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NASA FLIGHT OPPORTUNITIES

Welcome to the Community of Practice Webinar Series!

First, a bit of housekeeping…

- Please mute your microphone and turn off your camera
- Today's session will be recorded
- Recordings for this and all future sessions will be posted on the Flight Opportunities website
- Please engage!
  - Use the chat throughout the session to ask questions

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NASA FLIGHT OPPORTUNITIES

National Aeronautics and Space Administration

Welcome to the Community of Practice Webinar Series!

Flight Opportunities hopes these webinars will enable researchers, program staff, and flight providers to connect informally and share information

- Designed to distill and share the most important lessons learned to:
  - Increase the impact of suborbital flight tests
  - Transfer best practices
  - Optimize the experience of current and prospective program participants
- Part of a broad effort to capture, organize, and communicate lessons learned by suborbital researchers
- An opportunity to hear from subject matter experts on best practices for preparing for suborbital flight tests

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National Aeronautics and Space Administration

Join us for future Community of Practice webinars!

Subscribe to our newsletter for updates on future webinars!

https://www.nasa.gov/directorates/spacetech/flightopportunities/newsletter

Future webinars

- Webinars are held 1st Wednesday of each month at 10 a.m. PT
- Topics will be announced in the Flight Opportunities newsletter and website
- Session recordings will be posted on the Flight Opportunities website
- Let us know session topics you would like to see covered

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Now open: NASA TechLeap Universal Payload Interface Challenge

- Challenge seeks interface systems that can efficiently integrate diverse payloads onto a range of flight vehicles, including suborbital, orbital, and planetary lander vehicles
- **Register by Thursday, February 1, 2024 at 5 pm ET**
- Applications due Thursday, February 22, 2024 at 5 pm ET
- Winners are eligible to win up to $650K in prizes and an opportunity to flight test their system

www.upic.nasatechleap.org

NASA TechLeap PRIZE

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NASA FLIGHT OPPORTUNITIES

National Aeronautics and Space Administration

Today's Speakers

Edward Balaban
Research Scientist
NASA's Ames Research Center

Wanessa Priesmeyer
Campaign Manager / Deputy Technical Lead for the Integration of Automated Systems
NASA's Armstrong Flight Research Center

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November 2023 I Edward Balaban
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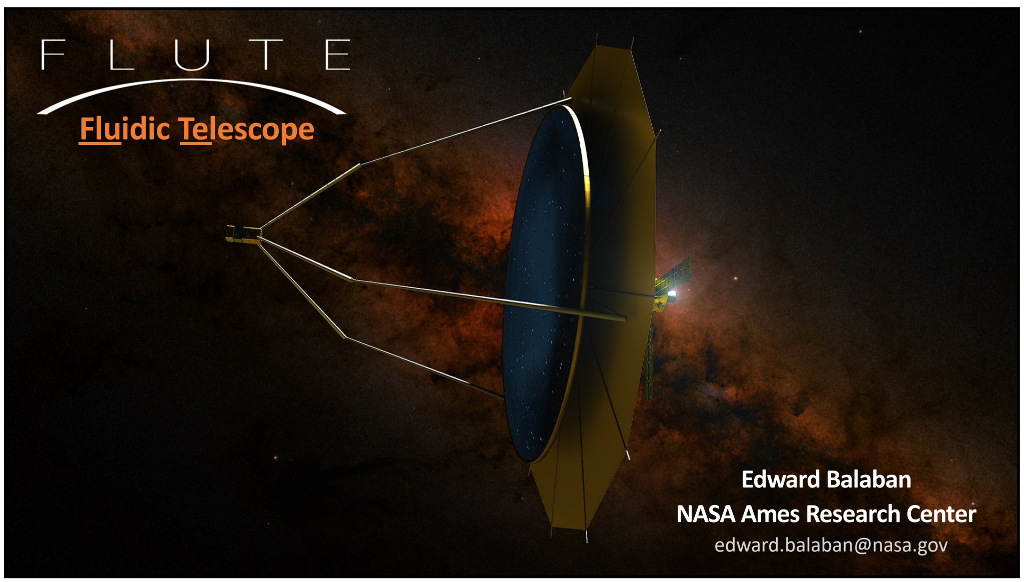
F L U T E
Fluidic Telescope
Edward Balaban
NASA Ames Research Center
edward.balaban@nasa.gov

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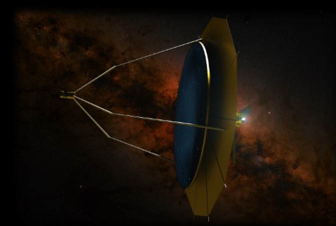
What is FLUTE?

- The Fluidic Telescope (FLUTE) project aims to develop space observatories with large-aperture unsegmented liquid primary mirrors.
- Such mirrors will be created via a novel approach based on fluidic shaping in microgravity.
- The approach enables a molecularly smooth, self-healing mirror surface and can lead to telescope mirrors measuring in tens or even hundreds of meters in diameter.
- FLUTE can help address some of the highest priority objectives of the Astro2020 survey: Earth-like exoplanets, first generation stars, and early galaxies.
- FLUTE is a joint effort between NASA and Technion — Israel Institute of Technology



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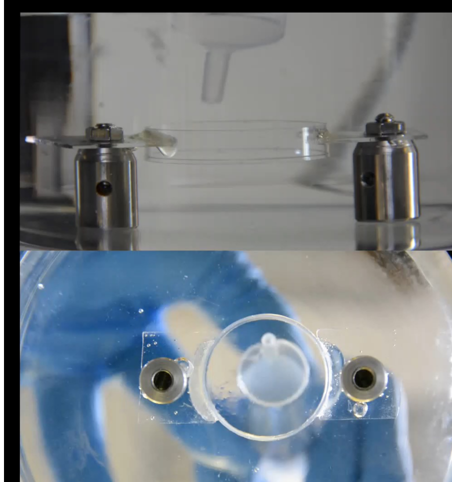
Fundamental approach



- Employs fluidic shaping to create optical components of a variety of useful geometries
- Microgravity serves as the enabling environment
- Natural surface tension of liquids is leveraged to achieve surface quality rivaling the best achievable with state-of-the-art methods (< 1 nm RMS)
- Scale invariant: the same physical properties remain regardless of component size
- Both lenses and mirrors can be produced
- Components may remain liquid — allowing for dynamic modulation of their properties — or can be solidified
- Has the potential of being a game-changer both for space telescopes and for in-space optics manufacturing

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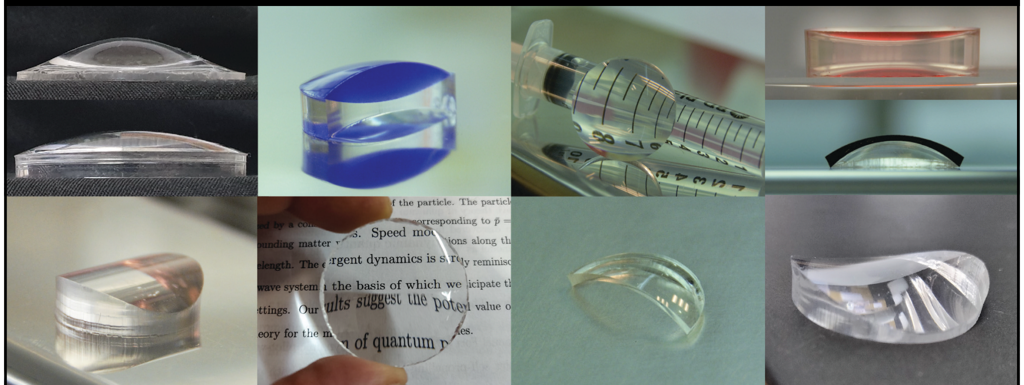
Examples of other optical geometries



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Team

- Edward Balaban (NASA ARC, PI-NASA)
- Moran Bercovici (Technion, PI-Technion)
- Rus Belikov (NASA ARC, astronomy/optics)
- Enrico Biancalani (UMD, instruments)
- Jay Bookbinder (NASA ARC, astronomy / optics)
- Penny Boston (NASA ARC, astrobiology / ionic liquids)
- Howard Cannon (NASA ARC, project manager)
- Kevin Carrico (NASA ARC, visualization)
- Alan Cassell (NASA ARC, mission design)
- Shintaro Chofuku (NASA ARC / JAXA, mission design)
- Anthony Colaprete (NASA ARC, instruments)
- Michael Dickey (NCSU, gallium alloys / ionic liquids)
- Vivek Dwivedi (NASA GSFC, mirror coatings / ionic liquids)
- Mor Elgarisi (Technion, fluid mechanics)
- Jonathan Erickson (Technion, experiment design)
- George Fiedziuszko (NASA ARC, thermal analysis)
- Valeri Frumkin (Technion, fluid mechanics)
- Israel Gabay (Technion, modeling)
- Khaled Gommed (Technion, experiment design)
- Christine Gregg (NASA ARC, structures)
- Jessica Koehne (NASA ARC, measurements)
- Omer Luria (Technion, optics / experiment design)
- Dylan Morrison-Fogel (NASA ARC, mission design)
- Duy Nguyen (NASA ARC, mission cost analysis)
- Collin Payne (NASA ARC, mission design)
- Titus Szobody (NCSU, IL reflectivity)
- Rachel Ticknor (NASA ARC, mission design)
- Daniel Widerker (Technion, experiments)

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Special thanks

NASA ARC (Partnerships, Legal, Management, Programs, Finance, Communications, and Administrative): Georgia Bajjalieh (ARC-CPP), Jill Bauman (ARC-D), Thomas Berndt (ARC-DL), Meredith Blasingame (ARC-DL), Karen Bradford (ARC-DI), Rhys Cheung (ARC-DL), Jacob Cohen (ARC-D), Gianine Figliozzi (ARC-DO), Matthew Holtrust (ARC-DI), Rachel Hoover (ARC-DO), Julia Kong (ARC-TI), Sonie Lau (ARC-TI), Mai Nguyen (ARC-TI), Terry Pagan (ARC-DI), Robert Padilla (ARC-DL), Harry Partridge (ARC-D), Oscar Rivas (ARC-TI), Brenden Sanborn (ARC-DI), Alexander Van Dijk (ARC-DI), and Darryl Waller (ARC-DO).

NASA ARC Space Portal: Lynn Harper (ARC-DI), Graham Mackintosh (ARC-TN), Mark Newfield (ARC-DI), Bruce Pittman, Dan Rasky (ARC-DI), Lisa Vestal (ARC-DI), and Allison Zuniga (ARC-DI).

NASA HQ (Partnerships, Legal, and Programs): Christopher Baker (HQ-OA), Kent Bress (HQ-TF), Judith Carrodeguas (HQ-TF), Michael Lapointe (MSFC-ST20), Andy Parks (HQ-TF), Trenton Roche (HQ-MC), Brian Stanford (HQ-MD), and Brian Wessel (HQ-ME).

NASA AFRC (Flight Opportunities Program and Finance): Earl Adams (AFRD-570), Andrea Basham (AFRC-210), Elizabeth DiVito (AFRC-300), Tiffany Goodwin (AFRC-210), Gregory Peters (AFRC-330), Wanessa Priesmeyer (AFRC-310), and Chloe Tuck (AFRC-570).

NASA Shared Services Center: Karen Artis (NSSC-XD).

Technion (Partnerships, Legal, Management, and Administrative): Aliza Shultzer and Nili Weitzman.

Funding: NASA ARC Center Innovation Fund, NASA Flight Opportunities Program, NASA GSFC Center Innovation Fund, NASA GSFC Internal Research and Development (IRAD) fund, NASA Innovative Advanced Concepts (NIAC), Technion CSST Fund, Israel Ministry of Innovation Science and Technology, and European Union (ERC, Fluidic Shaping, 10104451).

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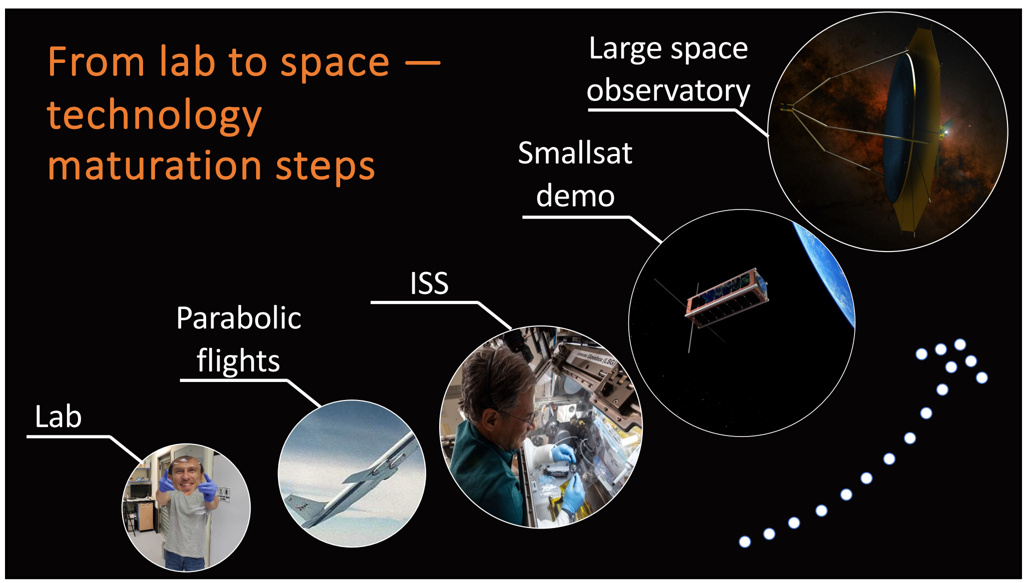

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Technology maturation through flight-testing

Test campaign	Objectives	Status
Zero-G parabolic flights, Dec 2021 • 2 x 25 microgravity parabolas • Technion-led	• Focus on liquid lenses • Confirm fundamental principles and physics • Collect real-time data on lens surface quality and geometry	• Experiments successfully completed — first freestanding liquid lenses created in microgravity • Excellent surface and optical quality observed
ISS experiments, Apr 2022 • 2 x 25 microgravity parabolas • Technion-led execution • NASA-led analysis	• Focus on solidified components • Test both UV and thermal curing approaches • Analyze component geometry and surface quality	• Experiments successfully completed — first optical components created in space • Also fit in a bonus experiment with large liquid lenses • Lenses returned on CRS-25 • Currently being analyzed at Ames
Zero-G parabolic flights, Nov 2022 • 2 x 25 microgravity parabolas • NASA-led	• Focus on mirror surfaces and model validation • Test ALD equipment	• Experiments successfully completed • Equipment being completed and tested
Zero-G parabolic flights, Dec 2023 • 2 x 25 microgravity parabolas • NASA-led	• Focus frame-liquid interaction and surface disturbances models validation	• Frame-liquid interaction and surface disturbance models developed • HW and SW ready to go

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December 2021 parabolic flight tests

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The crew

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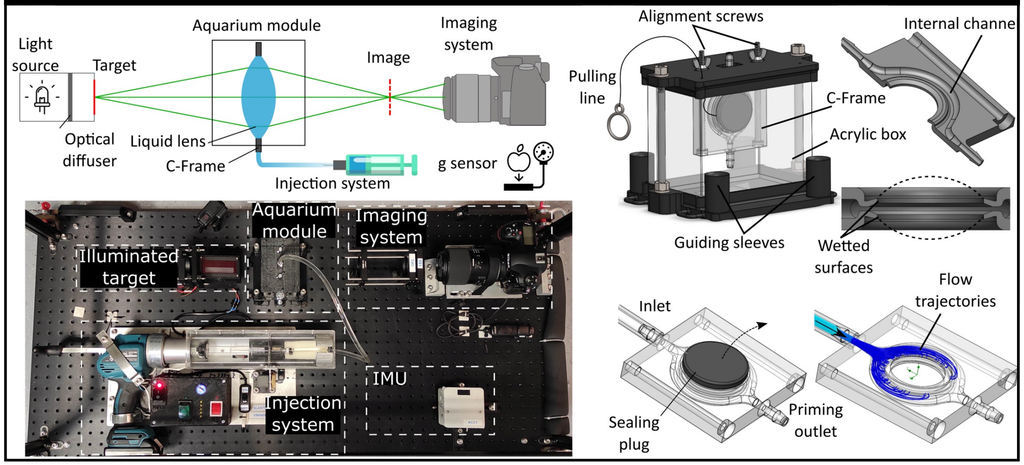
Experimental hardware



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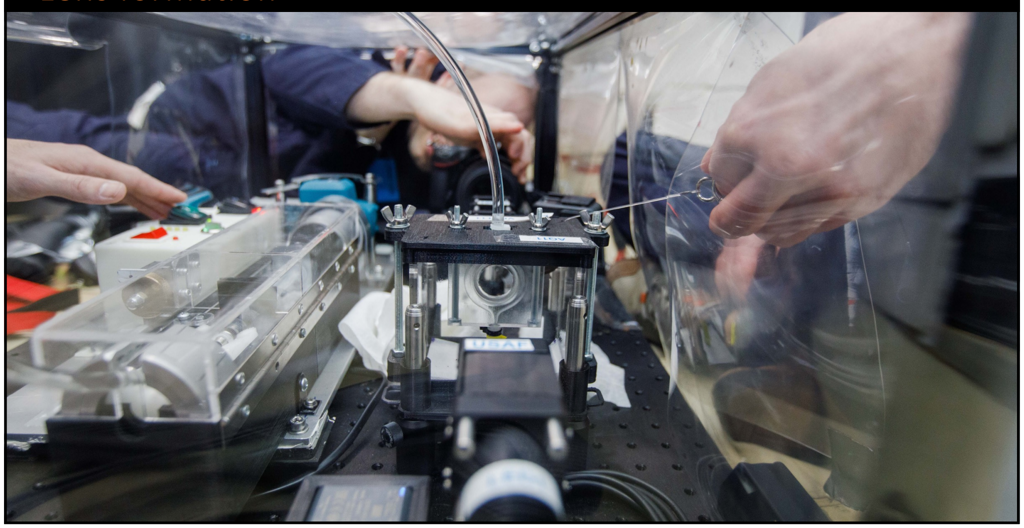
Lens formation



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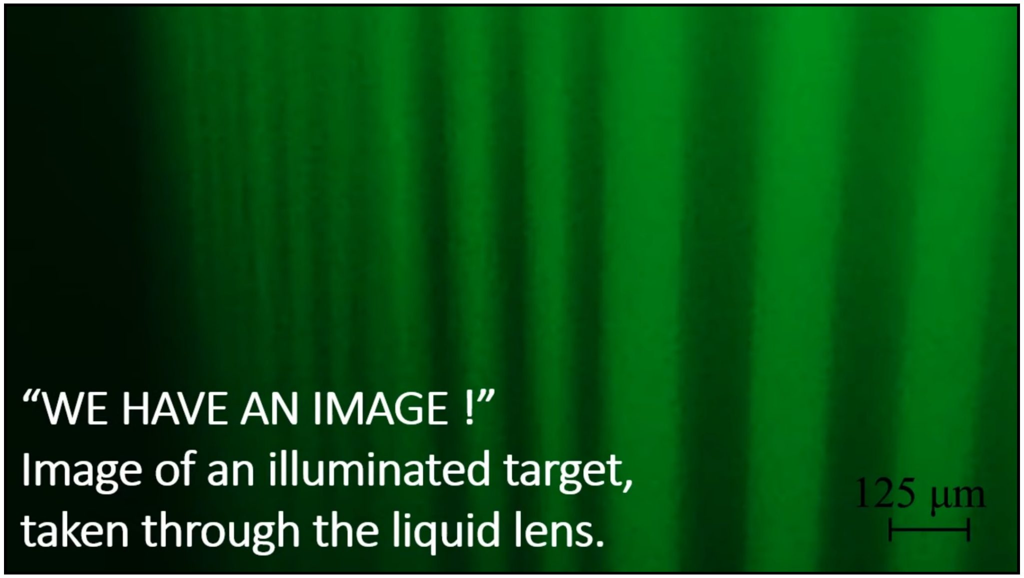

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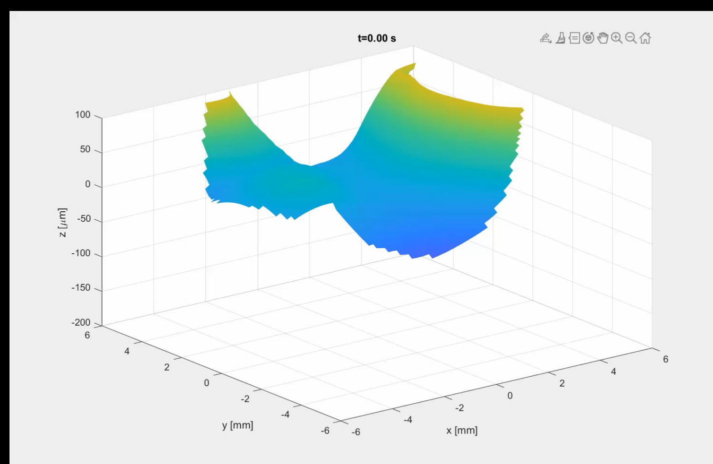
Lens wavefront measurements



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November 2022 parabolic flight tests

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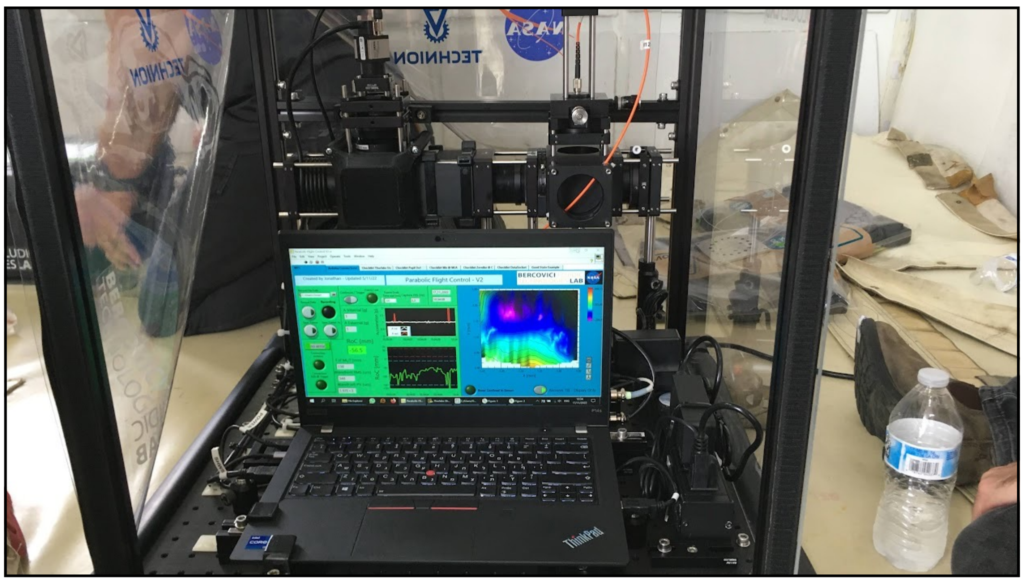

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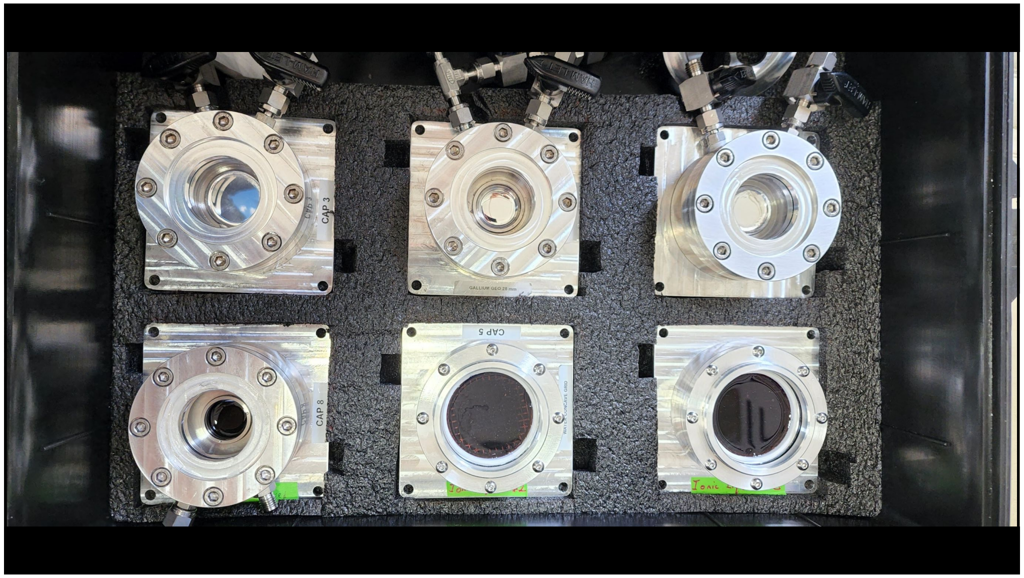

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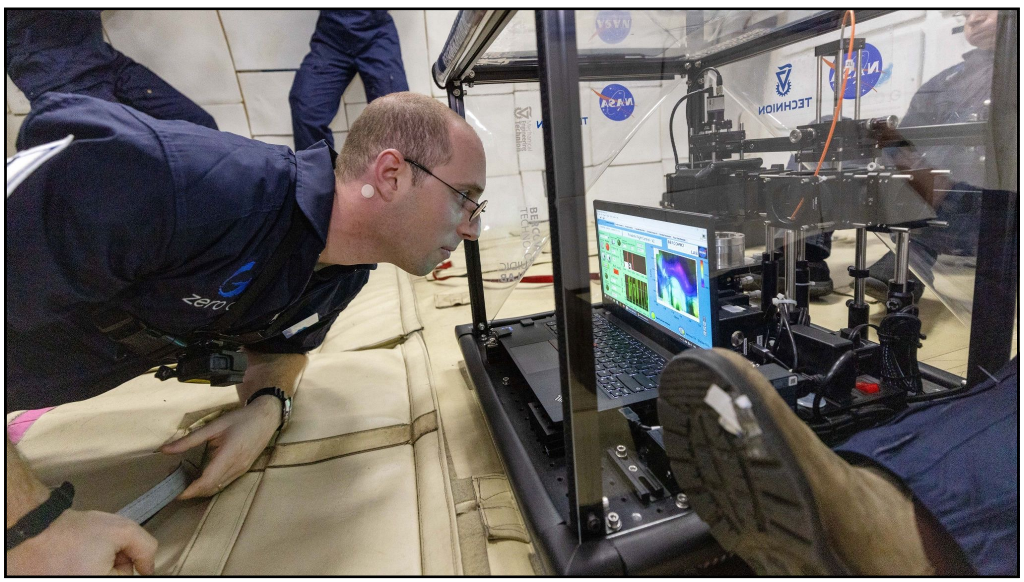

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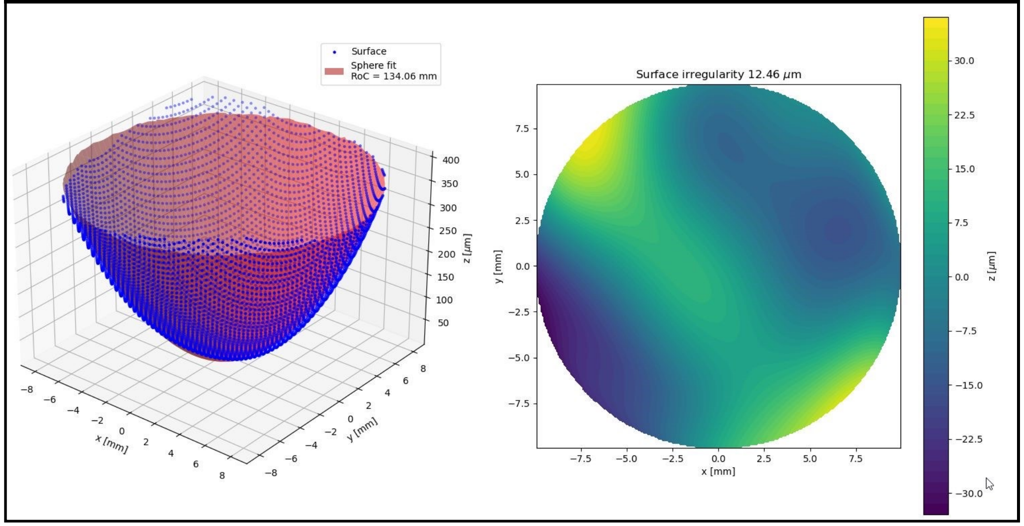
Ionic liquid mirror example



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December 2023 parabolic flight tests (being postponed to 05/24)

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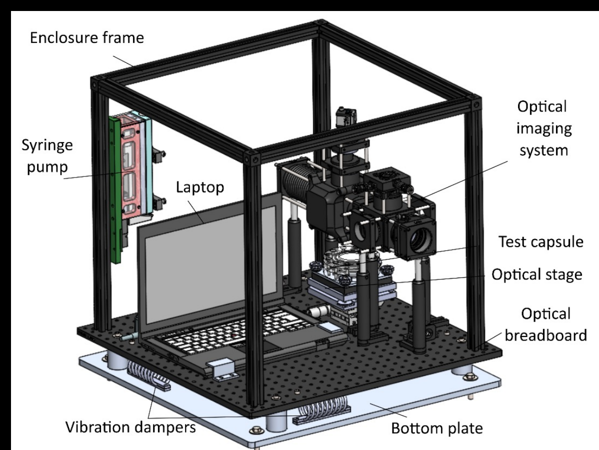
Liquid dynamics experiment



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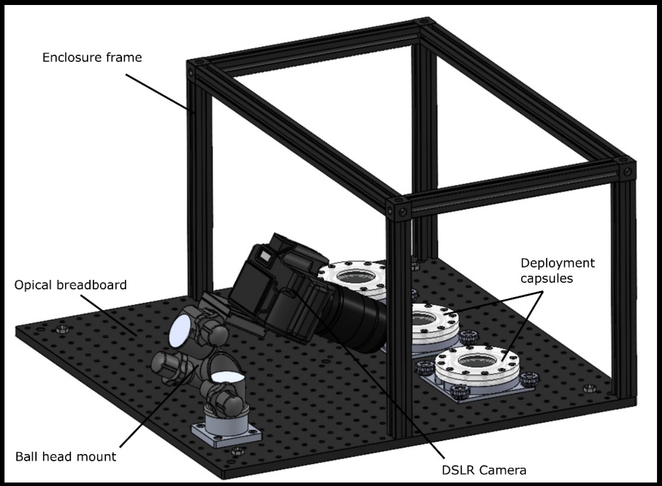
Liquid deployment experiment



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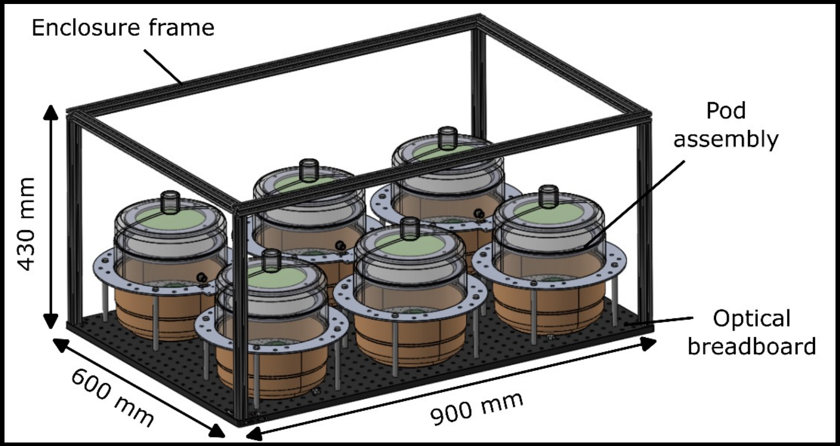
UV curing experiment



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Parabolic flights impact

- Parabolic microgravity flights were an invaluable opportunity for us.
- They allowed us to demonstrate the feasibility of creating liquid optical components in a microgravity environment — nothing convinces people like a credible real-life demonstration.
- It would have been impossible for us to experiment with gallium alloys in a laboratory neutral buoyancy environment, as no suitable immersion liquid exists.
- Similarly, it would have been very challenging to experiment with ionic liquid mirrors in a neutral buoyancy environment, as we cannot solidify them for measurements outside the NB tank and cannot effectively measure the surface with the wavefront sensor through the immersion liquid.

We are sincerely grateful to Flight Opportunities
for making these experiments possible.
Thank you!

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Suborbital flights?
BLUE ORIGIN
• Frame deployment validation
• Liquid deployment techniques validation

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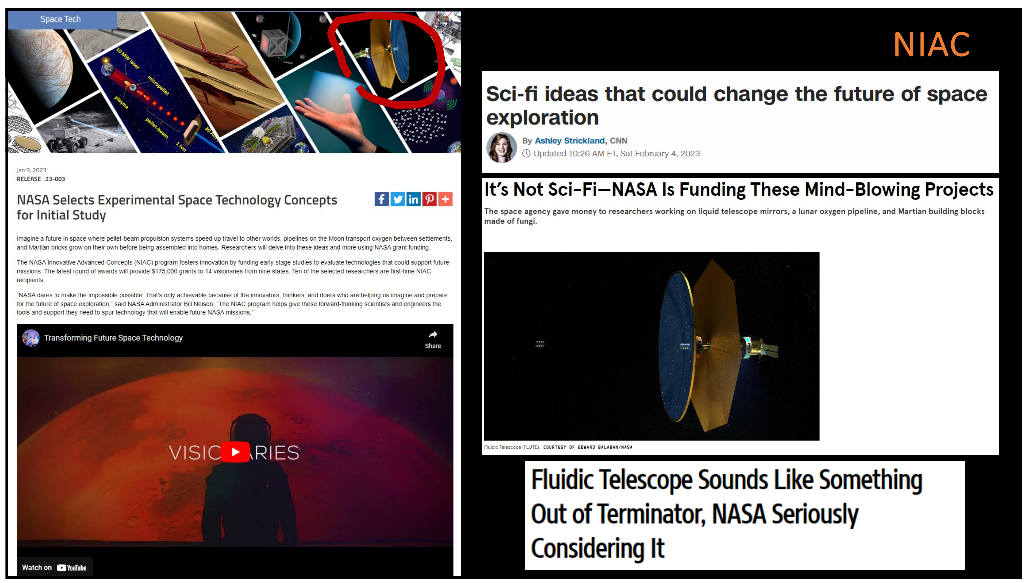
NIAC
Space Tech
Jan 9, 2023
RELEASE 23-003
NASA Selects Experimental Space Technology Concepts for Initial Study
Imagine a future in space where pellet-beam propulsion systems speed up travel to other worlds, pipelines on the Moon transport oxygen between settlements, and Martian bricks grow on their own before being assembled into homes. Researchers will delve into these ideas and more using NASA grant funding.
The NASA Innovative Advanced Concepts (NIAC) program fosters innovation by funding early-stage studies to evaluate technologies that could support future missions. The latest round of awards will provide $175,000 grants to 14 visionaries from nine states. Ten of the selected researchers are first-time NIAC recipients.
"NASA dares to make the impossible possible. That's only achievable because of the innovators, thinkers, and doers who are helping us imagine and prepare for the future of space exploration," said NASA Administrator Bill Nelson. "The NIAC program helps give these forward-thinking scientists and engineers the tools and support they need to spur technology that will enable future NASA missions."
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Sci-fi ideas that could change the future of space exploration
By Ashley Strickland, CNN
Updated 10:26 AM ET, Sat February 4, 2023
It's Not Sci-Fi—NASA Is Funding These Mind-Blowing Projects
The space agency gave money to researchers working on liquid telescope mirrors, a lunar oxygen pipeline, and Martian building blocks made of fungi.
Fluidic Telescope Sounds Like Something Out of Terminator, NASA Seriously Considering It

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F L U T E

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