Approach for Determining the Background Library Spectra Using a Pulsed D-T Source

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NNSA

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Monte Carlo Library Least Squares

- Same principle as least squares except library spectra are used as the input

- $y_i = \sum_{j=1}^{m} x_j a_{ij} + E_i, i = 1, n$

  - y_i is the counts per channel i

  - x_j are linear coefficients for each element j

  - a_{ij} are the library spectra, or counts in channel i of element j

  - E_i is random error in counts in channel i

- One determination missing is the use of a background library spectra

Previous Methods for Determining Background

- Take background counts with a separate tool, or on a separate run
  - Neither option cost effective
- Residual analysis
  - Perform original MCLLS fitting
  - Using residuals, determine missing elements/libraries
  - Add elements/libraries to MCLLS for final fitting
    - Not a true on-line analysis technique
- Generate "best guess" background composition libraries
  - Using individual nuclides
    - Adds complexity to MCLLS calculation
  - Using semi-empirical background fitting functions

Pulsed Neutron Generator (PNG) die-off time
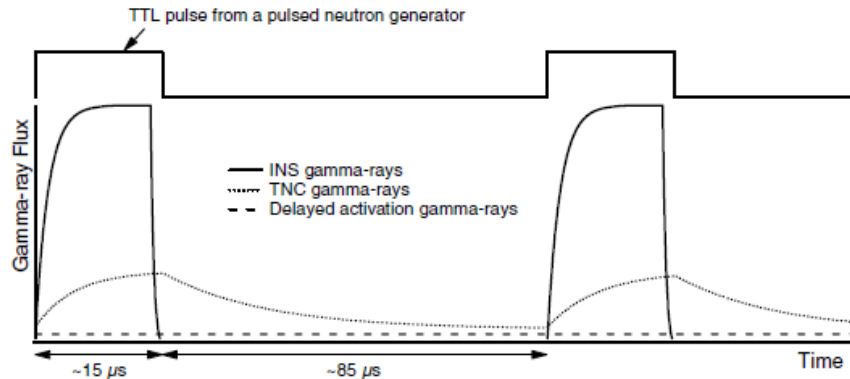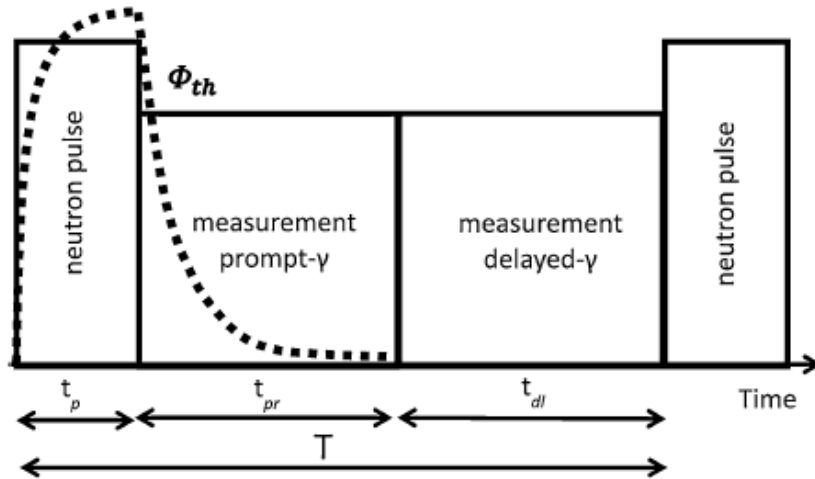
- Pulse from PNG

- Increase in gamma rays from inelastic scatter and neutron capture

- After 15-20 microseconds, inelastic gamma rays no longer contribute to total spectrum

- Neutron capture gamma rays continue exponential decrease until next pulse

Determining Background Using PNG

- Utilizing complex timing equipment, multiple spectra can be generated during the same pulsing sequence

- The burst spectrum is taken while the PNG is emitting fast neutrons, and includes both capture and inelastic gamma rays

- The capture spectrum is taken just after the PNG is deactivated, when only neutron capture gammas are being emitted

- After repetitive pulsing over a few milliseconds, a background spectrum can be collected before beginning the pulsing sequence again

KSU/RDRS equipment capabilities

- CAEN desktop digitizer
  - Model DT5730B
- Thermofisher B320 D-T Generator
- Canberra 2007P NaI(Tl) detectors
  - 3"x3"
- LND 252 He-3 detectors
  - 1"x8"

Next Steps

- Run preliminary tests to generate data
  - Very large data files
  - Determine best method to parse data into usable form that is also sharable
- Optimize timing sequence to gather only pertinent information in each timing segment
- Apply technique to full D-T cases at KSU testing facility

Questions/Discussions?

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