Coulomb Excitation in ^{80}Sr

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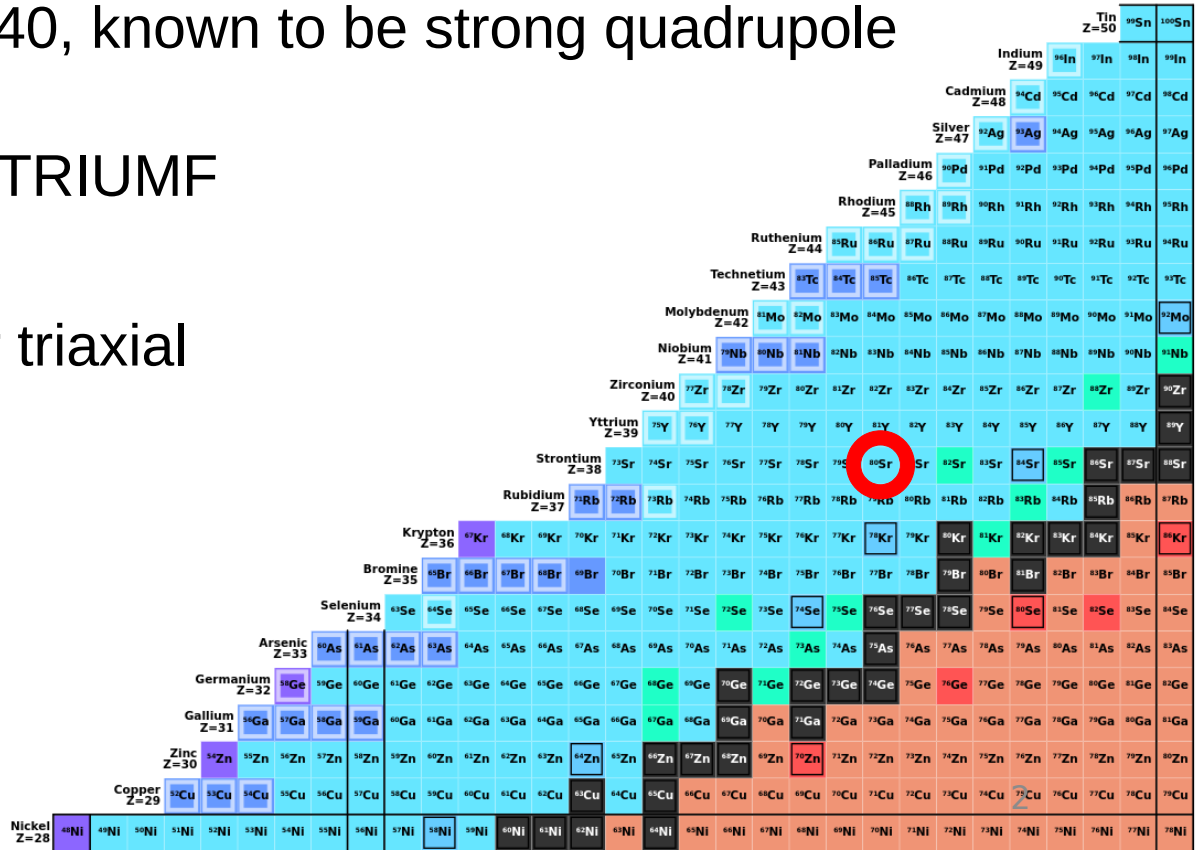
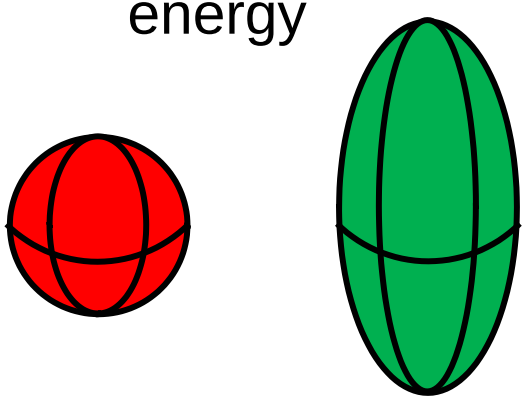
Introduction & Aims

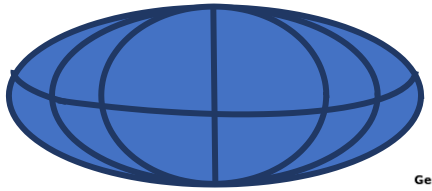
- ^{80}Sr lies in the region of Z=N=40, known to be strong quadrupole deformation
- Experiment with TIGRESS at TRIUMF
- States in ^{80}Sr
- Explore possible coexisting or triaxial shapes in ^{80}Sr$_{gnd}$
- Recent work has pointed at changes in collectivity around Z=40 and N=40

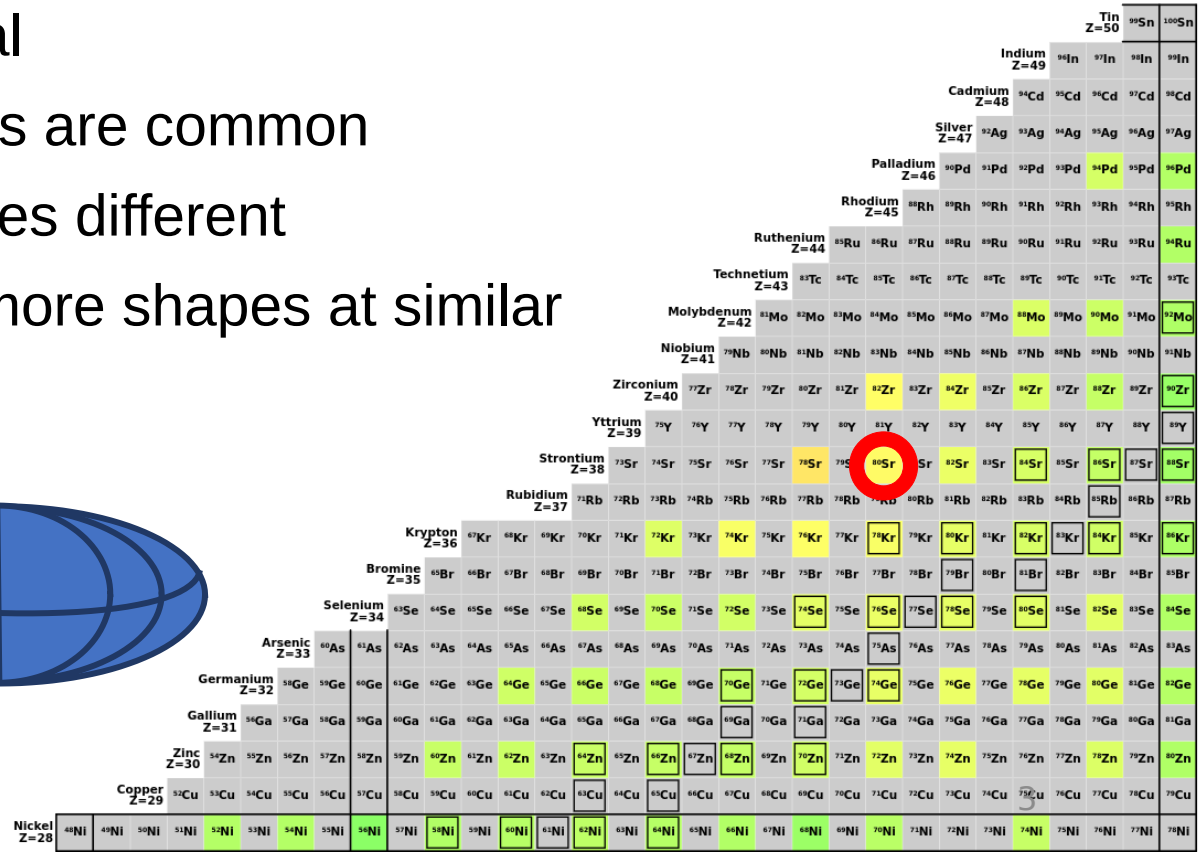


Nuclear Deformation

- Nuclei aren't always spherical
- Quadrupole deformed shapes are common
- Triaxial shapes – all three axes different
- Coexisting shapes – two or more shapes at similar energy

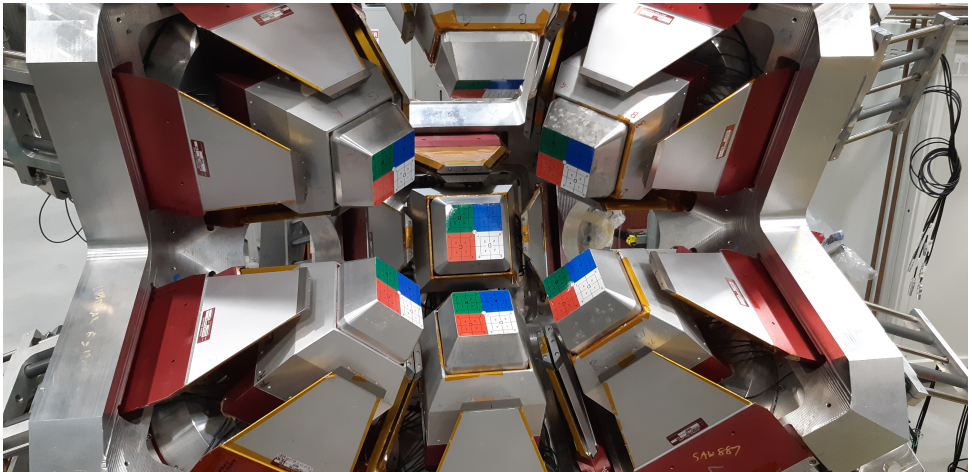


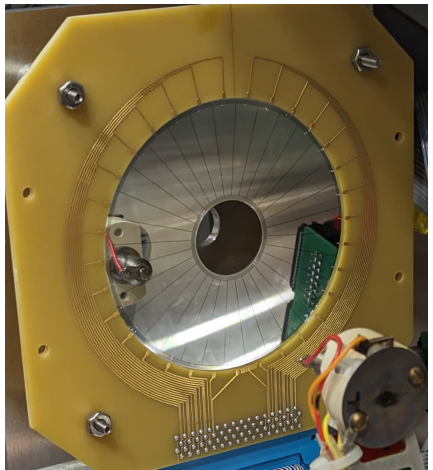




Overview of the Experiment

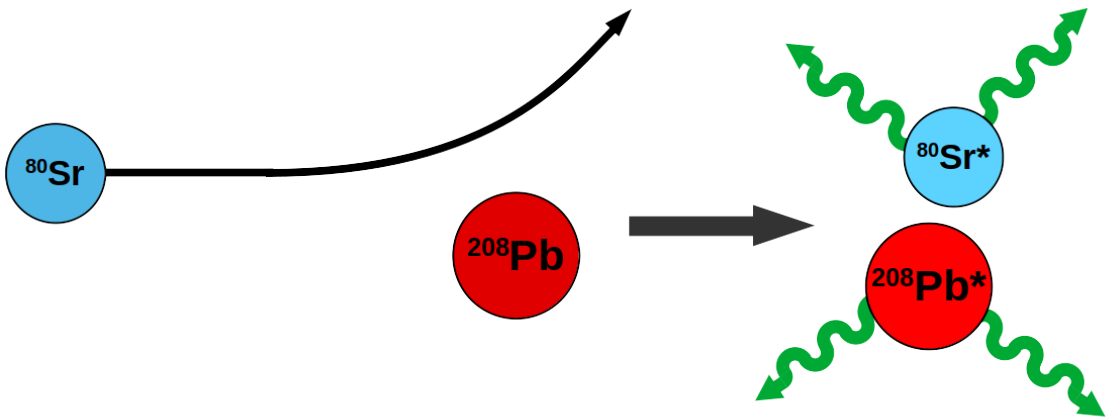
- ^{80}Sr beam on a 0.882 mg/cm^2 ^{208}Pb target
- Beam energy of 4.25 MeV/u
- Energy of the ^{80}Sr in the beam was 340.0 MeV
- Coulomb excitation of the ^{80}Sr was carried out





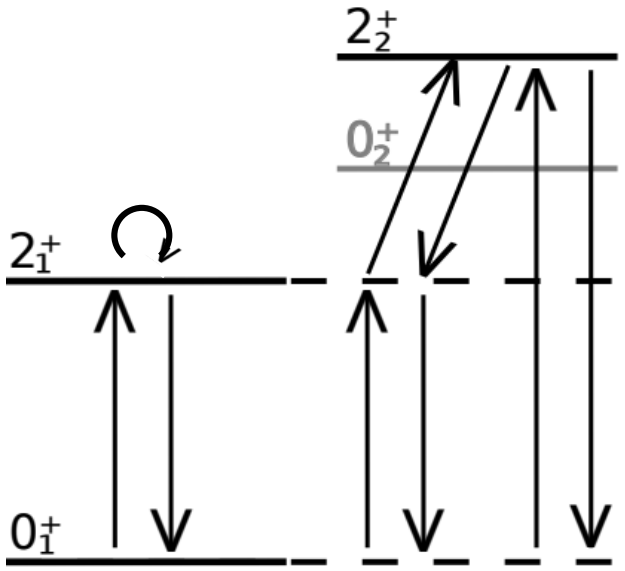
Coulomb Excitation

- Beam nucleus approaches the target nucleus
- The nuclei interact with one another, excite and scatter
- Excited nuclei decays by gamma emission
- A benefit is that it is selective, excitation is dominated by electric transitions.



Coulomb Excitation

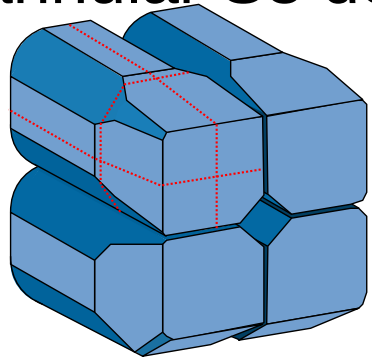
- Technique allows for measurement of the transition probabilities and spectroscopic quadrupole moments of states

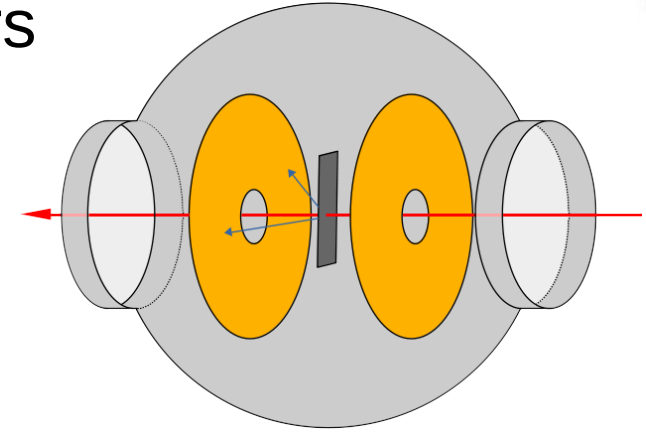


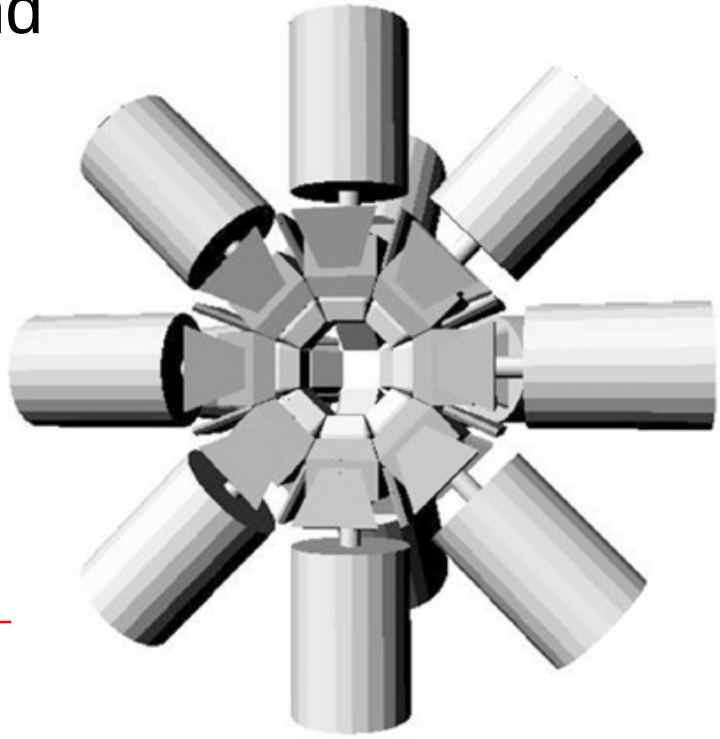
- Reorientation effect leads to an observable difference in the cross section with a dependence on scattering angle
- B(EL) comes from the off diagonal matrix elements
- Q_s comes from the diagonal matrix elements

Experimental Setup

- The setup at TRIUMF used TIGRESS and Bambino
- TIGRESS is a segmented germanium array for gamma detection
- Bambino is two up and downstream annular S3 detectors



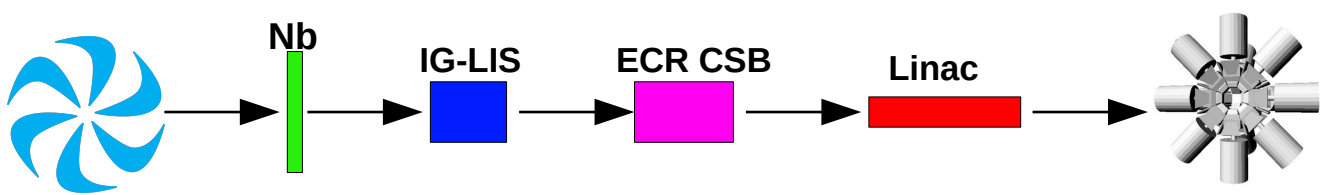


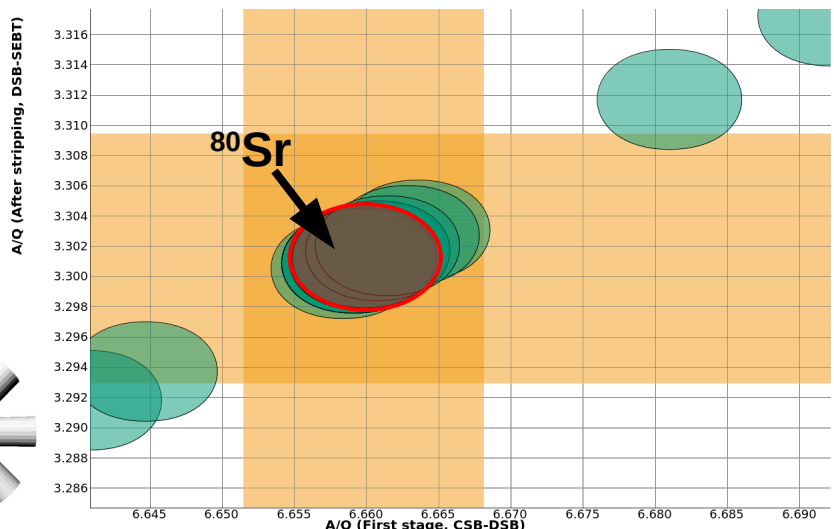


C E Svensson et al 2005 J. Phys. G: Nucl. Part. Phys. 31 S1663
E Lunderberg et al 2018 Nucl. Inst. and Meth. in Phys: A 885 30-37

Beam Production

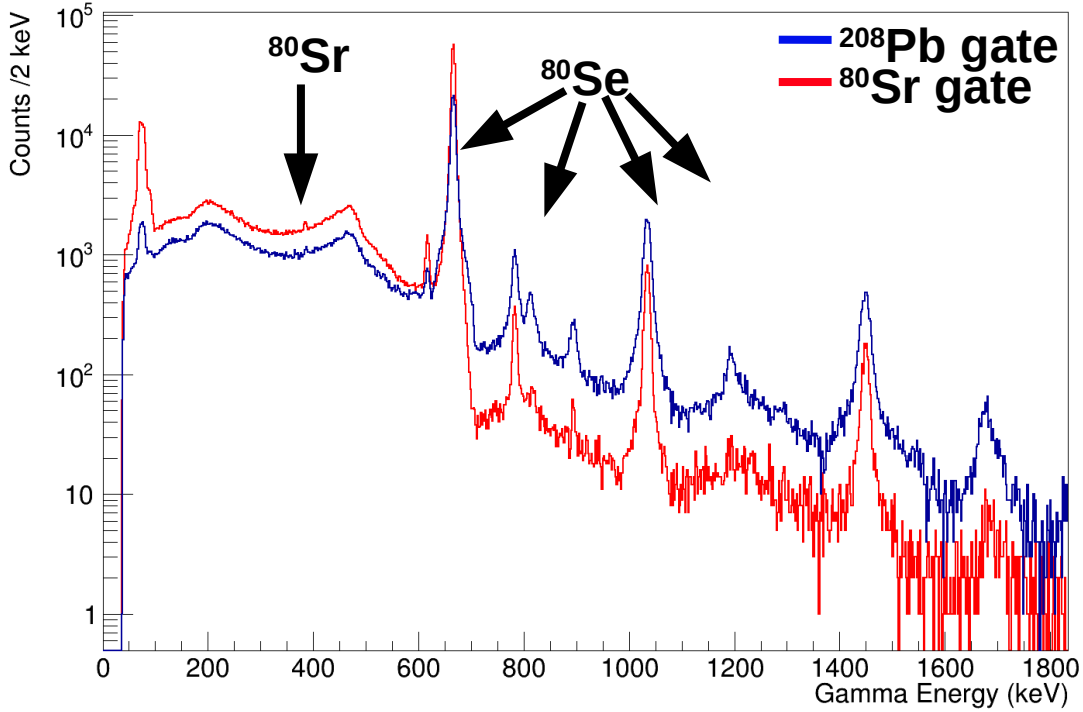
- Beam Produced using the TRIUMF cyclotron and a Nb target
- Ion-Guide Laser Ion Source (IG-LIS) for first stage
- Electron Cyclotron Resonance (ECR) Charge State Breeder (CSB) for second stage
- Stripped to a higher charge state and accelerated
- Isobaric contaminants will remain (such as ^{80}Se)



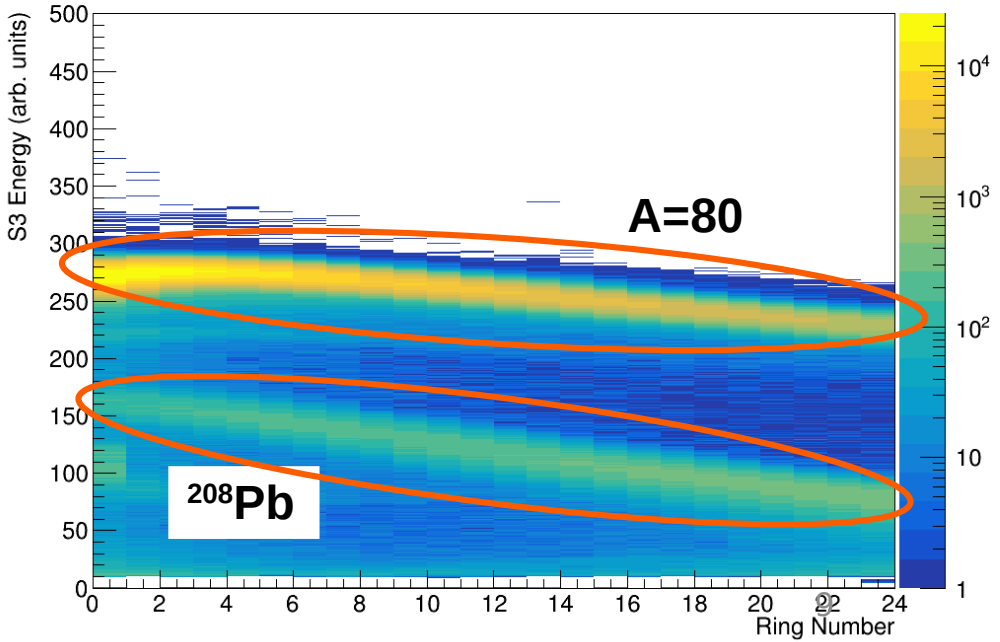


Analysis

The γ-ray spectra for doppler corrected for A=80 nuclei using gates on scattered A=80 and ^{208}Pb.

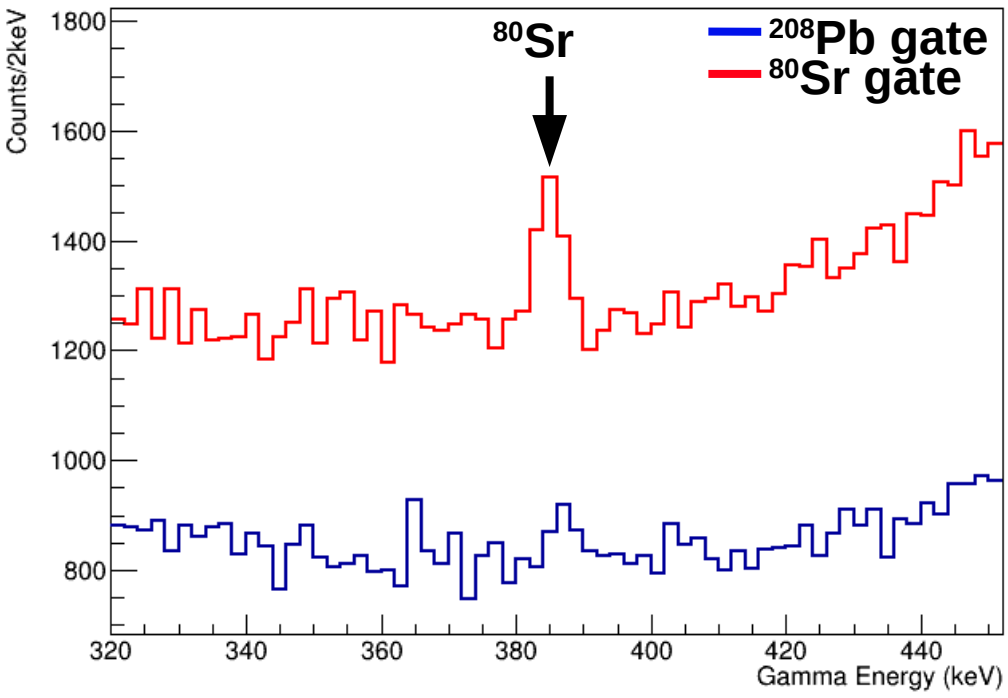


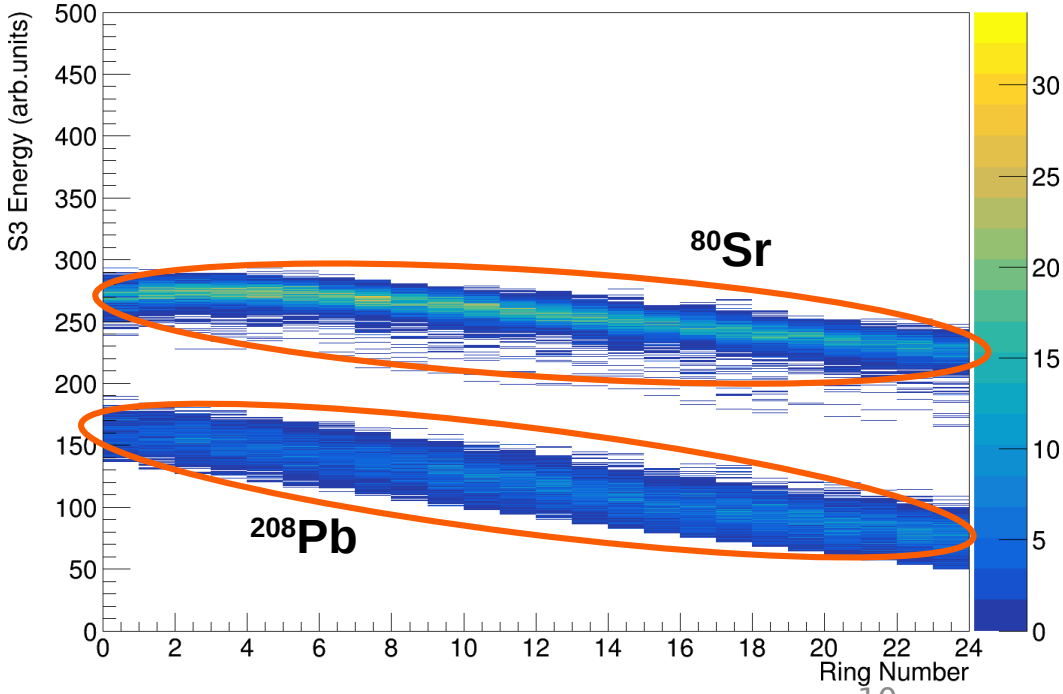
The particle identification plot from the downstream S3 detector. Red indicates approximate gates applied to the data from TIGRESS



Analysis

- When focusing on the $^{80}Sr\ 2^{+}_{1} \rightarrow 0^{+}_{1}$ we see ~700 counts in the A=80 cut and ~300 in the ^{208}Pb cut which can be attributed to ^{80}Sr:



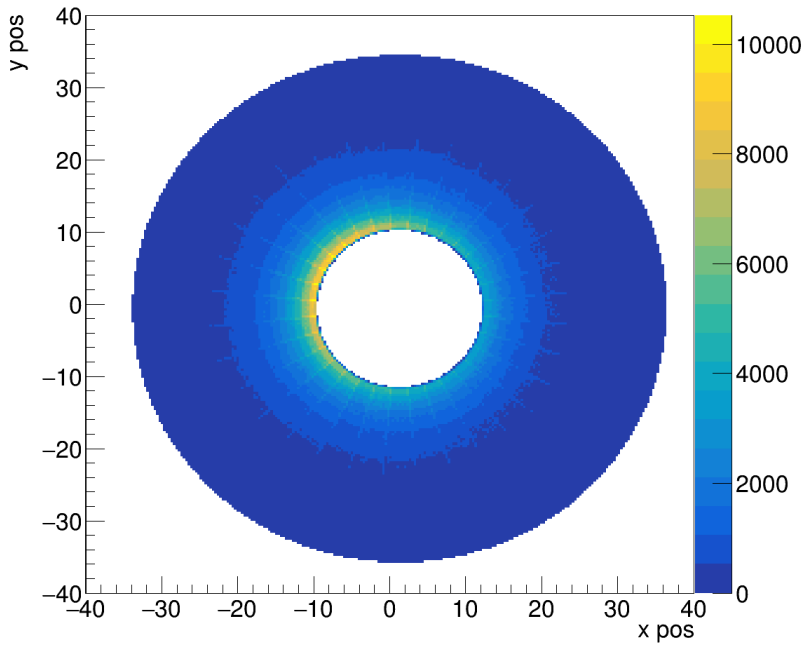


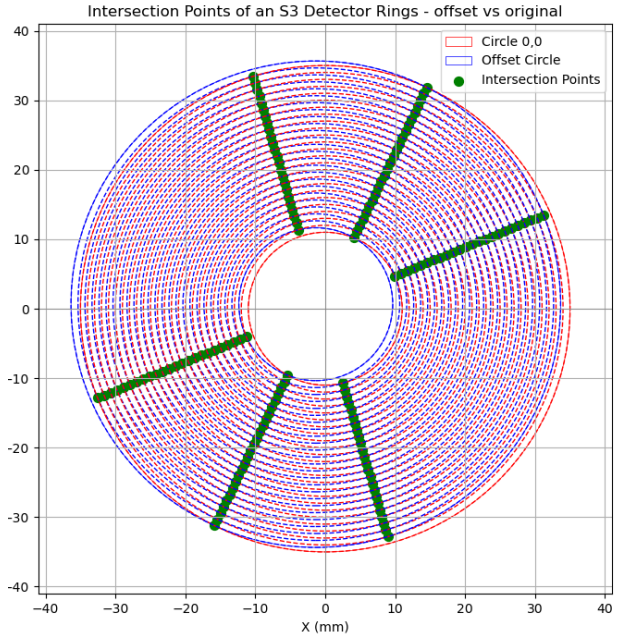
Analysis - GOSIA

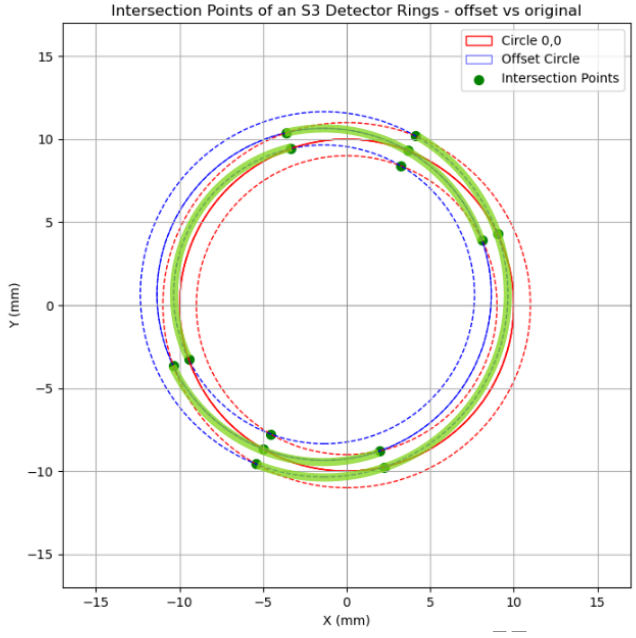
- GOSIA = Semi-classical coupled channels Coulomb excitation code
- Input yields and detection angles, output matrix elements
- Can be found from outputs:
  - Electric quadrupole moment of levels
  - B(E2) of transitions

Analysis

- Slightly off-centre beam → In GOSIA, “re-assigned” detector ring positions to the ring where the data is collected. Done by taking the intersection of the detector ring and the “effective” ring in the plane of the S3.







Results and Summary

- Q_s for first excited state of ^{80}Sr, this is the first measurement of this value.
- The current analysis for $Q_s(2^+_1)$ shows a likely oblate shape. Differing from other Sr isotopes in this region
- For an axially symmetric system, the limits of Q_s is expected to be |0.89|eb
- This work shows that ^{80}Sr is not consistent with an axially prolate system and is more akin to a triaxially soft prolate or oblate shape.
- Further work is needed to constrain uncertainties – Currently dominated by ^{80}Se Comptons

^{80}Sr	This Work
$Q_s(2^+_1)$ [eb]	0.73 (115)

Acknowledgements

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