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Infotekst

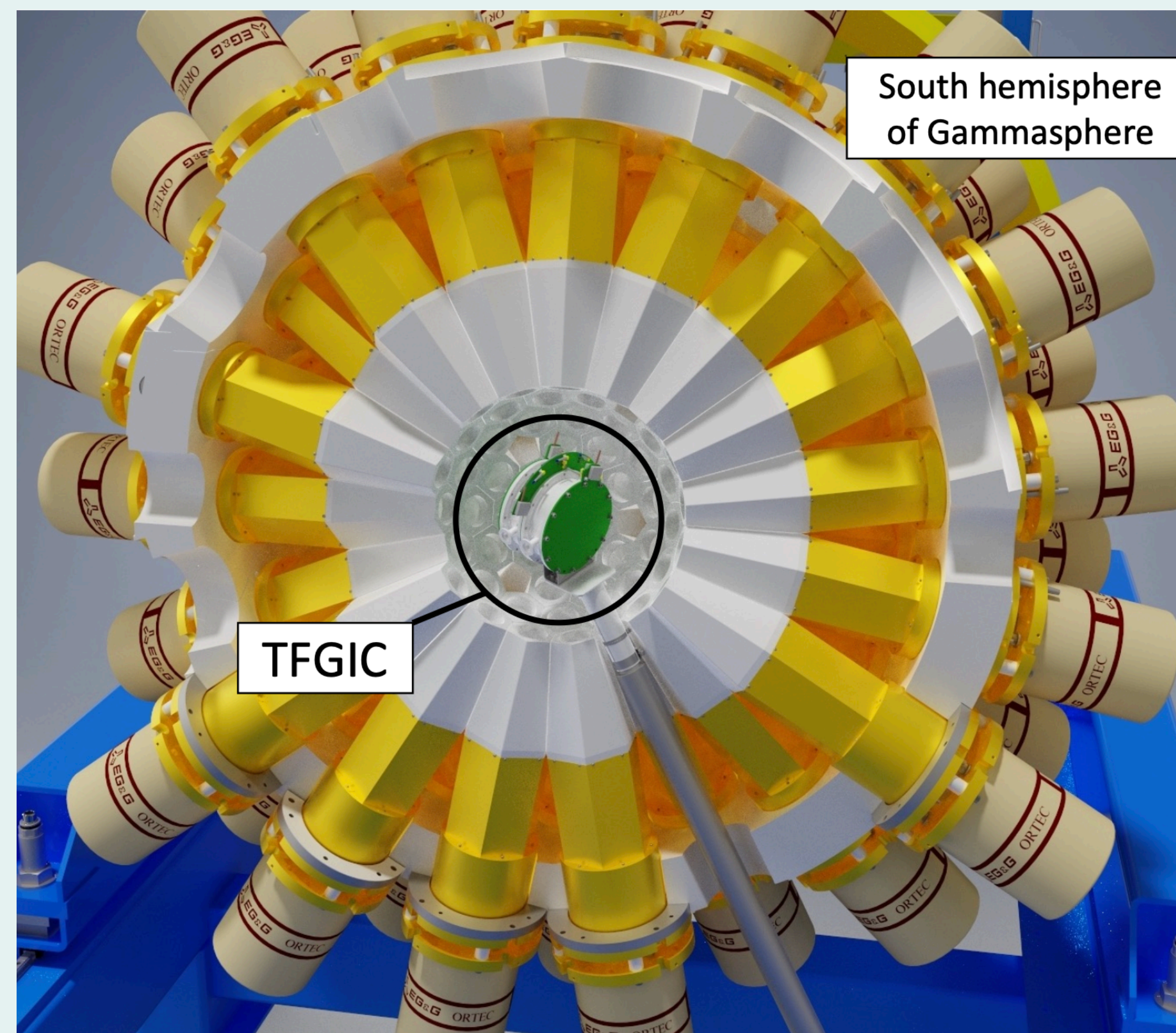


Angular distribution measurements of fission fragment γ rays

Henrik Haug

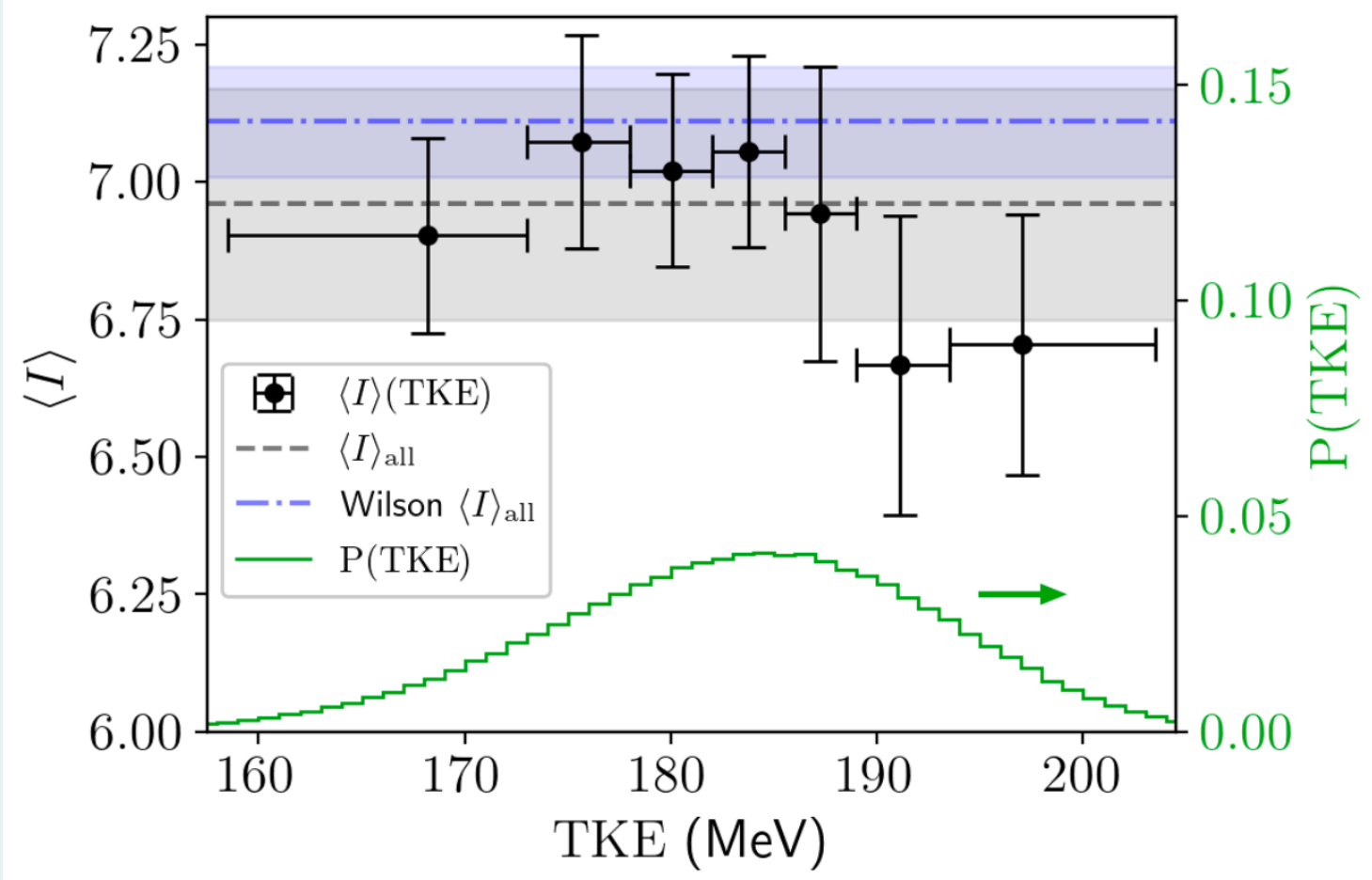
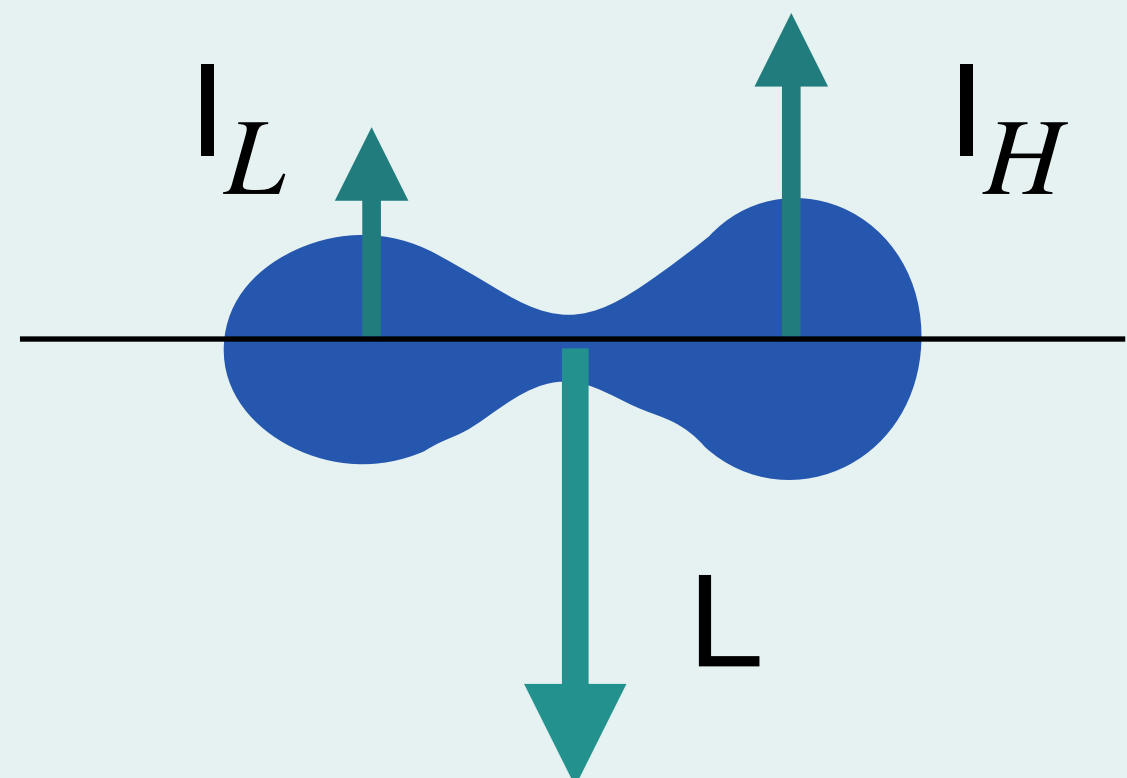
PhD student at University of Oslo

10 March 2026

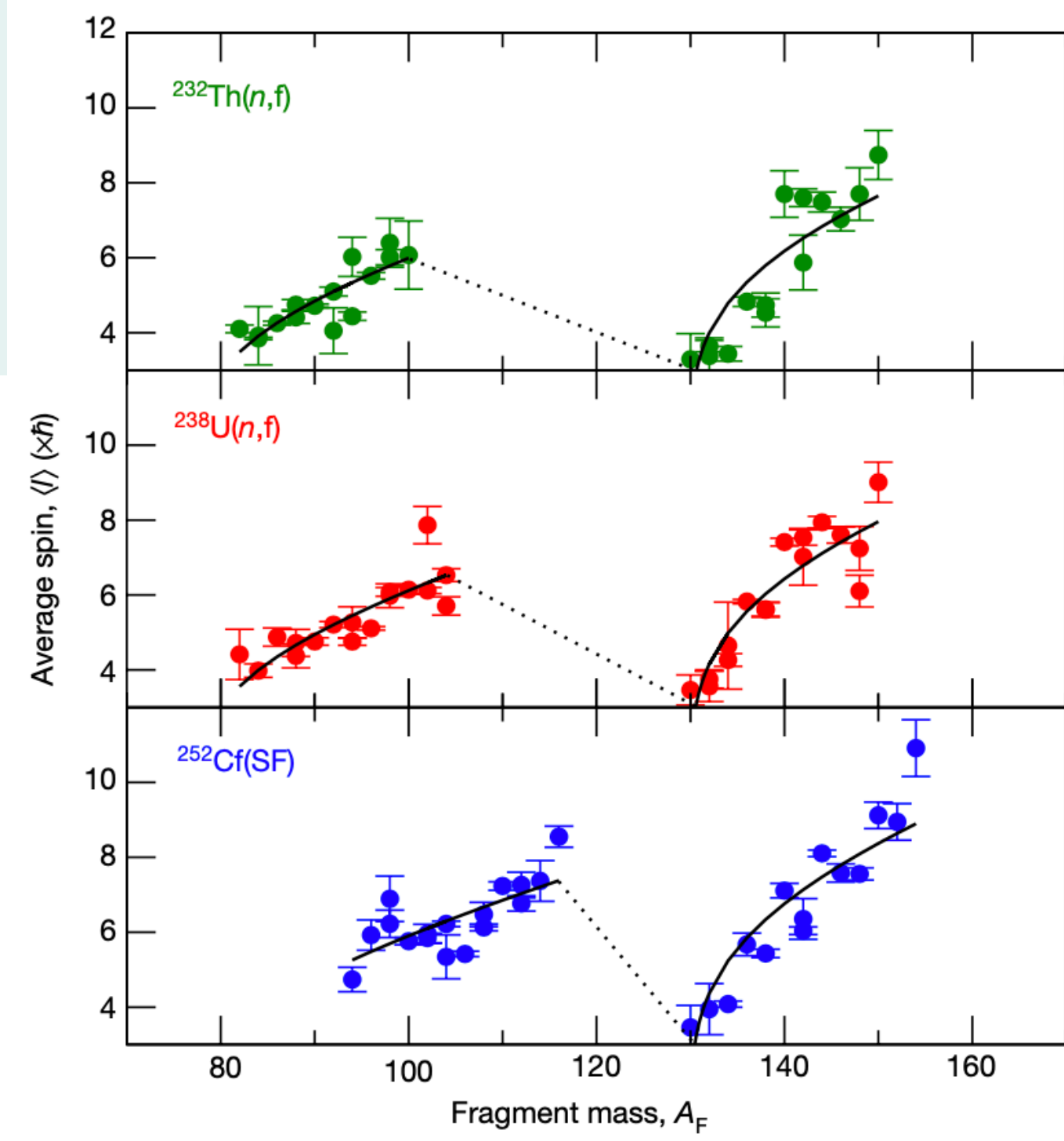


Fission fragment angular momentum

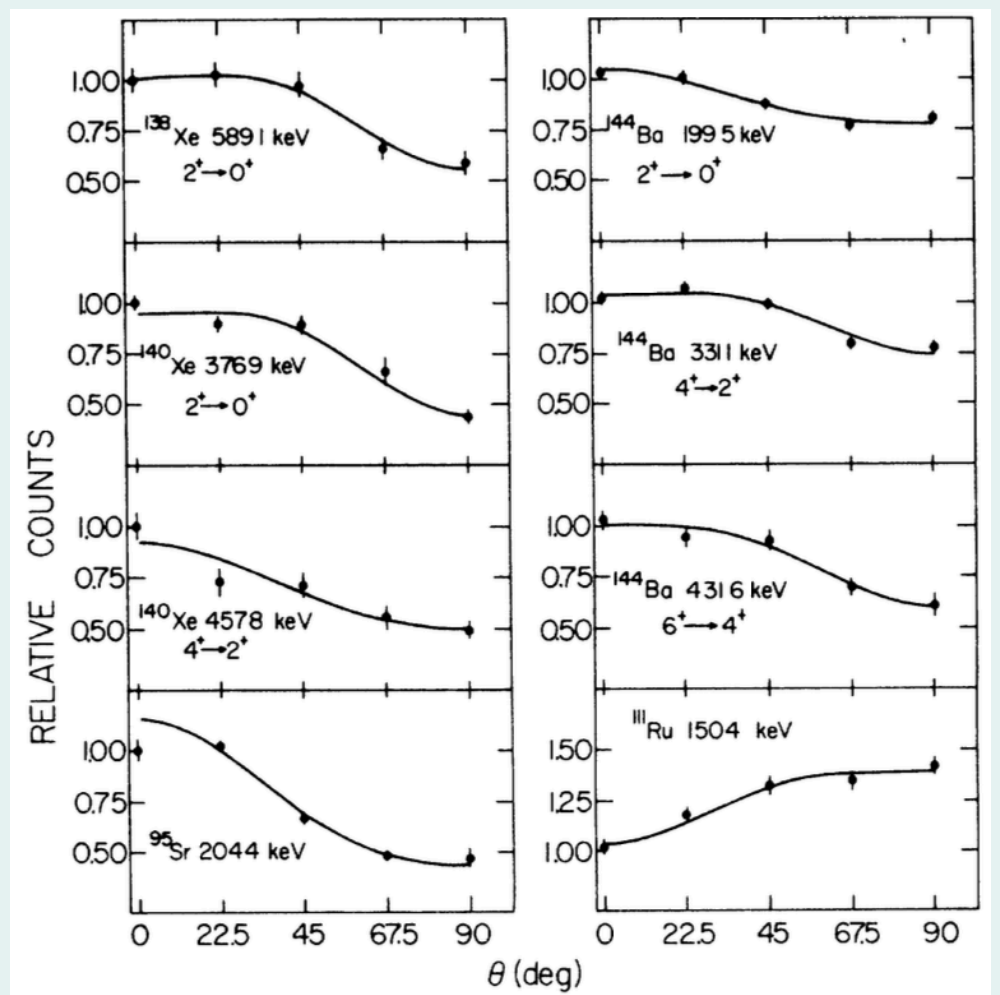
- Fragments created on average with about $6-7 \hbar$
- Saw-tooth pattern as a function of mass
- Dependent on TKE
- Uncorrelated spin magnitudes
- Perpendicular to the fission axis



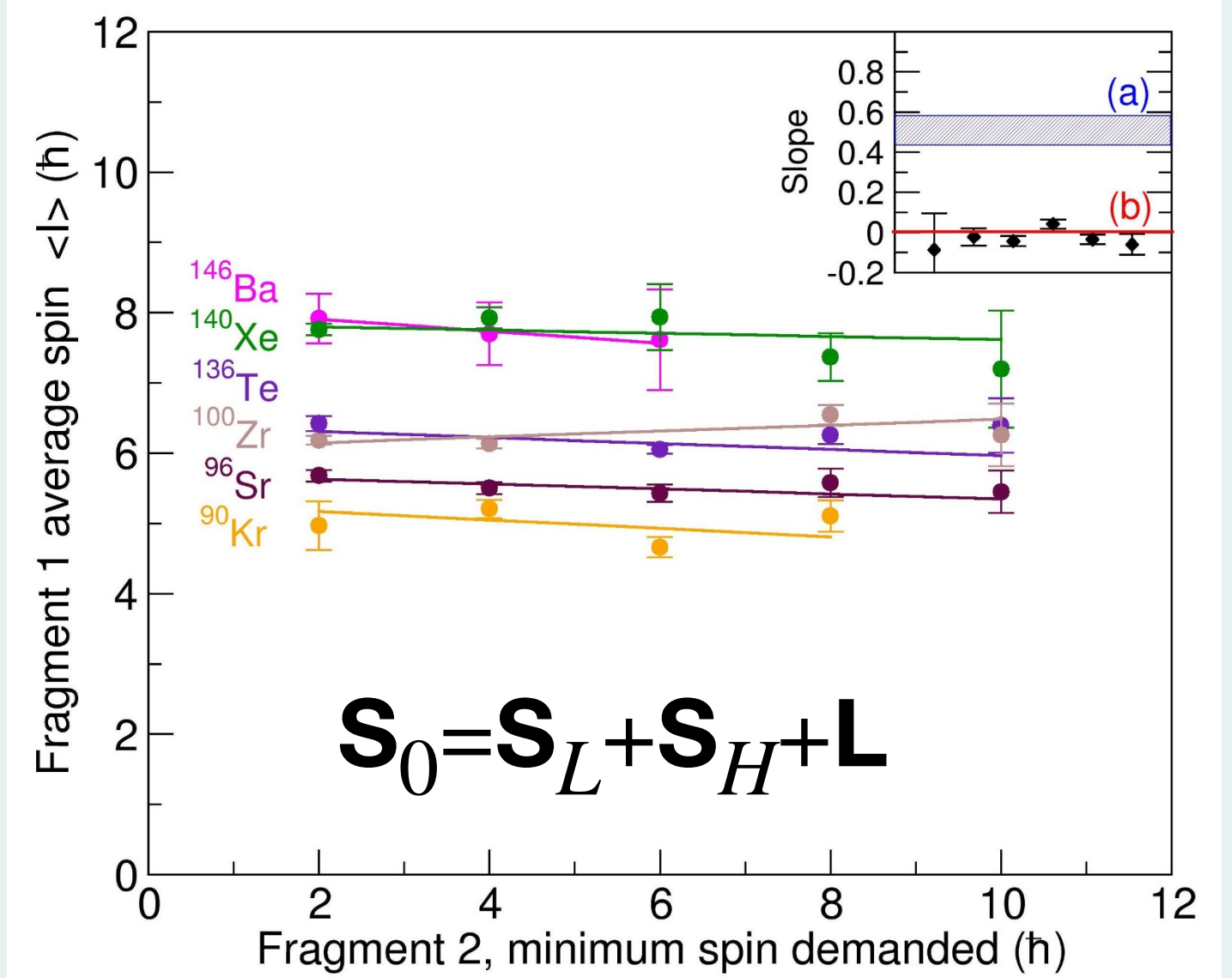
P. Ghia et al. Measurement of spin versus total kinetic energy of ^{144}Ba produced in spontaneous fission of ^{252}Cf . *Phys. Rev. C* **111**, 014605 (2025)



Wilson, J.N., Thisse, D., Lebois, M. et al. Angular momentum generation in nuclear fission. *Nature* **590**, 566–570 (2021). <https://doi.org/10.1038/s41586-021-03304-w>



A. Wolf and E. Cheifetz, *Phys. Rev. C* **13** 5 1952 (1976)



Fission fragment angular distributions

- Why angular distribution?
 - Angular distribution can reveal the orientation of the fragment spins relative to the fission axis
 - Reveal information about mechanisms involved in fission
- Perpendicular to the fission axis
 - Experiment from 1976 big error bars

A. Wolf and E. Cheifetz, Phys. Rev. C 13 5 1952 (1976)

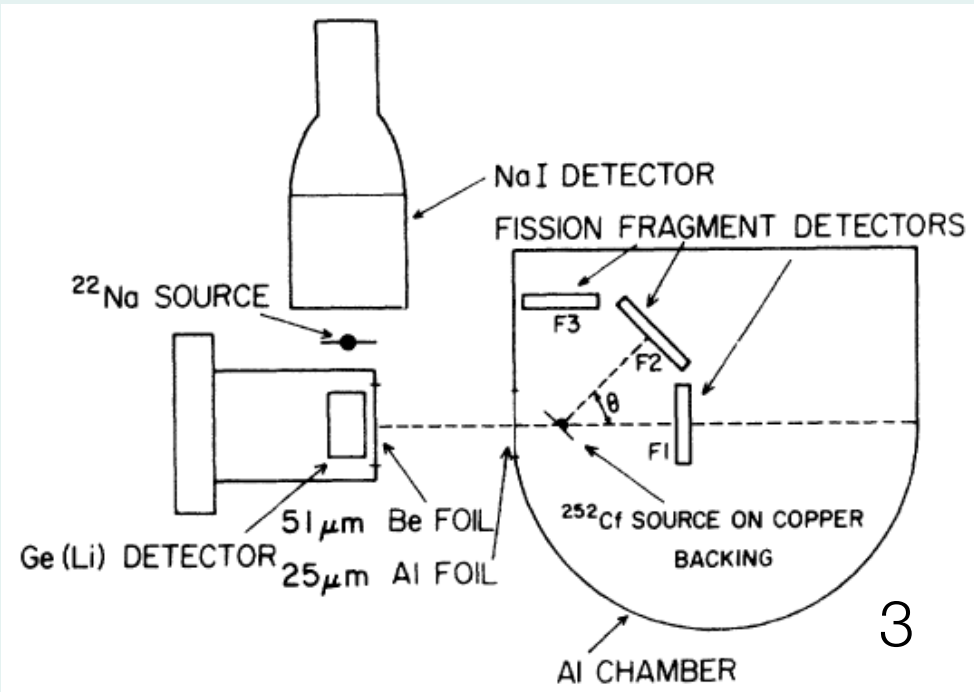
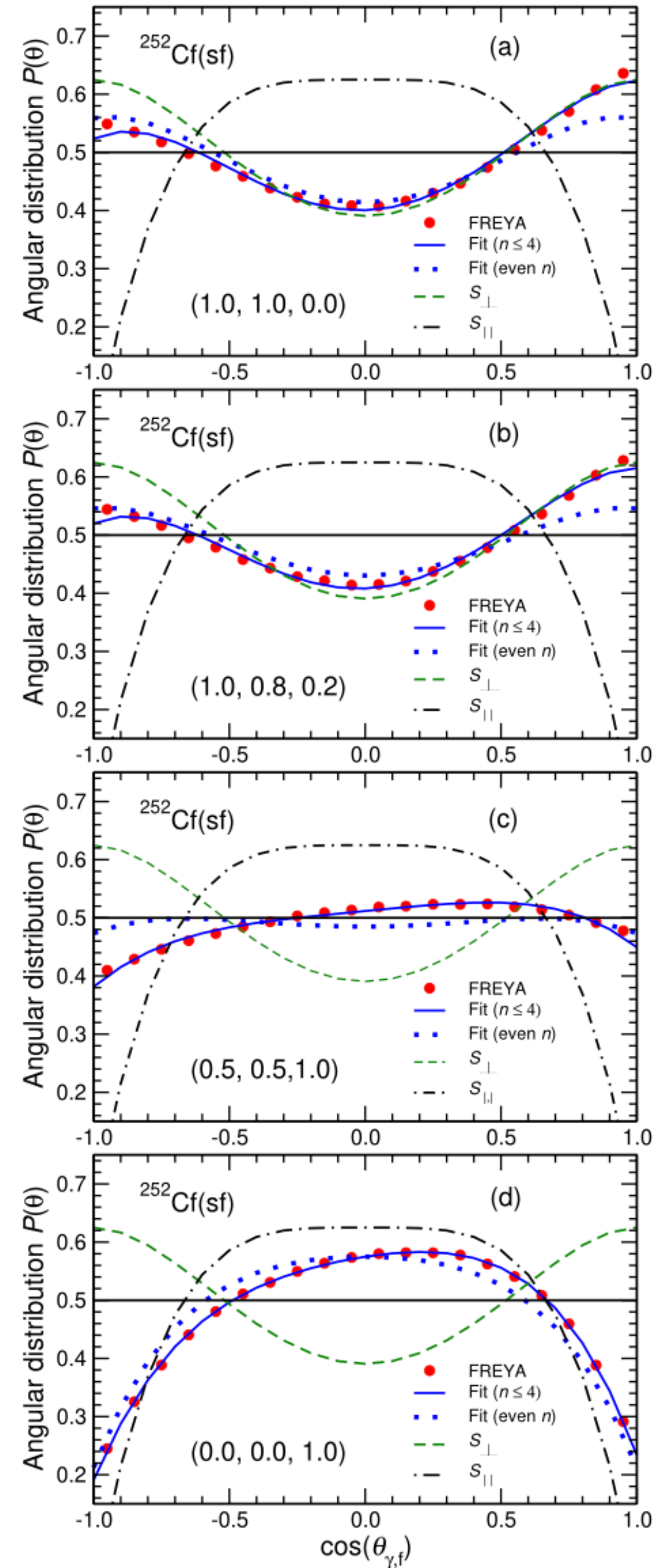
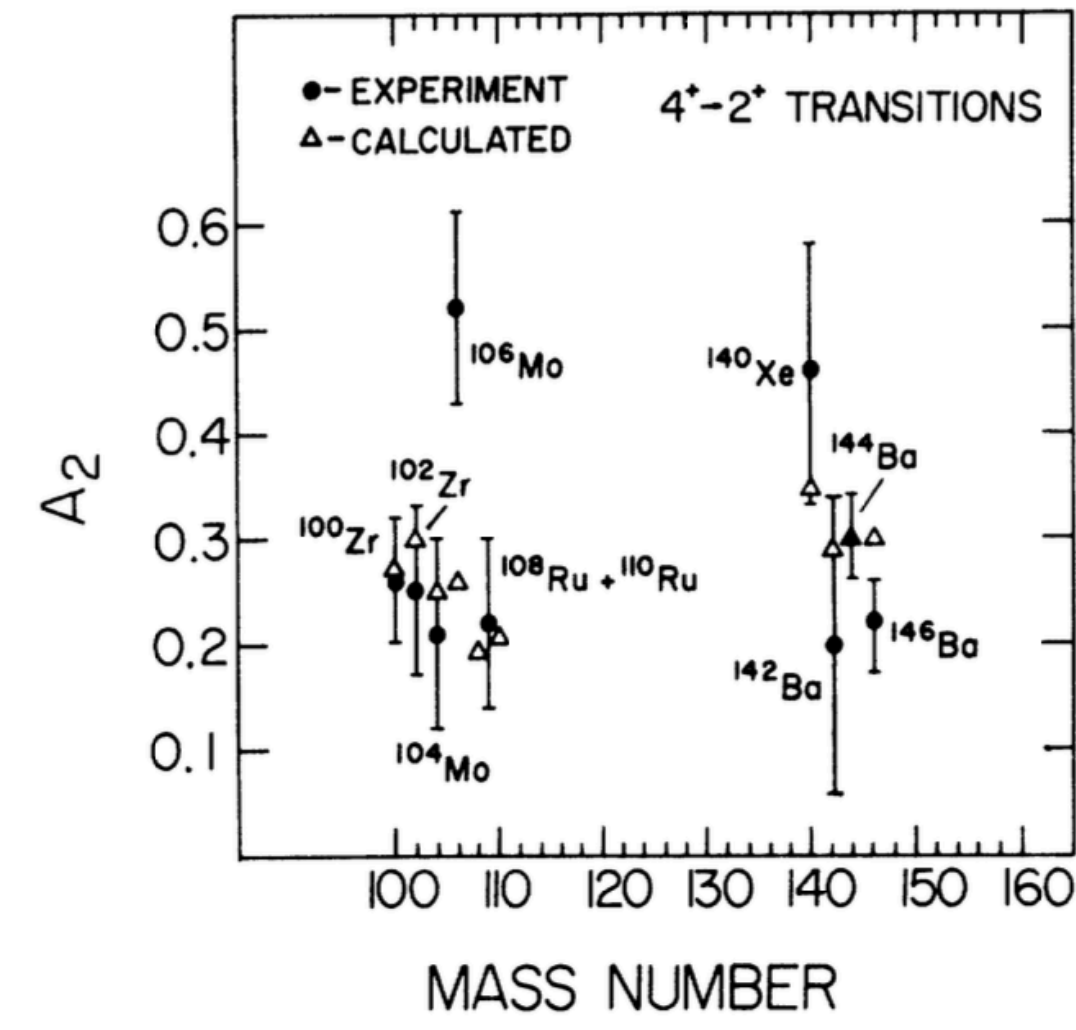
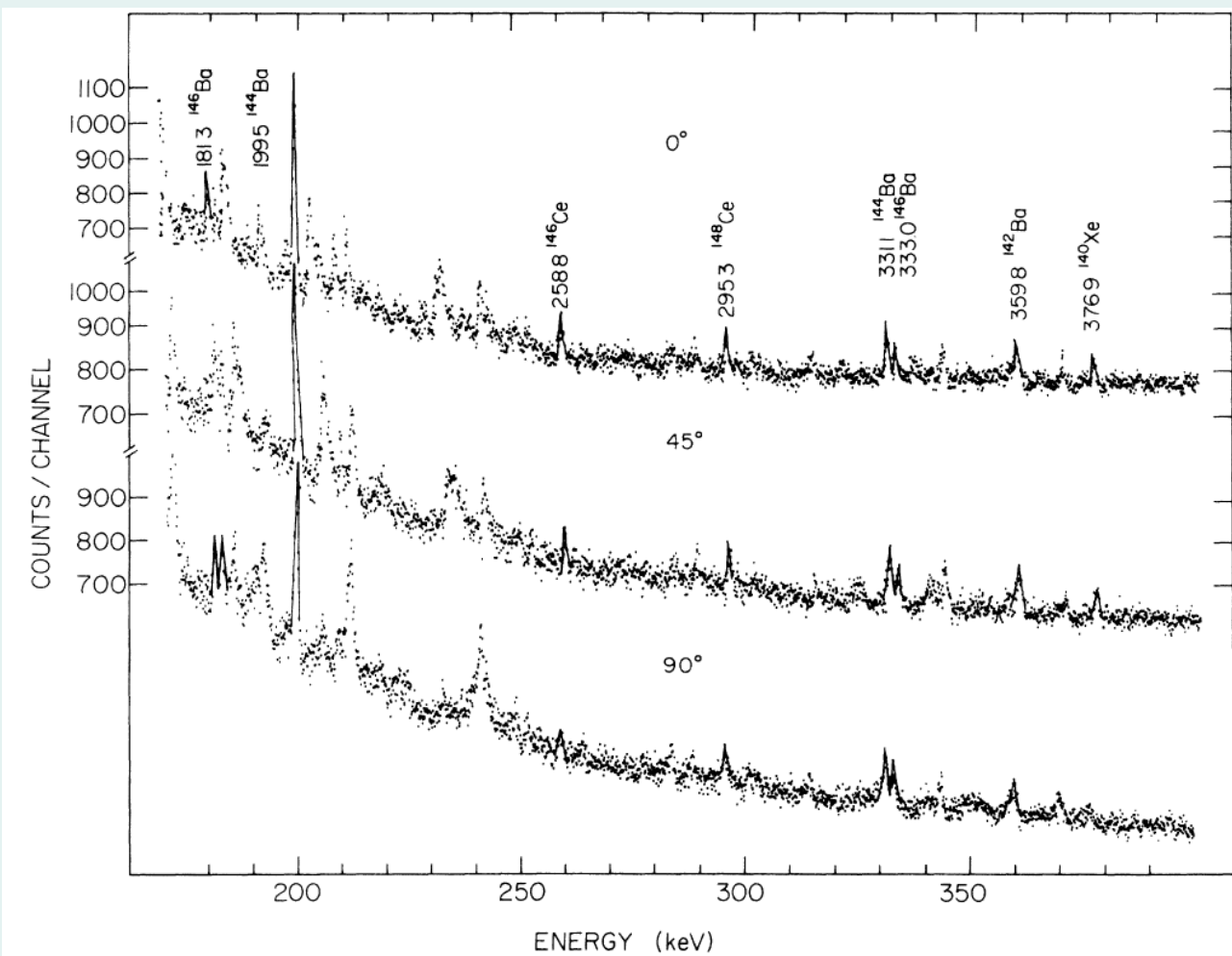
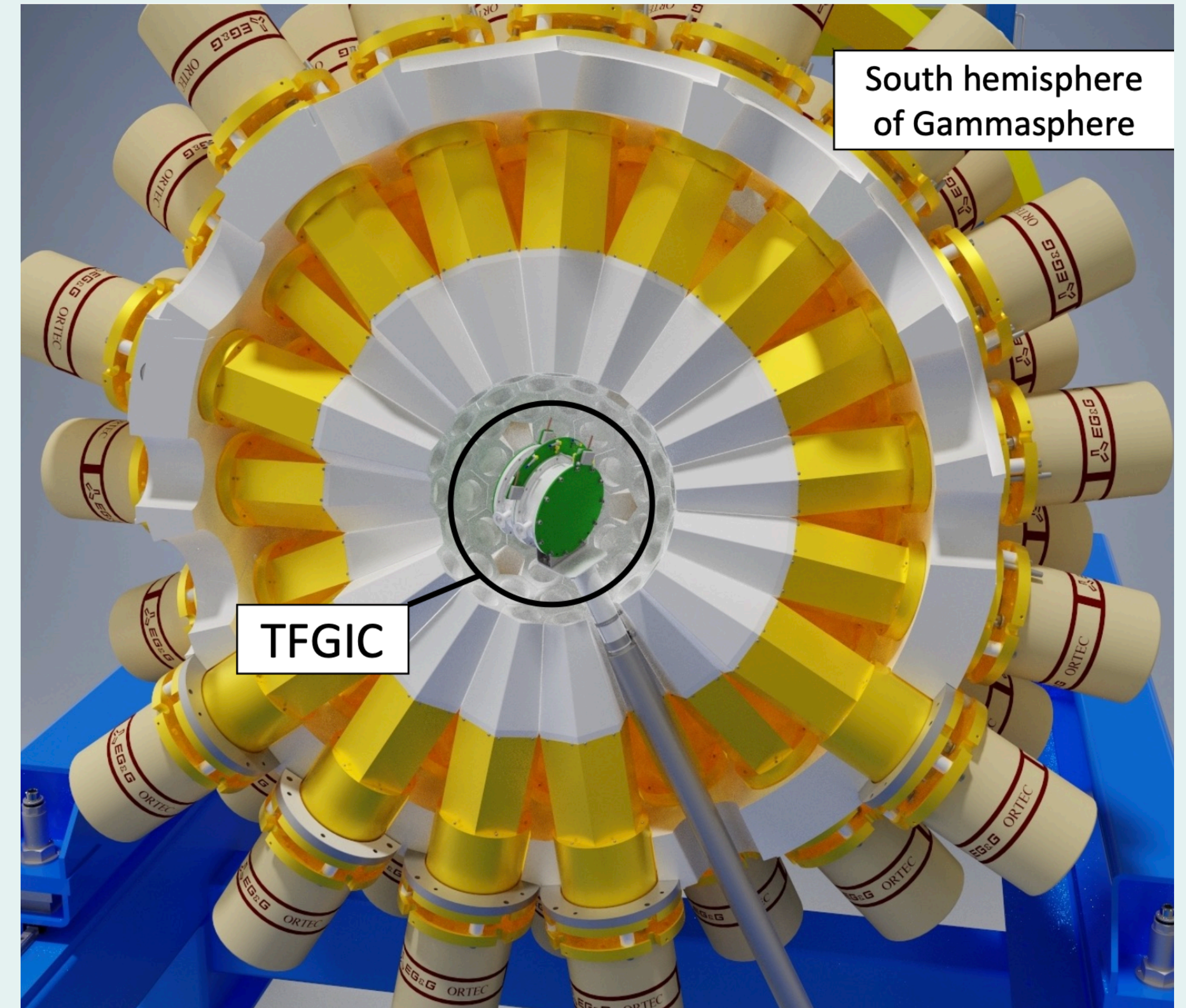


FIG. 5. Angular distribution coefficients A_2 of $4^+ \rightarrow 2^+$ transitions as a function of the mass number of the fragment. J. Randrup et al., Phys. Rev. C 106, 014609 (2022)

Experiment

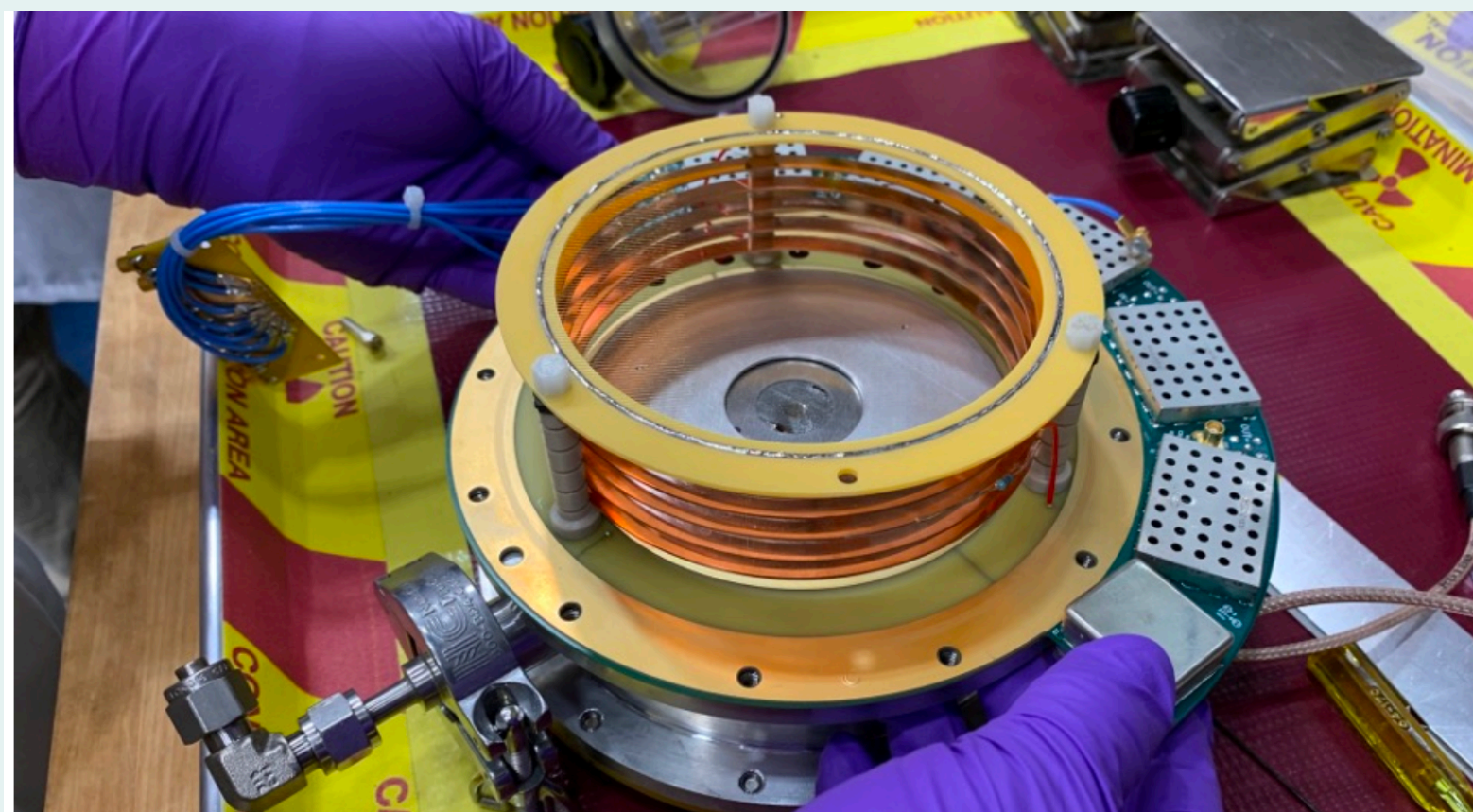
- Experiment was performed at Argonne NATIONAL LABORATORY
- Spontaneous fission of ^{252}Cf , with $2.5 \cdot 10^9$ fission events recorded
- Combining two detector systems
 - Twin Frisch-gridded ionization chamber (TFGIC)
 - Gammasphere Germanium detector array, used for γ -ray spectroscopy



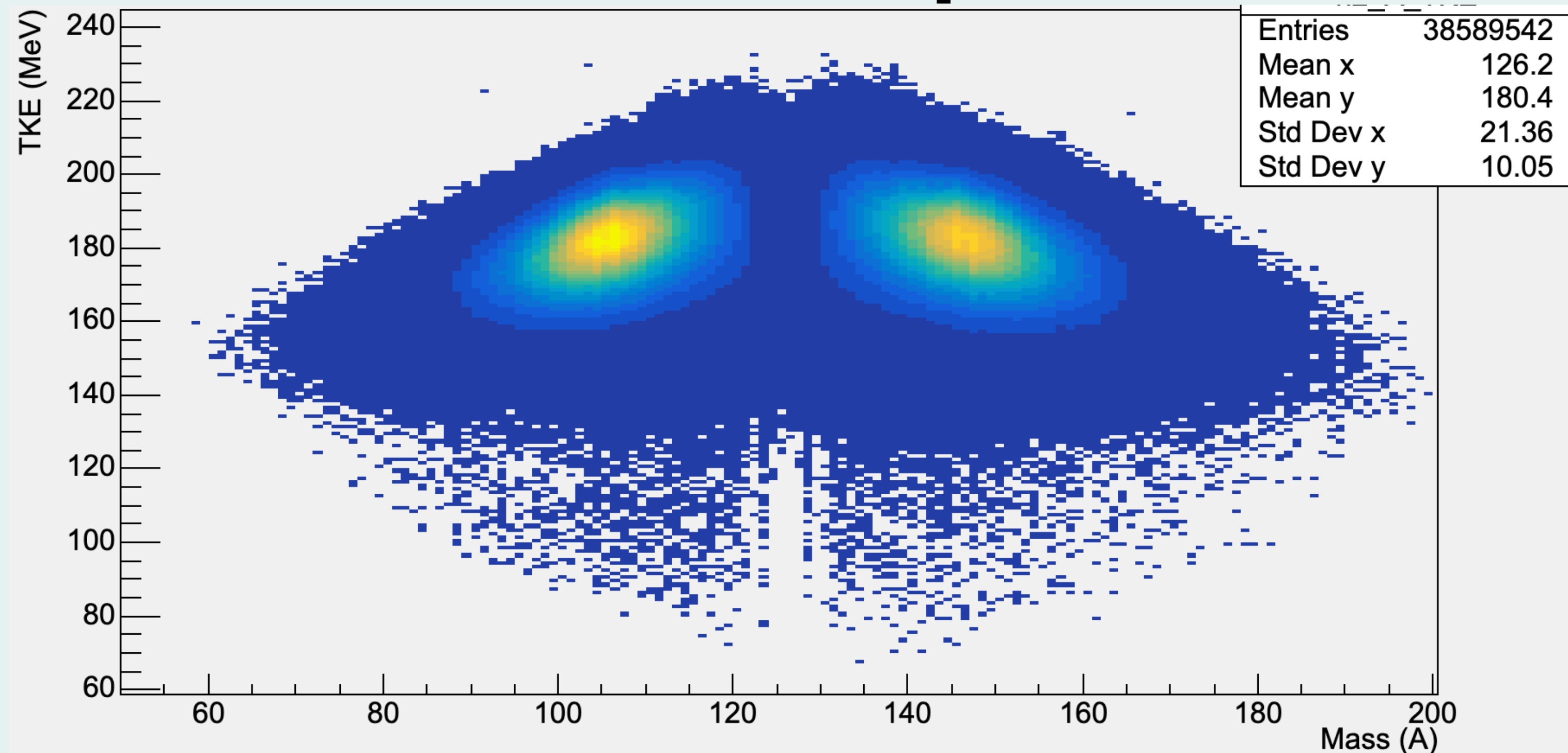
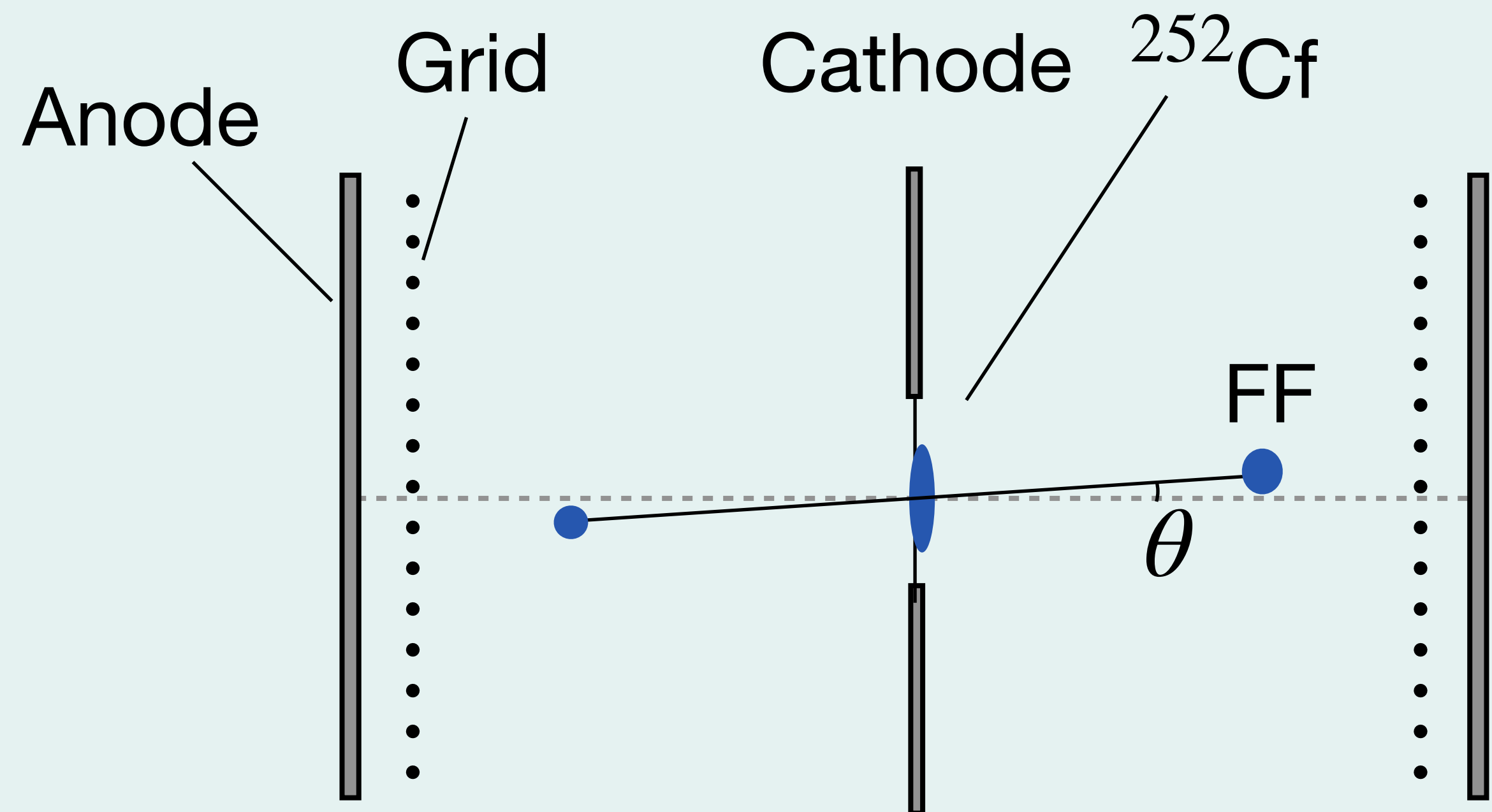
PhD thesis of Nathan P. Giha - University of Michigan

TFGIC

- Fission trigger
- Total kinetic energy
Resolution 3-4 MeV FWHM
- Mass
Resolution 5.9 amu FWHM.
- Fission axis
only θ , not ϕ . Only accept $\cos(\theta) > 0.95$



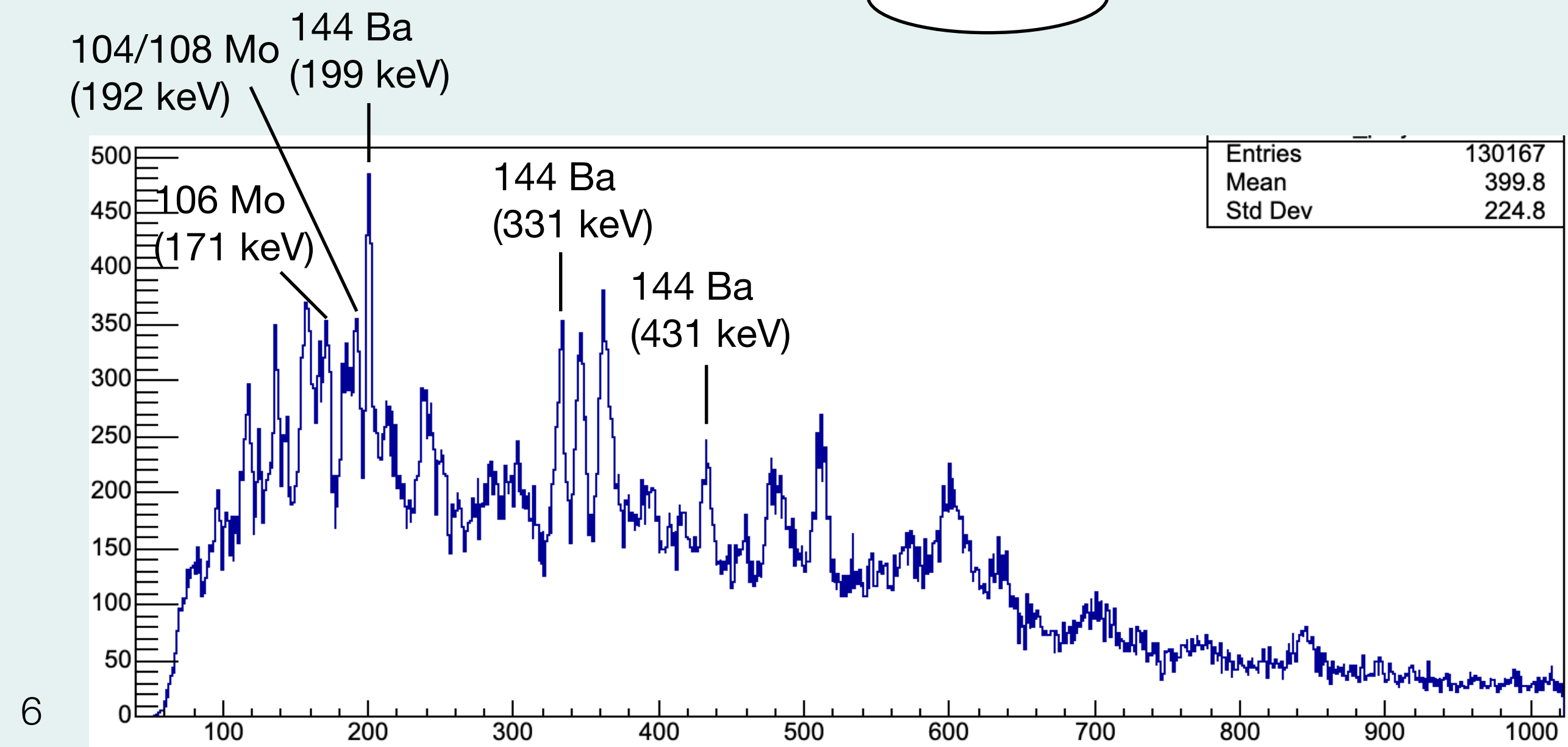
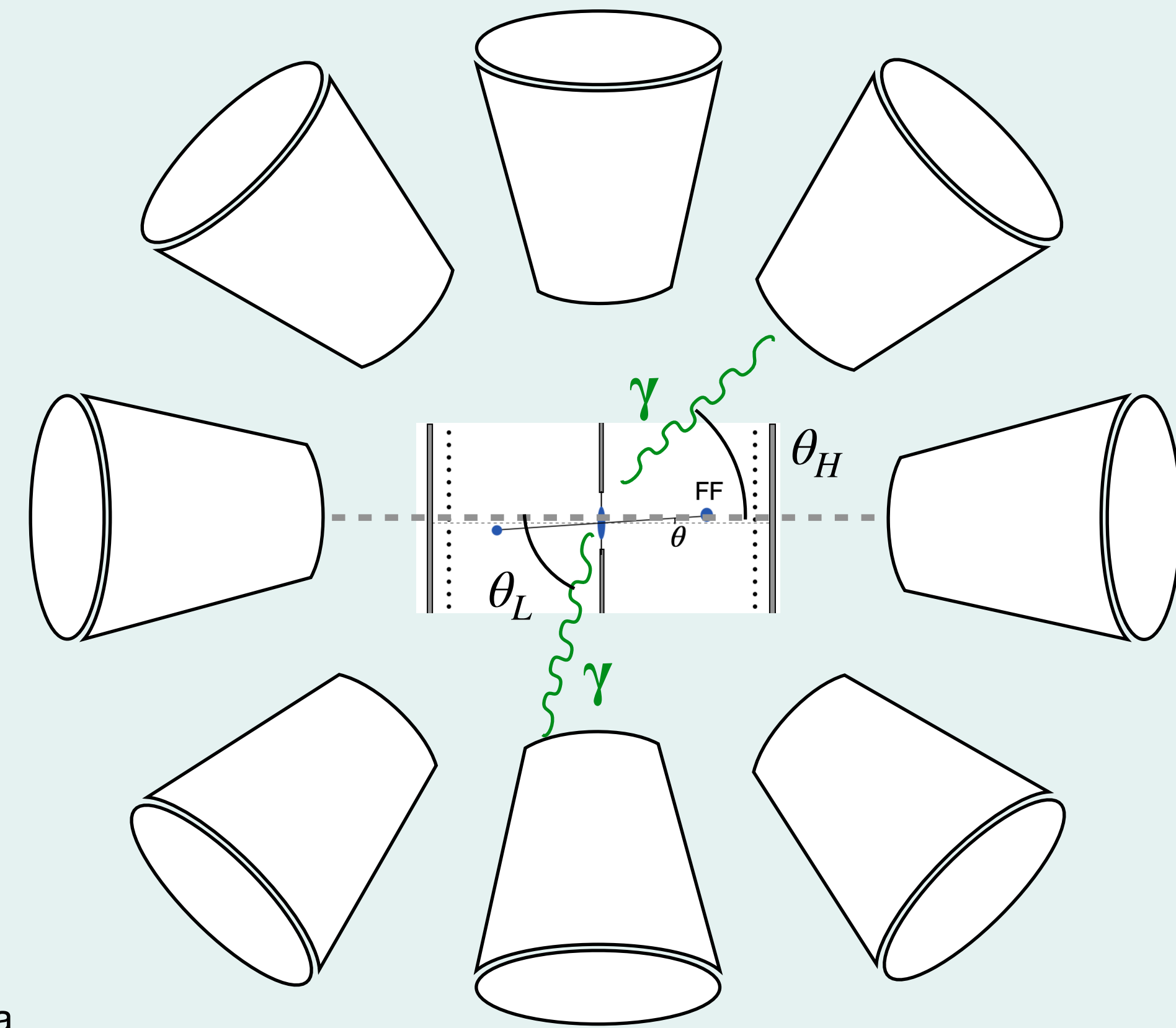
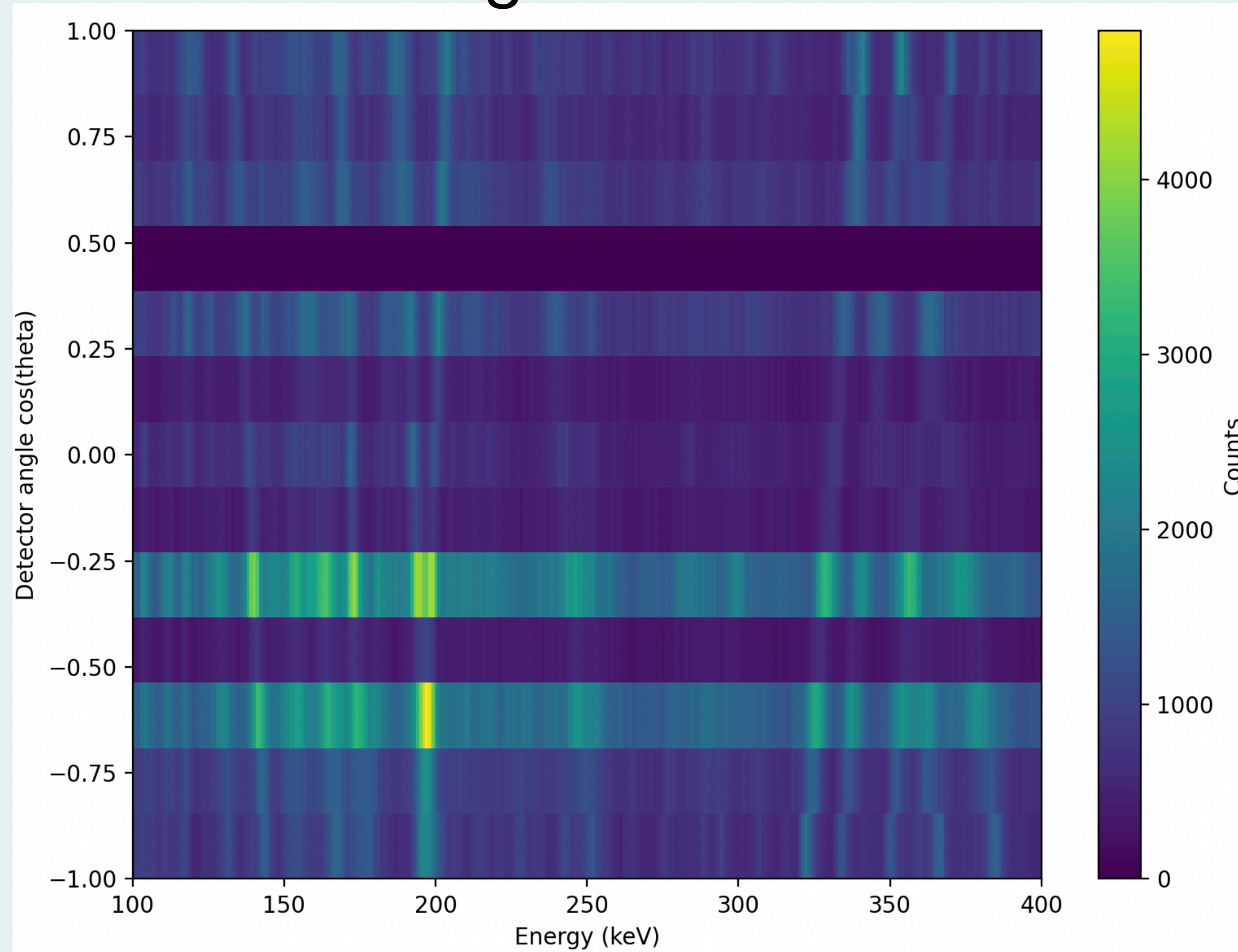
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Gammasphere

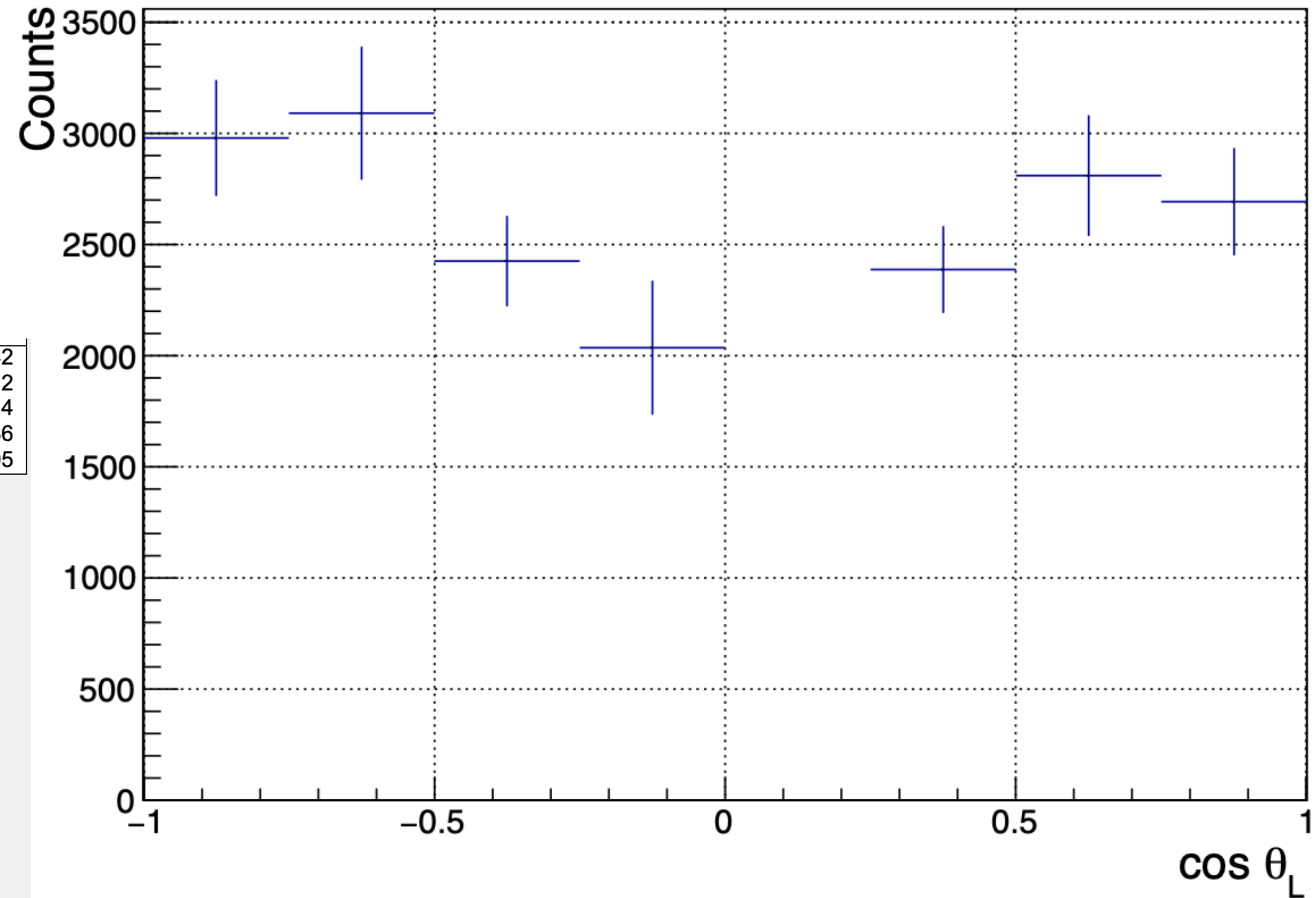
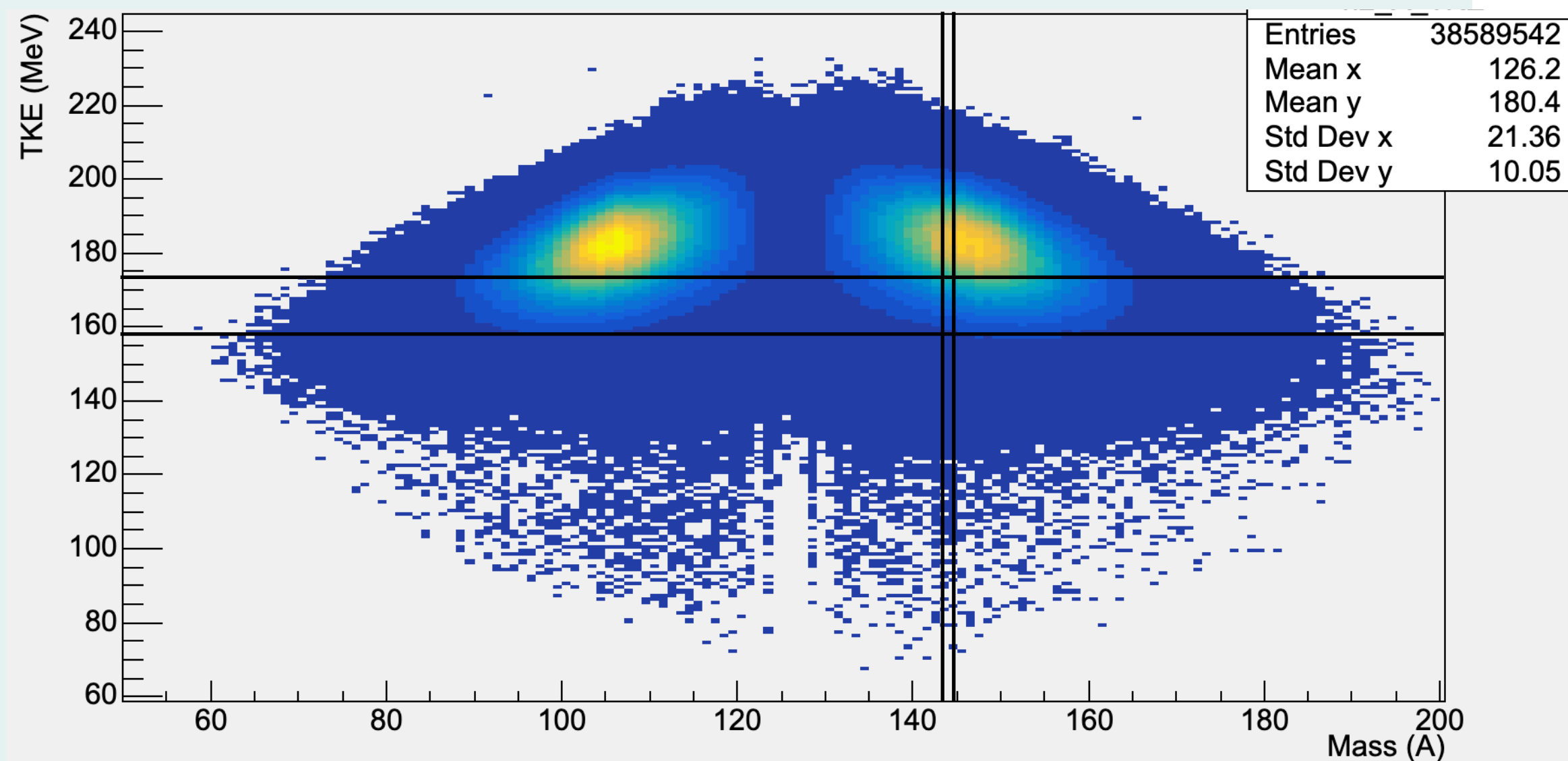
- 63 Compton-suppressed high-purity germanium detectors

Gating on mass 144



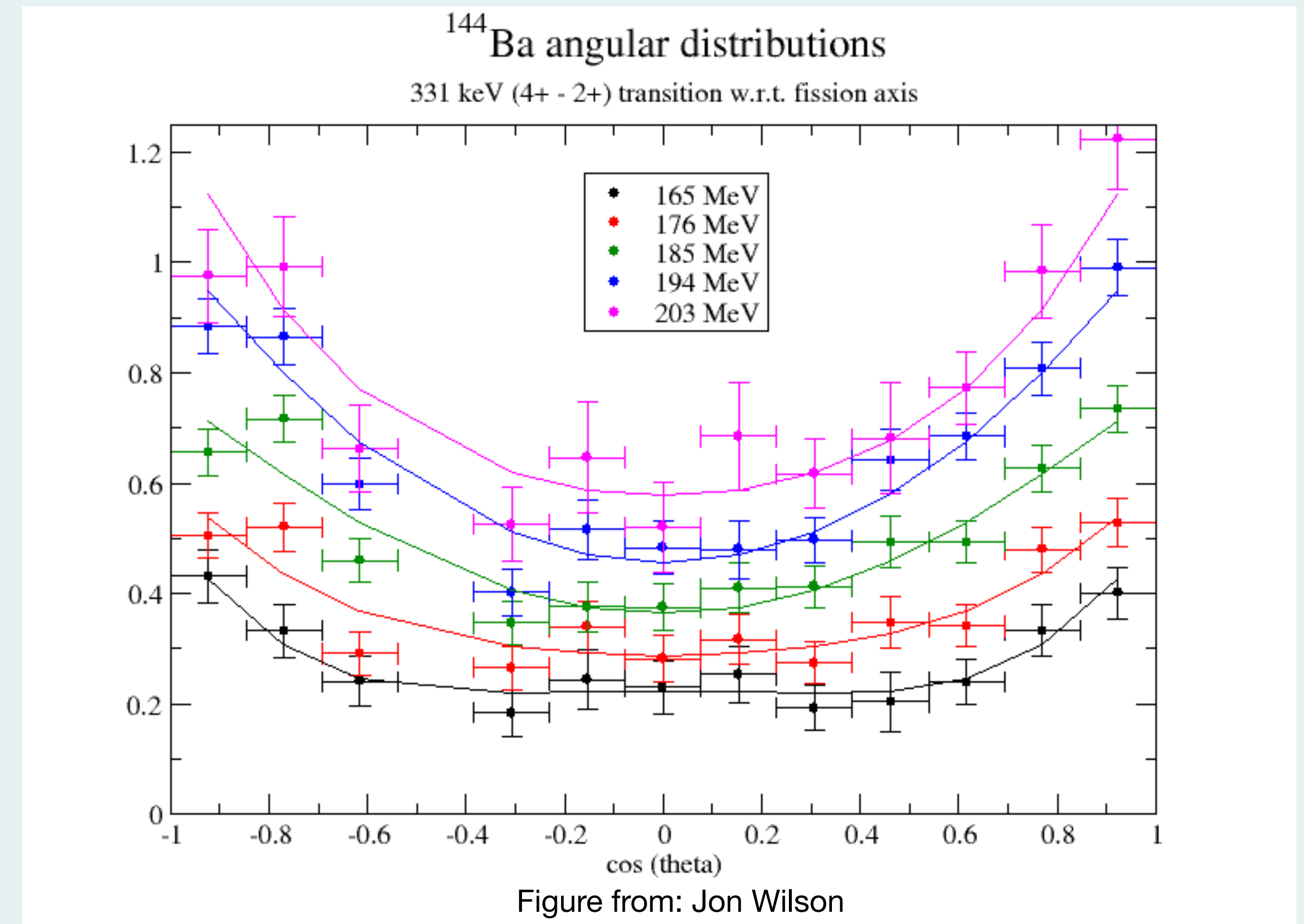
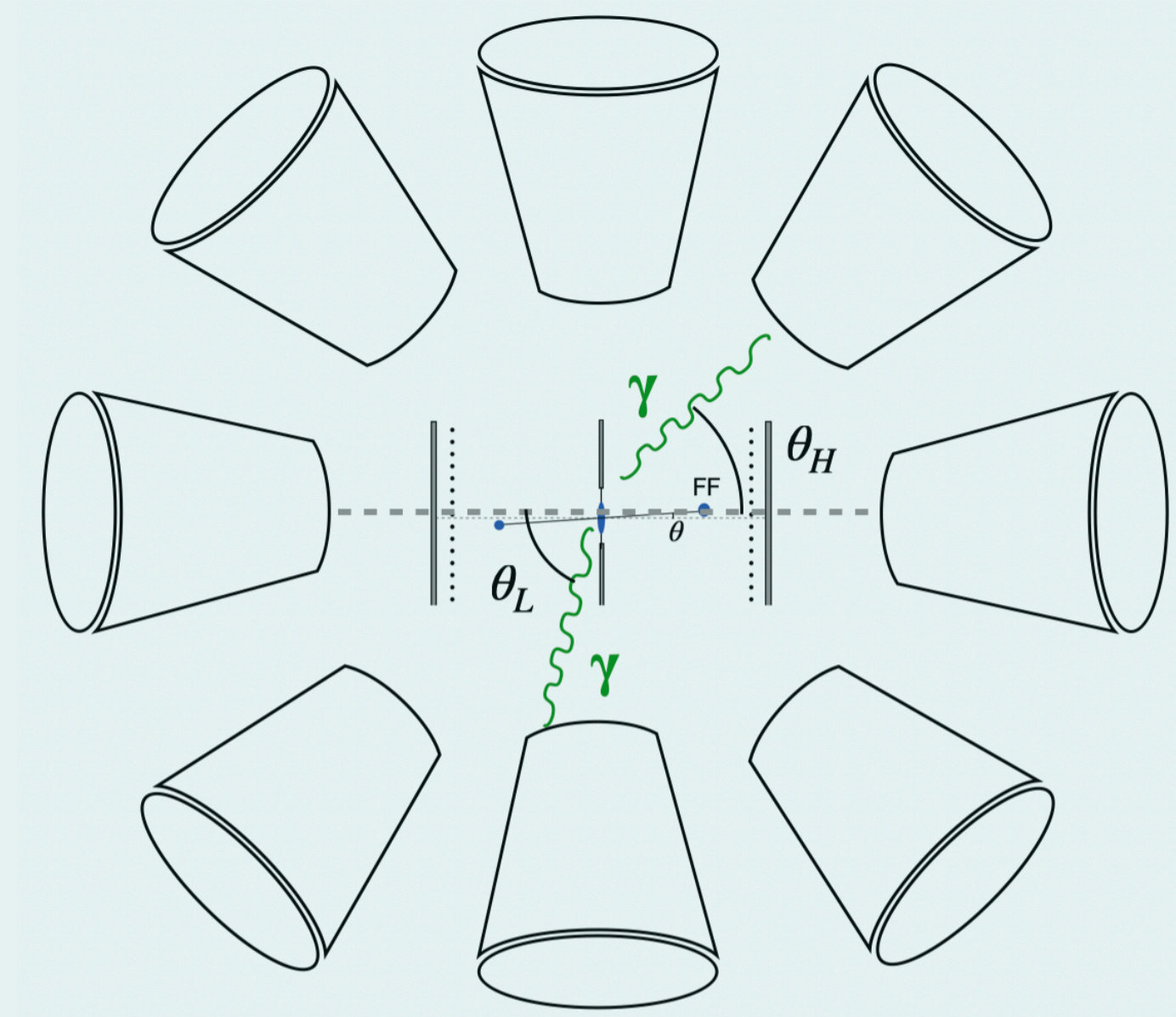
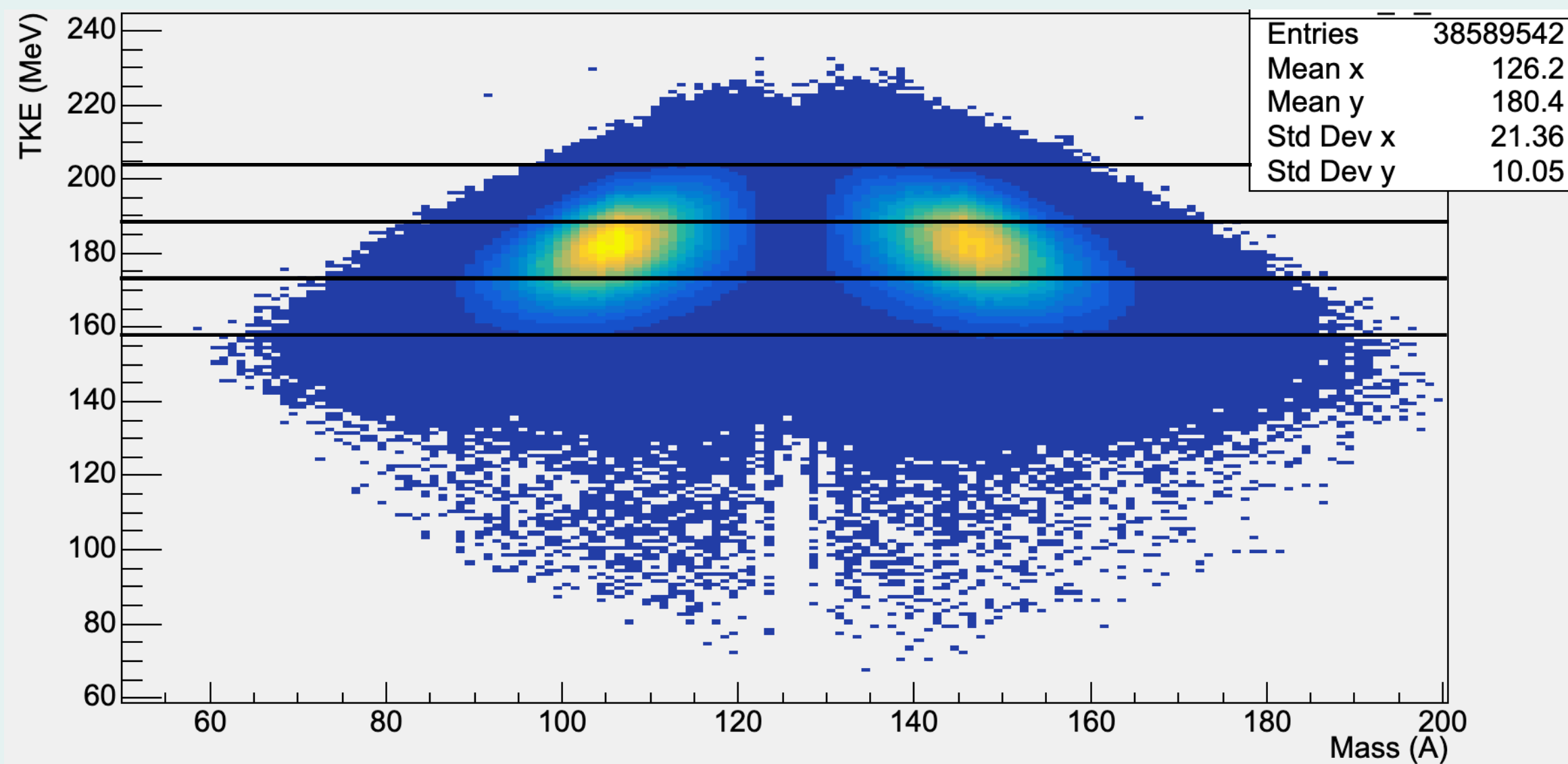
Angular distribution

Angular distribution of the 330.8-keV $4^+ \rightarrow 2^+$ ground-state-band transition for the $158.5 < \text{TKE} < 173 \text{ MeV}$ bin



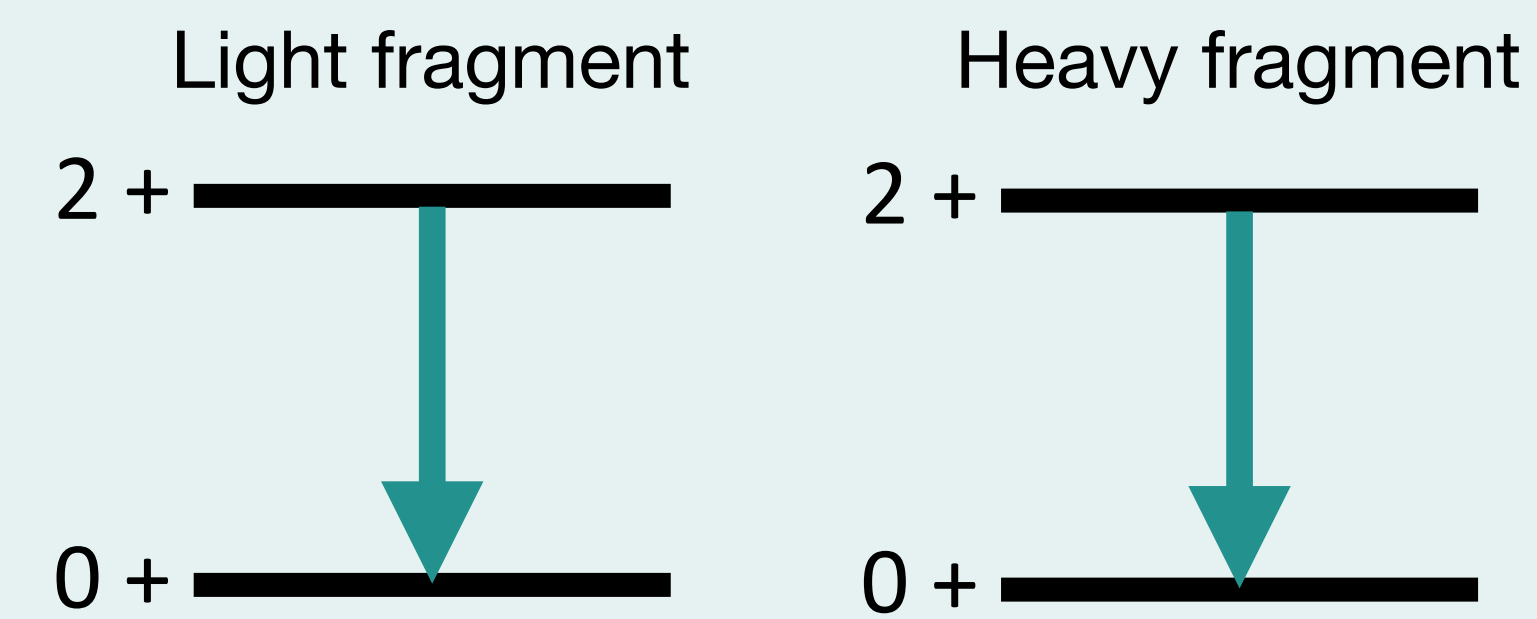
Outlook

- Angular distributions of different fragments
- Effect of changing the TKE bins
- Goal: Help constrain theoretical models



Outlook

Angular correlations of gamma rays from two fragments with respect to fission axis. Fragments AM generated in alignment state (coupled representation)



Results after emission can be reduced by a factor of 2-3 (2-5% max-min difference)

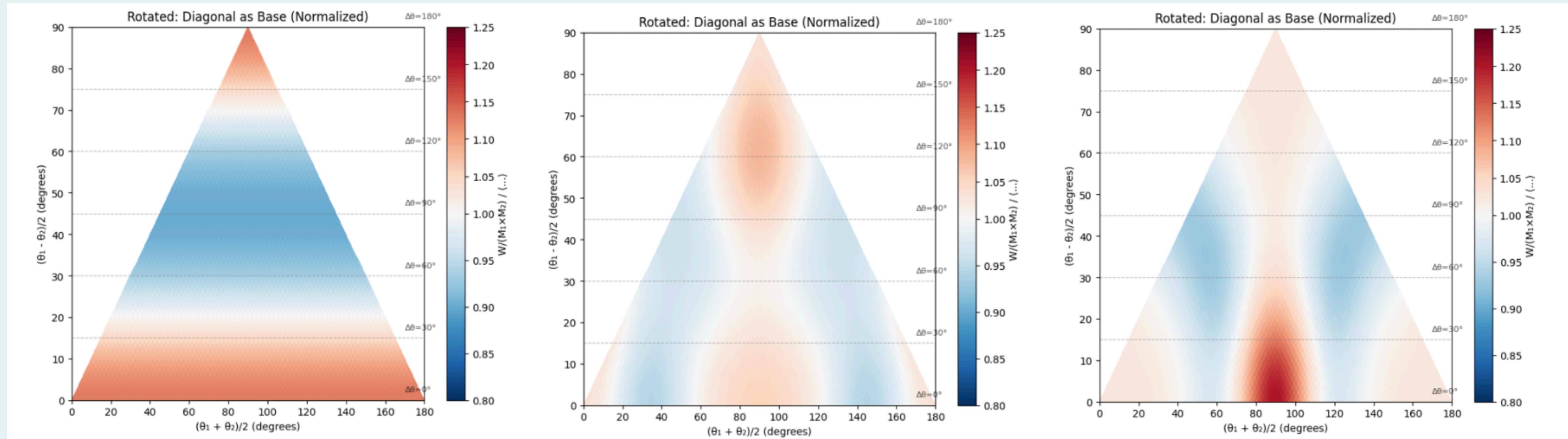
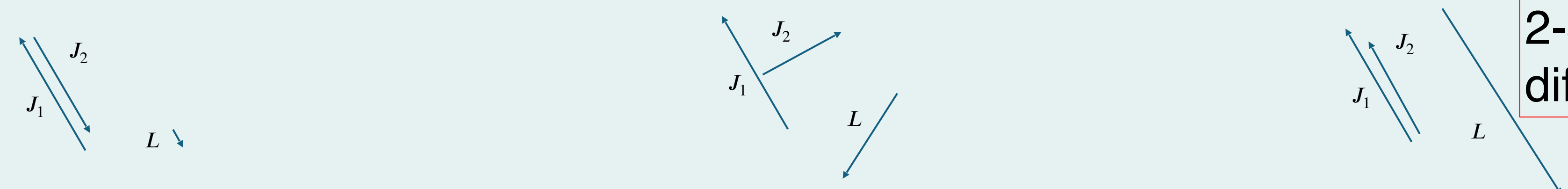
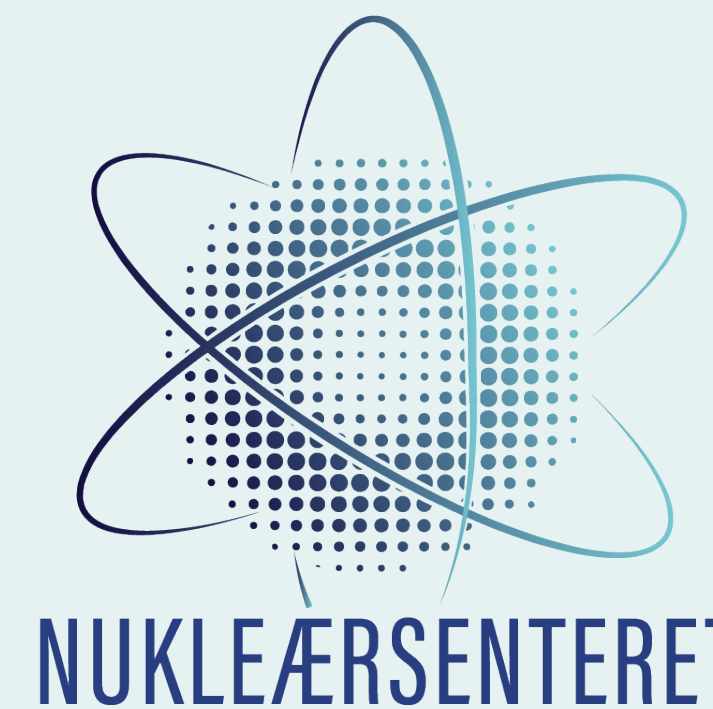


Figure from: Stefano Marin



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Thank you for the attention

Thank you to my collaborators: Stefano Marin, Nathan P. Giha, Ivan Tolstukhin, Ali Al-Adili, Jon Wilson, Dorthea Gjestvang and Sunniva Siem