

# Aerospace Europe Conference 2023

## Joint 10<sup>th</sup> EUCASS – 9<sup>th</sup> CEAS Conference

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Abstract #XXX (to be filled by the organizers)

Preferred Topics: SUSTSP

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Type: Oral

Status of corresponding author: Student

For student corresponding author: student member of one of the following:

3AF / AAAR / AIAE / AIDAA / CzAeS / DGLR / FTF / NVvL / PSAA / RAeS / SVFW / EUROAVIA

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### Title

## Assessment of the CZ-6A R/B and the H-2A DEB fragmentation events

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### Abstract

In the last decades, the growing in-orbit population of resident objects has become one of the main concerns for space agencies and institutions worldwide, and several Space Surveillance and Tracking (SST) related initiatives have been promoted to tackle this issue. Indeed, the presence of the so-called space debris may jeopardise the operative mission of active satellites, given that the possible impact with a space debris ranges from cumulative erosion of the satellite surface to the potential satellite destruction, with the generation of thousands of additional debris and inevitable environmental drawbacks with possible cascade effects, known as Kessler syndrome. Within this framework, the EUSST consortium was established in 2015 to manage the SST-related activities at a European level, and the Fragmentation Analysis service is managed by the Italian Space Situational Awareness Centre (C-SSA) of the Italian Air Force. This work presents the analysis carried out by Politecnico di Milano in collaboration with the C-SSA, regarding two fragmentation events occurred on November 12th and November 17th, 2022, which involved the objects CZ-6A R/B and H-2A DEB respectively. These two events caught the attention of the SST operators because of their temporal proximity and possible Kessler syndrome implications, also considering that H-2A DEB was a conical adapter (with no on-board energy source) and its explosion was supposed unlikely.

To determine whether the aforementioned events had been interrelated each other, a screening scenario of the H-2A DEB fragmentation (the second event) was set up, by searching for possible conjunctions between the Spacetrack TLEs of the objects possibly associated with the CZ-6A R/B fragmentation (the first event) and the H-2A DEB TLE, the ephemeris of the second fragmentation parent, by also taking into account its uncertainty. The possible colliding pairs were searched for on an analysis time window including the official H-2A DEB fragmentation epoch. First, geometric and temporal filters were applied, and, for those pairs which passed this filter, the Time of Closest Approach (TCA) was then identified, together with the related Miss Distance (MD) and the Minimum Orbital Intersection Distance (MOID). All the potential conjunctions with either a MD or a MOID lower than a selected threshold were extracted, and the related TCA was eventually clustered in time. At the end, a bunch of the TLEs possibly related to the CZ-6A R/B fragmentation passed this filtering process and, so, featured trajectories moving in close proximity to H-2A DEB. Then, it was checked whether these TLEs were actually related to the CZ-6A R/B fragmentation through a tailored software for fragmentation detection and characterization (PUZZLE). A portion of them results not to be related to such an event, and this suggests that they may actually be fragments generated by the second event. Another portion instead results to be included in the CZ-6A

R/B fragmentation cloud, and this may suggest a relationship between the two events, as if one CZ-6A R/B fragment (either one among the TLEs returned by the process or an unknown one with a similar trajectory) may have provoked the H-2A DEB fragmentation.

## References