



ISS EXISTING HARDWARE, IMPLEMENTATION PARTNERS & HARDWARE PROVIDERS

CASIS strongly encourages prospective proposers to learn about the availability and capability of flight hardware and integration services by directly communicating with the implementation partner and the CASIS Operations team (opsinfo@iss-casis.org). CASIS encourages proposers to initially see if the desired hardware can be utilized in its current form before investigating modifications. The CASIS Operations team is available to answer questions by email and/or to facilitate pre-submission discussions to help prospective proposers determine relevant options for on-orbit investigations. Answers will appear on the CASIS website at <http://www.iss-casis.org/Opportunities/Solicitations/Combustion/FAQ.aspx>. However, CASIS will not post answers that would jeopardize intellectual property or proprietary information.

Implementation Partners for Flight Experiments

NanoRacks:

NanoRacks, LLC was formed in 2009 to provide quality hardware and services for the U.S. National Laboratory onboard the International Space Station. The company operates the first commercial laboratory in low-earth orbit. Today, NanoRacks has three research platforms onboard, which can house plug and play NanoLabs using the CubeSat form factor for inside the Space Station.

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Space Tango:

Space Tango provides a wide array of services for ISS customers. Including experiment design (including Exomedicine), mission manifesting*, on orbit operations and terrestrial logistics. Space Tango's TangoLab-1 facility is a general research platform allows multiple automated CubeLab experiments to run simultaneously. This architecture minimizes astronaut interaction reducing complexity while increasing scalability. Users will be able to interact with and retrieve their data via the web based customer portal.

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Teledyne Brown Engineering:

Teledyne Brown Engineering (TBE) offers unsurpassed expertise in the entire payload operations and integration process. The company has proudly supported NASA's efforts for over 30 years in areas ranging from payload concept development through hardware fabrication, physical and analytical integration and software development. TBE has also provided well over 100,000 continuous hours of real-time science operations support to the International Space Station community since NASA's Payload Operations Integration Center became operational in February 2001.

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Tec Masters:

Tec-Masters, Inc. (TMI) has 20 years' experience designing, developing, prototyping, assembling, integrating and operating flight hardware for NASA. TMI has developed and supported scientific investigations, high temperature materials processing, and control avionics payloads flown aboard the Shuttle and the International Space Station (ISS). TMI also supports ongoing flight operations of the Microgravity Science Glovebox (MSG) facility aboard the ISS including systems engineering, payload integration/verification, thermal and structural analyses

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Techshot:

For nearly 30 years, Techshot has been developing complex payloads for microgravity research professionals. Our devices have flown aboard parabolic-flight aircraft, sub-orbital rockets, space shuttles, the SpaceX Cargo Dragon and currently are aboard the International Space Station. From experiment design to hardware development to crew training and mission support, Techshot is your one-stop spaceflight integration/implementation partner.

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ZIN Technologies:

ZIN Technologies, Inc. is an experienced AS 9100 implementation partner that can provide advanced engineering services, systems design, and test and evaluation services; support safety testing and certification; and complete ISS payload development and integrations services. ZIN's in-house mechanical manufacturing facility can produce concept, breadboard, prototype, and ground/flight hardware. ZIN technicians are certified based on NASA standards for cabling, soldering, staking components, and conformal coating. ZIN manages the CIR, ACME, BASS, CVB, OASIS, and CSLM experiments.

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ISS National Lab Facilities for Combustion and Thermal Transport Research

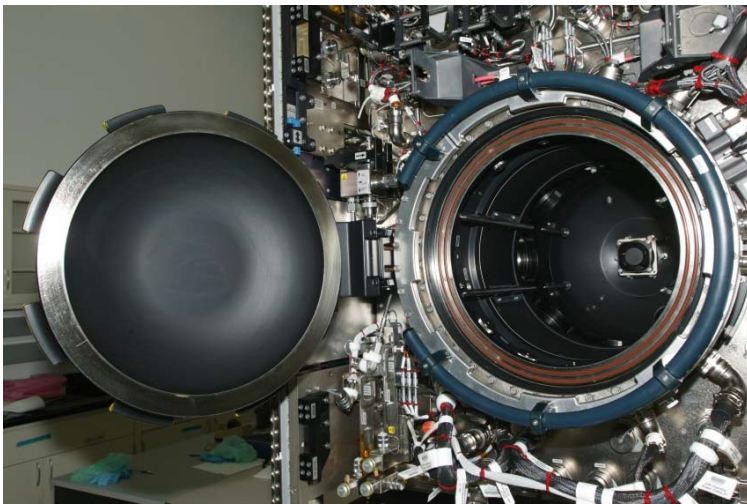
(Images courtesy of NASA)

Combustion Integrated Rack (CIR)

The CIR is an ISS facility specifically designed to support the investigation of combustion physics with unique capabilities that extend the range of potential investigations to additional research areas. The facility features a large 105-liter combustion chamber that provides containment of up to 5 atmospheres. The Test Chamber is supported with an array of facility provided diagnostic cameras, a collimated laser illumination source, analog and digital I/O lines. The facility also provides ISS nitrogen and optional gases from replaceable pressurized gas bottles.

- Internal 100 Mbps LAN
- ISS High Rate, Medium Rate, Video D/L and Command uplink

<https://spaceflight systems.grc.nasa.gov/sopo/i hho/psrp/fcf/cir/>



CIR Combustion Chamber

Advanced Combustion via Microgravity Experiments (ACME)

ACME is the first gaseous combustion project planned to operate in the Fluids & Combustion Facility (FCF) Combustion Integrated Rack (CIR). This hardware can assist in research that helps improve understanding of materials flammability, combustion at lean fuel conditions where both optimum performance and low emissions can be achieved, flame stability and extinction limits, soot control and reduction, oxygen-enriched combustion which could enable practical carbon sequestration and the use of electric fields for combustion control.

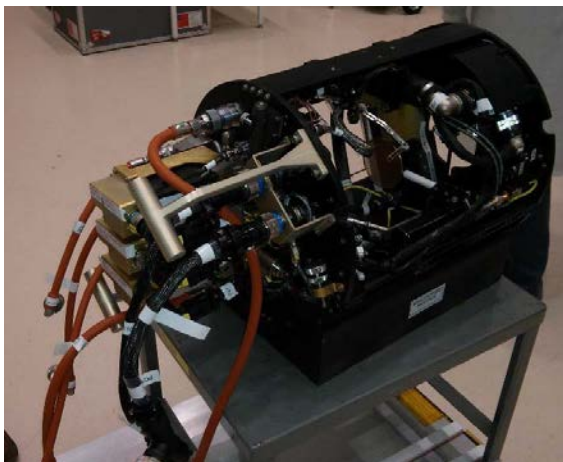
<https://spaceflight systems.grc.nasa.gov/sopo/i hho/psrp/fcf/fcf-investigations/acme/>

The Main System Diagnostics Include:

- Macro-Observation
- Color Cameras
- Hi-Bit Multi-Spectrum Camera
- Low Light Level UV Camera
- White Light LED Illumination
- Radiative Emissions
- Photomultiplier Tubes
- Chamber pressure measurements
- Chamber temperature measurements
- Flame temperature measurement
- Thermocouples
- Thin filament pyrometry
- All data downlinked using CIR facility

Applications:

- Study Materials Flammability Characteristics
- Improve Combustion Performance
- Reduction of Soot Emission



ACME Unit Chamber Insert

Burning and Suppression of Solids (BASS) Hardware

This hardware is capable of supporting the burning of solid fuel samples such as waxes, fabrics, and plastics of various sizes and shapes. The samples are mounted to a holder within the flow duct by the crew. The samples are ignited via a hot wire igniter of various designs including those embedded into the sample. The airflow through the flow duct is controllable up to approximately 40 cm/s. Hardware is capable of burning gases such as pentane, methane, and propane. The gas flow rate is controllable up to 500 sccm. A video camera provides an edge view of the sample along with telemetry including air and gas flow rates. A Nikon D300 camera provides a top view of the sample. This camera is capable of being programmed to acquire a set of images or video. The crew can also control the acquisition of images.

<https://spaceflight systems.grc.nasa.gov/sopo/i hho/psrp/msg/bass/>

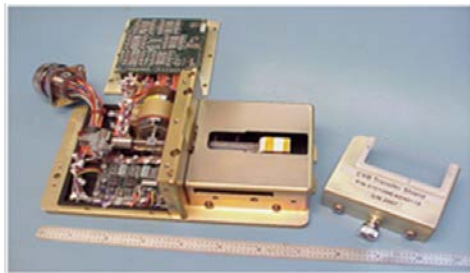


BASS Hardware Unit

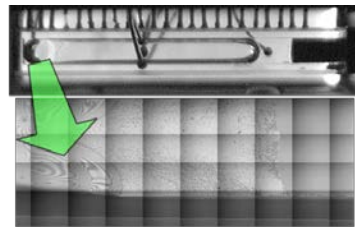
Constrained Vapor Bubble (CVB)

The CVB hardware consists of a suite of two remote controlled modules operated in the Light Microscopy Module on the ISS. The CVB has a quartz cuvette that is heated and cooled to simulate a fin heat pipe in microgravity. CVB-2 was designed to determine the overall stability of a complex (~94% Pentane/ 6% Iso-Hexane) fluid, the fluid flow characteristics, the average heat transfer coefficient in the evaporator, and heat conductance of the constrained vapor bubble, under microgravity conditions, as a function of vapor volume and heat flow rate. CVB-1 was pure (99.5 pentane). A new experiment could choose to employ other fluid compositions. CVB-1 with pure Pentane demonstrated that the wickless design operates at higher temperatures (more efficient in microgravity) than on earth. Mixed fluids expand the options to optimize wickless heat pipes.

<http://spaceflightsystems.grc.nasa.gov/SOPO/ICHO/IRP/FCF/Investigations/LMM/CVB/>



CVB 30mm module



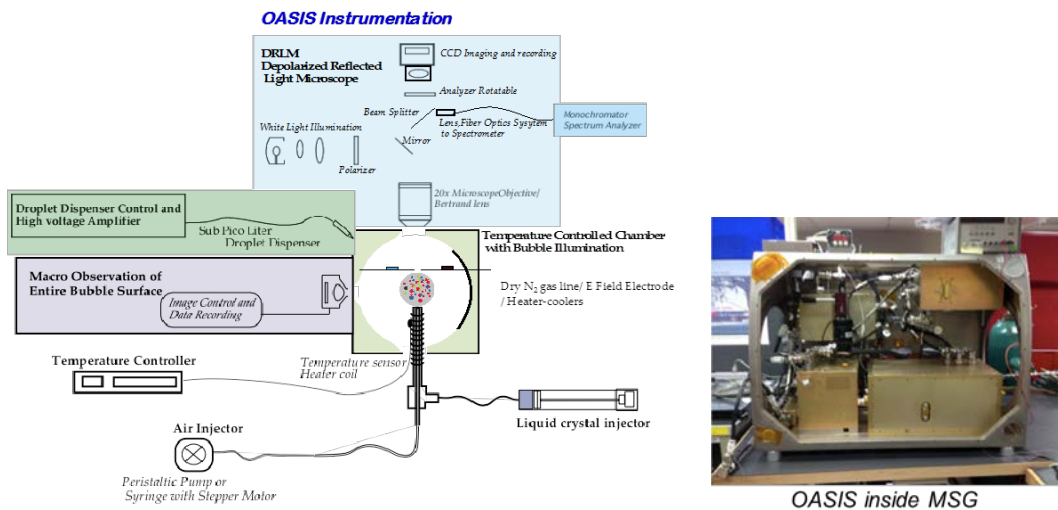
CVB operations are implemented by imaging the cuvette at different temperature gradients And stitching the images in post processing. 10X and 50X images reveal scientific characteristics of the fluid.

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The Observation and Analysis of Smectic Islands in Space (OASIS)

The OASIS system was developed to study structures and dynamics of freely suspended liquid crystals and other colloidal materials. Major components include temperature controlled liquid crystal (any other colloidal materials) deployment chamber, color macro video system, color video microscope to study detail structures of sample materials, spectrometer for spectrum analysis to verify layer thickness of the sample, and 5 sets of exchangeable 2 Terabyte hard drives for video and data storage. The sample chamber is preferentially designed to study very thin liquid crystal bubble films. The chamber is under a temperature-controlled environment, variable intensity sample illumination system, controlled air jet needle system (up to 150 sccm), pico liter liquid droplet dispensing system, a 1 mm gap electrode for 2 KHz AC and DC Electric field up to 90 V, 1 mm gap, and temperature field gradients up to 50 °C for thermocapillary studies. As OASIS was designed as an integrated component system, the sample chamber can be modified easily to study bulk 3D colloidal suspensions.

<http://spaceflightsystems.grc.nasa.gov/SOPO/ICHO/IRP/MSG/OASIS/>

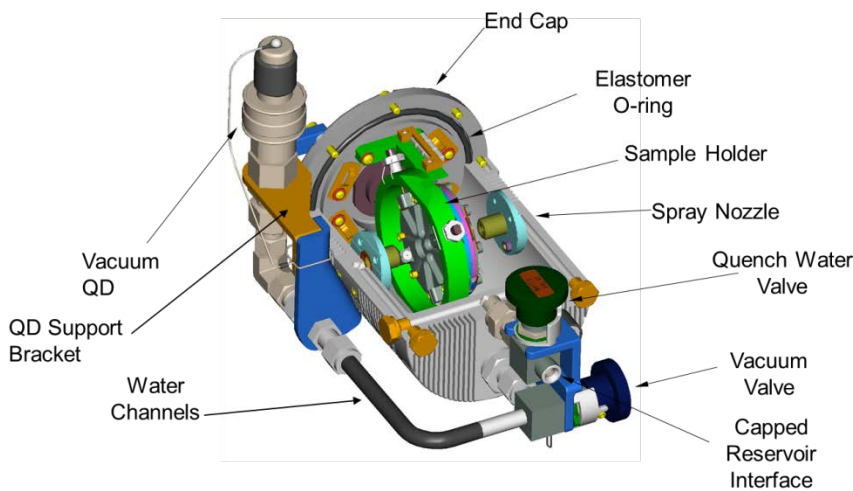


Coarsening in Solid Liquid Mixtures (CSLM) Experiment

CSLM can be used to process low melting point alloys and other systems that sinter at low temperatures. This could include (unpressurized) sintering and compaction of polymeric materials as well as metals. CSLM can also be used as a small chemical reactor for many systems that react safely at these temperatures. It has fast quenching capabilities as well.

Heating System: Two disc resistance heaters and one ring resistance heater are utilized to evenly heat the samples to a desired temperature (e.g. 185°C). Four RTDs are installed in the Sample Holder to accurately measure the temperature of the samples. An over-temperature thermistor is mounted on the Sample Holder so that power can be cut to the heaters if the temperature exceeds the threshold.

<https://spaceflight systems.grc.nasa.gov/sopo/i hho/psrp/msg/cslm-2-cslm-2r/>

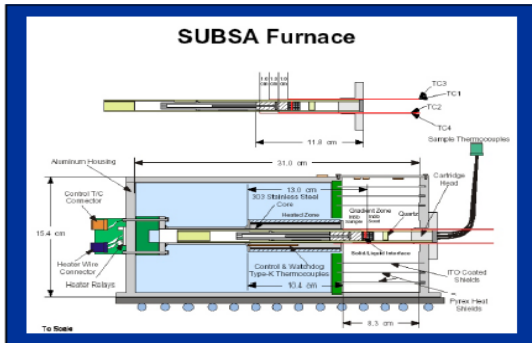


CSLM Hardware Design

Solidification Using a Baffle in Sealed Ampoules (SUBSA) Furnace

The SUBSA furnace can be used for semiconductor crystal growth, and consequently, will allow reaching temperatures approaching 800°C. Investigators can send commands to the experimental unit, changing temperatures, melt times, and other factors that affect processing of the sample. The 'baffle' in SUBSA allows additional control and suppression of the melt motions near the growing crystal-melt interface, beyond that accessible by reduced gravity alone.

<https://www.nasa.gov/centers/marshall/news/background/facts/SUBSA.html>



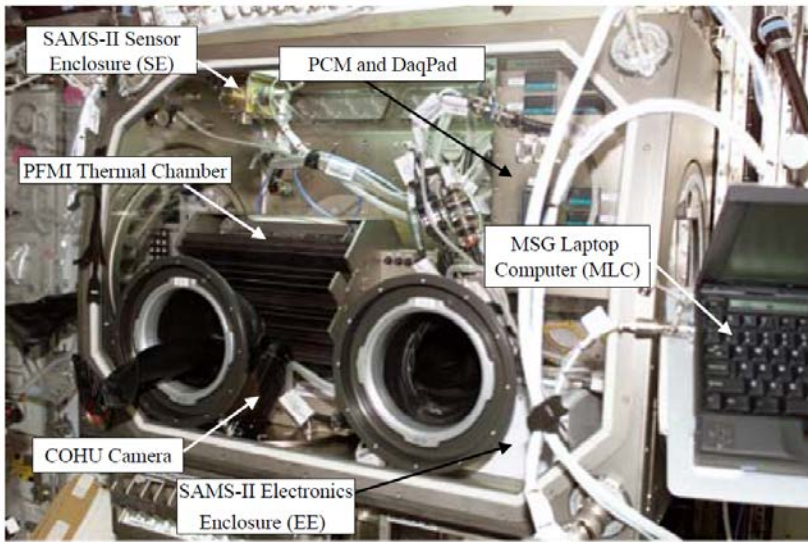
SUBSA Furnace Capabilities

- Type Of Processing: Gradient Freeze
- Minimum Cooldown Rate: 0.5°C/min
- Thermal Gradient: Up to 110°C/cm depending on sample material and configuration
- Gradient Zone Length: 8 cm
- Maximum Sample OD: 12mm
- Maximum Sample Length 30 cm
- Sample Processed Length: Up to 13 cm depending on sample material and configuration
- Max Temperature: 850°C
- Heater Stability Control: +/- 0.15°C
- Ampoule Dimensions: OD 16mm, Length 30 cm
- Sample Instrumentation: Up to 4 Type K Thermocouples
- Temperature Data Recording Rate: up to 1/sec
- Video: S Video with one camera view of the gradient zone, Recording rate 30fps, Zoom 22:1
- Commanding: Remote commanding capability of all processing parameters as well as camera zoom and focus

Pore Formation and Mobility Investigation (PFMI) Furnace

The maximum temperature of PFMI is limited (130°C), so the range of melts that could be accommodated by new investigators is limited to low-melting point systems. PFMI could be of use for projects involving bubble/drop dynamics associated with a moving solid interfaces.

<https://www.nasa.gov/centers/marshall/news/background/facts/PFMI.html>



PFMI Furnace Capabilities & Critical Performance	
Type of Processing	Bridgman
*Max Thermal Gradient	up to 110°C/cm
Transparent Gradient Zone Length	2.5 cm to 0.5 cm selectable
Max. Sample Outside Diameter	10 mm
Max. Sample Length	23 cm
*Max. Sample Process Length	12 cm
Max. Heater Temperature	130°C
Cold Zone Min. Temperature	5°C
Heater Stability	+/- 1°C
Translation Velocity	0.5 micrometers/sec to 100 micrometers/sec
Translation Stability	+/- 5%
Sample Ampoule Dimensions	OD 12.75 mm, Length 28 cm
Sample Instrumentation	up to 6 Type K Thermocouples inside the ampoule
Temperature Data Recording Rate	up to 1/sec
Video	S video record rate 30fps, zoom
Commanding	Remote commanding of heater/cold zone temp. & camera zoom/focus
* Depends on sample material & configuration	