

MARWIN: A MOBILE AUTONOMOUS ROBOT FOR MAINTENANCE AND INSPECTION



SPEAKER / AUTHOR

André Dehne B. Eng.
Research Engineer
dehne@hs21.de

CO-AUTHORS

Prof. Dr.-Ing. Thorsten Hermes
hermes@hs21.de

Nantwin Möller
nantwin.moeller@stud.hs21.de

Dr. Reinhard Bacher
reinhard.bacher@desy.de

INTRODUCTION

- Research cooperation between German Electron Synchrotron (DESY) and hochschule 21
- Proof-of-concept for robot-based radiation measurement
- Autonomous use in accelerator facility
- Clarification is needed: Heavy radiation load vs. non-protected consumer hardware



MOTIVATION

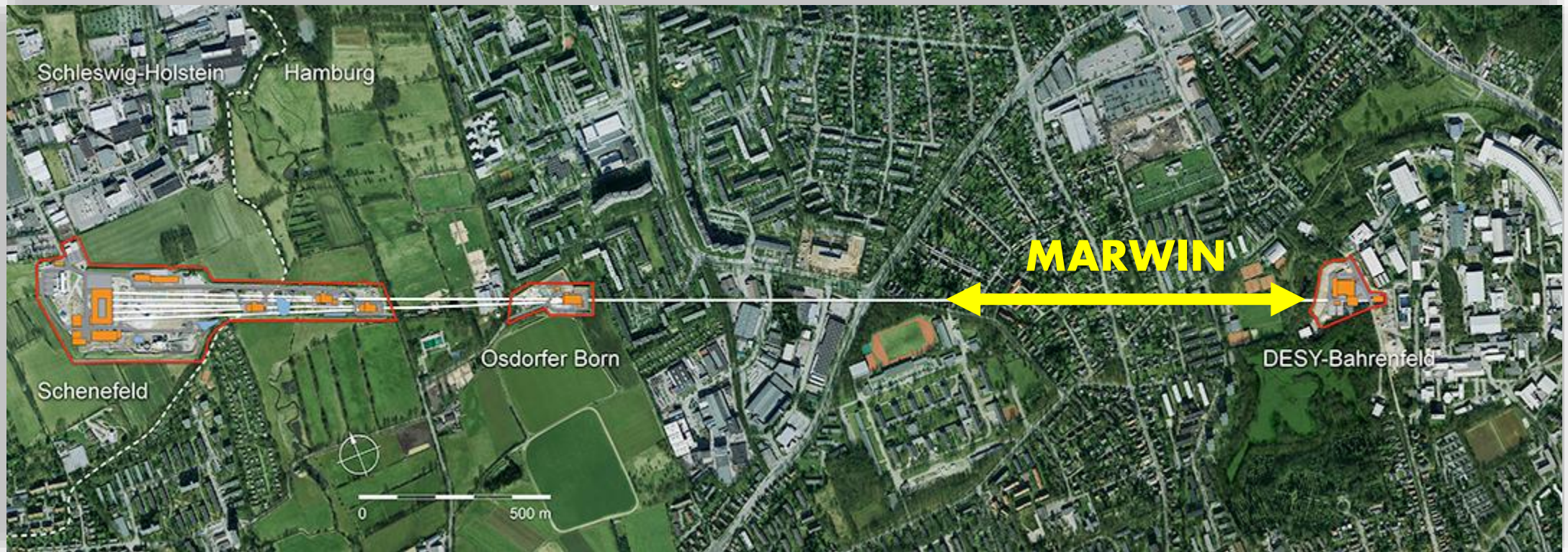
- **Automated systems in exploration of hazardous environments steadily growing**
 - eg. nuclear and accelerator hazards
- **Accelerators generally overbooked, eg. Petra III or FLASH (both at DESY)**
 - Accelerators must be serviced
 - Minimize maintenance time
 - Minimize risk of radiation exposure for staff



By Stefan Kühn – Own work, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=94202>

CONDITIONS

Application inside XFEL



CONDITIONS

- Limited space inside XFEL
- Limited access
- Components are very high
- Autonomous radiation measurement at predefined positions and sections
- Mobile robot for inspection without accelerator shut down



ROBOT DESIGN



different sensors
and actuators

additional 96.000
lines of code

redundant
hardware inside

Linux + ROS

an expandable
scissor lift

MECANUM
wheels

LIDAR based
localization

LOCALIZATION

GLOBALLY

- with QR-codes on XFEL wall,
detected by a CCD camera



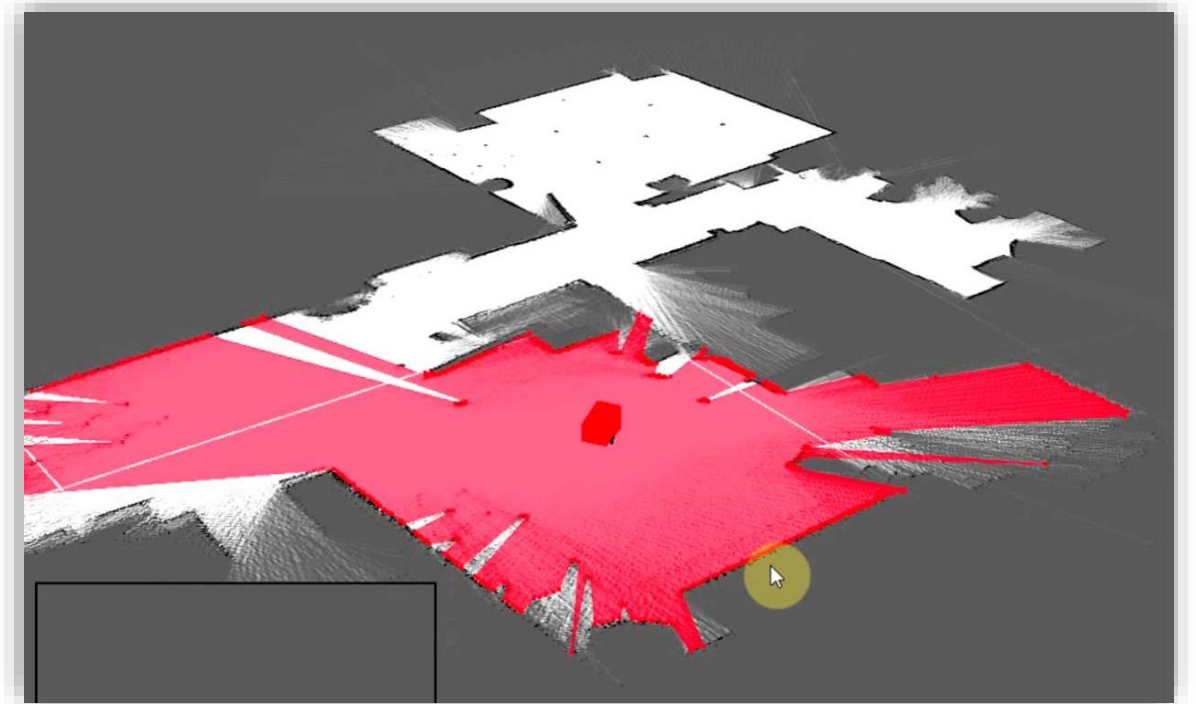
Site: Hamburg
Bldg: 719 XTL (Linactunnel)
Room: T0.001
z (m): 117.84



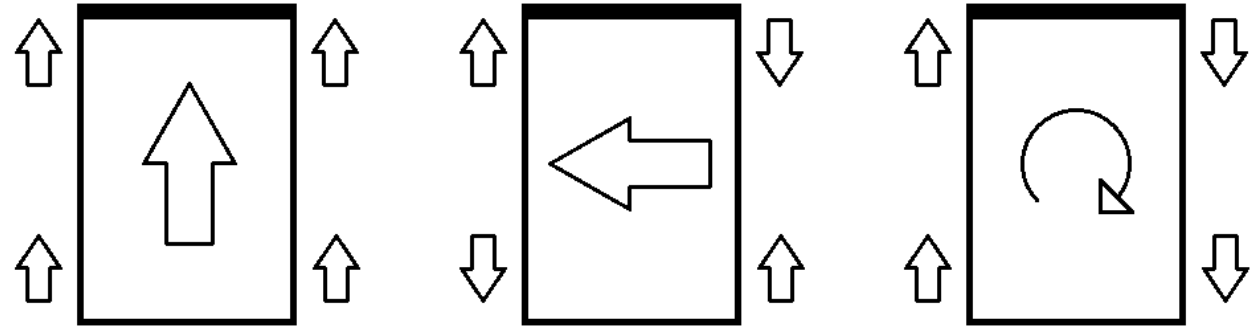
LOCALIZATION

LOCALLY

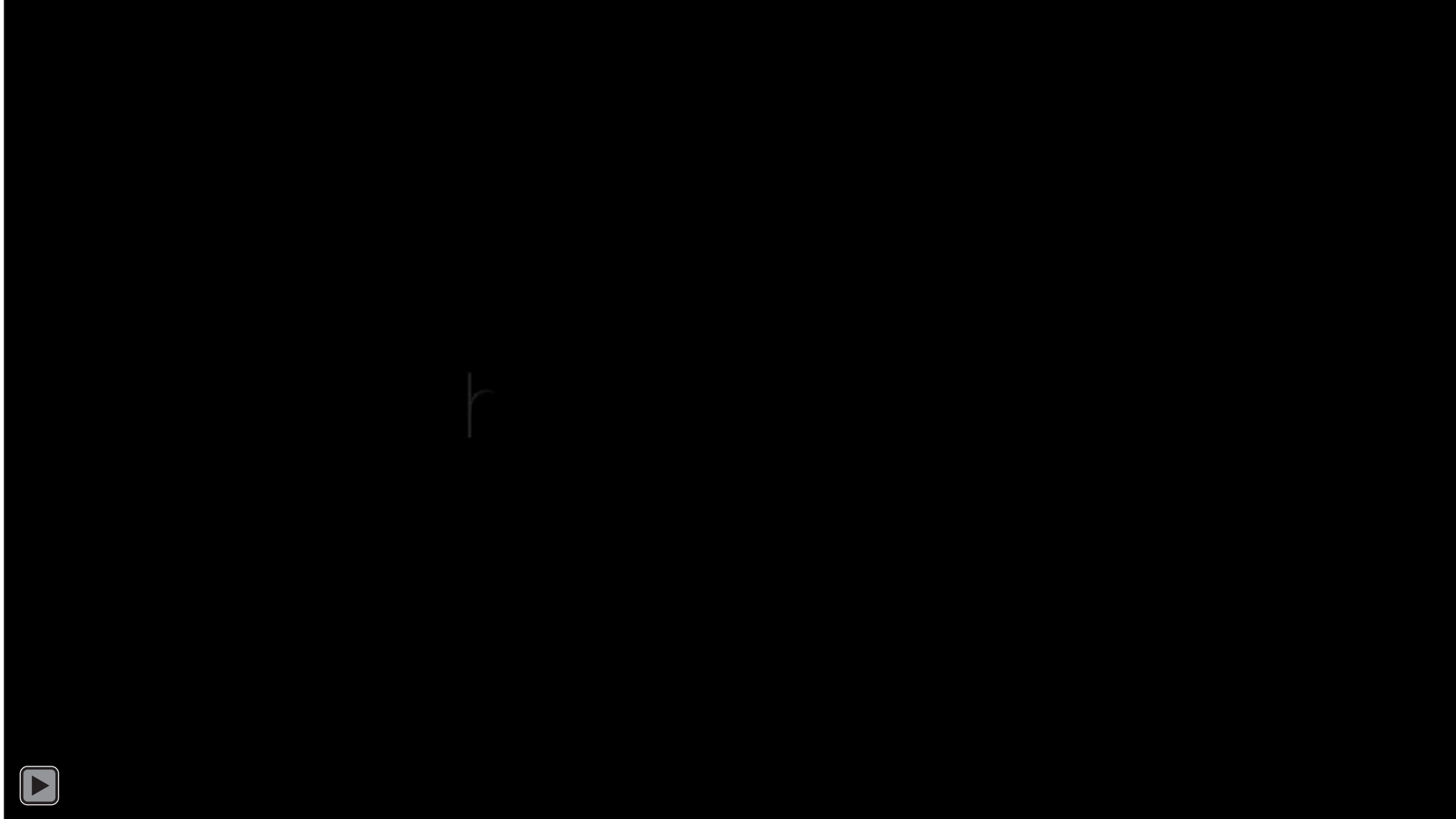
- with 2D laser based SLAM algorithm



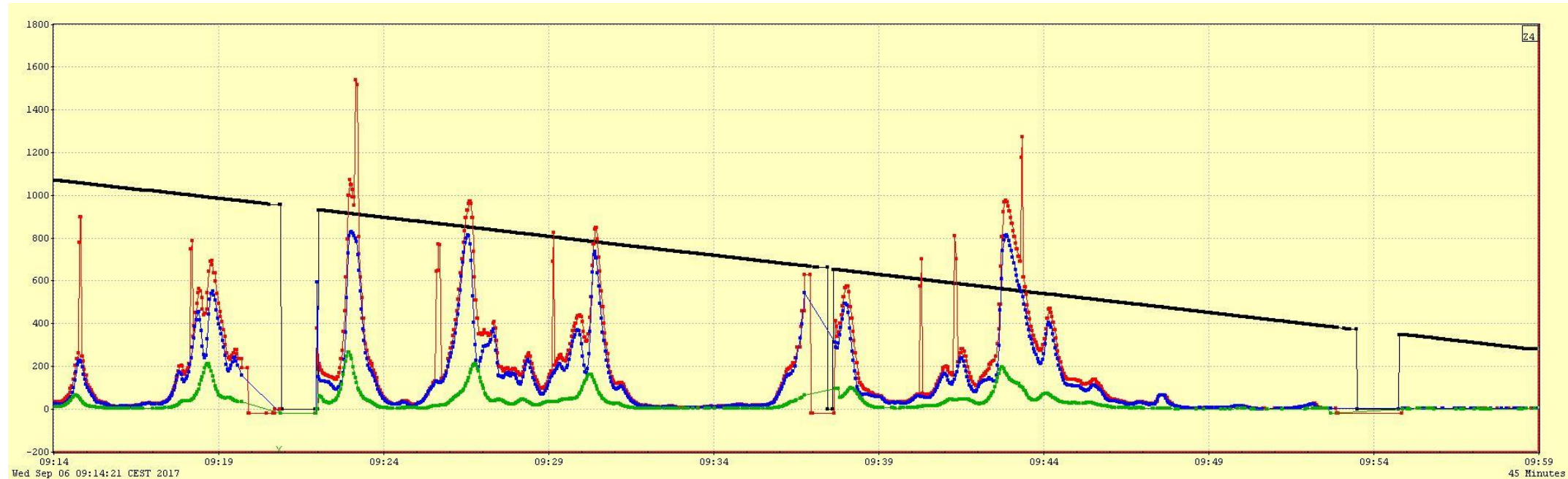
OMNIDIRECTIONAL MOVEMENT



AUTONOMOUS TEST RUN



AUTONOMOUS TEST RUN - RESULTS



Radiation profile along XFEL accelerator

black: robot position [m]; red: dose rate [$\mu\text{Sv/h}$]; blue: avg. gamma dose rate [$\mu\text{Sv/h}$]; green: avg. neutron dose rate [$\mu\text{Sv/h}$];
missing data: wireless data connection temporarily lost

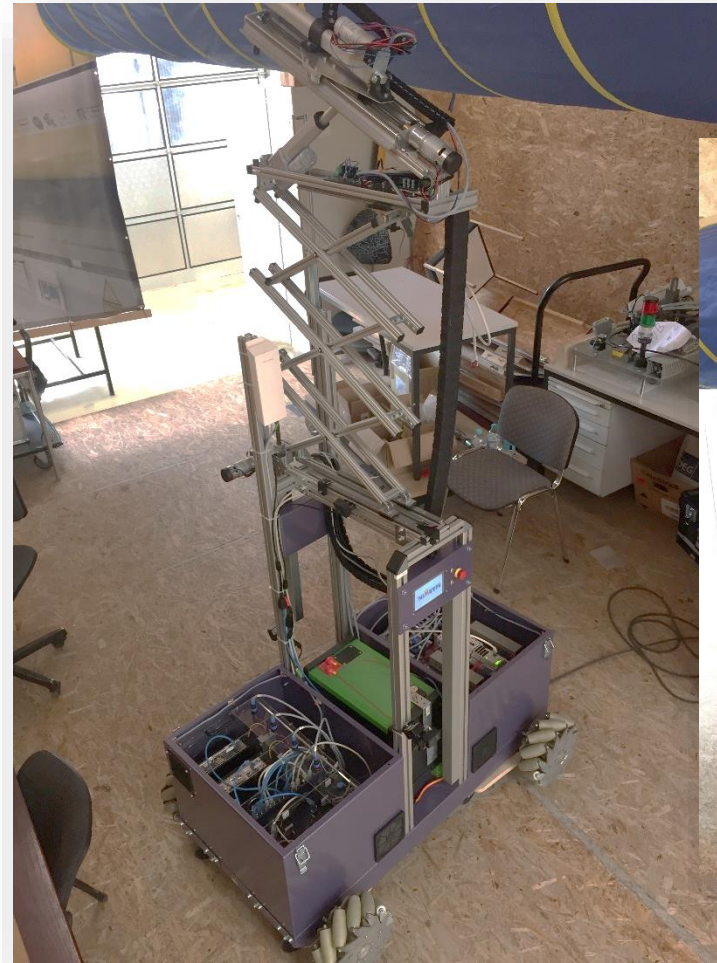
OUTLOOK

Interlock door at 1100m



MARWIN2 is coming

- for the tunnel section 1070 to 2000 meters
- several „lessons learned“ advantages
- more flexible scissor lift
- new operator interface
- integrated data analytics
- delivery Q4/2017



CONCLUSION

- Use of non-protected consumer hardware possible
- Awakens desires in other departments of DESY
- Several ideas and incentives for further developments



Thank you for your attention! Questions?

