

UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Analysis and modelling of spacecraft fragmentation in consequence of in-orbit collisions

Stefano Lopresti - 39th Cycle

Supervisor: Prof. Alessandro Francesconi

Co-Supervisor: Dr. Lorenzo Olivieri

3° year admission - 10/09/2025



Outline

-  Hypervelocity facility updates
-  MCAST follow-up
-  IS Impact sensor testing
-  Transparent Impact sensor development
-  Other activities
-  Future directions



MCAST follow-up



Journal of Space Safety Engineering

Available online 20 August 2025

In Press, Corrected Proof [What's this?](#)



ASTROBEAT: Advancing cold-welding technology for in-situ spacecraft repairs

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Received 21 February 2025, Revised 6 August 2025, Accepted 13 August 2025, Available online 20 August 2025.





MCAST follow-up



Acta Astronautica

Available online 15 August 2025

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Rapid Prototyping of Satellite Shields: 3D Printed Carbon Fiber and Kevlar Composites for Hypervelocity Impact Protection

Stefano Lopresti¹, Leonardo Barilaro², Alberto Abiti¹, Lorenzo Olivieri³

Show more

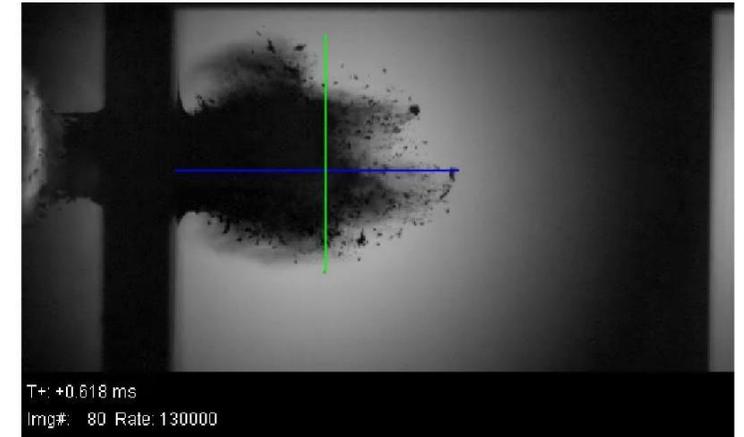
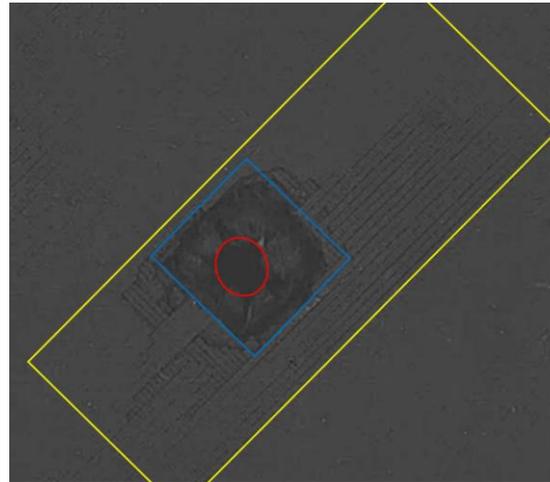
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<https://doi.org/10.1016/j.actaastro.2025.08.029>

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Highlights

- Satellite shields are 3D printed in CFRP and Kevlar;
- Single Shield and Whipple Shield configuration were studied;
- 10+1 hypervelocity impact tests performed;
- Crated and delamination analysis performed;
- Debris cloud video analysis performed.

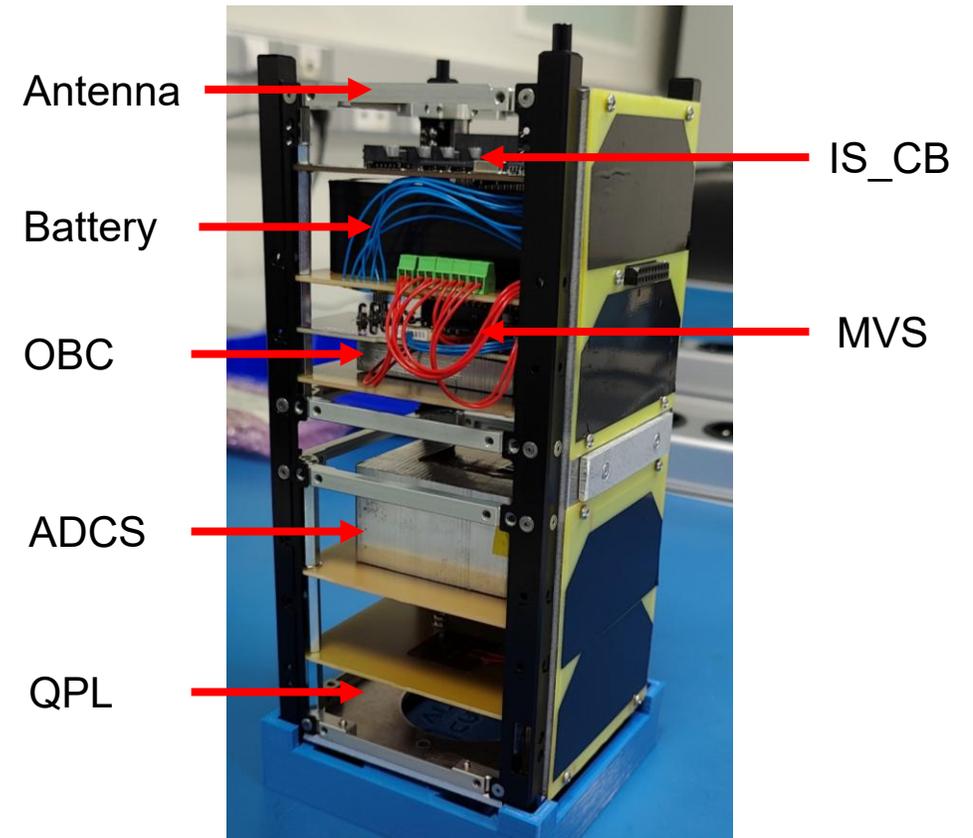




IS development and testing

Environmental test campaign at system level:

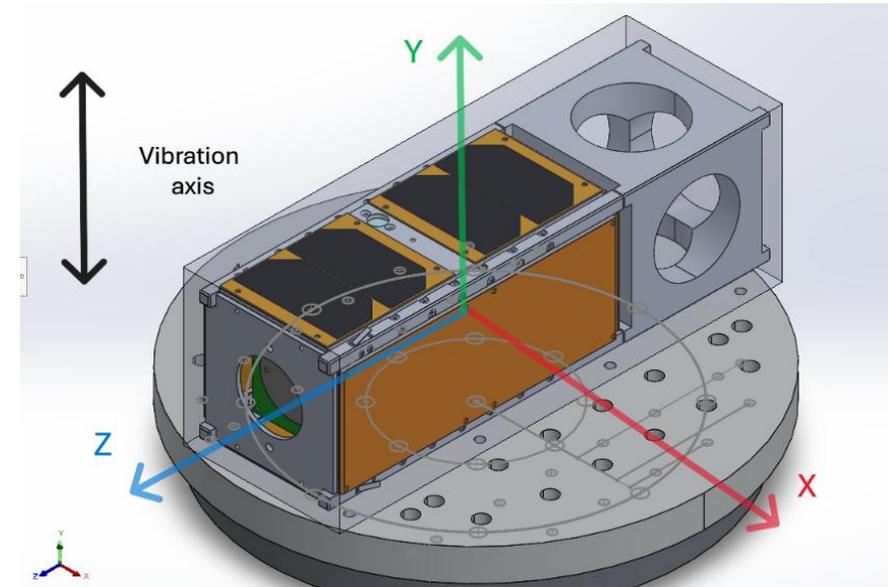
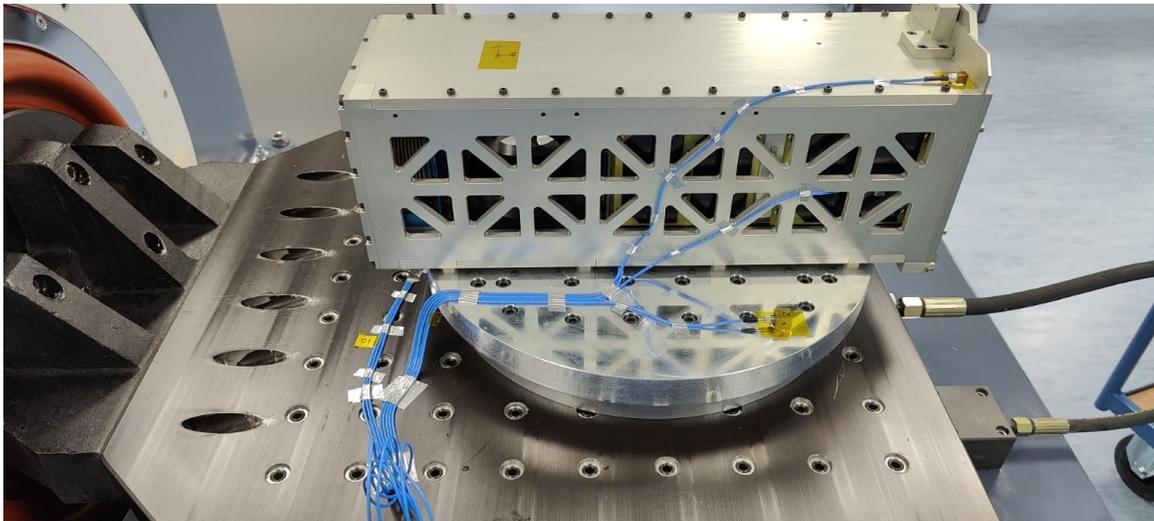
- 3 EQM: IS, MVS, CCR
- FM structure
- 5 dummy masses with heaters
- Dummy solar panels
- Umbilical connection simulating OBC





IS development and testing

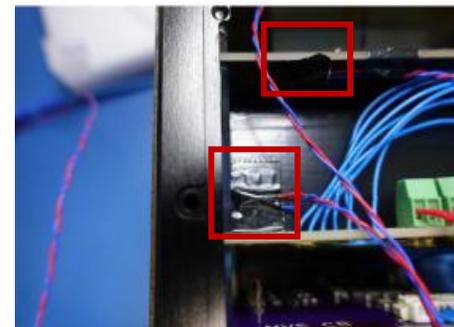
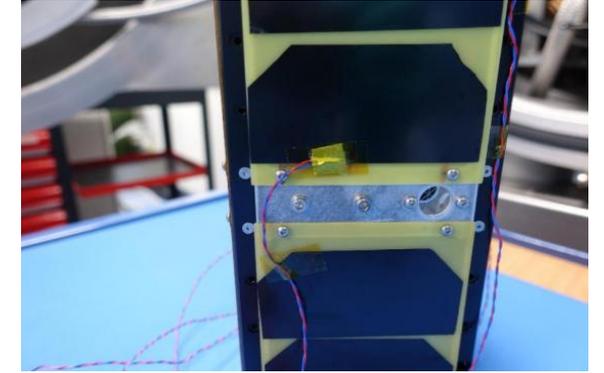
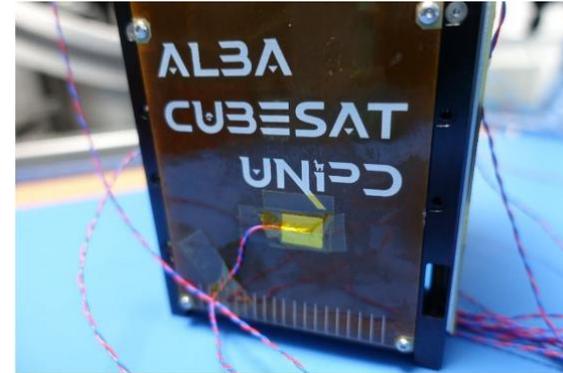
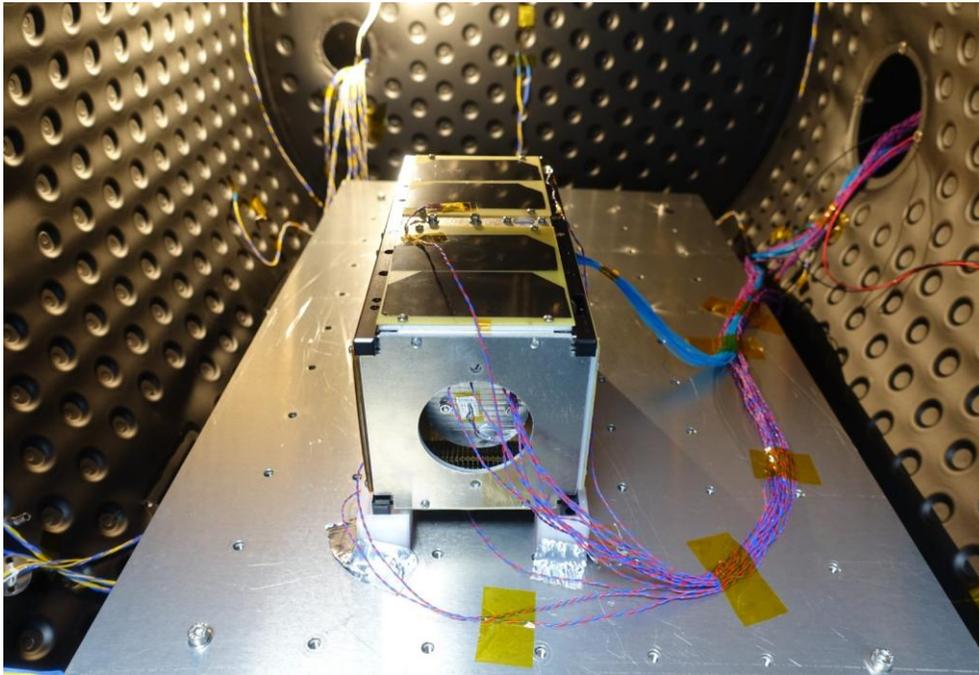
Vibrational test campaign





IS development and testing

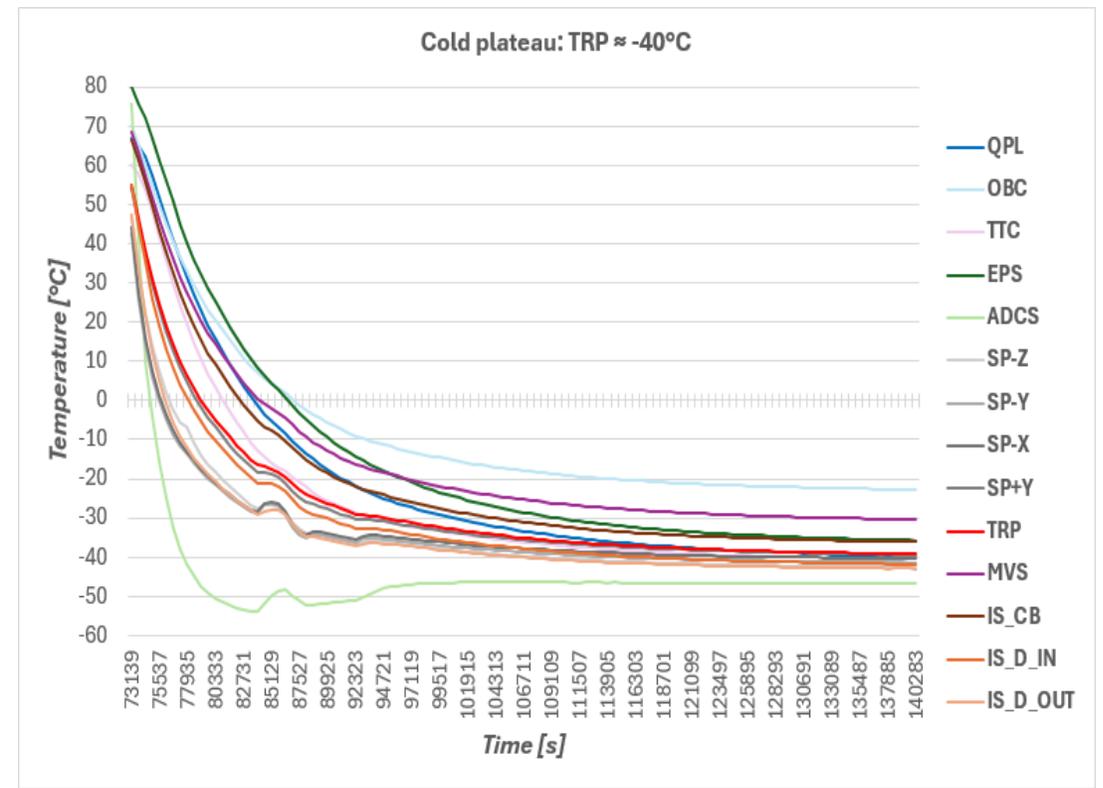
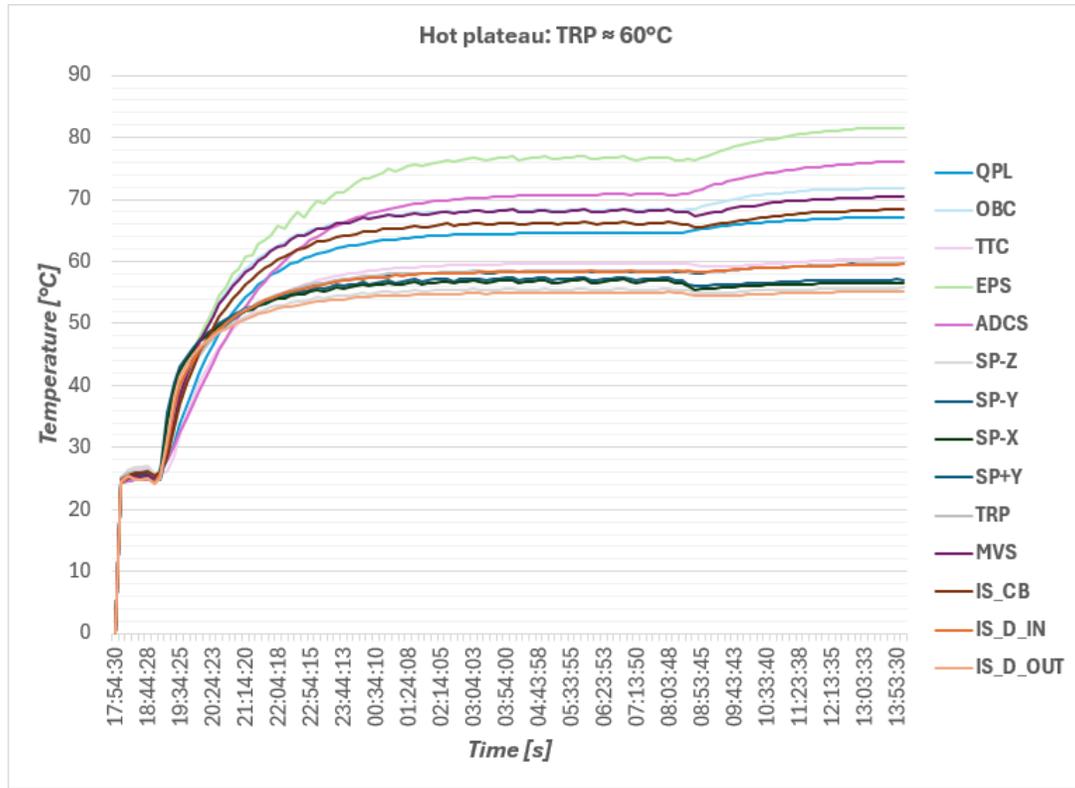
TVAC test campaign



14 + 1 thermocouples
installed in the
chamber

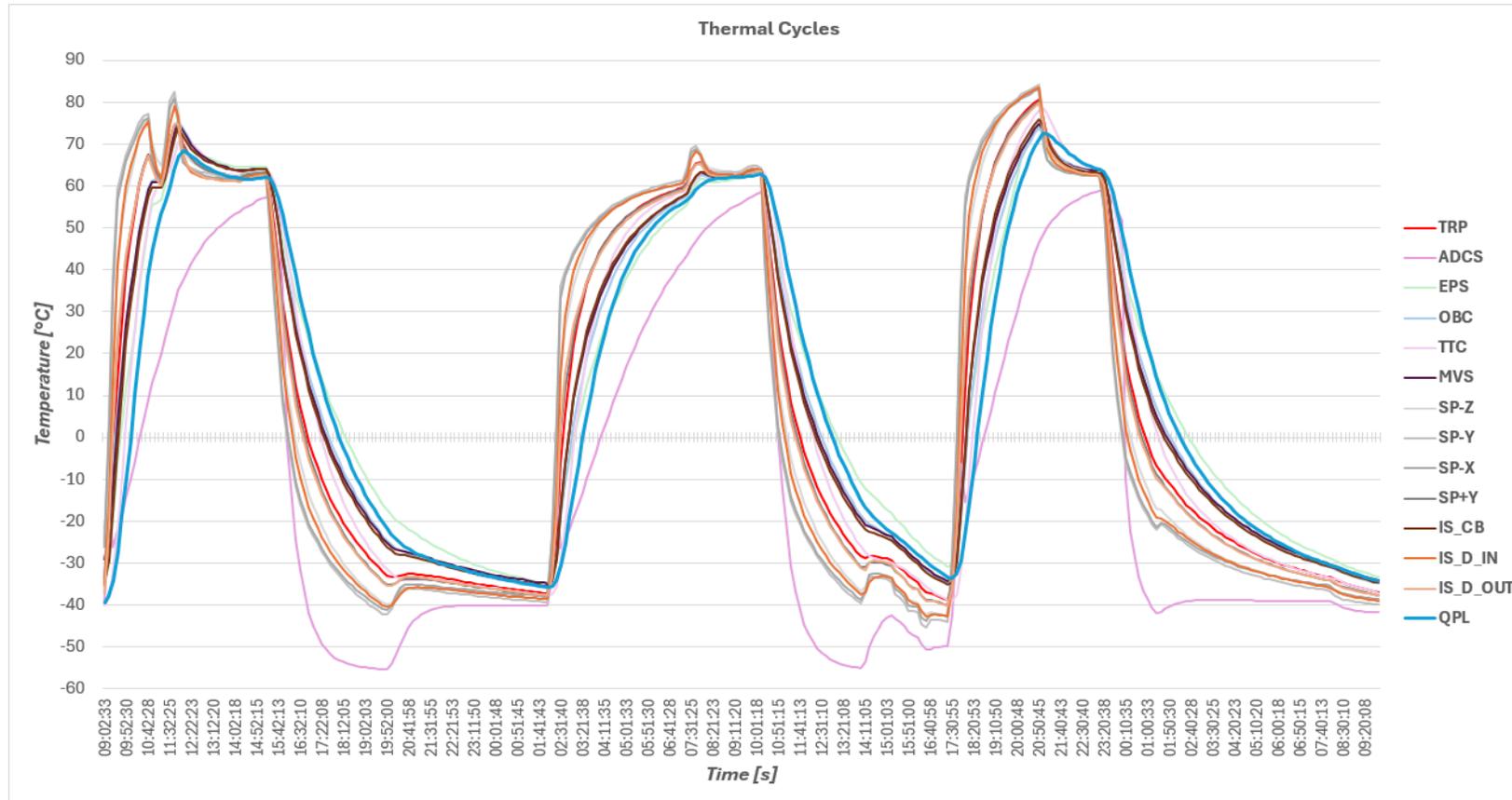


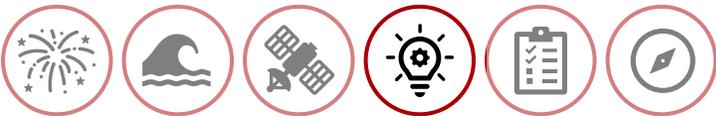
IS development and testing



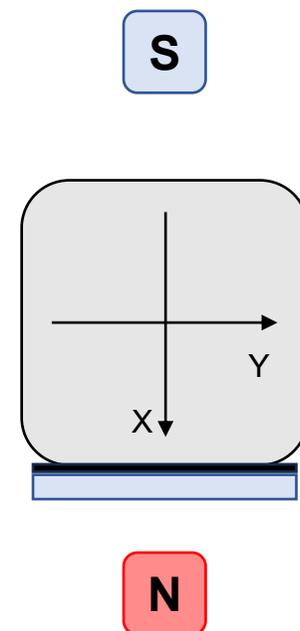
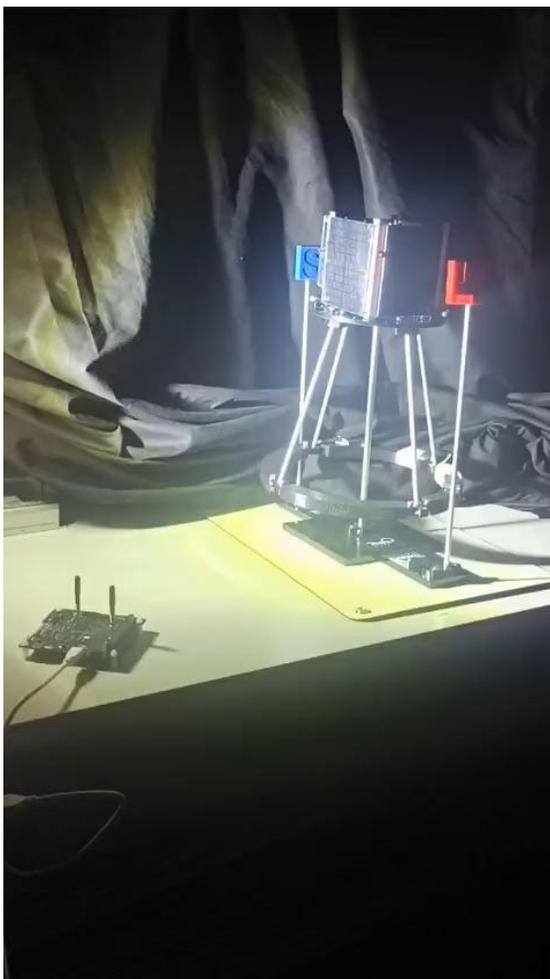


IS development and testing





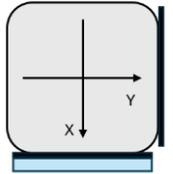
Transparent IS development



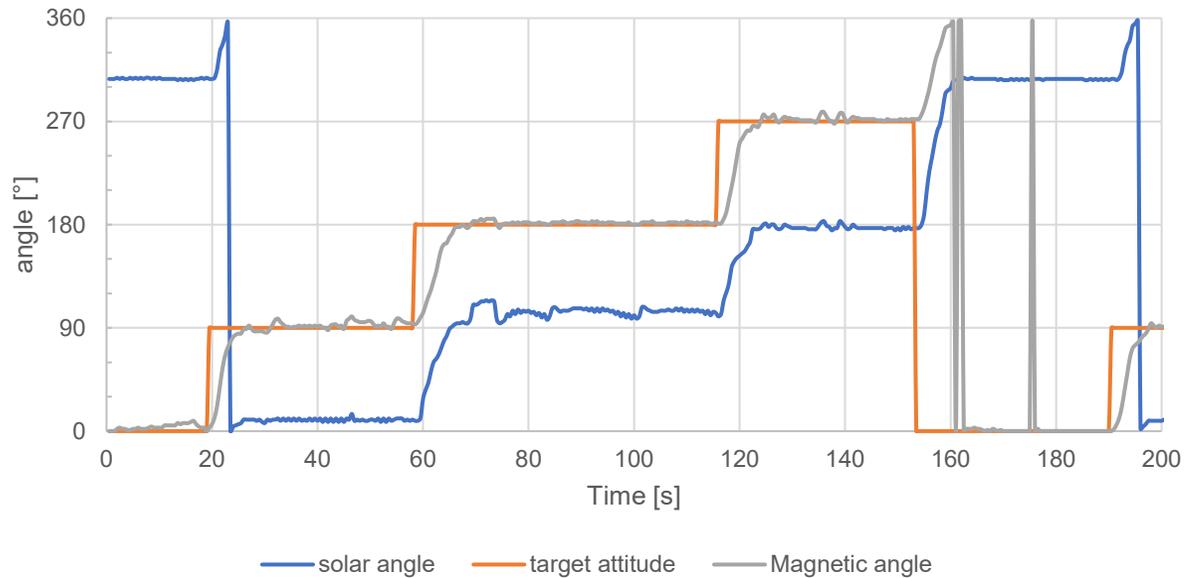


Transparent IS development

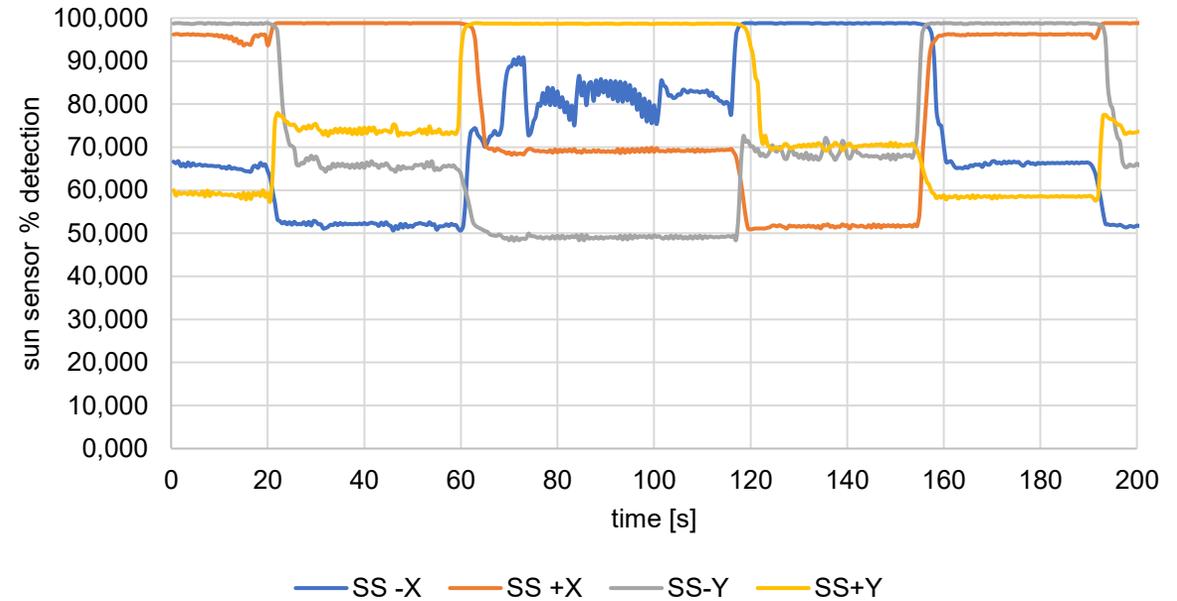
Magnetic control vs solar control



Attitude



Sun sensor detection

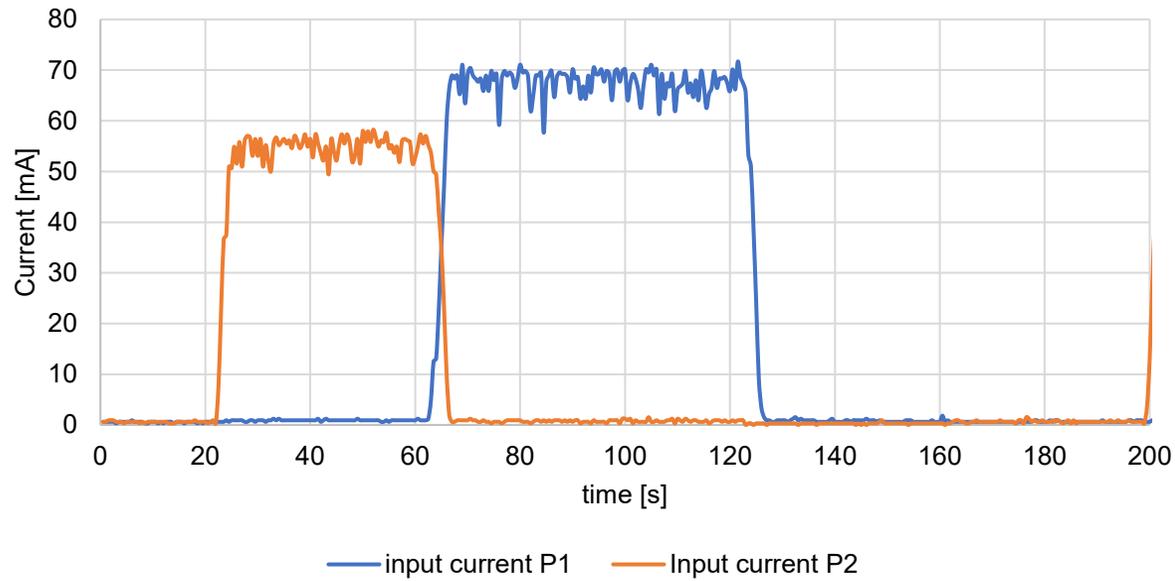




Transparent IS development

Current production

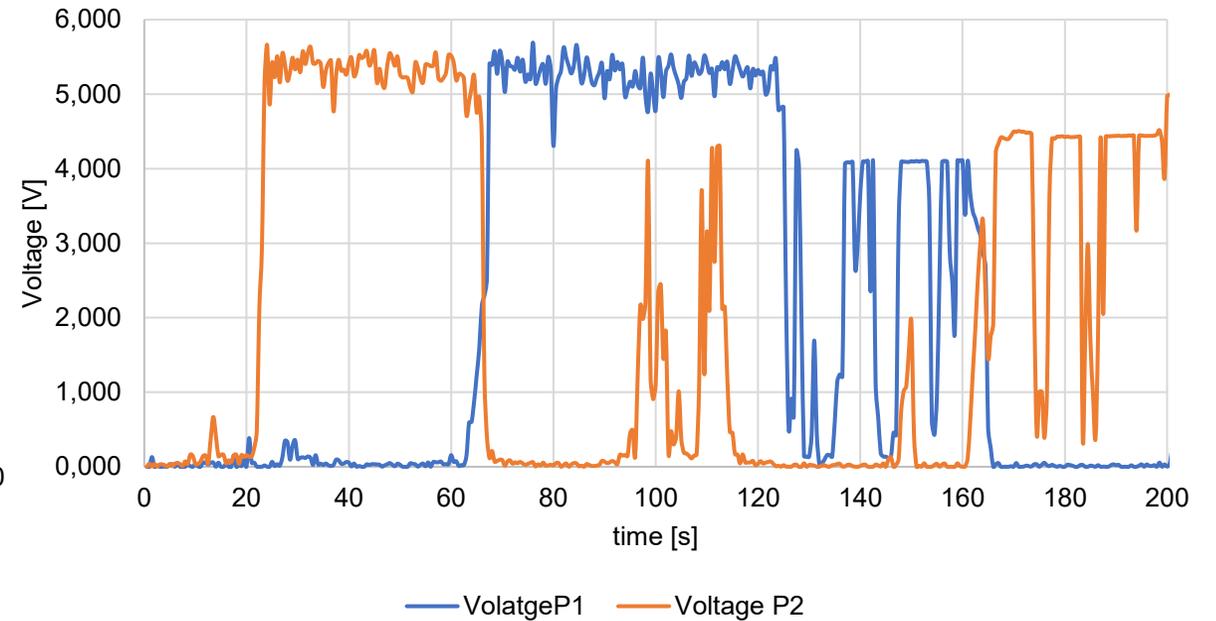
Current in input from solar panels



AVG panel 1: 67,45mA
AVG panel 2: 54,83mA

Current production loss: 18,7%

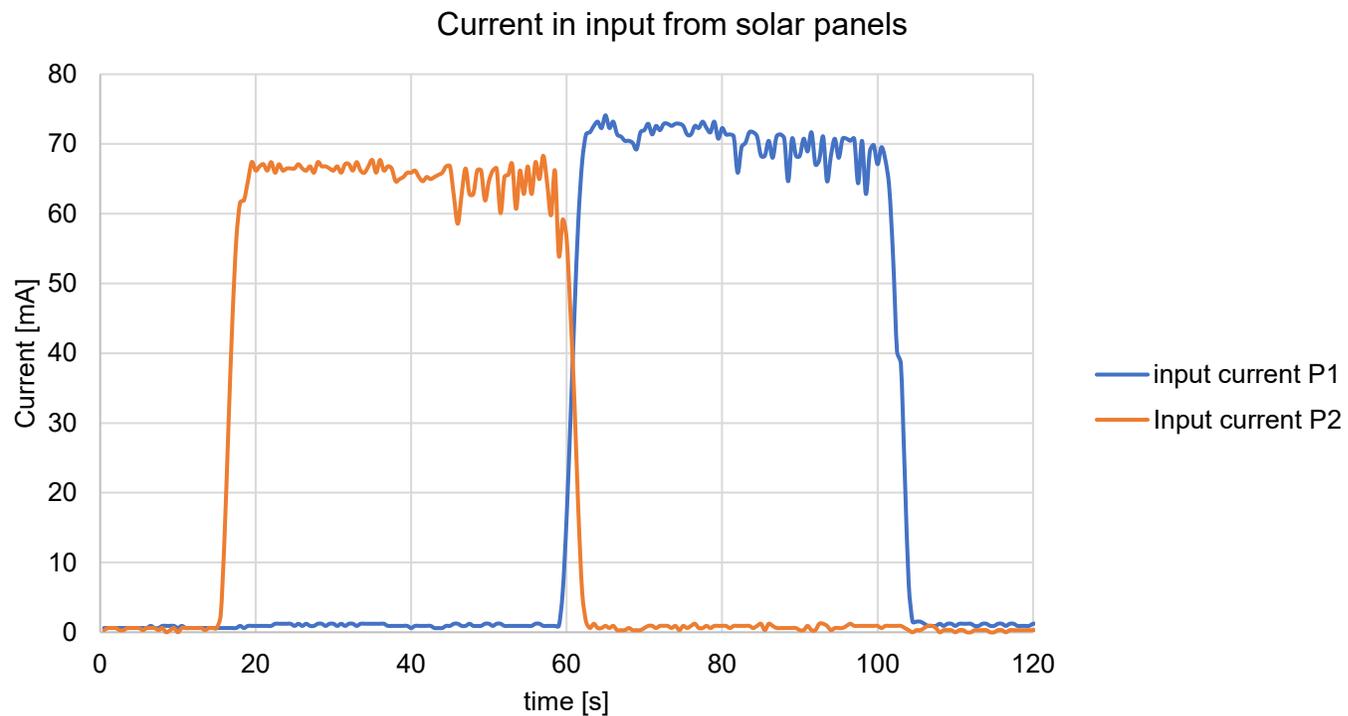
Voltage in input from solar panels





Transparent IS development

Actual current production loss



AVG panel 1: 70,48mA
AVG panel 2: 65,53mA

Nominal difference: 7%

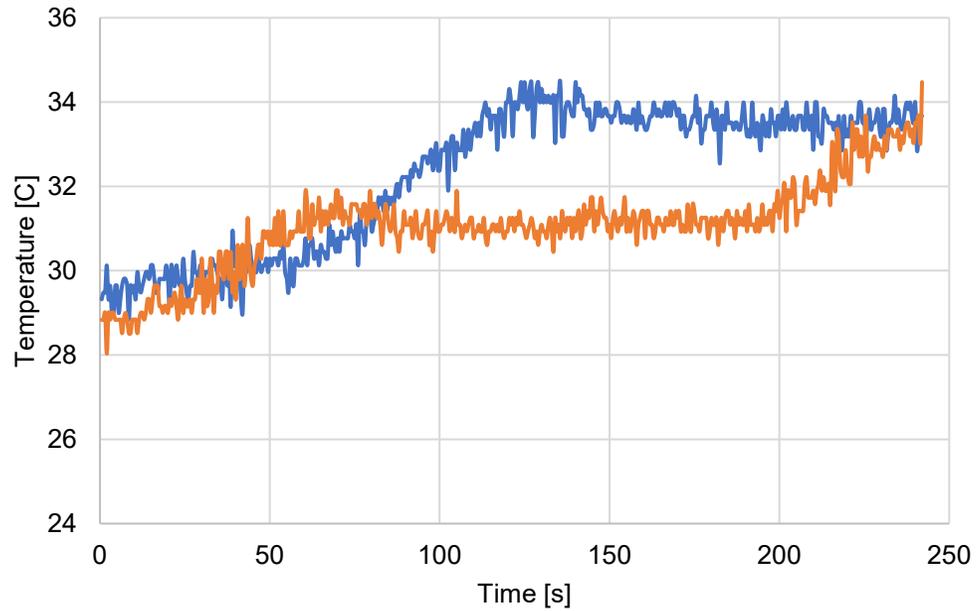
**Effective production loss:
12%**



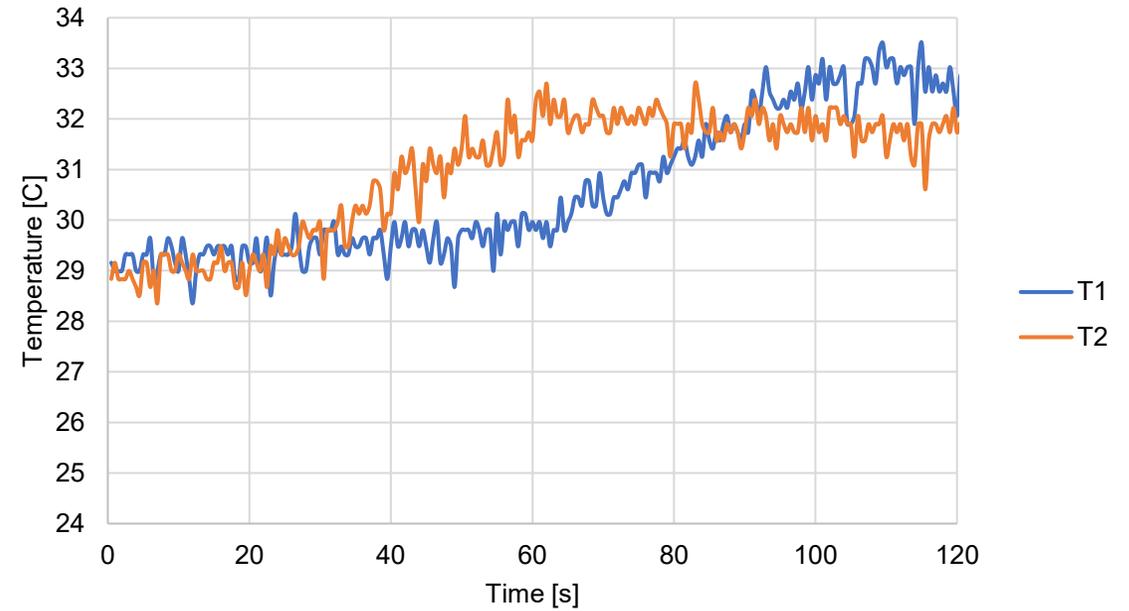
Transparent IS development

Temperature differences

Solar panel temperatures with PC



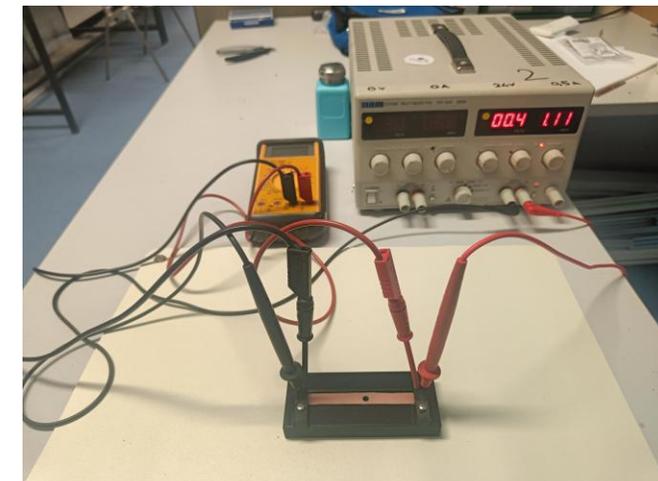
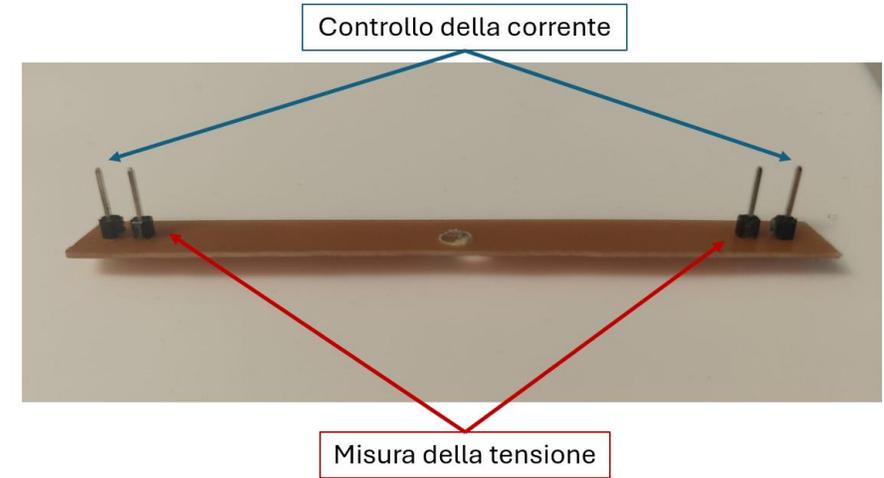
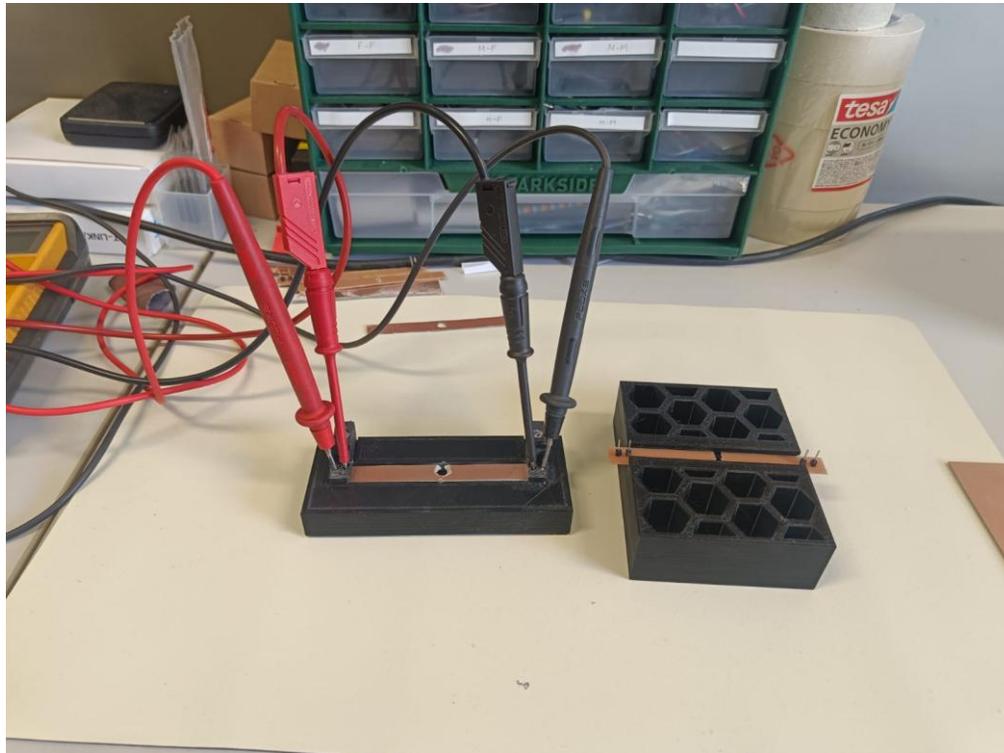
Solar panel temperatures NO PC

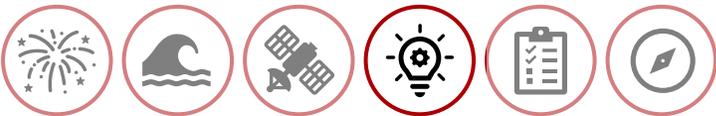




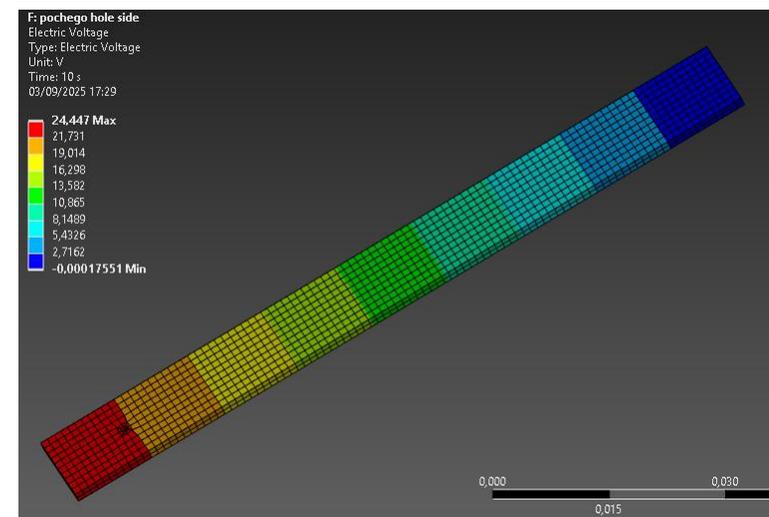
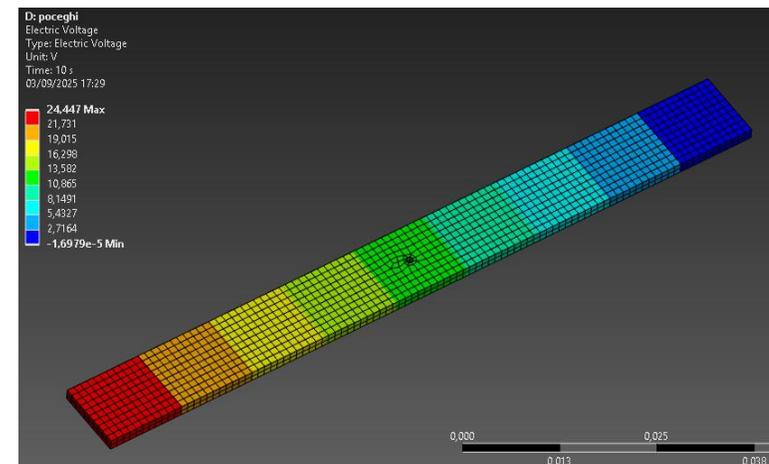
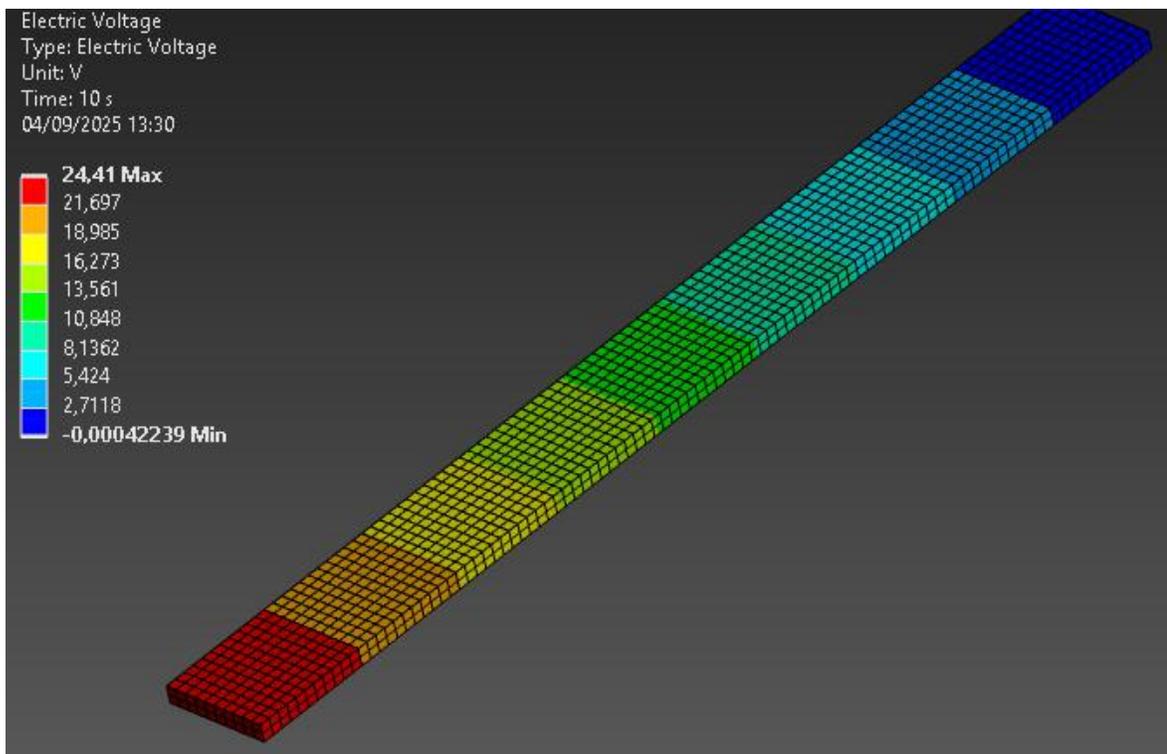
Transparent IS development

Resistance measurements





Transparent IS development





Other Activities

Peer reviewed international journals:

Olivieri, L.; Giacomuzzo, C.; **Lopresti, S.**; Francesconi, A. Simulation of In-Space Fragmentation Events. *Aerotecnica Missili & Spazio*, 1-8. (2023)

Olivieri, L.; Faergestad, R. M.; Giacomuzzo, C.; **Lopresti, S.**; Pitacco, G.; Francesconi, A.; Cardone, T.; Holmen, J. K.; Borvik, T. Investigation of aluminium Whipple Shield response to hypervelocity impacts close to ballistic limit between 2.5 and 5 km/s. *Acta Astronautica*, 219, 41-47. (2024)

Lopresti, S.; Basana, F.; Olivieri, L.; Giacomuzzo, C.; Francesconi Overview of Spacecraft-Fragmentation Testing, *Aerotecnica Missili e Spazio*, (2024).

Faergestad, R. M.; Olivieri, L.; Giacomuzzo, C.; **Lopresti, S.**; Pitacco, G.; Francesconi, A.; Ford, K. A.; Holmen, J. K.; Hopperstad, O.S.; Borvik, T. Hypervelocity Impact Against Aluminium Whipple Shields in the Shatter Regime with Systematic Parameter Variation: An Experimental and Numerical Study. *International Journal of Impact Engineering*, vol. 195, 734-743 (2025)

Abiti, A., **Lopresti, S.**, Olivieri, L., Giacomuzzo, C., Francesconi, Alessandro. (2025). Simulation and validation of a fragmentation model for carbon fibre reinforced polymers subjected to hypervelocity collision. *ACTA ASTRONAUTICA*, vol. 234, p. 445-454 (2025)

Lopresti, S.; Barilaro, L.; Abiti, A.; Olivieri, . Rapid Prototyping of Satellite Shields: 3D Printed Carbon Fiber and Kevlar Composites for Hypervelocity Impact Protection (Accepted by ACTA Astronautica, journal pre proof).

Barilaro, L.; **Lopresti, S.**; Olivieri, O.; Wylie, M.; ASTROBEAT: Advancing cold-welding technology for in-situ spacecraft repairs, *Journal of Space Safety Engineering* (2025, in press).



Other Activities

International Conferences

Olivieri L., Faergestad R. M., Giacomuzzo C., **Lopresti S.**, Pitacco G., Francesconi A., Cardone T., Holmen J. K., Borvik T. (2023). Investigation of aluminium Whipple Shield response to hypervelocity impacts close to ballistic limit between 2.5 and 5 km/s. In: Proceedings of the International Astronautical Congress, IAC, Baku, Azerbaijan. (2023)

Lopresti S., Olivieri L., Giacomuzzo C., Francesconi A. (2023). Glancing Impact on a Picosatellite Mock-up: Test Results. In: Proceedings of the International Astronautical Congress, IAC. vol. 2023-, International Astronautical Federation, IAF, Baku, Azerbaijan, 2023

Giacomo Battaglia, Samuele Enzo, Giovanni Trevisanuto, **Stefano Lopresti**, Francesco Marin, Giovanni Bezze, Lorenzo Olivieri, Federico Basana, Alessandro Francesconi (2023). A CubeSat-sized space debris impact sensor. In: Proc. of 74th International Astronautical Congress (IAC). Baku, Azerbaijan, 2-6 October (2023).

Luca Lion, Federico Basana, **Stefano Lopresti**, Samuele Enzo, Lorenzo Guglielmini, Massimo Giacomini, Michela Carrossa, Sofia Farinella, Francesca Filippini, Giulia Stocco, Lorenzo Olivieri, Andrea Stanco, Carlo Bettanini, Alessandro Francesconi (2024). Overview of the AlbaSat mission the first CubeSat from University of Padova. In: 4S Symposium 2024 Proceedings.

Lopresti, S.; Olivieri, L.; Giacomuzzo, C.; Francesconi, A. Recent Development of CISAS numerical tool for in-space fragmentation, in proceedings of 73rd ARA meeting, Bryan, Texas, 2024.

Lopresti, S.; Olivieri, L.; Giacomuzzo, C.; Francesconi, A. Hypervelocity impact testing and simulation at the University of Padova, in proceedings of 17th HVIS, Tsukuba, Japan, 2024

Lopresti, Stefano, Abiti, Alberto, Giacomuzzo, Cinzia, Olivieri, Lorenzo, Polli, Eduardo Maria, Francesconi, Alessandro (2024). A Numerical Model for CFRP Fragmentation Under Hypervelocity Impacts. In: Proceedings of the International Astronautical Congress, IAC, Milano, Italy (2024).

Alberto Abiti, **Stefano Lopresti**, Cinzia Giacomuzzo, Lorenzo Olivieri, Alessandro Francesconi (2025). Numerical models for aluminum honeycomb sandwich structures fragmentation. In: Proceeding of the 9th European Conference on Space Debris. vol. 9.



Other Activities

Below are listed the international travels made for conference and other educational activities during the second year of the Ph.D.

EVENT	LOCATION	START DATE	END DATE	TOTAL NUMBER OF DAYS
Space Sustainability Conference	Hong Kong	02/11/2024	05/12/2024	4
FYSI Test opportunity	ESEC (Belgium)	11/05/2025	22/05/2025	12

Below are listed the visiting periods planned for the next year:

EVENT	LOCATION	START DATE	END DATE	TOTAL NUMBER OF DAYS
Visiting period 1	ESA (Estec)	08/09/2025	07/12/2025	90

Total number of days spent abroad: 112/180 days (without considering the visiting period of the 3rd year)

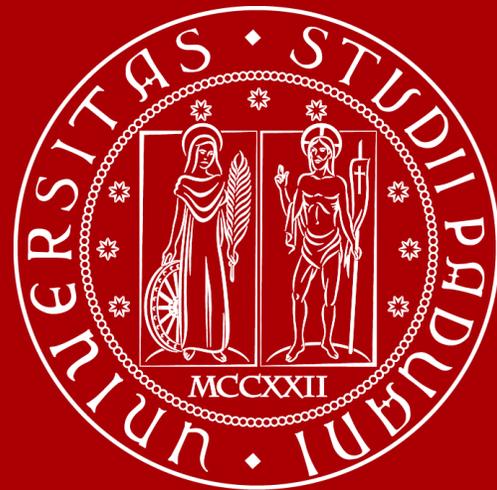




Future directions

- Test with the laser-driven facility in ESTEC
- Updates of the transparent IS with Esa Experts guidance
- Tests with hypervelocity facility
- CSTS codes updates

Thanks for your attention



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