Demisability analysis of Solar Array Drive Mechanism

P. Kärräng

The casualty risk for any re-entry shall not exceed 10^{-4}

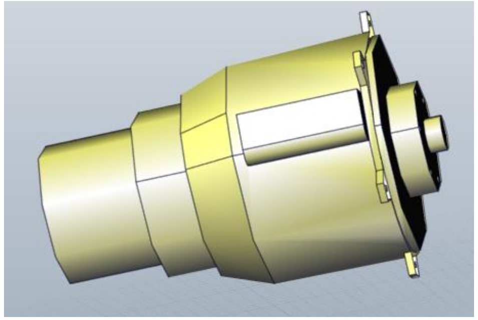
- One way of reducing the on-ground casualty risk is by limiting the number of fragments surviving until ground.

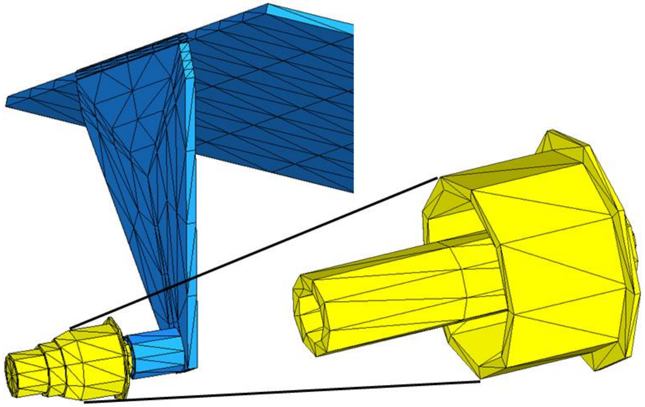
- The fragments which survive a re-entry are often from recurring spacecraft components.
  - Propellant tanks, reaction wheels, solar array drive mechanisms, magnetic torquers , balance masses and optical payloads

- Within ESA's "*High Fidelity Re-Entry Simulations on Critical Spacecraft Platform Equipment*" project:
  - Model and perform analysis of SADMs demise process during atmospheric re-entry
  - Assess the impact of D4D modifications on demisability

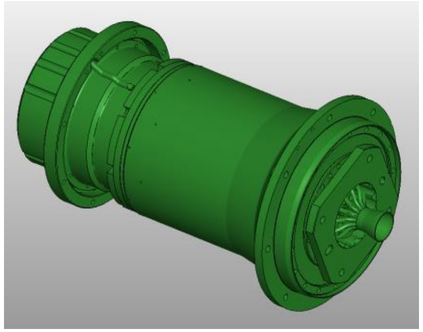
Previous SADMs used in SCARAB

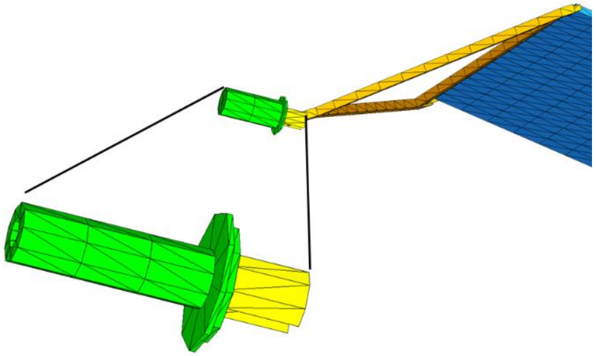
CarbonSat



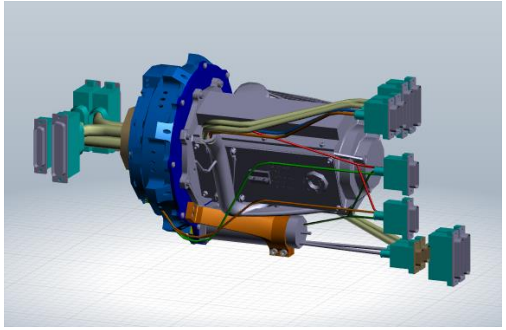


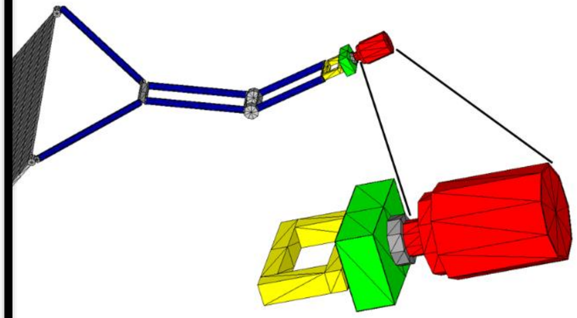
Sentinel-2





Sentinel-3

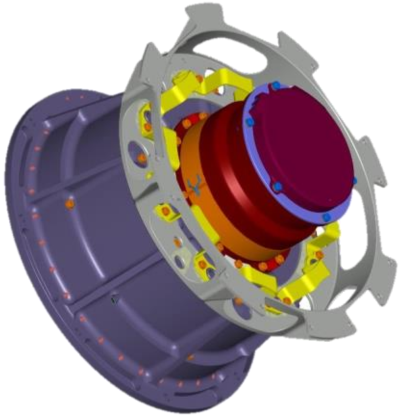


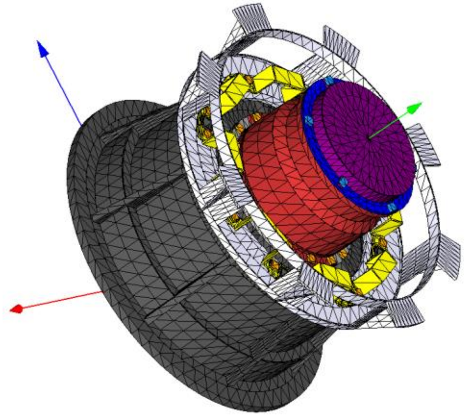


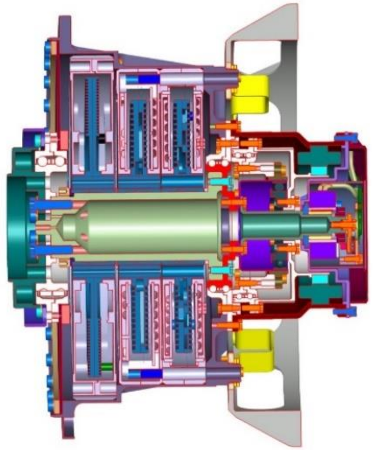
Baseline model of component

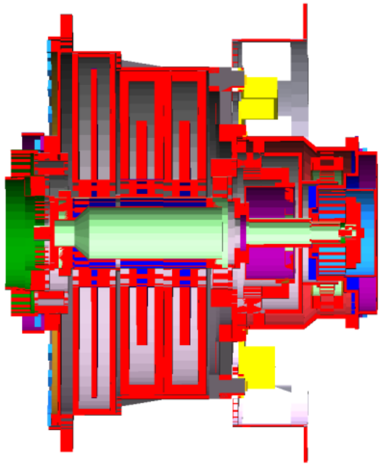
CAD model
(provided by RUAG)

SCARAB model



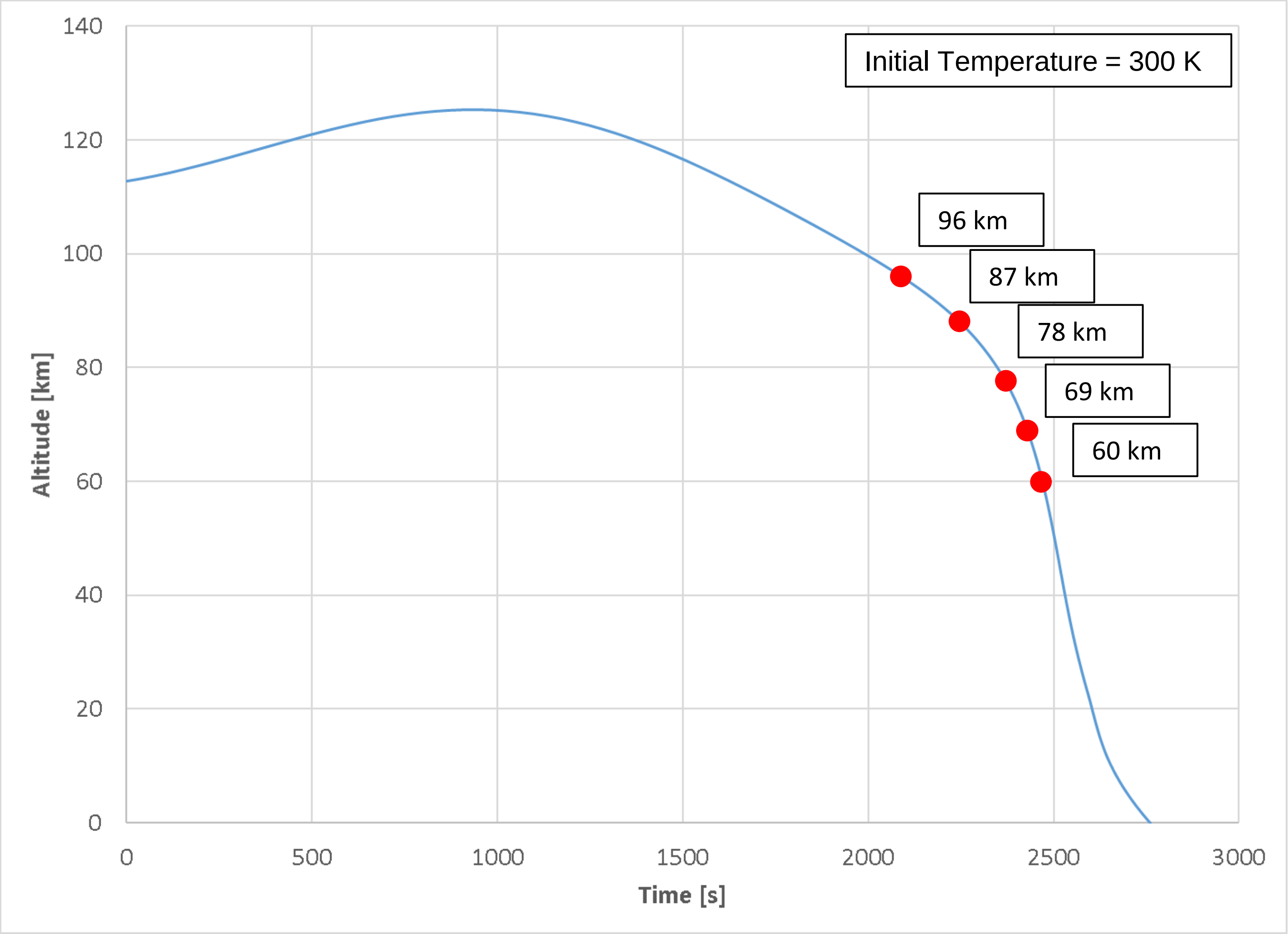




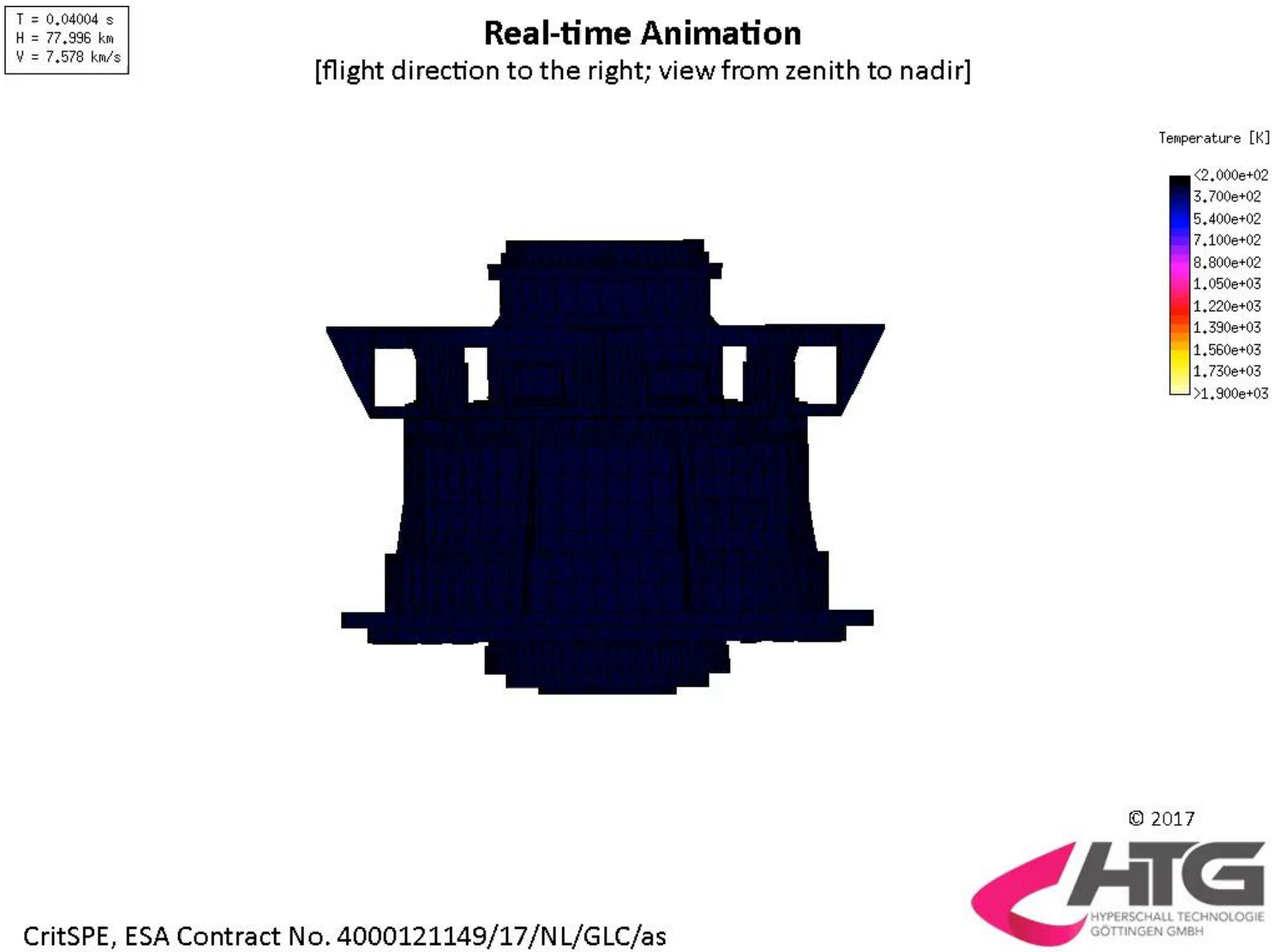


Initial re-entry conditions for component

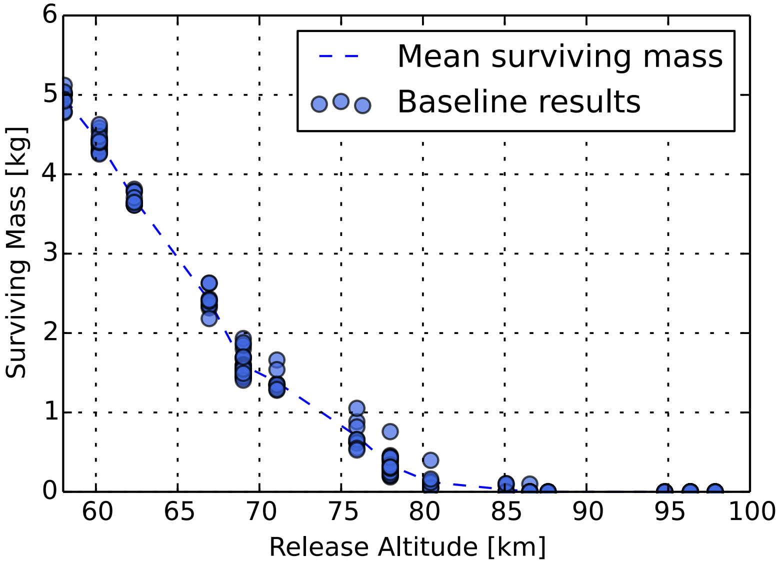
CleanSat reference trajectory



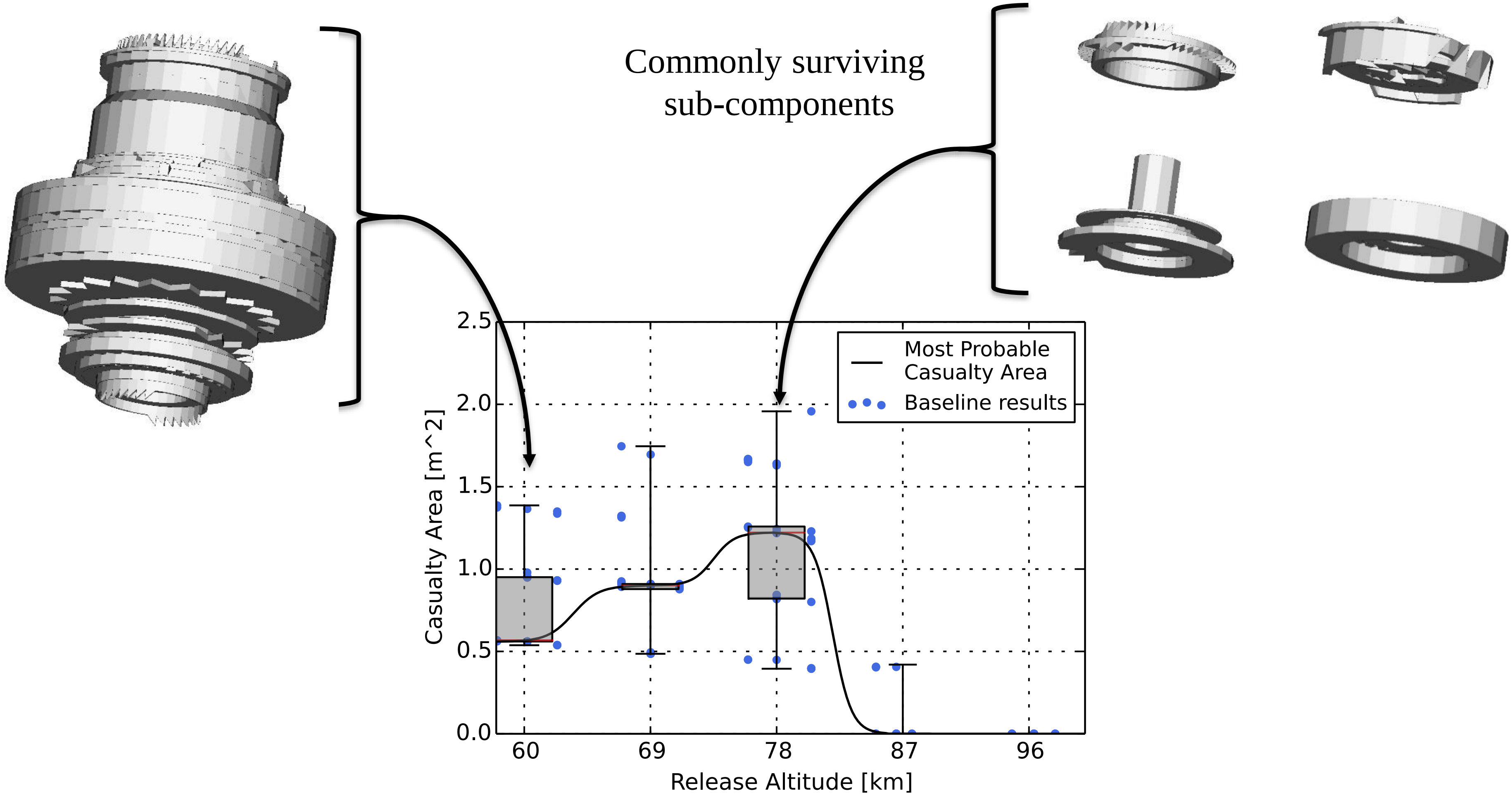
Assessment of baseline model



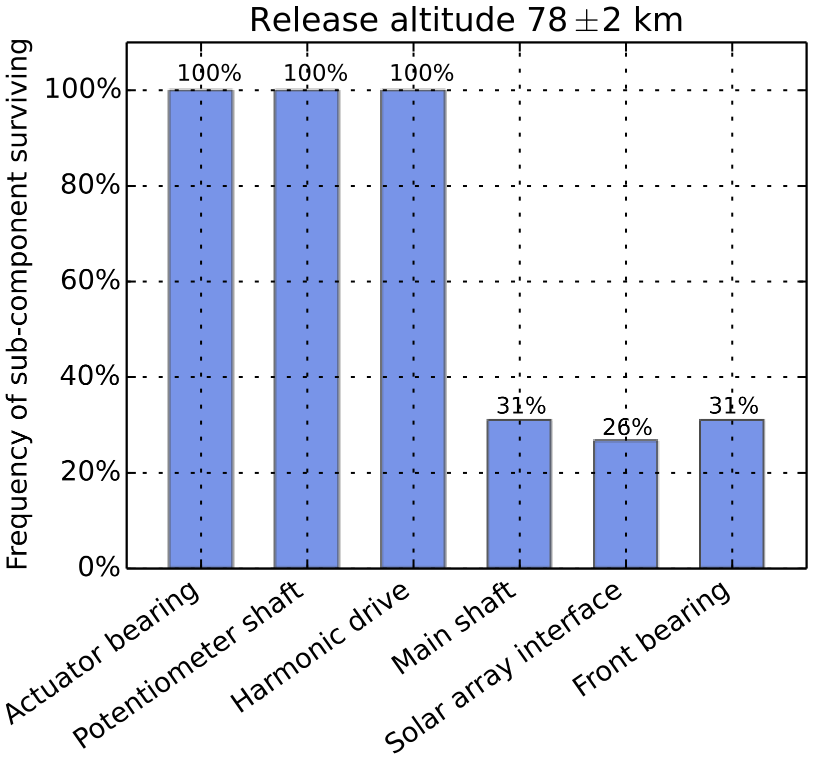
Assessment of baseline model



Assessment of baseline model



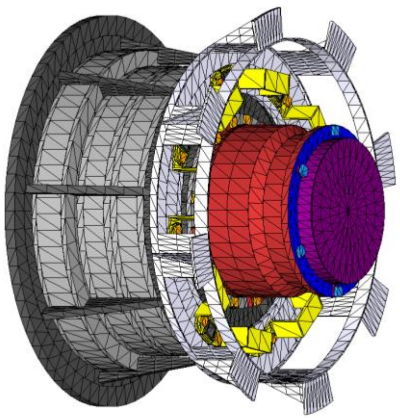
Identify critical sub-components for Baseline



HYPERSCHALL TECHNOLOGIE GÖTTINGEN GMBH

Together with manufacturer feasible D4D modifications were identified

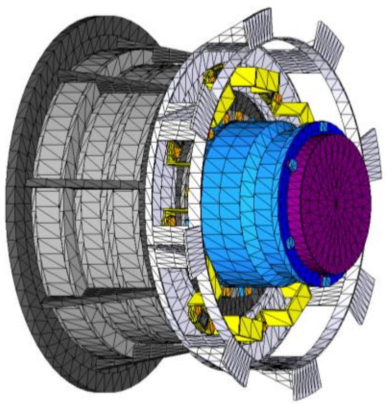
<u>Open SADM</u>



Removed parts of the main housing assembly, the idea is to expose the SADM interior to the flow earlier.

<u>Open SADM w/ aluminum actuator</u>

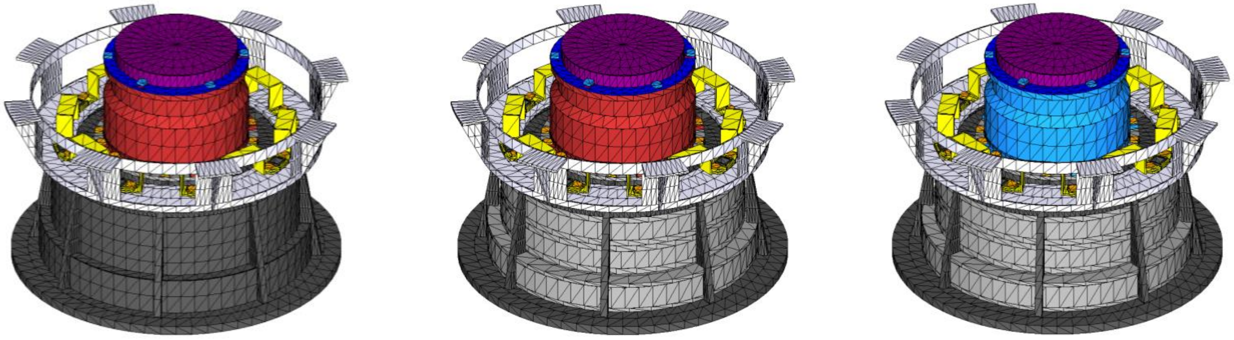
The wall thickness of the modified sub-components has **<u>NOT</u> been changed*

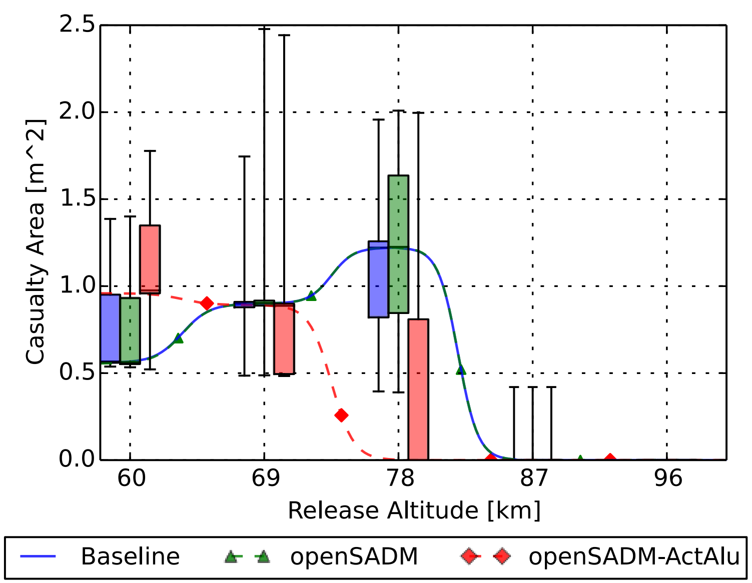


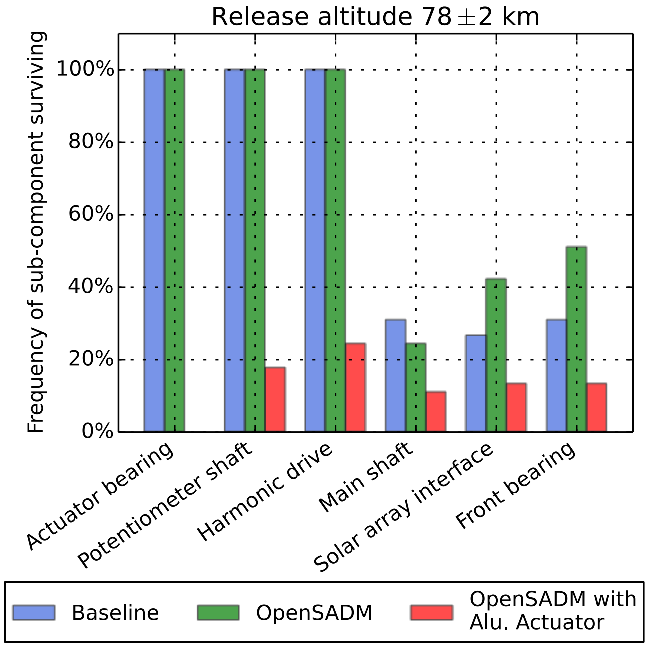
Keeping the open SADM design and in addition changing some Actuator components material to aluminum (from titanium) thereby reducing the heat required for complete demise (Q_{demise}).
Actuator components which were changed:

- Actuator housing
- Potentiometer shaft
- Potentiometer housing

Evaluation of design modifications







HYPERSCHALL TECHNOLOGIE GÖTTINGEN GMBH

Summary

- Baseline model **demise above if released above 87 km**

- Critical sub-components surviving have been identified:
  - Actuator bearing, Potentiometer shaft, Harmonic Drive, Main shaft, Solar array interface and Front bearing

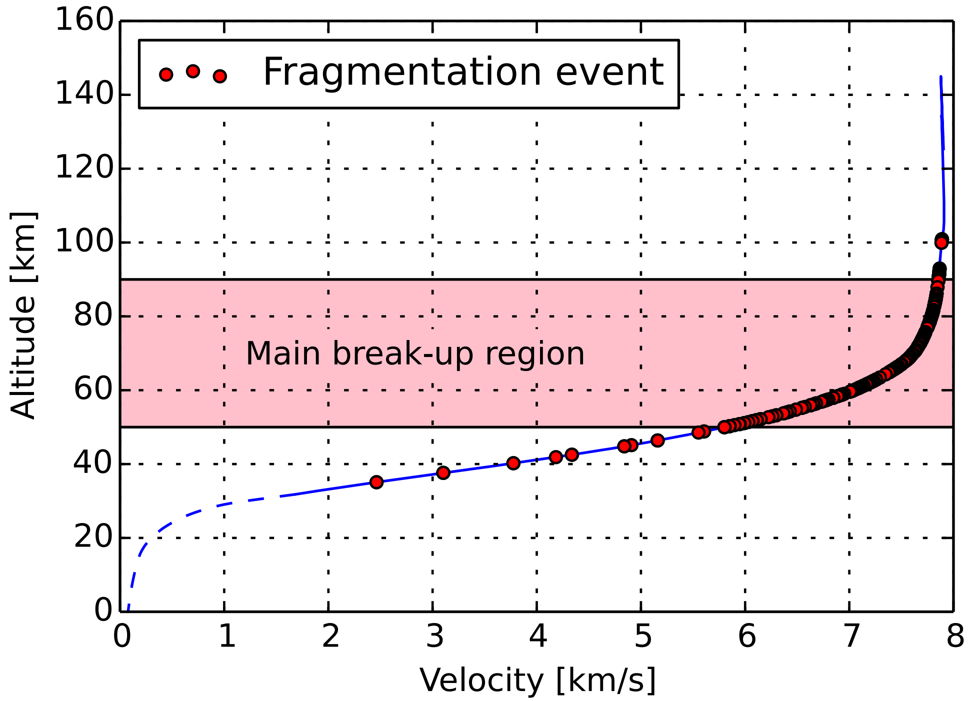
- D4D modification (1): Open SADM
  - Demise for release altitudes above 87 km
  - Tendency to generate more fragments for release altitudes above 67 km. (Larger casualty area on average)
  - Similar “most probable” Casualty Area distribution to the baseline model.

- D4D modification (2): Open SADM w/ Aluminium Actuator
  - Tendency to generate more fragments for release altitudes below 69 km.
  - Minimum demisable altitude around 78 km.

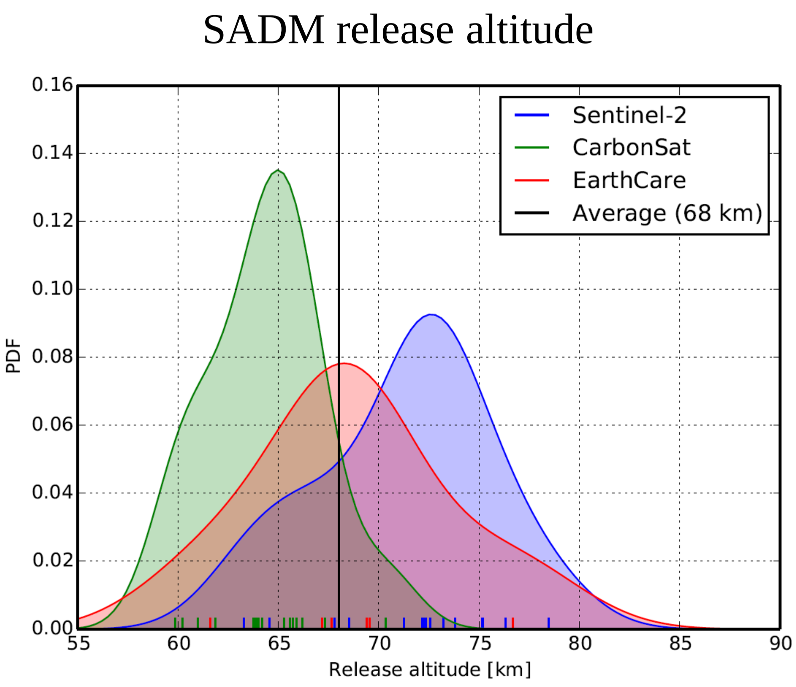
Thank you for listening!

Contact:
Patrik Kärräng
p.kaerraeng@htg-gmbh.com

Typical fragmentation altitudes during re-entry simulation with SCARAB



SADM - Initial release conditions:



**only thermal fragmentation simulated*