WARR Hyperloop II
About WARR

**WARR = Wissenschaftliche Arbeitsgemeinschaft für Raketentechnik und Raumfahrt**

- Student group since 1962
- First German hybrid rocket (1974)
- Multiple project groups (~350 member):
  - Hybrid cryogenic rockets (WARR-Ex 3)
  - CubeSat miniature satellites (MOVE-II)
  - Space elevator prototypes/competitions
  - Interstellar space flight studies
The Vision

In 35 min from Munich to Berlin (580 km at ~962 km/h)
The Hyperloop Concept

High-Speed Ground Transportation System
Proposed by Elon Musk (SpaceX, Tesla) in 2013

Track: elevated vacuum tube
Speed: 1200 km/h
The Hyperloop Concept

Air bearing based capsule concept from the initial alpha study (2013)
(http://www.spacex.com/hyperloopalpha)
SpaceX Hyperloop Pod Competition

Competition vacuum tube at SpaceX, Hawthorne, California
SpaceX Hyperloop Pod Competition

• Student competition to encourage innovation and prototype development

• 1.2 km vacuum tube provided by SpaceX

• Optional pusher vehicle for propulsion
The Team
The Pod
The Pod

- Structure
- Compressor
- Computer
- Friction & Eddy Current Brakes
- Battery
- Levitation & Wheels
Compressor

- Low pressure compressor Larzac 04 C5 (Alphajet)
- Powered by 30 kW electric motor
- Capacitive water cooling
Passive Levitation

- Passive electrodynamic suspension with permanent magnets
- Lift through relative motion over conductive track
- Motion on wheels until liftoff speed
Braking

• Fail-safe, spring actuated pneumatic friction brakes

• Wear-free electrodynamic eddy current brakes
• Microcontroller based control and navigation system

• Controller communication via CAN

• Ground station control via tube network
Energy Supply

- 450V Lithium Ion battery system
- Custom battery management system
- Vacuum-tight pressure container
Testing

• Subsystem level testing:
  • Braking test stand
  • Levitation test stand
  • Sensor testing
  • Vacuum testing:
    • Pneumatics
    • Electronics
    • Compressor
  • Battery testing
  • …
Pre-Competition
Testing Week
Testing Week
Lessons Learned

• Flexibility is necessary

• Testing is key

• Customs can be a pain

• Magnets produce drag
Lessons Learned

- Magnets and Batteries kept in customs for separate inspection

- Team members flew in batteries with carry-on luggage

- Know your backup plans
Lessons Learned

• Motor controller of low-speed propulsion blew on-site
• Any system can fail
• Have a backup system ready
Lessons Learned

- Testing always takes longer than expected
- Additional tests can be deemed necessary at any time
- Be well prepared, stay late and finish your safety checks asap
Competition Day
Lessons Learned

- Pusher vehicle performed below expectations and liftoff speed
- Magnets unmounted for competition run to reduce drag
- Be flexible in your design
The Winners
Next up?
Competition II

- Competition Weekend II  
  25. – 27.08.2017

- Judging criteria: “Fastest Pod”

- Design Choice:  
  “As light and fast as possible”
WARR Hyperloop II: The Team
Pod II

Competition II vehicle unveiling in July 2017
Thank you!
Contact us

WARR e.V.
c/o TUM Lehrstuhl für Raumfahrttechnik
Boltzmannstrasse 15
85748 Garching

Email: hyperloop@warr.de
Phone: +49 (0) 89 289 16028

hyperloop.warr.de
facebook.com/WARRHyperloop