Progress on Tissue Equivalent Dosimeters being developed at Oklahoma State University

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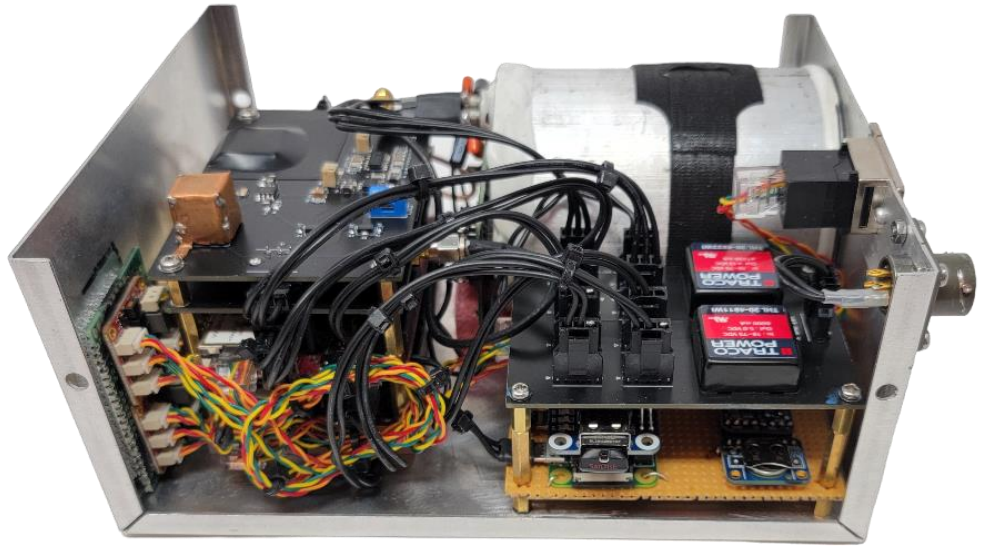
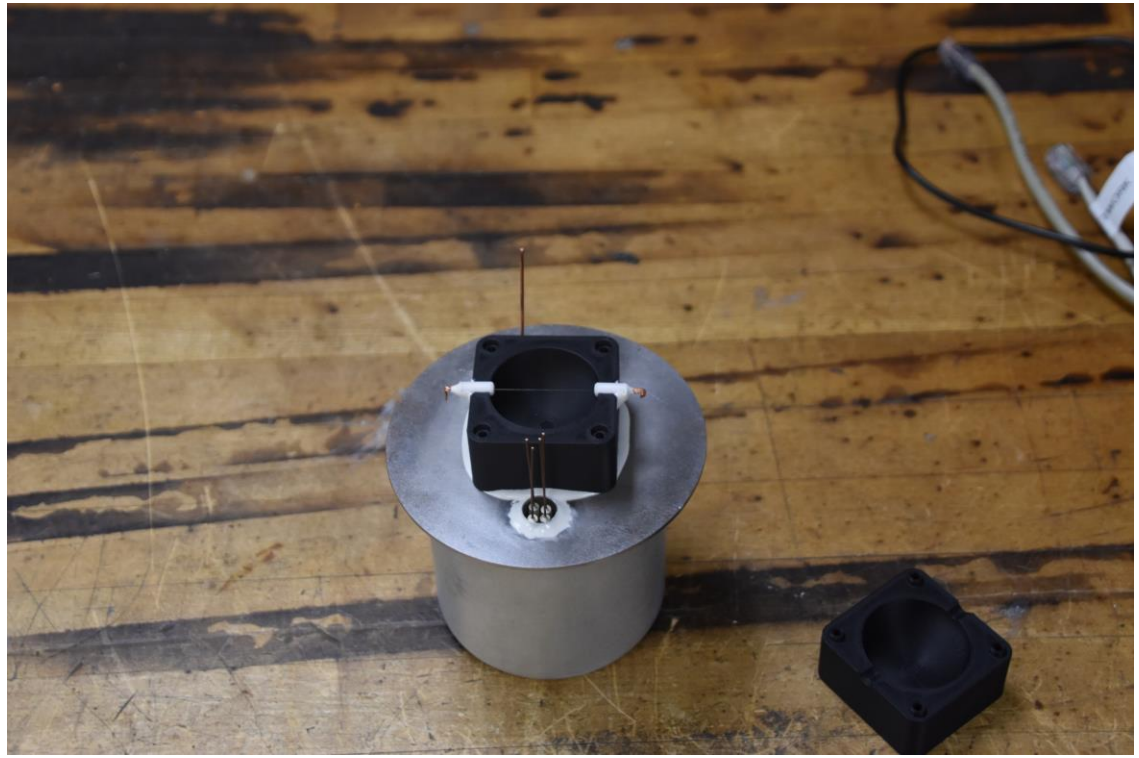
AirTED/SpaceTED Overview

- Measures absorbed dose and dose equivalent received from ionizing radiation during flight.
- Size of shoebox, weighs ~2 kg
- 10-Watt power draw
- Two detectors to better cover expected particle species and energy ranges at aviation altitudes
  - Tissue Equivalent Proportional Counter (TEPC) for high-LET particles (neutrons)
  - Silicon PIN diode for low-LET (electrons, photons)
- Environmental sensor suite including RTC
- AirTED time-resolved data can be interpreted spatially and temporally with services such as FlightAware



Tissue Equivalent Proportional Counter (TEPC)

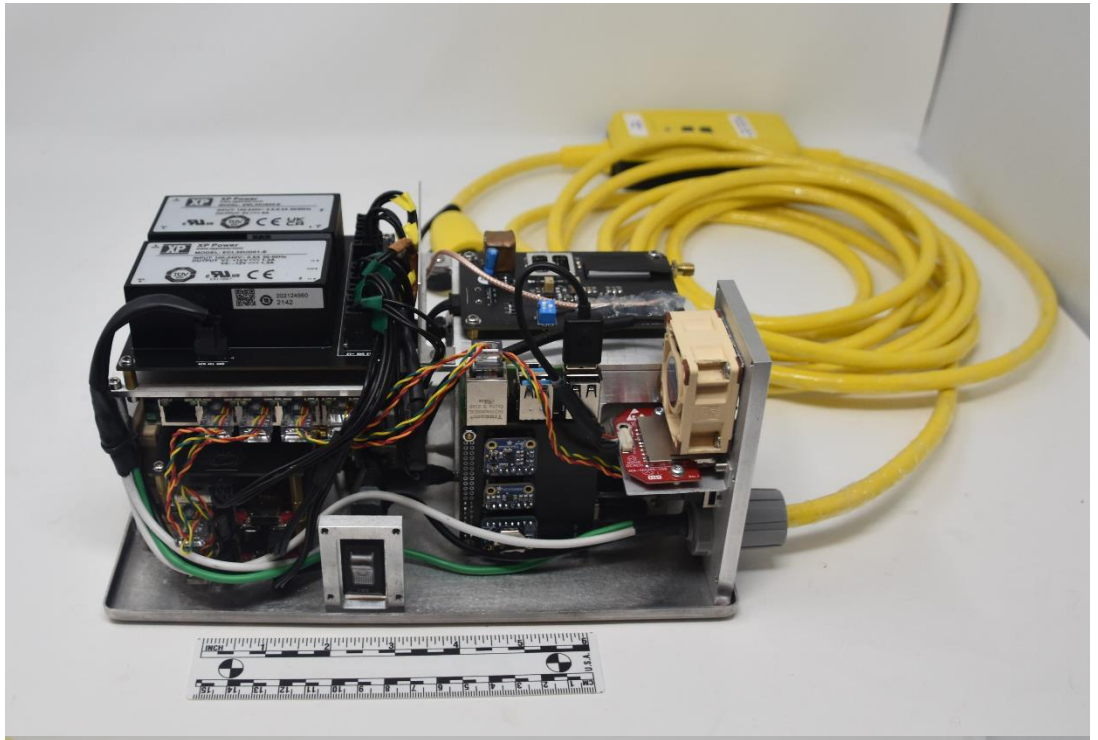


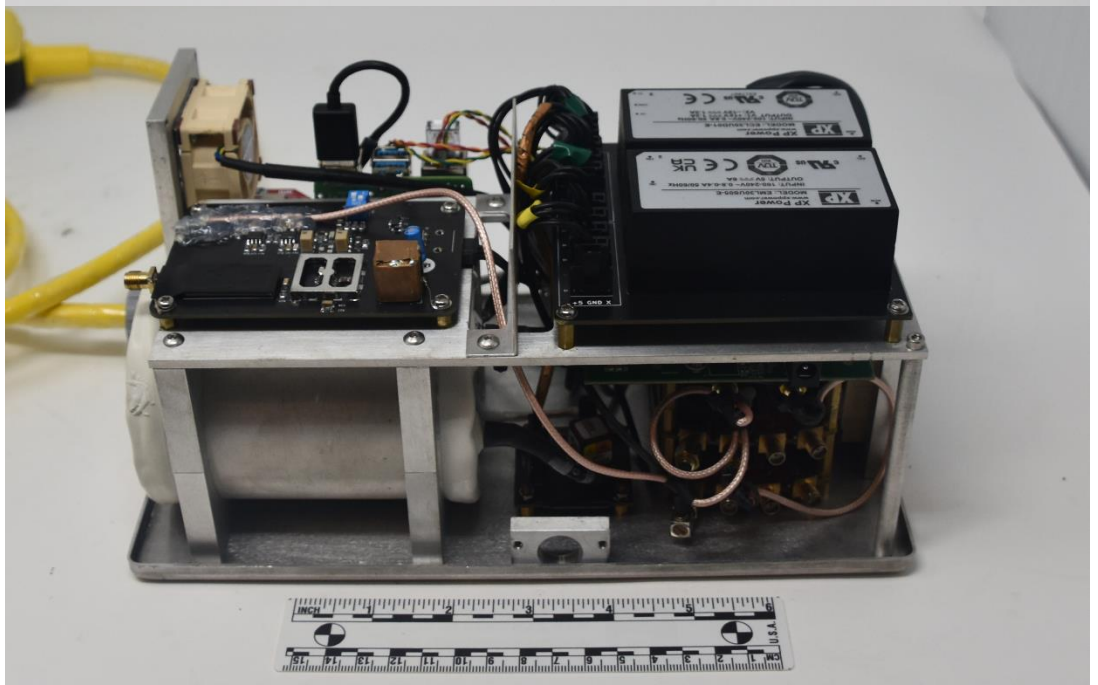
- Low pressure gas-filled detector
- 3D Plastic printed wall simulates living tissue
- Detects neutrons through elastic (n,p) interactions with hydrogen in the wall
  - Secondary proton penetrates gas volume, ionizes gas and induces current in anode proportional to energy deposited in the gas
- Most sensitive to the high-LET component of air showers
- Calibrated with neutron source
- Yields lineal energy spectra, absorbed dose, and dose equivalent

Silicon PIN Diode

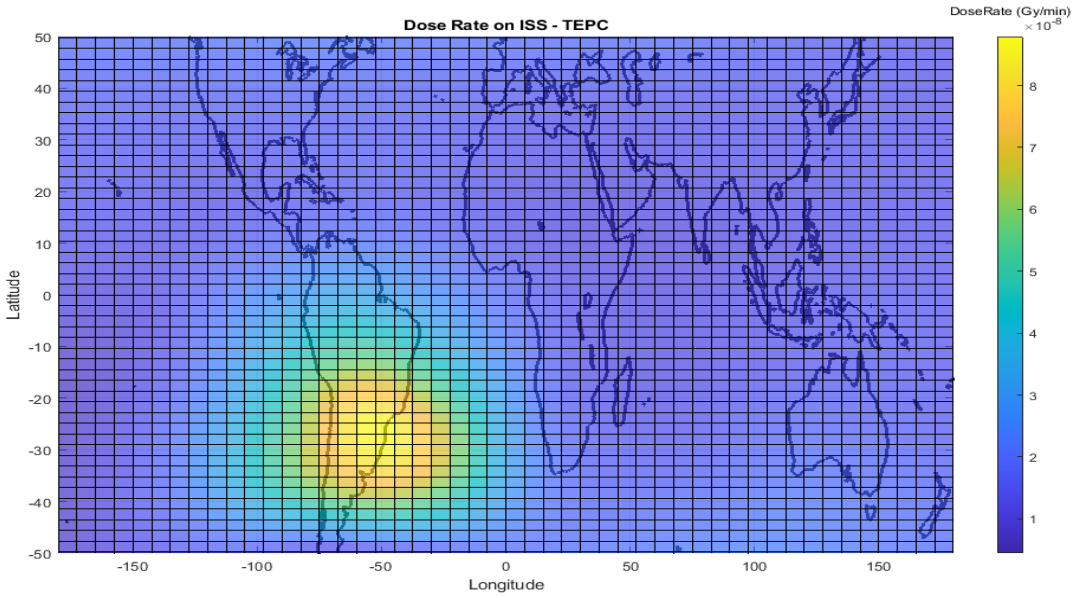
- Detects radiation through production of electron-hole pairs in silicon
- Sensitive to low-LET component of air showers (electrons, photons, etc.)
- Yields energy deposition spectra

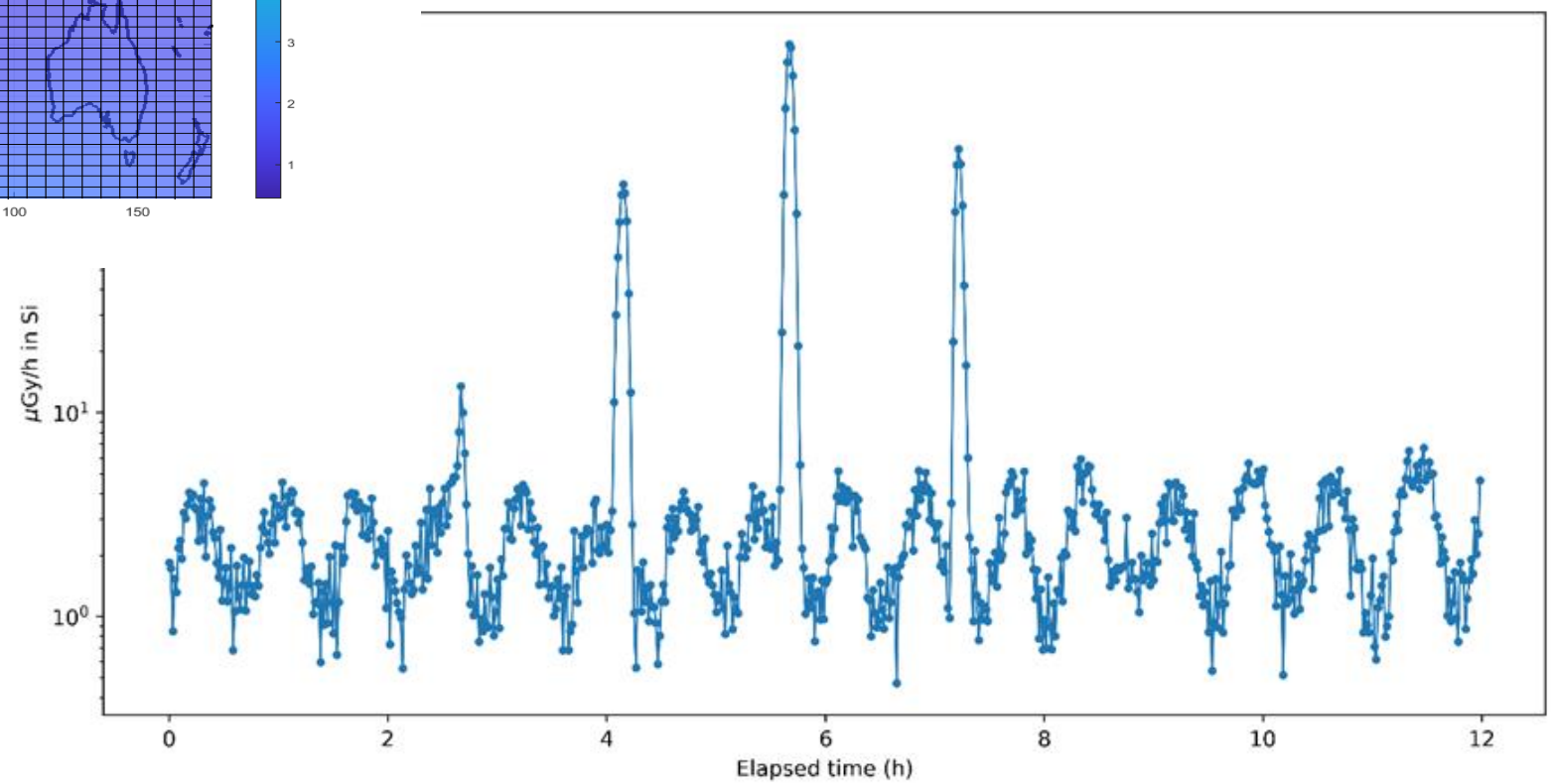
SpaceTED on ISS





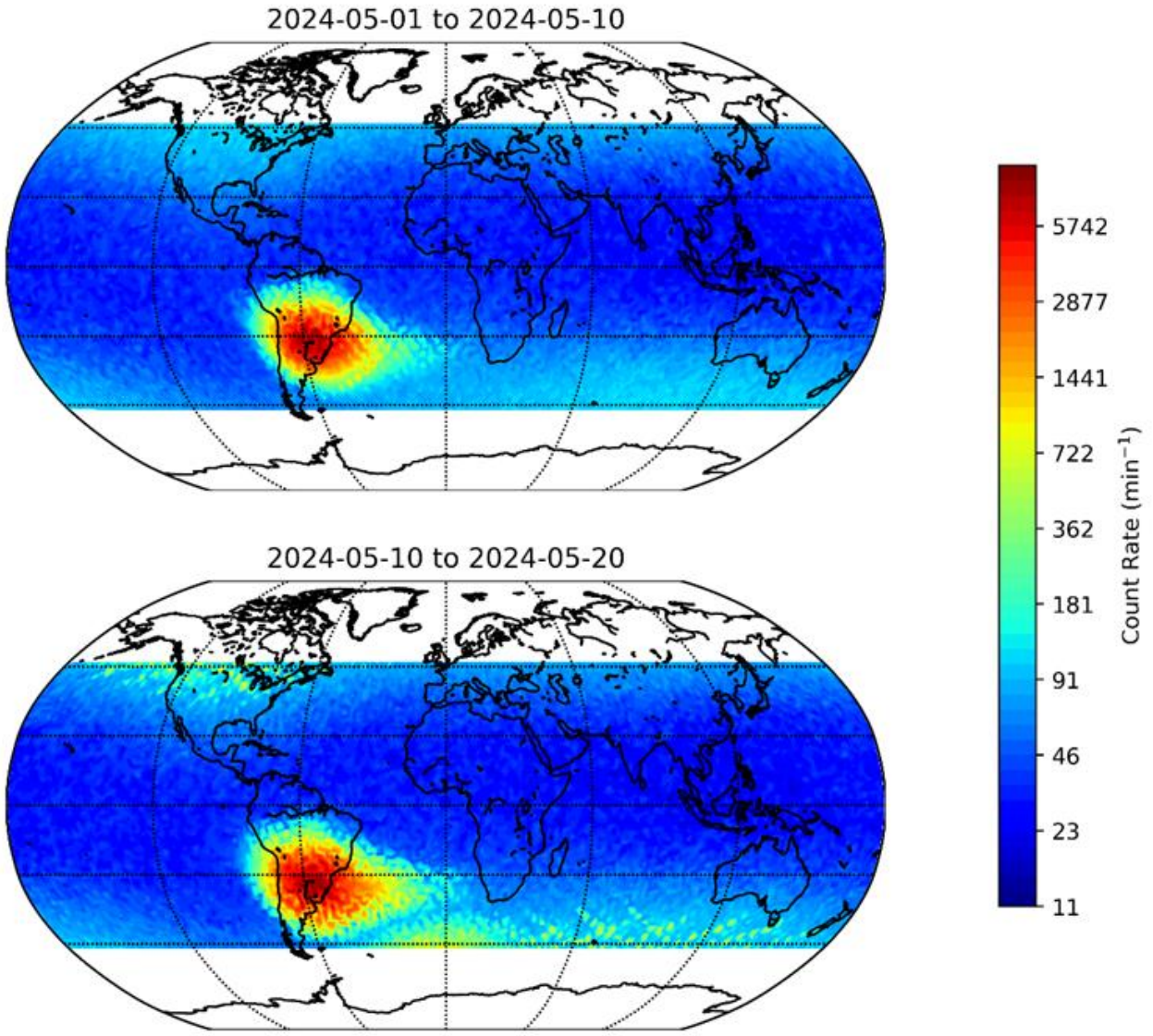
SpaceTED Aboard the ISS



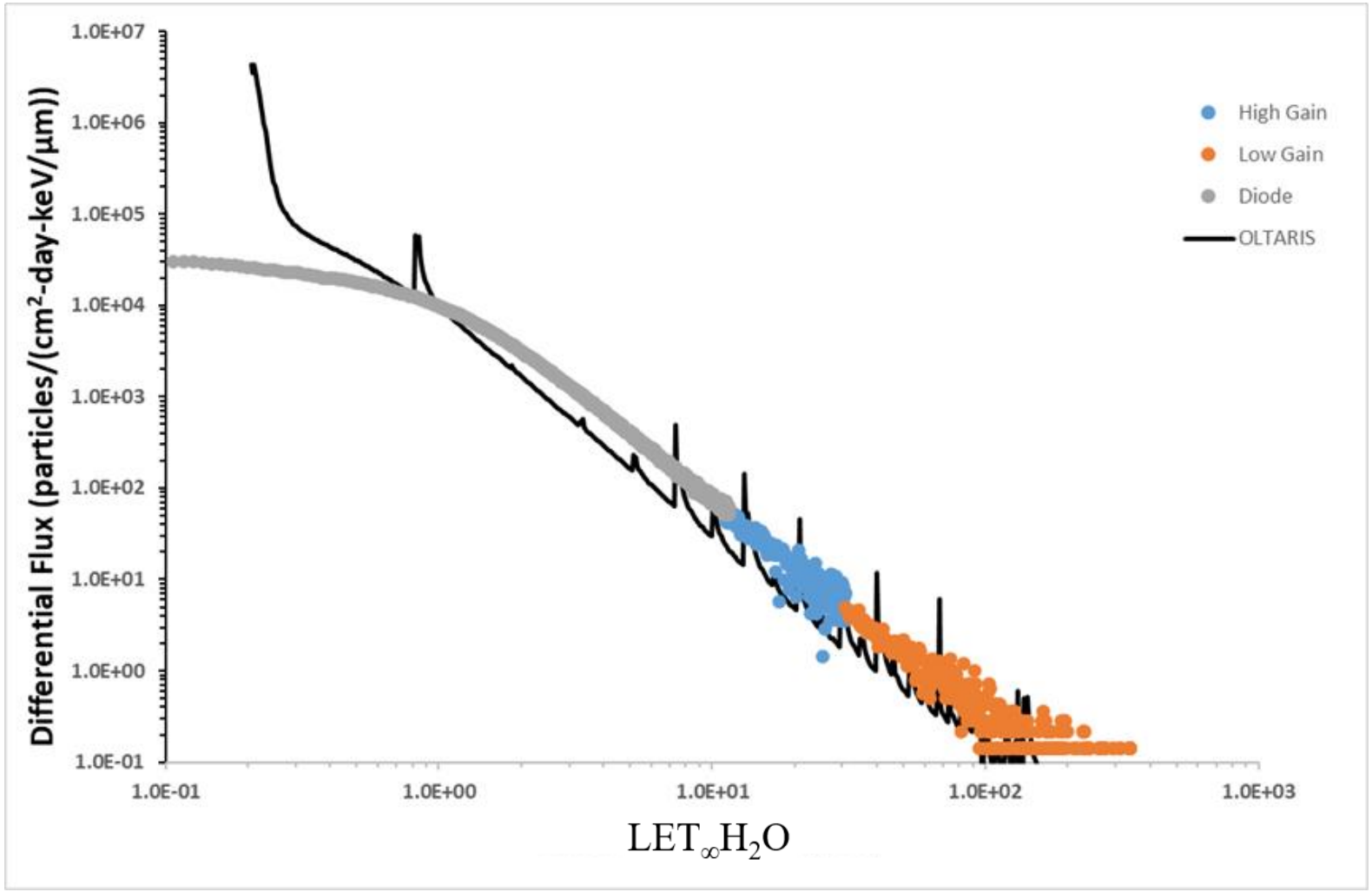


Detected effect of SPE aboard the ISS

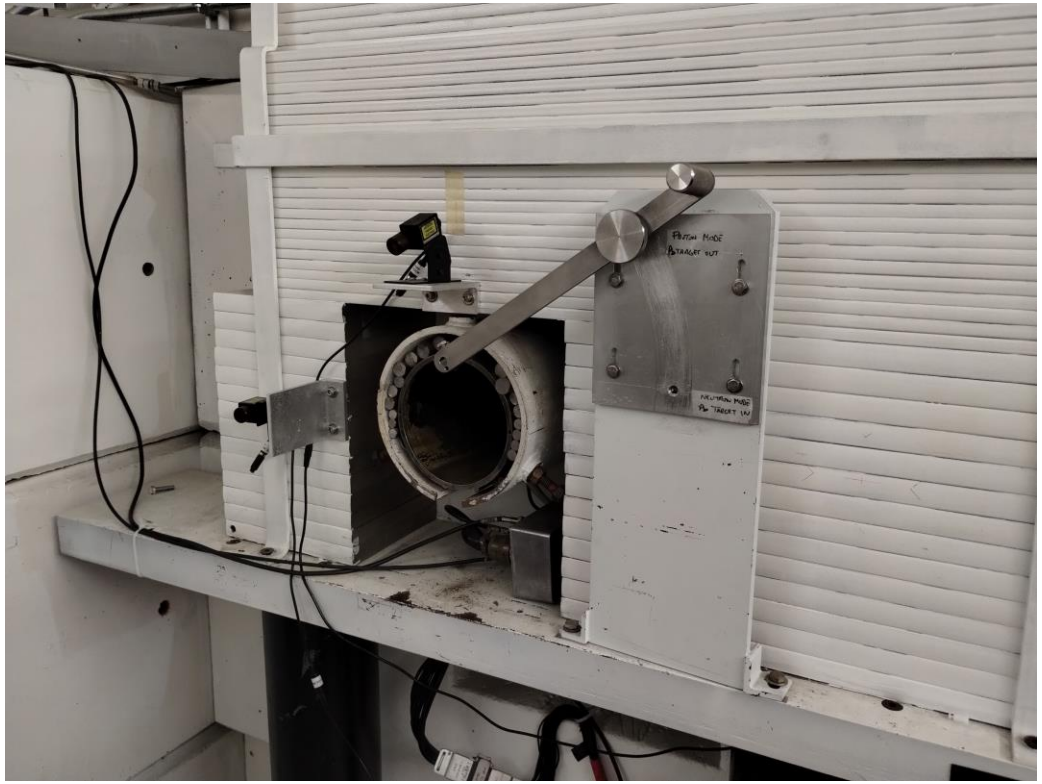
- 11 May 2024 Solar Particle Event
- Earth-directed CME injected energetic particles into the trapped radiation belts
- Disrupted geomagnetic field
- SAA and Electron Cusp regions intensified
- Aurora borealis seen as far south as Florida



SpaceTED ISS Results
Linear Energy Transfer Spectra



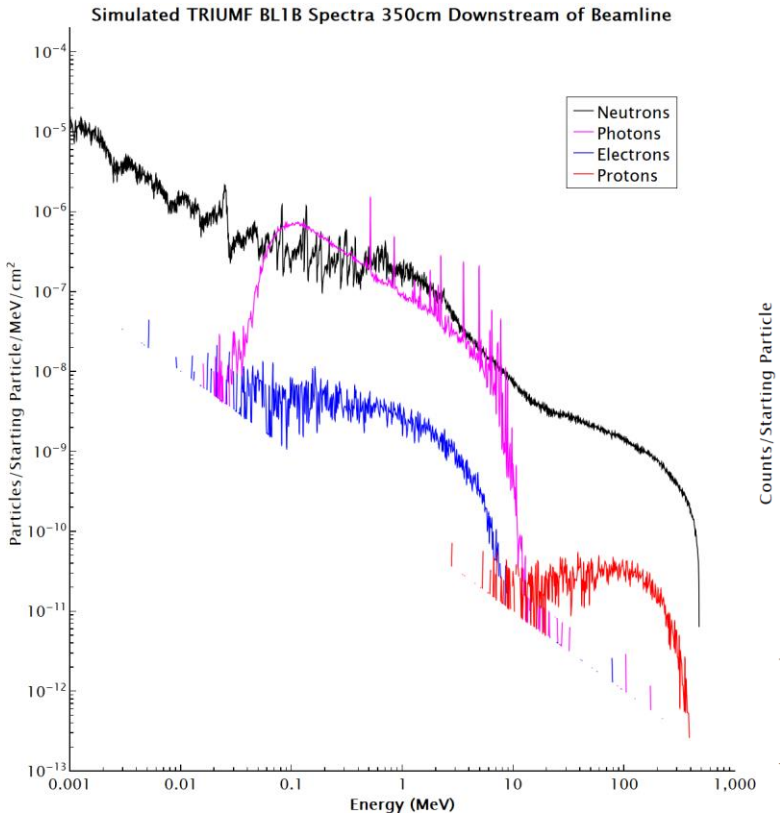
Characterization of 500 MeV Spallation Neutron Source at TRIUMF, October 2024

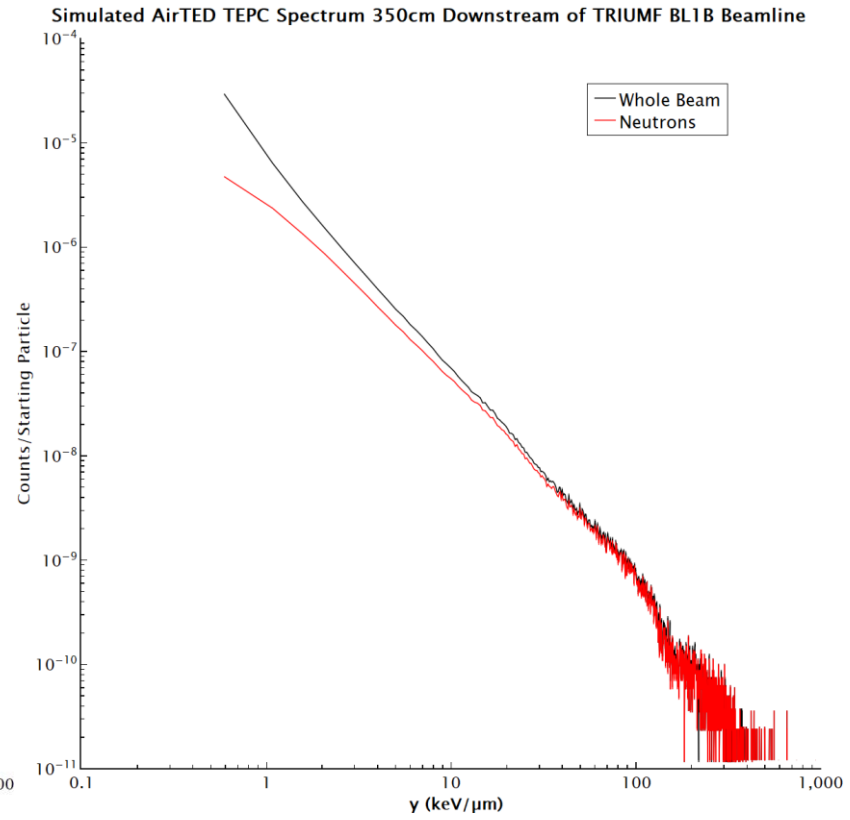


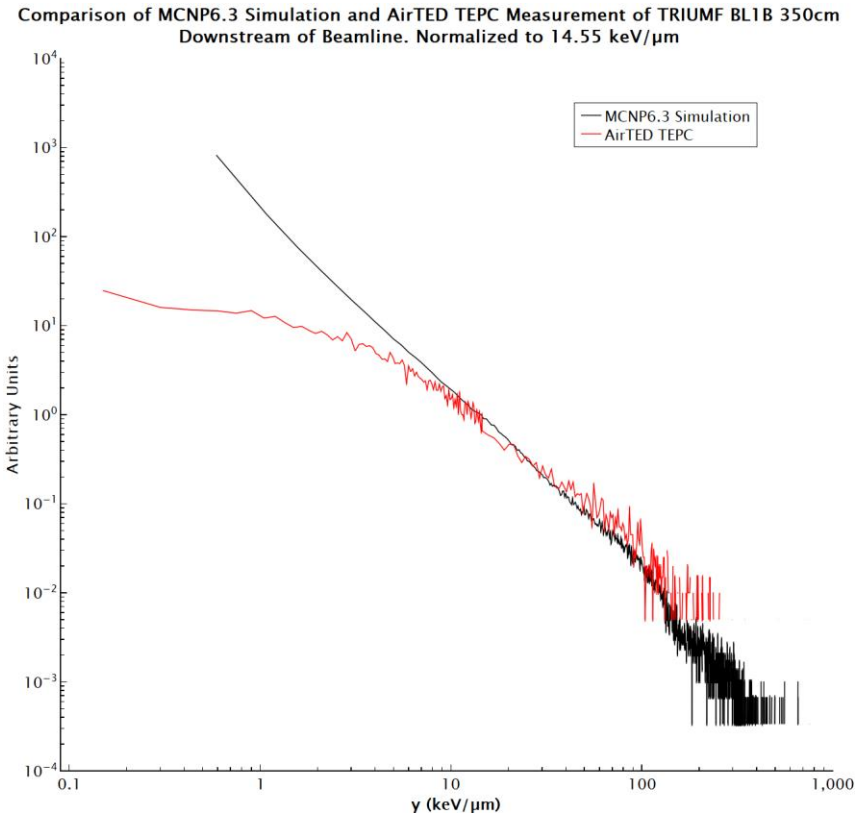
Pb target placed in and out of beam via Al handle.

AirTED TEPC positioned directly in front of beam port, Pb target in place.

MCNP Simulation of TRIUMF 500 MeV spallation neutron source and comparison with AirTED TEPC lineal energy spectrum

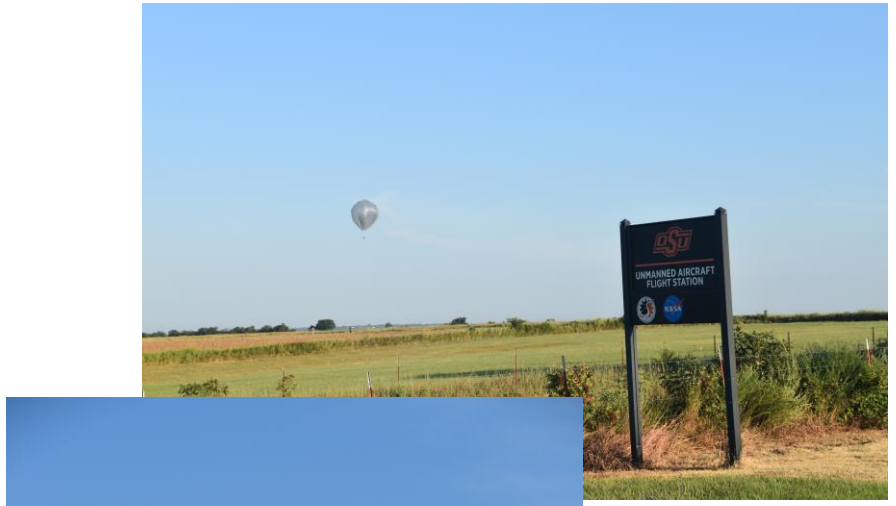






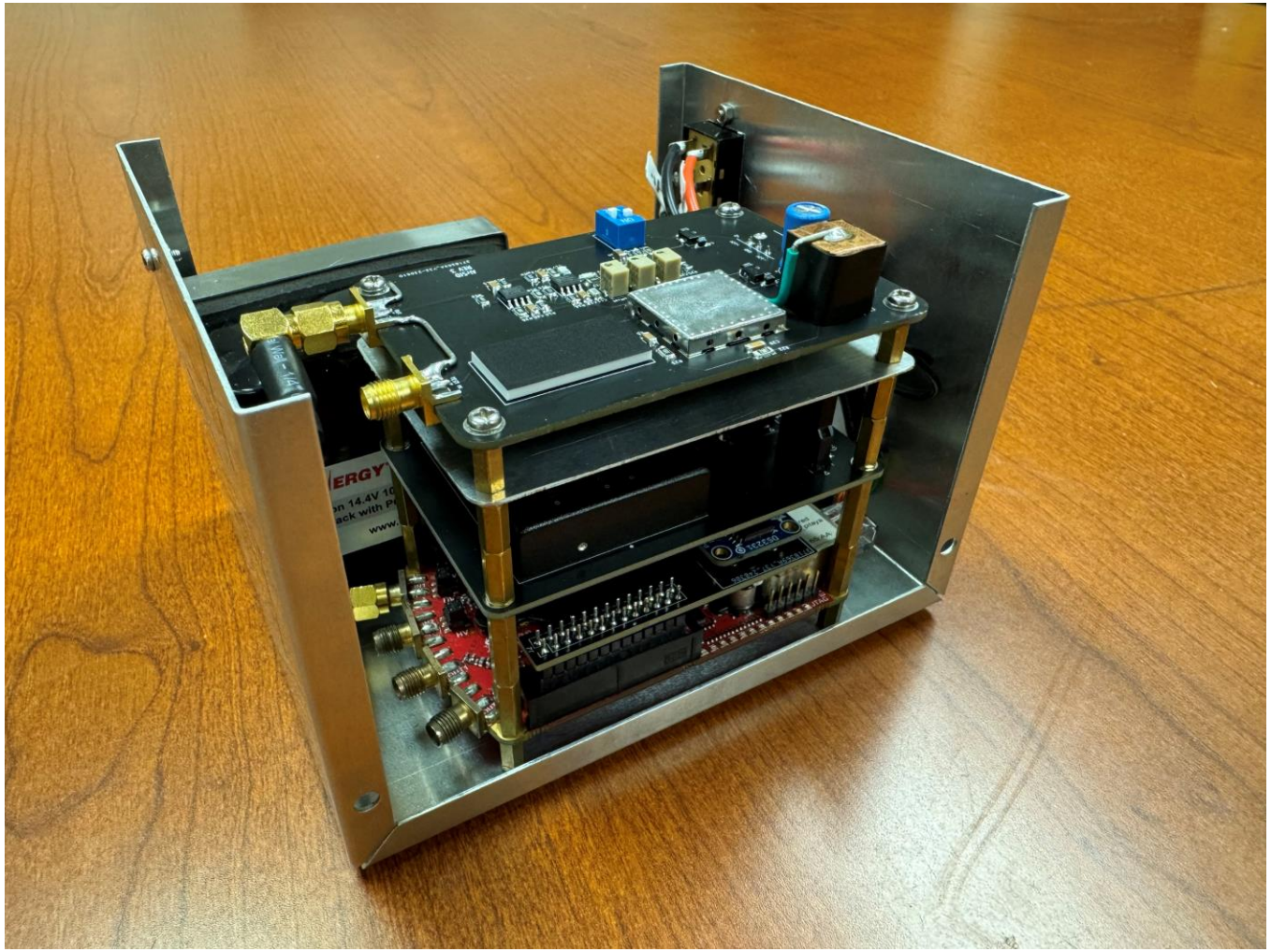
AirSiD Heliotrope Flights

- Heliotrope (Solar Balloon) flights launched from OSU Unmanned Aircraft Flight Station
- Balloons made of painters drop plastic, clear packing tape and Carbon Black (to help balloons absorb heat).
- 3 kg max payload, including transponder, cut down mechanism.
- Payload automatically cut down when balloon reaches programmed latitude or longitude or after specified flight duration.
- Two flights this summer (June 10 and August 14) and (maybe) one this week.
- Longer term plan to develop technology so we can launch during an SPE and also to include full, battery-powered AirTED.

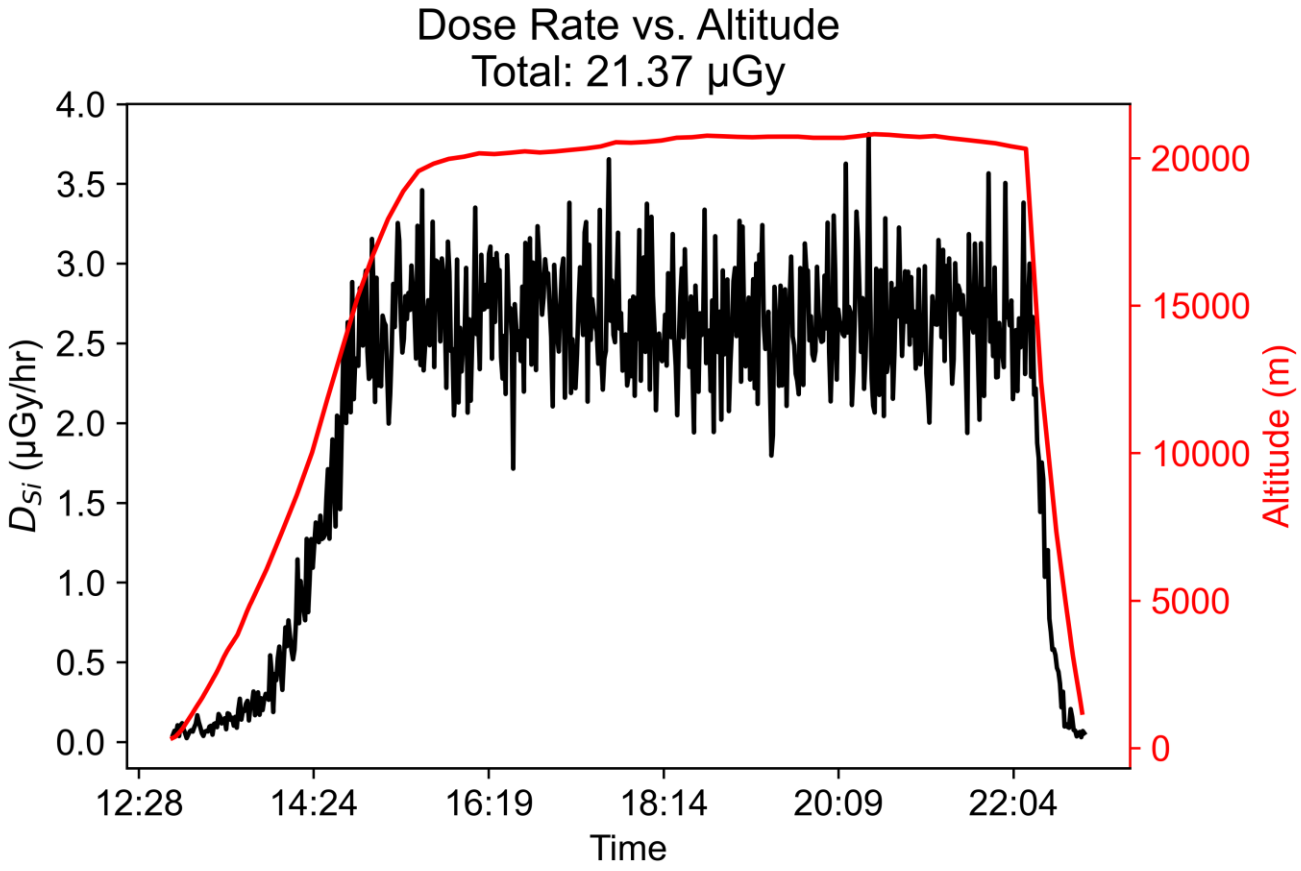


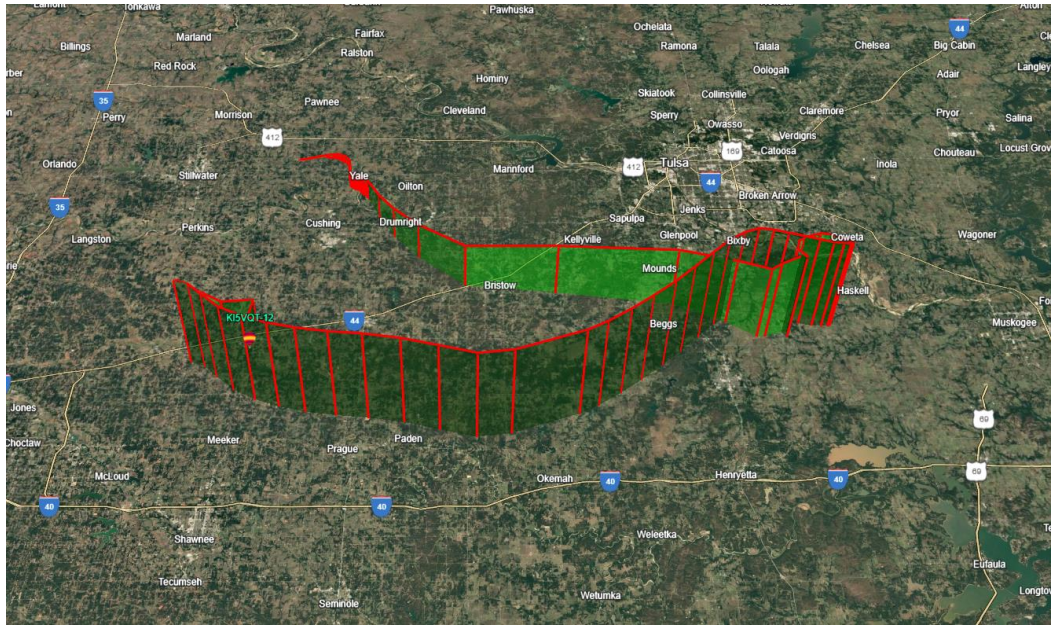
AirSiD = AirTED – TEPC + battery power

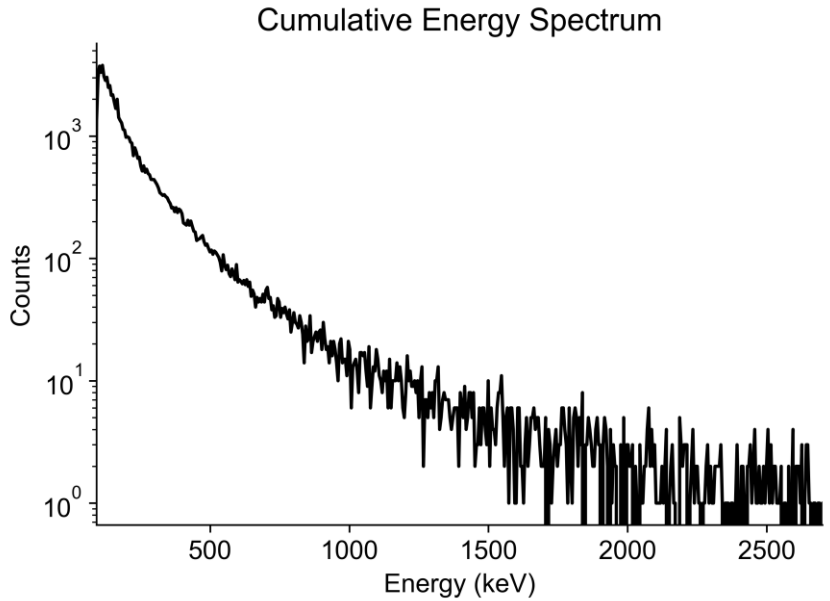
- AirSiD contains Si PIN diode, 3D accelerometer, temperature and pressure sensors, Red Pitaya spectrometer.
- Rechargeable battery pack good for ~20 hours of operation.
- Mass with batteries, 1.7 kg.



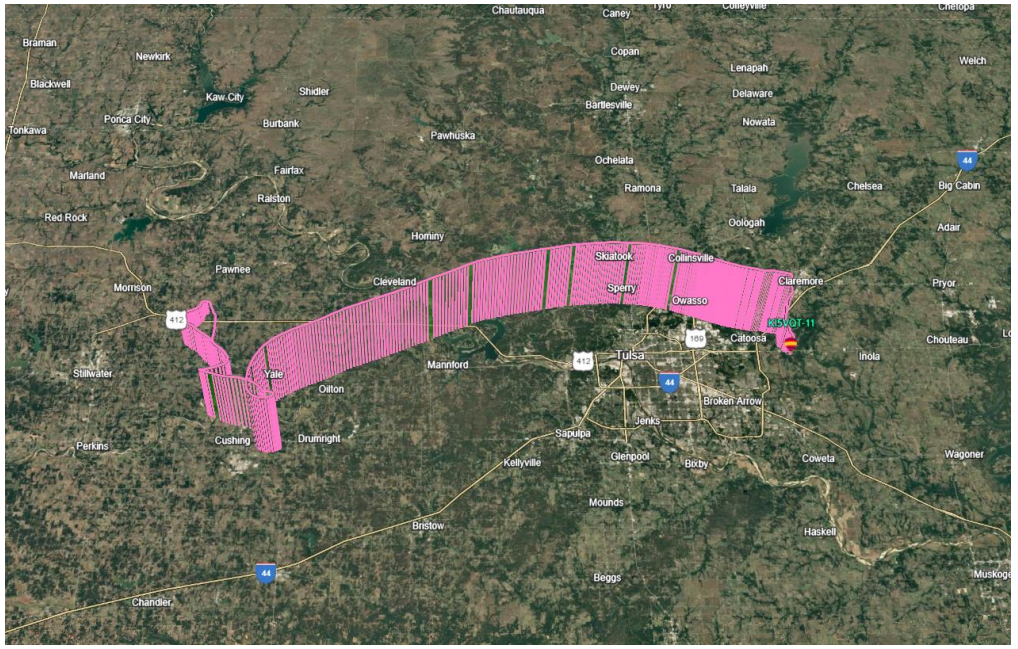
June 10, 2025 Flight
AirSID Measurement: 21.4 μGy
CARI-7A estimate: 23.2 μGy

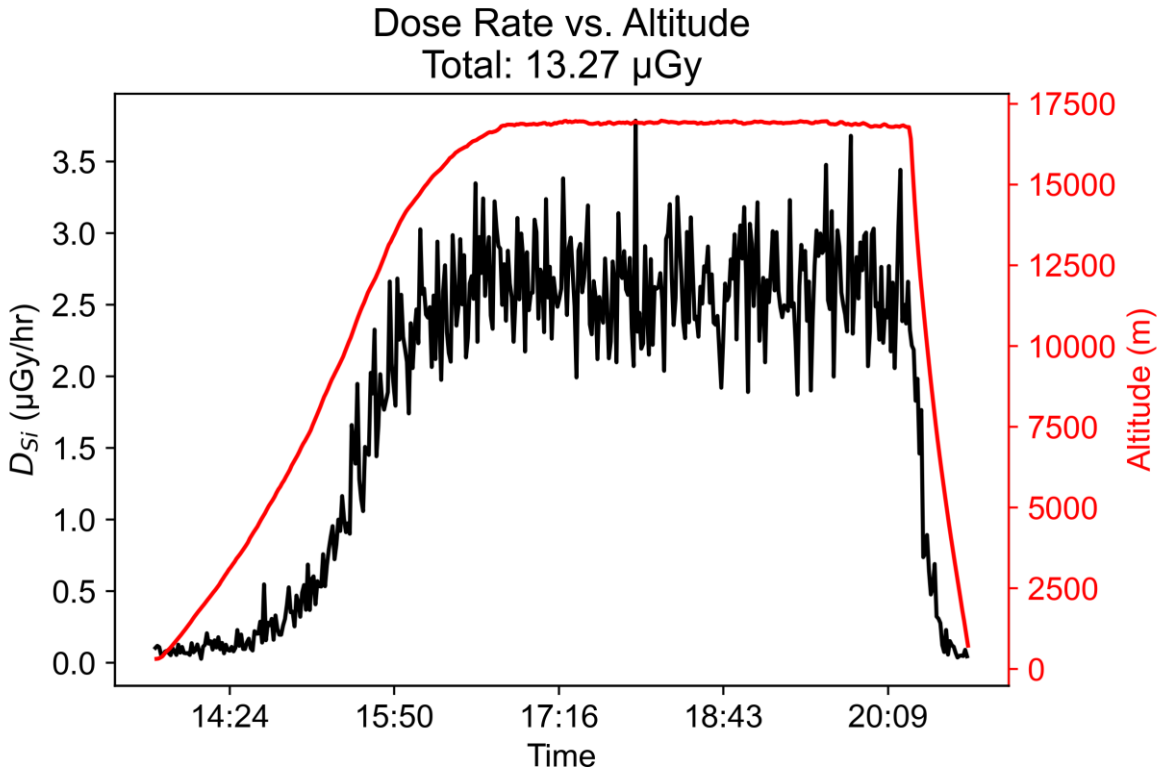


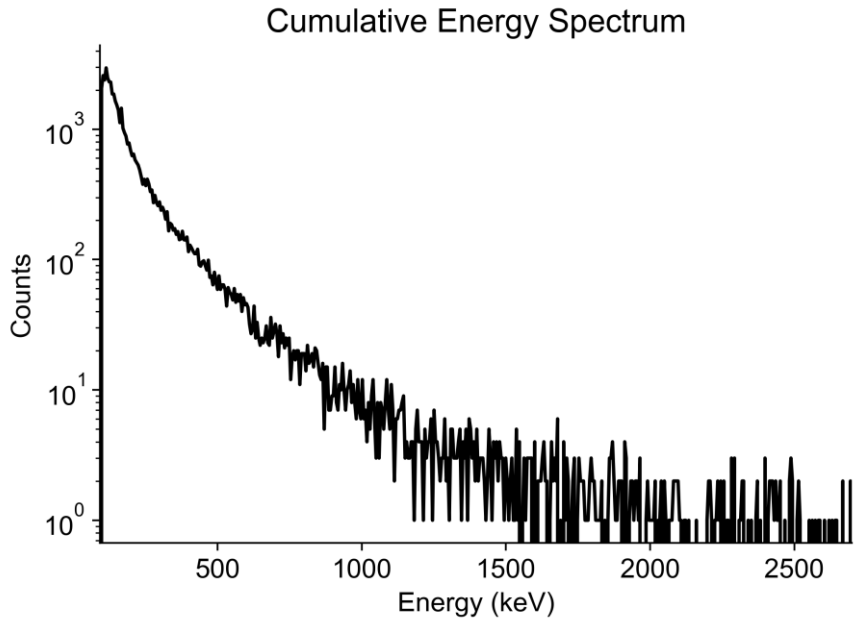




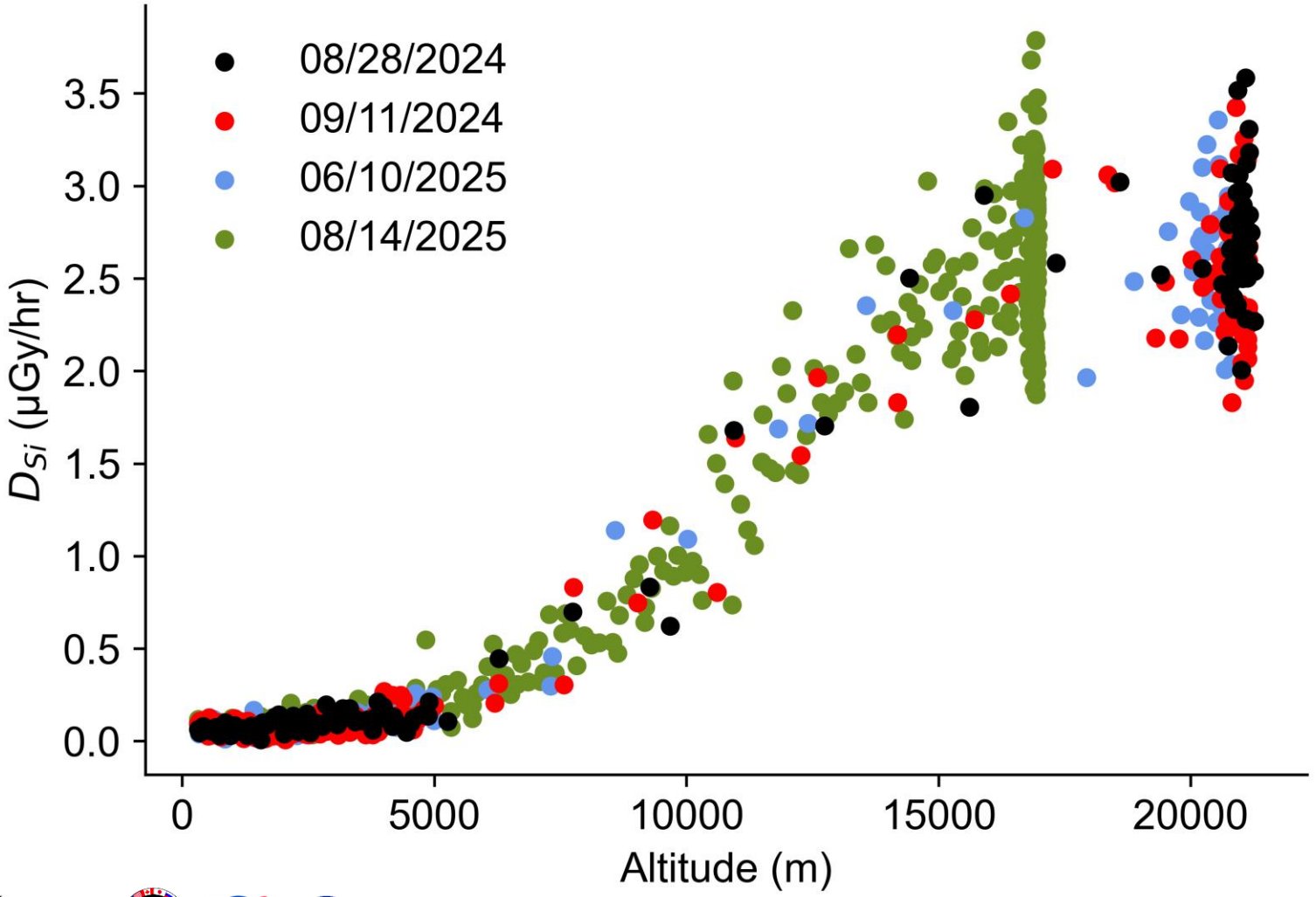
August 14, 2025 Flight
AirSID Measurement: 13.3 μGy
CARI-7A estimate: 14.8 μGy







Dose Rate as a function of Altitude
Measured during four Heliotrope Flights



Conclusions

- SpaceTED returned from ISS on SpaceX-31 in December, 2024. Analysis of nearly one year of data is ongoing.
- Concentrating on own Heliotrope flights from OSU's Unmanned Launch Facility.
- Adapting AirTED for smaller, lower mass, battery powered operation so can fly on Heliotrope and high-altitude balloons
  - new 4 input Red Pitaya spectrometer board greatly simplifies electronics
  - 3-D printed TEPC heads simplifies construction and reduces size.
- Continuing to characterize our instruments at HIMAC, LANSCE and now TRIUMF.

Current Graduate Students:

- Conner Heffernan,
- Garrett Thornton,

Undergraduate Students

- Nicholette DuCom,
- Lydia Moore,
- Jack Massar,

Former Students:

- Tristen Lee, (graduated 2024)
- Martin Yang, (graduated 2024)
- Bryan Hayes, (graduated 2021)
- Paul Inman, (graduated 2021)

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- Alex Hands and staff at TRIUMF