

Proposal for HIE-ISOLDE based on the Letter of Intent
Transfer Reactions and Multiple Coulomb excitation in the ^{100}Sn region

Multiple Coulomb Excitation of $^{110,108,106,(104)}\text{Sn}$

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Lund, Oslo, Liverpool, Cologne, York, Manchester, Warsaw, Leuven, Edinburgh, Darmstadt, Jyvaskyla,
Munich, CERN, MSU, CEA...



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Goals:

- Errors for the $B(E2; 0^+ \rightarrow 2^+)$ are on the 10-30% level. Comparison between models now requires higher precision.
- No measurements of the lifetimes of the higher lying states below the 6^+ isomeric states has been performed beyond ^{112}Sn .
This includes the 2^+_2 , 0^+_2 , 4^+_1 and 3^-_1 states
- Explore quadrupole moments
- Comparison of effective charges in 2^+ , 4^+ and 6^+ states as test of correlations across gap



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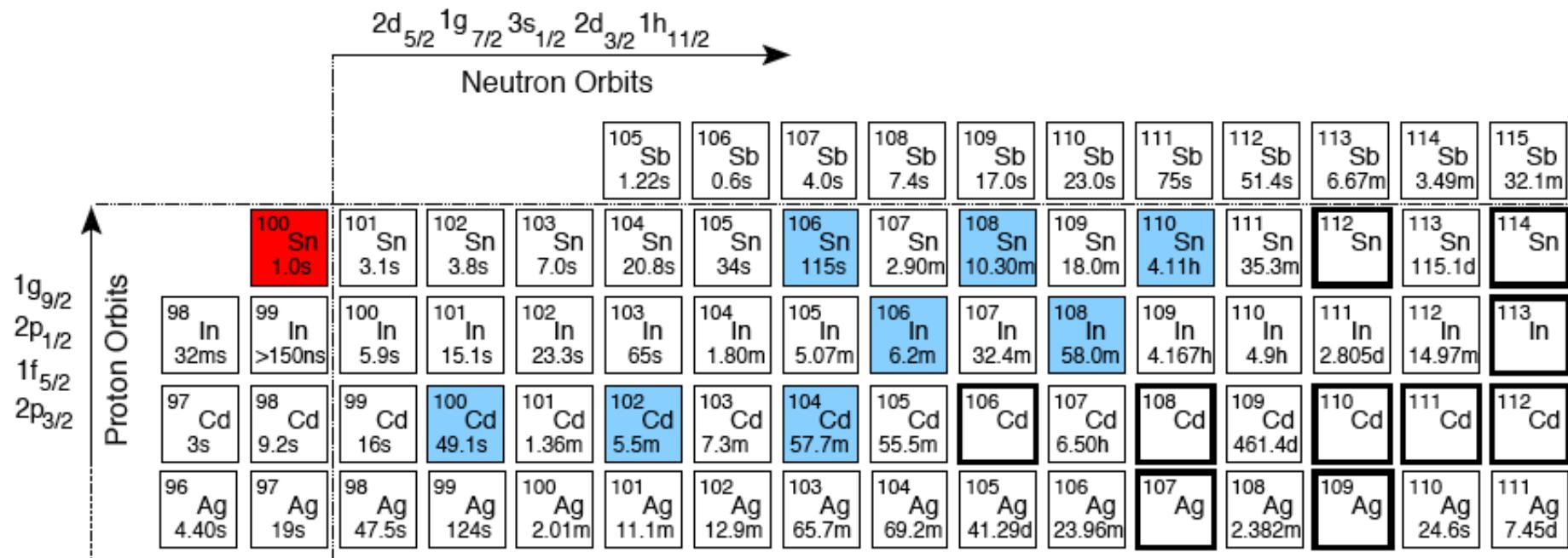
Results so far at 3 MeV/u

- ^{110}Sn PRL 98 172501 B(E2; $0^+ \rightarrow 2^+$)
- $^{108,106}\text{Sn}$ PRL 101 012502 B(E2; $0^+ \rightarrow 2^+$)
- $^{104,102,100}\text{Cd}$ PRC 80 054302 Q(2^+) and B(E2)
- $^{106,108}\text{In}$ EPJA 44 335 Multiplets
- ^{107}Sn EPJA 48 105 Single-particle order
- ^{109}Sn PRC 86 031302 (R) Collective and s.p. excitation
- ^{107}In Submitted to PRC Core excitation model



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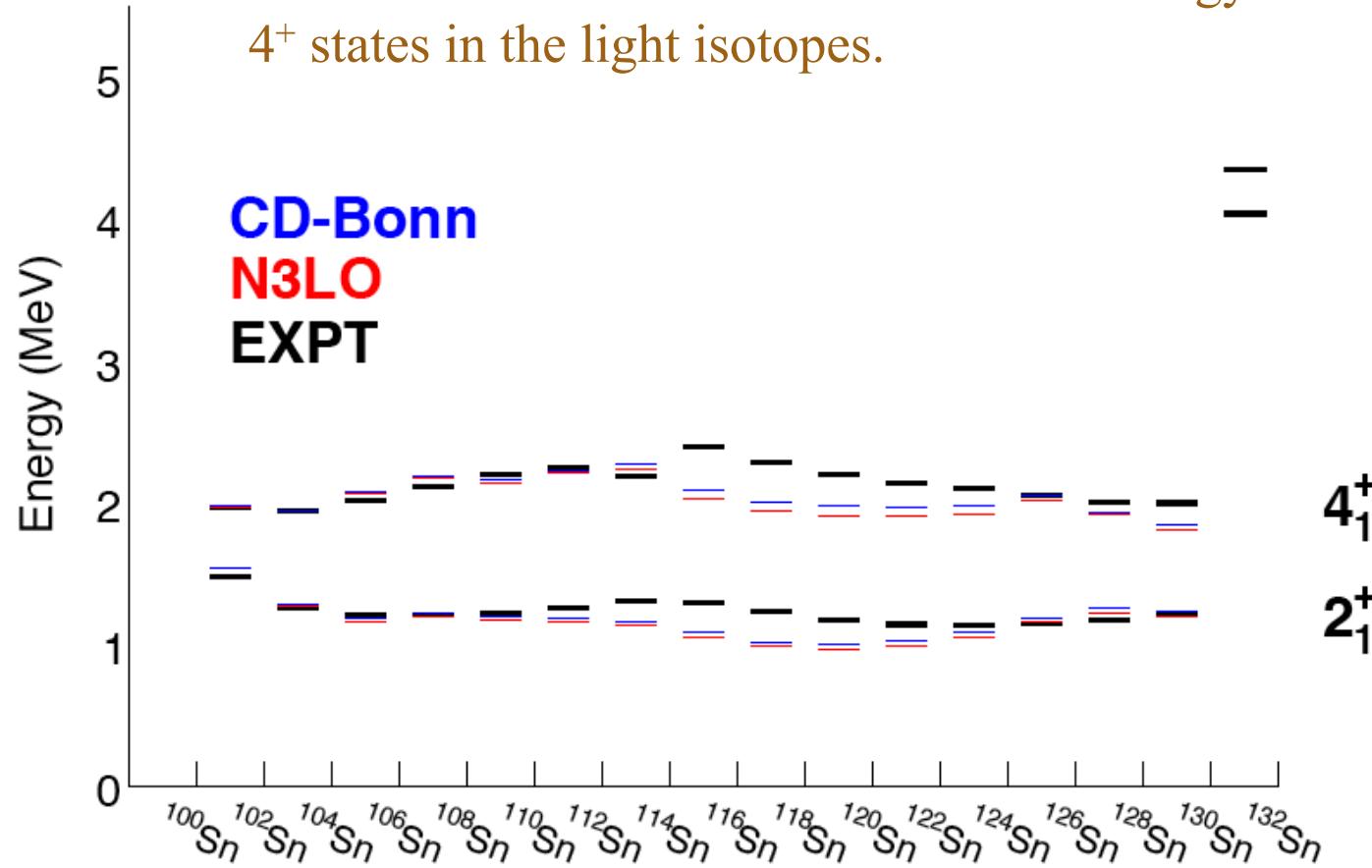
Model Space



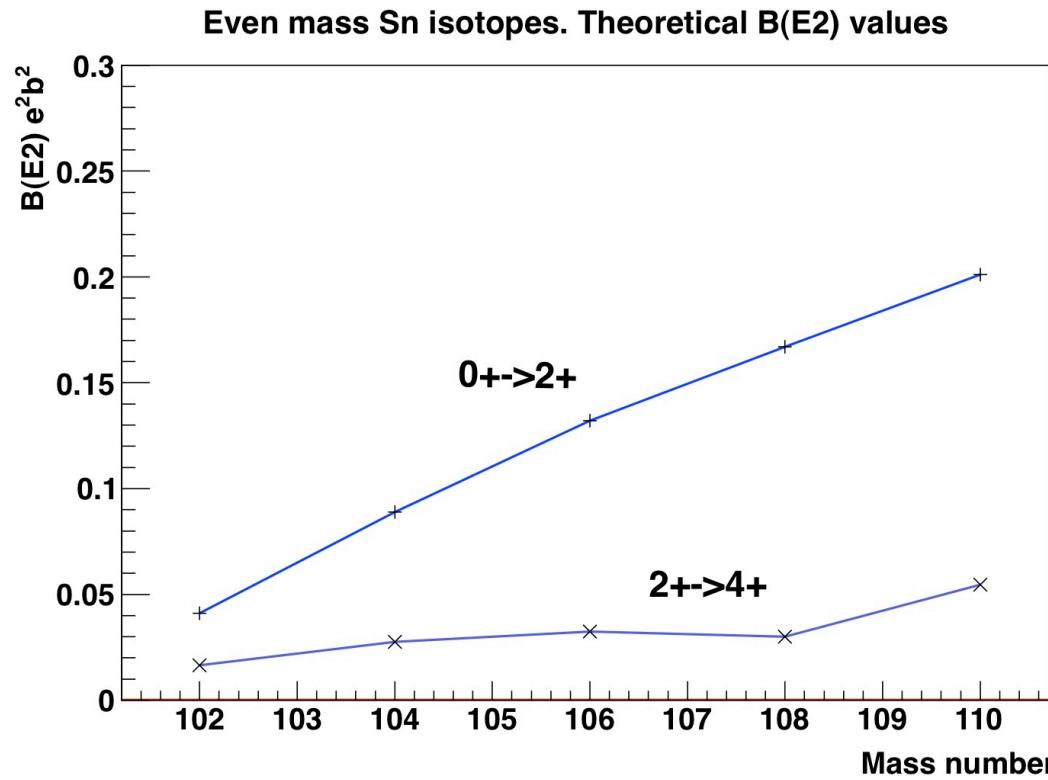
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Starting point

The 6^+ states are isomeric due to small energy difference to 4^+ states in the light isotopes.

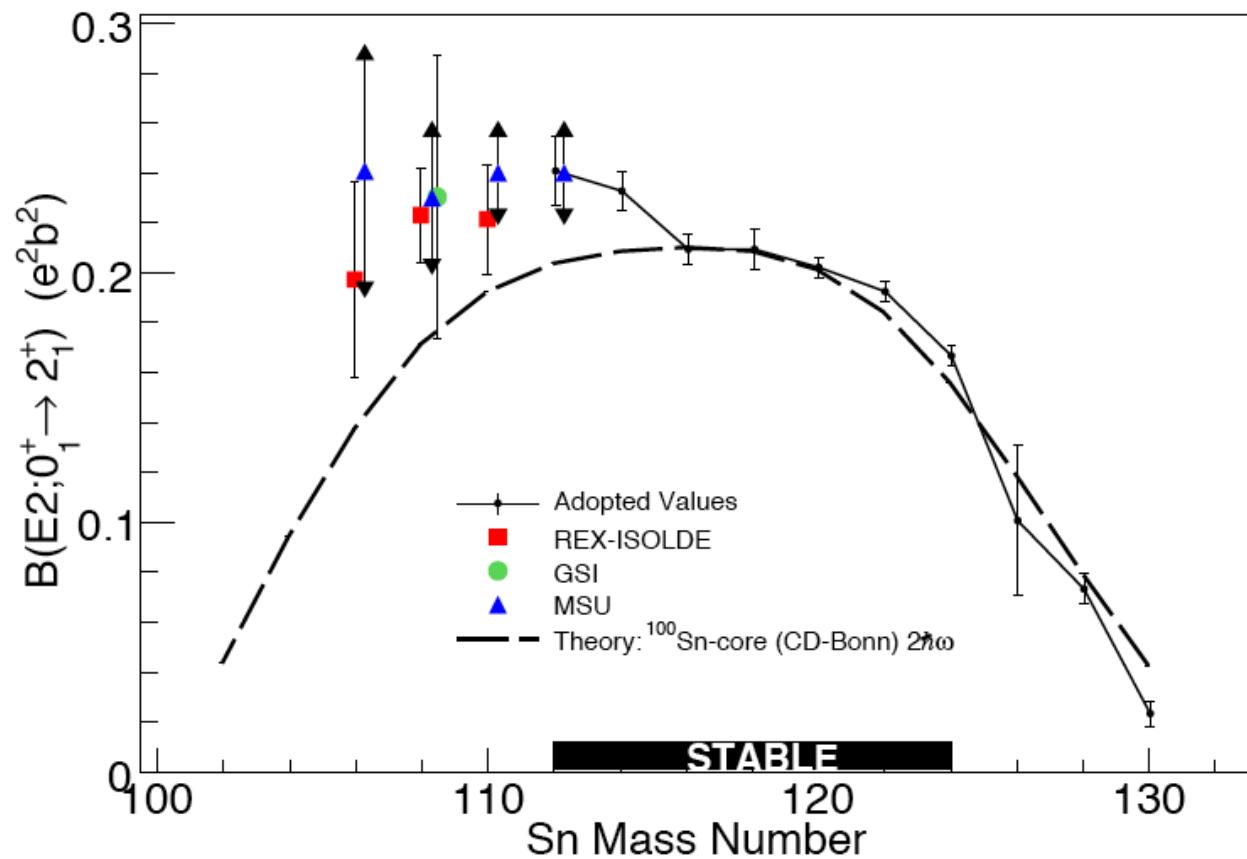


Shell model B(E2)

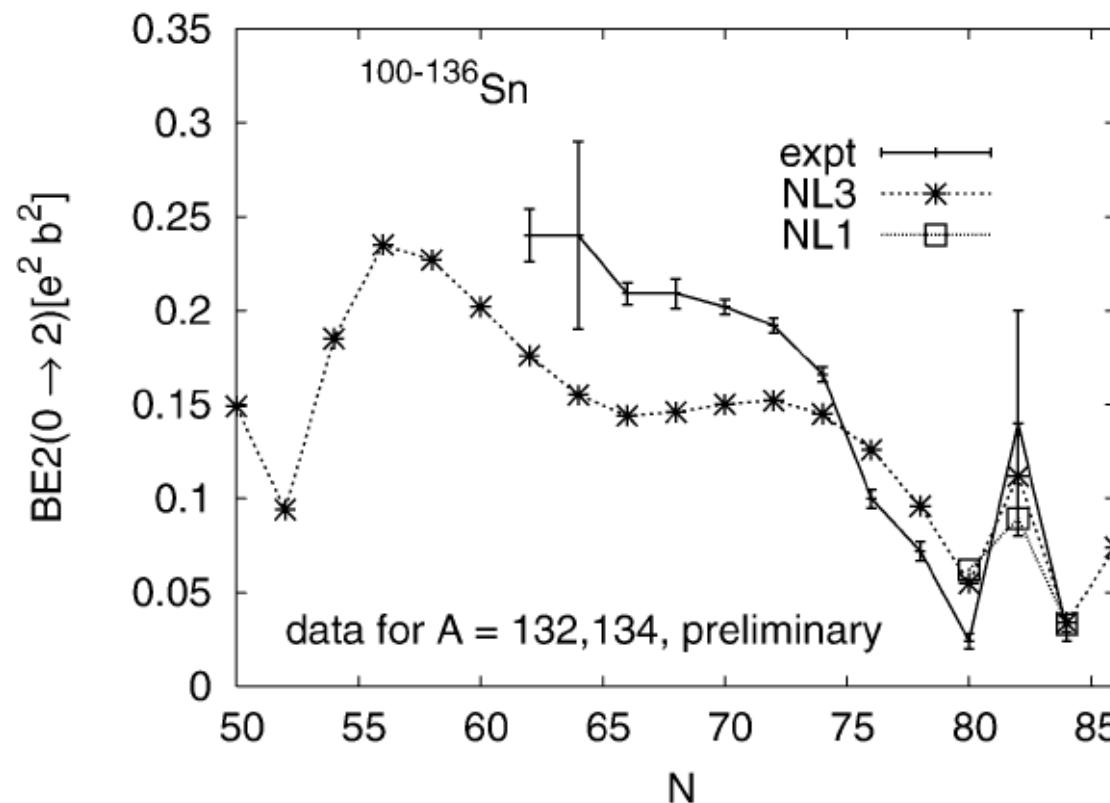


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Starting point: truncated spaces



Other developments: RQRPA



A. Ansari PLB 623 37 (2005)

Other developments: RQRPA

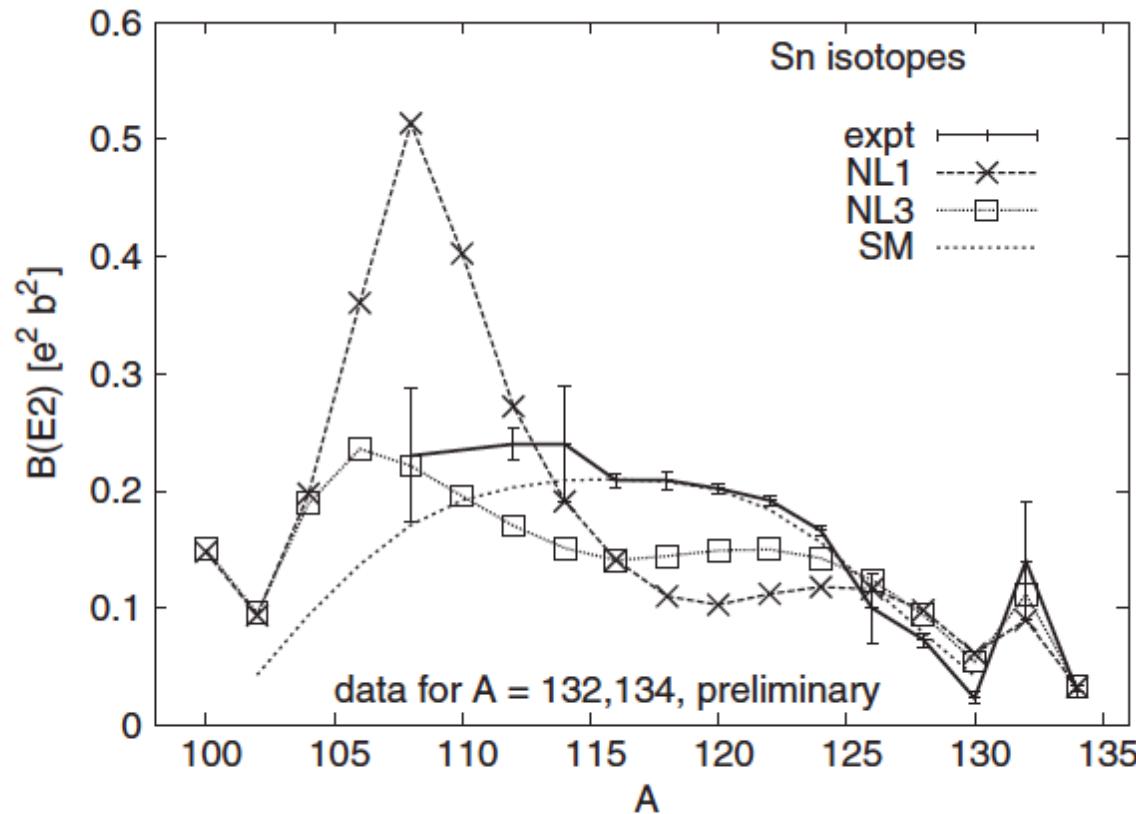
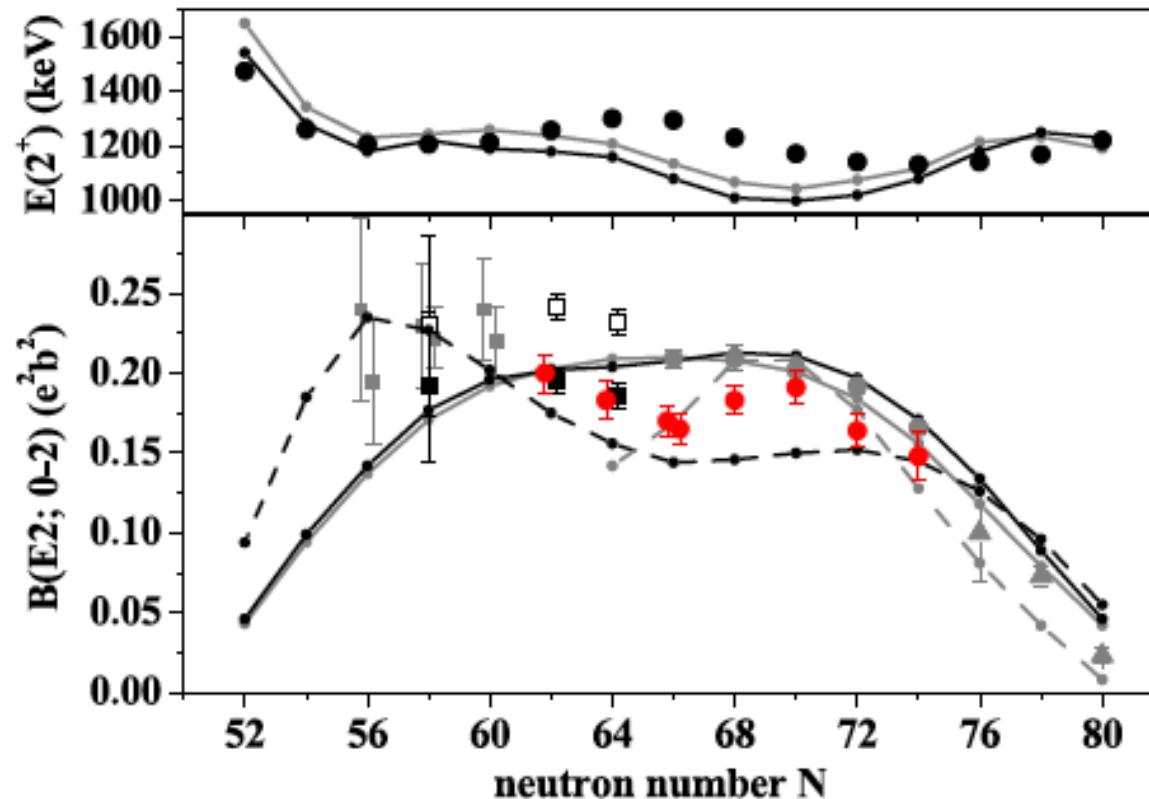


FIG. 9. Same as Fig. 8 for the $B(E2) \uparrow$ transition rates.

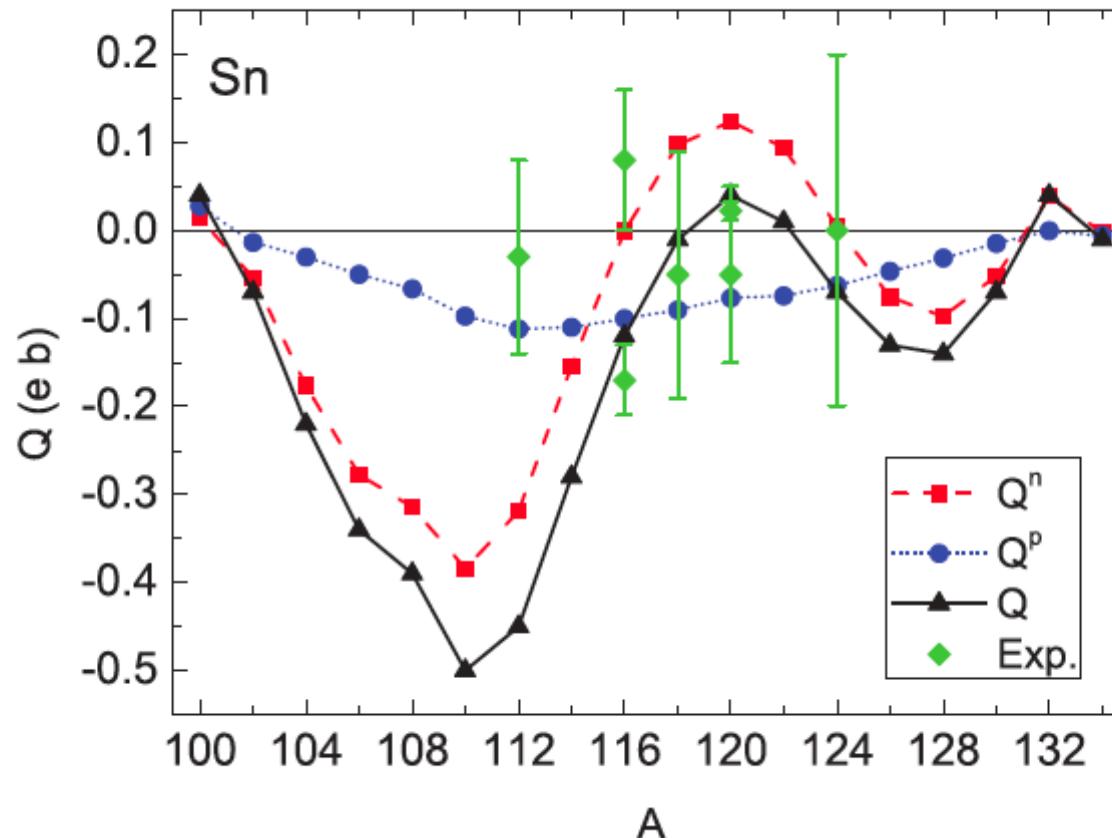
A. Ansari & P. Ring PRC 74 054313 (2006)

Other developments: Experiments



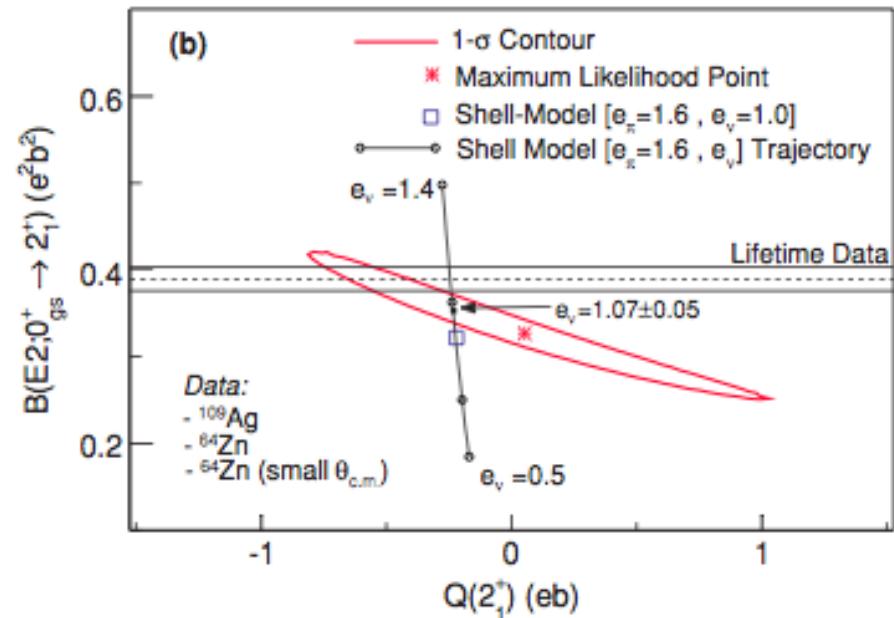
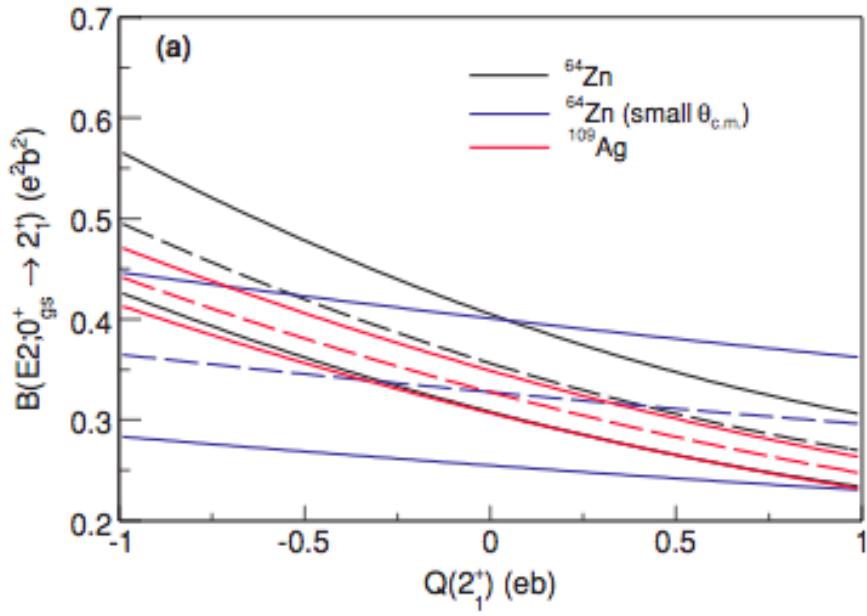
A. Jungclaus *et al.* PLB 695 110 (2011)

Quadrupole moments: Greens fnc & EDF



D. Voitenkov *et al.* PRC 85 054319 (2012)

Quadrupole moments: An example



Selection of different targets and/or angles.
Well known and under full control using GOSIA code

A. Ekstrom *et al.* PRC 80 054302

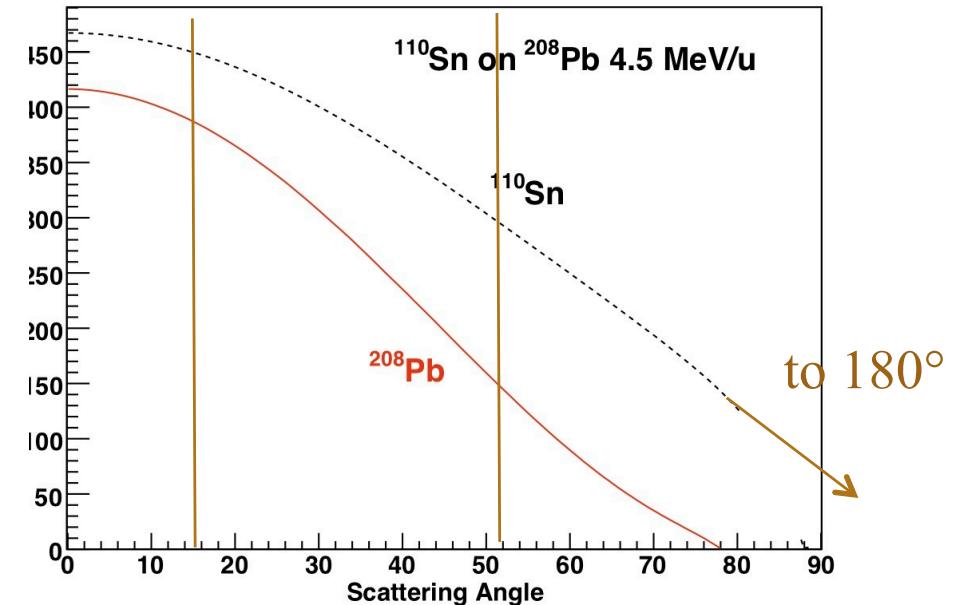
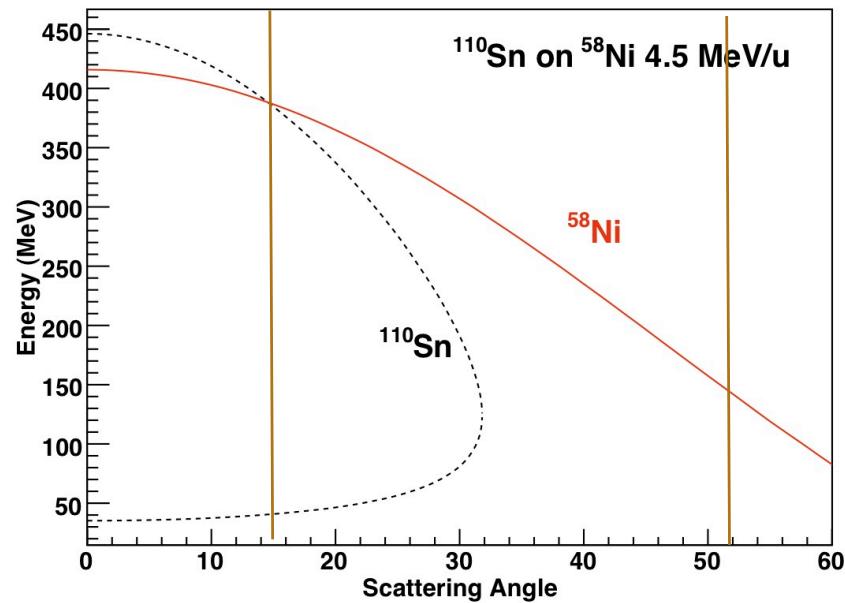
Some technical details

- Beams: $^{110,108,106}\text{Sn}$ @ 4.5 MeV
- Explore ^{104}Sn intensity with new solid state RILIS
- Target: ^{206}Pb is safe up to $\sim 140^\circ$ at 4.5 MeV/u
- Backscattering gives sensitivity to $Q(2^+)$
- Kinematical selection of target or projectile can be done using forward located CD. Detectors for coincidence measurement of 2p events exist (T-REX and LuSia)
- Planned setup: MINIBALL + CD



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Kinematics: examples Ni and Pb

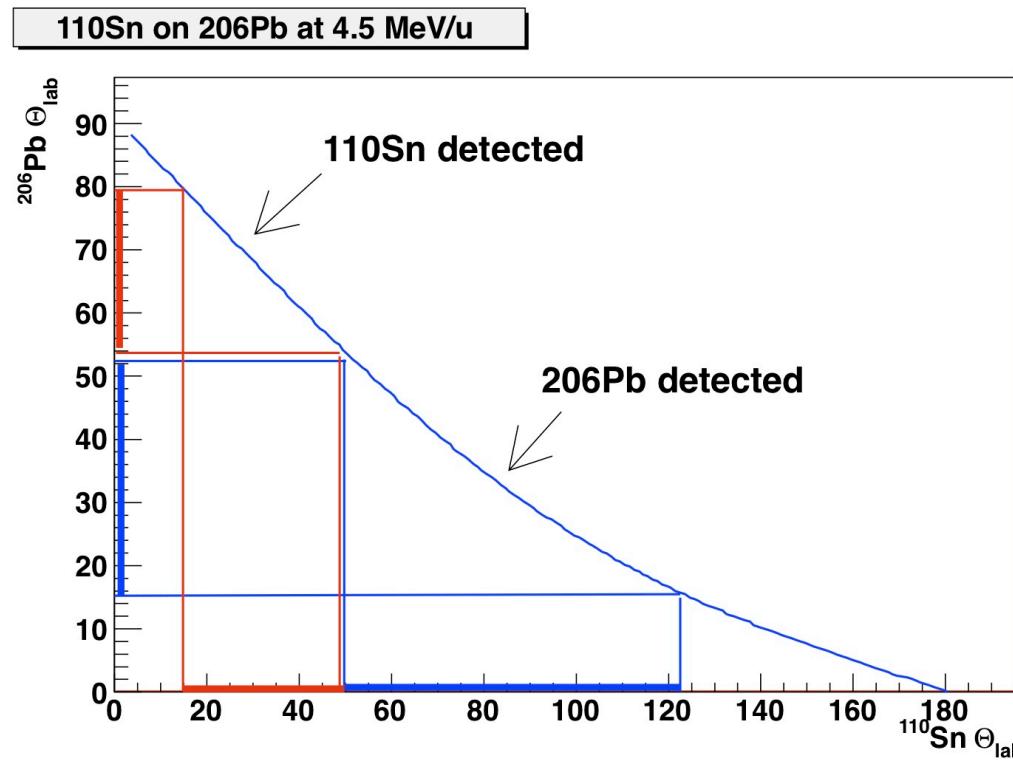


Two-body scattering; extension of detection range possible by complementary detection of target and projectile.



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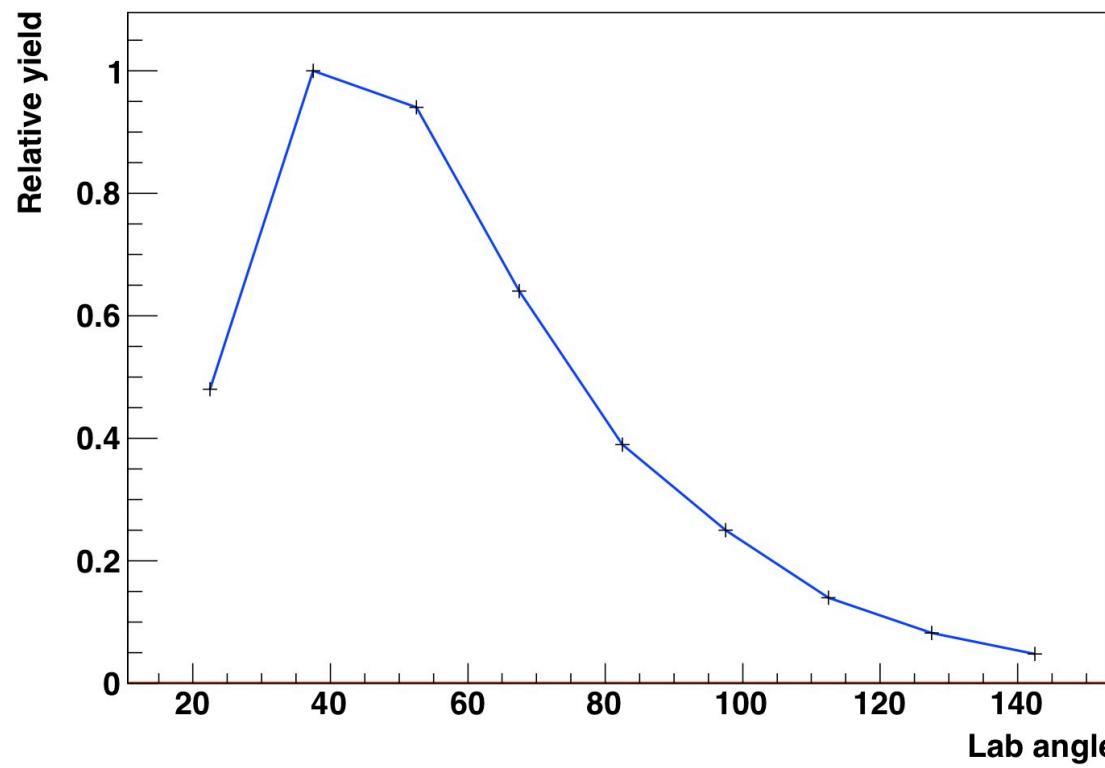
Kinematics: an example for Pb target



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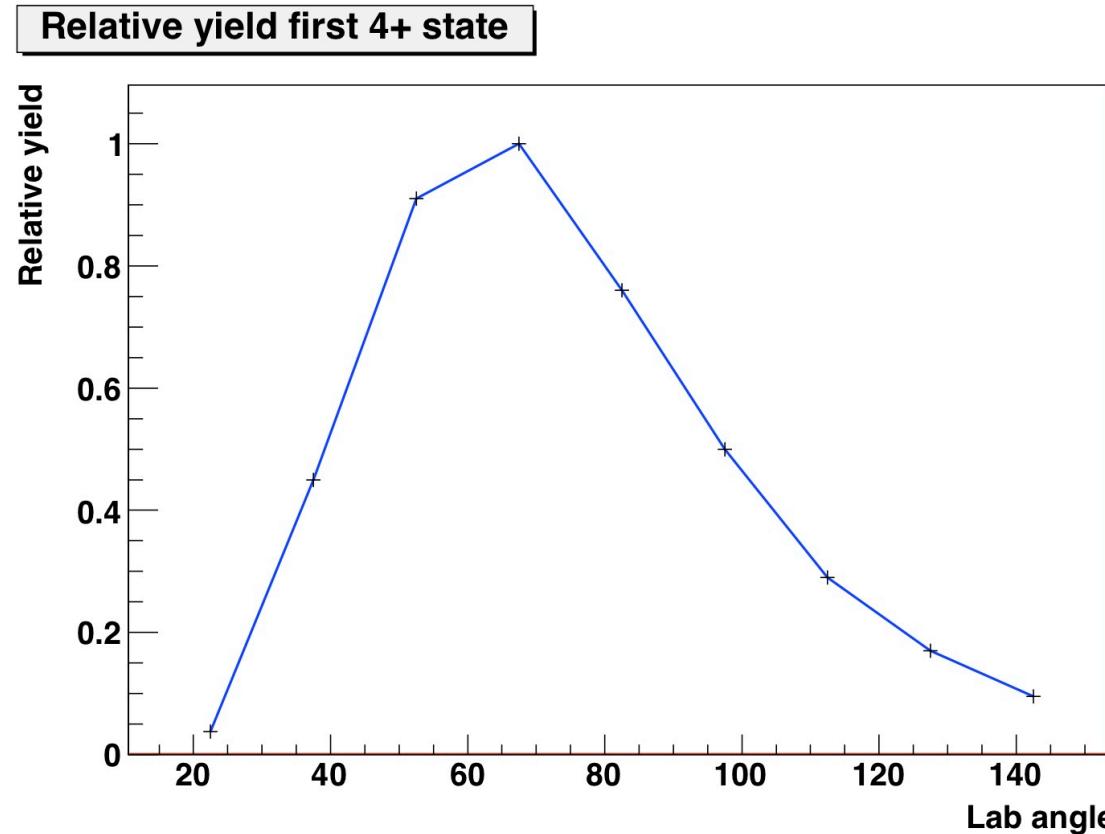
Relative yields

Relative yield first 2+ state



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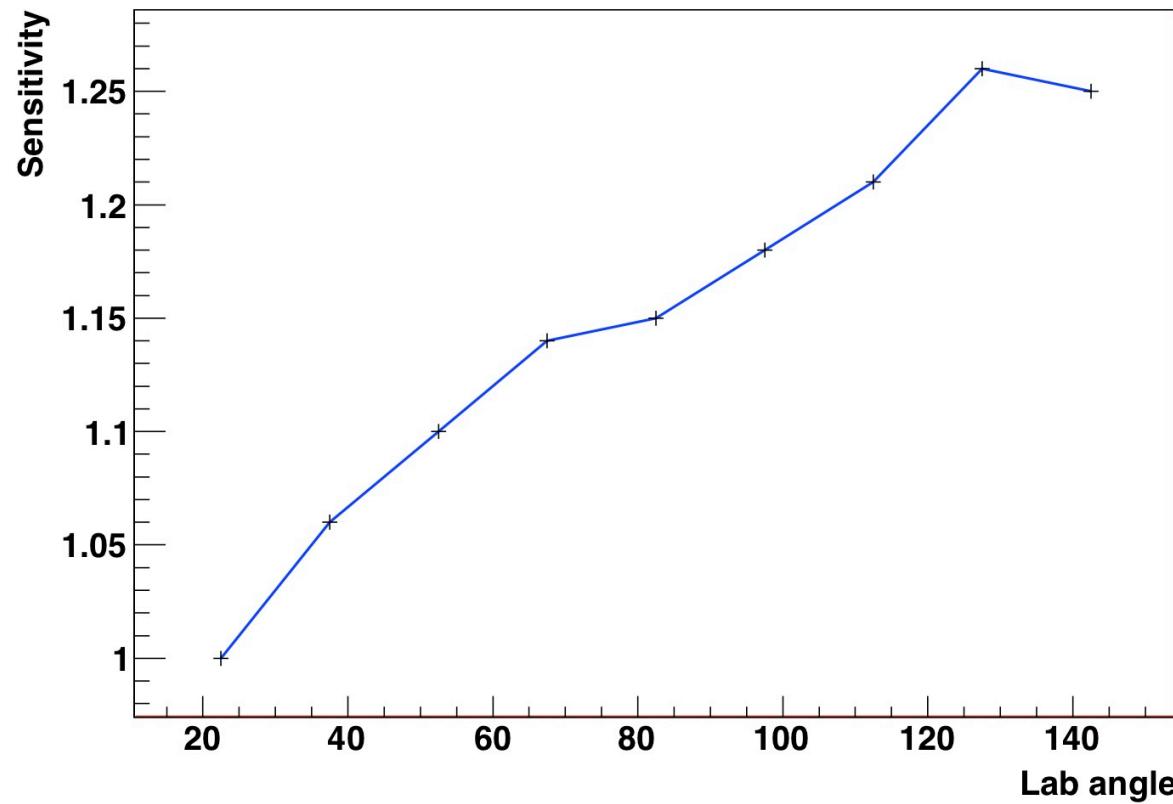
Relative yields



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Relative yields

Q(2+) sensitivity



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Beams

Target: LaCx + RILIS.

^{110}Sn : up to 1E7 pps, main contaminant ^{110}In at 10%

^{108}Sn : up to 1E7 pps, main contaminant ^{108}In at 40%

^{106}Sn : up to 1E5 pps, main contaminant ^{106}In at 70%

Measured rate for contaminant depends on beam gate settings

In addition: explore ^{104}Sn with new solid state RILIS



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Count rate estimates

Using yields and intensities measured in the 3 MeV/u campaign and for comparison integrating the yield only over the scattered beam in the CD detector 10 shifts will give:

Isotope/transition	$2^+ \rightarrow 0^+$	$4^+ \rightarrow 2^+$
^{110}Sn	$\sim 1.4\text{E}5$	~ 700
^{108}Sn	$\sim 1.4\text{E}5$	~ 700
^{106}Sn	$\sim 1.8\text{E}3$	

If the full safe angle is used e.g. via complementary detection of beam and target particles, the yield for the 2^+ transition increases by ~ 2.1 and for the 6^+ transition by ~ 5.8 .



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Beam time request

We ask for 10 shifts each for the isotopes $^{110,108,106}\text{Sn}$
giving a total of 30 shifts that can be divided over 2 years.

Thank you!

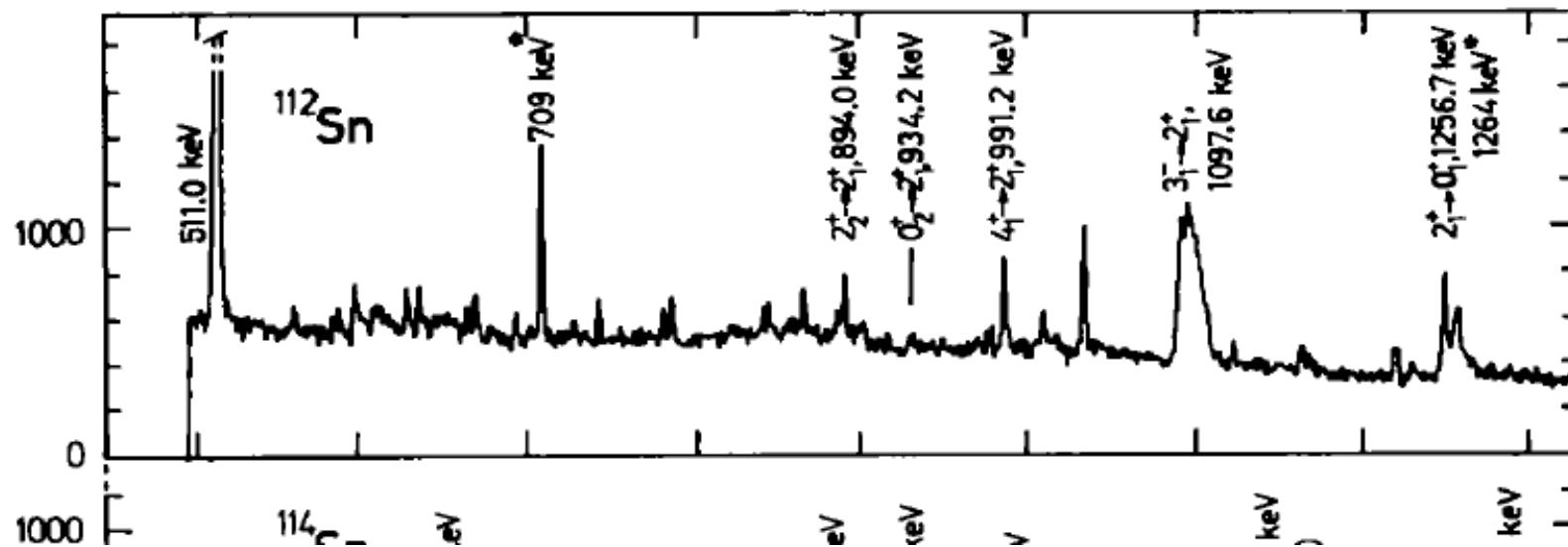


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^{112}Sn Coulomb excitation

336

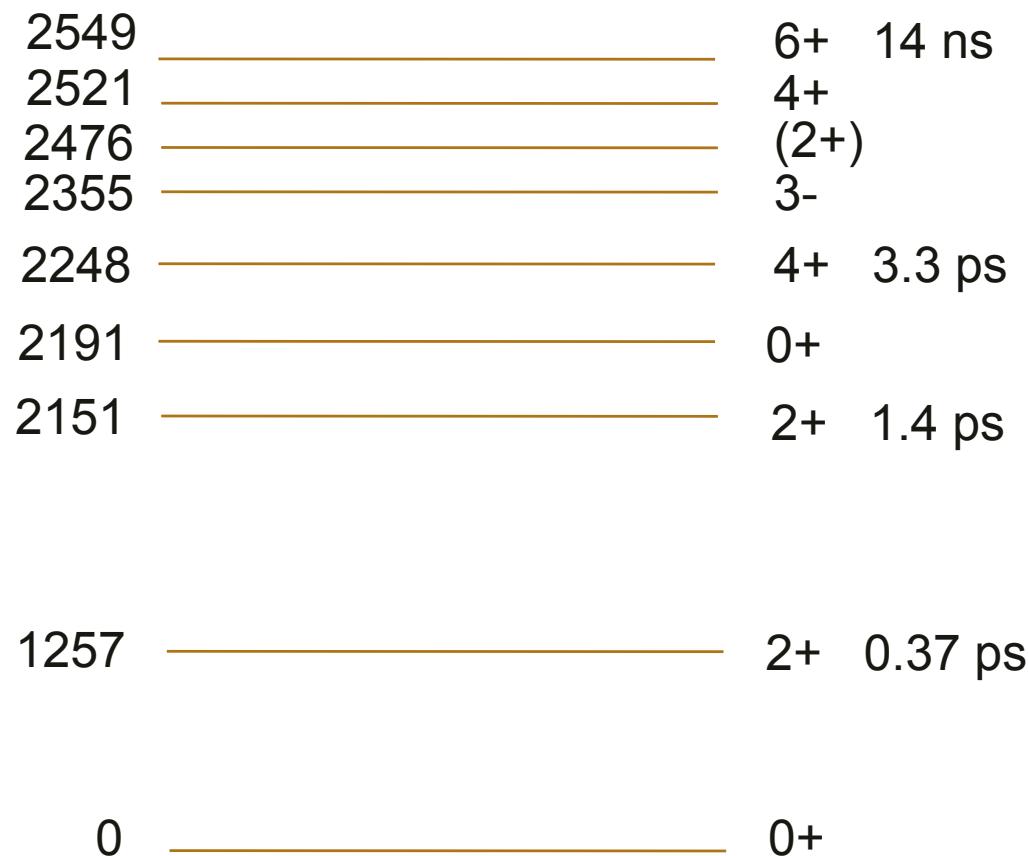
N.-G. Jonsson *et al.* / Collective states



(coincidence)

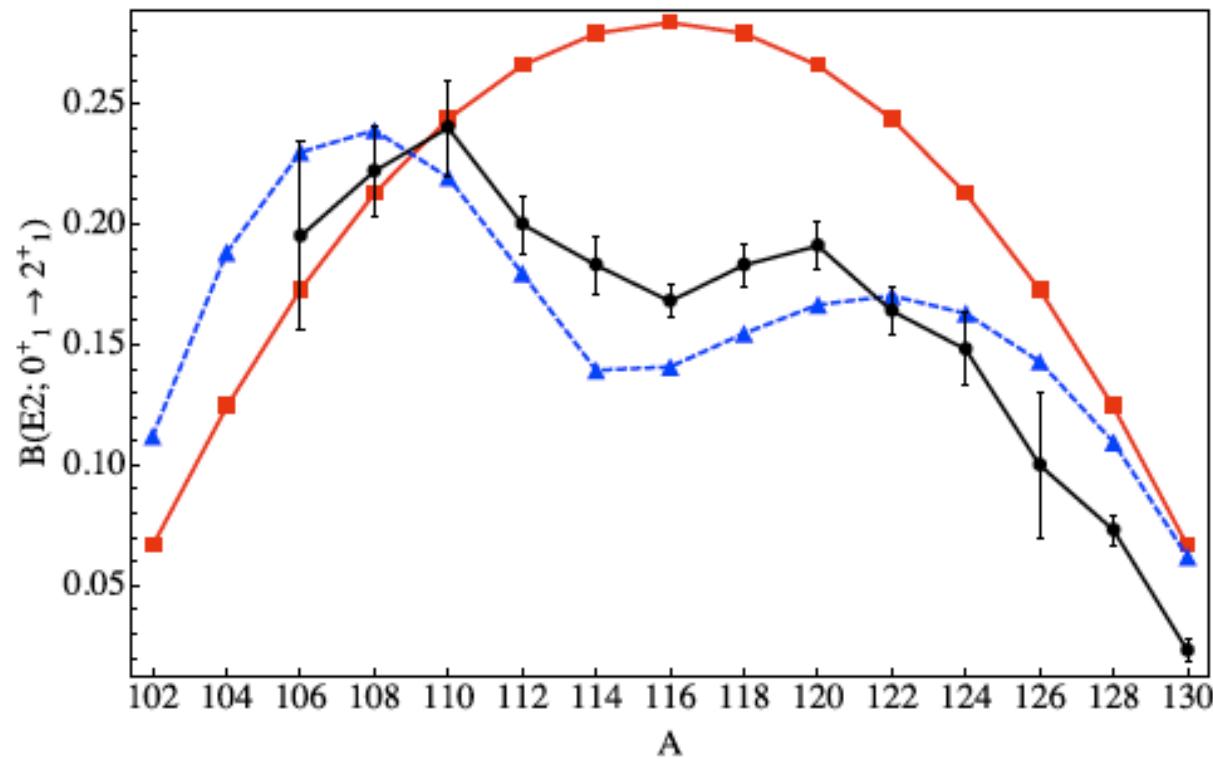
N.-G. Jonsson *et al.* NPA 371 333 (1981)

The ^{112}Sn level scheme



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Generalized Seniority: Two level model



I. O. Morales, P. Van Isacker, I. Talmi PLB 703 606 (2011)