



# Learning-based Anticipatory Control of Microreactors

August 2022

*Changing the World's Energy Future*

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**Prepared for the  
U.S. Department of Energy  
Under DOE Idaho Operations Office  
Contract DE-AC07-05ID14517**

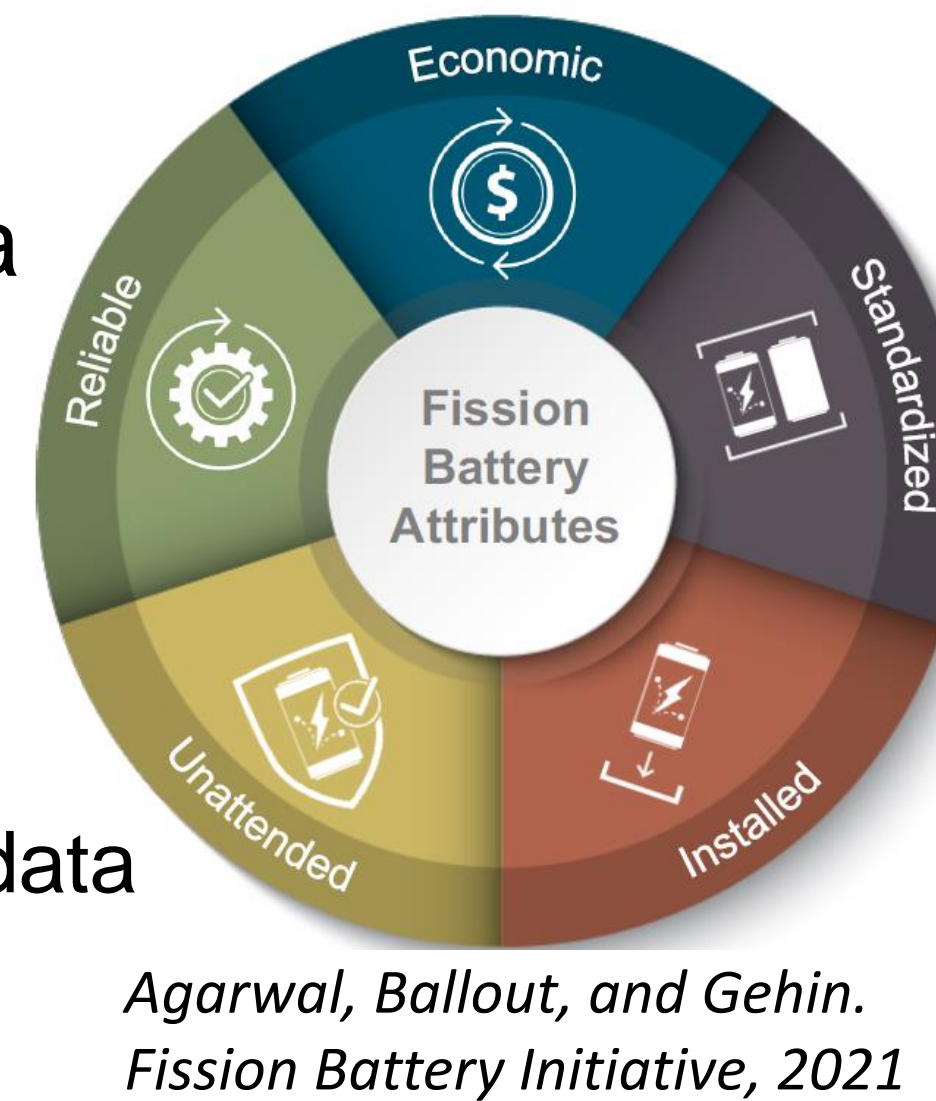


# Learning-based Anticipatory Control of Microreactors

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## Motivation

- Fission batteries are a specialized class of reactor providing a “**plug-and-play**” functionality for nuclear energy.
- Control algorithms for fission battery systems must enable **unattended operation** by being:
  - Autonomous**: operate with no onsite human involvement
  - Adaptable**: continuously learn and improve by using sensor data

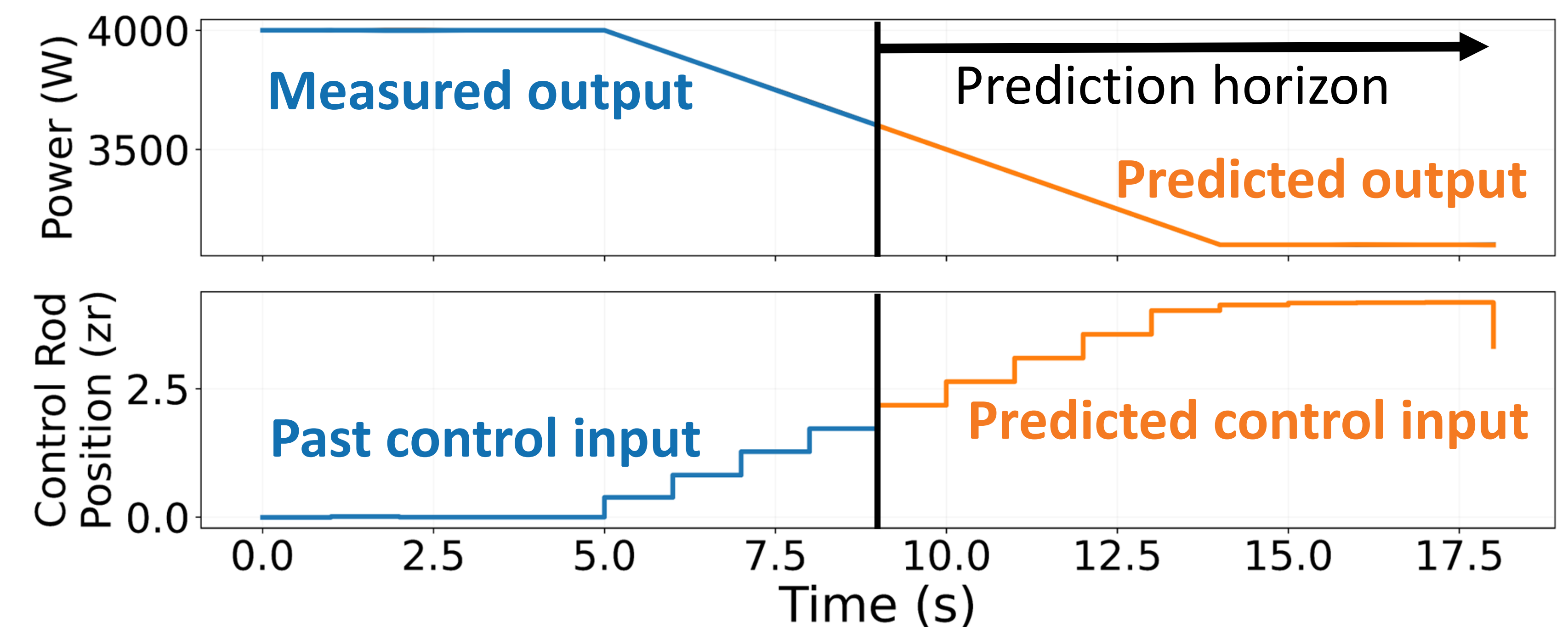


## Model Predictive Control

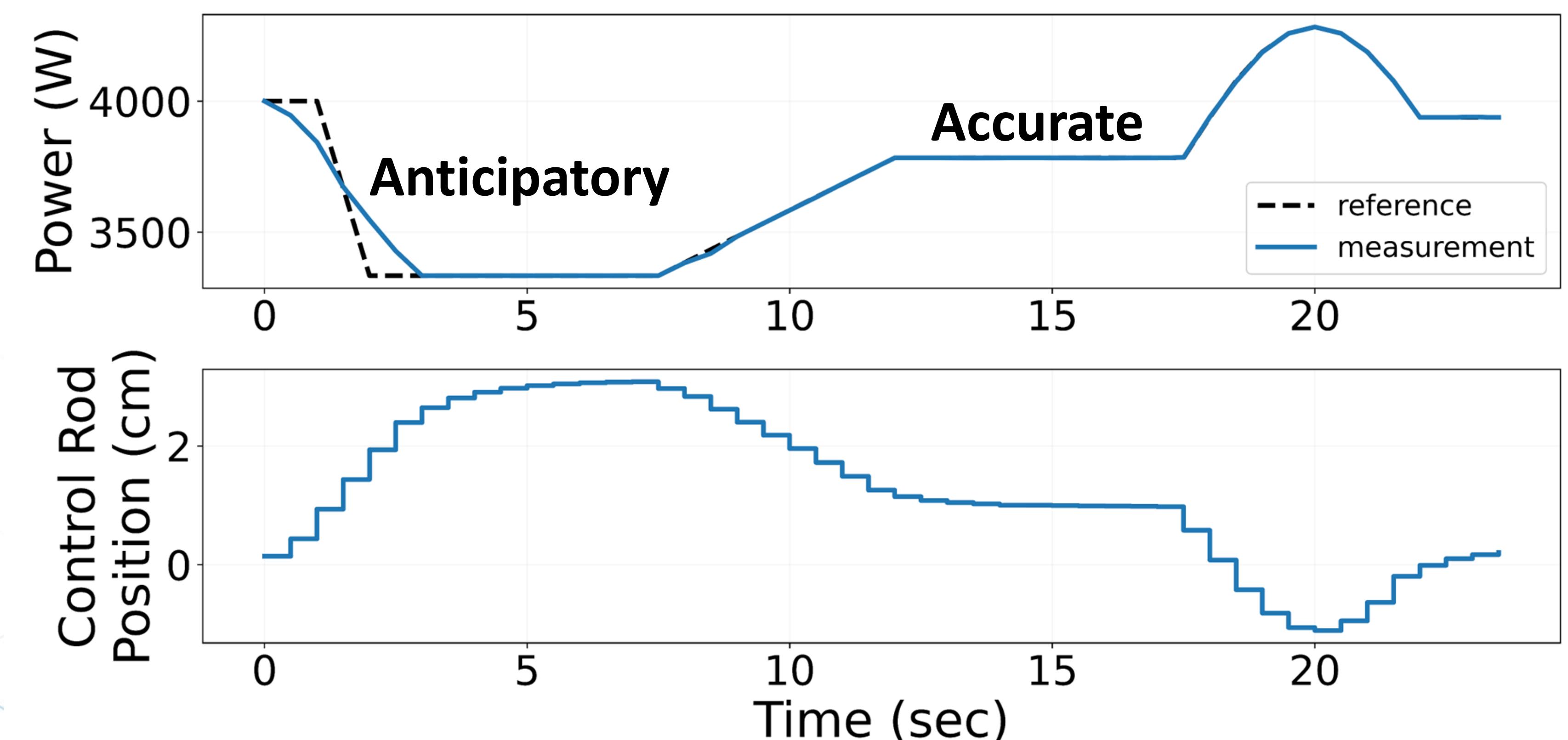
- A surrogate model **anticipates** the system’s response to a control action before the action is performed.
- An optimization algorithm uses the surrogate to select the best control action by predicting system responses to many possible inputs. The surrogate must be:
  - Faster than real time**
  - Accurate**
- The surrogate can be **physics-based** (differential equations), or it can be approximated via a **learning-based** approach (e.g., a neural network).

## Anticipatory Control Strategy

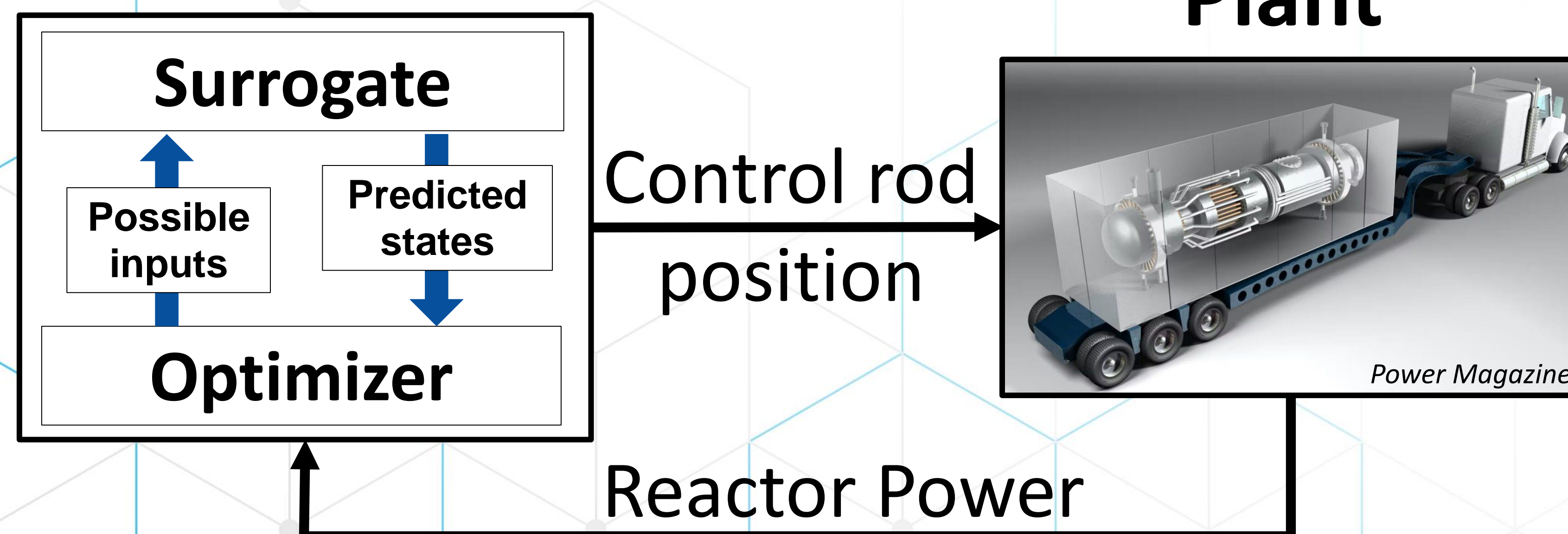
The **prediction horizon** is a tunable hyperparameter dictating how far forward in time the controller “looks” when making predictions via the surrogate model.



## Results: Reference Tracking



## Controller



## Contribution

Anticipatory control **advances the level of autonomy** of microreactor control systems and is one of the key considerations for the **unattended operation of a fission battery**.



## Next Step

Incorporate on-line updating of the surrogate model via reinforcement learning.

Work supported through the INL Laboratory Directed Research & Development (LDRD) Program under DOE Idaho Operations Office Contract DE-AC07-05ID14517

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