Study of shape transitions in the neutron-rich Os isotopes

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Outline

The neutron-rich W, Os and Pt isotopes

- Existence of Isomers
- Different shapes in their ground-state
  prolate, oblate, triaxial, and spherical
- Shape transitions
- Region is a crucial testing ground for nuclear models

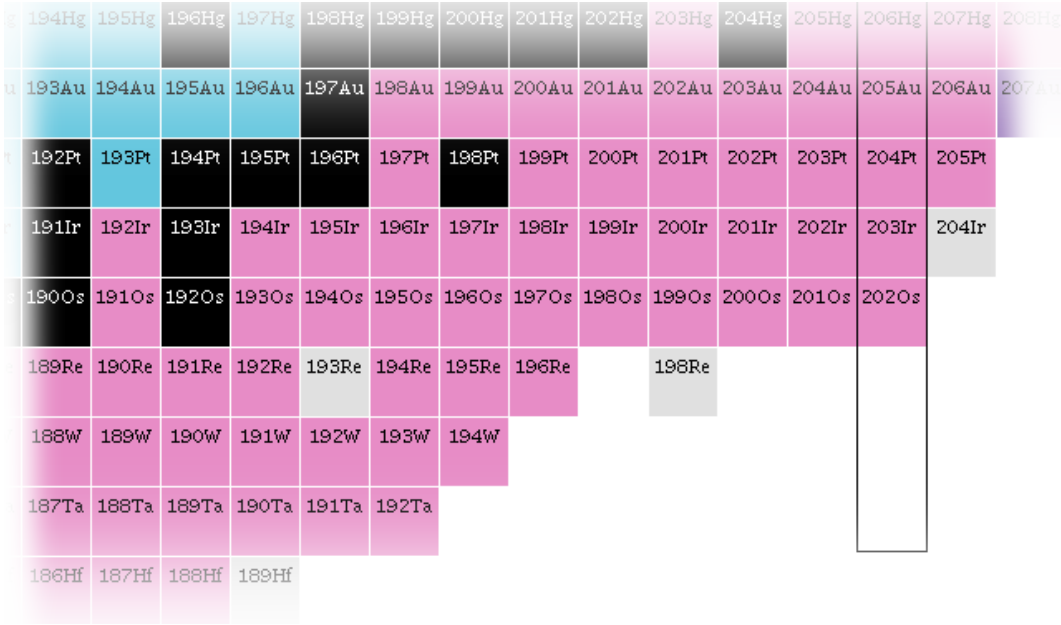

Chart taken from: Nuclear Data Database NUDAT 2, http://www.nndc.bnl.gov/nudat2.

- Region studied using both stable and radioactive beams:
  No spectroscopic information about ^{196}Os

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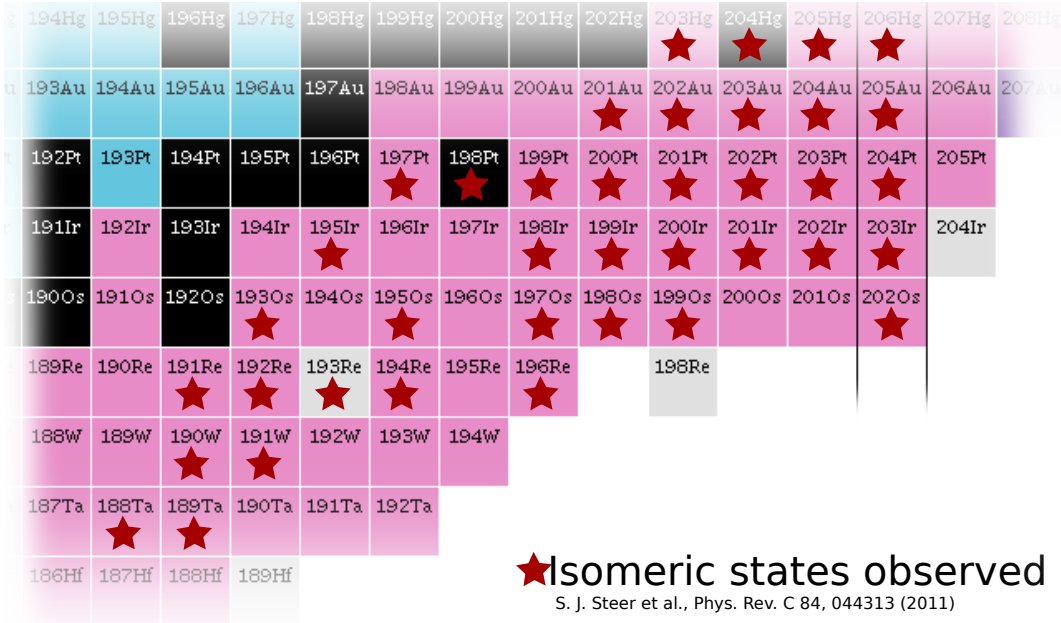

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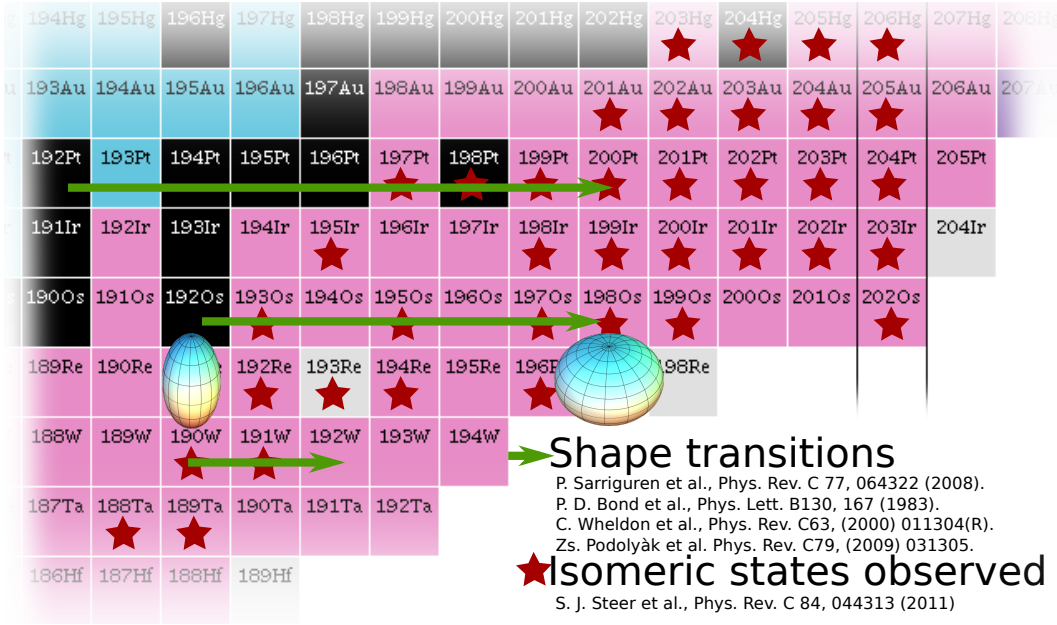

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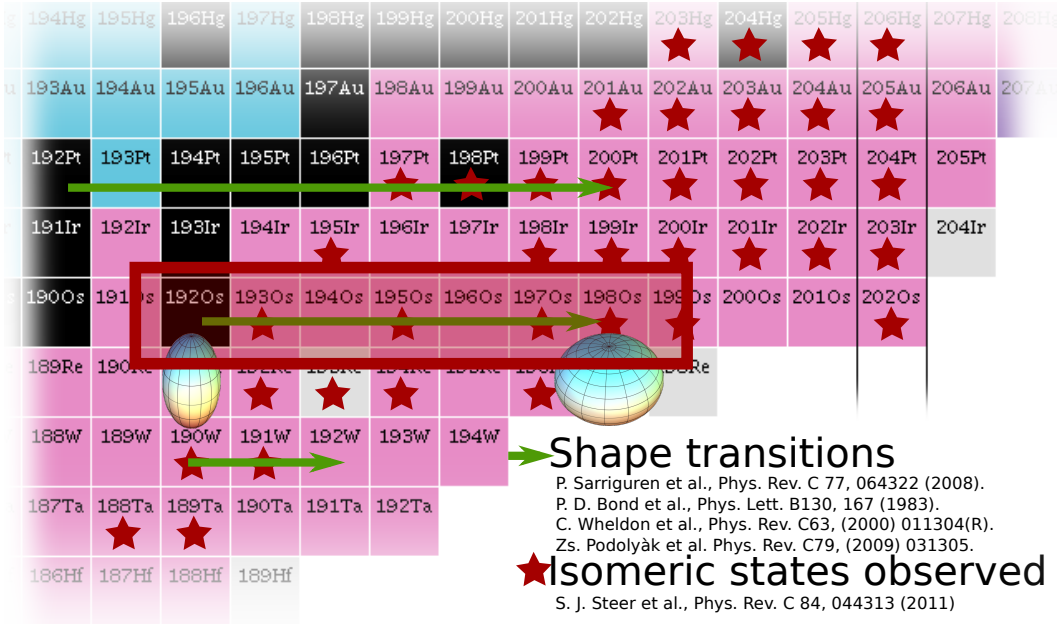

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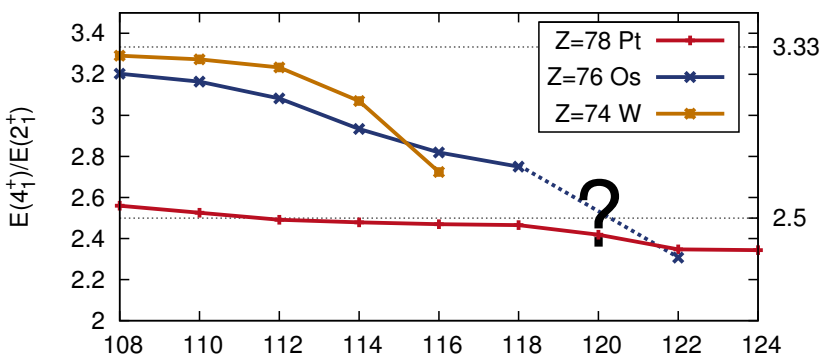
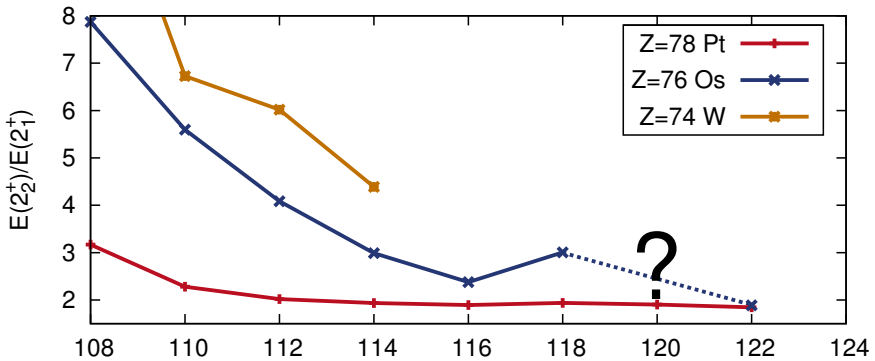
Shape transitions in the neutron-rich W, Os and Pt isotopes

W Sudden prolate to oblate shape transition predicted for A=190-192
P. Sarriguren et al., Phys. Rev. C 77, 064322 (2008).

Pt Transition region starts with A=192 and persists till A≈200 with γ-soft ground states
P. D. Bond et al., Phys. Lett. B130, 167 (1983).

Os Prolate deformed groundstate of ^{194}Os, oblate deformed groundstate for ^{198}Os found.
C. Wheldon et al., Phys. Rev. C63, (2000) 011304(R). Zs. Podolyák et al. Phys. Rev. C79, (2009) 031305.





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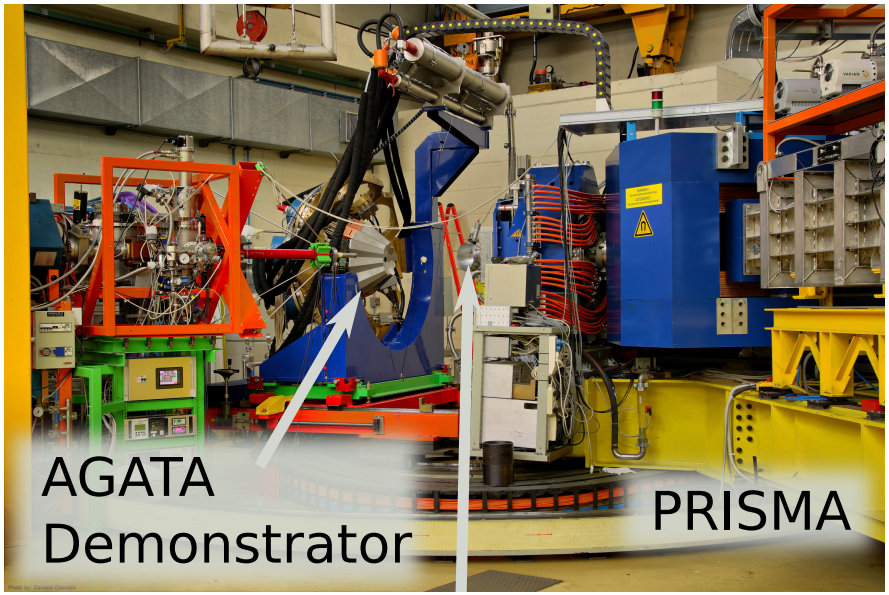
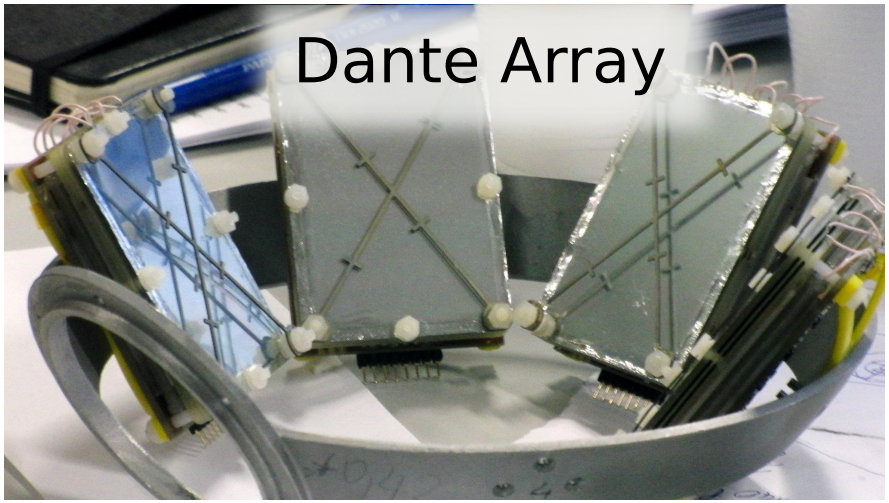
Setup

The experiment was performed at LNL, Italy using

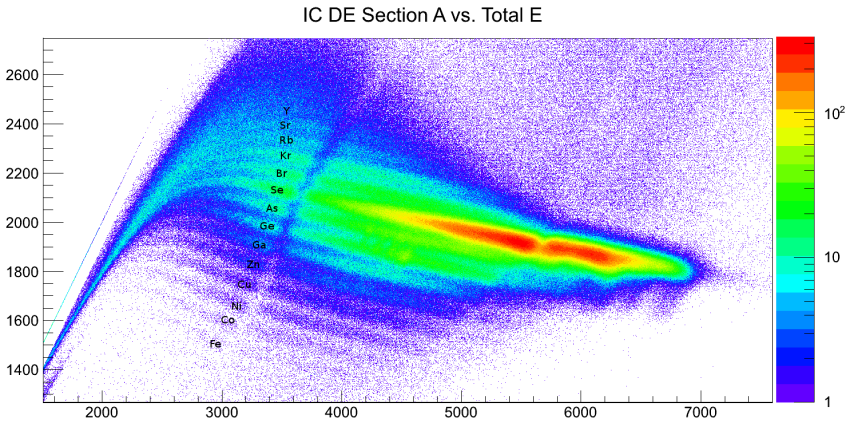
- a 426 MeV ^{82}Se beam
- a 2 mg/cm^2, self-supporting ^{198}Pt target
- AGATA Demonstrator (5 Cluster)
- large-acceptance magnetic spectrometer PRISMA@57° **detecting the lighter beam-like recoils**
- DANTE heavy ion detector (for additional particle-particle-γ-γ coincidences without particle identification)

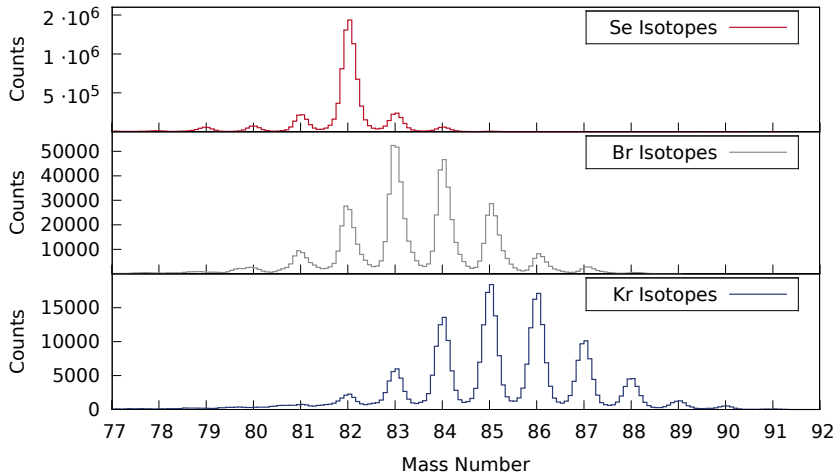




Particle Identification using PRISMA

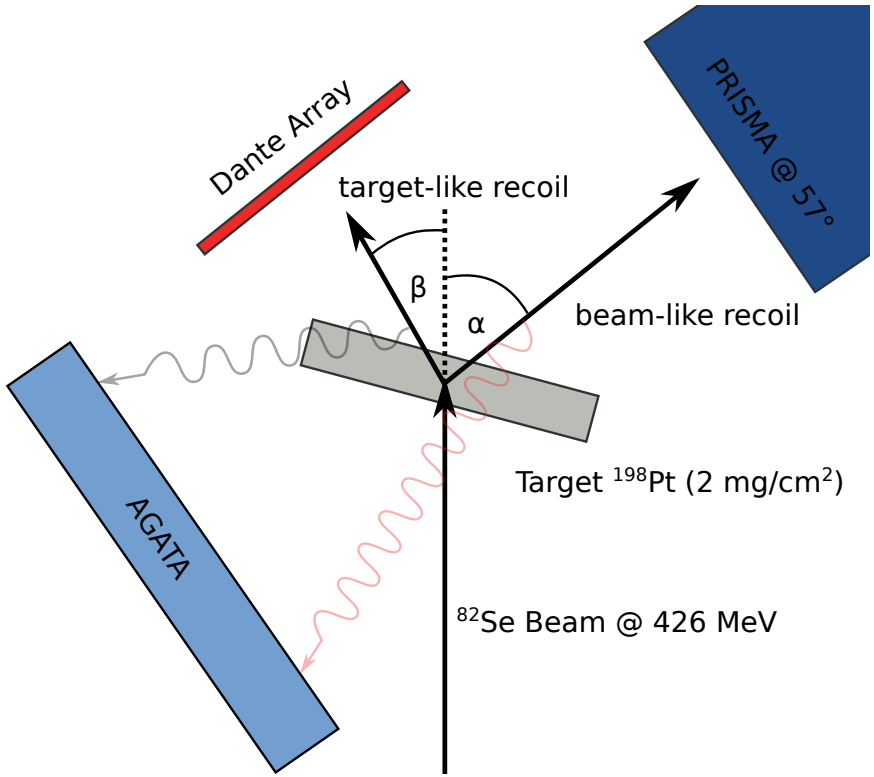
- Event by event particle identification using PRISMA
- Only the lighter beam-like fragment is unambiguously identified
- Event by event Doppler correction for the beam-like ions
- Heavier ions of interest are partly detected in the DANTE array
- Need to reconstruct angle and velocity of target-like ions





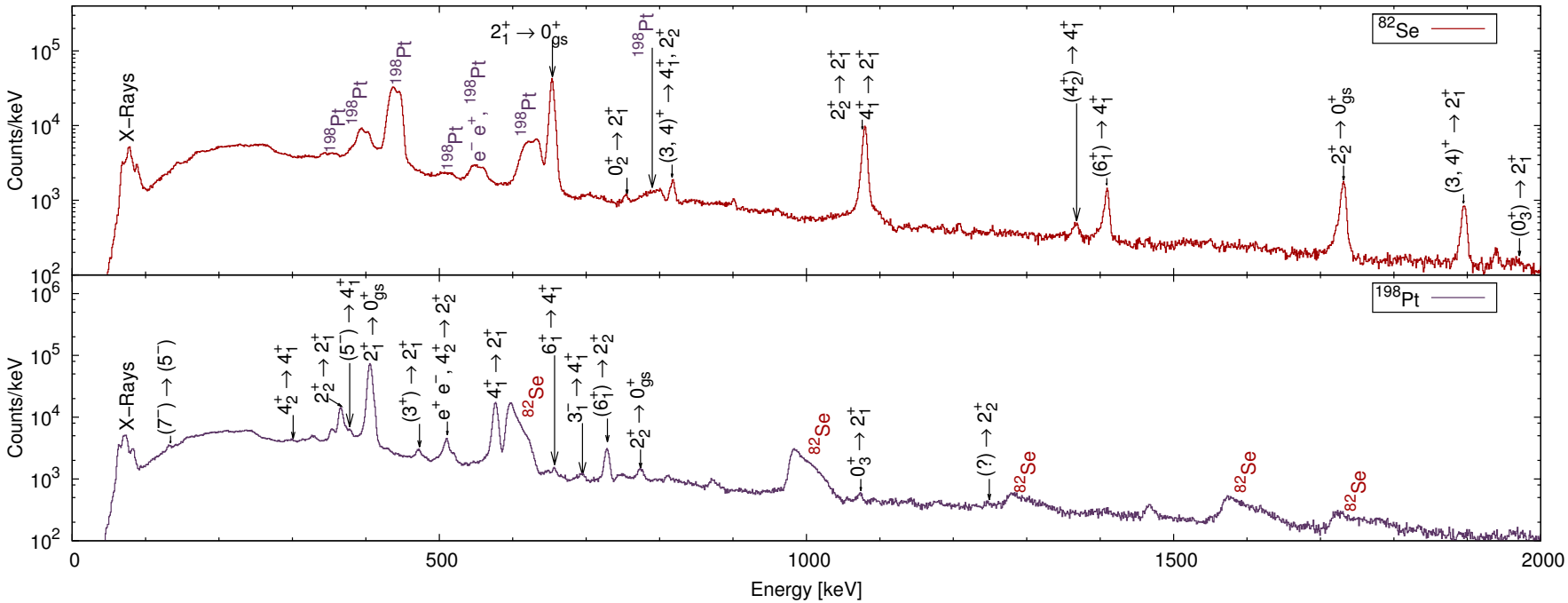
Doppler Correction using the Binary Partner Method

- Reconstruct the velocity vector of the un-detected heavier ion event by event using
  - Relativistic two-body reaction
  - Exact masses
  - Q-value of reaction
  - Energy loss in the target for all participants
  - **Assumption: No particle evaporation**
- Implementation in *libPRISMA* $\Rightarrow$ can be easily adopted for other experiments



Preliminary Spectrum of ^{82}Se and ^{198}Pt

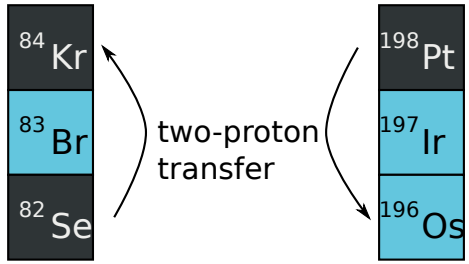
- Good Doppler correction with
  - FWHM of 6.21 keV for the $2_2^+ \rightarrow 0_{gs}^+$ of ^{82}Se at 1731.5 keV (3.59‰)
  - FWHM of 7.4 keV for the $2_1^+ \rightarrow 0_{gs}^+$ of ^{198}Pt at 407.21 keV (1.8%)

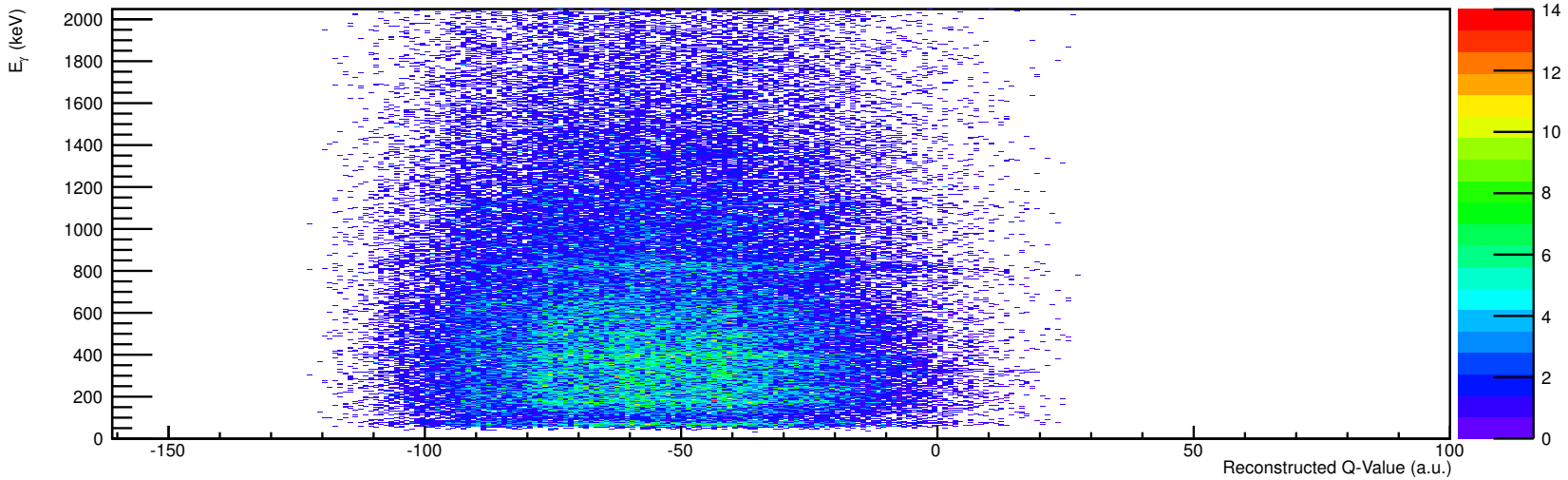


Transitions tentatively assigned based on previously reported gamma ray energies.
H. Xiaolong,Nuclear Data Sheets 110, 2533 (2009). J. K. Tuli, Nuclear Data Sheets 98, 209 (2003).

Reconstructing Q-Value

- Two-Proton transfer channel
- Neutron evaporation for beam-like and target-like fragments leads to a misinterpretation of the measured gamma rays
- Reconstruct Q-value based on momentum conservation
  A.B. Brown et al., Phys. Rev. 82, 159 (1951)





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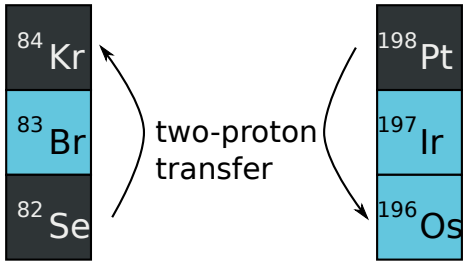
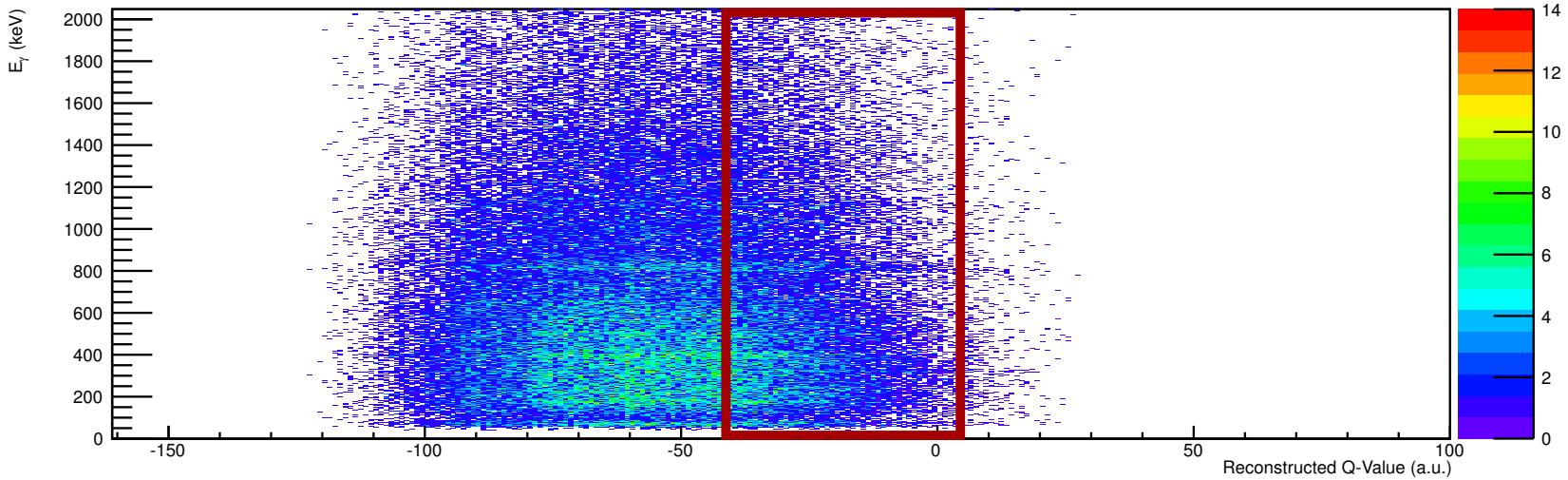
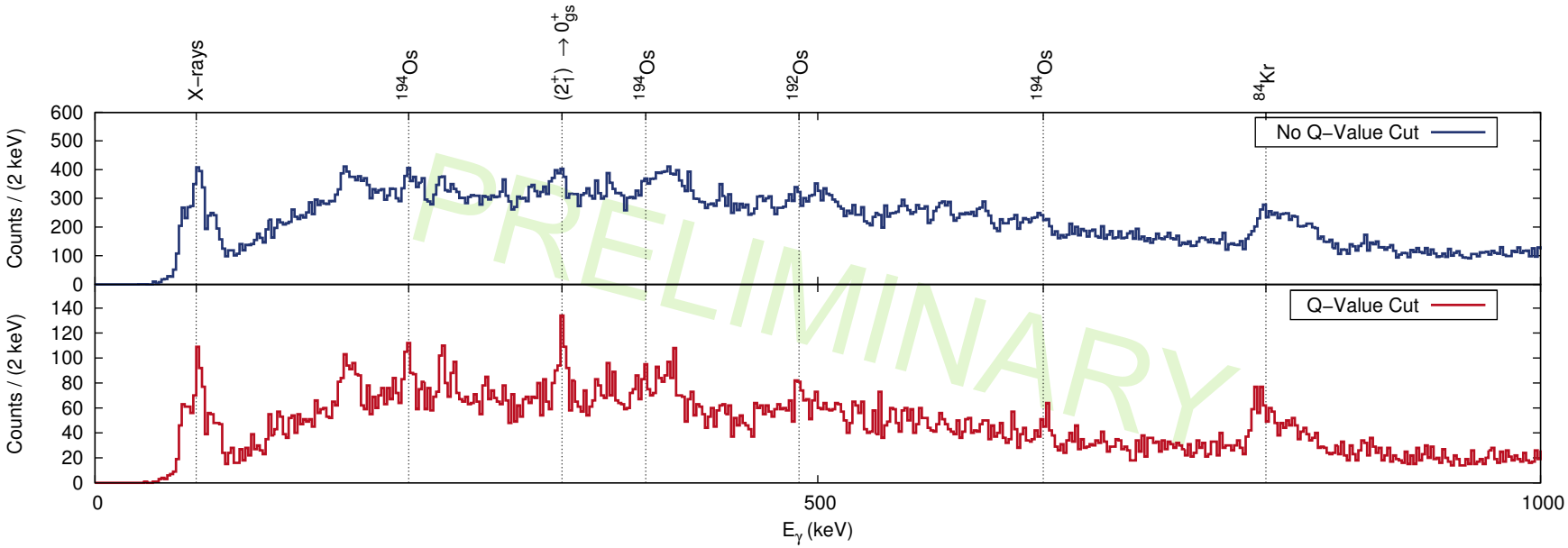




Spectra for ^{196}Os

- Cut on the reconstructed Q-value reduces contribution of nuclei produced by neutron evaporation
- Transition ($2_1^+ \rightarrow 0_{gs}^+$) was observed for the first time
- Statistics is high enough for $\gamma - \gamma$ coincidences



Conclusions and Outlook

- A multi-nucleon transfer reaction was used to populate medium-to-high spin states in the neutron-rich nuclei around $A = 190$.
- Reconstructing the velocity vector for the undetected heavier target-like fragment provides an effective Doppler correction.
- A cut on the reconstructed Q-value reduces contribution in the spectra due to nuclei produced by neutron evaporation.
- This experiment provides for the first time spectroscopic information on ^{196}Os and will help to elucidate the shape evolution in the neutron-rich Os nuclei
- Data analysis still in progress. Especially DANTE Array is not used yet.
- Many other transfer-channels need to be studied, i.e., W, etc.

Thank you for your attention