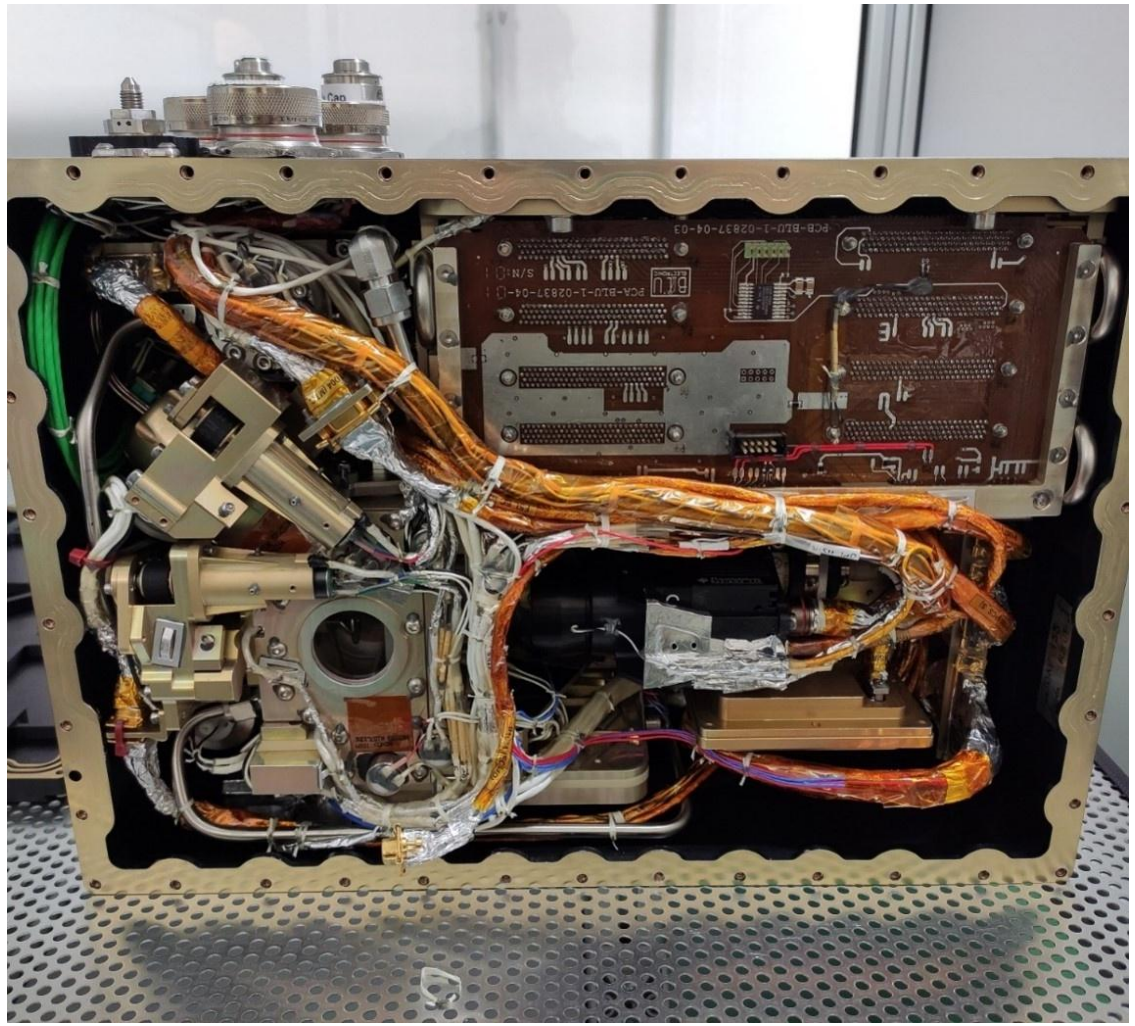
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MULTISCALE BOILING ON THE ISS

From single bubbles to lasting science

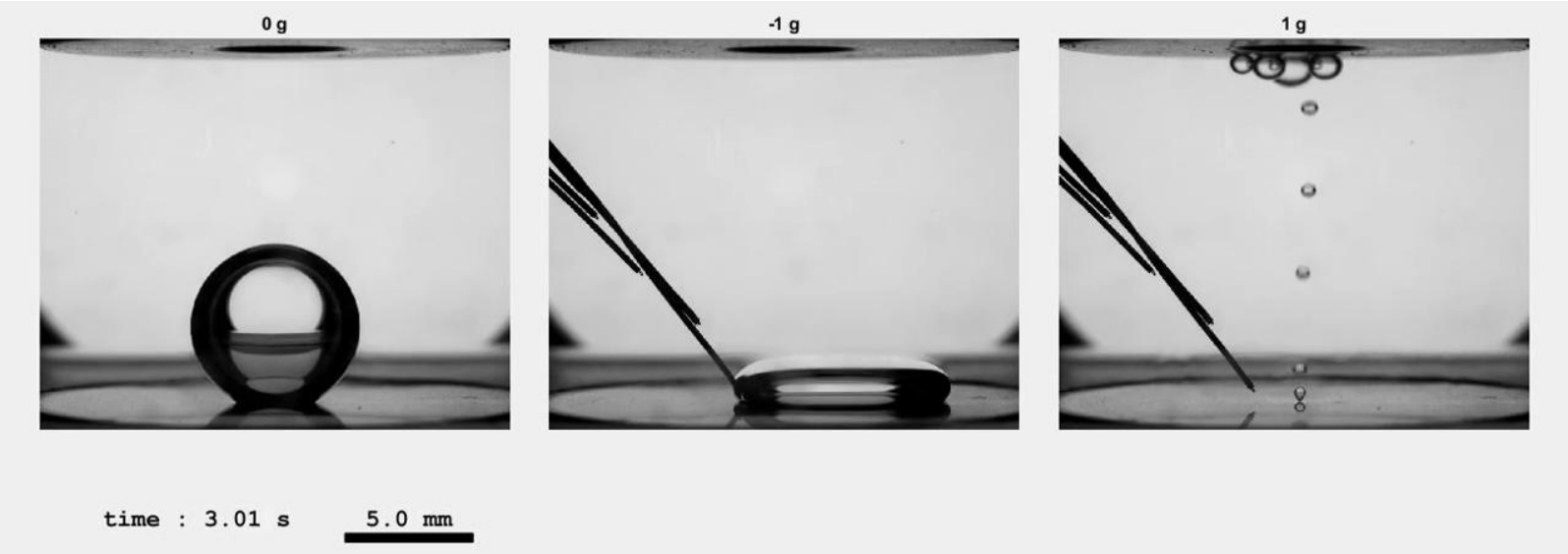
FSL Closing Ceremony · B.USOC, Brussels · 9 October 2026

Axel Sielaff · TU Darmstadt · for the Multiscale Boiling Science Team



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WHY BOIL IN SPACE?



Same heater, same conditions: 0 g (ISS) · −1 g · 1 g (ground)

GOAL

Inside into boiling phenomena, Ref. data

EARTH

Buoyancy wins

small, fast bubbles

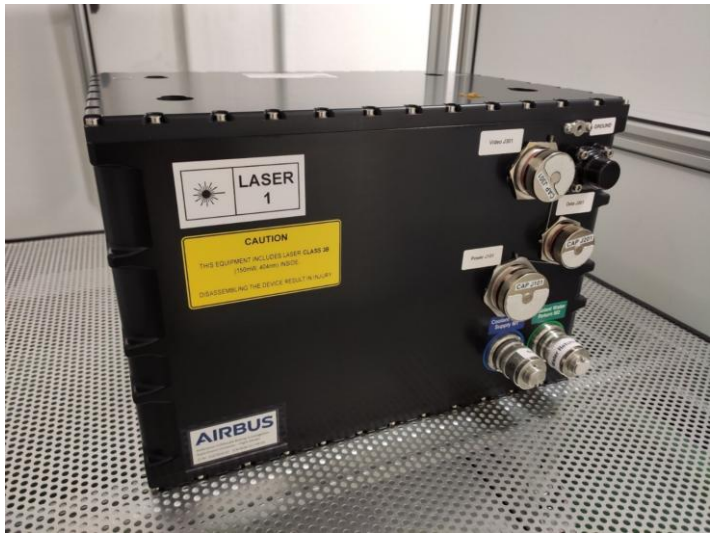
ISS

Microgravity

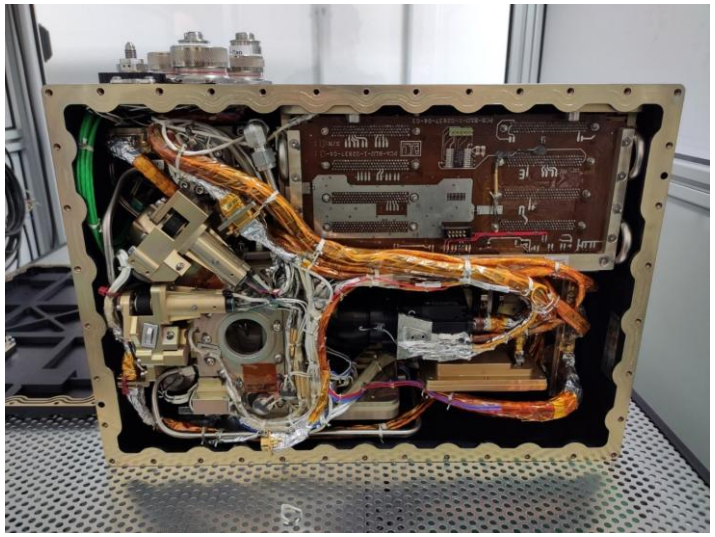
large, slow bubbles – measurable

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THE EXPERIMENT



Experiment container (Airbus DS)


Inside: cell, cameras, electronics


Installation by L. Parmitano, 2019 (NASA)

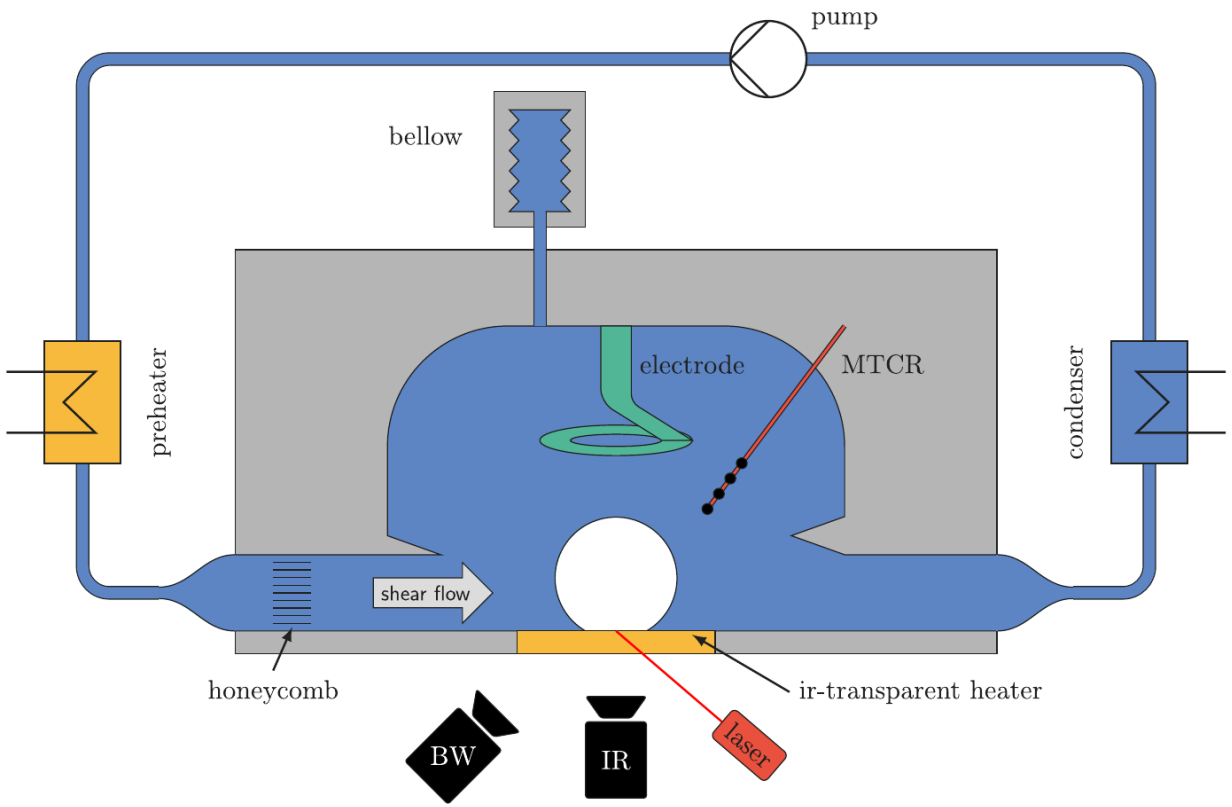
2 **campaigns**
2019 – 2021

> 3000 **experiment runs**
in 11 months

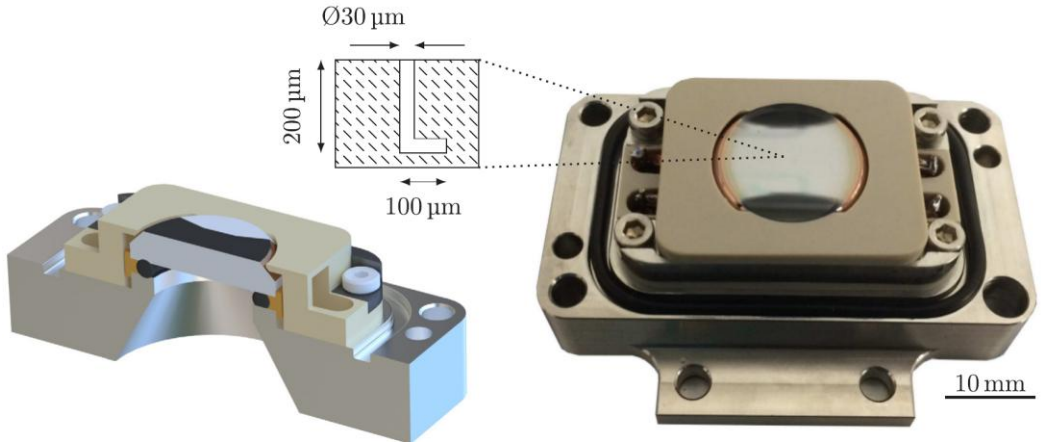
13 - 8 **research groups**
from 8 countries

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SETUP



Figures: Sielaff et al., Appl. Therm. Eng. 205 (2022) 117932

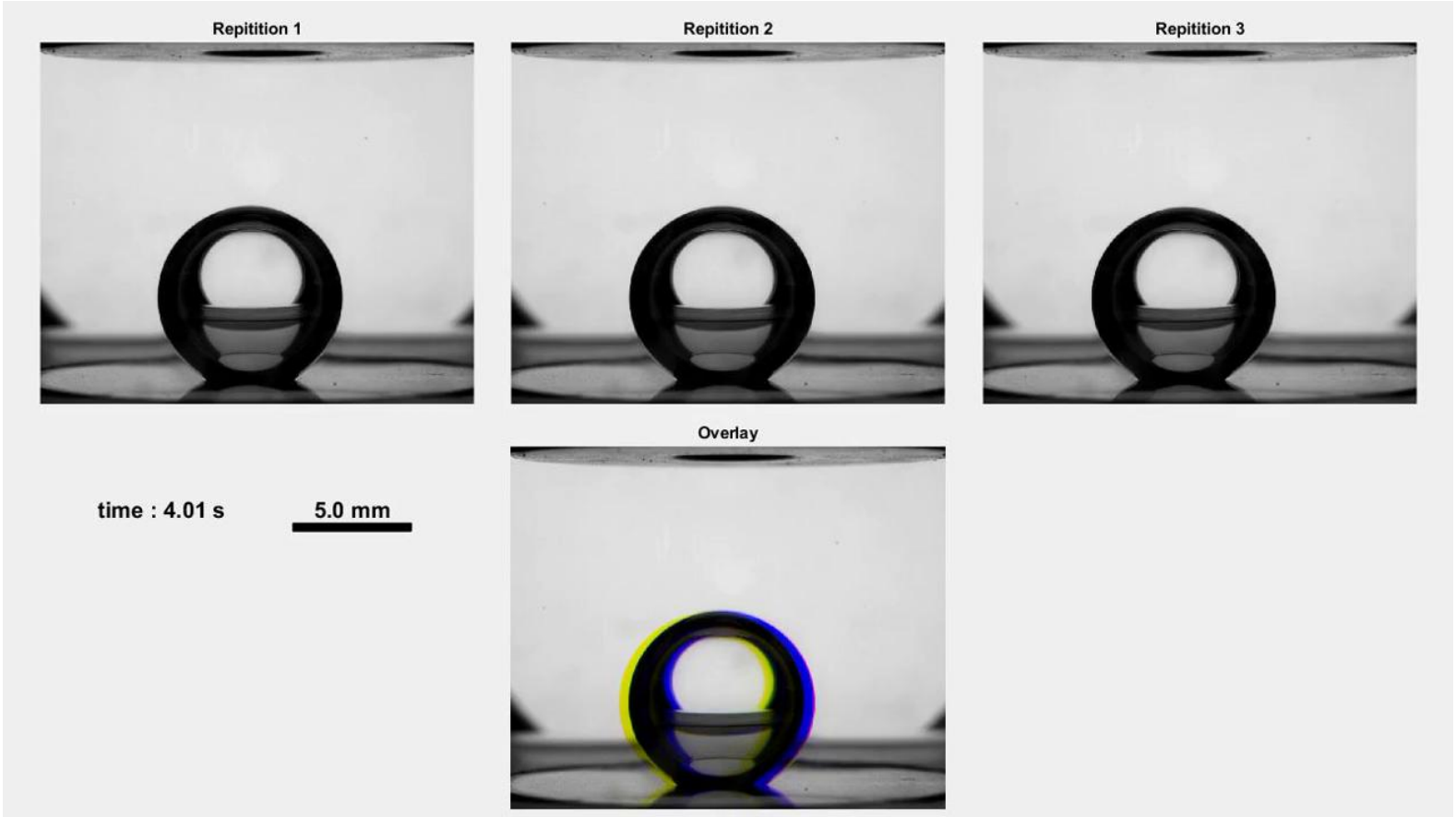


IR-transparent heater with artificial cavity (Ø 30 µm)

Fluid **FC-72**	Pressure **0.5 – 1 bar**	Heat flux **≤ 2 W cm⁻²**
Shear flow **≤ 700 mL min⁻¹**	Electric field **≤ 15 kV**	Diagnostics **HS · IR · MTCR**

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REPRODUCIBLE



25 reference runs

9 different days

3.3 % deviation in bubble size

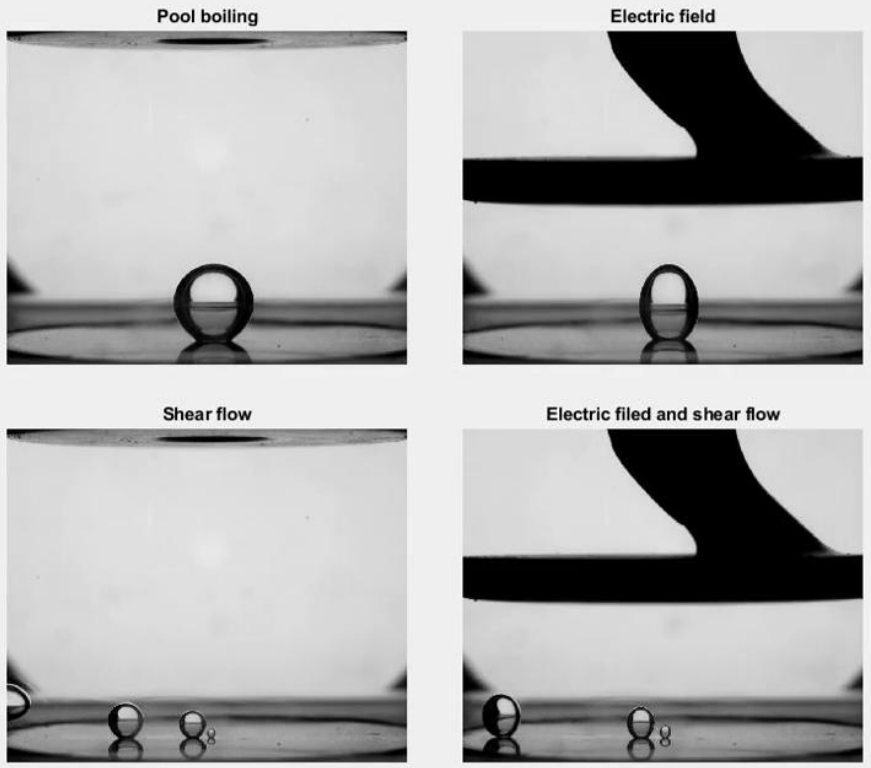
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EXTERNAL FORCES

time = 2.50 s

heating power = 1 W/cm^2
pressure = 750 mbar
subcooling = 5 K
voltage = 15 kV
flow rate = 500 ml/min

5.0 mm



Pool boiling
bubble stays

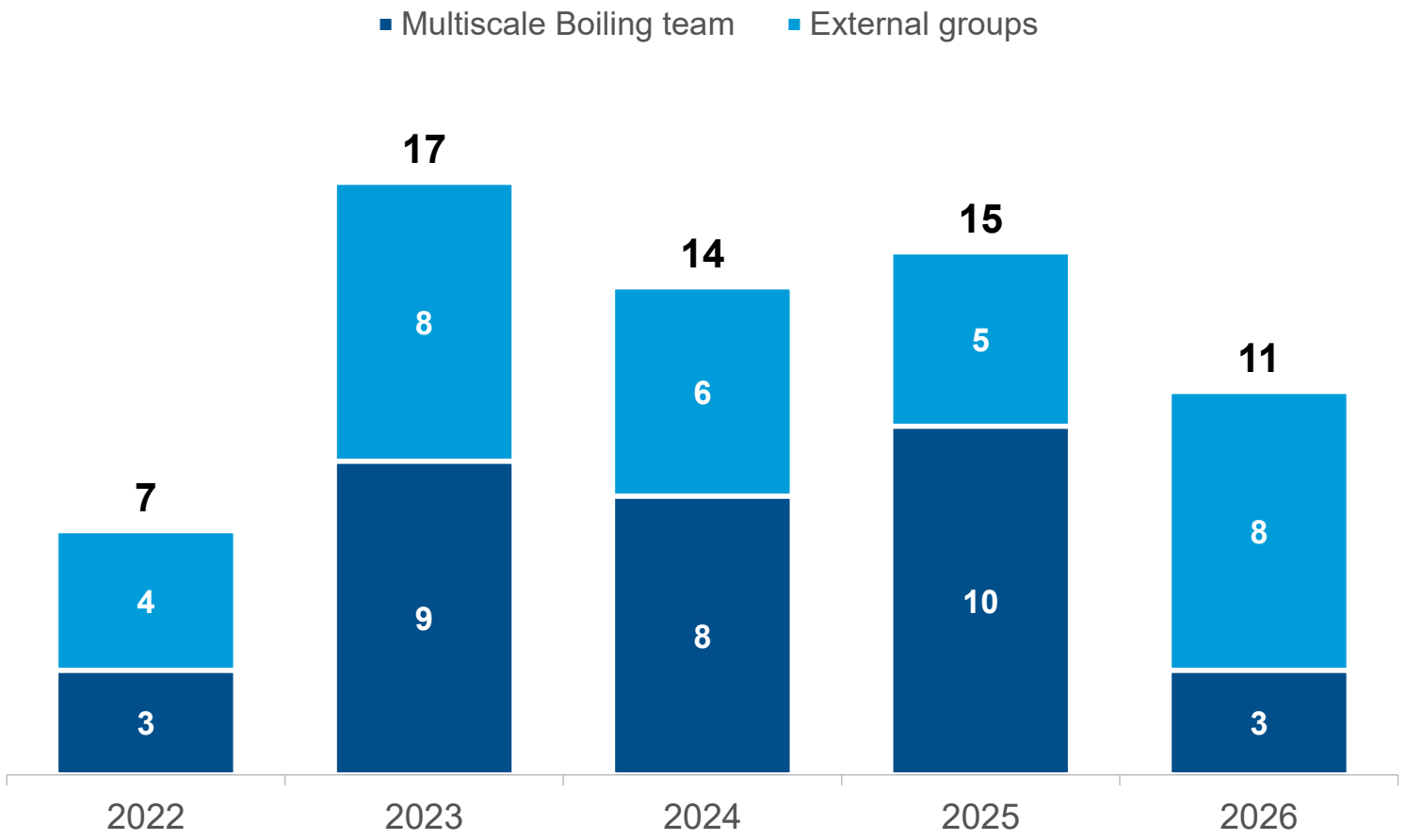
Electric field
regular detachment

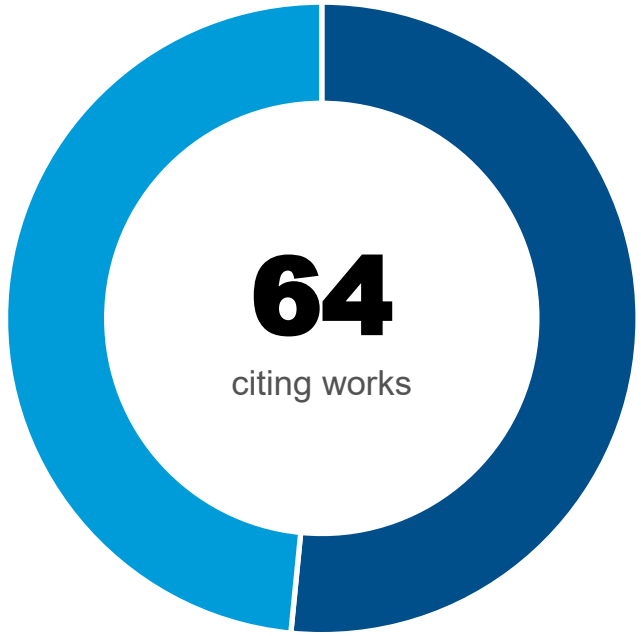
Shear flow
sliding · new bubbles

Field + flow
elongated · sliding

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SCIENTIFIC IMPACT





33 team publications

31 external works

Works citing Sielaff et al., ATE 205 (2022) 117932

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TEAM RESEARCH

8
Bubble growth
subcooling · gas content · growth laws

3
Electric field
early departure · electric stress

3
Shear flow
sliding · coalescence jumping

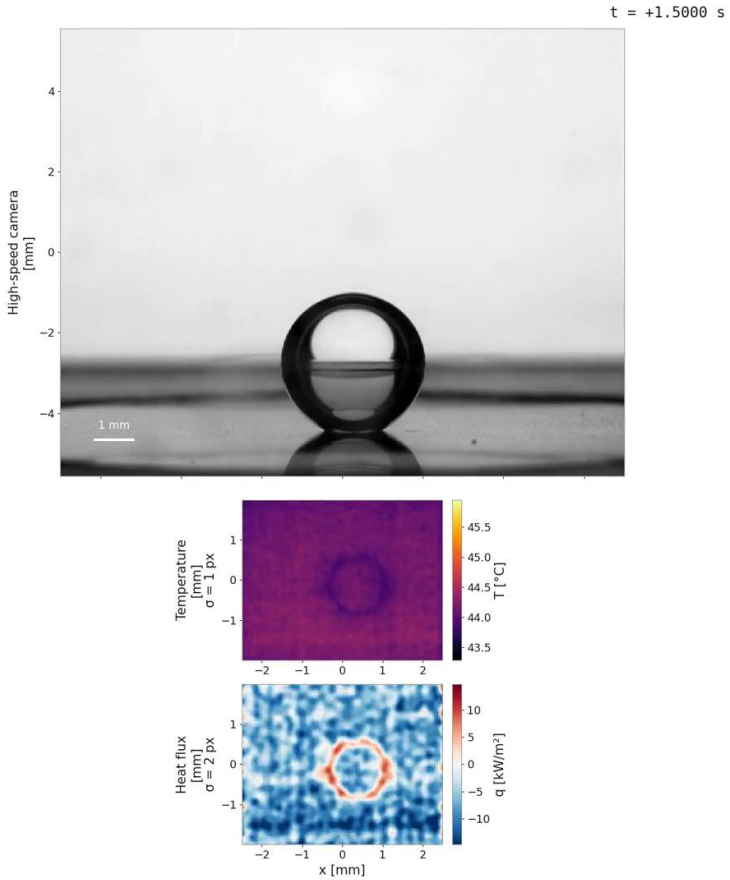
2
Image analysis
algorithm benchmark · open data

4
Simulation
validated models · gas effects

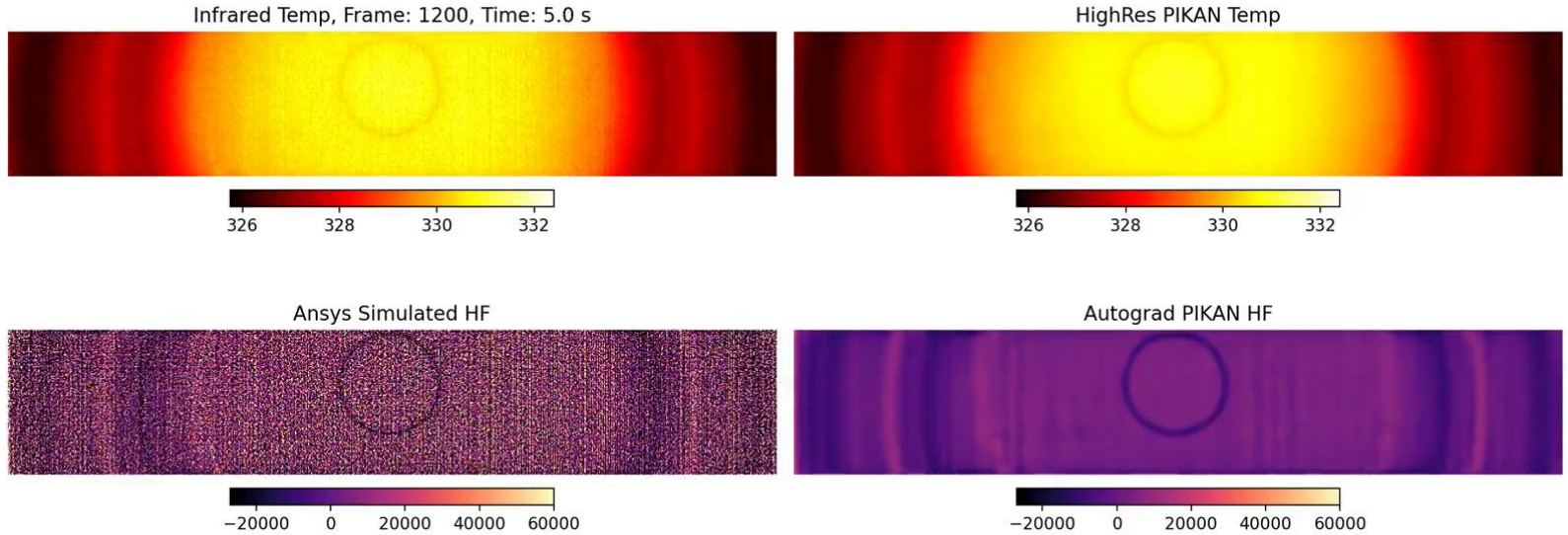
13
Operations & more
B.USOC operations · spin-off research

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ONGOING WORK



Bubble · IR temperature · heat flux



Left: classical evaluation · right: physics-informed (PIKAN) · 2× speed

Classical
noisy heat flux

PIKAN
clear contact line

Science Team
still meets regularly

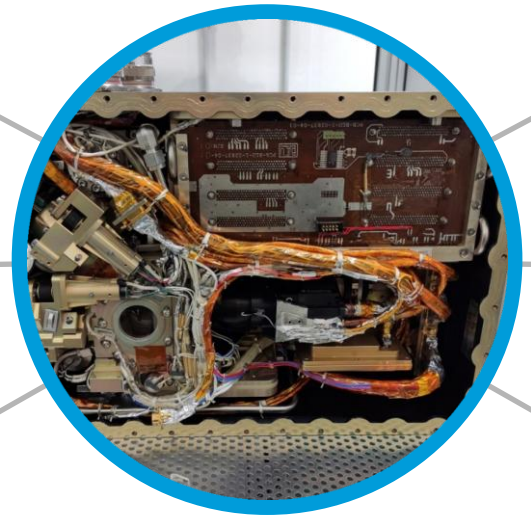
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THANK YOU

ESA
programme & funding

Airbus Defence and Space
hardware

ESA astronauts
installation on the ISS



B.USOC
11 months of operations

Science Team
13 groups · 8 countries

National agencies
DLR · CNES · BELSPO · …