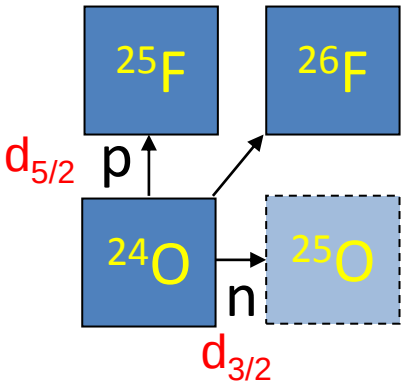
Study of nuclear interactions for the weakly bound nucleus ^{26}F

- Physics motivations : using of the ^{26}F to probe the proton-neutron interactions
- Experimental study of the ^{26}F through
  - > in-beam gamma spectroscopy
  - > G.S. and isomer decay studies

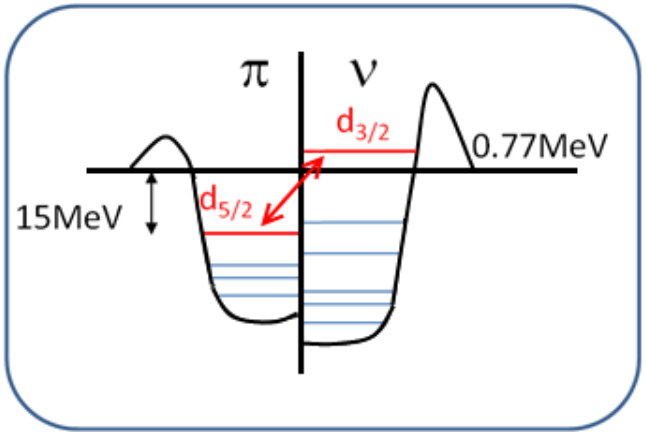
Alexandre Lepailleur

GANIL

The ^{26}F to probe the p-n interaction at neutron drip line

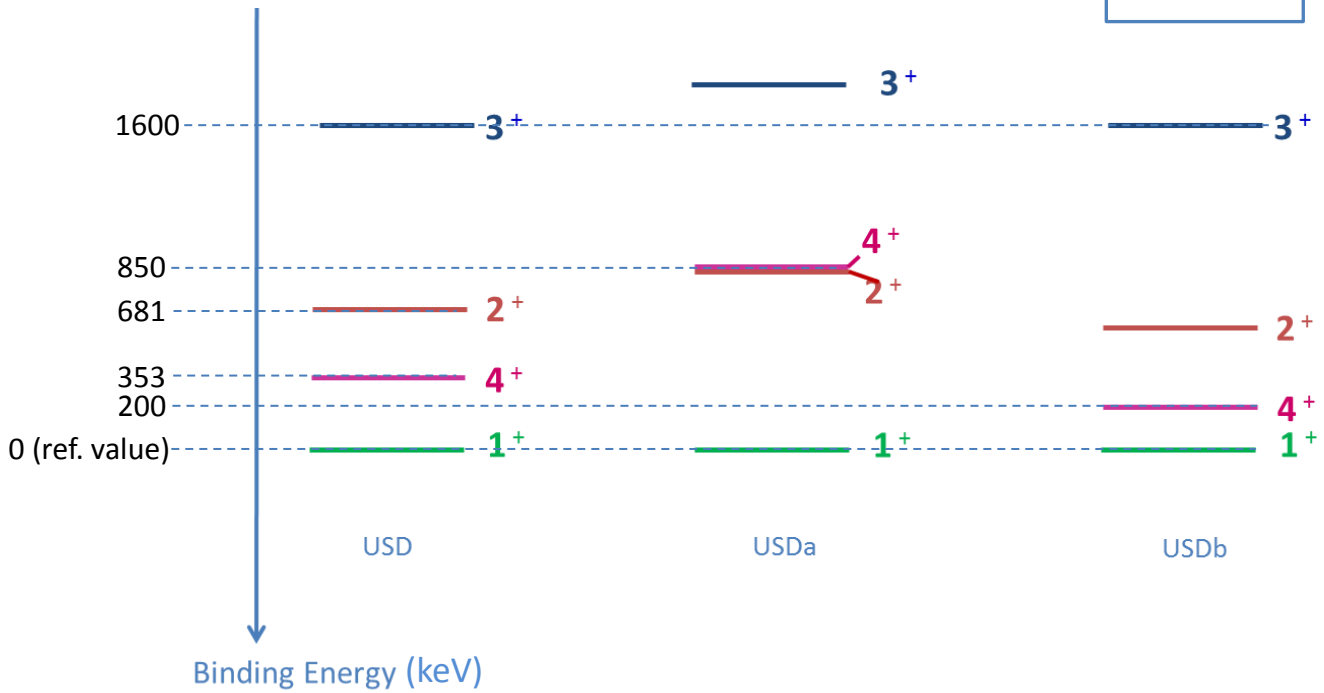


^{24}O E2: Hoffman et al, PRL 100 (2008)
^{25}O : Hoffman et al., PLB 672 (2009)

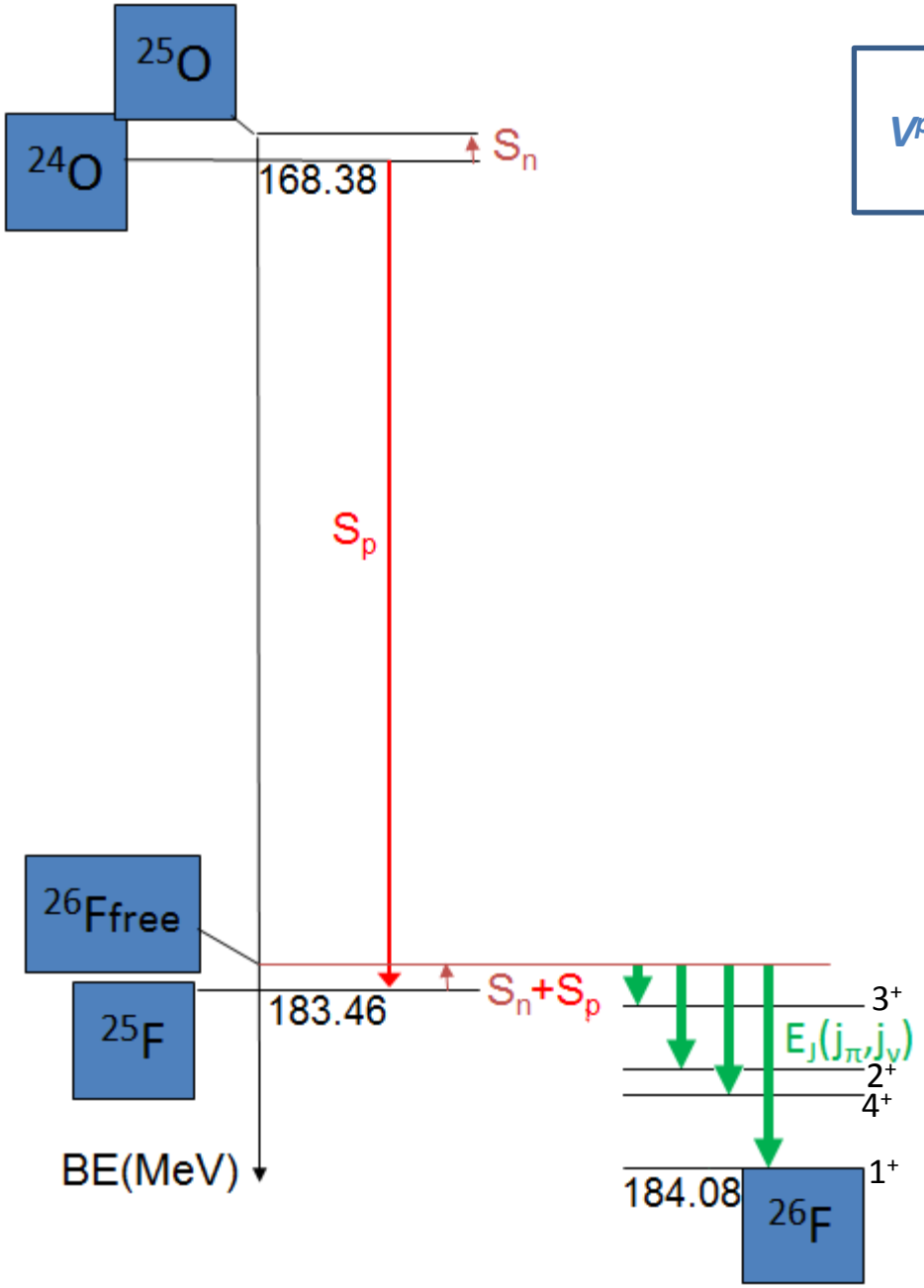


| 5/2 – 3/2 | ≤ J ≤ | 5/2 + 3/2 |

1 ≤ J ≤ 4



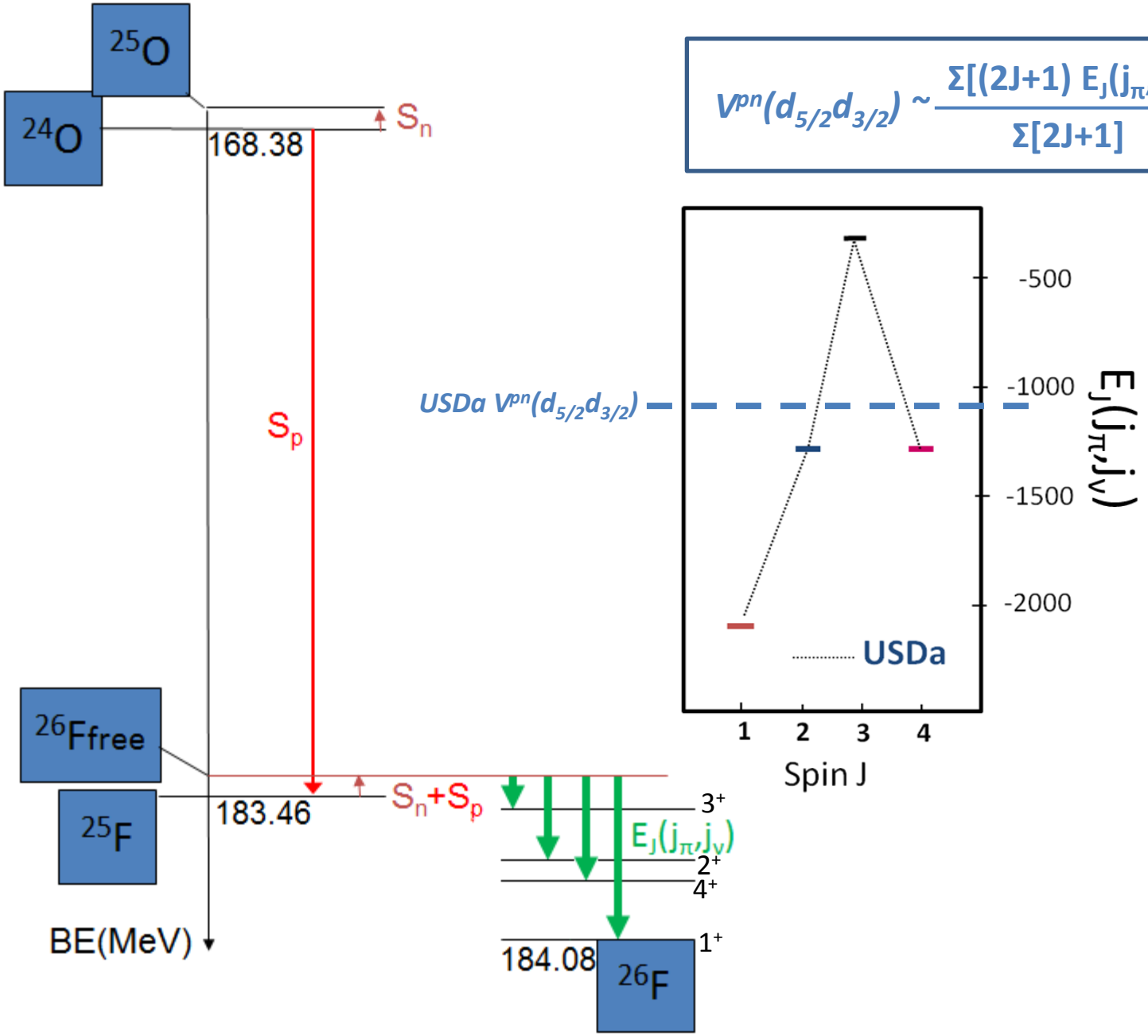
The ^{26}F to probe the p-n interaction at neutron drip line



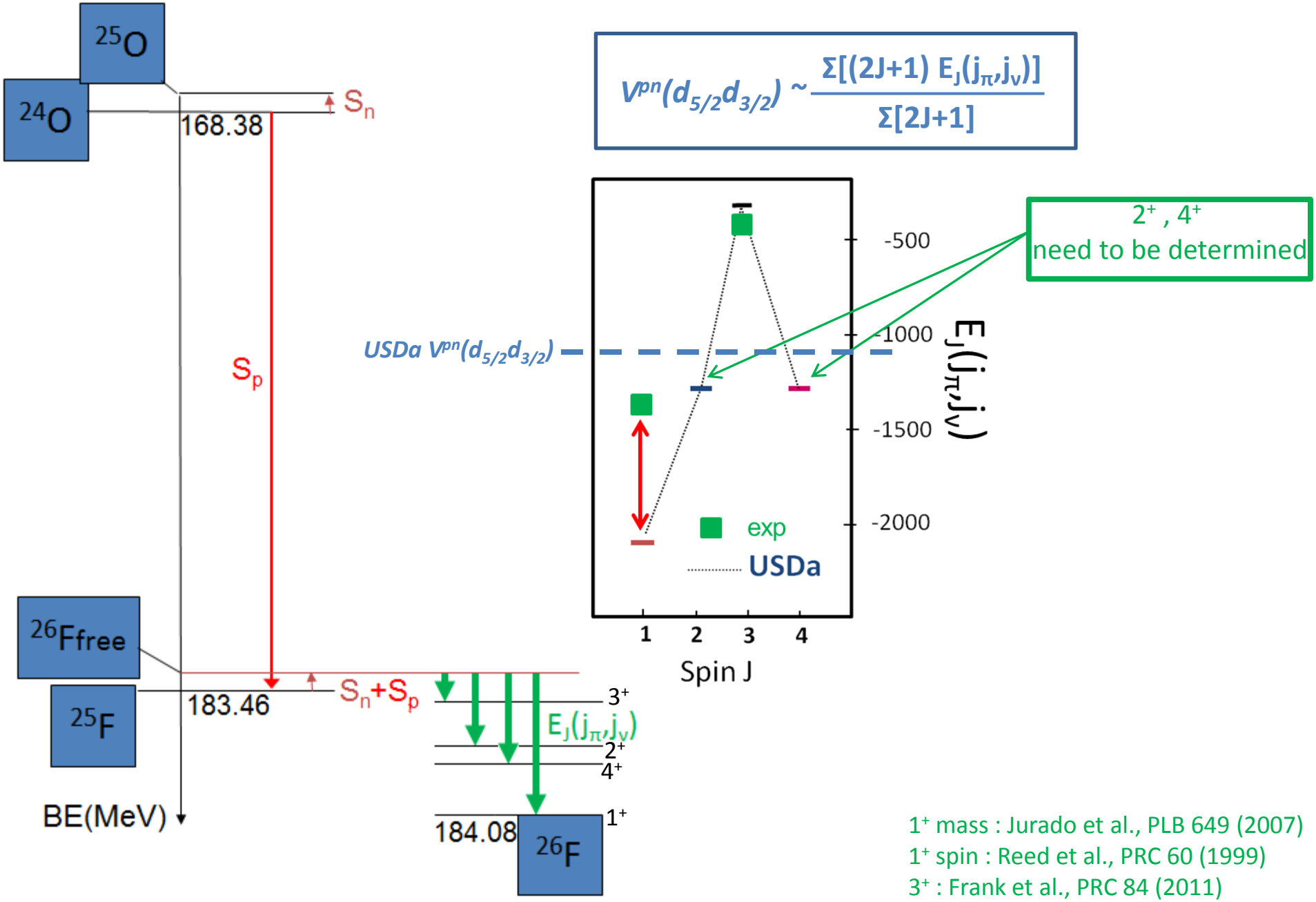
$$V^{pn}(d_{5/2}d_{3/2}) \sim \frac{\Sigma[(2J+1)\, E_J(j_\pi, j_\nu)]}{\Sigma[2J+1]}$$

The ^{26}F to probe the p-n interaction at neutron drip line

$$V^{pn}(d_{5/2}d_{3/2}) \sim \frac{\Sigma[(2J+1)\, E_J(j_\pi, j_\nu)]}{\Sigma[2J+1]}$$

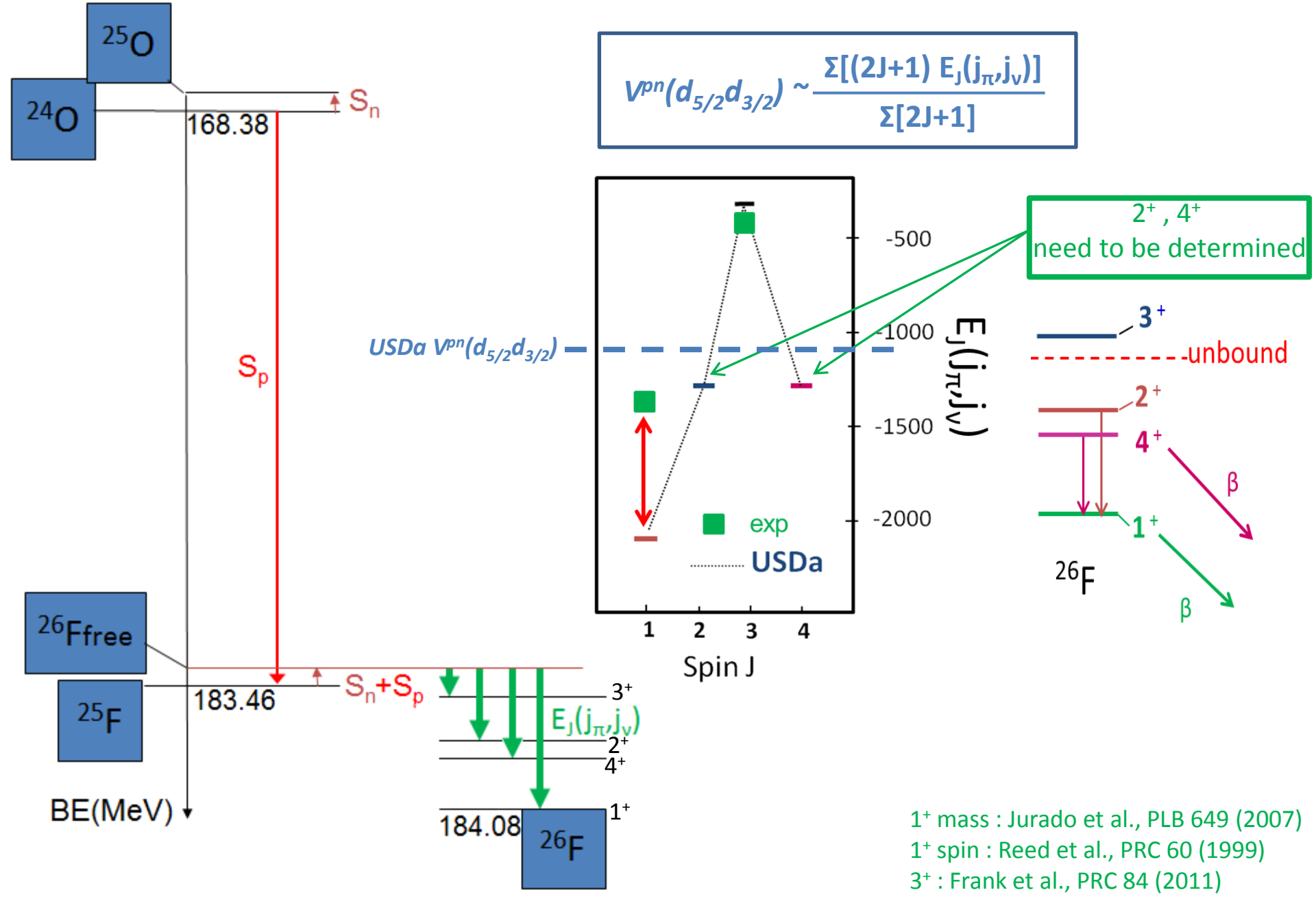


The ^{26}F to probe the p-n interaction at neutron drip line



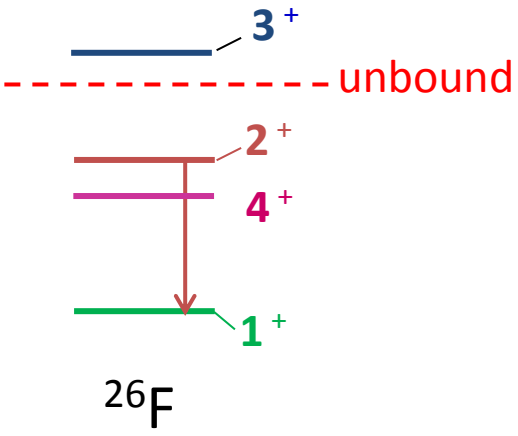
1^+ mass : Jurado et al., PLB 649 (2007)
1^+ spin : Reed et al., PRC 60 (1999)
3^+ : Frank et al., PRC 84 (2011)

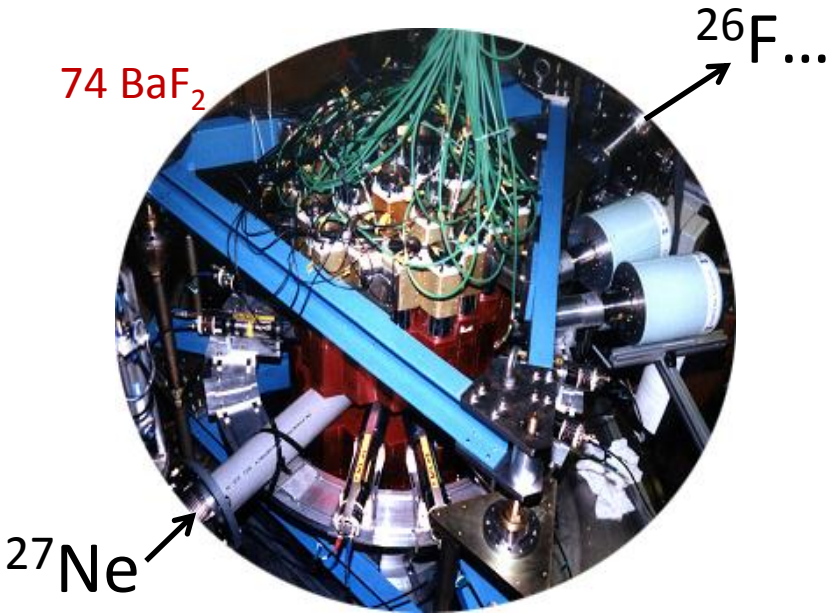
The ^{26}F to probe the p-n interaction at neutron drip line



1^+ mass : Jurado et al., PLB 649 (2007)
1^+ spin : Reed et al., PRC 60 (1999)
3^+ : Frank et al., PRC 84 (2011)

Determination of the 2^+ state of ^{26}F

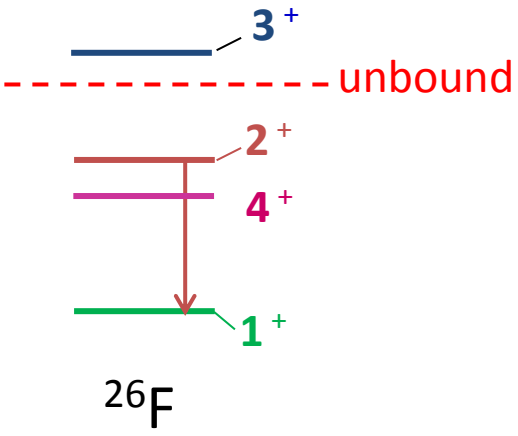


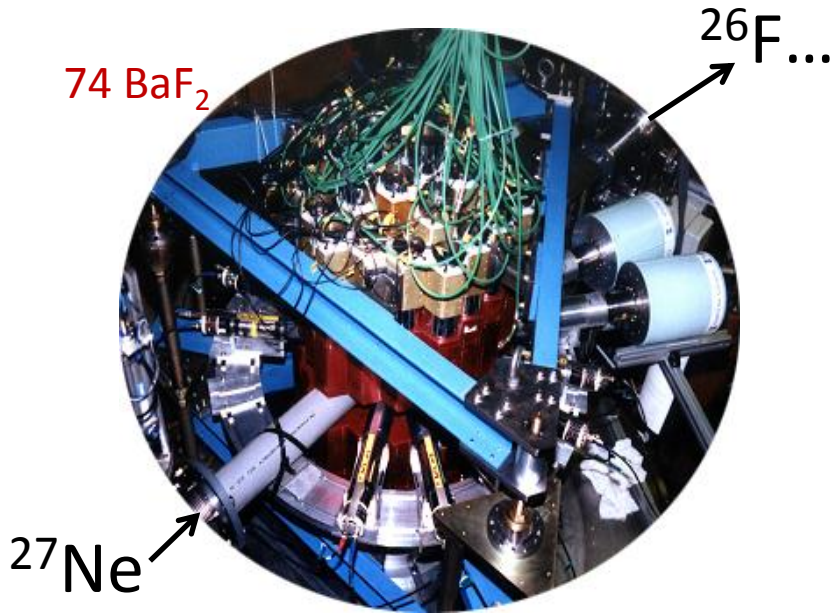


- In beam experiment at GANIL.
- ^{26}F produced by double step fragmentation.
- Gammas detected with 74 BaF_2 detectors
- Produced nuclei identified at the focal plane of the SPEG spectrometer.

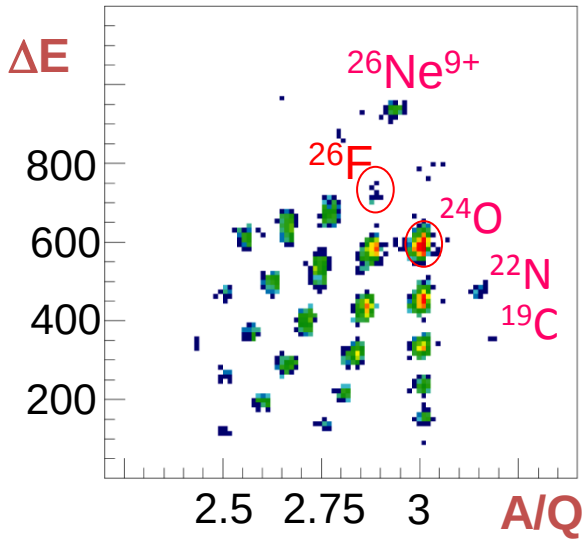
Stanoiu et al., PRC 85 (2012)

Determination of the 2^+ state of ^{26}F



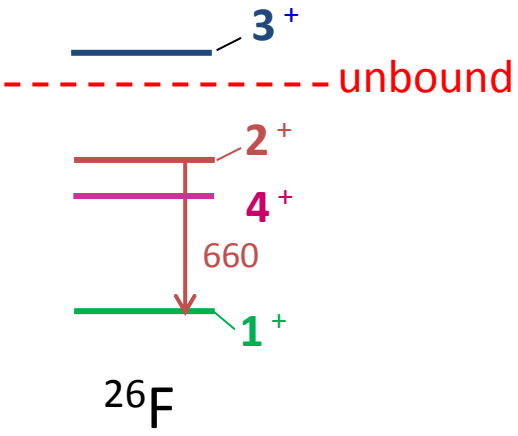


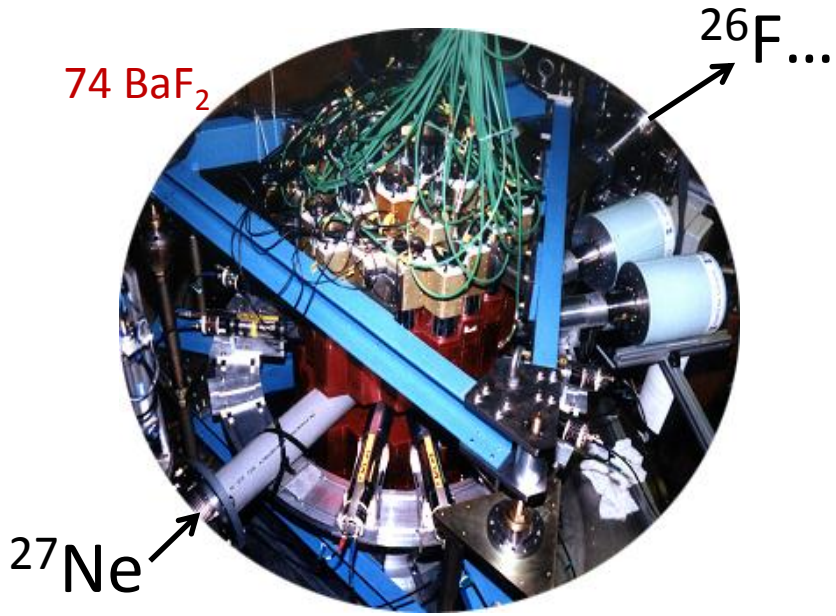
- In beam experiment at GANIL.
- ^{26}F produced by double step fragmentation.
- Gammas detected with 74 BaF_2 detectors
- Produced nuclei identified at the focal plane of the SPEG spectrometer.



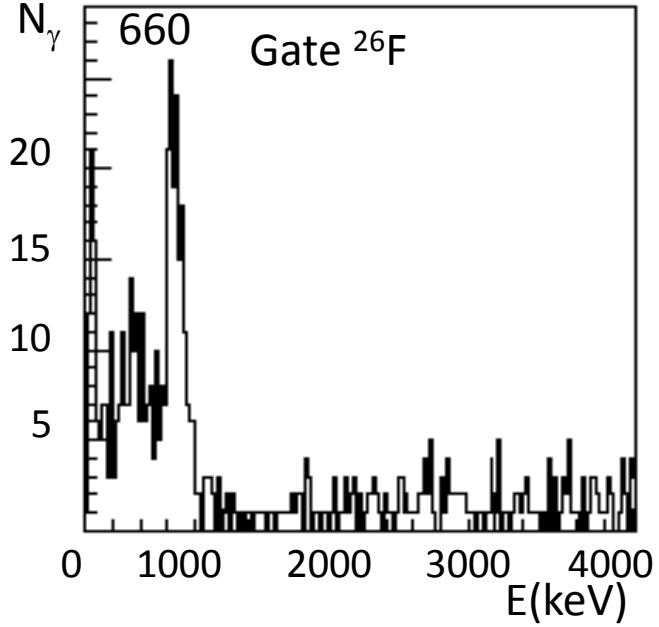
Stanoiu et al., PRC 85 (2012)

Determination of the 2^+ state of ^{26}F



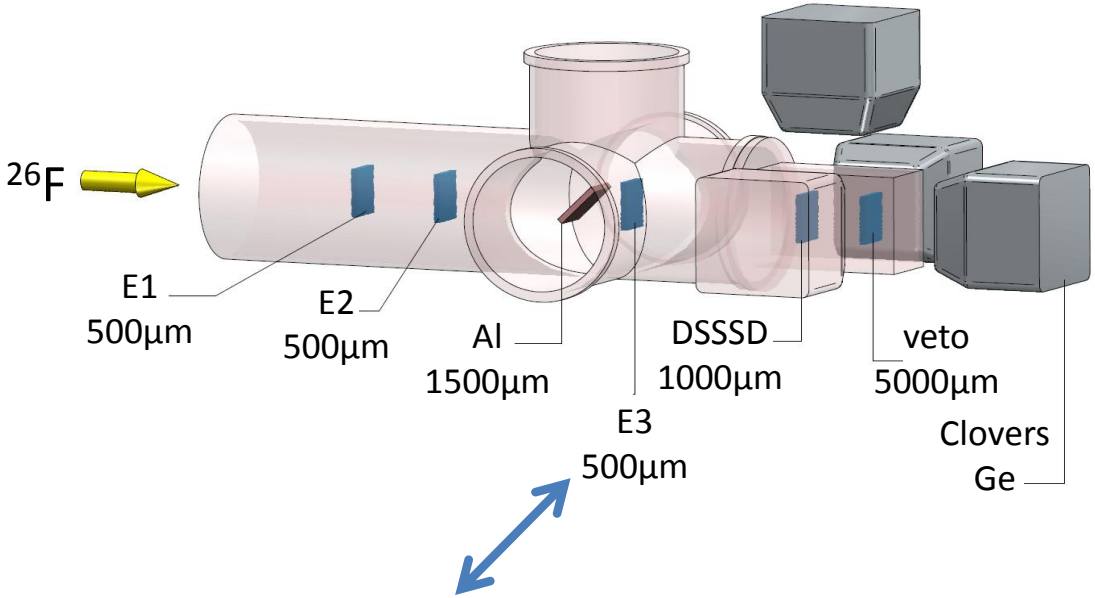


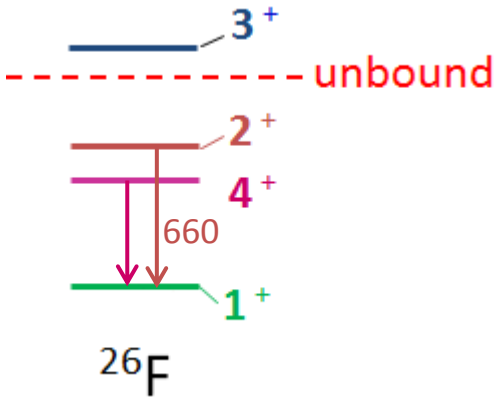
- In beam experiment at GANIL.
- ^{26}F produced by double step fragmentation.
- Gammas detected with 74 BaF_2 detectors
- Produced nuclei identified at the focal plane of the SPEG spectrometer.

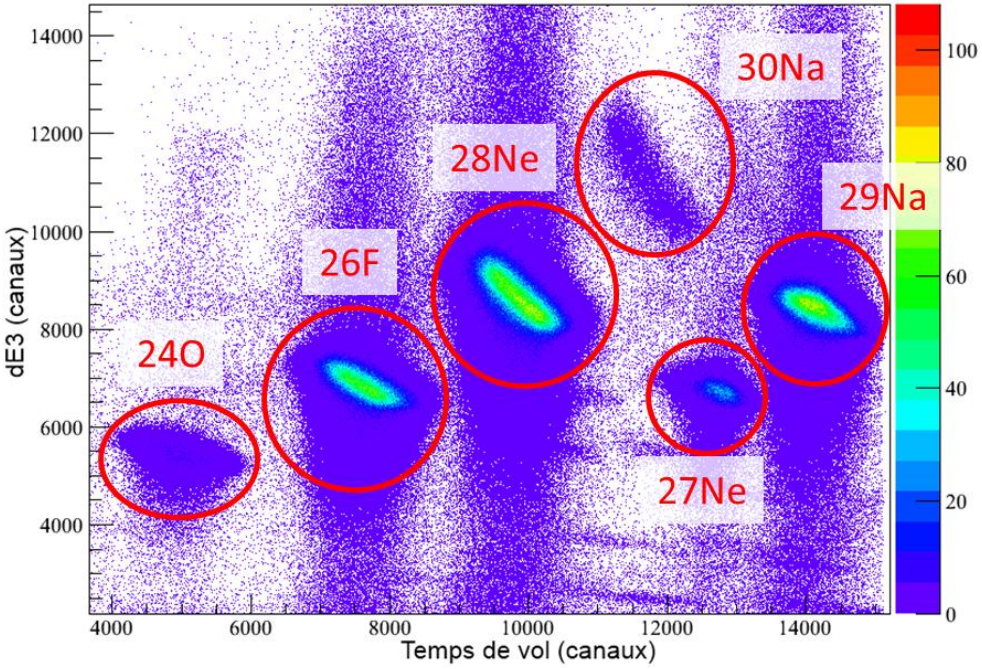


Stanoiu et al., PRC 85 (2012)

Search for the isomeric 4^+ state in ^{26}F





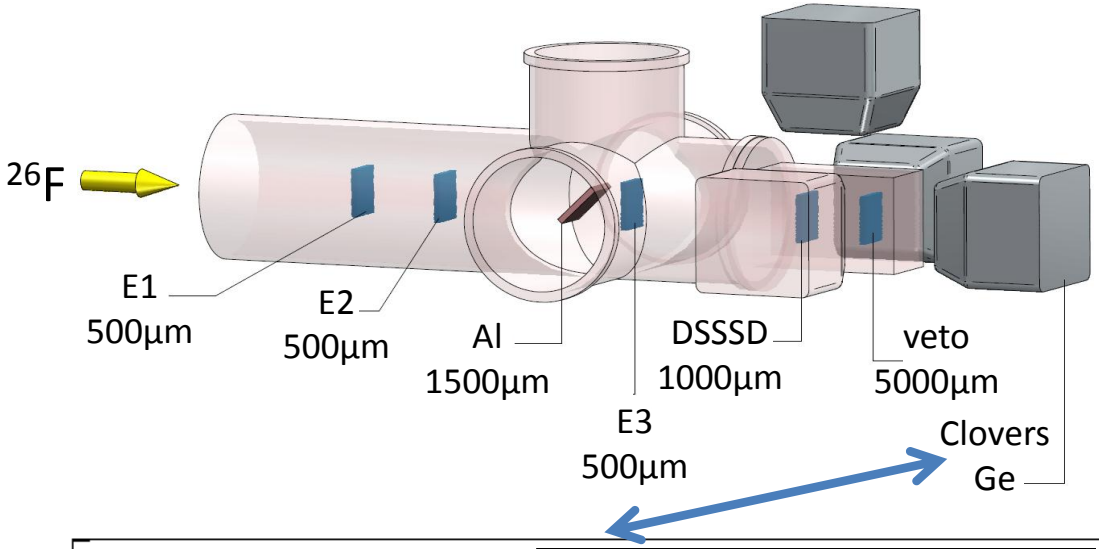


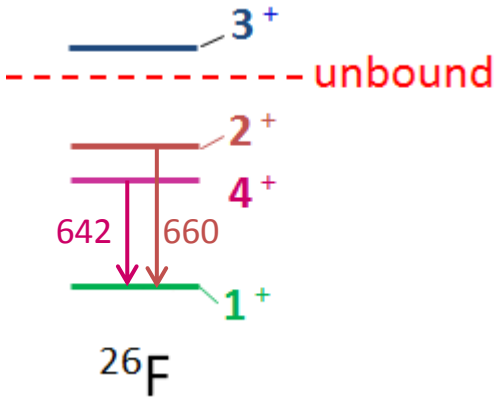
^{28}Ne : 10.4/s

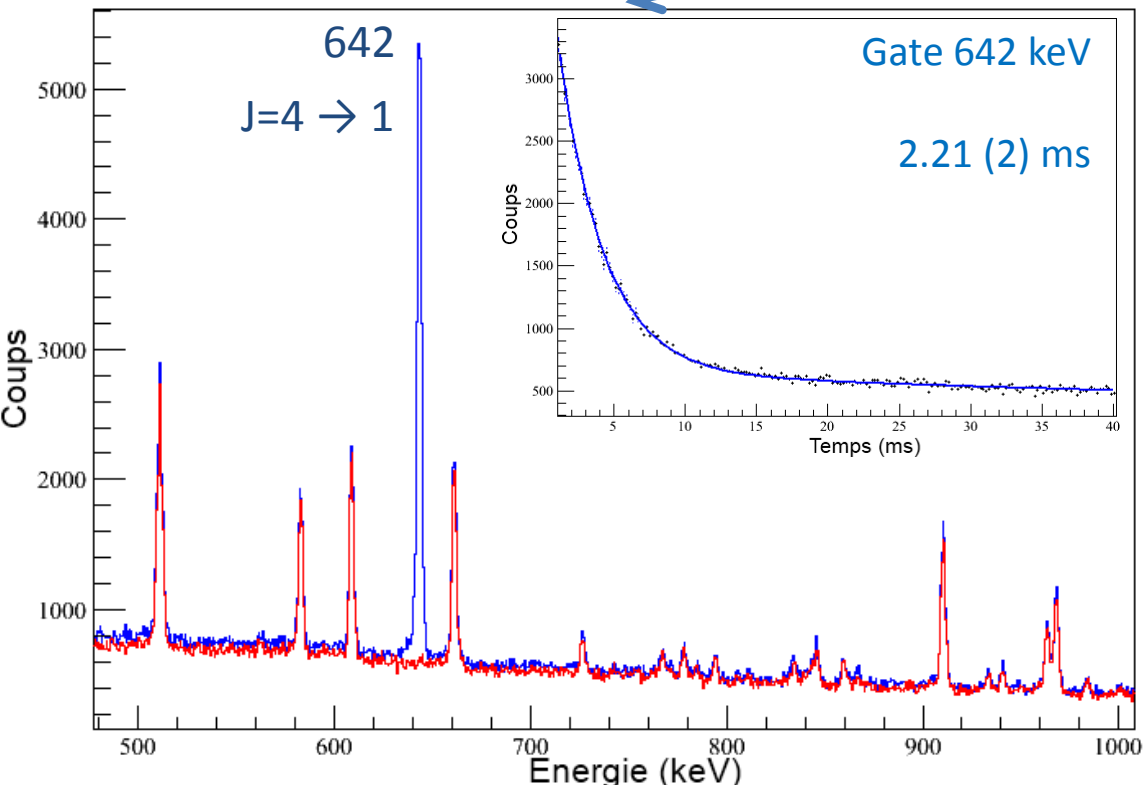
^{26}F : 5.5/s

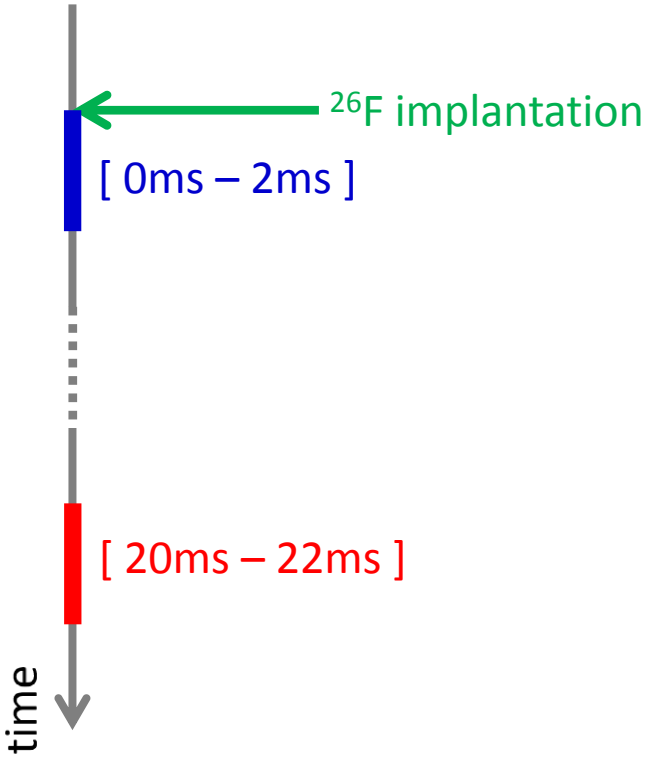
^{24}O : 0.058/s

Showing of this isomeric 4⁺ state in ^{26}F

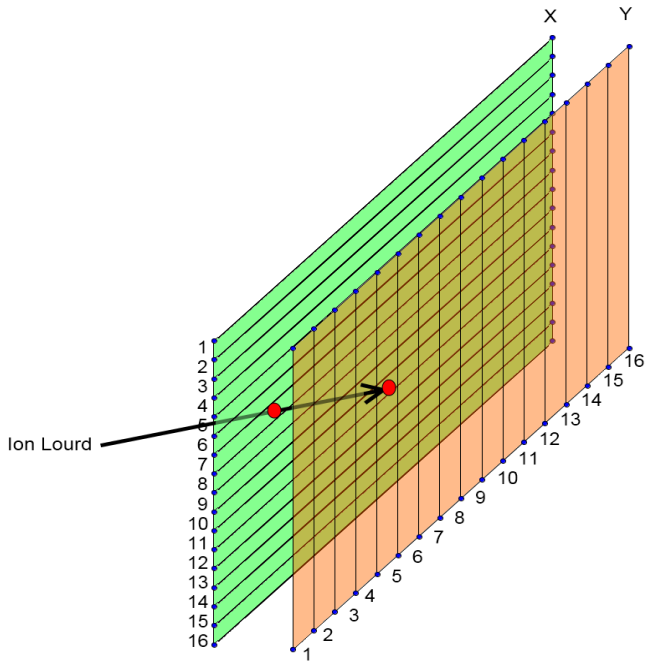


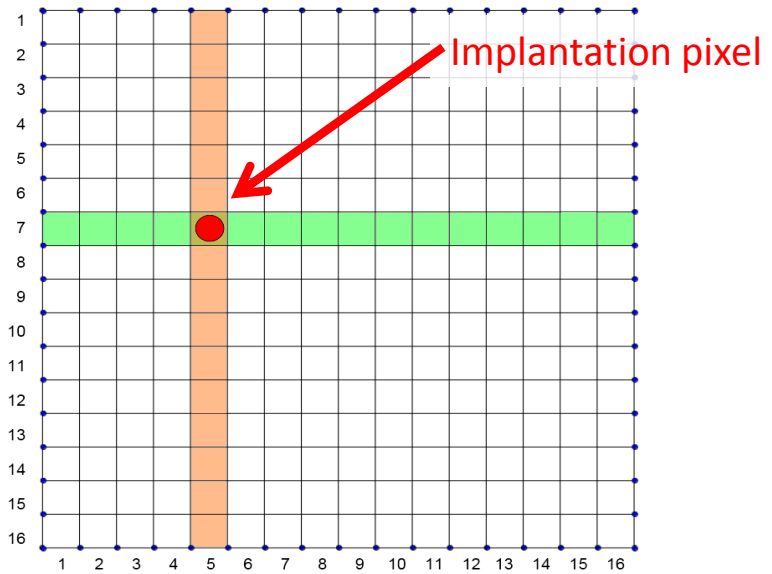


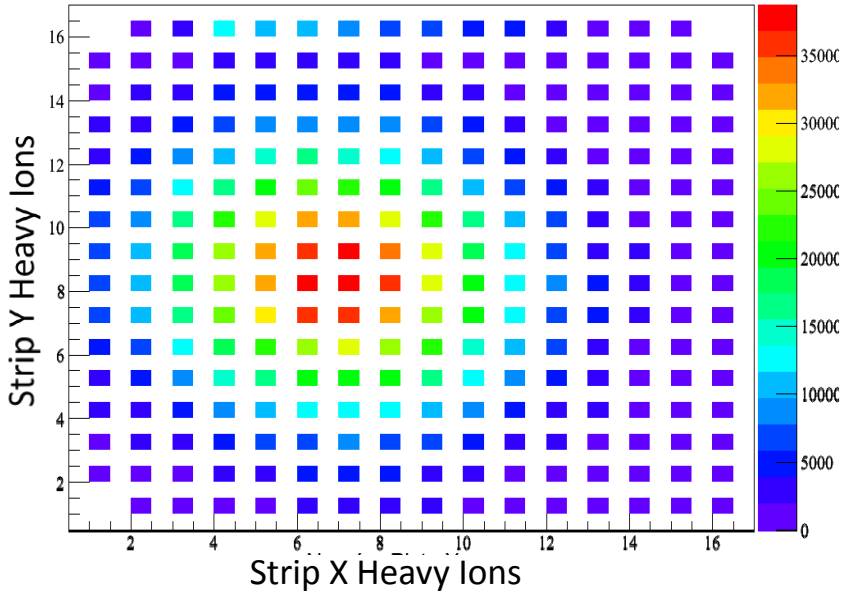


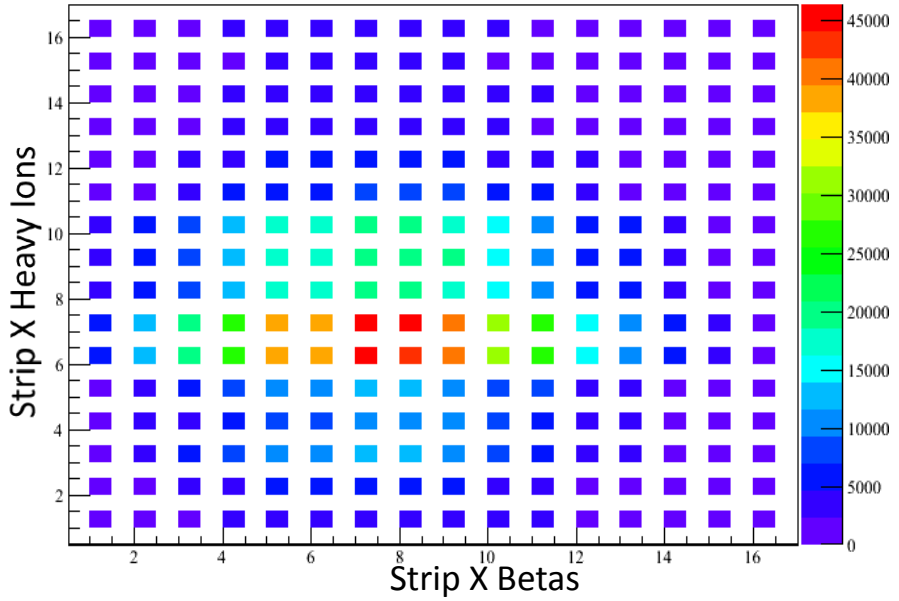


Correlations of the heavy ions and the betas

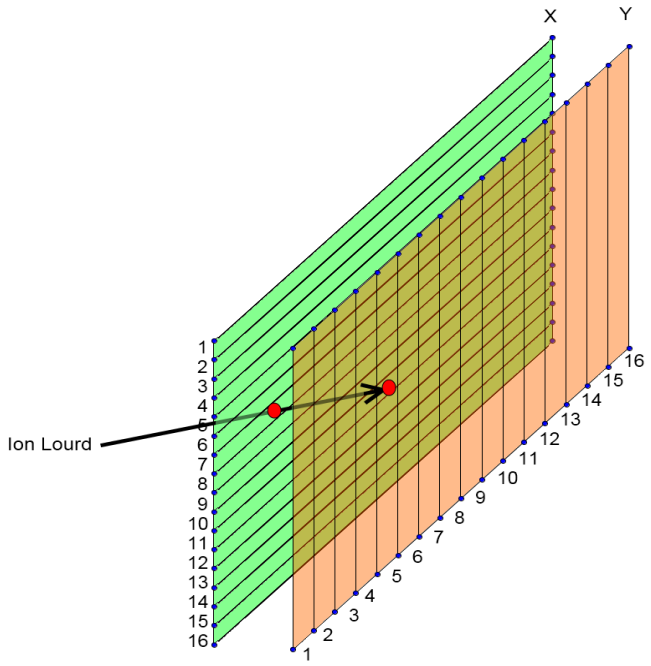


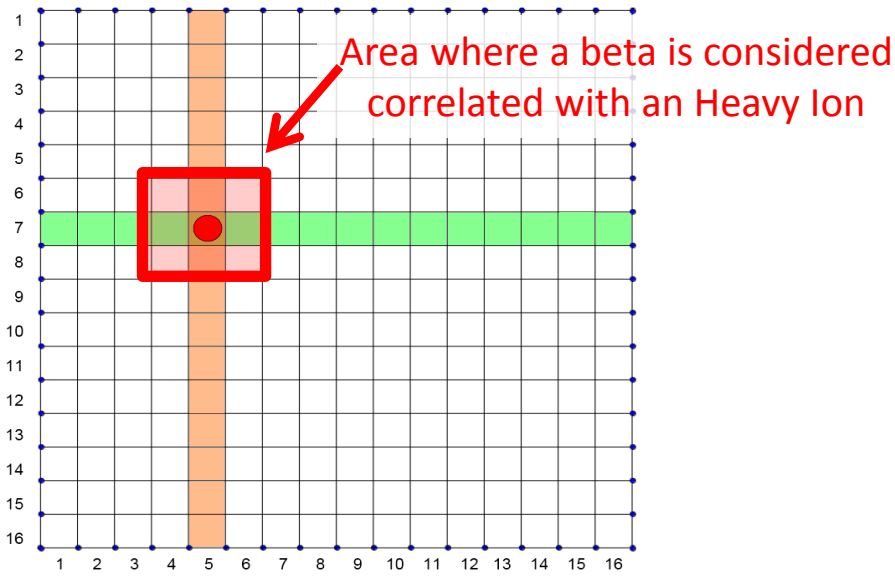


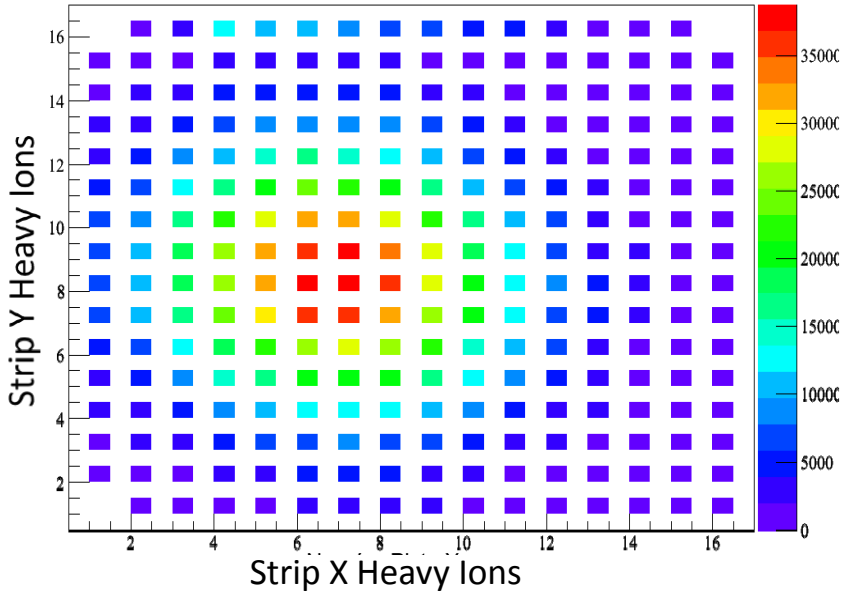


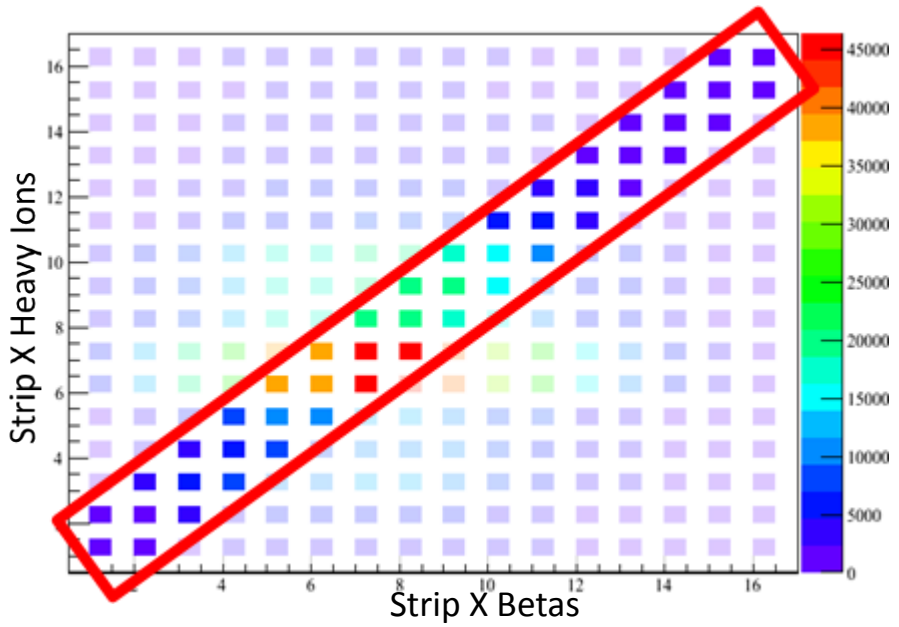


Correlations of the heavy ions and the betas



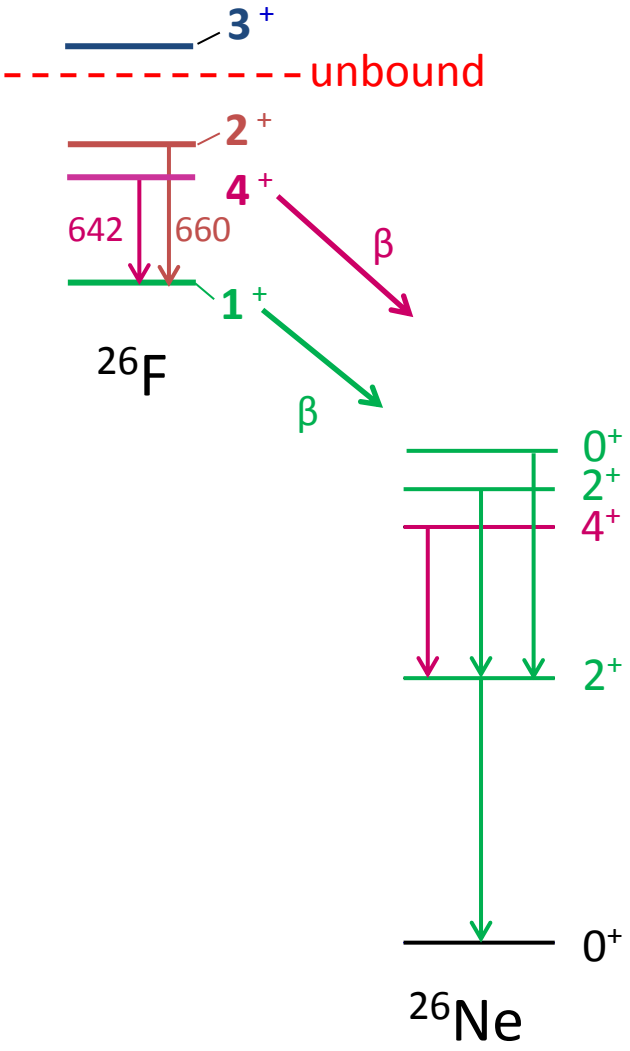






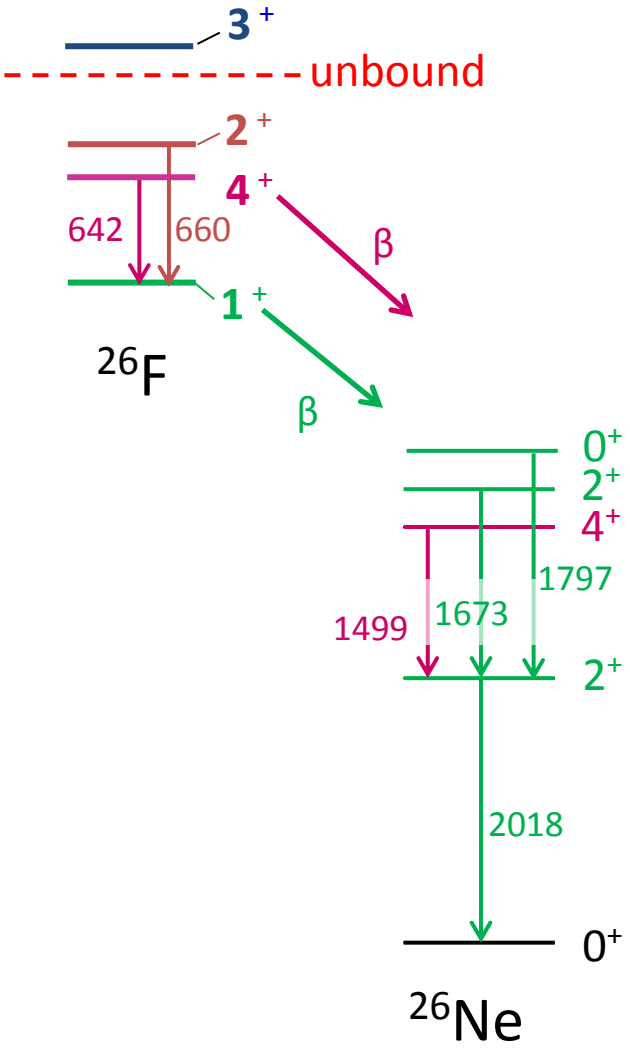
Study of the beta decay of ^{26}F

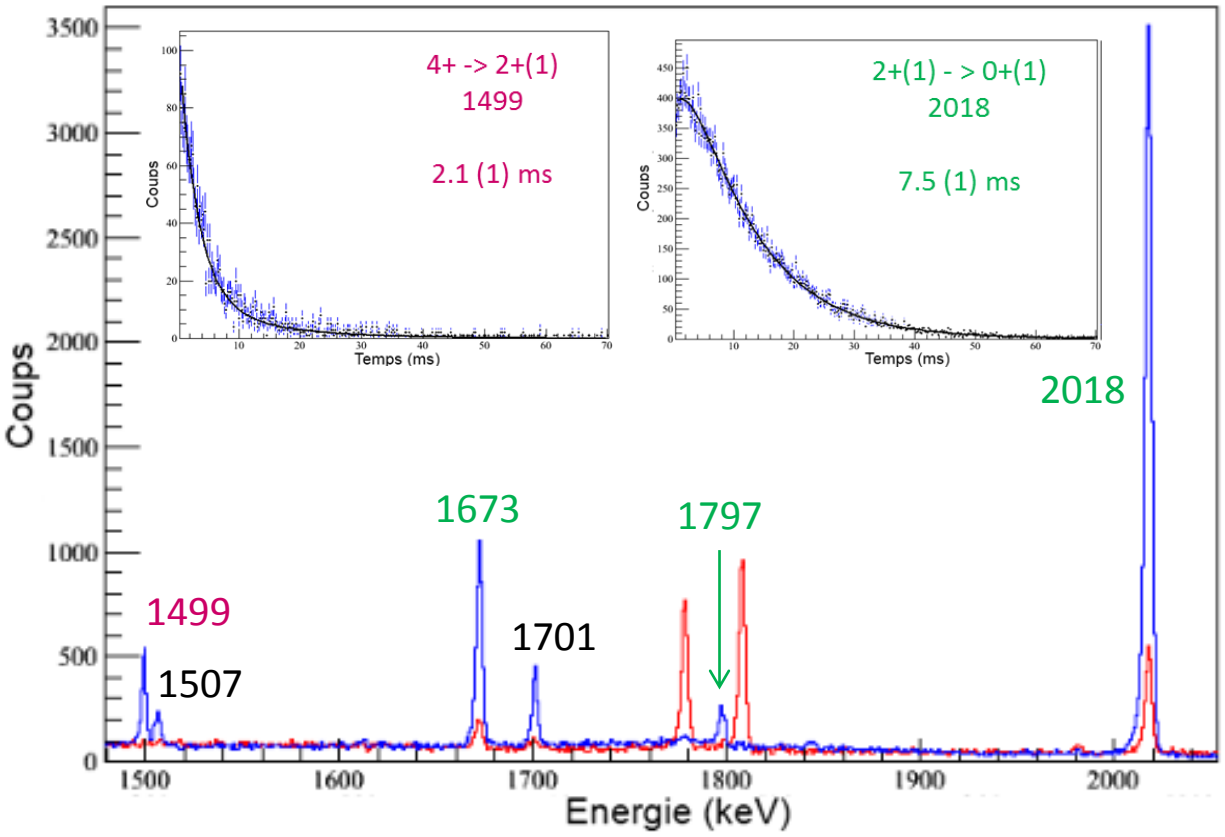
β-decay selection rules :
$\Delta J = 0 , \pm 1$

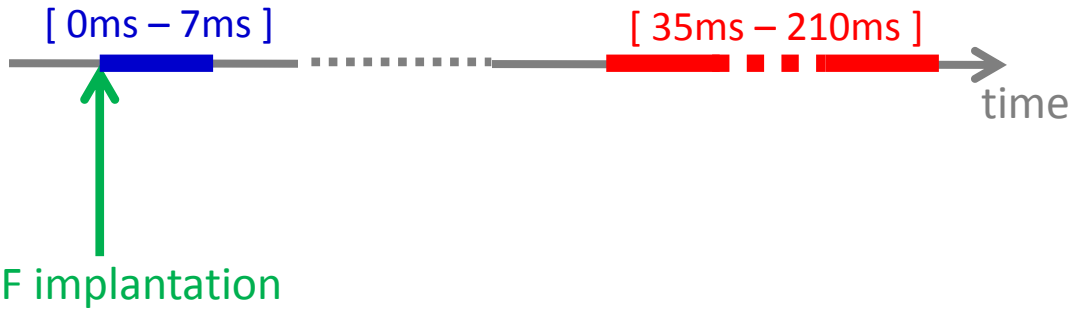


Study of the beta decay of ^{26}F

β-decay selection rules :
ΔJ = 0 , ±1

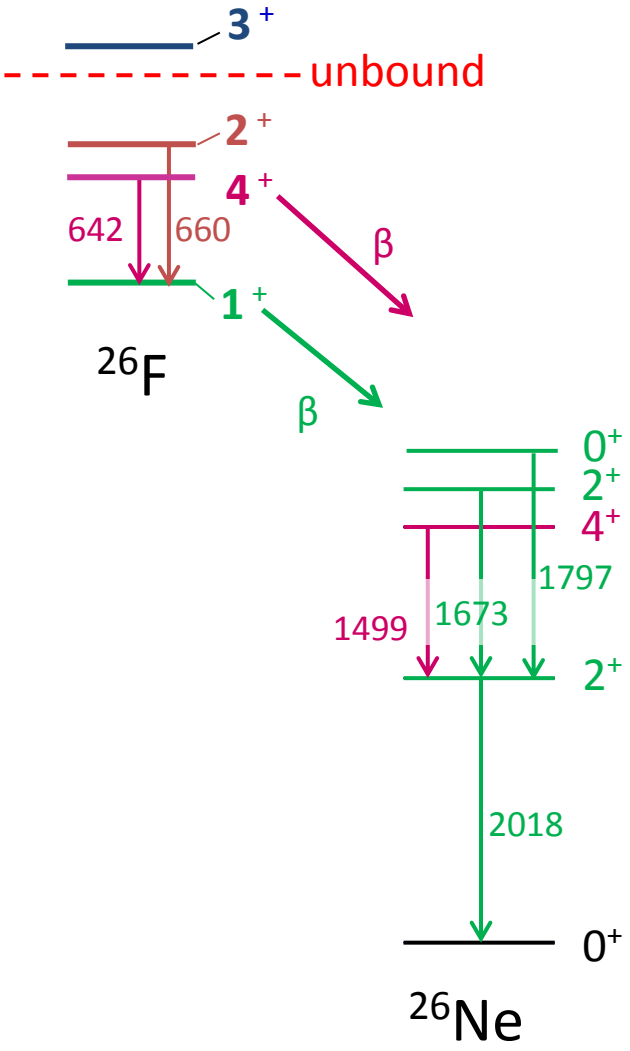


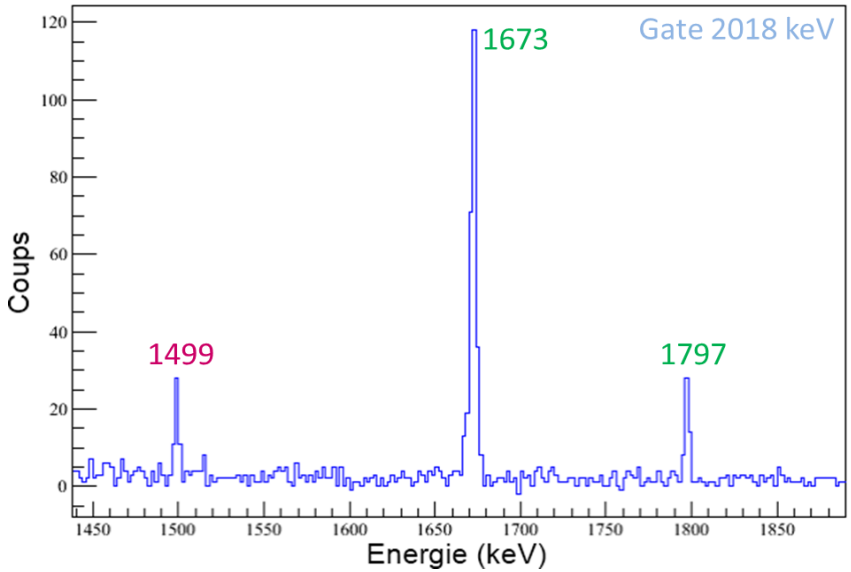


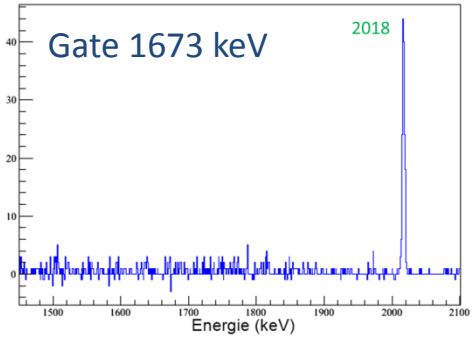


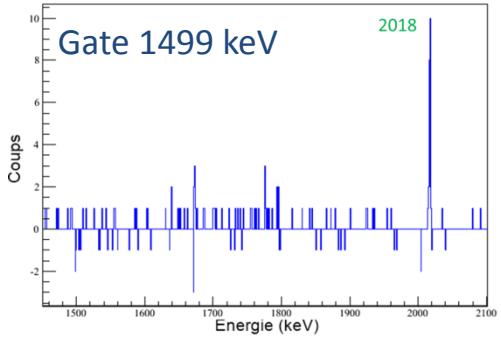
Study of the beta decay of ^{26}F

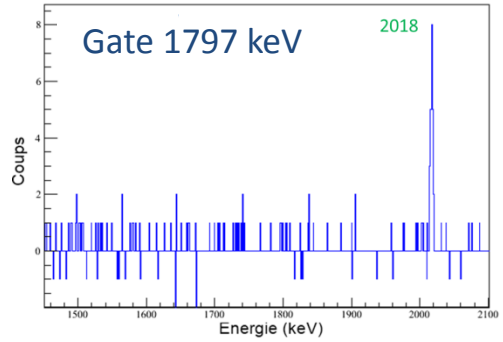
β-decay selection rules :
ΔJ = 0 , ±1









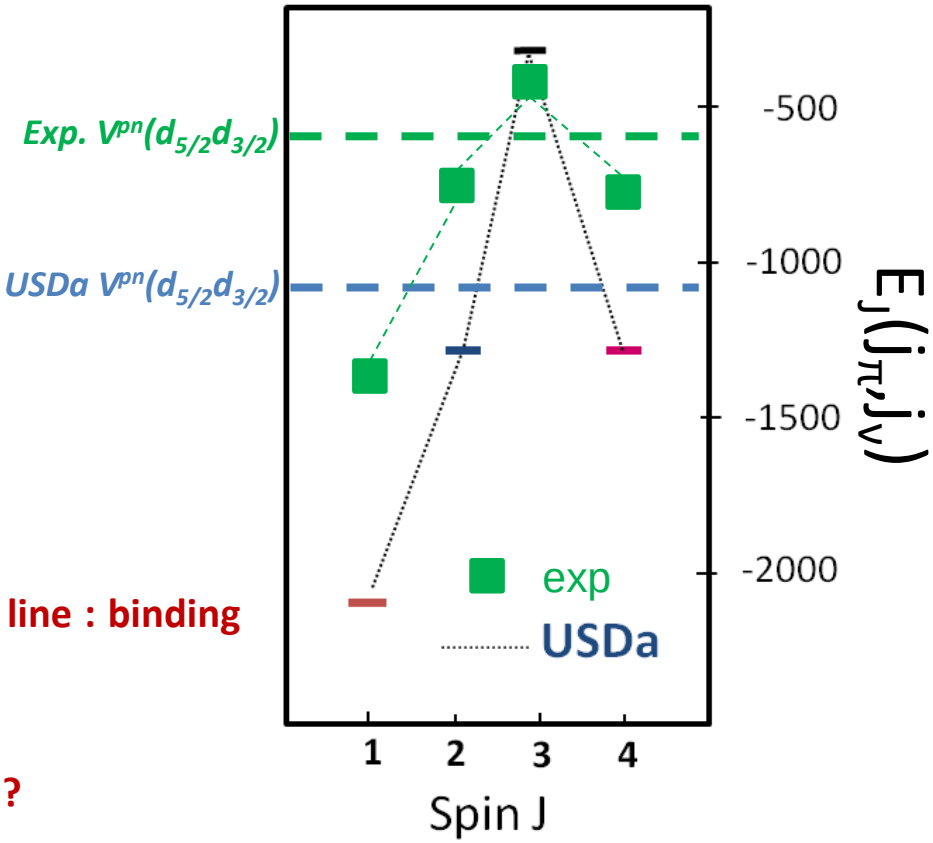


Conclusions

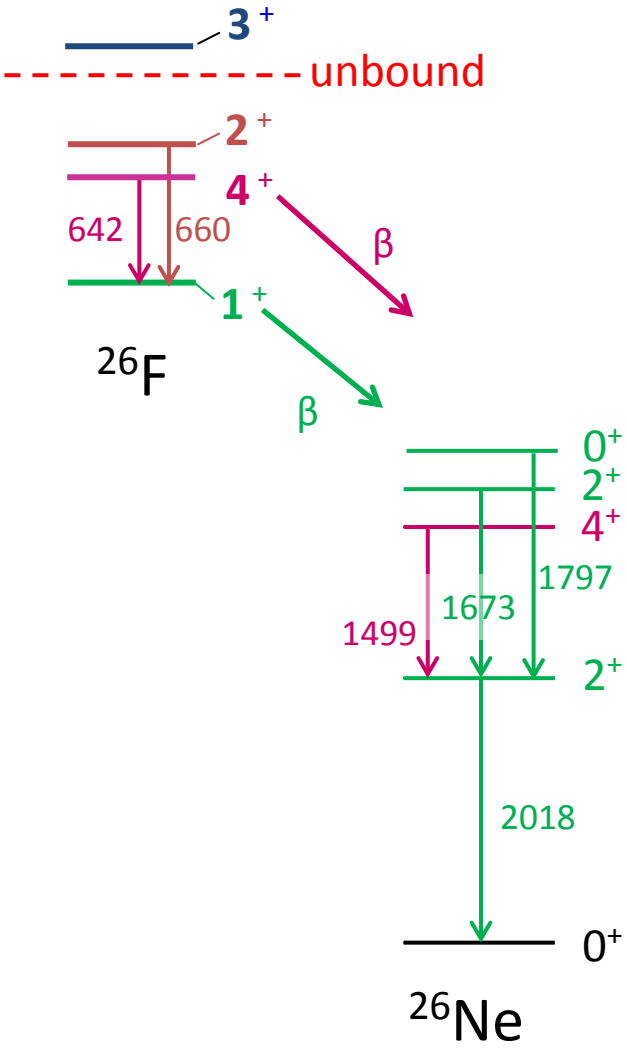
- 2^+ and 4^+ states of ^{26}F (previously unknown) were determined.
- J=1,2, 4 states in ^{26}F less bound than in calculations
- Experimental $|V^{pn}(d_{5/2}d_{3/2})|$ < USD $|V^{pn}(d_{5/2}d_{3/2})|$ by roughly 35%.
- Isomeric ratio (4^+) ~ 40%

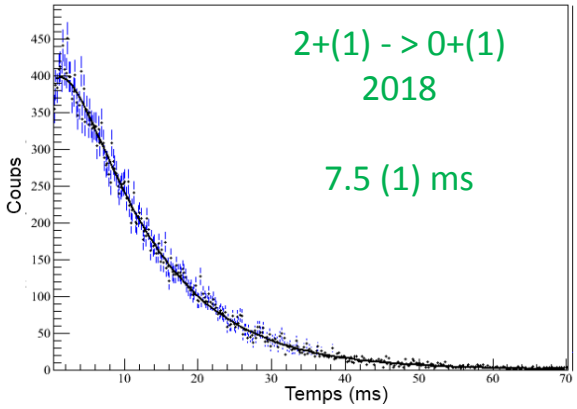
→ Changing of the nuclear interactions at the drip line : binding energy dependance ?

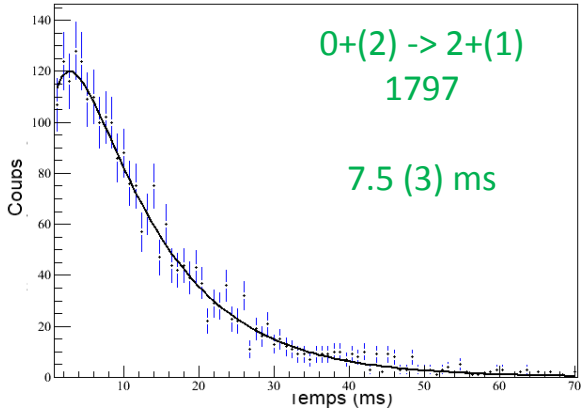
→ Real effect or issue with the mass measurement ?

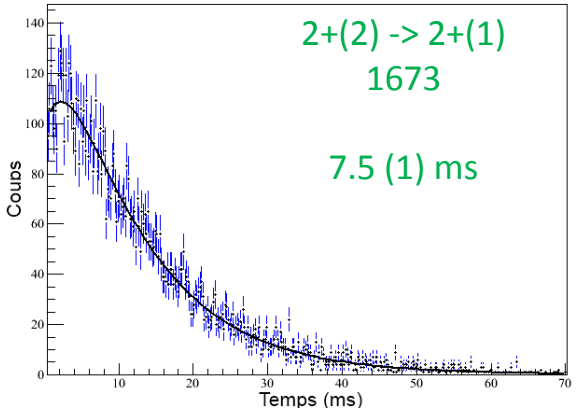


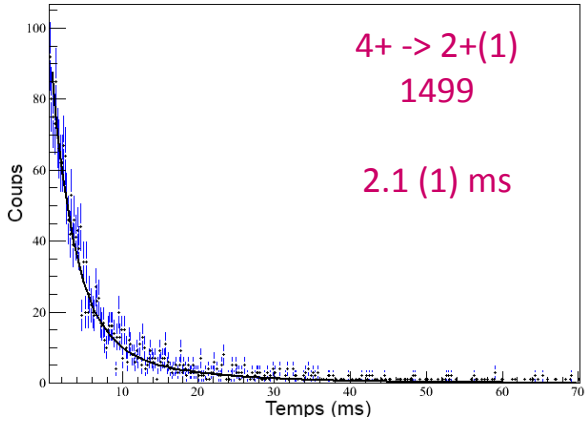
$\Delta J = 0 , \pm 1$

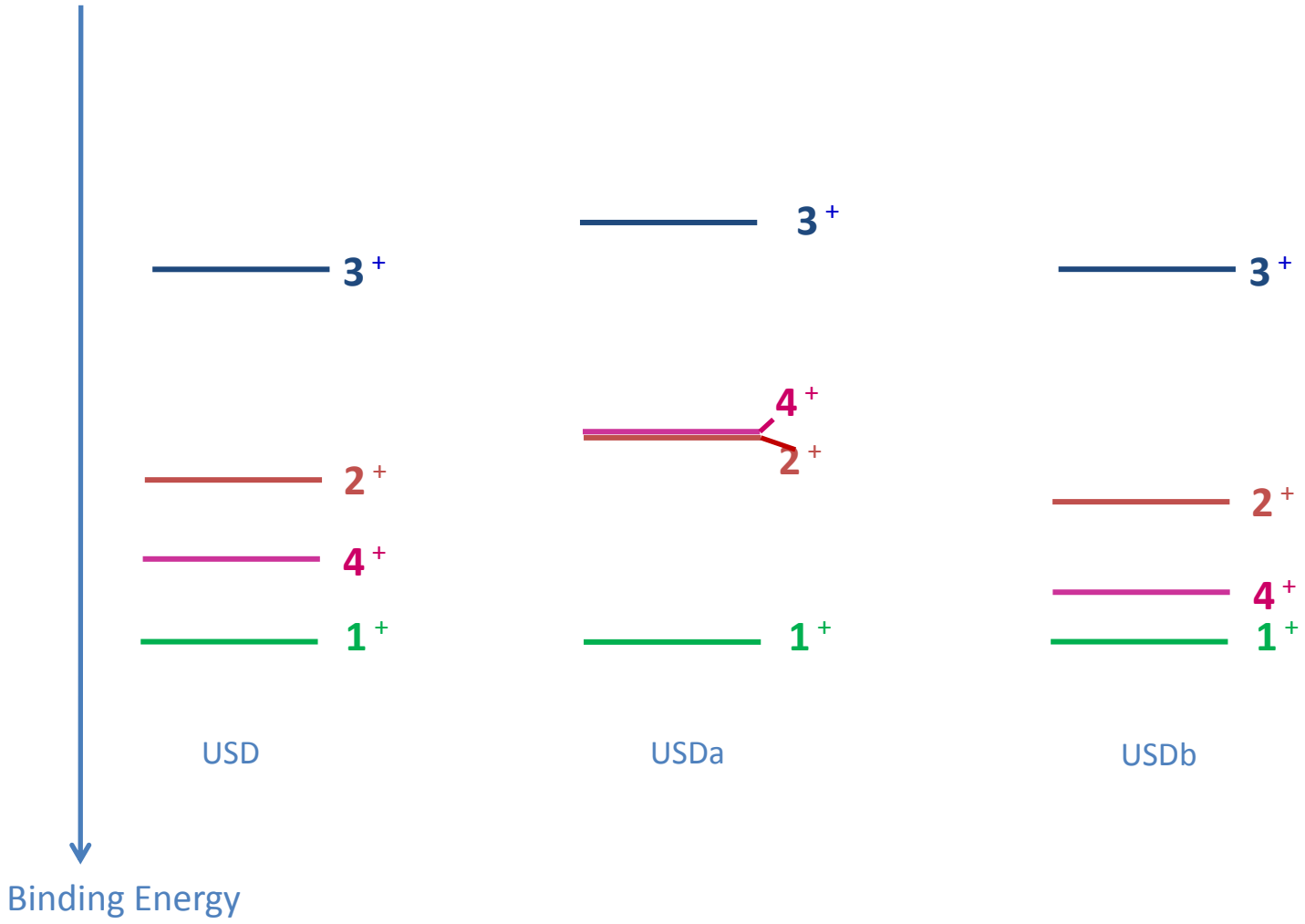

3+
unbound
2+
4+
642
660
β
1+
β
26F
0+
2+
4+
1797
1673
1499
2+
2018
0+
26Ne

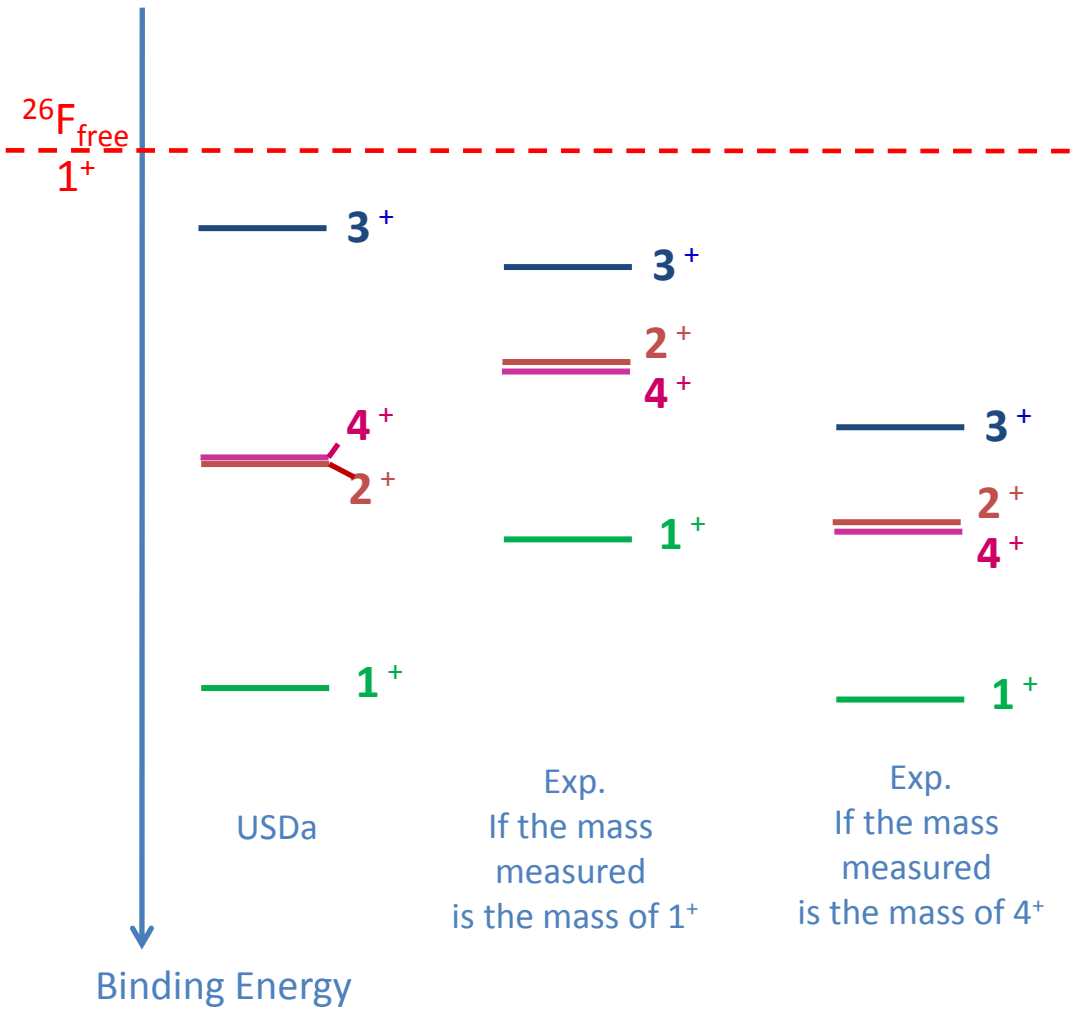

2+(1) - > 0+(1)
2018
7.5 (1) ms
Coups
Temps (ms)


0+(2) -> 2+(1)
1797
7.5 (3) ms
Coups
Temps (ms)


2+(2) -> 2+(1)
1673
7.5 (1) ms
Coups
Temps (ms)


4+ -> 2+(1)
1499
2.1 (1) ms
Coups
Temps (ms)


3 +
2 +
4 +
1 +
USD
3 +
4 +
2 +
1 +
USDa
3 +
2 +
4 +
1 +
USDb
Binding Energy


$^{26}F_{free}$
1^+
3^+
4^+
2^+
1^+
USDa
3^+
2^+
4^+
1^+
Exp.
If the mass
measured
is the mass of 1^+
3^+
2^+
4^+
1^+
Exp.
If the mass
measured
is the mass of 4^+
Binding Energy