



Workshop for Radiation Monitoring on the
International Space Station

September 3-5, 2003

Berkeley, California

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



Space Radiation Program



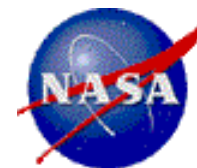
Since 2 Nov 2002 when the Expedition 1 crew arrived at the ISS, humans have had a permanent presence in space.

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
<p><i><u>Develop novel effective and lightweight, multi-use materials for shielding radiation in human-rated spacecraft design</u></i></p>	<p>Q1c, Q4d & e</p>	<ul style="list-style-type: none"> • Improve existing transport radiation codes. • Compare existing codes and develop a standard set for NASA applications. 	<ul style="list-style-type: none"> • Incorporating cross-section measurements, produce a comprehensive manual by 2011 the code.
		<ul style="list-style-type: none"> • Using ground-based accelerator facilities, measure fragmentation cross sections and test validity of existing codes for predicting fluences of fragments produced by interactions. 	<ul style="list-style-type: none"> • Provide reliable data for incorporation into radiation transport codes and the resulting documentation and users manual.
		<ul style="list-style-type: none"> • <u>Development of balloon-borne DSTB to test codes and materials.</u> • <u>Development of instrumentation for the DSTB.</u> 	<ul style="list-style-type: none"> • <u>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</u>
		<ul style="list-style-type: none"> • Research possible radiation shielding materials concentrating on composite and multifunctional concepts. 	<ul style="list-style-type: none"> • 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/cm² 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



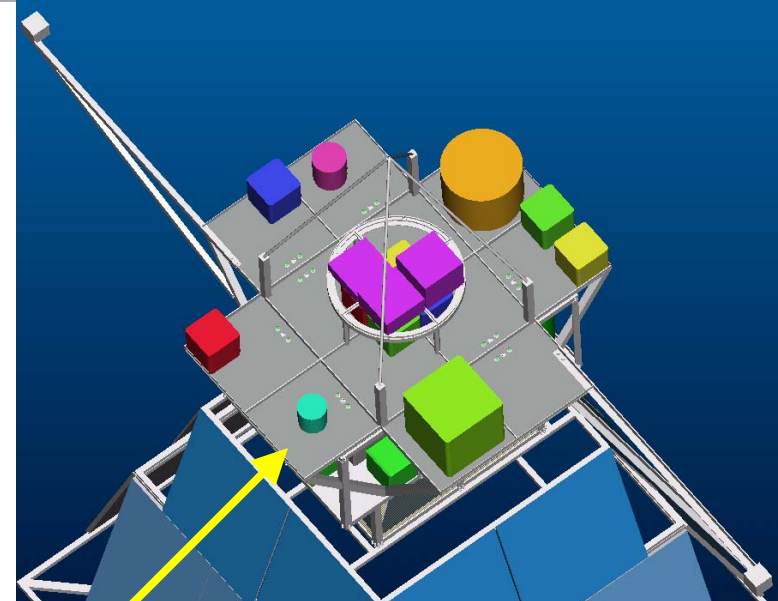
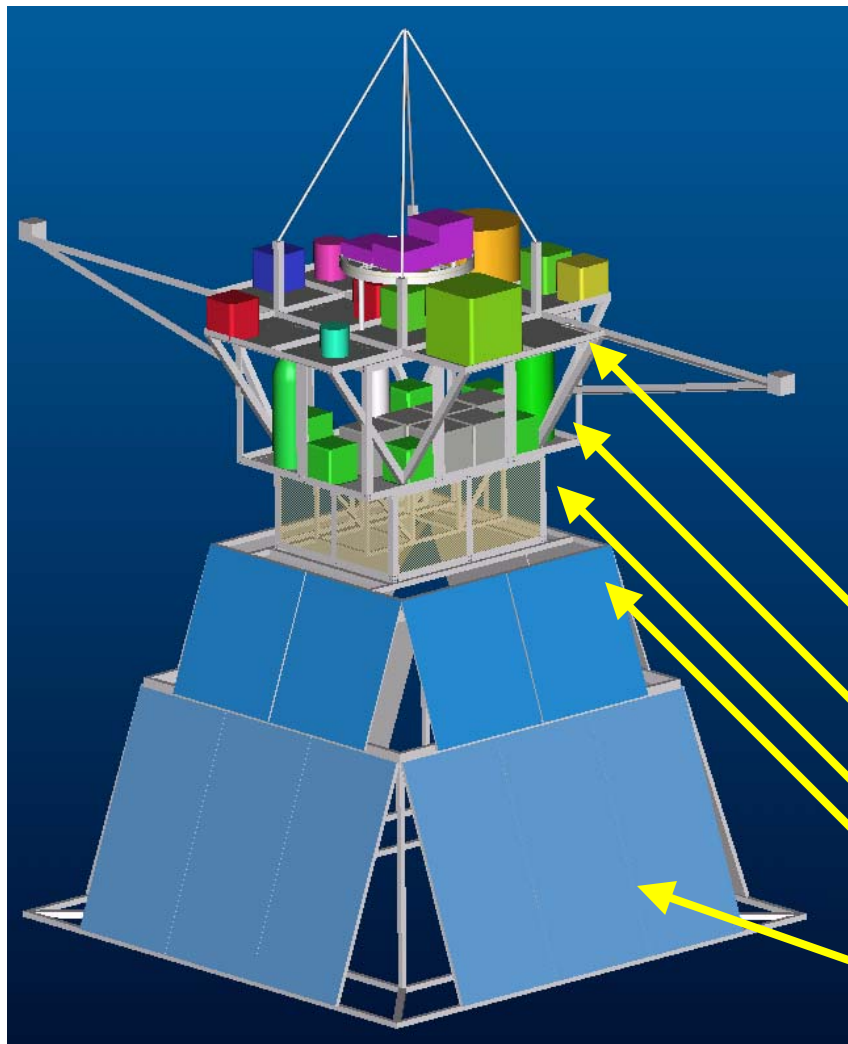
Elements of the DSTB Facility



- 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

Deep Space Test Bed (DSTB)



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

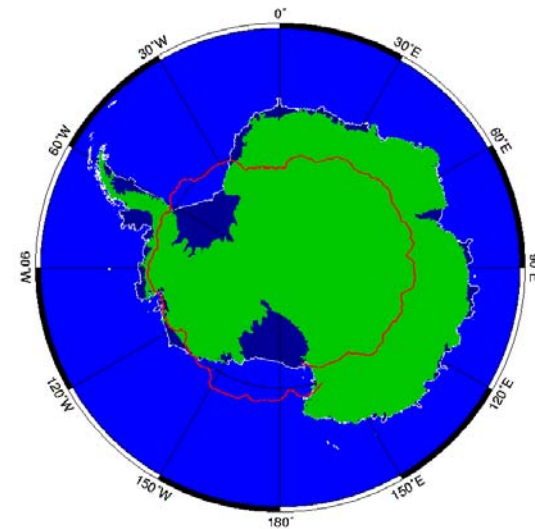
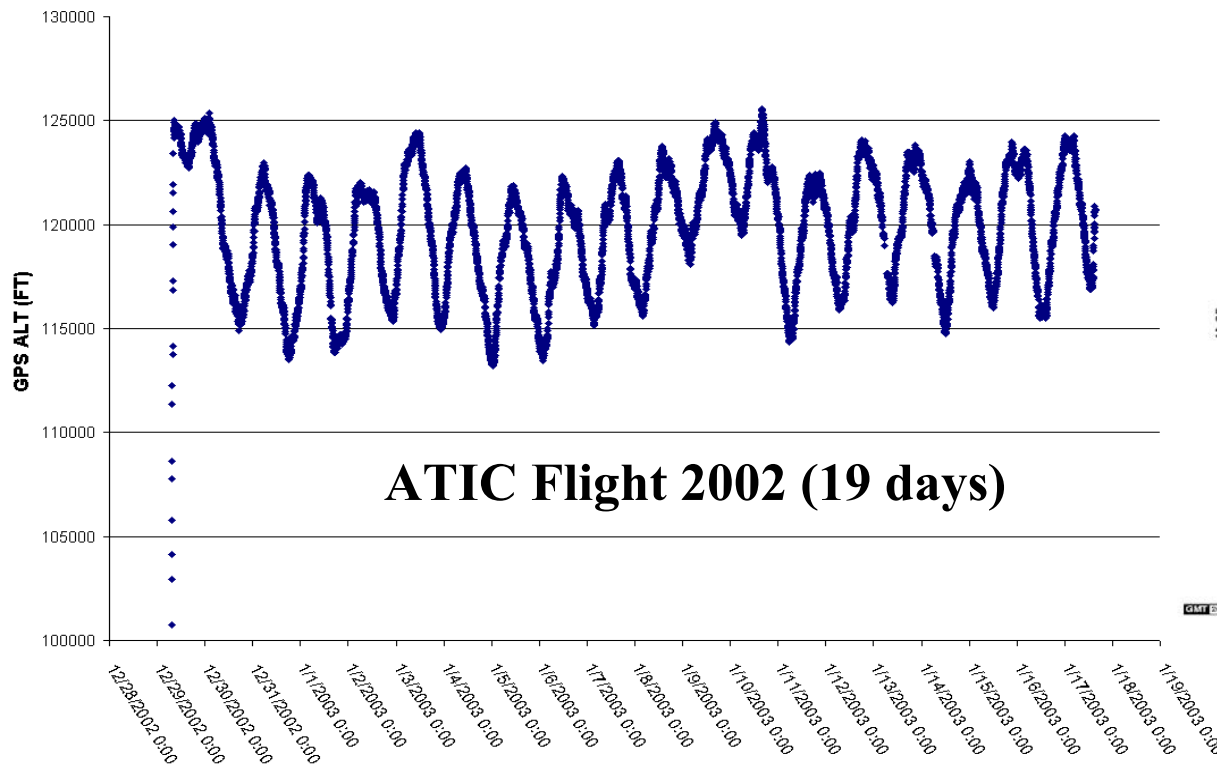
Avg. power: 60 watts per experiment



Polar Balloon Flights



2 Flights per Year/First Flight 1991

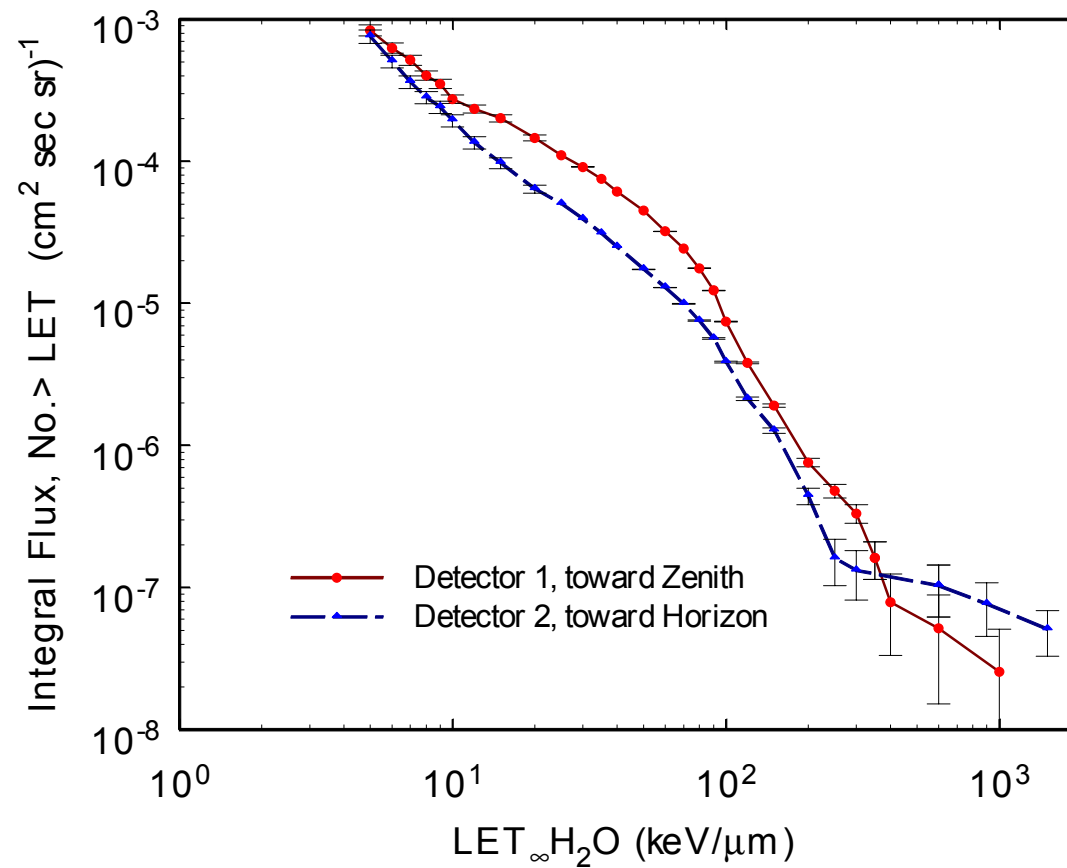




ATIC 2002/03 Mission



Integral LET Flux Spectra from ERI CR-39 PNTD

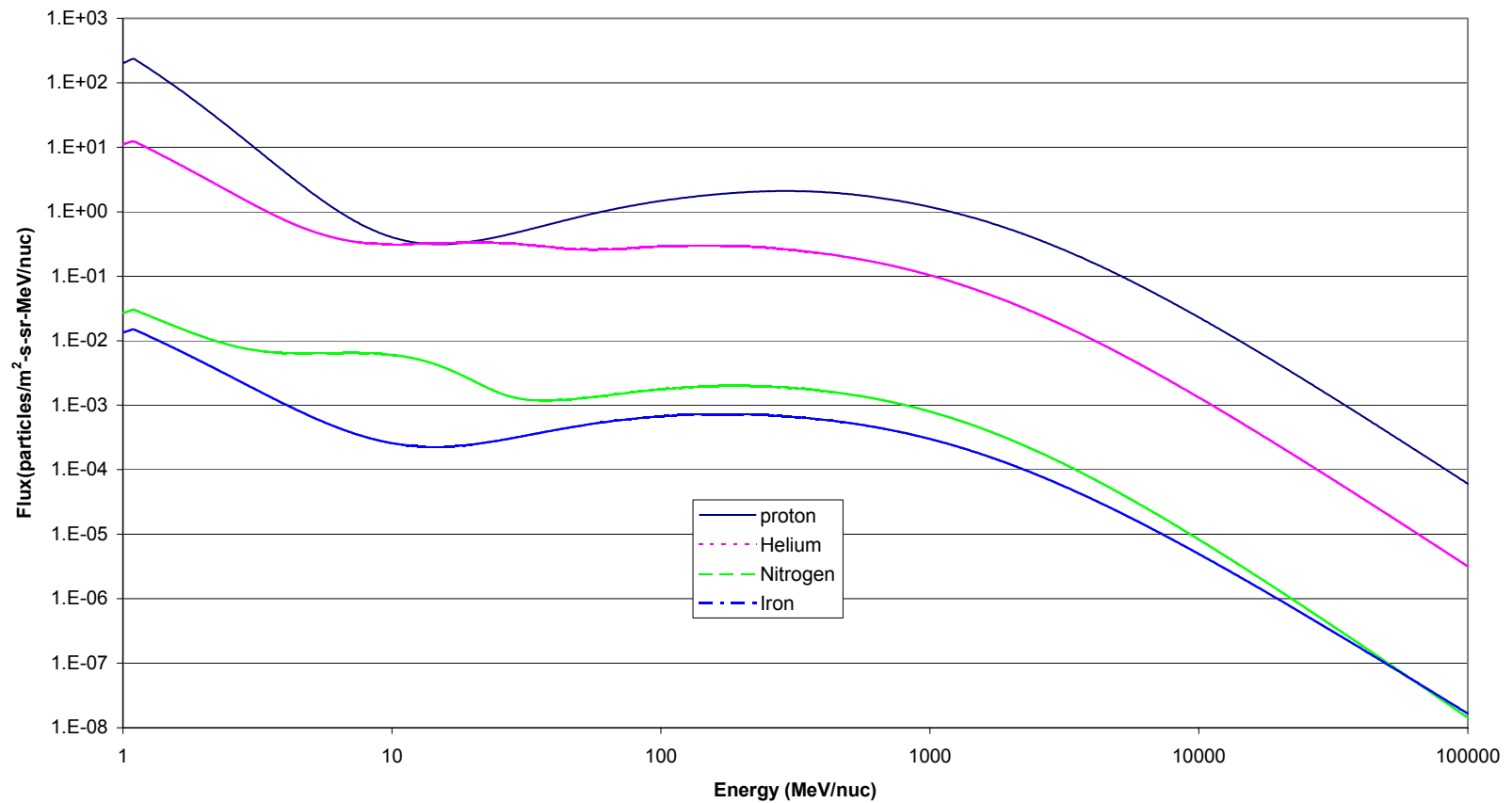




Free Space GCR Flux



Free Space Galactic Cosmic Ray Spectrum at Solar Minimum

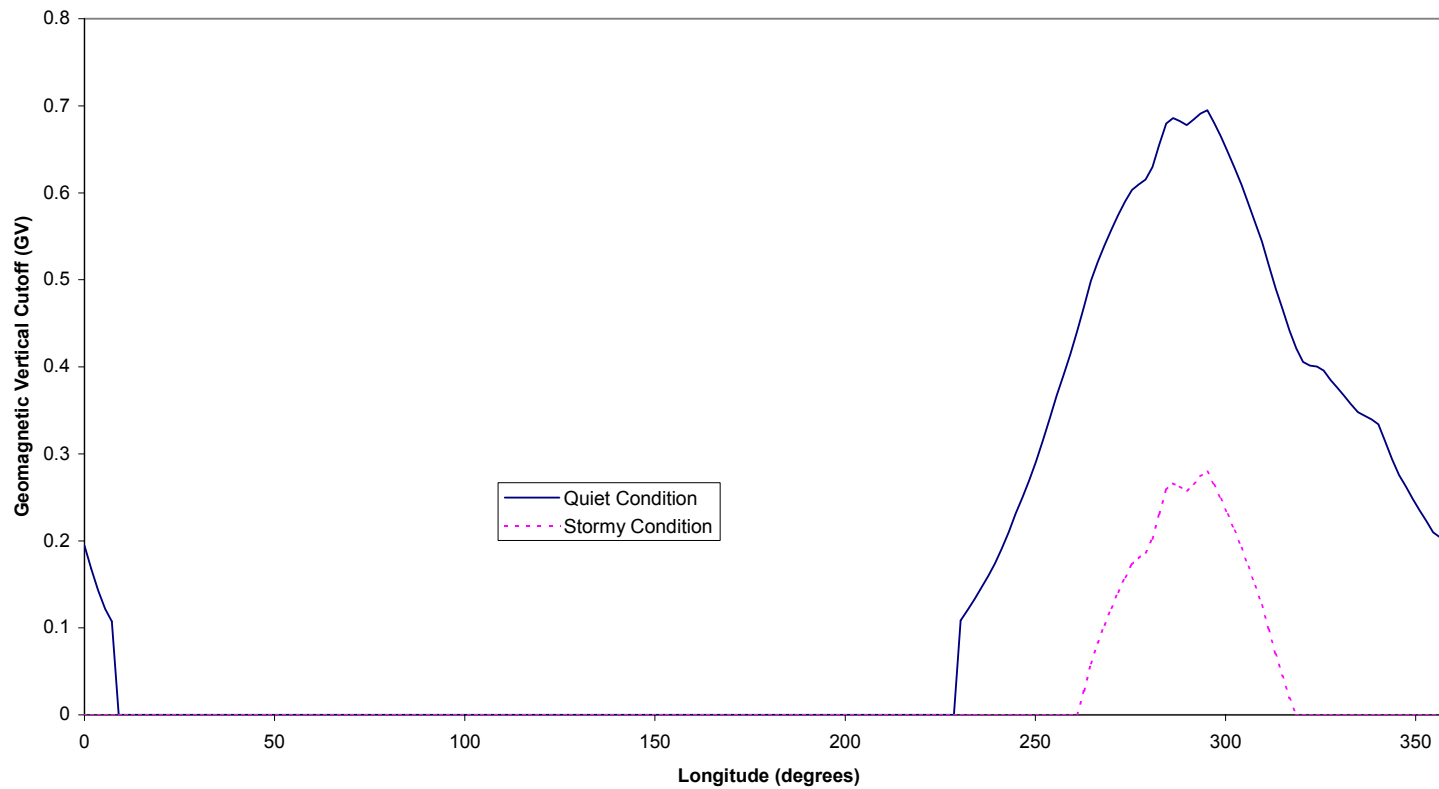




Geomagnetic Cut-off Antarctica



McMurdo Latitude (-77° 50')



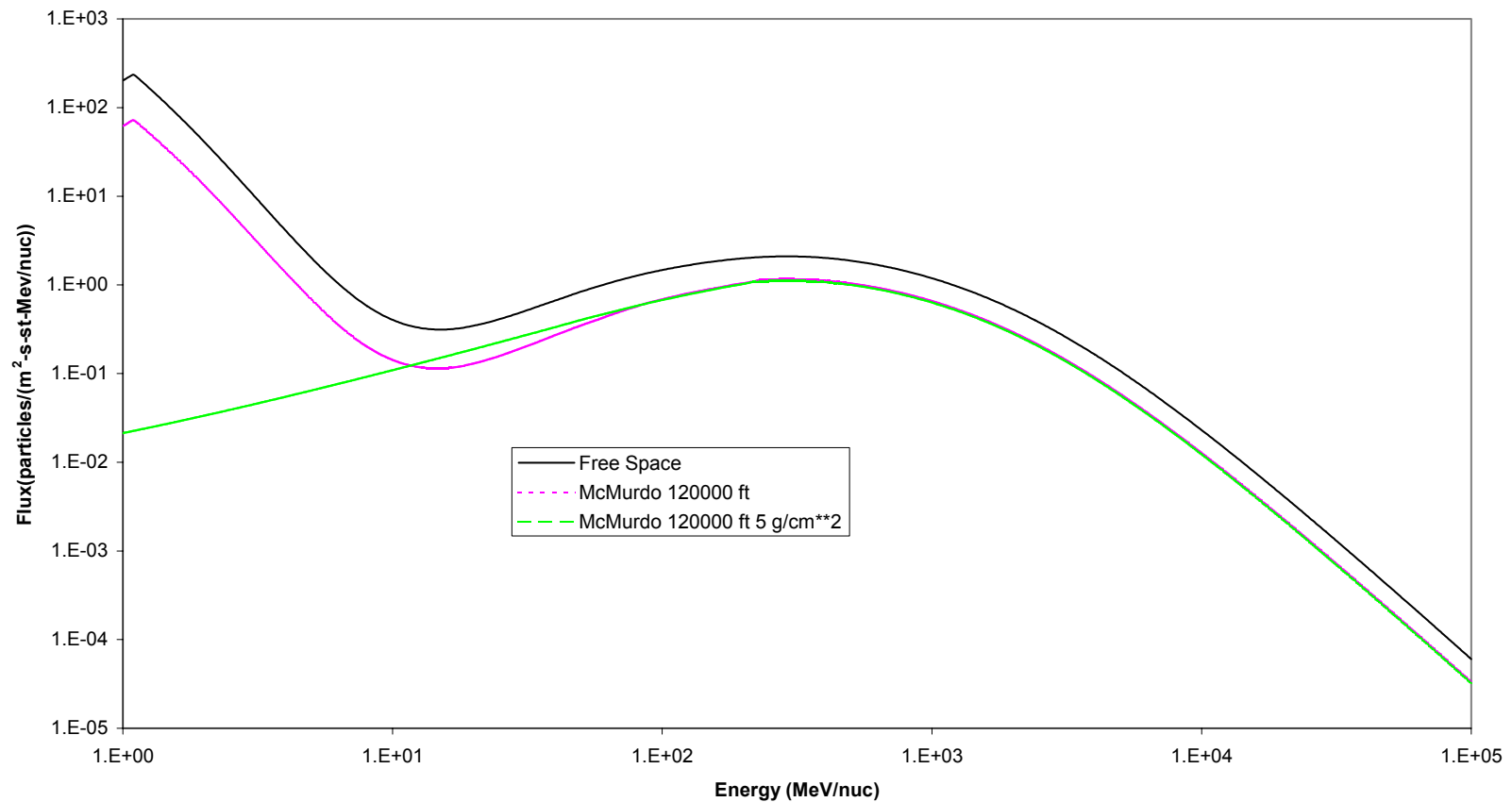
Deep Space Test Bed (DSTB)



Radiation Environment Antarctica



Solar Minimum Galactic Cosmic Ray Differential Proton Flux



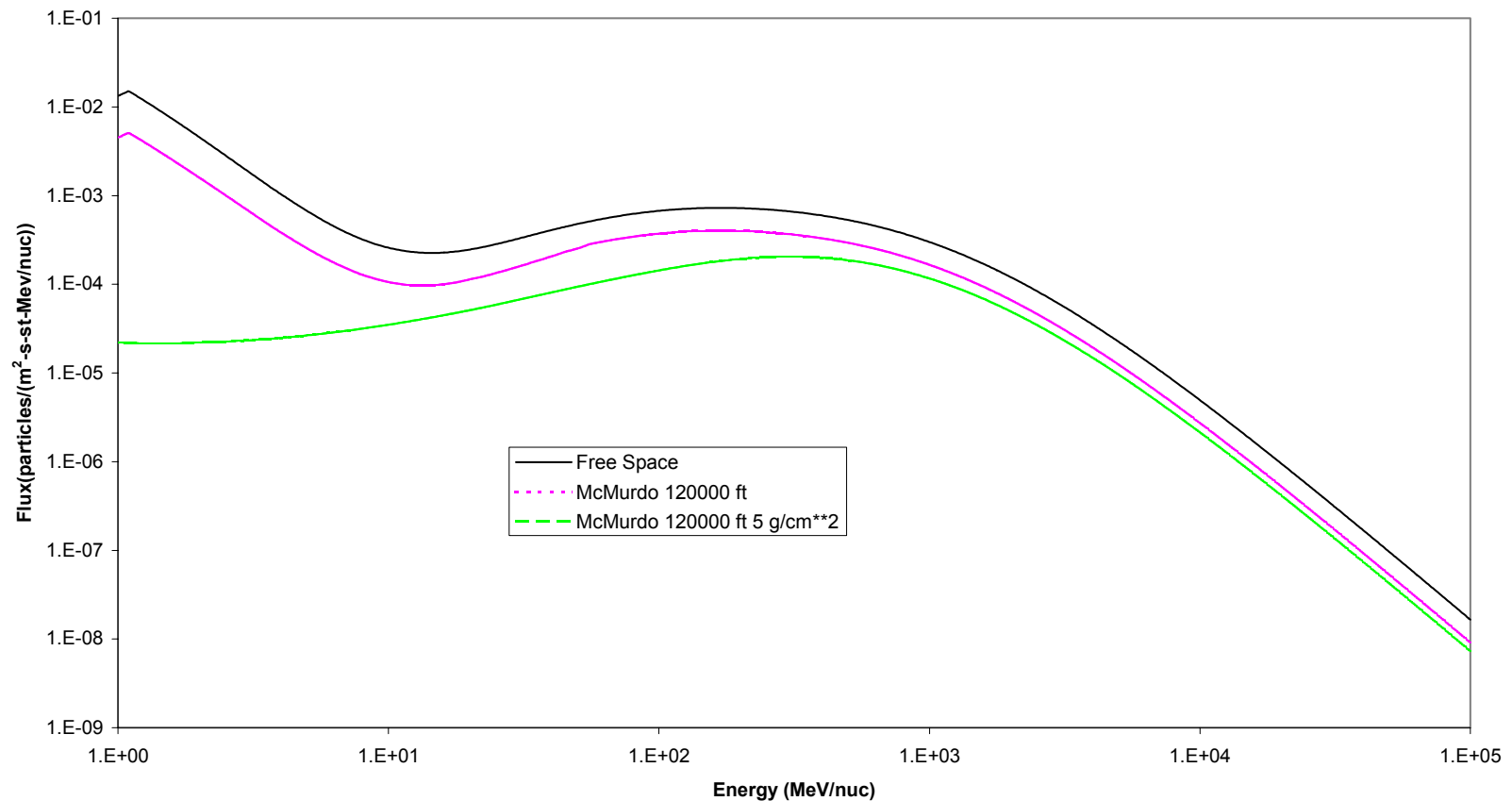
Deep Space Test Bed (DSTB)



Radiation Environment Antarctica



Solar Minimum Galactic Cosmic Ray Differential Iron Flux



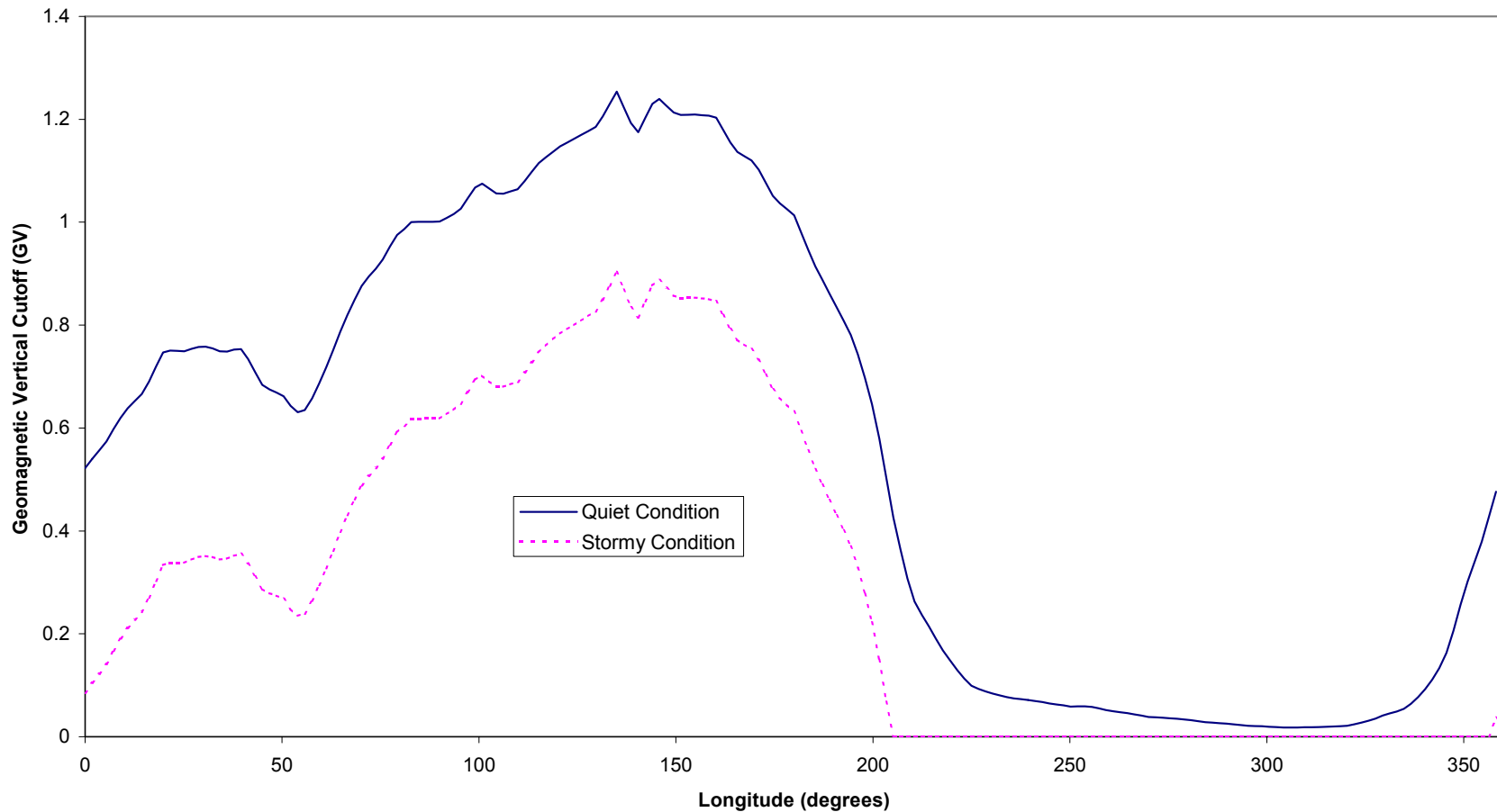
Deep Space Test Bed (DSTB)



Geomagnetic Cut-off Fairbanks, AK



Fairbanks Latitude (64° 48')



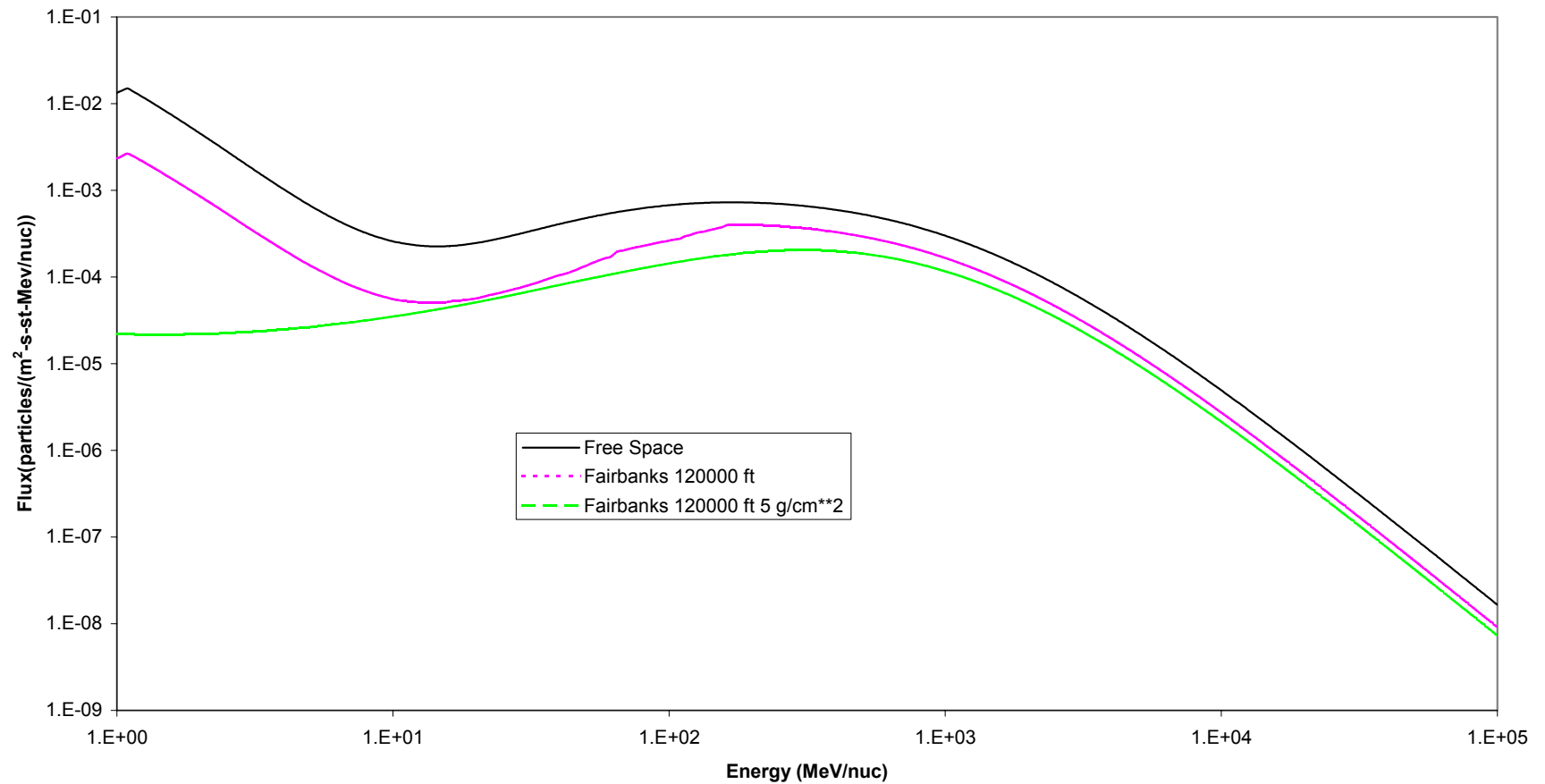
Deep Space Test Bed (DSTB)



Radiation Environment Fairbanks



Solar Minimum Galactic Cosmic Ray Differential Iron Flux



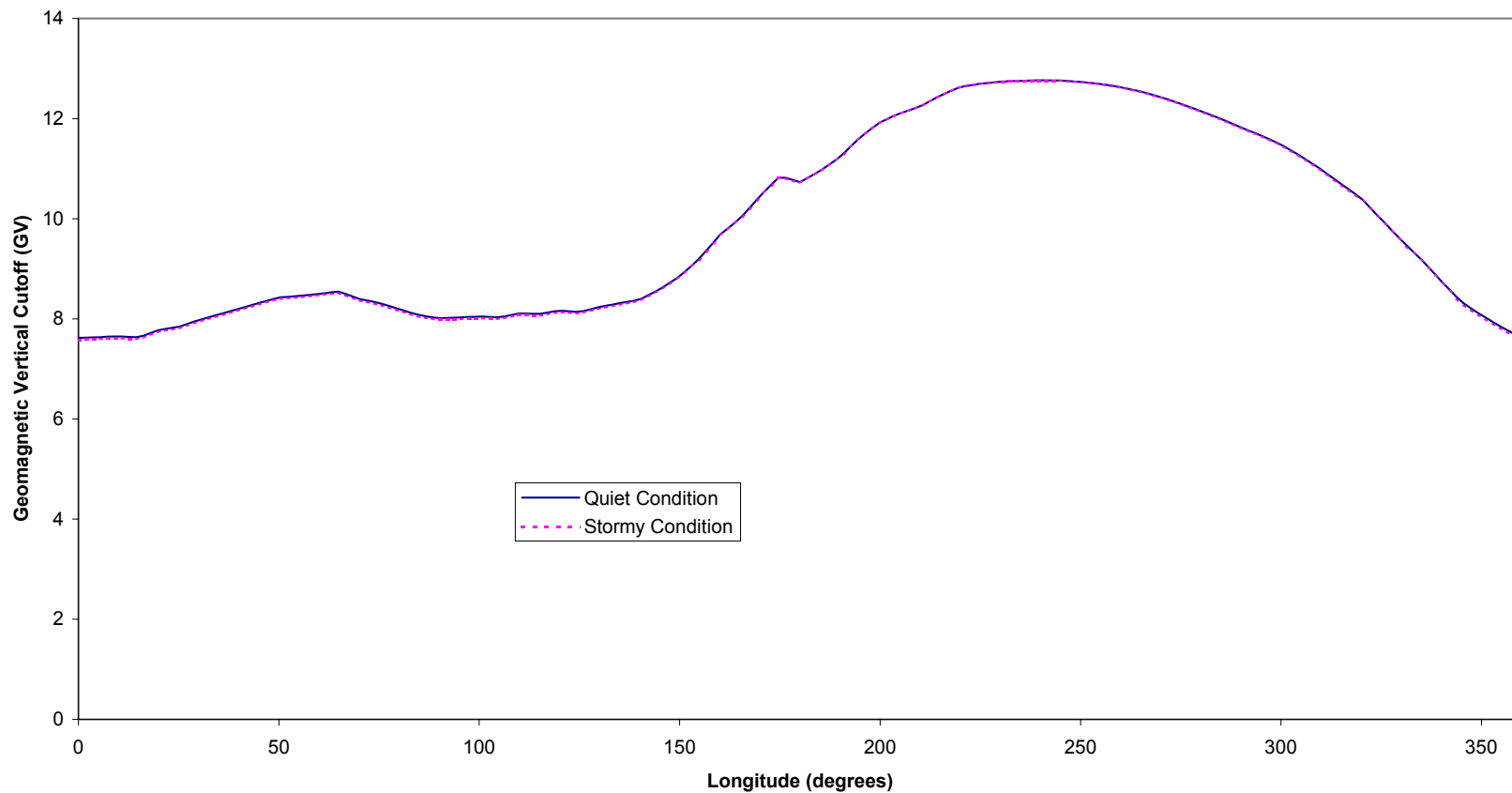
Deep Space Test Bed (DSTB)



Geomagnetic Cut-off Alice Springs, Aus.



Alice Springs Latitude (-23° 49')



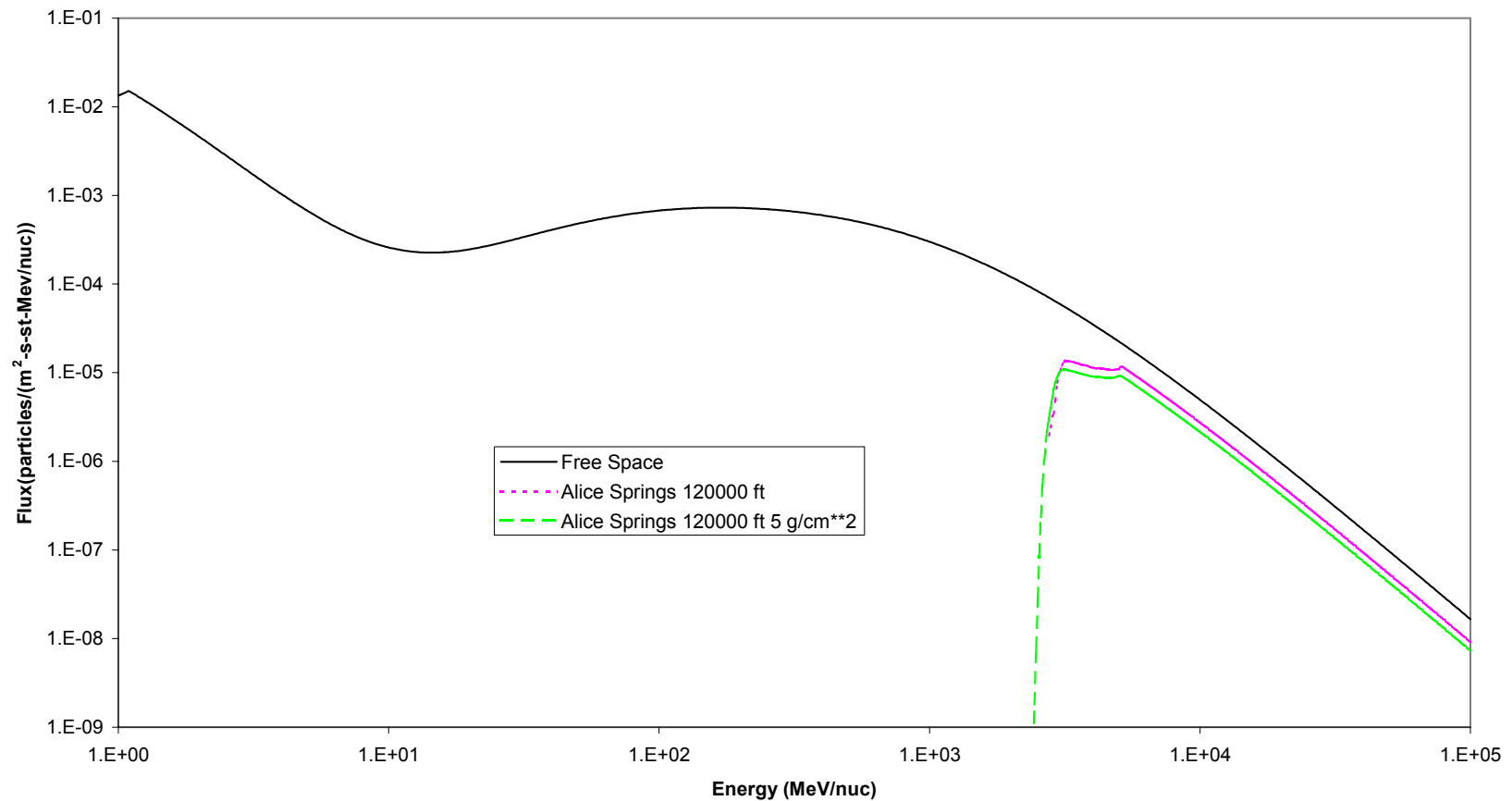
Deep Space Test Bed (DSTB)



Mid-Latitude Radiation Environment



Solar Minimum Galactic Cosmic Ray Differential Iron Flux



Deep Space Test Bed (DSTB)

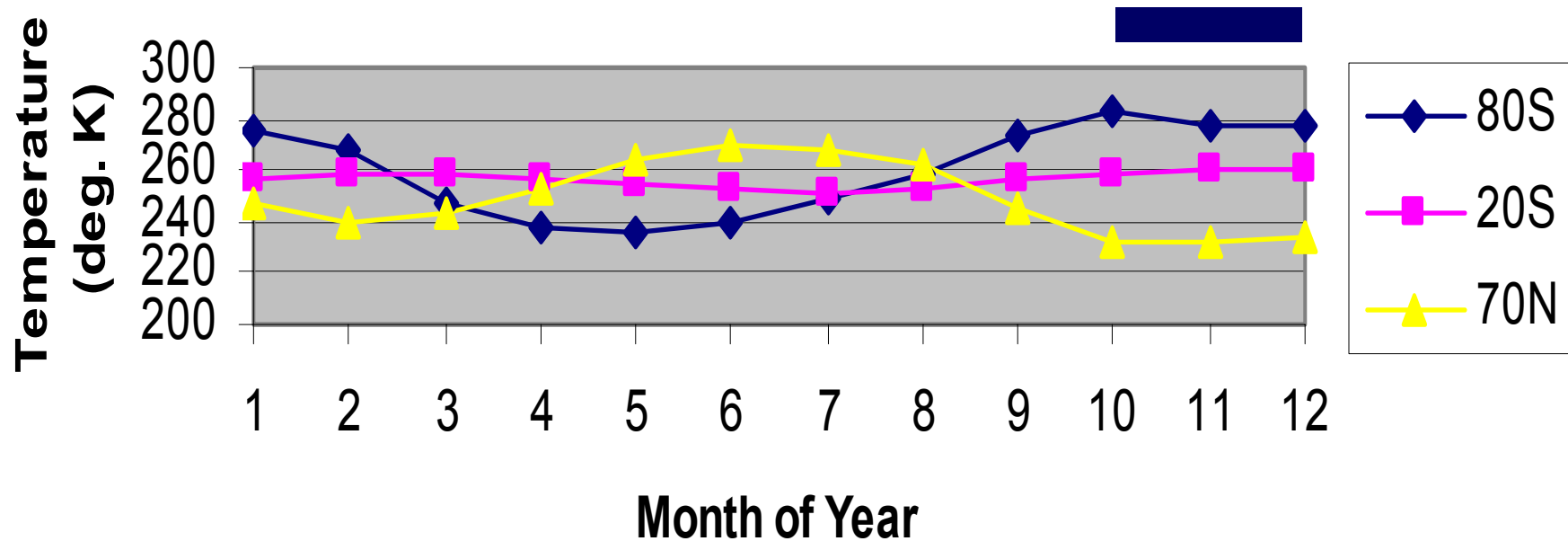


Thermal Environment



COSPAR International Reference Atmosphere (CIRA-86)

Zonal Mean Temperature at 40 km





DSTB Status



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- 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