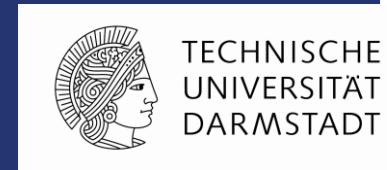


Evolution of quadrupole and octupole collectivity north-east of ^{132}Sn : the even Te and Xe isotopes

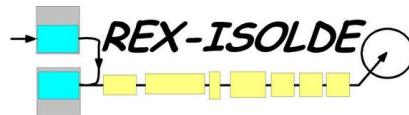
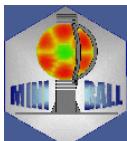


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CERN-INTC-2012-041, INTC-P-342

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IRNRE BAS Sofia – HIL Warszawa – Univ. Köln – Central Michigan Univ.
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Helsinki Inst. of Physics – IPHC Strasbourg – Univ. York – UC Madrid



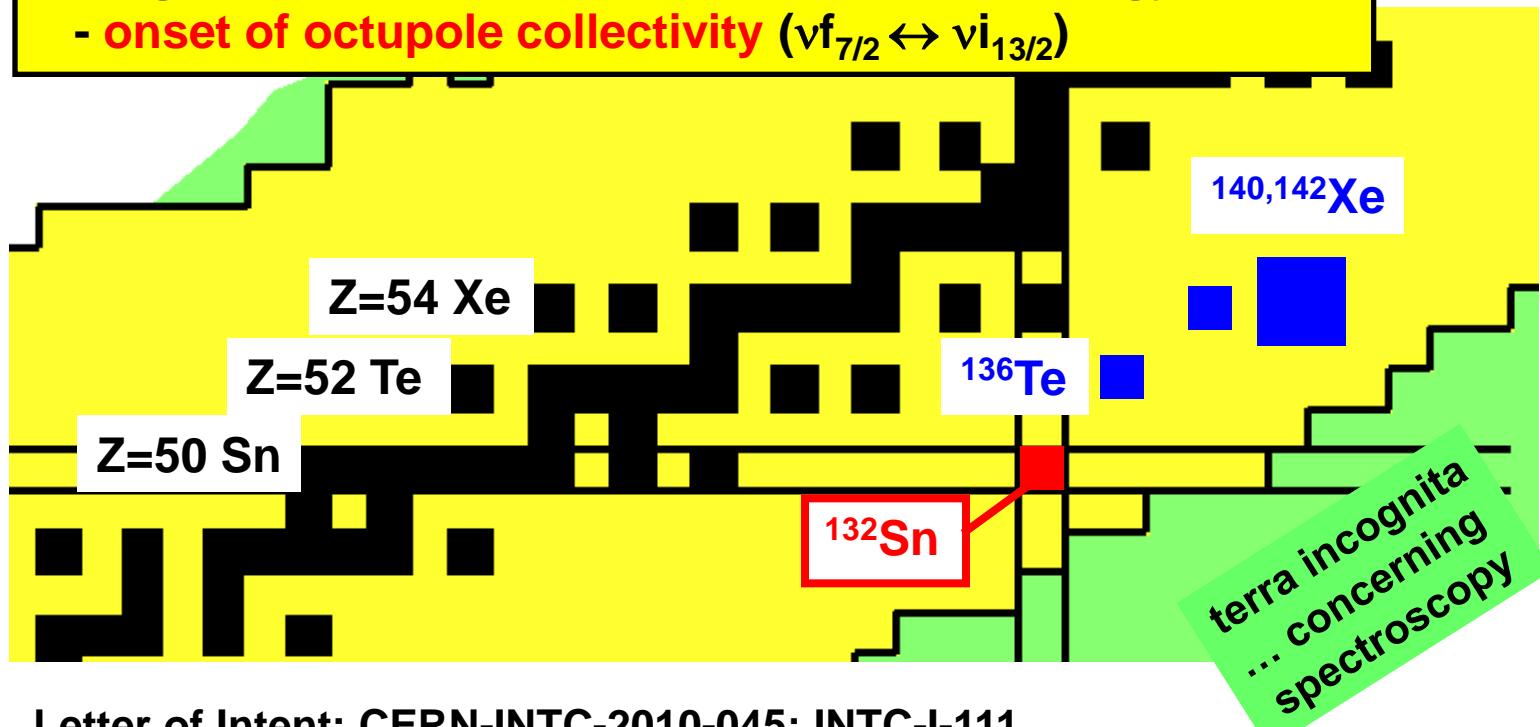
Bundesministerium
für Bildung
und Forschung

Work supported by BMBF (Nr. 06DA7040), LOEWE / HIC for FAIR,
and the MINIBALL/REX-ISOLDE collaborations

Region of Interest

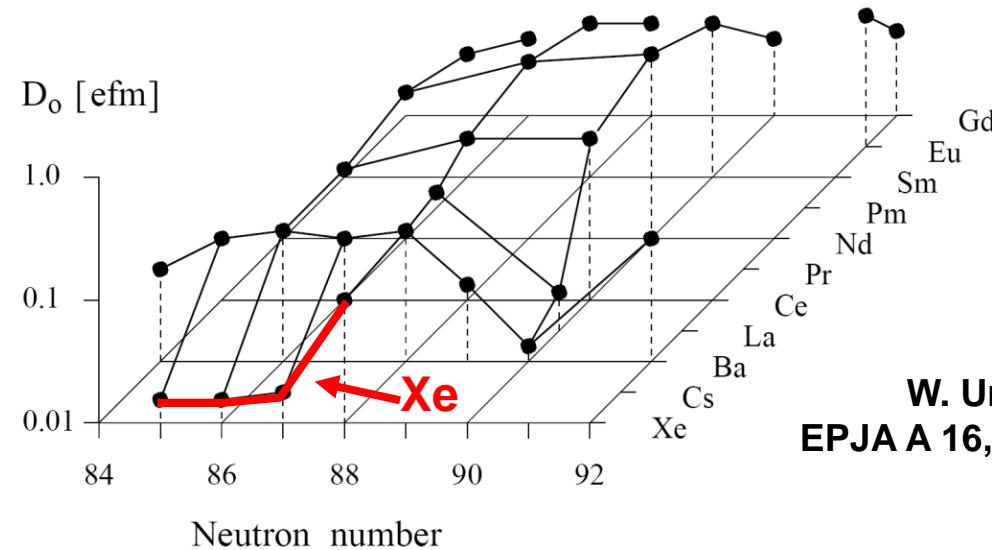
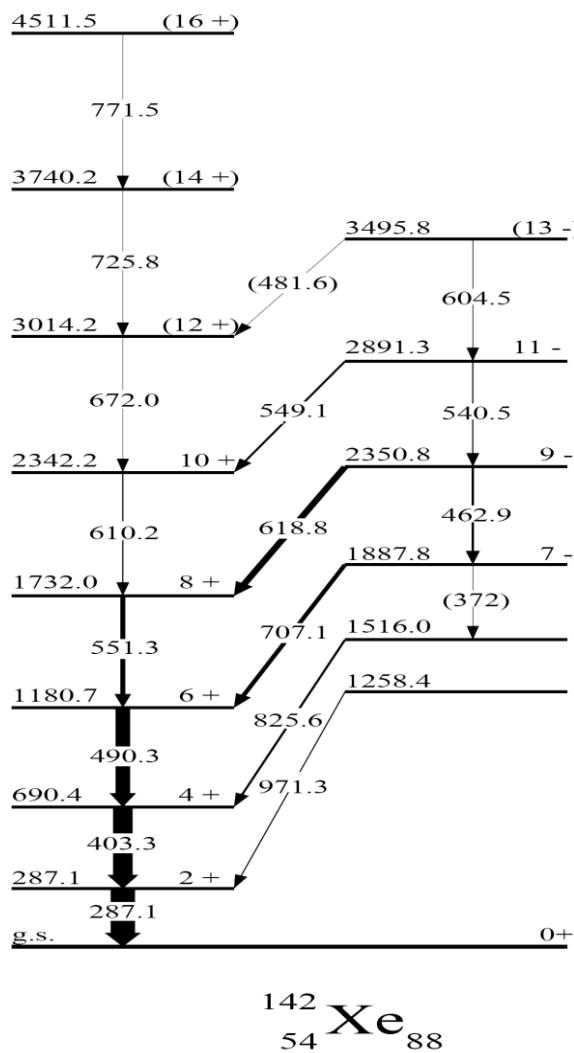


- Doubly-magic shell closure in ^{132}Sn
- ± 1 pair of neutrons and 1 pair of protons
→ irregular behaviour in ^{128}Cd (IS477) and ^{136}Te
- Xe isotopes:
 - regular behaviour at low spin/excitation energy (IS411)
 - onset of octupole collectivity ($\nu f_{7/2} \leftrightarrow \nu i_{13/2}$)



Letter of Intent: CERN-INTC-2010-045; INTC-I-111

Octupole states in ^{142}Xe



W. Urban et al.,
EPJA A 16, 303 (2003)

- Increasing D₀ towards N=88 (maximum, “magic”???)
... indirect sign of increasing octupole collectivity?
... octupole collectivity expected to be smaller than in Ba with the octupole “magic” Z=56
- Only indirect determination of D₀ (except ^{140}Xe)
- No octupole states known for ^{144}Xe (N=90)
- **No B(E3) values known in Xe above N=82!**

Particle detector



HIE-ISOLDE energies allow for heavy target / normal kinematics

- Multiple Coulomb excitation
 - Reorientation best measured at backward CM angles
- large angular coverage needed: T-REX

Elastic scattering at forward angles cause problem (radiation damage)
(in IS411 with Xe beams the inner rings of the standard CD had to be covered)

→ Modified T-REX configuration

No forward CD

Moving forward barrel away from target

Angular resolution: 2-6°

Max. Θ_{Lab} (forward): 75°

No forward barrel

Moving CD closer to target

Angular resolution: 2.5°

Max. Θ_{Lab} (forward): 65°

... works successfully

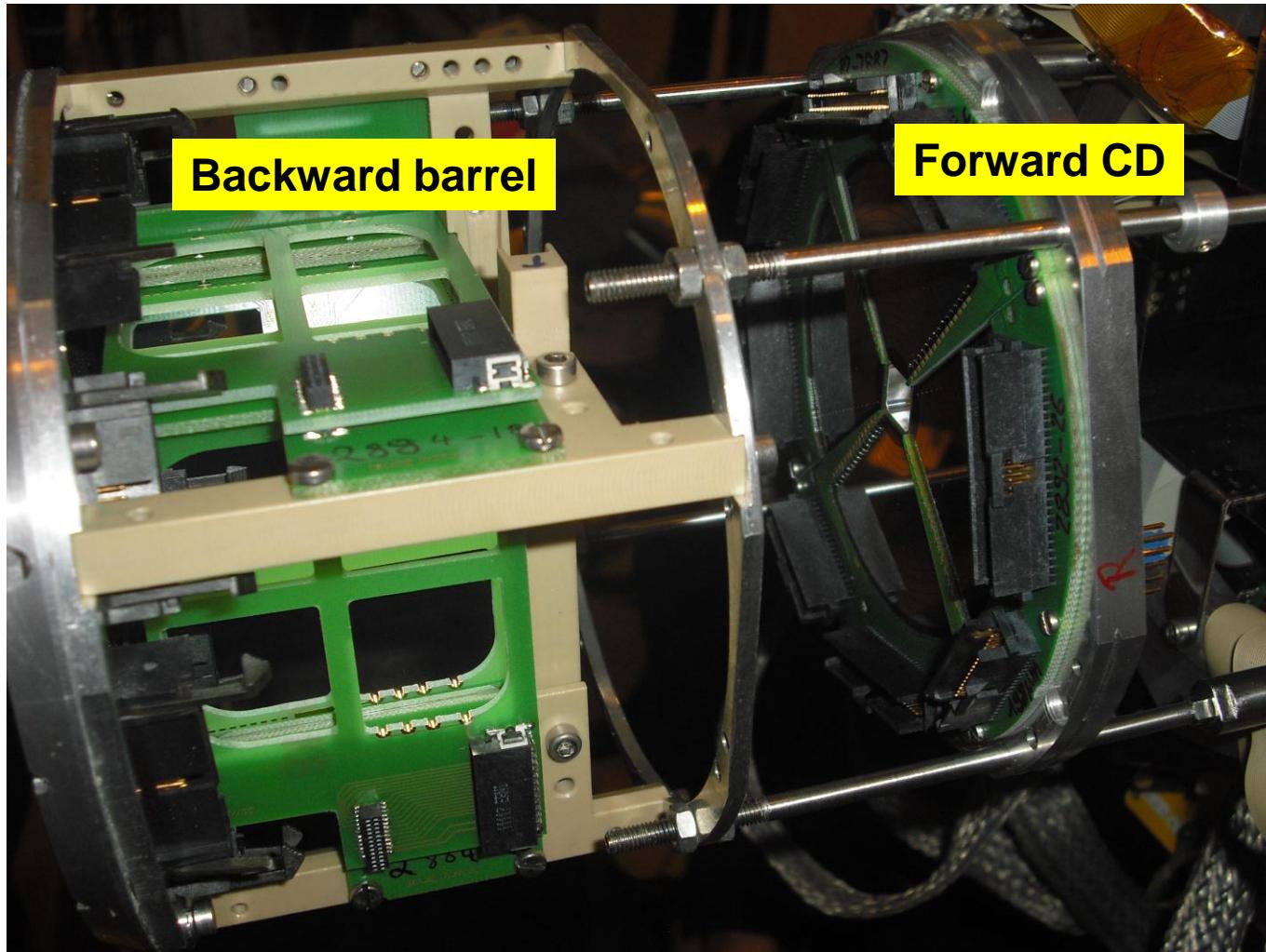
@ intensity > 10⁷/s

D. Mücher et al. (IS510)

Particle detector



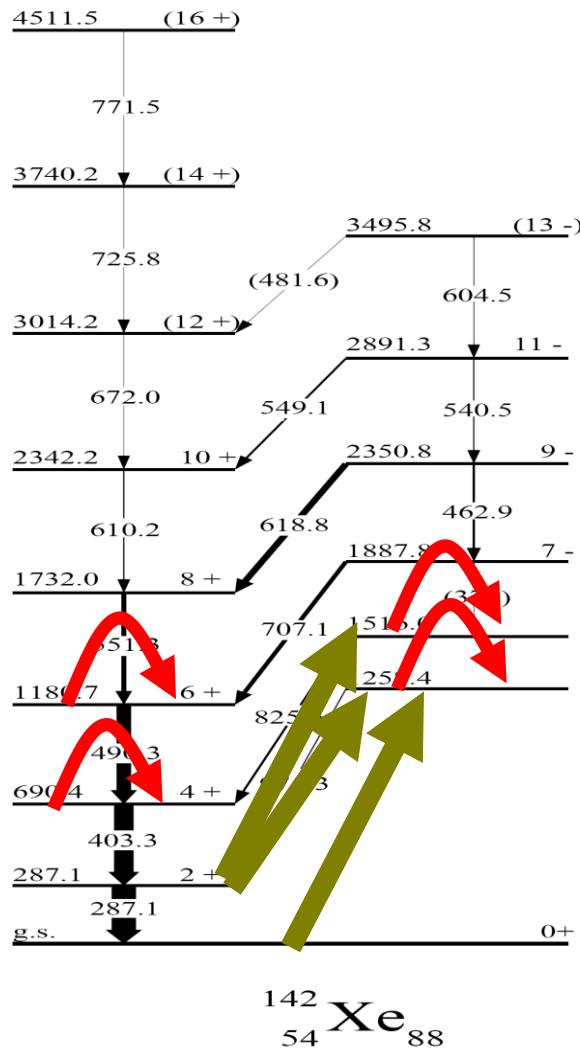
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Physics aims



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Multiple Coulomb excitation

Observed yields depend on many transitional and diagonal MEs (E1,E2,E3)

Additional input needed!

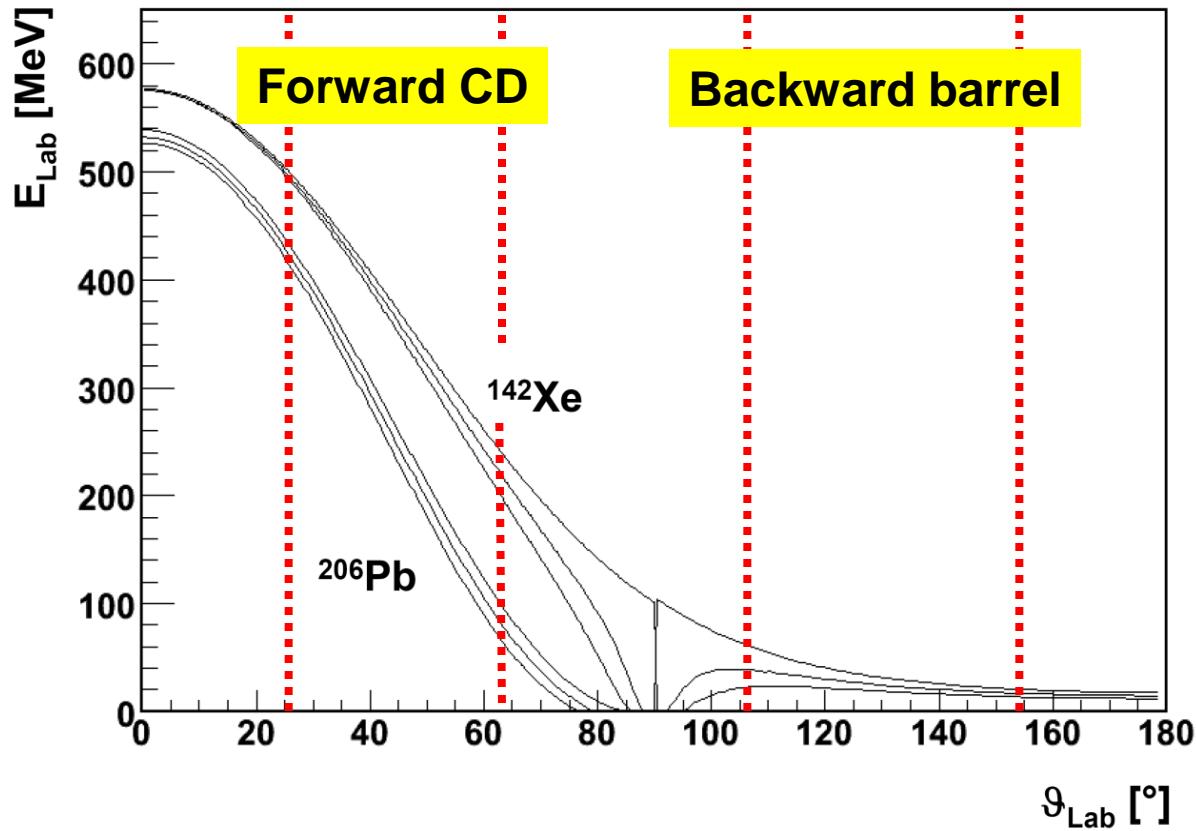
- Coulex data from IS411 (lower beam energy, other target)
- lifetimes will be measured at ILL

Physics aims

- diagonal E2 MEs (above 2^+ state)
→ quadrupole moments Q_2
- transitional octupole MEs
→ $B(E3)$ values

... quantities not be determined by other methods!!!!

Target



- $1 \text{ mg/cm}^2 \text{ }^{206}\text{Pb}$
 - $^{142}\text{Xe} @ 4.5 \text{ MeV/u}$
- middle of target
 $E = 4.38 \text{ MeV/u}$

Good separation in
region covered by CD

- Pulse height deficit ✓
- energy loss (SRIM) ✓

Rate estimate / beam time request (I)



$$\frac{\sigma(6^+)}{\sigma(2^+)} = 2.8 \cdot 10^{-2}$$

$$\frac{\sigma(6^+)}{\sigma(2^+)} = 1.8$$

40 x σ at REX

	Ruth	2 ⁺	6 ⁺	3 ⁻
24° < $\vartheta_{\text{Lab},3}$ < 63°	(40° < ϑ_{CM} < 100°)	15.9	6.1(2)	0.17(1)
24° < $\vartheta_{\text{Lab},4}$ < 63°	(54° < ϑ_{CM} < 132°)	8.6	3.9(1)	0.38(3)
105° < $\vartheta_{\text{Lab},3}$ < 153°	(147° < ϑ_{CM} < 171°)	0.2	0.035(10)	0.046(11)

10 x σ at REX

- B(E3) values estimated S. Raman et al., Phys. Rev. C 43, 556 (1991)
- B(E2) from IS411
- Sensitivity to diagonal ME up to 30% (ME = ± 0.5 eb)
- Large angular range (CMS): 40°-132°, 147°-171°
→ different sensitivities on single/multiple excitation and reorientation
- Safe energy: 4.5 MeV/u (²⁰⁶Pb target)
Cross section for target excitation: 0.5 mb → normalisation

Rate estimate / beam request (II)



- MINIBALL + T-REX, ^{206}Pb target (1 mg/cm^2)
- Beam intensity like in IS411 ($10^6/\text{s}$) ... good for Day-1 experiment
- Beam contaminant: ^{142}Cs , decay product of ^{142}Xe ($T_{1/2} = 1.23 \text{ s}$)

Most challenging is the 3^- state:

- 200 particle- γ -coincidences/d
- doubly-differential cross section
 - split data set into 7 angular bins (5 forward, 2 backward)
 - < 10% statistical error per angular bin in 10 days of beam time
- sensitivity on transitional ME: $> 10\%/0.5 \text{ eb}$... for positive parity states
 - Q_2 values will be determined with much better precision
- + beam development for ^{136}Te
 - ... already on our wish list for 10 years (IS411 and IS415)

We request 30 shifts (10 days) of beam time