Collectivity of the 4^+ state in ^{70}Zn studied by Coulomb excitation

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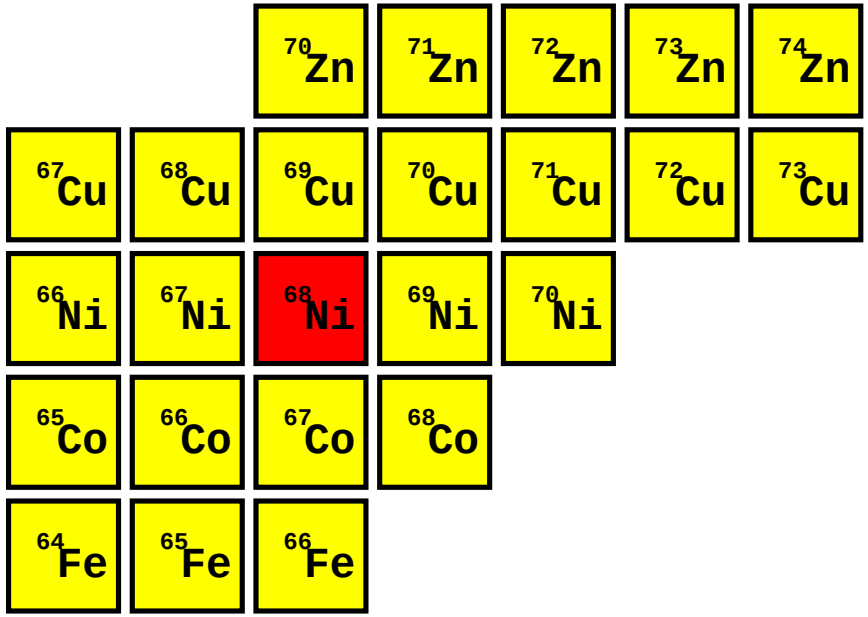
- Motivation: the vicinity of ^{68}Ni
- Coulomb excitation of ^{70}Zn
- Perspectives

Vicinity of ^{68}Ni



high excitation energy of the 2^+ state
and low B(E2) in ^{68}Ni

weakness of the N=40 shell gap:
rapid onset of collectivity
when moving away from ^{68}Ni

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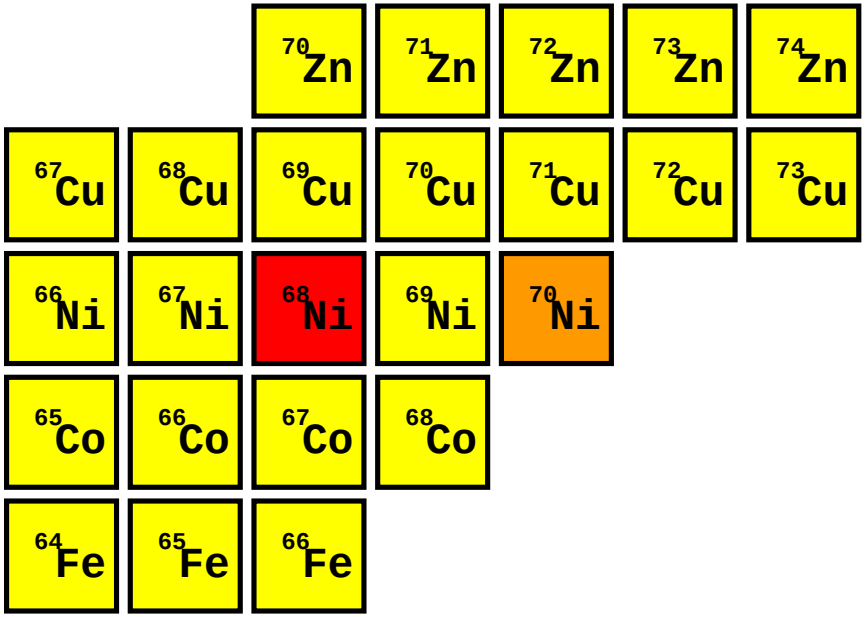

- polarisation of the Z=28 proton core in ^{70}Ni
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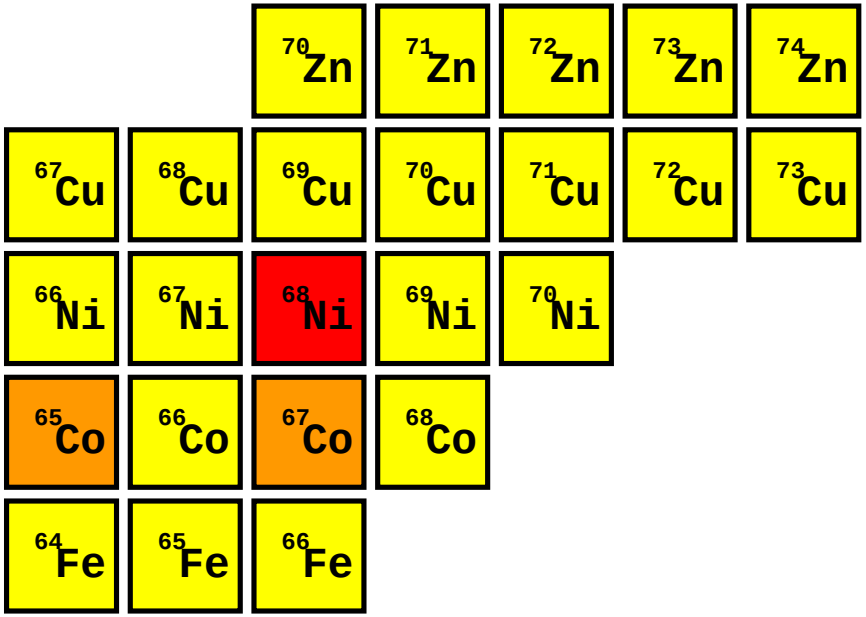

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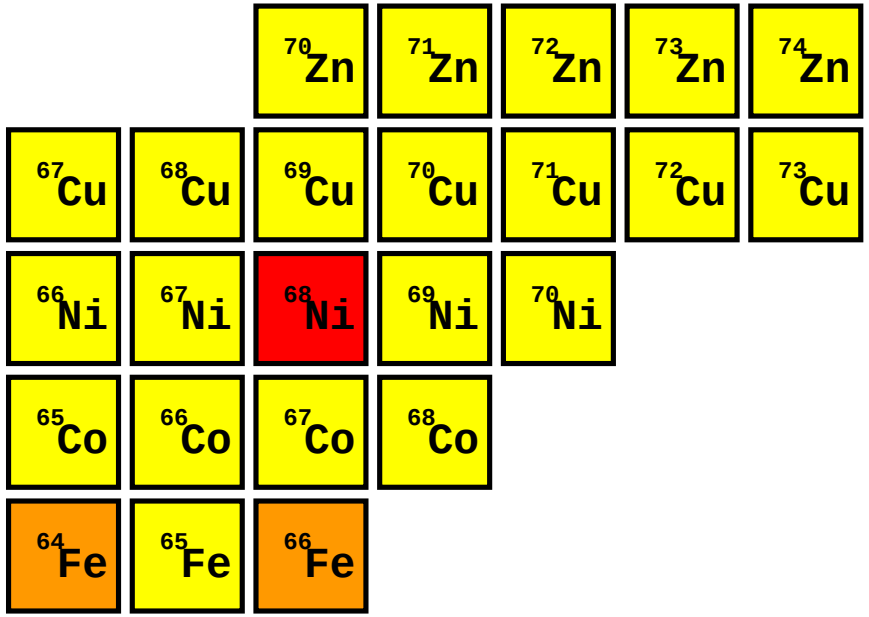

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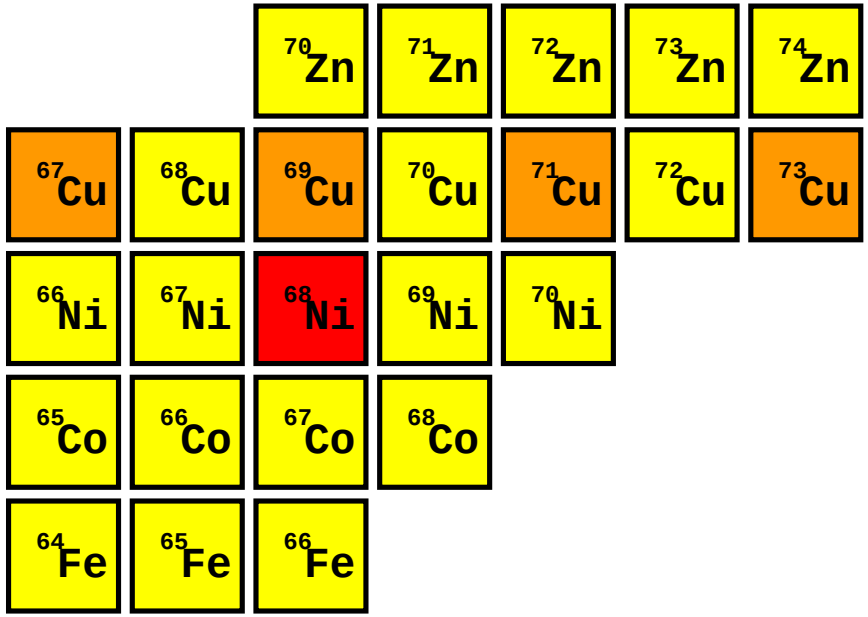

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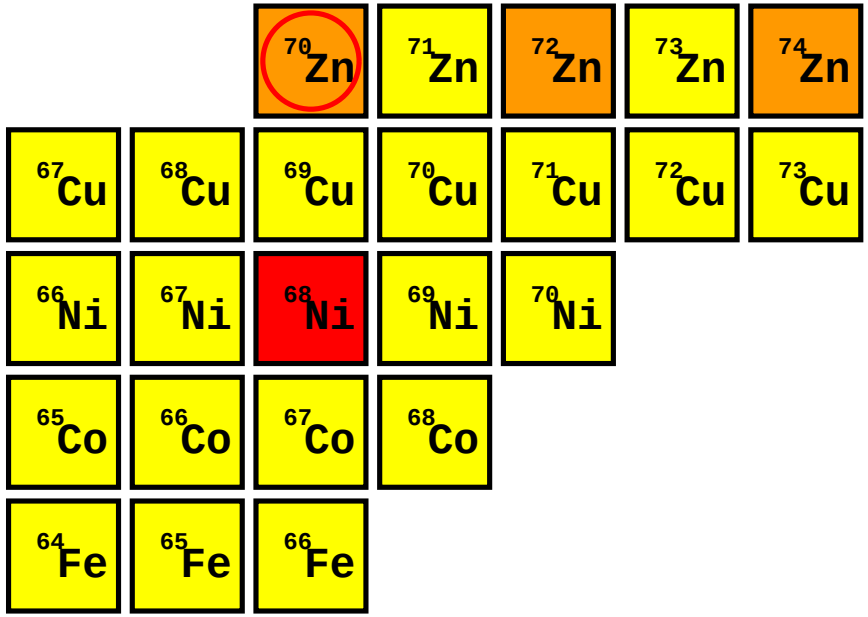

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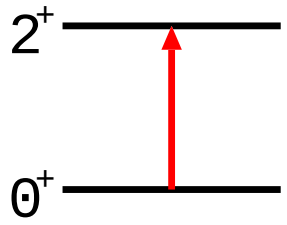
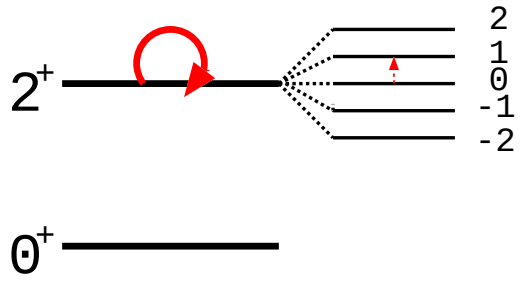
Experimental methods to measure transition probabilities around ^{68}Ni

- Lifetime measurements after deep-inelastic reactions
  - yrast states
  - problem of unknown feeding



$\langle 2^+ || E2 || 0^+ \rangle^2$
$\sim B(E2; 2^+ \rightarrow 0^+)$

- Coulomb excitation
  - collective states
  - Coulex cross-sections depend on quadrupole moments

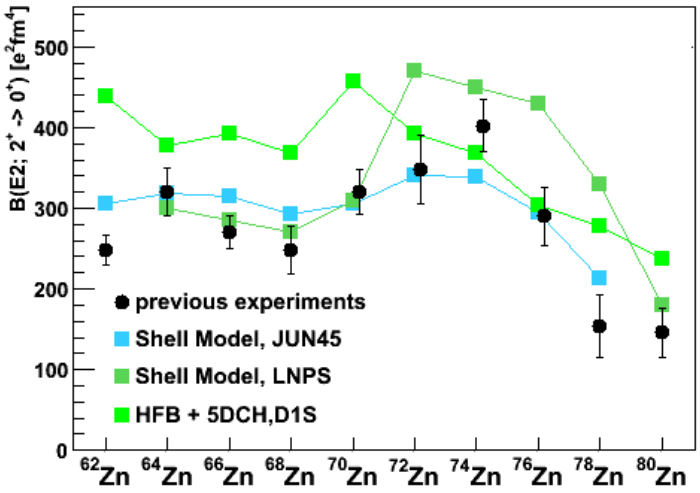


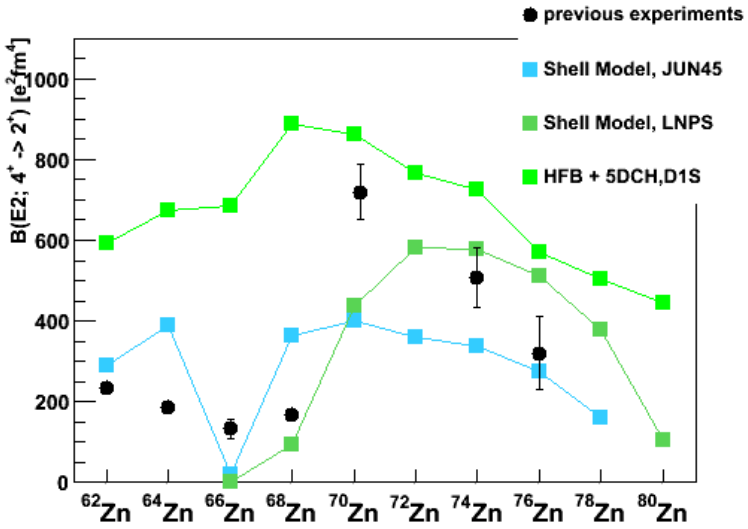
$\langle 2^+ || E2 || 2^+ \rangle \sim Q_0$

Combination of both methods should in principle give information on quadrupole moments, but it depends strongly on accuracy and quality of the results...

Transition probabilities in Zn isotopes

- B(E2)'s for stable Zn isotopes: Coulex, RDDS, DSAM: some important discrepancies (^{66}Zn)
- heavy Zn isotopes: Coulex, high-energy Coulex for 2^+



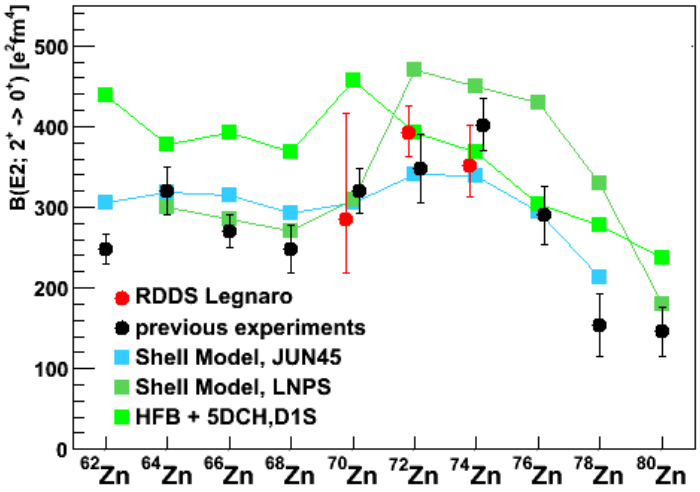


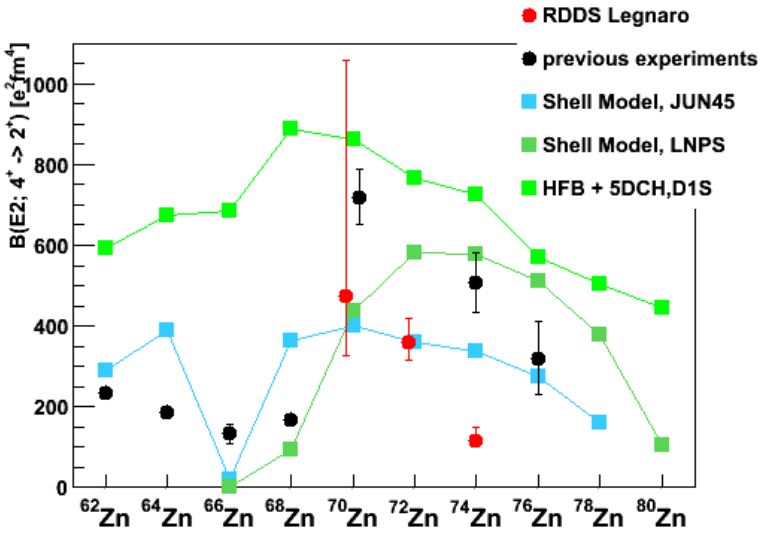
- B(E2; $4^+ \rightarrow 2^+$) better test for theories than B(E2; $2^+ \rightarrow 0^+$)
- collectivity overestimated by beyond mean field calculation

Transition probabilities in Zn isotopes

C. Louchart, PRC 87 (2013) 054302

- RDDS measurement with AGATA (Legnaro)
- new lifetimes for the 2^+ states in agreement with previous B(E2; $2^+ \rightarrow 0^+$) values
- good agreement with model calculations for the 2^+





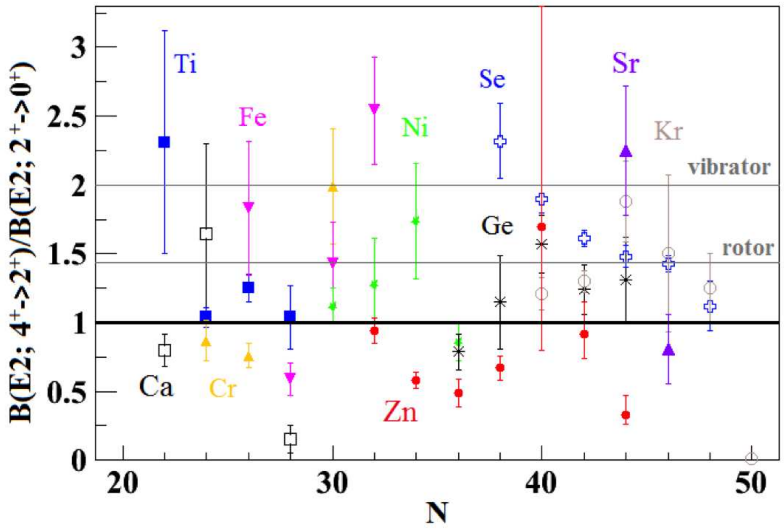
- discrepancy of the new lifetimes for 4^+ states with low-energy Coulex results (especially for ^{74}Zn)
- shell model calculations do not reproduce the observed trend for the 4^+

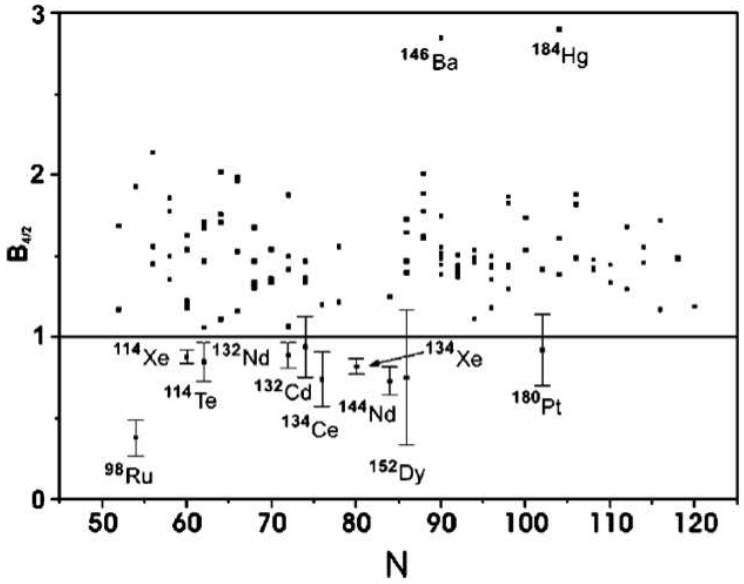
Collectivity of 4^+ states

Z<40 nuclei

40<Z<80 nuclei

R.B. Cakirli et al. PRC 70, 047302 (2004)

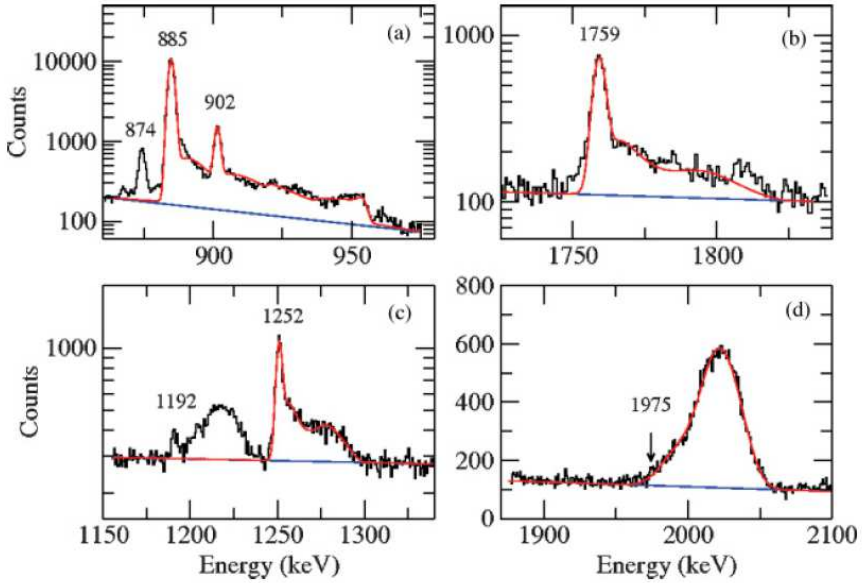


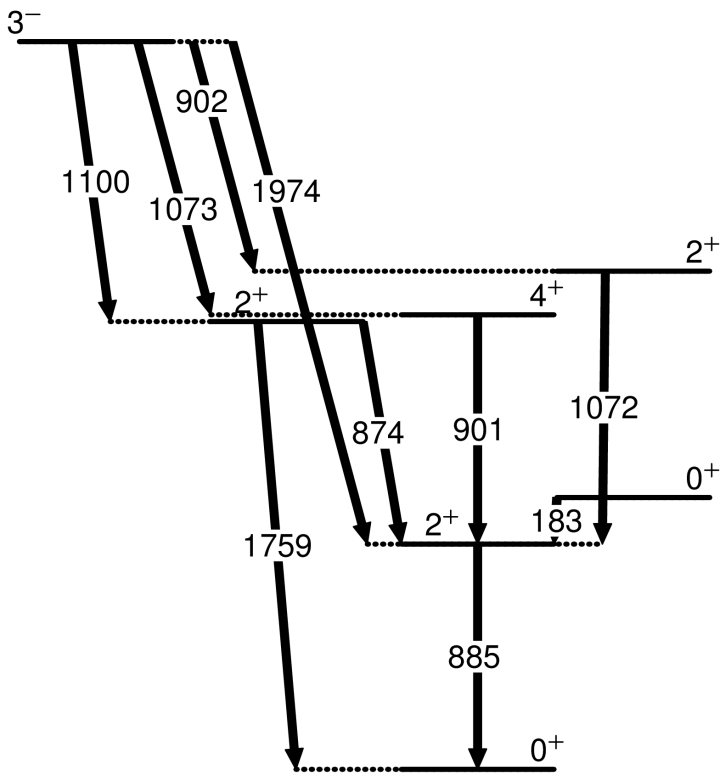


- Small B(E2;$4^+ \rightarrow 2^+$)/B(E2;$2^+ \rightarrow 0^+$) ratio for all Zn isotopes $\rightarrow$ indication of a non-collective character of the 4^+ states

Transition probabilities in ^{70}Zn

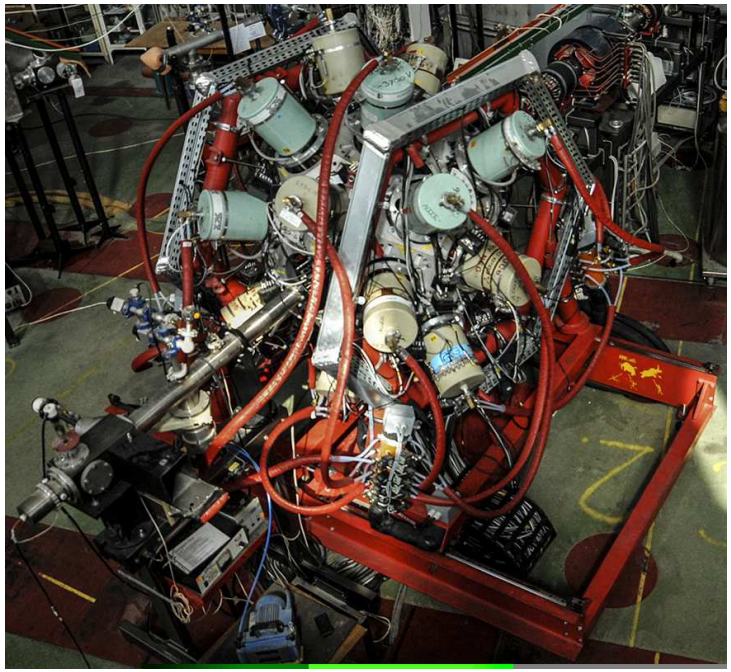
D. Mücher et al PRC 79 (2009)

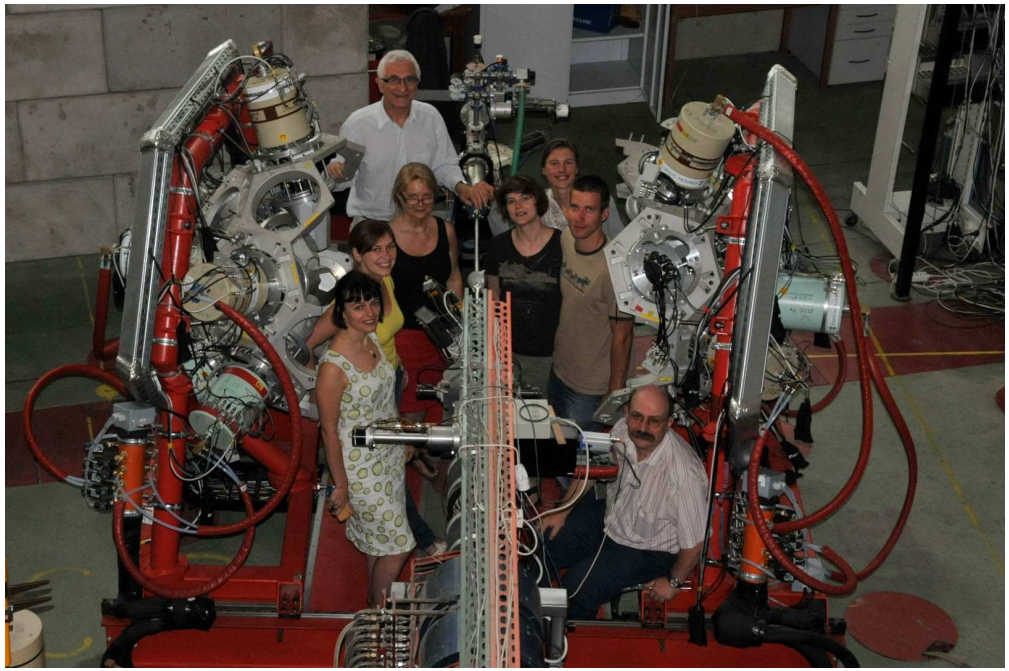




- $4^+ \rightarrow 2^+$ (901 keV) and $2^+ \rightarrow 0^+$ (885 keV) close in energy
- Coulomb excitation seems a more appropriate method to measure B(E2)'s in ^{70}Zn (no double peaks/tails)
- dedicated Coulomb excitation experiment to measure B(E2; $4^+ \rightarrow 2^+$) in ^{70}Zn: November 2012, HIL Warsaw, Poland
- low-Z beam (^{32}S) to minimize the contribution of the 3^- decay to the 902 keV line

EAGLE spectrometer at HIL Warsaw

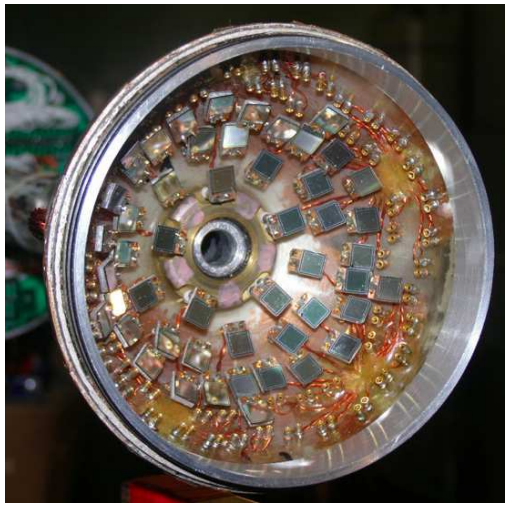


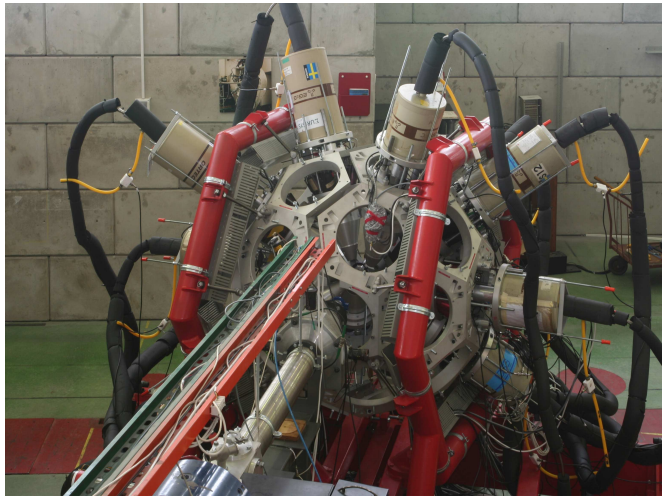


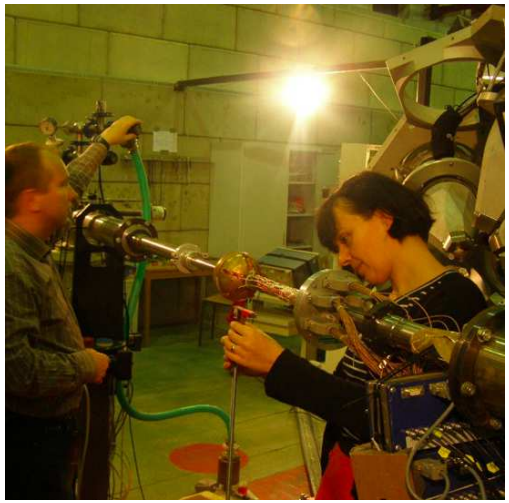
- 15 Phase-I HPGe detectors with ACS, loaned by Gammapool (July 2011 – June 2013)
- total efficiency about 2%
- ancillary detectors: electron spectrometer, plunger, multiplicity filter, compact Coulex chamber...

Coulomb excitation of ^{70}Zn

HIL Warsaw, November 2012







48 PIN diodes (120° – 155°)

^{32}S beam (68 MeV),
^{70}Zn target (0.7 mg/cm^2)
5 days of data-taking

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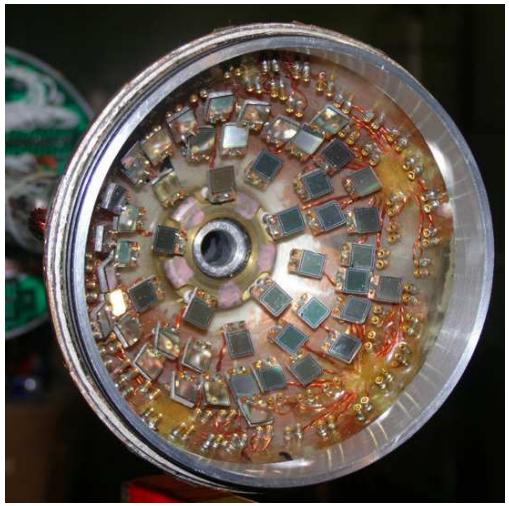

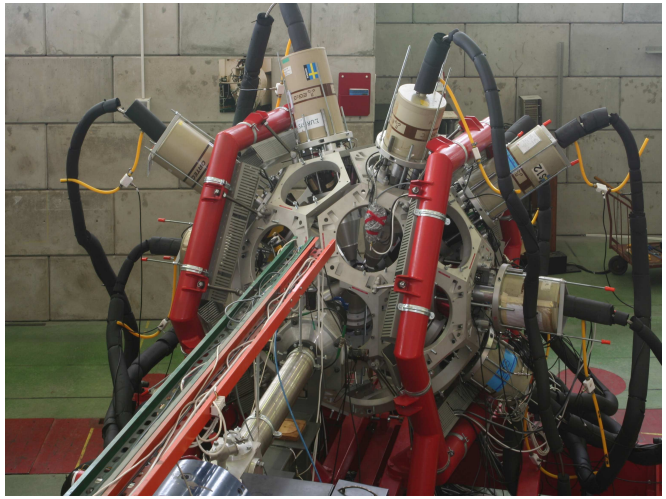

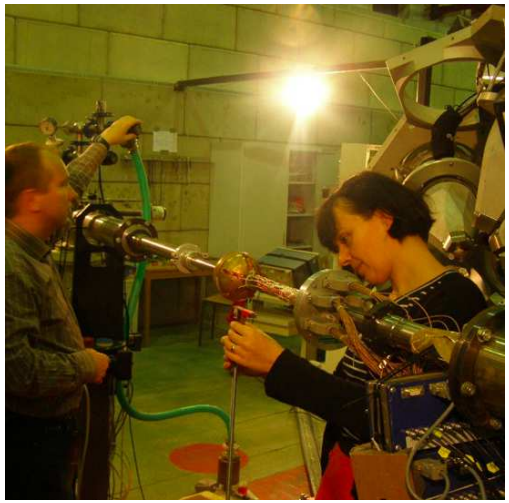

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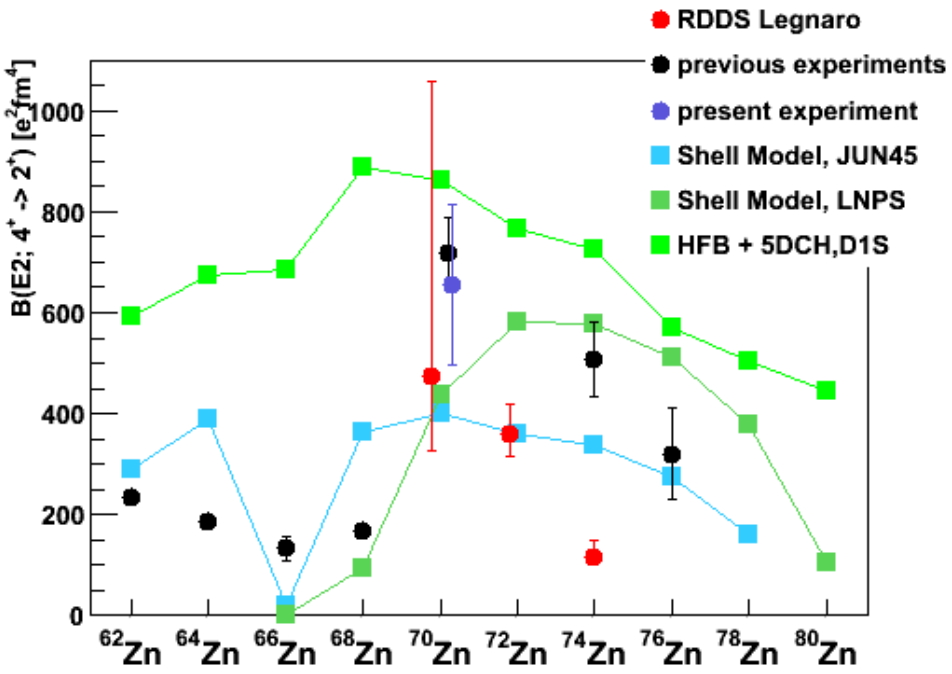
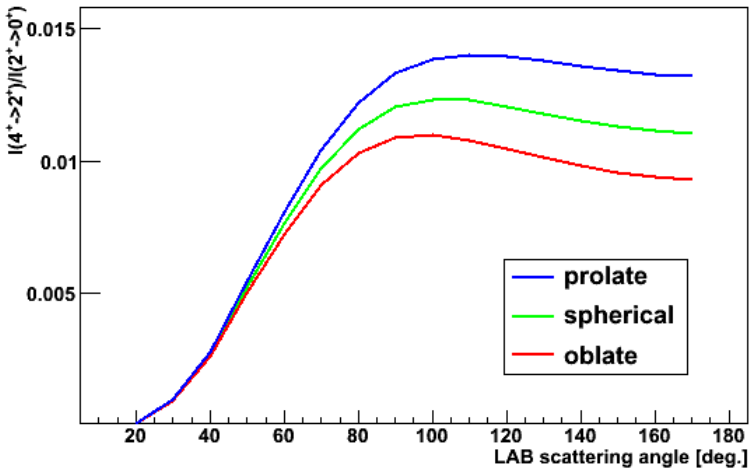
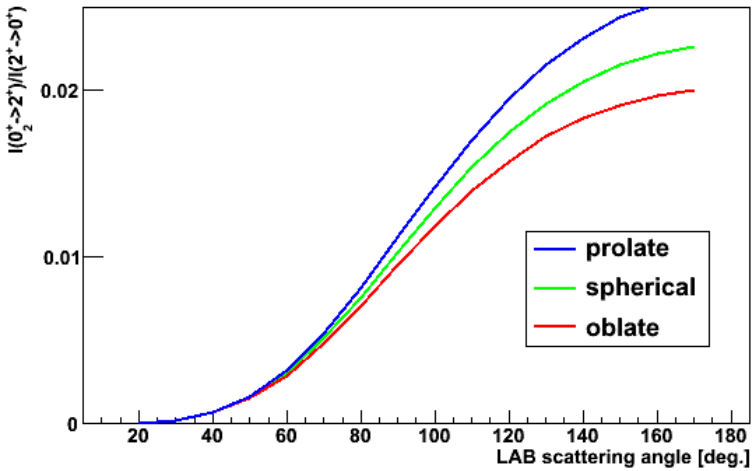
Preliminary – data only from particle detectors at 155°



Perspectives

- finalisation of the Coulex analysis for ^{70}Zn - data from particle detectors at lower scattering angles
  - better accuracy ($\approx$ 10%)
  - quadrupole moment of the 2^+ state?





- Coulomb excitation of ^{72}Zn at ISOLDE (spokesperson D. Mücher, 2012) – data under analysis
- Coulomb excitation of $^{74-80}$Zn at HIE-ISOLDE: proposal accepted by INTC
  - collectivity of higher-lying states
  - quadrupole moments in exotic Zn isotopes?

Collaboration:

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Georges Fremont[2], Kasia Hadyńska-Klęk[3], Jędrek Iwanicki[3],
Łukasz Janiak[4], Nele Kesteloot[5], Wolfram Korten[1], Michał Kowalczyk[3],
Andrzej Molenda[4], Paweł Napiorkowski[3], Jarek Perkowski[4],
Justyna Samorajczyk[4], Julian Srebrny[3], Anna Stolarz[3],
Kasia Wrzosek-Lipska[5]

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5) KU Leuven, Belgium.