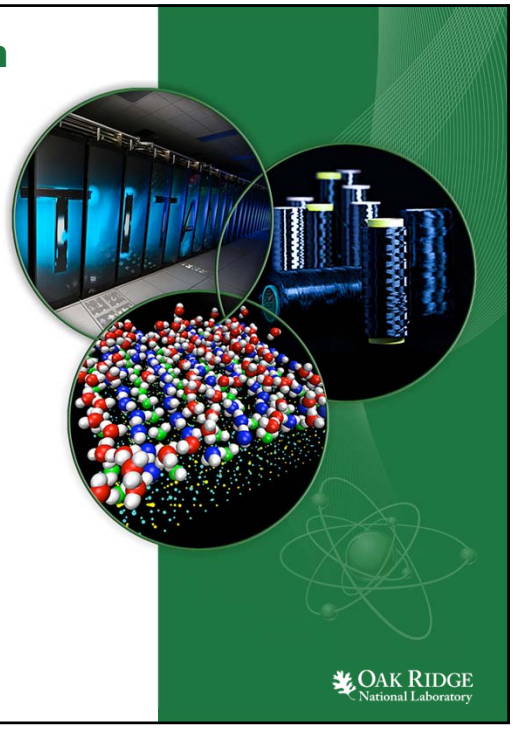
Multi-Agency Urban Search Experiment Detector and Algorithm Test Bed (MUSE)



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ORNL is managed by UT-Battelle
for the US Department of Energy

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MUSE Overview

Motivation: Create a **test bed** for radiation detectors and algorithms

- Validate model methodology
  - Conduct a series of **data collections**
  - Full site characterization with **benchmark quality**
  - **Inform and validate** modeling and simulation
- Understand model/data parameter sensitivity - How good is good enough?
- Create sets of synthetic data via **interpolation** and **statistical sampling** of modeled detector response

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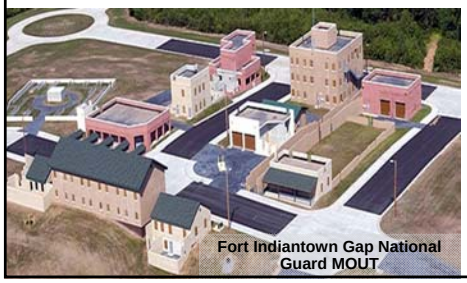
MUSE Overview

Data Collection

- 200 points of static 2”x4”x16” NaI(Tl) data
- 300 points of GPS data
- 100 points of LIDAR data
- 60 points of HPGe data
- 2 locations of correlated static weather and radiation data over 7 days
- 50 dynamic data trials (car and cart)



Model development and validation

- Model of the FTIG developed for SCALE/MAVRIC
- NORM concentrations derived from HPGe measurements for model materials
- Data analyzed for consistency
- Validation of model with measured/analyzed data
- Weather anomalies analyzed

Synthetic data production

- Static measurement interpolation
- Compare with dynamic data
- Interpolation of validated transport model results

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Data Collection

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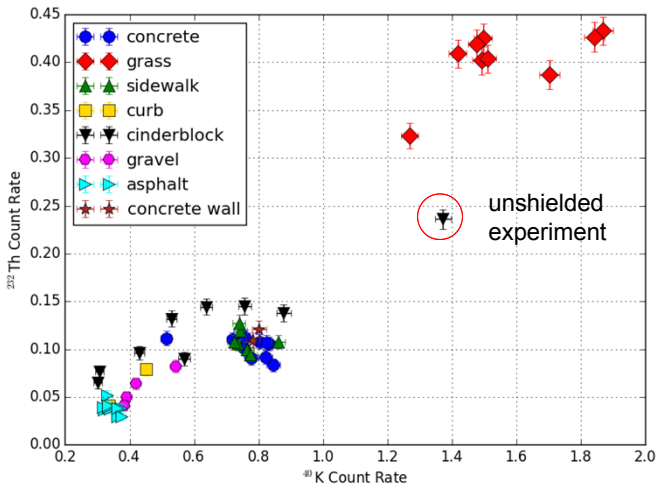
HPGe Measurements



More then 63 separate high precision HPGe measurements throughout the range providing necessary input to model for extracting background source terms for each material type

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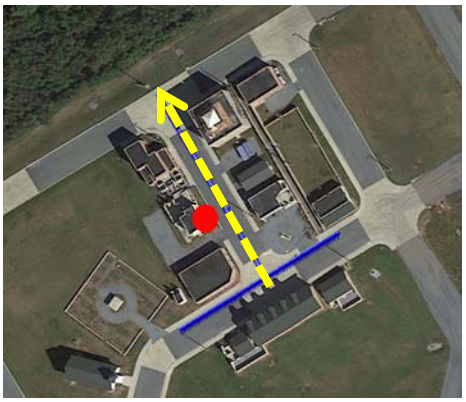
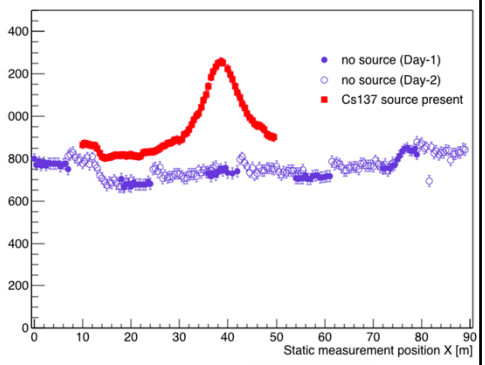
Static measurements on Main St.: Cs137 source vs background



Full spectral integral



- Static Background measurements made along 90m path on Main St. every 50 cm
- More static measurements with ~ 10μCi ^{137}Cs source placed about 5m off the path
- Both background and source data showing good sensitivity to the surrounding environment (beneficial for model validation)

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Model Development and Validation

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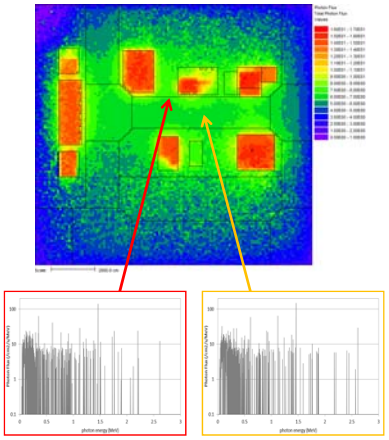
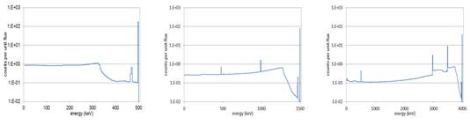
Model Validation – Split Transport and Response

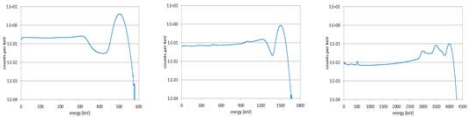
1. Transport calculation – SCALE/MAVRIC
   - Compute energy-dependent flux anywhere
   - Specific regions or a mesh tally
   - Automated variance reduction



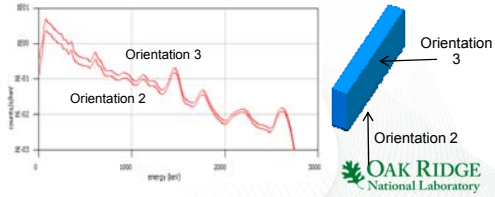
2. Energy deposited per unit flux – MCNP



3. Convolve and apply resolution function (like GADRAS)



Note: For non-isotropic detector, steps 2 and 3 are directionally dependent



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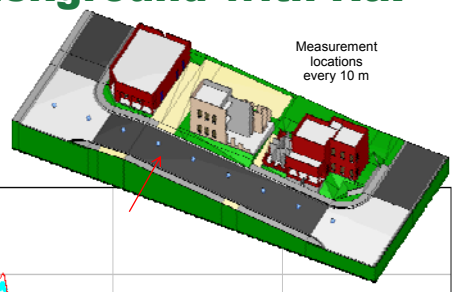
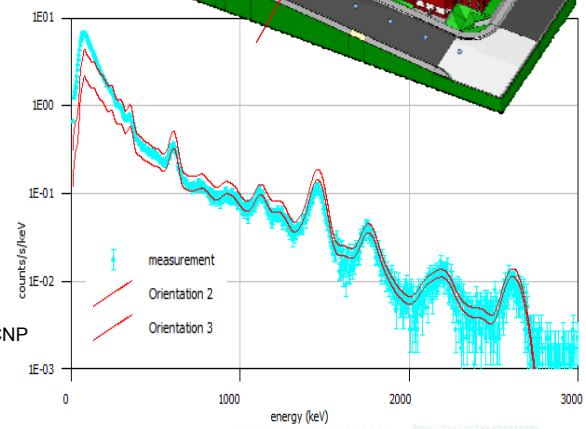
Model Validation – Background with NaI

Measurements: Along centerline of main street
Used standard issue 2”×4”×16” NaI detector





1. Flux computed by SCALE/MAVRIC
2. Flux-to-Pulse Height computed with MCNP
3. Energy response applied for two orientations

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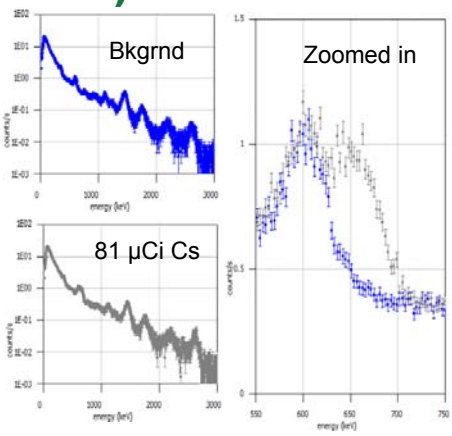
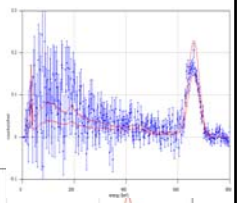
Model Validation – Threat Source (81 µCi ^{137}Cs)

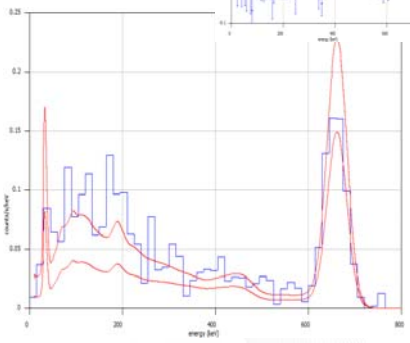


Measurements (2”×4”×16” NaI detector)

Measurements: 30 minutes, 3 keV bins

Compare MC simulation of threat source (two detector responses) to background-subtracted measured values





Use coarser bins in background-subtracted measured values to show scattered contribution

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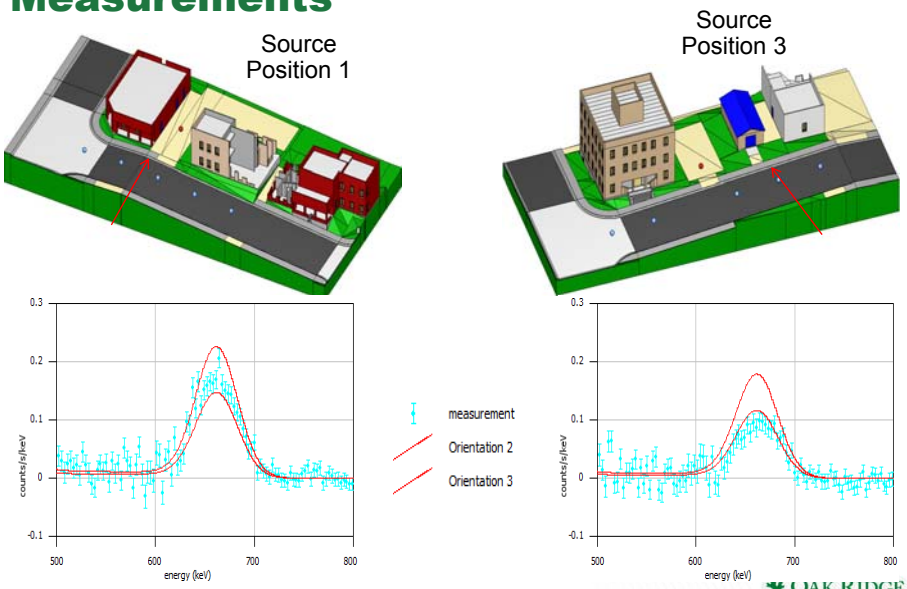
Model Validation – Simulation of ^{137}Cs Measurements



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Synthetic Data Development

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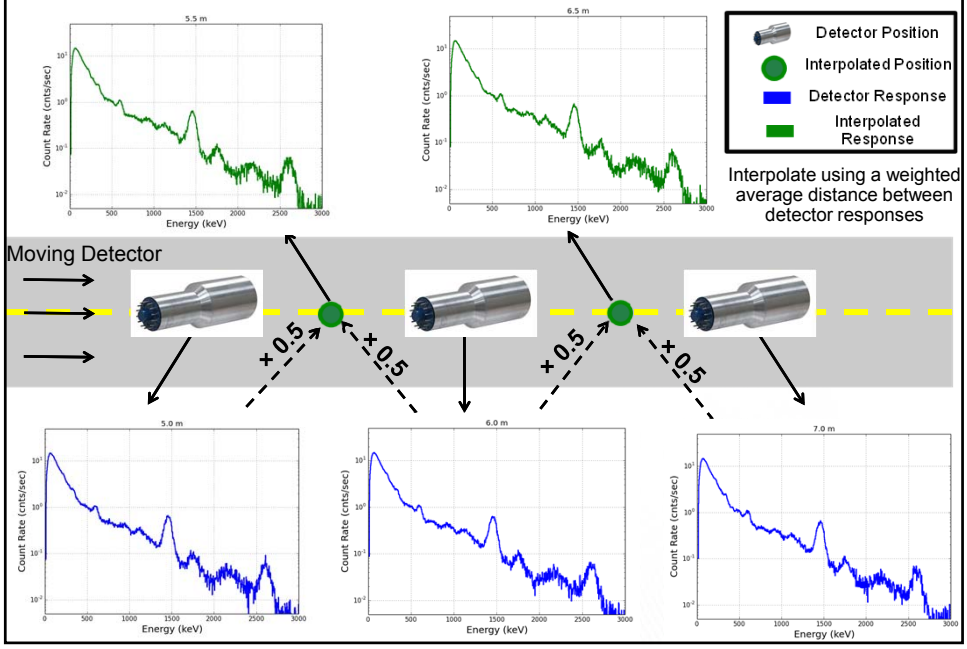
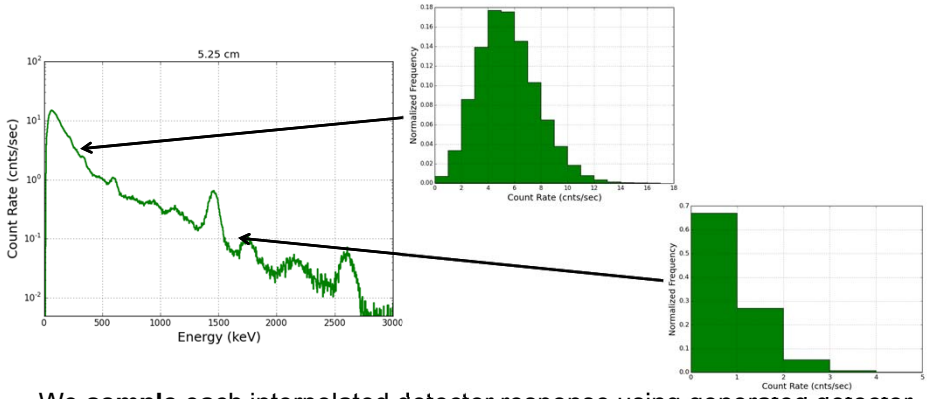
Synthetic Data Generation - Interpolation



Synthetic Dataset Generation - Sampling



- We **sample** each interpolated detector response using generated detector integration time normalized **Poisson distributions** for each energy bin
- By doing this, we simulate a detector response over a **short period of time** from well formed distribution
- This can be done many times, to simulate **random variations** between measurements to generate **synthetic dataset ensembles**

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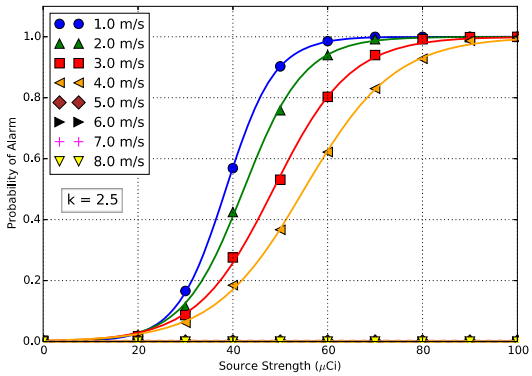
Synthetic Dataset Ensemble – Algorithm Performance

- After generating many sets of synthetic data, evaluate algorithm performance from **synthetic dataset ensembles** over a variety of parameters
- Each **synthetic dataset ensemble** will have a different set of:
  - Source strengths
  - Source types
  - Detector speeds
  - Shielding or changing geometry
  - Background composition and variability
- We can use these **ensembles** to test algorithm performance over a variety of parameters

K-Sigma Algorithm Example



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Thank you and we would love to answer any questions

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