



NASA Conditioned Stowage Capability

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NASA Managed Cold Stowage Resources

- Cold Stowage Fleet
 - Mixed fleet of active and passive systems to maximize mission flexibility and redundancy
 - Temperature range available for Payloads is +48°C to -130°C.
 - All systems are compatible with Shuttle and ISS and some systems are compatible with Progress, HTV, SpaceX CRS and Orbital Cargo CEV (ascent only).
- Active Systems
 - Minus Eighty Laboratory Freezer for ISS (MELFI)
 - Glacier
 - Microgravity Experiment Research Locker/INcubator (MERLIN)
- Passive Systems
 - Cold Stowage Insulated Sample Bag (Double Coldbag)
 - Ice Bricks and Icepac Assemblies

IPs: Usage of NASA Cold Stowage hardware must be negotiated with the OZ Office under a separate barter agreement.

NOTE: ISS Payload Cold Stowage Info can also be found at: <http://iss-www.jsc.nasa.gov/nwo/payload/oz2/web/ColdStow.shtml>



Active Freezers/Refrigerators



**Glacier
(Double MDL)**

MELFI



**MERLIN
(Single MDL)**

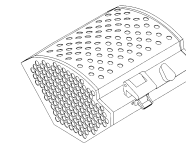
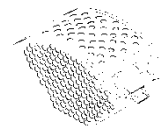




MELFI Rack

MELFI – On-orbit cooling and low temperature science storage facility.

- MELFI complement
 - Three Flight Units on orbit
 - Flight Unit 1 (JEM) powered on
 - Flight Unit 2 (US Lab) powered on
 - Flight Unit 3 (JEM) not powered
 - One Training Unit, one Laboratory Ground Model, & one Engineering Unit
 - ❖ Ground units are all located at JSC.
- Each MELFI has four identical dewars which can be controlled independently at certain set points (as long as Dewar 2 is at -95°C). The three set points for dewar temperatures are -95°C , -35°C , and $+2^{\circ}\text{C}$. One MELFI can hold 175 liters.
 - Dewars are divided longitudinally into four quadrants, each of which holds a long tray. Trays contain $\frac{1}{4}$ and $\frac{1}{2}$ box modules which hold individual science samples. Eventually all will have $\frac{1}{2}$ box modules.



- MELFI Power off hold time: MELFI can maintain temperature below (-68°C) with power off duration of 8 hours



MELFI Box Modules

MELFI Exterior Dimensions * (approximate)

Code ->	a	b	c	d	e	f	g	
Internal Volume (L)	Max Width (cm)	Min Width (cm)	Max Width (cm)	Min Width (cm)	Length/Depth (cm)	Door Width (cm)	Door Length (cm)	Max per tray
Tray	24	7.6	14.5	10	57.5			
1/2 Box Module	5.79	22	7.5	14.3	10.5	27	18.5	26
1/4 Box Module	2.67	22	7.5	14.3	10.5	13	18.5	11.9

* Wall is approximately 1 mm in thickness



Glacier

Glacier – On-orbit low temperature science storage facility, as well as cold stowage transportation to and from orbit.

- Glacier complement
 - Six Flight Units
 - Two additional Flight Units to be built to support extension of ISS (2011)
 - One Engineering Unit
- Active ascent/ descent in Shuttle Middeck, SpaceX CRS and Cargo CEV. Passive ascent in ATV, HTV and Shuttle MPLM.
- Glacier supports a selectable temperature range of +4°C to -130°C
 - Middeck (36 cfm) or EXPRESS (30 cfm) air cooling mode minimum temperature: -95°C
 - EXPRESS water cooling mode (50 lbs/hr) minimum temperature: -130°C
 - Maximum cooling rate 1°C/min to -130°C
- Glacier is a double Middeck locker equivalent in size



Glacier

- For Glacier in the forward Middeck position, Glacier can accommodate **6.22 kg** (13.72 lbs) of total payload mass.
- For Glacier in the aft Middeck position, Glacier can accommodate **4.82 kg** (10.62 lbs) of total payload mass.
- For Glacier in SpaceX Dragon, Glacier can accommodate a minimum of **6.22 kg** of total payload mass. The exact payload mass will be determined after the Dragon loads have been defined.
- Glacier can accommodate a payload as large as 23.1 cm x 16.6 cm x 7.4 cm. (2.84 liters)
 - This is the internal dimension of a GLACIER tray
 - There are four GLACIER trays (effective total volume of all trays is 11.35 liters)
- Power off hold time: Glacier can maintain samples below -68°C for ~ 20 hrs., if it has been operating at -160°C and is 75% full volume. If operating at -95°C, the samples will reach -68°C in ~6 hours, with 75% full volume in Glacier.



GLACIER

- Active Glacier – Ascent (Middeck, COTS vehicles)
 - Launched at cold temperatures with samples installed prior to turn over
 - Payload delivery for late installation at Pad is L-3 days (Middeck) if science is cold conditioned.
 - Payload delivery for late installation at Pad is L-4 days if science is NOT cold conditioned
 - Requires power during transport to pad (supplied by KSC provided ground battery unit)
 - Power interrupts needs to be limited to no more than 30 minutes during ground installation to prevent temperature warm up at or below + 6°C.
 - Turnover times for COTS vehicles is TBD, but could range from L-4 to L-1 days.

- Active Glacier – Descent (Middeck or Dragon)
 - Early destow (science specific – typically R+6 hours for Middeck operations)
 - Requires power during transport from landing strip to the lab (supplied by ground battery unit)
 - De-integration in off-line laboratory
 - Early destow for Dragon vehicle is TBD

- Two Glaciers are planned to be on ISS after the Shuttle Program has completed.



MERLIN

MERLIN – On-orbit low temperature and incubation science storage facility, as well as cold/incubation stowage transportation to/from orbit.

- MERLIN complement
 - Seven Flight Units owned by University of Alabama
 - One Qualification/Trainer unit
- Active ascent/descent in Shuttle Middeck. Passive ascent in ATV and Shuttle MPLM.
- MERLIN supports the following temperature ranges
 - Approximately +4°C to +48.5°C in air cooling mode (Middeck). (Air cooling operations may be colder based on payload configuration.)
 - Approximately -20°C to + 48.5°C in water cooling mode (EXPRESS).
 - Maximum heating rate 15°C/min to +48.5°C (MERLIN) (payload specific)
- MERLIN can support **10 kg** of experiment samples (13 kg if c.g. is ideal)
- MERLIN supports a maximum payload size of **7.62 cm x 17.53 cm x 31.24 cm (4.17 liters)**
 - Maximum dimensions based on payload inside of MERLIN pouch
 - Dimensions reflects 1” of foam on the inside walls of the pouch
- MERLIN is a Middeck Locker Replacement
 - 70 lb max weight for integrated configuration (includes internal items and 4.0 lb VPMP)



MERLIN

- Active MERLIN - Shuttle Ascent – (utilizes Middeck AAA interface via VPMP)
 - Launched at cold or warm temperatures with samples installed prior to turn over
 - **Payload delivery for late installation at Pad is L-3 days if science is cold conditioned**
 - **Payload delivery for late installation at Pad is L-4 days if science is NOT cold conditioned**
 - Requires power during transport to pad (supplied by ground battery unit)
 - Power interrupts need to be limited to no more than 5 minutes during ground installation when operating temperatures are above or below ambient temperatures by more than 10°C. This will prevent temperature drift away from the desired set point.
- Active MERLIN - Shuttle descent - (utilizes Middeck AAA interface via VPMP)
 - Early destow (science specific – typically R+6 hours for Middeck operations)
 - Requires power during transport from the pad (supplied by ground battery unit)
 - De-integration in off-line laboratory
- MERLIN launched as a Shuttle sortie on 13A.1 supporting SPEGIS.
- MERLIN launched on flight 1J/A supporting the WAICO payload for descent.
- MERLIN was launched on ULF-2 where it serves as a refrigerator/freezer system for crew food and drink storage in the Galley.
- MERLIN launched on 19A supporting JAXA NeuroRad for ascent and other JAXA payloads for descent.



Passive Cold Stowage Resources



Double Coldbag



Icepac assemblies



Ice Brick assembly



Coldbag

Coldbag – Passive low temperature science storage resource for transportation to/from orbit.

- Coldbag complement consists of
 - 14 Double Coldbags
 - Ice Bricks/Icepacs to provide cold conditioning for Coldbag contents.
- Temperature hold time depends on Ice Brick type & quantity, sample requirements, and environment. (For return - minimum 5.3 to 6 days).
- Double Coldbag
 - One Middeck locker insert in size and weighs 8.2 kg
 - Ice Brick Configuration
 - Supports samples up to **9.53 cm x 22.86 cm x 33.02 cm** in size. (cavity inside 14 Ice Brick configuration) – **7.2 liters**
 - Supports **5.0 kg** of contents including 14 (-32C) Ice Brick assemblies.
 - Max mass with phase change materials (PCMs) and samples – 24.4 kg.
 - Compatible with Shuttle Middeck, MPLM, ISS, Progress, and loaded tested for ATV, HTV and future vehicles.
- Coldbag - ascent
 - Coldbags need to be stowed in early retrieval locations. It can be stowed in a locker or soft stowed. If soft stowed, heavy items must not be stowed on top of the Coldbag.
 - Late loaded at the Pad if containing cold samples
 - Samples and Phase Change Material installed prior to turnover
- Coldbag - Descent
 - Early destow if returning cold samples
 - De-integration in off-line laboratory



Ice Brick Assemblies

Ice Brick – Solid-liquid phase change material in a hard plastic rectangular container compatible with the cold stowage systems

- Ice Bricks provide cold conditioning for Coldbag and are designed to be re-freezable on-orbit in active freezers (e.g. MELFI, Glacier, MERLIN).
- Ice Bricks are available in specific melting temperatures: +4°C, -26°C, -32°C, and other temperatures are under investigation.
 - Temperature hold time depends on Ice Brick type & quantity, sample requirements, and environment.
 - Each type is a different color.
 - ~14 Bricks required per Double Cold Bag
- Two Ice Bricks are incorporated into a sleeve which bends in the middle.
- Each Ice Brick assembly weighs between 0.71 – 0.80 kgs. and has a volume of 1.31 liters.
- Cold Stowage Team will determine the Ice Brick configuration based on mission requirements.



Icepac Assemblies

Icepac – Solid-liquid phase change material in a hard plastic capsule compatible with the cold stowage systems

- Icepacs are being phased out in favor of Ice Bricks
- Icepacs provide cold conditioning for Coldbag and are designed to be re-freezable on-orbit in active freezers (e.g. MELFI, Glacier, MERLIN).
- Icepacs are available in specific melting temperatures: +4°C, 0°C, -32°C and others.
 - Temperature hold time depends on Icepac type & quantity, sample requirements, and environment (typically 4 – 10 days). Each type is a different color.
- Icepacs are incorporated into a belt assembly of eight identical Icepac types.
- Each Icepac assembly weighs between 0.97 - 1.29 kgs. and has a volume of 1.9 liters.
- Engineering/EC2 will determine the Icepac configuration based on mission requirements.



Cold Stowage Team

- Cold Stowage (CS) Responsibilities
 - Provide Engineering oversight for hardware development and operations.
 - Deliver CS hardware to KSC for flight and perform off-line operations.
 - Support Cold Stowage hardware and cold stowage operations on-orbit.
 - Integrated Cold Stowage Performance analysis
 - Compatibility Analysis for Safety
- Cold Stowage Partners
 - NASA JSC
 - OZ Payloads Office
 - EC Thermal System and Engineering Support
 - Contractors
 - Jacobs Engineering (Engineering Science Contract)
 - University of Alabama Center for Biophysical Science and Engineering



Cold Stowage Services Available to Payloads

- On-orbit operation of MELFI, MERLIN, Glacier systems for contained payloads in full coordination with MSFC POIC.
- Cold sample launch is supported at the launch location.
- Cold sample return is supported at the landing location, including back-up landing sites.
- Testing in Cold Stowage Laboratory
 - Ability to conduct thermal cycle testing (i.e. acceptance thermal cycle, cryo-cycle, etc.) in the range of +93 C to -191 C.
 - Conduct thermal performance tests (e.g. determine how long will samples will stay cold in Double Coldbag or MELFI during a power off)
 - End-to-end/Science Verification testing duplicating planned on-orbit scenarios with CS Fleet
 - Load testing of samples in range +93°C to -150°C
- Crew Training
 - MELFI Cold Skills Training
 - Coldbag/Ice Brick Packing Training
 - MERLIN/Glacier Expert or User Training
- Engineering Evaluations
 - Full function Engineering Units of all systems including MELFI, Glacier, and MERLIN
 - Conduct fit checks and develop packing plans for Payloads utilizing Cold Stowage Fleet