ISOLTRAP status report (2009 – 2014)

David Lunney

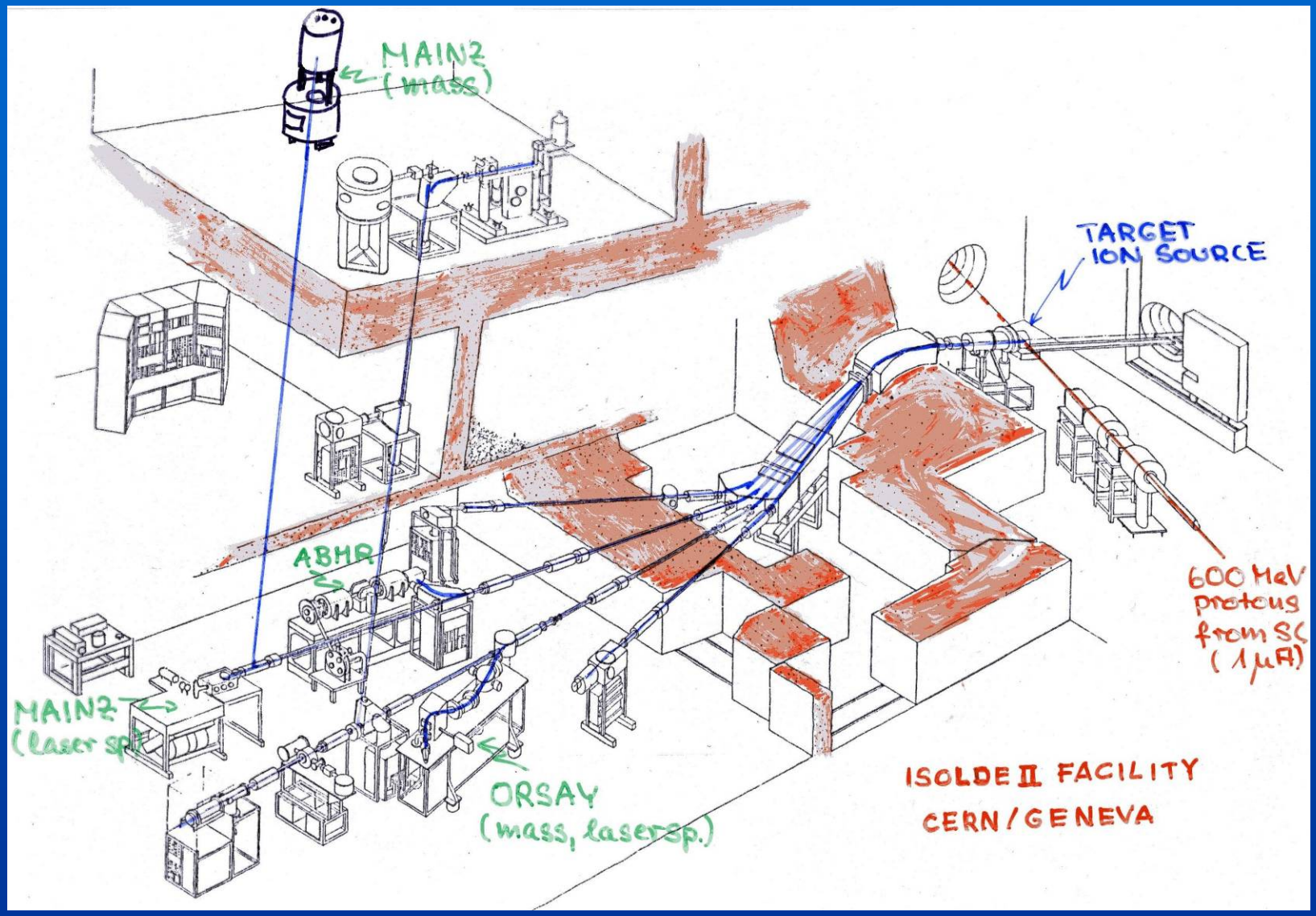
CSNSM/IN2P3/CNRS, Université de Paris Sud, Orsay

on behalf of the

ISOLTRAP Collaboration

CERN contact: Vladimir Manea

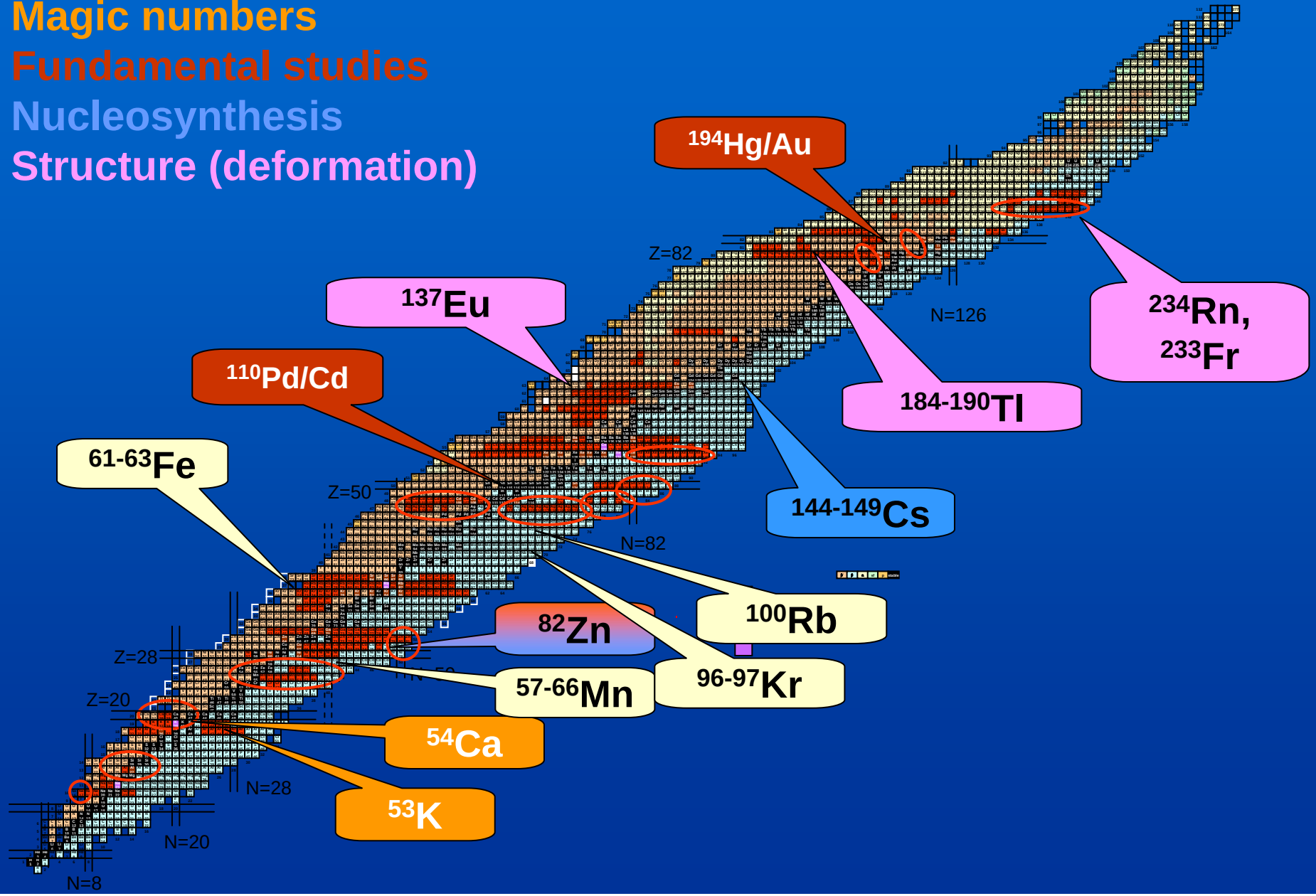
ISOLTRAP @ ISOLDE-II (1986)



one of the longest running experiments at ISOLDE

ISOLTRAP highlights (2010 – 2013)

Magic numbers
Fundamental studies
Nucleosynthesis
Structure (deformation)



Summary of accepted ISOLTRAP experiments (2007-2012)

Exp.	Approved shifts	Remaining shifts	Requested isotopes	Observations
IS463	22	4.5	$^{207-210}$Hg,$^{208-214}$Tl	
IS473	5	5	^{202}Tl	addendum approved
IS490	28	16	$^{46-48}$Ar,$^{70-72}$Kr	
IS498	8	4.5	^{168,170}Dy,^{174}Er,^{178,180}Yb	
IS513	21	21	^{193,195,197,199}Po	not yet scheduled
IS518	34	4.5		shifts transferred to IS534
IS532	21	3	$^{52-55}$Sc	addendum submitted separately
IS535	14	10	$^{76-79}$Cu	
IS542	9	9	^{32}Ar	not yet scheduled
IS565	8	8	^{23}Mg/^{23}Na, ^{21}Na/^{21}Ne	not yet scheduled
IS567	17	17	^{34}Mg	not yet scheduled
IS574	19	19	$^{129-132}$Cd	not yet scheduled

IS463: Masses & spectroscopy on n-rich Hg and Tl (2007)

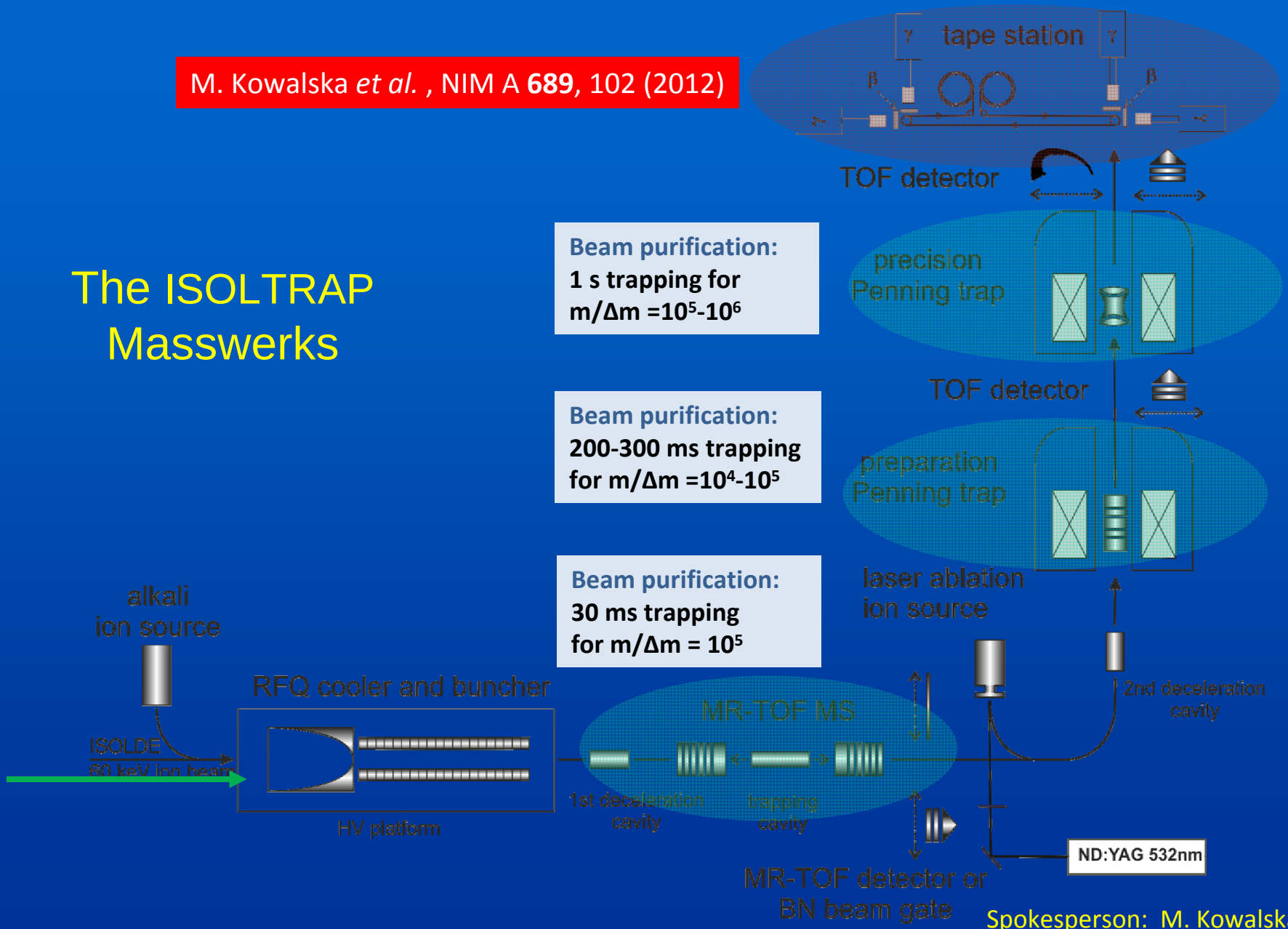
M. Kowalska *et al.* , NIM A **689**, 102 (2012)

The ISOLTRAP Masswerks

Beam purification:
1 s trapping for
$m/\Delta m = 10^5$-10^6

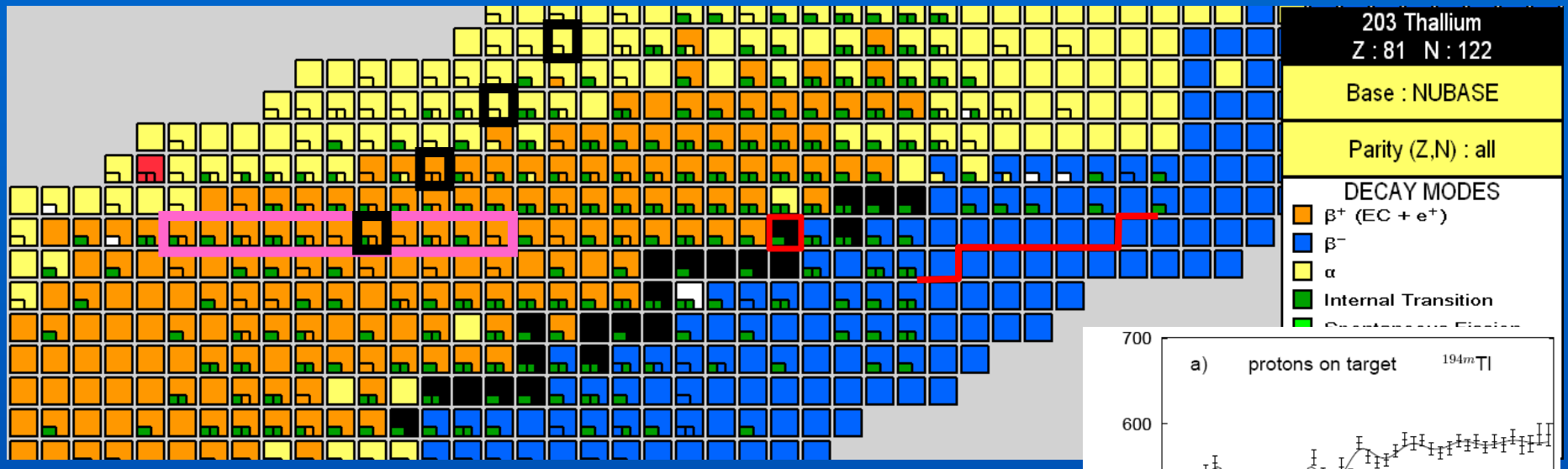
Beam purification:
200-300 ms trapping
for $m/\Delta m = 10^4$-10^5

Beam purification:
30 ms trapping
for $m/\Delta m = 10^5$

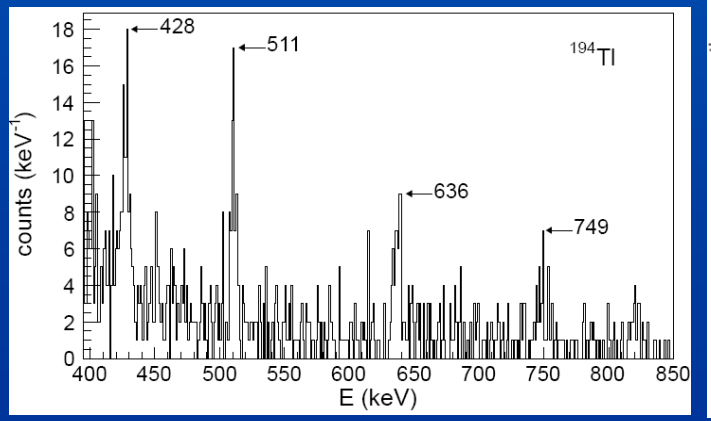


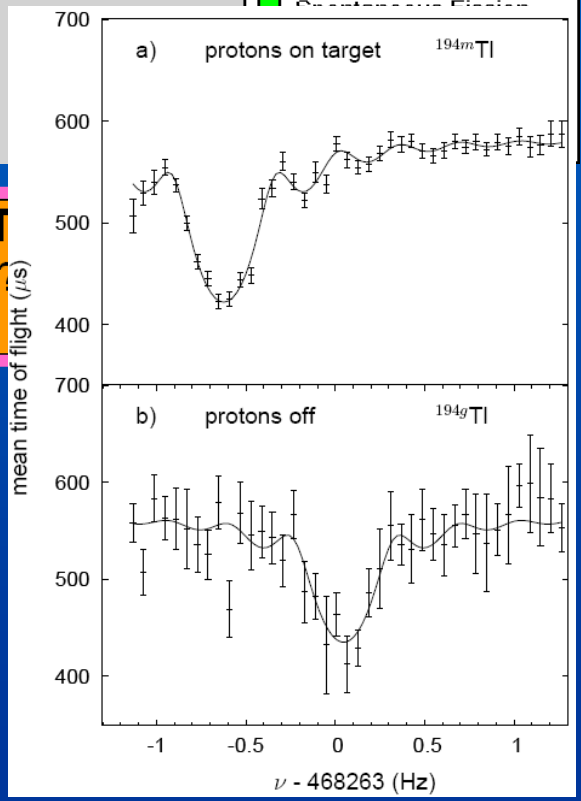
Spokesperson: M. Kowalska

IS463: Masses & spectroscopy on n-def Tl (plan B)



^{184,186}Tl et al.:
Ch. Boehm *et al.*,
in preparation





4.5/22 shifts (2007) → TISD
(TAC: n-cap on Pb for Hg + quartz)

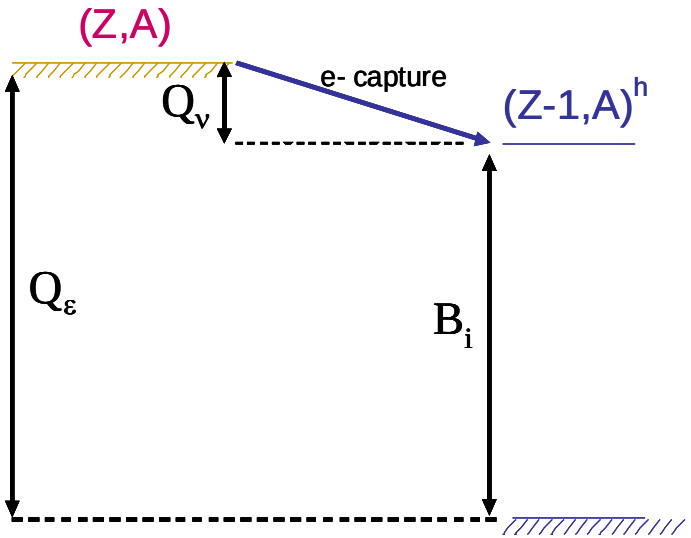
^{190,190m,194,194m}Tl: J. Stanja *et al.* , PRC (2013)

IS473: electron capture & neutrino mass (2011 - addendum)

ISOL TRAP

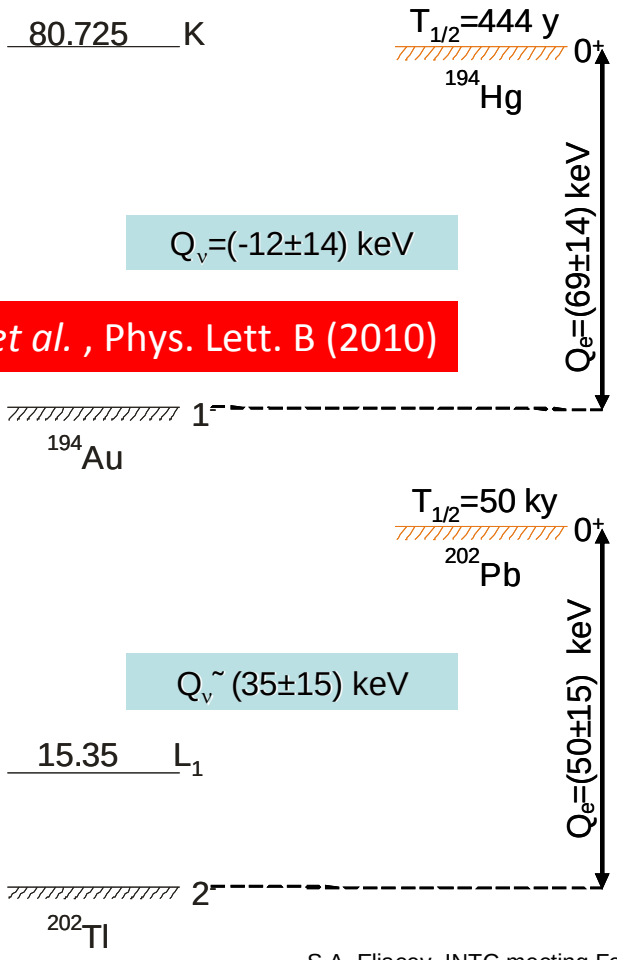
Possible candidates: ^{194}Hg-Au, ^{202}Tl-Pb

Electron capture:



$$Q_\nu = E_\nu + m_\nu = Q_\varepsilon - B_i$$

To be a candidate for neutrino-mass determination $Q_\varepsilon - B_i < 1$ keV

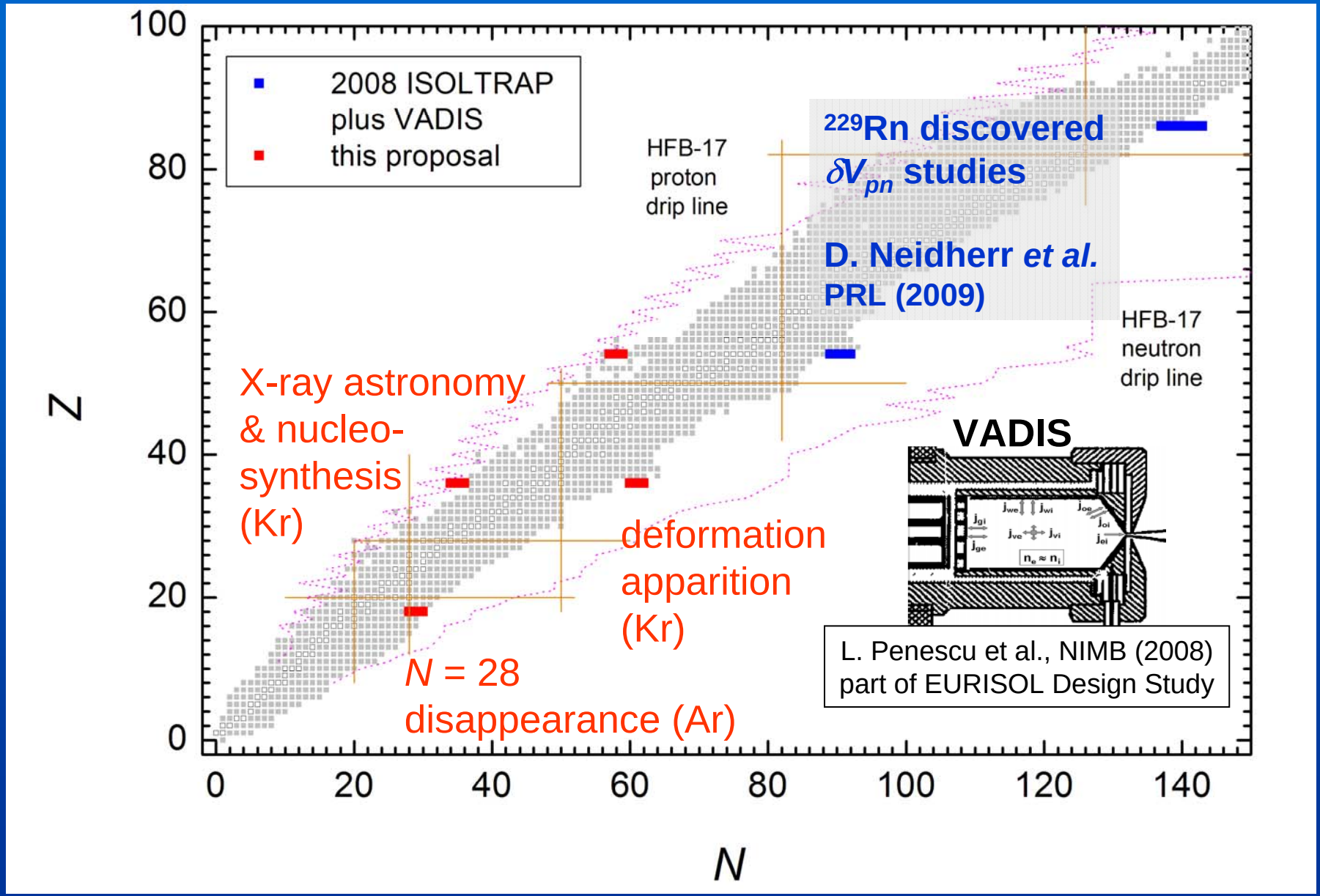


S.A. Eliseev. INTC meeting Feb08

5/5 shifts (2011 add.) → never scheduled
(TAC: no comments) ^{202}Tl with RILIS

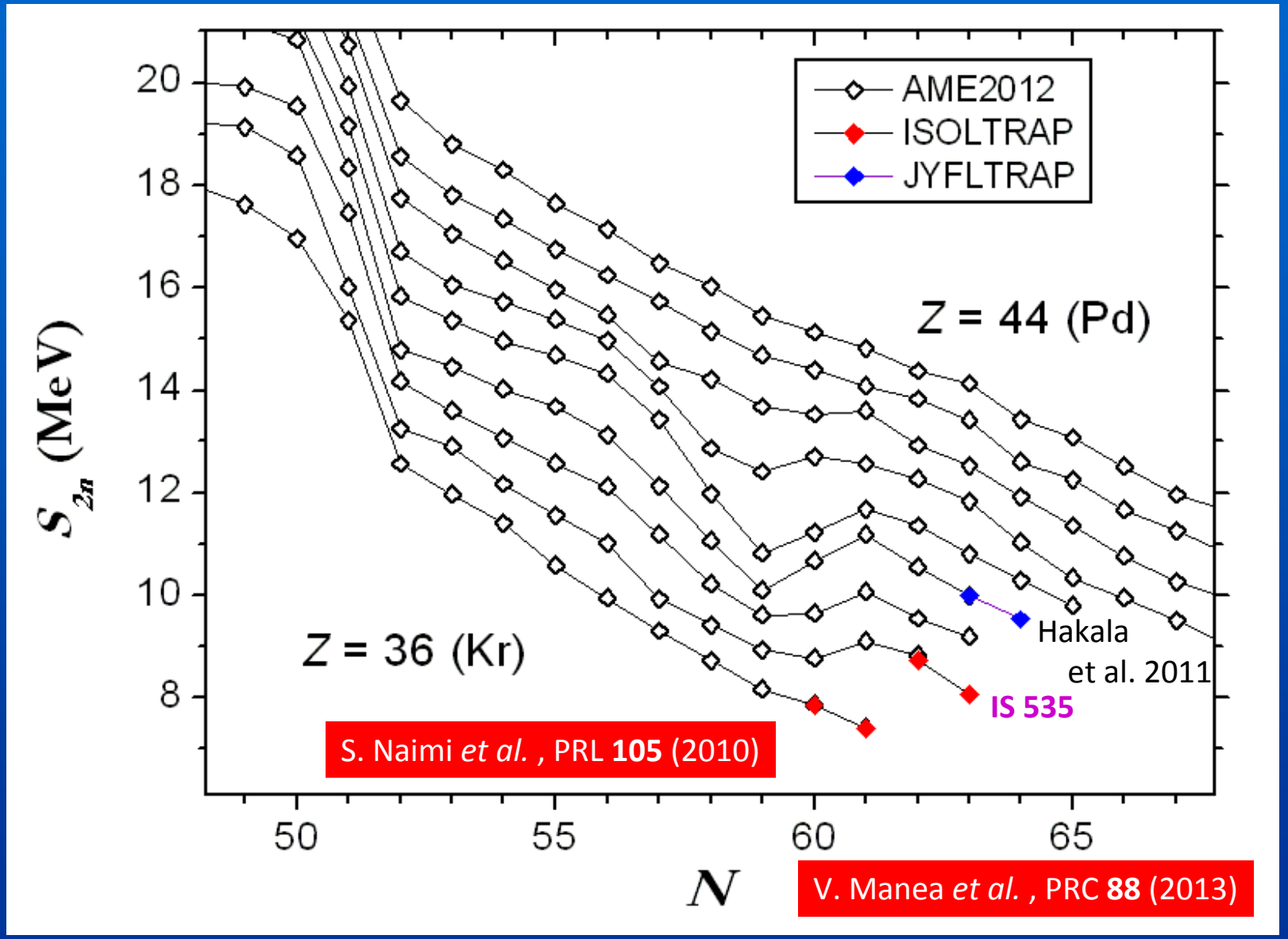
Spokesperson: S. Eliseev

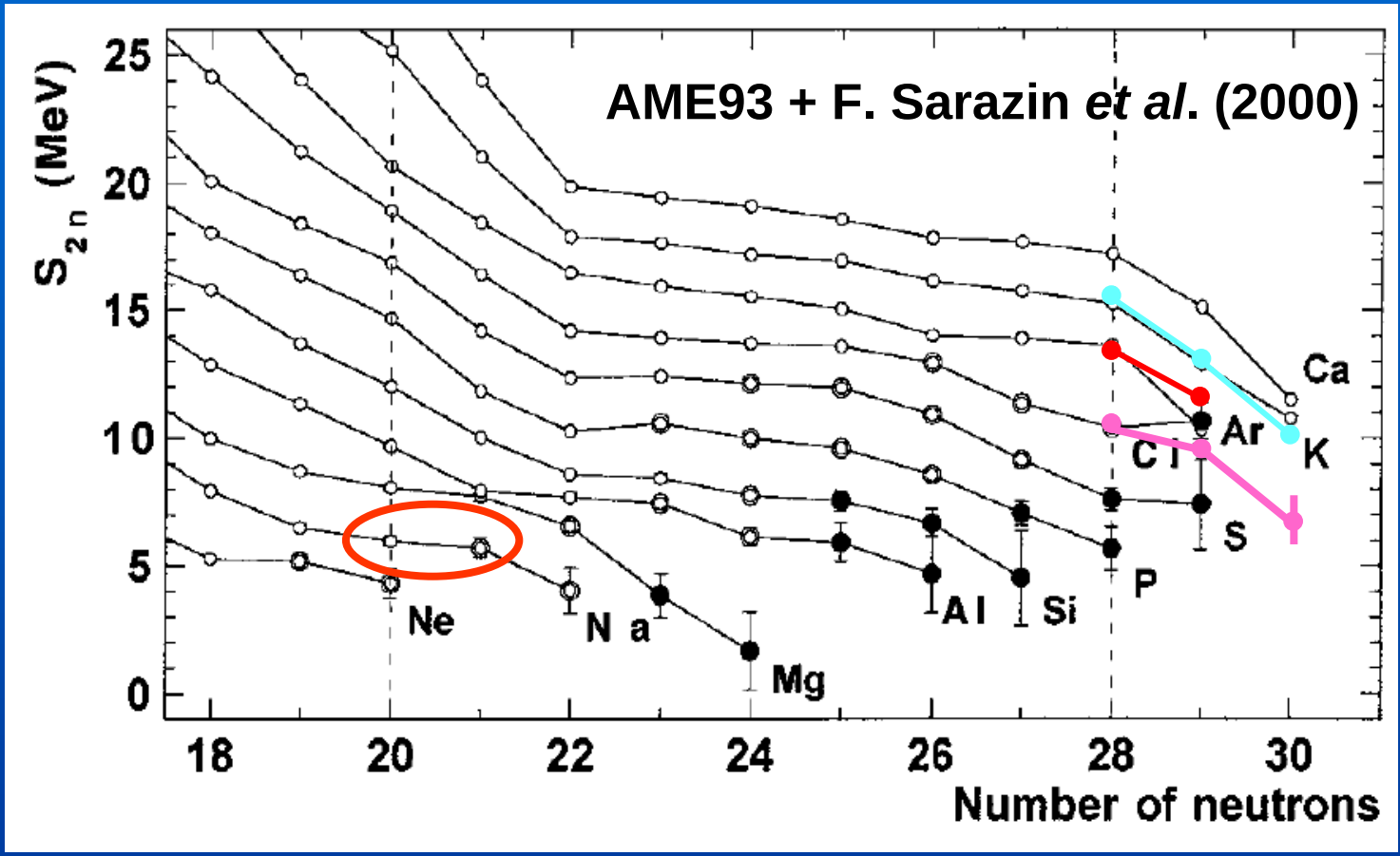
IS 490: Masses of Noble Gases (2009)



Spokesperson: Jørs Truly

IS 490: is Kr part of the A = 100 region of deformation ?





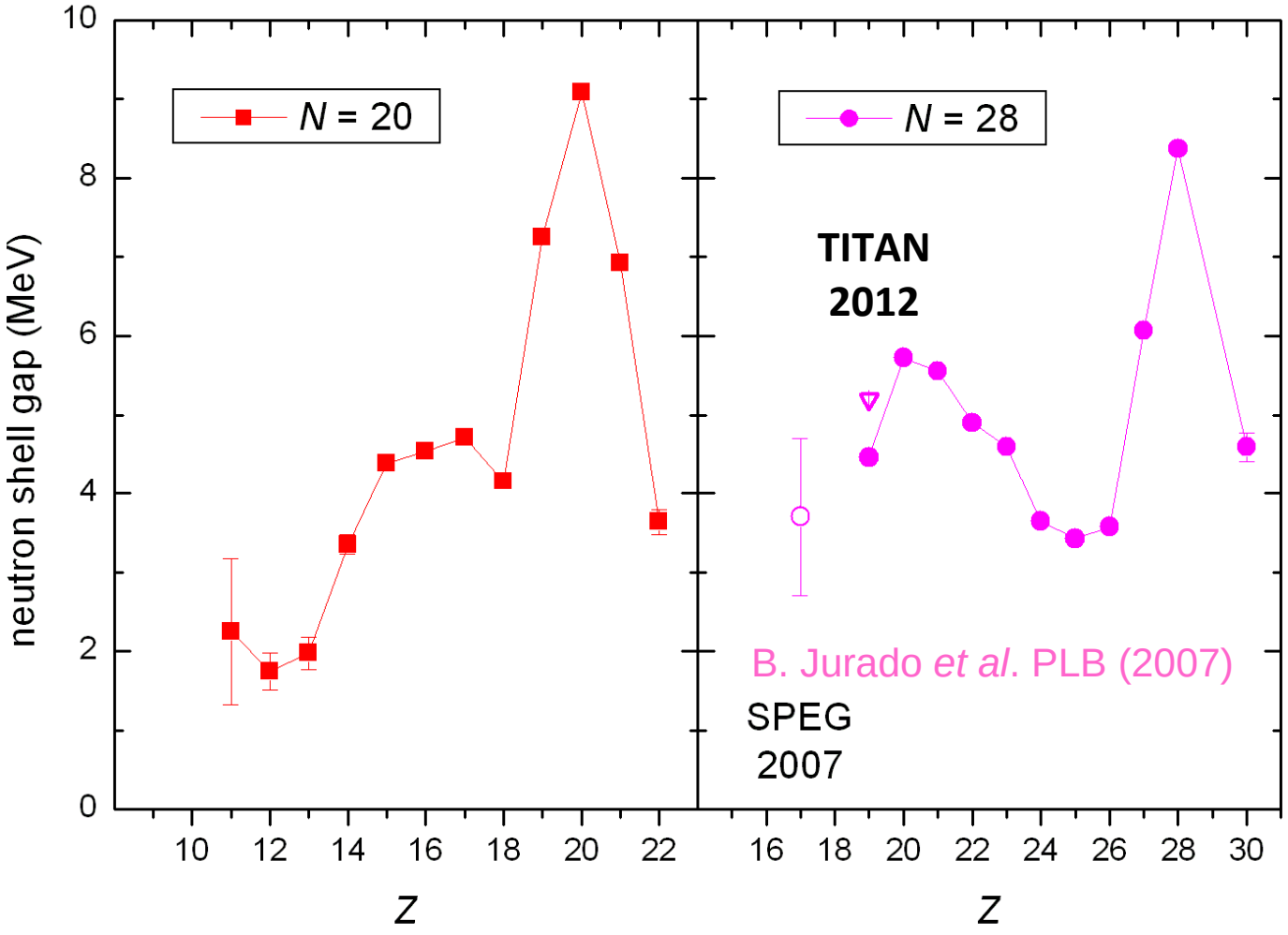
C. Thibault *et al*. (1975)

A. Lapierre *et al*. (2012)

L. Gaudefroy *et al*. (2006)

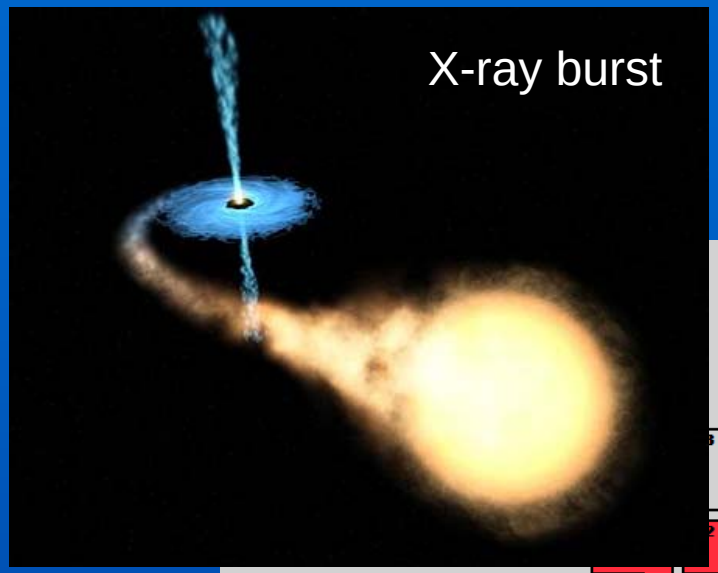
B. Jurado *et al*. (2007)

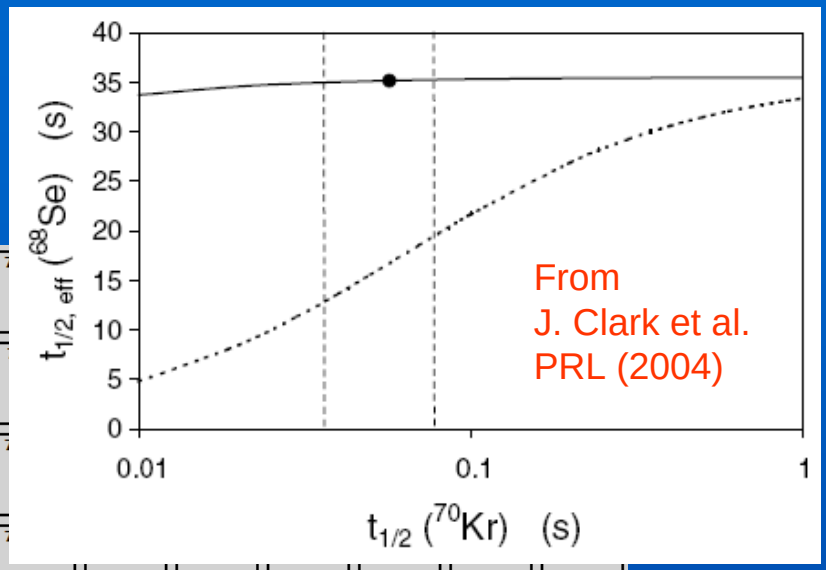
IS490: is the N = 28 shell quenched ?

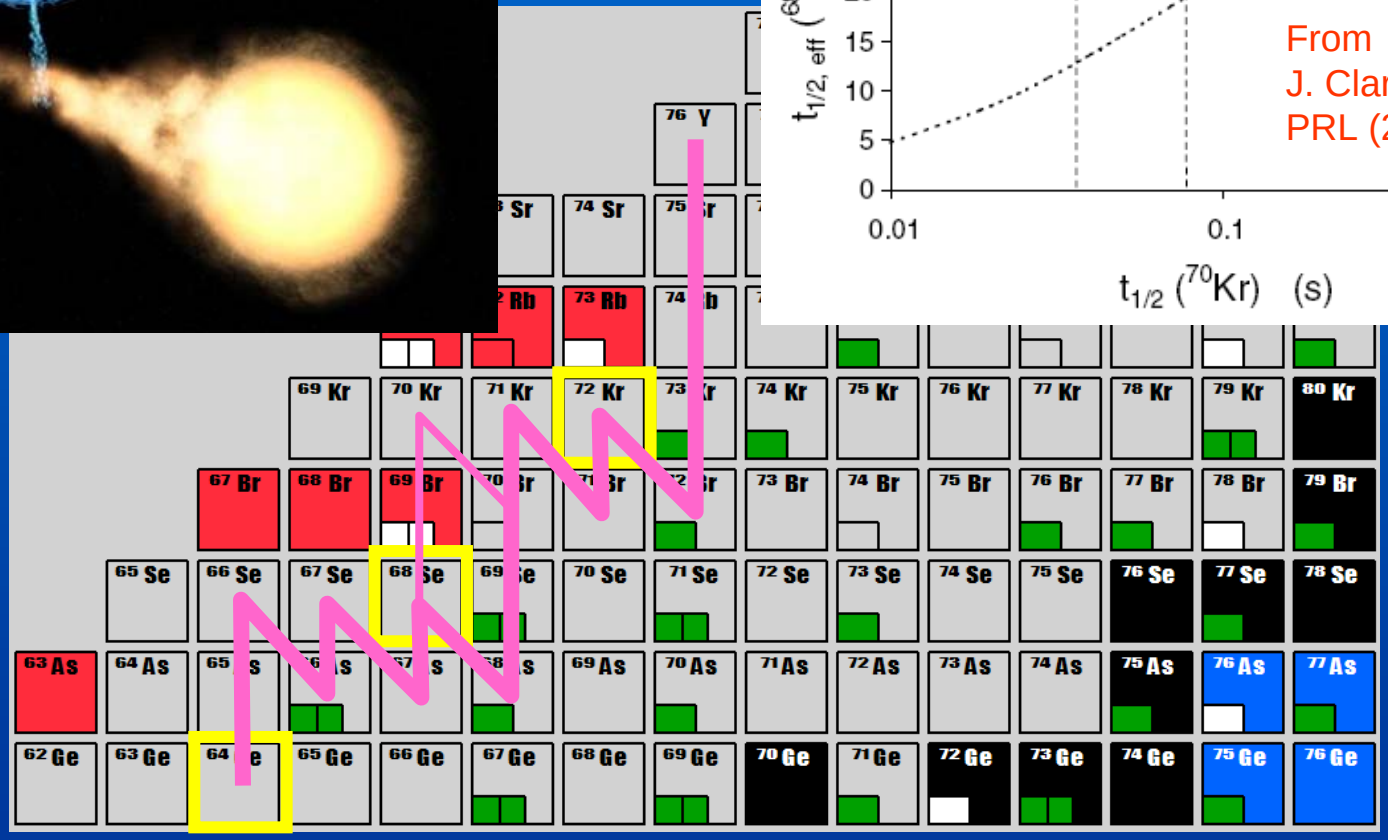


16/28 shifts (2009); 12 for $^{46-48}$Ar
(TAC: yes, MR-ToF can do it)

IS 490: rp-process nucleosynthesis



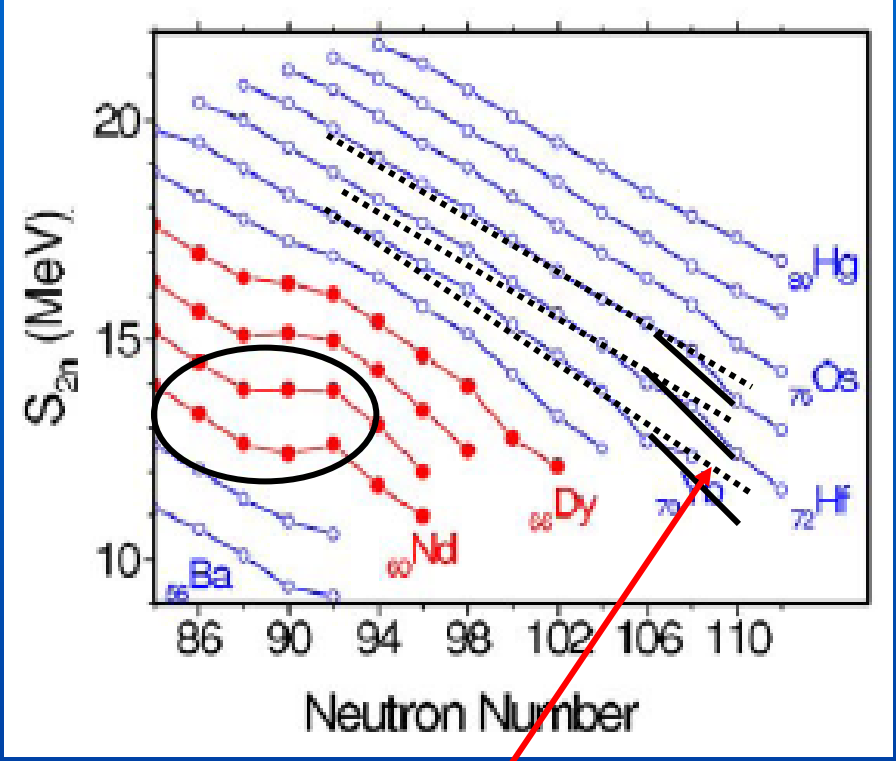


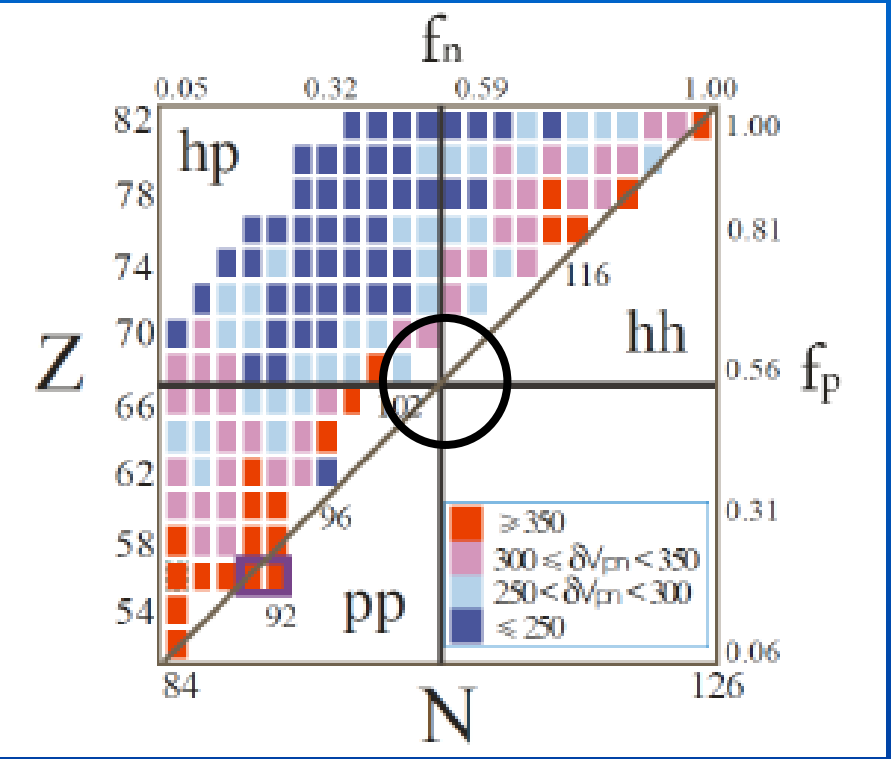


^{71}Kr meas. to 130 keV (CSR) but need 4-5 times better

16/28 shifts (2009); 4 for ^{71}Kr/TISD
(TAC: ^{72}Kr Zr/NaF; ^{71}Kr YO 10 uC; MR-ToF)

IS498: proton-neutron interaction in the rare-Earths (2009)



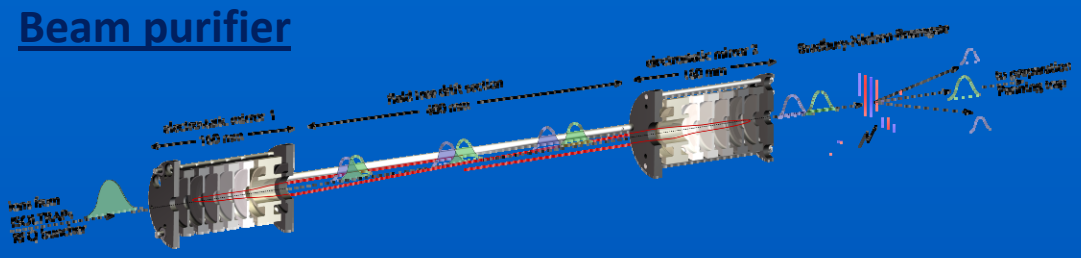


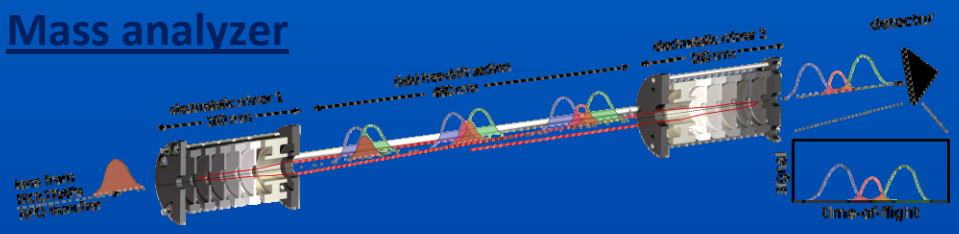
^{179}Yb: under analysis

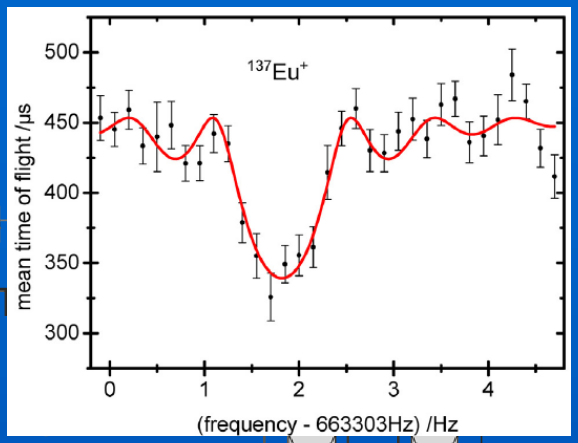
4.5/8 shifts (2009); for ^{180}Yb and/or ^{174}Er
(TAC: Er RILIS under development)
TISD run → addendum if successful

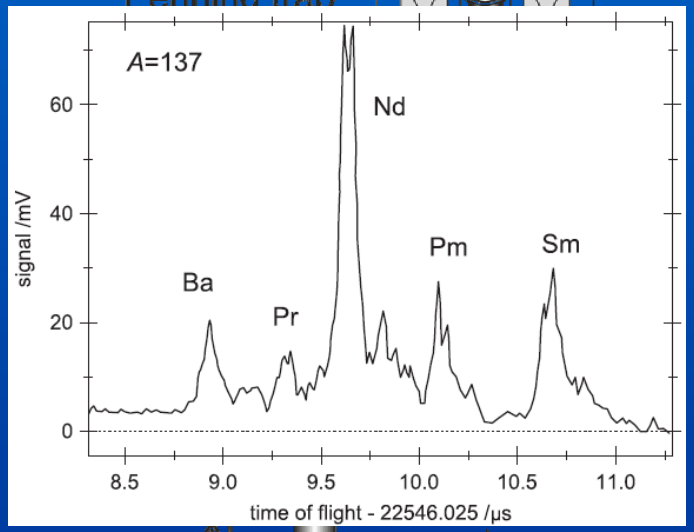
Spokesperson: R.B. Cakirli

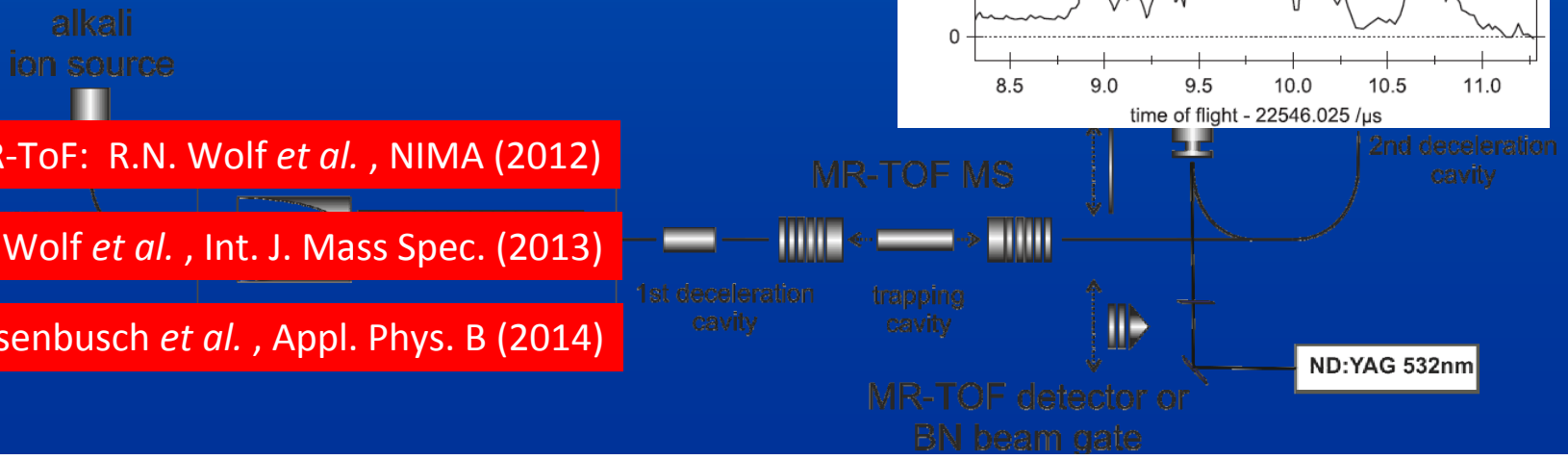
IS498: helped realize important technical developments









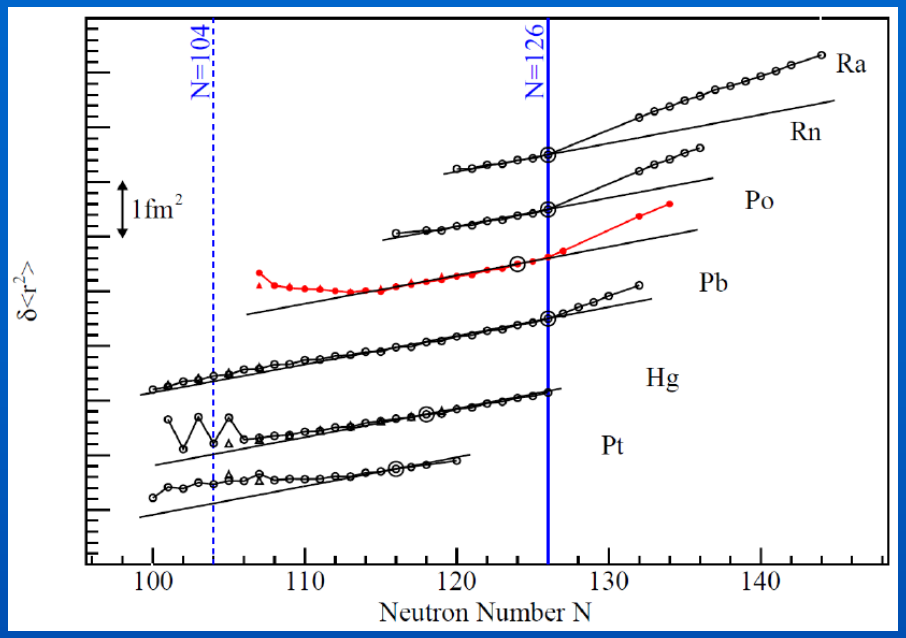


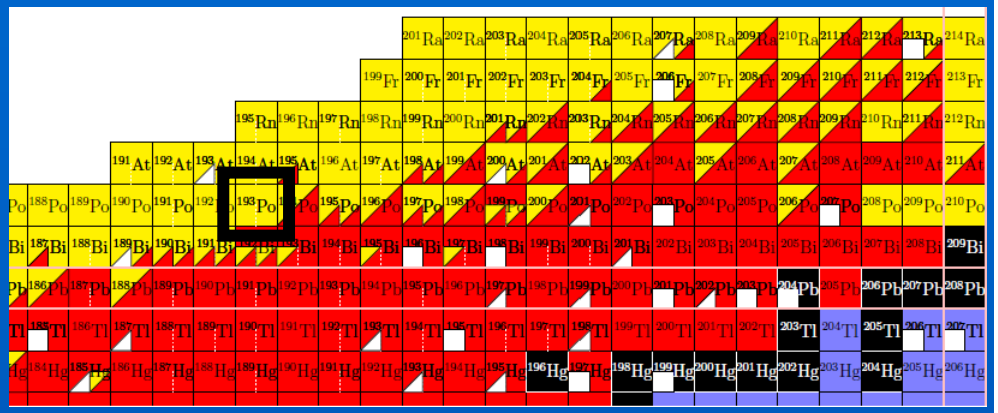
MR-ToF: R.N. Wolf *et al.* , NIMA (2012)

^{137}Er: R.N. Wolf *et al.* , Int. J. Mass Spec. (2013)

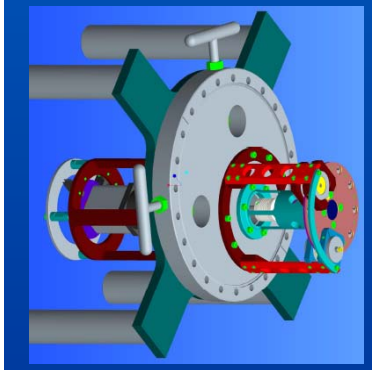
M. Rosenbusch *et al.* , Appl. Phys. B (2014)

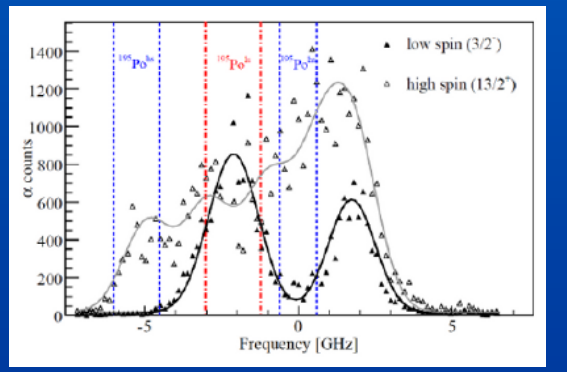
IS513: high-spin isomers in n-deficient Po (2011)





even-Z, odd-A $^{3}/_{2}^{-}$ and $^{13}/_{2}^{+}$ isomers

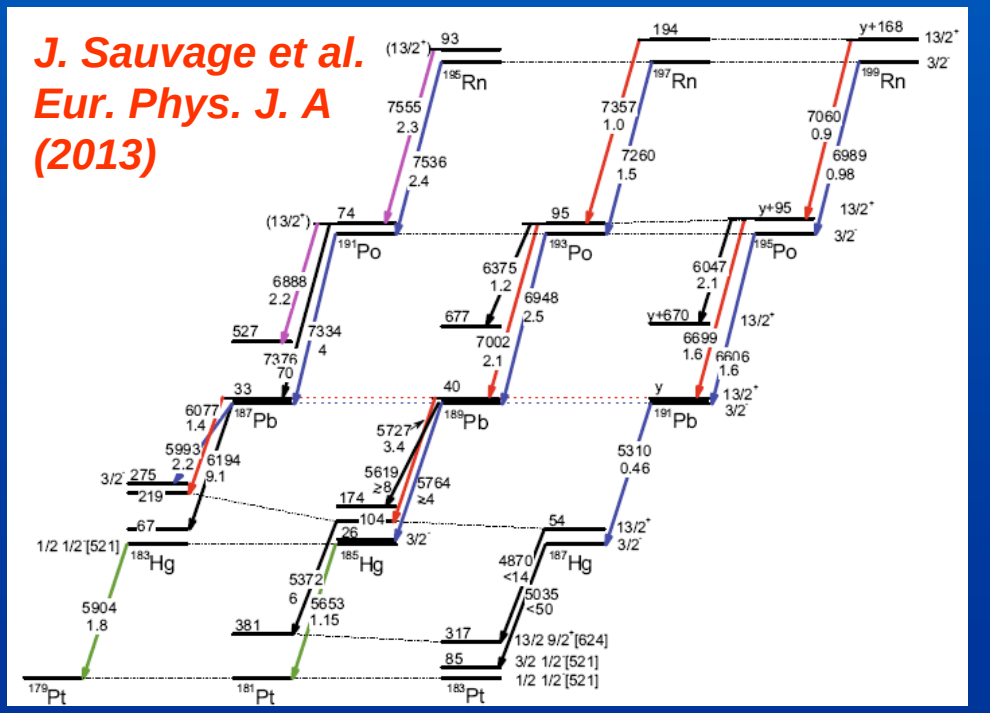




ISOLTRAP: $E(^{187m}\mathrm{Pb})$ = 33(13) keV;
C. Weber et al. Phys. Lett. A (2005)

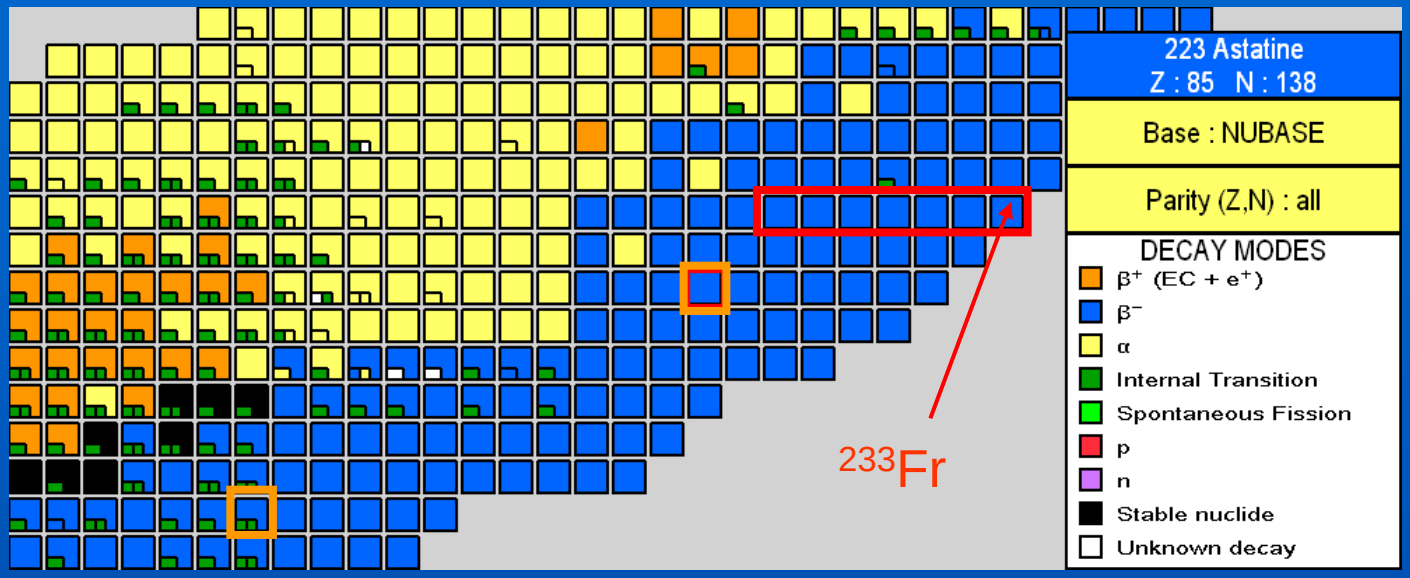
21/21 shifts (2011) for ^{193,195,197,199}Po
(TAC: RILIS OK); never scheduled

J. Sauvage et al. Eur. Phys. J. A (2013)

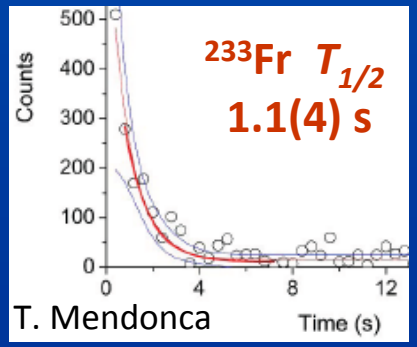


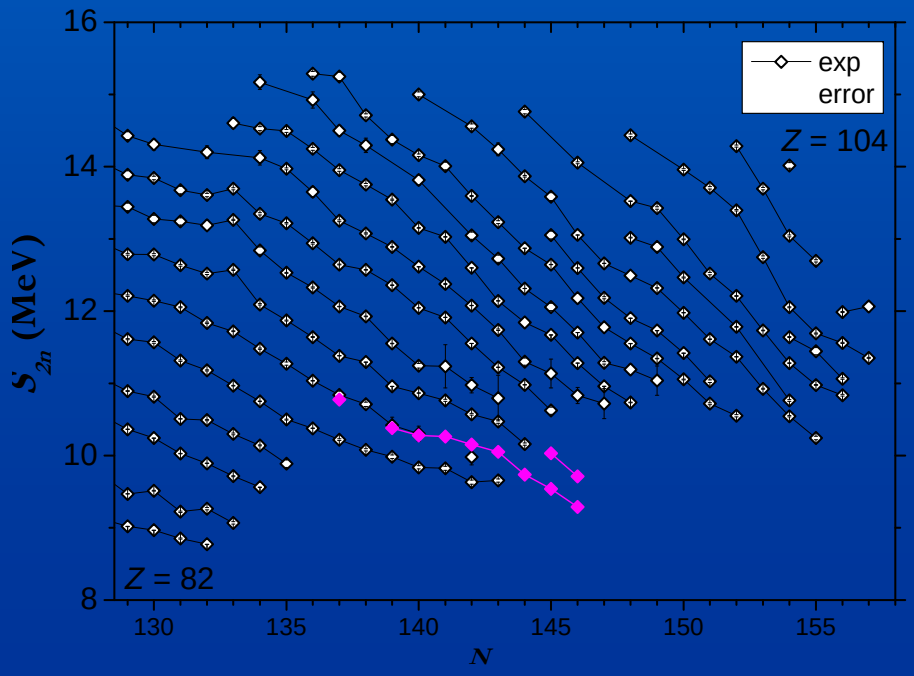
Spokesperson: T.E. Cocolios

IS518: exploring south and north-west of ^{208}Pb (2011)



Couldn't get no gold…
At was swamped by Fr
(so we measured Fr…
including $T_{1/2}$ of ^{233}Fr)

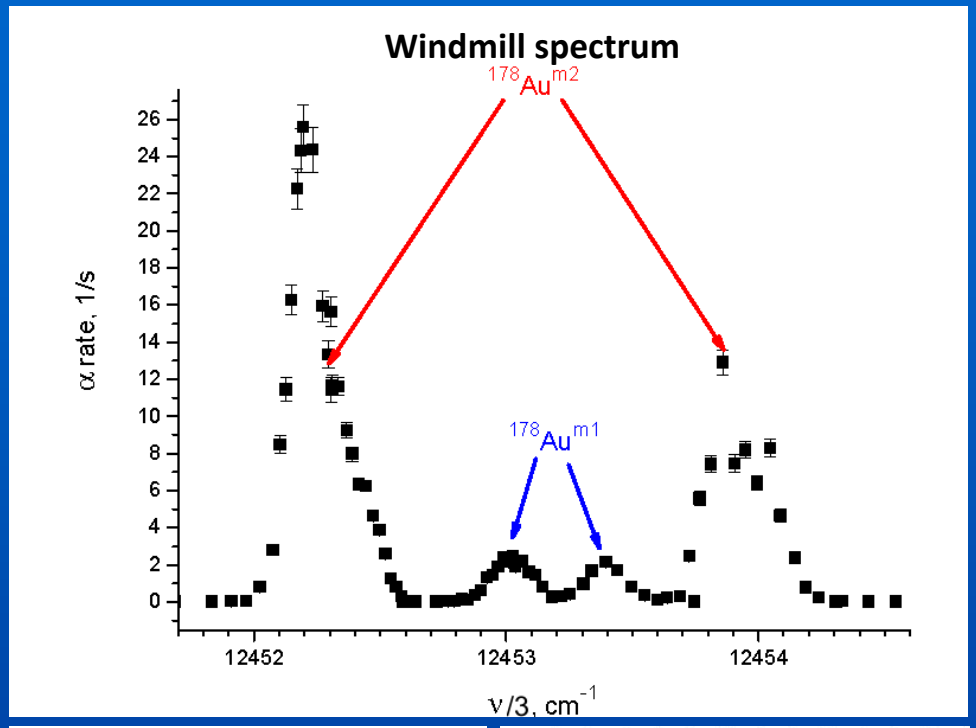


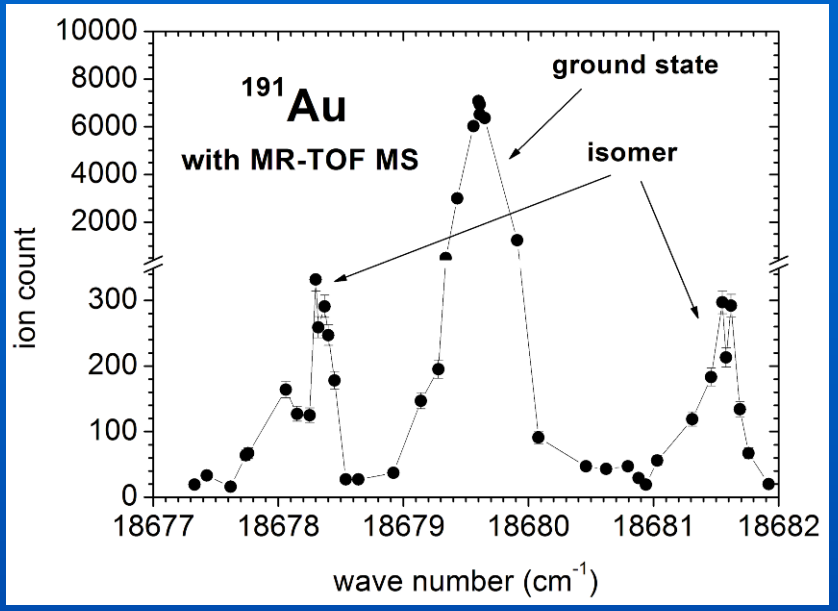


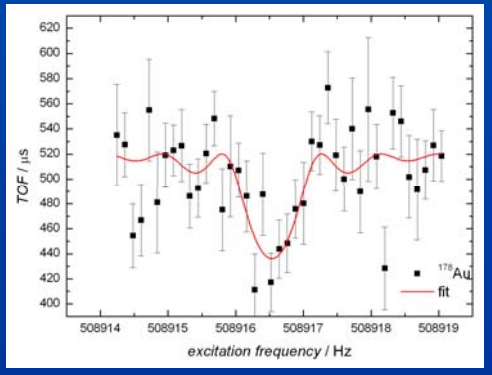
S. Kreim *et al.* , in preparation

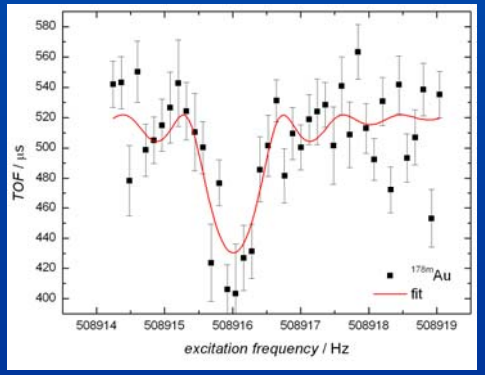
Spokesperson: S. Kreim

IS 518 and IS 534: striking gold!





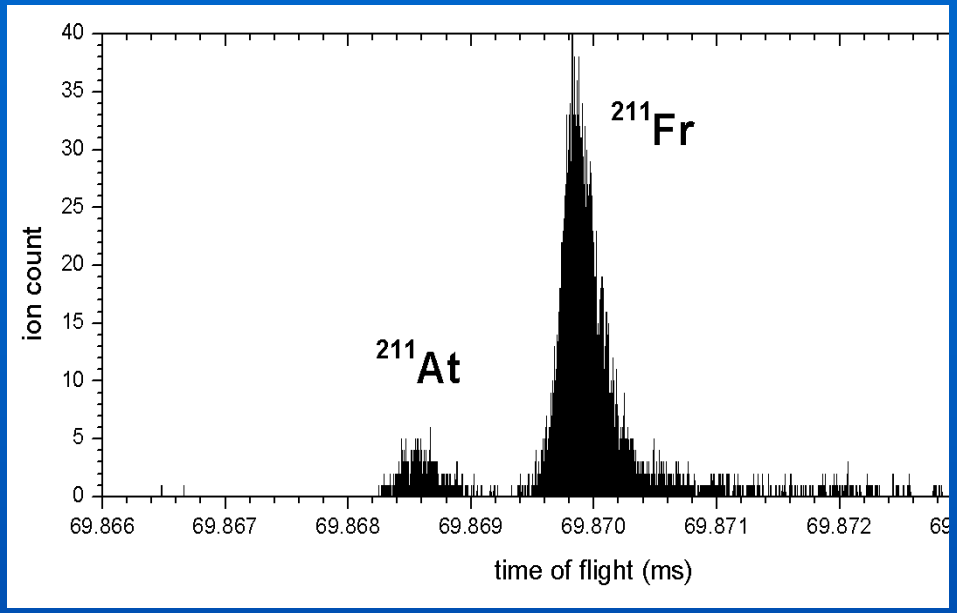


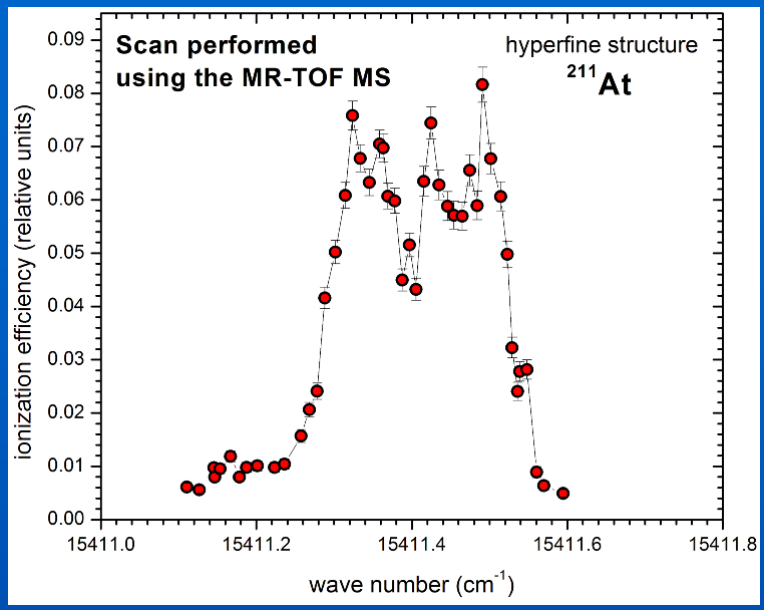


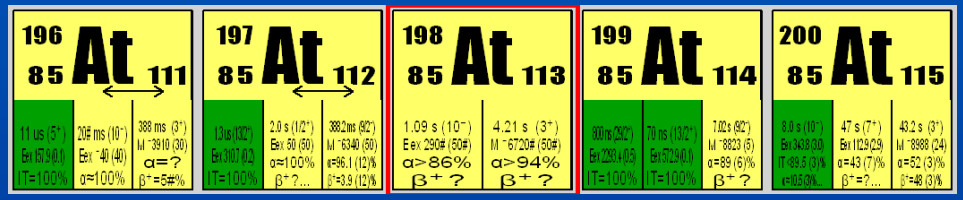
- Proof of principle of resonance ionization laser spectroscopy with the MR-TOF MS.

- Excitation energy of isomer in ^{178}Au.

IS 518 and IS 534: the MR-ToF brings new synergy!

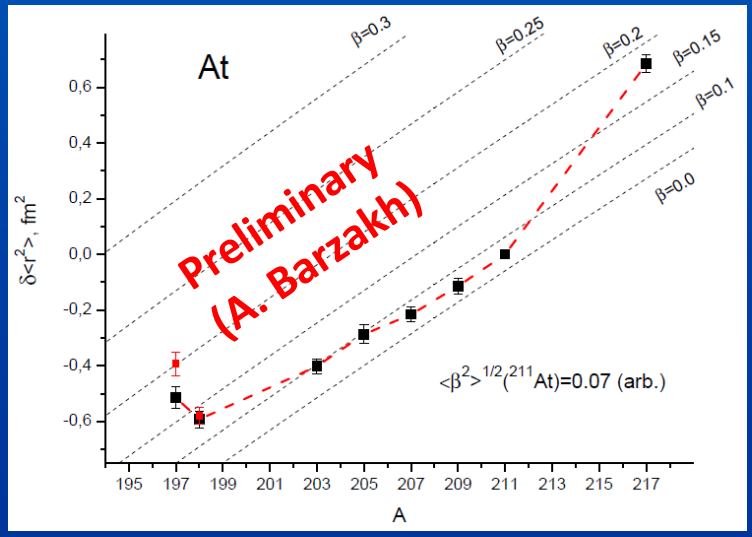






^{198}At: J. Stanja et al. PRC (2013)
^{197}At: under analysis

A. Andreyev and V. Manea
ISOLDE Newsletter (2013)
...plus upcoming publications!



4.5/34 shifts (2011) for At (isomer) masses
REQUEST transfer to IS 534 (close IS 518)

IS 532: purported magic number N = 32 (2011)

New technique using the MR-ToF as a mass spectrometer (10/s yield and a tof spectrum in 2 shifts)

new theory using 3-body + chiral EFT

F. Wienholz *et al.* , Nature (2013)

LETTER

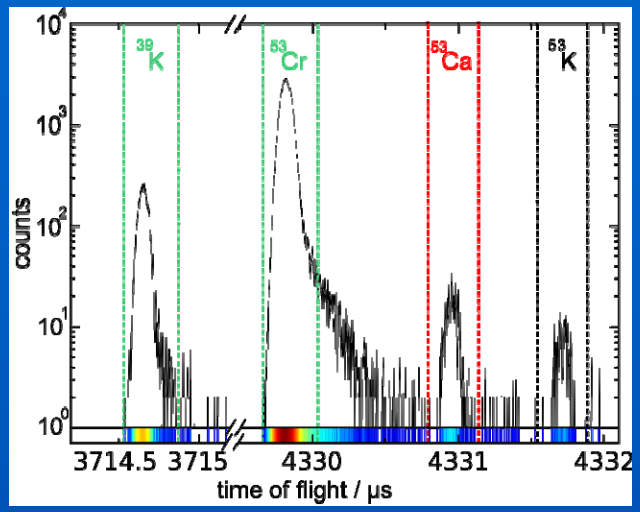
doi:10.1038/nature12226

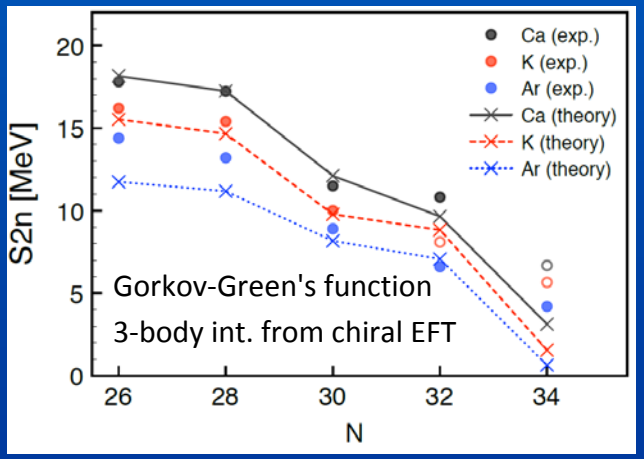
Masses of exotic calcium isotopes pin down nuclear forces

F. Wienholtz[1], D. Beck[2], K. Blaum[3], Ch. Borgmann[3], M. Breitenfeldt[4], R. B. Cakirli[3,5], S. George[1], F. Herfurth[2], J. D. Holt[6,7], M. Kowalska[8], S. Kreim[3,8], D. Lunney[9], V. Manea[9], J. Menéndez[6,7], D. Neidherr[2], M. Rosenbusch[1], L. Schweikhard[1], A. Schwenk[7,6], J. Simonis[6,7], J. Stanja[10], R. N. Wolf[1] & K. Zuber[10]

Spokesperson: S. Kreim

IS532: new magic number N = 32 very localized





V. Somà, Th. Duguet, Private Comm. (2013)

^{53}K: M. Rosenbusch *et al.* , in preparation

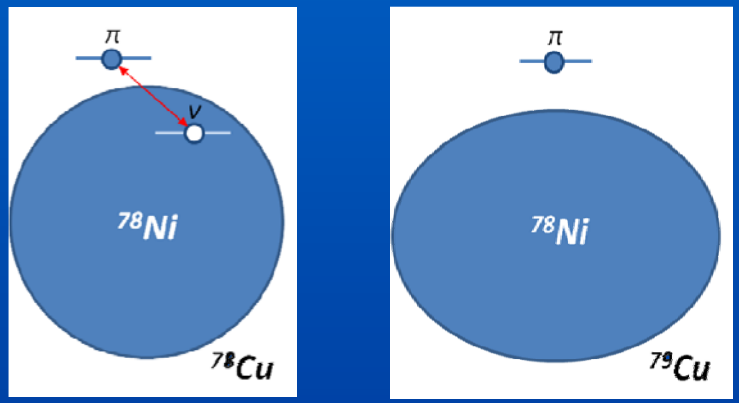
Onset of spherical stabilization

3/21 shifts (2011) for $^{52\text{-}55}$Sc (ADDENDUM: +6)
(TAC: slow Sc release → TISD run)

IS 535: n-rich Cu to probe N = 50 strength (2012)

- Target had a new neutron-converter geometry
  - Prototype had heating problems
  - Converter broke and likely touched the line
- Measured ^{99,100}Rb and $^{132,144\text{-}149}$Cs

K. T. Flanagan et al., Phys. Rev. Lett. 2009
COLAPS proposal: INTC-2011-052



Using ISOLDE UCx target plus extras:
neutron converter
laser ionization
quartz transfer line
isobaric mass purification

^{100}Rb: V. Manea *et al.* , PRC **88** (2013)

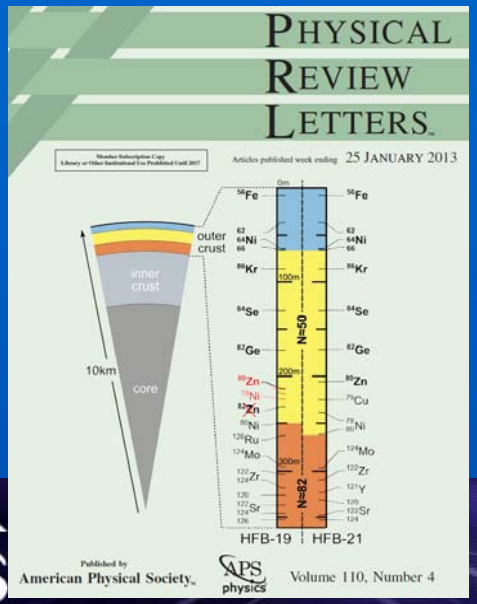
^{149}Cs: D. Atanasov *et al.* , in preparation

10/14 shifts (2012)
(TAC: n-convertor requested; lower yield OK)

Spokesperson: V. Manea

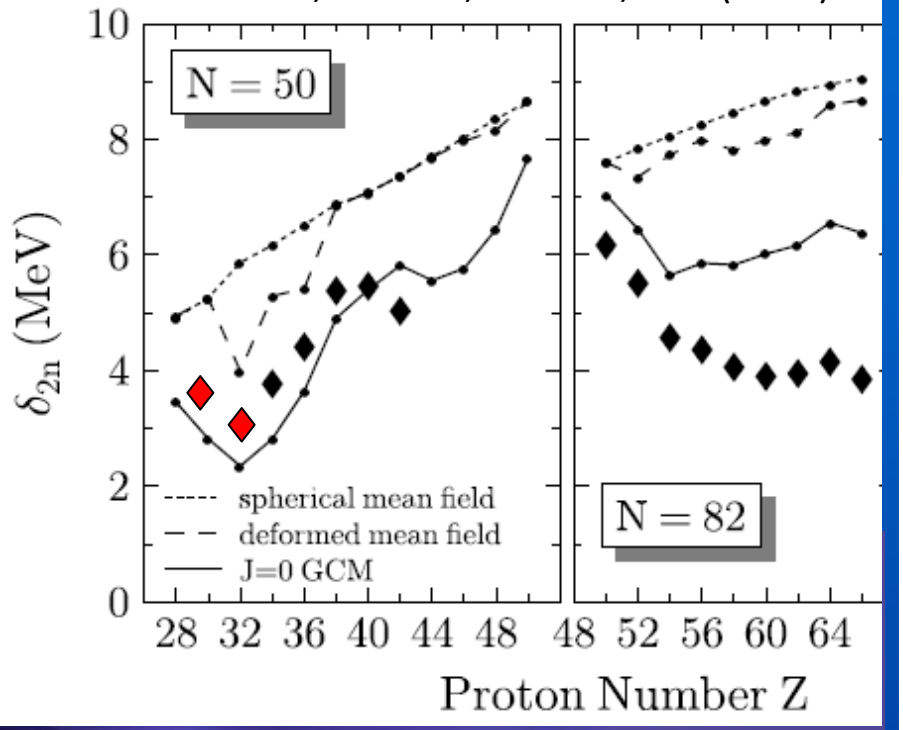
IS 535: testing models of masses beyond the mean field

^{82}Zn: R.N. Wolf *et al.* , PRL (2013)



Physics
spotlighting exceptional research

Bender, Bertsch, Heenen, PRC (2006)



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Synopsis: Weighing Models of Neutron Stars

NASA/CXC/M. Weiss

Plumbing Neutron Stars to New Depths with the Binding Energy of the Exotic Nuclide ^{82}Zn

R. N. Wolf, D. Beck, K. Blaum, Ch. Böhm, Ch. Borgmann, M. Breitenfeldt, N. Chamel, S. Goriely, F. Herfurth, M. Kowalska, S. Kreim, D. Lunney, V. Manea, E. Minaya Ramirez, S. Naimi, D. Neidherr, M. Rosenbusch, L. Schweikhard, J. Stanja, F. Wienholtz, and K. Zuber

Phys. Rev. Lett. **110**, 041101 (2013)

Published January 22, 2013

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Subject Areas

ISOLTRAP Scientific Production (2010 – present)

experiment	Author(s)	Journal/University	Pub. date
(IS 413)	R.N. Wolf et al.	Phys. Rev. Lett.	2013
IS 463	J. Stanja et al.	Phys. Rev. C	2013
IS 463	J. Stanja (Ph.D.)	Uni-Dresden	2013
IS 463	M. Kowalska et al.	Nucl. Instrum. Meth. A	2012
IS 463	Ch. Boehm et al.	Phys. Rev. C	in prep.
IS 463	Ch. Borgmann (Ph.D.)	Uni-Heidelberg	2012
IS 473	S. Eliseev et al.	Phys. Lett. B	2010
^{110}Pd-^{110}Cd	D. Fink et al.	Phys. Rev. Lett.	2012
$2\beta0\nu$ decay	D. Fink (Dipl.)	Uni-Heidelberg	2012
IS 490	S. Naimi et al.	Phys. Rev. Lett.	2010
IS 490	S. Naimi et al.	Hyp. Interact.	2011
IS 490	A. Herlert et al.	Hyp. Interact.	2011
IS 490	S. Naimi (Ph.D.)	Uni-Paris VII	2010
IS 498	R.N. Wolf et al.	Int. J. Mass Spectrom.	2013
IS 498	M. Rosenbusch et al.	Appl. Phys. B	2014
IS 532	F. Wienholz et al.	Nature	2013
IS 532	R.N. Wolf (Ph.D.)	Uni-Greifswald	2013
IS 532	M. Rosenbusch et al.	Phys. Rev. Lett.	in prep
IS 535	V. Manea et al.	Phys. Rev. C	2013
IS 535	D. Atanasov et al.		in prep.

The girls and boys of ISOLTRAP (without whom…)

P. Ascher, D. Atanasov,
G. Audi, D. Beck, K. Blaum,
Ch. Böhm, G. Bollen,
Ch. Borgmann, M. Breitenfeldt,
R. B .Cakirli, T. E. Cocolios,
S. Eliseev, T. Eronen,
S. George, F. Herfurth,
A. Herlert, D. Kisler

I. Kluge, M. Kowalska, S. Kreim,
Yu. A. Litvinov, D. Lunney,
V. Manea, E. Minaya Ramirez,
S. Naimi, D. Neidherr,
M. Rosenbusch, S. Schwarz,
L. Schweikhard, J. Stanja,
M. Wang, A. Welker,
F. Wienholtz, R. Wolf, K. Zuber

ISOLTRAP proposal summary

Experiment	Year	Spokesperson	shifts approved	shifts available	proposed action
IS 463	2007	M. Kowalska	22	4.5	^{207}Hg: TISD - Pb(n,γ) (TAC: try quartz line)
IS 473-Add	2011	S. Eliseev	5	5	^{202}Tl (RILIS): never scheduled
IS 490	2009	D. Lunney	28	16	^{48}Ar (12): MR-ToF OK ^{71}Kr (4): Zr/NaF or YO
IS 498	2009	R.B. Cakirli	8	4.5	^{180}Yb MR-ToF ready
IS 513	2011	T.E. Cocolios	21	21	^{193}Po (TAC: RILIS OK) never scheduled
IS 518	2011	S. Kreim	34	4.5	^{197}At: *REQUEST* transfer to IS 534 (close IS 518)
IS 532	2011	S. Kreim	21	3	request 6 (9 total) ^{54}Sc: TISD
IS 535	2012	V. Manea	14	10	MR-ToF ready OK for n-convertor