Characterisation of (p,α) and (p,γ) Decays in Proton-^{11}B Collision

Simulation Insights into α-Particle and γ-Ray Spectra for Detector Placement

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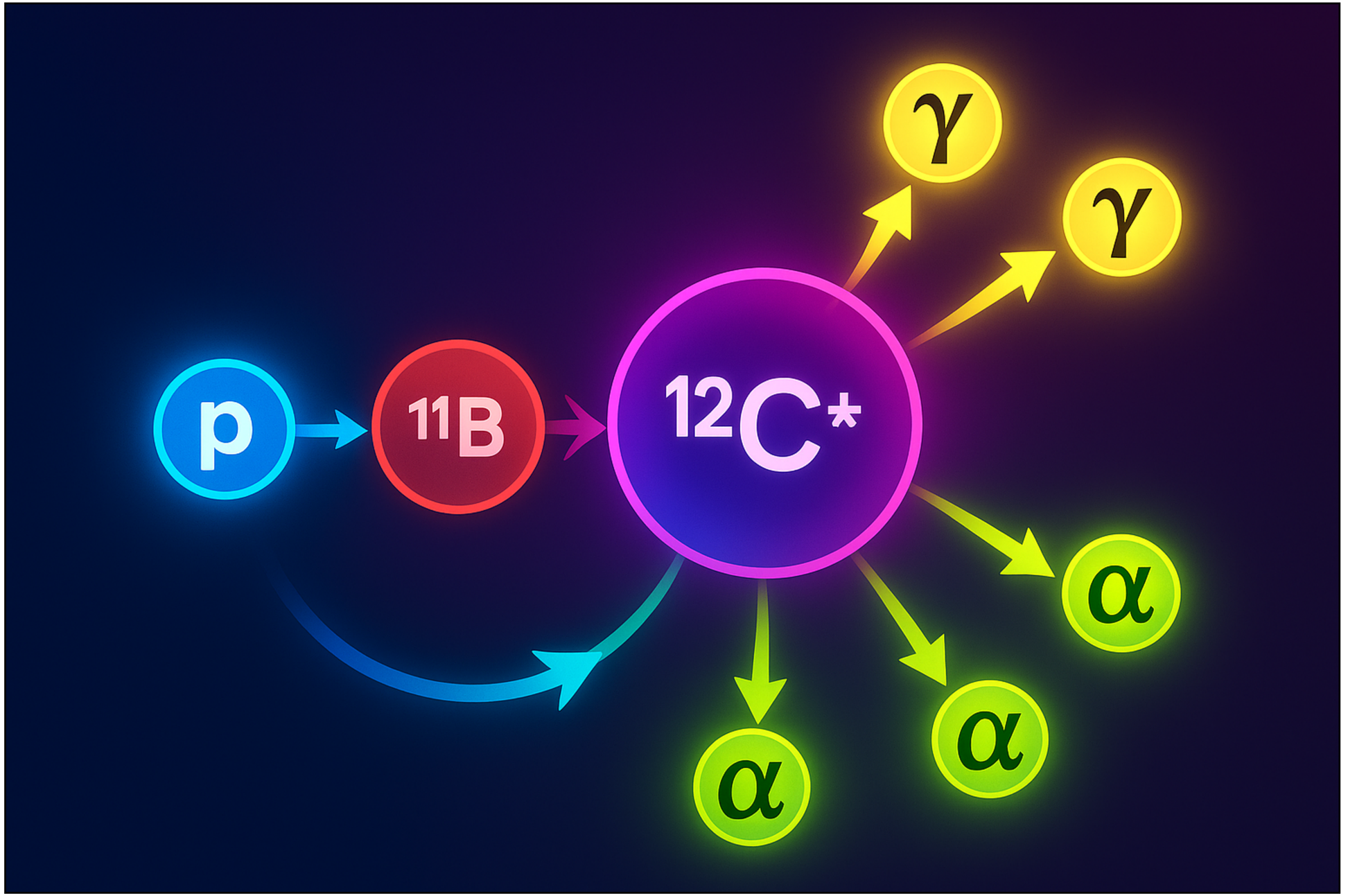
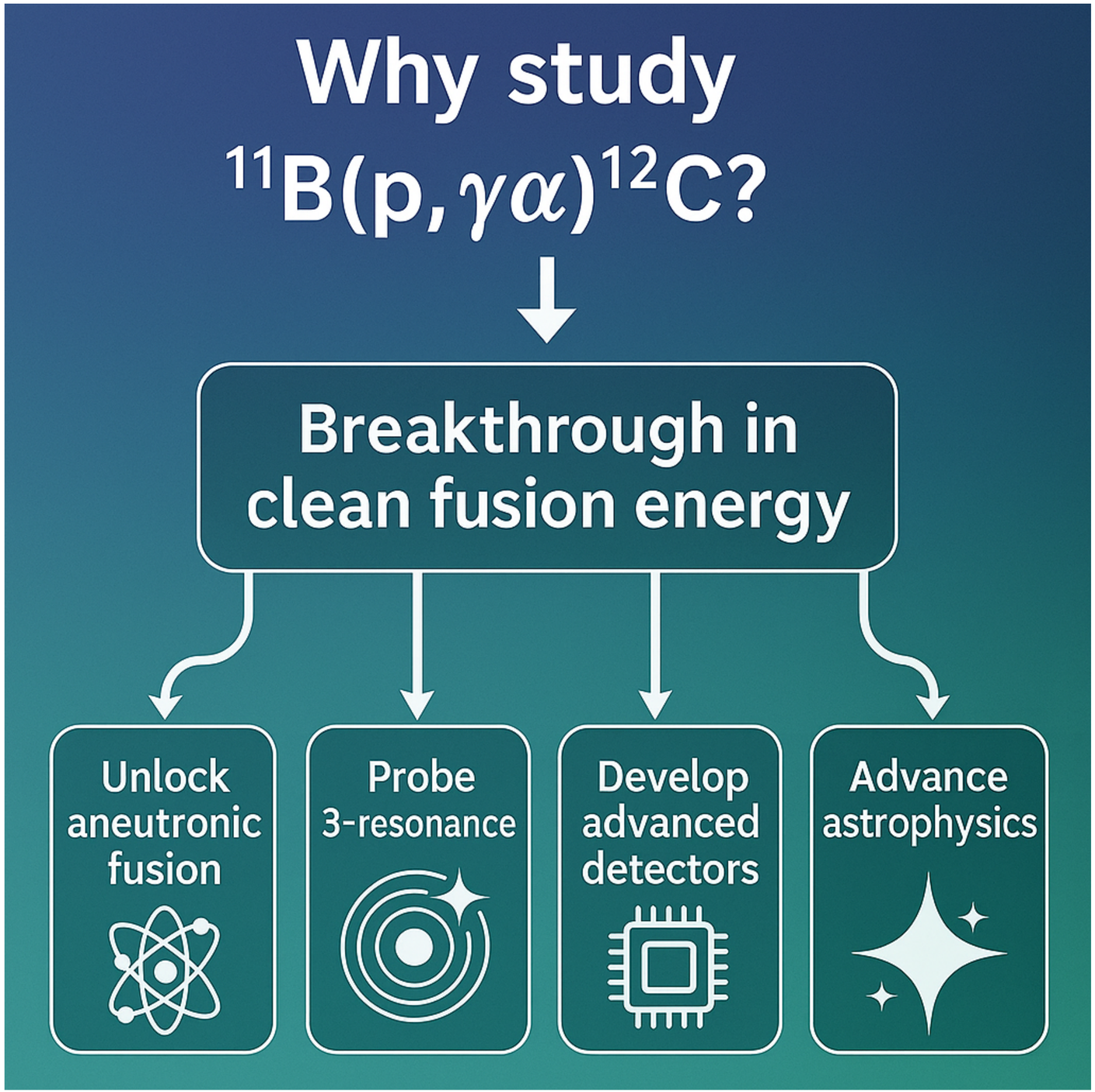
Hadron & Nuclear Physics Lab

Reaction Description



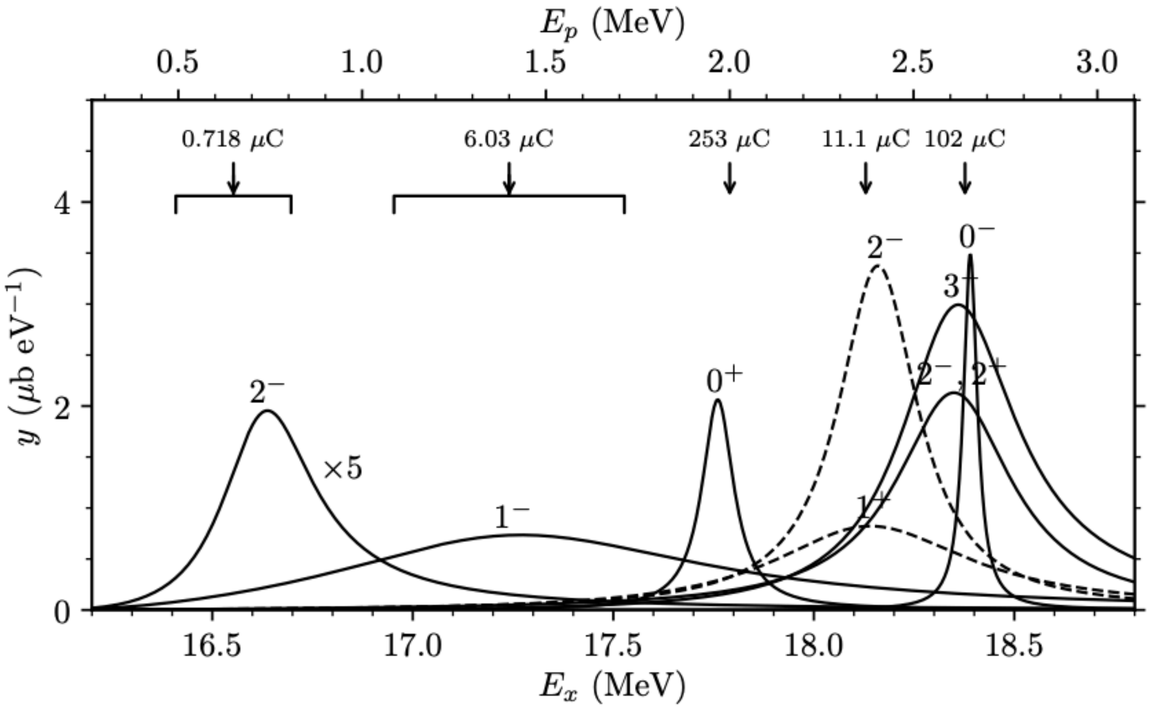

Why study
$^{11}B(p,\gamma\alpha)^{12}C$?
Breakthrough in clean fusion energy
Unlock aneutronic fusion
Probe 3-resonance
Develop advanced detectors
Advance astrophysics

Reaction Channel

Table 1: Minimum Proton Beam Thresholds for a proton beam on ^{11}B

Channel type	Reaction notation	Q-value (MeV)	Min Ep threshold
Elastic scattering	$^{11}\mathrm{B}(p,p)^{11}\mathrm{B}$	0	0
Inelastic scattering	$^{11}\mathrm{B}(p,p)^{/1}\mathrm{B}^{*} \rightarrow {}^{11}\mathrm{B} + \gamma$	2.12	0.10
Radiative capture	$^{11}\mathrm{B}(p,\alpha)^{12}\mathrm{C}$	15.96	0
Aneutronic fusion	$^{11}\mathrm{B}(p,\alpha)^{8}\mathrm{Be} \rightarrow 3\alpha$	8.70	0
Neutron emission	$^{11}\mathrm{B}(p,n)^{11}\mathrm{C}$	−3.30	3.30
Deuteron emission	$^{11}\mathrm{B}(p,d)^{10}\mathrm{B}$	−9.20	9.20
Helium-3 emission	$^{11}\mathrm{B}(p,{}^{3}\mathrm{He})\mathrm{Be}$	+1.50	11.50
Triton emission	$^{11}\mathrm{B}(p,t)^{9}\mathrm{C}$	28.40	28.40
Two-proton emission	$^{11}\mathrm{B}(p,2p)^{10}\mathrm{Be}$	20	−30
Two-proton emission		20	−30

Carbon Excitation Level Plan



Thick Target Resonance Scan

$\hat{E}_x$ (MeV)	Γ (keV)	Γ_p (keV)	J^π	T
16.62(5)	280(28)	150	2^-	1
17.23	1150	1000	1^-	1
17.768	96(5)	76	0^+	1
18.13	600(100)	-	(1^+)	(0)
18.16(7)	240(50)	-	(2^-)	(0)
18.35(5)	350(50)	68	3^-	1
18.35(5)	350(50)	-	$2^-, 2^+$	$0+1$
(18.39)	42	33	0^-	(1)

Known levels in ^{12}C between 16.5 MeV and 18.5 MeV.

$$y(E_x) = 4\pi\lambda^2\omega f(E_x)/\Gamma \qquad \sigma_{\gamma,\mathrm{R}} = 4\pi\lambda^2\omega\Gamma_p\Gamma_\gamma/\Gamma^2$$

Ref:- O. S. Kirsebom et.al

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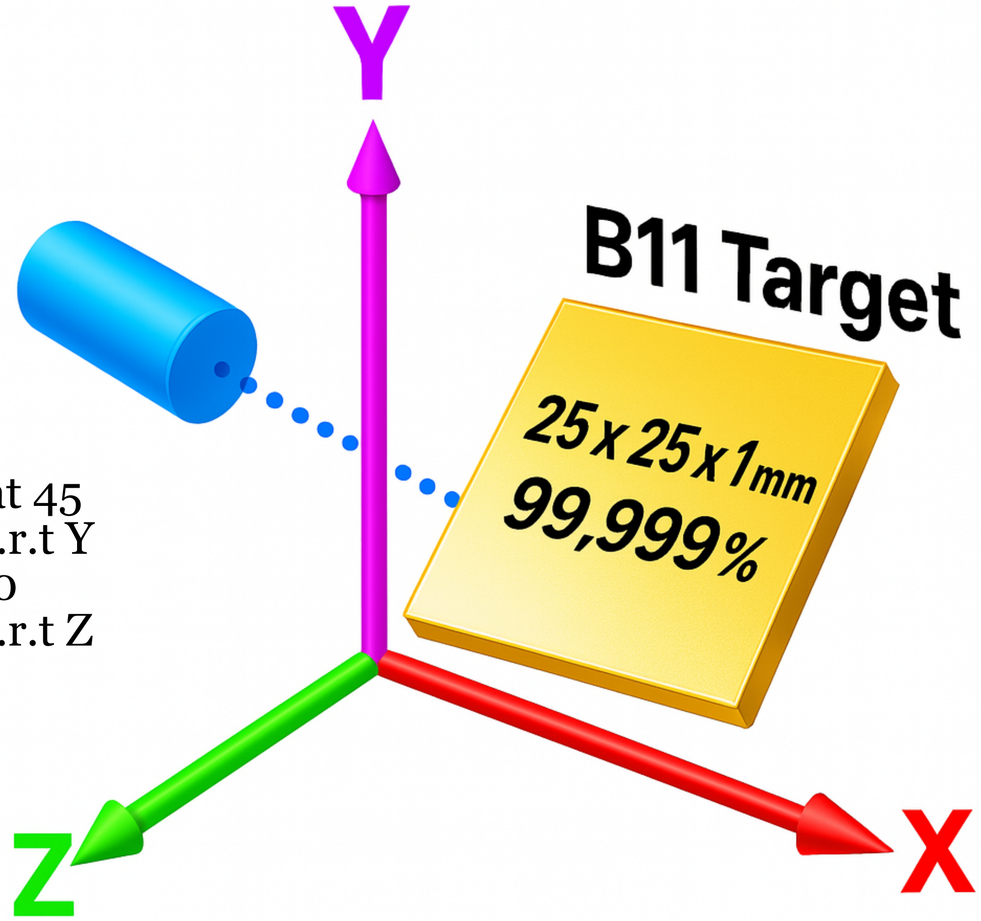
Target Description

Target is at 45 degrees w.r.t Y and by 180 degrees w.r.t Z axis



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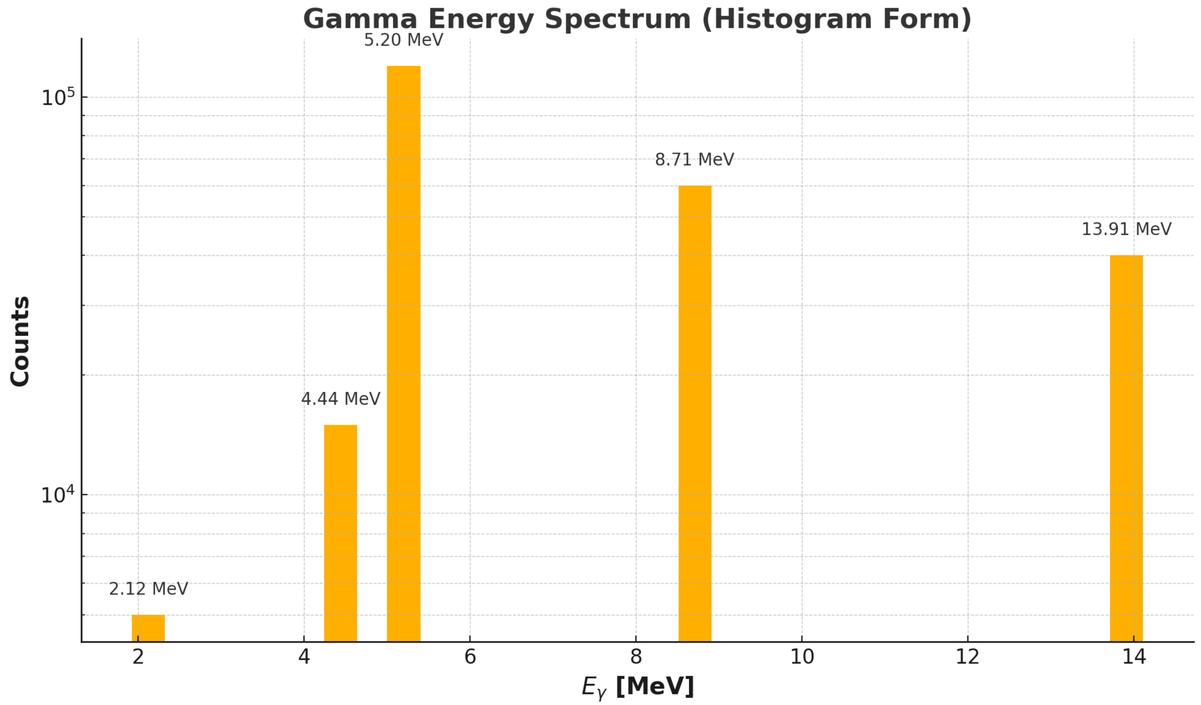
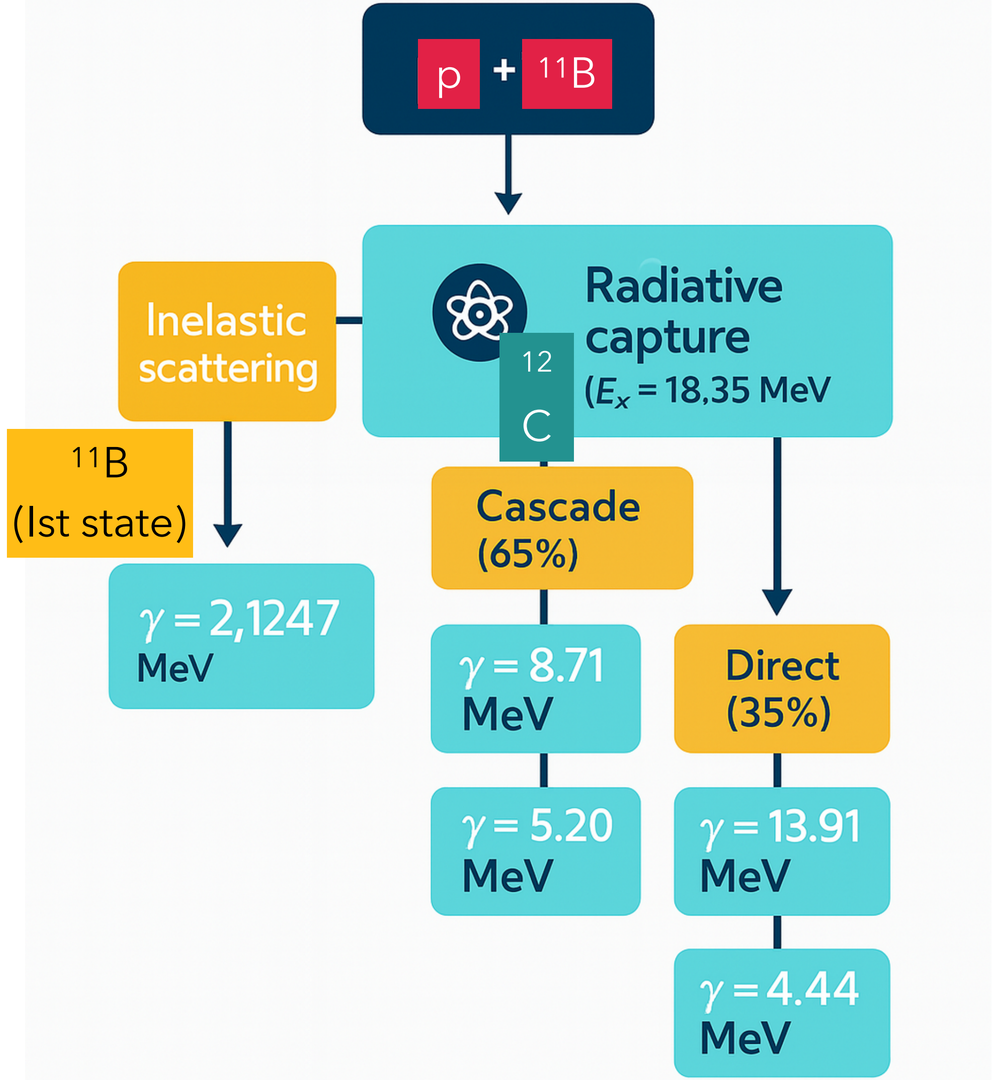
Expected Generation of Gamma Energ





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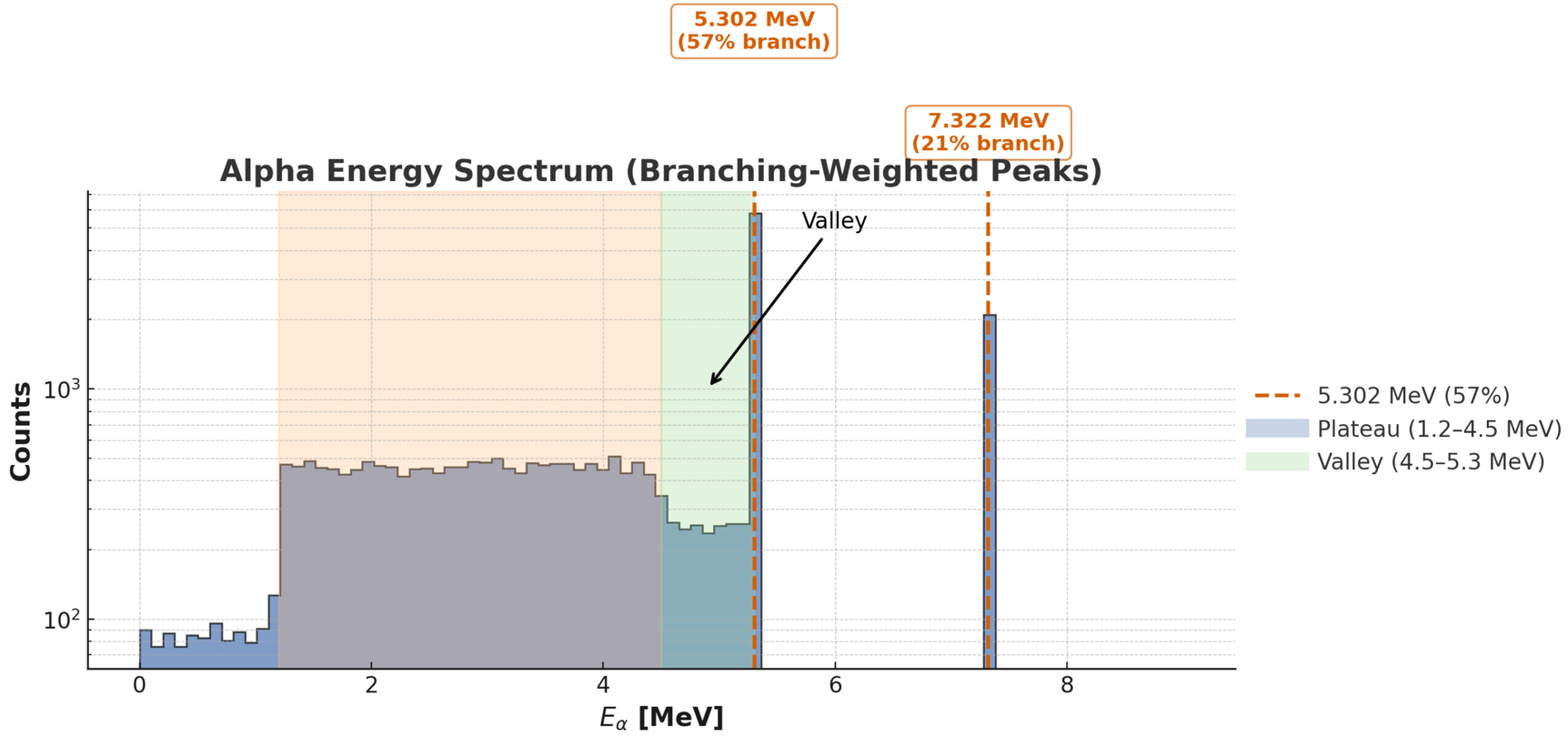
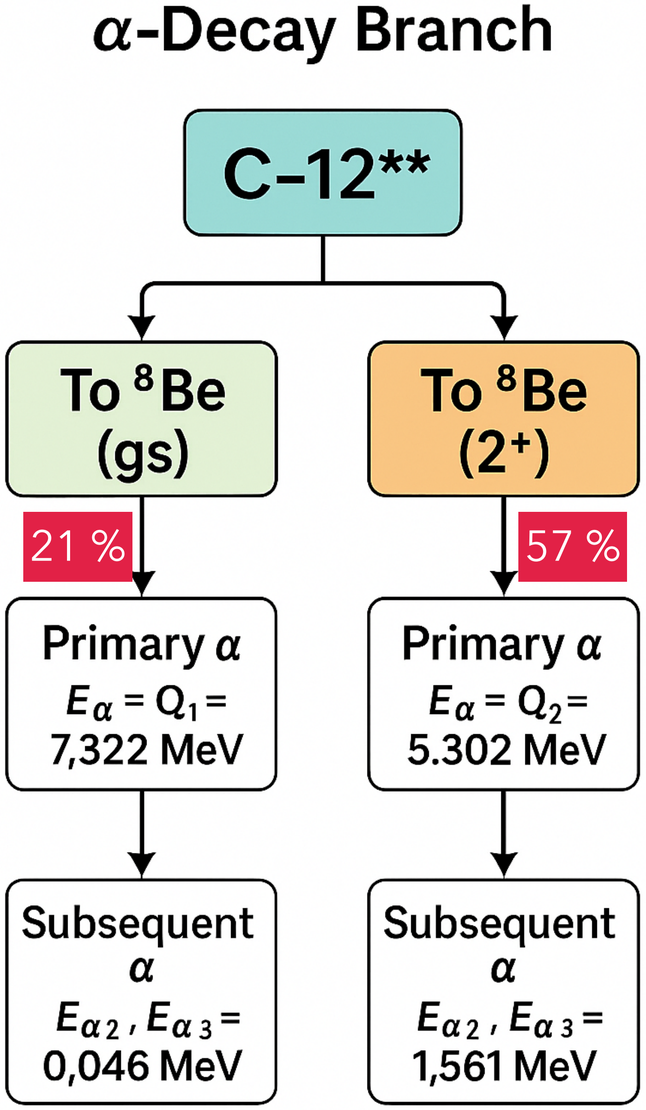
Expected Generation of Alpha Energy





Ref:-NNDC/ TUNL evaluation

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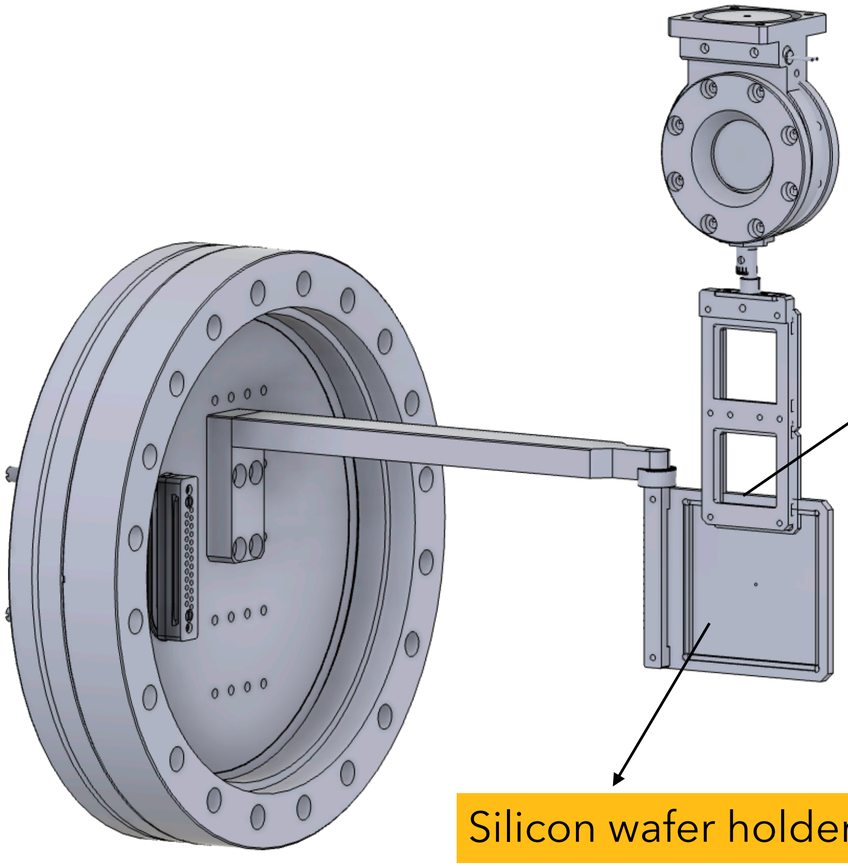
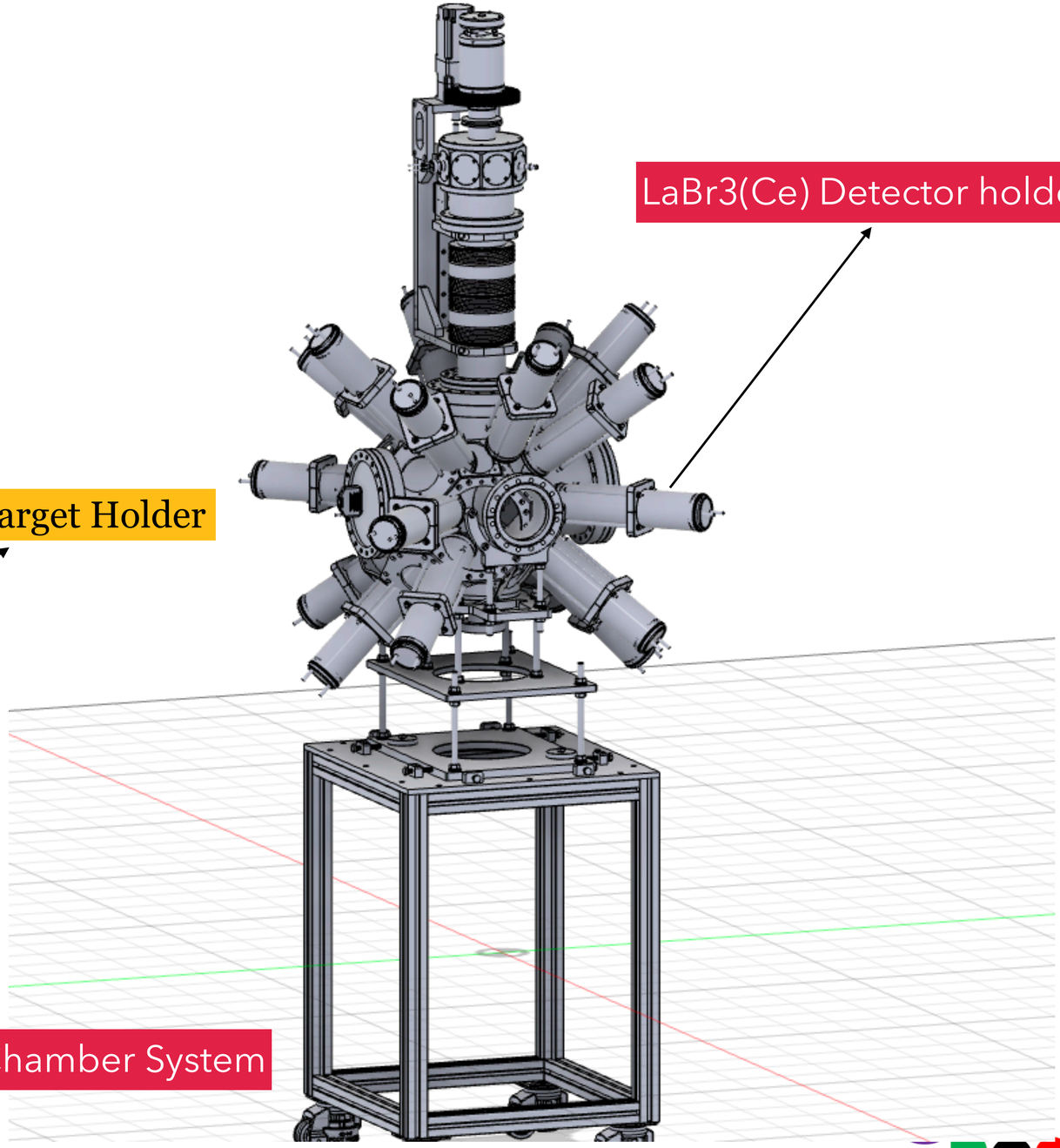
Target Placement



Target Holder

Silicon wafer holder



LaBr3(Ce) Detector holder

Whole Chamber System

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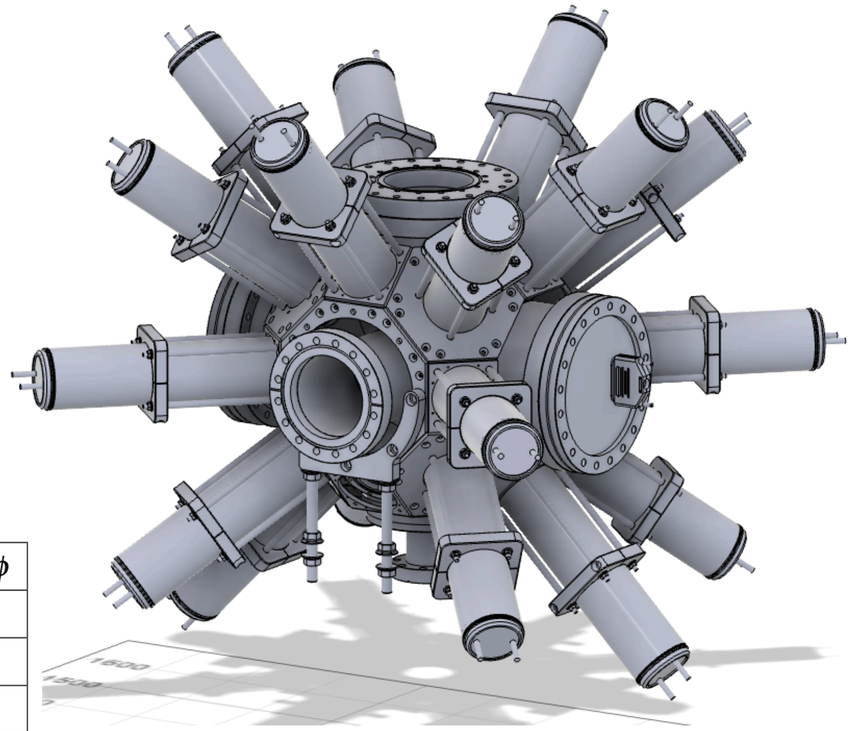
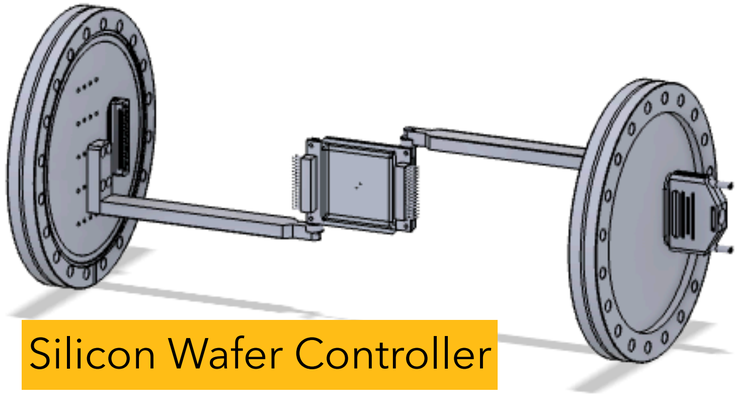
Detector Placement





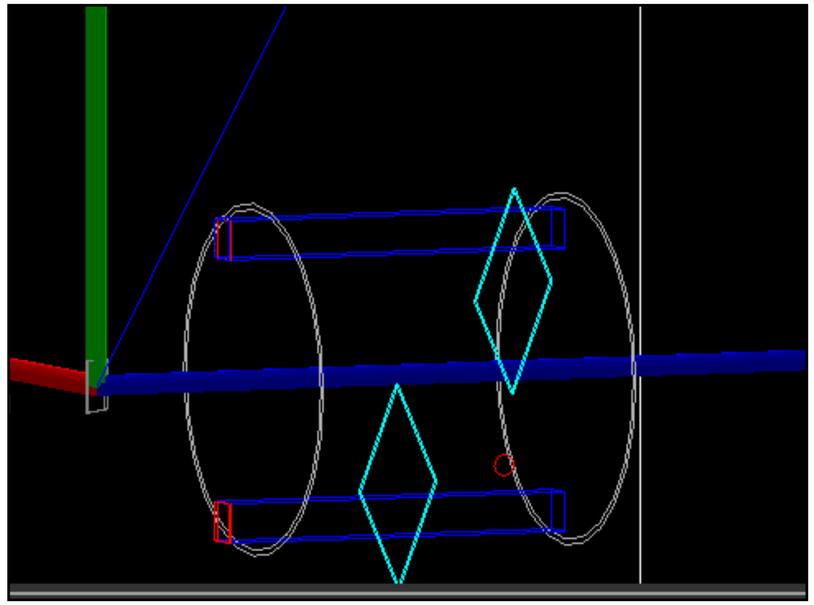
Silicon Wafer Controller

LaBr3(Ce)
Angle Position

Channel	Polar Angle θ	azimuthal Angle ϕ
0	54.7°	135°
1	54.7°	45°
2	45°	0°
3	90°	135°
4	90°	45°
5	125.3°	135°
6	135°	90°
7	125.3°	45°
8	135°	0°
9	135°	180°

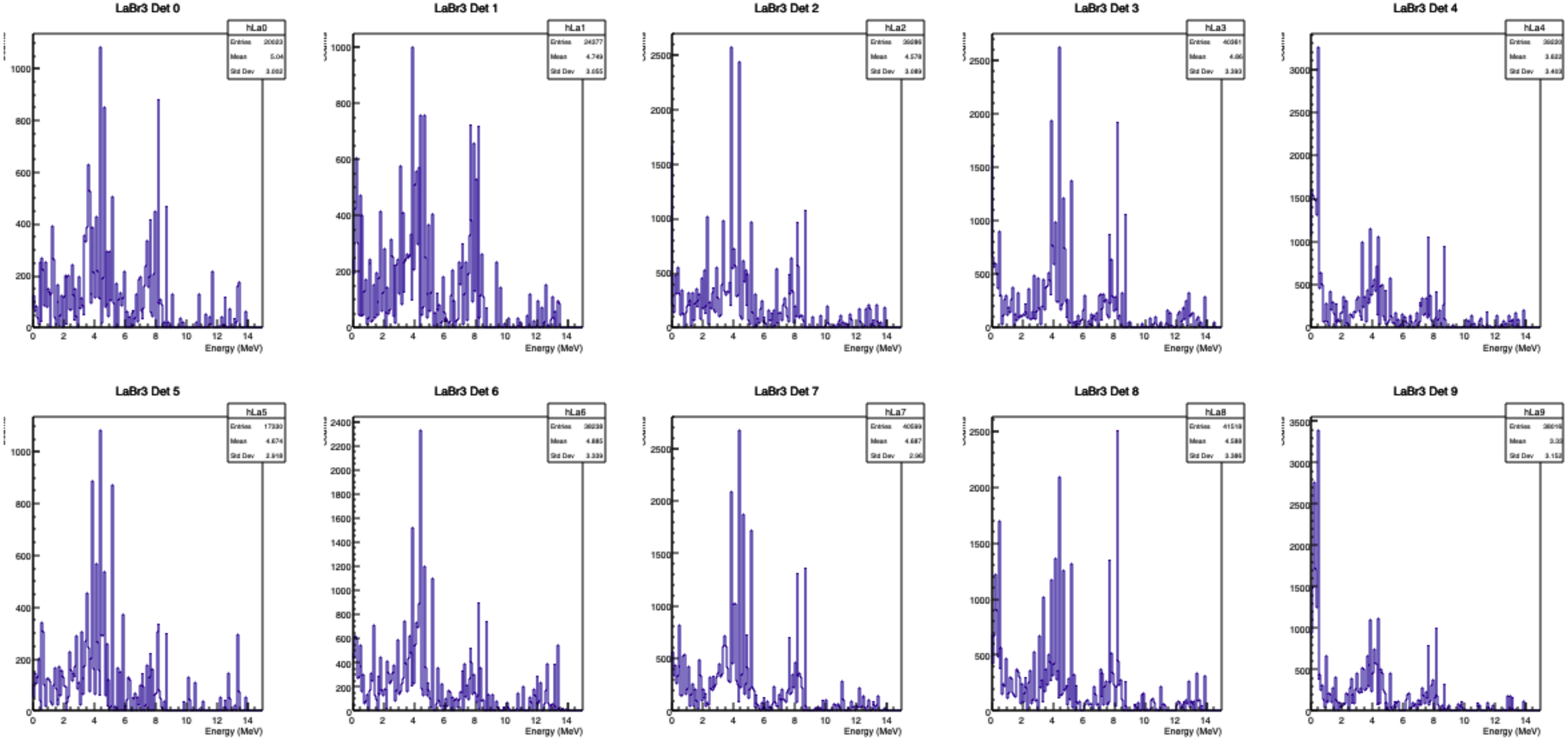
Orientation Of Silicon Detector in the simulation—

(1) Z(+45 deg.) Y(+90 deg) (2) Z(-45 deg.) Y(+90 deg.)

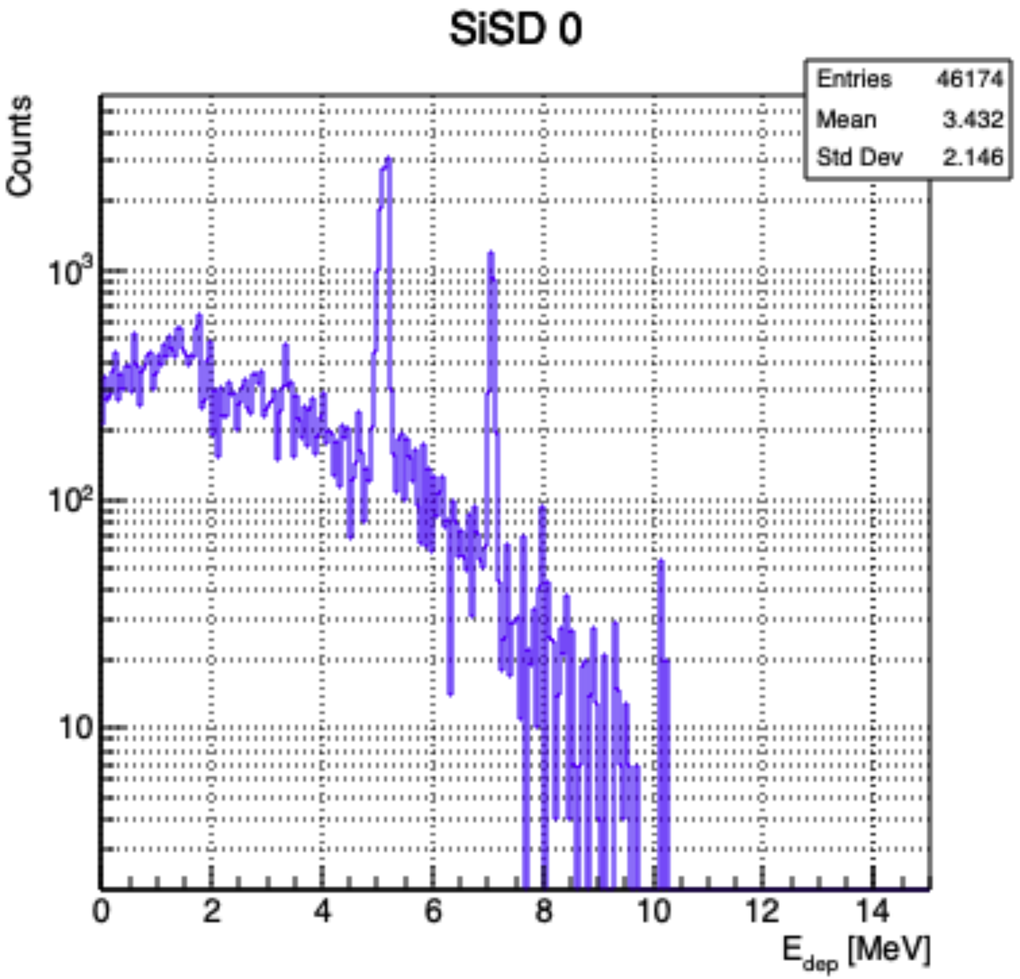


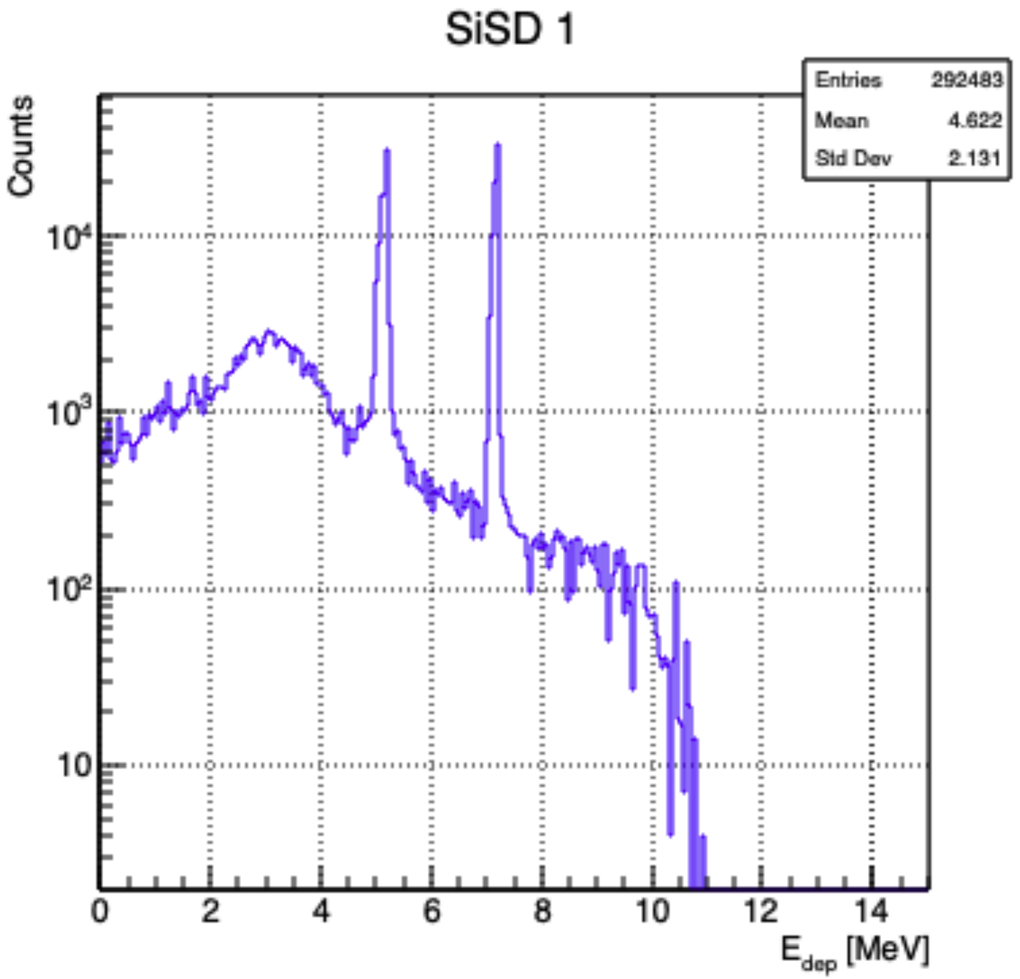
Simulated Setup for
Silicon Detector

Simulated Detection of Gamma Energy



Simulated Detection of Alpha Energy





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Future Plan

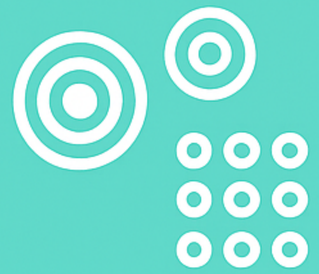
Completed GEANT4 simulation

(1 mm B–11 target)

Experiment at KIST beam center

(1 mm target, e.g., 2 Si detectors)

Future improvements



- Thin targets (< 1 mm)
- Increased number of silicon detectors (e.g, array)

Improved measurement precision

(angular/energy resolution)

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Thank You