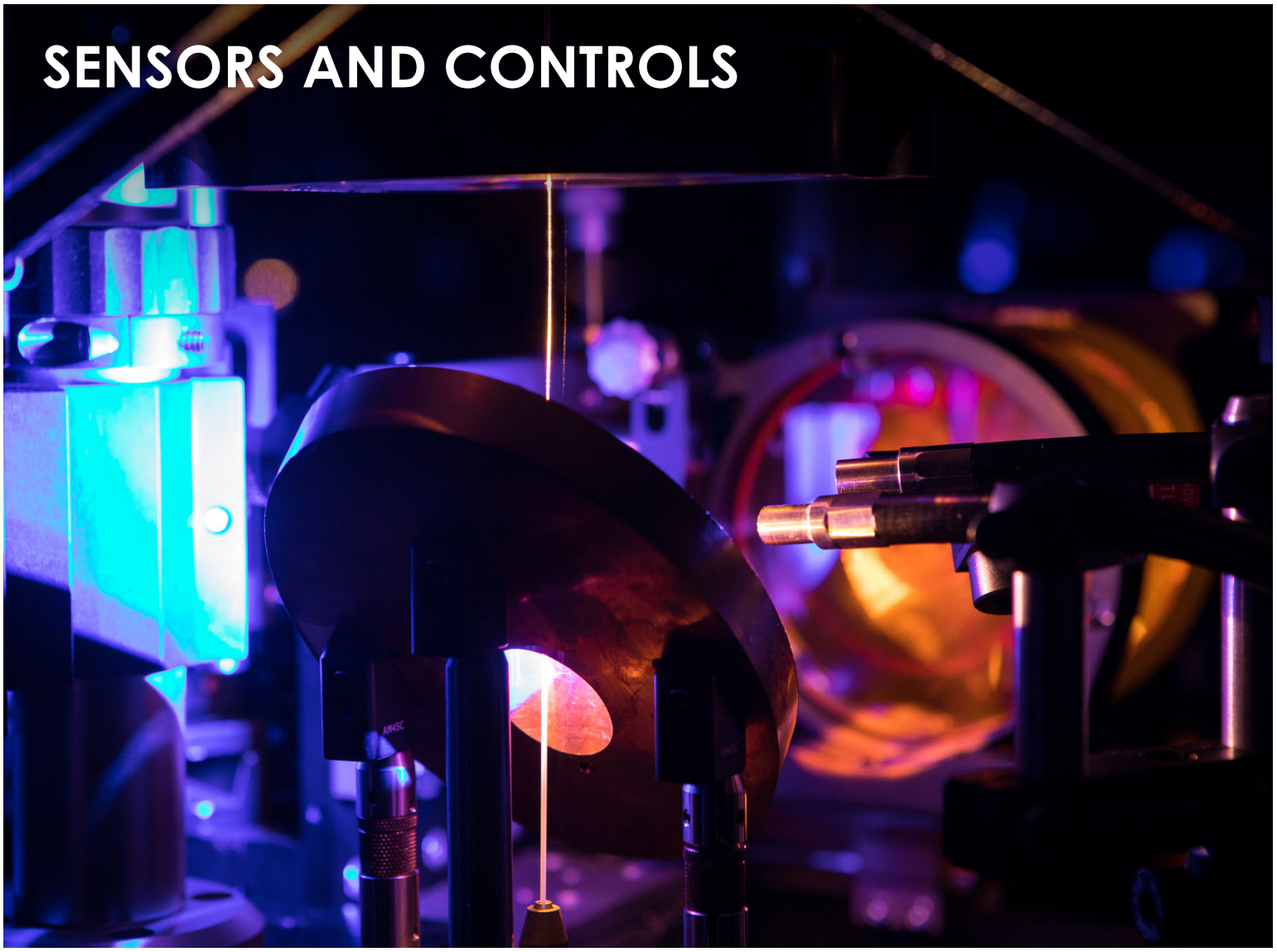
SENSORS AND CONTROLS



NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

The **Sensors and Controls technology program within the Crosscutting Research Portfolio** provides pivotal insights into optimizing plant performance, reliability and availability while utilizing and furthering technological megatrends, such as advanced manufacturing processes and Industry 4.0 principles.

Sensor research is investigating a range of advanced manufacturing techniques to determine the feasibility of embedding sensors, capable of operation in extreme environments and outfitted with condition-based monitoring algorithms, into turbine blades, boiler walls, piping, and tubing to predict component failure, anticipate maintenance needs, and reduce plant downtime.

Controls research is advancing the accuracy of artificial and distributed intelligence systems for process control, automation, and fault detection. The ability to monitor key plant parameters and align results in real time with self-organizing information networks will enable decision-makers to improve operational efficiency during challenging transient conditions, increase plant availability and dispatch, tighten cybersecurity and environmental control, and improve plant revenue profiles.

SENSORS AND CONTROLS

This program is exploring advances within, and the integration of technologies across, the following primary platforms:

- Advanced Sensors
- Distributed Intelligent Controls
- Cybersecurity

ADVANCED SENSORS — Researchers are devoted to creating novel sensor concepts that include optical, micro, and wireless sensors that can be embedded into several plant components using advanced manufacturing techniques. Advanced manufacturing techniques under investigation offer the potential to enable the design and rapid, cost-effective reproduction and wide distribution of new and novel sensors; amplify the ability to monitor key components and transmit data to a distributed network in real-time; and assist in improving plant efficiency, reliability and availability. Innovative approaches to sensing technologies, advances in manufacturing, and the timely utilization of sensor data have the potential to be transformative to the energy landscape, optimizing plant performance and increasing the expected life cycle of materials.

DISTRIBUTED INTELLIGENT CONTROLS — After sensors collect data from the power plants, the distributed control network then processes the data and delivers information to improve and reinforce decision-making. Research in this area is developing systems with fast dynamics for non-steady state operation and incorporating controls capable of handling systems that are inherently non-linear using real-time data. Using a dynamic process of highly integrated sensors, allows for increased control of the power plant and is more robust than the current slate of linear model predictive control algorithms. Research is also exploring sensor placement to improve performance, management and cost of the entire control system, and to further optimize cognitive capabilities.

CYBERSECURITY — US Power Generation assets are increasingly vulnerable to malicious attack both from insider threats and cybercriminals. Digital automation trends involving the addition of numerous distributed sensing nodes to the power plant, the communication of data – often wirelessly, and the multitude of data available to the operators creates a situation where automated data analytics and controls are essential both to optimize plant operability as well as mitigate malicious behavior. Research is underway to better define and prioritize the threat landscape for fossil power generation and developing innovative technology solutions to the most critical challenges. Additional research is focused on creating situational awareness tools to aid utilities in understanding when a cyberintrusion has occurred and in blockchain technologies that can harden data communication.

SENSORS AND CONTROLS RESEARCH UTILIZES ADVANCED TECHNOLOGICAL TRENDS TO IMPROVE POWER PLANT PERFORMANCE:

- Sensors and controls provide the basis for plant optimization and digitization strategies.
- Advanced data analytics, such as machine learning algorithms, facilitate optimization of plant control and operations.
- Advanced manufacturing techniques enable a digital supply chain that can cost-effectively create and embed sensors at a power plant.
- Advanced sensors require state-of-the-art cybersecurity systems as utilities deploy thousands of new smart parts to enable a cognizant, resilient control system.
- Cybersecure technologies enhance utility situational awareness and harden vulnerable communication infrastructure.

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