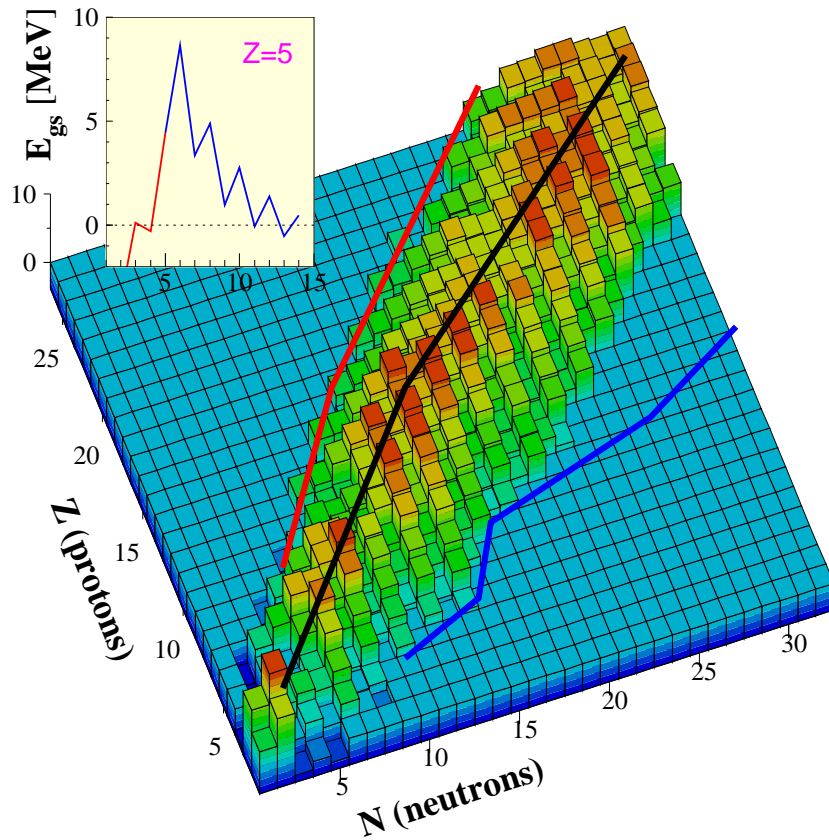


ARIS 2014

Advances in Radioactive Isotope Science

June 1-6, 2014, Tokyo (Japan)

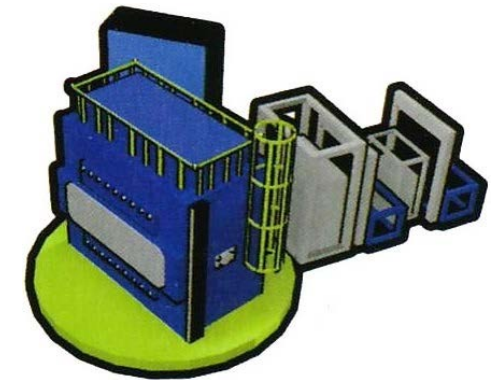


Structure beyond the dripline in the Boron isotopes : $16,18,20,21\text{B}$

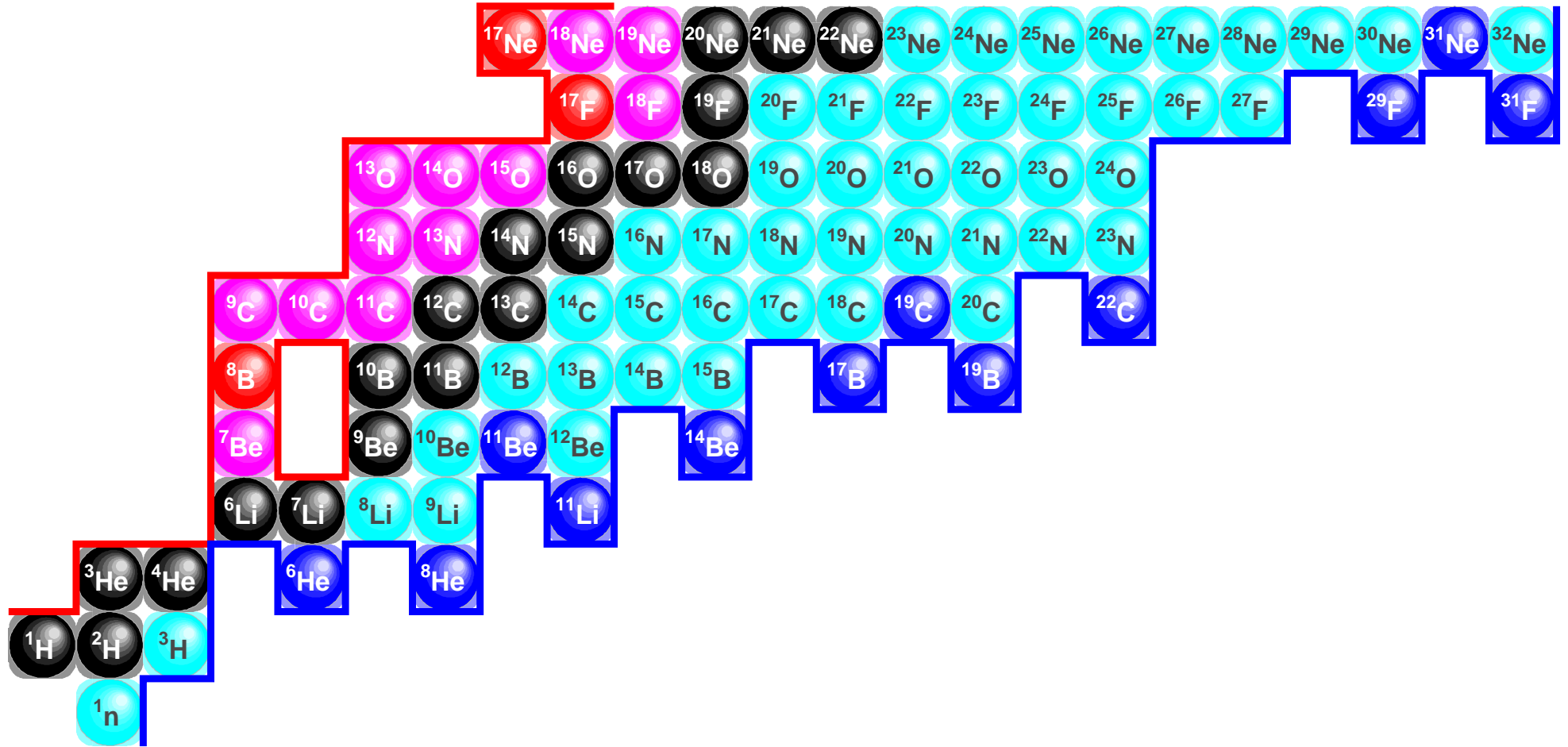
F. Miguel Marqués

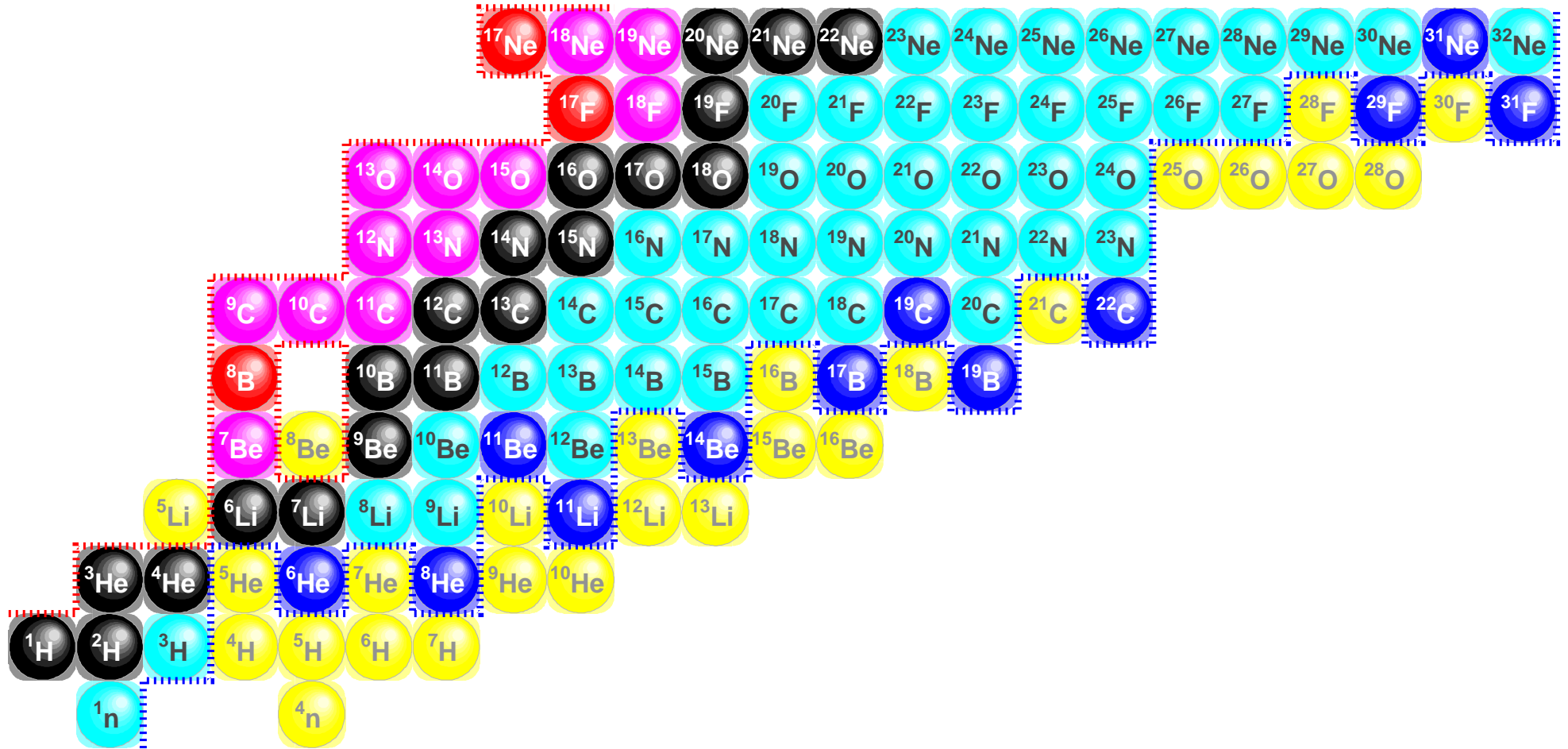


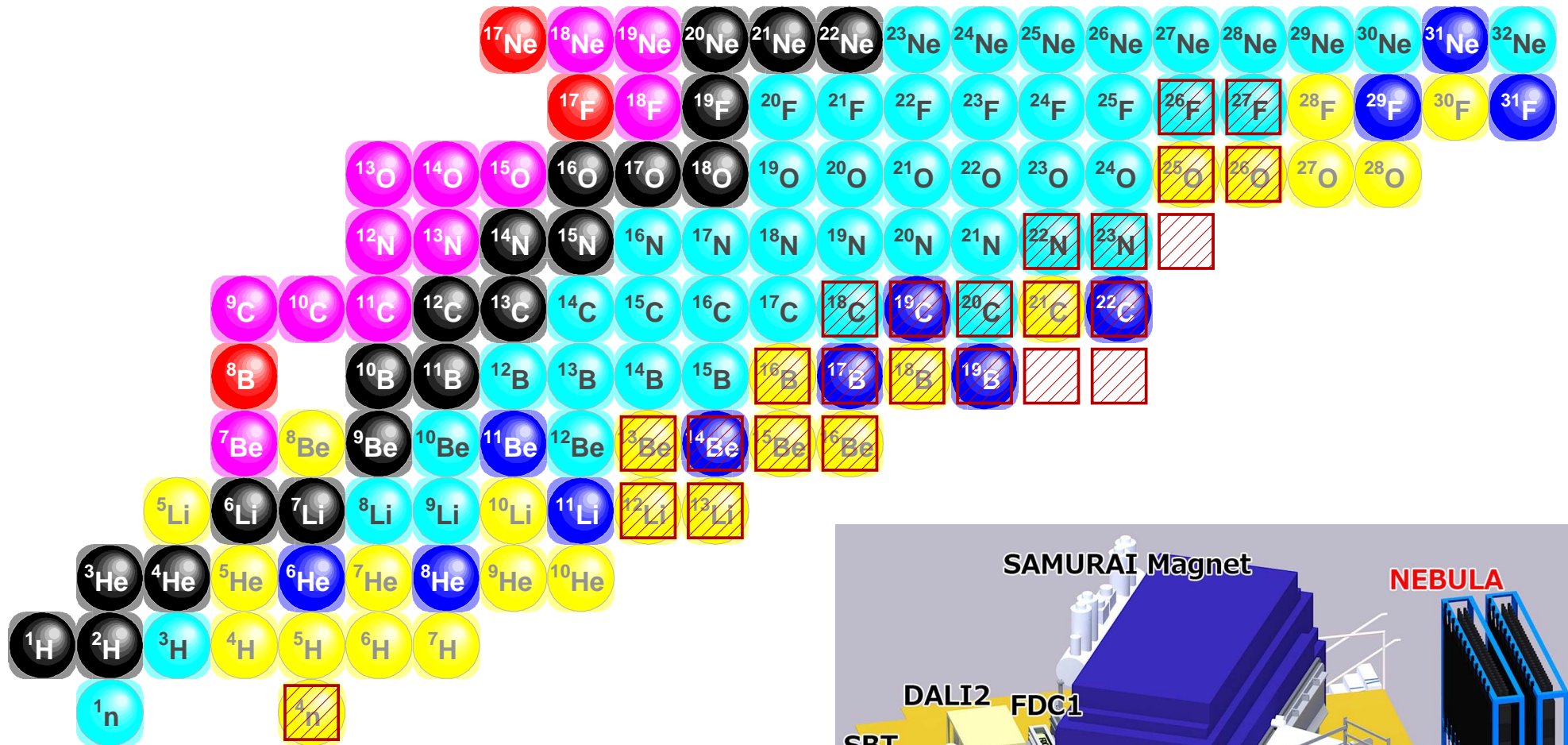
S. Leblond¹, J. Gibelin¹, N.A. Orr¹, S. Ogoshi², R. Minakata², Y. Kondo², T. Nakamura²,
R. Tanaka², N.L. Achouri¹, T. Aumann³, H. Baba⁴, F. Delaunay¹, P. Doornenbal⁴, N. Fukuda⁴,
J.W. Hwang⁵, N. Inabe⁴, T. Isobe⁴, D. Kameda⁴, D. Kanno², S. Kim⁵, N. Kobayashi²,
T. Kobayashi⁶, T. Kubo⁴, J. Lee⁴, T. Motobayashi⁴, D. Murai⁷, T. Murakami⁸, K. Muto⁶,
N. Nakatsuka⁸, T. Nakashima², A. Navin⁹, S. Nishi², H. Otsu⁴, H. Sato⁴, Y. Satou⁵,
Y. Shimizu⁴, H. Suzuki⁴, K. Takahashi⁶, H. Takeda⁴, S. Takeuchi⁴, Y. Togano¹⁰, A.G. Tuff¹¹,
M. Vandebrouck¹², K. Yoneda⁴



¹LPC-Caen, ²Tokyo Institute of Technology, ³Technische Universität Darmstadt, ⁴RIKEN, ⁵Seoul National University,
⁶Tohoku University, ⁷Rikkyo University, ⁸Kyoto University, ⁹GANIL, ¹⁰GSI, ¹¹University of York, ¹²IPN-Orsay

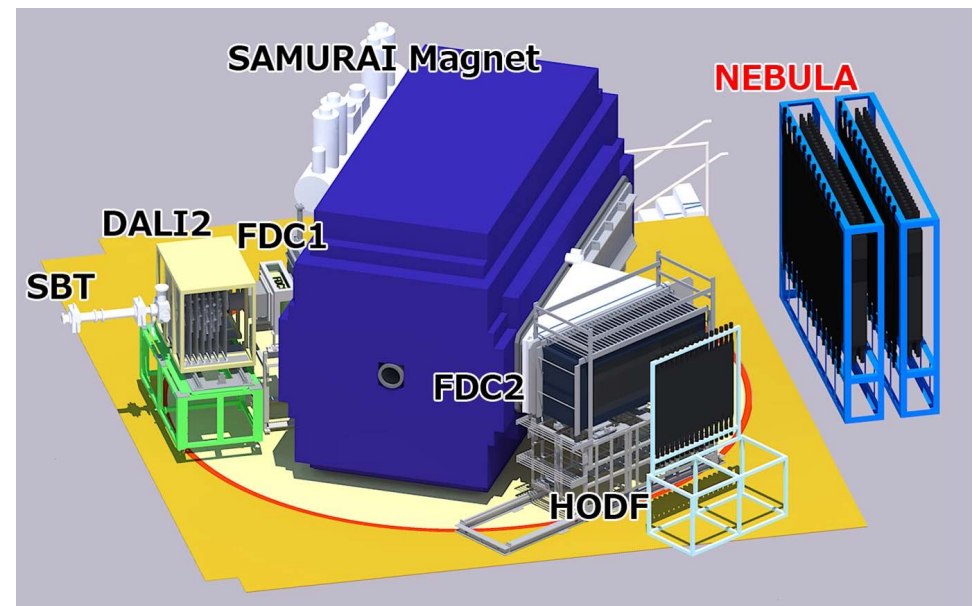


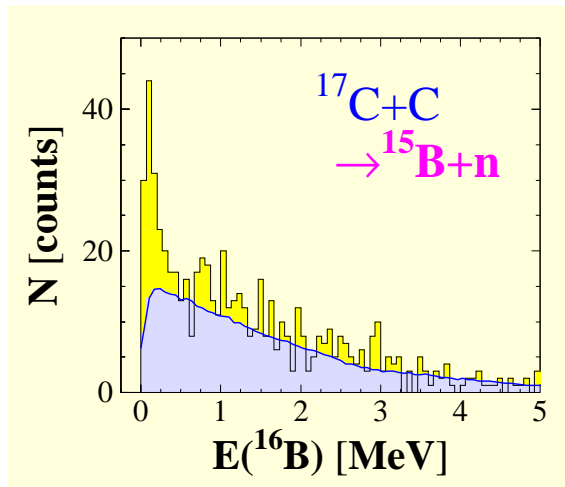
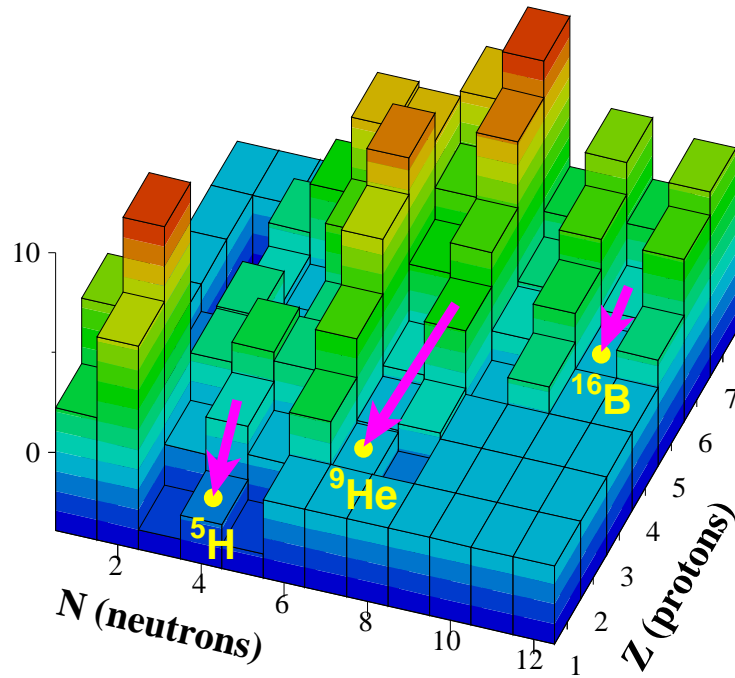




RIKEN+NEBULA

- correlations
- unbound systems
- multi-neutrons





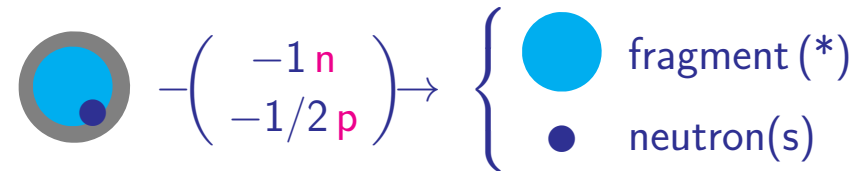
[Lecouey et al, PLB 672 (2009) 6]

- Shell evolution **around** the limits !
- Three-body systems (interactions) :

$${}^{17}\text{B} ({}^{15}\text{B-n-n}) \equiv {}^{16}\text{B} \otimes 2n$$

$${}^{19}\text{B} ({}^{17}\text{B-n-n}) \equiv {}^{18}\text{B} \otimes 2n$$

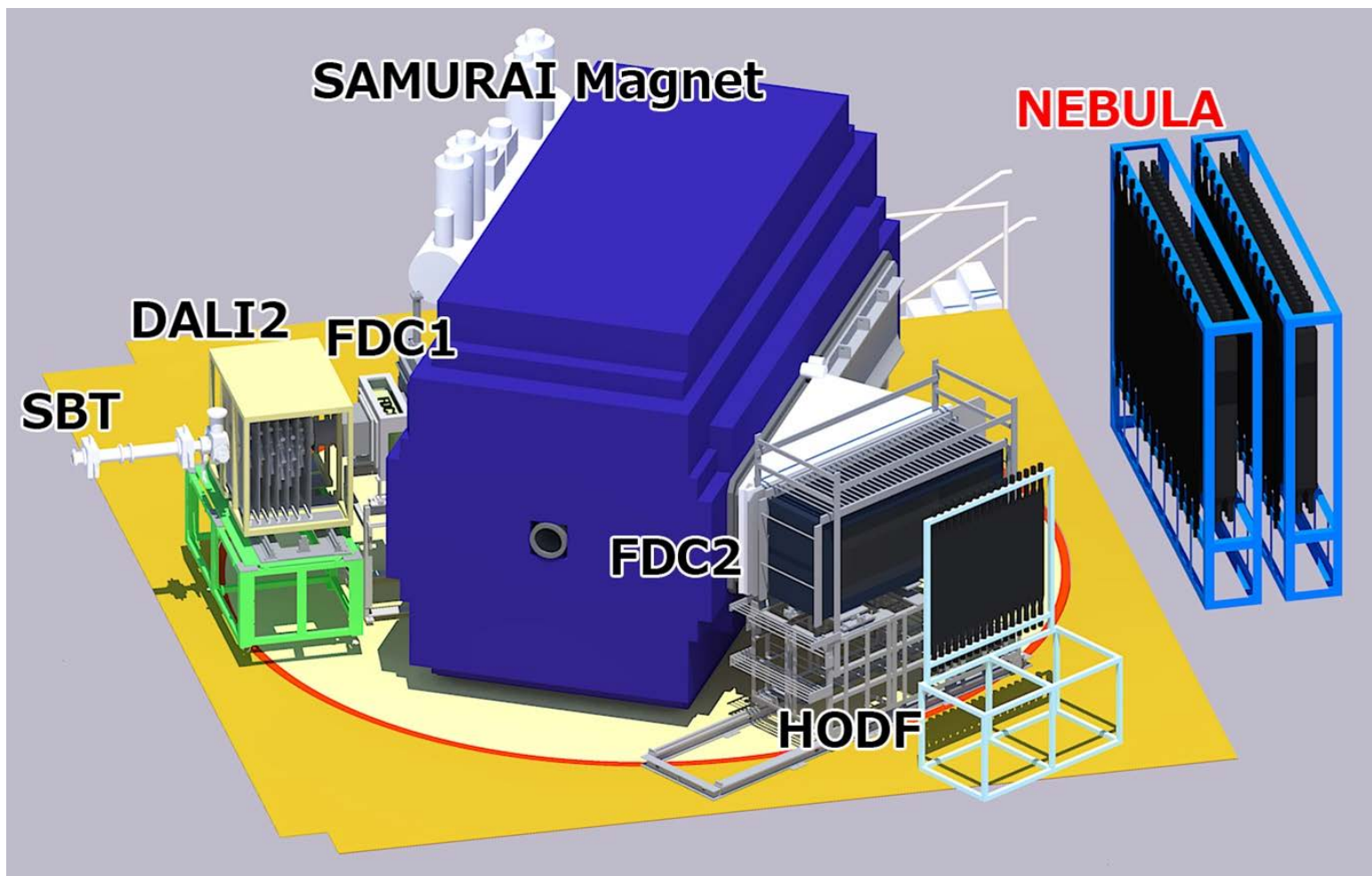
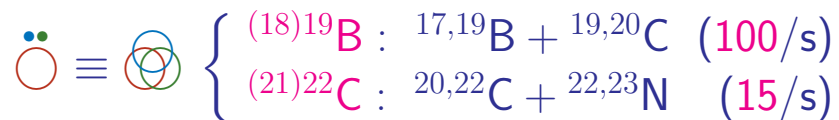
- Knock out from the dripline :



- fragment (γ) + neutrons : E_{rel}
- direct, fast reactions : **resonances** (J^π) \subset ●
- non-resonant distribution : event mixing (N_\otimes)

[FMM, PLB 476 (2000) 219]

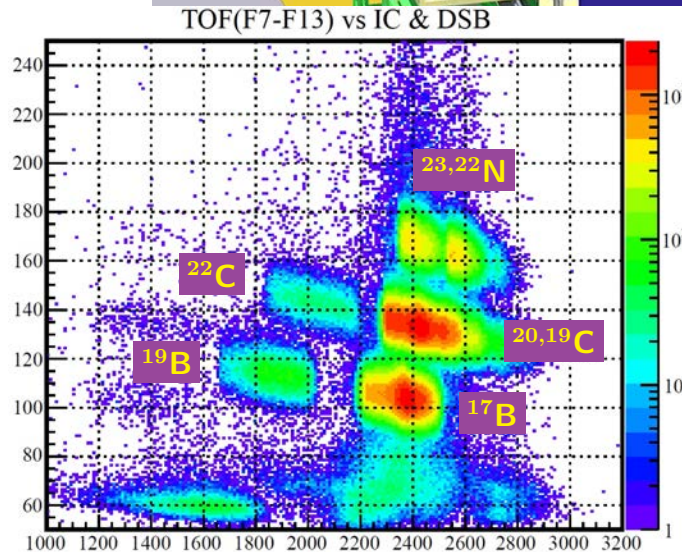
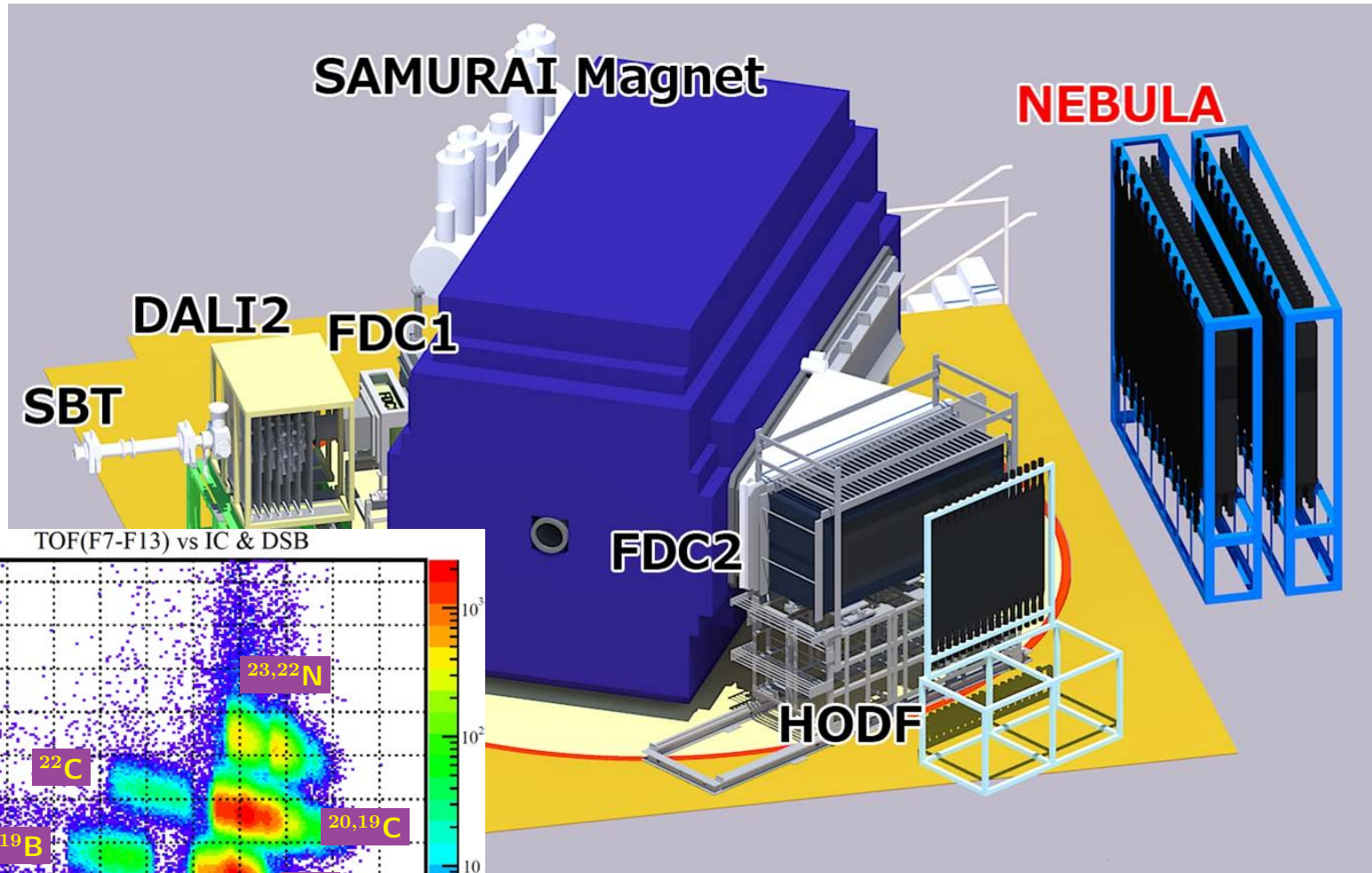
- The structure of Boron 19 & Carbon 22 :



- The search for Oxygen 26

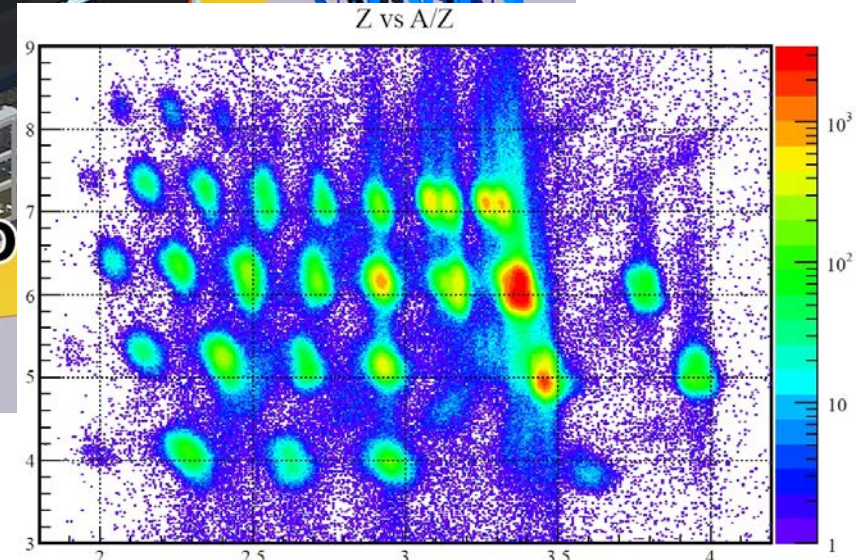
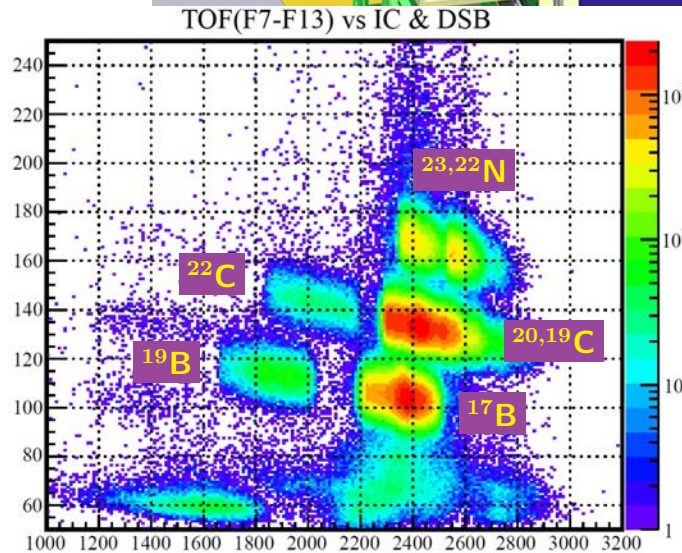
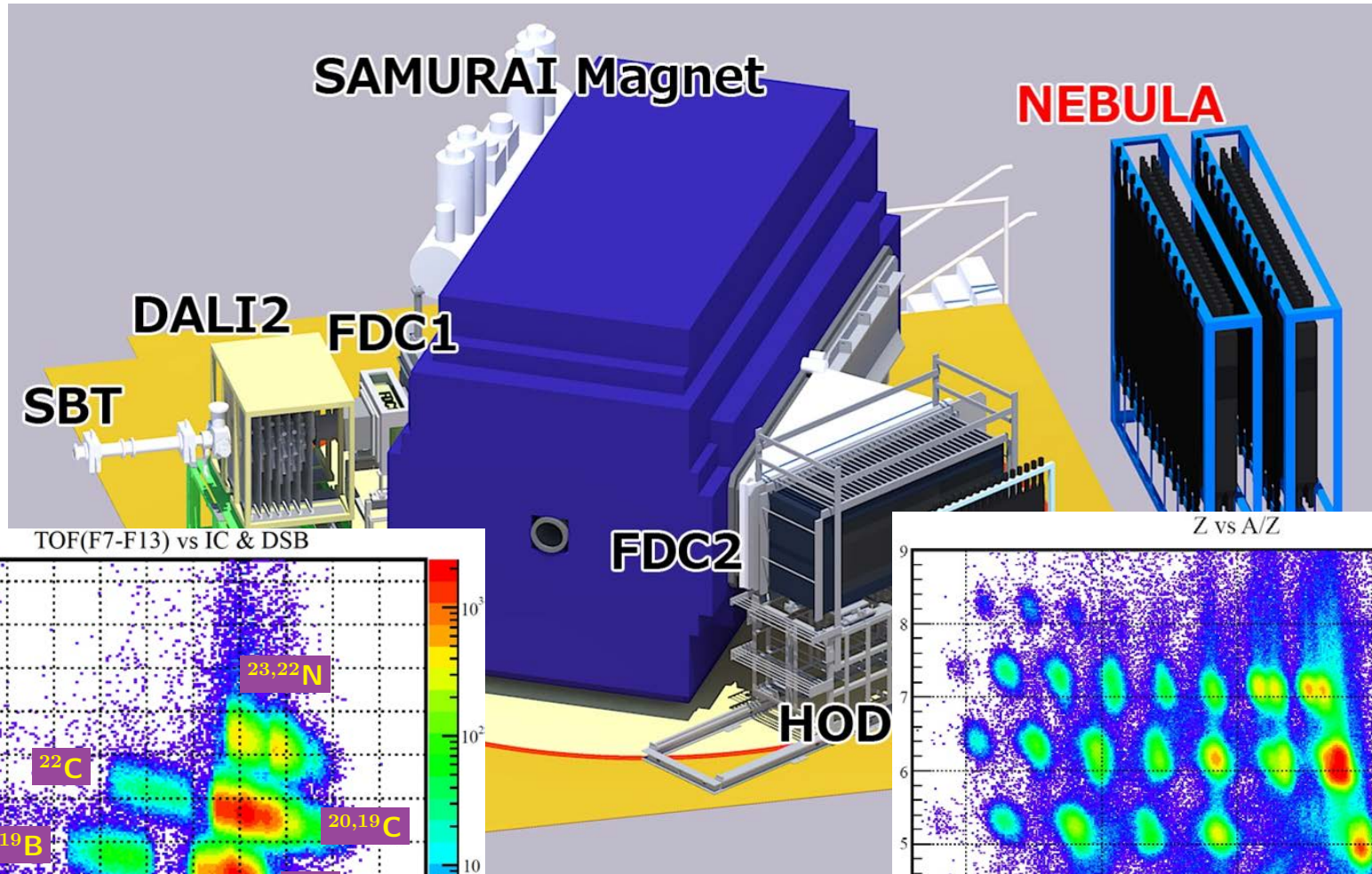
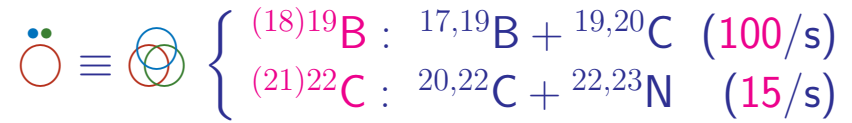
Kondo, June 3

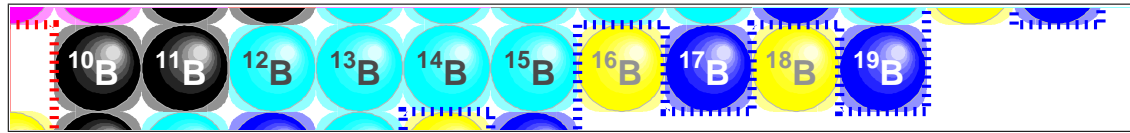
- The structure of Boron 19 & Carbon 22 :



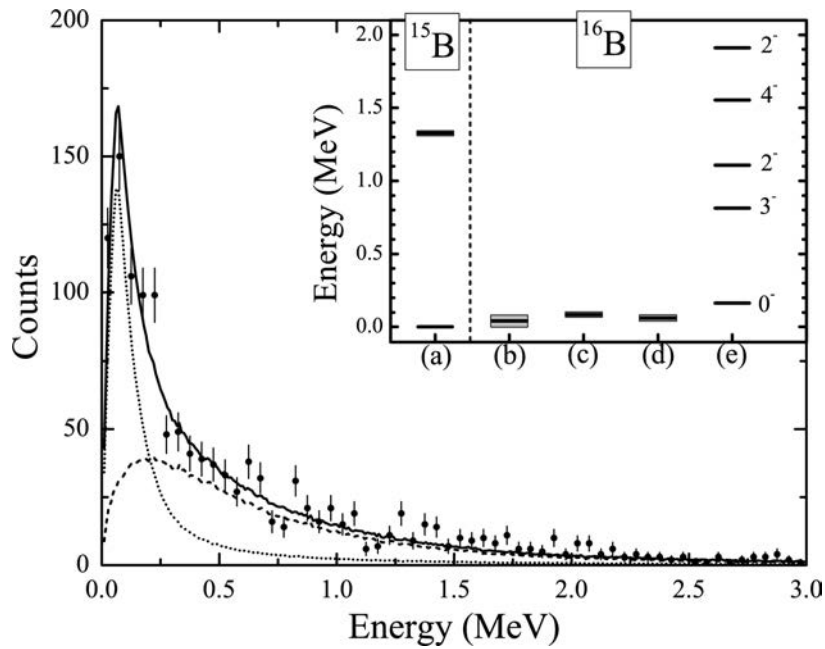
Kondo, June 3

- The structure of Boron 19 & Carbon 22 :

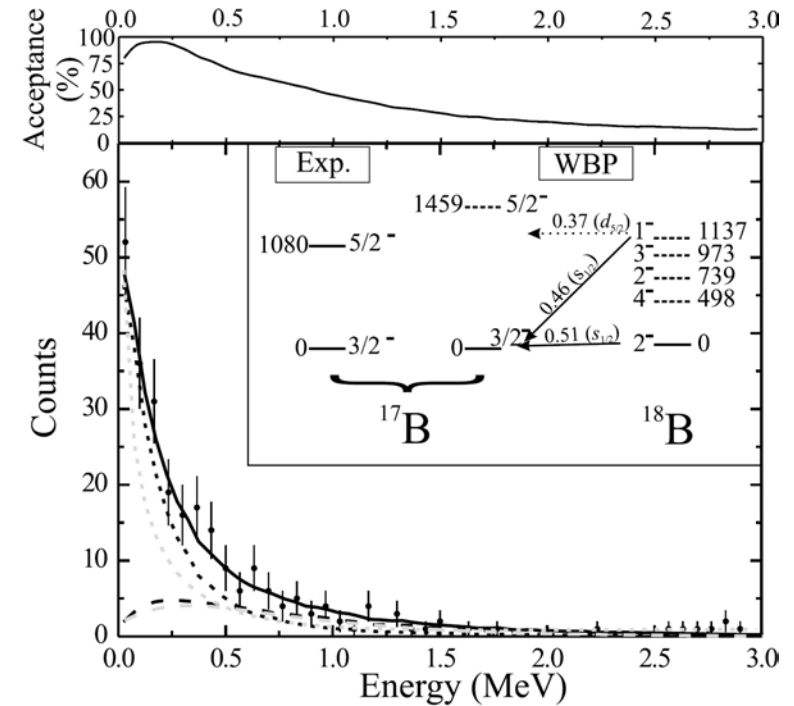




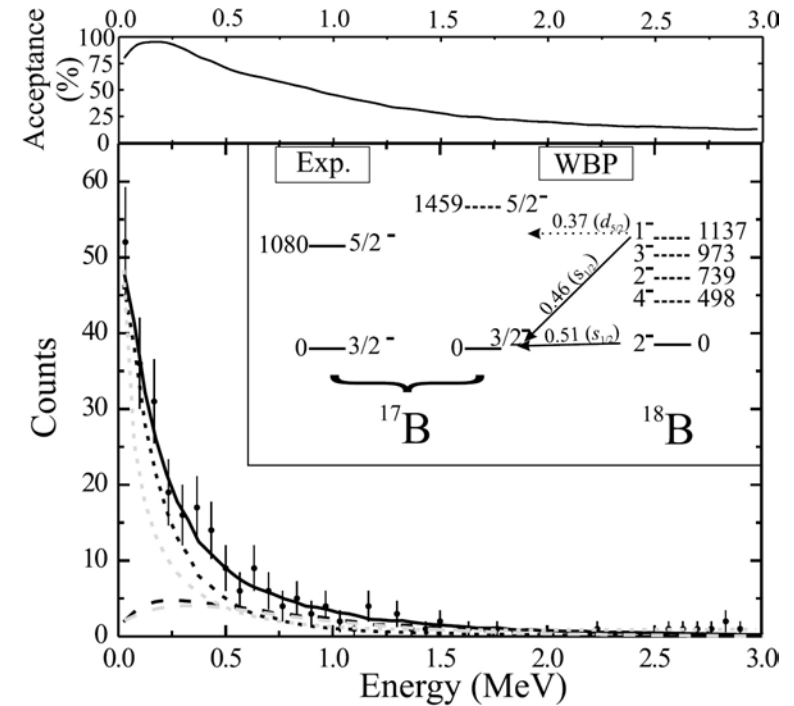
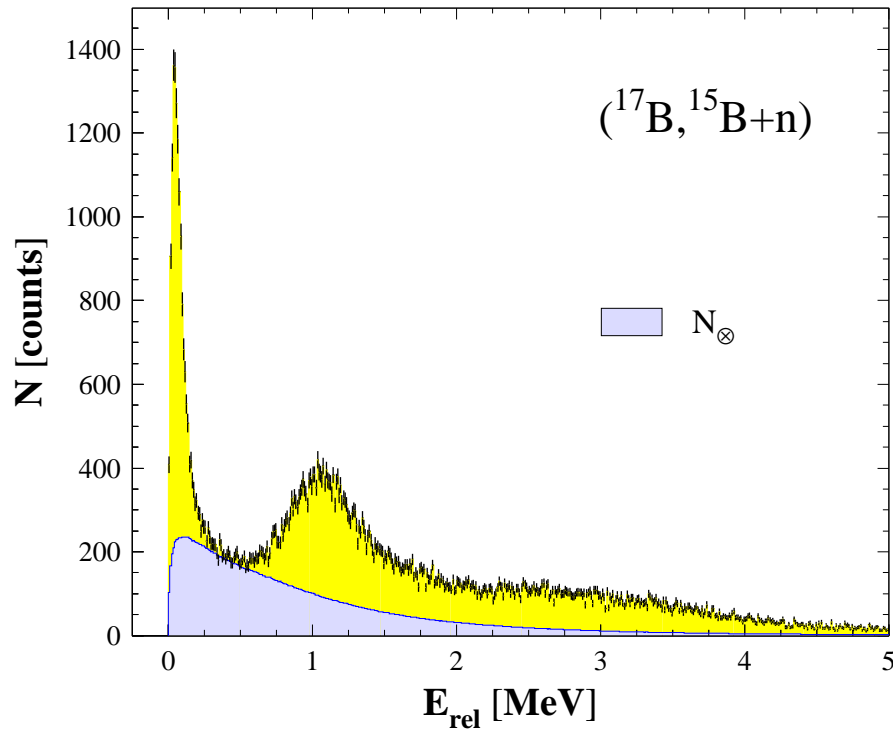
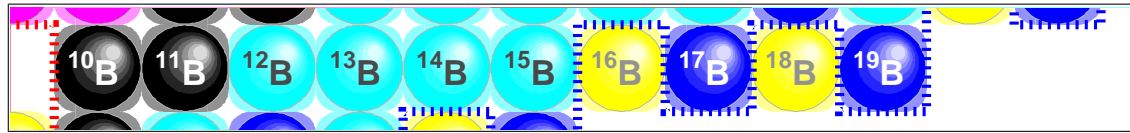
[Spyrou et al, PLB 683 (2010) 129]



- Maxwellian + $E_{gs} = 60 \pm 20$ keV

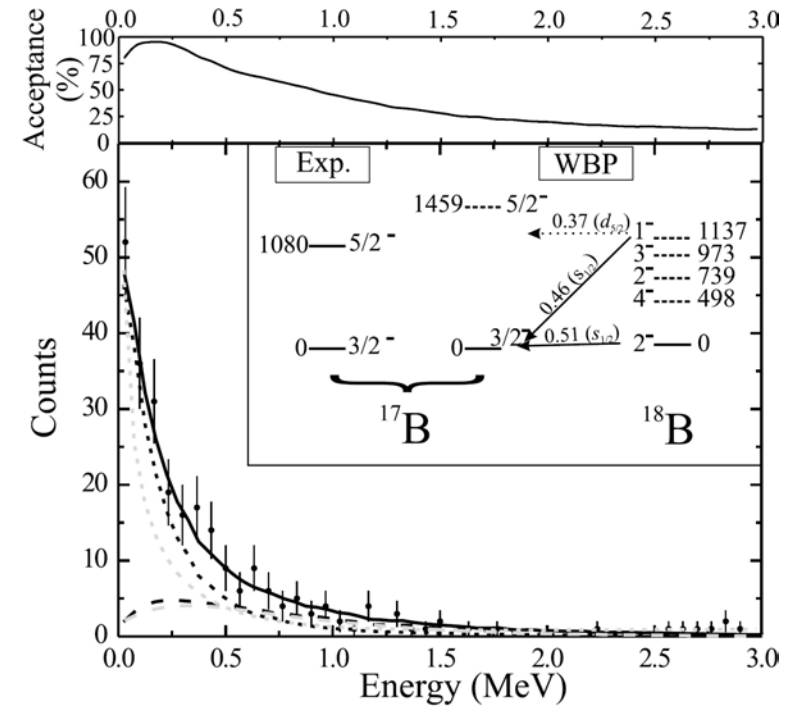
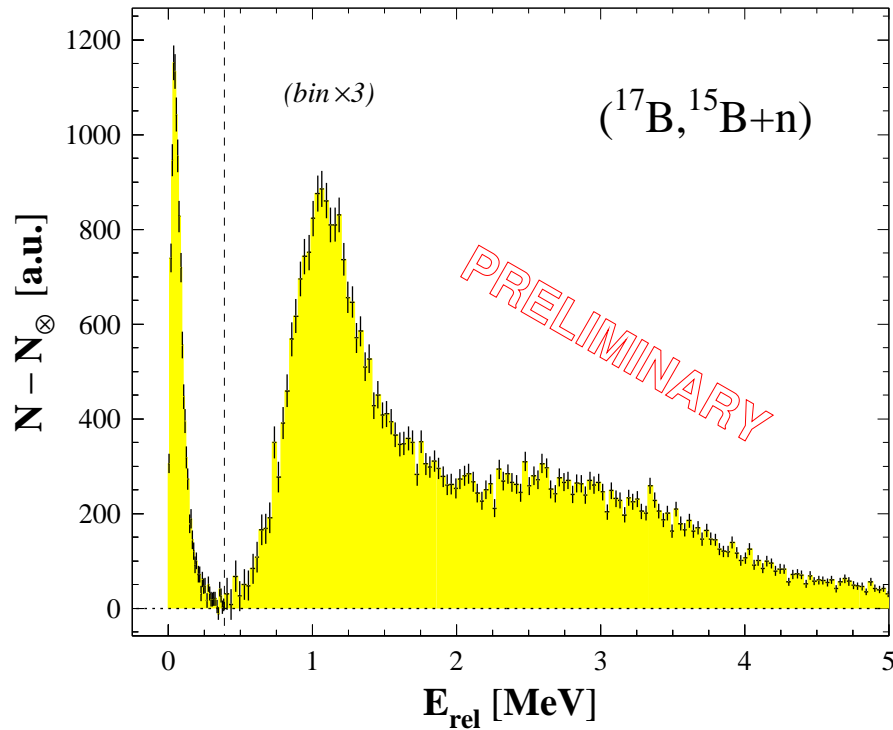
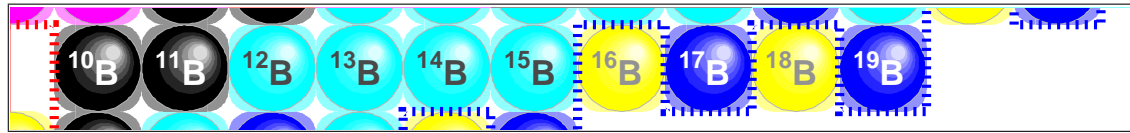


- Maxwellian + $E_{gs} < 10$ keV ...



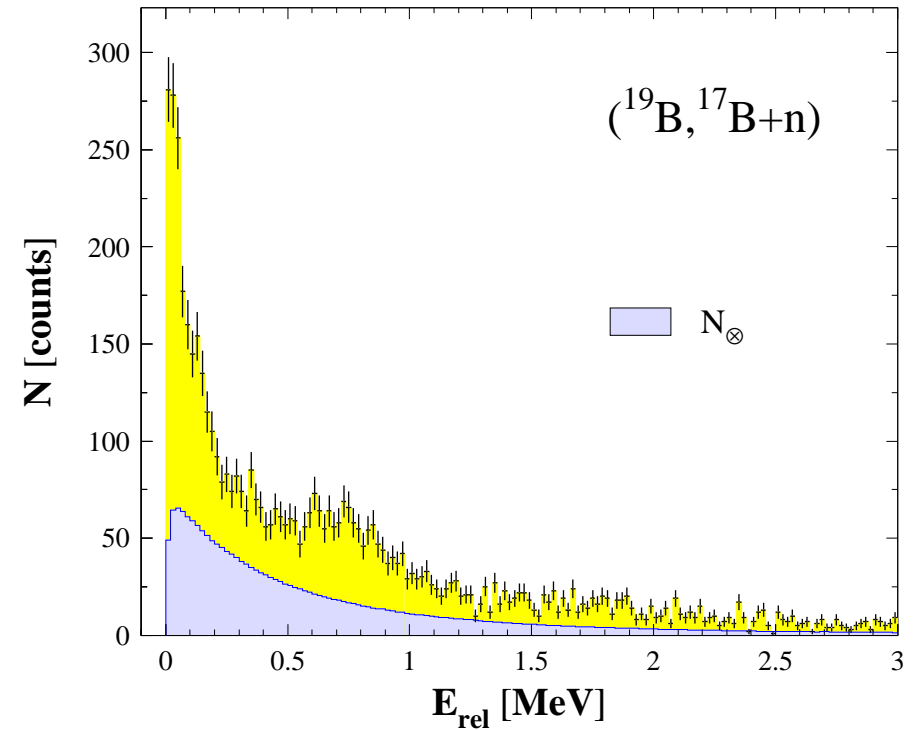
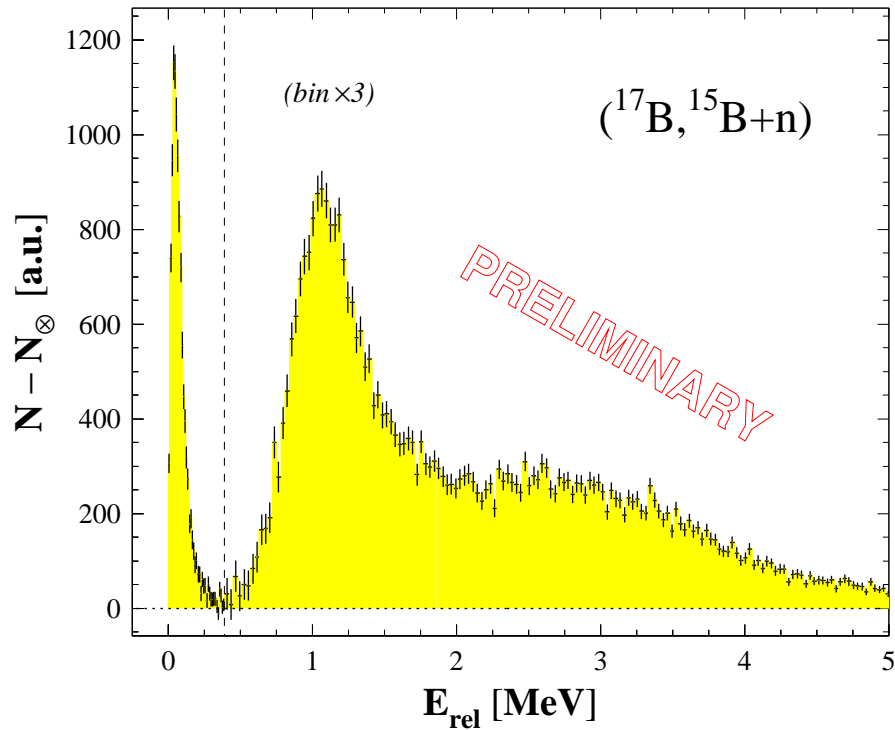
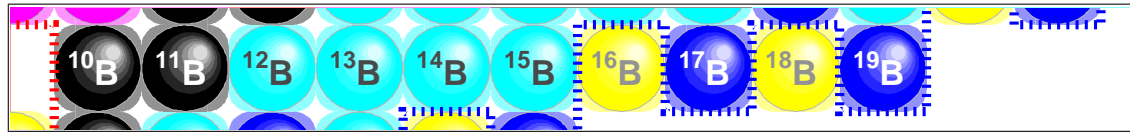
- RIKEN+NEBULA : $\sim 90k$ evts !
- global cross-check of analyses
- N_{\otimes} : event mixing ...

- Maxwellian + $E_{gs} < 10$ keV ...



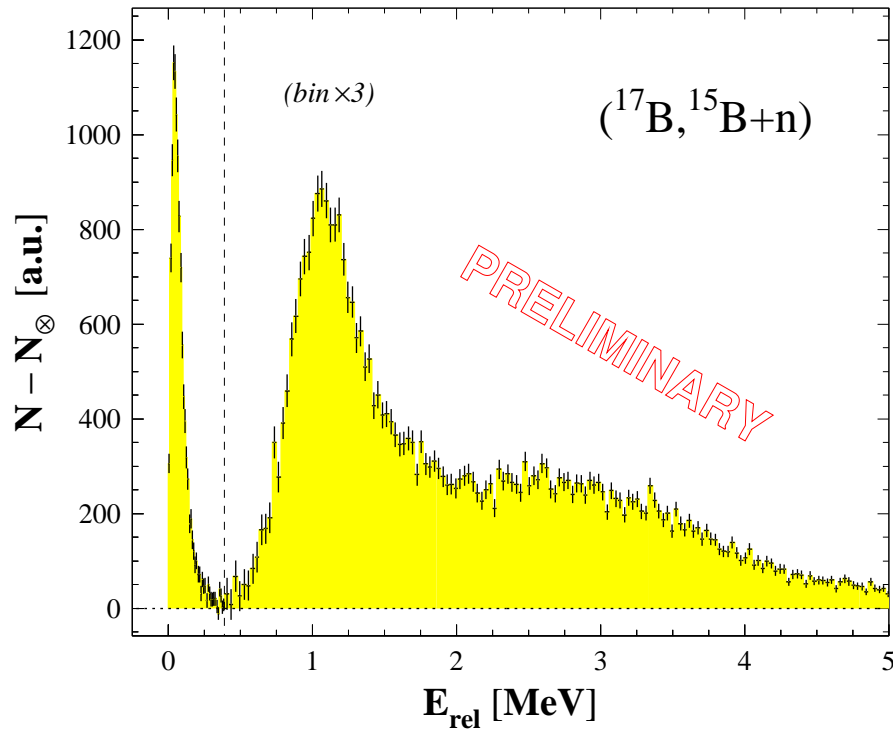
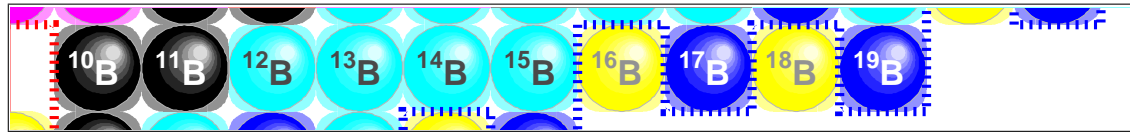
- $E_{gs} \sim (40 \pm \text{few}) \text{ keV} !$
- $E_{rel} \sim 1.1 \text{ MeV} \ \& \ 2\text{-}4 \text{ MeV} :$
 $+ E_{\gamma} \sim 1340 \text{ keV} \ ({}^{15}\text{B}^* + n) \dots$

- Maxwellian + $E_{gs} < 10 \text{ keV} \dots$

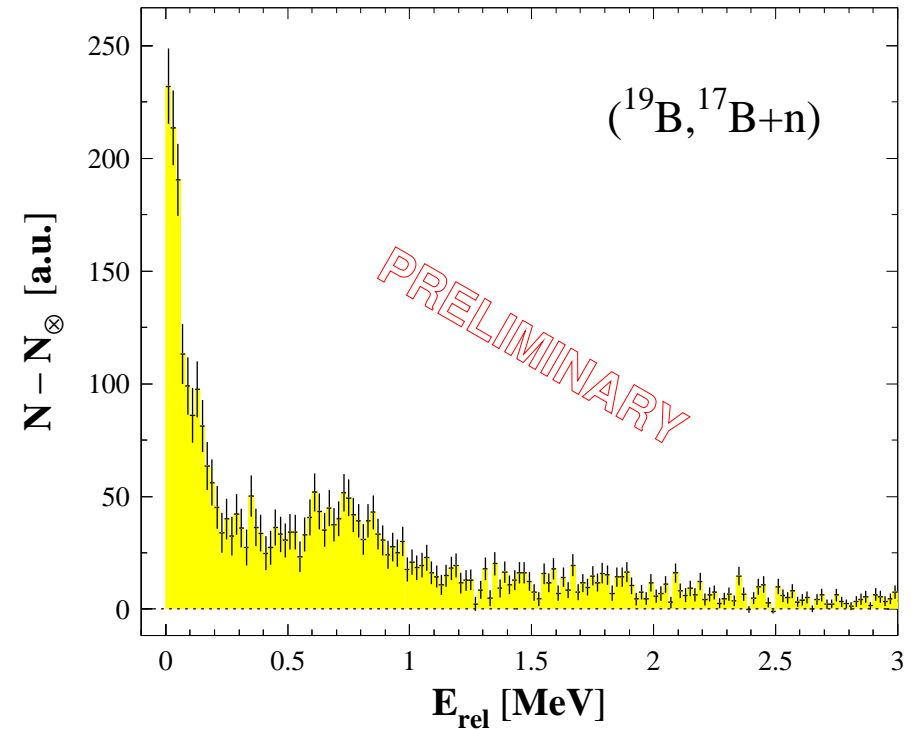


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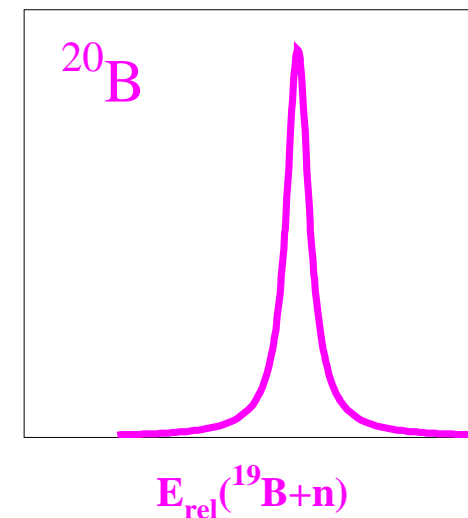
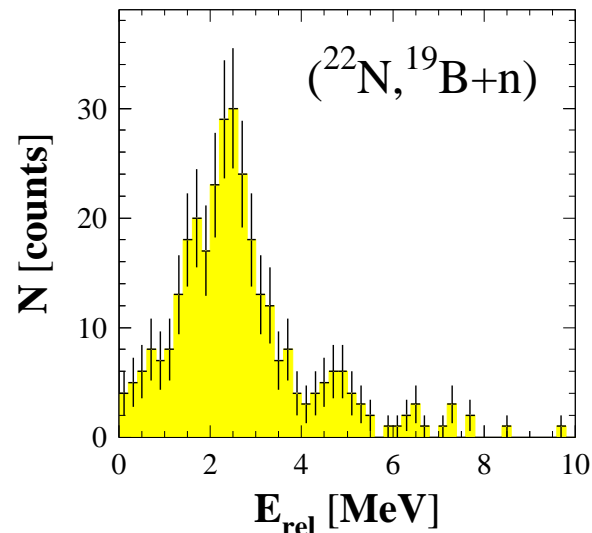
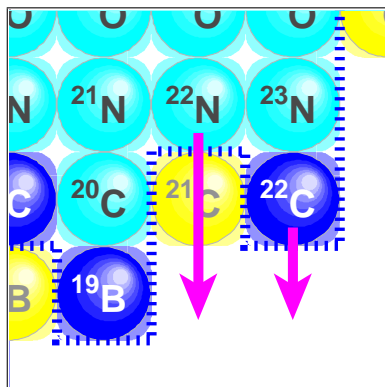
- Other channels ($-1p \ \& \ -2p$) :
 - different resonances !
 - different, non arbitrary, $N_{\otimes} \dots$



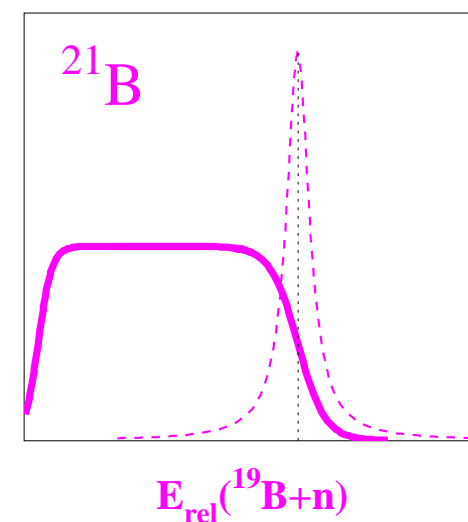
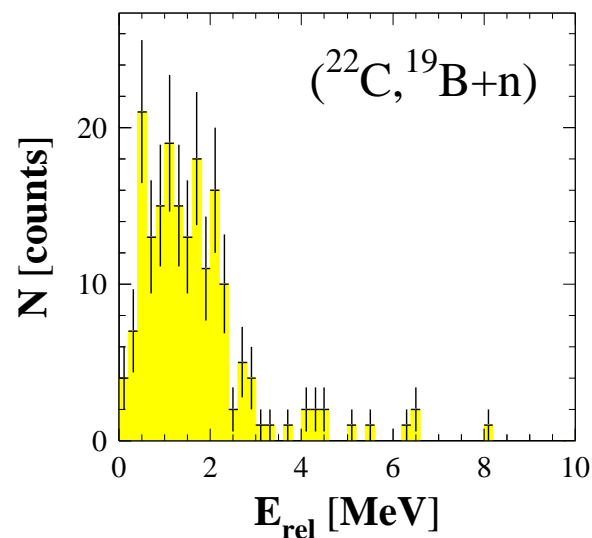
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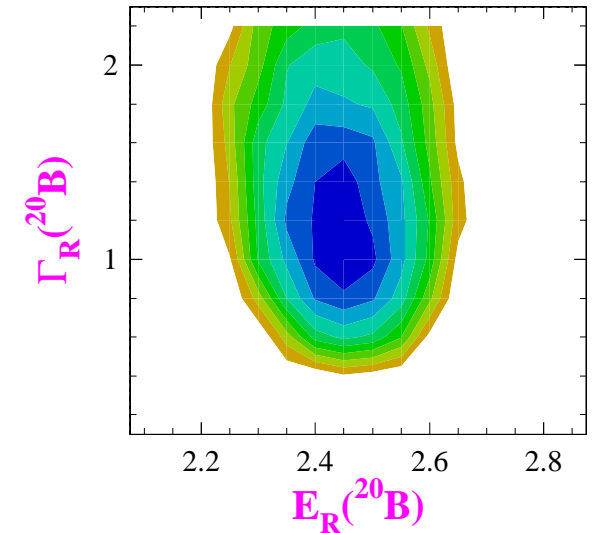
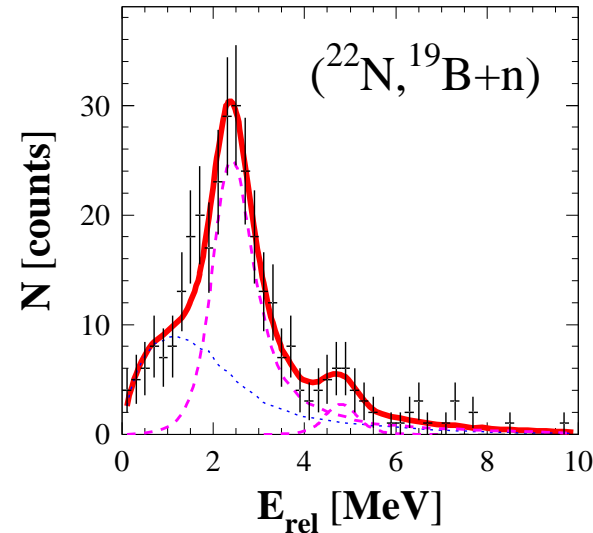
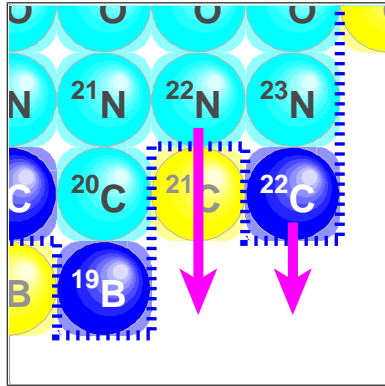
- threshold state(s) $\lesssim 150 \text{ keV} !$
- $E_{\text{rel}} \sim 0.8 \text{ MeV} :$
 + $E_{\gamma} \sim 1060 \text{ keV} \ (^{17}\text{B}^* + n) \dots$



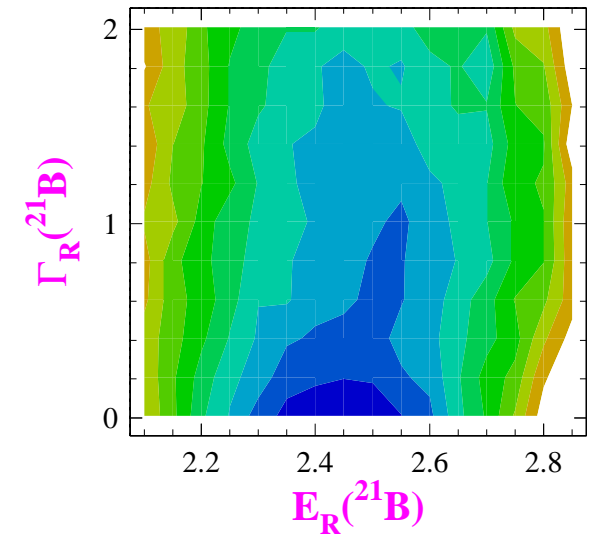
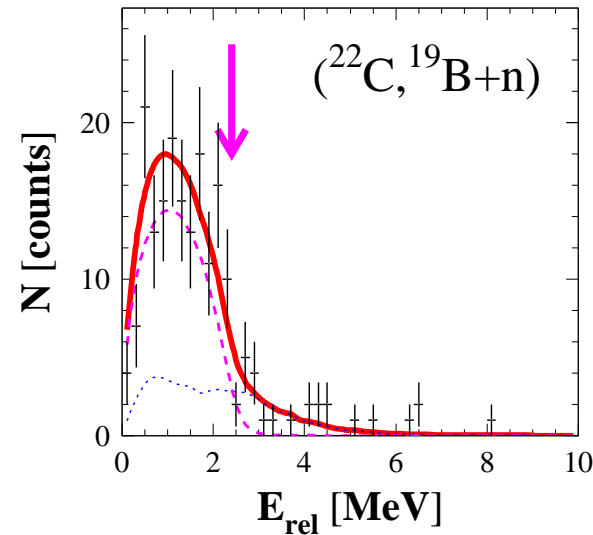
- $\{^{19}\text{B}+n\}$ events : \neq structures ...
 - $^{22}\text{N}(-2p)$: peak(s) ~ 2 (5) MeV ?
 - $^{22}\text{C}(-1pn)$: plateau $\sim 0-2$ MeV ...
 - \rightarrow 3-body $^{19}\text{B}+n(+n)$ decay ?



- **Fit** = $K [N_{\otimes}] + [(E_R, \Gamma_R)_{20/21}]_{MC}$
 - minimize χ^2 for $\{E, \Gamma, K\}$...



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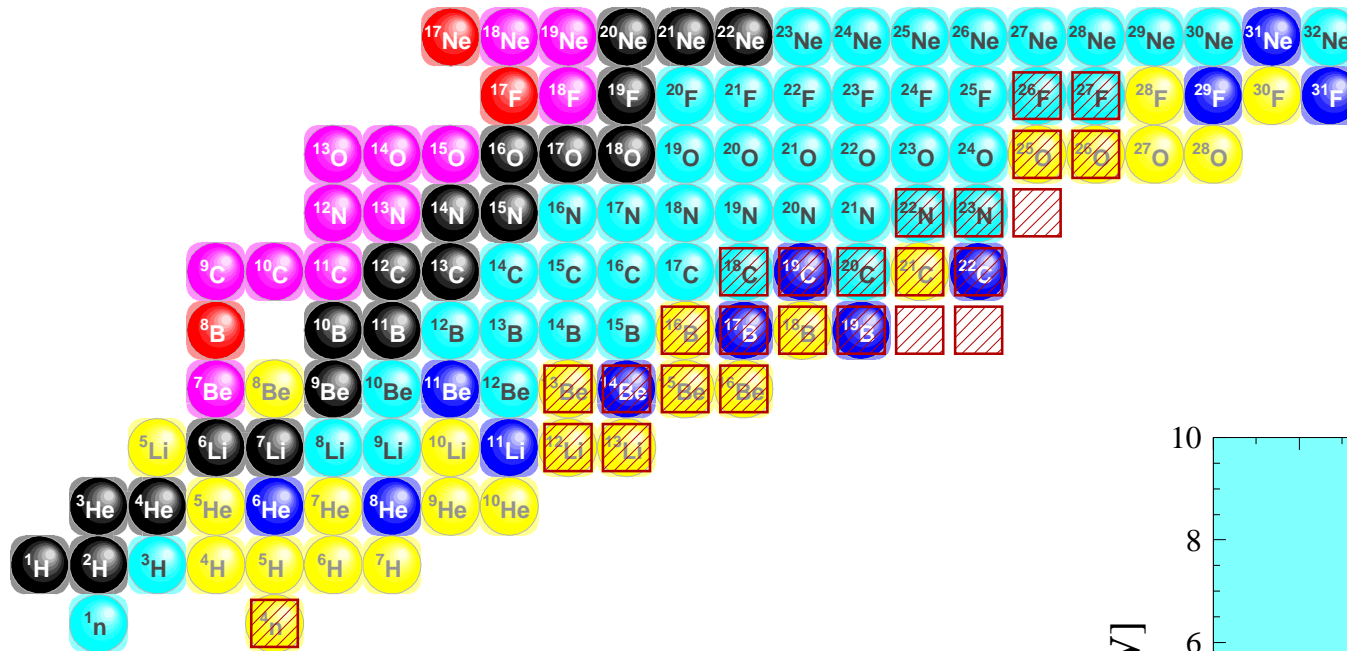


- **Fit** = $K [N_{\otimes}] + [(E_R, \Gamma_R)_{20/21}]_{MC}$
- minimize χ^2 for $\{E, \Gamma, K\}$...

PRELIMINARY results \Rightarrow

Boron 20 $E(\Gamma) \sim 2.5(1)$ MeV & $E^* \sim 4.8$ MeV

Boron 21 $E_{gs} \lesssim 2.4$ MeV ($^{19}\text{B}+n+n \dots$)



SAMURAI+NEBULA Commissioning & Day-One :

- Structure of $^{18,19}\text{B}$, $^{21,22}\text{C}$ & $^{25,26}\text{O}$: **Kondo, June 3**
- Wide (PRELIMINARY) survey of the 'neutron reef' :
 - $^{16,18}\text{B}$ improved mass & new excited states (+ γ)
 - $^{20,21}\text{B}$ measured for the first time !
 - other systems in progress ($^{15,16}\text{Be}$, $^{12,13}\text{Li}$...)

