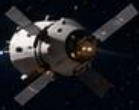


Space Diplomacy



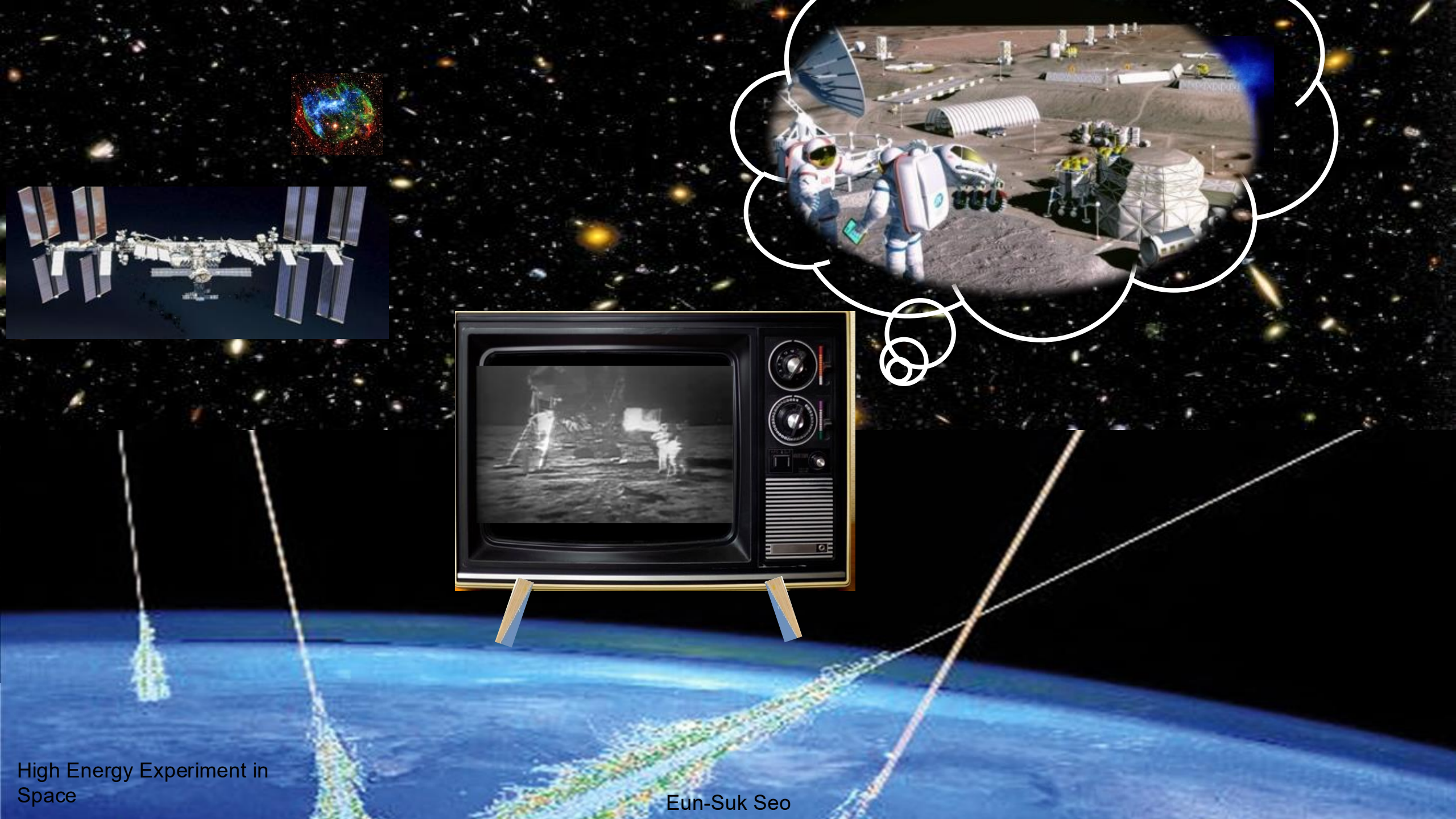
Eun-Suk Seo, Ph.D.
Professor of Physics
University of Maryland

Space Diplomacy

- Space has emerged as a new venue for global powers to compete and create dominance in competition and cooperation. The highly complex space technology offers international recognition, status and projects its soft-power.
- The art and practice of using space to conduct foreign affairs and advance national interests is Space Diplomacy.
- Efforts to advance continued U.S. space leadership and expand **international cooperation** on mutually beneficial space activities, while promoting **responsible behavior** from all space actors, strengthening the understanding of, and support for, U.S. national space policies and programs, and promoting international use of U.S. space capabilities, systems, and services.



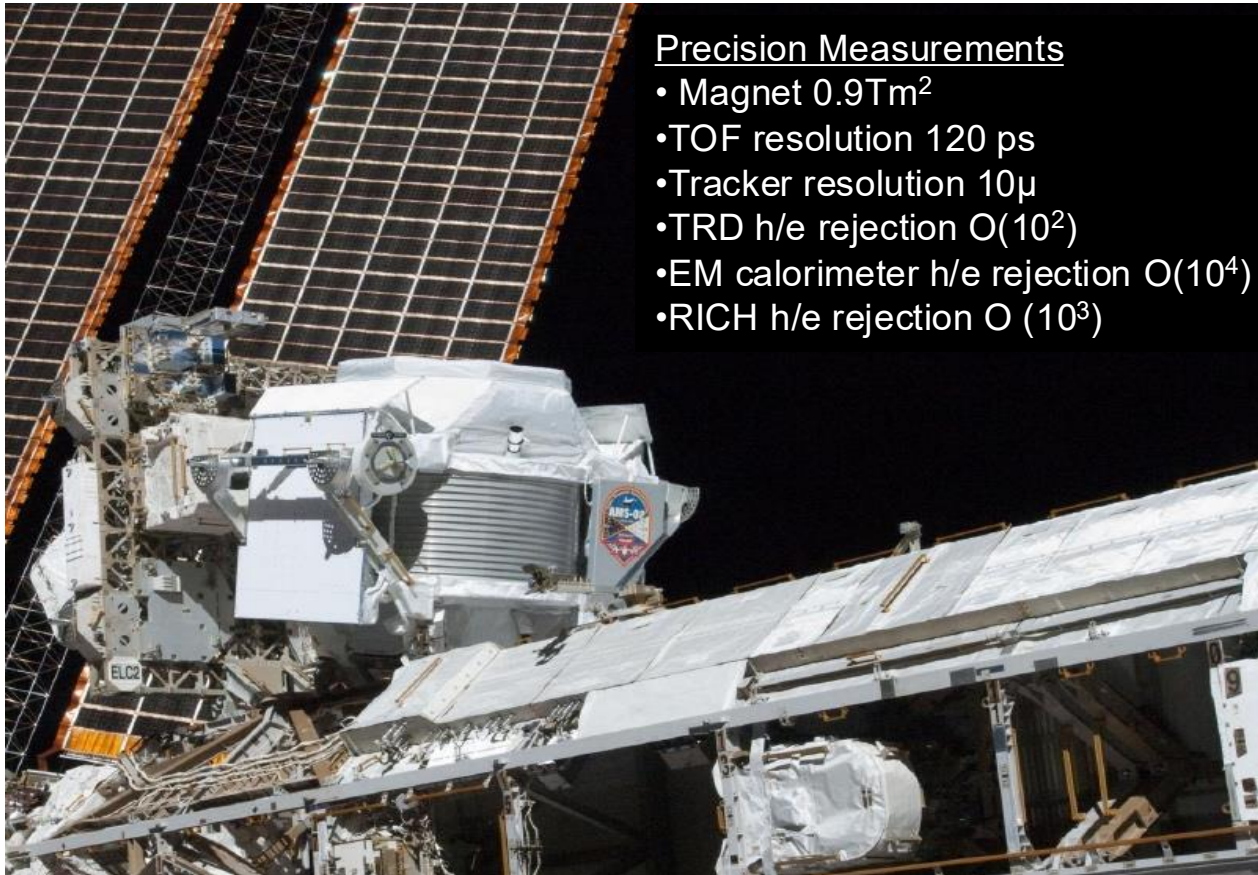
국익위한 전략적 국제협력



High Energy Experiment in Space

Eun-Suk Seo

- Search for dark matter by measuring positrons, antiprotons, antideuterons and γ -rays with a single instrument
- Search for antimatter on the level of $< 10^{-9}$

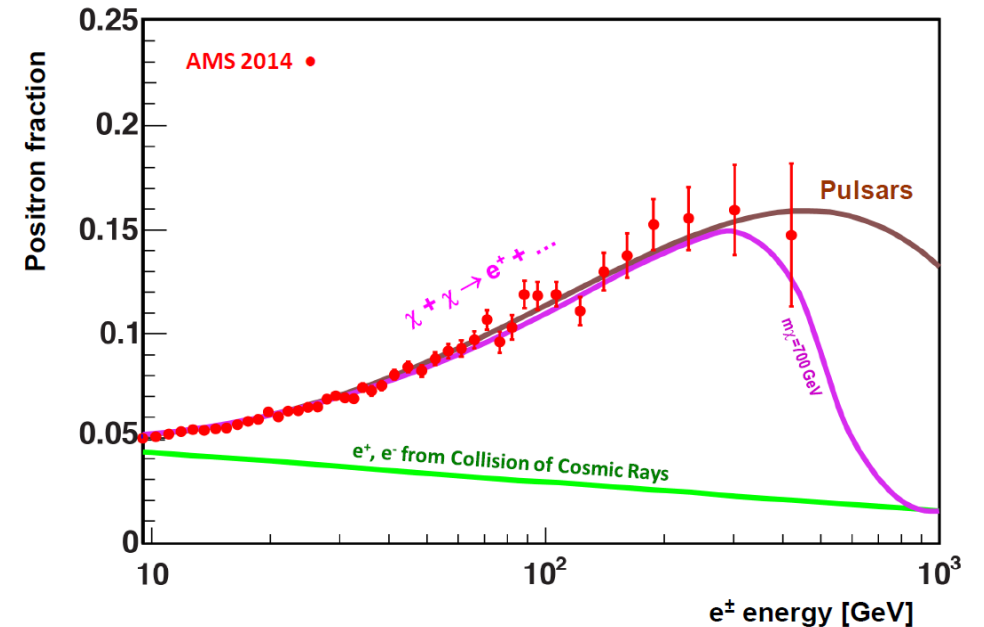


Precision Measurements

- Magnet 0.9Tm^2
- TOF resolution 120 ps
- Tracker resolution 10μ
- TRD h/e rejection $O(10^2)$
- EM calorimeter h/e rejection $O(10^4)$
- RICH h/e rejection $O(10^3)$

High Statistics Measurement of the Positron Fraction in Primary Cosmic Rays of 0.5–500 GeV with the Alpha Magnetic Spectrometer on the ISS

Accado et al., PRL 113, 121101, 2014





SUBSCRIBE
RENEW
DIGITAL EDITIONS
GIVE A GIFT

Home / News /

Latest measurements from the AMS experiment unveil new territories in the flux of cosmic rays

Like 1 Tweet 11 +1 6 Share 4

Latest measurements from the AMS experiment unveil new territories in the flux of cosmic rays

The excess positrons in the flux could be an indicator of dark matter particles annihilating into pairs of electrons and positrons.

By CERN, Geneva, Switzerland | Published: Friday, September 19, 2014

RELATED TOPICS: [SPACE PHYSICS](#) | [COSMIC RAYS](#)

"With AMS and with the LHC to restart in the near future at energies never reached before, we are living in very exciting times for particle physics as both instruments are pushing boundaries of physics," said CERN Director-General Rolf Heuer.

LATEST NEWS



Pulse of a dead star powers intense gamma rays

NBC NEWS HOME TOP VIDEOS MORE

AMS Space Experiment Sees Hints of Dark Matter Particles

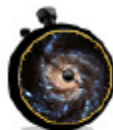
NASA

Scientists behind the \$2 billion Alpha Magnetic Spectrometer experiment are reporting new data pointing toward the potential

SCIENTIFIC AMERICAN™

Permanent Address: <http://www.scientificamerican.com/podcast/episode/dark-matter-looks-wimpy/>

Space » 60-Second Space

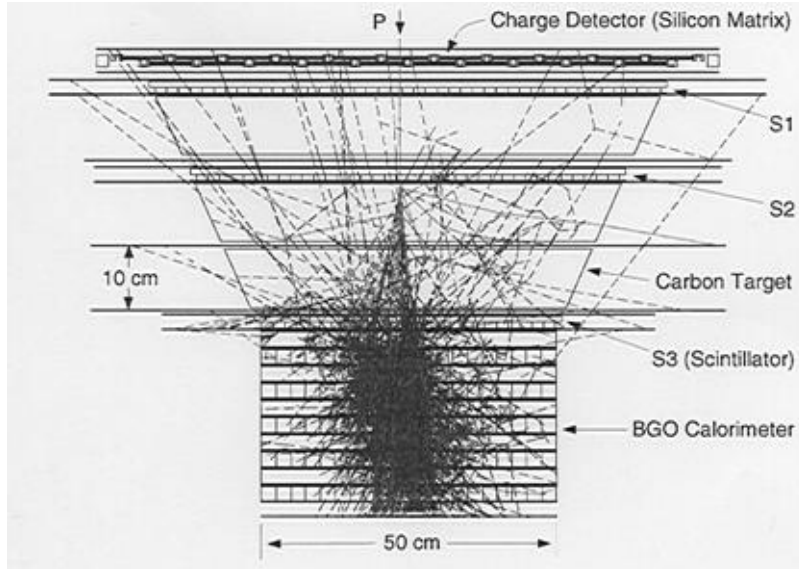


Dark Matter Looks WIMPY

Data from the International Space Station-based Alpha Magnetic Spectrometer experiment supports the idea that dark matter consists of the invisible particles called weakly interacting massive particles, or WIMPs. Clara Moskowitz reports

Sep 24, 2014 | By Clara Moskowitz |

Seo et al. *Adv. in Space Res.*, **19** (5), 711, 1997; Ganel et al. *NIM A*, **552**(3), 409, 2005



nature International weekly journal of science

Cited > 200 times in ~ 9 mo

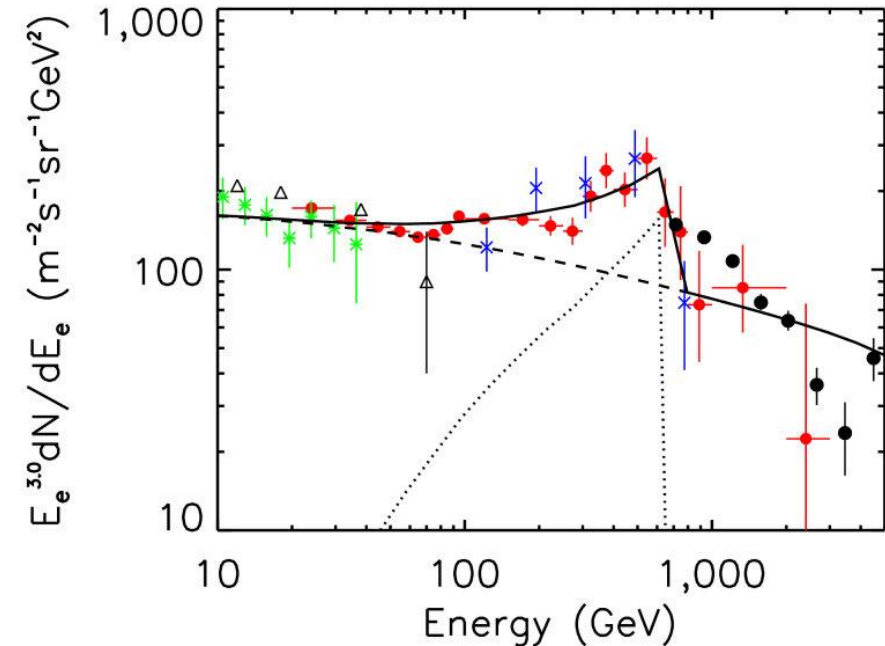
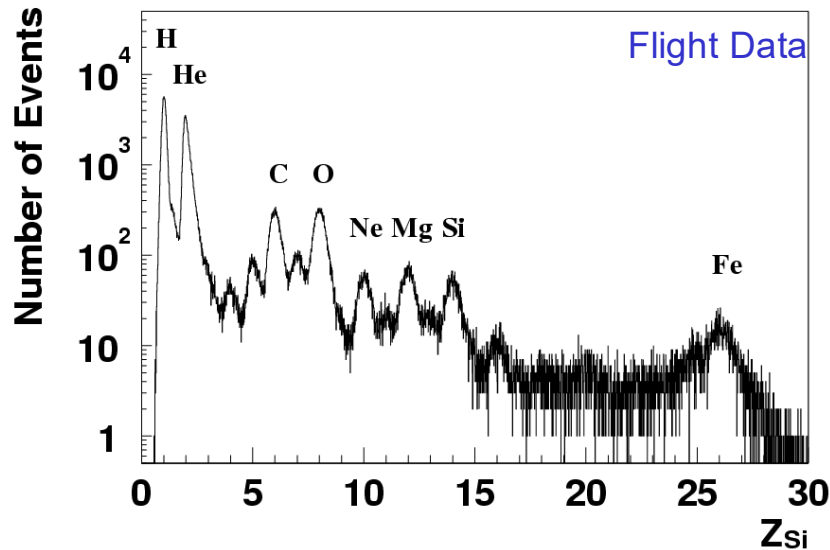
Letter

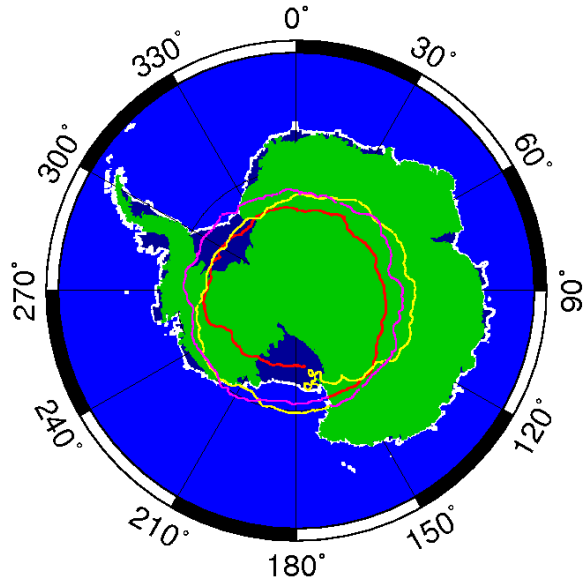
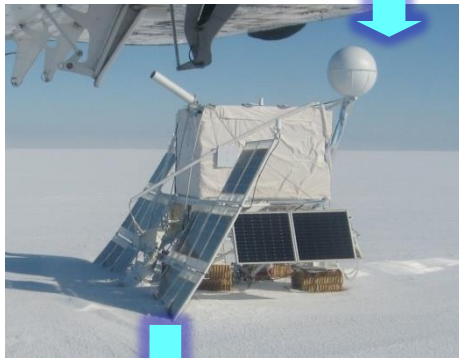
Nature **456**, 362–365 (20 November 2008) | doi:10.1038/nature07477; Received 23 May 2008; Accepted 1 October 2008

An excess of cosmic ray electrons at energies of 300–800 GeV

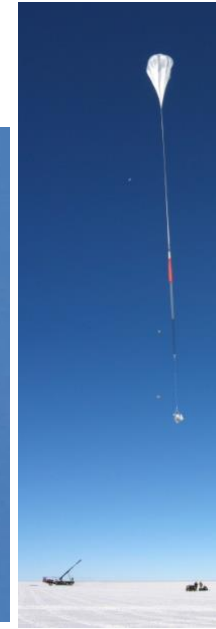
J. Chang^{1,2}, J. H. Adams³, H. S. Ahn⁴, G. L. Bashindzhagyan⁵, M. Christl³, O. Ganel⁴, T. G. Guzik⁶, J. Isbert⁶, K. C. Kim⁴, E. N. Kuznetsov⁵, M. I. Panasyuk⁵, A. D. Panov⁵, W. K. H. Schmidt², E. S. Seo⁴, N. V. Sokolskaya⁵, J. W. Watts³, J. P. Wefel⁶, J. Wu⁴ & V. I. Zatsepin⁵

1. Purple Mountain Observatory, CAS, 2 West Beijing Road, Nanjing 210008, China
 2. Max Planck Institute for Solar System Research, 2 Max Planck-Strasse, Katlenburg-Lindau 37191, Germany
 3. Marshall Space Flight Center, Huntsville, Alabama 35812, USA
 4. University of Maryland, Institute for Physical Science & Technology, College Park, Maryland 20742, USA
 5. Skobel'syn Institute of Nuclear Physics, Moscow State University, Leninskie gory, GSP-1, Moscow 119991, Russia
 6. Louisiana State University, Department of Physics and Astronomy, Baton Rouge, Louisiana 70803, USA





Typical duration: ~1 month/flight



Instruments are fully recovered, refurbished & reflight.



- The CREAM instrument had seven successful Long Duration Balloon (LDB) flights over Antarctica and accumulated 191 days of data.
- This longest known exposure for a single balloon project verifies the instrument design and reliability.

ISS-CREAM: CREAM for the ISS

SpaceX-12 Launch on 8/14/2017

ASTROPHYSICS

Cosmic ray catcher will probe supernovae from new perch

Balloon-borne detector moves to space to trap rare, high-energy particles that carry clues to their origin

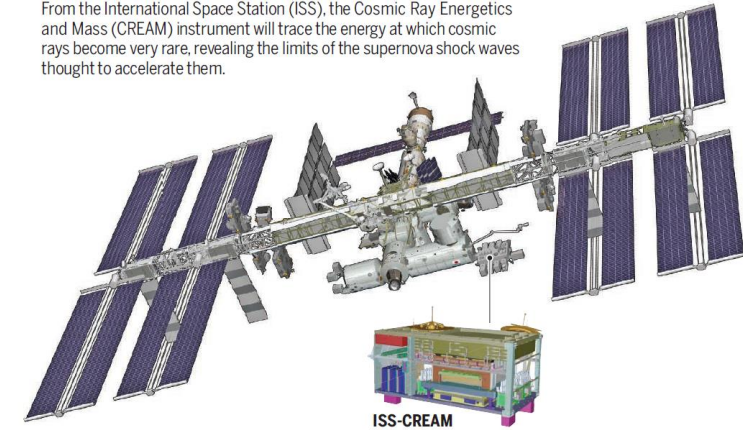
By Eric Hand

After 191 days aboard balloons sailing the stratosphere, an experiment designed to probe the galaxy's natural particle accelerators will move to higher ground: the International Space Station (ISS). The Cosmic Ray Energetics and Mass (CREAM) instrument and its successors floated above Antarctica seven times to collect high-energy cosmic rays, charged particles like protons and



Aiming high

From the International Space Station (ISS), the Cosmic Ray Energetics and Mass (CREAM) instrument will trace the energy at which cosmic rays become very rare, revealing the limits of the supernova shock waves thought to accelerate them.



Downloaded from <http://science.sciencemag.org/> on August 11, 2017

History of the ISS & Space Shuttle

- 1981.4.12 first Space Shuttle launch
- 1984.1.25 Reagan Directs NASA to build a space station
- President Ronald Reagan's State of the Union address directs NASA to build a space station within the next 10 years.
- 1986 Challenger launch failure
- 1991 Endeavour to replace Challenger
- 1993 Freedom to Alpha
- 1998.11.20 First ISS Segment Launches
- 1998.12.4 First U.S.-built component launches
- 2000.11.2 First crew to reside on station
- 2003 Columbia re-entry failure
- 2005. U.S. lab recognized as newest U.S. national laboratory
- 2008.2.7 ESA Columbus Lab becomes part of the station
- 2008.3.11 Japanese Kibo lab joins ISS
- 2010.11.2 ISS 10-yr anniversary of continuous human occupation
- 2011.7.21 STS-135 Final Visit to the ISS **Beginning of a new chapter with commercialization**



올드 스페이스에서 뉴 스페이스로

4차 산업혁명이 도래함에 따라 정부가 개발 사업을 제시하면 기업이 납품했던 정부주도 방식인 올드 스페이스에서
민간이 우주개발을 주도하는 뉴스페이스 시대로 발전

정부주도산업

- : 과거 우주개발은 군사, 안보, 경제개발, 과학지식, 국가위상제고를 위해 국가주도로 시행
- : 민간기업이 뛰어들기에는 우주산업은 사업성이 없고 위성과 같은 하드웨어 개발비용이 막대했음
- : 정부 주도적인 폐쇄적 시장



민간산업

- : 위성, 발사체같은 하드웨어 중심에서 상상력과 아이디어를 기반으로 한 소프트웨어 산업으로 변화
- : 민간주도의 개방적이고 경쟁적인 시장
- : 발사체나 위성제작 같은 하드웨어 기술 없이도 우주의 상업적 가능성에 기반한 새로운 비즈니스 모델을 제시하며 기회를 창출

모건 스탠리, 세계 민간 우주 산업이

2040년 1조 1000억 달러(약 1240조) 규모로 성장할 것이라 전망



Making History

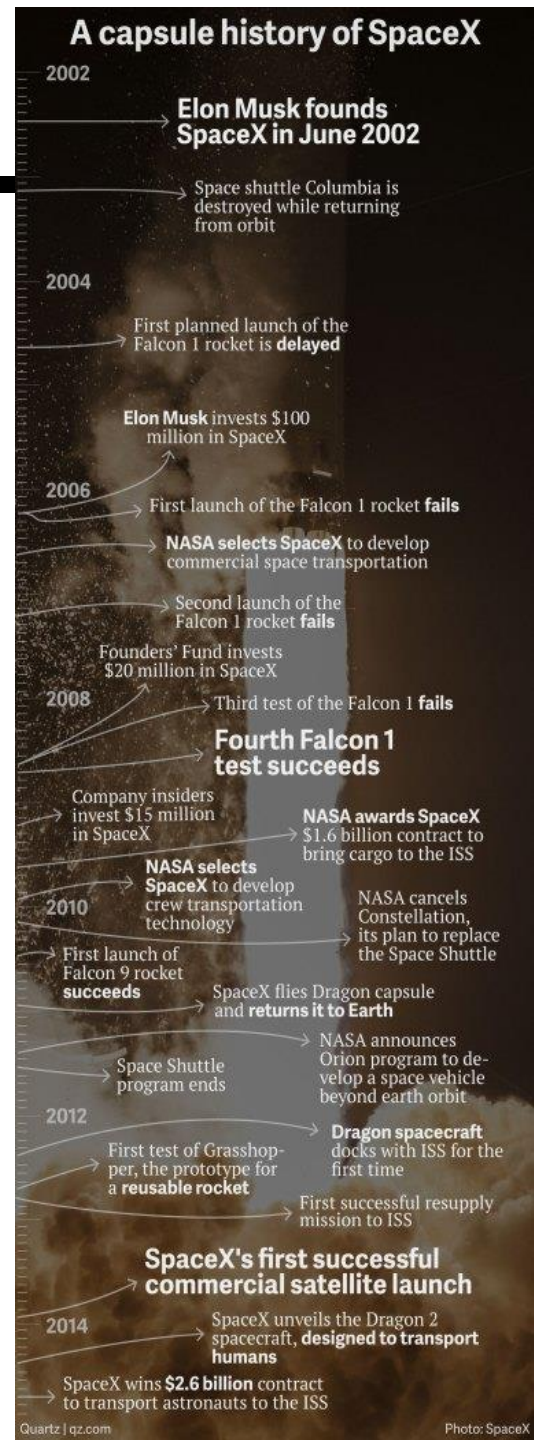
- 2008.12 NASA awards SpaceX \$1.6B Commercial Resupply Services (CRS) contract.
- 2009.7 Falcon 1 Flight 5 makes history, becoming the first privately developed liquid fuel rocket to deliver a commercial satellite to Earth orbit
- 2010.12 Dragon became the first privately developed spacecraft in history to re-enter from low-Earth orbit.
- 2012.5 Dragon becomes the first private spacecraft in history to visit the space station.



SPACE EXPLORATION TECHNOLOGIES CORP.

MUTUAL NONDISCLOSURE AGREEMENT

This Mutual Nondisclosure Agreement (the “Agreement”) is made as of 24 January 2012 (“Effective Date”), by and between SPACE EXPLORATION TECHNOLOGIES CORP., a Delaware corporation with a place of business at 1 Rocket Road, Hawthorne, California 90250 (“SpaceX” or “Company”) and the University of Maryland, a public agency and instrumentality of the State of Maryland, located College Park, Maryland, 20742 (“Counterparty”).



Export Control



United States Department of State

*Bureau of Political-Military Affairs
Directorate of Defense Trade Controls*

Washington, D.C. 20522-0112

DEC 1 2 2011

In Reply refer to
DDTC Case CJ-1085-11

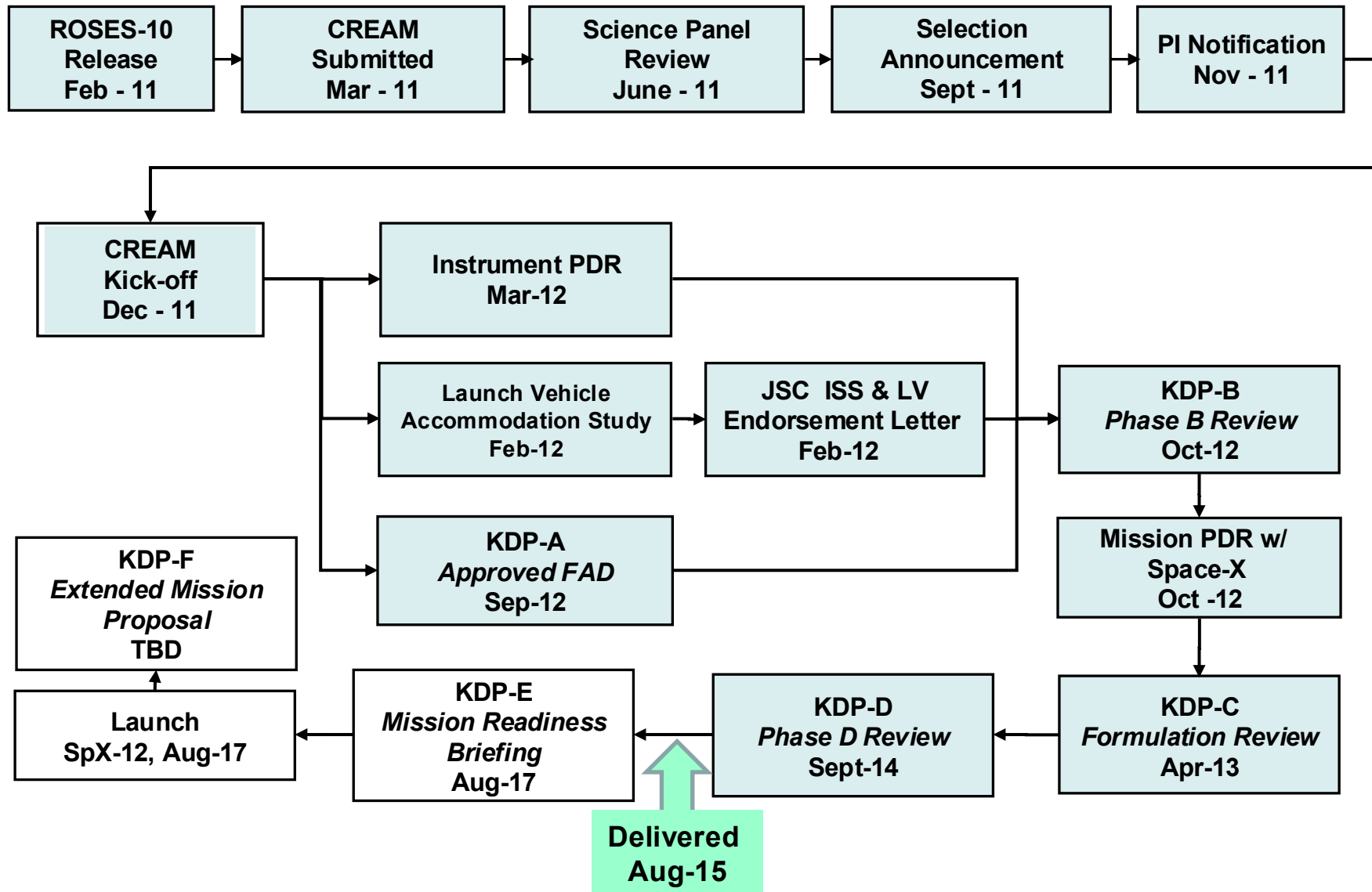
YOUR LETTER DATED: November 7, 2011

COMMODITY JURISDICTION DETERMINATION FOR: **Cosmic Ray
Energetics and Mass (CREAM) instrument**

US laws that regulate the distribution to foreign nationals and foreign countries of strategically important products, services and information for reasons of foreign policy and national security.


Mass (CREAM) instrument is not subject to the licensing jurisdiction of the Department of State. The Department of Commerce (DOC) advises that this item

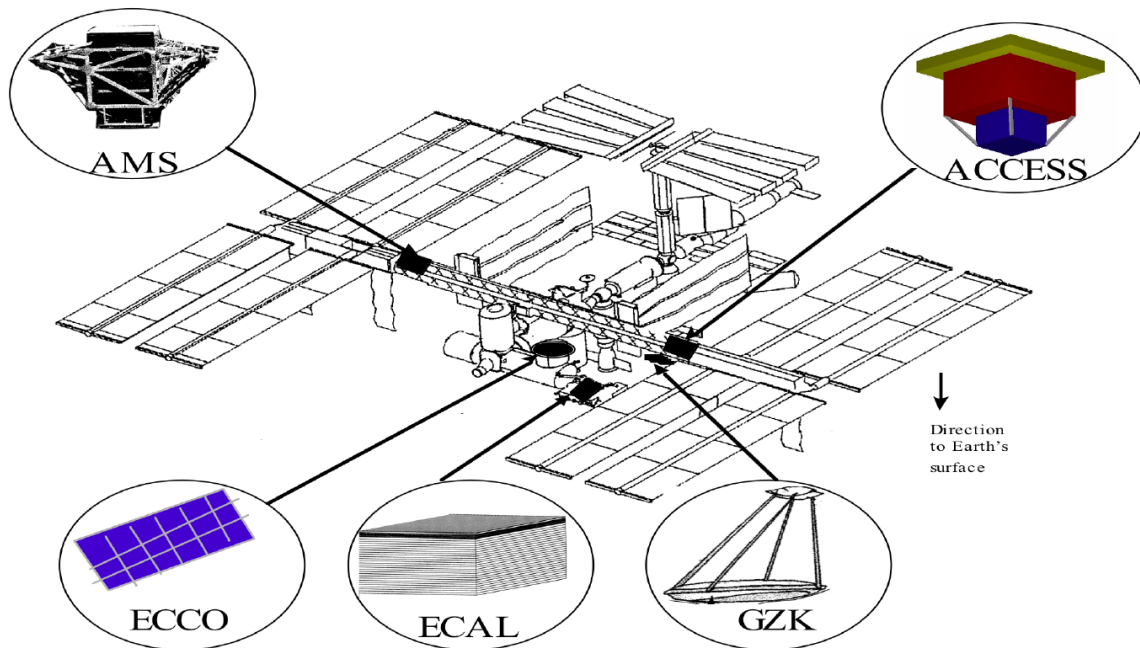
ISS-CREAM: Key Decision Points and Milestones



From Vision to Mission

- NASA-Korea Investigators Consultative Group (ICG) 1997 - 2002
- ACCESS Investigators Working Group (IWG) 1998 - 2001

 "The ISS as an Observatory for Cosmic-Ray Physics and Astrophysics"
W. Vernon Jones, STAIF-99



US Space Policy

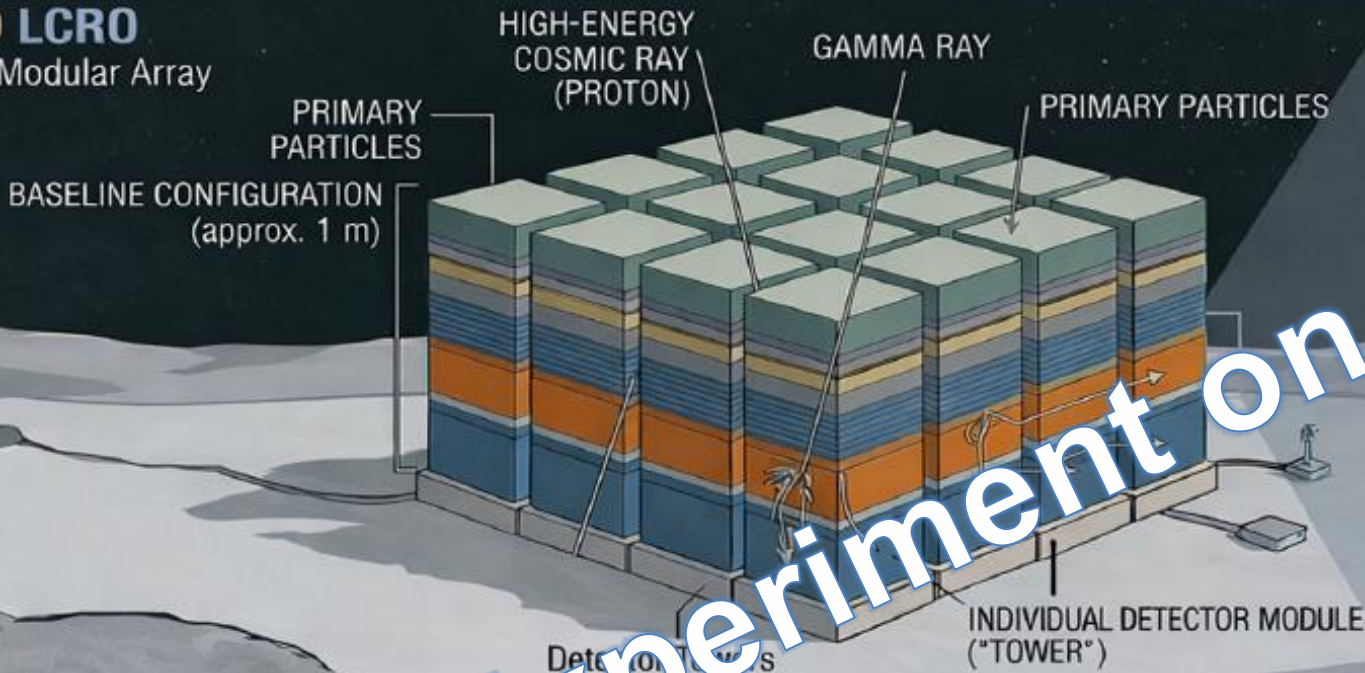


- Global Leadership & Exploration: Driving human exploration through the **Artemis program** to establish a sustainable presence on the Moon and prepare for Mars.
- Promoting Commercialization: Leveraging private-sector innovation to lower costs and lead in the emerging space economy.
- National Security: Modernizing the U.S. Space Force and satellite architectures to deter aggression and maintain superiority in a contested domain.
 - Geopolitical competition—particularly with China—is a central driver of modern policy. U.S. strategy focuses on maintaining technological advantages and strategic freedom of action in orbit to counter potential threats from foreign satellite maneuvering and anti-satellite capabilities.
- Sustainability & Norms: Prioritizing Space Situational Awareness and international cooperation to manage orbital congestion and prevent collisions.

LUNAR COSMIC RAY OBSERVATORY (LCRO) | CONCEPTUAL DETECTOR SYSTEM

FULLY-DEPLOYED LCRO

Progressively Deployable Modular Array



High Energy Experiment on the Moon

PHASED DEPLOYMENT STRATEGY

1 MISSION 1: PATHFINDER TOWER

Initial operation
Validation of environment
Core science return

2 SUBSEQUENT MISSIONS: EXPANSION

CLPS lander
Incremental Growth
2-5 Towers
Increased Collecting Area
Time: 5-6 YRS

3 EXPANDED FULL OBSERVATORY

Large-Area Array (>10m²)
Statistical significance at knee (~3×10¹⁵ eV)
Long-term operation (10-15 years)
10-15 YRS

KEY ADVANTAGES & OBJECTIVES

ADVANTAGES

Experiment Type	Measurement	Area
GROUND-BASED EXPERIMENTS	INDIRECT	Small
LOW EARTH ORBIT (LEO) INSTRUMENTS	DIRECT, SMALL AREA	Small
LCRO	DIRECT, LARGE AREA	Large

Uniquely high measurement precision, and large collecting power

SCIENCE OBJECTIVES addressed

- Origin of Cosmic Ray "Knee"
- Precision Composition Measurements (TeV–PeV)
- Sources of Electrons & Positrons
- Gamma Ray Observations (Galactic Center, Diffuse Emission)

TECHNOLOGY & MISSION INTERFACE

- Leverages Lunar South Pole Infrastructure
- Modular & Synchronized Units
- Compatible with Commercial Lunar Payload Services (CLPS)
- Supports Long-Duration Lunar Exploration