



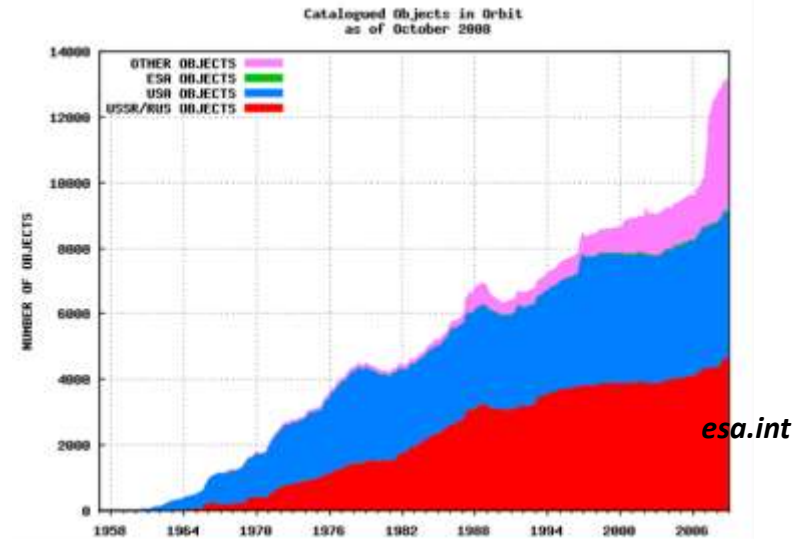
ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

FROM REDEMPTION TO ARTICA. THE ROAD FROM AN EDUCATIONAL PROJECT TO AN ACTUAL DEVICE

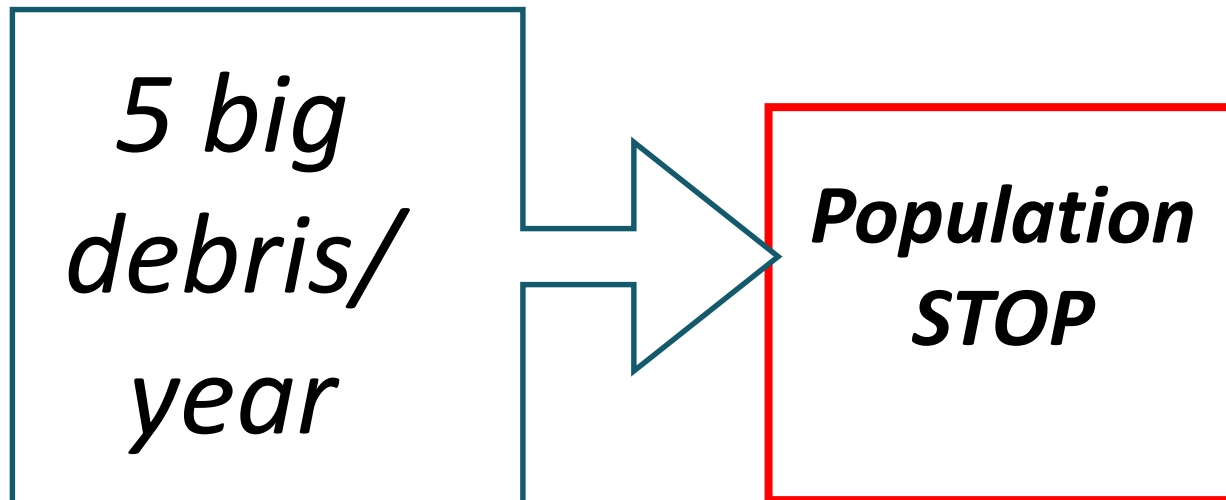
Marcello Valdatta

Space debris: *an increasing problem*

Debris environment in LEO is becoming a **critical problem** for space activities, and **population growth** will be inevitable



Possible to stop if

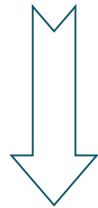


Importance of key-technologies:

To perform the **ADR**, a suitable debris **CAPTURE SYSTEM** is required!
It is well known that the *available technologies* are *too expensive* or could produce *other debris*.

Problem:

*Finding an **efficient system** to connect the cleaner satellite to the debris.*



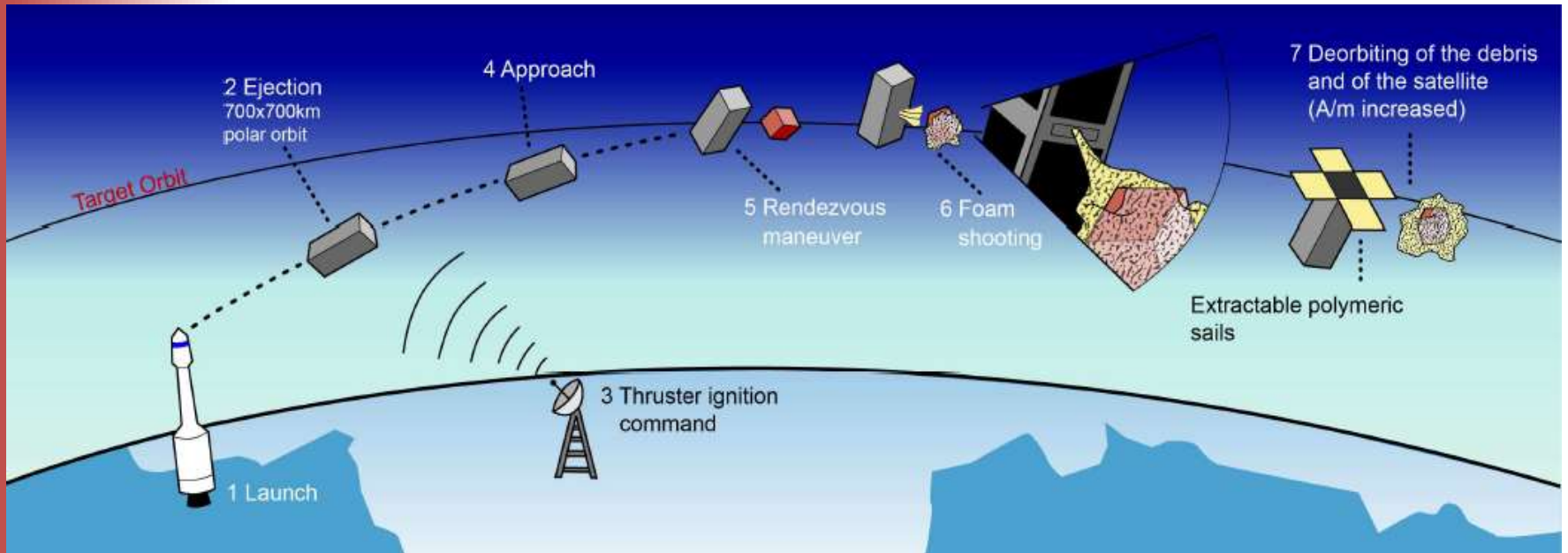
Solution:

*Why not to use a **sprayable link** to the satellite?
It could be a **feasible, not too expensive and compact** solution!*



Our Proposal

Mission Idea for an ADR using foam



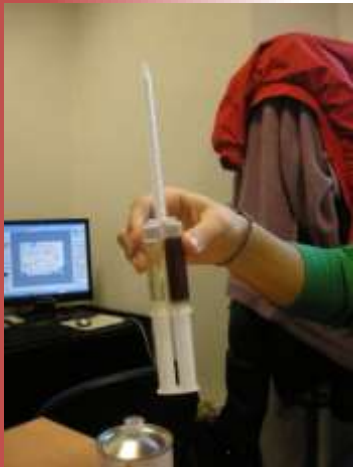
The test mission (on REXUS sounding rocket) was named REDEMPTION:

REMOVAL of DEbris using Material with Phase Transition:
IONospheric tests)

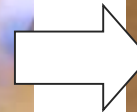


Our Proposal

2 liquid components



Mixing of the components



Expansion:

it is guaranteed by the CO_2 produced by the reaction. It does not use atmosphere.



The Foam :

A customized chemical formulation (thanks to Duna Group experts) has been found for operating in near – space conditions:



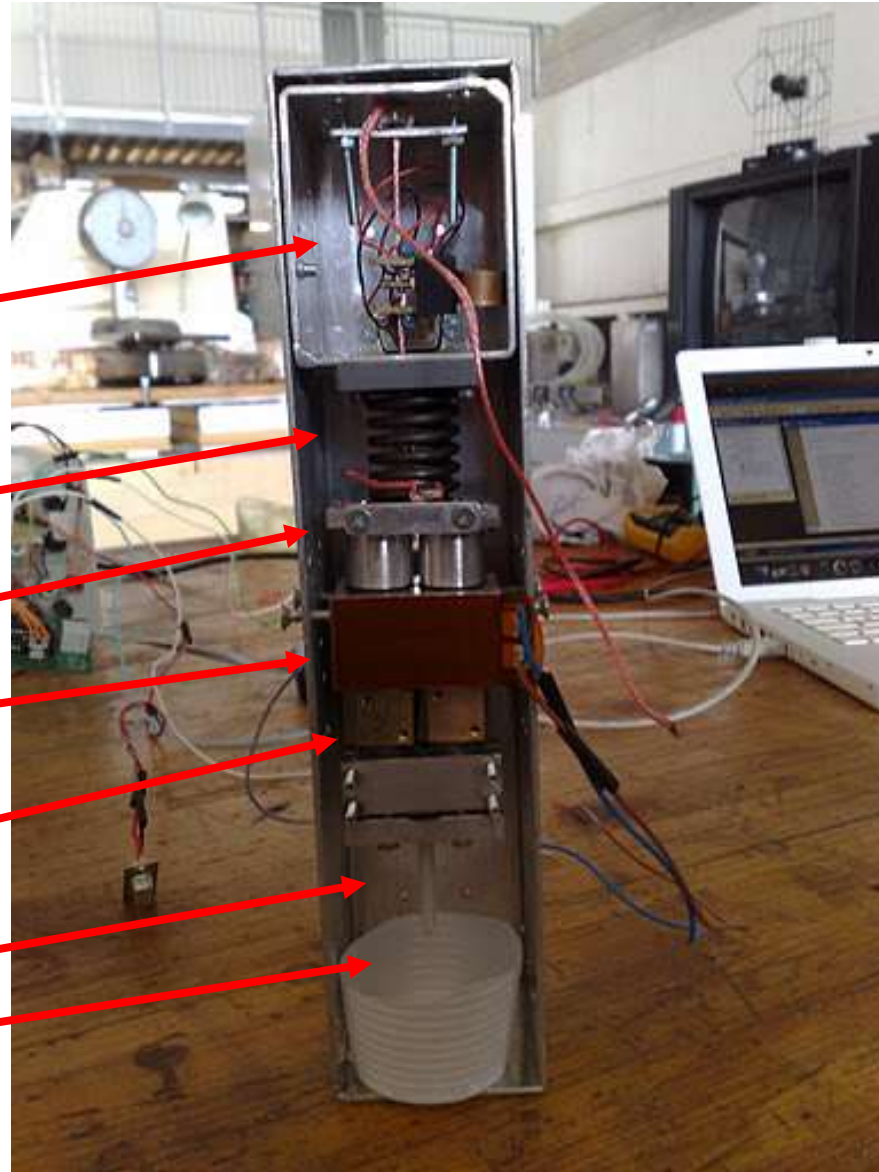
foam **without**
expansion in **atmospheric**
conditions....



.... but with perfect expansion in **vacuum**
conditions.



Test Cells



THERMAL CUT

SPRING

PISTON

TANK WITH HEATER

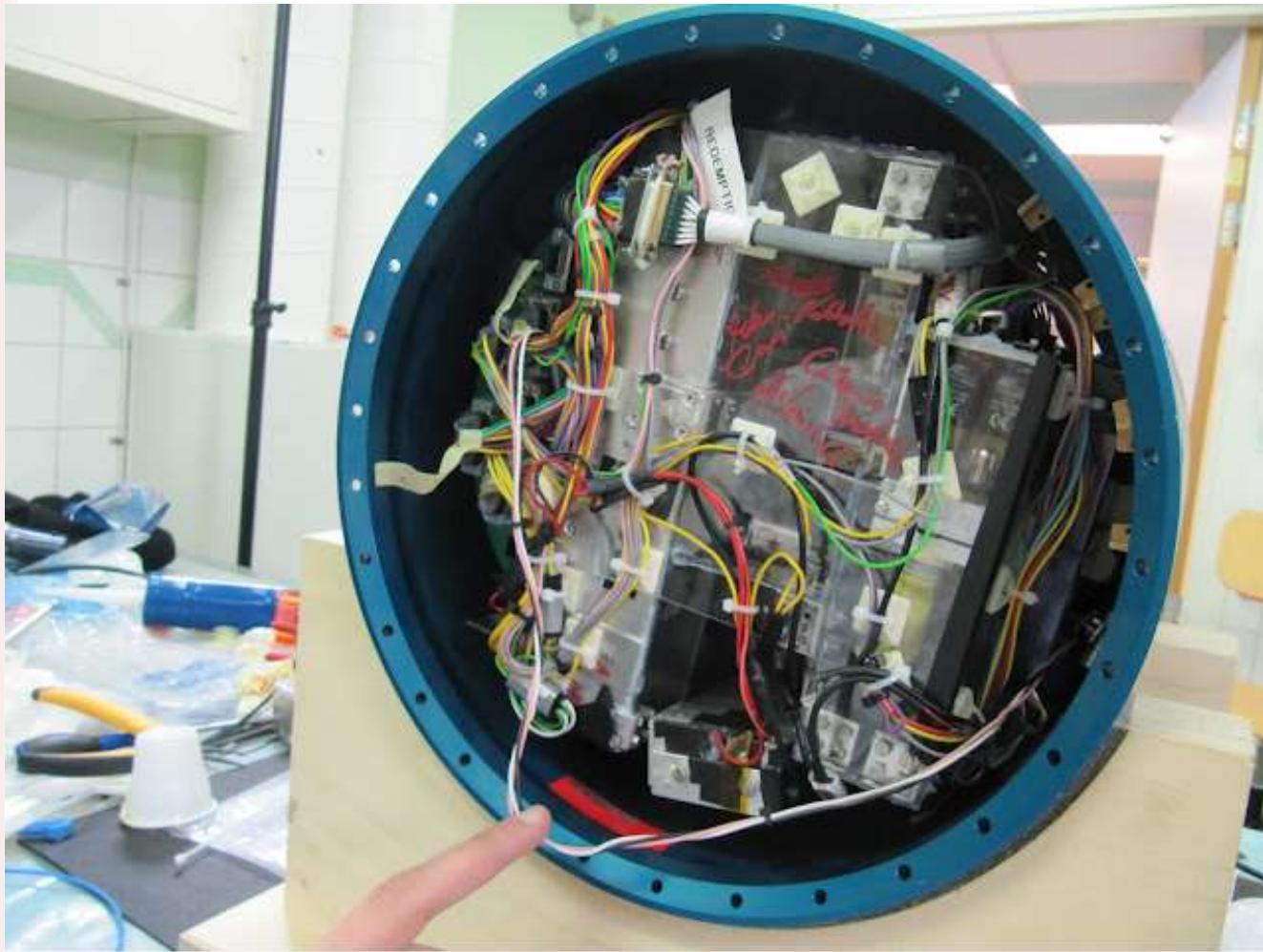
VALVE

MIXER

TEST SPACE



LAUNCH Campaign



LAUNCH campaign



LAUNCH campaign

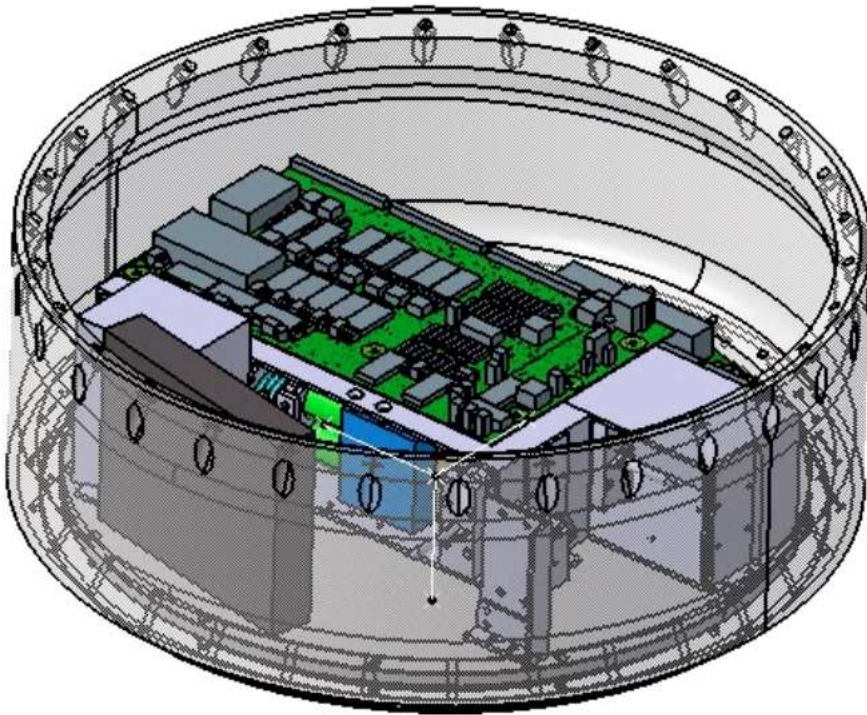


Some results were obtained:

- The structure and the mechanical part of the experiment survived the crash without loss of liquids (no parachute landing).
- Mechanical part of the experiment was working after the crash.
- Thermal control worked better than expected also thanks to the blower provided by SSC.
- the precaution taken against the humidity worked as the liquids were still in nominal conditions after days from the integration.
- Moreover, liquids did not introduce any problems in near space conditions during the flight of REXUS.



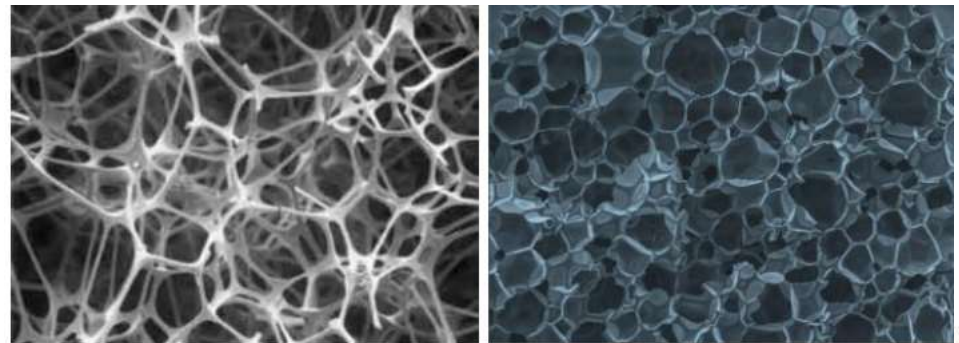
Redemption 2



REDEMPTION2 Resized and improved experiment adding the Open Cell foam test

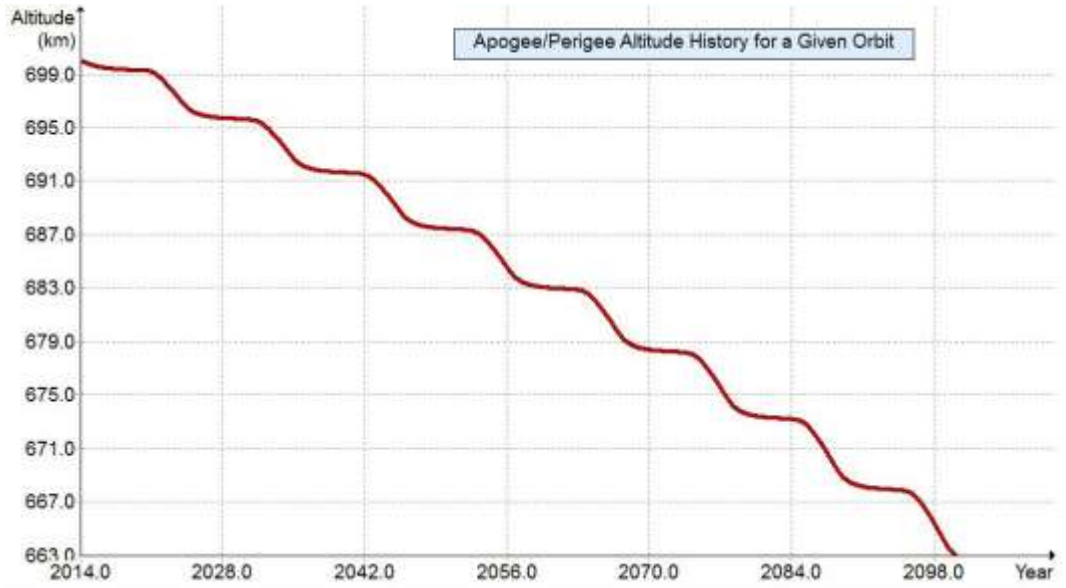
Mechanical Memory shape concept for sail and deployable structures

NOT SELECTED



Why a Sail

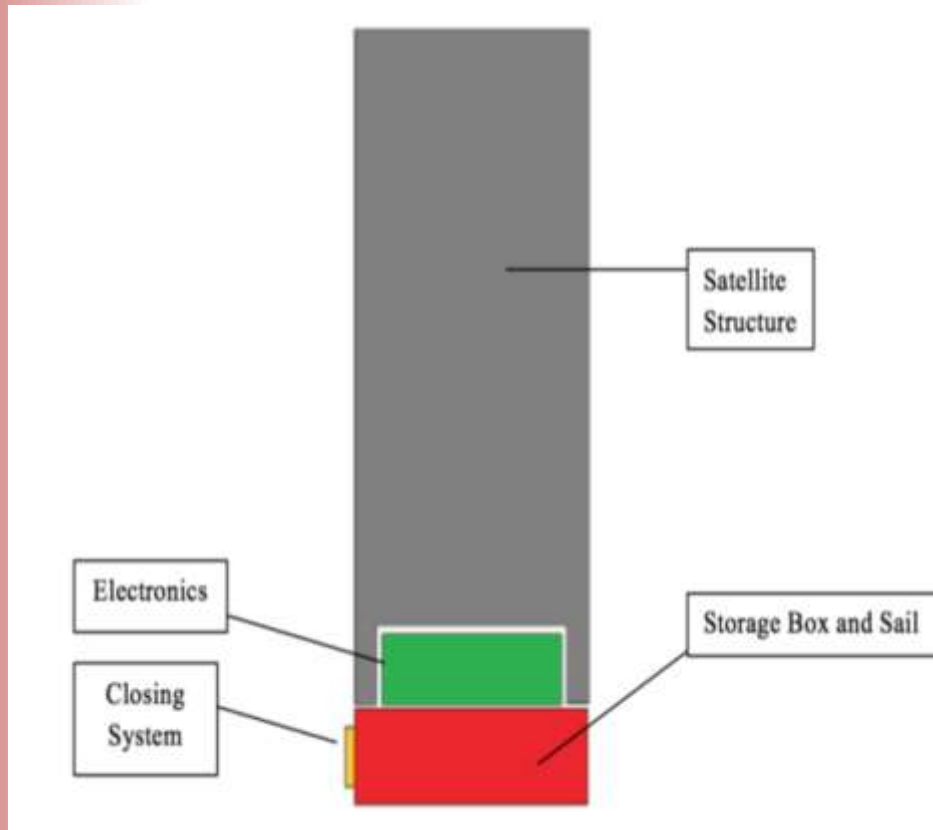
Without deorbiting system



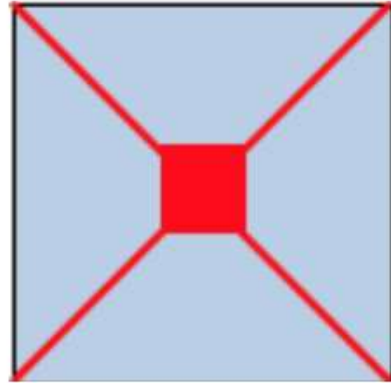
Expected results



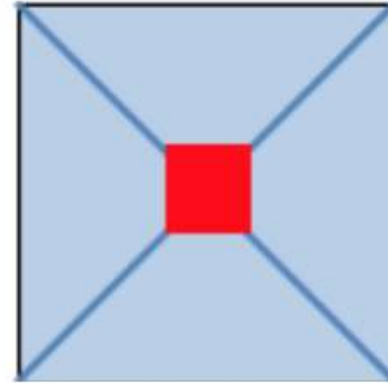
ARTICA: AERODYNAMIC REENTRY TECHNOLOGY IN CUBESAT APPLICATION



Open Cell Foam Application



Aluminum spars



Polymeric spars

ADVANTAGES OF THE CONFIGURATIONS:

- Less “high energy impact area”
- Less mechanical parts and electrical parts = Less failure points
- Eventually possibility to refold the system for multiple test
- Eventually lighter than a “normal” sail



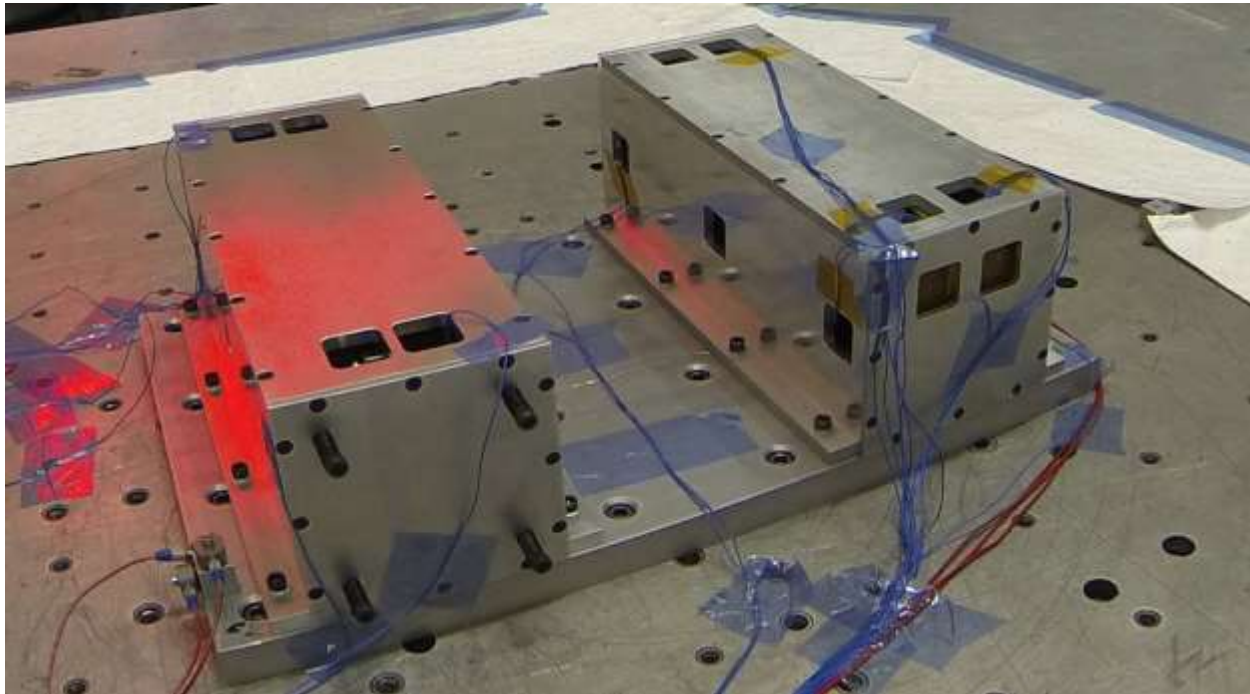
First Integration



Vibration Tests



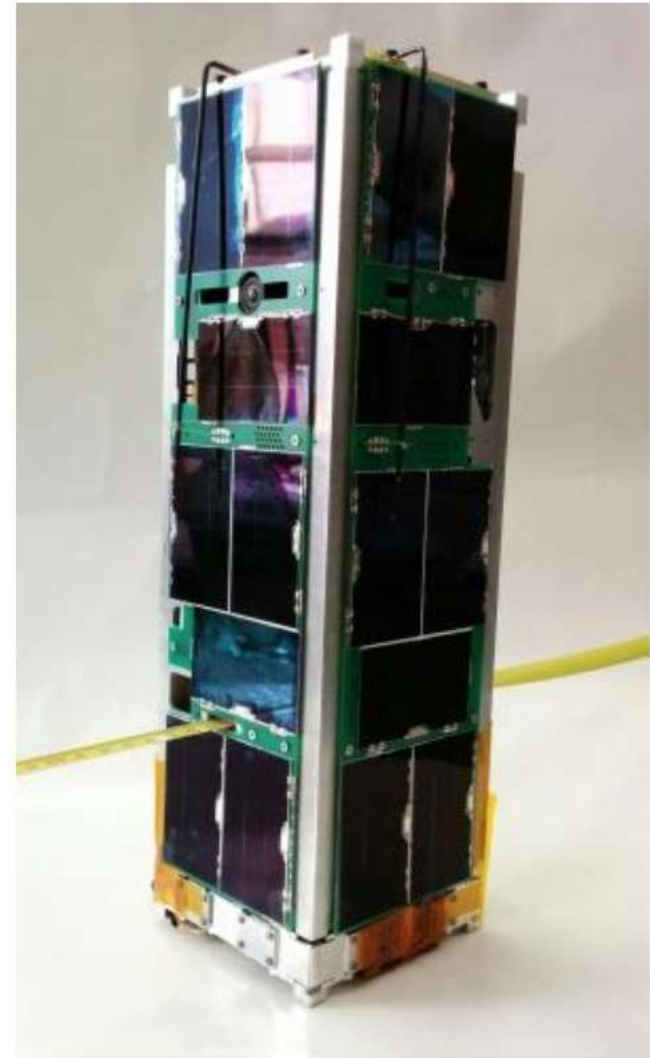
Vibration tests at David Florida Laboratory thanks to participation at Canadian Satellite Design Challenge



QB50URSA MAJOR

URSA MAJOR:

- ReDesign of the system
- ReSize of the system
- New vibration test
- General optimization
- Different Sail



CONCLUSION

- REXUS/BEXUS Program help to prove some concepts on space debris mitigation technologies
- The studies derived from Redemption bring to develop a deorbiting device based on the idea to use new materials to improve some performance of a normal sail
- The system was integrated and vibrated in two different satellites without problems
- More studies are necessary to get the orbit and obtain fly heritage



THANK YOU FOR YOUR
ATTENTION

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