Neutrino mass measurements using calorimetry require:
- High resolution
- Lots of counts!
- Well-understood theory

Why study $^{193}$Pt?
- Minimal sample preparation or deposition
- Nearly perfect absorber—entire absorber is single element aside from impurities
- Independent check on the theoretical calculations

Theoretical Spectrum

The theoretical spectrum for $^{193}$Pt has never before been published. The spectrum shown above in Figure 3 shows the differences in a single-hole spectrum with varying levels of fidelity in the atomic overlap calculation. The wavefunctions used to build the spectra are calculated with DFS atomic structure codes.

Model details:
- O(N) indicates N orbital overlap factors with unmatched quantum numbers
- V indicates Vatai approximation for the atomic overlap
- a indicates wavefunction evaluated at $r = 0$ au
- b indicates wavefunction evaluated at $r = 1.365 \times 10^{-4}$ au

Gamma Spectroscopy

HPGe spectra were used to identify isotopes created within the foil and their activities. The activity of the sample as of 4 July 2017 is dominated by $^{193}$Ir (18.6 Bq/µg). Its short half life (74 days) means that in a year this impurity will decay to a more favourable 0.7 Bq/µg, the same activity as $^{193}$Pt.

Isotope | Activity [Bq/10mg]
--- | ---
$^{192}$Ir | 186000
$^{193}$Pt | 7460
$^{40}$Sc | 897
$^{192m2}$Ir | 864

Table 1. Activities as of 4 July 2017.

Irradiation

A 10 mg sample of $^{192}$Pt-enriched Pt was irradiated for approximately 7 days with a predicted production of 2.8 Bq of $^{193}$Pt per µg of platinum.

Figure 1. The $^{192}$Pt-enriched Pt foil (left), placed within a polyethylene tube (upper right), was irradiated at the MIT reactor (lower right), exposing it to a high thermal flux to create $^{193}$Pt.

Experimental Calorimetric Spectrum

A small piece (≈0.04 µg) was cut from the irradiated foil and incorporated into a microcalorimeter detector. Shown in Figure 4 is the first experimental calorimetric electron capture spectrum of $^{193}$Pt.

TES details:
- 350 µm square Mo-Cu bilayer
- Transition temperature near 110 mK

Further analysis:
- External energy calibration
- Identify unknown peaks
- Quantify activity of $^{193}$Pt
- Direct comparisons with theory

Observations:
- Observed electron capture lines for $^{192}$Ir and $^{193}$Pt
- Unknown peaks between M- and L-clusters
- Comparable electron capture rates for $^{192}$Ir and $^{193}$Pt

Figure 4. (Top) A small piece was cut from the irradiated foil and attached to a TES. (Bottom) Preliminary calorimetric measurement of platinum foil. Electron capture peaks from $^{193}$Pt and $^{192}$Ir are visible. Some peaks are yet to be identified.