Study of the nuclear reaction

$$^{7}Li + ^{2}H \rightarrow ^{8}Li + ^{1}H$$

E. Vardaci

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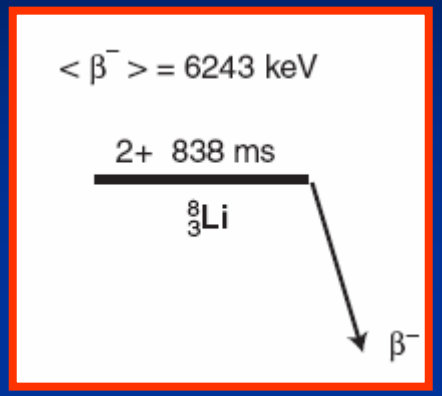
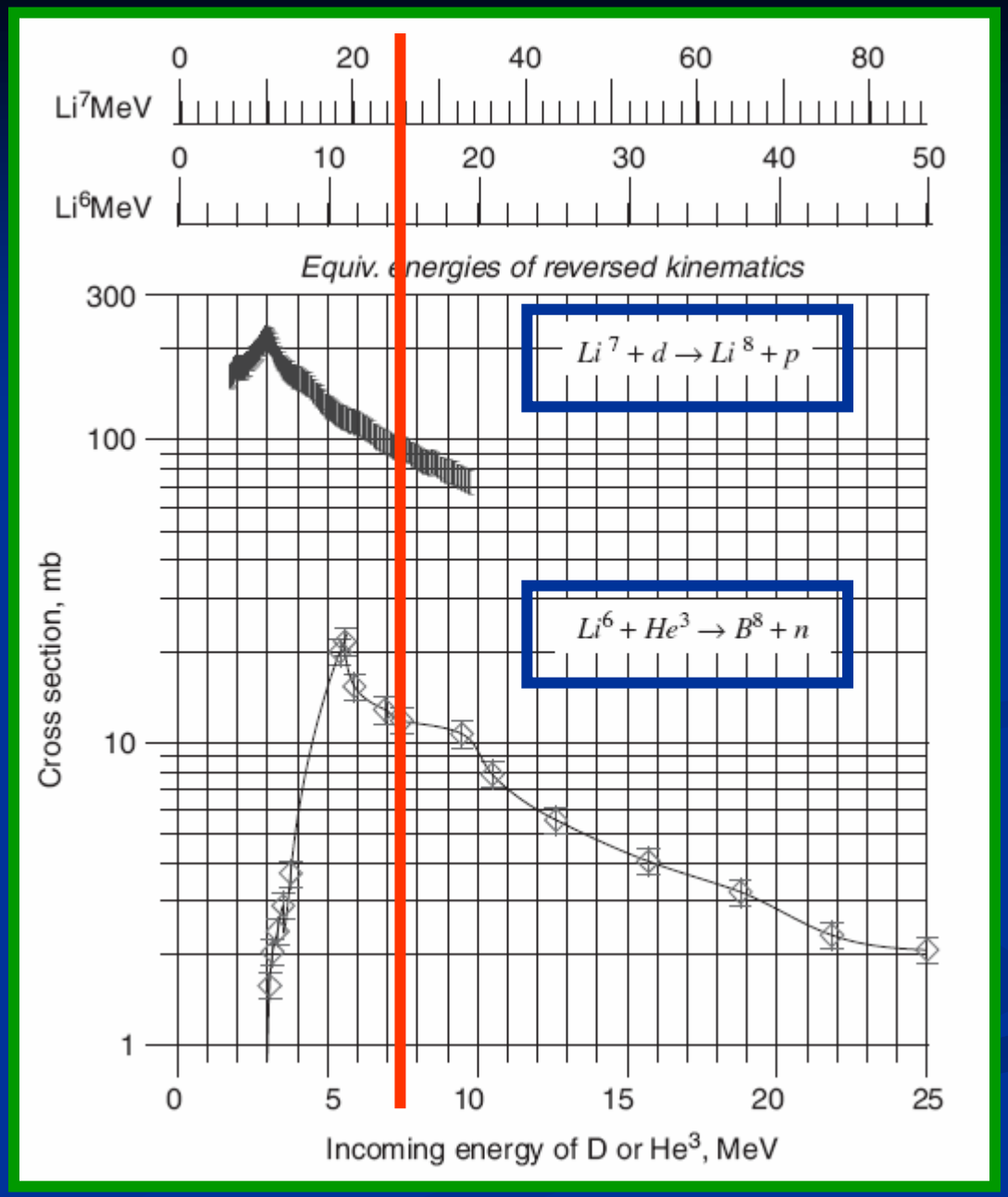


E_{lab} = 25MeV



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Questions

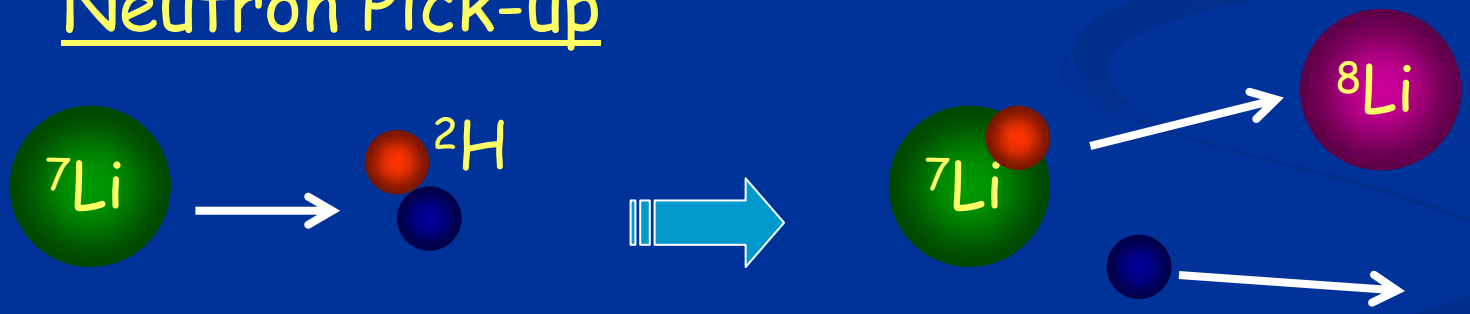
1. What is the angular distribution of ^{8}Li
2. How big is the cross section for the ^{8}Li production

Two possible mechanisms

Formation and decay of a compound nucleus

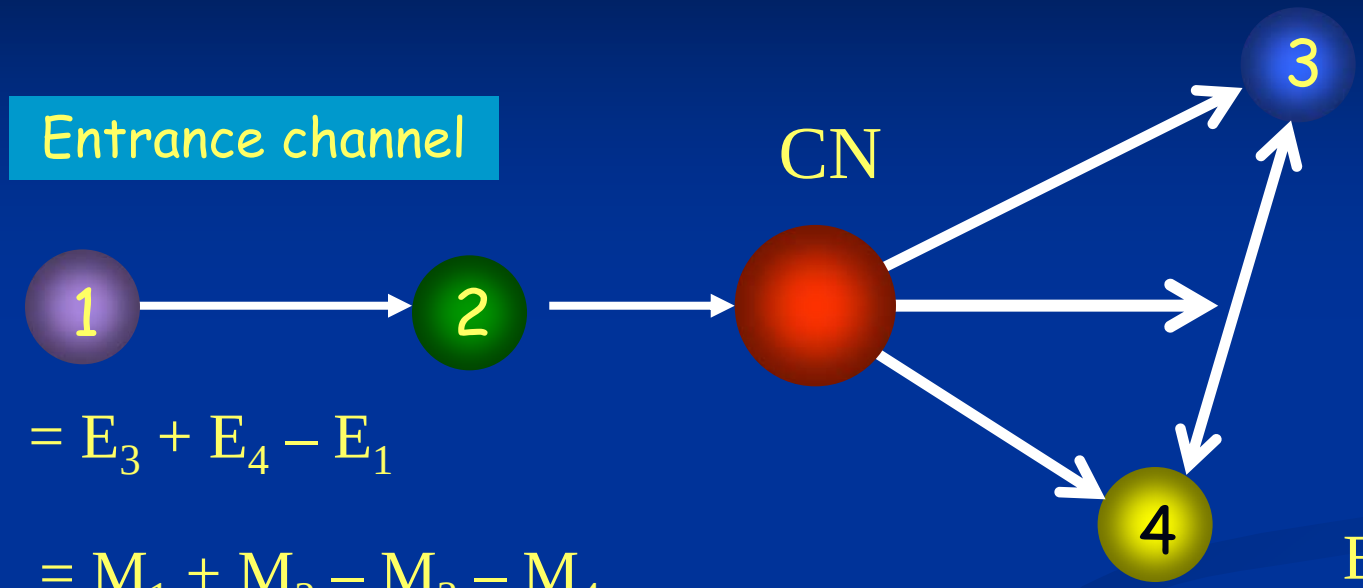
$$^{7}Li + ^{2}H \rightarrow ^{9}Be^{*} \rightarrow ^{8}Li + ^{1}H$$

Neutron Pick-up



Proton is a spectator

Two Body Kinematics 1/2



$Q = E_3 + E_4 - E_1$

$Q_{gg} = M_1 + M_2 - M_3 - M_4$

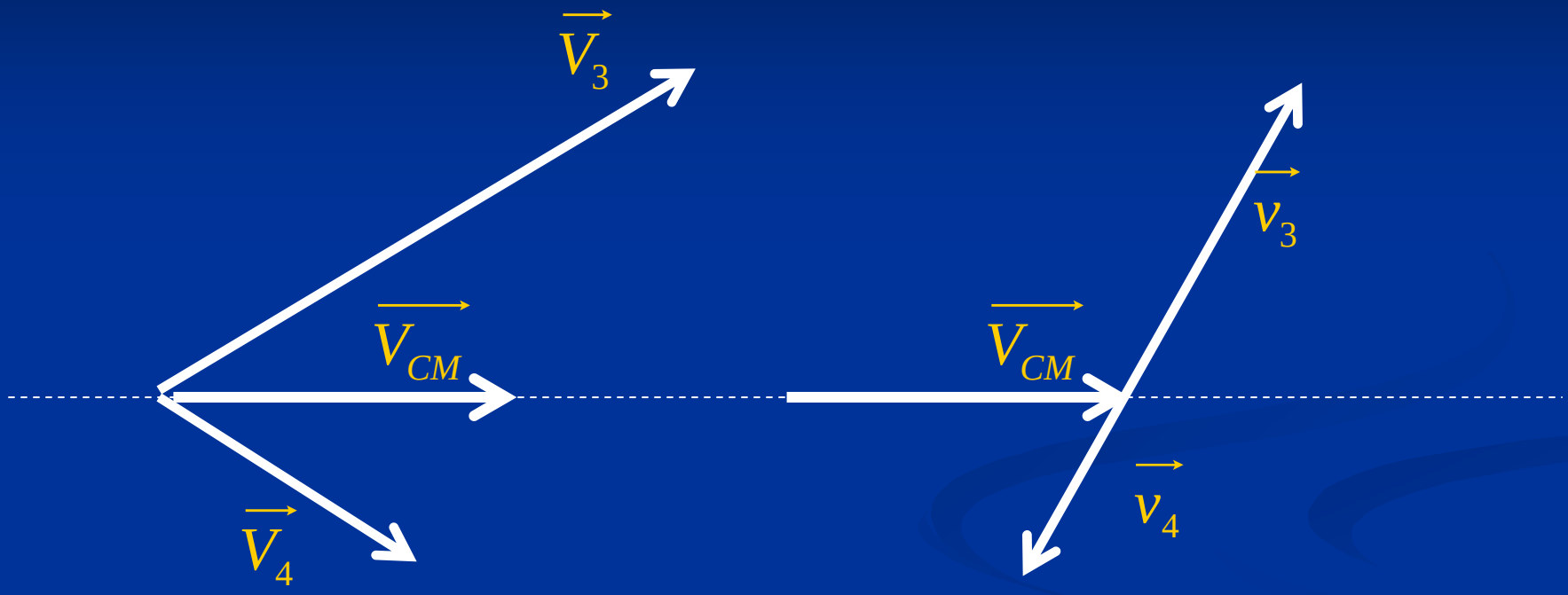
$Q_{fu} = M_1 + M_2 - M_{CN}$

$E_{Lab} = T_0 + T_{CM}$

$E_1 + Q = E_3 + E_4$

$^{7}Li + ^{2}H \rightarrow ^{9}Be^{*} \rightarrow ^{8}Li + ^{1}H$

Two Body Kinematics 2/2



Angles and velocities in the LAB frame and CM frame are correlated

Proposed experiment @ LNL

$^{7}Li + ^{208}Pb$ Elab = 30 - 40 MeV

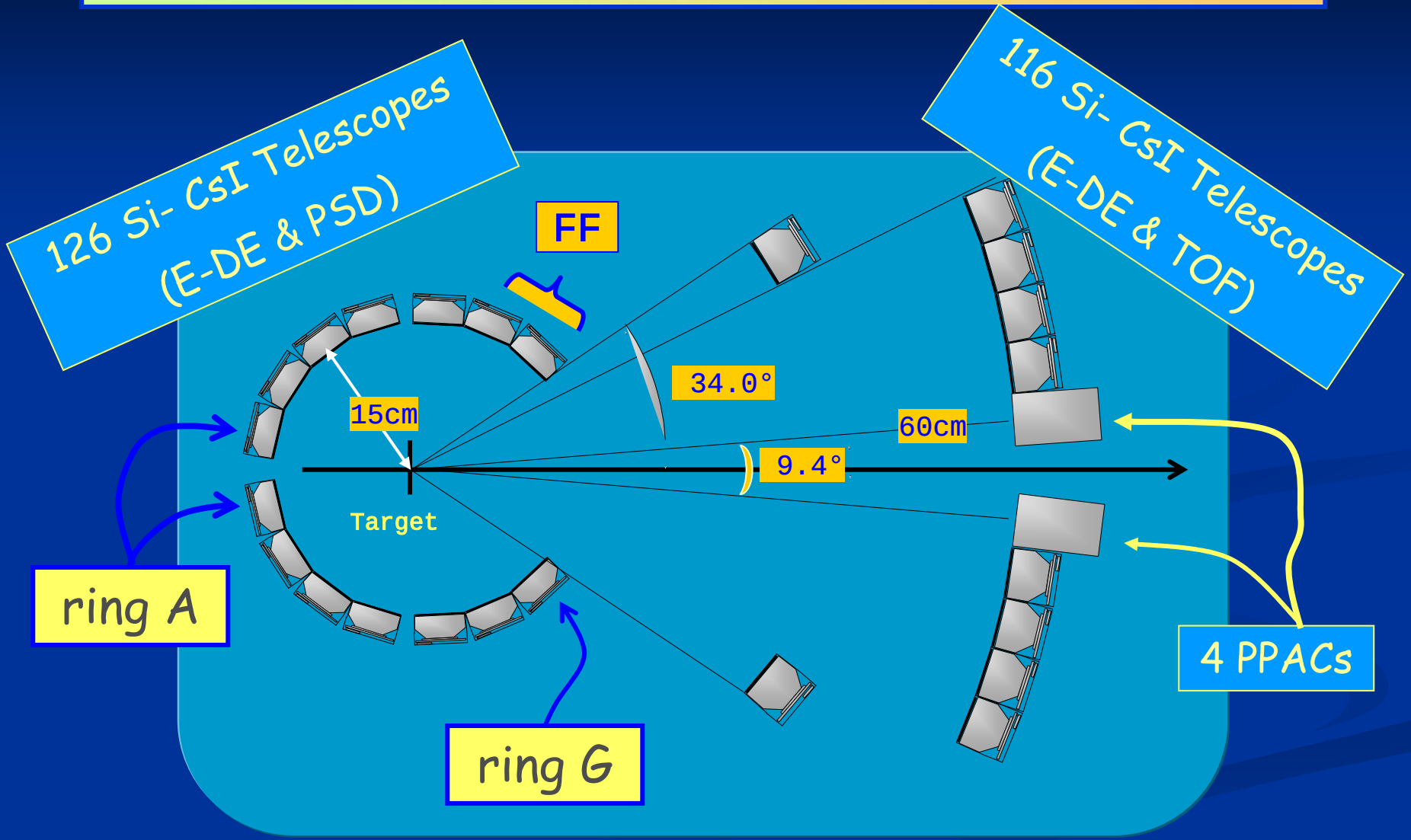
1. What is the implication of the binding energy on the breakup?
2. What is the percentage of exclusive breakup in ^{7}Li

Pros:

1. $^{7}Li \rightarrow \alpha + t$
2. Channel with negligible pollution

Purpose: evaluate the contribution of non-capture breakup in the inclusive α production from α-t angular correlations over 4π

8πLP layout


126 Si- CsI Telescopes
(E-DE & PSD)
116 Si- CsI Telescopes
(E-DE & TOF)
FF
15cm
34.0°
60cm
9.4°
Target
ring A
ring G
4 PPACs

The 8πLP setup

MAX ENERGY

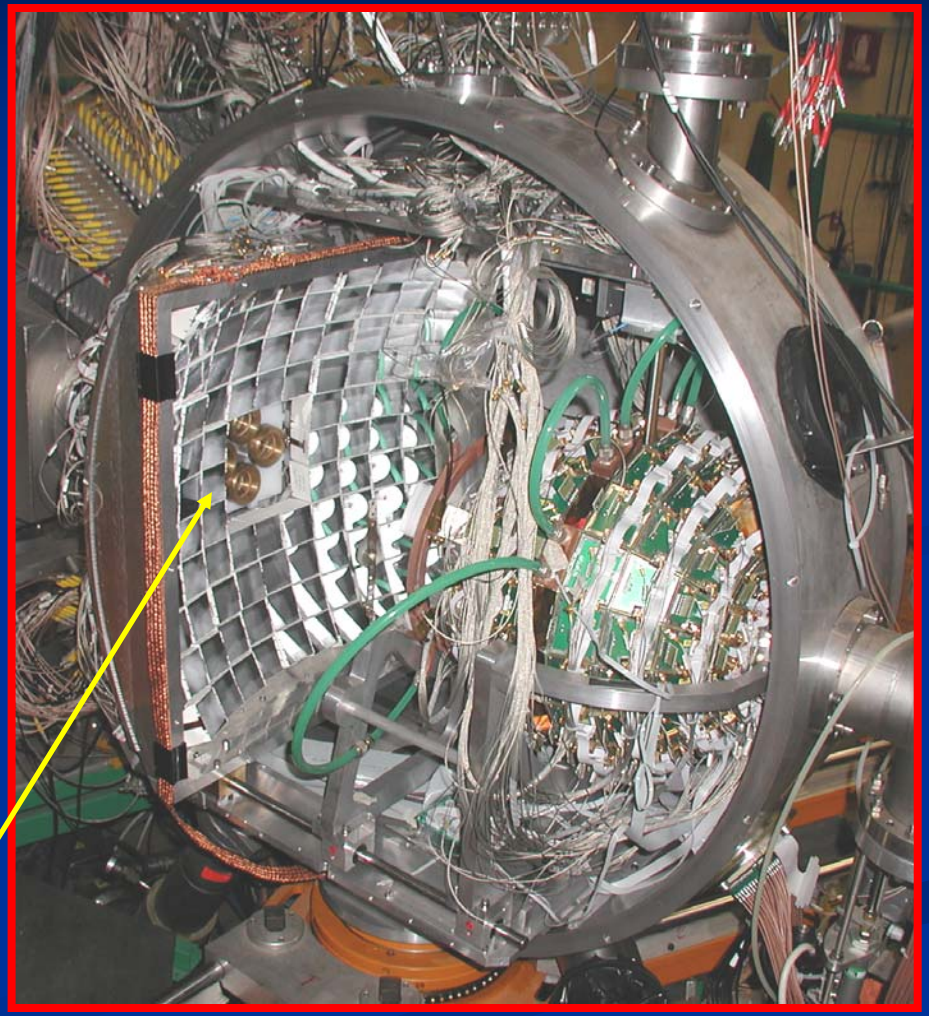
Wall: up to 64 AMeV
Ball : up to 34 AMeV

ENERGY THRESHOLDS

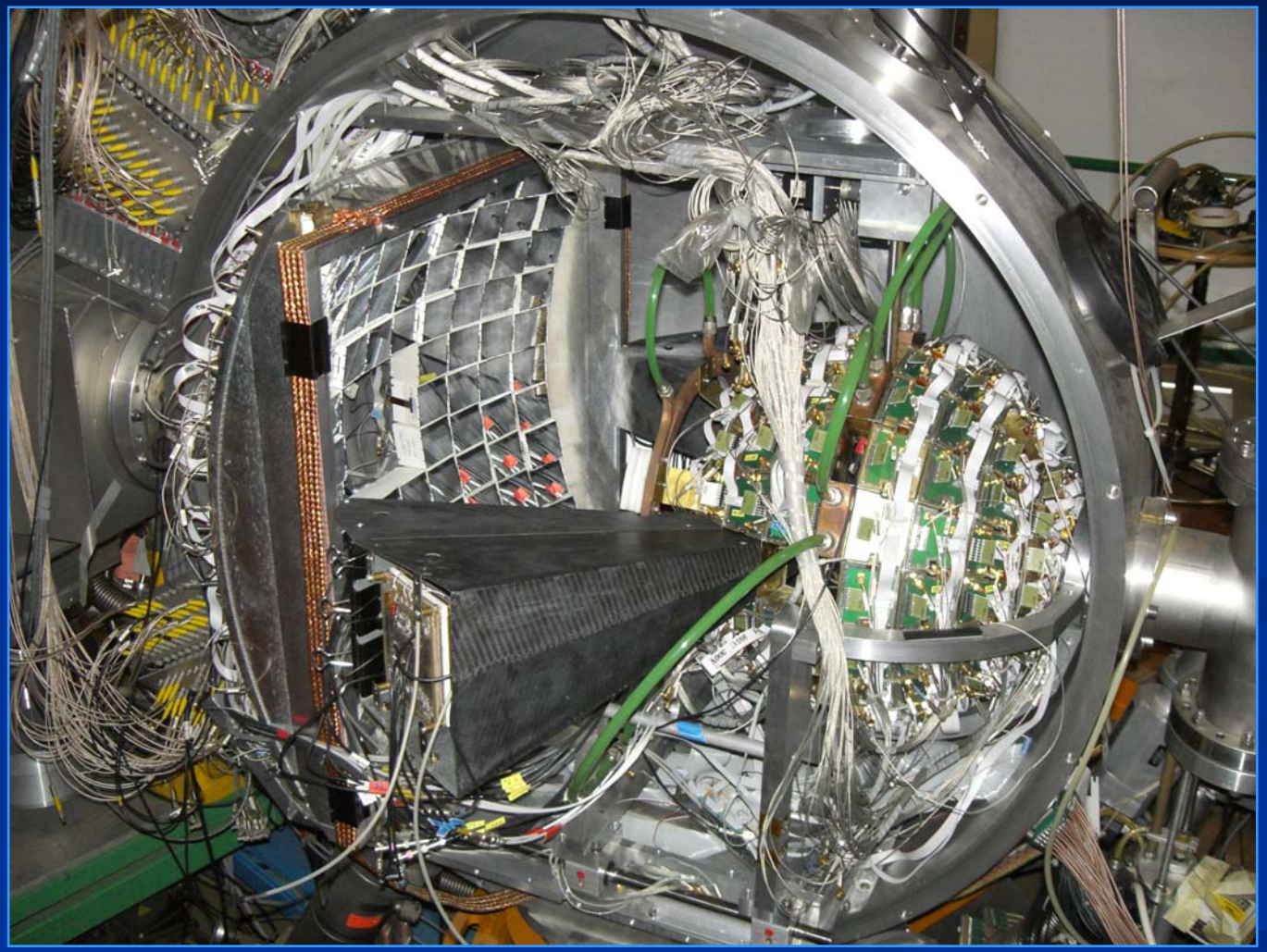
0.5 AMeV for *p* and α
2-3 AMeV for ^{12}C

TRIGGERS

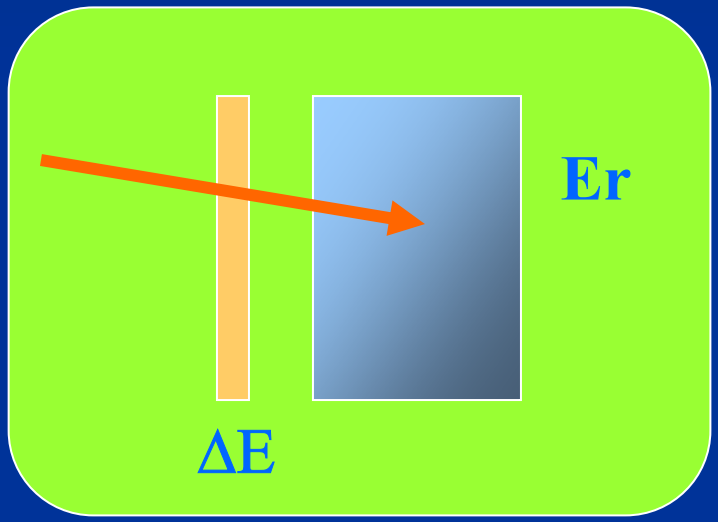
Fission Fragments in ring E/F/G
CORSET (E. Kozulin group, FLNR)
Evaporation Residues (4 PPAC- PPAC)

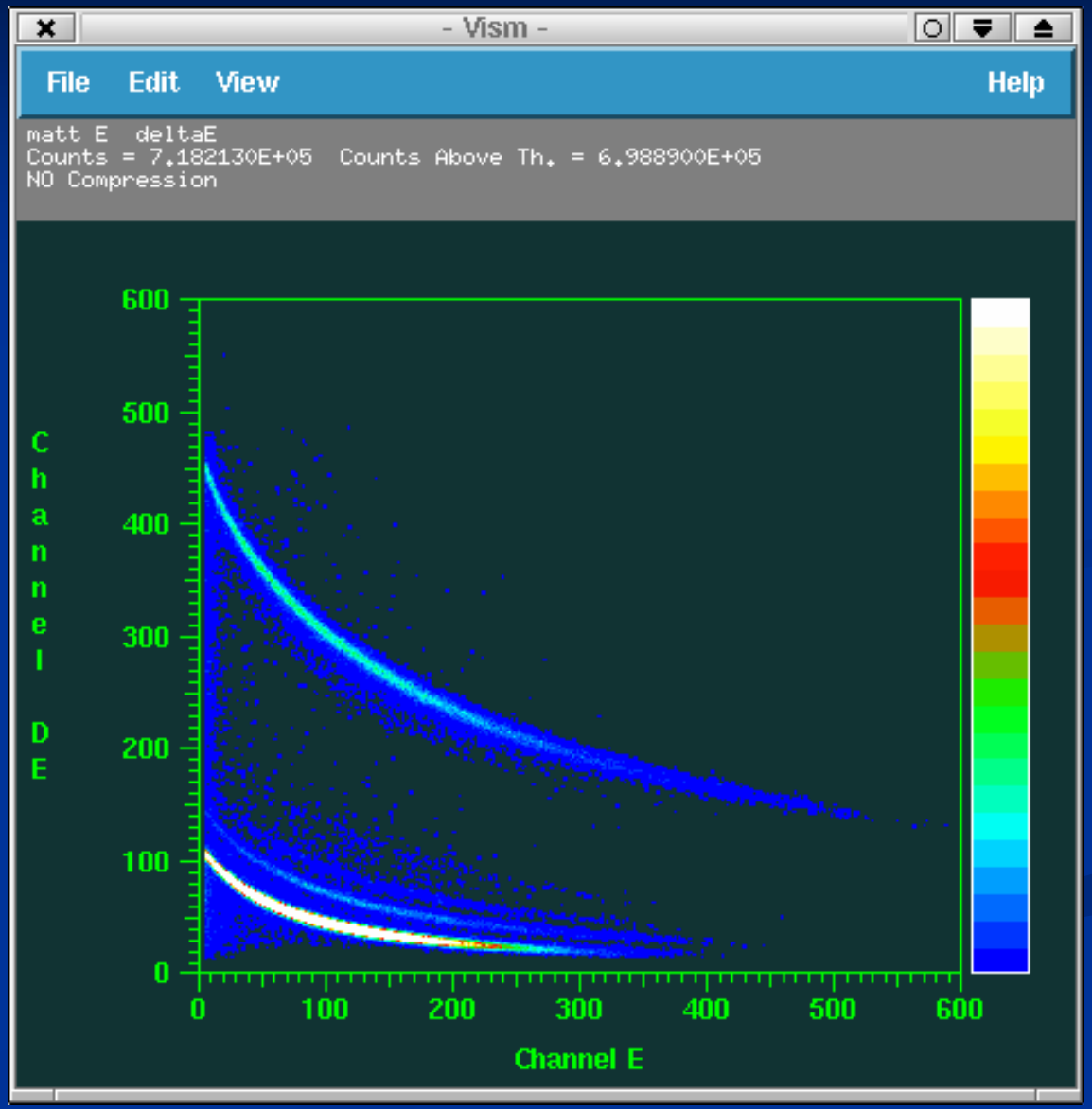


8πLP - CORSET TOF



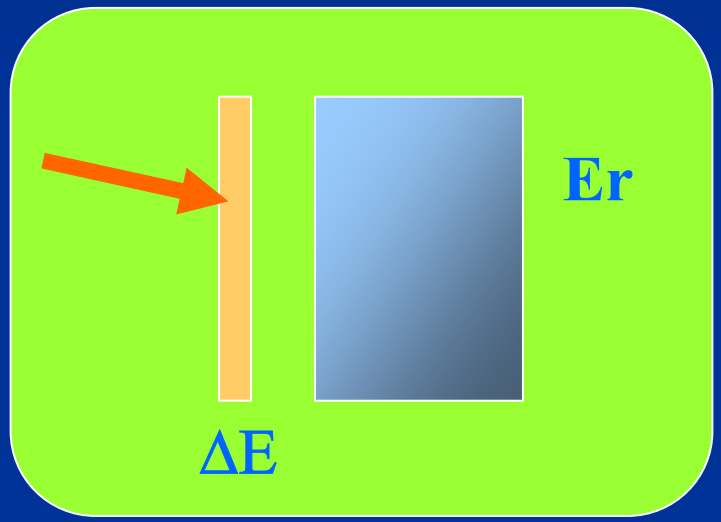
E- ΔE Technique

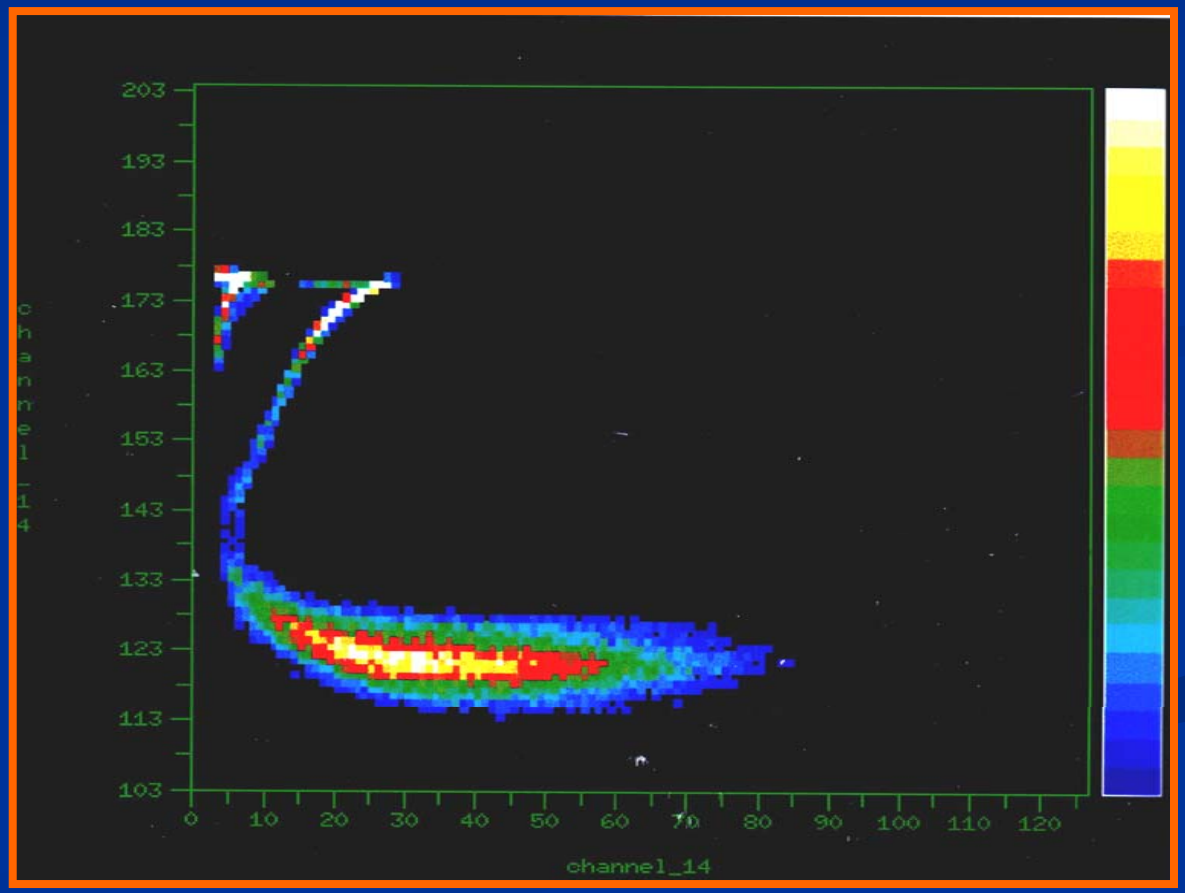




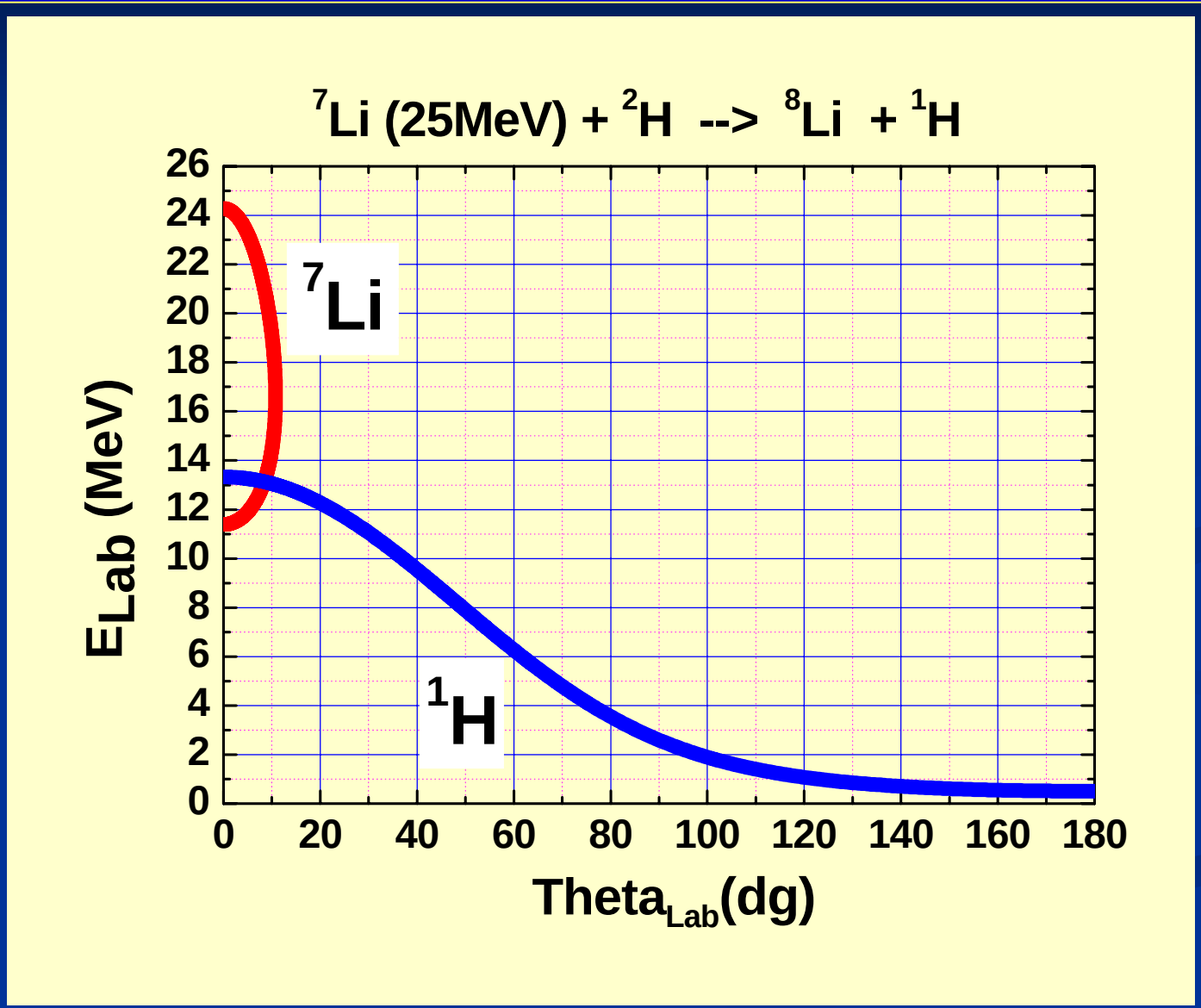
PSD Technique

Used for particles that stop in the first stage of the telescope.

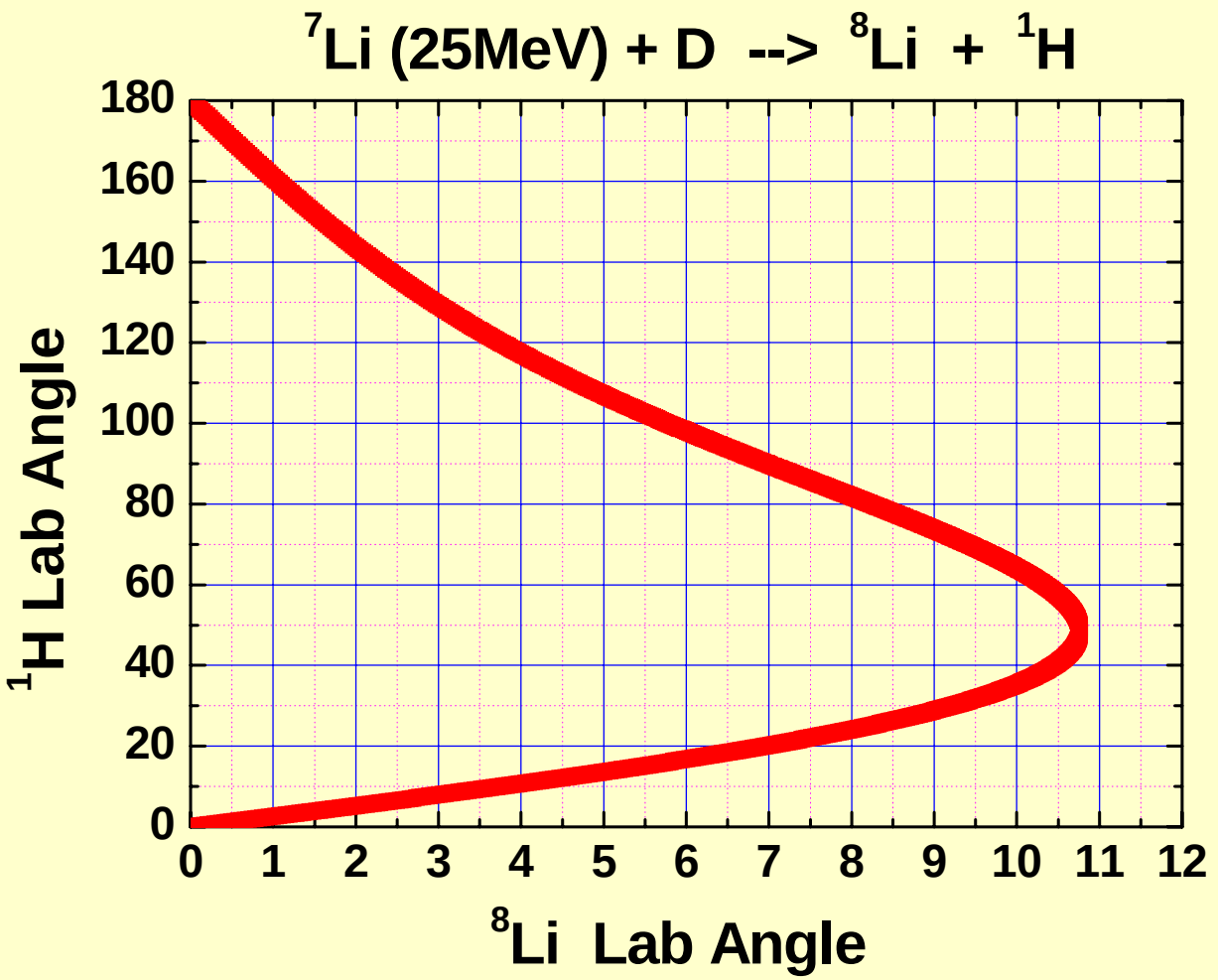




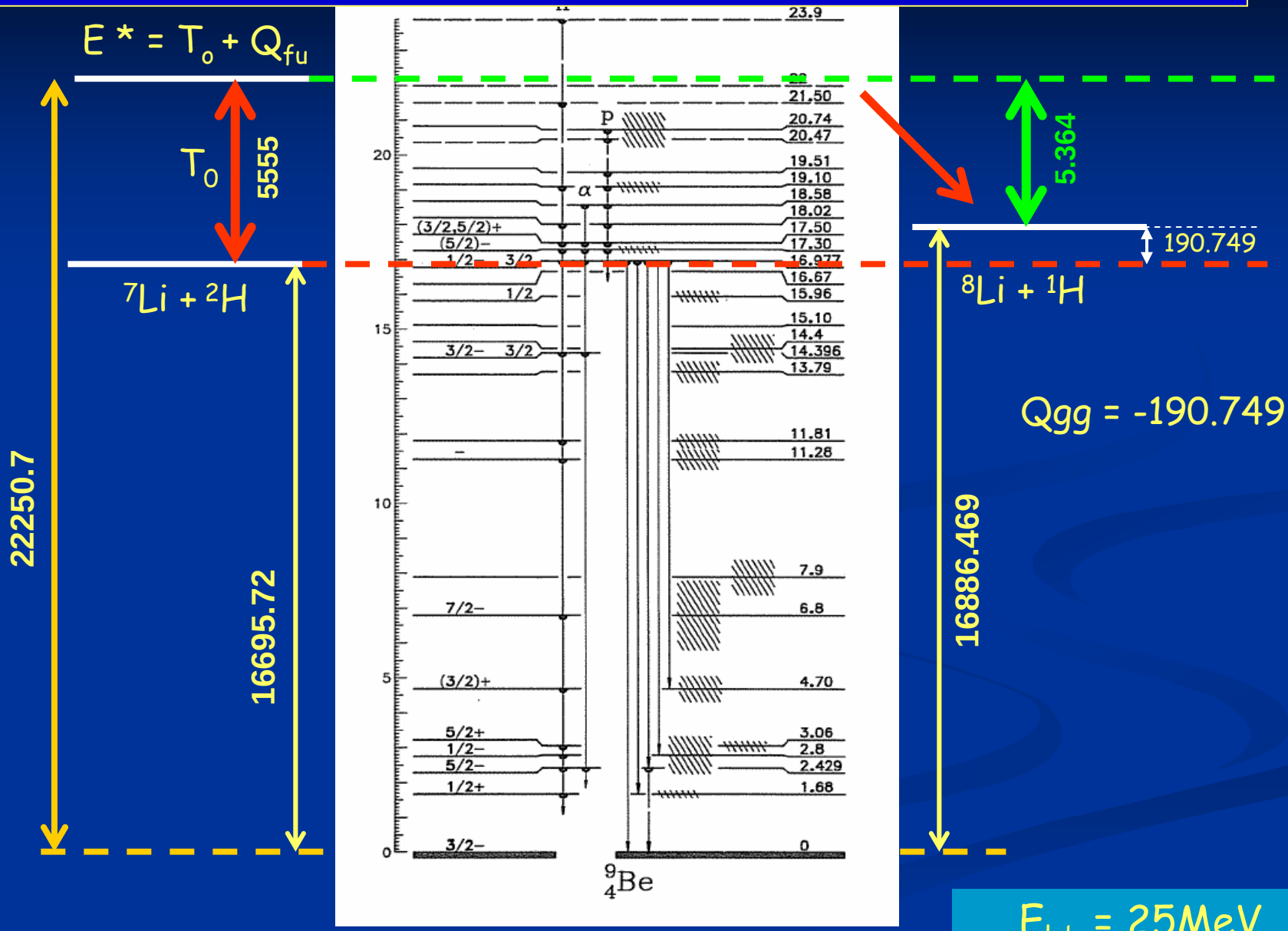
$^{7}Li + {}^{2}H \rightarrow {}^{8}Li + {}^{1}H$



$^{7}Li + {}^{2}H \rightarrow {}^{8}Li + {}^{1}H$



$^{7}Li + {}^{2}H \rightarrow {}^{9}Be^{*} \rightarrow {}^{8}Li + {}^{1}H$



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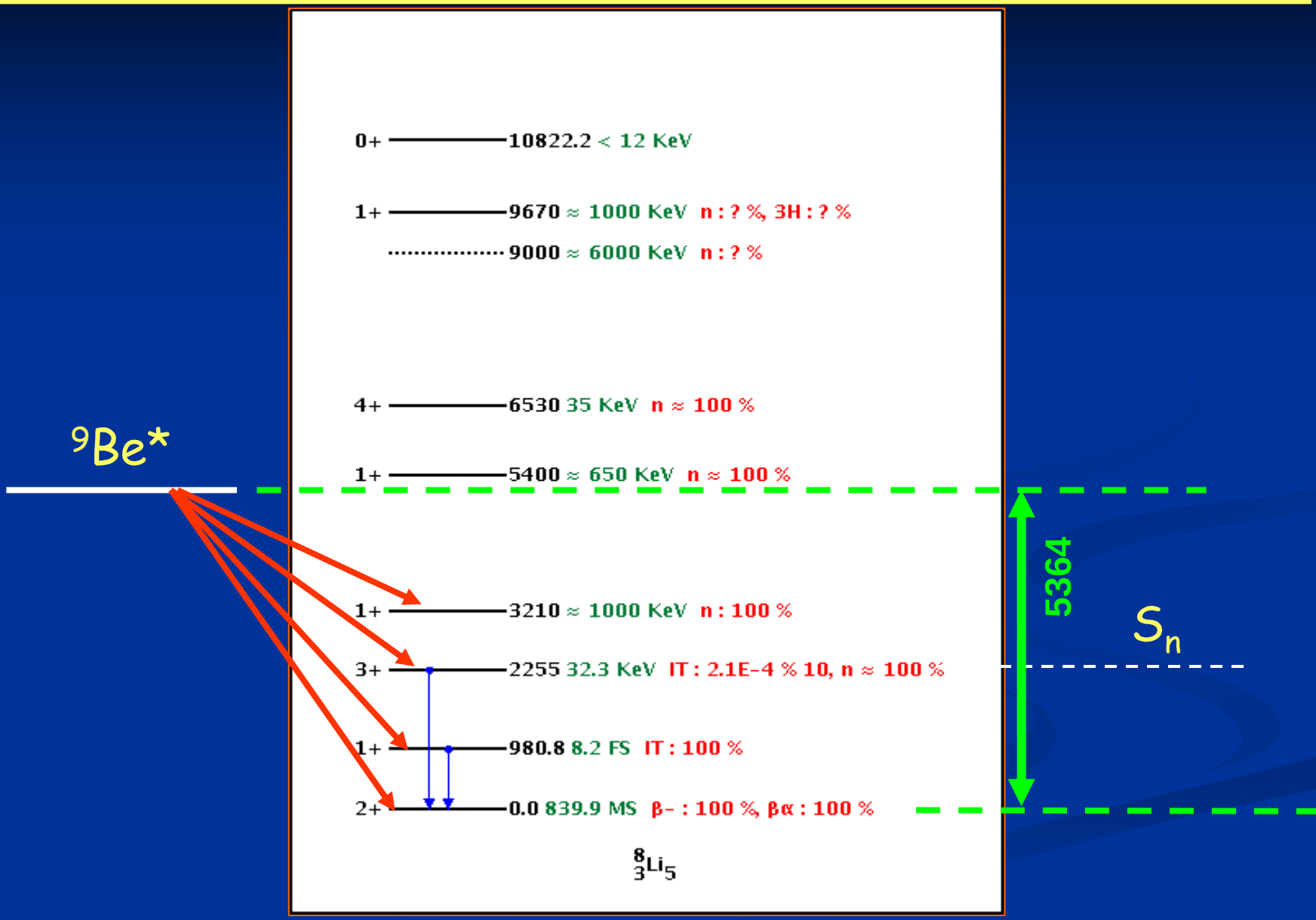
Population of ^{8}Li



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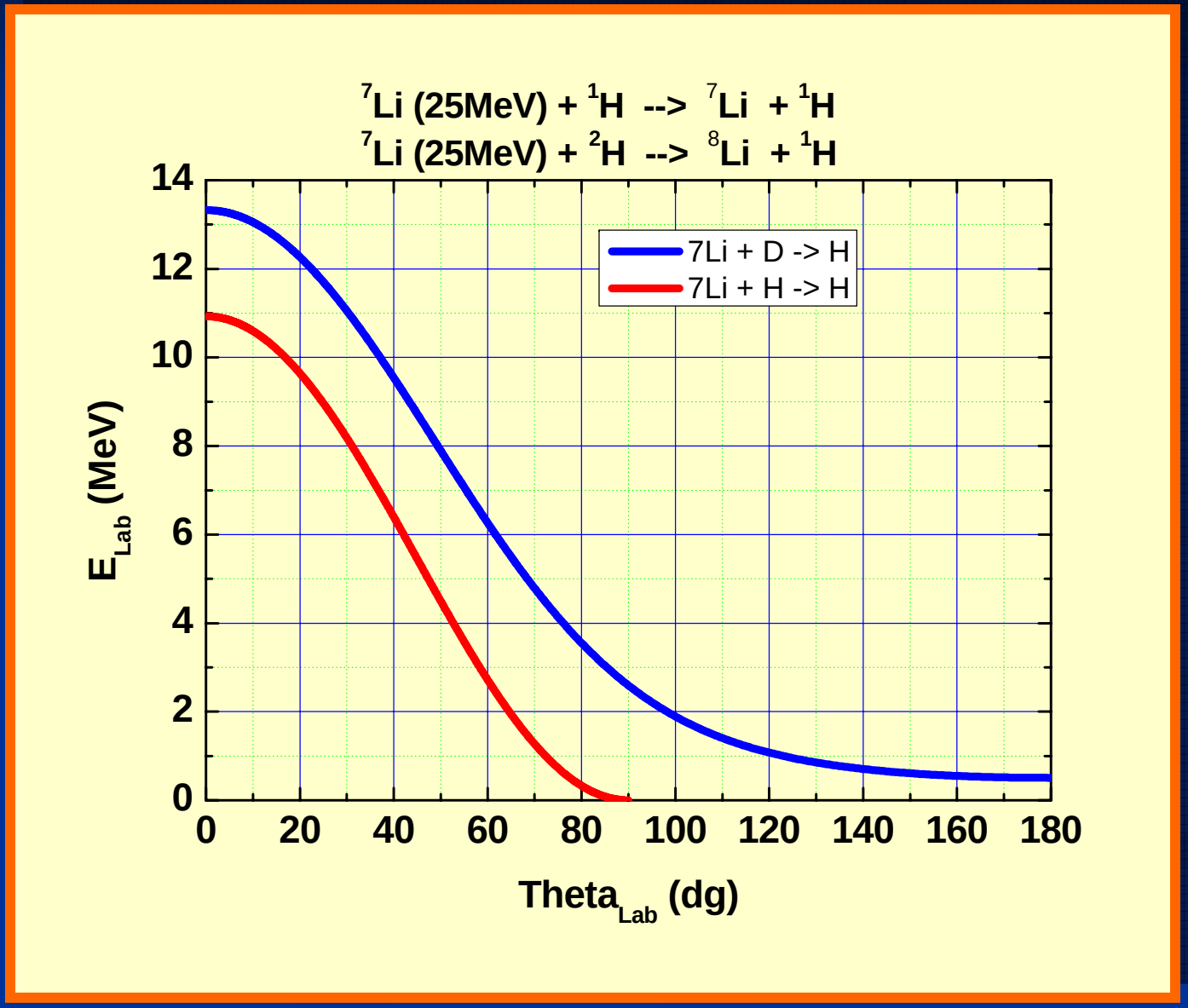
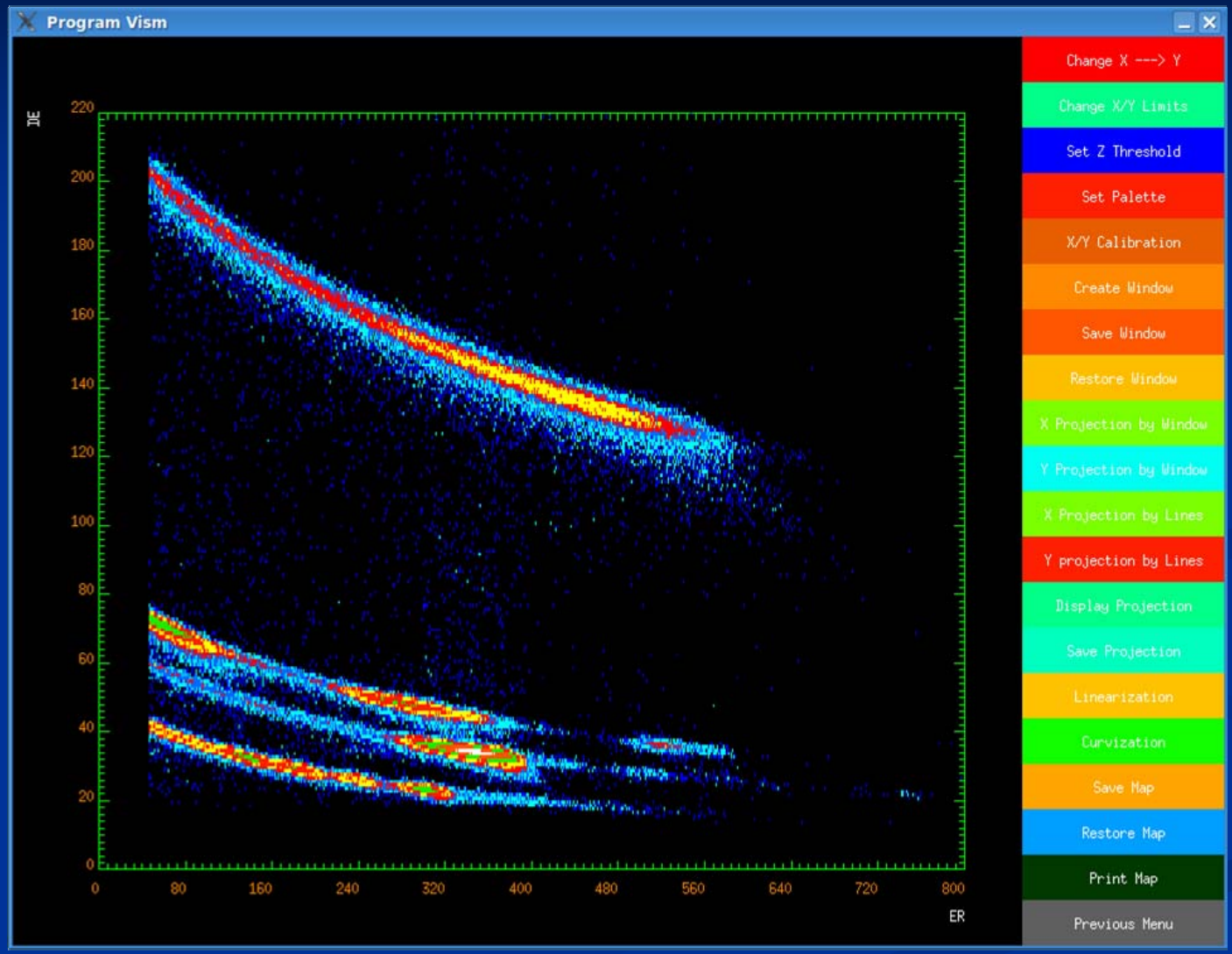
Hydrogen pollution in the Target

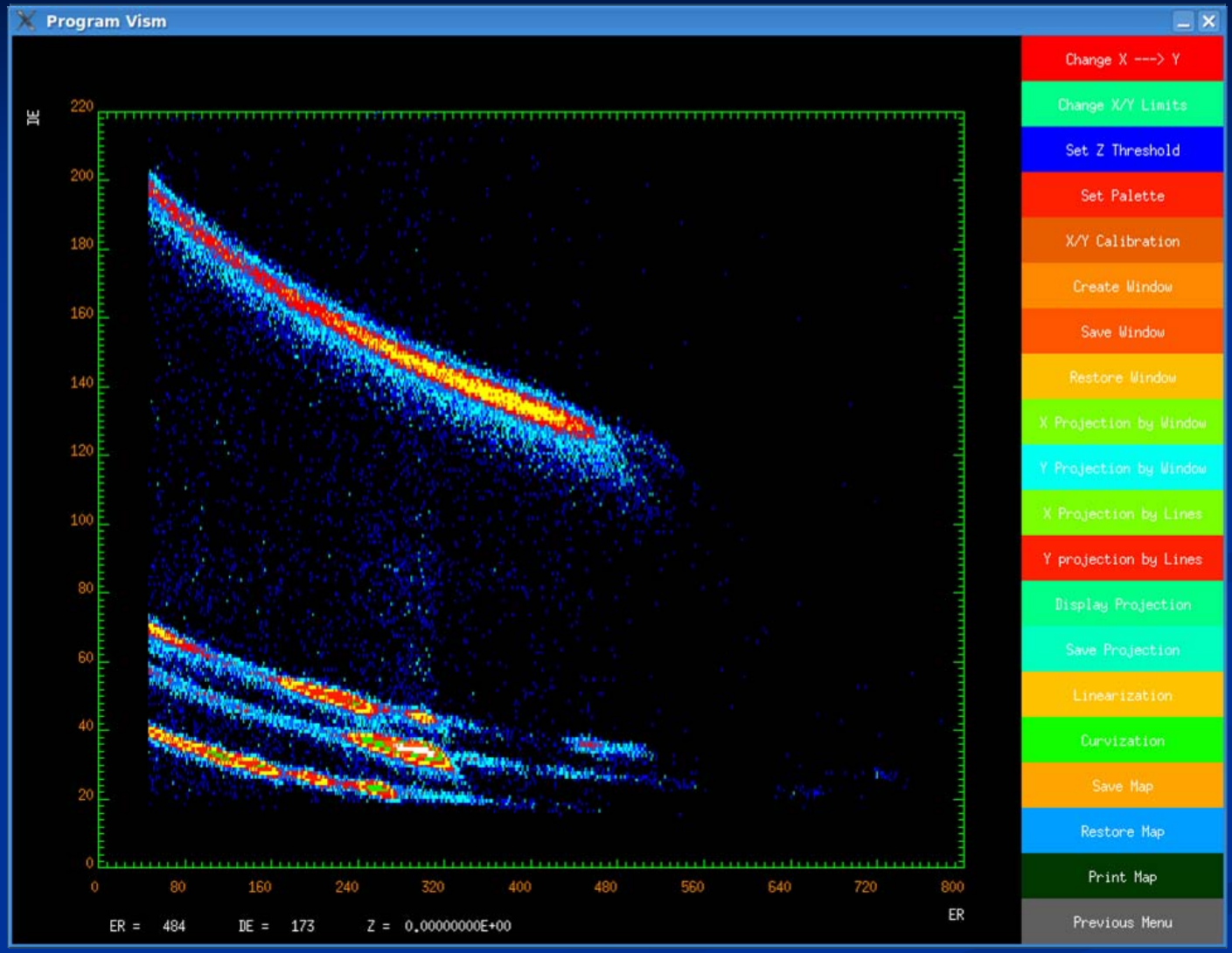


E-ΔE Particle Identification



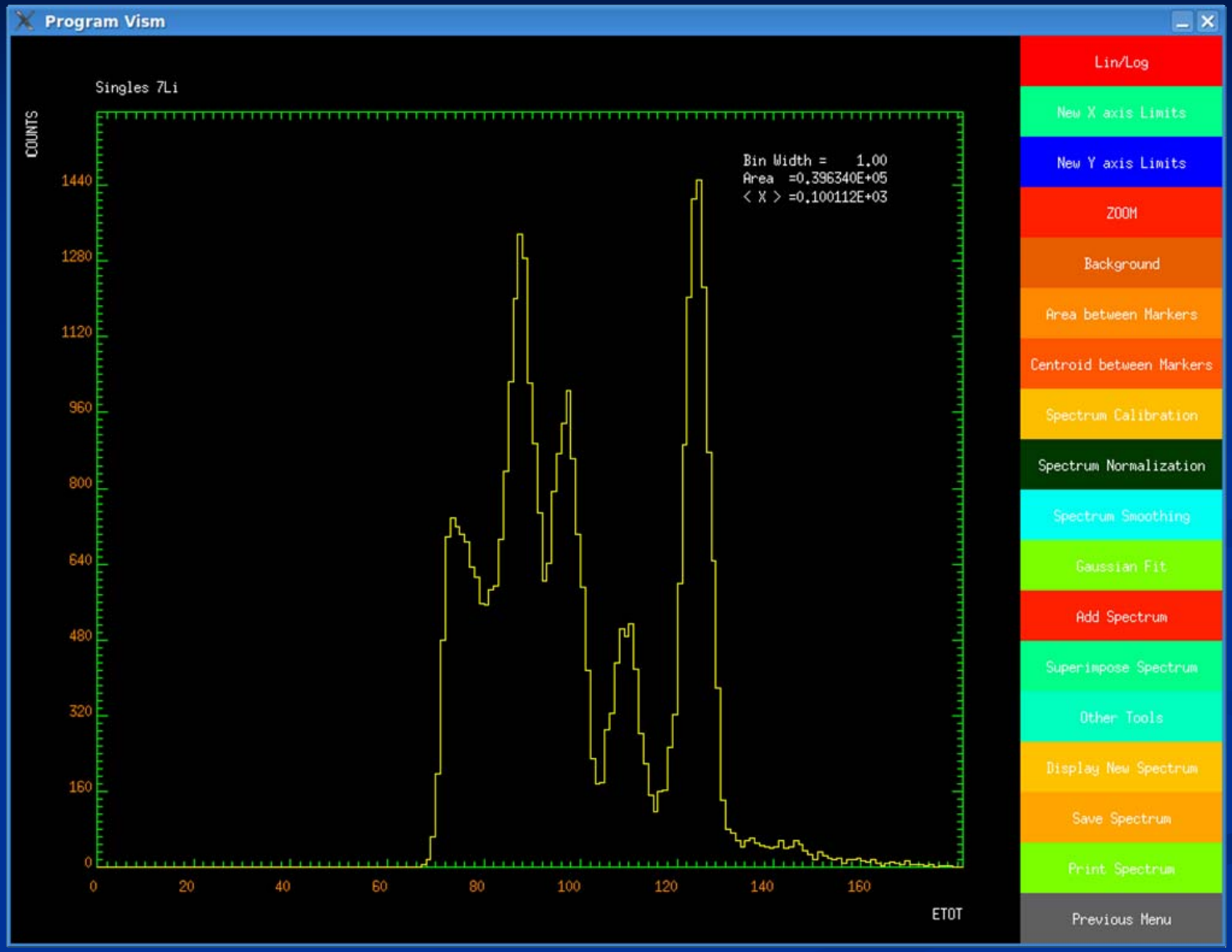
DET #72 20.6°

E-ΔE Particle Identification



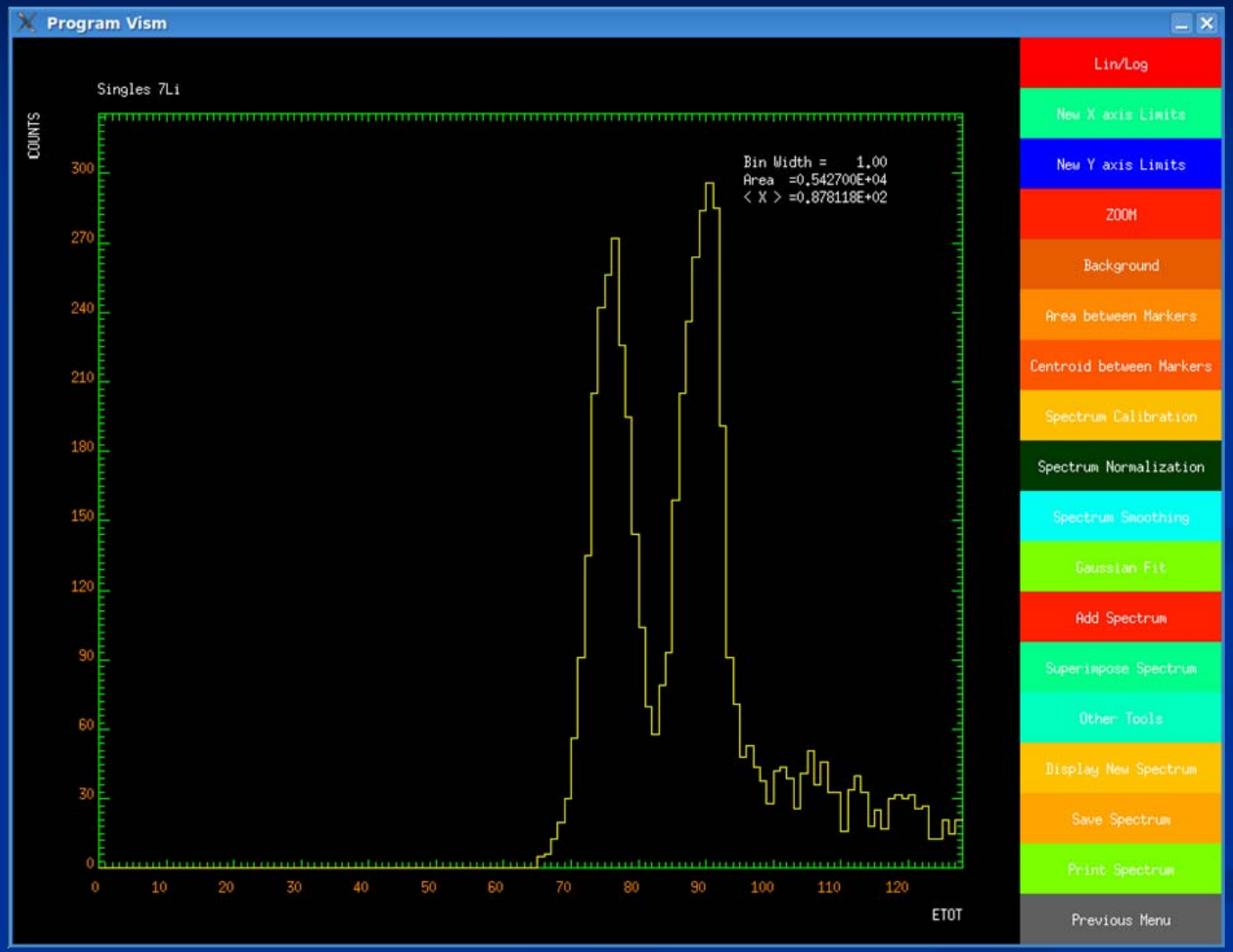
DET #99 22.2°

Protons Energy Spectra

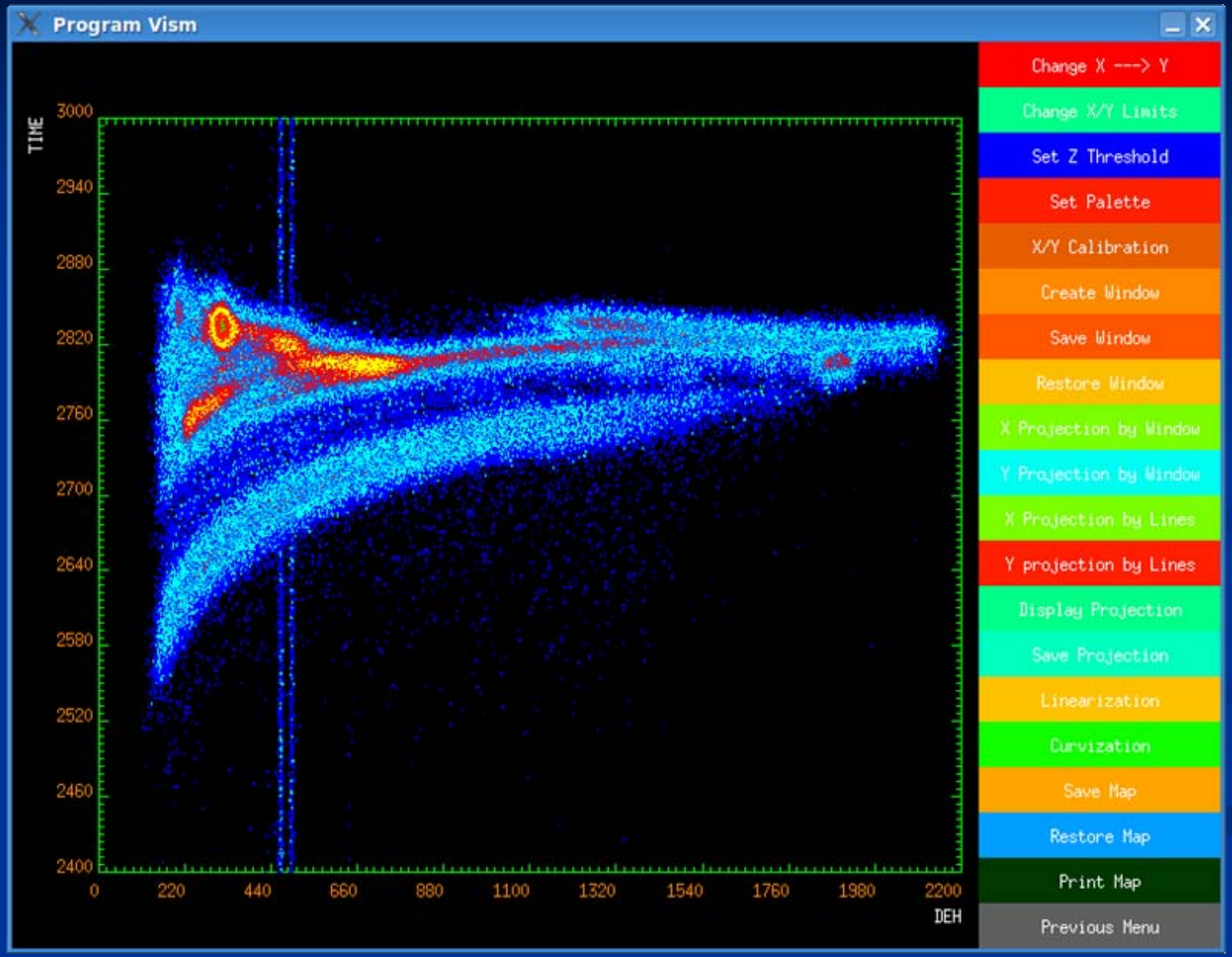


DET #72 20.6°

Protons Energy Spectra



DET #308 43.2°


Program Vism
TIME
3000
2940
2880
2820
2760
2700
2640
2580
2520
2460
2400
0
220
440
660
880
1100
1320
1540
1760
1980
2200
DEH
Change X ---> Y
Change X/Y Limits
Set Z Threshold
Set Palette
X/Y Calibration
Create Window
Save Window
Restore Window
X Projection by Window
Y Projection by Window
X Projection by Lines
Y projection by Lines
Display Projection
Save Projection
Linearization
Curvization
Save Map
Restore Map
Print Map
Previous Menu

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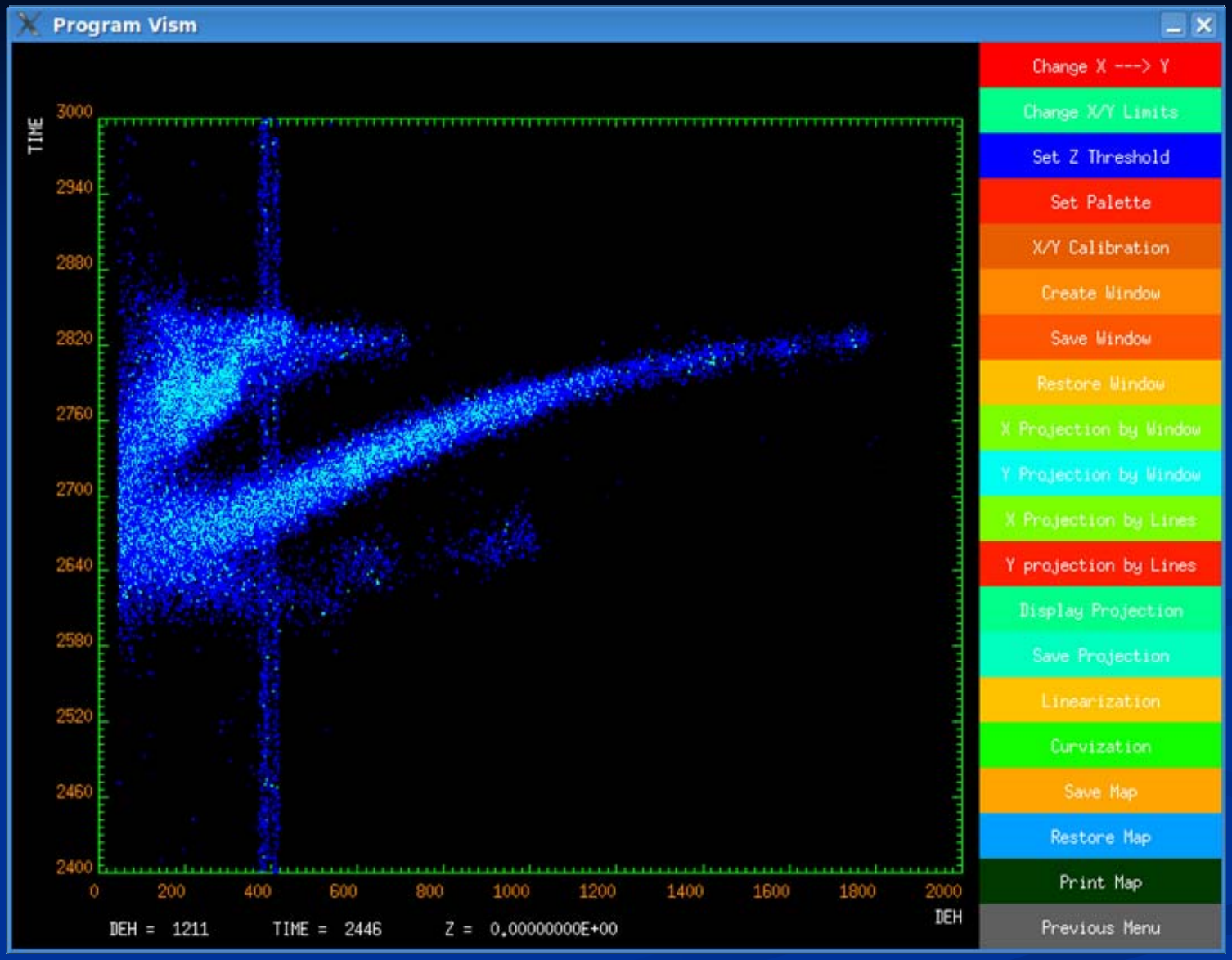
Program Vism
TIME
3000
2940
2880
2820
2760
2700
2640
2580
2520
2460
2400
0
200
400
600
800
1000
1200
1400
1600
1800
2000
DEH
DEH = 1211
TIME = 2446
Z = 0.00000000E+00
Change X ---> Y
Change X/Y Limits
Set Z Threshold
Set Palette
X/Y Calibration
Create Window
Save Window
Restore Window
X Projection by Window
Y Projection by Window
X Projection by Lines
Y projection by Lines
Display Projection
Save Projection
Linearization
Curvization
Save Map
Restore Map
Print Map
Previous Menu

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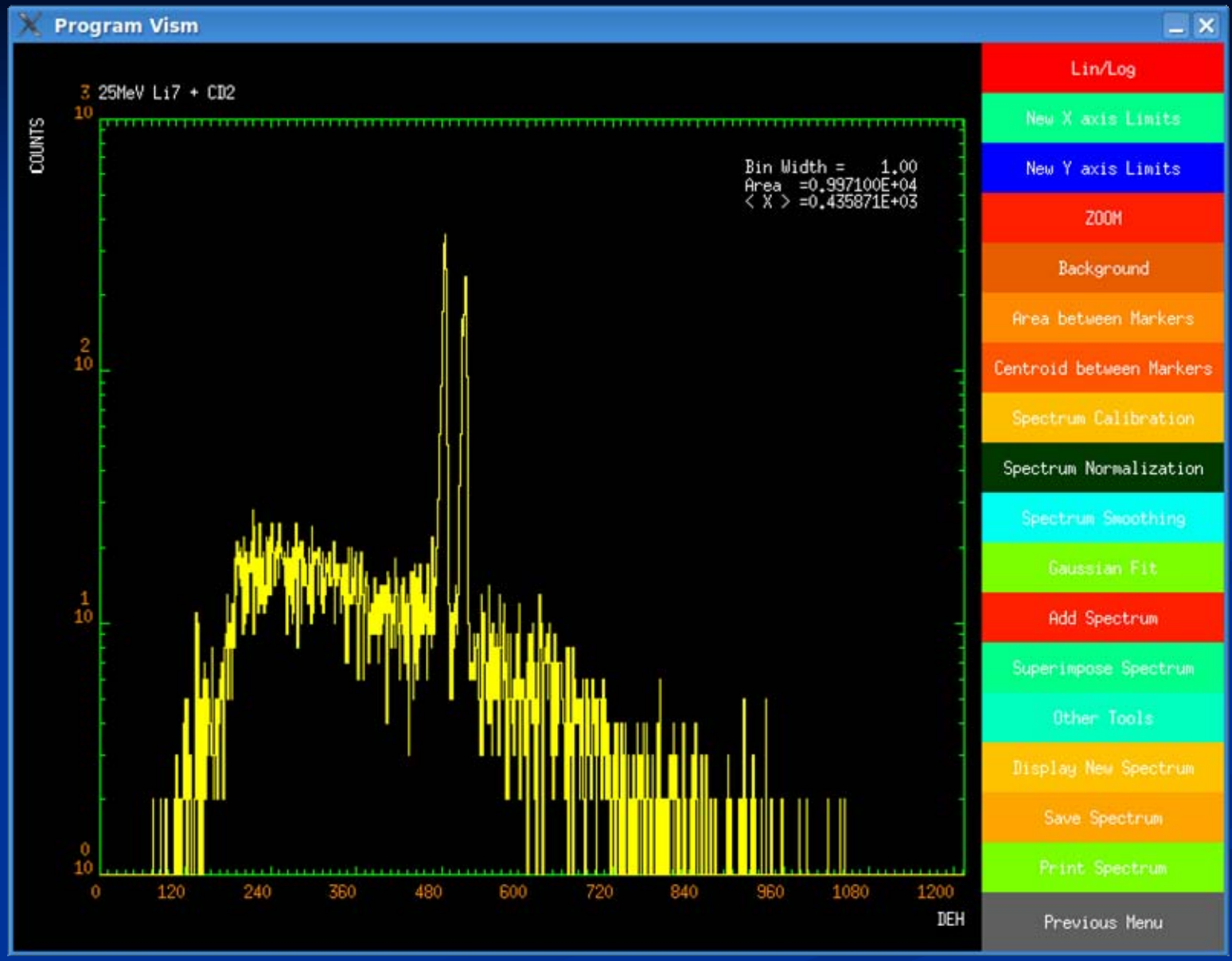
DET #261 102°



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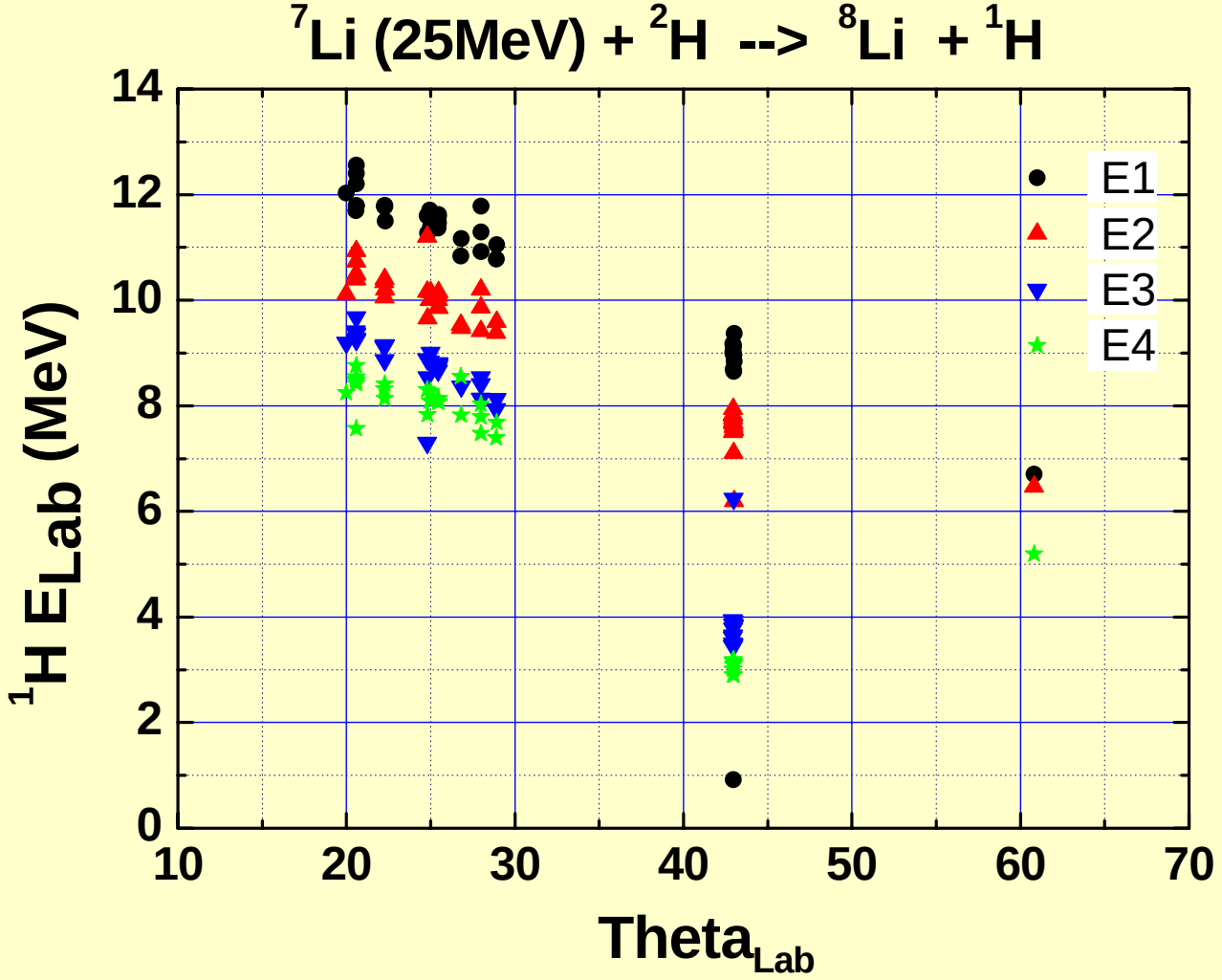
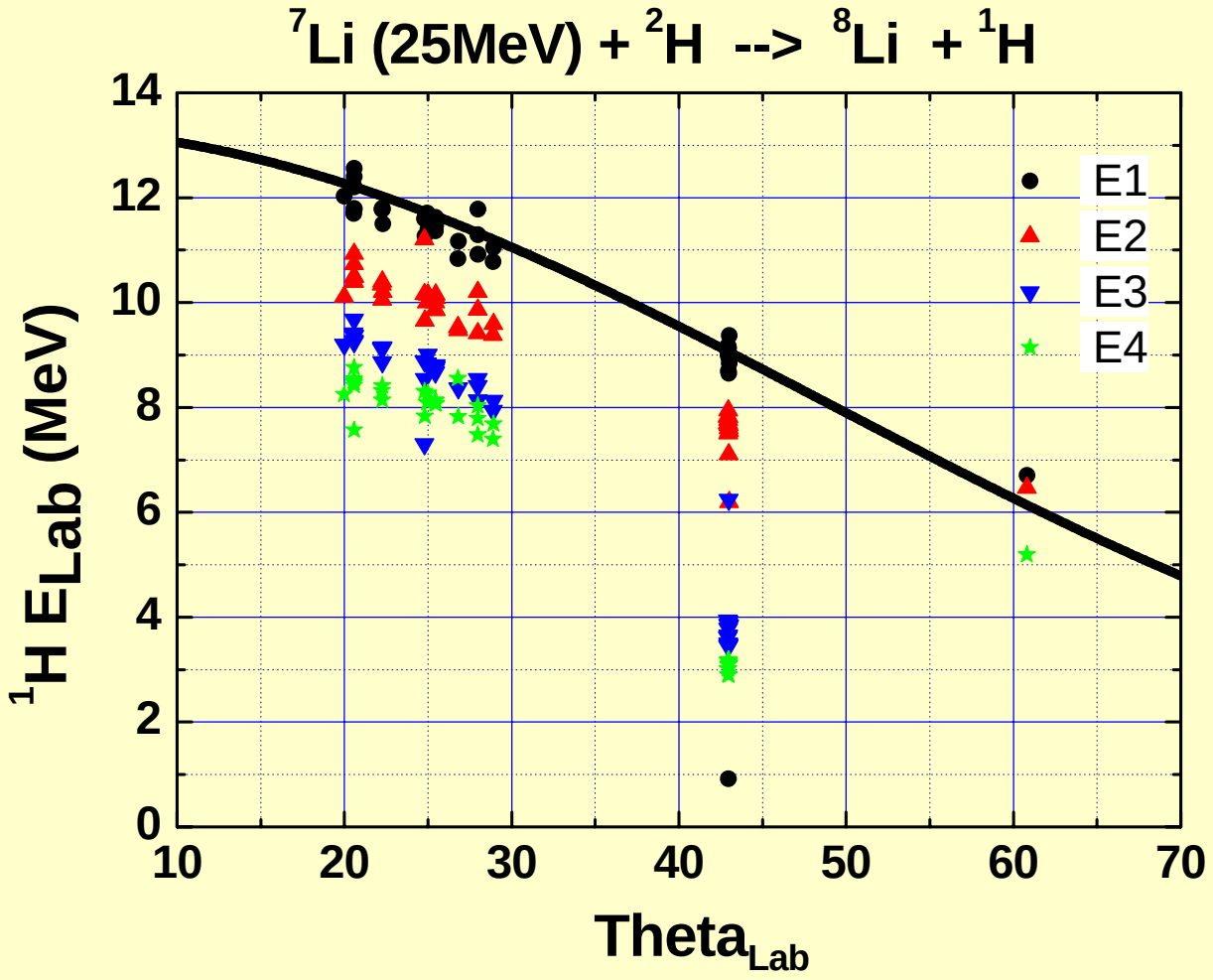
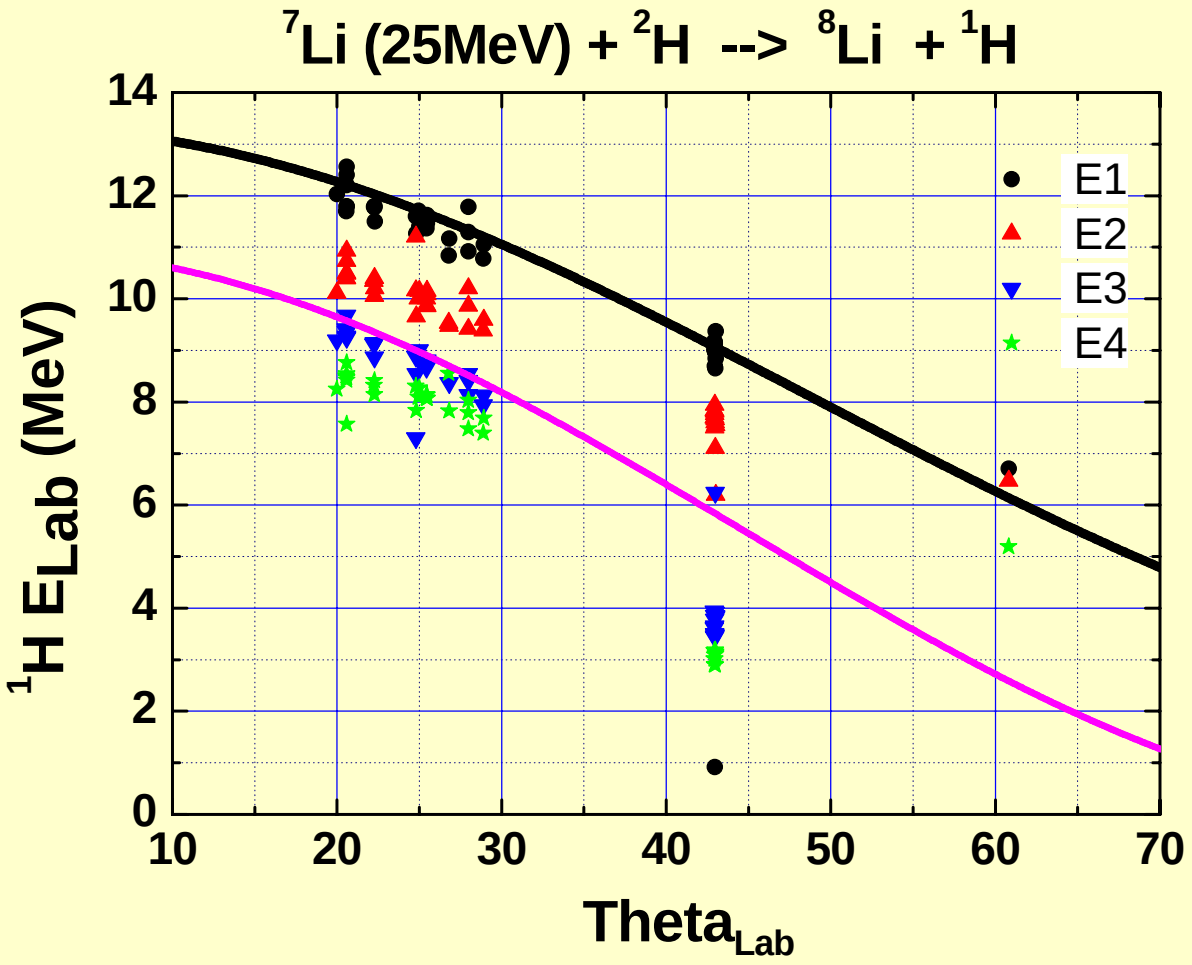
$^{7}Li + {}^{2}H \rightarrow {}^{1}H$ (Energy)



$^{7}Li + ^{2}H \rightarrow ^{1}H$ (Energy)



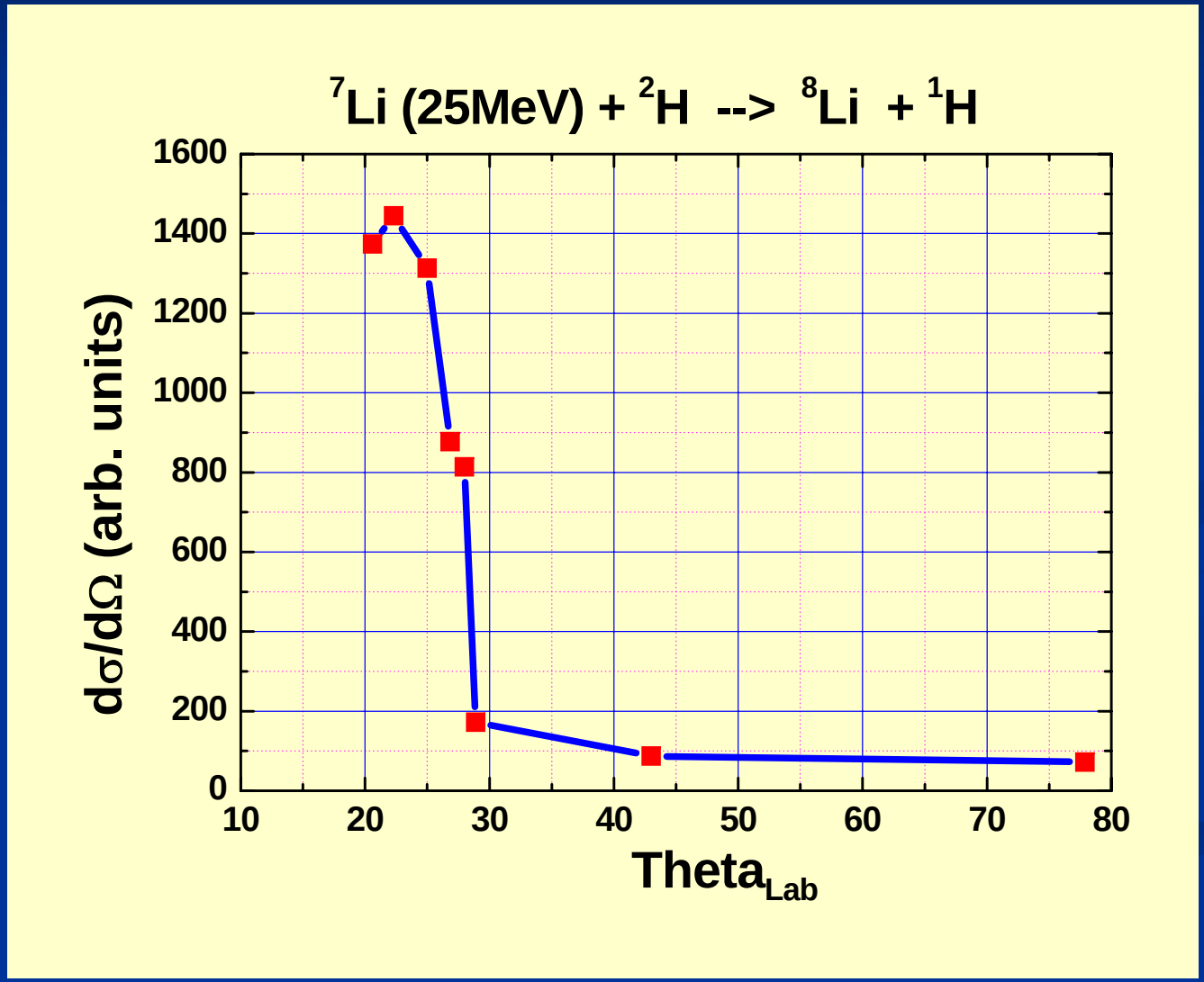
$^{7}Li + {}^{2}H \rightarrow {}^{1}H$ (Energy)



$^{7}Li + ^{2}H \rightarrow ^{1}H$

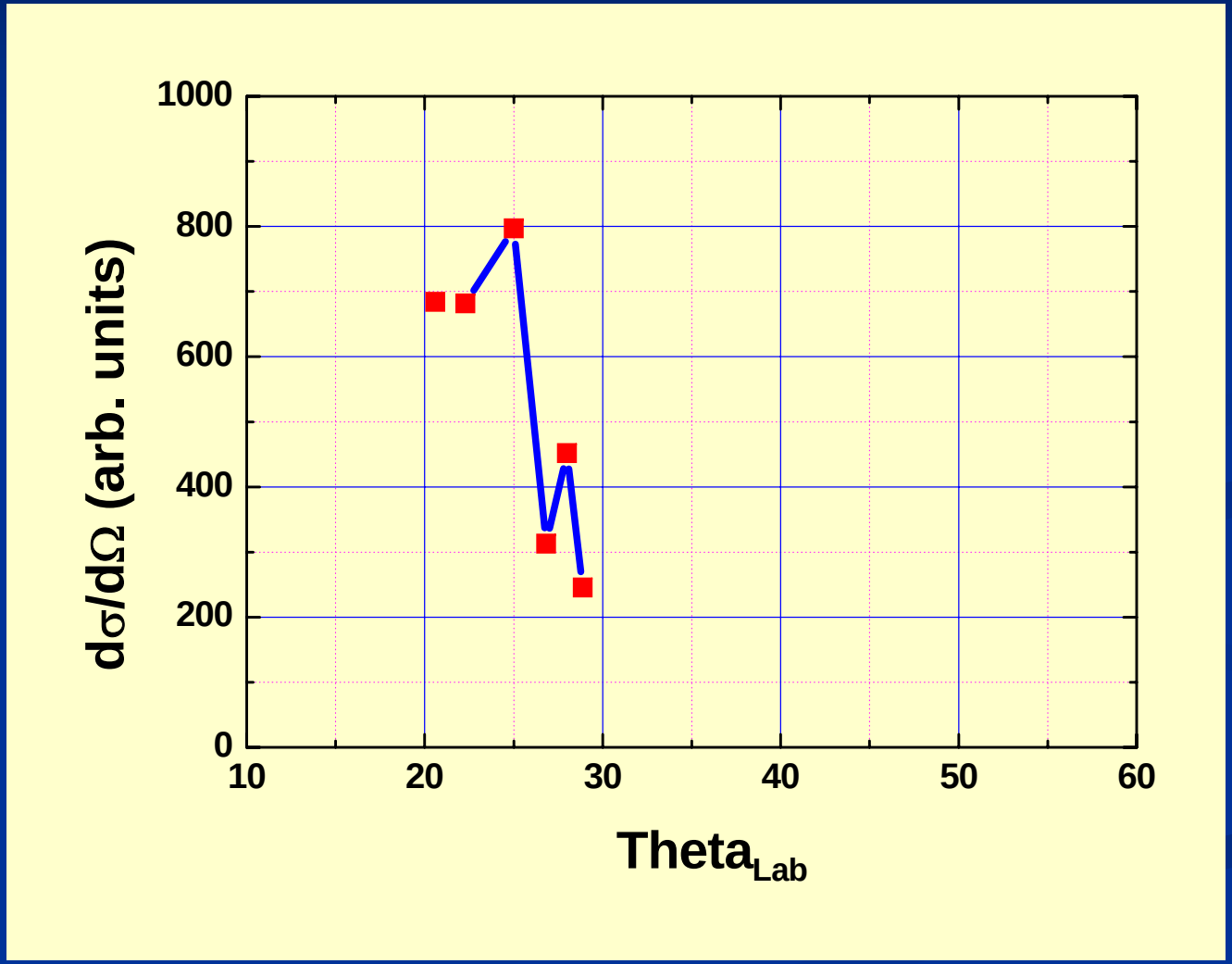
Preliminary

Lab Angular Distribution for E1



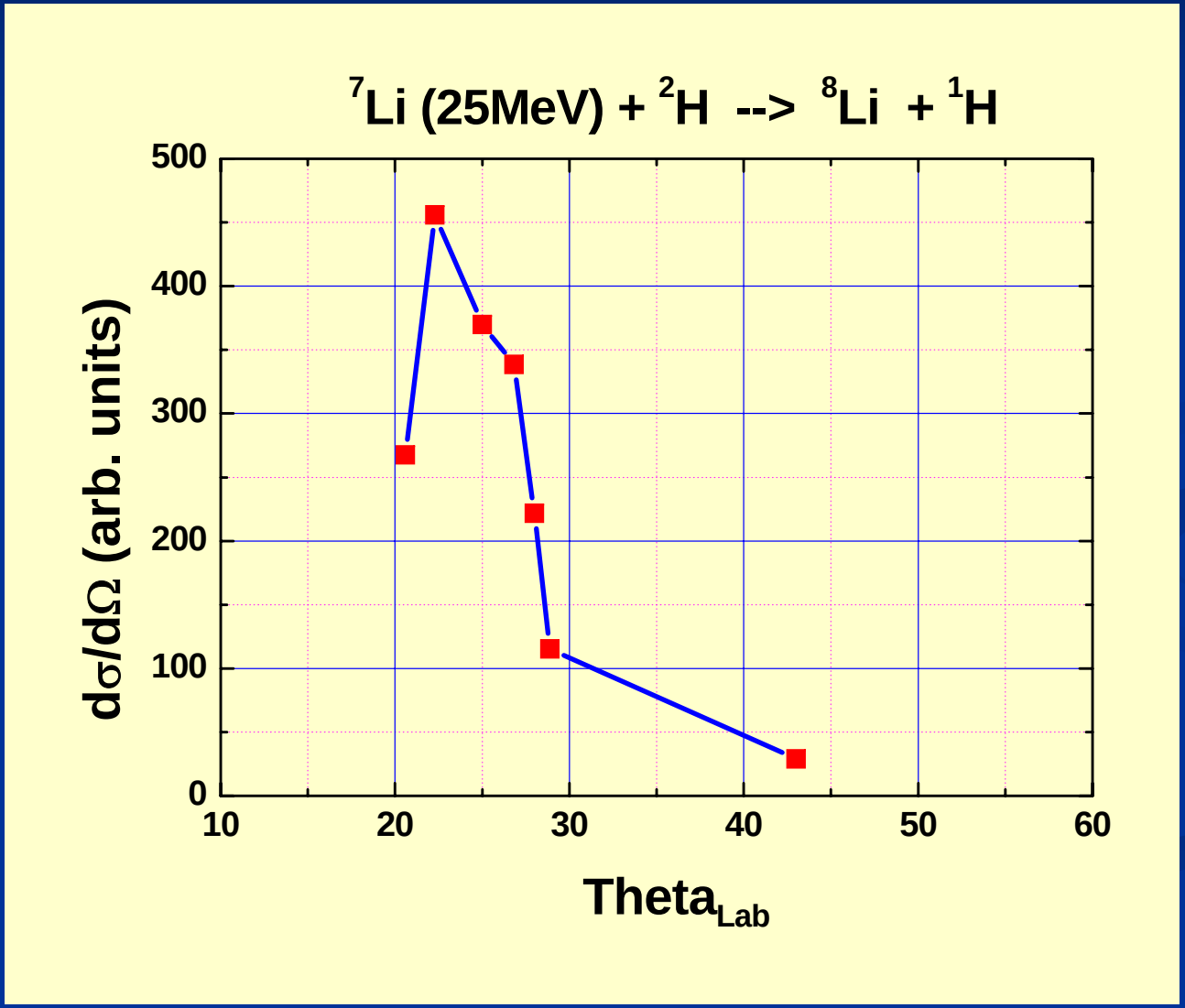
$^{7}Li + {}^{2}H \rightarrow {}^{1}H$

Lab Angular Distribution for E2



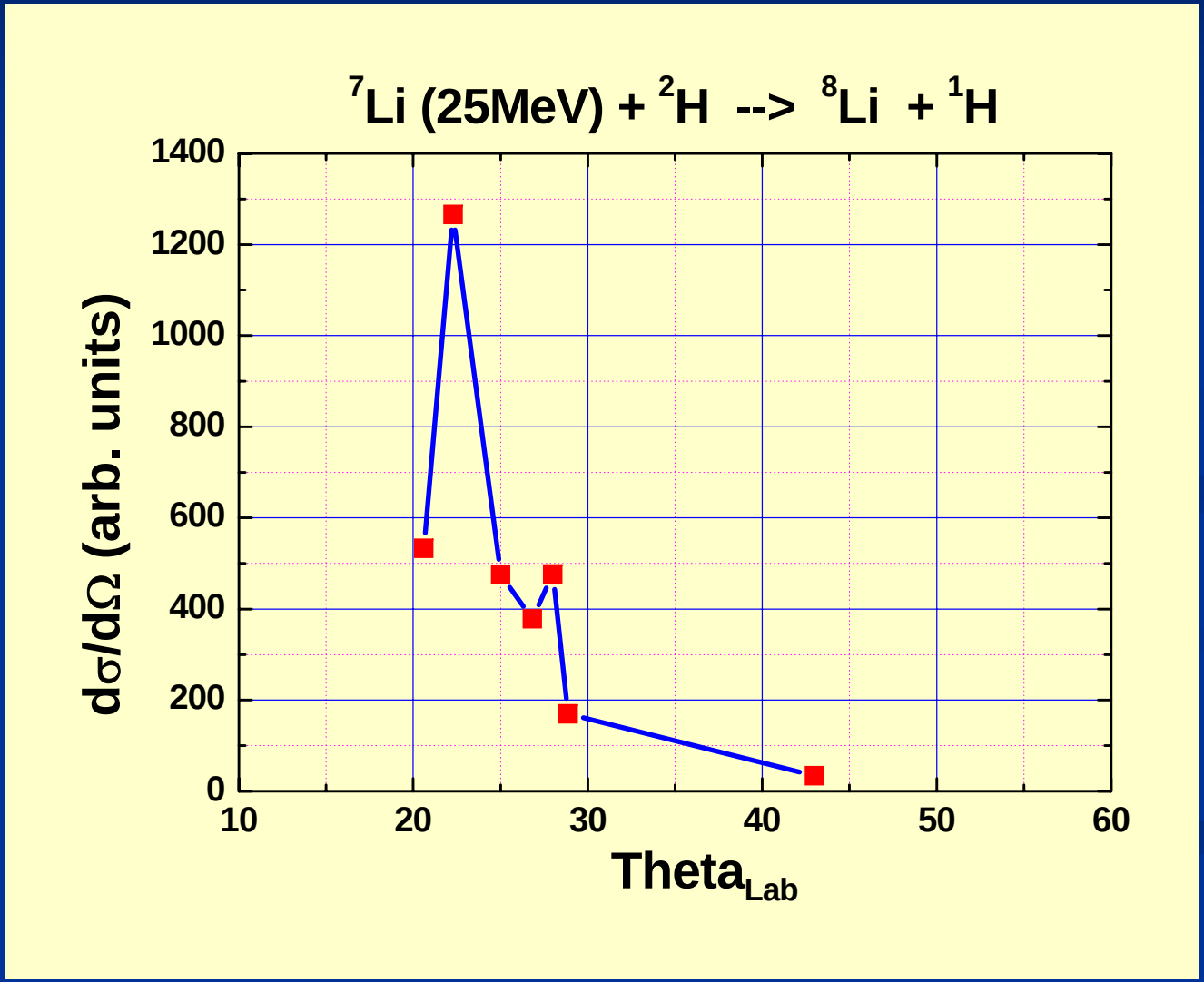
$^{7}Li + {}^{2}H \rightarrow {}^{1}H$

Lab Angular Distribution for E3

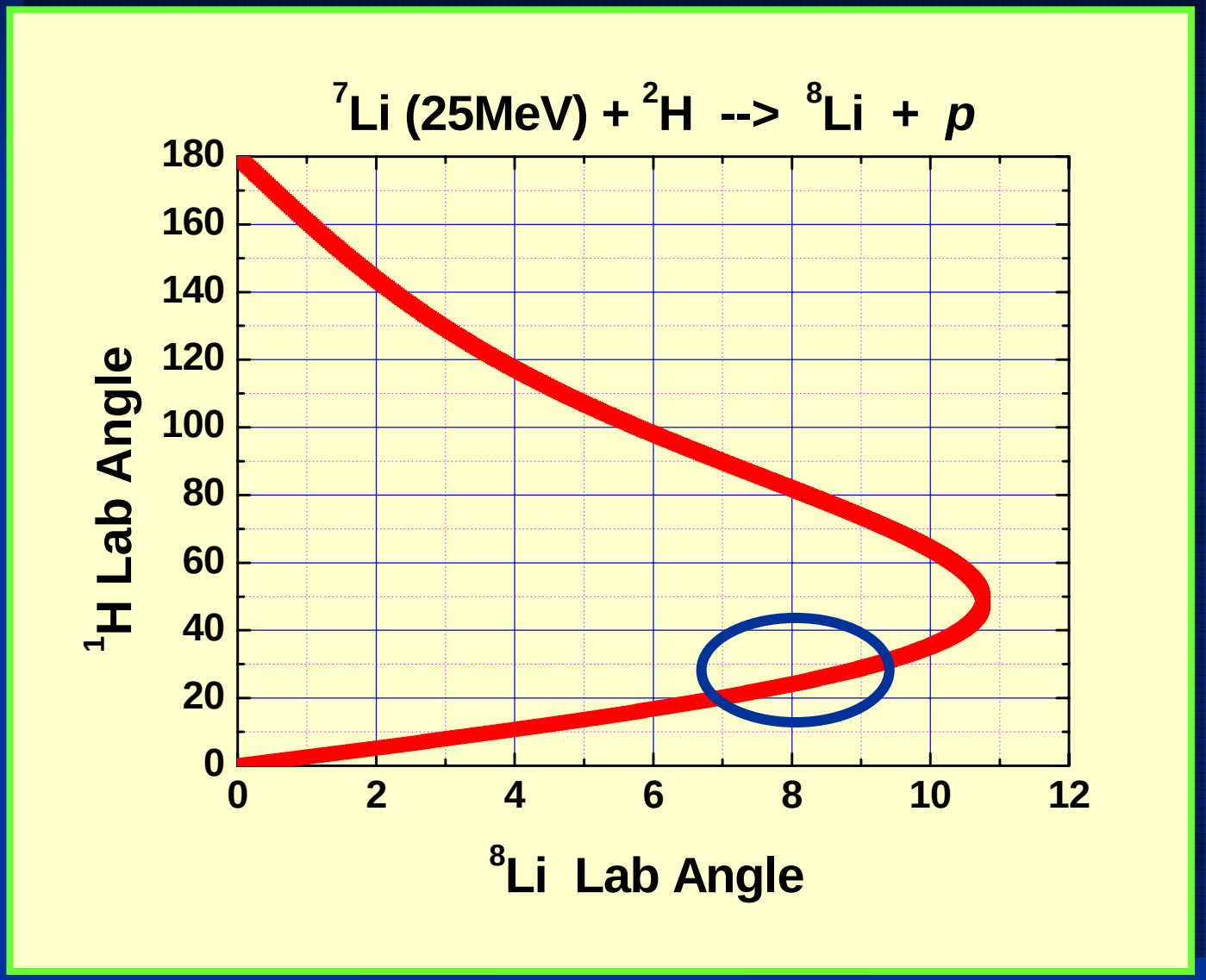


$^{7}Li + ^{2}H \rightarrow ^{1}H$

Lab Angular Distribution for E4



$^{7}Li + {}^{2}H \rightarrow {}^{8}Li + {}^{1}H$

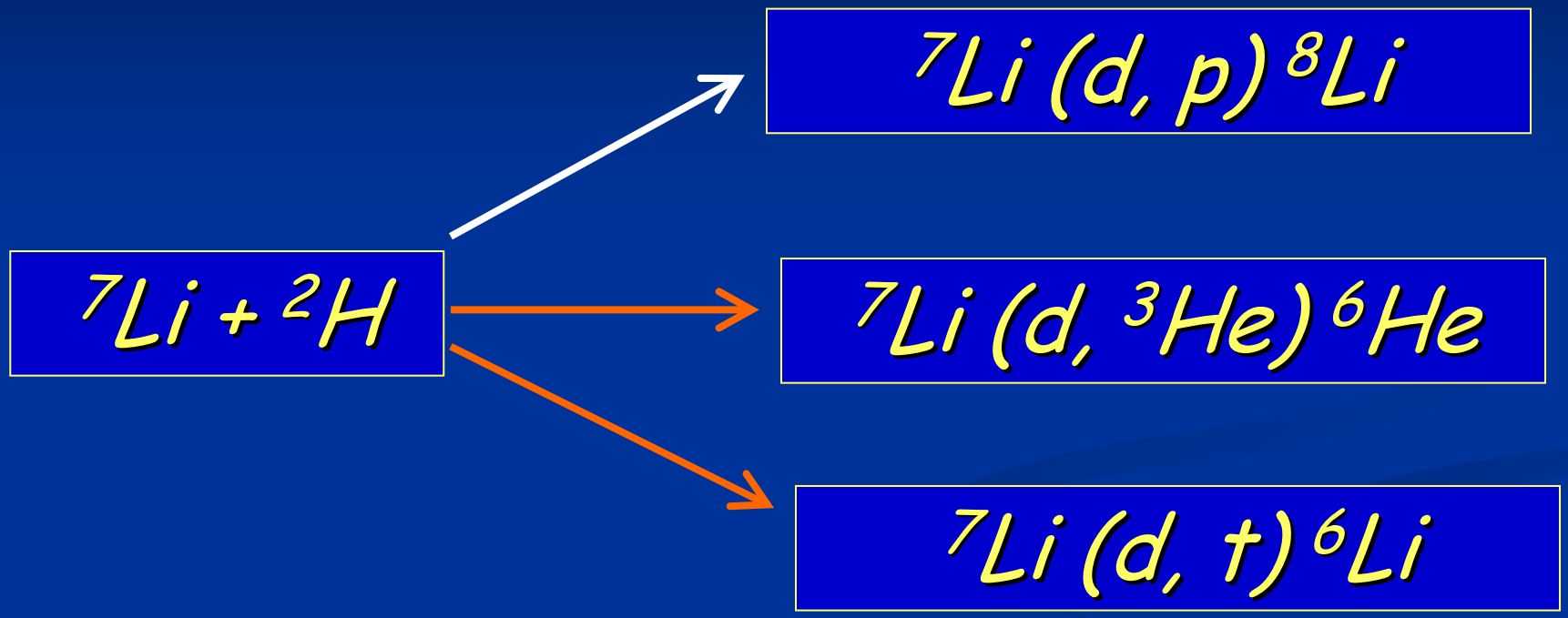


Furthermore

1. Normalize X-Sections
2. Energy Checks for the Excited states
3. Convert to CM frame
4. Analyze *t* and α channels

....WHY ?

More Channels



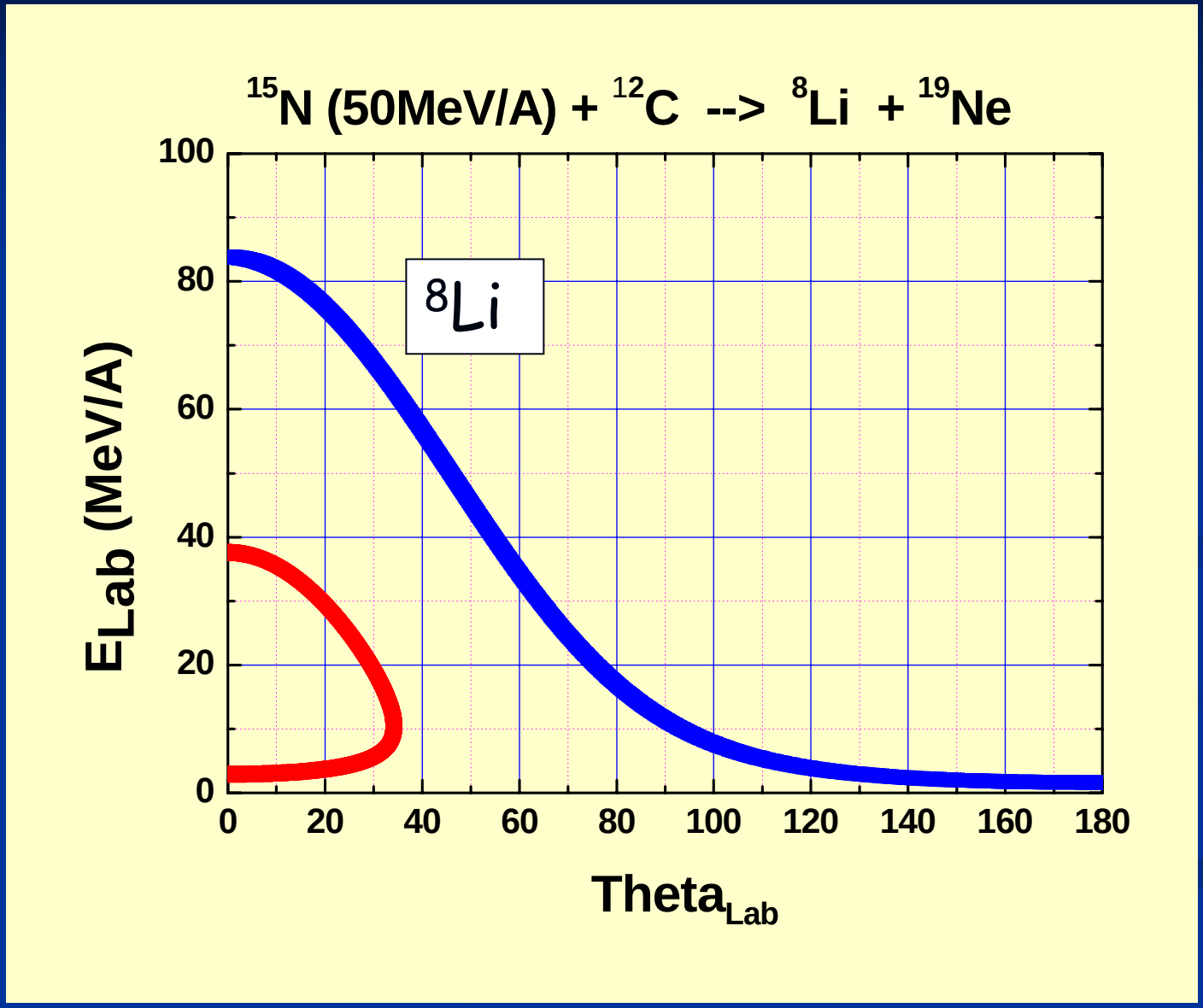
Candidate Reactions

$^{6}Li\,(t,\,p)\,^{8}Li$

$^{6}Li\,(^{3}He,\,n)\,^{8}B$

$^{10}B\,(p,\,t)\,^{8}B$

$^{12}C\,(^{15}N,\,^{8}Li)\,^{19}Ne$


15N (50MeV/A) + 12C --> 8Li + 19Ne
100
80
60
40
20
0
8Li
ELab (MeV/A)
0
20
40
60
80
100
120
140
160
180
ThetaLab

$$^{6}Li + ^{3}He \rightarrow ^{8}B + n$$

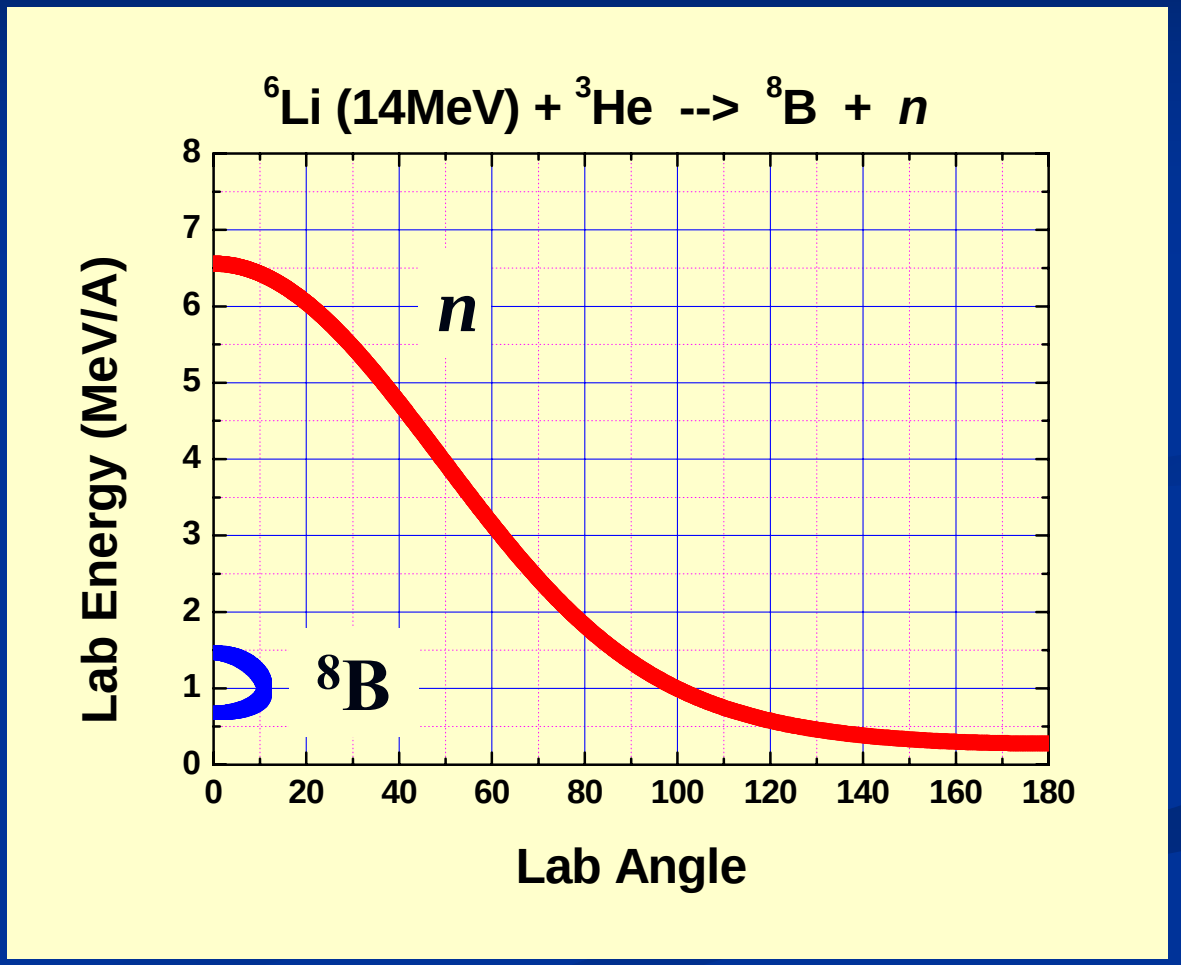
or

$$^{3}He + ^{6}Li \rightarrow ^{8}B + n$$

$^{6}Li + {}^{3}He \rightarrow {}^{8}B + n$

E_{lab} (^{6}Li) = 14 MeV

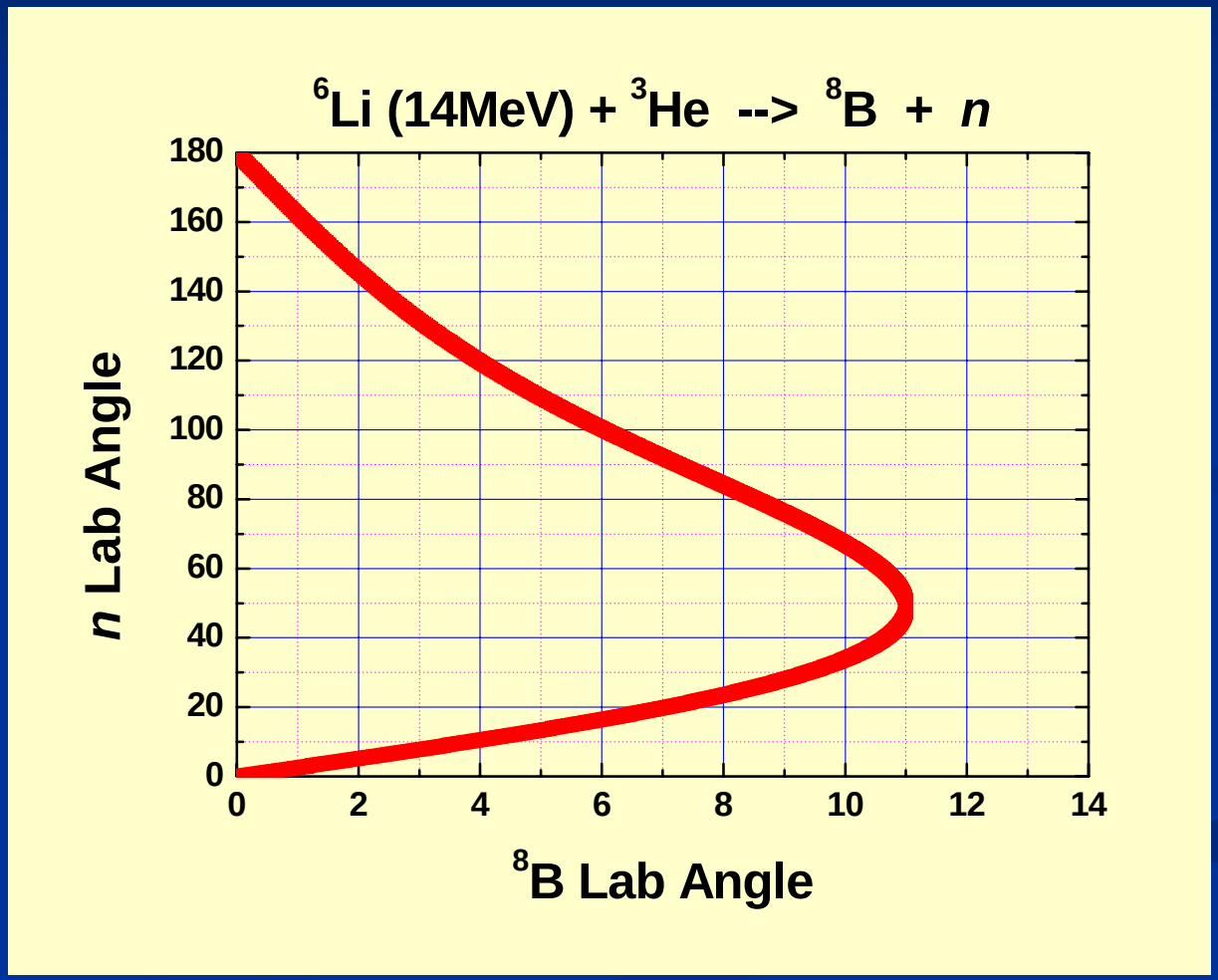
E_{lab} (^{3}He) = 7 MeV



$^{6}Li + {}^{3}He \rightarrow {}^{8}B + n$

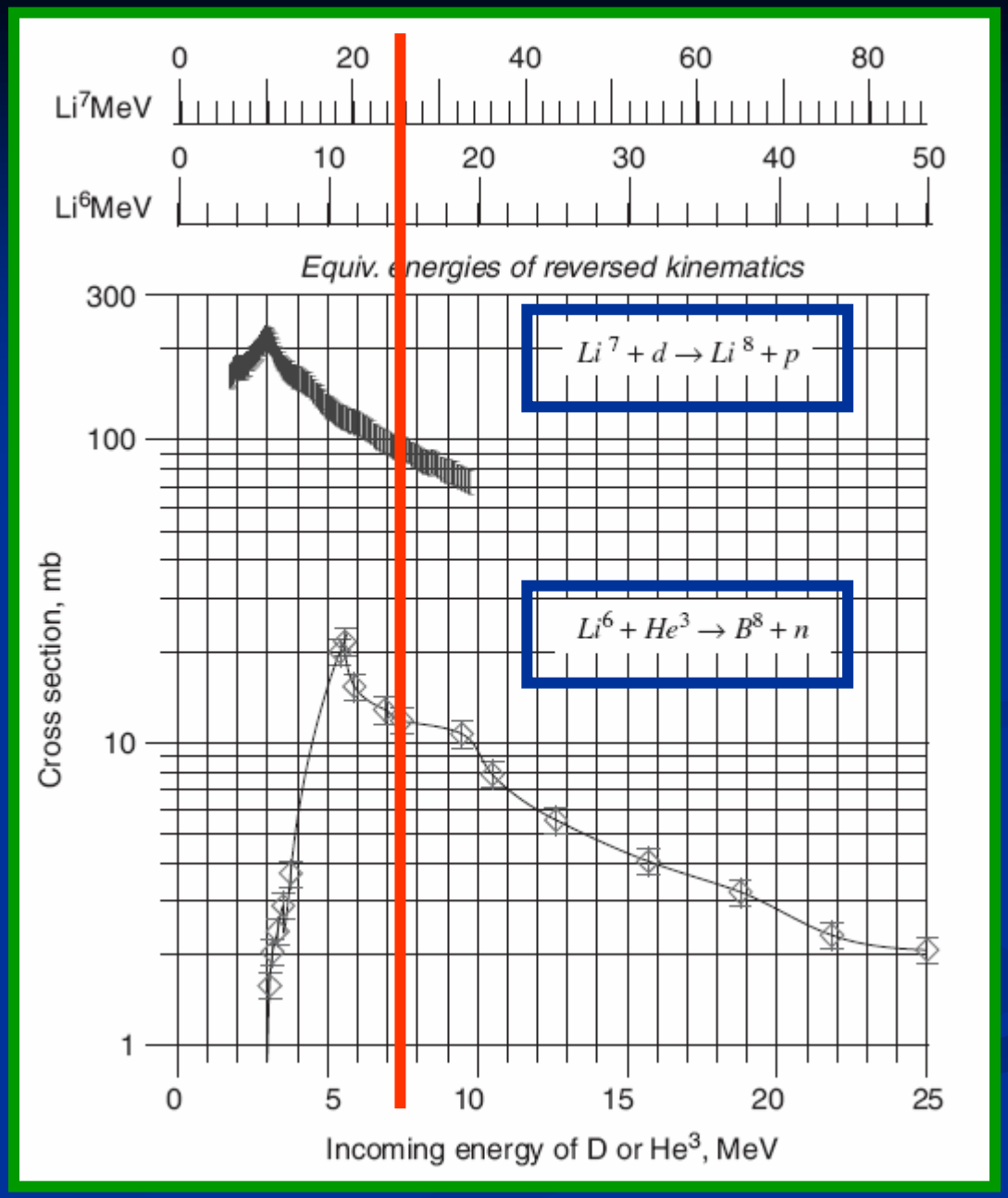
E_{lab} (^{6}Li) = 14 MeV

E_{lab} (^{3}He) = 7 MeV



E_{lab} (^{6}Li) = 36 MeV

E_{lab} (^{3}He) = 18 MeV

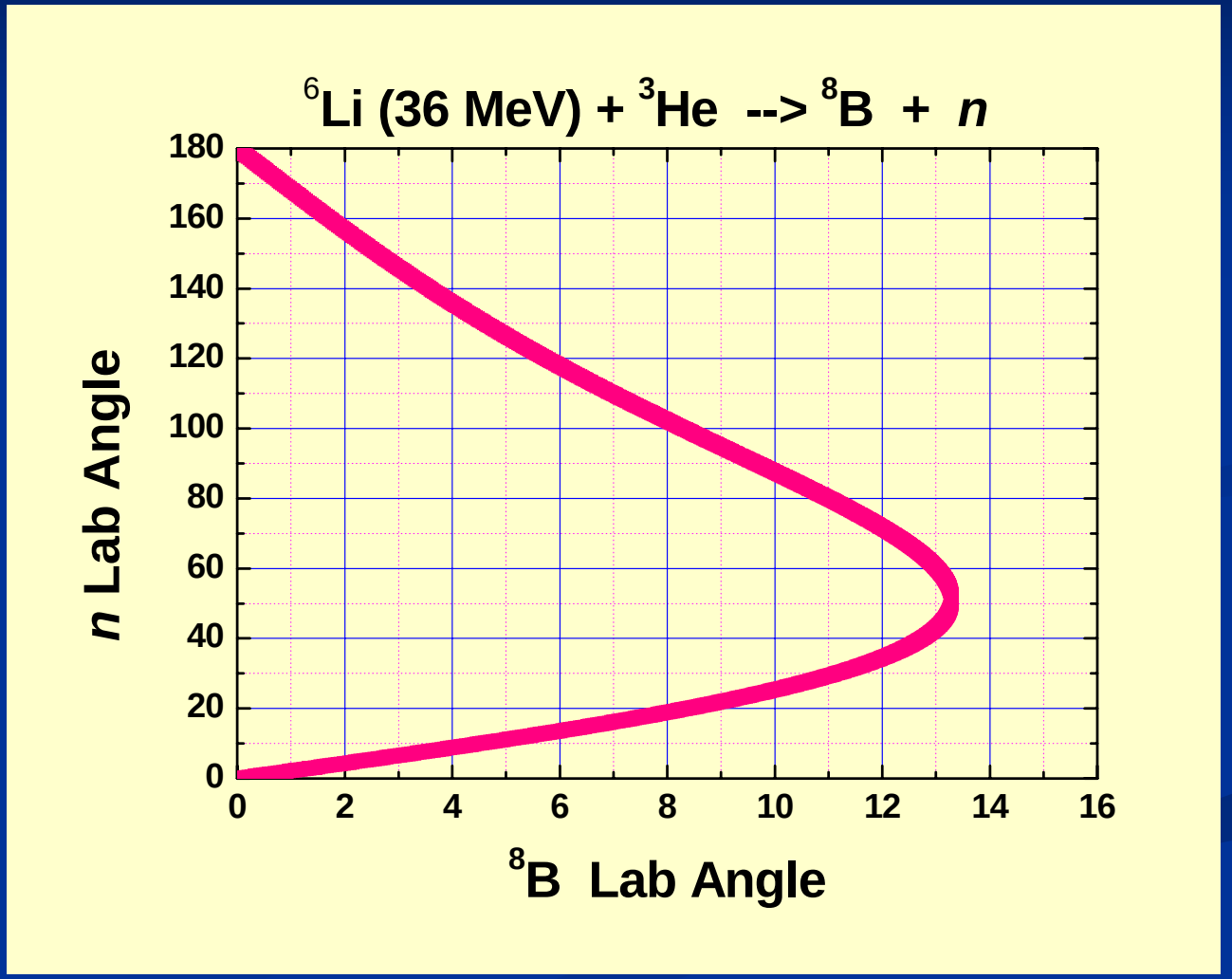


C. Rubbia et al., NIM A568 (2010) 475

^{6}Li (36 MeV) + ^{3}He -> ^{8}B + n

E_{lab} (^{6}Li) = 36 MeV

E_{lab} (^{3}He) = 18 MeV



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E_{lab} (^{6}Li) = 36 MeV

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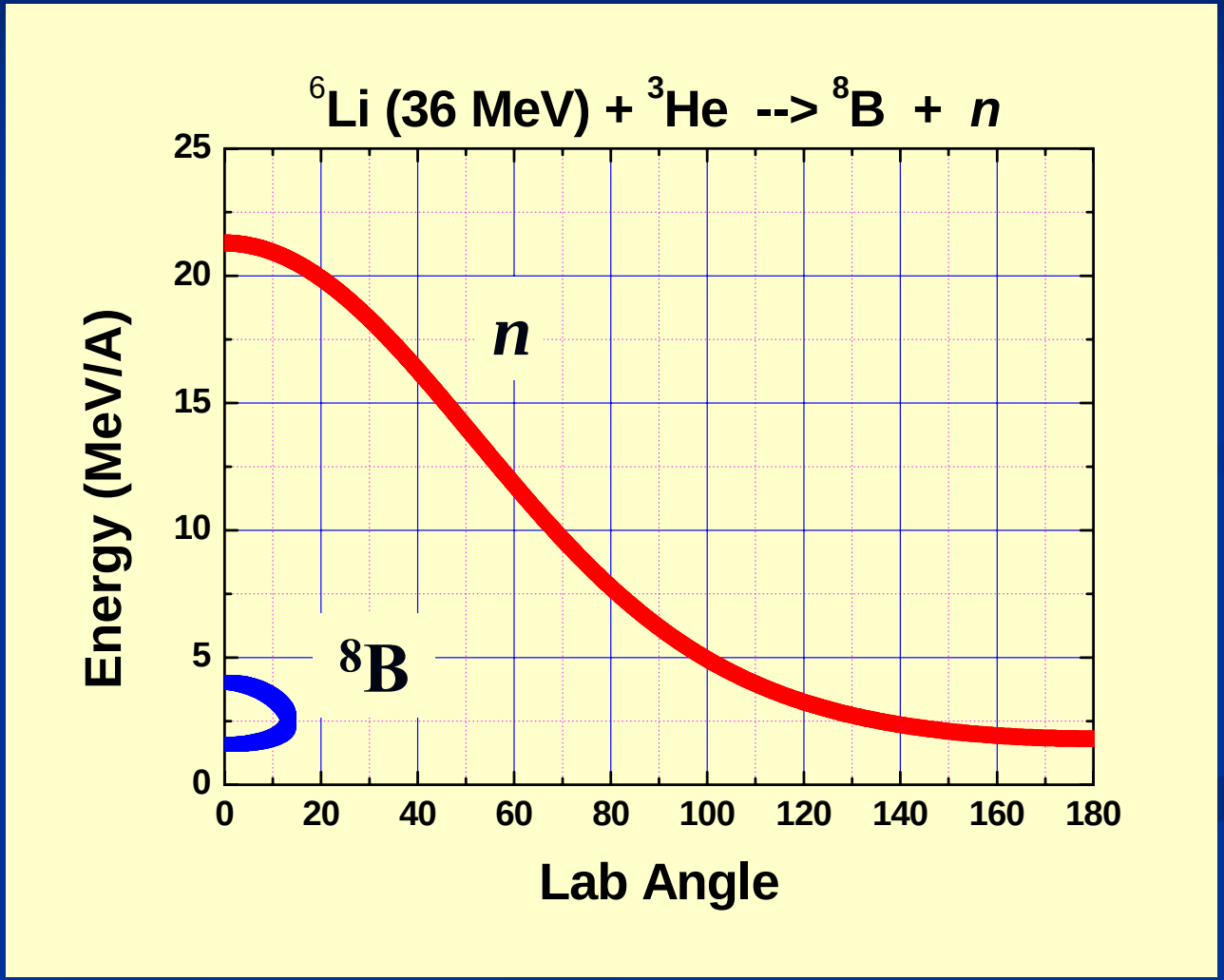
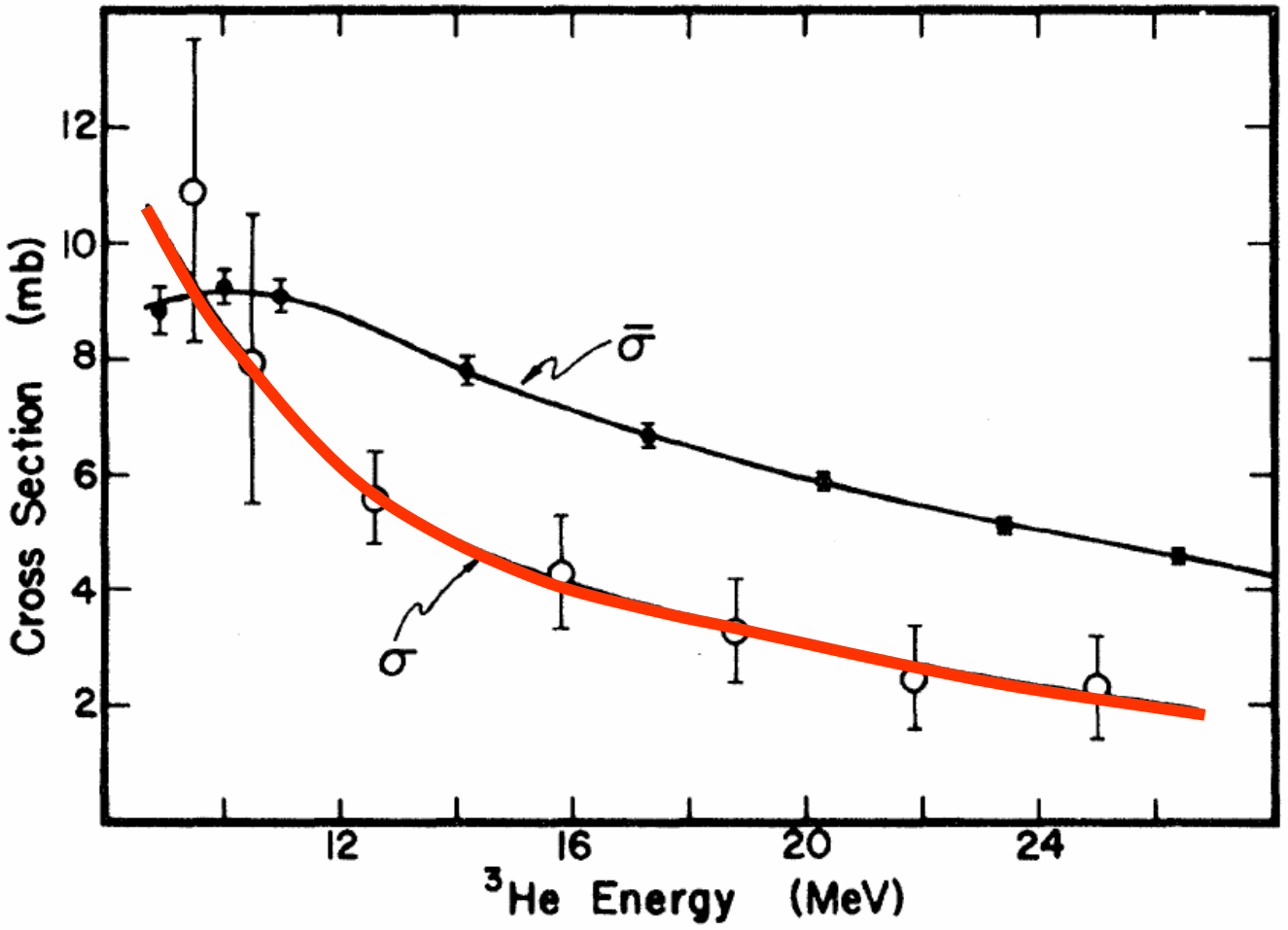
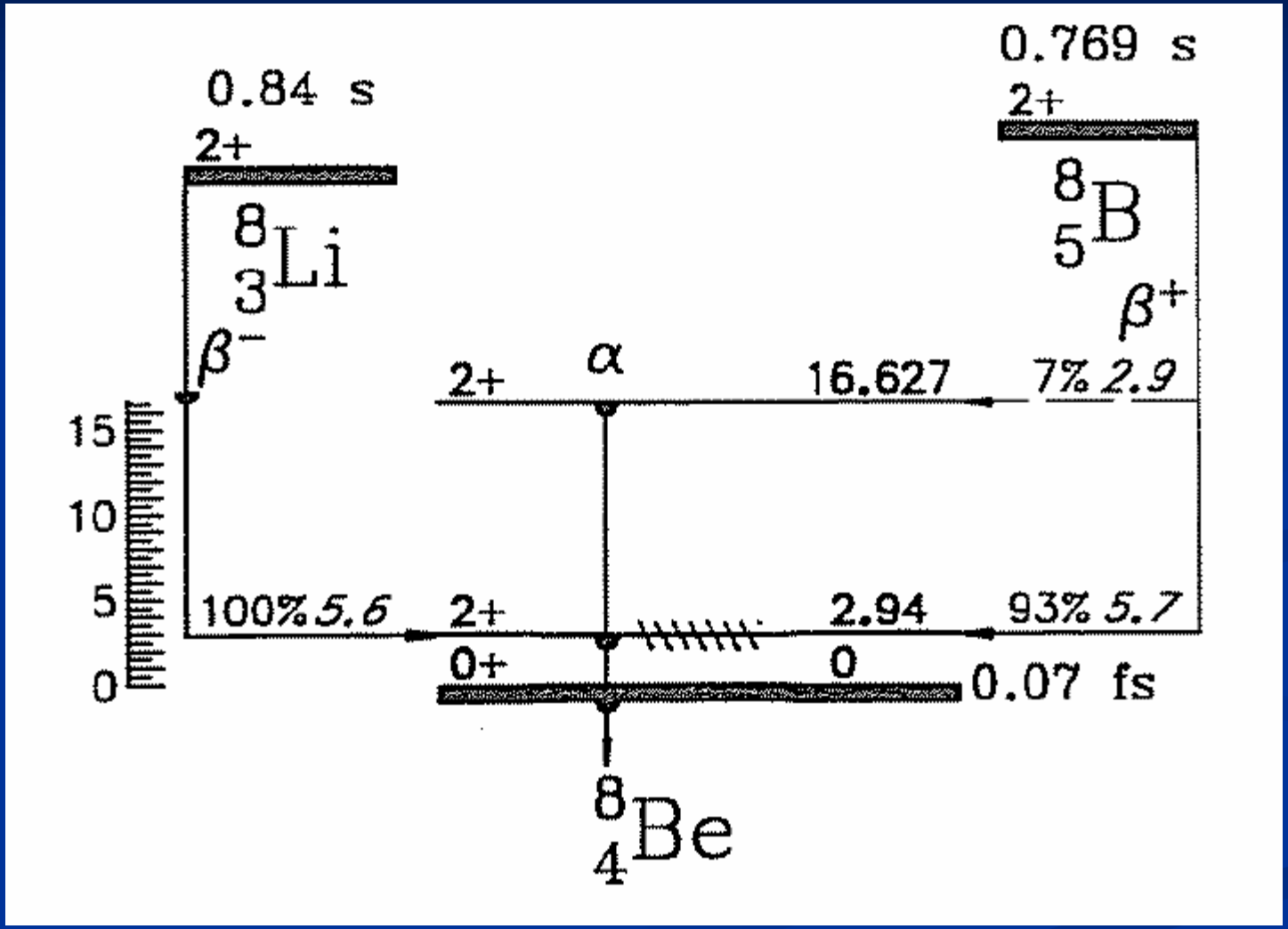


Marrs et al., PRC 8 (1973) 427

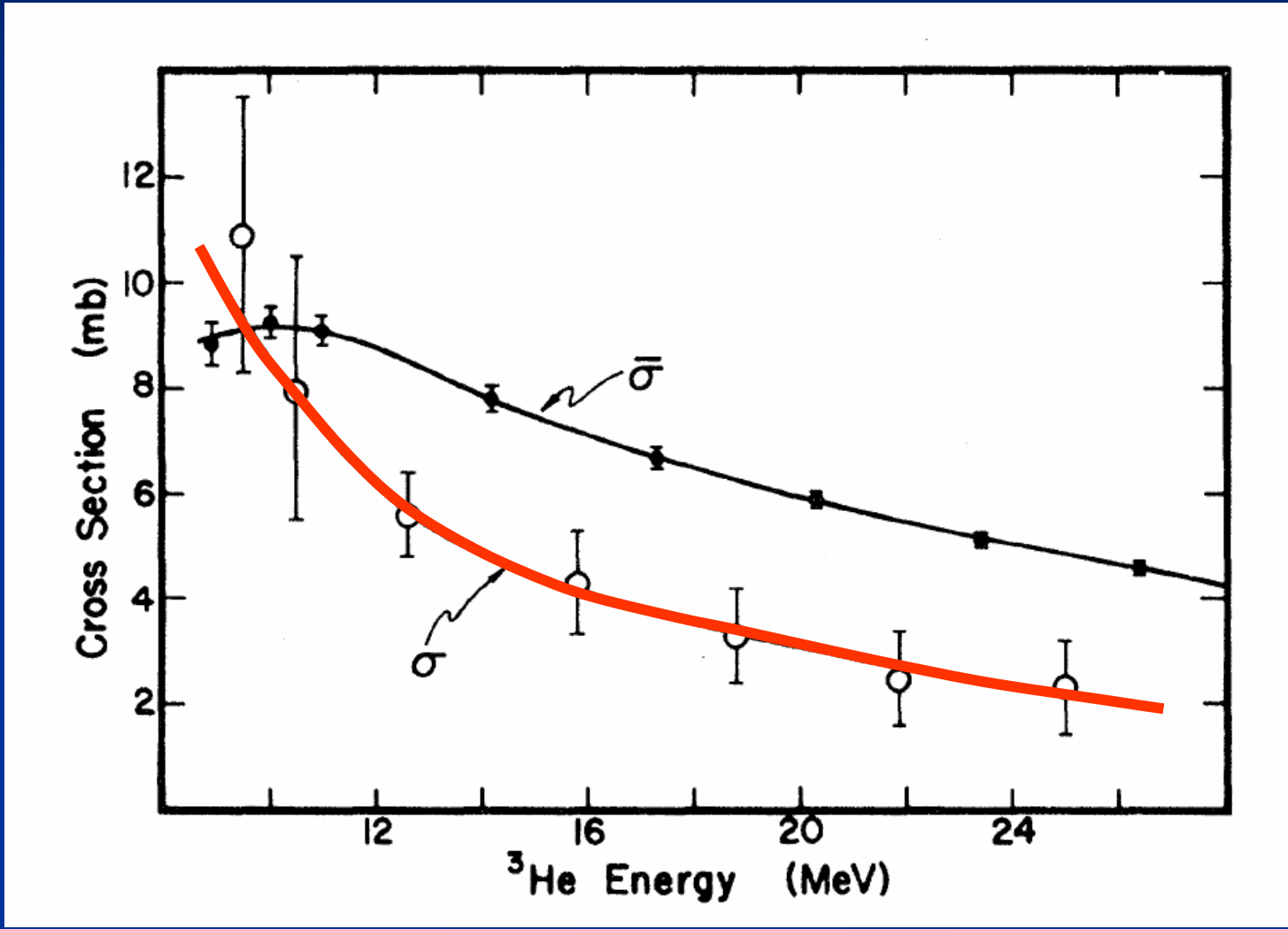
Accelerator Production of ^{8}B Neutrinos*

R. E. Marrs, D. Bodansky, and E. G. Adelberger
Department of Physics, University of Washington, Seattle, Washington 98195
(Received 23 April 1973)




0.769 s
0.84 s
2+
2+
$^{8}_{5}$B
$^{8}_{3}$Li
β^+
β^-
α
2+
16.627
7% 2.9
15
10
5
0
100% 5.6
2+
2.94
93% 5.7
0+
0
0.07 fs
$^{8}_{4}$Be

$^{3}He + {}^{6}Li \rightarrow {}^{8}B + n$



Marrs et al., PRC 8 (1973) 427

$^3He + ^6Li \rightarrow ^8B + n$

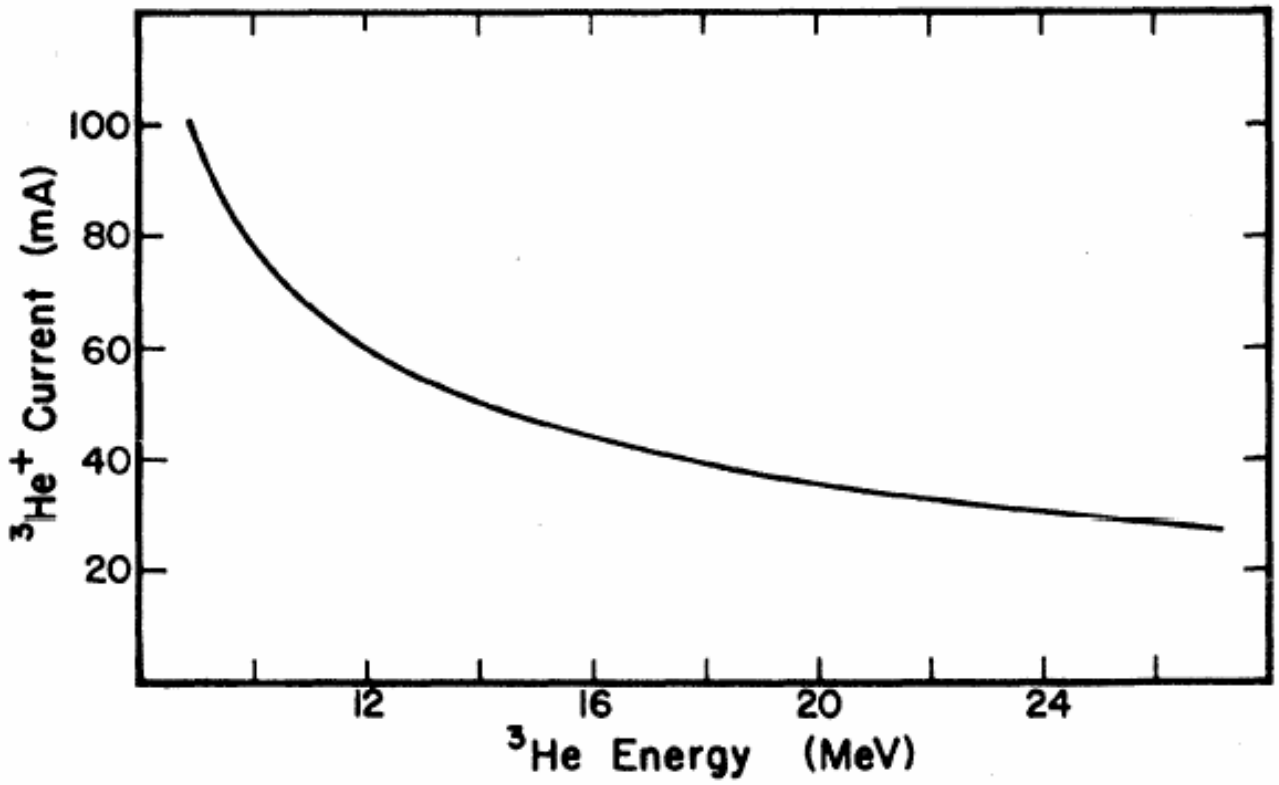
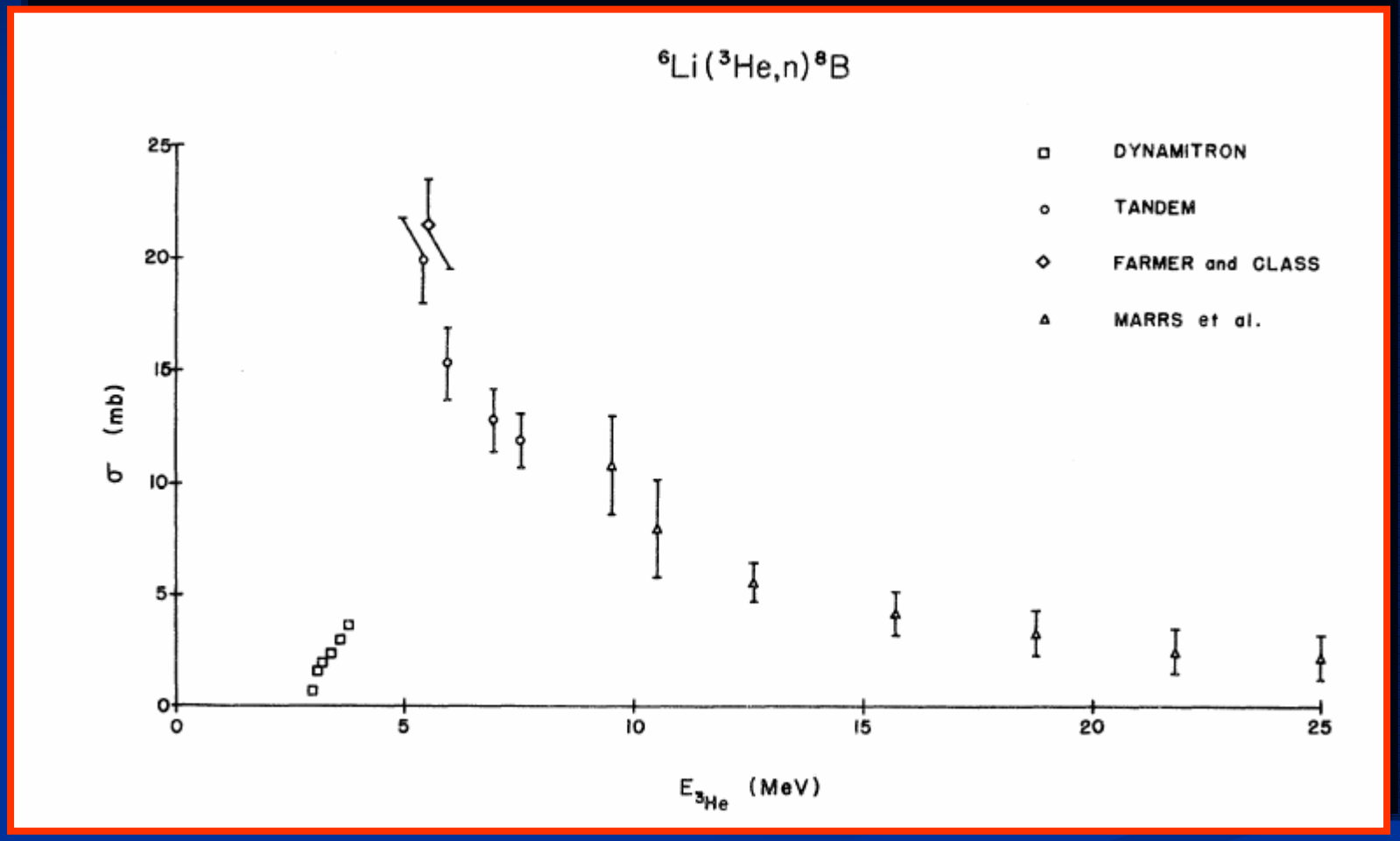


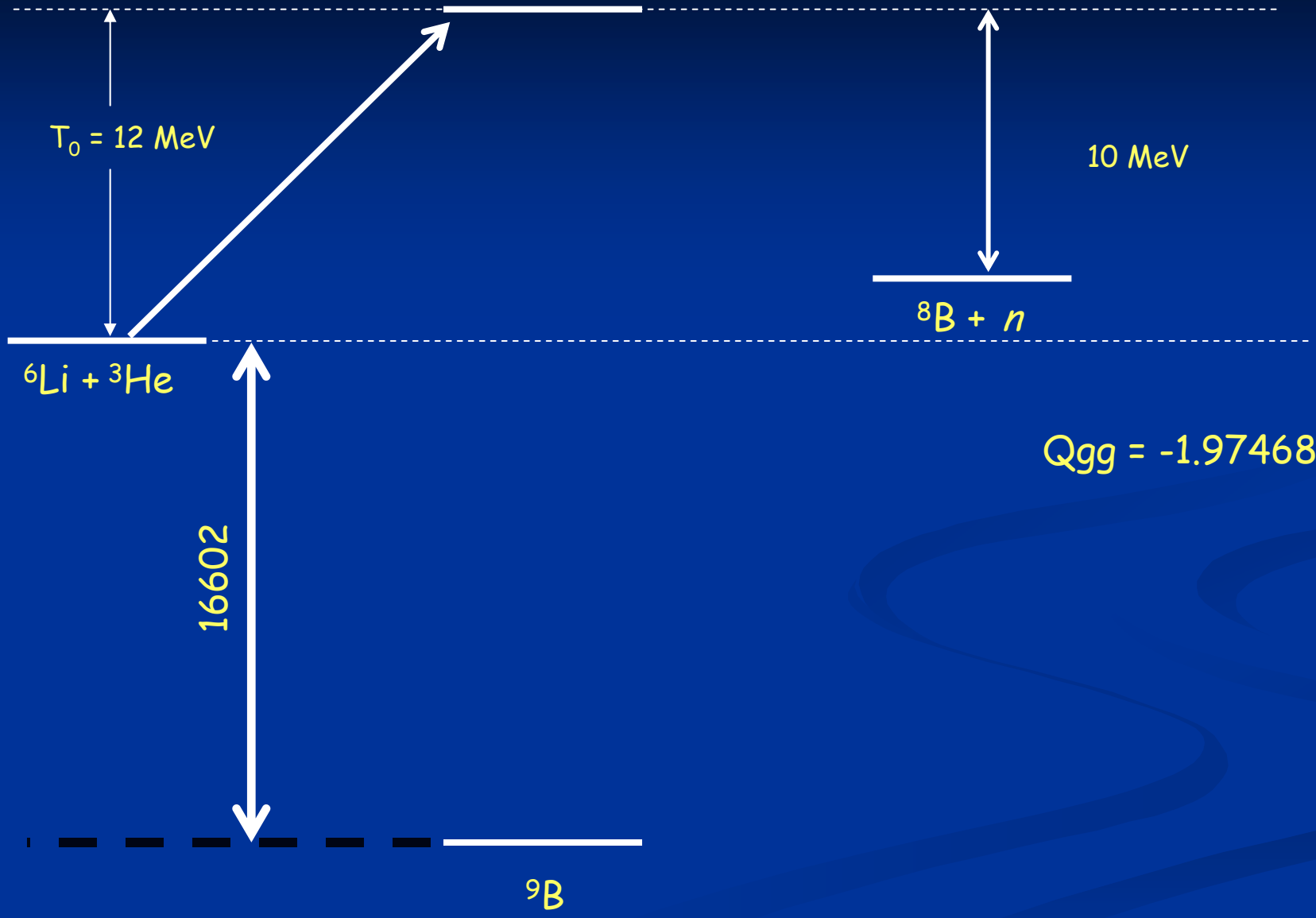
FIG. 3. $^3He^+$ current required to produce a flux of 0.74×10^6 ^8B neutrinos per cm^2 sec at a distance of 8 m, using the $^6Li(^3He,n)^8B$ reaction.

Marrs et al., PRC 8 (1973) 427

$^{3}He + {}^{6}Li \rightarrow {}^{8}B + n$



Mc Clenahan et al., PRC 11 (1975) 370



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