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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)

Production of energetic α -particles with

H-NBI, H-plasma + boron :

✓ $^{11}\text{B}(p, 2\alpha)^4\text{He}$ ($E_\alpha < 6$ MeV) $\rightarrow \sigma^{\text{max}}(0.67$ MeV) ≈ 1.4 b

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

✓ $^3\text{He}(\text{D}, p)^4\text{He}$ ($E_\alpha = 3.6$ MeV) $\rightarrow \sigma^{\text{max}}(0.42$ MeV) ≈ 0.8 b

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

✓ $\text{D}(^3\text{He}, p)^4\text{He}$ ($E_\alpha = 3.6$ MeV) $\rightarrow \sigma^{\text{max}}(0.63$ MeV) ≈ 0.8 b

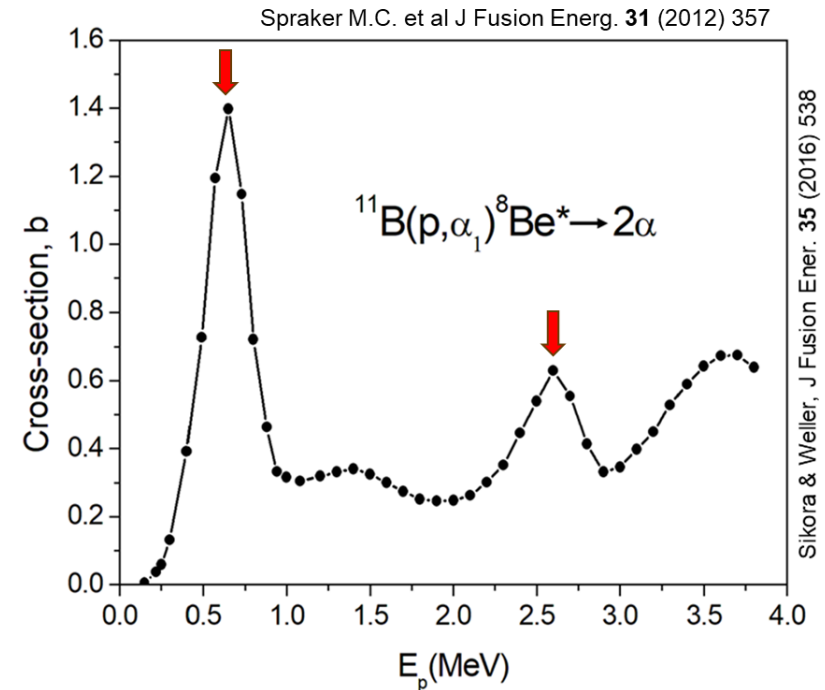
Characterisation of fast ions with γ -rays

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

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

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

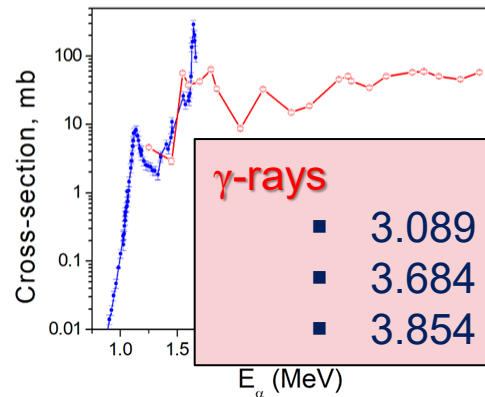
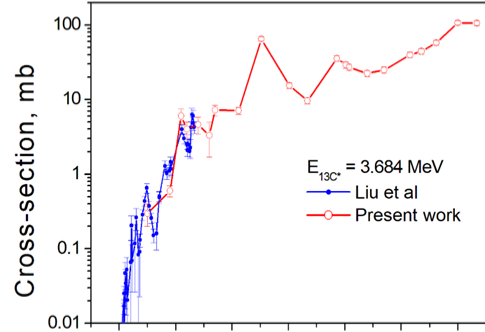
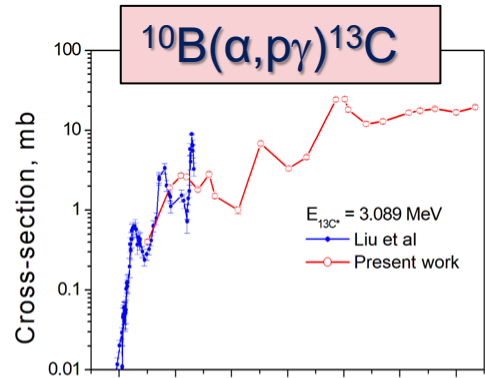
Kiptily, Ghani and Kazakov, APS DPP 2025; to be published in 2026 Nucl. Fusion



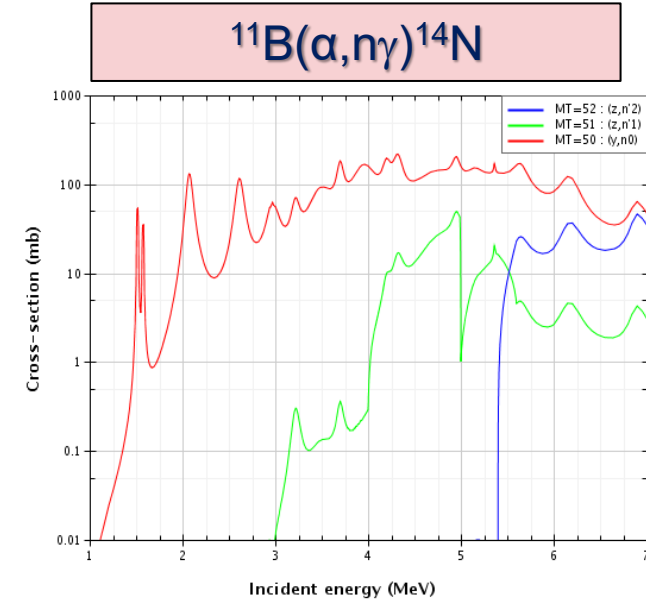
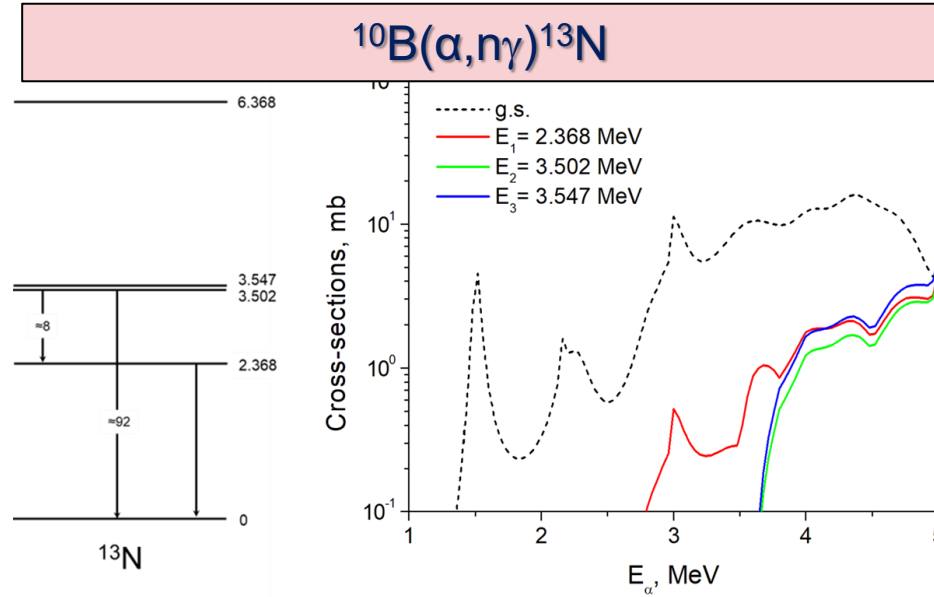
Also, see related references

- 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



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



- ✓ γ -rays
 - 2.368 MeV at $E_\alpha > 1.8$ MeV
 - + 3.50 MeV at $E_\alpha > 3.4$ MeV
 - ✓ neutrons
 - e.g. at $E_\alpha = 1.5$ MeV $\rightarrow E_{n0} \approx 2$ MeV
- Note: 2.5 MeV neutron emission from $D(D,n)^3He$ reaction could be an obstacle for α -particle studies

- ✓ γ -rays
 - 2.313 MeV at $E_\alpha > 3$ MeV
 - + 1.635 MeV at $E_\alpha > 4.6$ MeV
- ✓ neutrons
 - e.g. $E_\alpha > 3.6$ MeV $\rightarrow E_{n0} > 2.6$ MeV

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