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# Effects of Unsteady Motion on Separation and Separation Control

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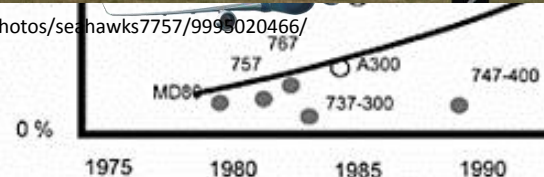
- Aviation industry moving toward composite materials
- Composite wing structures allow for higher aspect ratio, flexible wings



<https://www.flickr.com/photos/seahawks7757/9990020466/>



[https://en.wikipedia.org/wiki/Flow\\_separation#/media/File:1915ca\\_abger\\_fluegel\\_\(cropped\\_and\\_mirrored\).jpg](https://en.wikipedia.org/wiki/Flow_separation#/media/File:1915ca_abger_fluegel_(cropped_and_mirrored).jpg)



- Unmanned 1/5 Scale Aeromat AMT-200 Super Ximango



OpenLog  
Serial Data  
Logger

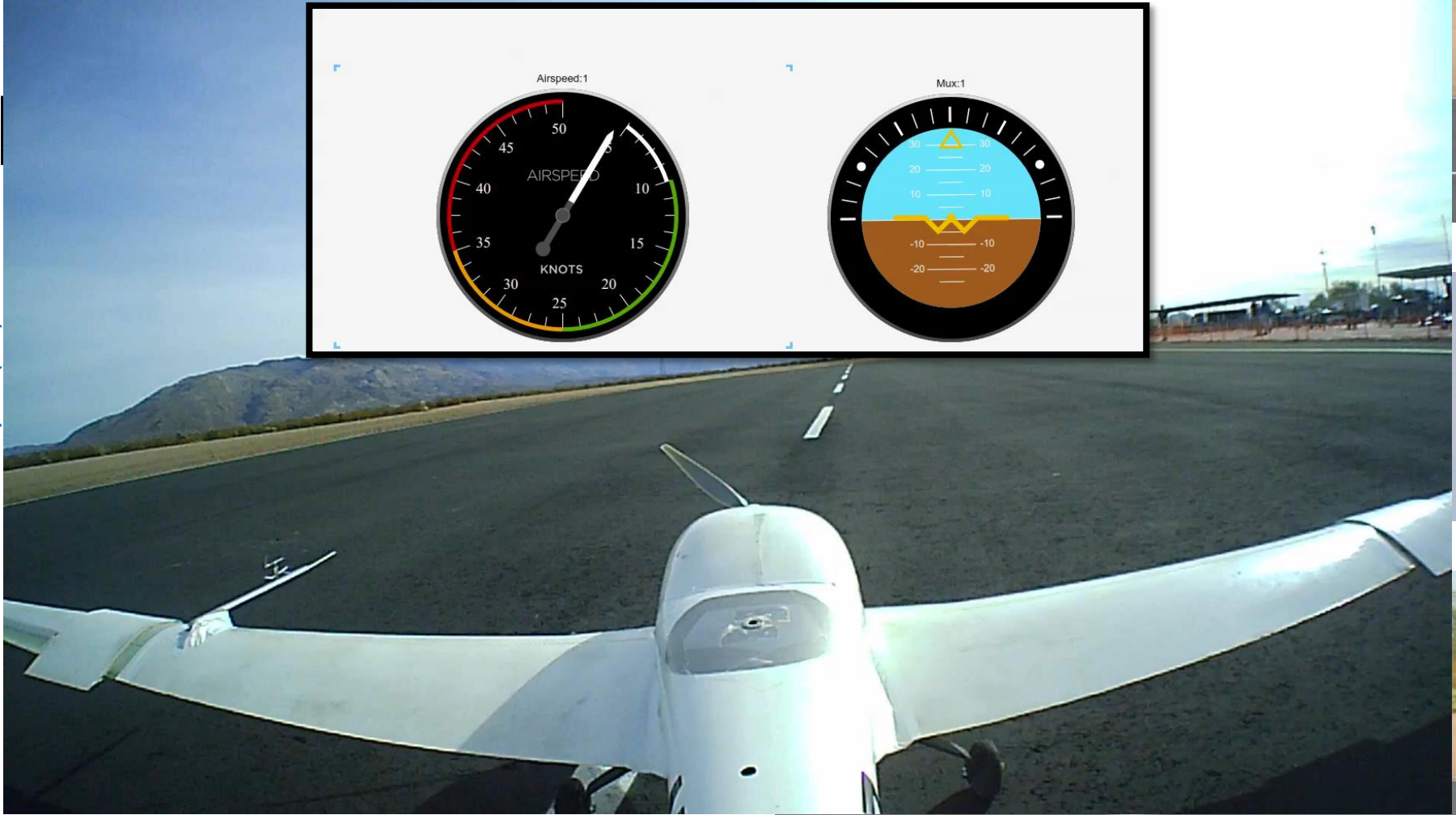


Adafruit  
MMA8451  
Accelerometer

- Initial flight test successfully completed November 12<sup>th</sup>, 2017

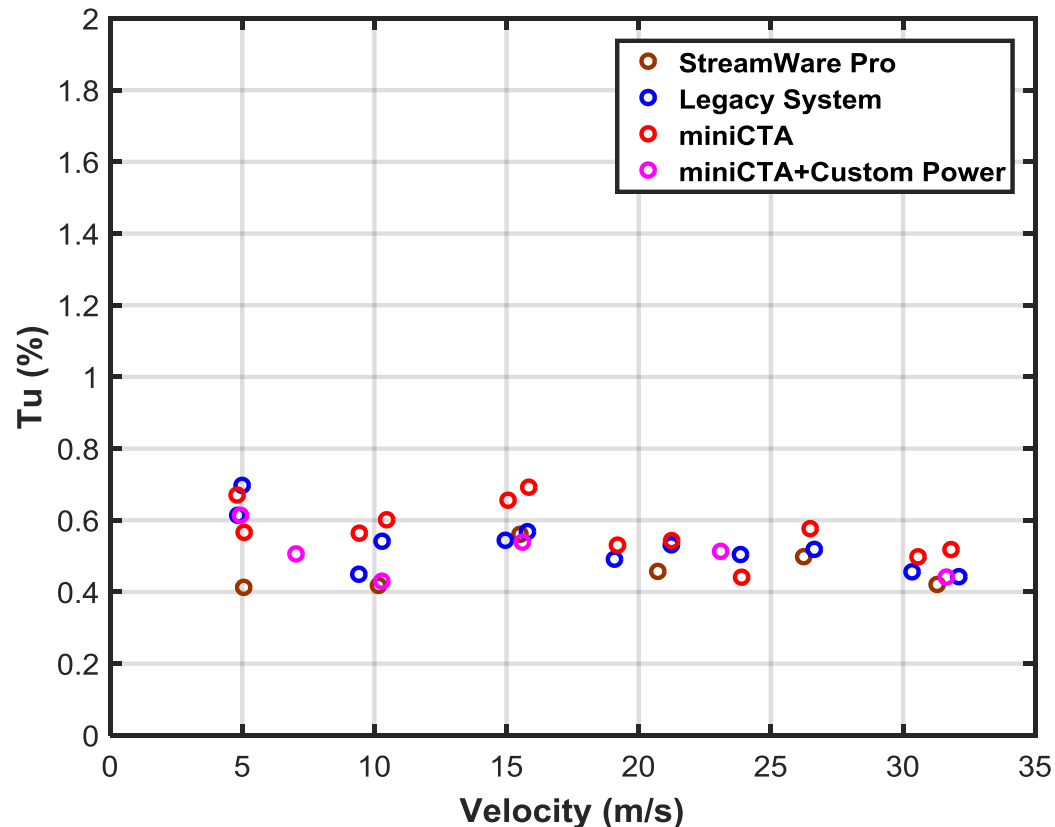


Airspeed (m/s)



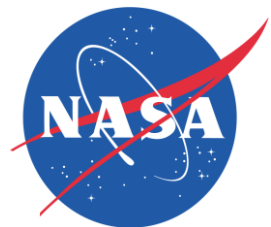


- Proposed System: Hot Wire Anemometry with MiniCTA and custom power
- Wind tunnel experiments conducted to validate system performance against accepted methods



- Baseline free flight test provided validated sensors
- Proposed system (MiniCTA) for capturing turbulence intensity in flight will provide accurate results
- Completion of initial tests allows for aircraft integration to capture freestream turbulence in flight

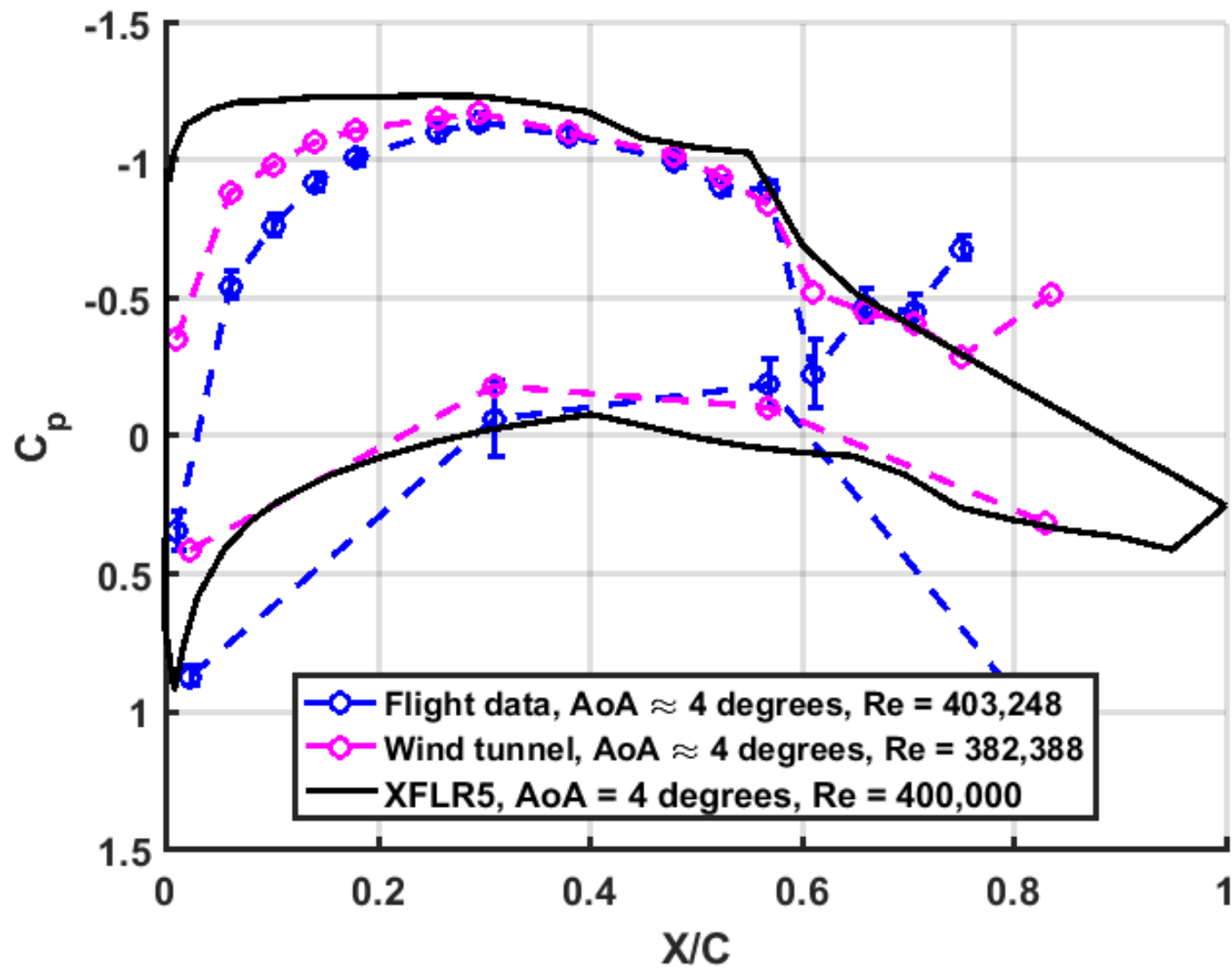
- U.S. Air Force Office of Scientific Research (FA9550-14-1-0184)
- Dr. Jesse Little
- Dr. Hermann F. Fasel
- Mark Agate, Doctoral Student
- The Department of Aerospace and Mechanical Engineering at the University of Arizona
- Arizona-NASA Space Grant Consortium

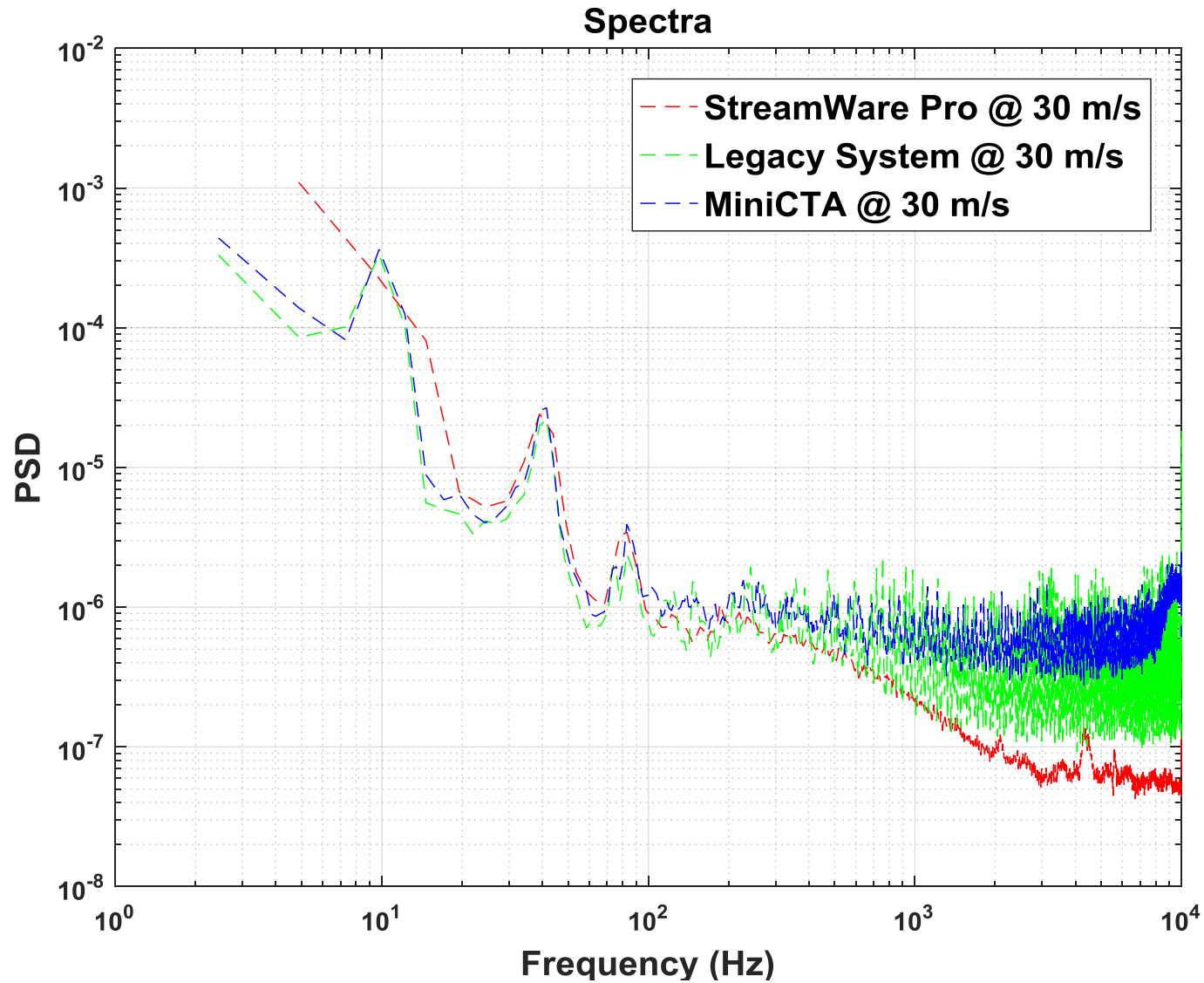






- [1] LockheedMartin, "X-56A - Lockheed Martin," 2015, 18 Dec. 2015.
- [2] Diancs, J., Ohno, Duncan., Fuggmann, S., Lay, Jonas., Heim, D., Fasel, H. (2014). "*Numerical and experimental Wind Tunnel and Flight Testing of Active Flow Control for Modified NACA 64<sub>3</sub>-618 Airfoil*". AIAA SciTech, Kissimmee, FL.
- Hosseinverdi, S. and Fasel, H.. "*Direct Numerical Simulations of Laminar-to-Turbulent Transition in Laminar Separation Bubbles in Three-Dimensional Boundary-Layer*", 46th AIAA Fluid Dynamics Conference, AIAA AVIATION Forum, (AIAA 2016-3793)
  - Mertens, C., Pineda, S., Agate, M., Little, J., Fasel, H., and Gross, A., "*Effects of Structural Motion on the Aerodynamics of the X-56A Airfoil*," AIAA SciTech, San Diego, California, USA, 2016. (AIAA 2016-2073).





Experiments & Theory  
 Simulations & Theory



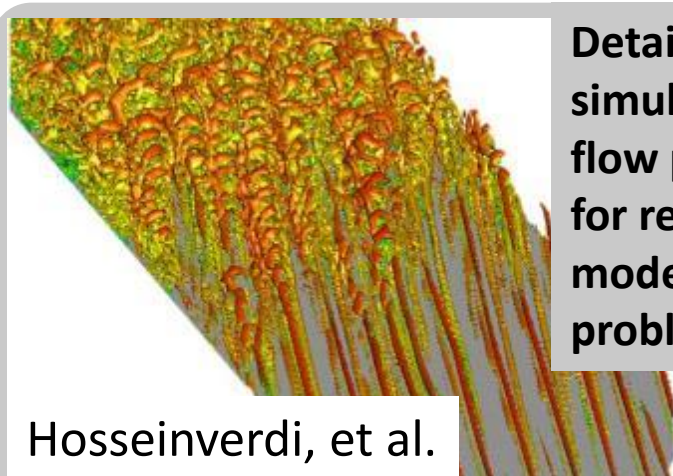
**Ximango 1/5 Scale**

Scientifically instrumented scaled flight experiments



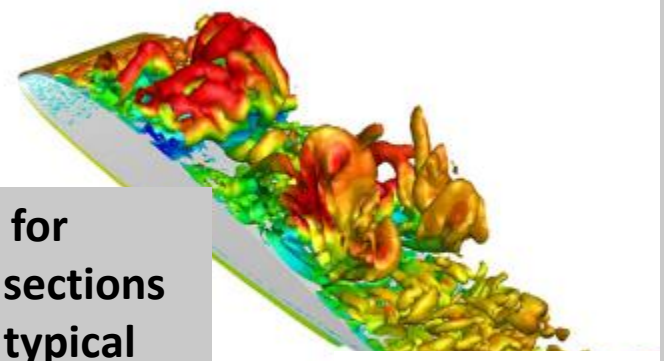
Wind tunnel experiments

- Modal decomposition (Fourier, POD, DMD)
- Linear Stability Theory, etc.



Detailed simulations of flow physics for relevant model problems

Hosseinverti, et al.



Simulations for entire wing sections undergoing typical structural motion

Gross, et al.