

PROVIDING HANDS-ON SPACE EDUCATION BY INVOLVEMENT OF COLLABORATING SELF-RELIANT STUDENT TEAMS

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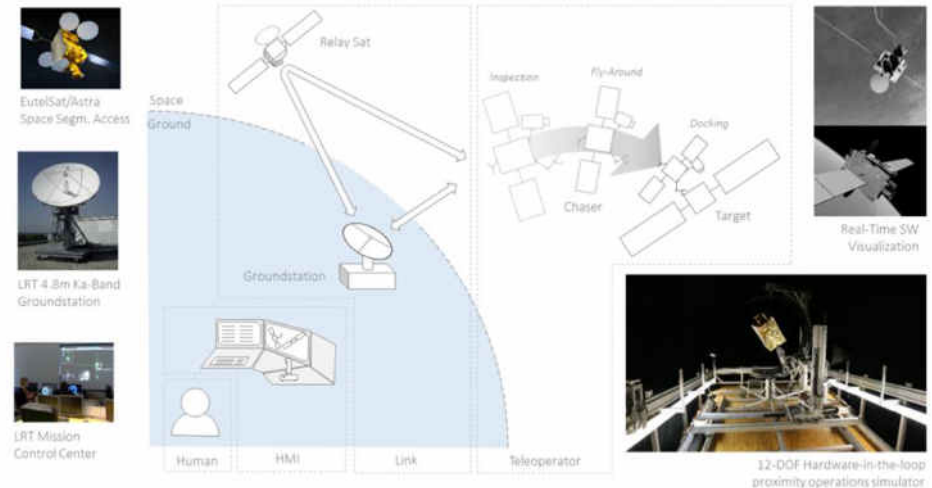
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Institute for Astronautics (LRT)

- Located at TUM Garching campus near Munich
- Current chairholder is Prof. Ulrich Walter
- Main areas of research:
 - Habitat simulation
 - Satellite and ground station antennas
 - Impact analysis
 - On-orbit servicing
 - Nanosatellite technology



Technische Universität München



WARR

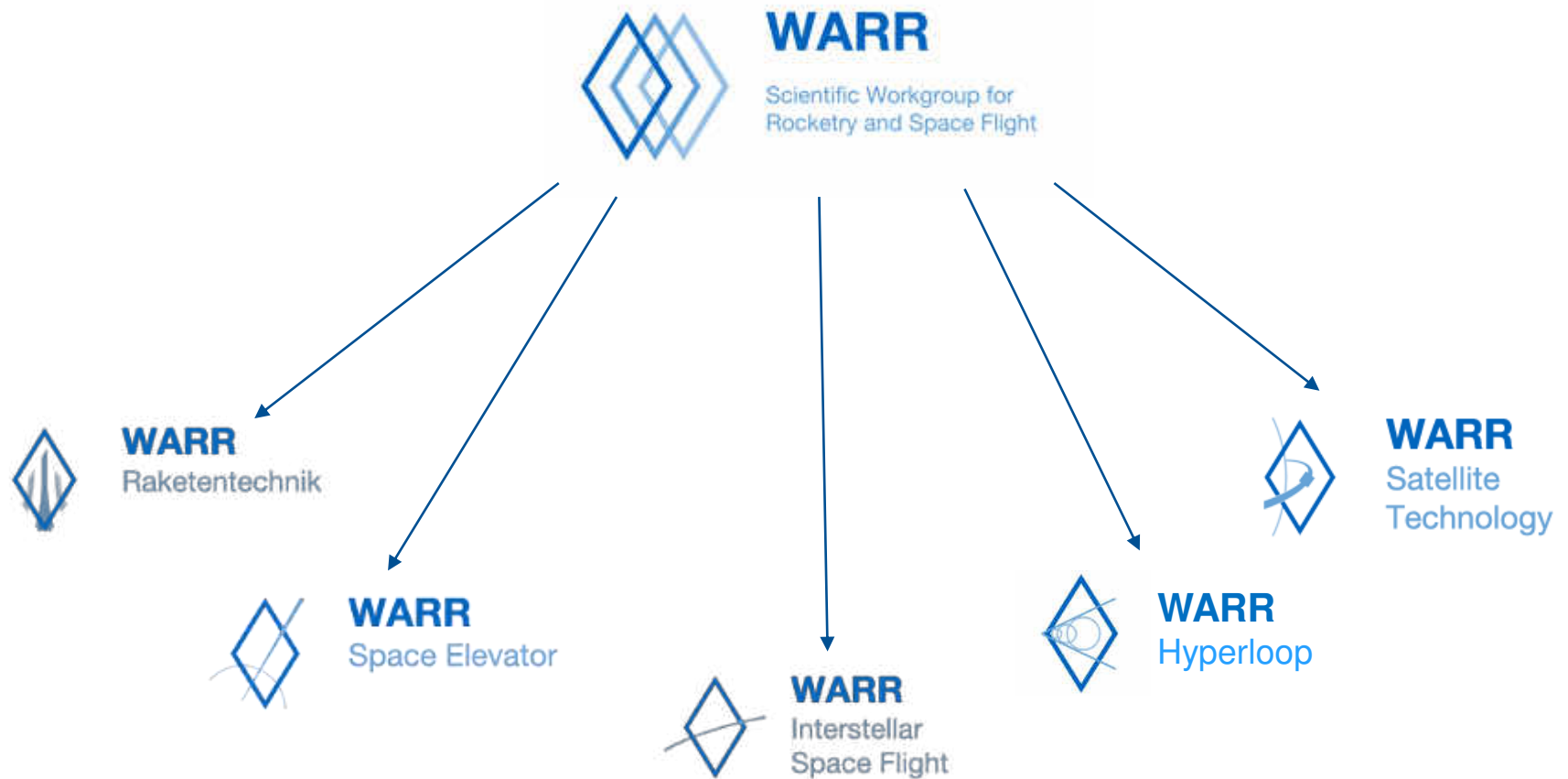
- Scientific Work Group for Rocketry and Space Flight (WARR in German)
- Founded in 1962 as a pure rocketry group
- Currently ~120 members in five project groups



WARR

Scientific Workgroup for
Rocketry and Space Flight

WARR - Current Structure



WARR Satellite Technology Group

Established based on lesson learned from First-MOVE satellite:

Student participation only via thesis projects + limited funding

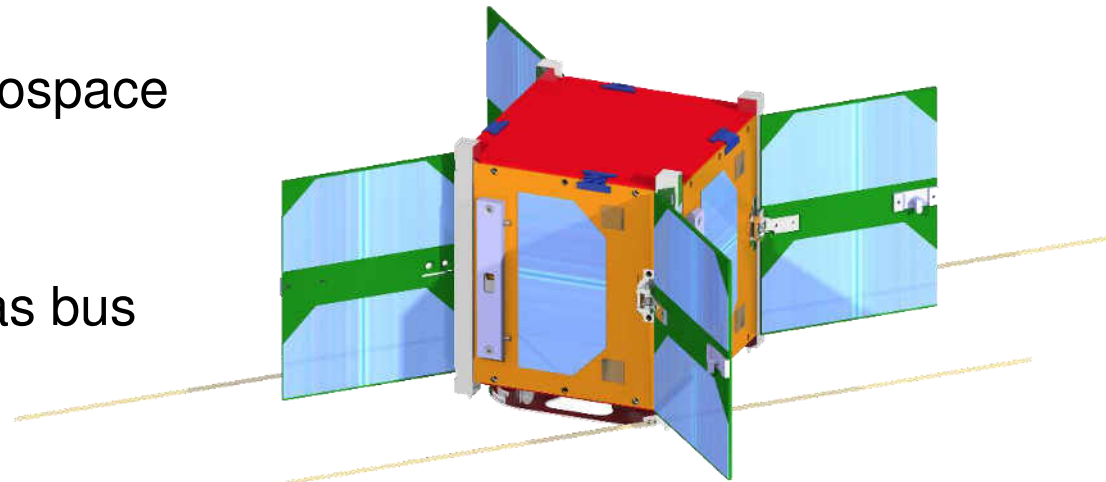
- Insufficient documentation
- Too little manpower
- Short satellite lifetime
- Limited scientific return

➤ Collaboration of WARR and LRT for successor MOVE-II



MOVE-II

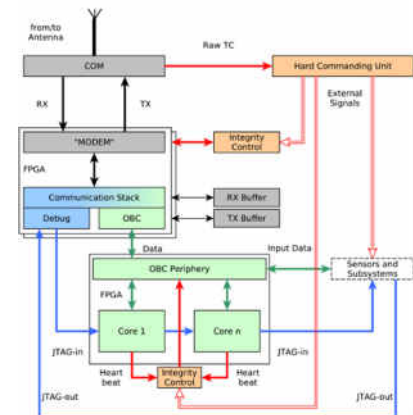
- Preliminary work starting in 2012
- Funding from German Aerospace Center (DLR) since 2015
- Single unit CubeSat built as bus for scientific payload
- Currently at System Definition Review level
- Launch date 2017



MOVE-II

MOVE-II Student Education

- PhD student as project manager, ~40 undergraduate and Master's students
- Students split into six subteams
- Thesis possible, otherwise students participate in free time (no course credit)
 - Students trained as subsystem experts
 - More stable team
- Students can conduct research and have published multiple papers already



REXUS and BEXUS Missions Based on MOVE-II

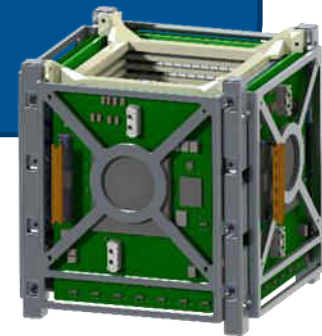
SMARD (Shape Memory Alloy Reusable Deployment Mechanism)

- Launched on REXUS 18 in 2015
- Novel CubeSat solar panel deployment mechanism



AFIS-P (Antiproton Flux in Space-Prototype)

- Launched on BEXUS 18 in 2014
- Reference Payload for MOVE-II



→ New BEXUS mission planned for 2016

WARR Rocketry Group

- Oldest part of WARR
- Launched Germany's first hybrid rocket in 1974
- Ground tests with liquid engines until 2000s
- Launched hybrid rocket to 4.5 km (speed $>$ Mach 1) in Brazil May 2015



Current Rocket Development

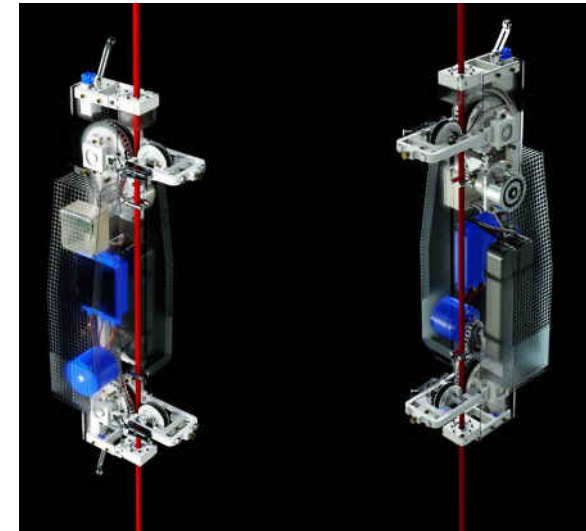
- Experimental rocket WARR-Ex 3
- Cryogenic hybrid (HTPB/Liquid Oxygen)
- Pressure-fed engine cycle
- Target altitude 15 km
- Funded under DLR STERN program
- Launch planned in 2017





Space Elevator

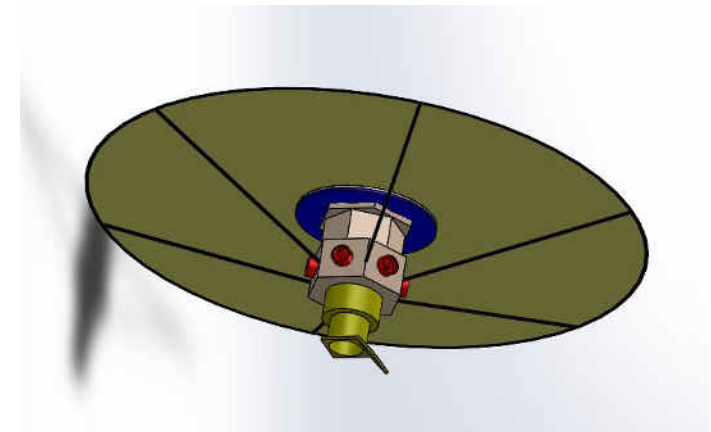
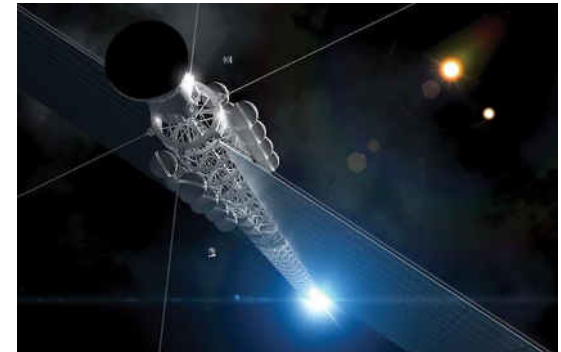
- Development of climbers for a future space elevator
- Participation in international competitions
- Hosted European Space Elevator Challenge in Garching in 2011 and 2013





Interstellar Space Flight

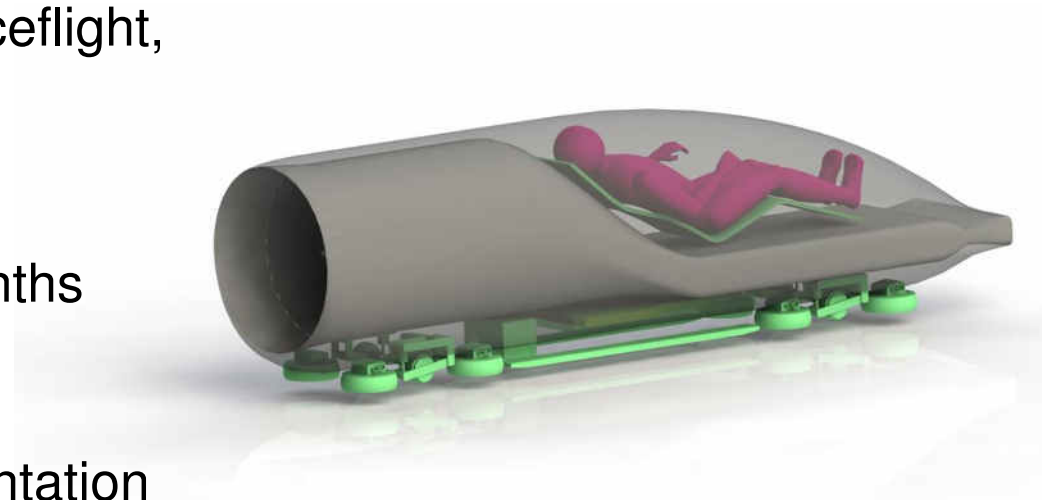
- Participation in international design competitions
- Winning entry to Project Icarus Design Competition in 2013 (nuclear fusion powered interstellar probe)
- Winnign entry to Project Dragonfly Design Competition in 2015 (laser sail powered interstellar probe)





WARR Hyperloop

- Participation in SpaceX Hyperloop Design Challenge
- No direct connection to spaceflight, but interesting engineering challenge
- Team formed only three months ago
- Concept accepted for presentation at Design Weekend in Texas in January 2016



Conclusion

- Shared infrastructure used by all project groups within WARR:
 - Workshop and office
 - IT (servers, software licenses etc.)
- Common outward appearance and corporate design raises visibility
- Students take responsibility and are thus educated not only in engineering but also project management etc.

Two big challenges:

- Acquiring funding for large projects is difficult for student group
- High fluctuation requires constant recruitment and documentation

Thank you! Any questions?

More information:

www.facebook.com/WARR.TUM

www.warr.de

www.move2space.de

