One Neutron Removal Cross Sections For ^{16}N Isomeric State

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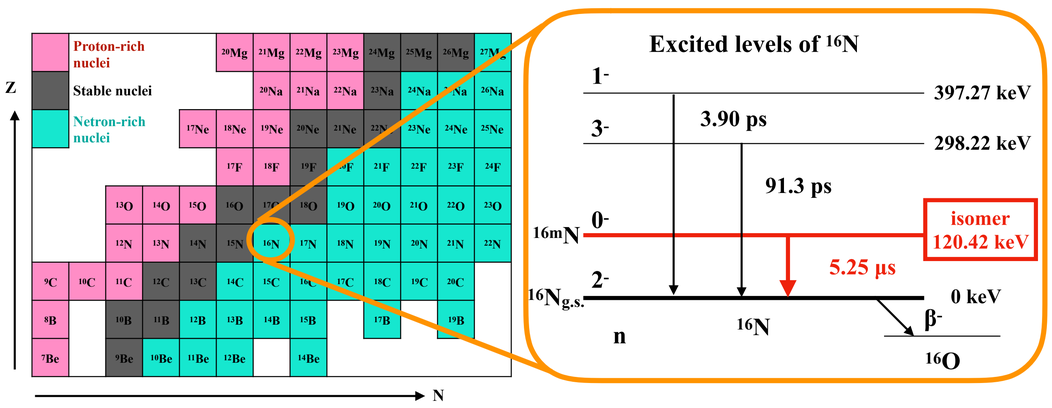
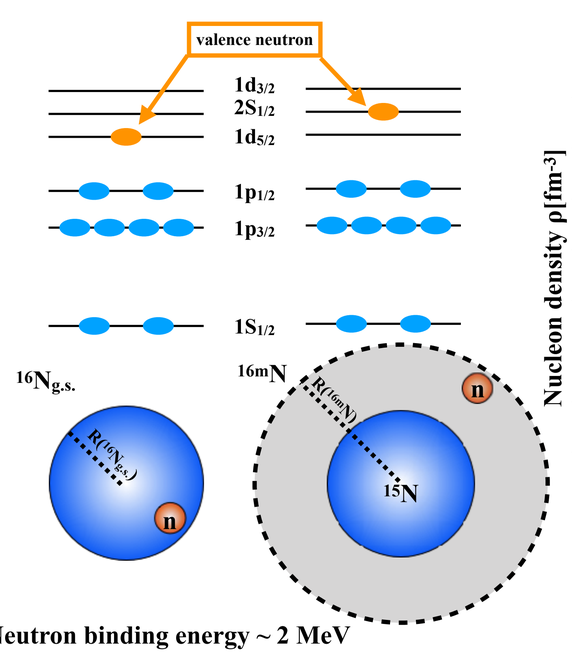
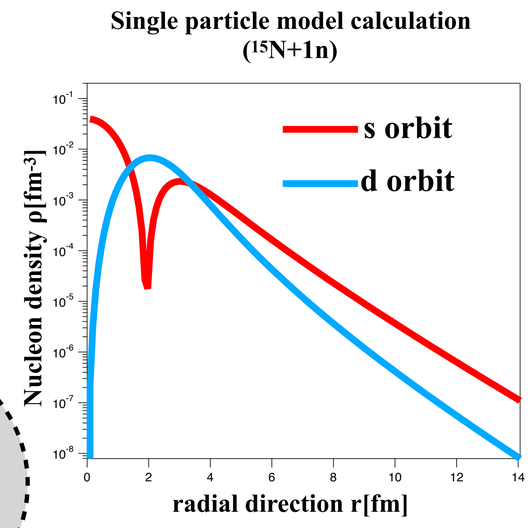
1. Introduction



Nucleosynthesis(s-process) is thought to be progressing in the stars at very high temperature,
~ 1 GK, ~100 keV, ~ ^{16}N isomer excitation energy
Isomer such as in ^{16}N may contribute to nucleosynthesis
→ Nuclear structure of isomer
: Useful for understanding nucleosynthesis mechanism

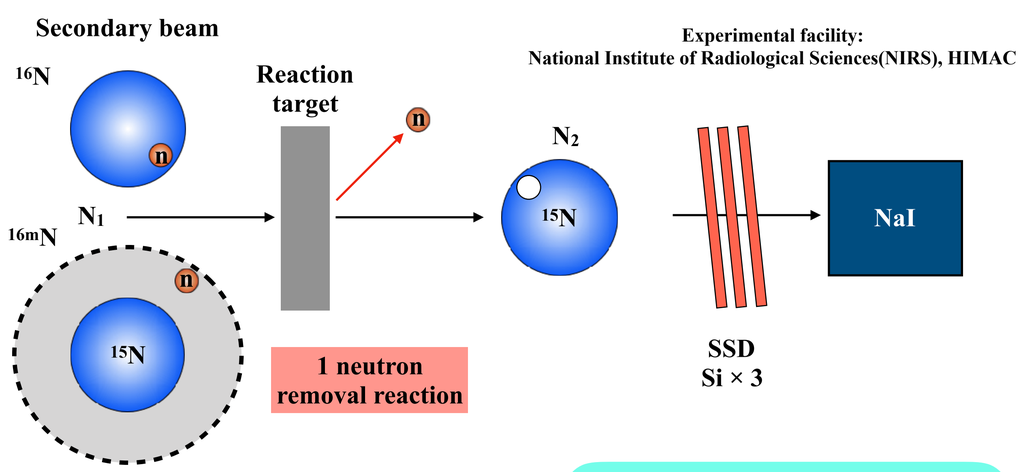
2. Difference in nuclear structure between ground state(^{16}N$_{g.s.}$) and isomeric state(^{16m}N)





R(^{16m}N)>R(^{16}N$_{g.s.}$)

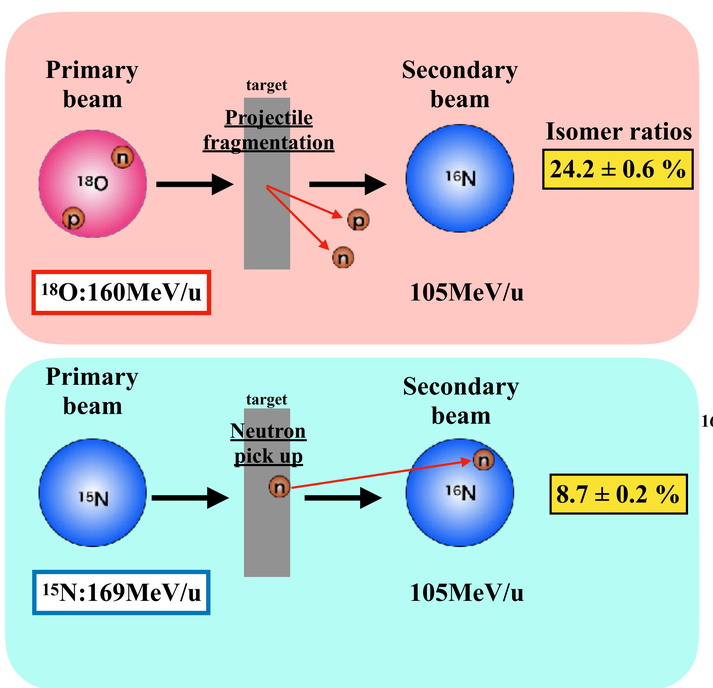
3. Measurement of one neutron removal cross sections



N$_1$:Number of incident particles(^{16}N)
N$_2$:Number of ^{15}N
t:target thickness

$$\sigma(-1n) = -\frac{1}{t}\ln\left(1-\frac{N_2}{N_1}\right)$$

4. Two types of beams with different isomer ratios



when

$$\frac{\sigma_{^{18}O}(-1n)}{\sigma_{^{15}N}(-1n)} > 1,$$

it qualitatively suggests that ^{16}N isomer is a neutron halo nucleus

5. Setup and Particle Identification before and after reaction target

Upstream of reaction target
$B\rho - TOF - \Delta E$

Magnetic rigidity: $B\rho \propto \frac{A}{Z}v$

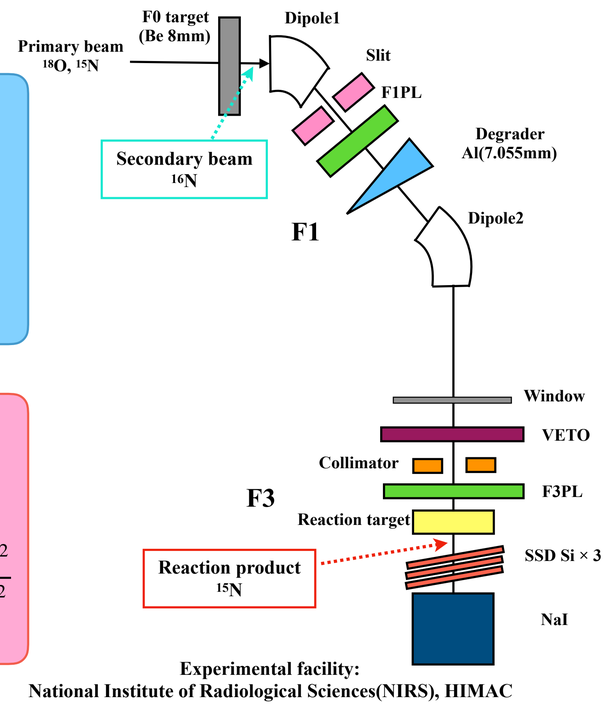
Time of flight between F1PL and F3PL: $TOF \propto \frac{1}{v}$

Energy loss at F3PL: $\Delta E \propto \frac{Z^2}{v^2}$

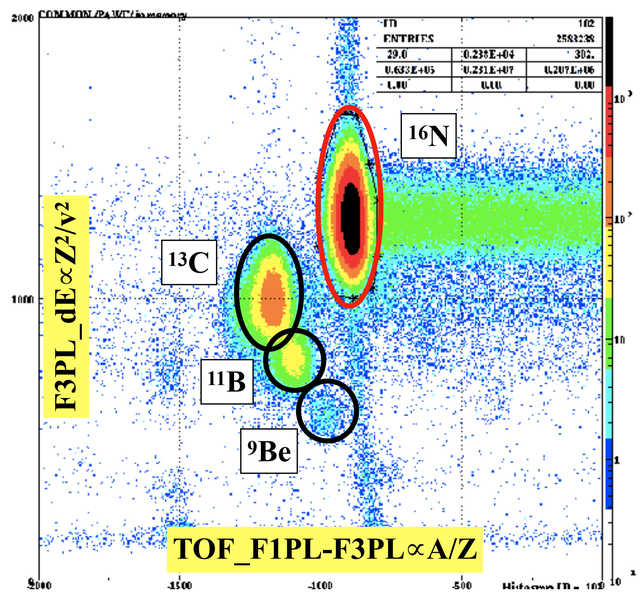
Downstream of reaction target
$E - \Delta E$

Total energy stopped at NaI: $E \propto Av^2$

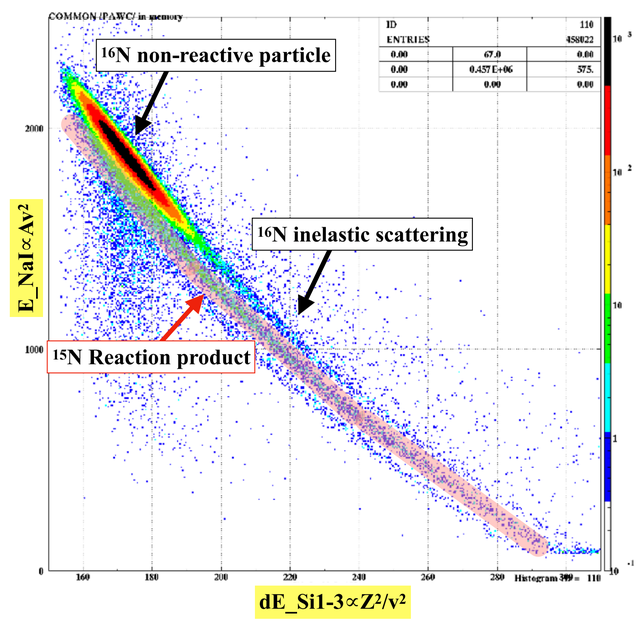
Energy loss at SSD Six3: $\Delta E \propto \frac{Z^2}{v^2}$



PI before R. target

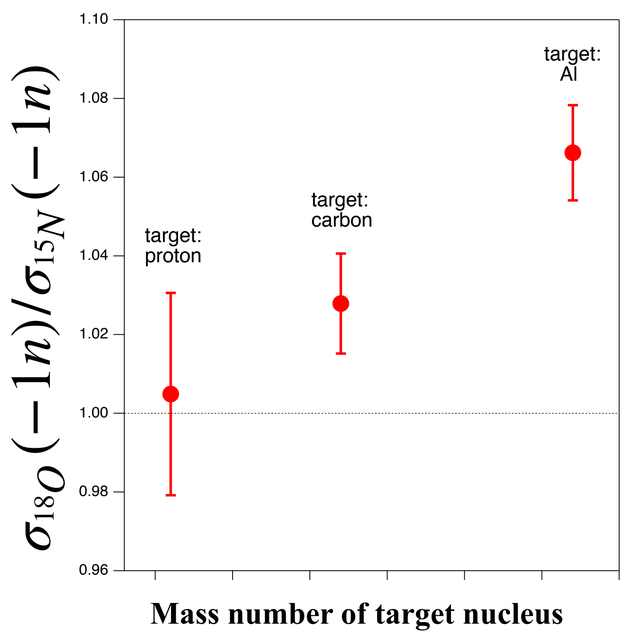


PI after R. target



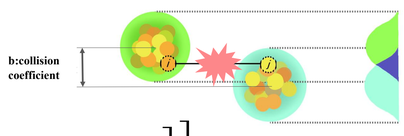
6. Results

- The experimental results showed that σ(-1n) was larger for the beam with a larger isomer ratio.
- It was also observed that this trend is larger for larger target mass number.



7. Calculation

Glauber Computational Model



$$\sigma_R = \int db\left[1-\exp\left[-\int d^2r\sum_{i,j}\sigma_{NN}(E)\,\rho_z^{P(i)}(r)\,\rho_z^{T(j)}(r-b)\right]\right]C(E)$$

$\sigma_{NN}(E)$: nucleon-nucleon total cross section
ρ_z^P : density distribution of incident nuclei
ρ_z^T : density distribution by target nuclei
C(E) : Coulomb force correction term

Assumption :
σ(-1n) = σ$_R$(^{16}N) - σ$_R$(^{15}N)

qualitatively : ○
quantitatively : ×

More elaborate theoretical calculations are desired for quantitative analysis.