



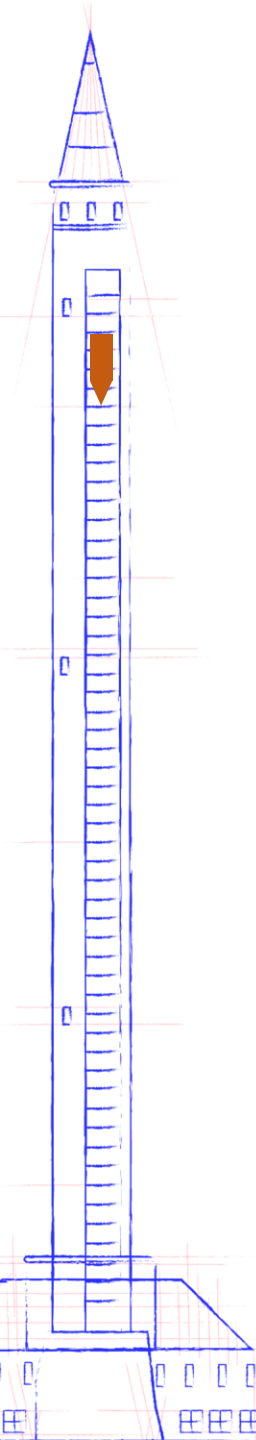
Investigating the ferrofluid sloshing in microgravity UNOOSA DropTES Programme 2019



Antonio J. García-Salcedo
Aeronautical & Space Engineer, MSc

Webinar for the Hypergravity/Microgravity track
Physical Science Part 2: Fluid dynamics

1. Background



1 - Seville



Plaza de España, Seville

BSc Aerospace Eng., MSc Aeronautical Eng.

2 - Milan



Duomo, Milan

MSc Space Eng.

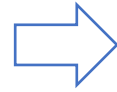


2. Motivation

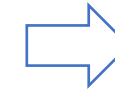
Liquid sloshing



μg environment



- Unpredictable
- Unstable
- Heavy control devices in satellites



Space mission

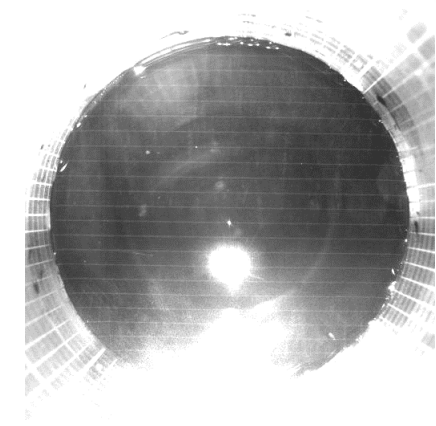
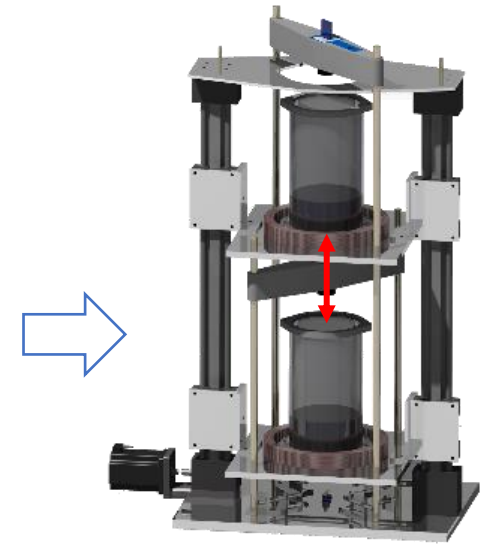
- T A TS-V, Intelsat IV series
- NEAR Shoemaker
- Gravity Probe B.1



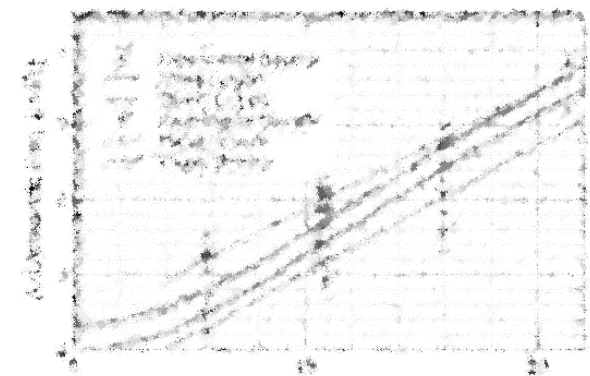
3. Liquid sloshing in space, our solution

Can we use magnetic fields to reproduce gravity?

- Predictable
- Stable
- Light control devices in satellites



2017



Discrepancy in frequency-current slope

Why is this happening?



Need for further experiments

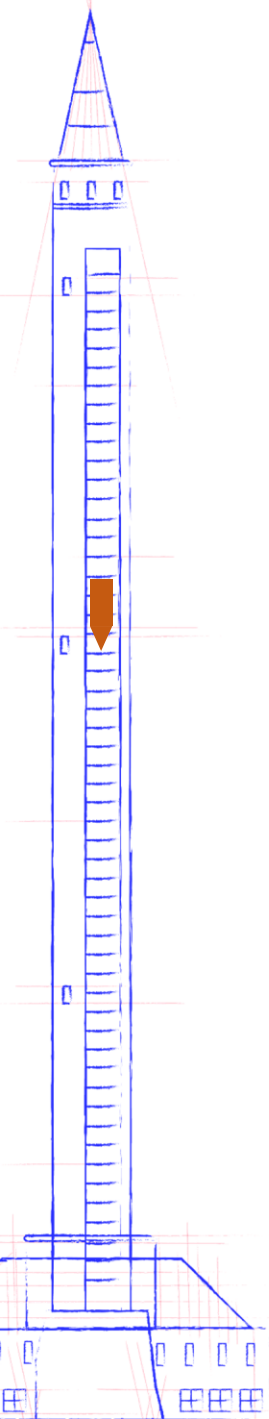


2019



Romero-Calvo et al., Axisymmetric ferrofluid oscillations in a cylindrical tank in microgravity, *Microgravity Science & Technology*, under review

4. UNOOSA DropTES - StELIUM



ZARM's drop tower

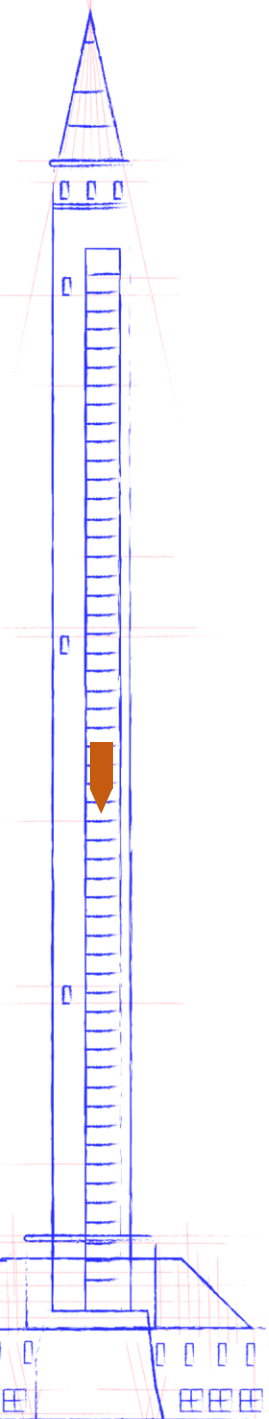
- 4.5 – 9.3 s in μg
- $10^{-6} g$
- 2 – 4 drop/day
- Low cost

StELIUM (Sloshing of magnEticLIquids in Microgravity)



StELIUM team in Politecnico di Milano

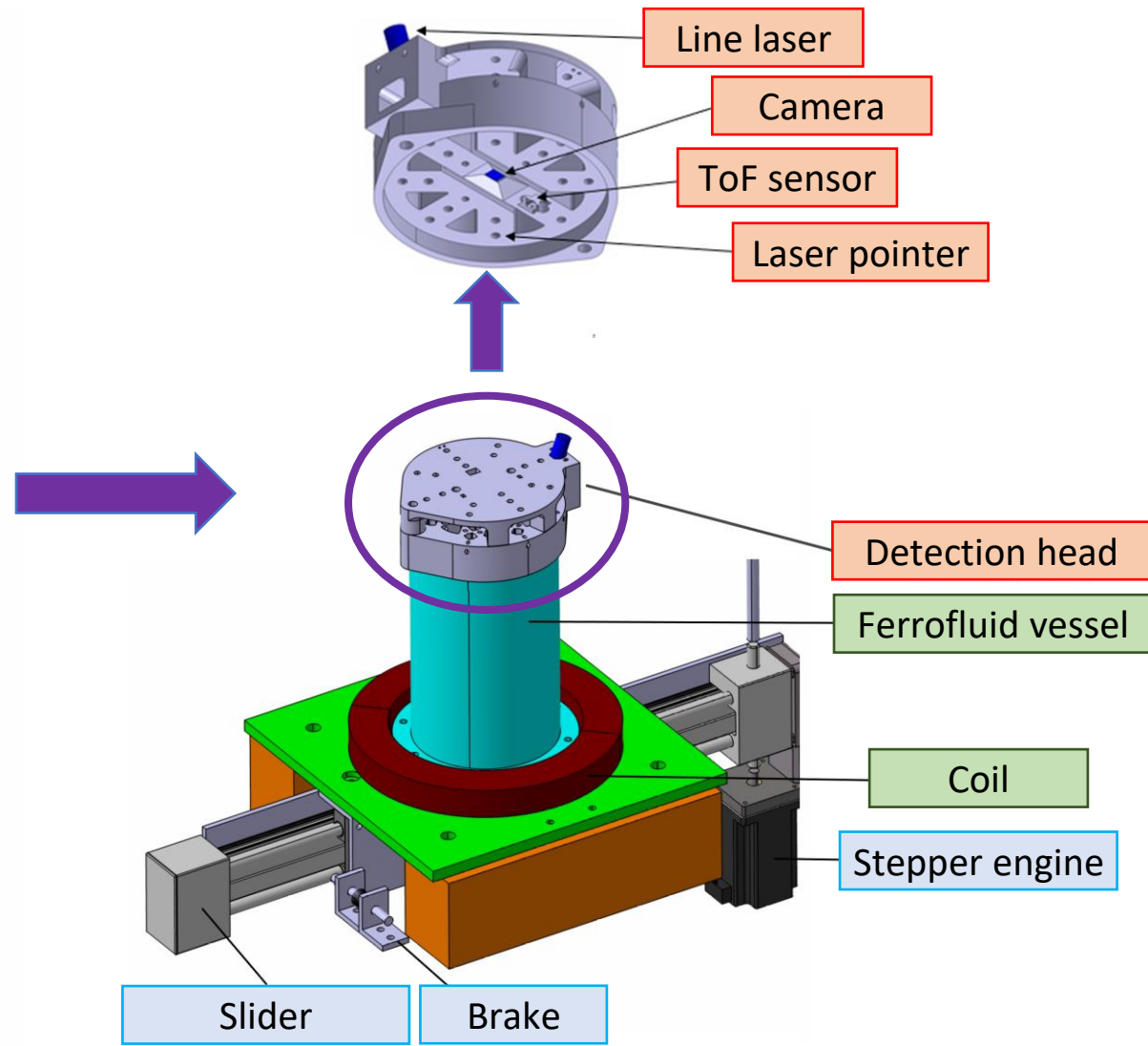
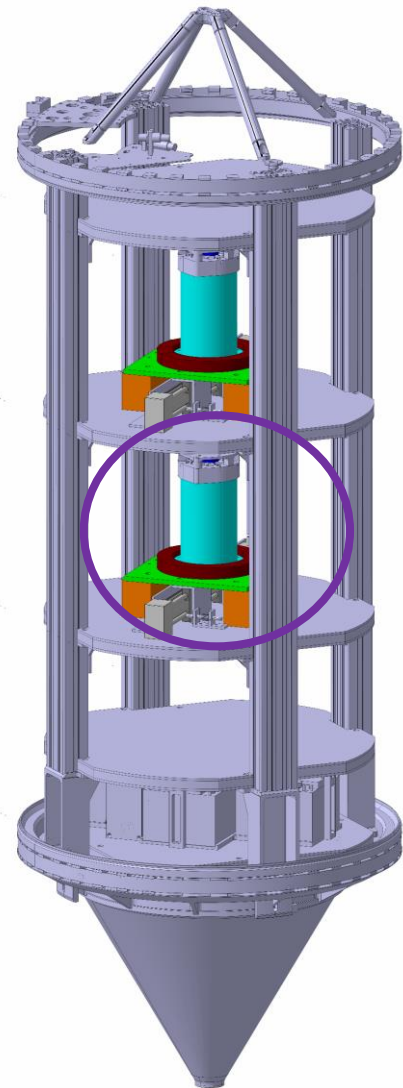
5. StELIUM – Experiment setup



Actuation subsystem

Detection subsystem

Magnetic subsystem

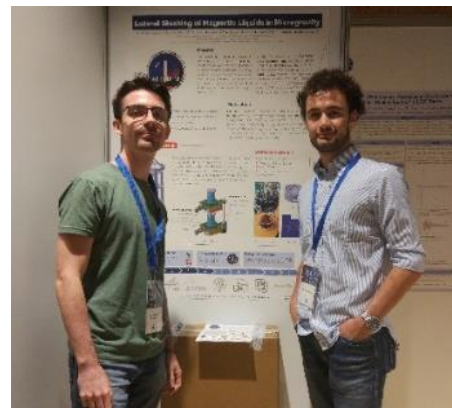


6. StELIUM public impact

Great public outreach!



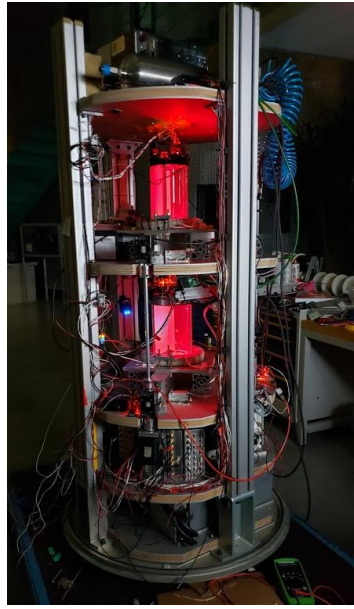
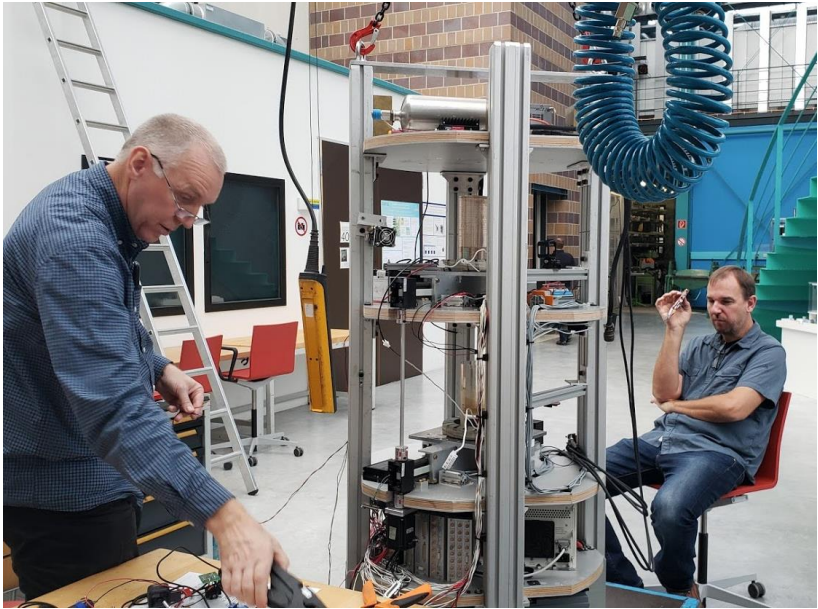
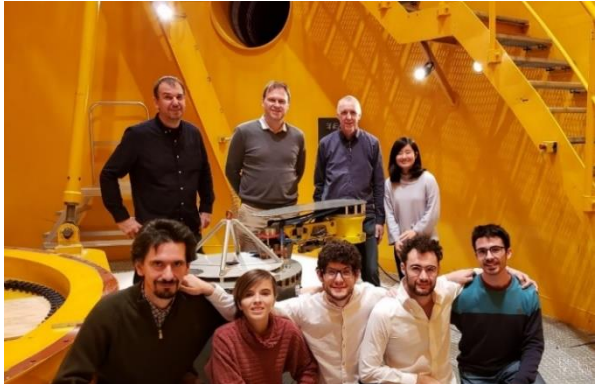
26th ELGRA Symposium and General Assembly - Spain

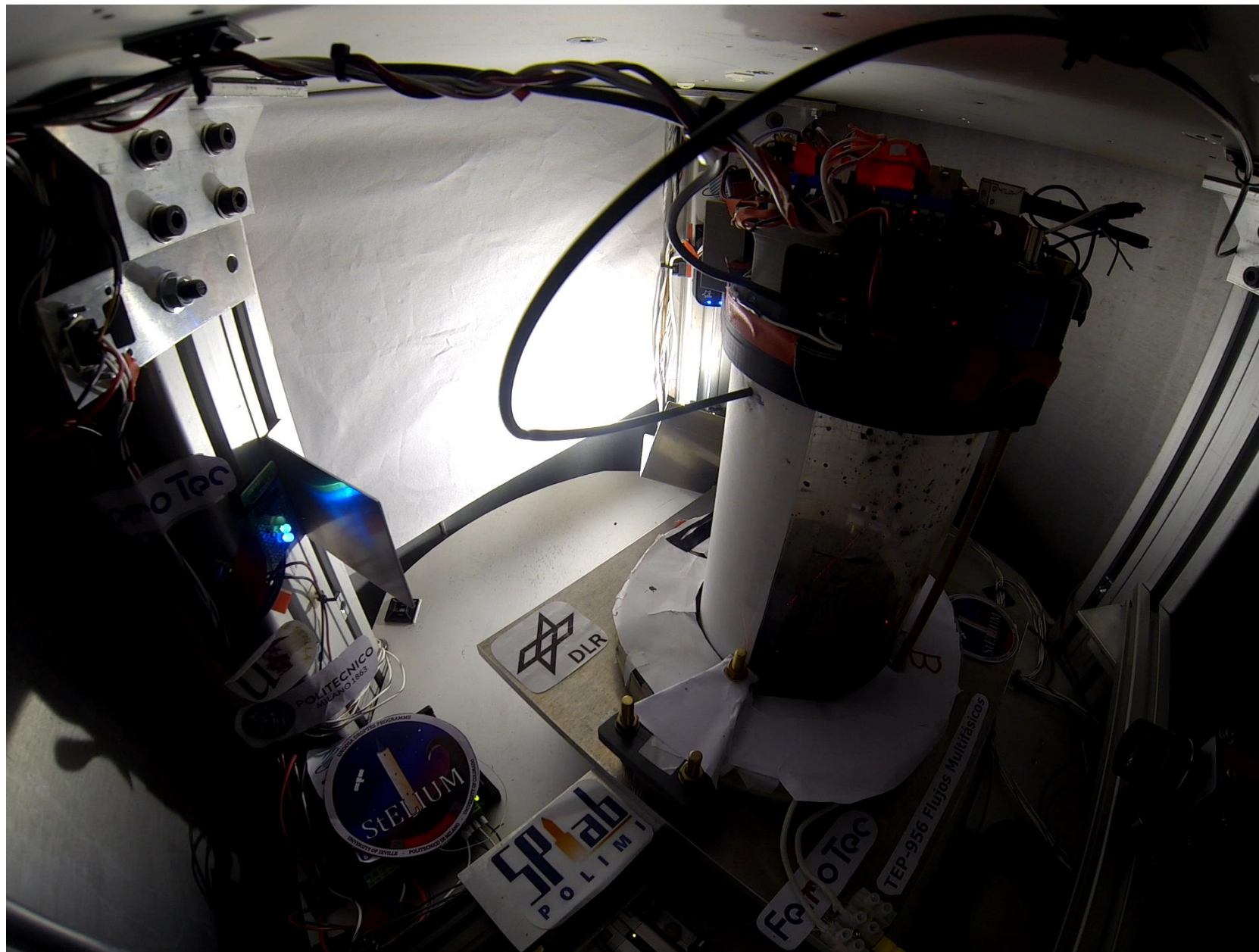
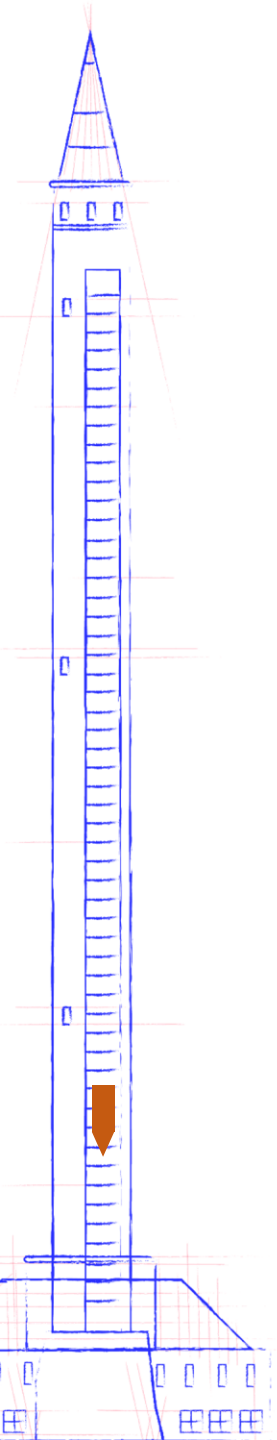


7. ZARM's drop tower campaign

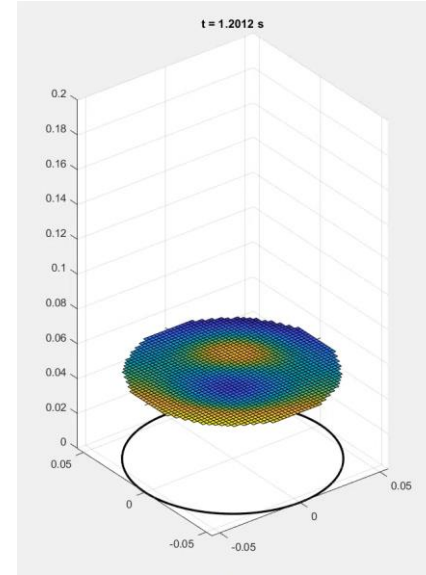
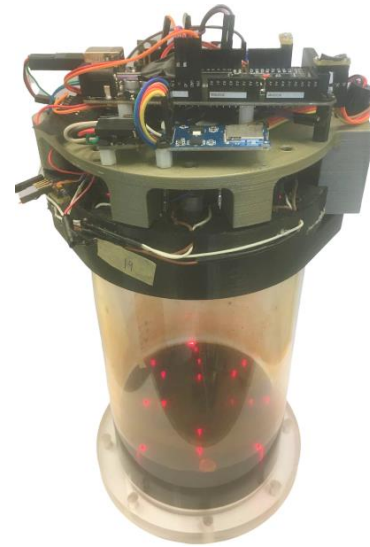
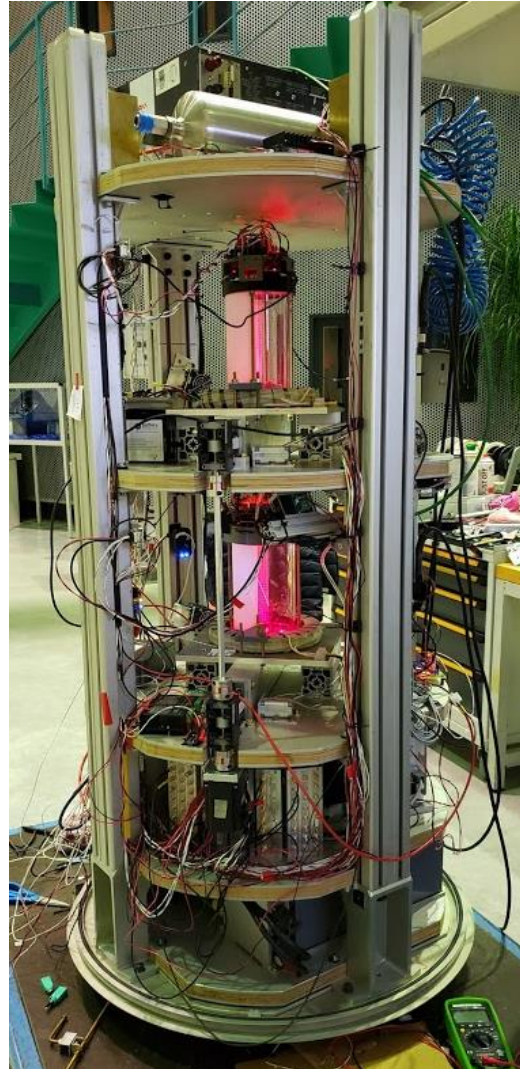


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8. Post campaign



Materials Sciences in Space (G)
Drop Tower Days (G0.2)
Consider for oral presentation.

AXISYMMETRIC AND LATERAL FREE SURFACE OSCILLATIONS OF FERROFLUIDS IN MICROGRAVITY

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ELSEVIER

stELIUM: A student experiment to investigate the sloshing of magnetic liquids in microgravity

Á. Romero-Calvo^{a,b}, A. J. García-Salcedo^b, F. Garrone^b, I. Rivoalen^b, G. Cano-Gómez^c, E. Castro-Hernández^d, M.Á. Herrada Gutiérrez^d, F. Maggi^b

Free surface reconstruction of opaque liquids in microgravity. Part 2: results of drop tower campaign

Á. Romero-Calvo^{a,b,c}, F. Garrone^b, A. J. García-Salcedo^b, I. Rivoalen^b, G. Cano-Gómez^c, E. Castro-Hernández^d and F. Maggi^b

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ARTICLE INFO ABSTRACT

Free surface reconstruction of opaque liquids in microgravity. Part 1: design and on-ground testing

Á. Romero-Calvo^{a,b,c}, A. J. García-Salcedo^b, F. Garrone^b, I. Rivoalen^b, G. Cano-Gómez^c, E. Castro-Hernández^d and F. Maggi^b

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LATERAL SLOSHING OF MAGNETIC LIQUIDS IN MICROGRAVITY

Á. Romero-Calvo^{1,*}, A. J. García-Salcedo¹, I. Rivoalen¹, F. Garrone¹, G. Cano Gómez², E. Castro-Hernández³, M. Á. Herrada Gutiérrez³, F. Maggi¹,

9. Space opportunities for students



- DropTES
- KiboCUBE
- Space4Youth competition
- Webinar series



- Workshops for students
- Drop Your Thesis
- Spin Your thesis
- Fly your thesis
- Conference sponsorship
- YGT

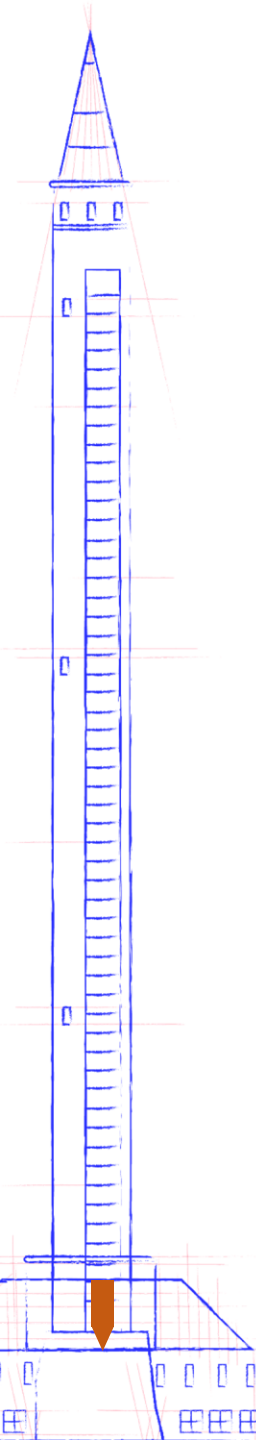


- Conference sponsorship
- Mentorship
- Webinar series
- Challenges



Top 3 tips

1. Explore
2. Be proactive
3. Get in touch



Thanks for your attention

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Space Propulsion Laboratory, Polimi



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PhD Student
University of Colorado Boulder



Inés Rivoalen
Space Navigation Intern
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Drop tower image credit:
Isabel Romero Calvo