ARC Cell Science Validation (CS-V) Payload Overview

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POIWG #41

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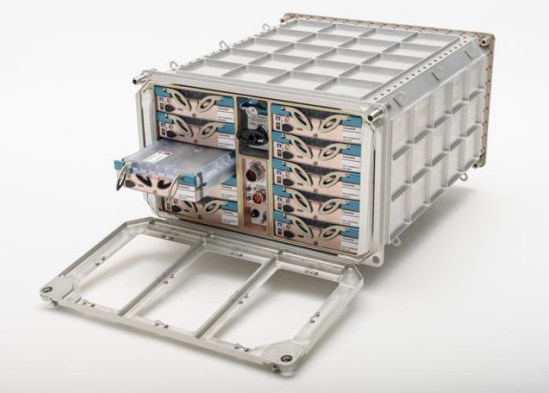
Description of the Bioculture System



- Automated cell biology system for laboratory and International Space Station (ISS) National Laboratory research.
- Enhanced cell culture platform that provides undisturbed culture maintenance, including feedback temperature control, medical grade gas supply, perfusion nutrient delivery and removal of waste, and automated experiment manipulations.
- Programmable manipulations include: media feeds/change out, injections, fraction collections, fixation, flow rate, and temperature modification within a one-piece sterile barrier flow path.
- Cassette provides 3 levels of containment and allows Crew access to the bioculture chamber and flow path assembly for experiment initiation, refurbishment, or sample retrieval and preservation.

CS-V Goal and Objectives

Goal: Validate the performance of the Bioculture System in the space flight environment on ISS.

Objective 1: Biology. The Bioculture System maintains viable cell cultures to the experiment requirements and preserves cells for post-flight analyses. Biology will use human Cardiomyocytes (four cassettes) and mouse MLO-Y4 osteocyte-like cells (four Cassettes) to validate culture maintenance hardware. The biology will be characterized and analyzed post-flight by examining cell morphology, quality of the cell conditioned medium, RNA quantity and quality, and gene expression.

Objective 2: Engineering. The Bioculture System operates as an automated incubator system for cellular and microbiological ISS research with capabilities to provide selectable environmental conditions. Engineering will have two dedicated Cassettes to conduct testing of the environmental and fluid subsystems.

Objective 3: Operations. The Bioculture System enables on-orbit crew operations for routine maintenance and experiment-specific tasks. Operations will evaluate crew procedures and on-orbit timelines, data handling, and ground commanding.

CS-V Timeline

Ship soft stow items to JSC

Turnover media stowage and sump stowage bags for change out on Orbit

Turnover late load items (Powered Bioculture System)*

Transfer Bioculture System from Dragon to EXPRESS*

Transfer soft stow items

8 Cassettes change-out of media and sump in MSG and stowage in MELFI

4 Bioreactors and 4 Sample Bags will be removed at Berth +12 to 14 d, and put in Cold Stowage; Gas Supply Assembly Change Out

No activities planned

Transfer Bioculture System from EXPRESS to Dragon*

Transfer cold and soft stow items

Early retrieval of powered Bioculture System and cold stow items*

Retrieval of soft stow items at JSC

L-9 w

L-3 d

L-24 h

SpX-13 Launch

Dragon Berth

Berth +24 to 48 h

Berth +3 to 5 d

Berth +9 to14 d

Berth +15 d

Berth +21 d

Return – 1 d

24 h prior to hatch close

Dragon Splashdown

On Dock

Return +1 d

*** Best effort for no more than 15 minutes powered off during transfers**

- Asynchronous ground controls: 8 to 10 day delay for ground controls at ARC

Operations Flight Overview

Manifested for SpX-13 Launch (Nov 2017) and SpX-13 Return (increment 53/54)

Powered internal payload, operational for full mission duration

Payload Integration Agreement (PIA) Letter (signed) contains the following unique agreements:

- Late load of L-24 hours or later (request for L-18 hours)
- 150 W powered on Dragon (2 locker spaces) - Power interruption of no more than 15 minutes at any time
- Early retrieval of continuously powered Bioculture System and cold stow samples at Recovery dock - Live cells returning in the Bioculture System
- Soft stowed items returned at JSC

Pre-flight specimen and hardware processing in the KSC SSPF

Post-flight science recovery at ARC laboratory

Use of ISS facilities:

- ExPRESS Rack
- Microgravity Science Glovebox (MSG)
- MELFI (and Cold Stowage on Dragon – GLACIER or DCB)
- Wetlab Items (gloves, wipes, absorbent pads)

PIA (#1 through #4)

#1: Requires early retrieval of the samples (returned in cold stowage) and the powered Bioculture System locker at Long Beach, CA for transport to the Science Lab at Ames Research Center in Moffett Field, CA

#2: Late load of L-24 hours for powered locker. The Bioculture System must be mounted on the Dragon's hatch.

#3: Powered locker required for: pre-launch, launch, on-orbit, return, and post-landing. Request to keep power interruptions to < 15 minutes.

#4: On-orbit use of Microgravity Science Glovebox (MSG) for operations on cassette(s): remove samples and bioreactors and replace media bags.

PIA (#5 through #8)

#5: On-orbit use of Wet Lab Kit: sterile wipes, gloves, absorbent pads.

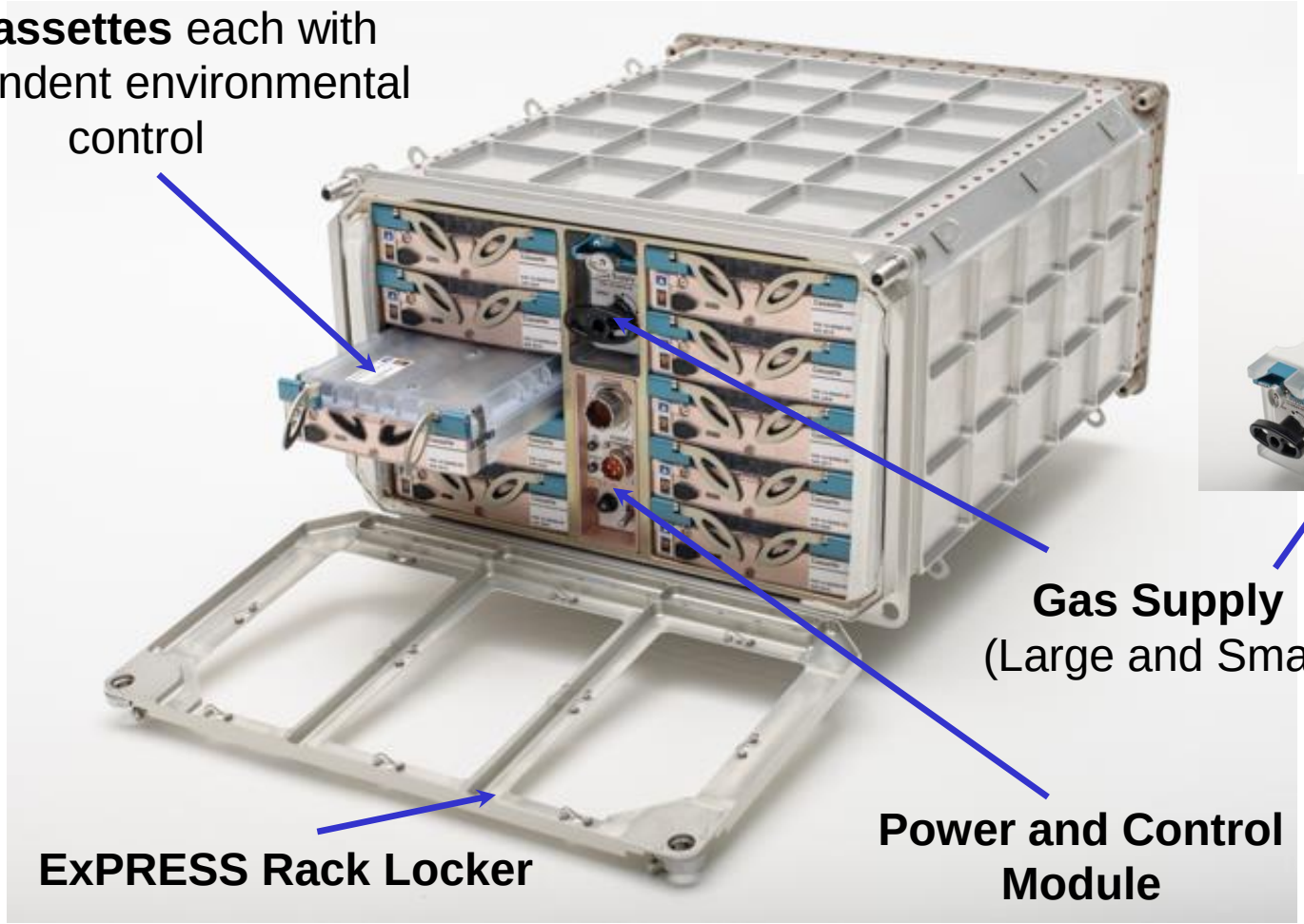
#6: Use of 3 labs at KSC Space Station Processing Facility (SSPF): 2 for Engineering, 1 for Science.

#7: The Bioculture System requires 150 W power for ascent and descent.

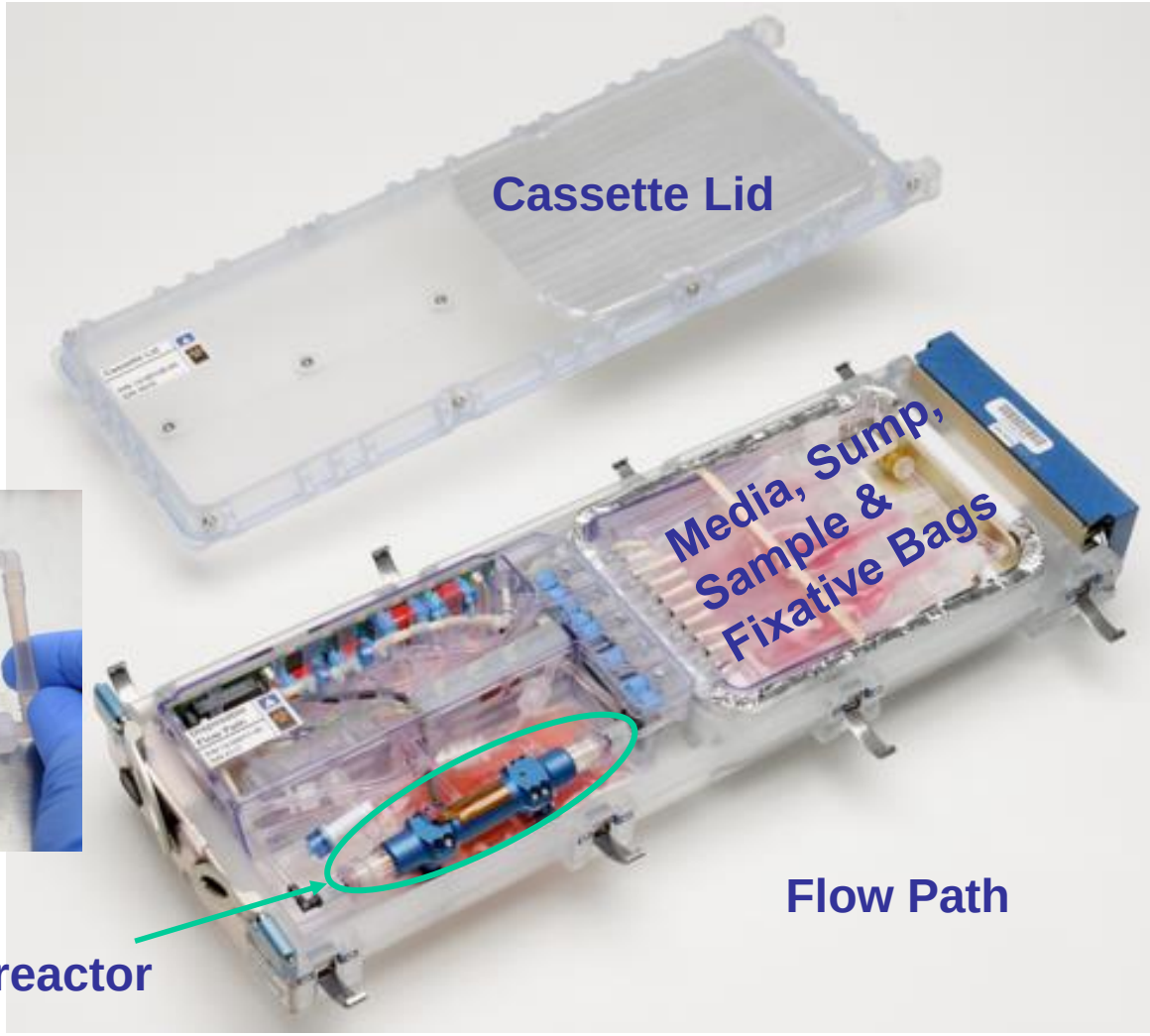
#8: The Bioculture System requires the standard health and status data provided by SpaceX along with the following non-standard data (post-flight only): cabin temperature, cabin total pressure, cabin relative humidity, cabin ppCO2 content, cabin ppO2 content.

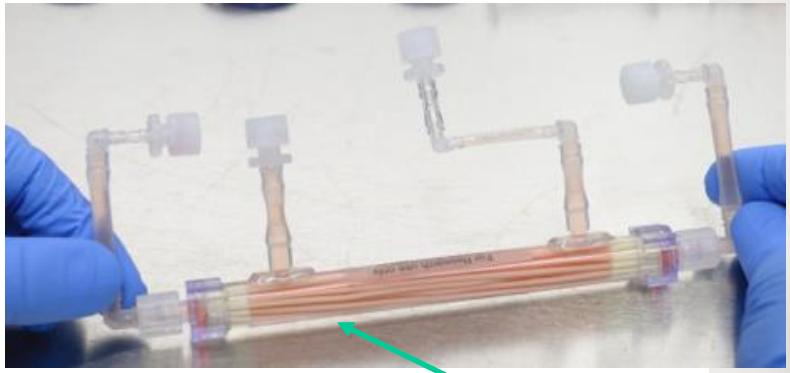
Bioculture System

10 **Cassettes** each with independent environmental control



Cassette with Flow Path





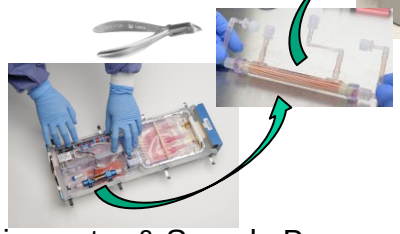
Bioreactor

CS-V On-Orbit Crew Ops

Transfer Ambient & Cold Stow items to ISS

MSG Set Up
*Assumption - leave MSG setup through bioreactor removal & last bag change-out

Bioreactors cut from Flow Path and placed in Bioreactor Container, Sample Bags Removed. Cassette & Flow Path return to Bioculture System. Bioreactor Container & Sample Bags to Cold Stowage



Transfer ambient & cold stow items to Dragon (no earlier than 24 hr before hatch close)

Berth

btwn FD 1-2

btwn FD 7-9

FD 9

FD 14

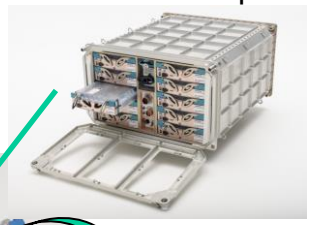
Bioreactor & Sample Bag Removal (MLO-Y4) in MSG

FD TBD

Undock

Transfer Powered Bioculture System to ExPRESS Rack

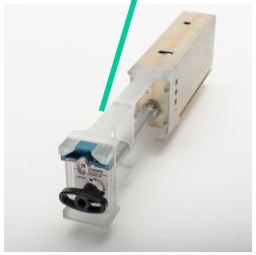
Bag Change Out of MLO-Y4 Media in MSG & MSG Clean Up



Bag change-out of iCardiomyocytes media in MSG & MGS clean up

Gas Supply Change Out

New Bags taken from Cold Stowage, used Bags returned to Cold Stowage



Retrieve full gas supply from CTB and replace with empty gas supply

Transfer powered Bioculture System to Dragon (as close to hatch close as possible)

Operational Support Hardware (OSH)

Ascent

Soft Stow:
- Bioreactor Container
- Waste Bag
- Wipes Kit (for use in MSG)
- Tube Cutter
- O-rings (for use in MSG)
- Replacement Gas Supply Assembly
- CO2 canister

Cold Stow:
- Media Stowage Bags
- Sump Stowage Bags

OpNom are still under development

Return

Soft Stow:
- Waste Bag
- Wipes Kit (for use in MSG)
- Tube Cutter
- O-rings (for use in MSG)
- Original Gas Supply Assembly
- CO2 canister

Cold Stow: -20 °C or colder
- Bioreactor Container
- Bioreactors
- Media Stowage bags
- Sump Stowage Bags
- Sample Bags

Cold Stowage Overview

Launch – L-3 Turn Over

- Media Stowage Bag A
  - 4 Media Bags for MLYO4 Cells
- Media Stowage Bag B
  - 4 Media Bags for iCardiomyocyte Cells

On-Orbit Usage

- Removed on FD 9
  - Media Stowage Bag A
- Added on FD 9
  - Return Bag A
    - 4 Used Sump Bags & 4 Used Media Bags
- Removed on FD 14
  - Media Stowage Bag B
- Added on FD 9
  - Return Bag B
    - 4 Used Sump Bags & 4 Used Media Bags
  - 1 Bioreactor Container:
    - 4 Bioreactors
    - 4 Sample Bags

Return at Dock

- Return Bag A
  - 4 Used Sump Bags & 4 Used Media Bags
- Return Bag B
  - 4 Used Sump Bags & 4 Used Media Bags
- 1 Bioreactor Container:
  - 4 Bioreactors
  - 4 Sample Bags

* Pending OpNom Approval

Thank you!

Mission Support team: Please join our splinter session