**Building 470 Pile – Foil Activation Experiment Plan**

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| Title: | Research Plan | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ |
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| Facility: WPAFB, Bld 470 | | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ |
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| Source Descr: Bld 470 Graphite Pile – PuBe | | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ |
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| Funds/Equipment Req:  Operation Pile with PuBe Source  Various Activation Foils  HPGe Operation – Bld 470, Rm 105 | | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ | \_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_ |

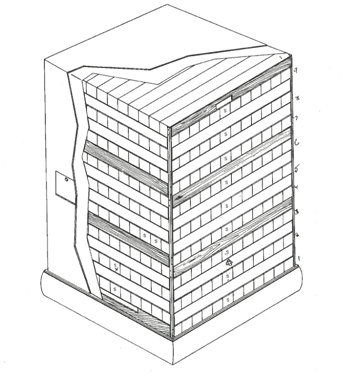
Abstract:

1. Purpose:

The purpose of this experiment is to characterize the neutron energy spectrum in the Building 470 pile with the PuBe source. The experiment to measure the neutron energy spectrum is a foil activation experimenthe using indium, gold, manganese, aluminum and tungsten foils of various thicknesses. The foils will be counted in an HPGe to determine the activity of the foils post-irradiation. The data will be used to unfold the incident neutron spectra using Pacific Northwest National Laboratory’s STAYSL code, which performs a least-square spectral fitting technique to unfold the neutron flux from the measured activities and nuclear data.

2. Description / Procedure:

(24-3 Aug ) Irradiate foils in Bld 470 pile for 10 days (Foils are In, W, Au, Mn, Al).

* Source: PuBe Source in Building 470 pile.
* Foil Description: (Need Geometry and Percentages still)
  + Tungsten
    - Mass: 0.6210 +/- 0.0001 g
    - Elemental Purity:
    - Dimensions: Thickness = 0.0254 cm, Diameter = 1.27 cm
  + Indium
    - Mass: 0.2352 +/- 0.0001 g
    - Elemental Purity:
    - Dimensions: Thickness = 0.0254 cm, Diameter = 1.27 cm
  + Gold
    - Mass: 0.5578 +/- 0.0001 g
    - Elemental Purity:
    - Dimensions:
  + Manganese
    - Mass: 0.2600 +/- 0.0001 g
    - Elemental Purity:
    - Dimensions
* Foil Location: Foils will be stacked and placed in the center of stringer 2 in the basement of the 470 pile. Stringer 2 is the second stringer to the bottom.
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PuBe source placed one stringer above foils. There is a slot for the PuBe source.

Foils placed in slot of stringer 2, which is the second stringer on side with lowest stringer.

(24-02 Aug) Characterize HPGe in Rm 105

* equipment used
  + ORTEC HPGe
  + DSA1000 detection system
  + Laptop / Genie 2000 Multi-Channel analyzer
* sources: Laboratory multinuclide source
  + A multinuclide source is used to calibrate the MCA for energy. This portion of the experiment is also used to determine the detector efficiency curve.
* experiment setup
  + The multinuclide source is acquired 4 inchesfrom the HPGe with a gain course gain of 20 and a fine gain of 1.5
  + The bias voltage is set to 4,000 V. The gain must be set so that the dynamic range of gamma ray energies of interest is measurable on the MCA (400 keV to 1300 keV)
  + More information on the setup is available in [2]

(03 Aug) Measure Al, Indium and Manganese Activation foils

* Measurement time: 3-5 hours. Foils will be measured until ~10,000 counts have been acquired
* Source: In and Mn foils activated in the pile
* Experiment setup and equipment: Identical to HPGe Characterization
* Measure Al foil after enough counts in In and Mn

(03 Aug – 06 Aug) Measure Tungsten and Gold foils

* Measurement time: Approximately 24 hours
* Source: W and Au foils activated in the pile
* Experiment setup and equipment: Identical to HPGe Characterization

(2-9 Aug) Analysis and preparation for research update

(9 Aug) Research Update

(9-16 Aug) Draft Project Article

(9-21 Aug) Spectrum Unfolding Using STAYSL

(16-23 Aug) Create Lab Procedures

(21 Aug) Lab Notebook

(21-30 Aug) Final Analysis

(21-30 Aug) Final Project Article

3. Safety Analysis:

a. *ALARA – Radiation Safety*

Personnel conducting the experiment will have ALARA training. ALARA includes minimizing exposure time and distance from radioactive sources. The expected sources are the activation foils, the neutron pile, and the multi-nuclide source. The neutron pile has more information available in a report performed on the energy distribution [1].

b. *Electrical Safety*

No specific electrical safety information is required. A potential danger is damaging electronics on the HPGe. The procedure for operation of the HPGe is outlined in [2].

c. *Expected Activities of Isotopes Produced*

- The isotopes produced are largely beta emitters with gamma emission.

- The initial activity of the foils anticipated on removal from the pile for W, In, Au, Mn are: 175, 1,395, 685, and 260 becquerels (Bq). The activities presented are only for the (n,gamma) reaction, which is the largest reaction by orders of magnitude. The total activity of all foils will have an upper bound of 3 kBq.

d. *Nonstandard Procedures / Administrative Controls*

This experiment requires no nonstandard procedures. No additional administrative controls are necessary to ensure safe operation.

e. *Radioactive Material Storage and Disposal*

Radioactive materials produced through the irradiation of the experiment will be stored on-site until the short-lived isotopes have decayed.

f. *Dosimetry Requirements*

All samples will be surveyed for beta / gamma radiation upon removal from the pile. Any personnel handling the experiment after irradiation shall wear ring badges in addition to their whole-body badges if the dose rate exceeds 100 mrem/hr. The foil activities modeled will be below this requirement.

g. *Other Safety Concerns*

None applicable.

4. References:

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| [1] W. Johnston, "Characterizing the Neutron Energy Distribution of the AFIT Building 470 Graphite Pil," NENG 725, 2018. |
| [2] K. Choe, W. Johnston and N. Quartemont, "High Purity Germanium Gamma-Ray Spectroscopy," NENG 650, 2017. |