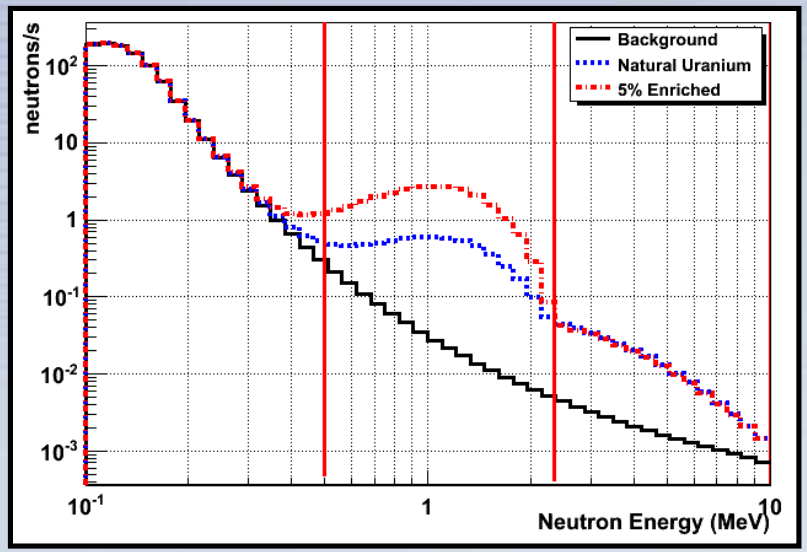
Using Fast Neutron Signatures for Improved UF_6 Cylinder Enrichment Measurements

SAND2011-1496P

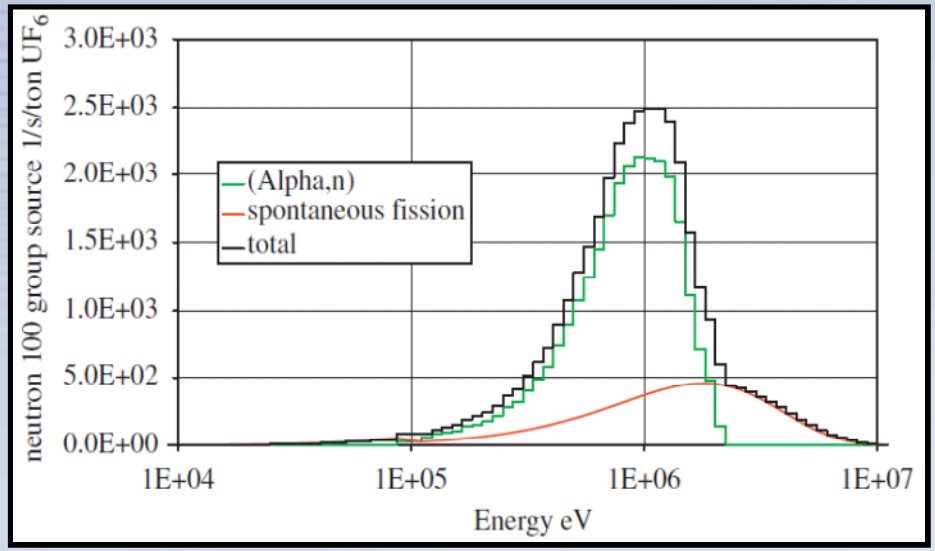
PI Scott Kiff (925-294-3583, skiff@sandia.gov), FY11-13

- Brief description of approach
- Desired measurements
- Proposed schedule
- Anticipated measurement systems



Technical concept: neutron spectrometry provides robust enrichment measurement

- **^{238}U generates neutrons via spontaneous fission and (α,n) reaction on F atoms**
- **^{234}U (and to a lesser extent ^{238}U) generates neutrons via (α,n) reaction on F atoms**
- **The two processes have measurably different energy spectra**
  - It will be possible to separate ^{234}U and ^{238}U contributions to the energy spectrum
  - Direct measurement of **^{234}U** and **^{238}U** masses
- **^{234}U content is proportional to ^{235}U content (proven by LANL for enrichment ≤ 5%)**



Desired measurements

- **30B cylinder contents**
  - Multiple enrichments from DU → ~5% ^{235}U
  - Empty cylinder (heels)
  - Reprocessed or downblended U vs. “virgin” material
  - Variety of fill masses? (nonlinear response due to multiplication)
- **Geometries (imaging test)**
  - 30B cylinders moved far from other cylinders
  - Same 30B’s moved near other cylinders
  - Internal UF_6 structure?
- **Measurement quality checks**
  - Facility declaration
  - Infinite-thickness gamma measurement

Proposed schedule

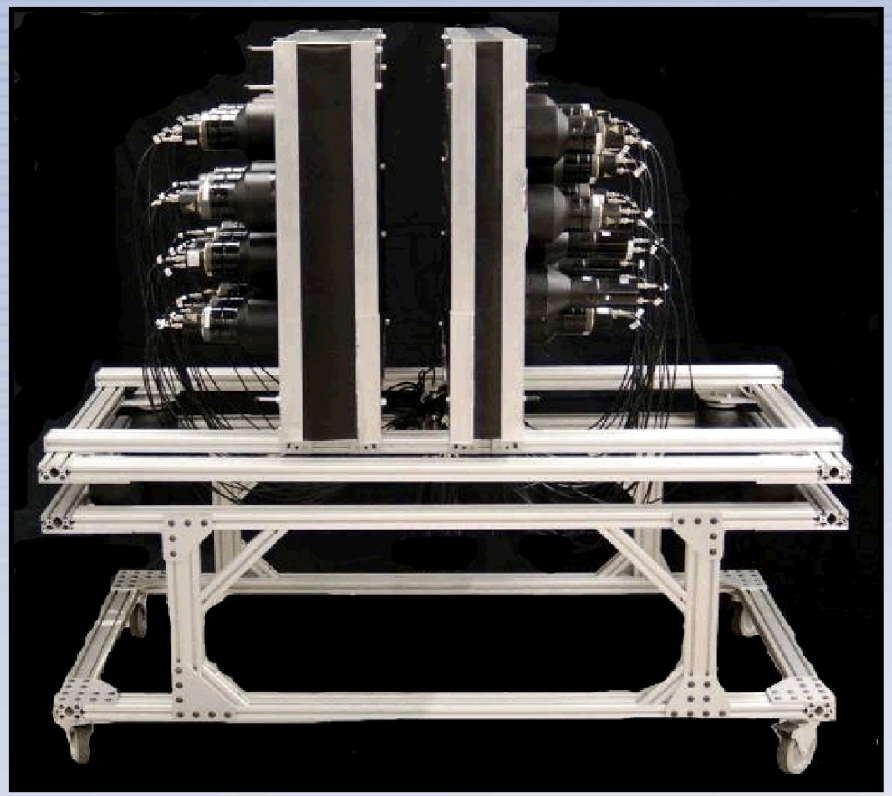
- **Summer 2011: initial scoping measurements**
  - Checking rates/spectroscopic information using simple detectors
  - Used to calibrate Monte Carlo models, understand real measurement complexities (dead time)
- **FY12: full spectrometry measurement**
  - Try spectrometric enrichment measurement on variety of 30B cylinders
  - Use existing system with minor modifications
  - Compare against facility declaration, ∞ thickness γ technique, neutron multiplicity measurement
- **FY13: optimized system measurements**
  - Repeat FY12 work using an optimized system
  - Attempt imaging to determine material distribution, background rejection

Scoping measurement system

Background Detection Assembly

- **Detectors**
  - ^{3}He tube
  - Liquid scintillator cell
  - Large NaI:Tl crystal
  - Plastic scintillator panel
- **Footprint**
  - A single crate contains
    - Detectors
    - NIM, VME crates
    - DAQ computer
- **Issues**
  - Power
  - Liquid scintillator, ^{3}He

Existing neutron imager/spectrometer



DTRA Neutron Scatter Camera

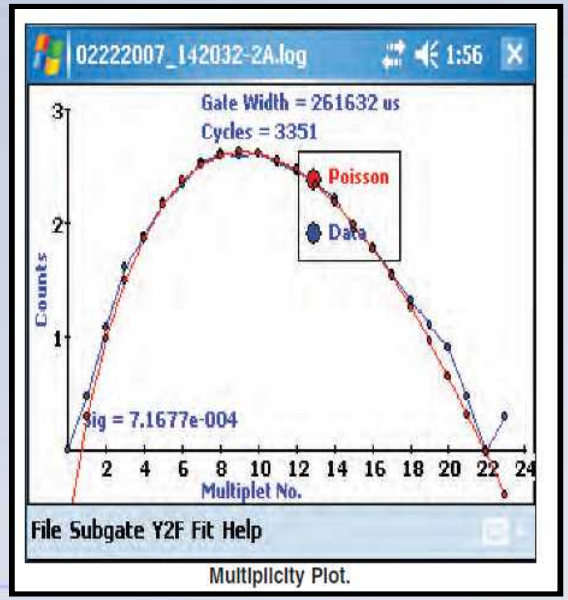
- **Detectors**
  - 24 liquid scintillator cells
- **Electronics**
  - 1 rack with VME, NIM crates and DAQ computer
- **Issues**
  - Power
  - Cylinder access
  - Liquid scintillator

LDRD
LABORATORY DIRECTED RESEARCH & DEVELOPMENT

Sandia National Laboratories

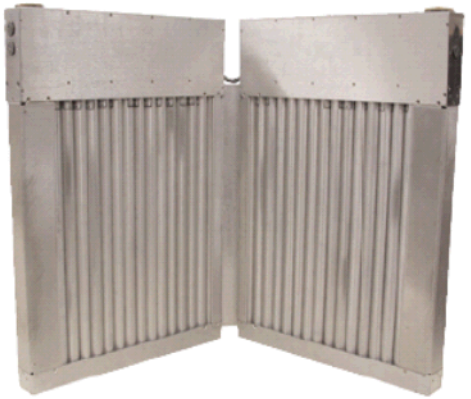
Neutron multiplicity measurements

- **Neutron multiplicity measurements**
  - Calculate fission, (α,n) source terms
  - Direct measurement of mass and enrichment?
  - Complications: poor efficiency, influence of surrounding cylinders
- **ORTEC Fission Meter (example)**



Multiplicity Plot.


Fission Meter hardware removed from carry bag, showing moderator side.


Fission Meter hardware showing ^{3}He tubes.

LDRD LABORATORY DIRECTED RESEARCH & DEVELOPMENT

Sandia National Laboratories