TAMU - SPIRIT

Quick Reference Guide - Fall 2026

//////

Texas A&M / Aegis Aerospace Multi-Use

Space Platform Integrating Research & Innovative Technology

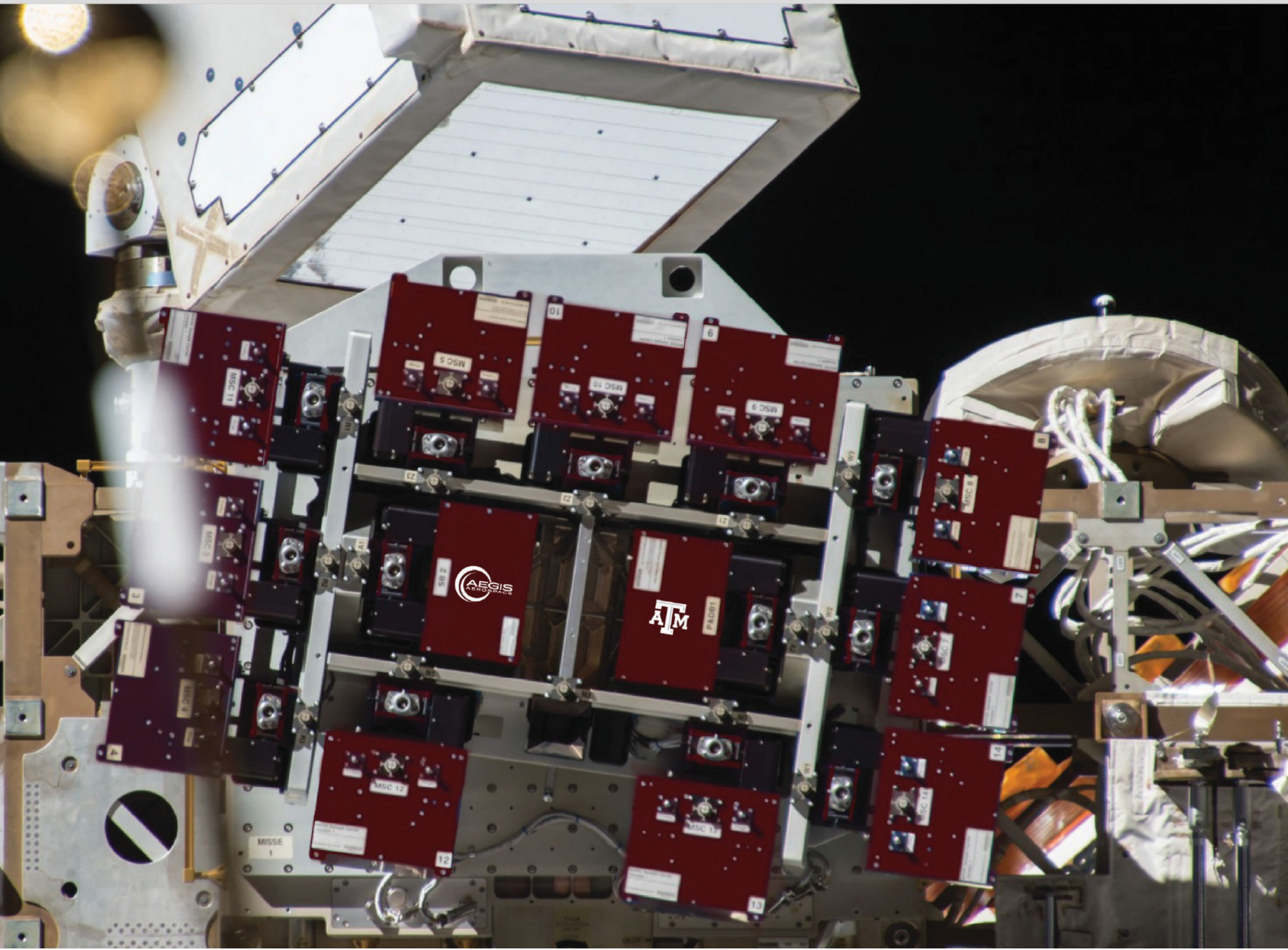


Table of Contents

Introduction / Overview

The Texas A&M/Aegis Aerospace Multi-Use Space Platform Integrating Research and Innovative Technology (TAMU-SPIRIT) facility, a first-of-its-kind Texas A&M-branded Low Earth Orbit (LEO) research platform to be flown aboard the International Space Station (ISS), is a unique resource that can accommodate a wide range of experiments and/or samples for Texas A&M System faculty, researchers, and students. This Quick Reference Guide (QRG) provides some basic information about TAMU-SPIRIT capabilities that will help you to start planning your TAMU-SPIRIT flight experiment. This Quick Reference Guide has two sections:

- TAMU-SPIRIT Basics
- Technical/Interface Information

The TAMU-SPIRIT Basics section provides an overview of all primary TAMU-SPIRIT components and a general description of one flight cycle, while the Technical/Interface Information section provides some details about the interfaces with the TAMU-SPIRIT system. Note that TAMU-SPIRIT is based on Aegis Aerospace's MISSE platform and so photographs and certain basic information in this document may show or reference MISSE components. All these photographs and references are directly relatable to TAMU-SPIRIT.

We hope this Quick Reference Guide provides the basic information you need for your TAMU-SPIRIT flight experiment. If you need more information, please reach out to the TAMU-SPIRIT team at **tamu-spirit@tamu.edu**. We are always ready to assist with additional information.

Thank you,

Jeffrey G. Buell

TAMU-SPIRIT Integration & Operations Manager

1.0 TAMU-SPIRIT Basics

This section is a basic guide for potential users considering spaceflight experiments on TAMU-SPIRIT. Your experiment will be integrated into a TAMU-SPIRIT Science Carrier (SC) or a TAMU-SPIRIT Pallet Carrier (PC), which will be launched to the International Space Station (ISS), installed robotically on the TAMU-SPIRIT Flight Facility, and operated from the Aegis Aerospace Payload Operations Control Center (POCC) in Houston.

1.1 Scope

This document is a starting point for experiment development and integration into an SC or PC. As the flight project progresses, formal design and integration documents will be produced by Aegis Aerospace and reviewed by you.

1.2 TAMU-SPIRIT Components

TAMU-SPIRIT supports the testing and evaluation of a wide range of technologies and materials. It is an R&D platform for orbital testing of materials, coatings, electronics, mechanisms, transmitters, cameras, sensors of all types, and even certain biological samples. TAMU-SPIRIT comprises four primary components:

1. TAMU-SPIRIT Flight Facility (TAMU-SPIRIT-FF)
2. TAMU-SPIRIT Science Carriers (SC) or TAMU-SPIRIT Pallet Carriers (PC)
3. Transfer Tray (TT)
4. Payload Operations Control Center (POCC) and ground support facilities in Houston, Texas.

The TAMU-SPIRIT-FF is the structure attached to the ISS truss that provides structural mounting and utilities to up to 12 SCs at a time (3 SCs/PCs on each of the four sides of the TAMU-SPIRIT-FF). Figure 1 and 2 are images of the MISSE Flight Facility, upon which TAMU-SPIRIT is based.

Figure 1: MISSE On Orbit. The flight facility structure (white) supports two utility boxes (blue in middle) and up to 12 interchangeable SCs (blue, sides, shown closed).

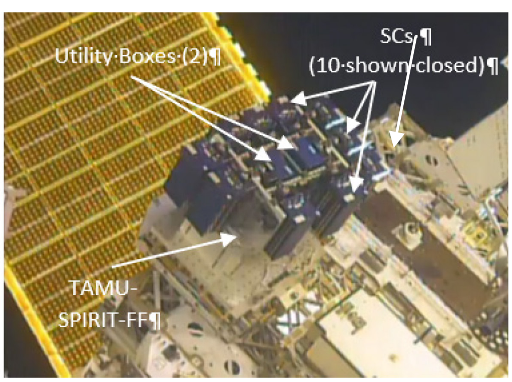


Figure 2: MISSE On Orbit. View of nadir face (right; one nadir SC slot is unoccupied) and ram face (left side of image). All SCs are opened.

SCs/PCs are the carriers for customer experiments/payloads/samples that typically contain several experiments supplied by one or more users (Figure 3 and Figure 4).

Figure 3: Opened SC with SC components labeled (left) and with experiments integrated (right). Note that experiments under the exposure decks are hidden from view (right).

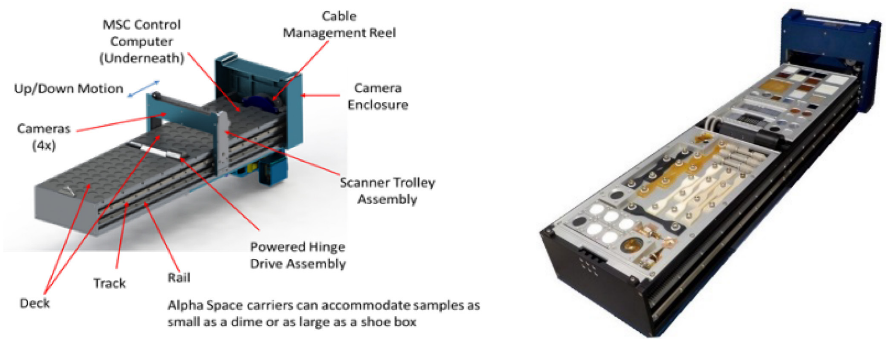
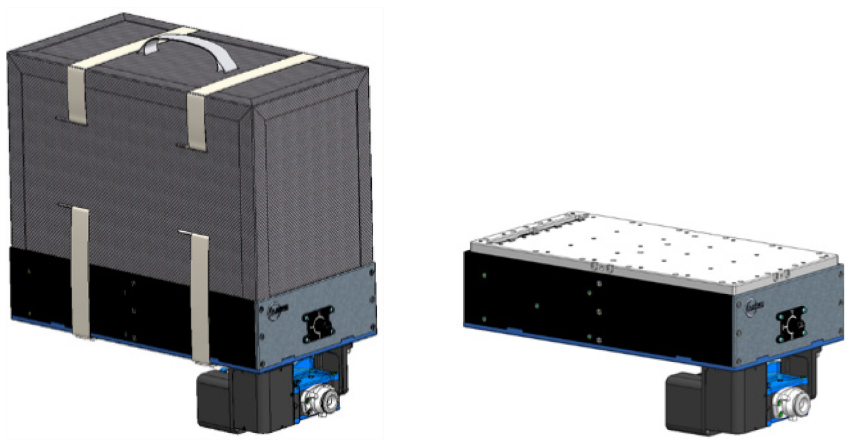
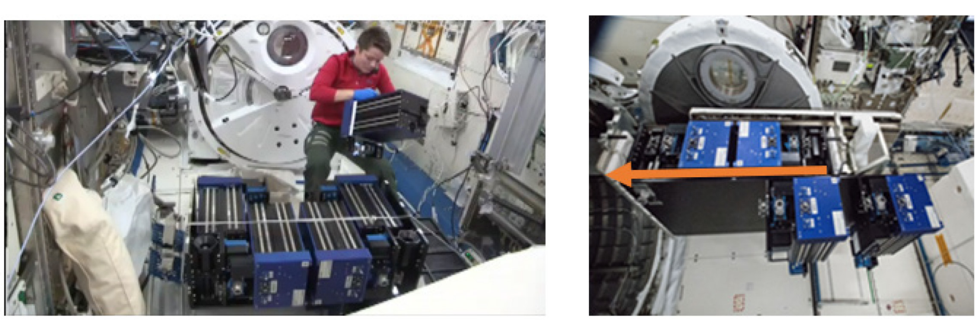


Figure 4: TAMU-SPIRIT Pallet Carrier (PC) with removeable cover attached (left) and with cover removed exposing the flat integration plate (right).



SCs are launched closed and PCs with a crew-removable cover. Both SCs and PCs are stowed as pressurized cargo on any ISS cargo resupply spacecraft (except Progress). Once on-orbit, the crew unpacks the SCs/PCs and installs them on the TT, which is a tray that enables the ISS robotics arm to access several SCs/PCs at once. The TT with attached SCs/PCs is transferred outside of the pressurized ISS modules through the Japanese Experiment Module (JEM) airlock (Figure 5).

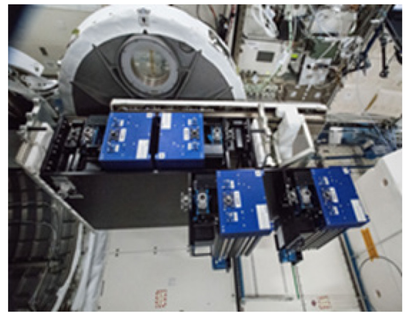
Figure 5: Crew member unpacking SCs and installing SCs on the MISSE TT (left). MISSE TT going into the JEM airlock for ISS robotic transfer to the external MISSE-FF (right)



Once outside the JEM airlock, the ISS robotics system takes the TT to the TAMU-SPIRIT-FF and swaps the SCs/PCs installed on a previous flight for the new set of SCs/PCs. The SCs/PCs from the previous

TAMU-SPIRIT mission are robotically placed on the TT and brought back inside the ISS through the JEM airlock where the crew packs them for return to Earth in a SpaceX Dragon (Figure 6).

Figure 6: MISSE TT on the ISS robotics arm during transfer of SCs to the MISSE-FF (left, circled). Robotic SC installation on the MISSE-FF (middle). MISSE TT being brought back inside the ISS for crew to pack the SCs that have been installed/exposed on the MISSE-FF for return to Earth in a SpaceX Dragon.



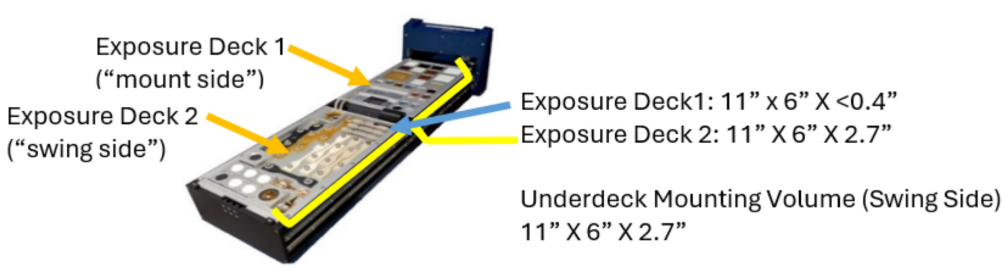
2.0 Technical/Interface Information

This section provides more detailed descriptions of TAMU-SPIRIT capabilities and limited technical and interface information that may be helpful in completing the TAMU-SPIRIT Experiment Questionnaire (a separate document). The information included in this section is not intended to be comprehensive. Detailed interface definition will be included in an Interface Definition Document (IDD), which is negotiated after an experiment is approved for a TAMU-SPIRIT mission.

2.1 SC Structural Interfaces

Passive experiments (that do not require electrical interfaces) are typically mounted to an exposure deck (Figure 7), which is directly exposed to the space environment. Passive experiments may also be secured under the deck for indirect exposure to space. Active experiments that require power and data interfaces (e.g., electronics cards, memory devices, etc.) may be mounted on an exposure deck or inside the structure of an SC under the deck.

Figure 7: Opened SC



2.1.1 Standard Material Sample Mounting Fixtures

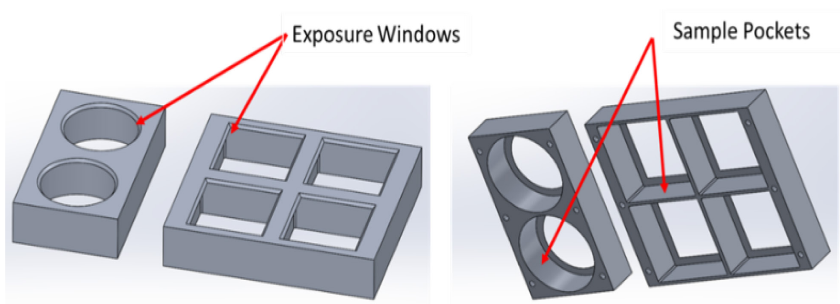
Passive material samples can be square, rectangular, or circular. Samples that are up to 0.40 inches thick are considered standard samples, but thicker samples (up to 3 inches thick) can be accommodated. All standard mounting fixtures are listed in Table 1. Non-standard mounting fixtures can be supported, but must be designed by experiment's technical team in collaboration with Aegis Aerospace and the TAMU-SPIRIT team.

Table 1: Standard Sample and Mounting Fixture Sizes

Sample Size [inch x inch]	Exposure Window [inch x inch]	Sample Size [inch x inch]	Exposure Window [inch x inch]
1" (diameter)	0.85" (diameter)	4 x 2	3.8 x 1.85
1 x 1	0.85 x 0.85	4 x 3	3.8 x 2.8
2" (diameter)	1.85" (diameter)	4 x 4	3.8 x 3.8
2 x 1	1.85 x 0.85	5 x 1	4.75 x 0.85
2 x 1.5	1.85 x 1.35	5 x 2	4.75 x 1.85
2 x 2	1.85 x 1.85	5 x 3	4.75 x 2.8
3 x 1	2.8 x 0.85	5 x 4	4.75 x 3.8
3 x 2	2.8 x 1.85	6 x 1	5.75 x 0.85
3 x 3	2.8 x 2.8	6 x 2	5.75 x 1.85
4 x 1	3.8 x 0.85	6 x 3	5.75 x 2.8

NOTE: Non-standard sample sizes and shapes can be accommodated in unique fixtures.

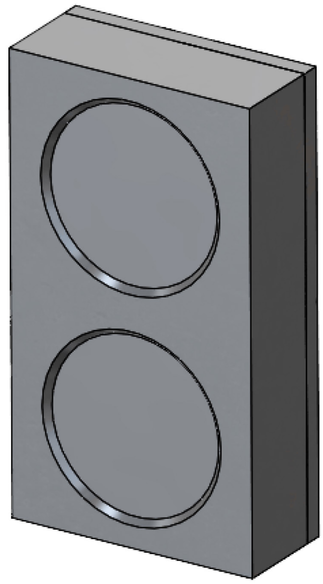
Figure 8: Representative Standard Mounting

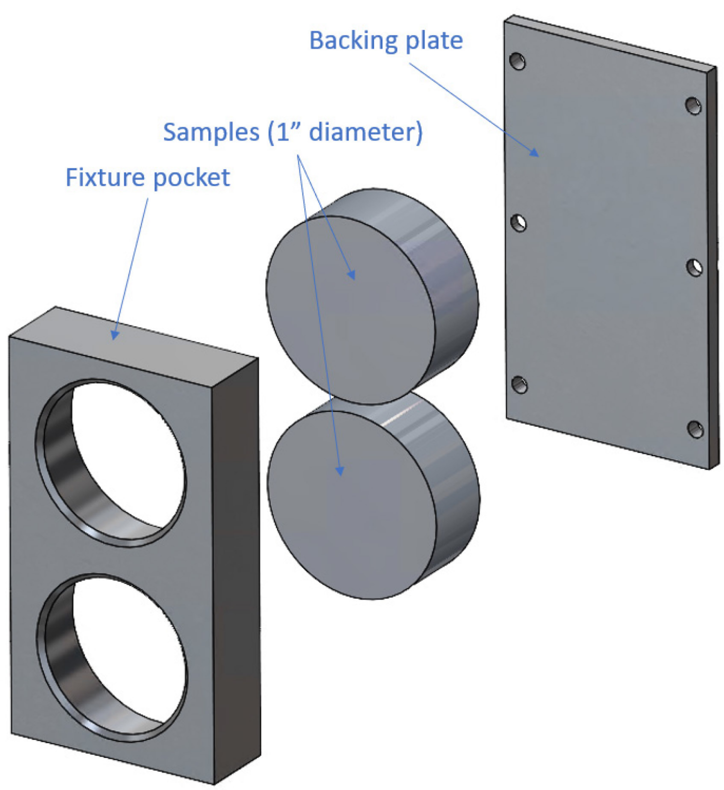


2.1.2 Material Sample Installation in Mounting Fixtures

The SC mounting fixtures used for material samples look like picture frames. A material sample is loaded into the fixture pocket from the back of the fixture, and if needed, a thin aluminum plate is placed into the fixture after the sample. Spacer plates and/or springs are used to push the sample into the fixture's frame, and a backing plate is fastened to the back of the mounting fixture, securing the material sample within the fixture. Note that a small area along the perimeter of the material sample is covered by the mounting fixture's frame during space exposure. Figures 8 - 10 depict sample loading into a standard SC mounting fixture.

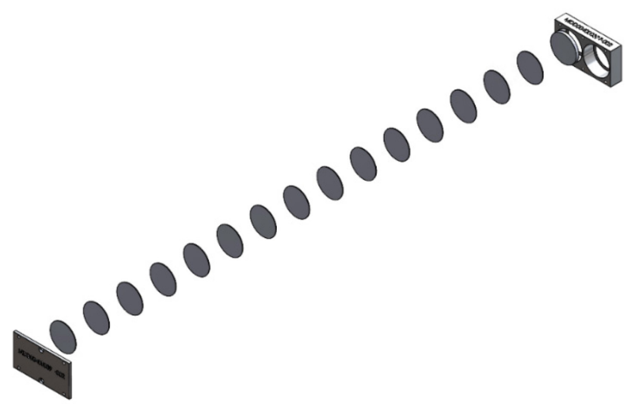
Figure 9: Example of 2 1" diameter samples integrated into mounting fixture





For thin samples, a series of thin spacers of the same sample size of 0.02" thickness are installed into the sample case.

Figure 10: Installation of a thin sample: fixture pocket, sample, and backing plate before assembly



2.1.3 Non-Standard Mounting Fixtures

Aegis Aerospace can also assist with experiment's technical team with the design and fabricate non-standard mounts as needed. The maximum size a standard SC can accommodate on the exposure deck is a flight article roughly 11" x 6" X 2.7" on Exposure Deck 2 (Swing).

2.1.4 Structural Mounting of Active Experiments

Active experiments are those that require power and data interfaces. These flight articles are usually mounted under the exposure deck of an SC (not directly exposed to sunlight and atomic oxygen). The maximum underdeck volume for active experiment hardware is very roughly 11" X 6" X 2.7" [279.4 mm X 152.4 mm X 68.5] L X W X H and the max mass of 4 kg; however, there are small protrusions that intrude slightly into that volume, and clearances must be kept. Active experiments will also need to have a small TAMU-SPIRIT-provided PCB mounted in that volume that provides the power and data interfaces.

2.1.5 PC Structural Interfaces

PC experiments must fit within the dimensions indicated in Figure 11 and within the orange volume shown in Figure 12. Volume dimensions are: 15" X 8" X 9" [381 mm X 203.2 mm X 228.6 mm] L X W X H and the max mass of 10 kg. The PC volume includes area for power connections and mounting; a drawing can be provided for keep-out zones. PCs are covered before launch, the cover is removed on orbit before installation on the TAMU-SPIRIT Transfer Tray, and the cover is replaced before packing once the PC is returned inside the ISS after mission duration.

Figure 11: Total PC Dimensions

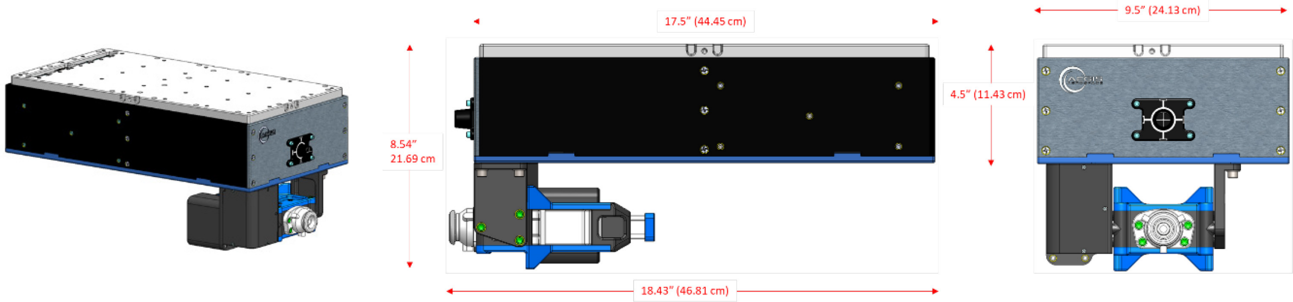


Figure 12: PC Payload Volume and PC Cover

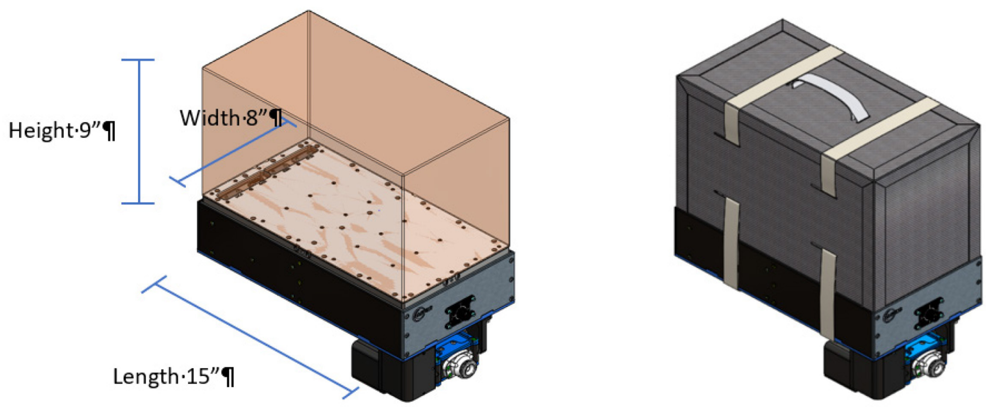
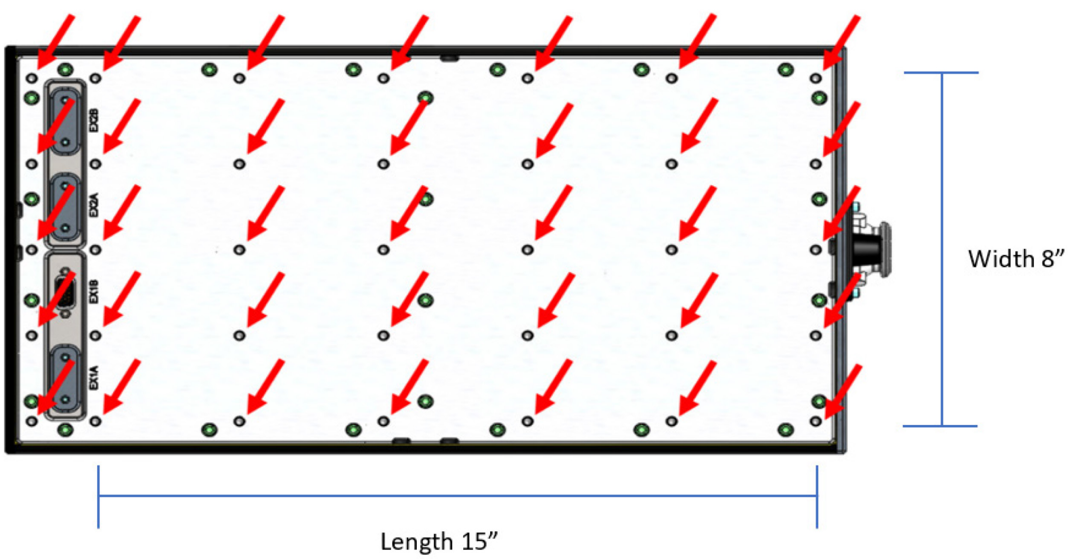


Figure 13: PC Mounting Plate with Attachment Hole Pattern and Electrical/Data Connectors



PC experiments must be installed in the holes shown in Figure 13. Holes are spaced 3” X 2” apart, threaded #8-32.

2.1.6 Structural Strength

The user must ensure their experiment is configured for flight. Please refer to the NASA 7000 GEVS standard to aid in experiment design. It is the user's responsibility to design the experiment so that it will pass vibration, thermal, and EMI testing. The user must include a secondary fastener locking feature such as Loctite 222MS, or a locking threaded insert (e.g. locking Helicoil). All fasteners must have the proper torque applied and documented. Experiment components must be thermally rated for the temperatures encountered during testing and on orbit to avoid failure.

All experiments are properly mounted and constrained during their integration into an SC or PC. After all experiments are integrated, each SC and PC undergoes environmental testing for flight certification. Vibration loads are provided in Figures 14 and 15. SCs and PCs are vibration tested hard-mounted, on all three axes (X,Y,Z). For launch, SCs and PCs are encased in bubble wrap and launched as pressurized cargo, which minimizes launch and landing loads.

Figure 14:TAMU-SPIRIT Sample Carrier Vibration Levels

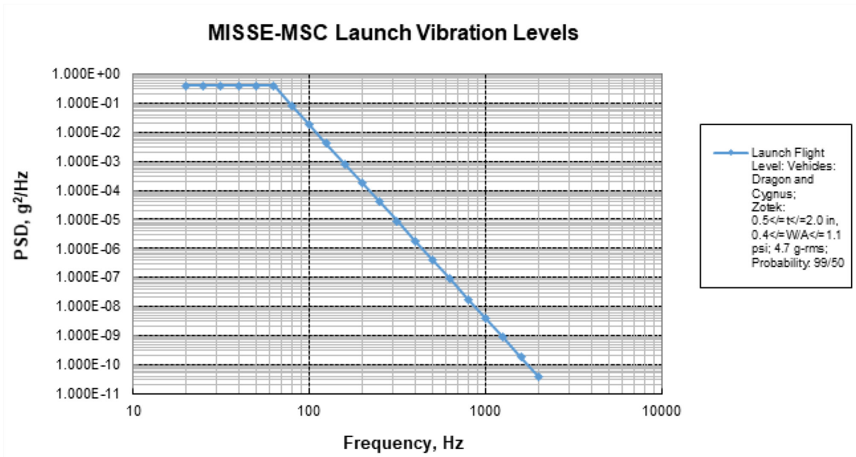
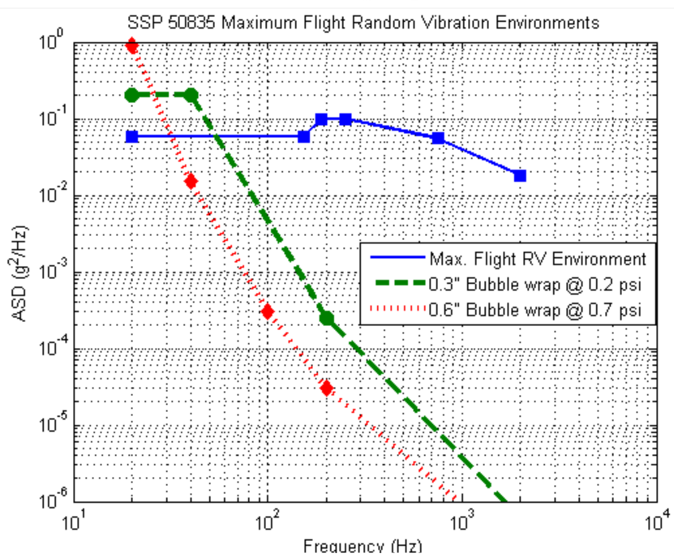


Figure 15: Attenuated Random Vibration Environments for 0.3-inch and 0.6-inch bubble wrap



2.1.7 Thermal

All experiments must be capable of withstanding temperatures of -50 °F (-46°C) to 130 °F (55°C) unpowered. Passive samples will be exposed to thermal cycles over this range as part of ground testing to ensure structural integrity and bake off any easily condensable materials. Active experiments do not receive thermal cycle testing, though it is recommended for reliability (and thermal vacuum testing if able). Aegis can provide additional specifications and methodology for testing.

Historically Aegis has found that "Industrial Grade" components with operating temperature ranges of -40 to 185 °F (-40 to 85 °C) are sufficient for both operating and survival temperatures, though it is the responsibility of the experiments to determine their exact limitations and implement operational constraints.

2.2 Electrical Interfaces

Experiment power and data are available as optional services. This section describes the standard interfaces for these services. Detailed interface information for every experiment is defined in an Interface Definition Document (IDD) developed collaboratively with each user immediately following experiment approval. Aegis Aerospace can provide design assistance to the experiment's technical team in meeting these interface requirements, upon request.

2.2.1 Power

Each experiment can use up to two power sources. Each power source can be independently configured to supply any voltage between 4.6 and 35 V. The power sources share a common ground. Total power consumption by experiments is limited to 50W on an SC and 60W on a PC. Power is shared across all experiments on a Carrier. The total current draw on each power source is limited to 2 Amperes for all Voltages. For example, if you want 5 V, the maximum power you can draw from that source is 10 W. Power may be removed from the experiment at any time without warning.

2.2.2 Data/Commanding Interfaces

Each SC/PC provides either RS-422 or Ethernet interface options for experiment data and commanding (Table 2). TAMU-SPIRIT data downlink from ISS is limited to about 5 Mbps. TAMU-SPIRIT data is routed through the Aegis Aerospace Payload Operations Control Center (POCC), and applicable experiment data is then distributed to each user. Aegis Aerospace commands experiments through its POCC in accordance with user requirements and NASA/ISS operational constraints. All commands are processed manually by TAMU-SPIRIT operators. Operators will work with the client to determine their individual commanding needs. TAMU-SPIRIT SC data is embedded in the ISS downlink, which is available near real time and nearly continuously but with short interruptions during

ISS Los of Signal (LOS). Experiments following the message format found in the TAMU Emulator Usage Instructions can add data to this downlink.

Table 2: SC and PC internal communication protocols

Comm	Data Rate (standard)	Data Rate (maximum)	Throughput	Note
RS-422	115.2 kbps	10-20 Mbps	0.01152 MB/s	Dependent on distance and bus integrity.
Ethernet 10/100	100 Mbps	100 Mbps	12.5 MB/s max. 4 MB/s sustained	Results vary.

2.3 Aegis Solar Cell Testbed

Aegis Aerospace provides comprehensive characterization services for photovoltaic solar cells using our Solar Cell Testbed (SCTB). Researchers populate the cell holders and establish the electrical connections prior to delivery. Each holder supports a 2 cm × 2 cm cell, with the ability to accommodate larger formats up to the physical limits of the carrier surface.

The SCTB performs characterization measurements at a rate of one sample every 10 seconds, depending on the researcher's configuration. The system can be customized to meet specific electrical requirements, particularly when a cell's open circuit voltage (Voc) or short circuit current (Isc) exceeds typical values (5 V and 2 A, respectively). Higher limits may be accommodated with appropriate SCTB modifications. For optimal illumination, carriers are ideally positioned at the zenith location to maximize direct sunlight exposure. Aegis can provide ephemeris data to assist researchers in identifying periods when solar incidence angles are closest to orthogonal to the cell surface.

Each characterization dataset includes a timestamp, I V curve data (typically 20 points), cell temperature during measurement, and associated ephemeris information to support sun-angle analysis.

After receiving the cells, Aegis installs a connector interface and integrates a temperature sensor to capture real time cell temperature during testing. Once instrumentation is complete, the cells are conformally coated, excluding the active photovoltaic surface.

2.4 Transmitters, Cameras & Sensors

SCs can accommodate experiments and technologies that include transmitters, cameras, and/or other sensors. Contact the TAMU-SPIRIT team at **tamu-spirit@tamu.edu** for information about Earth and space views available from the TAMU-SPIRIT-FF. Orbital sensors and cameras may require a NOAA and/or FCC license and a unique NASA viewing analysis.

2.5 NASA Safety and Flight Certification

Aegis Aerospace obtains NASA safety approval for all experiments/items as part of Aegis Aerospace's basic TAMU-SPIRIT service. Numerous experiments/items are integrated into each SC/PC and then Aegis Aerospace certifies the integrated Carrier as "safe to fly" through the traditional NASA safety process. Special materials, such as shatter-prone, contact-sensitive, and biological materials, can be accommodated but must be identified up front by the customer with Aegis Aerospace guidance. Aegis Aerospace works with NASA to ensure these materials are handled safely. SCs protect materials from handling by astronauts, EVA contact, and robotic contact in the closed configuration. Operational constraints are in place when the SCs are open to protect the experiments/items.

Electrical and operational safety requirements are met using SC electrical inhibits and operational constraints. In unique circumstances, Aegis Aerospace will guide the user in designing certain inhibits and monitors for their experiment/item.

2.6 Orbital TAMU-SPIRIT Sensor Data

All TAMU-SPIRIT users with experiments on the exposed Science Carrier decks receive a monthly HD image of their sample/item, along with temperature data (measured on the SC deck) and contamination data (measured from passive wafers) as part of the TAMU-SPIRIT standard service. Experiments mounted under the exposed decks receive only temperature data.

In addition to the standard orbital data described above, TAMU-SPIRIT has installed sensors that measure ultraviolet (UV) intensity and total ionizing radiation (in rads). The data from these sensors can also be provided as an optional service. Atomic oxygen fluence data is attained from measuring the weights of pre- and post-flight Kapton witness samples; this data is available for an additional cost. Passive dosimeters are added to an SC on each orbital direction; radiation measurements in mrem are available post-mission for an additional cost. Other optional data services include more frequent HD images and near real-time data delivery. These do not require experiment/item power or data connections.

2.7 Summary of Baseline/Standard Services

Passive and active (powered) experiments are supported using a set of standard services provided by an SC or PC. Experiments with criteria outside these standard services can, in many cases, still be accommodated with a customized solution. Aegis Aerospace will guide the user in tuning their experiment to be successful while fitting within the capabilities of an SC or PC.

2.7.1 Baseline/Standard Services for Passive Experiments

The summary of services in Table 3 and Table 4 outlines baseline requirements for an exposure deck or underdeck passive sample experiment.

*Table 3: SC Exposure Deck Passive Sample Standard Services**

Service	Baseline*
Sample Size Accommodated (X & Y dimensions)	Sample sizes listed in Table 1.
Sample Thickness Accommodated (Z dimension)	Sample thickness must be less than or equal to 0.4" on Exposure Deck 1 (Mount) and 2.7" on Exposure Deck 2 (Swing).
Integration Process	One sample placed into the sample pocket.
Integration Method	Aegis provided standard sample size case and backing plate, thin aluminum spacers to fill gaps, and wavy washer.
Standard Environmental Data	Available in the TAMU-SPIRIT portal: deck temperature (monthly) contamination data (post-mission)
Standard Exposure Deck Images	Once per month, available in TAMU-SPIRIT portal.
Sample Ground Handling	In a Class 10K cleanroom with lights on, temperature range from 68F to 75F, humidity is kept less than or equal to 40%.
Sample De-integration Packaging and Shipping	Sample will be returned in an Aegis plastic bag or a PI-provided sample case. The plastic bag or case is packed in a cardboard box with foam/bubble wrap and returned via ground shipping.

*NOTE: This table describes the standard/baseline services that are provided to a passive experiment on an SC exposure deck. Deviations to accommodate an experiment may be possible, and optional services are also available as described in this document.

*Table 4: SC Underdeck Passive Sample Standard Services**

Service	Baseline*
Sample Size Accommodated (X, Y, Z dimensions)	Less than or equal to 11" X 6" X 2.7"
Integration Method	A sample is placed in a mylar bag and heat-sealed on all edges. A few small holes are punched in the bag for air flow.
Integration Process	The mylar-bagged sample is secured to the bottom of the SC or to the bottom of the exposure deck with aluminum tape.
Sample Ground Handling	In a Class 10K cleanroom with lights on, temperature range from 68F to 75F, humidity is kept less than or equal to 40%.
Sample De-integration Packaging and Shipping	Sample will be returned in an Aegis plastic bag or a PI-provided sample case. The plastic bag or case is packed in a cardboard box with foam/bubble wrap and returned via ground shipping.

*NOTE: This table describes the standard/baseline services that are provided to a passive experiment integrated under an SC exposure deck. Deviations to accommodate an experiment may be possible and optional services are also available as described in this document.

2.7.2 Baseline/Standard Services for Active Experiments

The summary of services in Table 5 and Table 6 outlines baseline requirements for an active powered experiment on an SC or PC.

*Table 5: SC Active Experiment Standard Services**

Service	Baseline*
Experiment Hardware Dimensions Accommodated (Exposure Deck Mounting)	Less than 11” X 6” X 2.7” (L X W X H)
Experiment Hardware Dimensions Accommodated (Under Deck Volume)	Less than 11” X 6” X 2.7” (L X W X H)
Total Experiment Mass	Less than 4 kg
Total Experiment Power	Up to 50W (across all experiments)
Experiment Input DC Voltage	Up to 2x variable lines, 4.6-35 V
Experiment Current	Up to 2A per line (all voltages)
Experiment Telemetry	RS-422 or Ethernet
Experiment Data Downlink	Maximum 1 GB per weekday
Experiment Data Uplink	Maximum 5 MB per weekday
Experiment Commanding	TAMU-SPIRIT-FF Operator does not directly access user’s experiment’s computer All experiment commands are processed manually by TAMU-SPIRIT operators. Operators will work with the client to determine their individual commanding needs.
Experiment Operations	Initial activation and experiment setup. Up to 5 hours per week of experimental operations, including uploading and downloading data. Up to 10 hours per month to support anomaly resolution in experiment, if needed. Experiment operations are typically performed during normal Aegis Aerospace working days and hours.
Standard Environmental Data	Available on the TAMU-SPIRIT portal: deck temperature (monthly) contamination data (post-mission)

Service	**Baseline***
Standard Exposure Deck Images	Once per month, available on TAMU-SPIRIT portal
Experiment Ground Handling	In a class 10K cleanroom with lights on, temperature range from 68F to 75F, humidity is kept less than or equal to 30%.
Experiment De-integration Packaging and Shipping	Experiment will be returned in Aegis plastic bag or customer provided case. The plastic bag or case are packed in a cardboard box with foam/bubble wrap and returned via ground shipping.

*NOTE: This table describes the standard/baseline services that are provided to an active (powered) experiment integrated in an SC. Deviations to accommodate an experiment may be possible and optional services are also available as described earlier in this document.

*Table 6: PC Active Experiment Standard Services**

Requirement	**Baseline***
Experiment Hardware Dimensions Accommodated (Pallet Carrier)	Less than 15” X 8” X 9” (L X W X H)
Experiment Mass	Less than 10kg
Experiment Power	Up to 60W (across all experiments)
Experiment Input DC Voltage	Up to 2x variable lines, 4.6-35 V
Experiment Current	Up to 2A per line (all voltages)
Experiment Telemetry	RS-422 or Ethernet
Experiment Data Downlink	Maximum 1 GB per weekday
Experiment Data Uplink	Maximum 5 MB per weekday
Experiment Commanding	TAMU-SPIRIT-FF Operator does not directly access the user’s experiment computer. All experiment commands are processed manually by TAMU-SPIRIT operators. Operators will work with the user to determine the user's individual command needs.

Requirement	**Baseline***
Experiment Operations	Initial activation and experiment setup. Up to 5 hours per week of experiment operations, which includes uploading and downloading data. Up to 10 hours per month to support anomaly resolution in experiments, if needed. Experiment operations are typically performed during normal Aegis Aerospace working days and hours.
Standard Environmental Data	Available on the TAMU-SPIRIT portal: deck temperature (monthly) contamination data (post-mission)
Standard Exposure Deck Images	N/A
Experiment Ground Handling	In a class 10K cleanroom with lights on, the temperature ranges from 68F to 75F, and humidity is kept less than or equal to 30%.
Experiment De-integration Packaging and Shipping	The experiment will be returned in an Aegis plastic bag or a user-provided case. The plastic bag or case is packed in a cardboard box with foam/bubble wrap and returned via ground shipping.

*NOTE: This table describes the standard/baseline services that are provided to an active (powered) experiment integrated on an PC. Deviations to accommodate an experiment may be possible and optional services are also available as described earlier in this document.