# Real-time Health monitoring of Gas Turbine Components Using Online Learning and High-dimensional Data

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## Introduction

Big Data analytics holds enormous potential for enabling reliable operation of power generating gas turbines and combined cycle plants.

**The objective** of this research is to develop a Big Data analytics framework for critical gas turbine components through systematic experimentation that leverages unique industry-class turbine test rigs.

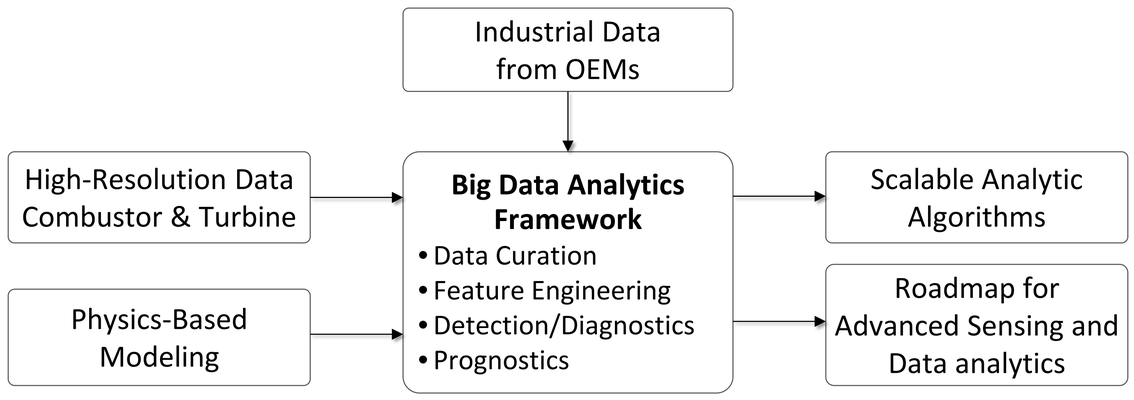


**Figure 1. Research Objective, Scope, and Deliverables**

## Experimental Plan

The Big Data analytics framework will provide the tools for synthesizing large volumes of data, extracting key fault features, and performing robust fault detection and life predictions. This will be supported by an extensive design-of-experiments that utilizes unique **industry-class testing facilities** at Georgia Tech and Penn State University, which target critical combustor and turbine faults.

## Combustor Faults

**Damaged Combustor Lining**
Temperature distributions, flow field features, and combustor acoustics.

**Altered Combustor Flow Paths**
Measure flame stability, emissions, and acoustics in a combustor

**Combustor Blowout**
Emissions and acoustics data, to develop LBO signatures

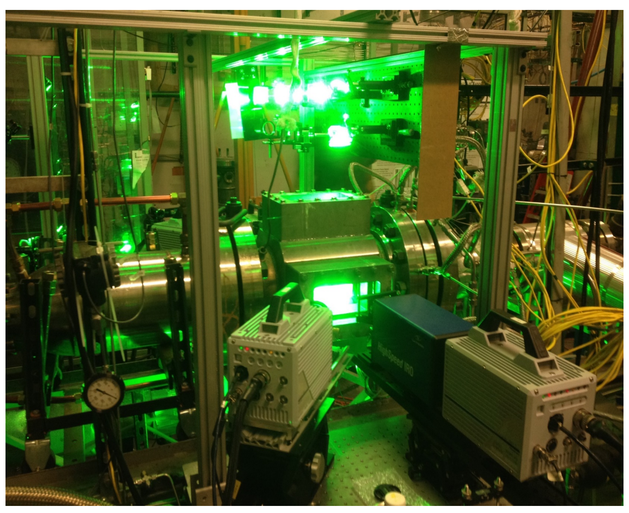

**Figure 2. Georgia Tech Combustor Fault Rig**

## Turbine Faults

**Inlet Temperature Transients**
Spatially-resolved and time-resolved blade temperatures

**Blade Coolant Loss**
Spatially-resolved and time-resolved heat flux

**Inter-stage Sealing Loss**
Sampling of $CO_2$ tracer gas

**Blade Tip Clearance**
Clearances adjusted by shaft placement; clearance probes

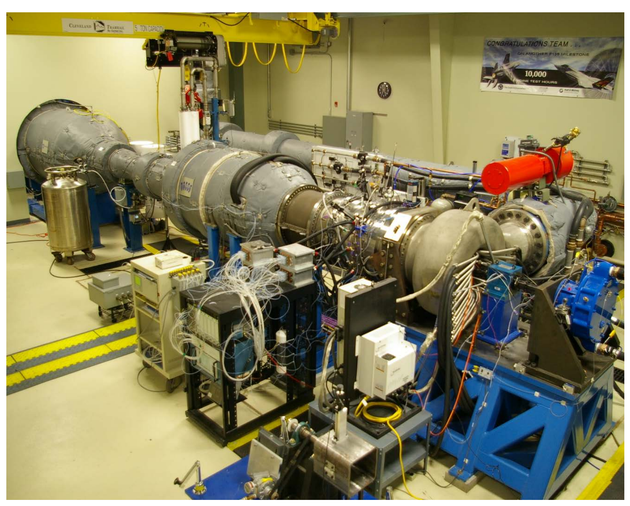

**Figure 3. PSU START Turbine Facility**

## Big Data Analytics for Gas Turbines

The proposed Big Data analytics methodology consists of four key components shown in Figure 4.

- Develop **Data Curation Procedures** that tackle data storage, data quality assessments, and integrity checks.
- Develop **Feature Engineering Tools** using physics-based models to guide data transformations and develop high-fidelity fault features
- Develop Machine learning-based **Fault Detection and Diagnostics Algorithms** that guarantee low false-alarm rates.
- Develop **Prognostic Models** for predicting and continuously updating remaining operational life of critical gas turbine components.

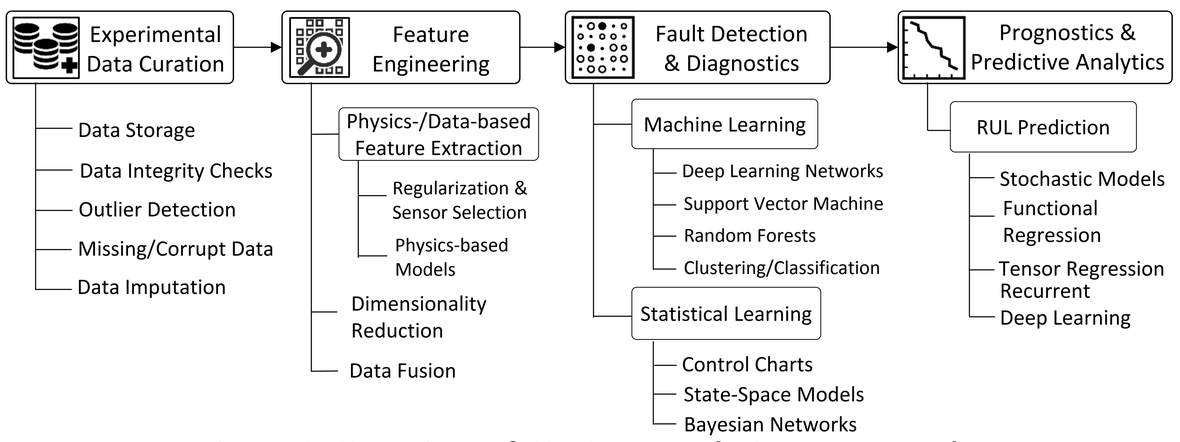


**Figure 4. Overview of Big Data Analytics Framework**

## Cloud-Based System Architecture

- A cloud-based architecture will be utilized for storing, sharing, and performing computations on Big Data.

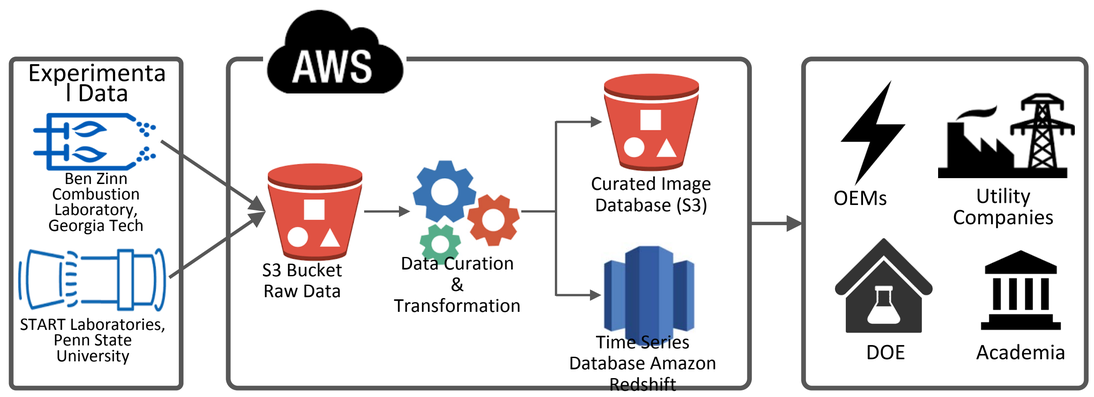


**Figure 5. Cloud-based System Architecture**

## Deliverables and Collaborative Opportunities

- In collaboration with our industry partners, the project is intended to generate public domain, industrially relevant data sets that the broader community can explore.
- Please contact us if you are interested in generating proprietary data sets and/or testing proprietary hardware that leverages the approaches developed in this program.

### Acknowledgments

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### References

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