

THE SHEFEX II EXPERIMENTAL RE-ENTRY VEHICLE: PRESENTATION OF FLIGHT TEST RESULTS

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Abstract

On 22. June 2012 the hypersonic flight experiment SHEFEX II was launched from Andoya Rocket Range, Norway. The goal of this second flight was to demonstrate the hypersonic re-entry at approx. 3 km/s with a fully aerodynamically controlled vehicle. The applied sharp edged ceramic canards and the faceted ceramic and metallic TPS were the key experiments of the flight. During the mission sensor data of almost 100 sensors and the full 6DOF flight mechanic characterization of the flight were gathered. These data are of immeasurable value for the post flight analysis to be performed in the next years.

The presentation introduces the SHEFEX II vehicle, its mission and will give a first overview of the huge amount of gathered flight data.

1 Introduction

The focus of the DLR flight test program SHEFEX (SHarp Edged Flight EXperiment) is the development of technologies for re-entry and hypersonic flight. Applying available sounding rockets this approach allows relatively cheap hypersonic flight experiments, which enable to obtain important flight data for the comparison with numerical simulations and ground tests to verify their results.

2 The SHEFEX I Flight (October 2005)

The successful SHEFEX I flight took place in October 2005 in Andoya, Norway [1]. During

the entire M=6 re-entry of 20 sec flight time a very valuable aerothermodynamic dataset, consisting of pressure, temperature and heat flux values was stored. Based on these data it could be proven that the entire heating process can be numerically predicted based on a direct coupling of the DLR TAU code and a FEM code. Additionally, the full 6DOF flight mechanic description along the entire trajectory is available from the DMARS platform. Applying, a direct coupling of a trajectory code and the DLR TAU code it enables to rebuild the flight mechanic behavior of SHEFEX I numerically. These works are underway to date [2].

2 The SHEFEX II Flight (June 2012)

On 22.06.2012 the SHEFEX II flight took place from the Andoya Rocket Range in Norway (**Fig. 1**). Participating partners from DLR were the Institutes of Aerodynamics and Flow Technology, of Structures and Design, of Flight Systems, of Materials Research, of Space Systems and the Mobile Rocket Base of DLR. The goal of this second flight was to demonstrate the hypersonic re-entry with a fully aerodynamically controlled vehicle. The speed range was extended up to 3 km/s and measurement time during re-entry was about 50 sec. Apart from the extension of the flight regime the size of the sharp edged nose of the payload is significantly increased and contains four independently controllable canards for the active control of the re-entry flight. These sharp edged ceramic canards and the faceted ceramic

and metallic TPS were the key experiments of SHEFEX II.



Fig. 1: The SHEFEX II re-entry vehicle

The autonomous control was supported by inertia platforms and a star tracker.

Additional experiments were an actively cooled TPS panel, innovative sensors for pressure, temperature and heat flux as well as high temperature antennas. National and international research institutions and the industry contributed passenger experiments to prove their ceramic and metallic TPS systems in flight. The pressure sensors were additionally applied as a currently passive flush air data system (FADS) which enables to predict the attitude of the vehicle based on the measured values.

The launcher of SHEFEX II (**Fig. 2**) consisted of a S40/S44 motor combination with modified tail can and fins and an interstage adapter with an active stage separations system. The motor

adapter was equipped with a destruct and separation system. During the launch phase the fins in the back of the re-entry configuration were covered by a CFK split fairing of 1.6m in length. The total length of the SHEFEX II configuration was almost 13m and it had a mass of almost 7 tons.

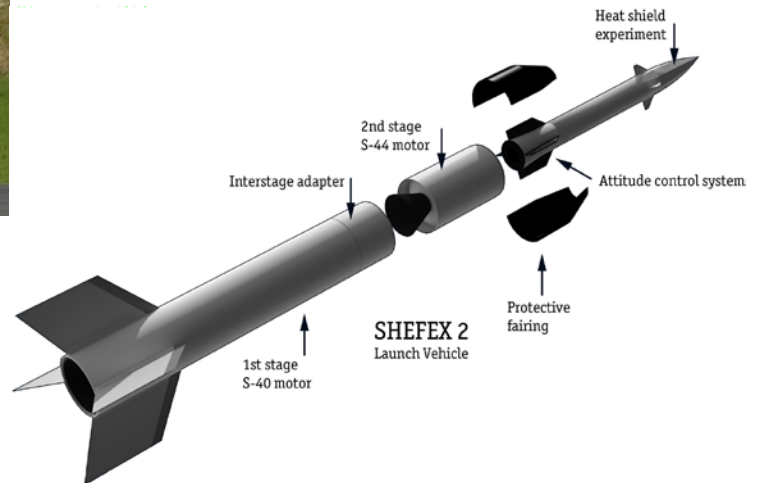


Fig. 2: The SHEFEX II launch vehicle (illustration: Trond Abrahamsen, Andoya Rocket Range, ARR)

The extremely challenging flight mission is illustrated in **Fig. 3**. The vehicle was launched almost vertically. After separation of the first stage the remaining vehicle was reoriented and the upper stage enabled an acceleration of the vehicle into a flat ballistic flight trajectory. The flight control system oriented the re-entry configuration to an initial flight path angle of 35° followed by a de-spin maneuver which together enable a re-entry phase of almost 50 sec. At low altitude the payload was separated in two aerodynamically unstable parts. The part with the canard experiment was intended to be recovered after a flat spin phase. During the entire flight from launch until the re-entry down to 29km all sensor data could be stored and additionally the entire flight mechanic description of the uncontrolled launch and the controlled re-entry is available (**Fig. 4**). These data are of immeasurable value for the post flight analysis to be performed in the next years.

The Shefex II Experimental Re-Entry Vehicle: Presentation of Flight Test Results

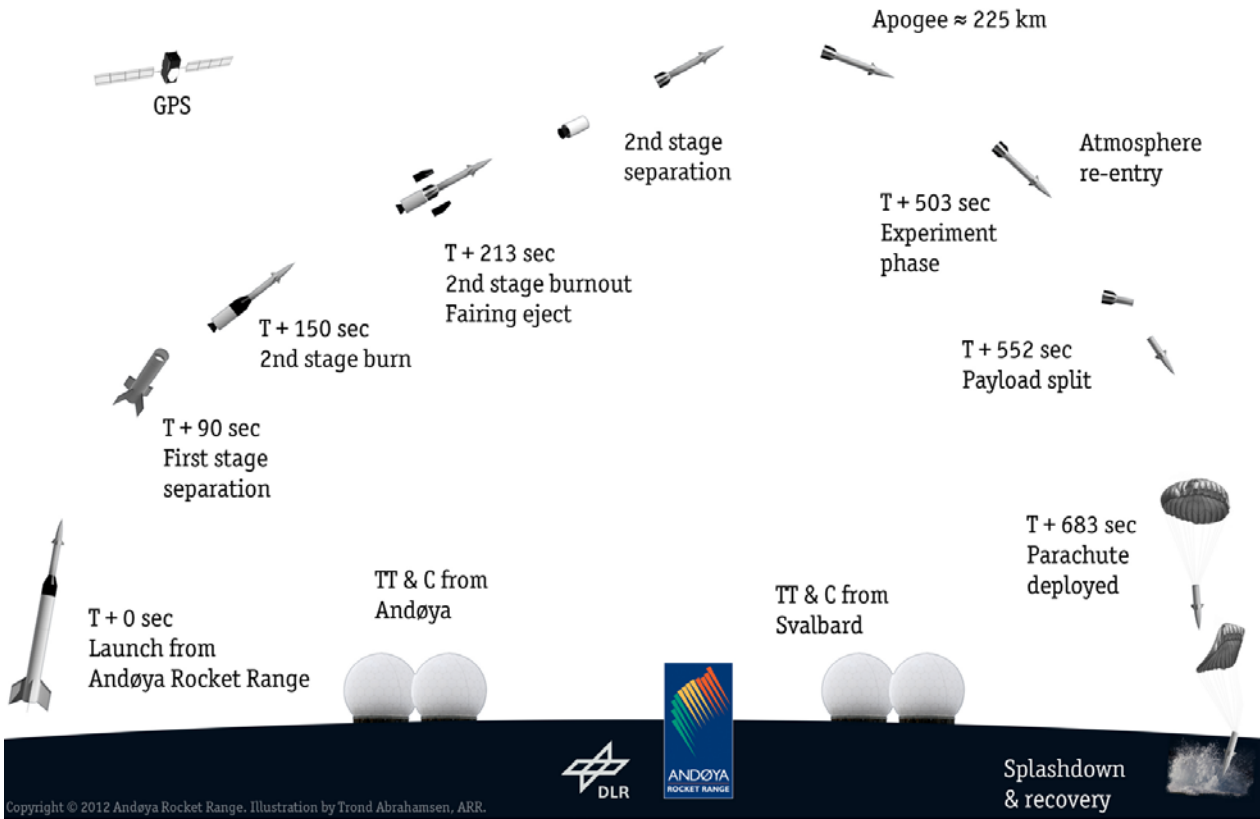


Fig. 3: The SHEFEX II mission (picture: ARR)

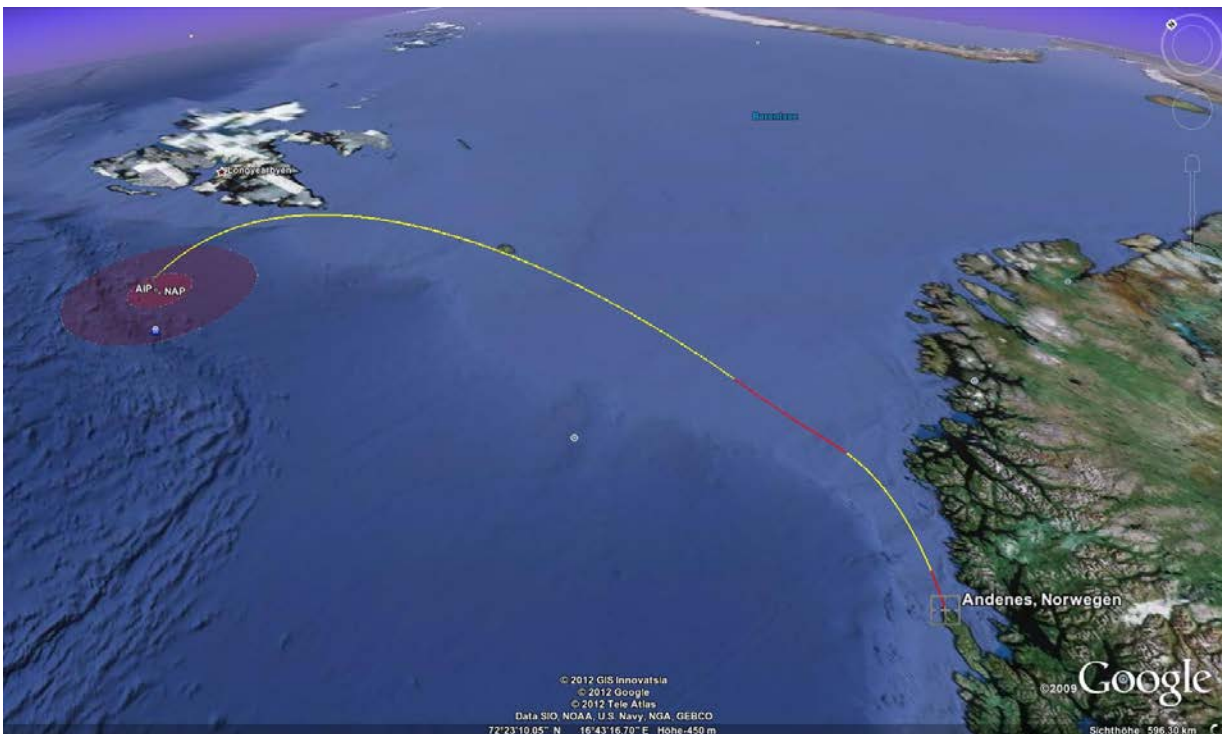


Fig. 4: GPS trajectory of the SHEFEX II flight

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