National Aeronautics and Space Administration

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

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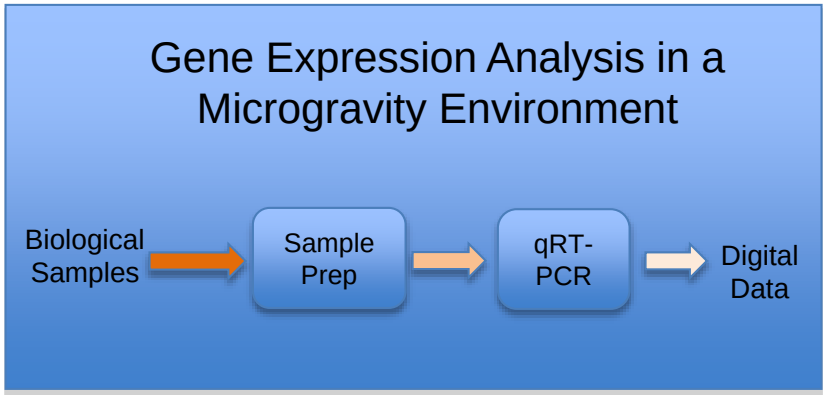
WetLab-2 Objectives

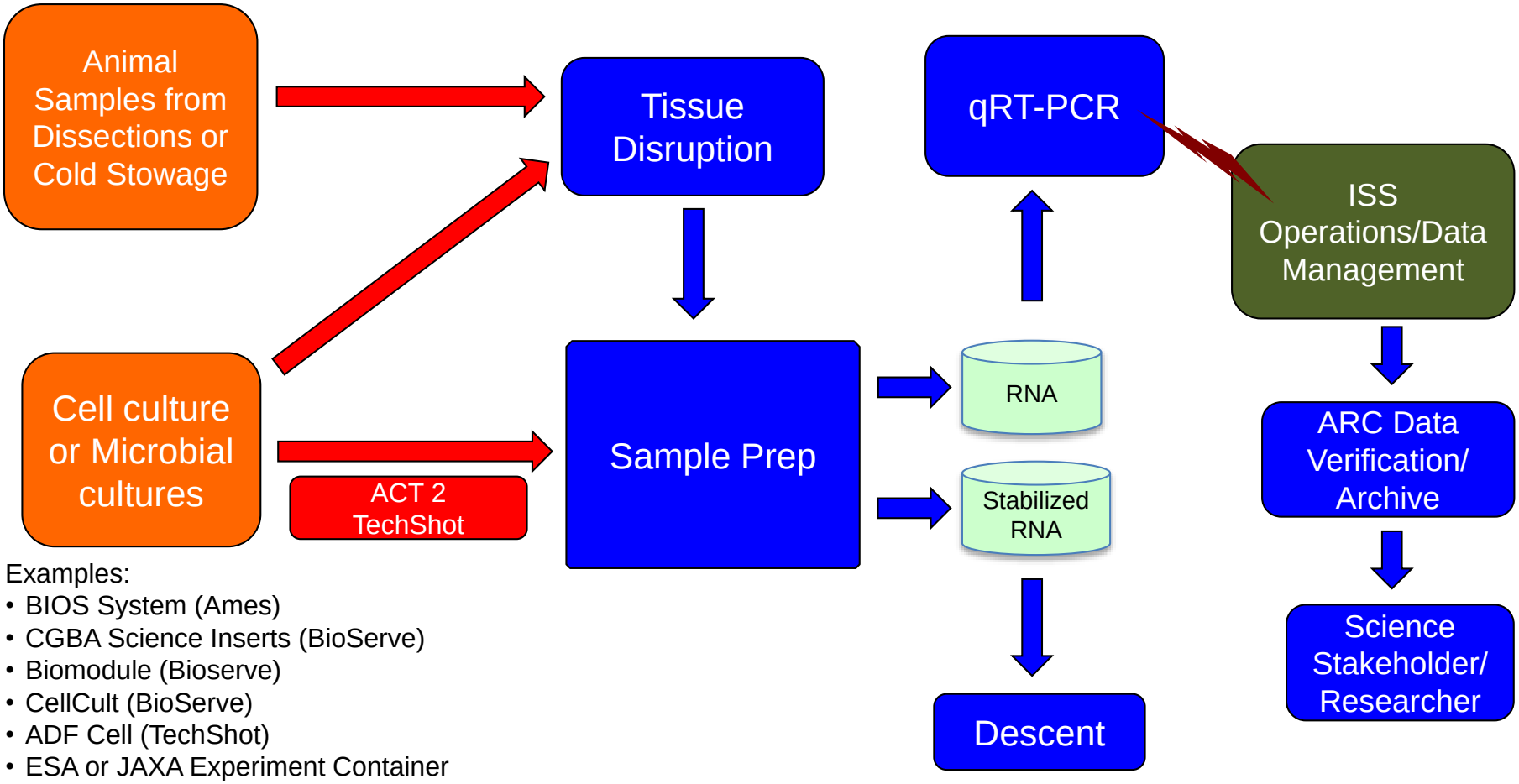
- To place on the ISS as a research platform to facilitate space biology gene expression research.
  - Capability to process samples and perform qRT-PCR
- Facility will support multiple sample types (bacteria, cells, tissue)
- The analyzer will remain on ISS, while the experiment-specific disposable 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

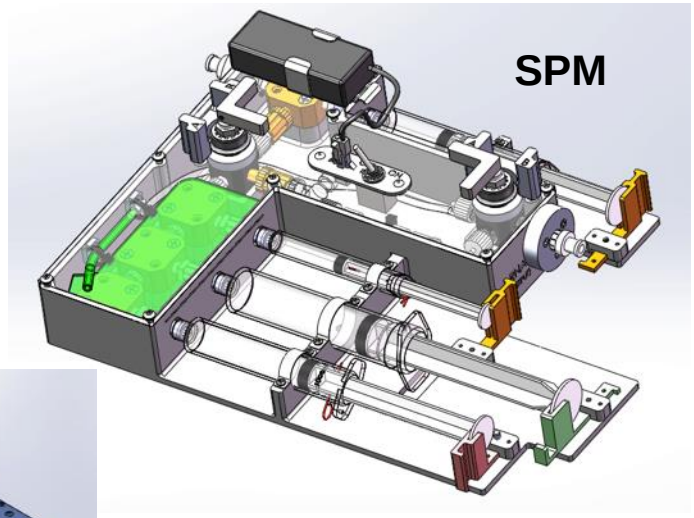


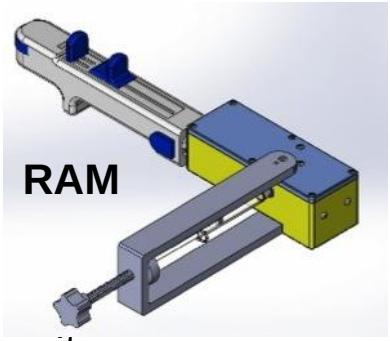
Examples:

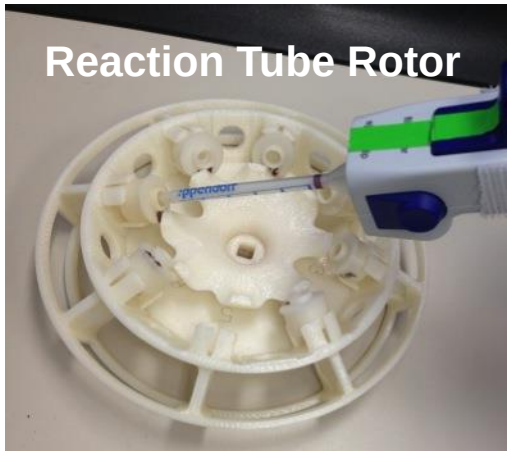
- BIOS System (Ames)
- CGBA Science Inserts (BioServe)
- Biomodule (Bioserve)
- CellCult (BioServe)
- ADF Cell (TechShot)
- ESA or JAXA Experiment Container
- Future Culture Hardware

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

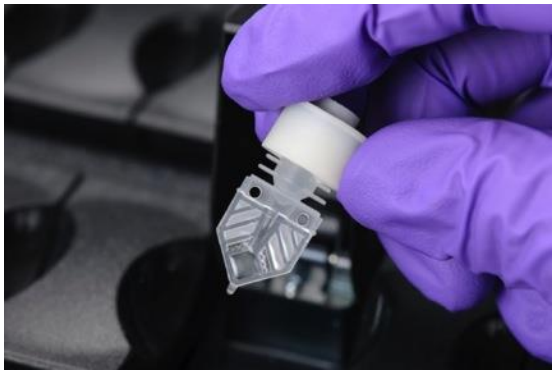




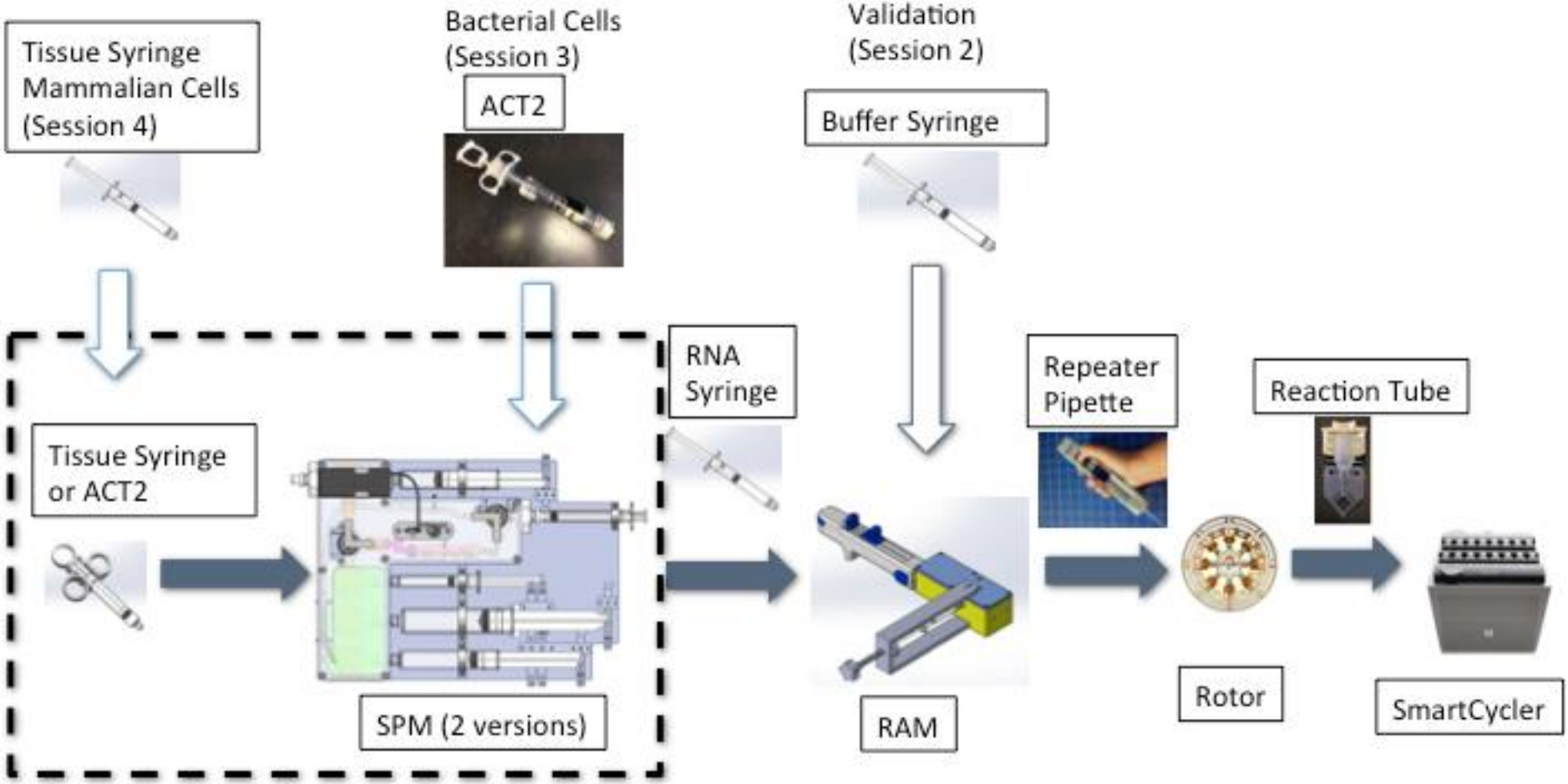


SmartCycler Hardware

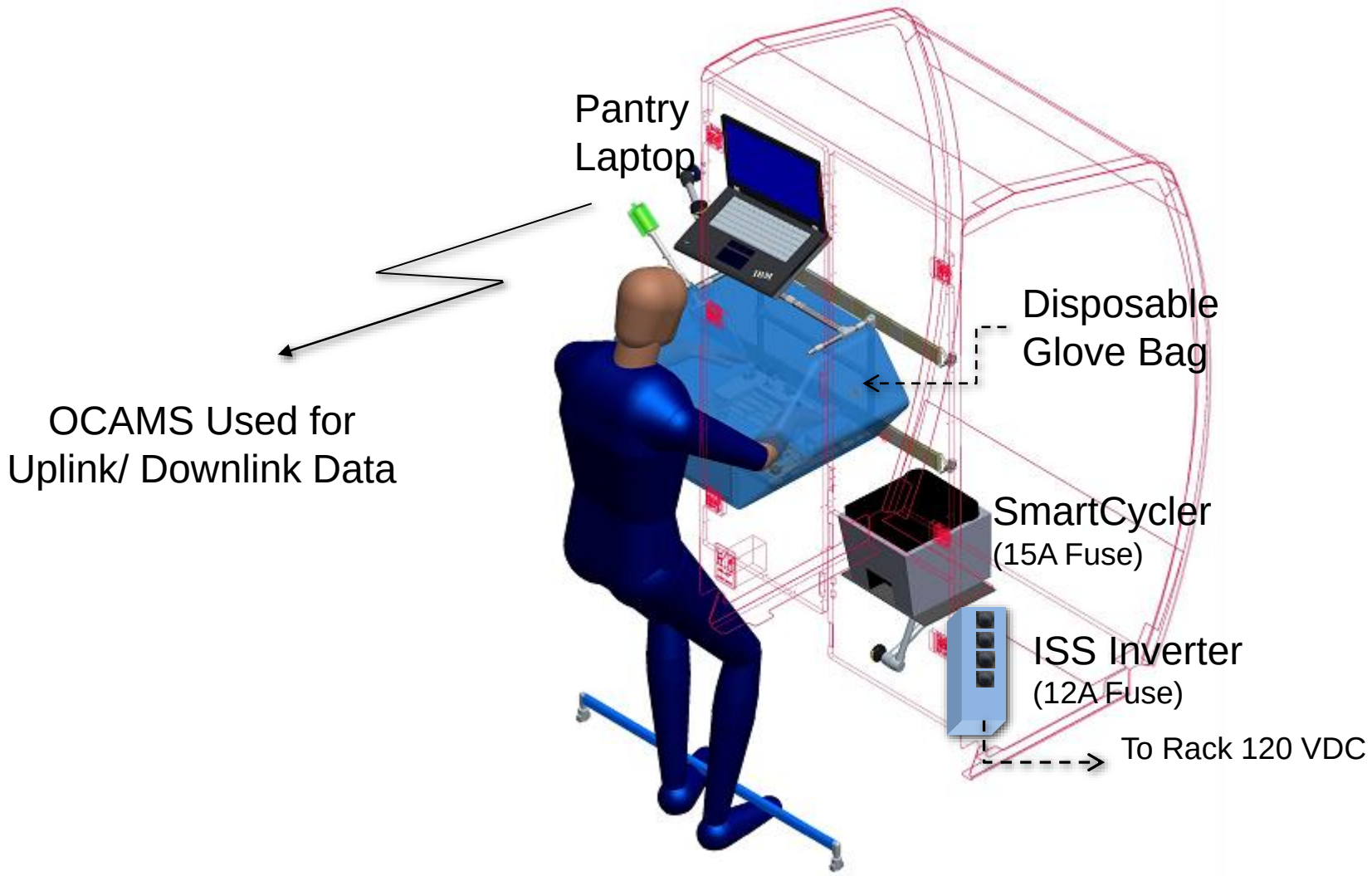
- Provides Quantitative Real-time Polymerase Chain Reaction (qRT-PCR)
- Ruggedized COTS instrument designed for field work
- Provides 16 Wells and multiplexing capability (4 channels/well)
- Will be mounted on Bogun Arm on rack front in the aisle



Fluidics Hardware Operations



COTS On-Orbit Interface



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

Conclusion

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.