DEMONSTRATION OF MULTI-GAMMA BASED SENSOR TECHNOLOGY FOR AS-FIRED COAL PROPERTY MANAGEMENT

(Award No. DE-FE00031750)

2020 Annual Project Review Meeting

Project Team :

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11/6/20

Acknowledgement – DOE NETL
Jessica Mullen – DOE NETL Project Manager

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U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

Presentation Overview

- **Project Information**
  - Project Team
  - Project Goal and Objectives
  - Project Structure and Schedule
- **Accomplishments**
  - MGA Sensor Lab Testing
  - Accumulation and Analysis Of Attenuation Signals
  - On-site Sensor Installation
  - MGA Data Acquisition and Processing System
- **Next Steps**

Project Team

- Technical Team:
  - Microbeam Technologies Inc.
  - Energy Technologies Inc.
  - Rochester Institute of Technology
    - Department of Software Engineering
- Funding Support:
  - U.S. Department of Energy, National Energy Technology Laboratory
  - Otter Tail Power's Coyote Station
  - Energy Technologies Inc.
  - Rochester Institute of Technology
- Project Support :
  - Minnkota Power's Milton R. Young Station
  - North American Coal Company

Project Goal

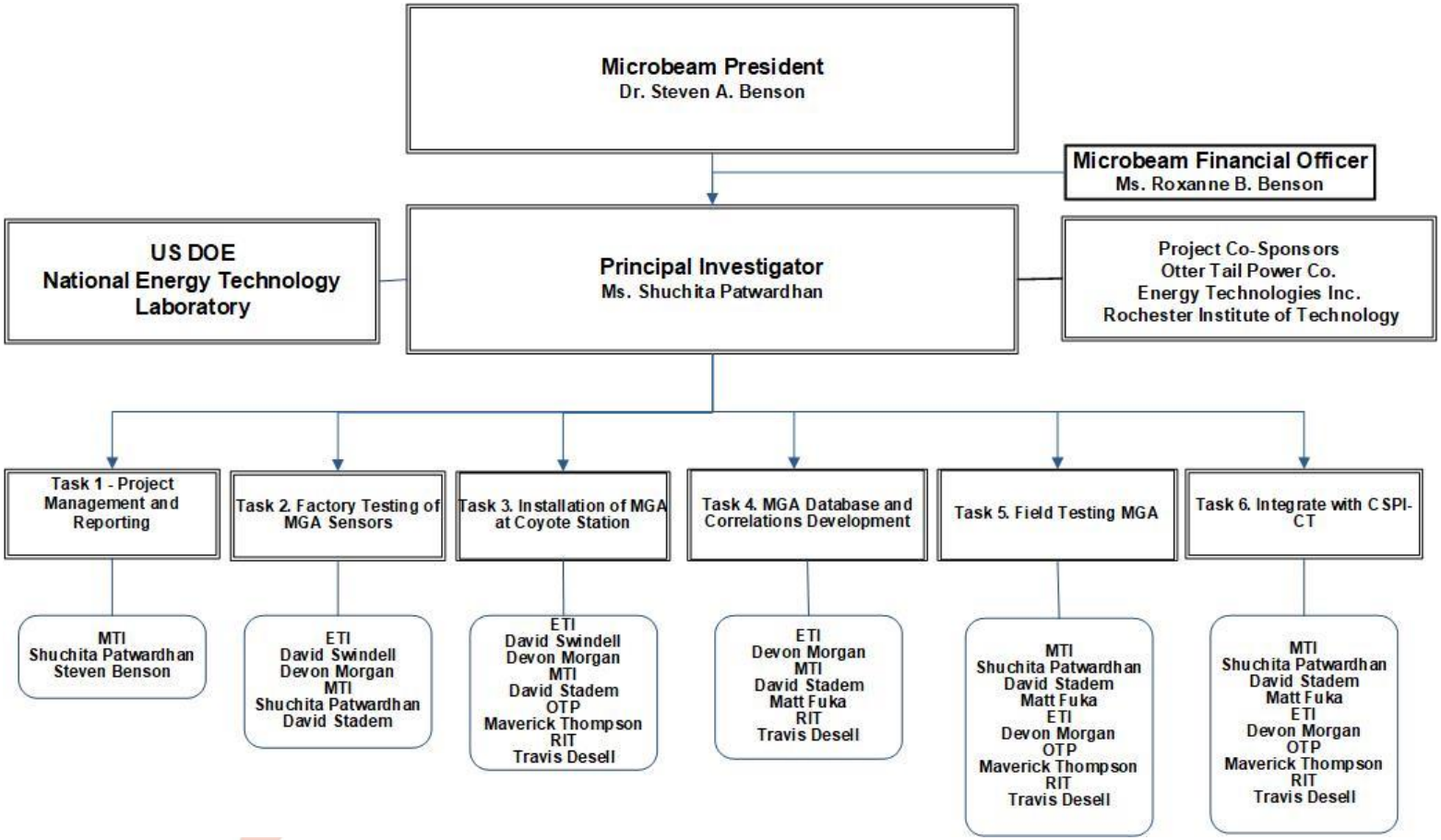
The overall goal of this project is to demonstrate the application of the use of an advanced multigamma attenuation (MGA) sensor to accurately and precisely measure coal properties at the point of injection into burners.

Objectives

- Test MGA sensors on a range of selected coal samples at ETI laboratories
- Accumulate and analyze attenuation signal information
- Develop relationships for coal quality parameters with statistical and neural network analysis
- Install MGA sensors on-site and develop MGA output database
- Develop MGA-FSEA correlations with neural networks and install MGA data augmented CSPI-CT on site
- Conduct a field test to validate augmented CSPI-CT findings
- Install a validated version of CSPI-CT on-site

FSEA – Full Stream Elemental Analyzer
CSPI-CT – Microbeam's Combustion System Performance Indices – CoalTracker program

Project Structure and Roles of Participants



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Schedule

			2019			2020											2021												2022								
	Start Date	End Date	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9
Task Dates			Budget Period 1																		Budget Period 2																
Task 1 - Project Management & Reporting	10/1/2019	9/30/2022																																				
Task 2 - Factory testing of MGA Sensors	11/1/2019	4/30/2020																																				
Task 3 - Installation of MGA at Coyote Station	3/1/2020	8/31/2020																																				
Task 4. MGA Database and Correlations Development	9/1/2020	3/31/2021																																				
Task 5. Field testing MGA	4/1/2021	4/30/2022																																				
Task 6. Integrate with CSPI-CT	5/1/2022	9/30/2022																																				

Total Project Length – 36 Months

Budget Period 1 – 10/1/2019 – 3/31/2021
Budget Period 2 – 4/1/2021 – 9/30/2022

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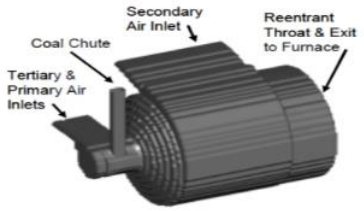
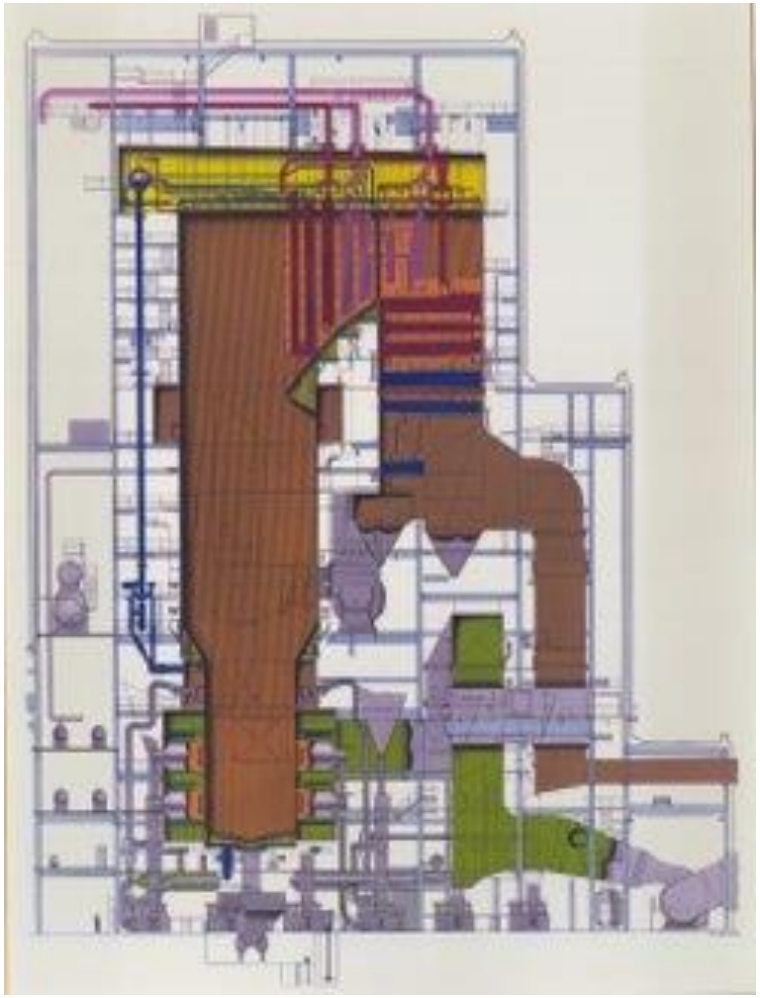
Testing Site



Primary site: Otter Tail Power's Coyote Station

- Cyclone Fired Boiler
- MW – 450
- Fuel – ND Lignite
- Daily fuel delivery – 7000 - 12000 tons of coal – 2.5 million tons of lignite annual consumption – Mine mouth plant



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Technology

- On-line analyzer adapted for analysis of coal flowing through feed pipes to burners that utilizes multi-energy gamma attenuation measurements of fuel properties that include heating value, ash content, and selected ash-forming components.
- System calibrated to different inorganic components through machine learning that contribute to the total ash composition.
- The core of the technology is a multi-energy gamma attenuation (MGA) source.
- This source improves the accuracy and precision of measuring the ash-forming materials for full-stream fuel delivery applications.

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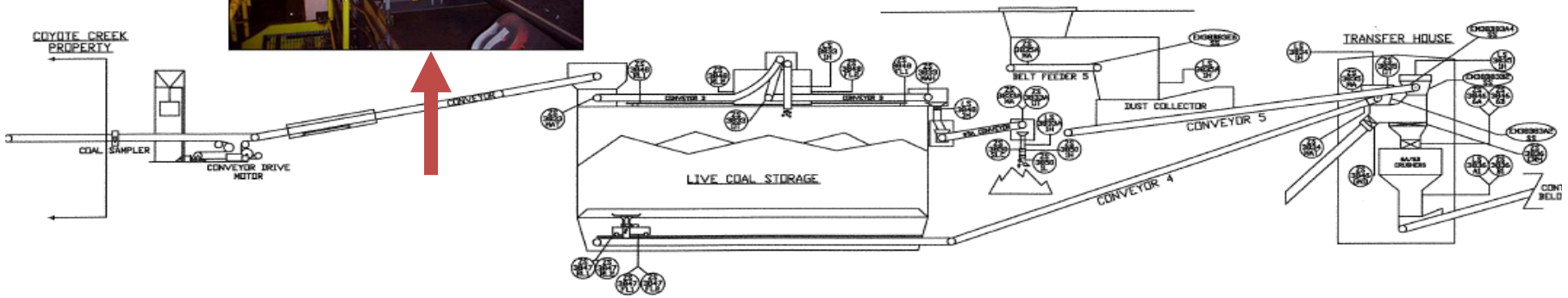
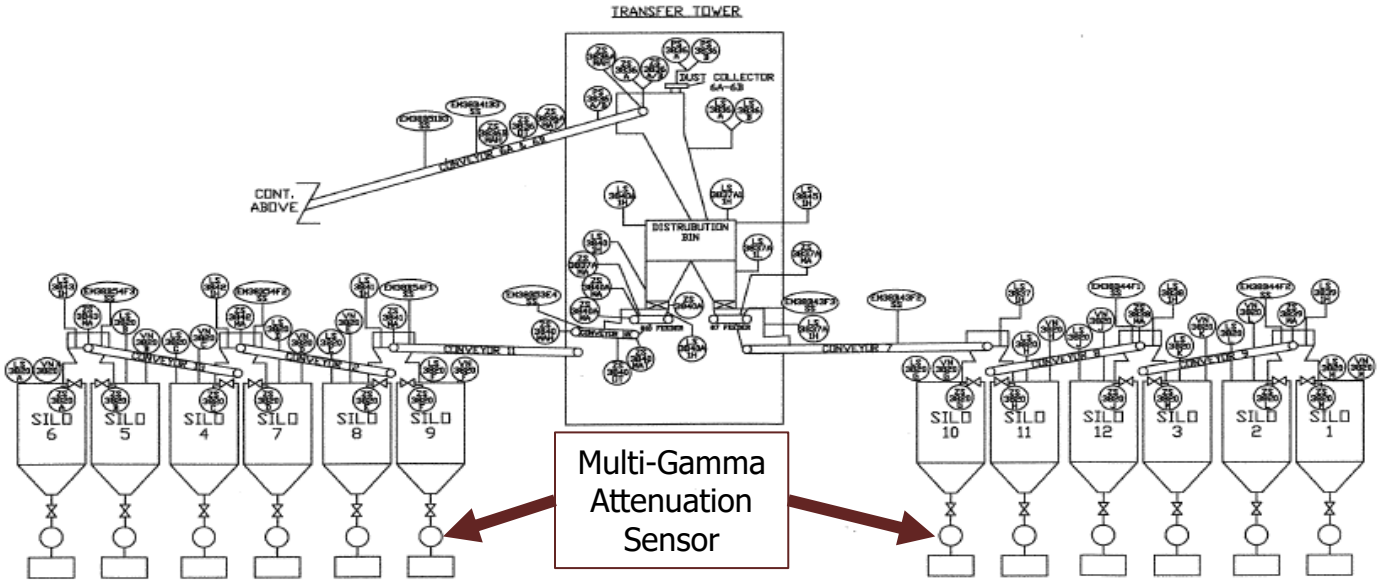
OtterTail Power's Coyote Station's Coal Handling System





Task Structure

Task 1 - Project Management and Reporting

Task 2 - Factory Testing of MGA Sensors

Task 3 - Installation of MGA at Power Plant

Task 4 - MGA Database and Correlations Development

Task 5 - MGA Field Test

Task 6 - Integrate with CSPI-CT

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Task 1
Project Management and Reporting

- Kick-off Meeting
- Project Management Plan
- Monthly Meetings
- Quarterly Reports
- MGA Factory Test Report
- Workforce Readiness Plan
- Field Test Report
- Commercialization Plan

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Task 1 Updates

- Monthly reports to DOE
- 4 quarterly reports submitted to DOE
- Factory acceptance test report submitted on 5/31/2020
- MGA Sensor Installation – delayed due to COVID-19

Task 2
Factory Testing of MGA Sensors

- Subtask 2.1 – MGA Setup in ETI Laboratories
- Subtask 2.2 – Identification of a range of lignite/test samples
- Subtask 2.3 – Accumulation of attenuation signals
- Subtask 2.4 – Analyze attenuation information
- Subtask 2.5 – Develop relationships/fingerprints for coal quality parameters

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Factory Testing Setup

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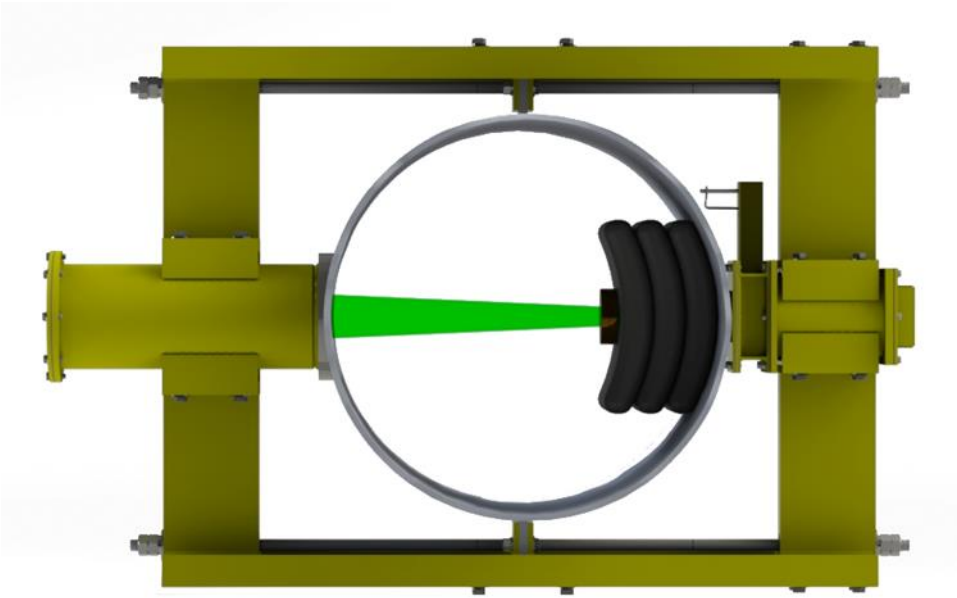
MGA Source Beam

Detector



Source

Lab Testing

- Empty pipe testing
- Coal placement optimization
- Coal thickness optimization
- Data acquisition time
- Fine tuning of data acquisition system

Test Matrix

- Coal composition database was developed
- Twenty-six coal samples selected for testing
  - Ten lignite coals
  - Nine sub-bituminous coals
  - 6 bituminous coals
  - One coal of un-identified rank

Lab Testing

- 110 Runs Complete
  - 26 coal sample runs
  - 79 runs with spiking elements
  - 3 runs with clay minerals
  - 3 runs with different petri-dish placement

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Task 3
Installation of MGA at Coyote Station

- Subtask 3.1 Design of MGA Sensor Frame and housing
- Subtask 3.2 Identification of installation locations and install
- Subtask 3.3 Set up data compilation system

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Coyote Feeder Pipe – Sensor Installation – Aug 2020

- Sensors installed in August 2020.
- Sensors will be upgraded in 2021.

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Field Test

Date	Condition	Time	Feeder Pipe 3	Feeder Pipe 10	Slag Samples	Fabric Filter/Hopper Ash Samples
25-Aug-20	D1C1	3:00 PM	X	X	X	X
	D1C2	6:00 PM	X	X	X	X
	D1C3	9:00 PM	X	X	X	X
26-Aug-20	D2C1	12:00 AM	X	X	X	X
	D2C2	3:00 AM	X	X	X	X
	D2C3	6:00 AM	X	X	X	X
	D2C4	9:00 AM	X	X	X	X
	D2C5	12:00 PM	X	X	X	X
	D2C6	3:00 PM	X	X	X	X
	D2C7	6:00 PM	X	X	X	X
	D2C8	9:00 PM	X	X	X	X
27-Aug-20	D3C1	12:00 AM	X	X	X	X
	D3C2	3:00 AM	X	X	X	X
	D3C3	6:00 AM	X	X	X	X

- Collected 26 coal samples, 13 slag samples and 13 fly ash samples
- Plant operations – full load with relatively steady operation.
- Working on sample analysis.

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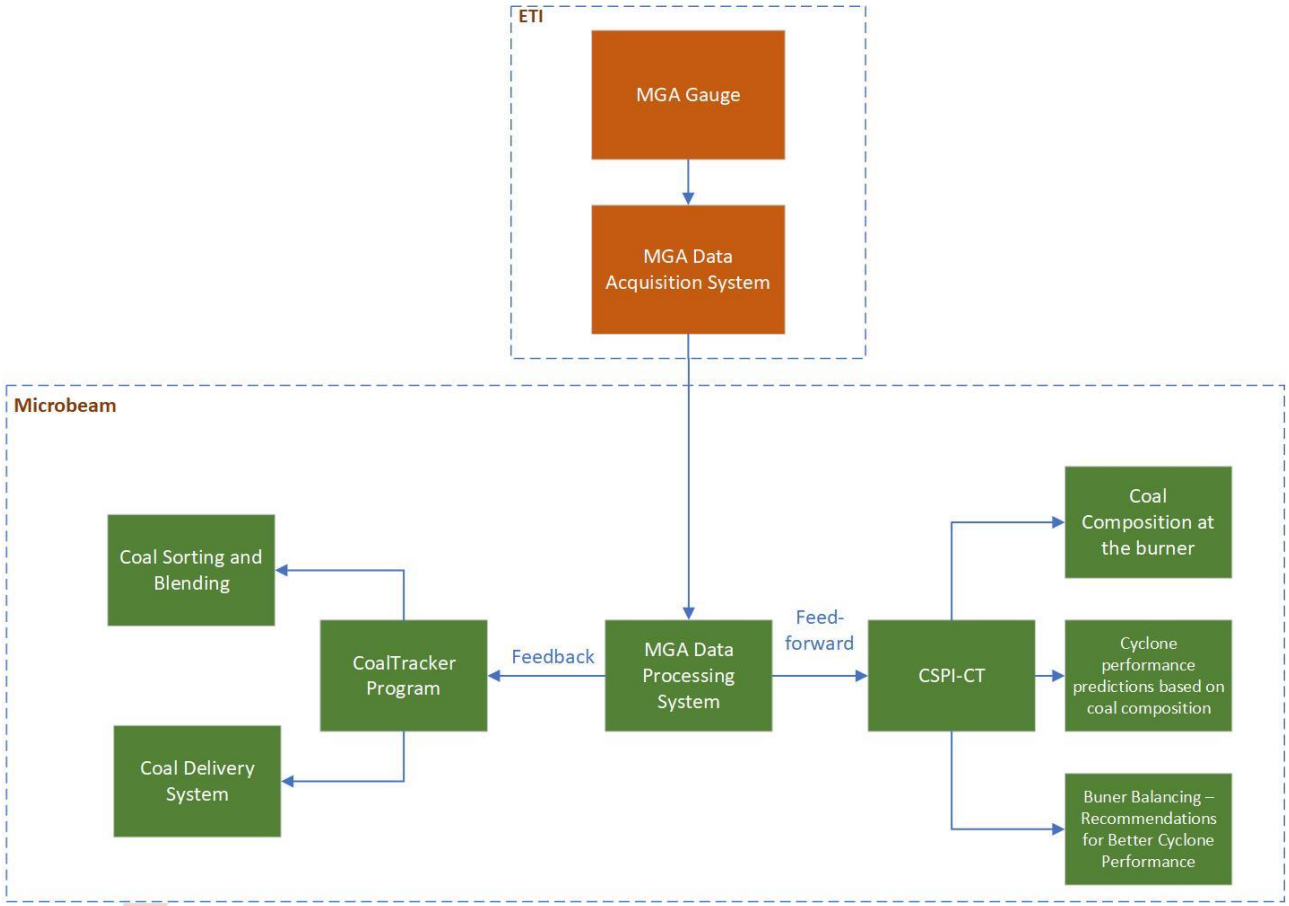
MGA Data Acquisition and Processing System



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Milestone

Budget Period	Task Number	Milestone Description	Planned Completion	Completion	Verification Method
1	1	Update PMP	10/30/2019	10/24/2019	PMP File
1	1	Kick-off meeting	10/17/2019	10/17/2019	Kick-off slides
1	2	MGA Factory Test Report	5/30/2020	5/30/2020	Report File
1	3	MGA Sensor Installation	6/30/2020*		Quarterly Report
1	3	Data Compilation System Setup	8/31/2020*		Quarterly Report
1	3	Workforce Readiness Plan	10/1/2020*		Report File
1	4	CoalTracker upgrade with MGA –FSEA Correlation Integration	3/31/2021		Quarterly Report
2	5	Field Test Report	11/30/2021		Report File
2	6	CSPI-CT 2.0 Installation	8/30/2022		Quarterly Report
2	6	Commercialization Plan	9/30/2022		Report File
2	6	Final Report	9/30/2022		Report File

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*Delayed due to Covid-19.

Questions?

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