Inelastic scattering with a segmented neutron/gamma calorimeter

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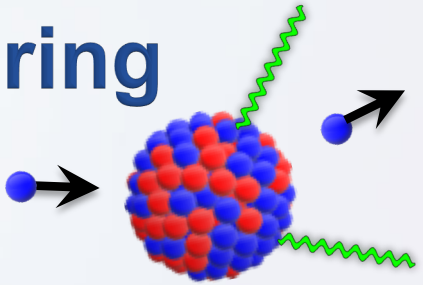
Odd-mass actinide inelastic scattering

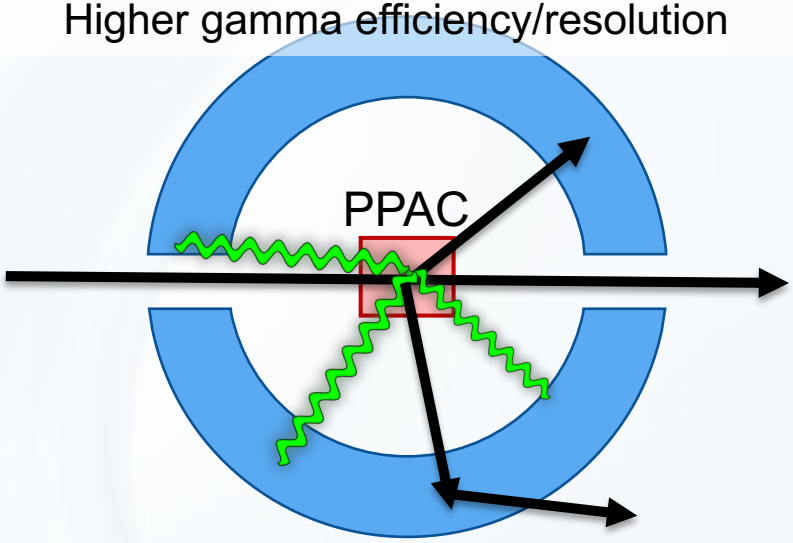


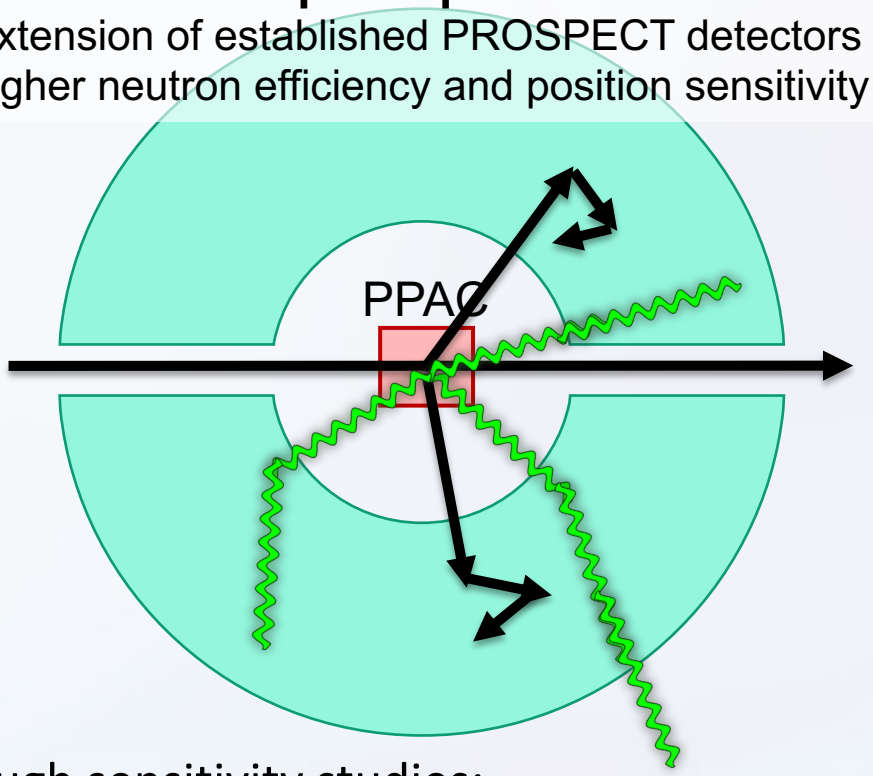
- There is renewed interest in inelastic scattering cross section uncertainties.
- Inelastic measurements become more difficult for some odd-mass actinides, where the level density is high and thermal neutrons can cause fission.
  - Gamma-tagging less useful: The level density is higher, more states internally convert, the nuclear structure is more complicated, and the fission background is worse.
  - Fission tag typically requires thin target, which results in lower event rate.
- Using sensitivity studies, we are exploring whether a high-efficiency segmented neutron/gamma calorimeter would be most effective for measuring inelastic scattering on odd-mass actinides.
- **Potential benefits:**
  - Significantly reduced background from scattering outside of the array.
  - Gamma calorimetry helpful with reconstructing excitation energy and determining fission efficiency for fission subtraction.
  - Multiple methods for reconstructing outgoing neutron energy.
  - Higher statistics.

Considered designs

Lithium-doped liquid scintillator
Extension of established PROSPECT detectors
Higher neutron efficiency and position sensitivity

Neutron-sensitive high-Z crystal (TLYC)
Higher gamma efficiency/resolution





- Specific questions we hope to answer through sensitivity studies:
  - Benefits of high gamma efficiency/resolution compared to high neutron efficiency and position sensitivity (e.g. fission efficiency, background rejection, residual energy).
  - Comparison methods for neutron energy determination: nToF, Cl(n,p), multi-scatter H(n,el), gamma sum.
  - Comparisons of both designs to simpler scattering experiments.
  - Necessity of pulsed mono-energetic beam vs. spallation source.
  - Neutron angle reconstruction for the two detector materials.

Conclusions

- A number of potential benefits of high-efficiency segmented neutron/gamma array have been identified.
- Sensitivity study will be applied to compare potential designs, using Geant4 or an MCNP model of experiment.
  - Showing that experiment is sensitive to nuclear data uncertainties is essential.
- Benefit and need for specific array should be demonstrated before planning actual experiment.