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# Enabling Autonomous Labs: The NSDF-ORNL Partnership for Real-Time Scientific Discovery

Autonomous labs are transforming scientific discovery by combining experimental steering, AI at the edge, real-time data movement, and in-situ decision making. Recent advances in these individual domains have made autonomous labs possible; however, the next major challenge is to break down disciplinary silos and build integrated ecosystems that make autonomous science accessible, scalable, and sustainable.

This talk highlights the successful collaboration between the National Science Data Fabric (NSDF) and the IN-TERSECT initiative at Oak Ridge National Laboratory (ORNL), advancing real-time monitoring and steering of autonomous experiments. We present a modular, multi-service architecture integrating NSDF capabilities for message processing, live visualization dashboards, and persistent cloud storage. These services are actively deployed at ORNL and CHESS, supporting autonomous neutron diffraction, quantum materials workflows, flow chemistry, smart manufacturing, and energy systems. Designed for portability and scalability, NSDF's containerized, Kubernetes-orchestrated infrastructure enables FAIR, AI-ready workflows that empower domain scientists, foster interdisciplinary research, and accelerate discovery through reusable and shareable data systems.

## Topical Area

AI and data science

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