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New Routes for the Production of Fission Products and Their Separation from the Source Material for the Development of Realistic Nuclear Forensic Debris

N. Gharibyan

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Disclaimer

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Mid-year Status Report

New Routes for the Production of Fission Products and Their Separation from the Source Material for the Development of Realistic Nuclear Forensic Debris

PI: Narek Gharibyan

Task 1: Characterize NIF neutron spectrum (expected completion date: 2/18/2016)

In order to fully characterize the NIF neutron spectrum, SAND-II-SNL software was requested/received from the Radiation Safety Information Computational Center. The software is designed to determine the neutron energy spectrum through analysis of experimental activation data. However, given that the source code was developed in Sparcstation 10, it is not compatible with current version of FORTRAN. Accounts have been established through the Lawrence Livermore National Laboratory's High Performance Computing in order to access different compiles for FORTRAN (e.g. pgf77, pgf90). Additionally, several of the subroutines included in the SAND-II-SNL package have required debugging efforts to allow for proper compiling of the code.

While the software is being modified to run on the available operating systems, a large number of materials have been or are in the process of being approved to be fielding at the irradiation locations at the NIF, Figure 1. Detailed assessment of each material is required prior to approval. Once the software has been optimized for characterizing the NIF neutron spectrum, these approved materials will be fielded at the irradiation locations to obtain the necessary activation data as required by the SAND-II-SNL software. We are currently on pace to have this task completed by the expected date, 2/18/2016.

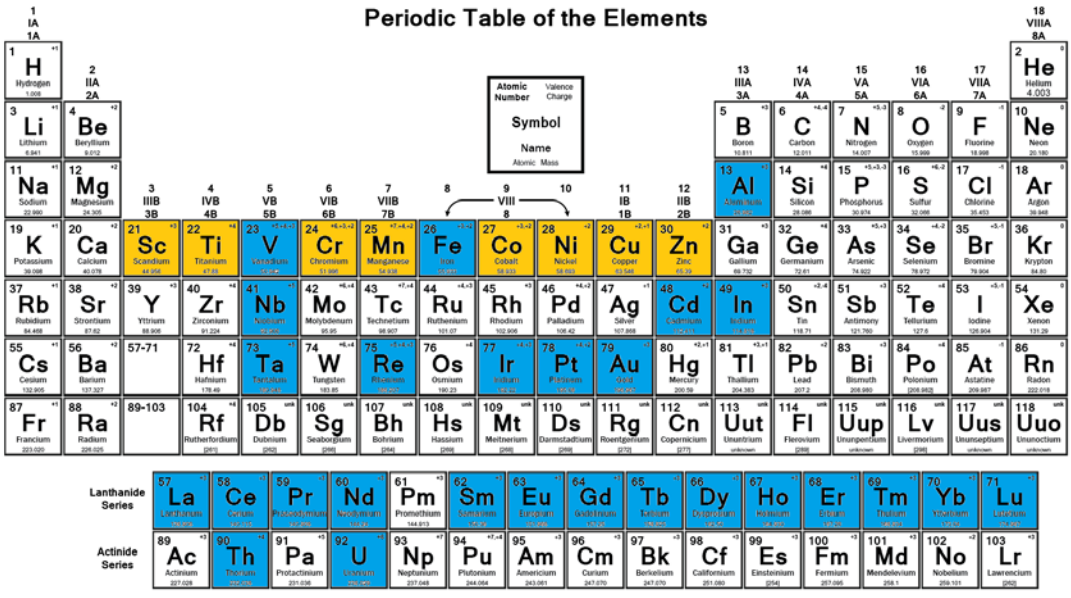

Figure 1. Metallic form of these elements can be irradiated at the NIF (blue=approved, orange=pending).

Task 2: Measure initial fission yields at NIF (expected completion date: 2/18/2016)

Approvals for fielding materials (Th-232, HEU: U-235) at the NIF have been completed for natural thorium while HEU approval will be completed by early October, 2015. The use of HEU at the NIF is bound by the 2011 Site Wide Environmental Impact Statement Supplement Analysis (SWEIS SA). As a result, an extensive work authorization process has been conducted, including obtaining final approvals from DOE, for the use of HEU at the NIF. The work authorization permit is almost complete which will allow us to field 1.2 g of HEU per sealed sample source (up to 3) on a single NIF shot.

The first irradiation for measuring 14-MeV neutron fission yields of natural thorium, Th-232, is scheduled for 10/22/2015 (expected DT yield of 1E16). Legacy thorium foils are available through the Experimental Nuclear and Radiochemistry group at LLNL. Radiochemical separation methods were investigated by a summer student, Kelly Kmak, where proton irradiated thorium foil was utilized as the starting material. Several different chromatography methods were investigated for the separation of thorium and its decay daughters from fission products. Kelly presented her work at the Nuclear Science and Security Consortium 2015 Summer School at the Los Alamos and Sandia National Laboratories. Results from her work will be utilized in the upcoming experiments focus on the initial fission yield measurements of natural thorium.

The first measurement of 14-MeV neutron fission yields of uranium (HEU, 93% U-235) will be performed as soon as the material arrives on site at LLNL. A purchase order has placed (mid-August) for 65 g of HEU (from NIDC/Y12, in collaboration with another project - PI: Kevin Roberts) of which 15 g will be used for the fission yield measurements as it relates to this project.

The initial fission yields for Th-232 and U-235 will be completed by the expected completion date if the purchased HEU material arrives on site at LLNL by November, 2015.

Task 3: Test new sample holder (expected completion date: 2/18/2016)

A new sample holder (Tree-frog, 10 cm from target chamber center, 7 mm diameter samples, max. thickness 1.42 mm) was designed and tested on several NIF shots. Based on calculations, this new sample container increases the solid angle coverage by almost a factor of 2 for only $1/13^{th}$ of the total area in comparison to the previously used sample container (Toad sample container, at 50 cm from target chamber center, 25 mm diameter samples, max. thickness 0.65 mm). An irradiation has been performed with a gold filled Tree-frog in order to perform a detailed comparison with a similar material irradiated with the Toad sample container, Figure 2. The data analysis is in progress and will be completed by the expected completion date.

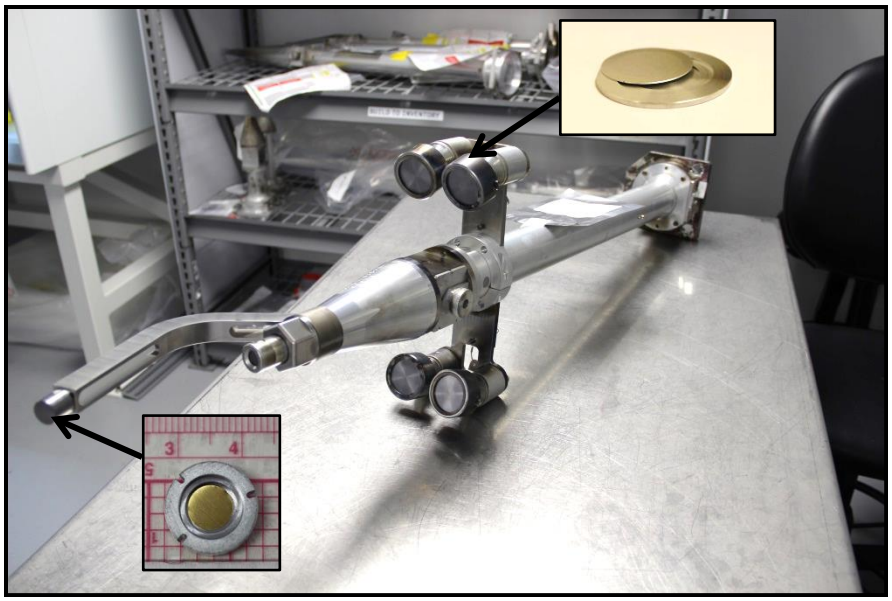

Figure 2. Location of the two sample containers: Tree-frog (bottom left) and Toad (top right).