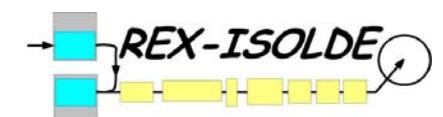
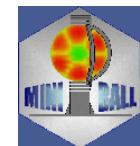
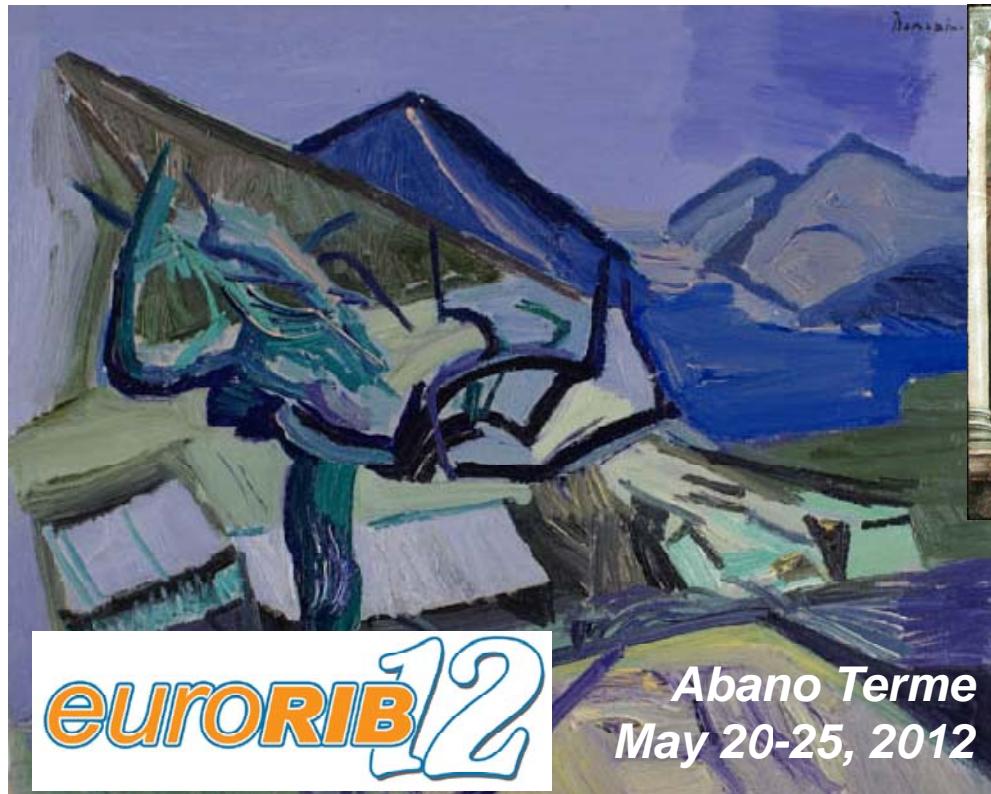


Study of quadrupole collectivity in neutron-rich ^{128}Cd



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Thorsten Kröll
for the IS411/IS477/IS524 collaborations



Work supported by BMBF (Nr. 06DA9036I), EU through ENSAR (No. 262010),
HIC for FAIR, and the MINIBALL/REX-ISOLDE collaborations

Outline



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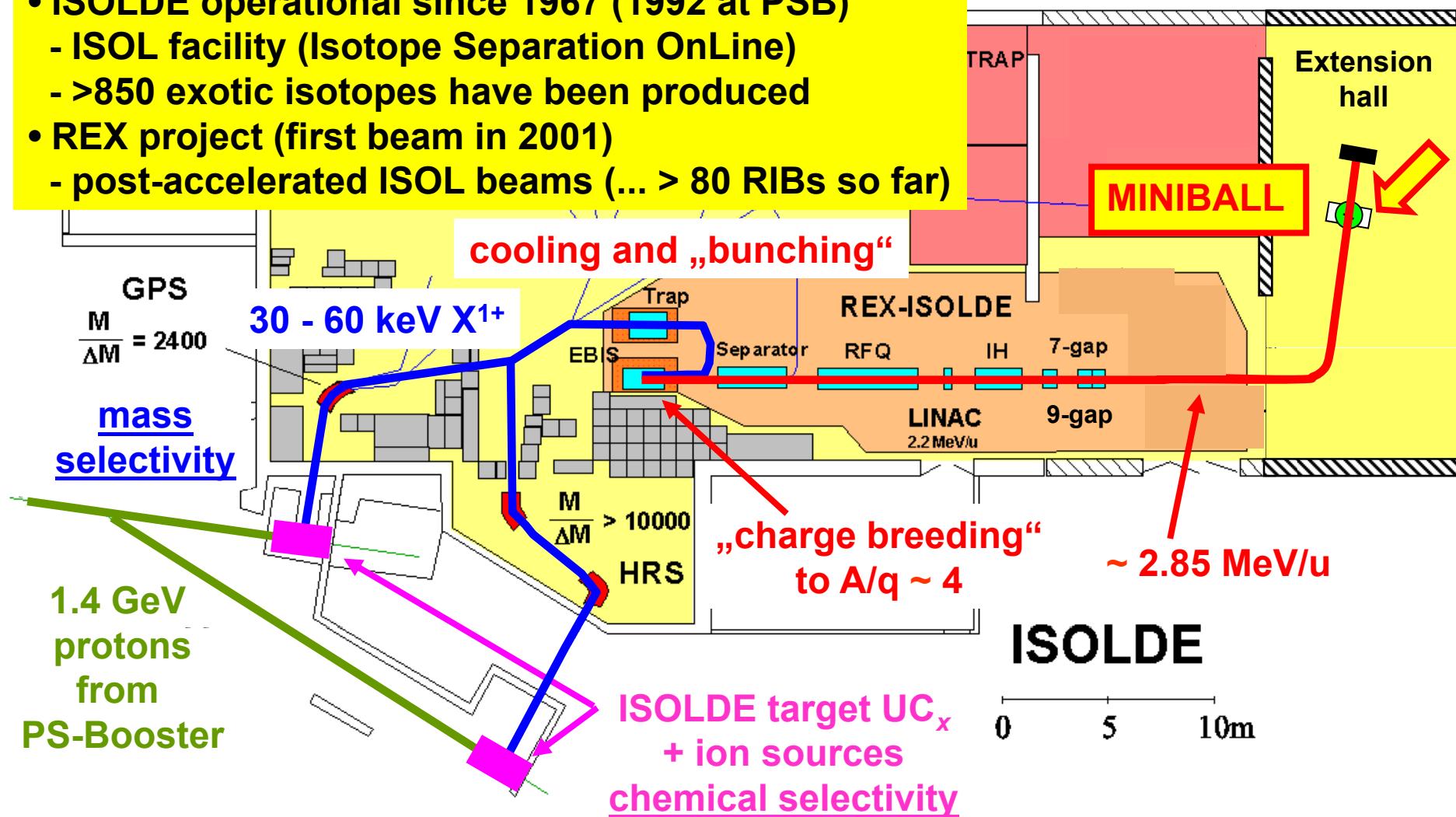
- REX-ISOLDE ... in a nutshell
- Experimental set-up
- New look on old data (IS411) ... $^{124,126}\text{Cd}$ revisited
- DSAM measurement in ^{126}Cd ... a try (IS477, August 2011)
- ^{128}Cd – physics motivation
- Coulomb excitation of ^{128}Cd (IS477, August 2011)
- The odd isotopes ... Coulomb excitation of ^{123}Cd (IS524, May 2012)
- Summary and Outlook

REX-ISOLDE @ CERN ... in a nutshell

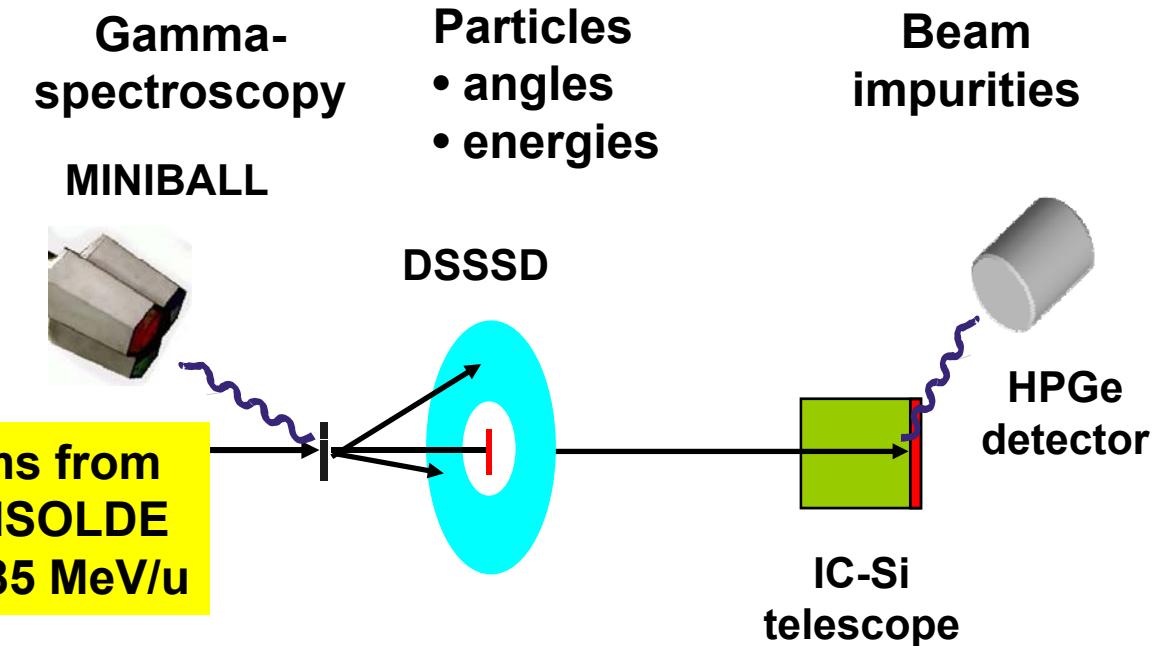


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- ISOLDE operational since 1967 (1992 at PSB)
 - ISOL facility (Isotope Separation OnLine)
 - >850 exotic isotopes have been produced
- REX project (first beam in 2001)
 - post-accelerated ISOL beams (... > 80 RIBs so far)



Experimental set-up



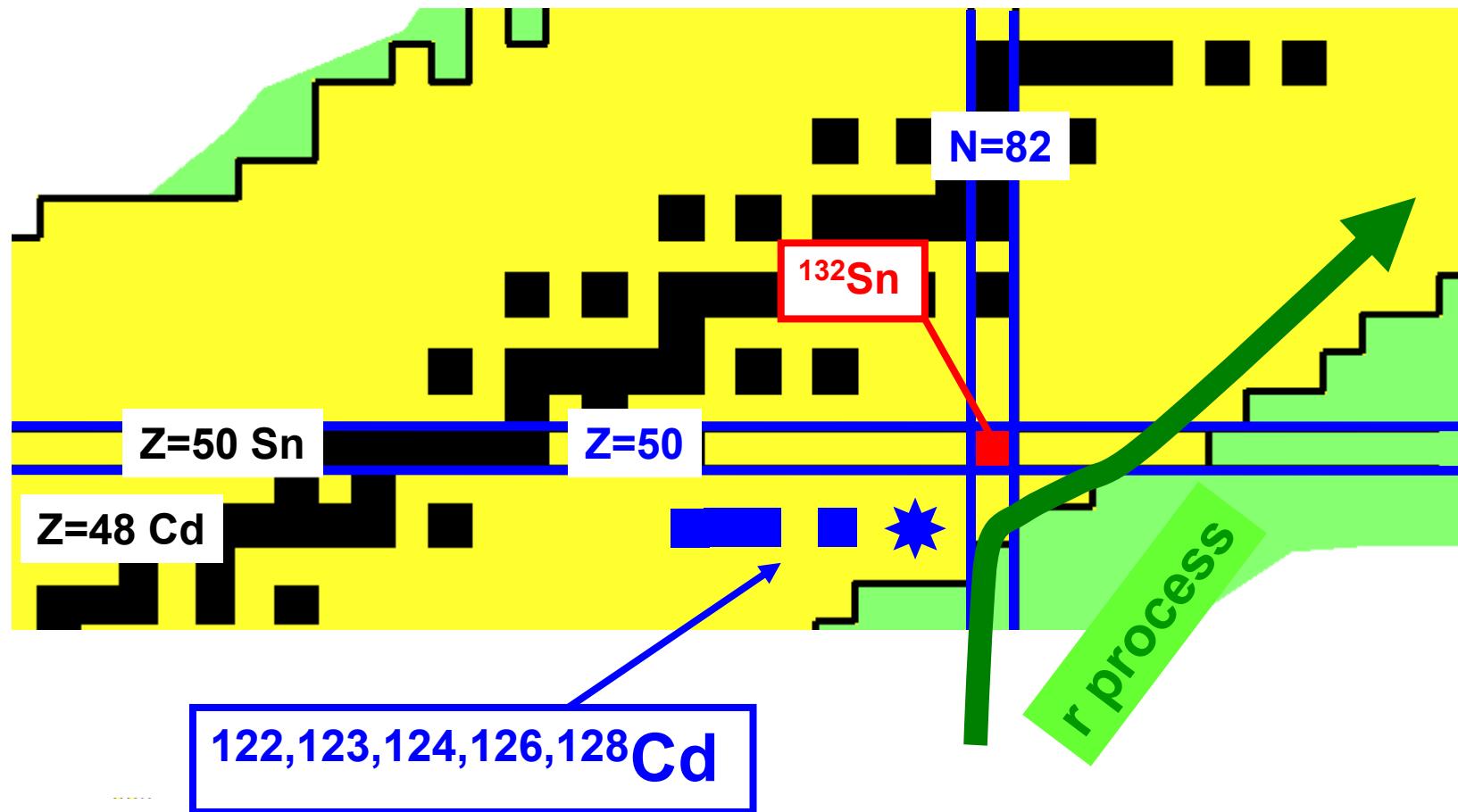
“Safe” Coulomb excitation

- Gamma – particle coincidences
- Isobaric beam contaminants
 - characteristic decay spectra in MINIBALL
 - beam dump detectors
 - Laser ON/OFF (RILIS)

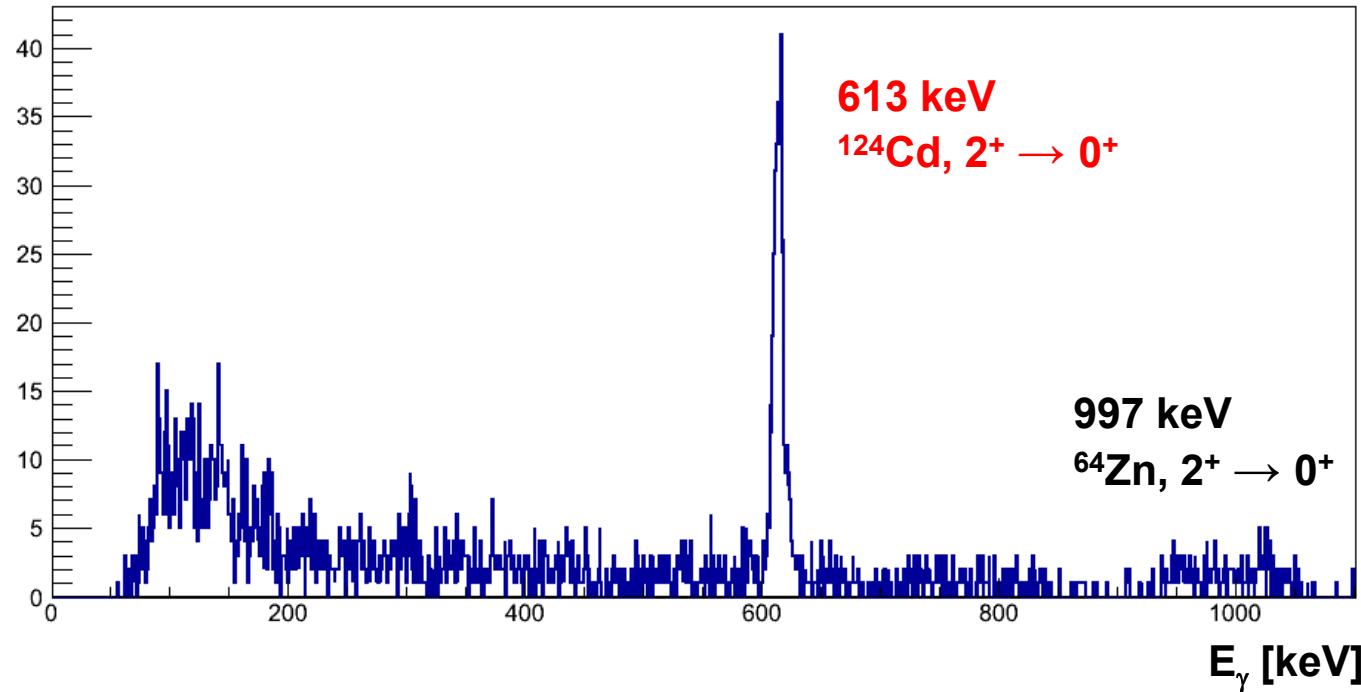
Region of interest



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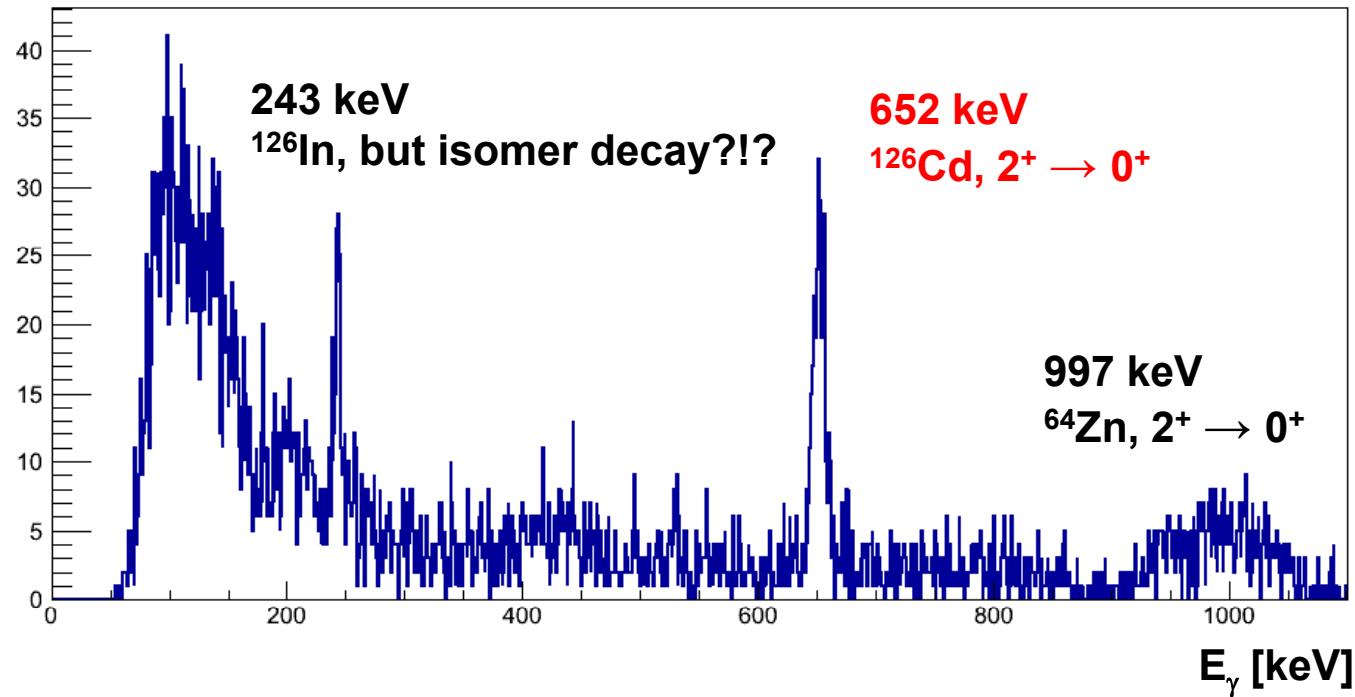
$^{124}\text{Cd} - \text{B(E2, } 0^+ \rightarrow 2^+\text{)}$



Analysis by
Stoyanka Ilieva
(TU Darmstadt)

- $0.41(6) e^2 b^2 / 0.35(5) e^2 b^2$ ($Q_2(2^+, ^{64}\text{Zn}) = -0.29 \text{ eb} / -0.01 \text{ eb}$)
 $Q_2(2^+, ^{124}\text{Cd})$ set to 0
- Beam intensity: $6.5 \cdot 10^3/\text{s}$
- Beam composition: 74(4)*% Cd, $\approx 20\%$ ^{124}In , $\approx 6\%$ ^{124m}In , no ^{124}Cs
* >80% in the beginning, drop to 30% towards the end

$^{126}\text{Cd} - \text{B}(\text{E}2, 0^+ \rightarrow 2^+)$



Analysis by
Stoyanka Ilieva
(TU Darmstadt)

- $0.22(2) \text{ e}^2\text{b}^2 / 0.19(2) \text{ e}^2\text{b}^2 (Q_2(2^+, {}^{64}\text{Zn}) = -0.29 \text{ eb} / -0.01 \text{ eb})$
 $Q_2(2^+, {}^{126}\text{Cd})$ set to 0
(previous analysis: $0.28(1) \text{ e}^2\text{b}^2$)
- Beam intensity: $1.4 \cdot 10^4/\text{s}$, proton beam on neutron converter
- Beam composition: $62(1)\% \text{ Cd}$, $\approx 30\% {}^{126}\text{In}$, $\approx 8\% {}^{126m}\text{In}$, no ${}^{126}\text{Cs}$

^{126}Cd – DSAM measurement



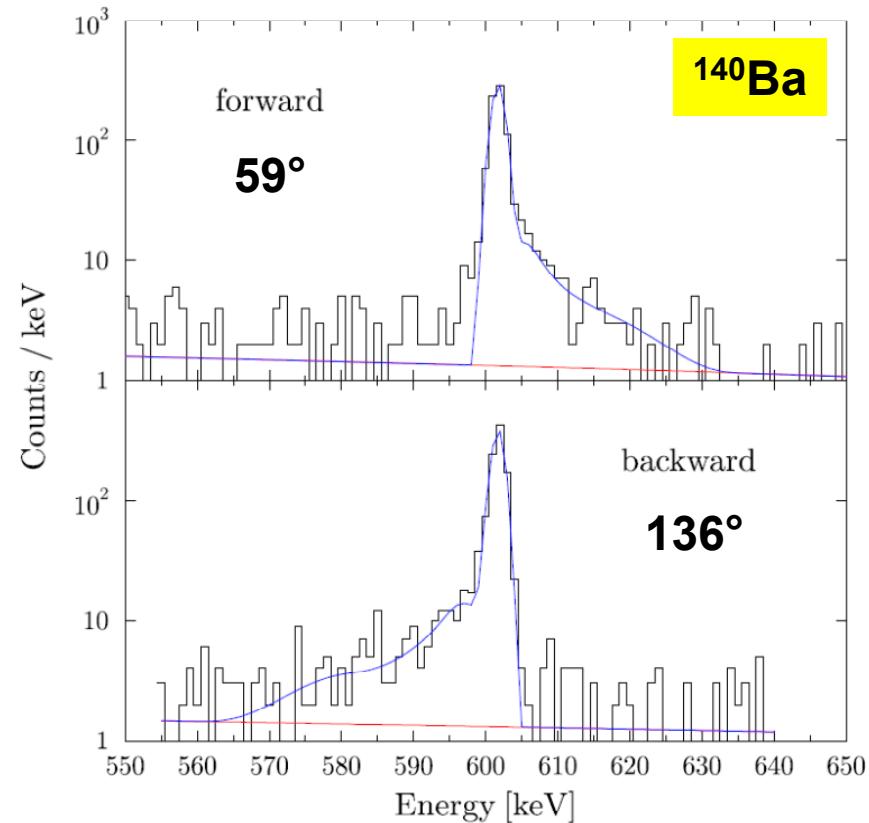
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$B(E2) = 0.28(1) \text{ e}^2\text{b}^2$
corresponds to $\tau = 12.4 \text{ ps}$
... DSAM possible?

Comparison with 2^+ in ^{140}Ba (IS411)

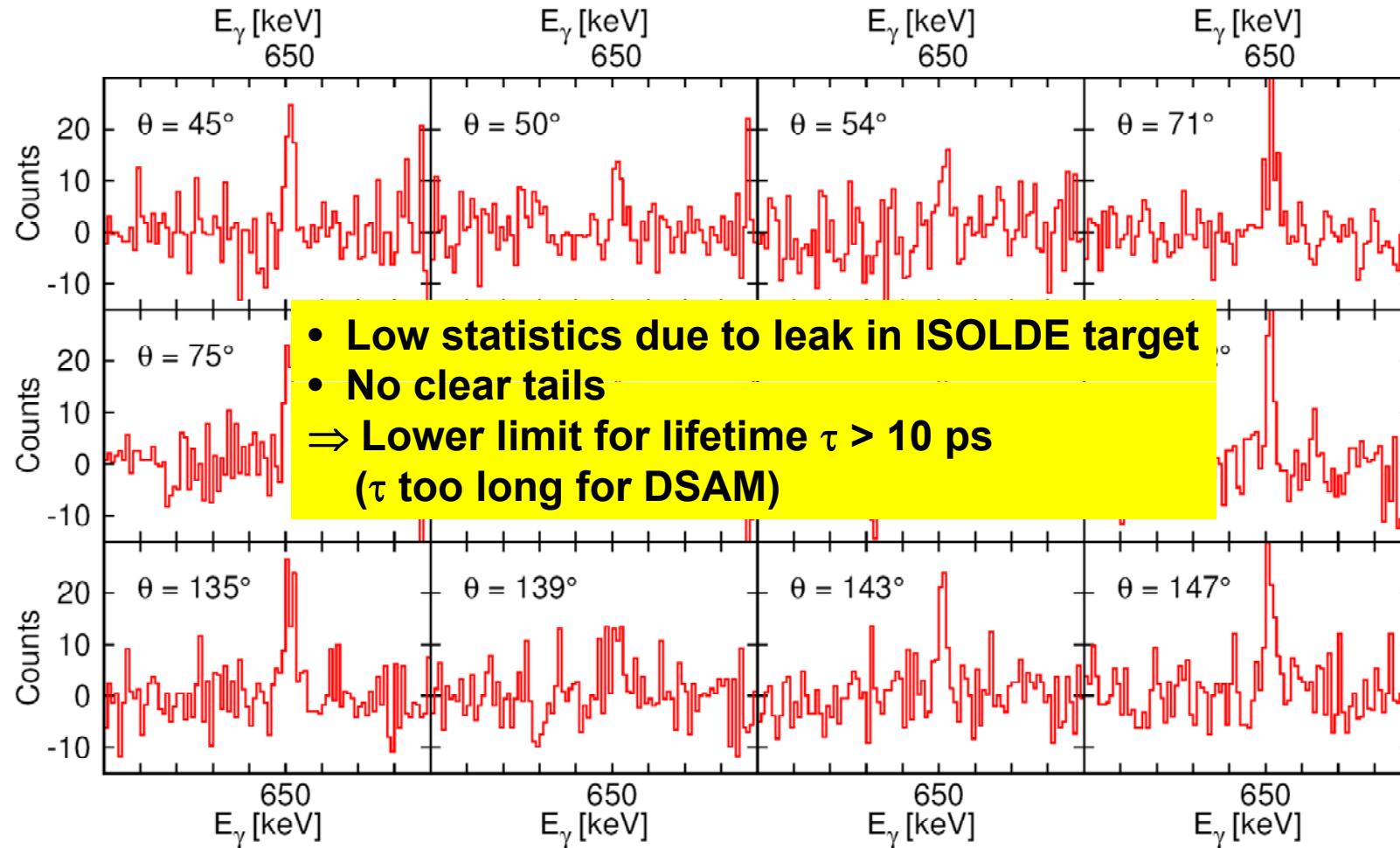
- First DSAM measurement with MINIBALL @ REX-ISOLDE
- First result obtained with APCAD:
 $\tau = 12.5(6) \text{ ps}$
- Improved APCAD version:
rather $\tau < 10 \text{ ps}$

C. Bauer et al.; to be published



DSAM analysis with APCAD (C. Stahl, TU Darmstadt; to be published)
... allows for simultaneous fit of lineshapes taken at various angles

^{126}Cd – DSAM spectra



Analysis by Michael Thürauf (TU Darmstadt)

^{128}Cd ... a special one!

$E(2^+)$ drops from ^{126}Cd to $^{128}\text{Cd}!$

Not reproduced by SM

Beyond Mean Field approach with

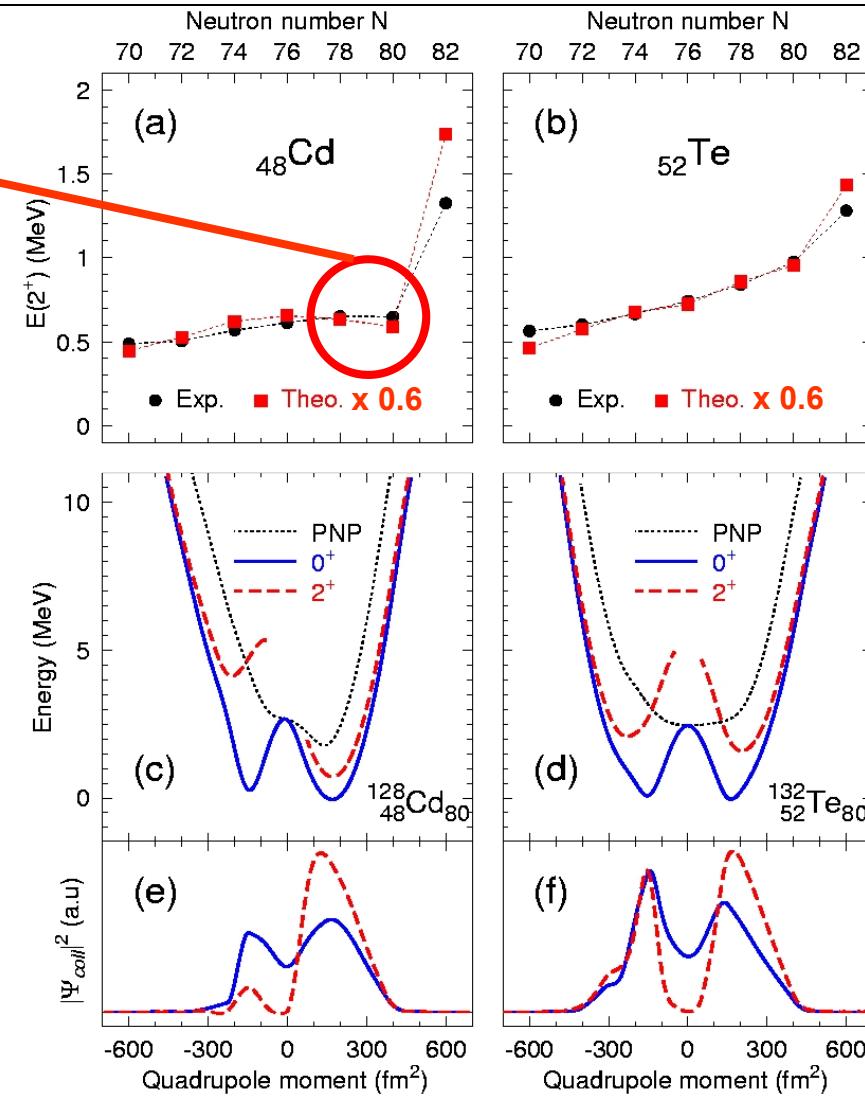
- angular momentum projection
- particle number projection
- configuration mixing

⇒

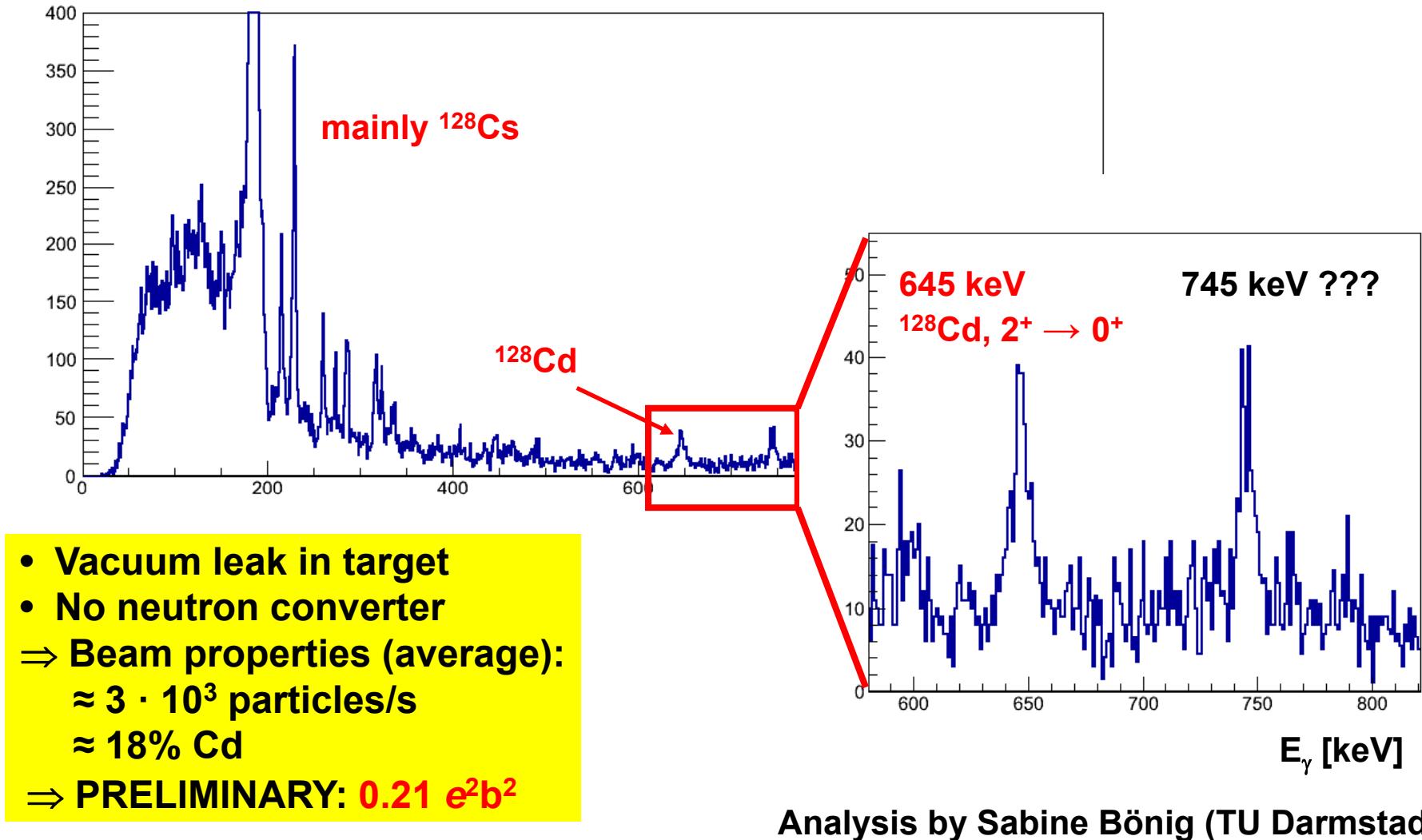
- behaviour of $E(2^+)$ reproduced
- $E(2^+)$ somewhat too large

^{128}Cd is prolate deformed!?

T. R. Rodríguez et al., Phys. Lett. B668, 410 (2008)



^{128}Cd - B(E2, $0^+ \rightarrow 2^+$)

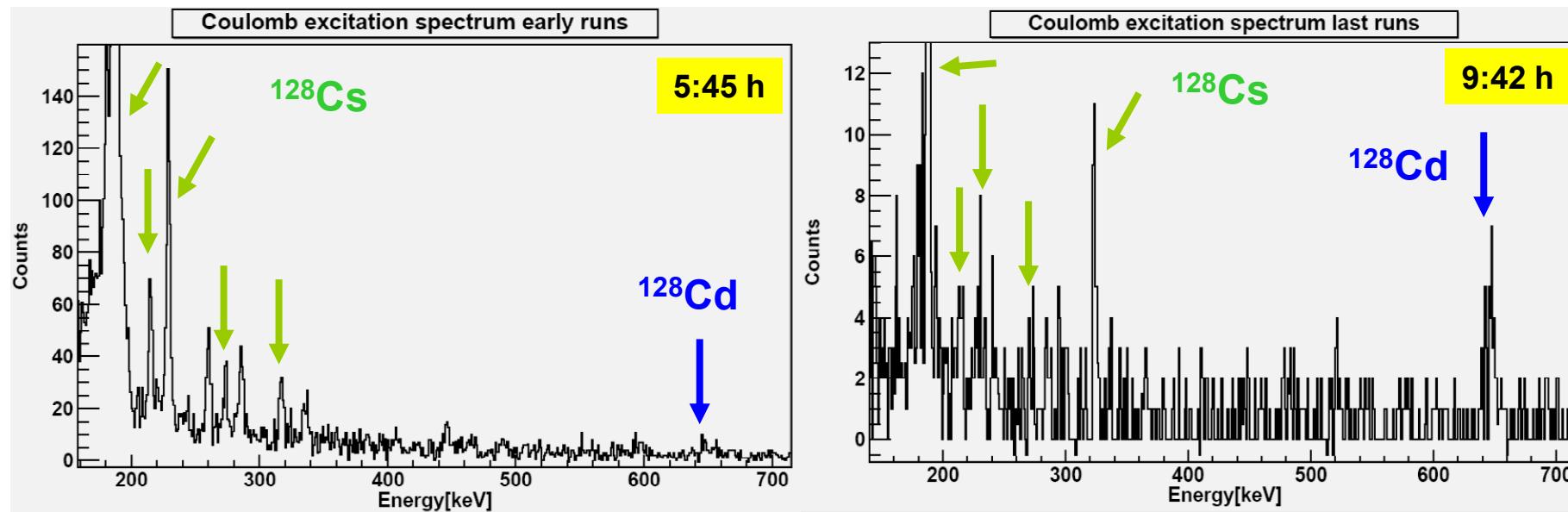


^{128}Cd – beam composition



The beam composition changed continuously during the run
... ratio Cd/Cs increased by up to a factor of 20 ☺ !?!

... decreasing total beam intensity ☹

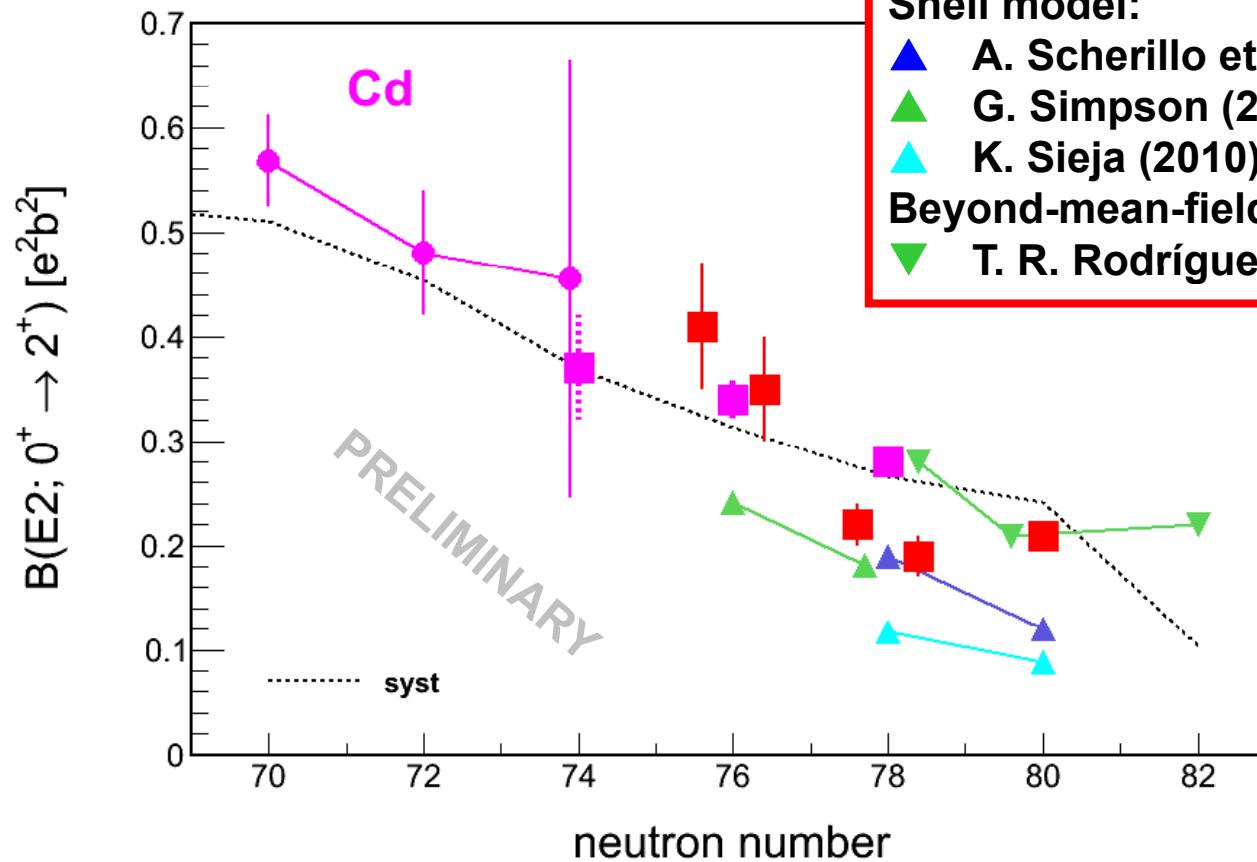


- Vacuum leak in target (reduced proton beam / reduced heating)
- Laser ON ... setting of lasers had been checked
- Yield measurement confirmed near disappearance of ^{128}Cs contamination

Collectivity in even Cd isotopes



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Exp. (IS411/IS477):

- T. Behrens (PhD, TU München, 2009)
- S. Bönig, S. Ilieva (TUD, 2012)

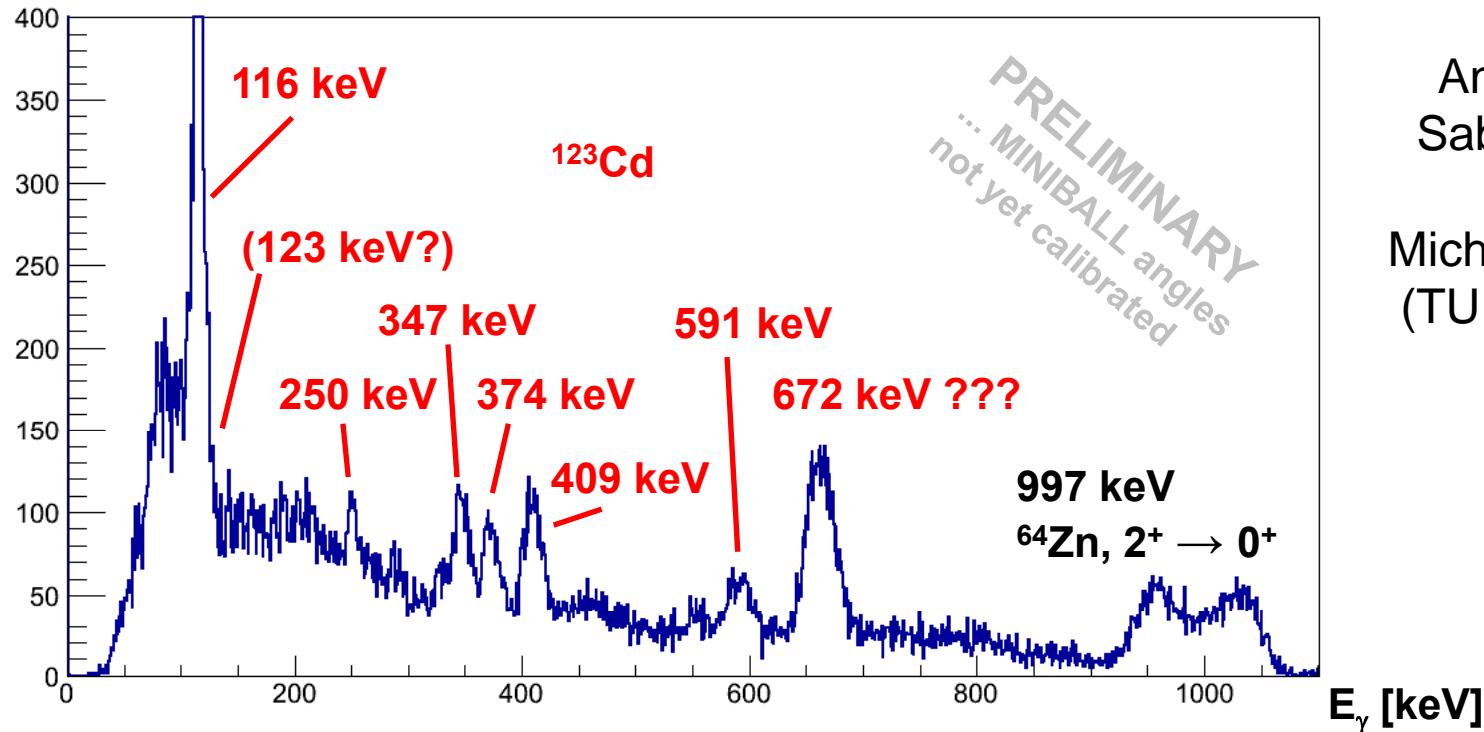
Shell model:

- ▲ A. Scherillo et al., PRC 70, 054318 (2004)
- ▲ G. Simpson (2011)
- ▲ K. Sieja (2010)

Beyond-mean-field (BMF):

- ▼ T. R. Rodríguez et al., PLB 668, 410 (2008)

^{123}Cd – Coulomb excitation



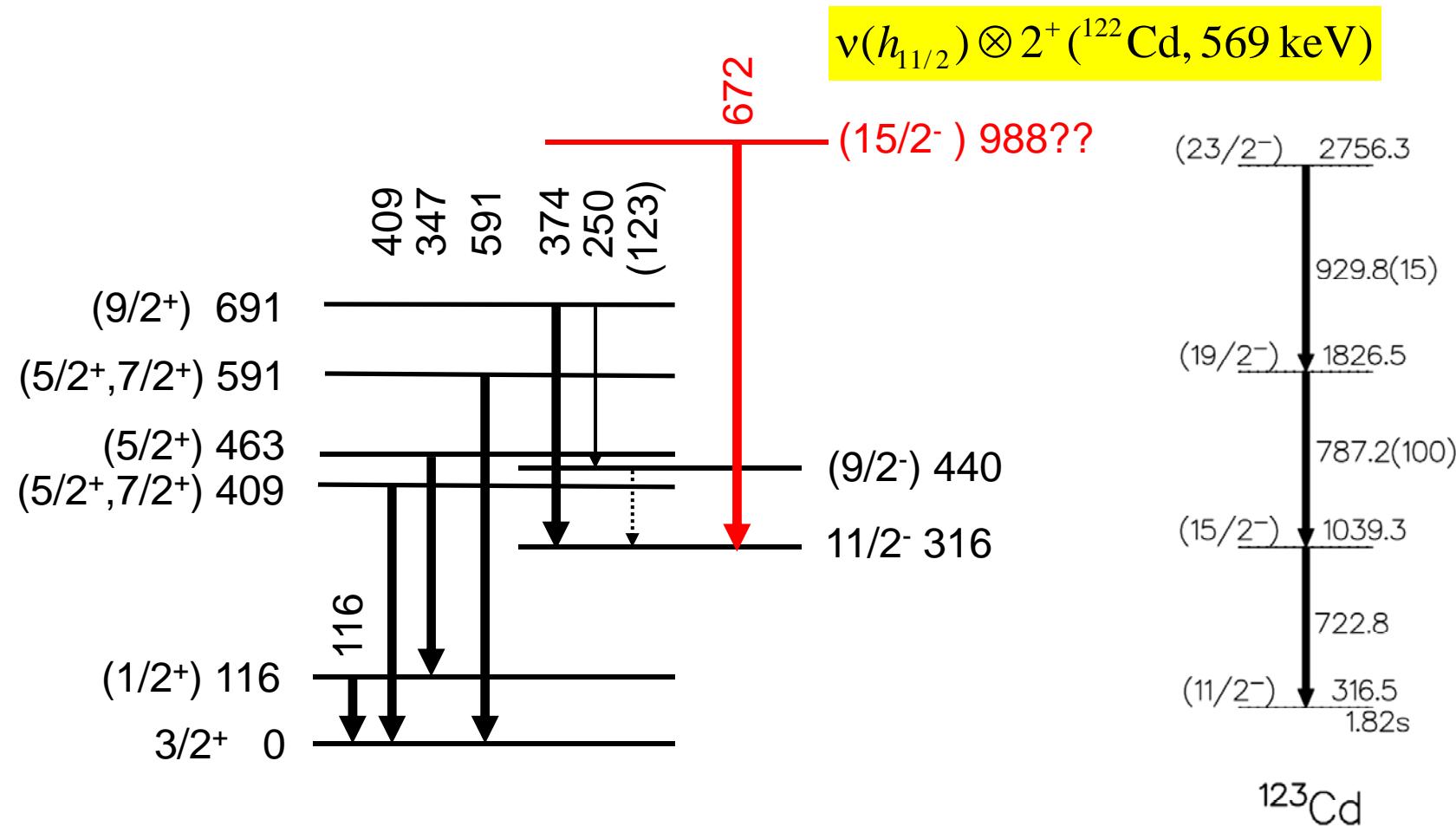
Analysis by
Sabine Bönig
and
Michael Thürauf
(TU Darmstadt)

- Beam intensity: $\approx 9 \cdot 10^4/\text{s}$
... vacuum leak in the ISOLDE target ... again ☹
- Beam composition: $\approx 100\%$ Cd; $\approx 2/3$ ^{123m}Cd , $\approx 1/3$ ^{123}Cd (neutron converter)
... tried to change ratio g.s./isomer by narrowing laser bandwidth in RILIS
(thanks to B. Marsh)

^{123}Cd – level scheme



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H. Huck et al., PRC 40, 1384 (1989)

J. K. Hwang et al., J. Phys. G 28, L9 (2002)

Summary and Outlook

- **Safe Coulomb excitation of even neutron-rich isotopes $^{122,124,126,128}\text{Cd}$**
- Indications that $B(E2)$ values are larger than predictions from large scale shell model calculations
 - ... still have to include the reorientation ($Q_2(2^+)$) in the analysis
- Attempt to measure lifetime in ^{126}Cd by DSAM
 - ... RDM with plunger will be the better option
- **First successful run with odd isotope ^{123}Cd**
 - ... indications for inconsistencies with results from decay studies
- Will continue programme at HIE-ISOLDE (... M. Huyse's talk)
 - multiple Coulomb excitation
 - lifetime measurements with plunger
 - ^{130}Cd (... worth a try?)
 - selective laser ionisation of g.s. or $11/2^-$ isomer in odd isotopes
 - transfer reactions to pin down single-particle properties

IS477 collaboration



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Thank you for your
attention!!!!

... and the IS411/IS524 collaborations