Other MAJORANA Applications of MaGe

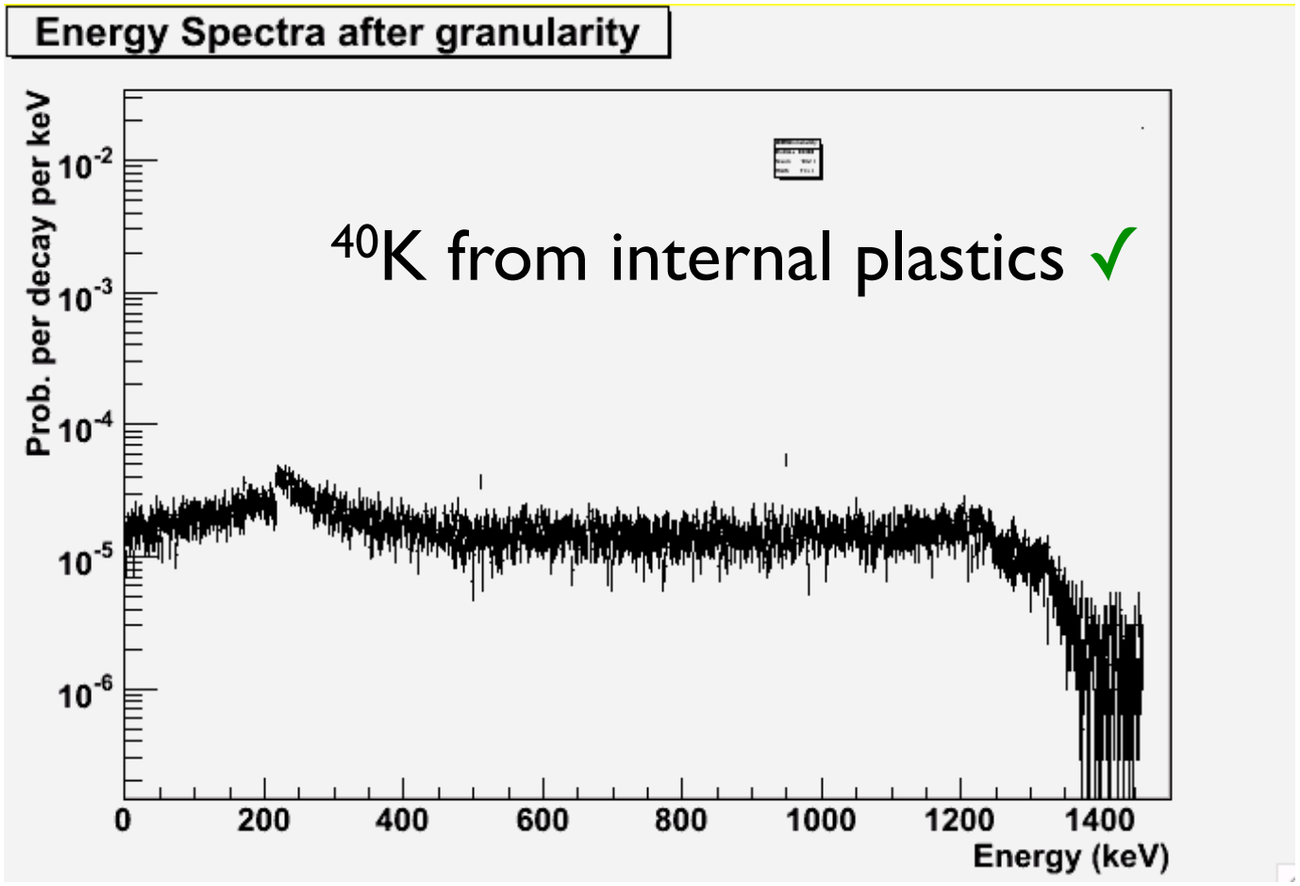
Jason Detwiler

MaGe Workshop 2010

18-20 January, Munich

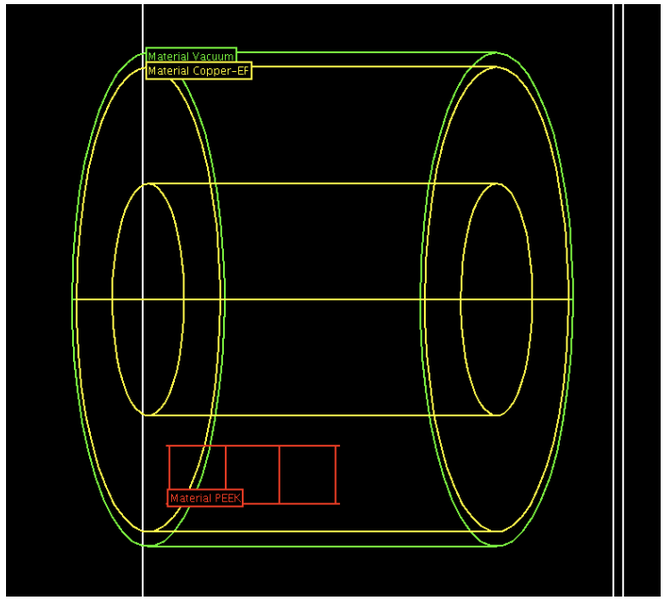
Design Support

Quickly address design questions as they arise

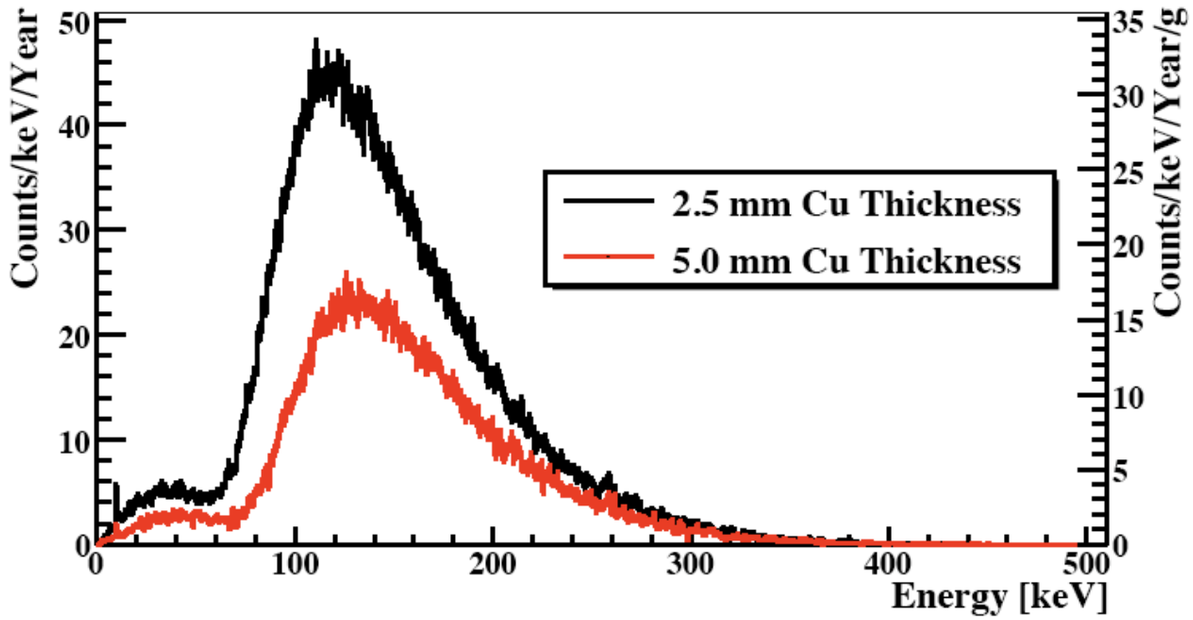


^{40}K from internal plastics ✓

Cross arm support plastic ✓



Indium wire seals ✗

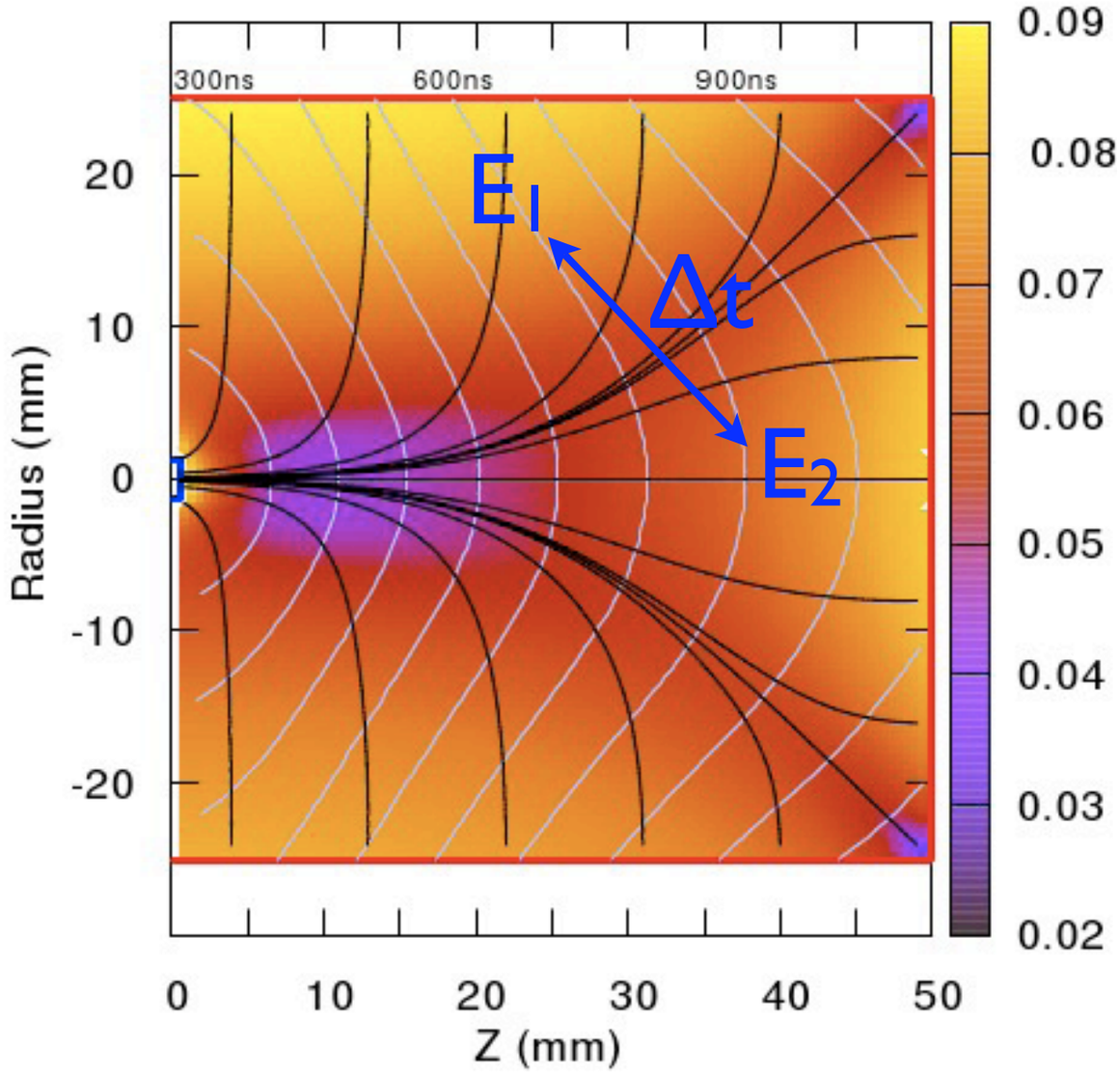


Other Design Simulations

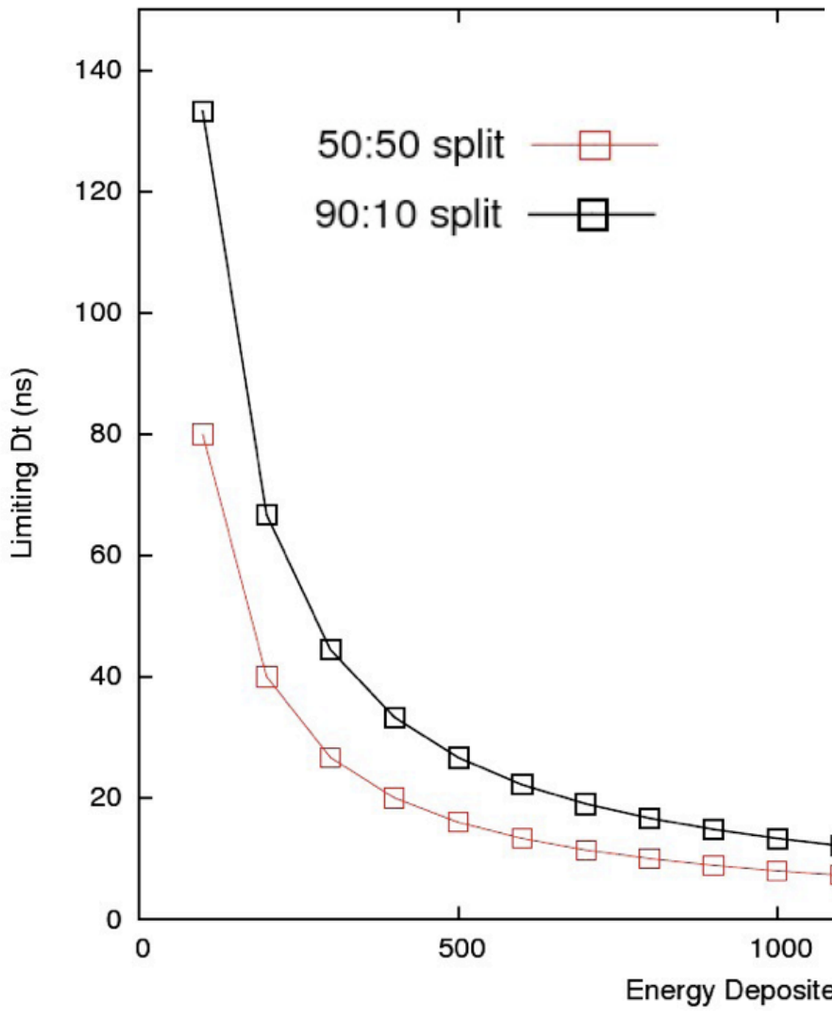
- **^{68}Ge / ^{60}Co in BEGes**
  PSD re-evaluated with new Δt heuristic; problematic in natural detectors
- **^{60}Co in copper mounts, cables, cryostat**
  Cables okay; other parts should stay underground
- **Front-End location**
  Moving close to detectors is okay; estimated background is ~0.01c/ROI/t/y
- **Aluminum on BEGe contacts**
  Okay if high-purity stock is used
- **Granularity loss from increased internal Cu**
  Probably okay, still evaluating
- **Tin contact pin bead**
  Okay for high-energy if clean stock is used. Need to check low-E lines / betas for impact on low-E physics.

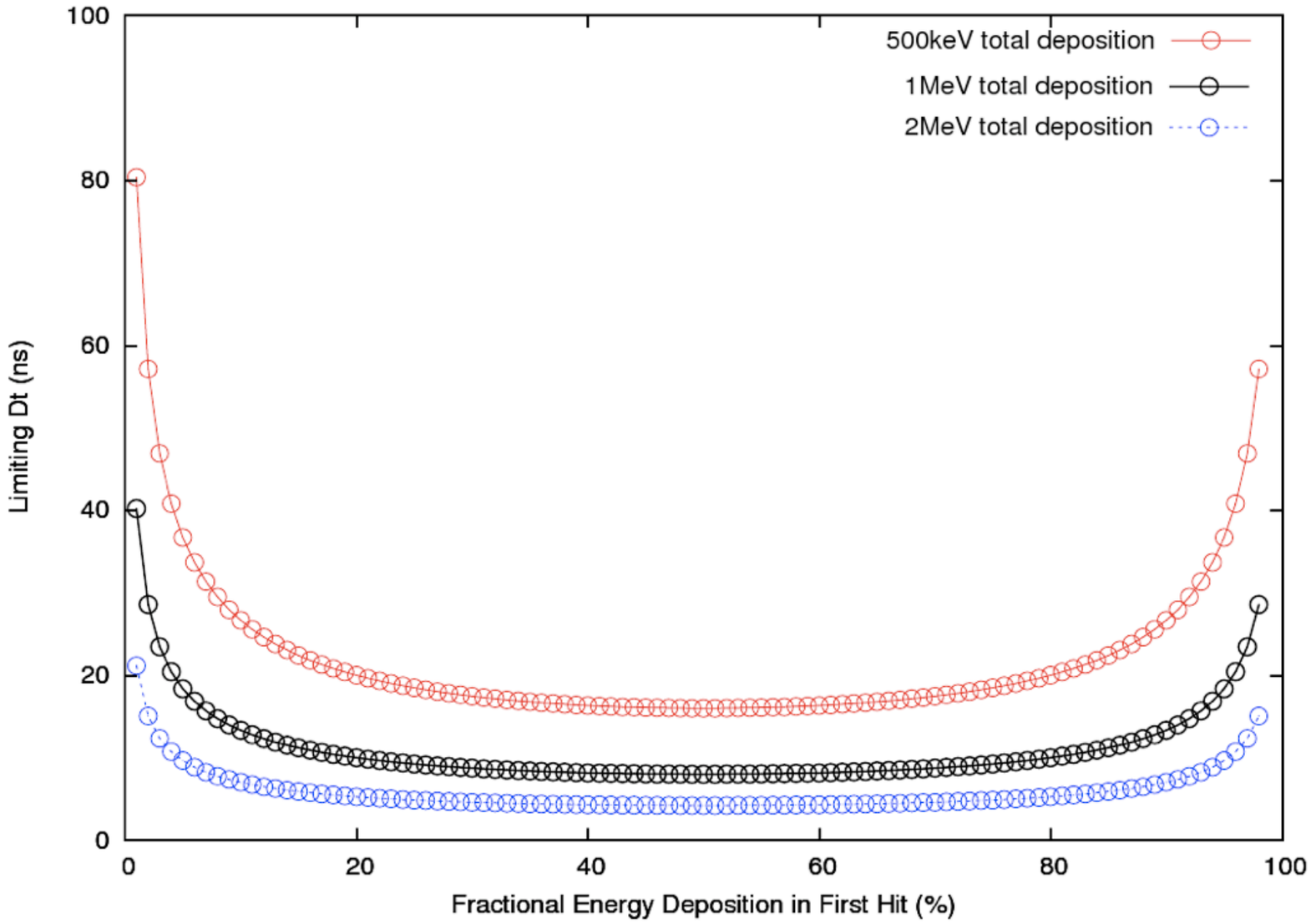
Δt Heurisitic

- Estimate PSA capabilities of BEGe / point contact detectors
- Cut based on Δt between energy depositions
- Cut depends on E, E_1/E_2; limiting Δt value taken from bandwidth analysis, χ^2-based PSA simulation

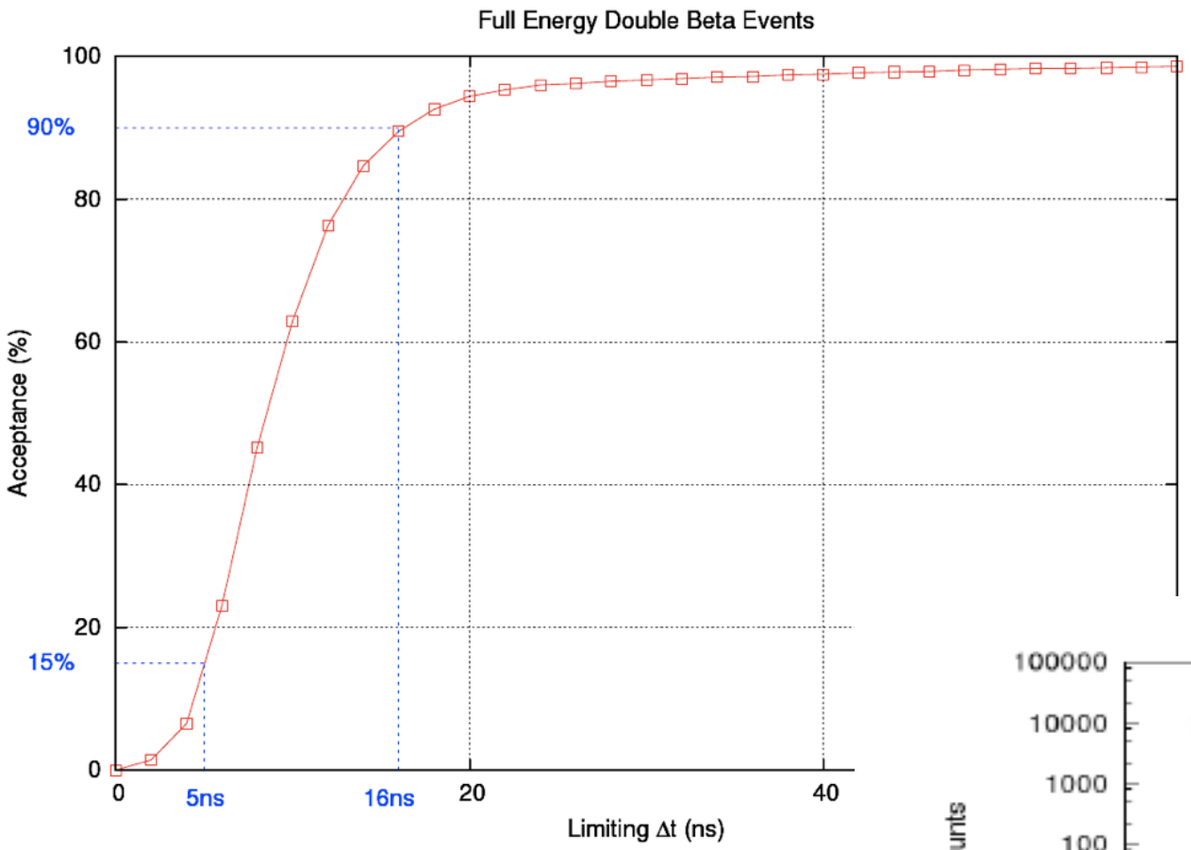


Δt Heurisitic

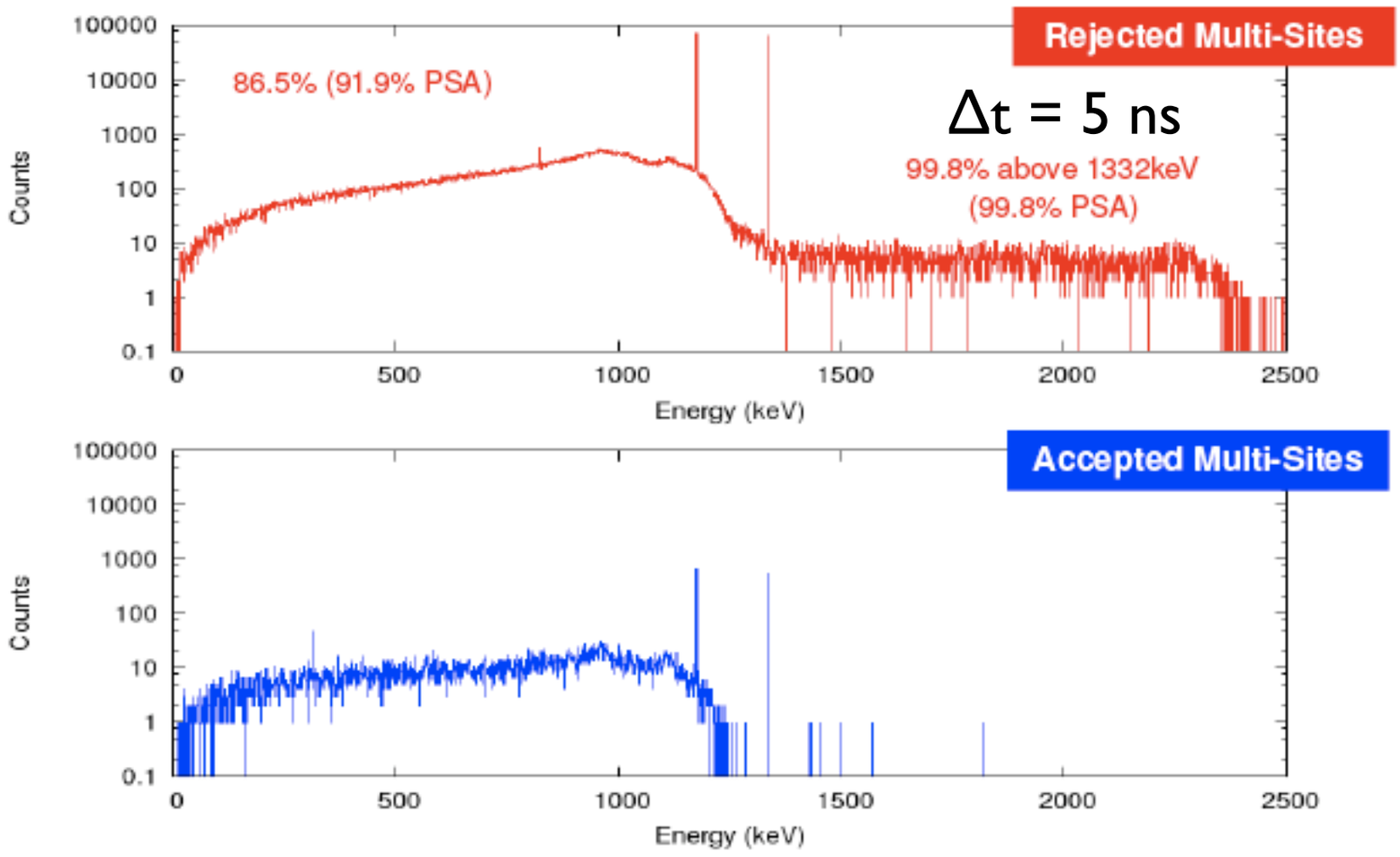




Δt Heurisitic

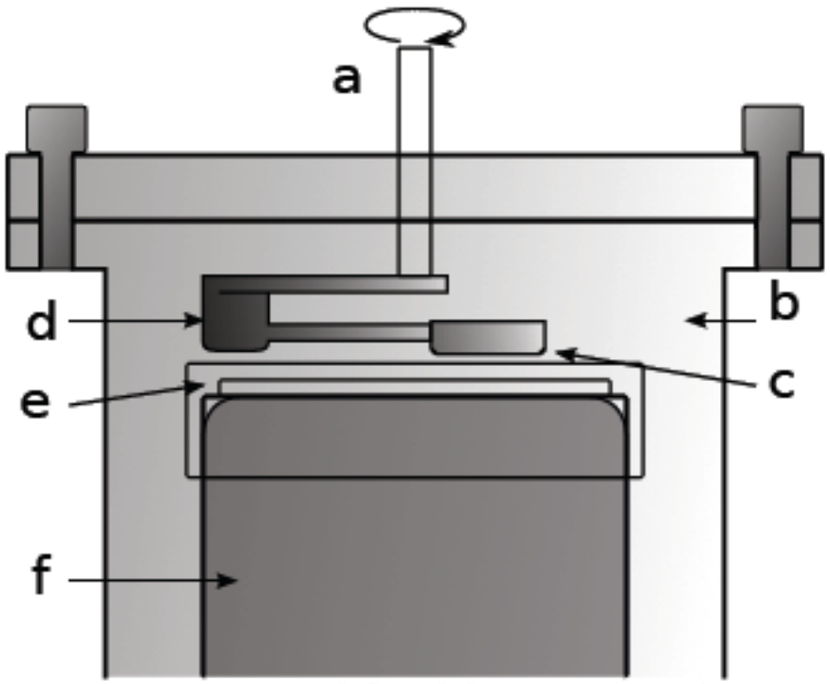


Working to verify further with data



Surface Alphas

Shine columnated alphas on the face of an n-type detector



a: rotational feedthru manipulator

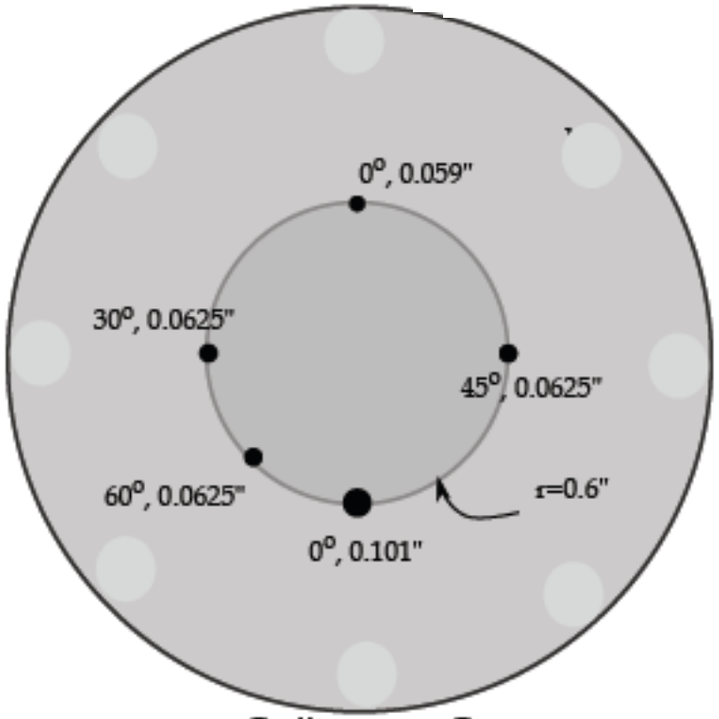
b: new outer cryostat

c: alpha source holder

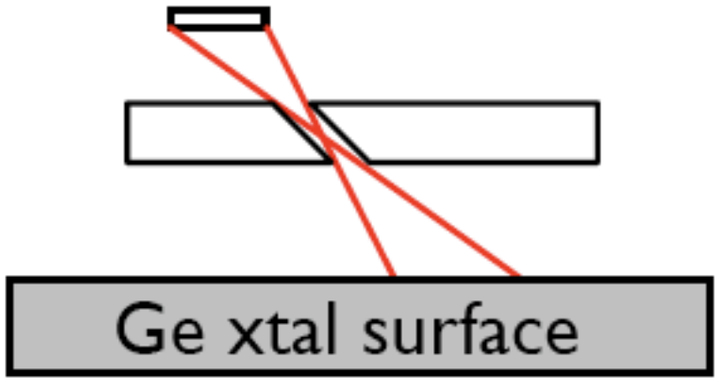
d: rotation arm

e: collimation cap

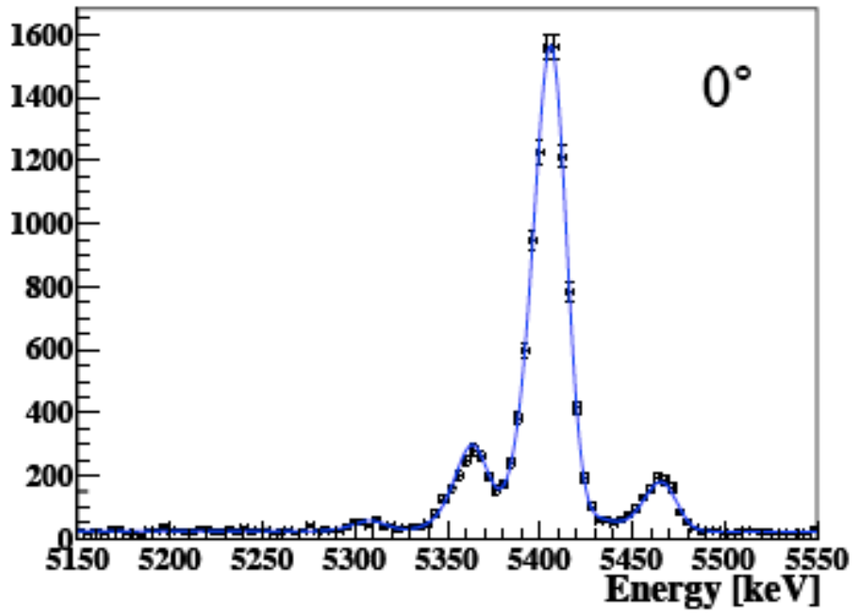
f: mounting cup / crystal

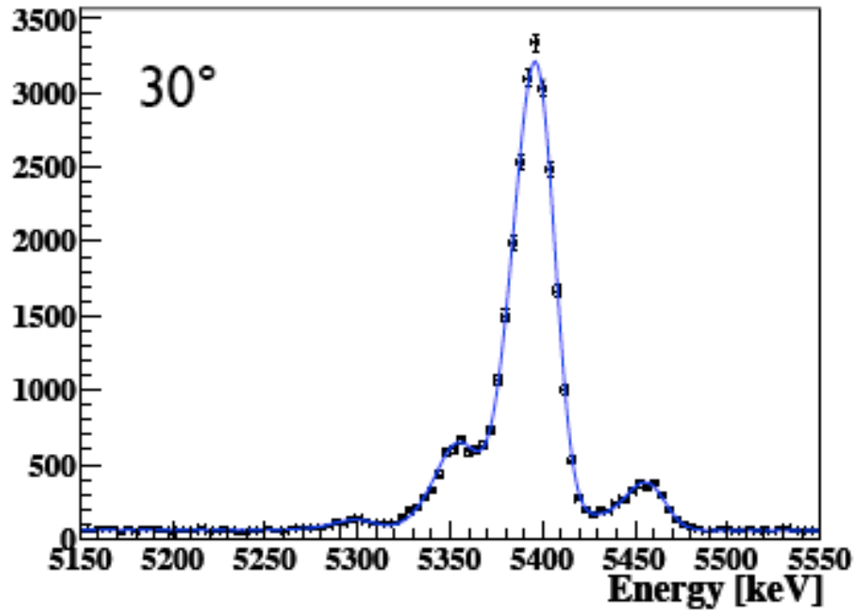


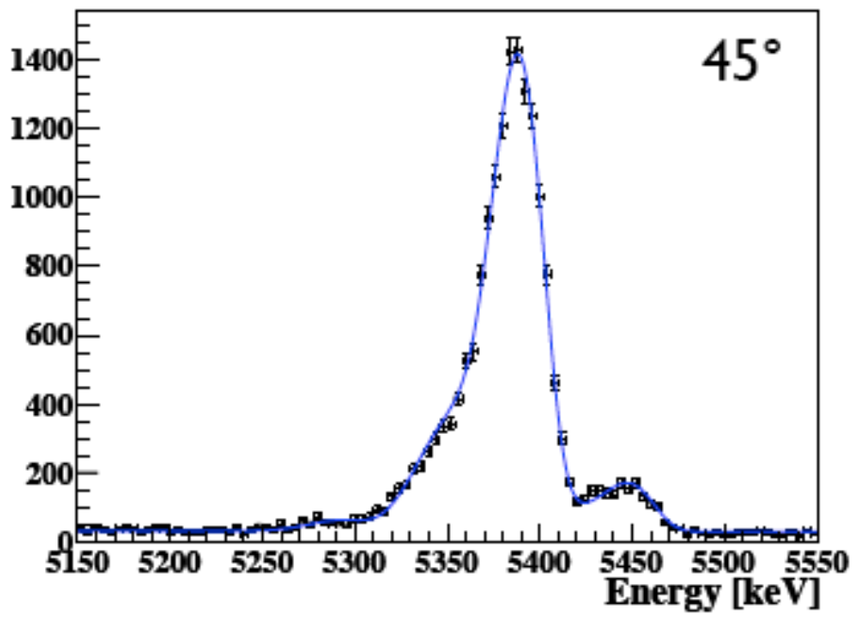
Collimator Cap
Top-Down View

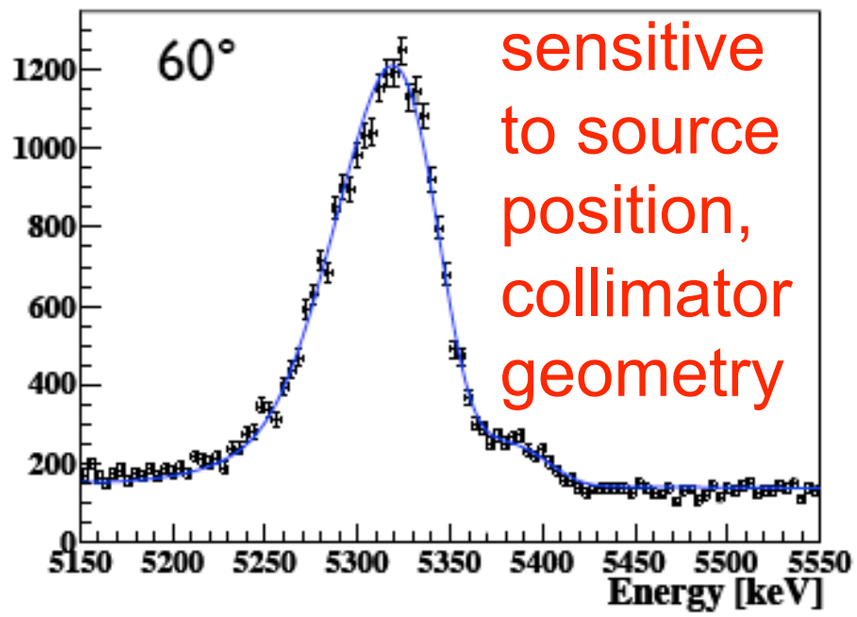


Surface Alphas





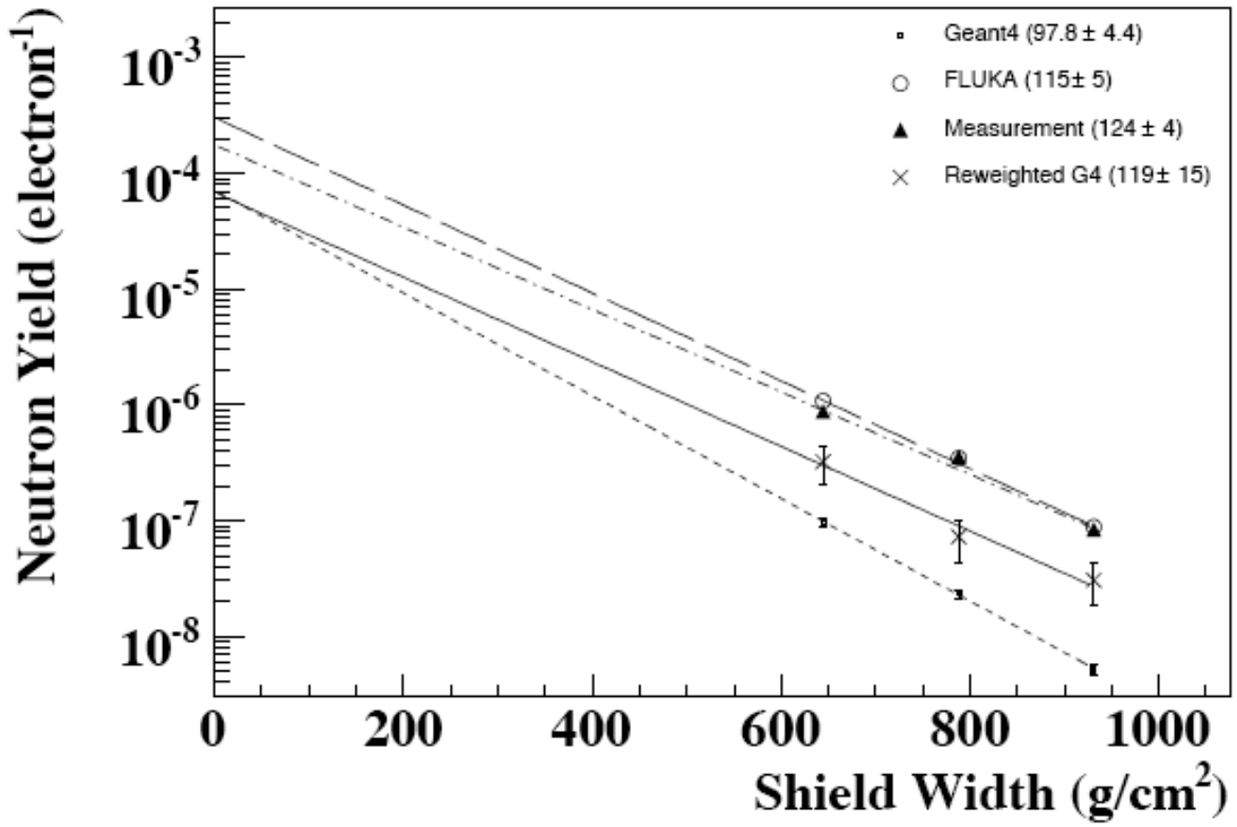


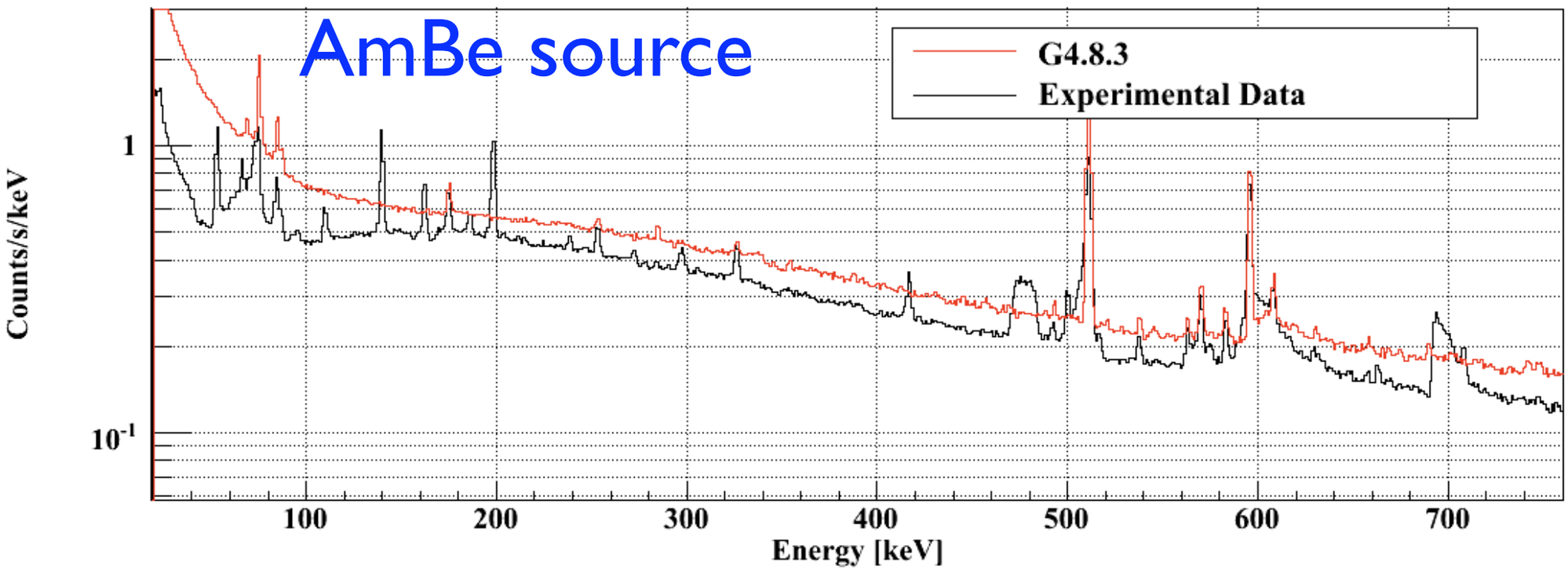


sensitive to source position, collimator geometry

G4 Neutron Validation

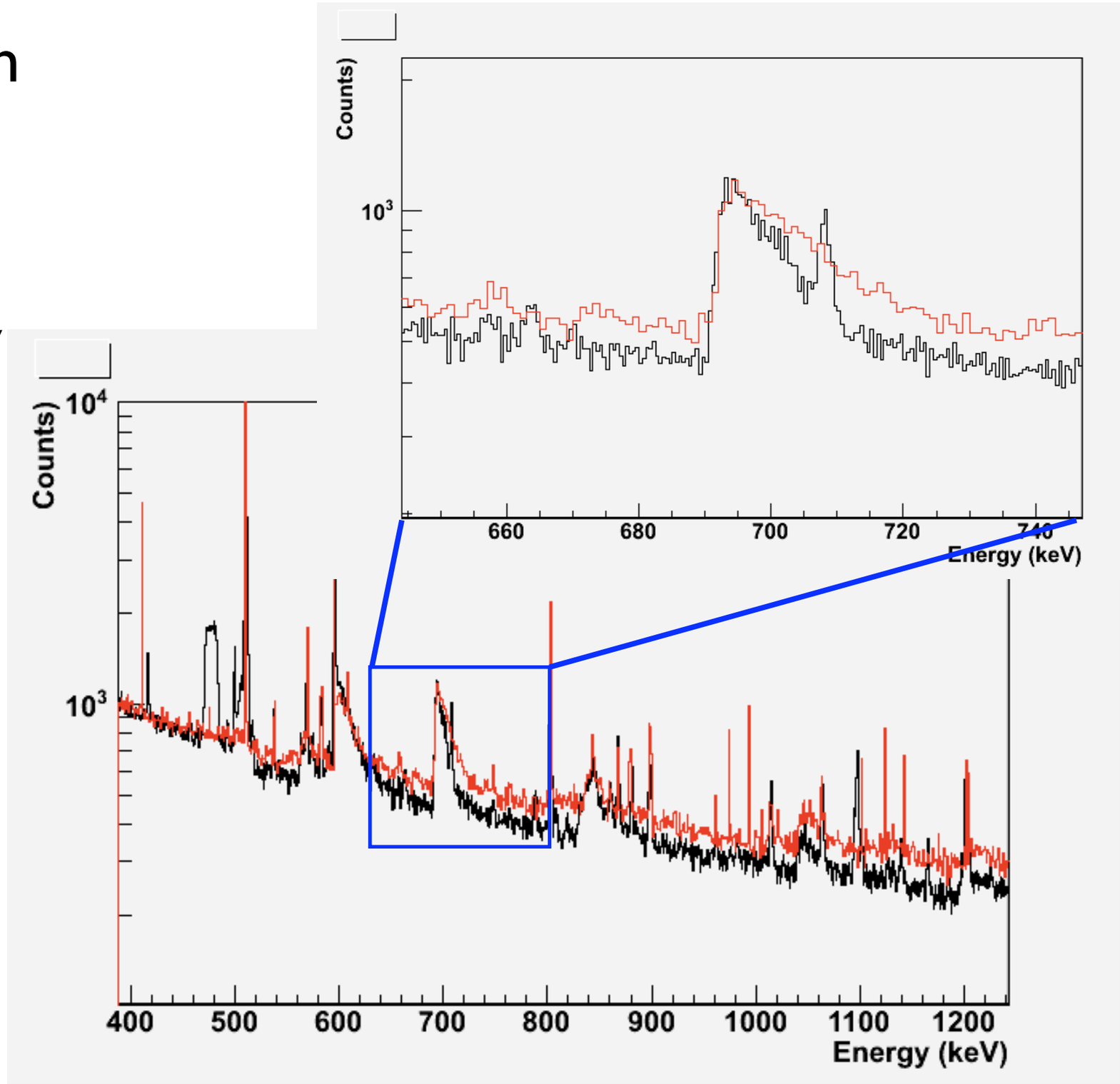
- Past work identified problems in
  - n production
  - n attenuation
  - missing / extra lines at low energy



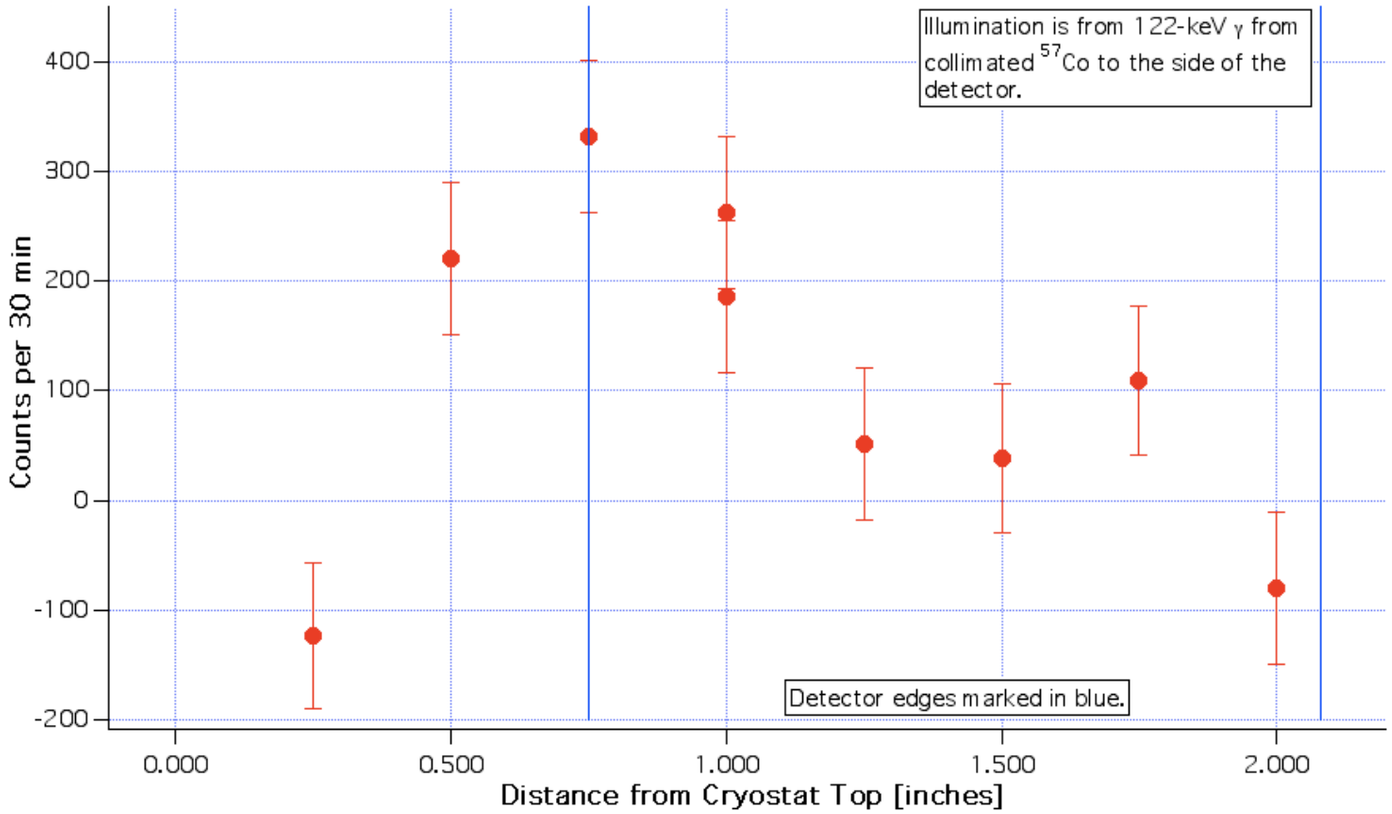


G4 Neutron Validation

- Bug fixes in conversion electron emission
- Added γ/e⁻-transition data files calculated by TALYS
- Peak now appears for E0 692 keV transition in ^{72}Ge
- Still investigating missing lines, quenching problems, spurious low-E γ's



Simulating Non-Ideal Dead Volumes



```
/MG/geometry/idealCoax/ExtraDeadLayerOn true
/MG/geometry/idealCoax/SetExtraDeadLayerBottomZ 0. mm
/MG/geometry/idealCoax/SetExtraDeadLayerMiddleZ 3. mm
...
```

See example macro code at

http://mjwiki.npl.washington.edu/bin/view/MaGe/NonidealDeadVolume

^{210}Pb Bremsstrahlung Generator

Energy Distribution:

$S = 2.757 - 180.1\varepsilon + 4107\varepsilon^2 - 27044\varepsilon^3$ 40 keV < E < 78.5 keV

$S = 7.763 - 143.9\varepsilon + 656.0\varepsilon^2$ 78.5 keV< E < 100 keV

$S = 1705\varepsilon^3 e^{-18.79\varepsilon + 11.82\varepsilon^2 - 11.07\varepsilon^3)}$ 100 keV < E < 1161 keV

Where E is photon energy and $\varepsilon = E$ / 1161 keV

Zenith Angle Distribution:

$A(\phi) = (1/N) \cos^q(\phi) \sin(\phi)$

Where ϕ is zenith angle, q is an energy dependent piece-wise function, and N is a normalization coefficient dependent on q.

- Investigating low-E peak
- Comparison to detailed simulation underway