SAND2016-7243PE

Exceptional service in the national interest

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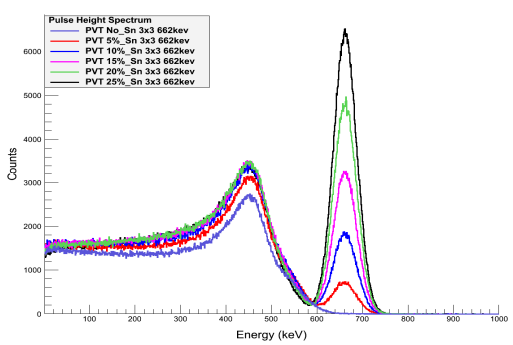
[Image of 4,4' stilbene di(tributylstannylester)]



Synthesis of Sn-Loaded Plastic Scintillators

J.D. Feist

U.S. DEPARTMENT OF ENERGY
National Nuclear Security Administration

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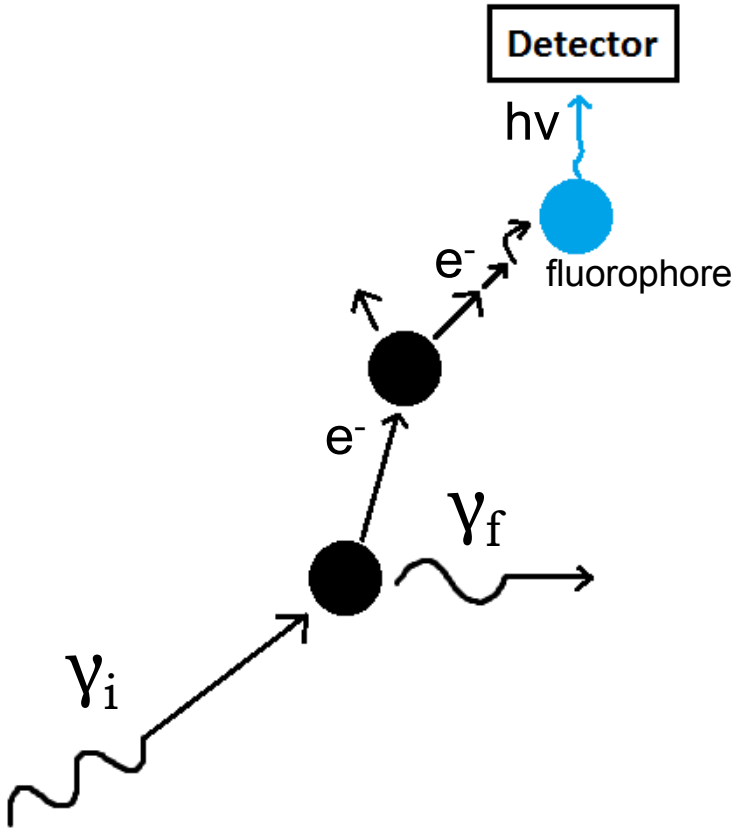
Background and Impact

- Scintillators are radiation detectors
- Plastics: bulk aromatic polymers absorb, fluorophores emit
- No photopeak response
  → no spectroscopic capabilities



Background and Impact

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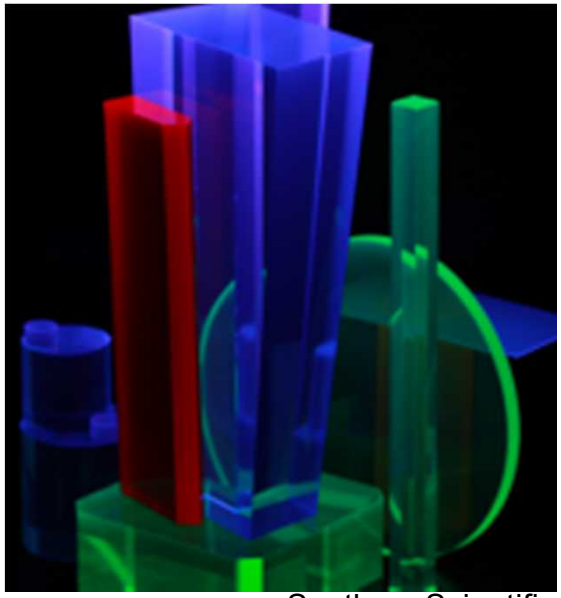
Current Plastic Scintillators

- Polystyrene/polyvinyltoluene
- Low gamma-ray cross section
- Compton scattering only
- Tangible disadvantages
  - Nonlinear response vs incident energy
  - Incomplete light collection
- One solution: Inorganic Crystals
  - NaI(Tl), BGO, etc.

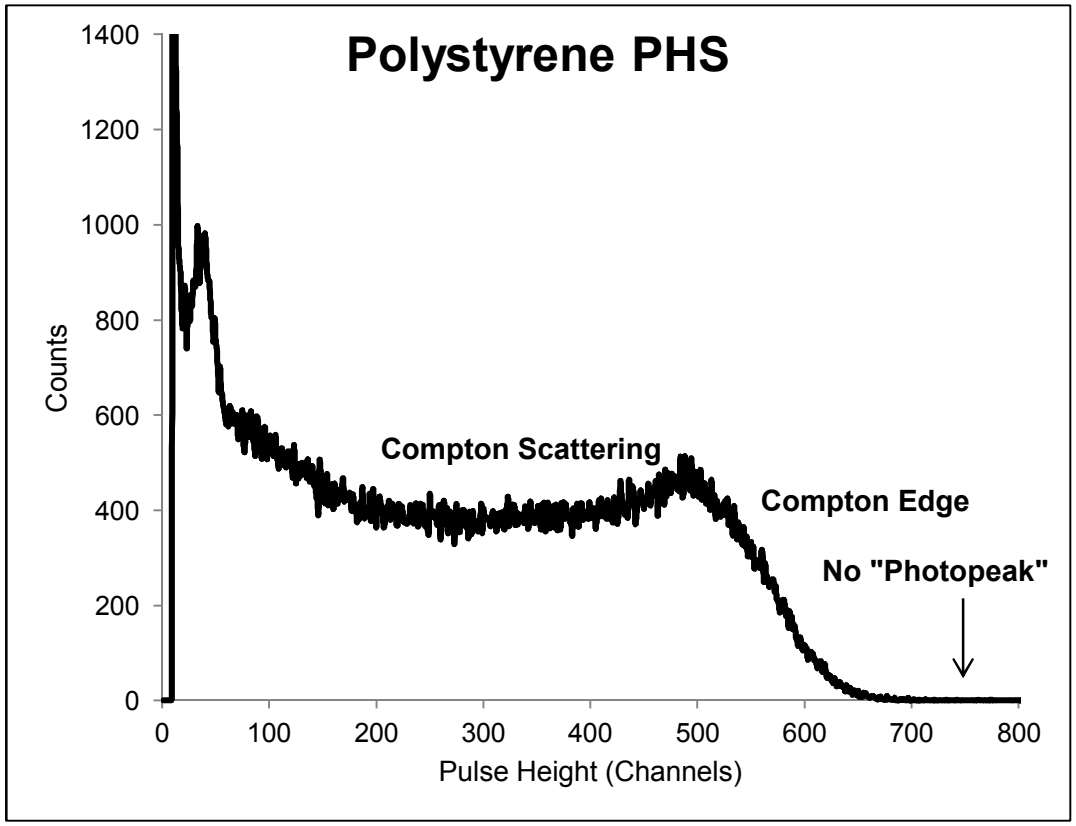


Southern Scientific

Kinheng Crystal

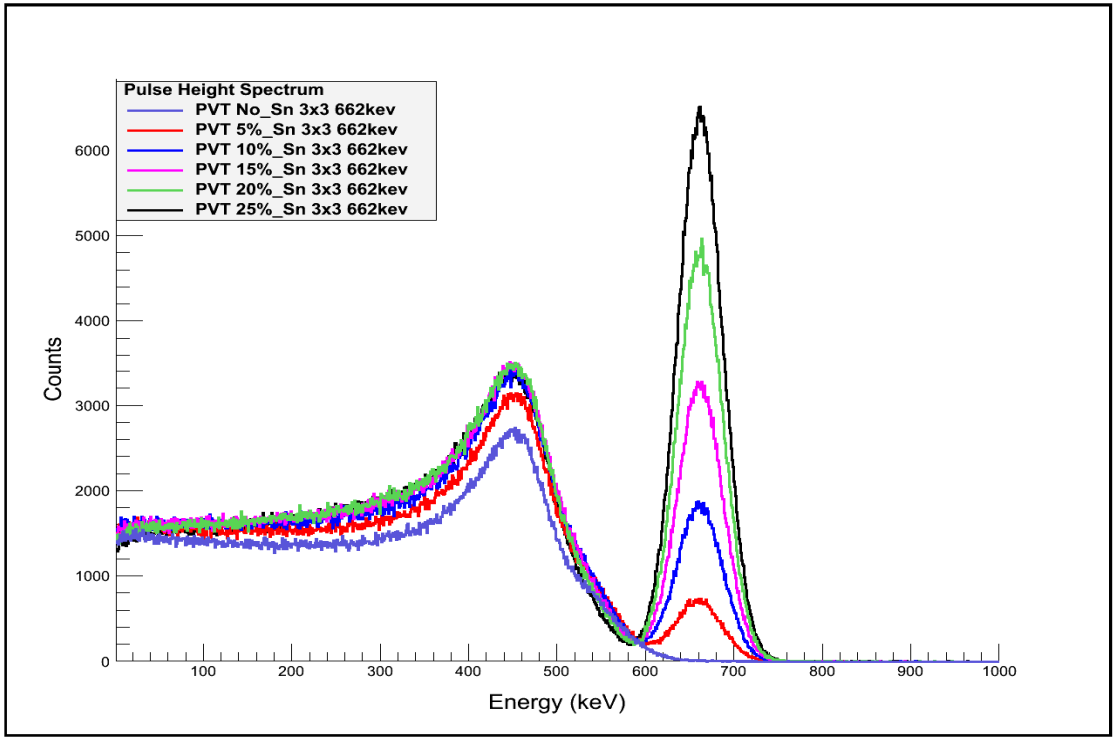
Background and Impact

- Spectroscopic scintillators
  - Applications in border security, SMN identification
- Large volume needed
  - Maximize sensitivity
- Previous Metal Loading
  - Heavy atom quenching



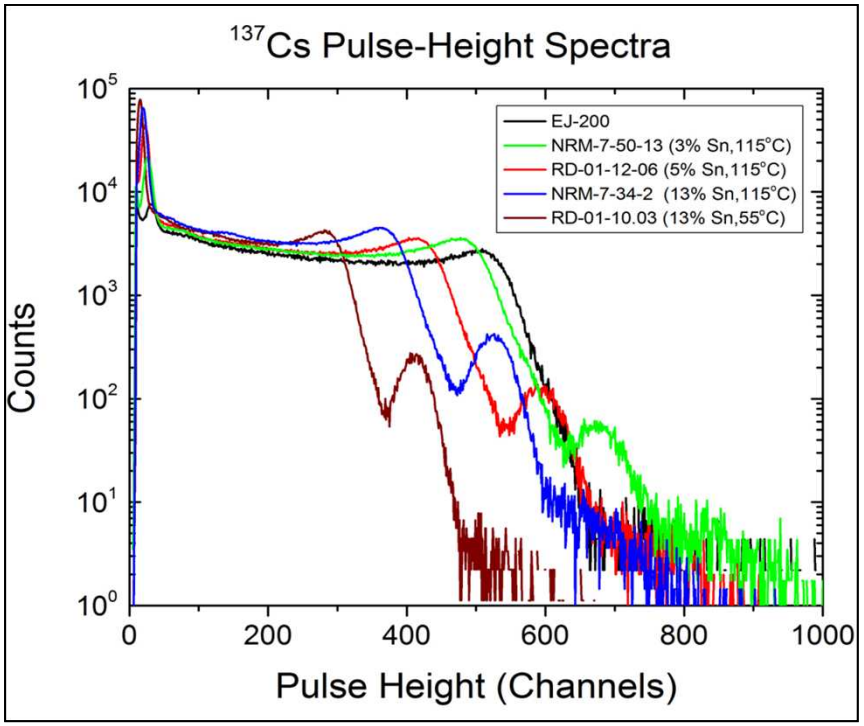
Approach

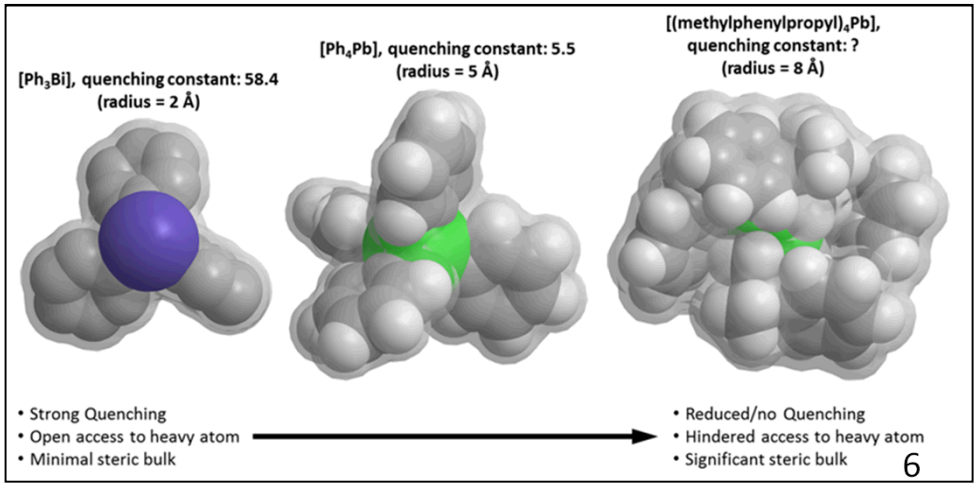
- Increase absorption crossection
  - Increase Z_{eff}
- Metal loading
- We want:
  - Maximized Z_{eff}
  - Minimized cost
  - Minimized heavy atom quenching
- Choose Sn



Properties of Sn

- Inexpensive
- Forms stable bonds with C, O
- Increases energy resolution
- Decreases light yield
- Synthetic flexibility
  - Reduction of quenching
  - Control miscibility





Loading Approaches

- Copolymerization
  - High potential loading
  - Unlikely to crystalize out
  - Polymerization kinetics
- Discrete molecules
  - Minimal impact to polymerization kinetics
  - Can contain multiple Sn atoms
  - Can be luminescent

Copolymers

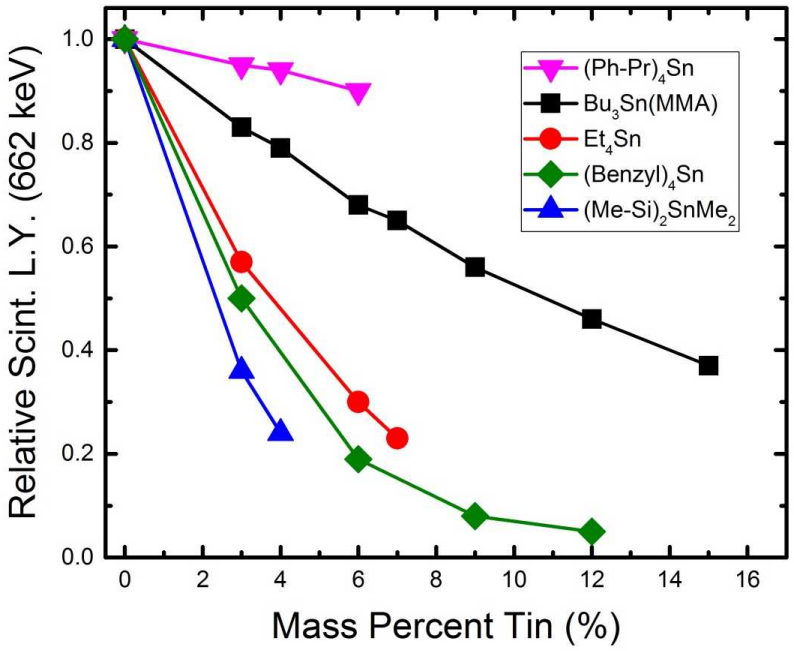
- Acrylic acid derivatives
  - Rapidly polymerize
  - Miscible with styrene
- Acrylic acid most promining
- Clarity maintained up to X% loading

[Image of $Bu_3SnAcrylate$]

[Mechanism for preparation of polymers]

Molecular Additives/Current Work

- Previous work: alkyl-Sn
- Low loading limits
- High rate of quenching
  - Distance-dependent
  - Lower than Pb and Bi compounds
- Resolved photopeak
  - Photopeak:Compton ratios



Current Work

- Polynuclear organotins
- Increase mass fraction Sn
- Fluorescent compounds

[Image of 1,4-NapthaleneDi(tributylStannylEster)]