LRTA Control System Stiffness Measurement

By
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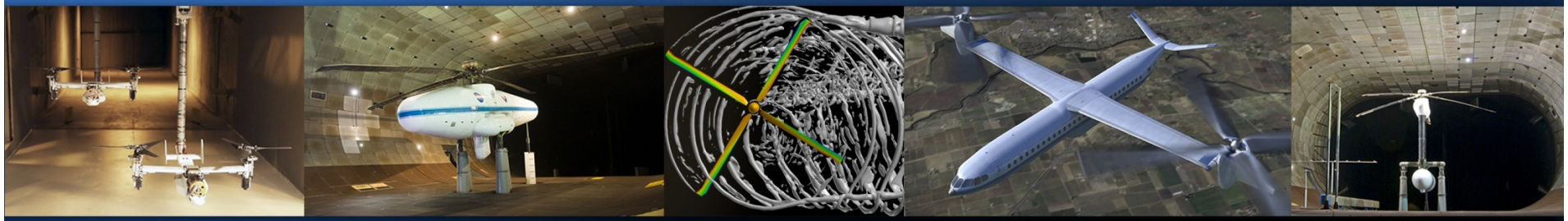
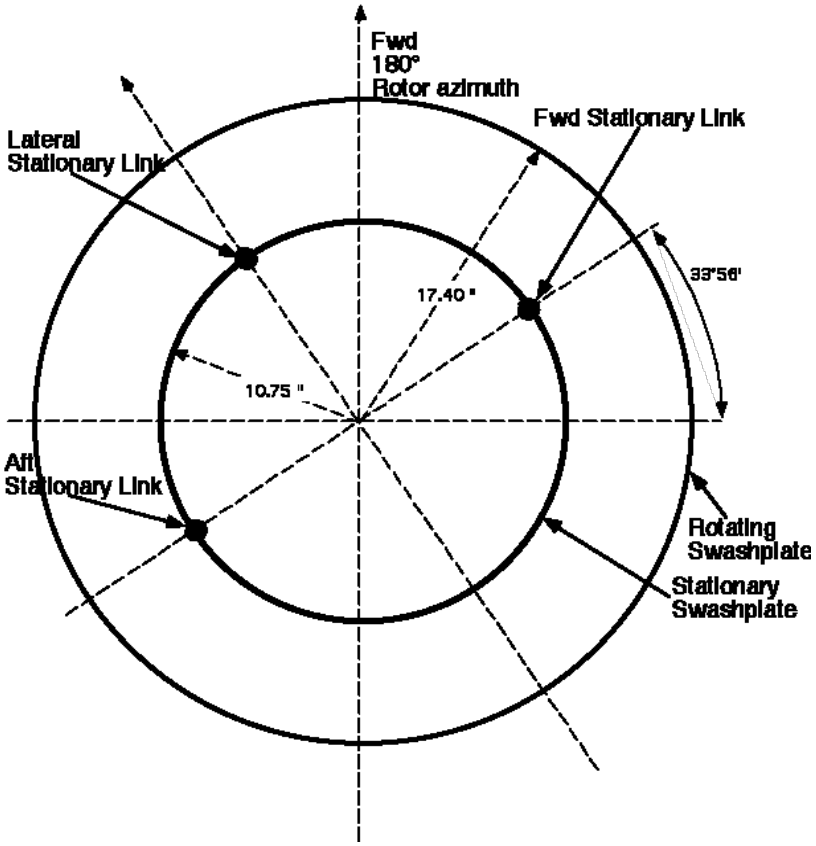


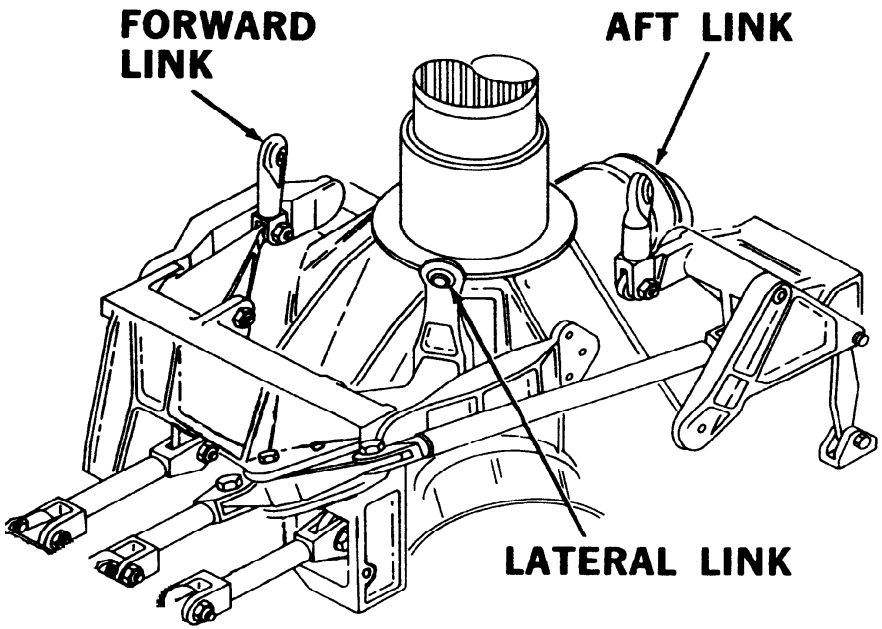
Outline

- Introduction
- UH-60 LRTA control system
- Experimental Setup/ Loading
- Sample Results
- Control System Stiffness
- Fixed System Calculations
- Conclusions

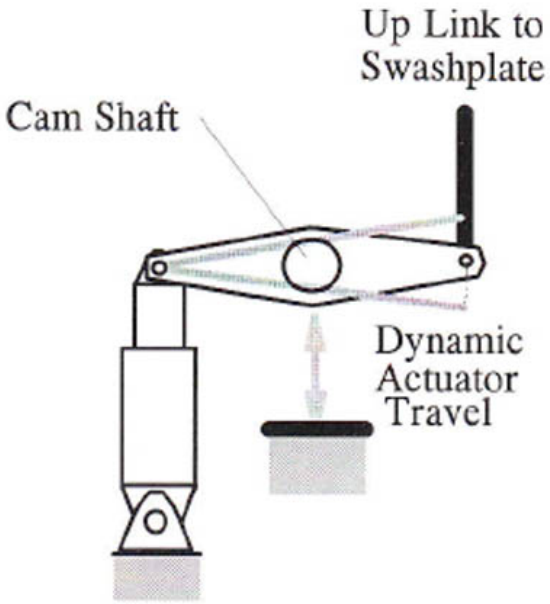
NFAC/LRTA/UH-60 Airloads Rotor

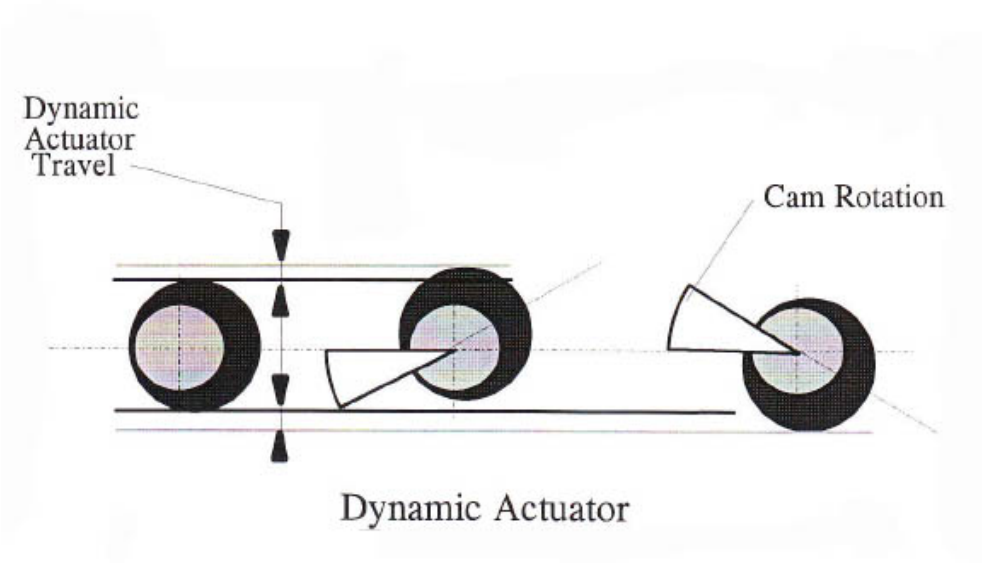
UH-60 Swashplate Schematic



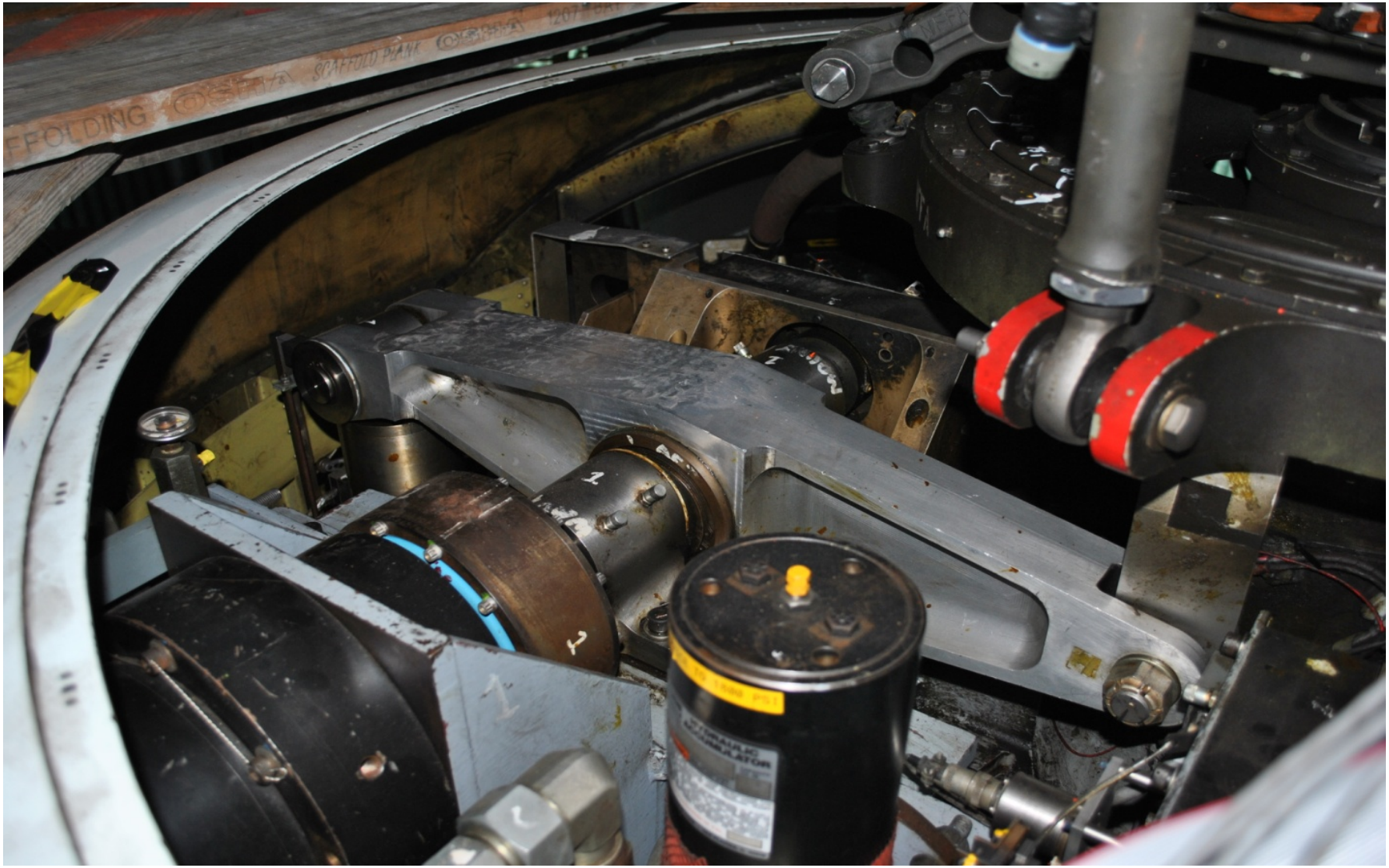


LRTA Stationary Actuators



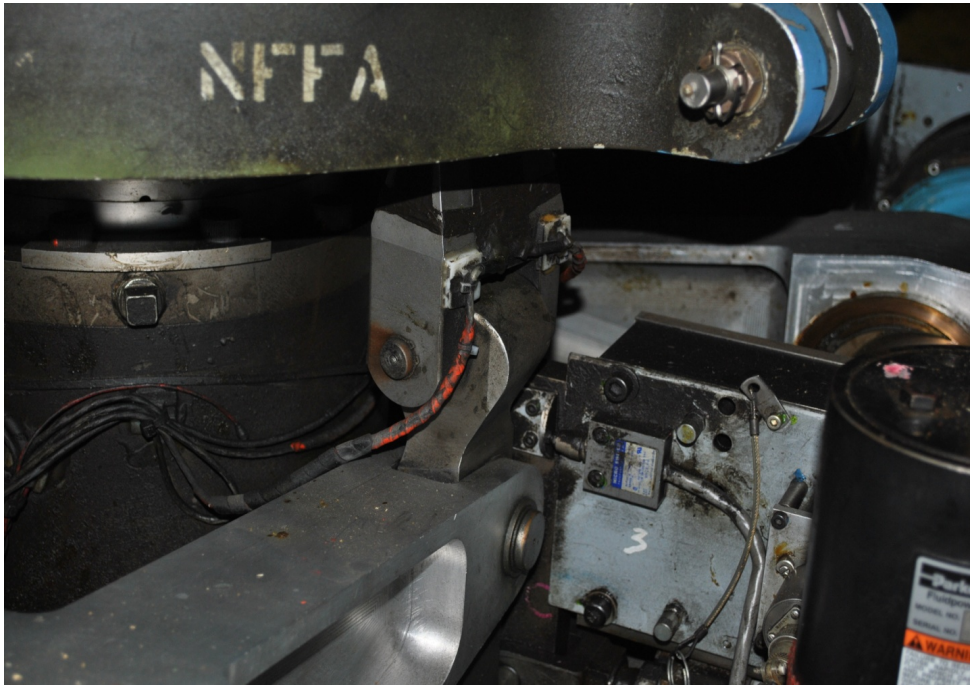


LRTA Actuator Photo



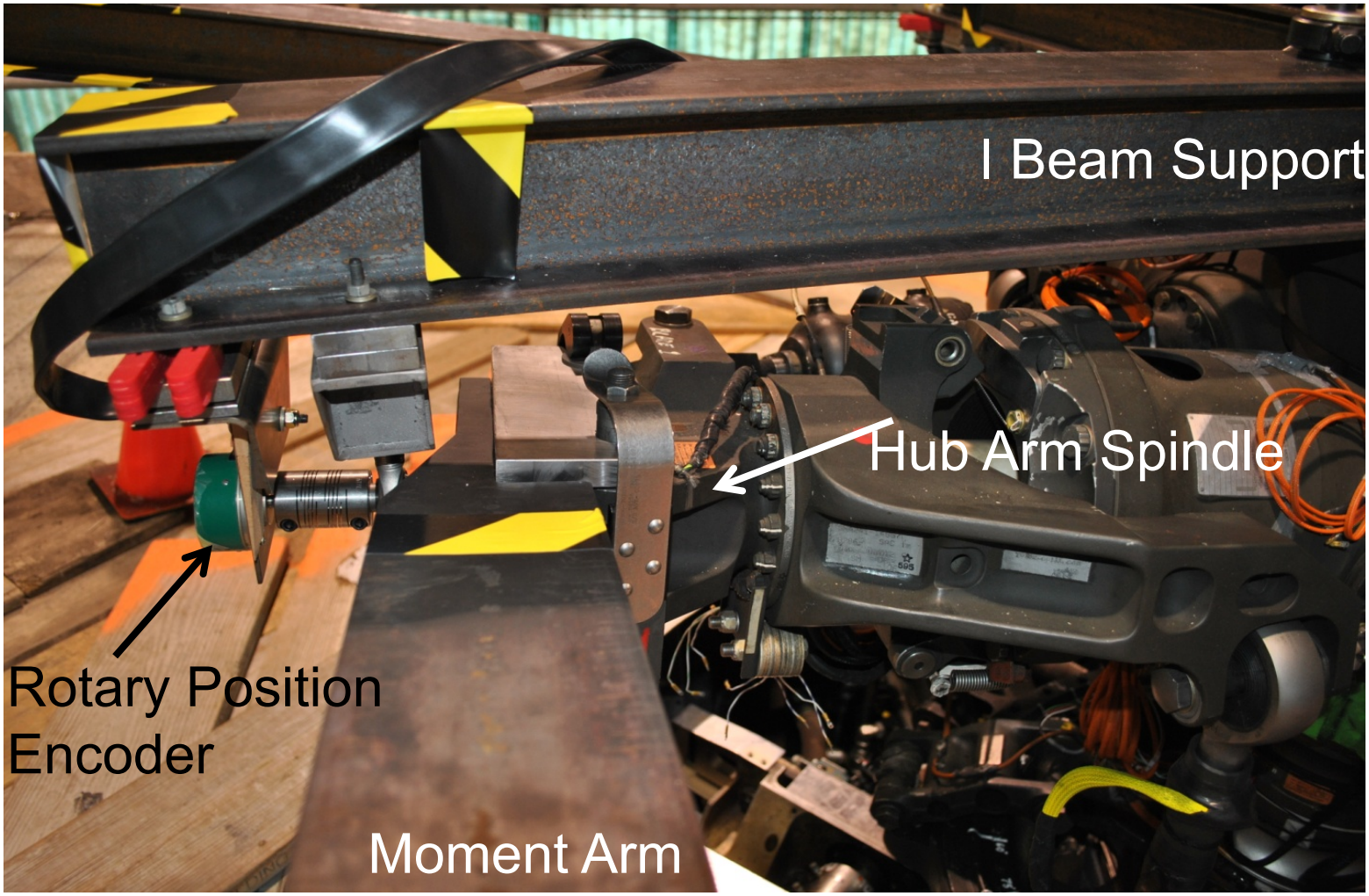
LRTA Stationary Links

Link 1



Link 2

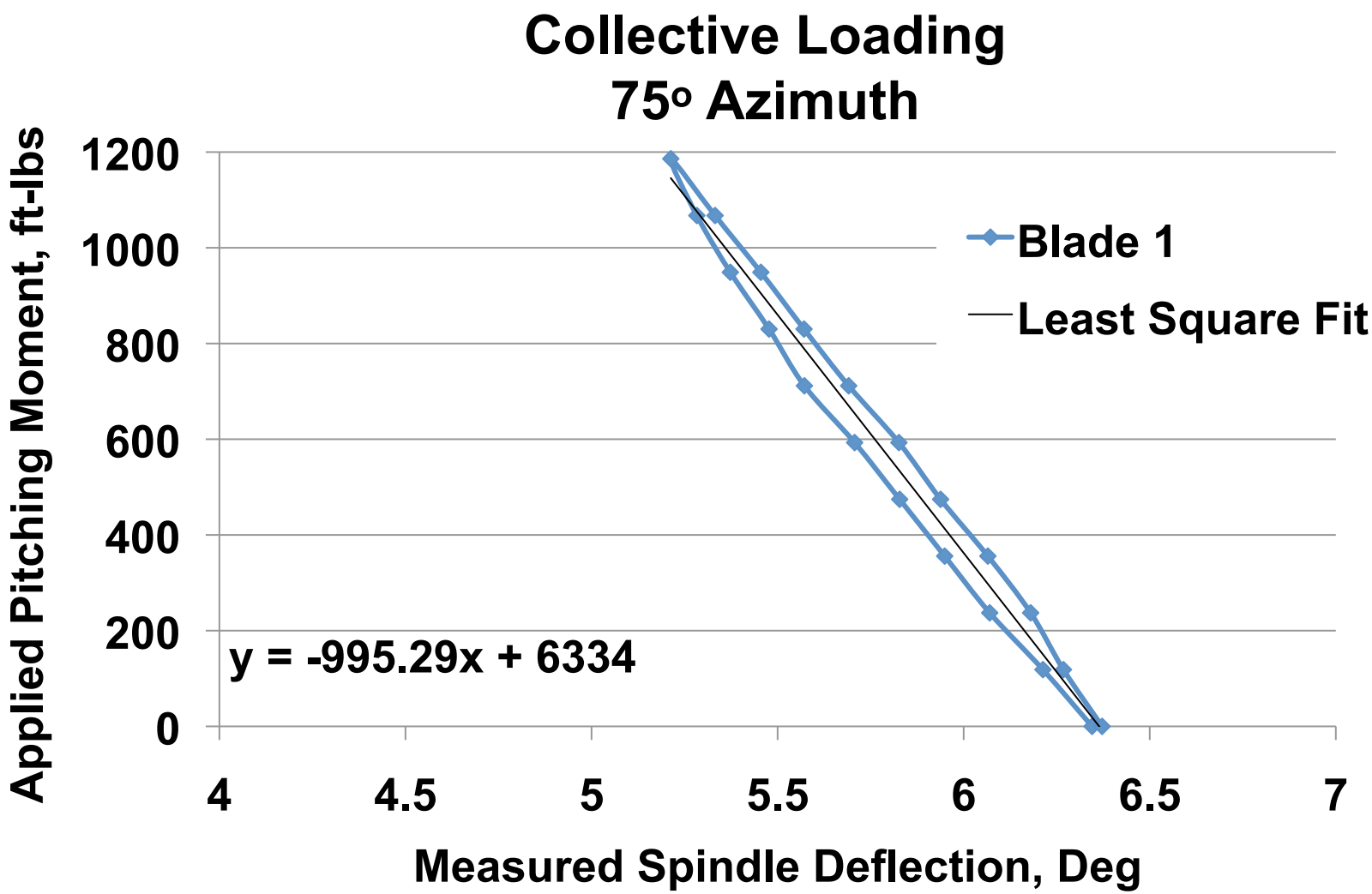
Test Setup


I Beam Support
Hub Arm Spindle
Rotary Position Encoder
Moment Arm

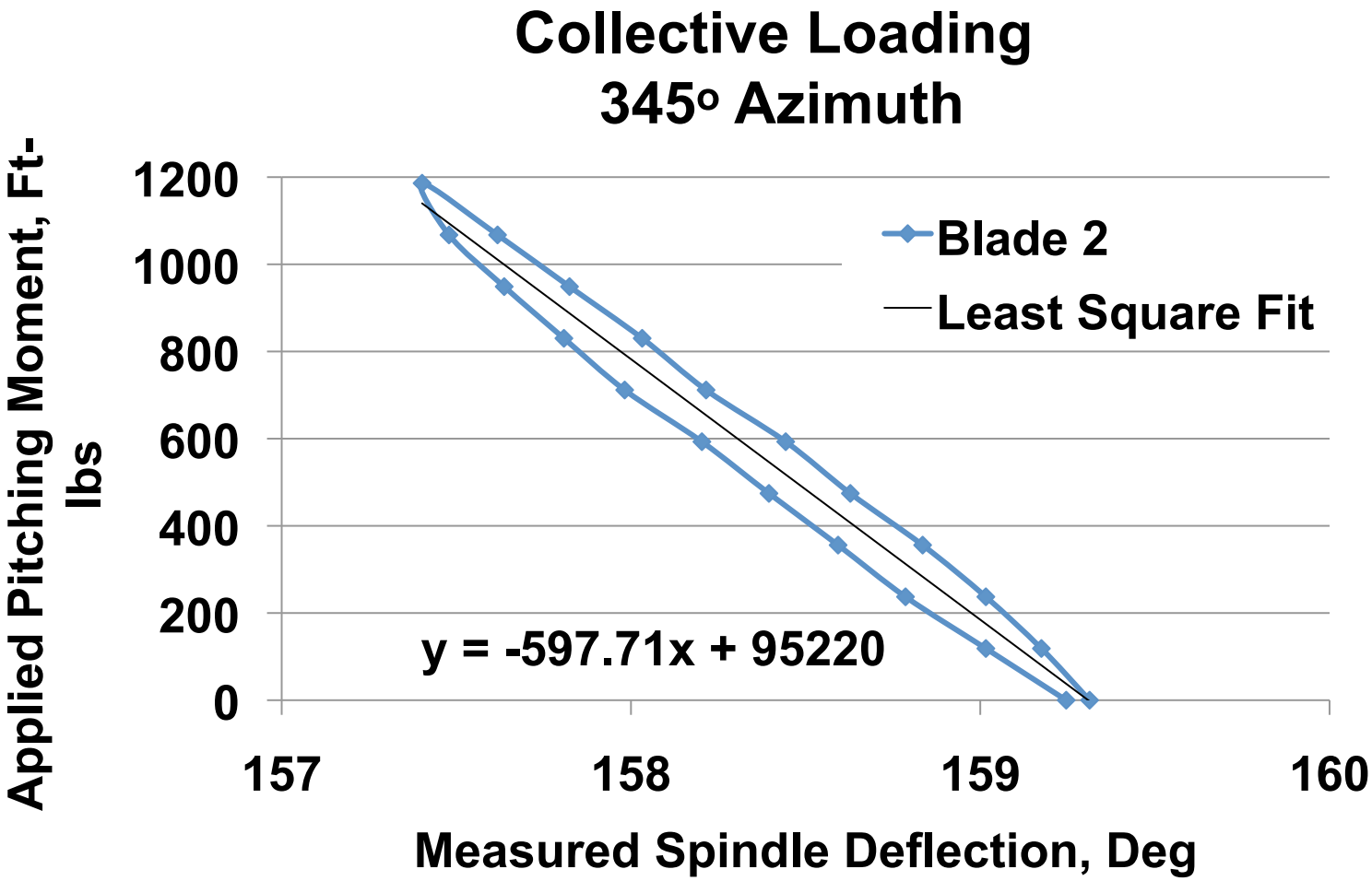
Collective Loading

Cyclic Loading

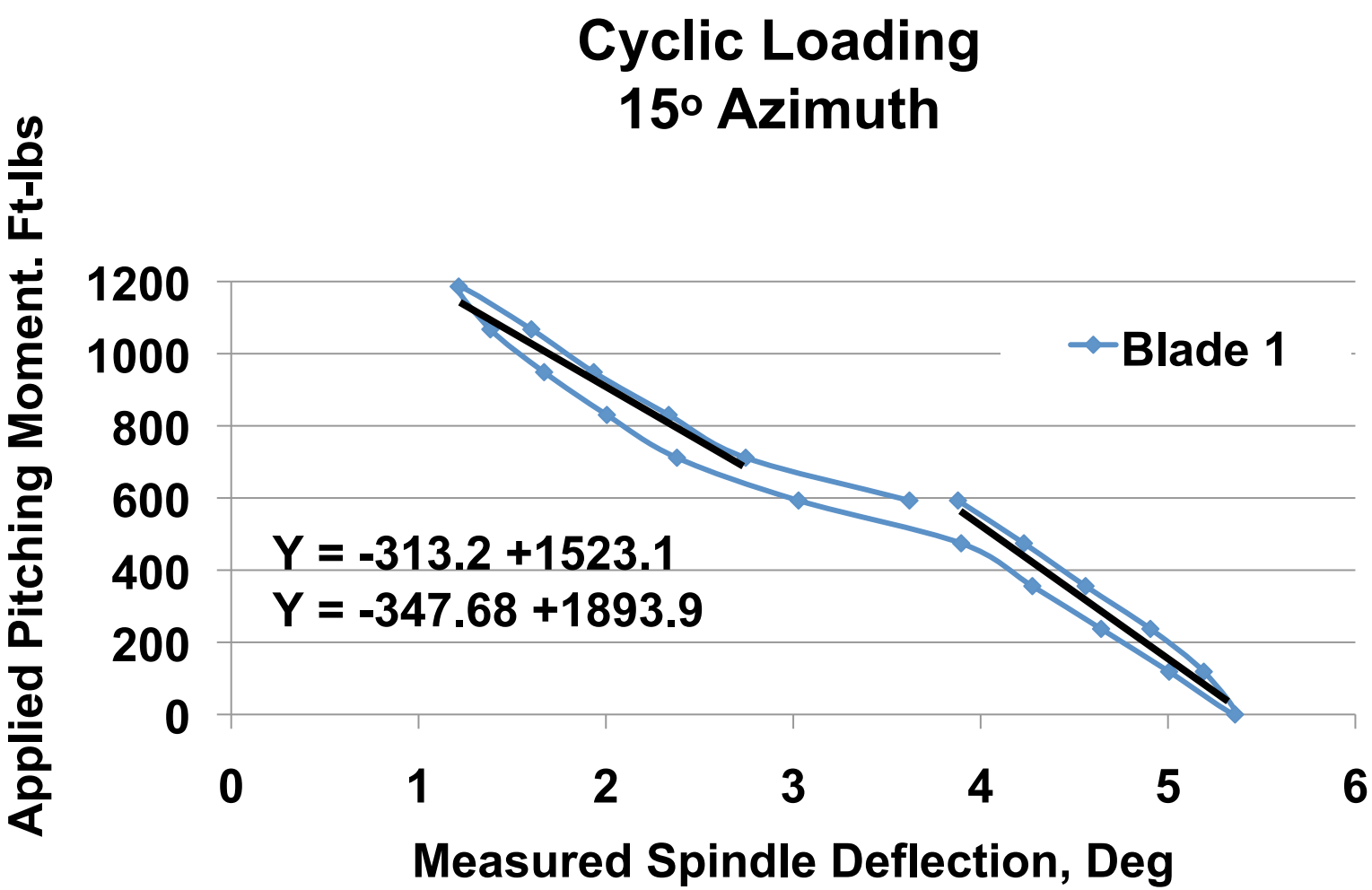
Sample Results



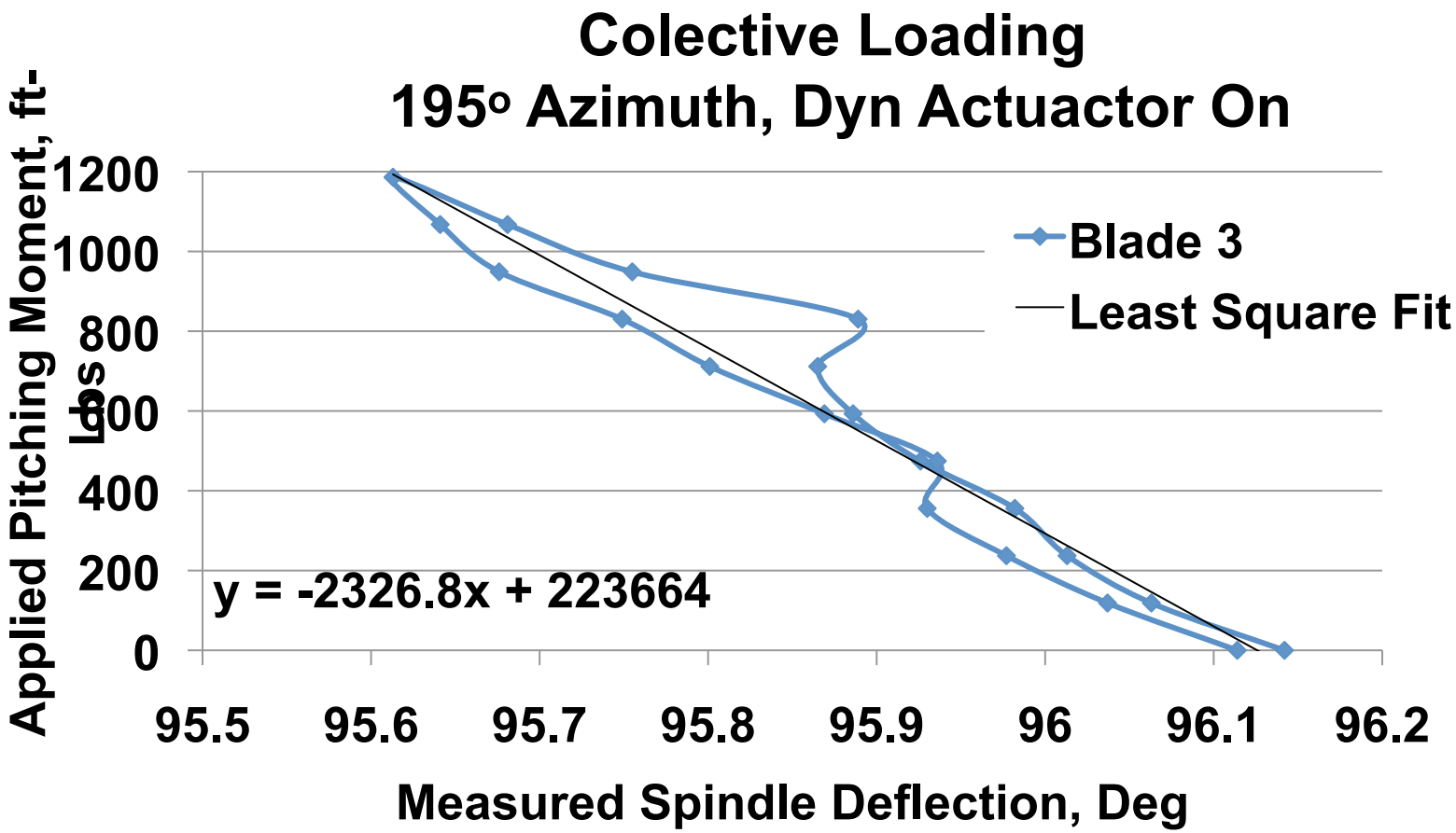
Sample Results



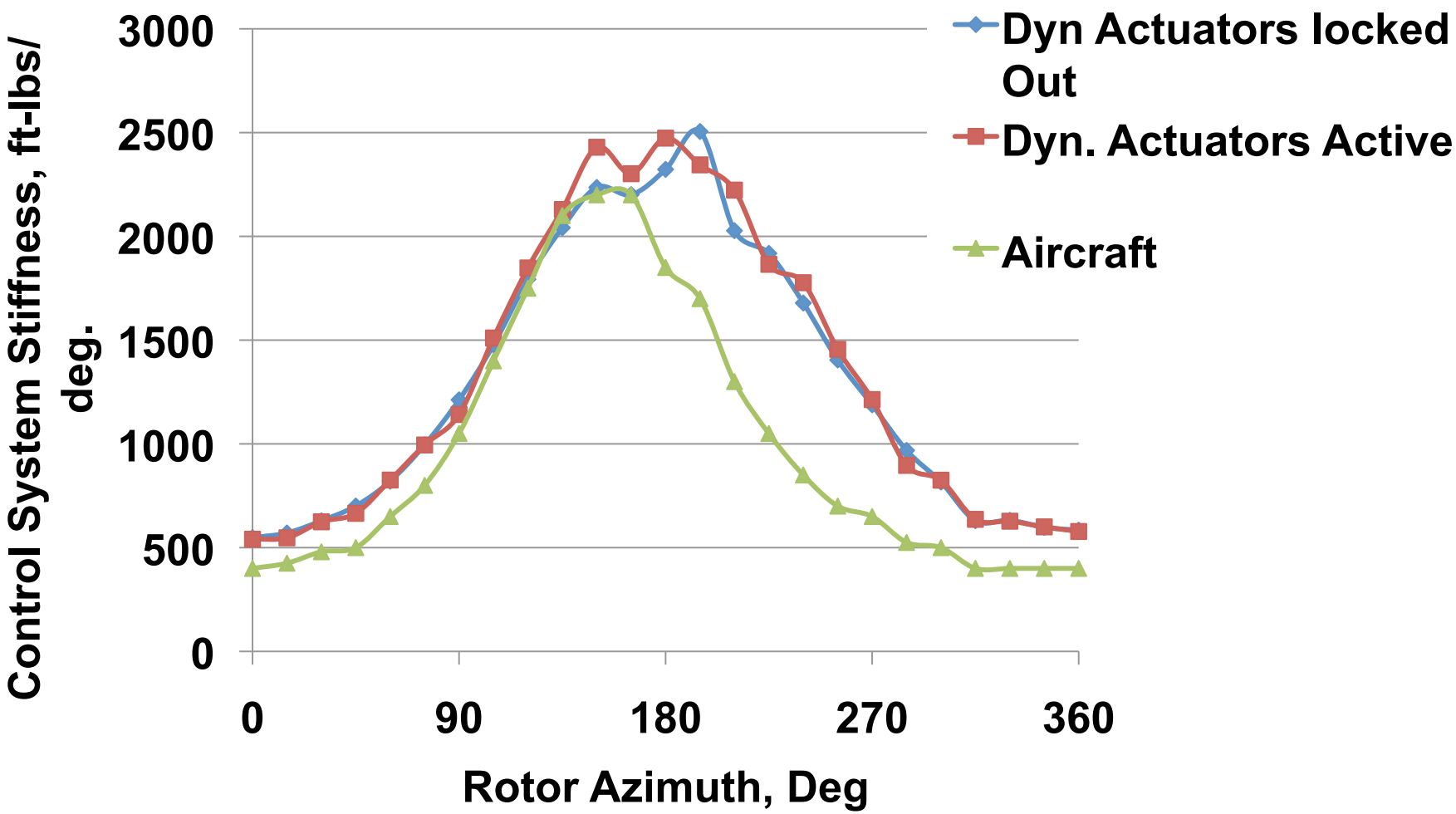
Sample Cyclic Loading



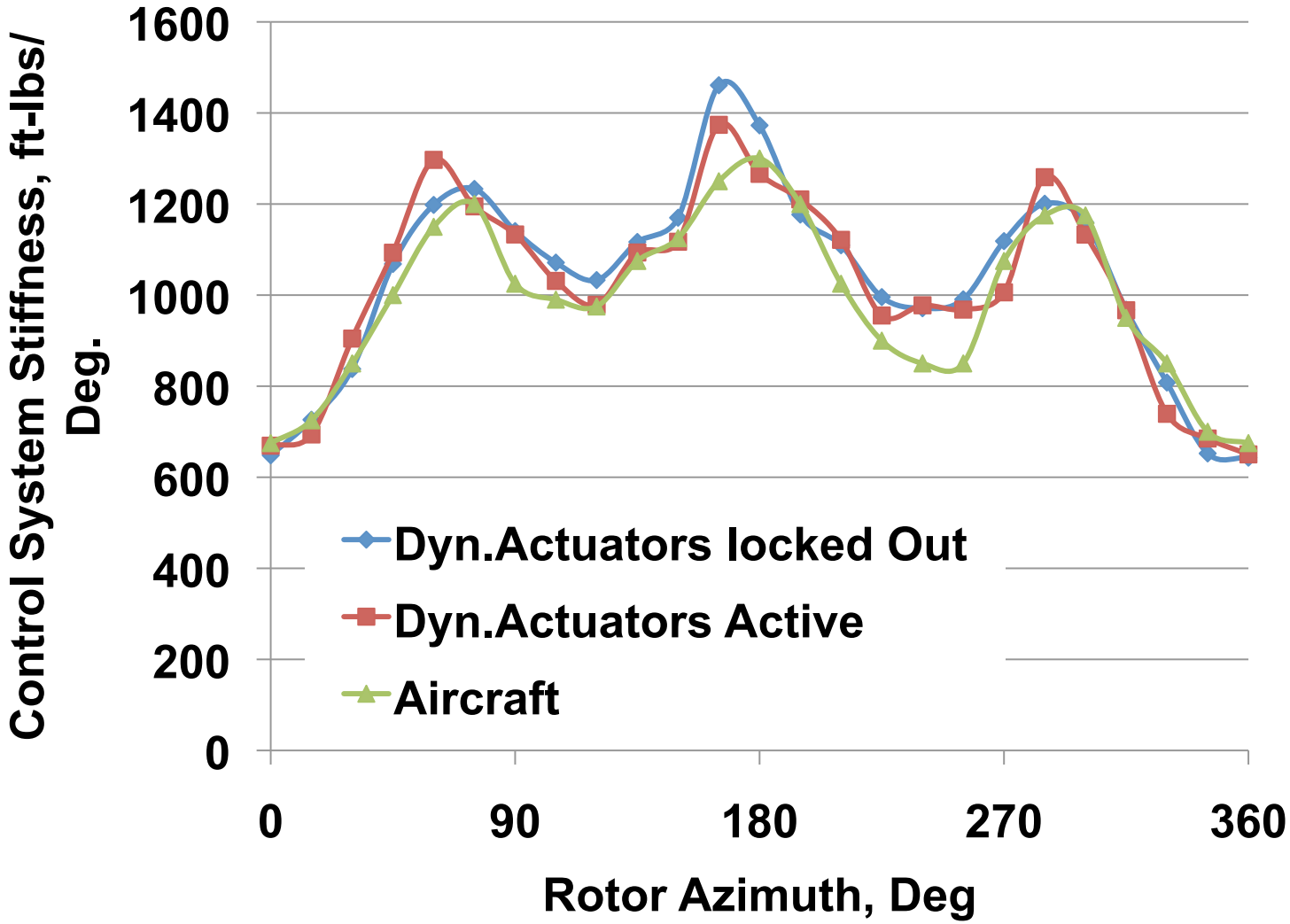
Sample Results



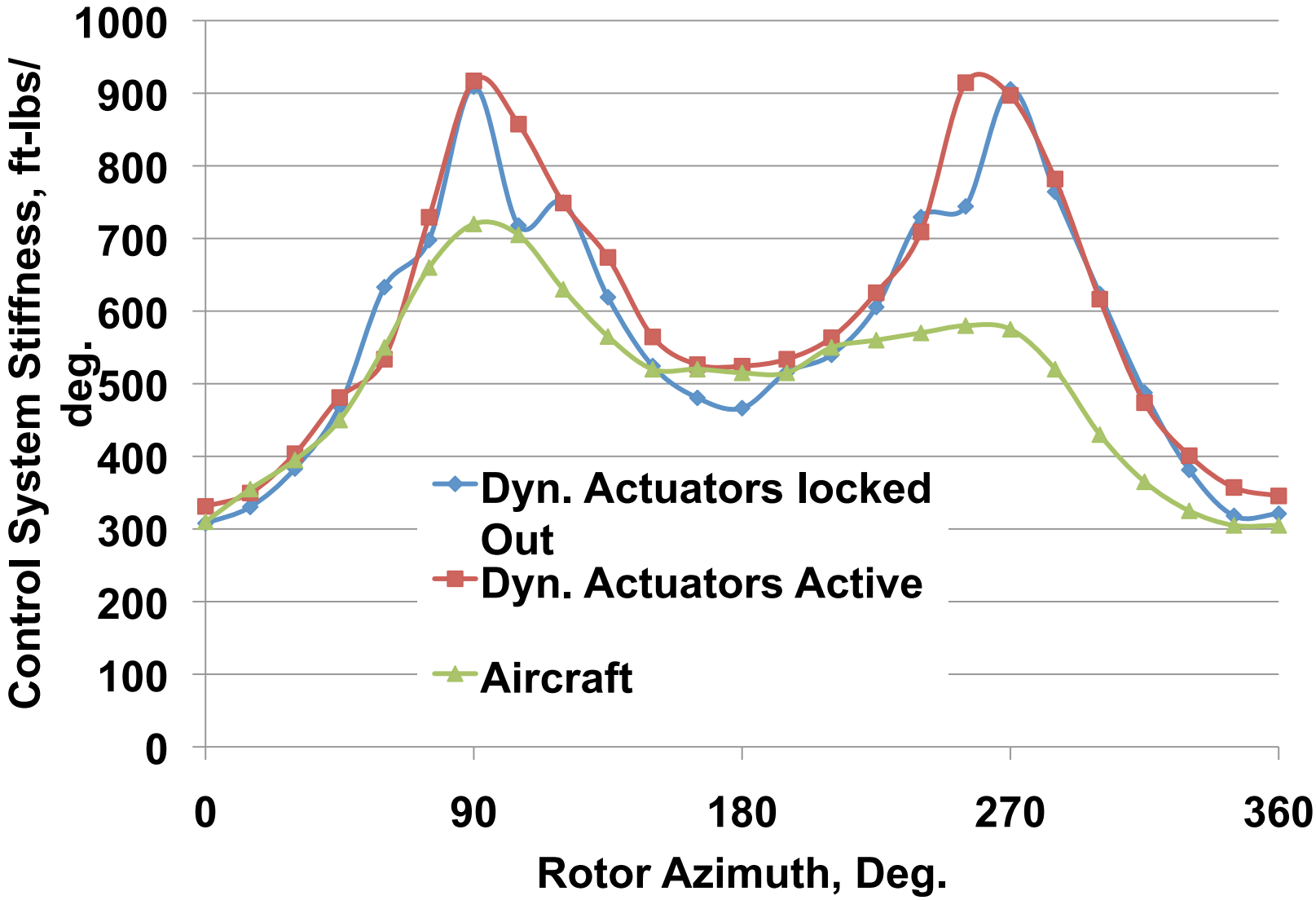
Measured Collective Stiffness



Measured Reactionless Stiffness



Measured Cyclic Stiffness



Control System Stiffness Model

$$K_{col} = \frac{1}{N}\sum_{m=1}^{N} K^{(m)}$$

$$K_{cos} = \frac{2}{N}\sum_{m=1}^{N} K^{(m)} \cos \Psi_m$$

$$K_{sin} = \frac{2}{N}\sum_{m=1}^{N} K^{(m)} \sin \Psi_m$$

$$K_{react} = \frac{1}{N}\sum_{m=1}^{N} K^{(m)} (-1)^m$$

Fixed Control System Stiffness

$$\begin{Bmatrix} M_{col} \\ M_{cos} \\ M_{sin} \\ M_{react} \end{Bmatrix} = \begin{bmatrix} 1354 & -952 & 35 & -7 \\ -53 & 496 & -6 & 9 \\ -4 & -6 & 713 & 43 \\ 7 & 2 & -10 & 1036 \end{bmatrix} \begin{Bmatrix} \theta_{col} \\ \theta_{cos} \\ \theta_{sin} \\ \theta_{react} \end{Bmatrix}$$

Conclusion

- LRTA Control System Stiffness was measured
- Negligible differences between Dynamic Actuator active/ locked out
- LRTA Control System Stiffness is similar but stiffer than aircraft
- Negligible differences between the LRTA and aircraft reactionless stiffness

NASA