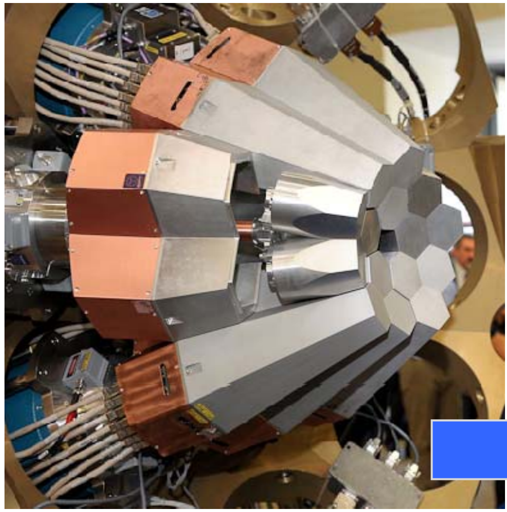
Nuclear structure of exotic neutron-rich nuclei with the AGATA spectrometer

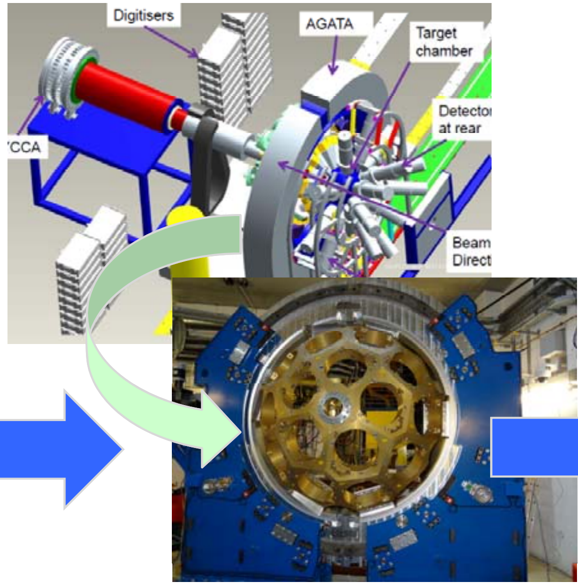
Jose Javier Valiente Dobón
Laboratori Nazionali di Legnaro (INFN), Italia

From stable to Radioactive Ion Beams

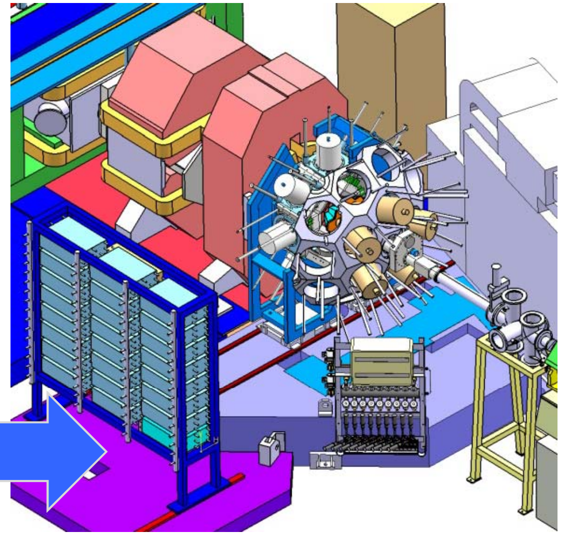
AGATA@LNL



AGATA@GSI



AGATA@GANIL



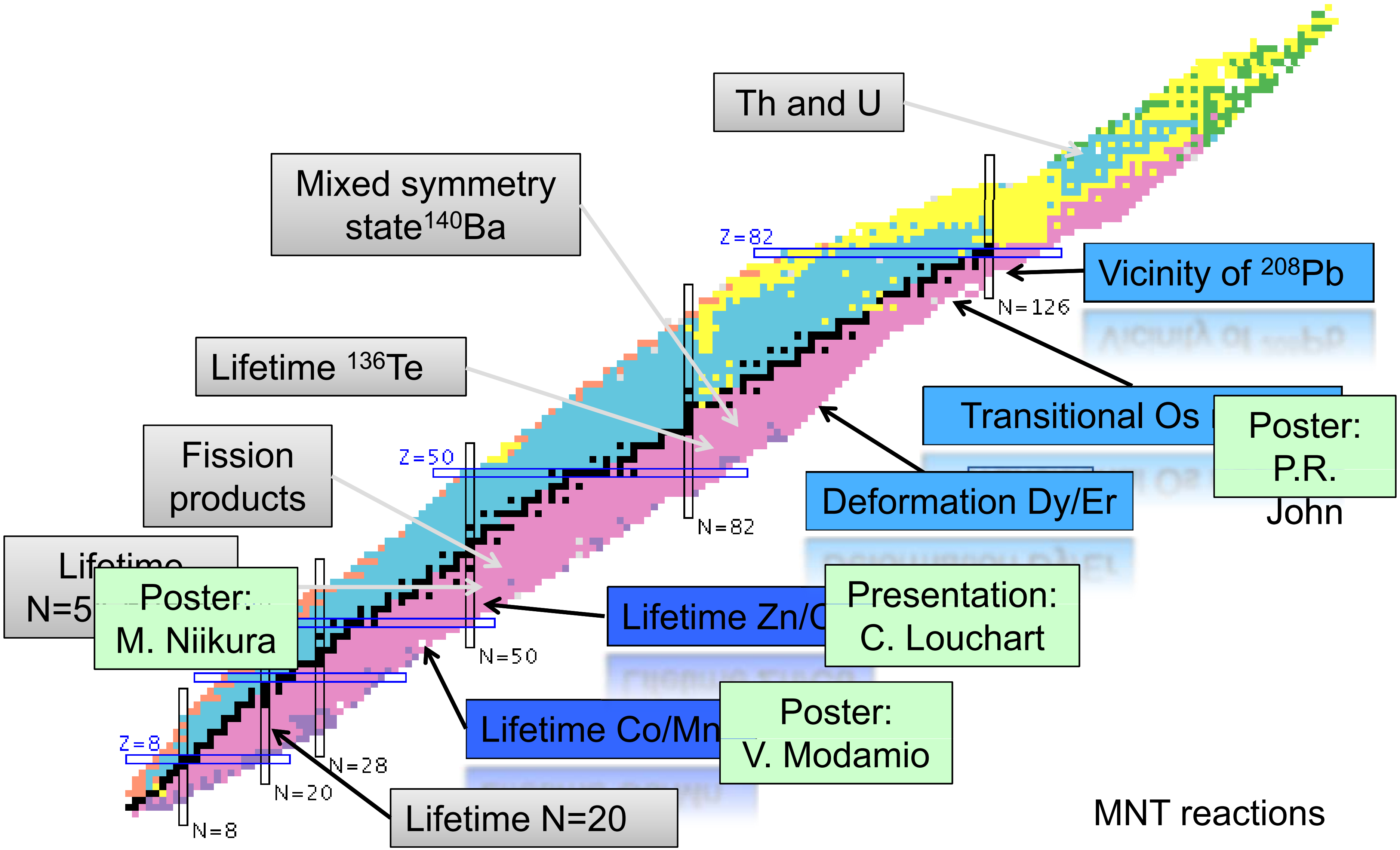
AGATA is a last generation gamma spectrometer built to serve the most demanding needs of present and future Radioctive Ion Beam (RIB) facilities.

Overview

- Introduction
- Lifetimes with AGATA
- Heavy neutron-rich via the binary partner
- Future perspectives

LNL experiments in the n-rich region

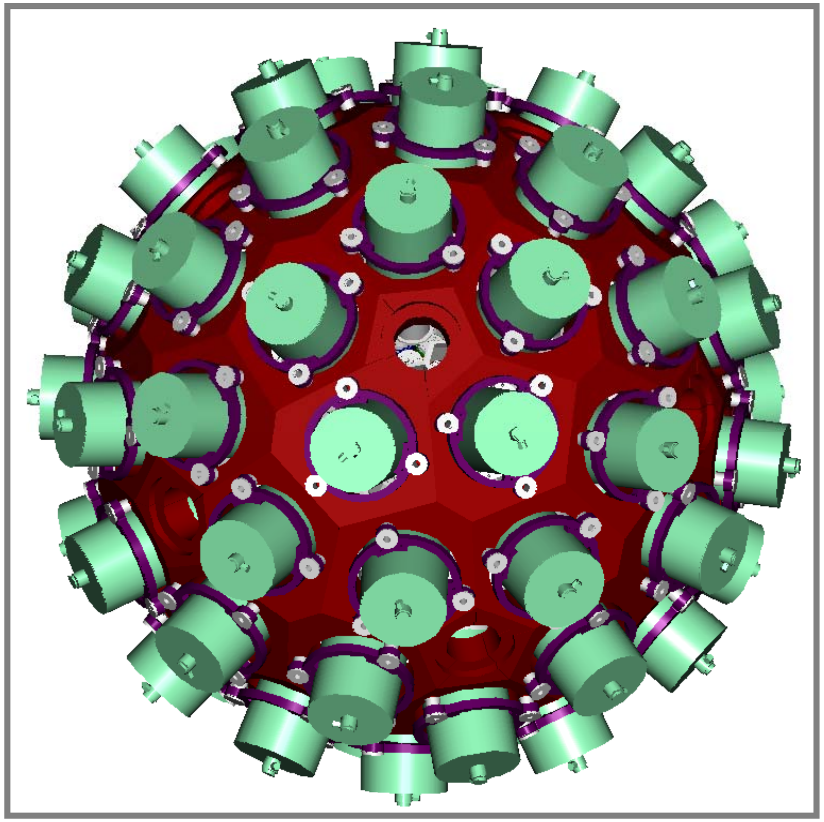
AGATA Demostrator



MNT reactions

AGATA

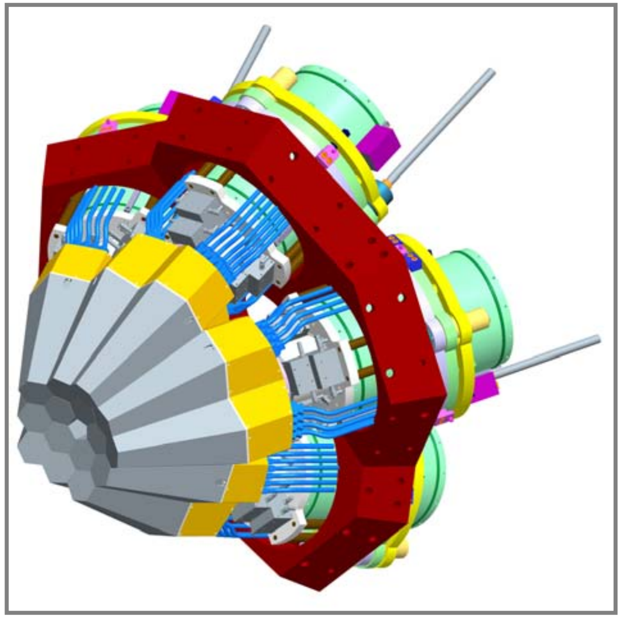
(Advanced GAmma Tracking Array)



No anticompton – No collimators a pure ball of Ge.

The innovative use of detectors (pulse shape analysis, γ-ray tracking, digital DAQ) will result in high efficiency (~40%), excellent energy resolution and high counting rates 50 kHz.

The AGATA demonstrator array



5 asymmetric triple-clusters

36-fold segmented crystals

555 digital-channels

Eff. 3 – 7 % @ M_g = 1

Eff. 2 – 4 % @ M_g = 30

On-line PSA and γ-ray tracking

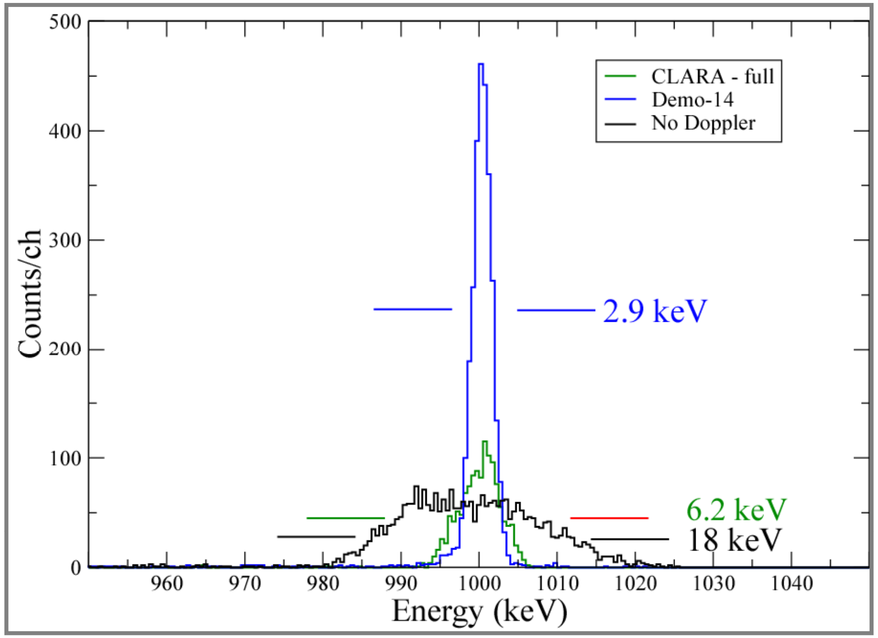
In beam Commissioning

First Test Site:

Laboratori Nazionali di Legnaro

Main issue is Doppler correction capability →
coupling to beam and recoil tracking devices

PRISMA



AGATA references

Nuclear Instruments and Methods in Physics Research A 654 (2011) 88–96

Contents lists available at ScienceDirect

Nuclear Instruments and Methods in Physics Research A

journal homepage: www.elsevier.com/locate/nima

Conceptual design and infrastructure for the installation of the first AGATA sub-array at LNL

A. Gadea[a,h,*], E. Farnea[b], J.J. Valiente-Dobón[a], B. Million[c], D. Mengoni[d,b,j], D. Bazzacco[b], F. Recchia[b], A. Dewald[e], Th. Pissulla[e], W. Rother[e], G. de Angelis[a], A. Austin[f], S. Aydin[b,t], S. Badoer[a], M. Bellato[b], G. Benzoni[c], L. Berti[a], R. Beunard[i], B. Birkenbach[e], E. Bissiato[a], N. Blasi[c], C. Boiano[c], D. Bortolato[b], A. Bracco[g,c], S. Brambilla[c], B. Bruyneel[e], E. Calore[a], F. Camera[g,c], A. Capsoni[c], J. Chavas[b], P. Cocconi[a], S. Coelli[c], A. Colombo[b], D. Conventi[a], L. Costa[a], L. Corradi[a], A. Corsi[g,c], A. Cortesi[c], F.C.L. Crespi[g,c], N. Dosme[r], J. Eberth[e], S. Fantinel[a], C. Fanin[b], E. Fioretto[a], Ch. Fransen[e], A. Giaz[g,c], A. Gottardo[d,b], X. Grave[k], J. Grebosz[n], R. Griffiths[f], E. Grodner[a], M. Gulmini[a], T. Habermann[l], C. He[a], H. Hess[e], R. Isocrate[b], J. Jolie[e], P. Jones[m], A. Latina[a], E. Legay[o], S. Lenzi[d,b], S. Leoni[g,c], F. Lelli[a], D. Lersch[e], S. Lunardi[d,b], G. Maron[a], R. Menegazzo[b], C. Michelagnoli[b], P. Molini[a], G. Montagnoli[d,b], D. Montanari[g,c,b], O. Möller[p], D.R. Napoli[a], M. Nicoletto[b], R. Nicolini[g,c], M. Ozille[i], G. Pascovici[e], R. Peghin[b], M. Pignanelli[g,c], V. Pucknell[f], A. Pullia[g,c], L. Ramina[b], G. Rampazzo[b], M. Rebeschini[a], P. Reiter[e], S. Riboldi[g,c], M. Rigato[a], C. Rossi Alvarez[b], D. Rosso[a], G. Salvato[b], J. Strachan[f], E. Sahin[a], F. Scarlassara[d,b], J. Simpson[f], A.M. Stefanini[a], O. Stezowski[q], F. Tomasi[c], N. Toniolo[a], A. Triossi[b], M. Turcato[b], C.A. Ur[b], V. Vandone[g,c], R. Venturelli[b], F. Veronese[b], C. Veyssiere[r], E. Viscione[c], O. Wieland[c], A. Wiens[e], F. Zocca[c], A. Zucchiatti[s]

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The AGATA and PRISMA Collaborations

Conceptual design and infrastructure for the sub-array of AGATA at LNL

AGATA

Nuclear Instruments and Methods in Physics Research A 668 (2012) 26–58

Contents lists available at SciVerse ScienceDirect

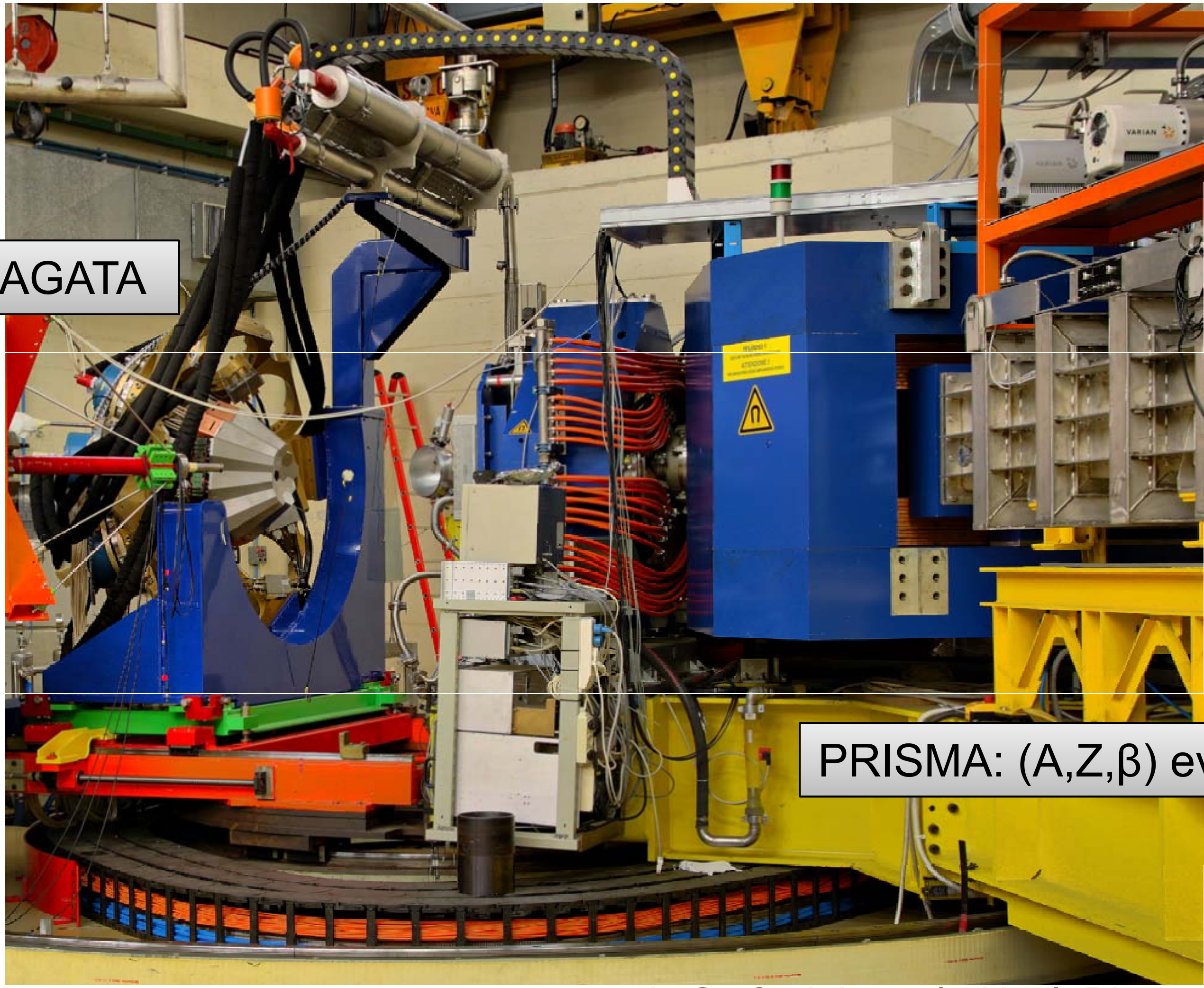
Nuclear Instruments and Methods in Physics Research A

journal homepage: www.elsevier.com/locate/nima

AGATA—Advanced GAmma Tracking Array

The AGATA demonstrator at LNL

The AGATA Demonstrator Array and the PRISMA spectrometer.

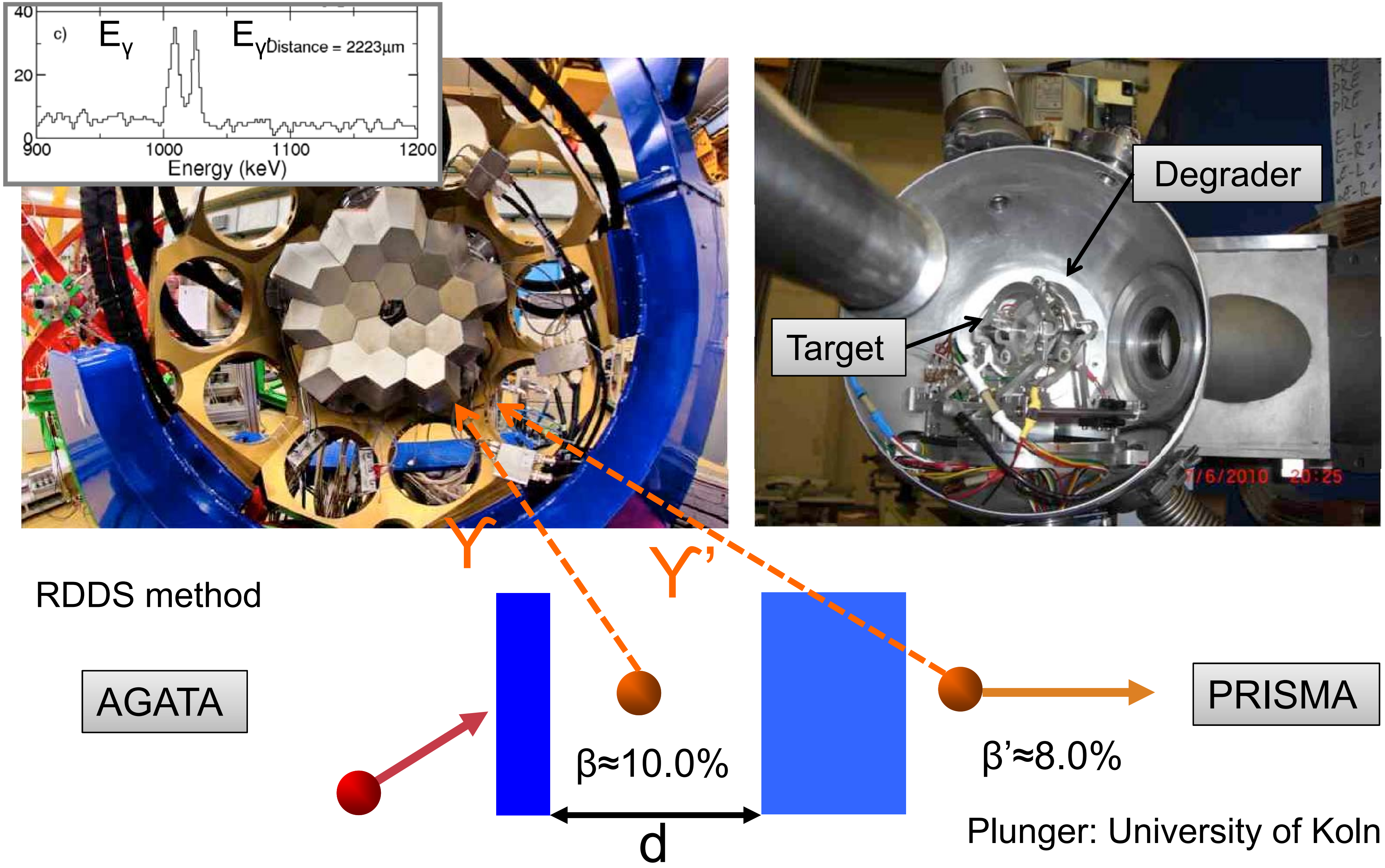


A. Stefanini, et al., Nucl. Phys. A 701, 217 (2002)

Lifetime experiments with AGATA+PRISMA via MNT reactions

Lifetime measurements

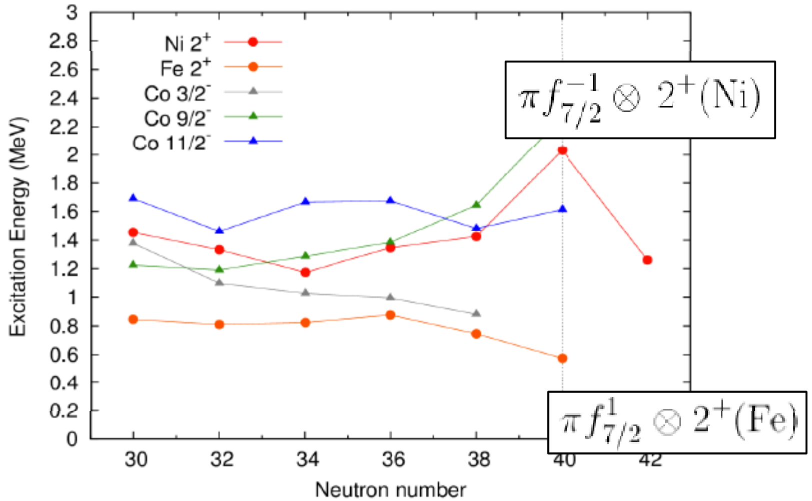
AGATA + PRISMA



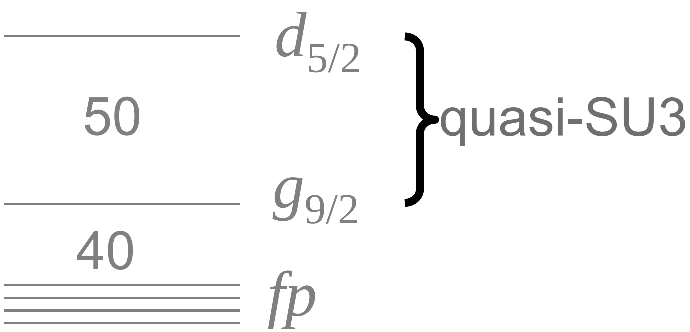
New island of inversion

Spherical

Deformed



S. Lunardi et al., PRC**76**, 034303 (2007)
W. Rother et al., PRL**106**, 022502 (2011)



RAPID COMMUNICATIONS

PHYSICAL REVIEW C VOLUME 52, NUMBER 4 OCTOBER 1995

Spherical shell model description of rotational motion

A. P. Zuker,[1] J. Retamosa,[2] A. Poves,[2] and E. Caurier[1]
[1]Physique Théorique, Bâtiment 40/1 CRN, Institut National de Physique Nucléaire et des Particles-CNRS/Université Louis Pasteur, Boîte Postale 28, F-67037 Strasbourg Cedex 2, France
[2]Departamento de Física Teórica, Universidad Autónoma de Madrid, E-28049 Madrid, Spain
(Received 13 July 1994)

Quasi-SU3

PHYSICAL REVIEW C **82**, 054301 (2010)

Island of inversion around ^{64}Cr

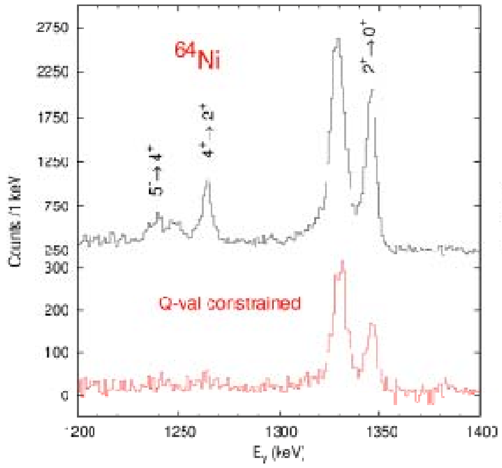
S. M. Lenzi,[1] F. Nowacki,[2] A. Poves,[3] and K. Sieja[2*]
[1]Dipartimento di Fisica dell'Università and INFN, Sezione di Padova, I-35131 Padova, Italy
[2]IPHC, IN2P3-CNRS et Université de Strasbourg, F-67037 Strasbourg, France
[3]Departamento de Física Teórica e IFT-UAM/CSIC, Universidad Autónoma de Madrid, E-28049 Madrid, Spain
(Received 10 September 2010; published 2 Novemb

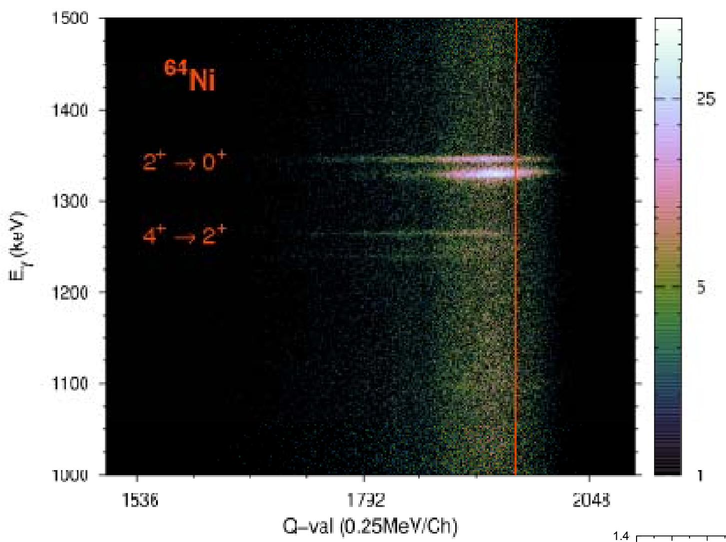
LNPS interaction

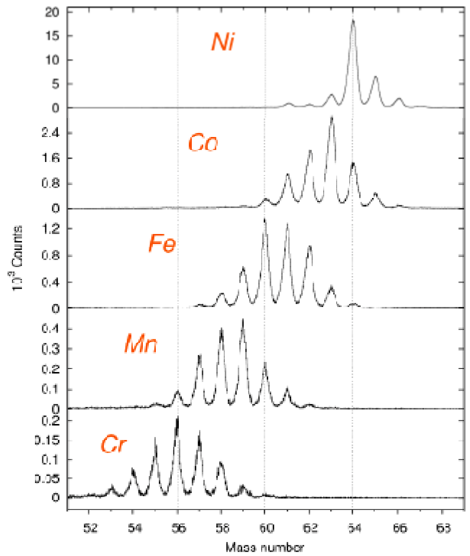
Spokepersons: J.J. Valiente-Dobon, S. Lenzi

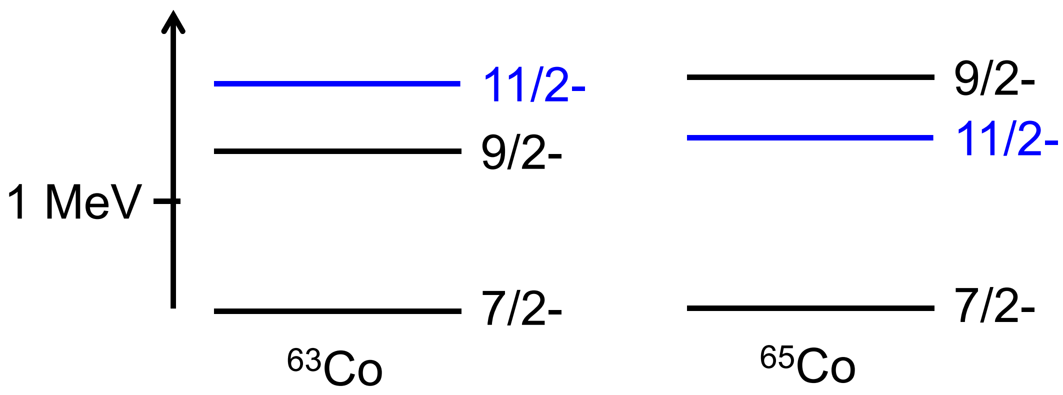
Lifetime of the 11/2$^-$ states

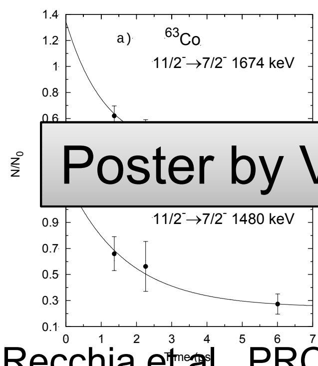
- ^{64}Ni @ 460 MeV (TANDEM+ALPI)
- ^{238}U target of 1.35 mg.cm^{-2} on 4 mg.cm^{-2} Nb backing











$T_{1/2}$=0.77±0.08ps

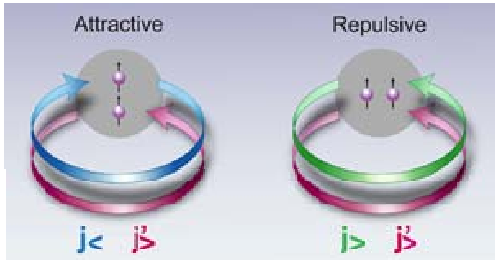
Poster by V. Modamio

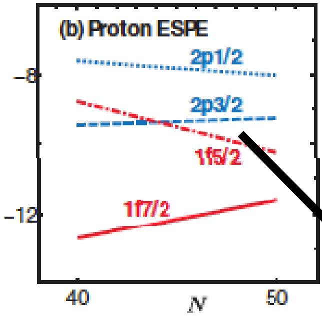
$T_{1/2}$=1.53±0.28ps

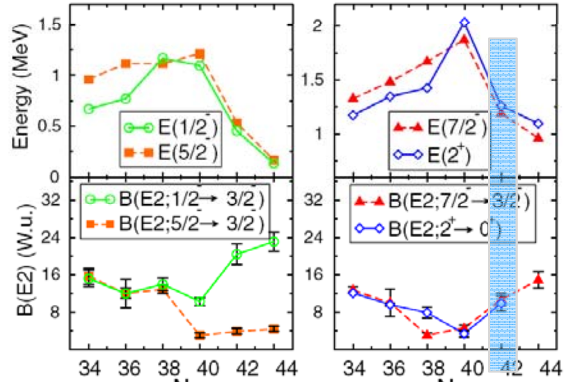
F. Recchia et al., PRC (in press)
V. Modamio et al., PRC (to be submitted)

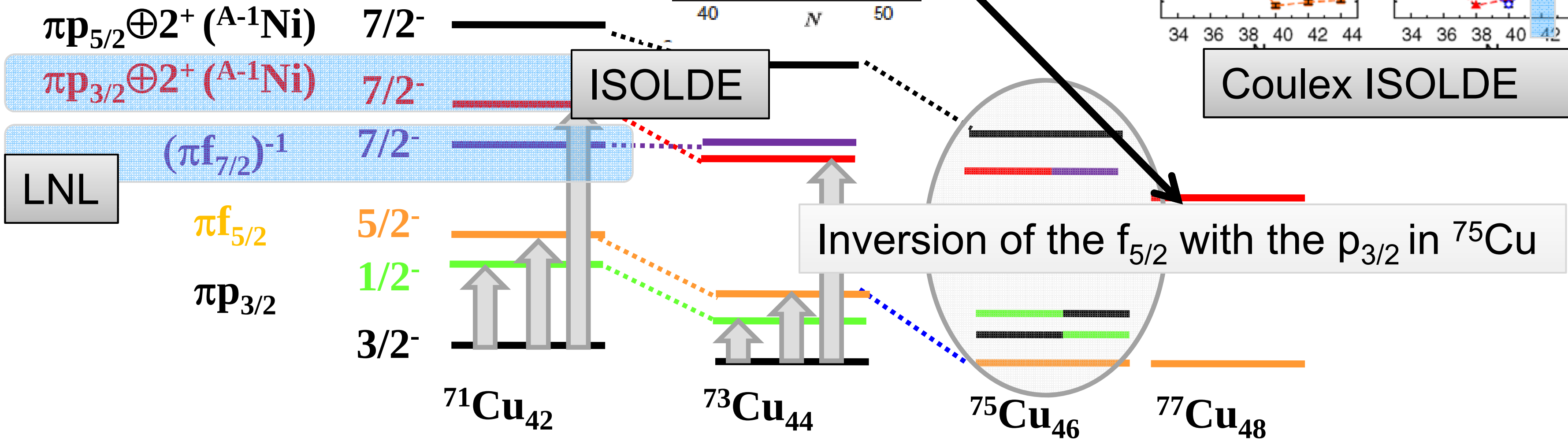
Shell evolution along the Cu isotopes

Systematic variation of effective single-particle energies due to the tensor interaction T. Otsuka et al. PRL 95, 232502 (2005)









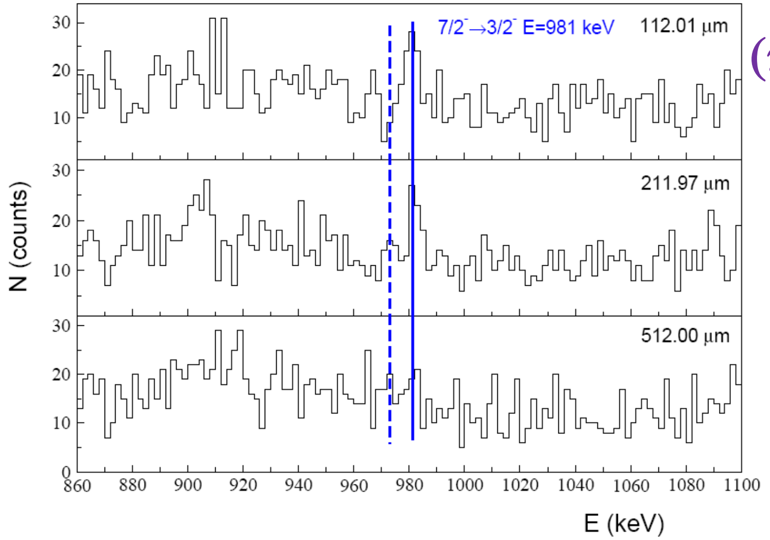
presence of both single-particle and collective states at low energy

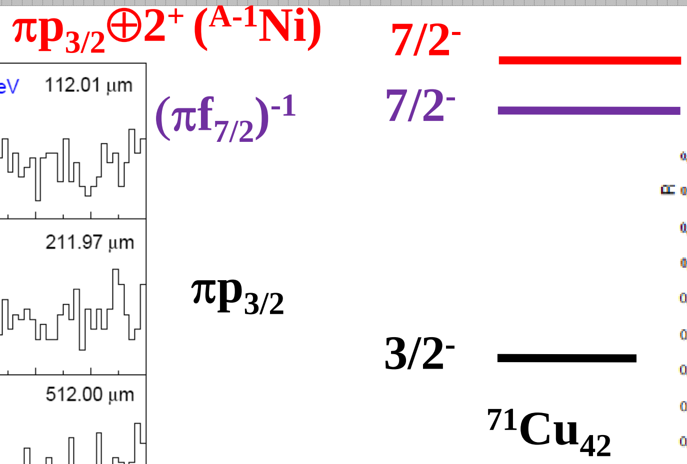
S. Franchoo et al., PRL 81, 3100(1998)
I. Stefanescu *et al.,* PRL 100, 112502 (2008)
K. Flanagan PRL, 103, 142501 (2009)
J. M. Daugas PRC 81, 034304 (2010)

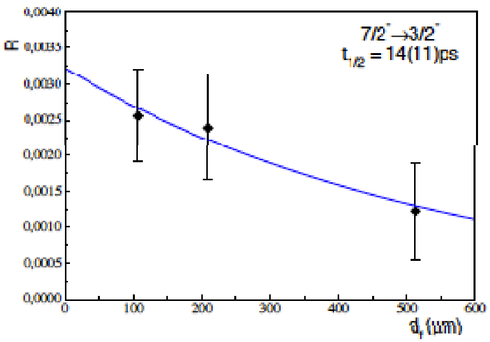
Spokepersons: E. Sahin, M. Doncel, A. Goergen

Character of the 7/2⁻ state

^{76}Ge + ^{238}U @ 577 MeV







τ=20+/-16ps

New approach for lifetime: normalization done with the number of ions (PRISMA)

LNPS interaction: shell-model calculations using an enlarged valence space: pf-shell orbitals for protons and $f_{5/2}$, $p_{1/2}$, $p_{3/2}$, $g_{9/2}$ and $d_{5/2}$ orbitals for neutrons.

transition	$B(E2\downarrow)\,exp\,(e^2fm^4)$	$B(E2\downarrow)\,th_2\,(e^2fm^4)$	
$7/2^-_1 \rightarrow 3/2^-$	45(36)	40.0 (3)	LNL
$7/2^-_2 \rightarrow 3/2^-$	187(21)	157.1	ISOLDE

Analysis by M. Doncel, E. Sahin

K. Sieja *et al.*, Private Communication.

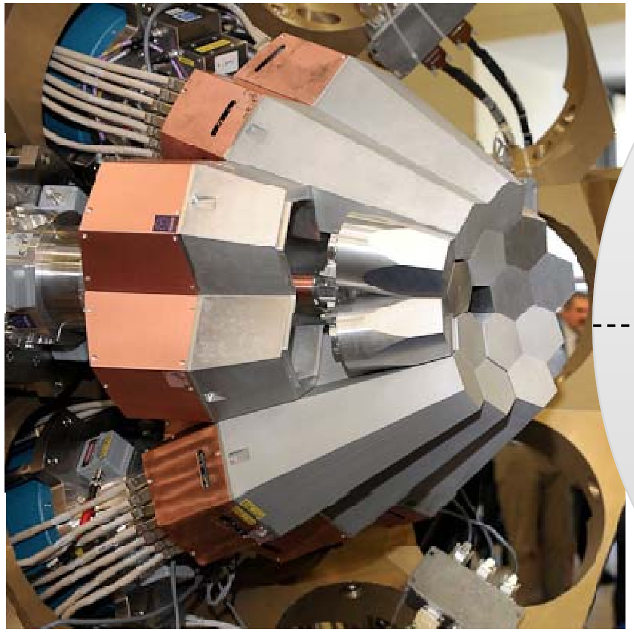
Spectroscopy via Binary Partner

Binary partner method

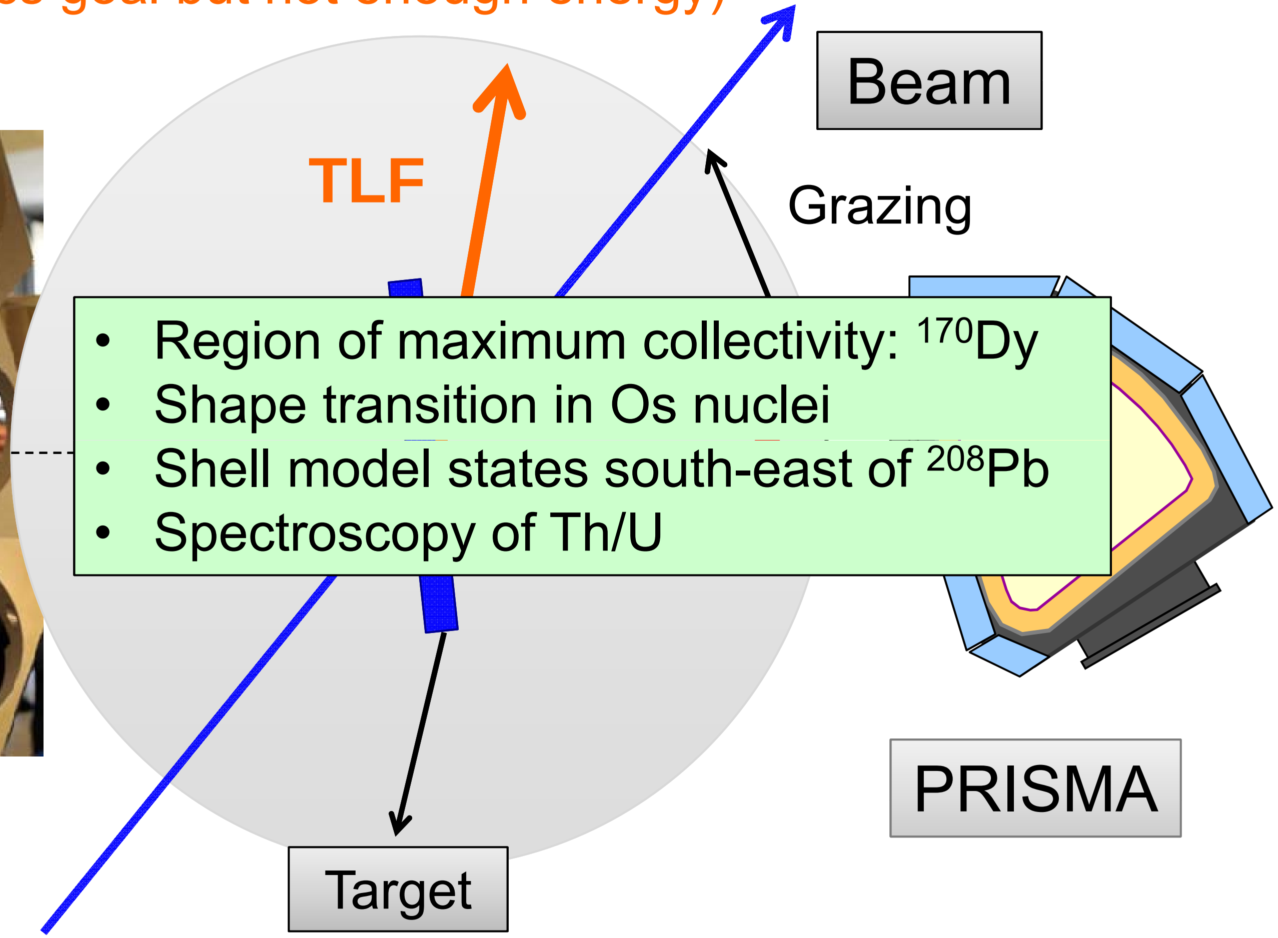
Direct kinematics, binary reaction:

BLF lighter (enough energy for identification)

TLF heavier (physics goal but not enough energy)

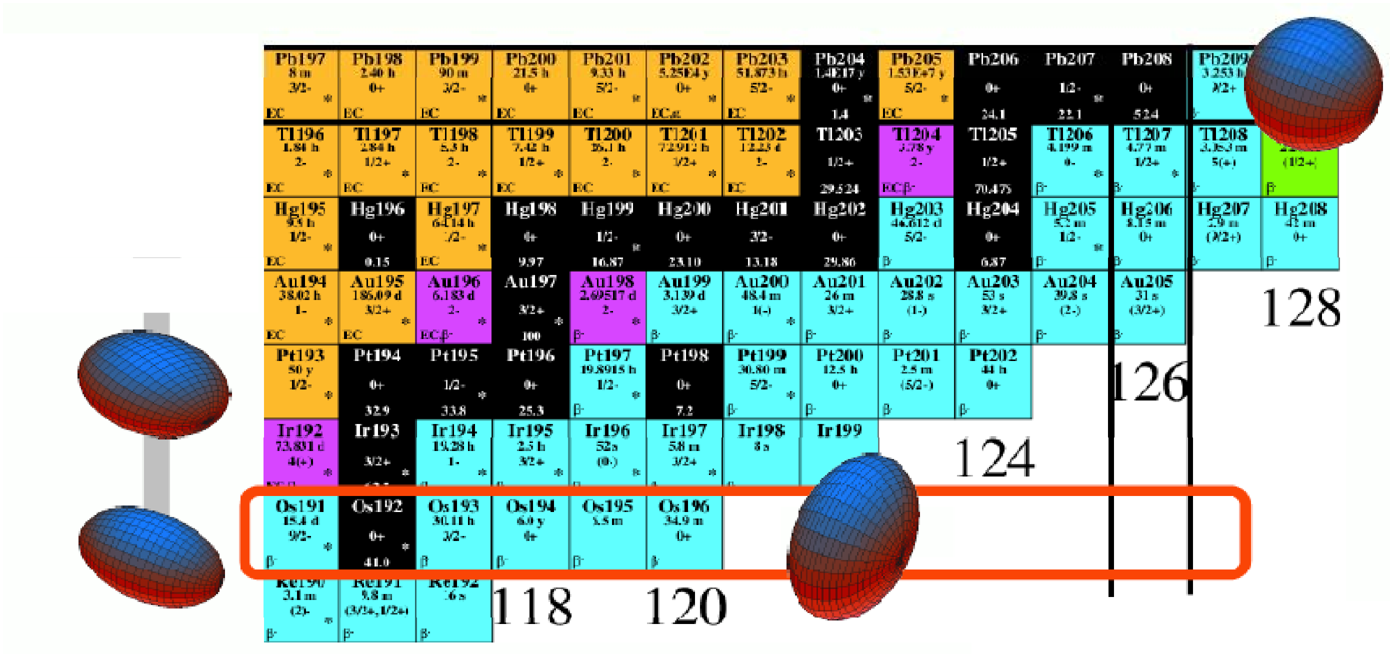


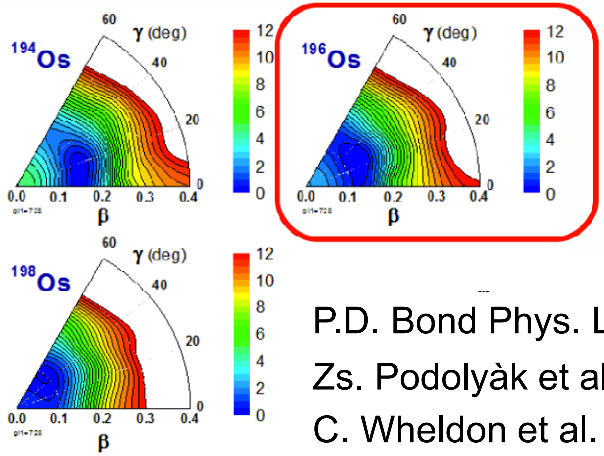
AGATA



- Region of maximum collectivity: ^{170}Dy
- Shape transition in Os nuclei
- Shell model states south-east of ^{208}Pb
- Spectroscopy of Th/U

Shape transitions in Os isotopes





Binding energy map βγ plane

Energy Density Functionals – D. Vretenar (Priv. Comm.)

P.D. Bond Phys. Lett. 130B, 167 (1983)

Zs. Podolyàk et al. PRC79, 31305(R) (2009)

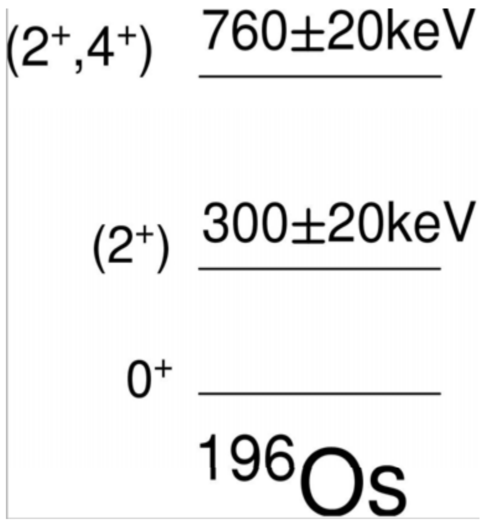
C. Wheldon et al. PRC63, 11304 (2010)

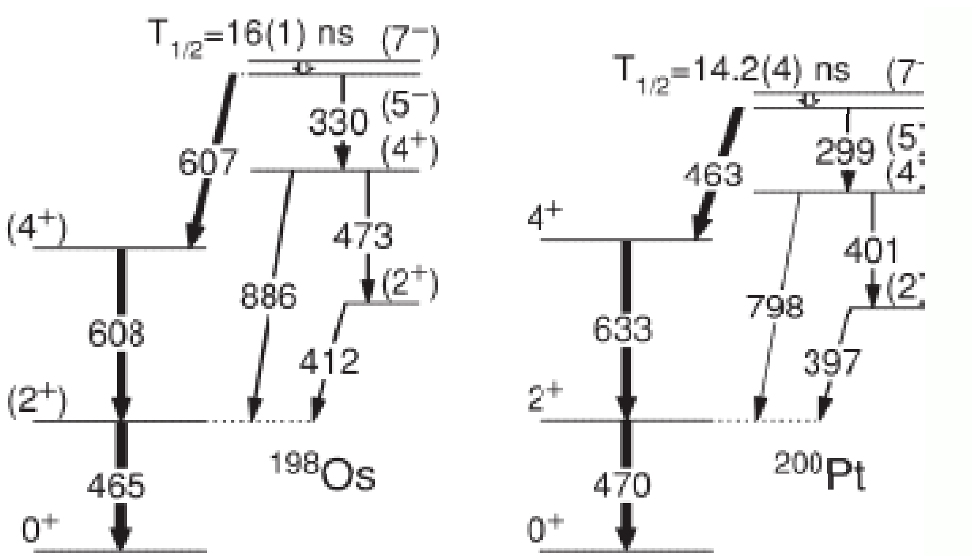
Spokepersons:
V. Modamio,
Zs. Podolyak
C. Wheldon,
W. Korten

Os isotopes studied at stable and RIB

2-proton transfer $^{198}Pt(^{14}C,^{16}O)^{196}Os$

RIB@GSI FRS+RISING Isomeric decay





P.D. Bond Phys. Lett. 130B, 167 (1983)

Level scheme built by comparison with ^{200}Pt. A weakly deformed **oblate** shape is proposed consistent with $E(4+)/E(2+)$ and $E(2+_2)/E(2+)$ evolution and TRS calculations.

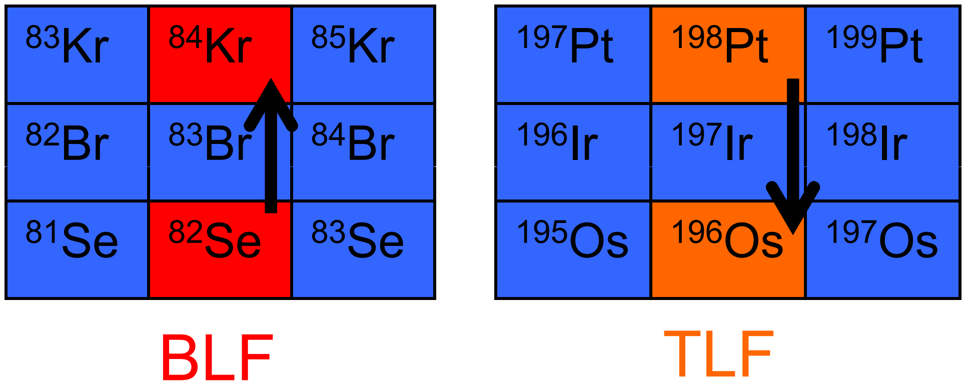
Zs. Podolyàk et al. PRC79, 31305(R) (2009)

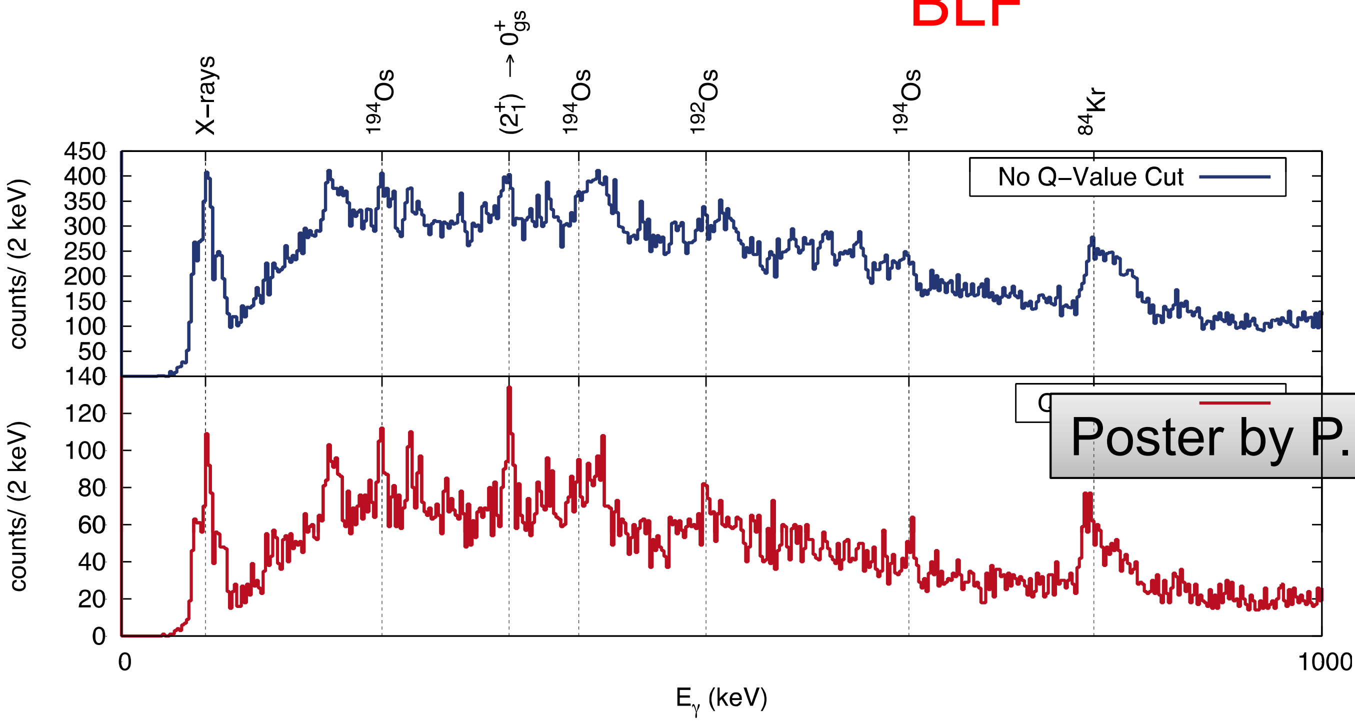
First evidence of ^{196}Os

$^{82}Se + {}^{198}Pt$ (2mg/cm^2) at 426 MeV

Beam and target Doppler corrected spectra using binary kinematics:

BLF: β~10% FWHM: 0.5%
TLF: β~3%   FWHM: 1.8%
Consider energy loss in the target
Analysis by P.R. John

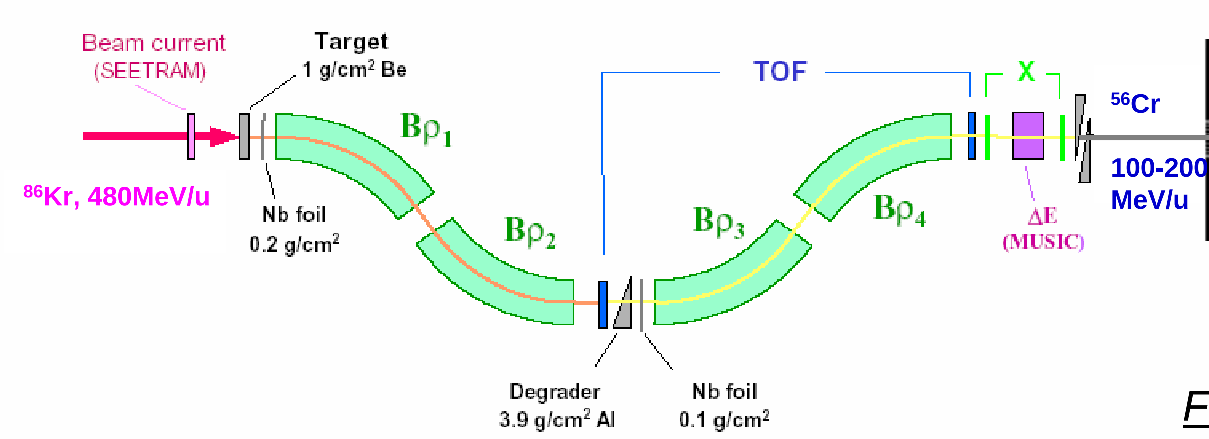


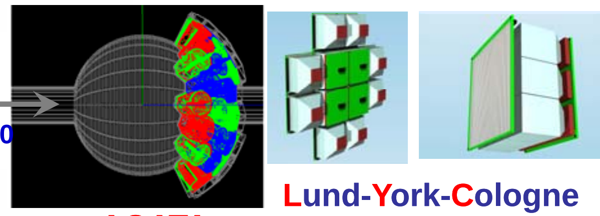


Poster by P.R. John

AGATA at RIB facilities: GSI/GANIL

AGATA at in-flight RIB



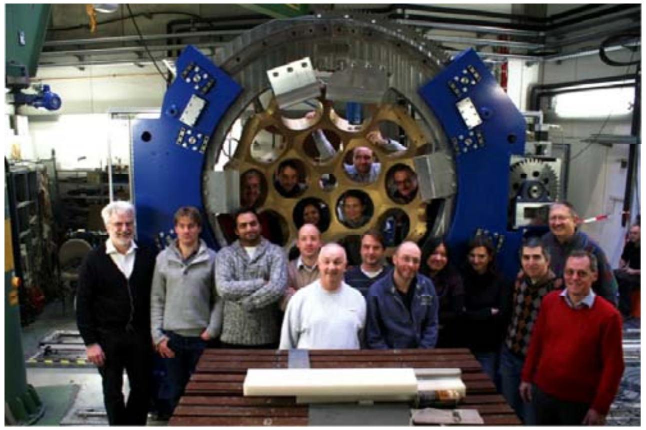


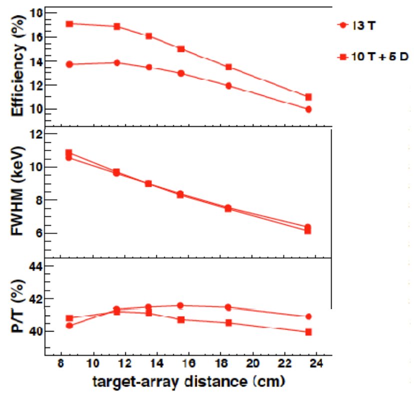
Higher SIS intensities and fast ramping

10^9(U) to 10^{10} (Xe, Kr) ions/spill

New FRS tracking detectors (>10^6 s^{-1} at S2, $10^5 s^{-1}$ at S4)

New LYCCA-0 particle identification and tracking system





__Full AGATA 1π array @GSI: (5 double Cluster 10 triple Cluster)__

γ-efficiency : 17.5%

γγ-efficiency : 2.5%

Target detector distance:
Variable: 10 - 23.5 cm

Energy resolution (FWHM):
4 – 8 keV

__Starting configuration (5 double Cluster 5 triple Cluster)__

γ-efficiency : 10%

γγ-efficiency : 1 %

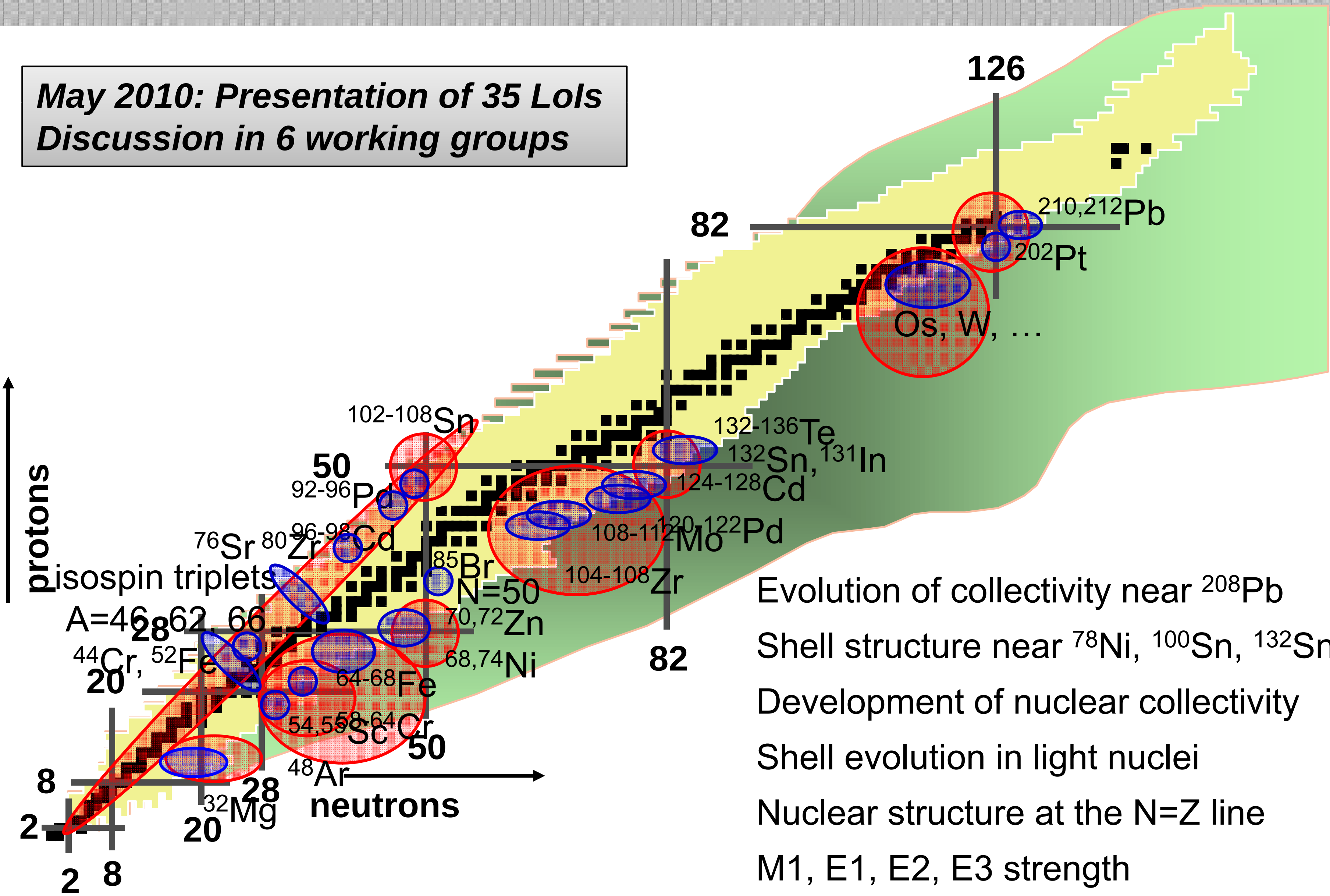
Conveners: M. Bentley, W. Korten and D. Rudolph

C. Domingo-Pardo et al., NIM (in prep).

+ DETECTOR

AGATA at an in-flight RIB

May 2010: Presentation of 35 LoIs
Discussion in 6 working groups



Evolution of collectivity near ^{208}Pb

Shell structure near ^{78}Ni, ^{100}Sn, ^{132}Sn

Development of nuclear collectivity

Shell evolution in light nuclei

Nuclear structure at the N=Z line

M1, E1, E2, E3 strength

AGATA – Prespec experiments

Total: 144 shifts (46 days) + (up to) 90 shifts parasitic commissioning beam time

S426 Relativistic M1-Coulex of ^{85}Br — **^{86}Kr, 700/800 A.MeV, 24 shifts**
Pietralla, Rainovski et al. — **Coulex (Pb/Au)**

S430 The Pygmy Dipole Resonance in ^{64}Fe and the properties of neutron skin — **^{86}Kr, 700 A.MeV, 21 shifts**
Wieland, Kmiecik et al. — **Coulex (Pb/Au)**

S427 Breaking of isospin symmetry in the mass 70 region: Study of the T_z=-1 nucleus **^{70}Kr** — ^{78}Kr, 770 A.MeV,15 shifts
Sahin, Wadsworth, Weisshaar et al. — Knock-out (Be)

S433 Coulomb excitation of the band-terminating 12^+ yrast trap in **^{52}Fe** — ^{58}Ni, 500 A. MeV, 15 shifts
Gadea, Ur et al. — Coulex (Pb/Au)

S434 Isospin Symmetry Breaking Transition Rates and Mirror Energy Differences in Isobaric Multiplets — ^{58}Ni, 420 A.MeV, 15 shifts
Bentley, Recchia et al. — Knock-out (Be) & Coulex (Pb/Au)

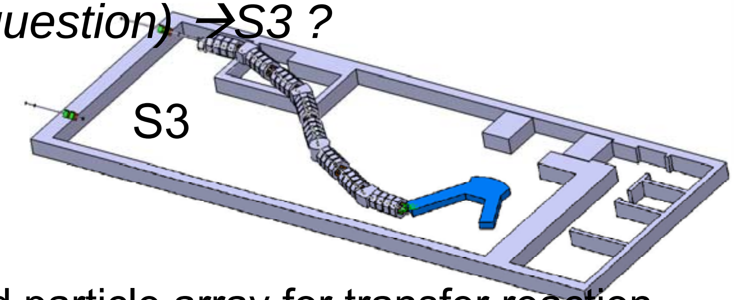
S429 Quadratic Evolution of Collectivity Around ^{208}Pb — **^{208}Pb, 1000 A.MeV, 18 shifts**
Rudolph, Podolyak et al. — **Coulex (Pb/Au)**

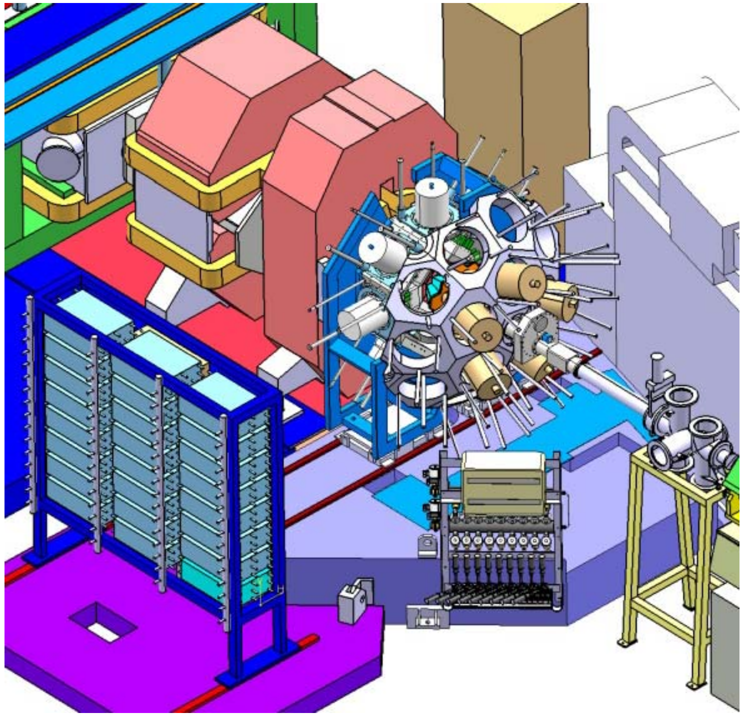
S428 Shape evolution in neutron-rich Zr isotopes — **^{238}U, 750A.MeV, 12 shifts**
Pietri, Doornenbal et al. — **Knock-out (Be)**

S431 Proton hole states in ^{132}Sn and N=82 shell structure — **^{238}U, 650A.MeV, 12 shifts**
Boutachkov, Korten et al. — **Knock-out (Be) & Coulex (Pb/Au)**

AGATA at GANIL

Any place in the existing GANIL facility but VAMOS remains the most versatile place for AGATA physics cases*(still an open question)* →*S3 ?*





- Charged particle array for transfer reaction MUST2/TIARA : (d,p) etc … program with SIB and RIB
- Charged particle array for prompt tagging : DIAMANT (Electronic Upgrade ?)
- Charged particle array for Recoil Decay Tagging : MUSETT
- Neutron detector : NWALL (Electronic Upgrade ?)
- Spectrometer : VAMOS, SPEG, S3
- Scintillator : BaF2 array, some LaBr3 (which Electronic?)
- Future detector : NEDA (n) , GASPARD (MUST2-like), PARIS (LaBr3)

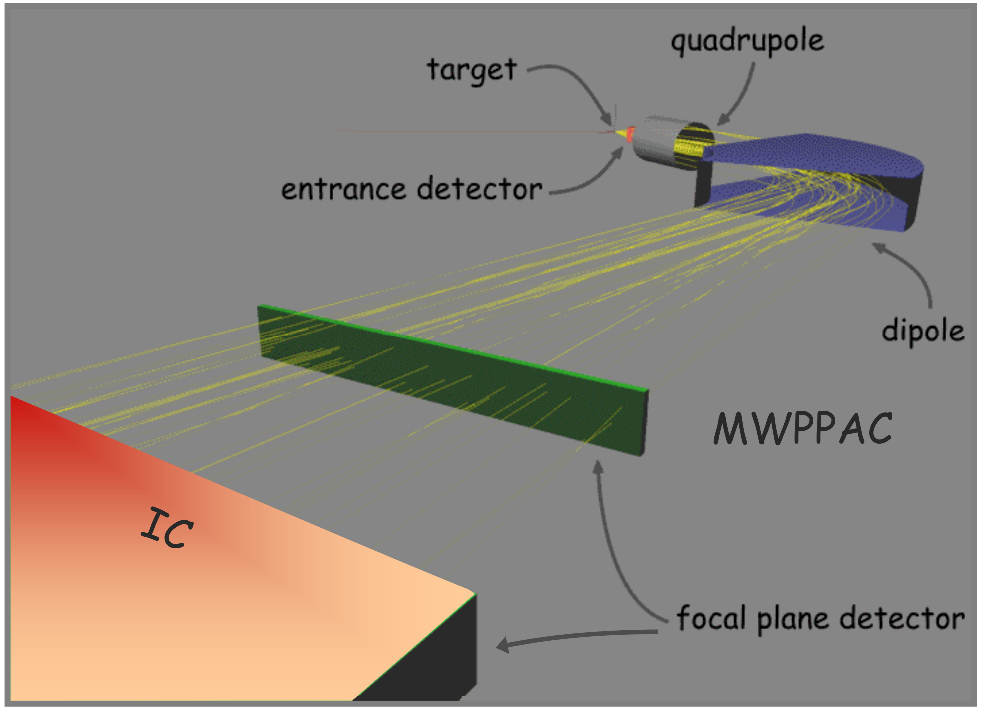
Summary

- First implementation of AGATA at LNL coupled to PRISMA
- Use of deep inelastic collisions to populate neutron-rich nuclei
- Lifetime experiments:
  - New island of inversion
  - Shell evolution along the Cu isotopes
- Binary partner method:
  - Region of maximum collectivity: Dy
  - Shape transition in Os nuclei
  - Shell model states south-east of ^{208}Pb
- Complementarity of stable beam facilities with RIB facilities
- Bright future is awaiting for gamma sectroscopy far from stability with AGATA at RIB facilities as well as stable beam facilities

The PRISMA spectrometer

Large-acceptance magnetic spectrometerc

- Formed by 1 Q, 1 D and detectors (MCP,MWPPAC, IC) to track the ions.
- $\Delta\Omega$ = 80 msr, $\Delta Z/Z \approx 1/60$, $\Delta A/A \approx 1/190$, $B\rho$ = 1.2 T.m
- Identifies nuclei produced in the reaction (A,Z,β) event by event



A. Stefanini, et al., Nucl. Phys. A 701, 217 (2002)
S. Beghini et al., NIM A551, 364 (2005)
G. Montagnoli et al., NIM A547, 455 (2005)

Island of inversion ESPE

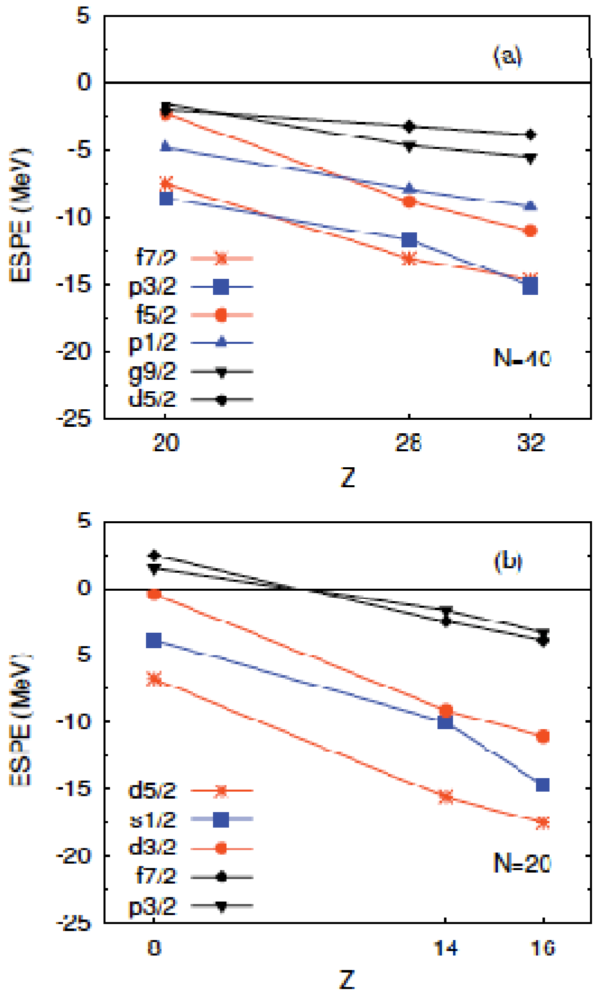
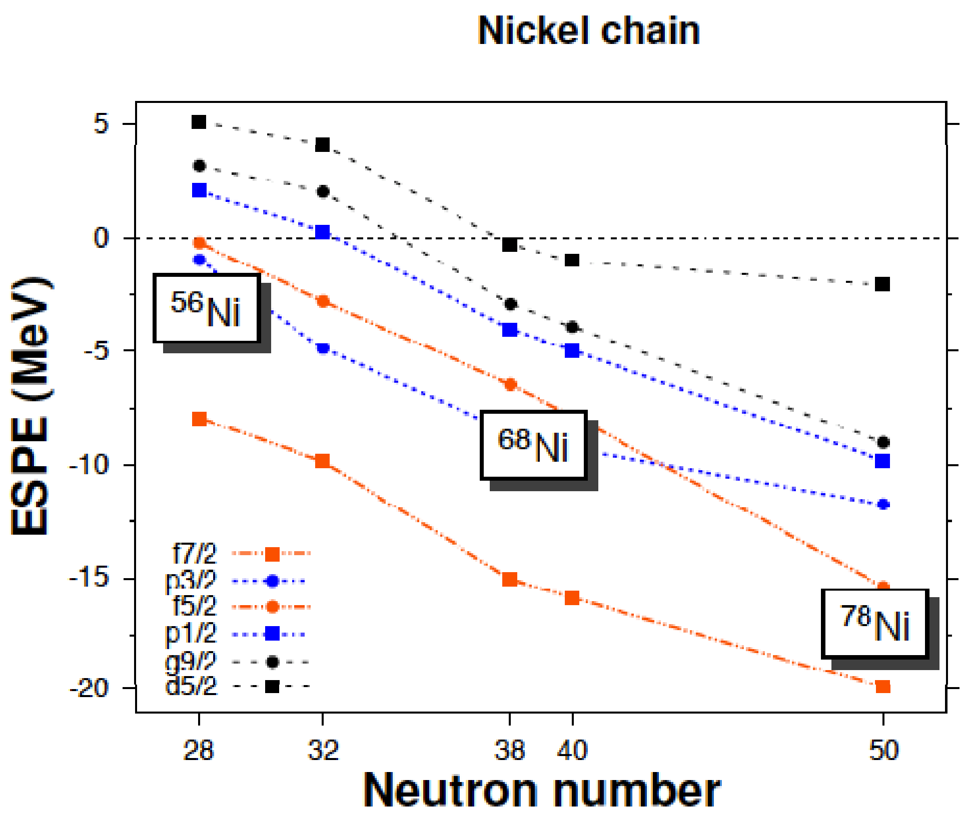


FIG. 1. (Color online) Neutron effective single-particle energies obtained with (a) the LNPS interaction at $N = 40$ and (b) with the SDPF-U interaction at $N = 20$.

The similarities
are striking. In the *N* = 20 case, a reduction of
the neutron
0*d*3/2-0*f7/2* gap takes place when protons are
removed from
the proton 0*d5/2* orbital. This feature,
accompanied by the
proximity of the quadrupole partner neutron
orbitals 0*f7/2* and
1*p3/2*, is responsible for the formation of the
island of inversion
at *N* = 20. At *N* = 40 one observes the same
behavior, but
for the neutron 0*f*5/2-0*g*9/2 gap when going
down from 68Ni
and the closeness of the quadrupole partners
0*g*9/2-1*d*5/2.

ESPE towards ^{78}Ni



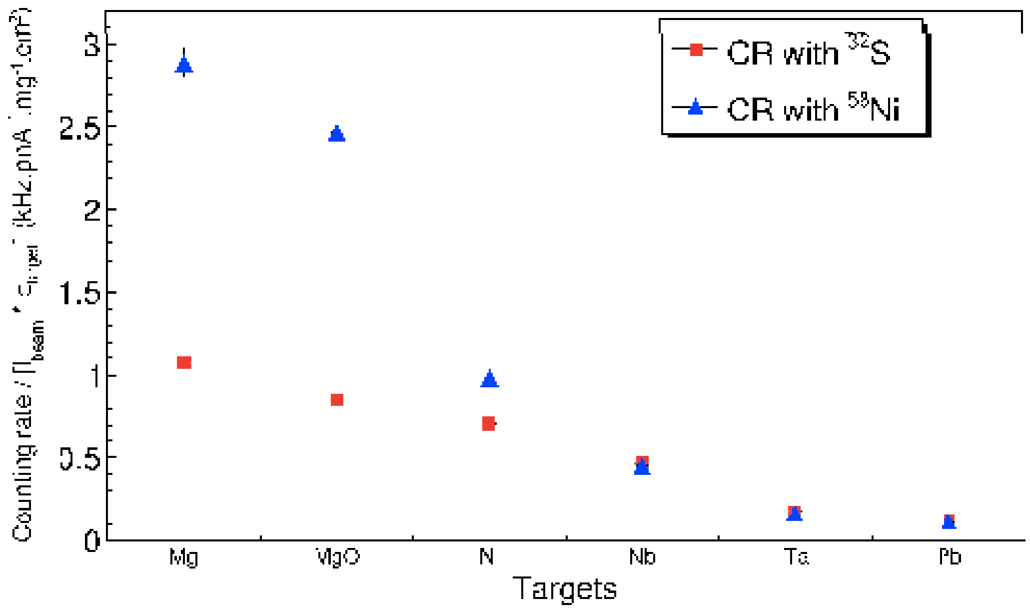
- ^{56}Ni: well doubly-magic, gap 6.5MeV
- ^{68}Ni mixture of magic and superfluid. *O.Sorlin PRL88 092501 (2002)*
- ^{78}Ni is supposes to be doubly-magic with a proton gap 5.0 MeV and neutron 4.6 MeV

K. Sieja et al., PRC81, 061303 (2010)

The rigidity of the gap in ^{78}Ni is also an important issue in astrophysics because it is a waiting point in the r-process.

AGATA counting rate

Test experiment to optimize the degrader



AGATA is not shielded and the large degrader thicknesses gave large counting rates **50-70 kHz** per crystal

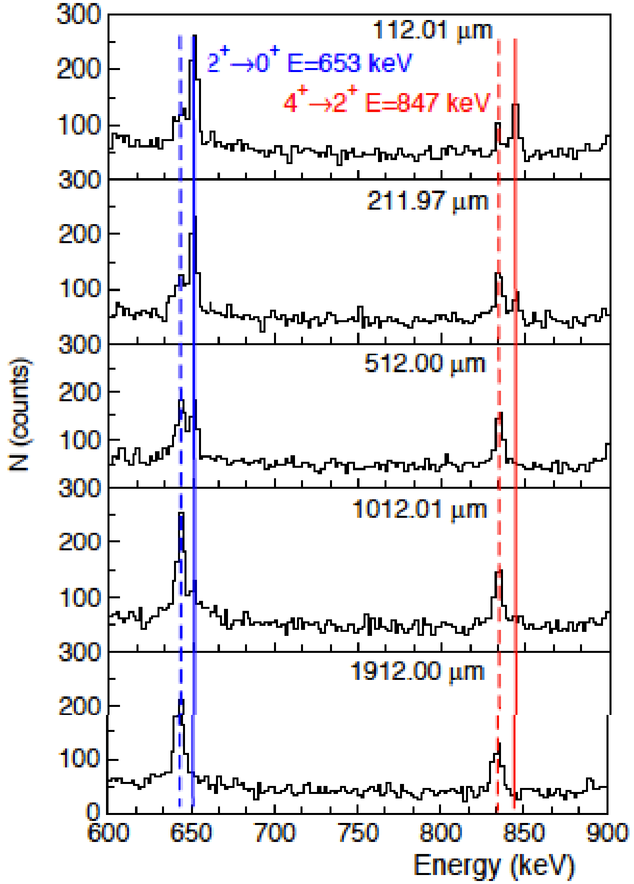
Degrader	Thickness	Nº atoms	Energy loss
Mg	4 mg/cm^2	10×10^{19}	~95MeV
Nb	4 mg/cm^2	2.5×10^{19}	~65MeV
Ta	4 mg/cm^2	1.3×10^{19}	~48MeV

New approach for lifetime determination

76Ge + 238U @ 577 MeV

The normalization is done considering the number of ions detected on PRISMA for each peak independently. This approach is essential for low statistic channels. Verified in ^{76}Ge and ^{72}Zn

^{72}Zn



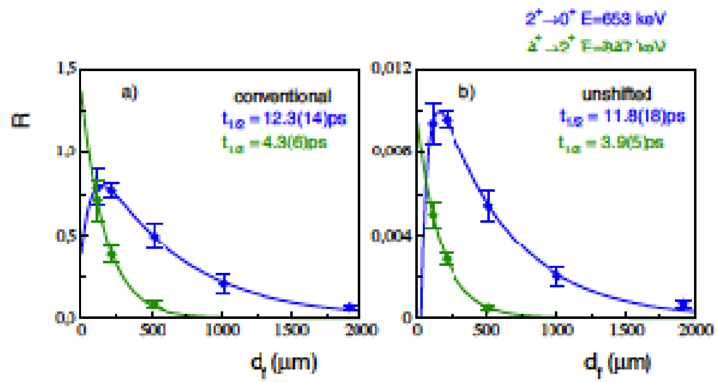


Figure 4.42: Fit of the $4^+ \to 2^+$ and $2^+ \to 0^+$ transitions at 847 keV and 653 keV, respectively. a) When the standard ratio for the RDDS method is applied and b) when only the unshifted peak is considered, normalized to the number of ions detected in PRISMA.

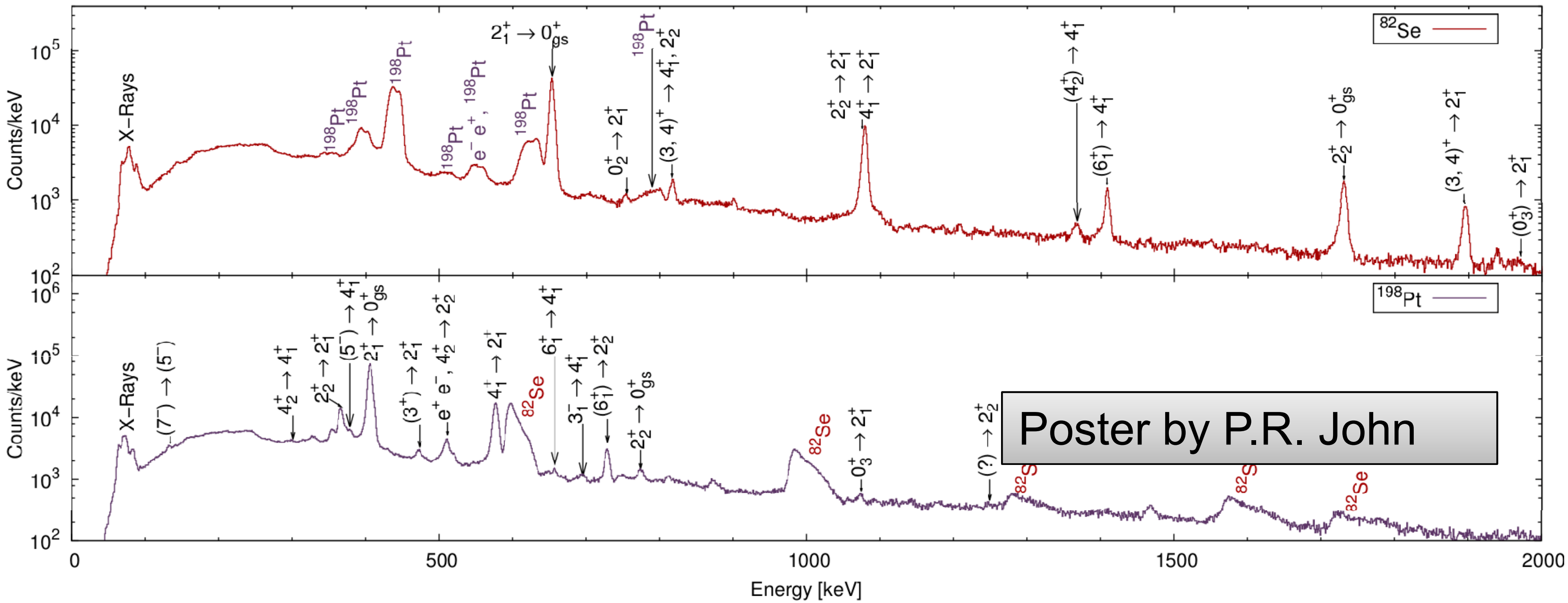
Table 4.22: Half life ($T_{1/2}$), lifetime (τ) and reduced transition probability ($B(E2\downarrow)$) for the $2^+ \to 0^+$ ^{72}Zn transition at 653 keV.

E = 653 keV $2^+ \to 0^+$			
Method	$T_{1/2}$ (ps)	τ (ps)	$B(E2\downarrow)(e^2fm^4)$
reference	13.7(17)	19.8(24)	348(42)
conventional	12.3(14)	17.1(19)	402(45)
unshifted	11.8(18)	17.0(19)	405(45)

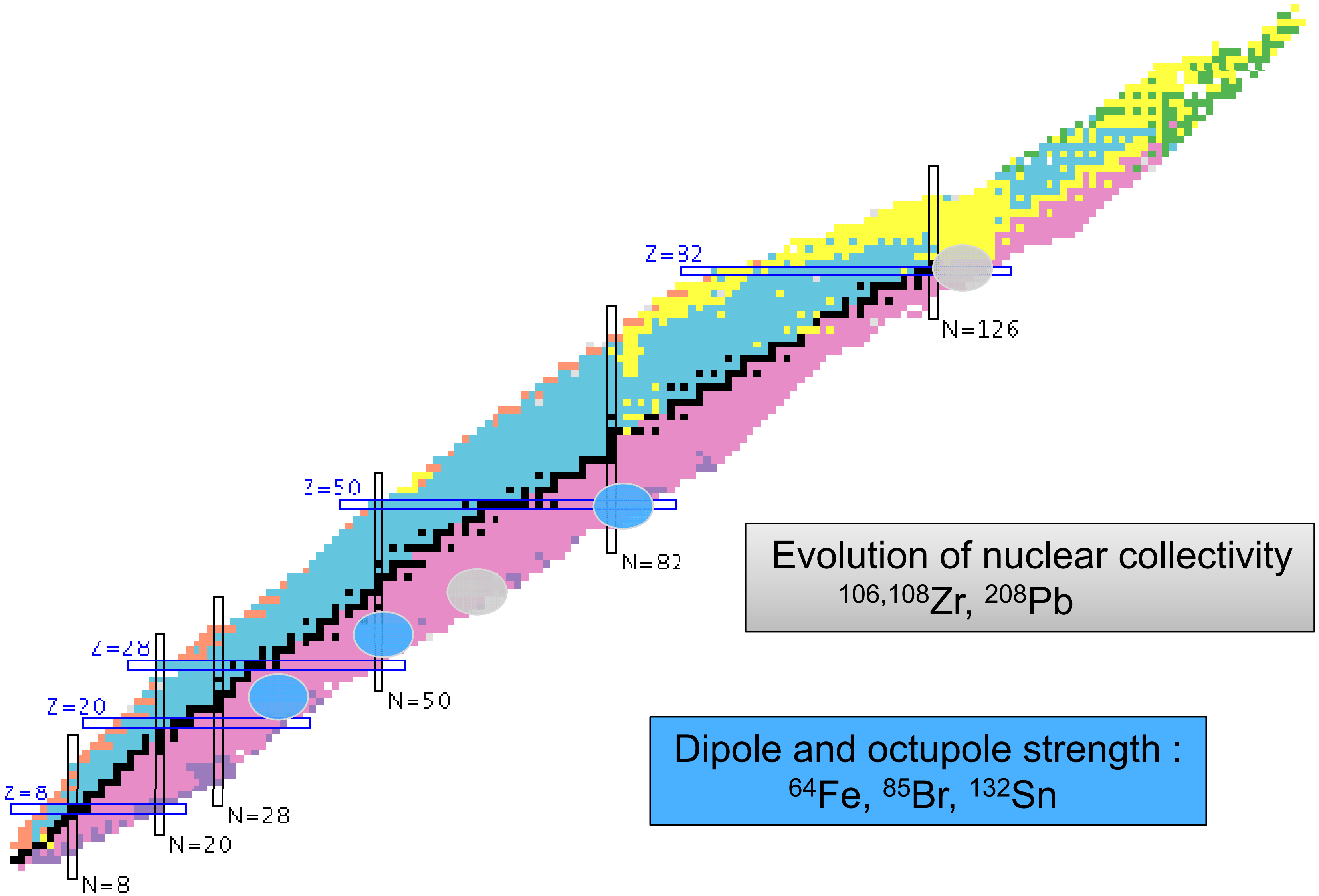
Experimental details

$^{82}Se + ^{198}Pt$ (2mg/cm^2) at 426 MeV

Beam and target Doppler corrected spectra using binary kinematics:
BLF: β~10% FWHM: 0.5%
TLF: β~3%   FWHM: 1.8%
Consider energy loss in the target at the various angles
Analysis by P.R. John



AGATA – Prespec proposals



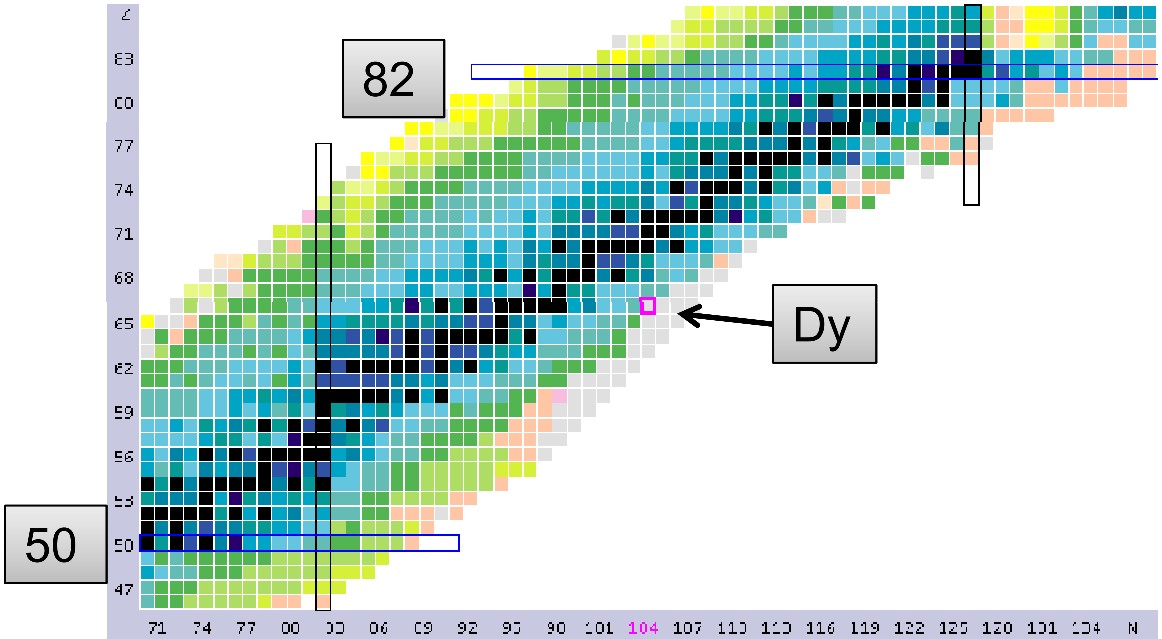
Evolution of nuclear collectivity
$^{106,108}Zr$, ^{208}Pb

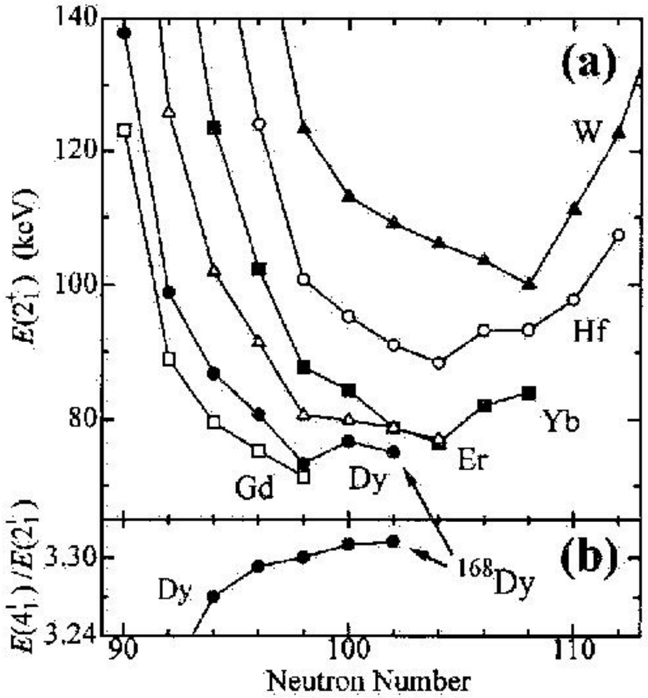
Dipole and octupole strength :
^{64}Fe, ^{85}Br, ^{132}Sn

Dy nuclei – large valence particles

Spokepersons: J. Nyberg, P.H. Regan, J. Simpson

Study the structure of yrast bands in the neutron-rich rare-earth nuclei $^{170}Dy_{106}$, located in the region of maximum collectivity, and search for high-K isomers in this region. ^{170}Dy is the most promising candidate for an SU(3) prolate rotor in the IBM. Identification of the γ band is required.





Neglecting any potential subshell closures, the nucleus with the largest number of valence particles with A < 208 is $^{170}Dy_{104}$

Experimental details

$^{86}Se + ^{170}Er$ @ 460 MeV CLARA+PRISMA

Gate in ^{84}Kr

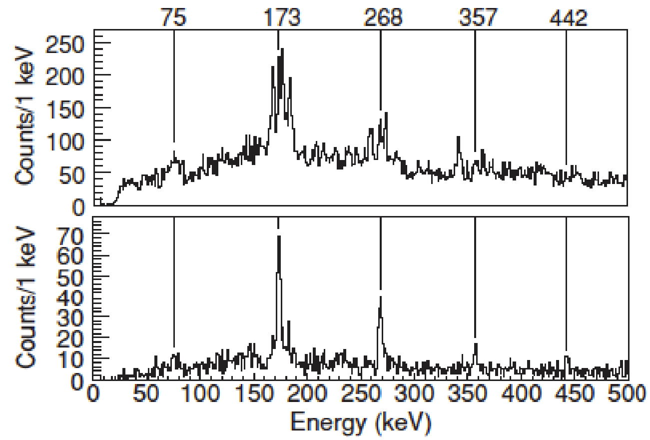
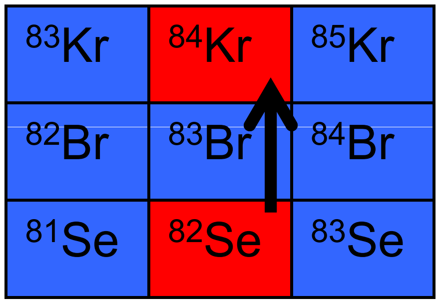


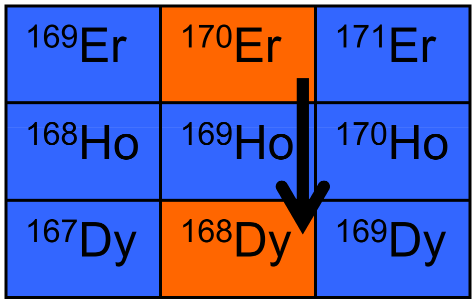
FIG. 3. Spectrum of γ-ray energies from targetlike fragments gated on the beamlike fragments ^{84}Kr (top) and on beamlike fragments ^{84}Kr plus a short time of flight (bottom). The transitions identified as the rotational band in ^{168}Dy are marked with solid lines.

PHYSICAL REVIEW C 81, 034310 (2010)

Spectroscopy of neutron-rich ^{168,170}Dy: Yrast band evolution close to the N_pN_n valence maximum

P.-A. Söderström,[1] J. Nyberg,[1] P. H. Regan,[2] A. Algora,[3] G. de Angelis,[4] S. F. Ashley,[2] S. Aydin,[5] D. Bazzacco,[5] R. J. Casperson,[6] W. N. Catford,[2] J. Cederkäll,[7,8] R. Chapman,[9] L. Corradi,[4] C. Fahlander,[8] E. Farnea,[5] E. Fioretto,[4] S. J. Freeman,[10] A. Gadea,[3,4] W. Gelletly,[2] A. Gottardo,[4] E. Grodner,[4] C. Y. He,[4] G. A. Jones,[2] K. Keyes,[9] M. Labiche,[9] X. Liang,[9] Z. Liu,[2] S. Lunardi,[5] N. Mărginean,[4,11] P. Mason,[5] R. Menegazzo,[5] D. Mengoni,[5] G. Montagnoli,[5] D. Napoli,[4] J. Ollier,[12] S. Pietri,[2] Zs. Podolyák,[2] G. Pollarolo,[13] F. Recchia,[4] E. Şahin,[4] F. Scarlassara,[5] R. Silvestri,[4] J. F. Smith,[9] K.-M. Spohr,[9] S. J. Steer,[2] A. M. Stefanini,[4] S. Szilner,[14] N. J. Thompson,[2] G. M. Tveten,[7,15] C. A. Ur,[5] J. J. Valiente-Dobón, V. Werner,[6] S. J. Williams,[2] F. R. Xu,[16] and J. Y. Zhu[16]





BLF

TLF

In order to try to identify the gamma rays from the TLF one needs to make gates in the Q value to minimise the neutron evaporation.

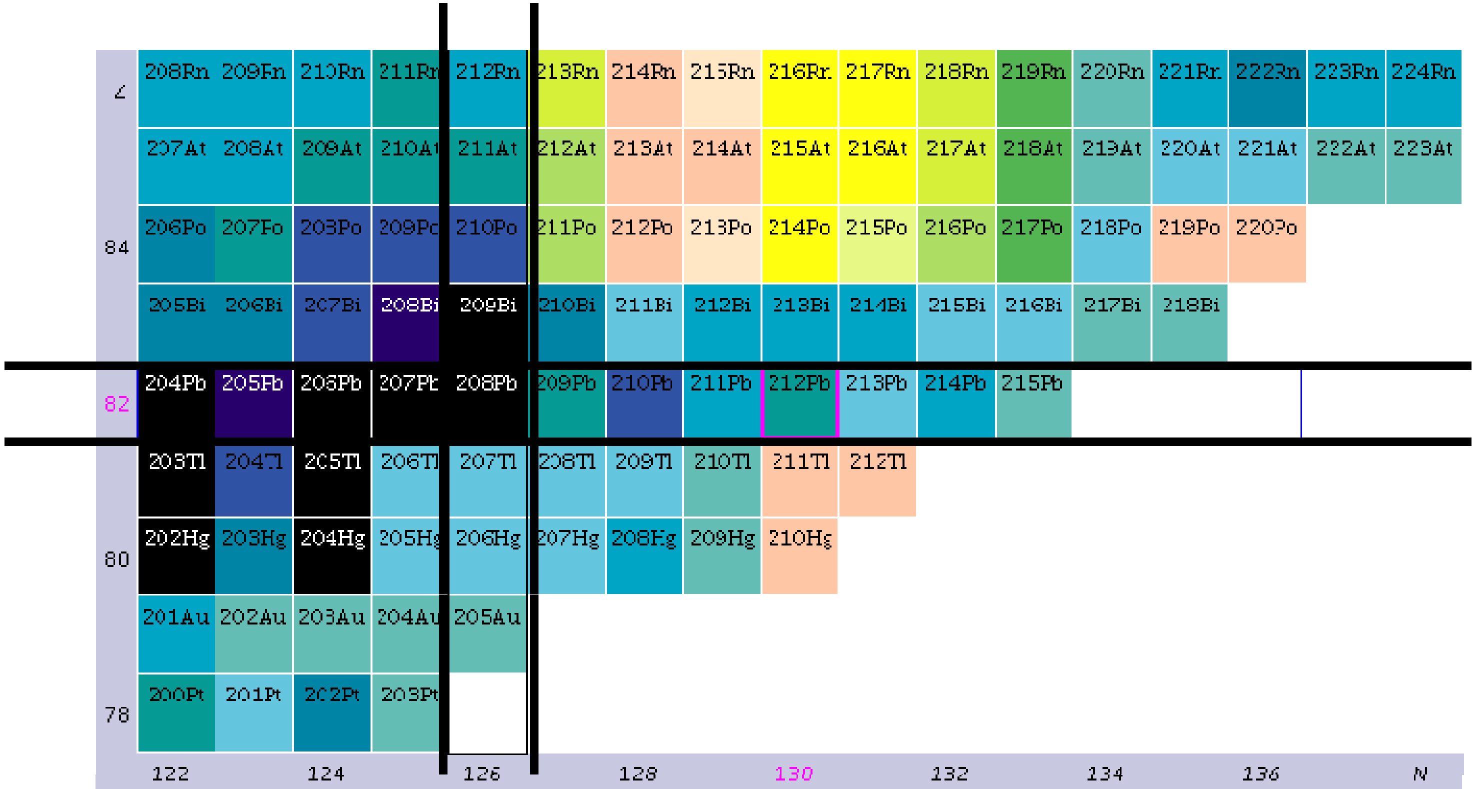
AGATA+PRISMA experiment done with a ^{136}Xe beam that has a larger cross section respect to ^{82}Se → Analysis by: A. Gengelbach, P. Hampson

Vicinity of ^{208}Pb

Spokepersons: Zs. Podolyak

South and south-east of ^{208}Pb is lacking in information: ^{208}Tl & ^{206,208}Hg

Obtain information on shell model states of nuclei along the N=126 line, and also where N>126 & Z<82

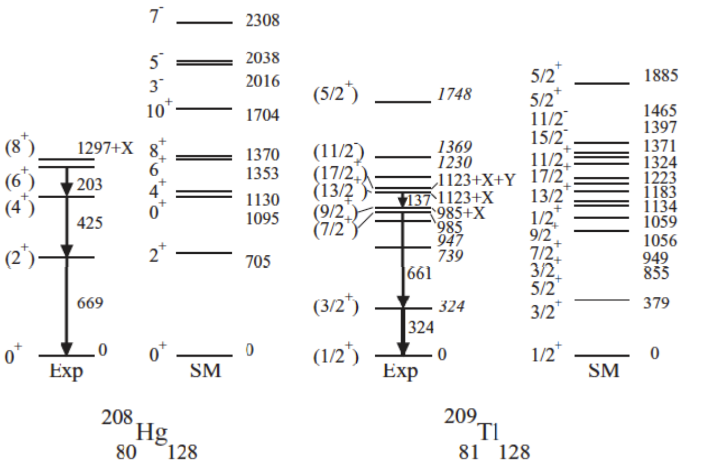


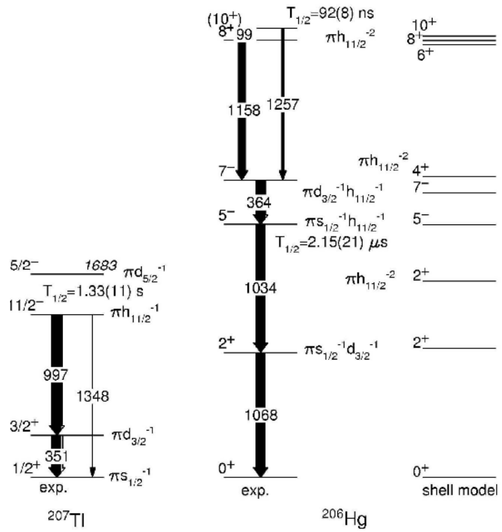
In the region

PHYSICAL REVIEW C **80**, 061302(R) (2009)

Nuclear structure "southeast" of ^{208}Pb: Isomeric states in ^{208}Hg and ^{209}Tl

N. Al-Dahan,[1,2] Zs. Podolyák,[1,*] P. H. Regan,[1] M. Górska,[3] H. Grawe,[3] K. H. Maier,[4] J. Gerl,[3] S. B. Pietri,[3] H. J. Wollersheim,[3] N. Alkhomashi,[1] A. Y. Deo,[1] A. M. Denis Bacelar,[5] G. Farrelly,[1] S. J. Steer,[1] A. M. Bruce,[5] P. Boutachkov,[3] C. Domingo-Pardo,[3] A. Algora,[6,7] J. Benlliure,[8] A. Bracco,[9] E. Calore,[10] E. Casarejos,[8] I. J. Cullen,[1] P. Detistov,[11] Zs. Dombrádi,[7] M. Doncel,[12] F. Farinon,[3] W. Gelletly,[1] H. Geissel,[3] N. Goel,[3] J. Grebosz,[4] R. Hoischen,[3,13] I. Kojouharov,[3] N. Kurz,[3] S. Lalkovski,[5] S. Leoni,[14] F. Molina,[6] D. Montanari,[9] A. I. Morales,[8] A. Musumarra,[3,15] D. R. Napoli,[10] R. Nicolini,[9] C. Nociforo,[3] A. Prochazka,[3] W. Prokopowicz,[3] B. Rubio,[6] D. Rudolph,[3,13] H. Schaffner,[3] P. Strmen,[16] I. Szarka,[16] T. Swan,[1] J. S. Thomas,[1] J. J. Valiente-Dobón,[10] S. Verma,[8] P. M. Walker,[1] and H. Weick[3]





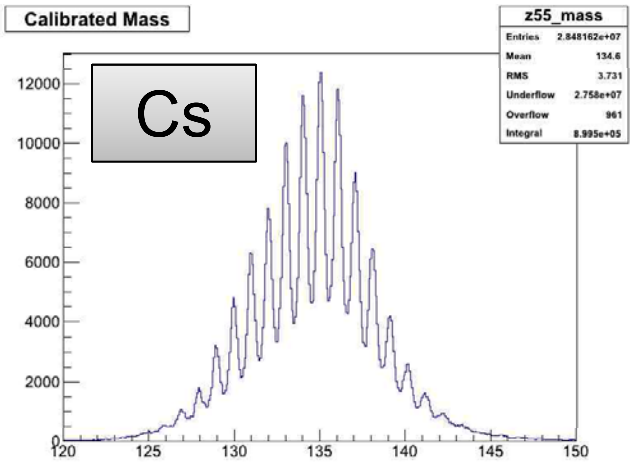
Experiemnts performed in RIB in fligh (FRS) The specroscopic information comes from the existance of an isomer → Stable facilities DIC yrast bands

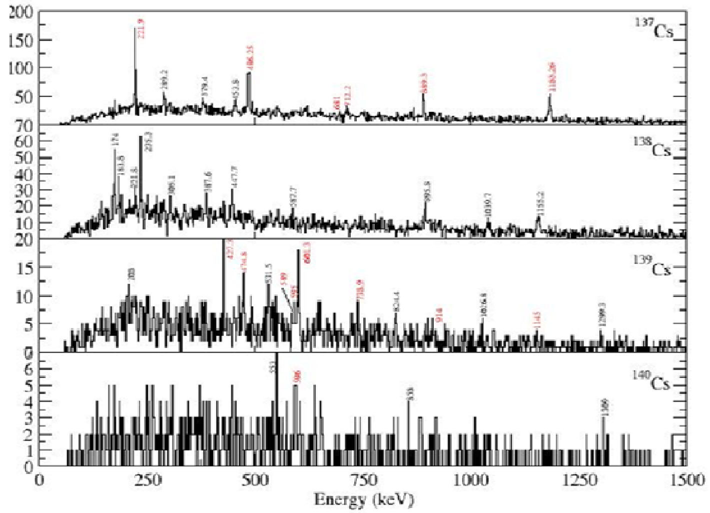
In nearby semimagic nuclei one can study in detail effects of the renormalized effective NN interaction like higher other effective 3-body forces. A.Gottardo et al., PR (submitted)

Experimental details

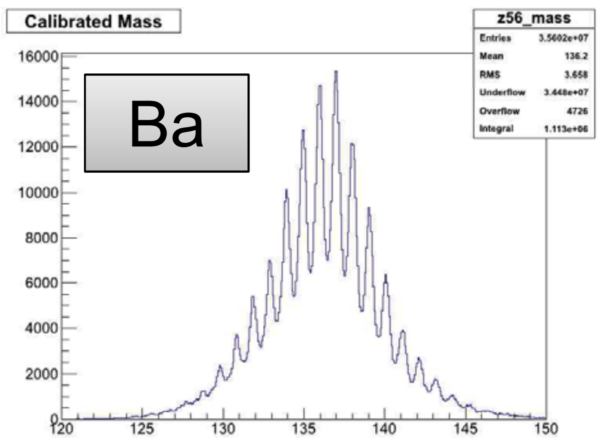
$^{136}Xe + ^{208}Pb$ (1mg/cm^2) at 940MeV

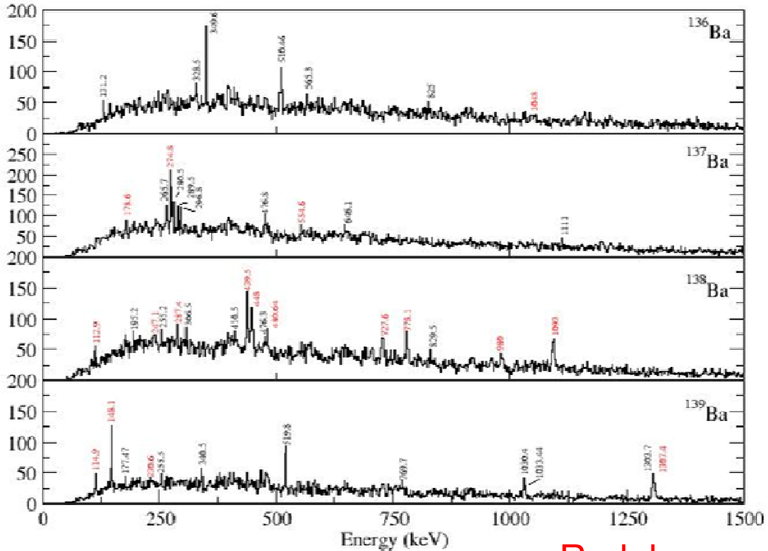
+1p





+2p





Ba partner is Hg

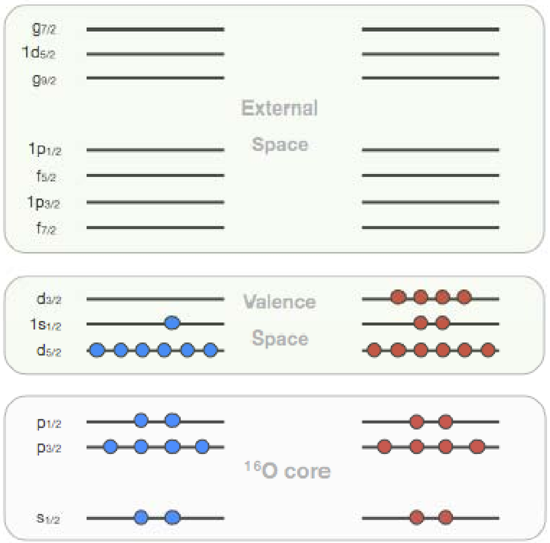
Analysis ongoing: R.S. Kempley

Red: known transitions

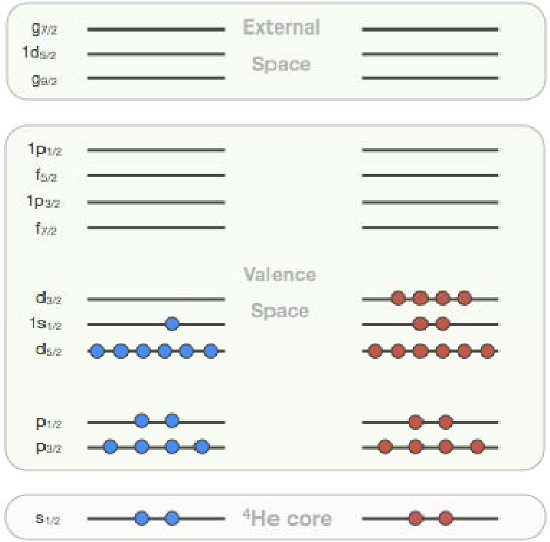
Lifetimes along the N=20

Spokepersons: F. Haas, R. Chapman

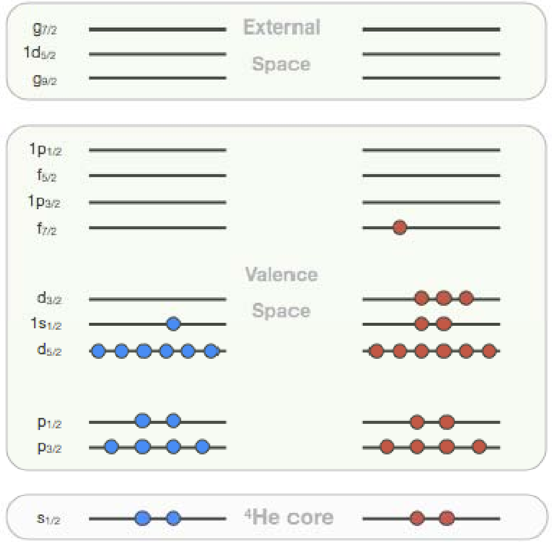
1(h/2π)w excitations in the N=20



USD valence space



PSDPF valence space with 0hw conf

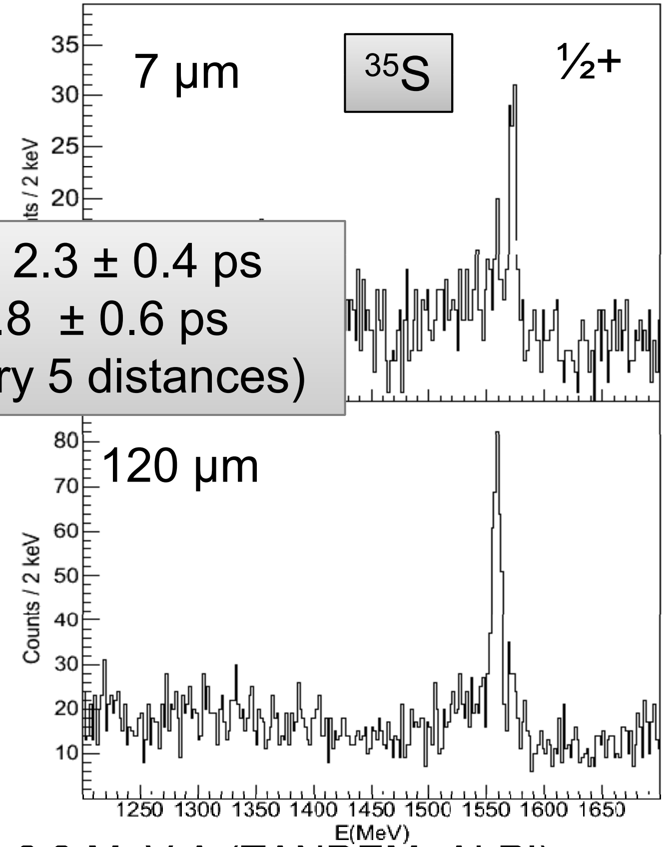


PSDPF valence space with 1hw conf

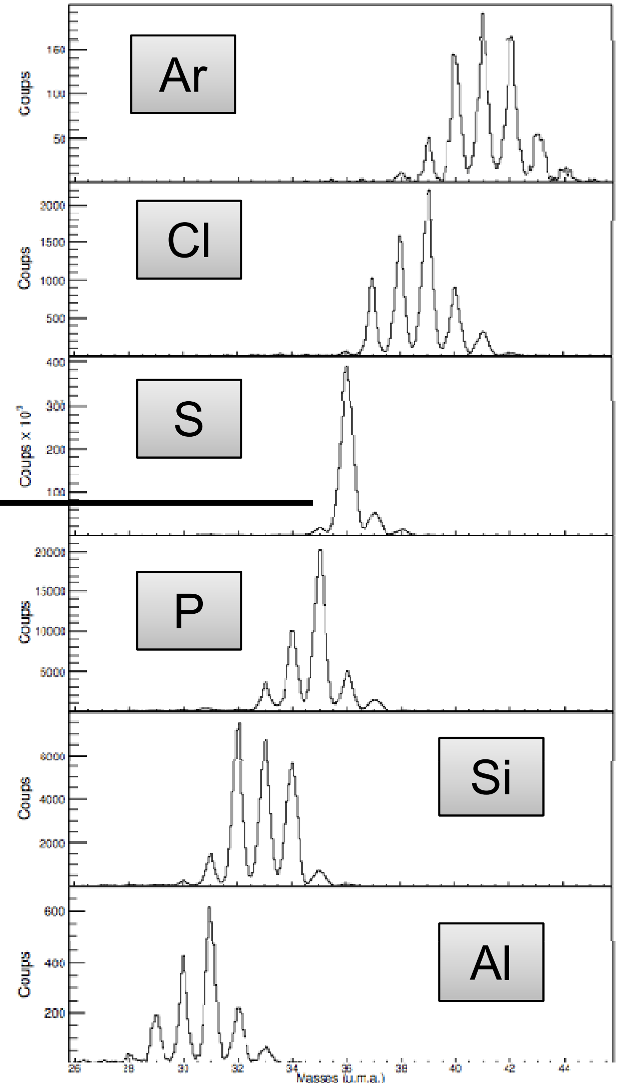
- Unified description of 0hw and 1hw states
- Prediction of lifetimes around N~20 in the range accessible by RDDS

PSDPF: M. Bouhelal, F. Haas, E. Caurier, F. Nowacki, A. Bouldjedri, Nuclear Physics A 864, 113 (2011)
USD: B. A. Brown, W. A. Richter, Phys. Rev. C 74, 034315 (2006).

Experimental details



Literature: 2.3 ± 0.4 ps
AGATA: 1.8 ± 0.6 ps
(preliminary 5 distances)



- $^{36}S^{9+}$ @ 6.3 MeV.A (TANDEM+ALPI)
- ^{208}Pb target of 1 mg.cm^{-2} on 1 mg.cm^{-2} Nb backing
- 3 mg.cm^{-2} Nb degrager
- First experiment with 5 clusters of AGATA
- Analysis ongoing: A. Goasduff, Laura Grocutt

Testing 1hw excitations

- New full 1hw Shell Model interaction for *sd*-nuclei
- Unified description of 0hw and 1hw states
- Good overall agreement with experimental data on excitation energies
- Need of further experimental data at the border of the shell (electromagnetic transitions, ...)
- Prediction of lifetimes around N~20 in the range accessible by recoil shift method