

Status of Miniball/TREX and plans for the experimental program in 2016

- Updated physics case
- Summary REX-ISOLDE aera
- Re-Installation at HIE-ISOLDE beam line
- Preliminary in-beam results
- Future experiments

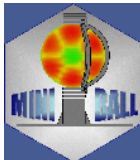
Peter Reiter
IKP, University of Cologne

ISCC meeting, 2nd February, 2016, CERN

GEFÖRDERT VOM



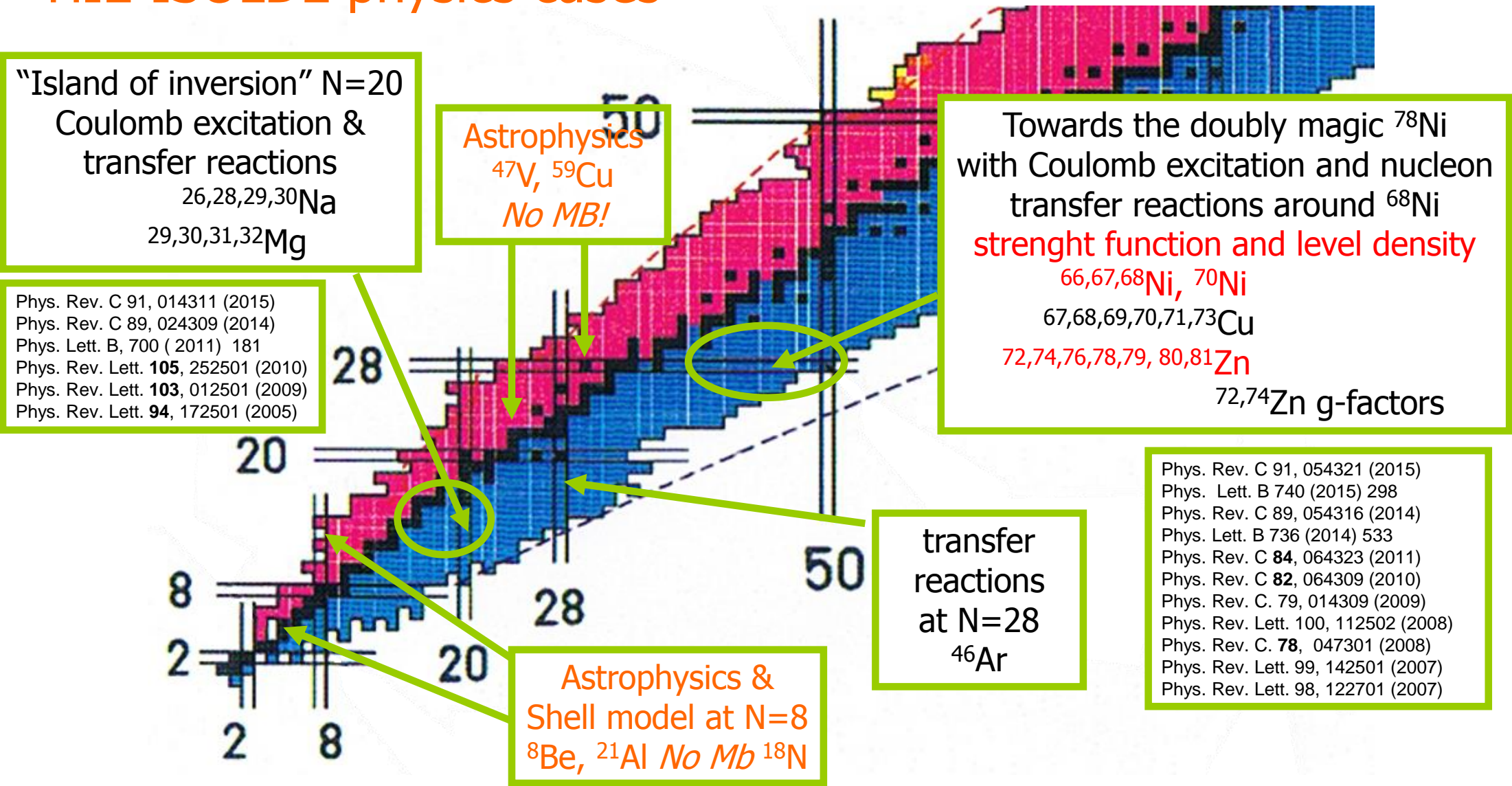
Bundesministerium
für Bildung
und Forschung



Physics case

Shell Model Physics with MINIBALL@REX-ISOLDE

HIE-ISOLDE physics cases



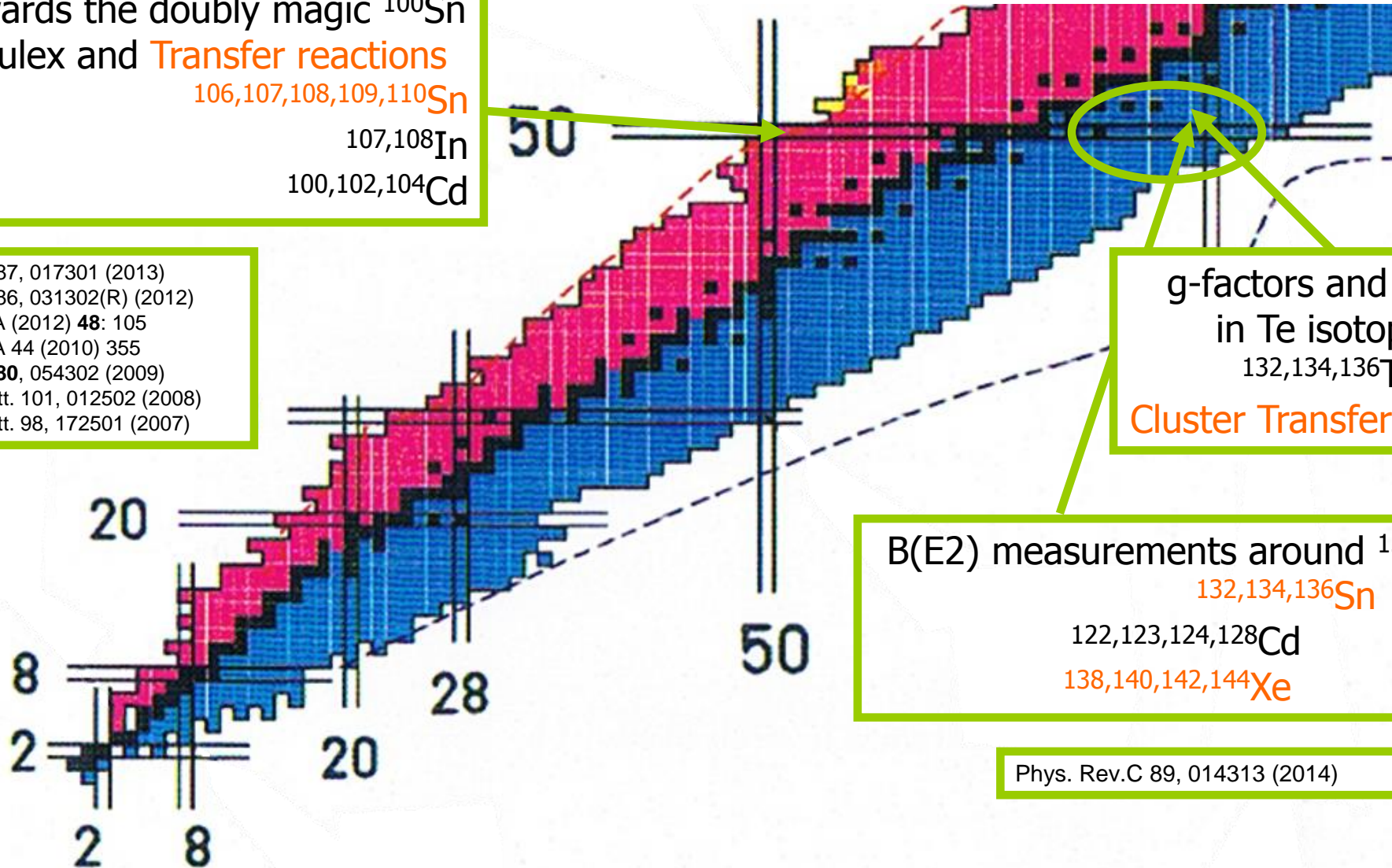
Physics case

Shell Model Physics with MINIBALL@REX-ISOLDE

HIE-ISOLDE physics cases

Towards the doubly magic ^{100}Sn
Coulex and **Transfer reactions**
 $^{106,107,108,109,110}\text{Sn}$
 $^{107,108}\text{In}$
 $^{100,102,104}\text{Cd}$

Phys. Rev. C 87, 017301 (2013)
Phys. Rev. C 86, 031302(R) (2012)
Eur. Phys. J. A (2012) **48**: 105
Eur. Phys. J. A 44 (2010) 355
Phys. Rev. C **80**, 054302 (2009)
Phys. Rev. Lett. 101, 012502 (2008)
Phys. Rev. Lett. 98, 172501 (2007)



g-factors and B(E2)
in Te isotopes
 $^{132,134,136}\text{Te}$
Cluster Transfer in ^{133}Sb

B(E2) measurements around ^{132}Sn
 $^{132,134,136}\text{Sn}$
 $^{122,123,124,128}\text{Cd}$
 $^{138,140,142,144}\text{Xe}$

Phys. Rev.C 89, 014313 (2014)

Physics case

Shapes & collectivity with MINIBALL@REX-ISOLDE HIE-ISOLDE physics cases

Shapes and collectivity
in the rare earth region

$^{138,140}\text{Nd}$
 $^{140,142}\text{Sm}$
 ^{142}Gd
 ^{144}Dy

Phys. Rev. C 91, 054326 (2015)
Phys. Rev. C 88, 021302(R) (2013)

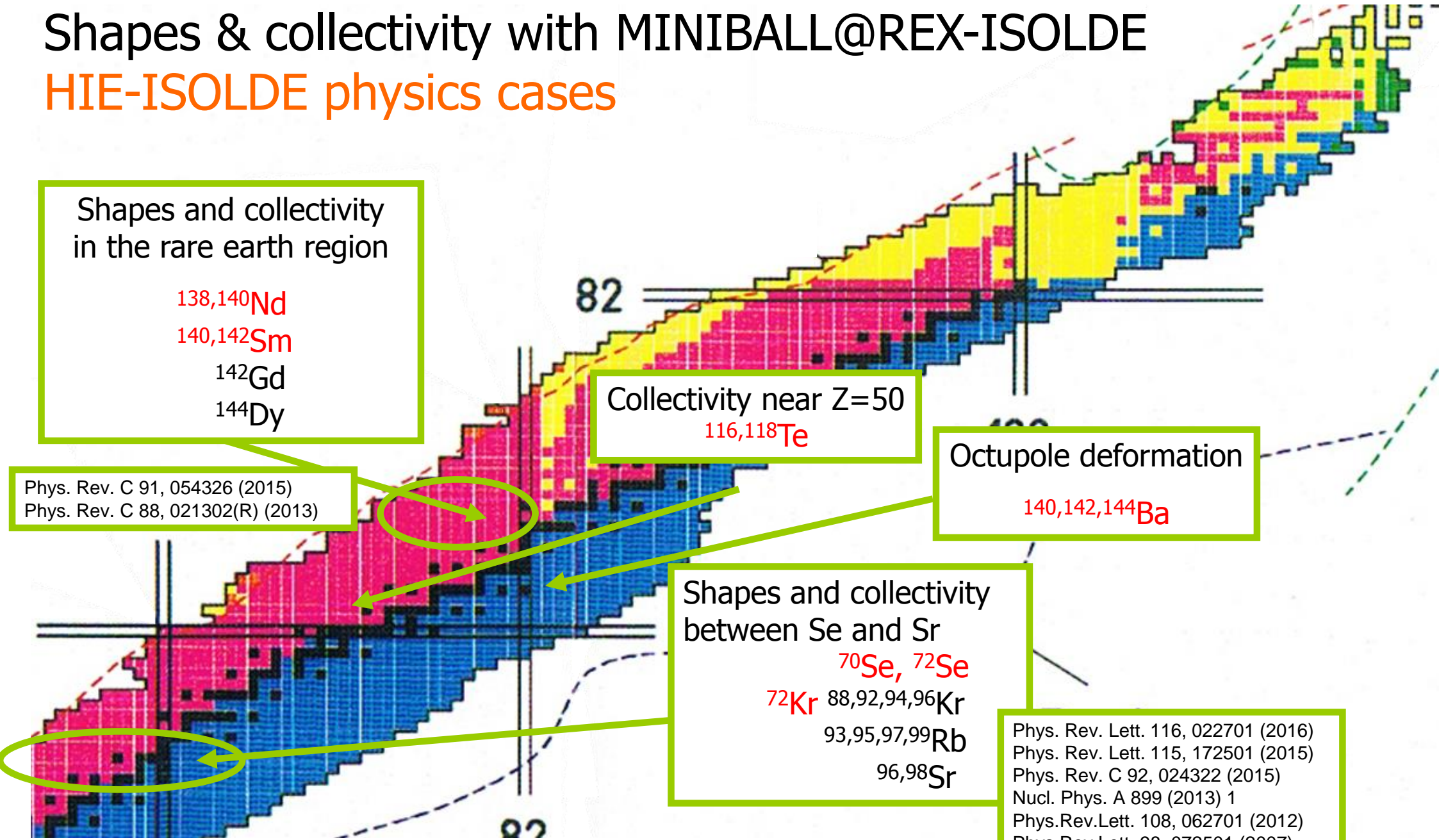
Collectivity near $Z=50$
 $^{116,118}\text{Te}$

Octupole deformation
 $^{140,142,144}\text{Ba}$

Shapes and collectivity
between Se and Sr

$^{70}\text{Se}, ^{72}\text{Se}$
 ^{72}Kr 88,92,94,96Kr
93,95,97,99Rb
96,98Sr

Phys. Rev. Lett. 116, 022701 (2016)
Phys. Rev. Lett. 115, 172501 (2015)
Phys. Rev. C 92, 024322 (2015)
Nucl. Phys. A 899 (2013) 1
Phys.Rev.Lett. 108, 062701 (2012)
Phys.Rev.Lett. 98, 072501 (2007)



Physics case

Shapes & collectivity with MINIBALL@REX-ISOLDE

HIE-ISOLDE physics cases

Shapes and collectivity
in light Po, Rn nuclei

$^{206,208}\text{Po}$
 $^{202,204,208}\text{Rn}$

Shapes in Hg, Pb, Po nuclei

$^{182,184,186,188}\text{Hg}$
 $^{188,190,192,194,196,198}\text{Pb}$
 $^{196,198,200,202}\text{Po}$

Neutron rich nuclei at 208Pb

$^{212,214}\text{Pb}$

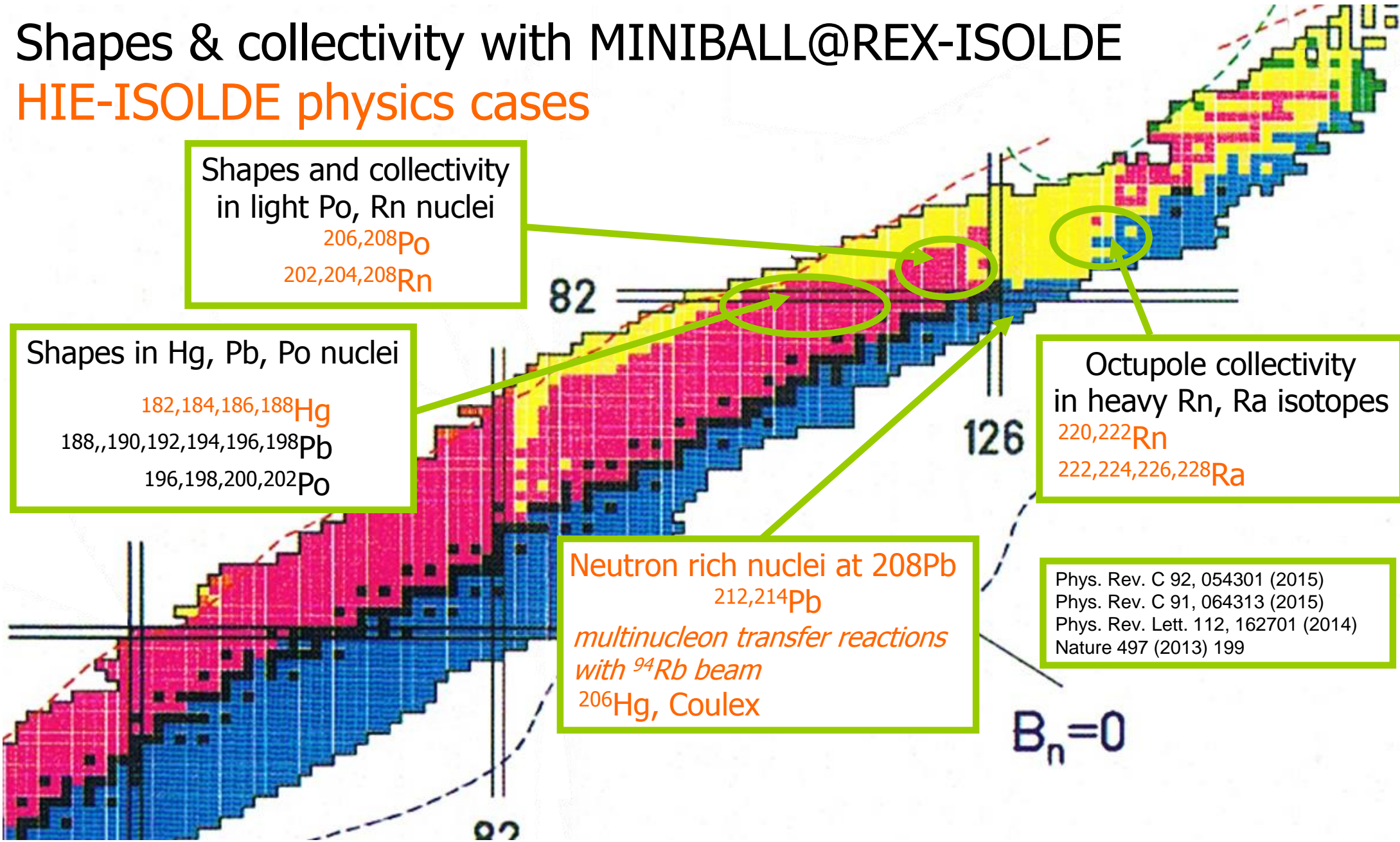
multinucleon transfer reactions
with ^{94}Rb beam
 ^{206}Hg , Coulex

Octupole collectivity
in heavy Rn, Ra isotopes

$^{220,222}\text{Rn}$
 $^{222,224,226,228}\text{Ra}$

Phys. Rev. C 92, 054301 (2015)
Phys. Rev. C 91, 064313 (2015)
Phys. Rev. Lett. 112, 162701 (2014)
Nature 497 (2013) 199

$B_n = 0$



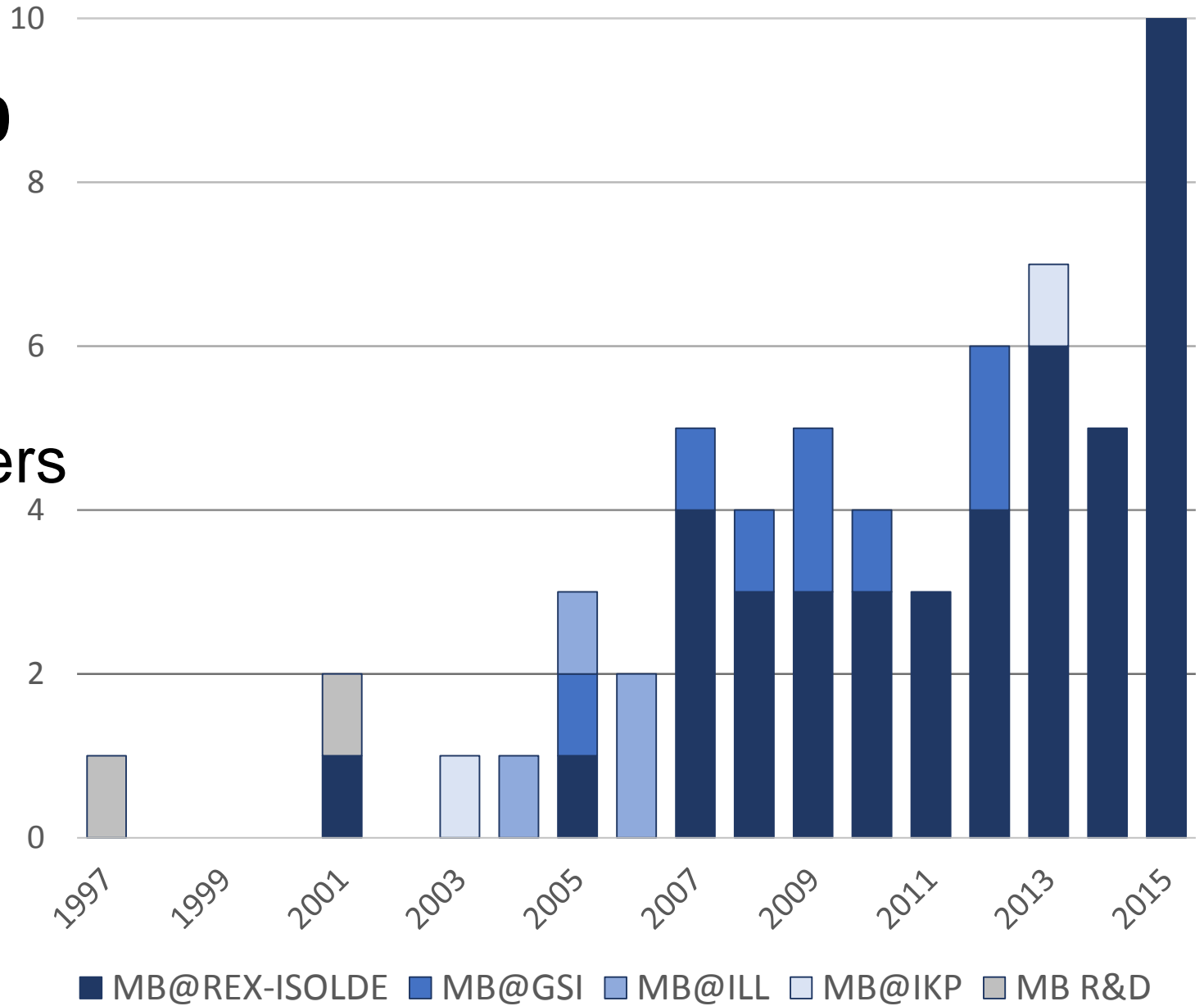
MINIBALL PAPERS / YEAR

Total number of publications: 110

20 letters

41 other peer reviewed papers

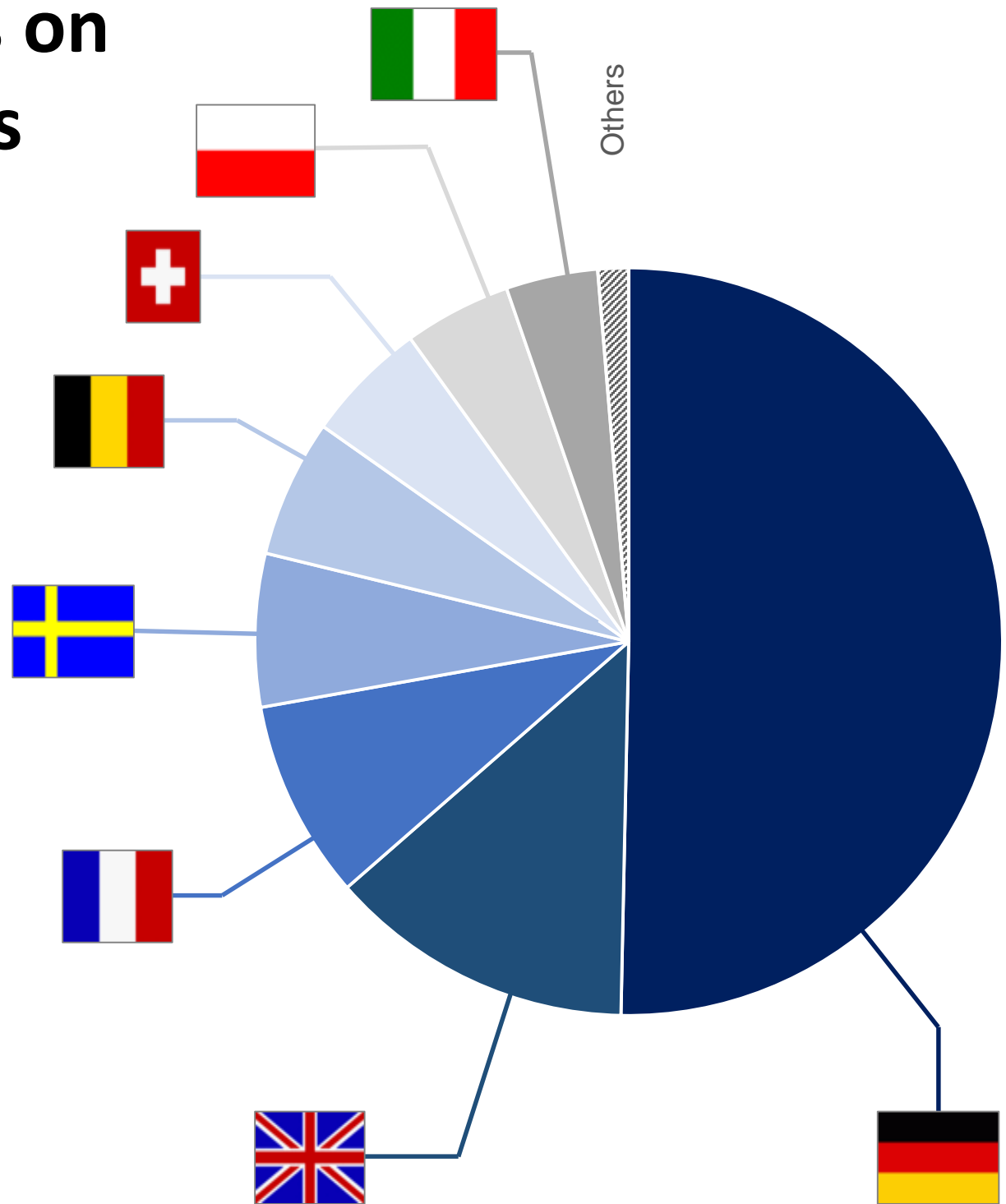
49 conference proceedings



Number of affiliations on MINIBALL publications

2001 - 2005

Collaborators
from
about 35
institutes
in 10 countries



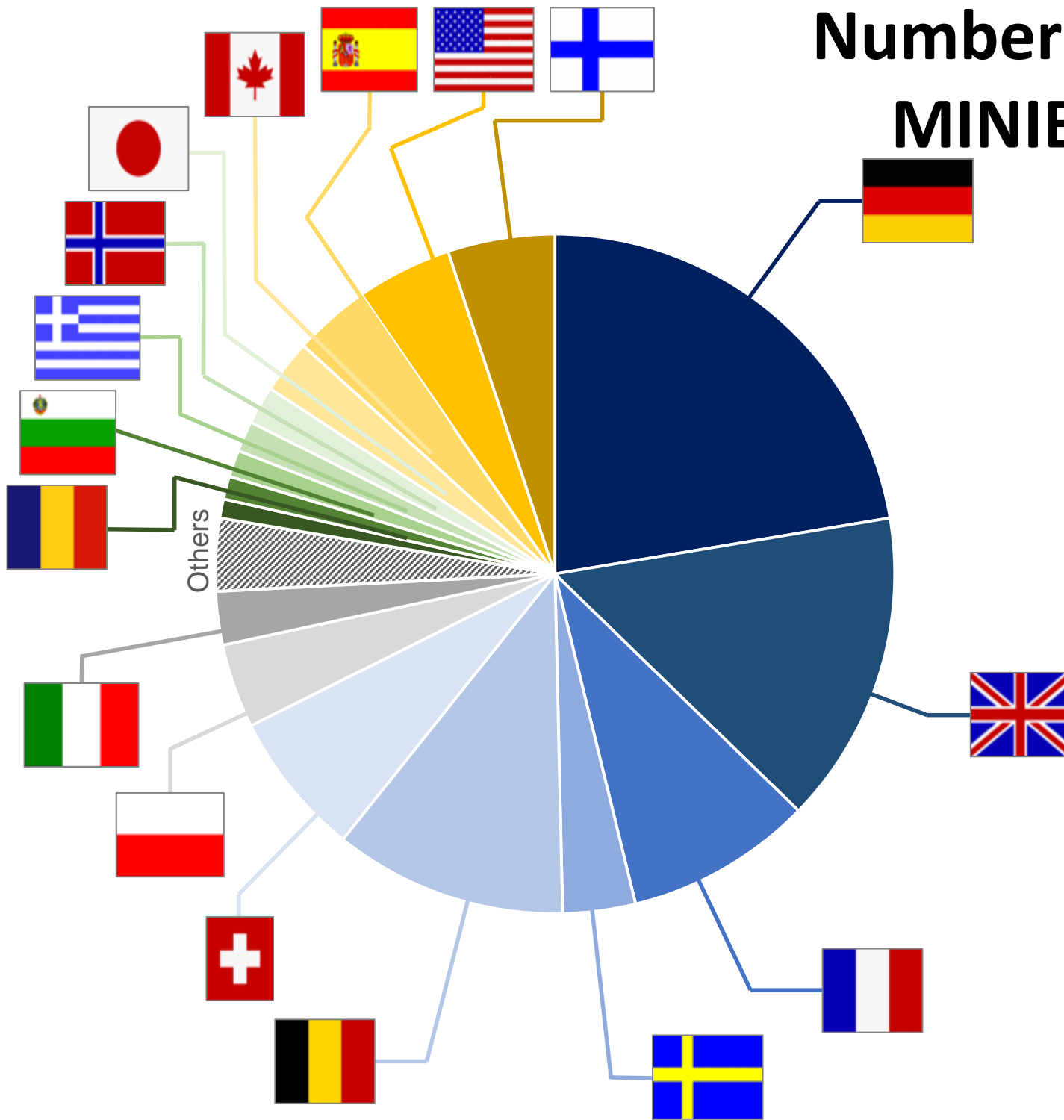
Number of affiliations on MINIBALL publications

2011 - 2015

Collaborators from

about 90 institutes

in 24 countries



MINIBALL @ HIE-ISOLDE

MINIBALL at the new beam line, state at April 2015



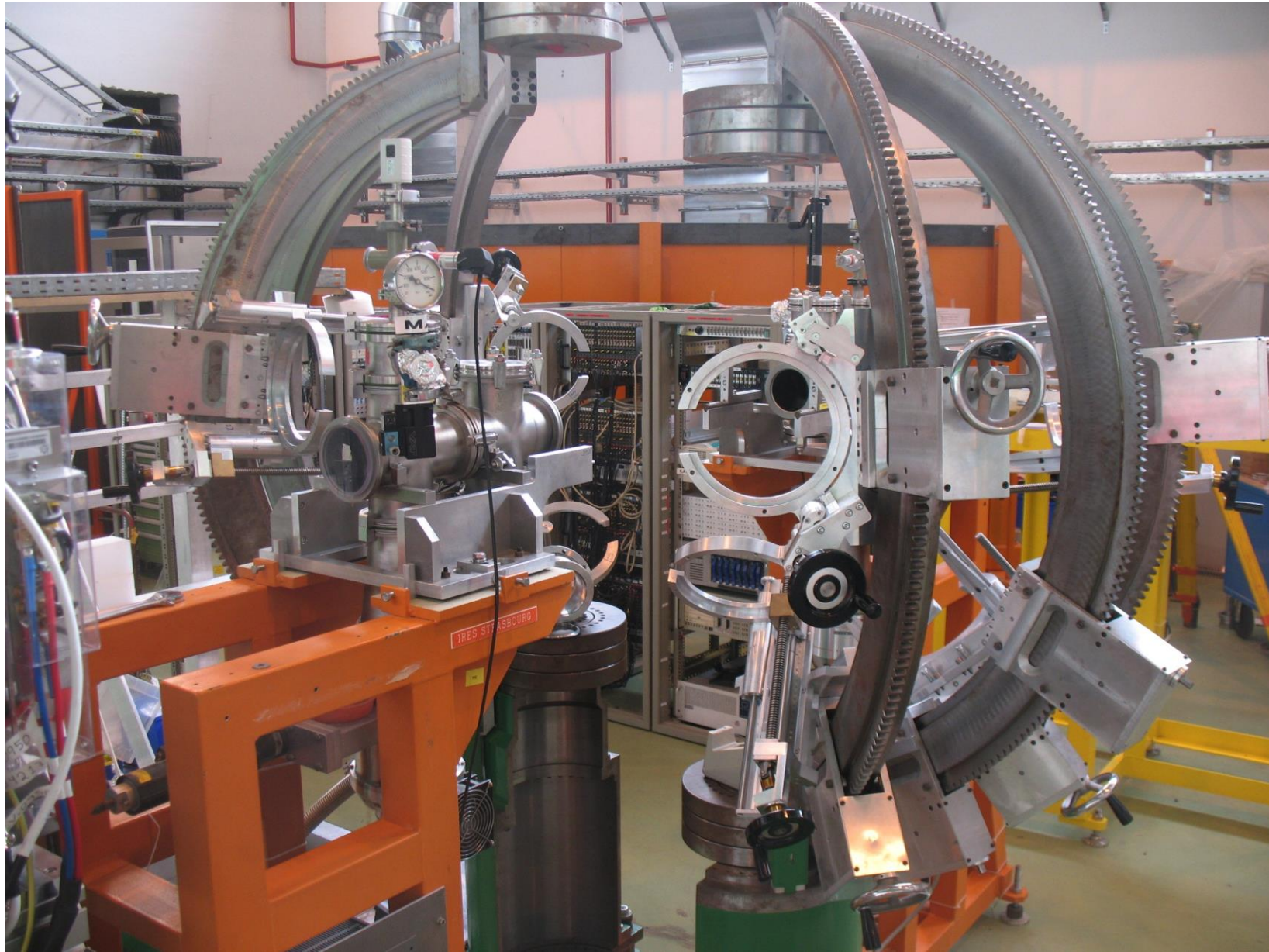
MINIBALL @ HIE-ISOLDE

MINIBALL at the new beam line



MINIBALL @ HIE-ISOLDE

MINIBALL at the new beam line



MINIBALL @ HIE-ISOLDE

MINIBALL installation at the new beam line

- empty space around the target position in April
- new frame support due to trench
- height adjustments to level with the floor slope
- new cable trays
- electricity and grounding connections
- pulling new ISOLDE signal cables
- network connections
- interfacing with a new beam line
- compressed air connection
- exhaust lines
- alignment with sub mm precision
- new LN2 hoses
- maintaining the LN2 dewars
- vacuum system and vacuum pump upgrade

Acknowledgements

D.M. Cox, L. Gaffney, C. Henrich, A. Illana Sison, T. Kröll, R. Lutter, L. Martikainen, J. Pakarinen, F. Papadakis, M. Queiser, P. Reiter, T. Rolke, D. Rosiak, M. Seidlitz, B. Siebeck, S. Thiel, N. Warr, M. Zielińska, H. De Witte, H. Hess

Experiment: J. Cederkall, L. Cortes, D. Doherty, C. Henrich, M. Huyse, A. Illana Sison, M. Komorowska, T. Kröll, M. Matejska-Minda, E. Nacher, A. Nannini, P. Napiorkowski, J. Pakarinen, P. Papadakis, E. Rapisarda, M. Rocchini, B. Siebeck, J. Snall, P. Van Duppen, N. Warr, M. Zielińska

MINIBALL @ HIE-ISOLDE

MINIBALL ready for the beam

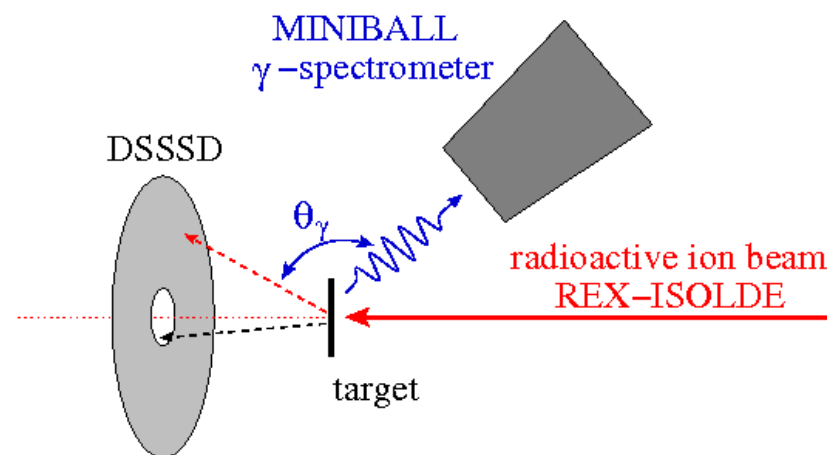
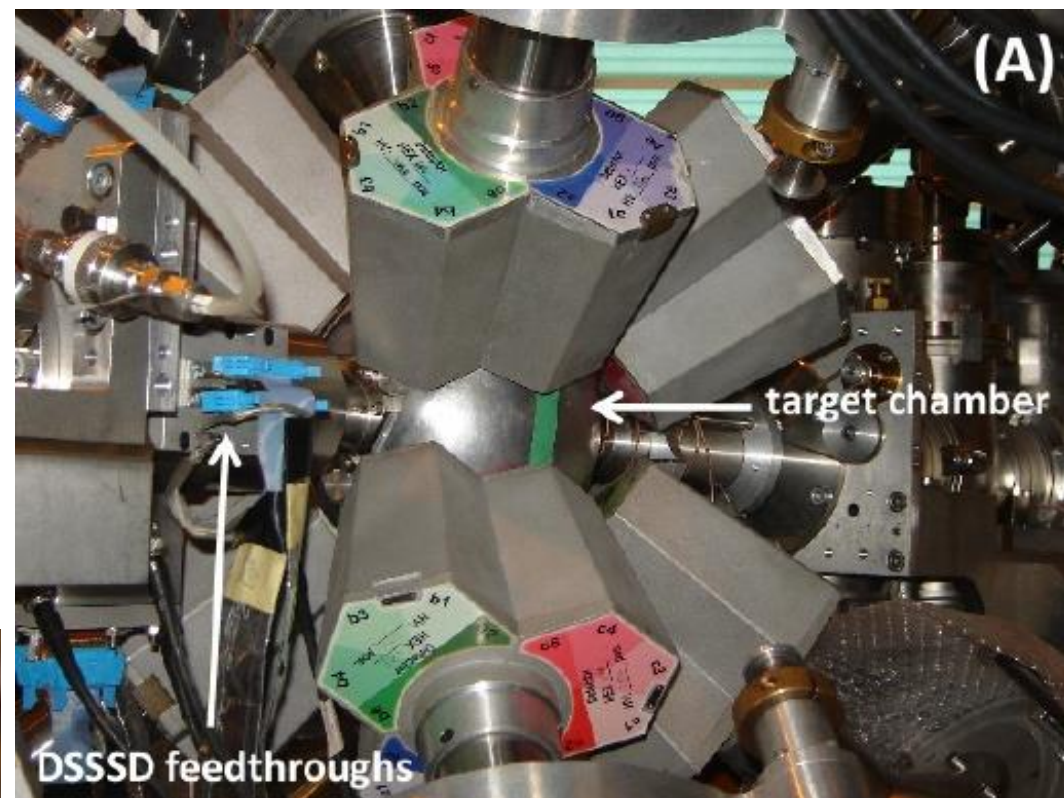
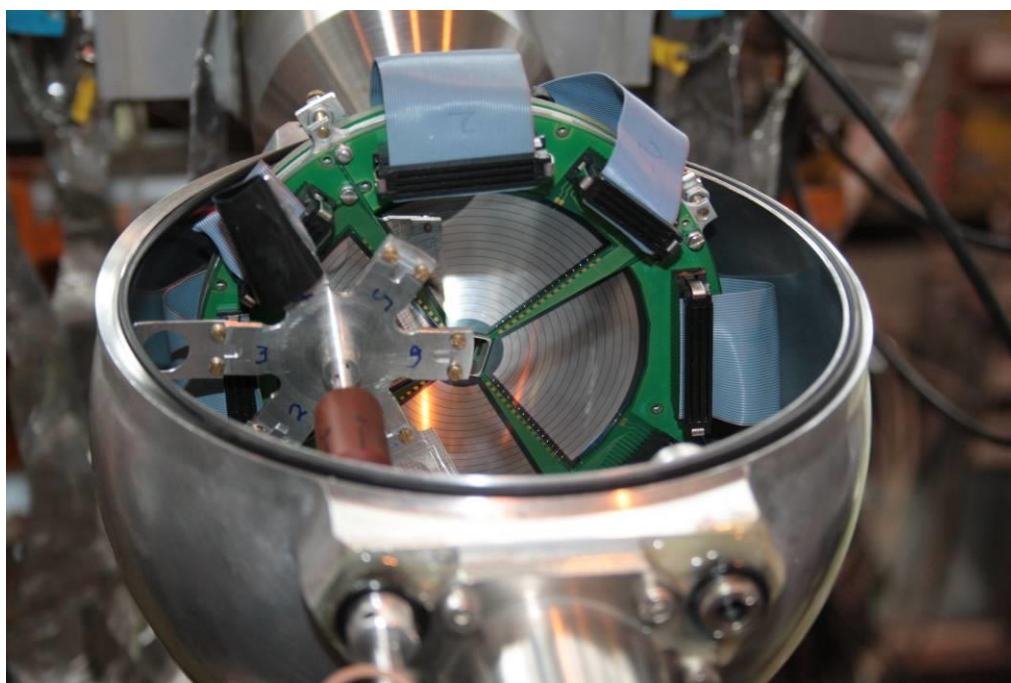


MINIBALL configuration 2015

MINIBALL Coulomb excitation setup

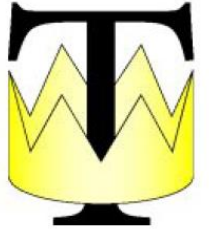
segmented Si detector for particle detection (DSSSD)

- 16 rings (front side)
- 96 strips (back side)
- angle coverage: $\theta_{\text{lab}} = 16\text{-}55^\circ$
- ΔE -E measurement possible (pad)



MINIBALL configurations

The MINIBALL T-REX (C-REX) setup



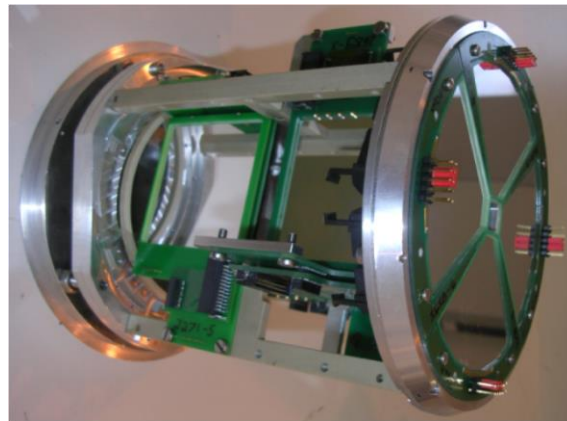
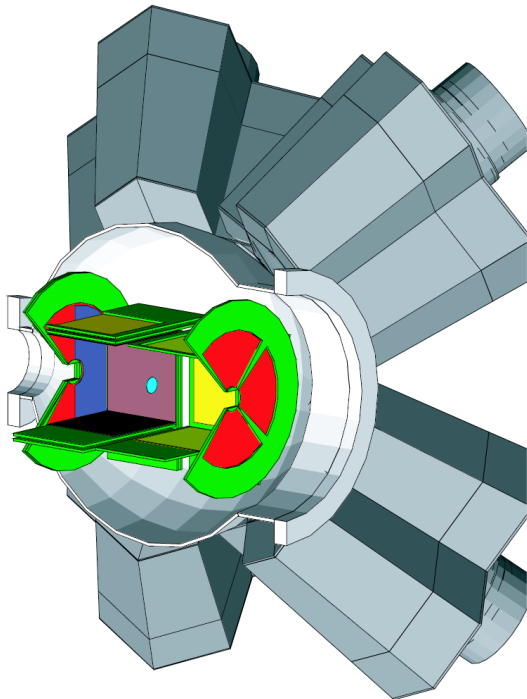
T-REX: Si detector array for Transfer experiments at REX-ISOLDE

- large solid angle (58% of 4π)
- position sensitive
- PID (ΔE -E): p, d, t, α ,
... and e⁻ from β -decay (!)

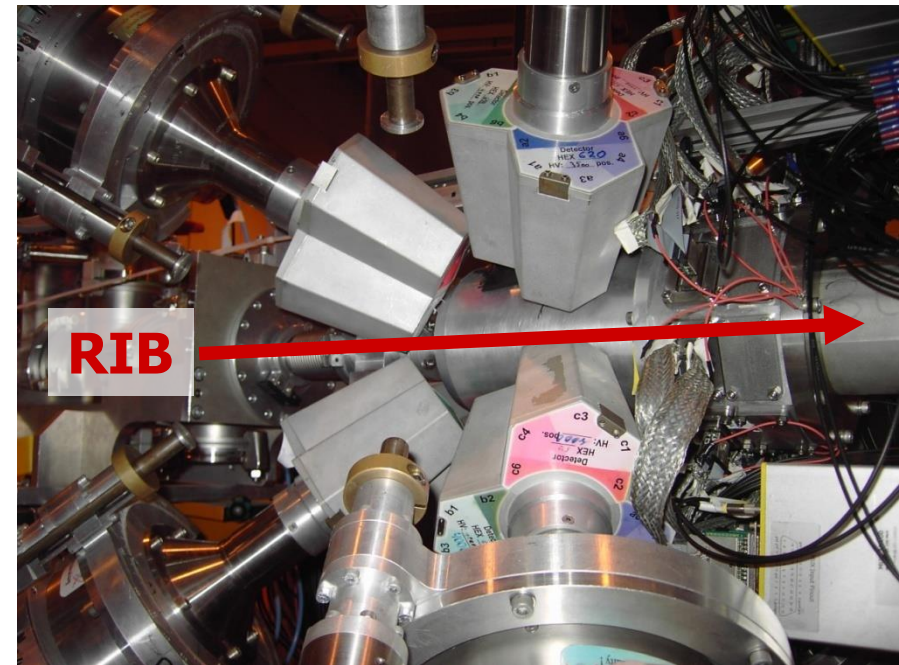
Technical details:

Barrel: 140 mm ΔE / 16 resistive strips
1000 mm E / pad

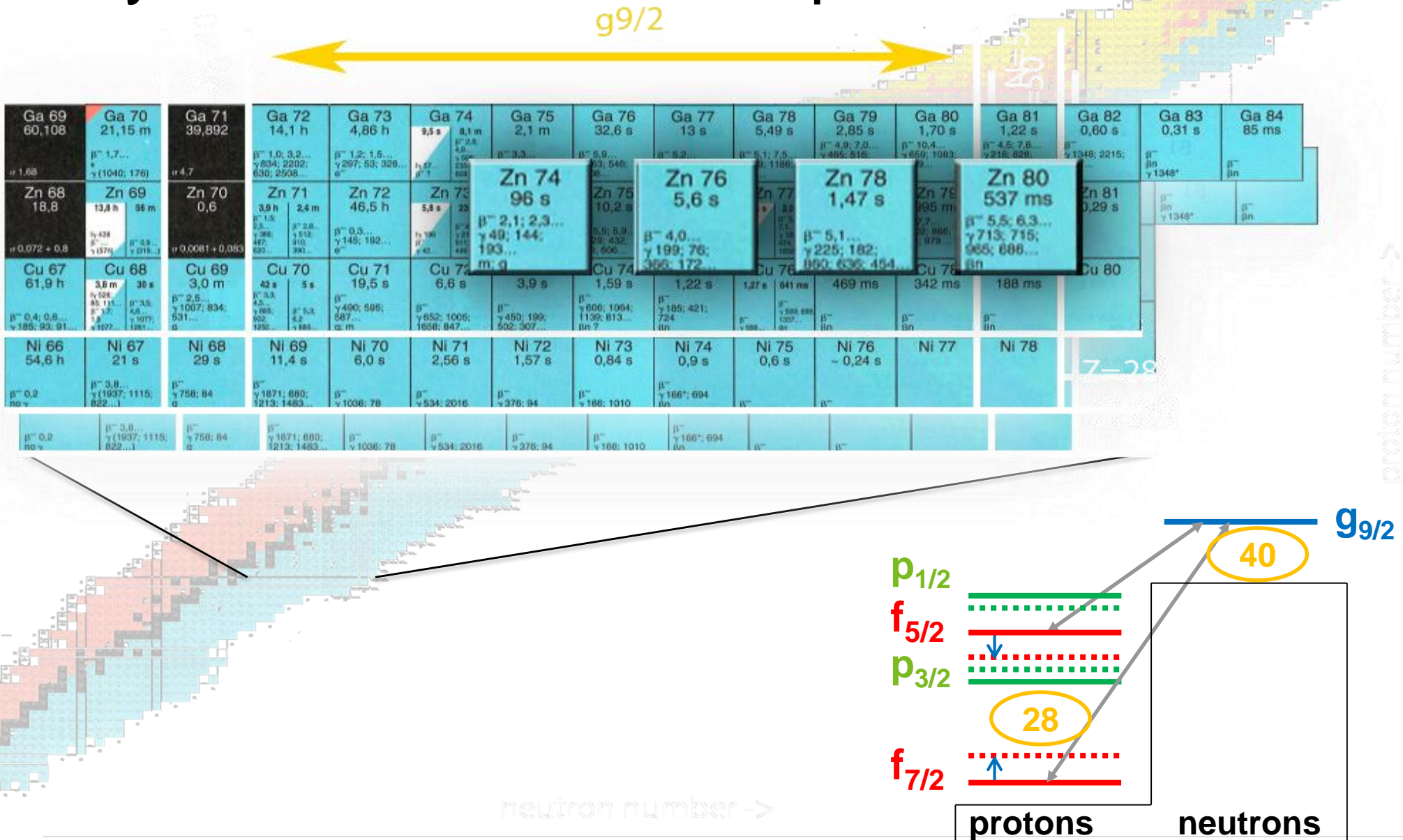
Backward CD: 500 mm ΔE / DSSSD
500 mm E / pad



V. Bildstein, K. Wimmer,
Th. Kröll, R. Gernhäuser et al.
(funded by TU München,
KU Leuven, U Edinburgh, CSNSM
Orsay, TU Darmstadt)



Coulomb excitation of $^{74-80}\text{Zn}$ probing the validity of shell-model descriptions around ^{78}Ni



Spokesperson M. Zielinska

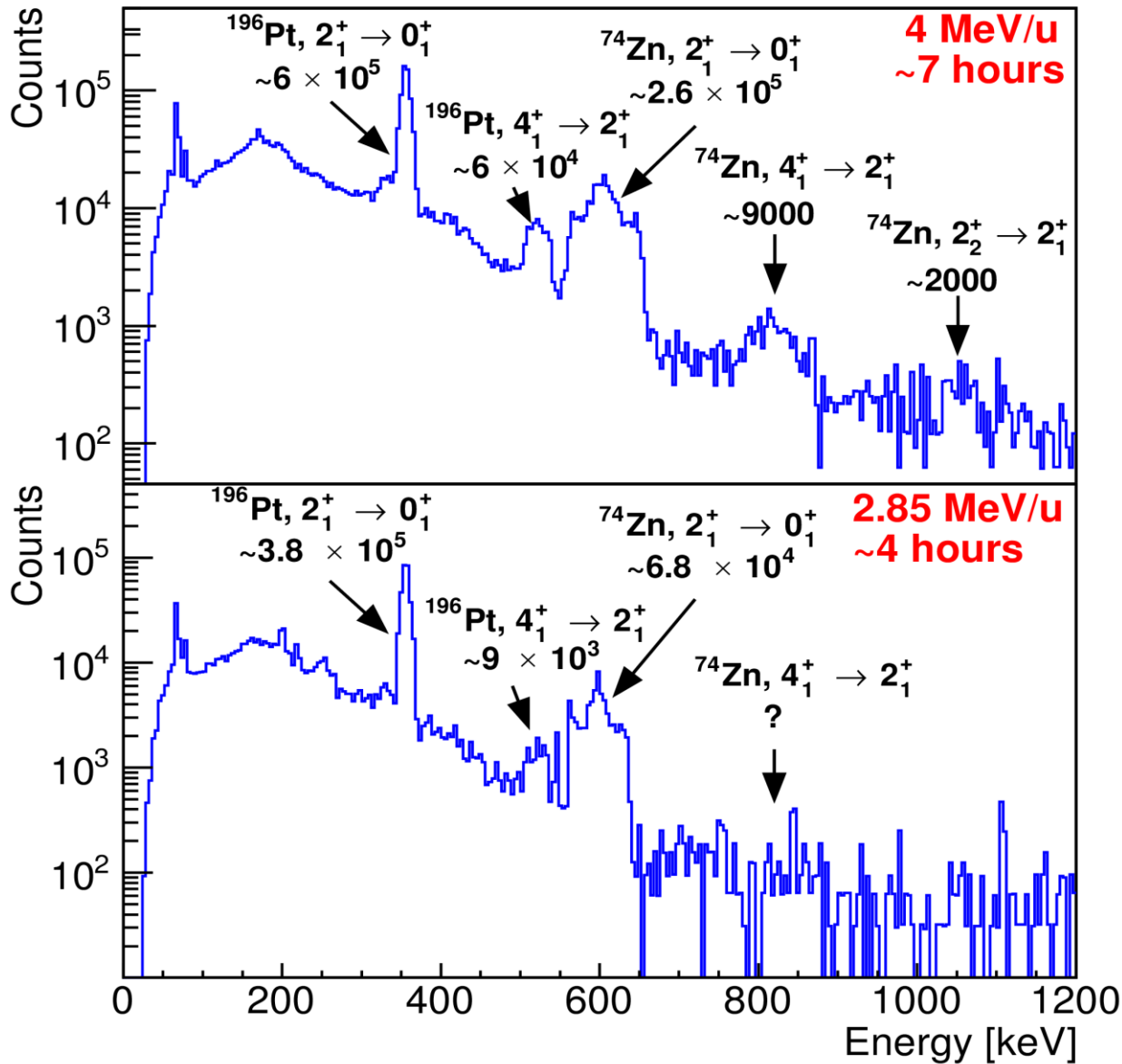
“neutron-proton interaction”

Coulomb excitation of $^{74-80}\text{Zn}$ probing the validity of shell-model descriptions around ^{78}Ni

- Beam time: 22 October – 13 November
23 days in total, 6h/daily work and 4 nights
- Targets: ^{196}Pt (2 mg/cm²) and ^{208}Pb (4 mg/cm²)

Isotope	Target	Energy (MeV/u)	Intensity (pps)	Total hours
^{74}Zn	^{196}Pt	2.85	$\sim 1.0 \cdot 10^6$	28
	^{196}Pt	4.0	$\sim 1.0 \cdot 10^6$	7
	^{208}Pb	4.0	$\sim 1.0 \cdot 10^6$	31
^{76}Zn	^{196}Pt	2.85	$\sim 5.0 \cdot 10^5$	20
	^{208}Pb	4.0	$\sim 5.0 \cdot 10^5$	14

Commissioning with radioactive beam



Coulomb excitation of ^{74}Zn beams on ^{196}Pt target

Gamma-spectroscopy with MINIBALL
(... no Doppler correction yet)

Enhanced probability for multiple step Coulomb excitation

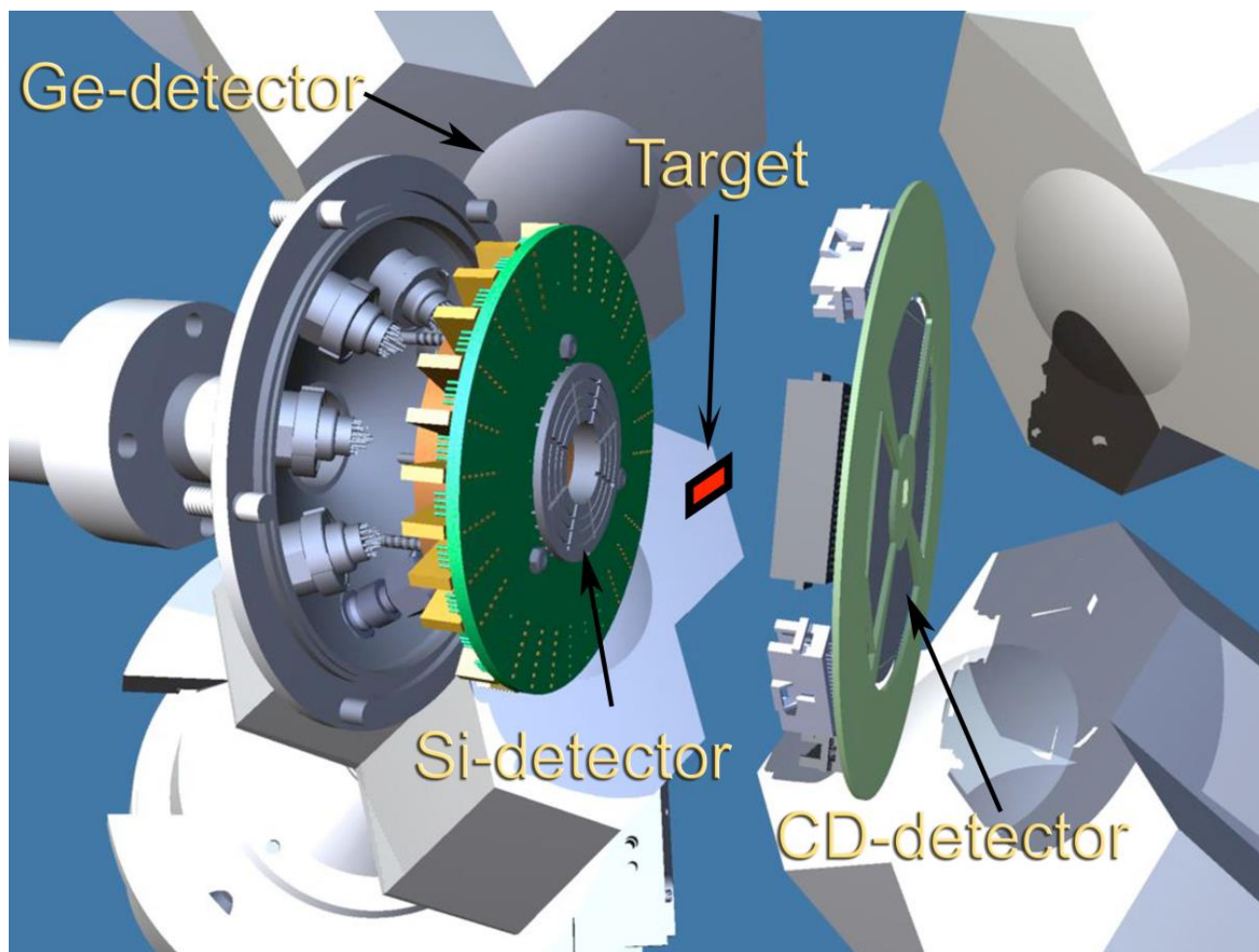
One of the motivations to build HIE-ISOLDE

(courtesy of Magda Zielińska)

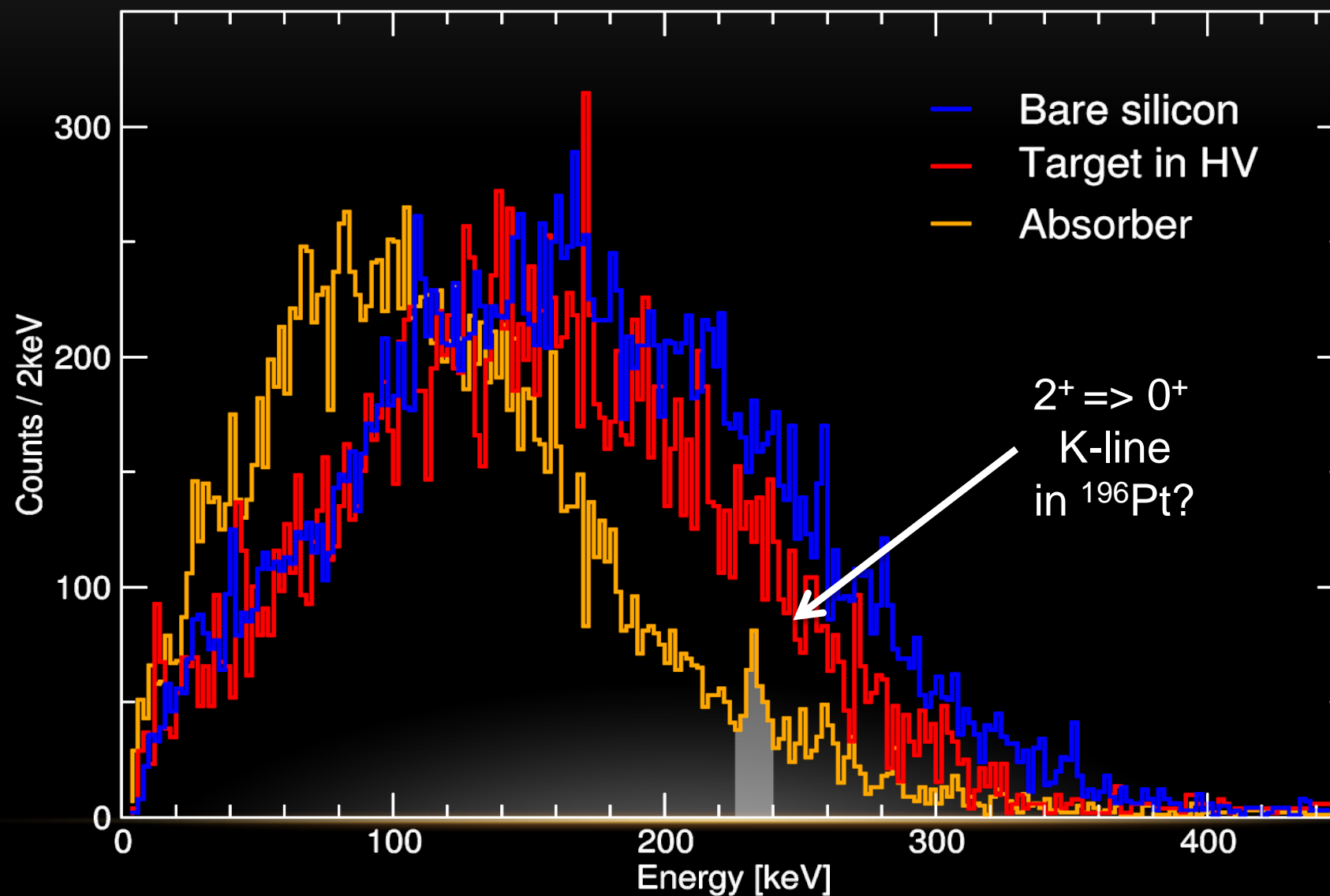
SPEDE - SPectrometer for Electron DEtection

Si detector in backwards geometry

Allows conversion electron spectroscopy – complete picture



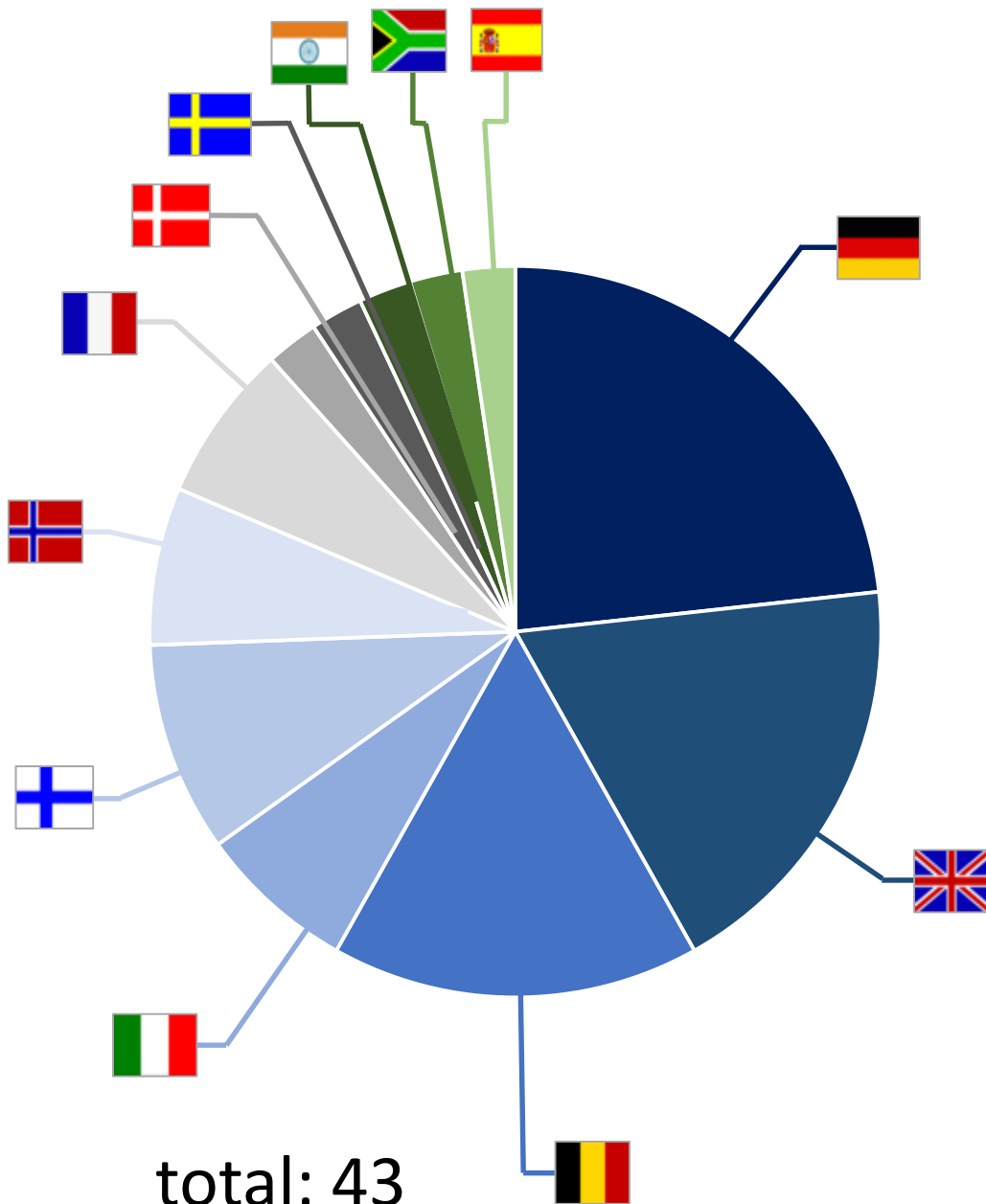
In-beam SPEDE spectra – particle gated



MINIBALL experiments at HIE-ISOLDE

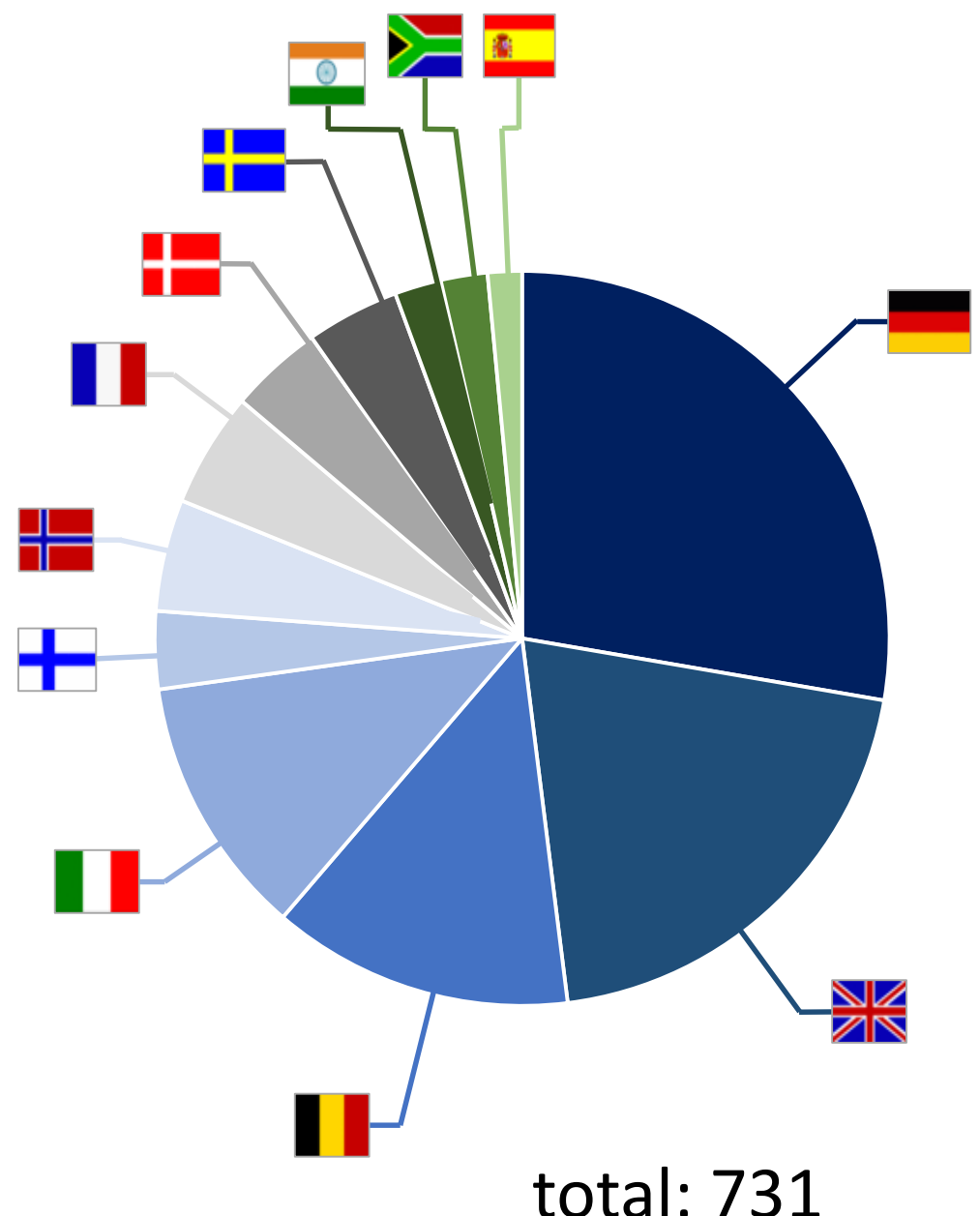
of approved experiments

of approved shifts



total: 43
exp.

Status January 2015



total: 731
shifts

HIE-ISOLDE Experiments Workshop 1.2.2016

Norbert PIETRALLA

IS546 - Study of the effect of shell stabilization of the collective isovector valence-shell excitations along the N=80 isotonic chain

Norbert PIETRALLA

IS596 - 2 + Anomaly and Configurational Isospin Polarization of ^{136}Te

Thorsten KROELL

IS548 - Evolution of quadrupole and octupole collectivity north-east of ^{132}Sn : the even Te and Xe isotopes

Thorsten KROELL

IS549 - Coulomb Excitation of Neutron-rich $^{134};^{136}\text{Sn}$ isotopes

Peter REITER

IS551 - Coulomb excitation of doubly magic ^{132}Sn with MINIBALL at HIE-ISOLDE

Peter BUTLER

IS553 - Determination of the $B(E3, 0^+ \rightarrow 3^-)$ strength in the octupole correlated nuclei $^{142}, ^{144}\text{Ba}$ using Coulomb excitation

Magdalena ZIELINSKA

IS557 - Coulomb excitation ^{74}Zn - ^{80}Zn (N=50): probing the validity of shell-model descriptions around ^{78}Ni

Dave JENKINS

IS569 - Solving the shape conundrum in ^{70}Se

Silvia LEONI et al.

IS595 - Spectroscopy of particle-phonon coupled states in ^{133}Sb by the cluster transfer reaction of ^{132}Sn on ^7Li : an advanced test of nuclear interactions

Zsolt PODOLYAK

IS547 - Coulomb excitation of the two proton-hole nucleus ^{206}Hg

Daniel Thomas DOHERTY

IS597 - Probing Shape Coexistence in neutron-deficient ^{72}Se via Low-Energy Coulomb Excitation

Tuomas GRAHN

IS506 - Mapping the boundaries of the seniority regime and collective motion: Coulomb excitation studies of N = 122 isotones ^{206}Po and ^{208}Rn

Tuomas GRAHN

IS516 - Coulomb excitation of ^{116}Te and ^{118}Te : a study of collectivity above the Z = 50 shell gap

HIE-ISOLDE Experiments Workshop 1.2.2016

Sunniva SIEM

IS559 - Statistical properties of warm nuclei: Investigating the low-energy enhancement in the gamma strength function of neutron-rich nuclei

B.S. NARA SINGH

IS478 - Shape determination in Coulomb excitation of ^{72}Kr

Katarzyna WRZOSEK-LIPSKA

IS563 - Coulomb excitation of $^{182-184}\text{Hg}$: Shape coexistence in the neutron-deficient lead region

Janne PAKARINEN

IS566 - Probing intruder configurations in $^{186,188}\text{Pb}$ using Coulomb excitation

Peter BUTLER

IS552 - Measurements of octupole collectivity in Rn and Ra nuclei using Coulomb excitation

Dhruba GUPTA

IS554 - Search for higher excited states of $^8\text{Be}^*$ to study the cosmological ^7Li problem

Riccardo Raabe

IS556 - Spectroscopy of low-lying single-particle states in ^{81}Zn populated in the $^{80}\text{Zn}(d,p)$ reaction

Joakim CEDERKALL

IS562 - Transfer Reactions and Multiple Coulomb Excitation in the ^{100}Sn Region

Giacomo DE ANGELIS

IS572 - Study of shell evolution around the doubly magic ^{208}Pb via a multinucleon transfer reaction with an unstable beam

Adrien MATTA

IS591 - ^{18}N : a challenge to the shell model and a part of the flow path to r-process element production in Type II supernovae

Riccardo RAABE

IS587 - Characterising excited states in and around the semi-magic nucleus ^{68}Ni using Coulomb excitation and one-neutron transfer

HIE-ISOLDE Experiments Workshop 1.2.2016

First conclusions

- 24 approved proposals ask for beam time in 2016
- Full energy range of accelerator up to 6.0 MeV/u
- Mass range from ^{18}N up to ^{228}Ra
- MINIBALL configuration for Coulomb excitation and transfer reactions will be installed for 2016 campaign
- Combination with SPEDE is available after successful stable beam commissioning in summer 2016
- High number of experiments should be provided to user community
- Everyone is eagerly awaiting the HIE-ISOLDE beams

Developments

Ongoing

- MINIBALL HPGGe detector upgrade
- SPEDE

Future projects

- New electronics and DAQ
- MINIBALL BGO suppression shields
- T-REX upgrade
- Plunger
- Neutron detectors NEDA



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