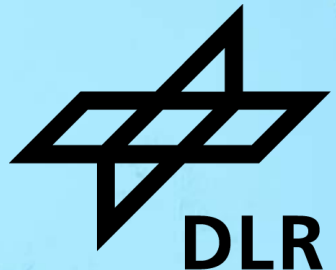


# HIGH-SPEED UNMANNED AIRCRAFT FOR SCALED FLIGHT TESTING OF MORPHING WING STRUCTURES

KOREA-EU Horizon Europe Researchers Networking Forum on Energy & Advanced Mobility

**Mark Spiller**, Lennart Kracke

German Aerospace Center (DLR)



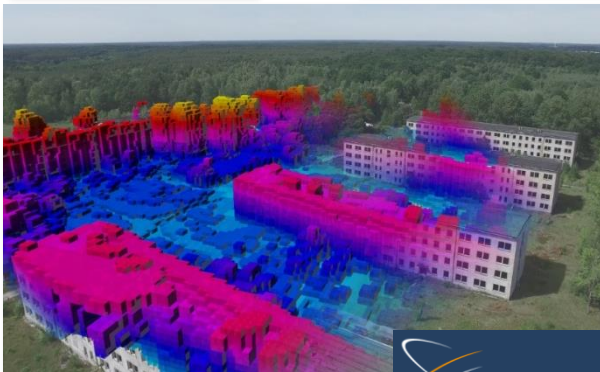


# DEPARTMENT OF UNMANNED AIRCRAFT

INSTITUTE OF FLIGHT SYSTEMS

## Safe Autonomy & Environmental Perception

- Artificial Intelligence
- Verification & Assurance
- Sensor Systems and Flight Instrumentation
- Runtime Monitoring & Contingency Management



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## Safe Operation

- UA Design and Integration
- Risk Assessments of Complex Scenarios
- Flight Test Planning and Performance
- Methods of Certification



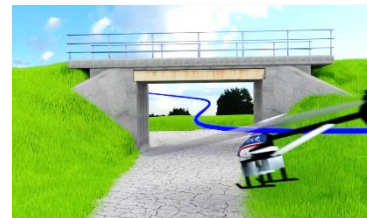
Joint Authorities for  
Rulemaking on Unmanned  
Systems



## Department of Unmanned Aircraft Fields of Research

### Guidance, Navigation & Control

- Adaptive Control and Precision Flight
- Flight Envelope Expansion
- Sensor Data Fusion
- Simulation



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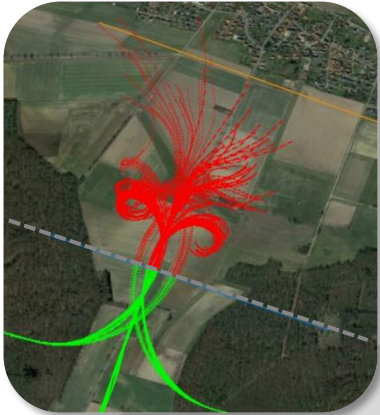


# Technology Demonstrators



# Unmanned Flight – Autonomy through Automation

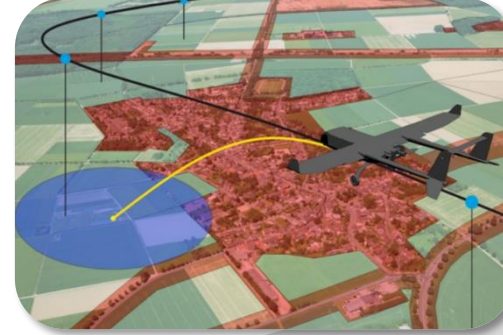
Geo-fencing and safe flight termination



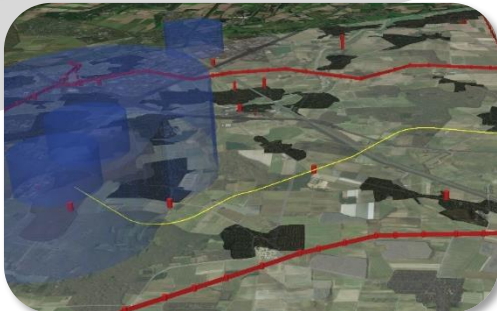
Safe operation and system health monitoring



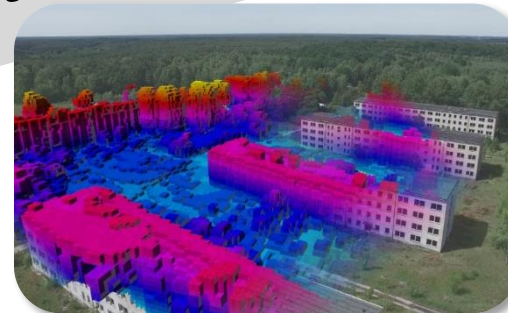
Onboard risk assessment and emergency landings



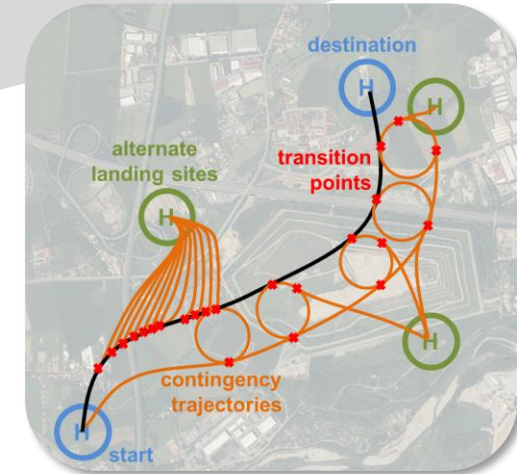
Increasing level of autonomy



Realtime mission and trajectory planning



Obstacle avoidance and navigation in complex environments

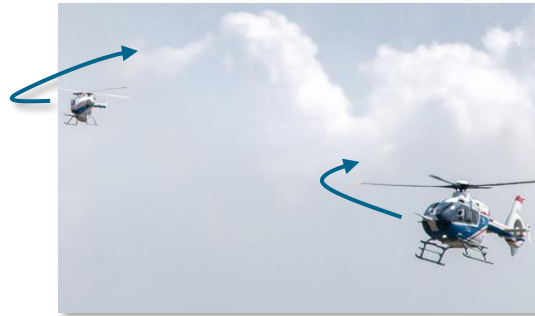


Automated contingency management

# Hybrid Teaming and Interaction

## Selected Applications

### Manned-Unmanned-Teaming



### Formation flight / In air coupling



### Ship deck landing





# **HIGH-SPEED UNMANNED AIRCRAFT WITH MORPHING WING STRUCTURES**

# Morphing Wing Test Vehicles

Unmanned research aircraft

- Morphing trailing edge
- Wingspan: 2,99 m
- $V_{\max}$ : 85 m/s
- MTOM: 70 kg

Potential goals:

Development of AI-based methods for

- Optimization of aerodynamic efficiency
- Gust and maneuver load alleviation
- High performance flight control
- Reconfiguration (fault-tolerance)



# Family of Test Vehicles



Proteus I:  
Jet aircraft trainer



Proteus II:  
Testbed for configuration changes

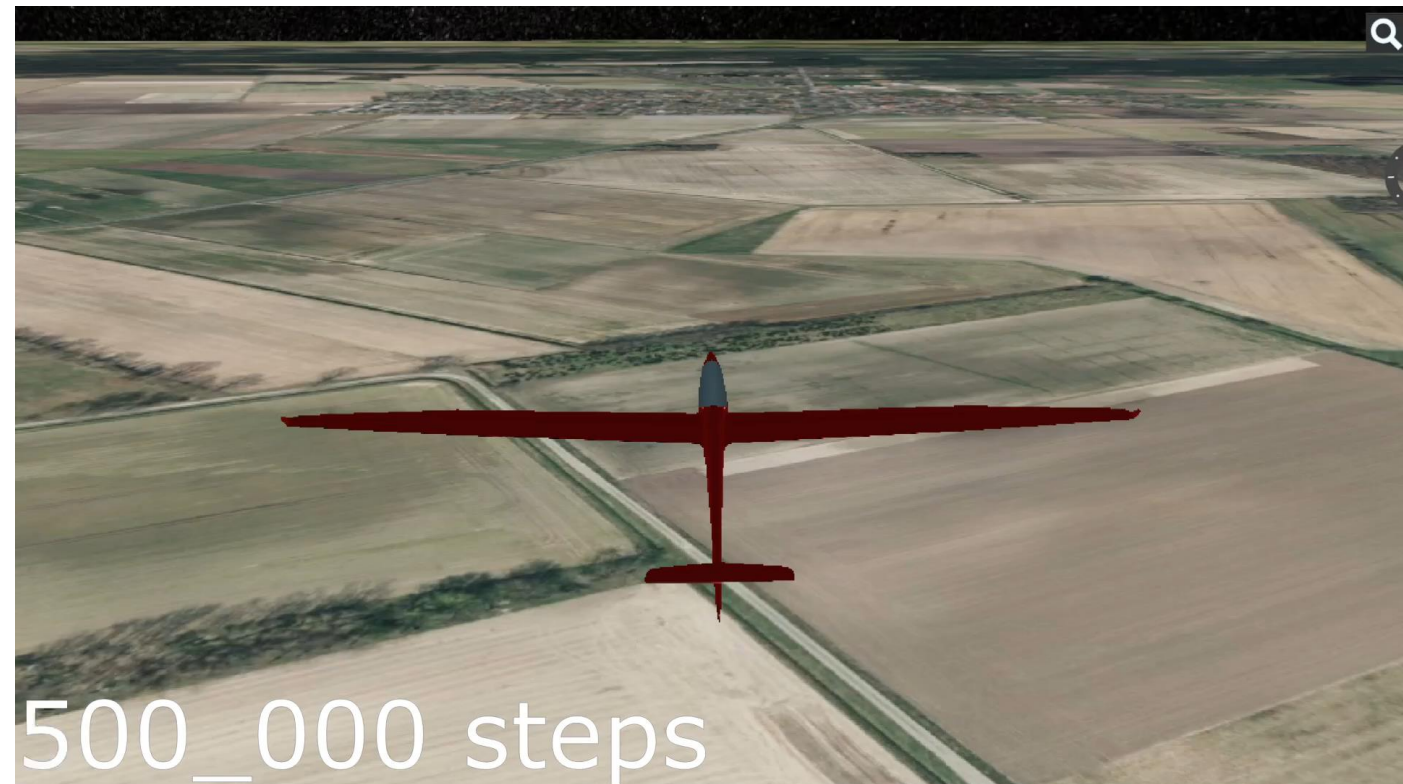
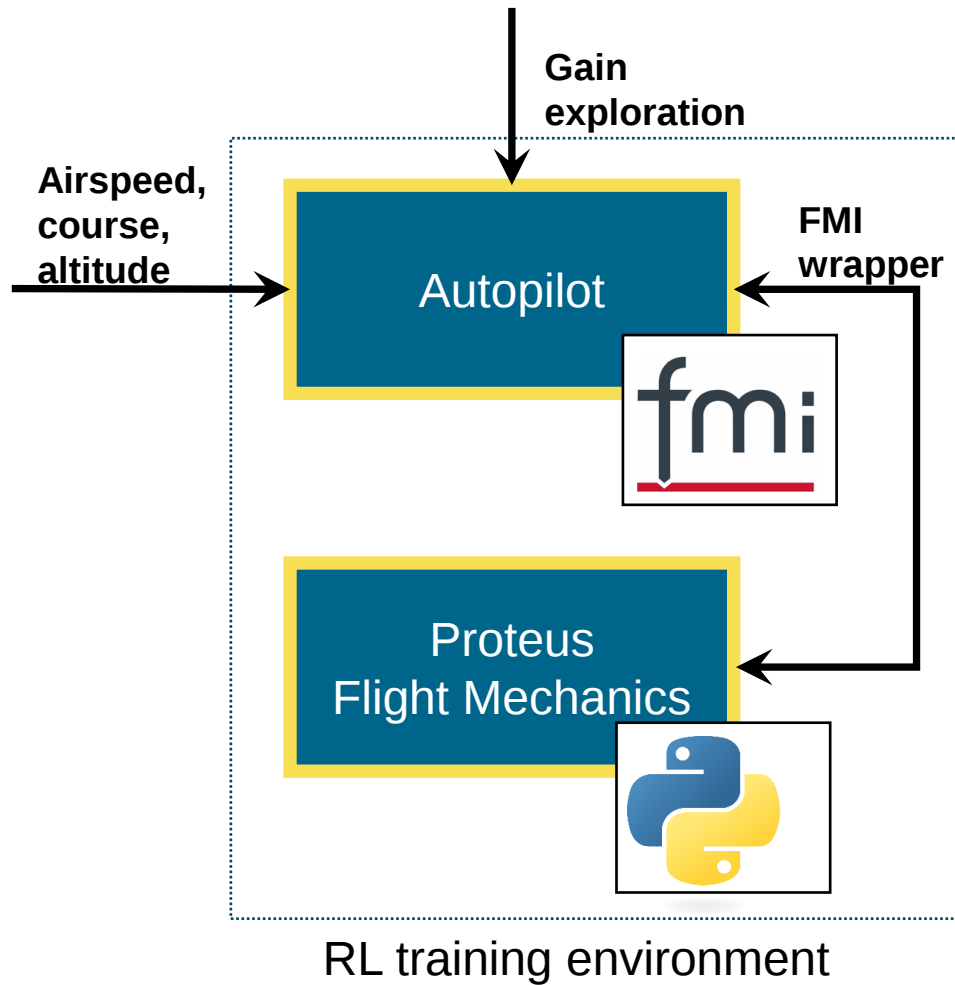


Proteus III:  
Main test vehicle



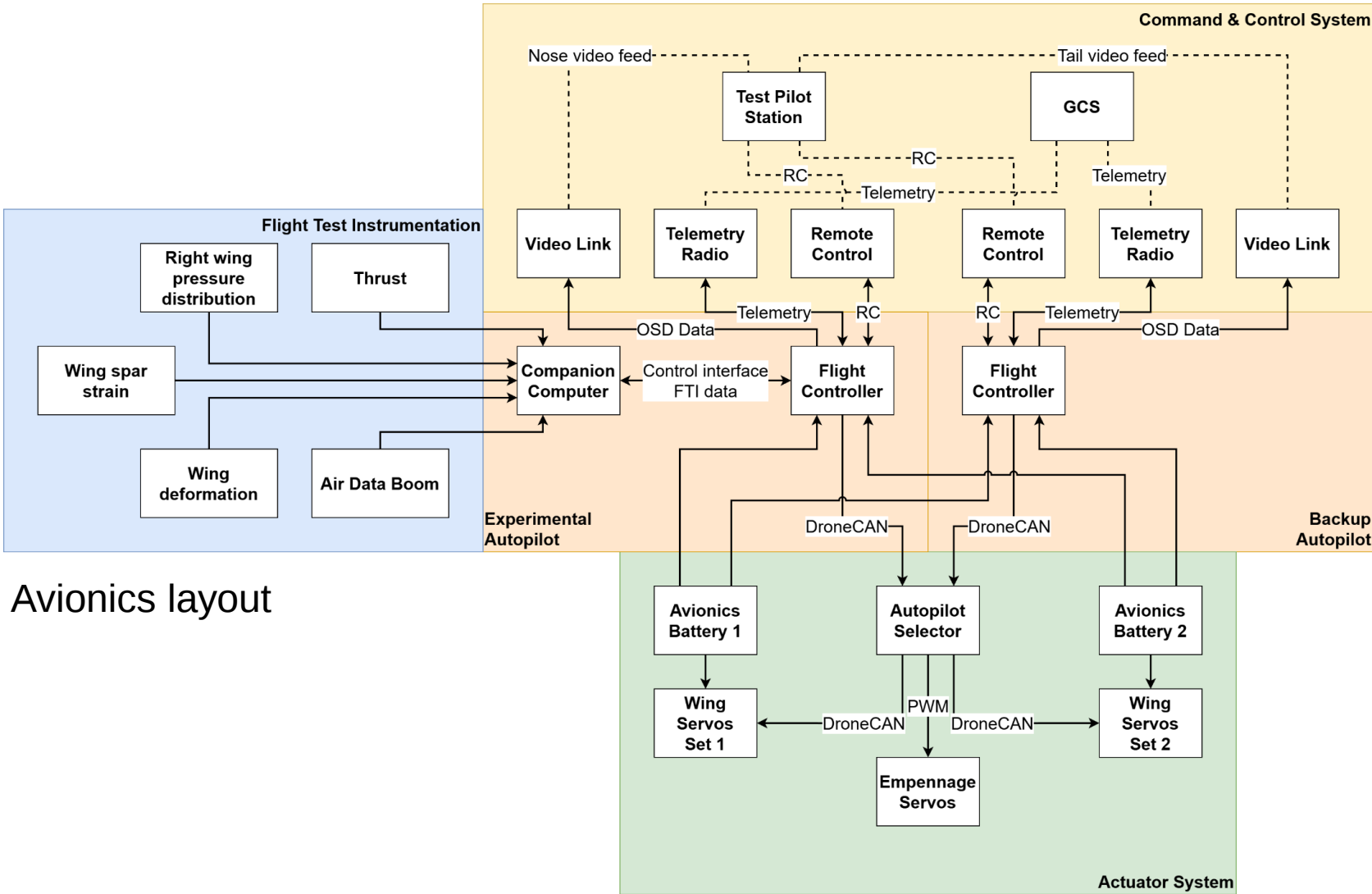
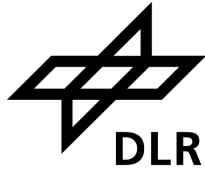
- Conventional reference & morphing wing available
- Proteus I is currently being changed to Proteus III configuration

# Controller Tuning Using Reinforcement Learning (RL)

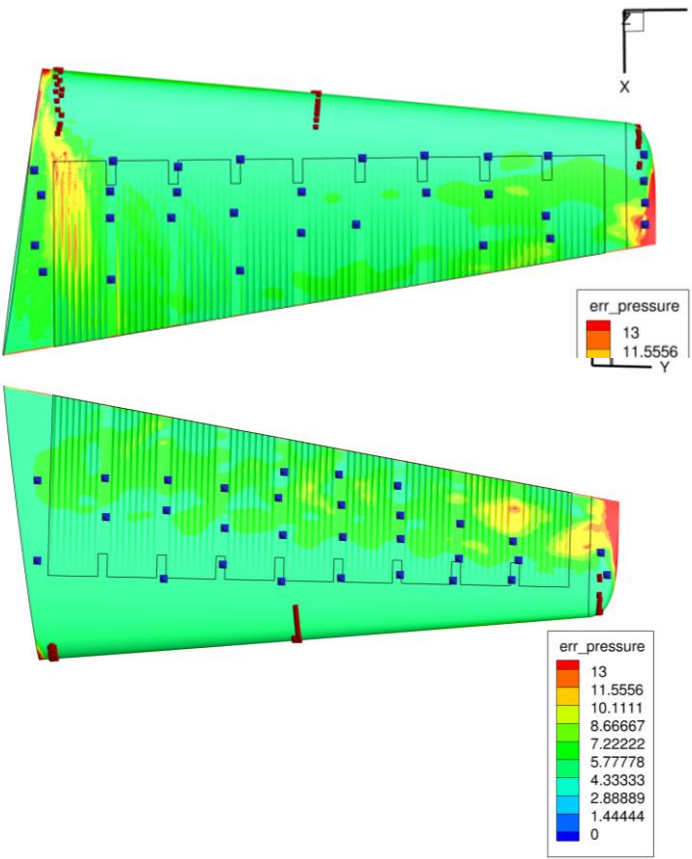


Progress of controller gain exploration

# Aircraft Instrumentation and Avionics



Avionics layout

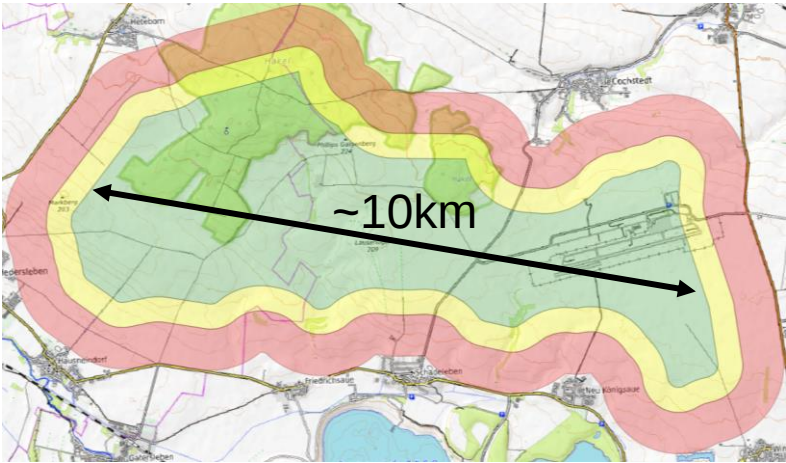


Pressure sensor distribution

# Flight Test Campaigns



First person view pilot station UAV control



National drone test center

Proteus I

- High-speed unmanned aircraft with morphing wings
- Advanced experimental platform for testing aerodynamic and control concept
- Large flight test zones for high-speed and complex maneuvers
- SORA-compliant operations for safe unmanned flights
- Versatile mission capability
  - Lift optimization and drag reduction
  - Gust load and maneuver load alleviation
  - High-performance flight control
  - Reconfiguration and fault-tolerance
  - ...



**THANK YOU FOR YOUR ATTENTION**

# Get in Touch



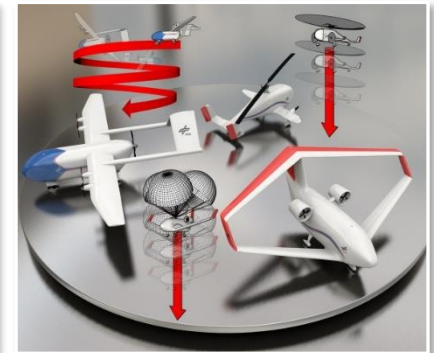
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Topic: High-speed Unmanned Aircraft for Scaled Flight Testing of Morphing Wing Structures

Date: 2025-10-14 (YYYY-MM-DD)

Author: Mark Spiller, Lennart Kracke

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