ARC EMCS Experiments (Seedling Growth-2) Experiment Status

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POIWG #37

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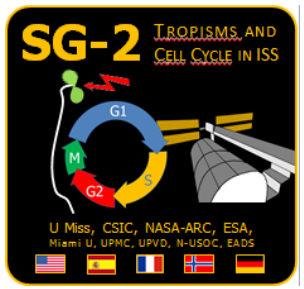


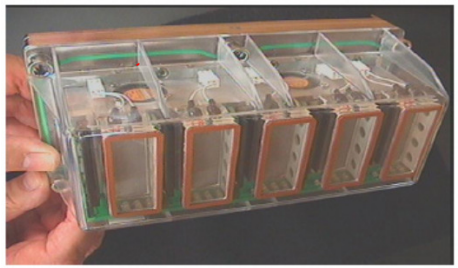
Experiment Hardware

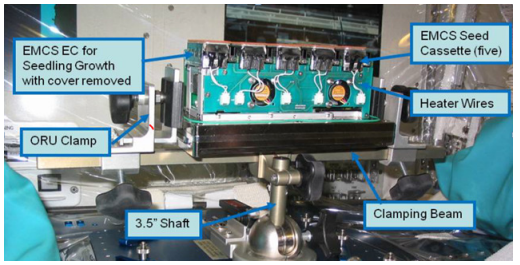
All the ARC ISS Space Biology Project EMCS Experiments use the same hardware suite.

- Proven ***highly successful*** starting with the Tropi series of experiments in 2006.

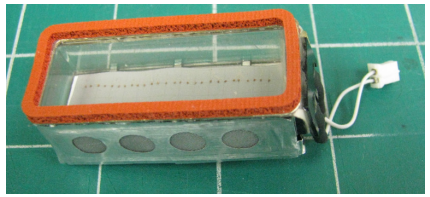
EMCS Facility

EMCS Experiment Containers (ECs) MWA set up for Sample Processing with ARC-developed EUE





ARC Cassettes (5 per EC)



EMCS Cold Stowage Bag with Cassettes

The Seedling Growth Experiments

BACKGROUND

The Seedling Growth experiment series is the result of a cooperative agreement between NASA and ESA to combine the proposals of a NASA PI and an ESA PI to maximize science return.

- NASA PI: Dr. John Kiss.
  - Emphasis on plant tropic responses using EMCS Image Data.
- ESA PI: Dr. Javier Medina.
  - Emphasis on structure and biochemistry using frozen samples.

Three Seedling Growth experiments are SG-1, SG-2 and SG-3.

- SG-1 NASA-led. (complete)
- SG-2 NASA/ESA 50/50. (RT Ops complete, on orbit awaiting SpX-5 return)
- SG-3 ESA-led. (in development, manifested Inc 45/46)

Seedling Growth-2

ARC EXPERIMENT PERSONNEL

Principal Investigators:	**John Z. Kiss, Ph.D., University of Mississippi, MS (NASA)** **F. Javier Medina, Ph.D., CIB-CSIC, Madrid, Spain (ESA)**	
Project Manager	**Marianne Steele, Ph.D.** **(650) 604-0523**	***Marianne.K.Steele@nasa.gov***
Deputy Project Manager/ **Operations Lead**	**Dave Heathcote, Ph.D.** **(650) 604-1303**	***David.G.Heathcote@nasa.gov***
Project Scientist	**Gwo-Shing Sun, Ph.D.** **(650) 604-3343**	***Gwo-Shing.Sun-1@nasa.gov***
Payload Scientist	**John Freeman, Ph.D.**	***jfreeman@intrinsyx.com***
NASA POC	**Elizabeth Pane.** **(650) 604-5053**	***elizabeth.pane@nasa.gov***

Seedling Growth-2

N-USOC Team Members

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Tore Martin Hauan
Irene Karoliussen
Basit Mohammad

EADS/Astrium Team Members

Maria Birlem (SG-2 EMCS PIM)
Reinhard Born

MSFC POIC SUPPORT

Amy Haas (SG-1 & 2 PIM)
Kevin Hargrave (Ops Lead)
Chris Traylor (PARC)
Entire POIC Cadre

Seedling Growth-2

EXPERIMENT SUMMARY

The objective of the Seedling Growth-2 experiment is to determine how gravity and light responses in plants influence each other and to determine the combined influences of light and gravity on plant development through the identification of changes in the mechanisms and regulation of essential cellular functions. These experiments rely in a large part on the use of known Arabidopsis thaliana mutant plants that are genetically altered in specific light-, auxin- or cell division- regulated processes

Launch:	SpaceX-4, Sept 21, 2014
Operations:	Increment 41/42
Return:	SpaceX-5 Feb TBD 2015

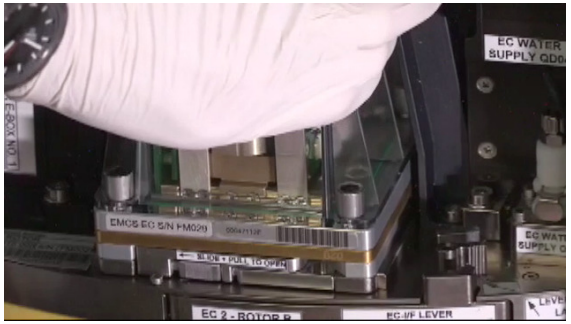
- Three 6-day runs were planned and completed:
  - Nov 1-7 - Primarily supports Dr. Medina's objectives - at 0 and 1.0 g
    - Eight ECs, used both EMCS rotors.
    - One EC (FM-030) failed to hydrate
  - Nov 8-14 - Continuation of Dr Kiss' SG-1 objectives - photo-stimulus given at 0.5 g
    - Four ECs, used 1 EMCS rotor only
  - Nov 15-21- Continuation of Dr Kiss' SG-1 objectives - photo-stimulus given at 0.8 g
    - Four ECs, used 1 EMCS rotor only

Seedling Growth-2

EXPERIMENT SUMMARY (Crew activities)

Although much of the operation of the EMCS is under the control of scripting software and ground commanding, crew involvement is required for EC loading into EMCS and during the end of run processing. CDR Butch Wilmore performed all these activities methodically and well, and holds the speed record for processing ECs on the MWA!!

EC insertion at start of run

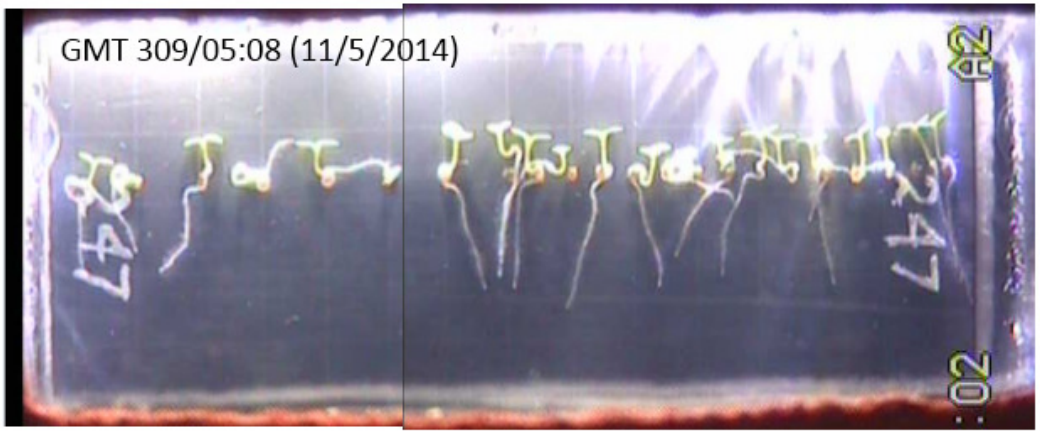


EC and Cassette processing on MWA at end of run

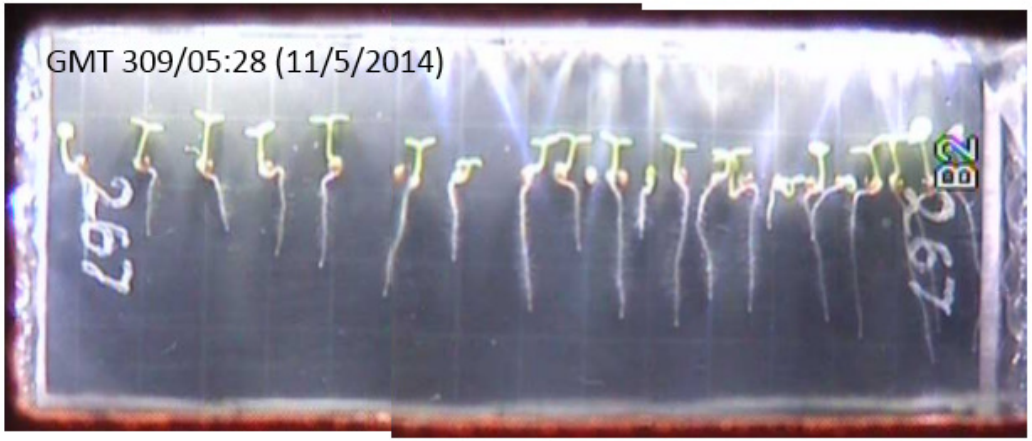
Seedling Growth-2 - Images

Images from Run 3 at 88 hours after hydration (Genotype tir 1)

Micro-g



1 g

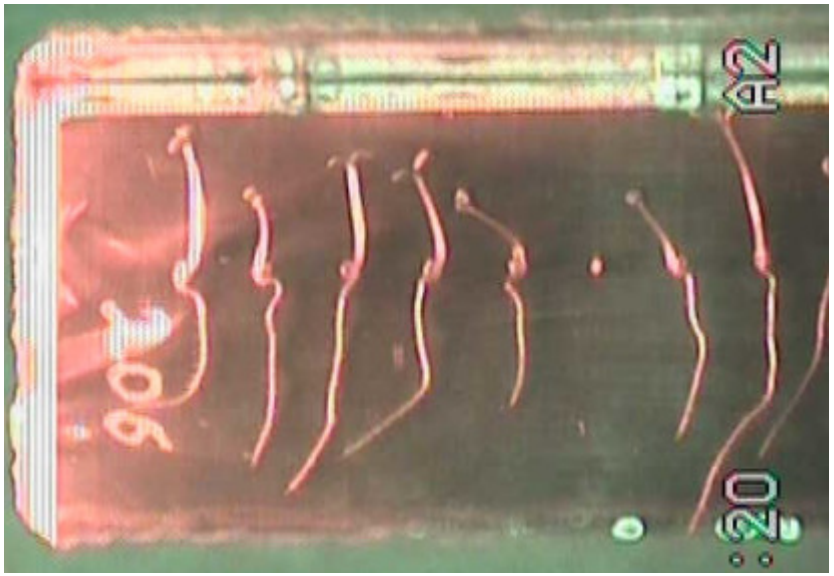


Some roots get a little "lost" in micro-g, shoots are oriented by the white light above

Seedling Growth-2 - Images

Older seedlings responding to a red light stimulus

Both roots and shoots are bending towards the red LED light source



Seedling Growth-2

EXPERIMENT SUMMARY

An additional activity was re-planned and executed to investigate the failed hydration of EC FM-030

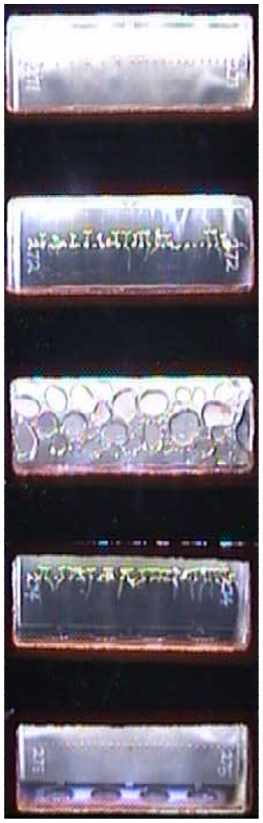
- An additional diagnostic test and 6-day run was completed:
  Only possible with intense re-planning of activities and co-operation with ESA and NASA Management, POIC, N-USOC, EADS Airbus, PIs, Science, Engineering and Operations teams.

  This was truly a team effort and provided additional science to the PI, and diagnostic data to engineering.

  Dec 9 - Engineering diagnostic and repeated hydration commands
  - Used FM-030 on Rotor A, Position A1. Reference ECs in other positions.
  - Partial success hydrating FM-030 (3 out of 5 cassettes hydrated)

  Dec 9-15 - 6-day run at 0g
  - Run at 0g as FM-030 not balanced by Reference EC in A3
  - Obtained additional images and biomass for PIs from 1 EC
  - No Image data obtained from cassette 3 (obscured by condensation - cassette heater malfunction suspected.)

FM-030



Seedling Growth-2

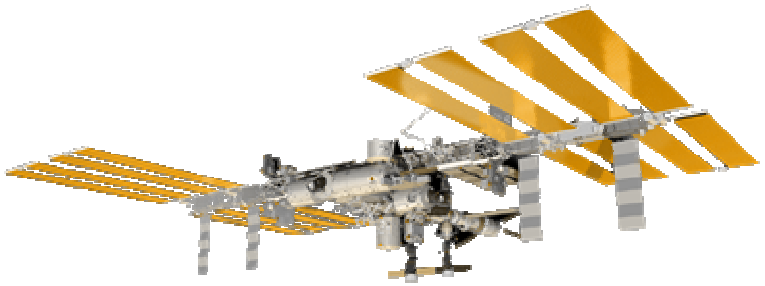
EXPERIMENT SUMMARY

- All four runs provided scientific return for the PIs
  - Images of seedling growth and tropic responses were captured for PI's analysis
  - Seed cassettes were removed from ECs and transferred to MELFI at the end of each run
  - Frozen samples and empty ECs are planned to return on SpX-5 (Feb 10 TBC, 2015)
    - Frozen samples return to S. California in GLACIER (or other powered CS resource)
    - ARC Representative will receive samples from JSC Cold Stowage Group at CA early access
    - Samples transferred to ARC Lab for stabilization procedure by PI representative.
    - After stabilization, ESA will arrange shipping logistics to PI lab in Spain for analysis.

- Both NASA and ESA PIs have expressed their great appreciation for the extra efforts of the entire team who made the successful performance of the Seedling Growth-2 payload possible, and provided the flexibility of planning to react to the hydration failure, providing additional science samples that will enhance the return.

Acronyms

ARC	Ames Research Center
ASAP	As Soon as Possible
EADS	European Aeronautic Defense & Space Company
EC	Experiment Container
EMCS	European Modular Cultivation System
ESA	European Space Agency
EUE	Experiment Unique Equipment
EVT	Experiment Verification Test
ExAM	Experiment Activity Manager (N-USOC)
FTP	File Transfer Protocol
GLACIER	General Laboratory Active Cryogenic ISS Experiment Refrigerator
IPLAT	ISS Payload Label Approval Team
ISS	International Space Station
JSC	Johnson Space Center
MELFI	Minus Eighty Laboratory Freezer for ISS
MMOC	Multi Mission Operations Center
MSFC	Marshall Space Flight Center
MWA	Maintenance Work Ared
NASA	National Aeronautics and Space Agency
NET	No Earlier Than
N-USOC	Norwegian User Support Operations Center
OVT	Operations Verification Test
PARC	Payload Activity Requirements Coordinator
PD	Payload Developer
PI	Principal Investigator
PIM	Payload Intergration Manager
POC	Point of Contact
SG-1	Seedling Growth-1 experiment
SpX	Space-X
TBC	To Be Confirmed
TBD	To Be Determined



Back-up Slides

The ARC Seed Cassette