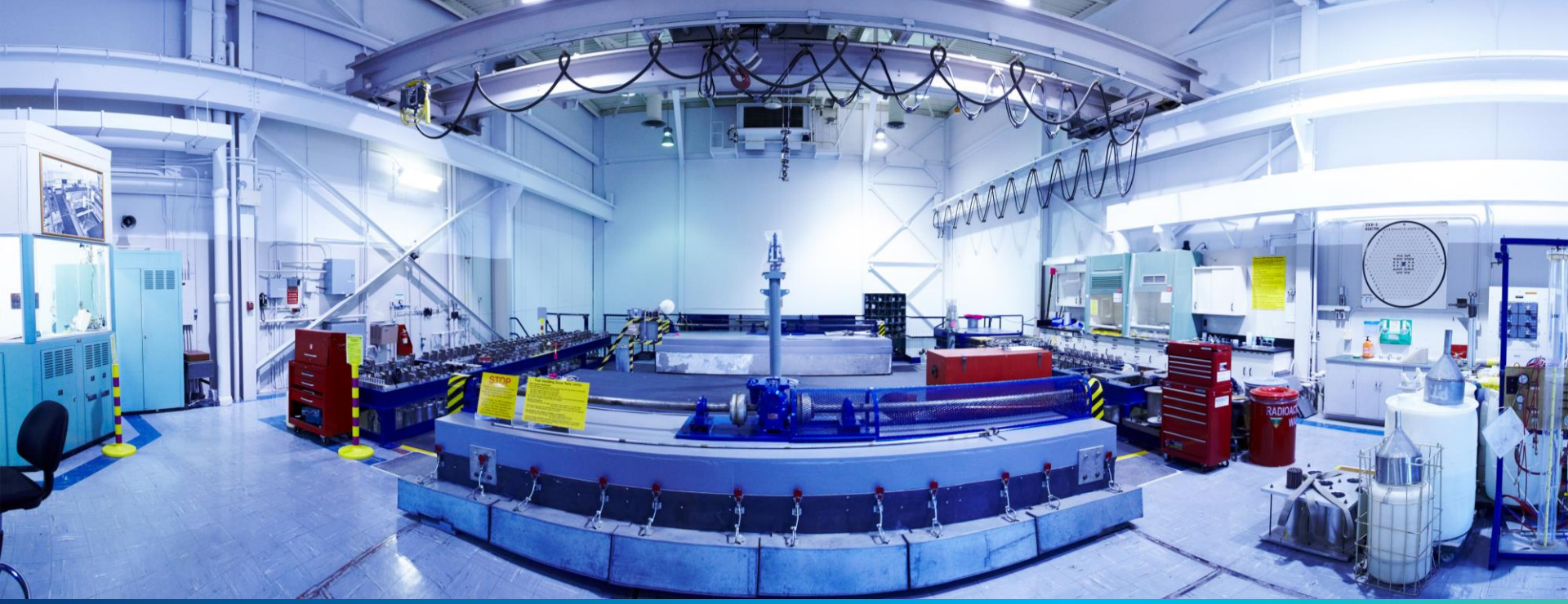


Status of the Zero Energy Deuterium (ZED-2) Research Reactor

J. Horner

TRTR Conference
San Diego, California
September 16th to 21st 2017

Presentation Overview

- ZED-2 Background
- ZED-2 Experiments
- System Health Program Background
- System Health Program Implementation
- System Health Program Upgrades

ZED-2 Background

Canadian Nuclear Laboratories (CNL) Location

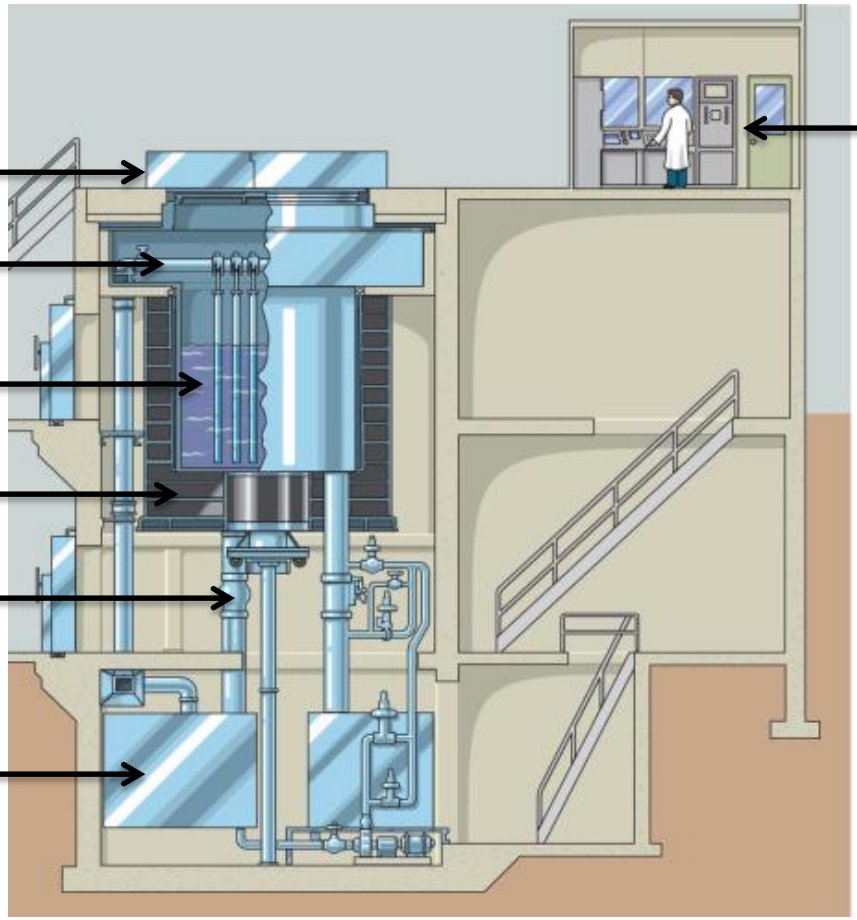
ZED-2 Background

ZED-2 Overview

- First Criticality: September 7, 1960
- Maximum Power: 200 W (indicated), 700 W (thermal)
- Maximum Neutron Flux: 1×10^{9} $n \cdot cm^{-2} \cdot s^{-1}$
- Moderator: Heavy Water
- Coolant: Air, Heavy Water, Light Water
- Fuel: NU, LEU, Other Mixed Oxides

ZED-2 Background

ZED-2 Facility Layout

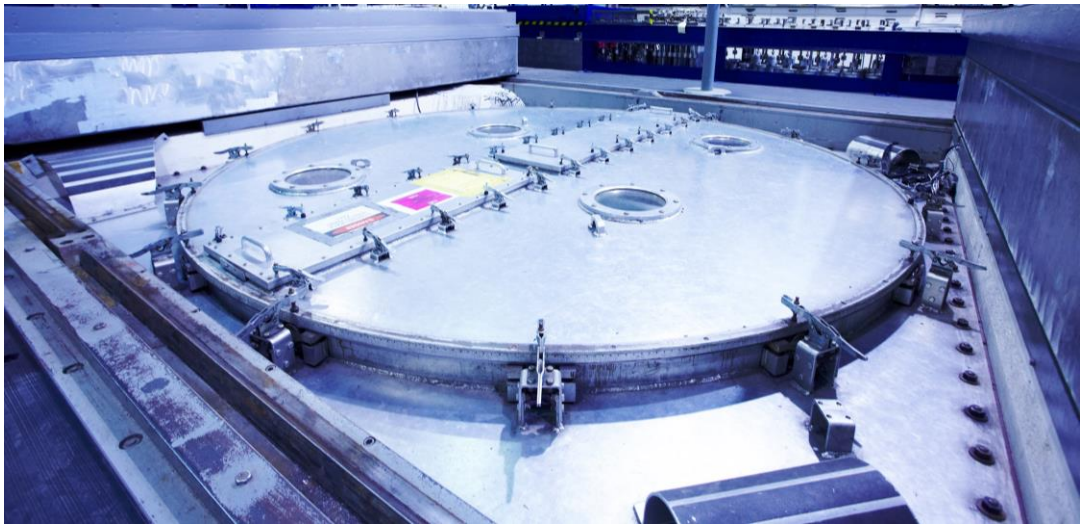


ZED-2 Background

ZED-2 Control Room

ZED-2 Background

ZED-2 Calandria



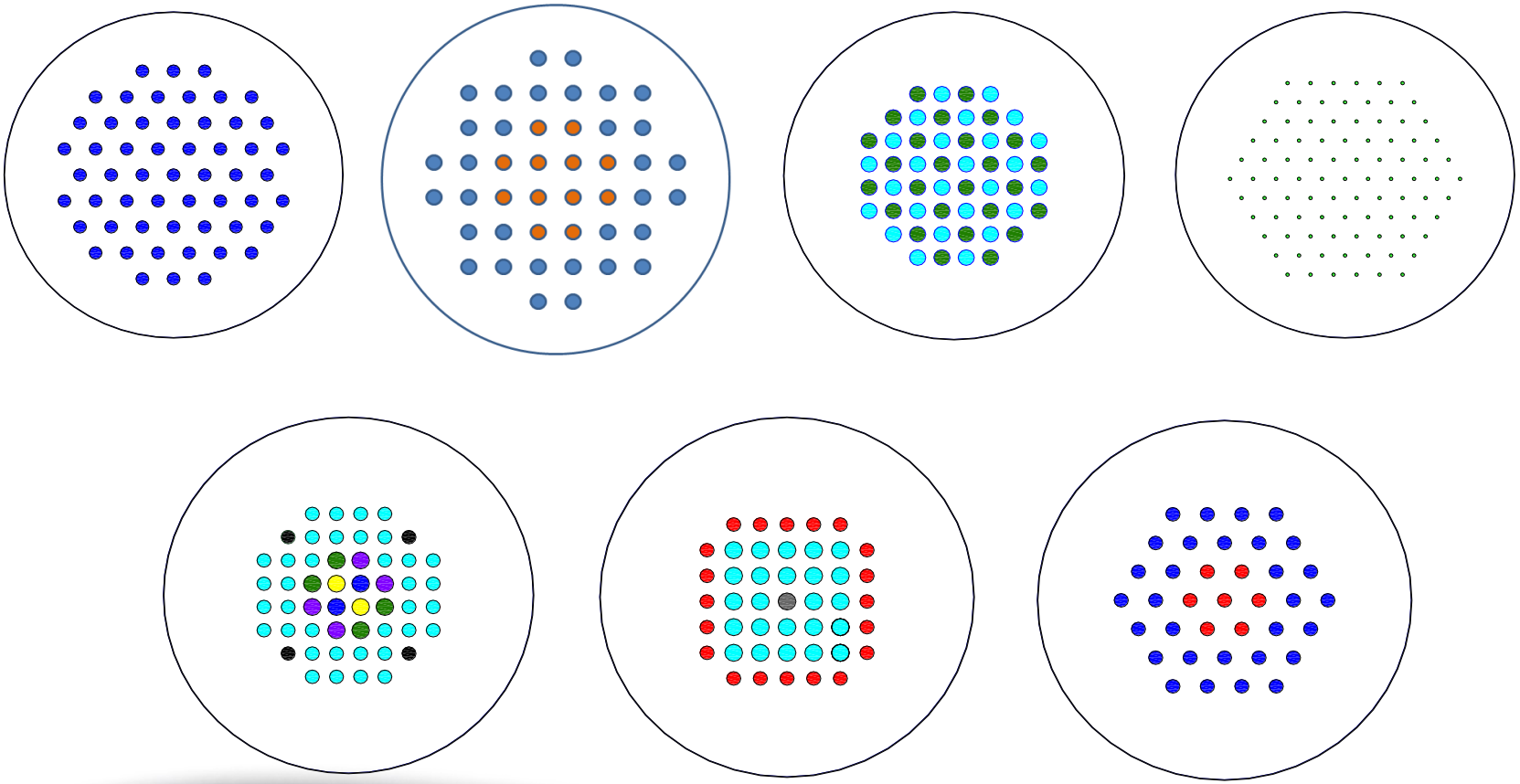
ZED-2 Experiments

Fuel Bundles

- Natural UO_2 Bundles
  - 7, 19, 28, 37, 43 element
- Uranium Carbide
- Uranium Silicide
- Uranium Metal
- Mixed Oxides
  - Pu-U (Depleted)
  - U^{233}-Th
  - Pu-Th
- Bundles with absorber elements
- Enriched or reprocessed UO_2 bundles (LEU, RU)

ZED-2 Experiments

Core Configurations



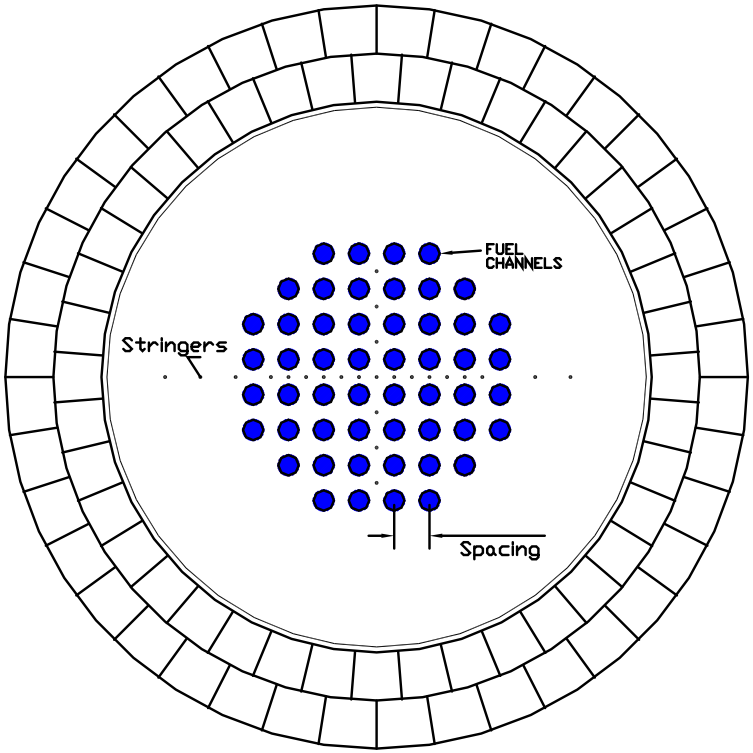
ZED-2 Experiments

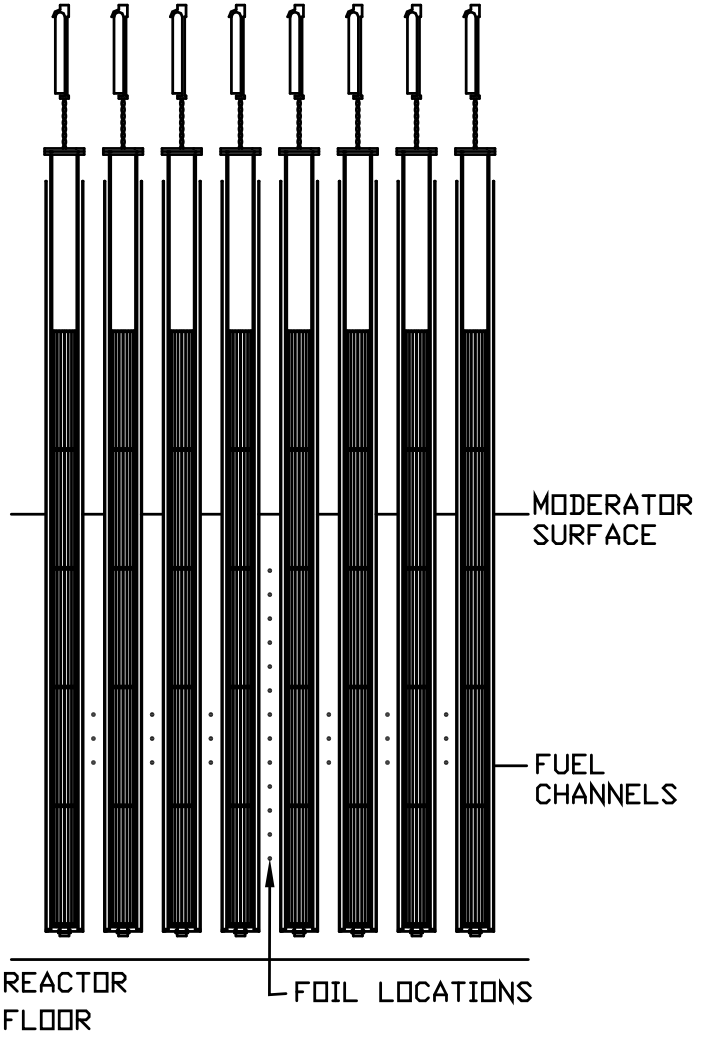
Ongoing Experiments

- Critical Height Measurements
  - Reactor Physics Code Validations
- Reactivity Transient Measurements
  - Nuclear Data for Thoria Based Fuels
  - Flux Perturber Experiments
- 3-D Kinetics Measurements

ZED-2 Experiments

Flux Maps

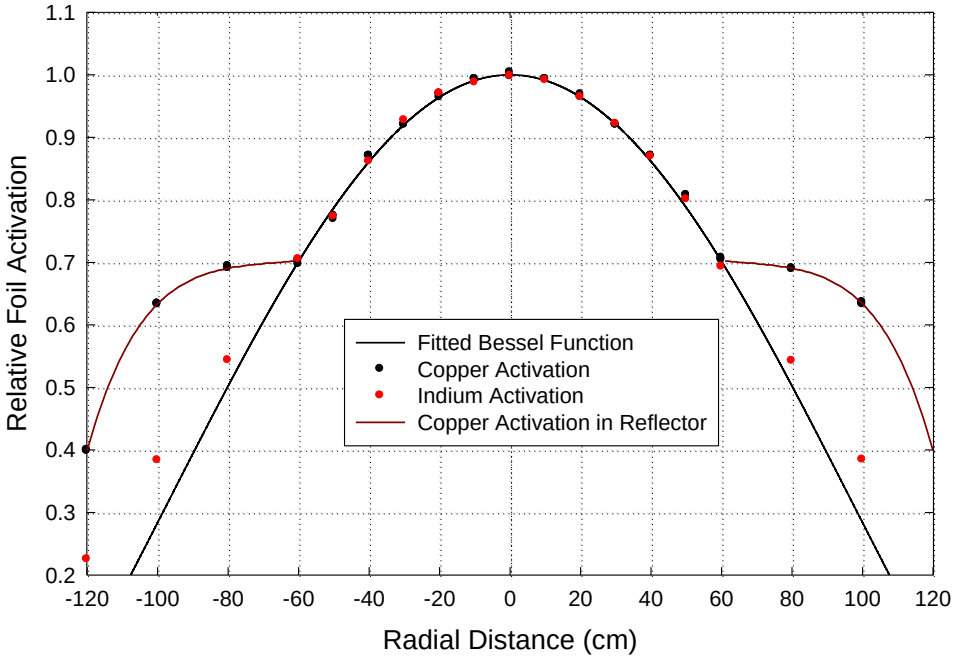




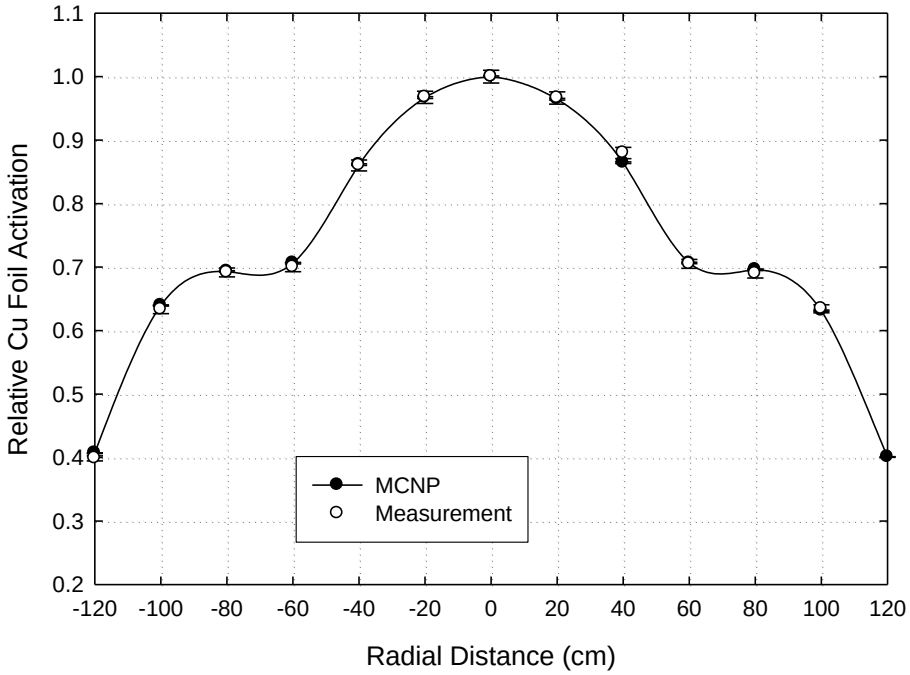
ZED-2 Experiments

Flux Maps

Experiment



Comparison to Calculation

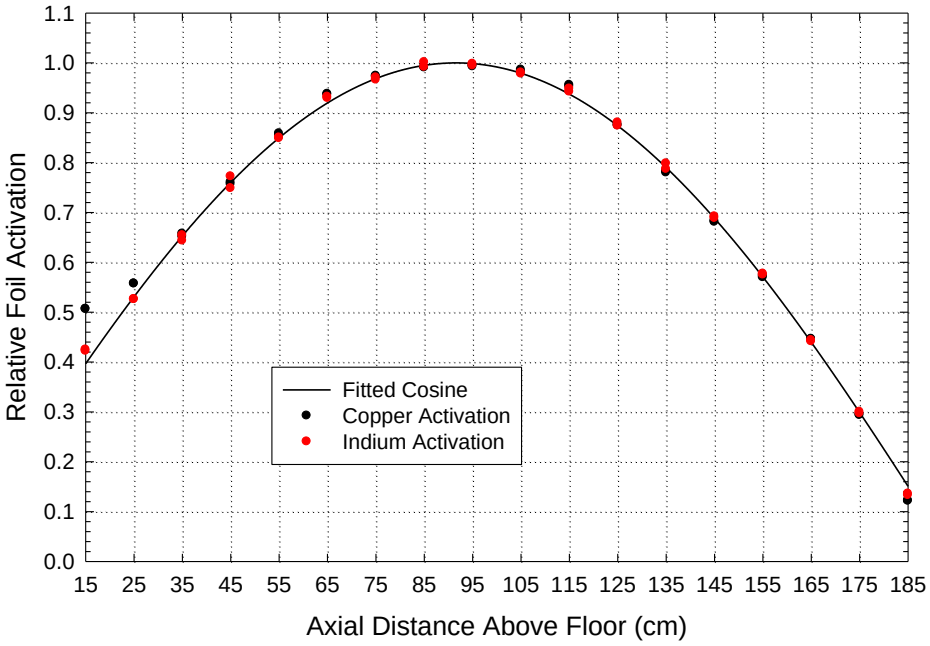


Radial Data

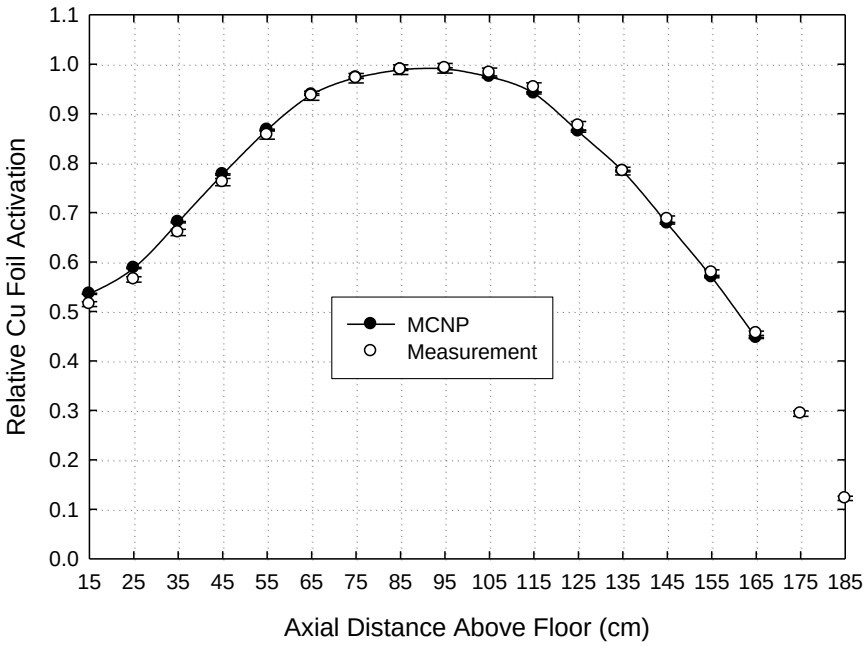
ZED-2 Experiments

Flux Maps

Experiment



Comparison to Calculation



Axial Data

ZED-2 Experiments

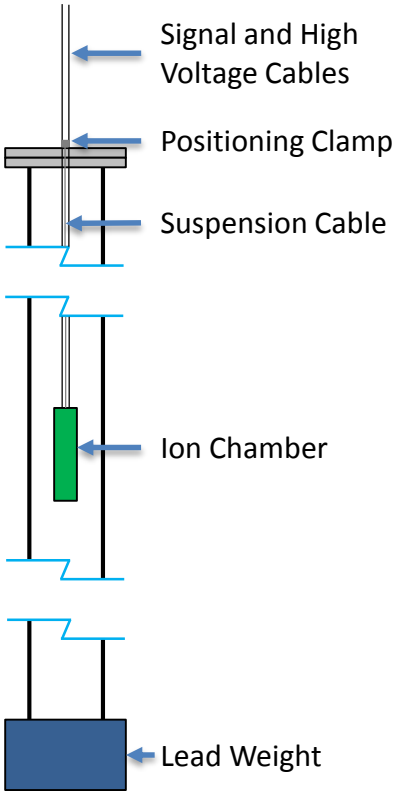
Self Powered Flux Detector Calibrations

- Calibrate 30 Vanadium Detectors per reactor operation
- Calibrate an entire CANDU 6 Reactor fleet in less than 1 week
- ZED-2 Counting Laboratory aids in calibrating detectors

ZED-2 Experiments

Ion Chamber Calibrations

- Low Flux (Maximum 10^9 $n \cdot cm^{-2} \cdot s^{-1}$)
- Same Day Handling
- ZED-2 Counting Laboratory Support



System Health Program Background

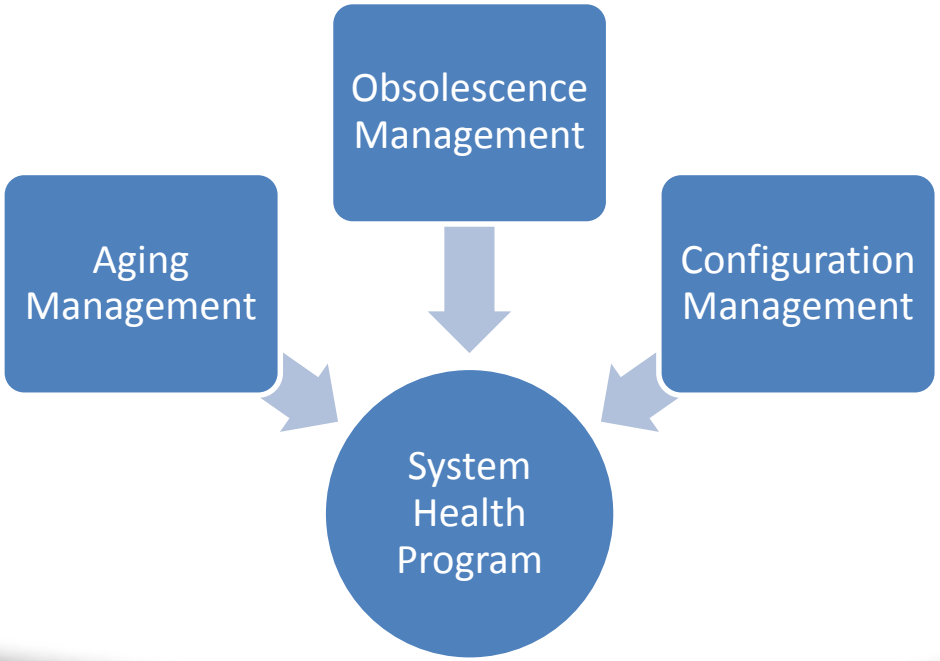
System Health Program Implementation Reasoning

- In operation for over 57 years with no plan to decommission
- Irradiation damage insignificant
- Aging electronic safety system
- Ensure all capabilities are maintained

System Health Program Background

Site System Health Program

- Four Main Documents for each System:
  - System Performance Monitoring Plan
  - Walkdown Plan
  - Walkdown Report
  - System Health Report



System Health Program Background

Site System Health Program

- System Performance Monitoring Plan:
  - Defines System Boundaries and Functions
  - Lists Maintenance Activities, Drawings, and Documentation
  - Assesses Aging Management Degradation Mechanisms
  - Evaluates Obsolescence Management Issues
  - Lists Spare Parts Inventory Levels

System Health Program Background

Site System Health Program

- Walkdown Plan:
  - Lists Hazards
  - Lists Components and Component Locations

- Walkdown Report:
  - Describes System Upgrades
  - Confirms Maintenance Activities
  - Evaluates Configuration Management Issues
  - Confirms Spare Parts Inventory Levels

System Health Program Background

Site System Health Program

- System Health Report:
  - Evaluates the system based on Performance Indicators
  - Recommends a strategy for improving the system reliability
  - Presented to Management to tailor the resources required

System Health Program Implementation

ZED-2 System Classification

- 16 ZED-2 Safety Related Systems
- 19 ZED-2 Not Safety Related Systems
- 8 System Health Program Systems

System Health Program Implementation

System Health Program Systems

1. Safety System Trip Circuits
2. Radiation Monitoring Systems
3. Fuel Storage and Support Structures
4. Moderator Systems
5. Engineered Manual Controls
6. Site Systems
7. Process Air and Ventilation Systems
8. Out of Service Systems

System Health Program Upgrades

Safety System Trip Circuits

Completed

- Safety System Trip Relays & Pump Timers
- 58 Safety System Auxiliary Relays
- Log Count Rate/ Log Power Recorder
- Back Off Amplifier Recorder
- Comparator Meter Relays

System Health Program Upgrades

Safety System Trip Circuits

In Progress

- Voltage Monitors
- Fission Chamber Replacement
- Start-Up Amplifier Overhaul

System Health Program Upgrades

Radiation Monitoring Systems

In Progress

- Slow Neutron Monitors

Fuel Storage and Support Structures

Completed

- Steel Structure Support
- Fuel Storage Cabinets Anchored

System Health Program Upgrades

Moderator Systems

Completed

- Dump Valve Magnets, Pneumatic Actuators, Air Regulators, Relays, Capacitors
- Drain Solenoid Control Valves

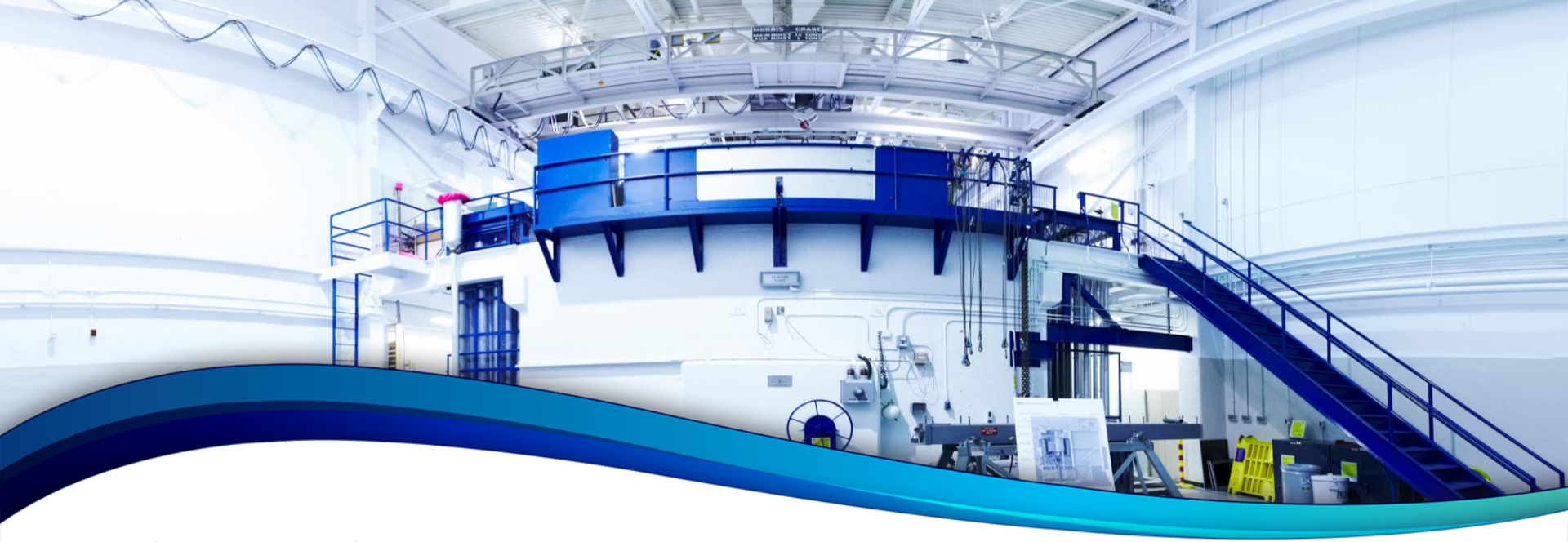
In Progress

- Accurate Height Probe Control Relays
- Control Room Pushbuttons and Indicators

ZED-2 Reactor Status Summary

Summary

- System Health Program is well underway with a positive impact on equipment reliability and reducing downtime
- Experiments are designed to validate reactor physics analysis codes and nuclear data libraries
- Excellent facility for reactor lattice properties
- Upcoming commercial work for calibrations



Thank you.

Questions?

Jake Horner
R&D Facilities Specialist
ZED-2 Reactor
jacob.horner@cnl.ca