

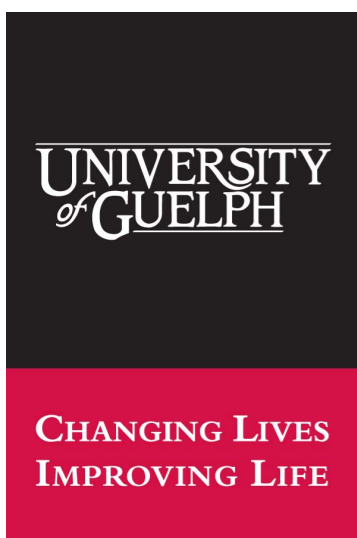
High-statistics β^+/EC -decay study of collectivity in ^{122}Xe

Badamsambuu Jigmeddorj
University of Guelph

February 16, 2018

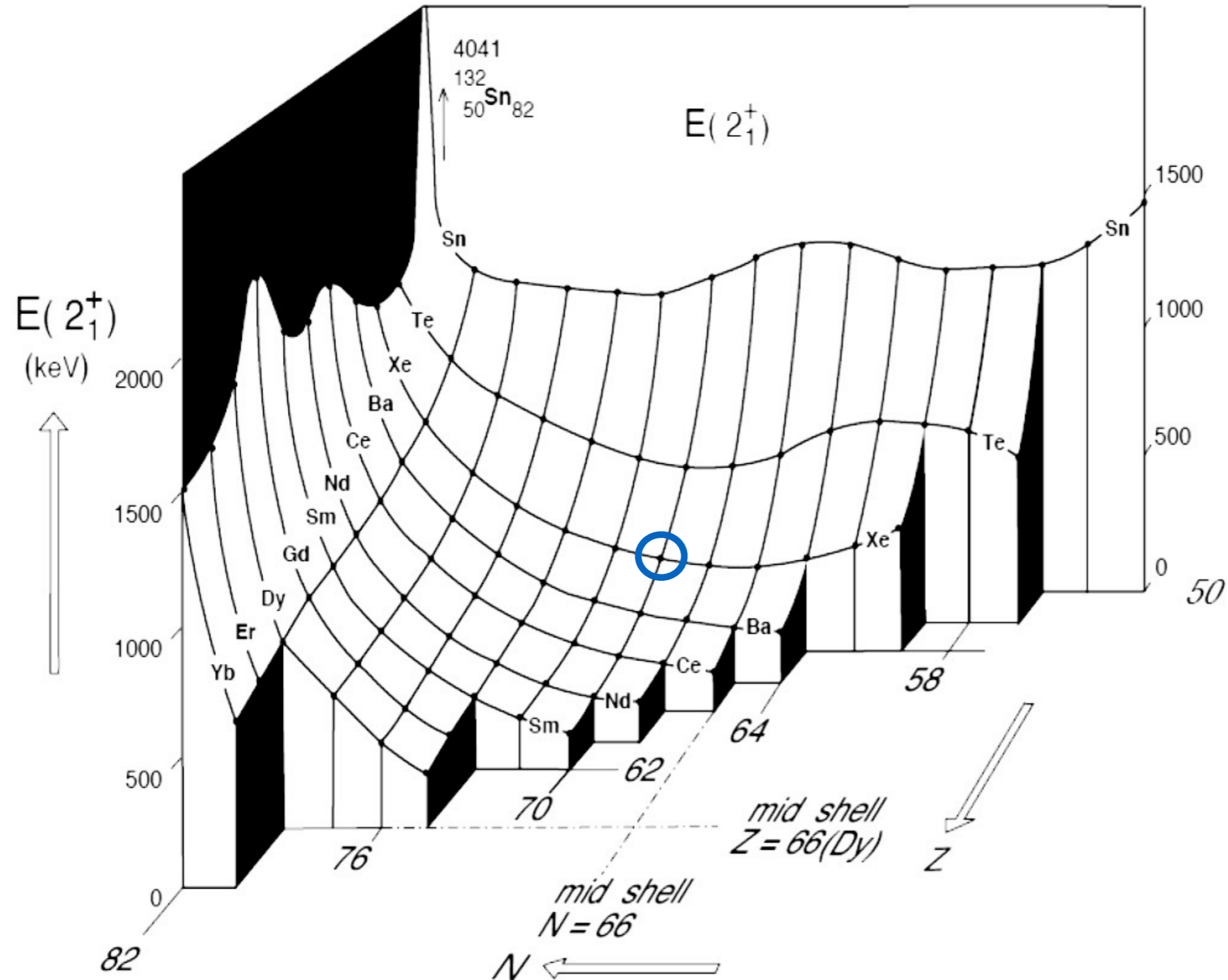


Mont Tremblant, Quebec



Motivation: Simple collective signature

K. Heyde, Basic Concepts and Ideas in Nuclear Physics, Institute of Physics, 2004

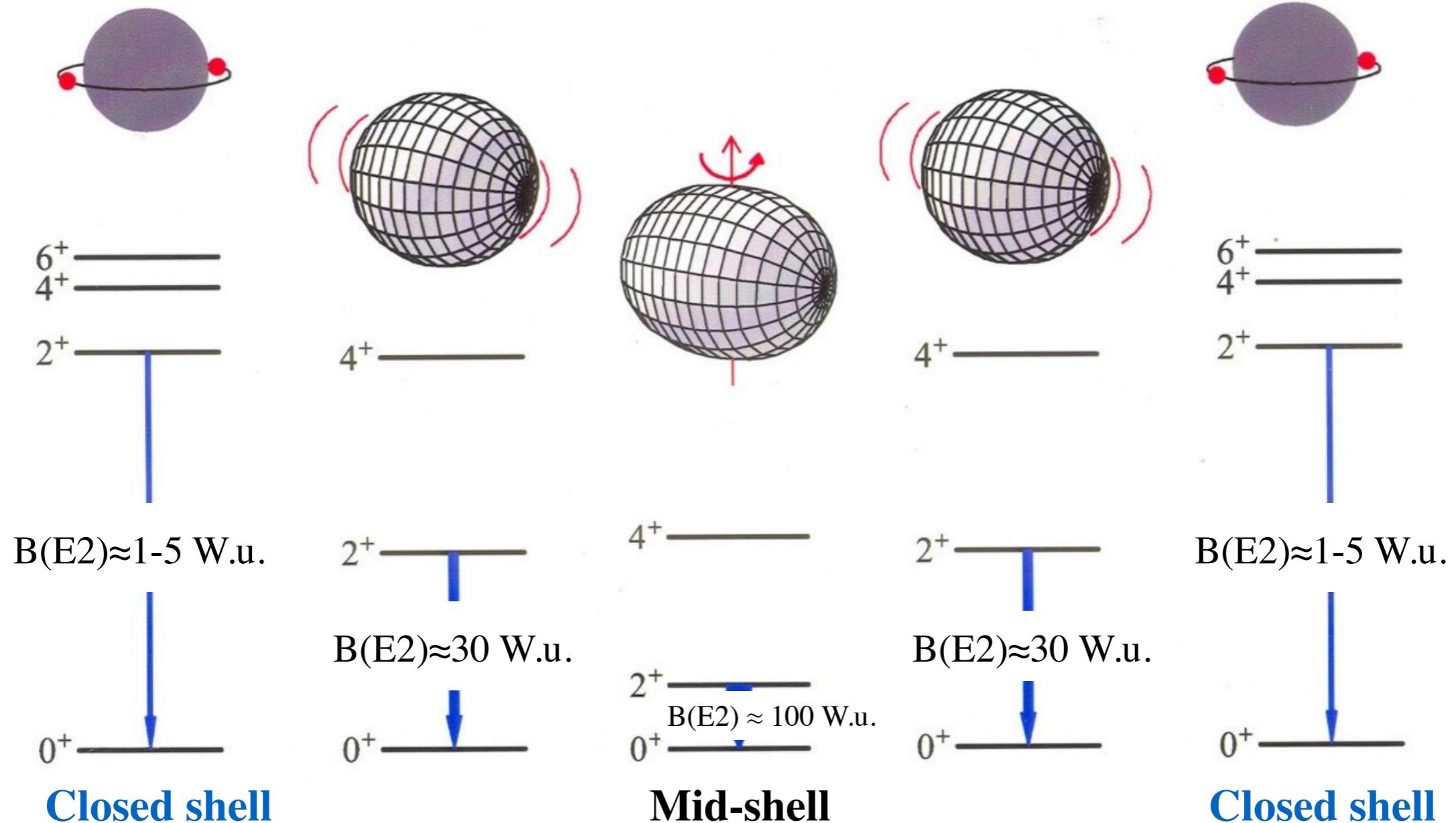


Collective properties

- **Energy of first 2^+ state**
- E2 transition strength
- Excited 0^+ states

Systematics of the first 2^+ state energy in $Z > 50$ and $N < 82$ region

Collective properties: E2 transition strength



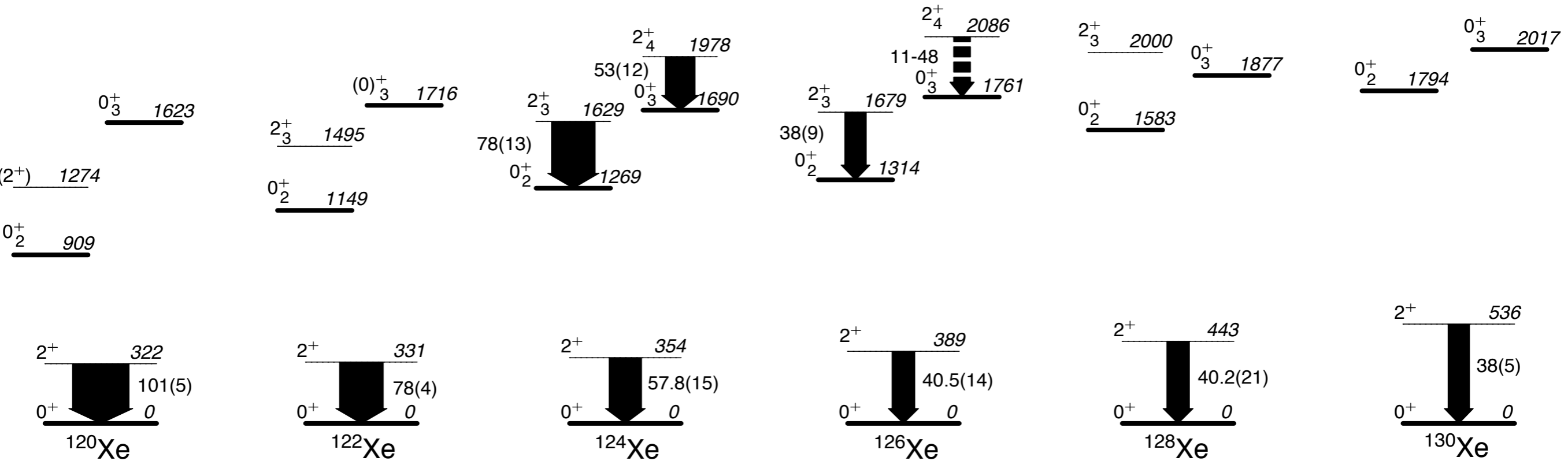
Collective properties

- **Collective model:** excited states are characterized by a result of surface vibrations and rotations
- **Shell model:** excited states are characterized by a result of orbital motion of individual nucleons

- Energy of first 2^+ state
- **E2 transition strength**
- Excited 0^+ states

Collective properties: Excited 0^+ states

A.J. Radich *et al.*, Phys. Rev. C **91**, 044320 (2015)



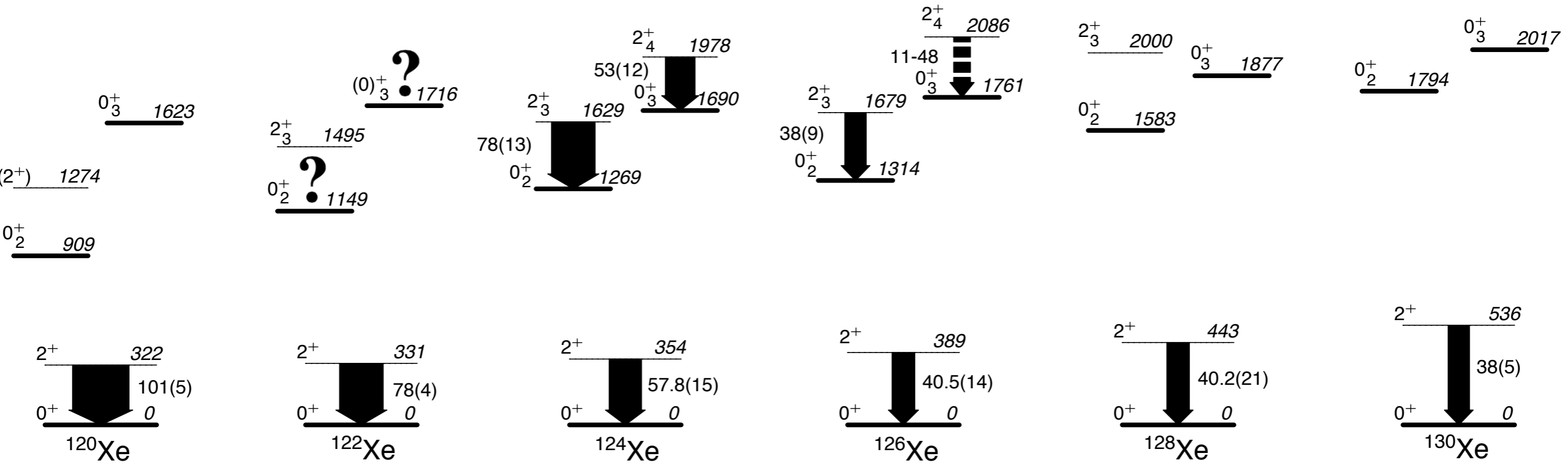
Systematics of the low-lying 0^+ states in the $^{120}\text{Xe} - ^{130}\text{Xe}$ isotopes.

Collective properties

- Energy of first 2^+ state
- E2 transition strength
- **Excited 0^+ states**

Why Xe-122?

A.J. Radich *et al.*, Phys. Rev. C **91**, 044320 (2015)



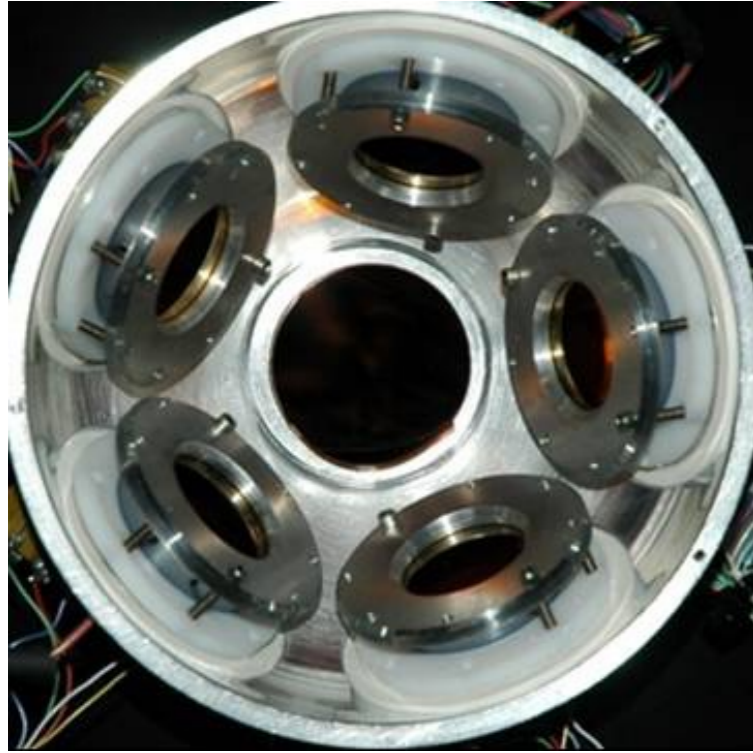
Systematics of the low-lying 0^+ states in the $^{120}\text{Xe} - ^{130}\text{Xe}$ isotopes.

Collectivity in Xe isotopes is poorly characterized beyond ground state band!

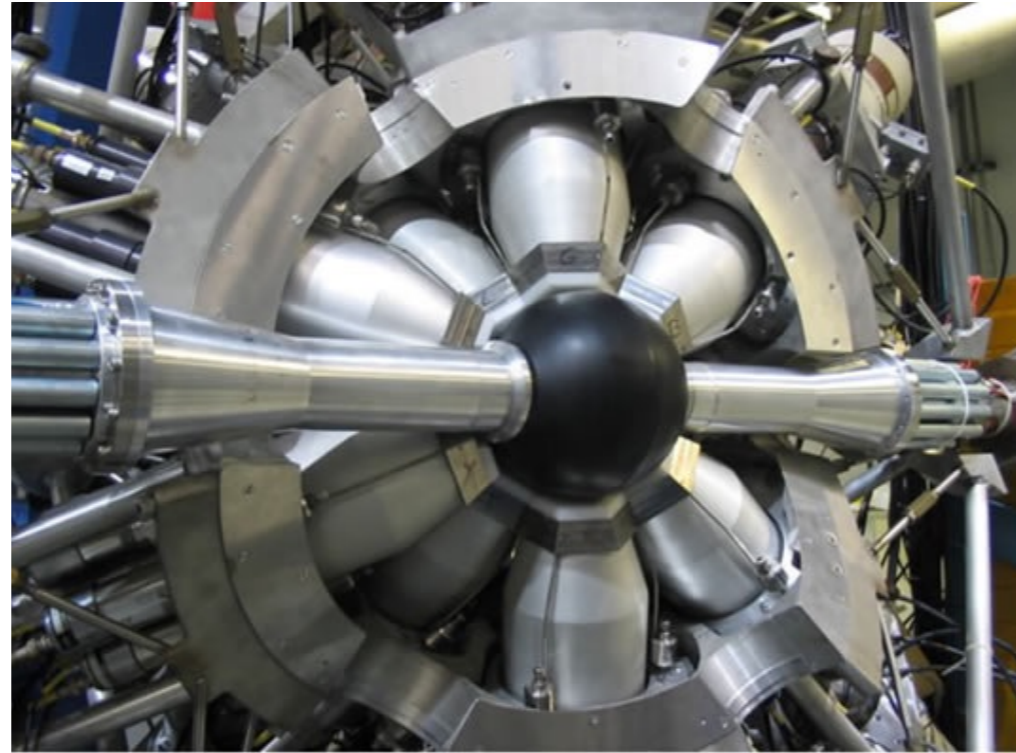
Need to investigate ^{122}Xe

Detectors

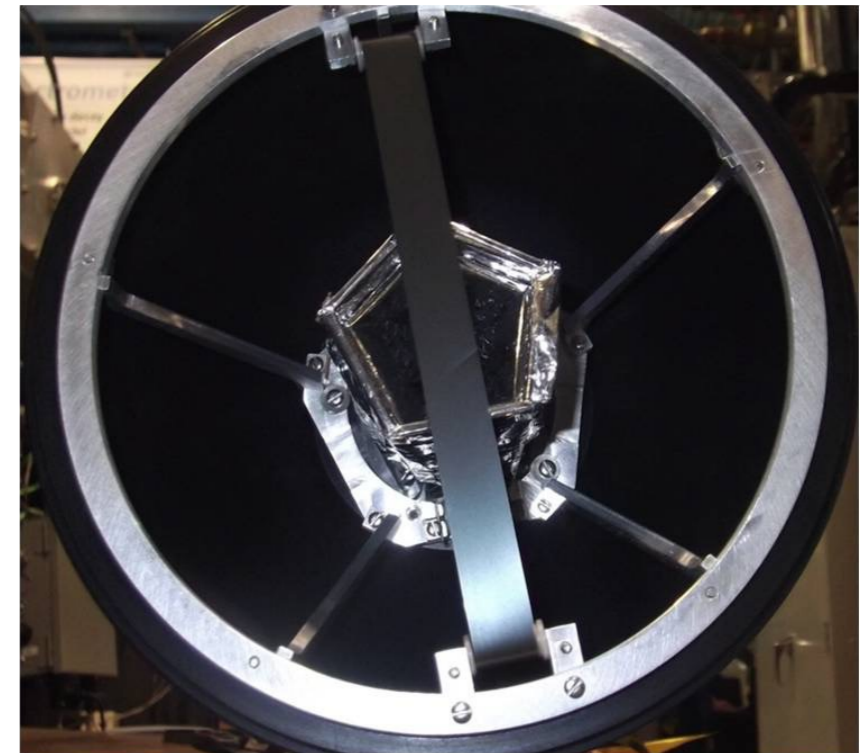
To study ^{122}Xe , β -decay experiment of ^{122}Cs was performed at TRIUMF-ISAC
At the centre of the 8π spectrometer, ^{122}Cs beam was implanted into a mylar tape.



5 Si(Li) PACES array



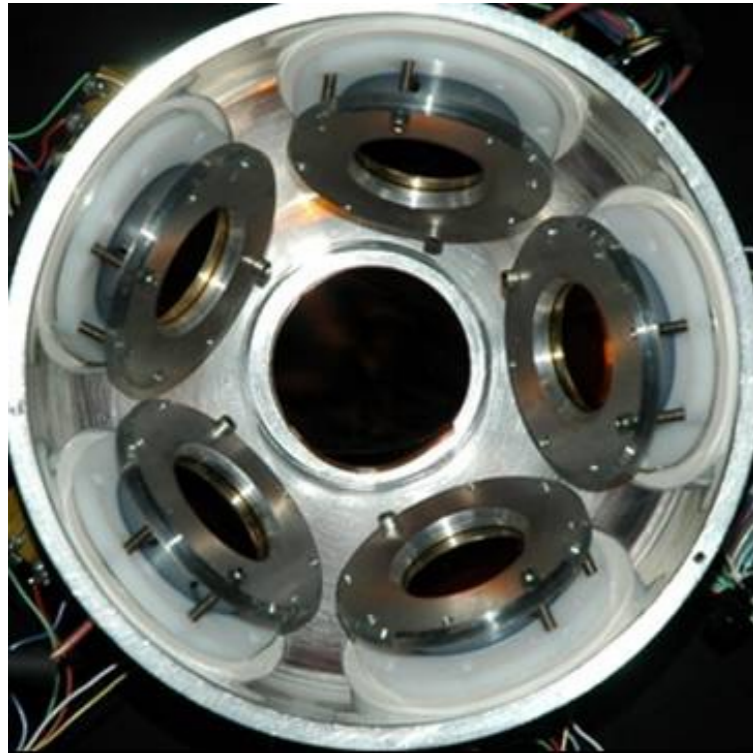
One hemisphere of the 8π



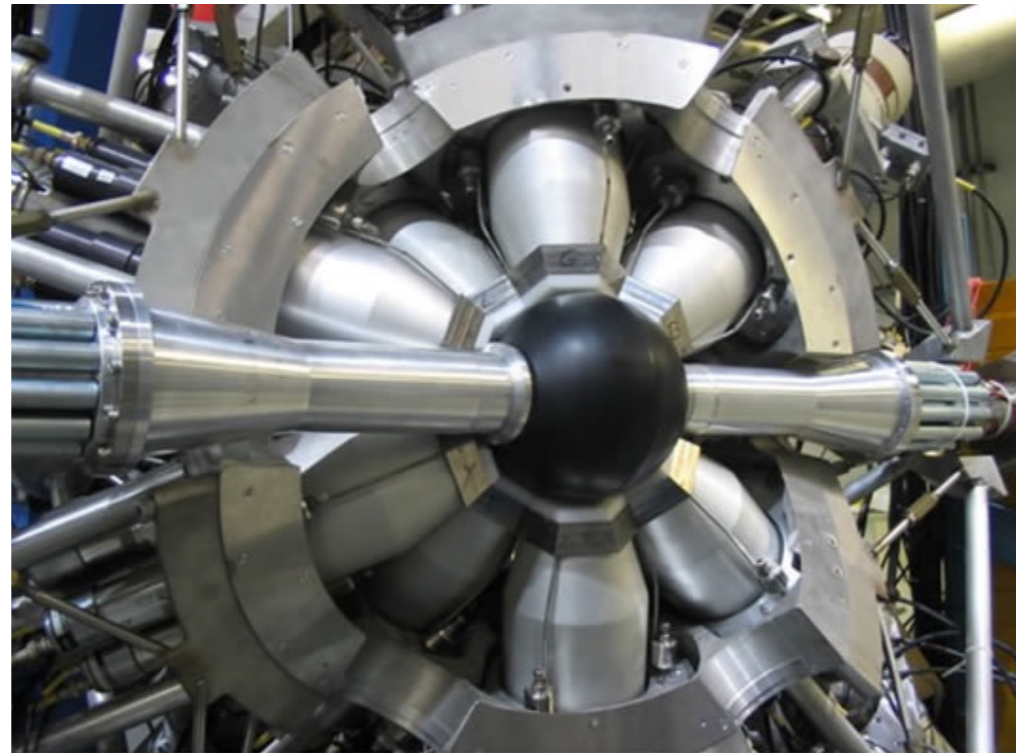
10 thin PSc. SCEPTAR array

Detectors

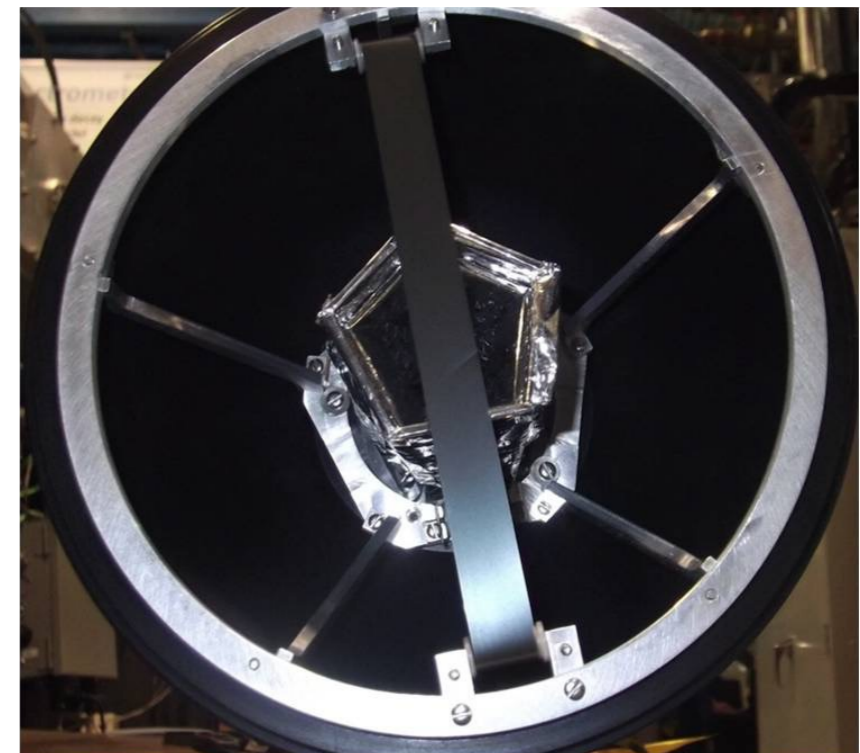
To study ^{122}Xe , β -decay experiment of ^{122}Cs was performed at TRIUMF-ISAC
 At the centre of the 8π spectrometer, ^{122}Cs beam was implanted into a mylar tape.



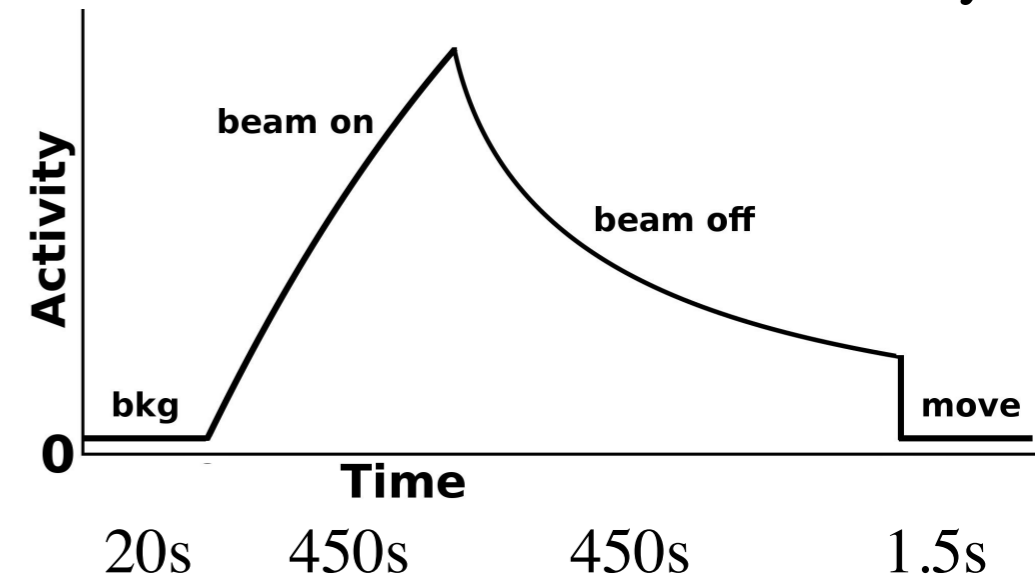
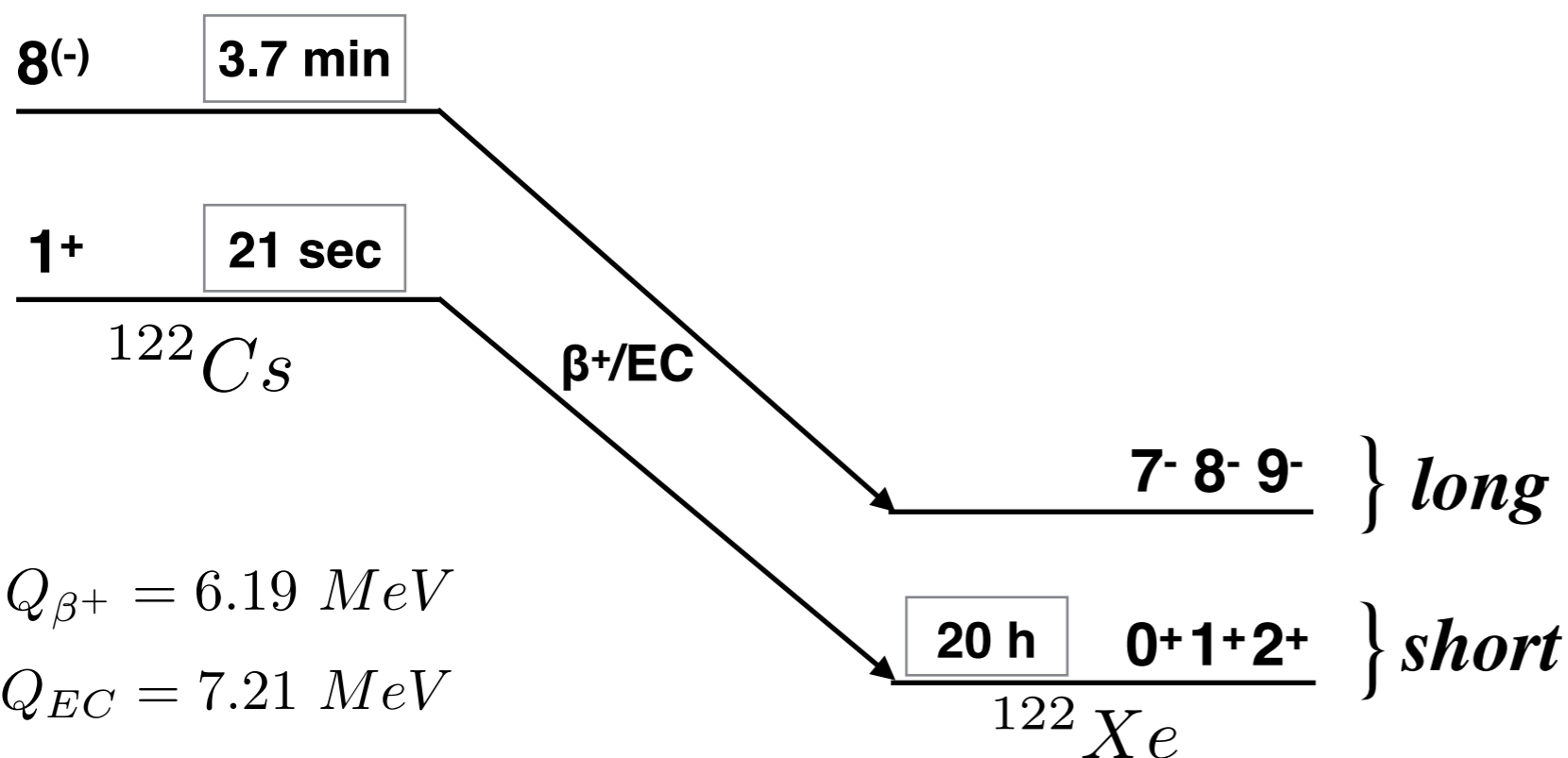
5 Si(Li) PACES array



One hemisphere of the 8π

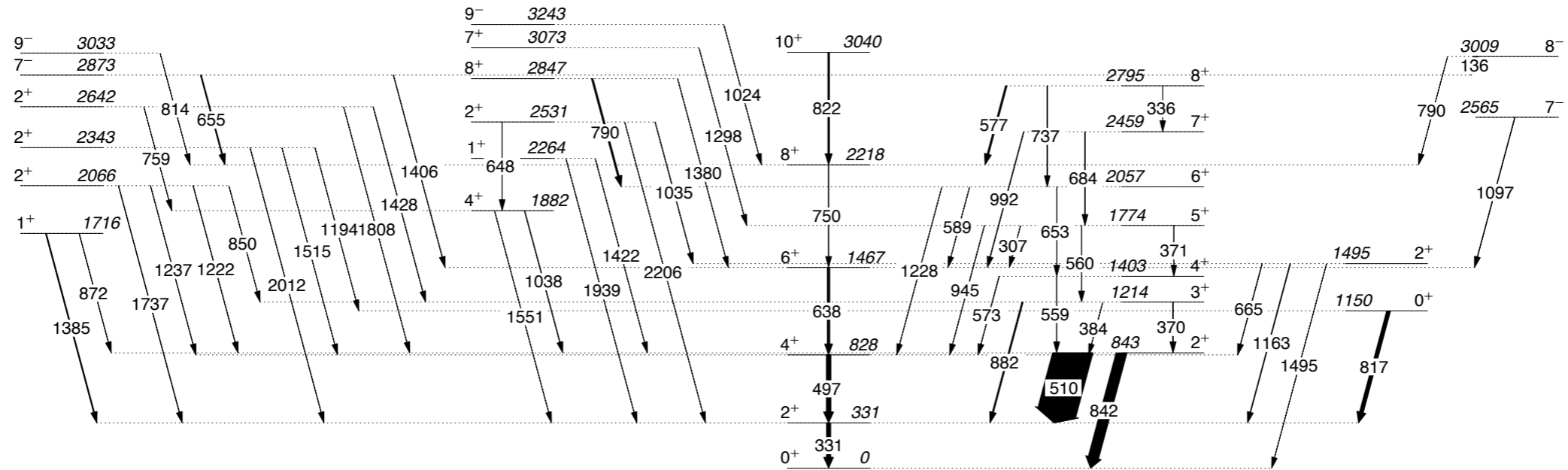


10 thin PSc. SCEPTAR array



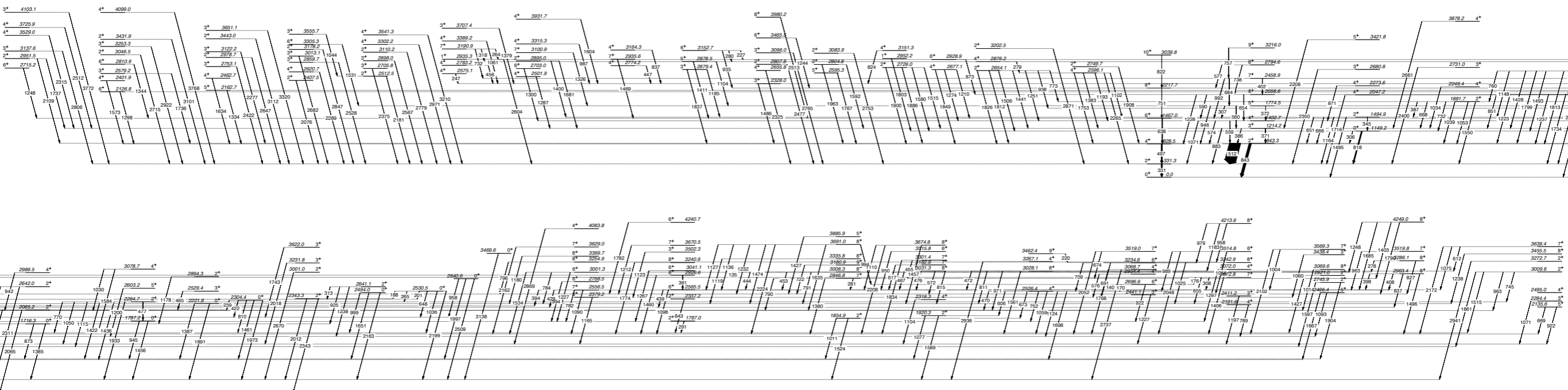
Results

Short cycle



Old 30 levels and 55 transitions

New level scheme of ^{122}Xe from **short** cycled runs optimized for the ground state decay of ^{122}Cs

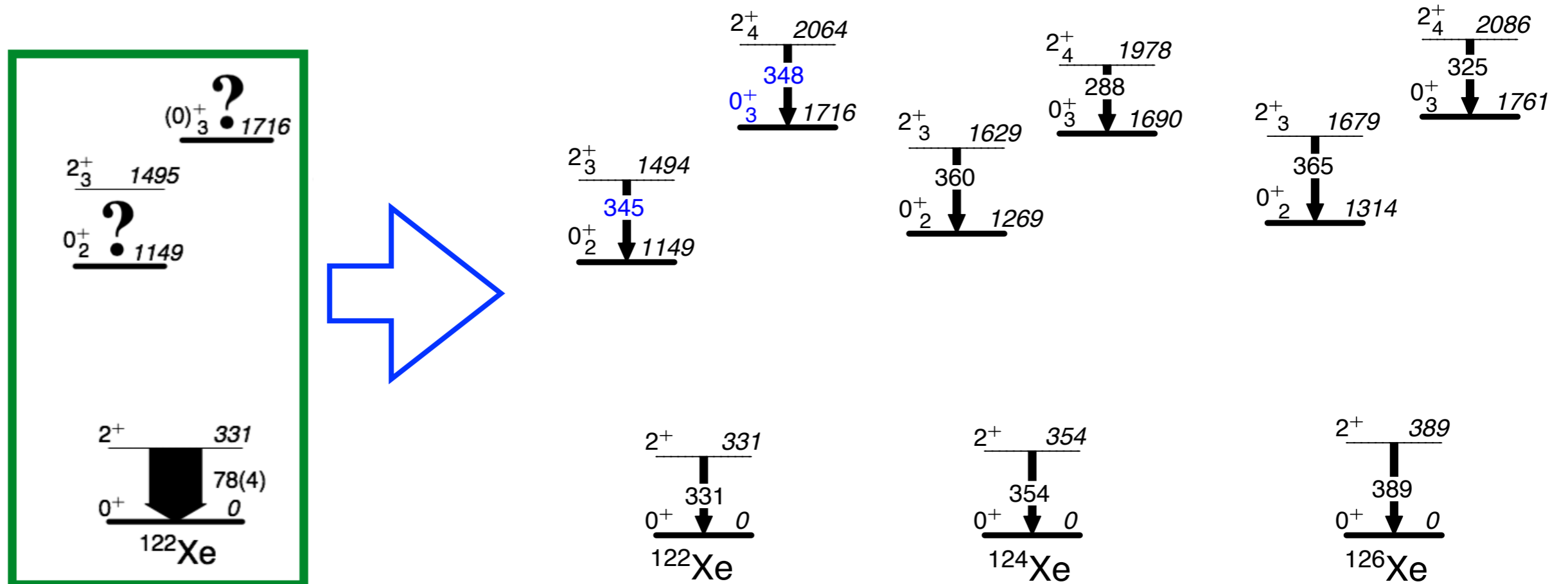


Xe-122 level scheme extended with 151 new levels and 270 new transitions

Results

Short cycle

We have seen two important in-band E2 transitions first time

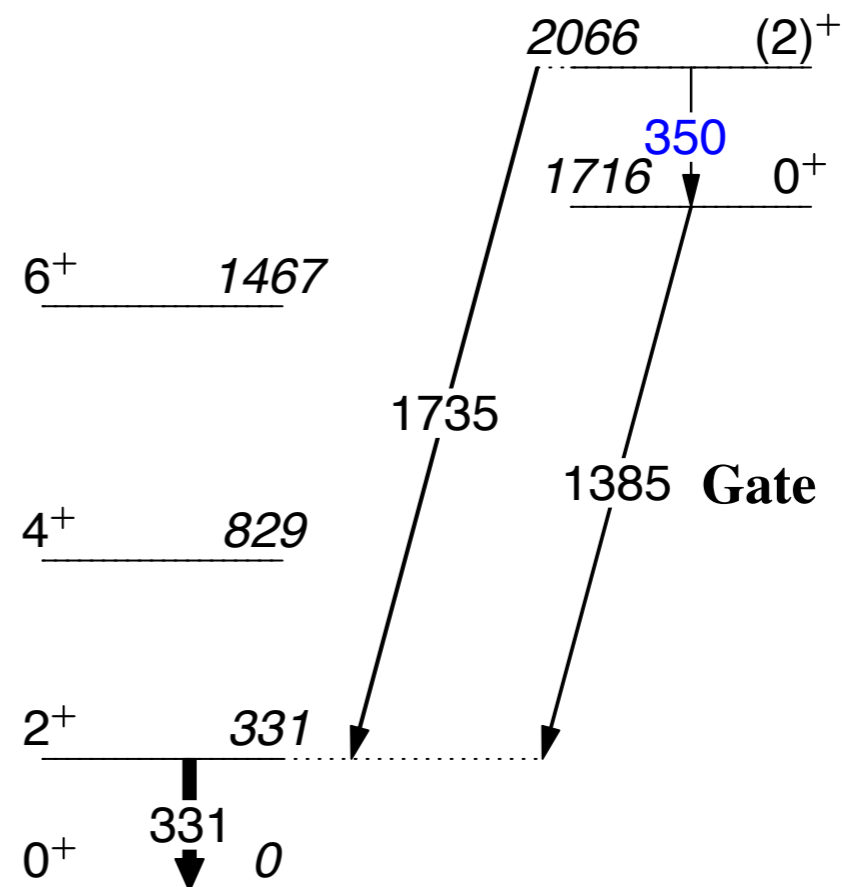
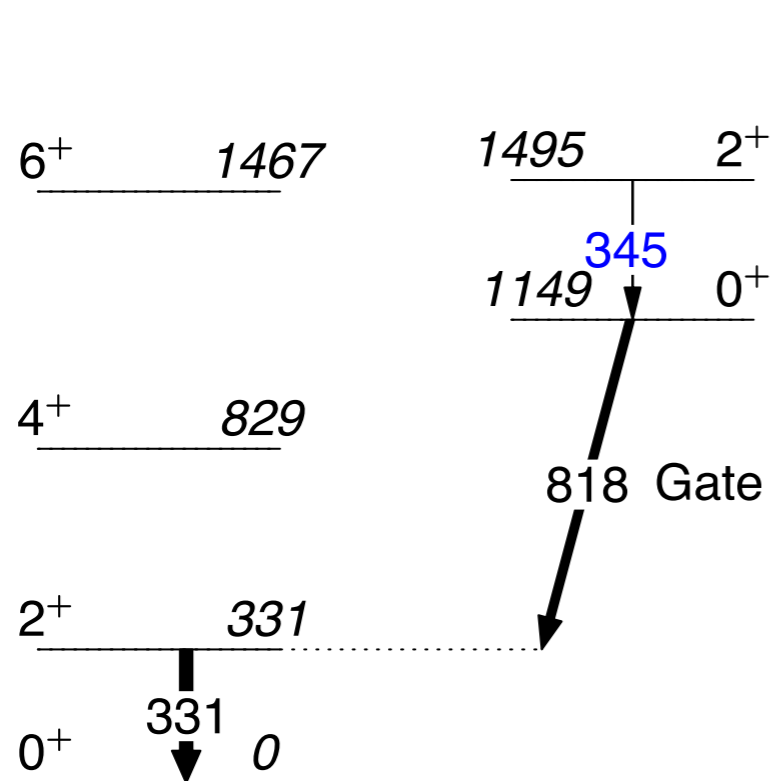
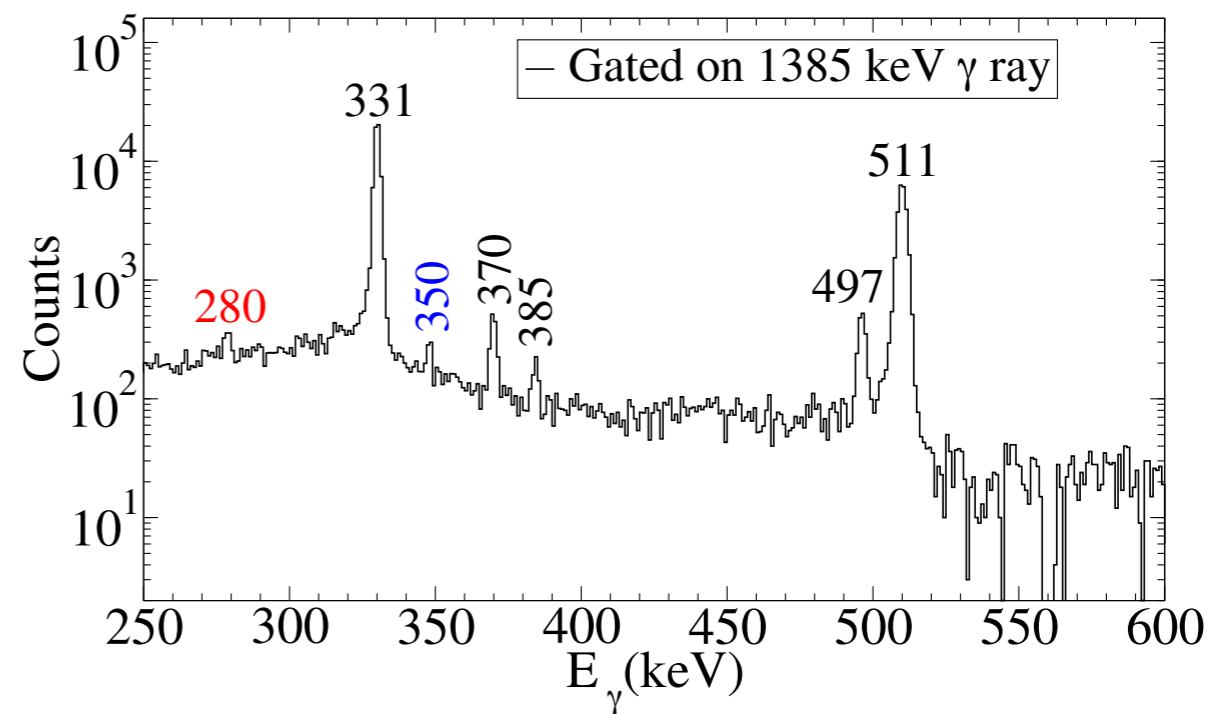
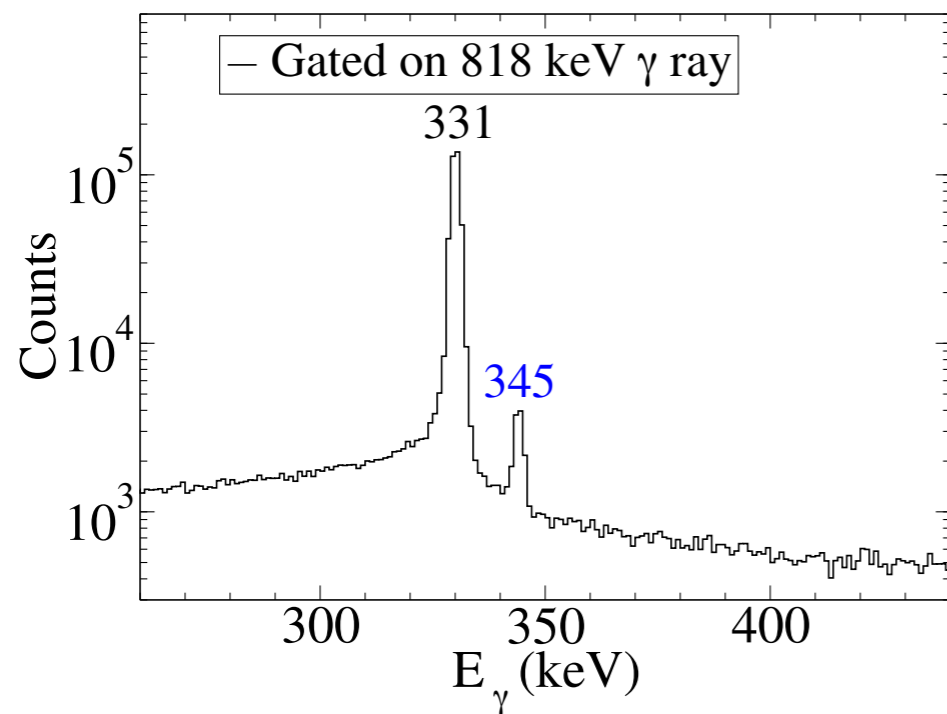


Systematics of the low-lying 0^+ states.

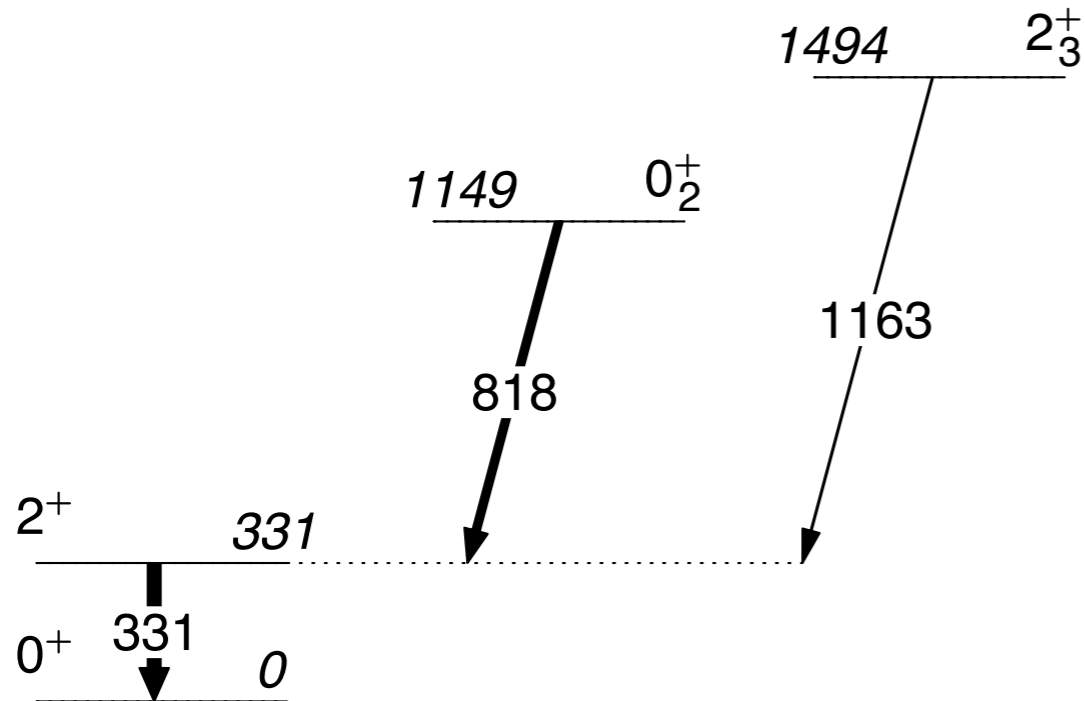
Results

Short cycle

We have seen two important in-band E2 transitions first time

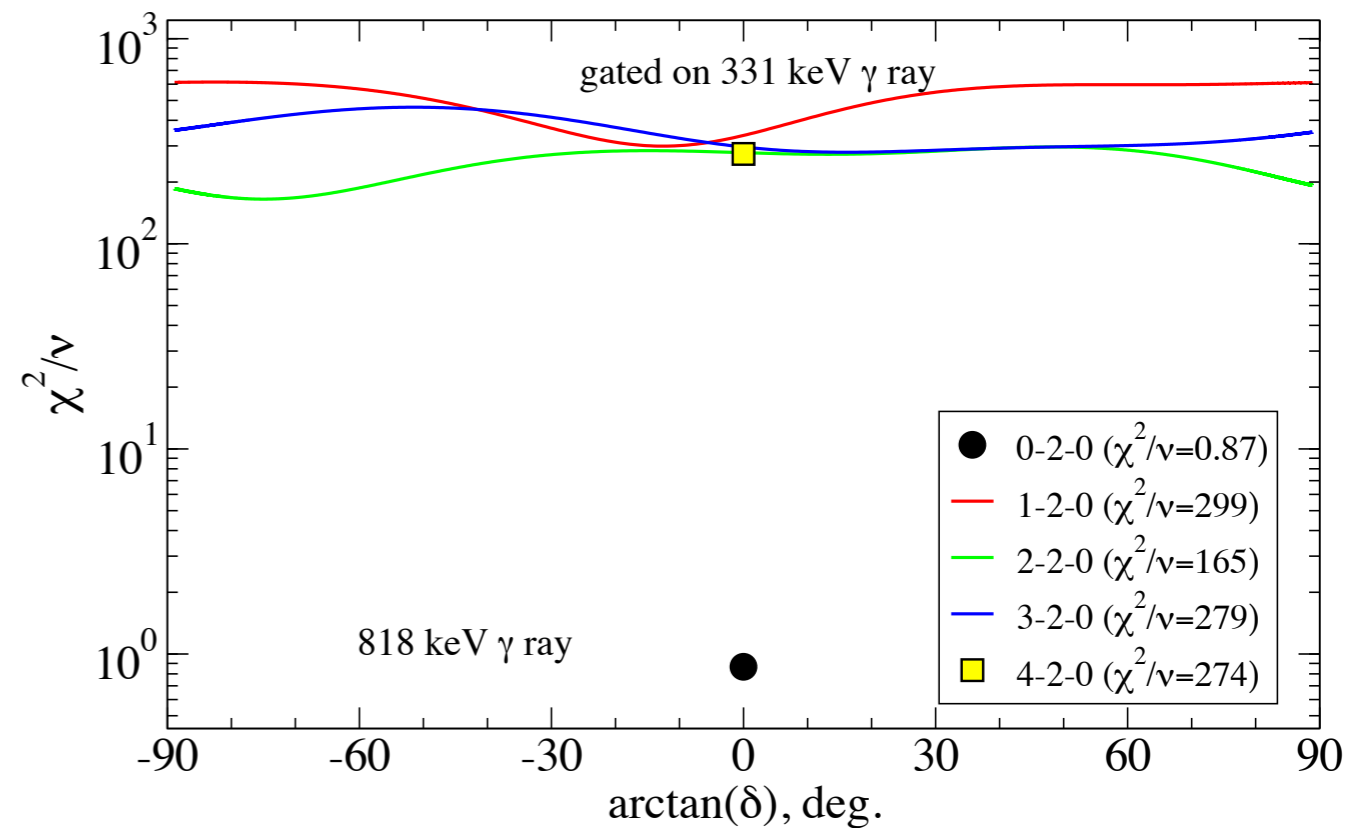
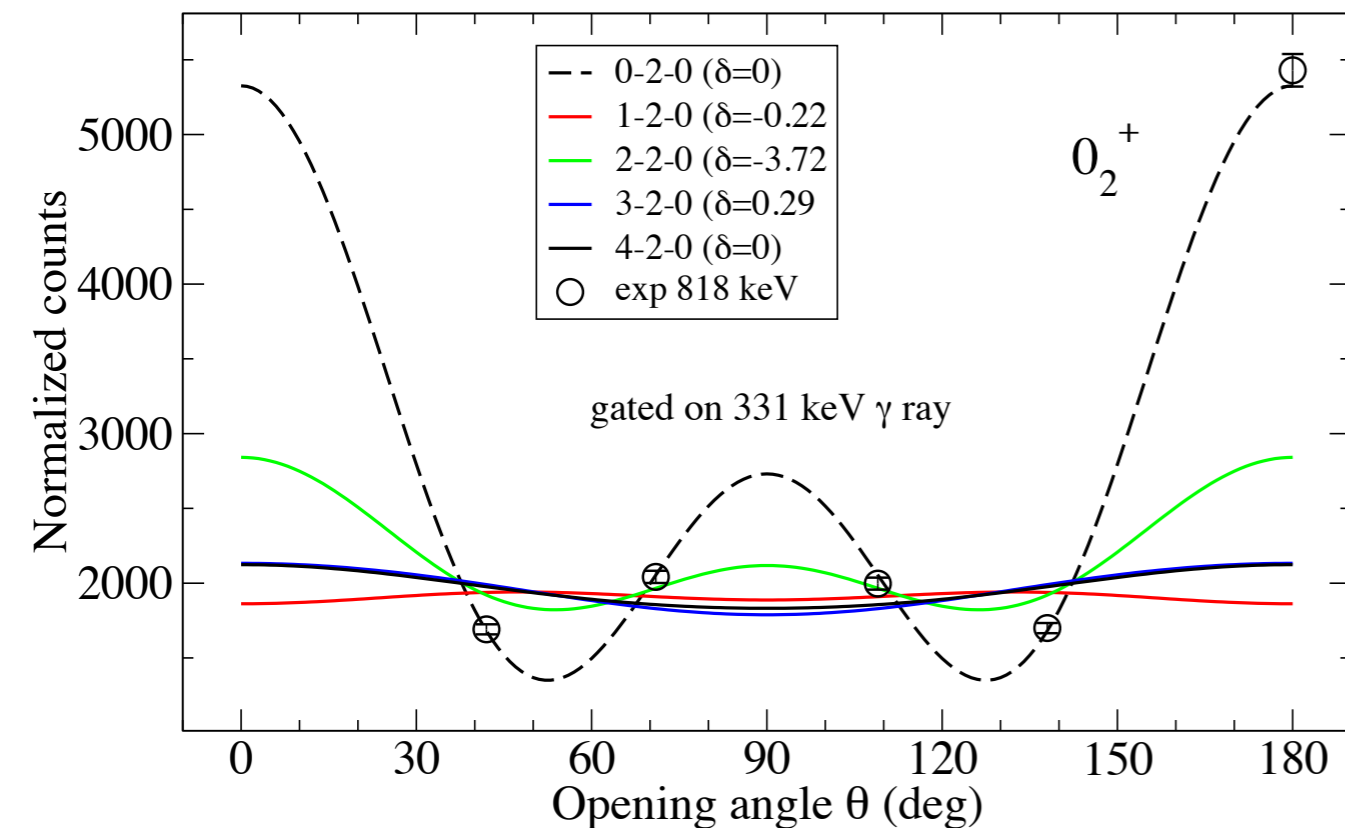


Results: Angular correlation analysis

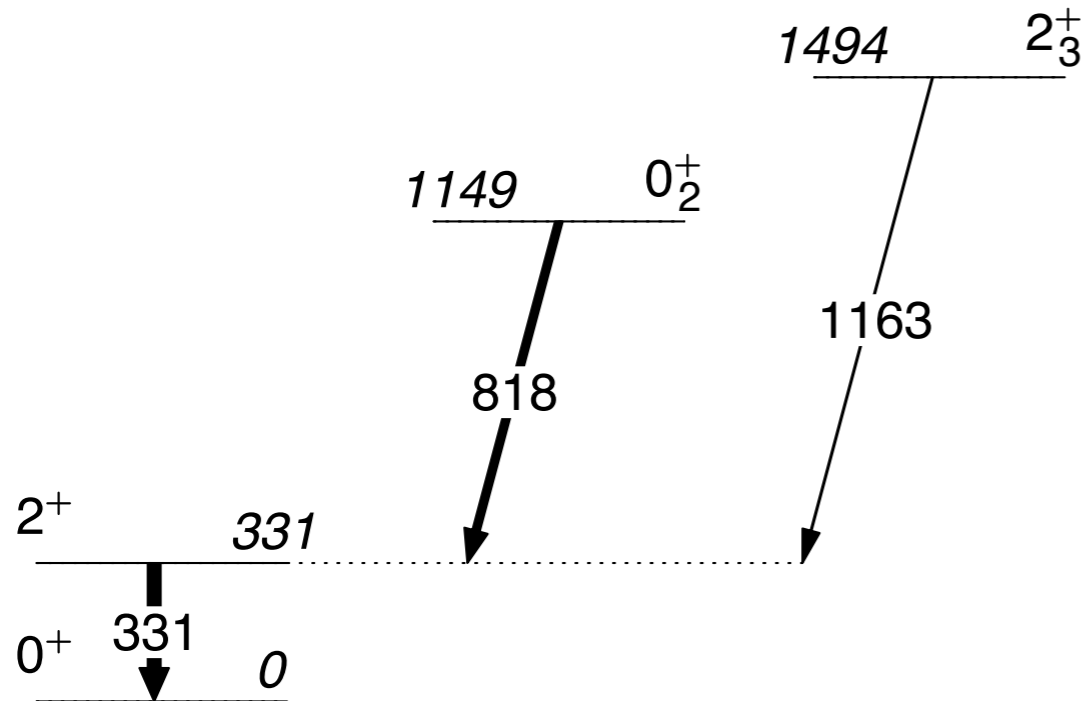


$$W(\theta) = \sum_{k=0}^{2L} a_k P_k(\cos\theta)$$

Legendre polynomials
 $a_k(J_i, \sigma l, \delta)$

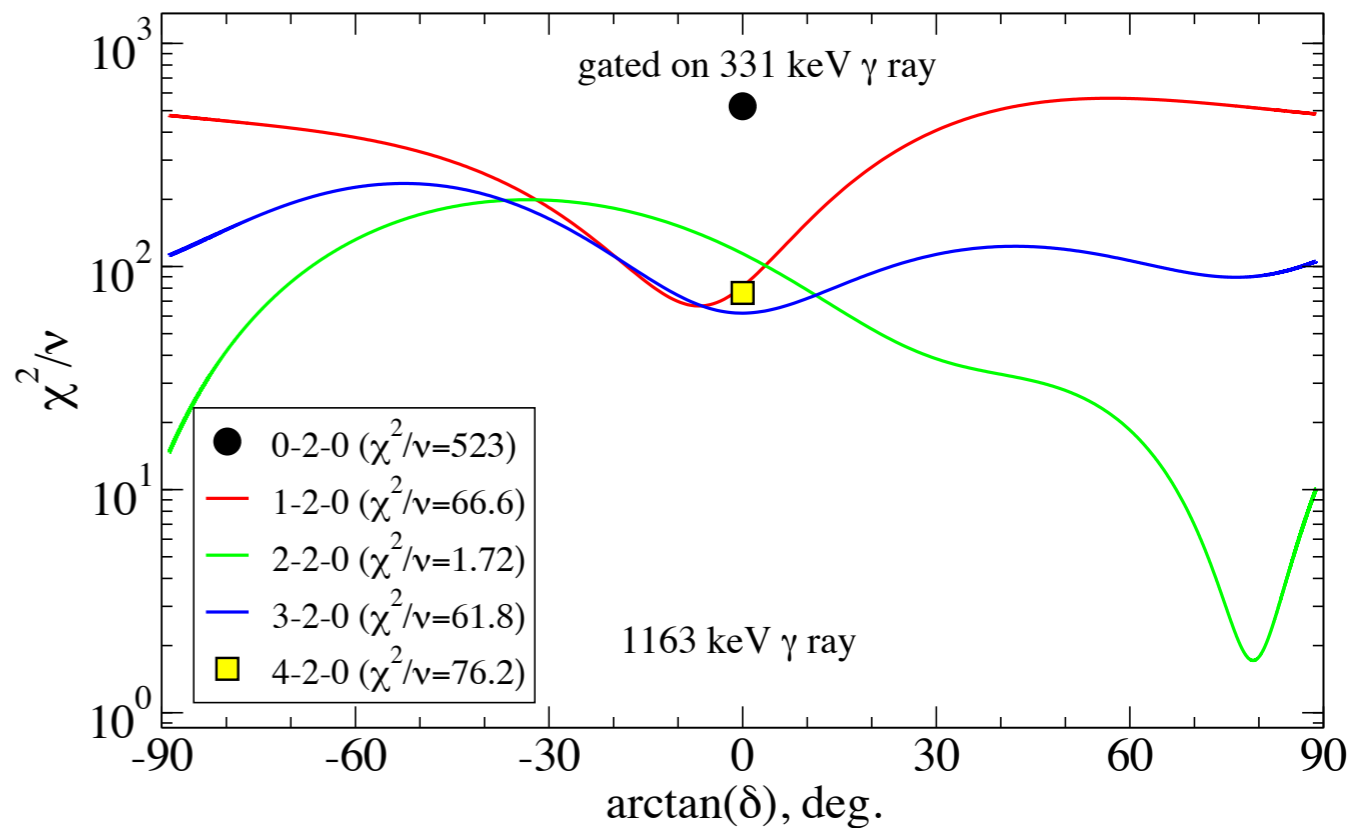
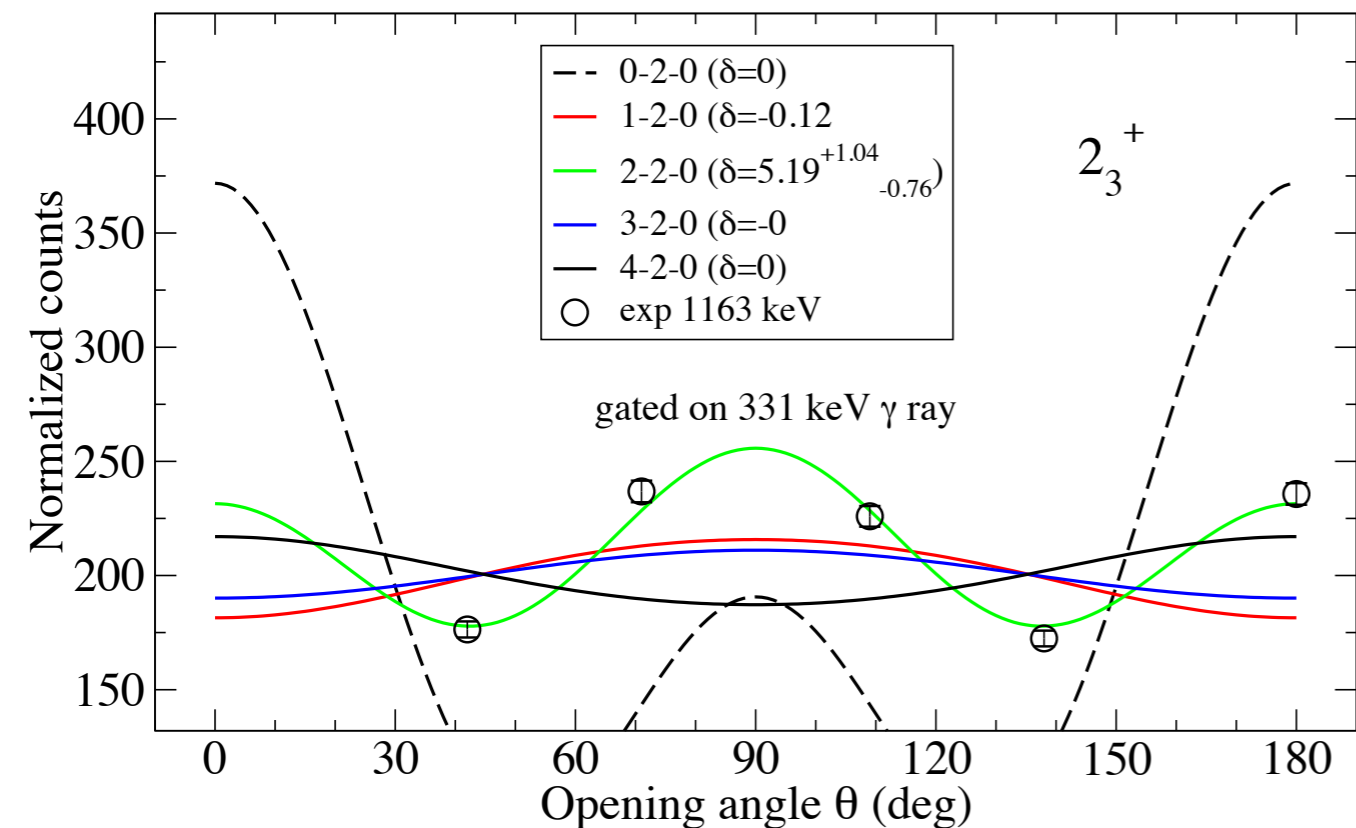


Results: Angular correlation analysis



$$W(\theta) = \sum_{k=0}^{2L} a_k P_k(\cos\theta)$$

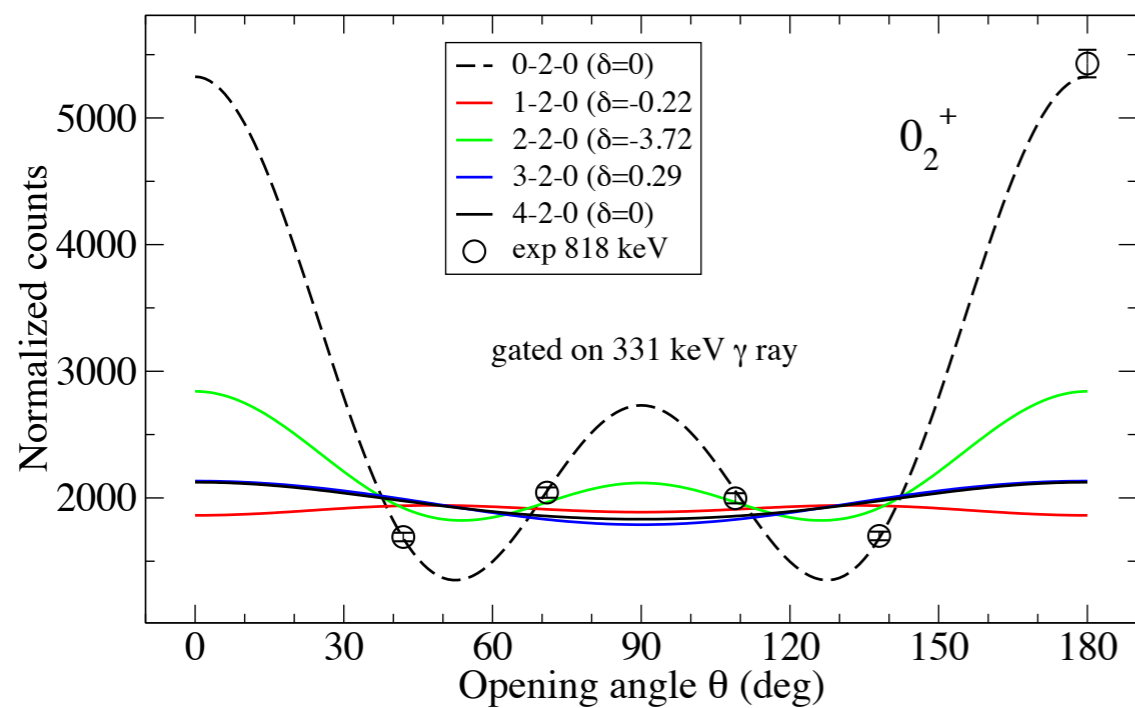
$a_k(J_i, \sigma l, \delta)$ Legendre polynomials



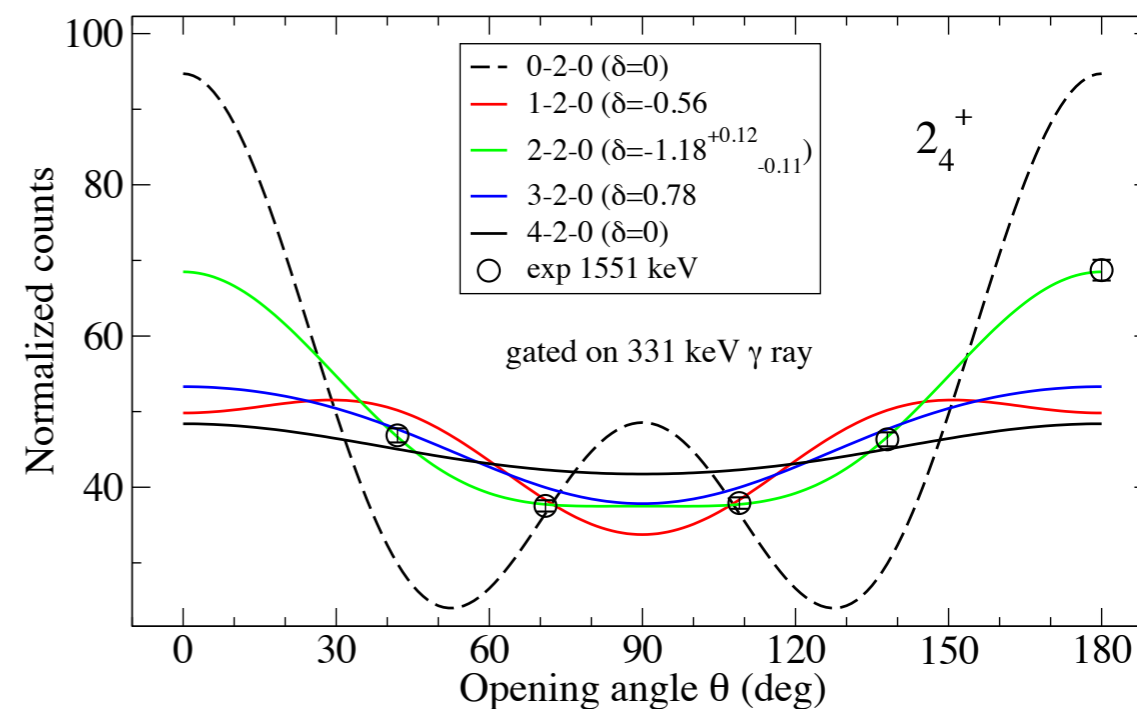
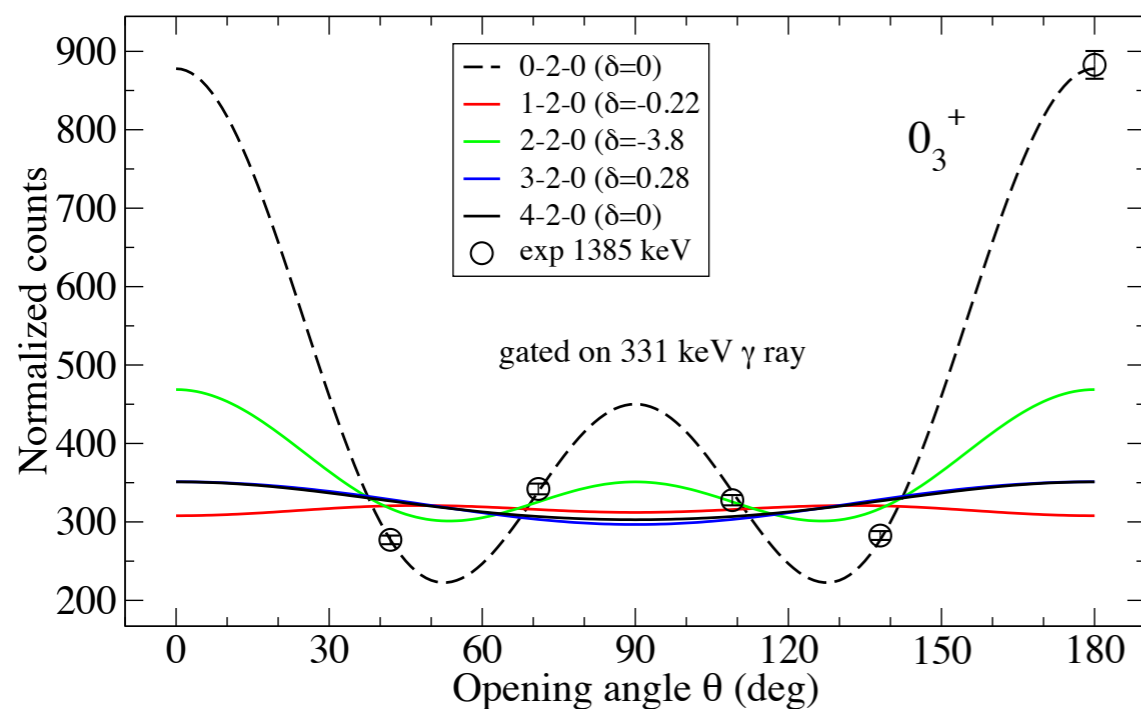
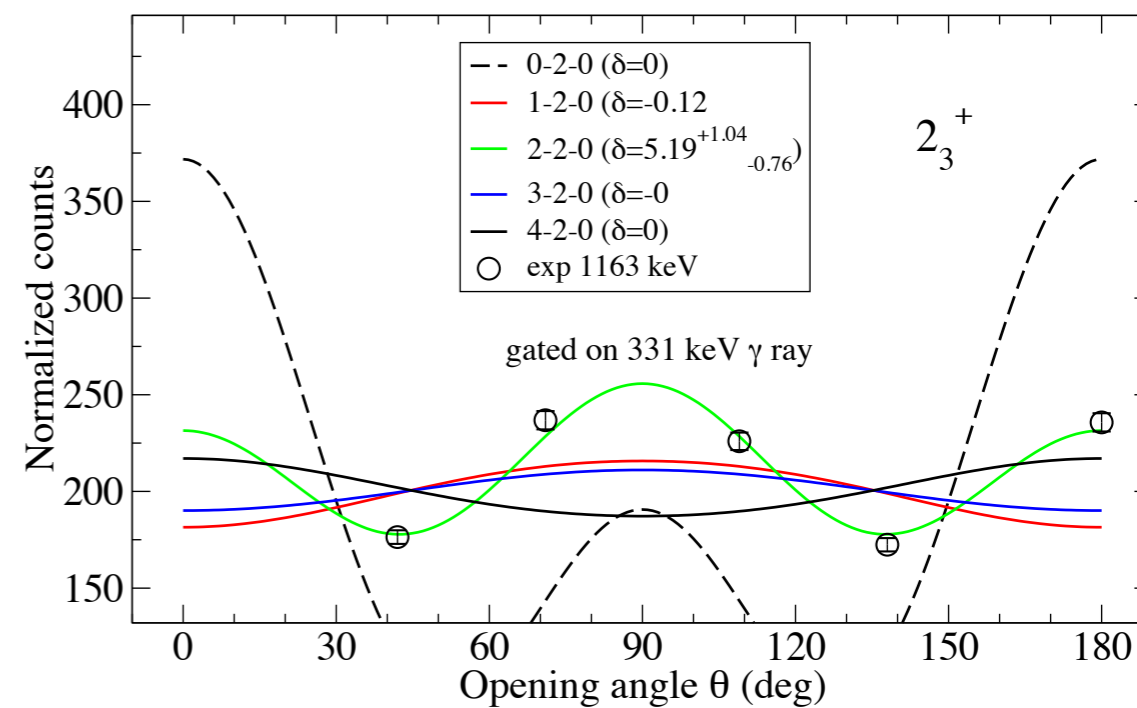
Results

Short cycle

- 0^+ states observed



- 2^+ states observed



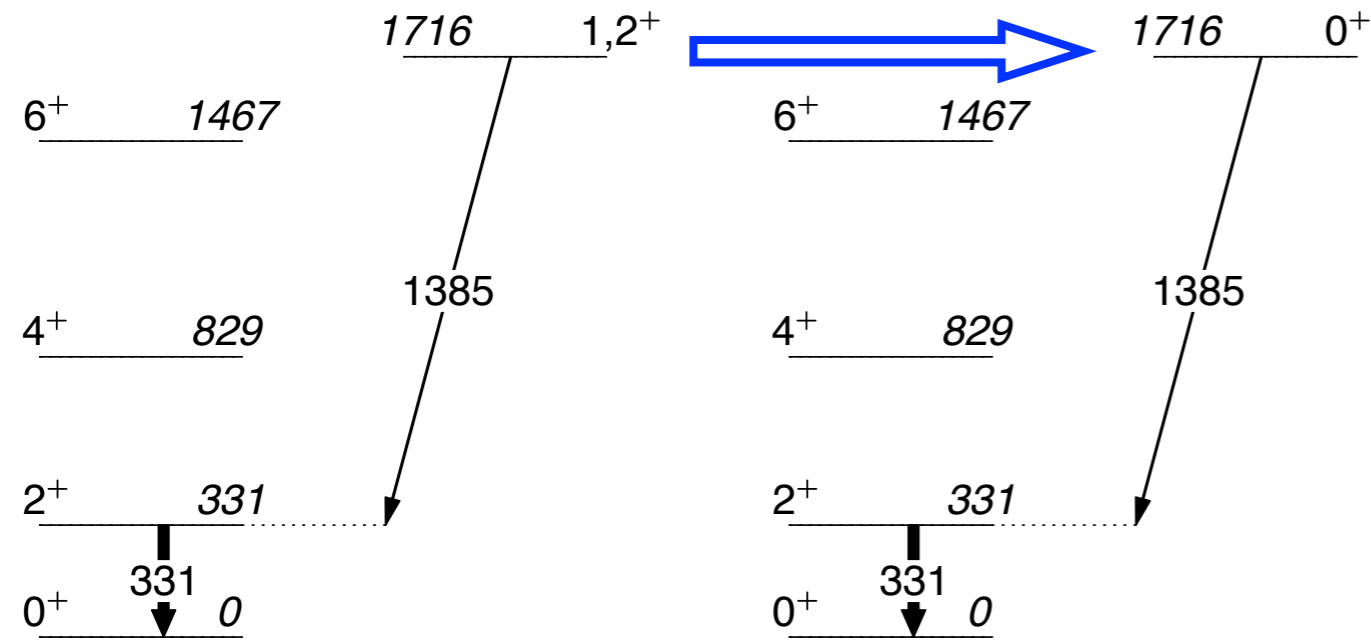
8 new 0^+ states observed

13 new 2^+ states observed

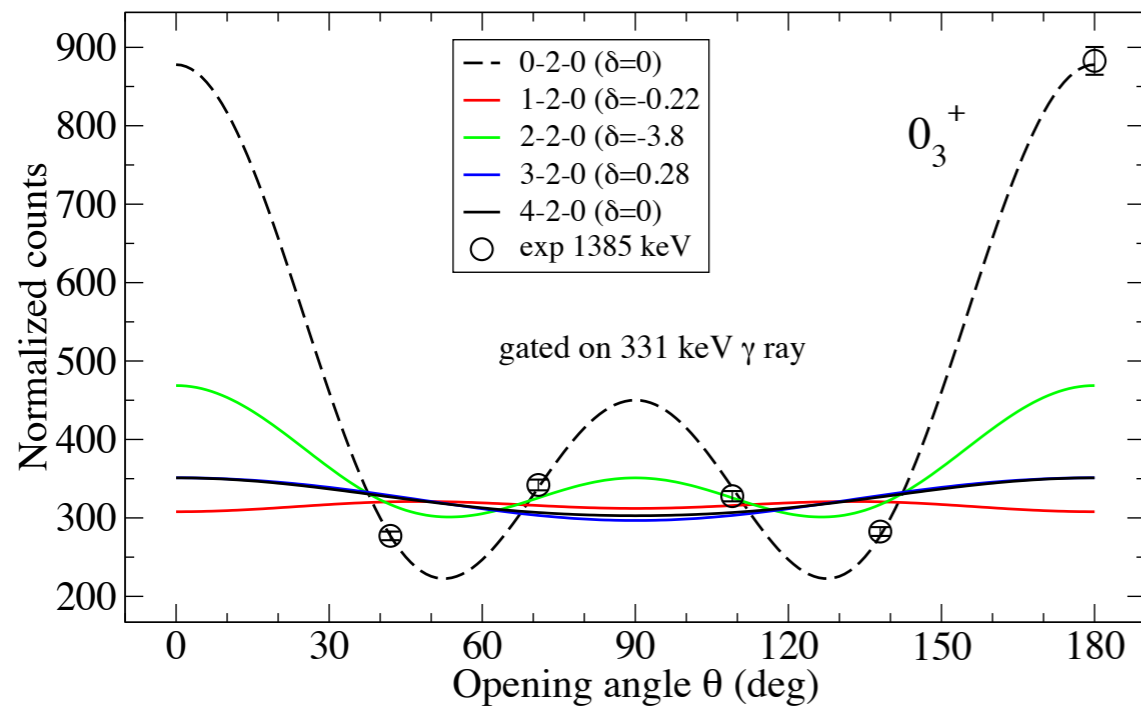
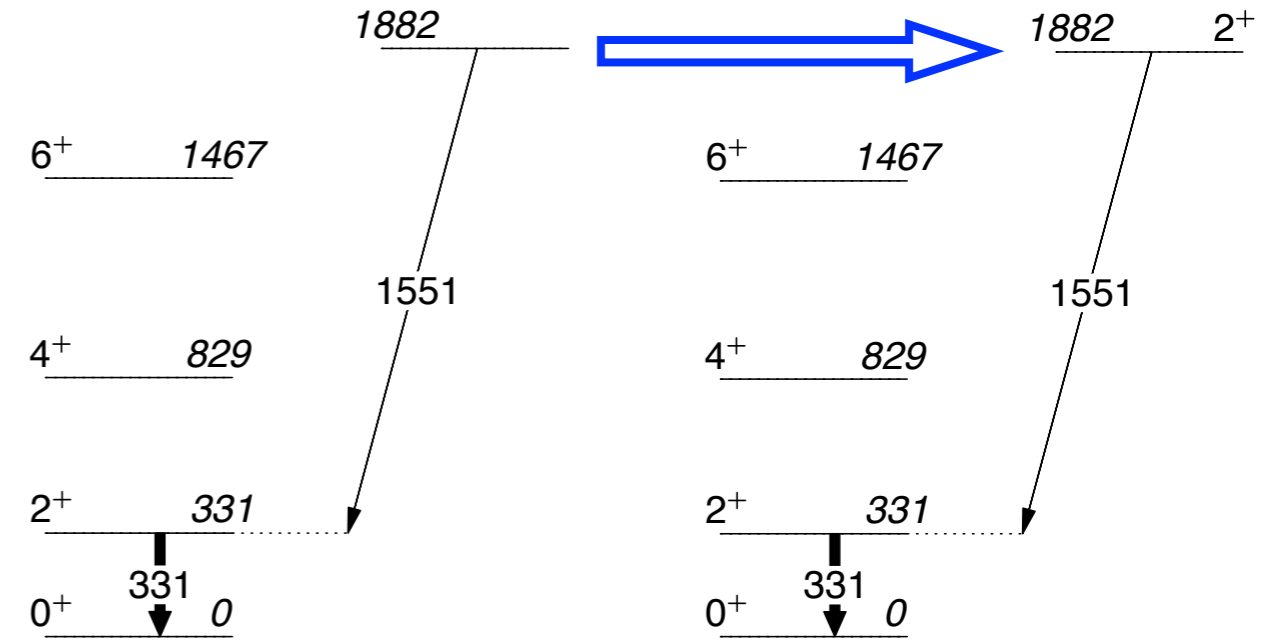
Results

Short cycle

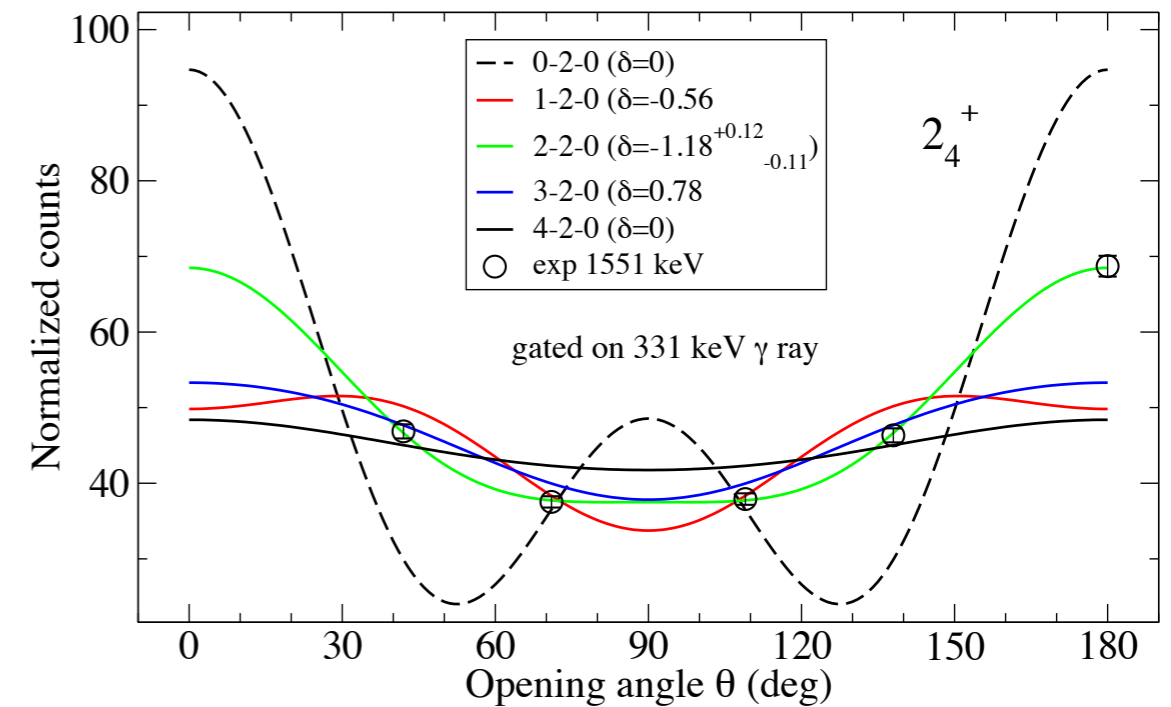
- 0^+ states observed



- 2^+ states observed



AC of 331 keV and 1385 keV

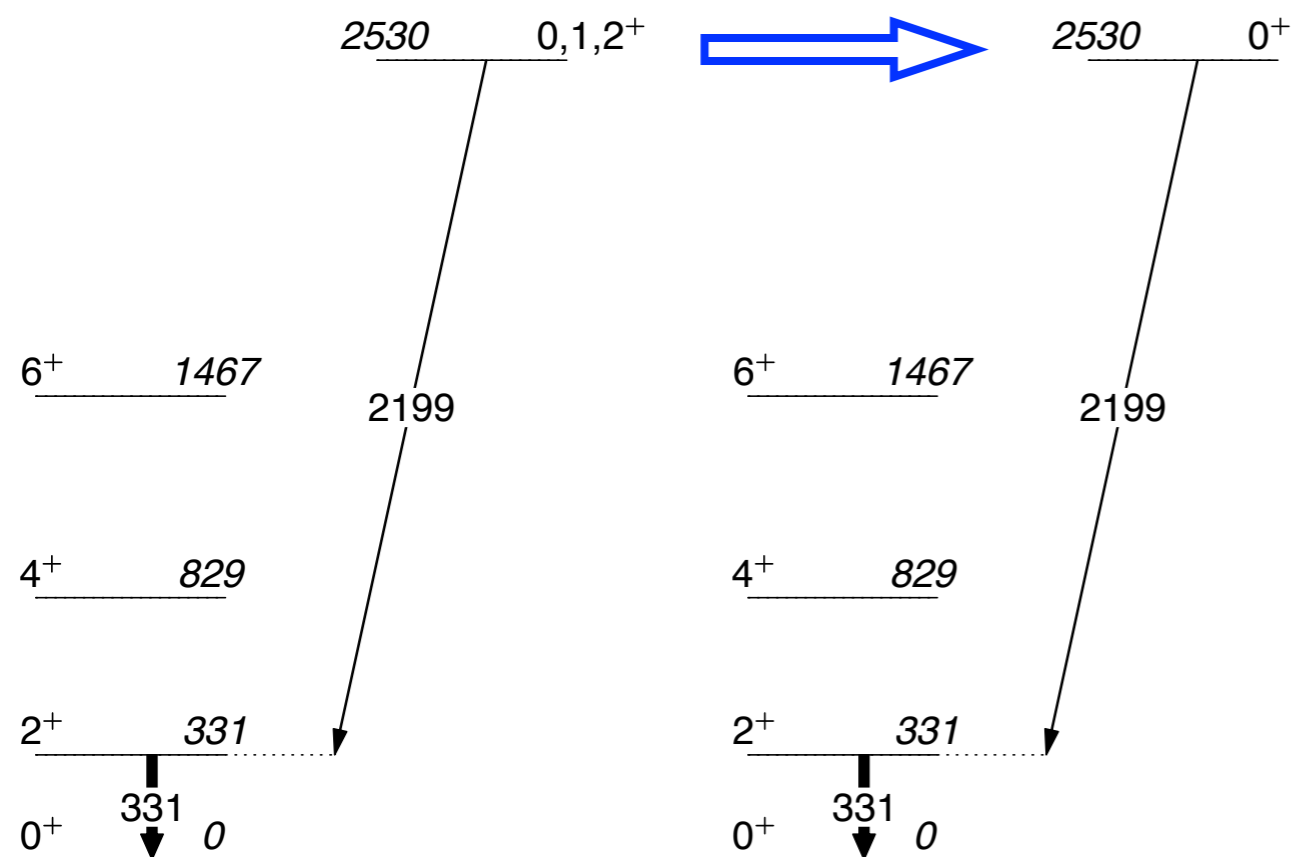


AC of 331 keV and 1551 keV

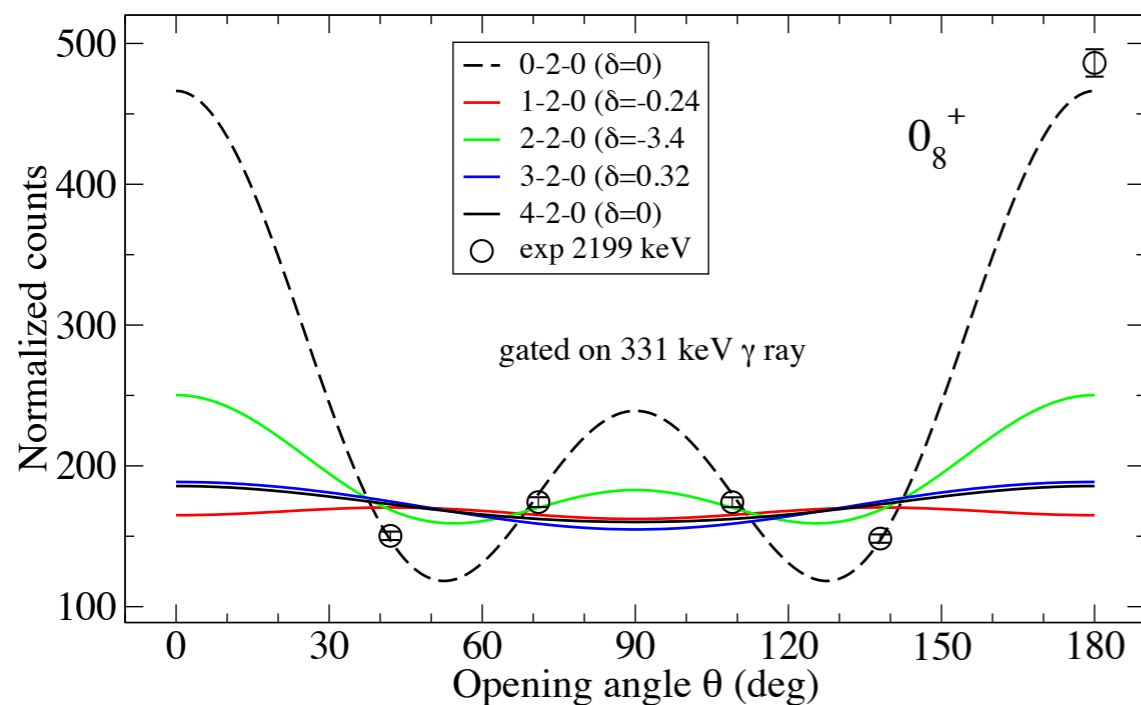
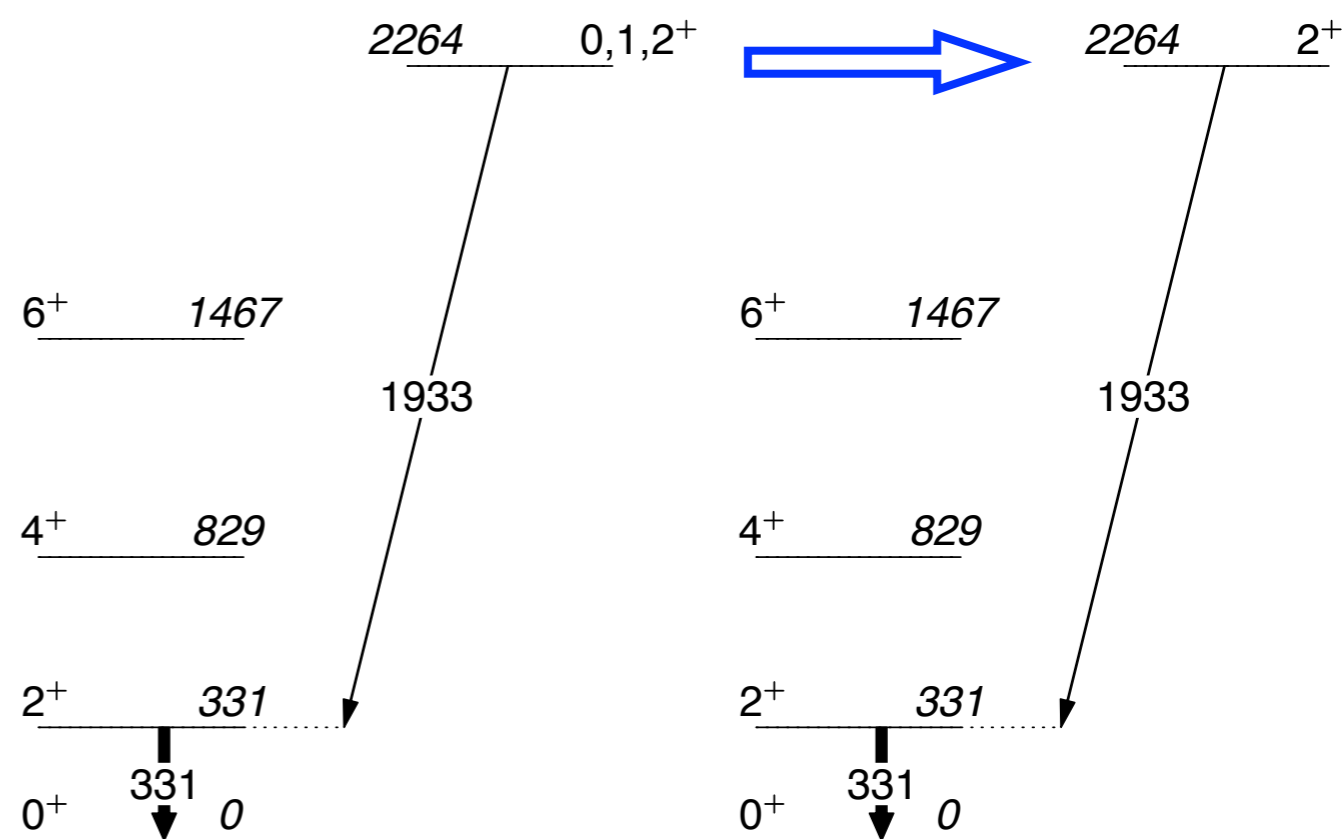
Results

Short cycle

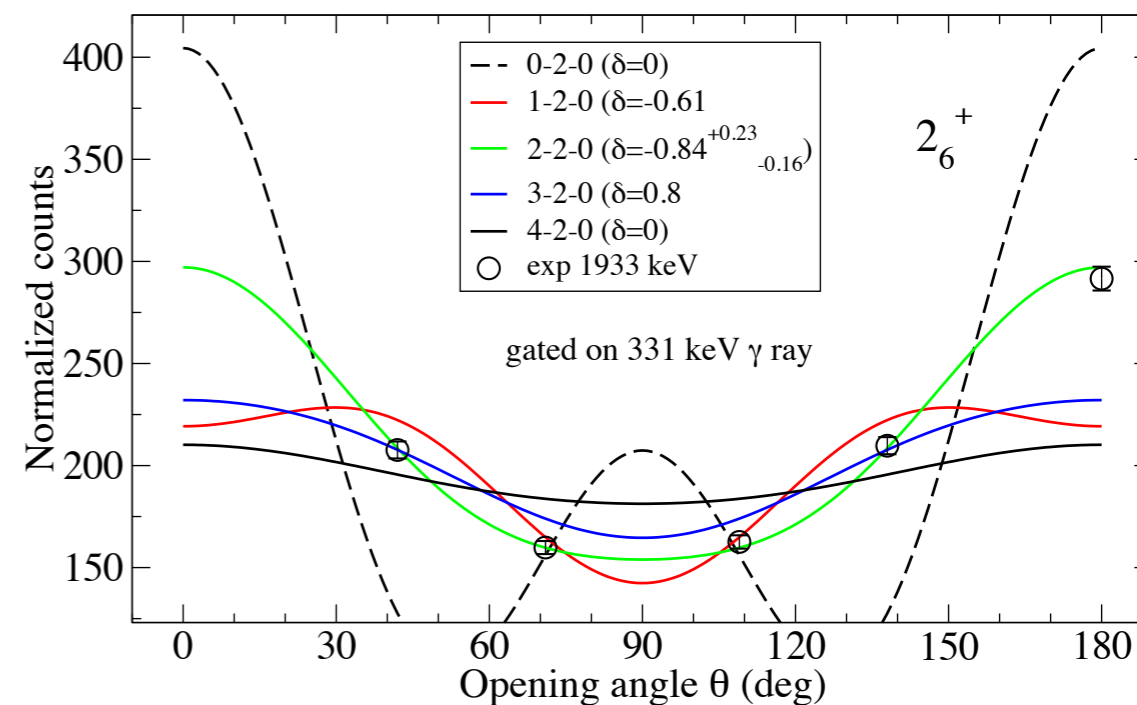
- 0^+ states observed



- 2^+ states observed



AC of 331 keV and 2199 keV

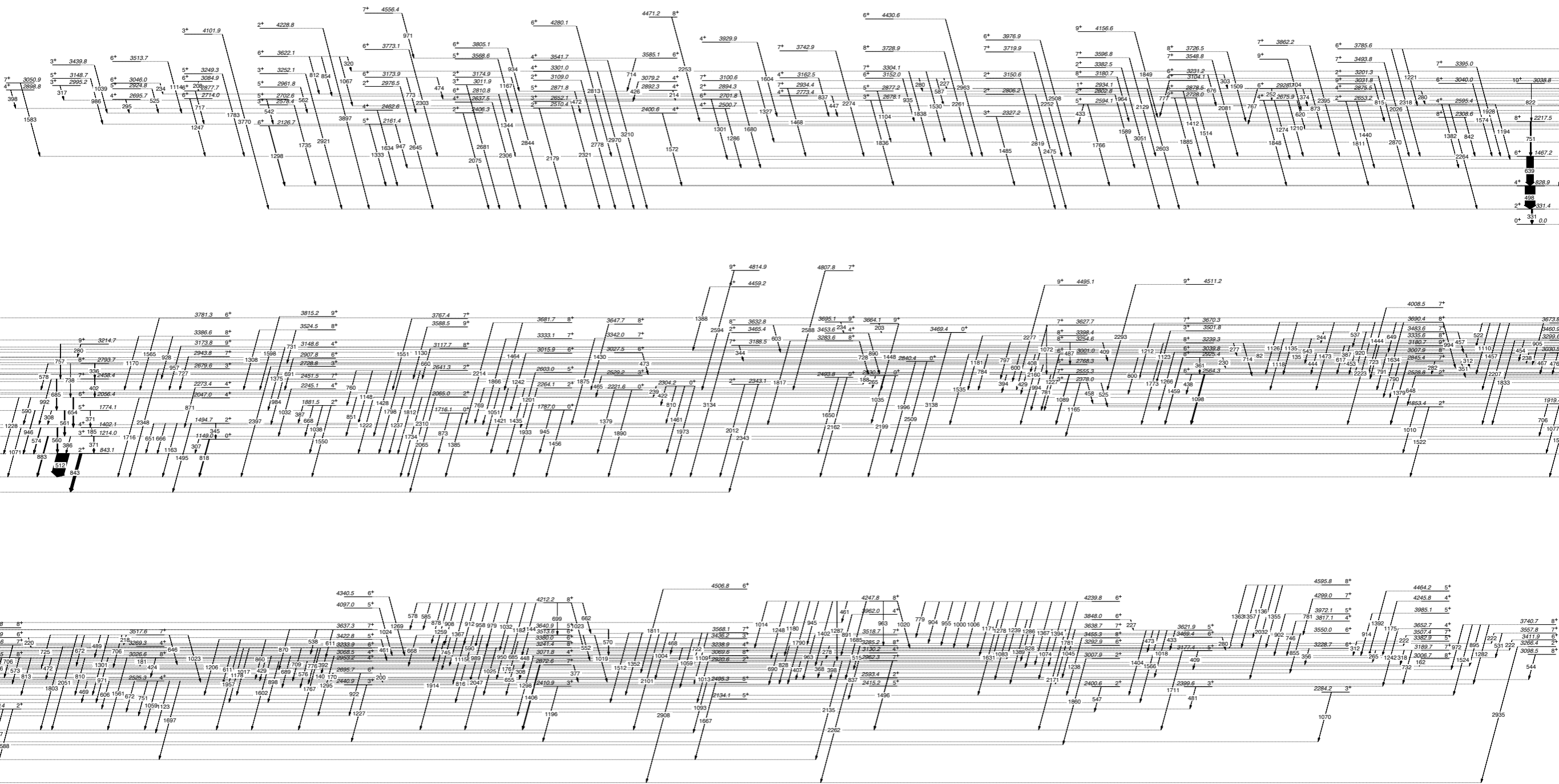


AC of 331 keV and 1933 keV

Results

Long cycle

New level scheme of ^{122}Xe from long cycled runs optimized for the isomer state decay of ^{122}Cs



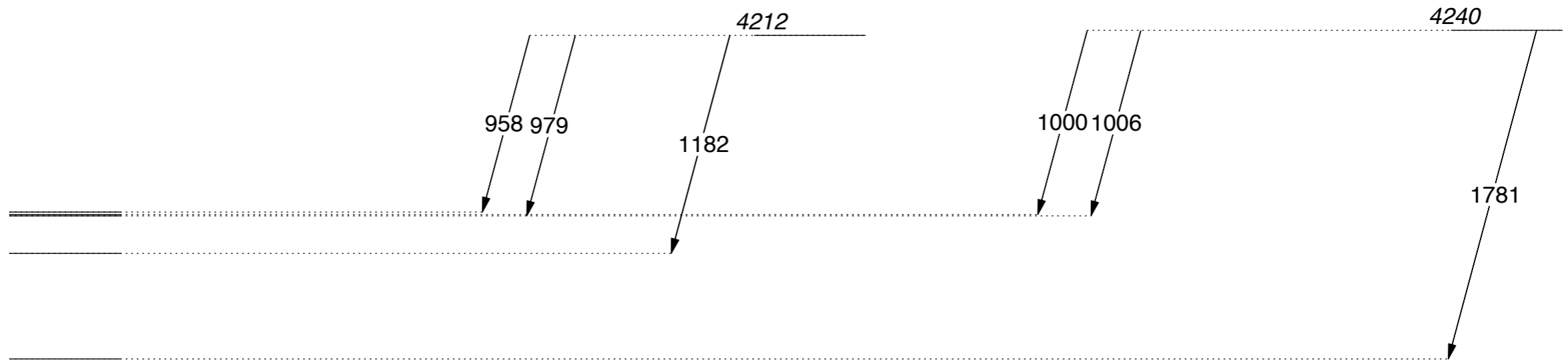
190 new transitions from short cycled runs are reproduced in long cycled runs

On top of the short cycled runs 90 new levels and 253 new transitions observed

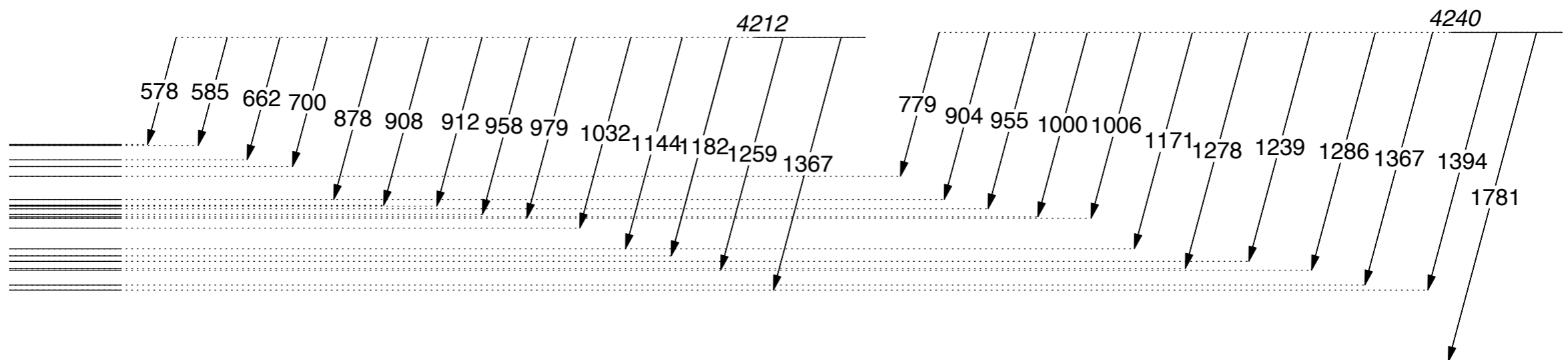
Results

Long cycle

High-spin states of ^{122}Xe from **short** cycled data



High-spin states of ^{122}Xe from **long** cycled data

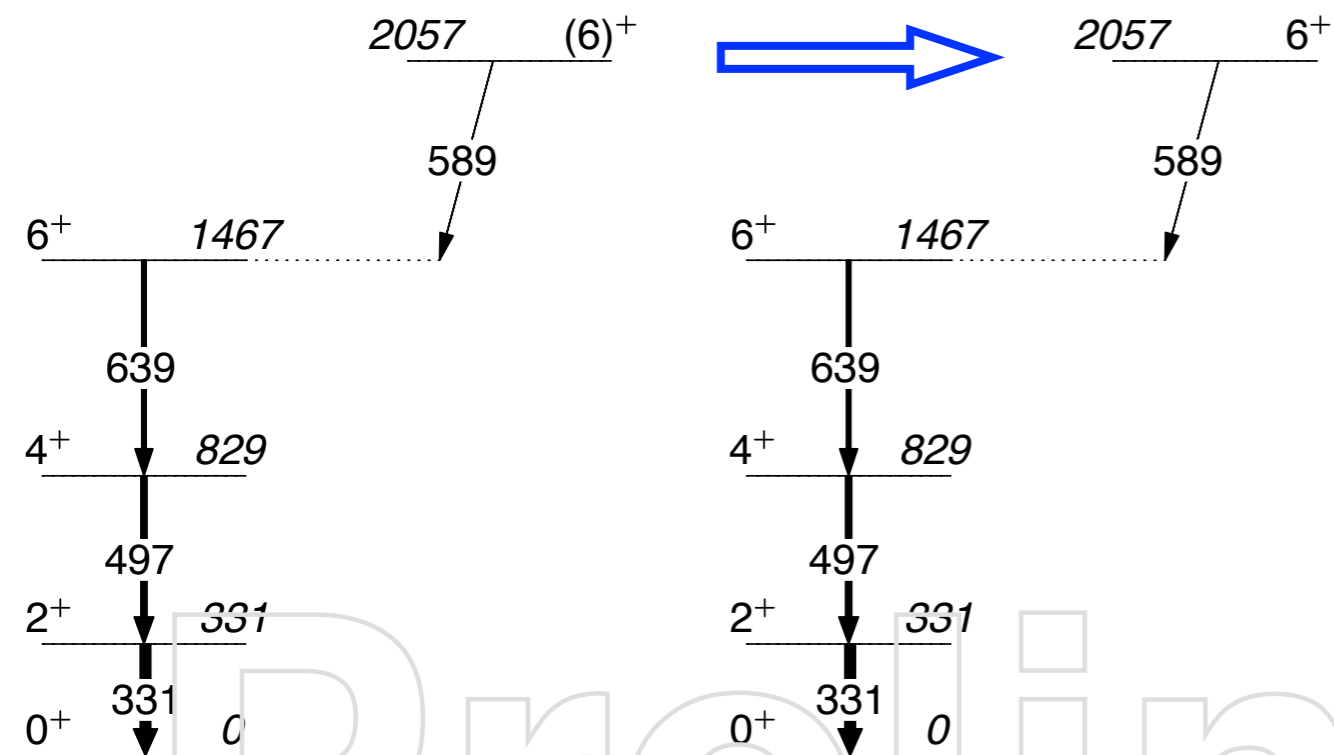


Long cycled runs strongly populate high-spin states and open many new weak branches

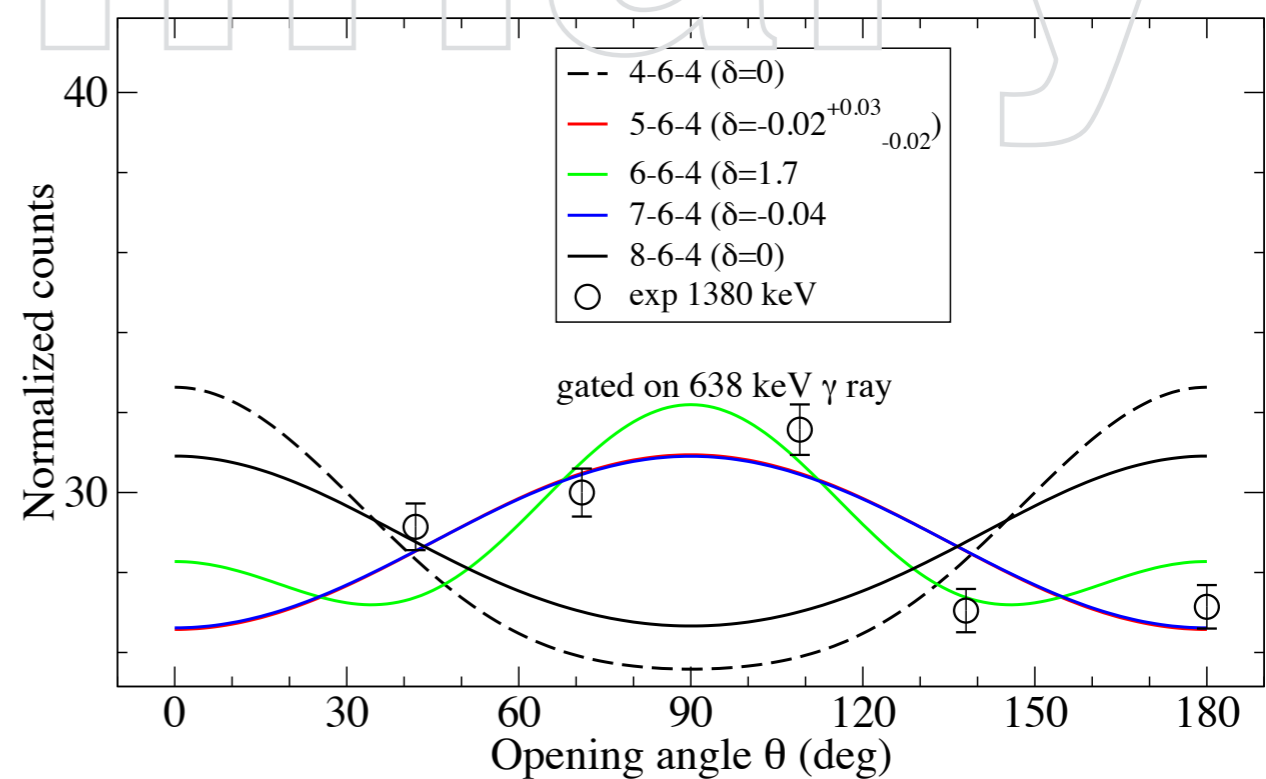
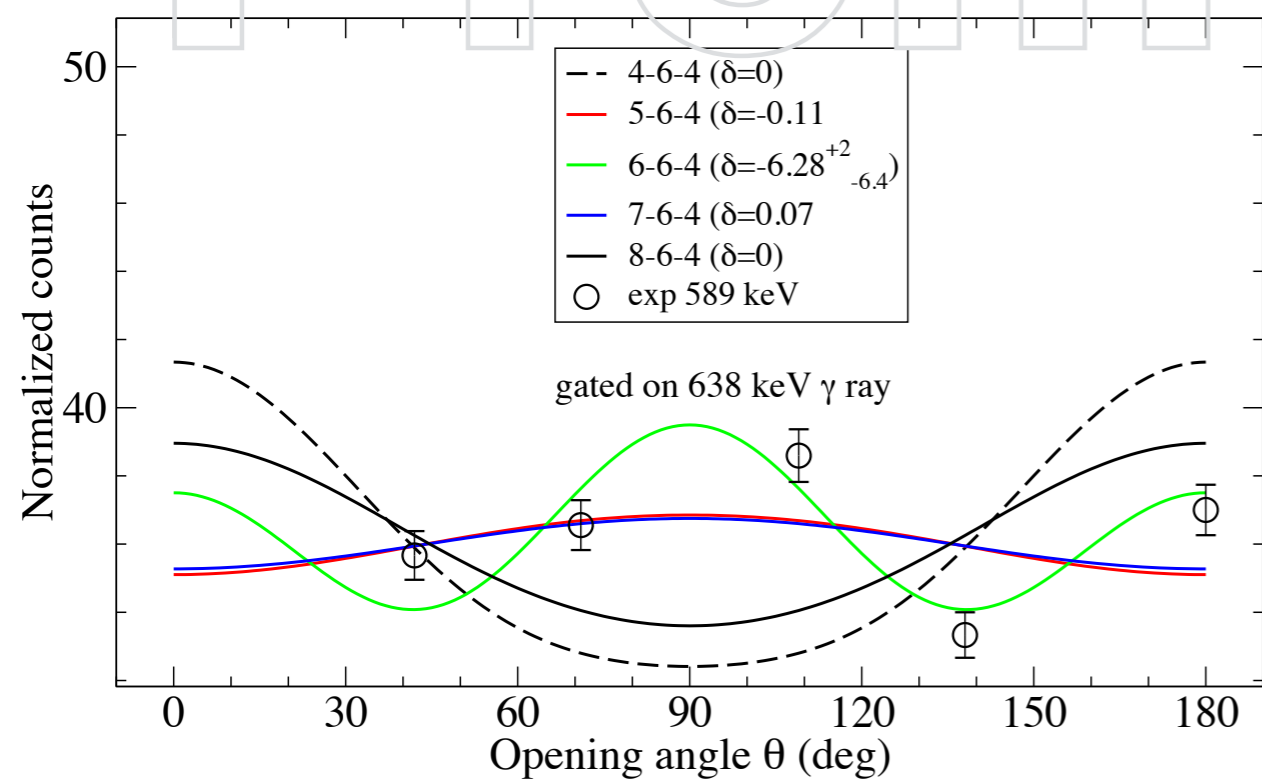
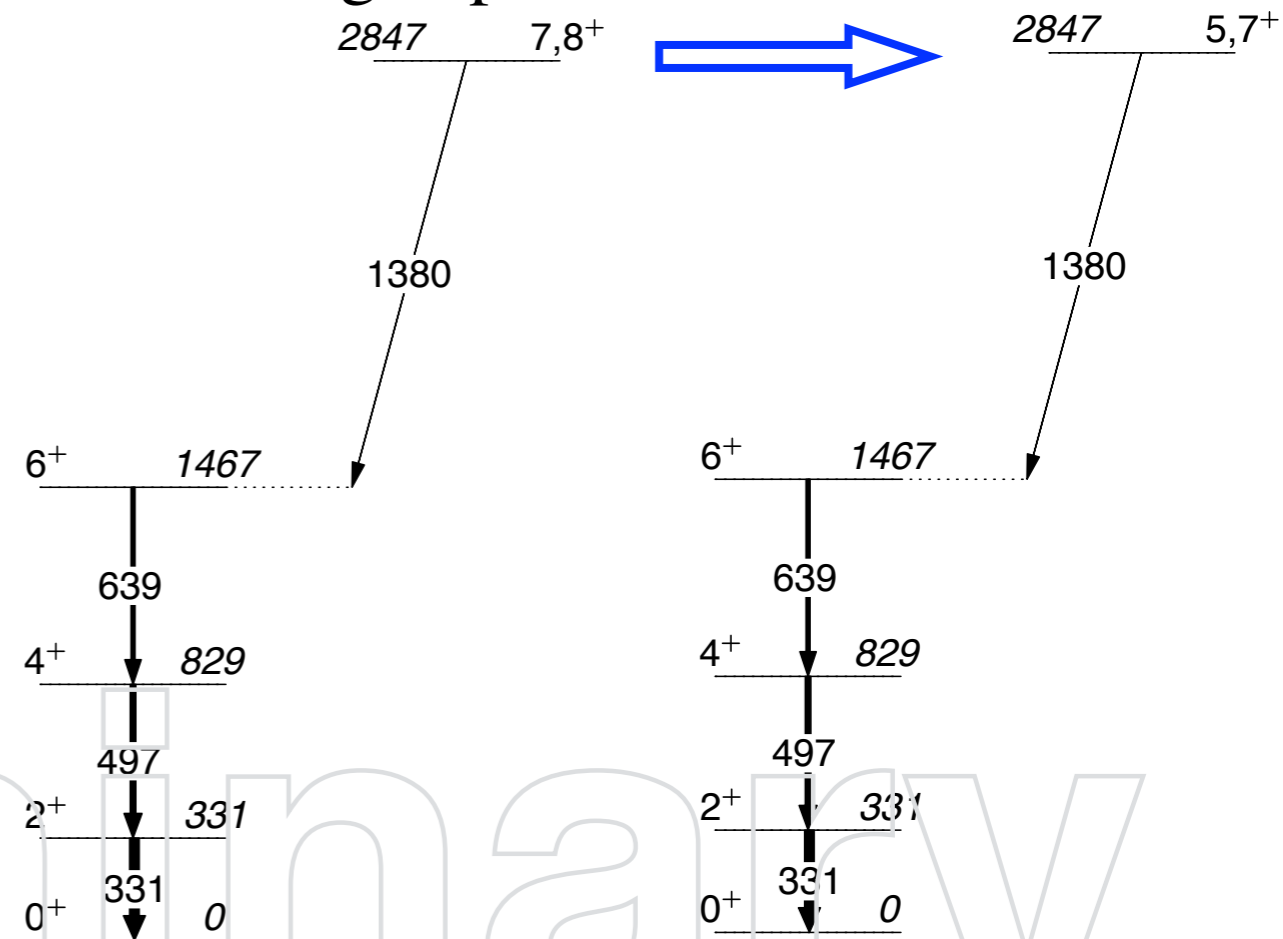
Results

Long cycle

- 6^+ state observed



- High-spin state observed



Conclusion

- The level scheme of ^{122}Xe has been extended with 240 new levels and 520 new transitions.
- Using angular correlation analysis, 60 new spin assignments have been made.
- Among them, we have seen 8 new 0^+ states and 13 new 2^+ states first time in this work.
- Two important E2 in-band transitions observed which will be crucial to characterize collectivity in ^{122}Xe .
- Angular correlation analysis is ongoing for high-spin states.

Acknowledgements



Paul Garrett

Baharak Hadinia

Allison Radich

Evan Rand

Carl Svensson



Corina Andreoiu

T. Bruhn

David Cross

Jennifer Pore

Usman Rizwan

Phill Voss



Gordon Ball

Adam Garnsworthy

Greg Hackman

Mohamad Moukaddam

Jason Park

Mustafa Rajabali

Zhimin Wang



John Wood



Steven Yates



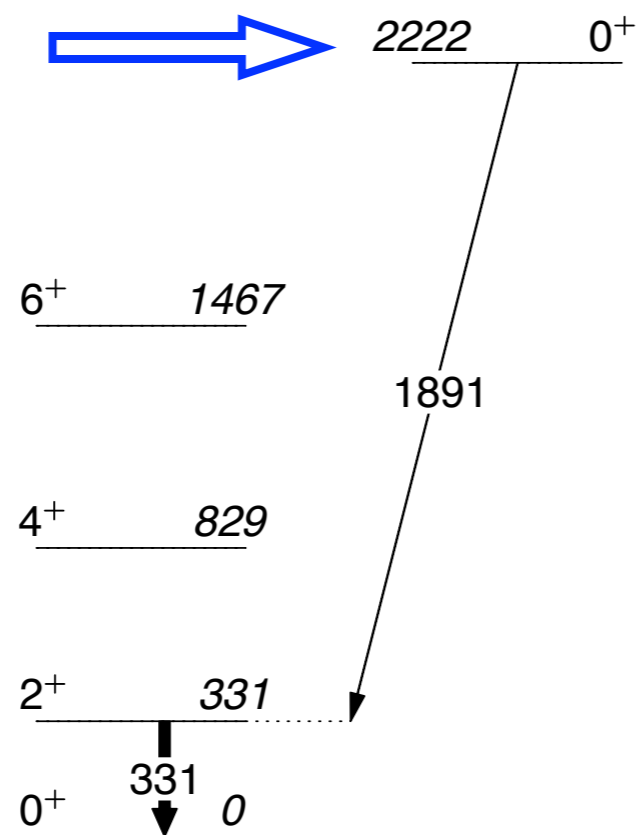
Thank you for your attention!



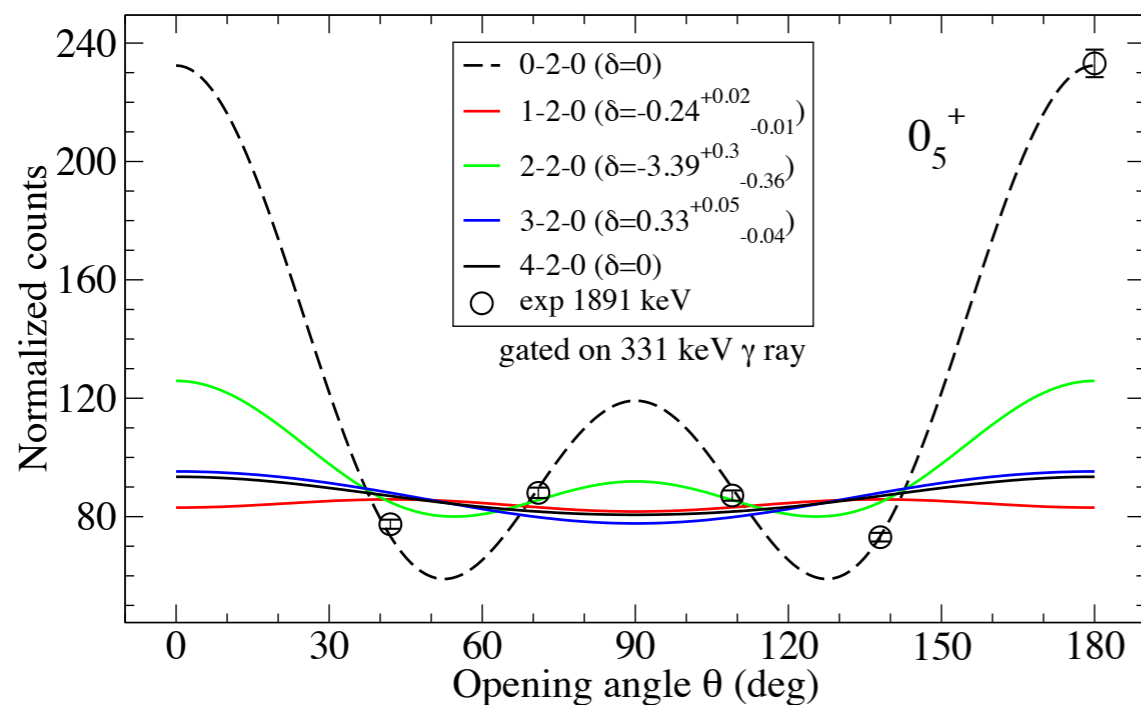
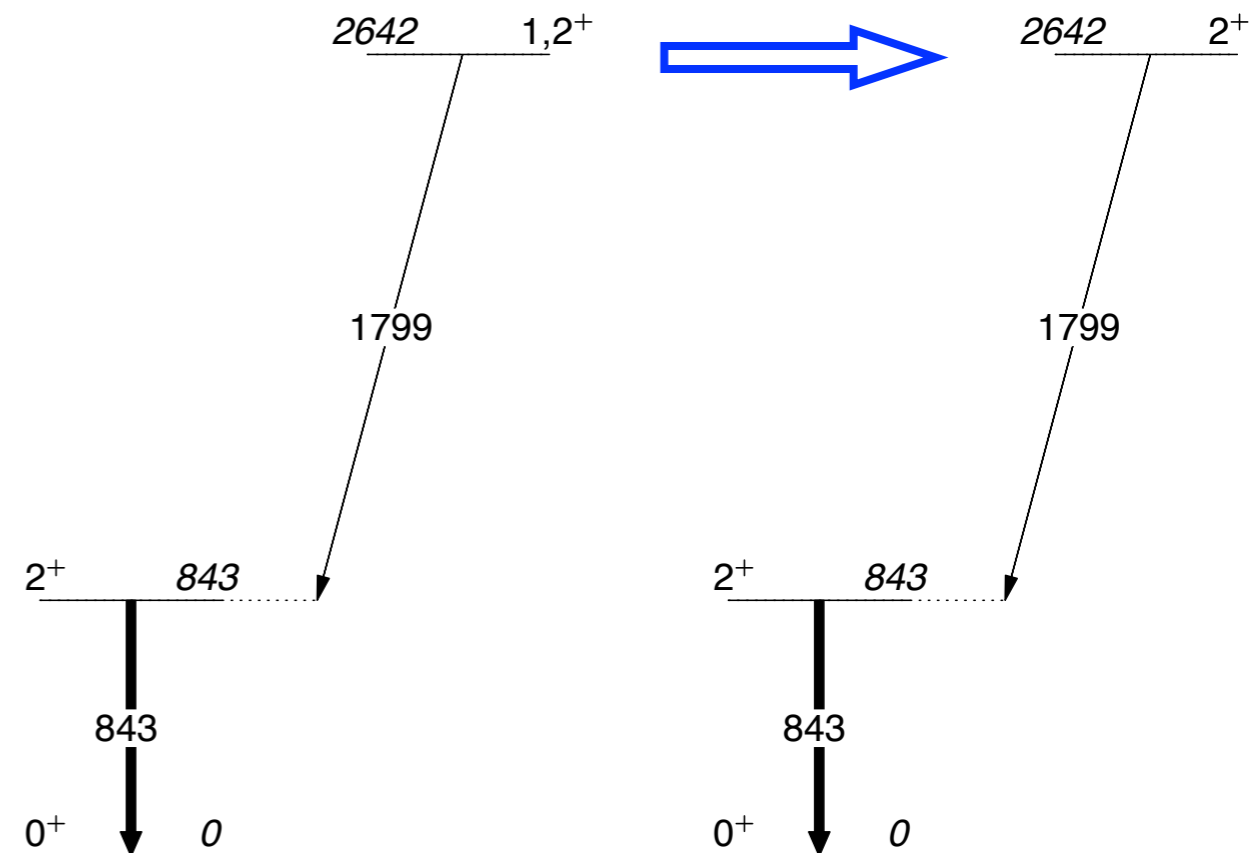
Results

Short cycle

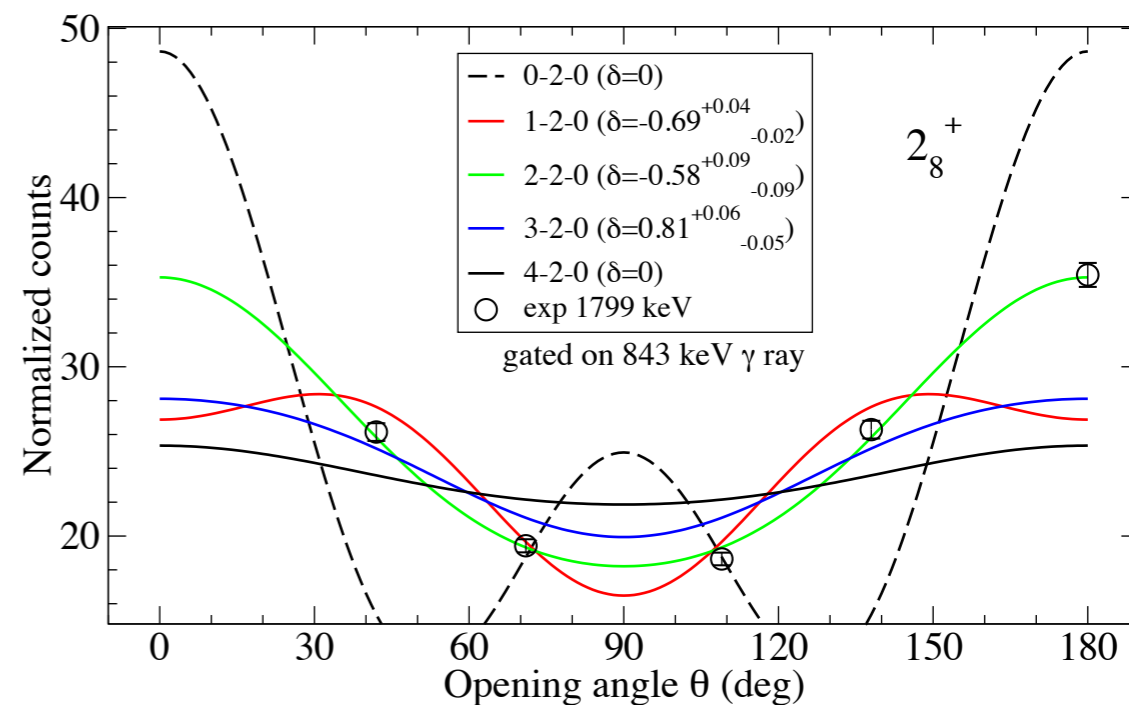
- 0^+ states observed



- 2^+ states observed

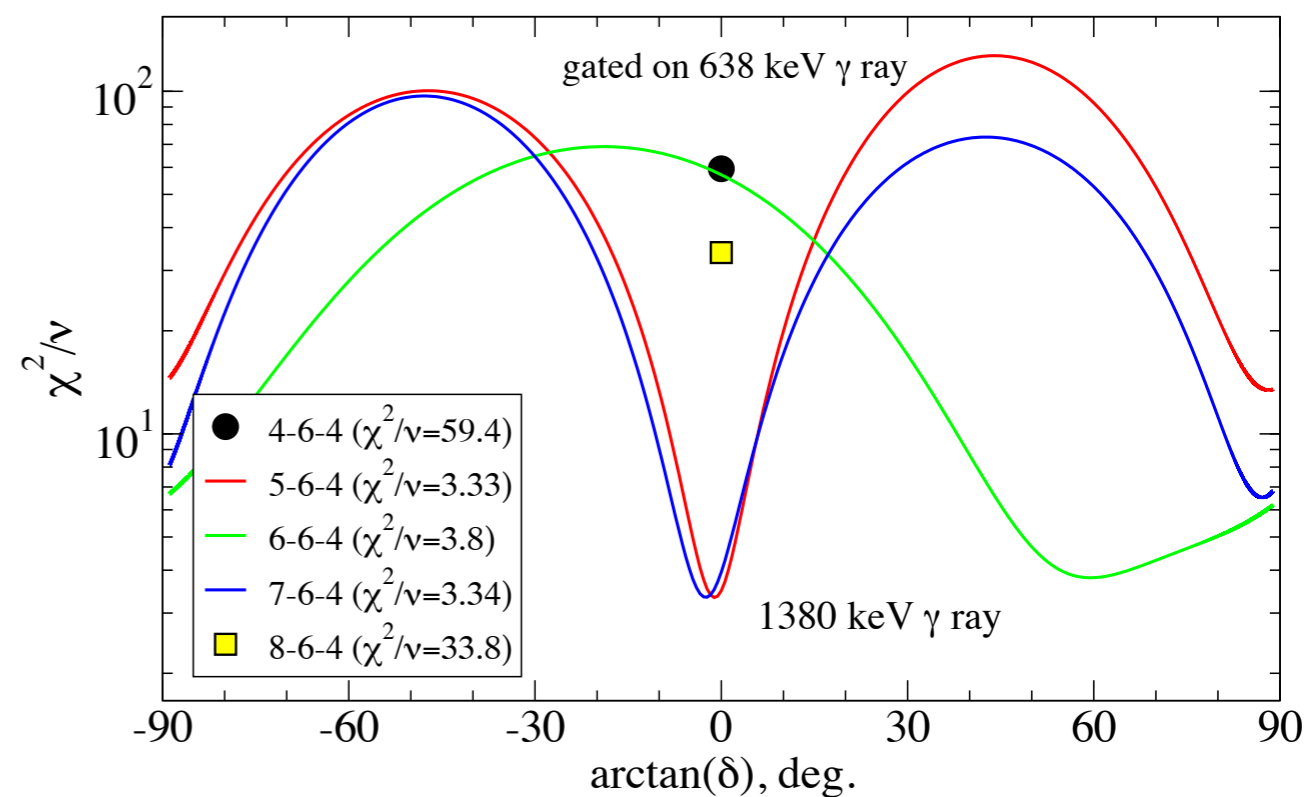
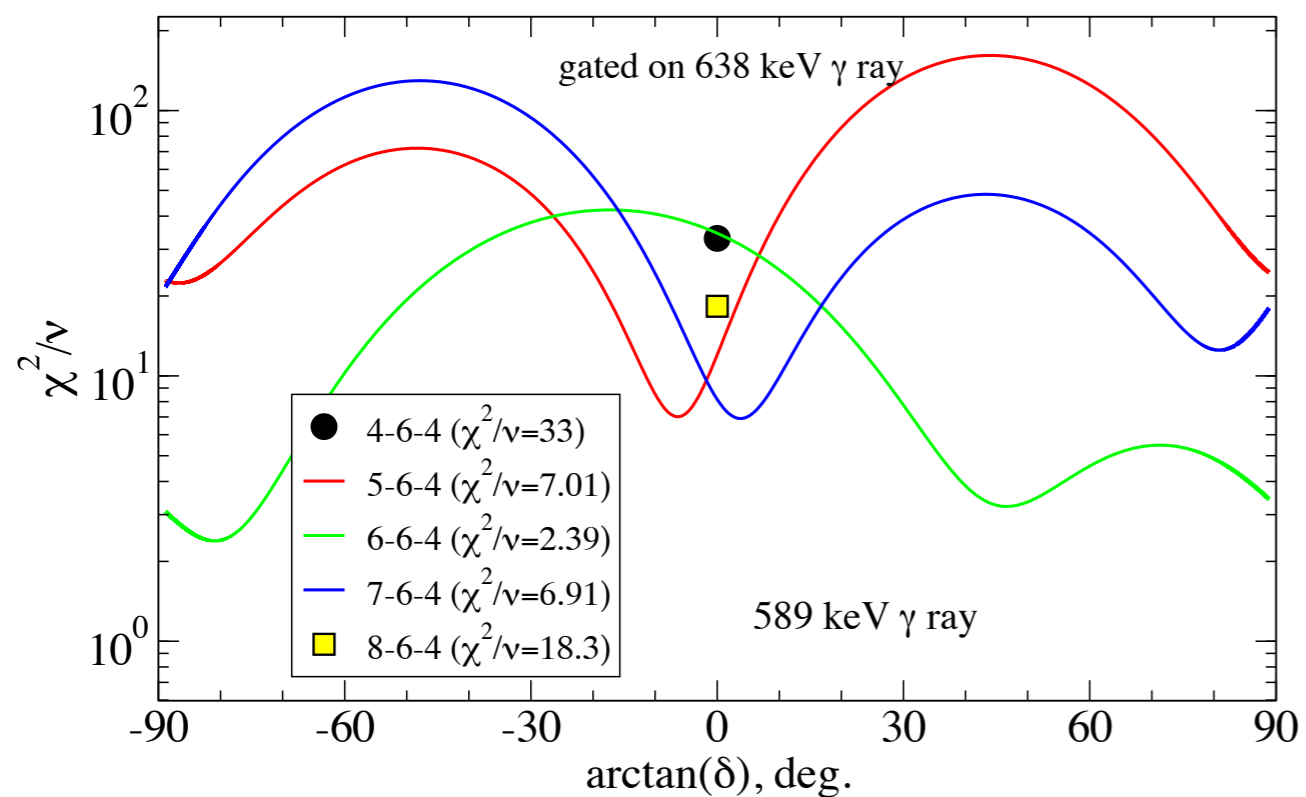
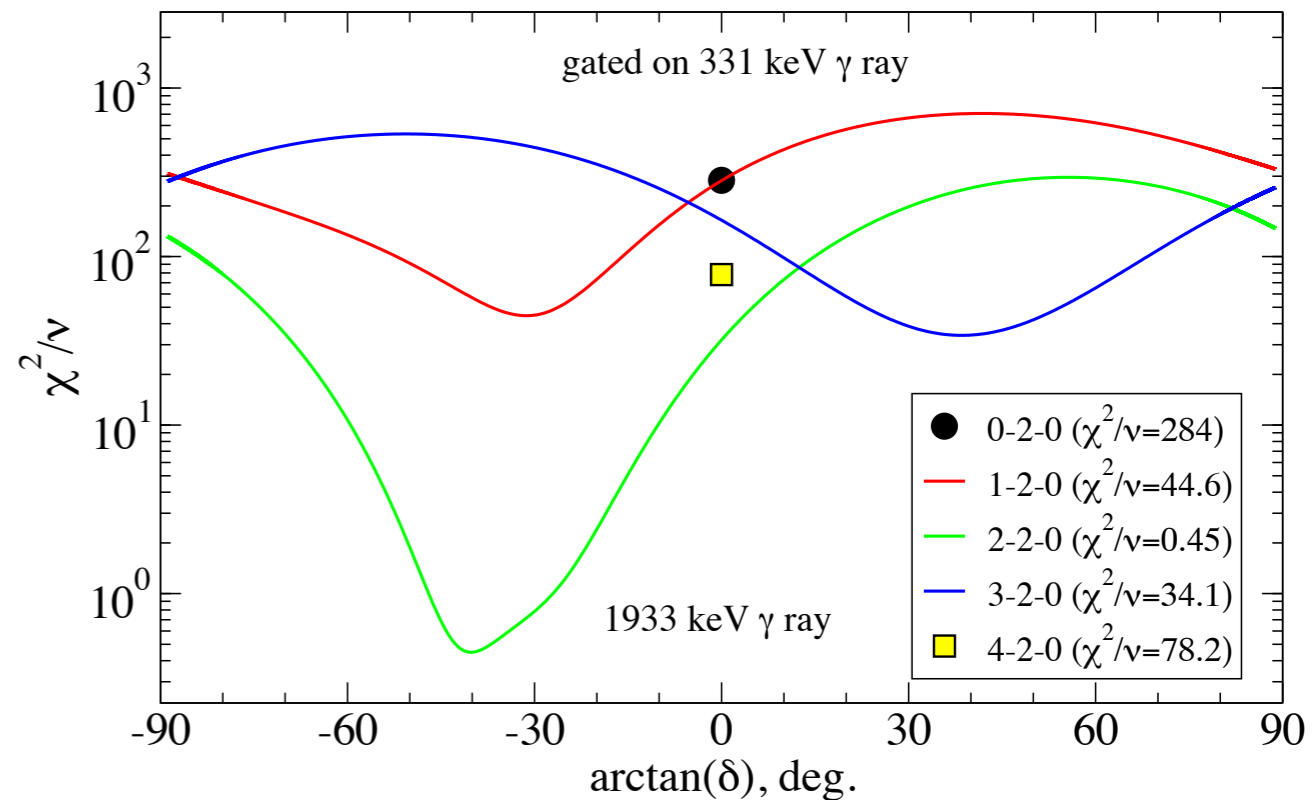
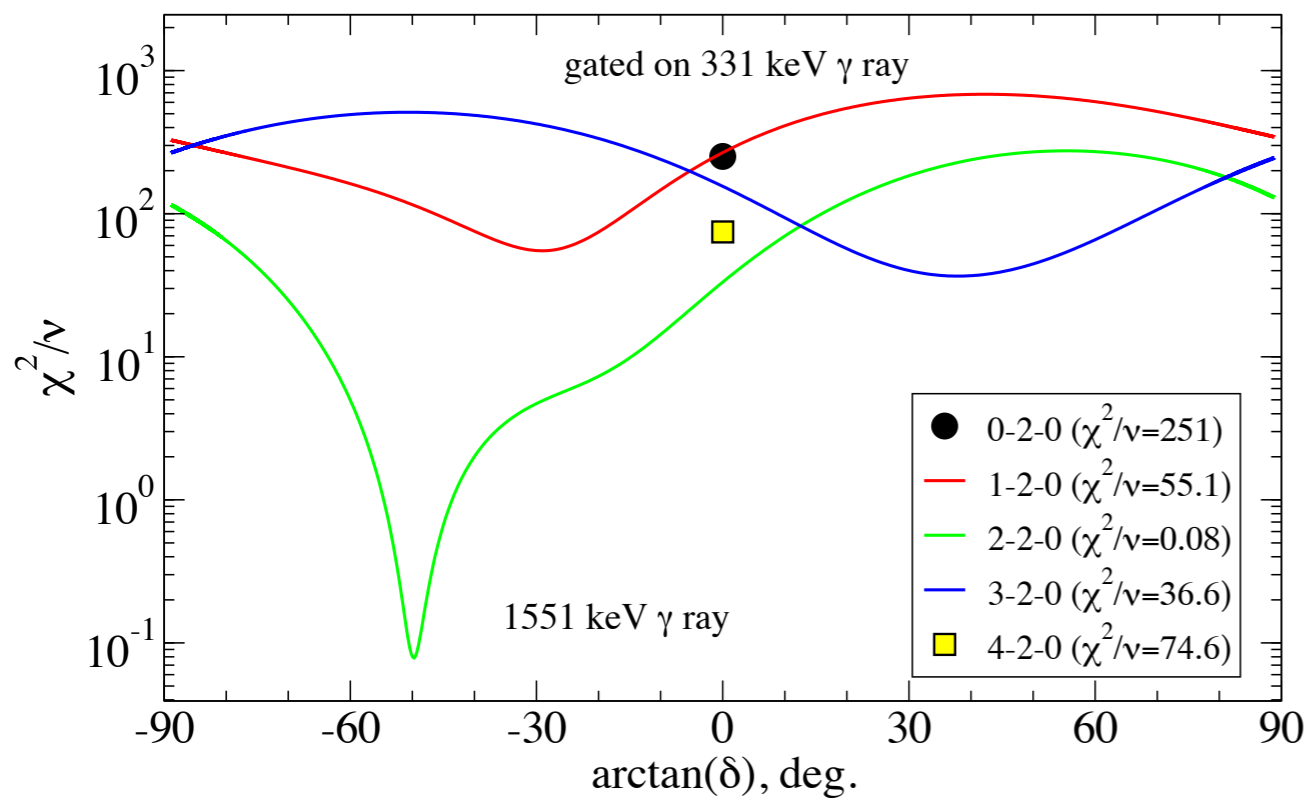


AC of 331 keV and 1891 keV



AC of 331 keV and 1799 keV

Results



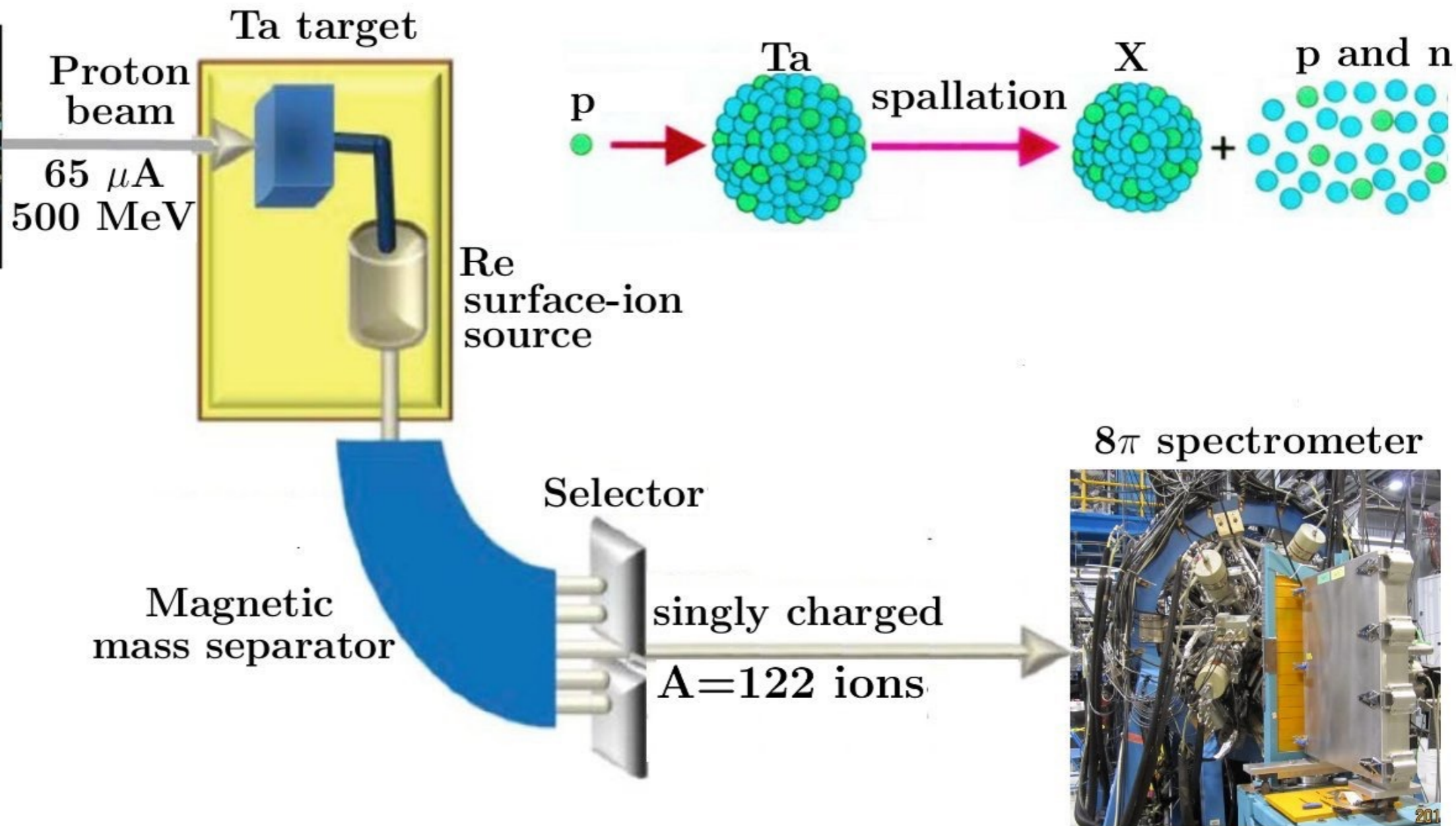
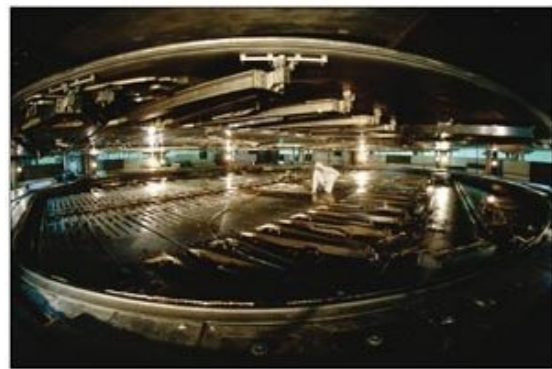
AC of 331 keV and 1891 keV

AC of 331 keV and 1799 keV

Experimental setup

To study ^{122}Xe , β -decay experiment of ^{122}Cs was performed at TRIUMF-ISAC facility located in Vancouver, Canada.

Cyclotron



The high-intensity beam of ^{122}Cs is delivered to the centre of the 8π spectrometer.