Acoustic and Vibration Data Acquisition for Surge and Stall Prediction

By

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Solutions for Today | Options for Tomorrow

U.S. DEPARTMENT OF ENERGY

About me!

From: Cayey, Puerto Rico

Interest

- ❖ Enhance Farm Operations with Machine Learning
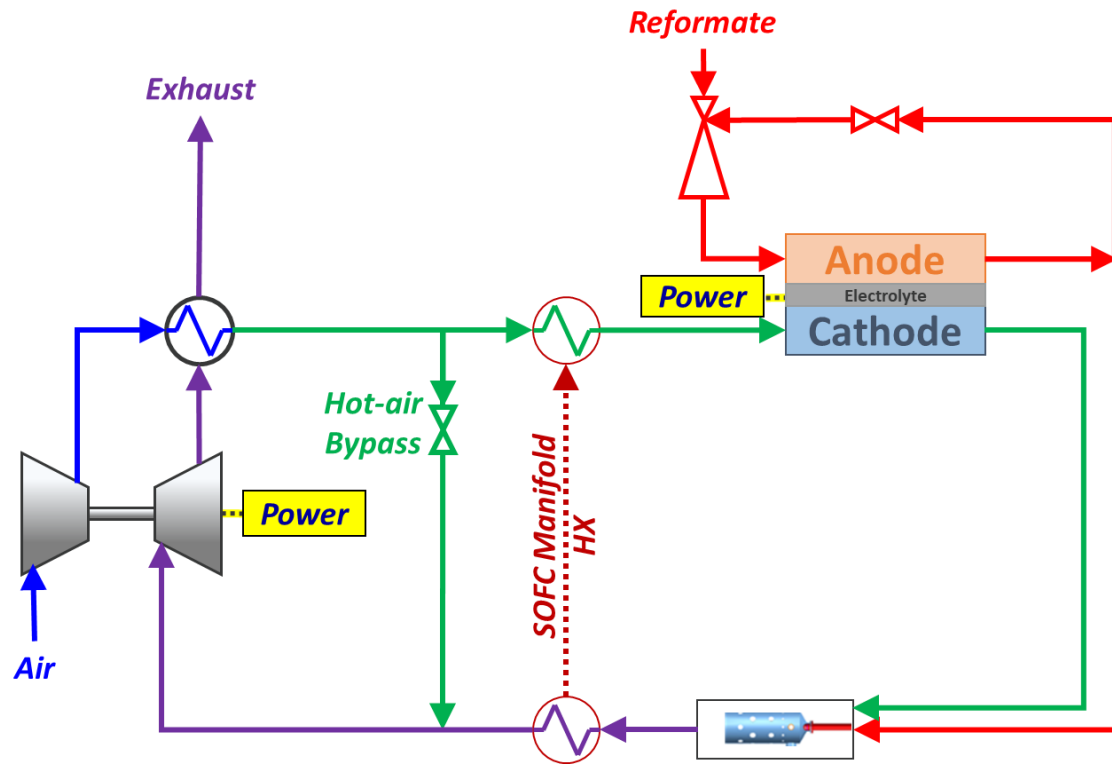- ❖ Environmental Monitoring Systems
- ❖ Airport Cybersecurity Analysis

Hobbies
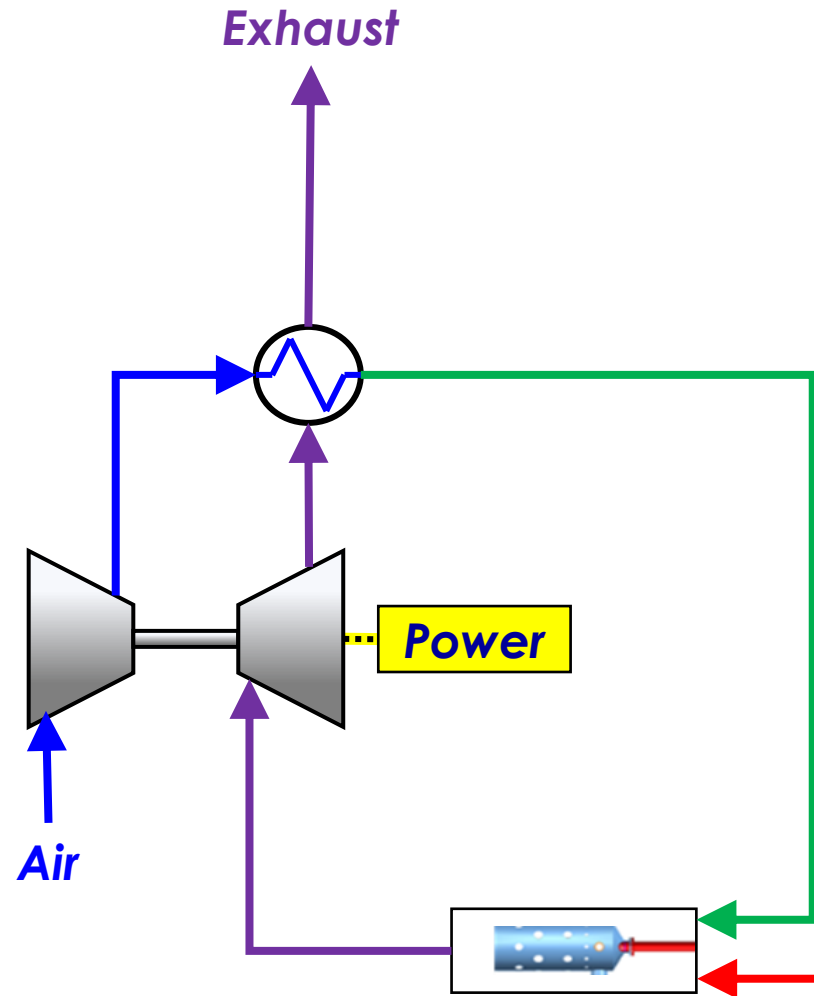
- ❖ Soccer
- ❖ Electronics
- ❖ Agriculture

Hybrid Performance Project (Hyper)

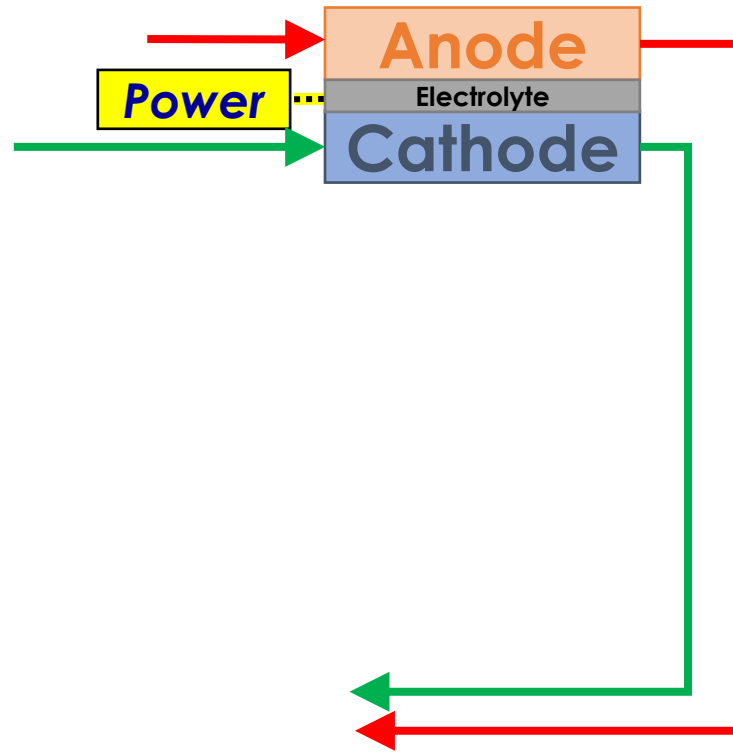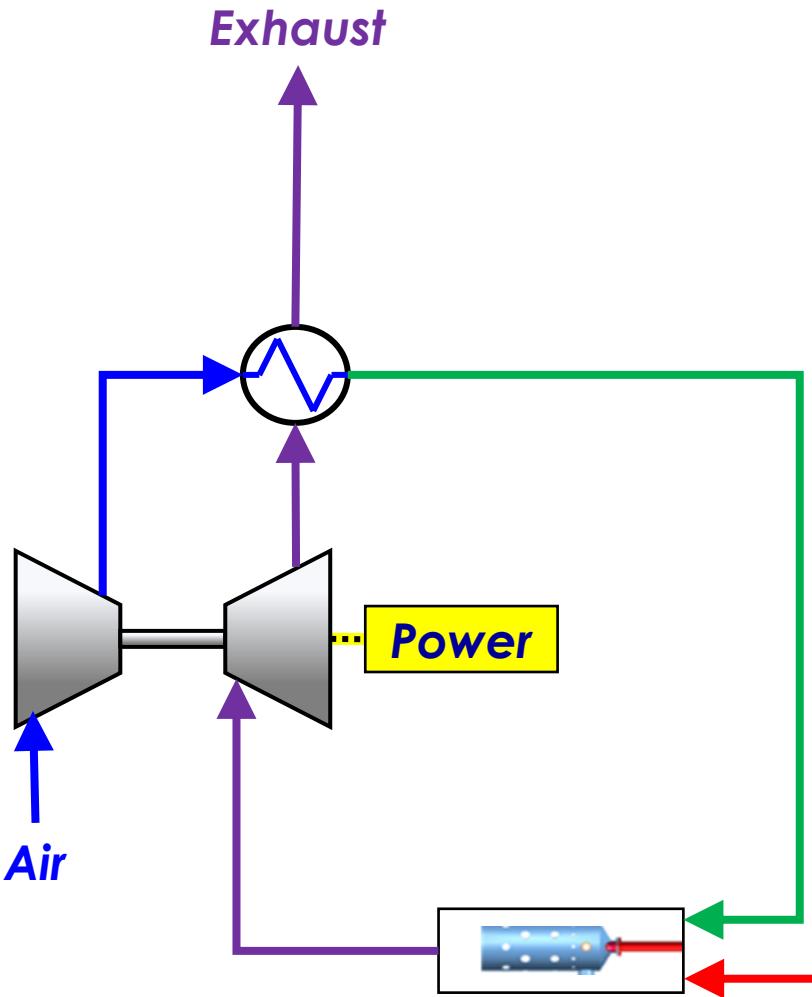❖ Integrated technologies using Cyber-Physical System

❖ Advance Controls Development
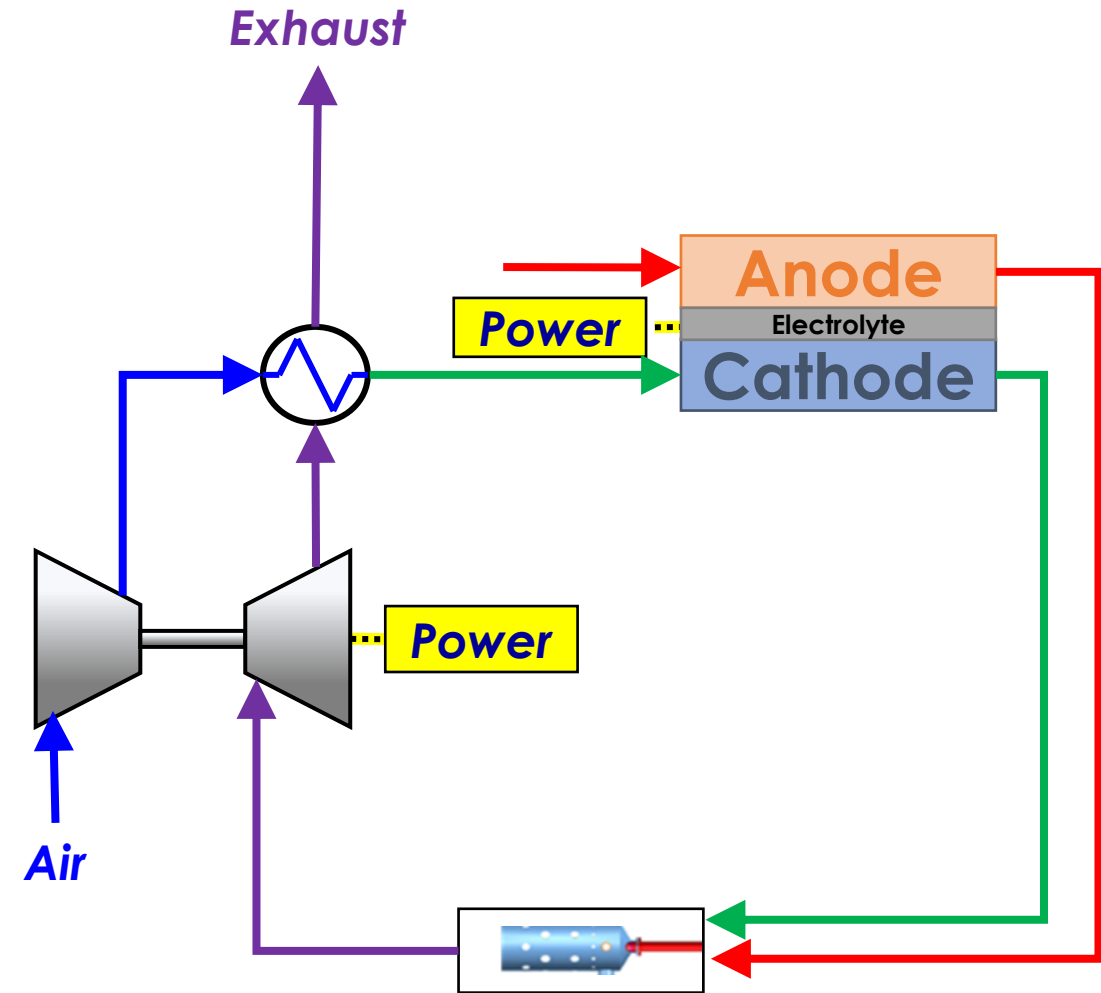
Cyber-Physical System

Brayton Cycle

❖ Compressor

❖ Gas Turbine

❖ Heat Exchange

❖ Combustor

30% system efficiency

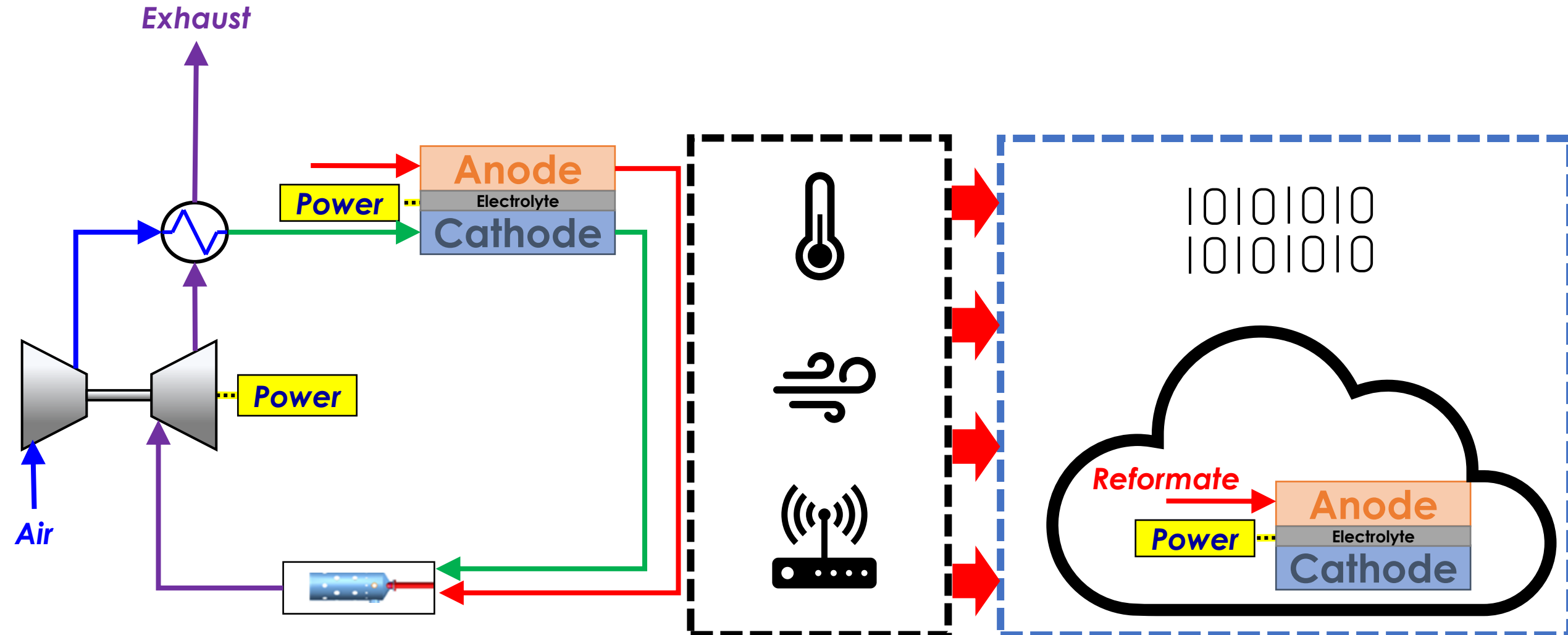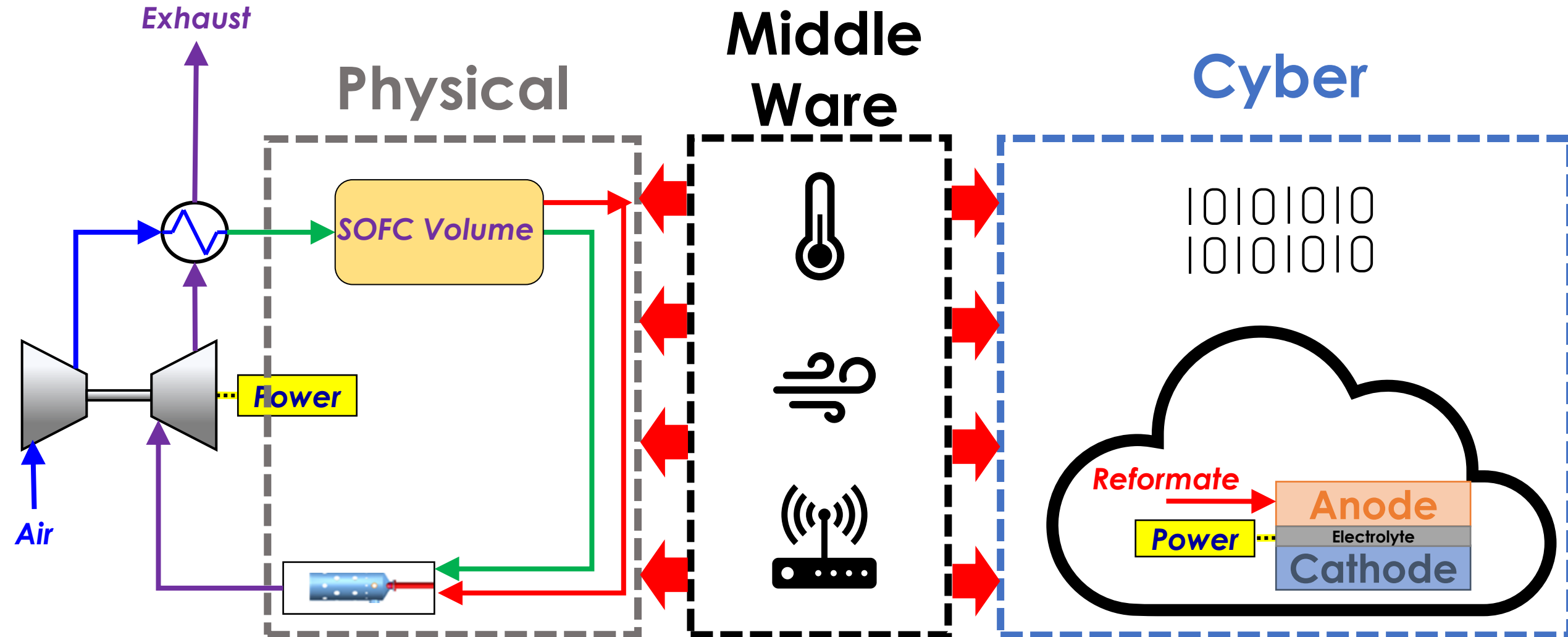# Cyber-Physical System

Cyber-Physical System

Cyber-Physical System

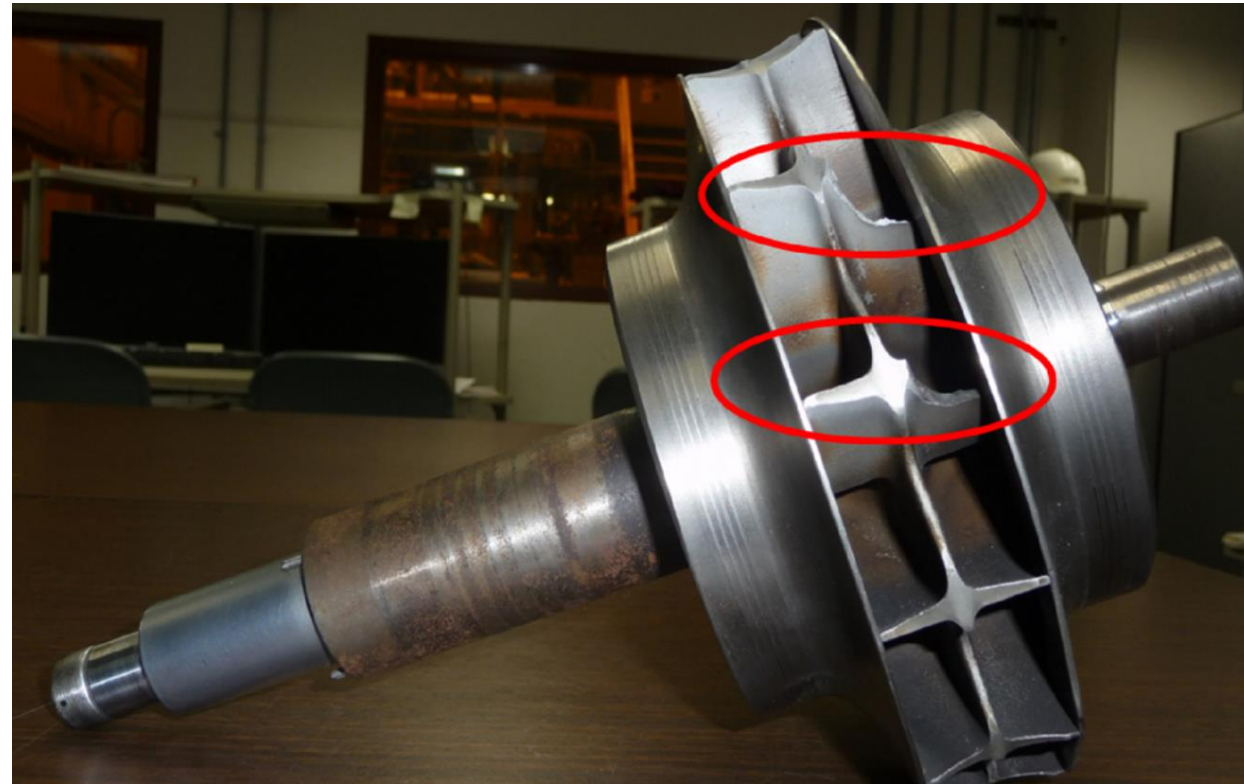# Cyber-Physical System

Compressor Surge and Stall

❖ Increase in pressure leading to back flow

❖ Mechanical Failure

❖ Damages to the Fuel Cell
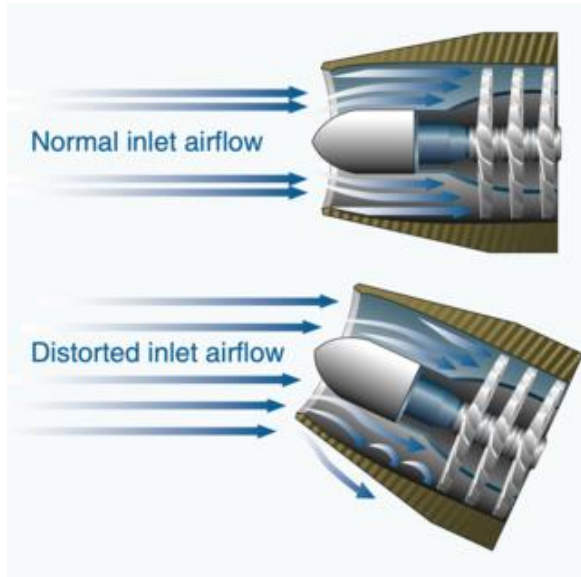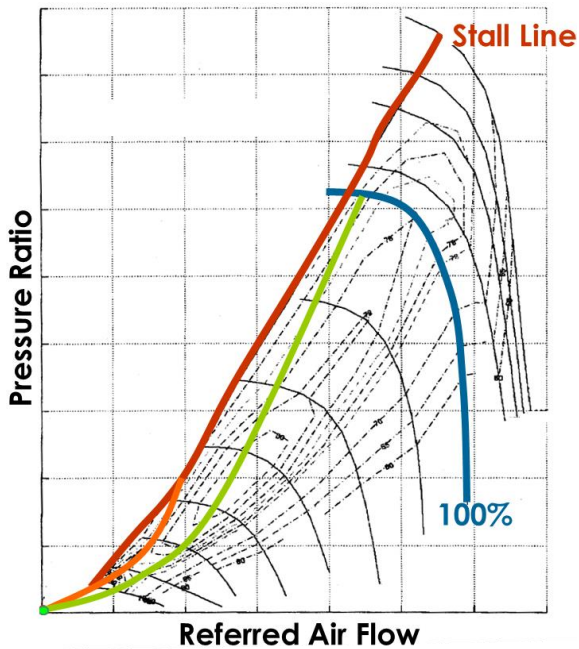
Summer Research Project

Acoustic and Vibration Data Acquisition for Surge & Stall Prediction

HYPER – CPS Middleware Configuration

Approach

❖ Usage of a DAQ/DSPi system.

❖ Acoustic, vibration, and speed sensors.

Results and Discussion

1ˢᵗ Test: Rotating Speed Data

Frequency   2 kHz/div
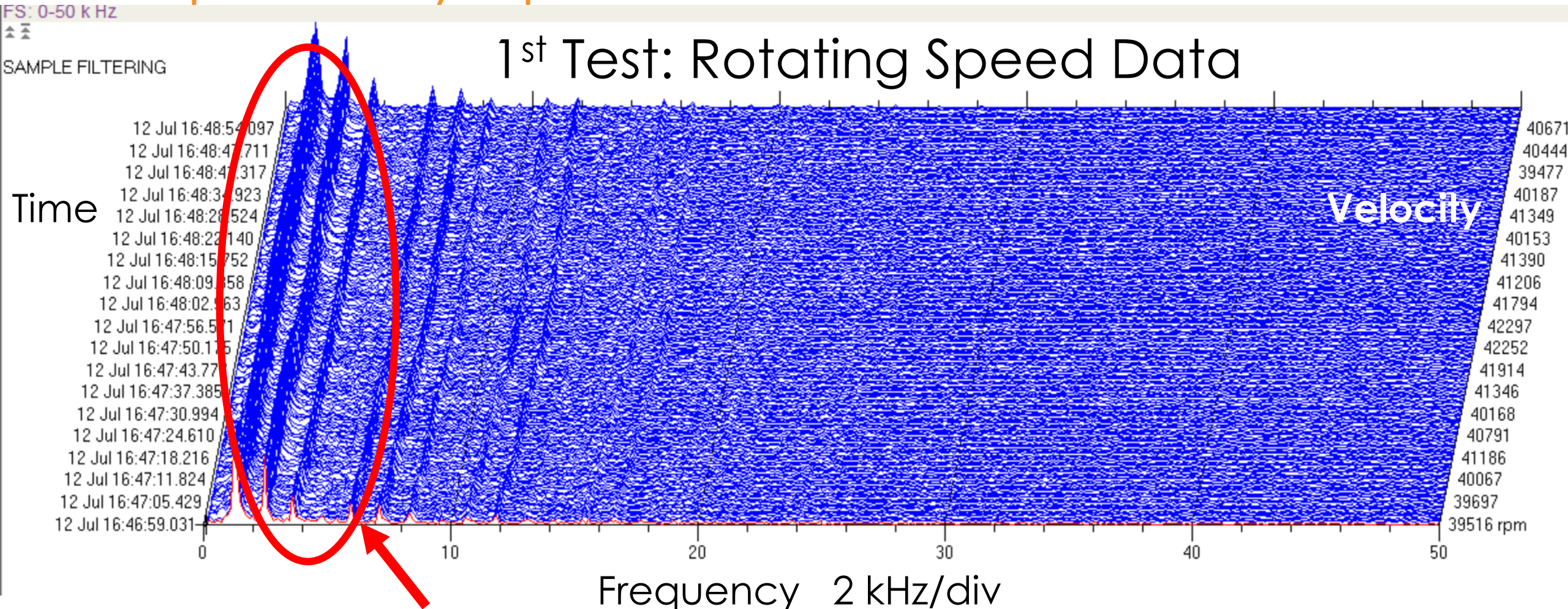
Frequencies lower than **5 kHz were to be observed.**

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Data Acquired and Analysis: Speed

NETL — NATIONAL ENERGY TECHNOLOGY LABORATORY

1ˢᵗ Test: Rotating Speed Data
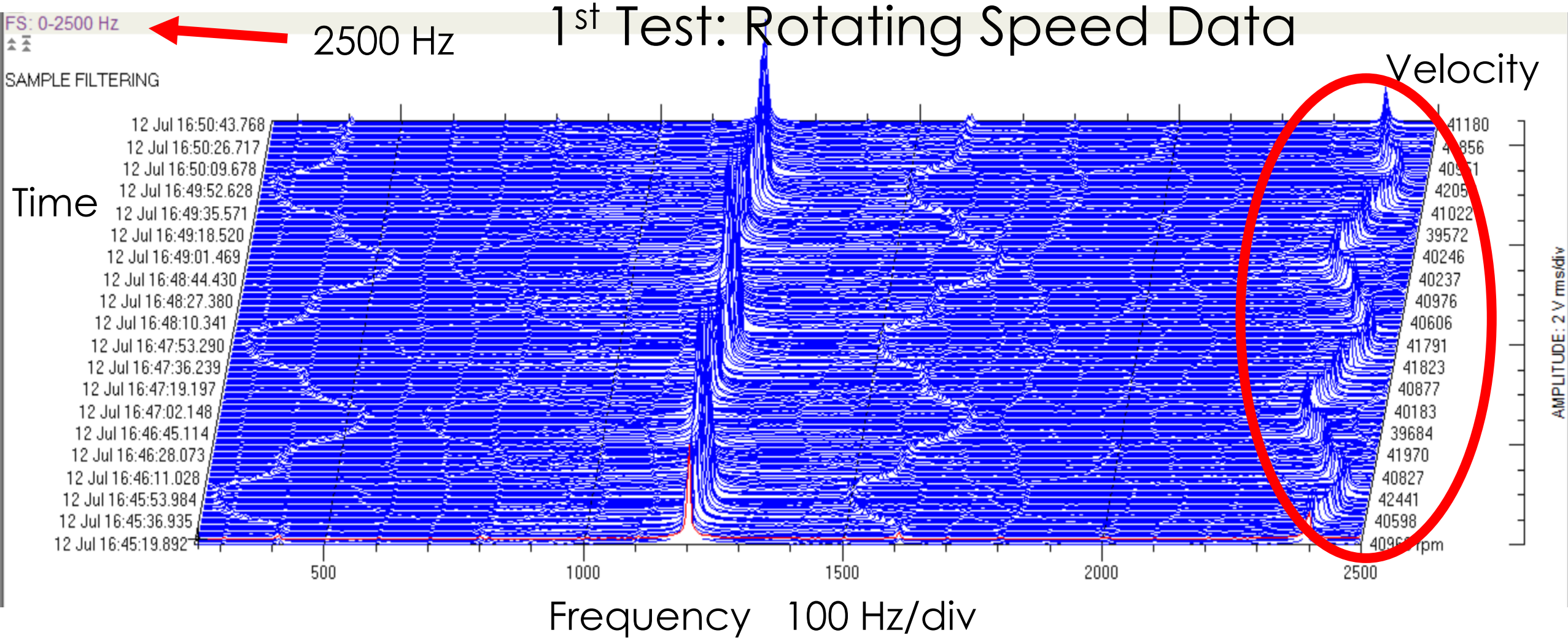
Summer Research Project

Data Acquired and Analysis: Speed and Acoustics

1st Test: Data at Startup

Time

12 Jul 15:12:29.373
12 Jul 15:12:18.454
12 Jul 15:12:07.572
12 Jul 15:11:56.652
12 Jul 15:11:45.717
12 Jul 15:11:34.790
12 Jul 15:11:23.876
12 Jul 15:11:12.988
12 Jul 15:11:02.078
12 Jul 15:10:51.137
12 Jul 15:10:40.229
12 Jul 15:10:29.272
12 Jul 15:10:18.290
12 Jul 15:10:07.289
12 Jul 15:09:56.258
12 Jul 15:09:45.223
12 Jul 15:09:34.192
12 Jul 15:09:23.176
12 Jul 15:09:12.143
12 Jul 15:09:01.096

Frequency   500 Hz/div
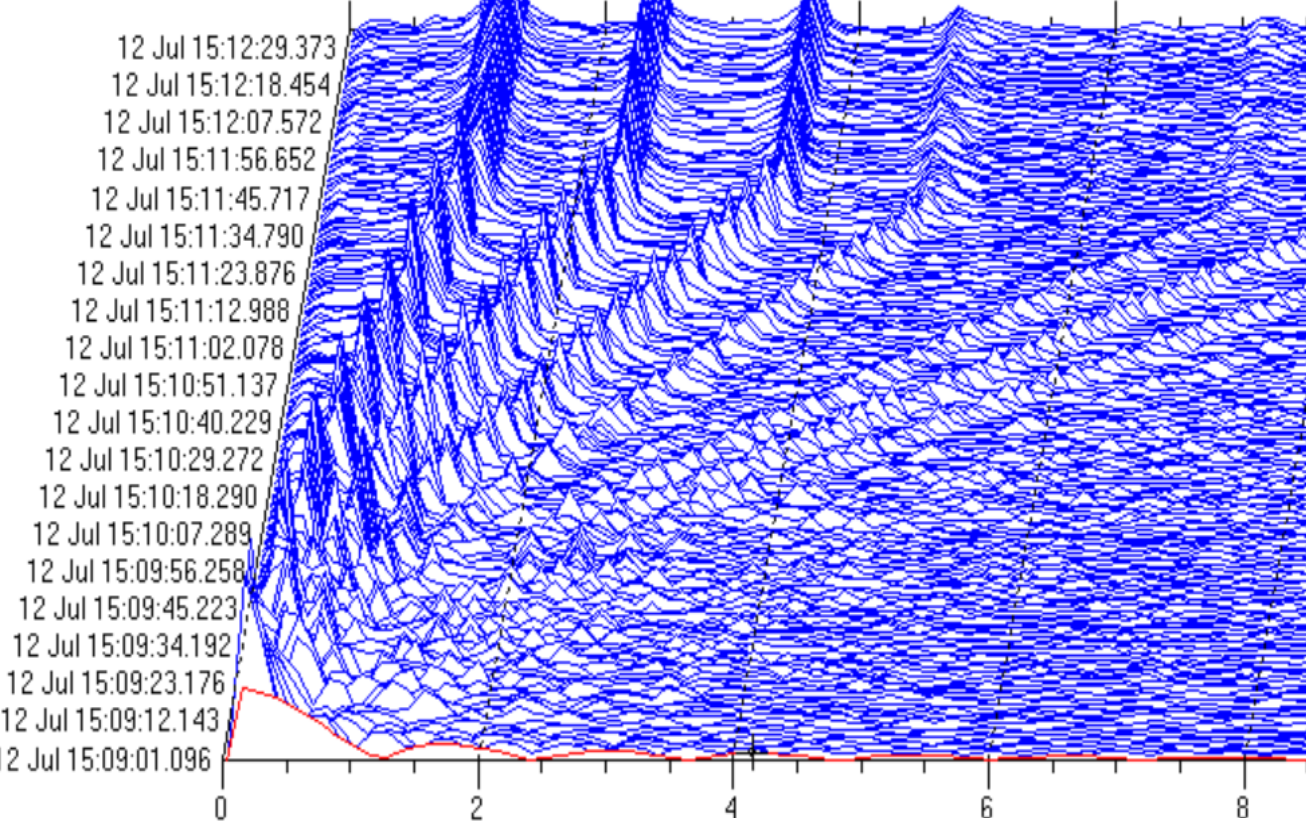
❖ Startup data for identifying Surge and Stall operations.

Summer Research Project

Data Acquired and Analysis: Vibration

Summer Research Project

Data Acquired and Analysis: Acoustics
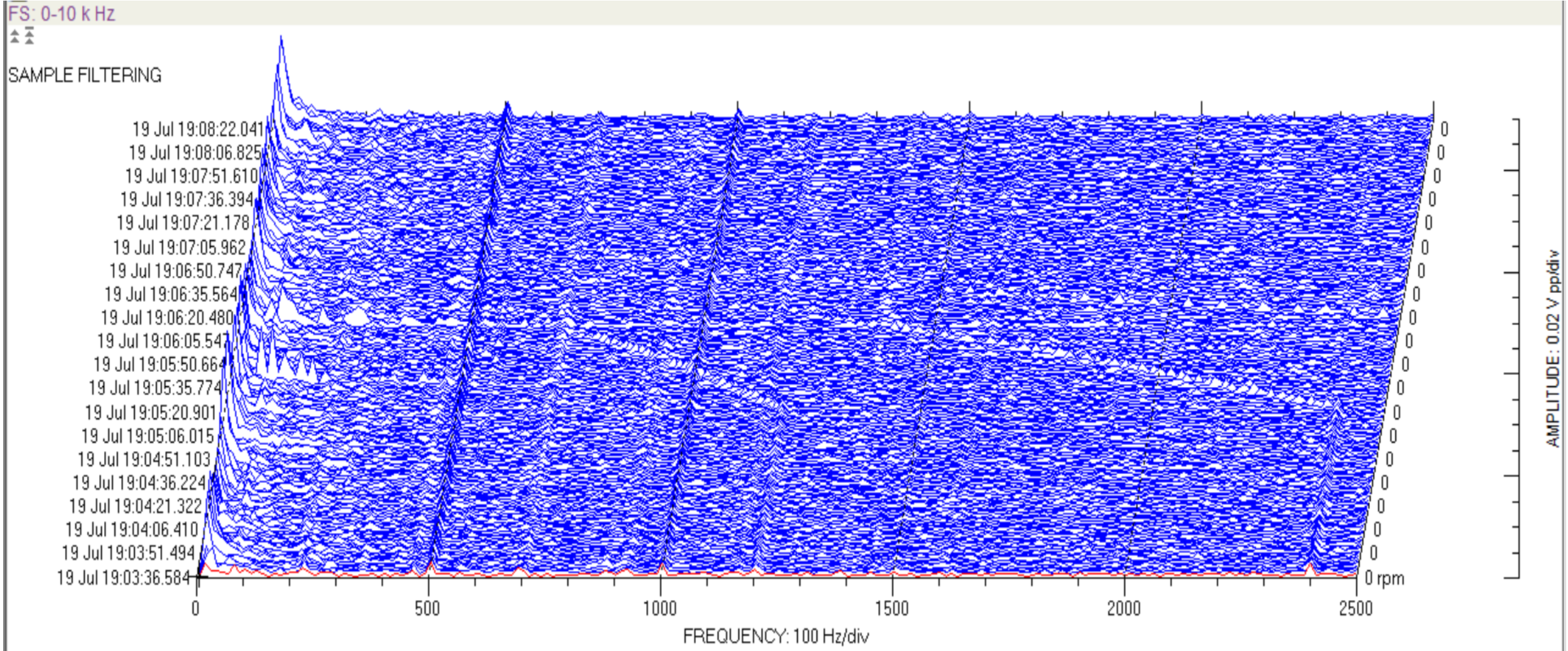
Conclusion

Acoustic and Vibration Data Acquisition for Surge & Stall Prediction

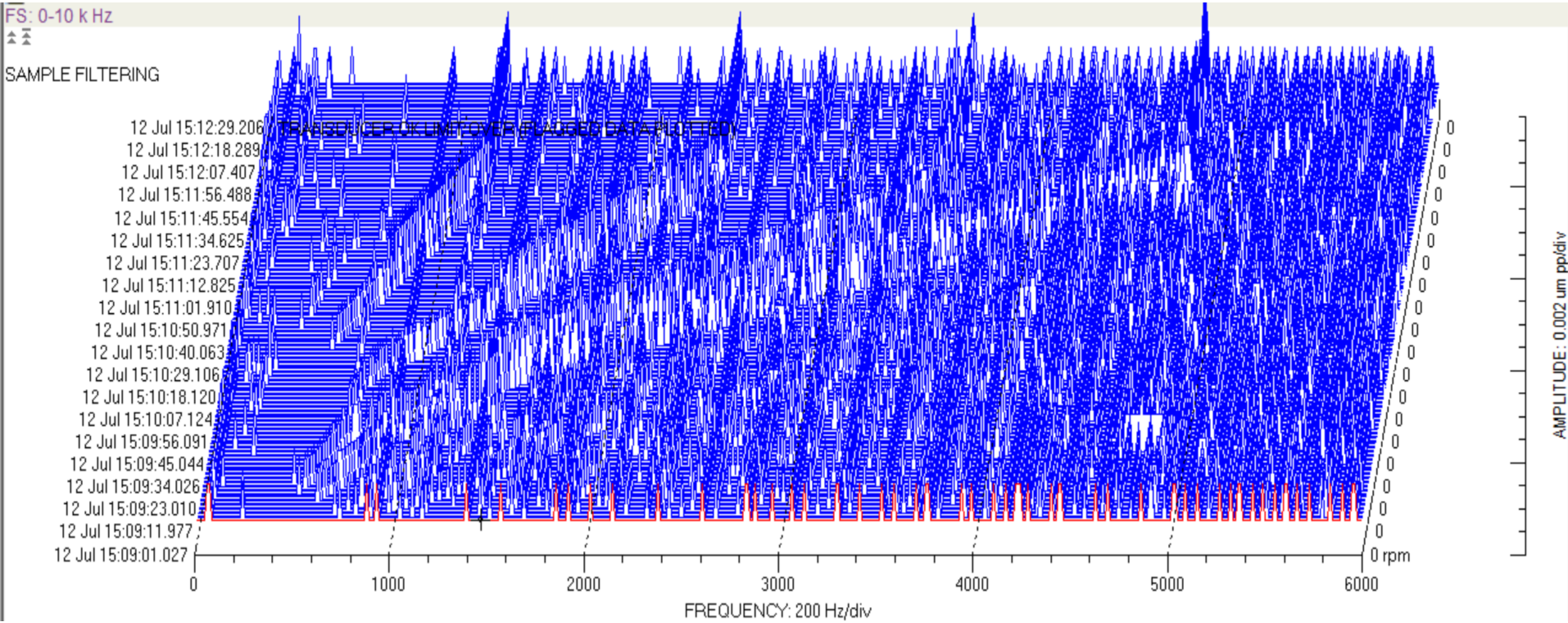❖ Frequencies lower than **5 kHz** were found to be appropriate to capture changes in speed/sound compared to frequencies at **50 kHz**.

❖ Speed and Vibrational data showed the largest oscillations during start up compared to acoustics with an **800 Hz** deference of the lowest point between all the sensor frequencies.

FREQUENCY: 200 Hz/div
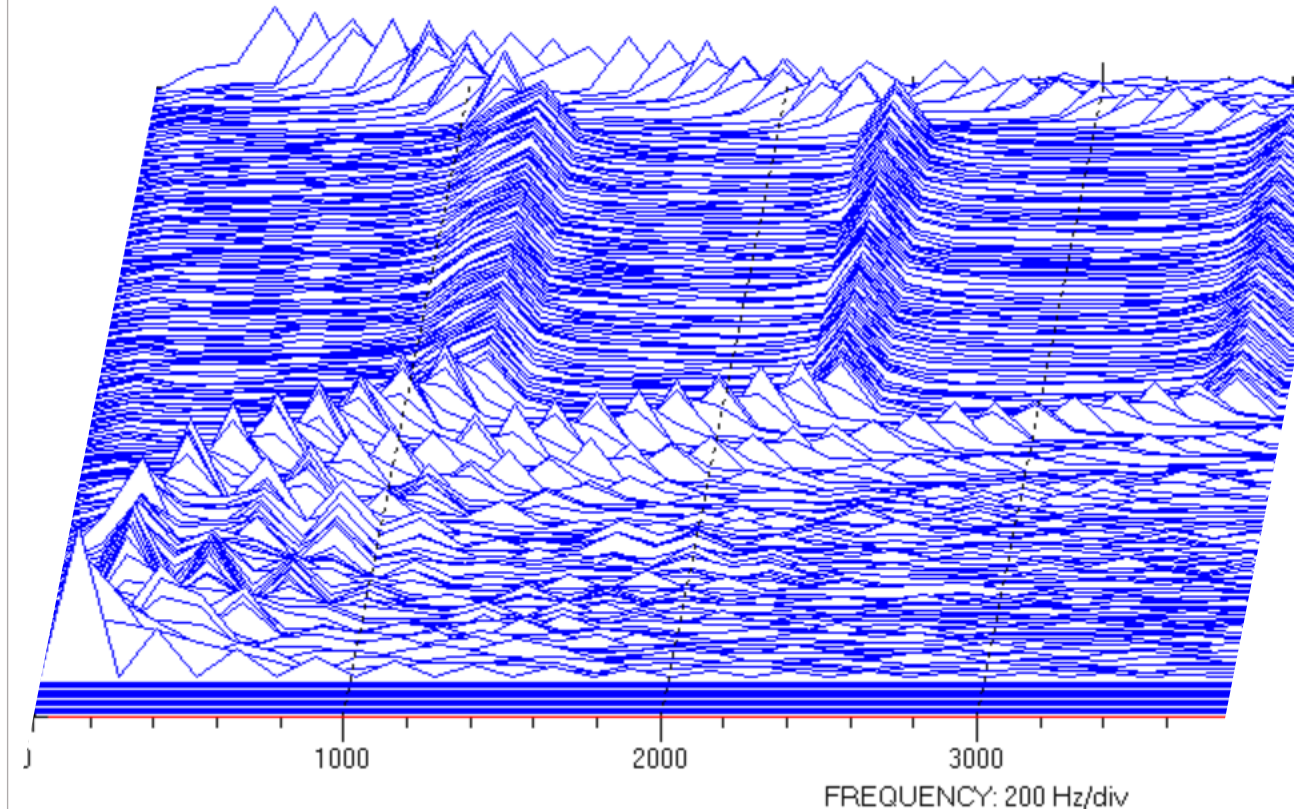
Future Work

Acoustic and Vibration Data Acquisition for Surge & Stall Prediction

❖ Design a program to open larger data files.

❖ Sensitivity analysis on frequencies lower than 5 kHz.

❖ Develop acoustic filters.

❖ Identify source of multiple frequencies captured.

❖ University of Genoa (Collaboration).

CHRES & NETL Research Program

Overall Research Experience

Disclaimer

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Thank you!