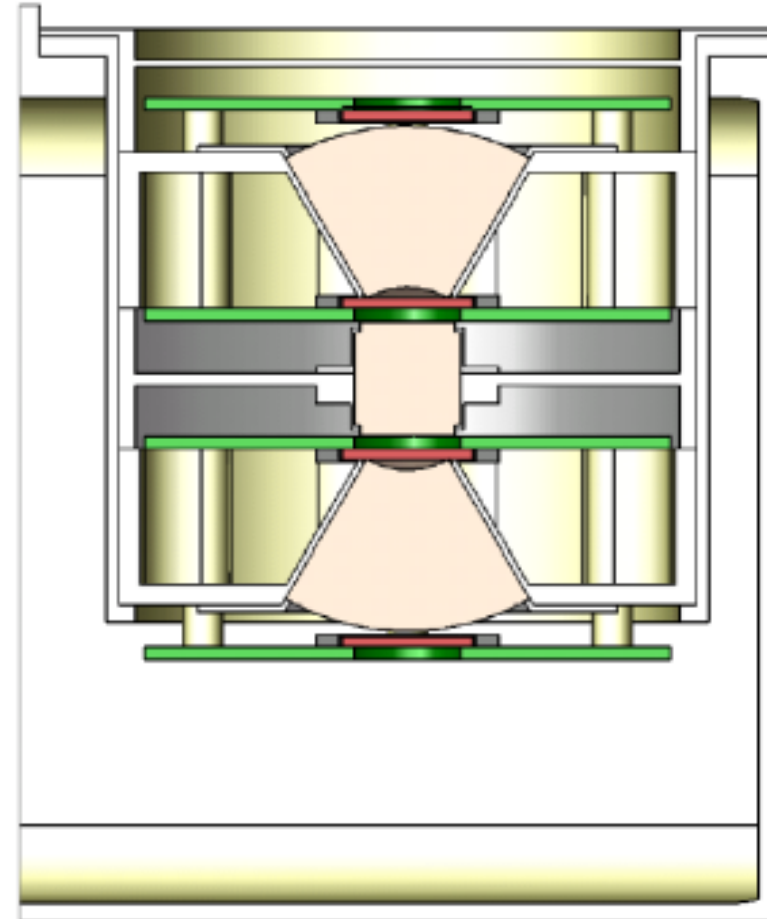
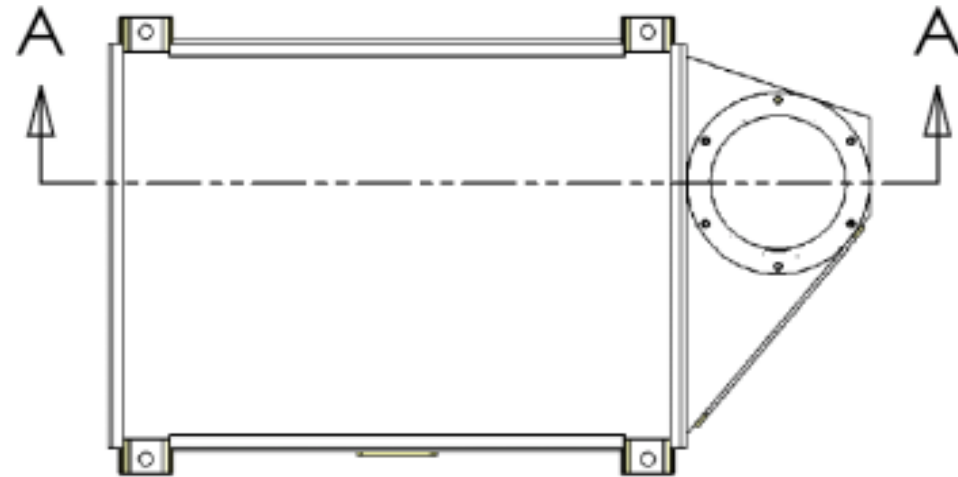
CRaTER
Objective

To characterize the global lunar radiation environment and its biological impacts.

CRaTER
Measurement
Goals

- 1. Measure and characterize that aspect of the deep space radiation environment, LET spectra of galactic and solar cosmic rays (particularly above 10 MeV) and their secondaries, most critically important to the engineering and modeling communities to assure safe, long-term, human presence in space*
- 2. Develop a novel instrument, steeped in flight heritage, that is simple, compact, and comparatively low-cost, but with a sufficiently large geometric factor needed to measure LET spectra and its time variation, globally, in the lunar orbit.*
- 3. Investigate the effects of shielding by measuring LET spectra behind different amounts and types of areal density, including tissue-equivalent plastic.*
- 4. Test models of radiation effects and shielding by verifying/validating model predictions of LET spectra with LRO/CRaTER measurements, using high-quality GCR and SCR spectra available contemporaneously on ongoing/planned NASA (ACE, STEREO, SAMPEX) and other agency spacecraft (NOAA-GOES).*

CRaTER Conceptual Design as Proposed



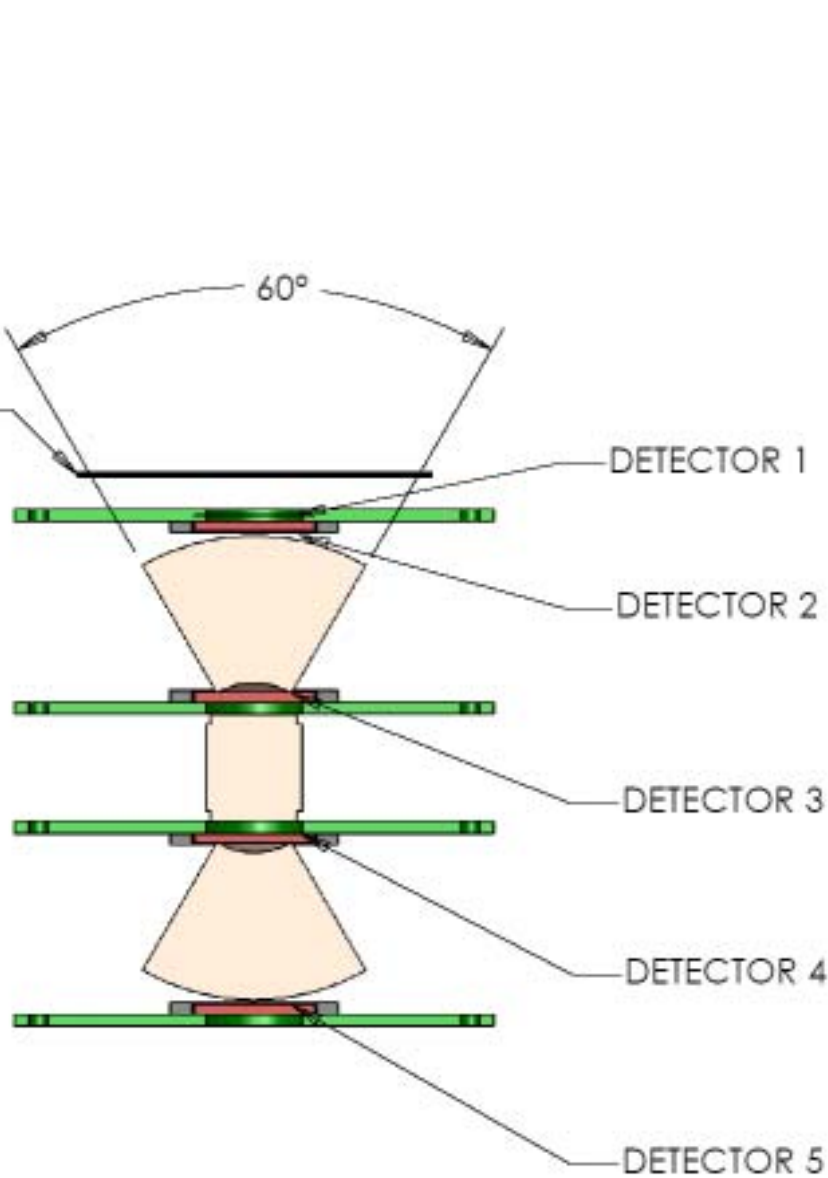
SECTION A-A

DETAIL B
SCALE 1 : 1

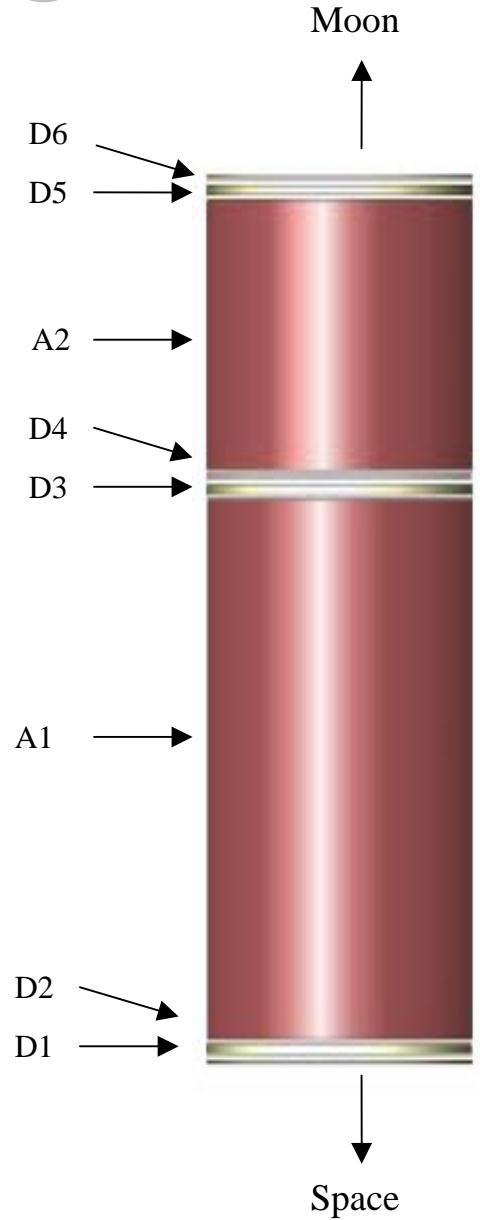
Science Trades

- As proposed design has evolved in response to selection debrief and as a result of detailed knowledge of s/c configuration and instrument accommodation
- Science trade studies ongoing that are refining telescope configuration – basic design is unchanged, but internal configuration has been modified in response to simulation studies
- One science driver that affects engineering is interplay between angular opening/length of scope/detector area – Justin Kasper will show more about this later
- Trade studies are still underway...

CRaTER Telescope Configuration

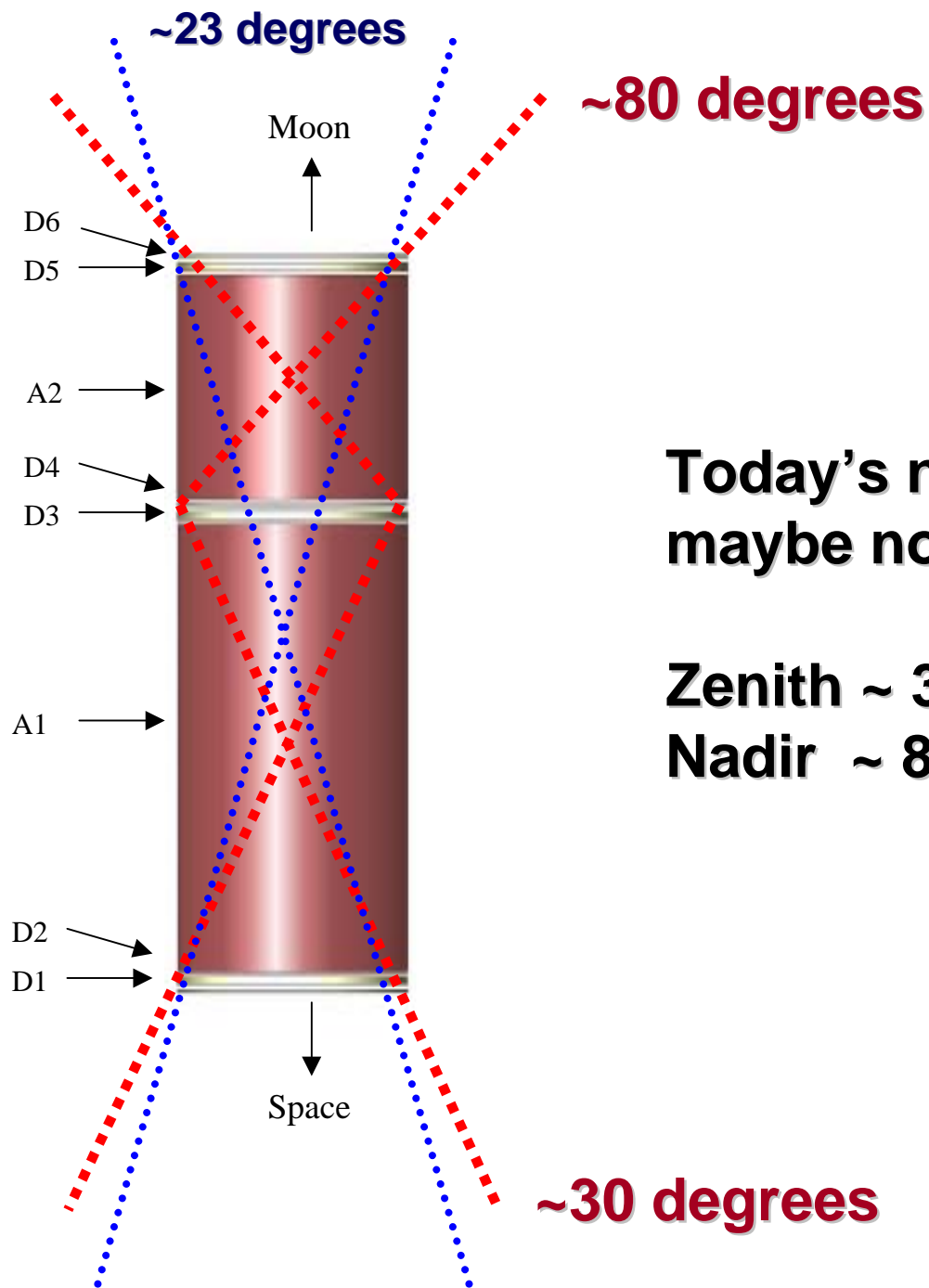


Cylindrical telescope rather than conical



Five-element detector stack with 3 volumes of TEP sandwiched between

Six-element detector stack with 2 volumes of TEP sandwiched between



Today's numbers (but maybe not tomorrow's...)

Zenith ~ 30° full angle
Nadir ~ 80° full angle