RADIATION IMAGING AND NUCLEAR SENSING LABORATORY

PURDUE UNIVERSITY

AI/ML for a Digital Twin of the Purdue Reactor PUR-1

2023 ASI Workshop

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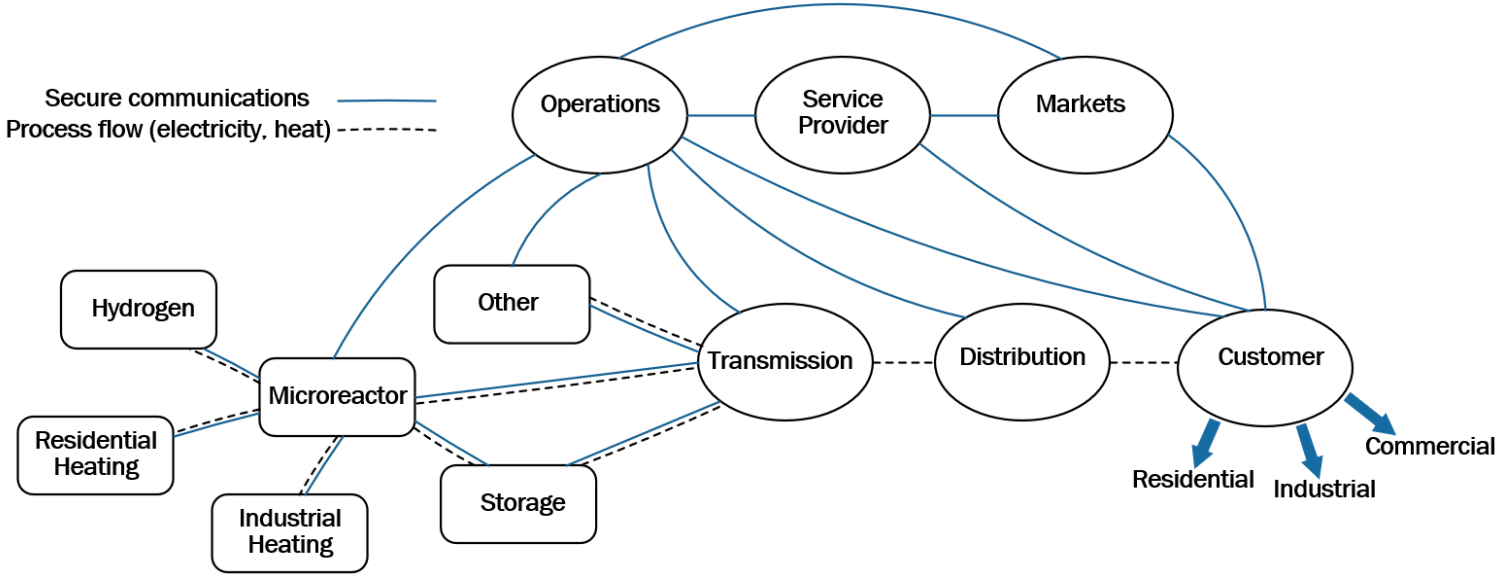
Team Info

- **Purdue**
  - Stylianos Chatzidakis (Assistant Professor and Associate Reactor Director, SRO)
  - True Miller (Reactor supervisor, SRO)
  - Brian Jowers (Electronics/I&C reactor staff, RO)
  - V. Theos, Z. Dahm, K. Vasili, K. Gkouliaras, W. Richards (Grad students)
- **UNM**
  - Mohamed El-Genk (Professor)
  - Timothy Schriener (Research Assistant Professor)
- **Collaborators**
  - Robert Ammon (Curtiss-Wright)
  - Rick Vilim (ANL)
- **TPOC:** Ben Baker (INL)

New technologies…new challenges



New reactor concepts => Significantly different requirements than existing fuel cycle facilities

Digitalization => New architectures and new vulnerabilities

New technologies => Quantum computing Adversaries now have access to new tools with unprecedent capabilities

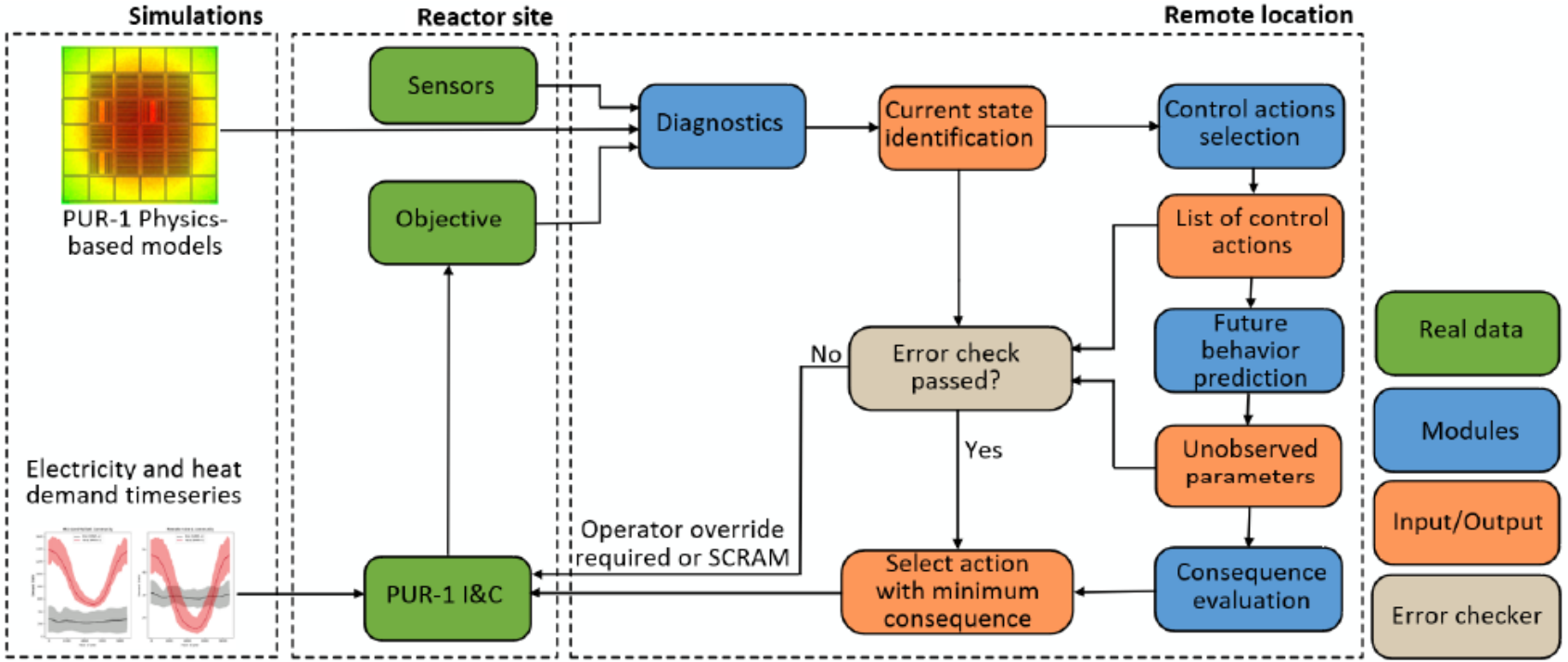
Goals & Objectives

Goal: Experimentally validate semi-autonomous control and demonstrate its use in PUR-1.

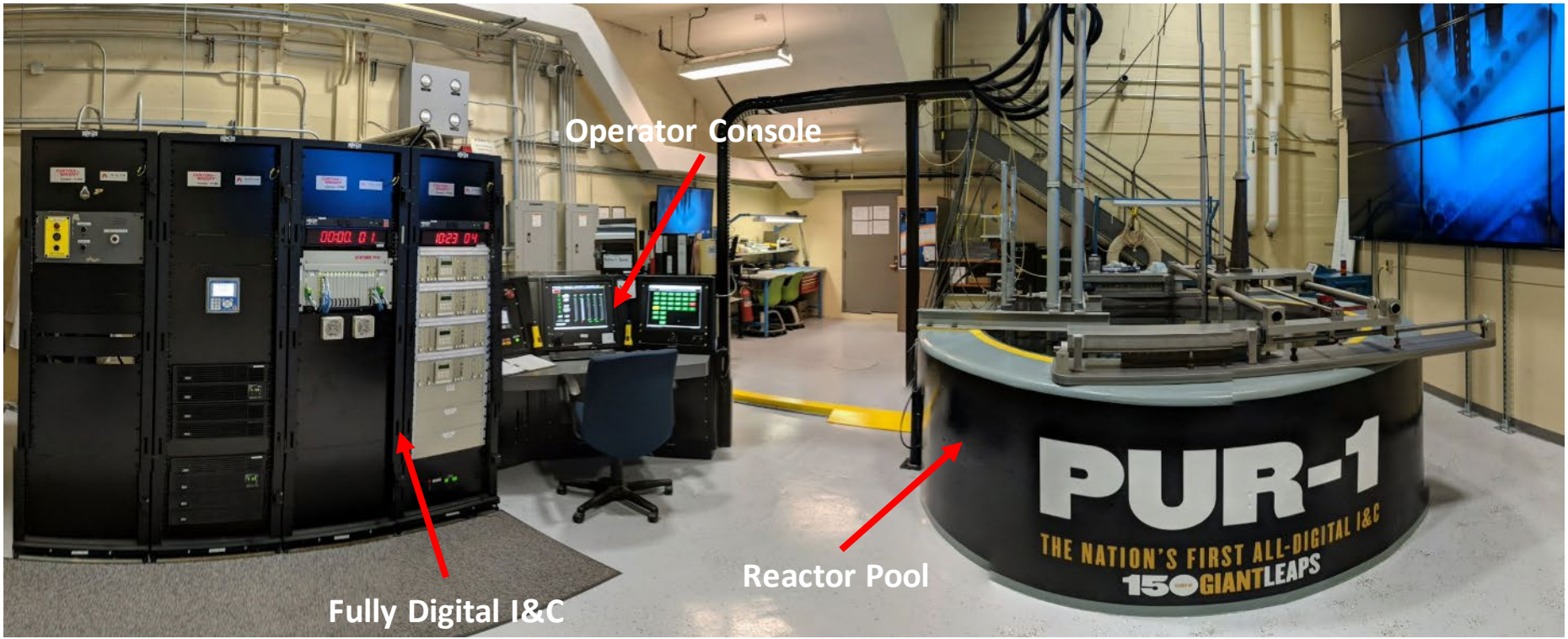
Objectives:

1. Develop a modular digital twin platform with various levels of automation using a remote workstation with AI/ML algorithms
2. Train AI/ML using physics-based microreactor models and real-time digital operation data collected from PUR-1
3. Perform testing and evaluate performance

Semi-autonomous Architecture



Introducing PUR-1

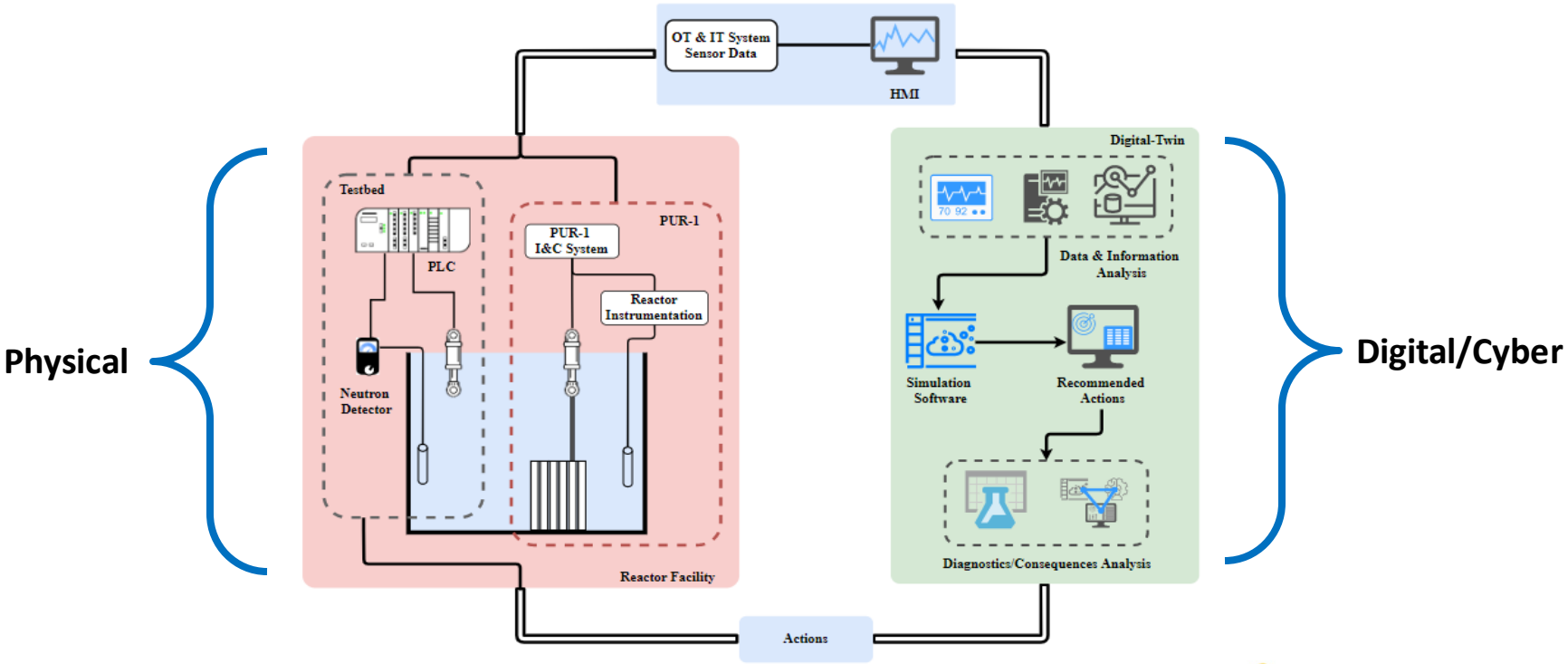


Before and after…

1960 - 2017

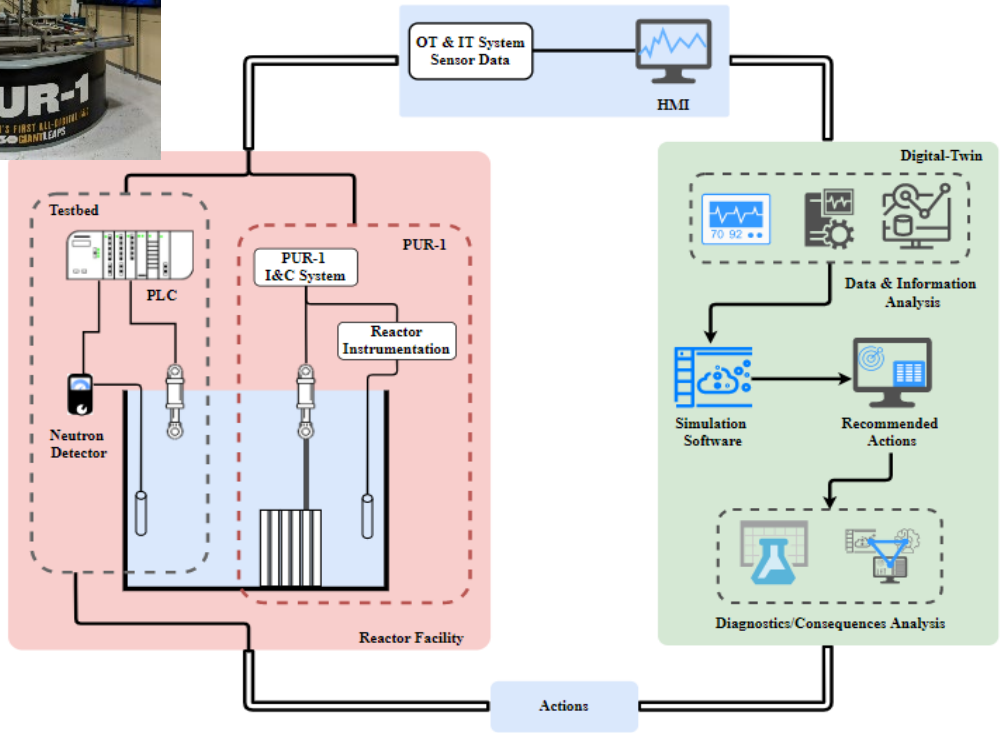
2019 - present

Towards a Real-Time Cyber-Physical Digital Twin



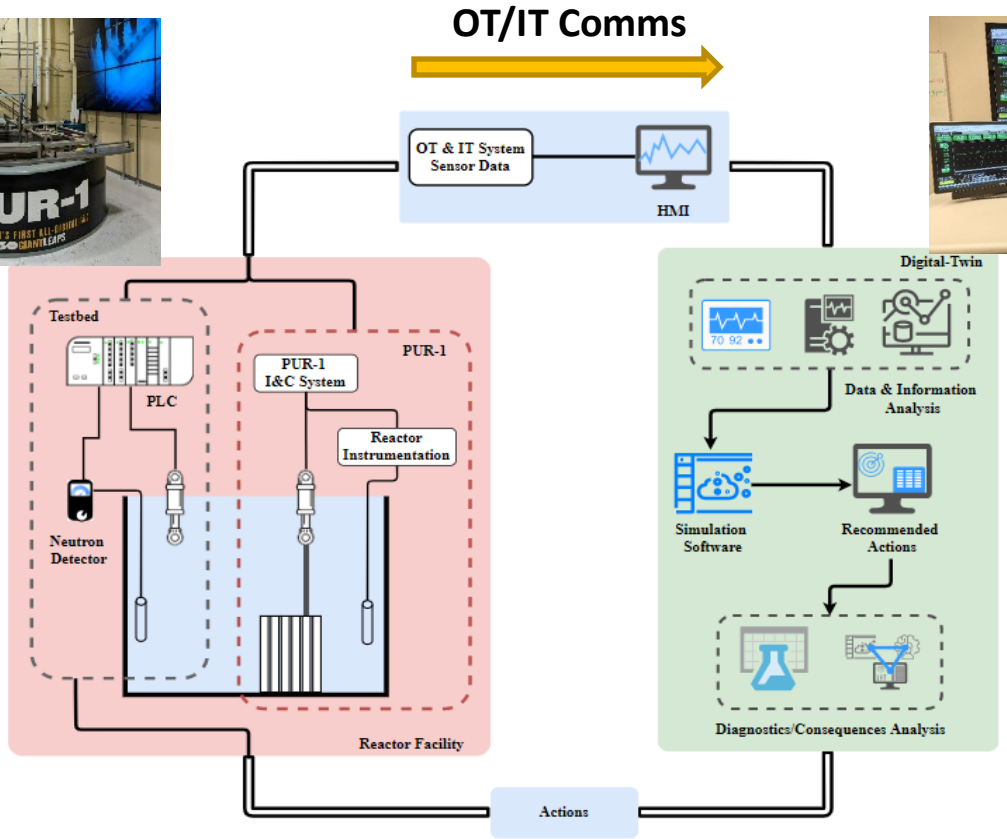
Towards a Real-Time Cyber-Physical Digital Twin

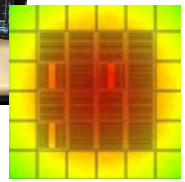
PUR-1



Towards a Real-Time Cyber-Physical Digital Twin

PUR-1



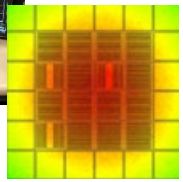


RMSS

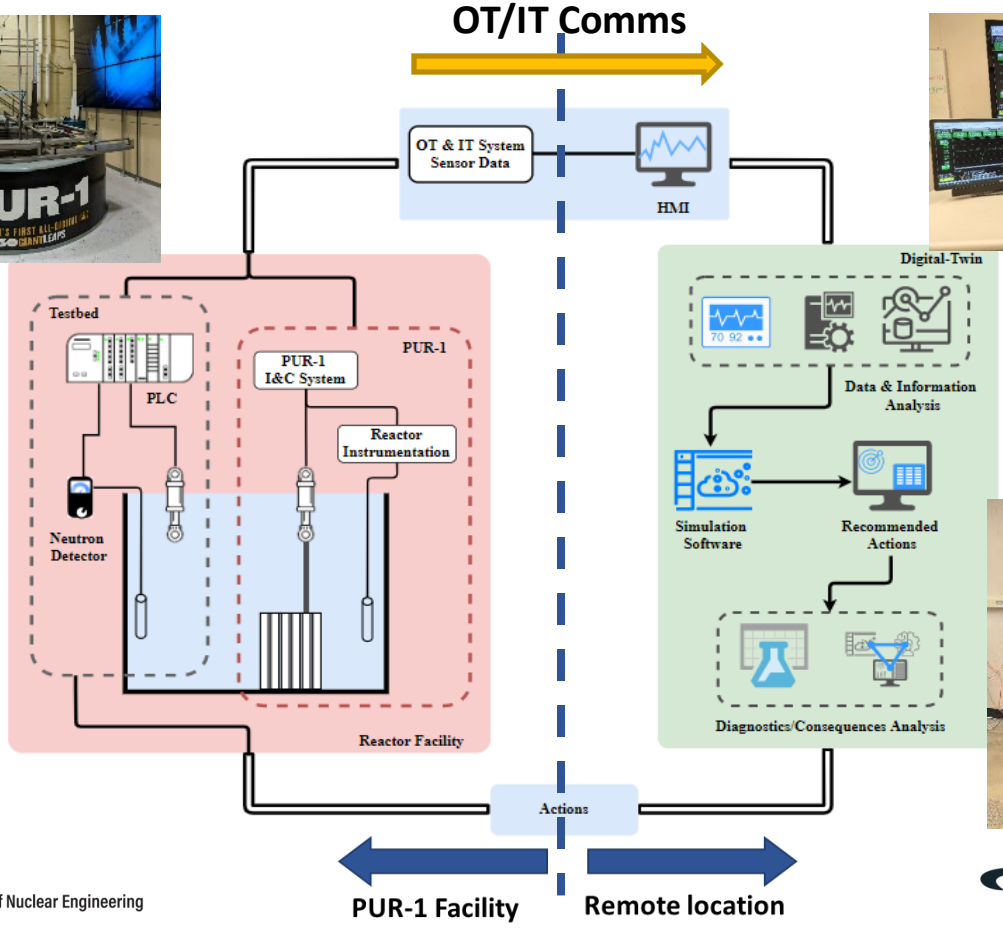
Towards a Real-Time Cyber-Physical Digital Twin

PUR-1

RMSS

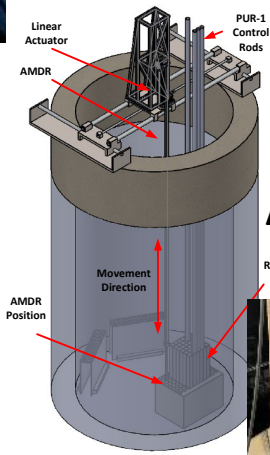


Control rack

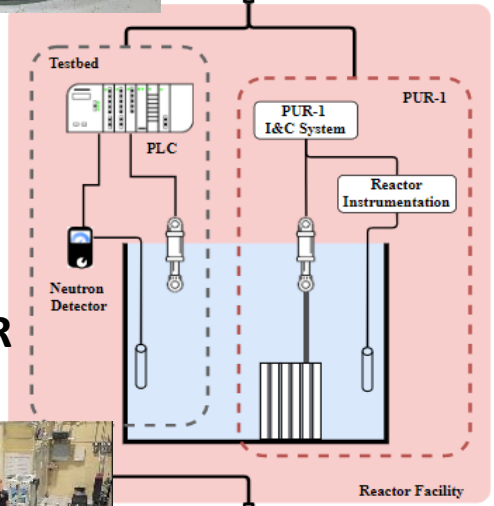


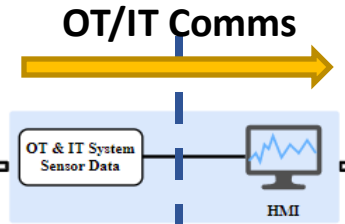
Towards a Real-Time Cyber-Physical Digital Twin

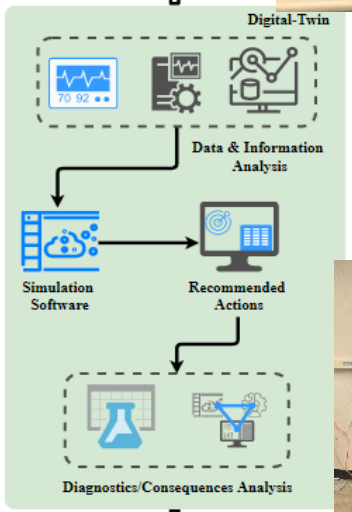
PUR-1



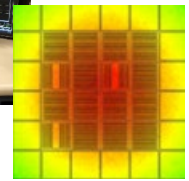
AMDR







RMSS



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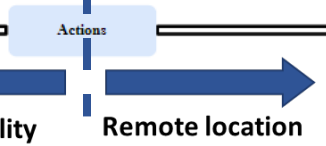
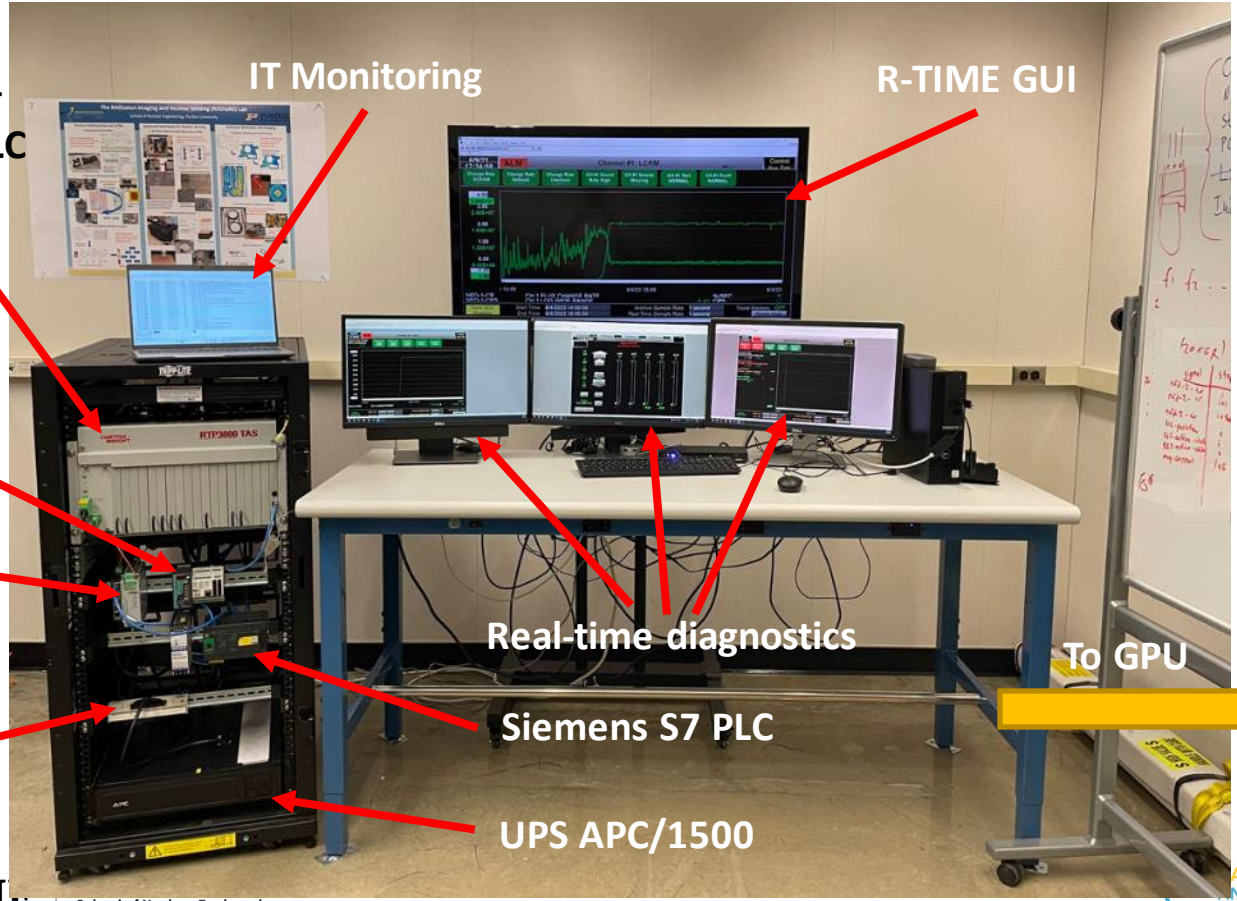
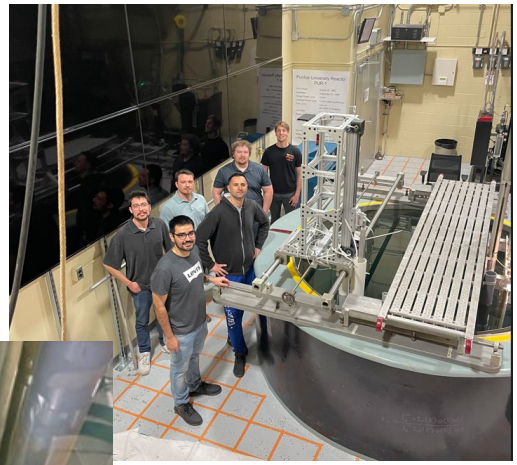


Digital/Cyber Remote Station



Installing and Testing AMDR

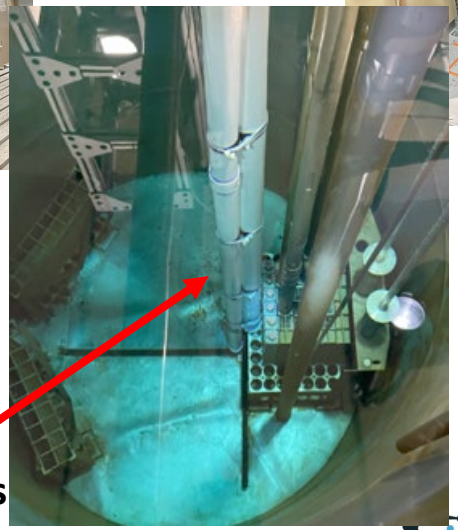
Actuator



Completed
May 2023

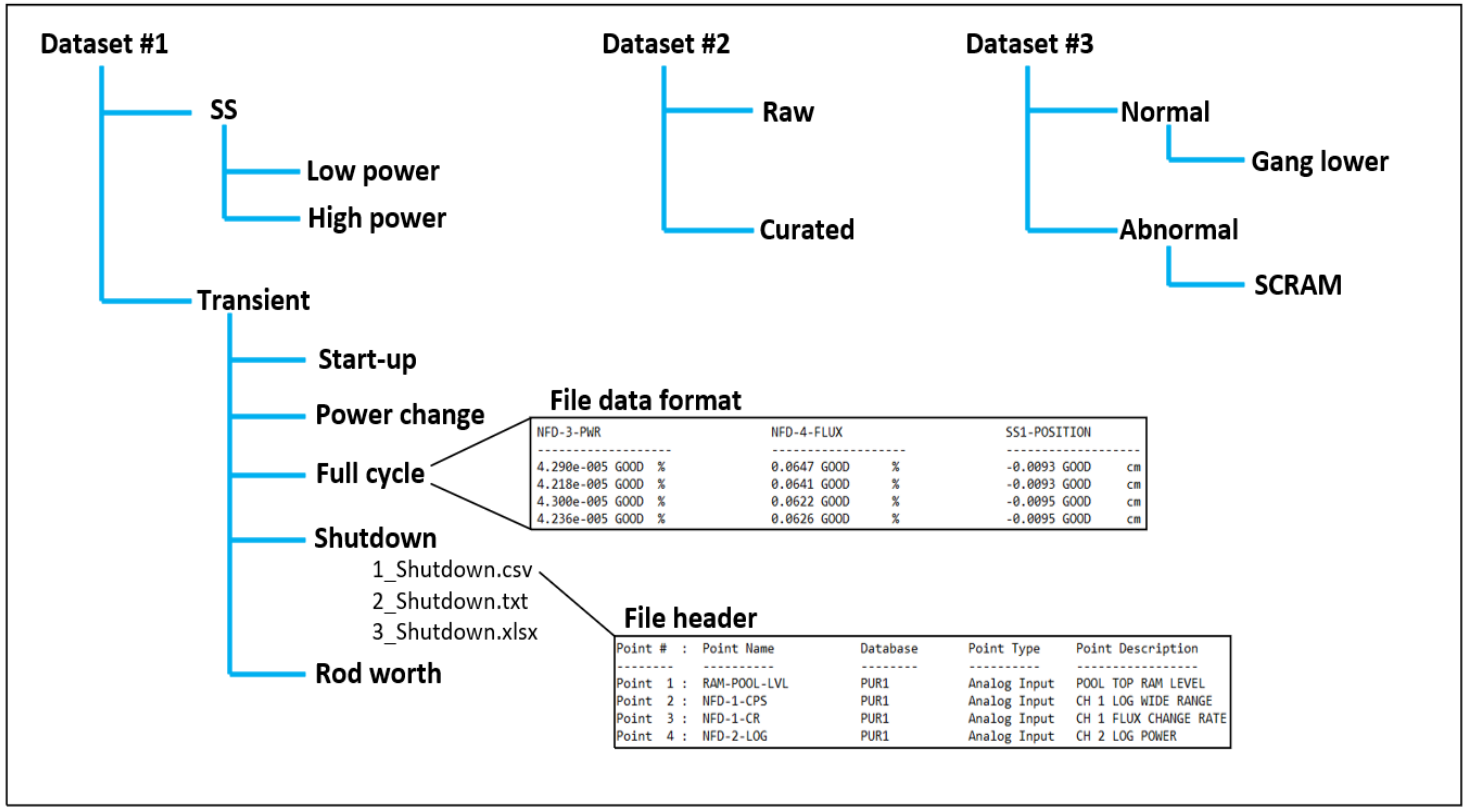
Support
structure

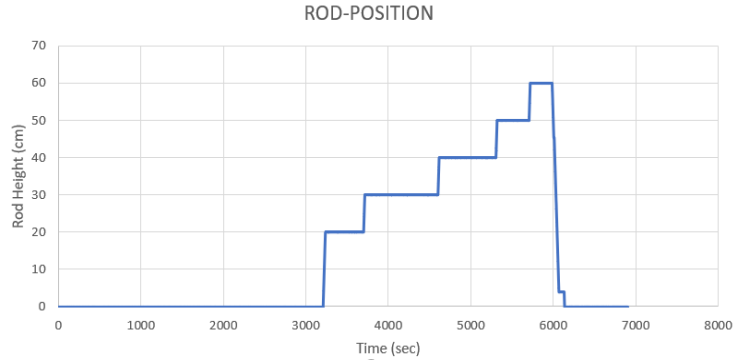
AMDR

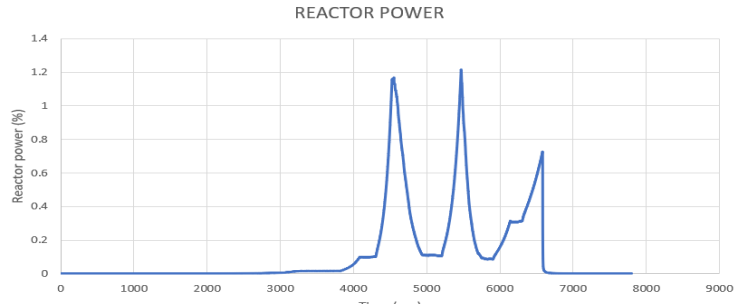


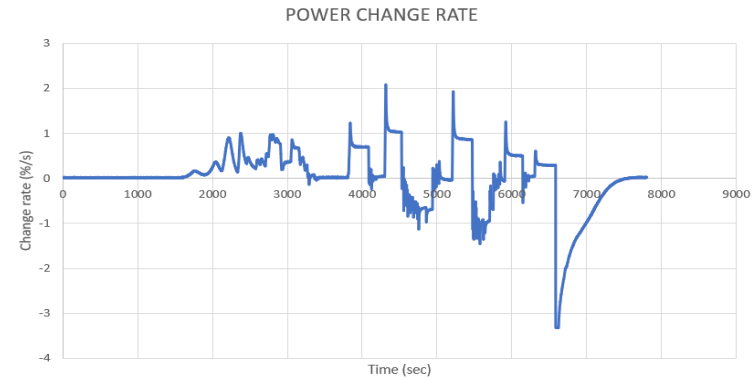
Guide tubes

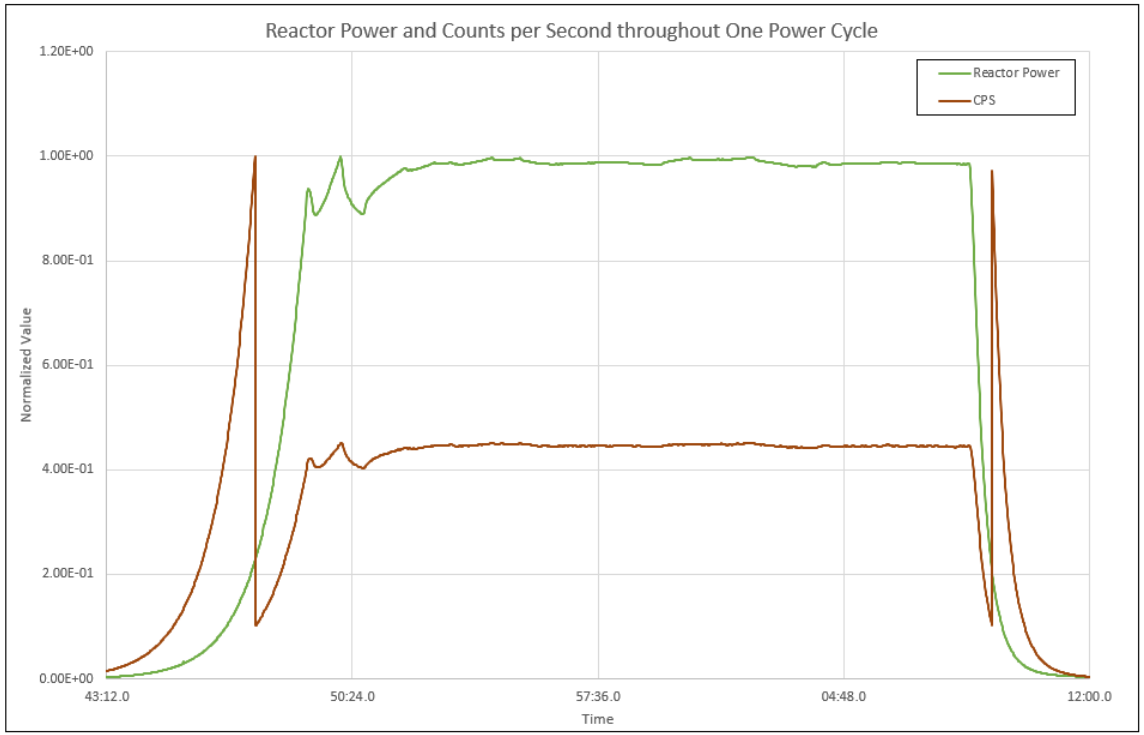
Datasets for Benchmarking











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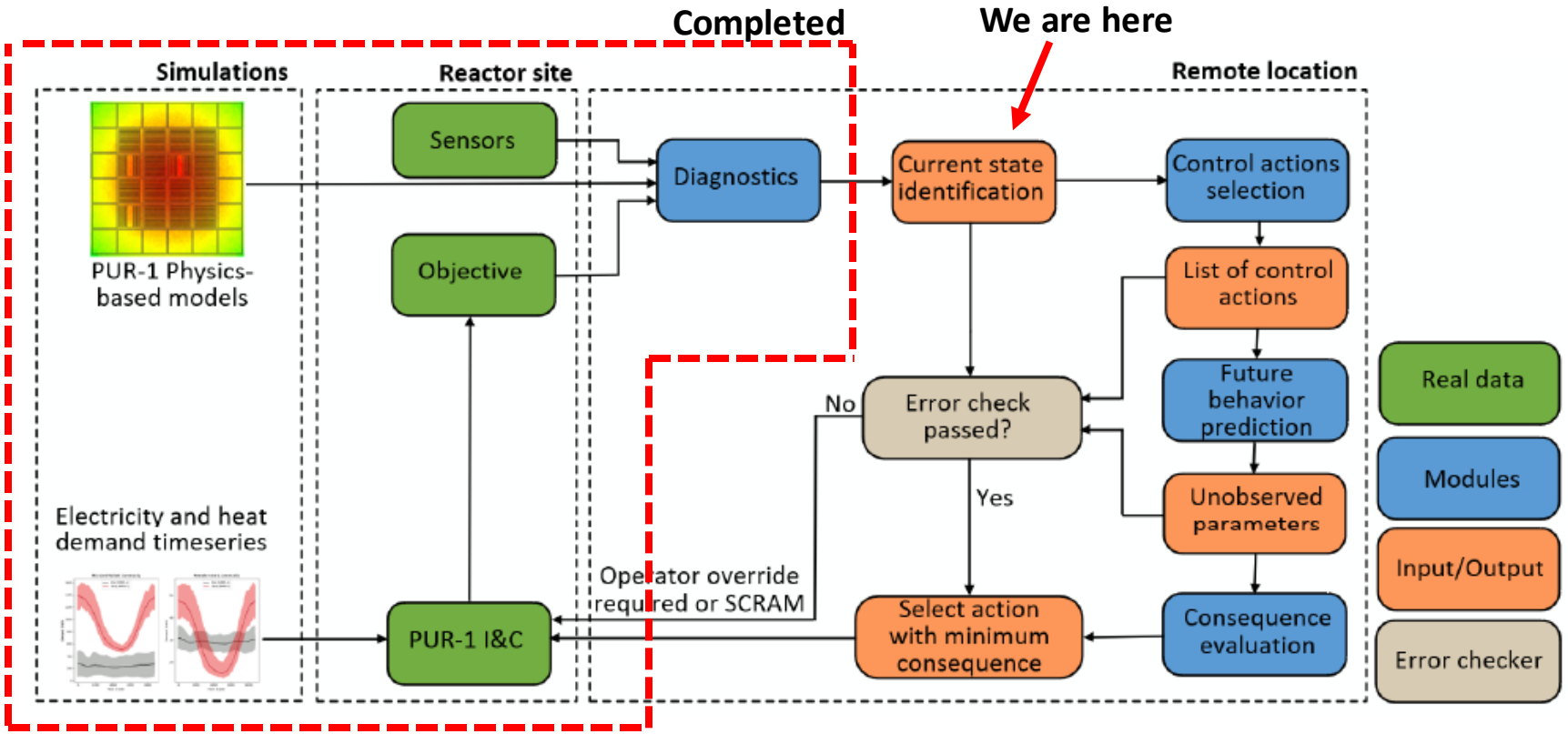
Semi-autonomous Architecture



Acknowledgements

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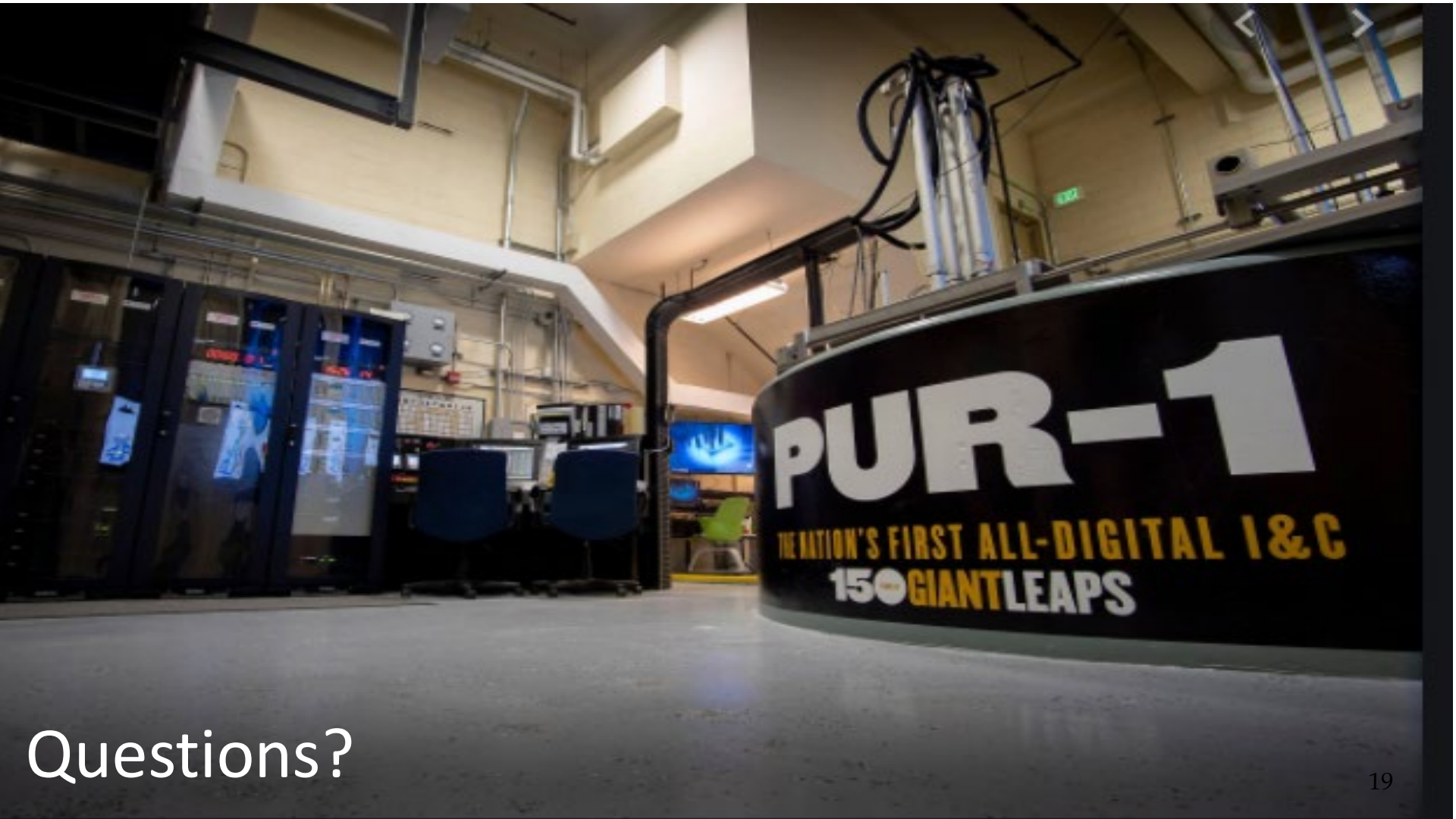

Questions?