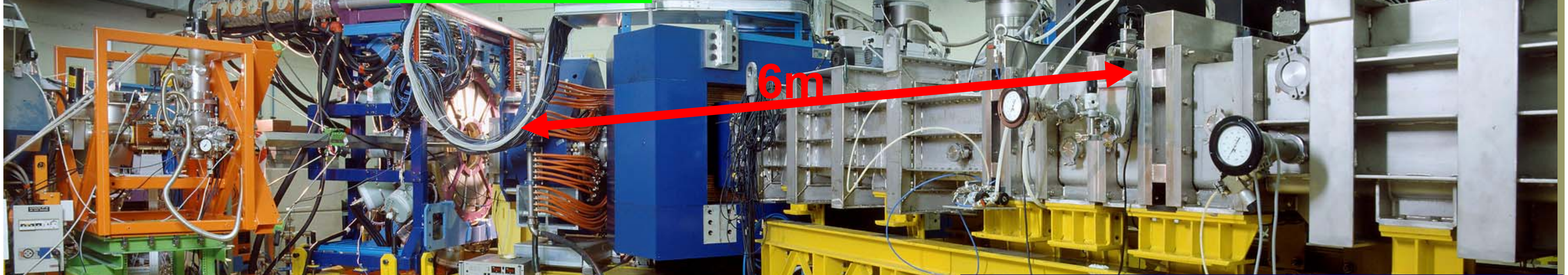
Spectroscopy of n-rich nuclei at LNL with CLARA-PRISMA

A.Gadea INFN-LNL

- Description of the setup, grazing reactions as mechanism to study the structure of moderately neutron-rich nuclei
- Results on n-rich nuclei from N=28 (A~40) to N=50 (A~80)
- Outlook (AGATA Demonstrator at PRISMA)



PRISMA: Large acceptance tracking Magnetic Spectrometer Q-D

Designed for the HI-beams from XTU-ALPI

Ω = 80 msr

$\Delta Z/Z \approx$ 1/60 (Measured) IC

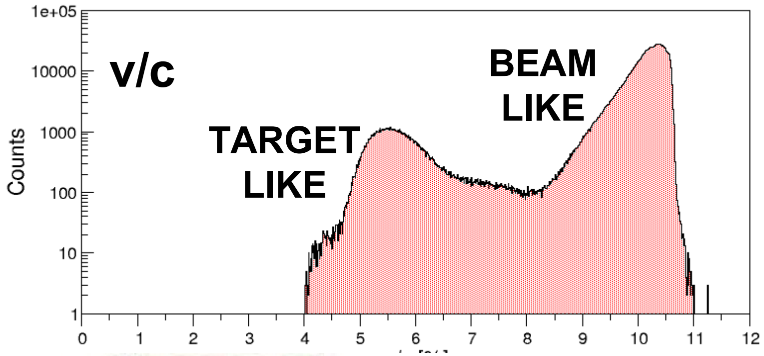
$\Delta A/A \approx$ 1/190 (Measured) TOF

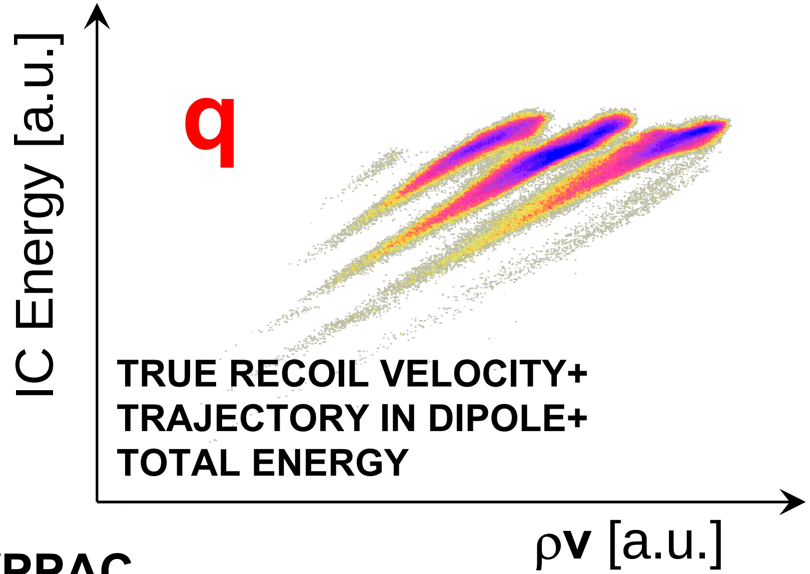
Energy acceptance ±20%

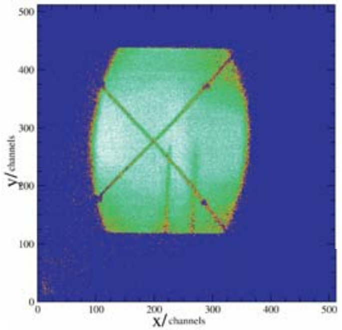
Max. $B\rho$ = 1.2 T.m.

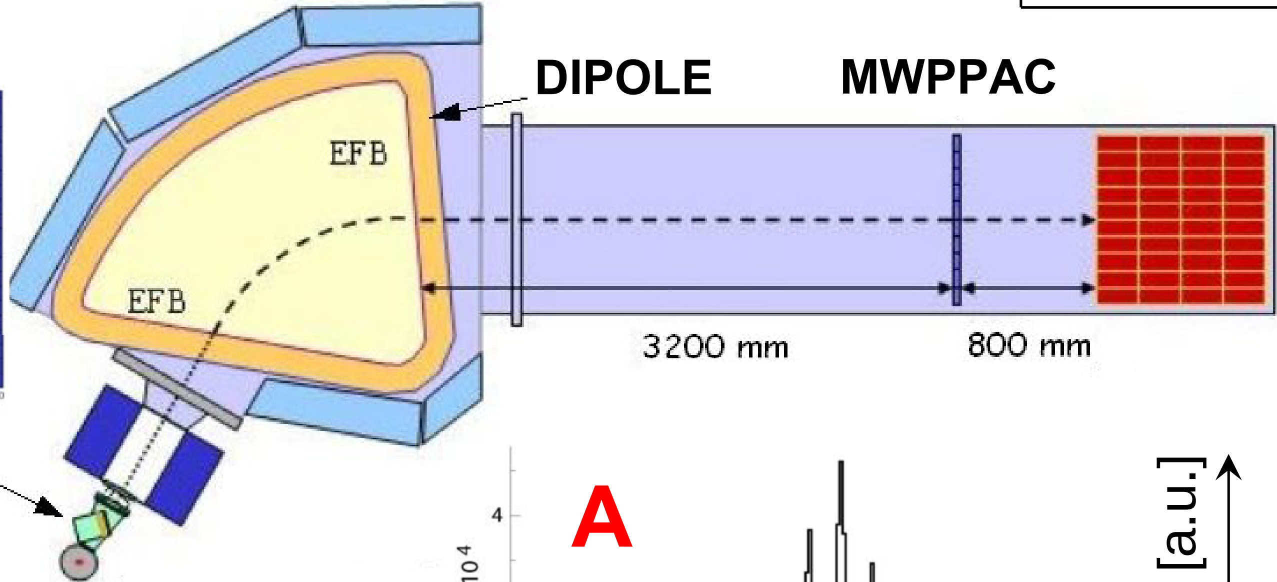
Tracking on PRISMA

A/q { **true recoil velocity** / **trajectory in dipole** }





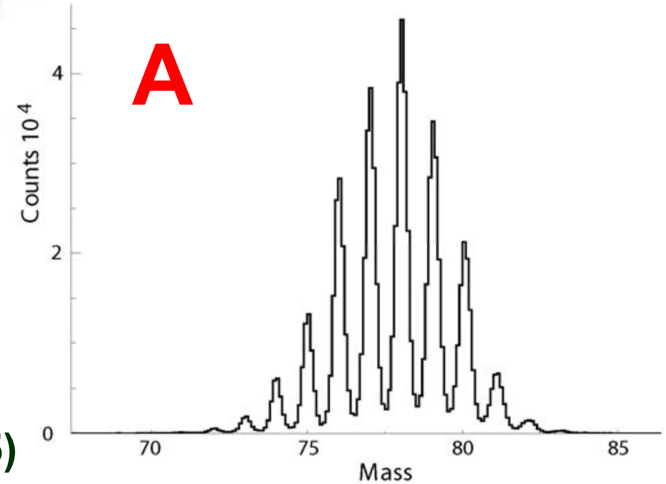


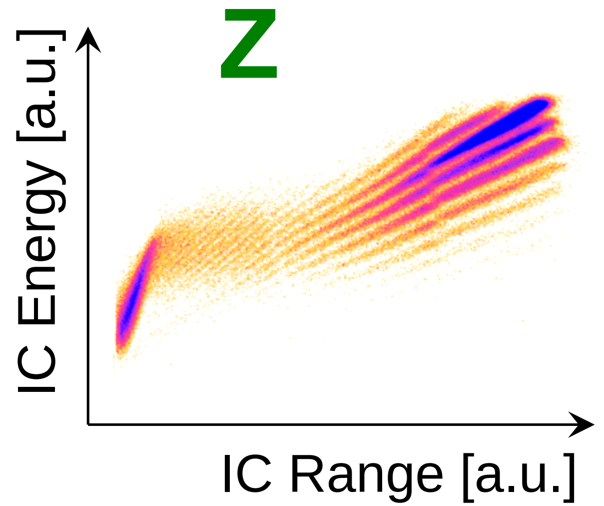


IONIZATION CHAMBER
5‰ Energy resolution

MCP Start Detector

MCP-MWPPAC
ΔTOF=0.5 ns

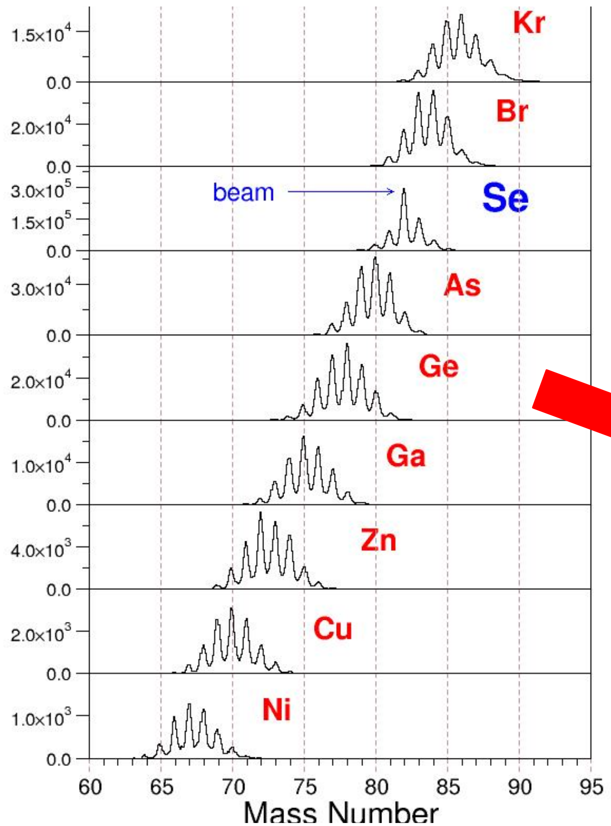




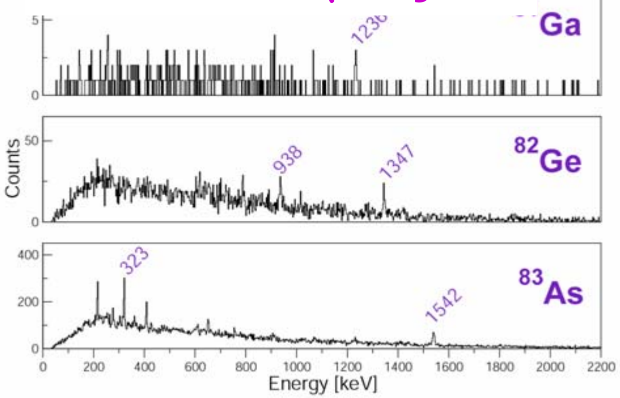
S.Beghini et al. NIM A551, 364 (05)
G.Montagnoli et al. NIM A547, 455 (05)

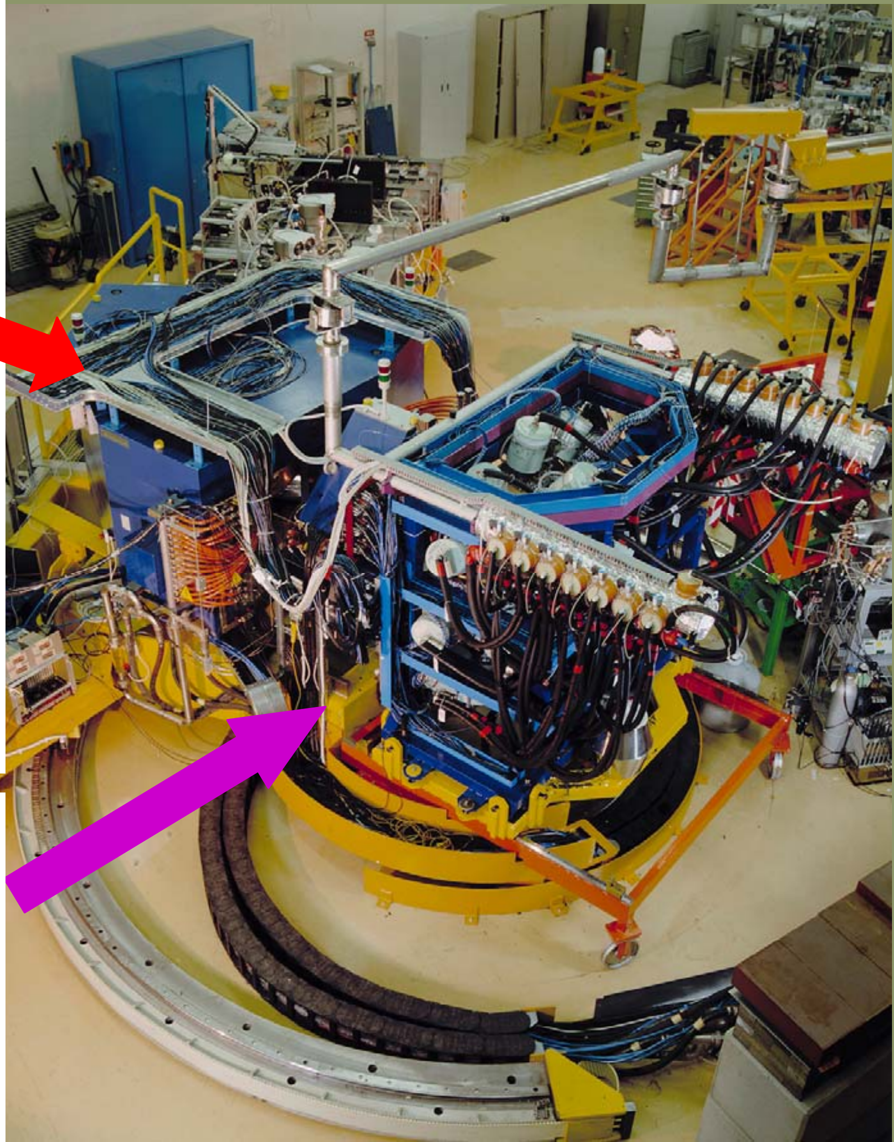
CLARA: Clover Detector array

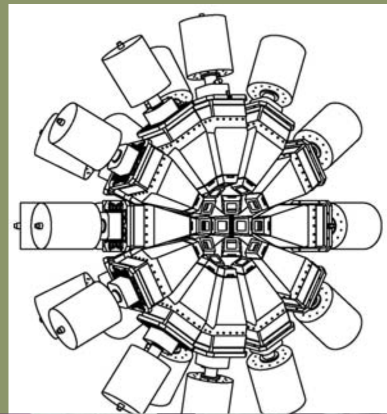
A & Z identification

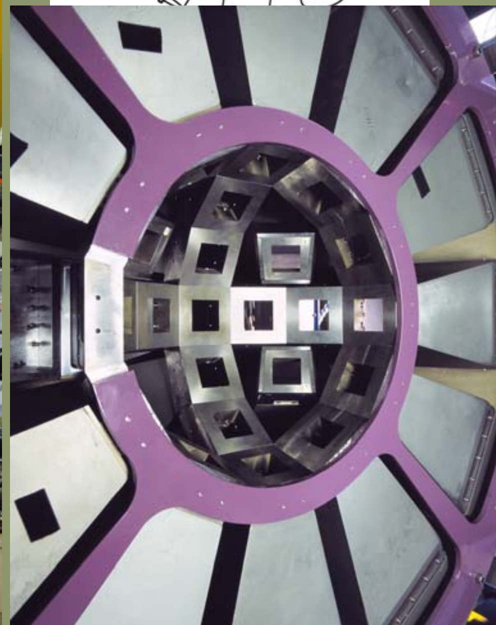


"in-beam" γ-ray









25 Euroball Clover detectors (EB GammaPool)

Performance at Eγ= 1.3MeV

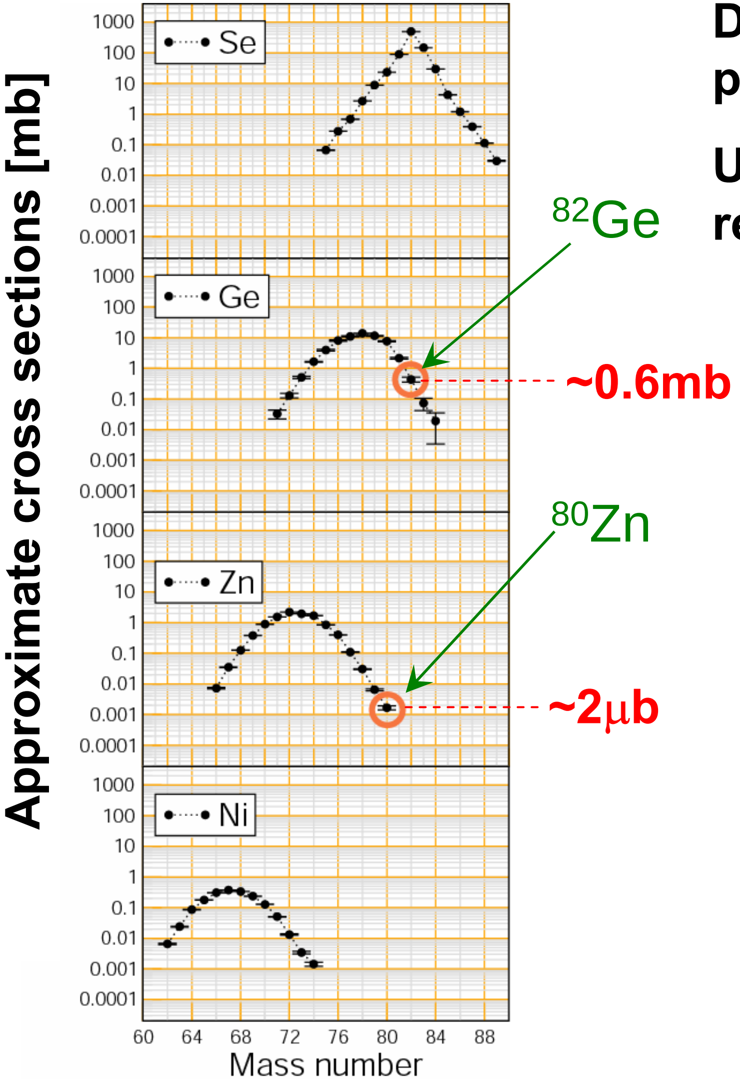
Efficiency ~ 3 %

Peak/Total ~ 45 %

FWHM < 10 keV

(at v/c = 10 %)

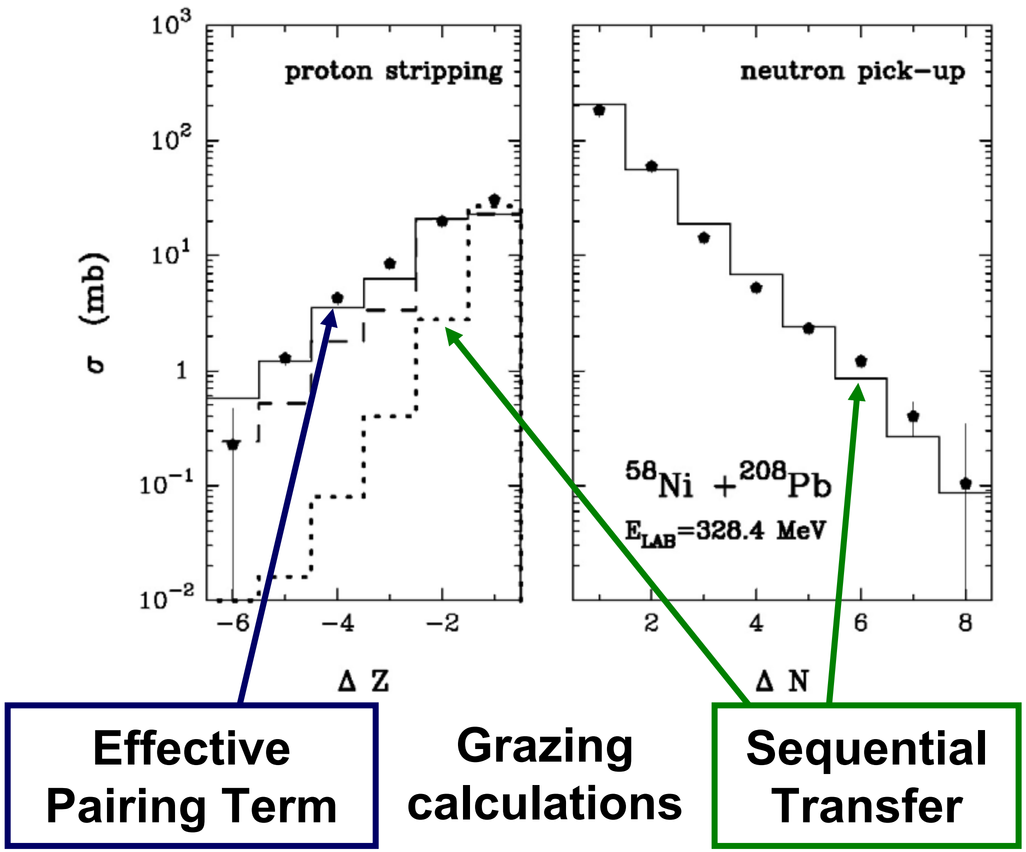
Grazing reactions transferring several nucleons as a tool to study n-rich nuclei



^{82}Se + ^{238}U E=505 MeV

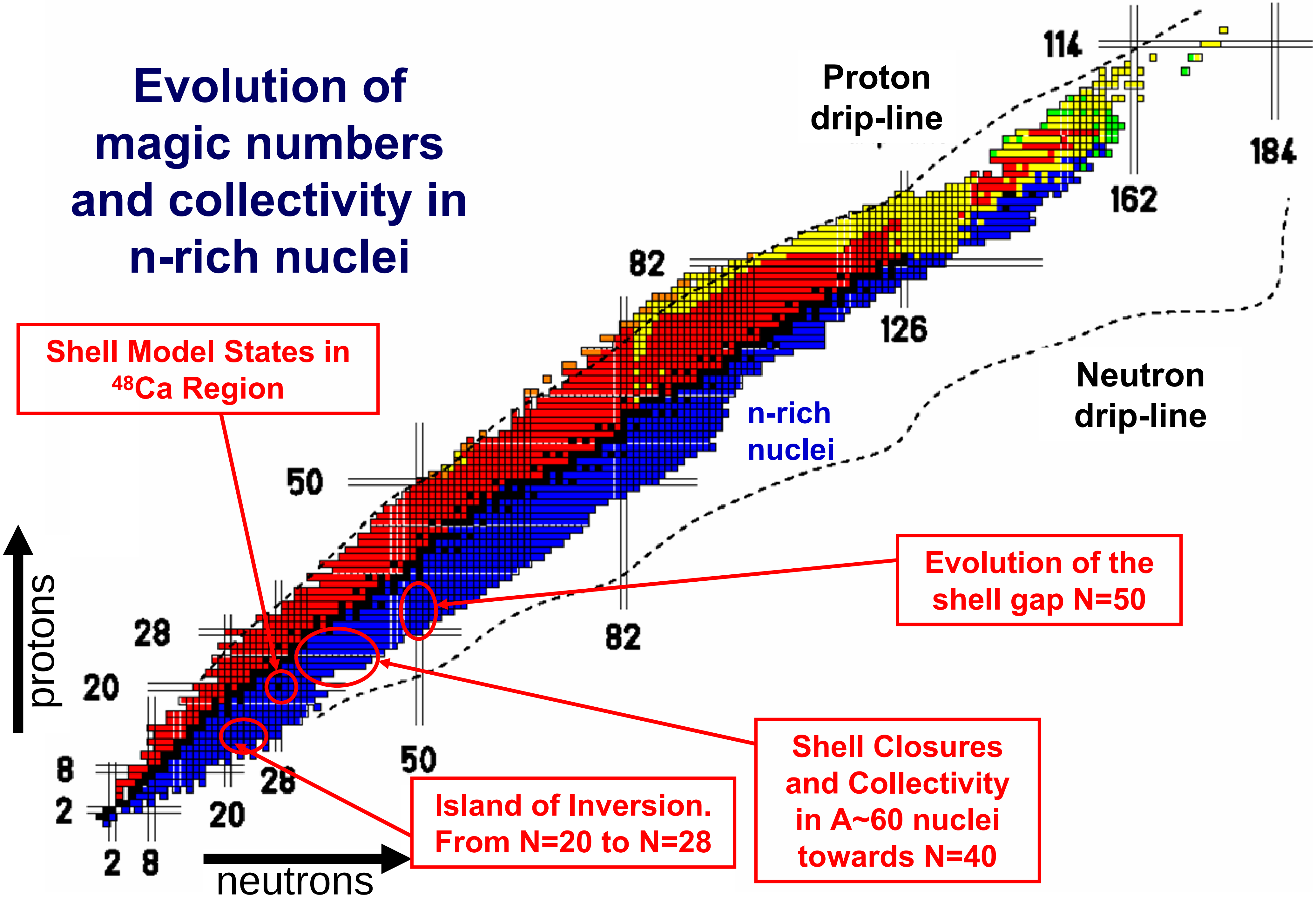
Deep-inelastic reactions used since thick target pioneering work of R.Broda et al. (PLB 251 (90) 245)

Use of Multinucleon-transfer triggered by the LNL reaction mechanism group.



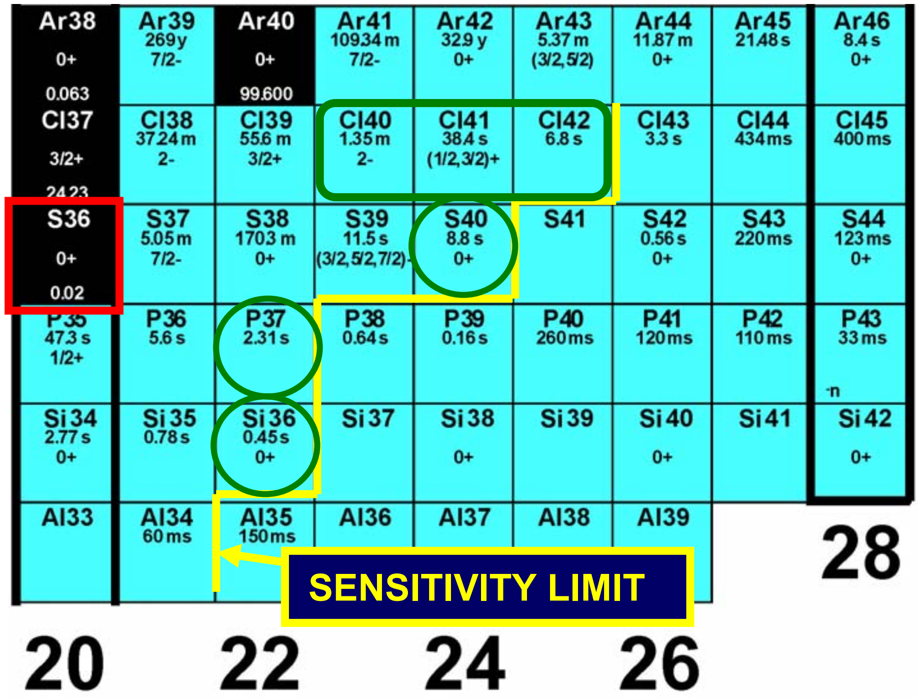
L.Corradi et al., Phys.Rev.C59 (99)261, Theory: G.Pollarolo

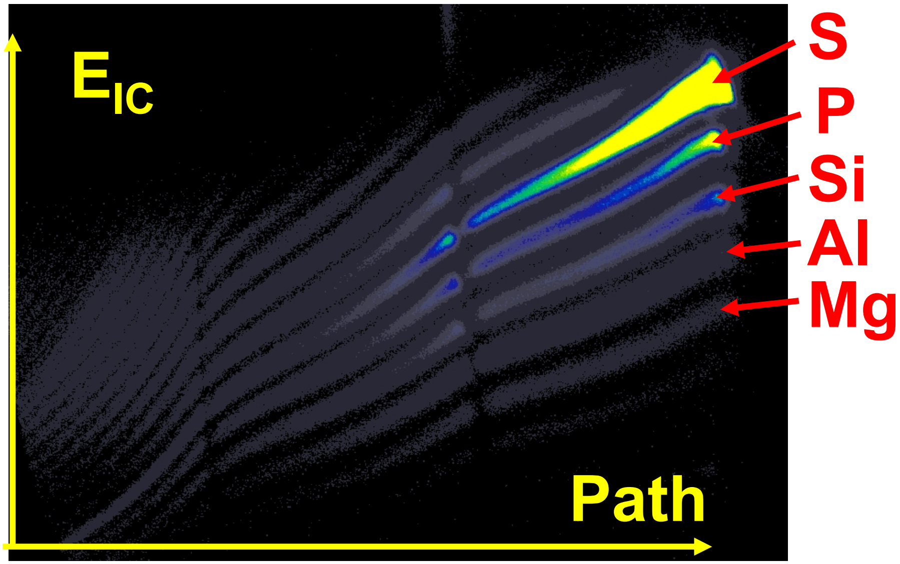
Evolution of magic numbers and collectivity in n-rich nuclei



From N=20 to N=28 ^{36}S 230 MeV + 208Pb θ_g=56^o

R.Chapman,X.Liang (Manchester), M.Stanoiu, F.Azaiez (IPN Orsay)

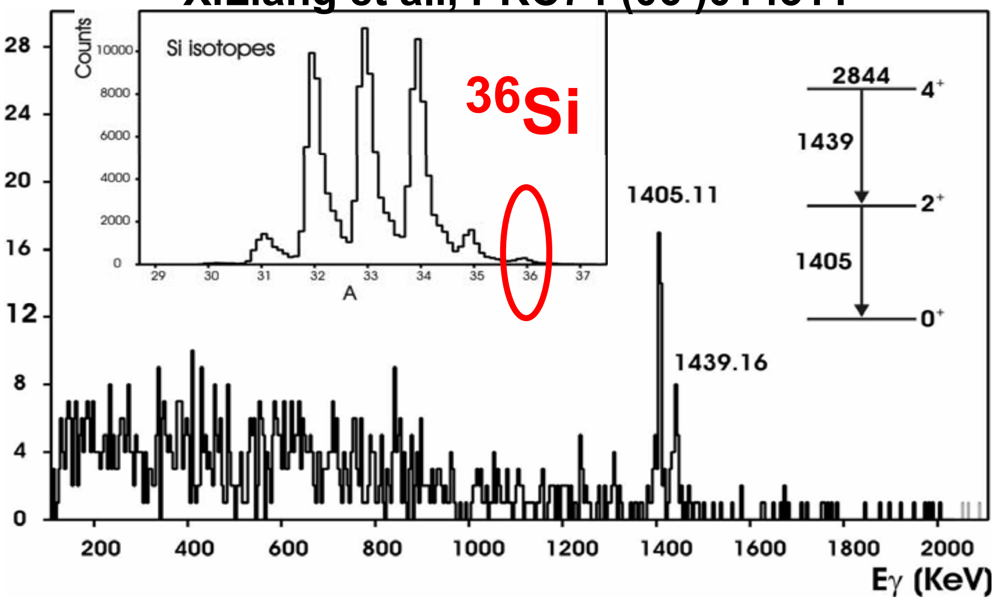


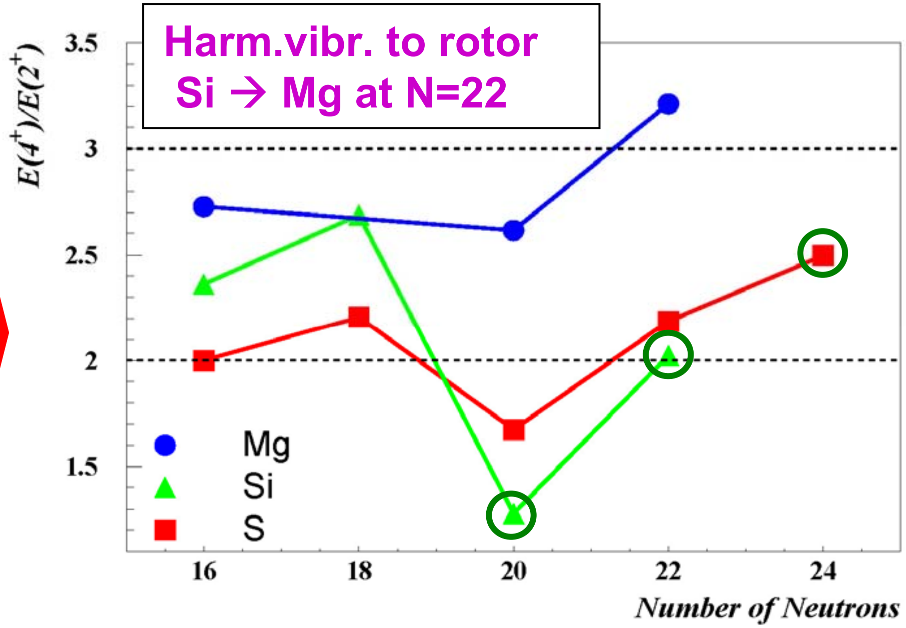


Effect of the occupancy of the $\nu 1f_{7/2}$ orbital on the $\pi d_{3/2}$ and $\pi s_{1/2}$ single particle energy separation.

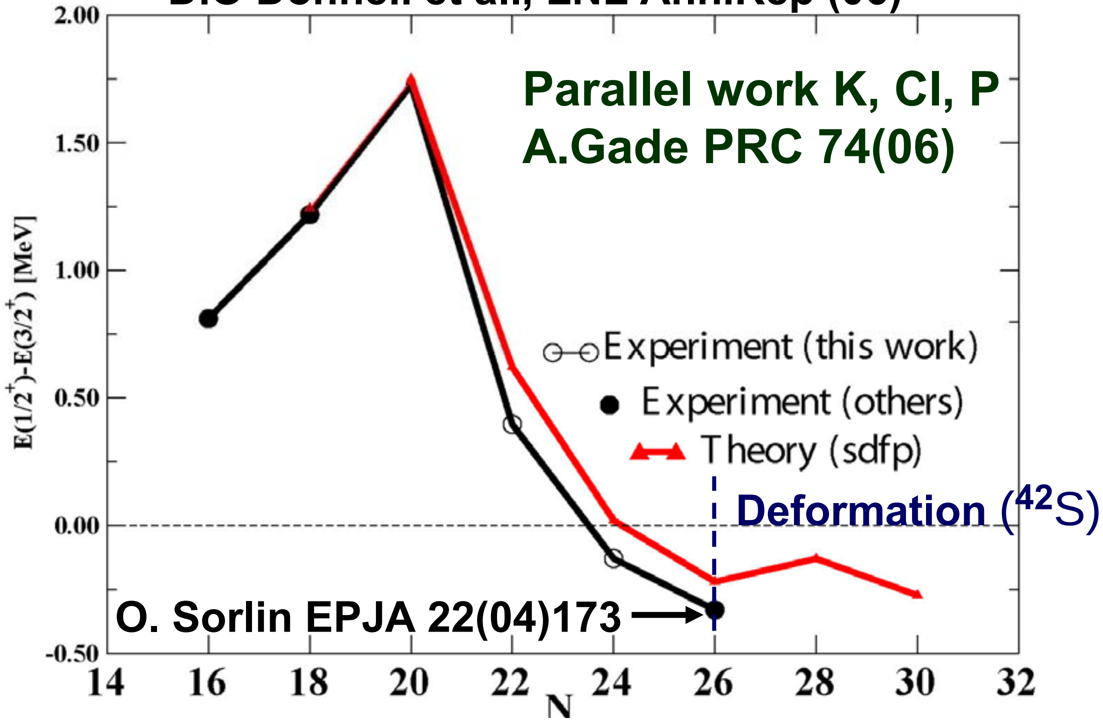
"Pseudo-SU(3)" symmetry and quadrupole deformation in n-rich S (N=24,26) isotopes

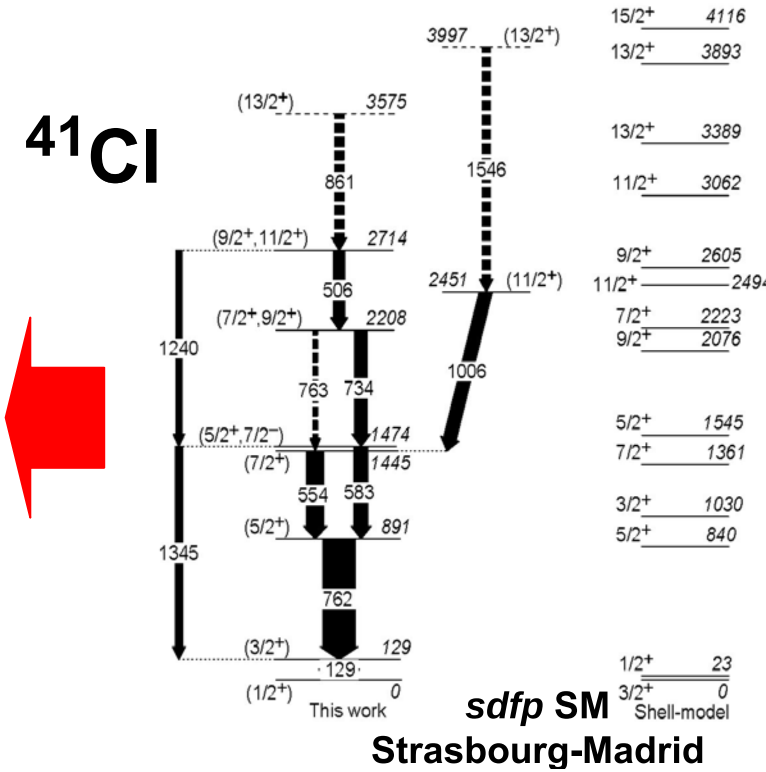
X.Liang et al., PRC74 (06)014311



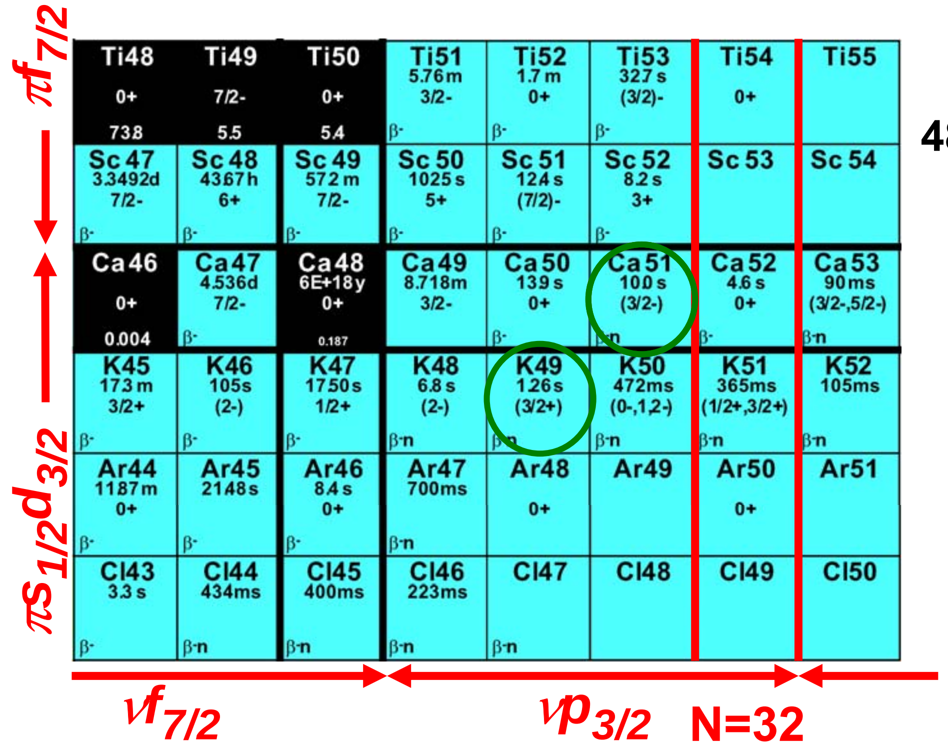


D.O'Donnell et al., LNL Ann.Rep (06)





Shell Model States in the ^{48}Ca Region

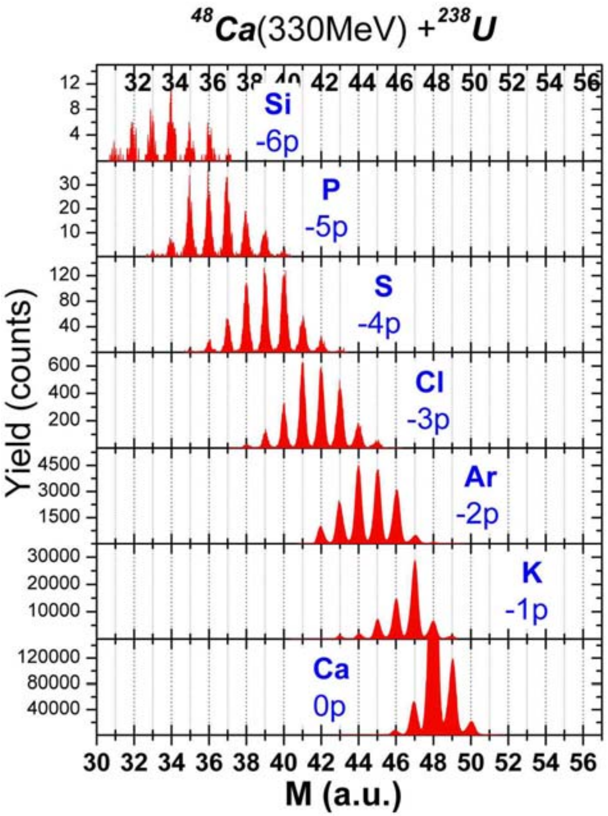


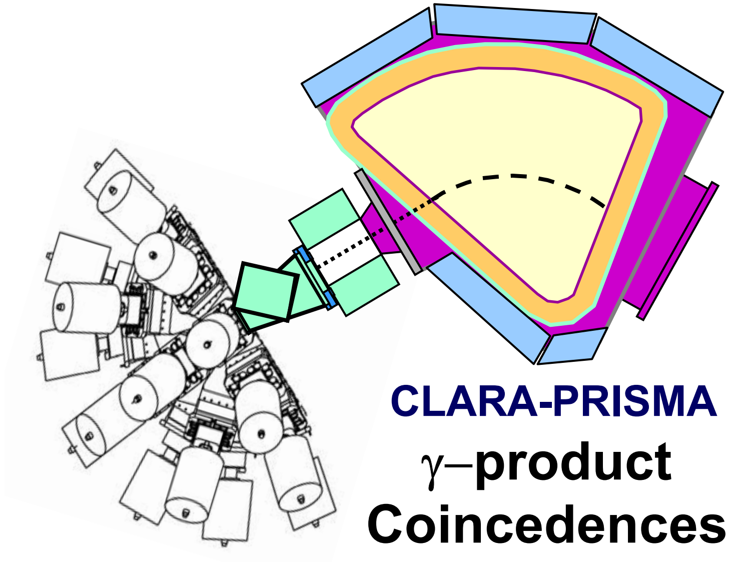
^{48}Ca 330MeV + ^{238}U

Tandem-ALPI

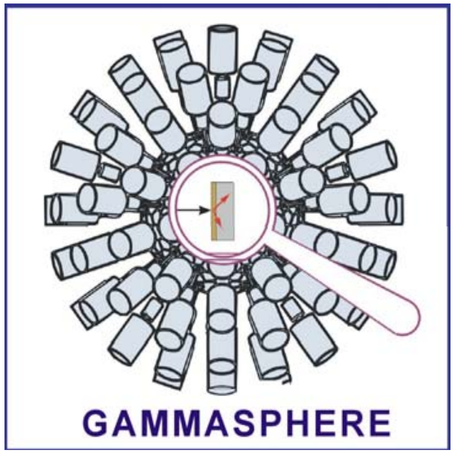
$\theta_g = 52^o$

R.Broda,
B.Fornal et al.,

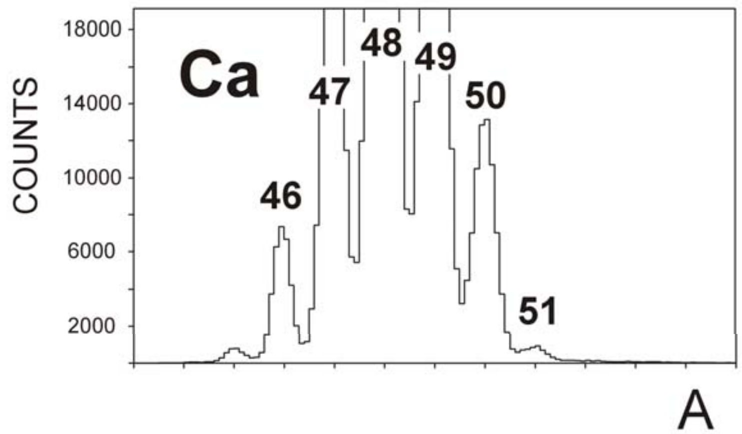


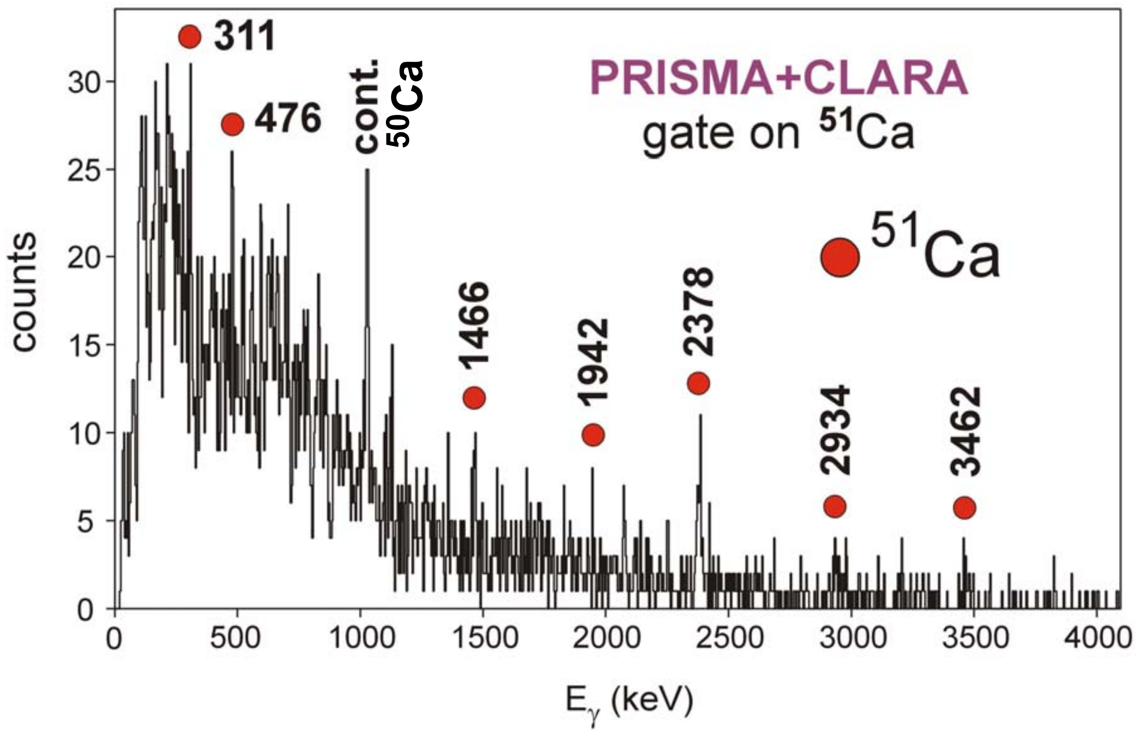


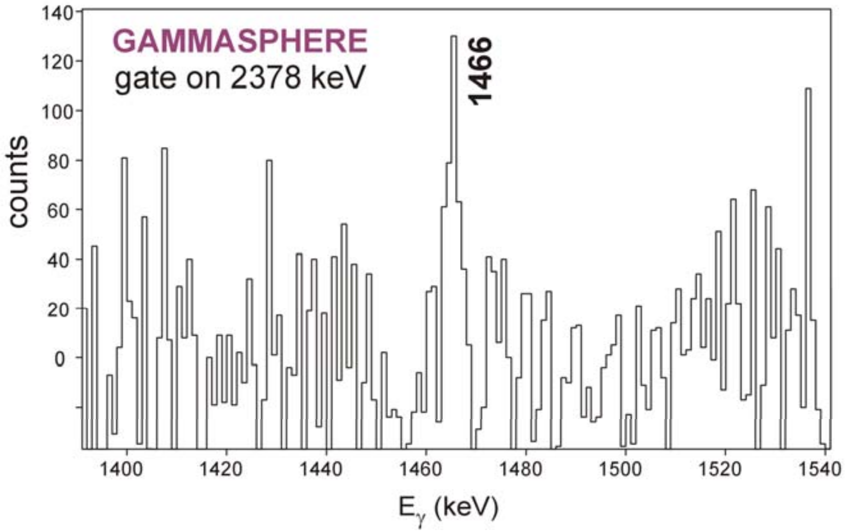
γ–product Coincedences

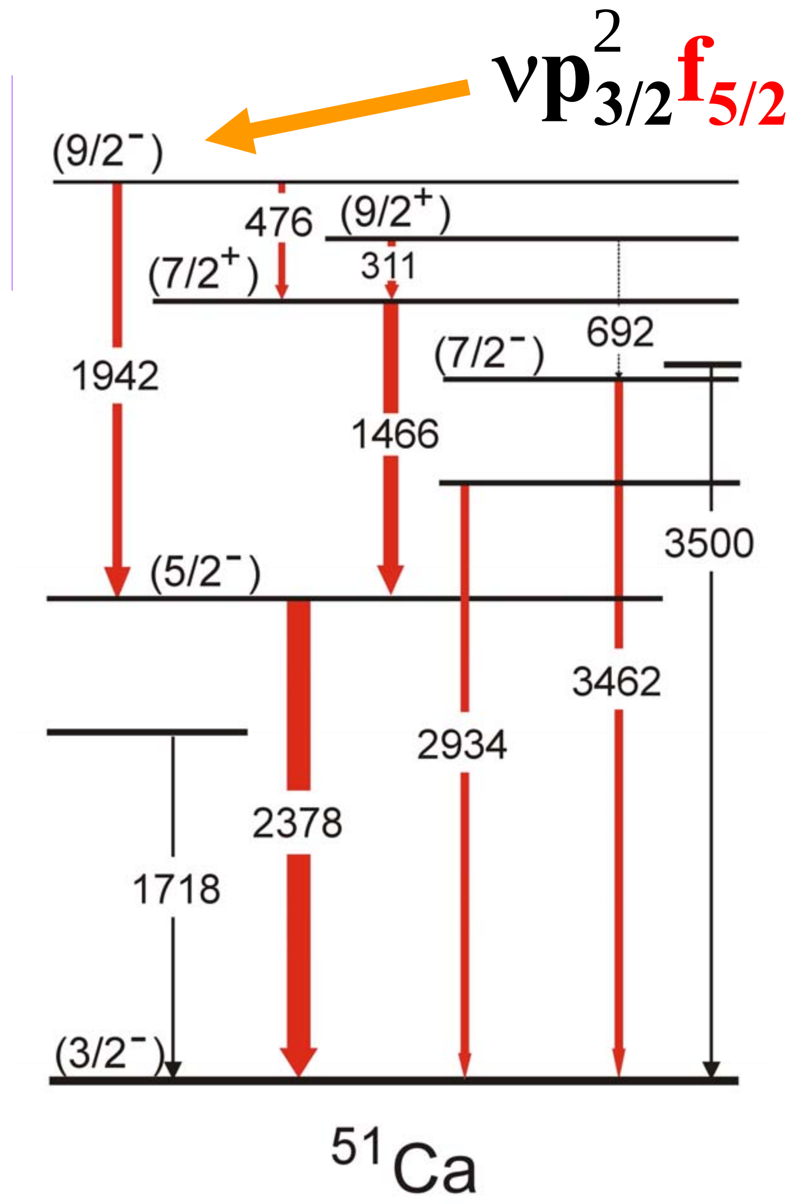


γ–γ Coincidences

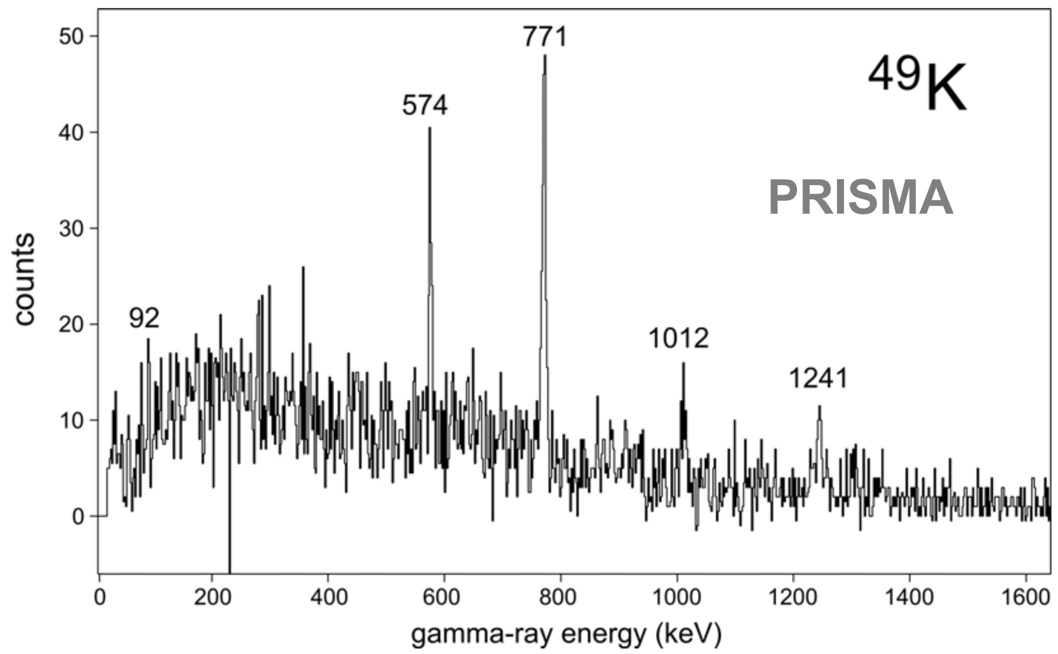


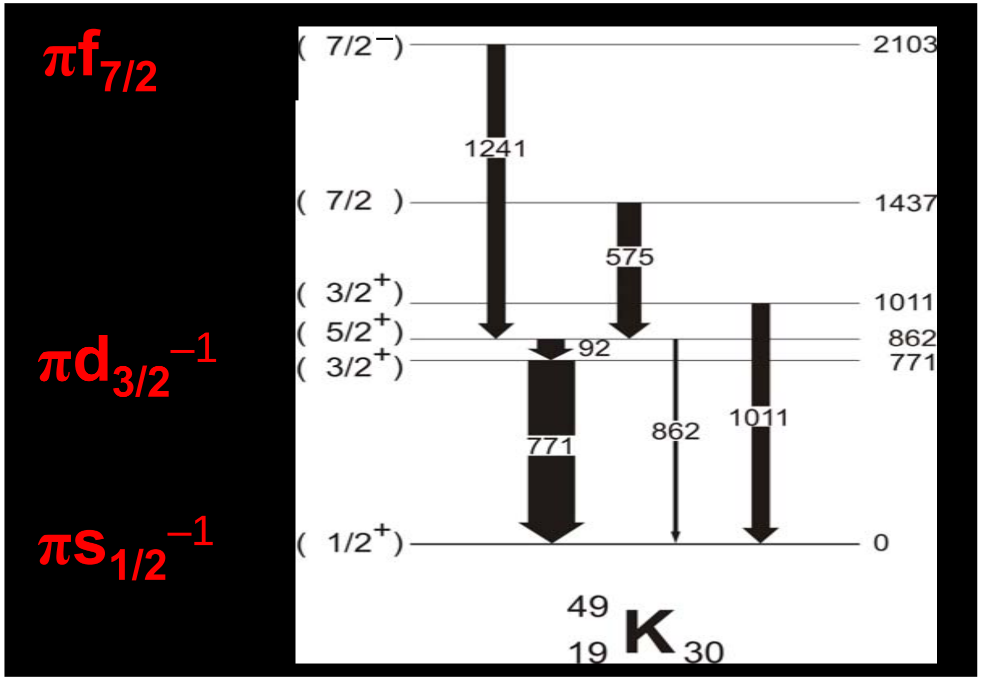


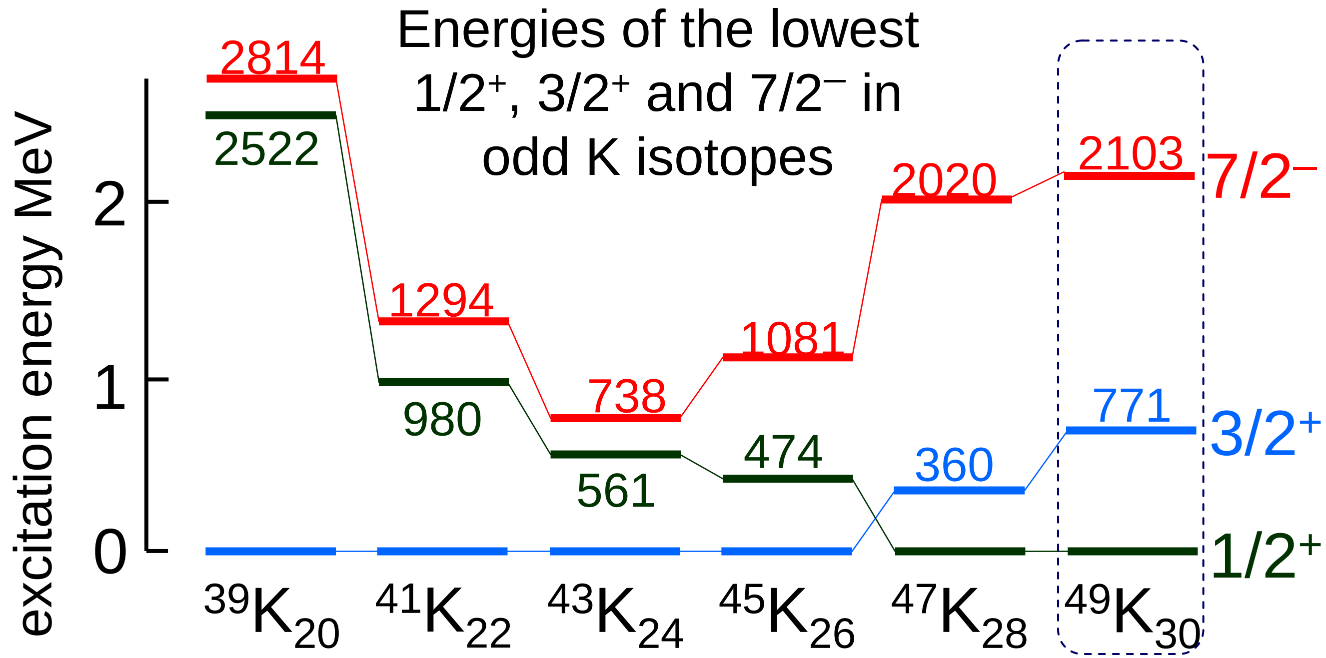




B.Fornal, R.Broda et al., to be published



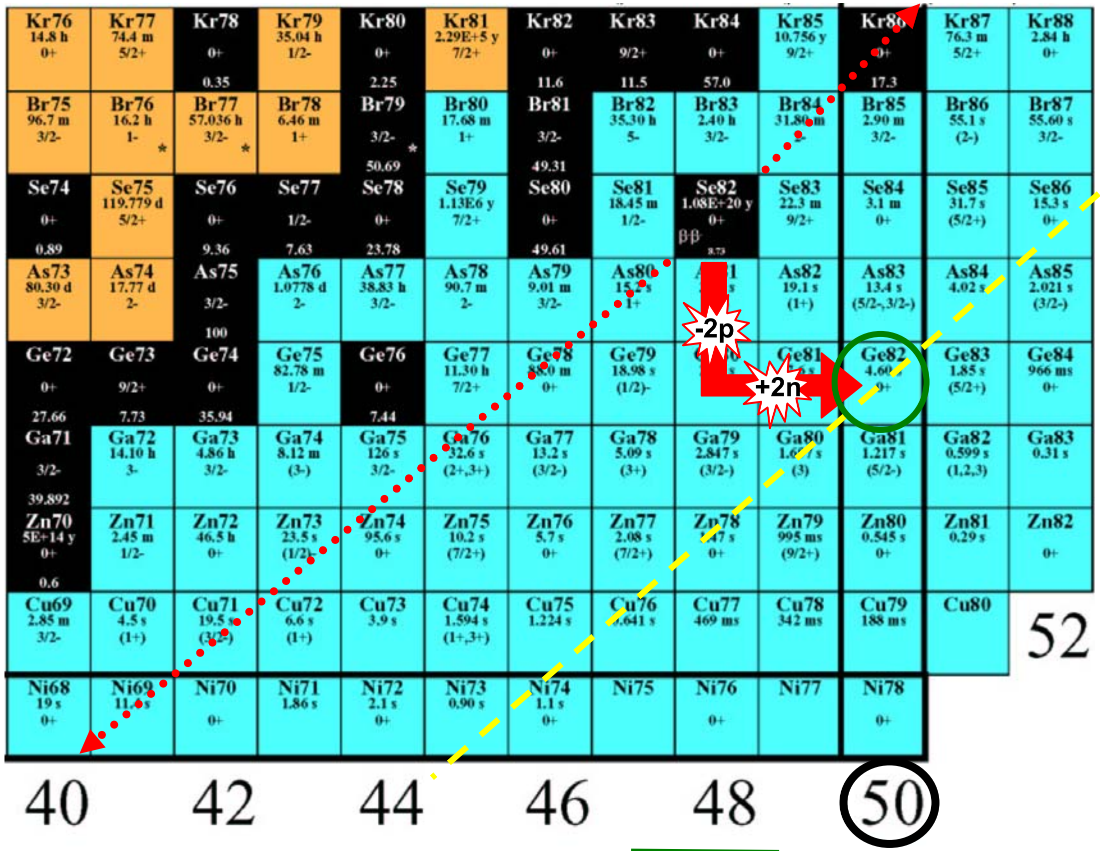


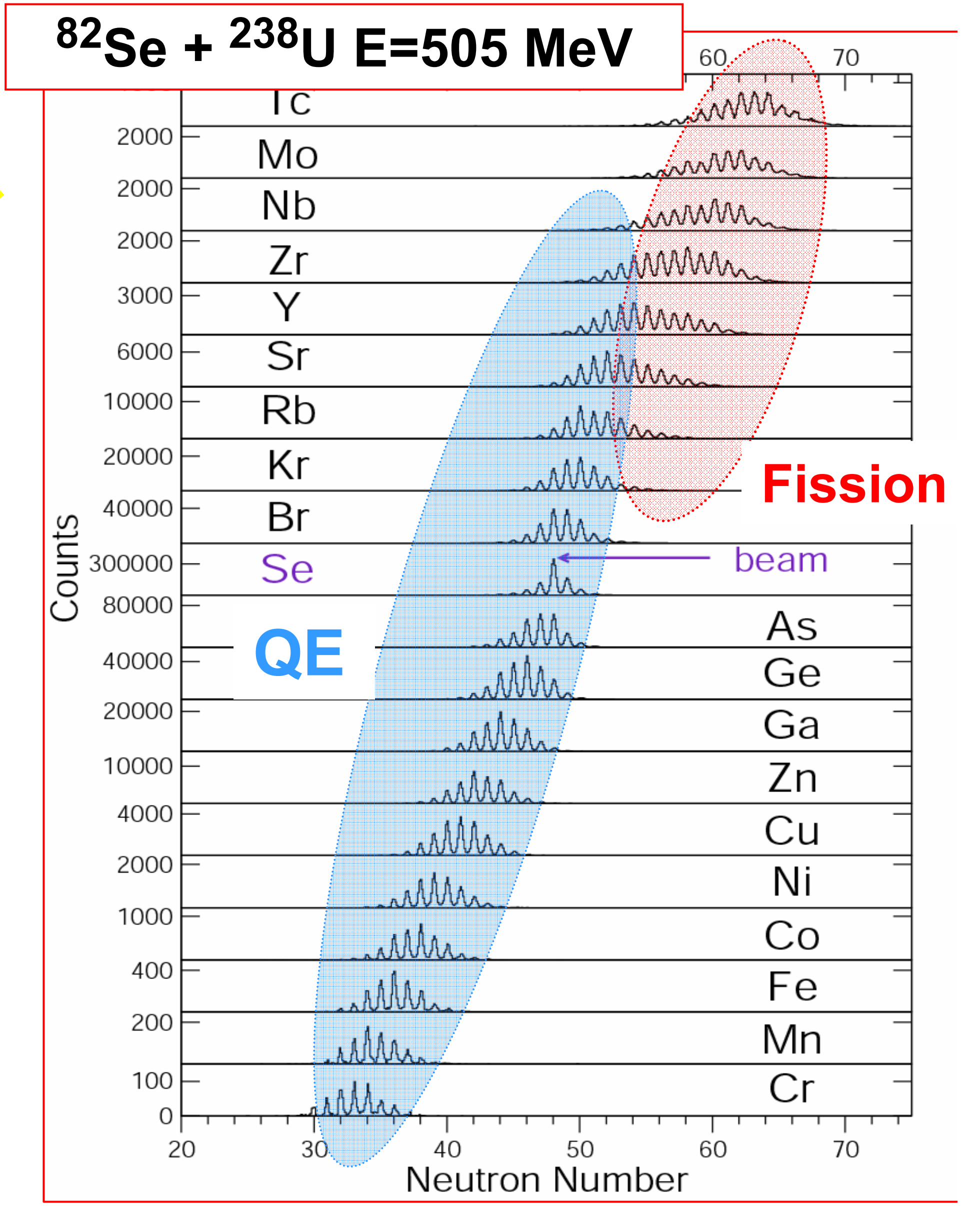


- Gamma lines identified from CLARA-PRISMA
- Level scheme from GammaSphere coincidence analysis

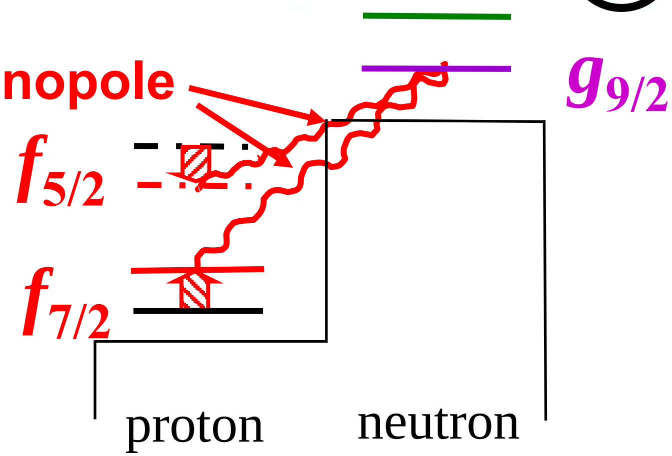
R.Broda, B.Fornal et al., to be published

Evolution of the N=50 Shell Gap





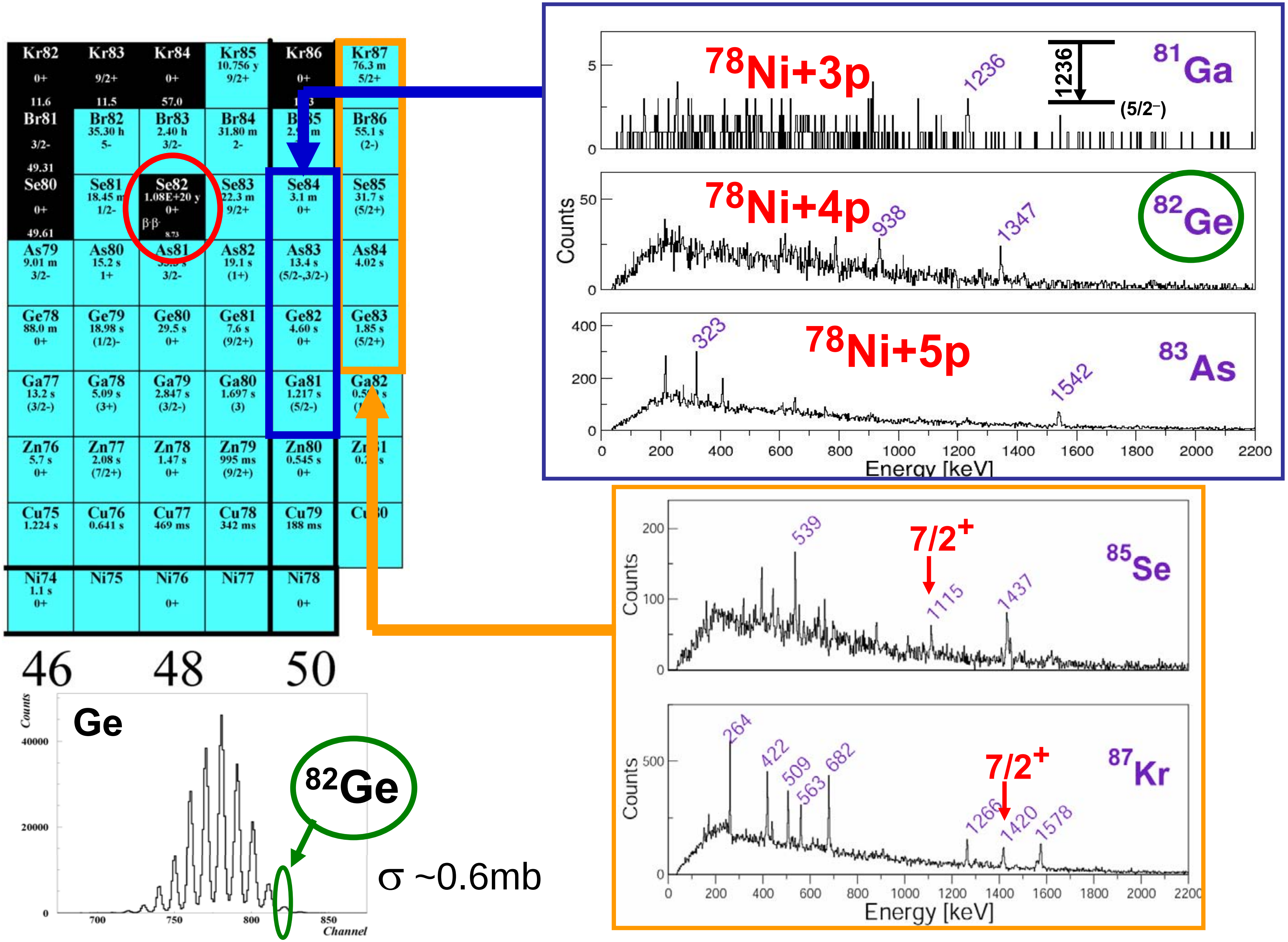
Tensor monopole



Major role in OBEP for π and ρ mesons

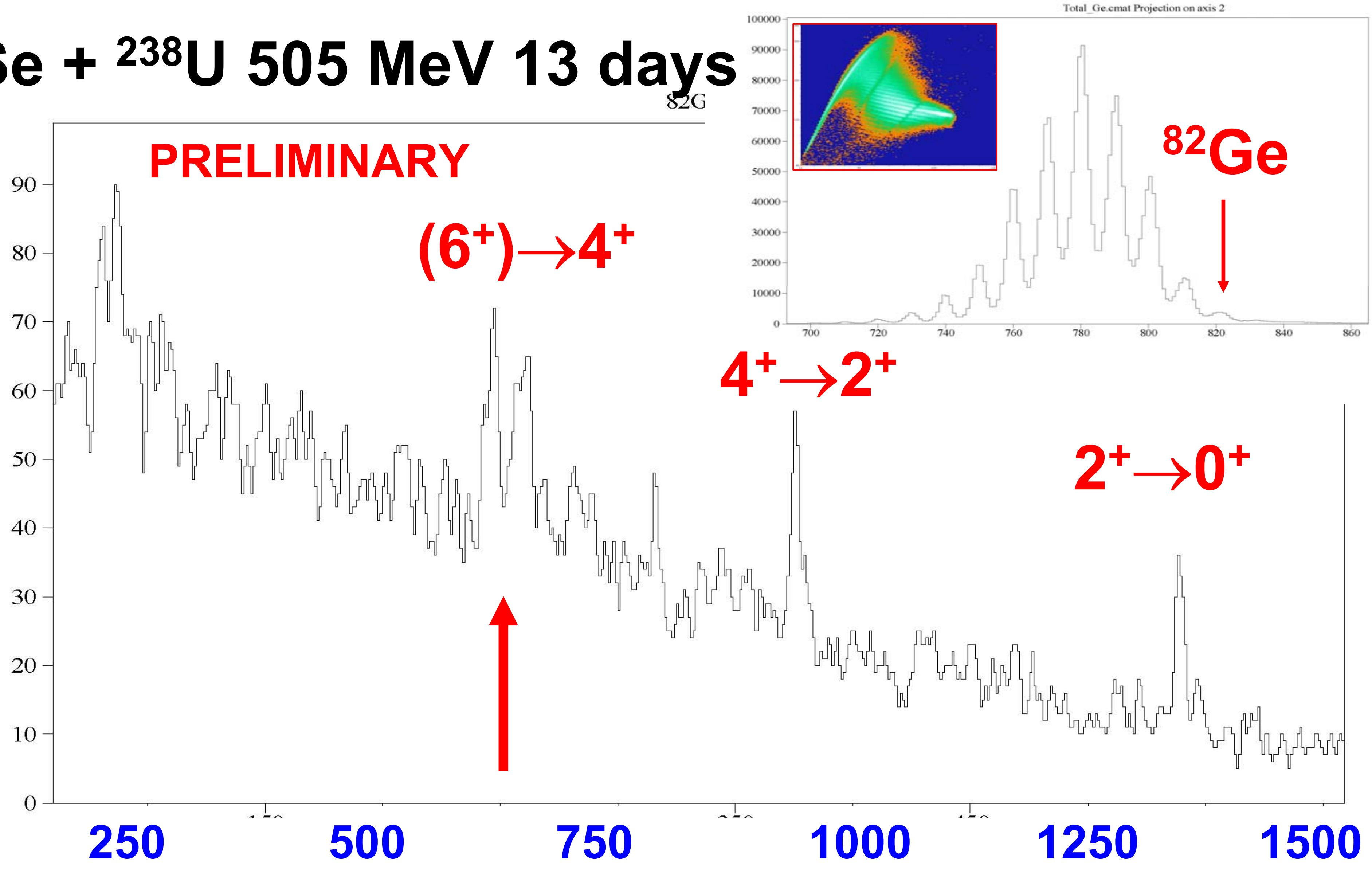
G.Duchêne, G.deAngelis, E.Sahin, T.Faul

Spectroscopy of the N=50 Isotones



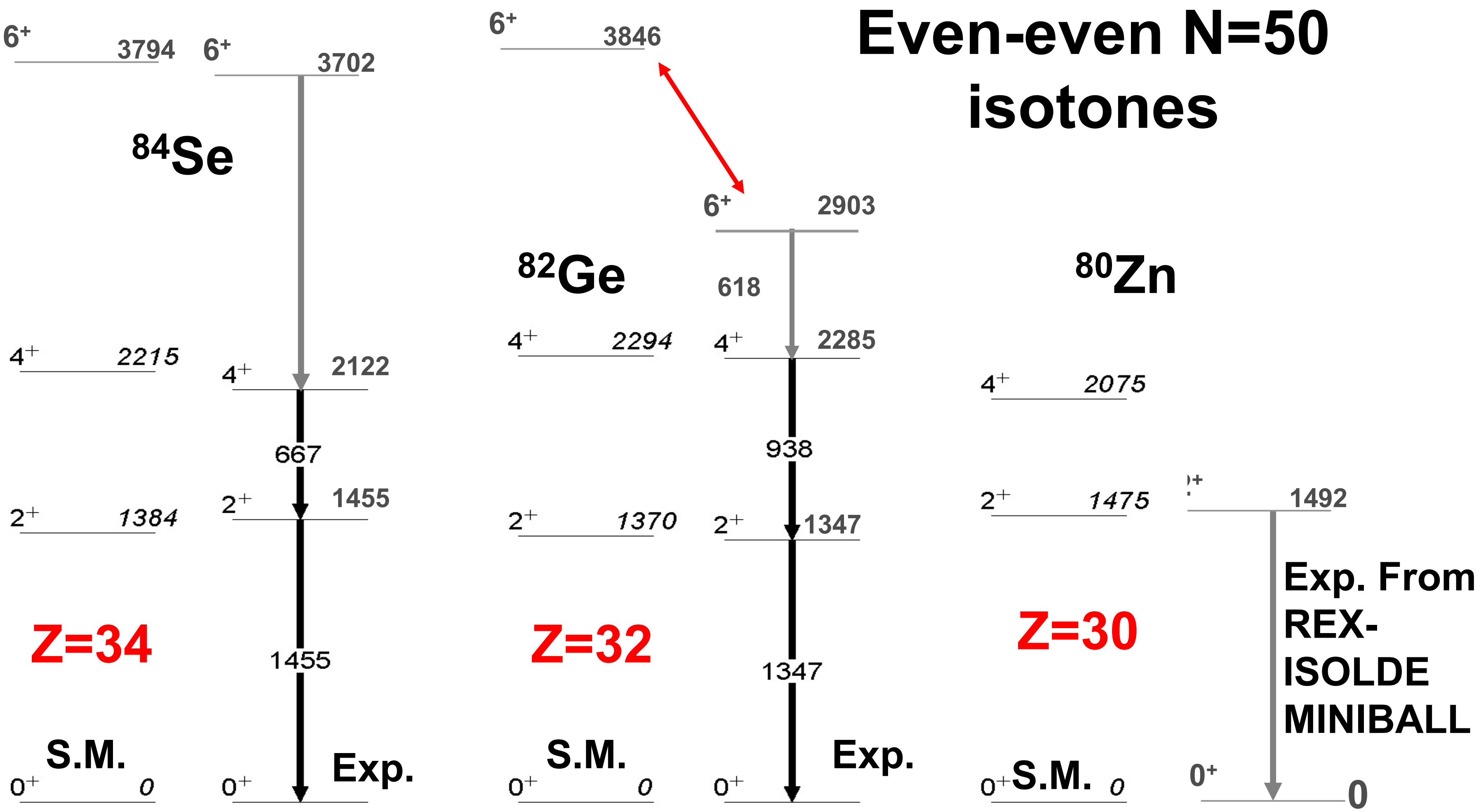
σ ~0.6mb

$^{82}Se + ^{238}U$ 505 MeV 13 days



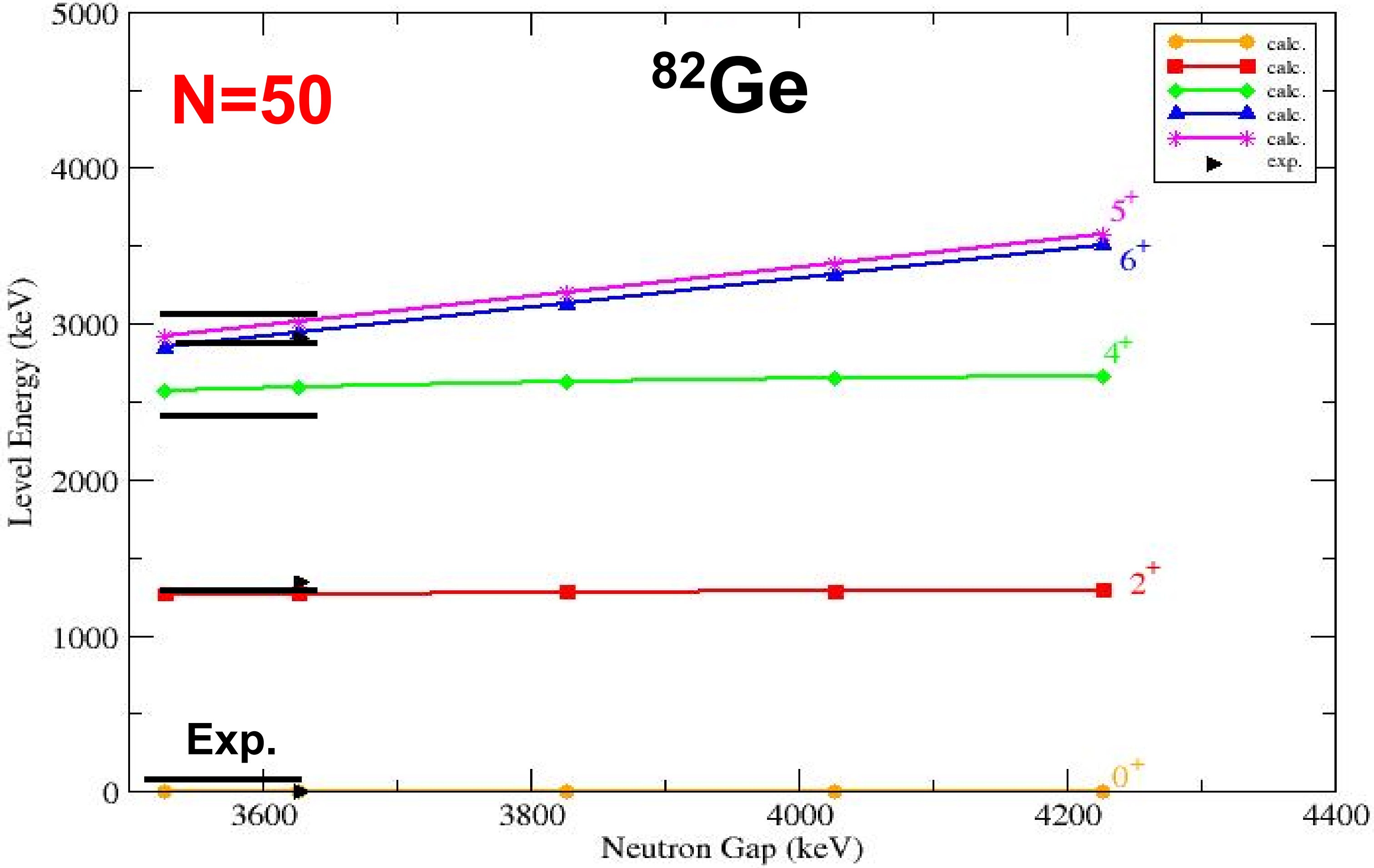
G.Duchêne, G.deAngelis, E.Sahin, T.Faul

Fix effective SPE and TBME for π



Interaction from A.F. Lisetskiy, B.A.Brown, M. Horoy, H. Grawe PRC 70 (2004) 44314, EPJA 25 s01 (2005) 95 (G-Matrix based on Bonn-C)

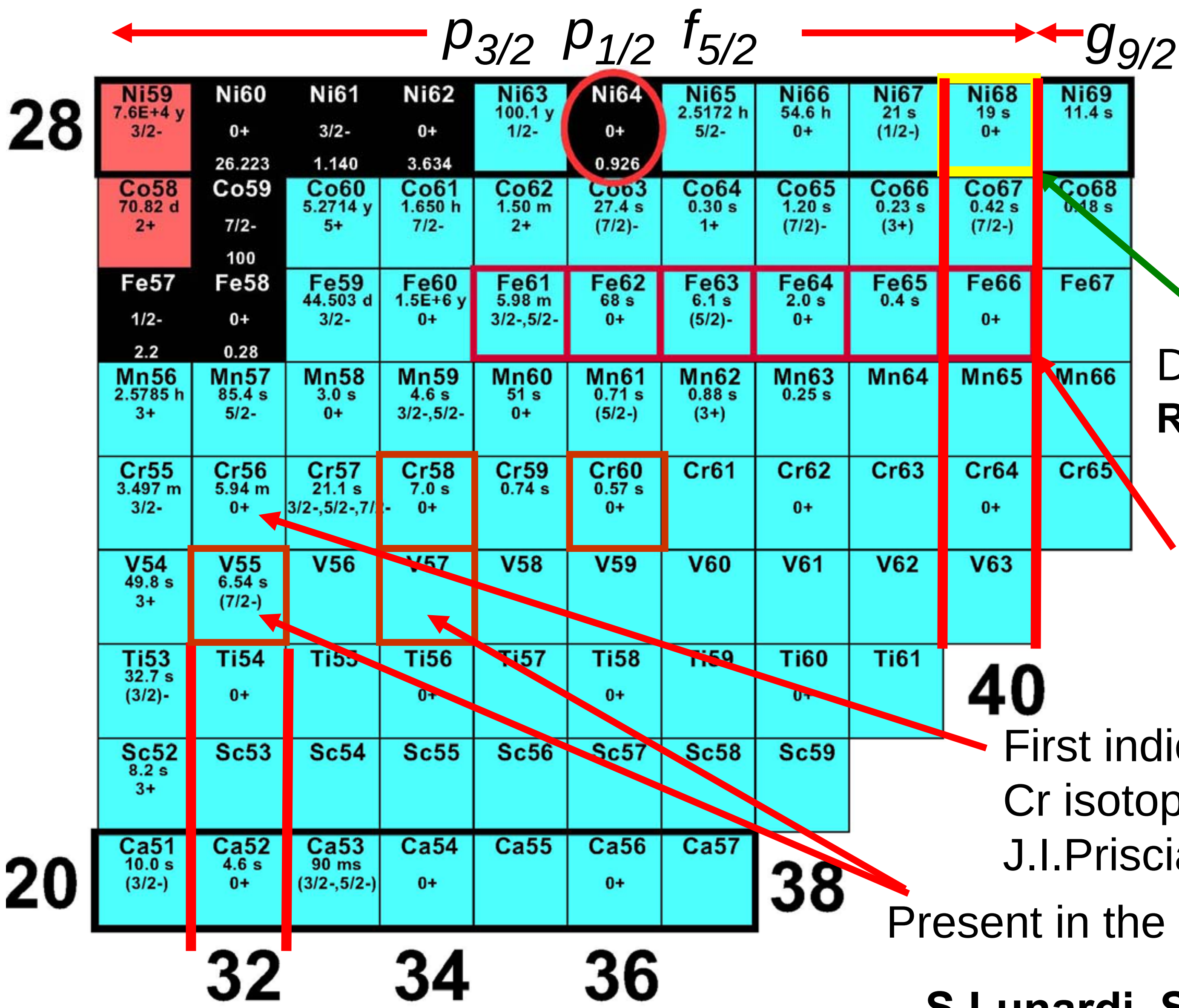
$\mathcal{E}(\nu d_{5\backslash 2}) - \mathcal{E}(\nu g_{9/2})$



Neutron energy Gap reduced of ~ 20%

Interaction from A. Hosaka, K. Kubo, H. Toki NP A444 (1985) 76, (bare G-Matrix + empirical values)

N~40: Neutron-rich Fe isotopes



^{64}Ni (400 MeV)+ ^{238}U

CLARA-PRISMA

$\theta_G = 64^o$

Doubly magic character
R.Broda et al., PRL 74 (95) 868

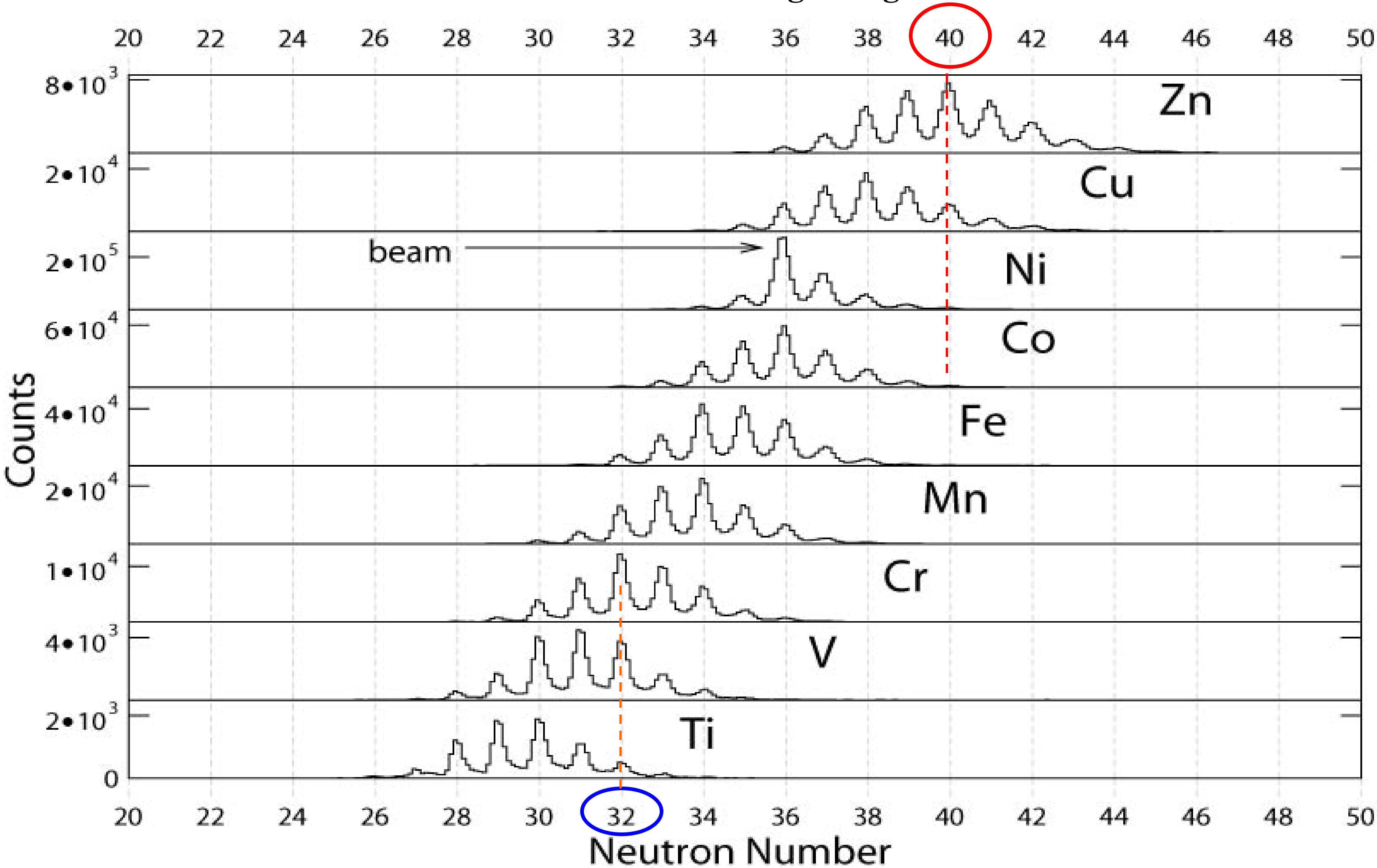
Yrast states: evolution of the collectivity towards N=40 in the Fe (Z=26) isotopes

First indication of N=32 shell gap in Cr isotopes
J.I.Prisciandaro et al PLB510(01)17

Present in the in the $1\pi f7/2$ band in ^{55,57}V

S.Lunardi, S.M.Lenzi, S.Freeman

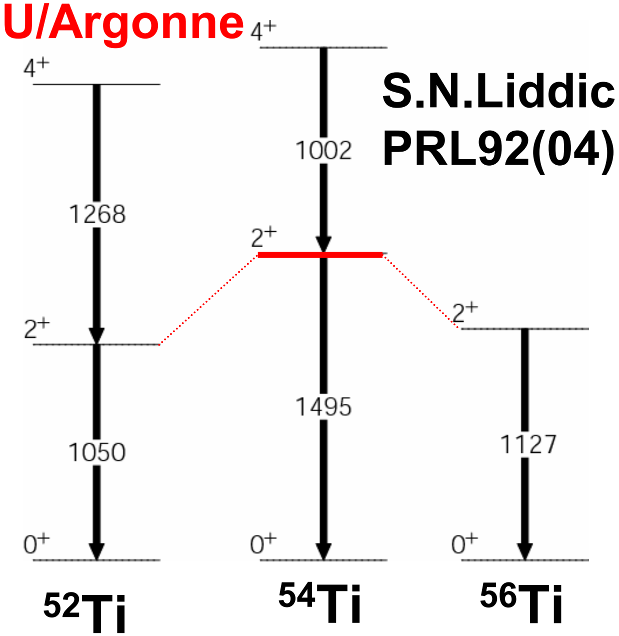
^{64}Ni (400 MeV)+ ^{238}U ($\theta_{grazing}$= 64˚)

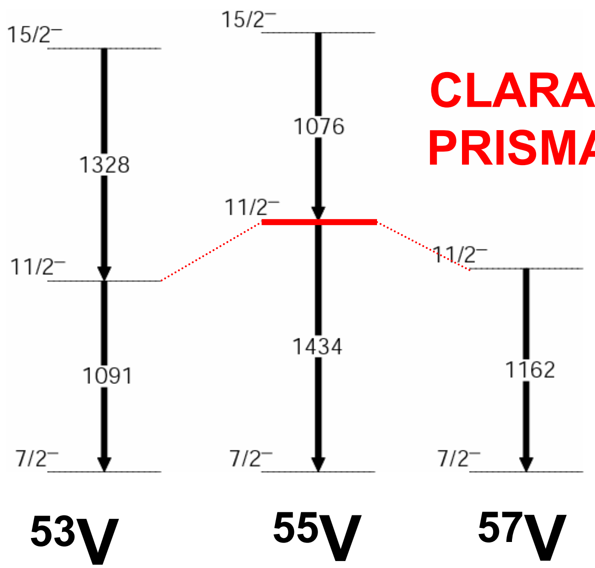


Spectroscopy around the N=32 shell closure

MSU/Argonne

S.N.Liddick PRL92(04)



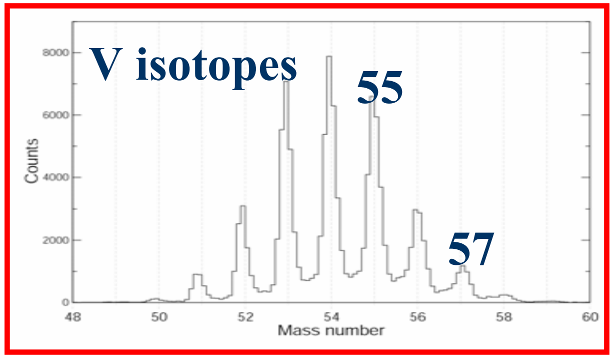


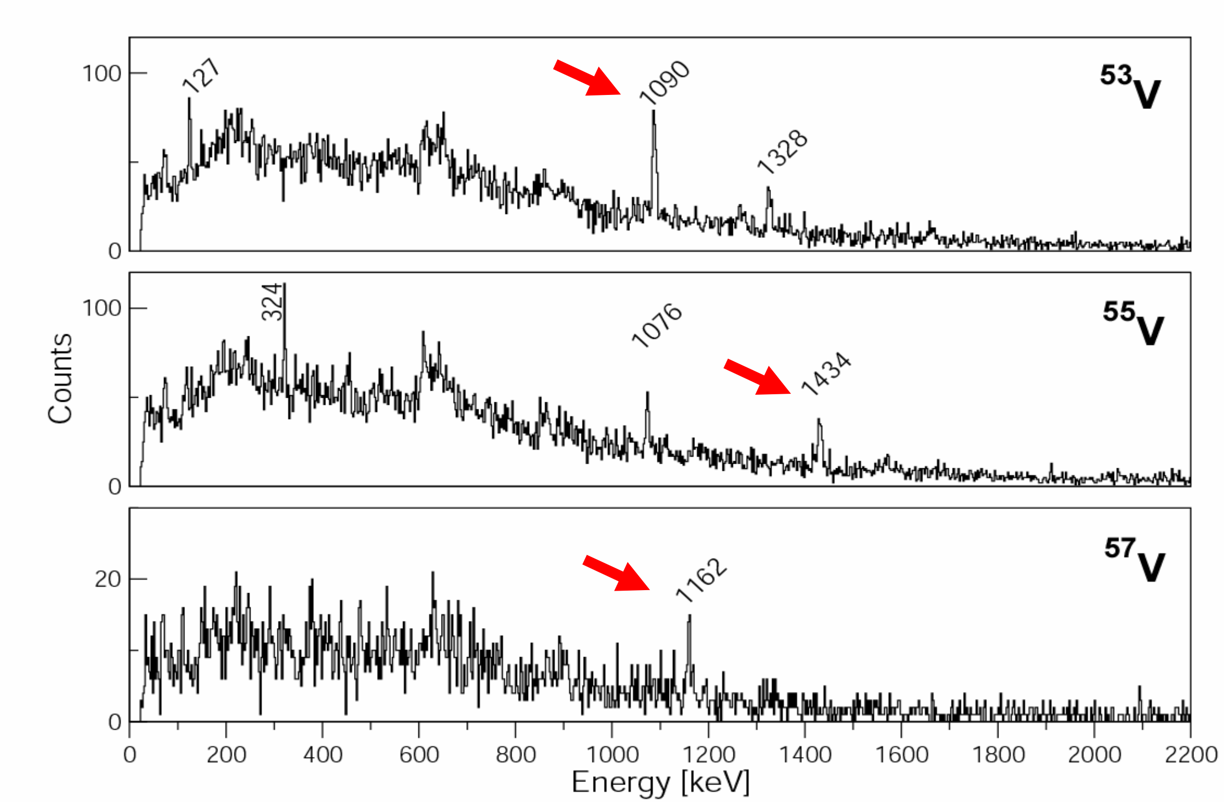
CLARA-PRISMA

N=32 **N=34**

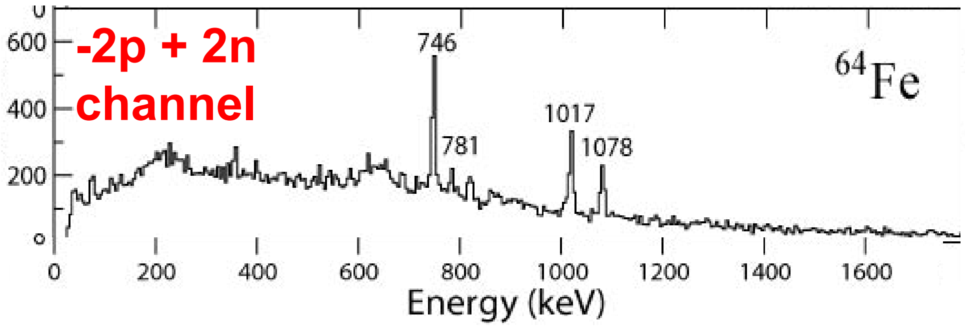
First identification of yrast states in ^{55}V and ^{57}V

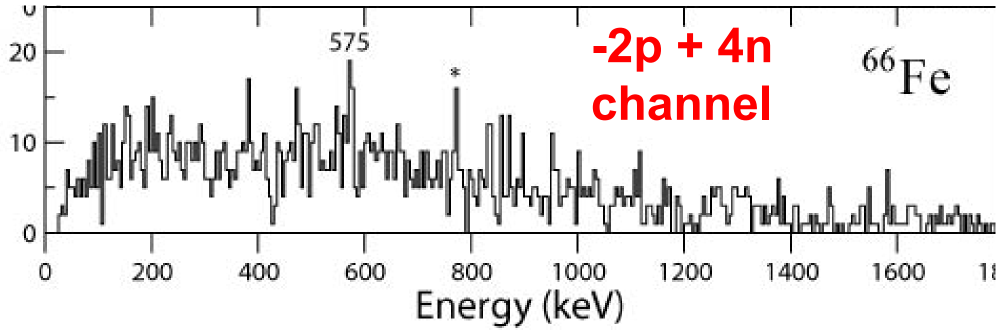
^{64}Ni(400 MeV) + ^{238}U

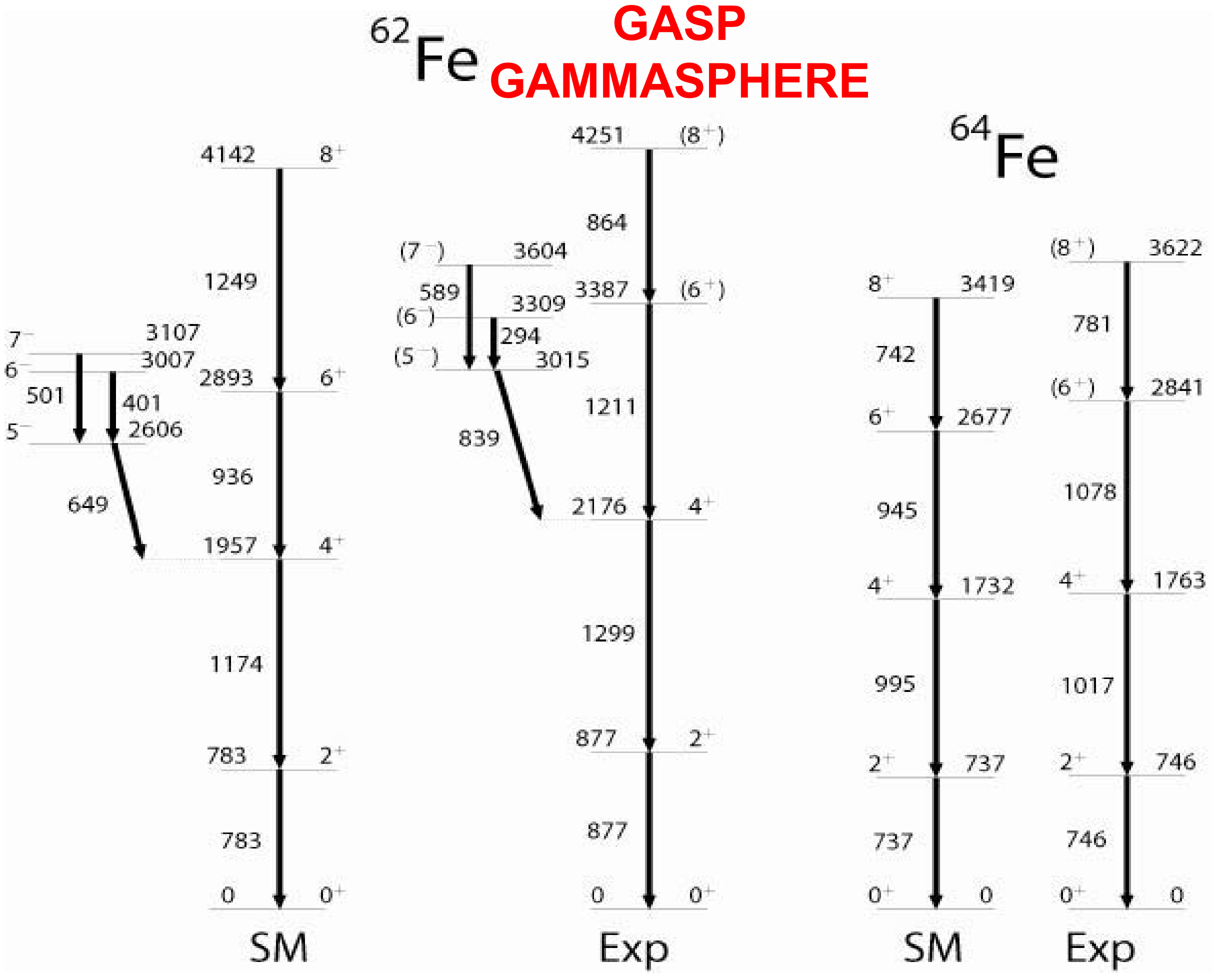




N=32 shell closure as previously observed in ^{54}Ti and ^{56}Cr, N=34 could not be confirmed.



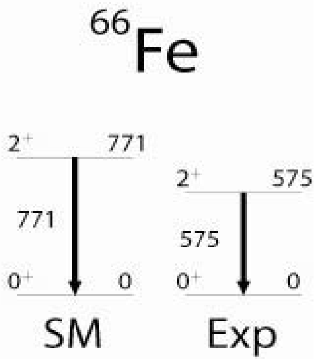




SM calculations for Fe nuclei

- Core ^{48}Ca
- *fp* **for protons**
- $p_{3/2}, f_{5/2}, p_{1/2}, g_{9/2}$ **for neutrons**

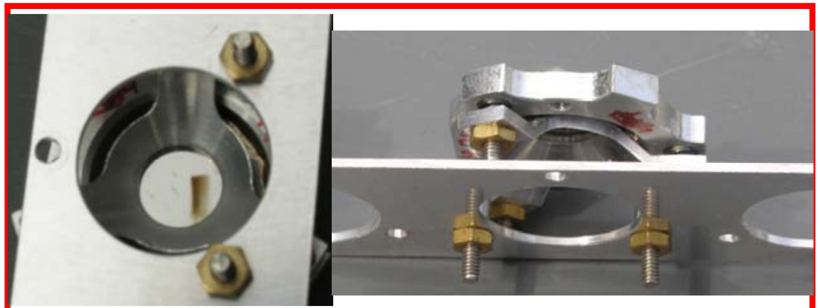
S.Lunardi, S.Lenzi et al.
to be submitted



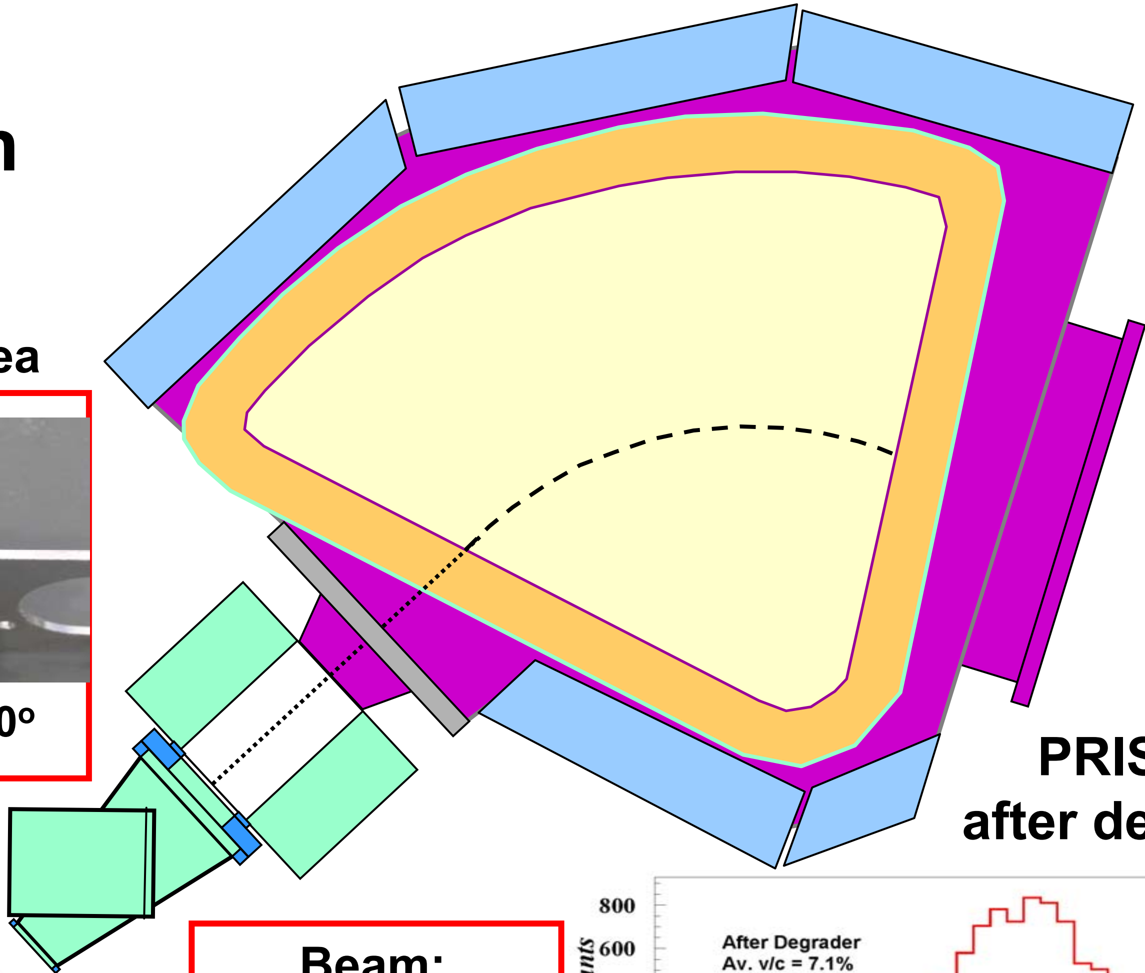
also in β-decay M.Hannawald et al., PRL 82 (99)

Differential RDDS Measurements with CLARA-PRISMA

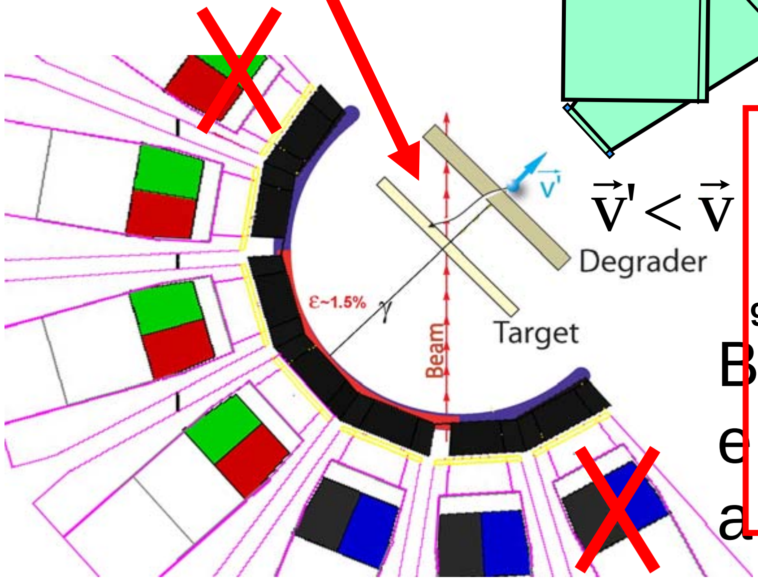
A,Dewald, N.Marginean, A.Gadea



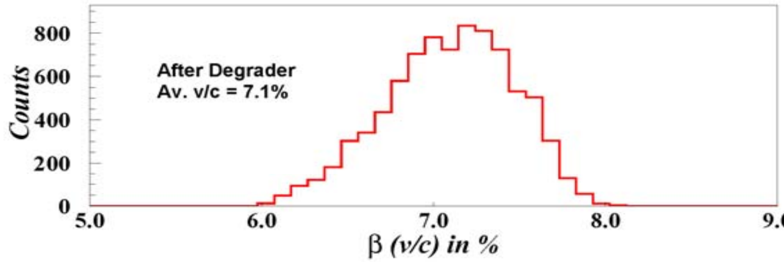
Differential Plunger for angles ≠ 0°

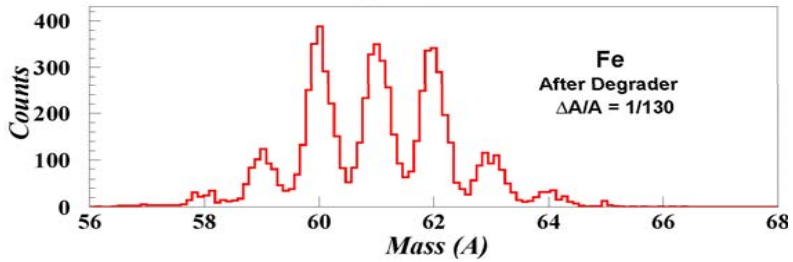


PRISMA after degrader

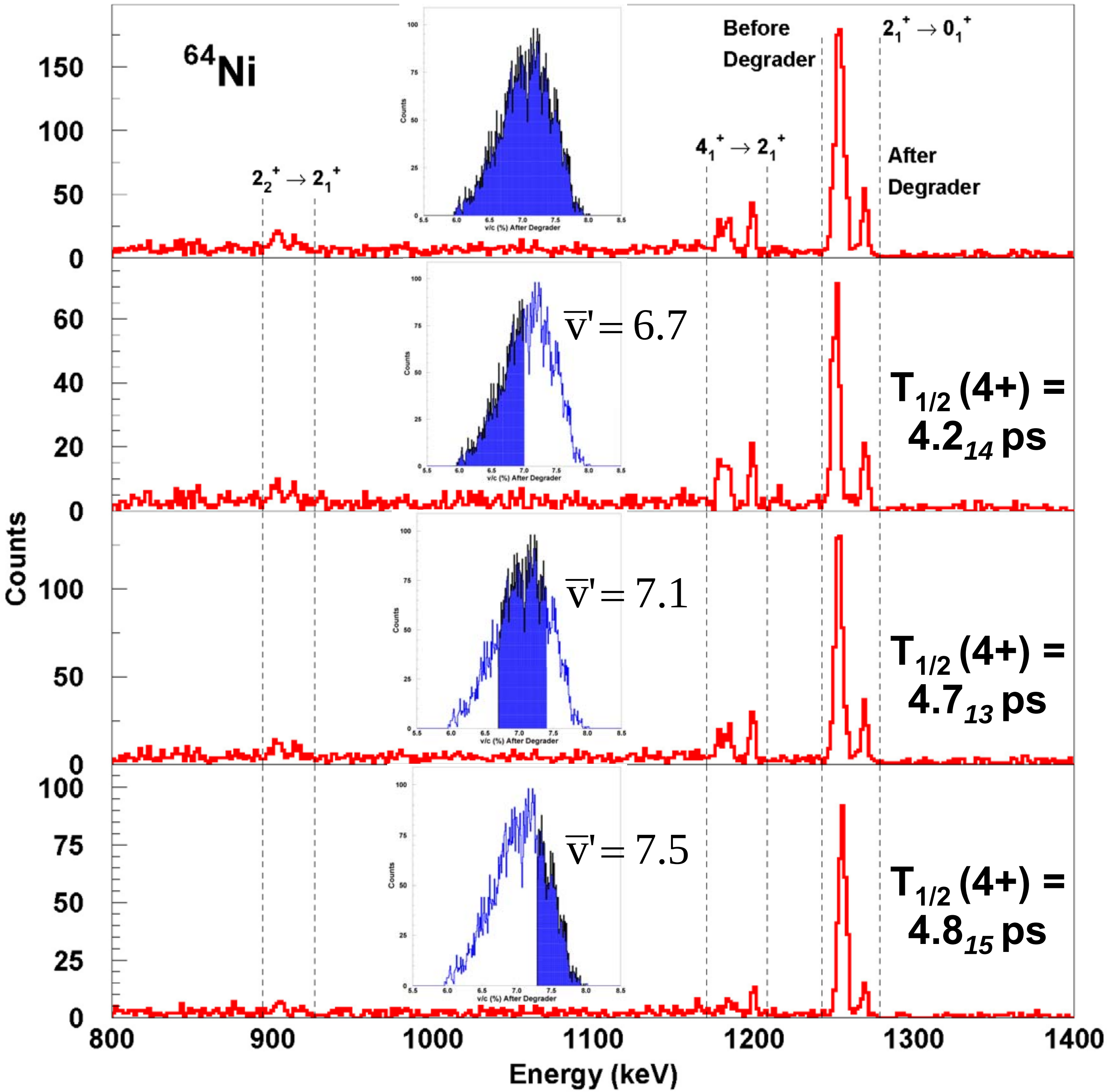


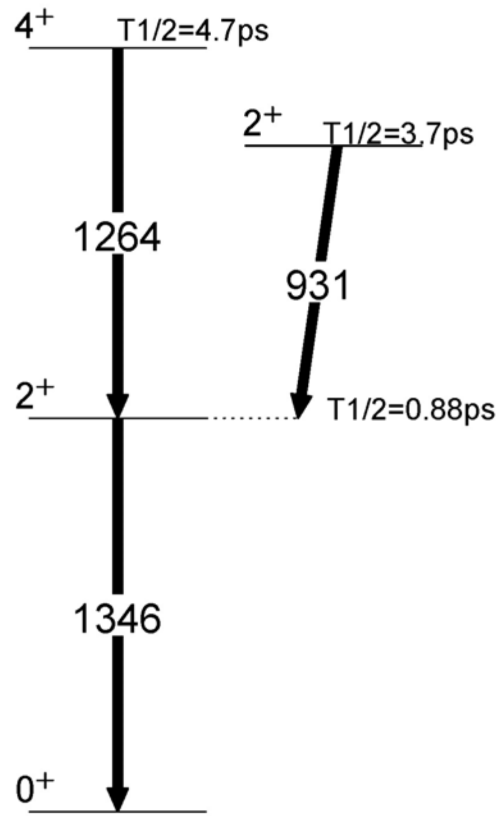
Beam:
^{64}Ni at 400MeV
Target:
^{93}Nb 1mg/cm^2 +
^{208}Pb 1mg/cm^2
Degrader:
^{24}Mg 2mg/cm^2



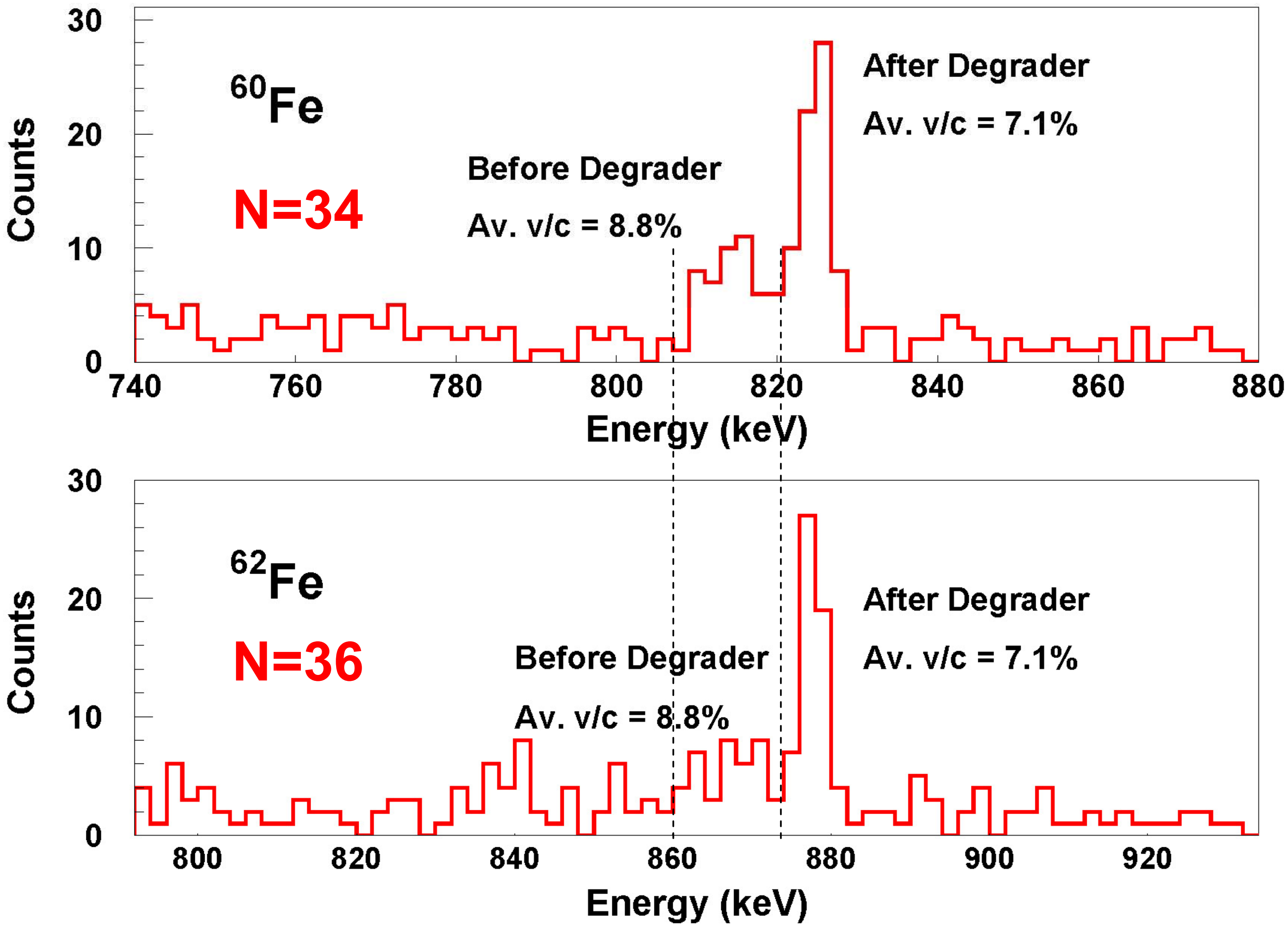


^{64}Ni Inelastic Scattering





Preliminary Results for 150μm Target-Degrader Distance



Test case ^{60}Fe

(2^+ at 824 keV)

$T_{1/2}$= 8.2(15) ps (agreement with known 8.0(15) ps)

B(E2)=0.018 e^2b^2 (13 W.u.)

sign of “longer” lifetime in ^{62}Fe

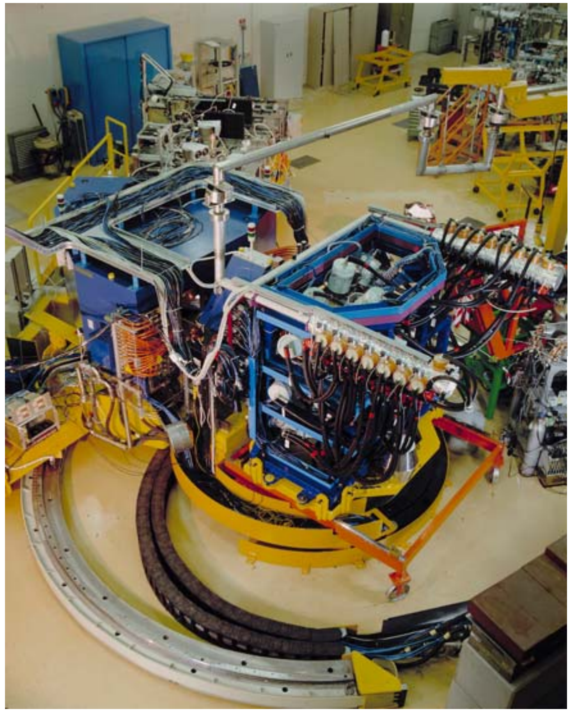
(2^+ at 877 keV)

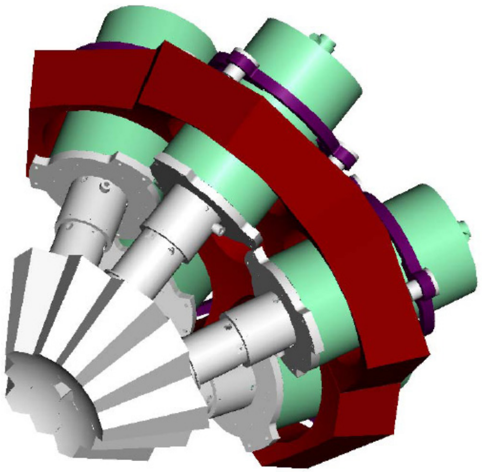
$T_{1/2}$~9.5(20) ps

B(E2)~0.012 e^2b^2 (8 W.u.)

Outlook:

- CLARA will be dismounted on Spring 2008 after 3 years providing valuable structure information on moderately n-rich nuclei.
- During 2008 the AGATA Demonstrator will be mounted and commissioned at the PRISMA target position.





- The AGATA Demonstrator will improve the efficiency (x2) and resolution (x3) of the setup.
- The experimental campaign with the new setup will start in 2009.
- The new research program will extend to heavier beams and will also cover RDDS measurements with the plunger device.

The CLARA-PRISMA collaboration

•France
IReS Strasbourg
GANIL Caen

•U.K.
University of Manchester
Daresbury Laboratory
University of Surrey
University of Paisley

•Germany
HMI Berlin
GSI Darmstadt

•Poland
IFJ-PAN Kraków

•Italy
INFN LNL-Legnaro
INFN and University Padova
INFN and University Milano
INFN and University Genova
INFN and University Torino
INFN and University Napoli
INFN and University Firenze
University of Camerino

•Spain
University of Salamanca

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