

# CASIS™

The Center for the Advancement of Science in Space

*Manager of the International Space  
Station U.S. National Laboratory*

## NASA Advisory Council Commercial Space Opportunities

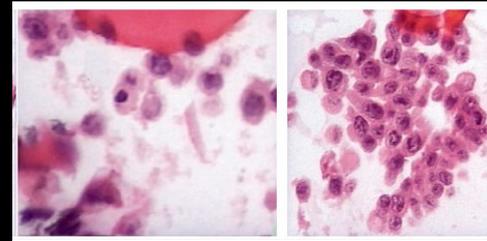
**Duane Ratliff, Chief Operating Officer**

30 July 2013

# THE NATIONAL LAB RESEARCH ENVIRONMENT

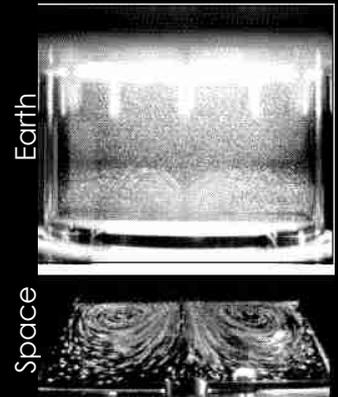


- ▲ Microgravity
- ▲ External Exposure
- ▲ LEO Observation Platform
- ▲ Technology Demonstration



Earth

Space

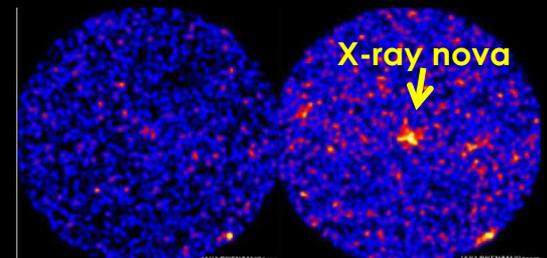
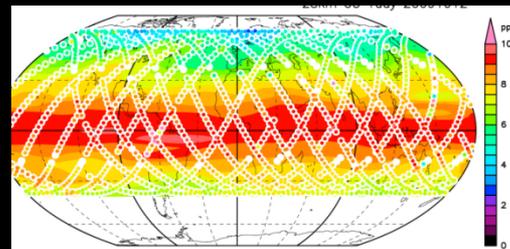


Earth

Space



*Research for Earth Benefit*



Oct 12, 2010

Oct 17, 2010

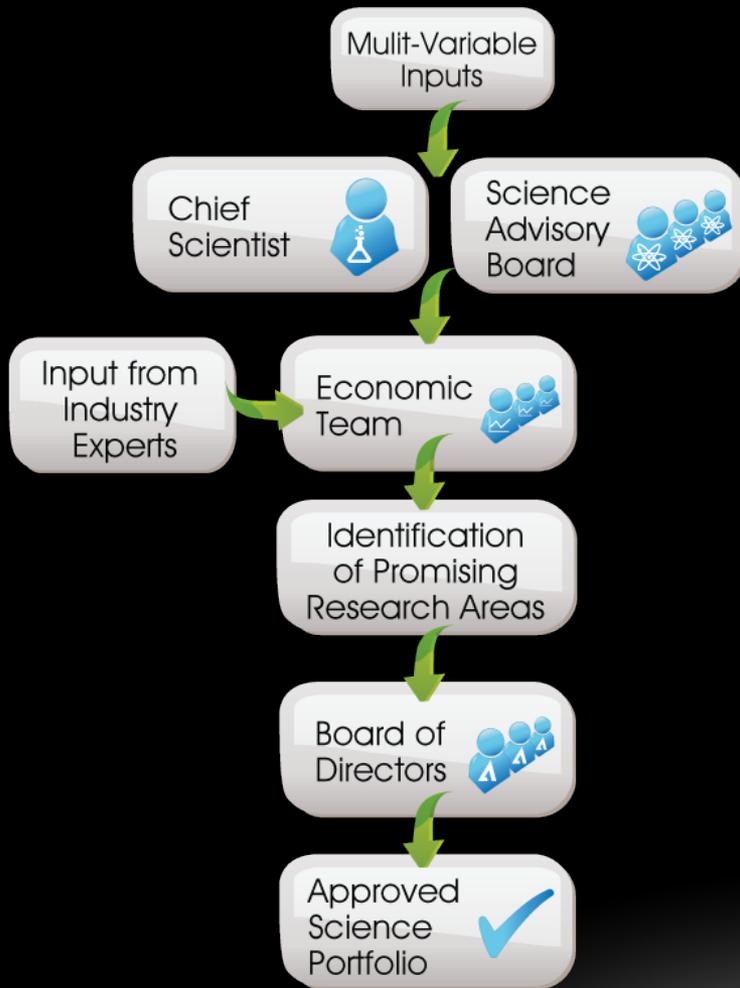
*Wilson et al. PNAS 104(41); 2007*

*Swan et al. PNAS 109(40); 2012*

*Kikuchi et al., Journal of Geophysical Research 115(D23306); 2010*

*Other images courtesy of NASA*

# CREATING OPPORTUNITY



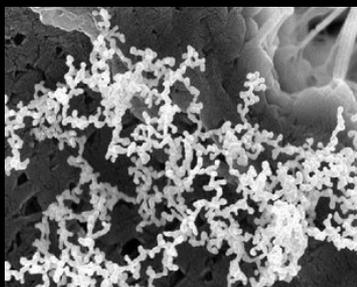
CASIS seeks to develop a robust and diverse research portfolio by:

- ▲ Identifying unique and promising capabilities of the National Lab
- ▲ Assessing market size, market interest and time to translate research benefits to National stakeholders
- ▲ Approve and execute research portfolios

# INITIAL RESEARCH PRIORITIES

- ▲ Biosciences
- ▲ Materials Science
- ▲ Earth and Space Observation
- ▲ Technology Demonstration

Osteoprotegerin testing in mice on Shuttle

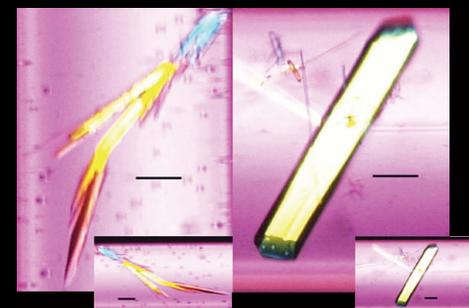


Metal nanoparticles produced in microgravity



Sarychev Peak Eruption, Kuril Islands

H-PGDS crystallized with novel inhibitors



Earth

Space

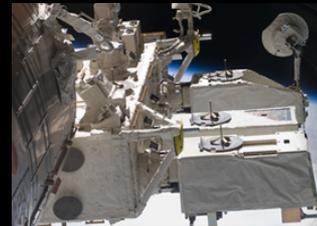
# RESEARCH SOLICITATIONS



*REQUEST FOR PROPOSALS*

Advancing Protein Crystallization  
Using Microgravity

*August 2012*



*REQUEST FOR PROPOSALS*

Materials Testing  
in the Extreme Environment of Space

*December 2012*



*REQUEST FOR INFORMATION*

Utilization of Existing  
ISS Hyperspectral Imaging  
for Commercial Product Development

*November 2012*



*REQUEST FOR INFORMATION*

Development of Strategies  
for Support of Stem Cell Research  
on the International Space Station  
U.S. National Laboratory (ISS NL)

*March 2013*

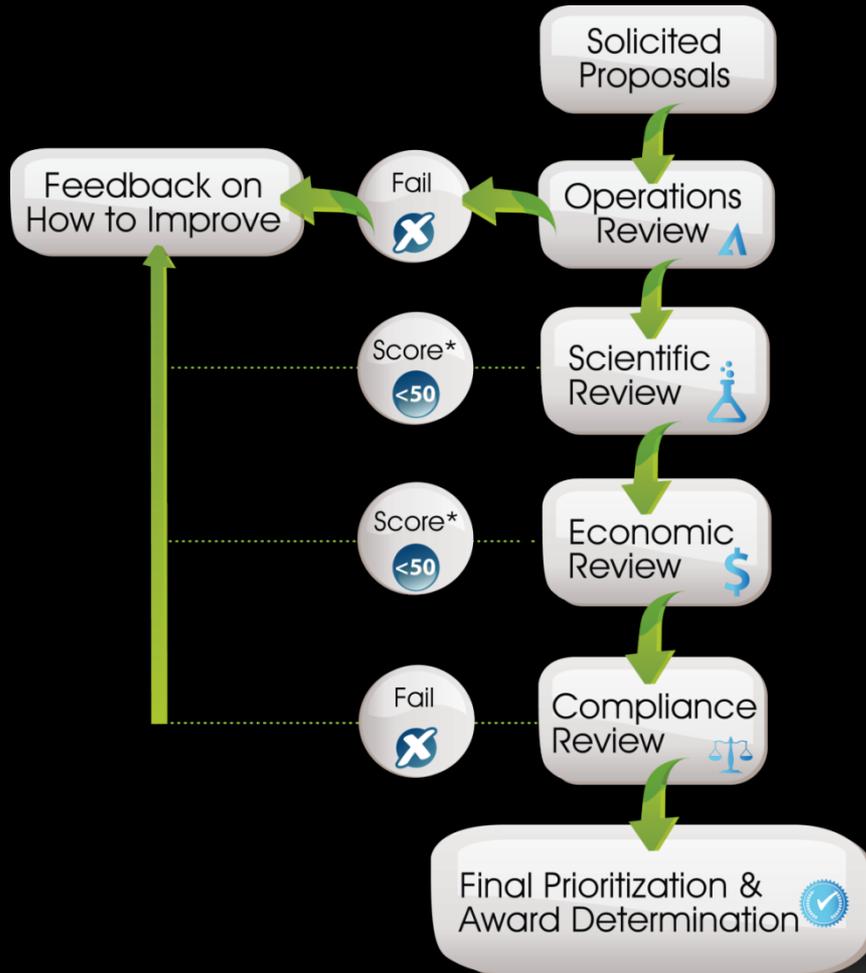


*REQUEST FOR PROPOSALS*

Funded Opportunity for  
**Stem Cell Research**  
Onboard the International Space Station

*Closed July 26<sup>th</sup> 2013*

# EVALUATION & SELECTION PROCESS



1. Operations team determines technical feasibility
2. Review for scientific merit by external panel of subject matter experts
3. Economic valuation to assess tangible and intangible value to U.S. taxpayer
4. Legal and Compliance team review of regulatory, compliance, IP and other potential legal issues
5. Final award and prioritization determinations by Executive Director, Chief Scientist and Chief Economist

# EXAMPLE PROJECTS

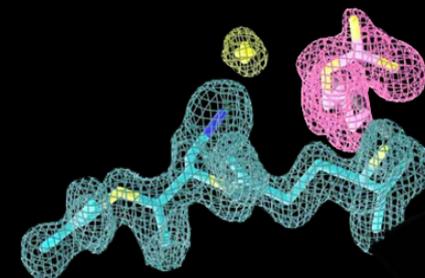
*Grant Awardees from Formal Solicitations and  
Selected Unsolicited Projects*

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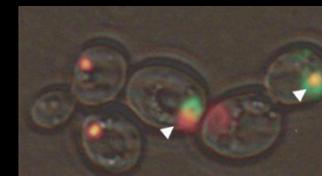
# PROTEIN CRYSTALLIZATION



- ▲ *Dr. Joseph Ng, iXpressGenes Inc.:* The location of IPPase-associated hydrogen atoms potentially involved in catalysis (using neutron diffraction)
- ▲ *Dr. Sergey Korolev, Saint Louis University School of Medicine:* Human calcium-independent phospholipase PLA2g6 and prothrombin
- ▲ *Dr. Edward Snell, Hauptman-Woodward Medical Research Institute at SUNY Buffalo:* Four medically-relevant proteins, two of which have large disordered regions: OXR1, ECHDC1, Srcasm and HSPA13
- ▲ *Dr. Pamela Bjorkman, California Institute of Technology:* Exon 1 polyglutamine repeat in huntingtin protein



HQL-79 crystallized on station



Cell aggresomes  
Credit: Yury Chernoff

# PROTEIN CRYSTALLIZATION



- ▲ *Dr. Stephen Aller, University of Alabama-Birmingham:* High-impact human membrane proteins, specifically ABC proteins, including multi-drug resistance transporters
- ▲ *Dr. Constance Schall, The University of Toledo:* Three medically important enzymes involved in amino acid and nucleotide biosynthesis and metabolism: MTAN, TS, and AAT



Thaumatococcus  
crystallized  
on station



Additional CASIS-sponsored PCG projects in preparation for flight include a Merck investigation into the structure of a medically relevant monoclonal antibody (PI Paul Reichert).

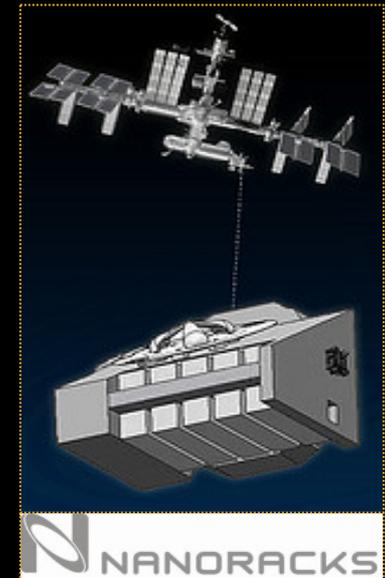
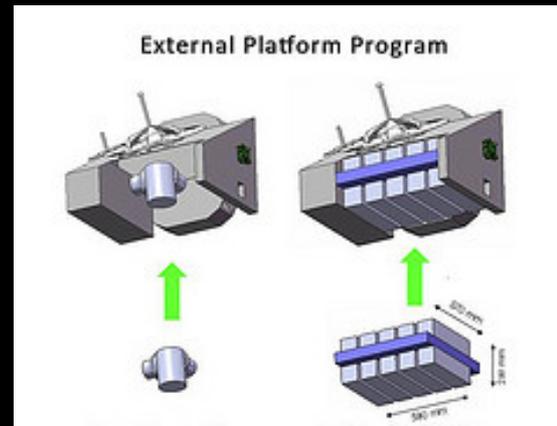


# MATERIALS SCIENCE



▲ *Dr. Kathleen Morse, Advanced Materials Applications, LLC: Use of the Gumstix™ Computer On Module in radiation studies to examine fault-tolerant computers*

▲ *Dr. W. Jud Ready, Georgia Institute of Technology: Development of cost-effective, energy-efficient photovoltaic cells made of lightweight carbon nanotubes*



*CASIS released an RFP broad in scope to promote use of the NanoRacks external platform for research with Earth applications*

# EARTH OBSERVATION

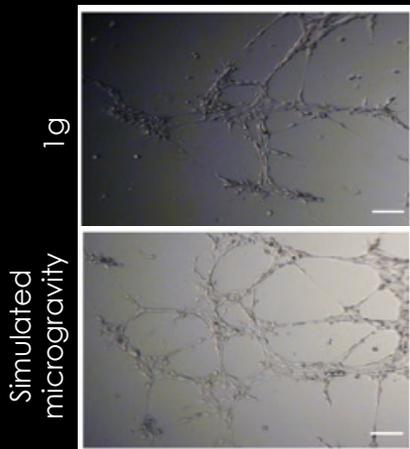


- ▲ CASIS issued an RFI to gauge commercial interest in using the Hyperspectral Imager for the Coastal Ocean (HICO)
- ▲ Of the many responses received, two were converted into formal proposals:
  - *Naval Research Laboratory*: Development of harmful algal bloom early detection, quantification, and classification algorithms
  - *HySpeed Computing*: Development of a prototype enterprise architecture for rapidly implementing new remote sensing algorithms and applications

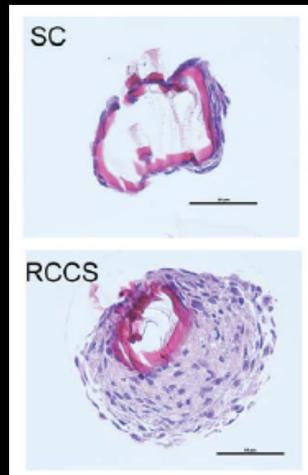


# STEM CELL PROPERTIES IN MICROGRAVITY

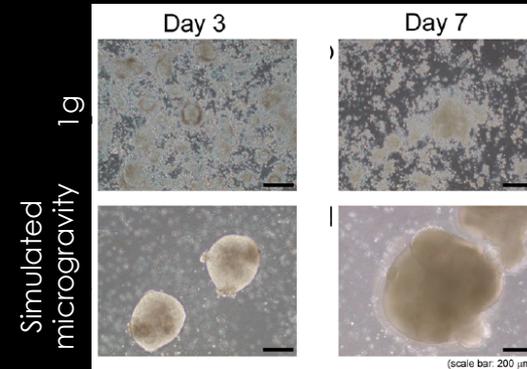
▲ Ability to either maintain pluripotency or improve differentiation



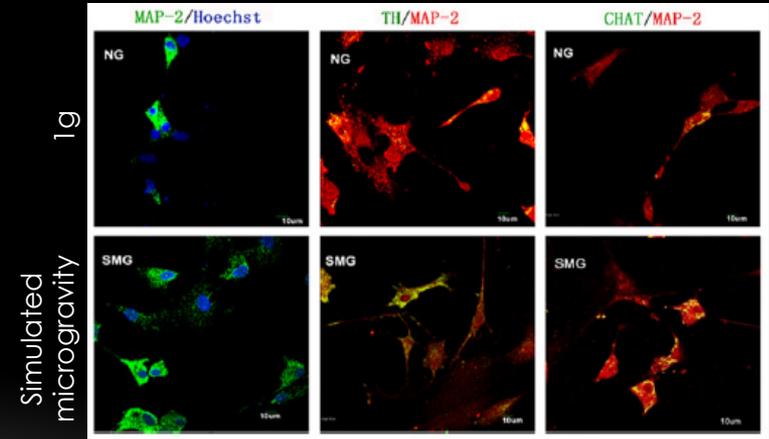
MSCs: Increased expression of endothelial markers, greater capillary formation



Epidermal stem cells: Multicellular structures maintain high proliferative capacity



Mouse embryonic stem cells: Large spheres remain undifferentiated and pluripotent



Enhanced MSC differentiation into neurons

# UNSOLICITED PROPOSALS



- ▲ Microgravity research has been NASA-focused, discovery in nature, not targeted to commercial application. As a result, research opportunities may not be understood or structured
- ▲ Unsolicited proposals provide an opportunity for research that may not fit within the requirements of a formal grant
- ▲ To date, the majority of CASIS' flight opportunities have been derived from this process



# UNSOLICITED AWARDS

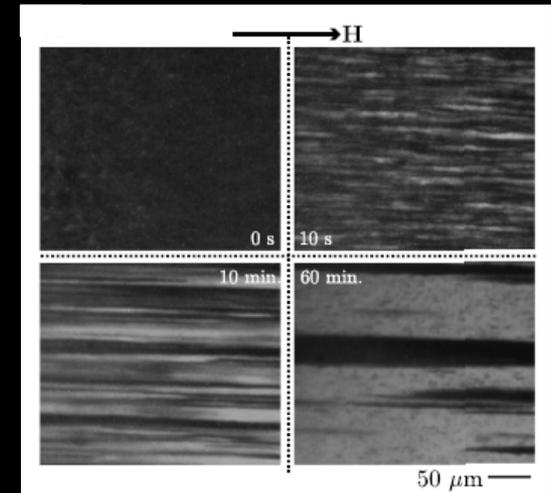


- ▲ *Dr. Anna-Lisa Paul, University of Florida:* Identification of genes involved in Arabidopsis root morphology/adaptive physiology
- ▲ *Methodist Hospital Research Institute:* Hardware development for the study of nanoscopic diffusive transport, toward healthcare applications
- ▲ *Southwest Research Institute:* Study of meteors that impact Earth's atmosphere, using the Window Observational Research Facility



# UNSOLICITED AWARDS

- ▲ *Proctor and Gamble/Zin Technologies*: Colloid phase transition and separation kinetics, toward improvement of product formulations and stability
- ▲ *Department of Veterans Affairs*: Evaluation of known and novel anti-cancer drug therapies using yeast chemical genomics
- ▲ *COBRA PUMA GOLF*: Bonding of dissimilar materials by electroplating, toward the improvement of alloys for commercial use



Particle aggregation in a magnetic field

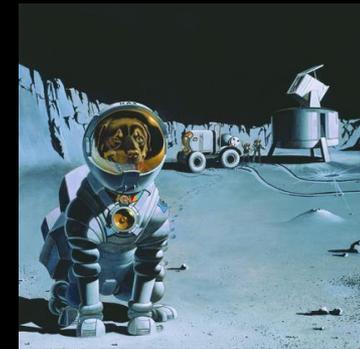
# EDUCATION OPPORTUNITIES



- ▲ *Windows On Earth: A suite of integrated software tools to help students, scientists and astronauts identify targets for photography from ISS (CASIS collaboration with TERC and the Association of Space Explorers)*



- ▲ Story Time From Space: An astronaut on the station will read from a children's book and perform simple related science demonstrations



# FUNDING

*Seeding Opportunity, Generating Funds,  
Partnering Financial Benefits*

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# ENTRY POINTS AND FUNDING MECHANISMS



## ▲ Formal Grant Call

- CASIS awards grant funding

## ▲ Unsolicited Proposals

- Result of BD, Outreach
- Options for seed funding from CASIS
- Support through institutional partnerships: venture capital, matching, philanthropic funding, in-kind resources



*Moving money  
within the CASIS  
Marketplace*

# LOOKING FORWARD

*Incentivizing Further Commercial Development*

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# UPCOMING OPPORTUNITIES



- ▲ Unsolicited proposal opportunities continue
- ▲ Science Advisory Board to evaluate research outcomes for future grant consideration
- ▲ Partnership maturation will create fund leverage & research streams
- ▲ Technology demo, validation and development
- ▲ Crowdsourcing: Generate ideas geared to identify out-of-the-box research that may be realized through partnering with expertise



# NATIONAL LAB UTILIZATION TO DATE



▲ To date >\$15M obligated for ISS NL research across 40 projects



▲ >\$2M non-NASA funds committed to targeted flight opportunities



▲ Commercial Partnerships with Boston Museum of Science, MD Anderson, Baylor College of Medicine, MIT, MassChallenge, Boeing, NSTA, The Broad Institute, etc.



▲ Flight Project Agreements with P&G, Merck, Cobra Puma, numerous universities



▲ MOAs in place and/or in development with NIH, NOAA, USDA, VA, DoD, NRL (Navy)



# HOW CAN COMMERCIAL UTILIZATION BE ACHIEVED



- ▲ Demonstrate that the fundamental questions re: microgravity can be answered
- ▲ Create opportunities to address these questions – seed funding, partnerships, grant challenges, outreach
- ▲ Familiarize the research community at large with the CASIS business model and utility of ISS
- ▲ Streamline process while preserving safety and integrity of crew and vehicle
- ▲ Achieve repeatability, reduce time to flight, and lower cost



**CASIS™**

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[www.iss-casis.org](http://www.iss-casis.org)

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