



# Integral Experiments for Criticality

## An overview of the SPARC facility

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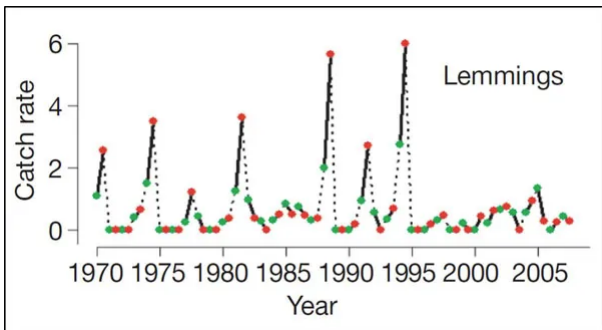


DOE/NRC Criticality Safety for Commercial-Scale HALEU for Fuel Cycle and Transportation



# Lemmings, and Neutrons

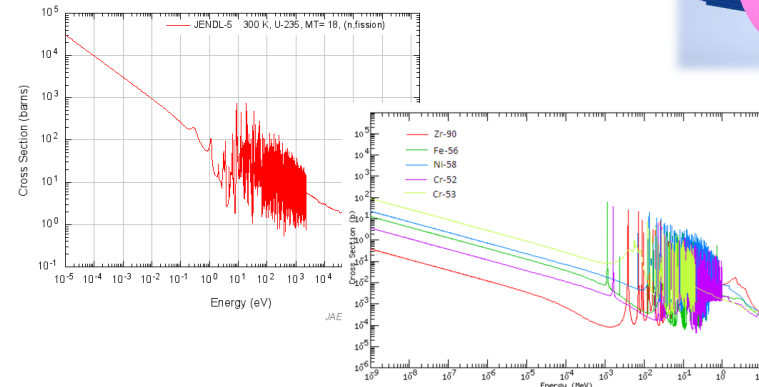
Lemmings: Chaotic population cycle due to complex interactions in birth rate, vegetation growth, and predation in the sparse arctic



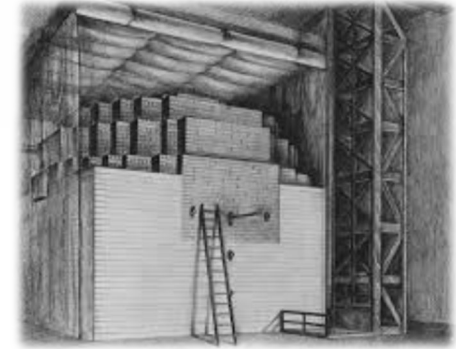
So, it is with reactors. Neutron birth and death rates must be balanced within a small fraction of the total (<1%) to operate at stable power



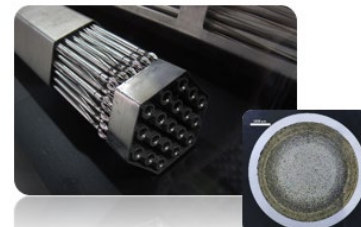
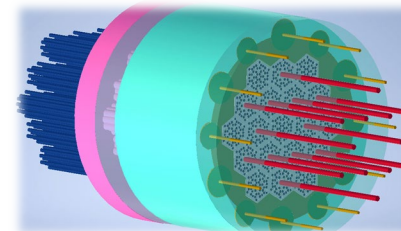
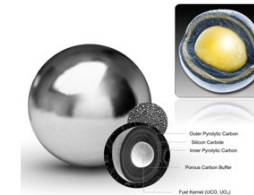
Modern transport codes are amazing, but unpinned by complex nuclear data for numerous reactions describing how nuclides & neutrons are born, bred, & lost



Zero-power criticals have always been indispensable in getting the balance right



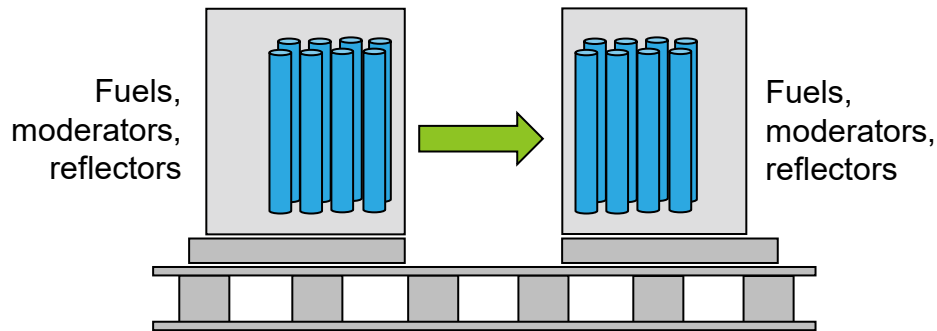
And crucial in validating predictions to prevent "unintentional reactors" within economic fuel batch size (manufacturing, shipping, storage)



New fuels, materials, and cores: Advanced reactors further this enduring need

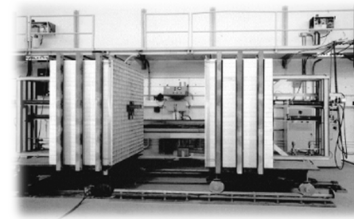
# A SPARC of Hope

- Large-scale critical experiments crucially needed, the U.S. (and western world) has lost this capability
  - Best met by a Horizontal Split Table (HST): The Swiss army knife of zero-power reactors
  - Support licensing & deployment of LEU+ and HALEU fuel cycle (factory, shipping, reactor operation, and storage)

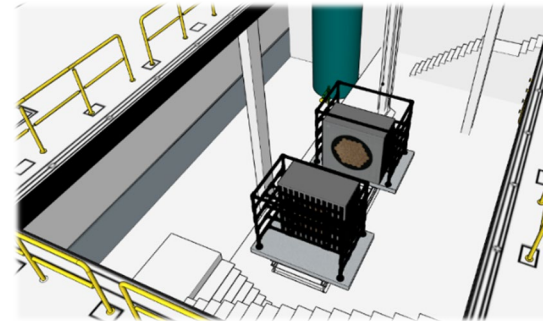
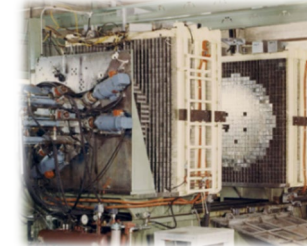
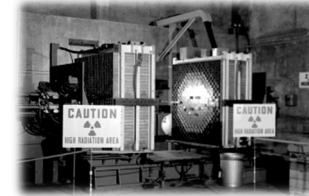


- DNCSH supporting INL to deploy a new HST for HALEU criticality safety research
  - Strong industrial support, direct relevance to executive orders
  - PBF-613 (former SPERT-IV building) selected
  - System Physics Advanced Reactor Critical facility (SPARC)

DOE/NRC Criticality Safety for Commercial-Scale HALEU Fuel Cycle and Transportation (DNCSH)

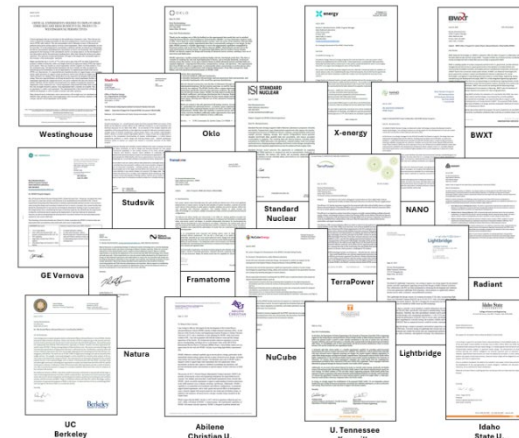


Historic HSTs in the U.S. (all now decommissioned)

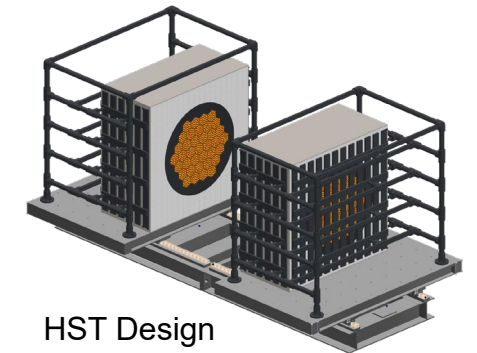


Rendering of HST in PBF-613

PBF-613



External Letters of Support



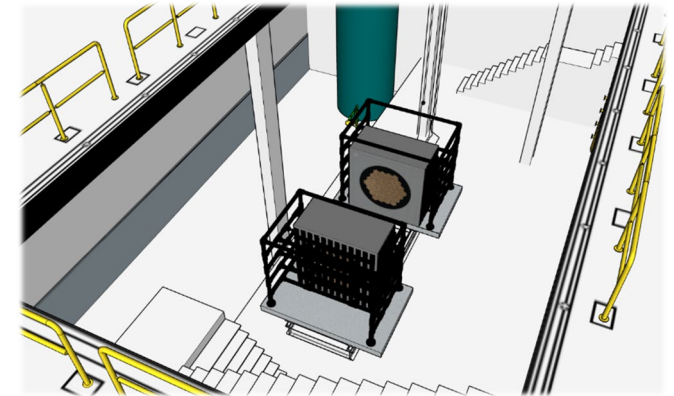
HST Design

# Facility Design

- PBF-613 (former SPERT-IV reactor)
  - Large “open basement”, low neutron room return
  - Stout floors, overhead crane, radiologically clean
  - Side wings for I&C, material storage



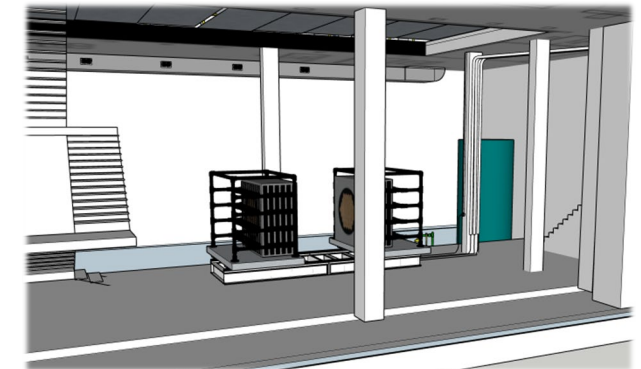
Basement of PBF-613



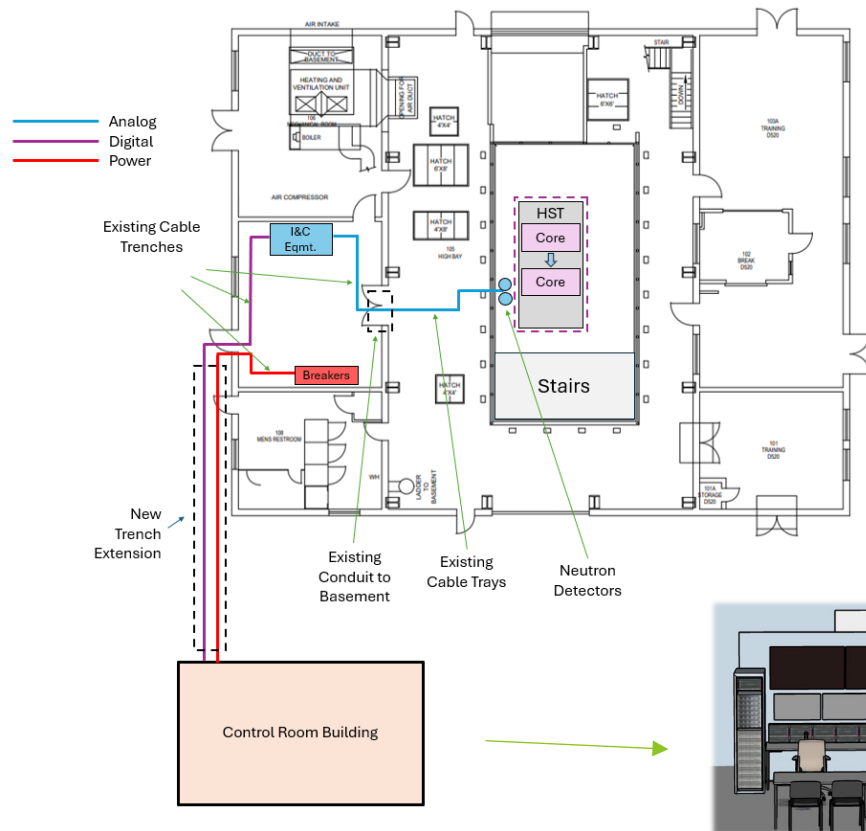
View from Main Floor



PBF-613



View from Basement

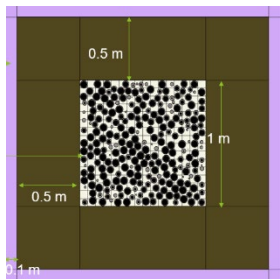


- SPARC project scope includes:
  - Safety basis creation for Hazard category 2 nuclear facility
  - Install modular building with control console
  - Install HST, I&C, and perform inaugural experiment

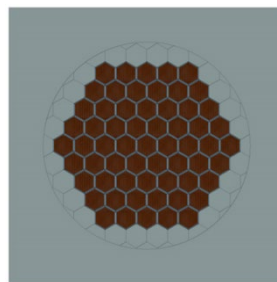
# Capability Plan

- Deploying as soon as possible with minimum viable capability package
  - Facility security posture for HALEU fuels and unclassified experiments
  - HST can support up to 2m cube, 24 MT core
  - “Open-source” mechanical fixturing design (threaded holes grid on table)
  - Fuel and hazardous materials clad or contained
  - Straightforward data and controls system (HST gap control, external neutron detectors)
  - Ample space for storing moderators & materials
  - Fuel storage area for  $\text{UO}_2$  RCF rods, U-Mo plates

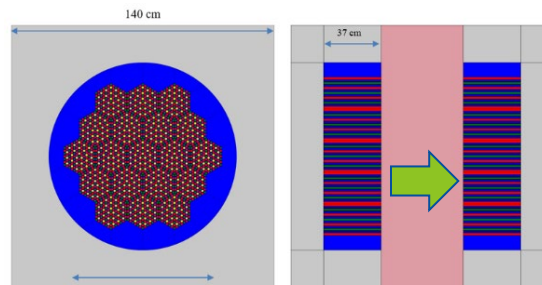
- Upgrades likely and/or feasible to come later
  - Storage area suitable for beryllium
  - Enhanced data and control system
    - Data acquisition for heavily instrumented experiments
    - Experiment electrical heating or chilling
    - Remote controllable reactivity shims and/or oscillators
  - Fuel storage racks for the full HALEU library
    - TRISO compacts and/or pebbles
    - $\text{UO}_2$ -in-poly blocks
    - U-Zr metallic fuel
    - Fueled salts, “other” uranium ceramics
  - On-site gamma spectroscopy
  - Suspect exhaust system for bare uranium
  - Mode-switchable protocols for experiments with elevated information security



TRISO Pebble Bed in Graphite Reflector



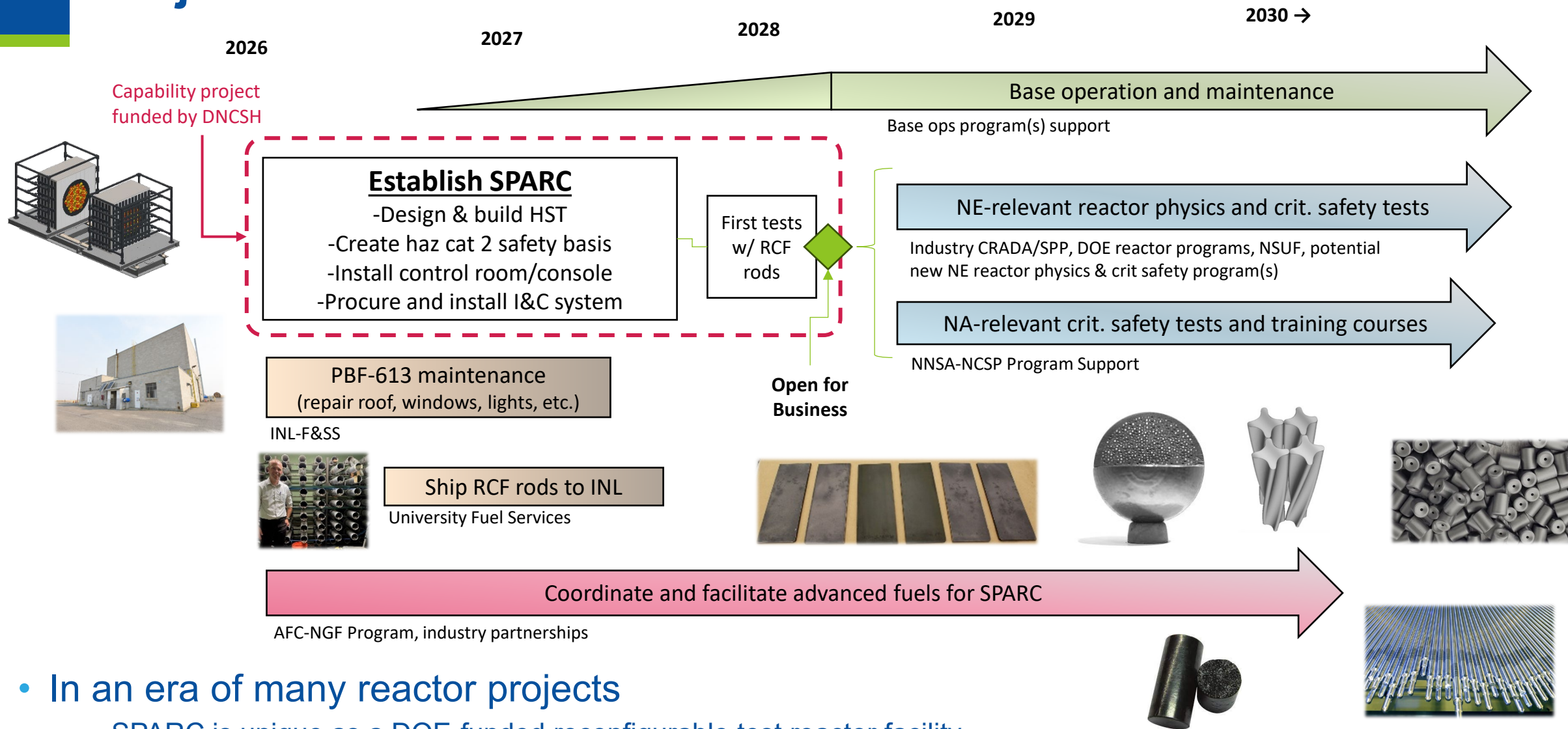
U-10Zr Metallic Fuel in SST Reflector, Fast Spectrum



Metal Hydride Heat Pipe Microreactor



# Project Vision



- In an era of many reactor projects

- SPARC is unique as a DOE-funded reconfigurable test reactor facility
- Earnest-but-balanced schedule while setting the stage for a multidecadal critical experiments facility