

# MARWIN: A MOBILE AUTONOMOUS ROBOT FOR MAINTENANCE AND INSPECTION



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## 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

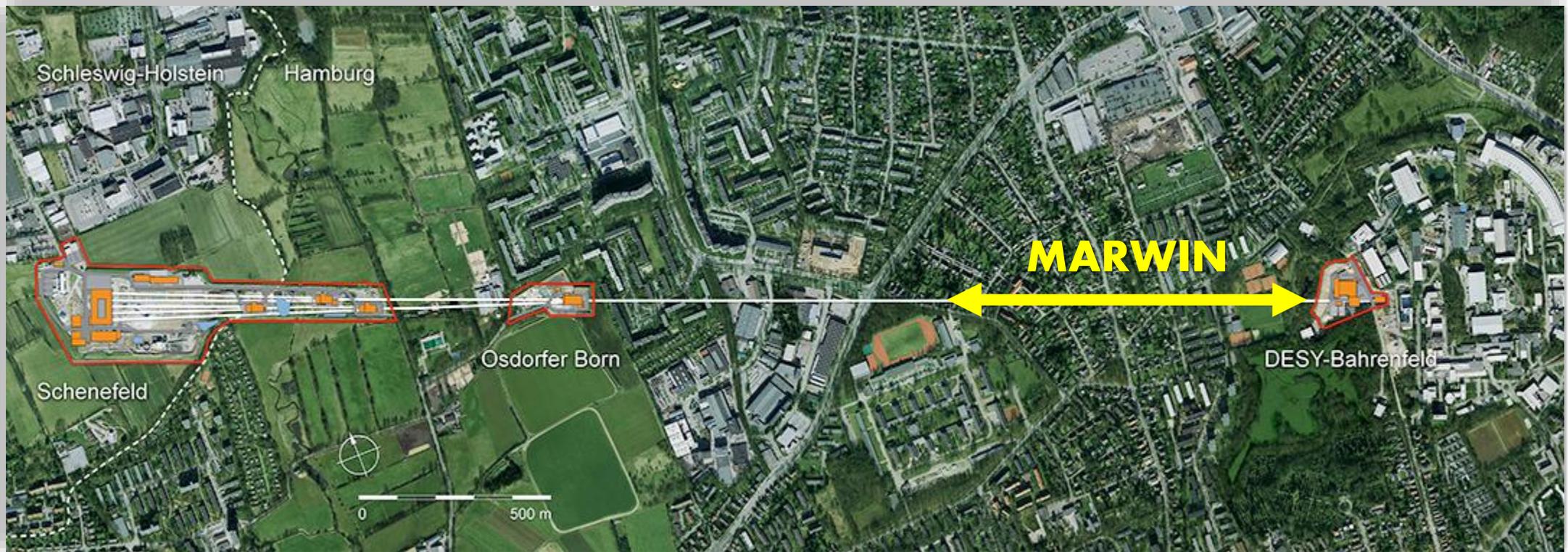
- **Automated systems in exploration of hazardous environments steadily growing**
  - eg. nuclear and accelerator hazards
- **Accelerators generally overbooked, eg. Petra III or FLASH (both at DESY)**
  - Accelerators must be serviced
  - Minimize maintenance time
  - Minimize risk of radiation exposure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



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# CONDITIONS

## Application inside XFEL

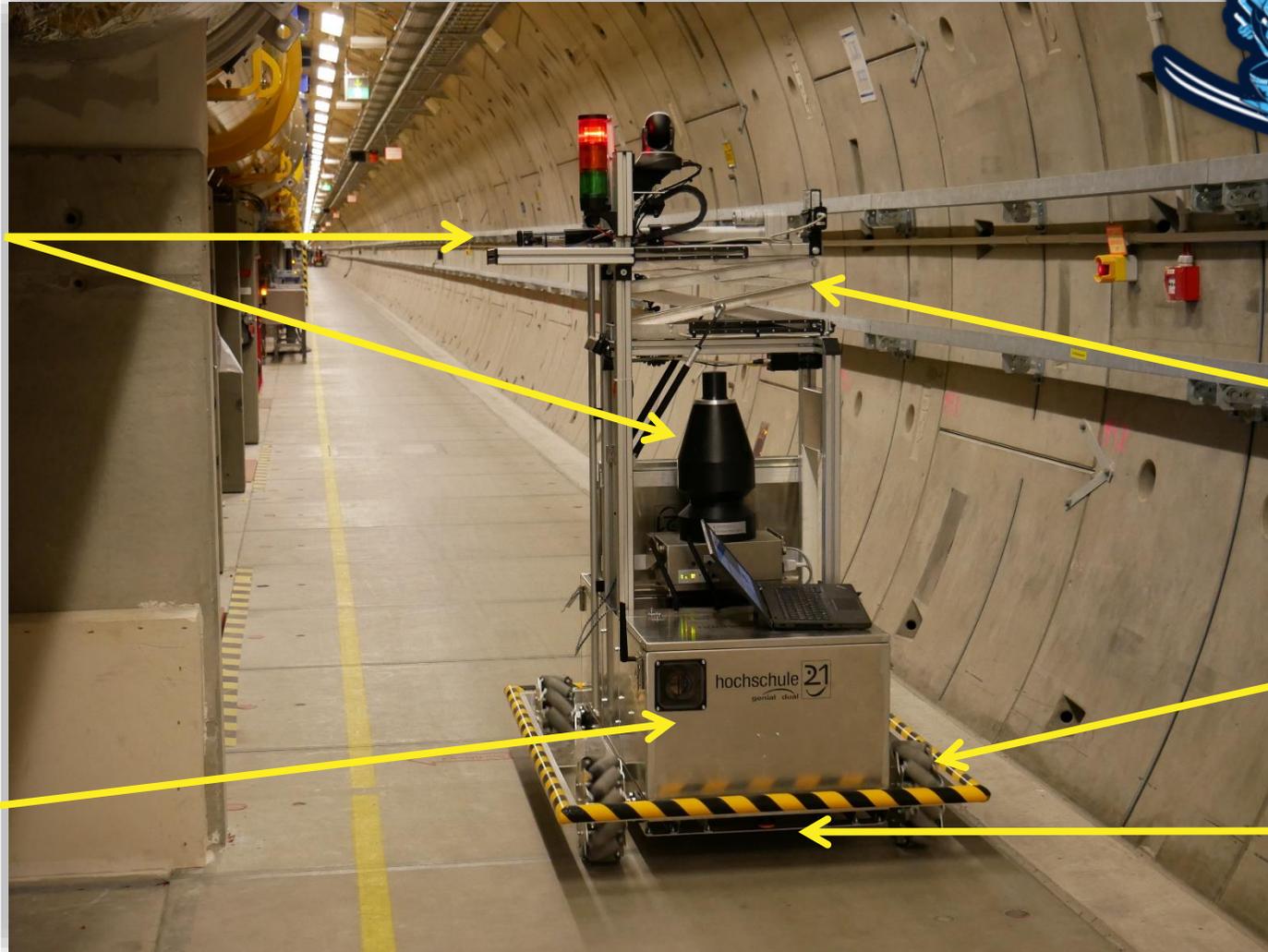


## CONDITIONS

- 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

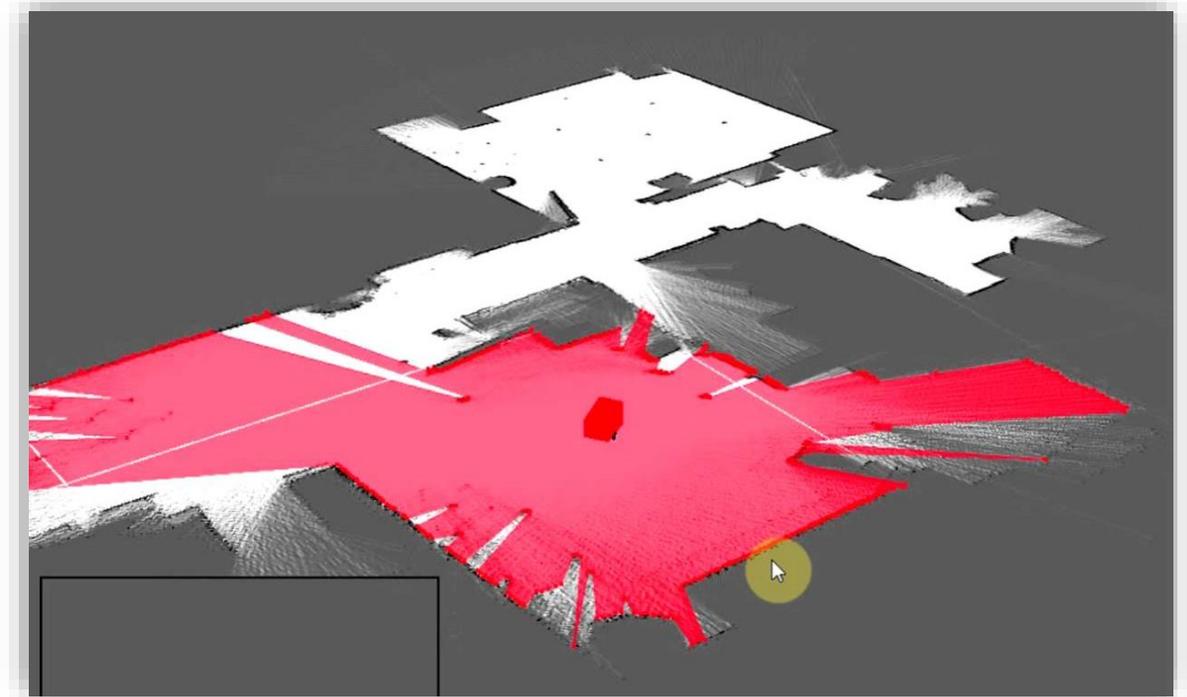
- with QR-codes on XFEL wall, detected by a CCD camera



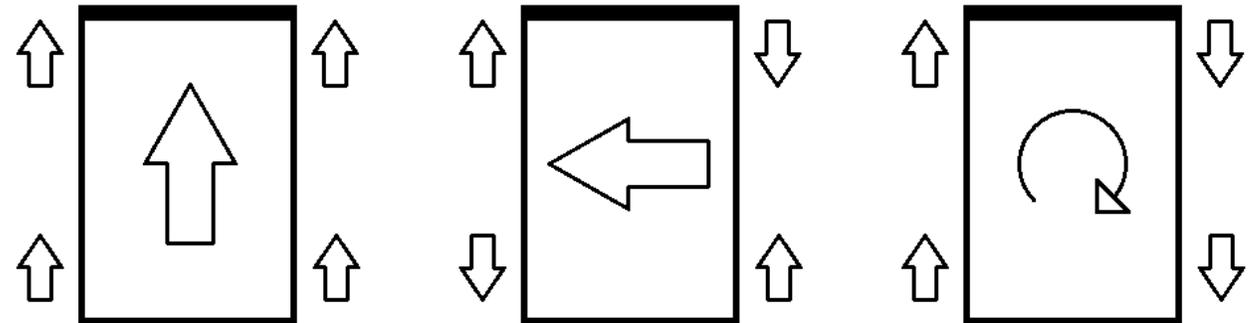
# LOCALIZATION

## LOCALLY

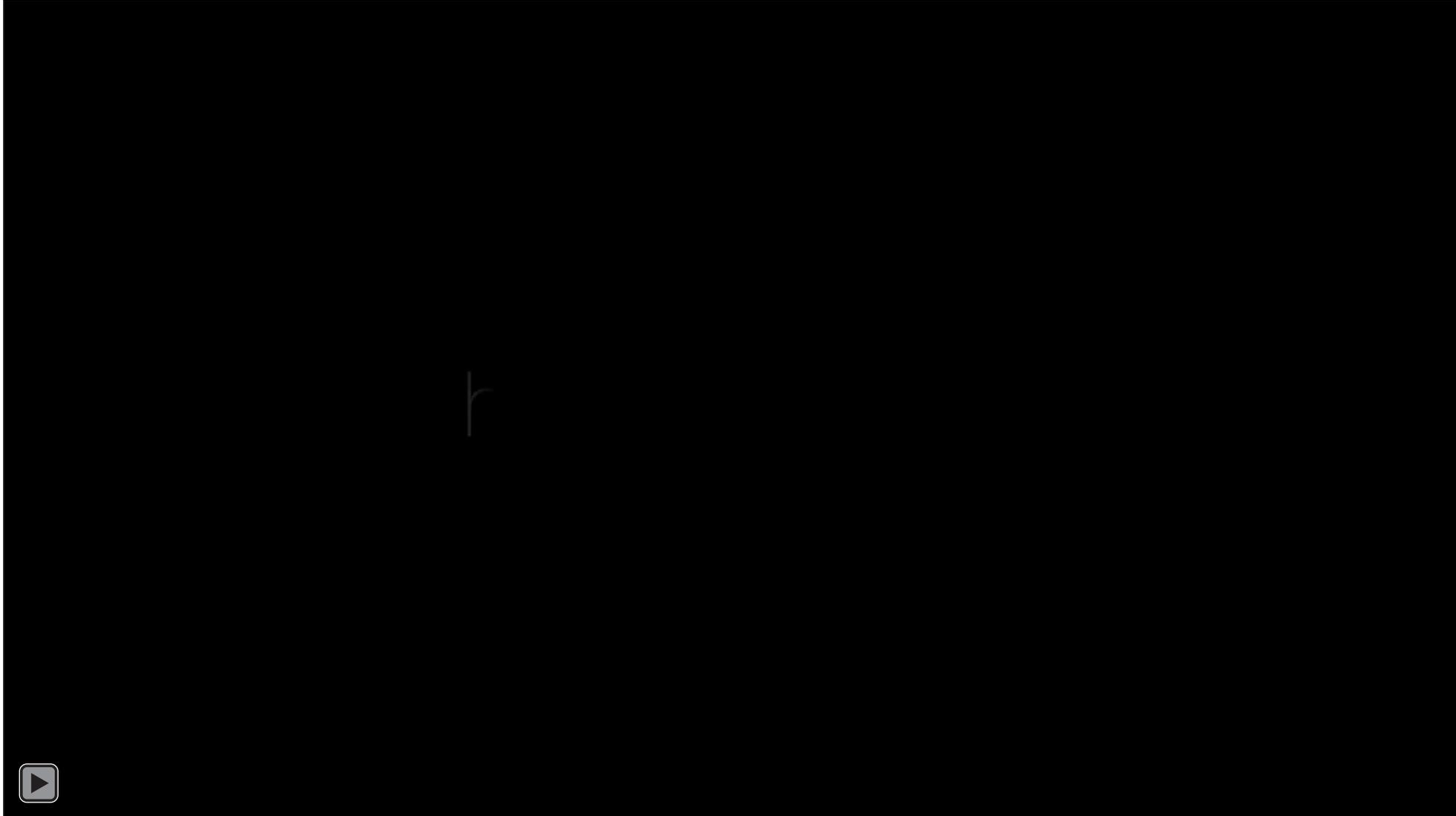
- with 2D laser based SLAM algorithm



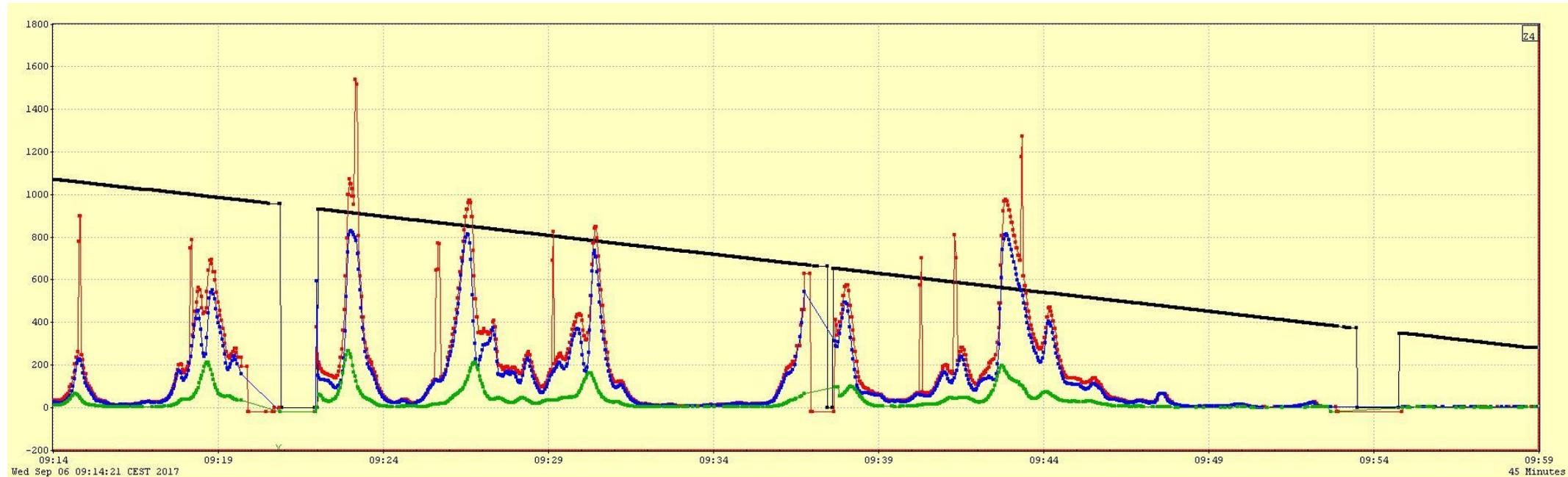
# OMNIDIRECTIONAL MOVEMENT



# AUTONOMOUS TEST RUN



# AUTONOMOUS TEST RUN - RESULTS

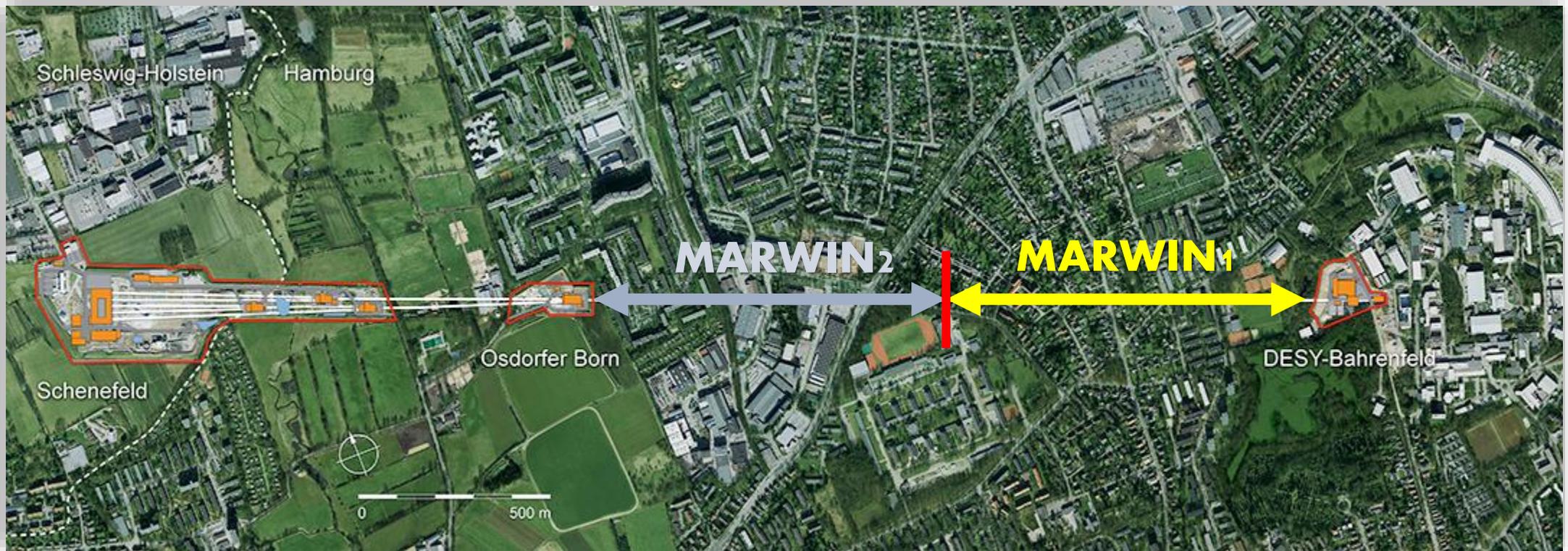


**Radiation profile along XFEL accelerator**

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

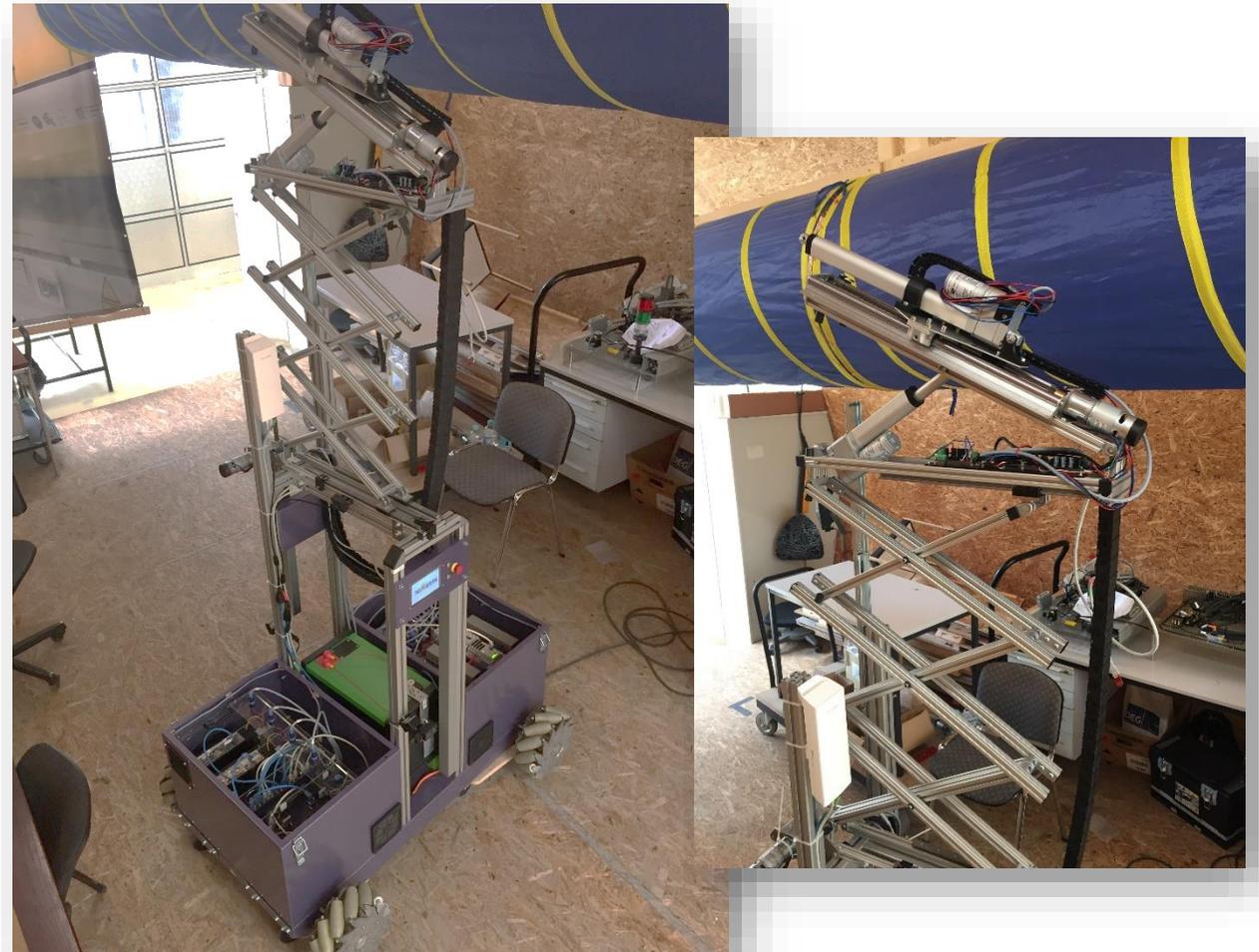
# OUTLOOK

## 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?**

