

# THE PHOENIX PROJECT

Coordinated Flight of Multiple Unmanned  
Vehicles

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# Goals



- Long Term
  - Fleet of 4 Aircraft
  - Way Point Navigation
  - Coordinated Aerobatic Maneuvers
- Short Term
  - Lateral Data Acquisition
  - Lateral and Longitudinal Data Acquisition
  - Linear Control for Stabilization

# The Hobbico Hobbistar 60

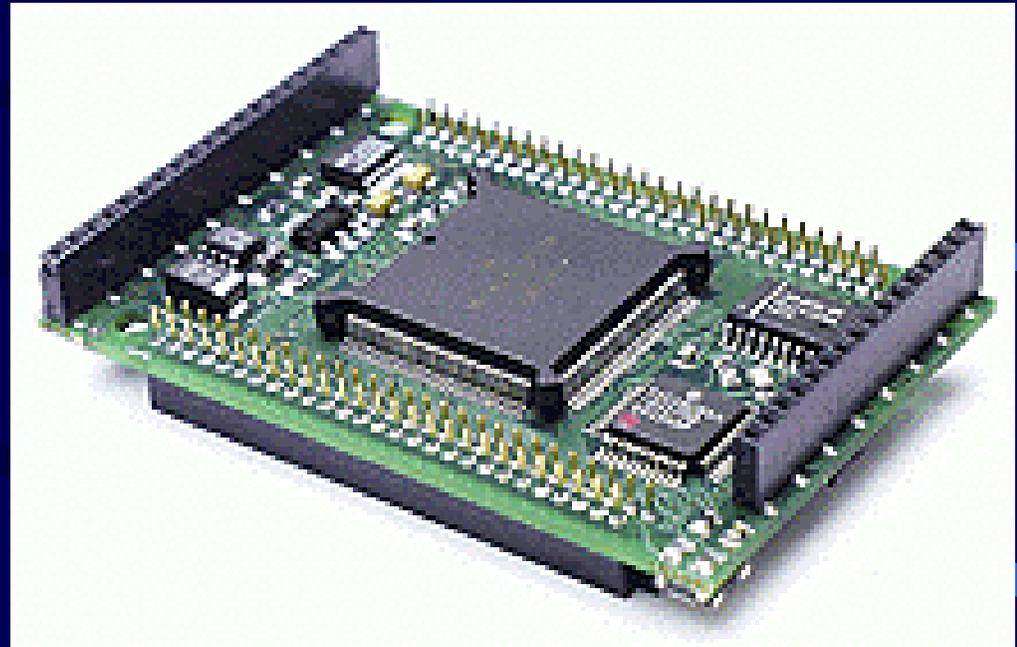
- Advantages
  - Remote Pilot
  - Inexpensive
  - Almost Ready to Fly
- Disadvantages
  - Small Payload



Phoenix 1

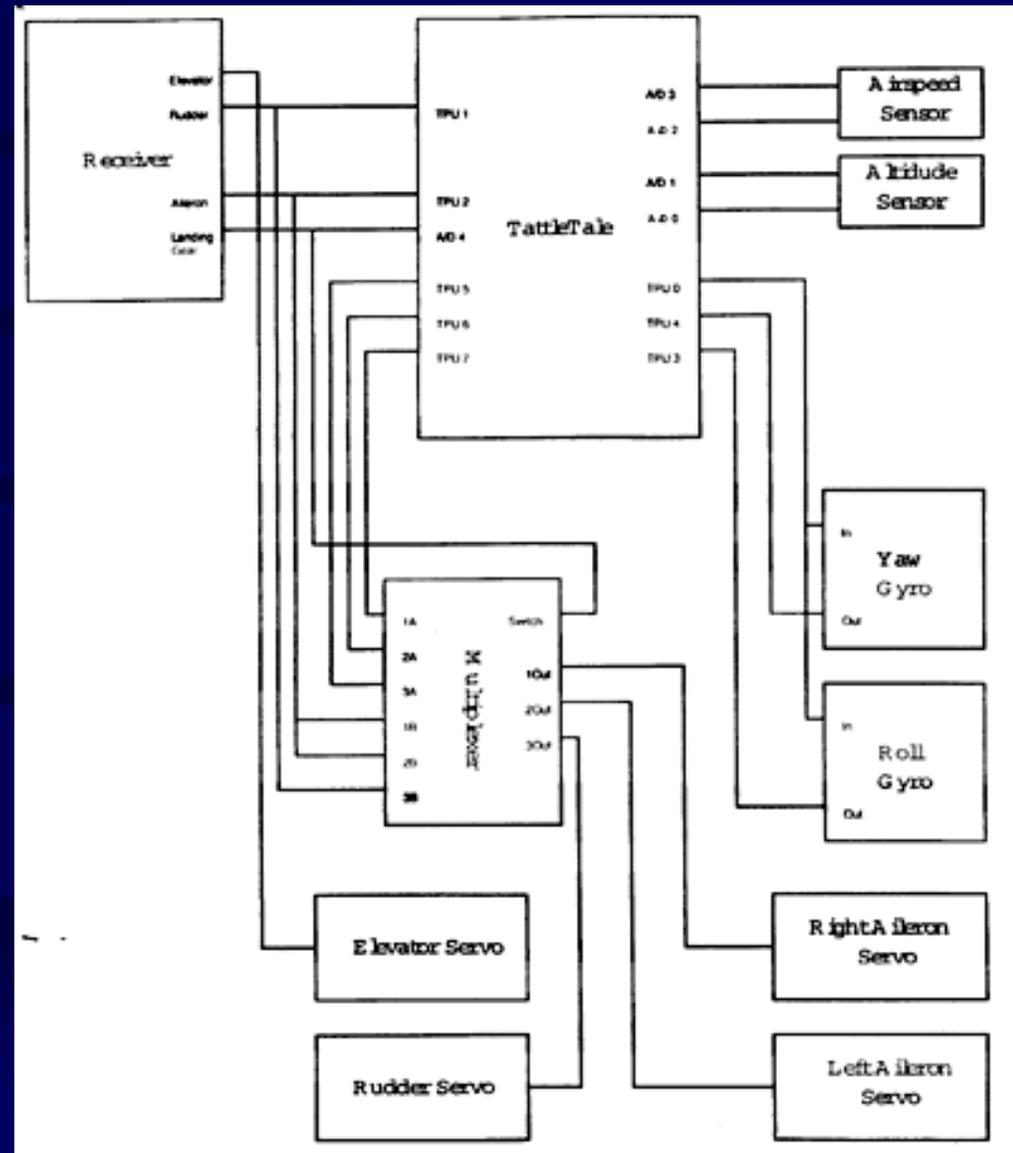
# The Tattletale Model 8

- A Small Data Logger
- Made by Onset Computers
- C Programmable
- 2 Interfaces
  - I/O Prototyping Board
  - PR-8 Prototyping Board



# Stage 1: Lateral Data Collection

- Find Working Components
- Reprogram Tattletale for Data Collection
- Modification of Aircraft



Data Collection System (Ouimet 14)

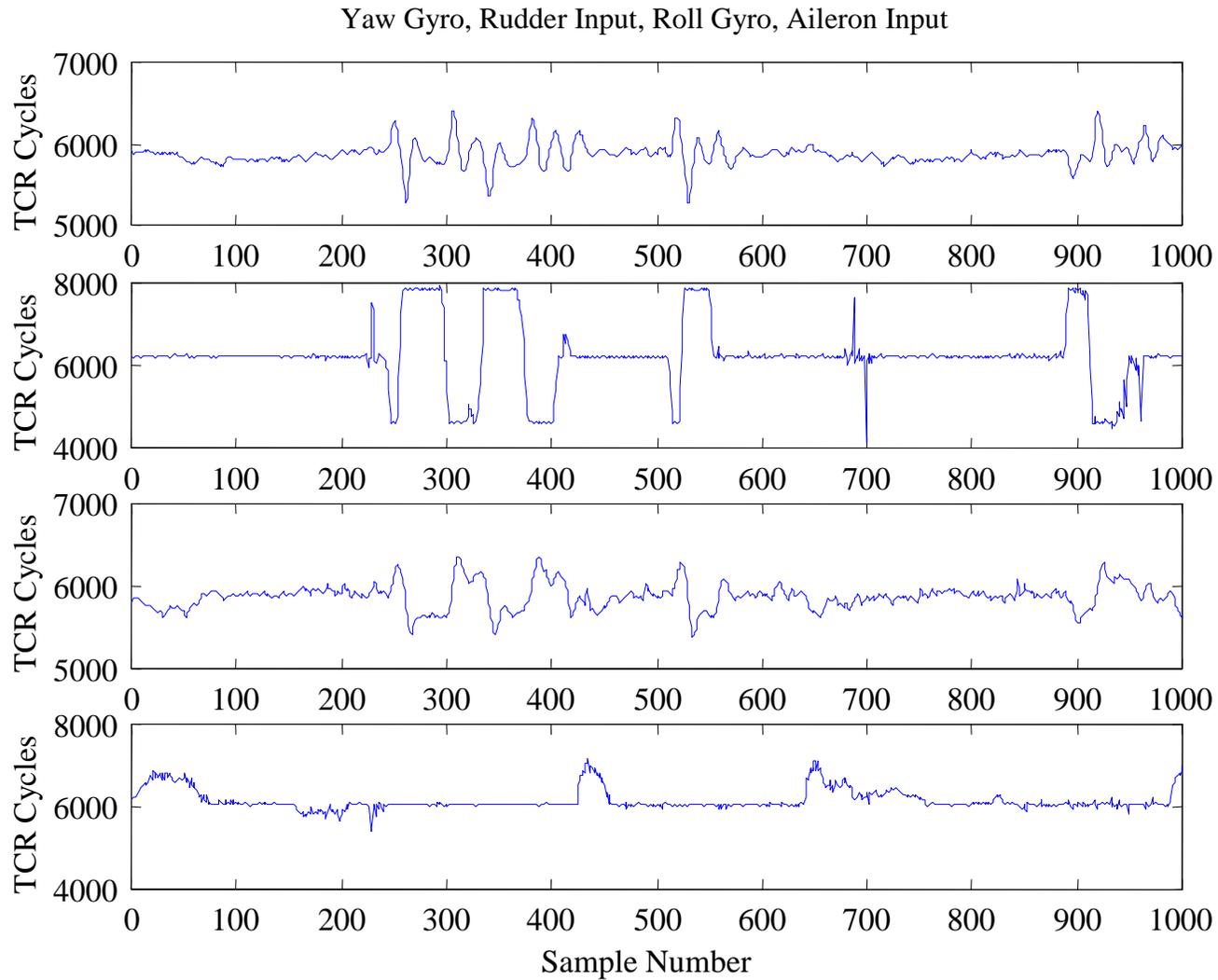
# Modifications



# The Flights

- Flight 1
  - Steady Level Flight: turns only when necessary to stay in range
- Flight 2
  - Concentrating on Rudder Kicks and then Aileron Kicks and Rolls
- Flight 3
  - More Kicks Followed by Tight Turns

# Data- Flight 2



Flight 2- First 1000 of 6000 Samples

# MATLAB Analysis

- System identification Toolbox
  - n4sid: creates a theta model of the system
  - th2ss: converts the theta model into a state space model
  - compare: graphs the given output data and the models output on the same graph
- Model based on Flight 3
  - First 4 eigen values most important
  - Fifth and Sixth eliminate drift

$0.5888 + 0.2560i$

$0.8660 + 0.2959i$

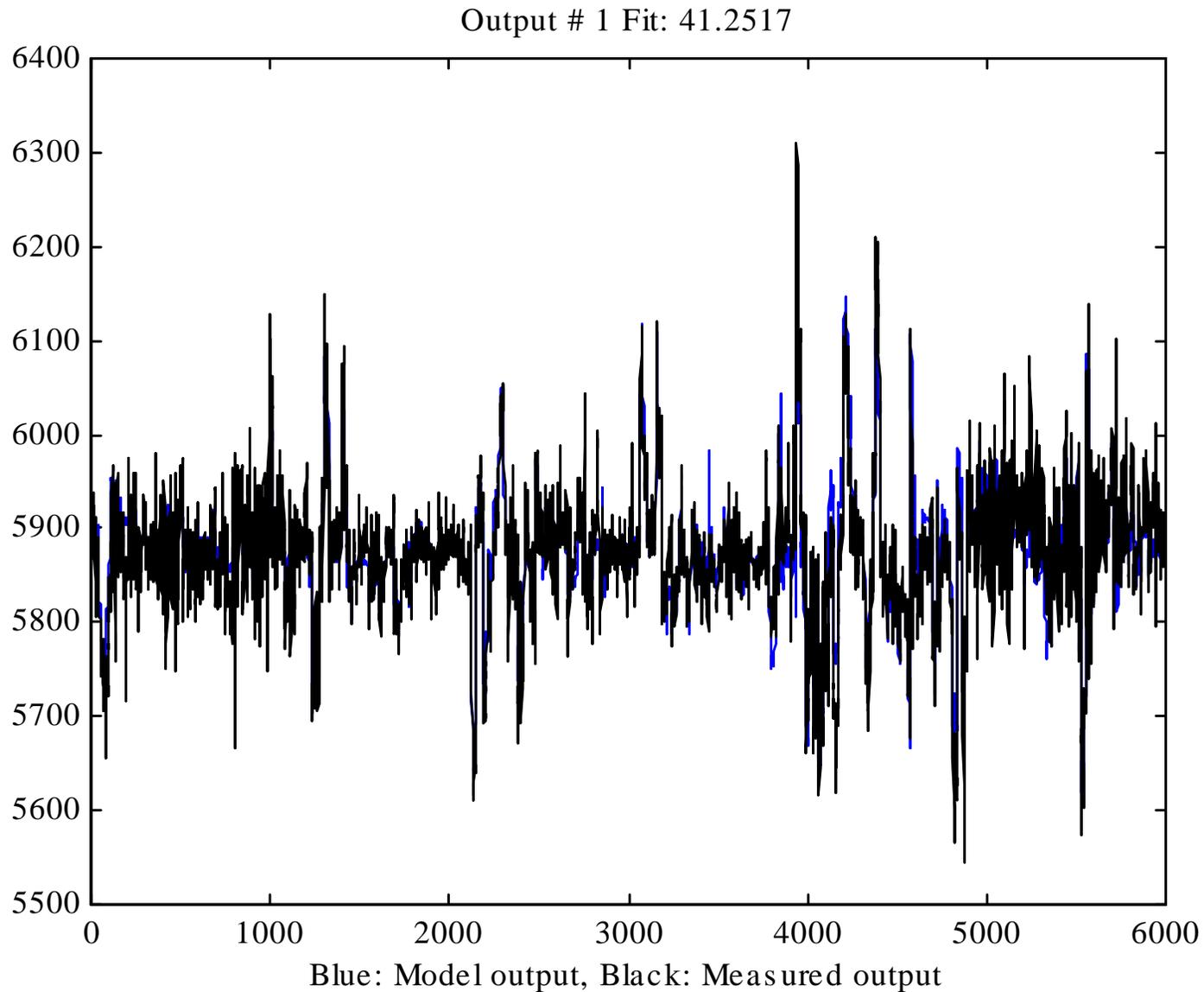
0.9989

$0.5888 - 0.2560i$

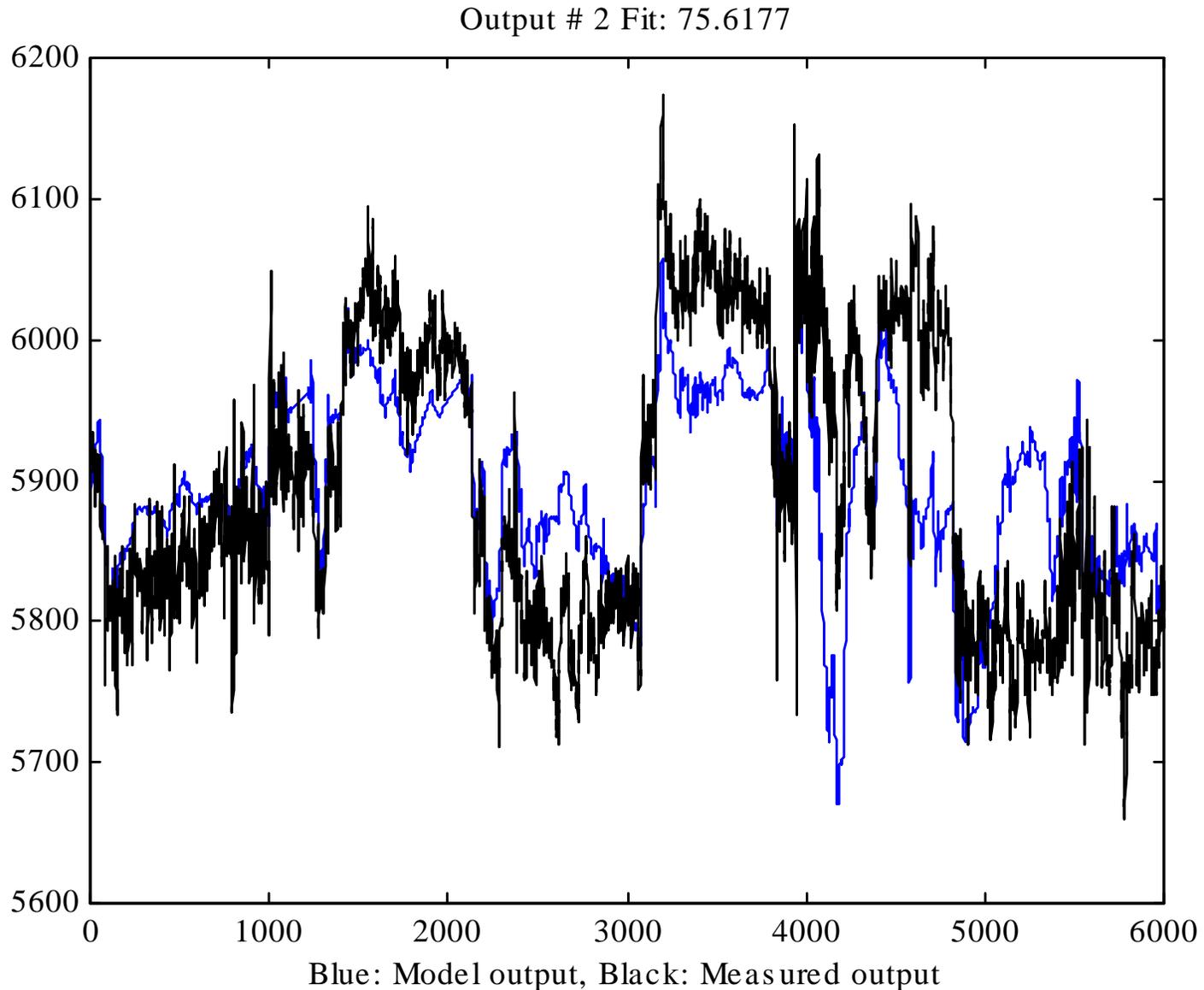
$0.8660 - 0.2959i$

0.9949

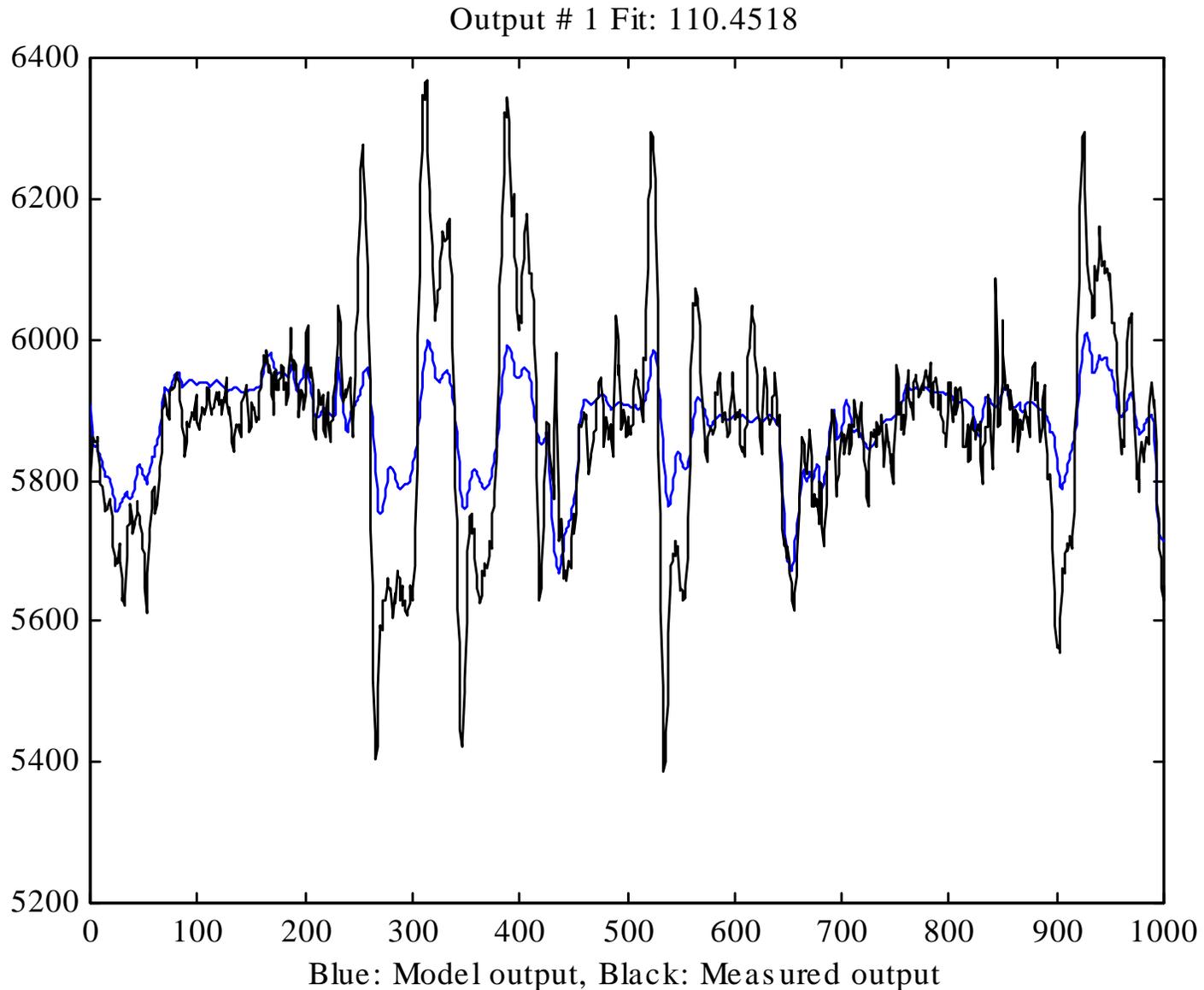
# Full Flight 3 Comparison- Roll



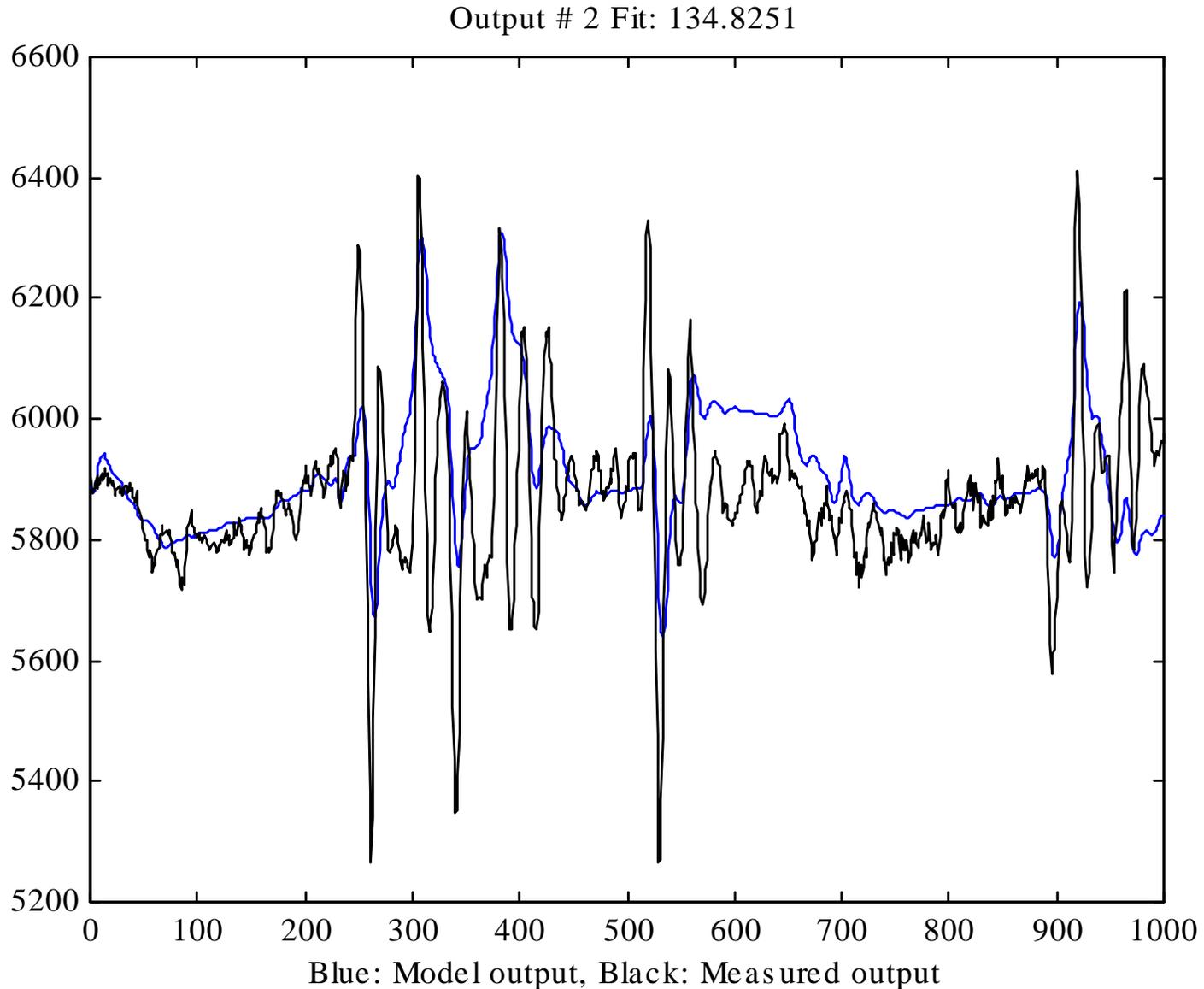
# Full Flight 3 Comparison- Yaw



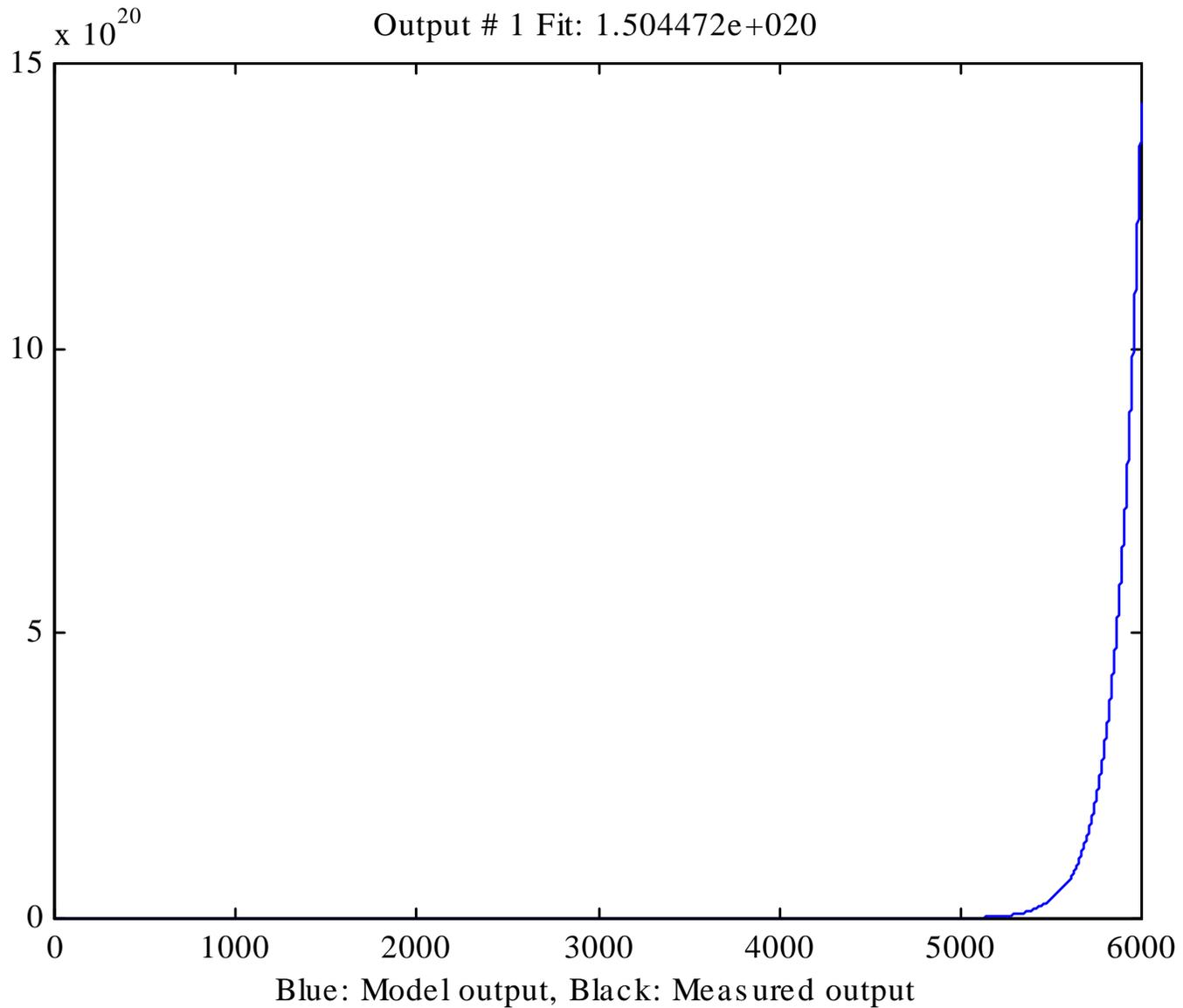
# Limited Flight 2 Comparison- Roll



# Limited Flight 2 Comparison- Yaw



# 8th Order Model- Roll



# Stage 2 - Add Longitudinal Data Collection

- Add a Pitch Gyro
- Add a 3-way Accelerometer
- Add Elevator Input
- Add Throttle Input
- Fix Pressure Sensors

# Stage 2- Switching to the PR-8

- Advantages
  - 12 Digital I/O Channels
  - 7 A/D Channels
  - Holds Multiplexer and Op-Amps
- Disadvantages
  - Does not Readily Fit into Aircraft
  - Squishy Bus Connectors

# Longitudinal Data Collection

- Problems
  - Accelerometers- may be broken
  - Pressure Sensors
  - Throttle Input- coding problem
- Progress
  - Rewired for payload space efficiency
  - Programming improvements
  - Purchase of new transmitter

# What's Next?

- Lateral and Longitudinal Data Collection
- Lateral and Longitudinal Data Analysis
- Linear Stabilization Control
- Addition of GPS
- Way Point Navigation Control

# Special Thanks

- Professor Stengel: for allowing my involvement in this project
- Chris Gerson: for joining the project and helping with programming.
- Olivier Laplace: for helping with the data analysis
- Professor Leonard's Dynamics Lab: for the use of their tools and their transmitter

# BIBLIOGRAPHY

- Ouimet, Martin. Design of a Failure Tolerant Control System Using a Parity Space Approach. Princeton University Senior Thesis: Princeton, NJ, 1998.