CASIS-NSF-NIH Webinar

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Devin Ridgley, PhD
Project Scientist
dridgley@hnuphotonics.com
Company Background and Operations

• Headquartered in Hawaii, HNu Photonics, LLC, www.hnuphotonics.com is a science and technology company that prides itself in transforming innovative ideas into state-of-the-art technologies.

• The focus of the company is defense and space-based photonics and specialized optics, opto-mechanical design, medical imaging and microfluidics technologies, introducing disruptive advances in each of these areas since 2006.
SCORPIO-V SpaceLabs: Overview

- SCORPIO-V provides pay-for-use instrumentation and operational support for microgravity research on our automated SpaceLabs platforms for life, material and physical sciences.

- SCORPIO-V’s SpaceLab suite enables researchers to perform long-duration automated cell biology experiments with live-cell imaging on-board the International Space Station, as well as short-duration flights on suborbital rockets.
BioChip SpaceLab Overview

The BioChip SpaceLab (BCSL) is capable of:

- Maintaining live-cell cultures for days to weeks to months
- Automated microfluidic delivery of multiple media formulations, reagents, fluorescently labelled probes and/or preservatives
- Automated bright-field and/or fluorescence imaging of cells for the duration of the experiment
- On-orbit 1G controls reference control experiments (via centrifuge)
- Optional ground based BCSL facility to perform calibrations and control experiments

The SCORPIO-V team provides experiment design, customization and end-to-end support for BCSL users.
BioChip SpaceLab: Live-Cell Experimentation

Observe live-cell experiments in real-time from minutes to hours to days to weeks:

- Time-course brightfield and fluorescence imaging
- Flexible configuration with adjustable parameters
- Automated multiple reagent delivery
- RNA/DNA preservatives and fixatives for post-flight analysis

- Characterize cell growth and proliferation
- Gene expression, cell function, migration, morphology
- Adherent, Suspension and Organoid cell cultures

Neuroblastoma Cell Differentiation
Cardiomyocyte Contractions
Human Lung Carcinoma Cells: 3D organoid
Cancer Cell Growth
BioChip SpaceLab: Fluorescence Microscopy

- Time-lapse fluorescence microscopy makes it possible to characterize cellular processes and sub-cellular functions in real-time.
  - 7 laser excitation wavelengths and multiple dichroic and emission filters offer a wide array of fluorescent imaging capabilities
  - Magnification options include 4x, 10x, 20x, 40x

Cell Cycle

Cell Migration

Cell Morphology
BioChip SpaceLab: Protocol Flexibility

Experimental design protocols tailored to investigator’s specific research

- **BioChip:**
  - 1, 2 and 4 well configurations for volumes ranging between ~500 µL & ~5 mL
  - Hollow Fiber: Provides a low shear environment for sensitive cell lines and suspension cell cultures

- **Centrifuge:**
  - Simultaneous 1G (or variable 0.1G-2G) control experiment while on-orbit

- **Ground Based BioChip SpaceLab:**
  - Calibrate protocols and/or conduct ground control experiments with BCSL equipment

- **Live or frozen-cell launch or experiment initiated on-orbit**
# Summary of BioChip Configuration Offerings

<table>
<thead>
<tr>
<th>Hollow-fiber</th>
<th>Number of Wells</th>
<th>Appropriate for Adherent Cell Cultures*</th>
<th>Appropriate for Suspension Cell Cultures*</th>
<th>Appropriate for Organoid/Tissue Cell Cultures*</th>
<th>General Experiment Application*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>4</td>
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<td>No</td>
<td>Yes</td>
<td>-Omics, Imaging</td>
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</table>

* General BioChip usage suggestions to guide the researcher during experiment design. The final determination of BioChip configuration is up to the investigator regardless of cell culture or type of experiment.
## Cell Culture Launching Scenarios

<table>
<thead>
<tr>
<th></th>
<th>Live Cell Launch</th>
<th>Frozen BioChip Cell Launch</th>
<th>Experiment Initiated on Orbit, Adherent Cell</th>
<th>Experiment Initiated on Orbit, Suspension Cell</th>
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<tbody>
<tr>
<td><strong>Cell Stowage Temperature</strong></td>
<td>37°C</td>
<td>-80°C</td>
<td>-150°C</td>
<td>-150°C</td>
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<tr>
<td><strong>Time to Start Experiment</strong></td>
<td>&lt;5 days</td>
<td>1-3 months</td>
<td>&gt; 1 year</td>
<td>&gt; 1 year</td>
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<tr>
<td><strong>Pre-Launch Cell Culture Preparation</strong></td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>x</td>
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<tr>
<td><strong>Adherent Cells</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
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<tr>
<td><strong>Suspension Cells</strong></td>
<td>✓</td>
<td>✓</td>
<td>x</td>
<td>✓</td>
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<tr>
<td><strong>ISS Biochip Seeding</strong></td>
<td>x</td>
<td>x</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>ISS Cell Incubation</strong></td>
<td>x</td>
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<tr>
<td><strong>Centrifuge Prior to Exp.</strong></td>
<td>x</td>
<td>x</td>
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</table>
Mobile SpaceLab

- A crossover platform
- Fly on SpaceX or Orbital ATK ISS resupply missions
- Perform long-term (25-35 days) live-cell microgravity investigations
- Automated microfluidics and microscopy, environmental control, and multiple reagent delivery
- No need for crew operations

-First flight scheduled for Q2 or Q3 2018
Mobile SpaceLab: Operations Overview

- Sample preparations prior to launch
- Appropriate levels of containment
- Launch powered to maintain experiments
  - 37°C for the cell culture and 4°C for reagents
- Unpowered option possible in 2nd gen system
- Transfer to ISS, connect to ISS telemetry and power
- Transfer back to SpaceX’s Dragon Capsule for sample return and analysis
- No crew operations aside from facility transfer to and from the launch vehicles
- SCORPIO-V operational support before, during and after the flight

SpaceX’s Dragon Vehicle
Orbital ATK’s Cygnus Vehicle
Microscopy SpaceLab

- Versatile state-of-the-art microscopy platform
- Material, physical, life sciences, and on-demand clinical investigations
- Programmable high resolution time-course imaging options

Specifications:
- Magnifications Ranging from 2X to 100X
- Upright & Inverted Illumination modes
- Phase Contrast, DIC and Polarization
- Fluorescence Imaging (multiple wavelengths)
- Confocal Microscopy
- Multiple modes of 3-D Imaging and Analysis
Triple-Bandpass Fluorescence Microscopy

Triple Band Pass Filter for FITC/Texas Red/DAPI

• Actin (red)
• Myosin (green)
• DNA (blue)

Muscle, 60x lens
3-D Fluorescence Microscopy of Brain Cells, 20X Lens
Tomography: Single Brain Cell, 100 microns thick, 60X Lens
SCORPIO-V Microgravity Research Support

Customized Solutions for each payload may include:
- Hardware modifications to meet scientific requirements
- Modified sample containers
- Full NASA integration documentation
- Experiment calibration support and preparation
- Other customizations possible pending requirements

Please visit www.scorpiov.com for additional information on each facility and/or contact any of the Principal Contacts on the next page to discuss your research project(s).
Thank You!

Principal Contacts

Dan O’Connell
Chief Executive Officer
doconnell@hnuphotonics.com

Caitlin O’Connell-Rodwell, Ph.D
Director of Life Sciences
ccoconnell@hnuphotonics.com

Devlin Ridgley, Ph.D
Project Scientist
dridgley@hnuphotonics.com

Robert Will
Project Manager
rwill@hnuphotonics.com