TECHNISCHE UNIVERSITÄT DRESDEN

Fakultät Maschinenwesen Institut für Luft- und Raumfahrttechnik

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Sounding Rocket Development with Liquid Propellants within the DLR STERN Programme

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Space Educational Activities
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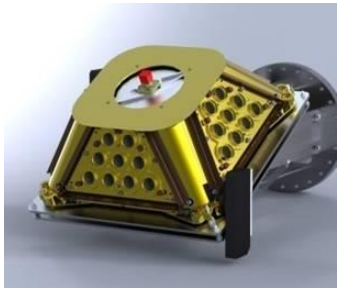
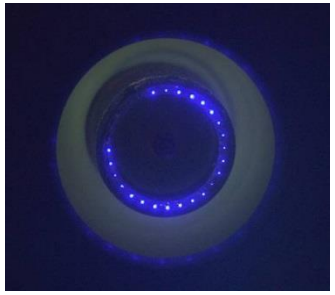
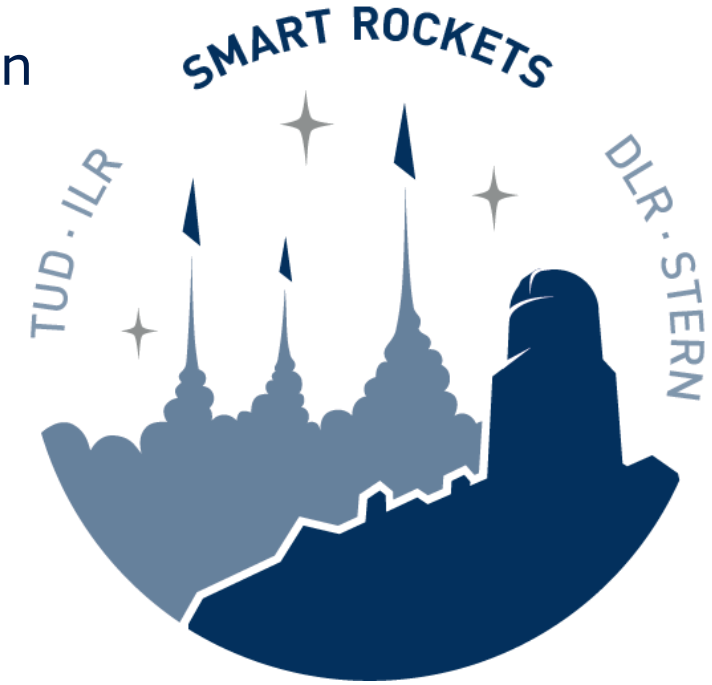




Outline

1. The Education Programme STERN
2. SMART Rockets @ TU Dresden
3. Evaluation of STERN
4. Outlook



1 The Education Programme STERN

- Initiated and conducted by the German Space Agency DLR (2012 – 2016)
- Supported by funds from the Federal Ministry of Economics and Technology

Motivation

- Economical and strategic importance for Europe to access space
- Considerable decrease of young professionals in space transportation

Objective

- Promotion of young academics in the field of launcher systems
- Well-educated & skilled employees to prevent a loss of competence

Execution

- Enable students to design, build and fly their own sounding rockets
- Practical education of students in the form of „real" space projects

Requirements

Requirements for participation:

- German universities focusing on aerospace particularly on launcher
- Teaching content at university must be linked to the project
- Support of the University

Operational requirements:

- Undergo reviews of DLR MORABA, DLR Institute of Space Propulsion and the DLR Space Administration
- Duration of 3 years

Technical requirements:

- Minimum peak altitude of 3 km
- Minimum velocitiy of speed of sound
- Integration of a recovery system
- Continuous tracking via telemetry unit

BUT:

- No upper limit regarding apogee
- Free choice of individually developed propulsion systems

Participating Teams

University	Engine	Propellants	Thrust (N)	Apogee (m)
Augsburg	Hybrid	HTPB + N_2O	1.000	5.000
Bremen	Hybrid	PE + N_2O	1.000	6.000
Bremen (ZARM)	Hybrid	Paraffin + LOX	1.800	10.800
Berlin	Solid	AL + APCP	3.000	7.500
Braunschweig	Hybrid	HTPB + N_2O	1.300	5.400
Dresden	Liquid	Ethanol + LOX	500	4.100
München	Hybrid	HTPB + LOX	8.000	15.000
Stuttgart	Hybrid	Paraffin + N_2O	10.000	46.000

2 SMART Rockets

Dimensions:

Diameter:	120 mm
Length:	approx. 3,5 m
Dry Mass:	approx. 15 kg
GLOW:	approx. 20 kg

Recovery System

Sensors & Communication

Pressurisation (N_2)

Fuel Tank (Ethanol)

Oxidiser Tank (LOX)

Thrust Chamber

Rocket Engine Test Bench

Design of an accurate functional model of the rocket propulsion system

Establishment of a proving ground for rocket engine tests

Hot fire test campaigns investigating ignition, injection, combustion, cooling and operations

3 Evaluation of STERN – First Launch Campaign

- Conducted in October 2015 on Esrange, Sweden
- 4 successful launches in 2 weeks

Rocket	Apogee (m)	Remarks
FAUST	5.700	Recovery system failed
HEROS	-	Non-nominal flight
SHARK I	5.500	No recovery
SHARK II	5.700	Recovered

Educational Benefits

- Up to date ca. 400 participants (volunteers excluded)
- Almost 200 conducted student theses
- Not limited to aerospace engineering, also many students from adjacent fields

- Students evolve their technical and scientific capabilities
- Students gain project management and social skills
- Fostering of interdisciplinary thinking and teamwork
- Early introduction of students to the work of space engineers, including
  - Quality assurance
  - Verification processes
  - Documentation

➔ Students are better prepared for their professional careers

Further Benefits

- Other students benefit from the established infrastructure at universites
- Student associations get more members due to the financial support
- Platform for exchange of experience and technical information
- Network of universities and research organisations with similar interests
- Inducement of further research projects and collaborations
- Public attention to Europe‘s launcher programme and Germany‘s participation due to many publications and received media coverage
- Esrange gains new capabilities to host commercial payload experiments
- New opportunities for for technology demonstration and maturation

4 Outlook

- Next launch campaign (both Bremen) in April 2016 from Esrange
- Both rockets will host payloads provided by Airbus Defence and Space
- STERN will come to an end in 2016 (final launch campaign in fall)
- Continuation within STERN II is currently negotiated (possible start in 06/2016)
- Teams can apply for a follow up after formal closing of the current projects

Future objectives:

- Establish a higher involvement of the industry in the future
- Strenghen ties between education, research and industry
- Optimisation of the transition between university and professional life

Thank you for your attention!

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Further Info: www.stard-online

YouTube: SMART Rockets @ TU Dresden

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STERN Launch Campaign Movie