Portable Fast-Neutron Radiography with the Nuclear Materials Identification System

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Outline

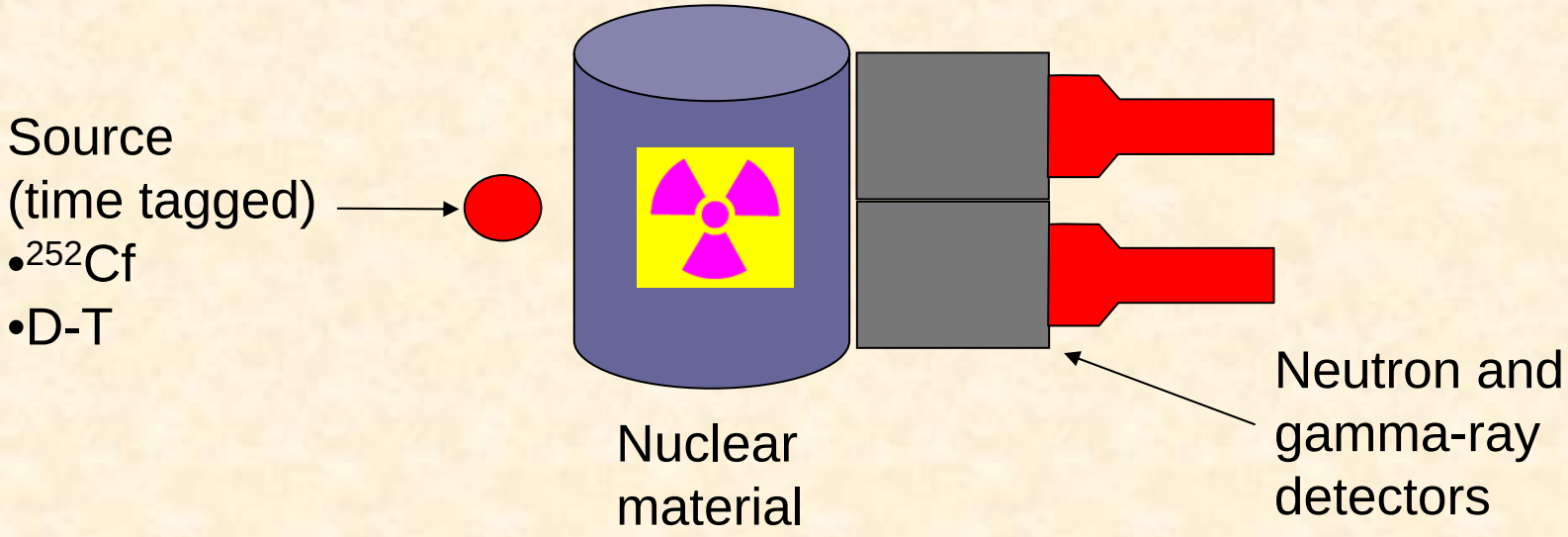
I. To imaging from the Nuclear Materials Identification System (NMIS)

II. Description of Test setup

III. Results

IV. Conclusions

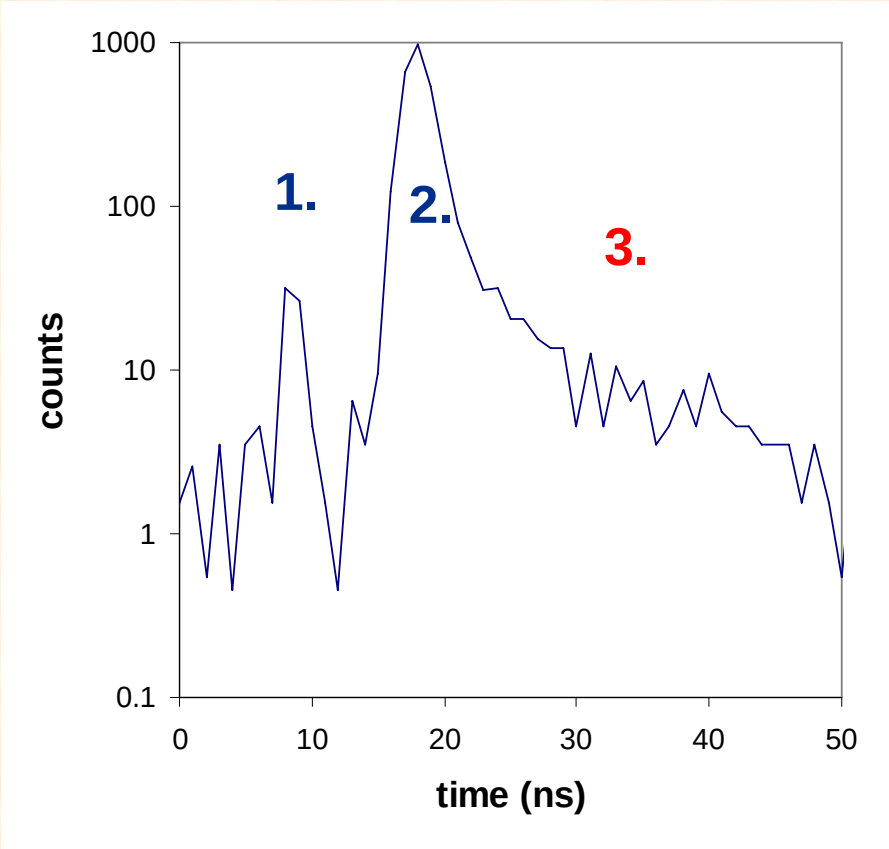
I. A. Historical NMIS measurement

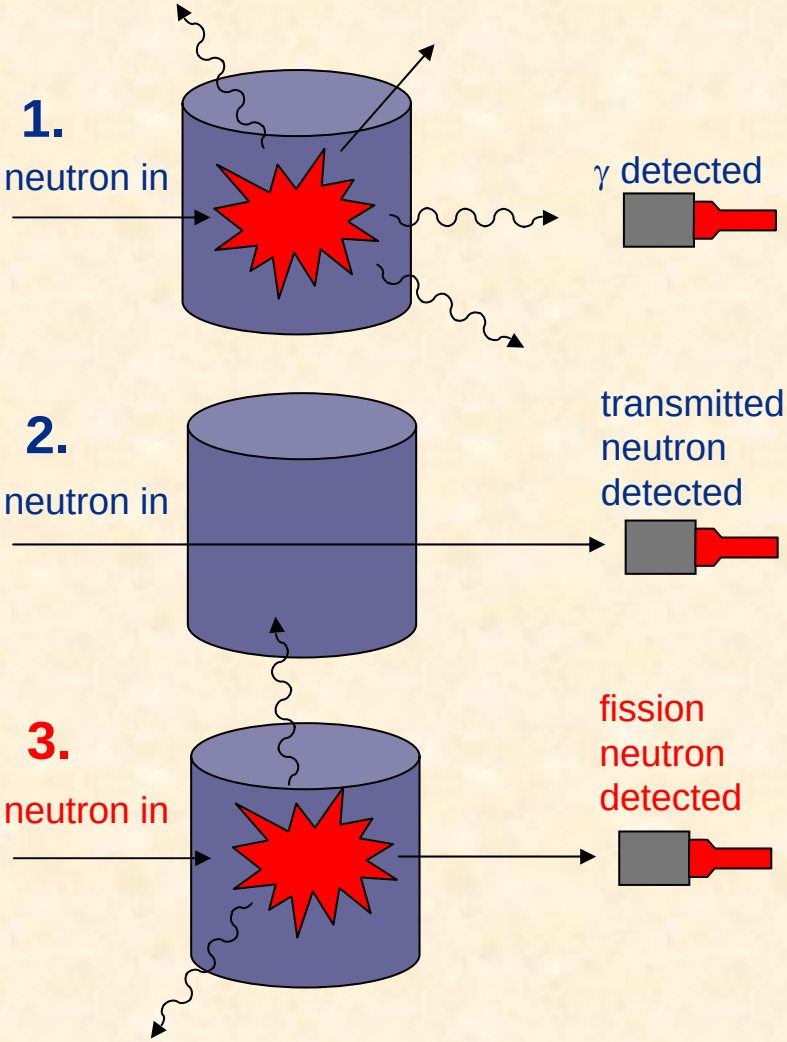


Applications: confirmation of receipts, NMC&A

- **Measure time distribution of detector counts after source event**
- **Extract number and time distribution of induced fissions to characterize nuclear material**
- **Readily interpreted for known geometries (through reference measurements)**

I. B. Time distribution of dounts after D-T reaction

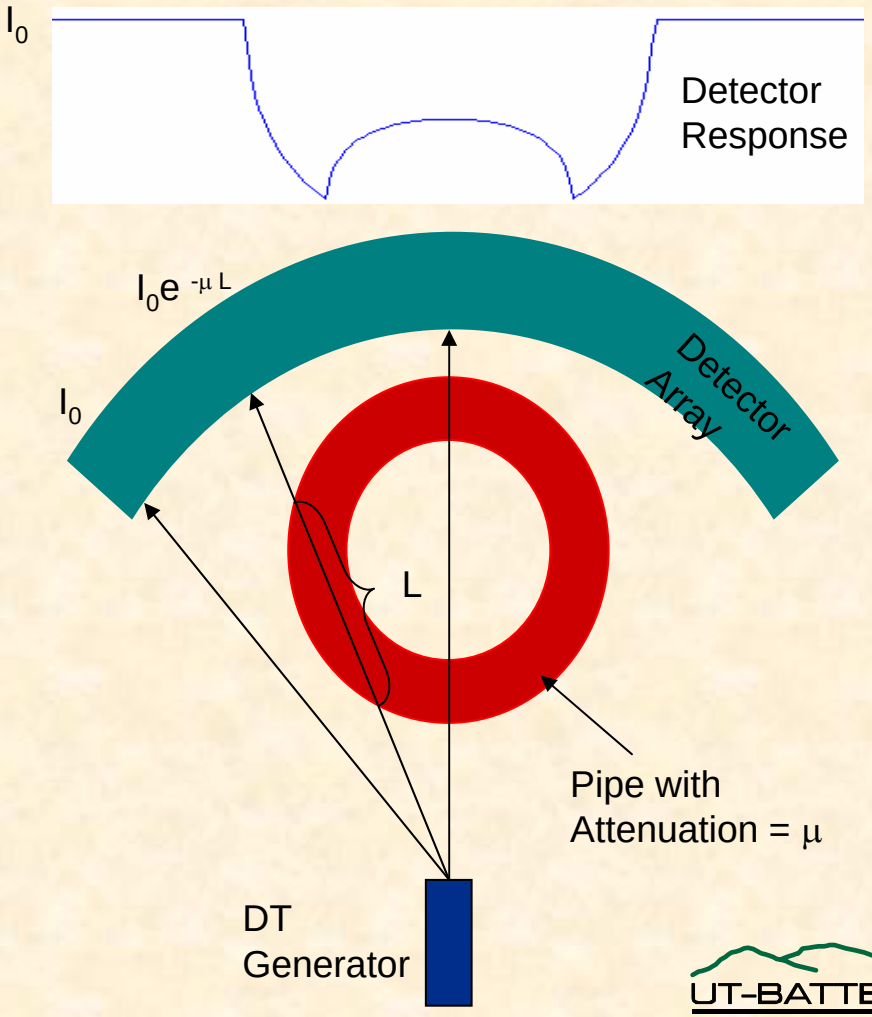




I. C. Need for imaging

Applications: characterization of unknowns, traceability through dismantlement (different settings), authentication, enhanced NMC&A

- **Geometric information encoded in transmitted counts as a function of position**
- **Character of nuclear material encoded in time dependence (given geometry)**
- **Reconstruct geometry**
- **Interpret induced counts**



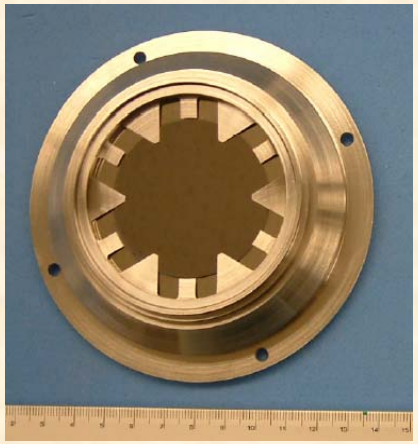
II. A. Test system

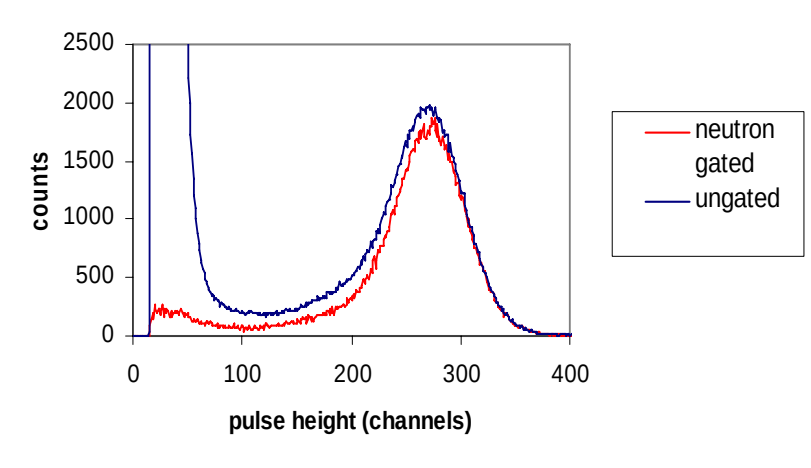
- **Associated-particle D-T neutron generator**
- **Eight – 1 x 1 x 6 in. plastic detectors on a moveable arm**
- **NMIS processor (synchronous GHz time sampling of ten channels)**
- **Analysis software**

II. B. D-T generator

- **API120 D-T neutron generator**
- **3 x 10^7 n/sec with 5-mm D-beam target spot**
- **YAP:Ce alpha detector covers 4% of 4π**
- **Small, light, requires little power**

II. C. Alpha detector

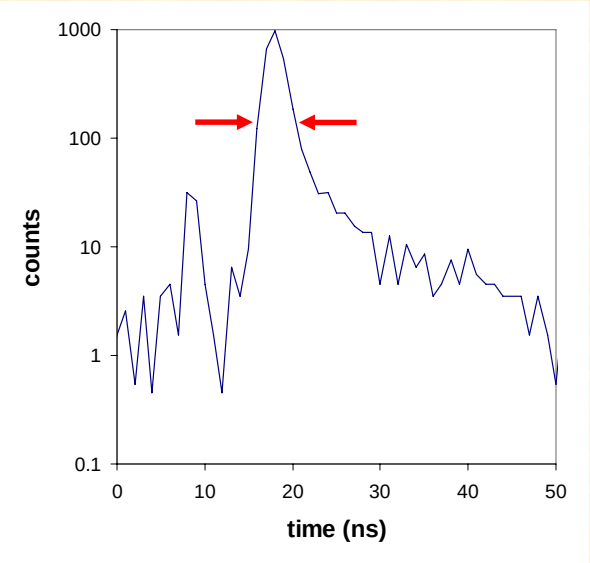




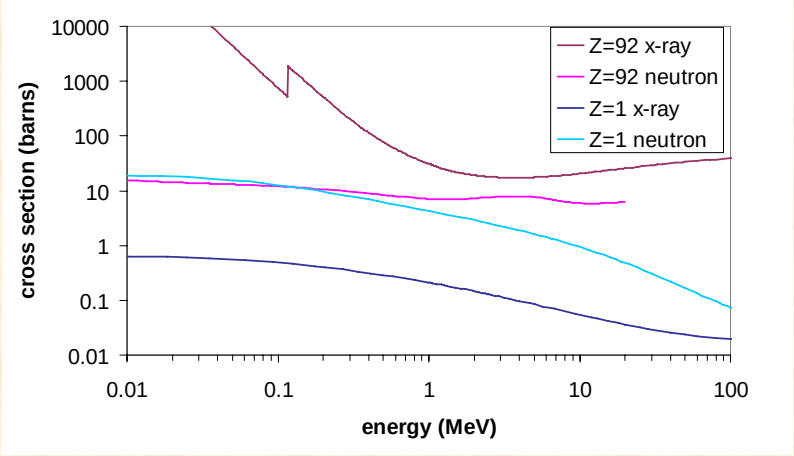
- **Cr-coated YAP:Ce viewed through fiber-optic faceplate**
- **Alphas well separated from X-rays**
- **Subnanosecond timing**
- **Present tests used single-pixel fan beam, but 1 –2 mm position resolution possible with available photons**

II. D. Advantages of the method

- **No physical collimators necessary**
- **Small portable source**

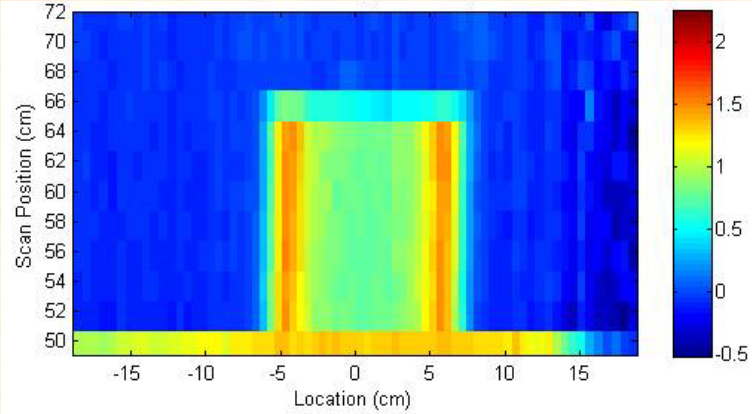


- **Sensitivity from coincidence allows measurement with high background or weak source**

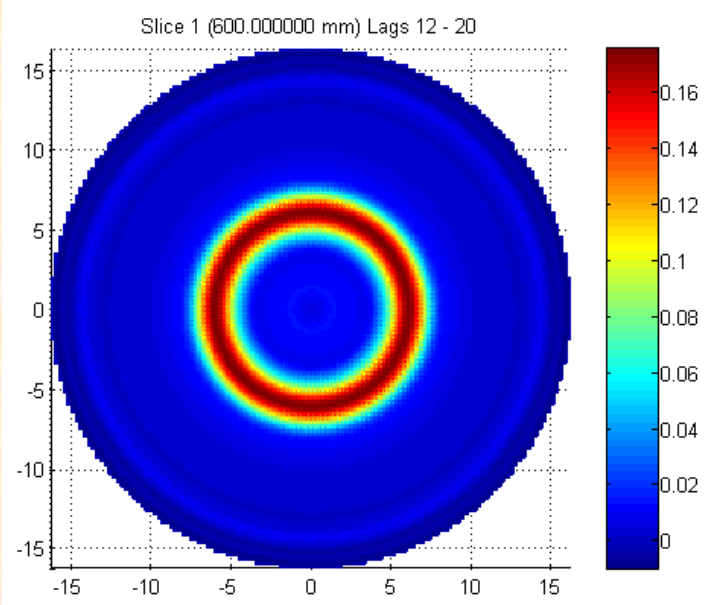


- **Fast neutrons readily penetrate high-Z shielding**

III. A. Measurement of depleted uranium casting

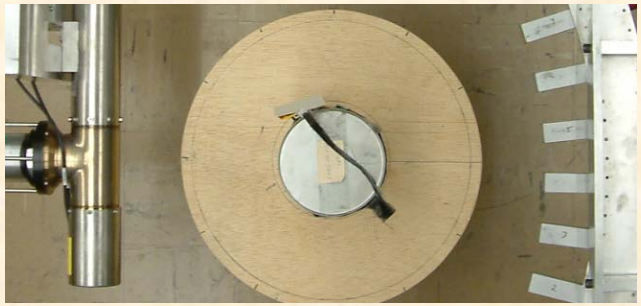


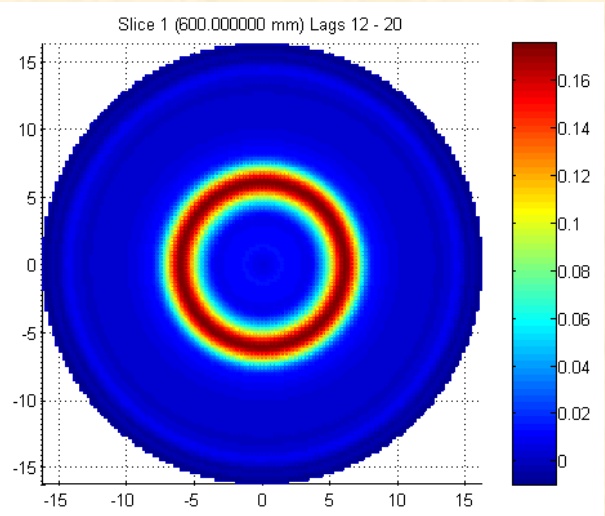
- **Radiograph showing projection of cylinder**

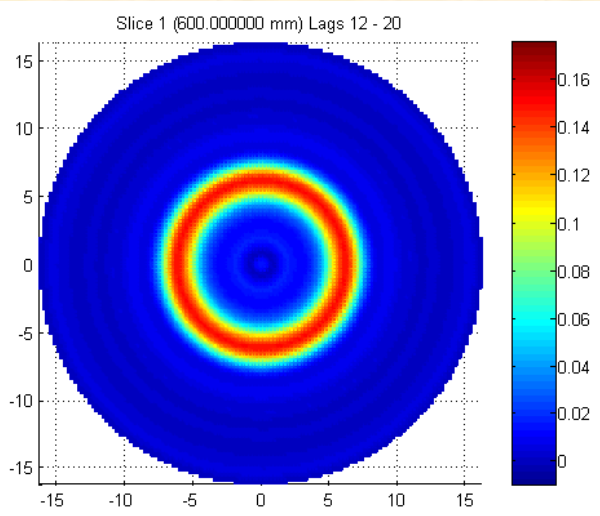


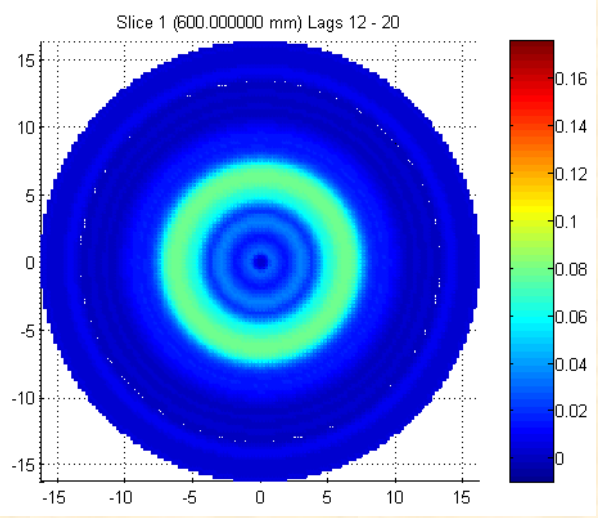
- **Pseudo-tomograph showing reconstruction of cross section**

III. B. Penetration of high-Z shielding





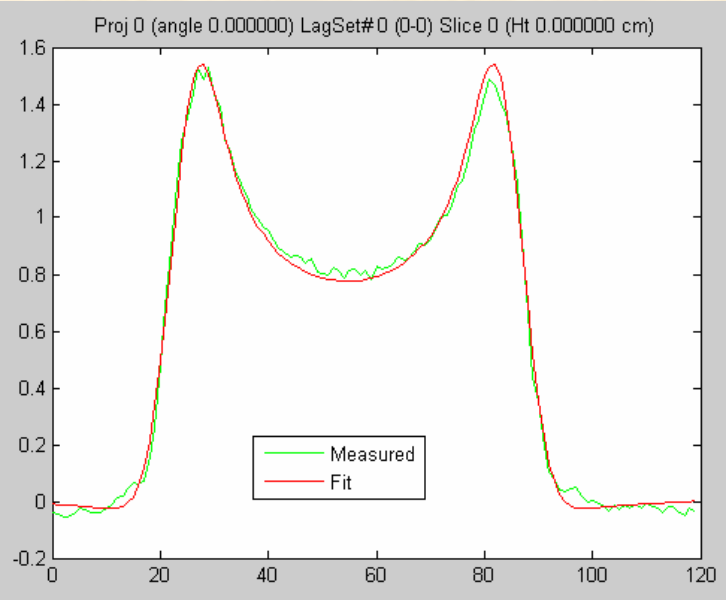


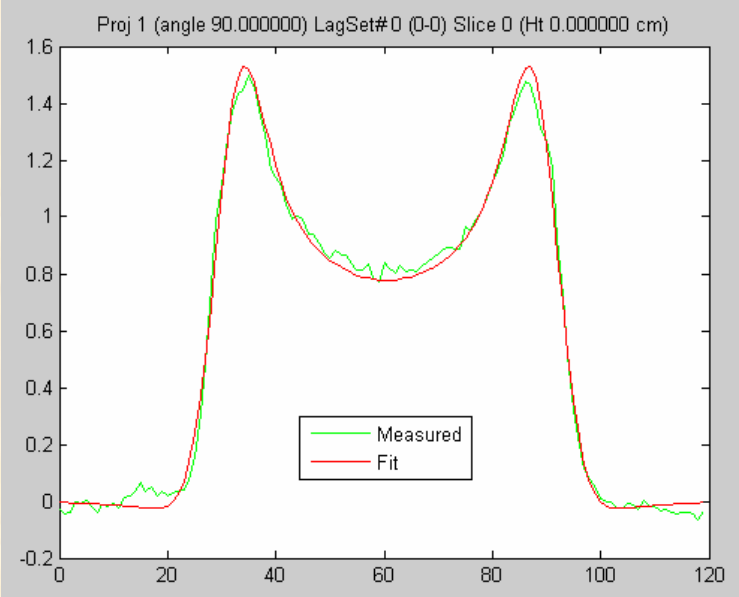


1. Bare DU casting **2. DU + 2-in. Pb** **3. DU + 10-in. Pb**

- Better penetration possible by elimination of in-plane scattering

III. C. Interpretation with ray-tracing and scattering





- **Ray-tracing model, which includes actual U cross section and small-angle scattering, reproduces casting measurement with correct dimensions**
- **Enables interpretation of ensemble of basic shapes with few views (as long as number of shapes is not large)**

IV. Conclusions

Capabilities of small portable D-T generator – based system:

- **Measure geometry of shielded unknown items**
- **Characterize shielded nuclear material**
- **Has applications in NMC&A, authentication of warheads, traceability in dismantlement, and counterterrorism**