Eucass 2013

Abstract: STERN - A Rocket Programme for German Students

Karsten Lappöhn, Denis Regenbrecht, Dario Bergmann
DLR Space Agency, Bonn, Germany

Launcher systems like Ariane 5 and Vega provide Europe with an independent access to space. To maintain this economically and strategically important capability, one needs to train young professionals under conditions that are as realistic as possible. Conducted by the DLR Space Administration of the German Aerospace Center and supported by funds from the Federal Ministry of Economics and Technology (BMWi), the STERN programme provides aerospace engineering faculties at universities with opportunities to introduce students realistically to subjects related to space transport.

STERN (**S**tudentische **E**xperimental-**R**aketen, also the German word for “star”) took off in April 2012 with the first two universities followed by six further ones until March 2013. During the project duration of three years the up-and-coming engineers will develop their own rockets. There are no limits regarding peak altitude or the propulsion system used (solid fuel, liquid fuel, steam or hybrid).

As a minimum, rockets must reach an altitude of three kilometres and the speed of sound. Further mandatory requirements include a telemetry unit to radio the most important trajectory data, such as acceleration, velocity, and flight altitude back to Earth, and a parachute or similar equipment to ensure that the rocket can be recovered safely. Focussing at the rocket design no payload is mandatory except the telemetry unit with flight parameters.

At present, most of the rockets have their own developed propulsion systems by the students and are expected to reach altitudes of ten to 20 kilometres and will normally be launched from the Esrange site near Kiruna in the north of Sweden.

Because of its complexity, students will work in groups and share out among themselves any special tasks such as trajectory calculation, flight stability, structure, propulsion system, tests, telemetry, et cetera. There are many possibilities for each of these exercises to become a regular part of classroom activities. Thus, for example, flight stability may be determined with the aid of modern computational fluid dynamics (CFD) and subsequently verified in wind tunnel tests. Similar options are available when designing pressure vessels (tanks, engine casings) and nozzles or calculating the strength of individual rocket elements with finite element method (FEM).

As in any 'real' development programme, students have to pass several reviews at various stages of the project. During this, they have to present and defend their rocket design before the review board, whose recommendations will serve to enhance the safety of the mission as well as the probability of its success. A last review covering the current configuration of the rocket, the launch infrastructure needed, all tests previously completed, and the flight performance expected will take place at the launch site itself. The launch will be given the go-ahead only after this review has been successfully completed.

DLR MORABA (Mobile Rocket Base), the DLR Space Propulsion Institute, and the DLR Space Administration are a major part of the Review-Board until flight. With a large number of high-altitude research rockets launched form Esrange, DLR's MORABA has acquired total system competence when it comes to assessing the structural integrity, flight behaviour, or flight performance of a rocket and makes access to Esrange possible. The DLR Space Propulsion Institute at Lampoldshausen has decades of experience in testing rocket engines, especially those belonging to the European Ariane programme that was launched in the 1970s. In addition, the centre conducts both applied and fundamental research in the field of rocket propulsion systems.