

Spanish User Support and Operations Centre (E-USOC): activities and research lines

AEE — JORNADA CIENCIA E INDUSTRIA
UAH, 5/2/25

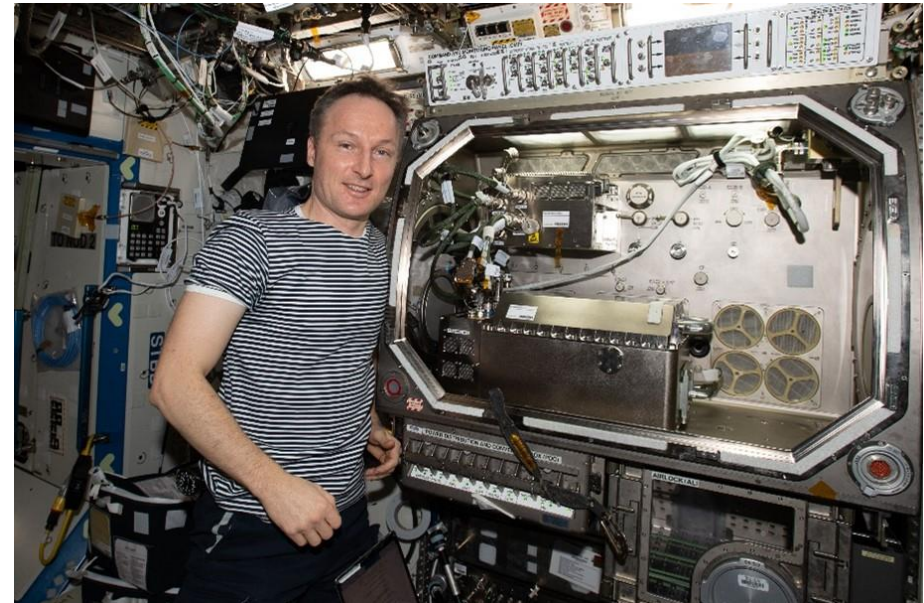
Outline

- **Who are we?**
- **E-USOC:** operations of ESA experiments on the ISS
- **HRE-SDC:** archiving, valorization and publication of ESA-HRE experiments data
- Research lines:
 - **Phase Change Materials (PCMs) and thermocapillary effects**
 - **Fluid (and sloshing) control in microgravity**
 - **Attitude control** in spacecraft
 - The educational satellite: **ESAT**



Who are we?

- **UPM** center specialized in **R&D activities** in the field of **space science** and **technology**
- In charge of the **preparation, execution,** and **post-flight analysis** of **ESA experiments** onboard the **ISS**
- **Responsible** for all **ESA's experiments** performed on **NASA's Microgravity Science Glovebox (MSG)**

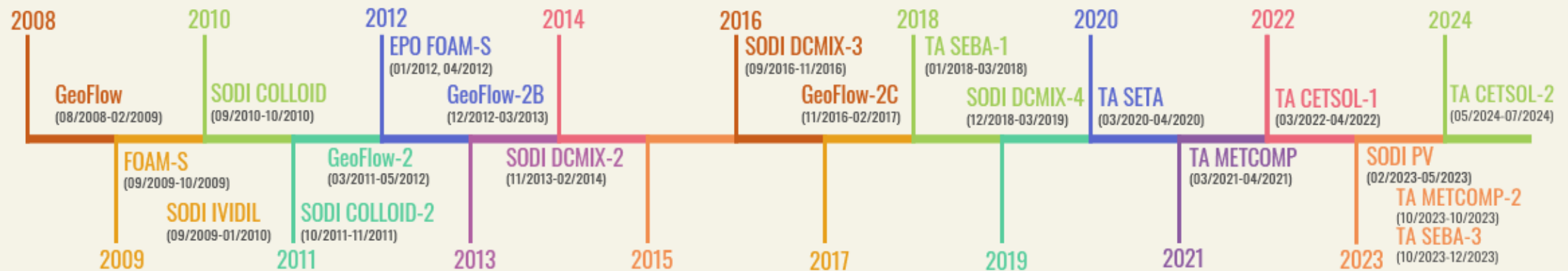


Matthias Maurer (ESA) with the Transparent Alloys instrument in MSG.
Credits ESA and NASA

E-USOC: ESA experiments on the ISS



EXPERIMENTS TIMELINE



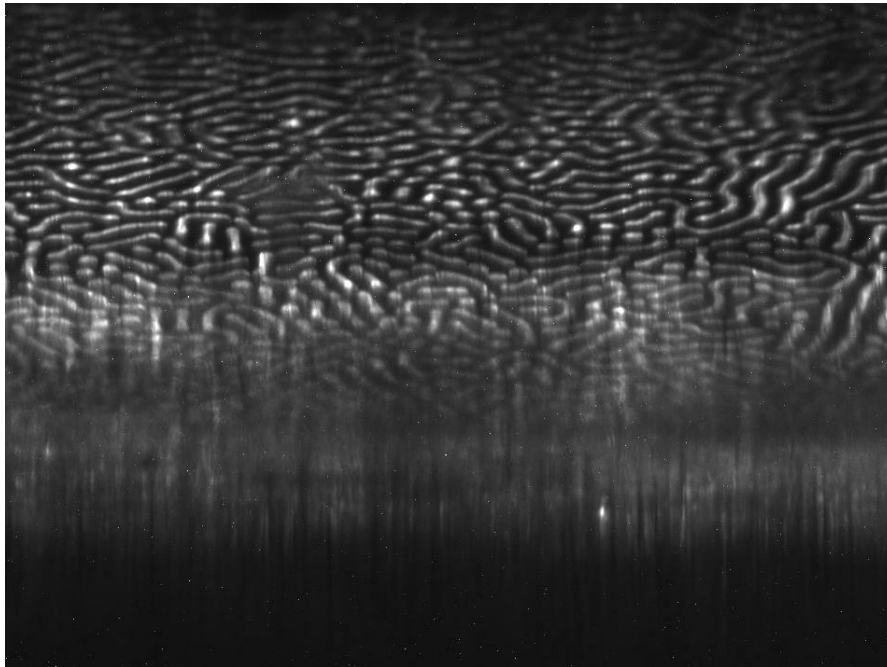
Planned experiments:

Colloidal Solids (2025-28), Giant Fluctuations (2026-29), MarPCM (NET 2026)

E-USOC: ESA experiments on the ISS



Transparent Alloys: Bridgman Furnace to control and monitor the melting and solidification of plastic (transparent) samples at micro-scale level



Transparent Alloys SEBA-1
Directional solidification of a binary mixture:
transition from rod-like to laminae structures.



Transparent Alloys CETSOL-2
Isothermal solidification: transition from columnar to
equi-axed patterns.

HRE-SDC: HRE Science Data Center



Human and Robotic Exploration (HRE) – Science Data Center (SDC)

*“A new entity for **storing, valorising and publishing** the data coming from ESA experiments”*



HRE-SDC: HRE Science Data Center



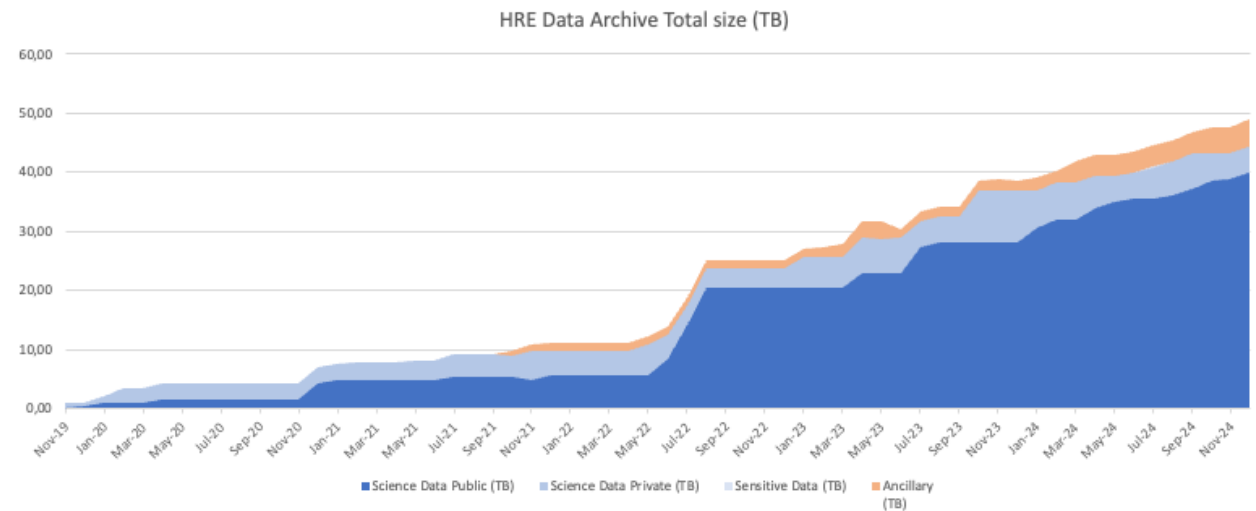
HRE Data Archive

<https://hreda.esac.esa.int/hreda>

*“[...] collects information and **data of investigations** funded by [...] **ESA’s HRE** and performed in **microgravity** and **ground-based facilities** since 1972.”*



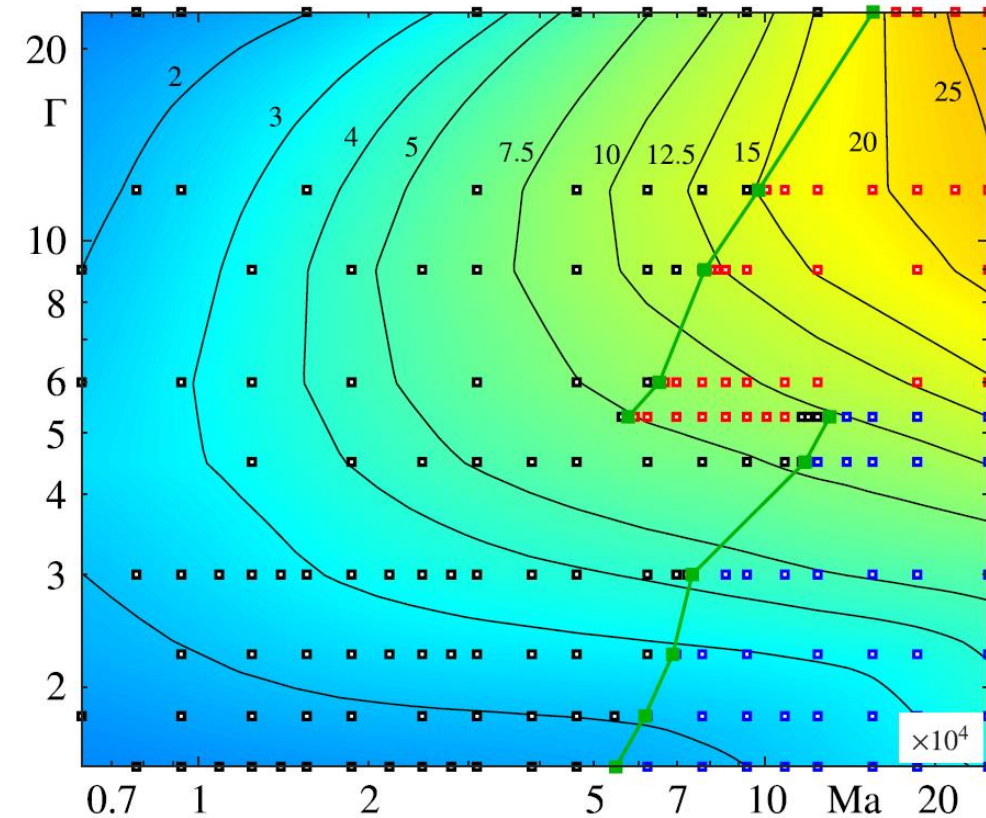
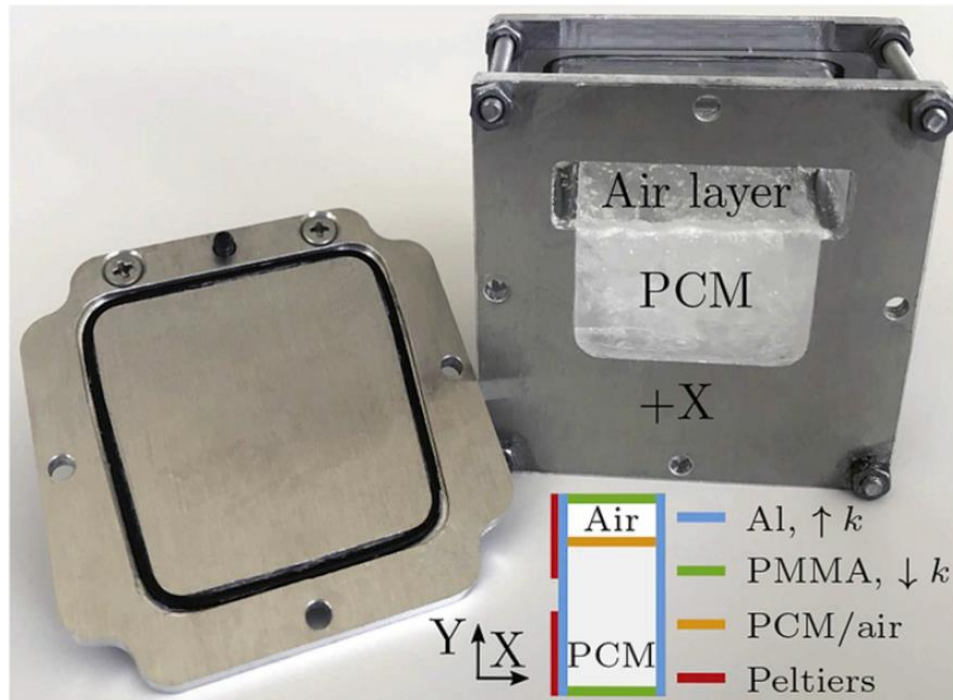
- 84 Investigations
- 2 Platforms
- > 50 TB



Research lines: PCMs and thermocapillary effects



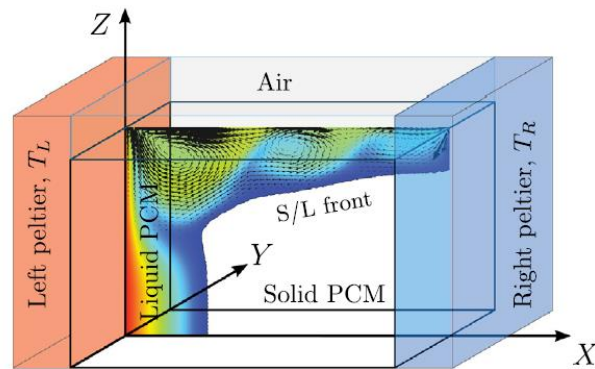
Thermocapillary-enhanced PCMs:



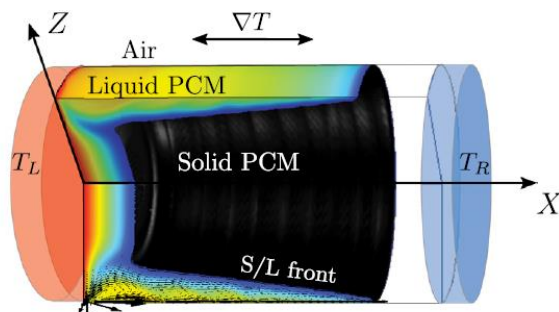
Research lines: PCMs and thermocapillary effects



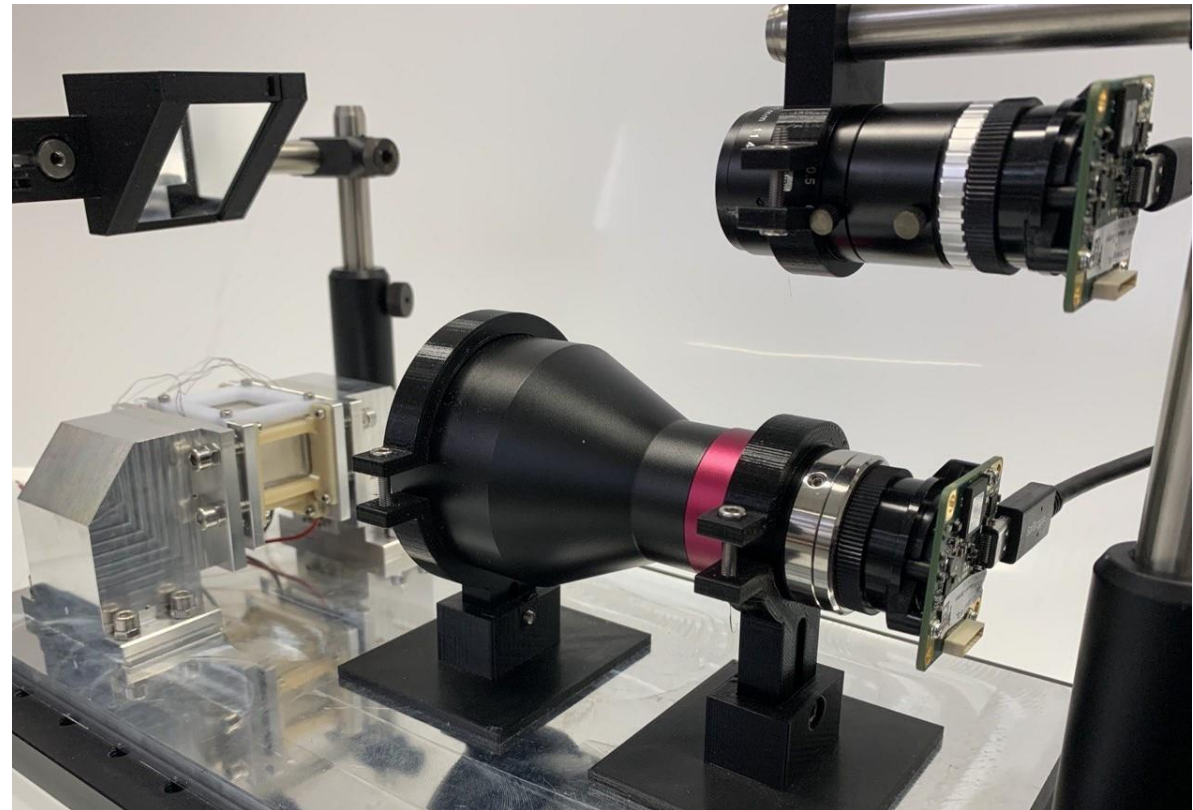
The “Marangoni in Phase Change Materials” (MarPCM) experiment:



(c) Cuboidal geometry



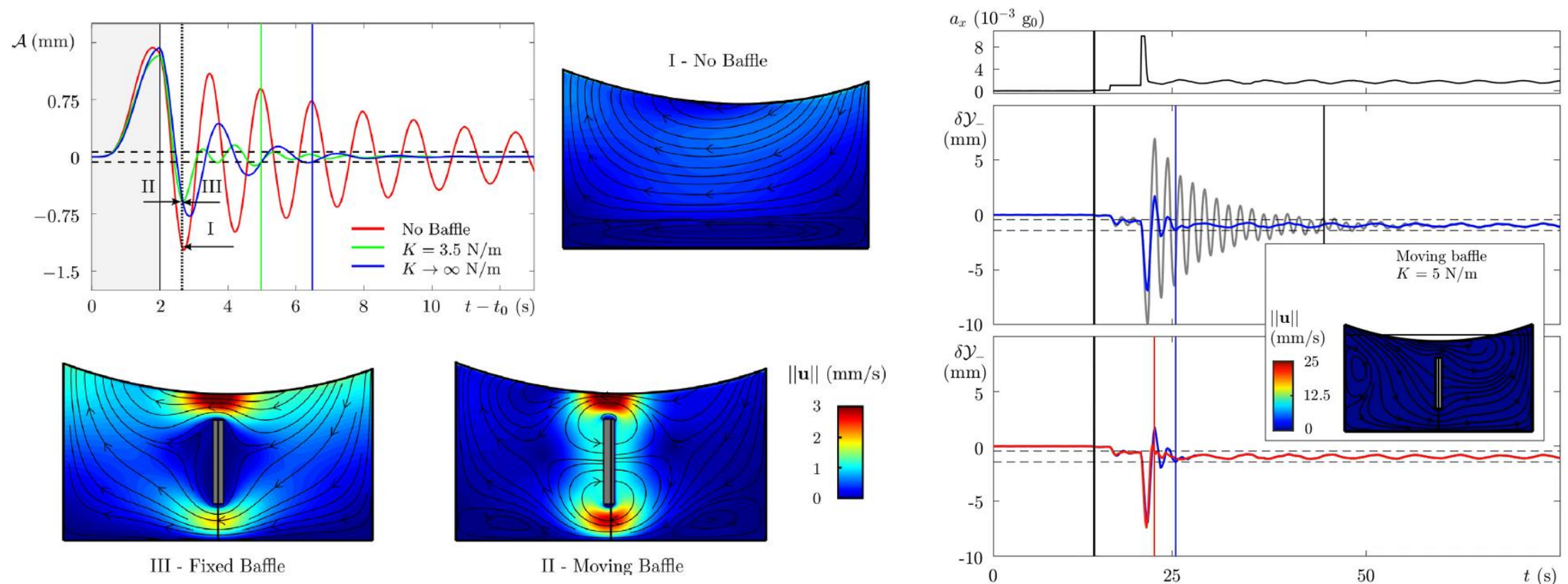
(d) Cylindrical (liquid bridge) geometry



Research lines: Fluid control in microgravity



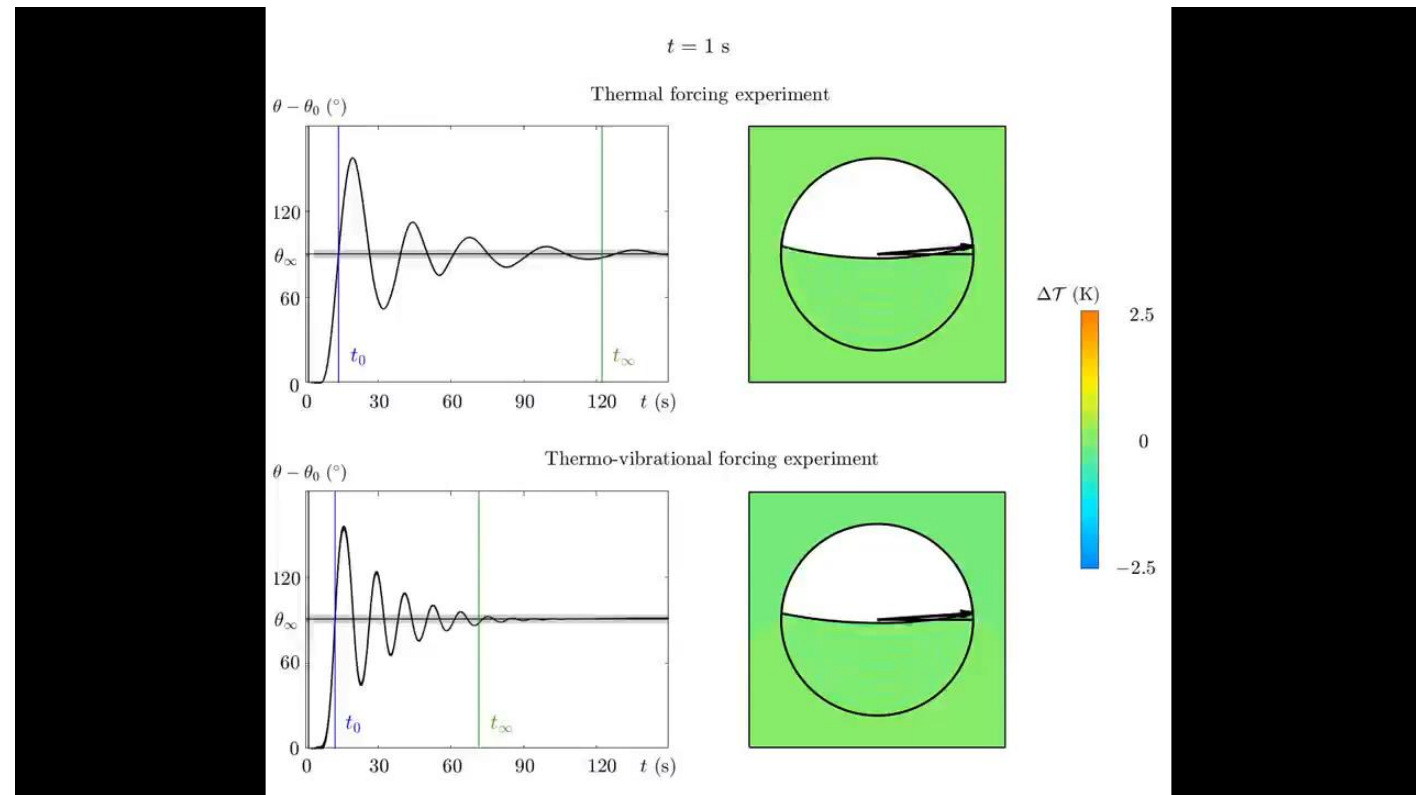
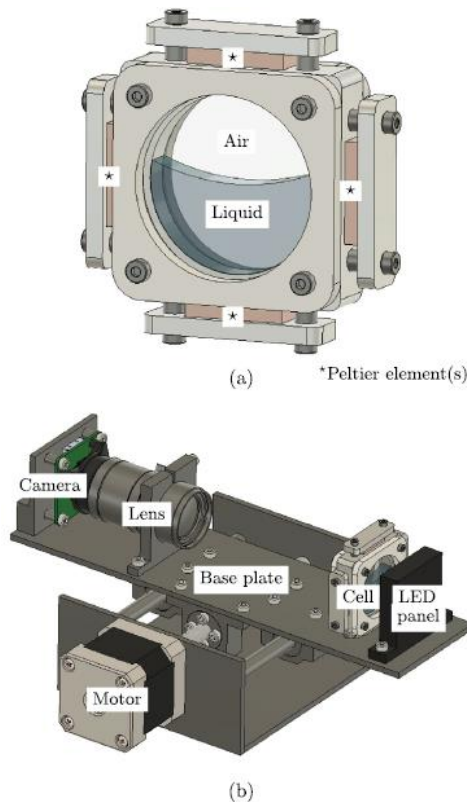
Sloshing reduction: passive oscillating baffles, thermocapillary control



Research lines: Fluid control in microgravity



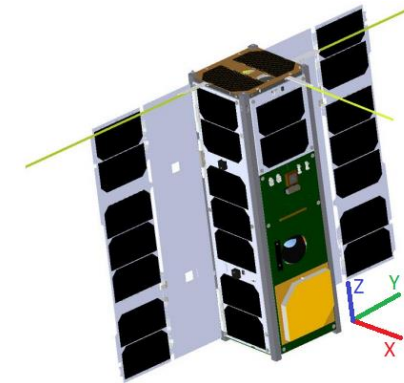
Thermocapillary-based control of fluids: ThermoSlosh experiment



Research lines: Attitude control in spacecraft

- Development of control algorithms based on **fuzzy logic**
- Analysis of optimal fuzzy controllers: **error vs. cost**
- Evaluation and validation of fuzzy controller's performance via **simulations, ground (using ESAT) and future onboard experiments.**

ESA satellite OPS-SAT

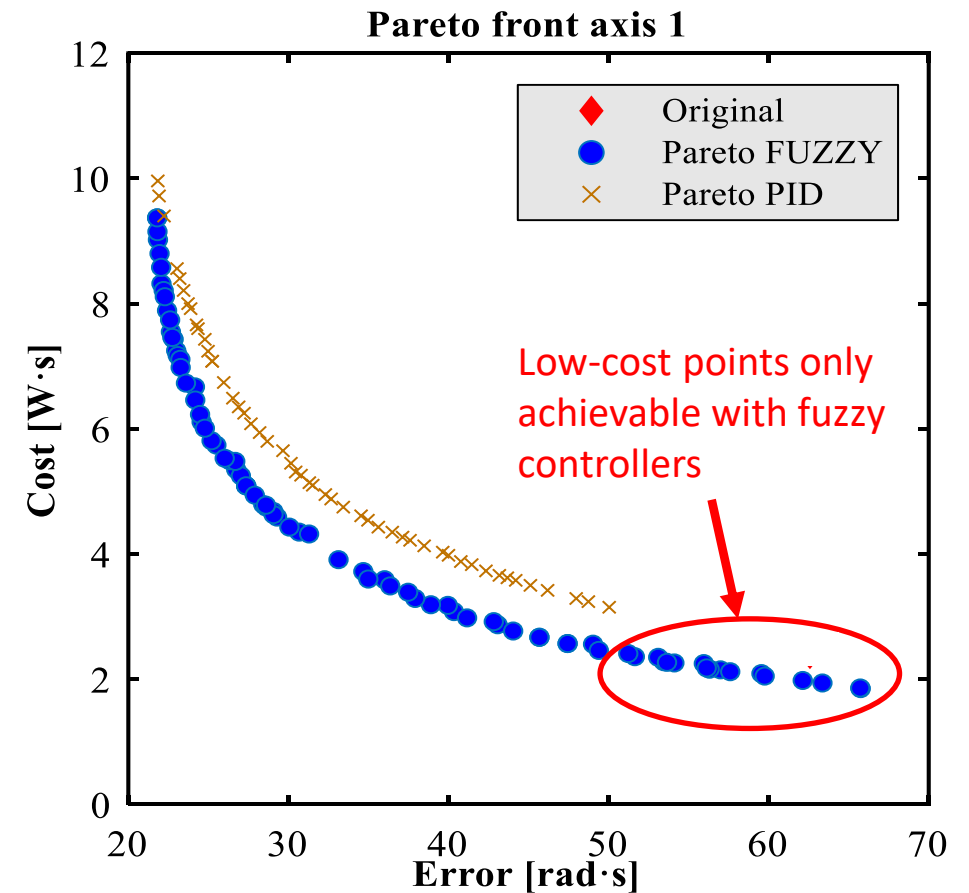


FuzzyBuzz in Astrobee (ISS)



Research lines: Attitude control in spacecraft

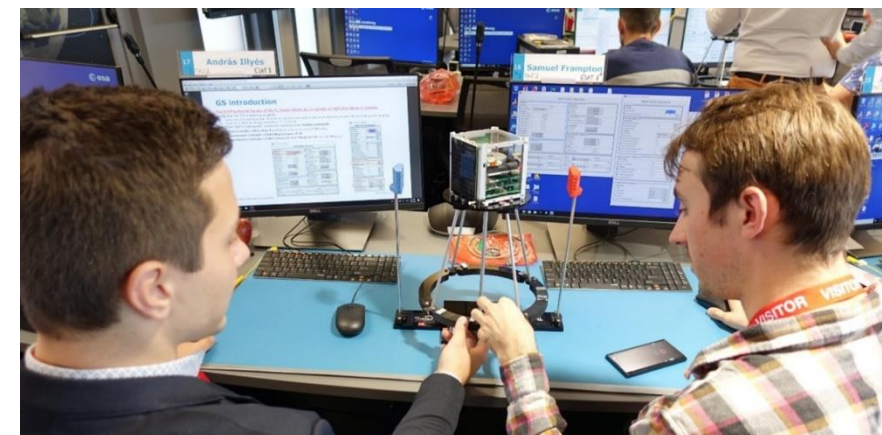
- Fuzzy controllers provide **better performance** than PID controllers in terms of **cost-accuracy**
- Fuzzy controllers significantly outperform PID controllers for low power consumption requirements
- Robustness of the fuzzy controllers verified using Monte Carlo tests



Research lines: ESAT



- **Development (and sale) of the educational/laboratory CubeSat ESAT:**
 - Subsystems: ADCS, COM, OBC, DHS, EPS
 - Free SW
 - Magnetic field and Sun simulators
- Used for teaching in:
 - **Master's degree in Aerospace Engineering at UPM**
 - **ESA Academy CubeSat Hands-on trainings**
- **More than 100 units** acquired by over **50 universities/institutions** worldwide.



Thanks for your attention!

