Assessment of Design for Demise Approaches for Reaction Wheels

Date October 24th, 2018

Presented by
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Agenda

- Program Description
- Modification Options
- Demisability test results
- Simulation results (work ongoing)

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Program Overview

- The program of funded by ESA in the frame of a TRP contract.
- The object of this study is to further investigate the break-up processes of a reaction wheel during re-entry, with the ultimate goal of having a fully demisable reaction wheel at the release altitude of 78km.
- The ball bearing unit (BBU) was already identified as a key element (demising late) during the demise process in previous studies.
- Potential design changes are analyzed with regards to the optimization of demisability.
- With the BBU being the key piece of technology in a reaction wheel, any design changes are carefully considered against heritage requirements.

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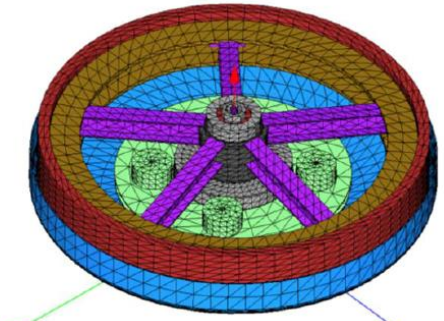
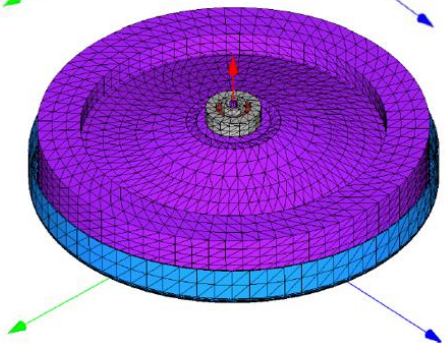
Modification Options

- Baseline wheels (from study:
- RSI 68 with steel rotating mass and RCD ball-bearing unit (BBU)
- RSI 68 (Al) with rotating mass made from Aluminum

RSI 68 SS

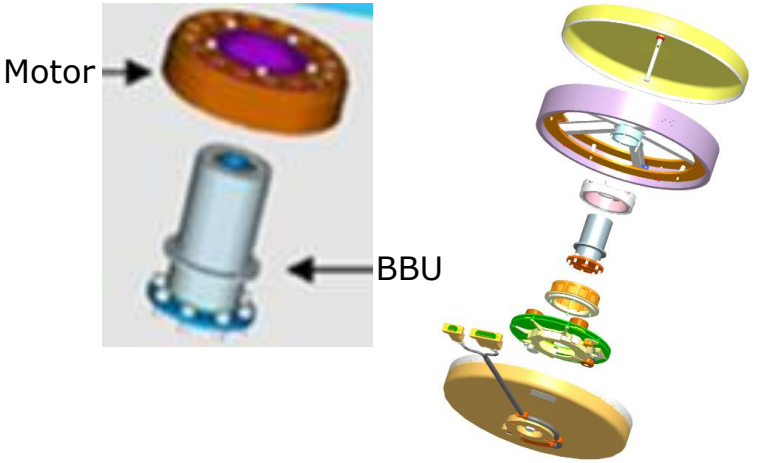


RSI 68 Al



Options to improve demisability of BBU

- Modify BBU threaded rings to trigger break-up earlier
- Glued connections to trigger break-up at lower temperature
- Further Ideas



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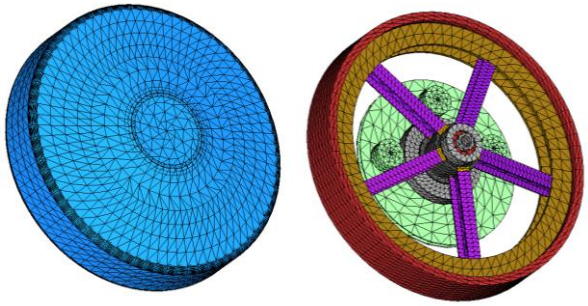
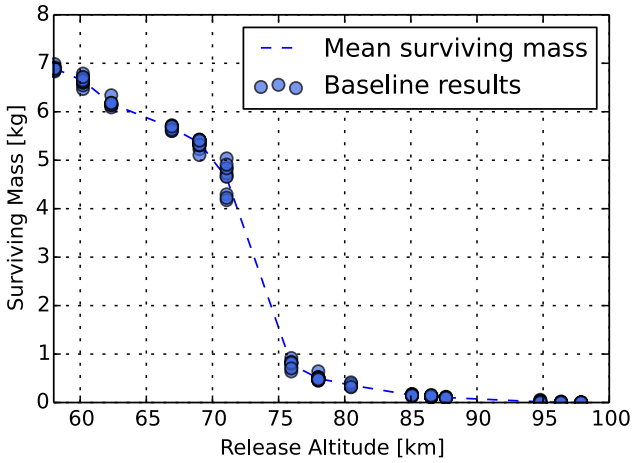
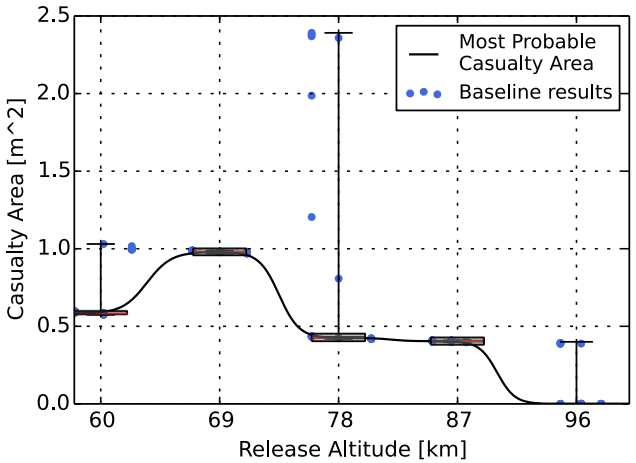
Baseline (RSI 68 Nms - Stainless steel)

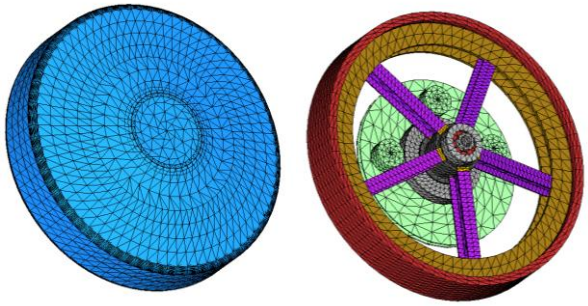
- Input conditions extracted along the CleanSat reference trajectory
  - Total of 225 cases in an altitude range between 58 and 98 km
    - 25 attitude variation cases for each main release altitudes (60, 69, 78, 87, 96)
    - 10 attitude variation cases at +- 2 km from the each main release altitude



Baseline (RSI 68 Nms - Stainless steel)







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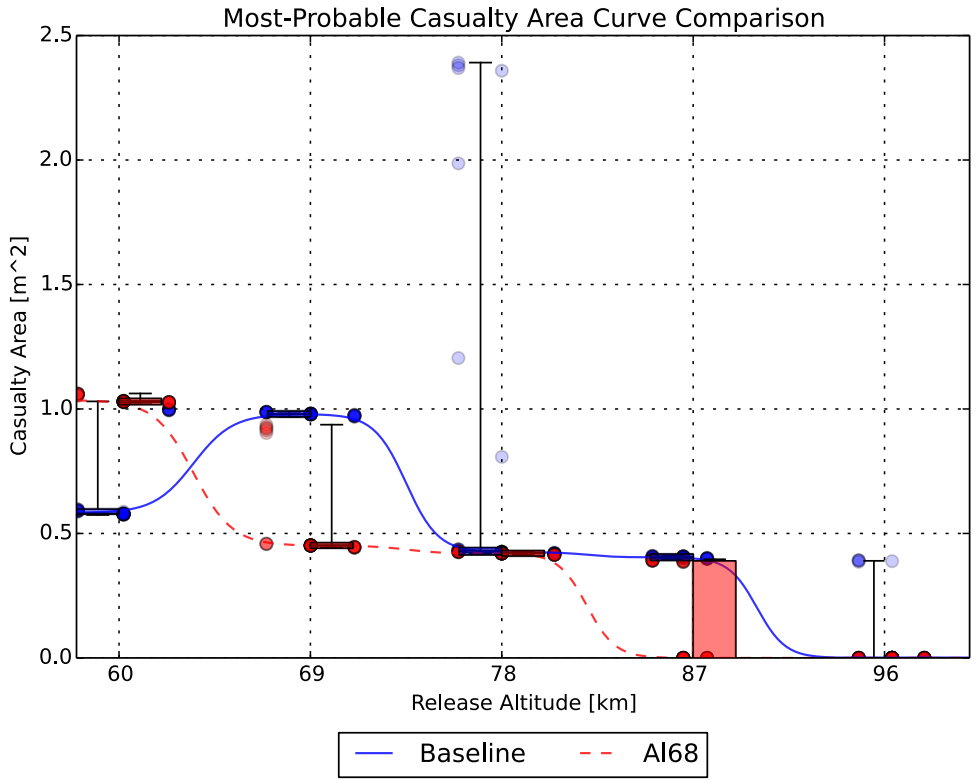
Comparison between Baseline and Al68 (RSI 68 Nms)



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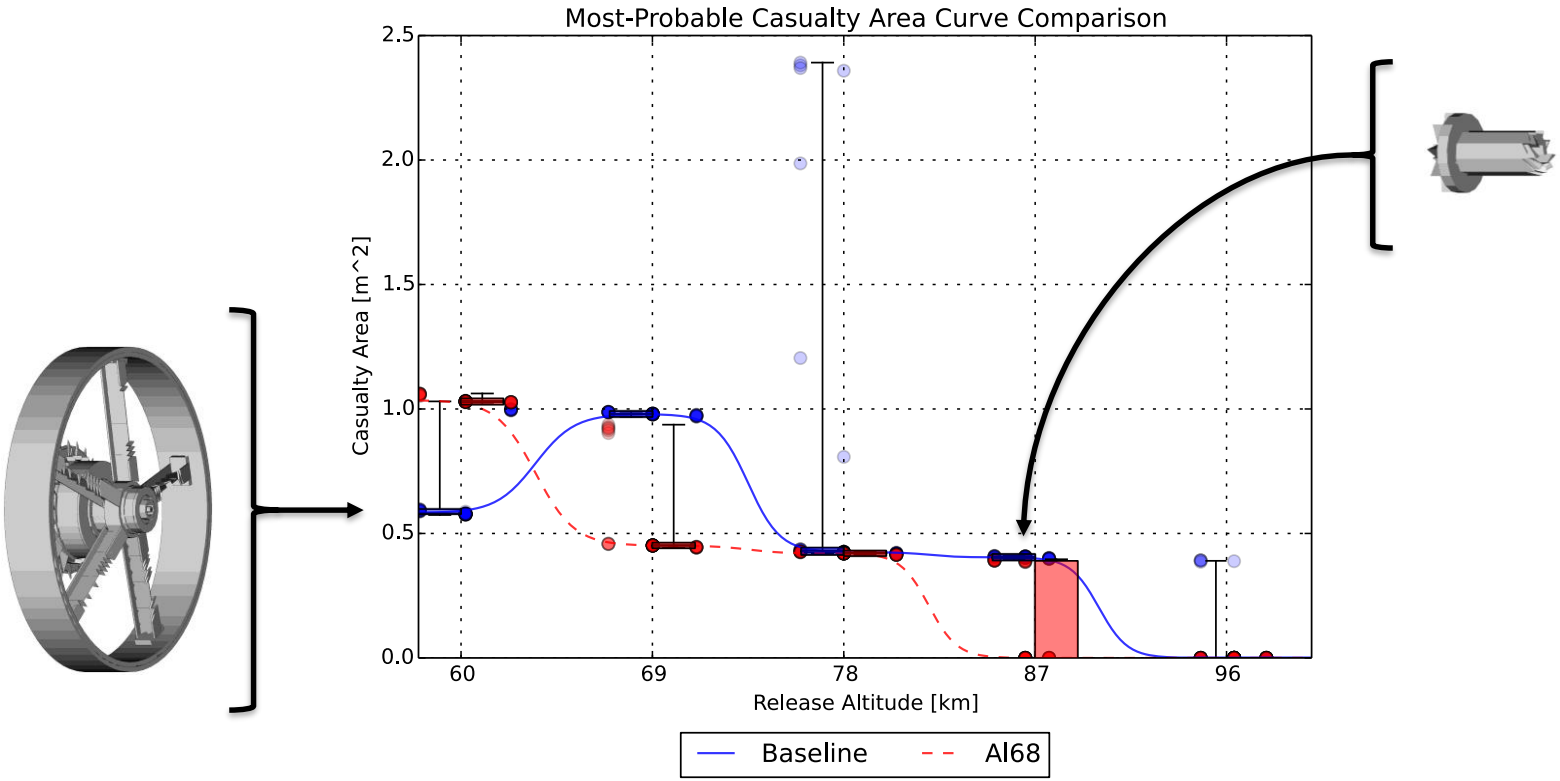
Surviving parts from Baseline model



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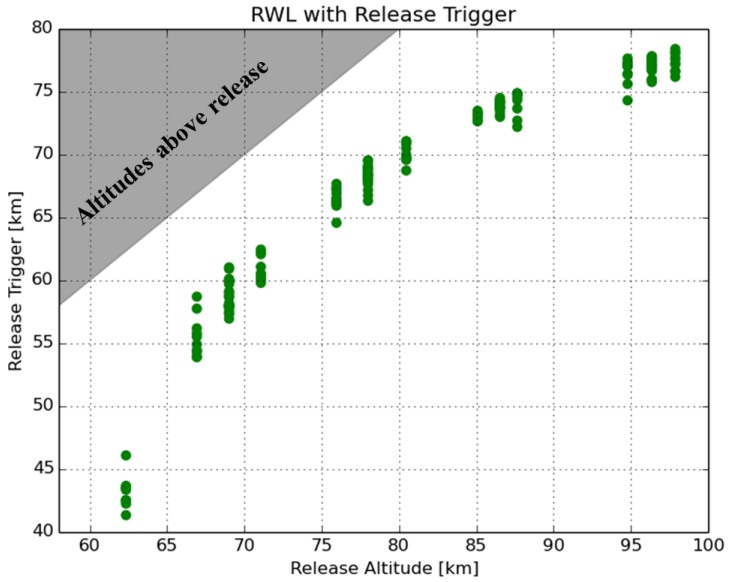
BBU - Release triggers

- Added temperature dependent release triggers inside the BBU to assist in its break-up.
- Triggers added at:
  - Threaded ring (at 900K releasing the shaft)
  - Rotor (at 490 K releasing the rotor rings)



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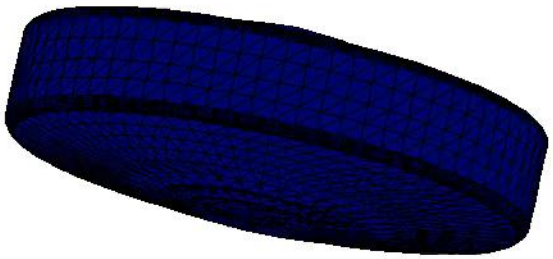
BBU - Release triggers

T = 2367.02 s
H = 77.996 km
V = 7.578 km/s

Real-time Animation
[flight direction to the right; view from zenith to nadir]



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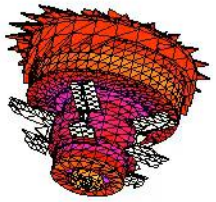
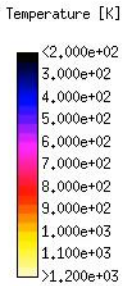
BBU - Release triggers

T = 2433.71 s
H = 67.132 km
V = 6.958 km/s

Slow-Motion Animation
[flight direction to the right; view from zenith to nadir]





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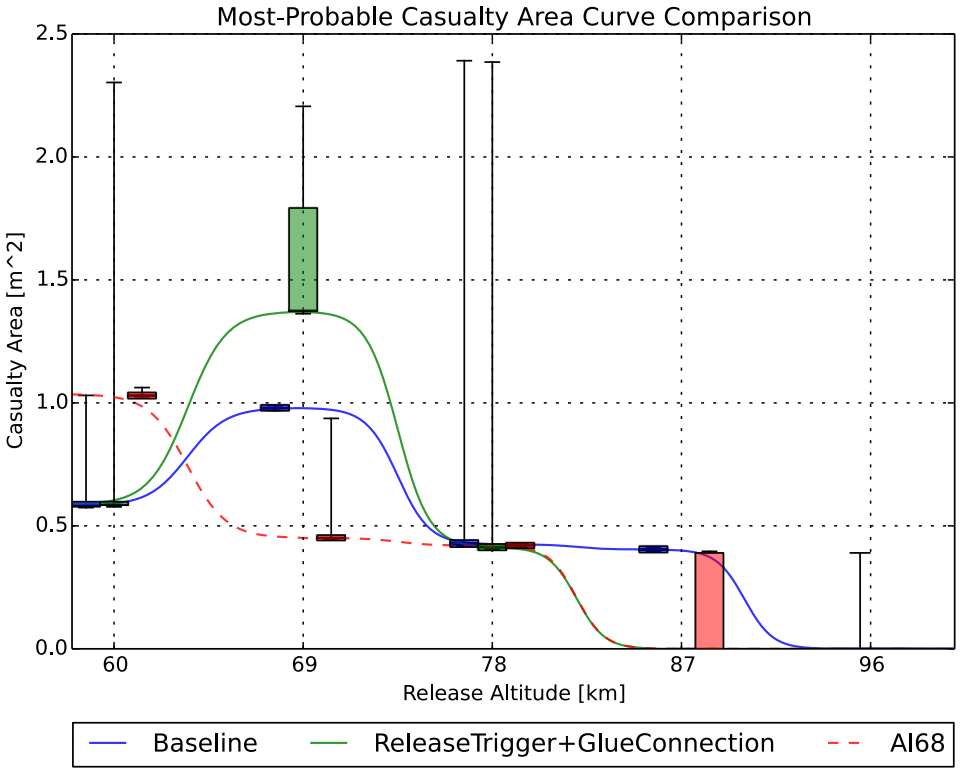
Comparison of most-probable casualty area



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Conclusion and Status as per October 2018

Simulation results show:

- RSI 68 (Al) (Aluminum rotating mass with no further modifications)
  - is demisable at and above release height of 87 km in 2/3 of the cases.
- RSI 68 (Steel rotating mass, with minor modifications of BBU)
  - is demisable at and above release height of 87 km

Next steps to further decrease the demise altitude

- Simulatation with smaller, but faster spinning wheel type: RSI 45 (Al)
- Use of thermite to increase the thermal energy within the BBU
- Combination of various modifications

The demise altitude has already been lowered to 87km and more options are available to improve the Demisability even further.

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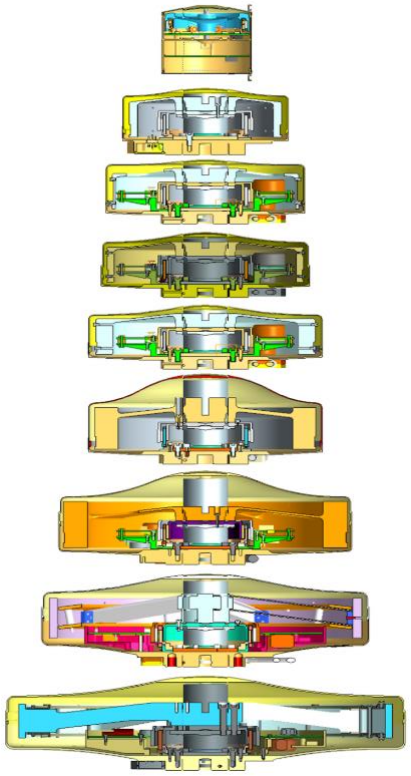
Rockwell Collins Germany Existing Productline

- Rockwell Collins Space qualified Aluminum rotating masses:

	(kgcm²)
Part Nr.	**Inertia**
73570-001	21,3
73825-001	51,6
52637-001	78,9
72159-001	84,9
71413-001	111,5
68307-001	182,7
69571-001	208,9
71513-001	272,0
70788-001	369,0
72346-001	383,0
72564-001	470,0
71674-001	703,0
73744-001	744,2
73971-001	1062,6



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