

UTSR Fellowship Summary

By

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In association with

UTSR Gas Turbine Industrial Fellowship Program

&

Woodward Governor

Presentation Overview

- What is the UTSR Gas Turbine Industrial Fellowship Program ?
- Projects I worked on this summer.
 - Type of project
 - Experience gained
- Continued Benefits
- Thanks

Program Description

“The UTSR Gas Turbine Industrial fellowship offers valuable “work experience” opportunities in research, engineering, and design at participating Industrial Sponsors”*

I was selected to participate at Woodward FST under the direction of Kelly Benson.

Program Description

Program Sponsors:

University Turbine Systems
Research Program

South Carolina Institute for
Energy Studies at Clemson
University

The U.S. Department of
Energy / National Energy
Technology Laboratory
(NETL)

Industrial Participants:

Woodward FST

General Electric Company

Pratt & Whitney/UTRC

Siemens Westinghouse
Power Corporation

Rolls Royce

Parker Hannifin

Ramgen Power systems

Solar Turbines, Inc.

Southern Company Services

Project Summaries

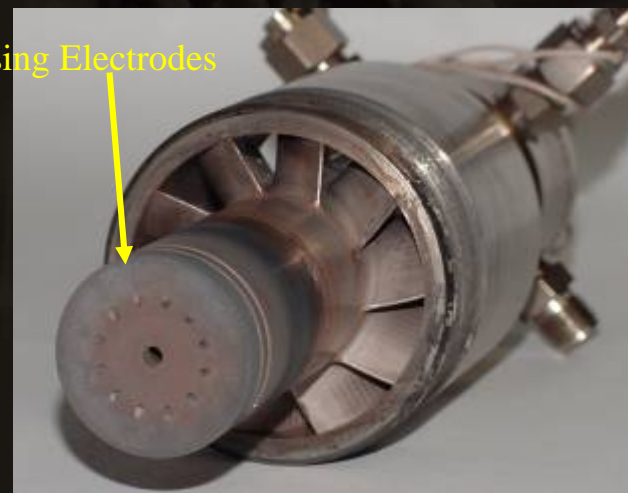
- Data reduction
 - Importation
 - Analysis
 - Presentation
- SmartFlame
 - Conceptual Development
 - Programming
- AC Ionization
 - Theory Development
 - Test Apparatus Design/Fabrication
- Video Editing
 - Igniters
 - Turbine Signal Overlays

Project Summaries – Data Reduction

- Conduct data analysis.
- Data acquired with Woodward CCADS (Combustion Control and Diagnostic Sensor) ion-sensing equipment.
- Tests were on large-frame turbine combustors as well as combustion test rigs.



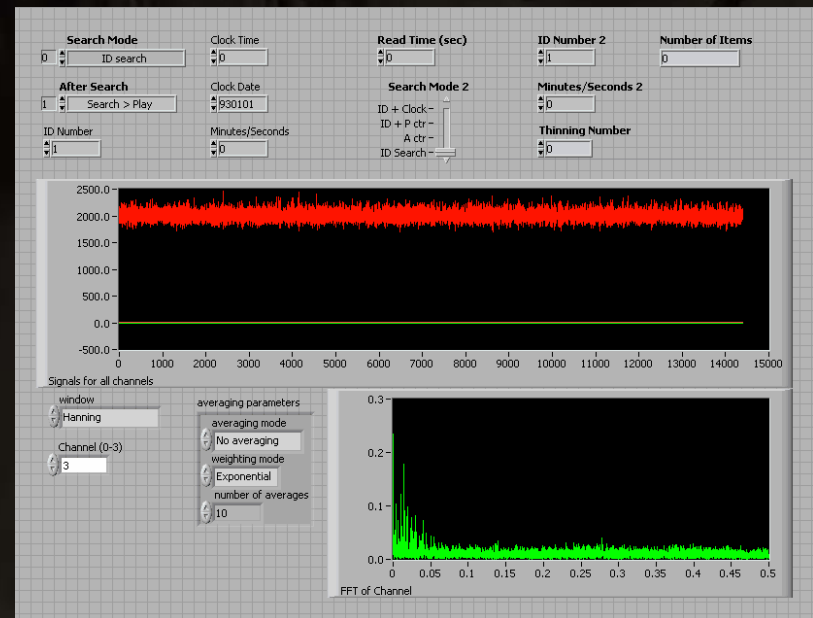
Ion Sensing Electrodes



CCADS equipped turbine nozzle assembly.

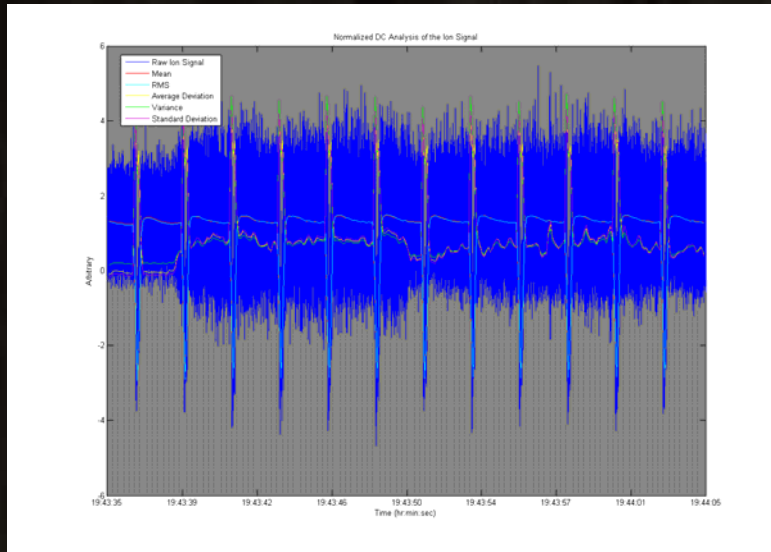
Project Summaries – Data Reduction

- Extract raw data from TEAC data recorder and other sources.
- Wrote LabVIEW program to control data extraction from TEAC recorder
 - Scan to desired times
 - Extract for desired length of time
 - Format data into files and label

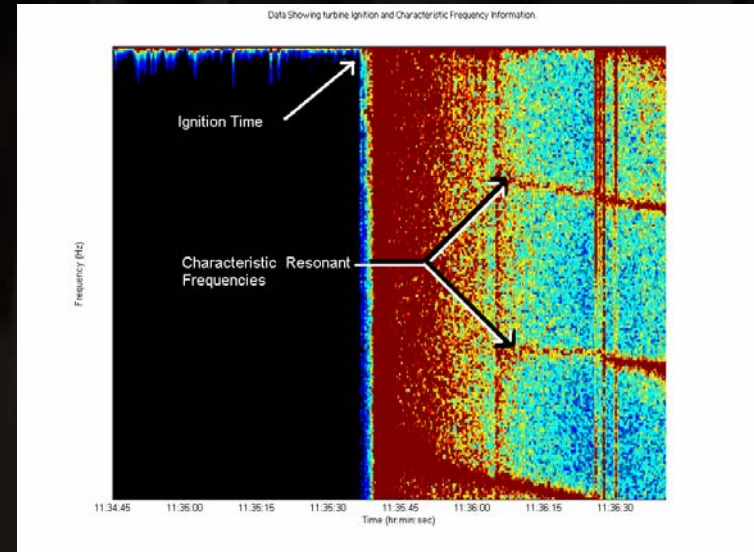


Basic LabVIEW program to import data.

Project Summaries – Data Reduction



Raw signal with DC analysis

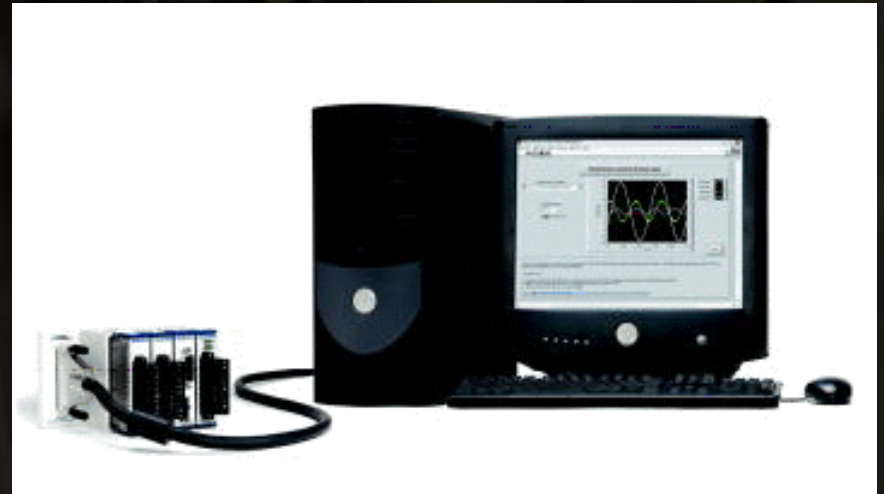


AC analysis: Frequency Image

- Wrote several custom programs in **MATLAB** to analyze the raw data and display the results in visual form.
- Data conditioning and filtering
- Created **PowerPoint** presentations of data for test reviews.
- Participated in test review meetings between Woodward and participating clients.

Project Summaries – SmartFlame

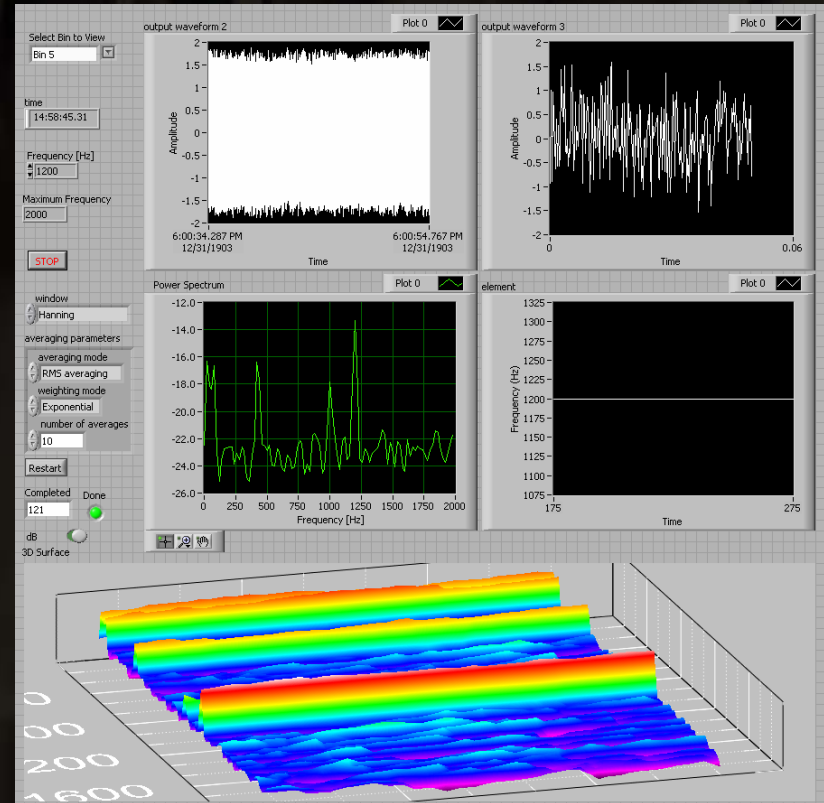
- Involved in Smart Flame product development.
- SmartFlame will incorporate CCADS abilities into a smaller platform (NI CompactRIO chassis)
- Capable of real-time analysis along with data collection and test management.



NI CompactRIO system connected to a Windows system running a front panel display.

Project Summaries – SmartFlame

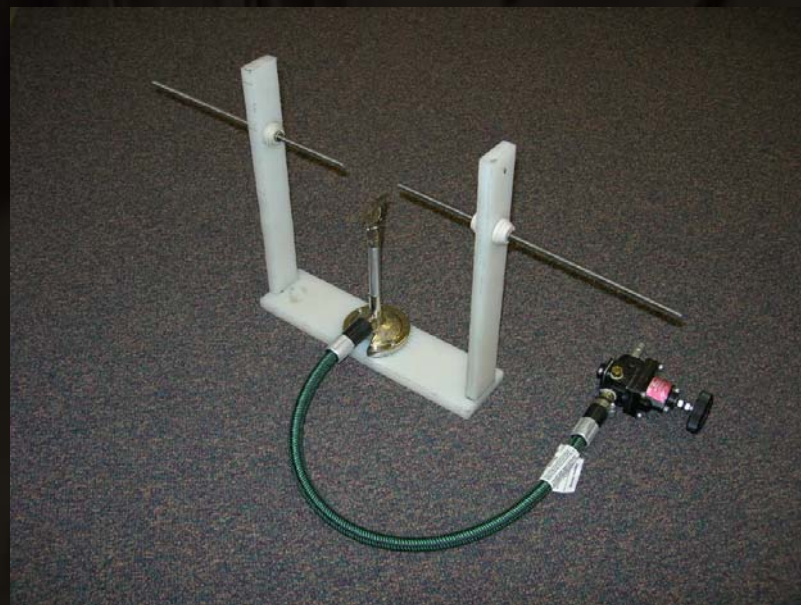
- Involved in initial concept meetings.
- Initial programming for platform to conduct data acquisition and analysis. (NI: FPGA, RT, Windows platforms)
- Incorporated acquired knowledge and methods from data reduction project into module features.



Initial front panel for SmartFlame performing test analysis.

Project Summaries – AC Ionization

- Involved in examination of benefits of AC ionization vs. DC ionization sensors.
- Reviewed basic theory involved in TOF (time of flight) for ionized species.
- Developed basic test associated with TOF calculations
- Designed and built rudimentary AC ionization test rig.



Rudimentary AC ionization test rig.

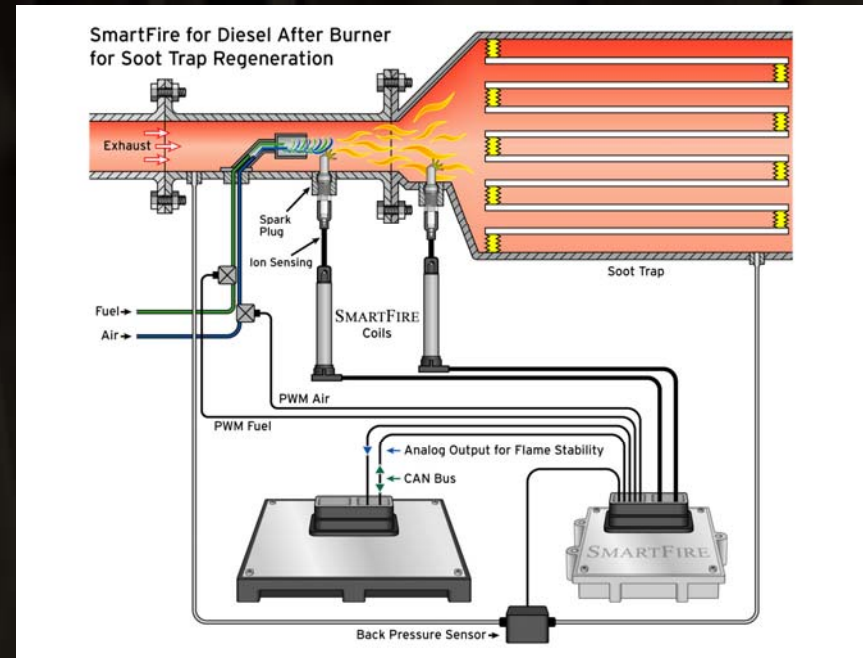
Project Summaries – Video Editing

- Edited video from combustion rig tests.
- Overlaid conditioned ion signal over footage of combustion inside the rig.
- Prepared for sales/advertising purposes.
- Also edited video from igniter tests.
- Added watermarked company logos.
- Changed video speed to examine initial combustion propagation.
- Utilized Adobe[®] and various other editing programs.

Continued Benefits

- Currently I am still employed (part time) at Woodward. I am continuing to work on the development of the SmartFlame module.
- Woodward is also funding my thesis research at CSU involving the development of a soot trap regeneration burner (SmartFire) for diesel engines.

Soot Trap Reformer with Ion Feedback



Conceptual diagram of SmartFire system.

Thanks!

I would like to thank the University Turbine Systems Research Program, the South Carolina Institute for Energy Studies at Clemson University, and the U.S. Department of Energy / National Energy Technology Laboratory (NETL) for their funding of this unique and extremely educational experience.

I would also like to thank Matt Viele, Craig Bladow, and especially Kelly Benson at Woodward for constantly taking the time to share their experience and knowledge with me over the course of my Fellowship.

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