Beta decay near the double shell closure at ^{78}Ni

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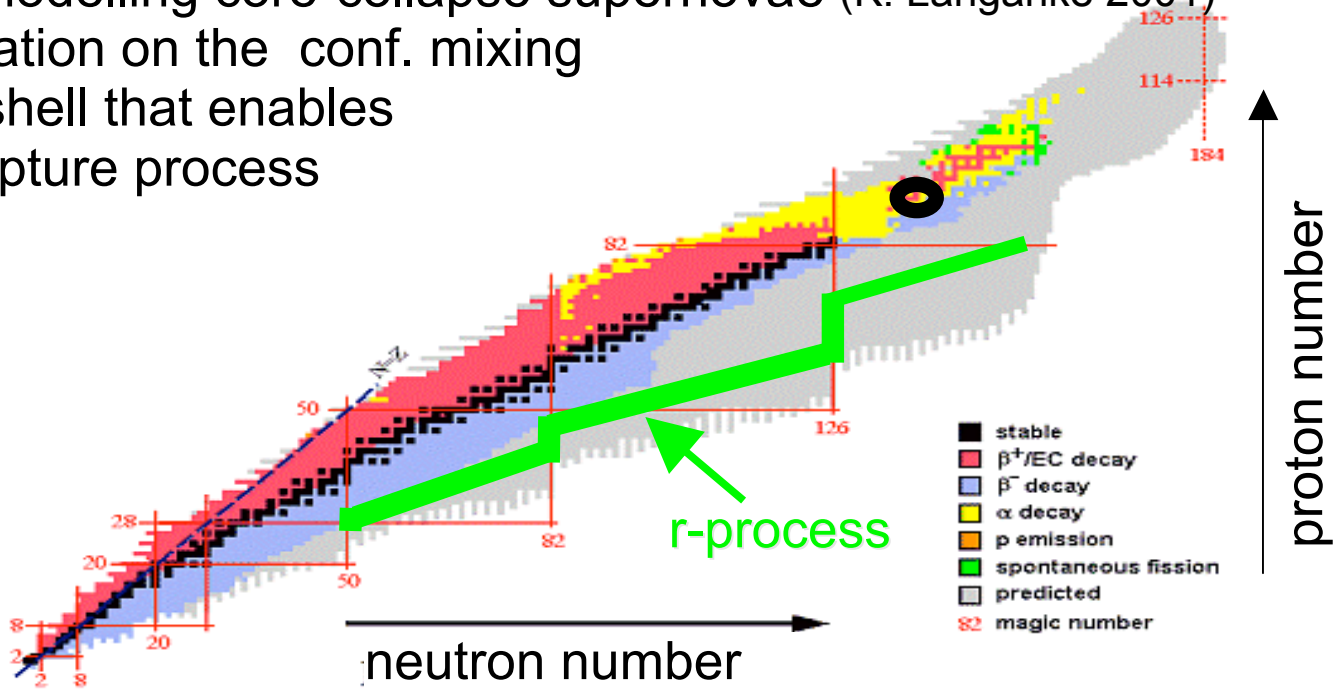
Introduction
Experimental method
Results:
beta-delayed neutron emission from $^{71-74}$Co
beta-decay half-lives of $^{69-72}$Fe, $^{71-74}$Co
Summary
Outlook

Astrophysics relevance

- calculations predict the path followed by the r-process
  - ⇛ measure: masses and separation energies / life-times
    - → modelling of the cooling phase
- modelling B_{GT-} important (I. Borzov 2000)
- B_{GT+} important role in modelling core-collapse supernovae (K. Langanke 2001)
  - ⇛ provide information on the conf. mixing in the $f_{5/2}pg_{9/2}$ shell that enables the electron capture process



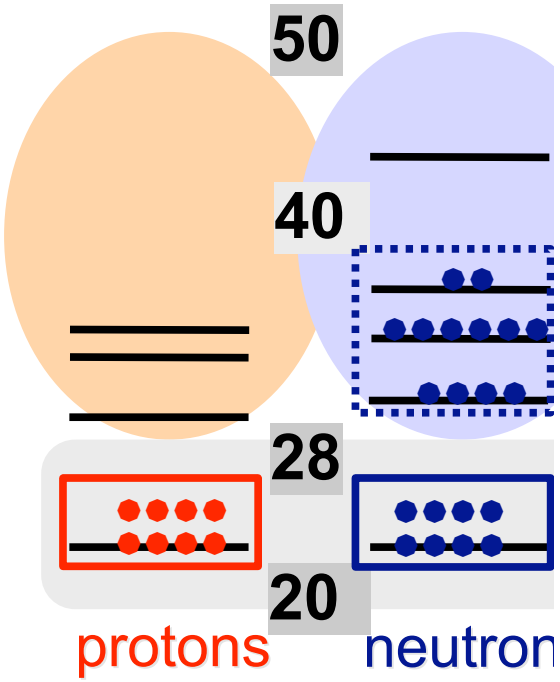
It is impossible to produce and measure the properties of all the r-proc nu
but it possible to make model predictions
→ models need to be tested in the most exotic nuclear systems

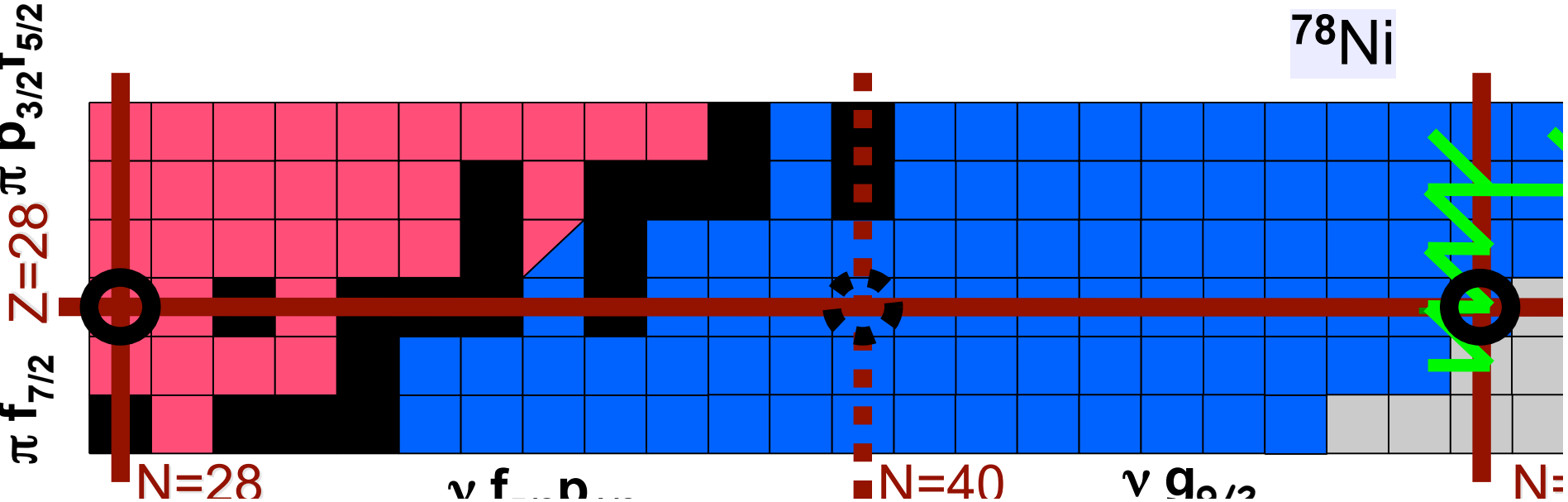
Shell-structure in the neutron rich Nickel region

Need for nuclear structure information:

- excited levels → evolution of single particle states
- half-lives
- masses → Q-values/separation energies
- branching ratios
- GT strength distribution

⇛ spectroscopy studies to test nuclear models





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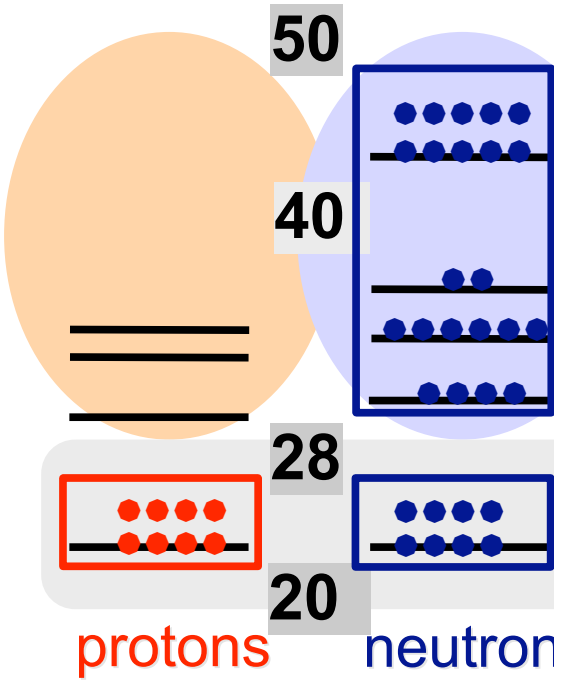
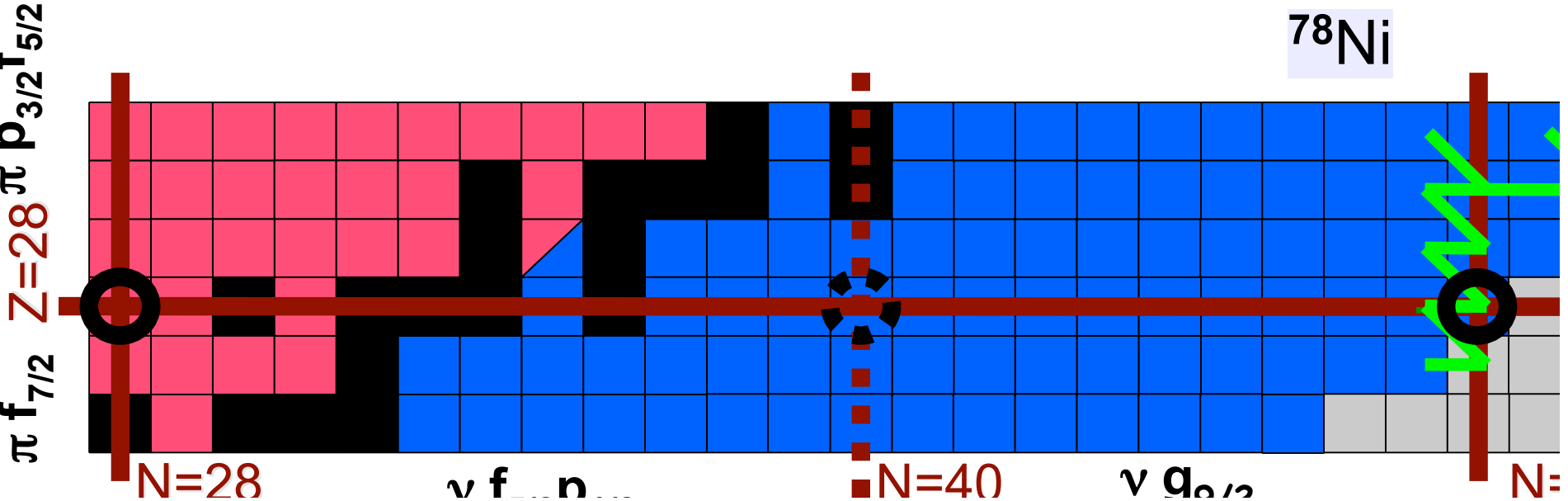
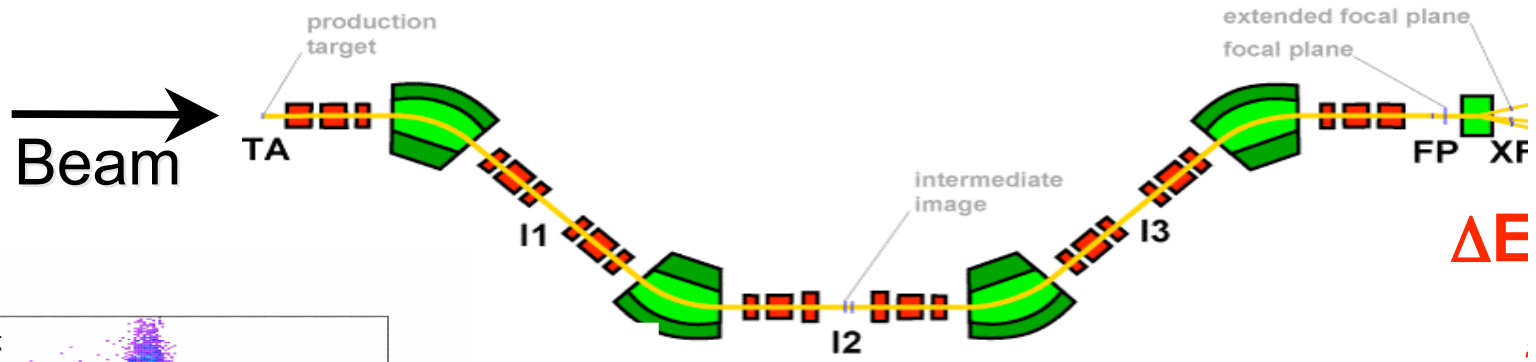


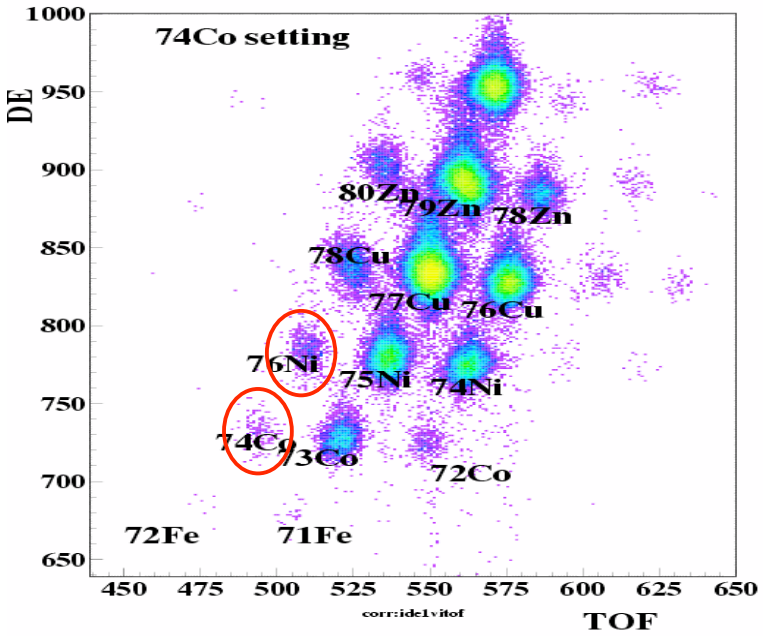


Experiment

- ^{86}Kr @140 A•MeV (15 part.nA) on ^{9}Be target
- Magnetic separation:

  A1900 spectrometer at NSCL, MSU



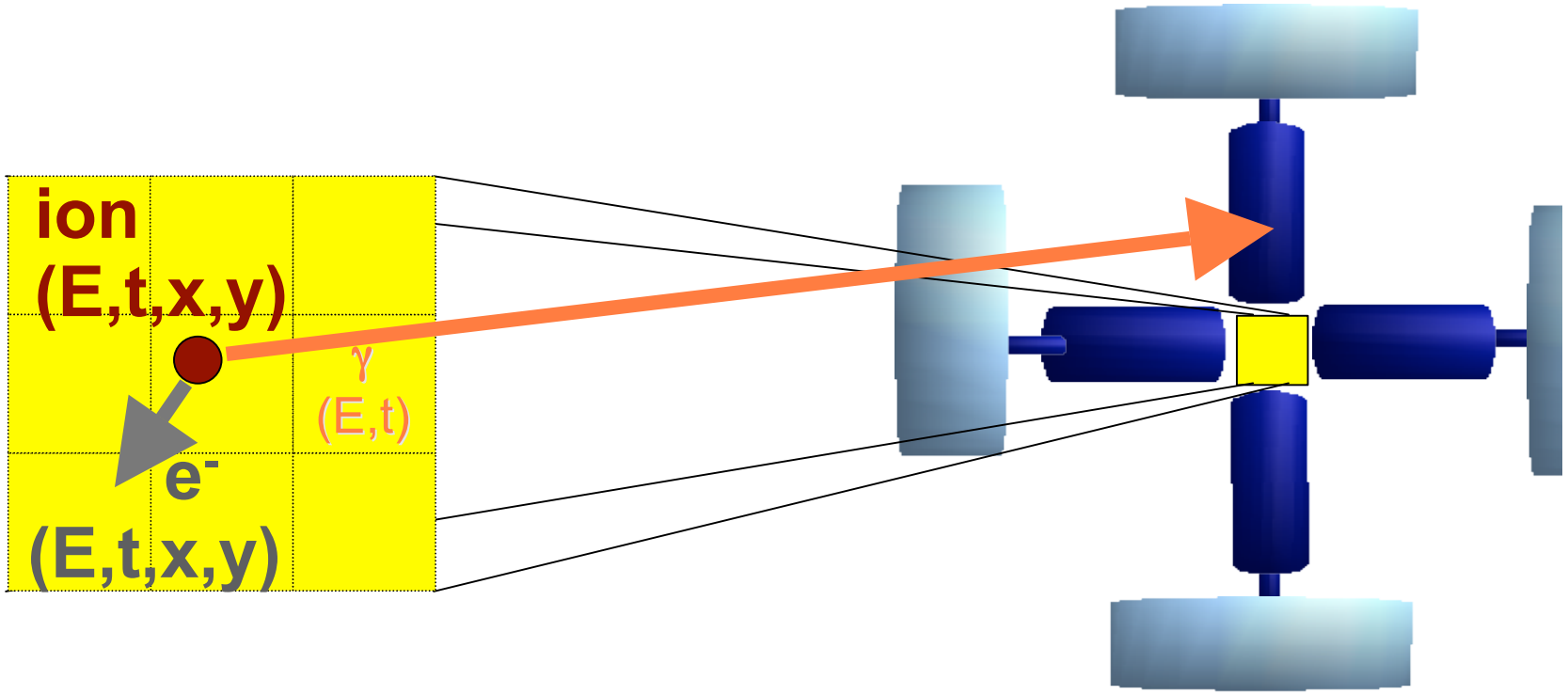


interesting reaction products (1 ppmin – 1 pph)

Experimental technique

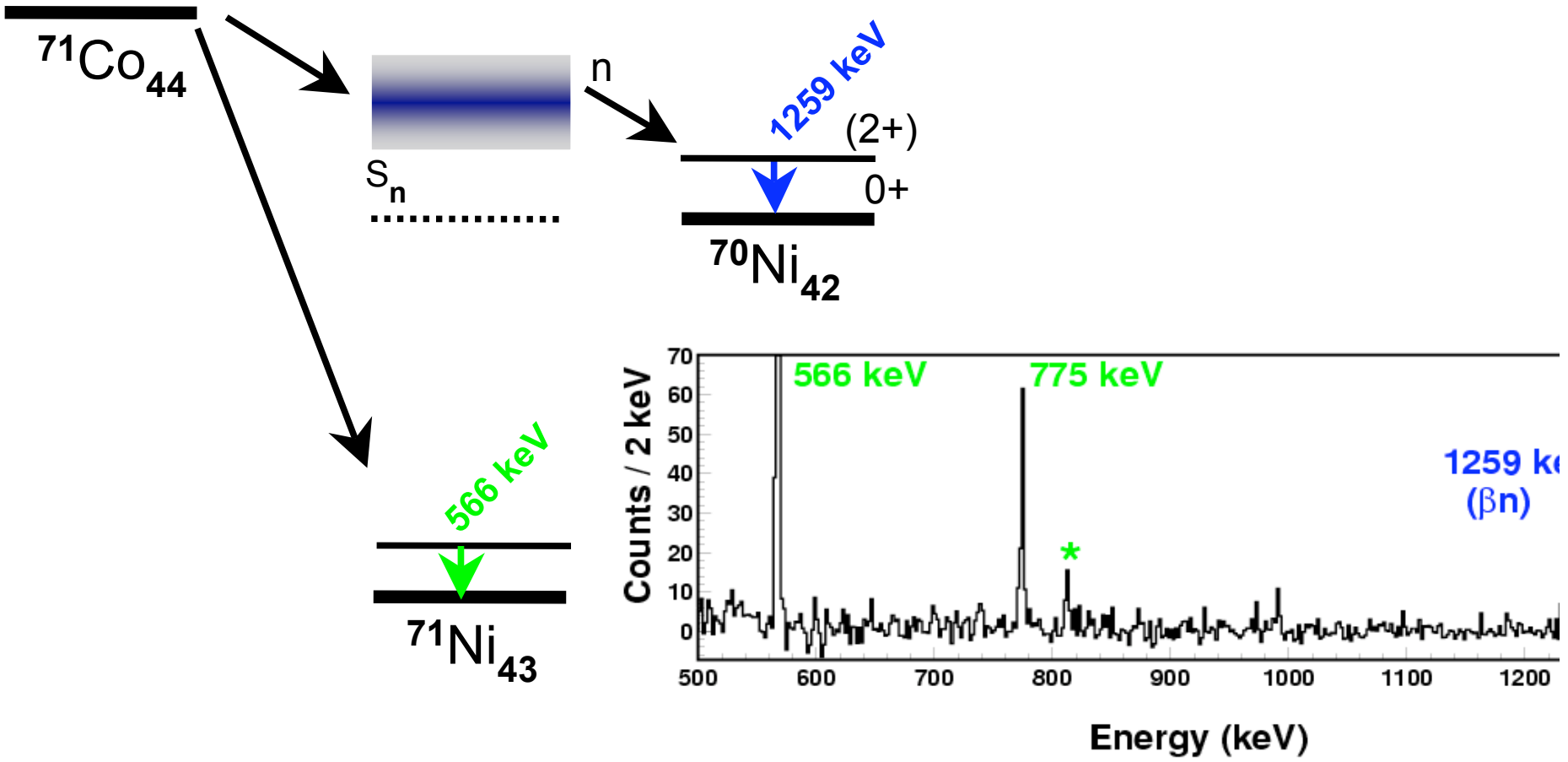
- Detection set up

  - DSSD detector (1.5 mm thick) for charged particles
    - implanted heavy ions and electrons
  - germanium detectors for high resolution γ spectroscopy (SeGA)



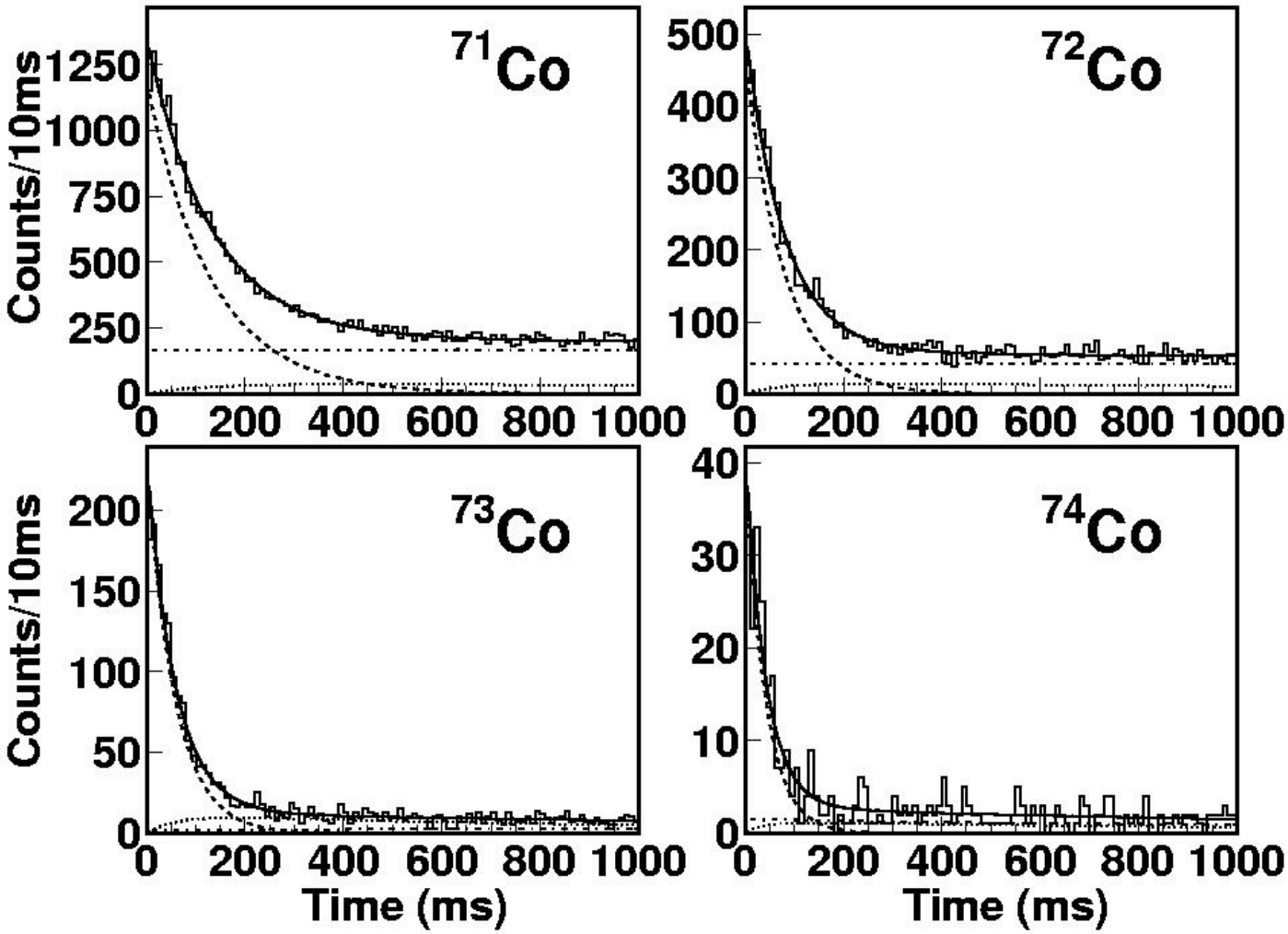
(Schematic

Evidence for β-delayed neutron emission from $^{71-74}$C



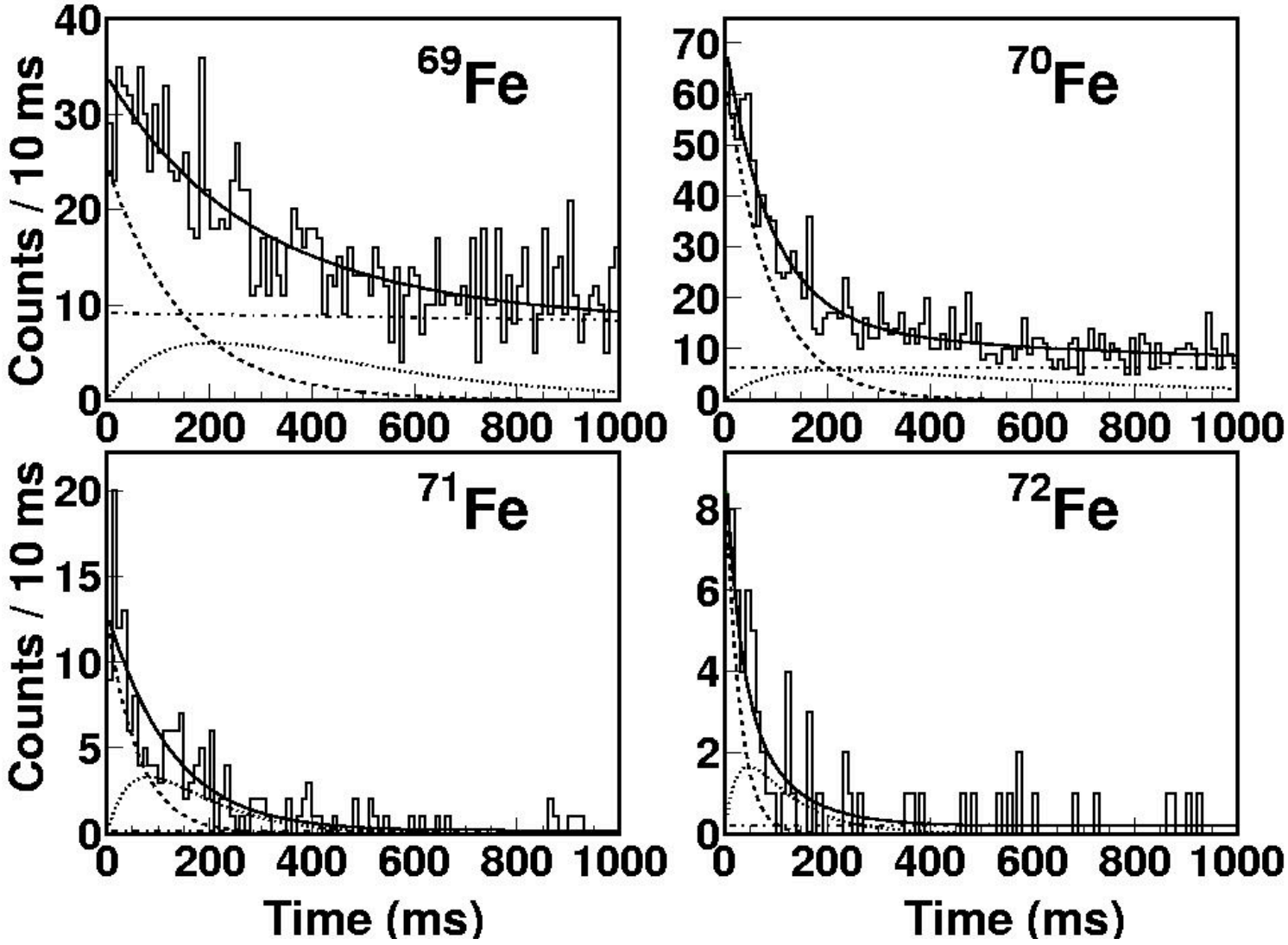
^{71}Co ion-gated β-coincident γ-ray spectrum

β-decay half-lives: $^{71\text{-}74}$Co



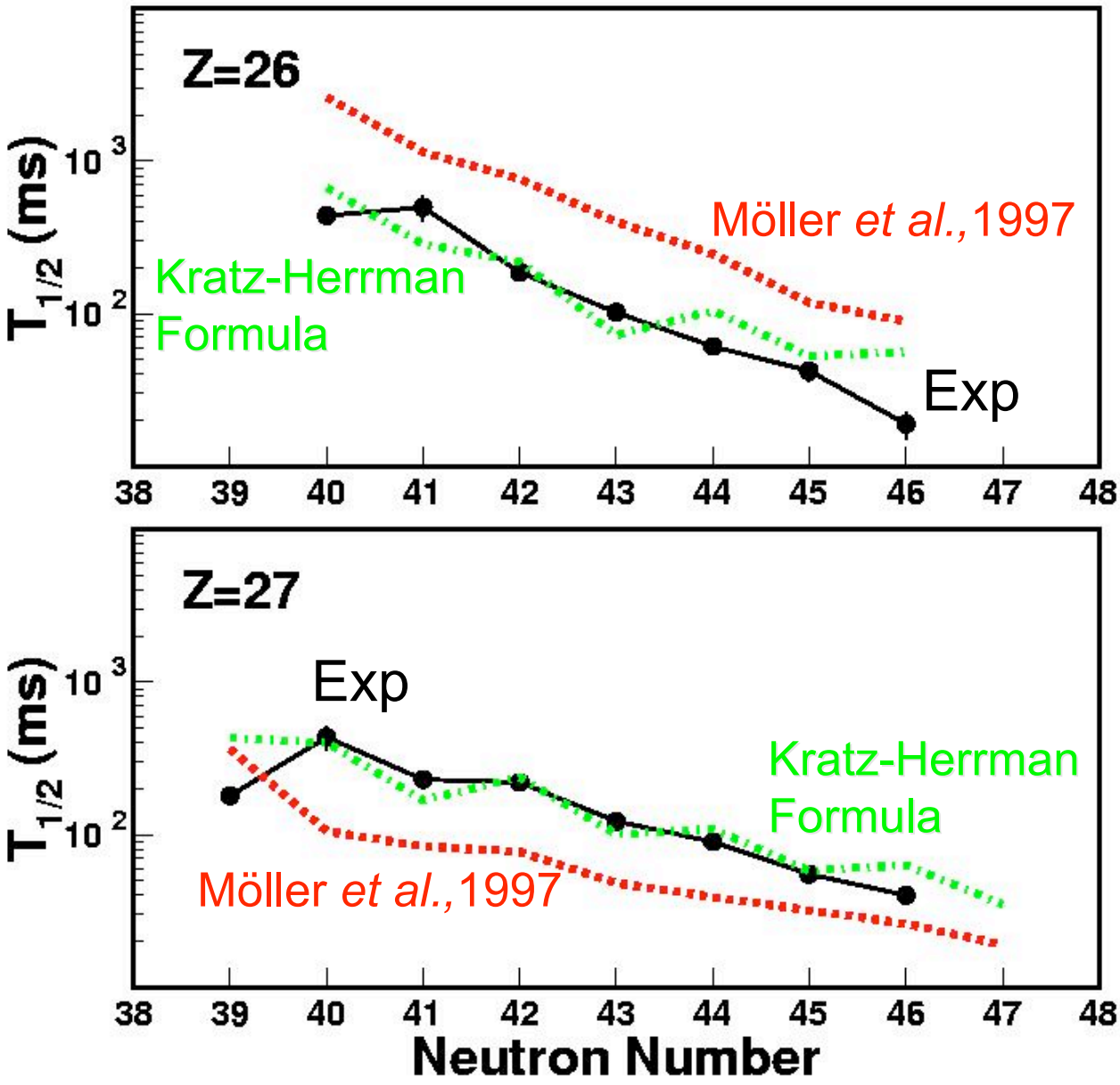
Prelimina

β-decay half-lives: $^{69\text{-}72}$Fe



Prelimina

β-decay half-lives: EXP vs THEORY



Prelimina

Summary

First evidence for beta-delayed neutron emission of $^{71-74}$Co:

→ lower limits for the branching ratios established

→ higher than total branching ratio predicted

but in good agreement with semiempirical approach

Half-life analysis of $^{69-72}$Fe and $^{71-74}$Co:

→ good agreement with literature (where available)

→ semiempirical approach well reproduces the beta half-life of the cobalt and iron isotopes

→ calculations overestimate by a large factor the half-life of the even-Z iron isotopes and underestimate that for the odd-Z cobalt isotopes

Outlook

Beta decay of neutron-rich manganese and iron isotopes:

→ absolute beta-delayed neutron and 2-neutron branching ratios

→ sampling of the GT strength above the n and 2n separation energy at the edge of the Q-value window

→ low energy level structure of iron and cobalt isotopes

Low energy level structure of nickel isotopes produced in beta decay of cobal

New experiments to explore the low-energy structure of odd-nickel isotopes

Two proposals for these experiments have been approved by the NSCL PAC

(decay of cobalts to nickels id going to run in December 2006

→ PhD of M. Rjabali -UT-)

Thank you! to

R. Grzywacz (UTennessee)

J. Batchelder (ORAU)

C. Bingham (Utennessee)

D. Fong (VanderbiltU)

J.H. Hamilton (VanderbiltU)

J.K. Hwang (VanderbiltU)

M. Karny (WarsawU)

W. Królas (JIHIR, ORNL)

S.N. Liddick (NSCL-MSU)

A.C. Morton (NSCL-MSU)

P. Mantica (NSCL-MSU)

W. Mueller (NSCL-MSU)

K. Rykaczewski (ORNL)

M. Steiner (NSCL-MSU)

A. Stolz (NSCL-MSU)

J. Winger (Mississippi State U)