Coulomb excitation of nuclei around ^{132}Sn

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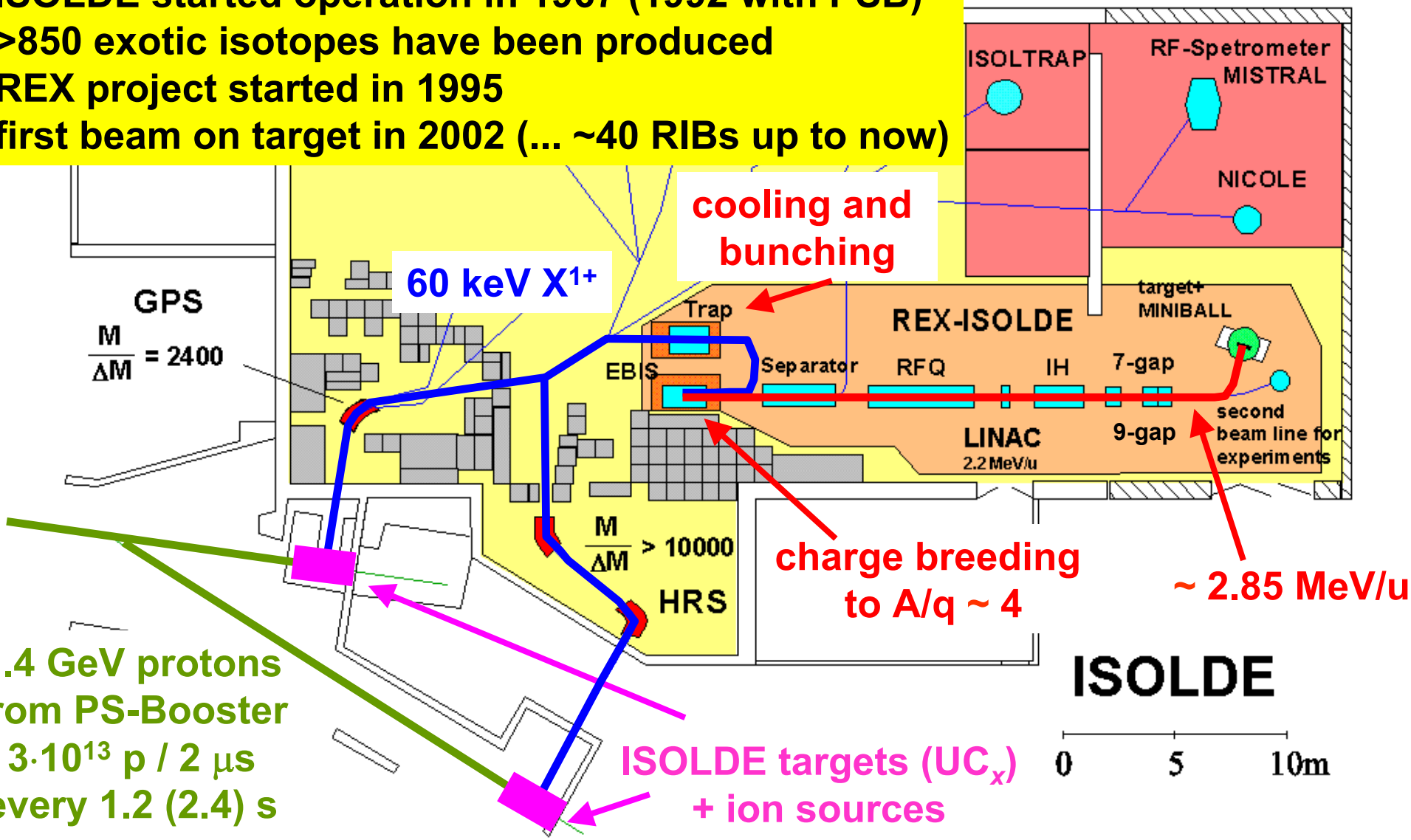
Outline

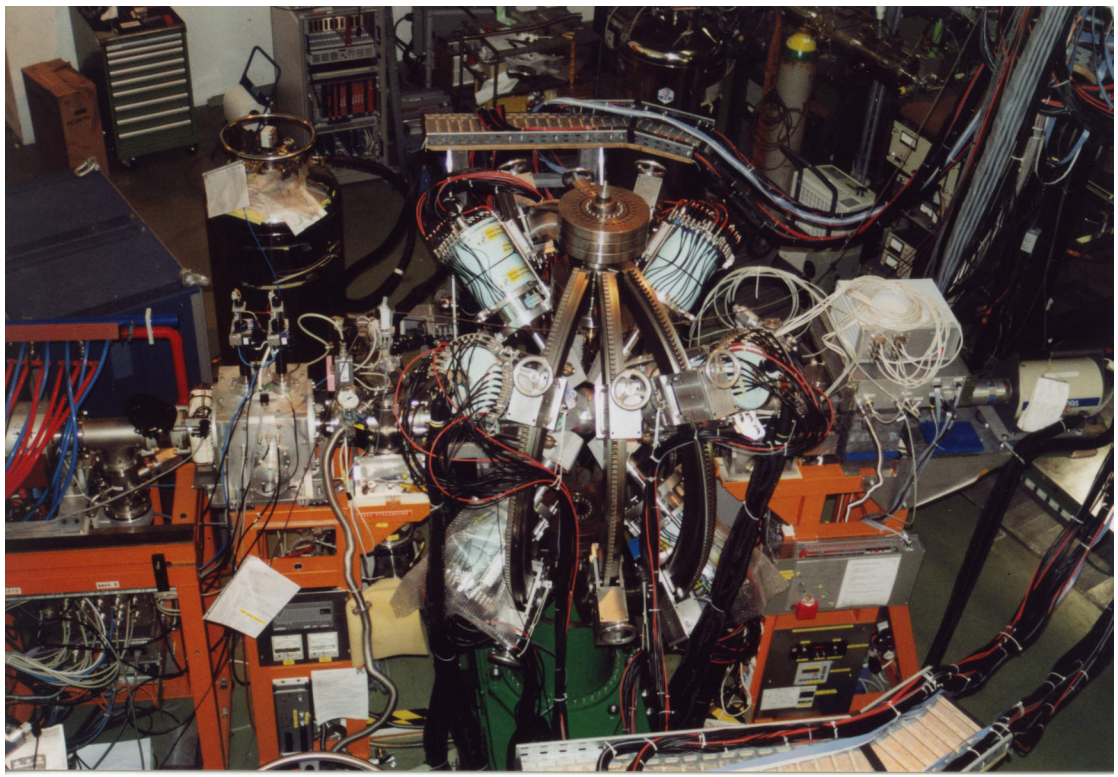
- REX-ISOLDE
- Physics case
- Experimental set-up
- Coulex of $^{122,124,(126)}$Cd
- Coulex of ^{138,140,142}Xe
- Test of g-factor measurement
- Conclusion and outlook

REX-ISOLDE

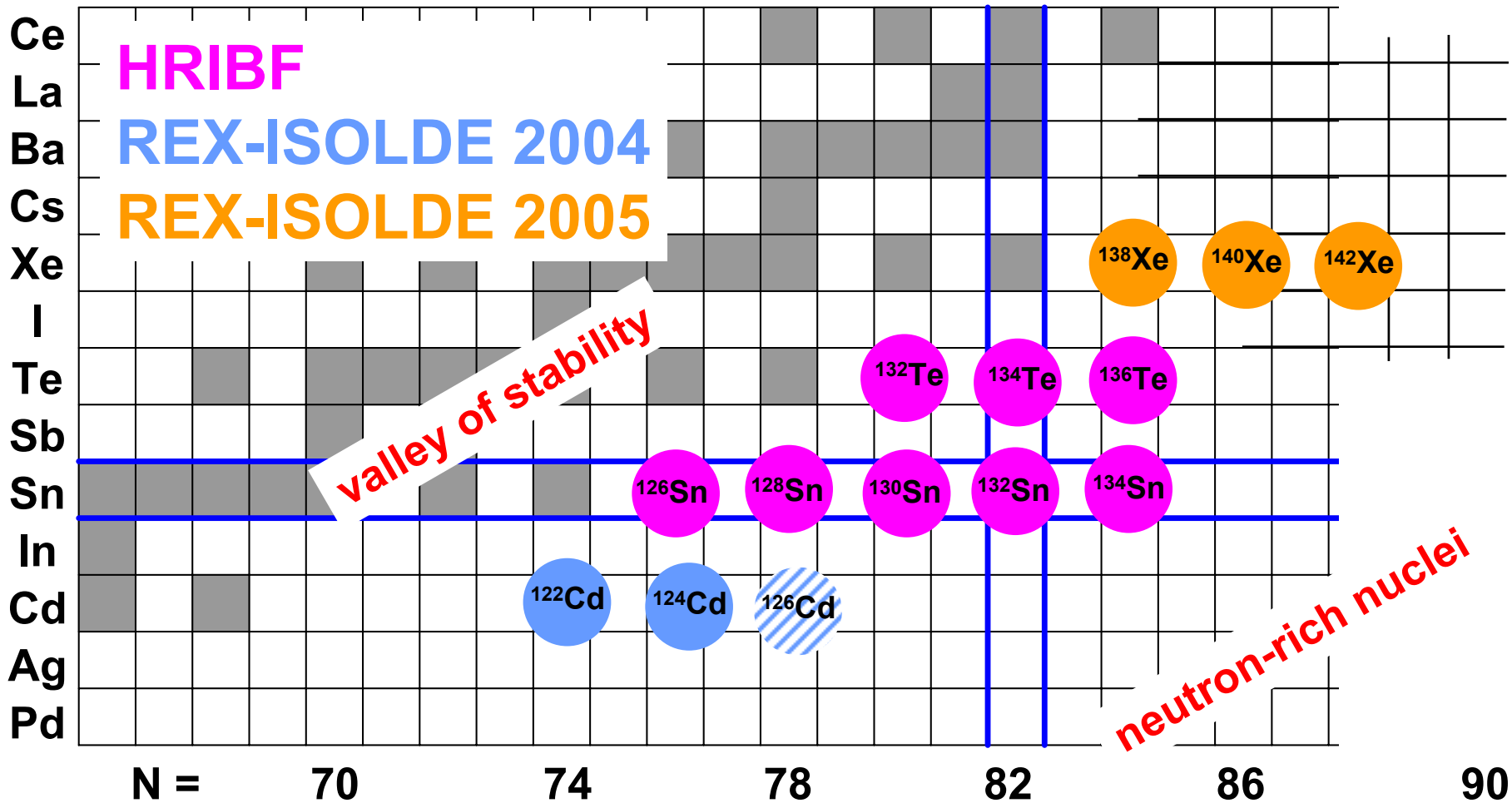
- ISOLDE started operation in 1967 (1992 with PSB)
- >850 exotic isotopes have been produced
- REX project started in 1995
- first beam on target in 2002 (... ~40 RIBs up to now)



REX-ISOLDE & MINIBALL 2004



Region of interest

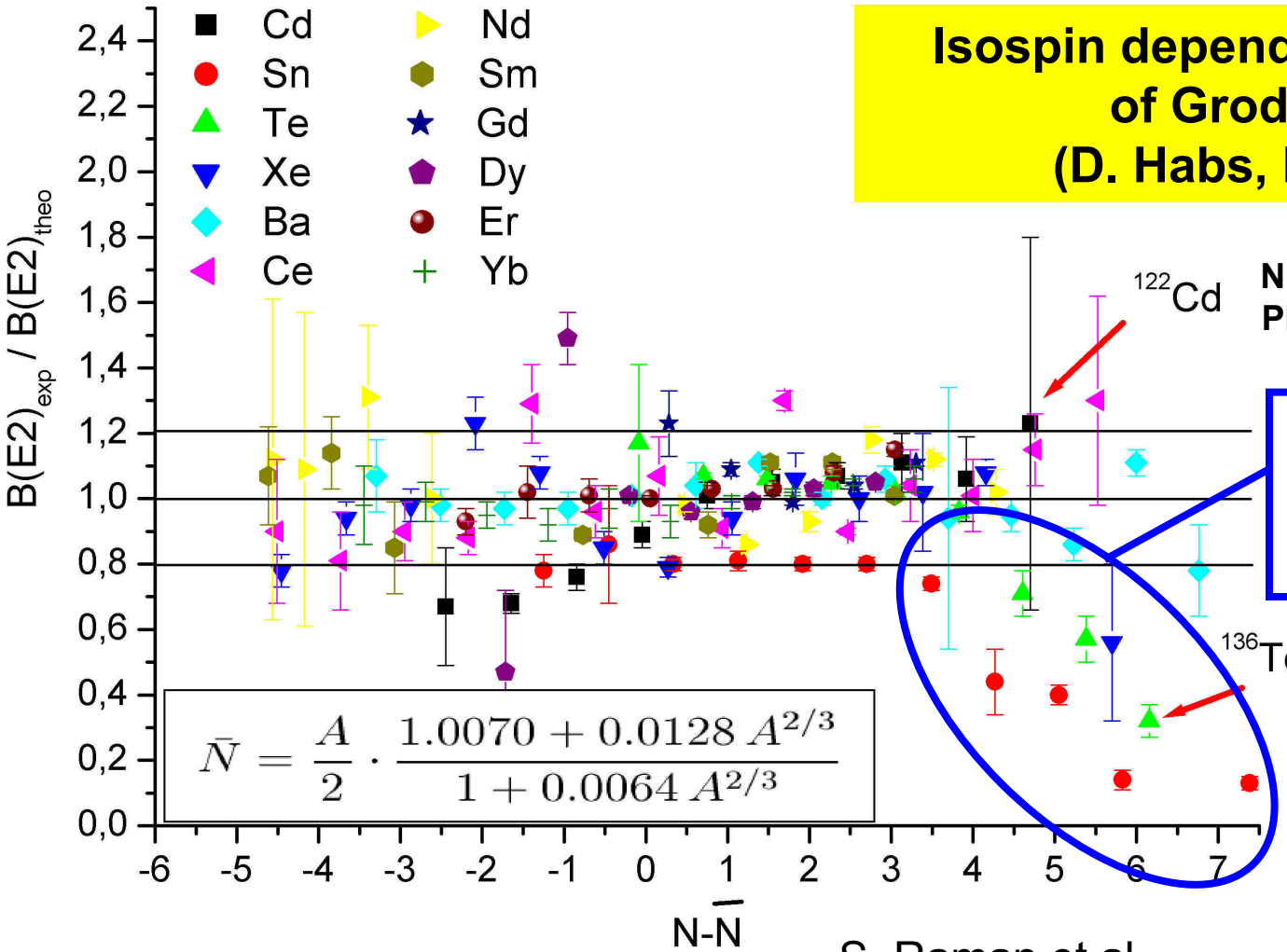


... Cd and Xe are beams unique to ISOLDE

Phenomenological systematics

$$E(2_1^+) * B(E2\uparrow)_{theo} = 2.57\, Z^2\, A^{-2/3}\left(1.288 - 0.088\,(N - \bar{N})\right)$$

Isospin dependent modification of Grodzins' rule (D. Habs, R. Krücken)



N.V. Zamfir et al., PRC 51, 98 (1995)

B(E2) smaller than expected from systematics

D. Radford et al., PRL 88, 222501 (2002)
INPC 2004, ENAM '04
Recent experiment indicates 30% larger B(E2) values!!!
C. Baktash, MAFF '05

S. Raman et.al., Atom. Data and Nucl. Data Tables 78, 1 (2001)

Preparation of the beams

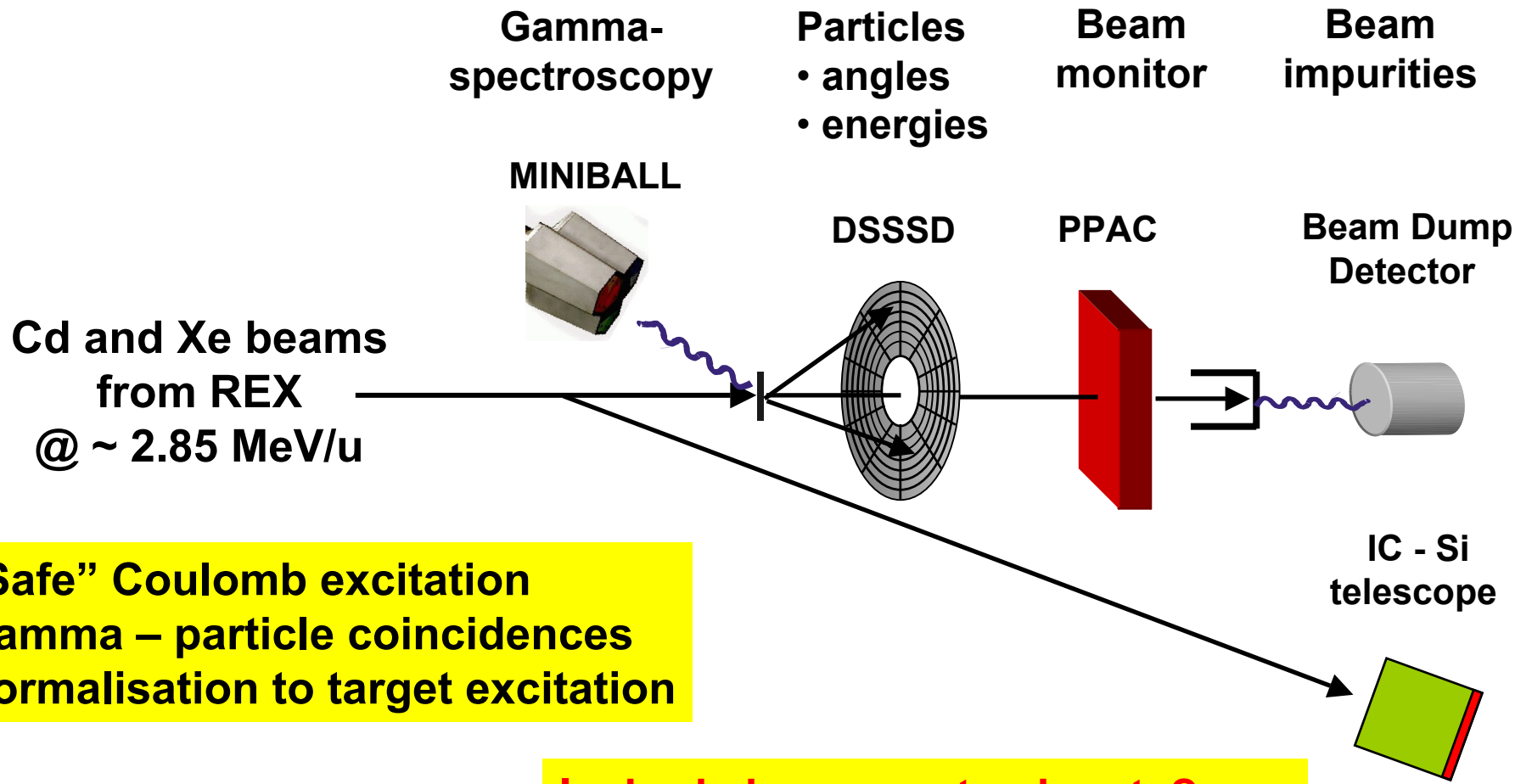
Cd-Run (2004)

- PSB beam on neutron converter target to reduce isobaric contaminants
- RILIS (Resonance Ionisation Laser Ion Source)
- GPS separator
- 148 ms breeding in EBIS to $^{122,124}Cd^{30+}$ and $^{126}Cd^{31+}$
- 2.86 MeV/u

Xe-Run (2005)

- PSB beam directly on UC_x target of ISOLDE
- MK7 (surface ioniser)
- HRS separator
- 198 ms breeding in EBIS to $^{138,140,142}Xe^{34+}$
- 2.83-2.85 MeV/u

Experimental set-up



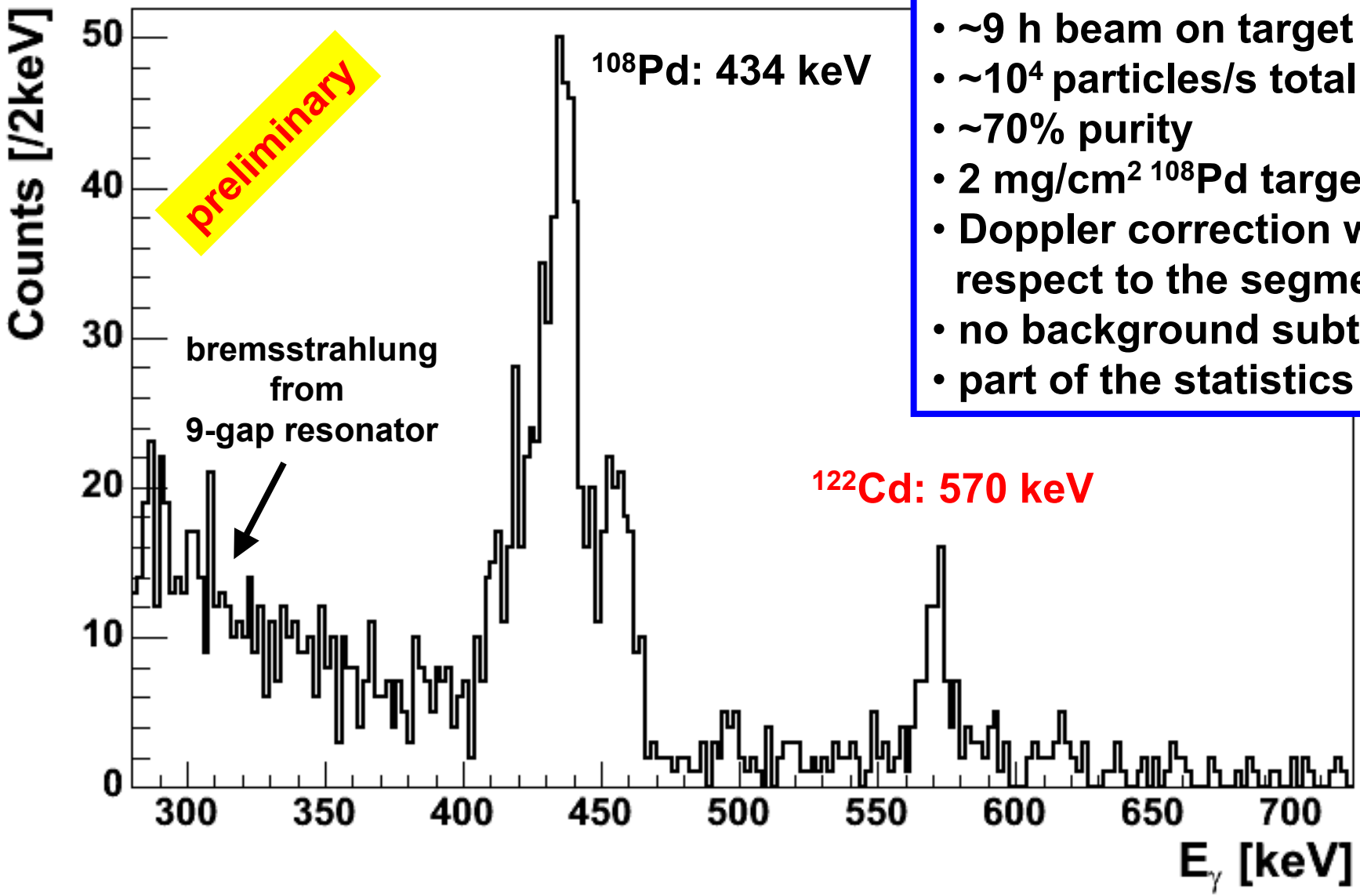
- "Safe" Coulomb excitation
- Gamma – particle coincidences
- Normalisation to target excitation

Isobaric beam contaminants?

- IC - Si detector telescope
- LaserON / LaserOFF
- Beam Dump Detector

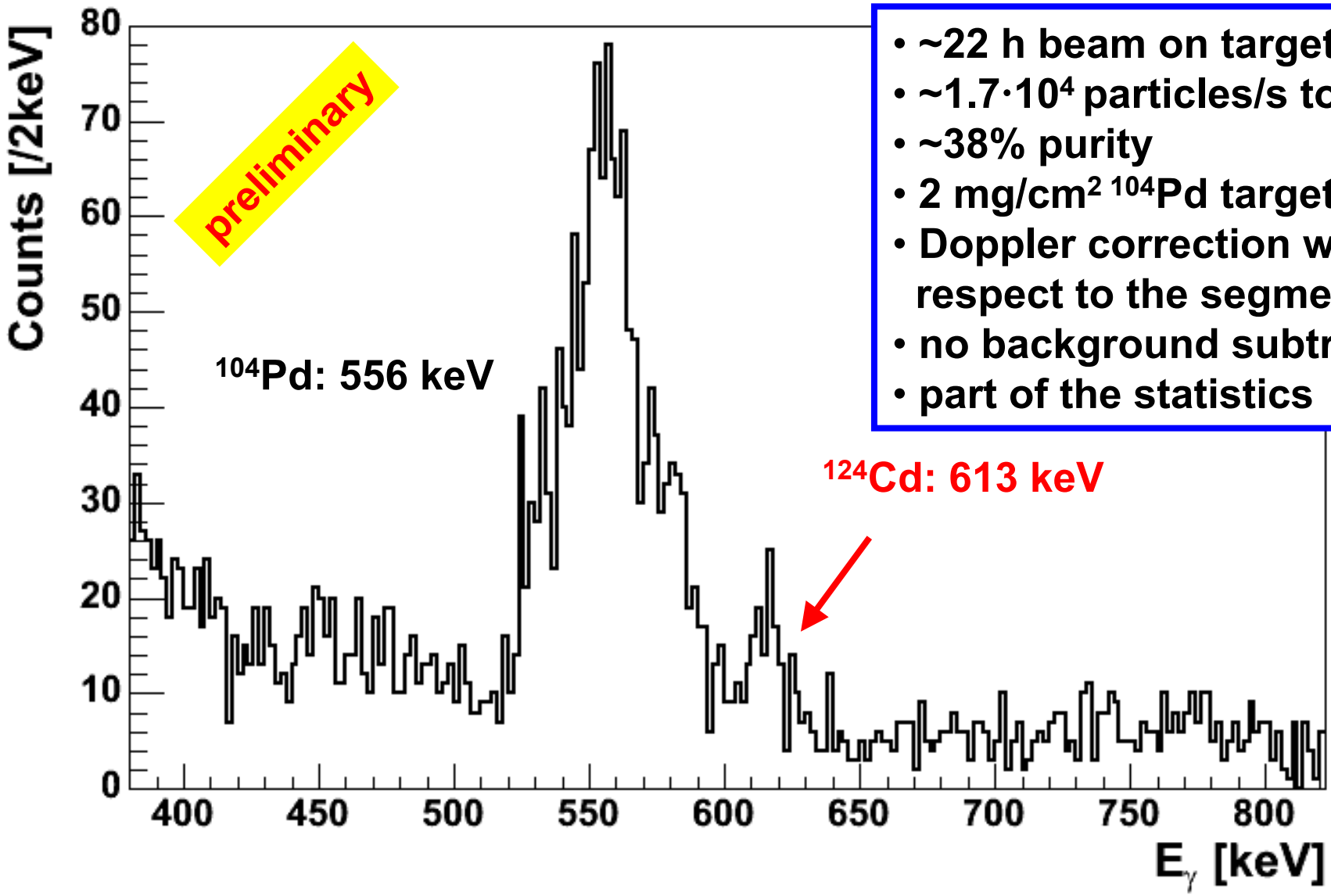
} Cd only

^{122}Cd on ^{108}Pd



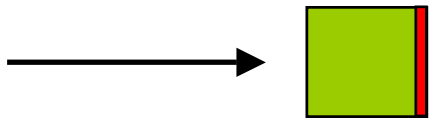
- ~9 h beam on target
- ~10^4 particles/s total
- ~70% purity
- 2 mg/cm^2 ^{108}Pd target
- Doppler correction with respect to the segments
- no background subtraction
- part of the statistics

^{124}Cd on ^{104}Pd



- ~22 h beam on target
- ~1.7·10^4 particles/s total
- ~38% purity
- 2 mg/cm^2 ^{104}Pd target
- Doppler correction with respect to the segments
- no background subtraction
- part of the statistics

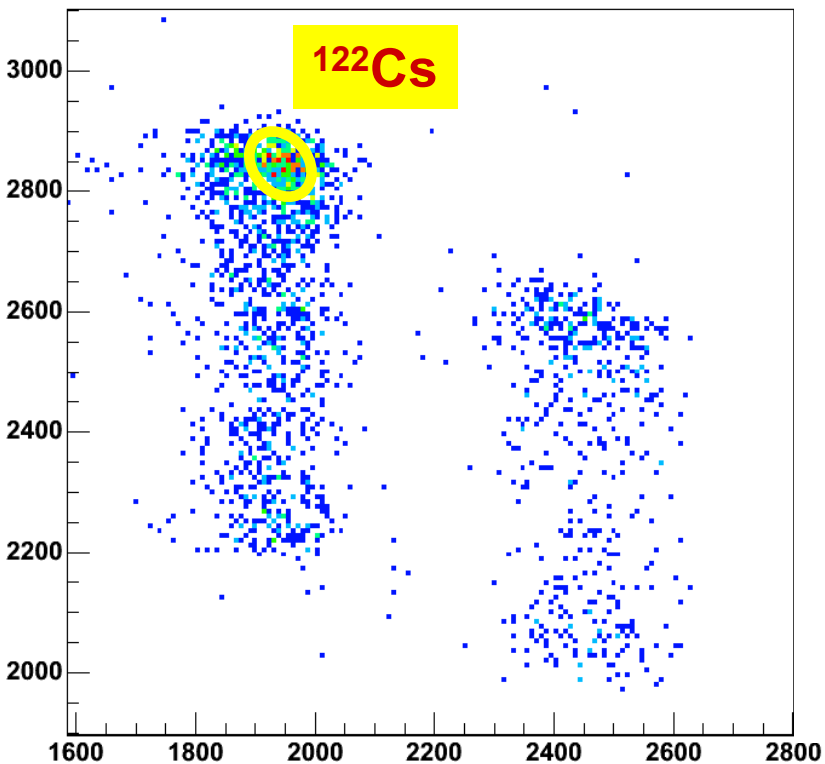
Effect of neutron converter target



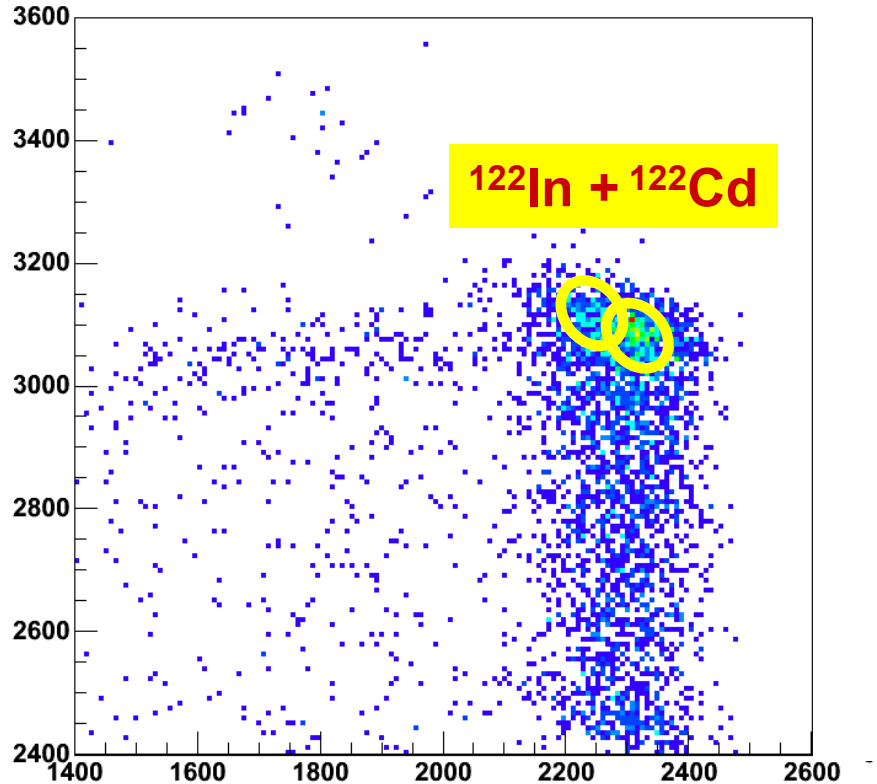
IC - Si telescope

- RILIS (Laser ON)
- Cd yield reduced by a factor ~ 3

without converter target

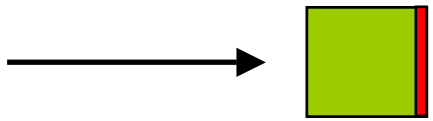


with converter target



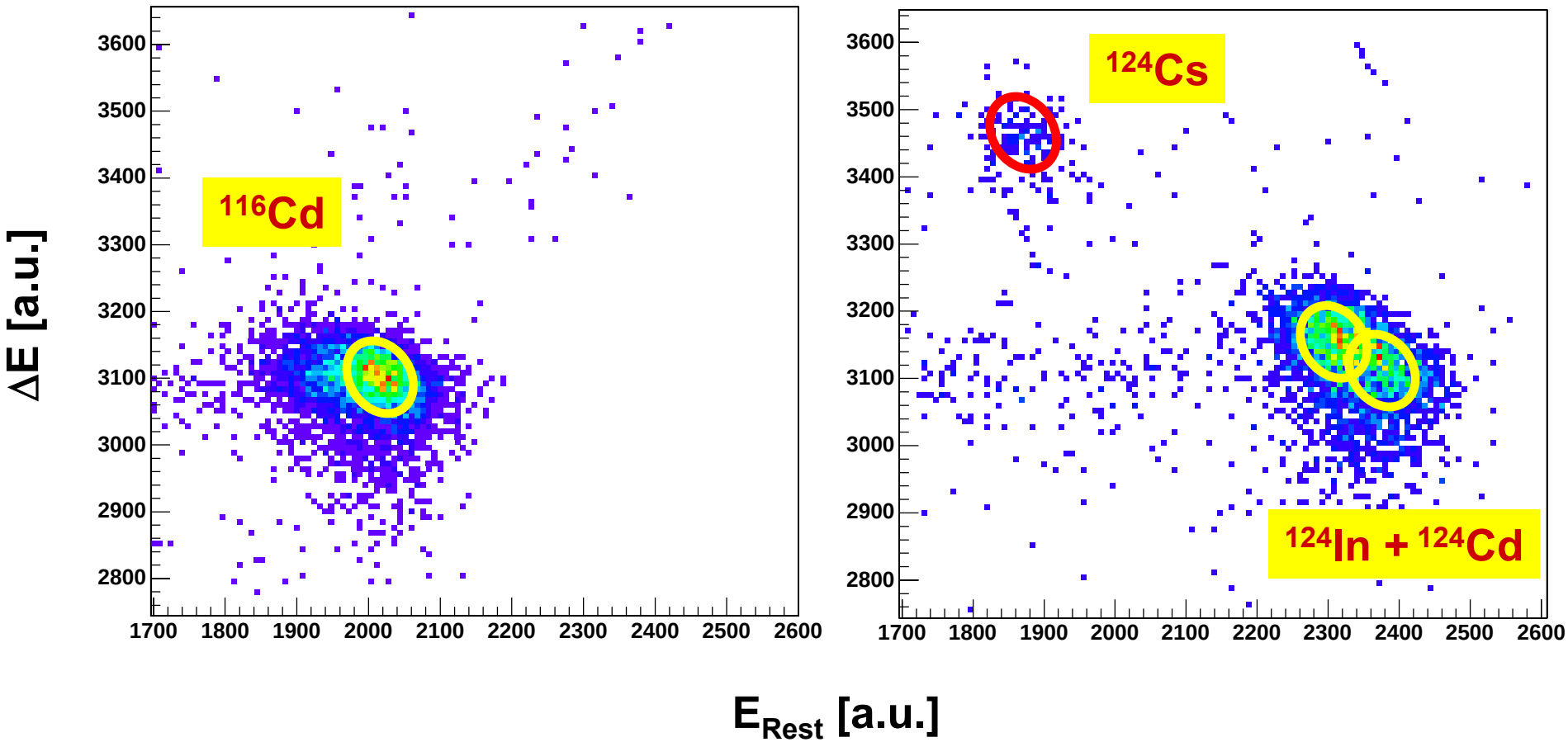
E_{Rest} [a.u.]

IC - Si telescope



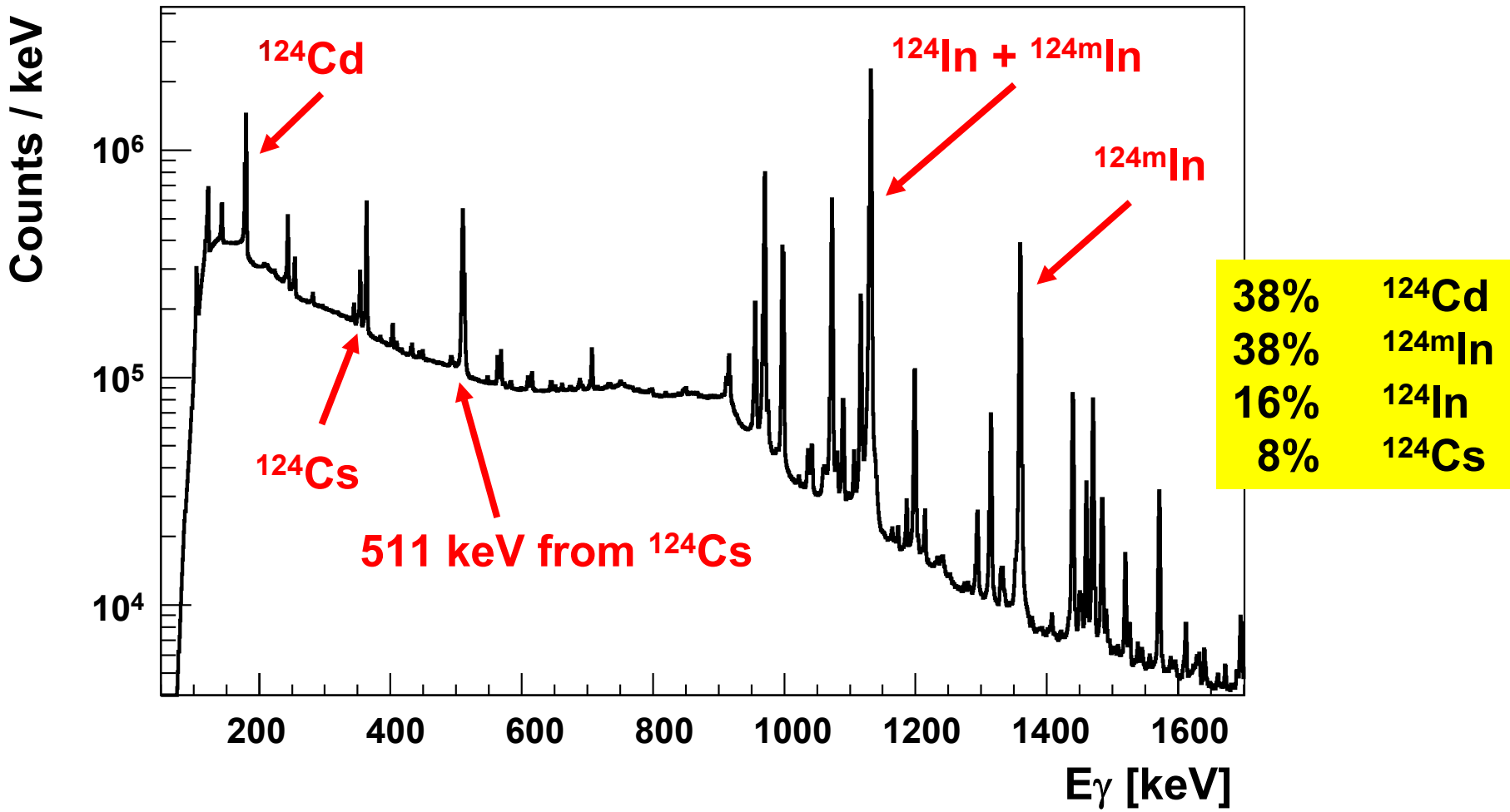
IC - Si telescope

- PSB beam on converter target
- RILIS (Laser ON)

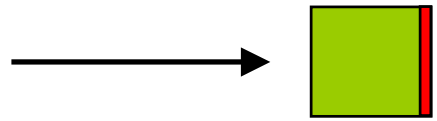


^{124}Cd (beam dump detector)

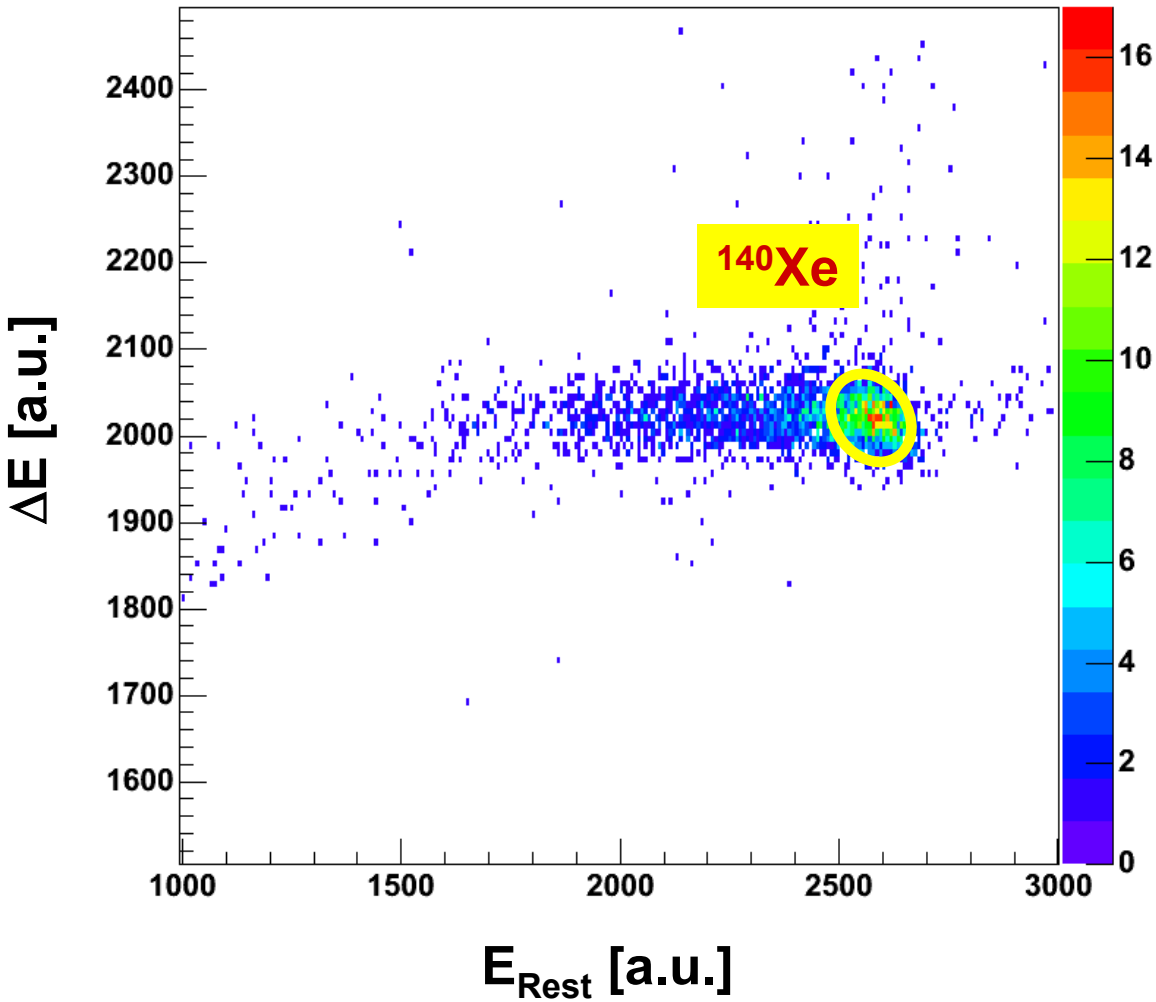
^{124}Cd → $^{124(m)}$In → ^{124}Sn and ^{124}Cs → ^{124}Xe



Si - IC telescope

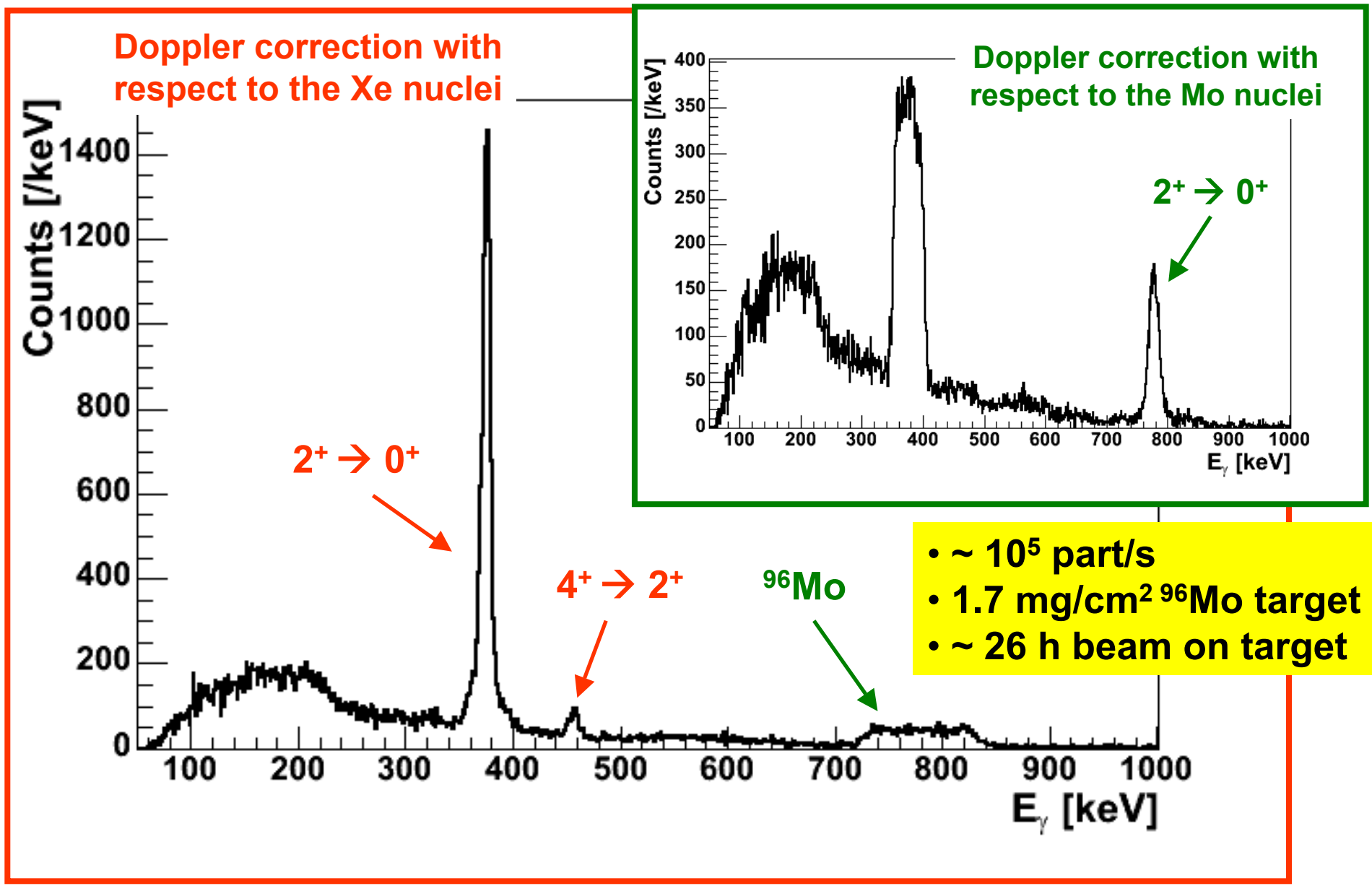


IC - Si telescope

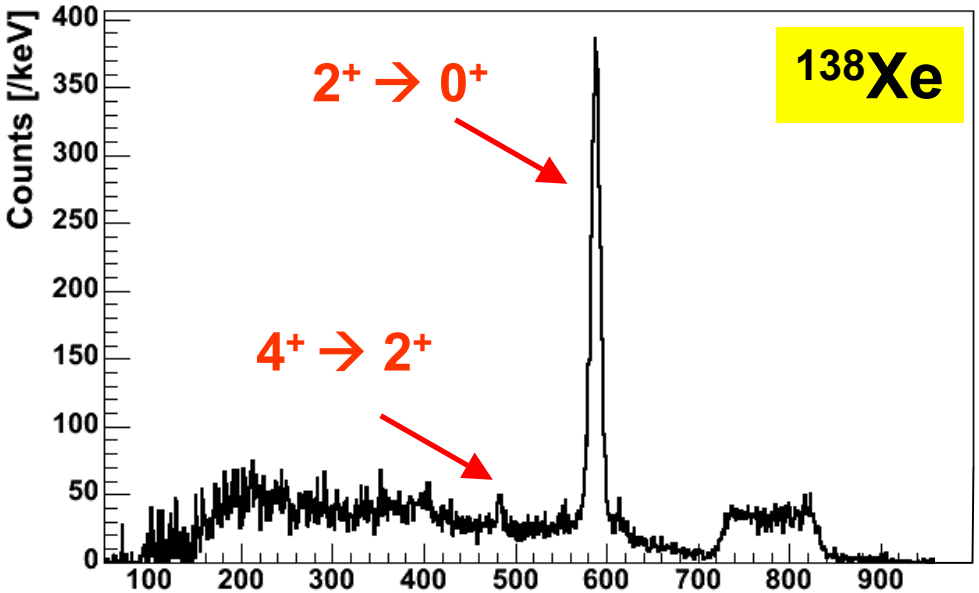


No isobaric contaminants in the Xe beams!!!!

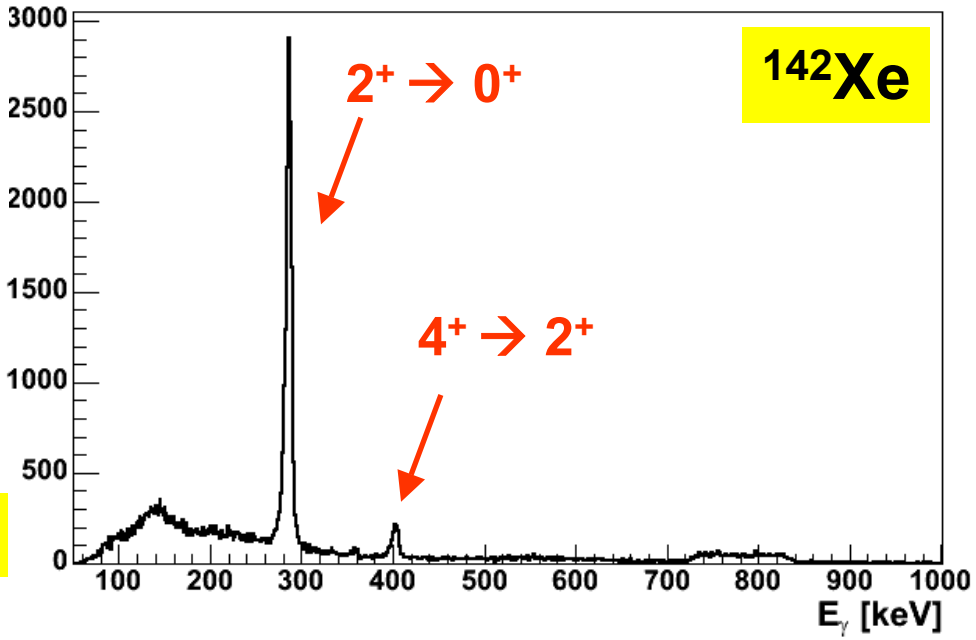
Coulex of ^{140}Xe



Coulex of ^{138,142}Xe

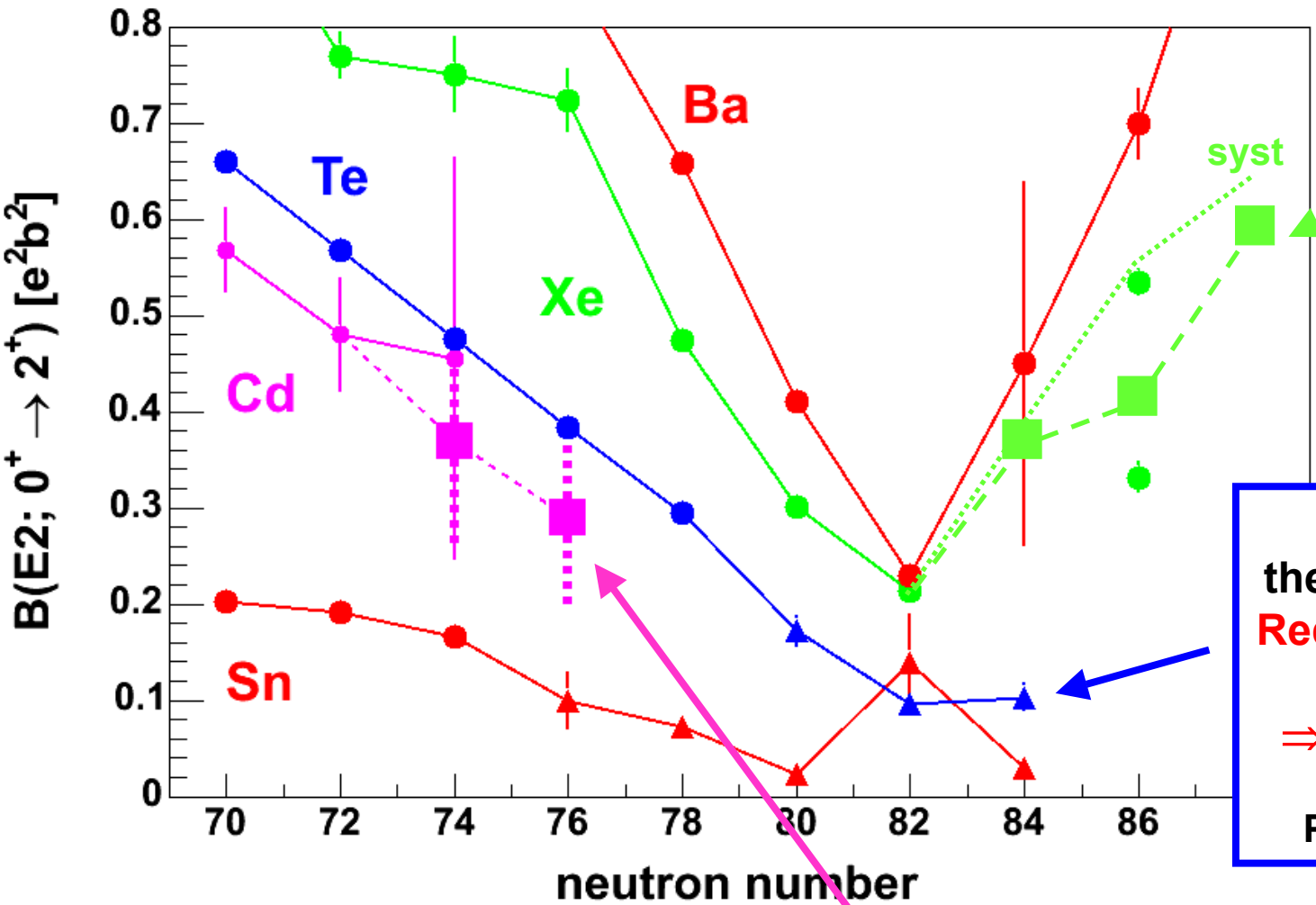


~ 10 h beam on target



~ 19 h beam on target

B(E2) values (preliminary)



"first guess" B(E2) values (2005)

Proposed theoretical explanation:
Reduced neutron paring above N=82
⇒ low B(E2) and E(2⁺)
J. Terasaki et al., PRC 66, 054313 (2002)

preliminary B(E2) values (run 2004)

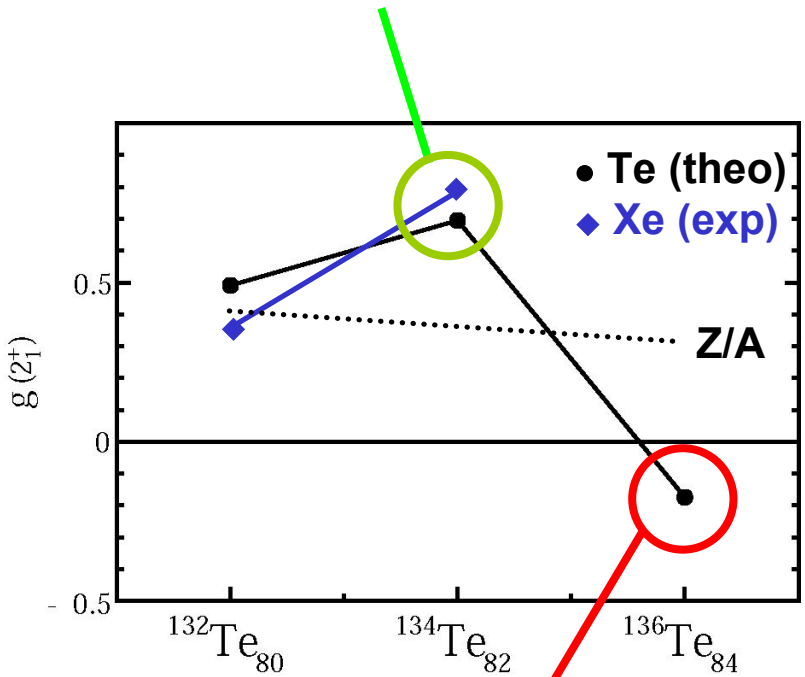
	$B(E2\uparrow)_{exp}$ [e²b²]	$B(E2\uparrow)_{syst}$ [e²b²]
^{122}Cd	0.37±0.11	0.37
^{124}Cd	0.29±0.09	0.31

Analysis by T. Behrens (TUM)

g-factor of 2^+ state in ^{132,134,136}Te

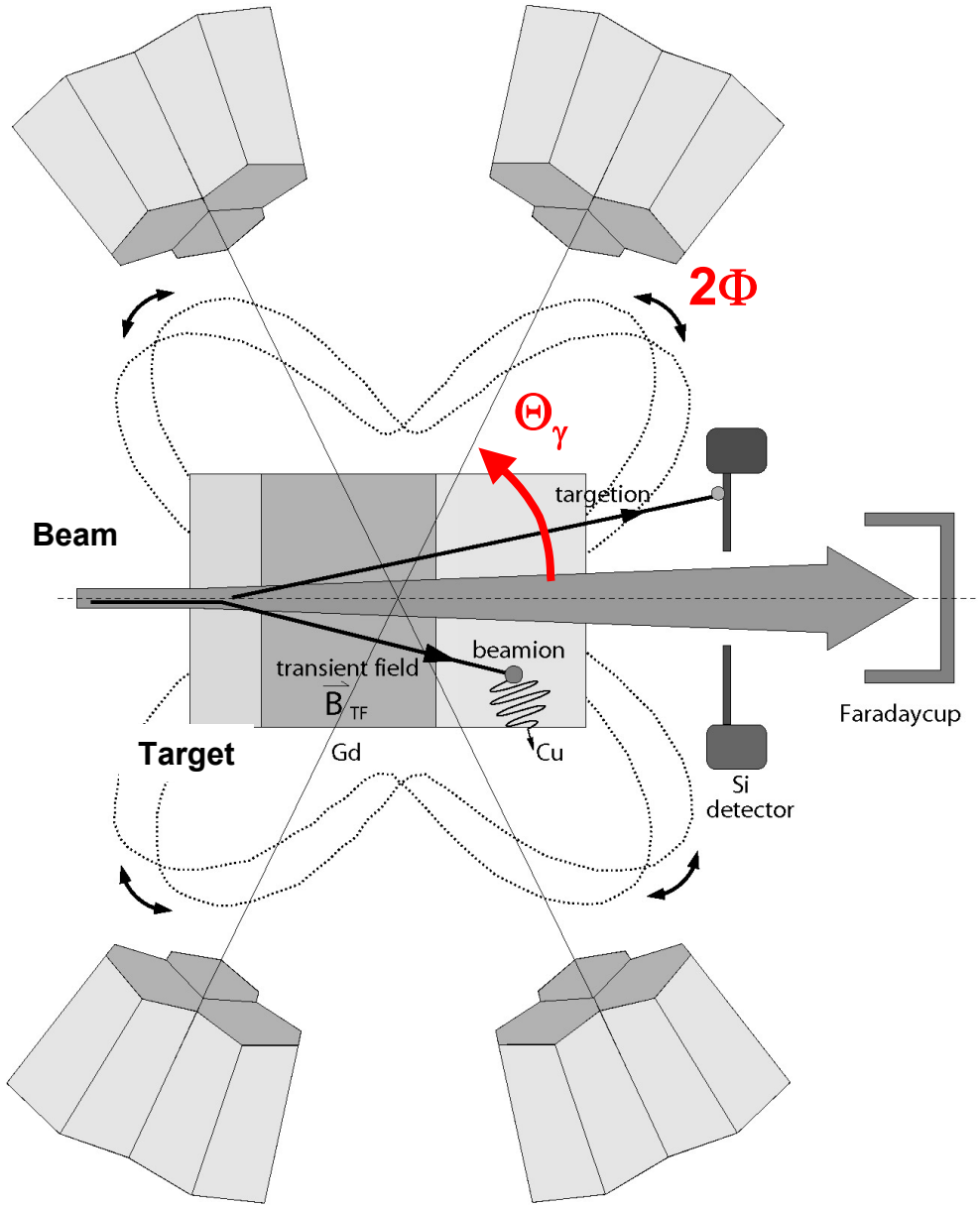
$$\left|{}^{134}Te\right\rangle = \left|{}^{132}Sn\right\rangle \otimes \left|(\pi\, g_{7/2})^2\right\rangle$$

$$\Rightarrow g^{eff}_{p,g_{7/2}}(2^+) = 1.45 > 0$$



$$g^{eff}_{n,f_{7/2}}(2^+) = -0.5 < 0$$

... more neutron content in wavefuntion due to reduced pairing



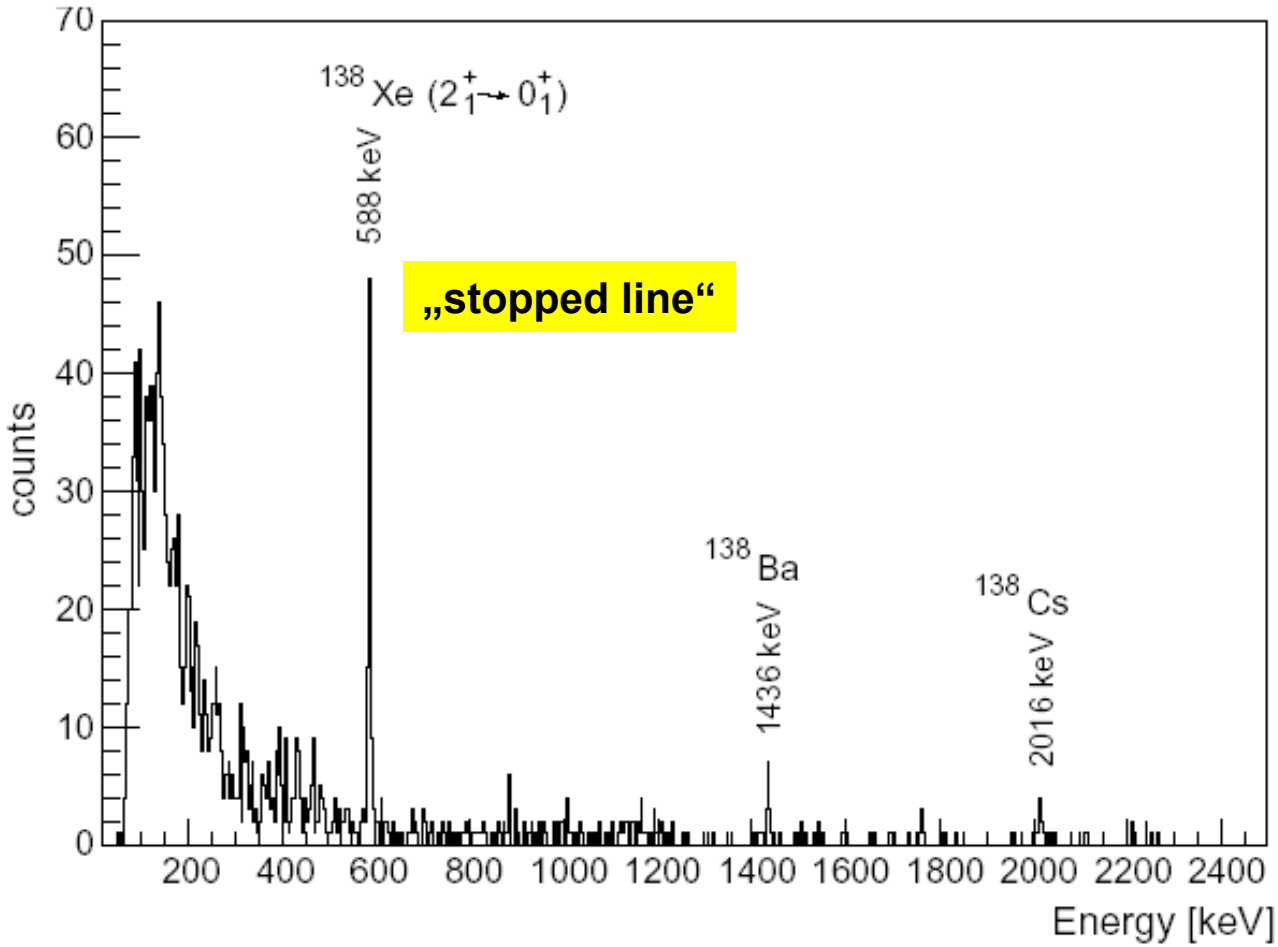
Test-experiment with ^{138}Xe beam

Problems:
- **scattering from thick target**
- **high count rate from radioactive decays**

→ Improved setup:
- **poor statistics (end of beam time!)**

→ no precession measurement

IS415
K.-H. Speidel et al., Uni Bonn and TUM



Conclusion

"Safe" Coulomb excitation of neutron-rich nuclei around ^{132}Sn

Beams of neutron-rich Cd and Xe isotopes @ 2.85 MeV/u from REX

… these beams are unique to ISOLDE

… heaviest nuclei delivered by REX to MINIBALL so far

^{122,124}Cd measured ➔ preliminary B(E2) values

- **^{122}Cd: B(E2↑) = 0.37 ± 0.11 e^2b^2 … improved accuracy**
- **^{124}Cd: B(E2↑) = 0.29 ± 0.09 e^2b^2 … determined for the first time**

… both values are within the expectations for vibrational nuclei

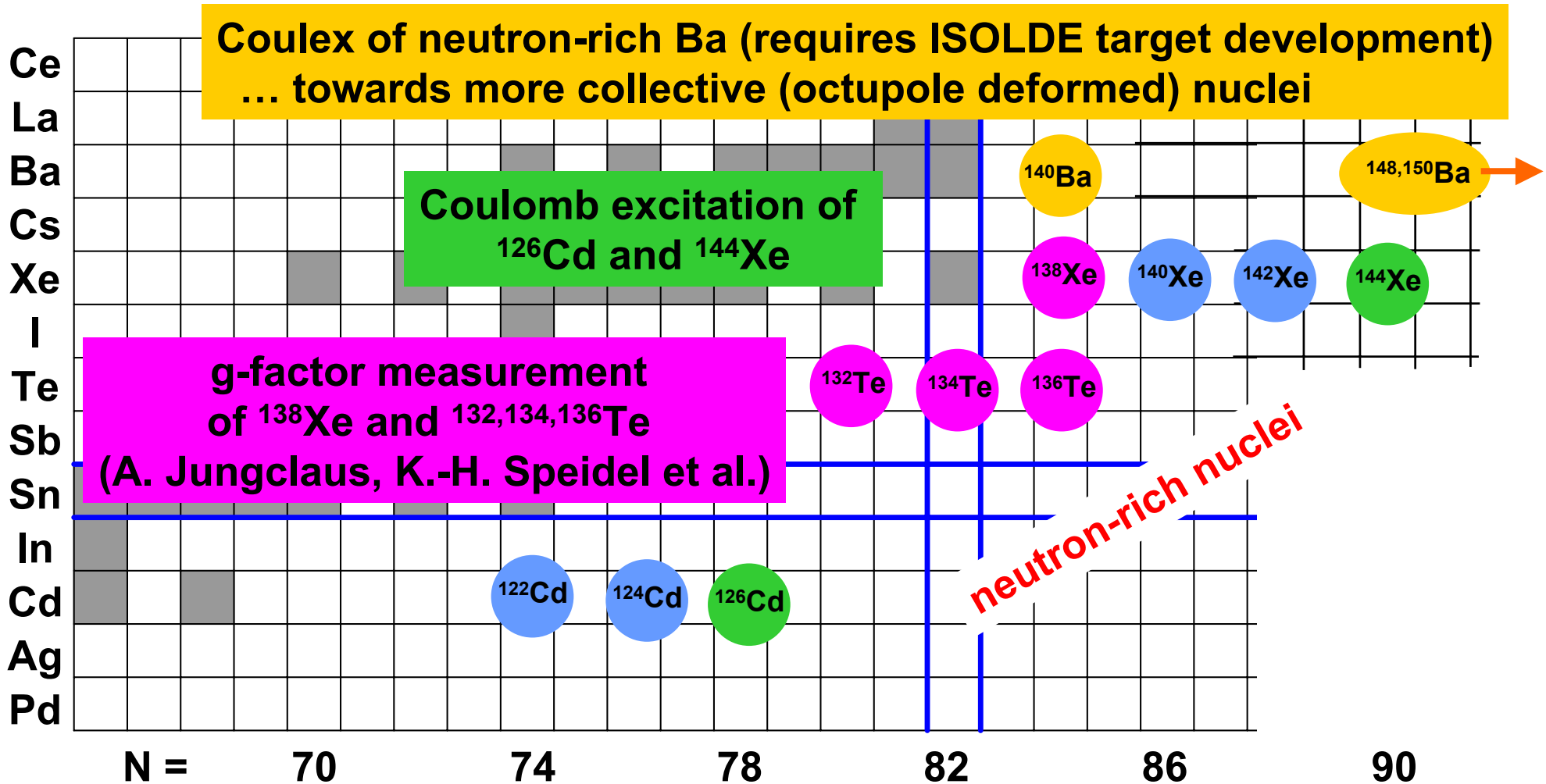
- **Test with ^{126}Cd beam successfully performed**

^{138,140,142}Xe measured with high statistics

Demonstrated the feasibility of a g-factor measurement in ^{138}Xe

… and the future

… and the future



… and
- upgrade of REX to 5.4 MeV/u (HIE-ISOLDE)
- transfer reactions in inverse kinematics

Th. Kröll[1], T. Behrens[1], R. Krücken[1], T. Faestermann[1], R. Gernhäuser[1], M. Mahgoub[1], P. Maierbeck[1], M. Münch[1], P. Thirolf[2], T. Morgan[2], D. Habs[2], O. Kester[2], R. Lutter[2], M. Pasini[2], K. Rudolph[2], F. Ames[2], H. Scheit[3], O. Niedermaier[3], V. Bildstein[3], D. Schwalm[3], N. Warr[4], D. Martin[4], D. Weisshaar[4], J. Iwanicki[5], P. Delahaye[6], F. Wenander[6], L. Fraile[6], P. Butler[6,9], T. Sieber[6], U. Köster[6], G. Georgiev[6], J. Cederkäll[6,3], D. Voulot[6], S. Franchoo[7], A. Scherillo[4,8], A. Hurst[9], P. Mayet[10], P. Van Duppen[10], J. Van de Walle[10], I. Stefanescu[10], M. Huyse[10], O. Ivanov[10], M. Pantea[11], T. Davinson[12], P. Kent[13], A. Ekström[14], K.-H. Speidel[15], J. Leske[15], S. Schielke[15] and the REX-ISOLDE and MINIBALL collaborations

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[4]Universität zu Köln – [5]SLCJ Warszawa – [6]CERN Genève
[7]IPN Orsay – [8]ILL Grenoble – [9]University of Liverpool
[10]KU Leuven – [11]TU Darmstadt – [12]University of Edinburgh
[13]University of York – [14]Lunds Universitet – [15]Universität Bonn