Scientific Ballooning Technologies Workshop
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DSTB: A Balloon-borne Multiple Payload Experiment Facility for Radiation Studies

- **To conduct investigations in the near space environment**
- **Supports multiple investigations on each flight**
- **Platform for instrument development**
- **Implemented through NASA's Balloon Program**

DRAFT NASA Research Announcement1 (NRA) “Space Biology Research Utilizing Antarctic Balloon Flight Campaigns” (NNH17ZTT001J).

NASA requests your comments on the scope and content of the solicitation “Space Biology Research Utilizing Antarctic Balloon Flight Campaigns”

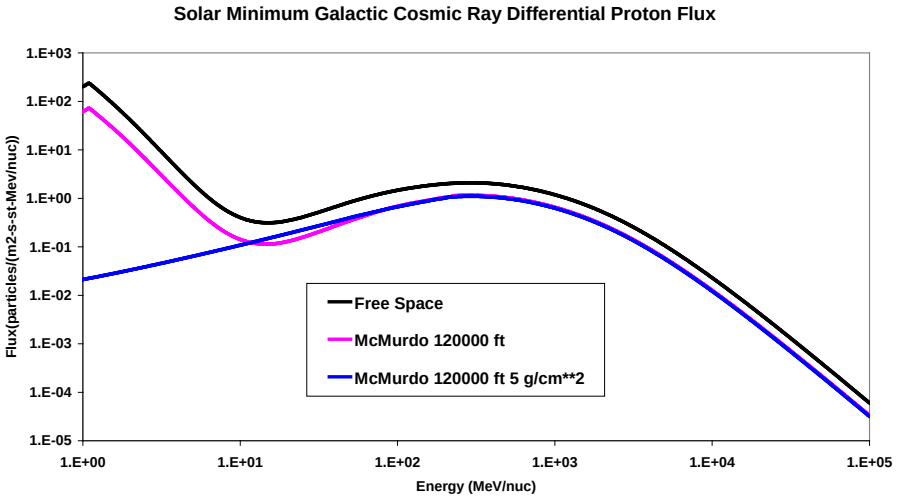
“Research Opportunities in Space Biology (ROSBio)–2016”.

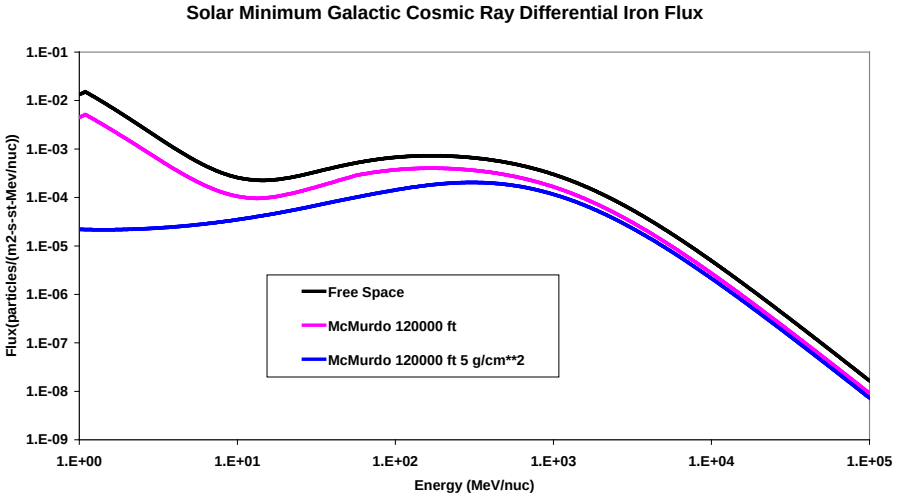
Berkeley Space Radiation Workshop Recommendations

- Develop ability to simulate and transport GCR-type H-Fe; elemental spectra + all secondaries and neutrons behind shielding materials to within 25% of measured fluences
- Ascertain accuracy of current transport codes through benchmark tests
- Measure needed cross sections for code improvement
- Improve accuracy of transport codes
- Improve cross-sections database for secondary heavy nuclei/neutrons
- Validate radiation transport codes: ground & space-based tests
- Two dedicated consortia: Transport code development and cross-section measurements
- Ground [NSRL] & space-based [DSTB] measurements of shielding effectiveness

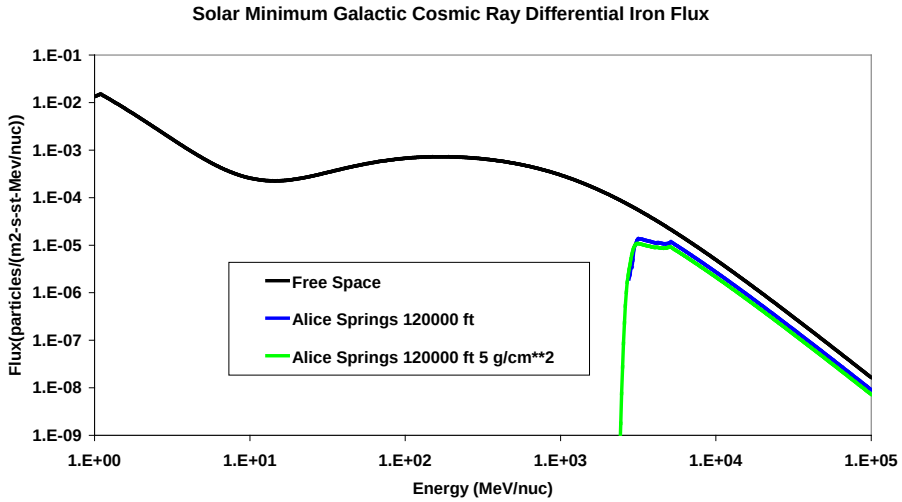
Geomagnetic Cut-off

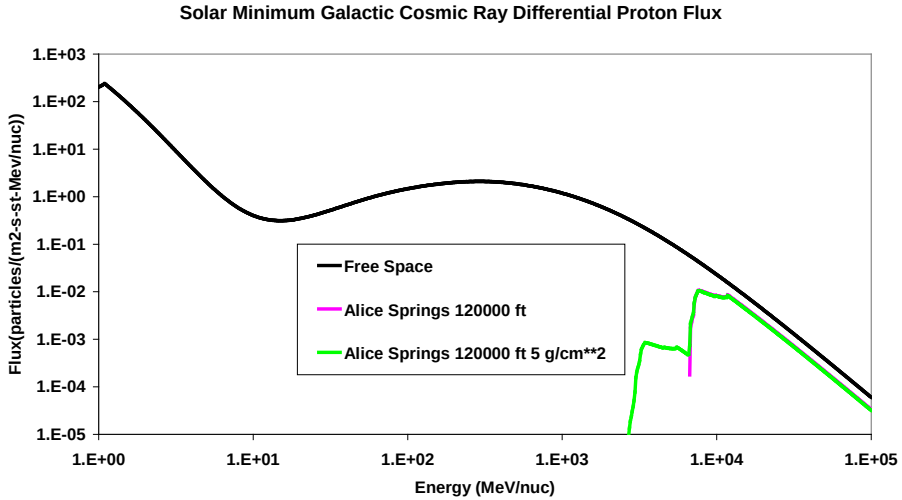
Polar Latitude





Middle Latitude





DSTB Objectives

The DSTB is implemented using NASA's polar LDB program to provide access to the deep space GCR elemental abundance and flux to:

- Test accuracy of radiation transport code prediction behind shielding materials
- Characterize the radiation shielding effectiveness of candidate shielding materials
- Test new radiation monitoring equipment
- Conduct exposures for biological studies

DSTB Design Strategy

- Design as a facility to conduct multiple science and technology investigations on single balloon flights
- Assume maximum allowable science payload at any launch site
- Share available resources among payloads and provide isolation/protection from faults
- Use standard interfaces between DSTB and payloads, and CSBF equipment
- Accommodate multiple investigations with varying degrees of complexity and ballooning experience
- Measure relevant exposure parameters with a standard instrument suite (charged particle fluxes, dose, temperature, position, altitude)
- Flexible architecture to meet wide range of requirements gathered from potential users

Capabilities

- **Resources:**

Payload up to 4000 lbs
Power 600 watts
Telemetry
6kbs OTH
300 kbs LOS

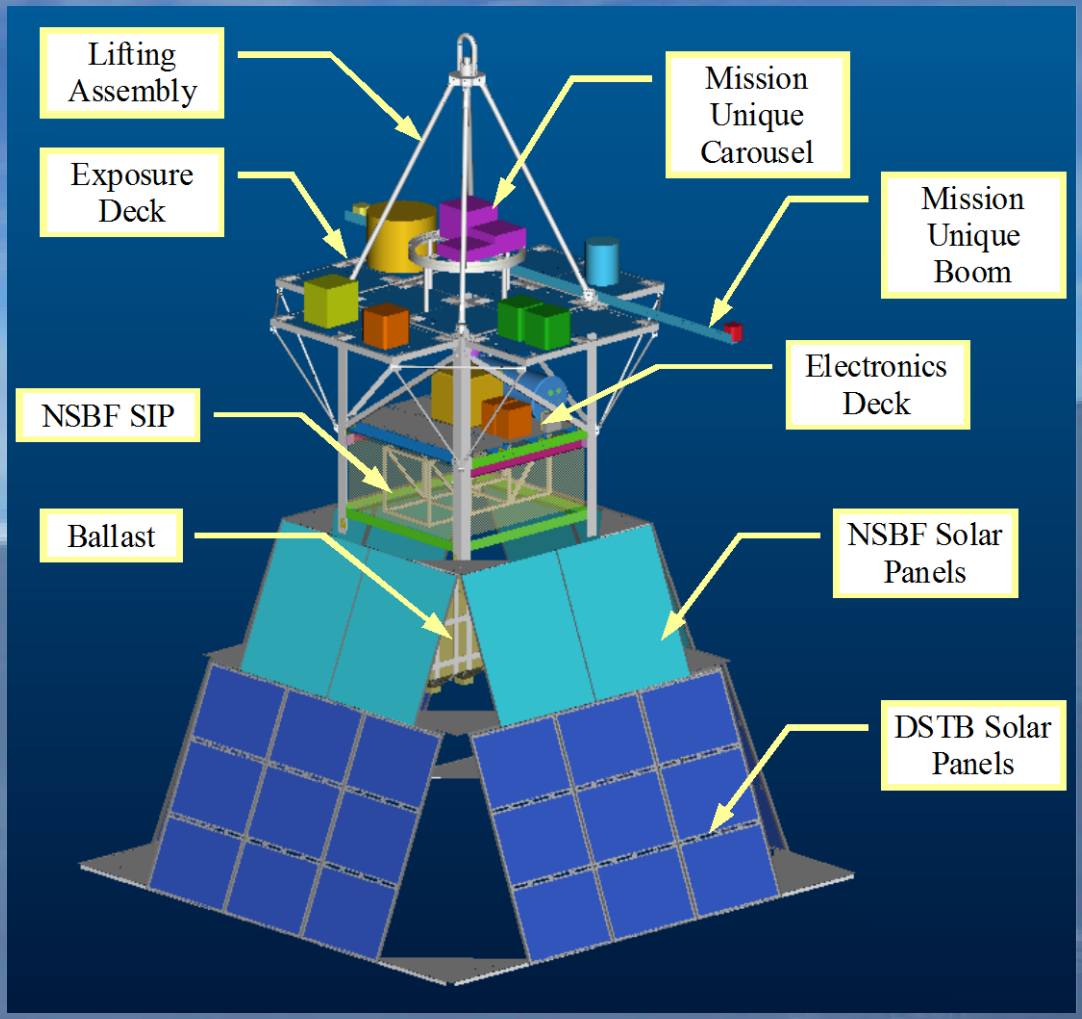
- **10 Payloads per flight**
- **Instrument Field of View**

Skyward, Nadir, Horizon

- **Special Attachment points:**

Extended Booms
Tethered below

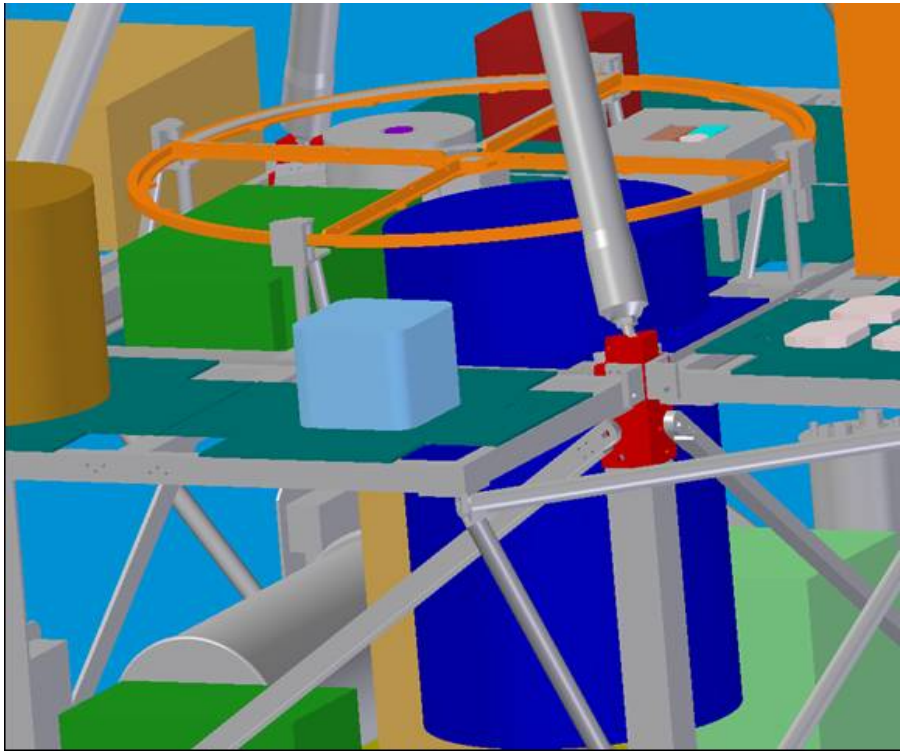
- **Standard data and power interfaces to payloads**



- **Ground support equipment**
- **Data access is web based**
- **NSSTC Integration facility**
- **Suitable for any current launch site**

Payload Attachment

- **Gondola was designed for maximum payload mass for launch in Antarctica: 4000 lbs (1820 kgs) total "science" payload**
- **Typical attachment trays 150 lbs (68 kgs) and up to 2×2 ft^2 (61 × 61cm^2)**
  - **12 attachment trays on the exposure deck**
  - **Neighboring locations can be combined to support 2× and 4× the mass and footprint**
- **Electronic deck supports experiments up to 1000 lbs (455kgs)**
- **Special attachment points:**
  - **Boom: length(ft)×mass(lbs)**
    - **4×87, 8×50, 10×36**
  - **Carousel: 40" diameter**
    240 lbs load mass
    - **program control of rotation**
  - **Suspended experiments**
- **Other gondola configurations**
  requires new stress analysis

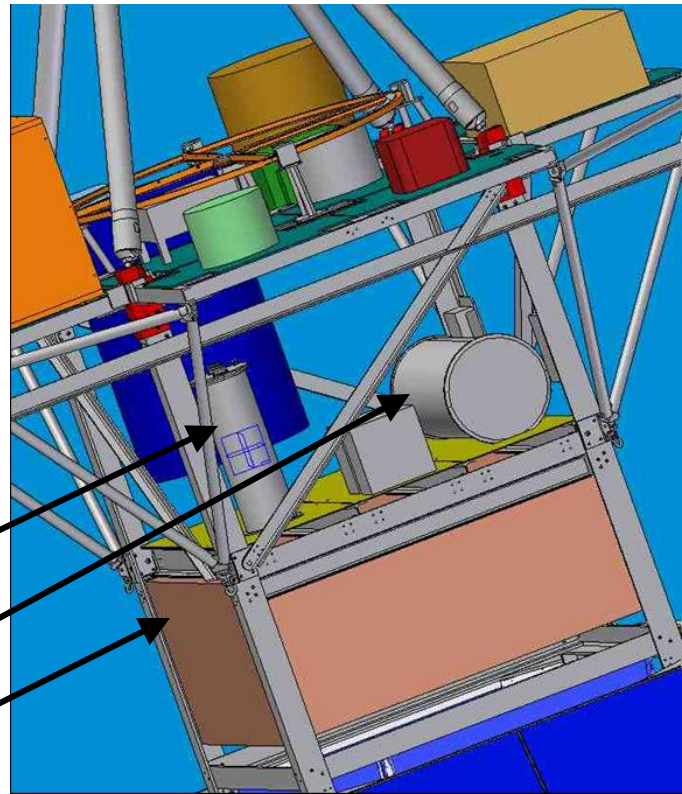


Flight Data System

- **Three components:**
  - **Flight Control and Data Storage (FCDS)**
  - **Smart Data Connector (SDC)**
  - **Balloon Flight Equipment (Science or Command Instrument Package)**

- **FCDS stack uses PC104 bus**
  - **Command (uplink) and data stream (downlink) parsed for individual instruments: bandwidth allocation based on instrument requirements**
  - **Existing Solid state disk 20-40 GBytes: allocation based on instrument requirements**
  - **20 Tbase-100 ports (interface to SDCs)**
  - **ADC/DAC IO cards**
  - **Telemetry card for OTH/LOS data stream**
  - **PDU controller/monitor**

- **SDC based on Netburner controller board**
  - **2 standard interface port (RS-232, RS-422)**
  - **Data rate regulated**
  - **5/6 digital inputs/outputs**
  - **8 temperature sensors**
  - **4 Analog inputs**
  - **3 latching relays**
  - **2 momentary switches**



Power and Distribution

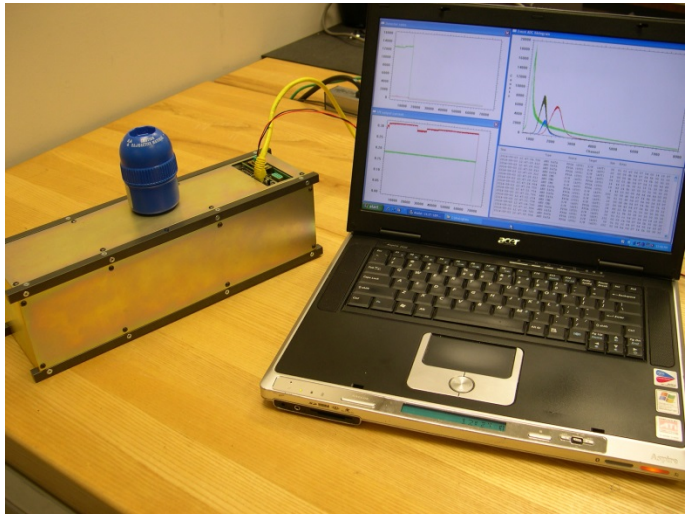
• Power is developed from solar arrays for long duration flight; batteries for shorter flights

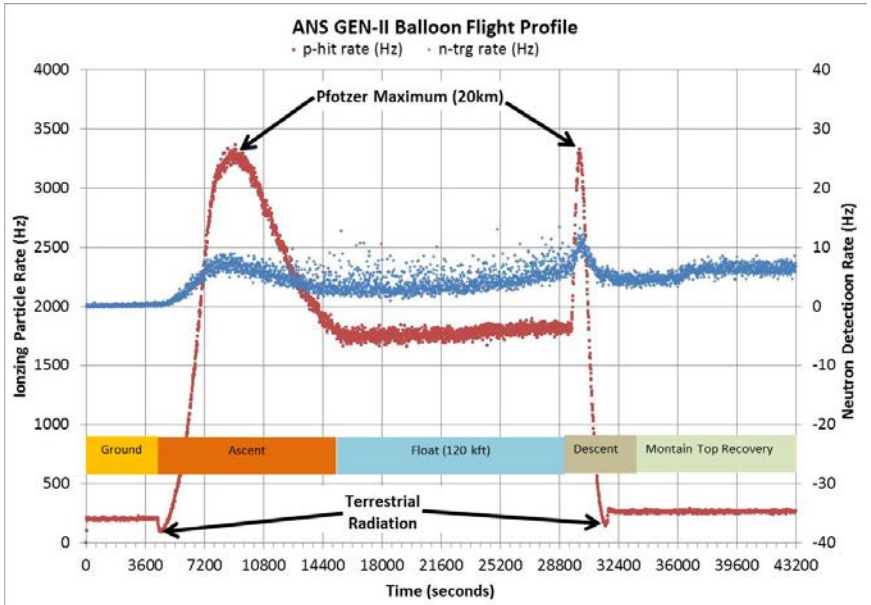
• Solar arrays (600 watts, Antarctica)
- **Omni-directional or sun pointed solar array configurations**
- **Peak power tracking for battery charging**
- **Regulated 28 volt output for instruments**

•Battery packs
- **4 separate battery carriers**

• Power Distribution Unit (PDU): 20 branch circuits, 1 for each instrument;
- **Each branch controlled/protected by a re-settable circuit breaker**
- **Circuit breakers: 0.5, 1.0, 2.0, 5.0 and 10.0 Amps**
- **Operate up to 120% of rated load and trip at 125%**
- **Breakers/Instruments can be commanded on/off from ground station**
- **Sub-systems have a dedicated circuit**

Radiation Monitoring Suite





DSTB Operations

- Provide instrument compatibility review
- Interface with investigators and provide interface document details, and support
- Support integration and testing on gondola at NSSTC
- Provide remote access for command and data during flight
- Return instrument and data set after fight

Payload Support and Integration

- **Ground station and support equipment**
  - **Dedicated ground computer/server with large data storage**
  - **Interfaces to CSBF data streams to uplink commands and receive telemetry data**
  - **Parses data stream for individual instruments and sub-systems**
  - **Provides a web-based interface for data access by investigators**
  - **Functions as test station during integration**
  - **Portable mechanical and electrical workstations**

- **NSSTC Integration facility**
  - **High bay facility for complete integration of gondola**
  - **Overhead crane and standalone hoist**
  - **Machine shop co-located**
  - **Standard laboratory equipment and supplies available**
  - **Users work space and office space available**
  - **IT services provided**

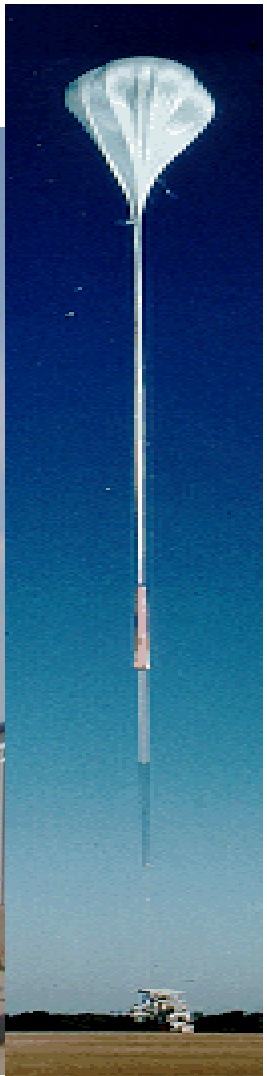
DSTB Field Support

- **Balloon Flight Equipment Integration and Compatibility Test**
  - **Transportation of integrated DSTB facility to test site**
  - **Support balloon equipment installation (CIP/SIP) and check-out**
  - **Compatibility and Hang Tests**

- **Flight Support and Interface to CSBF**
  - **Transportation to launch site**
  - **Functional test of DSTB payload**
  - **Flight requirements and readiness reviews**
  - **Conduct instrument operations during flight**
  - **Support investigators access to data in near-real time**
  - **Recovery operations and return transportation**
  - **Experiment data set delivered including flight exposure parameters**

DSTB Test Flight

- 8 hour test flight Ft. Sumner NM, June 2005
- 6 proto-type instruments for radiation shielding studies (charged particle spectrometer, dosimeter, gamma ray spectrometer, neutron counter)
- 6 student payloads
- Exercised power and data systems
- Qualified for polar flights



DSTB Status

- **Design and fabrication completed:**

  simple interfaces (power, data, mechanical) to minimize integration time, suitable for science teams inexperienced with ballooning

- **Two gondolas available:**

  can support 1 or 2 flights per year

- **DSTB monitoring instrumentation developed:**

  charged particle spectrometer, dosimeter, proportional counter, neutron spectrometer

- **DSTB integration process developed and simple**
- **Development team resides at NASA/MSFC and UAH (NSSTC)**
- **Qualification Flight completed:**

  all subsystems tested, capable of launching from all current launch sites,

  test flight payload included 12 independent instruments/investigations

- **Documentation on DSTB was developed for distribution to potential users for a previous NRA**