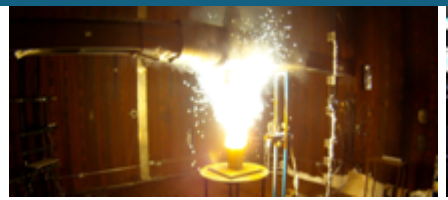
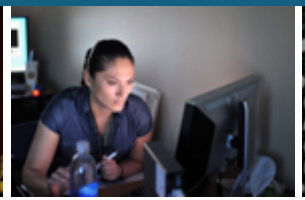
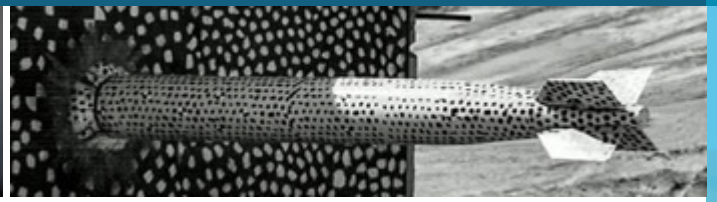
SAND2020-11375PE

Sandia National Laboratories

Recent GADRAS Developments







Greg Thoreson

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Select recent developments and features

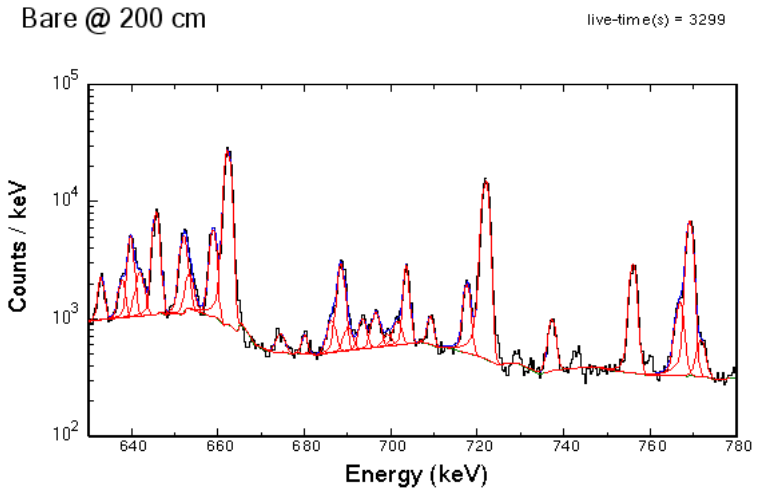
Improved peak-fitting

Advanced regression fitting

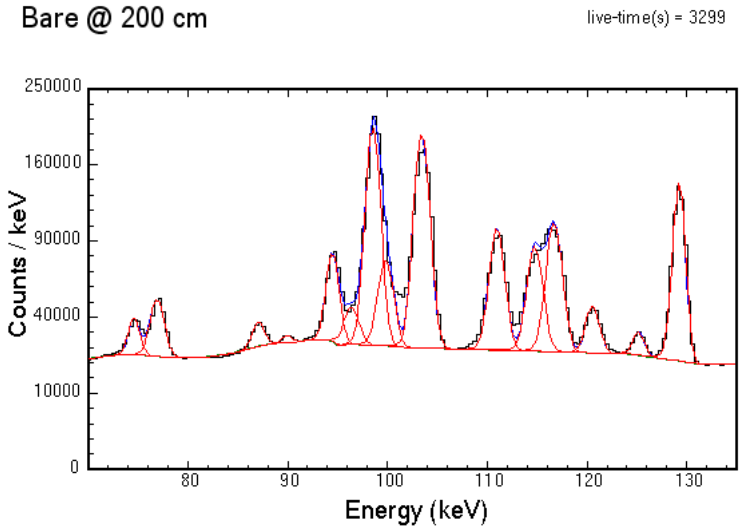
Scatter-source for 3D calculations

Improved peak fitting

Targeted improvements for high-resolution (HPGe) detectors and detectors with peak tailing (CZT)

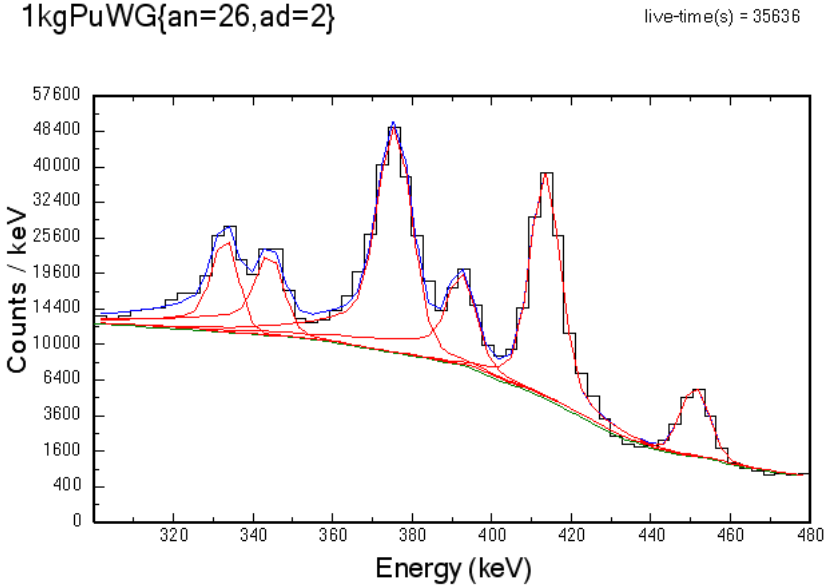


HPGe of WGPu 600 keV Region



HPGe of WGPu x-ray Region

Peak multiplet fitting improved



CZT of WGPu in 300 keV Region

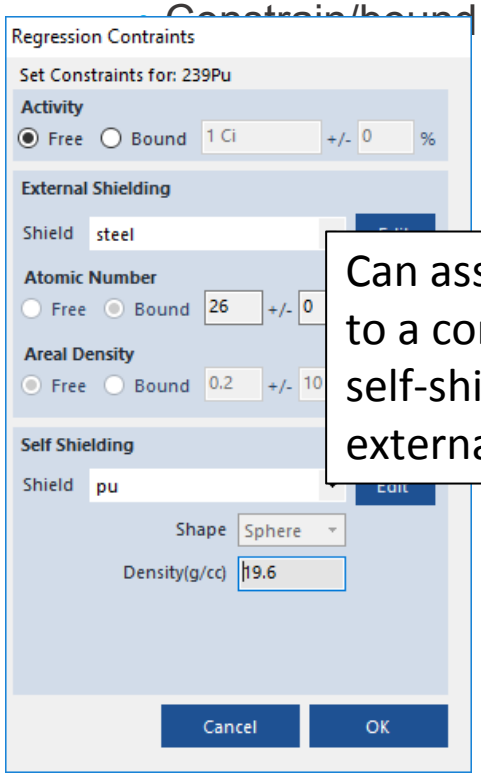
Overlapping tail fitting greatly improved

Advanced Regression Fitting: self-shielding example with BeRP ball

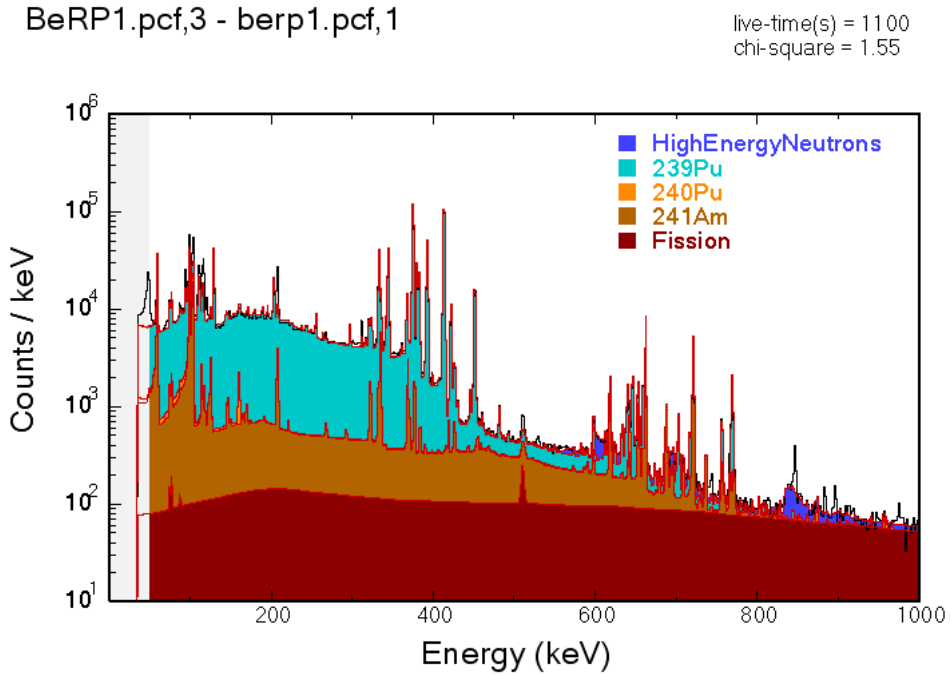
Regression fitting has always been based on point-models (as opposed to 1D/3D modeling in GADRAS)

Added advanced point-model options

- Self-attenuation (sphere, cylinder, slab)
- Multiple external shields
- Constrain/bound activity and shielding



Can assign Pu239, Pu240, Am241 to a common “pu” material for self-shielding, and a common external steel shield



Fit yields 4.56 kg Pu239 (actual is 4.19 kg) in 0.74 seconds

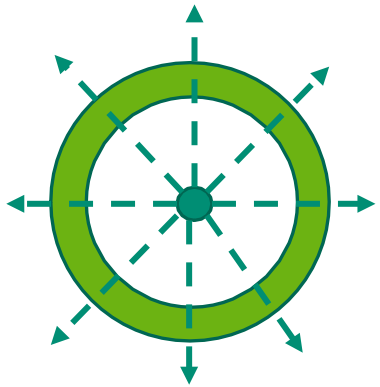
Scatter-source for 3D calculations

Scatter table

Create scatter lookup table using a source inside a spherical shield

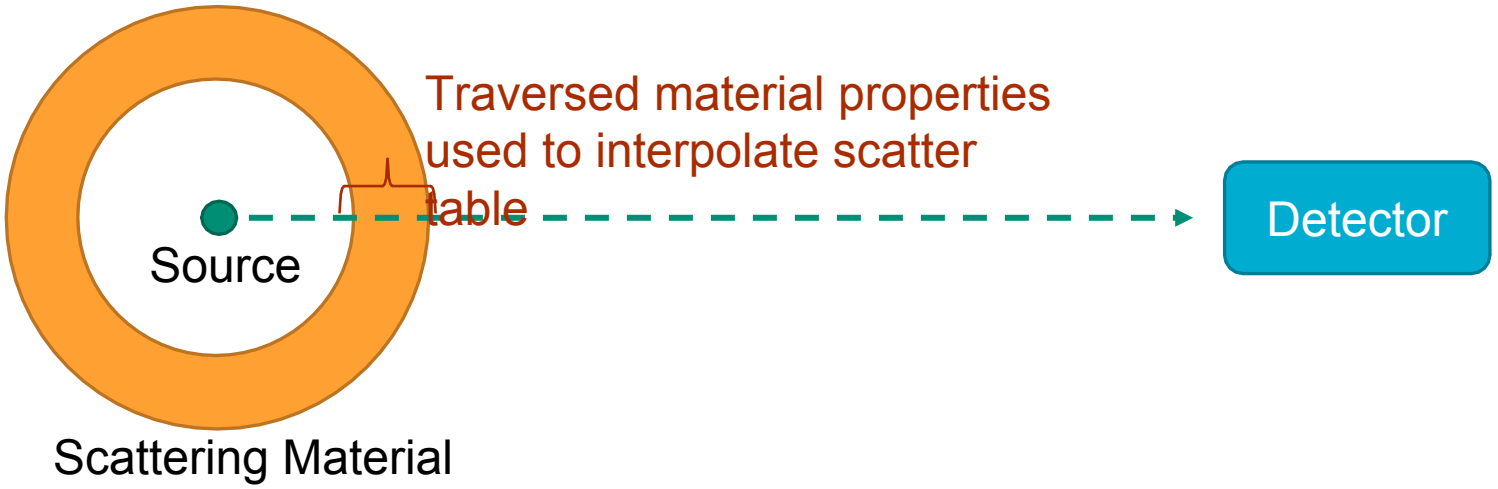
Table takes the following into account:

Source energy
Shield material
Shield areal density
Distance between source and shield



Previous methodology

For a given source / shield configuration, the scatter values are interpolated from the lookup table using the ray drawn from the source to the detector

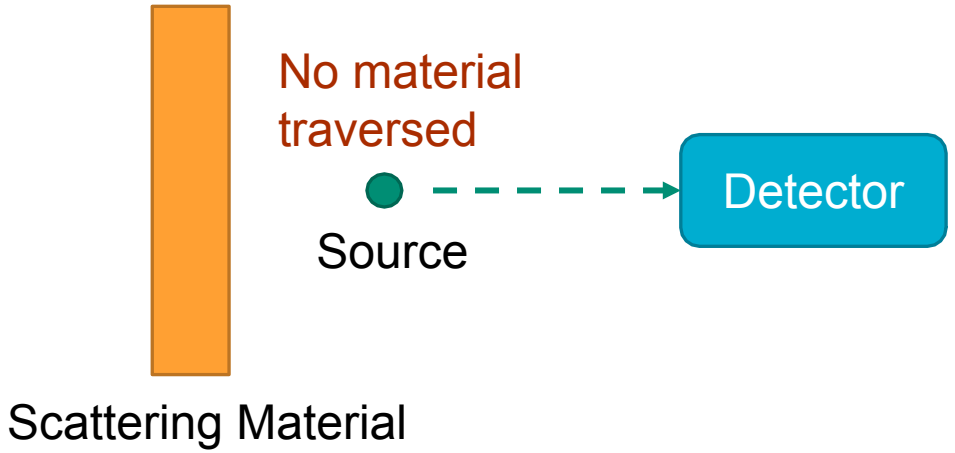


Advantages:

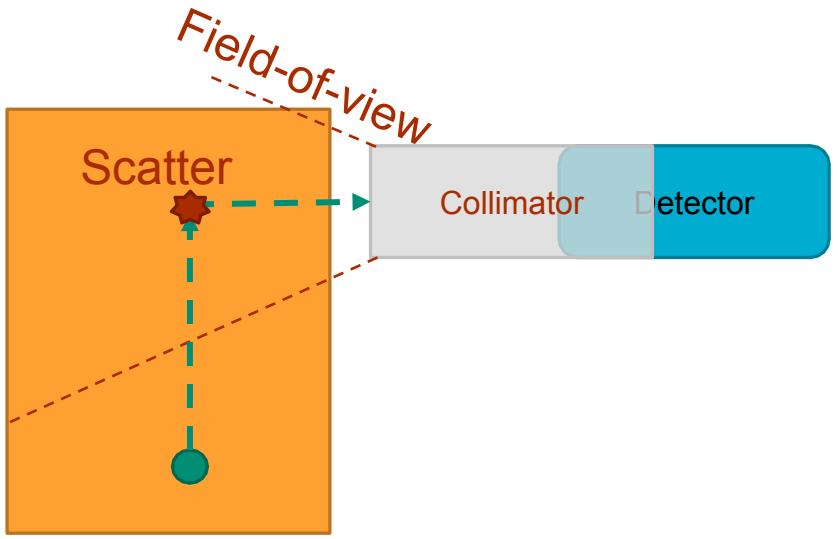
- Very fast (3D calculations can be done < 1 minute)
- Continuity between 1D and 3D calculations
- Accurate for most scenarios

Limitations of previous methodology

Source in front of scattering material will show no scatter in computed spectrum



Source embedded in scattering material with collimated detector will generate less scatter than is observed in measurement



These effects are usually only observable for gamma imagers and collimated detectors

New Scatter Algorithm

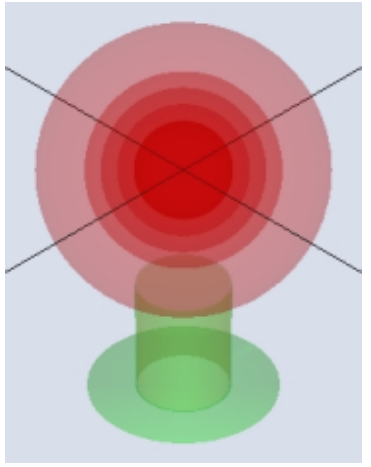
To overcome deficiencies, it is necessary to create scatter “source” location for scattering materials

Leverage previous adaptive mesher for 3D calculations

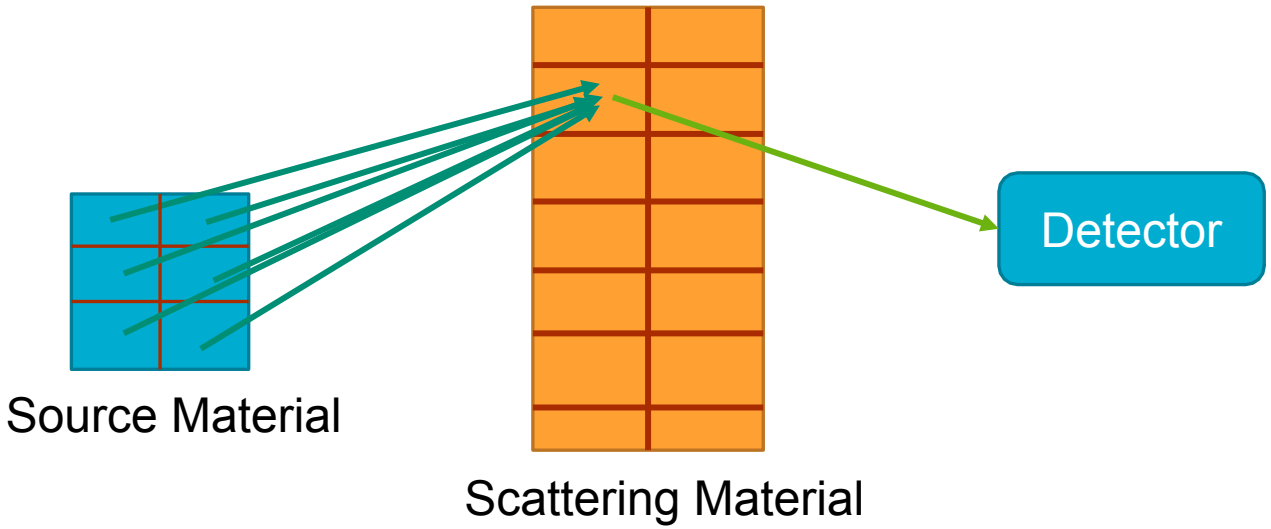
Create scatter-source voxels

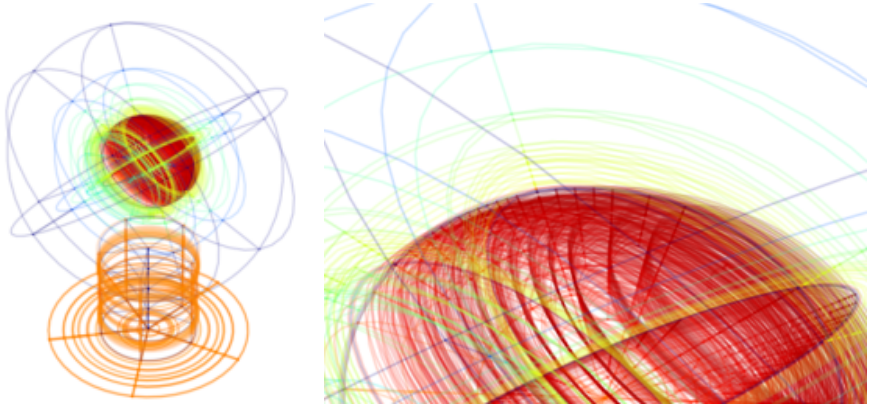
Calculate photon uncollided fluence rate on each scatter voxel from all source voxels

Use Klein-Nishina probability to calculate probability of scattering toward detector to create “scatter source term”



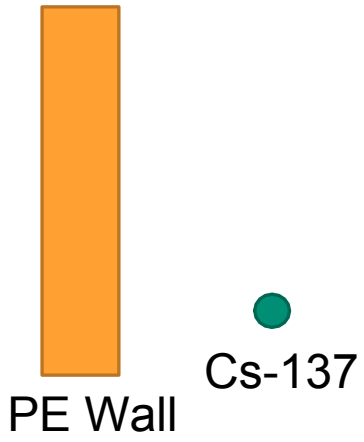
3D model of BeRP ball on stand



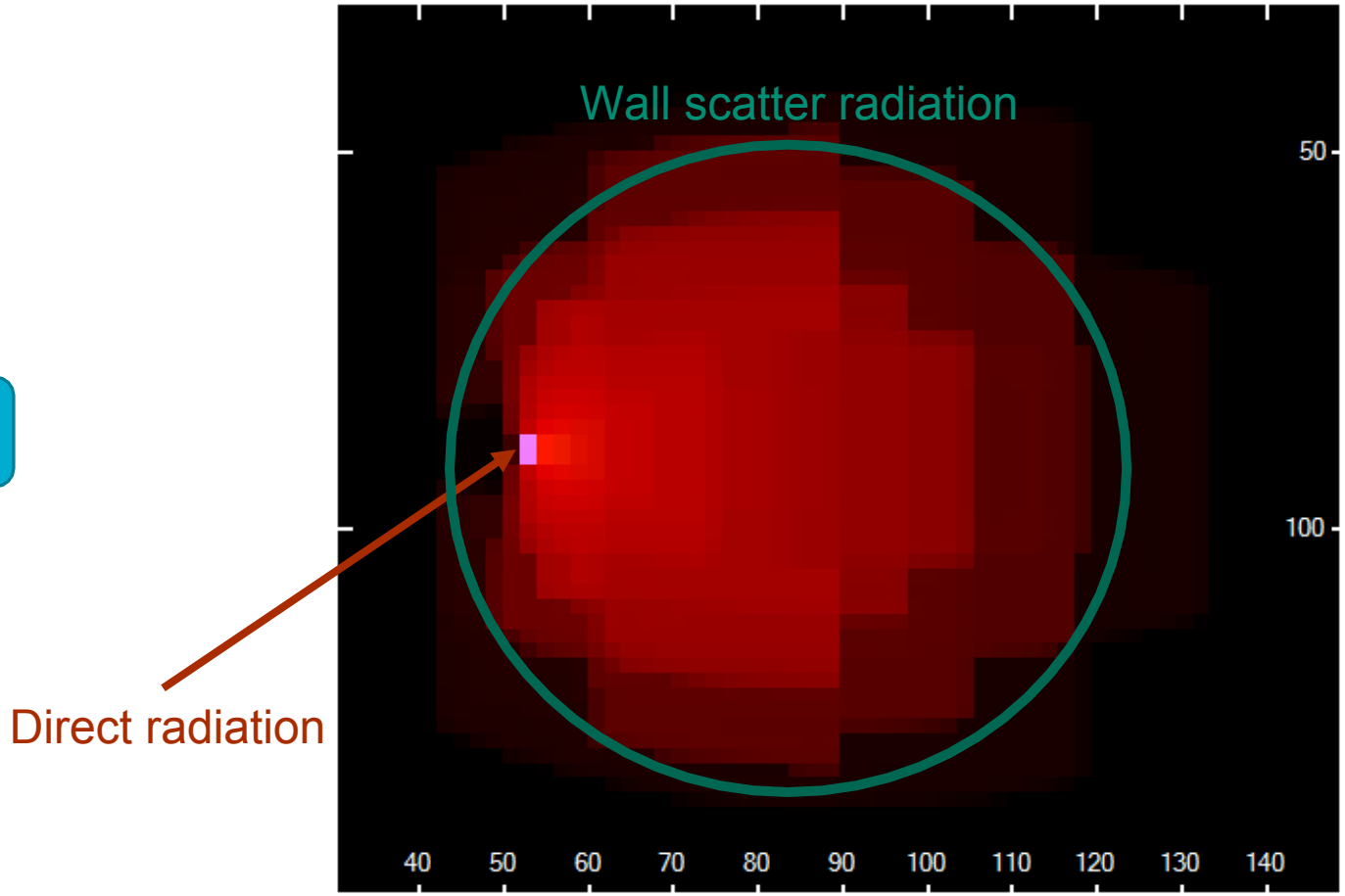


Optimized source voxels

Cs-137 in front of PE wall



Gamma Imager



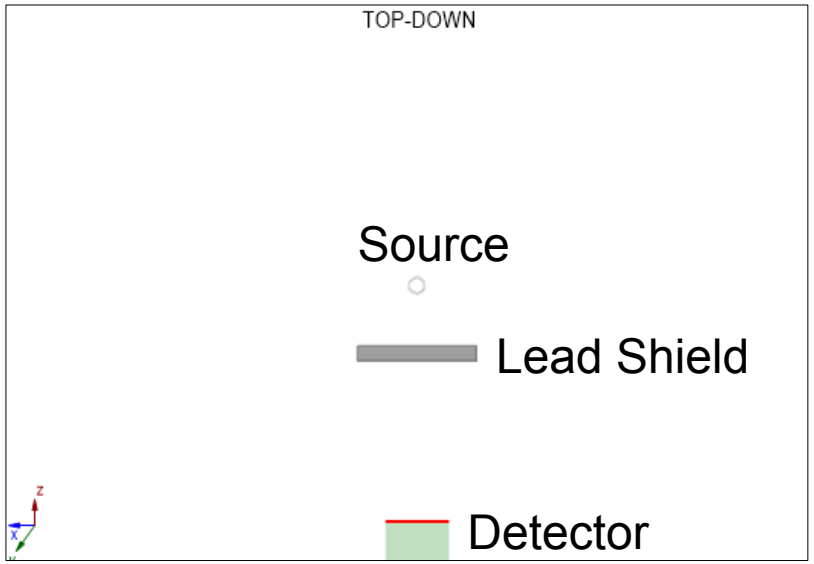
Simulated Compton camera image of source and scatter (spherical coordinates)

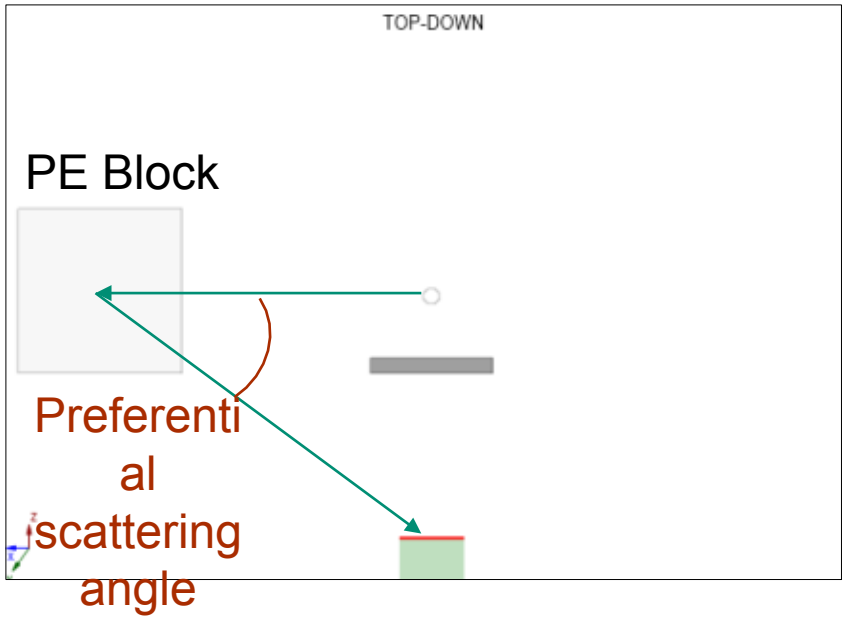
Comparisons with Scatter Material and Shielded Source

Collected laboratory measurements of various sources shielded by 1.9 cm thick lead brick

Added polyethylene (PE) block not in line-of-sight of source-to-detector

Took difference of measurement with PE to without PE and compared to simulations





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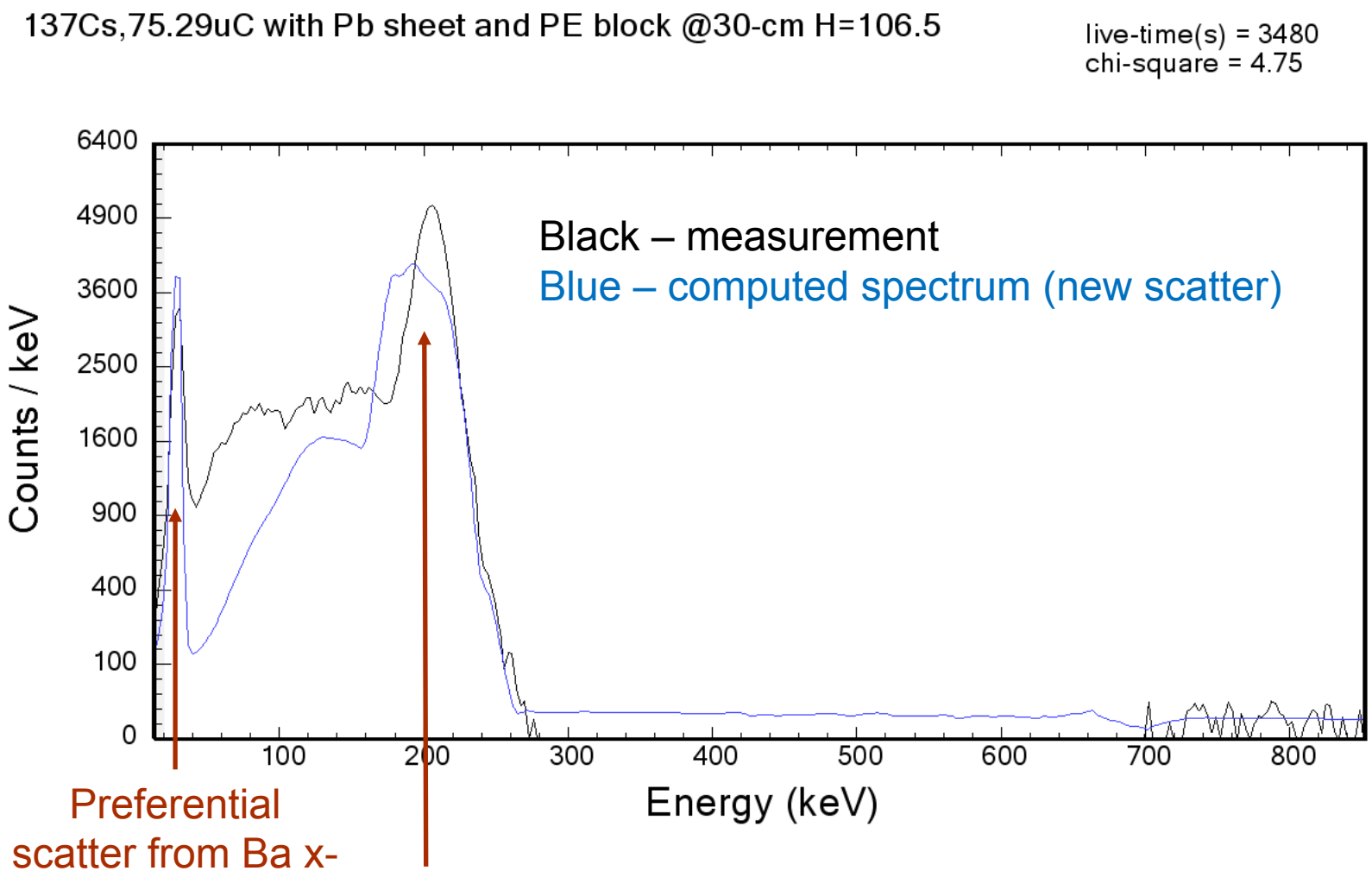

Path forward for scatter source calculations

Initial results are promising

Still under active development

Computation time is greater than we'd like, but we have ideas on how to reduce it

Impact:

- Gamma imagers (forward simulation, inverse analysis)
- Collimated detectors (e.g. portal monitor simulation)