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Initial hiRX Performance Characterization of Pu in Nuclear Spent Fuel Matrix

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A new prototype instrument, hiRX (high resolution X-ray), offers a paradigm shift for plutonium assay in nuclear spent fuel. This new approach offers direct, active, nondestructive interrogation of nuclear spent fuel for plutonium content. This instrument is based upon technology known as monochromatic wavelength dispersive X-ray fluorescence (MWDXRF) which utilizes two doubly curved crystal (DCC) optics. The DCC optics provides monochromatic transmission of X-rays through the crystal. The MWDXRF technology uses one DCC optic for excitation and another for detection of the target analyte, in this case plutonium. The advantage of using monochromatic optics reduces the background and employs selective X-ray energy detection resulting in a high signal-to-noise ratio. The high signal-to-noise ratio offers low detection limits, elimination of radiation background and high selectivity detection for Pu. This highly selective and sensitive method offers a new capability for plutonium quantitative characterization in nuclear spent fuel matrices. This technology has been developed into a prototype production instrument. The prototype instrument offers enhanced safety by using only a 4 microliter sample of nuclear spent fuel solution. This low amount of solution significantly reduces the radiation exposure for the operator as well as reducing the amount of waste which needs to be disposed. A measurement can be obtained within 10 minutes of receiving the sample which is achieved by simply pipetting the volume into a disposable plastic sample cell. The operation is straightforward with results displayed in g/L of uranium. The expected uncertainty performance of the hiRX prototype instrument is around 5%. The ultimate uncertainty goal is less than 1% which can be achieved through further refinement and development of improved hardware and software. LA-UR-14-22443

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Primary author: HAVRILLA, George (Los Alamos National Laboratory)

Co-authors: MISSIMER, David (Savannah River National Laboratory); MCINTOSH, Kathryn (Los Alamos National Laboratory); HOLLAND, Michael (Savannah River National Laboratory); GILMORE, Robert (Savannah River National Laboratory)

Presenter: HAVRILLA, George (Los Alamos National Laboratory)

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