

Recent results on clustering investigation from the CHIRONE collaboration



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Sezione di Catania

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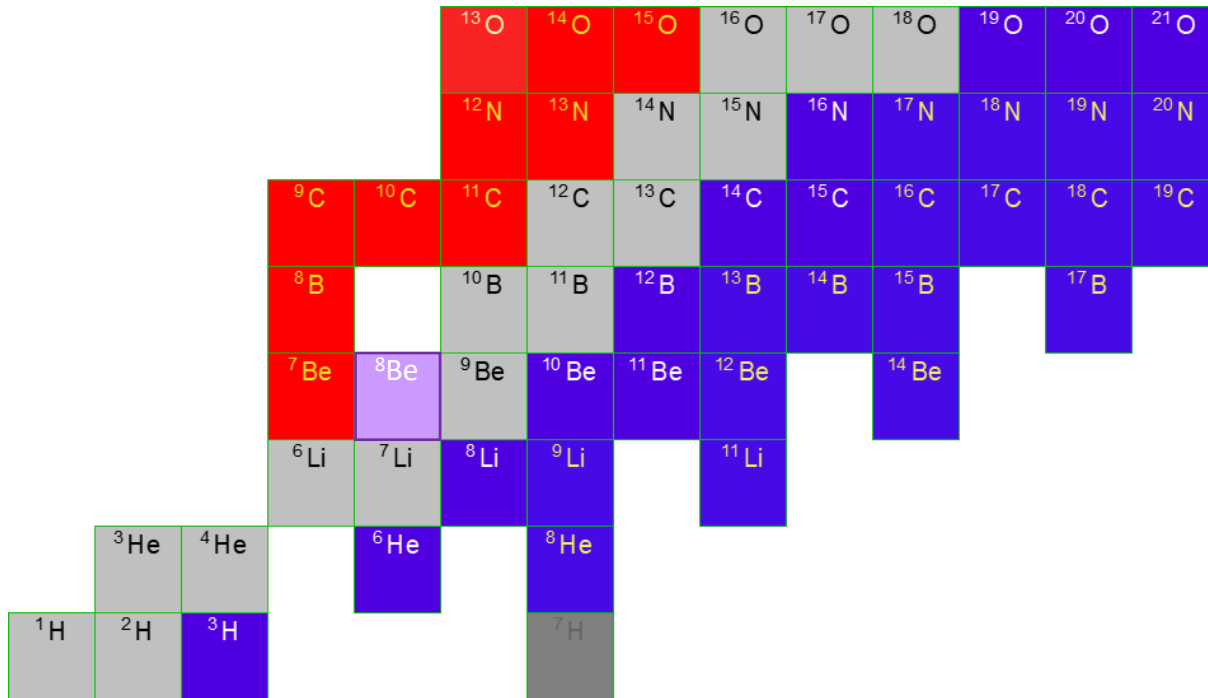
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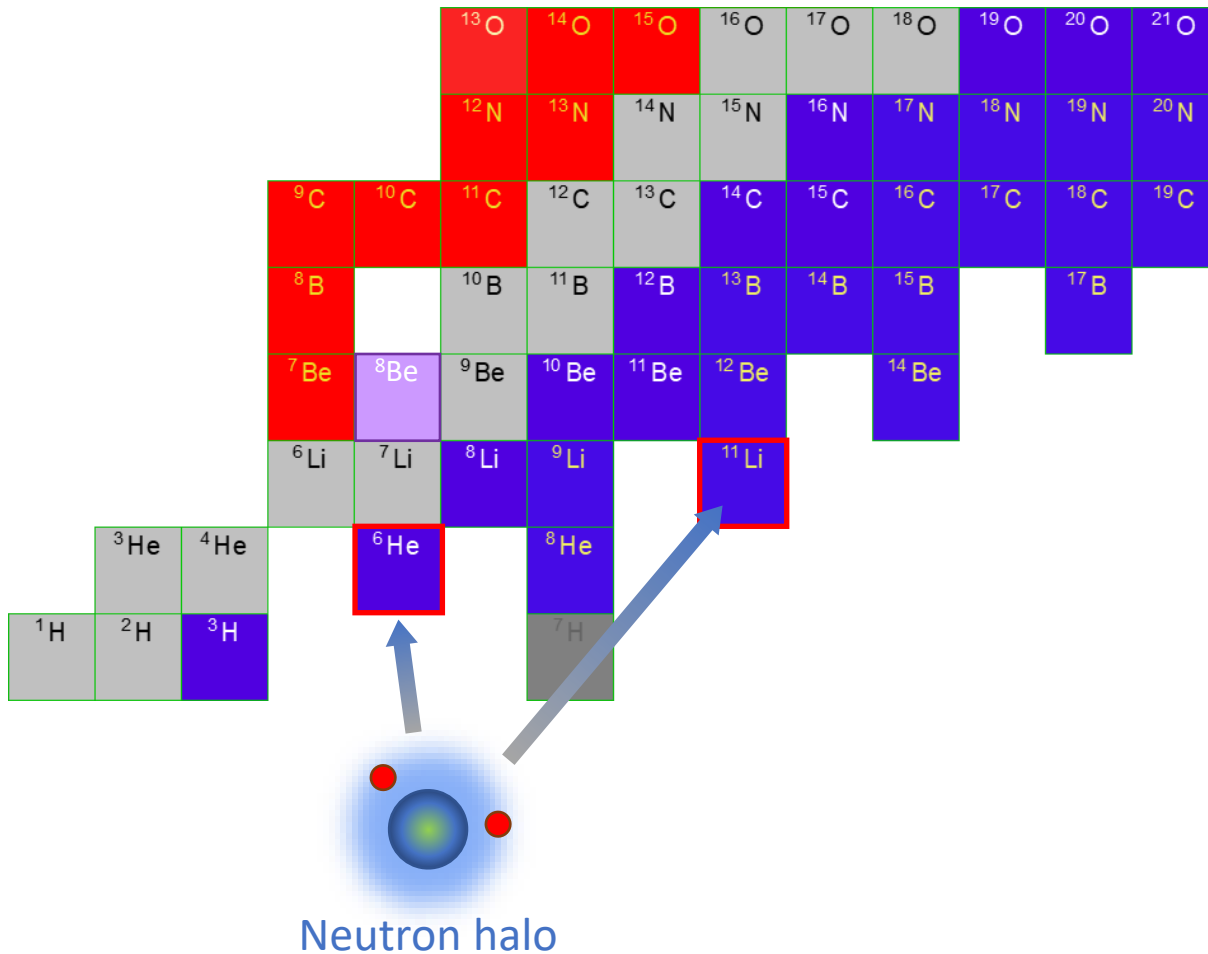
Clusters in light ions

- The study of clustering phenomena in nuclear physics
 - Investigation of the strong nuclear force and insights on the EOS of nuclear matter;



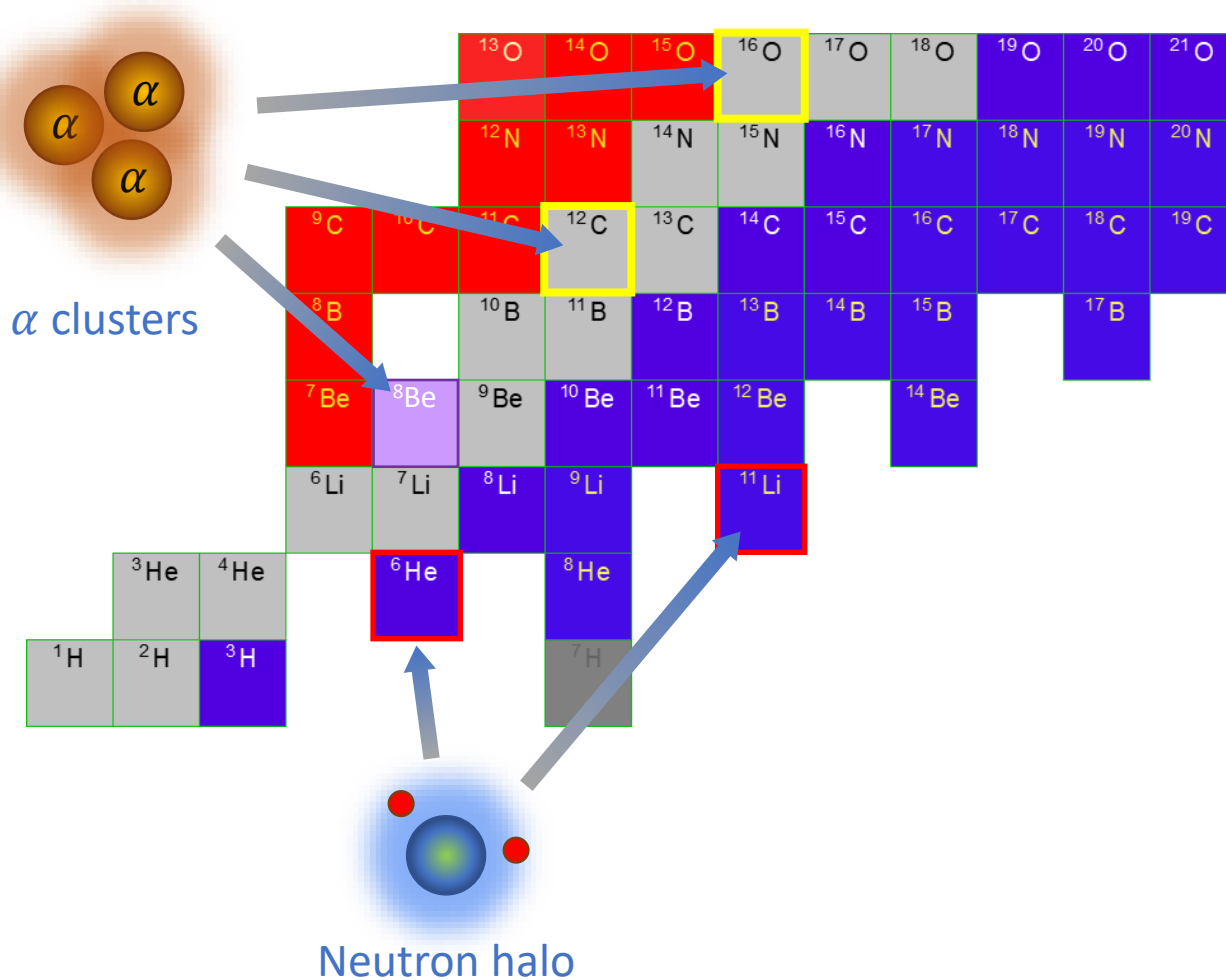
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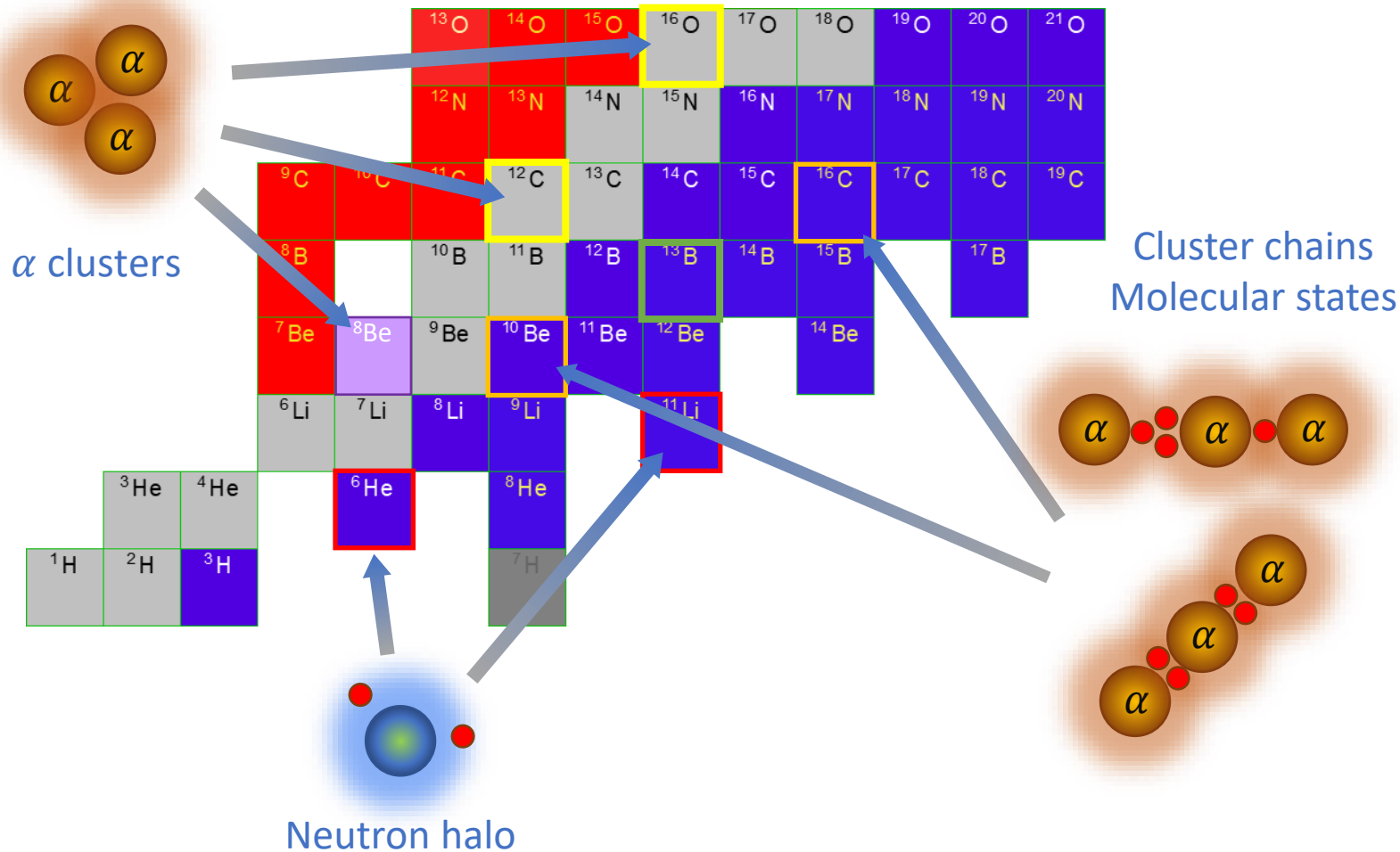
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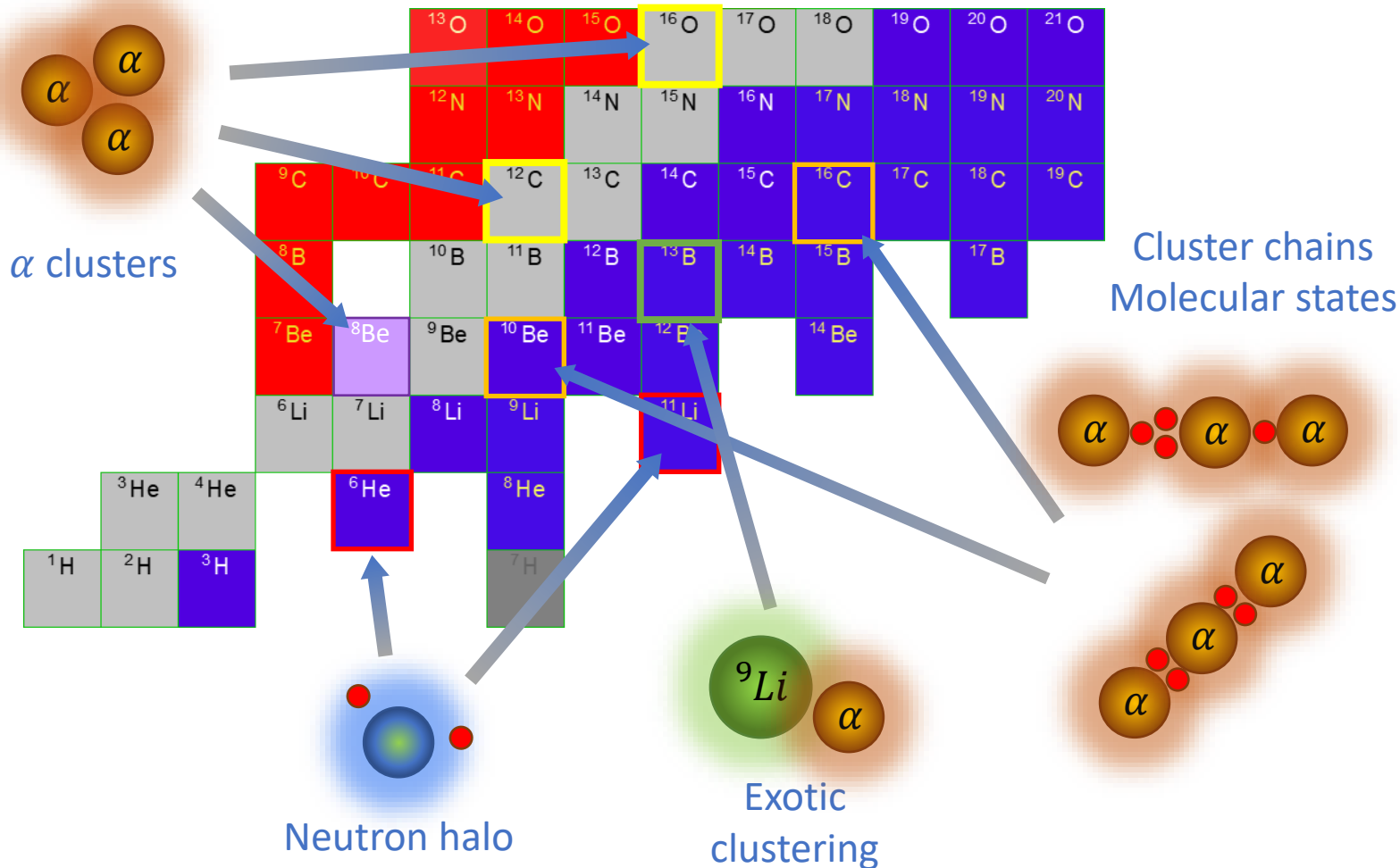
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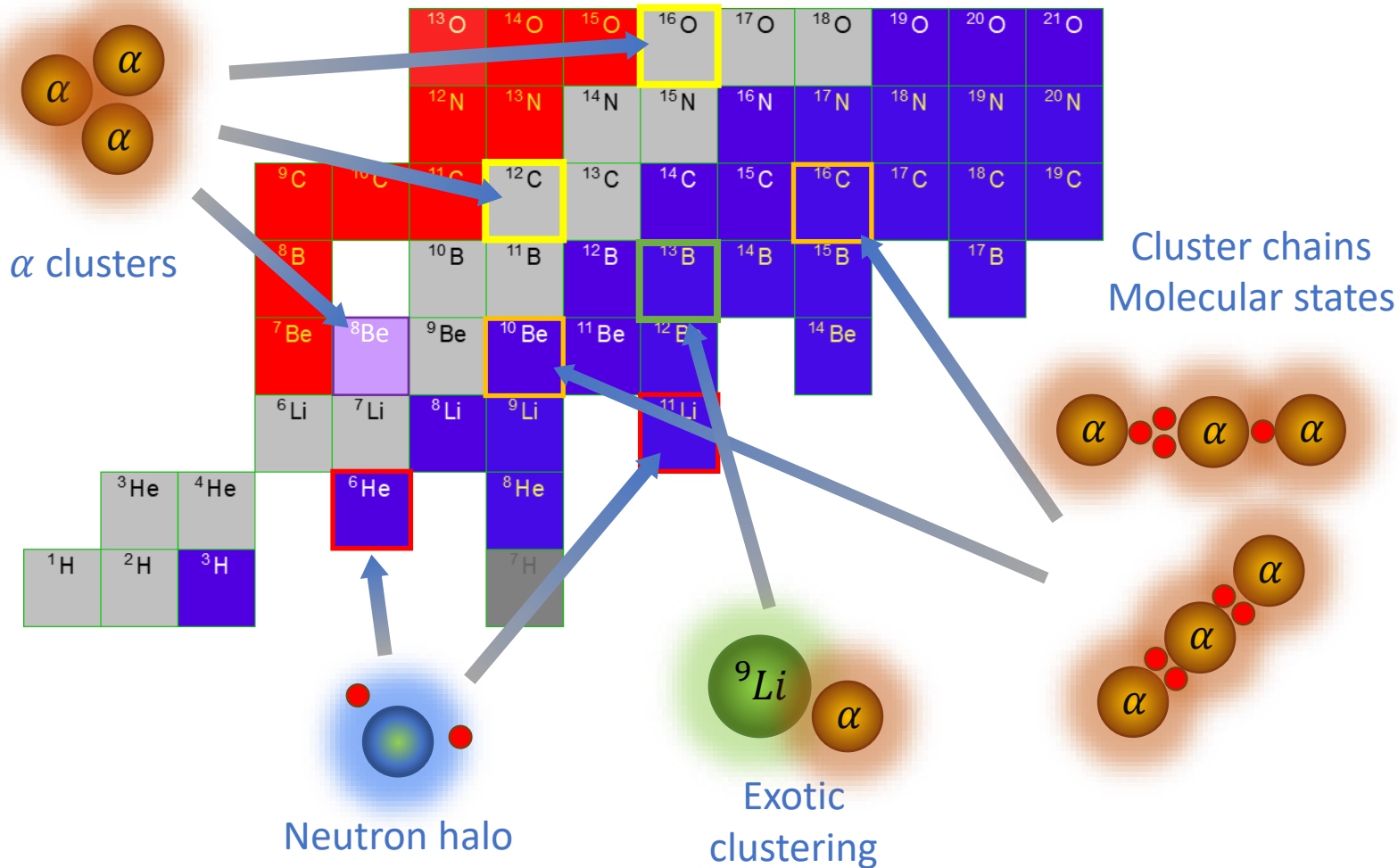
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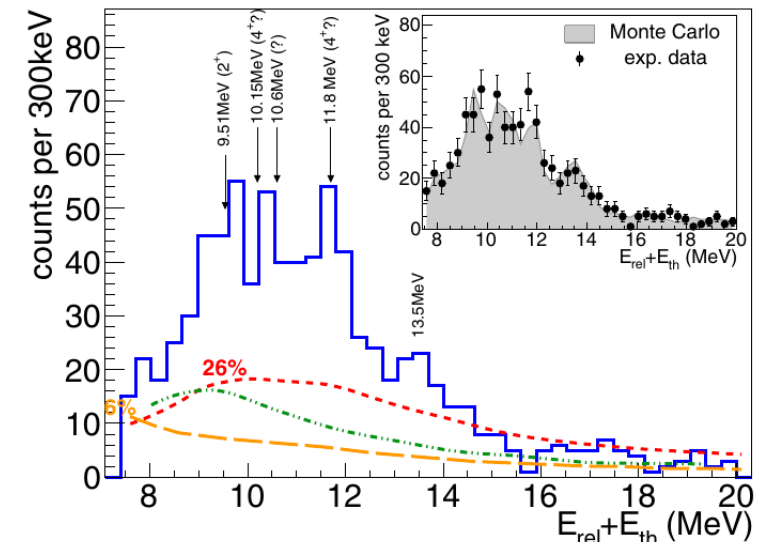
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^{10}Be case study

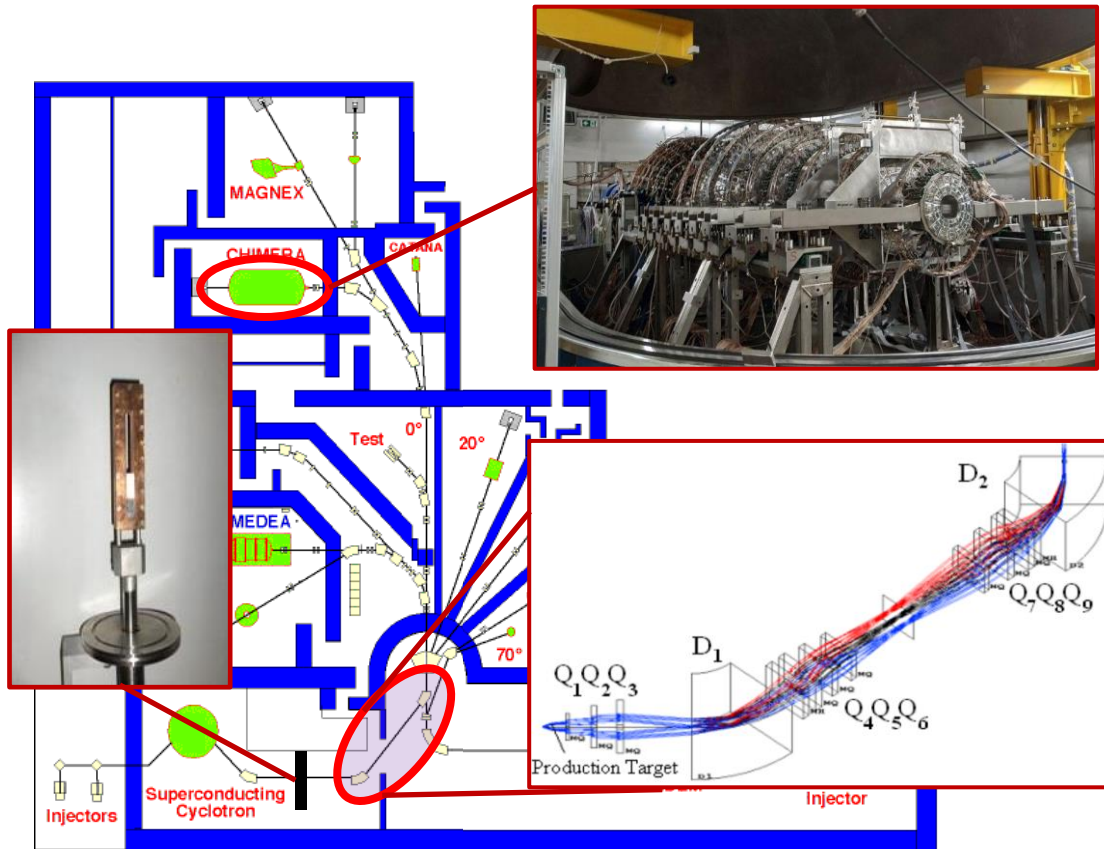
- $^{10}\text{Be} \rightarrow \alpha:2\text{N}:\alpha$ structure;
- ^{10}Be spectroscopy with the CHIMERA multidetector and investigated a «new» state at 13.5 MeV (6^+)



D. Dell'Aquila et al., Phys. Rev. C, 93 (2016) 024611

The CLIR experiment FRIBs@LNS

- CLIR: *Clusters in Light Ion Reactions*
- **FRIBs@LNS** - In-Flight Radioactive Ion Beams @ Laboratori Nazionali del Sud
 - In-Flight fragmentation technique

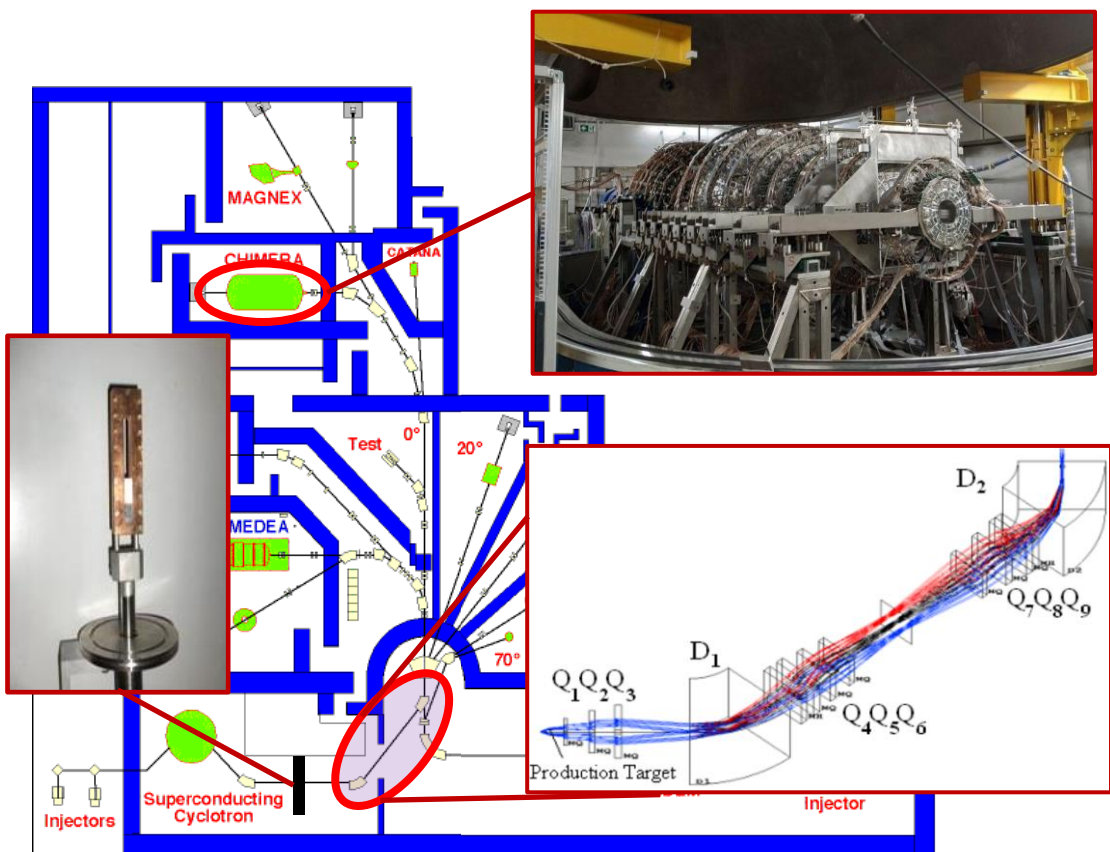


Rusotto P. et al., Jour. of Phys.: Conf. Series, 1014 (2018) 012016

Martorana N.S., Il Nuovo Cimento 44 C (2021) 1

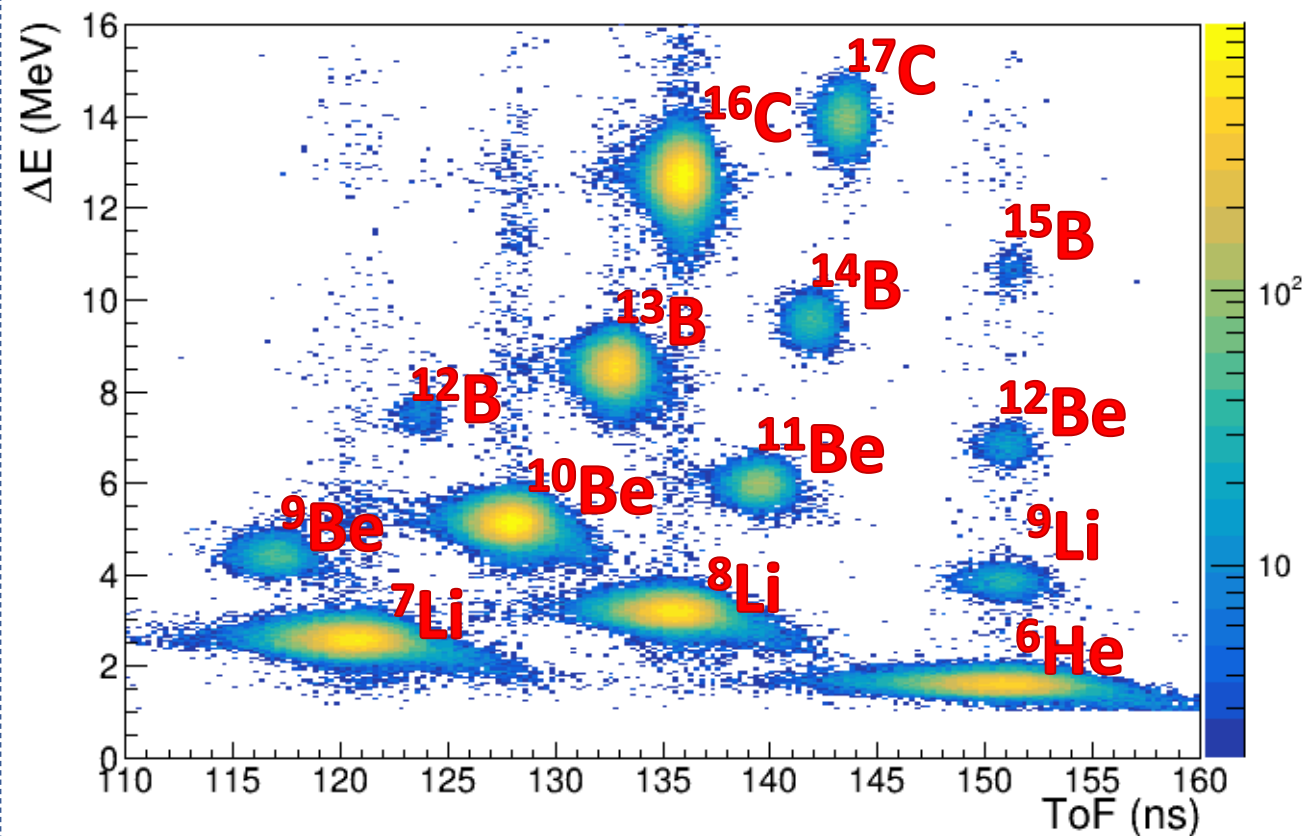
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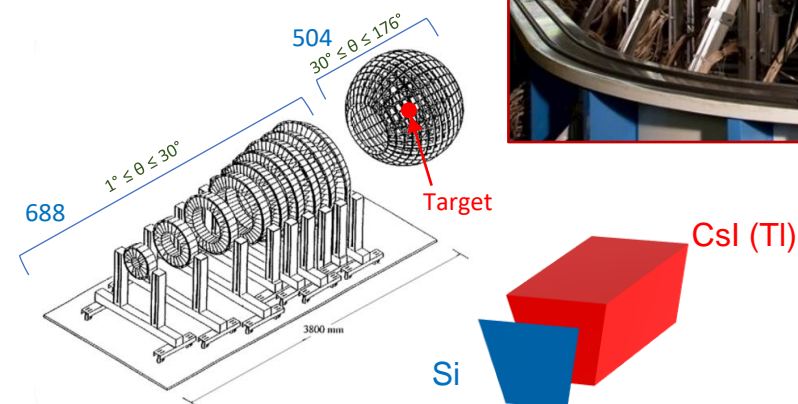
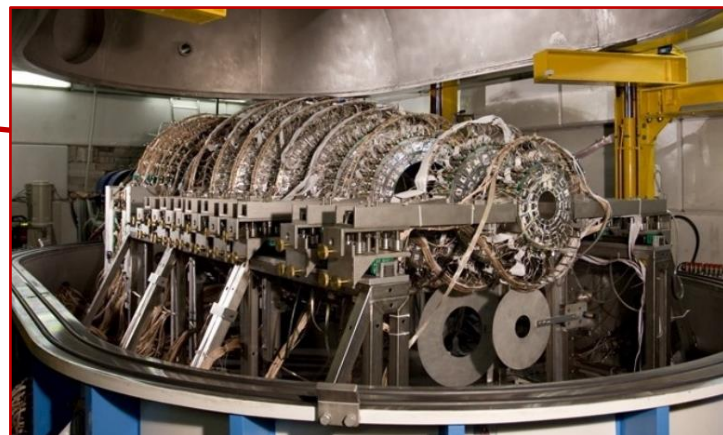
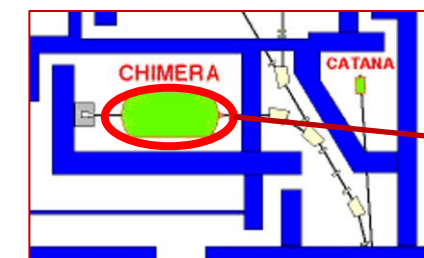
Identification of all isotopic species and calibration of ΔE -ToF through LISE++ simulations



F. Risitano et al., Il Nuovo Cimento C, 47 (2024) 43

Experimental details

- CHIMERA 4 π multi-detector



1192 units:

- 9 rings forward (688 detectors)

$$1^\circ \leq \theta \leq 30^\circ$$

- Sphere (504 detectors)

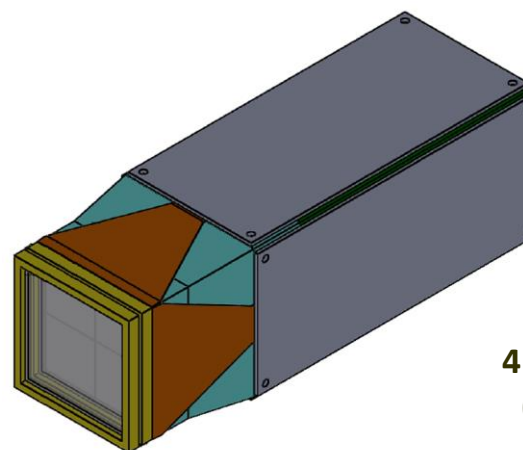
$$30^\circ \leq \theta \leq 176^\circ$$

- 4 FARCOS telescopes

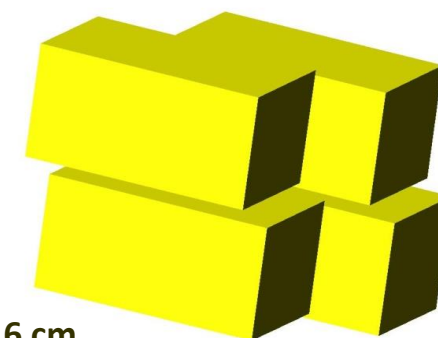
- Femtoscope **ARray** for **CO**rrelation and **S**pectroscopy

- Placed at small angles between R9 and sphere
- ≈ 75 cm from target

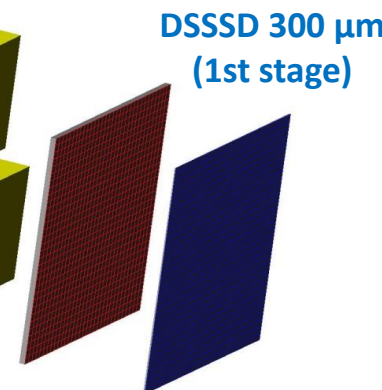
$$1.6^\circ \leq \theta \leq 8.5^\circ$$



4 CsI(Tl) 6 cm
(3rd stage)



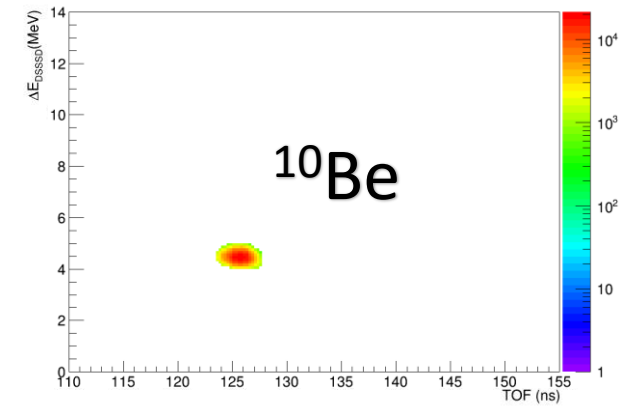
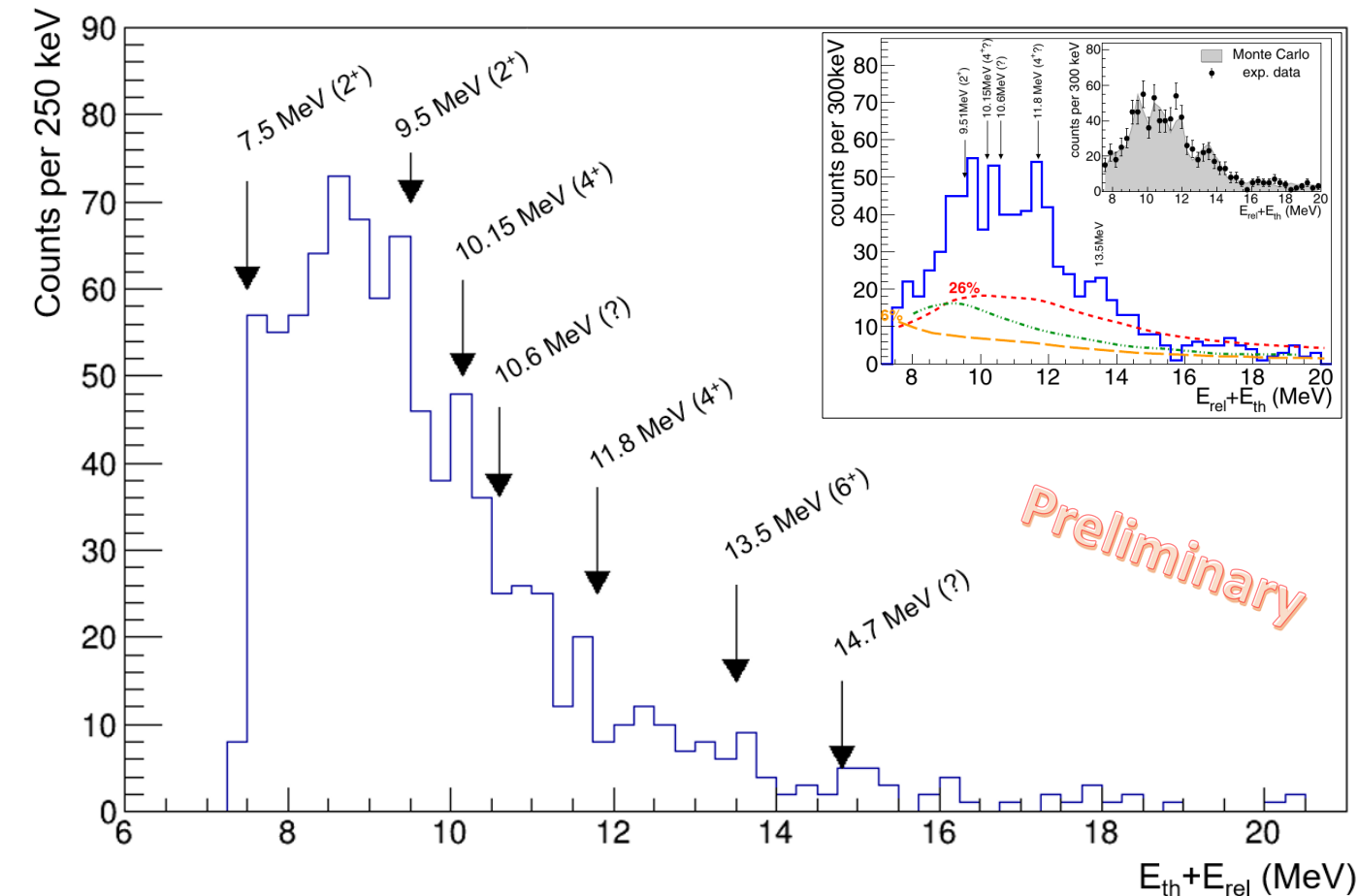
DSSD 1500 μ m
(2nd stage)



DSSD 300 μ m
(1st stage)

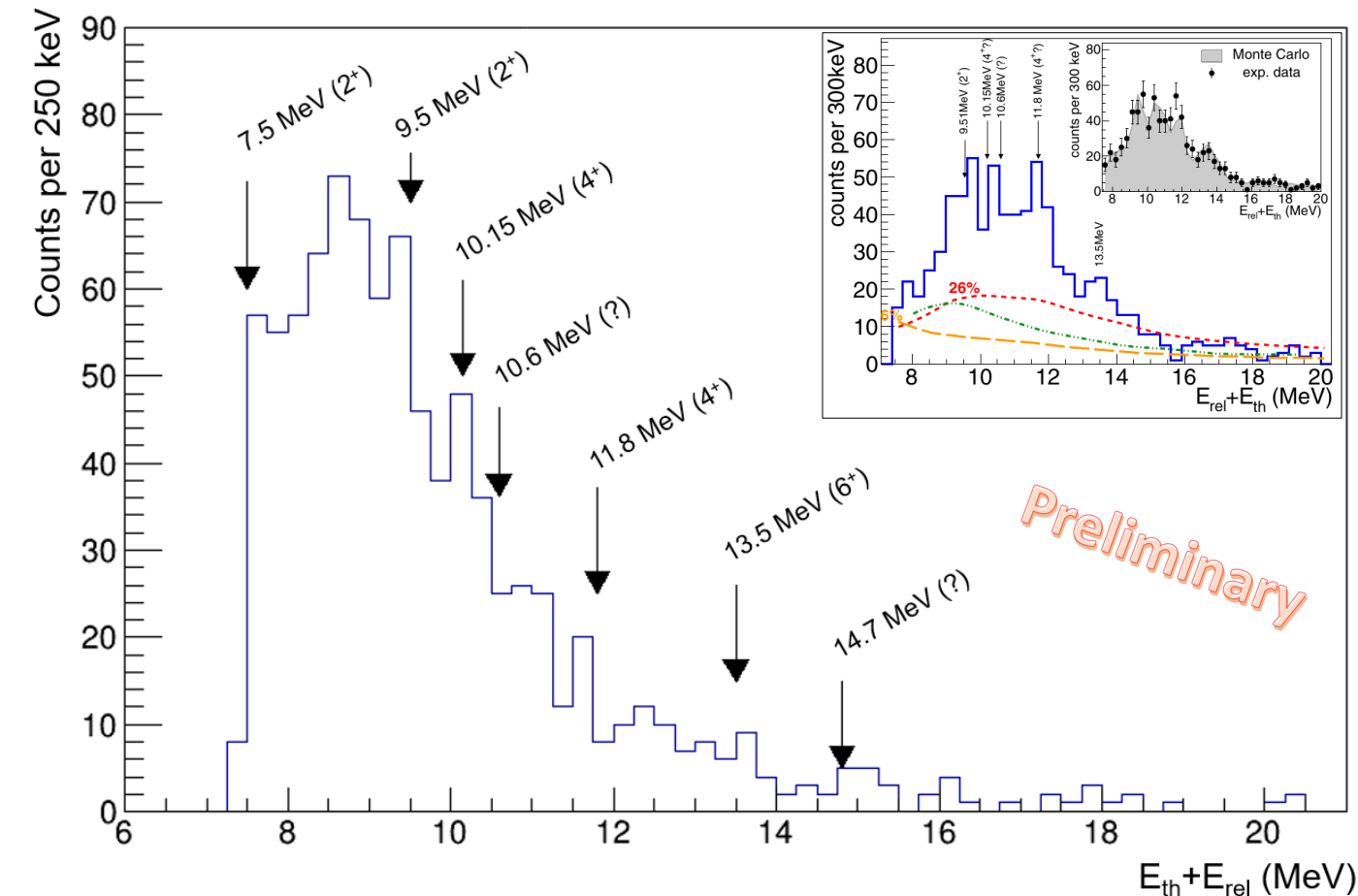
Preliminary work on ${}^6\text{He}+{}^4\text{He}$ breakup

- ${}^6\text{He} + {}^4\text{He}$ event couples identified, applying a cut on ${}^{10}\text{Be}$ distribution on the ΔE -ToF tagging matrix



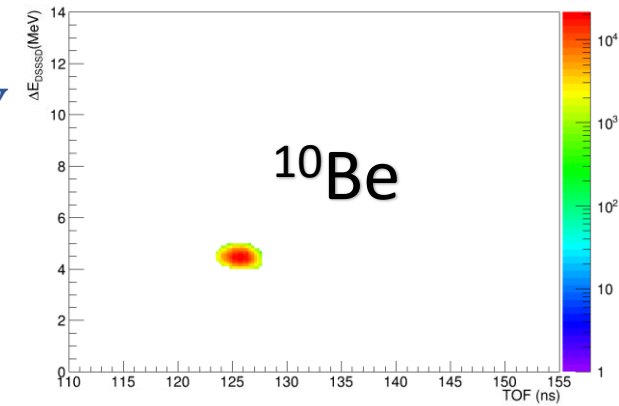
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- Reconstruction of ${}^{10}\text{Be}$ excitation spectrum from invariant mass technique



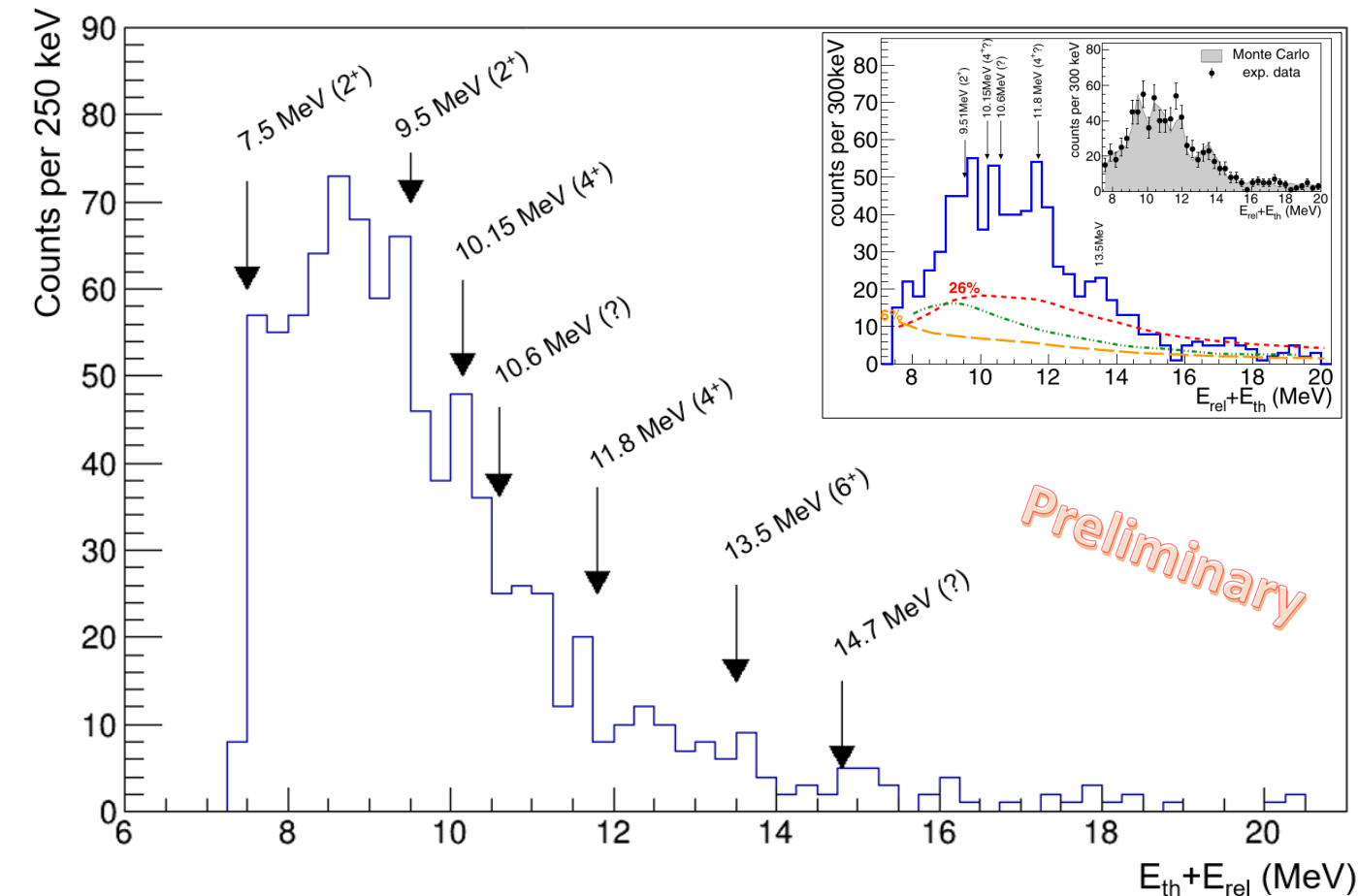
$$E_{th}(-Q_{val}) = 7.409 \text{ MeV}$$

$$E_{exc} = E_{th} + E_{rel}$$



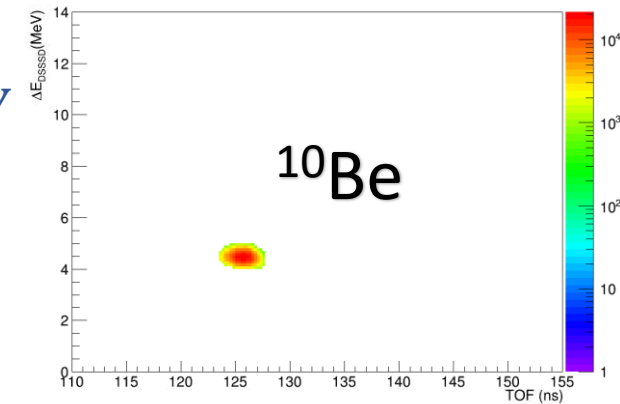
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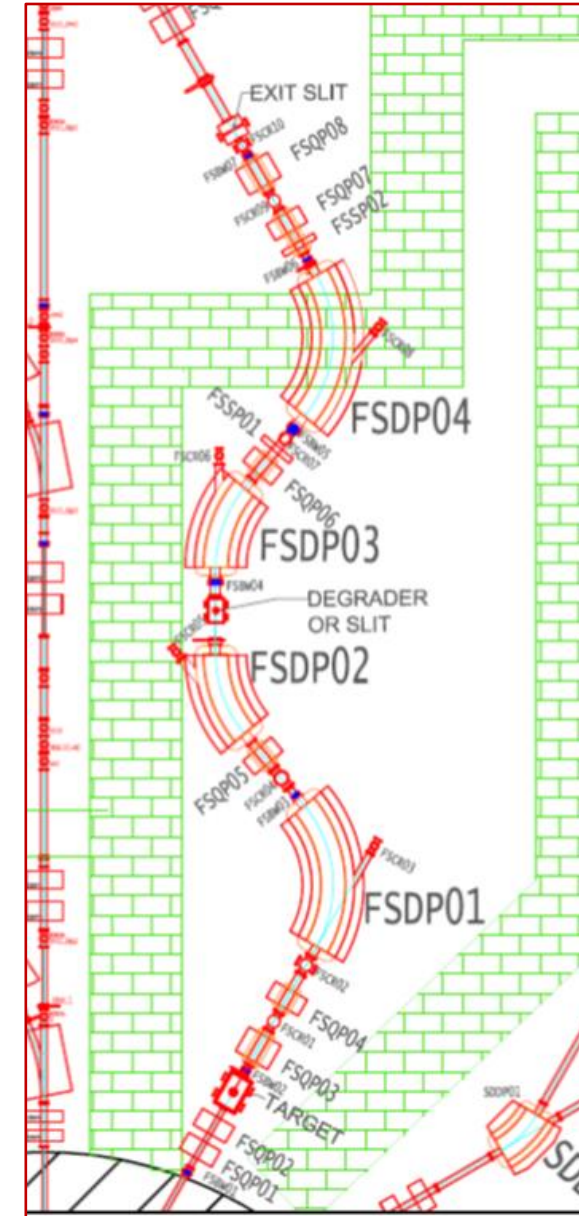
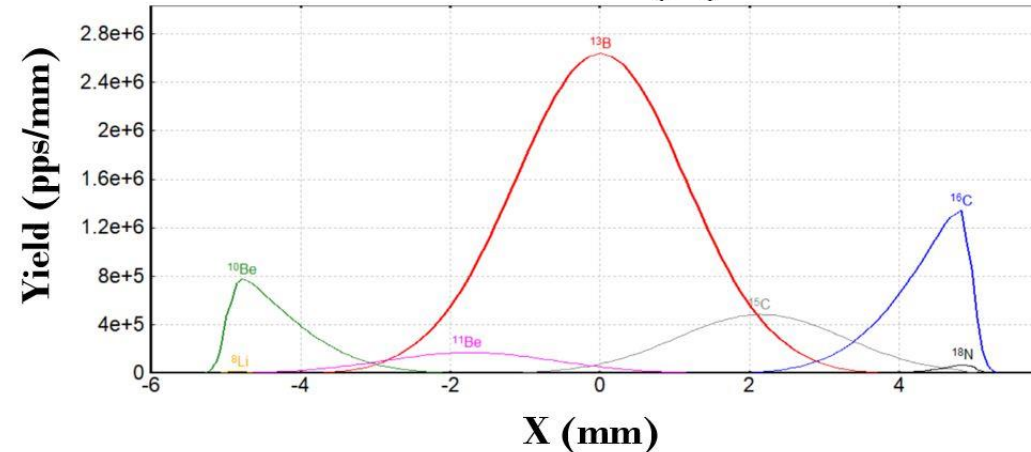
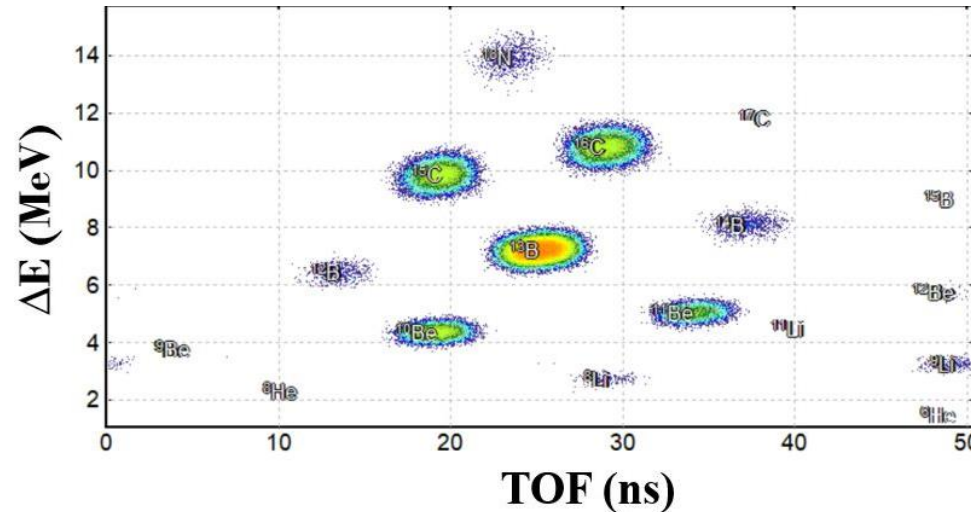


- Work in progress to **evaluate the background**:
 - Event-mixing
 - Detection efficiency with ${}^{12}\text{C}$ or hydrogen;
- Coincidences with proton (CH_2 target) still missing (**analysis on CHIMERA**);

Future perspectives: the new FRAISE fragment separator

- POTLNS upgrade project:
 - **Superconducting Cyclotron** upgrade (power up to 10 kW);
 - Fragment separator **FRAISE** (light and medium-mass RIBs at Fermi energies);

- LISE++ simulations have been produced for many RIBs of interest;
- CLUB experiment (^{13}B production)
 - ΔE -ToF
 - Horizontal distribution



N.S. Martorana et al., Front. Phys. Sec. Nucl. Phys. 10, (2022)
A.D. Russo et al., NIM B 463 (2020) 418
F. Risitano, Il Nuovo Cimento 45 C (2022) 68
B. Gnoffo et al., Front. Phys. Sec. Nucl. Phys. 10, (2022)



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***Thank you for your
attention!***

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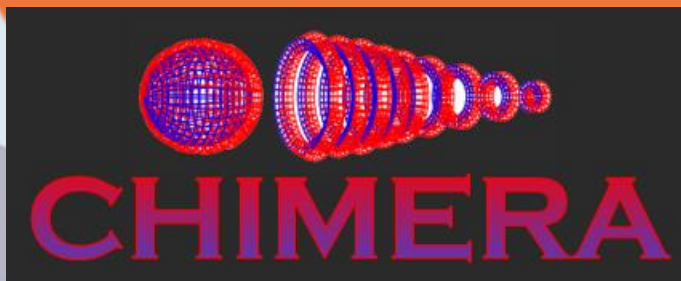
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26 | 28 Febbraio