OSU Dosimetric Experiments aboard the ISS

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Active Tissue Equivalent Dosimeter Scientific Objectives

- Continuously measure the Linear Energy Transfer (LET) spectra, absorbed dose and dose equivalent as functions of time with ~30 second resolution.
- Demonstrate the operational capability of the Active Tissue Equivalent Dosimeter
- Correlate time resolved data with ISS orbital position, altitude and orientation.
- Determine average dose and dose equivalent rates from galactic cosmic rays, trapped protons in the South Atlantic Anomaly, and trapped electrons at high latitudes.
- Compare results with model calculations (HZETRN/OLTARIS).
- Analyze operational performance of instrument and identify problems and lessons learned for improvement in next generation.

Active Tissue Equivalent Dosimeter Physics Specifications

- External Dimensions: 25.5 cm × 15.8 cm × 13.0 cm
- Mass: 3.22 kg (1 kg is just the power chord!)
- Power: 7.6 Watts
- Power Source: 120 Vac from ISS inverter
- Maximum internal voltage: +900 Vdc
- Operational Period: Continuous for 6 months, with short interruption for sample data download to ground via ISS laptop
- 3” diameter acrylic spherical chamber simulating ~2 μm diameter cell volume.
- 8K channel spectrum every 30 seconds.
- Data: 32 Gbyte SDRAM card, compatible with ISS laptop

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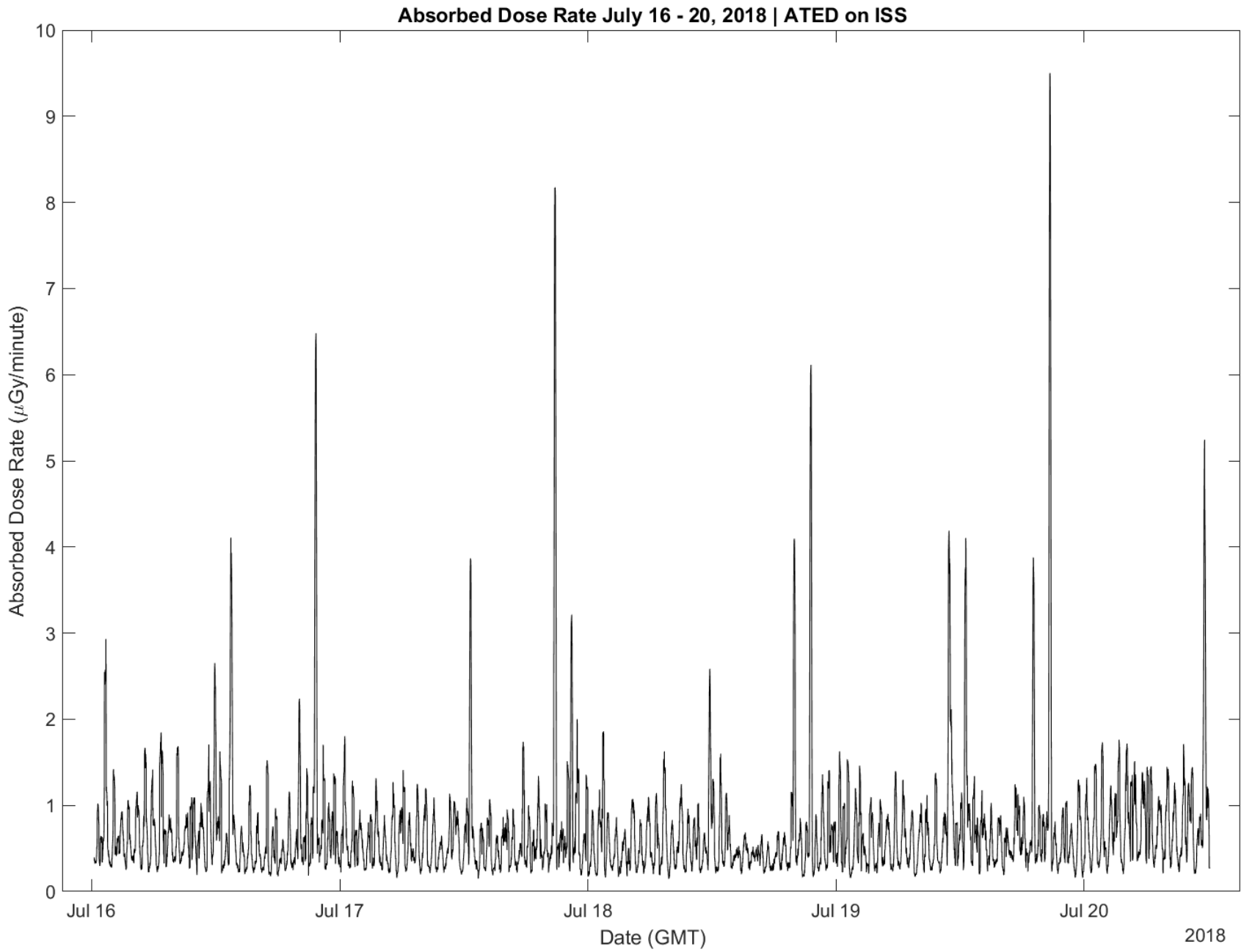
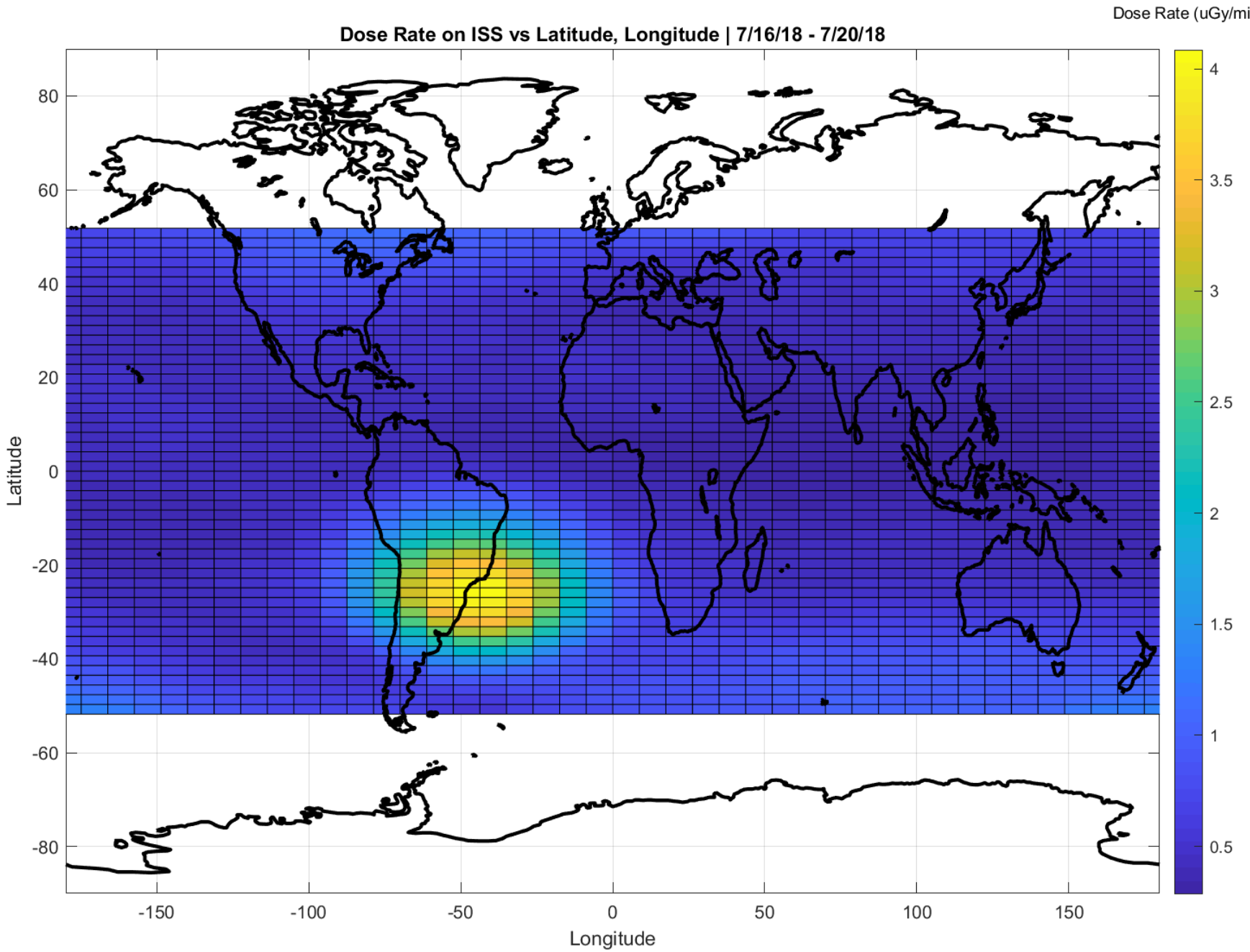
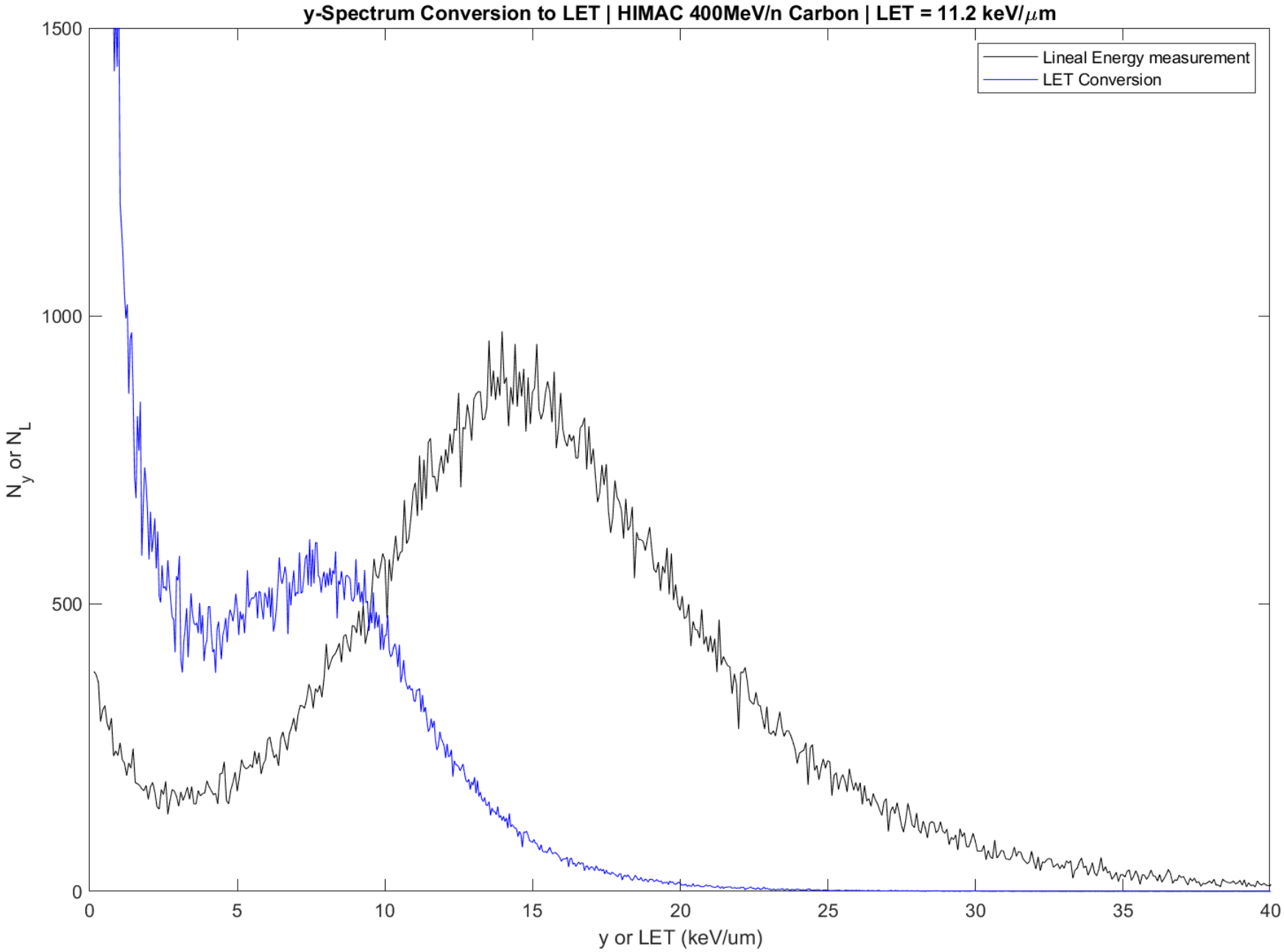
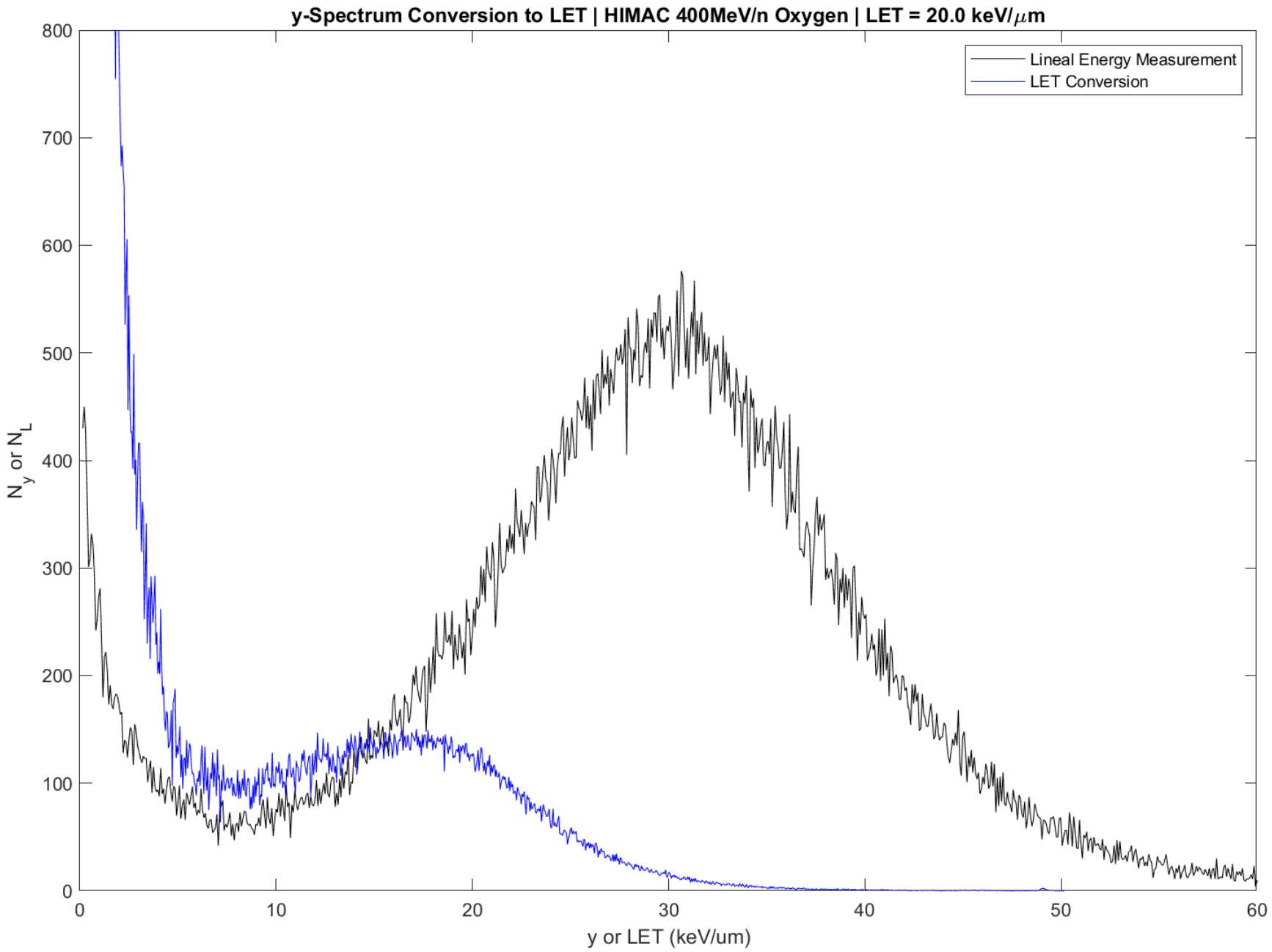
Spaceflight Version
Active Tissue Equivalent Dosimeter (ATED)

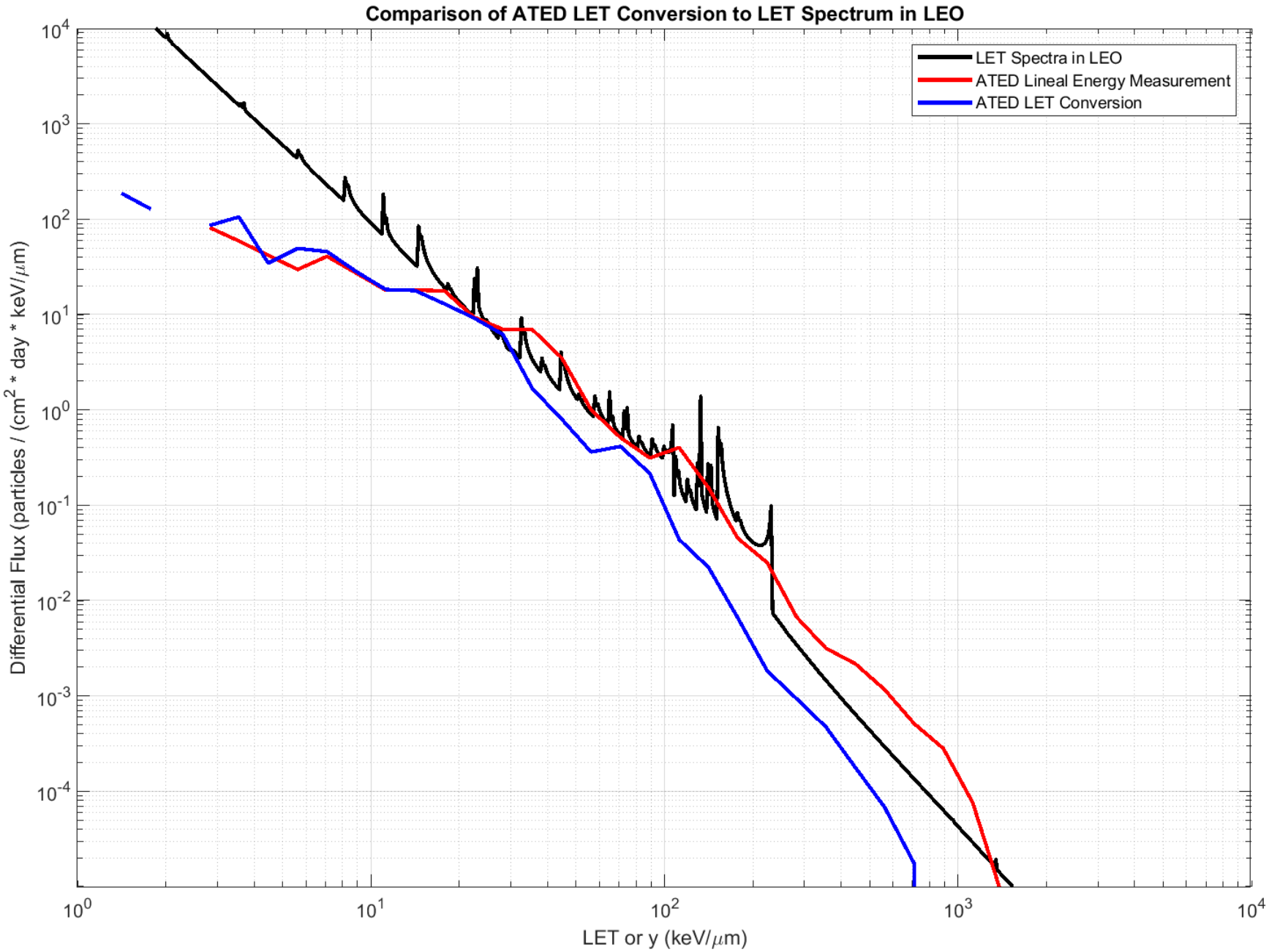

EMERGENCY USE
FIRE PORT
NOD3F3
Active Tissue Equivalent Dosimeter
P/N ATED-001
OKLAHOMA STATE UNIVERSITY
EMERGENCY USE
FIRE PORT
NOD3 FD3
EMERGENCY USE
FIRE PORT
NOD3FD3
F 4


Absorbed Dose Rate July 16 - 20, 2018 | ATED on ISS
Absorbed Dose Rate (μGy/minute)
0
1
2
3
4
5
6
7
8
9
10
Jul 16
Jul 17
Jul 18
Jul 19
Jul 20
Date (GMT)
2018


Dose Rate on ISS vs Latitude, Longitude | 7/16/18 - 7/20/18
Dose Rate (uGy/min)
Latitude
Longitude
80
60
40
20
0
-20
-40
-60
-80
-150
-100
-50
0
50
100
150
4
3.5
3
2.5
2
1.5
1
0.5


y-Spectrum Conversion to LET | HIMAC 400MeV/n Carbon | LET = 11.2 keV/μm
Lineal Energy measurement
LET Conversion
N_y or N_L
y or LET (keV/um)
0
500
1000
1500
0
5
10
15
20
25
30
35
40


y-Spectrum Conversion to LET | HIMAC 400MeV/n Oxygen | LET = 20.0 keV/μm
Lineal Energy Measurement
LET Conversion
N_y or N_L
y or LET (keV/um)
0
100
200
300
400
500
600
700
800
0
10
20
30
40
50
60


Comparison of ATED LET Conversion to LET Spectrum in LEO
LET Spectra in LEO
ATED Lineal Energy Measurement
ATED LET Conversion
Differential Flux (particles / (cm^2 * day * keV/μm)
LET or y (keV/μm)
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^0
10^1
10^2
10^3
10^4

Future Work

- Plan to fly on 1 month long, 24 km altitude balloon flight (Worldview)
- Version of ATED with cylindrical ionization cavity specifically for use in charged particle beams to be tested at HIMAC in Nov. 2019
- Accelerator time for further development in October (Los Alamos Neutron Science Center) and Japan (HIMAC) in November and January.
- Interest in our ATED from other agencies, groups, countries.
- Of course, we'd like to implement the lessons learned for another flight if NASA EPSCoR is interested.
- Main Focus: Designing new version of ATED that incorporates charged particle/neutron discrimination by surrounding active volume of TEPC with plastic scintillator-based coincidence detector.

Assessment of Radiation Shielding Properties of Novel and Baseline Materials External to ISS

- **Primary Objectives:**

1. The experiment will demonstrate the ability of multifunctional SC2020 carbon fiber composite as a superior radiation shielding material.
2. Obtain space radiation shielding measurement to validate radiation environment, transport codes and computer codes.

- **Experiment Description:**

1. Samples of SC2020 and baseline materials (Al, Cu and polyethylene) are mounted onto standard MISSE on the exterior of the of the ISS.
2. Passive radiation detectors (thermoluminescence detectors and CR-39 plastic nuclear track detectors) are positioned behind the samples and measure radiation as a function of sample thickness.

- **Expected Results:**

1. Demonstrate the use of SC2020 Composite for use in spacecraft in terms of structural and other material characteristics, and of shielding space radiation.
2. Obtain LET spectrum, absorbed dose and dose equivalent as functions of shielding depth behind SC2020 Composite and baseline materials for use in validating space radiation transport models

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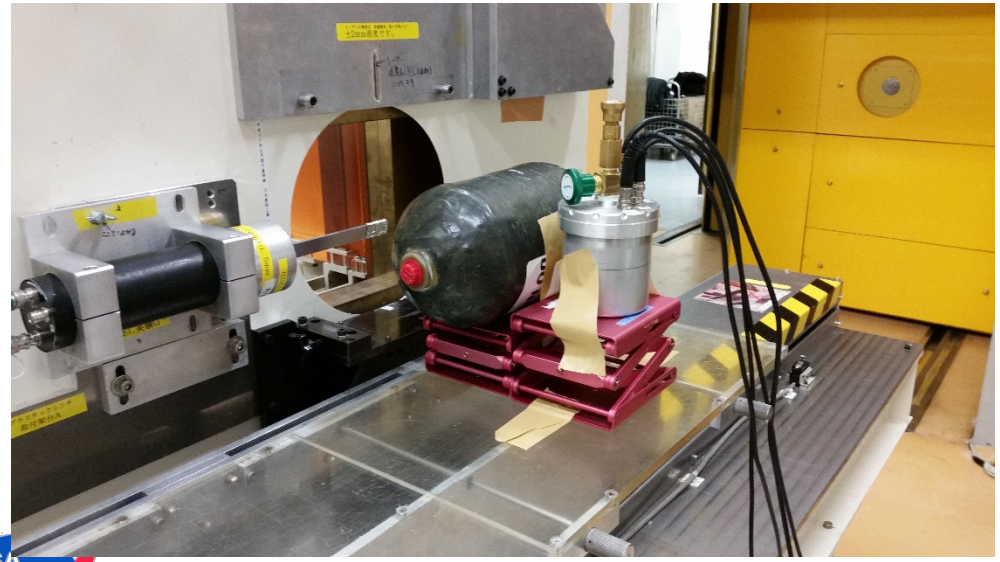
SC2020: BN loaded HDPE in C fiber composite



Initial Hybrid Tank:

- HDPE-BN
- Carbon fiber epoxy prepreg
- Length: ~0.8 m
- Diameter: ~0.3 m

- First attempt at creating a hybrid tank was successful.

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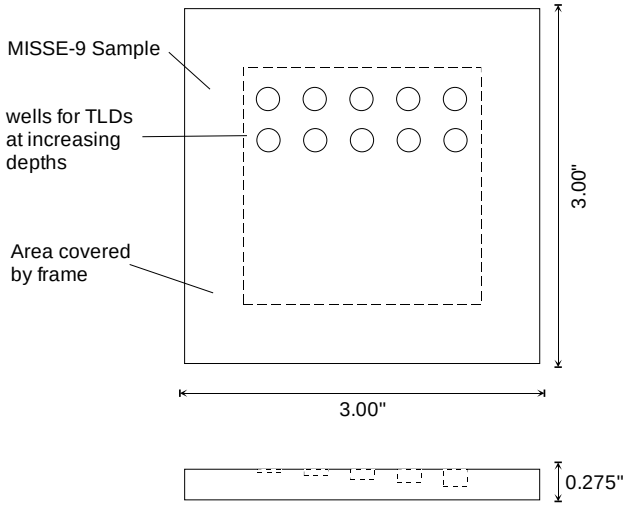
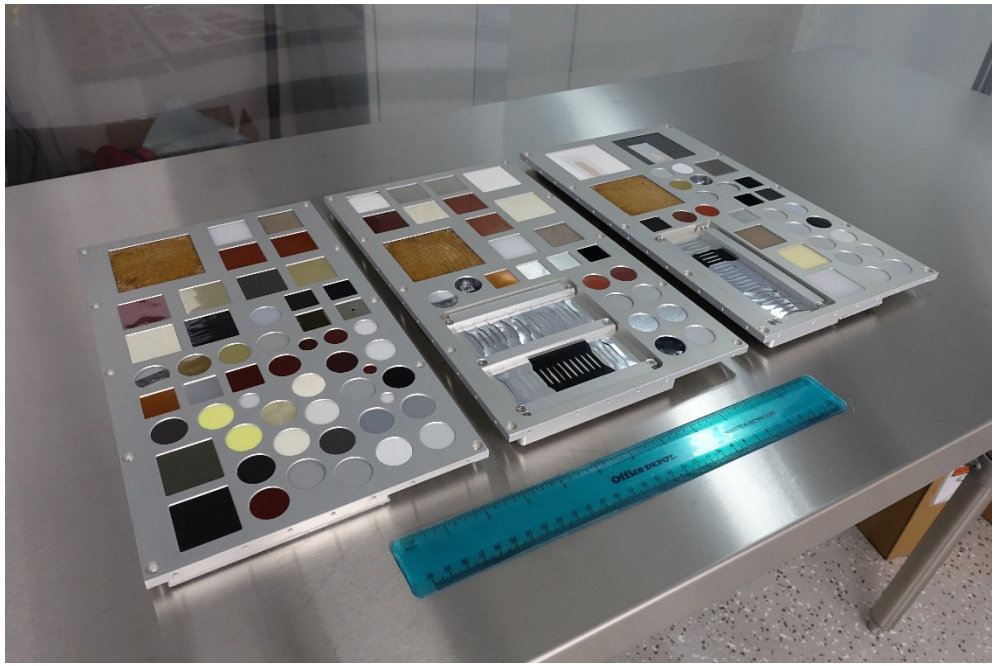
Materials on ISS Experiment (MISSE)

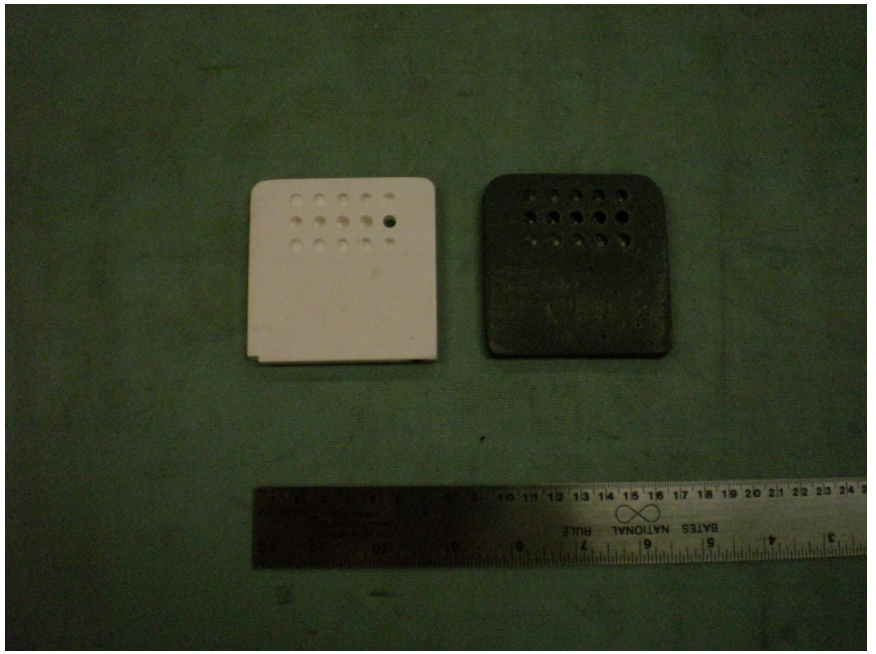
Formerly NASA run facility, now run “privately” by Alpha Space, LLC, part of The Center for the Advancement of Science in Space (CASIS)

MISSE-9 Experiment with NASA LaRC Materials Science

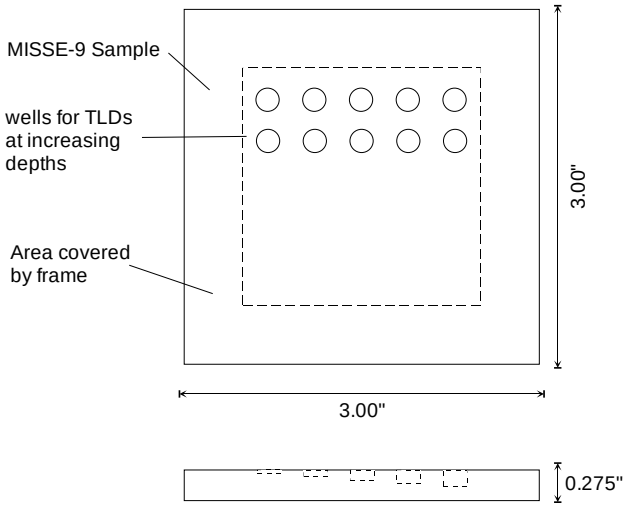


- Two samples (BN in PE, BC in PE) measuring 3” x 3” 0.275”
- TLD-700 stacked to measure absorbed dose as function of depth
- TLDs being read out as we speak!





MISSE-11 Experiment with SC2020 and Baseline Materials



- Samples SC2020 Space Composite, PE, Al and Cu
- TLD-700 and Al_2O_3 stacked to measure absorbed dose as function of depth
- CR-39 PNTD for LET spectra measurements
- Currently in orbit on ISS.