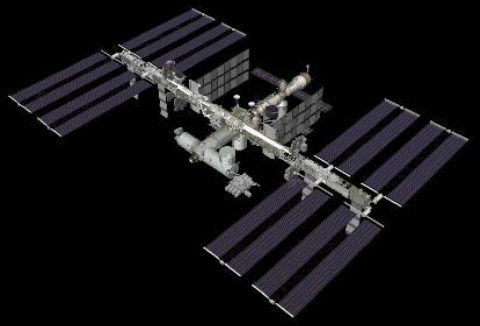
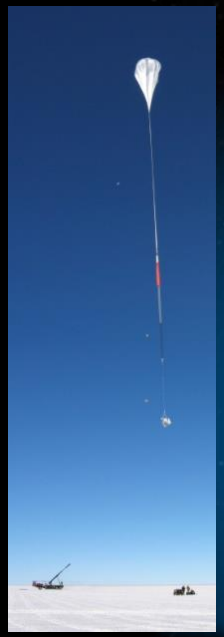
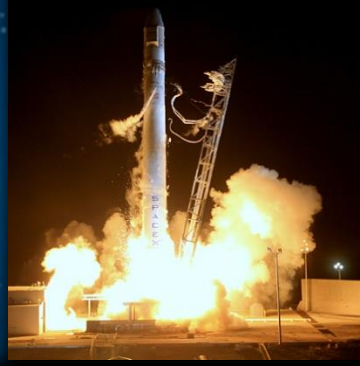
APS April Meeting, April 13, 2015

Cosmic Ray Science Interest Group

CosmicSIG







Eun-Suk Seo
seo@umd.edu
Inst. for Phys. Sci. & Tech. and
Department of Physics
University of Maryland

PAGs and SIGs

http://pcos.gsfc.nasa.gov/physpag/

NASA Science Mission Directorate Astrophysics Division Programs

- Exoplanet Exploration (EXEP) Program Analysis Group (ExoPAG)
- Cosmic Origins (COR) Program Analysis Group (CoPAG)
- **Physics of the Cosmos (PCOS) Program Analysis Group (PhysPAG)**
  - IPSIG (Inflation Probe SIG)
  - GWSIG (Gravitational Wave SIG)
  - XRSIG (X-ray SIG)
  - GammaSIG (Gamma ray SIG)
  - TechSAG (Technology)
  - **CosmicSIG (Cosmic Ray SIG)** approved in 2012
    - The goals of the Cosmic Ray Science Interest Group (CosmicSIG) are to provide quantitative metrics and assessments to NASA in regard to current and future needs of the cosmic-ray astrophysics community and to act as a focal point and forum for the cosmic ray community.
    - PAG Executive Committee members are appointed by NASA with the concurrence of the Astrophysics Subcommittee, and their responsibilities include collecting and summarizing community input with subsequent reporting to NASA SMD via the NAC.
      - ❖ Angela Olinto (2013-2015)
      - ❖ Eun-Suk Seo (2014-2016)

Preparing for the 2020 Decadal Survey

Preparing for the 2020 Decadal Survey
Large Mission Concepts

Part A – 2015

- Identify a small set of candidate large mission concepts to study
  - Incorporate community input through the three Astrophysics Program Analysis Groups (PAGs)

Part B – 2016-2019

- Initiate studies
  - Includes community-based Science and Technology Definition Teams
- Conduct studies
  - Includes NASA Center-provided engineering teams
- Identify technology requirements to motivate early technology development
  - Enables funding through existing Astrophysics technology programs
- Deliver results to 2020 Decadal Survey committee

Planning for the 2020 Decadal Survey: An Astrophysics Division White Paper
available at http://science.nasa.gov/astrophysics/documents

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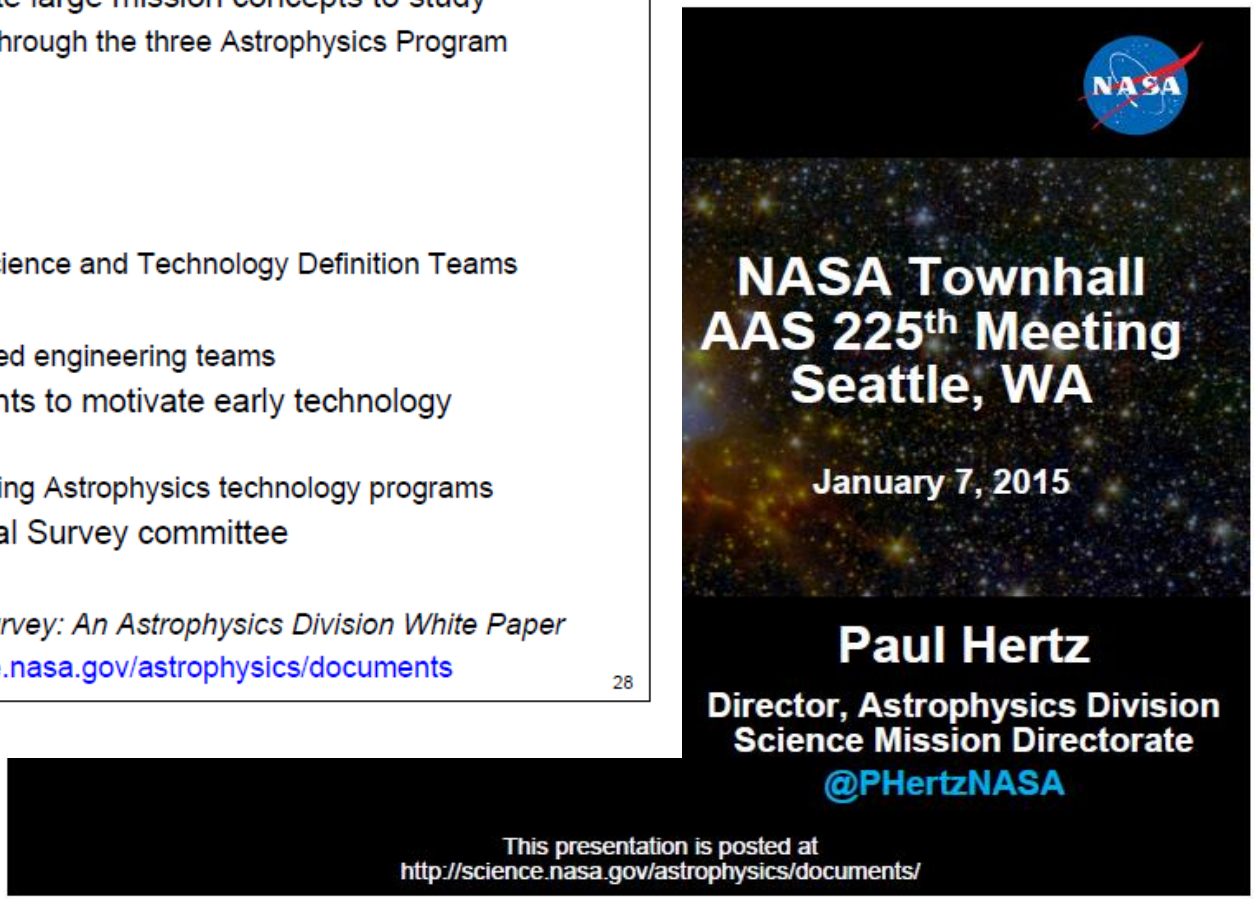


The 4 mission candidates

National Aeronautics and
Space Administration
Headquarters
Washington, DC 20546-0001

Charge to the Astrophysics PAGs regarding Large Mission Concept Studies
January 4, 2015

Background

One of the important tasks of the 2020 Decadal Survey will be to prioritize large missions to follow JWST (the highest priority large space mission of the 2000 Decadal Survey) and WFIRST (the highest priority large space mission of the 2010 Decadal Survey). To enable this prioritization, NASA will provide information on several candidate large mission concepts for consideration by the 2020 Decadal Survey Committee.

Existing strategic planning documents, including the 2010 Decadal Survey, *New Worlds, New Horizons in Astronomy and Astrophysics*, and the NASA Astrophysics Visionary Roadmap, *Enduring Quests, Daring Visions: NASA Astrophysics in the Next Three Decades*, provide candidate mission concepts for the large missions that will follow JWST and WFIRST and could be developed in parallel to ESA's Euclid, Athena, and L3 missions in which NASA is participating. These documents have been developed by the astrophysics community and provide the starting point for planning future missions.

Taking into account current programmatic considerations, NASA has identified a small set of candidate large mission concepts to be studied sufficiently to provide appropriate information for the consideration of the 2020 Decadal Survey Committee. The members of the small set follow, in alphabetical order.

- Far IR Surveyor – The Astrophysics Visionary Roadmap identifies a Far IR Surveyor with improvements in sensitivity, spectroscopy, and angular resolution.
- Habitable-Exoplanet Imaging Mission – The 2010 Decadal Survey recommends that a habitable-exoplanet imaging mission be studied in time for consideration by the 2020 decadal survey.
- UV/Optical/IR Surveyor –The Astrophysics Visionary Roadmap identifies a UV/Optical/IR Surveyor with improvements in sensitivity, spectroscopy, high contrast imaging, astrometry, angular resolution and/or wavelength coverage. The 2010 Decadal Survey recommends that NASA prepare for a UV mission to be considered by the 2020 decadal survey.
- X-ray Surveyor – The Astrophysics Visionary Roadmap identifies an X-ray Surveyor with improvements in sensitivity, spectroscopy, and angular resolution.

The rationale for this small set of candidate large mission concepts is provided in the Astrophysics Division White Paper, *Planning for the 2020 Decadal Survey*[1].

[1] http://science.nasa.gov/astrophysics/documents

Probes?

- Should be part of process of planning for next decadal survey
  - Could be done outside of this particular flagship process
- Need to have NASA define probes
- Need to understand costing of probes
- Do probes need mission-funded technology development?

CosmicSIG e-mail request to the community

Preparation for the Decadal Survey, 2/12/15

Dear Cosmic ray folks,

You are invited to provide your input on a set of candidate large mission concepts to be studied in preparation of the upcoming Decadal Survey. As some of you may already know, NASA Astrophysics Director Paul Hertz charged 3 Program Analysis Groups (PAGs) to review these candidates and suggest additions, subtractions and other useful comments. The full text of his charge can be found at http://science.nasa.gov/media/medialibrary/2015/01/28/White_Paper_-_Planning_for_the_2020_Decadal_Survey_-signed.pdf

The Cosmic Ray Science Interest Group (CosmicSIG) is asked to provide a paragraph (including the community's reaction to the mission list, possible modifications to that list, what questions need to be answered, and the timescale for further plans) by 2/19, in time for a Physics of the Cosmos PAG (PhysPAG) telecon later this month. Your quick response would be appreciated.

Although the final reports are to focus on Large missions, PAGs can also include appendices, at their discretion, discussing Medium class ("Probe") missions at the <$1B level. So, you are welcome to provide such comments.

CosmicSIG's Response, 2/19/15

- NASA's candidate large mission concepts identify four missions that will provide significant improvements in the IR to UV, and X-ray wavelengths. However, such a program does not take research interests of the cosmic ray community into consideration.
- As highlighted in the NASA Astrophysics Roadmap Enduring Quests Daring Visions (December 2013) a "less apparent component of galaxies" and the intergalactic medium (IGM) are high-energy charged particles, collectively called cosmic rays. These dynamically important particles provide about a third of the interstellar medium (ISM) energy density, and their origin is still unclear. At low energies they may be accelerated by Galactic supernova remnants, pulsars, and interstellar shocks, while at ultrahigh energies their unknown sources are extragalactic. Acceleration of particles is yet to be understood processes in astrophysical sources and their escape into the interstellar and intergalactic medium, the role of cosmic rays in galactic dynamics, their connection to galactic and extragalactic winds and magnetic fields are some of the questions that can be addressed with MIDEX scale missions. The direct measurements of cosmic rays must complement the indirect information that is deduced from observations in radio to gamma-rays and neutrinos. **A comprehensive program of cosmic ray studies must be a part of NASA's plan**.
- The bulk of cosmic ray data have been obtained with great success by balloon-borne instruments. However, to address open questions in cosmic ray astrophysics, future missions require the exposure offered by spaceflight for rare species, such as isotopes, ultra-heavy elements, and high energies ("knee" and above). Isotopic composition measurements of $1 \leq Z \leq 28$ up to ~10 GeV/nucleon that are critical for understanding the interstellar propagation and the origin of elements are still to be accomplished. The cosmic ray composition in the knee (PeV) region holds keys to understanding the origin of cosmic rays. In addition to the forthcoming ISS-CREAM and CALET, a EUSO-like mission for ultrahigh energy cosmic rays and a Super-TIGER-like mission for ultra heavy nuclei could accomplish a vision of a complete cosmic ray observatory on the ISS. **Strong support of the MIDEX category of payloads would be needed for the completion of these missions over the next decade.**

Status & Plan

http://pcos.gsfc.nasa.gov/physpag/

- March 17-18 Astrophysics Subcommittee
- March 19 Joint PAG Executive Committee
- April 13 CosmicSIG
- April 14 PCOS mini-symposium
  10:45 AM Room *Key1*
- May/June Joint PAG Virtual Town Hall
- June 29-July 1 Special HEAD meeting, Chicago
- August 3-14 IAU-AAS meeting, Honolulu
- August Joint PAG Virtual Town Hall
- July – Sept. Write PhysPAG report
- October 2015 Astrophysics Subcommittee

Agenda

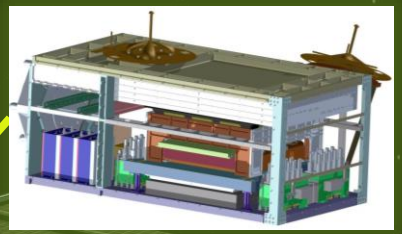
USA Toll Free #: 1-844-467-6272
USA Local/Toll #: 1-720-259-6462
Participant Passcode: #: 152481

- CosmicSIG update: Eun-Suk Seo
- ISS-CREAM Status: Eun-Suk Seo
- Balloon News: W. Vernon Jones
- Antiparticles/antinuclei: John Mitchell
- Light Isotopes: Thomas Hams
- Ultra Heavy nuclei: Bob Binns
- Electrons: Brian Rauch
- EUSO Status: Angela Olinto
- UHE neutrinos: Peter Gorham
- ICRC plan: Tom Gaisser, Francis Halzen, David Kieda et al.

APS April Meeting, April 13, 2015

Cosmic Ray Energetics And Mass for the International Space Station

ISS-CREAM



Eun-Suk Seo

Institute for Physical Science & Technology

Department of Physics

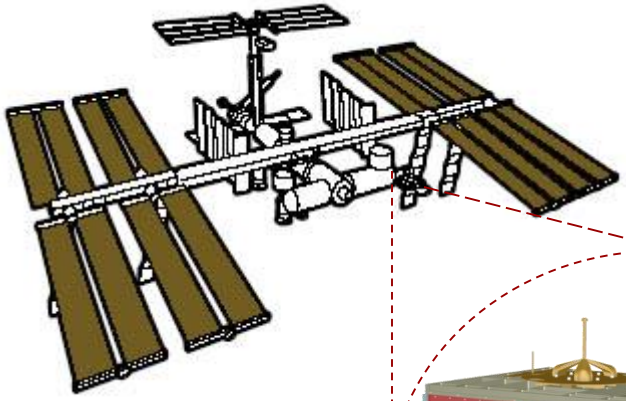
University of Maryland

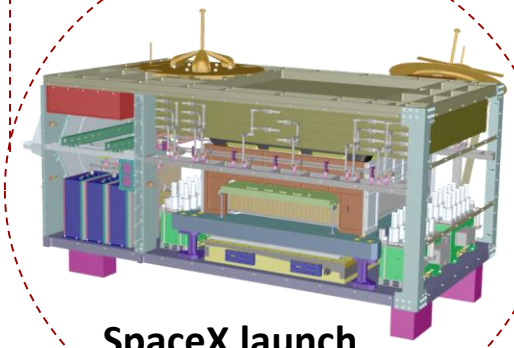
ISS-CREAM
(CREAM for the ISS)

Cosmic Ray Energetics And Mass

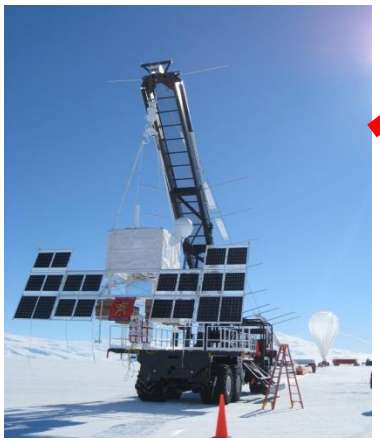
PI: Eun-Suk Seo, University of Maryland

- The balloon-borne CREAM was flown 6 times over Antarctica with ~161 days of total flight time, the longest exposure to date for a single balloon project.
- ROSES 2010 proposal: Building on the success of the balloon flights, the payload is being transformed for accommodation on the ISS (NASA's share of JEM-EF).
- CREAM measures the energy spectra from 10^{12} to $>10^{15}$ eV over the elemental range from protons to iron.
- It extends the energy reach of direct measurements of cosmic rays to the **highest energy possible** to probe their origin, acceleration and propagation.





SpaceX launch



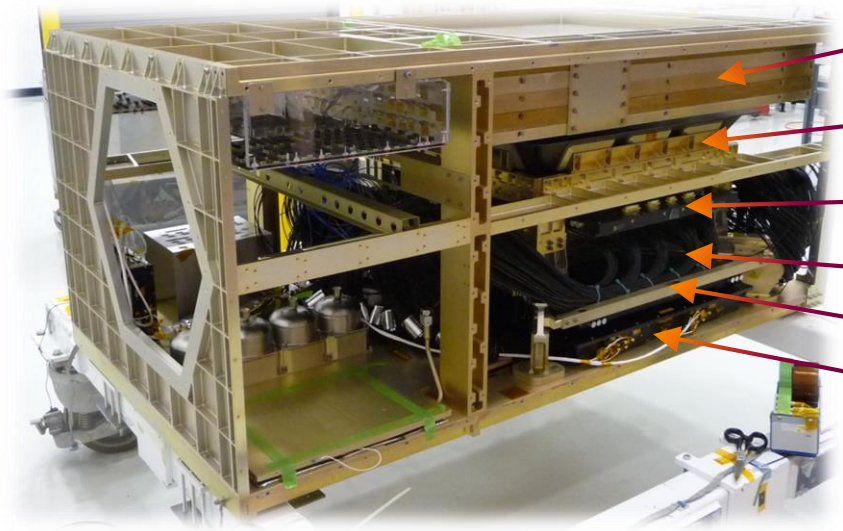
Increase the exposure by an order of magnitude

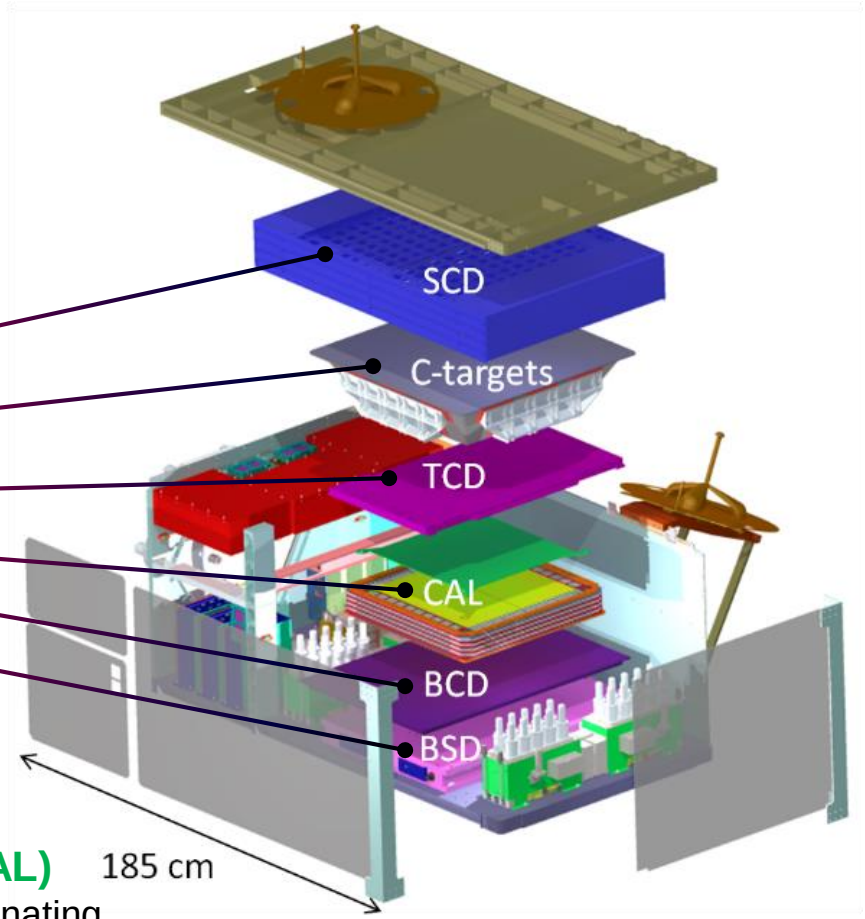
ISS-CREAM Instrument

Seo et al. (CREAM Collaboration) Adv. in Space Res., **53**/10, *1451*, 2014

Silicon Charge Detector (SCD)

- Precise charge measurements with charge resolution of ~ 0.2e.
- 4 layers of 79 cm x 79 cm active area (2.12 cm^2 pixels).





Top/Bottom Counting Detector (T/BCD)

- Plastic scintillator instrumented with an array of 20 x 20 photodiodes for e/p separation.
- Independent trigger.

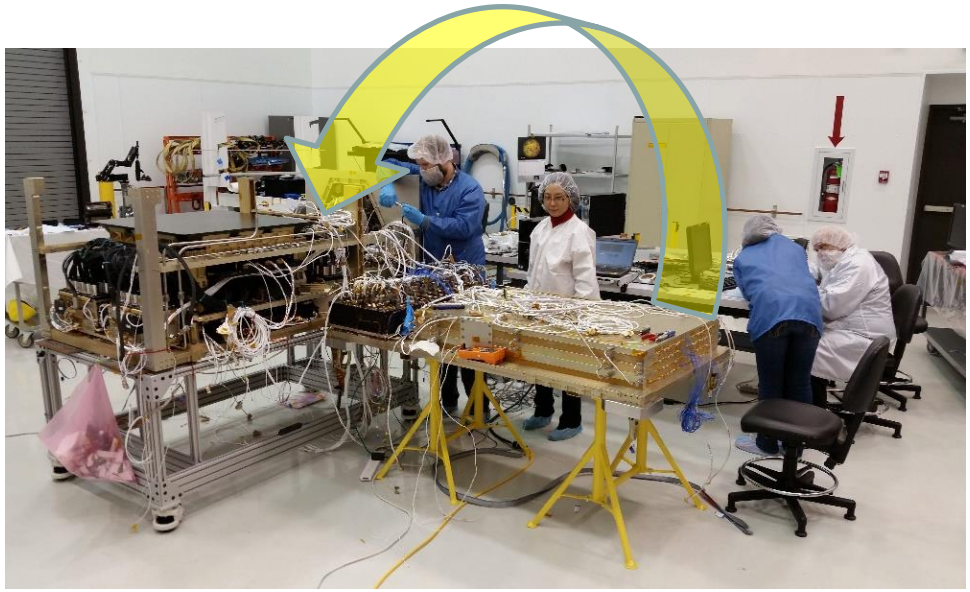
Calorimeter (CAL)

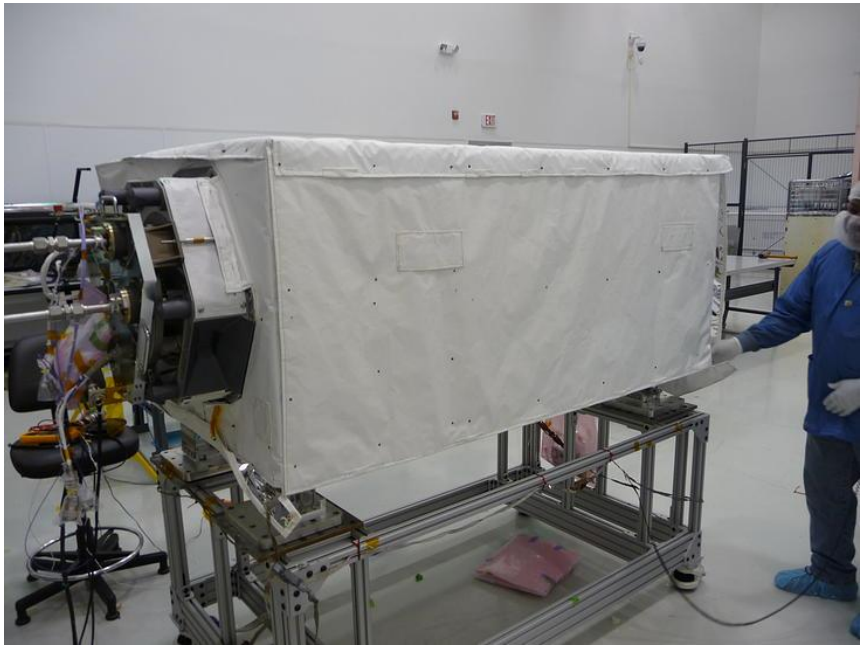
- 20 layers of alternating tungsten plates and scintillating fibers.
- Determines energy.
- Provides tracking and trigger.

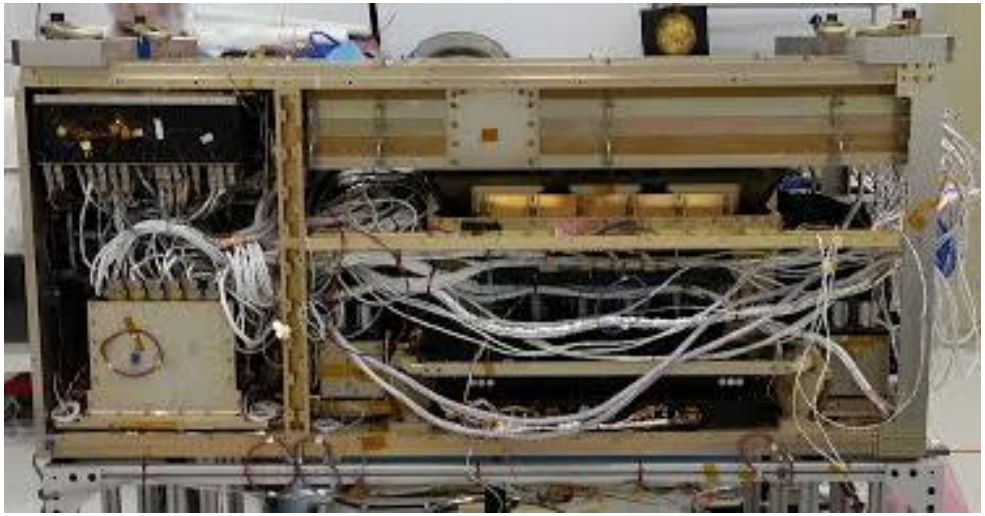
Boronated Scintillator Detector (BSD)

- Additional e/p separation by detection of thermal neutrons.

CREAM Integration at WFF







Magazine

U-Md.-Goddard programs offer students out-of-this-world opportunities

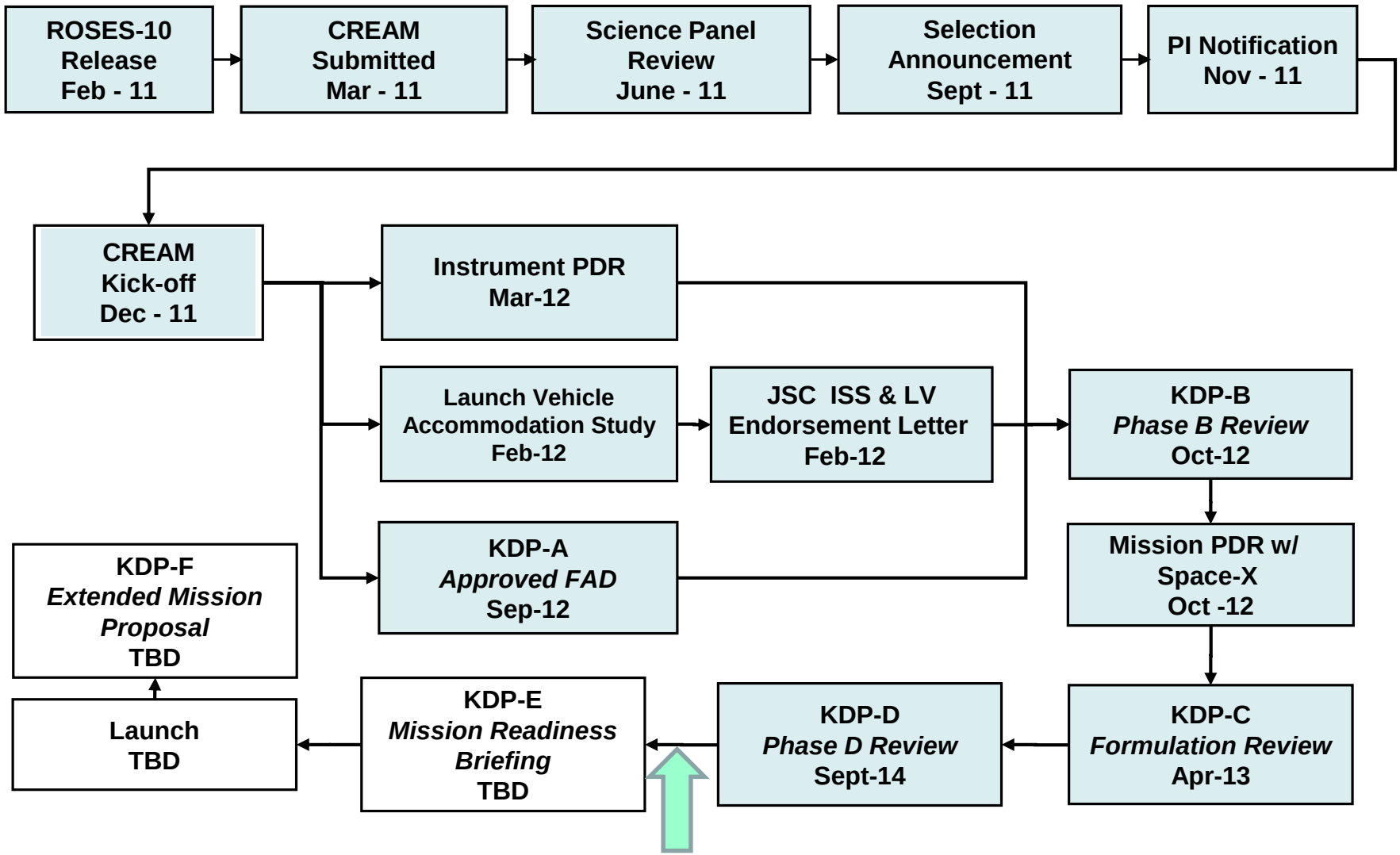
By Allison Klein October 31 at 6:00 AM

Professor Eun-Suk Seo at the University of Maryland Laboratory stands in front of the Cosmic Ray Energetics and Mass detector, which NASA will launch to the International Space Station. (Greg Powers/For The Washington Post)

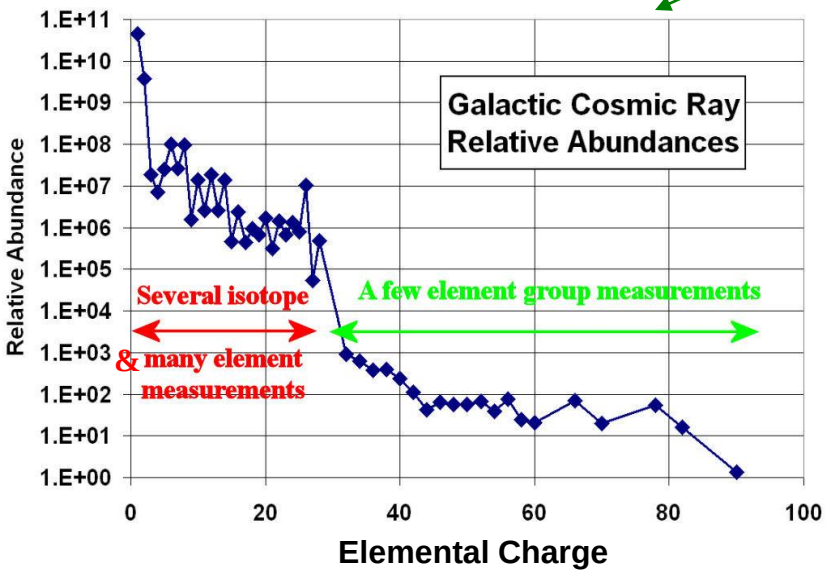
Dozens of students at the University of Maryland have toiled in the physics lab, some soldering metal parts, some debugging software and some simply slicing black pieces of paper into perfectly sized triangles.

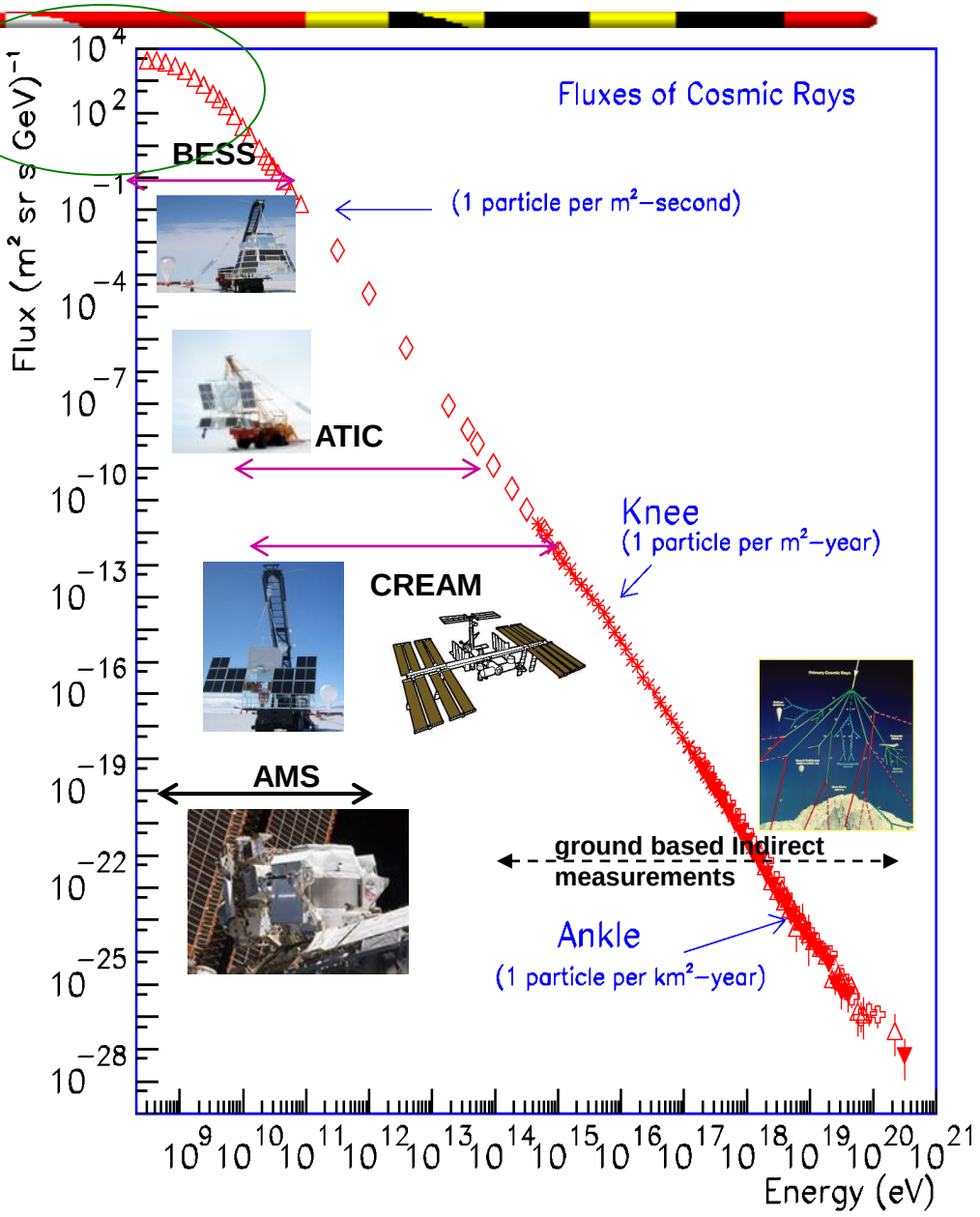
To physics professor Eun-Suk Seo, all of their work is critical. Students are helping her build a payload that is scheduled to launch to the International Space Station next year, the culmination of more than 10 years of her painstaking work on cosmic rays in a collaboration with NASA.

Key Decision Points and Milestones



How do cosmic accelerators work?

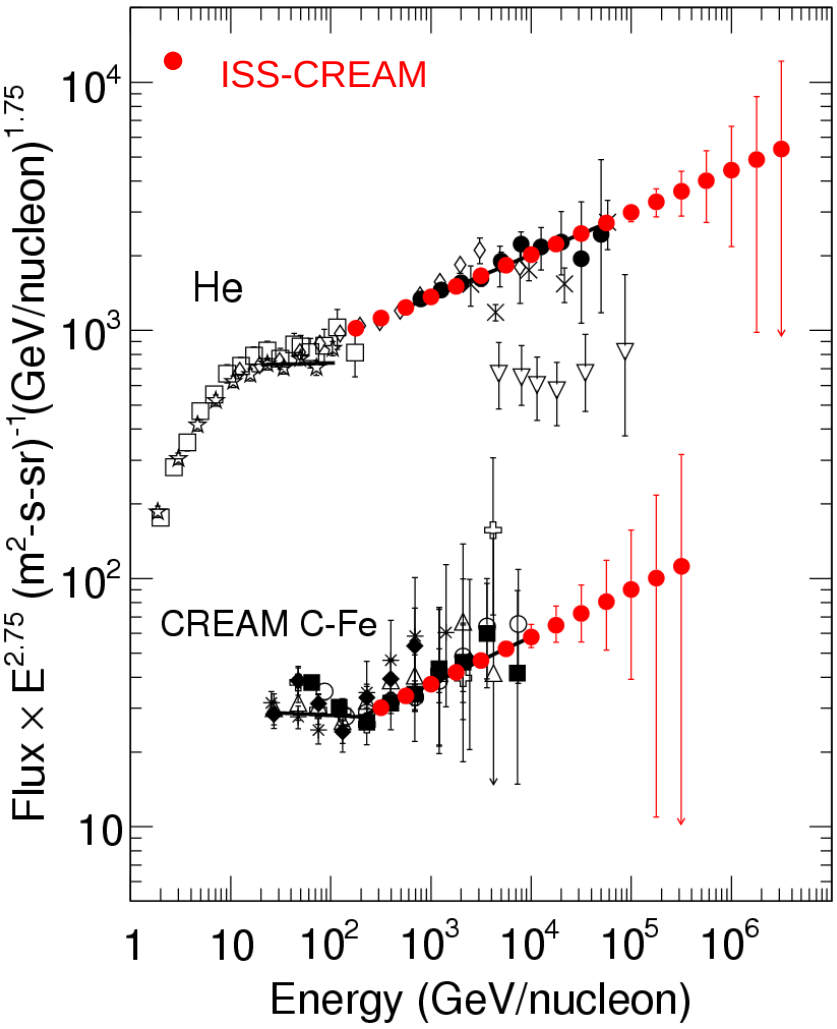




The ISS provides an excellent platform for our quest to investigate the low fluxes of high-energy cosmic rays.

ISS-CREAM takes the next major step

- The ISS-CREAM space mission can take the next major step to 10^{15} eV, and beyond, limited only by statistics.
- The 3-year goal, 1-year minimum exposure would greatly reduce the statistical uncertainties and extend CREAM measurements to energies beyond any reach possible with balloon flights.



Ever closer to answering long standing questions

ISS-CREAM will address specifically the science objectives of the Advanced Cosmic-ray Composition Experiment for the Space Station (ACCESS) prioritized in the Small Space-Based Initiative category of the 2001 NRC Decadal Study Report "Astronomy and Astrophysics in the New Millennium."

4 SPACE NEWS www.spacenews.com

July 12, 2010

SMD Urged To Use Station

AMY KLAMPER, WASHINGTON

With the White House having directed NASA to continue supporting the international space station at least through 2020, the agency is looking for ways to more fully utilize the facility as a host platform for scientific payloads and for testing instrument technologies in orbit.

The research could involve any number of scientific disciplines, including astronomy, astrophysics, Earth science and planetary exploration, according to Vernon Jones, senior scientist for suborbital research in the astrophysics division of NASA's Science Mission Directorate (SMD).

Jones was speaking July 8 during a meeting of a group of outside scientists who reg-

al examples of such utilization are already under way, including the Alpha-Magnetic Spectrometer planned to launch aboard the final space shuttle mission early next year.

"Here's an asset that's been extended for several years that in the past hasn't been used, and is there usability for the science area?" Jones said.

Jones said the space station provides a good platform for a variety of non-microgravity science and technology payloads because it offers mounting points for large instruments, moderate stability, ample power and high-bandwidth communications capabilities. He said all four of the NASA Advisory Council's Science subcommittees had been asked to propose potential science and technology research ideas to the full committee in ad-