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Advancing Digital Twin Development of Research Reactors Through a Shared Platform

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U.S. Department of Energy's Office of Nuclear Energy

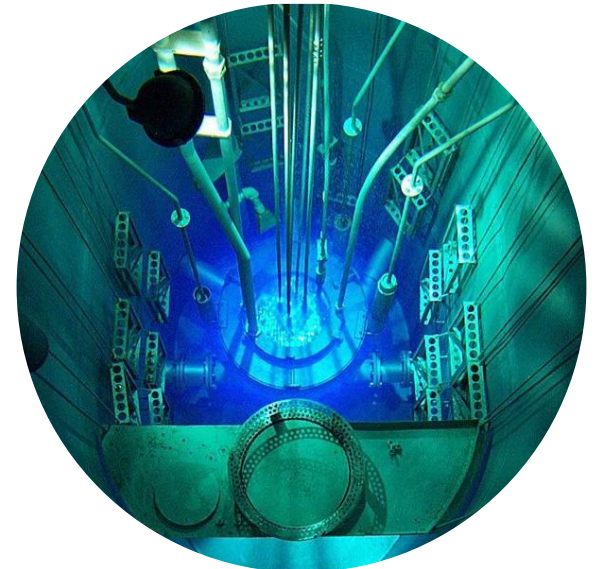
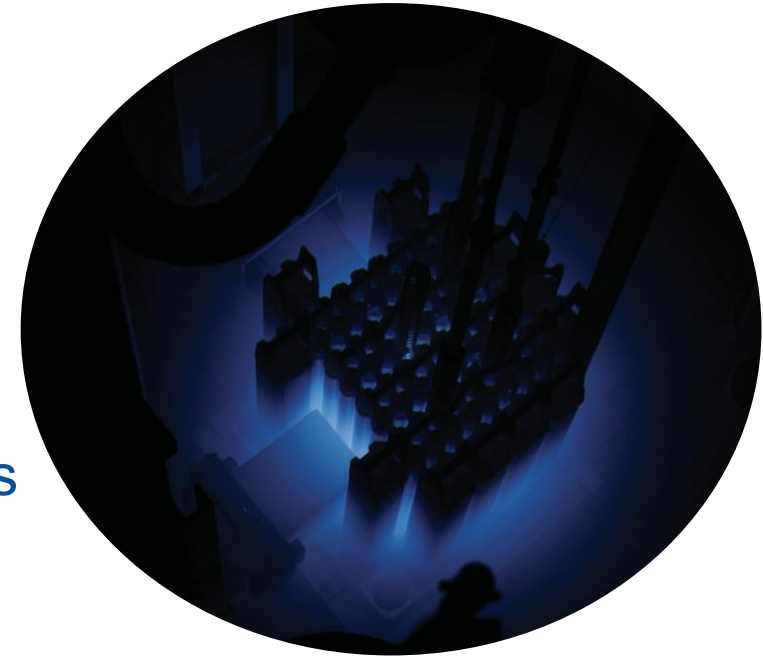


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The Problem We All Share

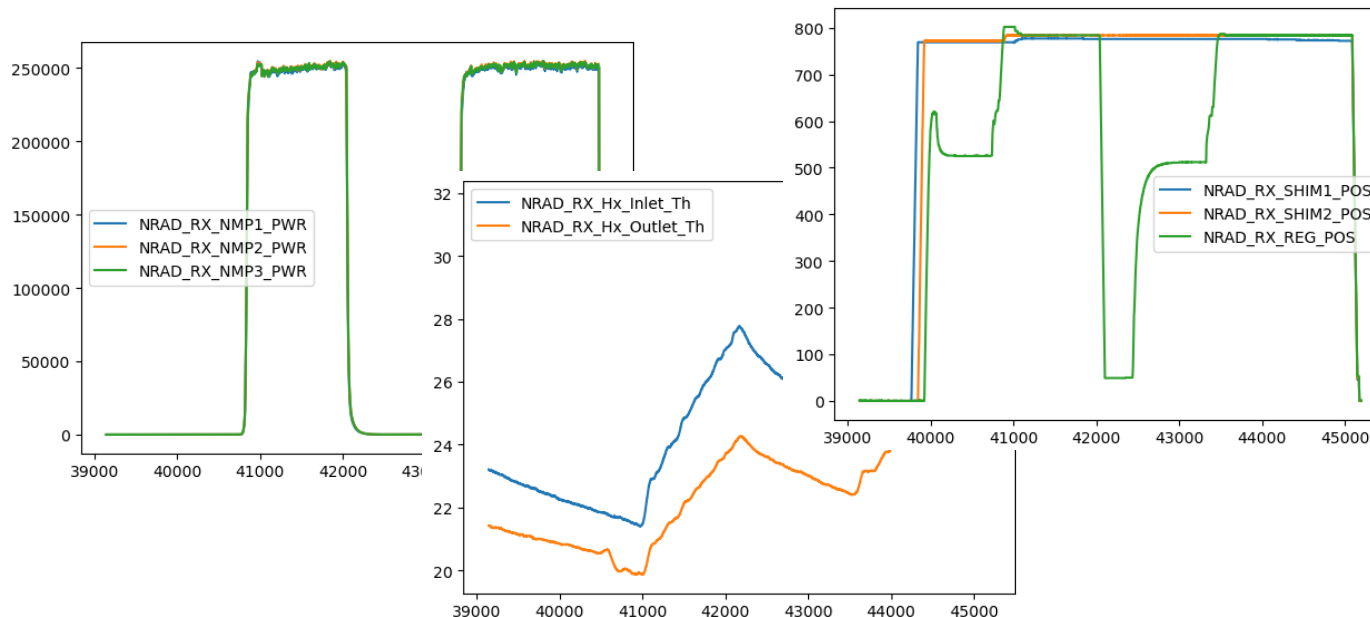
- Researchers working towards a digital twin share the same core problems: data ingestions, physics and machine learning modeling, and human machine interfaces
- Digital twin development isn't just a modeling problem: multiple stakeholders (experimentalists, operators, and modeling & simulation experts) see different aspects
- Our goal is to help bring these groups together to accelerated digital twin development
- A shared platform helps address both of these issues

Discussion: What are the greatest challenges experienced by your teams: rebuilding something others have done or ensuring a common language among stakeholder.



Shared Benchmarks

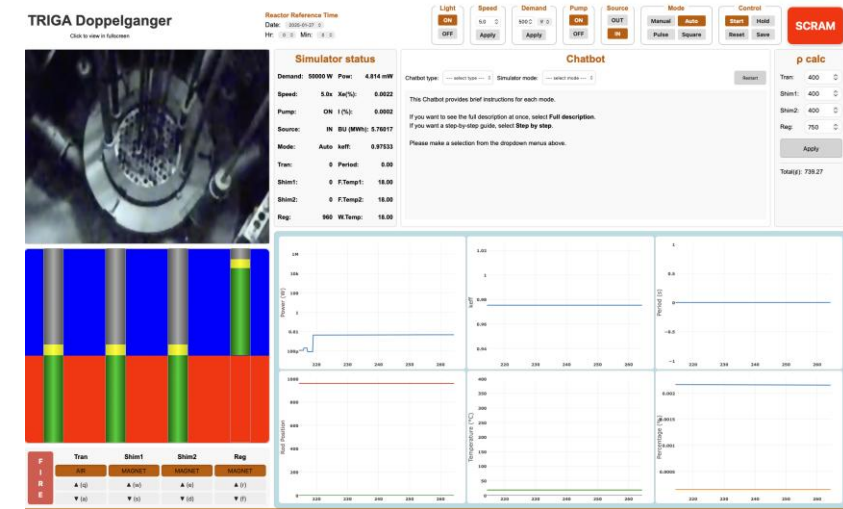
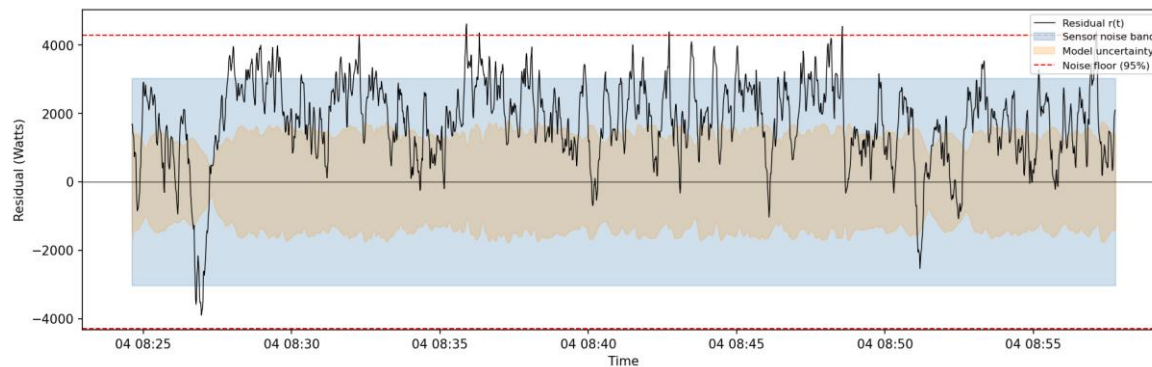
- **Goal:** Provide shared open-source data sets to provide “real-world” operational data that captures basic operations, and interesting transients
 - Power readings, control rod positions, coolant temperatures, etc.
 - Ensure no one has to train on synthetic data alone



Discussion: It is also okay **not** to share data, but what is stopping data from being shared? Is it technical, policy, or just nobody has asked?

Shared Tooling, Not Shared Answers

- **Goal:** Showcase what methods are useful for reactor physics, machine learning, statistical analyses, control, etc.
- We are **not proposing** we all use the same architecture or models
- We **are proposing** not everyone builds the same pieces from scratch (i.e. ingestion pipelines, model scaffolding, HMI templates)



Discussion: If one piece of this were open-sourced tomorrow, which pieces would be most valuable, and would you use?

Trust Across Institutions and Stakeholders

- **Goal:** Amalgamation of data streams and lessons learned that can be used for building trust among stakeholders and provide opportunities for federated learning
- Example:
 - Pantheon project data ingestion (UT-Austin & Oregon State)
 - Concept of Operations, Test Plans, regulatory adherence strategies

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**Concept of Operations for
Keeper—At Build for
Human in the Loop Testing**

January 2026

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Discussion: What does each stakeholder need to see before trusting a digital twin of a nuclear system? What are the barriers to trust?

What do you actually want from this?

- **Goal:** Understand what you want from a digital twin of a reactor
- Examples:
 - Monitoring
 - Autonomous Control
 - Improved Operational Planning (i.e. experiments)
 - Design of Experiments
 - Power Upgrades
 - Proof of Principle for DT designs
 - Determination what an Experiment Experienced During Operations

Discussion: Which aspects are important to your research interests? What are we missing?

Questions?

- What are the greatest challenges experienced by your teams: rebuilding something others have done or ensuring a common language among stakeholder?
- It is also okay **not** to share data, but what is stopping data from being shared? Is it technical, policy, or just nobody has asked?
- If one piece of this were open-sourced tomorrow, which pieces would be most valuable, and would you use?
- What does each stakeholder need to see before trusting a digital twin of a nuclear system? What are the barriers to trust?
- Which aspects are important to your research interests? What are we missing?



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