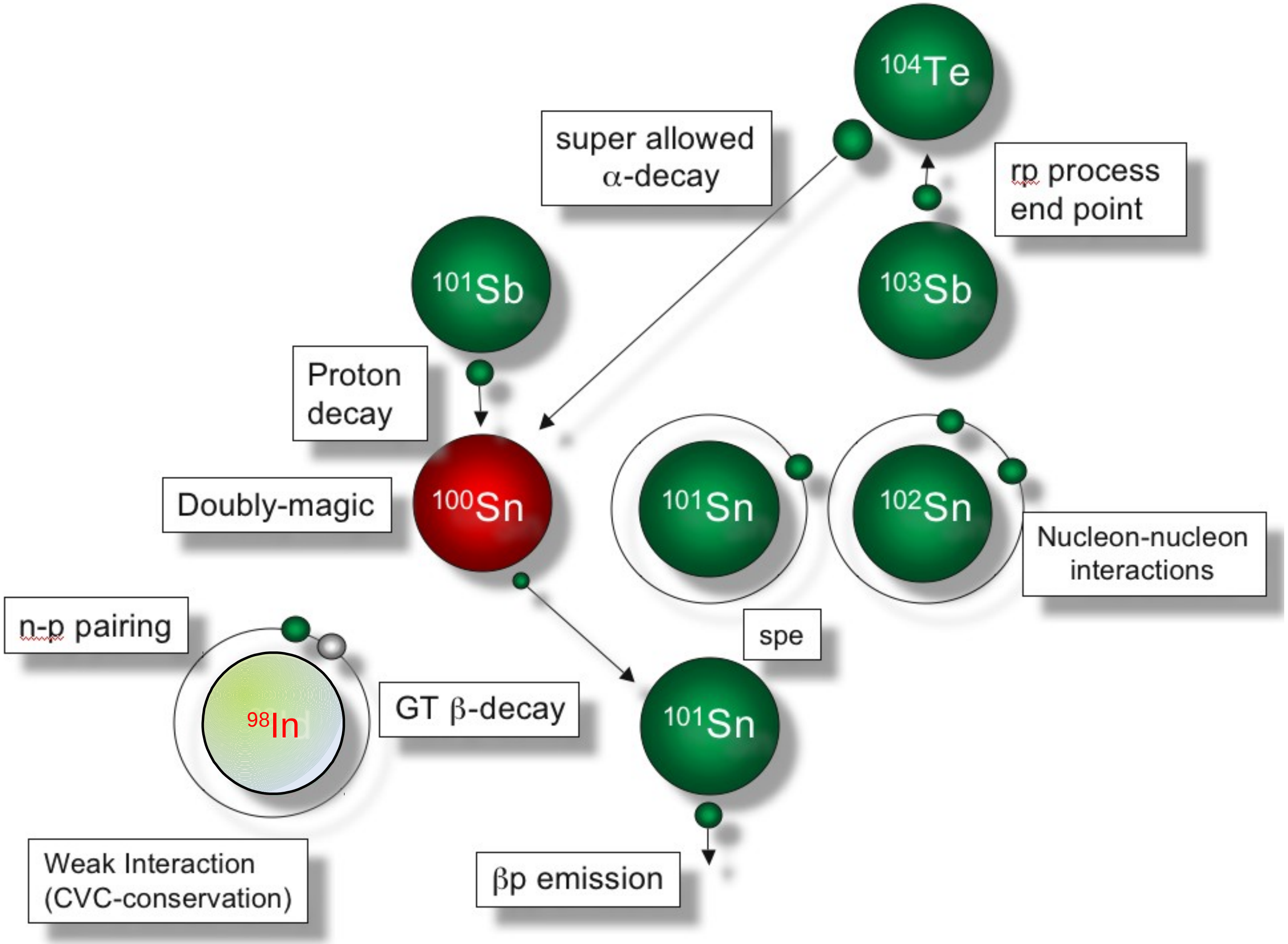
# Single particle states and π-ν interaction in the $^{100}Sn$ region

L. Caceres (GANIL)
in behalf of the S3 – LEB collaboration

# $^{100}$Sn region



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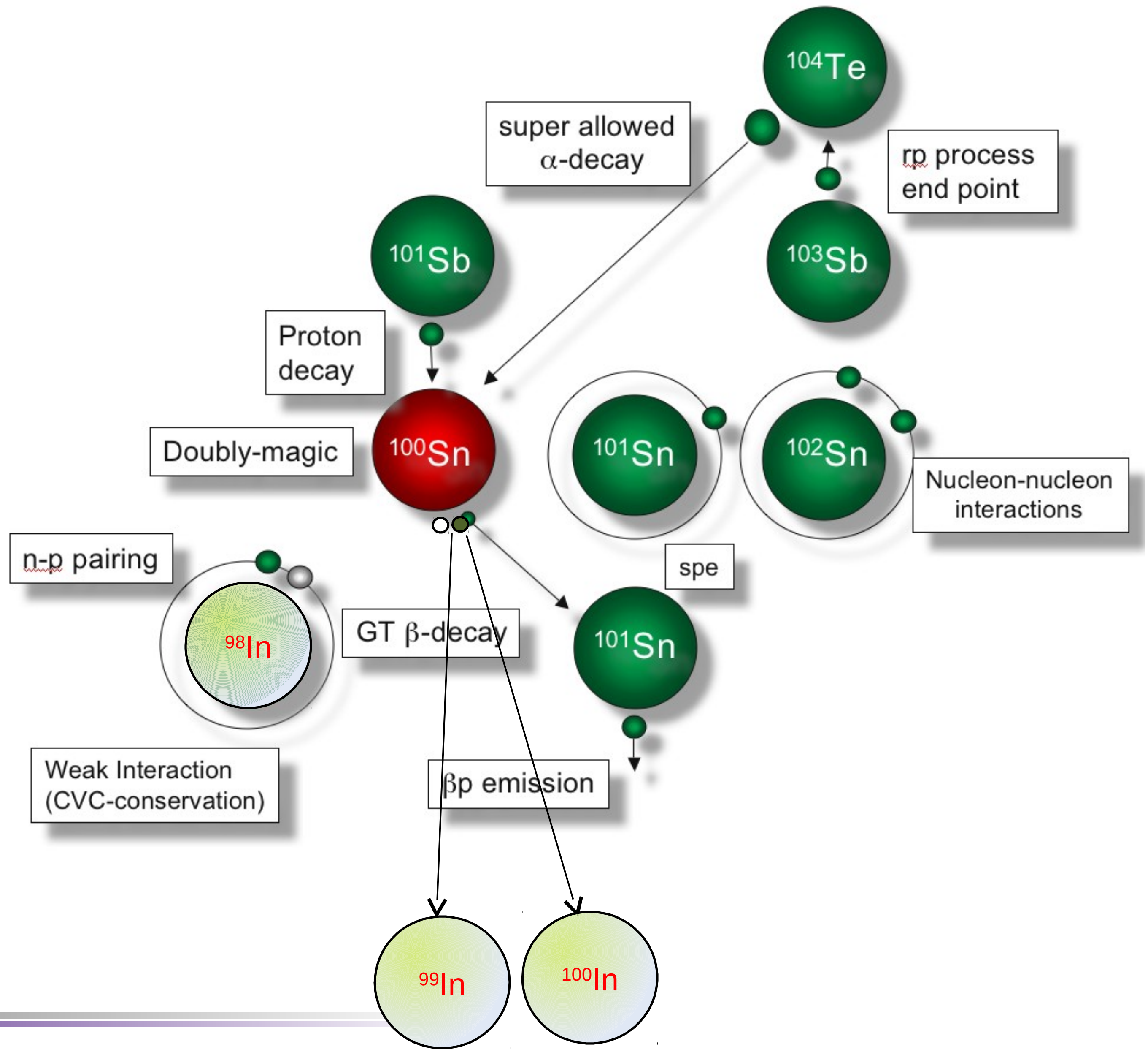
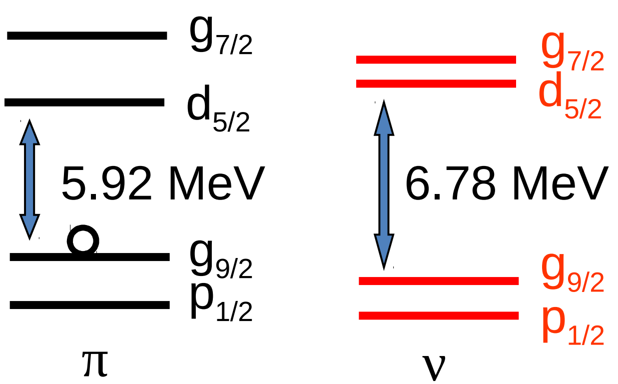


# In Isotopes

| Z/N | 49 | 50 | 51 |
|---|---|---|---|
| 50 | | $^{100}Sn$ | |
| 49 | $^{98}In$ | $^{99}In$ | $^{100}In$ |



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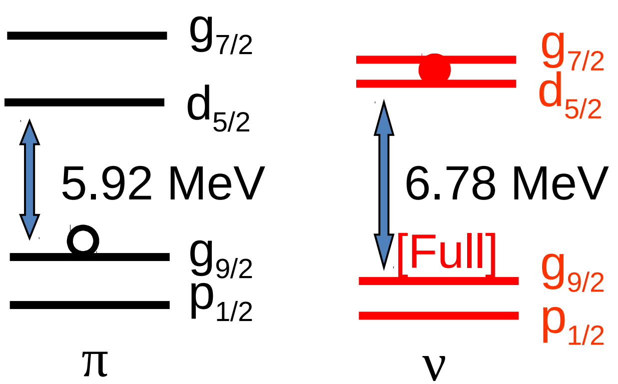


$^{100}In_{49}$; $\pi(g_{9/2})^{-1}$ $\nu(d_{5/2})^{1} \rightarrow 2^{+} - 7^{+}$

$\nu(g_{7/2})^{1} \rightarrow 1^{+} - 8^{+}$

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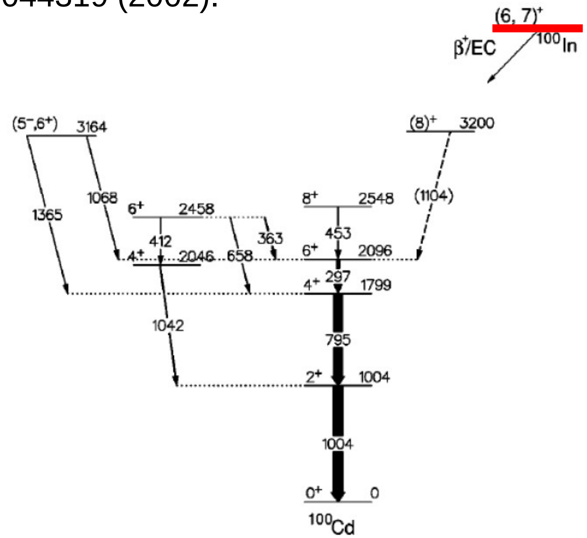
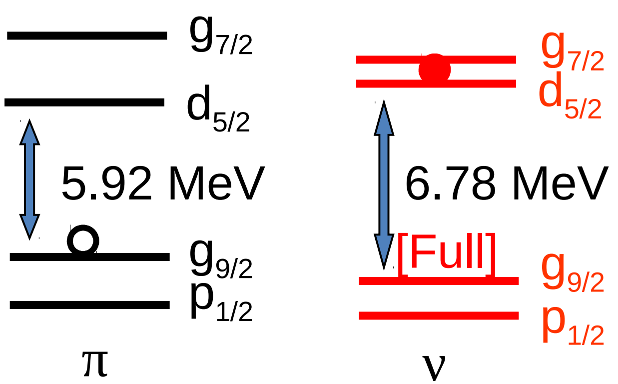
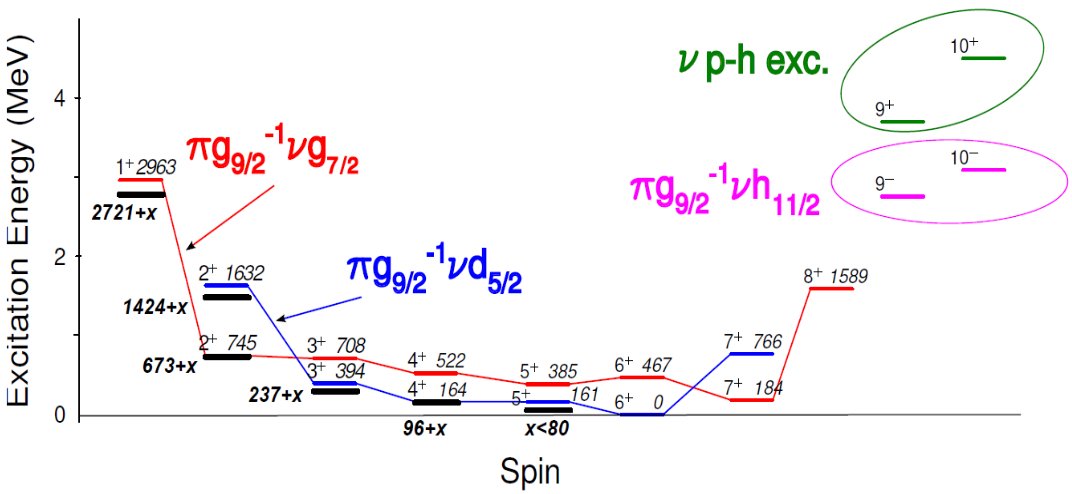
C. Plettner et al., Phys. Rev. C70 044319 (2002).




$^{100}In_{49}$; $\pi(g_{9/2})^{-1}$ $\nu(d_{5/2})^1 \rightarrow 2^+ - 7^+$

$\nu(g_{7/2})^1 \rightarrow 1^+ - 8^+$

LSSM calculations: K. Sieja, priv. communications

C. B. Hinke et al., Nature (London) 486 (2012) 341

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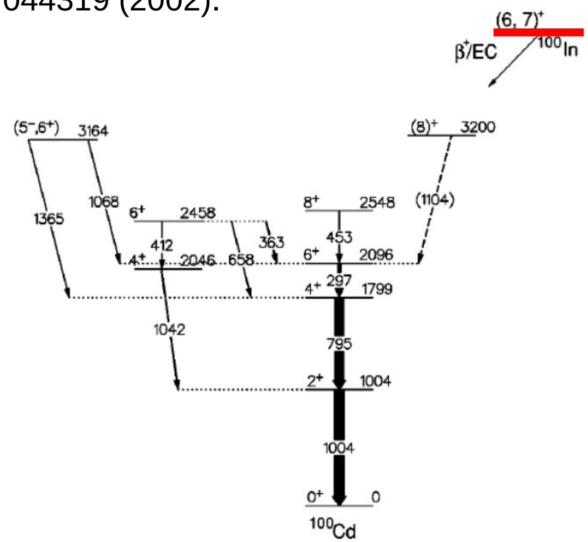


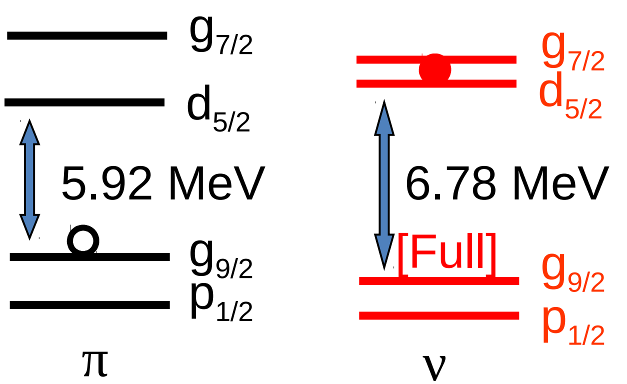

g.s. → MASSES

MR-TOF-MS

Spin & Parity g.s.($6^+$ or $7^+$)

In-beam spectroscopy

X-rays

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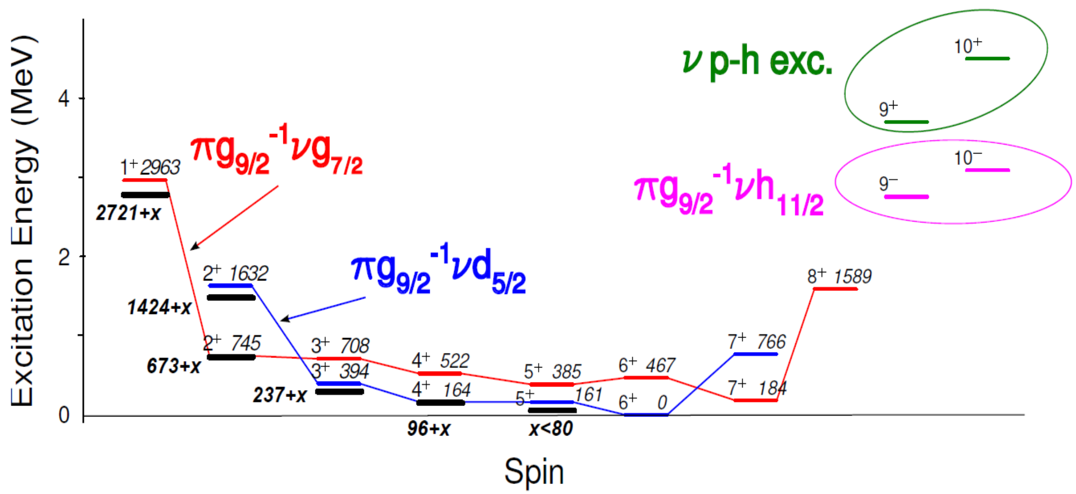


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# $^{99}In$

| Z/N | 49 | 50 | 51 |
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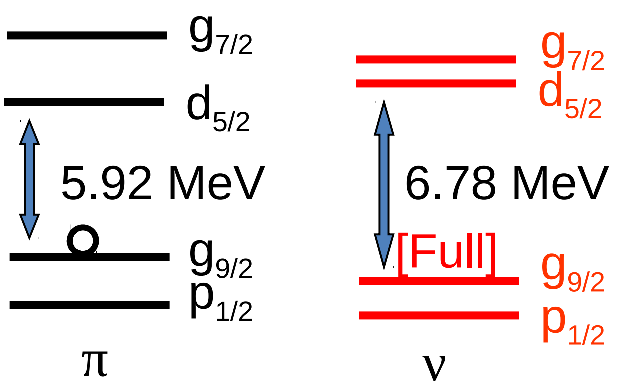
| 50 | | $^{100}Sn$ | |
| 49 | $^{98}In$ | $^{99}In$ | $^{100}In$ |




$^{99}In_{49}$; $\pi(g_{9/2})^{-1} \rightarrow 9/2^{+}$

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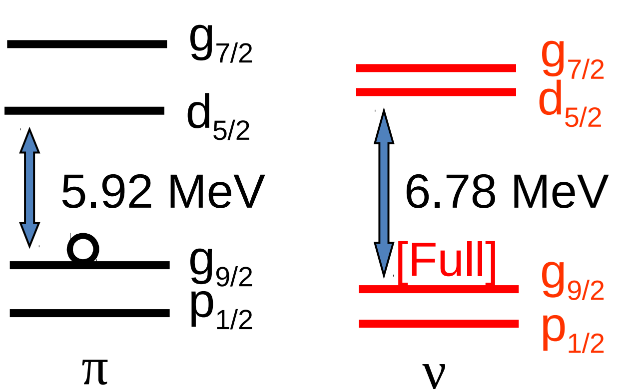
$^{99}$In: $t_{1/2}$ (g.s.) = 3.0 (8) s

P. Kienle et al. Prog. Particle and Nucl. Phy. 46, 73 (2001).

No excited states known

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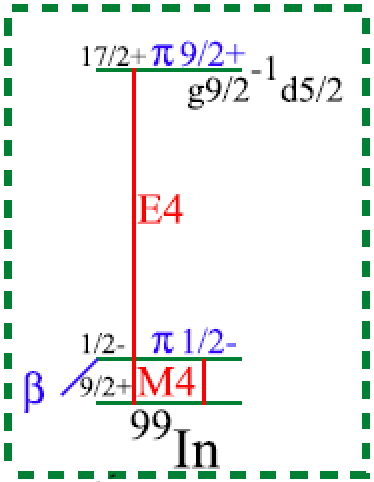


T. Faestermann et al.
Prog. Part. And Nuclear Phys. 69 (2013)85

Assuming Weisskopf Single-Particle transition rates for M4 multipolarity:

If E= 1 MeV → $t_{1/2}$ = 21 s

If E= 600 keV → $t_{1/2}$ = 35 min

If E= 150 keV → $t_{1/2}$ = 17 y !

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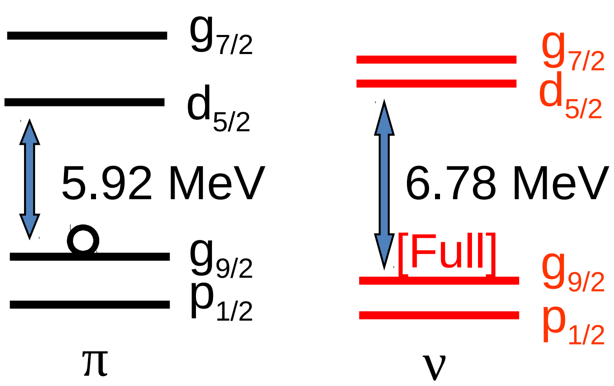
ΔE($9/2^+$-$1/2^-$) → MASSES

MR-TOF-MS

Spin & Parity

In-beam spectroscopy

X-rays

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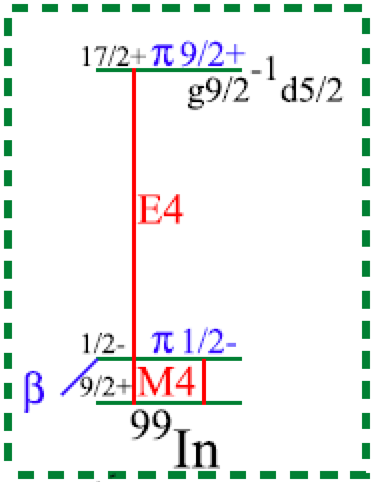


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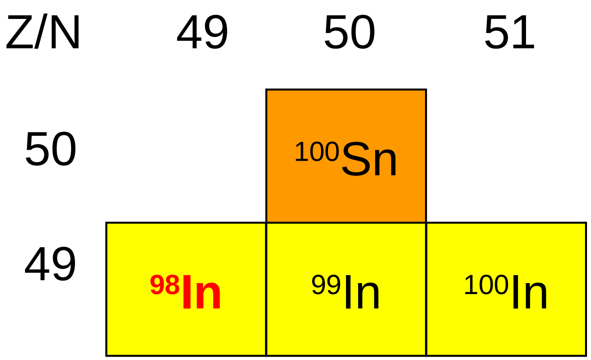


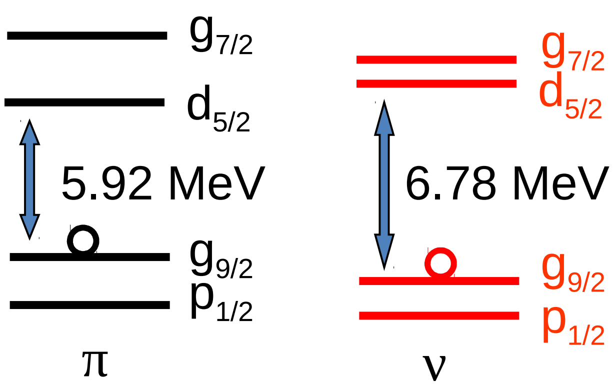


$^{98}In_{49}$; $\pi(g_{9/2})^{-1}$ $\nu(g_{9/2})^{-1} \rightarrow 0^{+} - 9^{+}$

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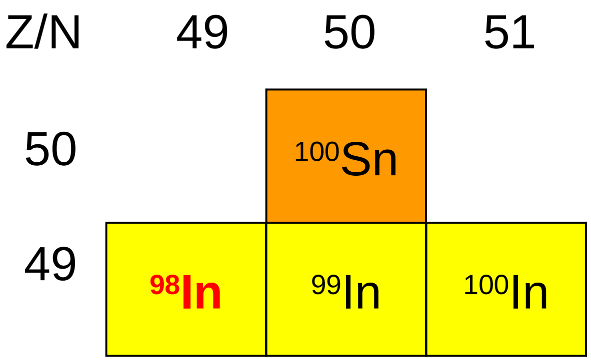
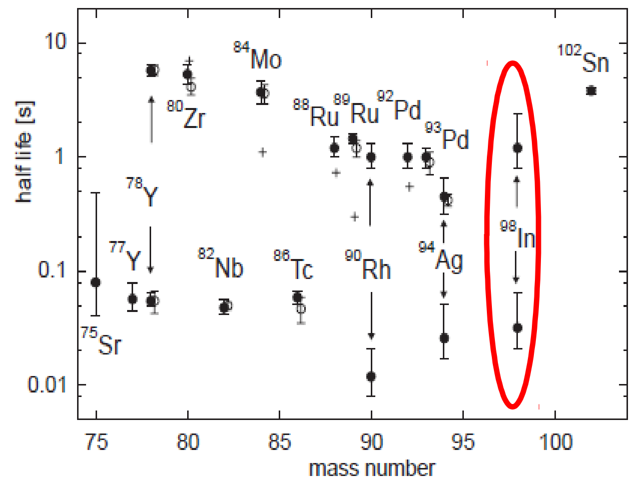
# $^{98}$In



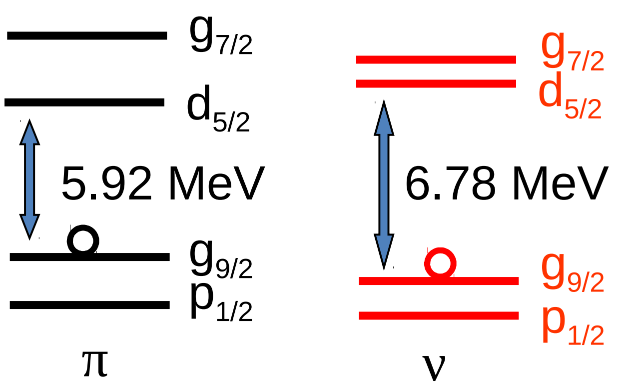




$^{98}$In: $t_{1/2}$ (g.s.) = 47(13) ms

$t_{1/2}$ (iso.) = 0.66 (40) s

D. Bazin et al. PRL 101, 252501 (2008).
P. Kienle et al. Prog. Particle and Nucl. Phy. 46, 73 (2001).

No excited states known

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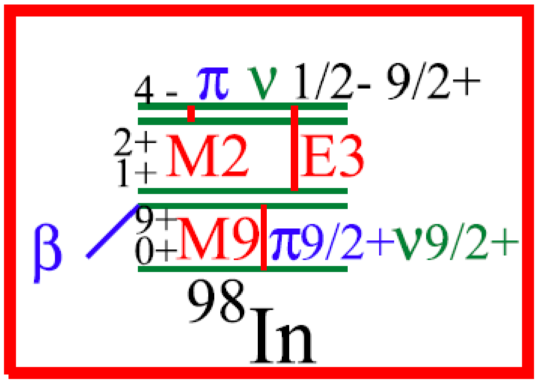


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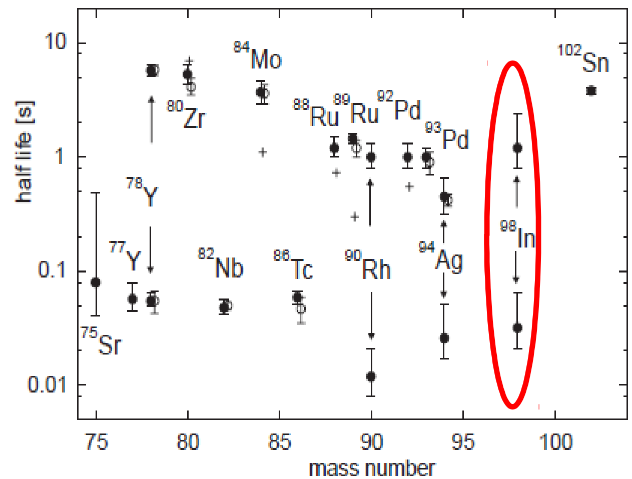


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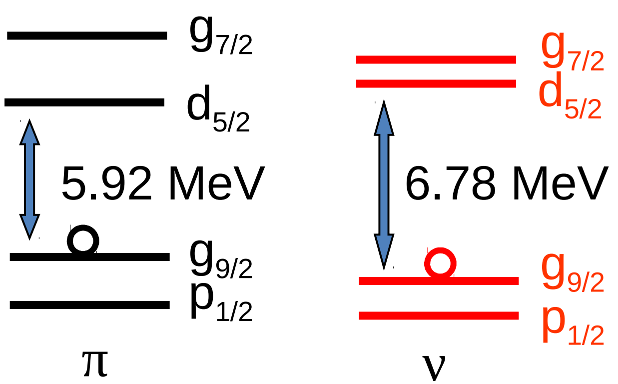


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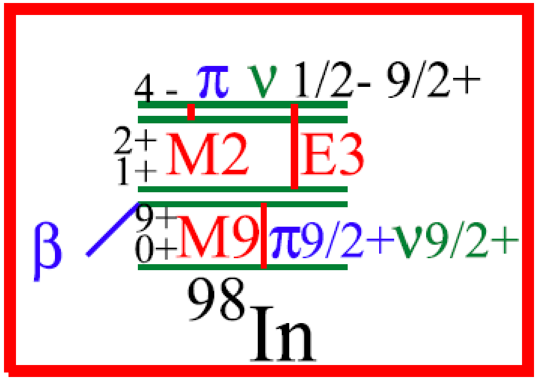


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$\Delta E(9^{+}\text{-}0^{+})$ → MASSES
MR-TOF-MS
ML-TRAP@DESIR

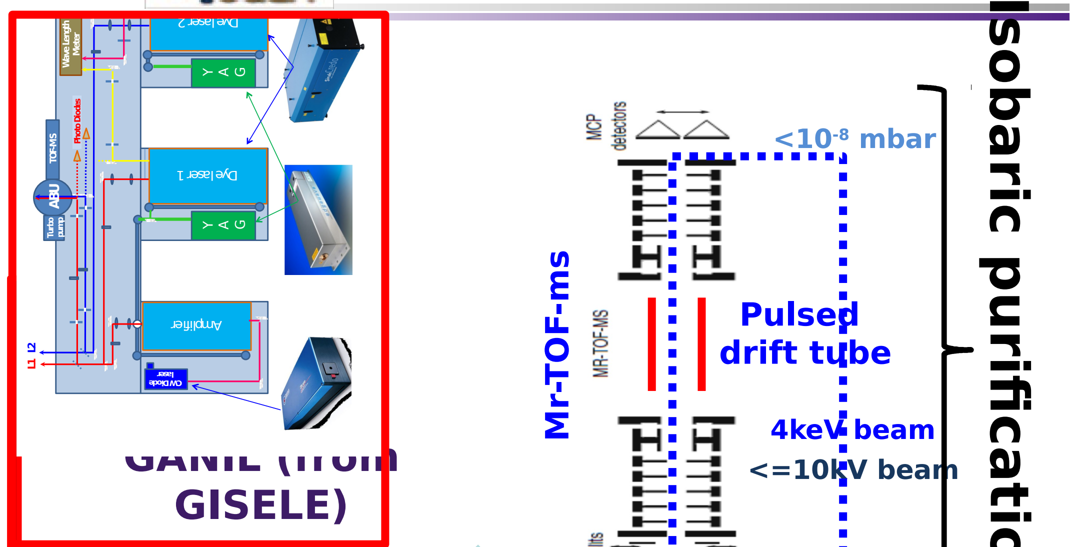
Spin & Parity

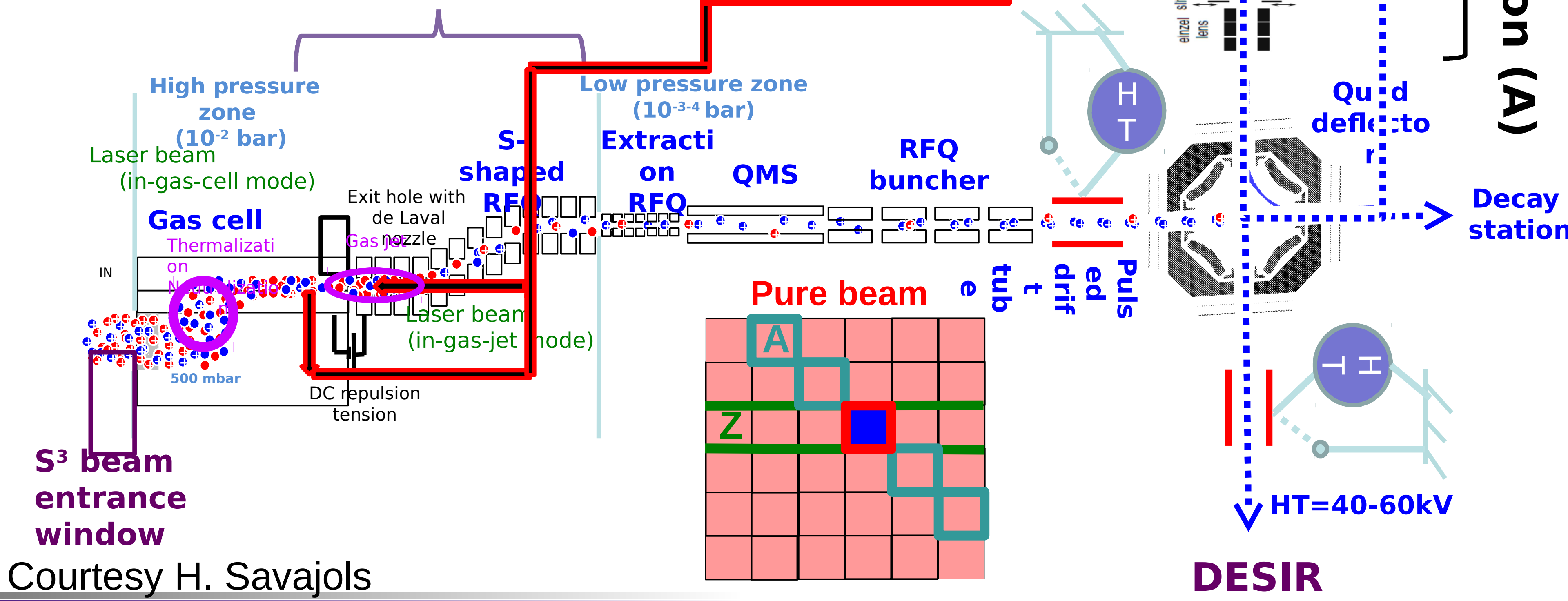
REGLIS³

Excited states →
In-beam spectroscopy
X-rays

# REGLIS³

- ✓ **Efficient :** down to ~ 1 pps
- ✓ **Selective :** 1/10 000
- ✓ **Relatively fast :** up to ~ 250 ms
- ✓ **Spectral resolution: 200 MHz** determine the isotope/isomer shift and hyperfine structure, spin, moments…

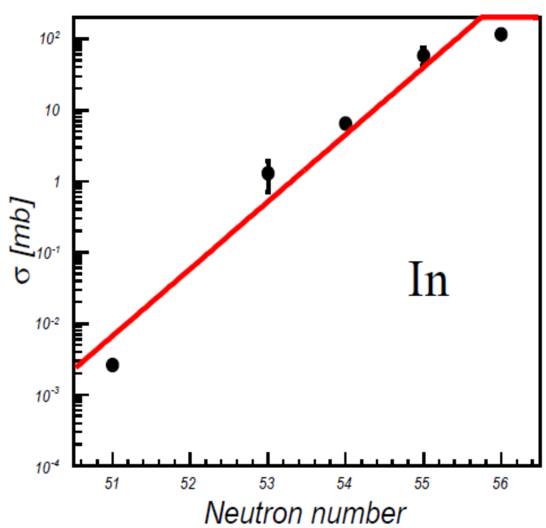



Courtesy H. Savajols

# Some numbers…

| | I [pps / 1 pμA] | Tr (S3) [%] | | $t_{1/2}$ | I [after S3] | I [after LEB] | Tr [LeB] | I [MR-TOF-MS] |
|---|---|---|---|---|---|---|---|---|
| **98In** | 0.8 | 50 | g.s. | 47(13) ms | 0.4 | 4.79 E-03 | 4.79 E-04 | 1.10 E-04 |
| | | | Iso. | 0,66(40) s | 0.4 | 0.29 | 0.029 | 0.026 |
| **99In** | 9 | 45 | g.s. | 3,0(8) s | 4.5 | 4.20 | 0.42 | **0.410** |
| | | | Iso. | 35 min?? | 4.5 | 4.08 | 0.41 | **0.39** |
| **100In** | 90 | 54 | g.s. | 5,8 s | 45 | 43.4 | 4.34 | **4.29** |



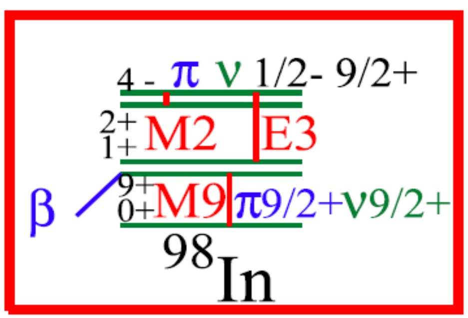

$^{100}$In σ = 2.6 x $10^{-3}$ mb
$^{99}$In σ = 2.95 x $10^{-4}$ mb
$^{98}$In σ = 3.37 x $10^{-5}$ mb

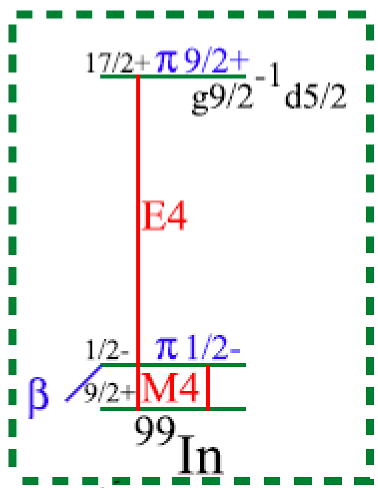
New XS evaluation
From B. Blank soon

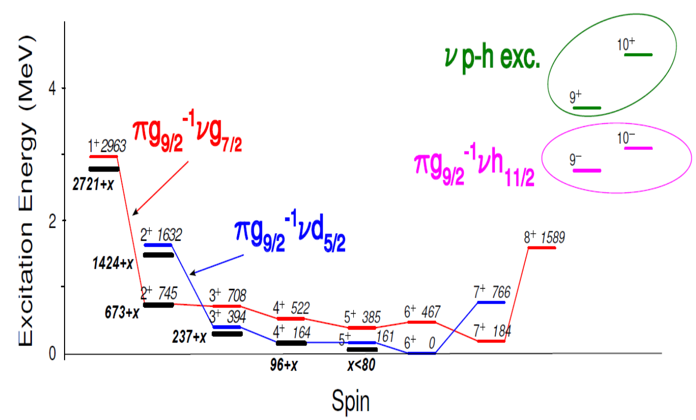
Beam: $^{58}$Ni @ 1 pμA
Energy ~ 254 – 318 MeV
Target: $^{46}$Ti
Thickness ~ 0.4 – 07 mg/cm$^2$
TOF (S3) ~ 2.3 µs
LEB ~ 300 ms
Tr (LEB) ~ 10%
Isomeric Ratio ~ 50 %

# Conclusions…

| | $^{98}$In | $^{99}$In | $^{100}$In |
|---|---|---|---|
| **Day 1** | - | Masses<br>Spin & Parities | Mass<br>Spin & Parities<br>Magnetic moments |
| **Day 2** | - | - | - |
| **Day 3 ++ (A/Q=7)** | Masses<br>Spin & parities<br>In-beam | In-beam | In-beam |



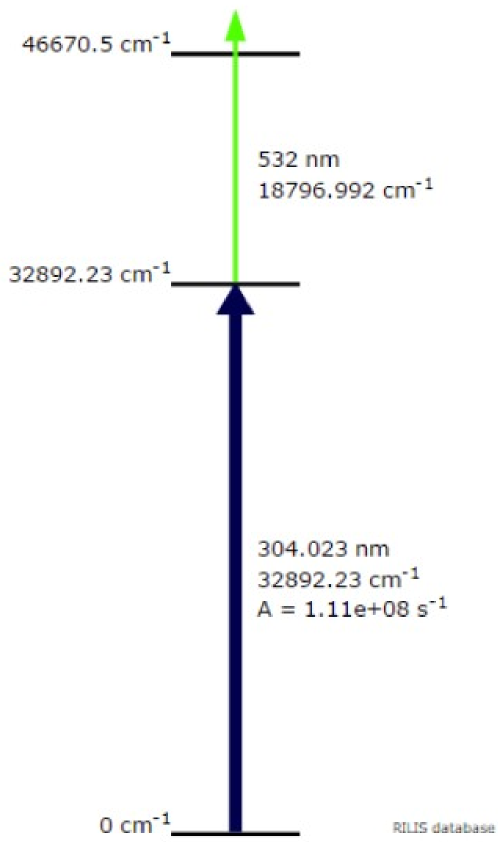



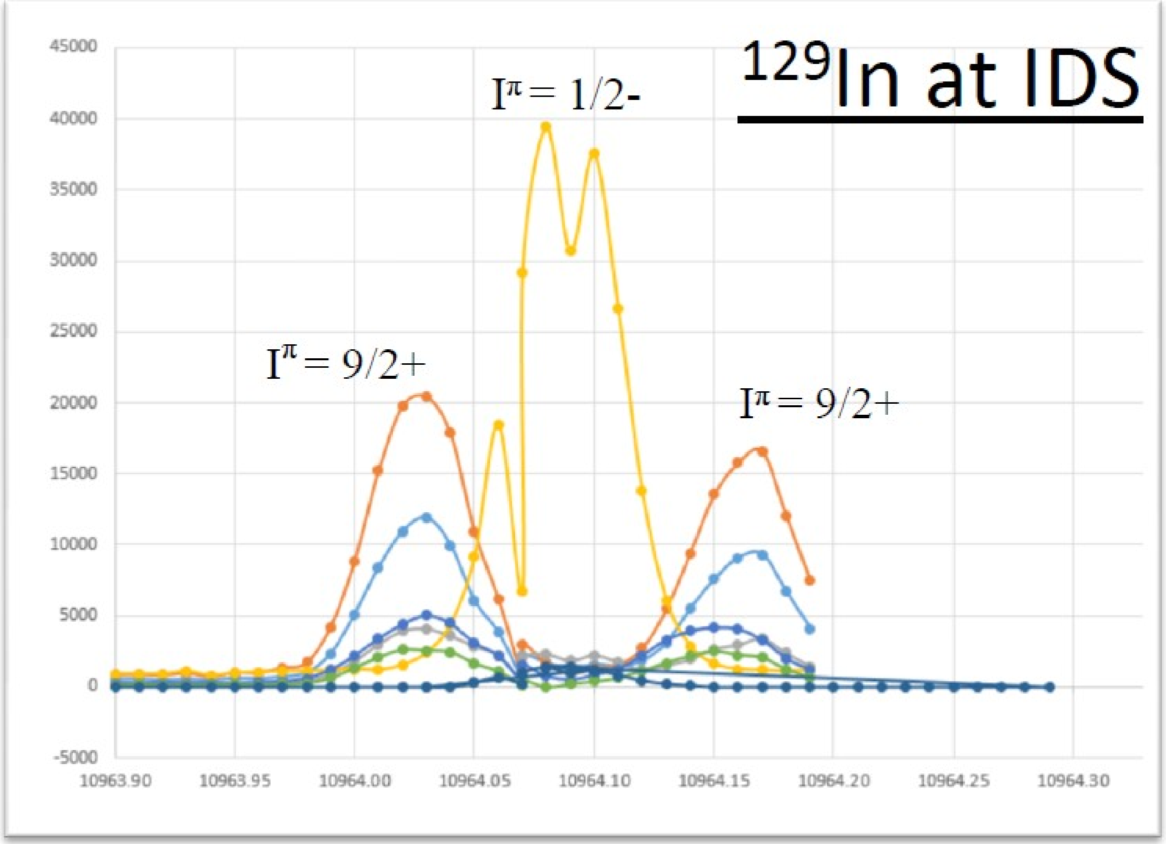




10 pμA
50 ms extraction LEB
50 ms MR-TOF-MS
0.1 pps of short lived state in $^{98}$In

# Linewidth optimization: indium

Achieved using 3ω light from a "narrowband" (~800 MHz) Ti:Sa




To be applied again soon



Courtesy T. Day Goodacre

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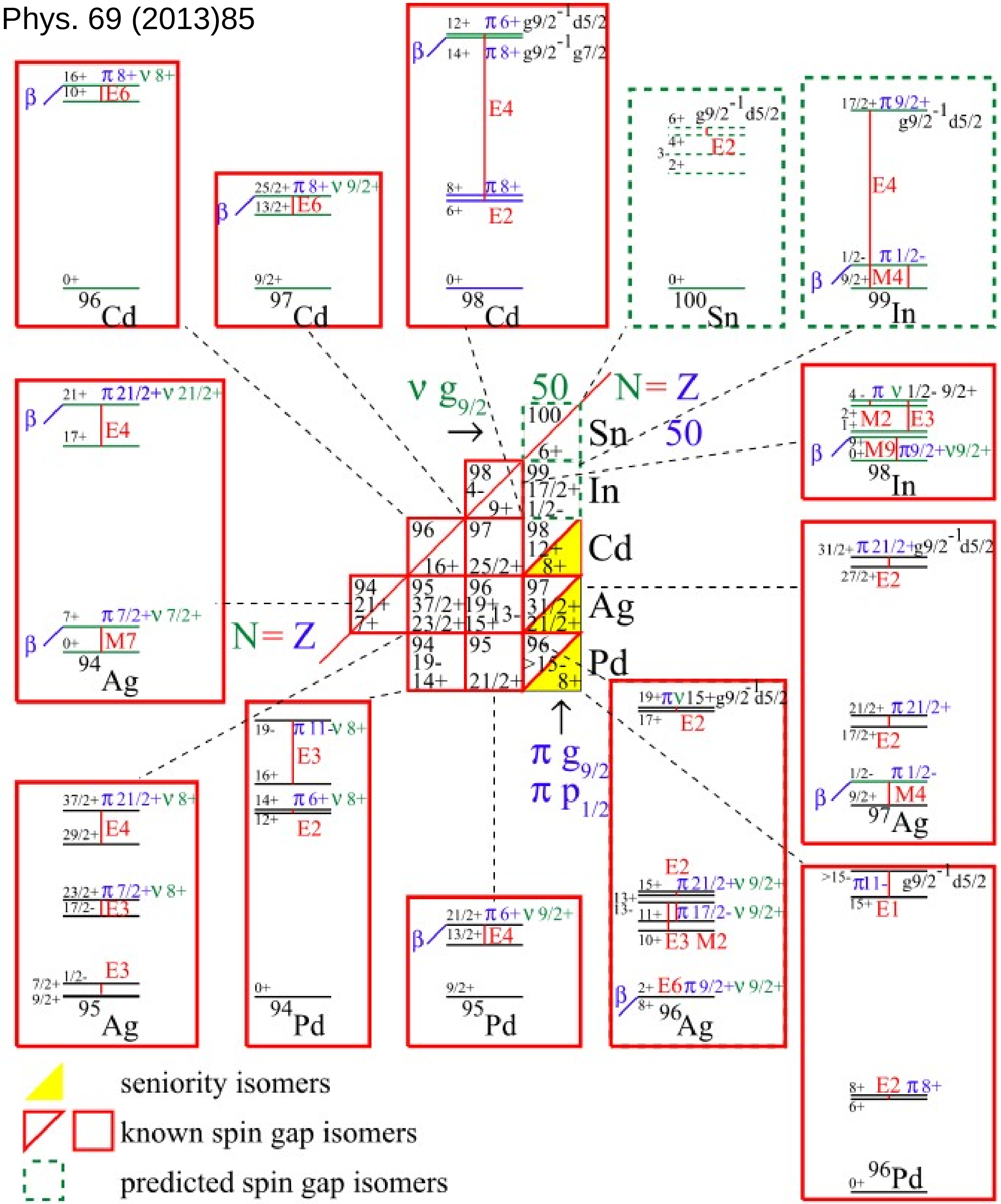


**Fig. 5.1.1.** Spin gap isomers below $N = Z = 50$ as updated from Ref. [325]. The $\gamma$-decay hindrance is indicated by its multipolarity and the dominating decay by $\beta$.