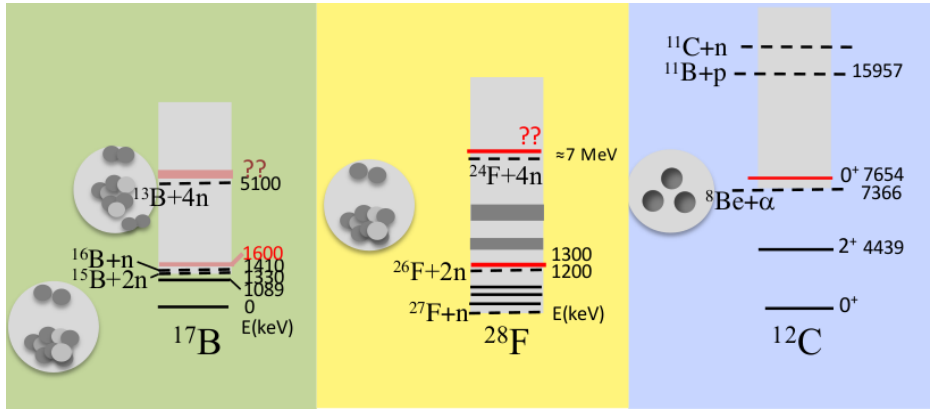
STATUS OF THE S509 EXPERIMENT

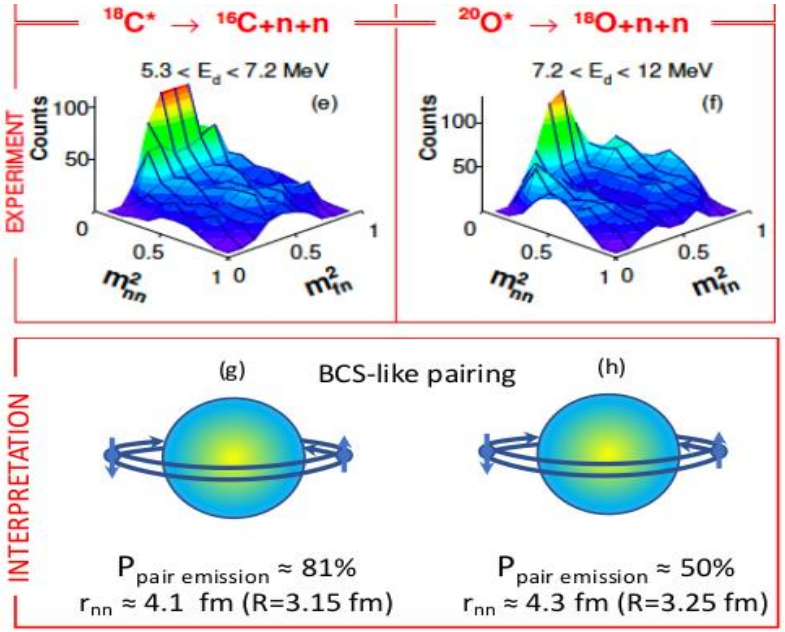
Spokesperson :
O. Sorlin

PhD students involved
(for future data analysis):
Barrière Antoine,
Mozumdar Nikhil,
Fernandez Ruiz Daniel,
...

I) Motivations to use (p,pn), (p,2p) and (p,pα) QFS reaction

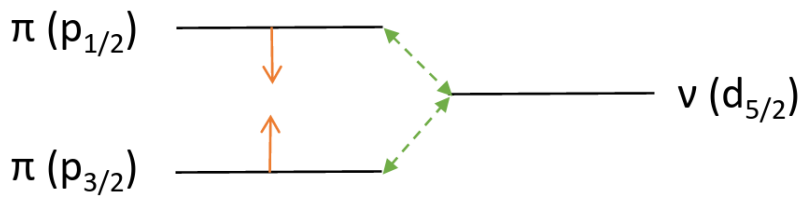
- Generalized Ikeda conjecture on multi-neutron clusters (2n, 4n) : the search for narrow resonances near the S_{2n} and S_{4n}.





- Multi-neutron correlations (2n, 3n, 4n):
  - size of the clusters (FSI model required),
  - evolution of the direct/sequential decays ratio,
  - the corresponding spectroscopy.

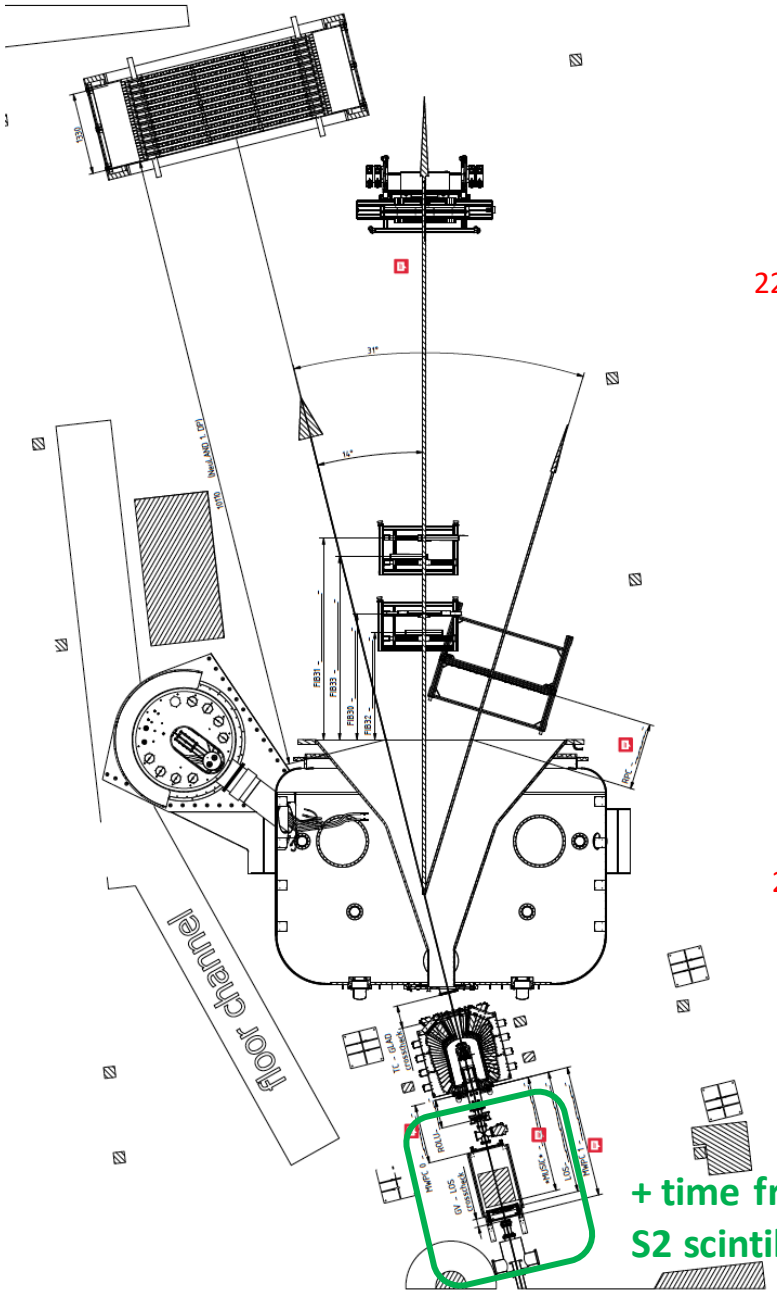
- Shell evolution:
  - influence of the tensor force on the SO splitting (filling of $d_{5/2}$)
    -> ^{21}N(p,2p)^{20}C , ^{19}N(p,2p)^{18}C, ^{22}O(p,pn)^{21}O;
  - p-n interaction near island of inversion -> ^{15}B(p,pn)^{14}B.



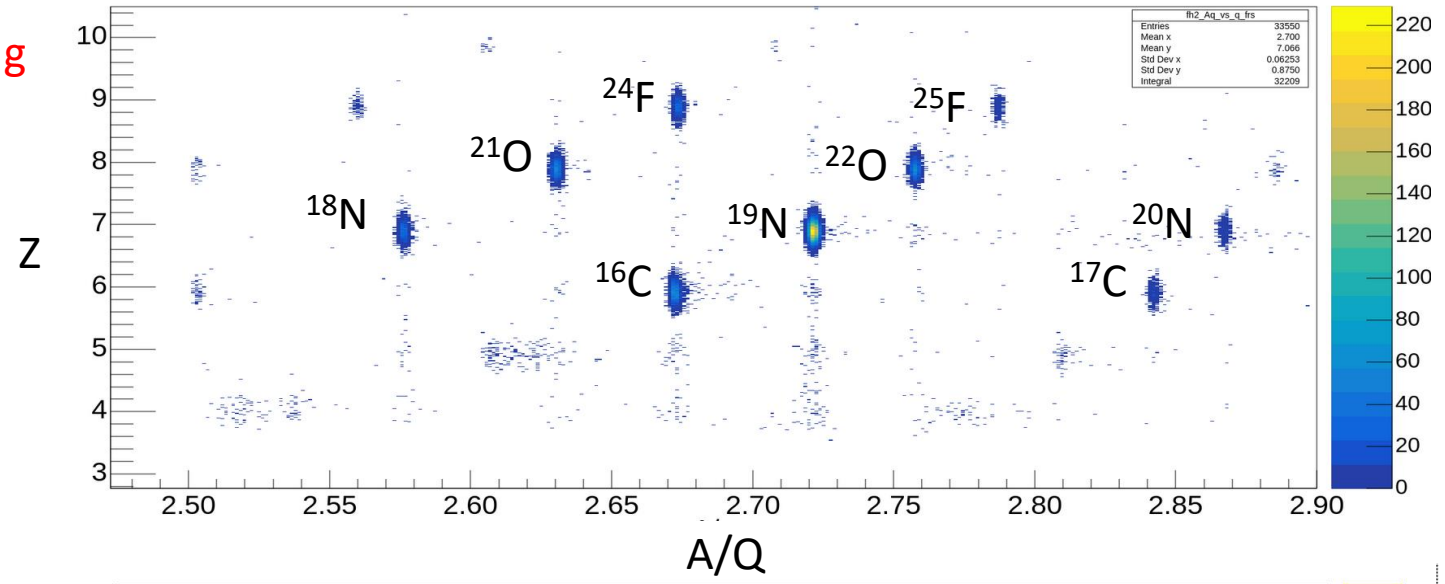
II) Incoming PID

SIS : ^{40}Ar@600MeV/A was sent on Be target

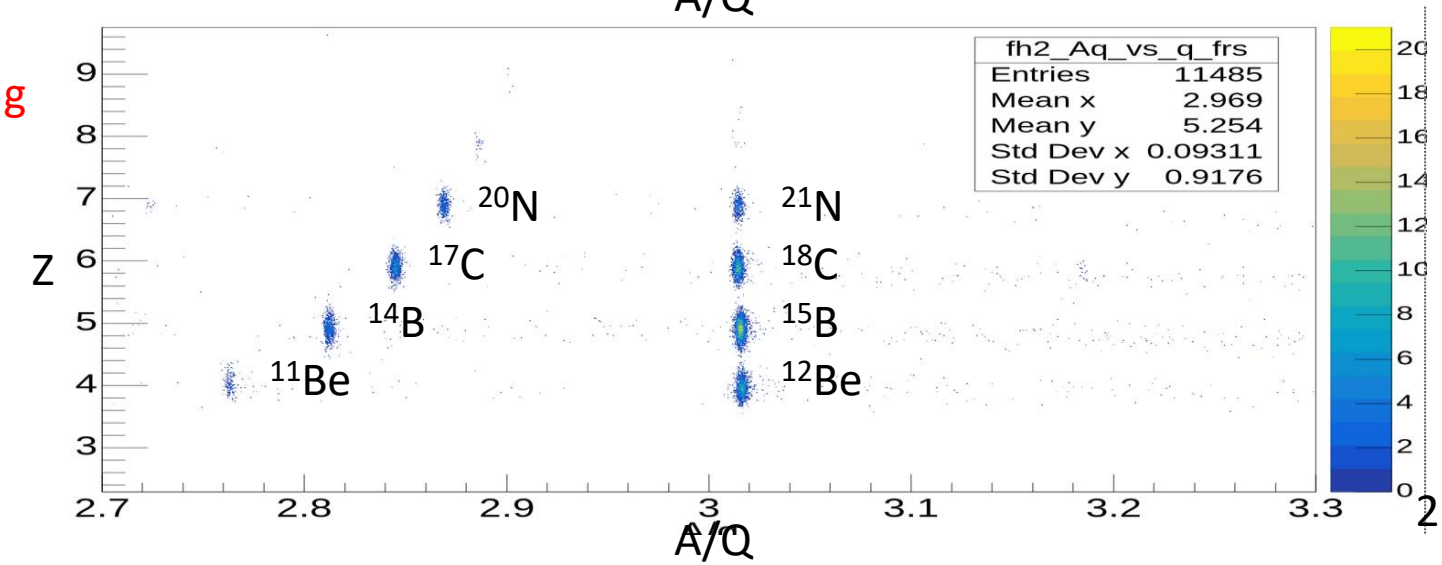
FRS : 2 settings for cockail beam were used with ~ 530 MeV/A in Cave C



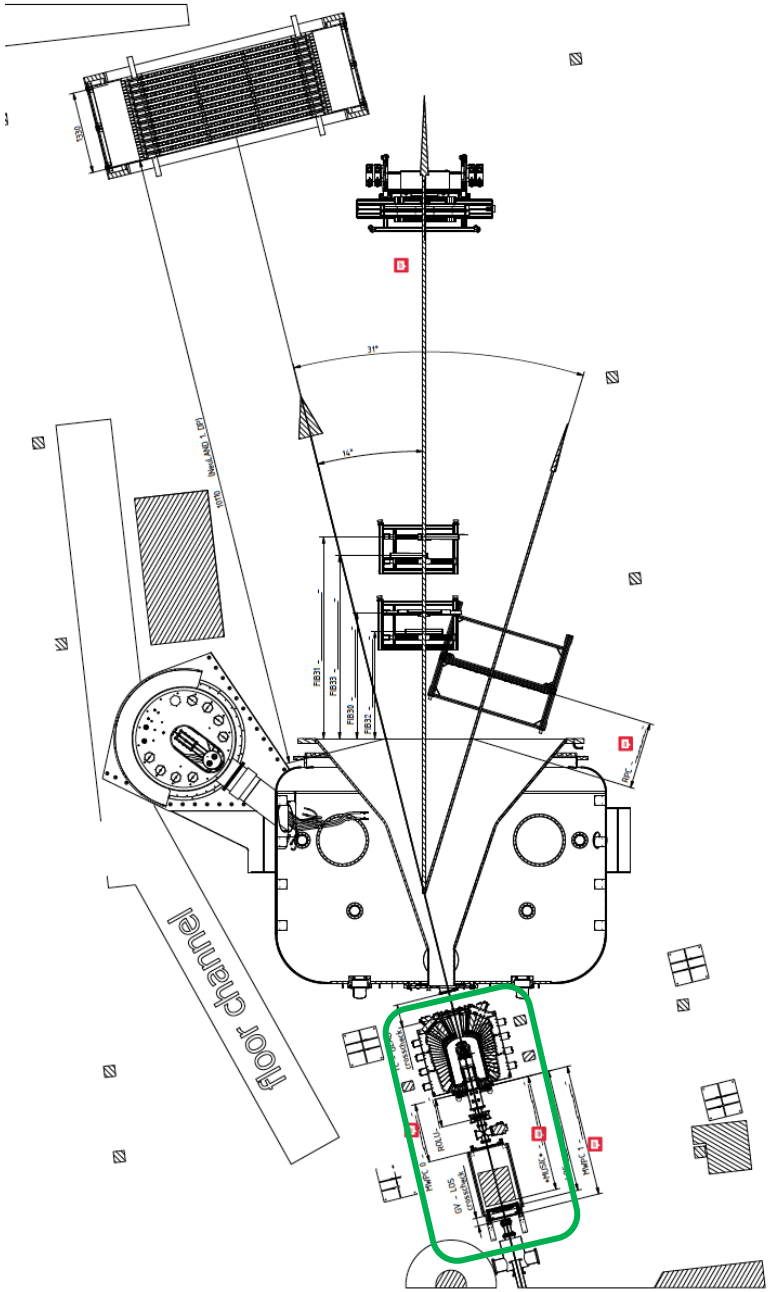
^{22}O-^{19}N setting
~ 1 kHz
10 shifts

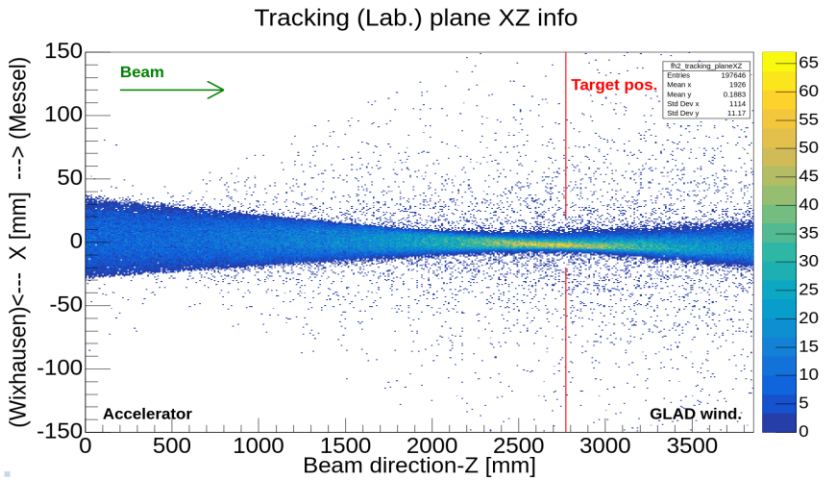


^{21}N-^{18}C setting
~ 1.8 kHz
6 shifts

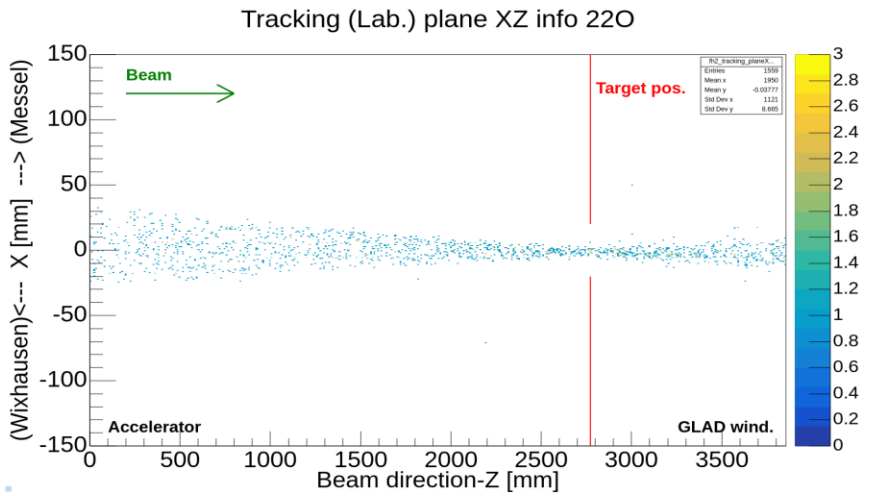


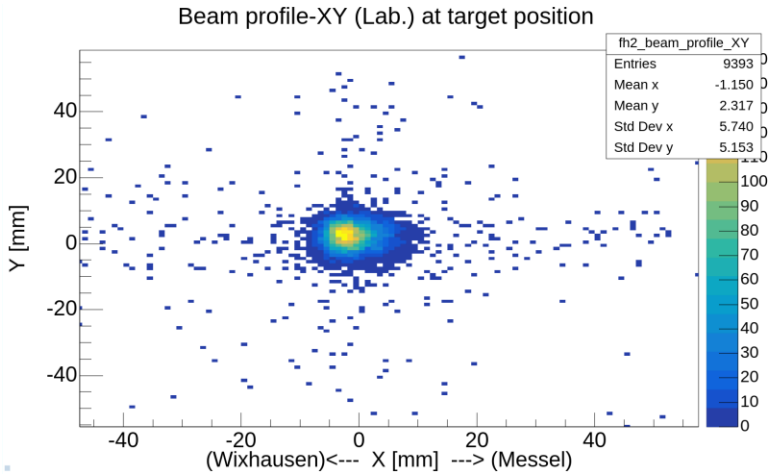
III) Tracking before the target

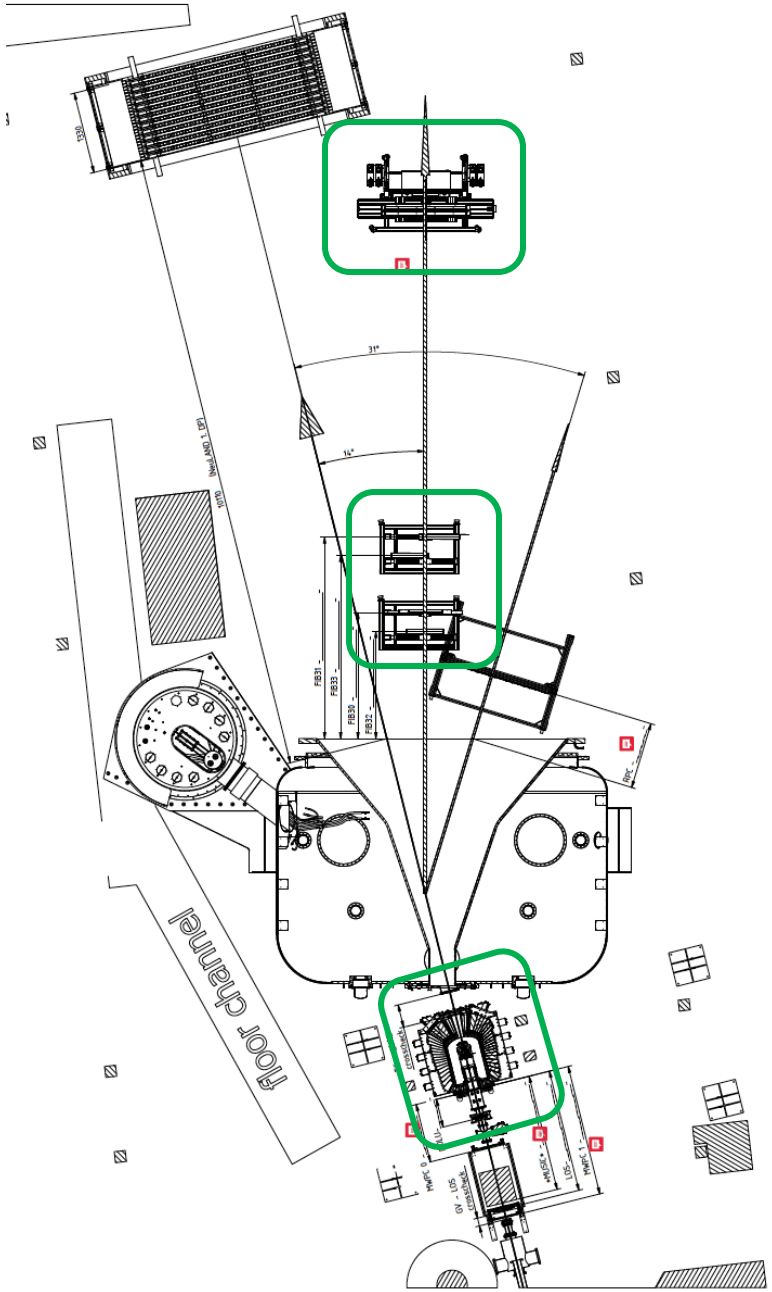




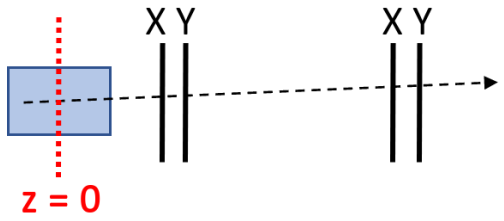
gated on ^{22}O incoming nuclei



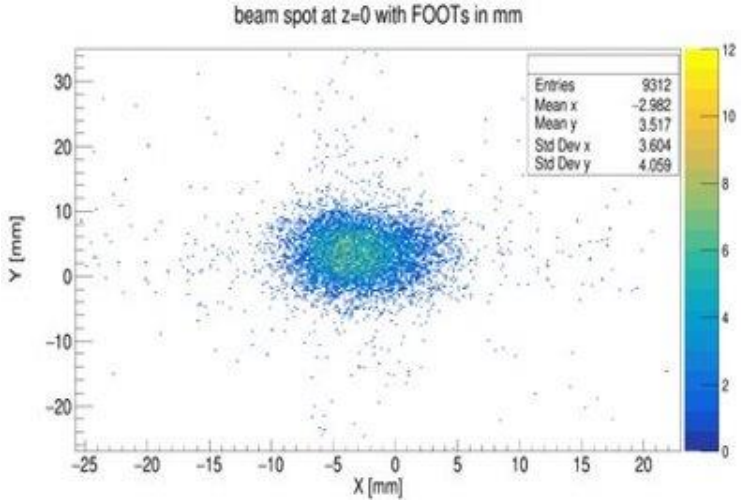


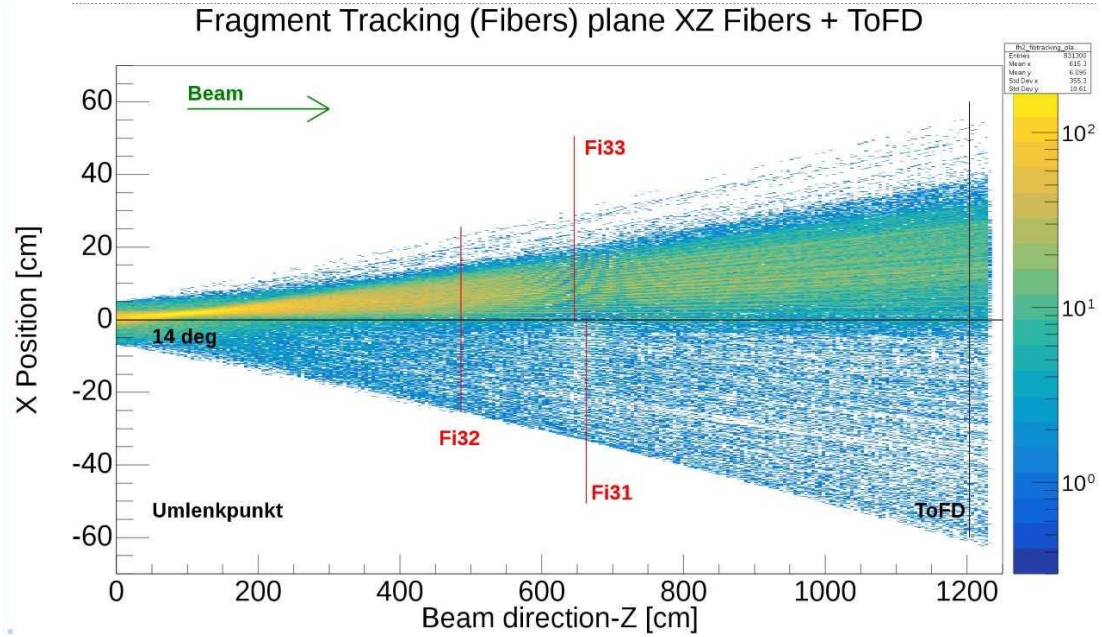


IV) Tracking after the target

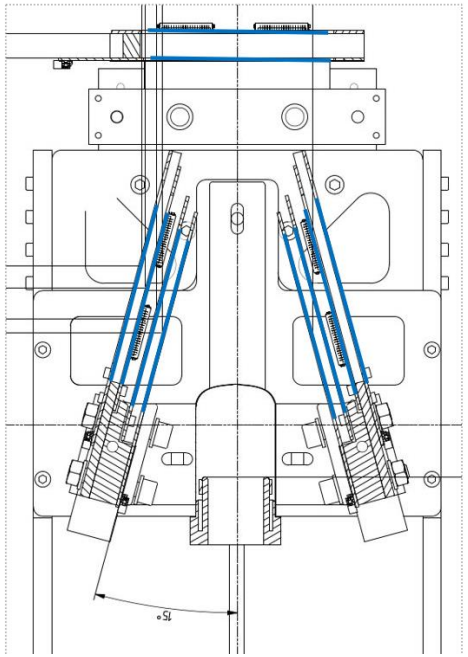


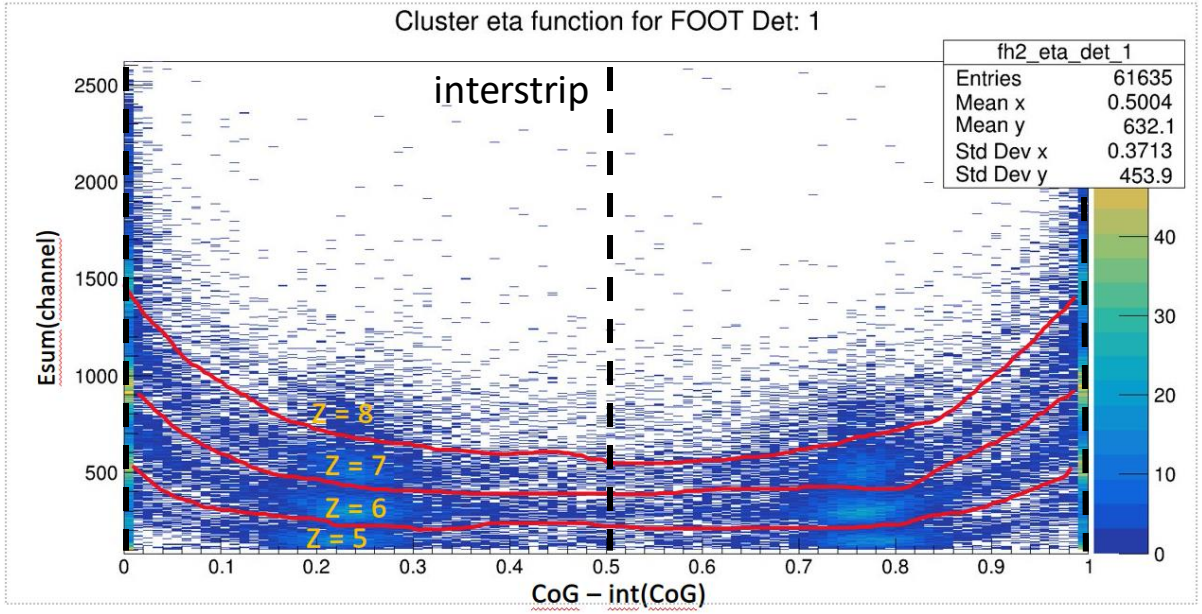
Using the 4 FOOTs in-beam



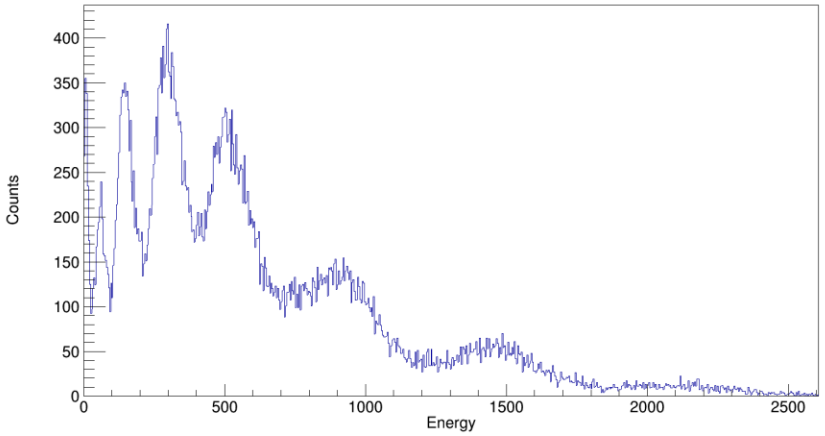


V) Charge identification with FOOTs

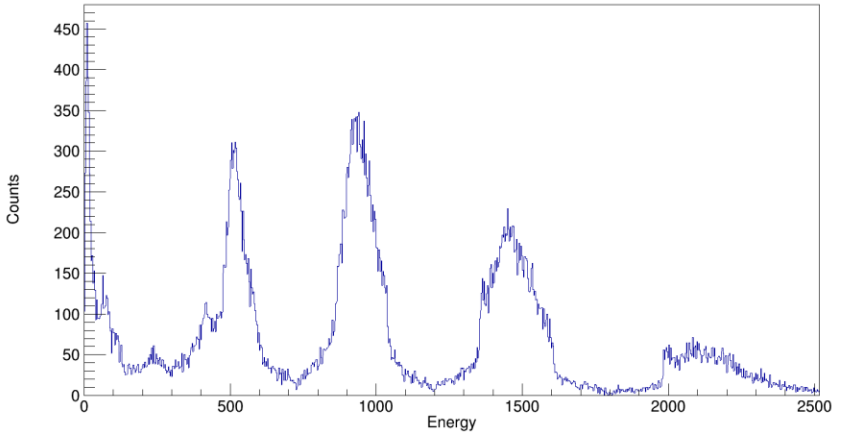


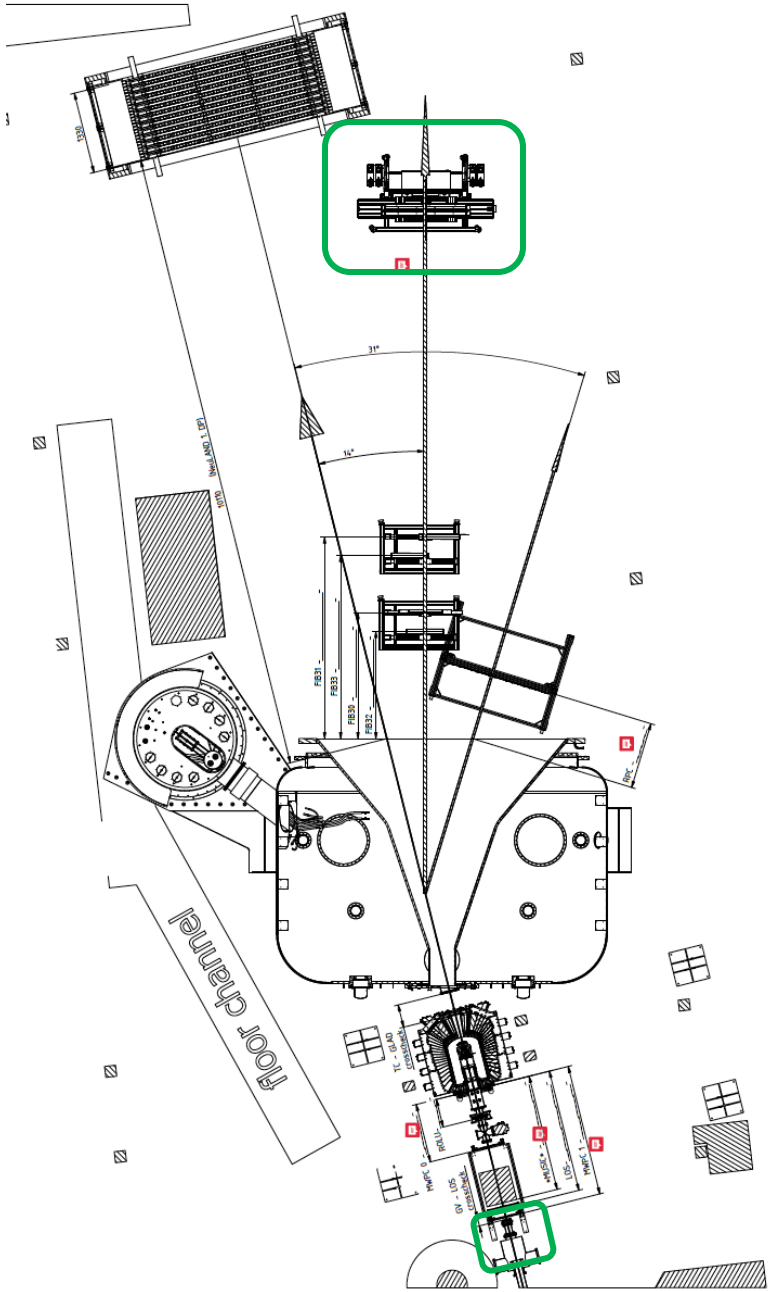


The collection of charges depends on the hit position on the width of the strip.

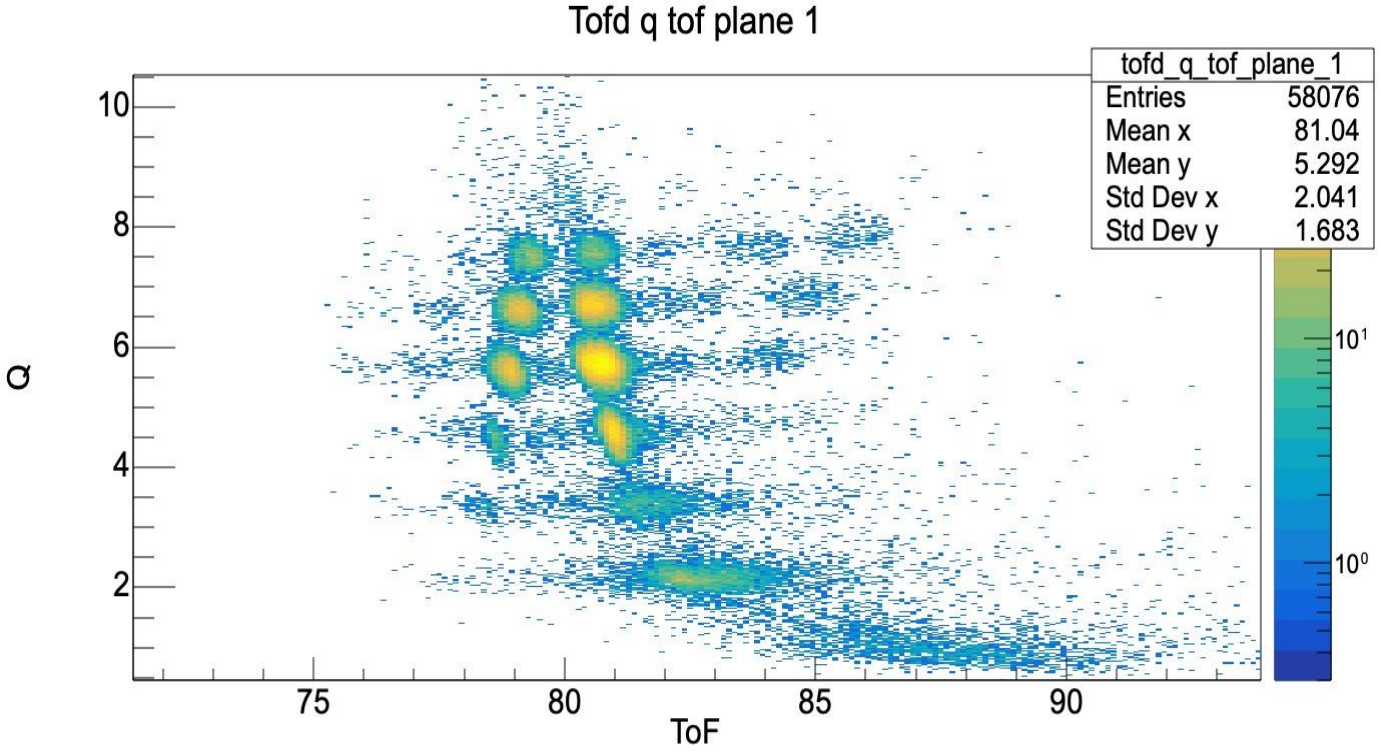


First attempt to correct this effect





VI) ToFD PID



Here for ^{21}N-^{18}C setting
Using dE(ToFD) - ToF(ToFD-LOS)

Incoming nucleus	Fragment	Reaction	Total incoming nuclei ($x10^6$)	Physical interest
^{11}Be	^{10}Be	(p,pn)	4.3	A
^{12}Be	^{8}He, ^{6}He + 2n, ^{4}He + 4n	(p,pα)	36.5	E
^{13}B	^{12}Be	(p,2p)	6.3	A
^{15}B	^{14}Be	(p,2p)	58.2	C , D
^{15}B	^{14}B	(p,pn)	58.2	B
^{18}C	^{17}B	(p,2p)	38.0	C , D
^{19}N	^{18}C	(p,2p)	113	B , C , D
^{21}N	^{20}C	(p,2p)	8.6	B , C , D
^{21}N	^{20}N	(p,pn)	8.6	B
^{22}O	^{21}N	(p,2p)	26.1	B , D
^{22}O	^{21}O	(p,pn)	26.1	B

A : Calibration

B : Shell evolution

C : Ikeda conjecture

D : Multi-neutron correlations

E : Clustering

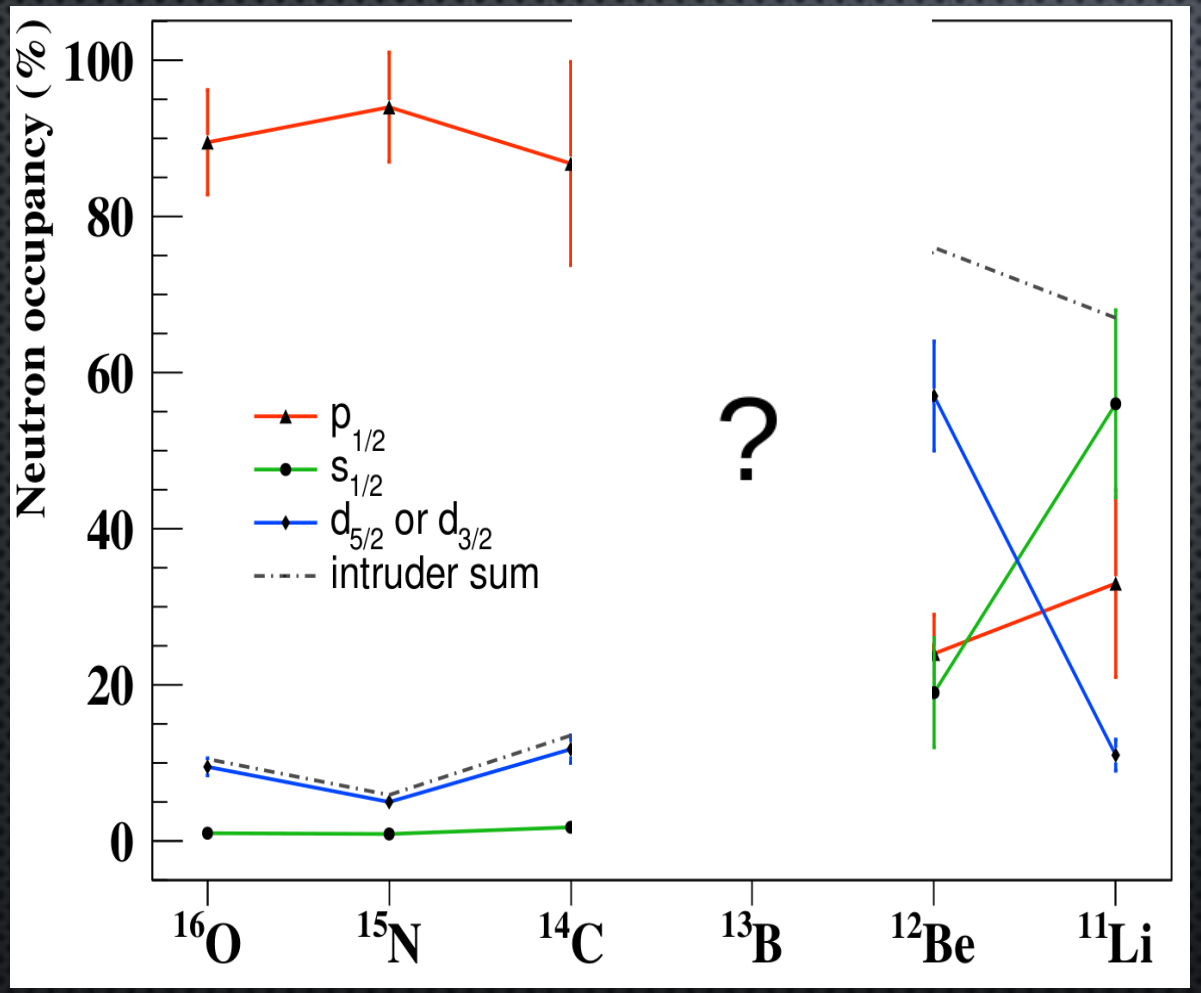
NEUTRON MAGICITY AT N = 8 PRESERVED IN ^{13}B

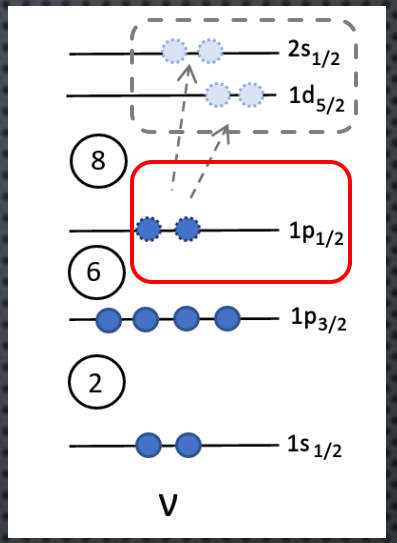
Article presented to the R3B Scientific Council

BARRIERE Antoine
Supervised by SORLIN Olivier

I) Context of this study

Review of the fractions of neutron occupancy for *psd*-shell in N=8 chain:





Intruder configuration

Normal configuration

Sources:

^{11}Li - A. Sanetullaev et al., Phys. Lett. B 755, 481 (2016)
- Yu. Aksyutina et al., Phys. Lett. B 718, 1309 (2013)

^{12}Be - J. Chen et al., Phys. Lett. B **781**, 412 (2018)
- R. Meharchand et al., Phys. Rev. Lett **108**, 122501(2012)

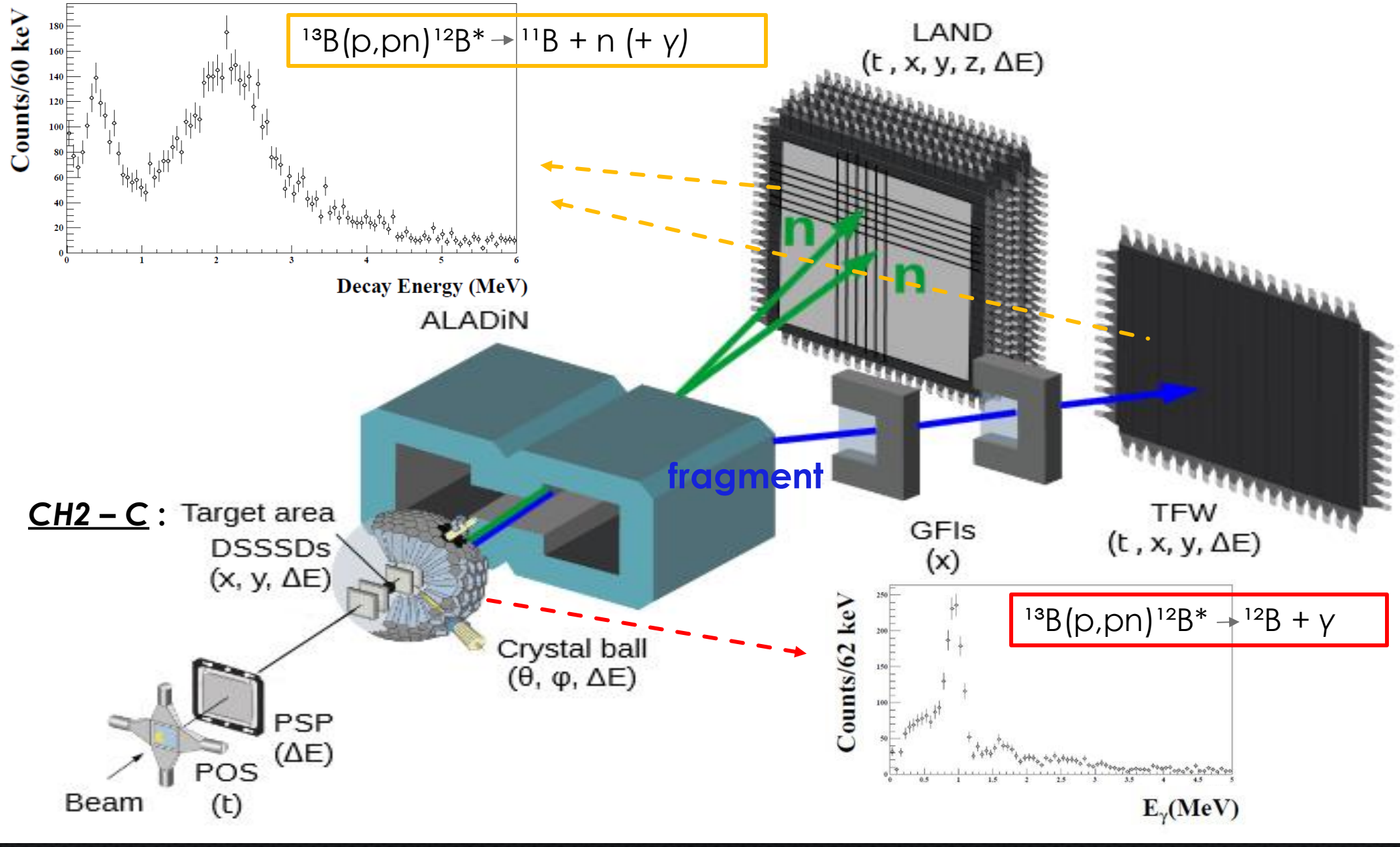
^{14}C - M. Yasue *et al.*, Nucl. Phys. A **509**, 141 (1990)

^{15}N - S. K. Saha et al., Phys. Rev. C **40**, 39 (1989)

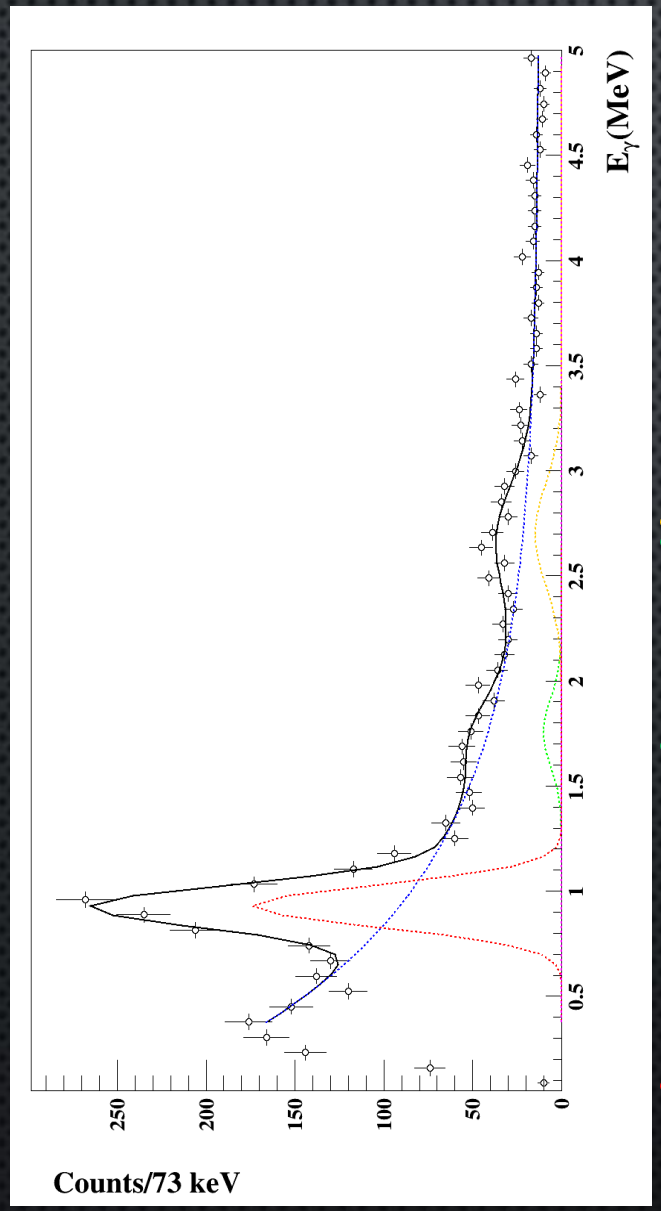
^{16}O - J. Snelgrove and E. Kashy, Phys. Rev. **187**, 1246 (1969)

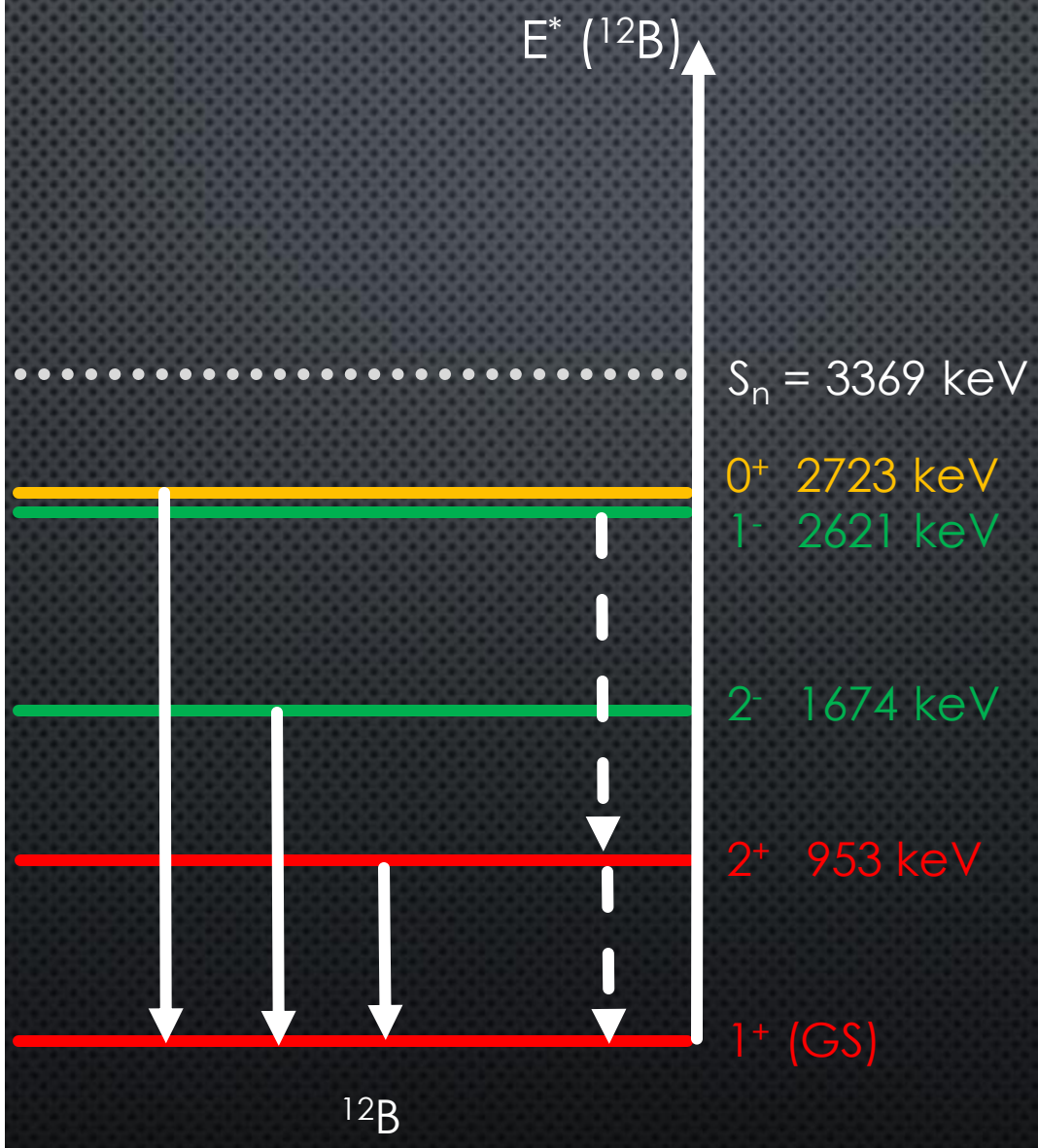
➡ Is magicity preserved in ^{13}B or already eroded ?

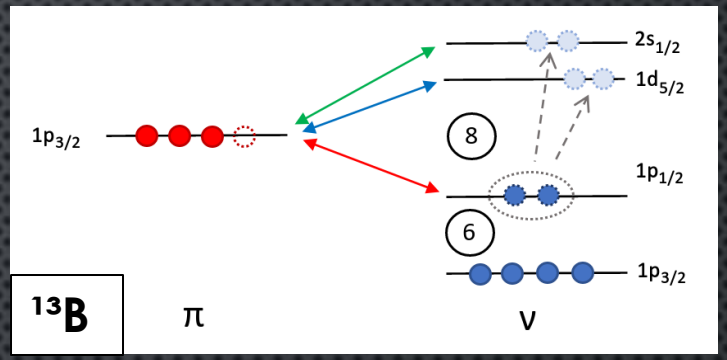
II) Experiment s393



III) Results







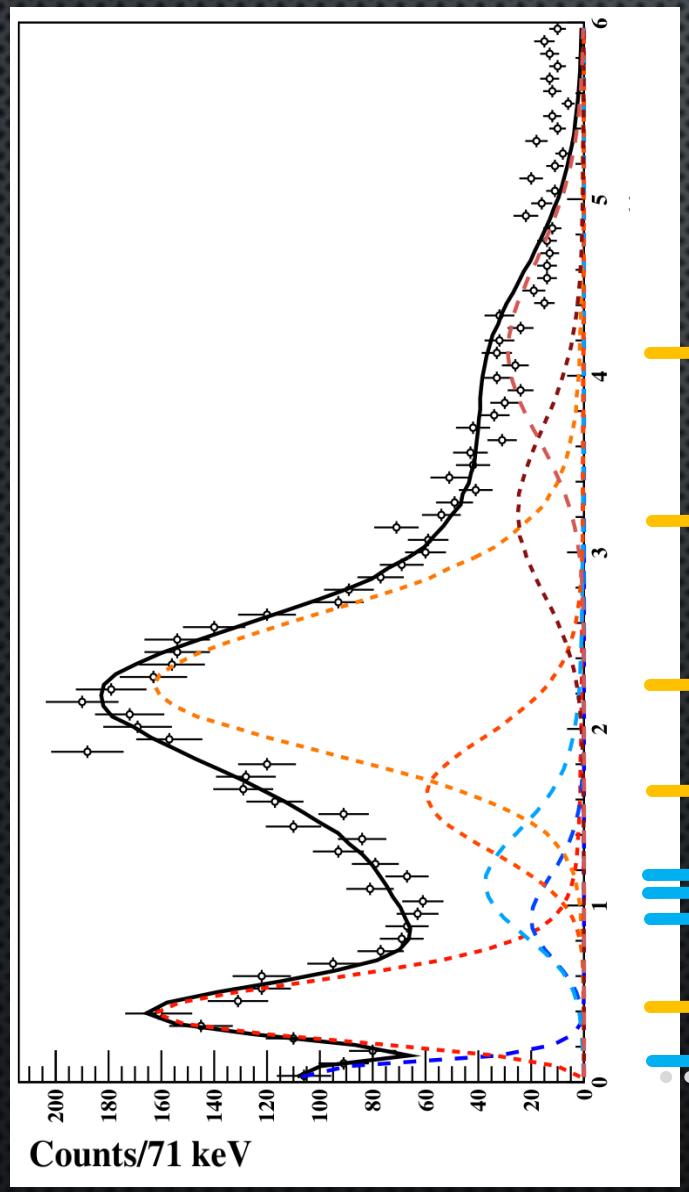
$\pi(1p_{3/2})\otimes\nu(1p_{3/2})$ -> $(0^+,1^+,2^+,3^+)$

$\pi(1p_{3/2})\otimes\nu(2s_{1/2})$ -> $(1^-,2^-)$

$\pi(1p_{3/2})\otimes\nu(1p_{1/2})$ -> $(1^+,2^+)$

The main contribution for the bound states is given by the **$1p_{1/2}$** orbital

III) Results



Er(^{11}B+1n)

? 4175 keV

1$^+$ 3230 keV

3$^+$ 2240 keV

1$^+$ 1620 keV

4$^-$ 1153 keV

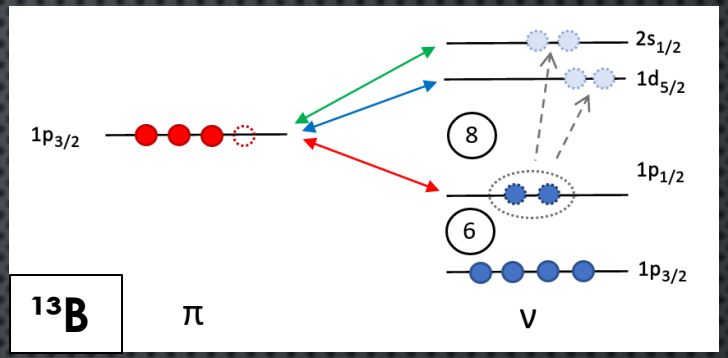
2$^-$ 1090 keV

1$^-$ 932 keV

2$^+$ 390 keV

3$^-$ 20 keV

^{12}B



$\pi(1p_{3/2})\otimes\nu(1p_{3/2})$ $\longrightarrow$ $(0^+,1^+,2^+,3^+)$

$\pi(1p_{3/2})\otimes\nu(1d_{5/2})$ $\longrightarrow$ $(1^-,2^-,3^-,4^-)$

The main contribution for the unbound states comes from the $1p_{3/2}$ orbital

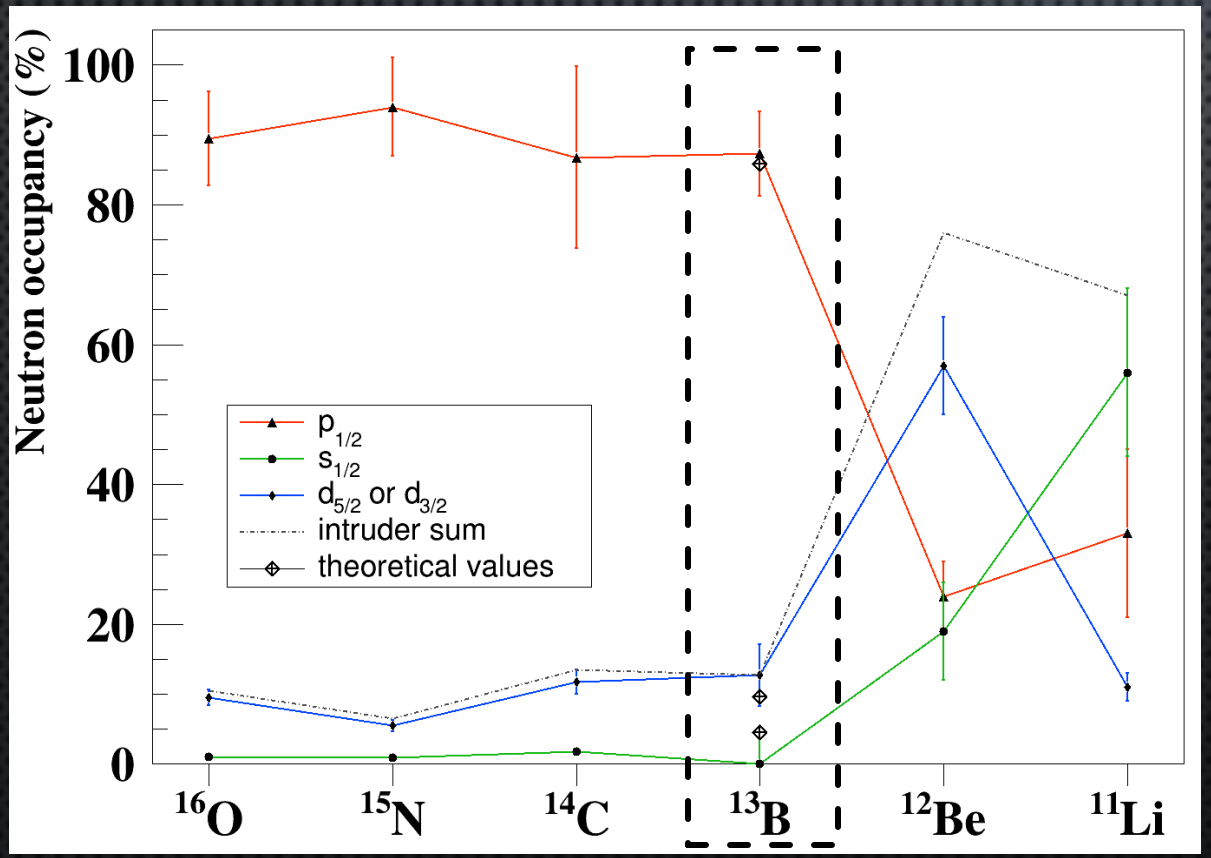
Cross section of multiplet coming from **$1d_{5/2}$** ~ 15% of the one from **$1p_{1/2}$**

IV) Spectroscopic Factors and ^{13}B magicity

Eikonal approach was used to calculate theoretical cross-sections (C.Bertulani).

$$C^2S_{exp} = \frac{\sigma_{exp}}{\sigma_{theo}}$$

These values are then compared to the experimental ones to determine the corresponding C^2S values.



$1p_{1/2}$: 88.1(59)%
$2s_{1/2}$: <4.6% (1 sigma)
$1d_{5/2}$: 11.9(45)%

The magicity of N=8 is remarkably preserved in the ^{13}B nucleus

In good agreement with:

- Shell Model calculations of Cenxi Yuan;

- the experimental results from ^{13}B(p,d)^{12}B reaction (W. Liu *et al.* Phys. Rev. C 104, 064605 , 2021) :

$1p_{1/2}$: 83(6)% **$2s_{1/2}$: 5(2)%** **$1d_{5/2}$: 12(2)%**

To be followed ...

^{13}B(p,2p)^{12}Be to search for spherical stats in ^{12}Be,
this nucleus having a deformed ground state