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

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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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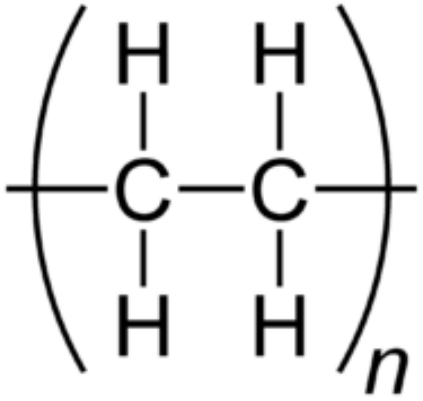
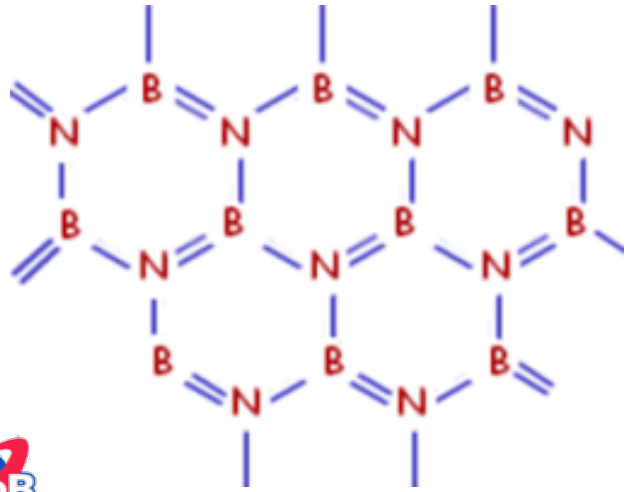
Material and Sample Fabrication



- **High Density Polyethylene (HDPE):** valued for radiation shielding capabilities +
- **Boron Nitride (BN):** valued for positive material fabrication and mechanical properties
- **Carbon Fiber Composite** outer shell for structure.



Addition of BN to HDPE improves the mechanical properties of the material, increases the melting temperature of HDPE, allows HDPE and Carbon Composite to be cured at the same time.

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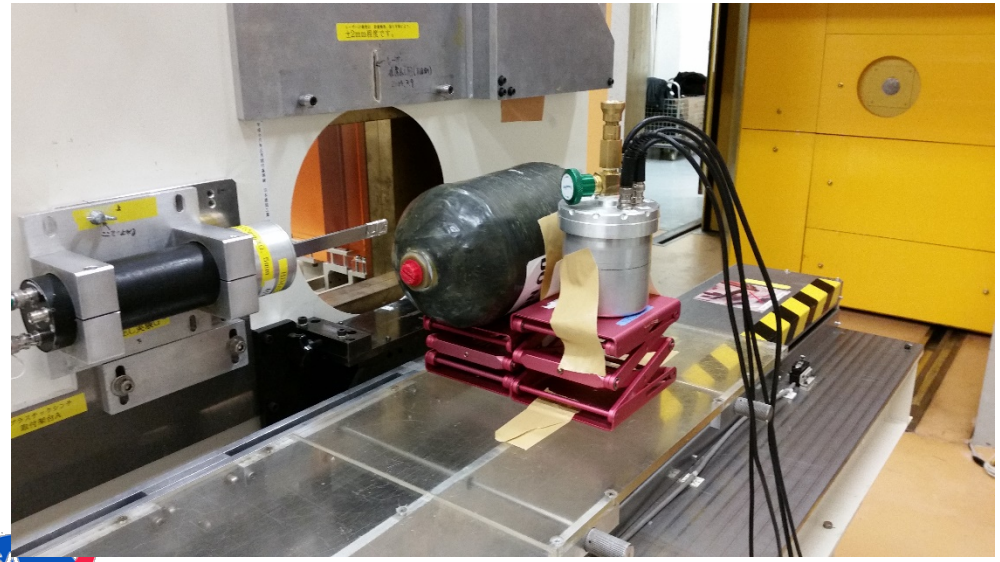
SC2020: BN loaded HDPE in C fiber composite



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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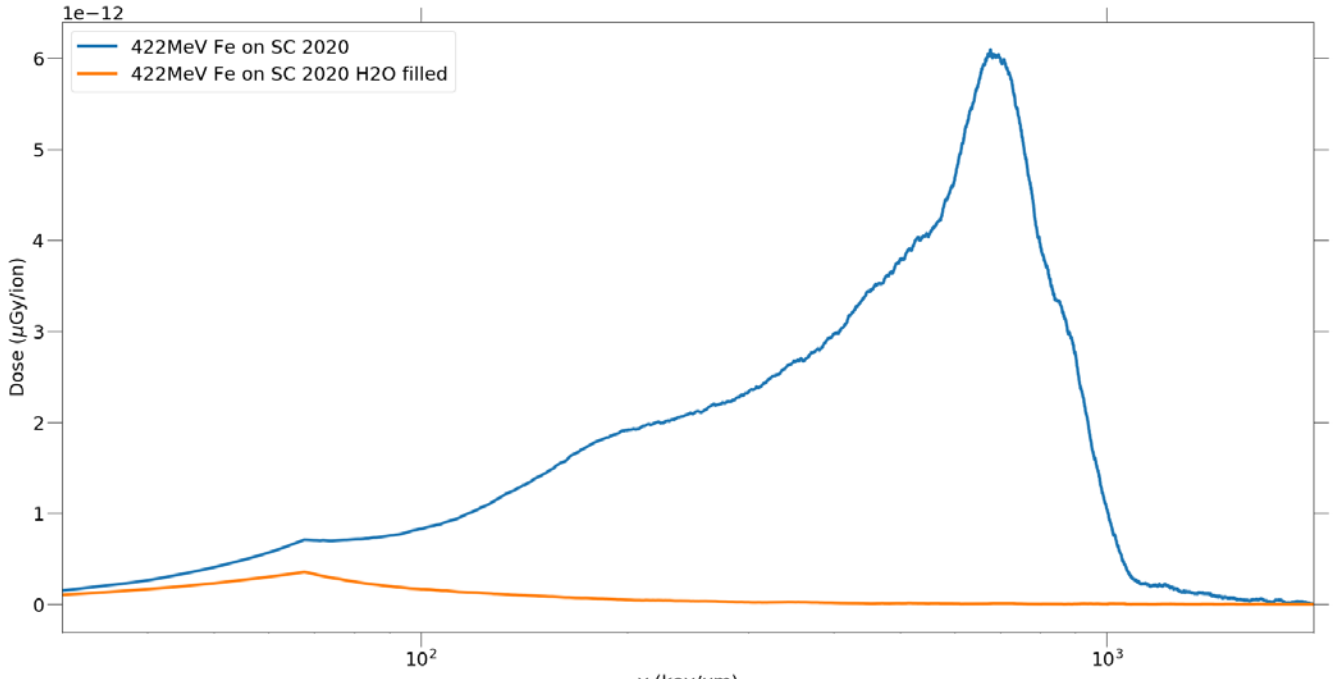
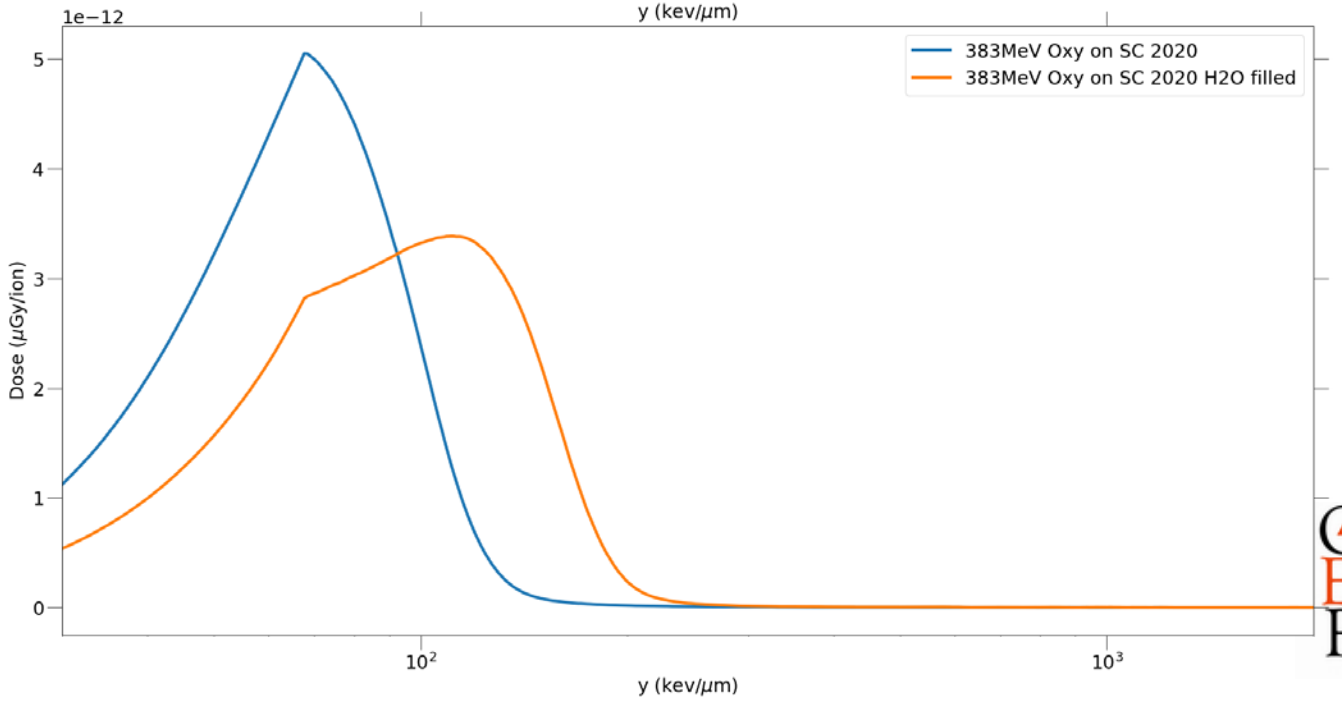
HIMAC Testing

SC2020 Tank in 422 MeV/n Fe beam, empty and filled with water.

SC2020 Tank in 383 MeV/n O beam, empty and filled with water.

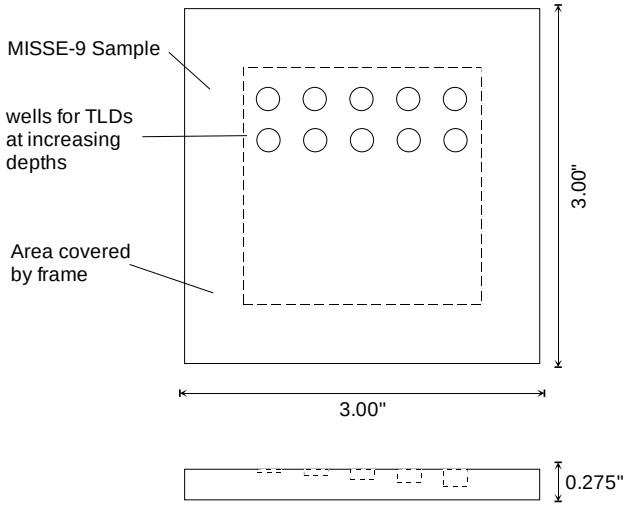




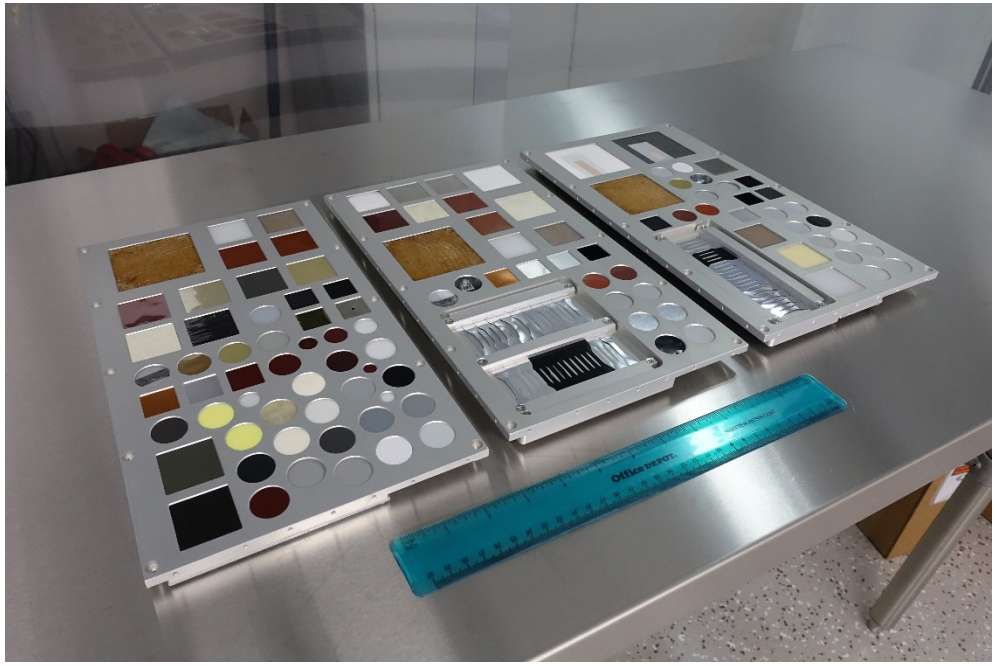
Materials on ISS Experiment (MISSE)

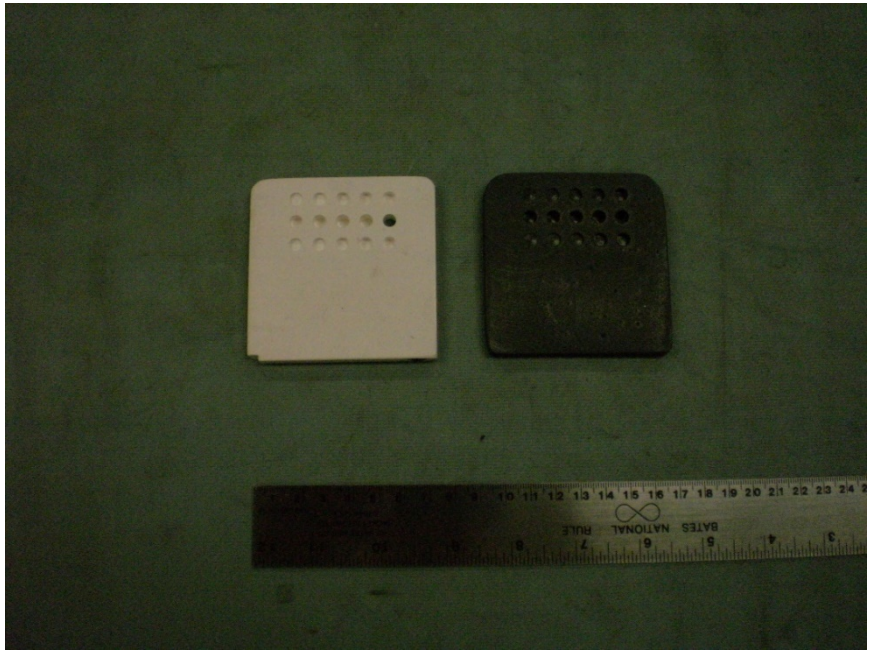
Formerly NASA run facility, now run “privately” by Alpha Space, LLC, part of The Center for the Advancement of Science in Space (CASIS)

MISSE-9 Experiment with NASA LaRC Materials Science



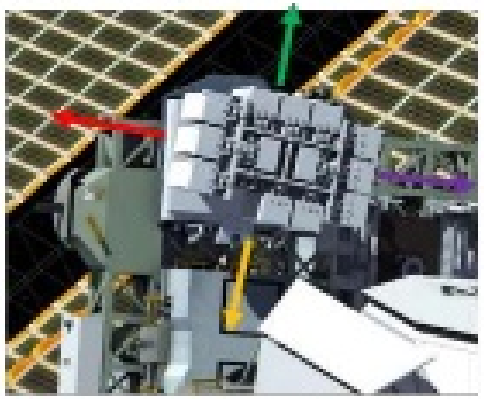
- Two samples (BN in PE, BC in PE) measuring 3” x 3” 0.275”
- TLD-700 stacked to measure absorbed dose as function of depth





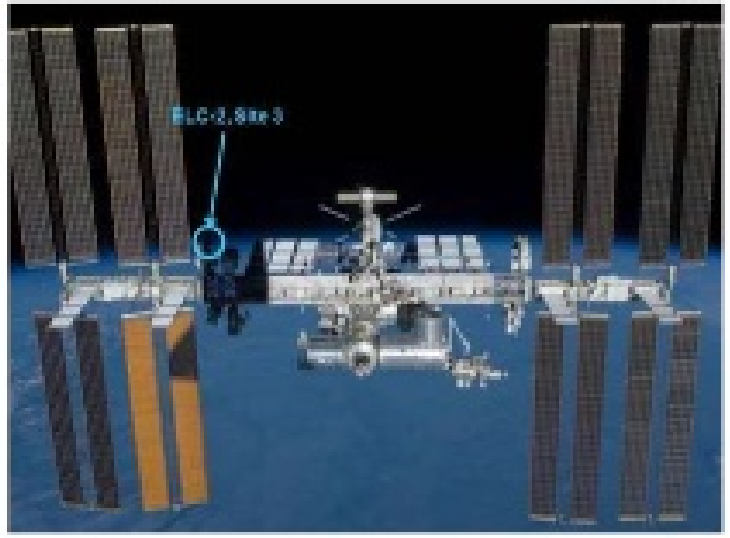
Location of MISSE

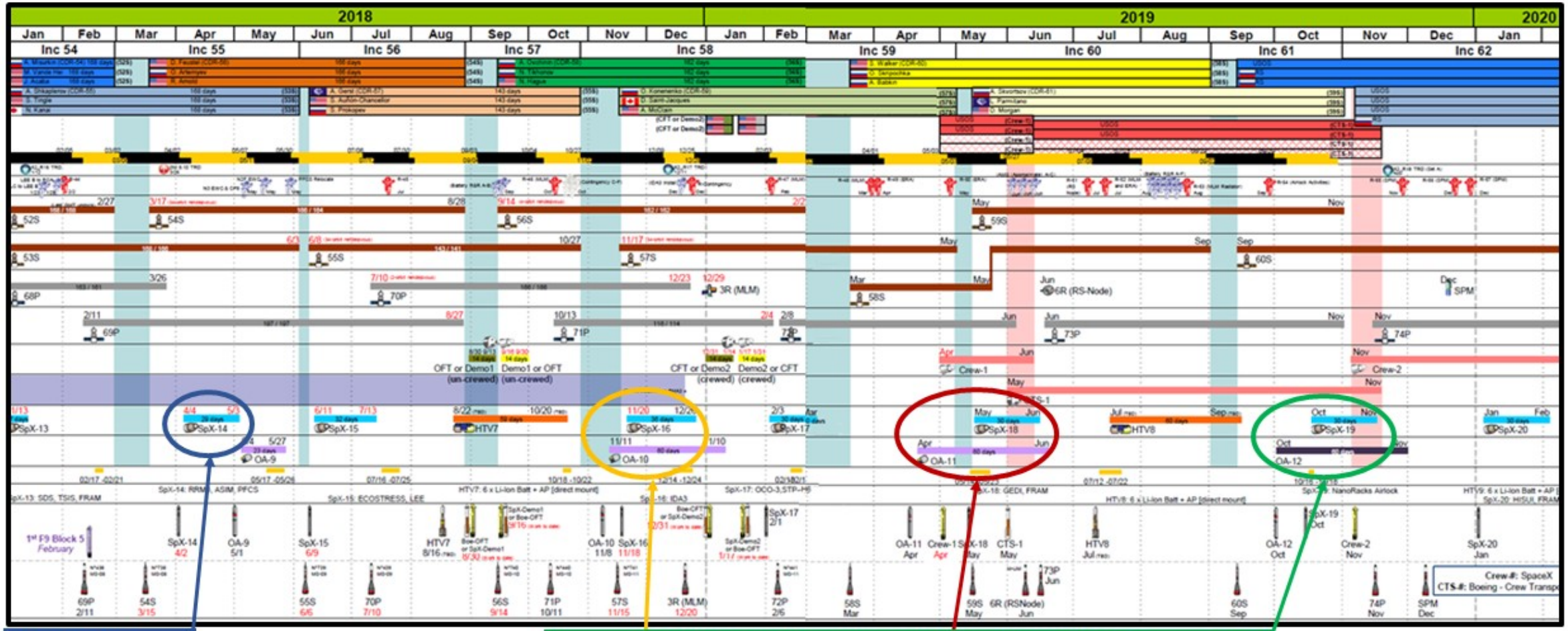
- MISSE is fixed to the exterior of the ISS (ELC-2, Site 3)
- All with little-to-no contamination with ability to close MSCs
- MISSE yields accelerated and accurate testing results for experiments varying from space suits and flight hardware to car paint and electronics



- Ram view unobstructed
- Zenith view unobstructed
- Wake view over ISS structure
- Nadir view into ISS structure

Express Logistics Carrier – 2, Payload Site 3





MISSE-9 (5 Up)

Apr 2018 Launch

MISSE-12 (4 to 7 Up OA-12)

MISSE-10 (4 to 6 Down SpX-19)

Jul 2019 Sample Delivery

Oct 2019 Launch

MISSE-10 (4 Up OA-10)

MISSE-9 (1 Down SpX-16)

Jul 2018 Sample Delivery

Nov 2018 Launch

MISSE-11 (4 to 5 Up OA-11)

MISSE-9 (4 Down SpX18)

Jan 2019 Sample Delivery

Apr 2019 Launch

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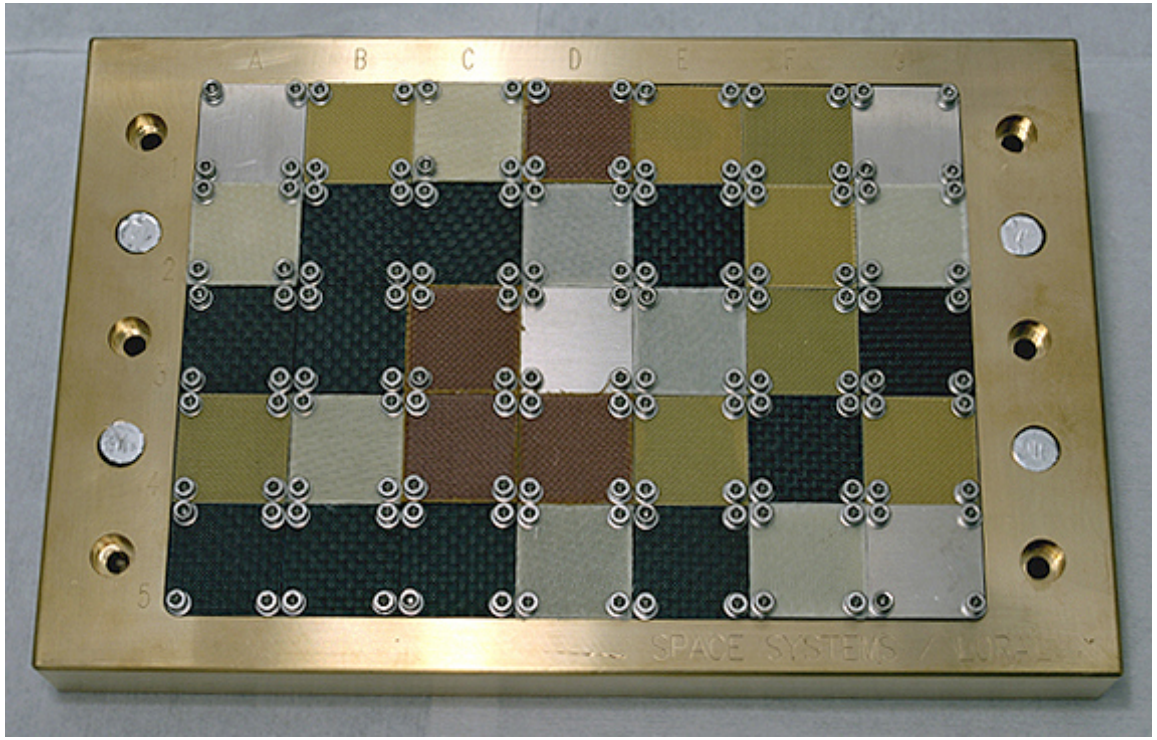
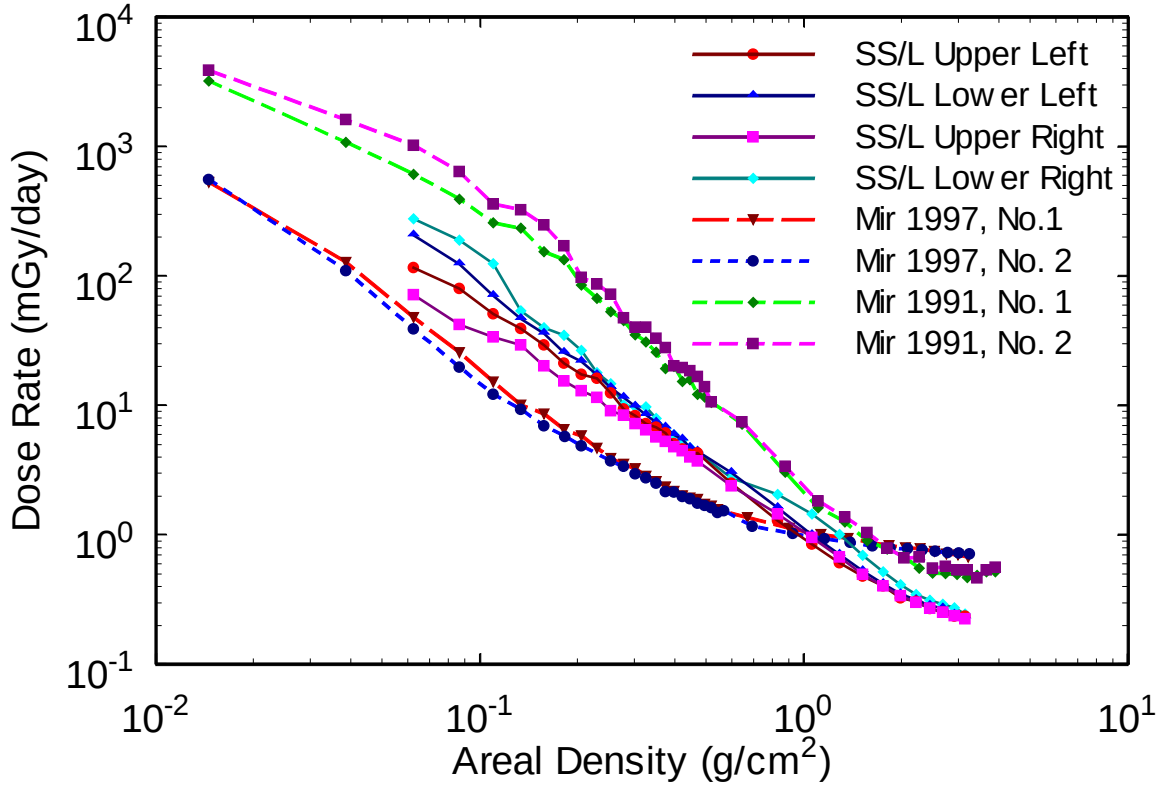
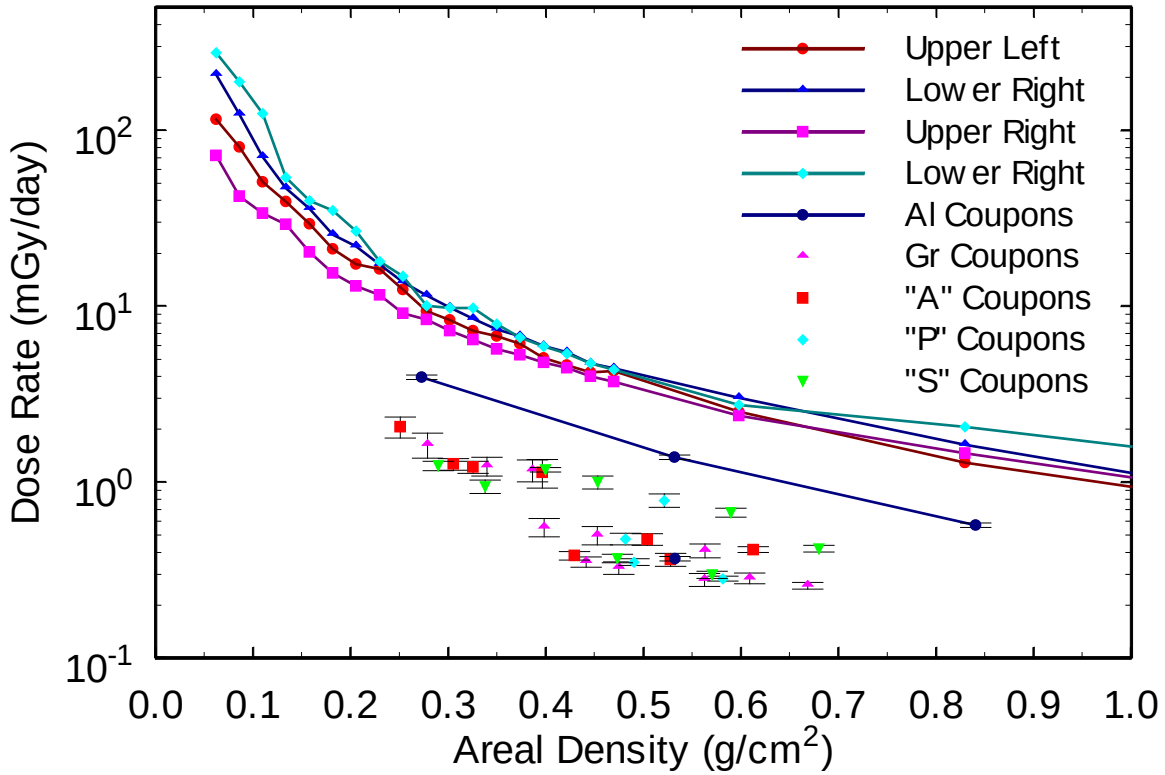
Previous Experiment with Space Systems/Loral on MISSE-1, August 2001 to August 2005



MISSE-1 TLD Results and Comparison with Previous TLD results from MIR

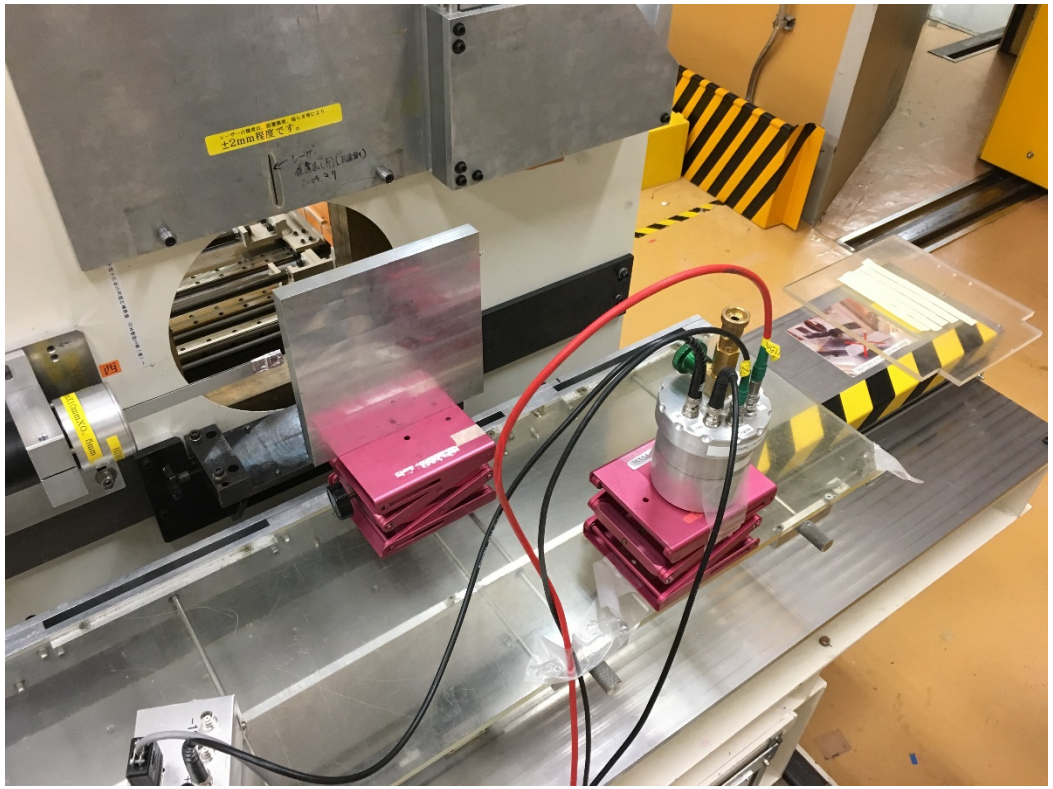


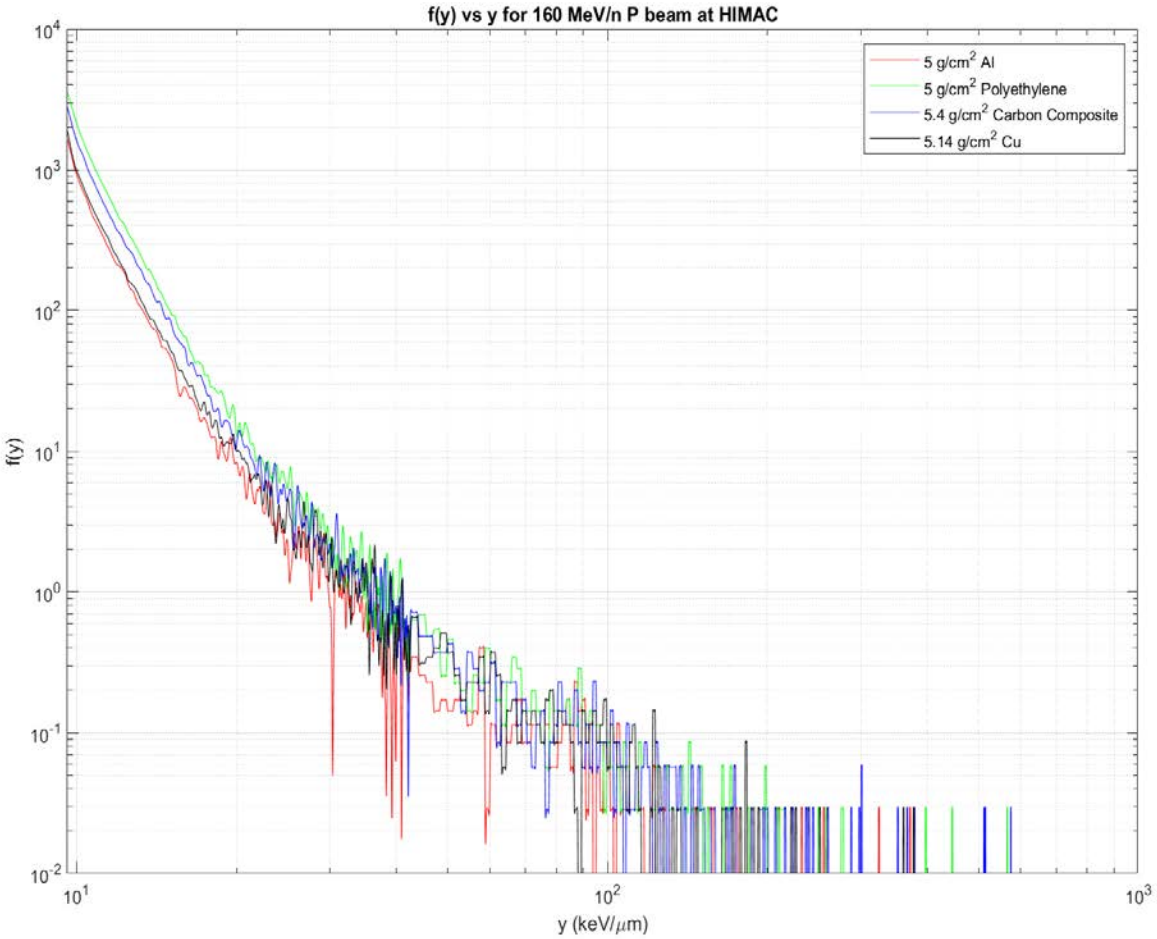


MISSE-11 Experiment,

- 3” x 3” x 1” SC2020 sample with TLD, CR-39 PNTD and post flight material properties degradation measurements
- 1.5” x 1.5” x 1” Baseline Material samples (PE, Al, Cu) with TLD and CR-39 PNTD
- Thicker (1”) samples permits measurements more similar to interior of spacecraft.
- MISSE-11 launch scheduled for April 2019 and 6-12 month exposure duration in the Zenith Direction.

Measuring Neutrons off-axis in the HIMAC BIO Beam





Conclusions

- SC2020 is based on similar C composite developed at OSU used for CNG tanks in cars. These tanks can be pressurized to 150% of maximum for Stainless Steel tanks.
- SC2020 could be used for the pressure vessel of the habitable volume of a spacecraft.
- SC2020 can be used for tanks holding consumables (Air, Water, Waste) and arranged around the spacecraft habitable volume.
- Testing has been carried out at HIMAC and now as part of the MISSE-9 experiment.
- More comprehensive testing, both of radiation shielding properties and materials properties will be carried out on MISSE-11.