

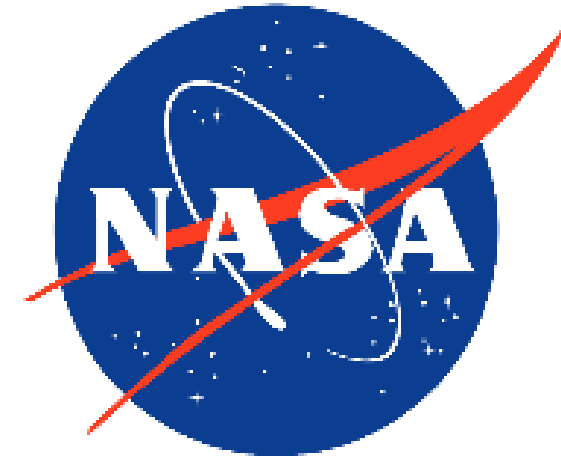
Partnering with NASA: Florida Tech's Impact



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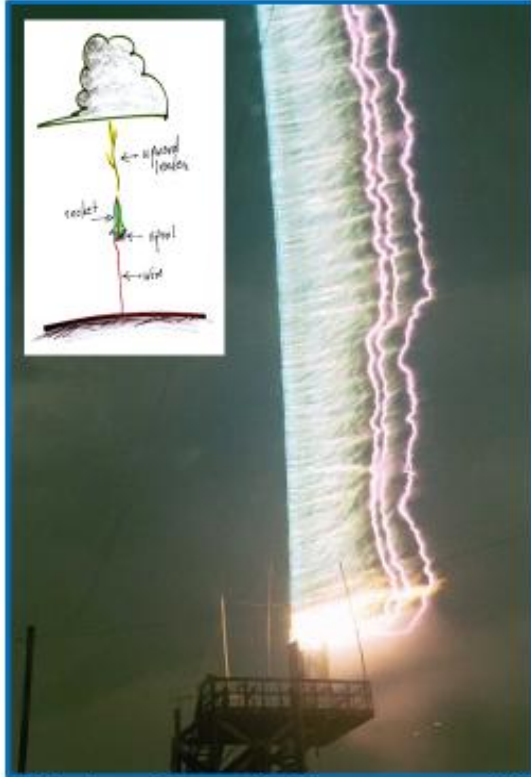
**Hamid K. Rassoul, Space Plasma Physicist
Chief Research Officer, Florida Tech**

2nd SpaceU Symposium, UCF – November 7, 2025



Brief introductions – the Presenter & Florida Tech

... about the presenter



Lightning *when* and *where* you want it!
UF/FIT ICLRT facility -- Camp Blanding, FL

Prof. Hamid K. Rassoul

Professor of Aerospace, Physics & Space Sciences
American Physical Society & American Geophysical Union
(Emeritus Member)



"Captain Lightning!"

- Career Highlights
 - NASA staff Engineer/Researcher (MSFC)
 - FMR. Department Physics Head & Dean of Science
 - Distinguished University Professor
- Regular Courses
 - Geophysics (UG) & Planetary Interiors (G)
 - Physics of Atmosphere (UG) & Planetary Atmospheres (G)
 - Electromagnetic Theory (UG & G)
 - Classical Mechanics (UG & G)
- Research Interests
 - **Lightning & EMPS** – initiation, propagation, and attachment
 - **Cosmic rays** – Interplanetary propagation modulations
 - **Space Weather** – ionospheric dynamics; magnetic storms and substorms
 - **Space Instrumentation** – Particle, Field, and Radiation sensors

- Distinguished University Professor of Physics & Space Science (since 2010)
- Interim Provost (2023)
- Chief Research Officer (since 2024)

Scientific Journey

Jupiter: Voyager Missions



Mars: Viking Mission



Magnetosphere: IMP-8, AE & DE Missions



Ionosphere: AE & DE, Atlas Missions



Troposphere: GOES, ASIM, GLM Missions

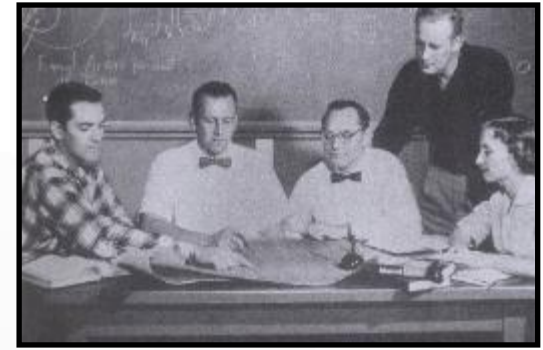


Geophysics?

... about Florida Tech (FIT)

Florida Institute of Technology: Legacy in Space Education and Innovation (academic home of 7 astronauts)

- **Founded in 1958** to support Cape Canaveral's space program
- Located near KSC (35 miles); strategic NASA partner
- Faculty and alumni **contributed to Apollo, Space Shuttle, and Artemis missions**
- Focus on **planetary exploration, astrophysics, robotics, astronaut & rocket/payload safety, and commercialization**
- Committed to advancing **space research, education, and technology**



Founded to Support the U.S. Space Program

... a young university 1958-2025 (67 years)

- BEC (1958) → FIT or FL Tech (1966)
- **Countdown College** ... 3, 2, 1 ... lift off! The nickname is attributed to **Dr. Wernher von Braun**, because many of its first students were 'missilemen' (engineers/technicians)
- Nation's **Oldest** UG Space Science Program
- **FIT**: A legacy **interwoven** with **NASA**, built through **challenges** and **sacrifice**.
 - Dream of a senior missileman out of a 37-cents as his first endowment – **Dr. Jerome P. Keuper**
 - Upheld by the altruism of an African-American missileman – **Mr. Julius Marvin Montgomery** →

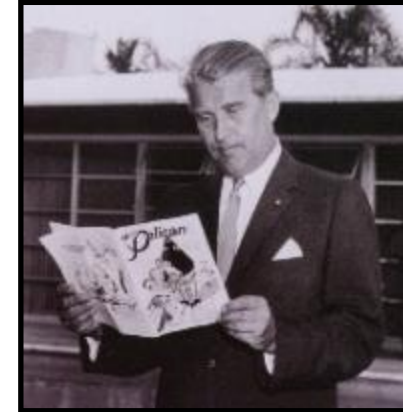
First endowment : 37 cents!



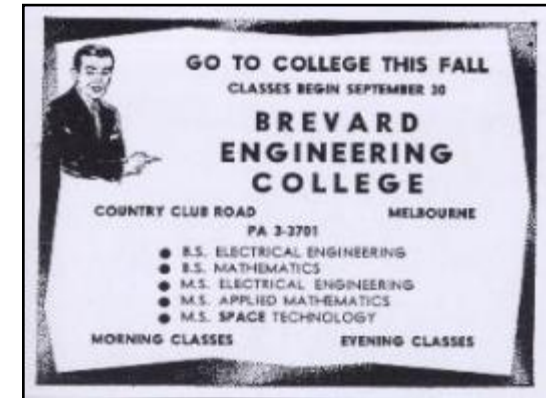
JEROME P. KEUPER (1921-2002)

Nuclear Physicist

- B.S. MIT
- M.S. Stanford
- Ph.D. University of Virginia
- Senior Engineer – RCA Systems Analysis, Missile Test Project
- **FIT President 1958-1986**



Wernher von Braun



"Gus" Grissom



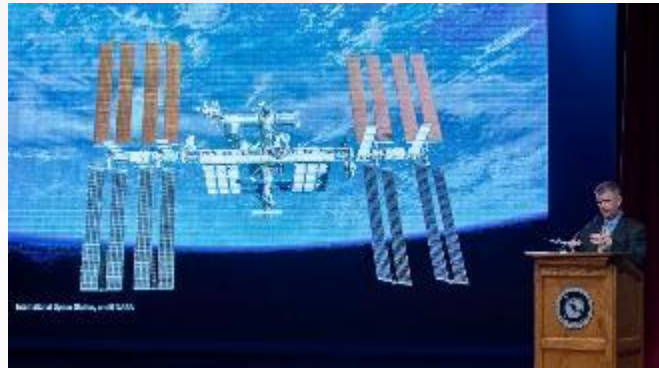
Edward Teller

Space & Defense - Our DNA

- **Colleges:** Engineering & Science, Aeronautics, Applied Psychology & Liberal Arts, and **Business** (Management, Data Science, Innovation)
- **Programs:** 185 undergraduate, 85 master's, and 25 doctoral programs
- **Enrollment: 10,000+** (On campus: ~ 5,000; Online: ~ 5000) -- **46% M, 54% F**
- **Alumni:** Over 70,000 worldwide
- **Research Portfolio:** **\$79M** open contracts • **\$21M** annual expenditure • **500** pubs/yr
 - **170** tenured-stream faculty • **14:1** Stu–Fac Ratio
- **Federal Sponsors:** DoD, NASA, NSF, NIH, and DOE



Sunita Williams, NASA, U.S. Navy Captain



Mike Moses – President Virgin Galactic



Winston Scott, FMR
Astronaut, Prof//Dean,



Dr. Nicklow and USSF
General Tim Sejba



Drs. Nicklow and FMR
NASA Administrator
Nelson

Florida Tech- “Space & Defense Heritage”

Applied Research & Comprehensive Training (Learning by Doing)

- Aeronautics, Space, and Applied Electromagnetics
- Cybersecurity & Cyber Resiliency
- Ocean & Marine Engineering and Science
- Biomedical Engineering and Science
- Applied Social Sciences and Managements



Interested in our research or looking to collaborate? Reach out anytime at rassoul@fit.edu. I'll gladly connect you with the right project leaders.





L3HARRIS CENTER FOR SCIENCE AND ENGINEERING

GEORGE M. NELSON HEALTH SCIENCES

Science, Engineering, and Technology in Action: Florida Tech's NASA Projects

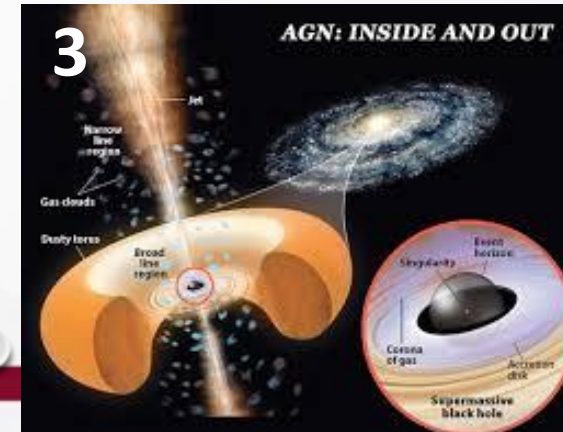
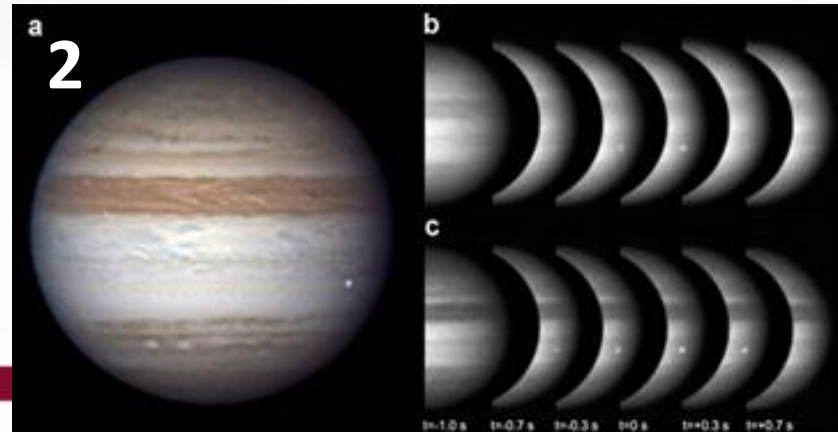
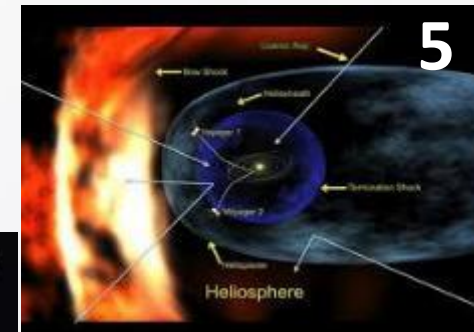
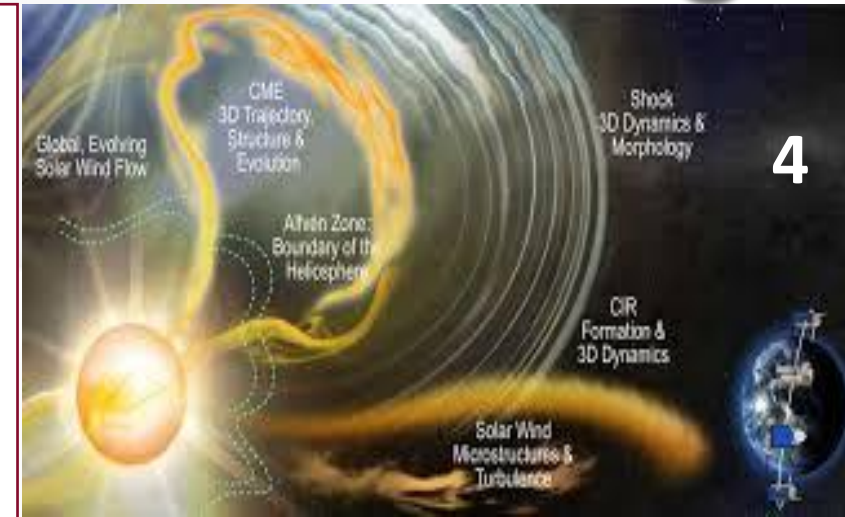
Highlighting Some NASA Research Projects at Florida Tech

Science, Engineering, and Technology in Action

- 1. Space Science & Exploration**
- 2. Space Biology**
- 3. Earth & Environmental Sciences**
- 4. Technology & Engineering Innovations**
- 5. Human Systems & Life Sciences**
- 6. Education, Workforce, & Outreach**

(1) Space Science & Exploration: Planetary science, Astrophysics, Heliophysics

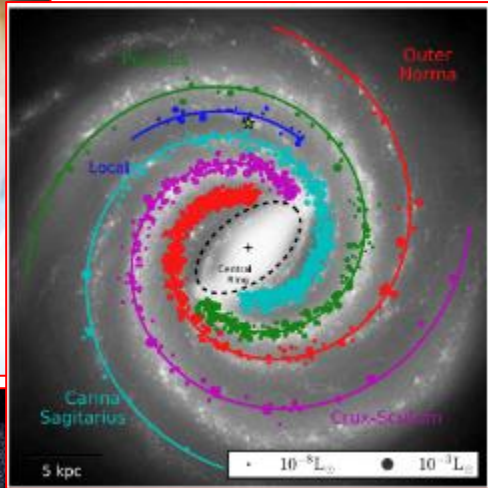
1. Milky Way's structure and evolution
2. Exoplanet Atmospheres
3. Dynamics of Jupiter's Atmosphere & Meteoroid Impacts
4. Supermassive black hole & AGN jets
5. Solar Wind: Alfvénic and MHD Turbulence
6. Cosmic Rays Physics: Galactic (supernova), Solar (flare & CME), Extragalactic (quasars & black holes) sources



Example-1: Multi-wavelength Research in Galactic Stellar populations and Exoplanetary Astrophysics



Dr. Luis Quiroga



- Research combines stellar dynamics, variable star astrophysics, and planetary science to explore the **Milky Way's structure and evolution**.



- Sagittarius Stream Mapping: Using Gaia data to characterize disk-embedded stars and constrain **Galactic disk populations** vs stream stars.



- **Variable Star Research** (NASA FINESST Award) focuses on pulsating stars via ZTF-Gaia data supporting NASA's time-domain astrophysics goals.



- Exoplanetary Science that explores **habitability around white dwarfs** ; published in The Astrophysical Journal Letters.



IOPscience
THE ASTROPHYSICAL JOURNAL LETTERS

OPEN ACCESS

Potential for Life to Exist and be Detected on Earth-like Planets Orbiting White Dwarfs

Caldon T. Whyte, L. H. Quiroga-Núñez, Manasvi Lingam, and Paola Pinilla
Published 2024 December 12 • © 2024. The Author(s). Published by the American Astronomical Society.

[The Astrophysical Journal Letters, Volume 977, Number 2](#)

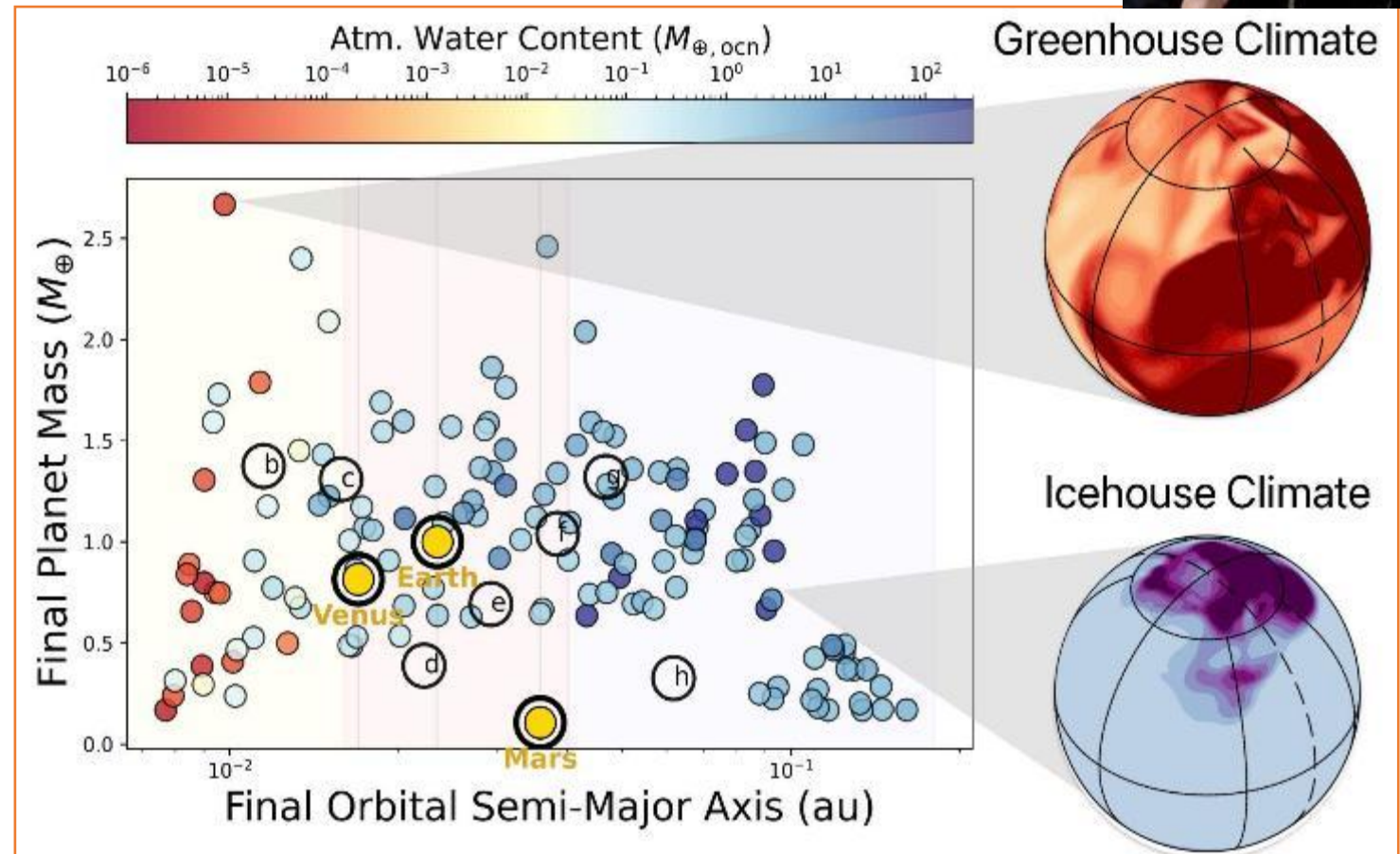
Citation Caldón T. Whyte et al 2024 *ApJL* **977** L38

[DOI: 10.3847/2024.1000000000000000](#)

Example-2: Born Dry or Born Wet? Exploring whether rocky planets in compact systems obtain substantial water inventories

- **Planet Formation & Evolution** -- linking random accretion histories to full climate and atmospheric chemistry models (ongoing)
- Supported by **CHAMP initiative** (Consortium on Habitability and Atmospheres of M-dwarf Planets) supported by APL-JHU & NASA)
- Parts of **published results** was **reported by CNN** in a JWST new piece on September 28th

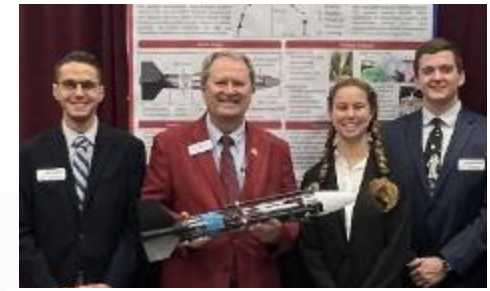
Dr. Howard Chen; named one of 25 “*Rising Stars in Astronomy*” by the Astronomy Magazine in 2023



(2) Space Biology: Science of Life in Space

Plant physiology and space biology focusing on **plant tropisms**.

- Investigates **gravitropism** and **phototropism** responses in plants to **gravity** and **light** in space.
- **Nine** spaceflight projects studying plant **adaptation to microgravity** and **low gravity** (Moon & Mars).



Dr. John Z. Kiss and team



Dr. Drew Palmer

Quorum Sensing in Algae

Research on *Chlamydomonas* algae reveals how cell density affects **swim speed** and **signaling molecules**.

Perchlorate Removal on Mars

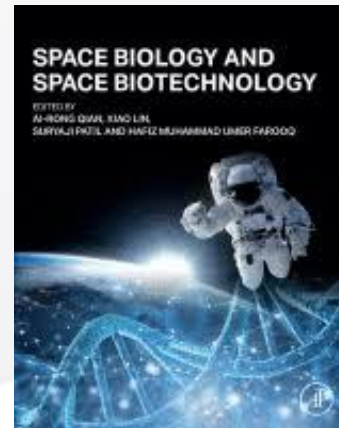
Microbial consortia detoxify toxic perchlorate salts in **Martian soil** to **support crop growth**.

Cyanobacteria for Nutrient Fixation

Anabaena cyanobacteria fix nitrogen and bioleach nutrients to **improve growth** in **extraterrestrial soils**.

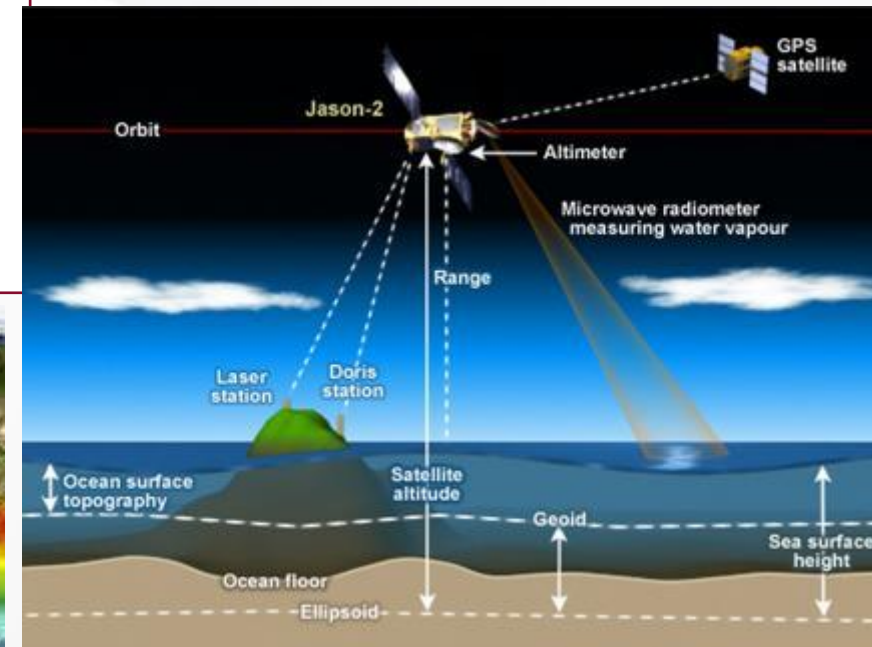
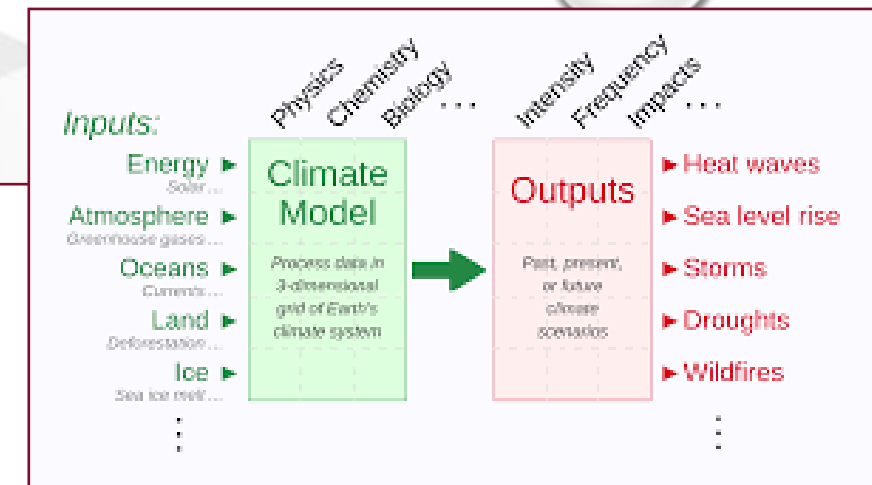
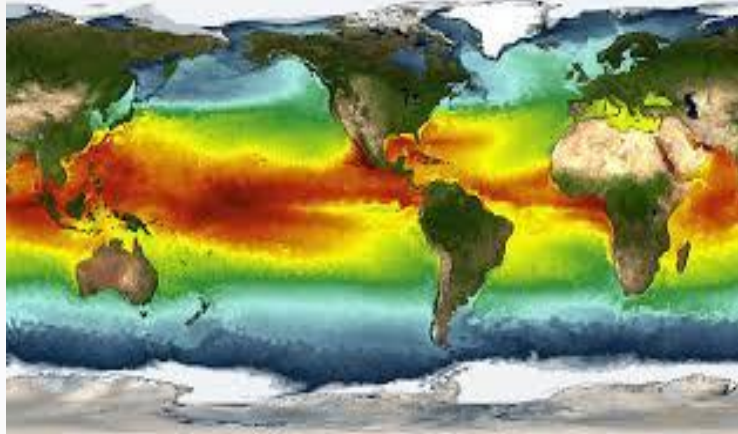
Space Plant Growth –Bacteria

Bacteria from ISS Veggie unit promote **plant growth under microgravity** by producing hormones and nutrients.



(3) Earth & Environmental Sciences

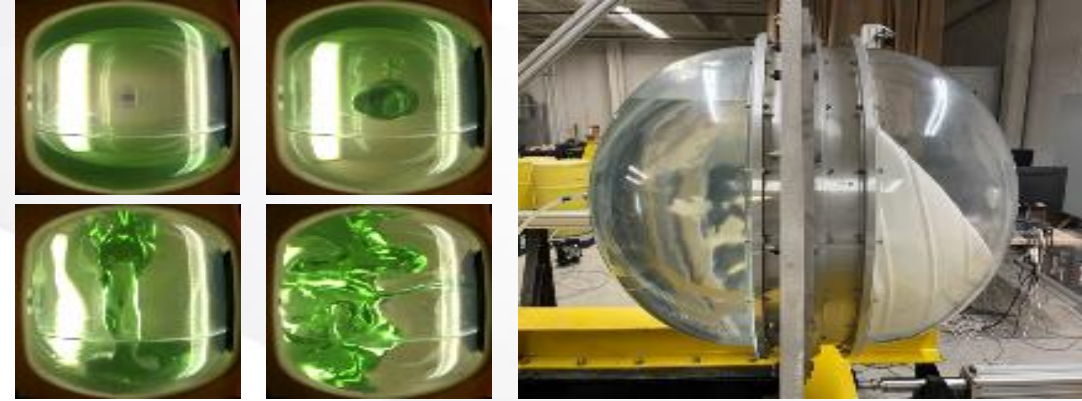
1. Climate modeling, Earth observation, and remote sensing
2. Atmospheric studies (**TGFs, TLEs, Sprites halos, Nox**, etc.) using NASA satellite data (e.g., **GLM, TEMPO, ISS-LIS**)
3. Oceanic studies (**sea level rise**, sea surface **temperature** for marine heatwaves and coral bleaching, **tracking ocean currents** for El Niño events, ocean color data to locate **algal blooms & plankton distributions**, etc.) using NASA satellite data (e.g., **Sentinel-6** and **Jason** series, **Aqua** , **ICESat-2**)



(4) Technology & Engineering Innovations at the Edge of Space

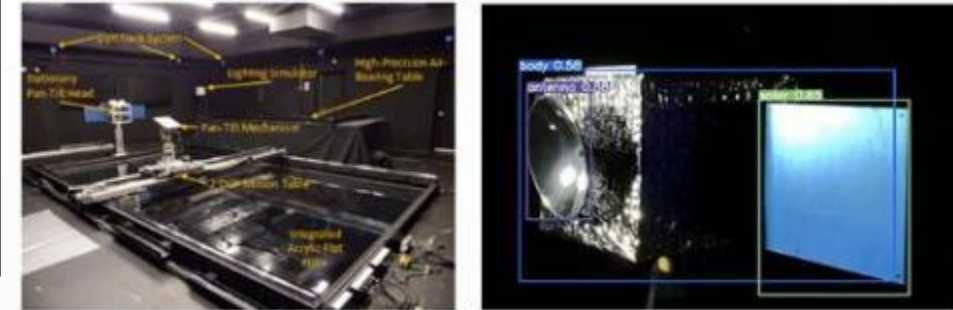
Propulsion Lab – Rocket Science

- Cryogenic **fuel behavior in zero-gravity** and **thermal conditions**
- Simulations for **rocket propellant stratification** and **tank design**



NETS Lab: Autonomous Spacecraft Vision Systems

- AI-driven vision systems for on-orbit object tracking
- Supports autonomous operations near non-cooperative satellites
- Deep learning used for component recognition & navigation



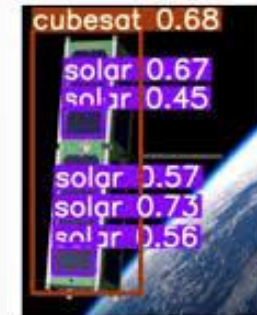
Oxygen from Moon Rocks — ILMENOX Project

- NASA-funded international collaboration to extract oxygen from lunar regolith
- Partners with KSC, British Titanium, and University of Cambridge
- Uses FFC Cambridge Process — molten salt electrochemical reduction



Other Examples of Technology & Engineering Innovations – Cont.

- Application of **Machine Learning** and **Advanced Additive Manufacturing** in novel ways to support rocket, satellite, and spacecraft applications (Rendezvous, Proximity Operations, Docking, and **Slosh experiment**)
- Integrated **quantum technologies** to advance frontiers in science and technology in material science
- Deep Learning for Autonomous Space Operations: **in-orbit servicing** and **space debris-capture** missions
- Creating and Guiding **Lightning** discharges as **Illuminator**, Passive **OTH Radar**, **Object tracking & Threat detection**



Example-1: Adaptive Control for Smarter, Longer-Living Satellites



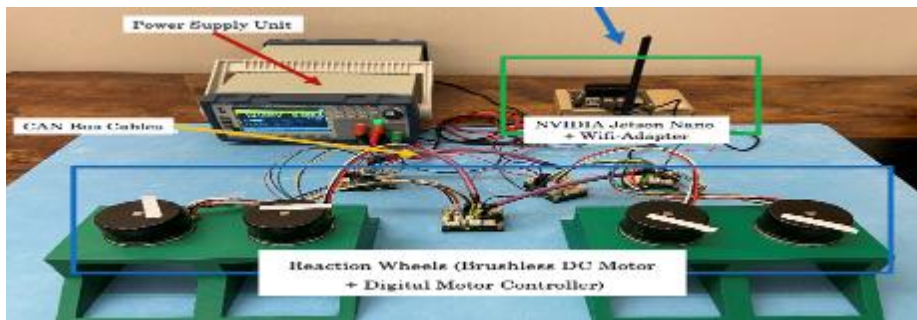
Dr. Riano-Rios

The Problem

- Reaction Wheels (RW) are the most used actuators for precise pointing control in satellites.
- Prone to degradation/failure due to harsh conditions in space.

Current Status

We advanced from computer simulations to real-time Hardware-in-the-Loop (HIL) testing to prove the system can run directly onboard.



[3] M. Sakal, G. Nehma, C. Riano-Rios, and M. Tiwari, "Real-Time Testing of Satellite Attitude Control with A Reaction Wheel Hardware-In-the-Loop Platform," 2025 AAS/AIAA Astrodynamics Specialist Conference, Boston, MA, 2025.

Our Approach

We are developing adaptive controllers that simultaneously control the satellite orientation and estimate the health of actuators.

[1] C. Riano-Rios, G. Nehma, and M. Tiwari, "Adaptive controller for simultaneous spacecraft attitude tracking and reaction wheel fault detection," in AAS/AIAA Astrodynamics Specialist Conference, Broomfield, CO, 2024.

[2] M. Sakal, G. Nehma, C. Riano-Rios, and M. Tiwari, "RBFNN-based Adaptive Attitude Controller with Reaction Wheel Health Estimation," 2025 AAS/AIAA Astrodynamics Specialist Conference, Boston, MA, 2025.

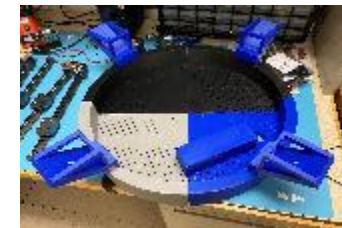
Next Steps

Full-Scale Ground Test: Pushing Our Adaptive Controllers to the Limit:

Moving forward to a complete on-ground test on a state-of-the-art attitude simulation testbed, bringing us closer to flight-ready validation.



CAD



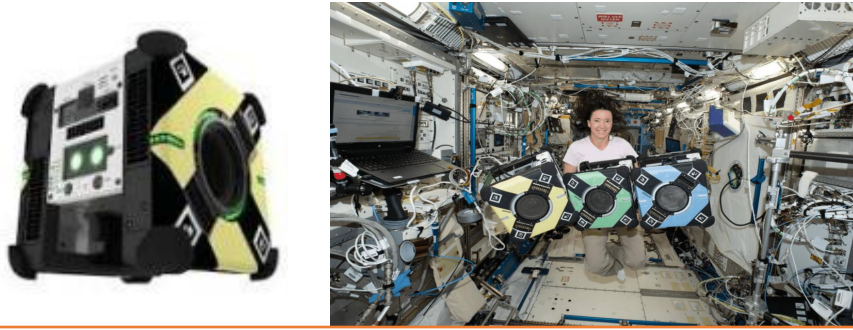
Prototype



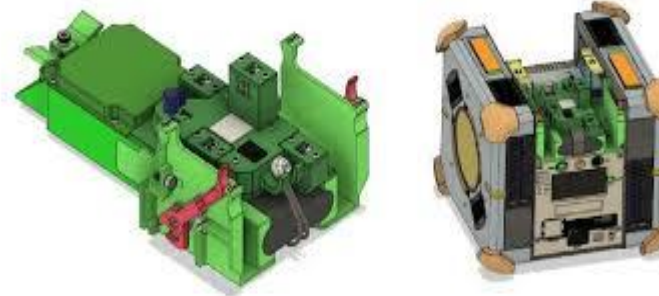
Integration

Example-2: Vision-Based Navigation for Formation Flight on ISS

SVGS-1&2: Smart Video Guidance Sensor for Astrobees localization



free
flying
robot
platform

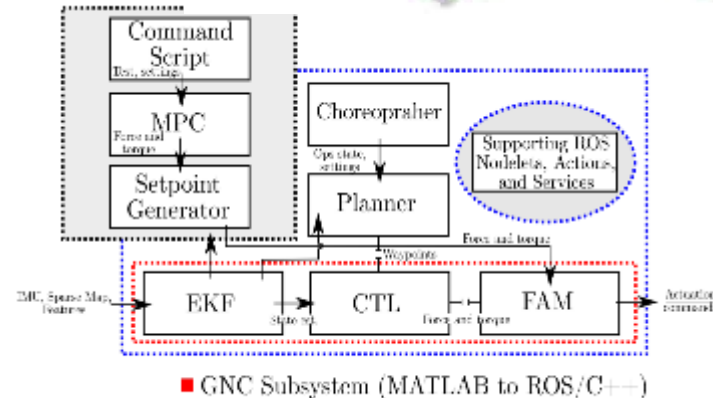


Dr. Hector
Gutierrez



- SVGS defines a coordinate system attached to NavCam (SVGS-1 flew)
- SVGS measurements fused with Astrobees localization pipeline
- MLP can send force/torque commands as needed to achieve tracking

→ robust formation flight of multiple Astrobees independent of localization

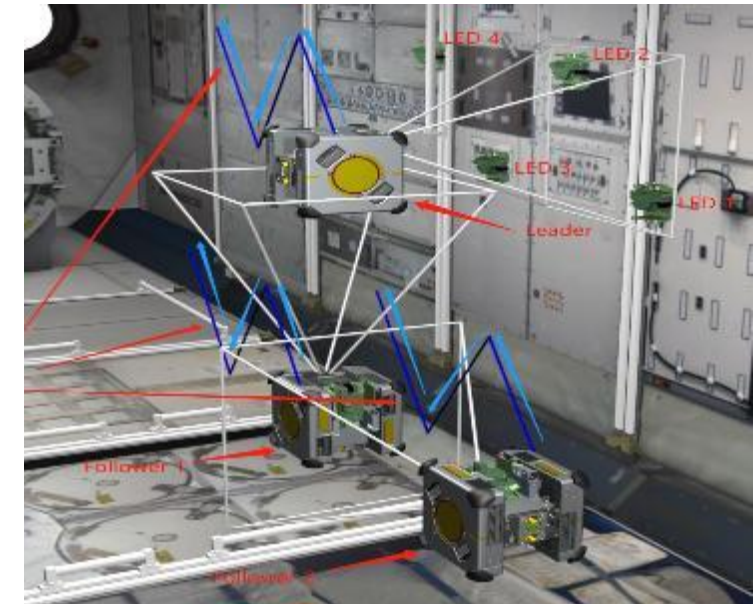


Software Update CONOPS

- Deploy ROS package to enhance Astrobees localization suite at MLP level
- Package interfaces with robot EKF, IMU propagator and cameras (modified Astrobees workspace)
- Changes in localization and FAM needed for integration
- Setup:** upload source code to MLP + build through remote access (ssh/adb)

Three-robot formation flight maneuver

- 4 SVGS beacons
- 3 Astrobees robots
- Maneuver time: 10 min



Example-3: Space Vehicle Propellant Management and Control

State-of-the-art **analytical**, **numerical** and **experimental** tools to support *basic* and *applied* research in:

- Space vehicle systems
- Propulsion, Fluids, Thermodynamics
- Combustion, Acoustics, and Controls

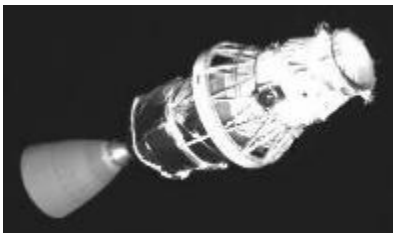
Unique facilities to simulate propellant dynamics (**sloshing**) and **control system response** to enhance mission assuredness



Dr. Daniel Kirk
Dir. of ASAP (**A**erospace
Systems **A**nd **P**ropulsion)
Laboratory



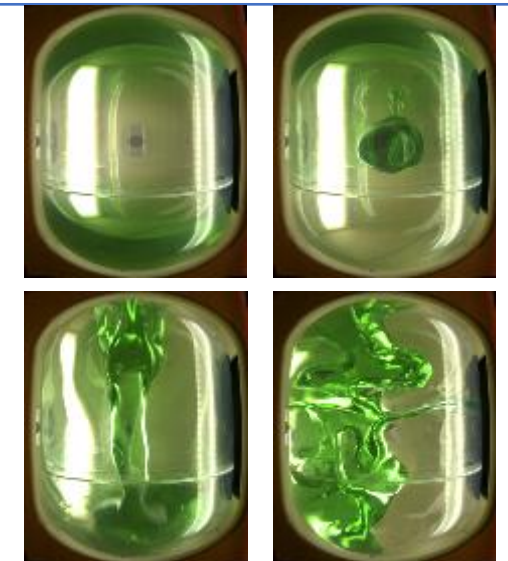
Acquisition of **long-duration micro-gravity propellant** data on **International Space Station** used for model validation for rockets, spacecraft, and in-space assets



1/5 scale upper-stage LH2 and LOX
tanks under test at ASAP Lab



**SPHERES Slosh Experiment
on ISS**



**Micro-gravity fluid
dynamics**

(5) Human Systems & Life Sciences

- **Bioastronautics:** Research on astronaut health and radiation effects
- **Optimizing Human Behavior:** Supporting psychological well-being, social interaction, and productivity through behavioral science
- **Human-Centered Design in Space:** Research on safety, human factors, cockpit/cabin simulations, and spacesuit operations.
- **IPEX Mission Control:** Enhancing Mission Control through HSI (Human Systems Integration) for Next-Gen IPEX (ISRU Pilot Excavator).



(6) Education, Workforce, & Outreach

Broader Impact: Expanding science to the community, building technical skills, and strengthening Florida Tech's STEM leadership.

Telescope Restoration: Florida Tech's 32-inch telescope refurbished as a hands-on engineering project (optics, dome, controls).

KSCVC Partnership: Includes the portable observatory built to track asteroids, used for outreach and for undergraduate and graduate training.

Educational Outreach: K–12 school visits, community nights, and tactile astronomy.

SSEP (Student Spaceflight Experiments Program): 4 student designed hands-on experiments, with one experiment set to fly to the ISS in Spring 2026 and another in 2027.

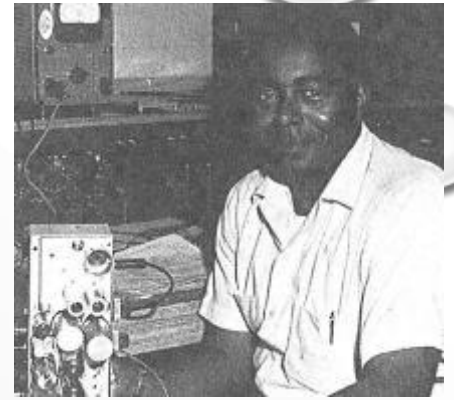
Mentorship Pipeline: Larsen Motorsports + NASA HUNCH: Students gain hands-on STEM experience by building real NASA hardware through **welding, machining, and fabrication.**



In Closing

- At **Florida Tech**, we are driven by curiosity, collaboration, and the pursuit of discovery.
- We welcome all colleagues who share our passion to **push the boundaries of knowledge and technology**.
- Together, we strive to **inspire and empower the next generation of STEM leaders** through research, innovation, and mentorship.
- This talk is dedicated to **Mr. Julius Montgomery**, whose *vision* and *sacrifice* ensured that Florida Tech not only survived, but continues to **grow, thrive, and shape the future**.

Thank you.



Julius Montgomery at work as a “Range Rat.” The Range Rats repaired the electronics in malfunctioning ballistic missiles. USAF/AMR Cape Canaveral.



J. Montgomery (1929-2020)

