

# Space Tissue Equivalent Dosimeter (SpaceTED)

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# SpaceTED Experiment Description and Objectives:

- Scientific Merit: Demonstrate the SpaceTED tissue equivalent proportional counter (TEPC) and Si PIN diode with sensitivity low and high LET ionizing radiation.
- Technical Description: The low-cost, self-contained, and portable SpaceTED is sensitive to ionization radiation, including secondary neutrons, of the types and energies encountered in space and can provide real time dosimetric data on space crew radiation exposure.
- Physical Description: SpaceTED is self contained in a flight qualified aluminum box and requiring only external power.
- Objectives: Fabricate, test, characterize and calibrate SpaceTED, implementing lessons learned from the 2018 ISS ATED experiment including a newly designed ionization cavity to reduce microphonic noise and adding a capability to detect lower LET radiation (not completely registered in the TEPC) via Si PIN diode.
- Implementation: SpaceTED will be positioned in a quiet location within the habitable volume of ISS (JEM near airlock) and operate continuously for ~6 months. Data will be periodically downloaded to ground via an ISS laptop. Launches on SpX-29 (1 November 2023).

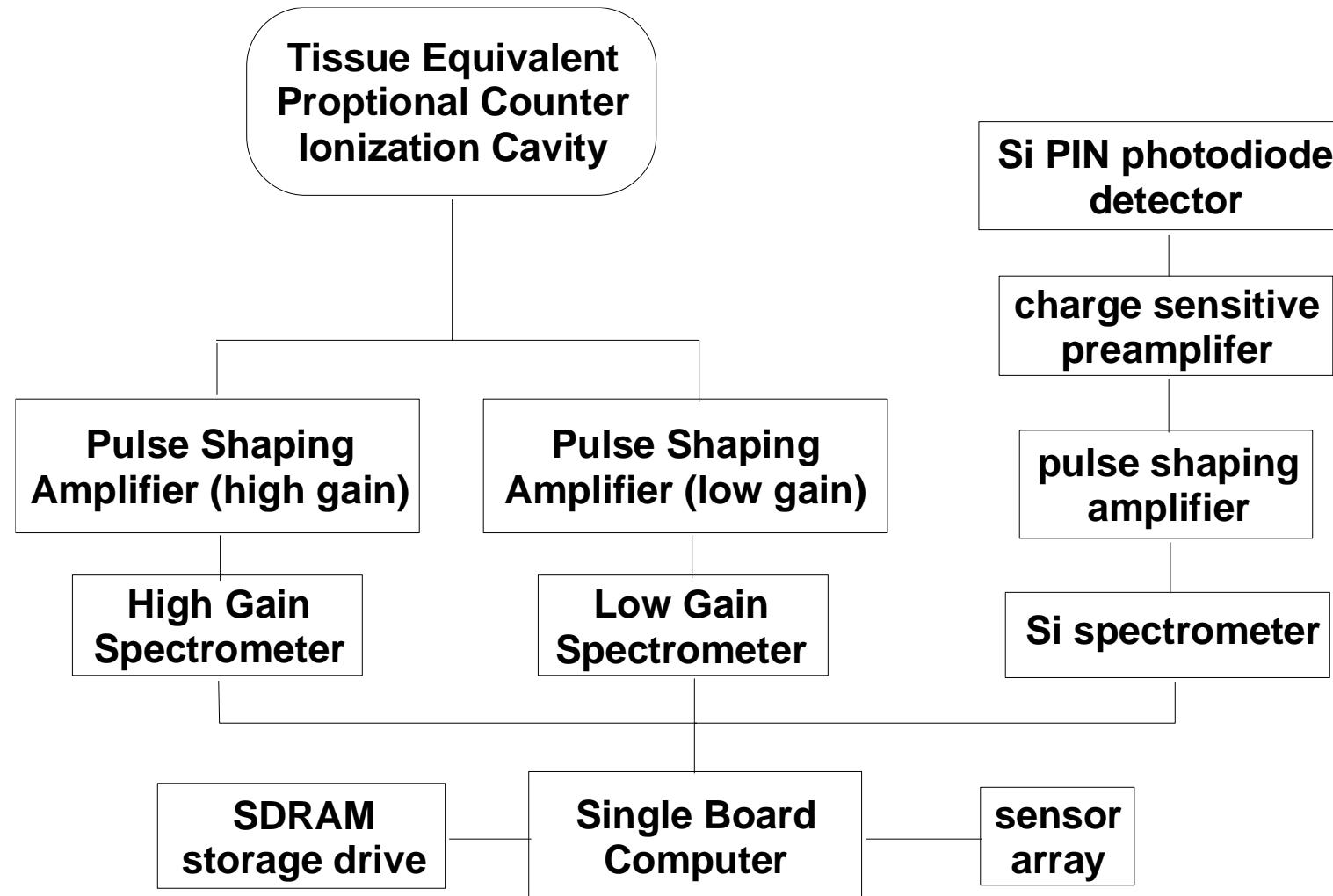
# SpaceTED Instrument Overview

## Parameter

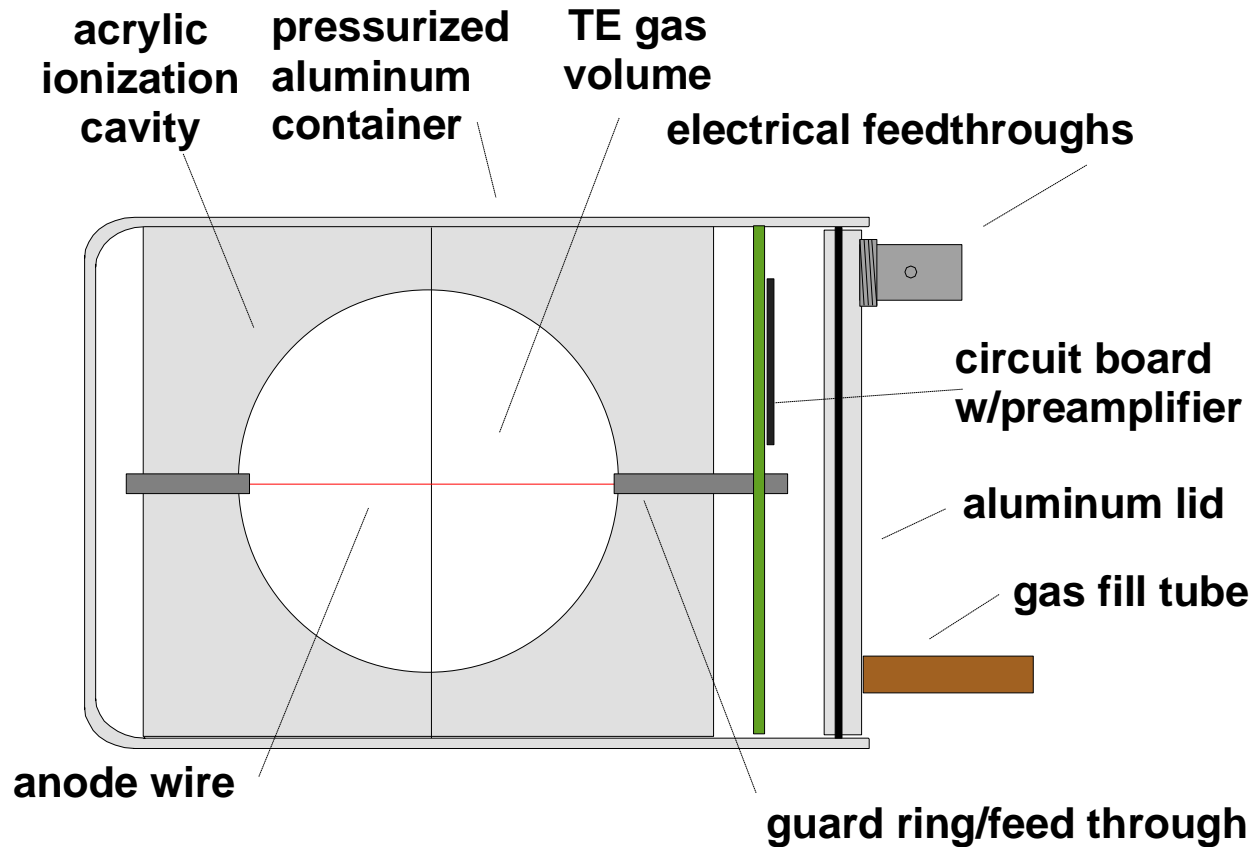
## Description

- Transport: Pressurized on SpaceX-29
- Duration:  $\geq 6$  months
- Location : ISS JEM near airlock
- Crew Time: Short crew time needed to install, start device. Periodically (e.g. fortnightly) remove and download data from of SDRAM cards. Return instrument at end of mission.
- Power:  $< 20$  W (120 Vac from ISS Inverter)
- Volume: 25.5 cm  $\times$  15.5 cm  $\times$  12.5 cm aluminum (Zero Mfg.) enclosure (not including power cable).
- Total Mass: 3.6 kg (including power cable).
- Data: Data stored on device on SDRAM cards. Data transferred to ground via ISS laptop.

# Block Diagram of SpaceTED Detector with low LET Si Detector

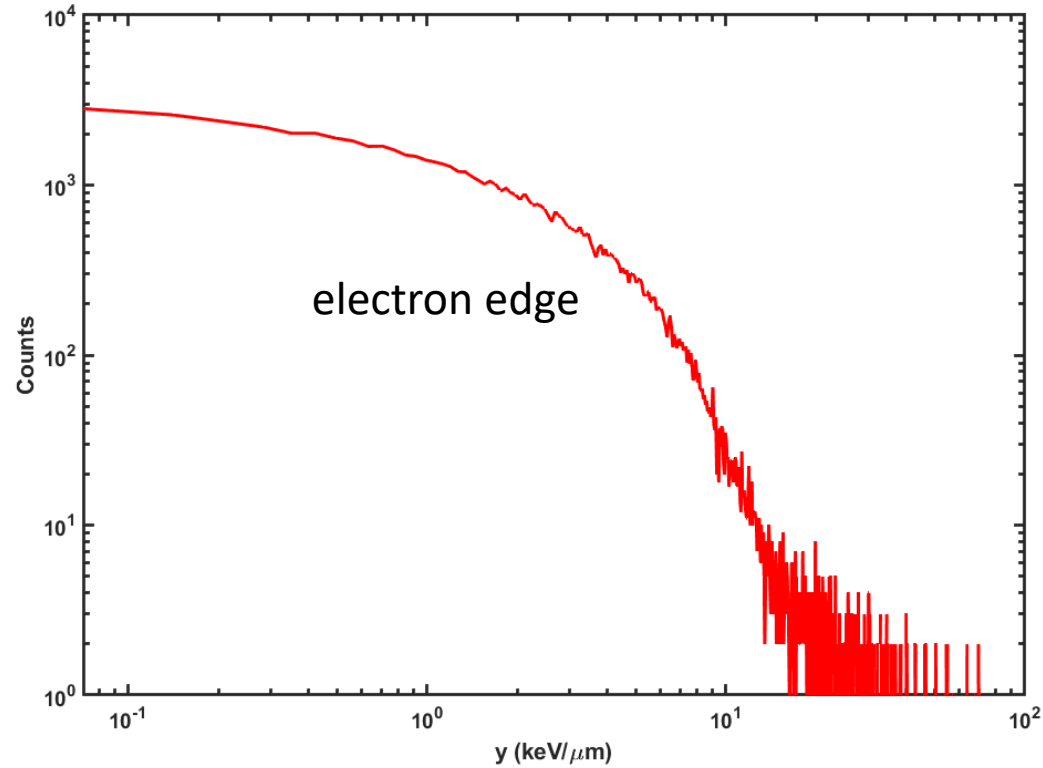


# New SpaceTED Detector Head Design

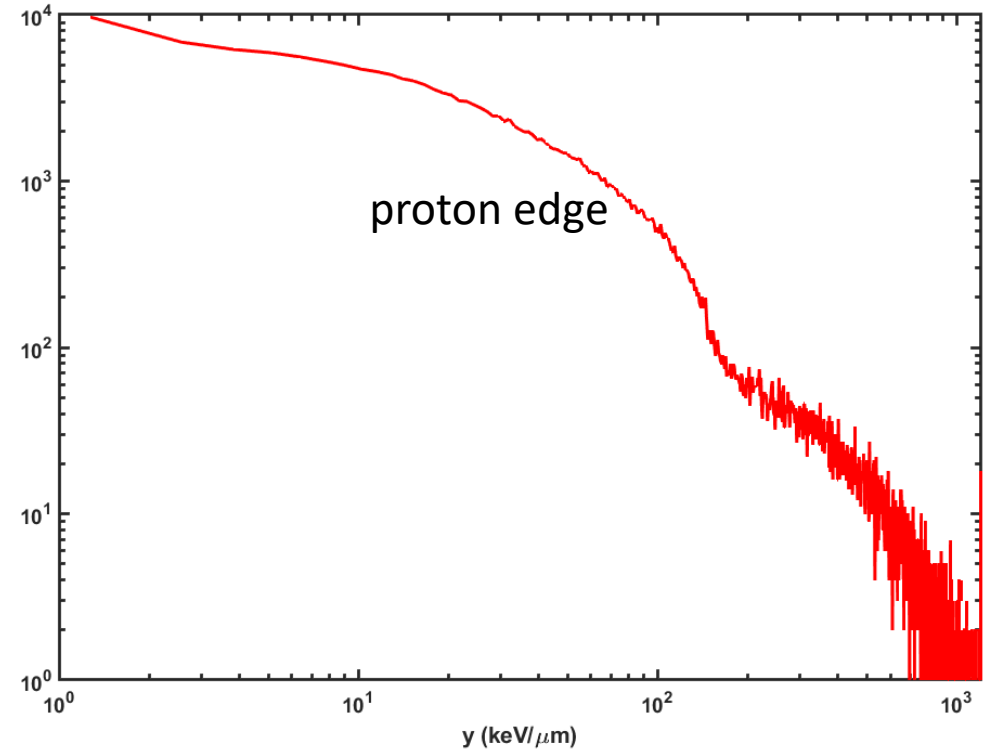


- Ionization cavity is made by hollowing out hemispherical volumes in two pieces of cylindrical acrylic and placing them together to make a spherical cavity.
- Anode wire is 2 mil Tungsten...stiffer than the 2 mil stainless steel used in ATED.

# SpaceTED Calibration Lineal Energy Spectra

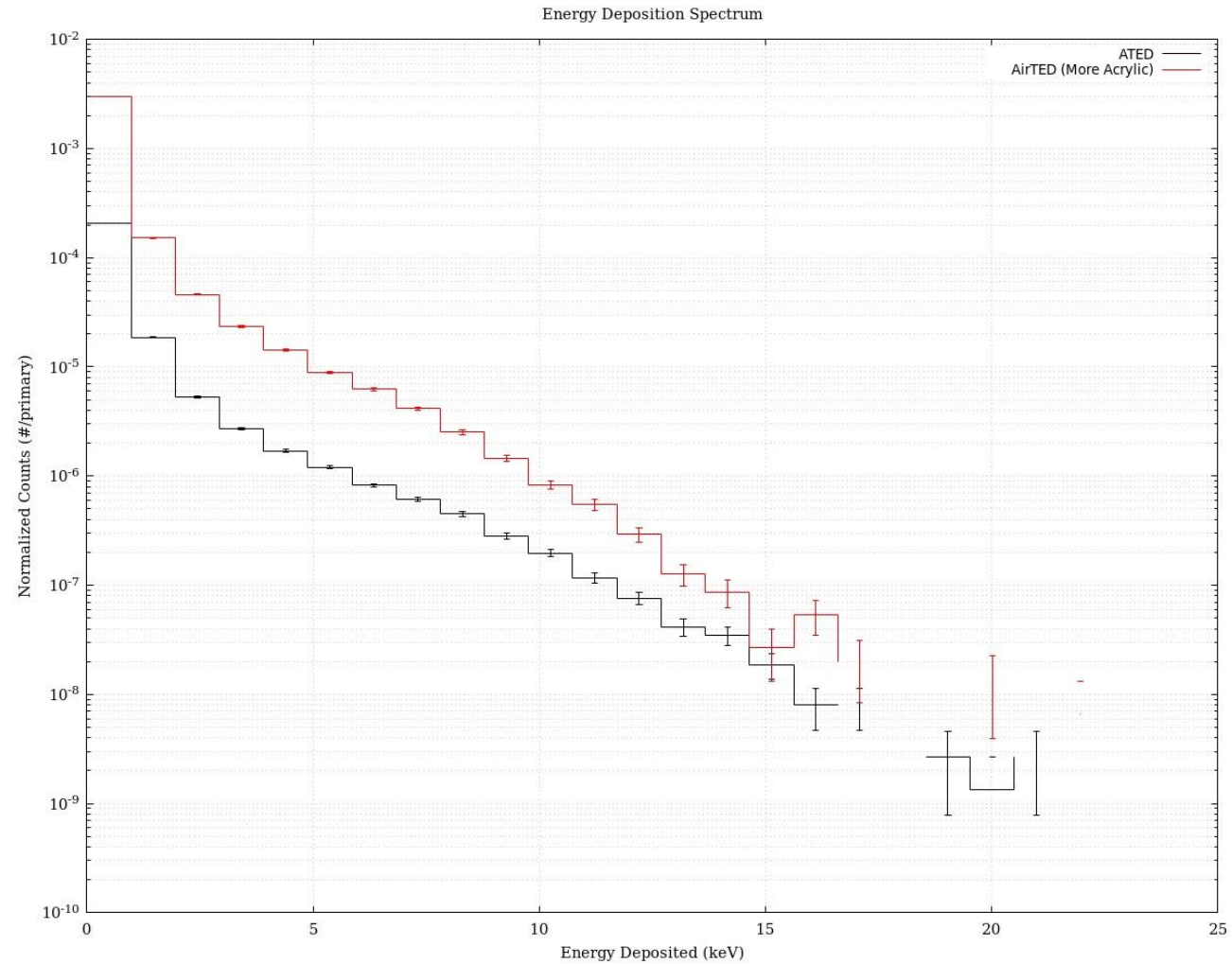


$^{137}\text{Cs}$  Gamma Source



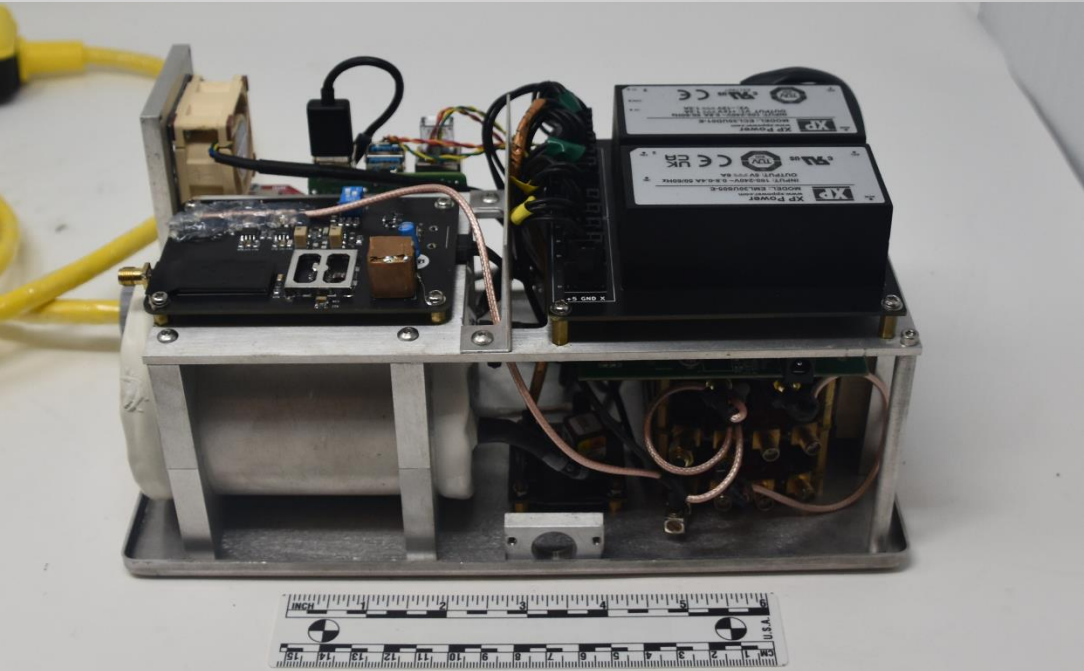
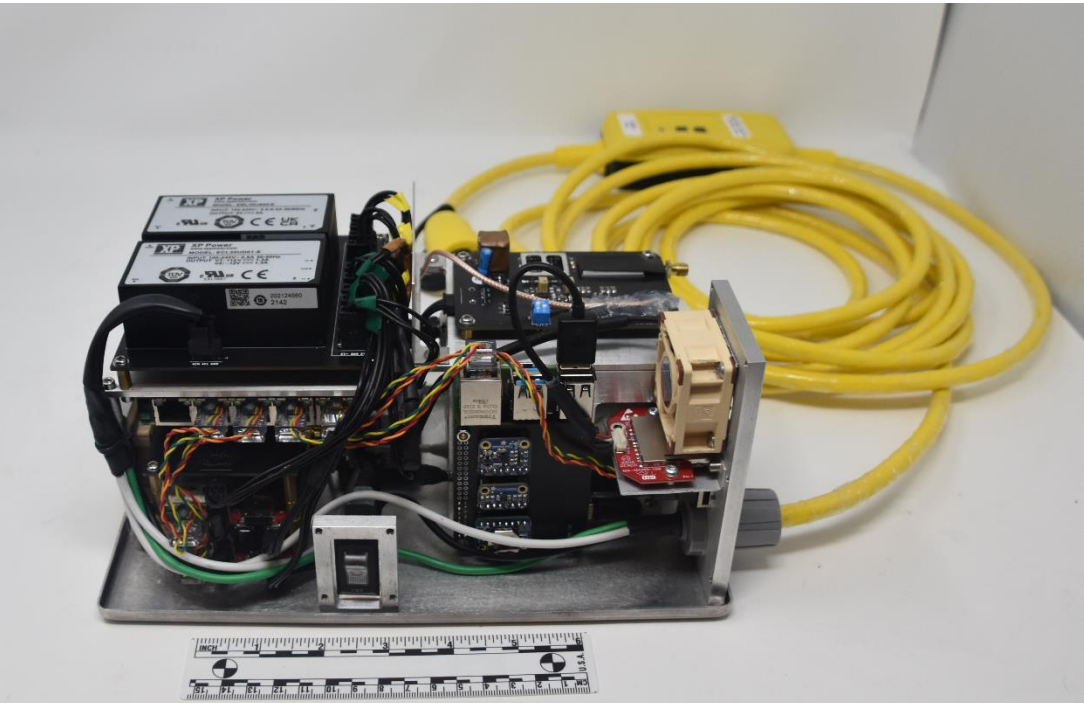
PuBe Neutron Source

# Fluka Simulation of New vs. Old Detector Head Cavity Gamma Source



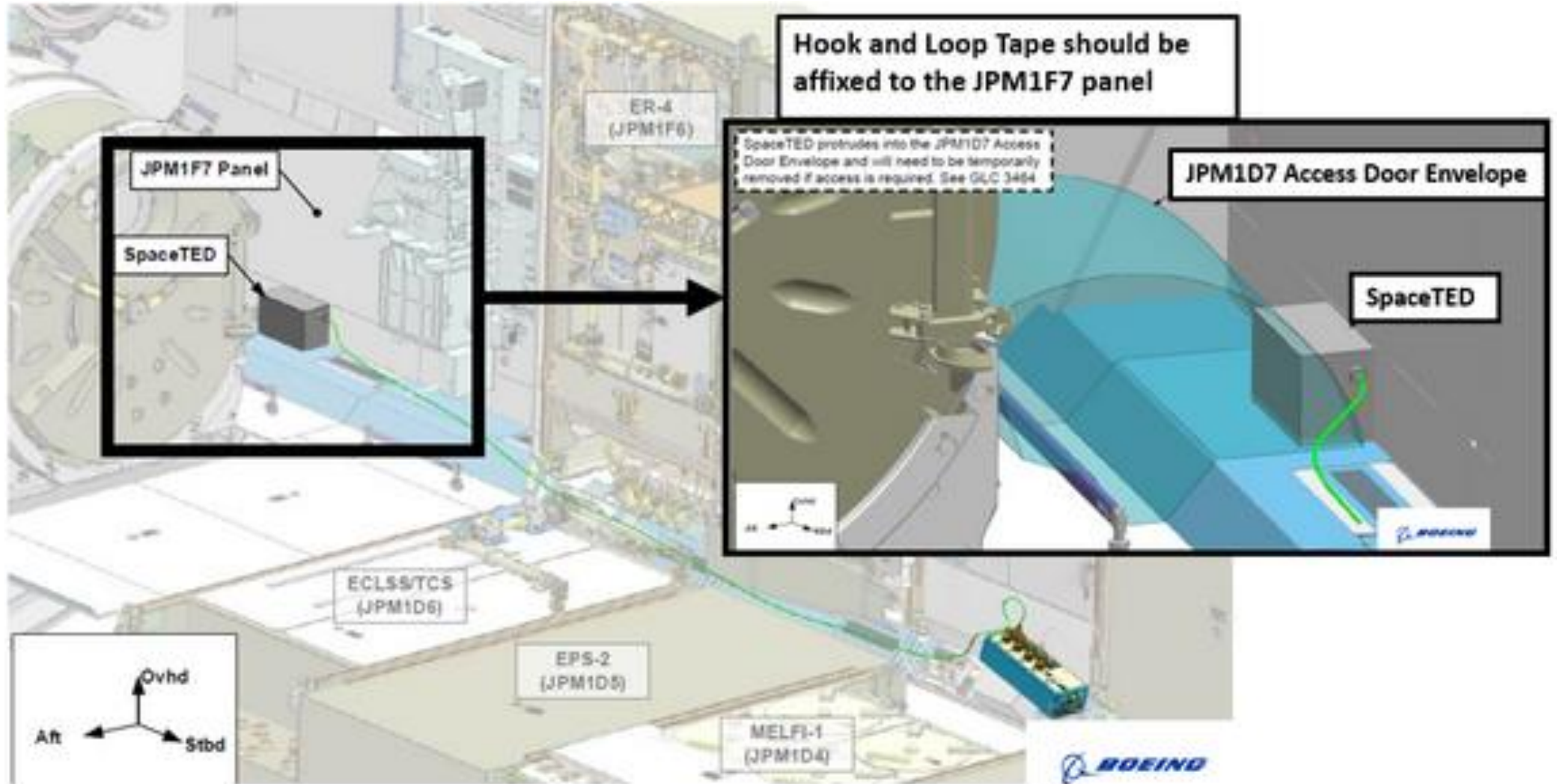


# SpaceTED Flight Unit

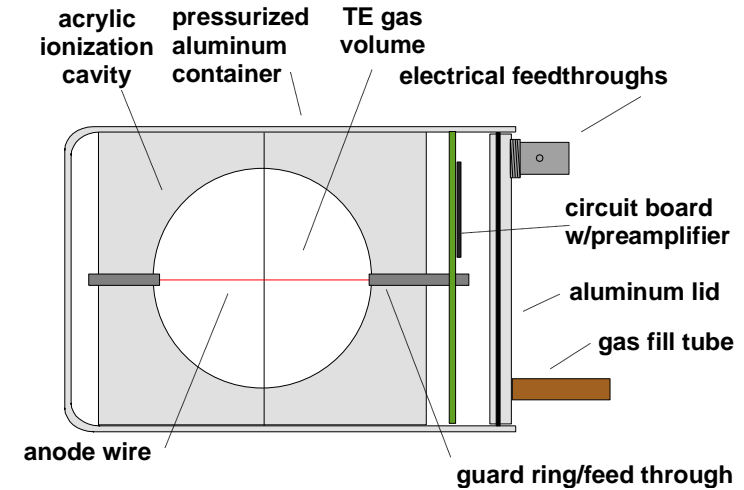




# SpaceTED Exposure Location in ISS JEM



# Atmospheric ionizing radiation Tissue Equivalent Dosimeter (AirTED) Tissue Equivalent Proportional Counter on NASA WB-57

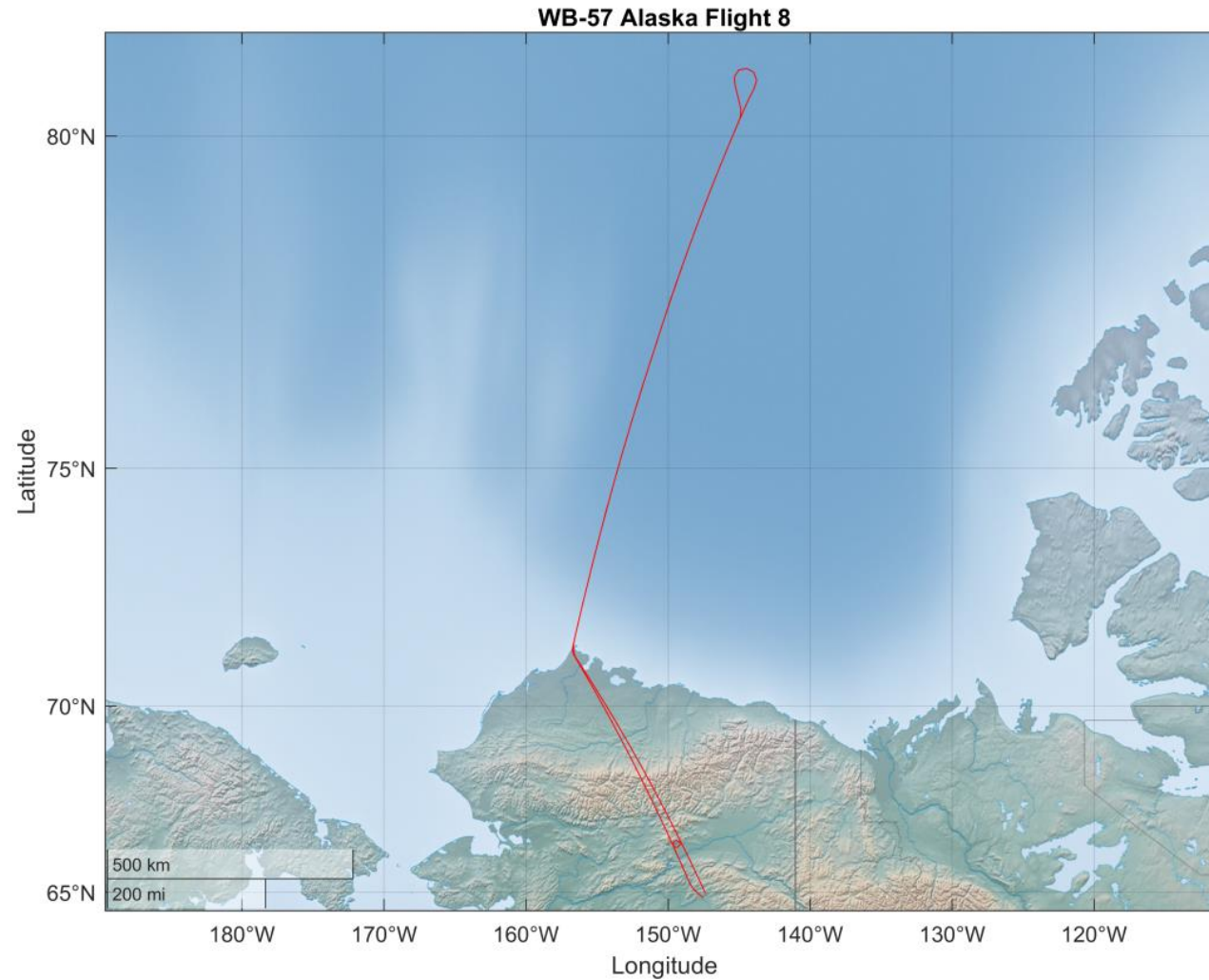


Credit: NASA



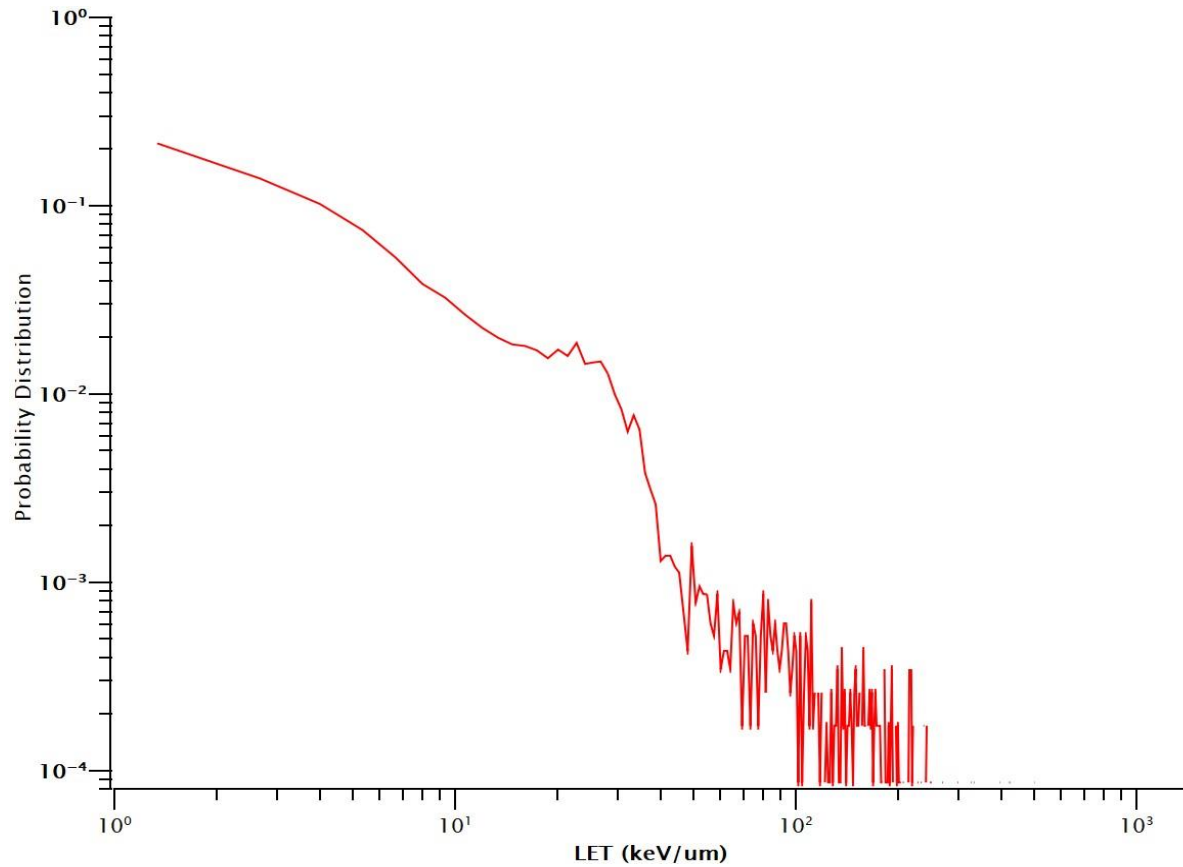
Credit: NASA

# WB-57 Flight from Eielson AFB, Alaska towards North Pole

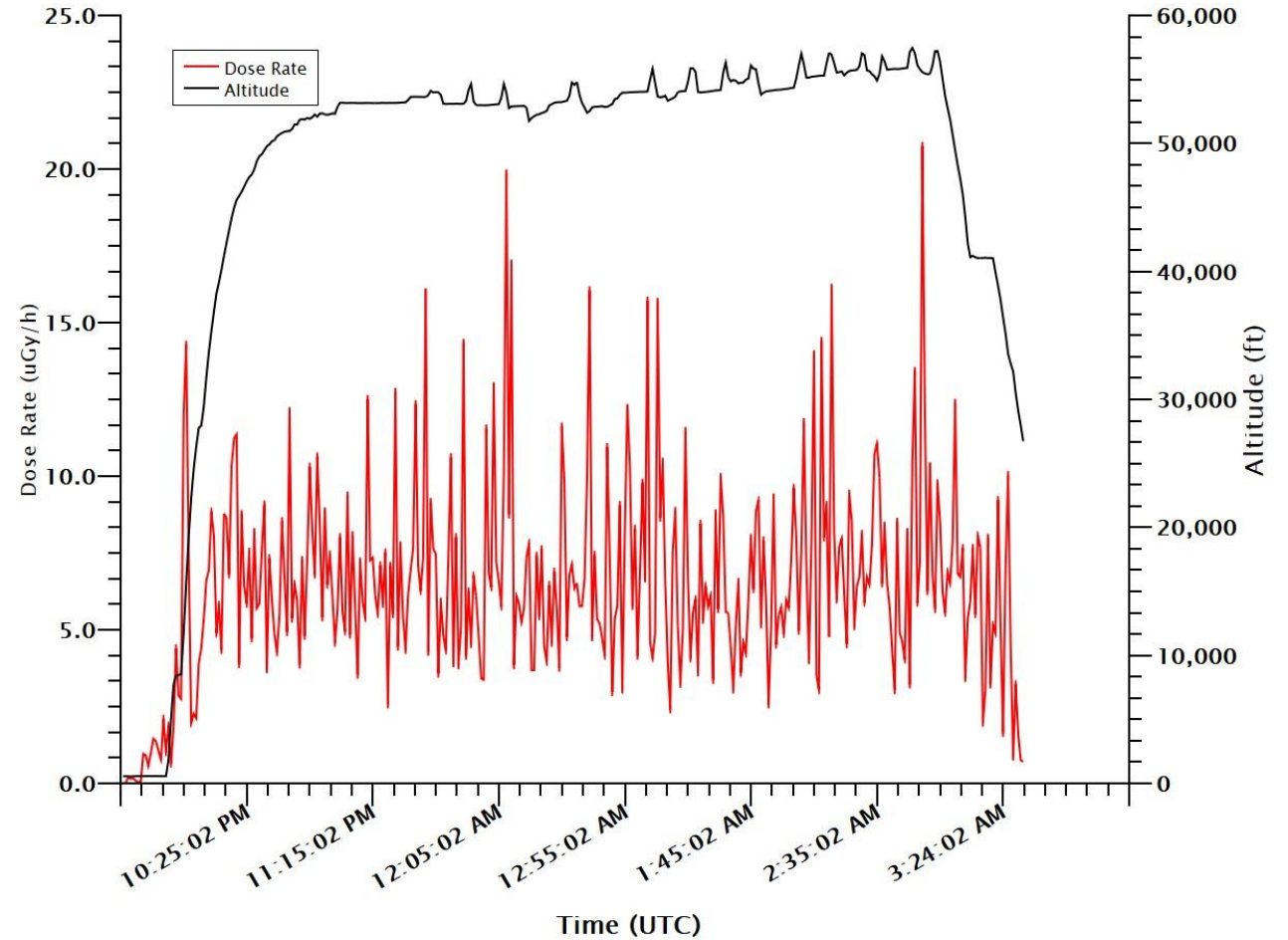




# AirTED Measurements on WB-57 Alaska Flight



Preliminary Lineal Energy Spectrum from TEPC



Preliminary Dose Rate Profile from TEPC

Measured Absorbed Dose Si

12.24  $\mu\text{Gy}$

CARI-7 Absorbed Dose in Si

17.85  $\mu\text{Gy}$

Measured Absorbed Dose Rate in Si

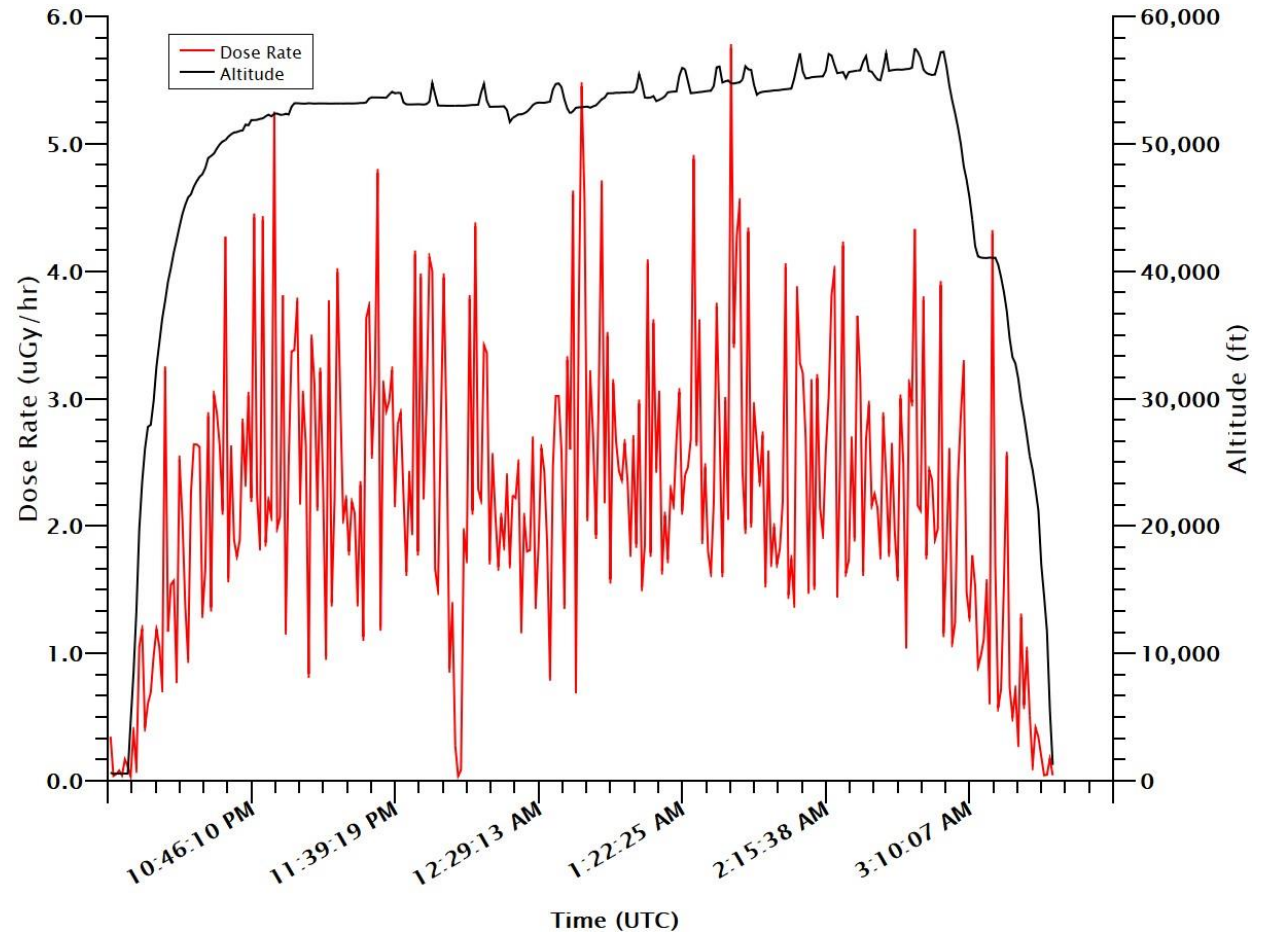
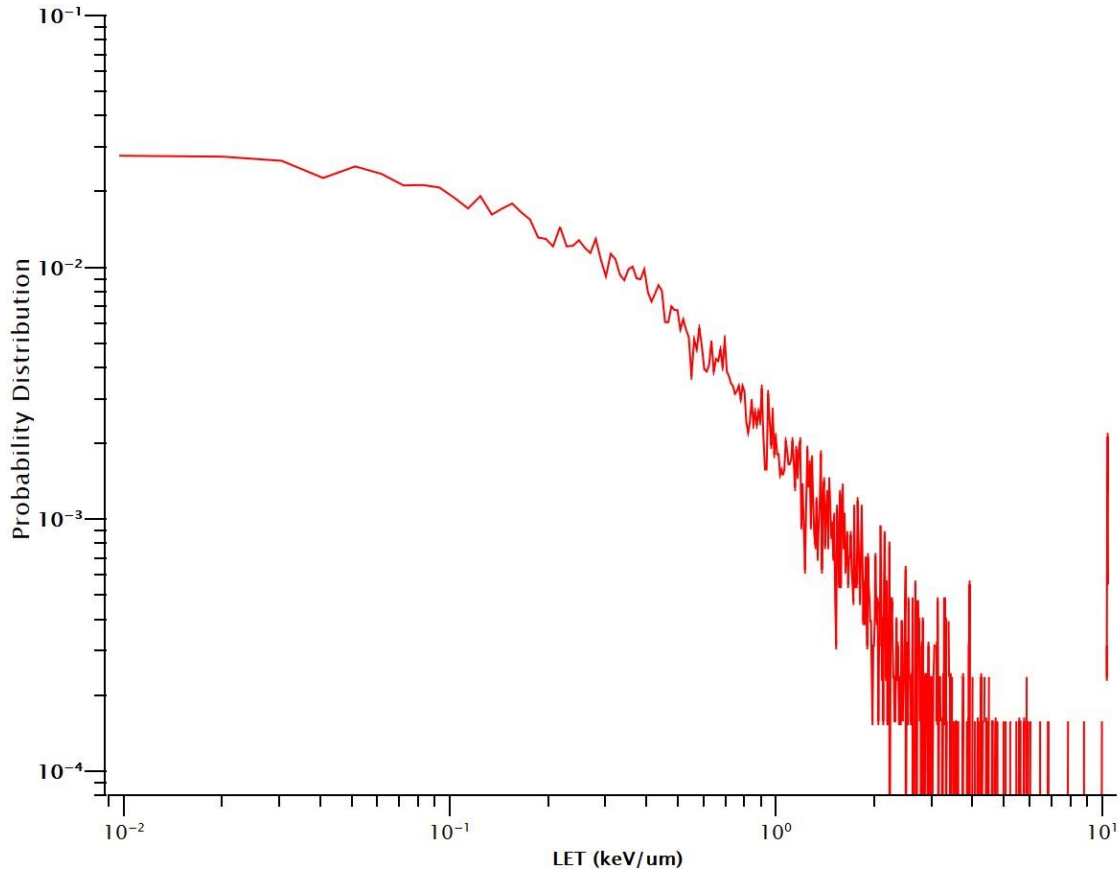
1.95  $\mu\text{Gy/hr}$

CARI-7 Absorbed Dose Rate in Si

2.84  $\mu\text{Gy/hr}$



# AirSiD Measurements on WB-57 Alaska Flight



Preliminary LET Spectrum from Si PIN Photodiode

Preliminary Dose Rate Profile from AirSiD

Measured Absorbed Dose H<sub>2</sub>O

38.58  $\mu$ Gy

CARI-7 Absorbed Dose in H<sub>2</sub>O

20.80  $\mu$ Gy

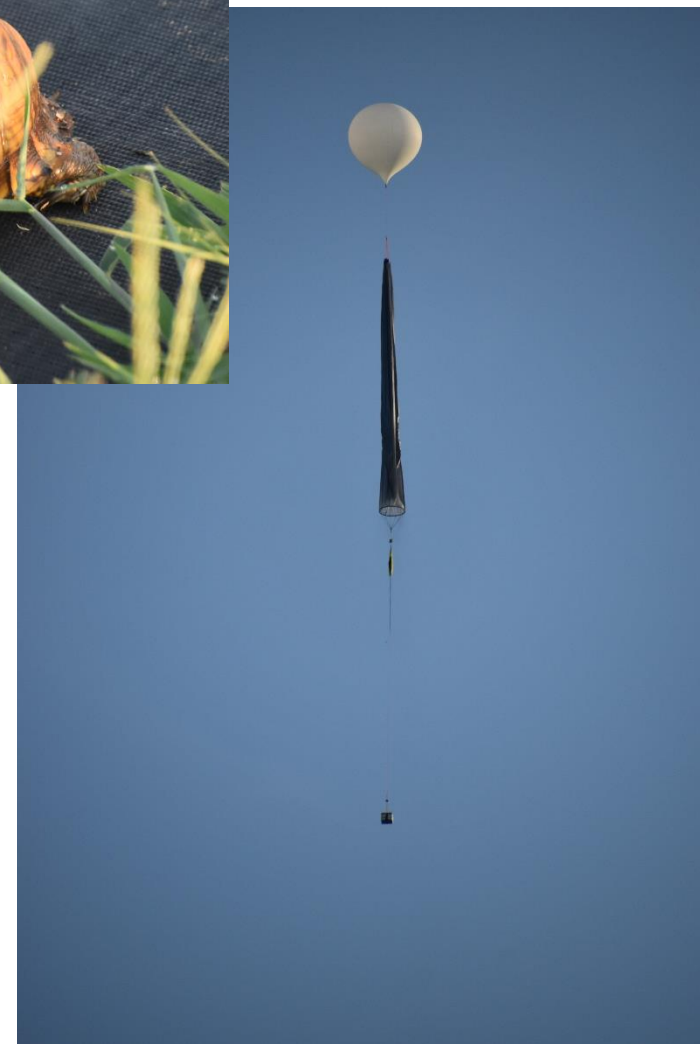
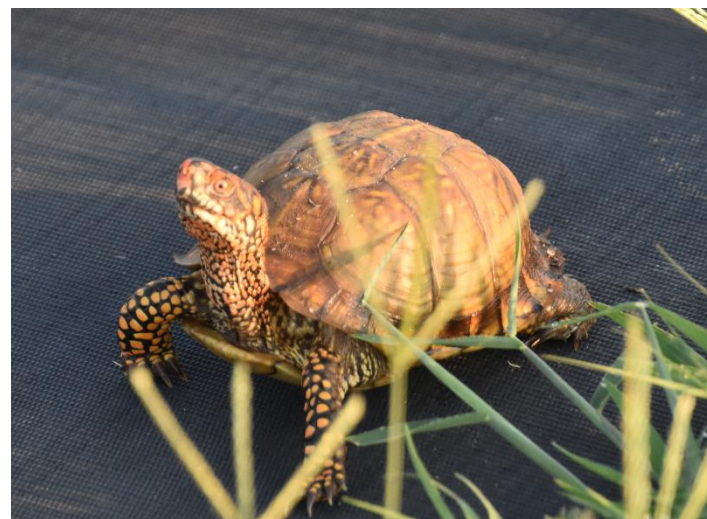
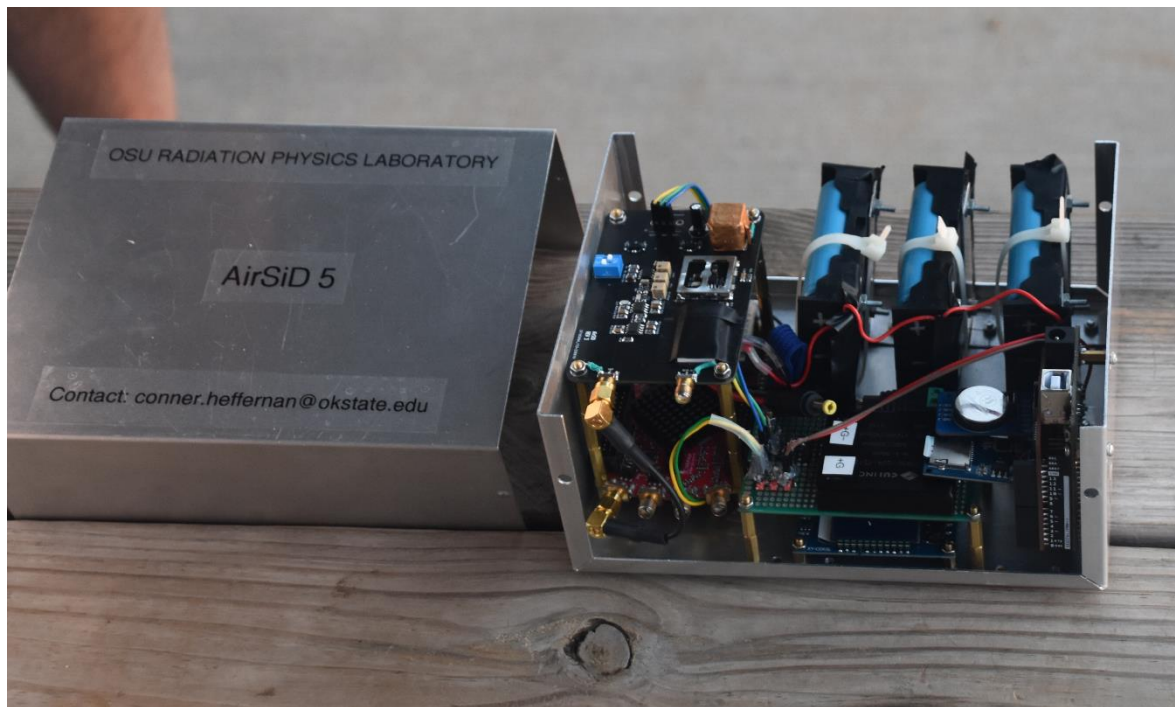
Measured Absorbed Dose Rate in H<sub>2</sub>O

6.14  $\mu$ Gy/hr

CARI-7 Absorbed Dose Rate in H<sub>2</sub>O

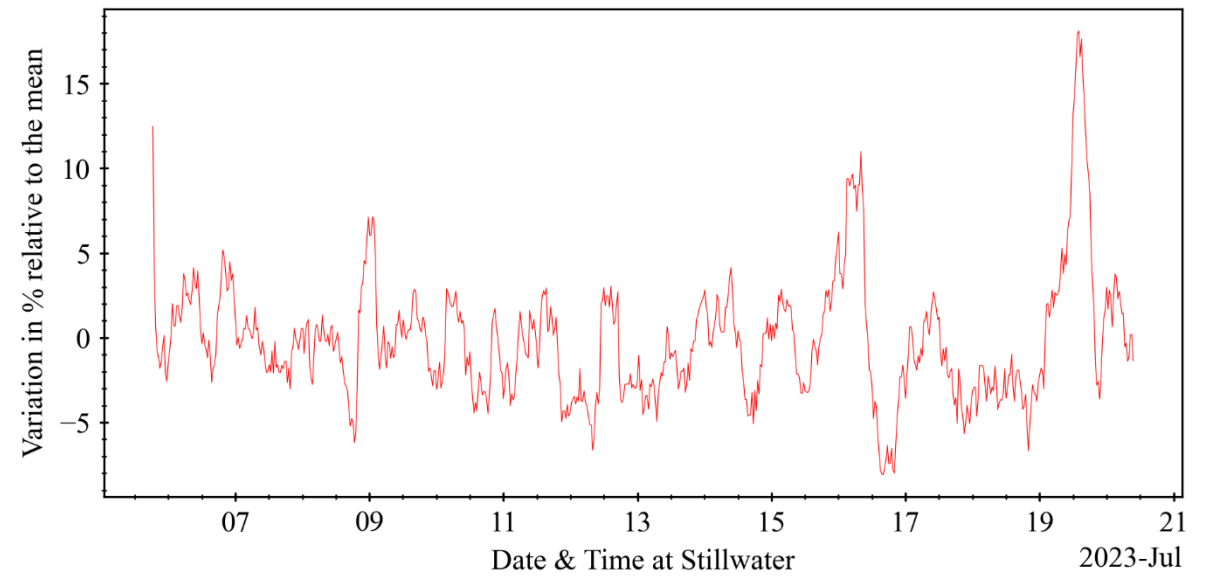
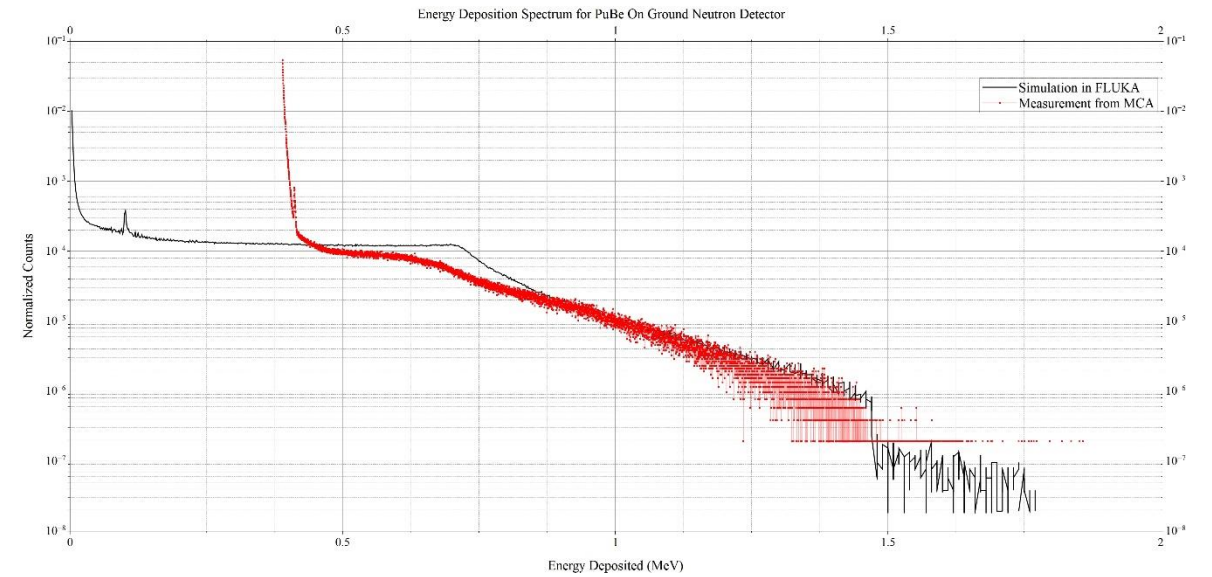
3.31  $\mu$ Gy/hr

# AiRSiD on Solar Balloon





# Ground-based Neutron Monitor





# Conclusions: AIRE Institute Current Projects

- SpaceTED experiment on ISS:
  - 6 months duration,
  - launch on SpaceX-29 in November 2023,
  - combined TEPC and Si Spectrometer;
- NASA WB-57 ongoing flights with AirTED:
  - deployed to Alaska in Winter/Spring 2023 campaign,
  - combined TEPC and Si Spectrometer;
- Solar Balloon flights with AirSiD, then mini-AirTED;
- Ground-based Cosmic Ray monitors (neutron, muon, x-ray);
- Herado AlmarAIR personal aviation dosimeter;
- AirTED experiment on Blue Origin New Shepard suborbital flight:
  - no earlier than Spring 2025,
  - dosimetry for space tourism.

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## AIRE Institute Personnel

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- Kyle Copeland, U.S. FAA, Civil Aerospace Medical Institute
- Brad “Buddy” Gersey, Founders Classical Academy

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- Conner Heffernan, OSU Physics Ph.D. student
- Garrett Thornton, OSU Physics undergraduate student

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- Stephen Wender, Los Alamos Neutron Science Center, DOE LANL
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