Magneto-ν: Neutrino Physics with Precision ^{241}Pu Decay measurement

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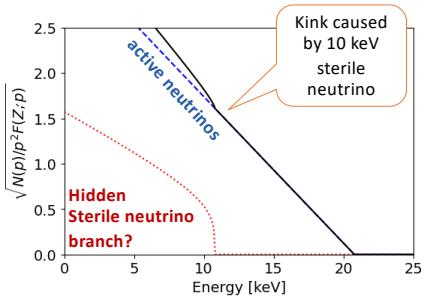
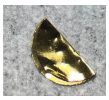
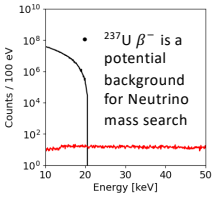
Motivation

- **O(10) keV-sterile neutrino**: warm DM candidate.
- If ν_e couples with ν_4, β^- spectrum endpoint is shifted by m_4.
  → A **kink** in the spectrum
- β^- decay Less susceptible to atomic physics.



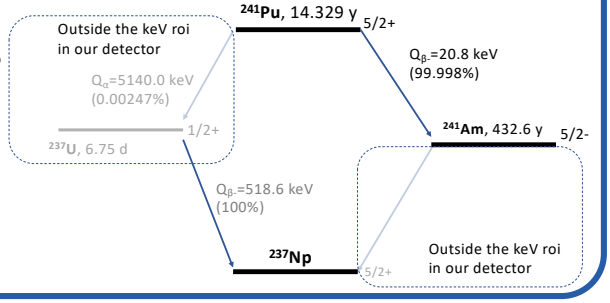


- Enriched (> 99.9%) ^{241}Pu source, deposited on a gold foil, is easy to handle without special facility



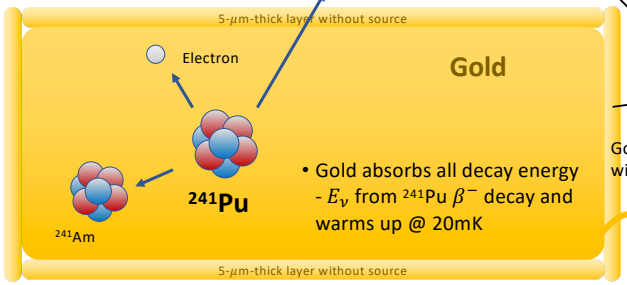
^{241}Pu?

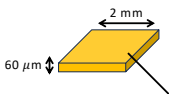
- Simple, single stage decay with a small Q
- Q = 20.78 keV, ideal for ~10 keV-scale sterile neutrino search.
- Uncertainty in theoretical model, end-point & spectral shape.



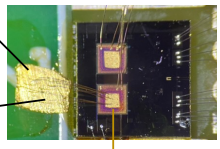
Methods

Sterile neutrino?





Actual setup

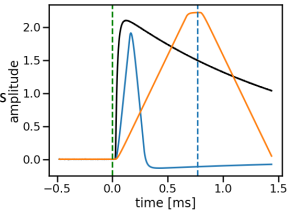


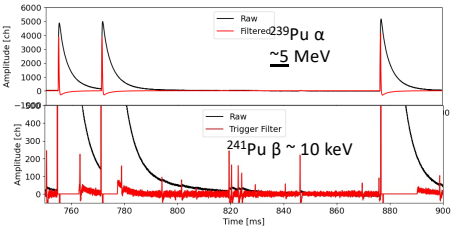
Gold wire

- Magnetic quantum sensor + quantum magnetometer measures temperature change

- ~100% detection efficiency
- O(100) eV energy resolution
- High count rate: 100 counts/s
- Simultaneously measure β^- and α decays.

- Trapezoidal shaping to calculate amplitudes

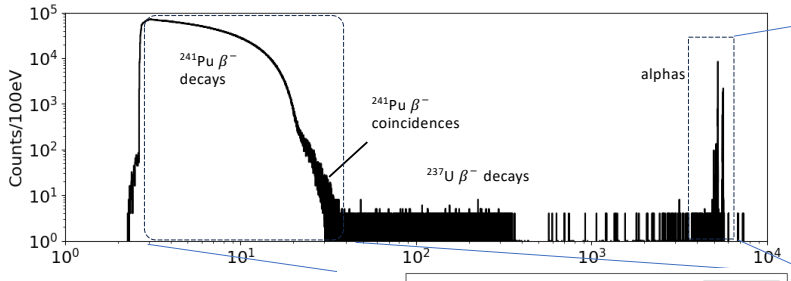


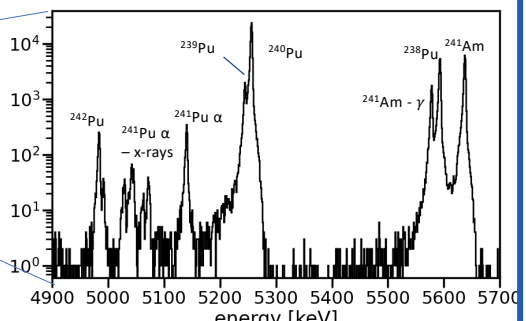


Nuclear decay → Heat & **T** rise → Change in **M**

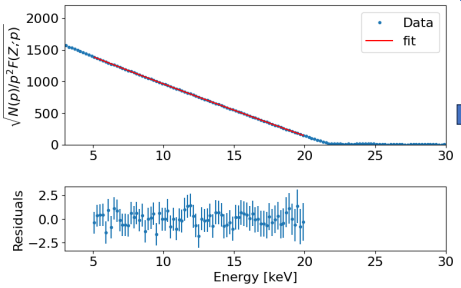
Results

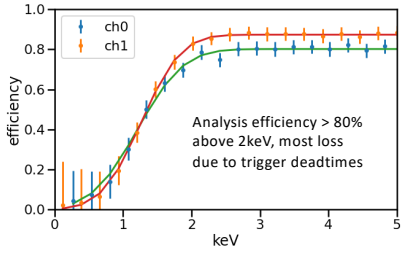
- Calibration using Actinide alpha decays: 2.4 keV FWHM resolution.



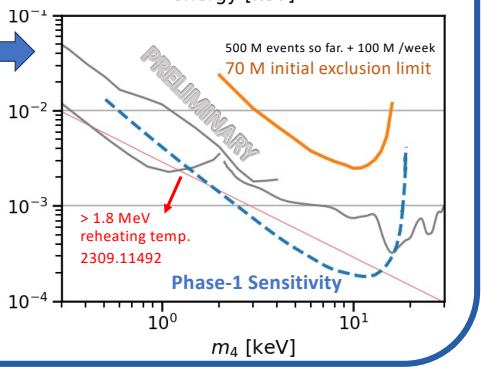


- **Highest statistics to date**!
  500 M events so far, + 100 M /week.
  → 1.5 B stats goal in current funding stage.
- 70 M analyzed and shown.
  Data processing & analysis ongoing.





- Initial fit of single β^- and accidental coincidence agrees with theoretical model
- **Phase-I (current):** target $|U_{e4}|^2 \sim 10^{-4}$ with 1.5B events.
- **Phase-II:** 1-year measurement with hundred pixels and 1 kBq each, using "ultra-fast MMC" detectors.



Acknowledgement: This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. This work was funded by LLNL LDRD program 23-LW-043.

LLNL-POST-2000192