

# AN AIRCRAFT MODEL FOR COMPUTATIONAL SIMULATION

XIV Air Transportation Symposium (SITRAER 2015)

Daniel Baraldi Sesso

Rafael Yudi Imai

Lucio Flavio Vismari

João Batista Camargo Junior

## Safety Analysis Group (GAS)

Computer and Digital Systems Engineering Department (PCS)

School of Engineering (Escola Politécnica - Poli)

University of São Paulo (USP)

São Paulo, Brazil

# Outline

- Safety Analysis Group
- Objectives
- Introduction (Context)
- Aircraft Modelling
  - Why BADA?
  - Why LabVIEW?
- Implementation
- Test scenarios and procedures
- Results
- Final Remarks

# Safety Analysis Group



a Research Group at “Computer and Digital Systems Engineering Department” (PCS) in the School of Engineering at USP (Poli-USP).

**Academic Research and Consultancy Projects**  
related to Computer-based Dependable-Critical Systems  
(mainly Safety, Reliability and Availability)

Our main research topics:

**Safety and Risk Analysis Methodologies**

**Certification to Safety**

**Fault Tolerance (Software Quality aspects included)**

**Safe Software**

**Redundancy Techniques (HW/SW)**

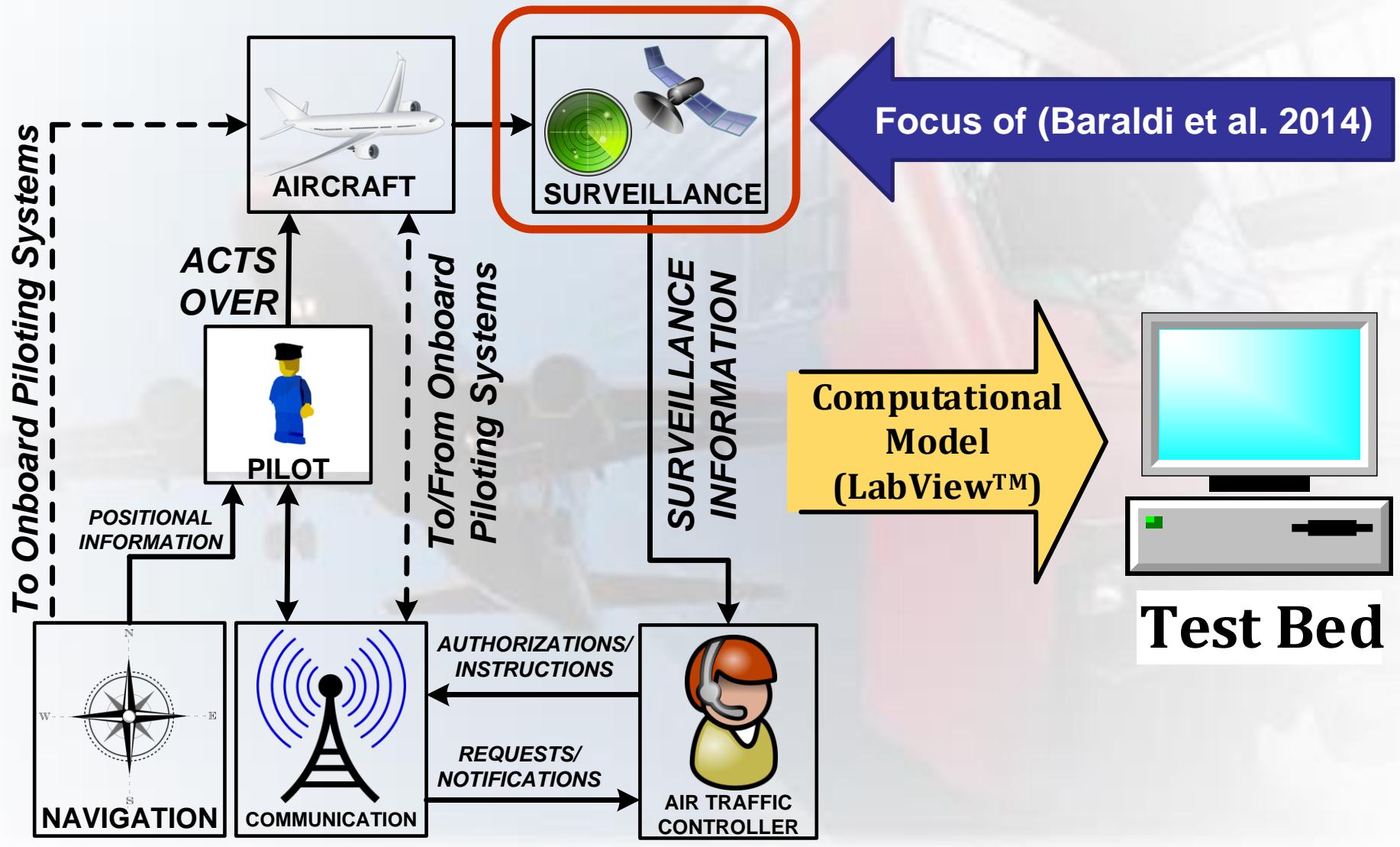
**Human Reliability/Usability**

# Objectives

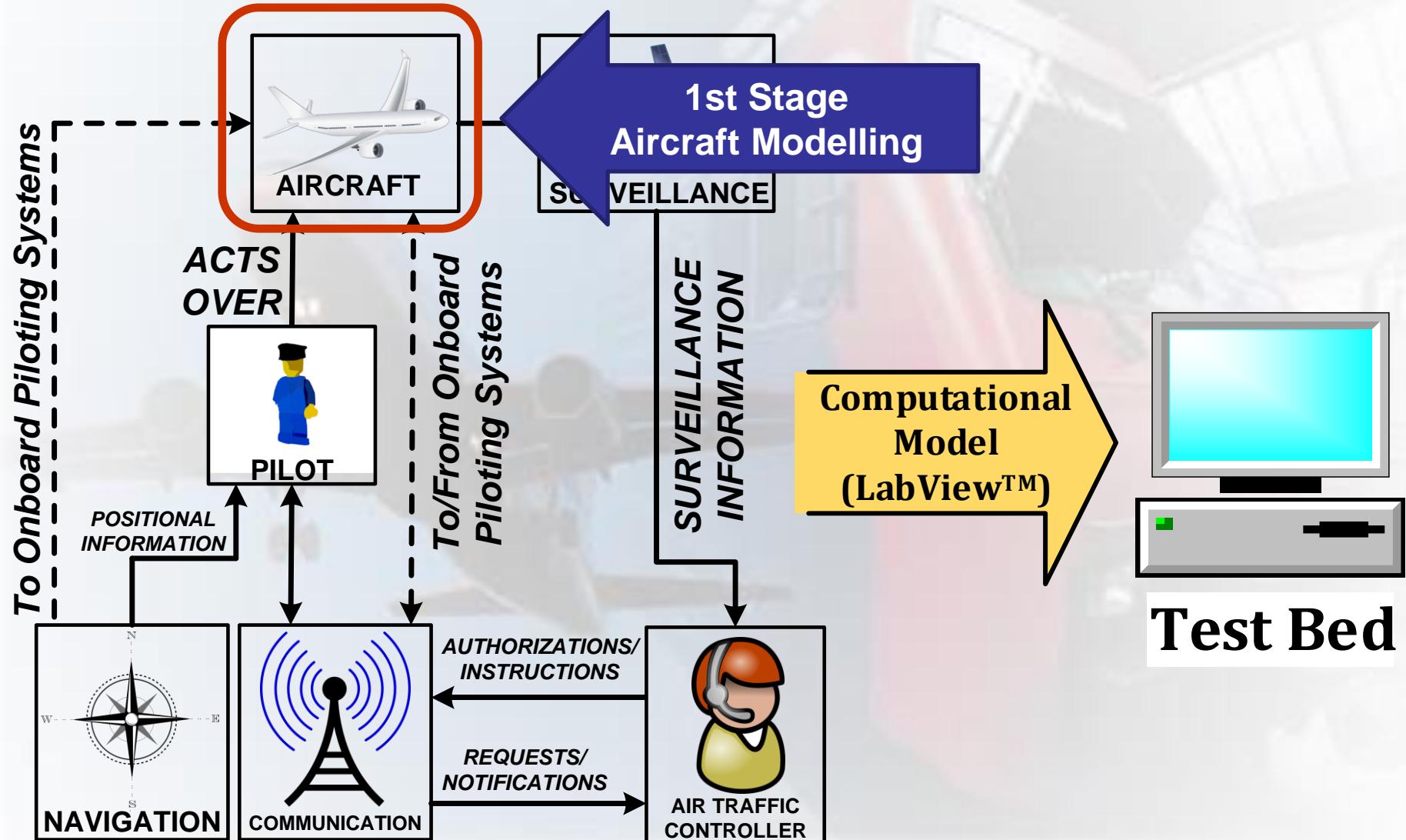
**To model an aircraft within the ATC model  
for computer simulation**

**This modelling aims to support the study  
previously proposed in Baraldi Sesso et. al,  
(2014)**

# Introduction (Context)



# Introduction (Context)



# Aircraft Modelling

- Aircraft described as a point with mass and energy
- Displacement based in a set of equations obtained by Glover and Lygeros (2004)
  - Calculates aircraft motion
- Aircraft dynamics' calculations (forces involved) based on BADA standards (Eurocontrol, 2009)

# Why BADA?



- Able to simulate many of the most common commercial aircraft (Airbus A320)
- Provide resources for different flight phases
- Already used on ATM studies
- Access to documents and specification provided free of charge

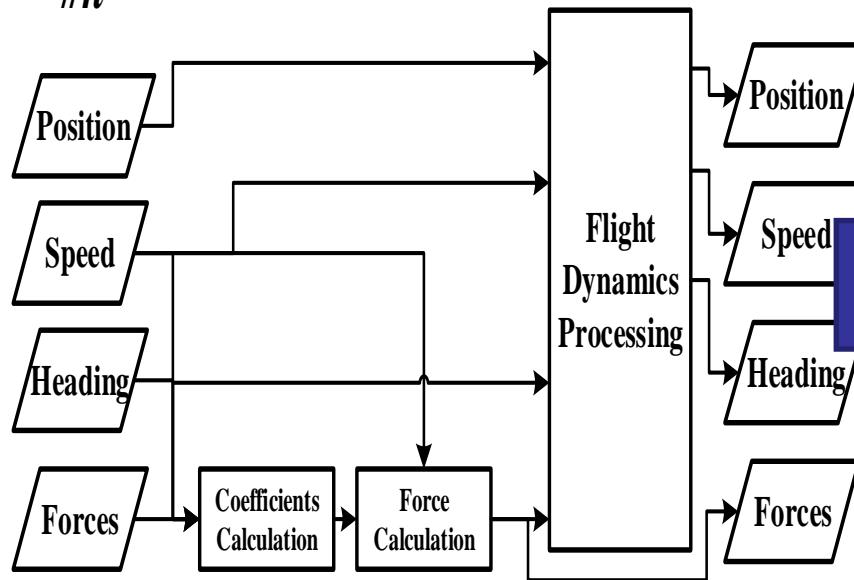
# Why LabVIEW?



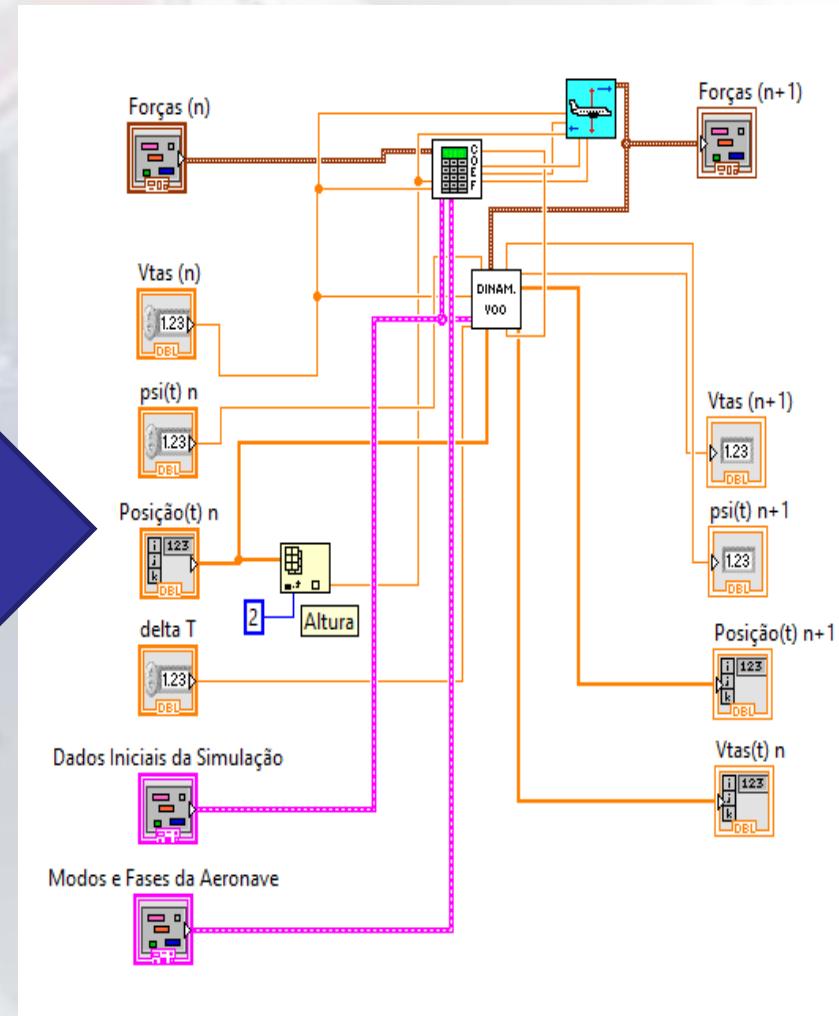
- Graphical language
- Simpler programming
  - Less effort and time
- Integration with other blocks of ATC model
- Integration with data acquisition tools
  - Hardware-in-the-loop simulation

# Implementation

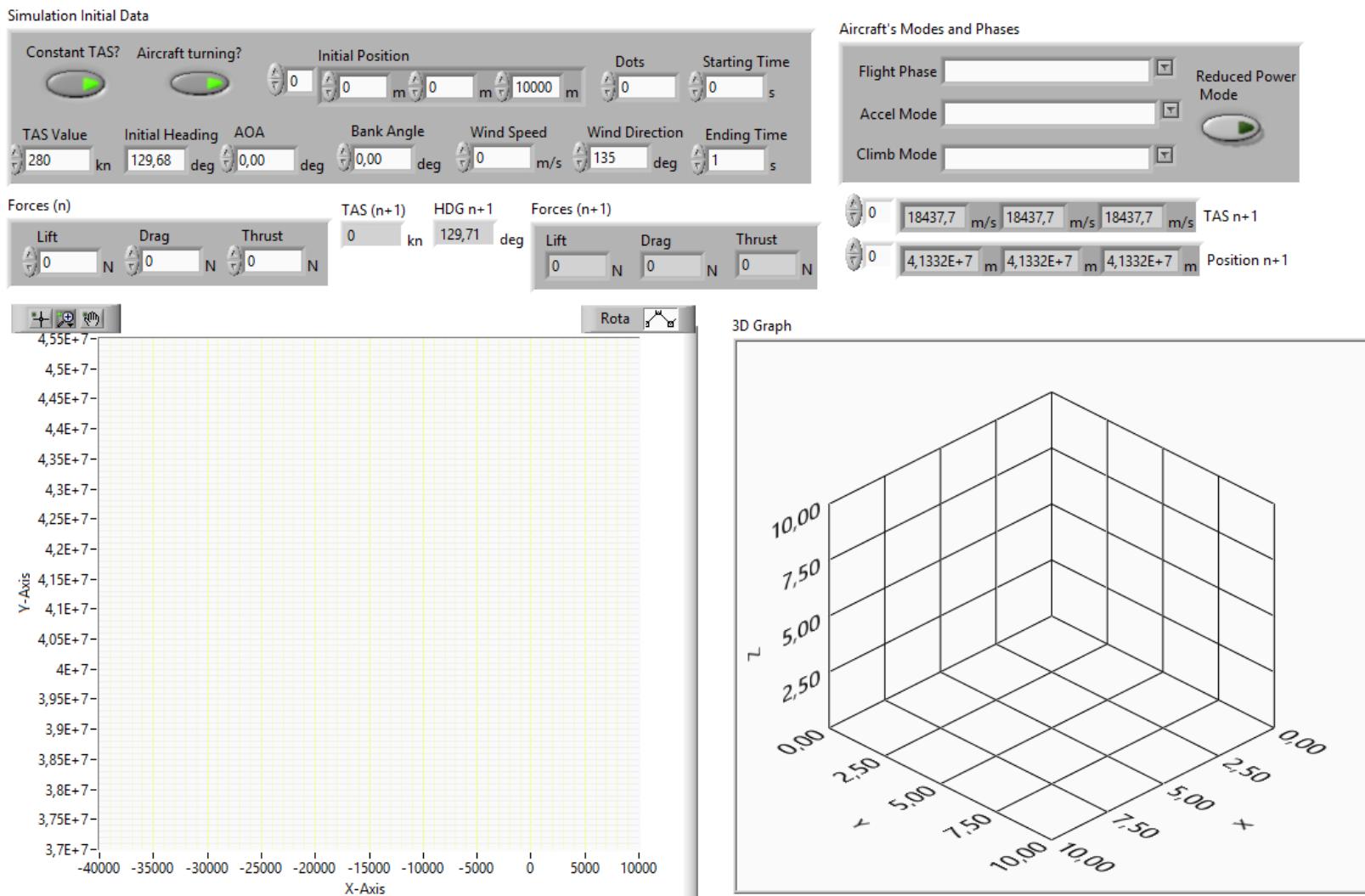
*Iteration*  
 $\#n$



*Iteration*  
 $\#(n+1)$



# Implementation



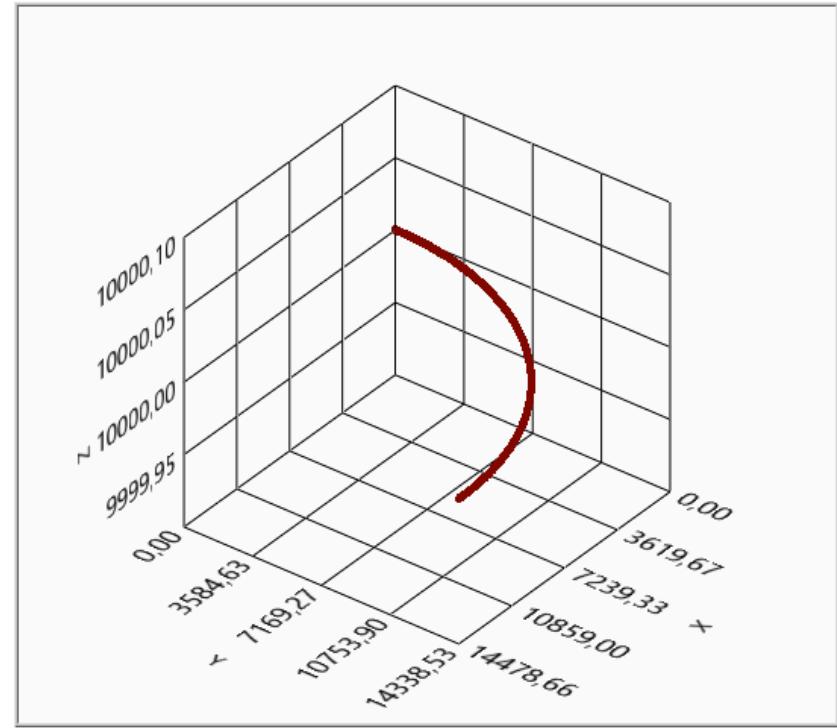
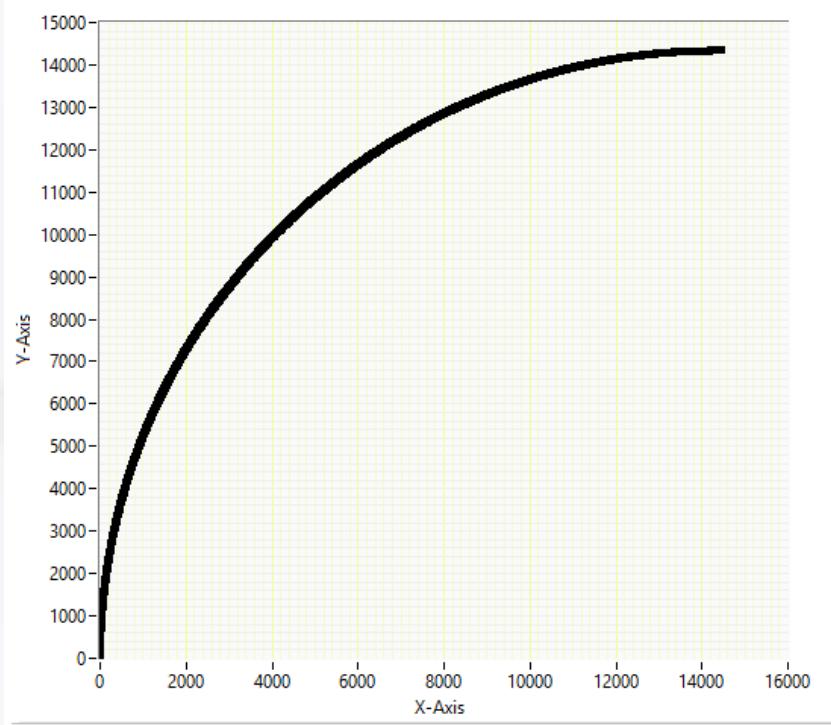
# Test Scenarios and Procedures

- Basic maneuvers
- Composed by common flight procedures
- Cruise-compatible altitude and speed
- Focused on proving the maneuverability of the model
- Minor adaptations were done in the last test to show the ability of the aircraft to follow a route

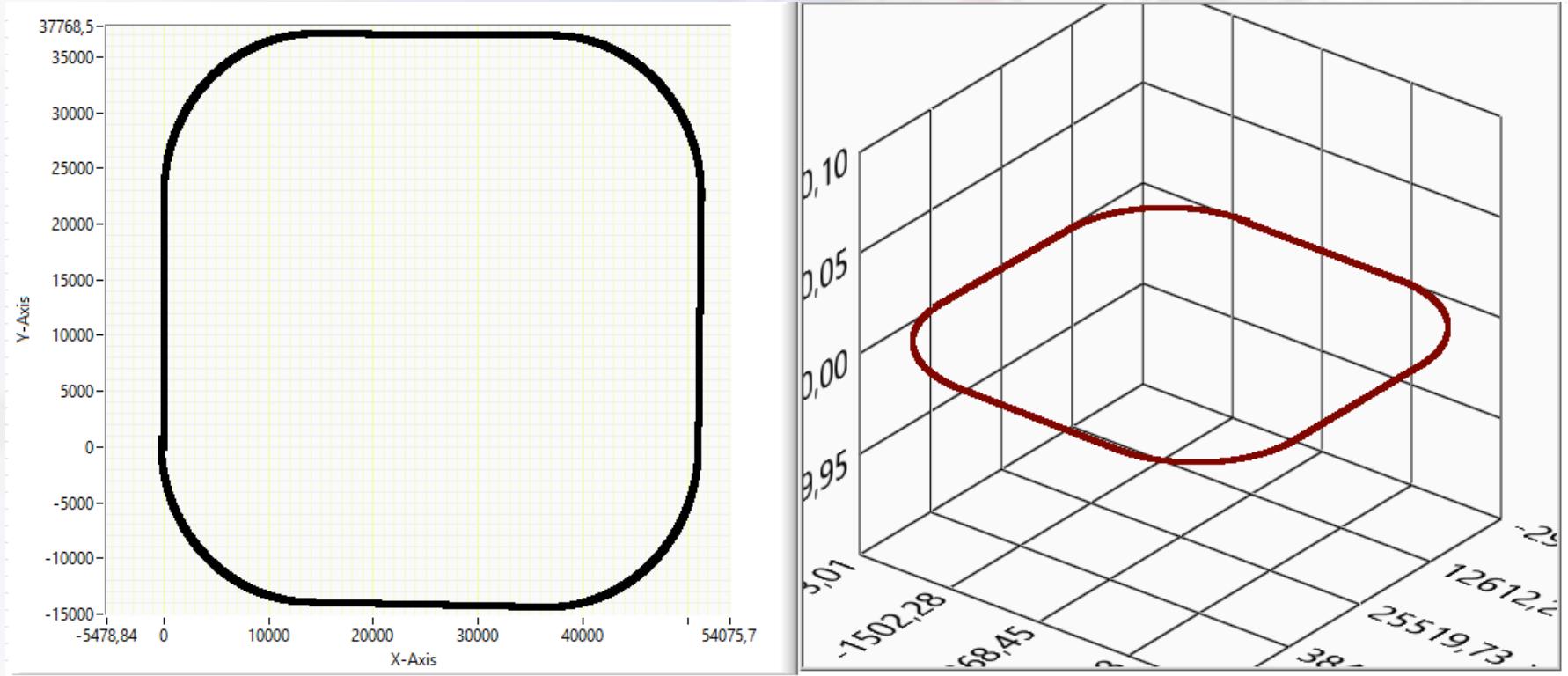
# Test Scenarios and Procedures

Condition	Value
Heading	0 deg
TAS	440 kt, ( $\approx$ 814 km/h).
ISA Temp.	288.15 K (at the sea level)
ISA Atmospheric Pressure	101,325 Pa
ISA Air Density	1.225 kg/m <sup>3</sup>
Wind Speed	0
AOA	0 deg
Coordinates	(0 ,0, 10000) m, unless otherwise stated.

# Test Result #1 – $\frac{1}{4}$ circumference turn, constant altitude



# Test Result #7 – Square route with rounded edges



# Final Remarks

- Aircraft model for computation simulation
- Aerodynamics of model based in a set of equations
  - Point with mass and energy
- BADA standards used for forces calculation
  - Thrust, drag and lift
- Use of LabVIEW as programming language
- Support researches involving computer simulation of an ATC model

# THANK YOU!

For further information, contact us or visit our website:  
<http://www.gas.pcs.poli.usp.br>

## Contact Info:

**Daniel Baraldi Sesso, M.Sc.Cand.**

**[daniel.baraldi@usp.br](mailto:daniel.baraldi@usp.br)**

Phone: +55 11 3091-0673

**Rafael Yudi Imai, UG**

**[rafael.imai@usp.br](mailto:rafael.imai@usp.br)**

Phone: +55 11 3091-0673

**Lucio Flavio Vismari, D.Sc.Cand**

**[lucio.vismari@usp.br](mailto:lucio.vismari@usp.br)**

Phone: +55 11 3091-5734

**João Batista Camargo Junior, D.Eng.Prof.**

**[joaocamargo@usp.br](mailto:joaocamargo@usp.br)**

Phone: +55 11 3091-5401