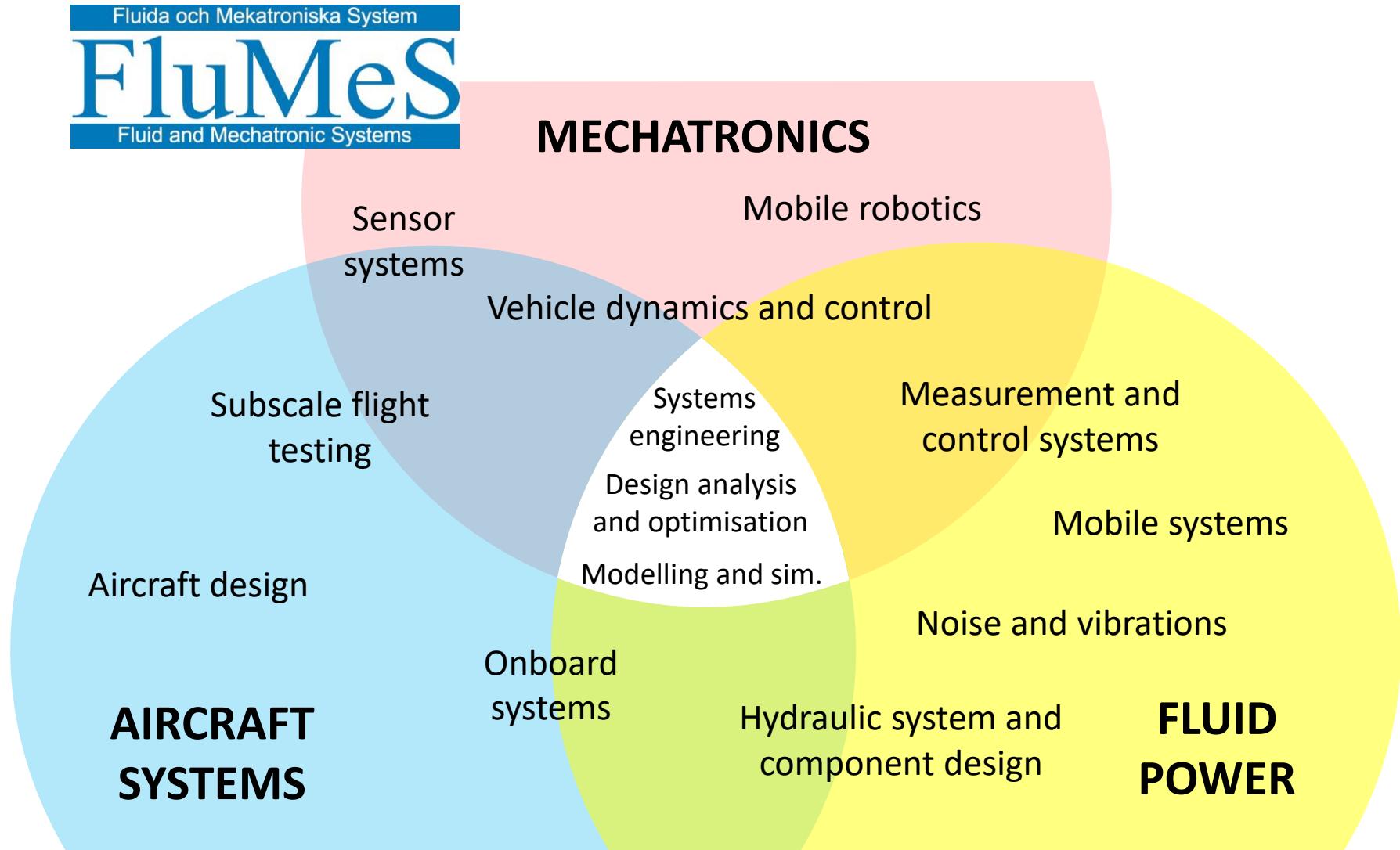


# An open-source application for subscale flight test analytics and system identification

**A. SOBRON, A. ARUSTEI, D. LUNDSTRÖM, P. KRUS**

Linköping University, Sweden







## MECHATRONICS

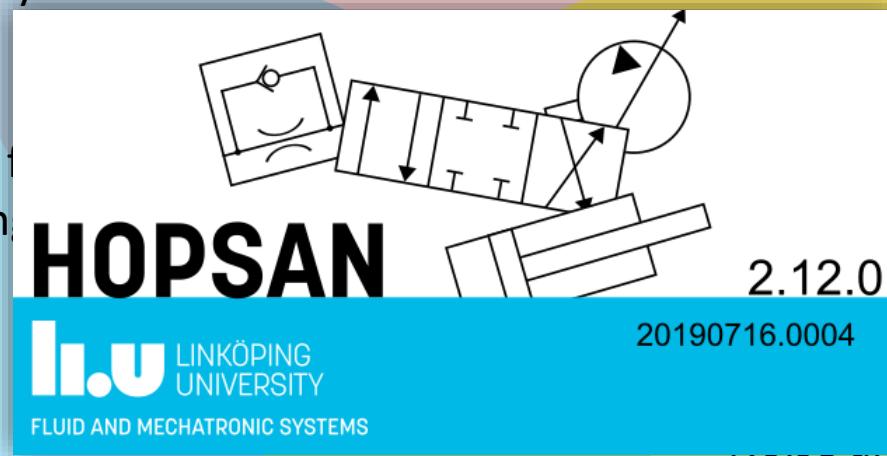
Sensor  
systems

Mobile robotics

Subscale  
testing

Aircraft design

**AIRCRAFT  
SYSTEMS**



ment and  
systems

Mobile systems

and vibrations

Onboard  
systems

Hydraulic system and  
component design

**FLUID  
POWER**

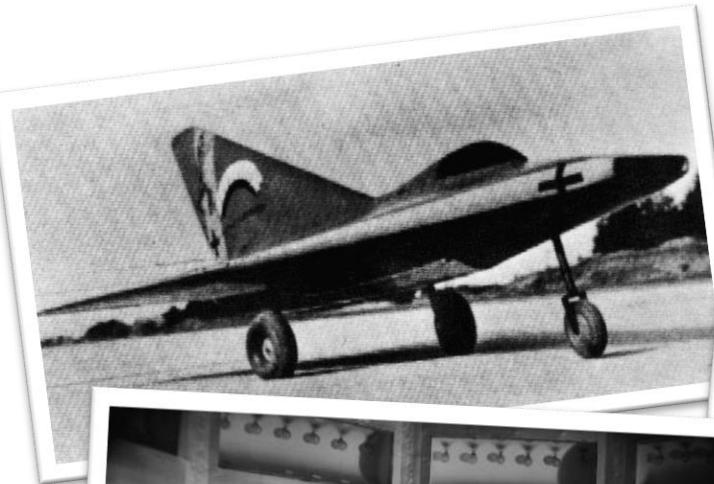
# Why flight testing RPA?

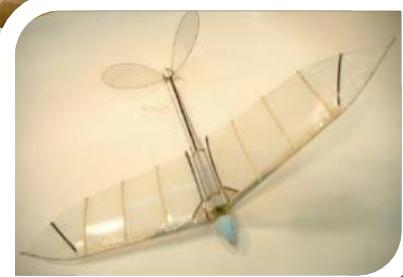
UAS development



Subscale Flight Testing (SFT)



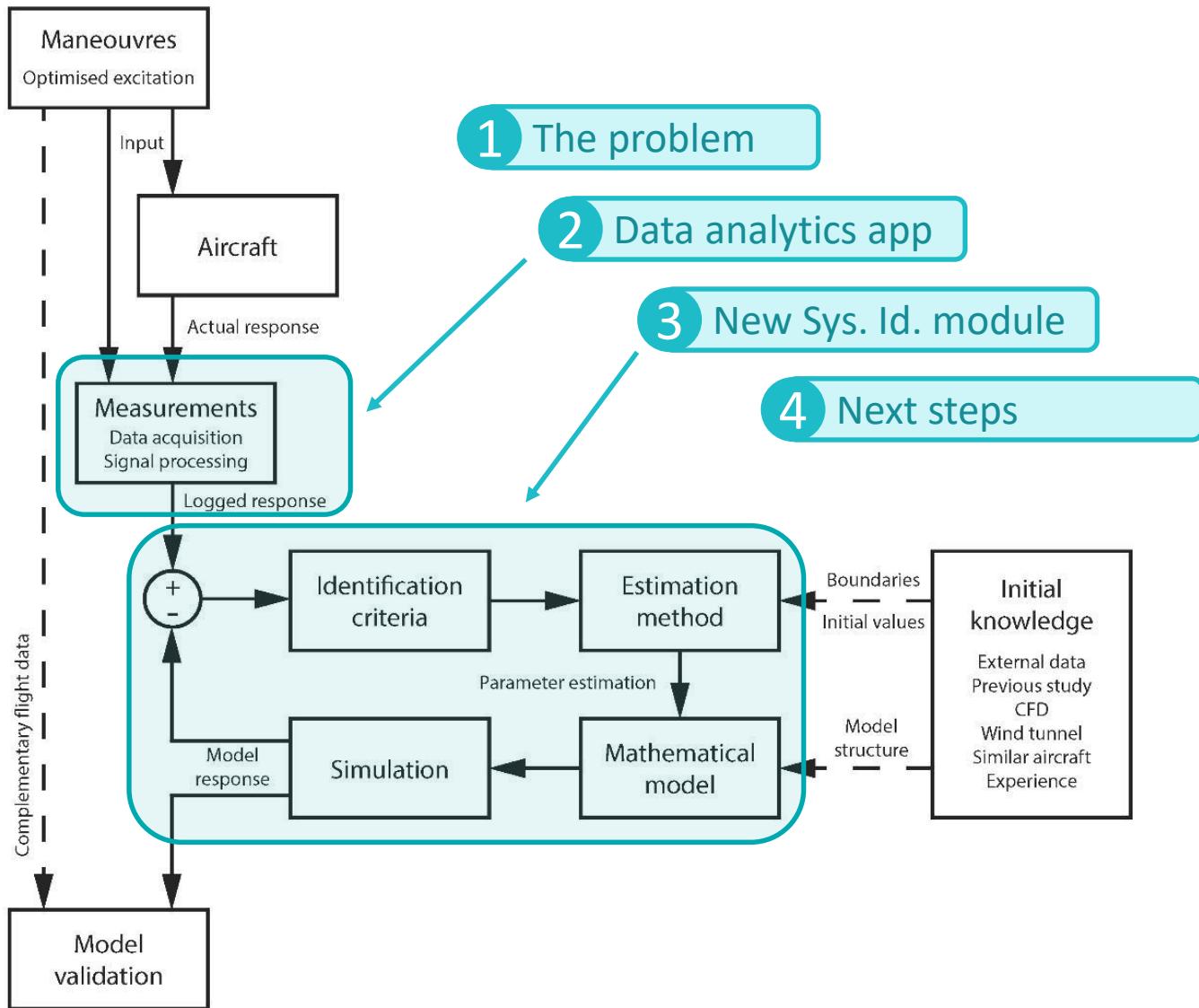




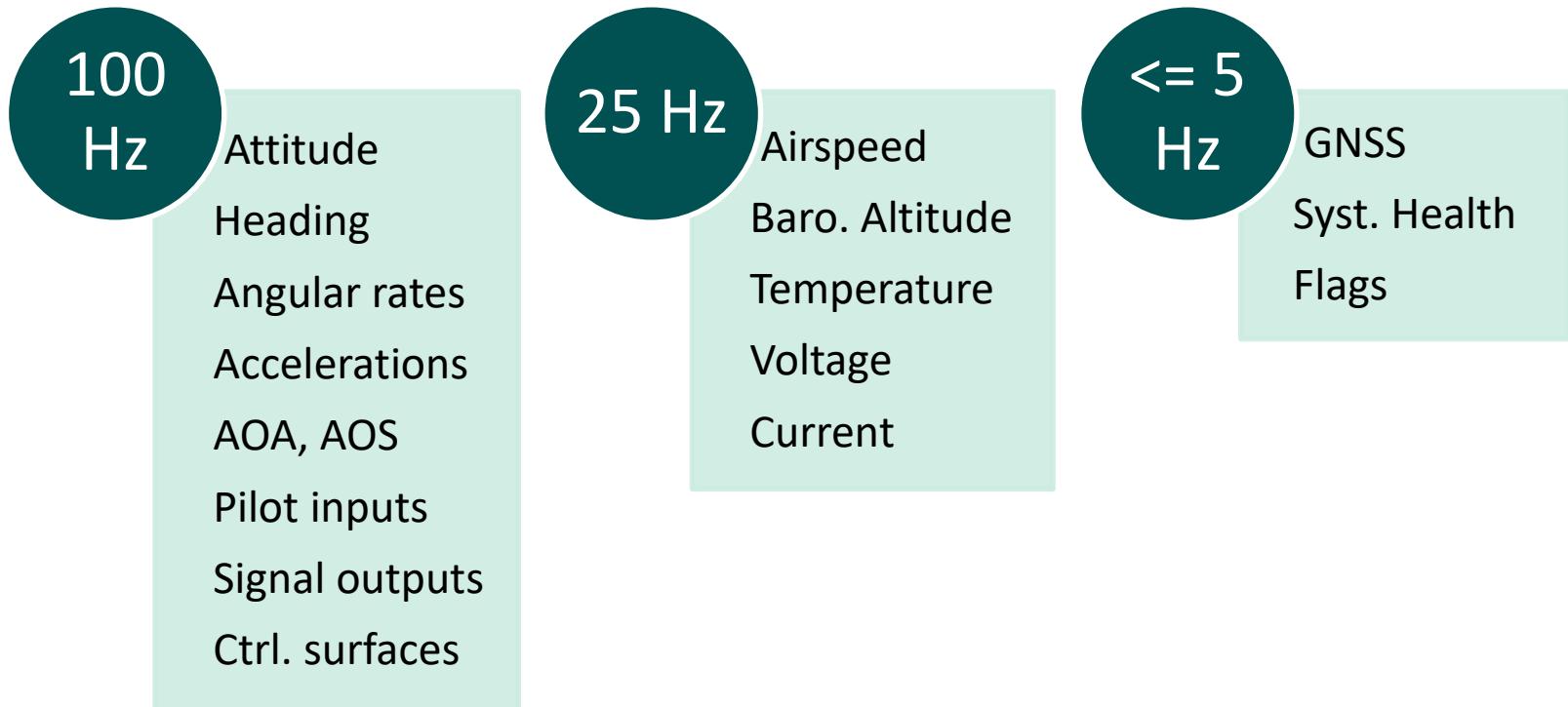


<https://youtu.be/srUr0ztw6Do>

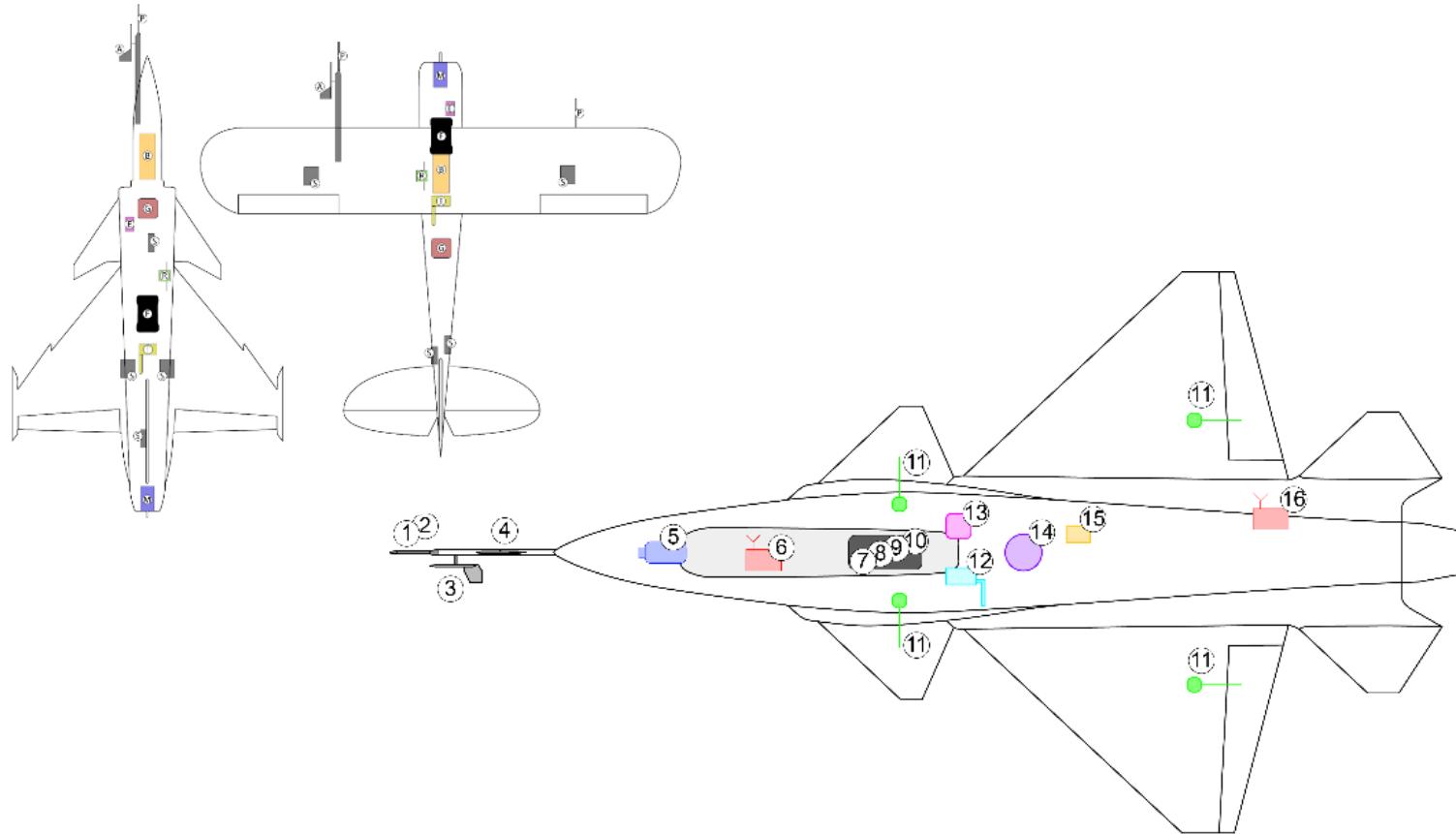




# Many sensors = loads of data

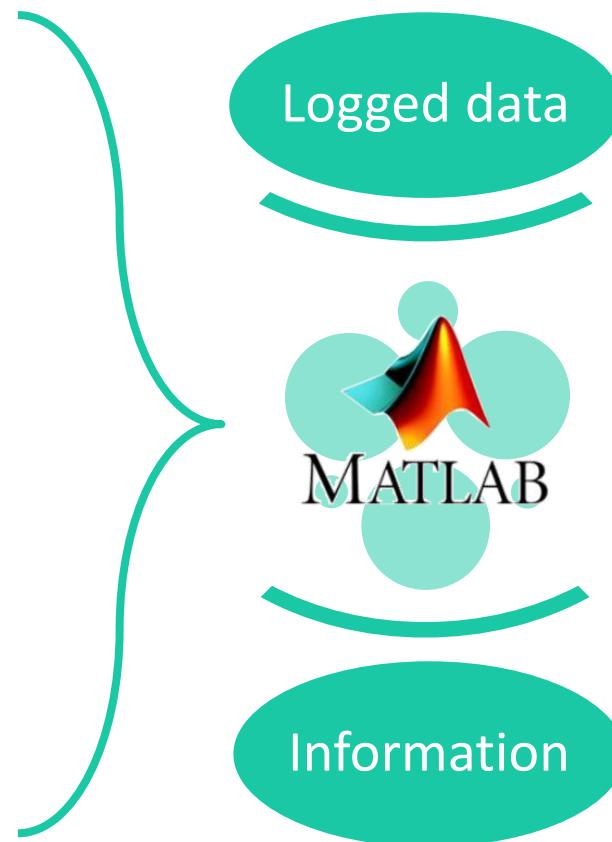


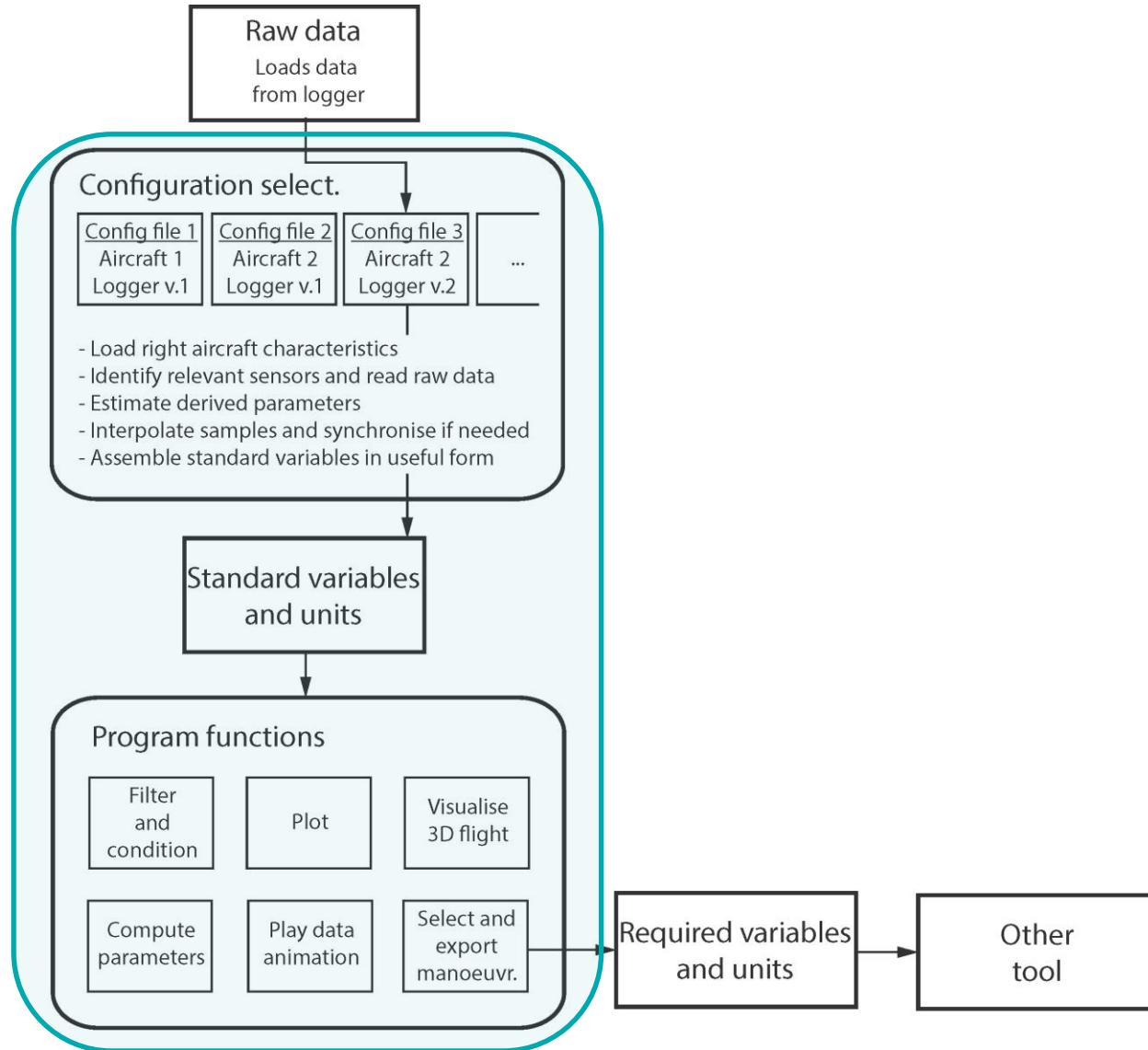
# Many platforms = difficult to handle



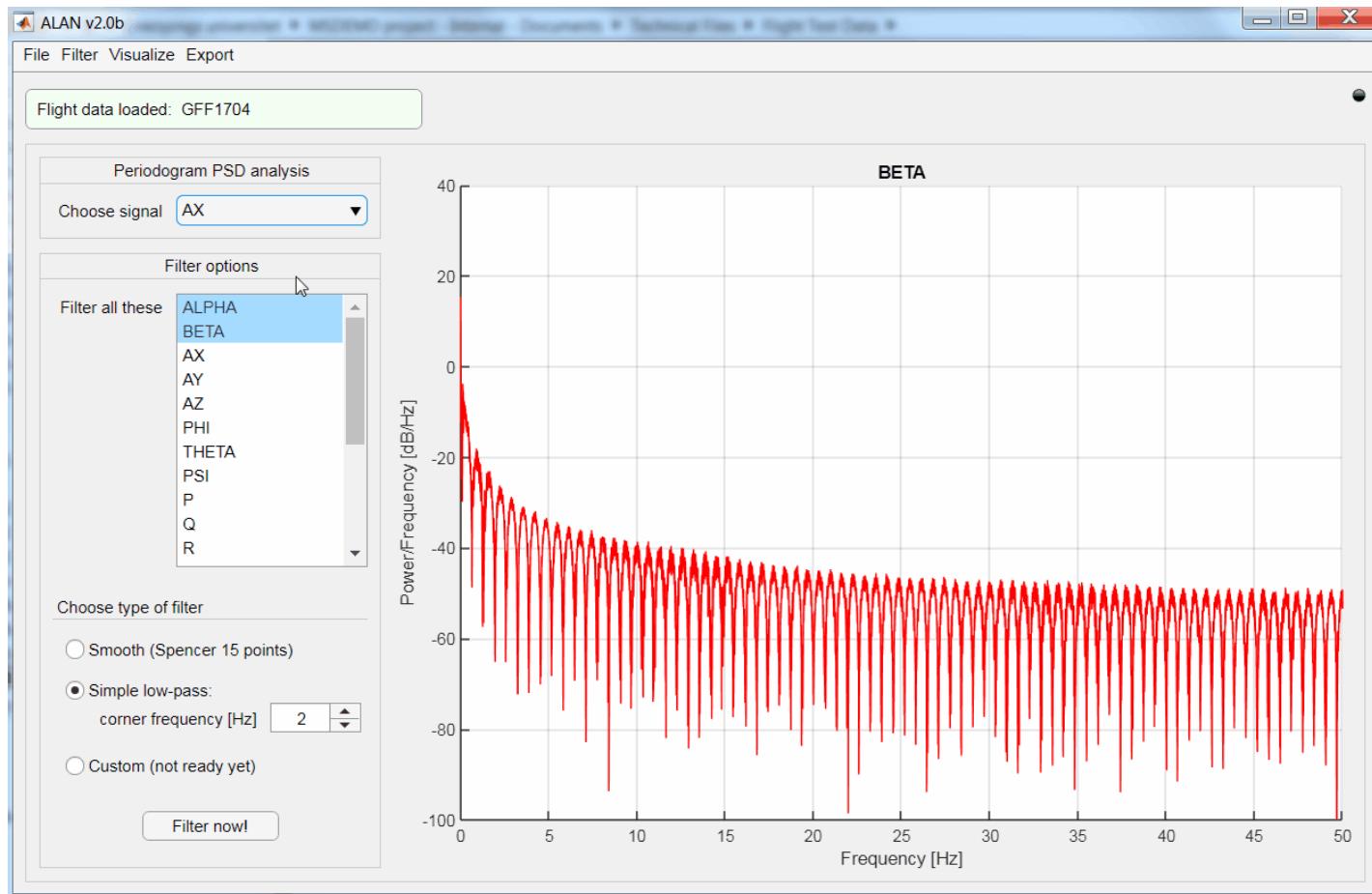
# Aircraft Log Analysis (ALAN)

- Verification
- Transformation
- Integration
- Visualisation
- Extraction (export)

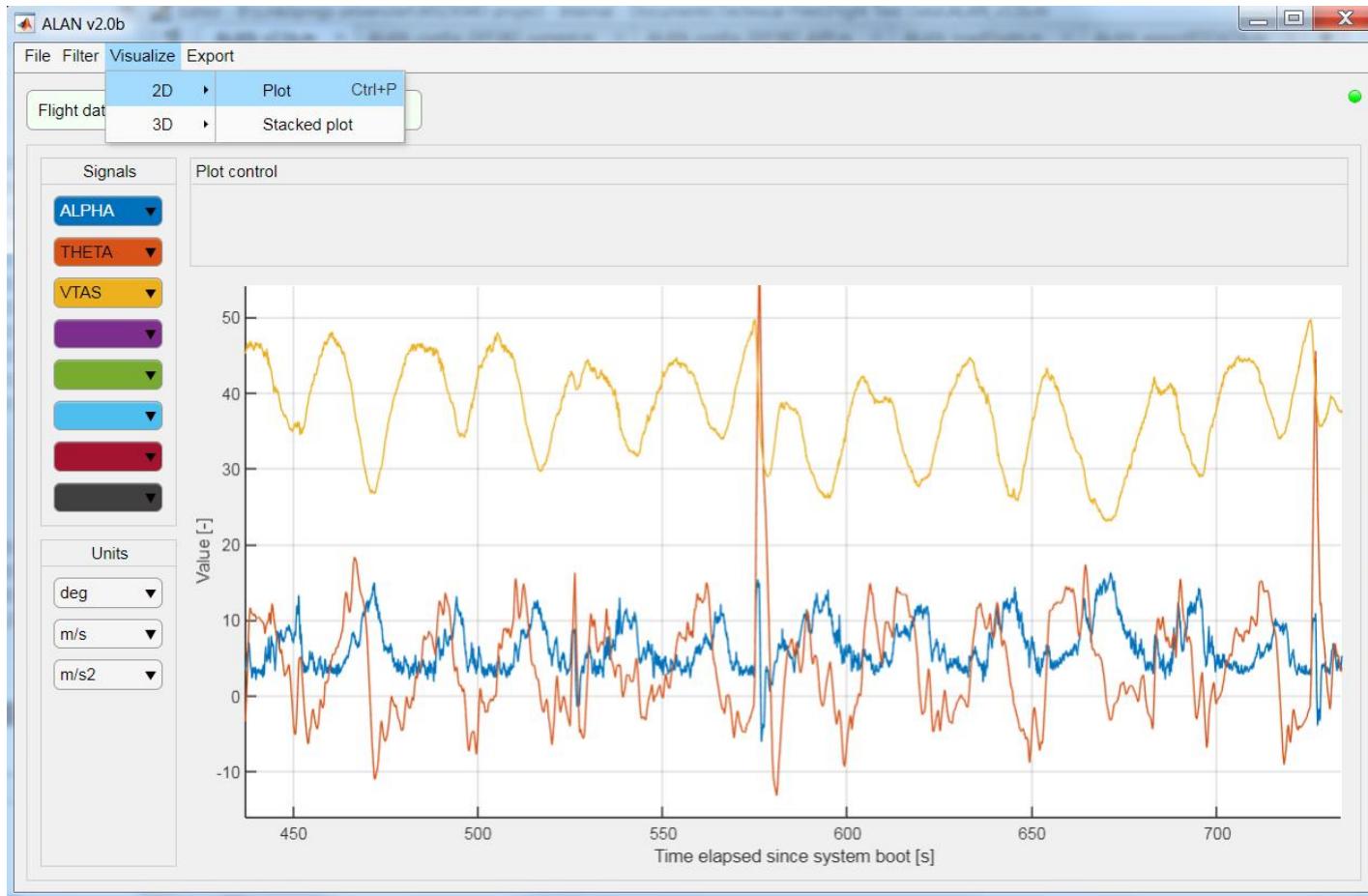




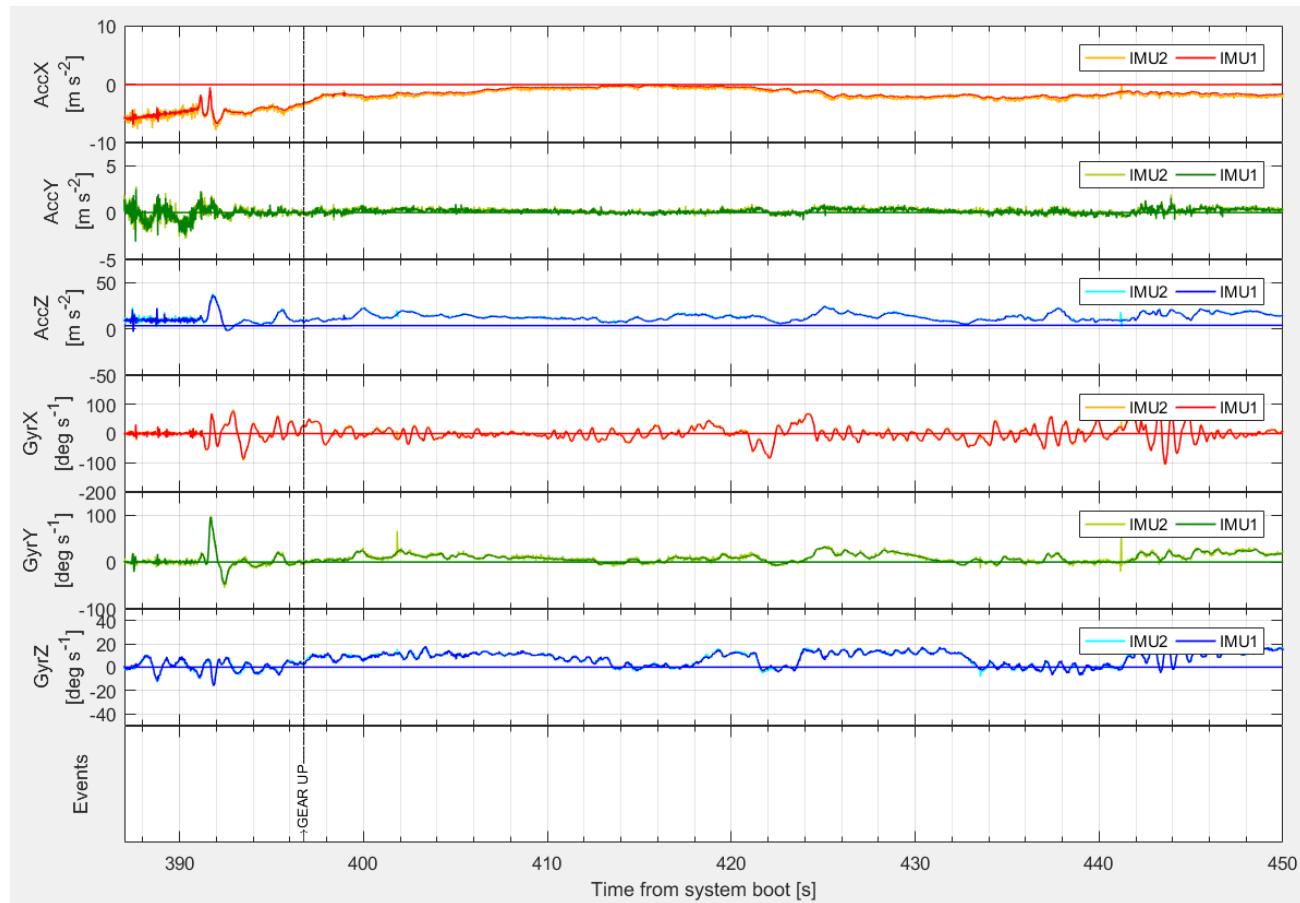
# Signal conditioning



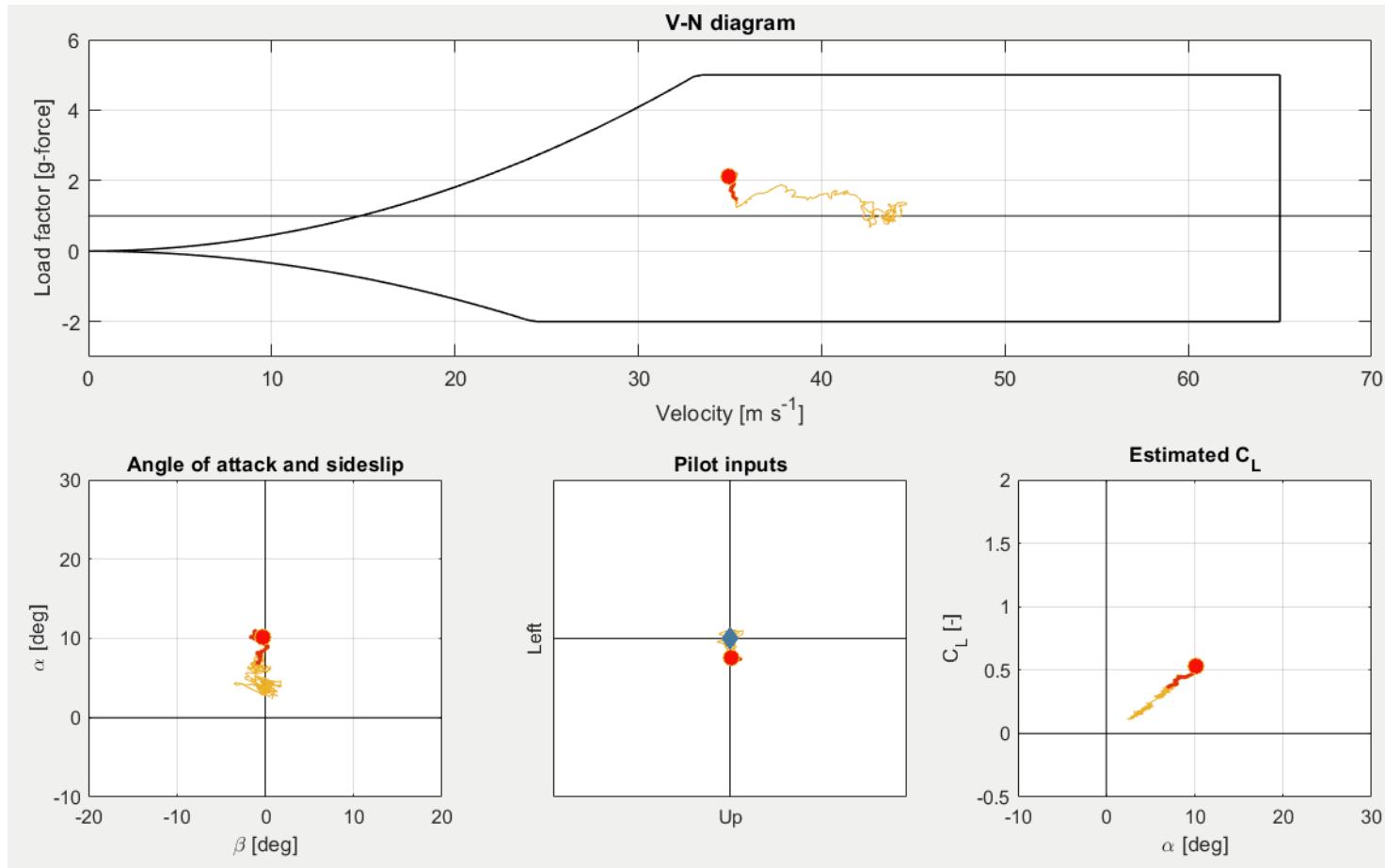
# Plotting



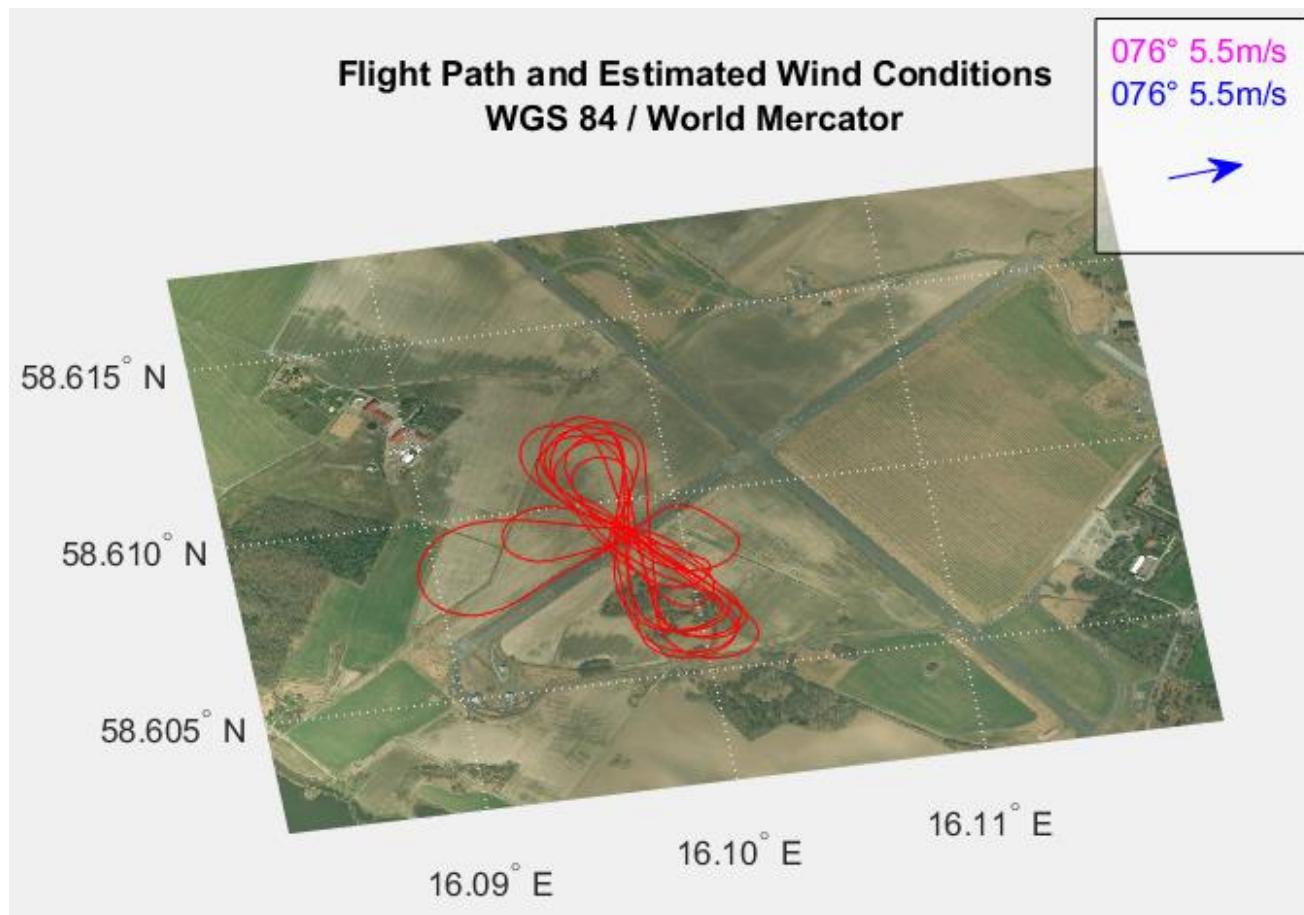
# Plotting



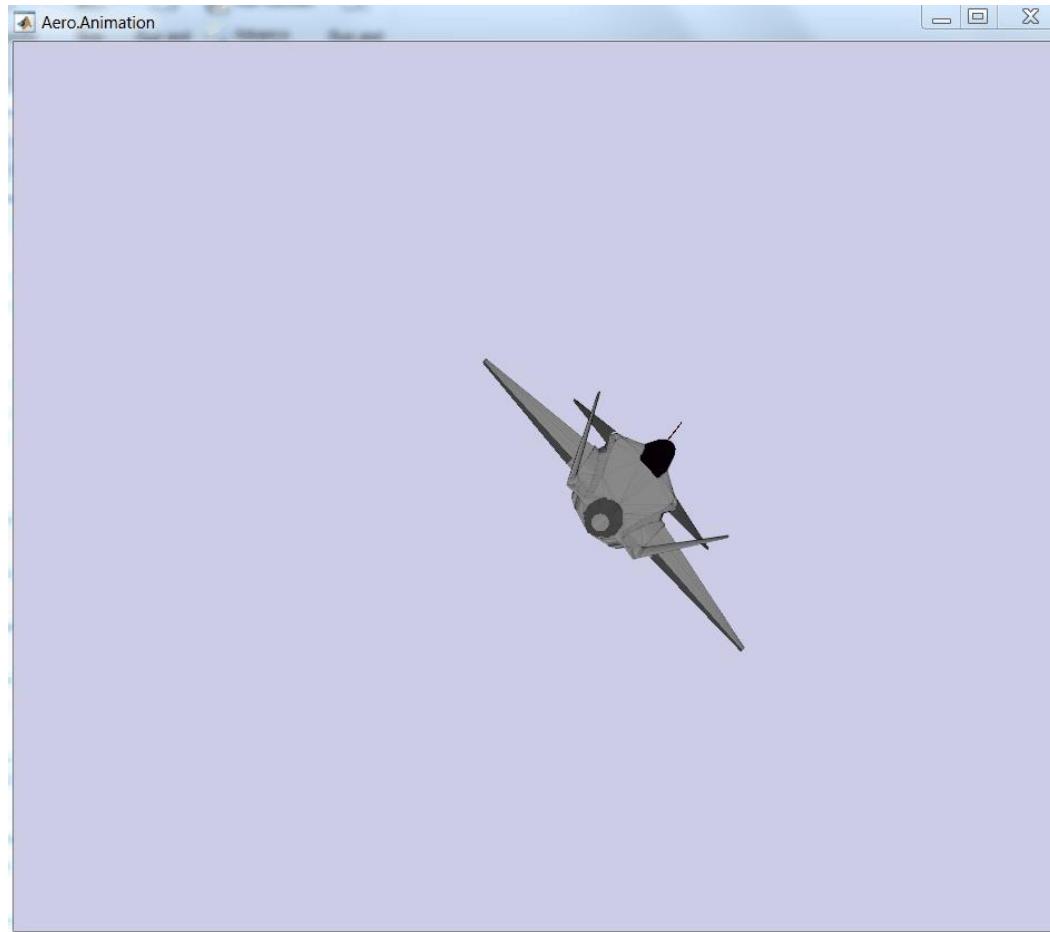
# Flight data animation



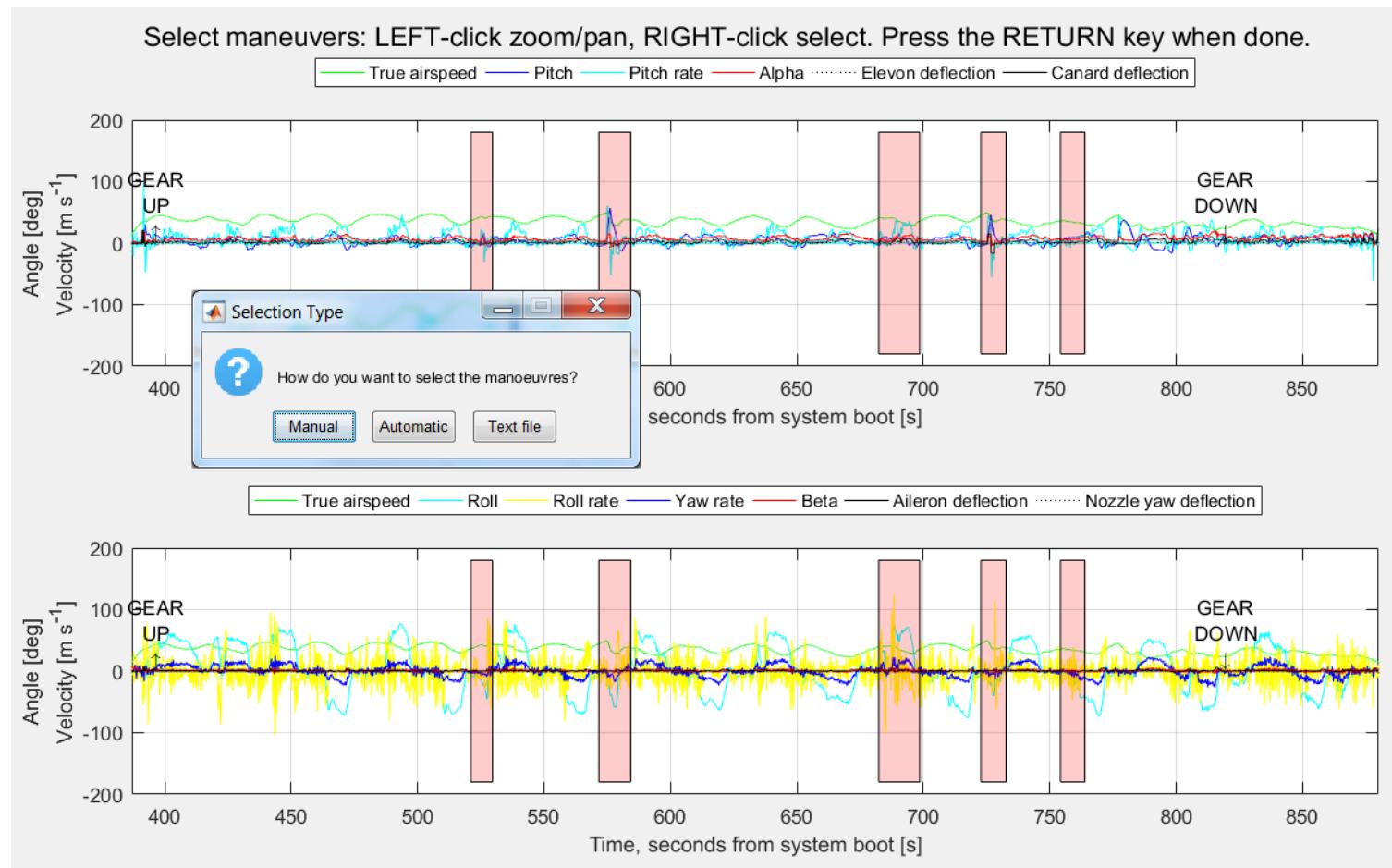
# Trajectory visualisation



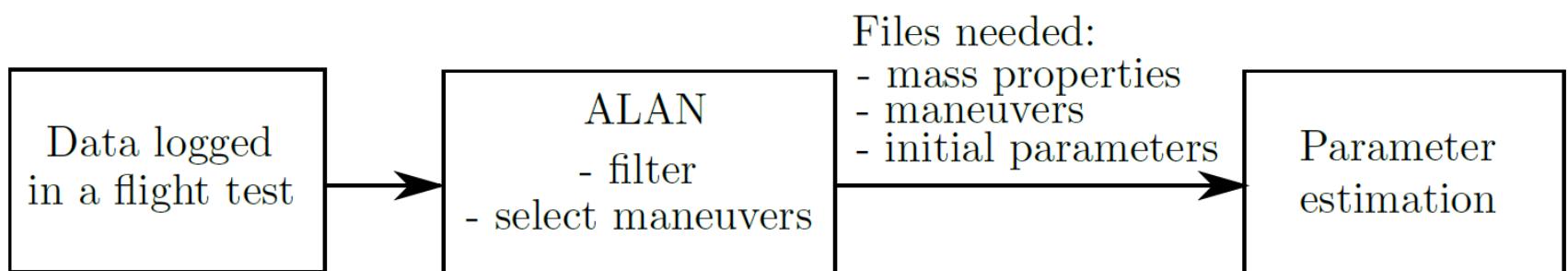
# 3-Dimensional flight replay



# Data extraction



# System identification module



# System identification module

- **Master's thesis:** "*Development of a System Identification Tool for Subscale Flight Testing*", Adrian Arustei, Linköping University, 2019.
- **Time-domain** methodology
- **Two parameter-estimation methods:**
  - Equation Error
  - Output Error
- **Other functions:**
  - Data compatibility check (flight-path reconstruction)
  - Model structure identification

# System identification module

Operations

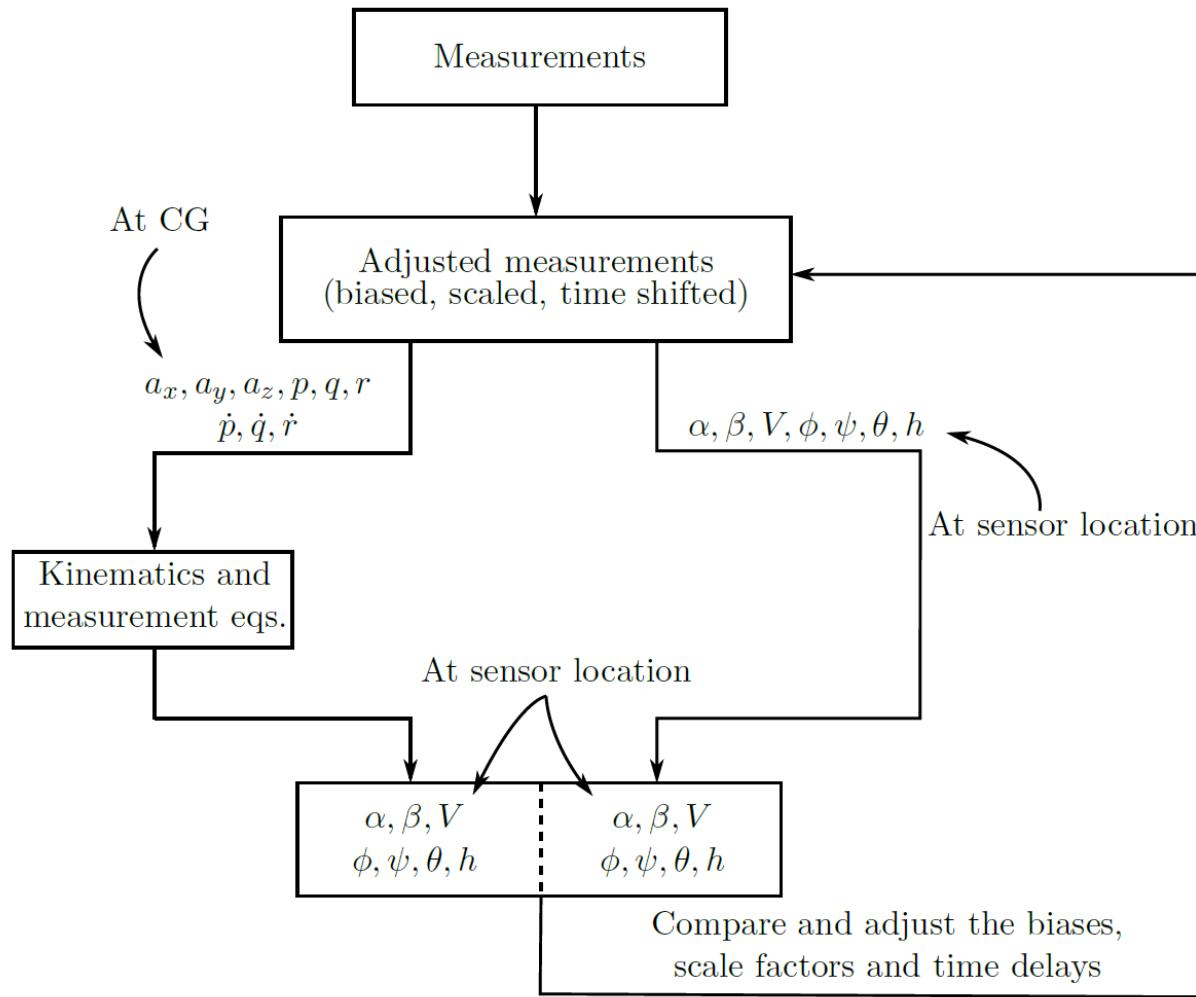
<a href="#">Check FPR</a>	Check the Flight Path Reconstruction.
<a href="#">Optimize FPR</a>	Find a new set of biases, factors, and time delays.
<a href="#">Check Longitudinal</a>	Check the Longitudinal model.
<a href="#">Optimize Lon.</a>	Find a new set of Longitudinal derivatives.
<a href="#">Check Lat-Dir</a>	Check the Lateral-Directional model.
<a href="#">Optimize Lat-Dir</a>	Find a new set of Lateral-Directional derivatives.
<a href="#">Check Full 6DOF</a>	Check the full 6 Degrees of Freedom model.
<a href="#">Optimize Full 6DOF</a>	Find a new full set of aerodynamic derivatives.
<a href="#">Compare Parameters</a>	Select parameter files to compare.
<a href="#">Model Identification</a>	Identify the aerodynamic model structure.

Settings

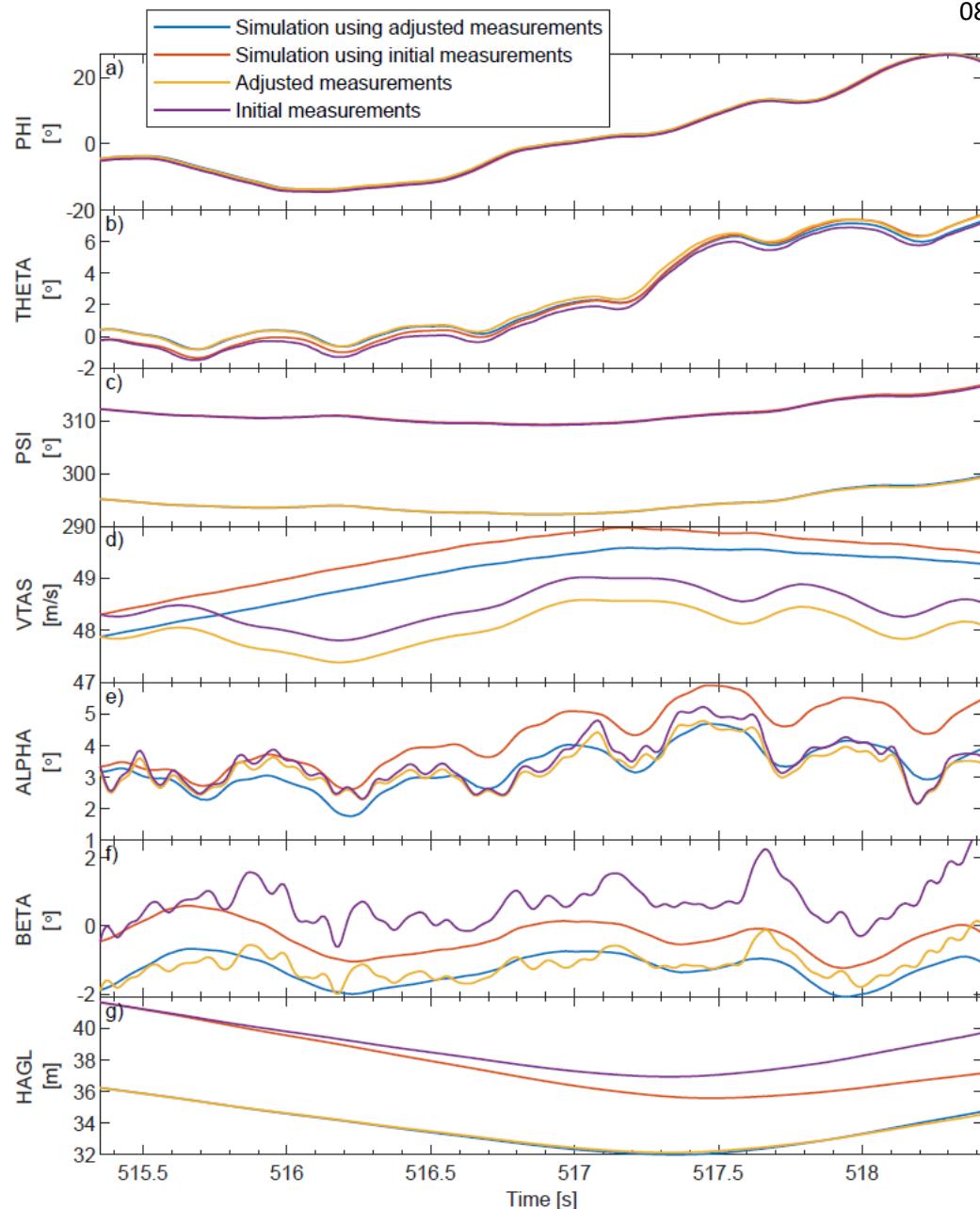
Optimization method	Parallel processing
<input checked="" type="radio"/> Gradient Free	<input checked="" type="radio"/> Default
<input type="radio"/> Particle Swarm	<input type="radio"/> Parallel
<input type="radio"/> Genetic Algorithm	
Population/Swarm size	
<input type="button" value="◀"/>	<input type="button" value="▶"/>
Population: 100	
Parameter estimation method	
<input checked="" type="radio"/> Equation Error	
<input type="radio"/> Output Error	
Model structure identification	
Downscale factor:	<input type="text" value="1"/>
Maximum polynomial degree	<input type="text" value="1"/>
Overfit penalty factor	<input type="text" value="1"/>

[Tips](#) [Close figures](#)

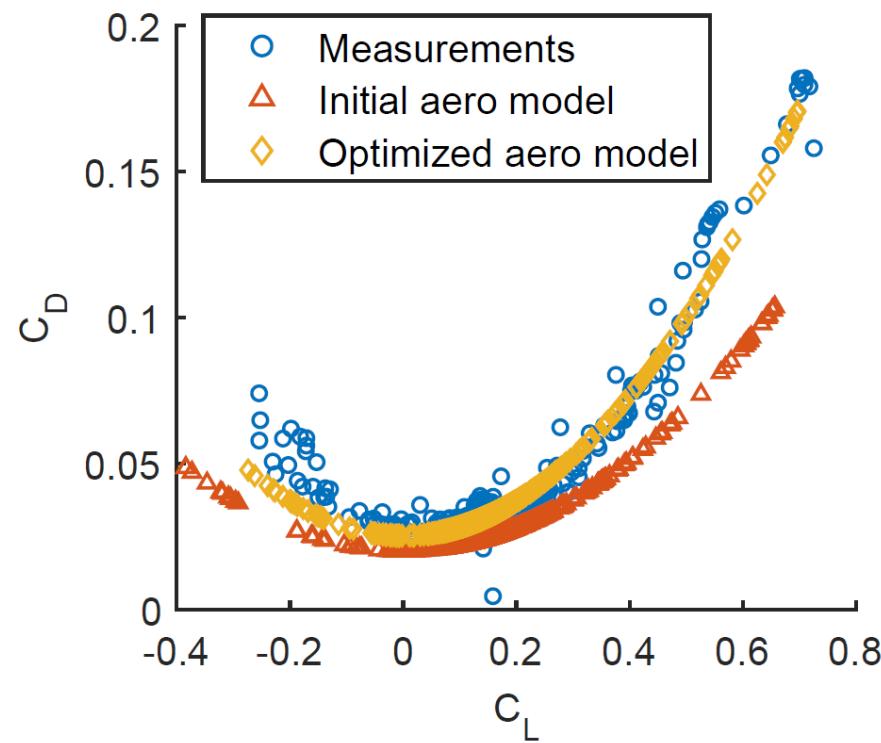
# FPR



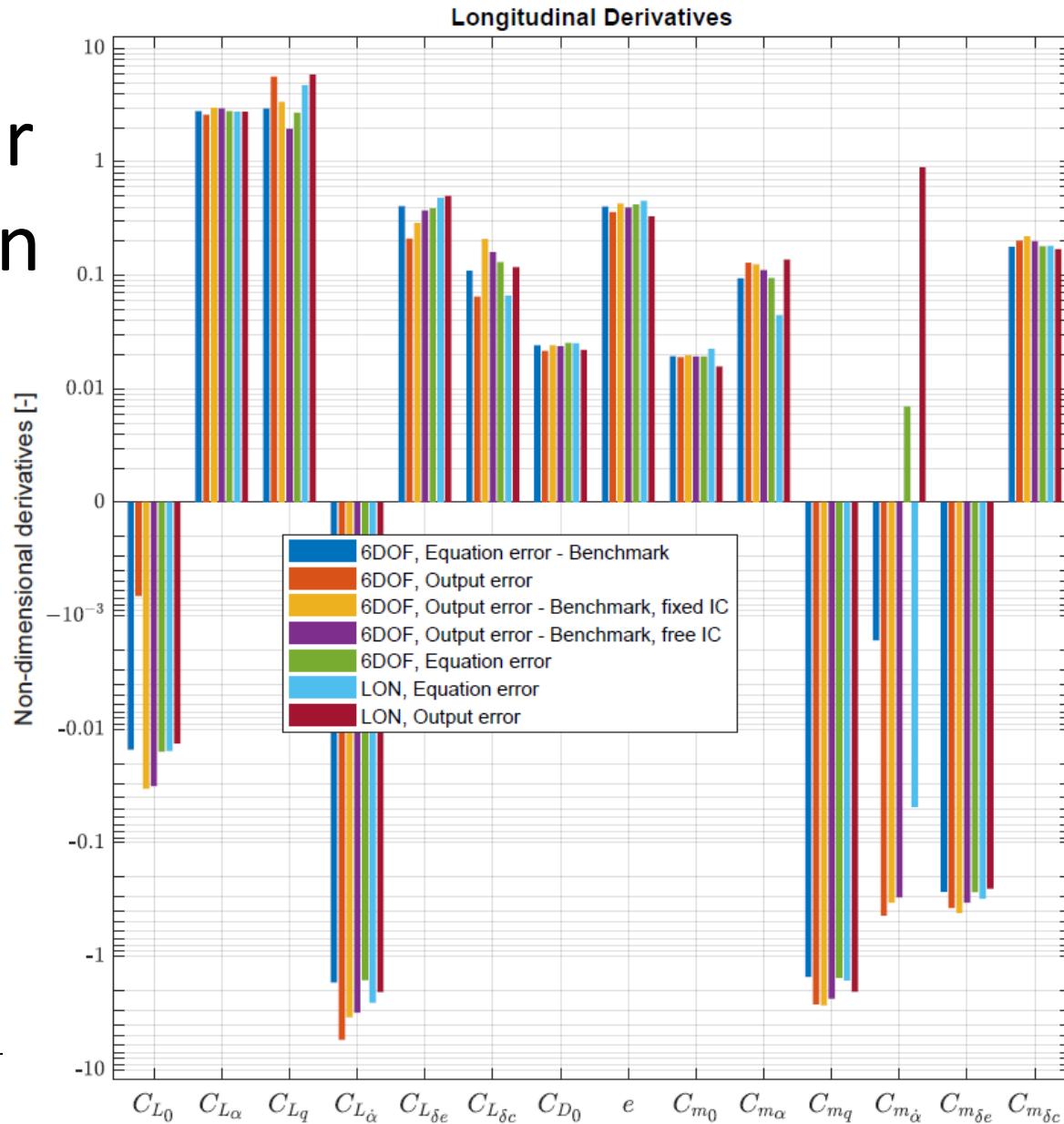
FPR



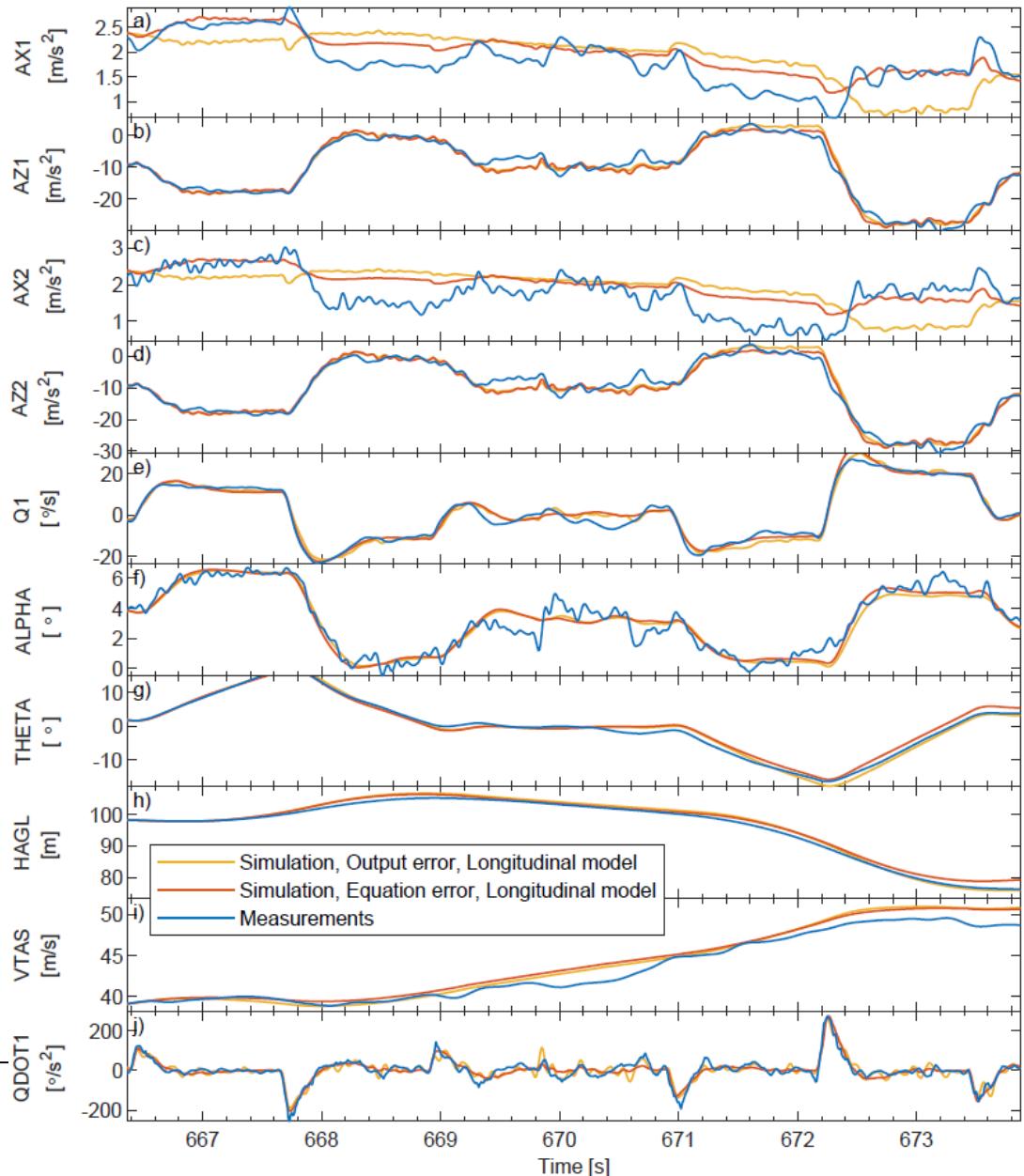
# Parameter estimation



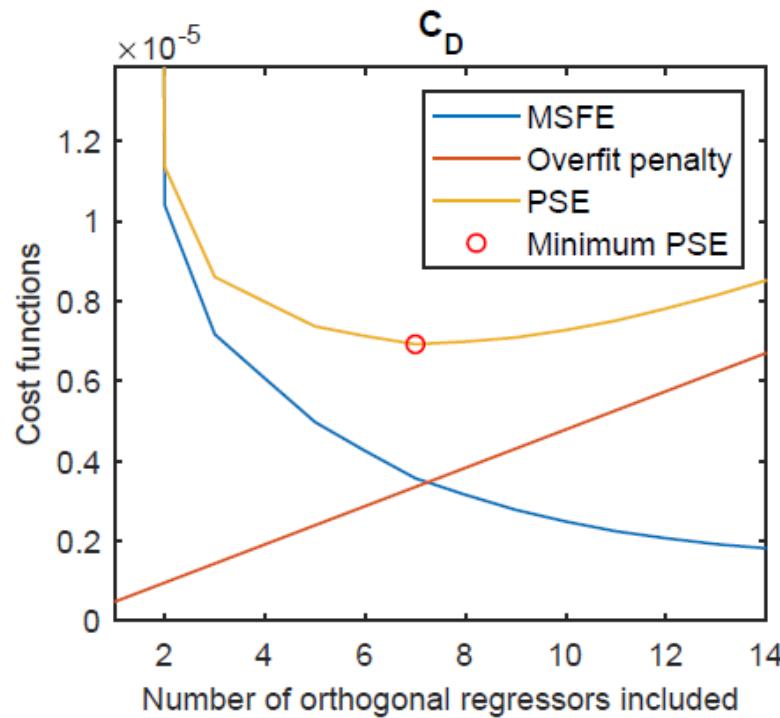
# Parameter estimation



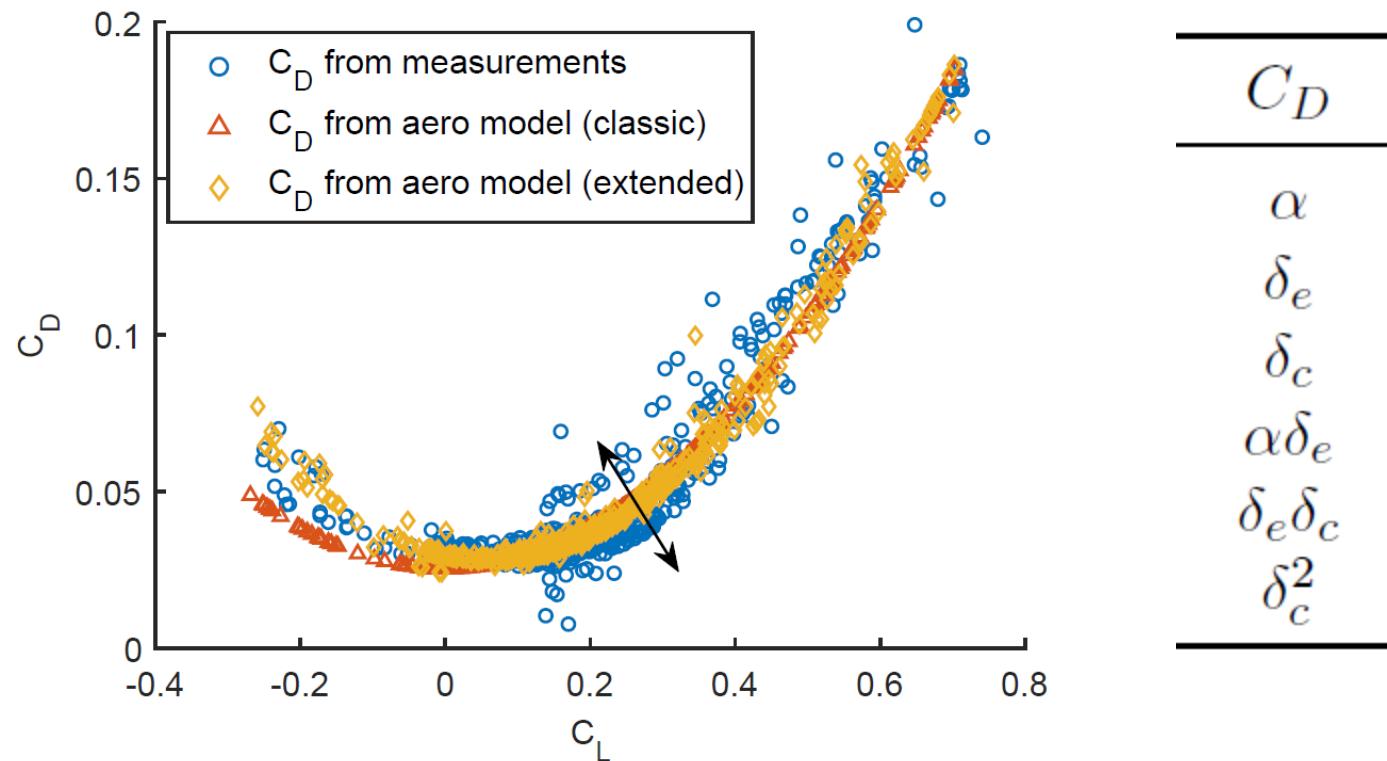
# Parameter estimation



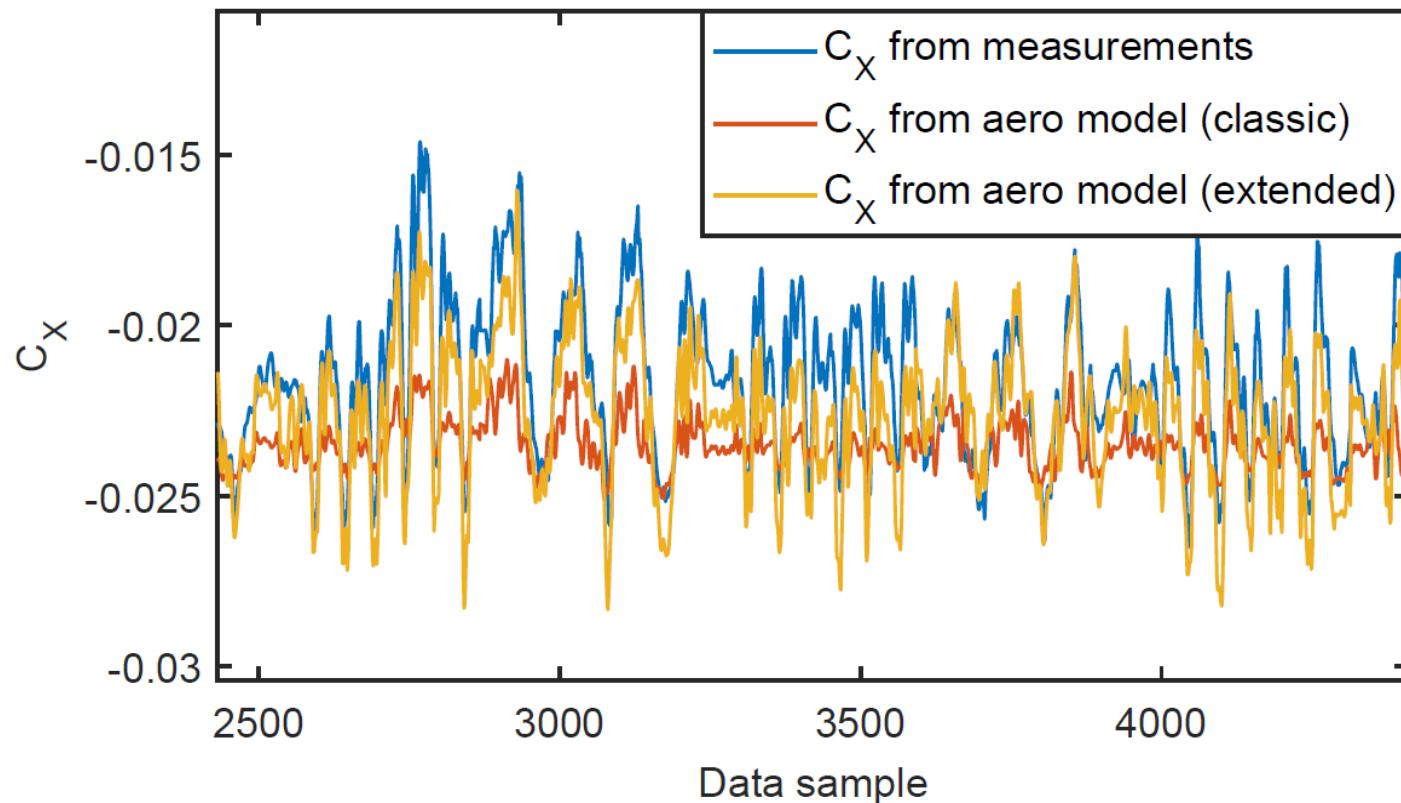
# Model identification (multivariate orthogonal function modelling)



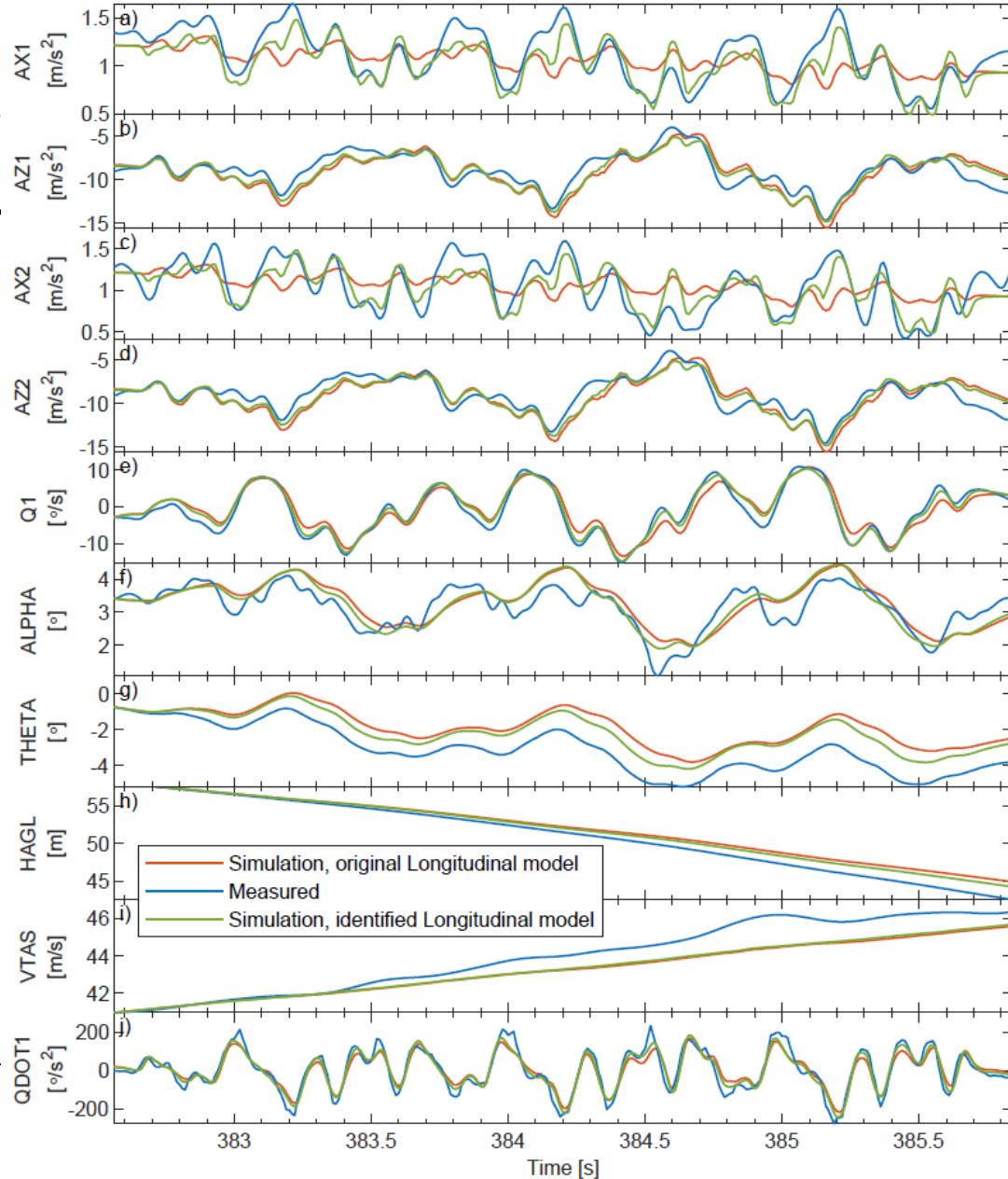
# Model identification (multivariate orthogonal function modelling)



# Model identification (multivariate orthogonal function modelling)



# Model identification (multivariate or univariate)



# Next steps

- Finishing touches and UI tweaks (Matlab GUI > App)
- Complete documentation
- Open-source publication
- Coupling to Hopsan aero model & simulation
- Future expansion:
  - New functions?
  - New sys. identification methods?
  - [Insert your idea here!]

# Conclusions

**ALAN is a Matlab application developed specifically for subscale flight testing analytics**

**Recent addition of basic system identification capabilities**

**It will be published in the near future (Q1 2020) as open-source**

**Looking forward to bring in your ideas and suggestions**

# THANK YOU FOR YOUR ATTENTION

Part of project MESTA (NFFP-2017-01505):  
*“Methods for Subscale Flight Testing and Analytics”*

More information:

[alejandro.sobron@liu.se](mailto:alejandro.sobron@liu.se)