Workshop for Radiation Monitoring on the International Space Station

September 3-5, 2003

Berkeley, California

Presented by Eric Benton

POC Mark.J.Christl@NASA .GOV

http://sd.msfc.nasa.gov/cosmicray/DSTB/DSTB.htm

Space Radiation Program

Since 2 Nov 2002 when the Expedition 1 crew arrived at the ISS, humans have had a permanent presence in space.

Expedition 1	136 days	Expedition 2	147 days
Expedition 3	117 days	Expedition 4	181 days
Expedition 5	171 days	Expedition 6	162 days
Expedition 7	~170 days		

Radiation exposure is a factor limiting Expedition duration.

Space Radiation Shielding Roadmap

Objective	OBPR Question	2003-2008 Targets	2008-2015 Targets
Develop novel effective and lightweight, multi-use materials for shielding radiation in human-rated spacecraft design	Q1c, Q4d & e	• Improve existing transport radiation codes. • Compare existing codes and develop a standard set for NASA applications.	• Incorporating cross-section measurements, produce a comprehensive manual by 2011 the code.
		• Using ground-based accelerator facilities, measure fragmentation cross sections and test validity of existing codes for predicting fluences of fragments produced by interactions.	• Provide reliable data for incorporation into radiation transport codes and the resulting documentation and users manual.
		• *Development of balloon-borne DSTB to test codes and materials.* • *Development of instrumentation for the DSTB.*	• *Multiple flights of DSTB using a variety of candidate shielding materials, for measuring radiation dose and particle spectra. Planned testing of environment completed, thus ensuring sufficient data are available for vehicle fabrication for long duration crew-tended missions*
		• Research possible radiation shielding materials concentrating on composite and multifunctional concepts.	• Incorporate into the design manual new materials and concepts for use beyond LEO. Establish practical multifunctional shielding materials and concepts. • Provide effective radiation protection with less mass

DSTB Objectives

- Provide a platform for direct exposure to the full composition and energy spectra of Galactic Cosmic Rays (GCR)
- Enable experimental validation of NASA's radiation transport codes in a realistic GCR environment
- Test shielding effectiveness of typical spacecraft materials as well as novel materials in the GCR flux
- Test new radiation monitoring instrumentation

DSTB Implementation

- Utilize NASA's scientific balloon program to provide high-altitude exposures:
  - Operates under reduced restrictions compared to flight experiments: reduced costs, shorter schedules and reviews
  - <5 g/cm^2 atmospheric overburden
  - 15-20 days of exposure
- Conduct multiple flights (one flight per year)
- Develop an architecture to conduct multiple experiments on each flight
- Accommodate changes in the payload configuration from year to year

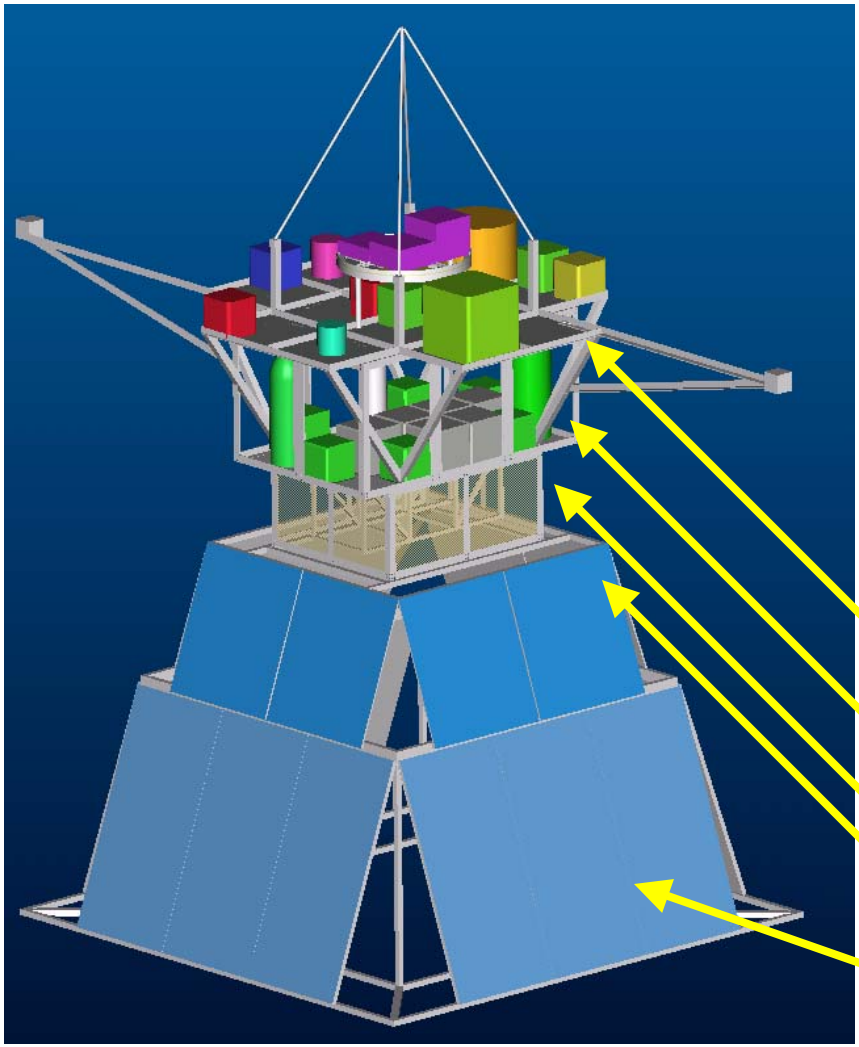
Development Plan

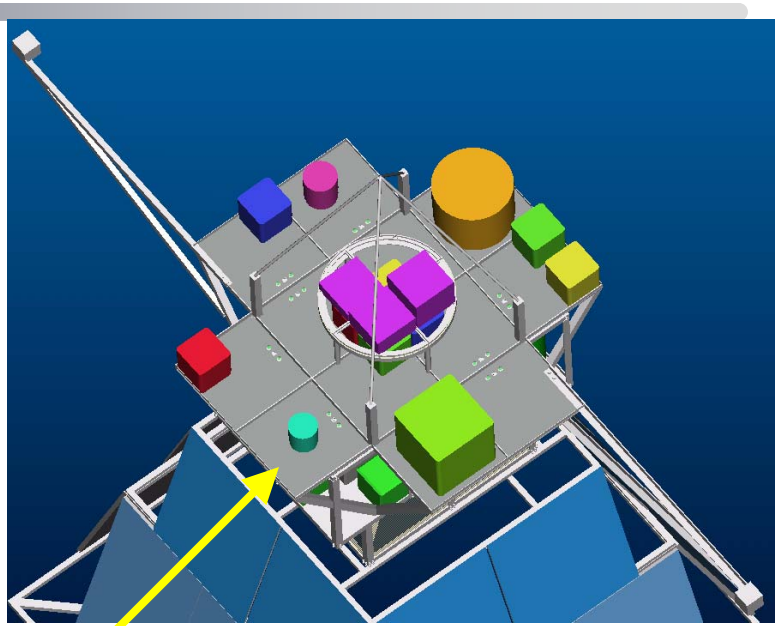
- CY03: Requirements and design
- CY04: Gondola fabrication, development of subsystems and ground facilities, testing
- CY05: Test flight and first polar flight
  - Integration (January)
  - CONUS Flight: Palestine, TX. (March)
  - Refurbish, test and integrate Palestine, TX. (Aug)
  - 1st Polar Flight, Antarctica (Oct-Mar)
- CY06: Data analysis/begin second cycle

Elements of the DSTB Facility

- Gondola: mechanical structure, power system, communication and data system
- Ground Facility: experiment integration and testing
- Operations: coordination with NSBF, flight operation support, logistics
- Environment Modeling: incident radiation, atmospheric overburden, influence of gondola structure, albedo , thermal environment

DSTB Conceptual Design





Exposure Deck

Electronics Deck

SIP Deck (Balloon Equip.)

SIP Solar Arrays

DSTB Solar Arrays

DSTB Capabilities

Gondola dimensions: height 19.6 ft., width 11.7ft.

Maximum science payload: 4000 lbs./ 5500 lbs. with balloon equipment (shared resource)

Power: 600 watts at 28 VDC (shared resource)

Omni-directional or pointed gondola

Telemetry: 6 kbits/second

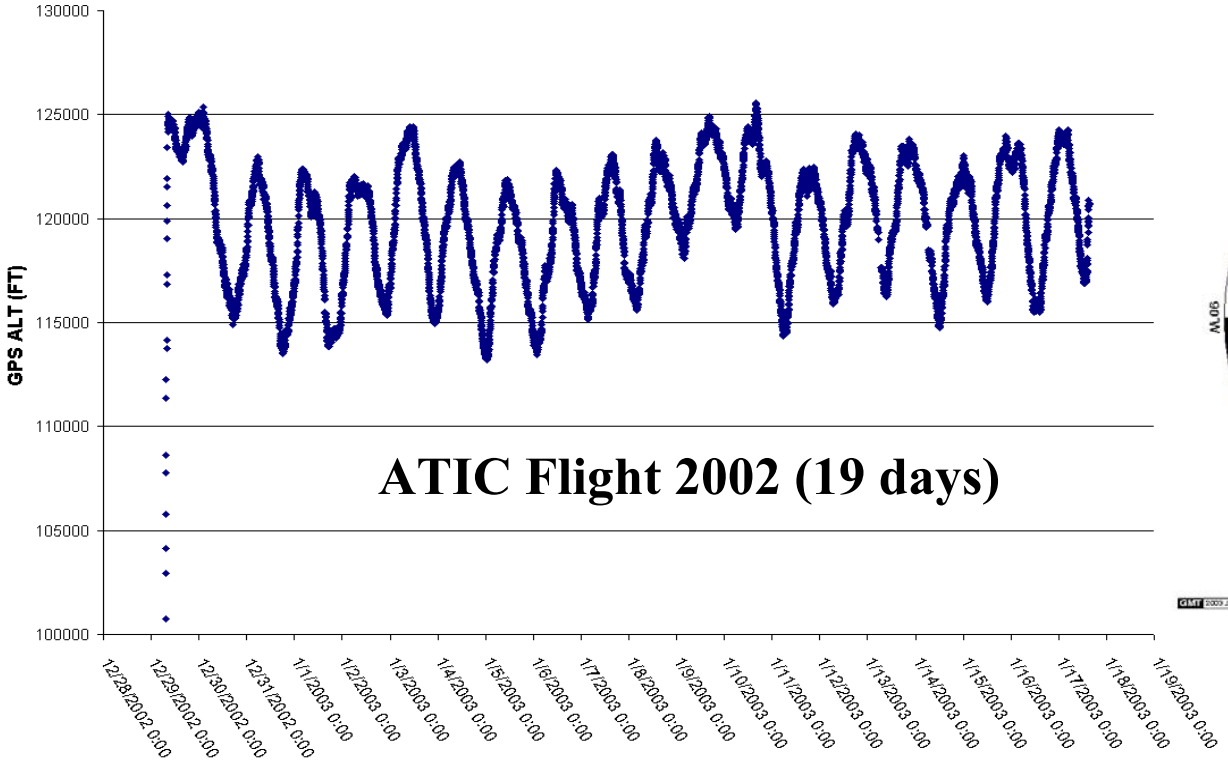
Experimental interface: RS-232, parallel, DIO, smart-port (LAN)

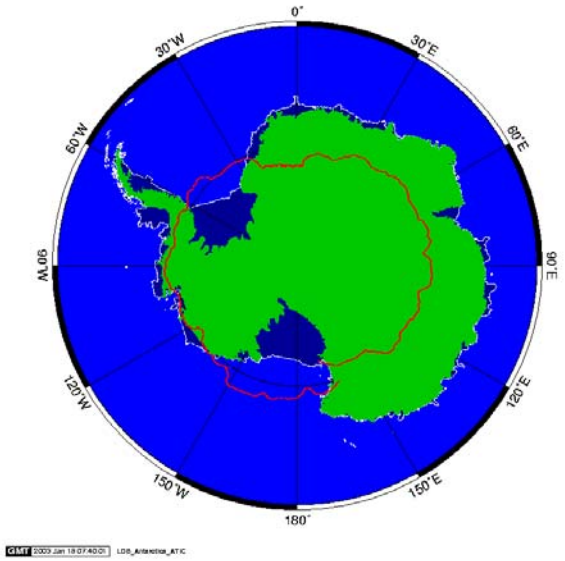
Average of 10 experiments per flight:

- Avg. mass: 150 lbs. per experiment
- Avg. power: 60 watts per experiment

Polar Balloon Flights

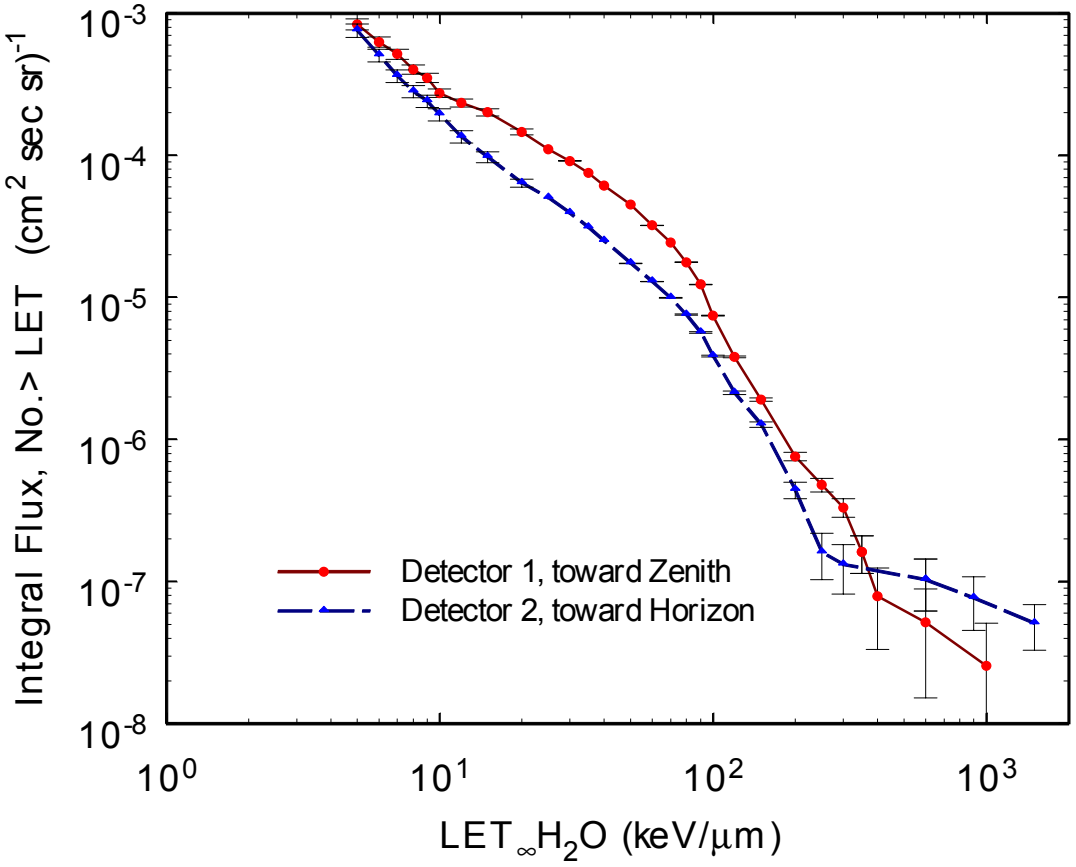
2 Flights per Year/First Flight 1991



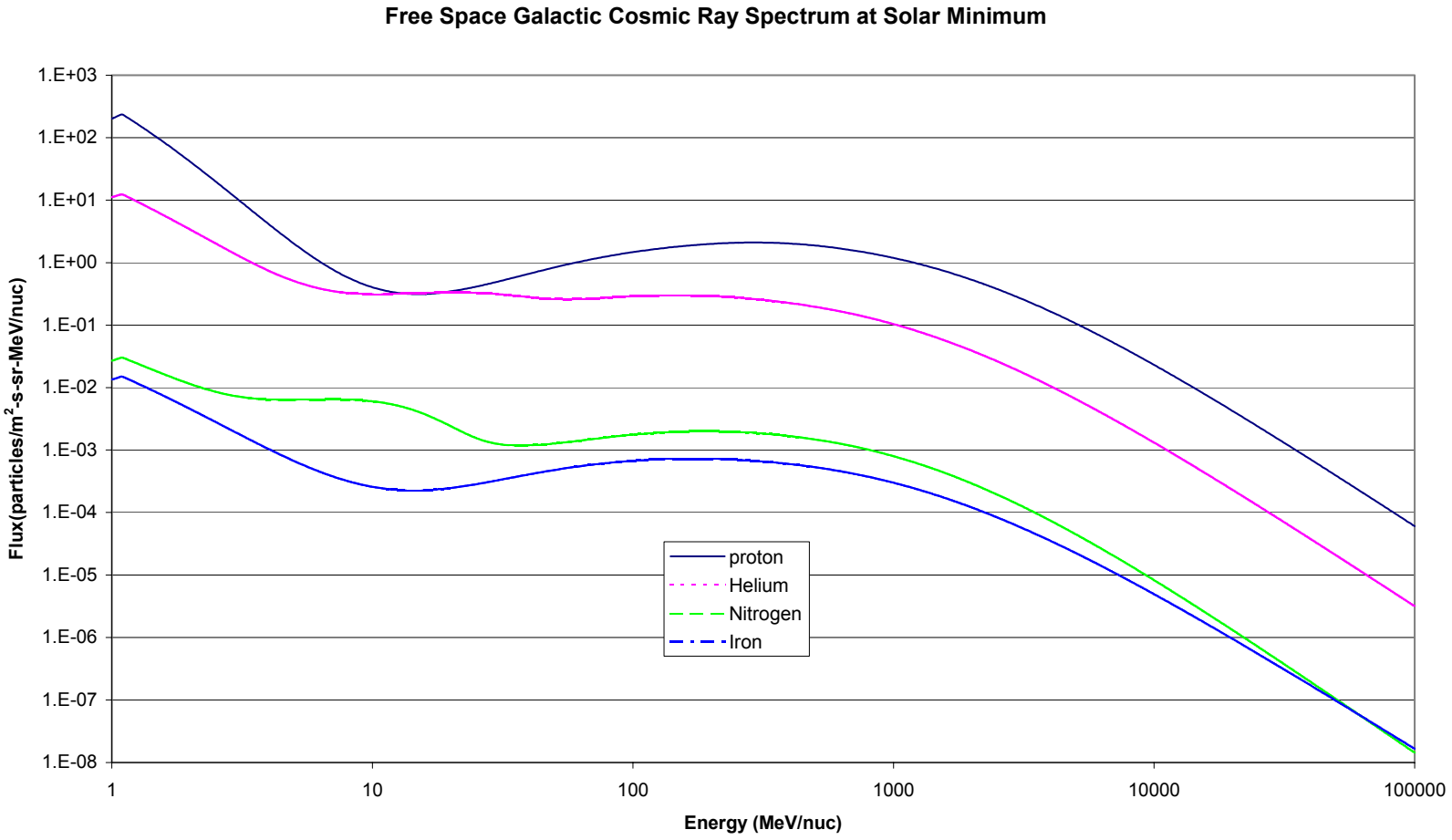


ATIC 2002/03 Mission

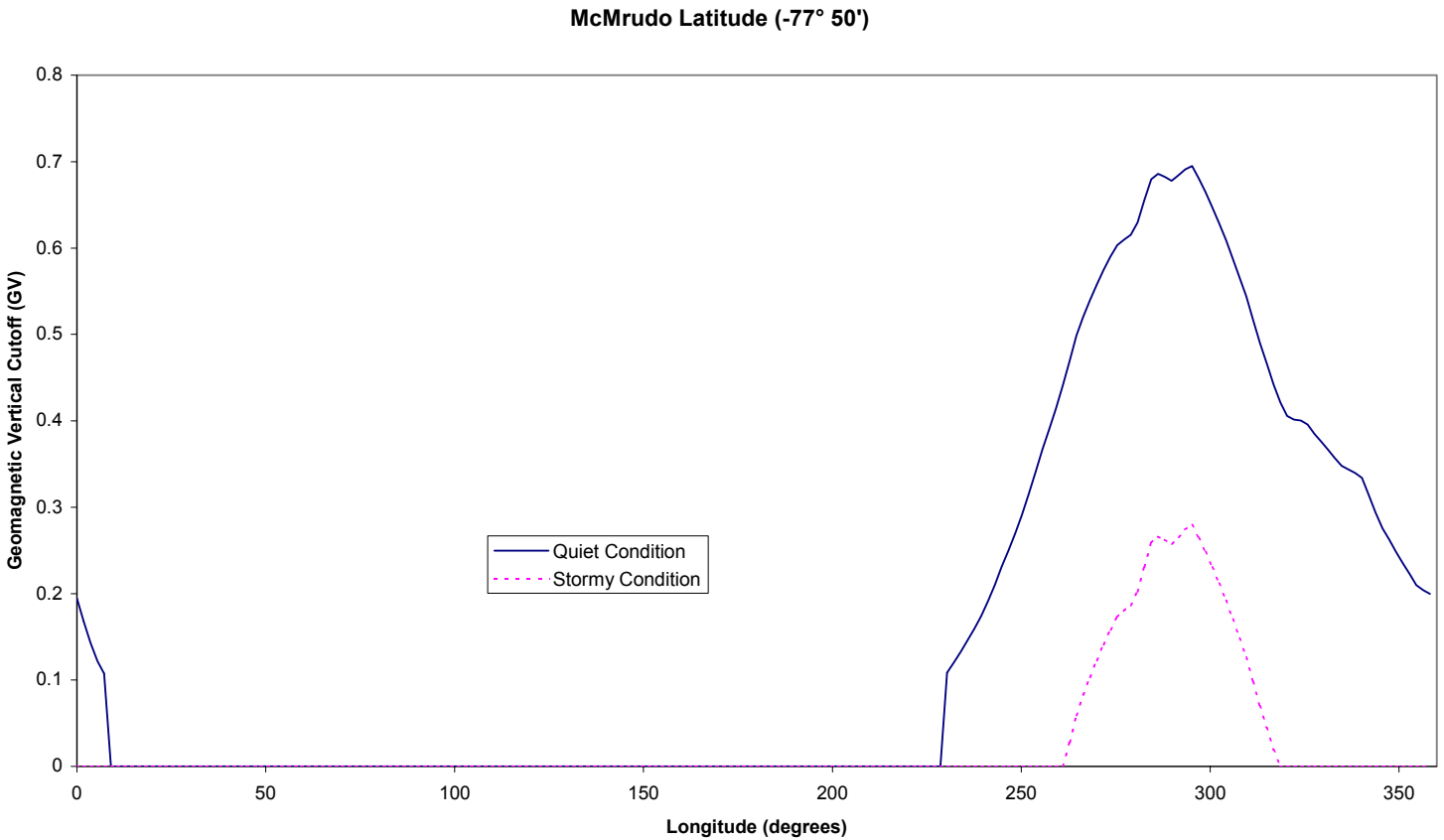
Integral LET Flux Spectra from ERI CR-39 PNTD



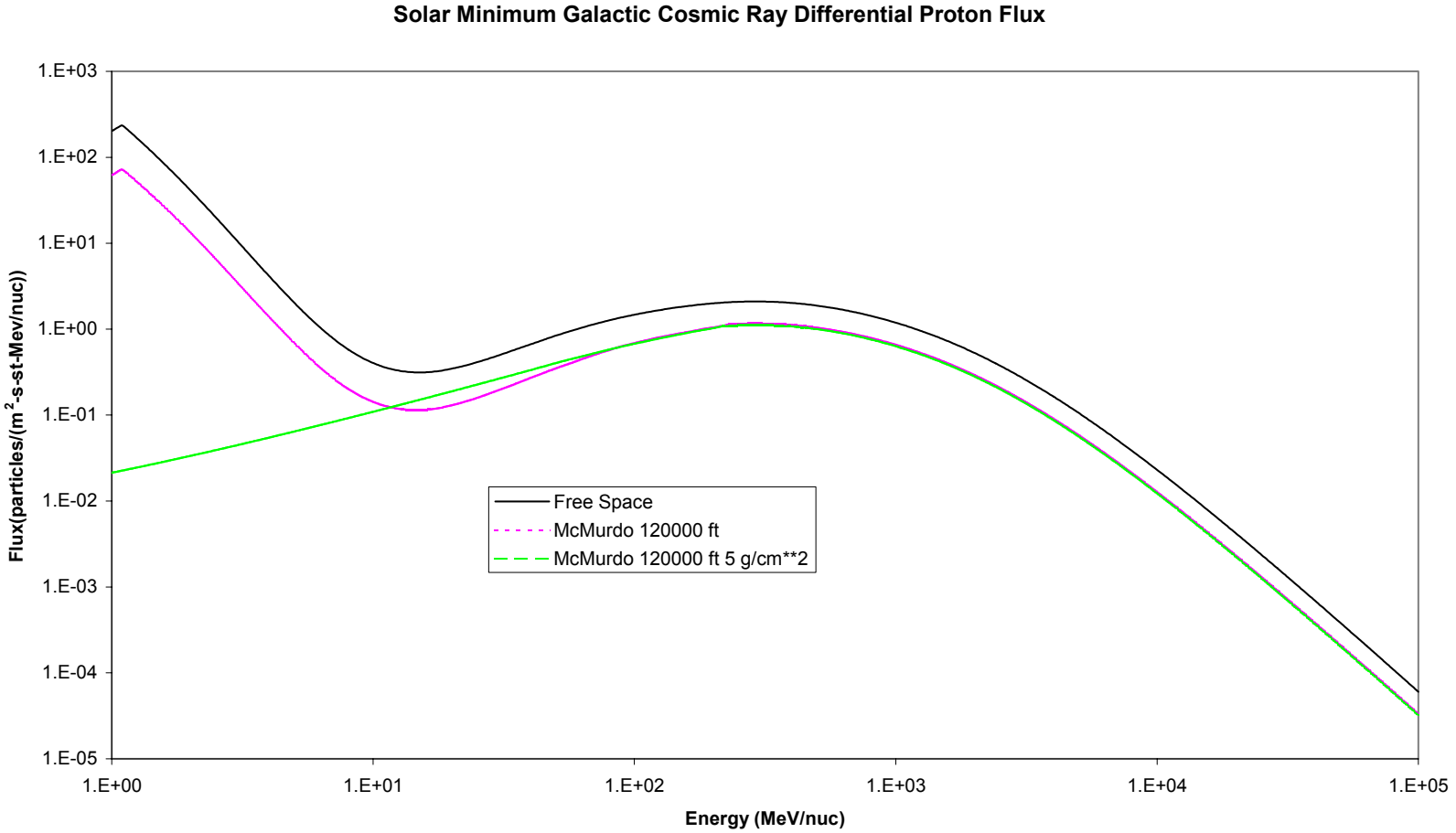
Free Space GCR Flux



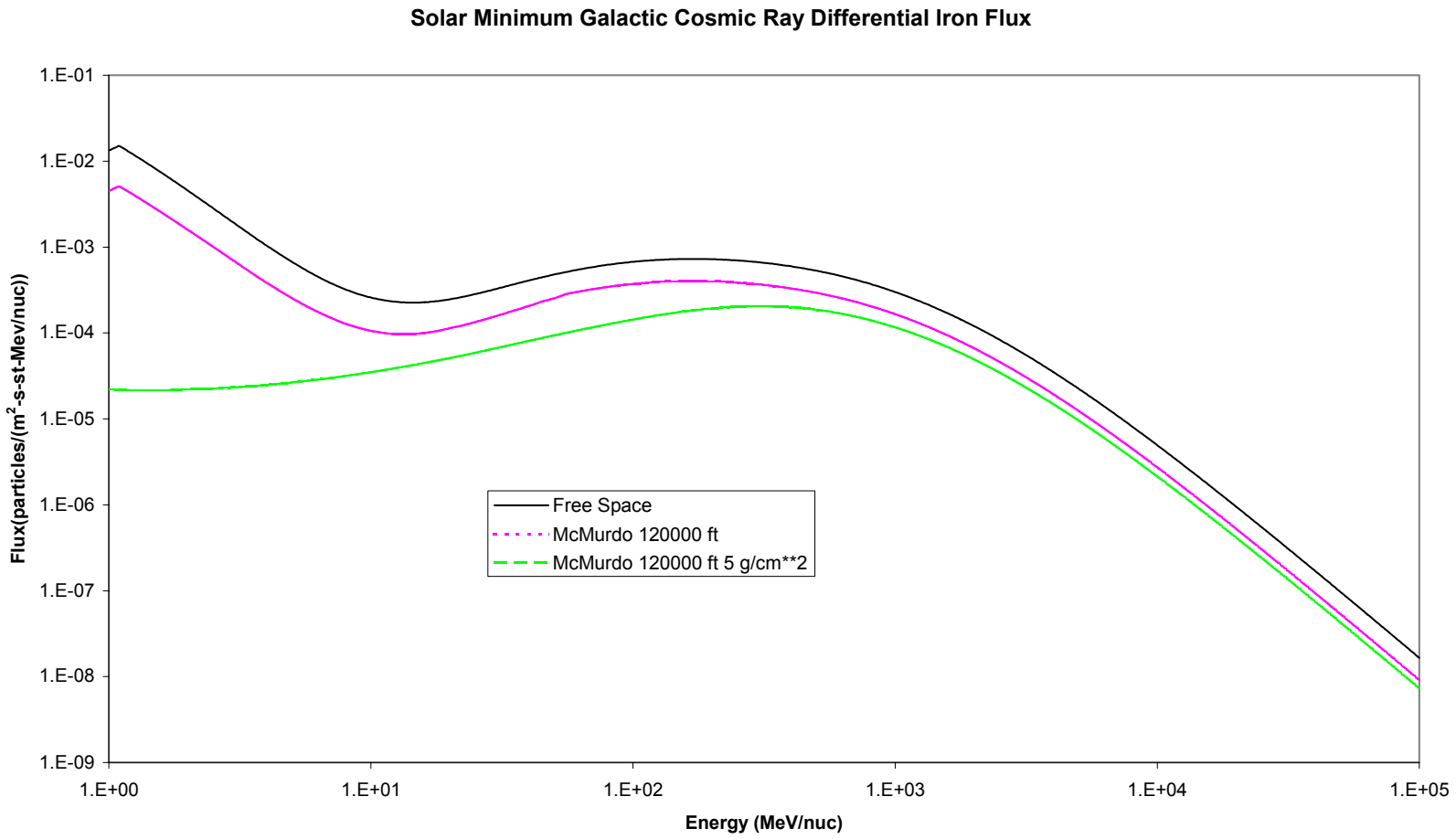
Geomagnetic Cut-off Antarctica



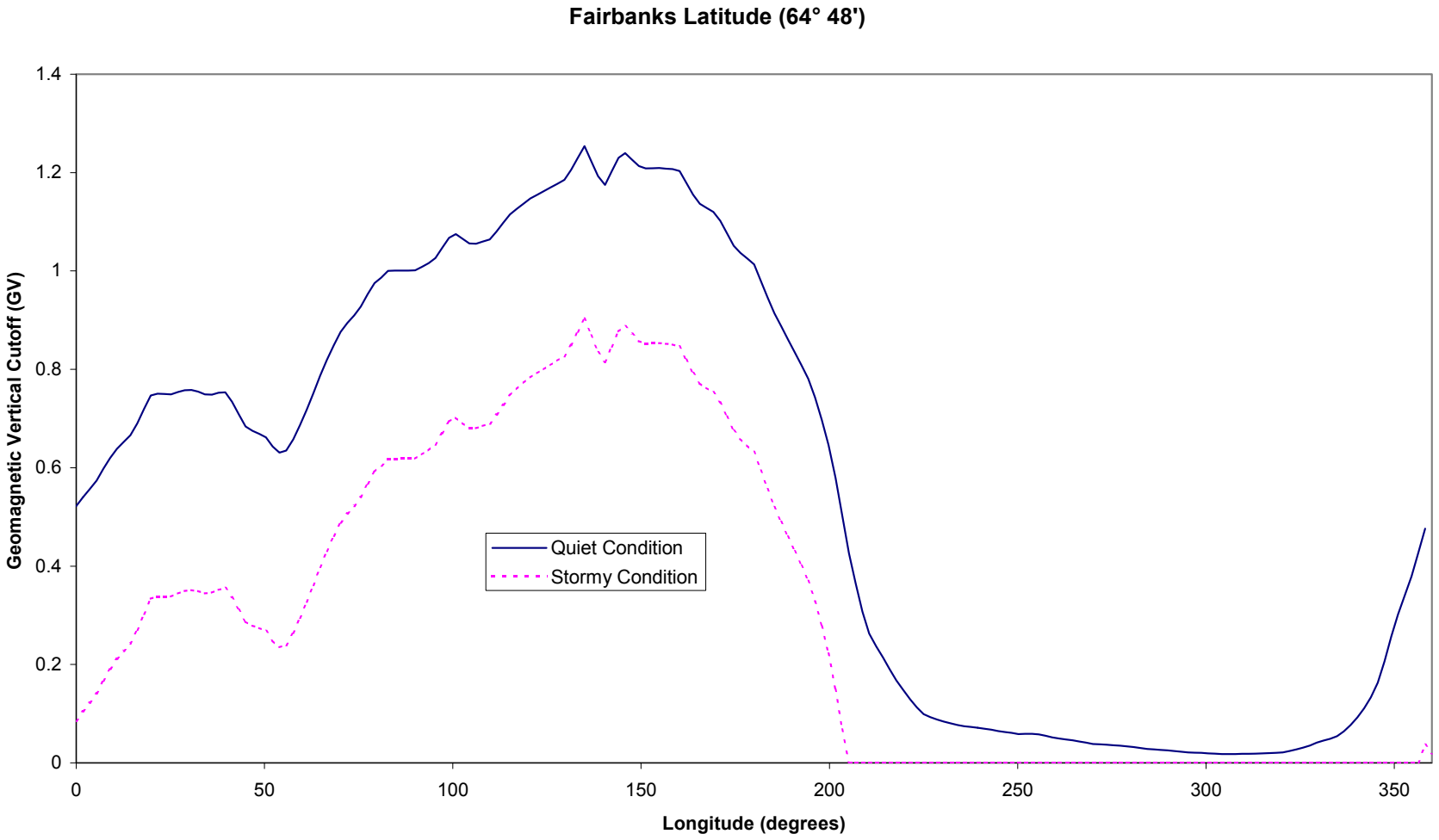
Radiation Environment Antarctica



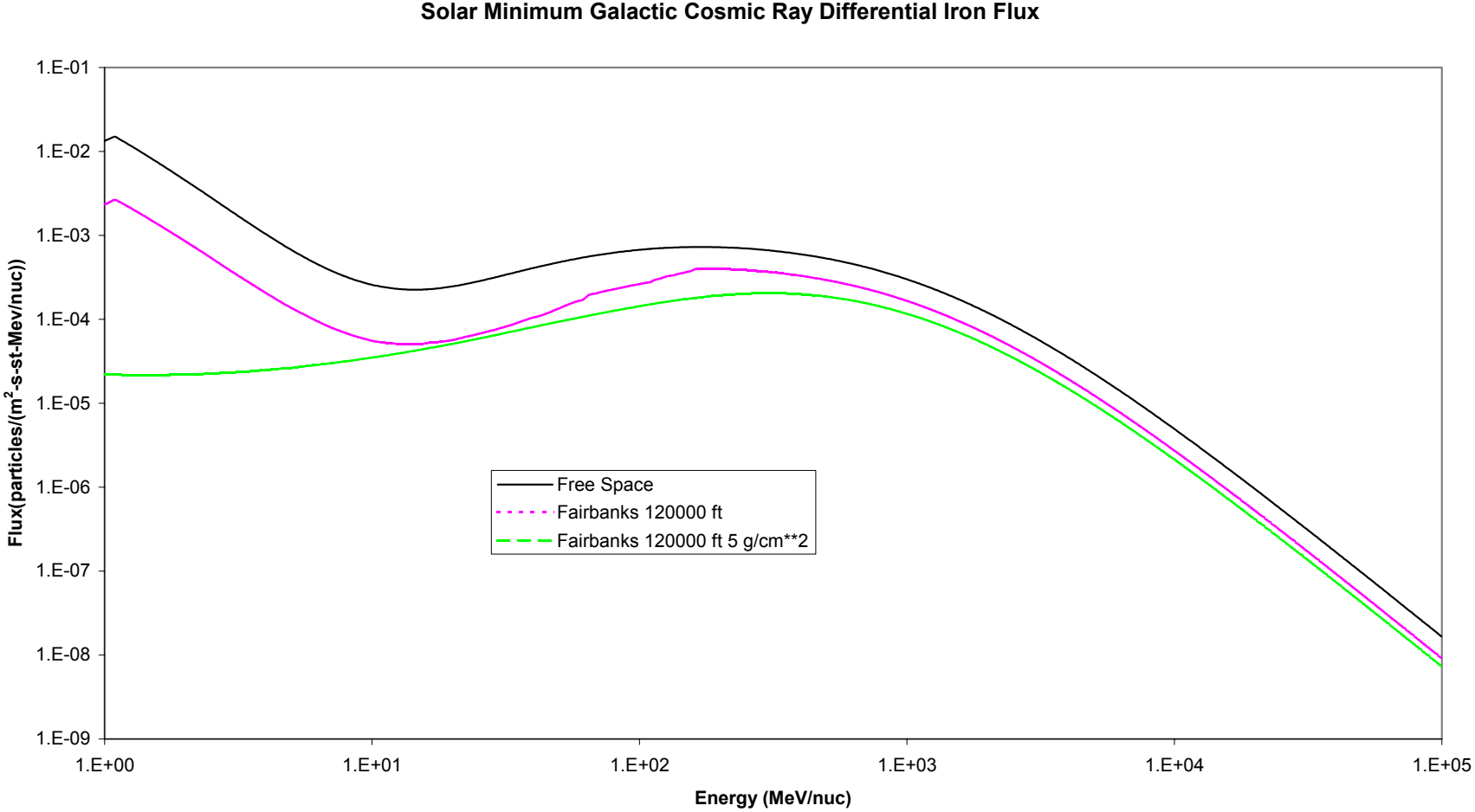
Radiation Environment Antarctica



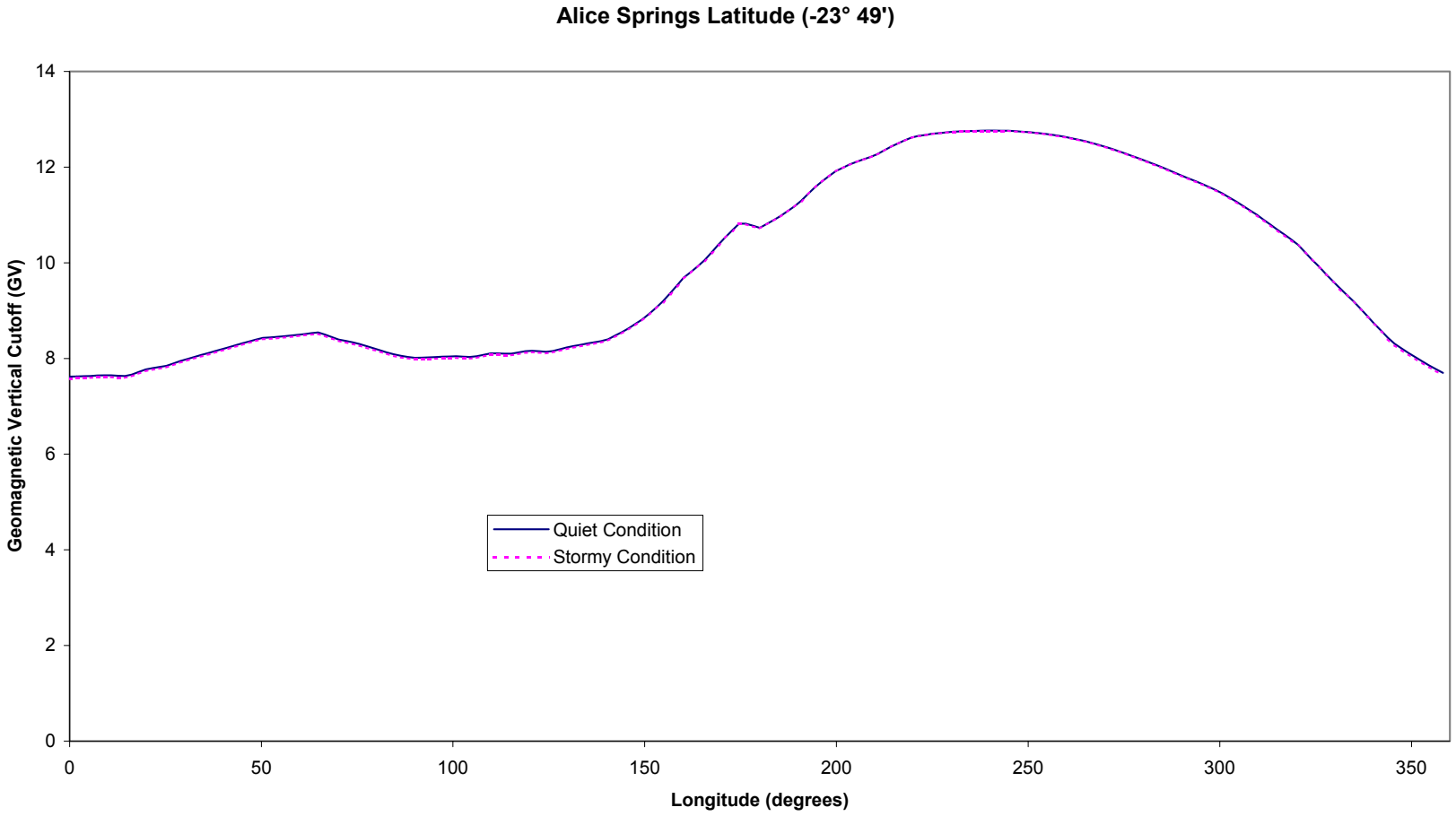
Geomagnetic Cut-off Fairbanks, AK



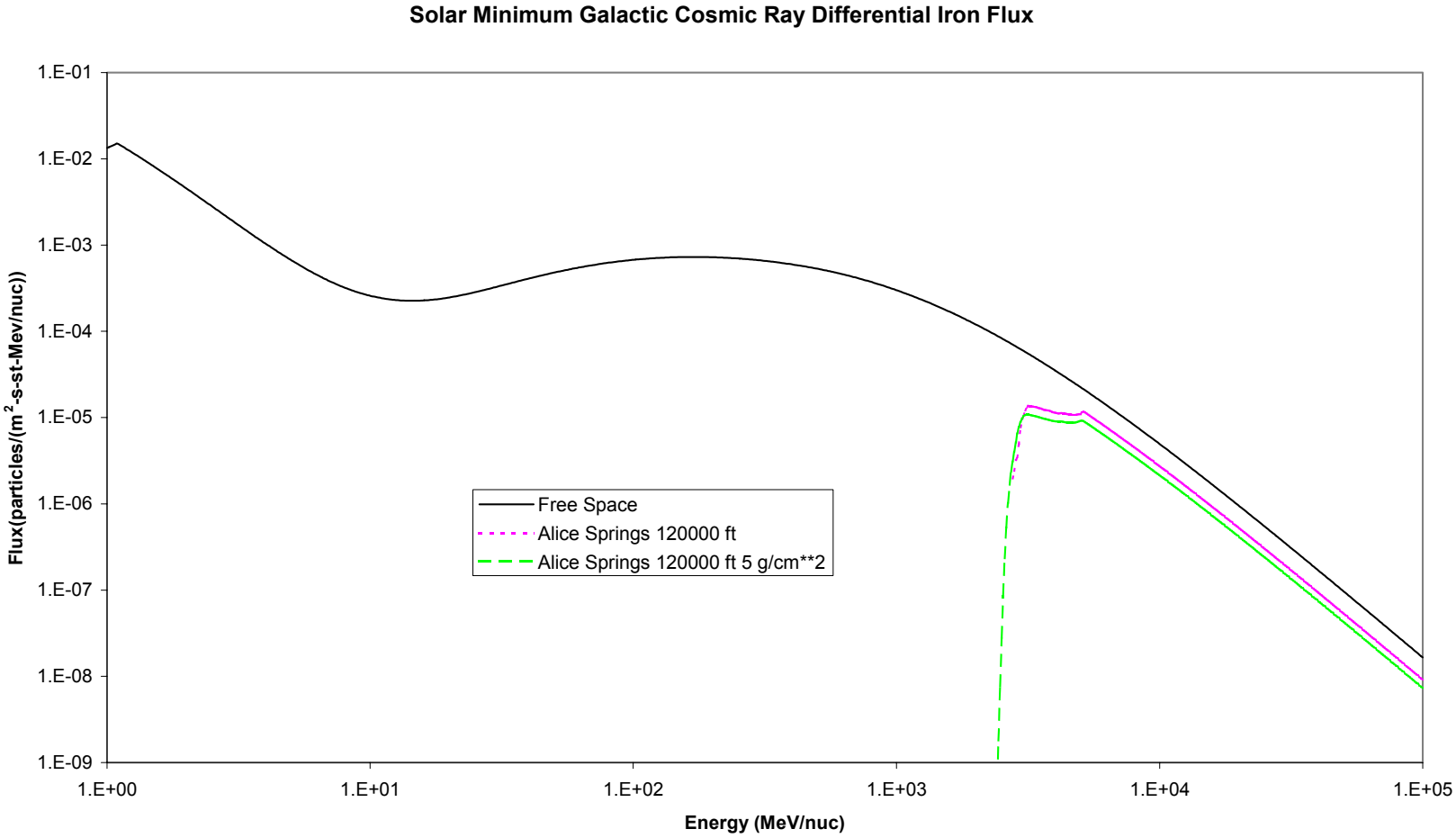
Radiation Environment Fairbanks



Geomagnetic Cut-off
Alice Springs, Aus.

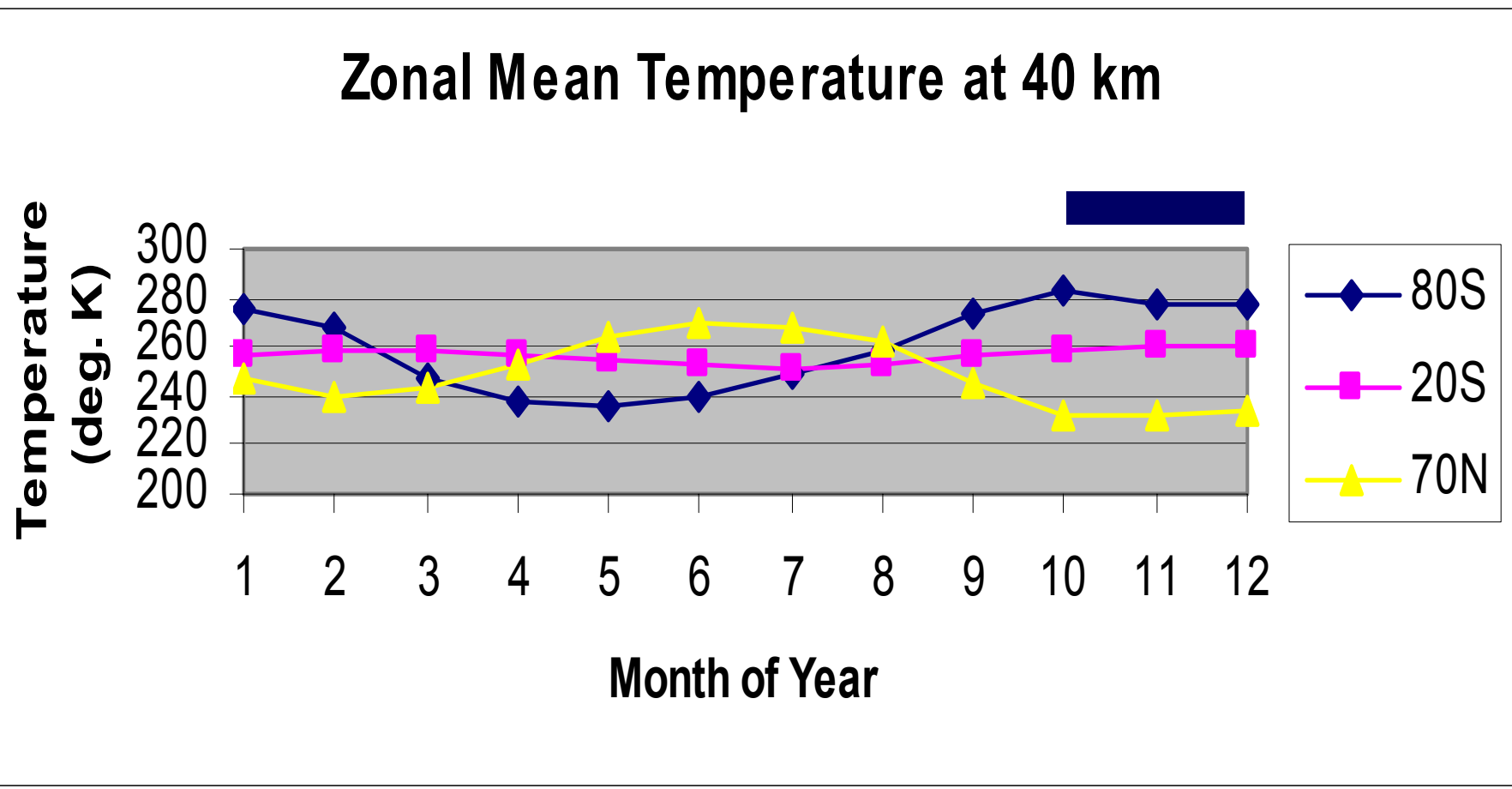


Mid-Latitude Radiation Environment



Thermal Environment

COSPAR International Reference Atmosphere (CIRA-86)



DSTB Status

- Preliminary design phase for mechanical structure and sub-systems is in progress
- Conducting definition of the DSTB standard instrument suite for radiation monitoring
- Simulating high altitude and high latitude radiation environment using HETC and GEANT, preliminary focus is on influence of the atmosphere and gondola

  Additional issues for polar region:

  - Primary GCR angular distribution
  - Secondary particle angular distribution
  - Precipitating electrons and bremsstrahlung
  - Solar particle events