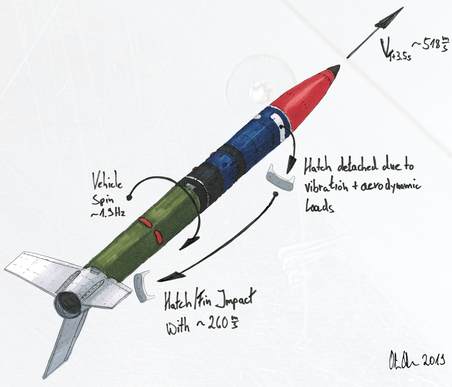
FOREIGN OBJECT DAMAGE
IMPACT TESTS ON SOUNDING ROCKET FIN STRUCTURES

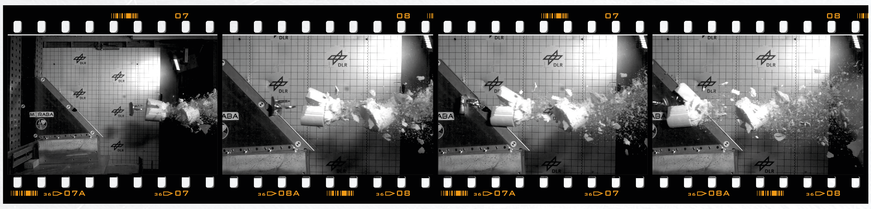
Background and Motivation

15 years after Space Shuttle Colombia's disastrous foam strike accident, DLR's Mobile Rocket Base (MORABA) performed high velocity impact tests on two Improved Orion (IO) fin structures thus supporting the failure investigation of the REXUS-24 flight anomaly.

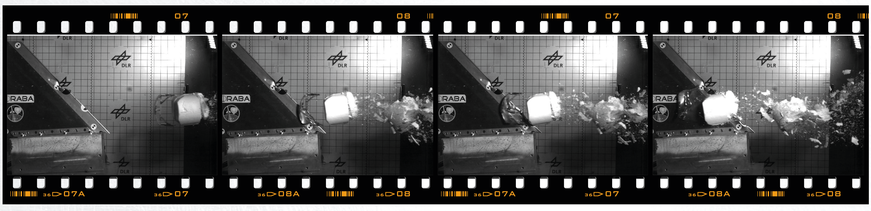
In total, seven impact shots were carried out with the 200mm calibre gas cannon at DLR's Institute of Structures and Design using original sized and downscaled 320 gram hatch assemblies as projectiles. The impactor's flight behaviour before and after impact as well as its induced damage pattern under different impact scenarios were the campaign's main objectives.



Test Setup and Performance

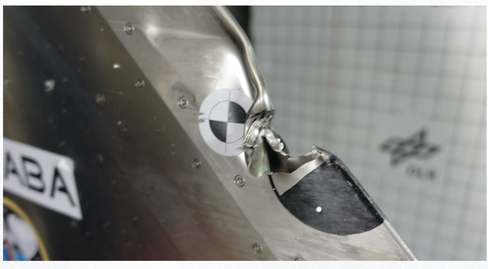


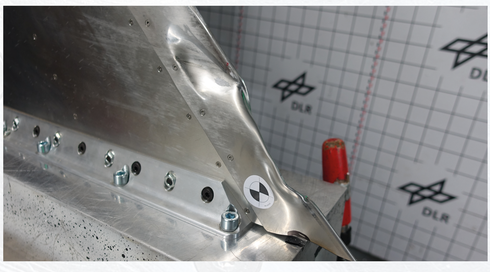
- Both fin assemblies were impacted at two leading edge positions each, one with a 0° and the other with a 2° angle of attack setting. For all shots the fin sweep angles were set to the original 45°.
- The impactor geometry was copied from a specific REXUS-24 experiment hatch design. Its previously calculated impact velocity was set to 260m/s.
- Depending on the impactor's predefined orientation the shot has been performed in original or downscaled configuration with comparable mass (320g) and inertia properties.
- All seven shots have been recorded by two high speed cameras, type Photron Ltd. Sa-Z Modell 2100K-M-16GB (30000fps, 1/40000 shutter, resolution 1024x688).



Test Results and Conclusion

- All impactors showed a stable flight behaviour with an average measured impact velocity of 257m/s.
- After impact all damage patterns showed strong but local destruction from cuts, bents, buckles, scratches and dents. Grazing shots with only marginal damage are possible for some impactor orientations.
- Right after the point of impact none of the impactors showed noticeable deflection or deceleration. All impactors disintegrated in several large pieces which stayed together in close formation on their predefined flight path.





Conclusion:
Effective failure can be induced however its failure mode is strongly dependent on the impact scenario. A complete disintegration of the fin structure seems rather unlikely by the given boundary conditions.

Contact

Oliver Drescher
DLR – MORABA
Münchener Straße 20
82234 Weßling
Germany
oliver.drescher@dlr.de

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Deutsches Zentrum
DLR für Luft- und Raumfahrt
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