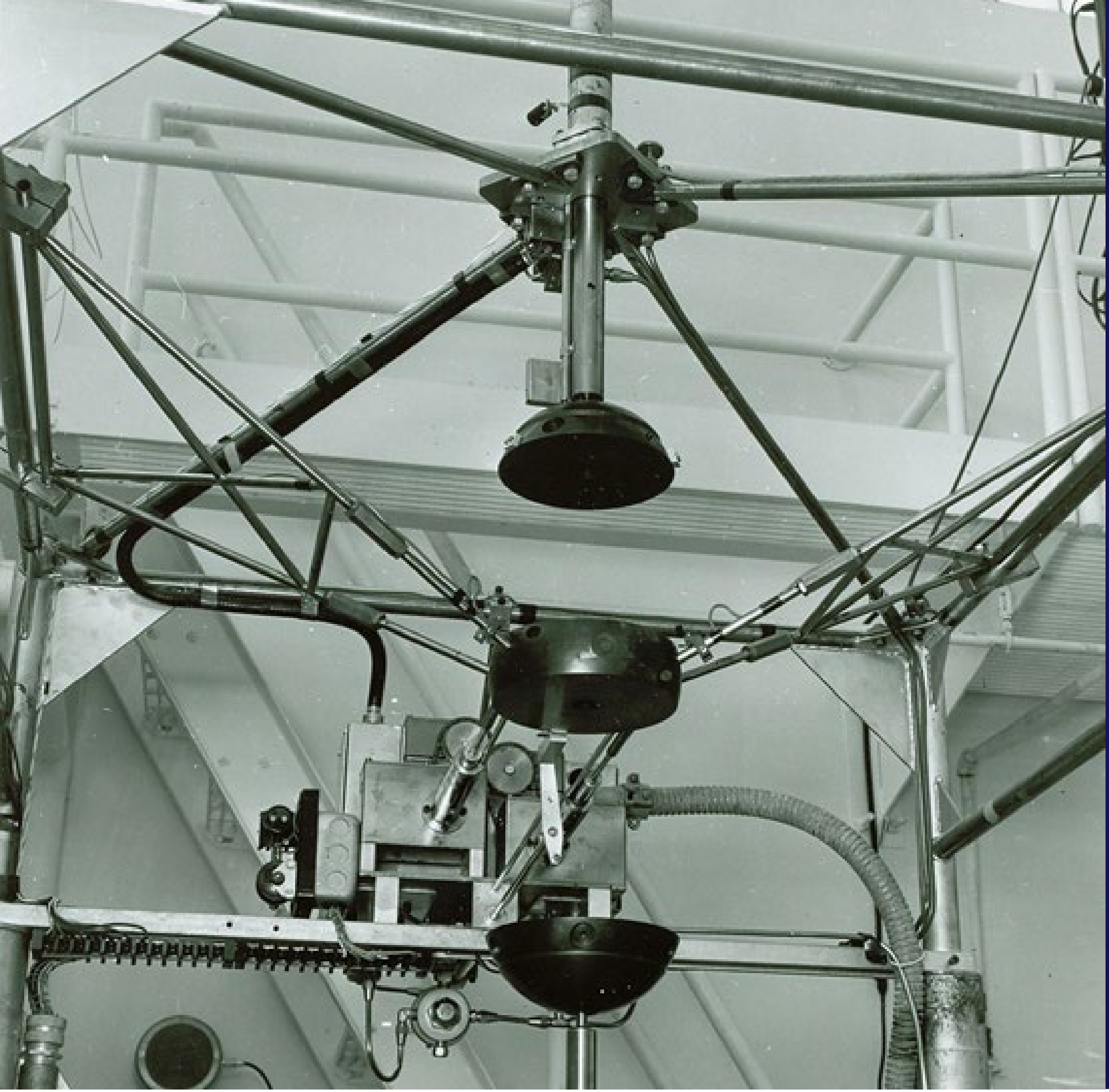

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National Nuclear Security Administration
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# Design of Experiment To Test Fast Electronics For Neutron Noise Measurements. (IER 453)

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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

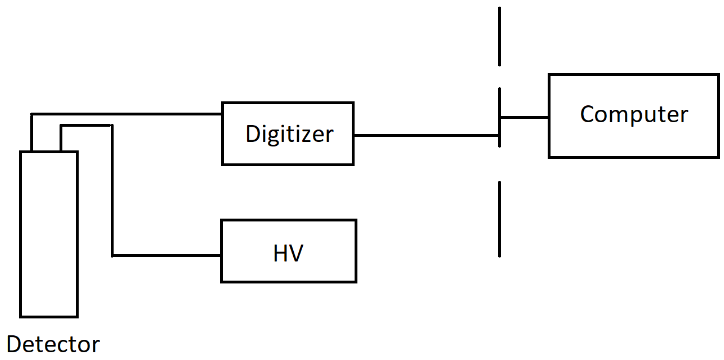
- At LACEF, neutron noise measurements were performed as early as the 1940s.
- The systems implemented there were capable of measuring the prompt decay on bare systems such as Lady Godiva.
- These systems implemented He-3 detectors, proton recoil detectors, stilbene detectors, and fission chambers.

# 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.

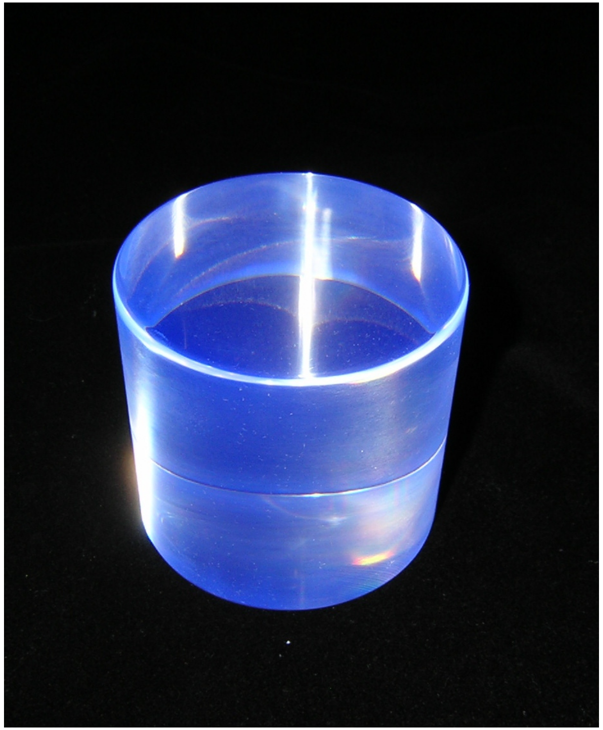
# New Fast Electronics System

- **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


EJ-309 Liquid Scintilator
Lot # 040814-309
EJ-301 Liquid Scintillator
Lot # 200814-301



# Equipment


CAEN
Desktop Digitizer
CH0
CH1
CH2
CH3
CH4
CH5
CH6
CH7
LINK
CLK IN
GPO
TRG IN
GPI
USB


Zoom Mode
HV
CAEN
GECO
2020

# 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

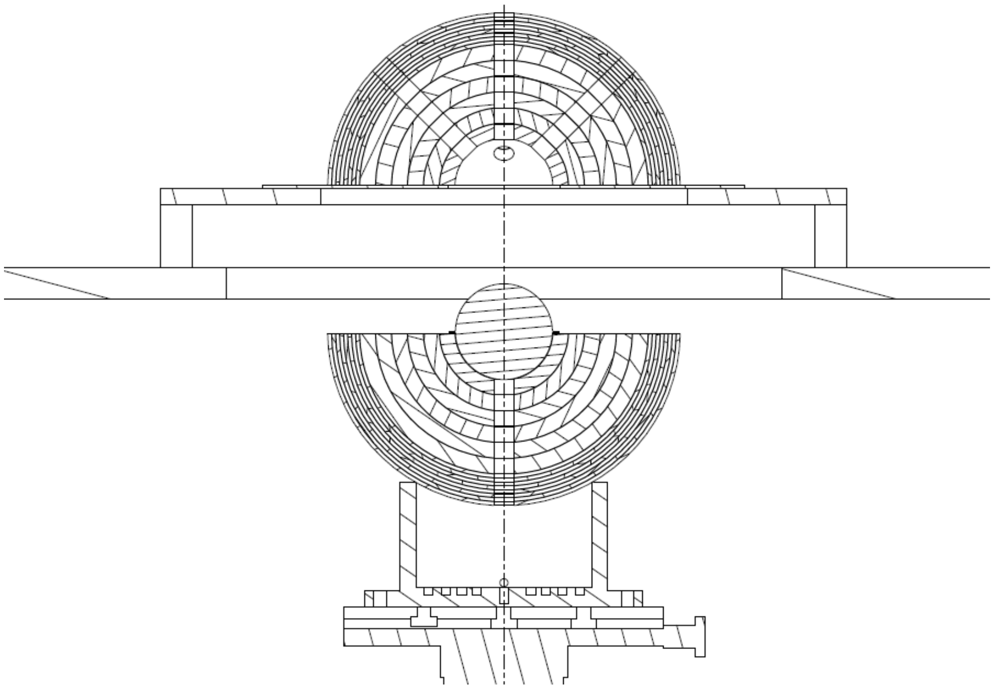
- **Design Constraints:**
  - The ability for the configuration to be built using a hand-stack approach – i.e., the ability to slowly approach the critical configuration.
  - The ability for the configuration to also support construction of numerous high-multiplication subcritical configurations.
  - 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**

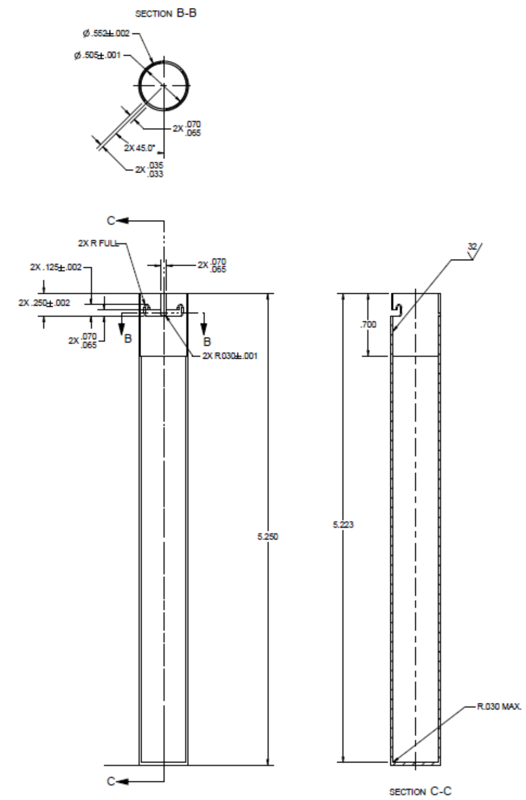


# BeRP Ball Reflected by Be

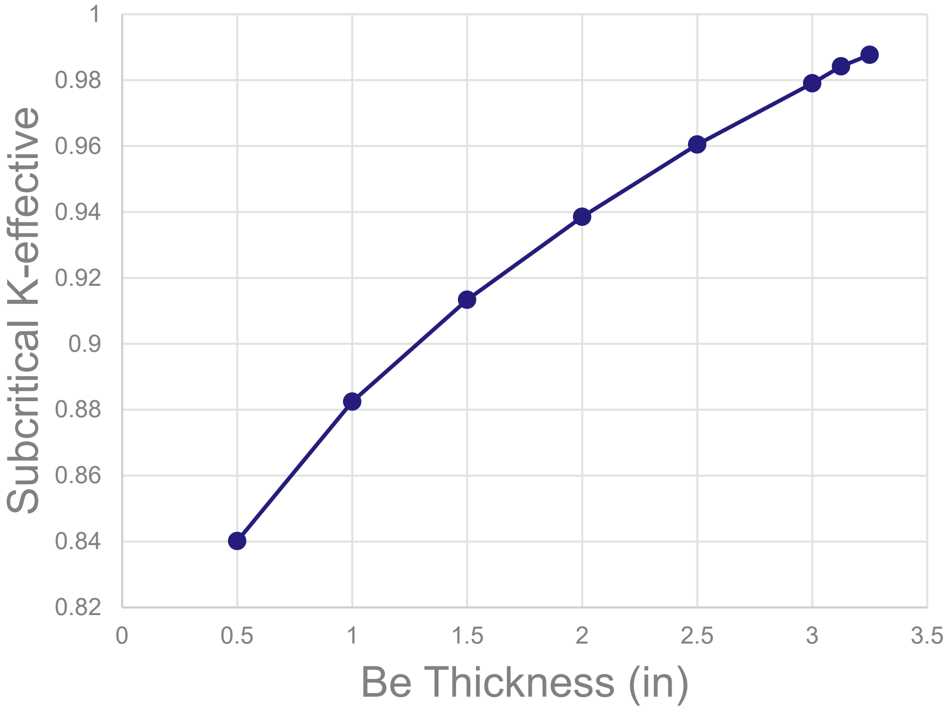
- **Hemishells: Allow for coarse reactivity addition as well as a hand stack approach**
  - High multiplication subcritical configurations
  - Future experiments could interleave other materials
  - Hemishells made male/female for alignment on membrane
  - Hemishell Thickness: 1/8” to 1/2”
  - Alternate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

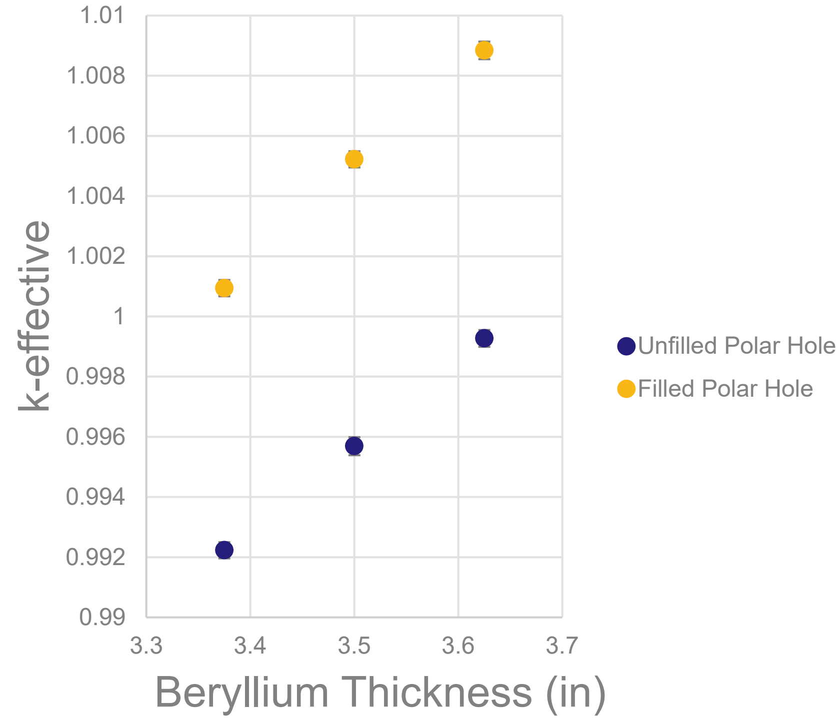
# BeRP Ball Reflected by Be

- **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

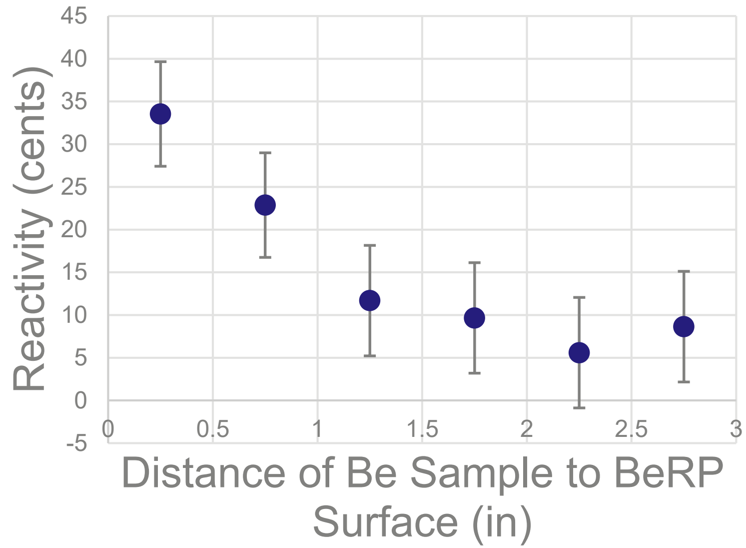


# BeRP Ball Reflected by Be

| Isotope | (n,2n) | Fission | Elastic | Total |
|---|---|---|---|---|
| Be-9 | 2.38E-02 | N/A | 2.67E-01 | 2.88E-01 |
| Pu-239 | 2.64E-04* | 6.77E-01 | 2.58E-02 | 7.02E-01 |
| Pu-240 | 6.96E-05* | 2.64E-02 | 5.73E-04* | 2.59E-02 |

* 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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