RESEARCH GROUP

FLIGHT PHYSICS & CONTROL

LNCA
get into new ideas
laboratory of new concepts in aeronautics

PE-AERO, SEPTEMBER 2015

IMAGE CREDITS: BOEING

FLIGHT PHYSICS & CONTROL RESEARCH GROUP

TEAM

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- L. C. S. Góes
- F. Almeida

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- Jaques G. (MSc candidate)
- Thiago V. (MSc candidate)
- Gefferson C. L. (MSc candidate)
- M. Ibrahim (MSc candidate)

FLIGHT PHYSICS & CONTROL RESEARCH GROUP

RESEARCH LINES

Dynamics and Control of Flexible Aircraft

- coupled flight and aeroelastic dynamics
- control of flexible aircraft and aeroservoelasticity
- ground and flight testing of aeroservoelastic systems
- flying qualities and PIO due to elastic effects

Flow Control

- time-domain transfer functions
- LQR with output feedback applied to ROM's

Intelligent Materials and Aeroelastic Control

- application of piezoelectric materials for active flutter control and gust load alleviation
- fusion of sensors and actuators for monitoring and controlling aeroelastic systems
- application of shape memory alloys (SMA) in passive aeroelastic control

DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

MOTIVATION

Aviation of the near future: **green aircraft**

- increase of efficiency and performance
- lighter structures: alternative materials
- reduction of induced drag: wings of higher AR

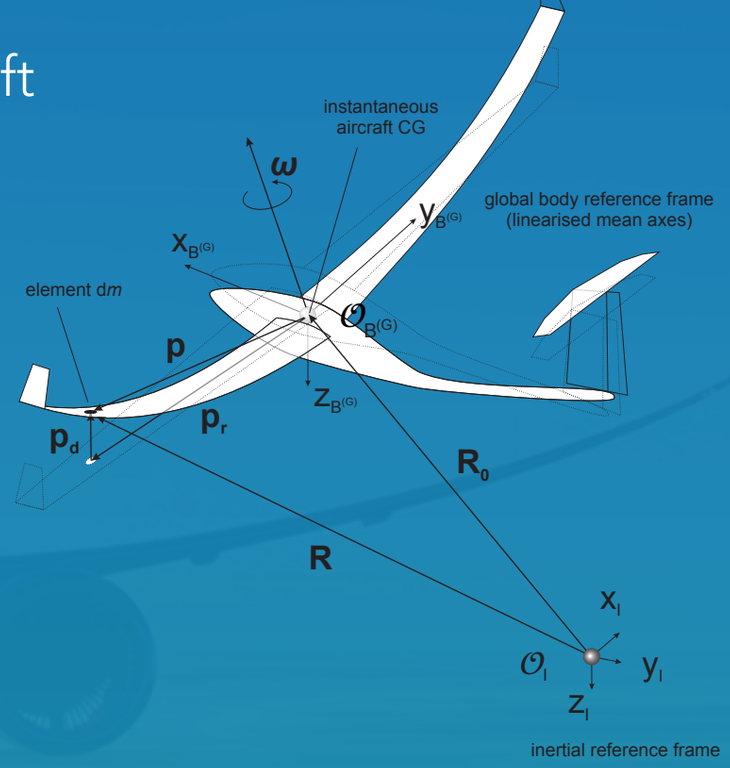
increase of airframe flexibility

Demands

- coupling AE + FM: need of integrated models for flexible aircraft
- aeroservoelastic stability
- aeroelastic control, load alleviation, comfort augmentation

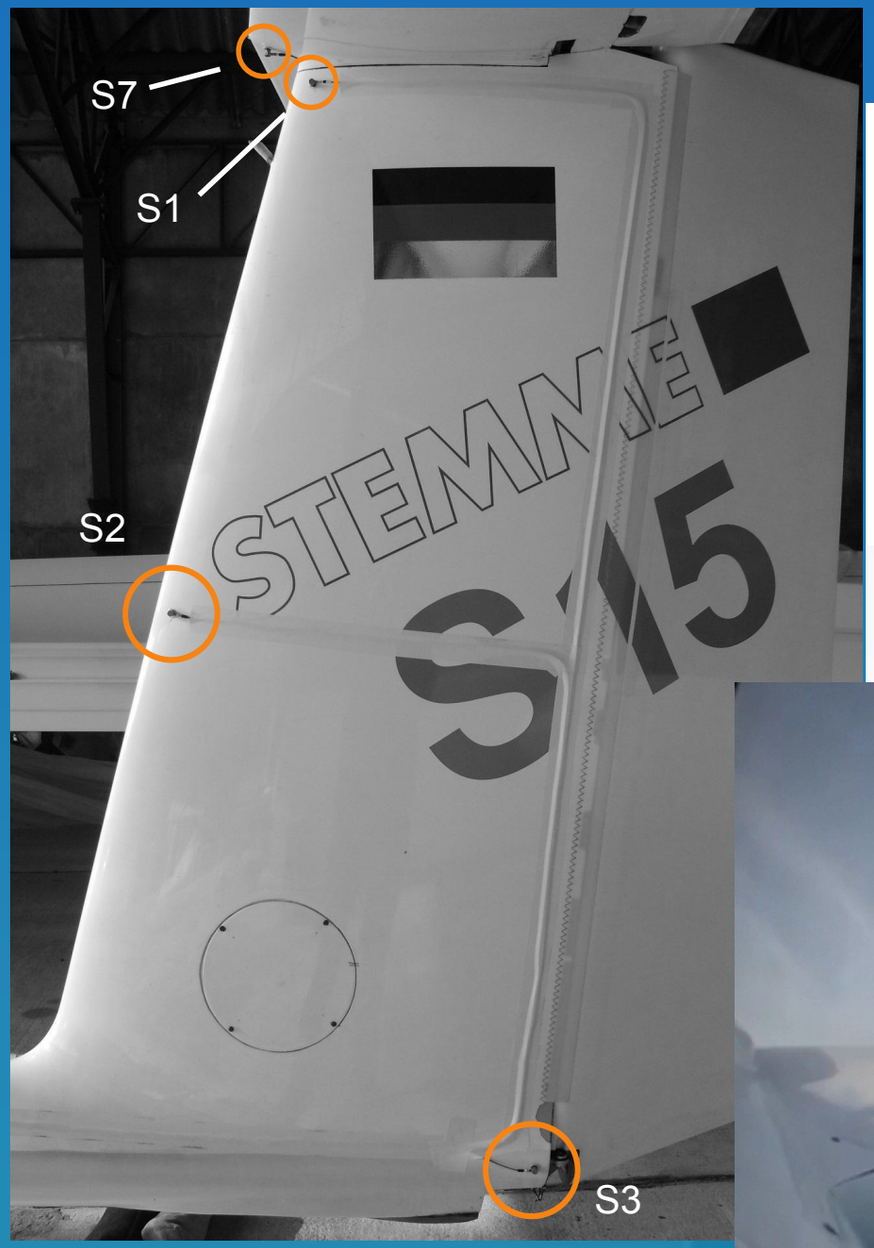
Challenges

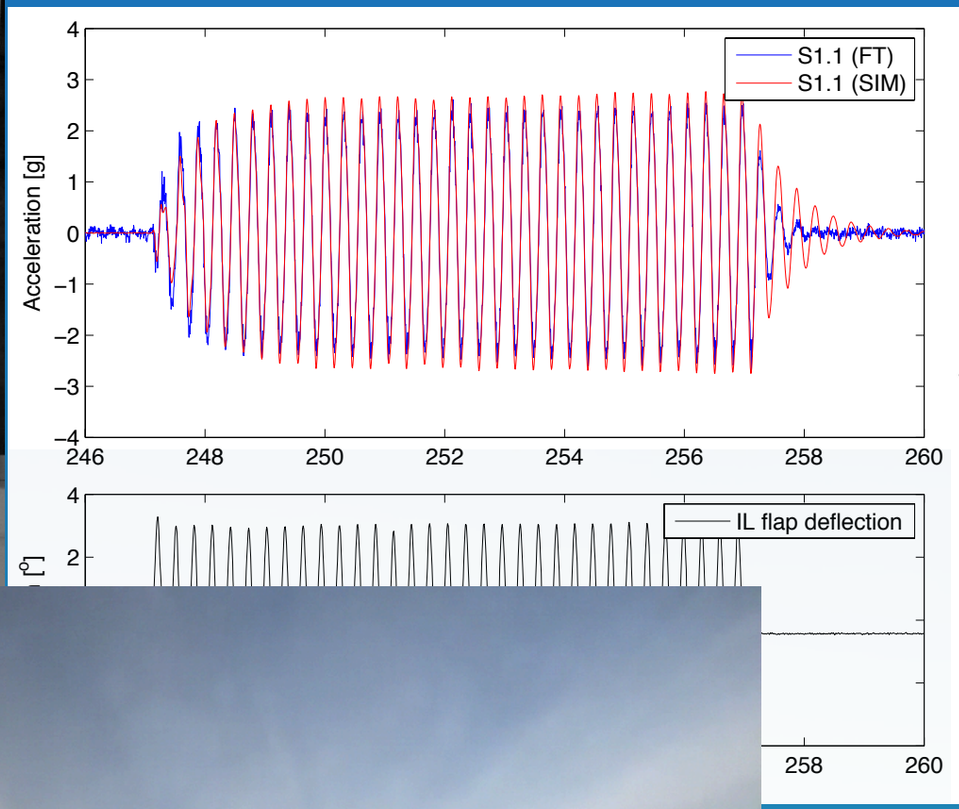
- model complexity
- computational capacity
- lack of experimental validation

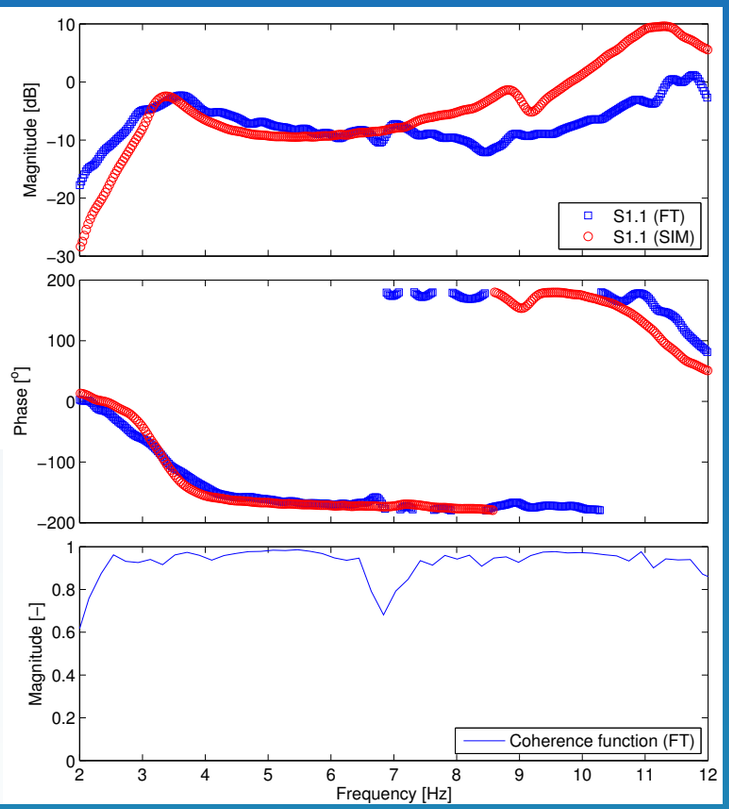


DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

DEVELOPMENT AND EXPERIMENTAL VALIDATION OF AE + FM INTEGRATED MODELS







Silvestre & Luckner, AIAA Journal, 2015

funded by DAAD Deutscher Akademischer Austausch Dienst German Academic Exchange Service

a cooperation with TU berlin

LNCA laboratory of new concepts in aeronautics get into new ideas

F. SILVESTRE

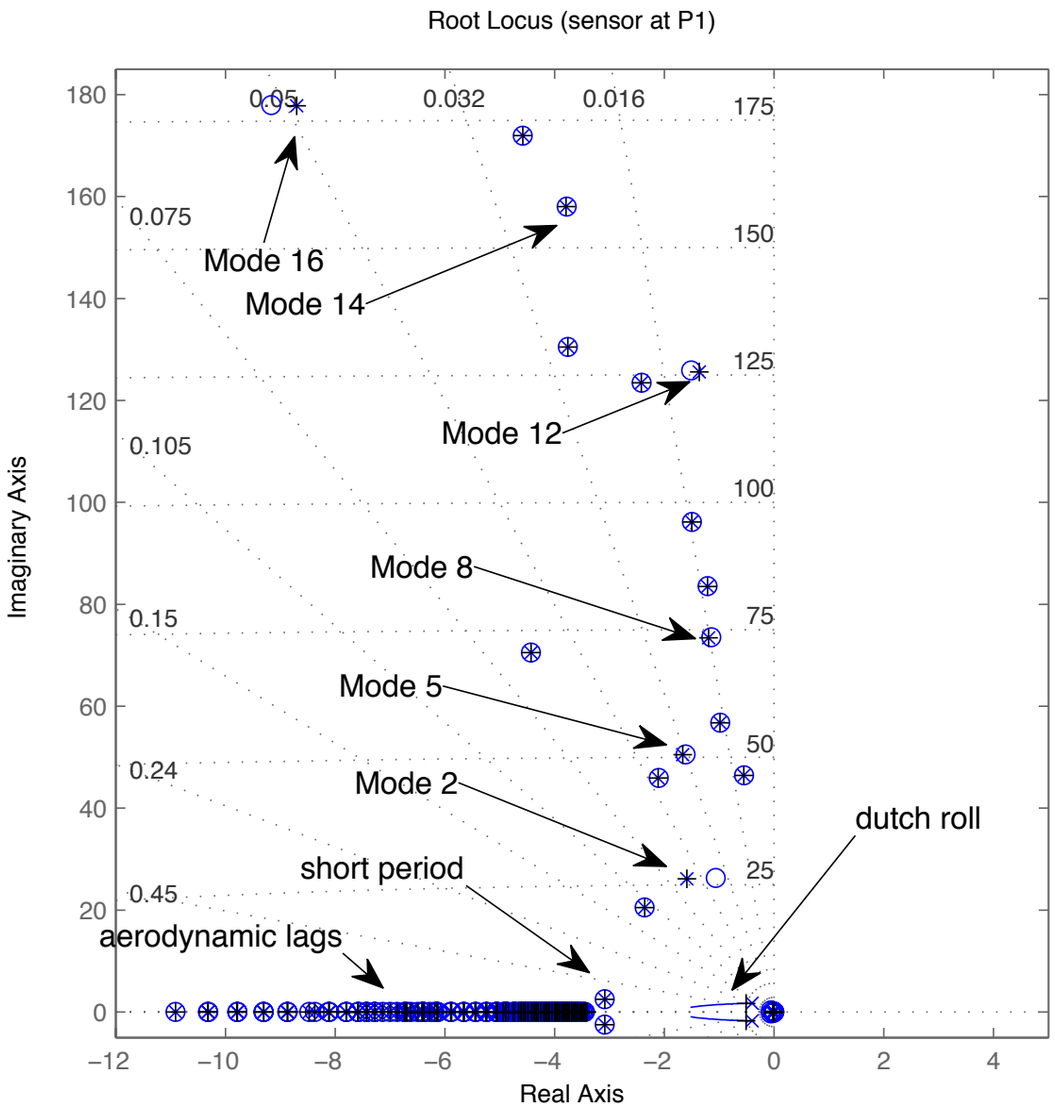
SEPTEMBER 2015

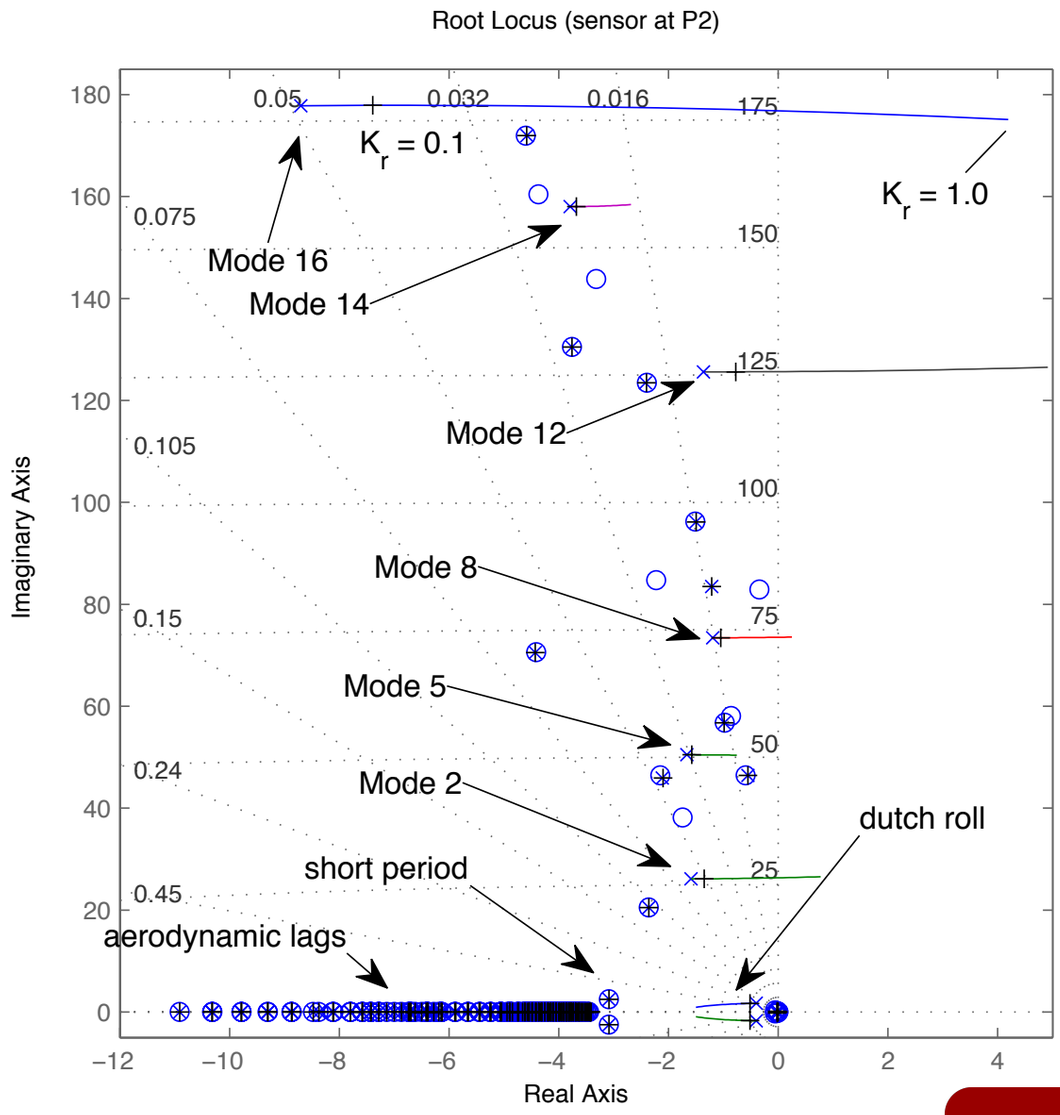
ITA

DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

AEROSERVOELASTIC STABILITY

Silvestre, CEAS, Springer Verlag, 2013





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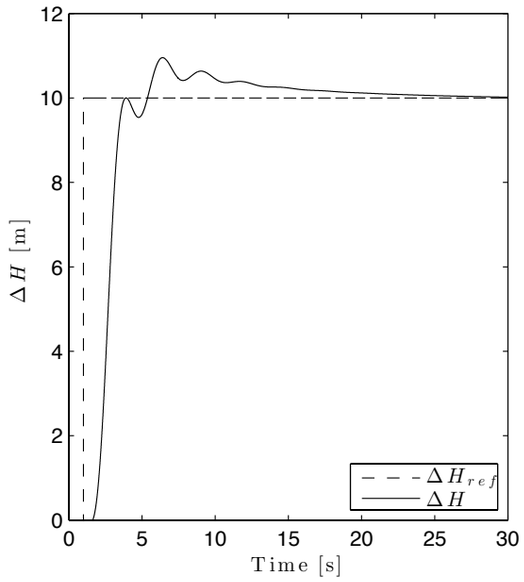
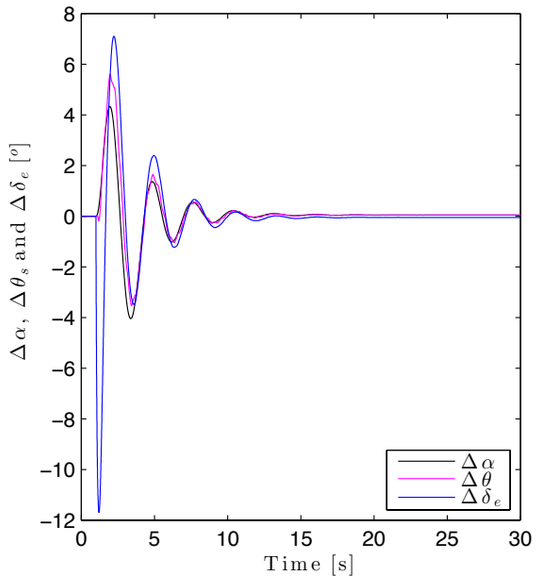
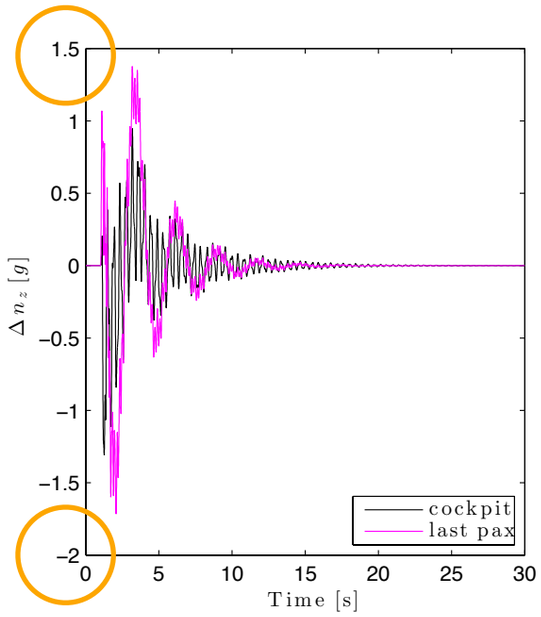
DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

AEROSERVOELASTIC STABILITY

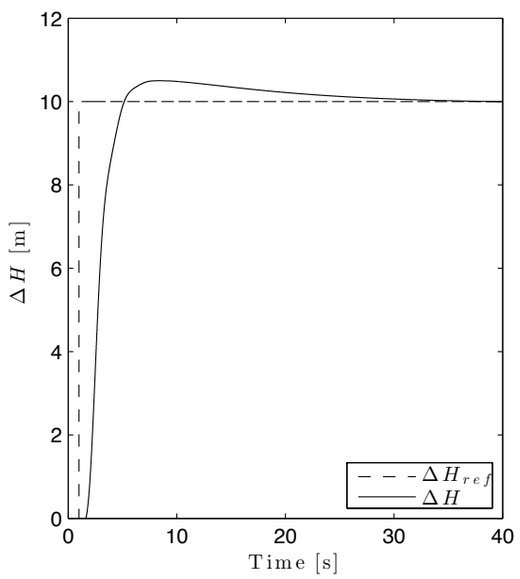
FLEX MODEL + FILTERS

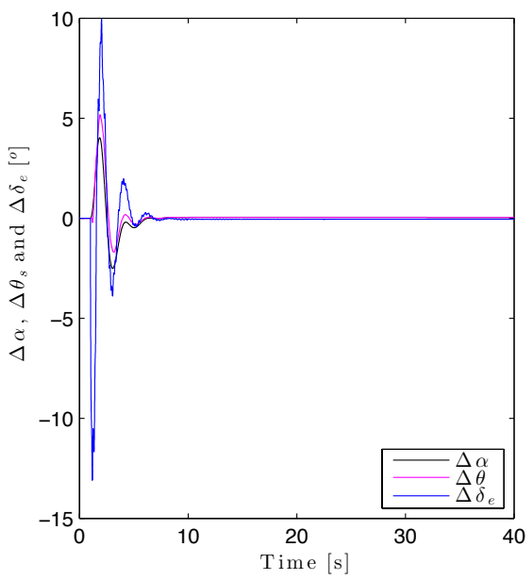


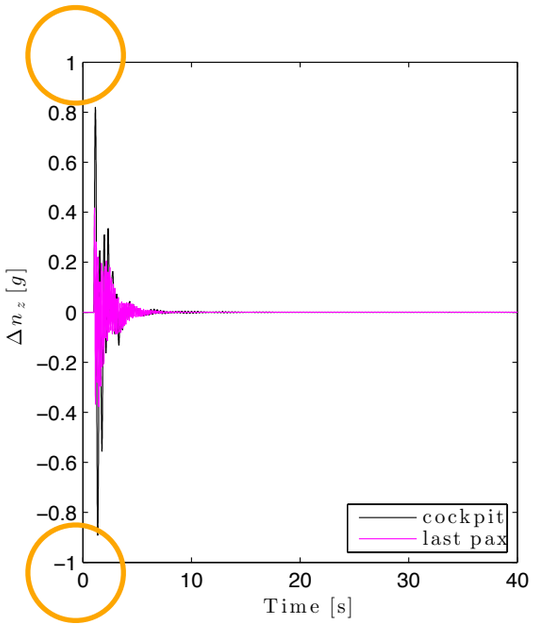


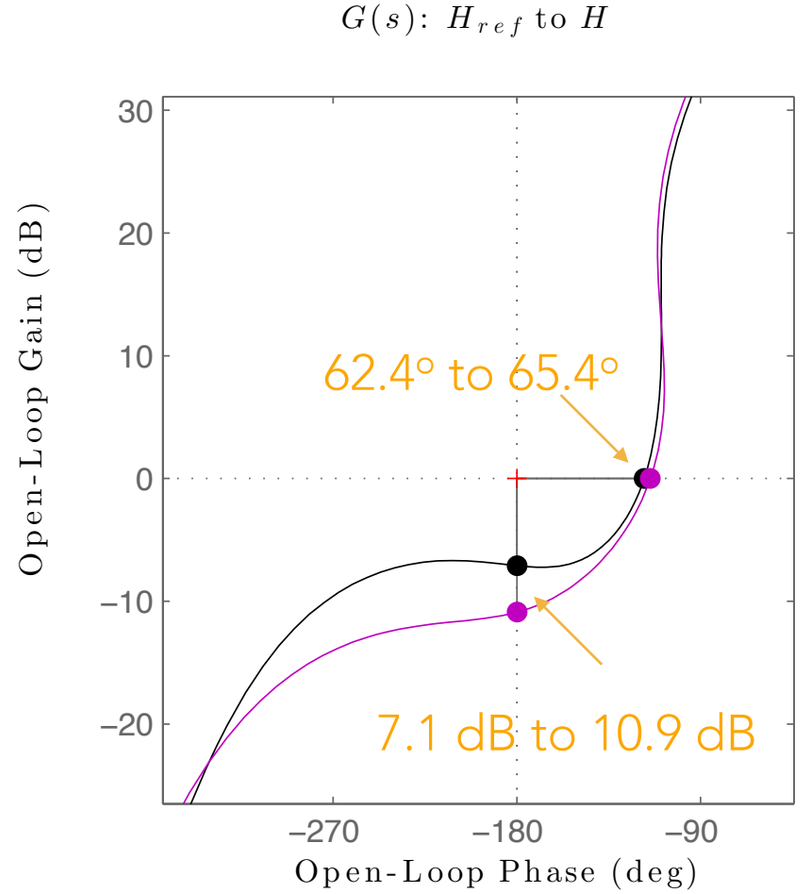


FLEX MODEL + AE SAS





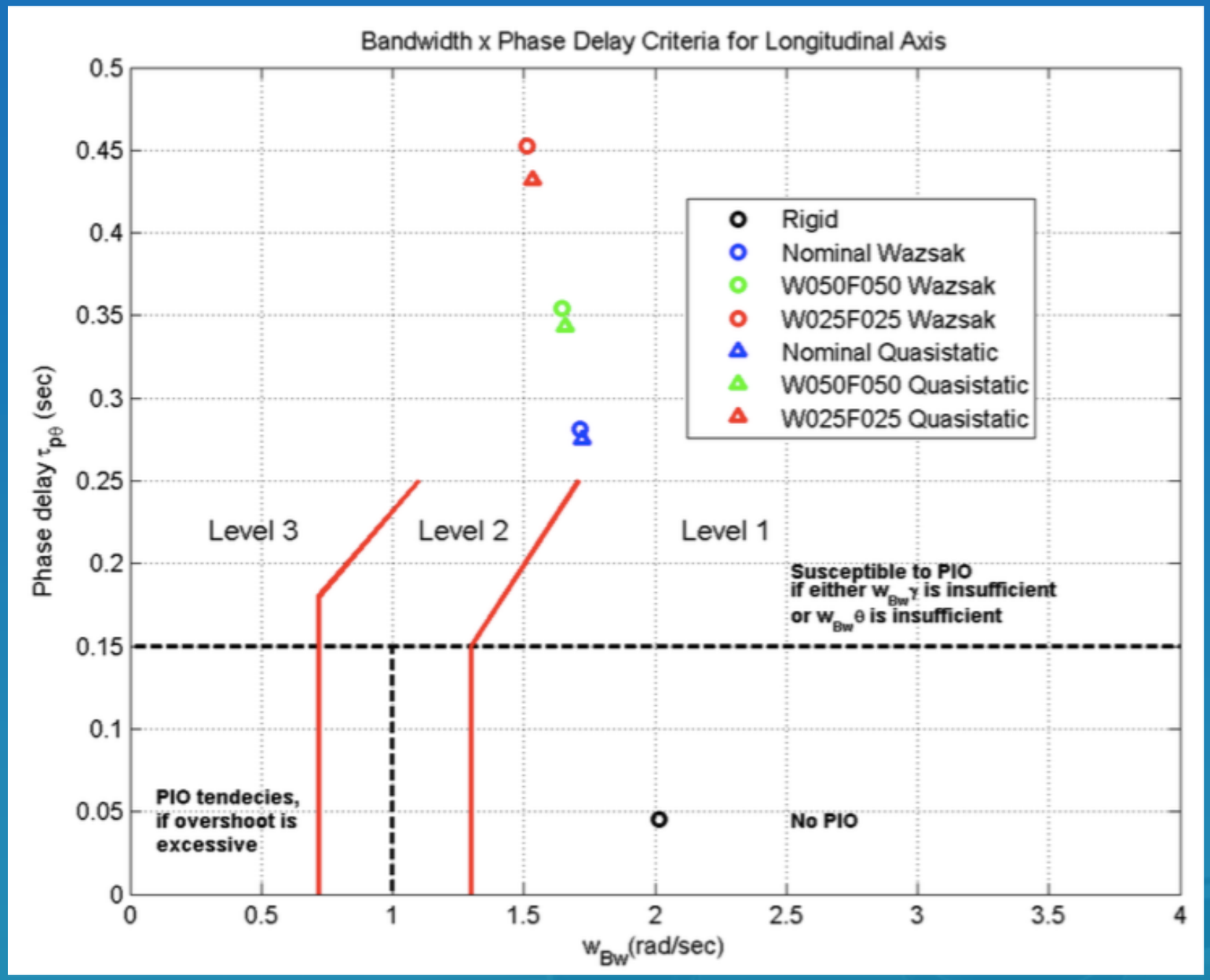




Silvestre et al, AIAA Aviation 2015

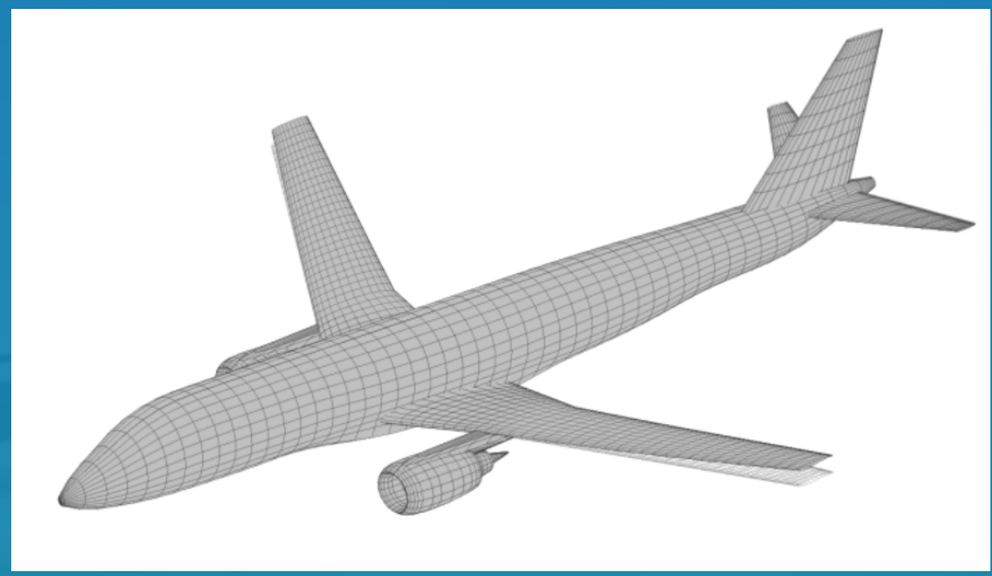
DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

FLYING QUALITIES AND PIO DUE TO AIRFRAME FLEXIBILITY



Drewiacki, Silvestre, Guimarães Neto & Silva, AIAA Journal 2016* (to be submitted)

Neto, PhD Thesis, 2014



DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

FLIGHT PHYSICS INOVA AERODEFESA

- validation of integrated models with different levels of complexity (moderately and highly flexible AC)
- coupling of AE and FM modes
- new techniques for control without notch filters —|| AE in the loop

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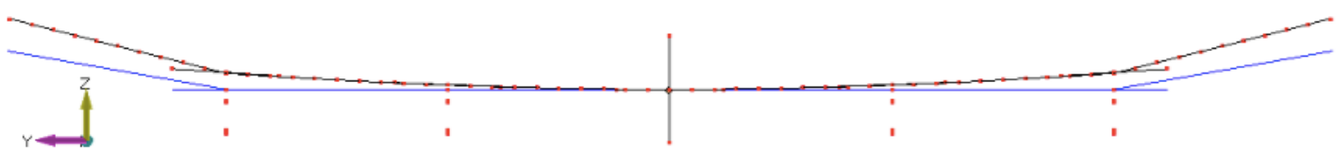
DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

FLIGHT PHYSICS INOVA AERODEFESA

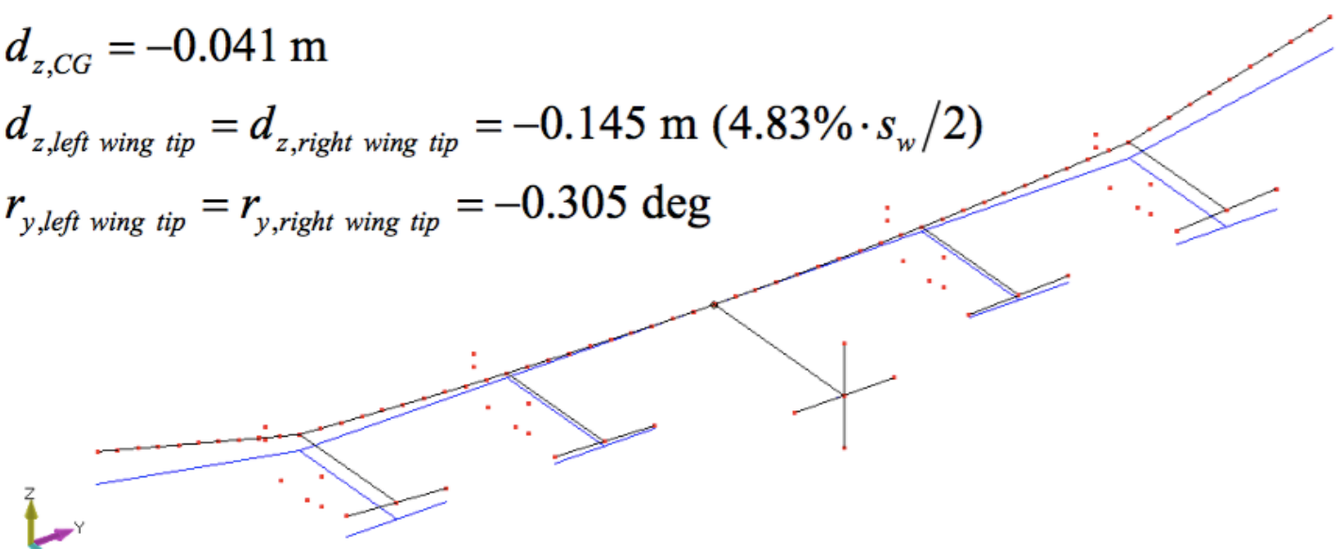
- project has started in 2015
- X-HALE is currently in construction
- Instrumentation & test pilot
- Ongoing studies on modelling, trimming and control

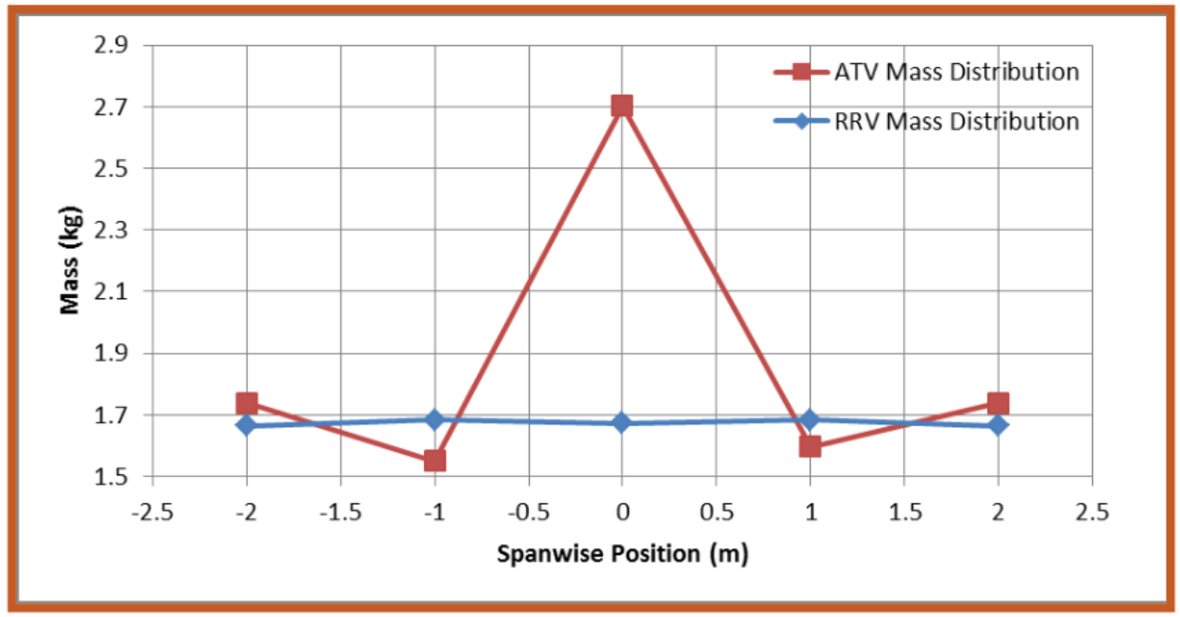


$$d_{z,CG} = -0.041 \text{ m}$$

$$d_{z,left\ wing\ tip} = d_{z,right\ wing\ tip} = -0.145 \text{ m } (4.83\% \cdot s_w/2)$$

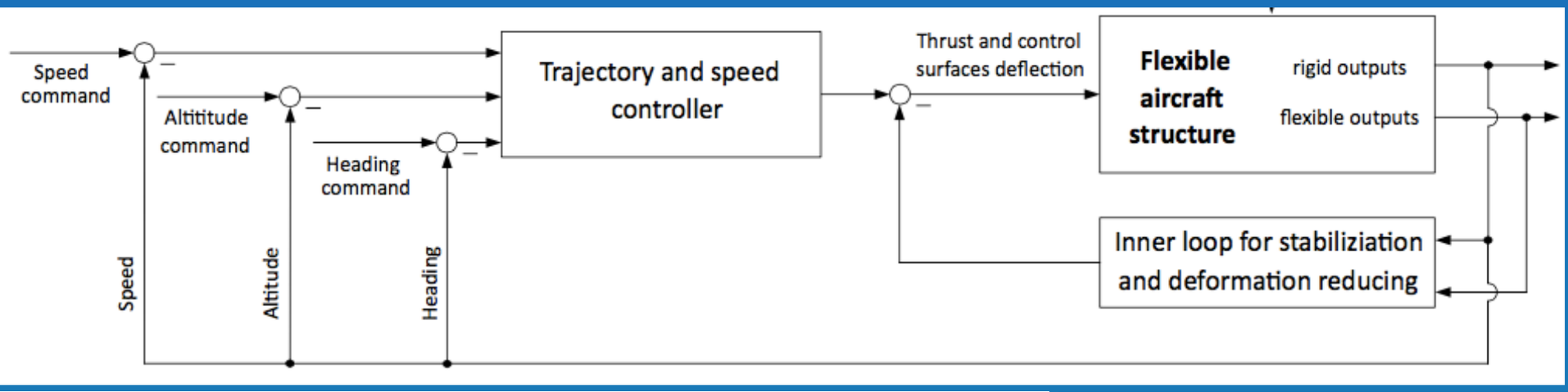
$$r_{y,left\ wing\ tip} = r_{y,right\ wing\ tip} = -0.305 \text{ deg}$$



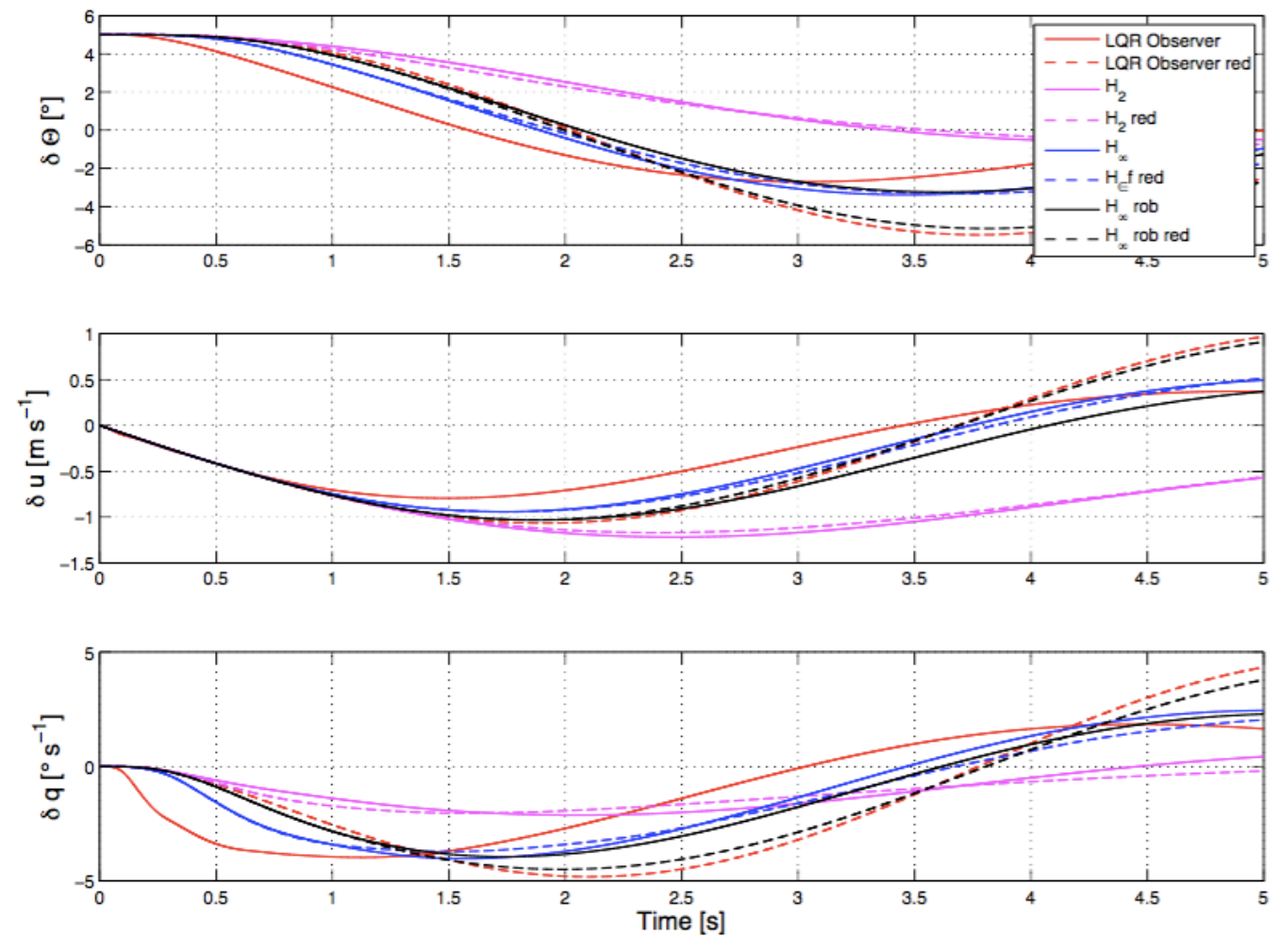


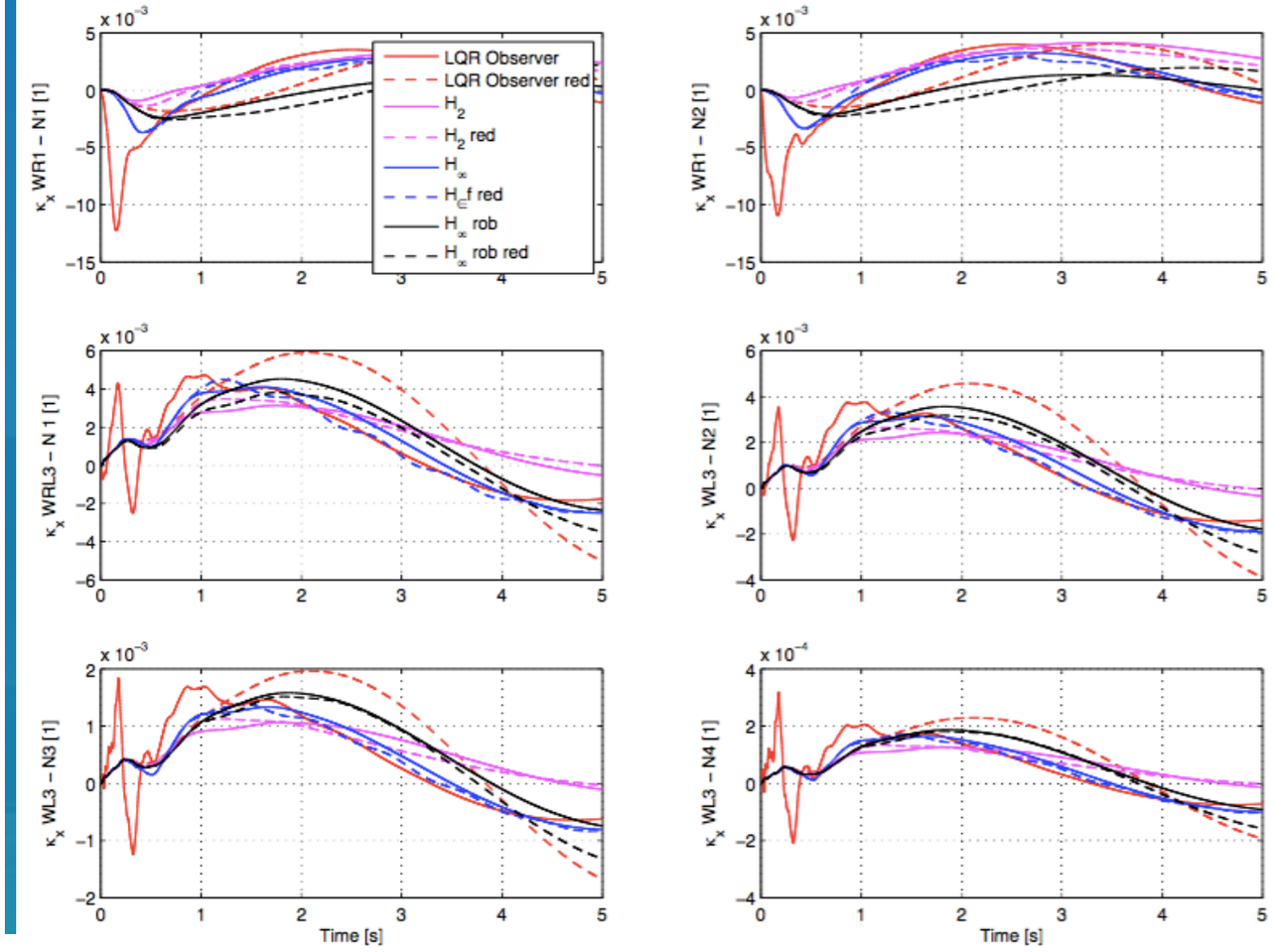
DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

FLIGHT PHYSICS INOVA AERODEFESA



Köthe et al., AIAA Journal 2015 (to be submitted)





DYNAMICS AND CONTROL OF FLEXIBLE AIRCRAFT

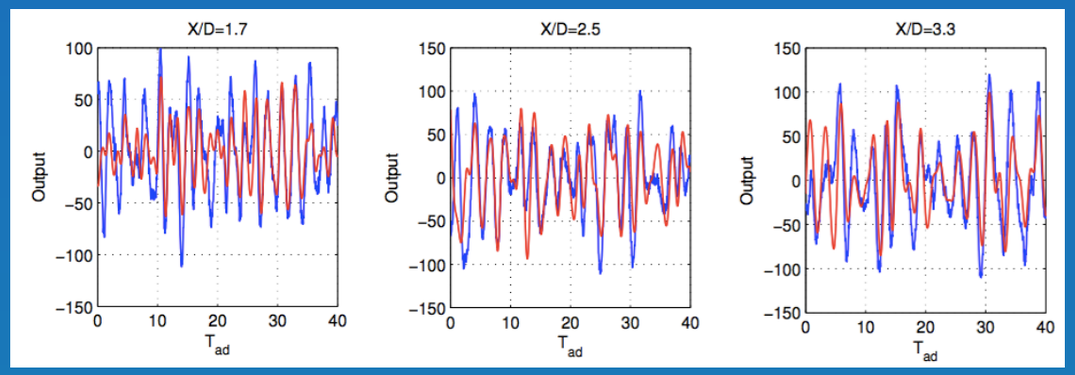
FLIGHT PHYSICS INOVA AERODEFESA

POSSIBLE PHD THEMES:

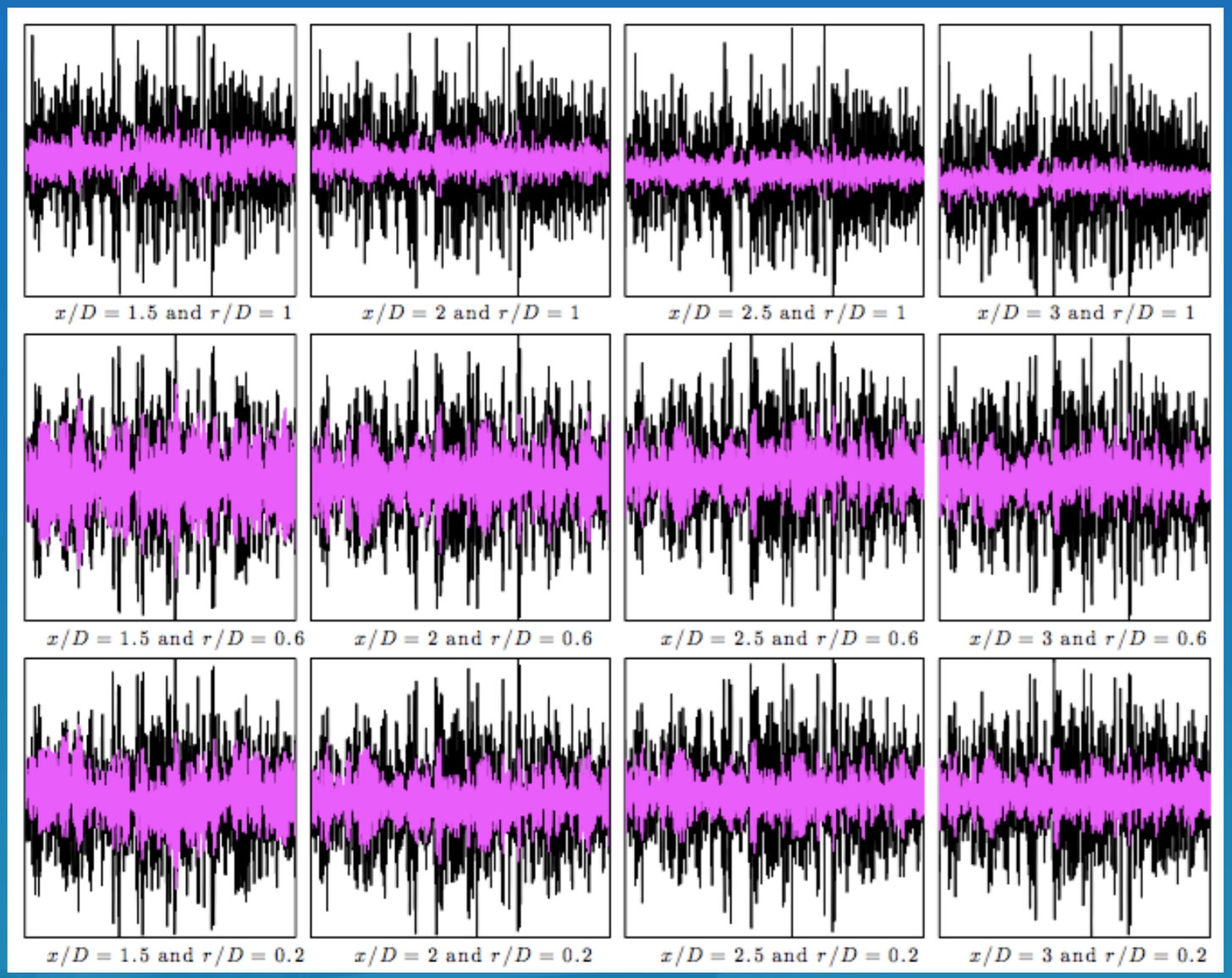
- Unsteady, Non-linear Aerodynamic Formulation for Aircraft Undergoing Large Airframe Deformations
- Non-linear Trajectory Control for Highly Flexible Aircraft
- Load Alleviation Control Law Design for Highly Flexible Aircraft
- Application of Intelligent Materials for Shape Control of Highly Flexible Aircraft

FLOW CONTROL

TURBULENT JETS USING TIME-DOMAIN TF'S



Kenzo et. al., AIAA Aviation 2015



Silvestre et. al., AIAA Aviation 2015

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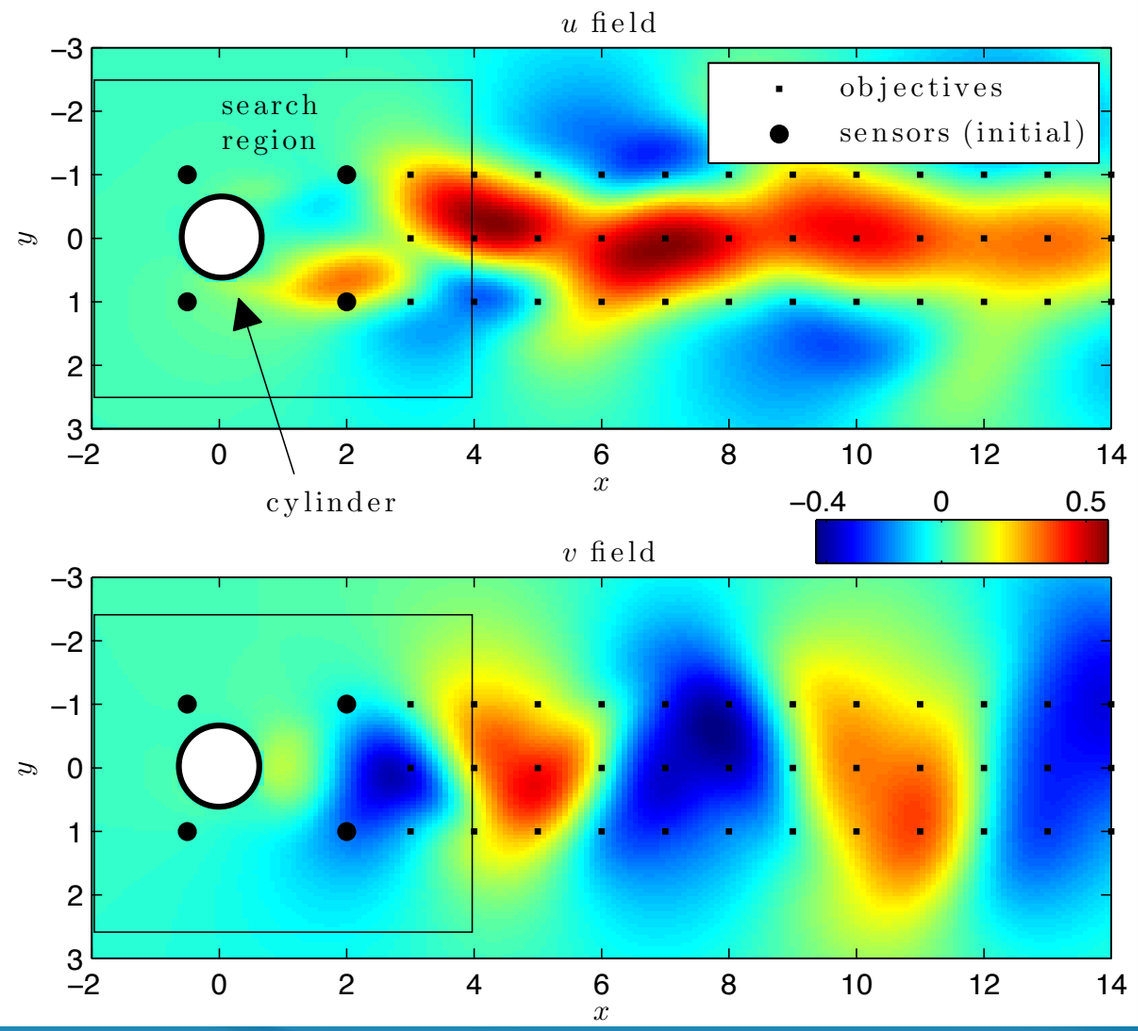
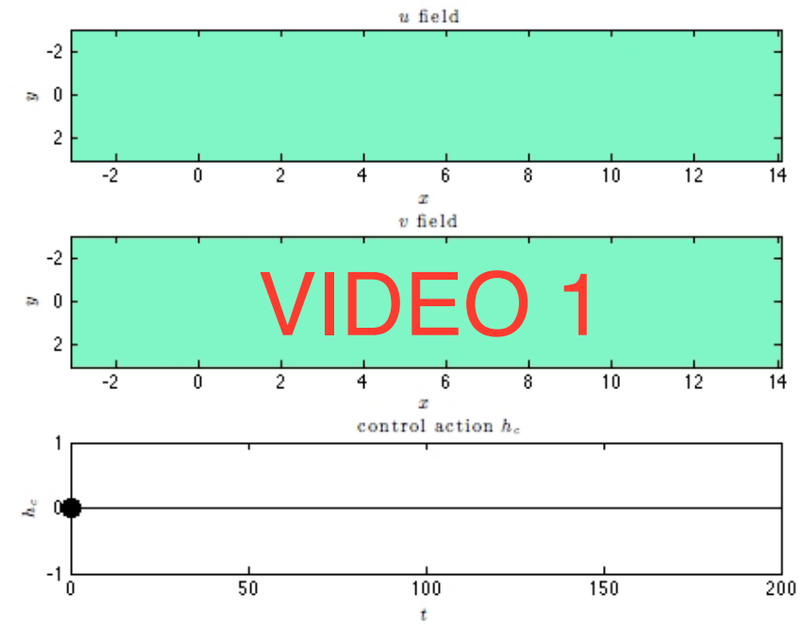
FLOW CONTROL

OUTPUT FEEDBACK BASED ON ROM & OPTIMAL SENSOR POSITIONING

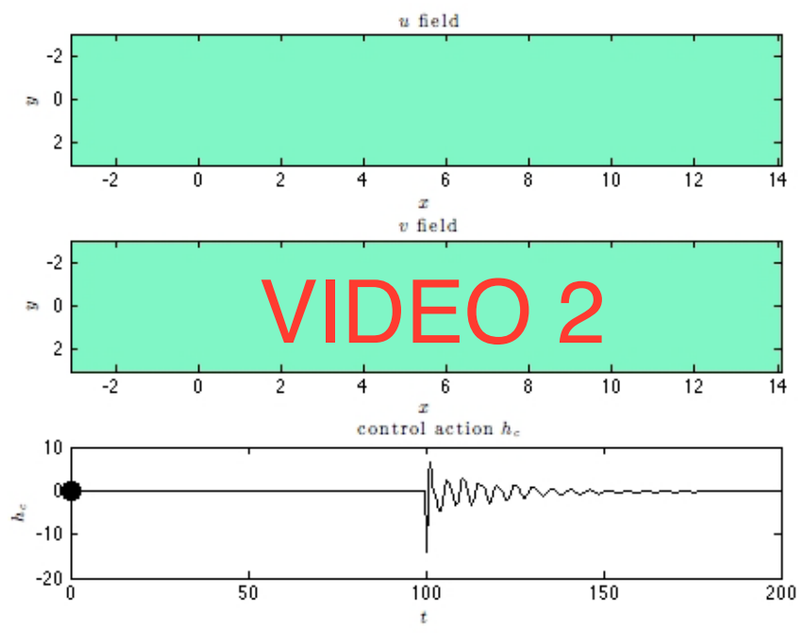


Silvestre, Tissot & Cavalieri 2015* (to be submitted)

OPEN-LOOP



CLOSED-LOOP



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FLOW CONTROL

POSSIBLE PHD THEMES:

- Output-feedback, fixed-order flow control based on ROM representation

- Jet noise reduction using active control based on time-domain transfer functions

INTERESTED? PLEASE CONTACT:

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