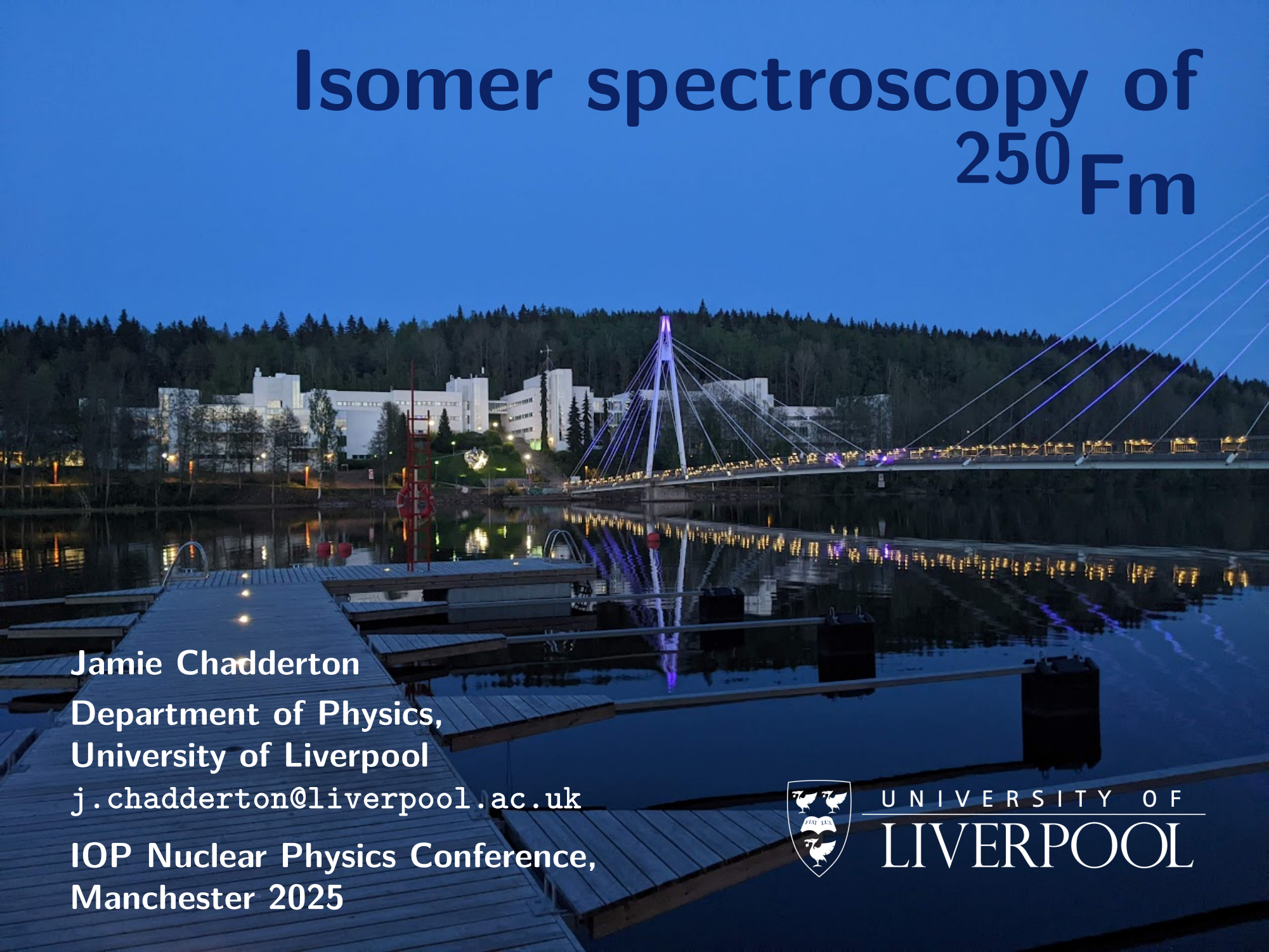
Isomer spectroscopy of ^{250}Fm



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IOP Nuclear Physics Conference,
Manchester 2025

UNIVERSITY OF LIVERPOOL

Isomer spectroscopy of ^{250}Fm

Introduction

- Superheavy elements and the island of stability
- K-Isomerism
- ^{250}Fm – previous work

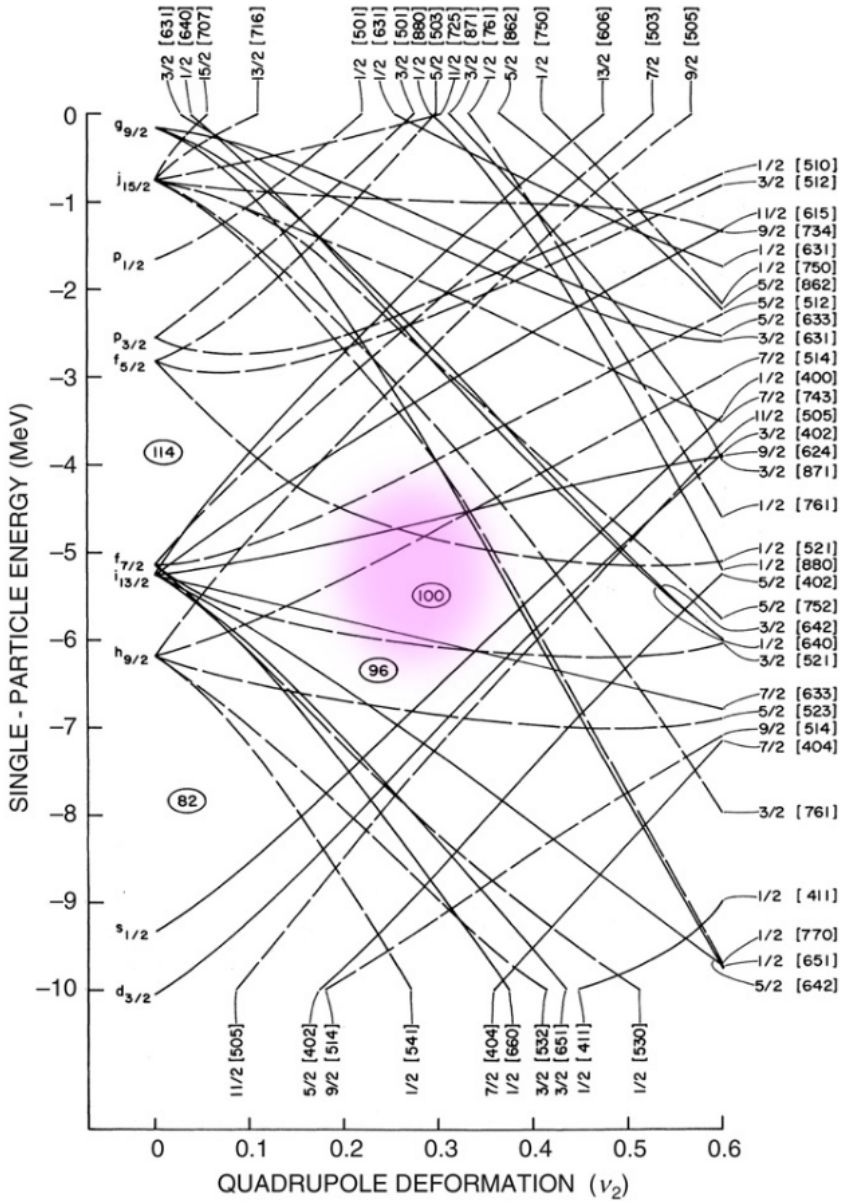
Experiment and simulation

- SAGE spectrometer
- S20 Experiment

Results

- $K^{\pi} = 8^{-}$ isomer
- Simulations

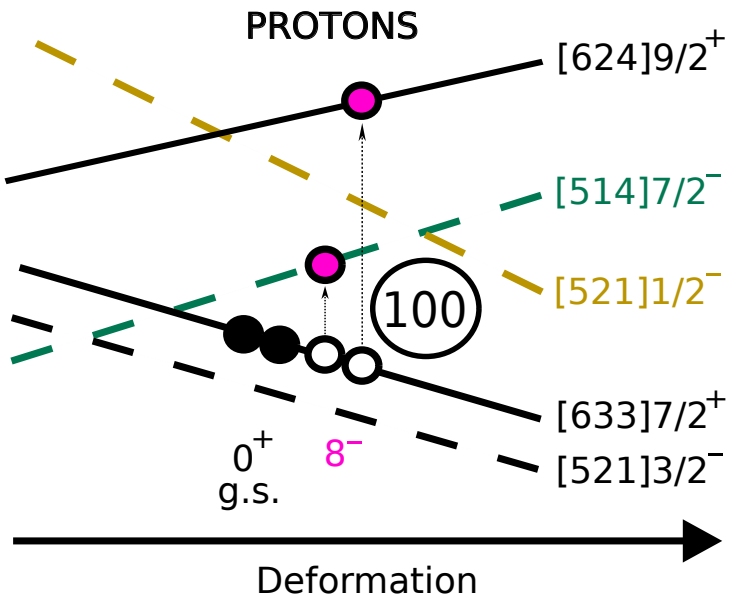
Why transfermium nuclei?

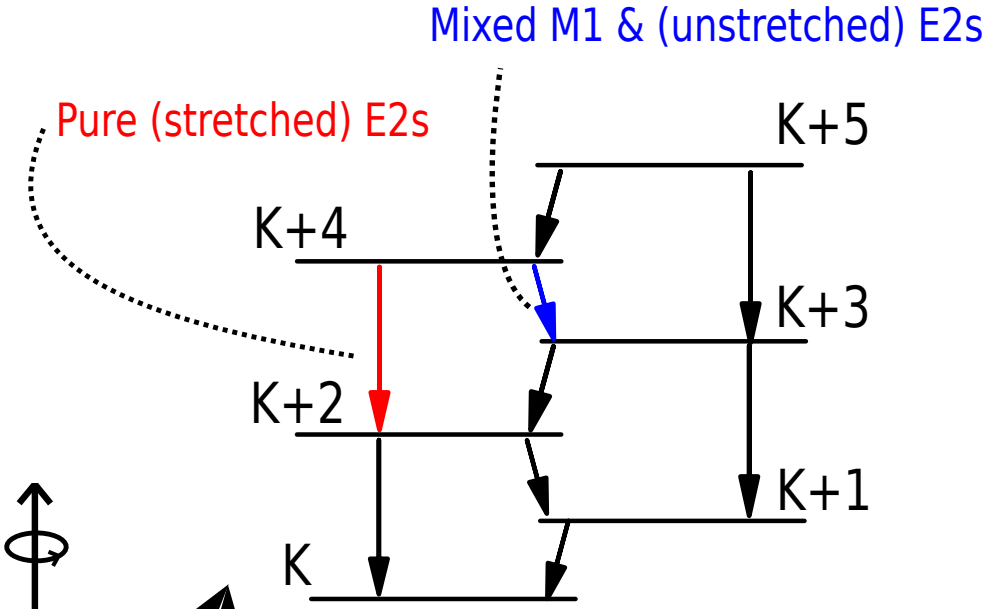


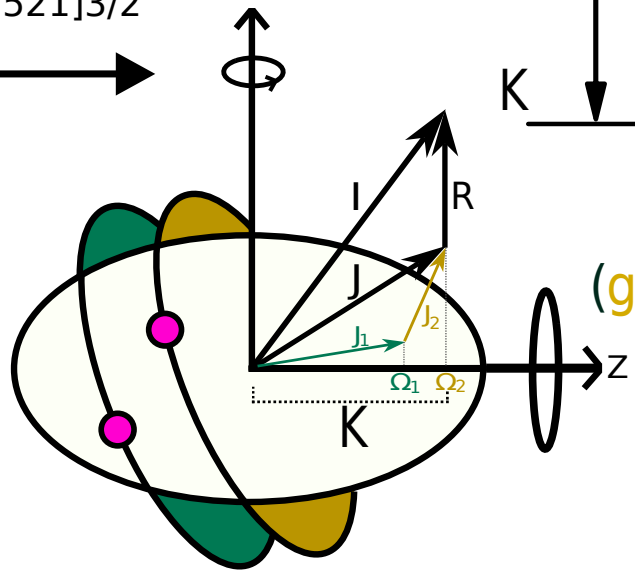
- Probe SP levels brought down by deformation from around shell gap, in lighter, deformed systems.

- Evidence for enhanced stability against α decay and fission. E.g. ^{270}Ds.
  RM Clark. *The European Physical Journal Special Topics*, pages 1–9, 2024.

K-Isomerism

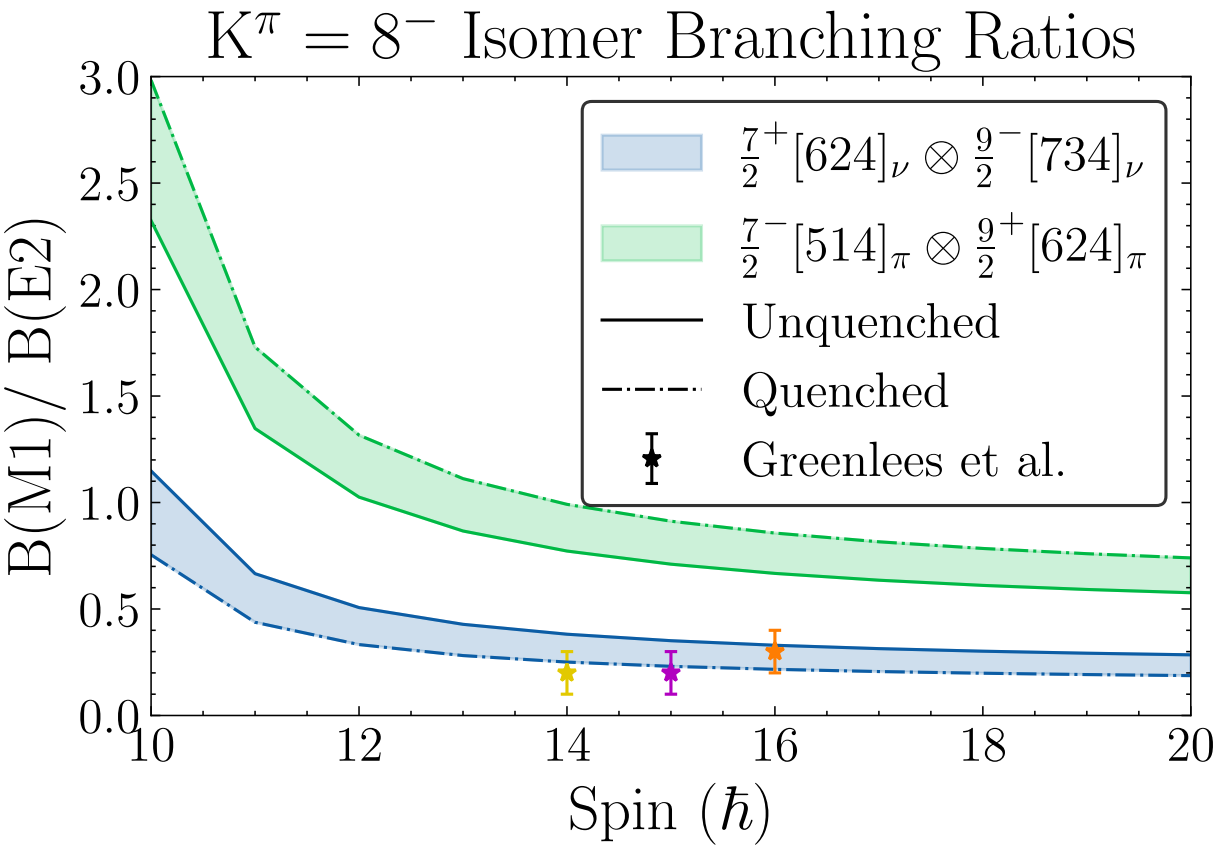


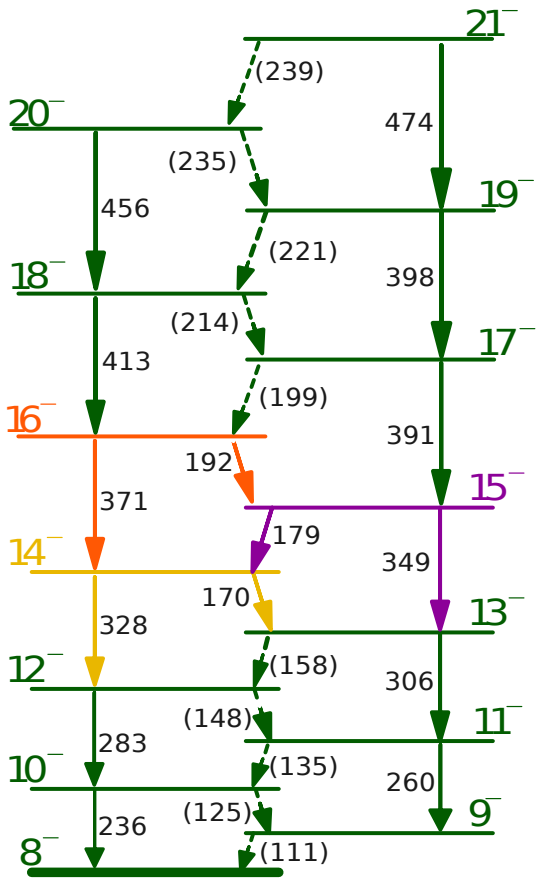




$(gK \otimes gK) \propto (I-2)/(I-1)$

Above the $K^\pi = 8^-$ isomer



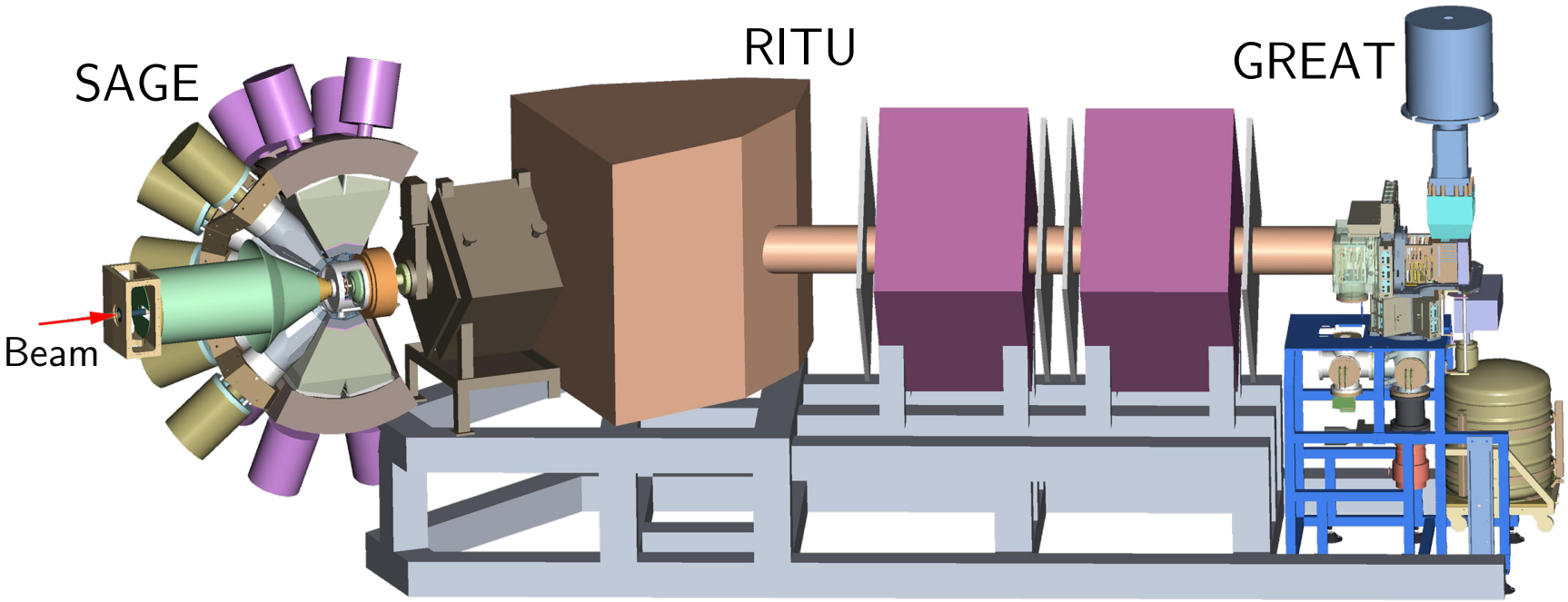


Adapted from: P. T. Greenlees, et al. *Phys. Rev. C*, **78**:021303(R), 2008

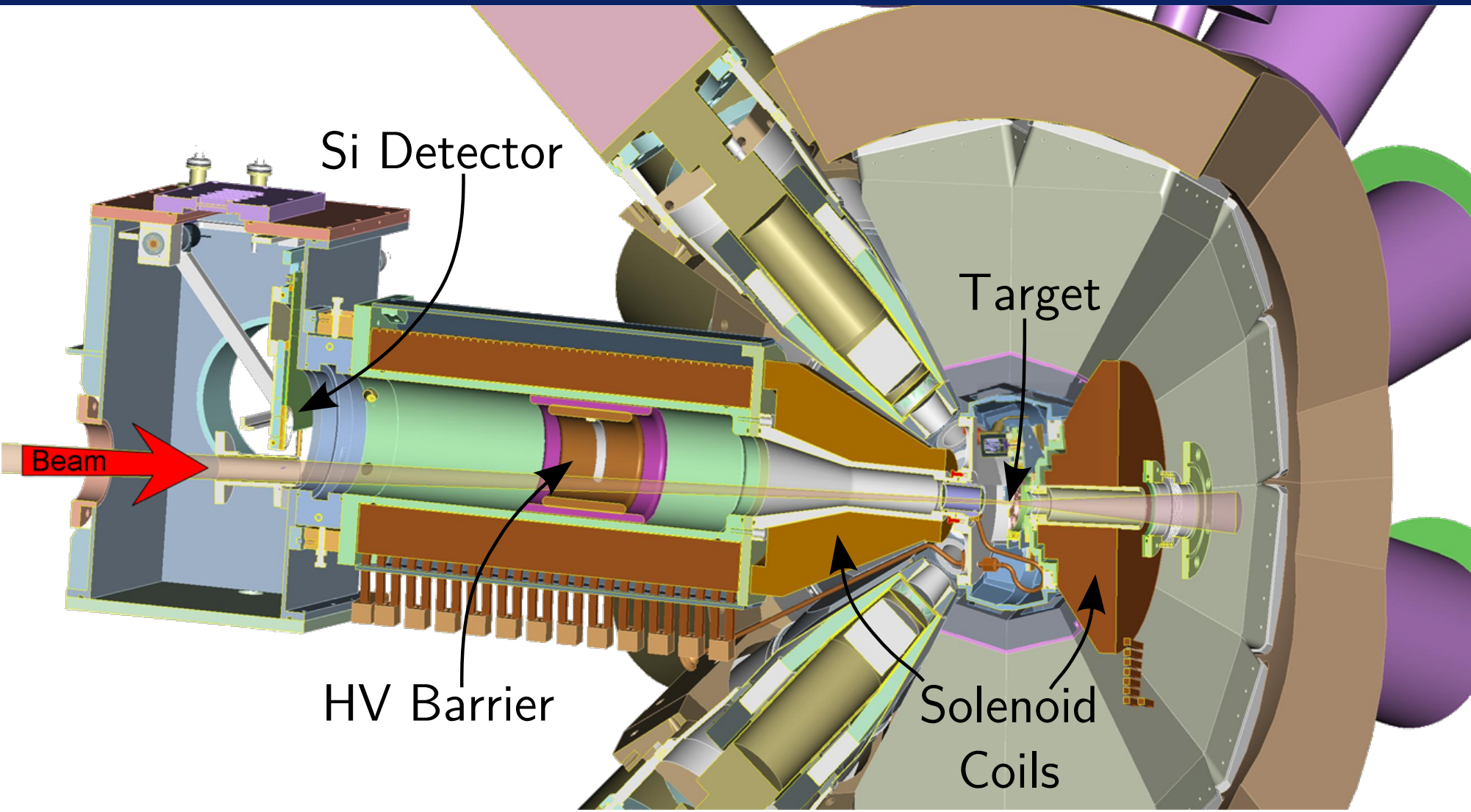
- $B(\mathrm{M1}) \propto (g_k - g_R)^2 \Rightarrow$ E2/M1 intensity ratio in band depends on g_K
- $B(\mathrm{E2}) \propto (Q_0)^2$

University of Jyväskylä

Spectroscopy at Jyväskylä



SAGE – conversion-electron spectroscopy

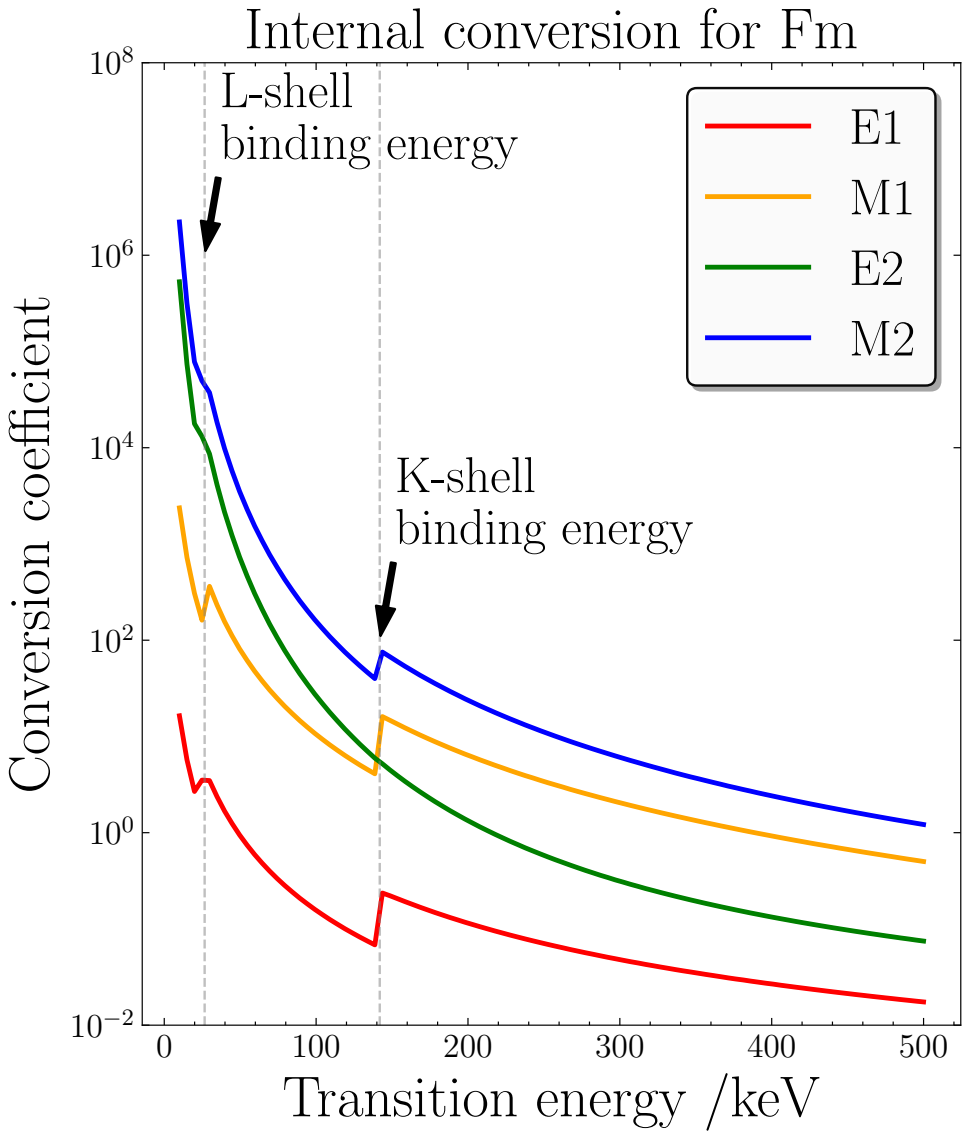


`http://ns.ph.liv.ac.uk/SAGE/home.html`

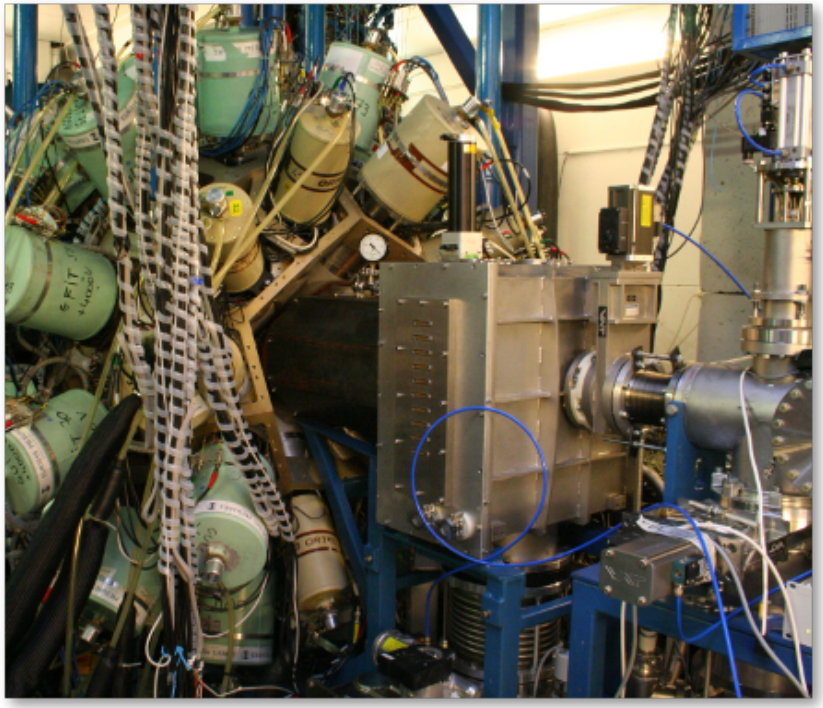
J. Pakarinen, et al. *Eur. Phys. J. A*, **50**:53, 2014

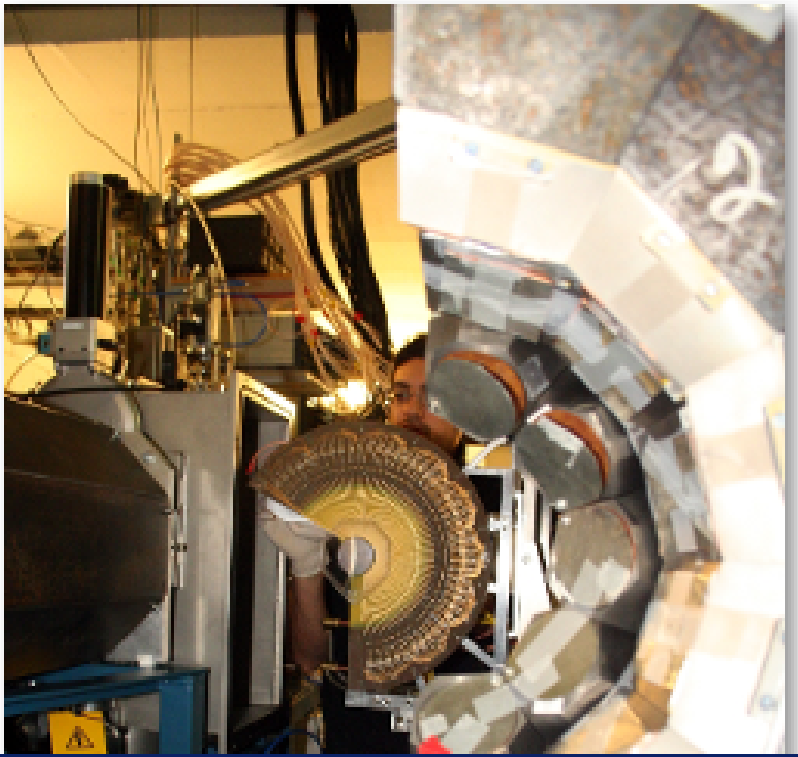
Internal conversion

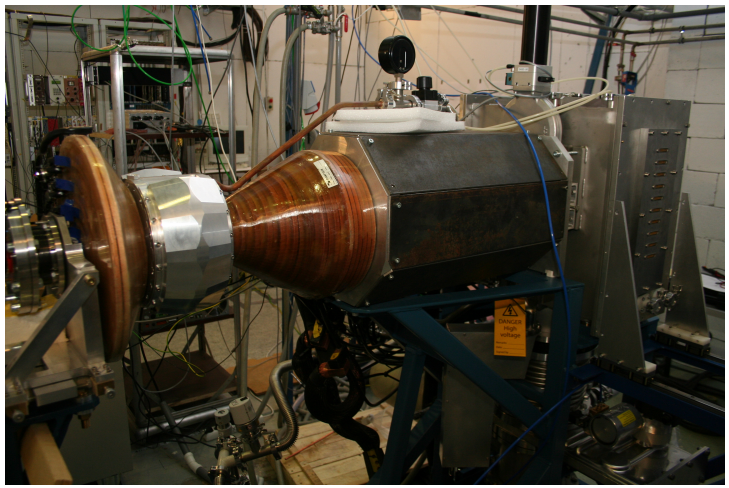
- Competes with γ decay, but an atomic electron is emitted not a photon
- $E_{e^-} = E_\gamma - E_{\text{binding}}$
- Conversion coefficient, $\alpha = \dfrac{\lambda_e}{\lambda_\gamma}$
- Higher at high Z
- Higher at low E
- Depends on transition multipolarity
- α also depends on electron shell (and sub-shell, L_{I}, L_{II}, $L_{\text{III}}\ldots$)



SAGE Team

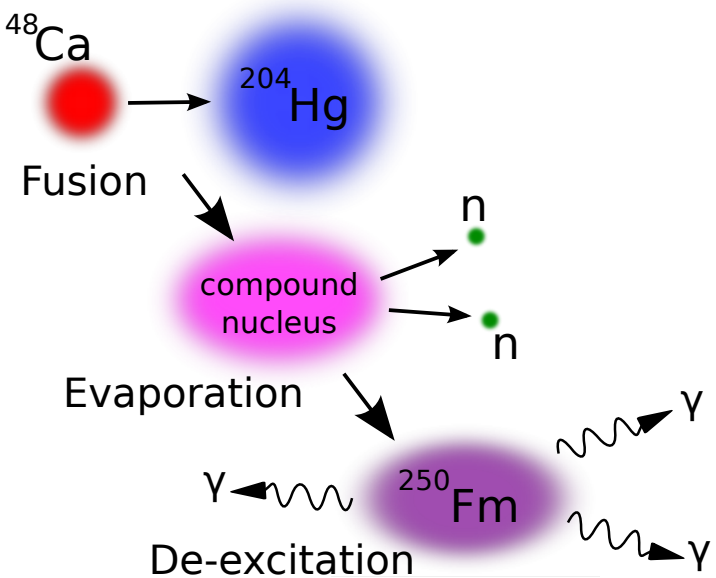


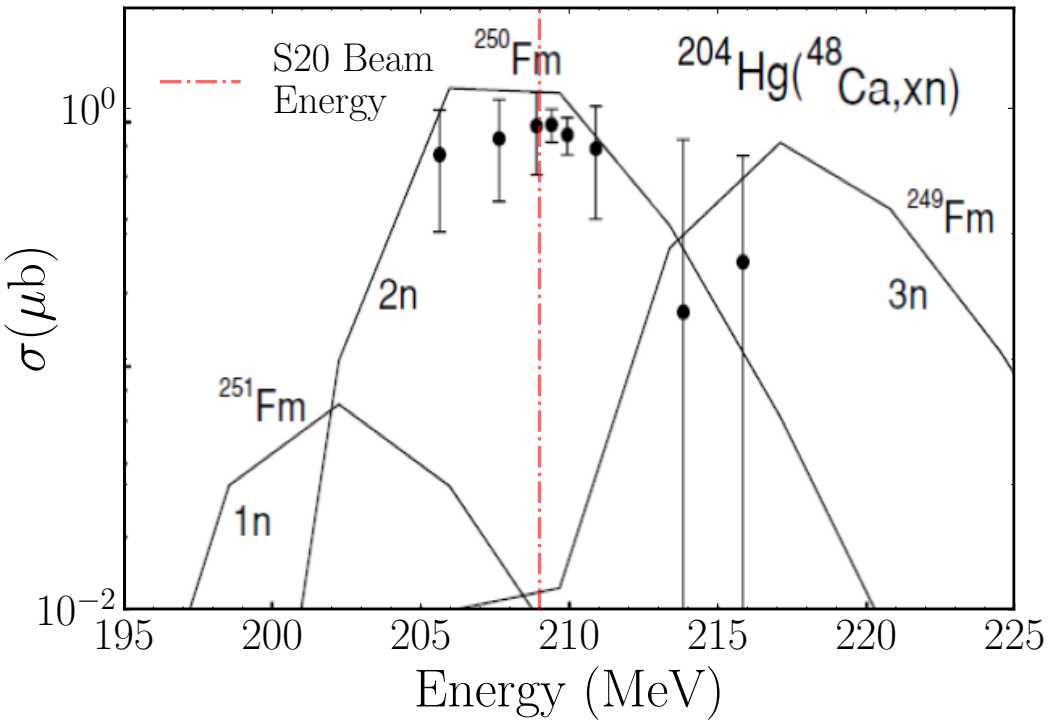




S20 Experiment

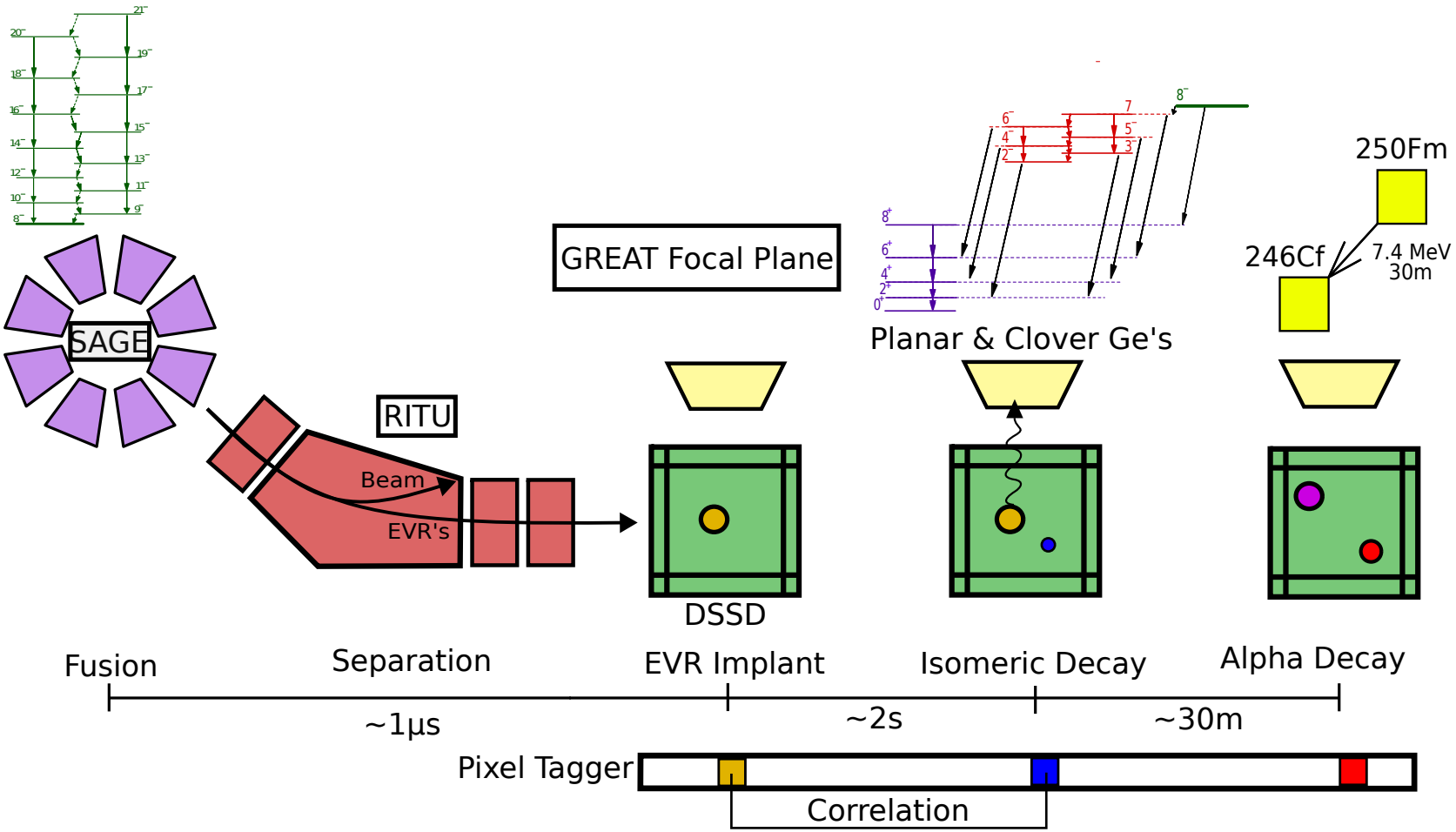
- Fusion-evaporation: ^{204}Hg(^{48}Ca,2n)^{250}Fm, $\leq$ 1 μb cross section
- SAGE + RITU + GREAT
- $\approx$ 9.3 days of data over 2 weeks



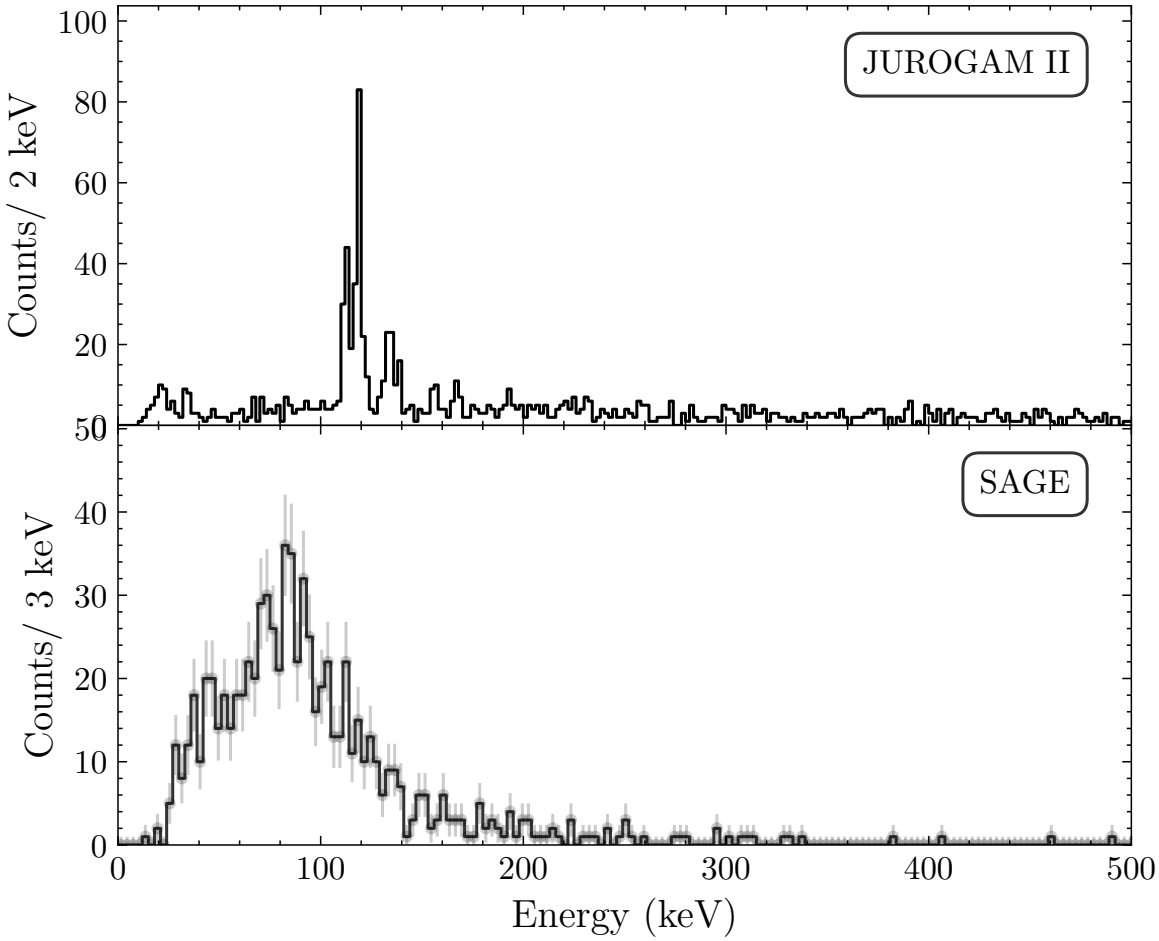


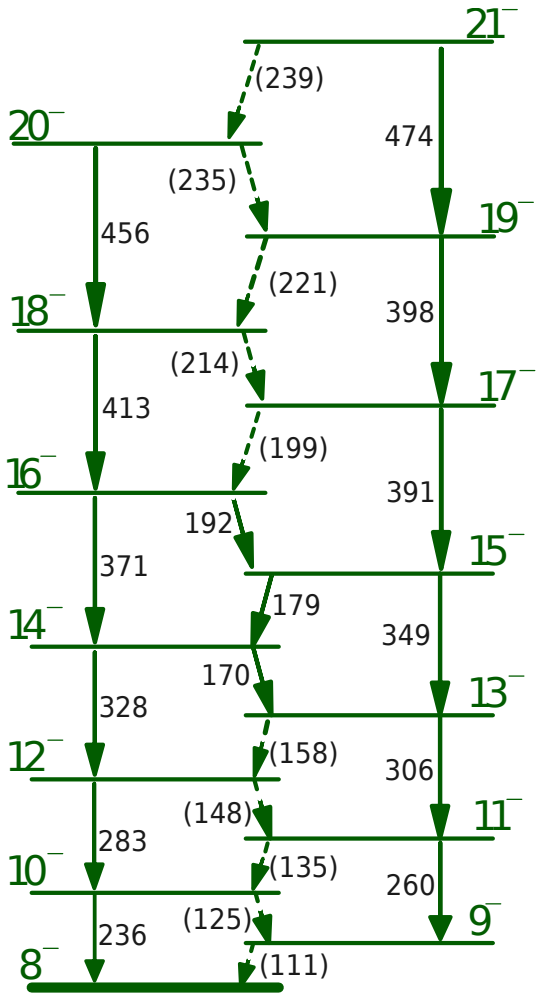
Adapted from: J. E. Bastin, et al. *Phys. Rev. C*, **73**:024308, 2006

Spectroscopy at Jyväskylä - Isomer Tagging



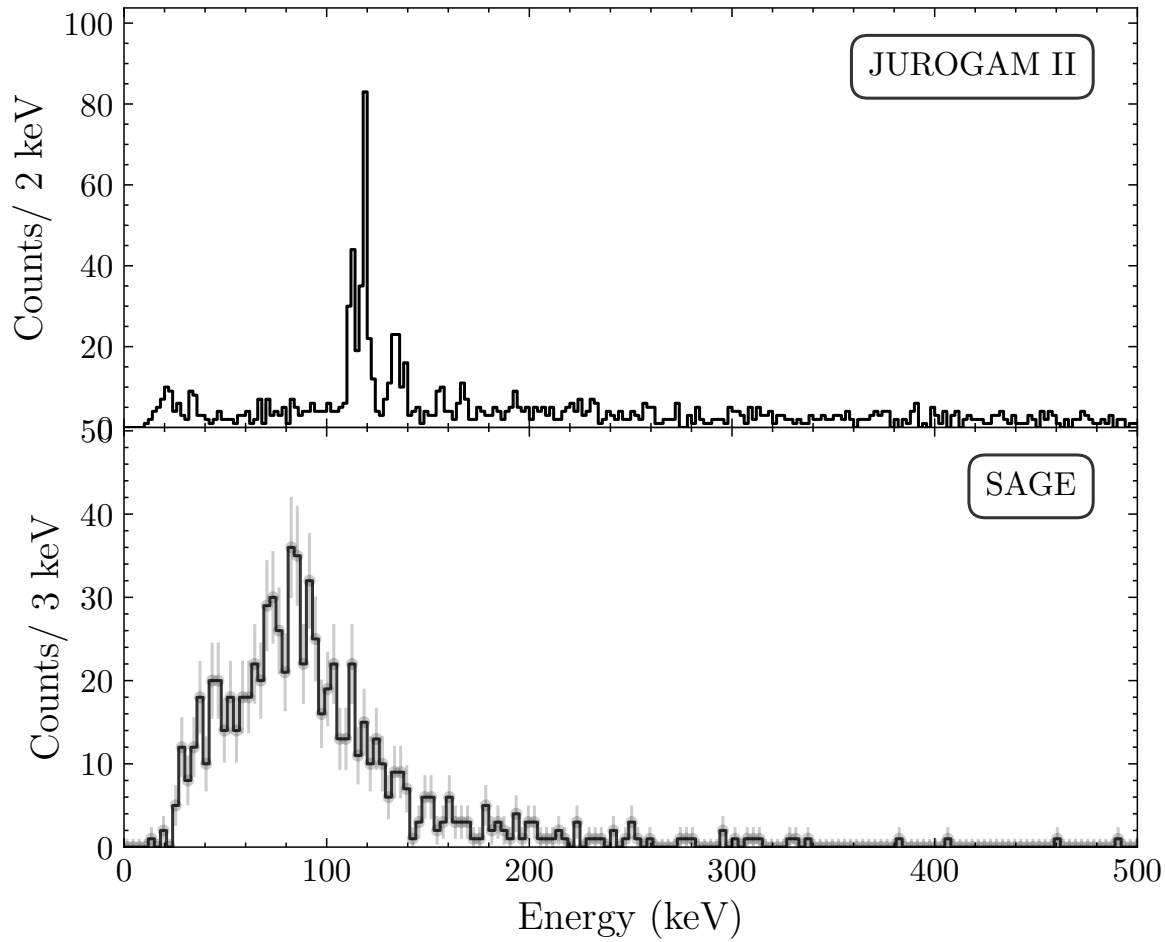
Above the $K^{\pi} = 8^{-}$ isomer

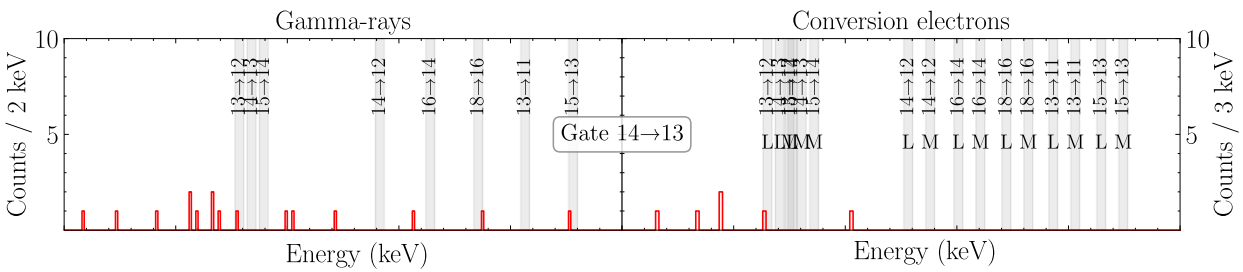


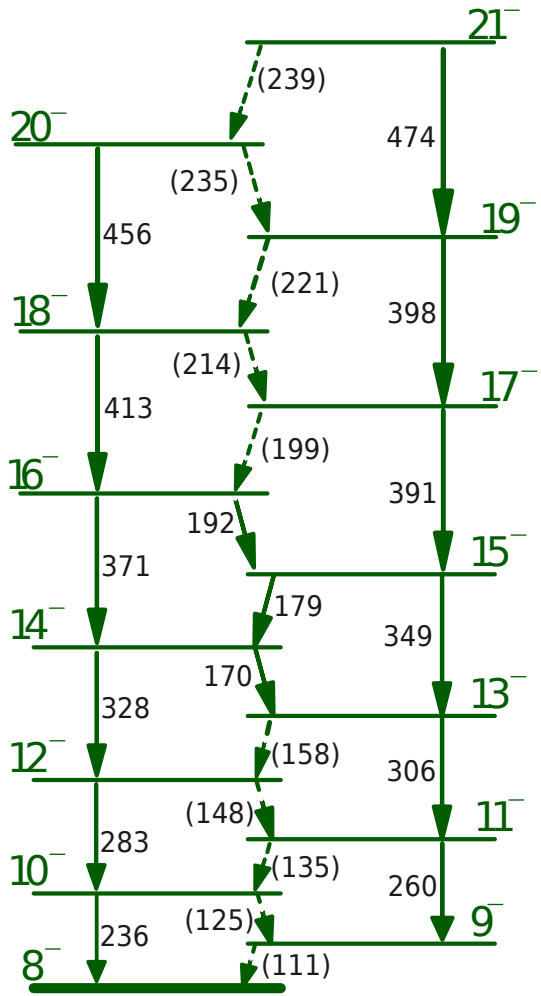


Adapted from: P. T. Greenlees, et al. *Phys. Rev. C*, **78**:021303(R), 2008

Above the $K^{\pi} = 8^{-}$ isomer







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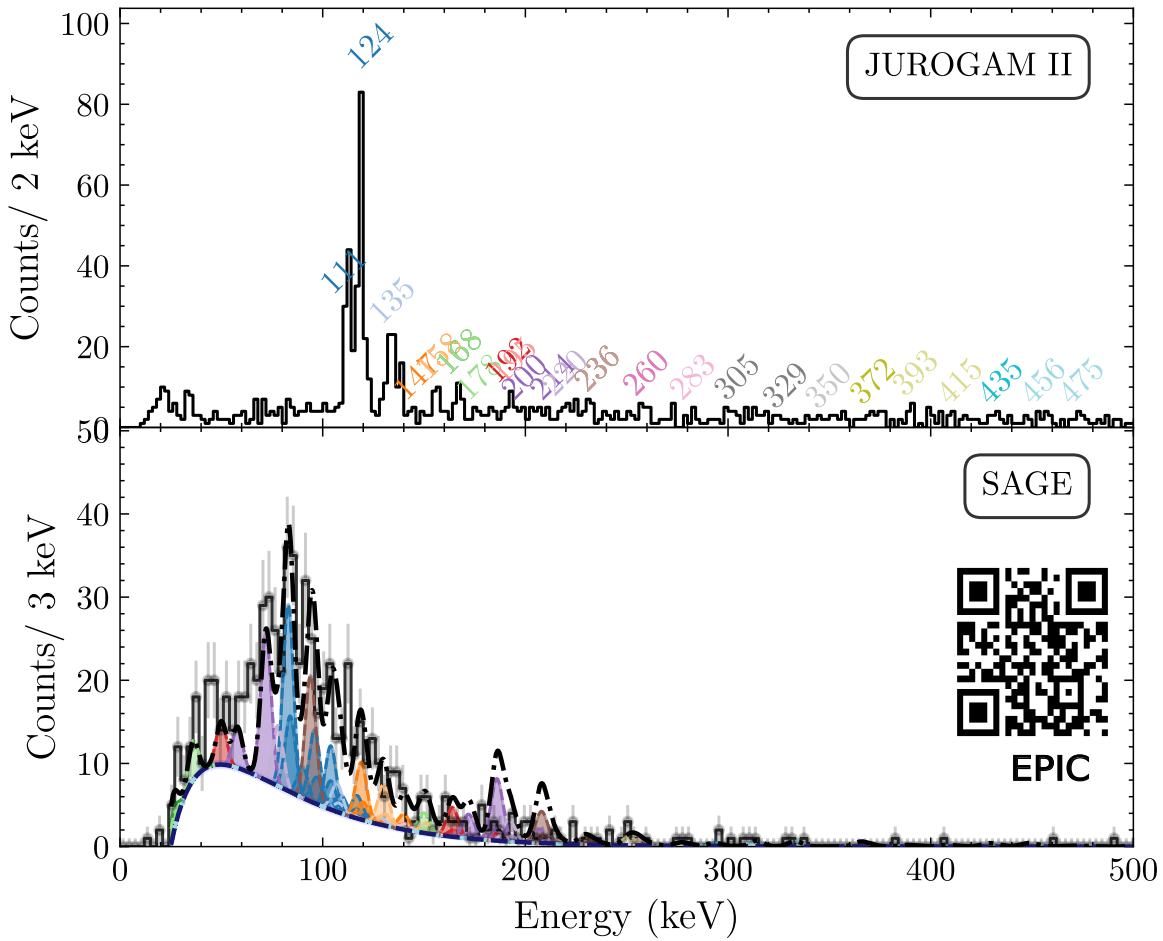
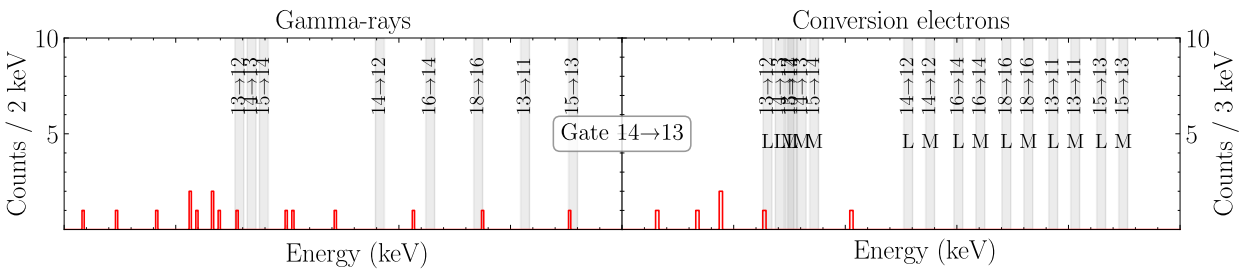
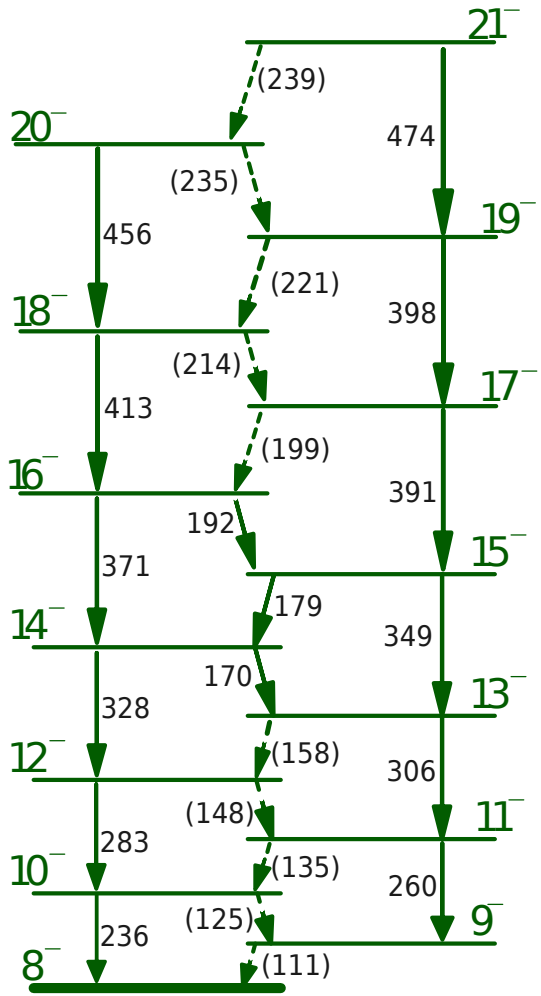
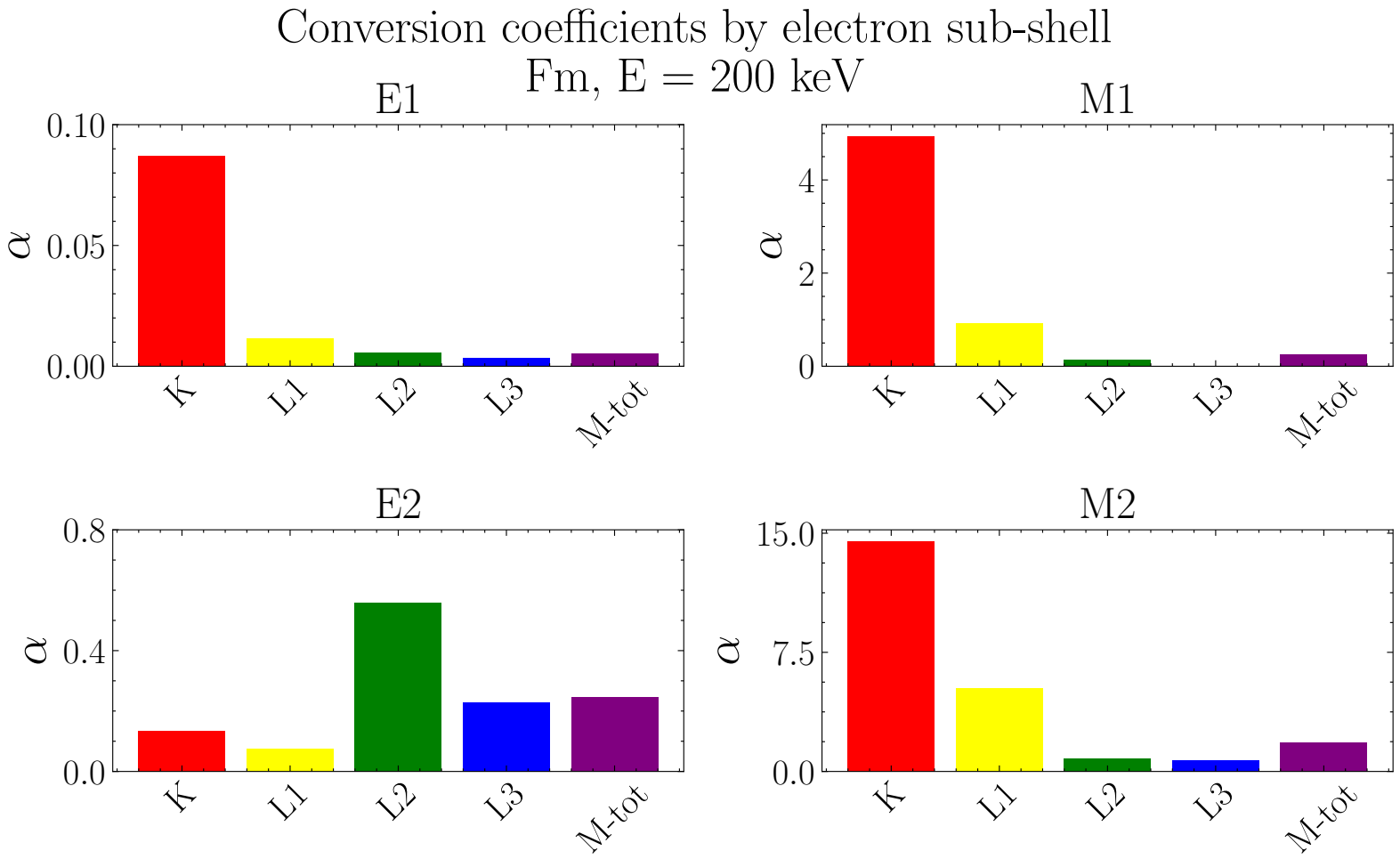




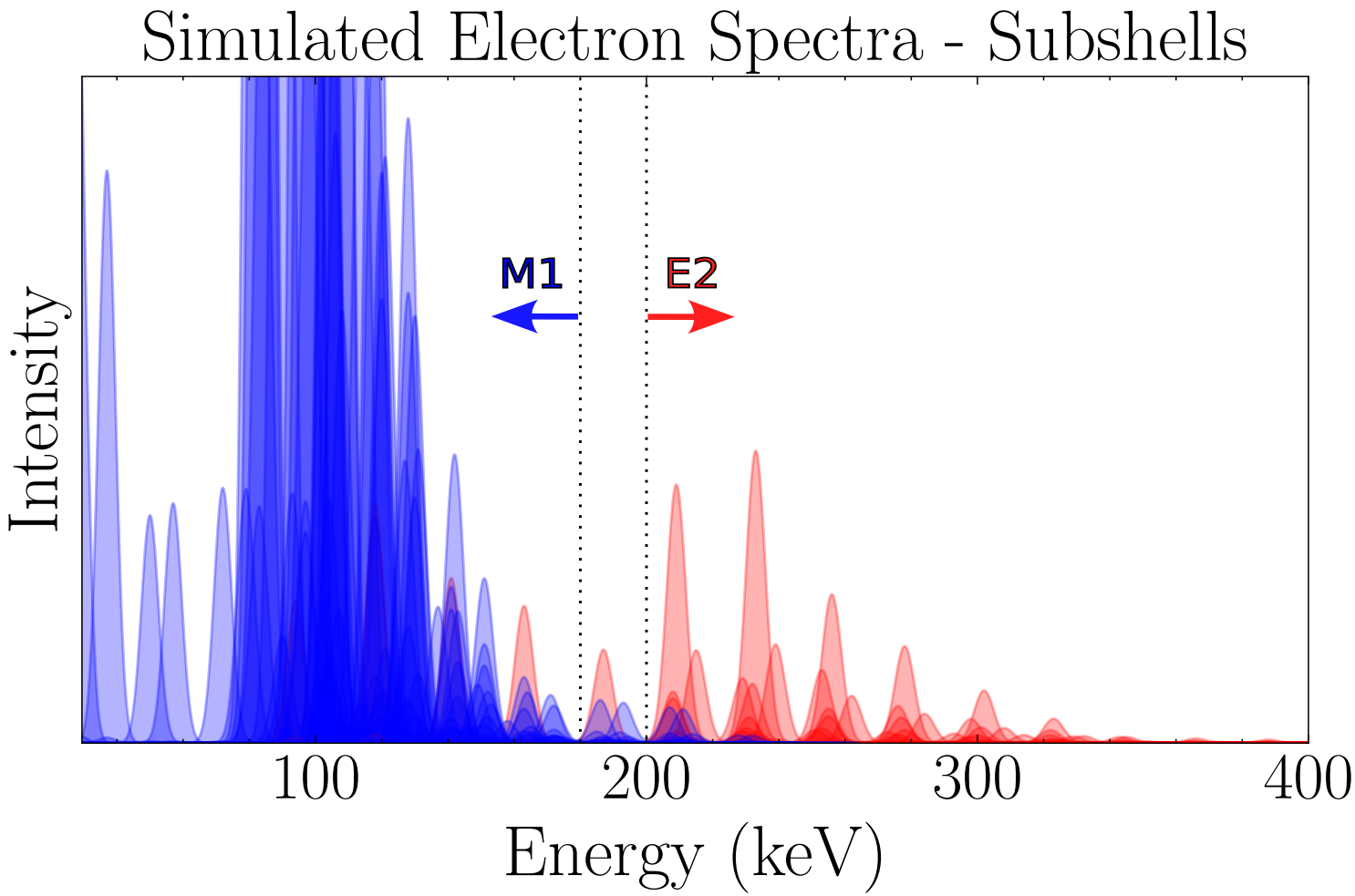


Adapted from: P. T. Greenlees, et al. *Phys. Rev. C*, **78**:021303(R), 2008

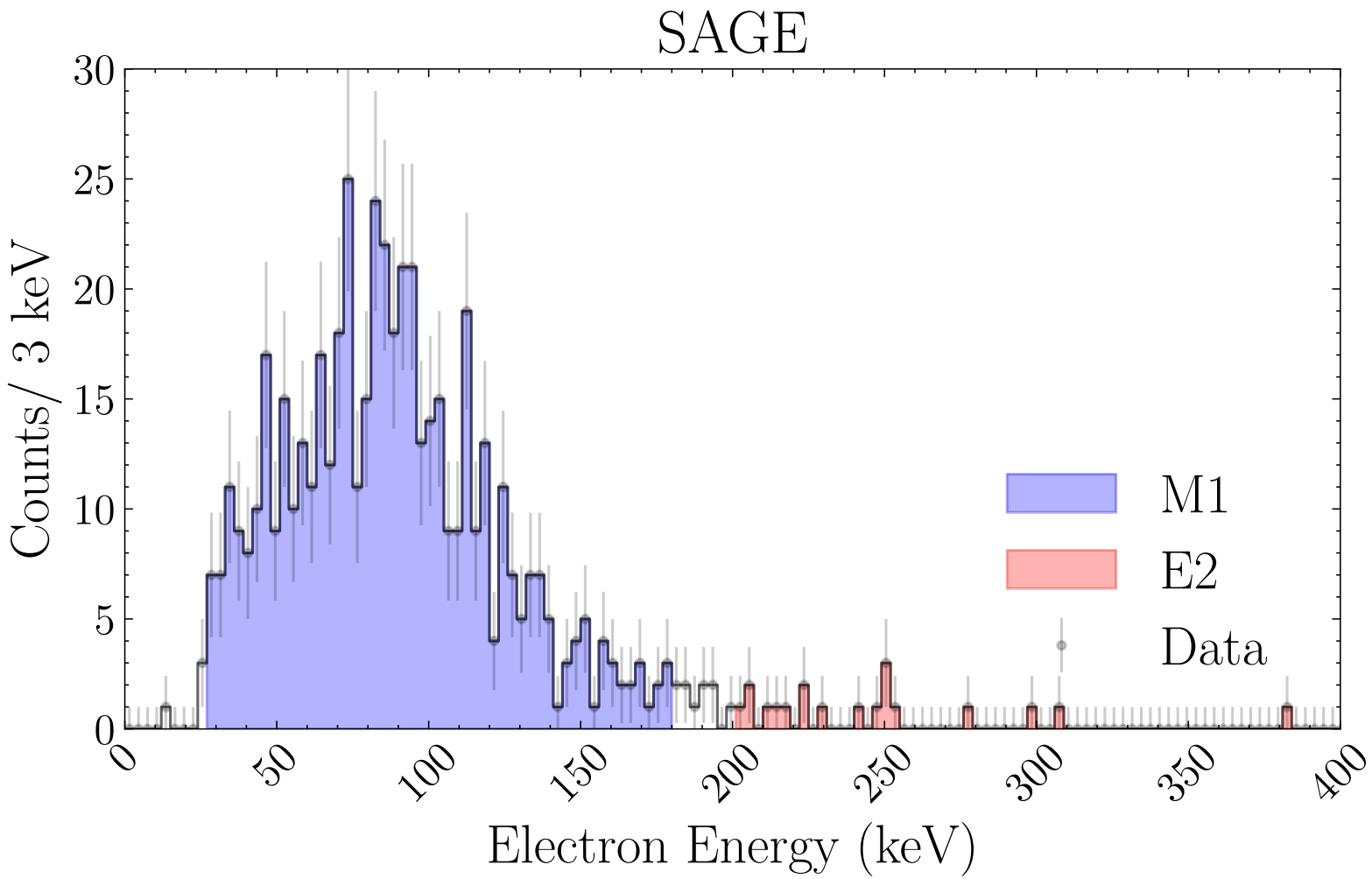
Internal conversion – transition multipolarity



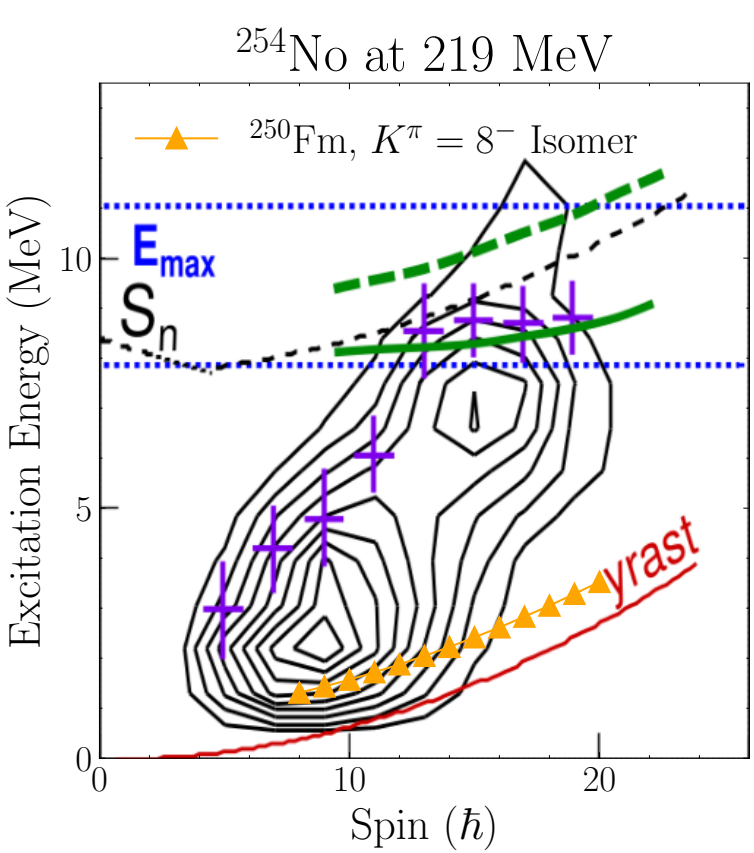
Separation of E2 and M1 electrons

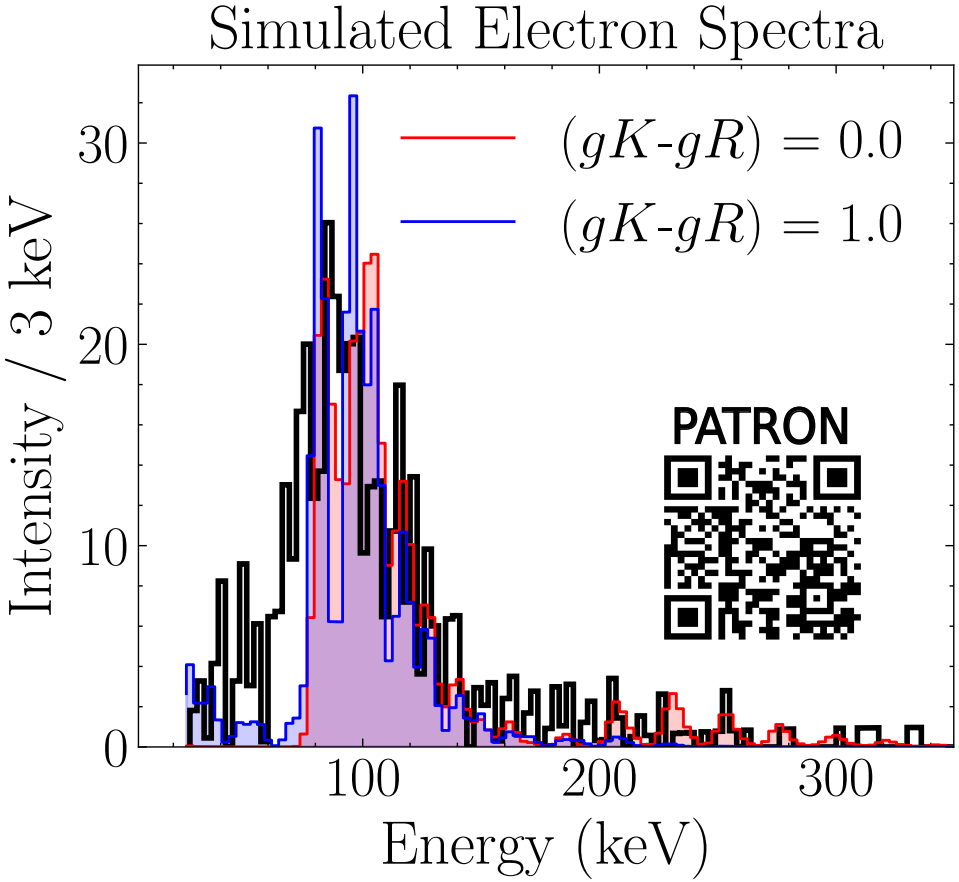


Separation of E2 and M1 electrons



Simulating the isomer

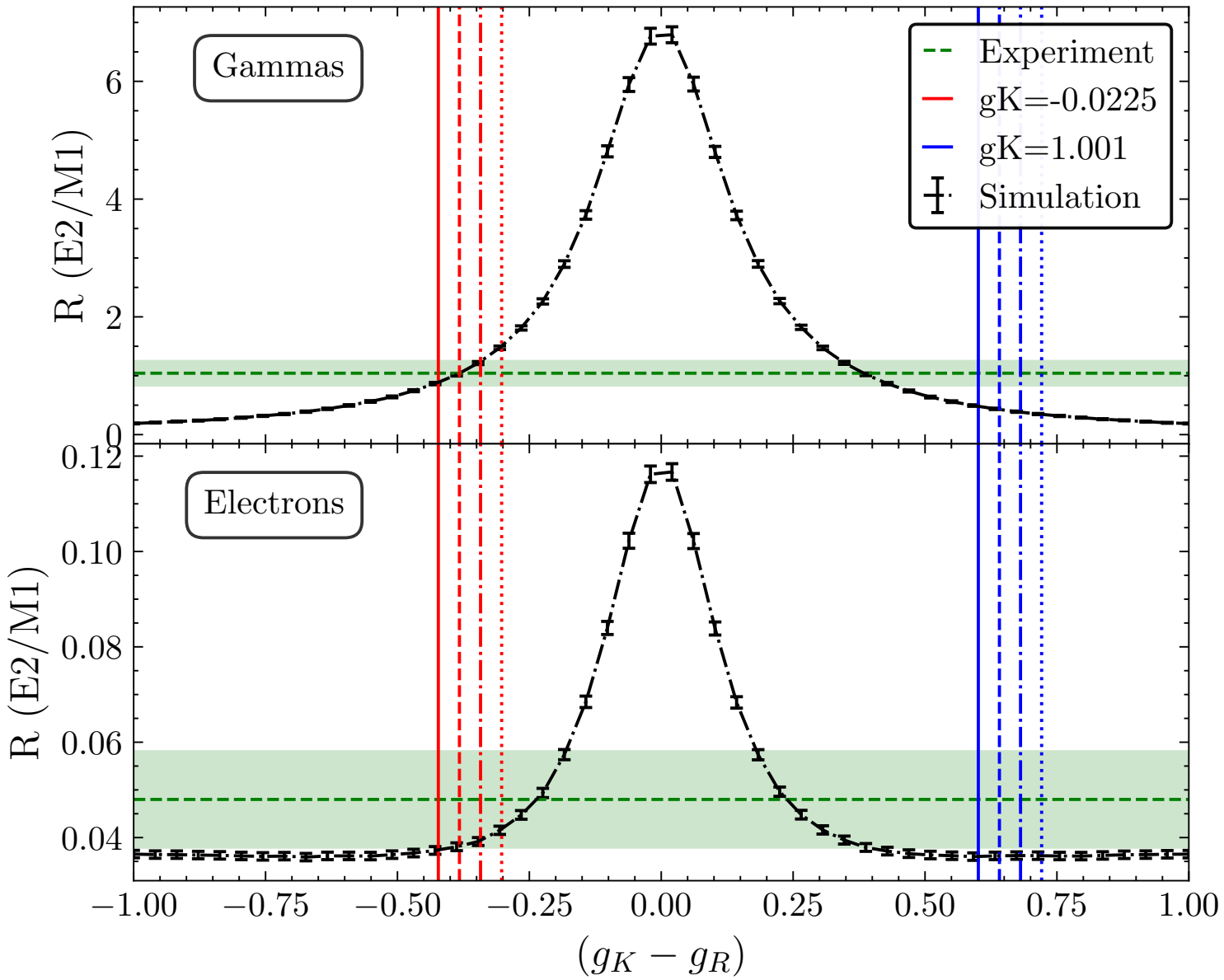




APPROACH: Simulate e^{-} spectrum with different $(g_k - g_R)$ values.

$\Rightarrow$ Compare $\Sigma(E2)/\Sigma(M1)$ of simulation to experiment.

R-Metric – sim vs exp vs theory



Summary

- K-Isomers are an avenue for SP orbitals relating to next spherical shell gaps
- ^{250}Fm $K^{\pi}=8^{-}$ isomer studied through e^{-}-γ spectroscopy for the first time.
- Alternative method for determining gK for low statistics data, applied to ^{250}Fm. 2ν state favoured, in agreement with previous studies
- N=152 and Z=100 Deformed shell gaps survive this round

Collaboration

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T.L. Khoo

Thank You!

Questions?

Find my work on GitHub:

github.com/JChads4

Thank you for your time!