WetLab-2
Wet Lab RNA SmartCycler
Providing PCR Capability on ISS

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WetLab-2 Objectives

• To place on the ISS as a research platform to facilitate space biology gene expression research.
  – Capability to process samples and perform qRT-PCR

• Facility will support multiple sample types (bacteria, cells, tissue)

• The analyzer will remain on ISS, while the experiment-specific disposable hardware will launch with the experiments.

• Also capable of supporting analysis of air, surface, water, and crew health.

• Validation Flight: SpaceX-7

• First PI Flight planned for SpaceX-9
Benefits of Wetlab-2 as an ISS Resource

• Wetlab-2 will provide on-orbit gene expression analysis data resulting in the following advantages
  – On-orbit analysis has the potential to reduce the need for downmass
  – Researchers can receive results within 24 hours of experiment run
  – On-orbit analysis is especially useful in cases where fixation or freezing of samples is problematic
  – On-orbit data can be used to guide the experiment in real-time
    • Provide indicators of best time to fix or otherwise conclude experiment
    • Allow researcher to change details (timeline, etc.) of future run without need for sample return, ground analysis and re-flight
  – System can be used to provide verification of results from ground analysis

• Facility can also be used for microbial monitoring
  – Will indicate if harmful bacteria are present in water supply, surfaces, etc.
  – Results would be available in as little as 90 min compared to current testing methods that take 3-6 months because they require sample return
ISS qRT-PCR Process

Animal Samples from Dissections or Cold Stowage

Cell culture or Microbial cultures

Sample Prep

Tissue Disruption

qRT-PCR

RNA

Stabilized RNA

Descent

ISS Operations/Data Management

ARC Data Verification/Archive

Science Stakeholder/Researcher

Examples:
• BIOS System (Ames)
• CGBA Science Inserts (BioServe)
• Biomodule (Bioserve)
• CellCult (BioServe)
• ADF Cell (TechShot)
• ESA or JAXA Experiment Container
• Future Culture Hardware
Fluidics Components

- Sample Transfer Tool (STT)
  - Extracts sample from a source
  - Delivers sample to SPM
- Sample Prep Module (SPM)
  - Two versions (mammalian, bacterial)
  - Lyses cells and extracts RNA
- Reaction Assembly Module (RAM)
  - Removes bubbles from RNA sample
  - Loads Repeater pipette
- ReactionTube Assembly
  - Custom cap/septum for loading in microgravity
  - Mounted on 8-tube rotor
- Reaction Tube Loading Rotor
  - Contains 8 tubes – serves as tube carrier
  - Serves to spin sample into window
SmartCycler Hardware

- Provides Quantitative Real-time Polymerase Chain Reaction (qRT-PCR)
- Ruggedized COTS instrument designed for field work
- Provides 16 Wells and multiplexing capability (4 channels/well)
- Will be mounted on Bogun Arm on rack front in the aisle
Fluidics Hardware Operations

Tissue Syringe
Mammalian Cells
(Session 4)

Bacterial Cells
(Session 3)
ACT2

Validation
(Session 2)
Buffer Syringe

RNA Syringe

SPM (2 versions)

Repeater Pipette

Reaction Tube

Rotor

SmartCycler
COTS On-Orbit Interface

OCAMS Used for Uplink/Downlink Data

Pantry Laptop

SmartCycler (15A Fuse)

Disposable Glove Bag

ISS Inverter (12A Fuse)

To Rack 120 VDC
Use of WetLab-2 on ISS

• The Decadal Survey calls for conducting science experimentation on-orbit in a fashion as similar as possible to that of ground laboratories, allowing for rapid/real-time on-orbit data acquisition and interactivity with experiments driven by analysis results.

• The WetLab-2 project provides multiple capabilities for processing and analyzing biological tissue samples through qPCR to provide gene expression data.

• Sample preparation was designed specifically to minimize complexity and crew time with RNA purified in under an hour.

• Real-Time PCR machine selected for flight is a robust COTS unit that was designed for field work.

• WetLab-2 begins the process for PIs and ISS crews to utilize ISS as a fully working laboratory.
**Validation Flight – SpaceX-7**

**Goal of Validation Flight:** On-orbit test and check-out of the WetLab-2 system in a systematic way to ensure it will return valid data to future researchers

Objectives of Validation Flight:
- Install software and set-up hardware (Session 1)
- Does real-time PCR data generated on-orbit match data on earth? (Session 2)
  - No convection or other microgravity related issues
  - Validate SmartCycler, RAM, tube loading and rotor functions
- Does the Sample Processing Module function correctly on-orbit? (Session 3)
  - All fluidic manipulations function properly
  - Prove out system with first sample type (*E. coli*)
  - Test system using on-orbit isolated RNA as input to SmartCycler
- Does the Homogenizer unit function correctly on-orbit? (Session 4)
  - All fluidic manipulations function properly
  - Prove out system with second sample type

Flight results from each session will be compared to results from ground controls

Ground controls will be run with a 2-24 hour delay from the flight samples
WetLab-2 will:

- Facilitate space biology gene expression research
  - Establishes a qRT-PCR analytical instrument on the ISS.
  - Provides a Standard Transfer System for sampling among Wetlab-2 and other bioprocessing & analytical systems (Techshot ACT2)
- Reduce need for downmass of samples due to on-orbit analysis
- Allow PIs and ISS crews to begin to utilize the ISS as a fully working laboratory
- Allow for on-orbit analysis of air, surface, water, and clinical samples to monitor environmental contaminants and crew health.

Effort to assess awarded proposals for those that can benefit from the WetLab-2 facilities is ongoing. More than 50% of proposals plan to use gene expression as part of their research.