Report on AGATA experiment number 22.11

Investigating shape coexistence in ^{74}Se using Coulomb excitation

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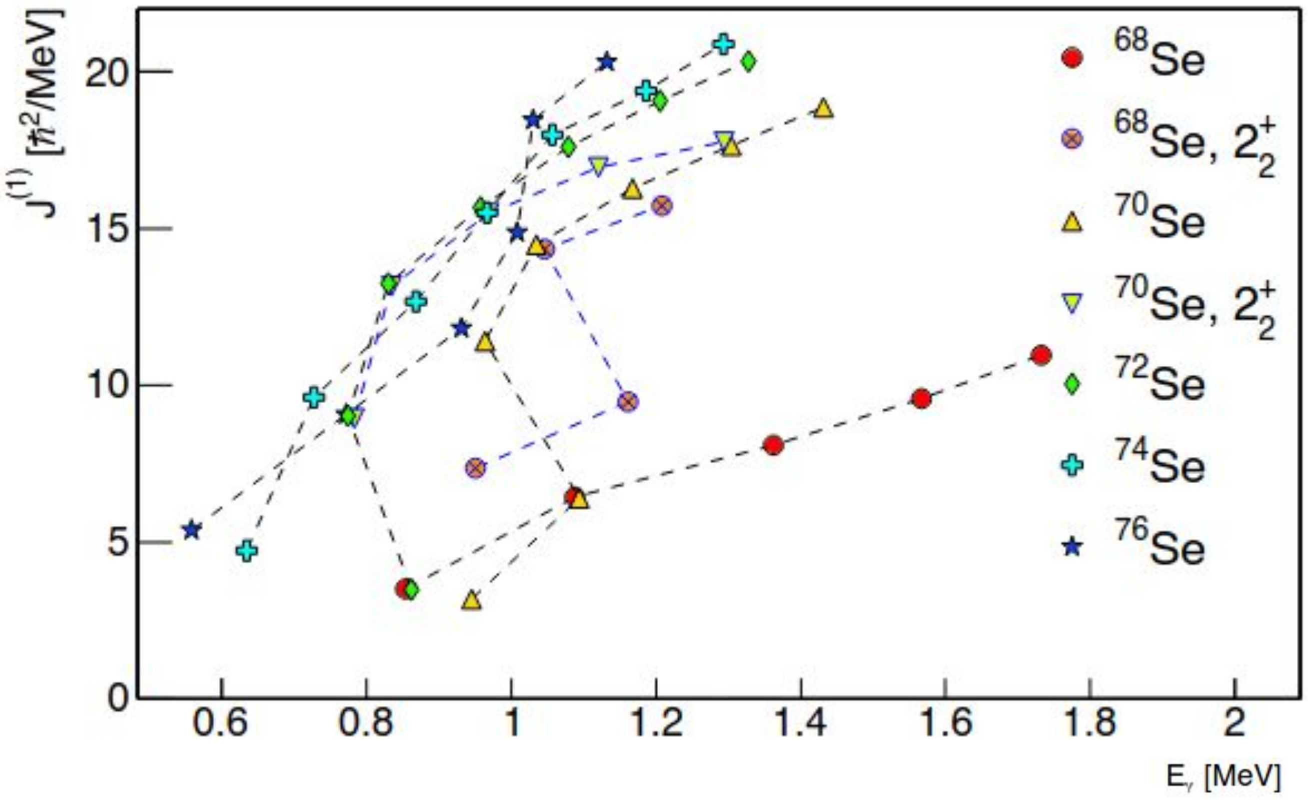
Motivation

The m.o.i. of g.s.b. in ^{68}Se behave very differently, which can be interpreted as an oblate shape in the ground state band *(S.M. Fischer et al., PRL 84, 4064 (2000))*

The m.o.i. of ^{70}Se and ^{72}Se are somewhere in between

The ^{70,72}Se data are consistent with prolate deformation at high spin, but suggest mixing with oblate structures at low spin

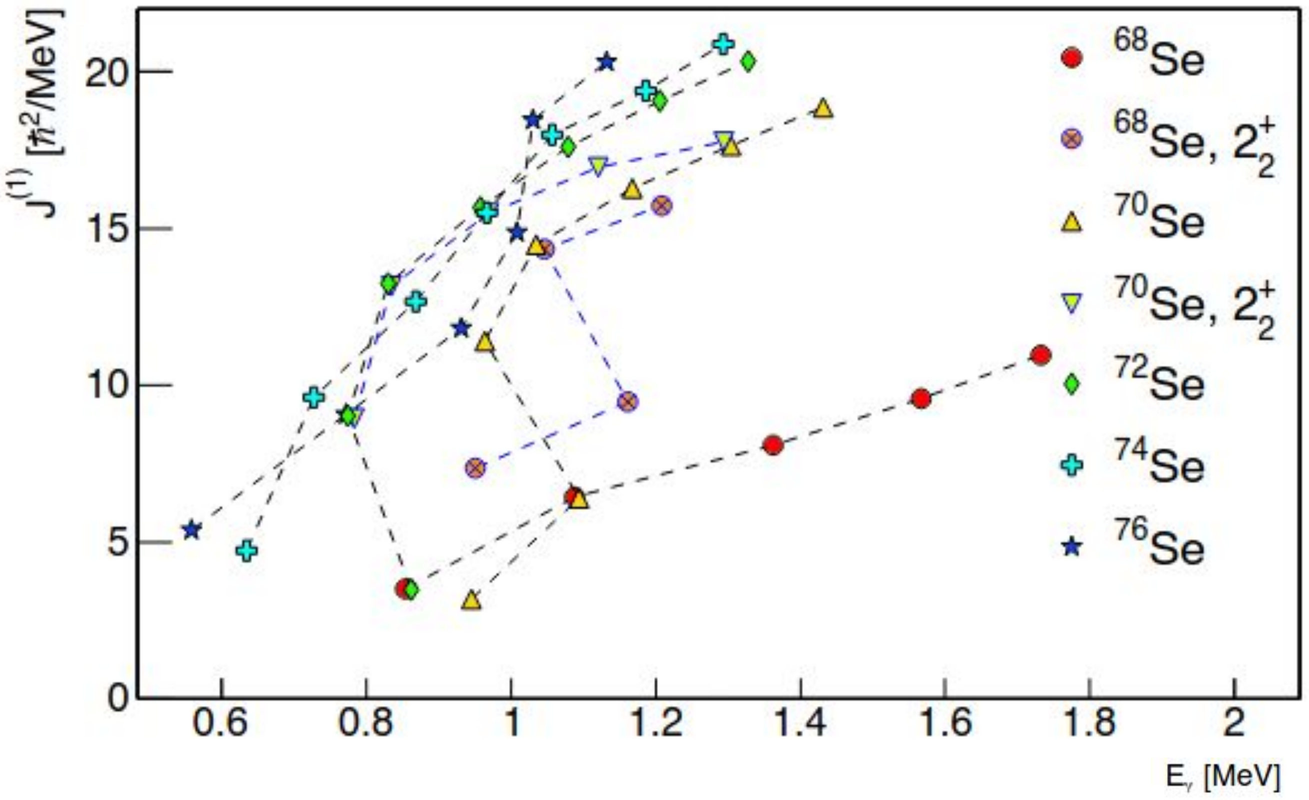
Hinohara plot ()



Motivation

Moments of inertia in ground state bands in ^{74}Se are very similar as to those in ^{76}Se

The 2^+_1 states in ^{72,76}Se have negative quadrupole, meaning their ground state bands are prolate
(J. Henderson et al., PRL 121, 082502 (2018); A.E. Kavka, NPA 593, 177 (1995))



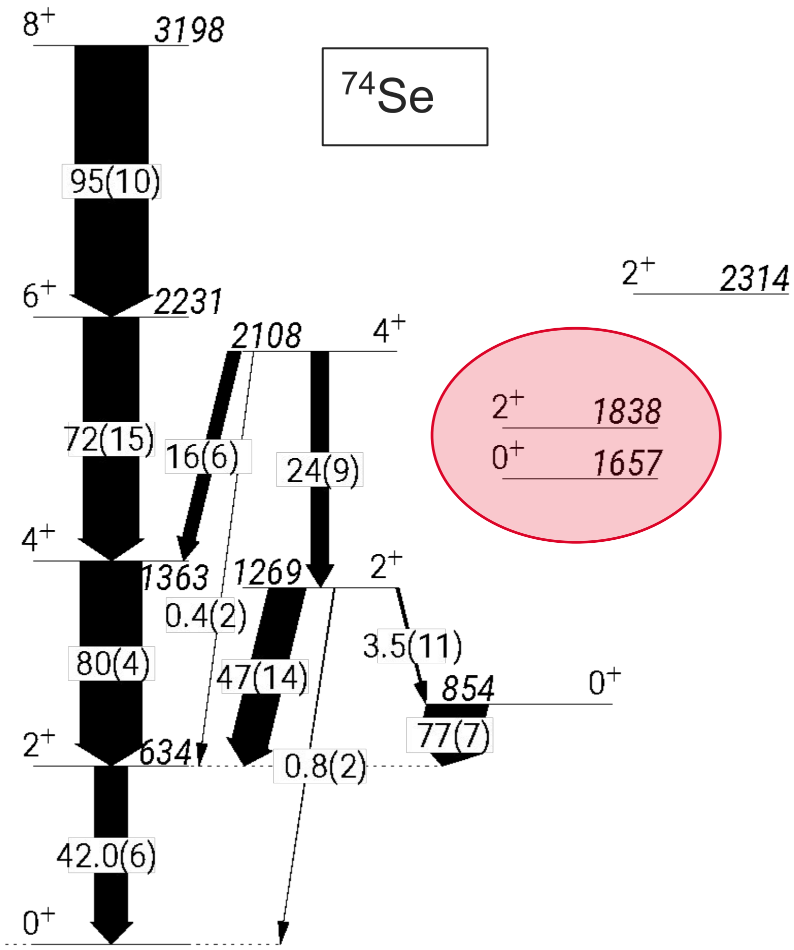
Motivation

The band on the left of the level scheme is considered to be prolate states

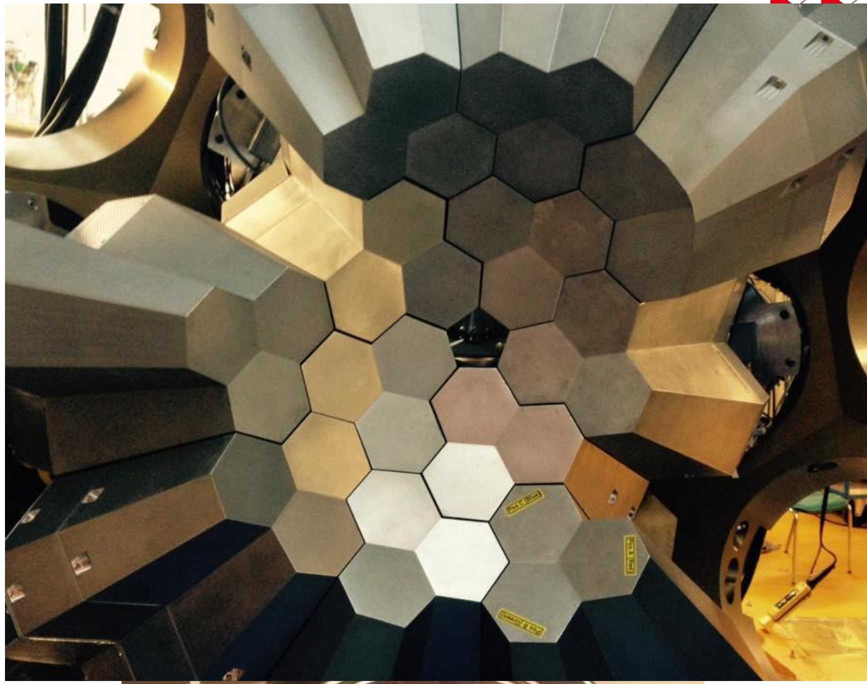
The structure on the right is believed to be weakly deformed oblate

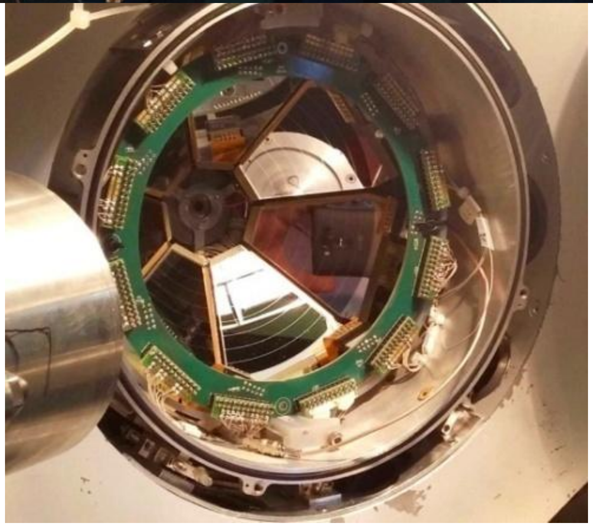
A much stronger argument can be made by measuring in-band B(E2) values and quadrupole moments. Measuring these is the main focus of this project

A different interpretation has been suggested based on IBM calculations in which the states highlighted in red are strongly deformed, while the the others are the result of a vibration of a weakly deformed ground state
(E. McCutchan et al, PRC 87, 014307 (2013))



Experimental Details





The experiment was run in October 27-31, 2022 in LNL, Legnaro, Italy (5 days of beam on target)

Beam of ^{74}Se at 240 MeV and 1pnA

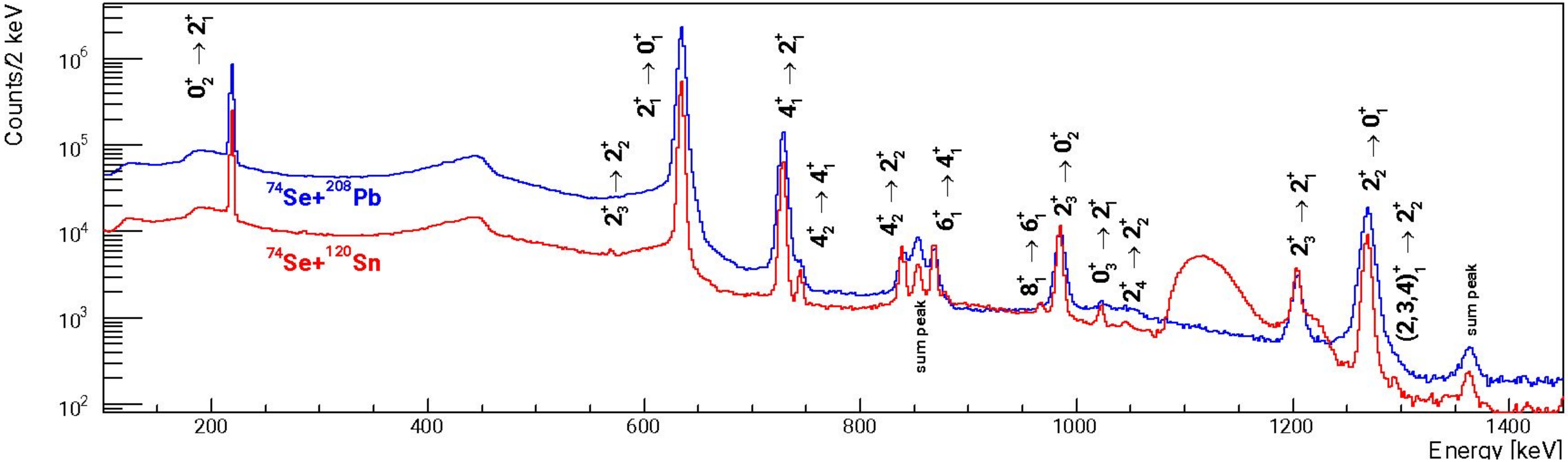
Two different targets: ^{120}Sn & ^{208}Pb

- For the ^{208}Pb target: beam energy of ~70% of the safe energy limit (as per Cline’s criterion)
- For the ^{120}Sn target: beam energy was as close as possible to the limit of safe Coulomb excitation

AGATA array (33 crystals in 11 triple clusters)

SPIDER silicon detector for scattered selenium ions (theta_lab = 128-159 deg)

Energy spectrum (<1400 keV)



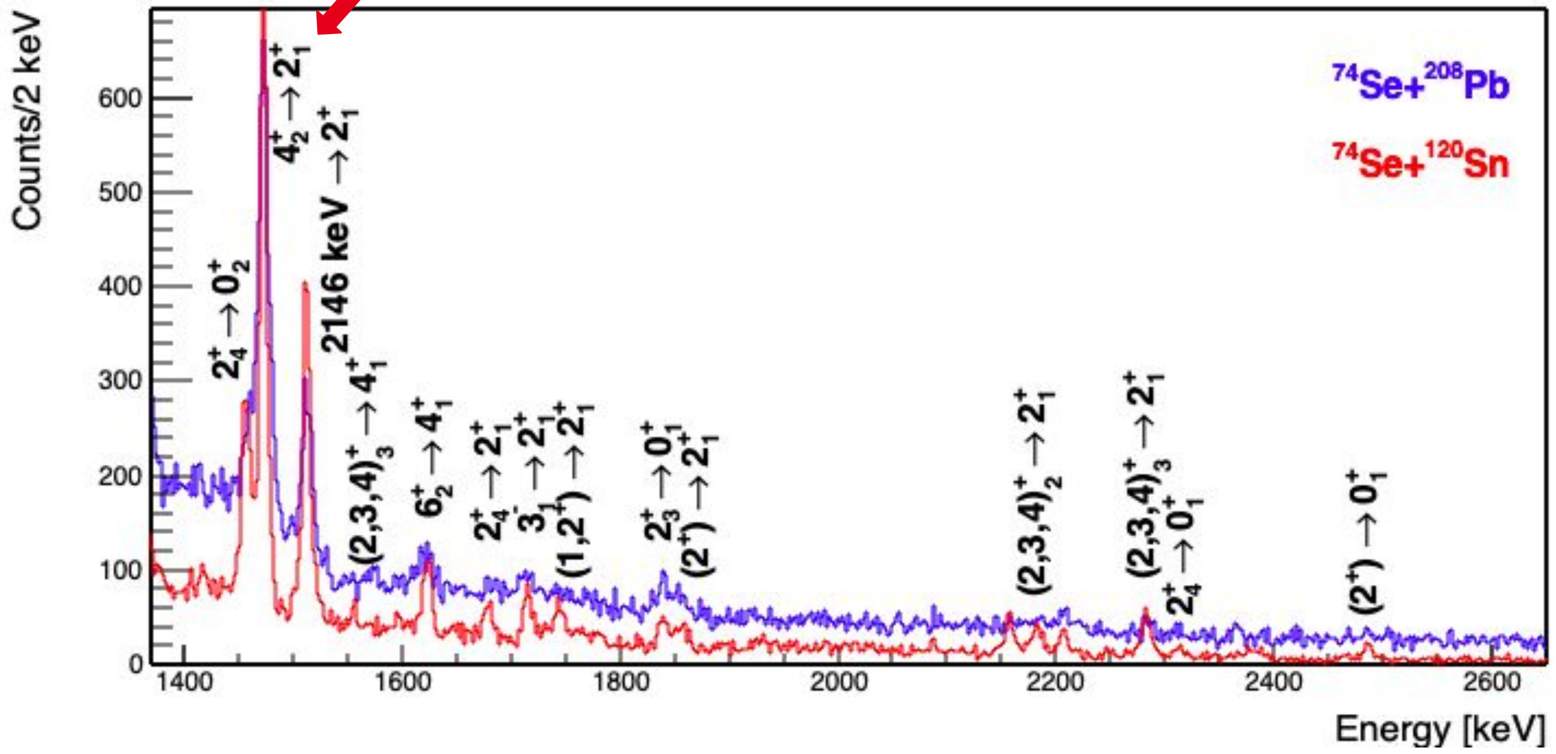
The 0^+_2 and 0^+_3 states are populated, which is key for our shape coexistence investigation

Note the difference in relative intensities of transitions between the ^{208}Pb and ^{120}Sn targets, and the width of the peaks

Significant sum peaks around ~850 keV and 1360 keV

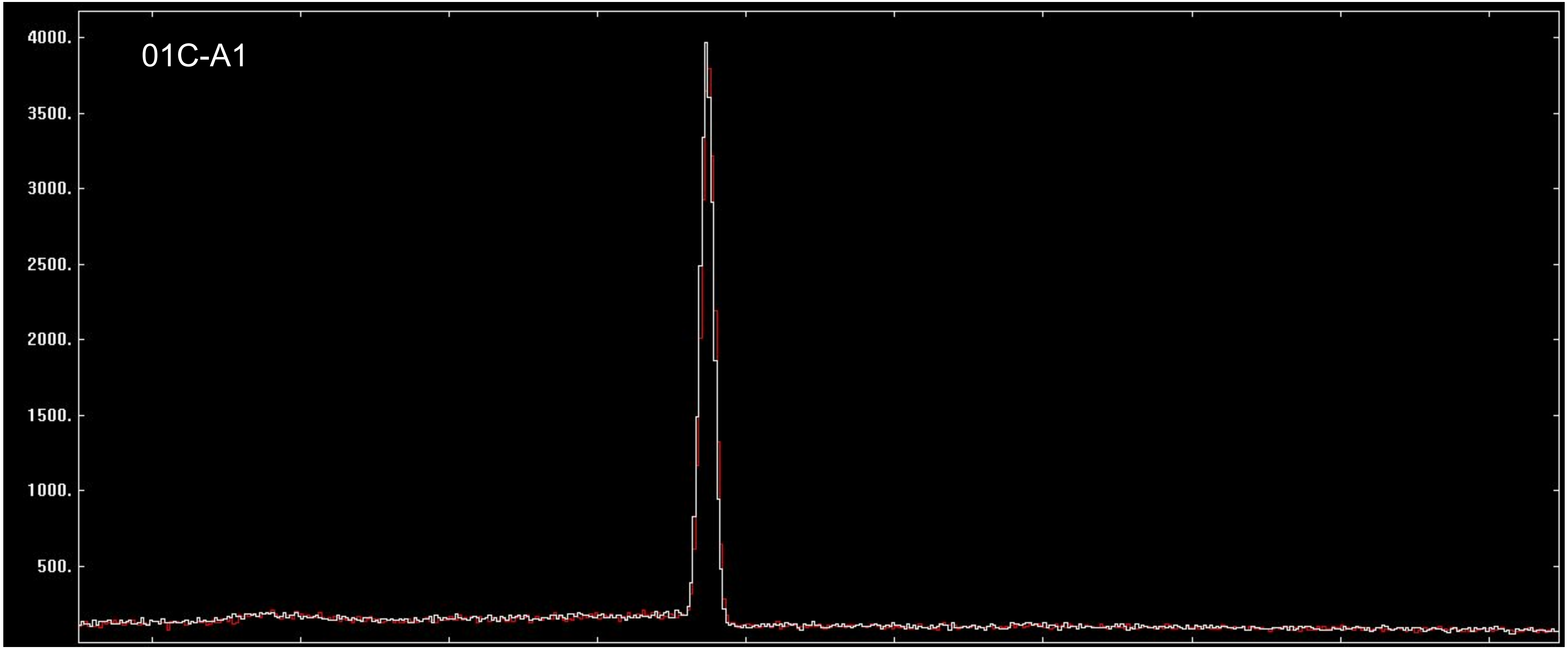
Energy spectrum (>1400 keV)

The transition from the 2146 keV state to the 2^+_1 state has never been observed in gamma-ray spectroscopy prior to this experiment

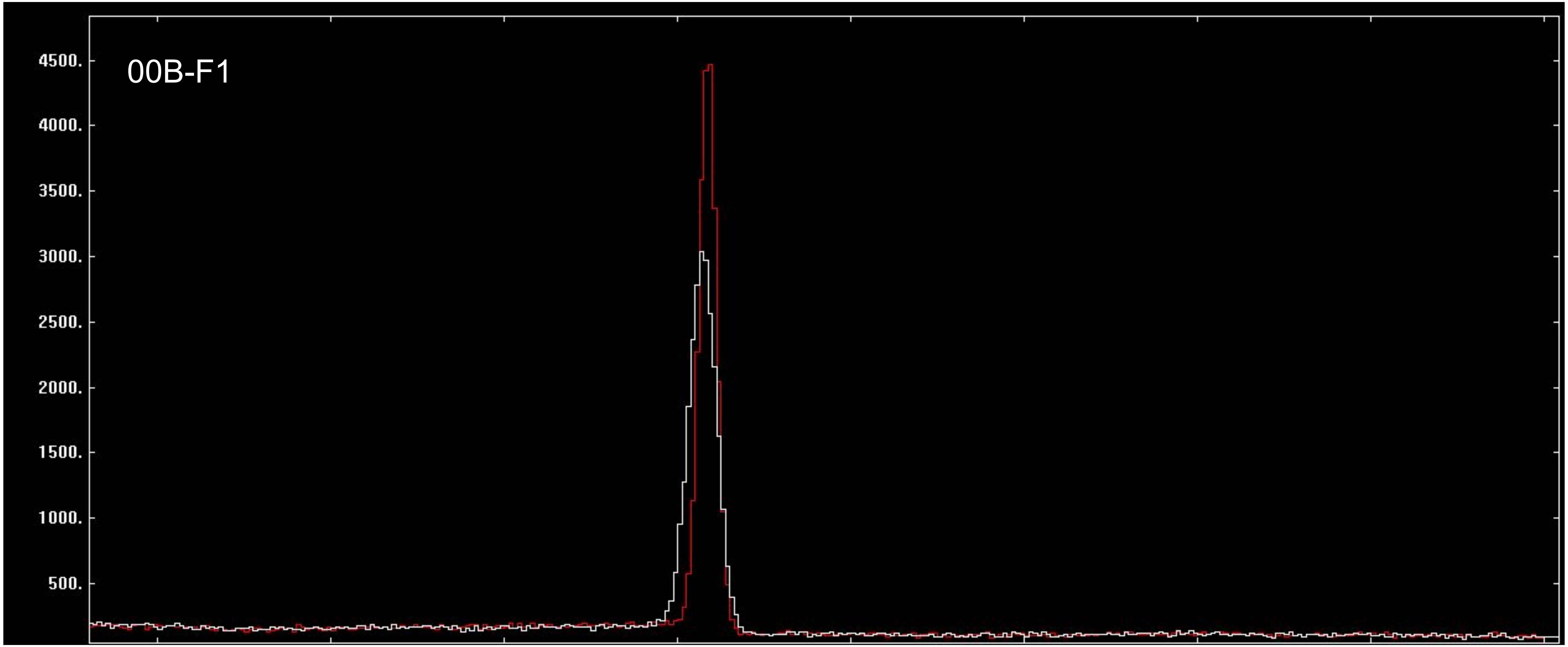


We use energies below the Coulomb barrier, so we don't have any transfer reaction contribution

Neutron Damage in AGATA



Neutron Damage in AGATA



Neutron Damage in AGATA

Crystals in AGATA where neutron damage correction is necessary in at least one segment:

	A	B	C
00	Needs correction	Needs correction	Needs correction
01	Needs correction	No correction	Needs correction
02	No correction	Needs correction	No correction
04	No correction	Needs correction	DEAD
05	Needs correction	No correction	DEAD
06	No correction	No correction	DEAD
07	No correction	No correction	DEAD
08	DEAD	DEAD	Needs correction
09	Needs correction	No correction	No correction
10	Needs correction	No correction	Needs correction
11	Needs correction	Needs correction	Needs correction

Data Analysis (Overview)

AGATA pre-processing:

- Neutron damage correction
- Energy recalibration

Selector:

- Refinement of time-random subtraction
- Cuts on total excitation energy

Perspectives

There is also a fusion evaporation contribution (particularly for the ^{120}Sn target) so we could improve our spectra with a cut on total excitation energy

Using GOSIA, we can obtain quadrupole moments and B(E2) values. We can use known branching ratios and mixing ratios as constraints

Simulations may be needed to account for summing effects (particularly summing out effect)