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PROJECT TITLE: Hybrid-K-edge/X-ray Fluorescense Densitometry with Laser-Compton Scattered X-rays

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Introduction:

The quantitative verification of the accountancy of fissile nuclear materials through independent measurements represents one of the key elements of nuclear materials Safeguards. Elemental probes of materials of interest to non-proliferation are critical to research strategy in order to identify sensitive advanced instrumentation detection technologies. Advanced instrumentation for material detection and accountability are needed for use in fuel cycle facilities for real-time in-process monitoring of separations-partitioning, fuels fabrication as well as for traditional safeguards activities. Radiation-based NDA (non-destructive analysis) techniques can provide some vital information about nuclear materials much more quickly, cheaply and safely than chemical or radio chemical analysis. Hybrid K-edge densitometry (HKED) is currently the most accurate nondestructive inspection technique that provides sensitive quantification of heavy metal contamination. HKED in a technique that exploits both K-edge absorption and X-ray fluorescence (XRF) and allows simultaneously greater elemental specificity and lower detection limits

During this grant period we have carried out the following tasks:
1-Measurement of laser spot size at interaction region.
2-Measurement of electron beam spot size at interaction region under laser-Compton scattering conditions and for minimum background.
3-Selection of liquid samples.
4-HKED experiments with uranium samples with concentrations labeled 300g/l and 200 g/l.
5-HKED experiments with U/Pu sample.

1-Laser beam tasks and optical setup:

The optical setup is shown in figures 1 and 2. The laser beam coming out of the 4 GW laser (located in the laser room, figure 1) is first expanded by a set of lenses and steered toward the optics room (figure 2). Expansion of the laser beam allows us to prevent the laser from diverging over long distances and also prevents damaging the optics along its path due to laser hot spots. The laser beam passed through a long hollow drift tube in order to minimize airflow and therefore beam instabilities i.e. pointing stability (figure 2a). After collimation in the optics room, the laser beam is focused by a set of lenses (converging and diverging) in order to focus the laser beam about 8 meters away. A periscope located after the converging lens allowed us to