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Design of Experiment To Test Fast Electronics For Neutron Noise Measurements. (IER 453)

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Overview

- **Why is a “fast” neutron measurement system a necessary upgrade to NCERC?**
  - Previous experiments performed
  - Capabilities previously at LACEF
- **Chosen system components**
- **Planned testing and measurements**
  - Godiva IV (known test)
  - Other fast systems (unknown tests)
- **Execution timeline**
Previously Performed Experiments

• Current neutron noise measurement capabilities at NCERC all consist of He-3 detection systems.
• He-3 tubes have dead-times on the order of µs.
• Fast/bare systems like Godiva IV are impossible to measure as the prompt decay signature happens within the tube dead-time.
• Attempted to measure decay signature on Godiva with N-generator
Previous Neutron Noise Capabilities at LACEF

• At LACEF, neutron noise measurements were performed as early as the 1940s.
• The systems implemented there were capable of measuring the prompt decay on bare systems such as Lady Godiva.
• These systems implemented He-3 detectors, proton recoil detectors, stilbene detectors, and fission chambers.
Fast Neutron Noise Measurement System

- IER 453 proposed implementation of a new scintillation detector system to be used in neutron noise measurements on fast systems.
- Scintillators were chosen because of their speed.
- New electronics system is capable of being used with a wide variety of detection systems.
New Fast Electronics System

- Consists of liquid and plastic scintillators
  - EJ-309 (liquid)
  - EJ-276 (plastic)
- Fast timing digitizer (500 MS/s)
- High Voltage Supply
- Computer
- Software for n/γ discrimination and neutron timing
  - Simple system creates less complication in setup and execution.
Equipment
Equipment
BeRP Ball Reflected by Be

- Request to design experiment with Be reflector
- Experimental Goals:
  - Experiment has high sensitivity to Be (scattering) cross sections
  - Ability to measure configurations at subcritical, critical, and supercritical
  - Ability to change reactivity/k-effective by small amounts
  - Ability to construct numerous subcritical configurations
BeRP Ball Reflected by Be

- **Design Constraints:**
  - The ability for the configuration to be built using a hand-stack approach – i.e., the ability to slowly approach the critical configuration.
  - The ability for the configuration to also support construction of numerous high-multiplication subcritical configurations.
  - The ability for the configuration to allow for experimental access – ie, the ability to add to the experiment such items as RTDs to measure temperature, small neutron detectors, fission chambers, etc.
  - The ability for the configuration to precisely determine the alignment, to assist in benchmarking of critical and subcritical configurations.
  - The ability for the configuration to add or remove reactivity in large amounts (i.e., coarse control of reactivity).
  - The ability for the configuration to add or remove reactivity in small amounts (i.e., fine control of reactivity).
  - A high cross section sensitivity to Be.
BeRP Ball Reflected by Be

- Previous calculated critical thickness (theoretical density, no impurities, no gaps): 2.5”-3.2” Be reflector
- PMF-038: 3.349” Be reflector
- Design calculations: 3.375”
BeRP Ball Reflected by Be

- Be hemishells surrounding BeRP ball
- Critical Assembly Machine: Planet or Comet
  - Half the hemishells sit on moveable platen (along with BeRP ball)
  - Half the hemishells sit on Be membrane
- Critical configuration achieved by moving platen up to membrane
- Polar holes: Experimental access, alignment, reactivity adjustment
BeRP Ball Reflected by Be

- **Hemishells**: Allow for coarse reactivity addition as well as a hand stack approach
  - High multiplication subcritical configurations
  - Future experiments could interleave other materials
  - Hemishells made male/female for alignment on membrane
  - Hemishell Thickness: 1/8” to 1/2”
  - Alternate membrane designed for subcritical measurements/handstacks not on critical assembly machine
BeRP Ball Reflected by Be

- Six polar holes (five upper, one lower):
  - Experimental access (RTDs, detectors, fission chambers, irradiation samples, etc)
  - Fine reactivity control
  - Experimental alignment
  - Polar hole dimensions based upon existing sample sizes (Godiva, Flat-Top)
  - Thin Al sheath lining
BeRP Ball Reflected by Be

Subcritical K-effective vs. Be Thickness (in)

k-effective vs. Beryllium Thickness (in)

- Unfilled Polar Hole
- Filled Polar Hole
BeRP Ball Reflected by Be

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* Indicates large relative uncertainties in the calculations
BeRP Ball Reflected by Be

- Final design is being iterated upon
- Working with interested parties to determine if design meets goals and needs
Timeline for IER 453

• Components have been ordered.
• Currently in discussions about the design of stands to secure detection system.
• Expect testing and set-up at LANL in Q3.
• Ship to NCERC.
• Measurements on Godiva IV expected end of Q3.
• Plan for unknown testing in FY20.
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