Battery containment: design objectives and roadmap for small satellites

Clean Space Industry Days 2022

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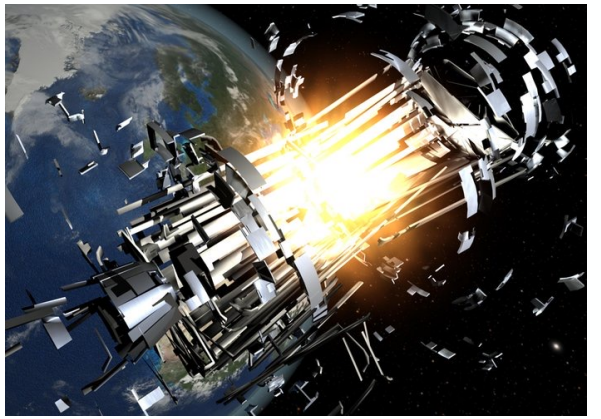
Introduction

- More than 60 years of space activities
- 31000 orbital debris tracked -1200 operational satellites
- More than 630 in-orbit fragmentation events (<10 were collisions); the **majority** of the events were **explosions** of spacecraft and upper stages
- Passivation operations in power and propulsion systems are currently performed on a best effort basis and not all the energy is depleted
- Uncompleted depletion of the stored energy can end-up in an explosion
- More small satellites with low reliability are launched



- A cheap solution to contain the energy released by the explosion of the batteries is required

ESA's objectives

Long-term objective: To develop and qualify a battery containment system in order to prevent break-up of the satellites in case the battery explodes. The target satellites' size is small satellites up to 100kg

Short-term objective: To size and understand the energy released due to the explosion of the battery – To design a containment system for small satellites

ESA's roadmap

Understand the mechanisms conducting to battery explosion
Measure the **energy** released by the battery when the explosion occurs

Design an energy containment system for small satellites
Test the containment system to fulfil its mission

Space qualification of a containment system

Short-term (TDE 2022)

Long-term

ESA's Technology Development Element 2022

- Design of containment techniques for batteries stored energy at End-of-Life
- Invitation To Tender (ITT 1-11414) issued in July 2022 and closed in September 2022
- Assessment of bidders' answers is on-going
- Starting of the contracted activity: December 2022
- Duration: 12 months
- Budget: 350 k€

ESA's Technology Development Element 2022

Main objectives of the activity - Analysis phase

- **To understand** how the batteries explode taking into consideration possible cascade effects that the explosion of a cell can cause (to the adjacent cells and on the module) and the batteries behaviour with respect to different levels of charge and level of temperature

- **To estimate** the energy released by the explosion of batteries used in small satellites (taking into consideration different cells types)

- **To assess** the scalability of the energy measured to different size of batteries

- **To assess** the representativeness of the tests to different types of batteries

ESA's Technology Development Element 2022

Main objectives of the activity - Breadboarding phase

- **To design** a containment system for small satellites based on the results of the analysis phase
- **To produce** a breadboard of the containment system and perform preliminary testing
- **And to test** a breadboard of the containment system under relevant space environment

ESA's Technology Development Element 2022

Main drivers - Breadboarding

- The containment system should retain the energy and fragments of the battery after it explodes
- The containment system should survive to space environment during the whole life of the satellite
- The containment system should be: cheap, light, easily demisable and have a minimal re-entry footprint

ESA's long-term activity

Main drivers – Qualification

- Ensure/Demonstrate that the containment system is able to retain the energy and fragments of the battery after it explodes
- Ensure that the containment mechanism is able to survive the space environment for the whole life cycle of the satellite
- Present use cases: including size of battery, cells types…
- Scalability of the design to bigger/smaller sizes

Thank you for your kind attention

If you have any questions or you want to know more about the topic you are welcome to contact me:
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