Spectroscopic and isomeric study of very neutron rich Iron isotopes

Decay, beta delayed spectroscopy

High K Isomer around $^{70,72}Fe$

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~«…Collaboration list»

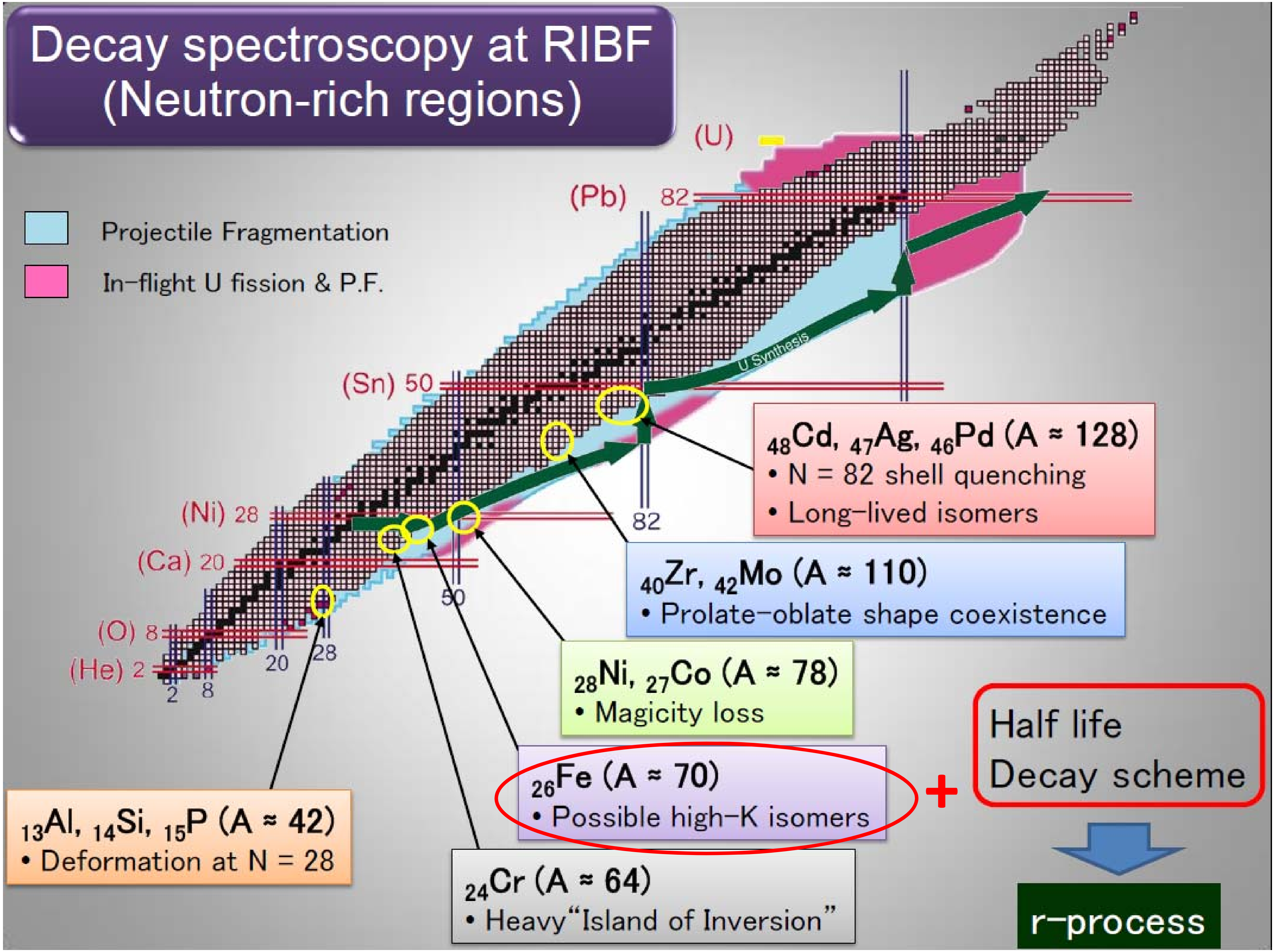
GSI EURICA WORKSHOP 2011
presented by O.Wieland

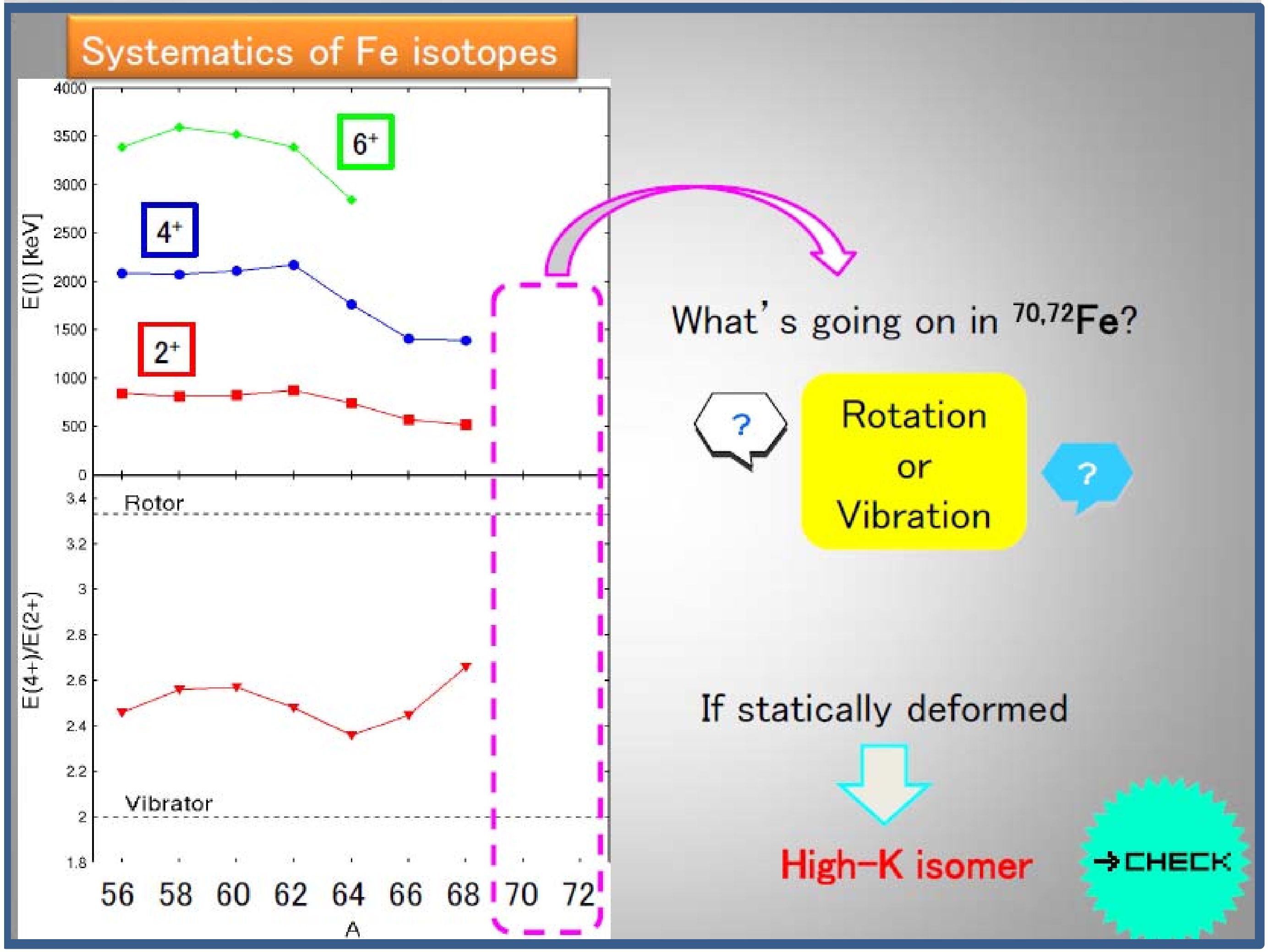
we «plan» to measure:

1) Beta **lifetime** in $^{70,72}Fe$ (^{70}Fe= 94 ms (2011), ^{72}Fe=unknown >150ns)
2) Beta **delayed gamma spectroscopy** after $^{70,72}Fe$ → $^{70,72}Co$ known, search for new bands
3) Gamma **spectroscopy** of first 2+ and 4+ states in $^{70(72)}Fe$=unknown
4) High K **isomer** search in $^{70((72))}Fe$=unknown

With **U(primary beam) → 3pps ^{72}Fe** and **^{70}Fe = 120pps**
[other beams: (^{136}Xe fragmentation, ^{86}Kr-later if possible) are lower , ^{76}Ge maybe higher]

Decay spectroscopy at RIBF (Neutron-rich regions)



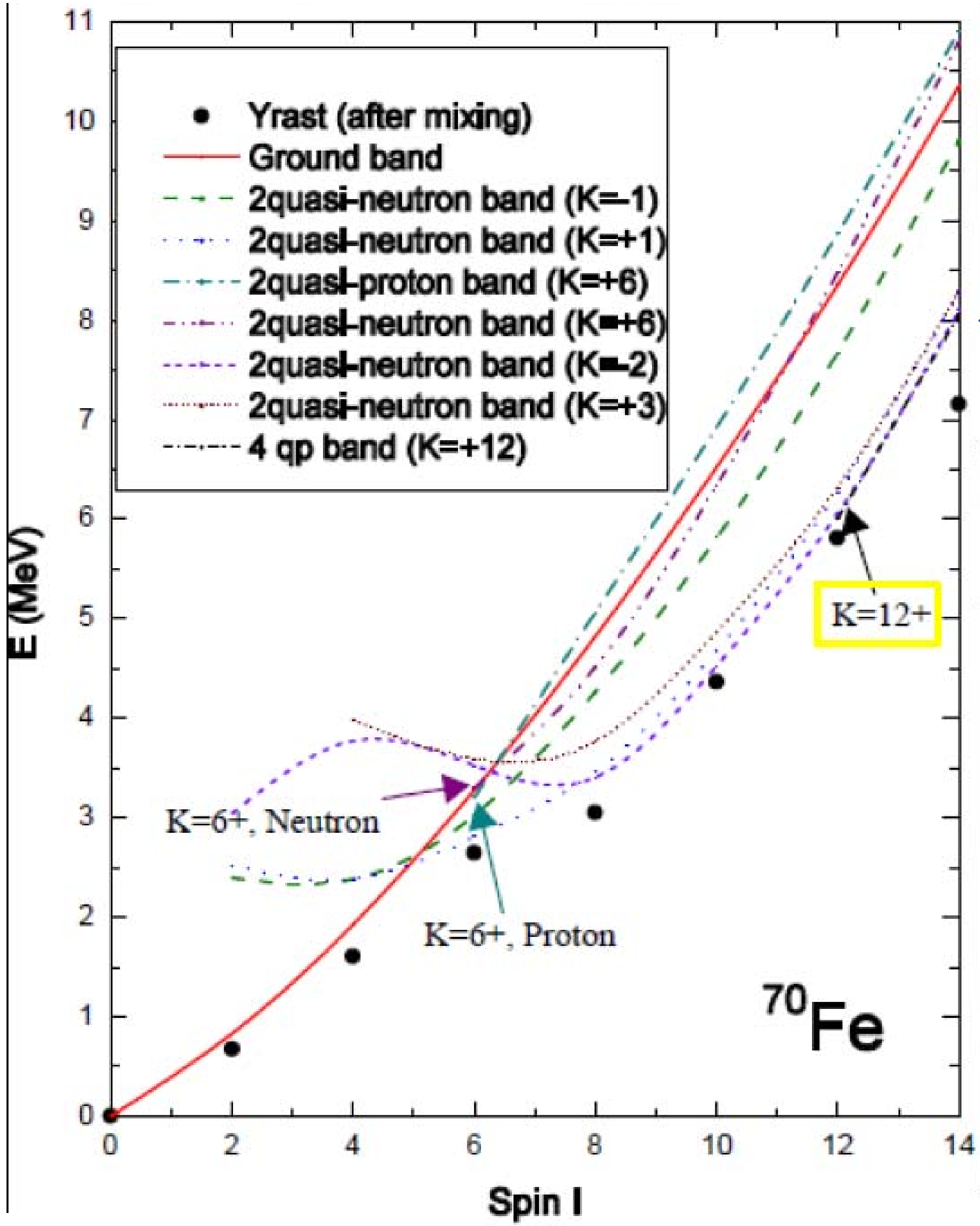


Hiroshi Watanabe

Recently*, experimental information in the region around N=40 neutron subshell closure in Fe, Cr and Ni isotopes suggests that **the N=40 energy gap** is **not strong** enough to **sustain spherical shapes** and that **deformation** sets in.

* [H.Grawe, Acta Physica Polonica B 34, 2267 (2003) and J.M. Daugas et al., PRC 83, 054312 (2011)]

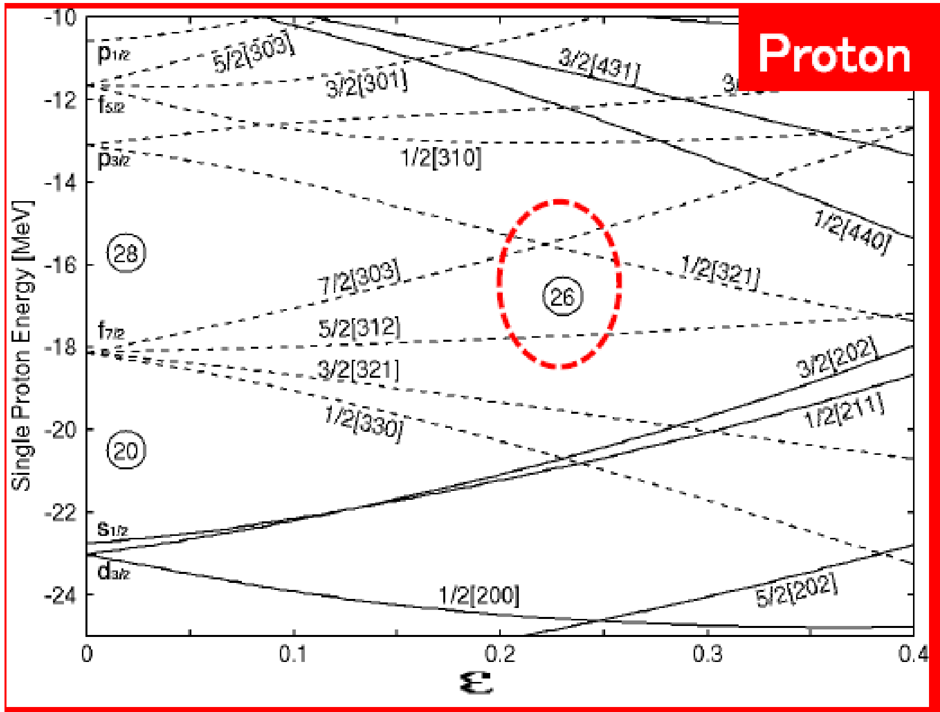
Possible high-K ISOMERS in n-rich Fe Isotopes

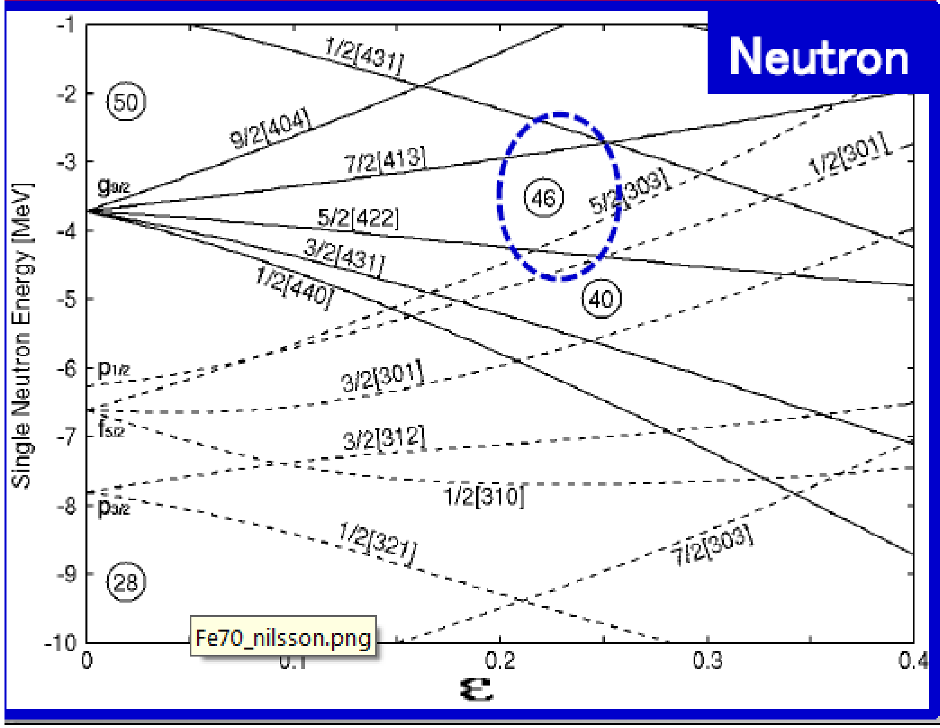


the N=40 energy gap is **not strong** enough to **sustain spherical shapes** and **deformation** sets in **?**

Nuclei	K^π	Configurations: Neutrons	Configurations: Protons
^{70}Fe	0^+	g.s.	
	6^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	
	6^+		$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$
	12^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$
^{72}Fe	0^+	g.s.	
	6^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	
	6^+		$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$
	12^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$

Calculated by Furong



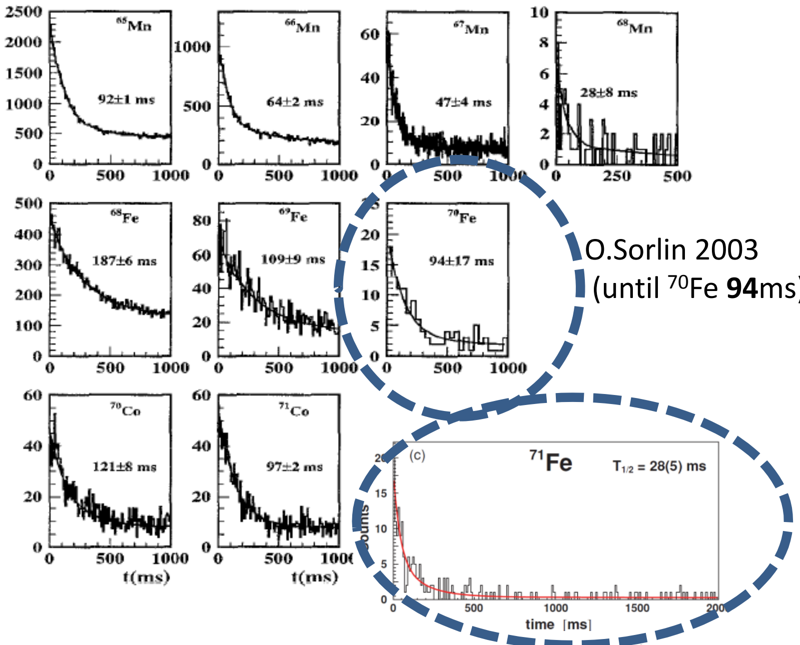


Possible high-K ISOMERS in n-rich Fe Isotopes

Nuclei	K^π	Configurations: Neutrons	Configurations: Protons
^{70}Fe	0^+	g.s.	
	6^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	
	6^+		$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$
	12^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$
^{72}Fe	0^+	g.s.	
	6^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	
	6^+		$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$
	12^+	$(\frac{7}{2}^+[413], \frac{5}{2}^+[422])$	$(\frac{5}{2}^-[312], \frac{7}{2}^-[303])$

Calculated by Furong

What is known so far



O.Sorlin 2003 (until ^{70}Fe **94**ms)

J.M. Daugas (until ^{70}Fe **71**ms ^{71}Fe 28ms)
Phys. Rev. C 83, 054312 (2011)

In particular we want to compare the **beta decay** information (**unknown for ^{72}Fe**) to theoretical predictions for the Fe isotopes

[T. Marketin and D.Vretenar, PRC 75, 024304 (2007)].

What is expected

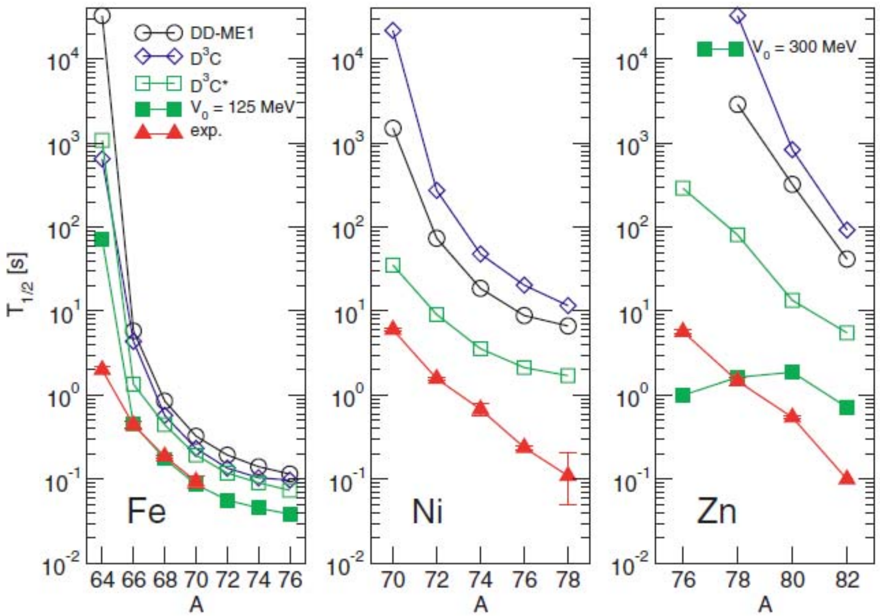


FIG. 2. (Color online) β-decay half-lives of Fe (left panel), Ni (middle panel), and Zn (right panel) nuclei, calculated with the DD-ME1, D^{3}C, and D^{3}C* effective interactions, compared with the experimental values [19]. Open symbols correspond to PN-QRPA values calculated without the inclusion of the $T=0$ pairing interaction. The filled squares are half-lives calculated with the D^{3}C* interaction and $T=0$ pairing, with the strength parameter $V_0 =$ 125 MeV for Fe, and $V_0 = 300$ MeV for Zn isotopes.

The proposed experiment aims at **using the high intensity uranium beam** at RIKEN to produce the neutron rich iron isotopes.

According to **LISE++ simulations (with BigRips)**, taking also into account the efficiency of the EURICA and DSSSD array, we expect around
4000 cts/day in the gamma ray spectrum of ^{70}Fe,
which should be sufficient to built up a level scheme in about 2 days.

In the case of ^{72}**Fe** we expect around **40cts/day** which should allow to determine basic spectroscopic information such as the energy of the first 2^+ and 4^+ states.

Similar rates are expected also for the odd isotopes and neighbor isotopes like ^{74}Co and ^{70}Mn.
In all cases we plan to search for "predicted" and unknown isomeric high-k states
[Y. Sun PRC 80, 054306 (2009) and F.Xu private communication].

Propose to measure:

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4) **High K-isomer** search in $^{70((72))}Fe$=unknown

With **U(primary beam)** → **3pps** ^{72}**Fe** and ^{70}**Fe = 120pps** → **4 days of beam on target !**
[other beams: (^{136}Xe fragmentation, ^{86}Kr-later if possible) are lower , ^{76}Ge maybe higher]