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Task SA-EN.IM.10-T002-D002

On relevant plasma scenarios for application of γ-ray spectrometer to energetic particle physics studies: α-particles

α-particle generation in low activation plasmas (OP3-OP4 campaigns)

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Production of energetic α-particles with

H-NBI, H-plasma + boron :

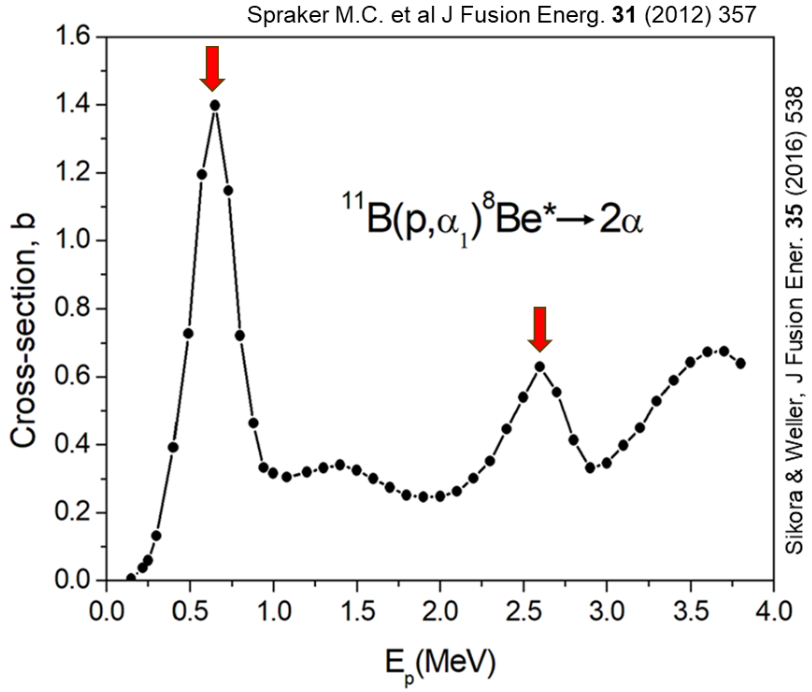
- ✓ $^{11}B(\mathbf{p},2\alpha)^4He$ (E_α < 6 MeV) → σ^{max}(0.67 MeV) ≈ 1.4 b

D-NBI, D-plasma + ^{3}He +boron :

- ✓ $^3He(\mathbf{D},p)^4He$ (E_α = 3.6 MeV) → σ^{max}(0.42 MeV) ≈ 0.8 b

ICRH, D-plasma + ^{3}He + boron:

- ✓ $D(^3\mathbf{He},p)^4He$ (E_α = 3.6 MeV) → σ^{max}(0.63 MeV) ≈ 0.8 b



Characterisation of fast ions with γ-rays

H-beam : $^{11}B(p,\gamma)^{12}C$, $^{11}B(p,p_1\gamma)^{11}B$, $^{10}B(p,\alpha_1\gamma)^7Be$

D-beam : $^{10,11}B(d,n\gamma)^{11,12}C$, $^{11}B(d,\alpha\gamma)^9Be$, $^{10}B(d,p\gamma)^{11}B$ & $^3He(D,\gamma_{17MeV})^5Li$

^{3}He-minority : $^{11}B(^3He,pn\gamma)^{12}C$ & $D(^3He,\gamma_{17MeV})^5Li$

Kiptily, Ghani and Kazakov, APS DPP 2025; to be published in 2026 *Nucl. Fusion*

Also, see related references
- Coelho R. et al, IAEA-FEC2025;
- Kazakov Ye. et al, IAEA-FEC2025;
- Ogawa K. et al, 2024 Nucl. Fusion 64 096028;
- Kamio S. et al, 2026 Nucl. Fusion 66 036020.

α-particle diagnosis with γ-rays & neutrons

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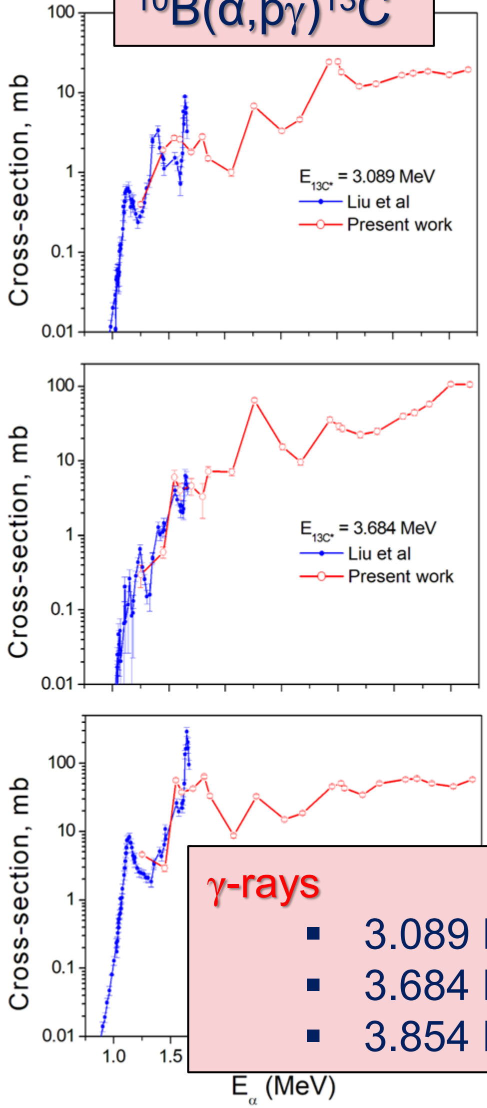
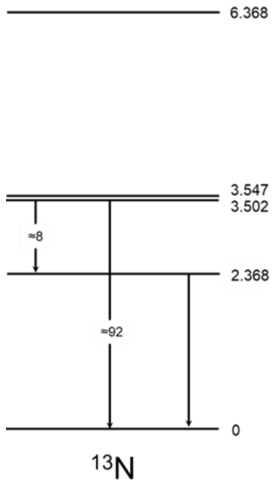
$^{10}B(\alpha,p\gamma)^{13}C$

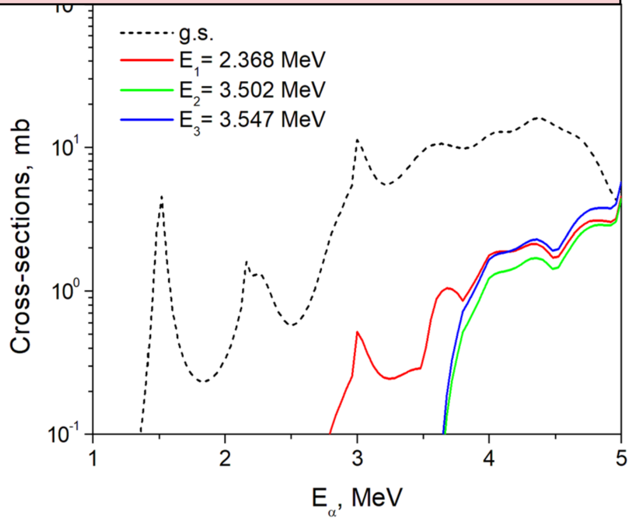


γ-rays
- 3.089 MeV
- 3.684 MeV
- 3.854 MeV

Kiptily V.G. 2025 Fusion Eng. Des. **215** 114959

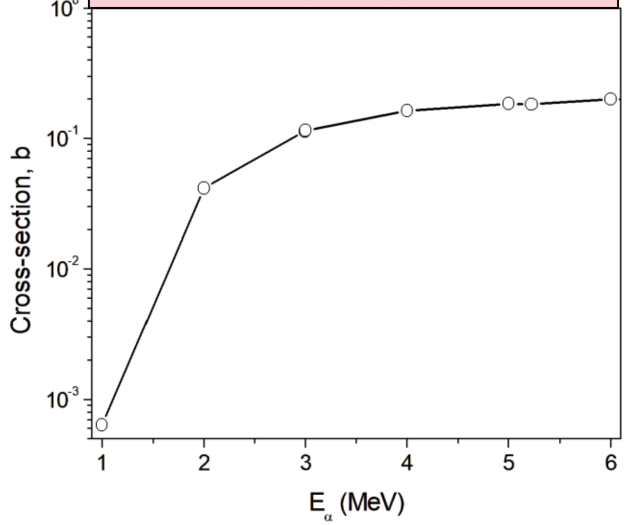
$^{10}B(\alpha,n\gamma)^{13}N$





- ✓ γ-rays
  - 2.368 MeV at E_α > 1.8 MeV
  - + 3.50 MeV at E_α > 3.4 MeV
- ✓ neutrons
  - e.g. at E_α = 1.5 MeV → E_{n0} ≈ 2 MeV

$^{11}B(\alpha,n\gamma)^{14}N$



- ✓ γ-rays
  - 2.313 MeV at E_α > 3 MeV
  - + 3.50 MeV at E_α > 4.6 MeV
- ✓ neutrons
  - e.g. E_α > 1.5 MeV → E_{n0} > 2.6 MeV

Note: 2.5 MeV neutron emission from *D(D,n)³He* reaction could be an obstacle for α-particle studies

Kiptily, Ghani and Kazakov, APS DPP 2025; to be published in 2026 *Nucl. Fusion*