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Title: Extended Dry Storage Signature Bench Scale Detector Conceptual Design

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INTRODUCTION

This report is the conceptual design of a detector based on research within the Extended Dry Storage Signature Development project under the DOE-NE MPACT campaign. This is the second year of the project; from this year's positive results, the next step is building a prototype and testing with real materials .

REVIEW

Previously, simulations have shown a strong correlation between the profile of a neutron signature collected around the outer surface of a cask at the axial midpoint of the fuel and the specific arrangement of used fuel within the cask itself. The specific arrangement of used nuclear fuel with a unique distribution of neutron producing fission products and multiplication provided by remaining fissile material in the fuel drives the shape of the profile. By normalizing the profile against the average of all counts around the outer surface, comparisons across decades of cooling time can be easily made, as the profile remains stable over long periods of time.

CONCEPTUAL DESIGN

The results of a long series of tests including tests with real data from real casks have shown through simulation that proposed signature can be used as a form of identification for used fuel dry storage casks. The next step would be to construct a prototype detector to ensure the signature could be collected reliably. A bench-scale detector will be built and tested with neutron sources in the laboratory. The laboratory work will include building a test stand, for testing both the method and the components of the detector and to help develop software for data acquisition and control of the detector. The prototype bench-scale detector will test the electronics, control and acquisition software, method, and data analysis of the full design without needing access to used nuclear fuel stored in casks.

The bench-scale detector will use 12 He-3 detector tubes attached to KM200 charge amplifiers. These amplifiers are proven for this type of application, and the IAEA currently uses them for safeguards measurements across the world. These amplifiers provide great stability, and should greatly help to achieve the relative efficiency between each detector tube. He-3 use in neutron detector tubes has a long history for safeguards uses, and is a good material for neutron detection in gamma fields.

The Single Chip Shift Register (SCSR) will collect the neutron count data from all the detector tube/KM200 units and report it to the control and data acquisition system. The SCSR includes a high voltage supply that is sufficient to also run the detector tube/KM200 units, and it includes ports for USB communication. The SCSR contains a Field-programmable gate array (FPGA) that is programmable to receive up to 32 inputs, so it is suitable for the bench scale detector but will need modification for a full-scale detector used on fuel casks.

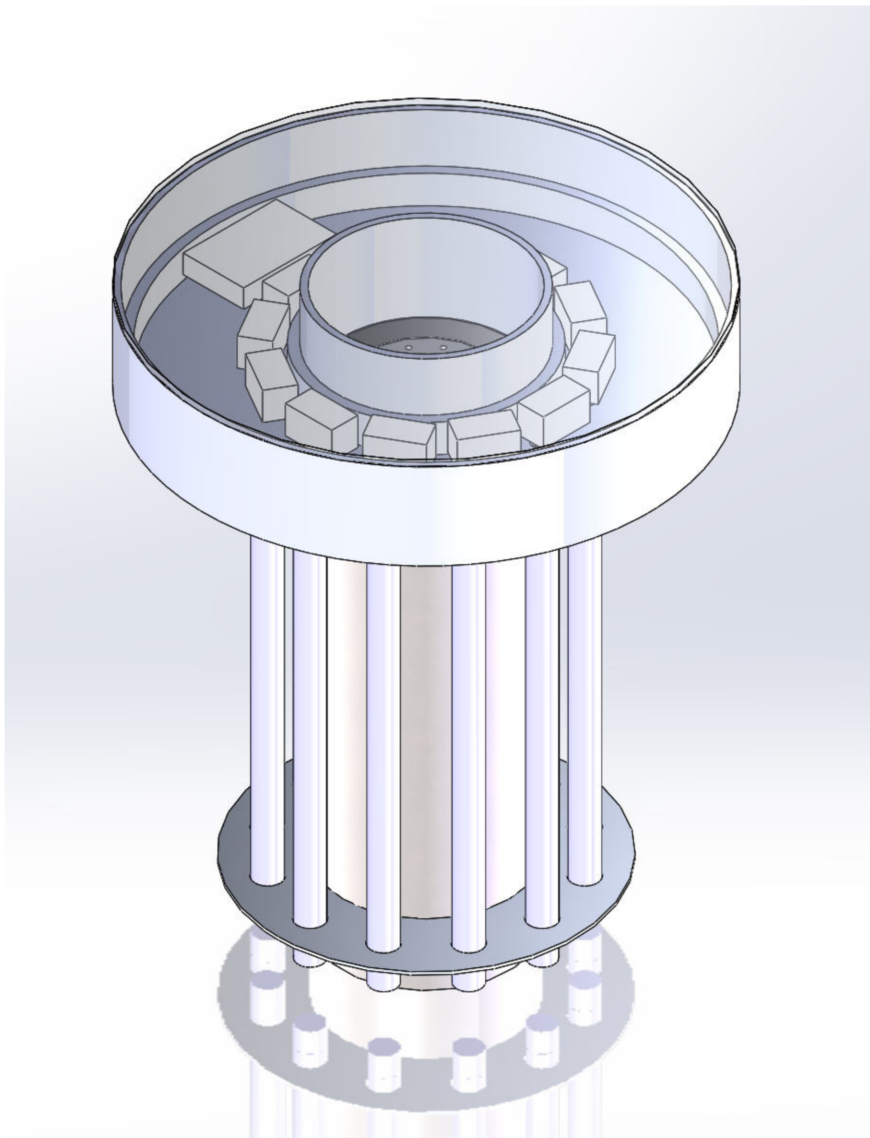

Figure 1: Conceptual Design of the Bench Scale Detector

The detector tubes are placed in an ~10" diameter pattern, with the overall unit being 20" tall with a 20" diameter.

COST

The cost breakdowns are as follows:

Item	Cost
Electronics	$10k
12 He-3 Tubes	$25k if gas provided, $64k if not
Test Stand Materials	$30k
Assembly Labor	$100k
Software Development	$50k
Simulation of Tests	$60k
Testing	$60k
Reporting and Attendance at WGM	$40k
Total	**$375k-$414k**

These costs are estimates. The assembly of the test stand and detector is straightforward, and should be a process that is well understood at this point, but uncertainties always creep up.

Given the anticipated FY16 budget of $250k, not all items listed above can be completed unless the project receives additional funding. At the FY16 anticipated funding level of $250K, construction and assembly of the hardware could begin and be mostly complete, however software development would be on hold for a future FY's. With a funding level of closer to $350k, the software development could be completed, along with some simulation testing, which would ensure a proper testing regime is performed, and initial laboratory scale tests with neutron sources could begin.