Wrażenia z konferencji

8th International Conference on Radioactive Nuclear Beams (RNB8)
Grand Rapids, Michigan

May 26 - May 30, 2009

COMEX 3

Collective Motions in nuclei under EXtreme conditions

June 2 - June 5, 2009

IFD UW ZSJ

Marek Pfützner

Wspólne seminarium Fizyki Jądra Atomowego i Struktury Jądra Atomowego,
18 listopada 2009

Historia

1989 – Berkeley (USA)

1991 – Louvain la Neuve (Belgia)

1993 – East Lansing (USA) ← ENAM'95 - Arles

1996 – Ohmiya (Japonia) ← ENAM'98 - Bellaire

2000 – Divonne (Francja) ← ENAM'01 – Hämelinna

2003 – Argonne (USA) ← ENAM'04 – Pine Mountains

2006 – Cortina d'Ampezzo (Włochy) ← ENAM'08 – Ryn

2009 – Grand Rapids (USA)

Połączenie RNB i ENAM w jedną "flagową" konferencję na temat egzotycznych nuklidów i wiązek radioaktywnych

2011 – Leuven (Belgia)

Advances in Radioactive Isotope Science (ARIS)

5 dni (3 pełne + 2 połówki) ok. 160 uczestników

RNB-8 Program Overview

- Structure & Reactions (16) *
- Spectroscopy & Structure (12) *
- Structure & Symmetries (3)
- Halo's & Structure (4)
- Exotic Decays (4) **
- Fundamental Interactions & Laser Spectroscopy (4)
- Nuclear Astrophysics (5)
- New Technology (8)
- New Initiatives (5)
- Non Exponential Decays (2) * *

New Results from Mass and Lifetime Measurement of Stored Exotic Nuclei at the FRS-ESR Facility

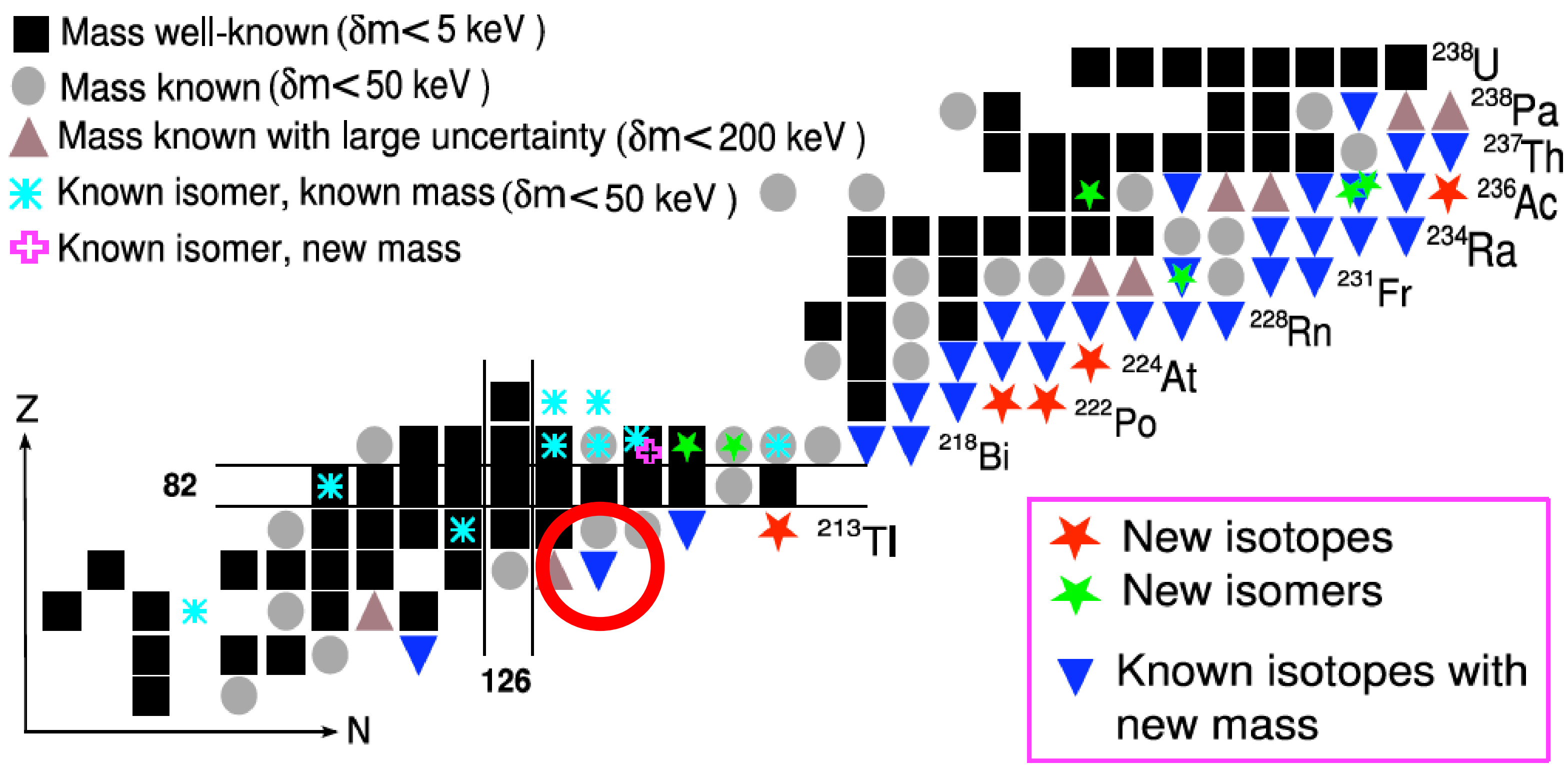
Lixin Chen*

GSI, Darmstadt, Germany
Justus-Liebig-University, Giessen, Germany

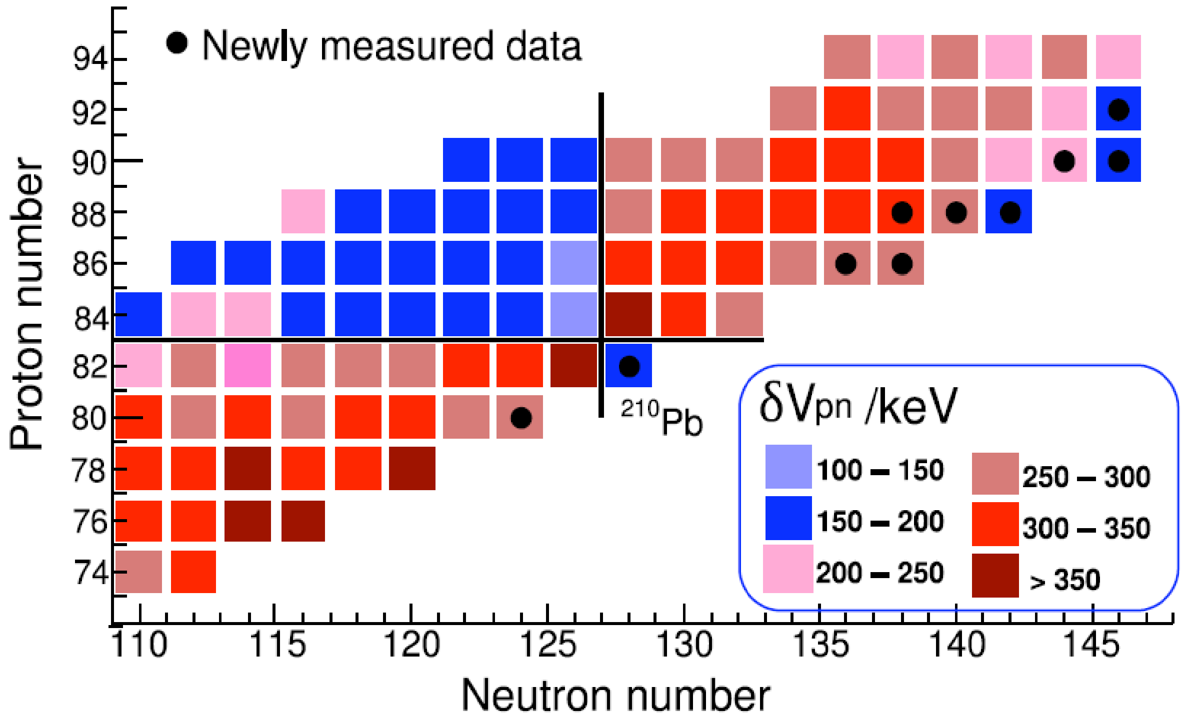
8th International Conference on Radioactive Nuclear Beams (RNB8)
Grand Rapids, Michigan

**present address: Cyclotron Institute, Texas A&M University, USA*

Discovery of New Isotopes and New isomers



Experimental Proton-neutron Interactions

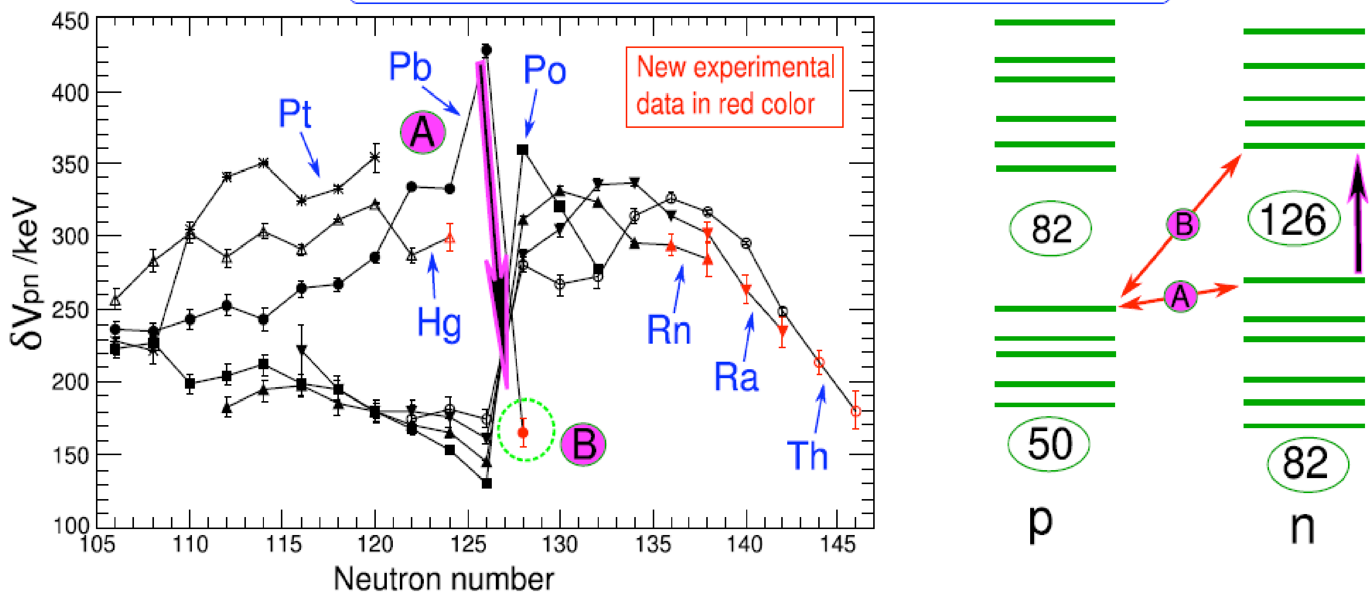


For even-even nuclei

$$\delta V_{pn}(Z,N) = \frac{1}{4}[\{B(Z,N) - B(Z,N-2)\} - \{B(Z-2,N) - B(Z-2,N-2)\}]$$

Experimental Proton-neutron Interactions

L.Chen, et al., PRL 102 (2009) 122503



p-n interactions are sensitive to the spatial overlaps of the proton and neutron wave functions.

Generic sequencing of shell model orbits

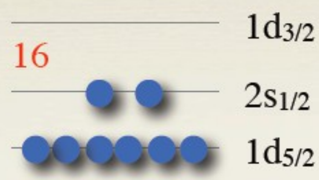
One-neutron removal from ^{24}O and the N=16 shell closure

R. Kanungo

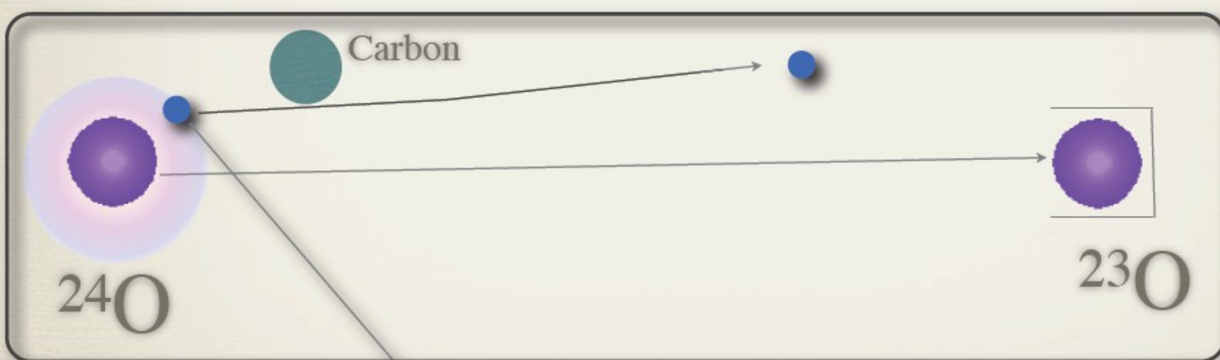
Saint Mary's University, Halifax, Canada

SAINT MARY'S UNIVERSITY SINCE 1802

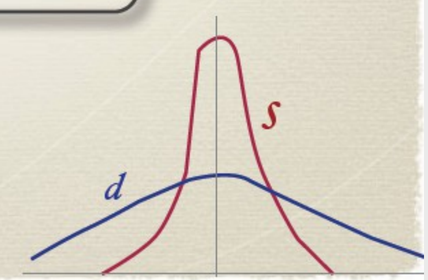
Where are the valence neutrons in ^{24}O ?



N=16 spherical shell closure → dominant $2s_{1/2}$ configuration

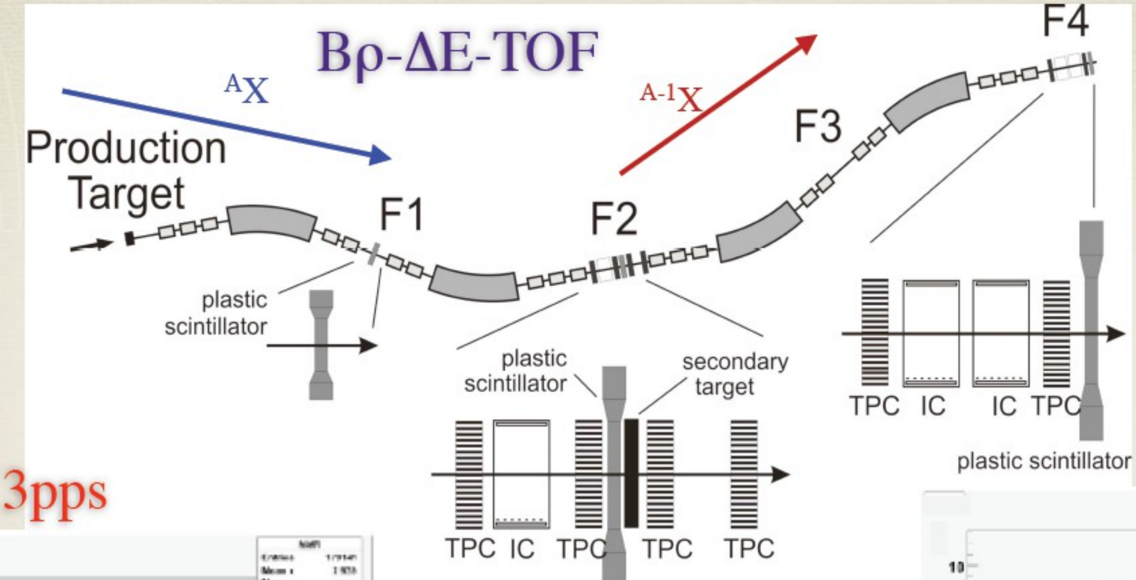


$$\frac{d\sigma}{dp_{//}} = \int d\mathbf{r_t} \left| \frac{1}{\sqrt{2\pi}} \int \varphi_0(\mathbf{r_t}, z) e^{ip_z z} \right|^2 \int d\mathbf{b} D(\mathbf{b}, \mathbf{r_t})$$

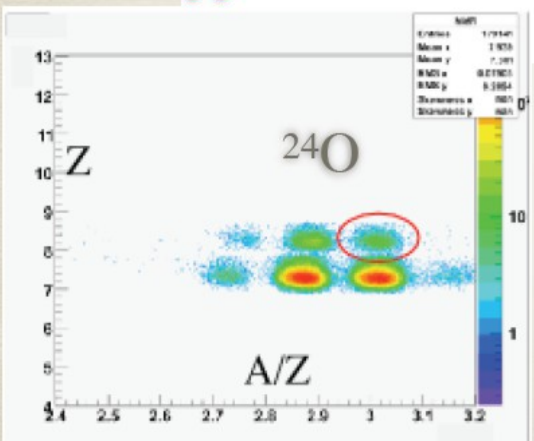


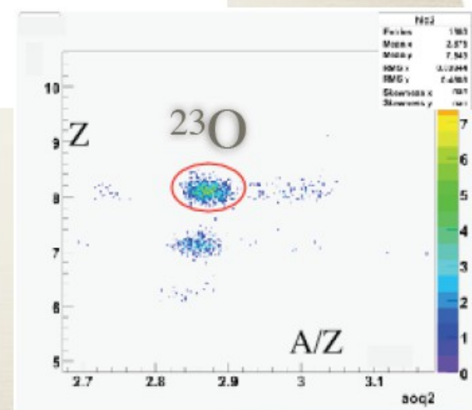
Experiment @ FRS, GSI

E/A ~ 920 MeV



^{24}O ~ 3pps





^{24}O one neutron removal: eikonal model

$^{24}O = ^{23}O + n$

$$\frac{d\sigma}{dp_{\parallel}} = \frac{1}{2\pi}\int dr \int dz\, \phi_0^*(r_\perp, z')\phi_0(r_\perp, z)\exp(ik_z(z-z'))\int db D(b, r_\perp)$$

$$D(b,r_\perp) = \exp\{-2\,\mathrm{Im}\,\chi_{FT}(b - \frac{1}{m}r_\perp)\}[1-\exp\{-2\,\mathrm{Im}\,\chi_{nT}(b - \frac{1}{m}r_\perp + r_\perp)\}]$$

Phase shift functions

$$i\chi_{FT}(b) = -\int\int ds\,dt\,T_F(s)T_T(t)\Gamma(b+s-t)$$

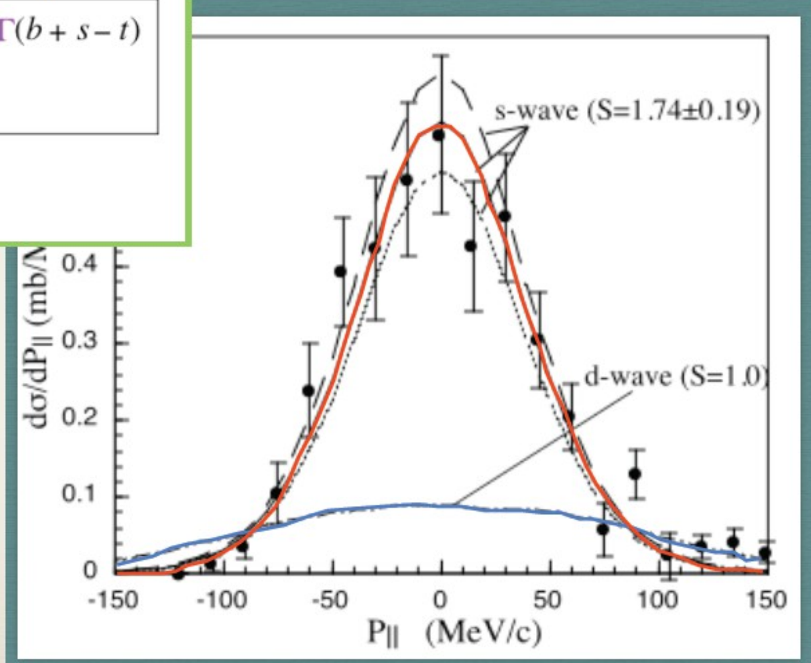
$$i\chi_{nT}(b) = -\int dt\,T_T(t)\Gamma(b-t)$$

Profile function

$$\Gamma(b) = \frac{1-i\alpha}{4\pi\beta^2}\sigma^{NN}\exp(-\frac{b}{2\beta^2})$$

Y. Ogawa et al., NPA 571(94)784, J.A. Tostevin, JPG 25 (99) 735.

❖ Nearly pure s-wave



R. Kanungo et al., PRL 102 (2009) 152501

Summary

❖ One-neutron removal from ^{24}O shows the valence neutrons to dominantly occupy the $2s_{1/2}$ orbital. $S(2s_{1/2}) = 1.74 \pm 0.19$

This confirms ^{24}O to be a doubly closed-shell nucleus at the neutron drip-line

❖ The spectroscopic factors decrease rapidly as we move to stable N=16 isotones. *^{30}Si , ^{32}S experimental re-confirmation will be useful.*

Thomas Faestermann
TU München

for the S330 and
RISING collaboration

$^{100}_{50}Sn_{50}$
and Neighbours

Silicon Implantation Detector and Beta Absorber SIMBA

7 x-strips

10 SSSD 60x40x1 mm³

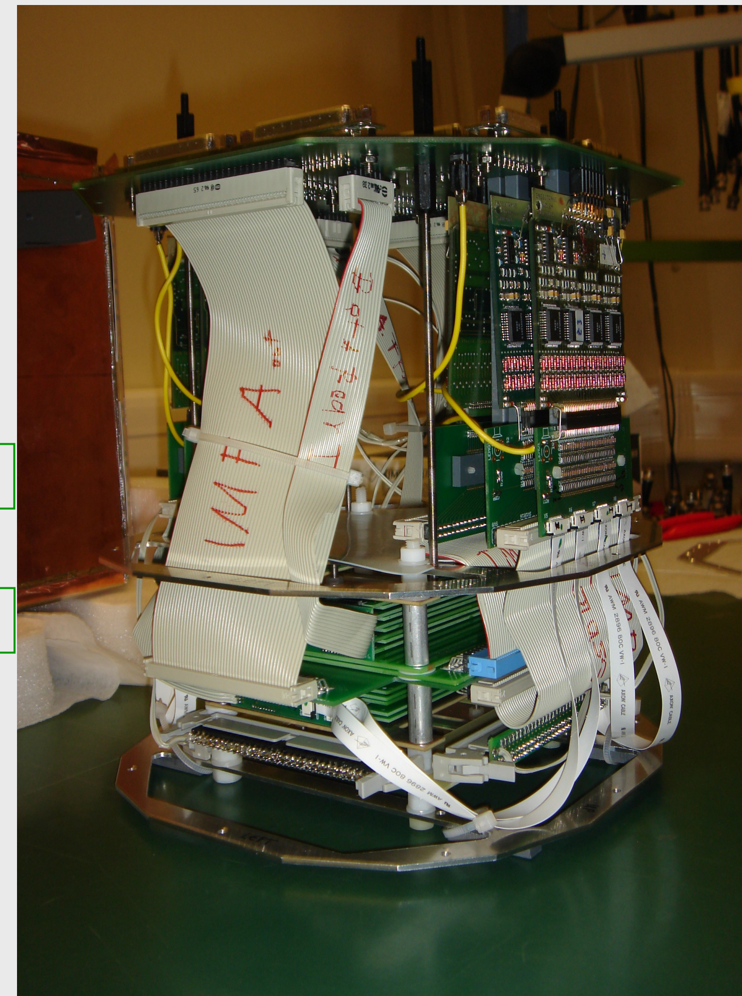
3 DSSD 60x40x0.7 mm³

10 SSSD 60x40x1 mm³

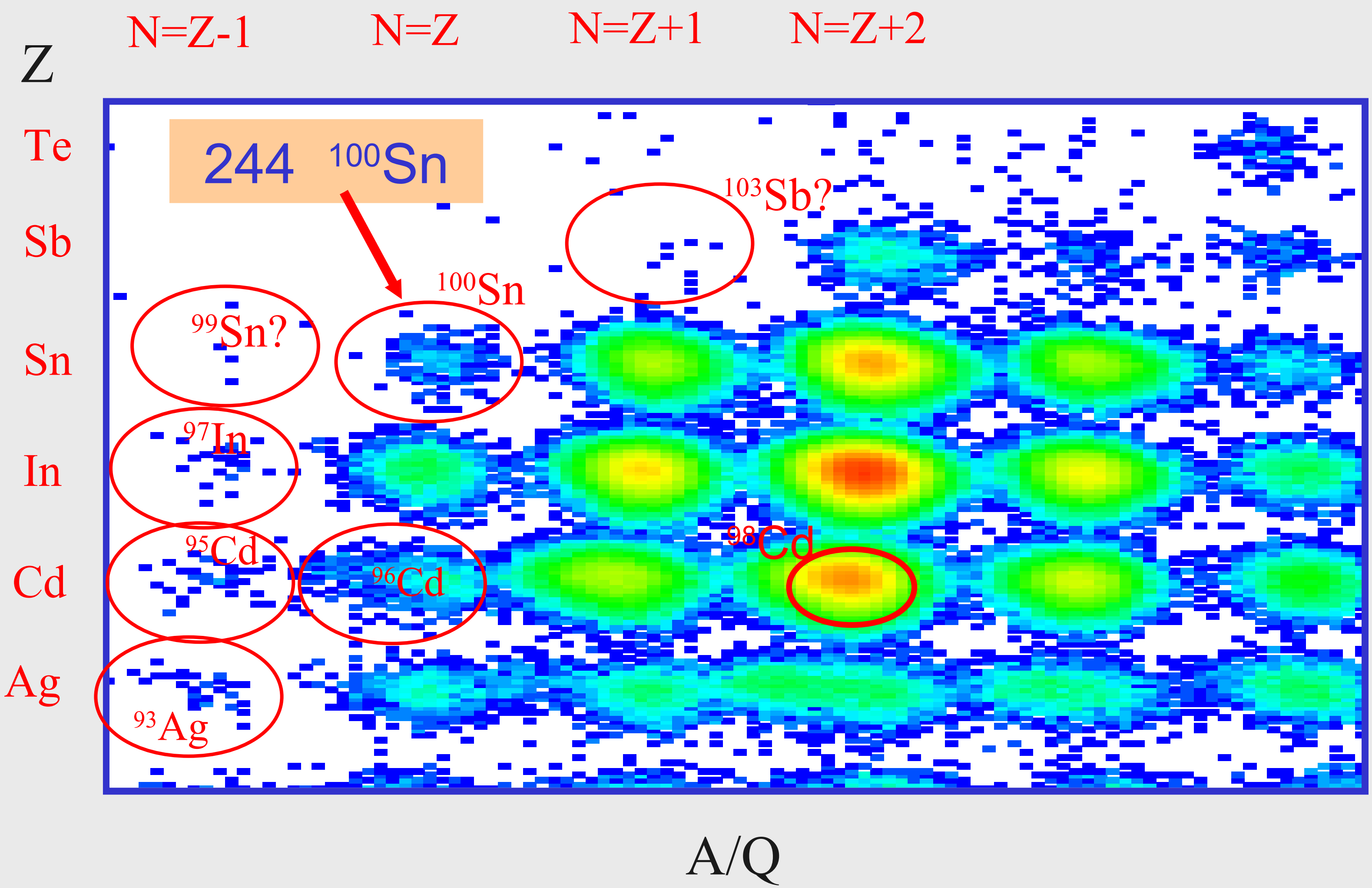
Y SSSD 60x60x0.3 mm³

X SSSD 60x60x0.3 mm³

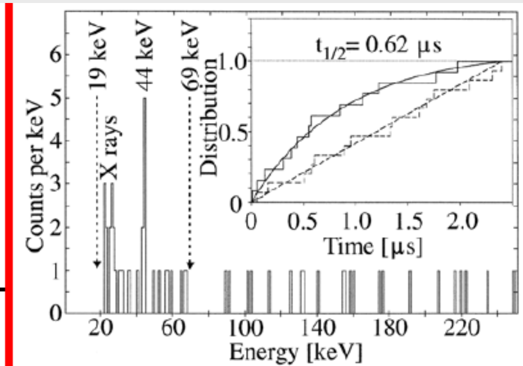
pixels in implantation zone:
3x60x40 = 7200



^{100}Sn setting (full statistics, 15 days)

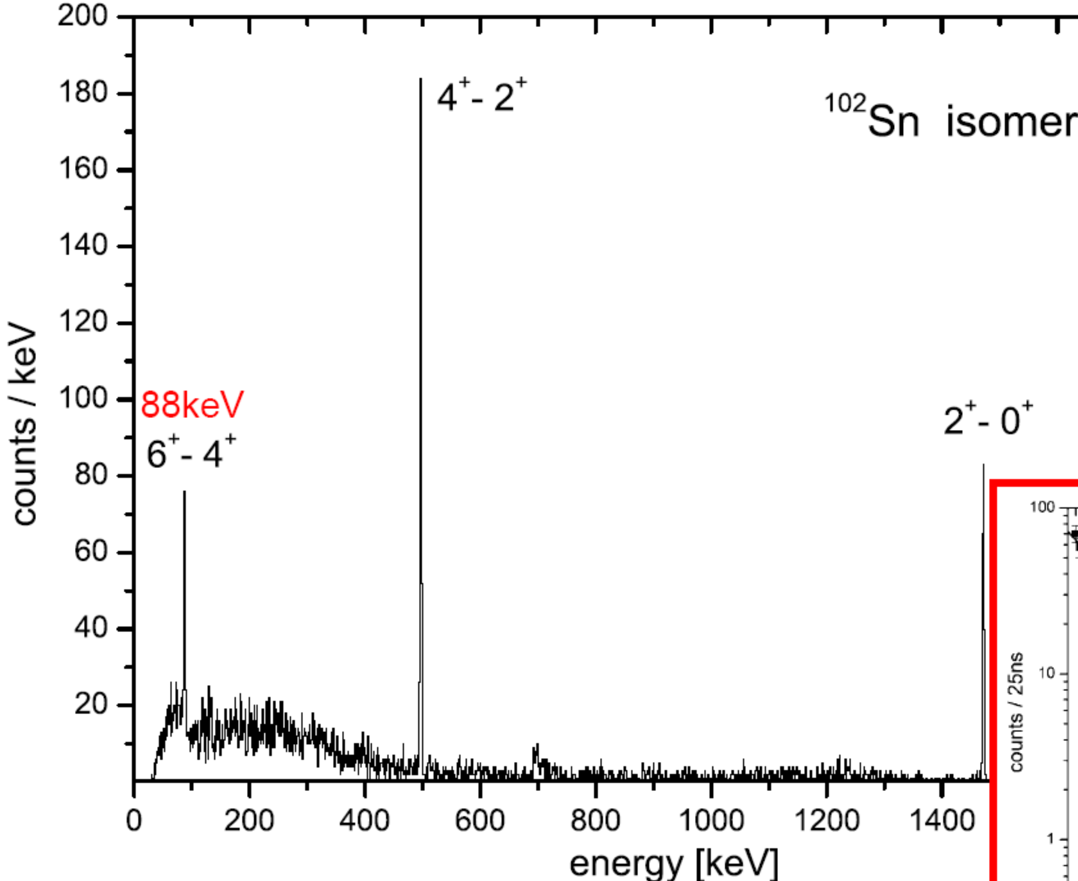


6^+ isomer in ^{102}Sn

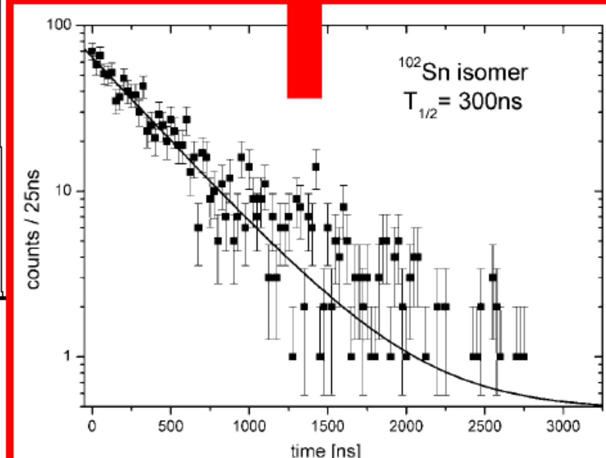


Lipoglavsek et al., PLB 1998

E(6-4) = 48keV



B(E2)=3.6 W.u.

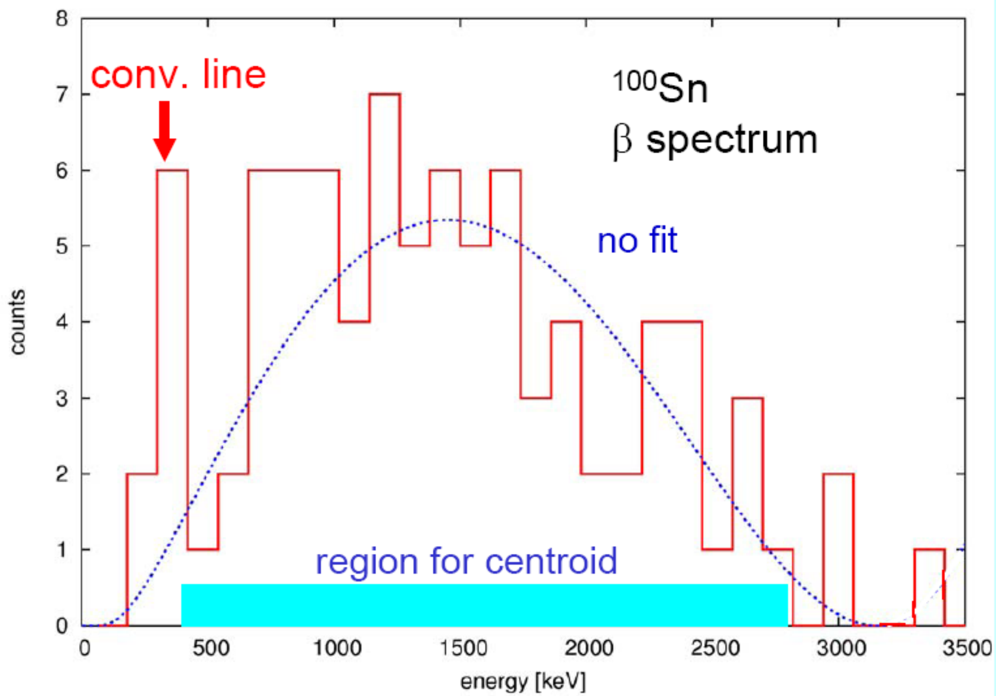


Extraction of Beta Spectrum

Sum over total energy within 3 s after implantation

in implantation zone + calorimeter

not yet tested for uninterrupted tracks



from centroid

$E_{max} = 3.15 \pm 0.20$ MeV

$Q_{EC} = 4.17 \pm 0.20$ MeV

to excited state

preliminary

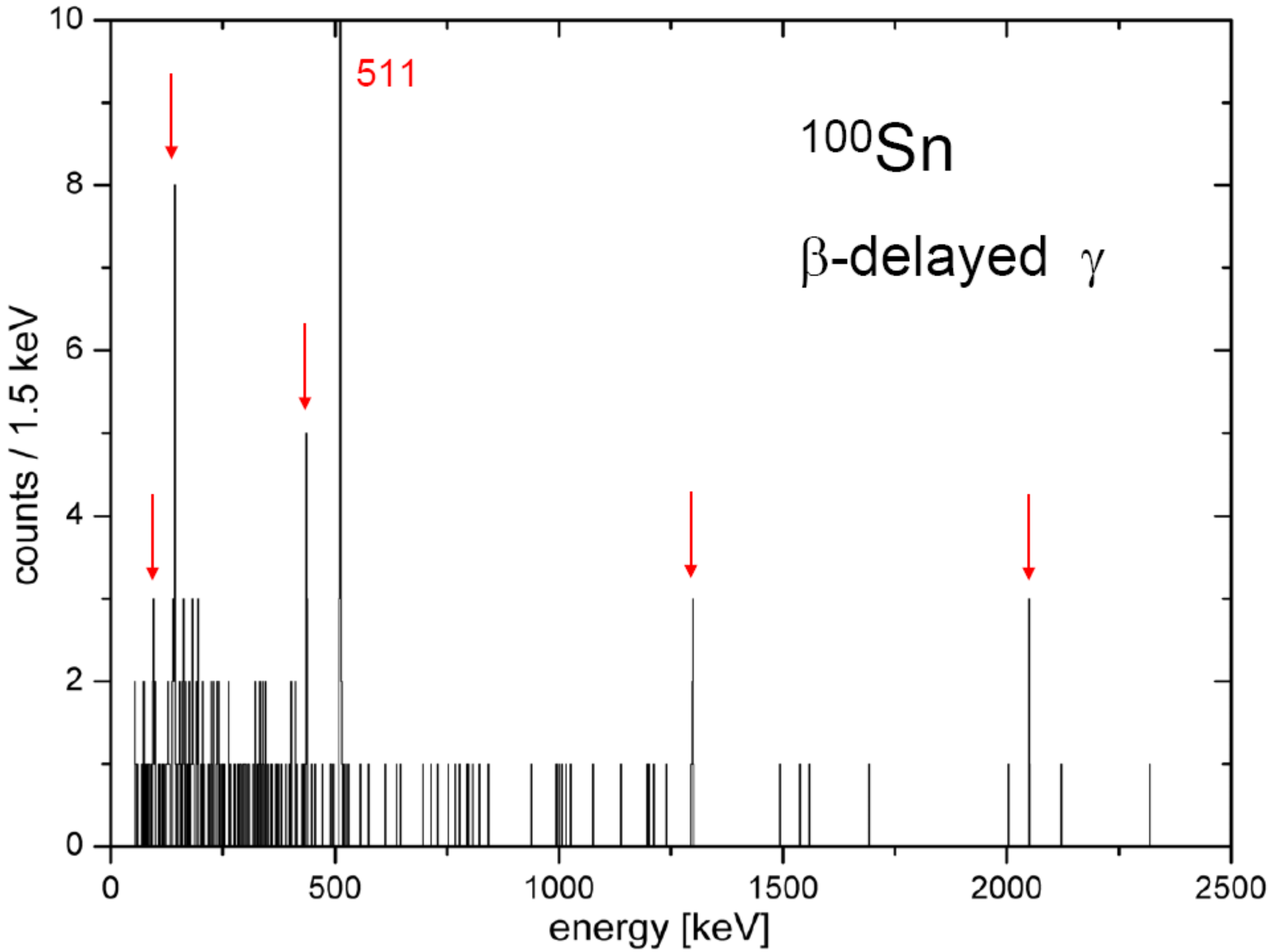
=> $I_\beta = 85\%$

log ft = 2.54 ± 0.20

that's record

Gamma Spectrum after Beta Decay of ^{100}Sn

all events within 4 s after implantation



Conclusions

- ^{100}Sn: not quite a RNB at GSI: $\approx$ 1 / hour
- First observation of ^{95}Cd, ^{97}In, and perhaps ^{99}Sn
- Reduced rate of ^{103}Sb: $T_{1/2} < 50$ ns
- ^{102}Sn: new isomeric state
- ^{100}Sn: $T_{1/2}$, E_{β}^{max}, E_{γ}, B_{GT}

$T_{1/2} = 1.16 \pm 0.20$ s

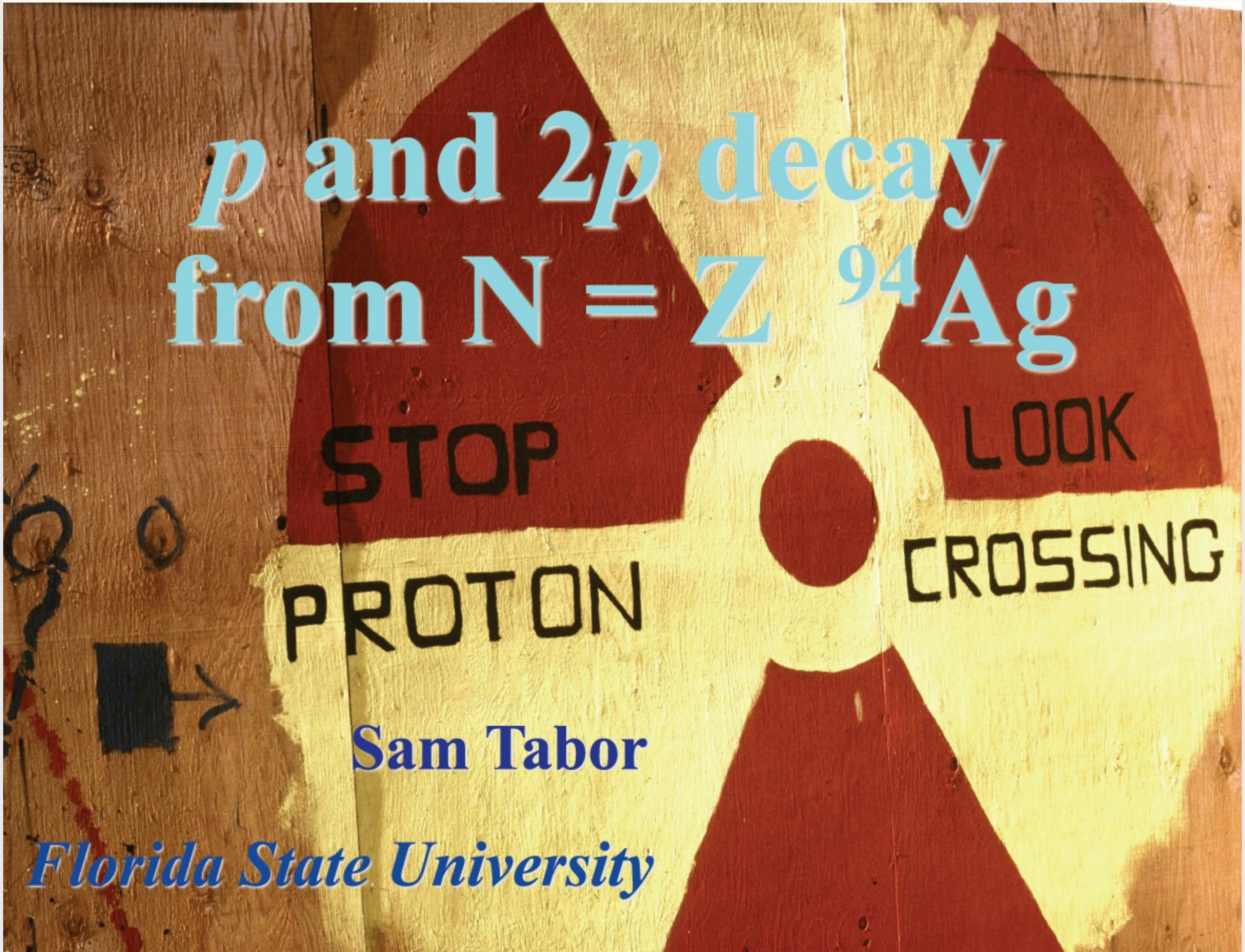
preliminary

Comparison:

MSU 2007	$0.55^{+0.70}_{-0.31}$ s
GSI 1997	$0.94^{+0.54}_{-0.26}$ s

and more to come

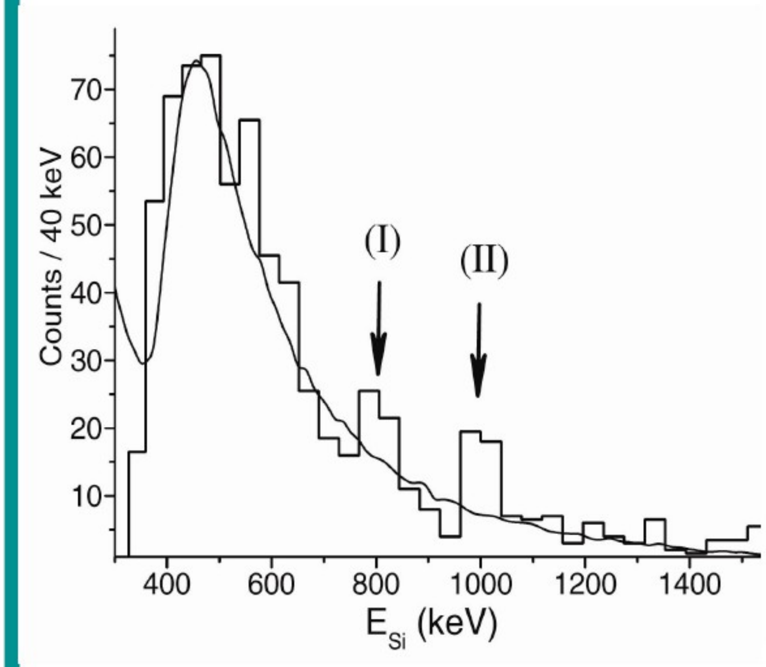
p and 2*p* decay from N = Z ^{94}Ag



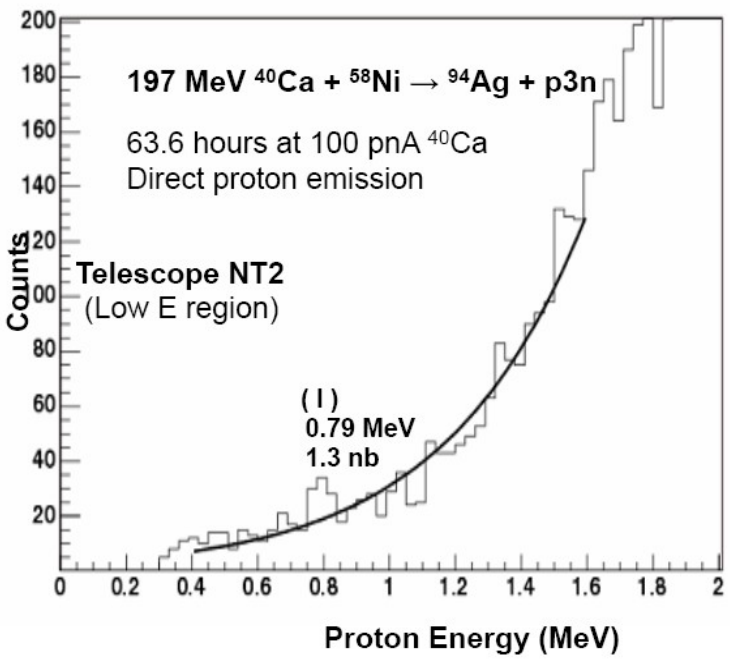
Sam Tabor

Florida State University

DIRECT 1*P* DECAY FROM ^{94}Ag 21^{+} ISOMER



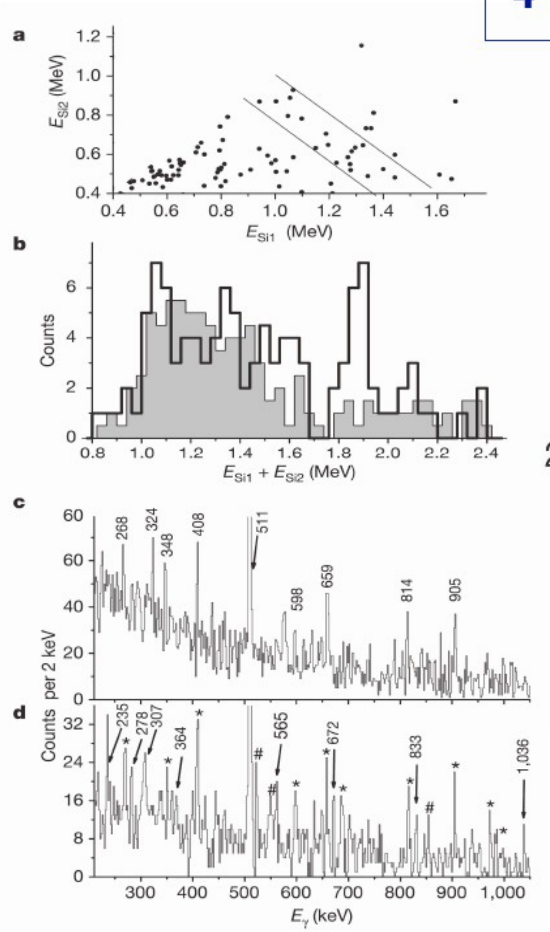
I. Mukha *et al.*, Phys. Rev. Lett. 95, 022501 (2005)

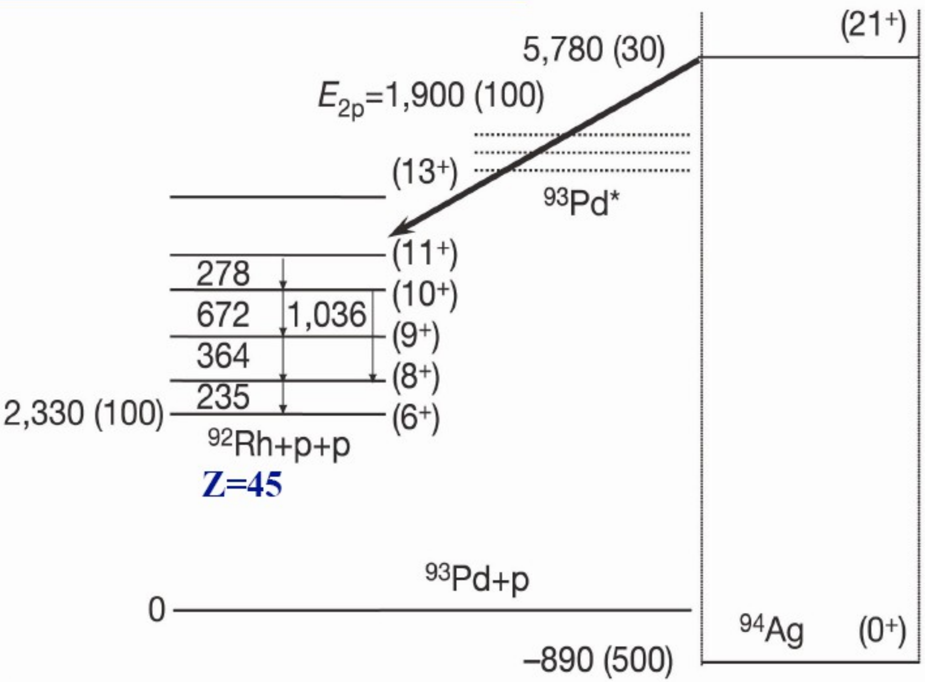


J. Cerny, ACS meeting April, 2008

CORRELATED 2-PROTON DECAY OF ^{94}Ag (21$^+$)

4-fold coincidences 2γ+2*p*





Z=45

I. Mukha *et al.*, Nature <u>439</u>, 298 (2006)

PRL **101,** 142503 (2008) PHYSICAL REVIEW LETTERS week ending 3 OCTOBER 2008

Mass Measurements and Implications for the Energy of the High-Spin Isomer in ^{94}Ag

A. Kankainen,[1,*] V.-V. Elomaa,[1] L. Batist,[2] S. Eliseev,[2,3] T. Eronen,[1] U. Hager,[1,+] J. Hakala,[1] A. Jokinen,[1] I. D. Moore,[1] Yu. N. Novikov,[2,3] H. Penttilä,[1] A. Popov,[2] S. Rahaman,[1] S. Rinta-Antila,[1,‡] J. Rissanen,[1] A. Saastamoinen,[1] D. M. Seliverstov,[2] T. Sonoda,[1,§] G. Vorobjev,[2,3] C. Weber,[1] and J. Äystö[1]

[1]*Department of Physics, University of Jyväskylä, P.O. Box 35, FI-40014 University of Jyväskylä, Finland*
[2]*Petersburg Nuclear Physics Institute, 188300 Gatchina, Russia*
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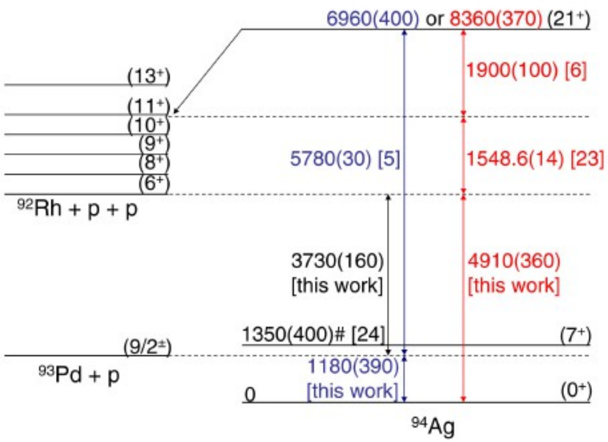
(Received 29 April 2008; published 1 October 2008)

TABLE I. Mass excess values Δ for ^{92}Rh and ^{94}Pd. The mass excess values were derived using the mass of a reference nuclide as given in Ref. [8]. In column four, "#" indicates a value that is derived from experimental, systematic trends [8].

Nuclide	Ref. atom	Δ_{JYFL} (keV)	Δ_{AME} (keV)	JYFL-AME (keV)
^{92}Rh	^{85}Rb	−62 998.6(4.3)[a]	−63 360(400)#	360(400)
^{94}Pd	^{94}Mo	−66 097.9(4.7)	−66 350(400)#	250(400)

[a]An average of the JYFLTRAP and SHIPTRAP values.

Excitation energies of 21$^+$ isomer based on 1*p* and 2*p* decay differ by 1400 (545) keV.



SUMMARY

^{94}Ag lives in interesting times!

GSI experiment most optimum but can't be repeated. Only limitation was lack of beta-proton separation.

Gas jet suitable for intense beams but selectivity limited.

One 1p direct decay mode confirmed.

No sign of ^{94}Ag yet in Gammasphere + FMA RDT exp.

Implications of JYFL mass measurements:

1p decaying state lies 1400 keV higher than reported because of missing gamma lines.

2p decaying state is different from 1p one and has higher energy and spin.

No 2p decay.

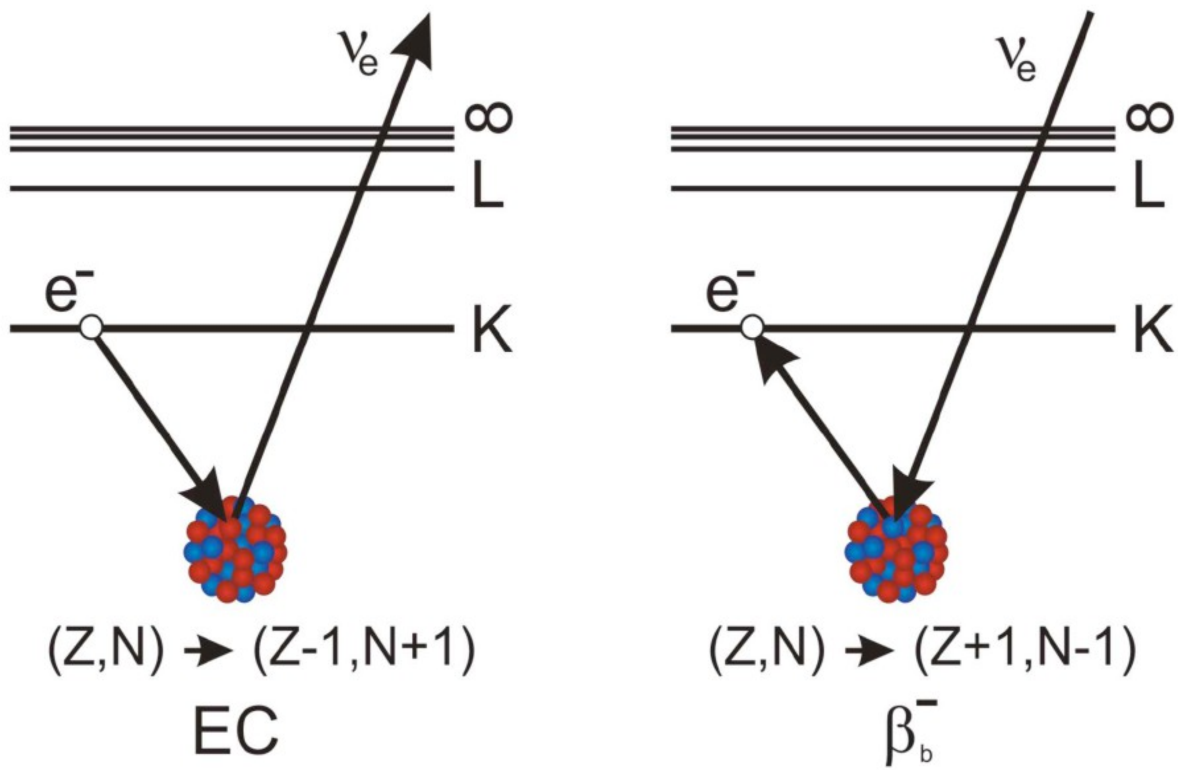
^{94}Ag is waiting for FRIB!!

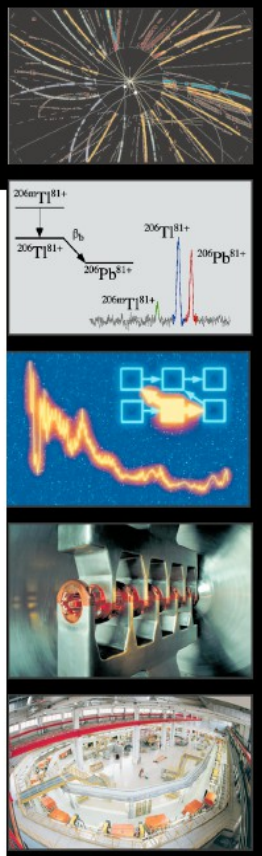
Wycieczka do Grand Haven nad jeziorem Michigan

Observation of non-exponential orbital electron-capture decay of stored H-like ions

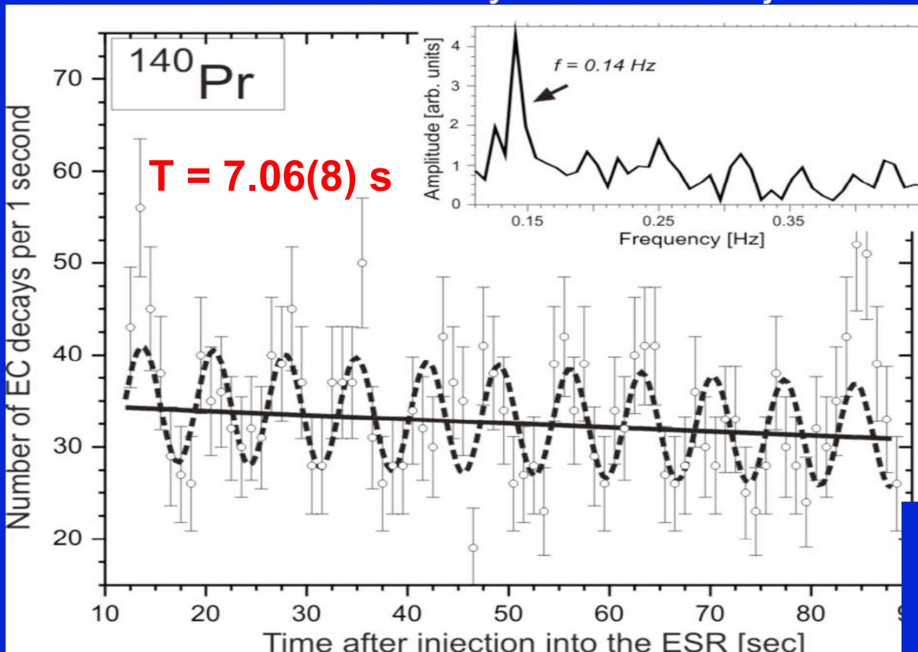
RNB8, Grand Rapids, May 26 –May 30, 2009

Fritz Bosch, GSI Helmholtzzentrum, Darmstadt, Germany

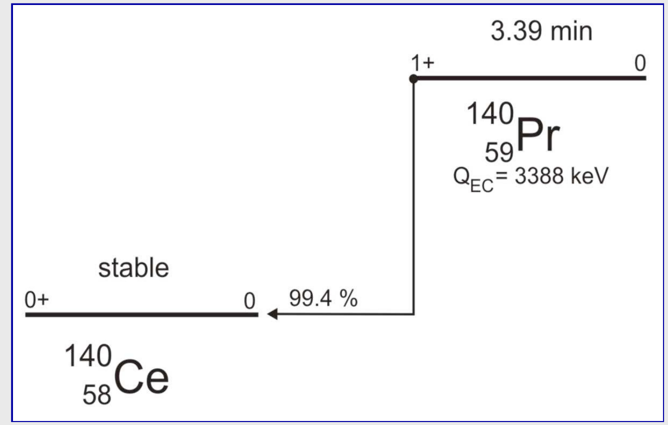




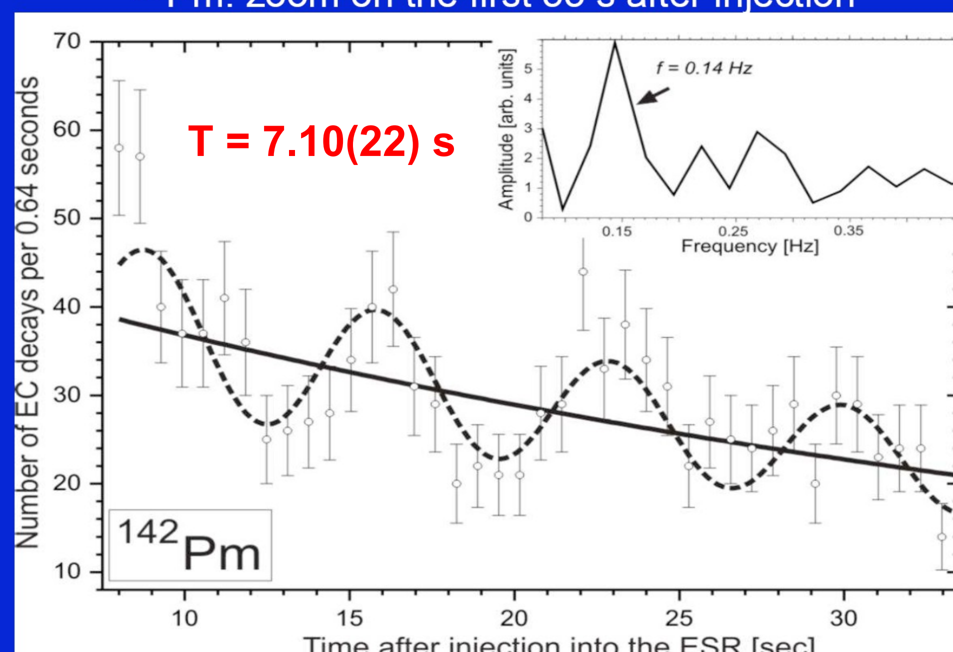
^{140}Pr all runs: 2650 EC decays from 7102 injections

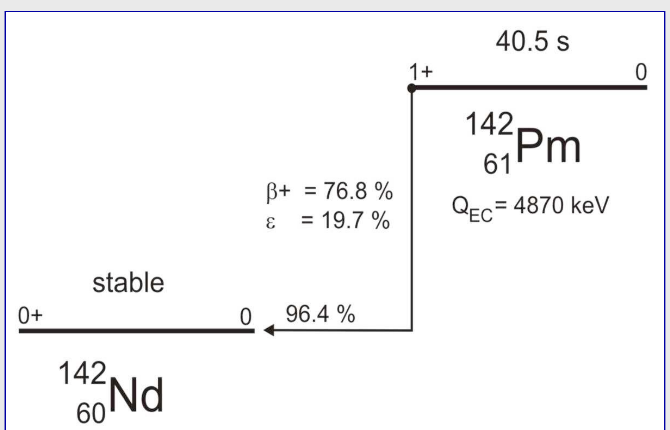


Yu.A. Litvinov et al., Phys. Lett. **B 664** (2008) 162-1

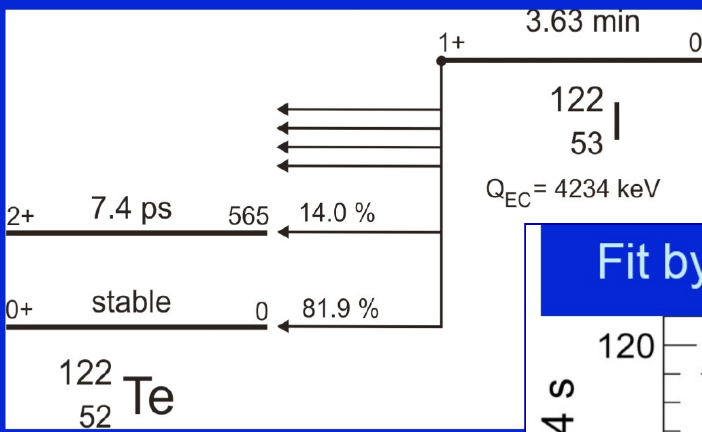


^{142}Pm: zoom on the first 33 s after injection



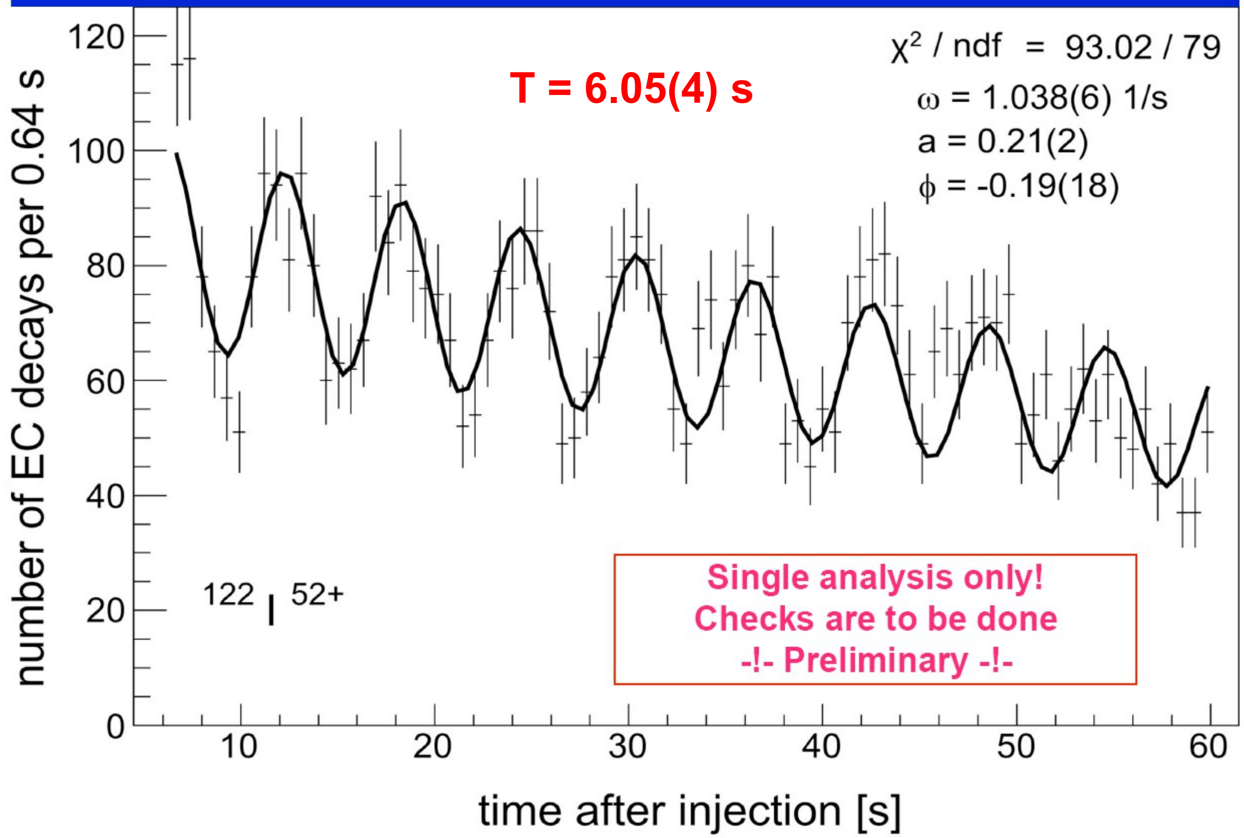


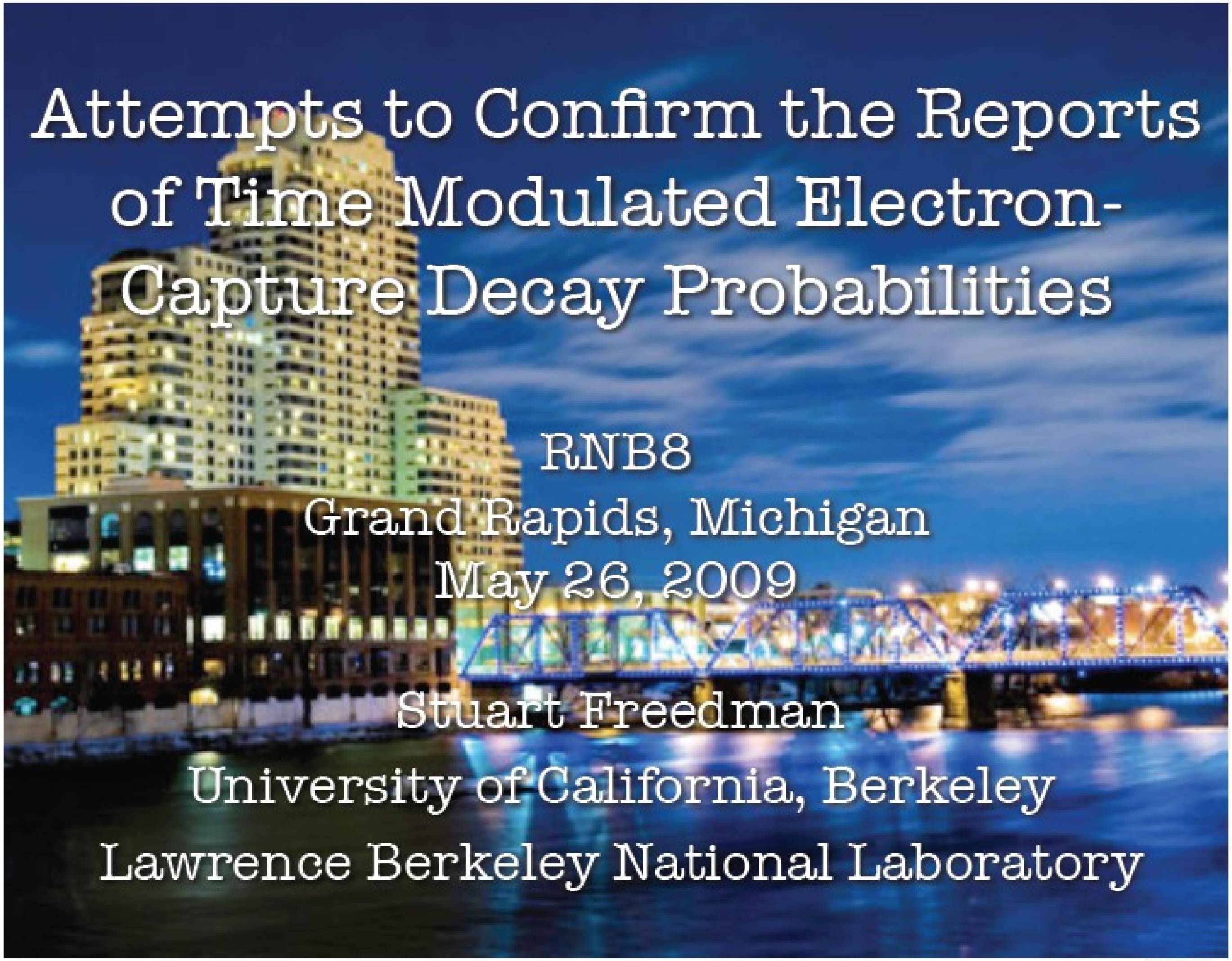
Decay scheme of ^{122}I



Experiment: 31.07.2008-18.08.2008

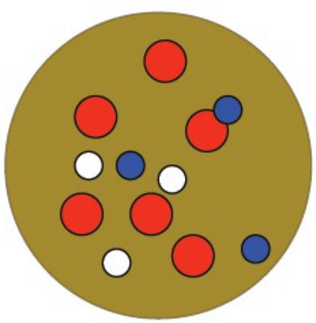
Fit by : $dN_{EC}/dt = N_0 \lambda_{EC} \exp(-\lambda t) [1 + a \cos(\omega t + \varphi)]$



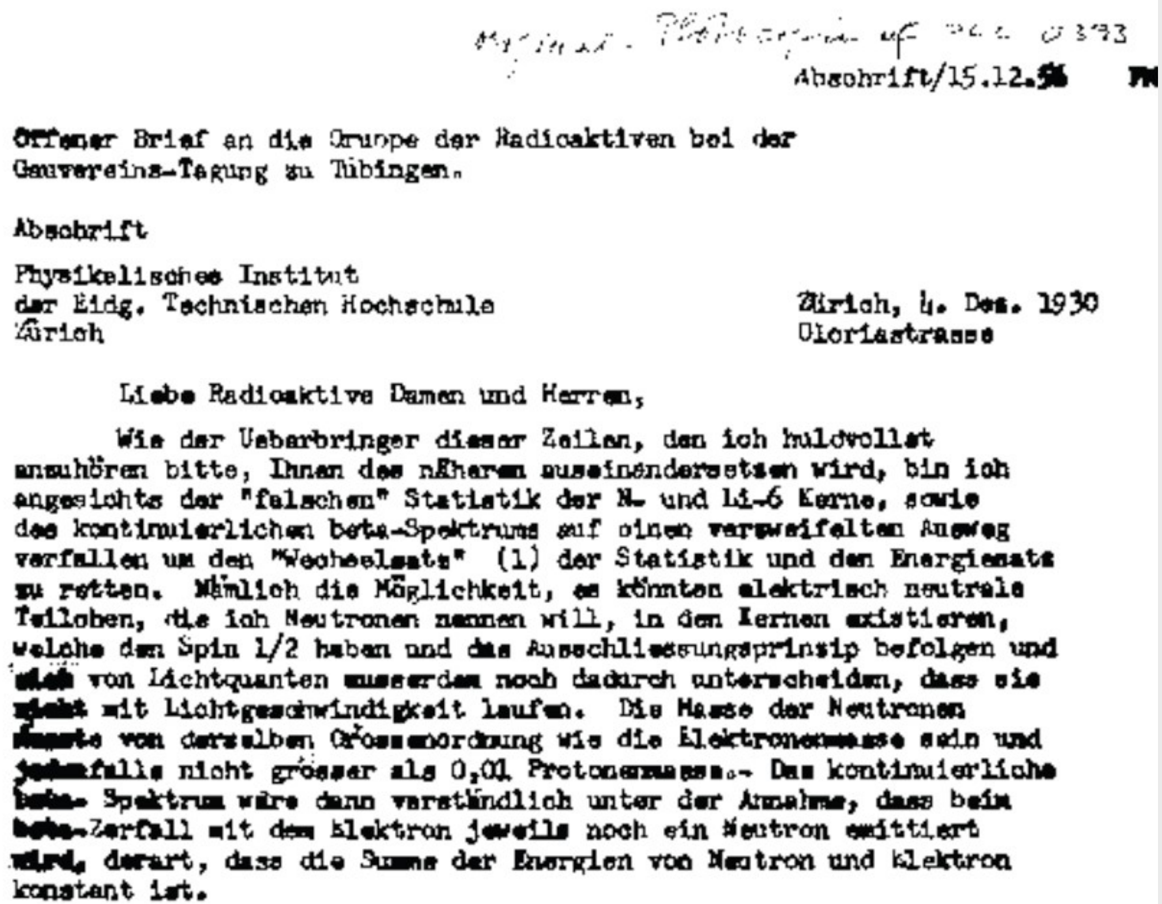

Attempts to Confirm the Reports of Time Modulated Electron-Capture Decay Probabilities
RNB8
Grand Rapids, Michigan
May 26, 2009
Stuart Freedman
University of California, Berkeley
Lawrence Berkeley National Laboratory

Pauli's Theory of Beta Decay

W. Pauli



^{6}Li



Abschrift/15.12.56

Offener Brief an die Gruppe der Radioaktiven bei der Gauvereins-Tagung zu Tübingen.

Abschrift

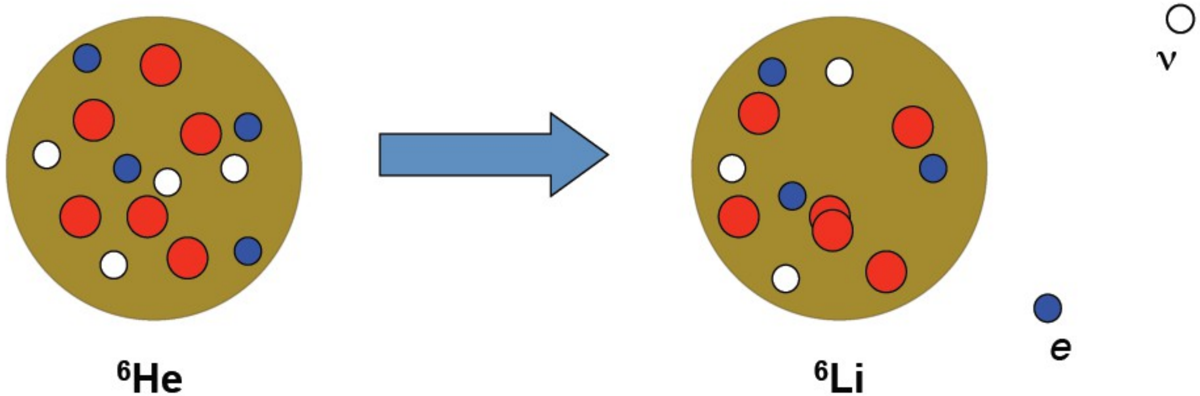
Physikalisches Institut
der Eidg. Technischen Hochschule
Zürich

Zürich, 4. Dez. 1930
Gloriastrasse

Liebe Radioaktive Damen und Herren,

Wie der Ueberbringer dieser Zeilen, den ich huldvollst anzuhören bitte, Ihnen des näheren auseinandersetzen wird, bin ich angesichts der "falschen" Statistik der N- und Li-6 Kerne, sowie des kontinuierlichen beta-Spektrums auf einen verzweifelten Ausweg verfallen um den "Wechselsatz" (1) der Statistik und den Energiesatz zu retten. Nämlich die Möglichkeit, es könnten elektrisch neutrale Teilchen, die ich Neutronen nennen will, in den Kernen existieren, welche den Spin 1/2 haben und das Ausschliessungsprinzip befolgen und sich von Lichtquanten ausserdem noch dadurch unterscheiden, dass sie nicht mit Lichtgeschwindigkeit laufen. Die Masse der Neutronen müsste von derselben Grossenordnung wie die Elektronenmasse sein und jedenfalls nicht grösser als 0,01 Protonenmasse.- Das kontinuierliche beta- Spektrum wäre dann verständlich unter der Annahme, dass beim beta-Zerfall mit dem Elektron jeweils noch ein Neutron emittiert wird, derart, dass die Summe der Energien von Neutron und Elektron konstant ist.

Pauli's Theory of Beta Decay



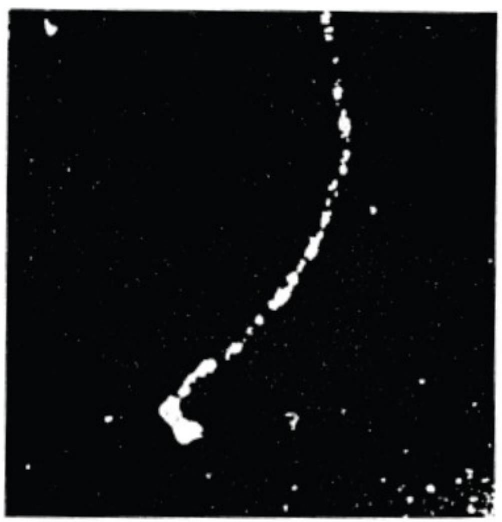


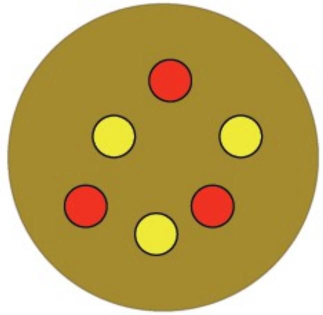
Fig. 1.2. Cloud chamber picture of the decay of He^6 (Csikai *et al.* [1958]).

$$P_{ee}(t) = 1 - \sin^2 2\theta \sin^2\left(\frac{(m_2 - m_1)c^2}{2\hbar} t\right)$$

$$\gamma = \frac{E}{(m_1c^2 + m_2c^2)/2}$$

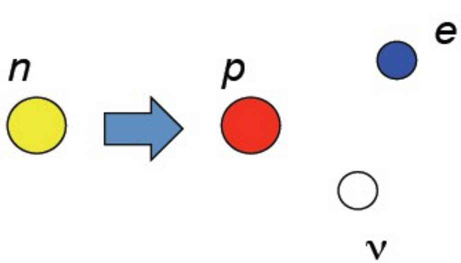
$$P_{ee}(t) = 1 - \sin^2 2\theta \sin^2\left(\frac{(m_2^2 - m_1^2)c^4}{4\hbar E} t_L\right)$$

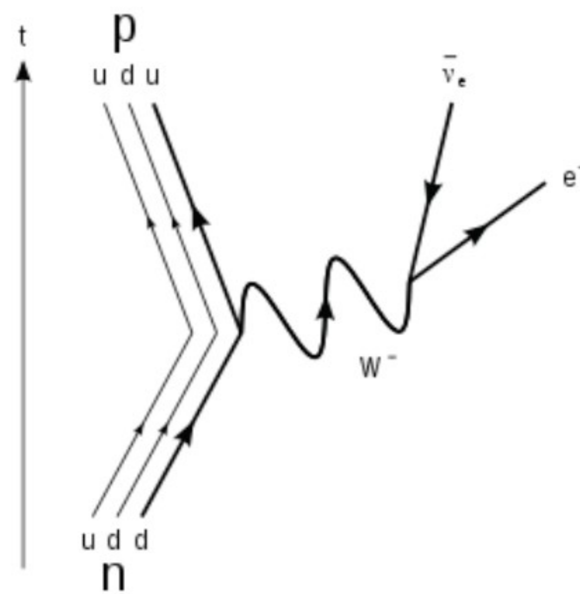
E. Fermi



Chadwick discovers the neutron

Fermi invents a new theory of β decay



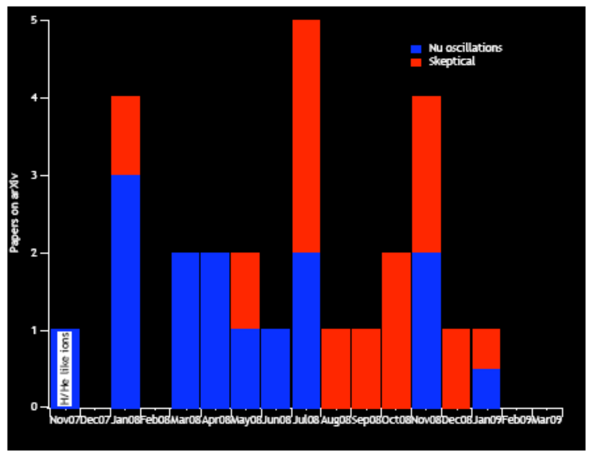


We now understand this as an example of a Quantum (Gauge) Field Theory

Is this surprising result another consequence neutrino mass and mixing like neutrino oscillations?

- B. Kayser poll: The answer "NO!" is favored by 13 out of the 18 theorists who have expressed a strong opinion.

Papers relating to GSI oscillations



Blue -- Neutrino Osc. Yes
Red -- Neutrino Osc. No

- While experimentalists usually remain agnostic some have come down in favor of "YES!".

- I have been in favor of an experimental resolution but "theory" has gotten in the way … I will come back to this point.

Pauli vs Fermi

Lifetime modulation possible:

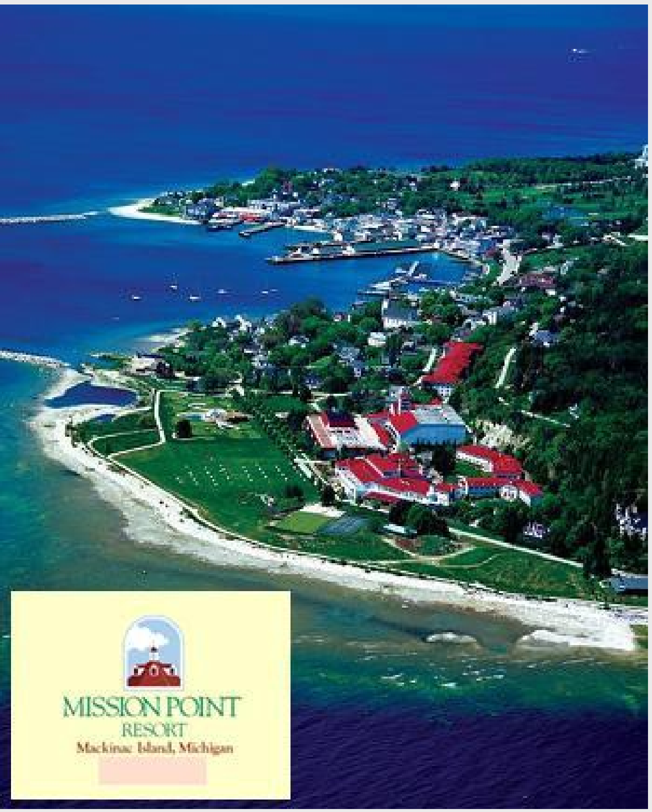
- Neutrinos existed in the initial state -- electron neutrinos at creation.
- A coherent mixture of mass eigenstates the "electron neutrino" is "measured" in the decay, which occurs later.

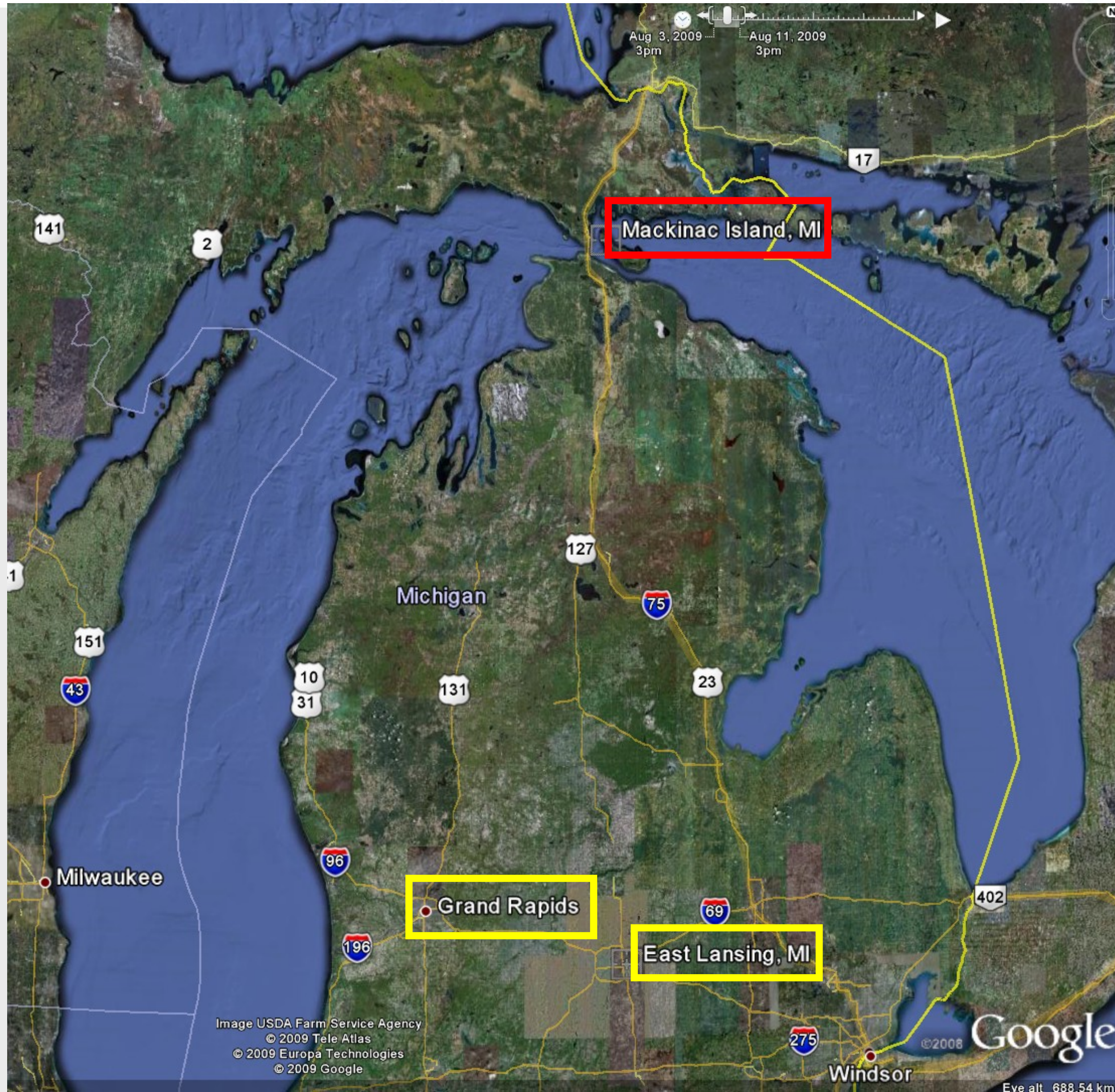
Lifetime modulation not possible:

- No Neutrinos existed in the initial state at the time of creation of the nucleus.
- Production and decay occur simultaneously.

COMEX 3

Collective Motions in nuclei under EXtreme conditions





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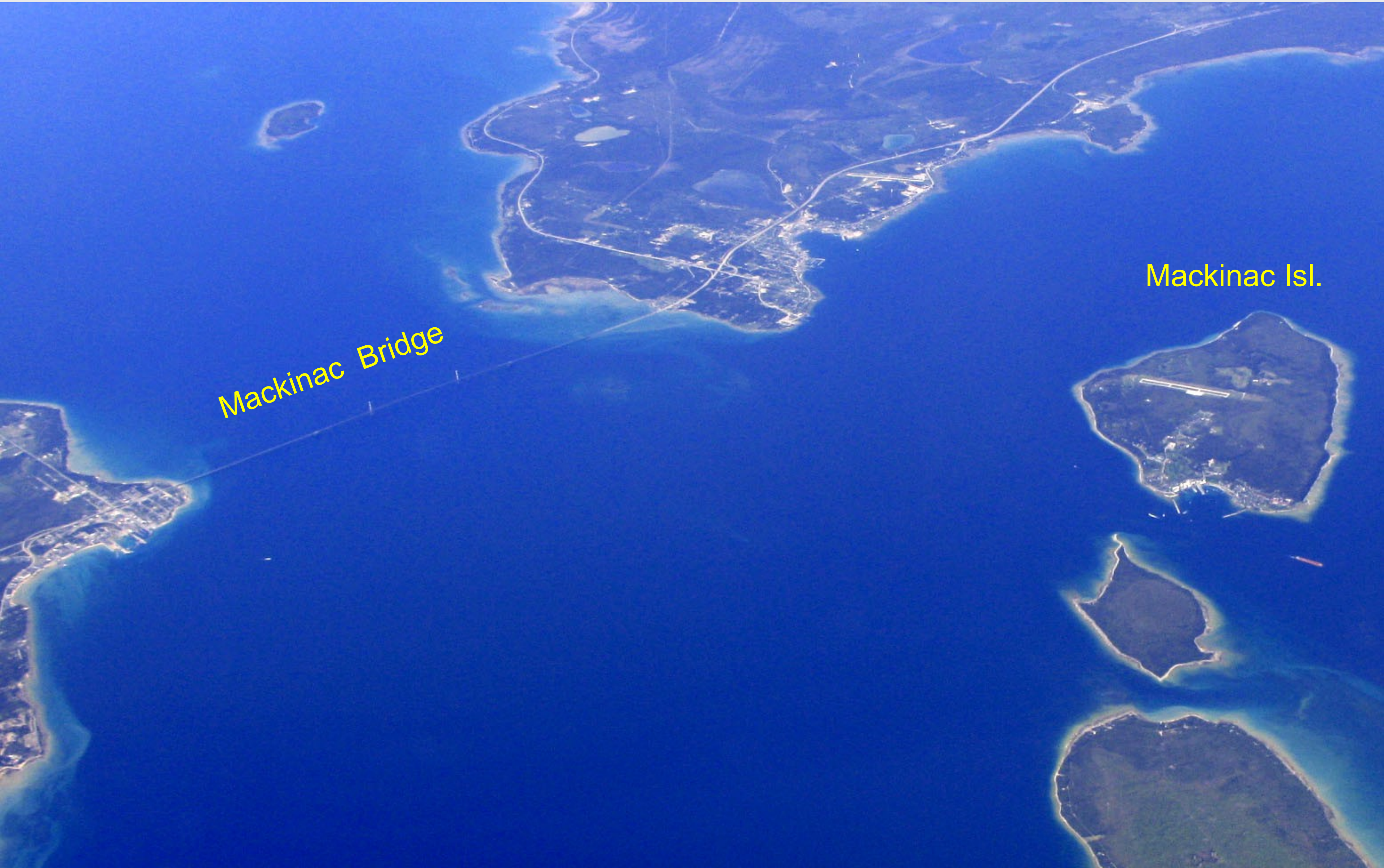

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Collective Motions in nuclei under EXtreme conditions

3.5 dni ok. 90 uczestników

Program

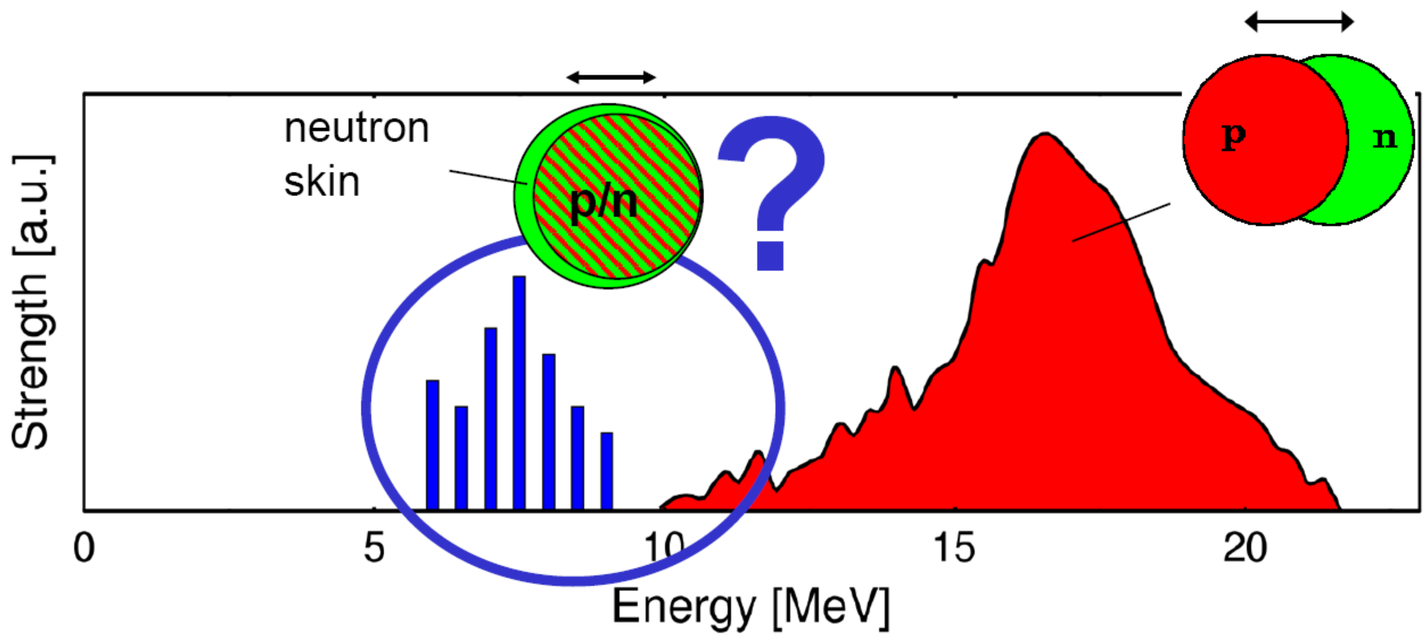
- Giant Monopole Resonanses
- Reactions
- Spin-isospin modes
- Nuclear dynamics
- Clustering
- Astrophysics
- Pygmy Resonanses × 2 *
- Many body physics
- Energy density functionals and shell model
- Double beta decay and charge exchange reactions
- Structure

Deniz Savran

Institut für Kernphysik, TU Darmstadt

E1 strength in (spherical) atomic nuclei

TECHNISCHE UNIVERSITÄT DARMSTADT



- Giant Dipole Resonance (GDR)
- Pygmy Dipole Resonance (PDR)

Study of the Pygmy Dipole Response using the Monoenergetic and Polarized Photon Beams at HIGS

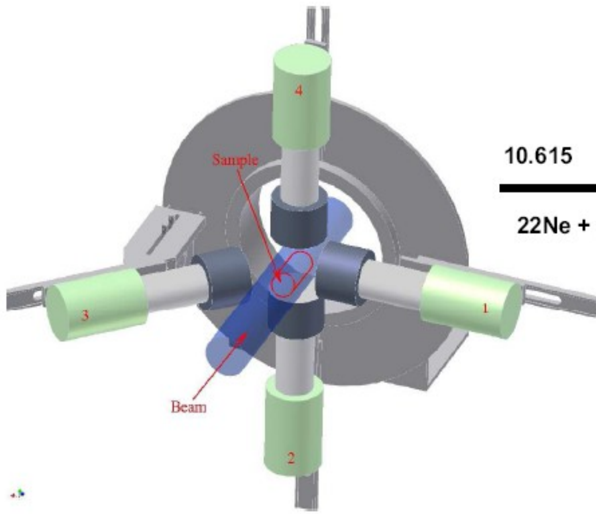
Anton P. Tonchev

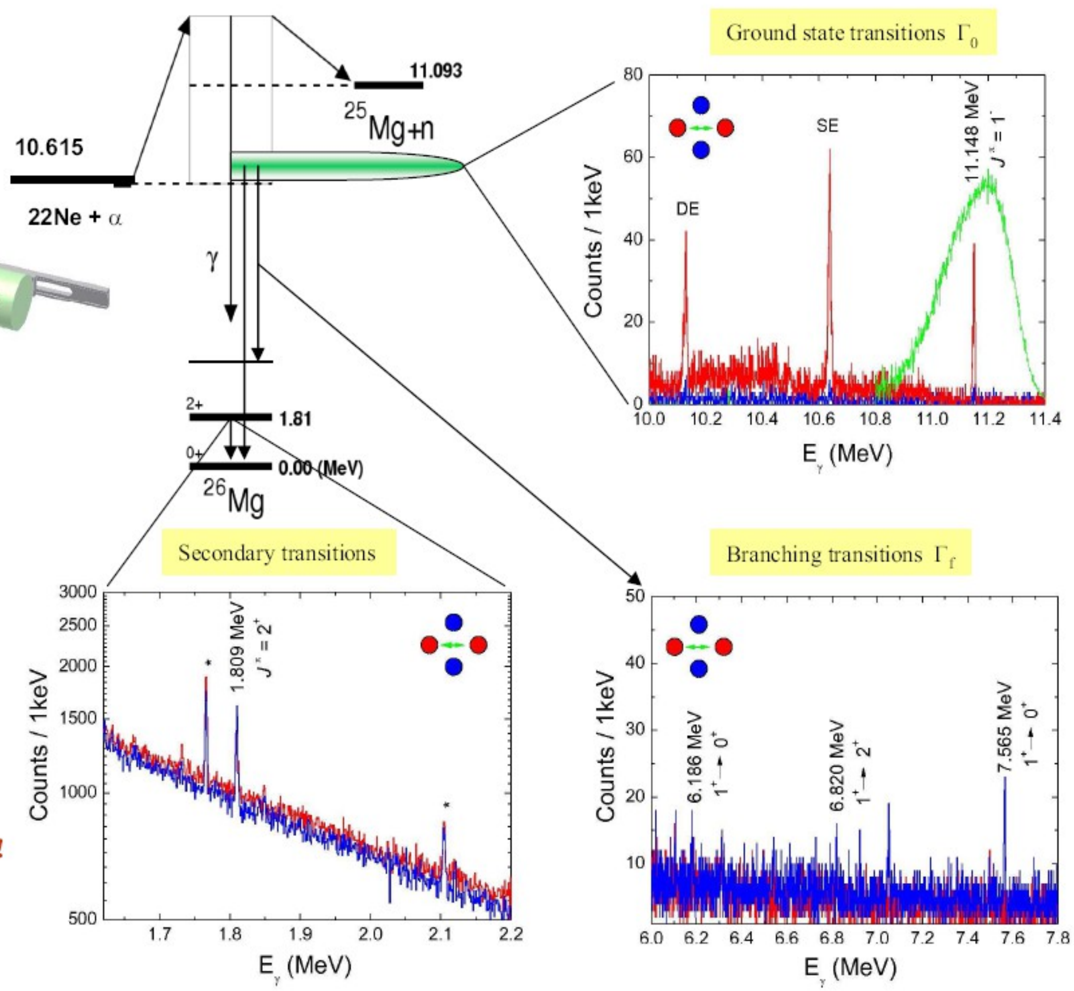
Duke University and
Triangle Universities Nuclear Laboratory

TUNL

COMEX 3, Mackinac Island, Michigan, June 2 - 5, 2009

Nuclear Resonance Fluorescence Technique: Pushing the Limit of Sensitivity





HIGS experimental observables:

- Excitation energy E_x
- Spin and parity J, π
- Decay width Γ_0
- Branching ratio Γ_i/Γ

In a completely model independent way !

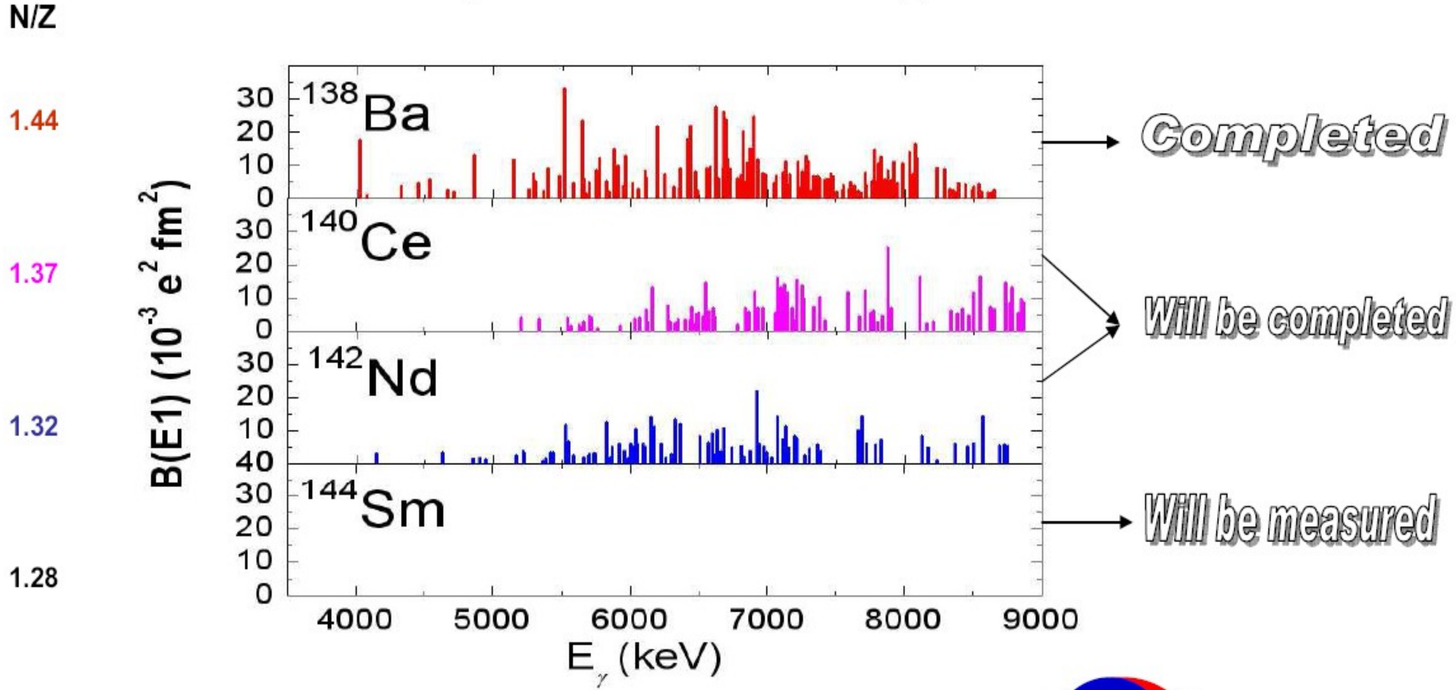
HIGS detection sensitivities:

resonance states with $\Gamma_{tot} \geq 1$meV

Dipole Strength Distribution from N = 82 Nuclei

HIGS data so far

(Ground state transitions only)



Not so strong N/P ratio → weak isospin effect

D. Savran et al., PRL 100, 232501 (2008)

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Coulomb excitation of ^{68}Ni @ 600 AMeV

Angela Bracco Oliver Wieland
INFN sect. of Milano

FRS+RISING ARRAY

Euroball 15 Clusters

Located at 16.5°, 33°, 36°
Energetic threshold ~ 100 keV

Hector 8 BaF_2

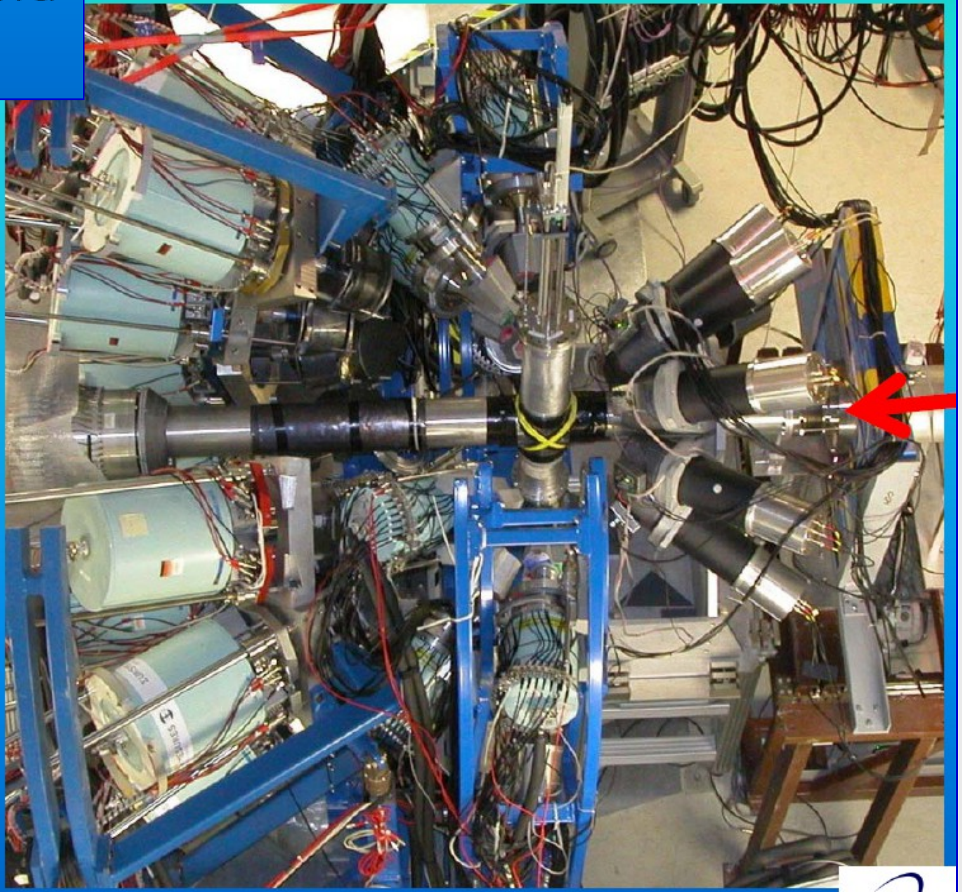
Located at 142° and 88°
Energetic threshold ~ 2 MeV

Miniball 7 HPGe segmented detectors

Located at 46°, 60°, 80°, 90°
Energetic threshold ~ 100 keV

Beam identification and tracking detectors

Before and **after** the target



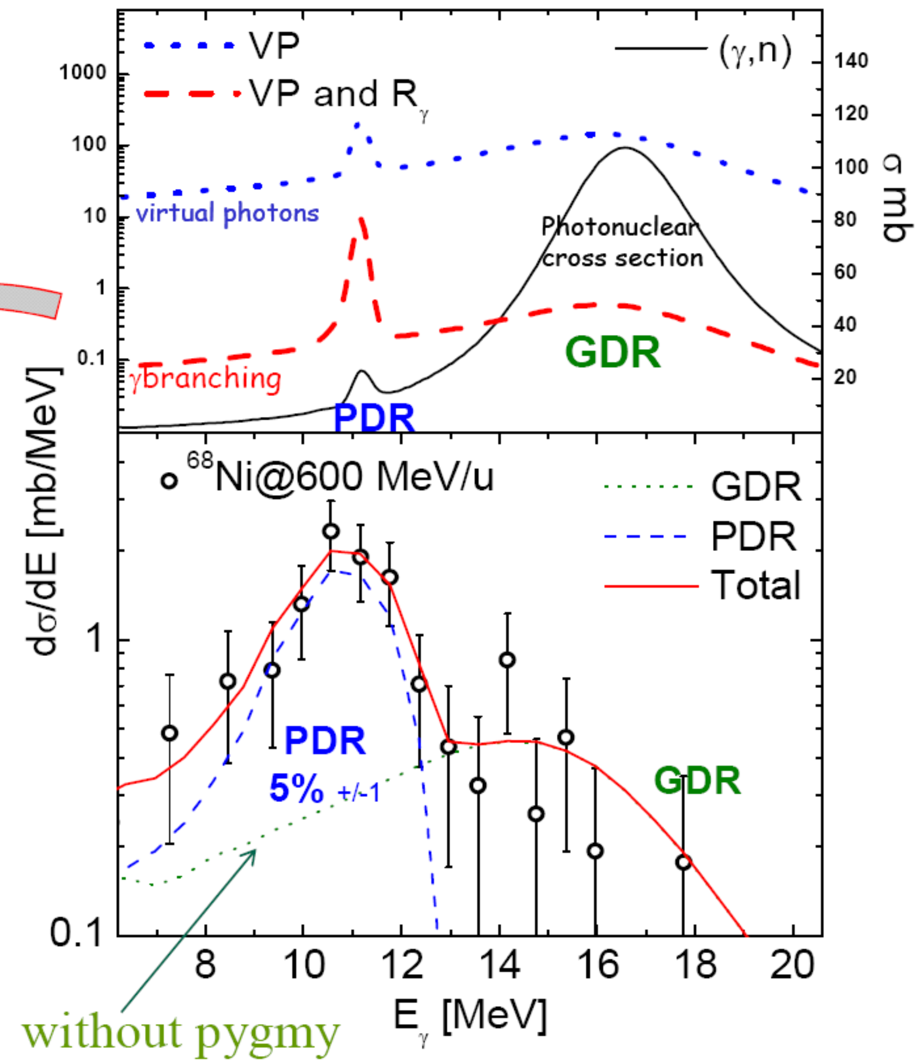
INFN

Relativistic Coulomb excitation probability is directly proportional [Eisenberg,Greiner, Bertulani, Baur, Alder,Winther, Weizsaecker, Williams…] **to the Photonuclear cross section**

$$\frac{d\sigma_{C\gamma}}{dE_\gamma} = RF\left\{\frac{1}{E_\gamma} N_\gamma(E_\gamma)\cdot\sigma_\gamma(E_\gamma)\cdot R_\gamma(E_\gamma)\right\}$$

ResponseFunction

Folded with the **detector response function**



O.Wieland et al. PRL 102, 092502 (2009)

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Collective Motions in nuclei under EXtreme conditions

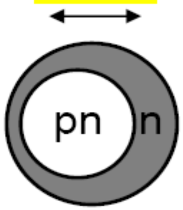
Electric and Magnetic Response of Skin Nuclei

N. Tsoneva, H. Lenske

Institut für Theoretische Physik, Universität Giessen, Germany

ELECTRIC DIPOLE

PDR

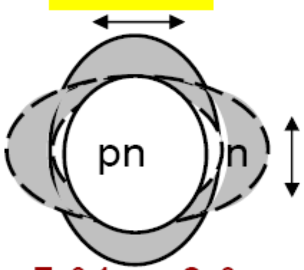


Δ T=0,1; Δ S=0

E*~ 6- 8 MeV, B(E1)~ 0.2 W.u.

ELECTRIC QUADRUPOLE

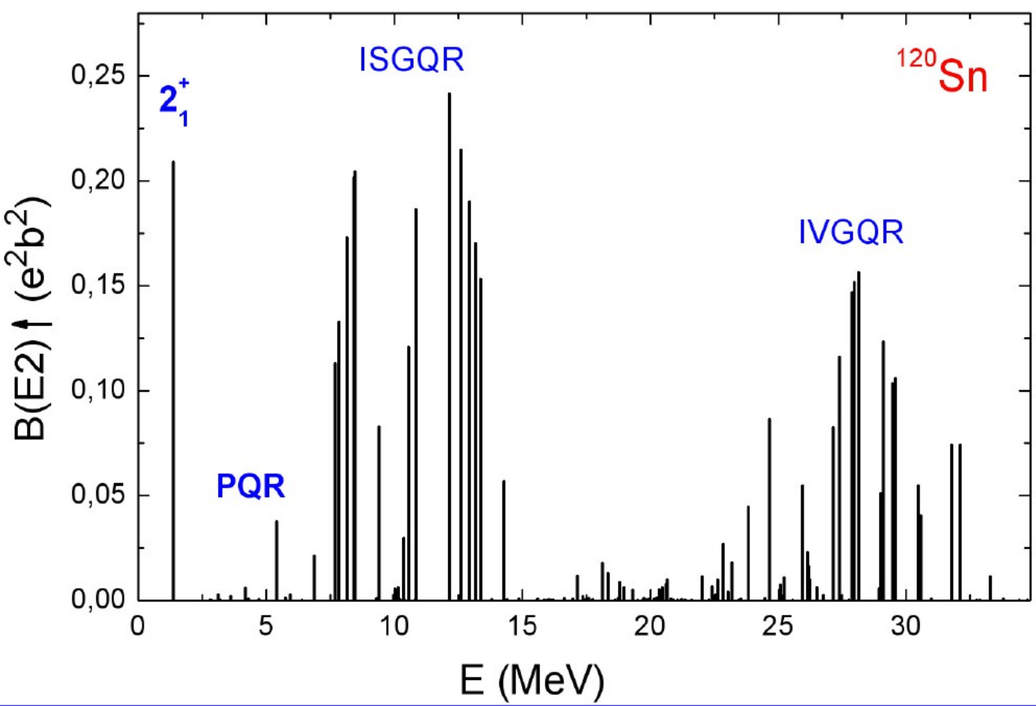
PQR ?



Δ T=0,1; Δ S=0

E*~ 2-8 MeV, B(E2)~ 0.6 W.u.

QRPA Calculations of Quadrupole States in ^{120}Sn



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Dwa wideoklipy o tematyce sub-atomowej autorstwa Kate McAlpine

Na temat LHC

→ Google: **Hadron Rap**

Na temat egzotycznych nuklidów i laboratorium NSCL/MSU

→ Google: **Isotope Rap**