



Lifetime measurements in neutron-rich Cr isotopes

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Approaching the N=40 subshell gap

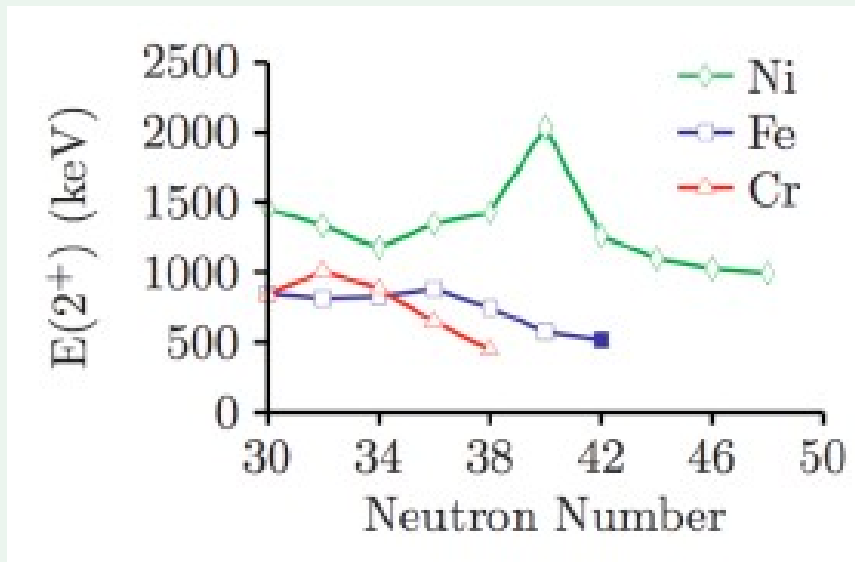
Ni60 0+ 26.223	Ni61 3/2- 1.140	Ni62 0+ 3.634	Ni63 100.1 y 1/2- β-	Ni64 0+ 0.926	Ni65 2.5172 h 5/2- β-	Ni66 54.6 h 0+ β-	Ni67 21 s (1/2-) β-	Ni68 19 s 0+ β-	
Co59 7/2- 100	Co60 5.2714 y 5+ *	Co61 1.650 h 7/2- β-	Co62 1.50 m 2+ β-	Co63 27.4 s (7/2-) β-	Co64 0.30 s 1+ β-	Co65 1.20 s (7/2-) β-	Co66 0.233 s (3+) β-	Co67 0.42 s (7/2-) β-	
Fe58 0+ 0.28	Fe59 44.503 d 3/2- β-	Fe60 1.5E+6 y 0+ β-	Fe61 5.98 m 3/2-, 5/2- β-	Fe62 68 s 0+ β-	Fe63 6.1 s (5/2-) β-	Fe64 2.0 s 0+ β-	Fe65 0.4 s β-	Fe66 440 ms 0+ β-	
Mn57 85.4 s 5/2- β-	Mn58 3.0 s 1+ β-	Mn59 4.6 s 3/2-, 5/2- β-	Mn60 51 s 0+ β-	Mn61 0.71 s (5/2-) β-	Mn62 0.88 s (3+) β-	Mn63 0.25 s β-	Mn64 140 ms (3+) β-n	Mn65 110 ms (5/2-) β-n	
Cr56 5.94 m 0+ β-	Cr57 21.1 s 3/2-, 5/2-, 7/2- β-	Cr58 7.0 s 0+ β-	Cr59 0.74 s β-	Cr60 0.57 s 0+ β-	Cr61 270 ms (5/2-) β-n	Cr62 190 ms 0+ β-n	Cr63 110 ms (1/2-) β-n	Cr64 0+ β-n	

f7/2



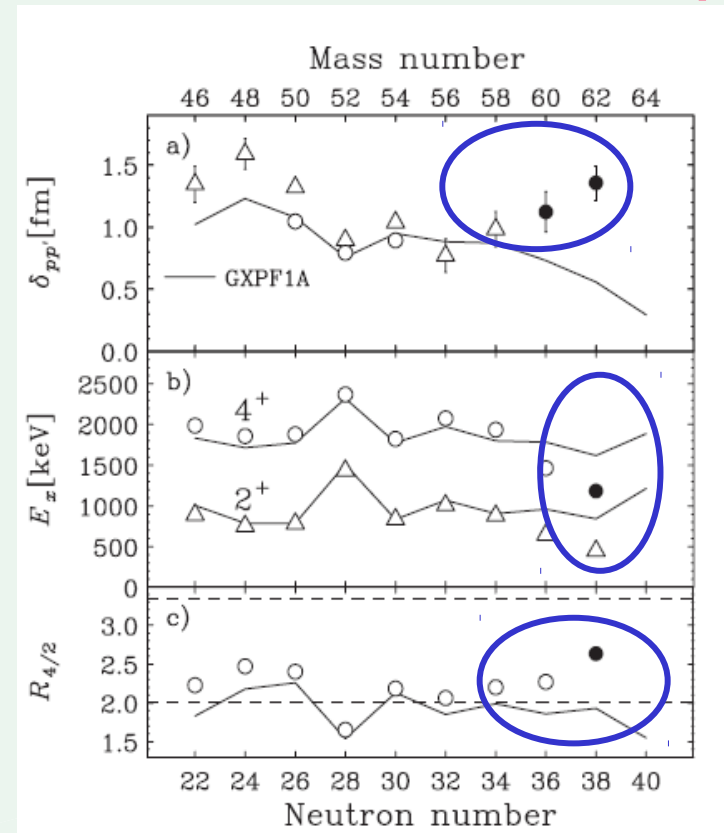
N=40 subshell gap in ^{68}Ni

N=40 subshell gap in ^{68}Ni disappears when protons are removed from the $f_{7/2}$ → Monopole part of the tensor interaction



S. Lunardi et al., Phys. Rev. C **76**, 034303 (2007).
 S. Lenzi et al., LNL Annual Report (2008).
 P. Adrich et al. Phys. Rev. C **77**, 054306 (2008).
 O. Sorlin et al., Eur. Phys. J A **16** 55 (2003).

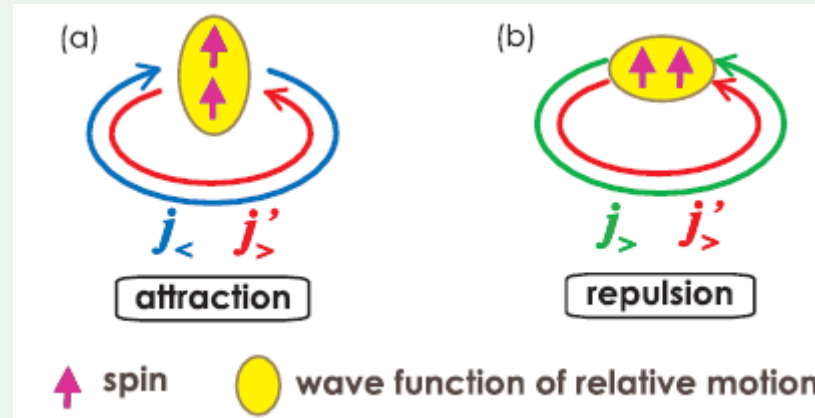
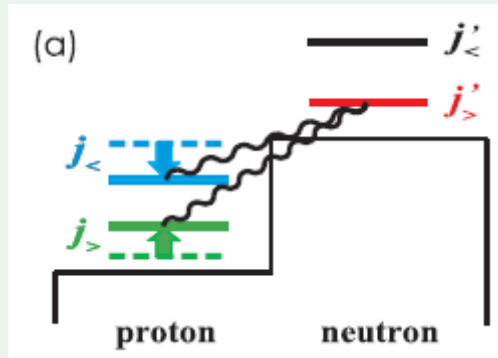
Calculations in the full fp shell



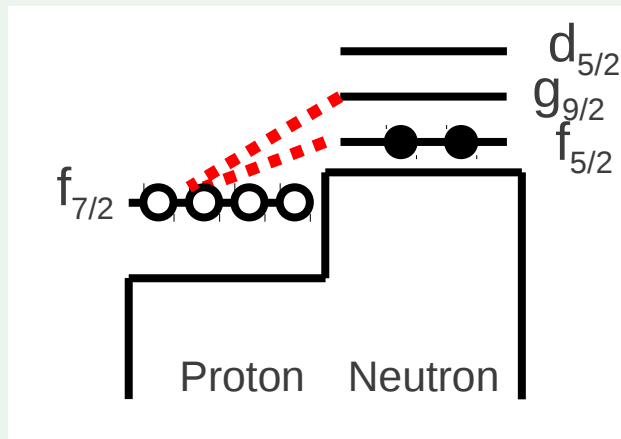
N. Aoi, et al., PRL **102**, 012502 (2009)
 (p,p') reaction with radioactive beams

Monopole effect of the tensor interaction

Monopole effect of the tensor interaction in shell evolution



T. Otsuka et al., PRL95 232502 (2005)



- Cr isotopes 4 holes in the $\pi f_{7/2}$
- Attraction between the $f_{7/2}$ and $f_{5/2}$
- Repulsion between the $f_{7/2}$ and $g_{9/2}$
- Disappearance N=40 subshell gap
- Role of the $d_{5/2}$?

The experiment

SETUP (June 2010)

AGATA D. (4-cluster)
PRISMA 60°
Köln Plunger

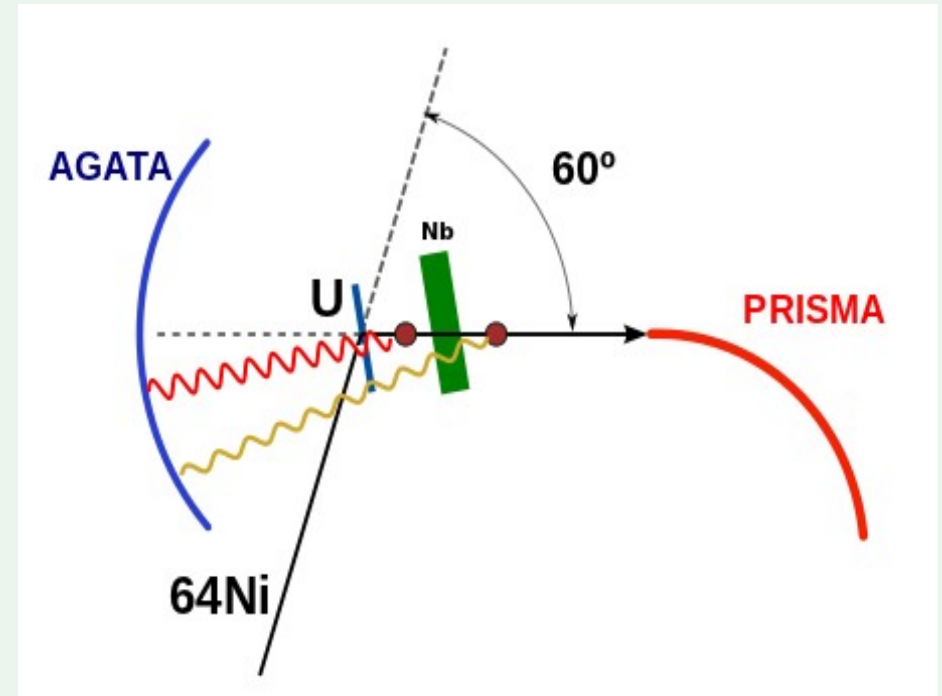
Multi-nucleon transfer reaction

$^{64}\text{Ni} + \text{U}$ (Grazing angle 60°)
Beam: 460 MeV (Intensity
~2.5 pA)
Target: U 1.35 mg/cm²

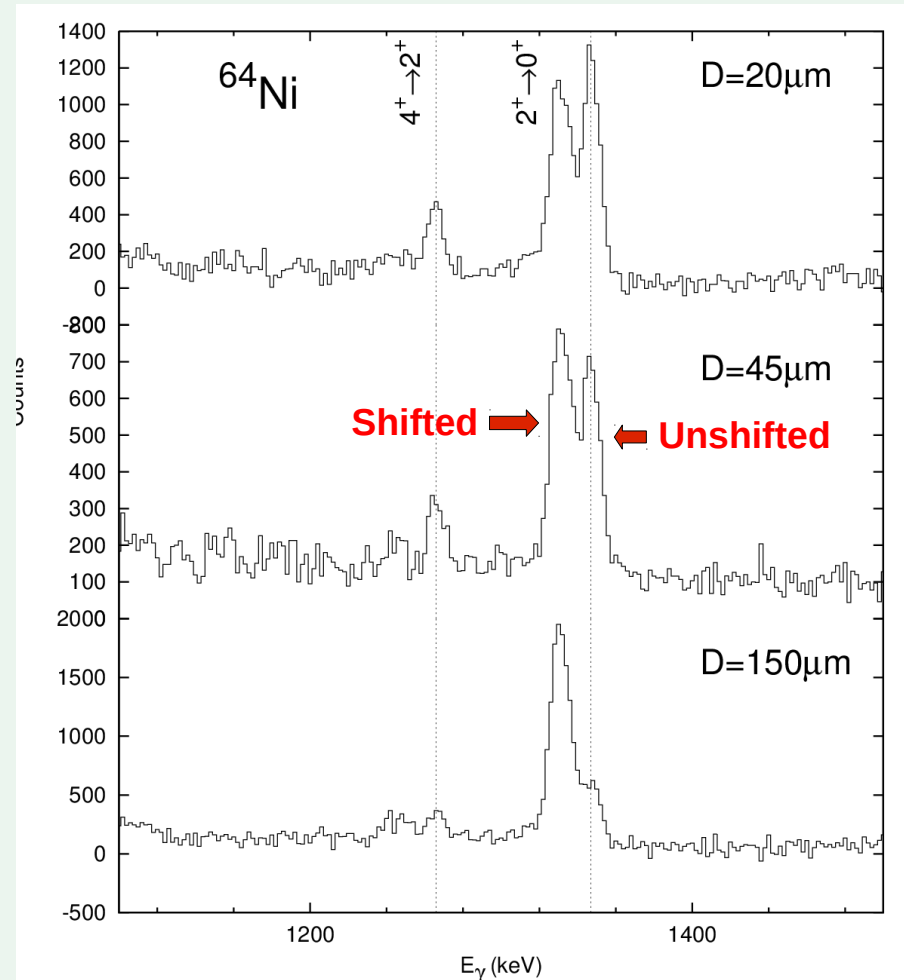
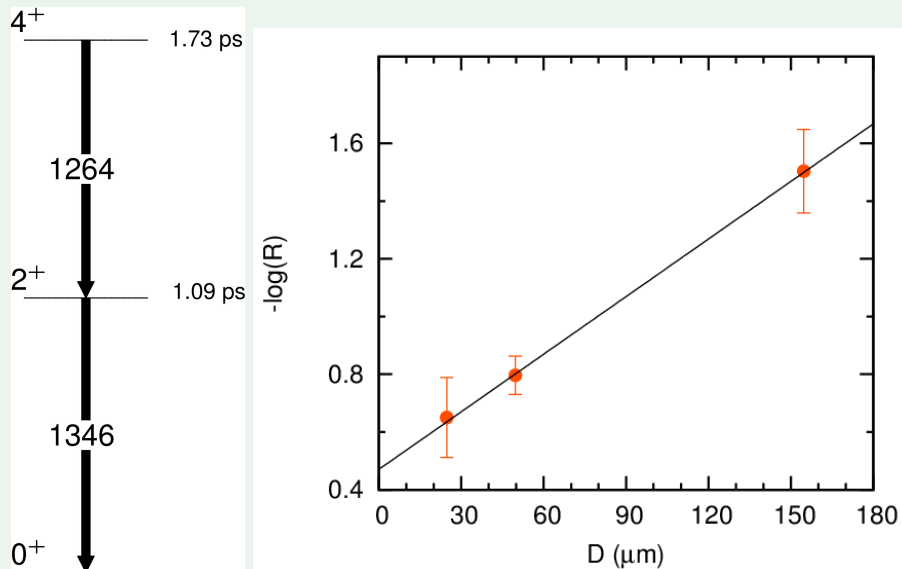
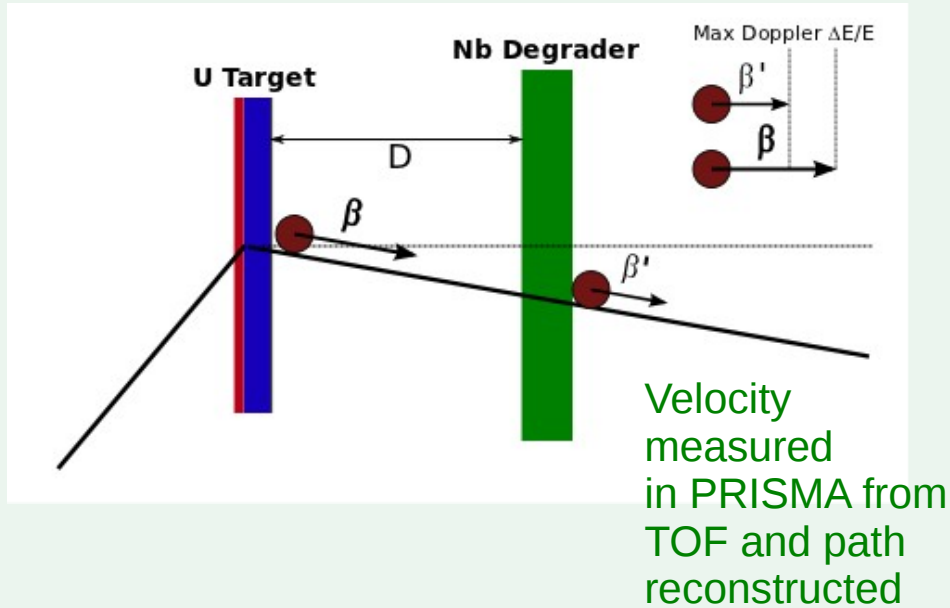
70-90 kHz per AGATA crystal!!

Plunger schedule 6 days experiment

D=45um (3 days) D=20um (1.5 days) D=145um (1.5 days)

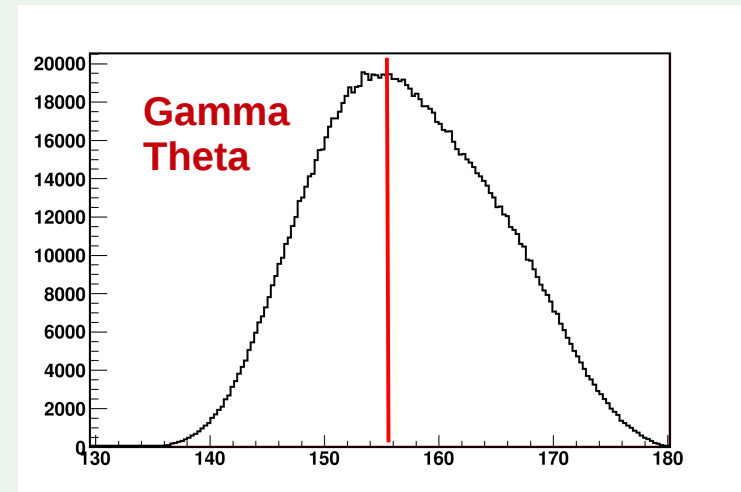
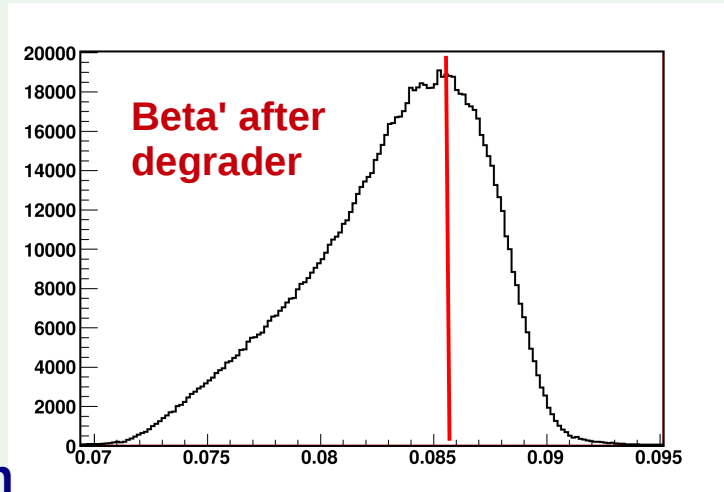
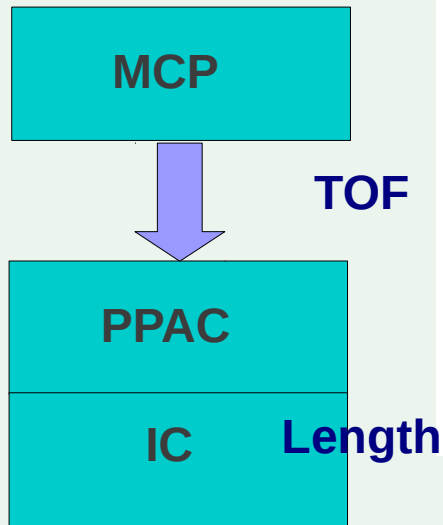


The RDDS method



$$R = \frac{I_{after}}{I_{before} + I_{after}} = \exp\left(-\frac{1}{\beta c \tau} D\right)$$

The RDDS method



$$\beta = \beta' + \frac{E_0^{shifted} - E_0}{\cos(\theta) E_0}$$

Velocity before degrader is deduced from the energy shift and the averaged gamma-ray detection angle.

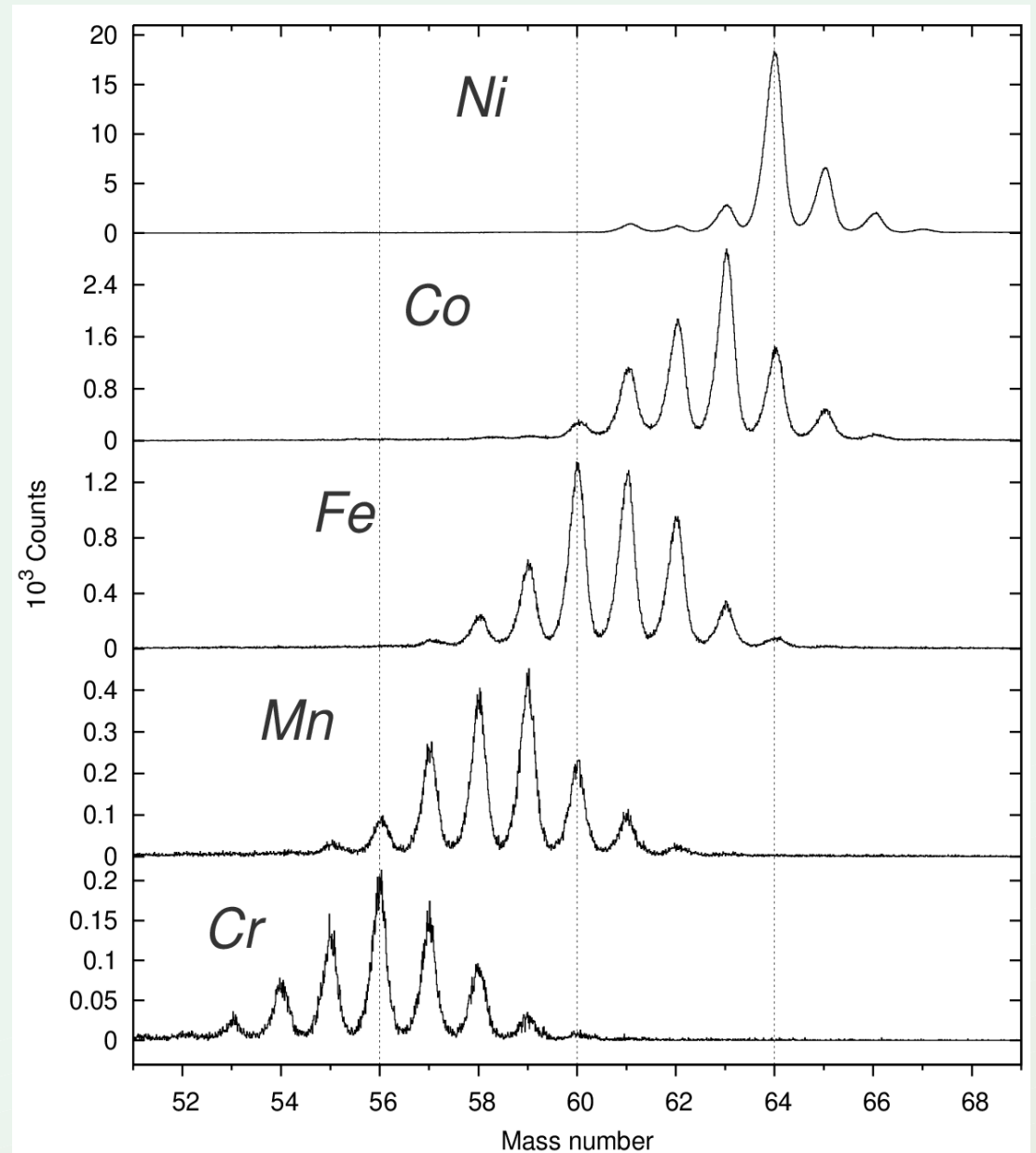
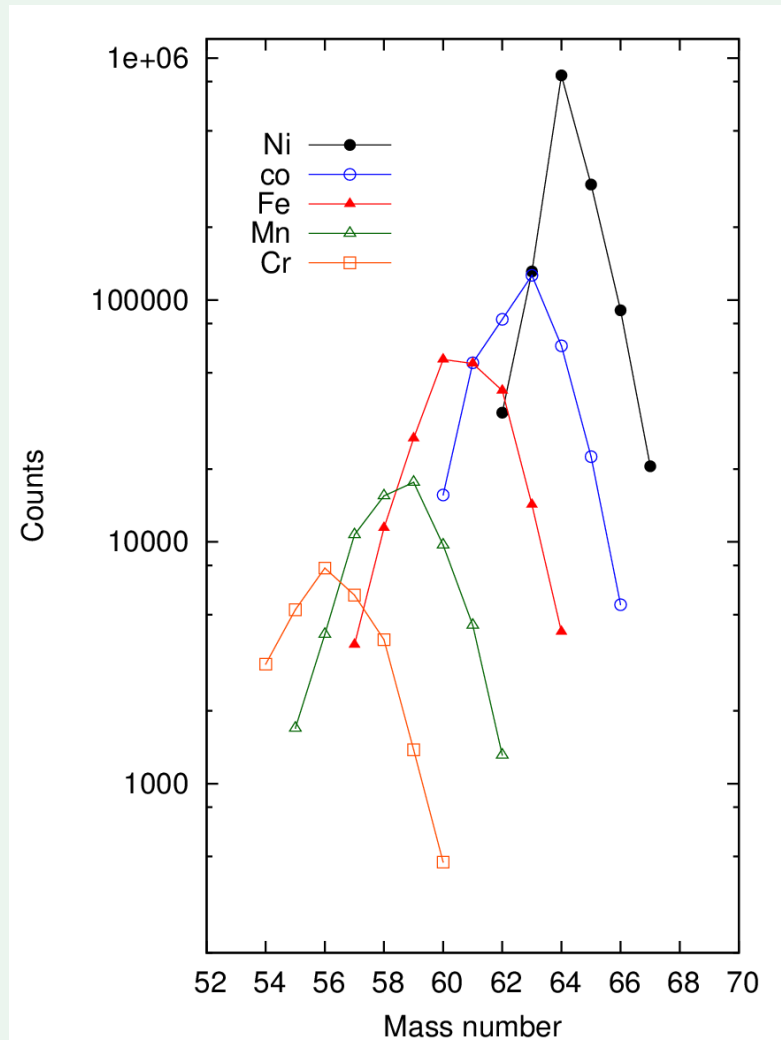
$^{64}\text{Ni } 2^+ \rightarrow 0^+ T_{1/2} = 3.5(7) \text{ ps}$

Previous $T_{1/2} = 1.088(35) \text{ ps}$

Need to take into account the feeding from the 4+ state.

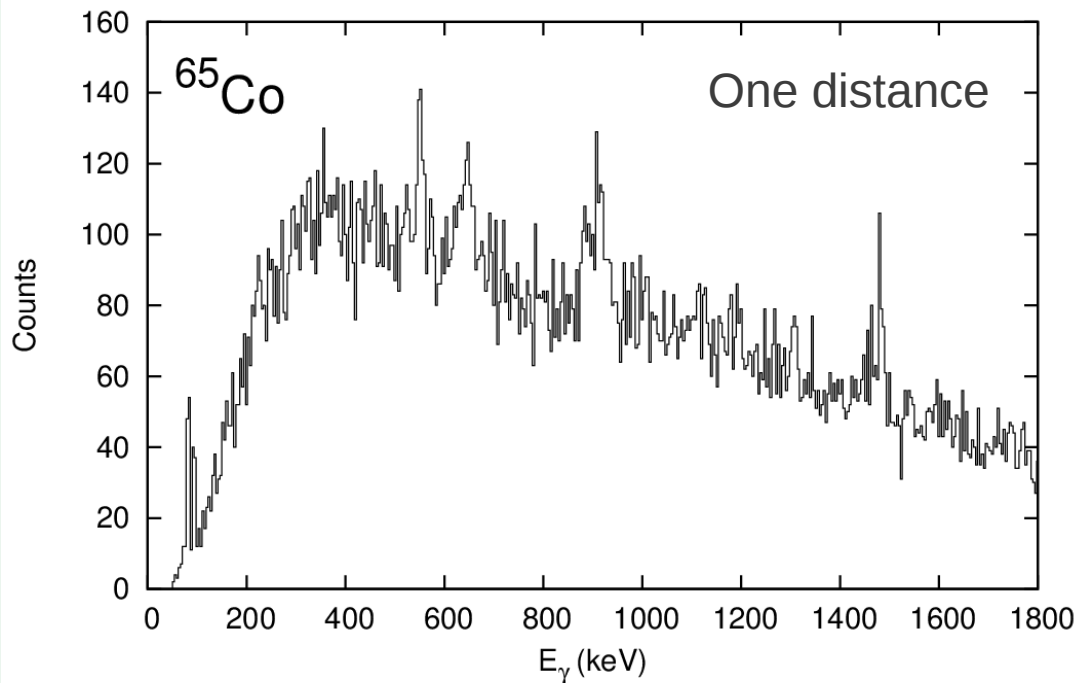
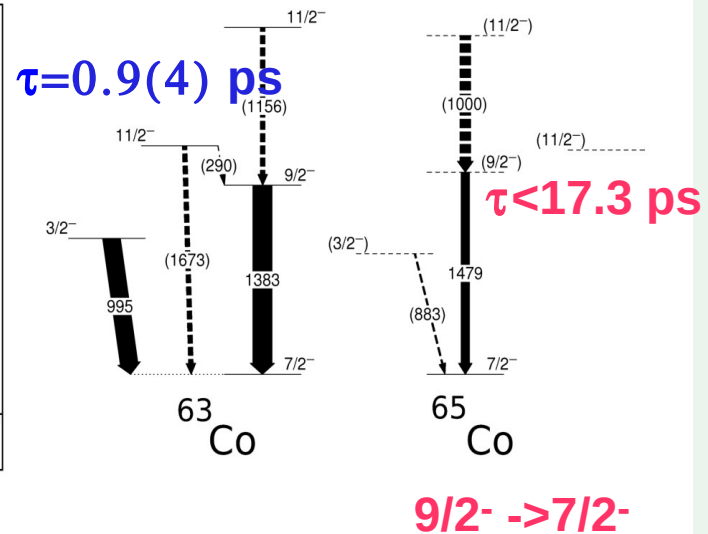
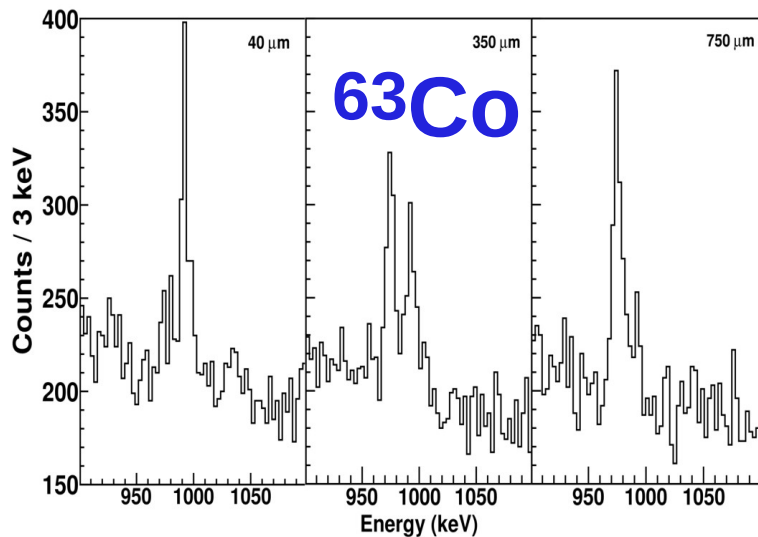
Yield in different masses

Statistics for one distance:



Cobalt isotopes

Known lifetimes
in neutron-rich
Co isotopes



Dijon et al. PRC 83, 64321 (2011)

*Possible lifetimes
measurements...*

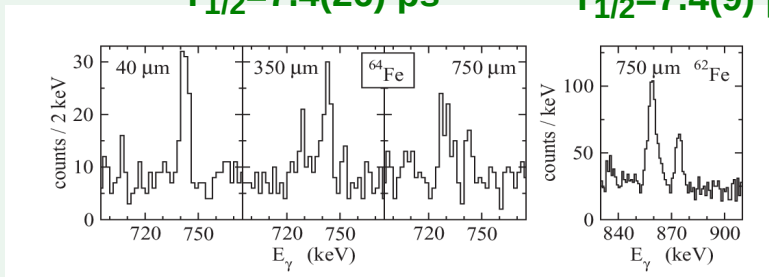
Iron isotopes

Known lifetimes in neutron-rich Co isotopes

First lifetime measurements for the 2^+ state in ^{64}Fe and ^{62}Fe

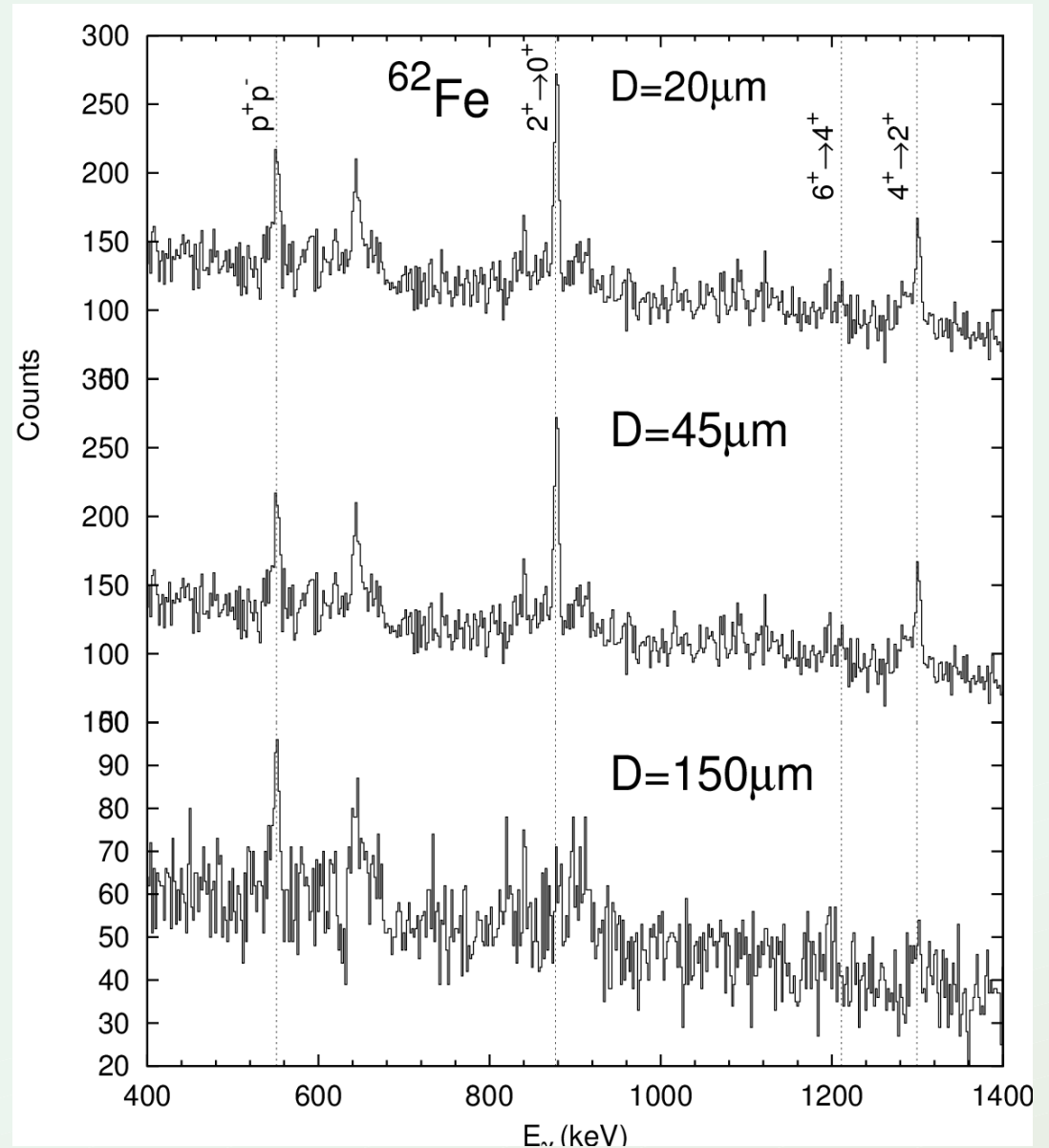
$T_{1/2} = 7.4(26)$ ps

$T_{1/2} = 7.4(9)$ ps



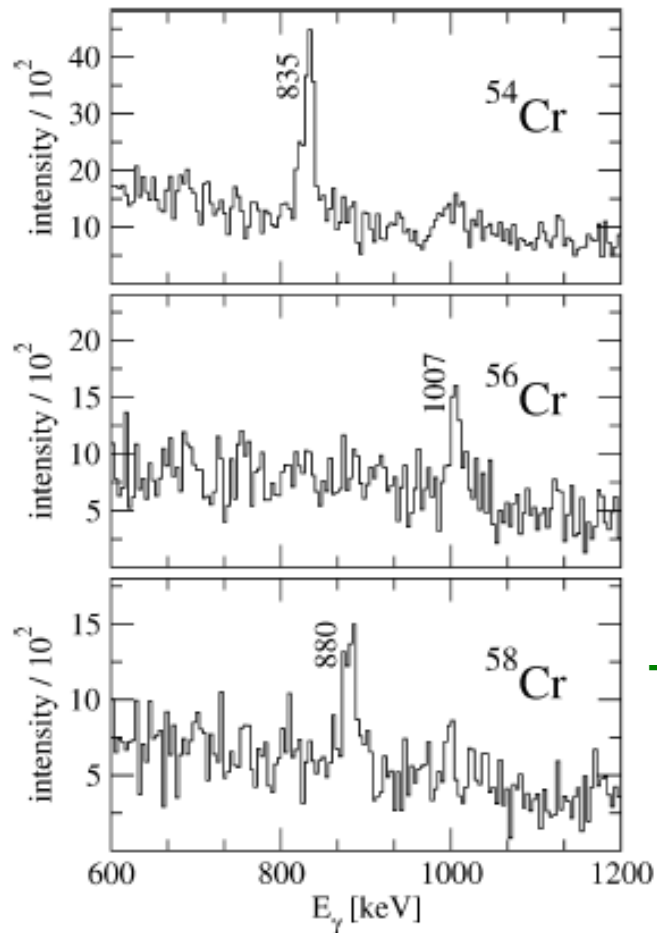
J. Ljungvall et al. PRC 81, 61301R (2010)

We will measure the 4^+ state lifetime for first time.

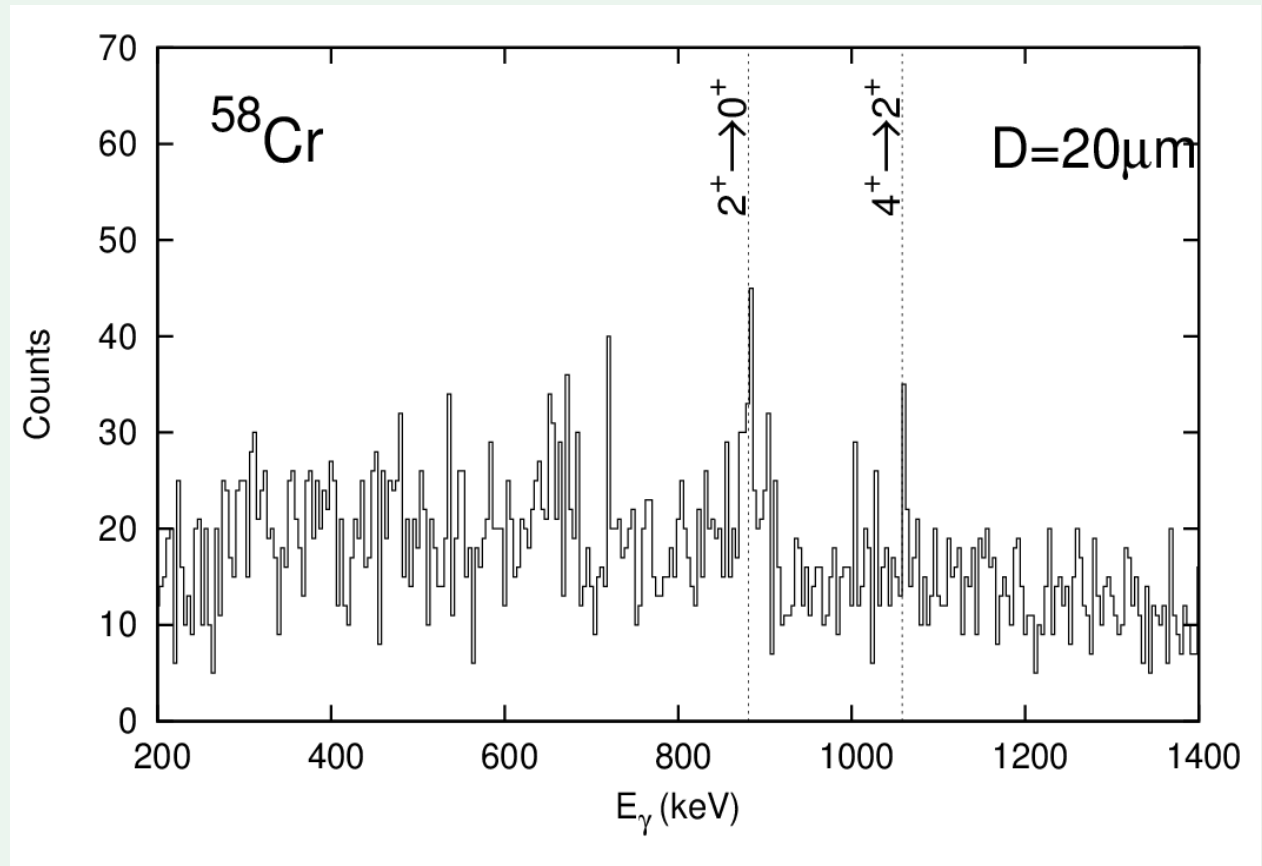


Cromium isotopes

GSI - FRS + RISING
Coulomb excitation at
relativistic energies



$T_{1/2} = 7.8$ ps



Analysis ongoing...