RÉPUBLIQUE FRANÇAISE
*Liberté Égalité Fraternité*

CNES CENTRE NATIONAL D'ÉTUDES SPATIALES

comet Les communautés d'experts

# COMET SCA

## Modelling and Control of Propellant Sloshing

## Monday, OCTOBER 26, 2026

## CONTEXT

The CNES **Control Systems and Automation (SCA) COMET** is pleased to invite you to attend a one-day event dedicated to the challenges of modelling and controlling propellant sloshing to ensure the pointing performance of satellites and launch vehicles.

This event will provide an opportunity to review recent advances and ongoing challenges in this field, through presentations and discussions involving key players from the space sector. A previous event on this topic was held in 2018, and this new edition aims to bring the community together once again to share the progress made since then. Discussions will focus on simulation and model validation issues, as well as control and slosh mitigation strategies.

## INSCRIPTION

Participation is free of charge and **subject to registration**.

The event will be held in a hybrid format, and you will be asked during registration to indicate whether you will attend in person in Toulouse or via videoconference (Teams).

**Registration link :** https://evenium.events/t06ecu8q/
Deadline : **2026/10/02**

## PRACTICAL INFORMATION

The seminar will be held at the **CNES Toulouse site**, in the **LEONARD DE VINCI room**. Participants attending in person should enter through the **NORTH Entrance**, located at **18 Avenue Edouard Belin, 31400 Toulouse**.

For those attending remotely, a **Microsoft Teams link** will be sent by email on the day before the event, **October 23, 2026**.

## ON-SITE ATTENDANCE: ACCESS REQUIREMENTS

As the CNES site is designated as a **Restricted Area (ZRR – Zone à Régime Restrictif)**, specific access requirements apply to participants attending the seminar in person:

- **All external visitors** (i.e. visitors who do not hold a CNES access badge) must provide, by October 2, 2026, **the number of their national identity card or passport**. This document must be valid on the day of the COMET and will need to be presented at the CNES reception desk upon arrival. This will ensure that visitor badges are ready upon arrival.

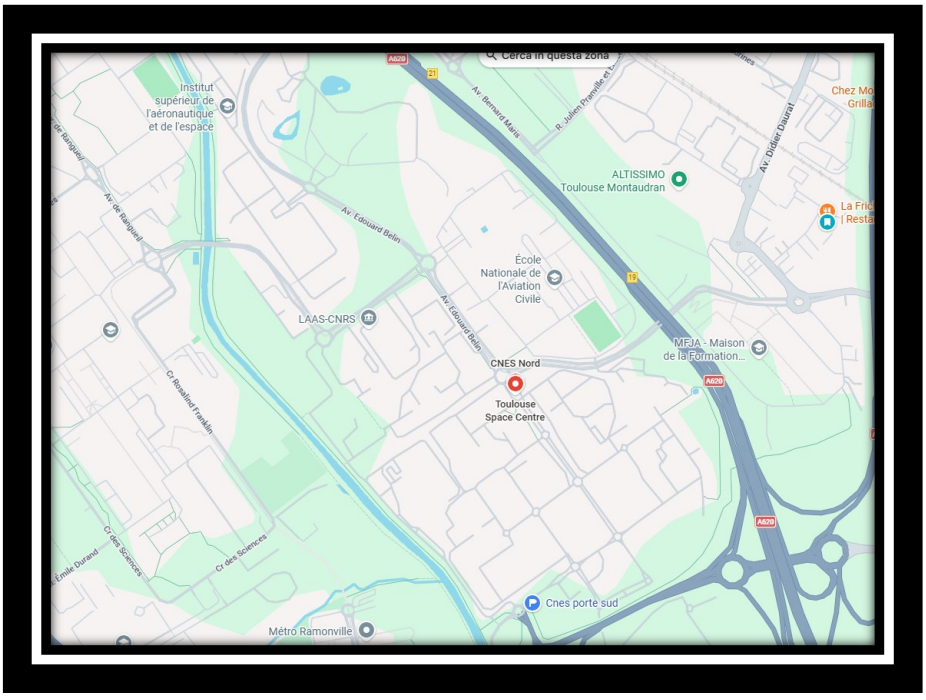
- In addition, **visitors who are not European nationals** must send, by October 2, 2026, a **copy of their identity document**, which must remain valid on the day of the COMET (front and back of the ID card, or the passport page showing the photograph).

This information should be sent to: magalie.visotti.external@cnes.fr ; comet-sca@cnes.fr

## ACCESS MAP

Access to the CNES Toulouse site will be via the **NORTH Entrance**:

18 Avenue Edouard Belin
31400 Toulouse
France




To reach the entrance by public transport, you can:

- From “Université Paul Sabatier” station on Metro Line B, take Bus L7 towards “Saint-Orens Piscine” and get off at “CNES – IAS” bus stop

- From “Ramonville” station, the terminus of Metro Line B, take Bus 37 towards “Jolimont” and get off at “CNES – IAS” bus stop.

# PROGRAMME

Abstracts of the various topics to be presented are available in the appendix.

The programme is subject to change and may be updated accordingly.

**CADMOS Visit (optional):**

To conclude the seminar, we invite you to discover **CADMOS**, the CNES centre dedicated to experiments and operations in microgravity. The visit **is optional and available by registration, subject to availability**. Please remember to select this option on the registration form when registering for the seminar.

| Dura-tion | Start | End | Title | Place |
|---|---|---|---|---|
| 0:20 | **9:00** | 9:20 | **Reception of external participants (Non-CNES visitors)** | **NORTH Entrance – CNES CST** |
| 0:30 | **9:30** | 10:00 | **COMET Welcome: All participants** | **Léonard DE VINCI room** |
| | | | | **Speaker** |
| 0:15 | 10:00 | 10:15 | **Introduction** | COMET SCA |
| 0:30 | 10:15 | 10:45 | Vision-Based Fluid Characterization in Microgravity: Enhancing Inertial Measurements through Digital Image Processing | **Claire THEVENOT, Xavier MANUEL JUANPERE (Airbus Defence and Space)**<br><br>**Clément BAZERQUE (Magellium)** |
| 0:30 | 10:45 | 11:15 | Modelling and Control of Propellant Sloshing in Microgravity | **Umberto ZUCCHELLI (ISAE SUPAERO)** |
| 0:30 | 11:15 | 11:45 | Design and preliminary validation of advanced control systems for slosh attenuation with application to the FLUIDICS-L model | **Jean-Marc BIANNIC, Clément ROOS, Mario CASSARO (ONERA)** |
| 1:15 | 11:45 | 13:00 | **Lunch & FLUIDICS Equipment Presentation** | |
| 0:30 | 13:00 | 13:30 | Action GDR MACS AC-RoFLo. / Reduced-order predictor feedback for LTI systems with input delay | **Jesus-Pablo TOLEDO-ZUCCO (LAAS)** |
| 0:30 | 13:30 | 14:00 | Sloshing Dynamics and Mitigation Strategies for Launchers | **Benoît VINIERE (ArianeGroup)** |
| 0:30 | 14:00 | 14:30 | MaiaSpace launcher sloshing challenges and opportunities | **Martine GANET, Yohan BLACODON, Coralie SOURGEN (MaiaSpace)** |
| 0:30 | 14:30 | 15:00 | Real-time System Identification as Enabler of Versatile Missions | **Charles DEHOMBREUX (Airbus Defence and Space)** |
| 0:30 | 15:00 | 15:30 | **Break** | |
| 0:30 | 15:30 | 16:00 | The Rutgers SPICESat Mission: Towards Low-g Fluid Sloshing Data Collection and In-Flight Mitigation Testing | **Laurent BURLION (Rutgers University)** |
| 1:00 | 16:00 | 17:00 | Round Table | **All** |
| 0:30 | 17:00 | 17:30 | Sur inscription : visite du CADMOS | **Jérôme DANIEL (CNES)** |
| **End of the day** | | | | |

# APPENDIX : ABSTRACTS

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| 10:15 | **Vision-Based Fluid Characterization in Microgravity: Enhancing Inertial Measurements through Digital Image Processing** | **Claire THEVENOT, Xavier MANUEL JUANPERE (Airbus Defence and Space)**<br><br>**Clément BAZERQUE (Magellium)** |

This study presents promising results on the application of image post-processing in conjunction with force sensors, marking a significant advancement over data collected in the FLUIDICS experiment from 2017 to 2023. While force sensors are valuable, they are susceptible to parasitic noise and may struggle with precision, especially for small movements. Image processing offers a complementary solution, enhancing our understanding of complex domains like capillary domain. The study identified limitations and recommendations, providing a roadmap for future improvements, aiming to enhance the precision of force sensors and open new research avenues.

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| 10:45 | **Modelling and Control of Propellant Sloshing in Microgravity** | **Umberto ZUCCHELLI (ISAE SUPAERO)** |

Future spacecraft carrying significant liquid propellant and lightweight flexible appendages can exhibit strongly coupled dynamics, as microgravity sloshing generates forces and torques that interact with spacecraft motion and structural modes. High-fidelity two-phase CFD and fluid–structure interaction simulations, based on the DIVA solver previously validated against FLUIDICS microgravity experiments aboard the International Space Station, are used to investigate these nonlinear interactions and provide reference data for coupled rigid–liquid–flexible configurations. Complementary reduced-order mechanical models enable rapid prediction across operating conditions, uncertainty analysis, and control design, while the high-fidelity CFD/FSI framework provides a nonlinear numerical environment in which the resulting controllers can be assessed with the resolved sloshing and structural coupling restored.

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| 11:15 | **Design and preliminary validation of advanced control systems for slosh attenuation with application to the FLUIDICS-L model** | **Jean-Marc BIANNIC, Clément ROOS, Mario CASSARO (ONERA)** |

This presentation focuses on comparing robust and adaptive control strategies for a slosh attenuation problem in the context of the FLUIDICS-L experiment. After a Lagrangian-based modeling step that casts the system in LFT (Linear Fractional Transformation) format, we examine the strengths and weaknesses of robust control techniques for solving the problem before turning to an adaptive-based approach. Finally, we outline future research directions aimed at combining these two classical approaches with learning-based techniques.

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| 13:00 | **Action GDR MACS AC-RoFLo. / Reduced-order predictor feedback for LTI systems with input delay** | **Jesus-Pablo TOLEDO-ZUCCO (LAAS)** |

The objectives of the Action GDR MACS “AC-RoFLo” will be presented. A dynamic controller, based on a reduced-order model is presented to approach a desired closed-loop behavior for LTI systems with input delay.

| 13:30 | **Sloshing Dynamics and Mitigation Strategies for Launchers** | **Benoît VINIERE (ArianeGroup)** |
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The sloshing of propellants in launchers can lead to significant challenges such as instability, propellant heating and pump un-wetting. To address these risks, it is essential to develop accurate models to predict sloshing dynamics and implement effective mitigation strategies. This presentation highlights ArianeGroup activities conducted over the past years on these topics, aimed at enhancing launcher performances, robustness and reliability.

| 14:00 | **MaiaSpace launcher sloshing challenges and opportunities** | **Martine GANET, Yohan BLACODON, Coralie SOURGEN (MaiaSpace)** |
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This presentation will highlight the challenges that MaiaSpace is facing with its full liquid propulsion launcher in terms of controllability, control design, modelling and validation. Some control and fluidics analysis will be shared and perspectives of coupled analysis will be discussed.

| 14:30 | **Real-time System Identification as Enabler of Versatile Missions** | **Charles DEHOMBREUX (Airbus Defence and Space)** |
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The growing complexity of space missions leads to complex and nonlinear dynamics, such as sloshing, which can be difficult to model a priori relying only on physical modelling or/and ground experiments. This presentation exposes how System Identification (SysID) can address this gap in a real-time fashion, expanding the mission feasibility domain and providing autonomous capabilities. Real flight data from station-keeping manoeuvres is considered alongside simulated data to validate the considered approaches.

Note : This study has been done in collaboration between Airbus Defence and Space and Technische Universität Dresden as part of the ESA-funded project No. 4000146466/24/NL/CRS named Real Time System Identification for Complex System Modelling and Autonomy Operations (OBSIRVA study).

| 15:30 | **The Rutgers SPICESat Mission: Towards Low-g Fluid Sloshing Data Collection and In-Flight Mitigation Testing** | **Laurent BURLION (Rutgers University)** |
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Rutgers University's SPICEsat mission aims to be the first 6U CubeSat platform to study sloshing dynamics in microgravity.

This talk will present recent advancements in reference governor control strategies designed to counteract sloshing effects.

Additionally, we will discuss the ongoing development of the SPICEsat mission, where students are actively working to test and refine these control methods prior to the CubeSat's final selection review.