Coulomb excitation of ^{68,70,m,g}Cu with REX-ISOLDE and Miniball (IS435)

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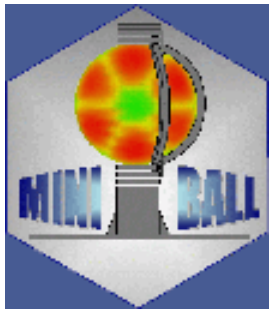
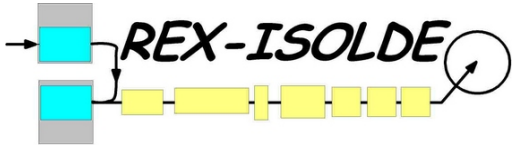
IKS, KU Leuven

G. Georgiev

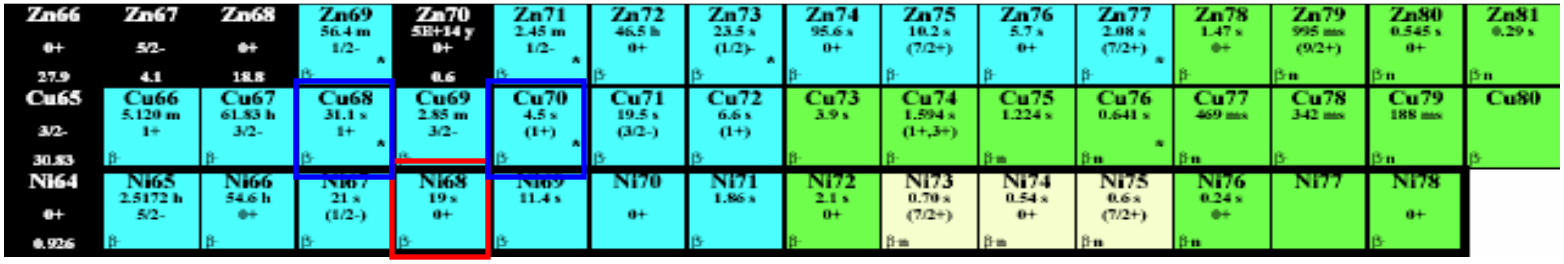
CSNSM Orsay, France

Miniball collaboration and **REX-ISOLDE** collaboration

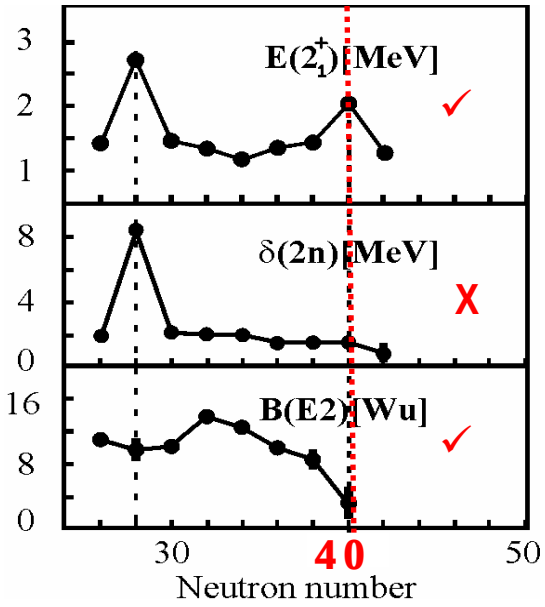


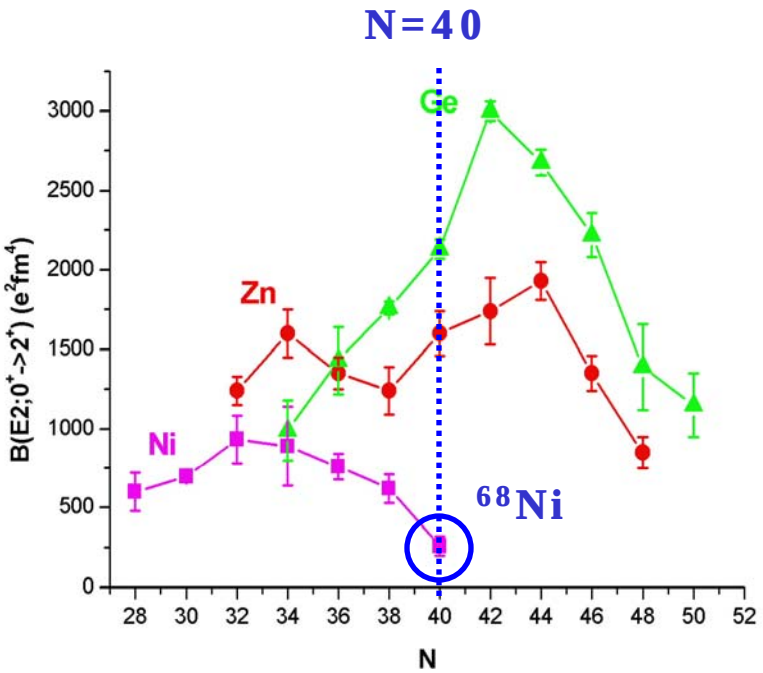


N=40: neutron-rich Cu isotopes



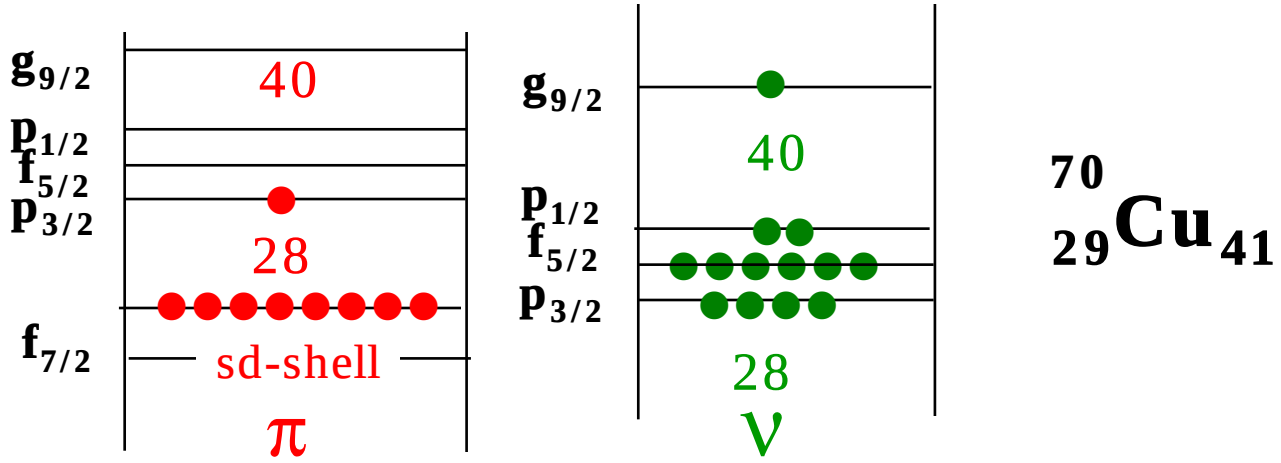
^{68}Ni





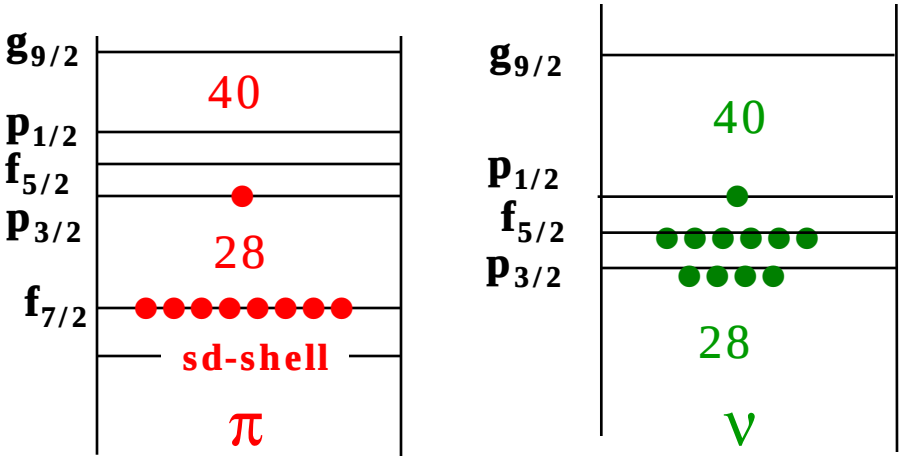
N=40: neutron-rich Cu isotopes

- ^{68}Ni a good core? ➔ determine the effective proton and neutron charges
- odd-A and odd-odd nuclei ➔ nuclear wave function dominated by single-particle configurations



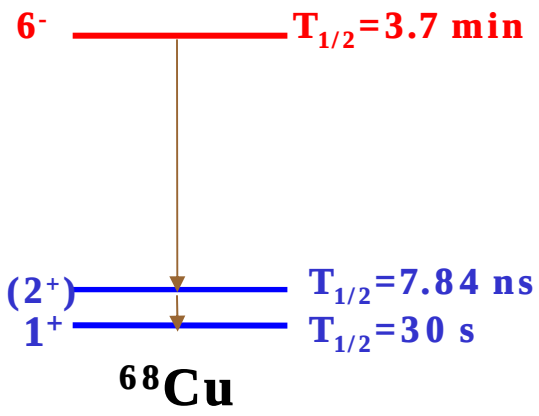
- Coulex of ^{67,69,71}Cu: effective proton charges
- ✓ Coulex of ^{68,70}Cu: effective neutron charges

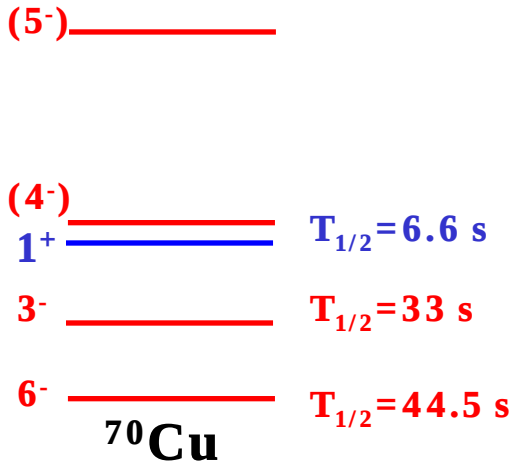
N=40: coulex of ^{68,70}Cu isotopes



$\pi p_{3/2} \otimes \nu g_{9/2}$ ($J^\pi = 3^-, 4^-, 5^-, 6^-$)

$\pi p_{3/2} \otimes \nu p_{1/2}$ ($J^\pi = 1^+, 2^+$)



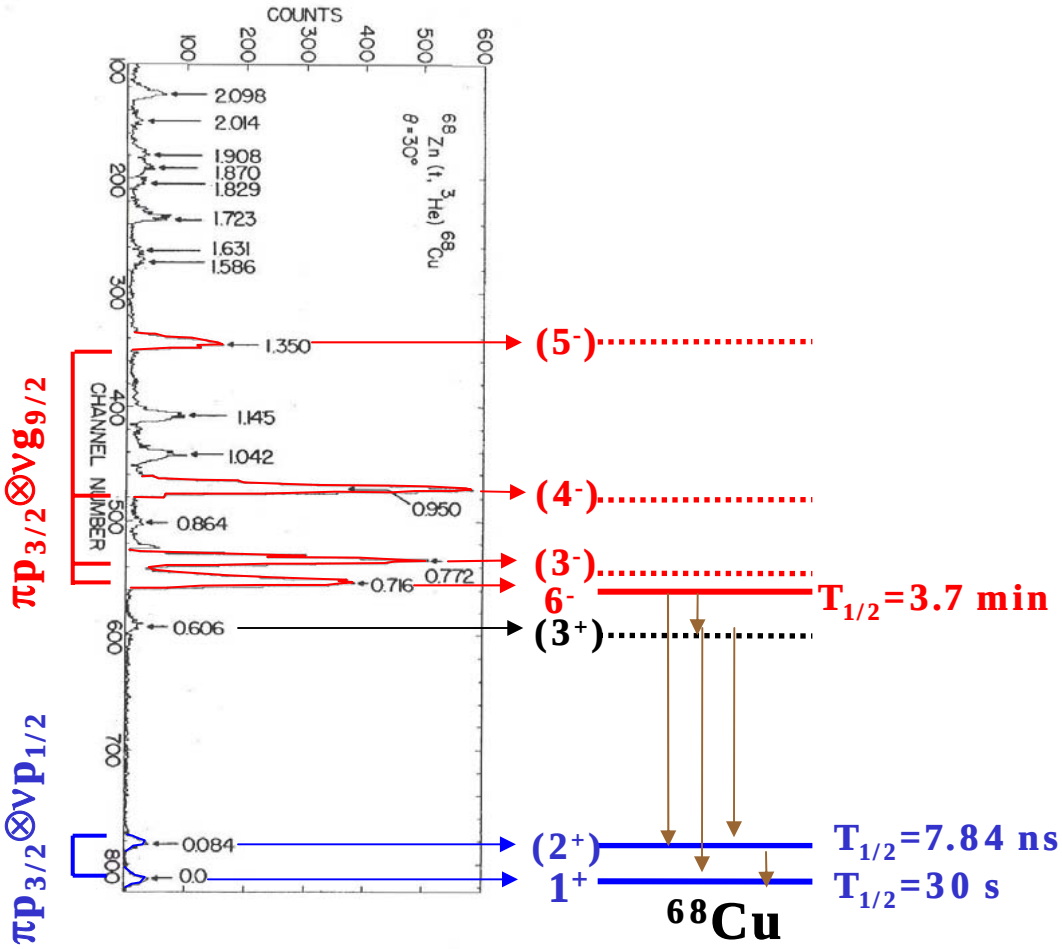


T. E. Ward et al., PR88, 1802(1969)
L. Hou et al., PRC68, 054306(2003)

J. Van Roosbroeck et al., PRL92(2004)112501
J. Van Roosbroeck et al., PRC69(034313).

Neutron-rich even-A Cu isotopes

- ^{68,70}Cu-



$\pi p_{3/2} \otimes \nu g_{9/2}$

$\pi p_{3/2} \otimes \nu p_{1/2}$

(5^-)

(4^-)

(3^-)

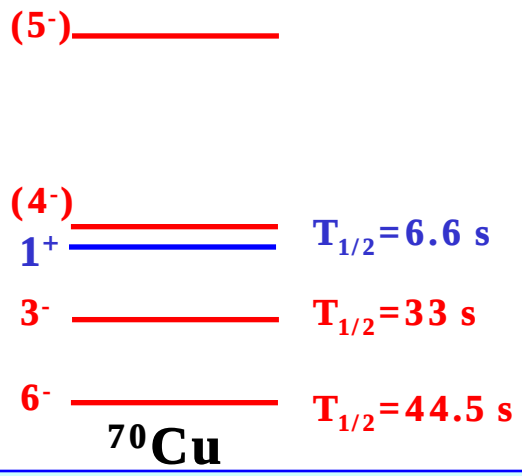
6^- $T_{1/2}$=3.7 min

(3^+)

(2^+) $T_{1/2}$=7.84 ns

1^+ $T_{1/2}$=30 s

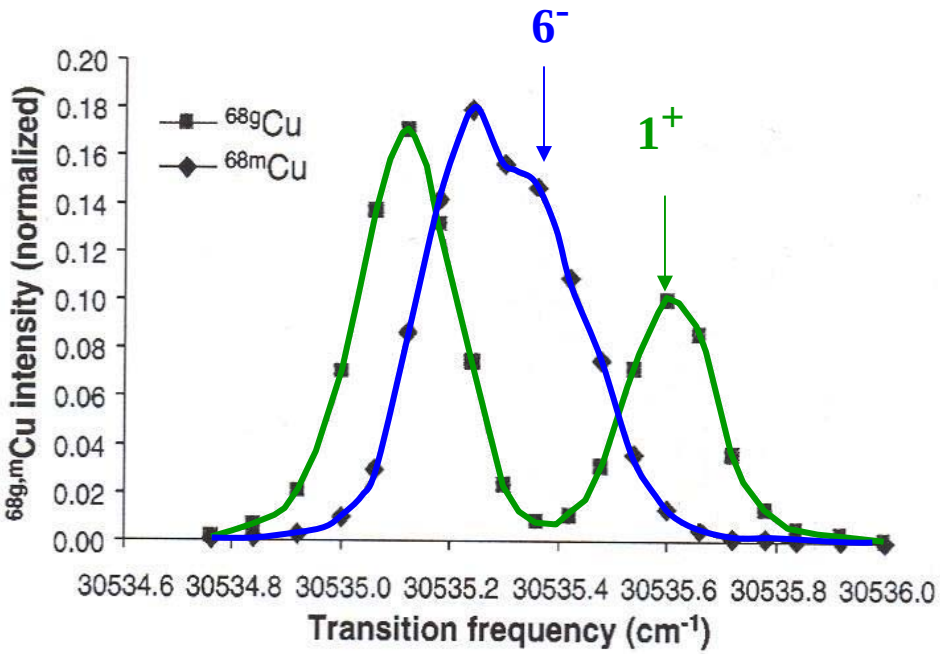
^{68}Cu

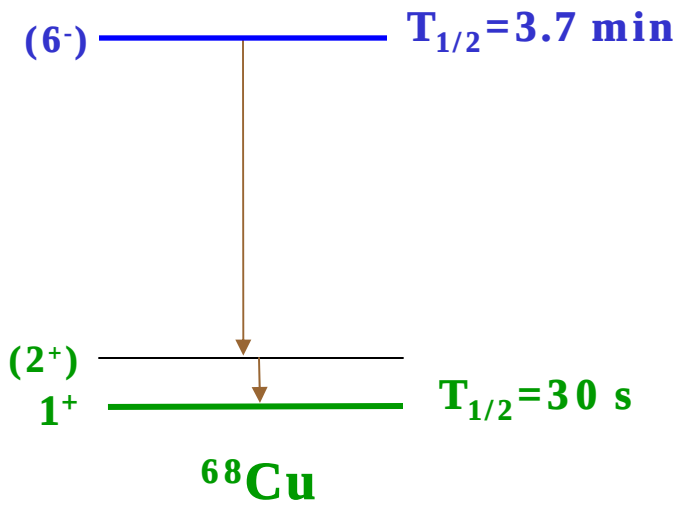


J.D. Sherman *et al.* PLB67 (77) 257
T. Ishii et al., Jaeri-Review, 2002-029, 25

^{68,70,m,g}Cu: production of isomeric beams

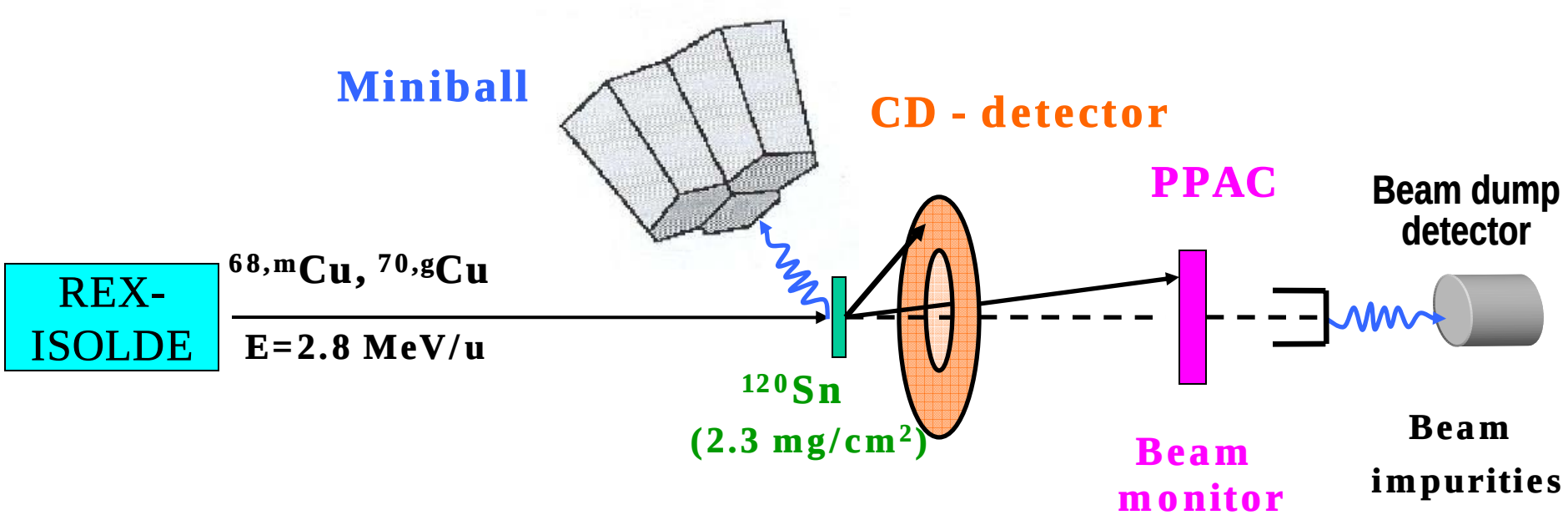
Example: ^{68}Cu





U. Koester et al., NIMB167(2000)528
^{70}Cu: J. Van Roosbroeck et al., PRL92(2004)112501

Experimental Setup



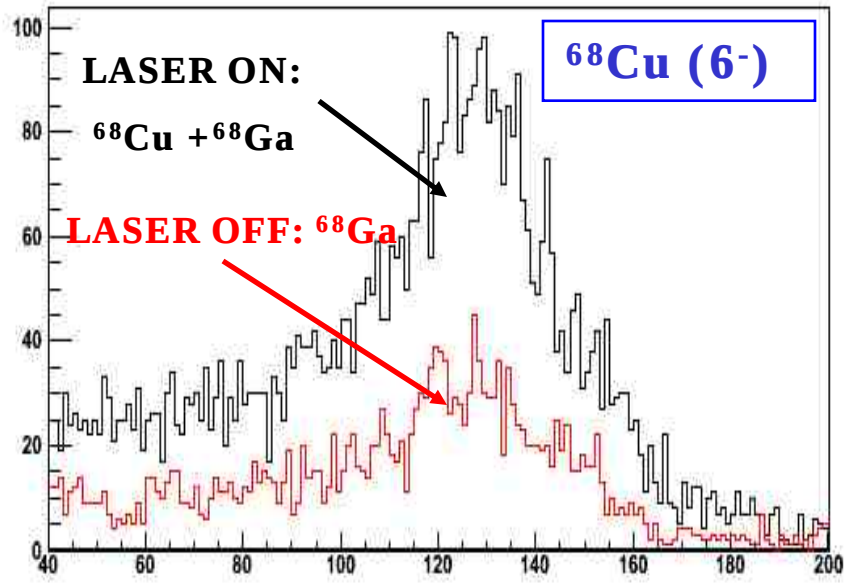
$Y_{MB}(^{68,m}Cu) \sim 3 \cdot 10^5$ pps

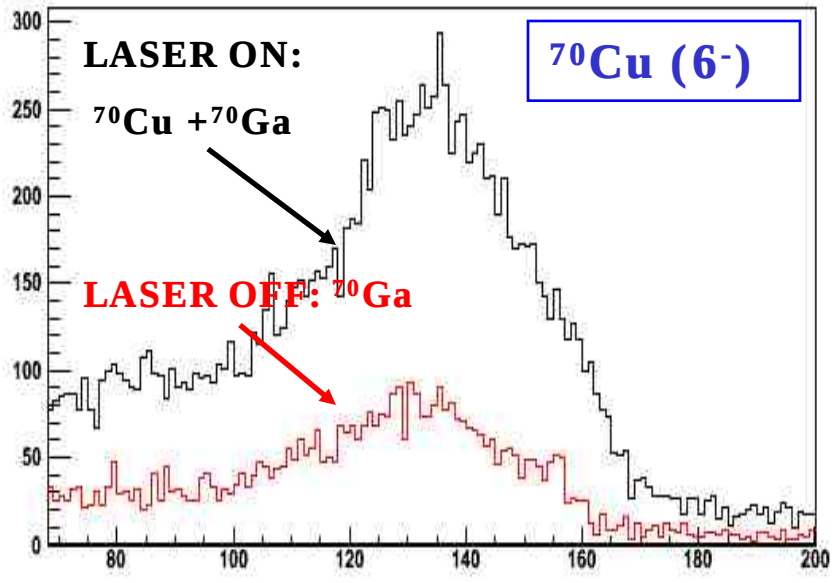
$Y_{MB}(^{70,g}Cu) \sim 5 \cdot 10^4$ pps

- 6 equidistant proton pulses per supercycle;
- $q=19^+$; breading time 98 ms.

Coulex of ^{68,70,m,g}Cu

➢ **Laser ON/OFF runs for determining isobaric contaminants**

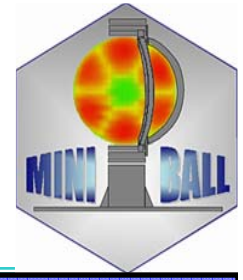


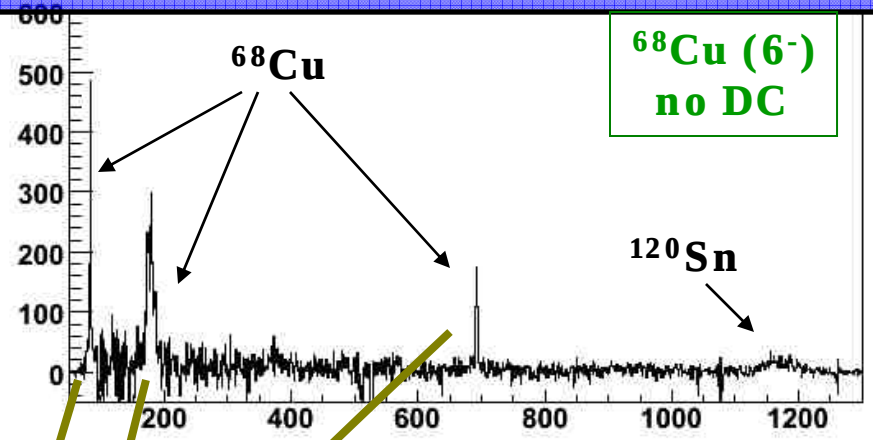


^{68}Cu/total = 74 ± 2 %

^{70}Cu/total = 70 ± 5 %

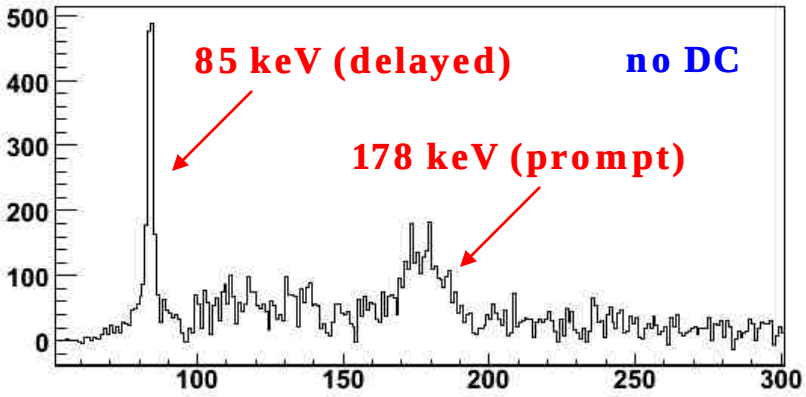
Coulex of ^{68,m}Cu

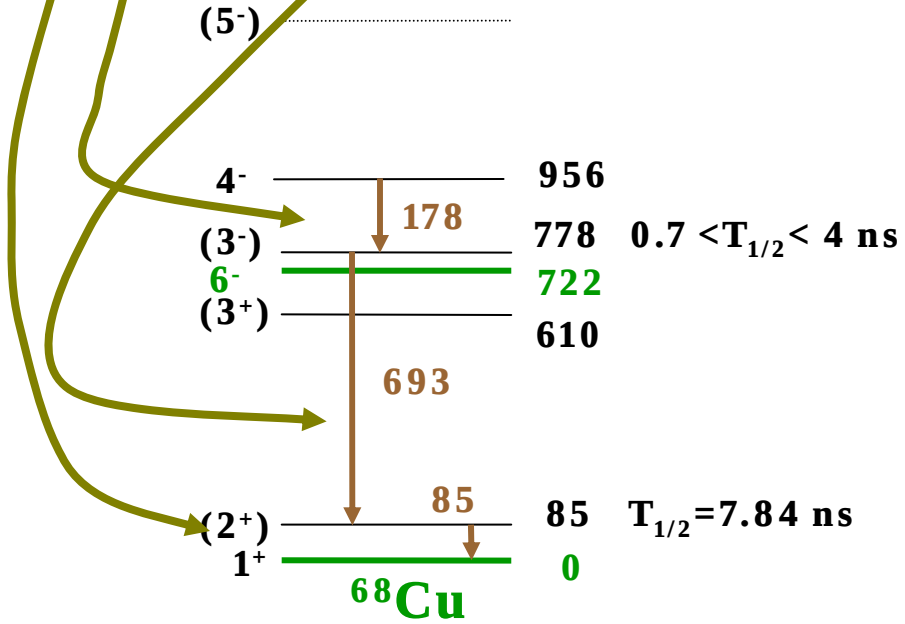


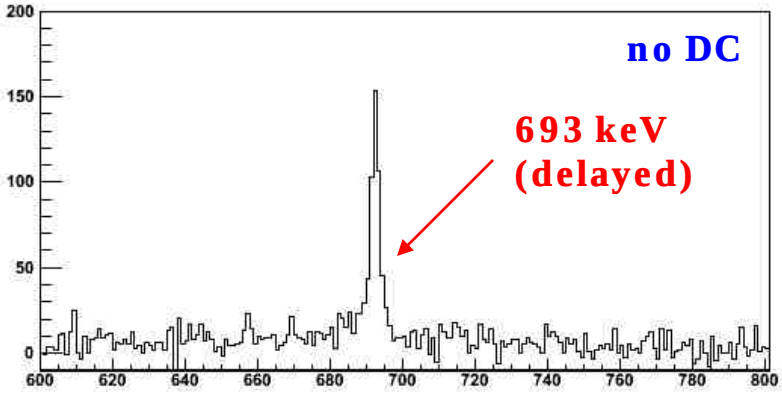


^{68}Cu (6$^-$)
no DC

➢ ^{68,m}Cu (2.86 MeV/u) @ ^{120}Sn (2.3 mg/cm^2)

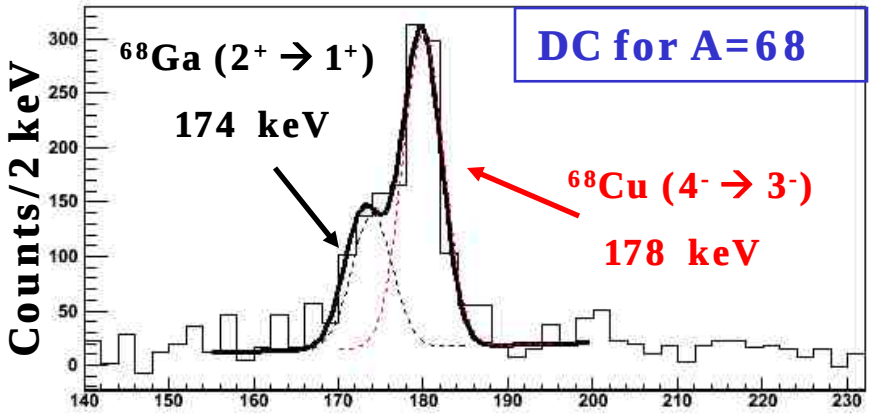


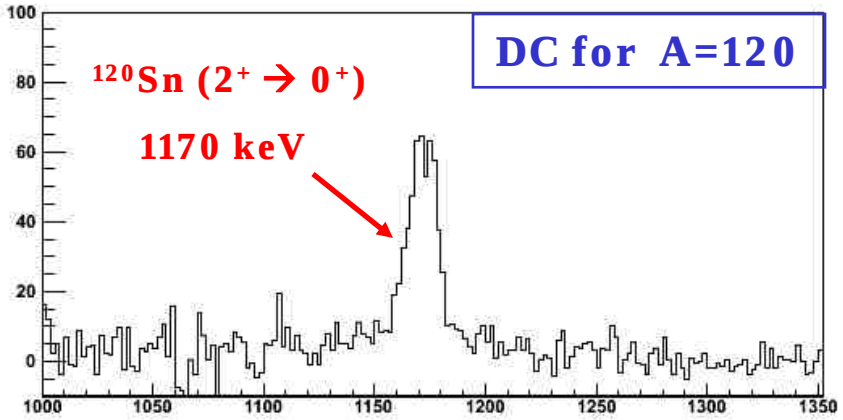




Coulex of ^{68,m}Cu

➢ ^{68,m}Cu (2.86 MeV/u) @ ^{120}Sn (2.3 mg/cm^2)





$B(E2; 6^- \rightarrow 4^-) \sim \sigma(E2; 6^- \rightarrow 4^-) \sim \sigma(E2; {}^{120}Sn) \cdot 1/r \cdot N_\gamma({}^{68}Cu) / N_\gamma({}^{120}Sn)$

^{68}Cu, preliminary : $B(E2; 4^- \rightarrow 6^-) = 88 \pm 7\ e^2fm^4$

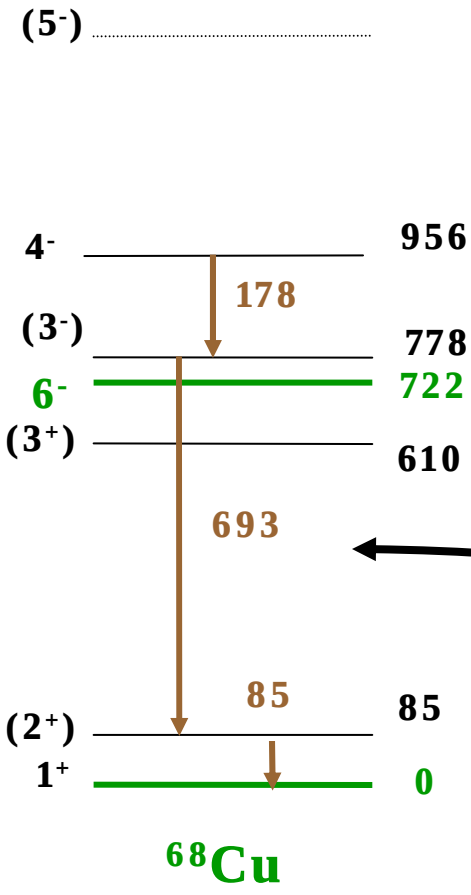
Coulex of ^{68,m}Cu

➢ ^{68,m}Cu (2.86 MeV/u) @ ^{120}Sn (2.3 mg/cm^2)

v/c = 7%

$D_{target-CD}$ = 3.25 cm

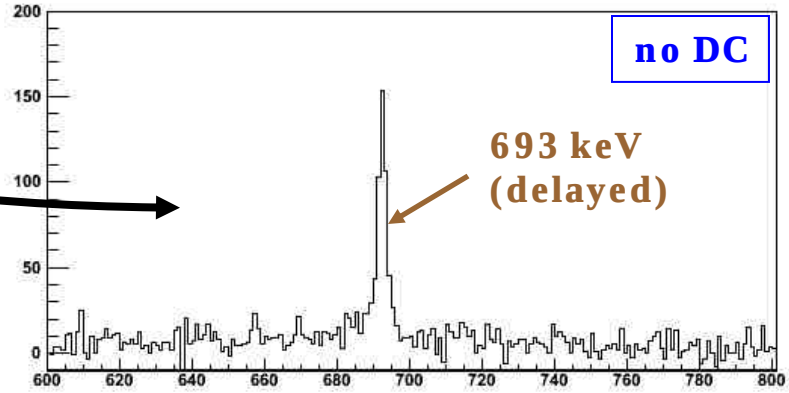
➔ τ = 1.6 ns



0.7 <$T_{1/2}$< 4 ns**

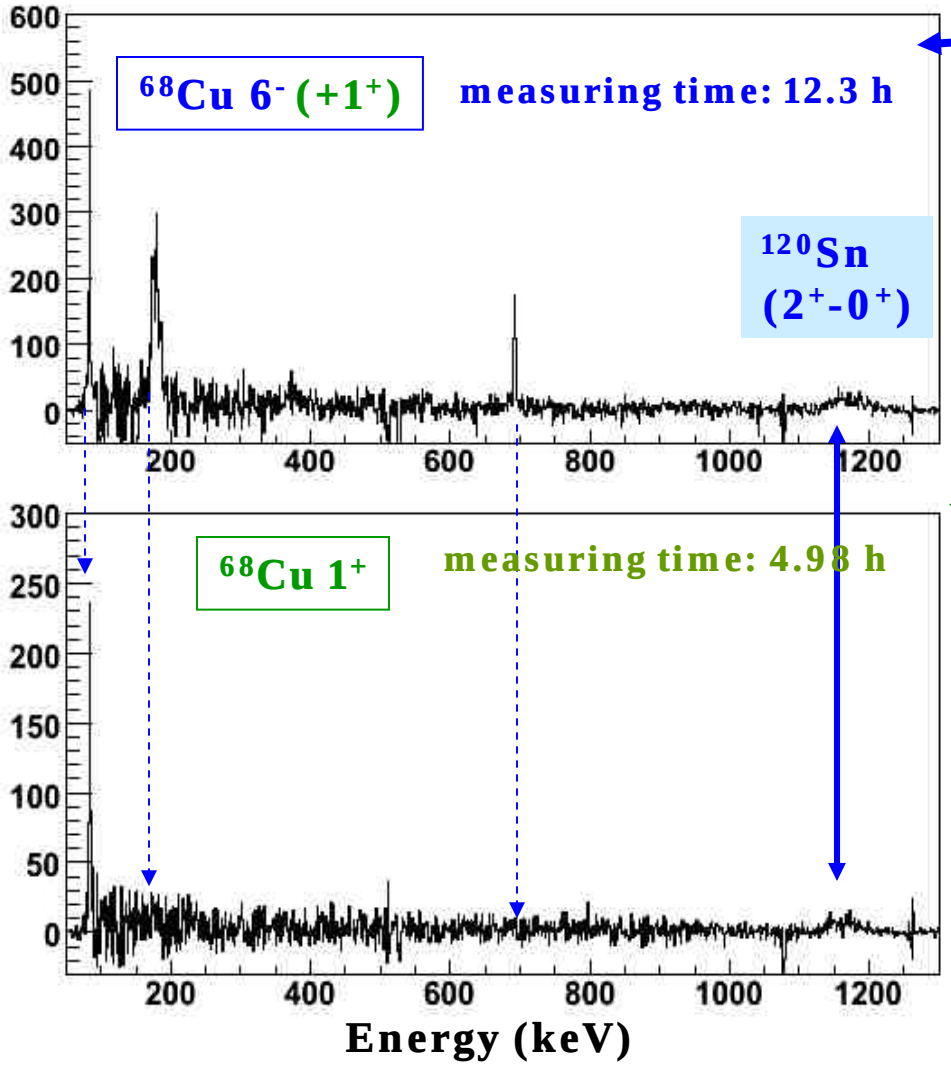
1.11 ns < $T_{1/2}$ < 4 ns

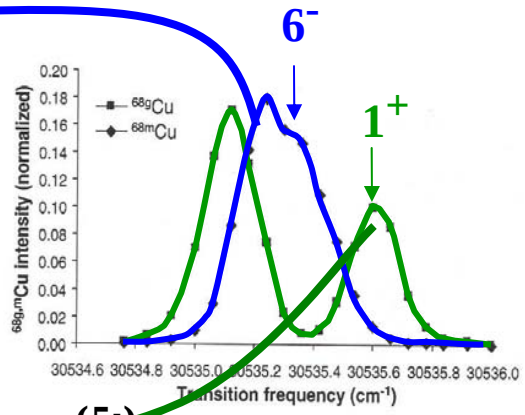
$T_{1/2}$=7.84 ns

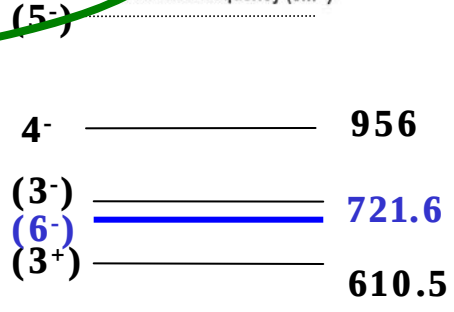


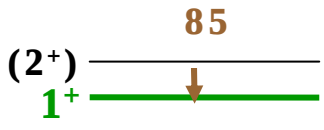
**T. Ishii et al., Jaeri-Review, 2002-029, 25

Coulex of ^{68,m}Cu





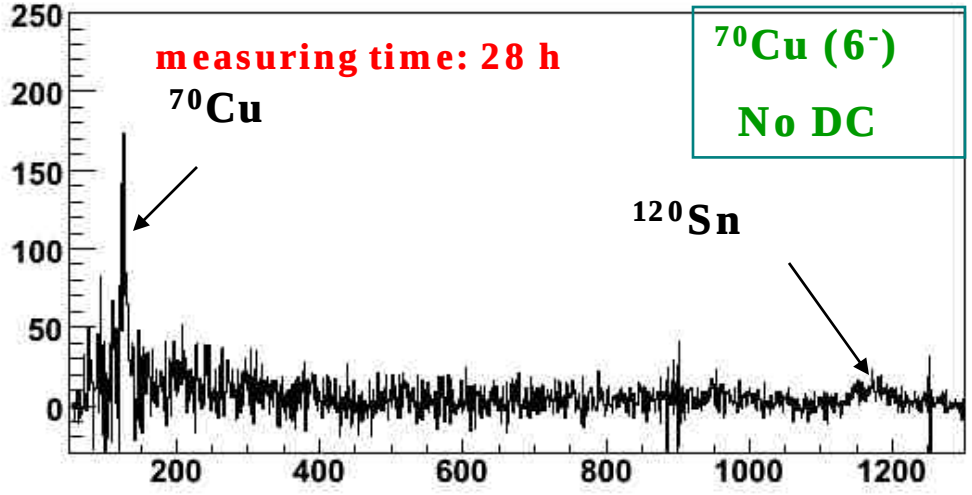


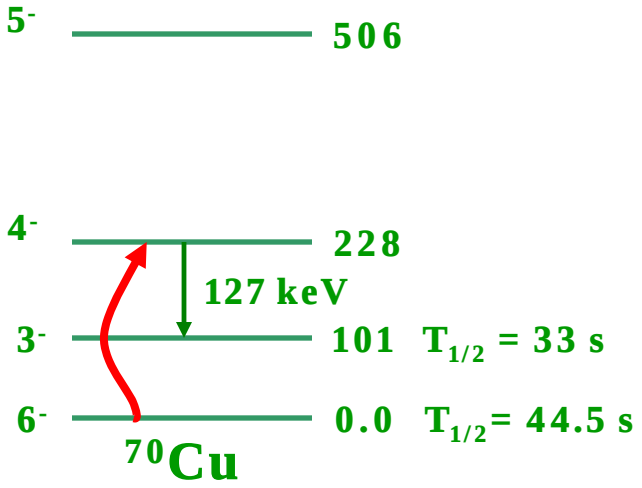


L. Hou et al., PRC 68, 054306(2003)

Coulex of ^{70,g}Cu

➢ ^{70,g}Cu (2.86 MeV/u) @ ^{120}Sn (2.3 mg/cm^2)





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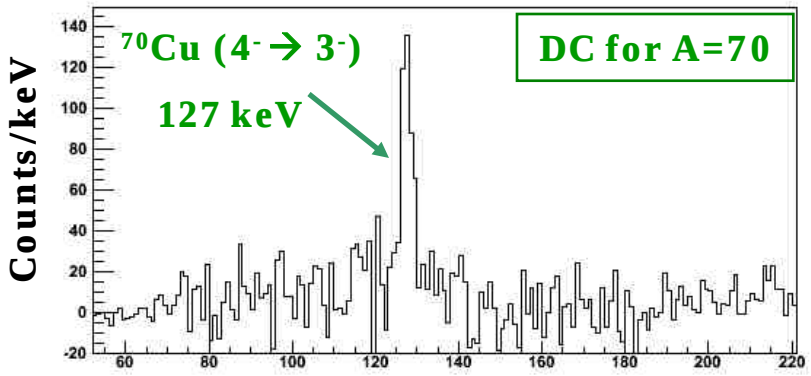
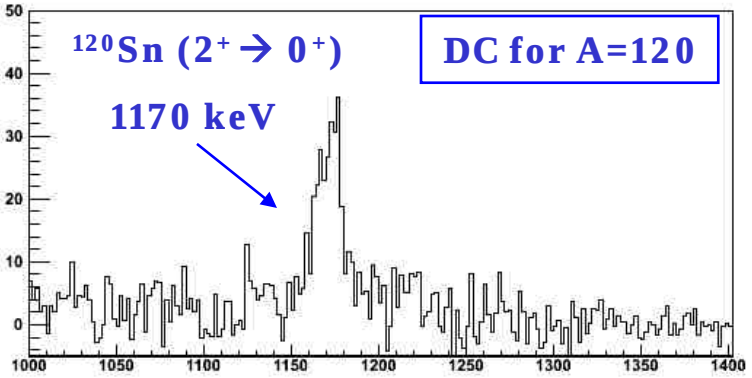


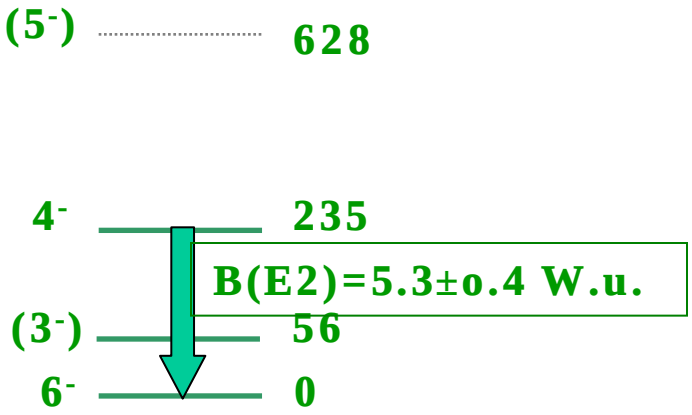


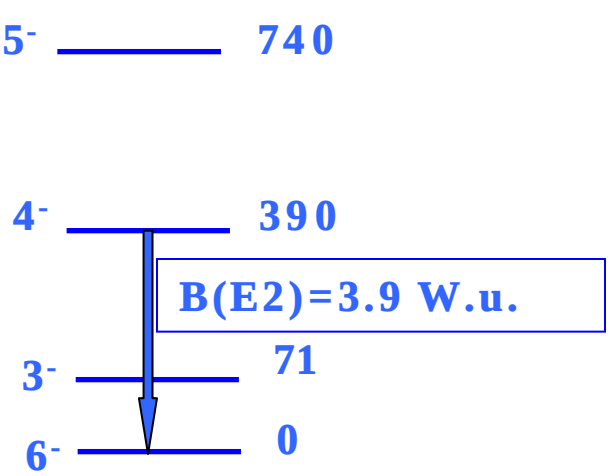
^{70}Cu, preliminary : $B(E2; 4^- \rightarrow 6^-) = 105 \pm 11$ e^{2}fm^4

Coulex of ^{68,70,m,g}Cu

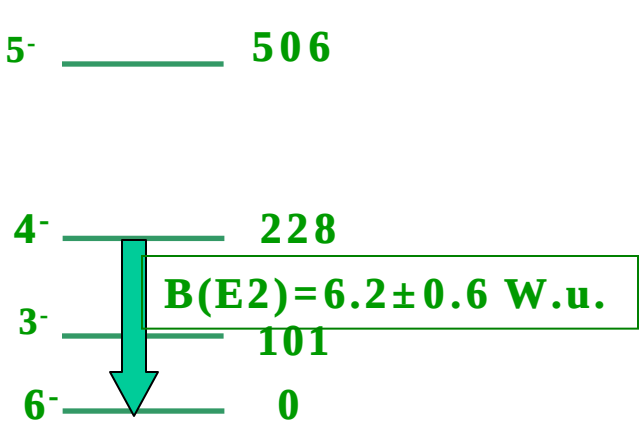
EXP.

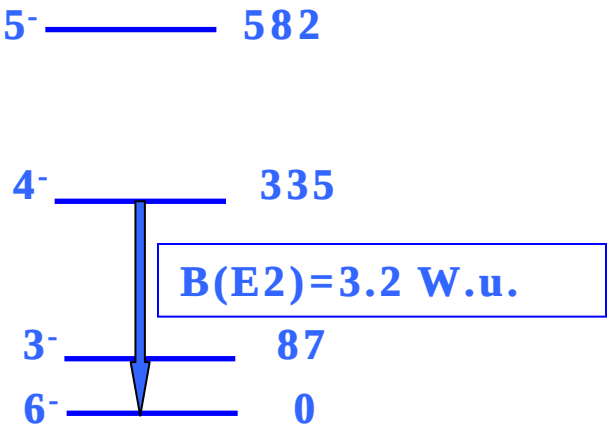
Shell-model**





^{68}Cu





^{70}Cu

**N. Smirnova, Private Communication

Conclusions and outlook

- ✓ **July 2005: for the first time isomeric beams are post-accelerated by REX-ISOLDE**
- ✓ **Coulex of ^{68,70,m,g}Cu was measured with Miniball**
- ✓ **$\pi p_{3/2} \otimes \nu g_{9/2}$ multiplet : B(E2; $4^- \rightarrow 6^-$) measured, energy and spin of the 4^- state fixed**
- ✓ **preliminary results in good agreement with the shell – model calculations**

➢ **summer 2006: coulex of ^{67,69,71}Cu**

→ **effective proton and neutron charges around ^{68}Ni**

The Collaboration

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the MINIBALL collaboration and the REX-ISOLDE collaboration

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[2] Max Planck Institut für Kernphysik, Heidelberg, Germany
[3] Institut fur Kernphysik, Universität zu Köln, Germany
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[5] LMU München, Germany
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[9] TU München, Germany
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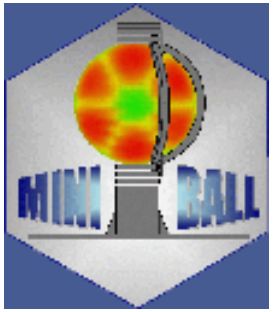
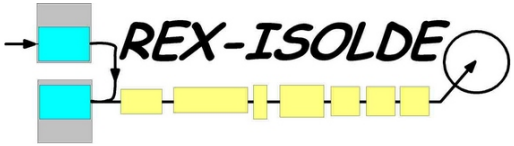
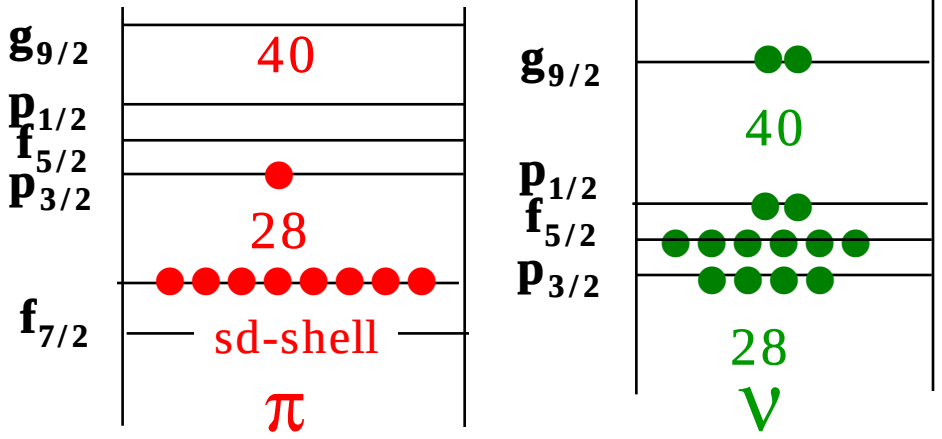
[11] NCSR Athens, Greece



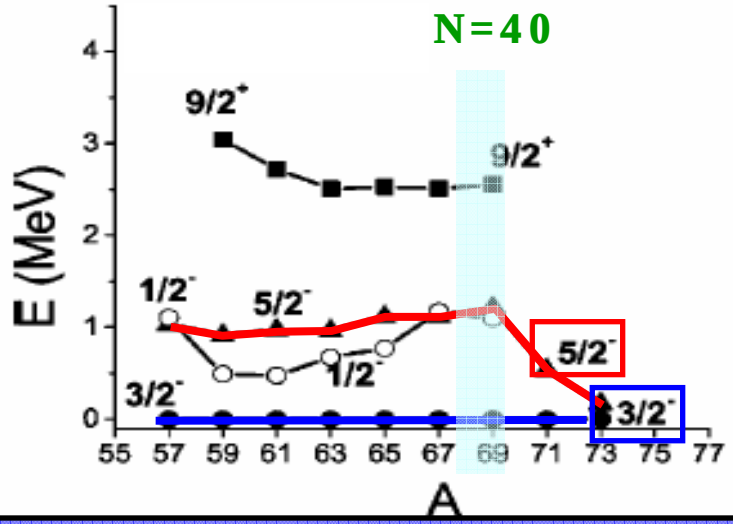


N=40: neutron-rich odd-A Cu isotopes and monopole migration

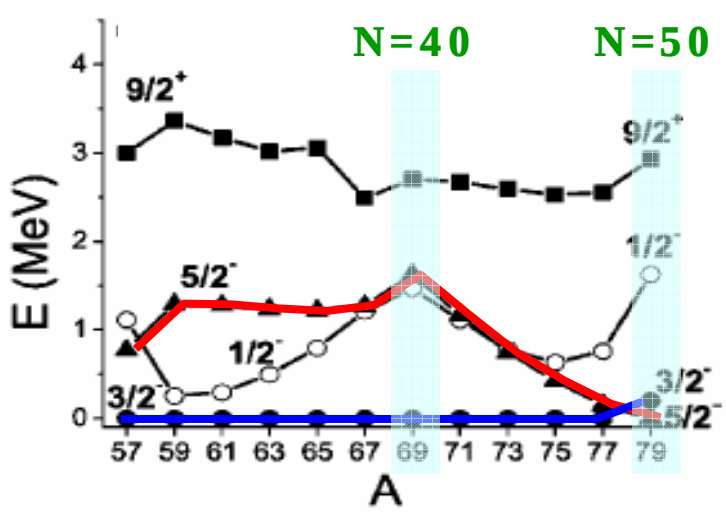


S. Franchoo et al., PRL81 (1998) 3100,
S. Franchoo et al., PRC64 (2001) 054308
N. Smirnova et al., PRC69 (2004) 044306

Experiment

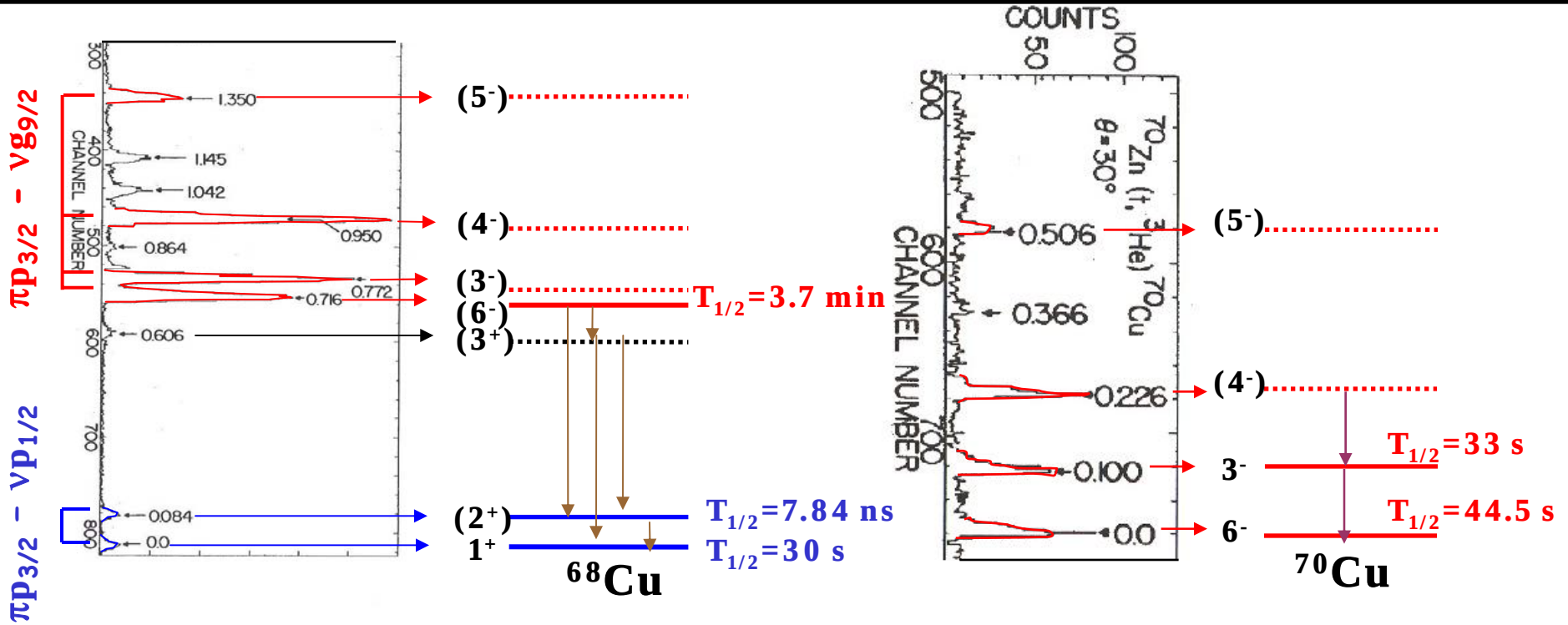


Shell-model



The neutron-rich even-A Cu isotopes

- ^{68,70}Cu-



- Transfer reactions: energies, half-lives *(J.D Sherman, PRL67(1977))*
- ISOLDE, LISOL → laser spectroscopy, beta-decay: spins, energies, magnetic moments, half-lives *(J. Van Roosbroeck, PRL92(2004), PRC69(034313))*.