Breakup, transfer and fusion of ^{6,7}Li with ^{208}Pb at barrier energies

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Fusion, transfer, breakup (and elastic scattering) of ^{6}He with $^{(206),208}$Pb

A. Szanto de Toledo, N. Carlin, R. Liguori Neto, M.M. de Moura, M.G.Munhoz, F.A. Souza ,A.A.P.Suaide, E.M.Szanto, J. Takahashi

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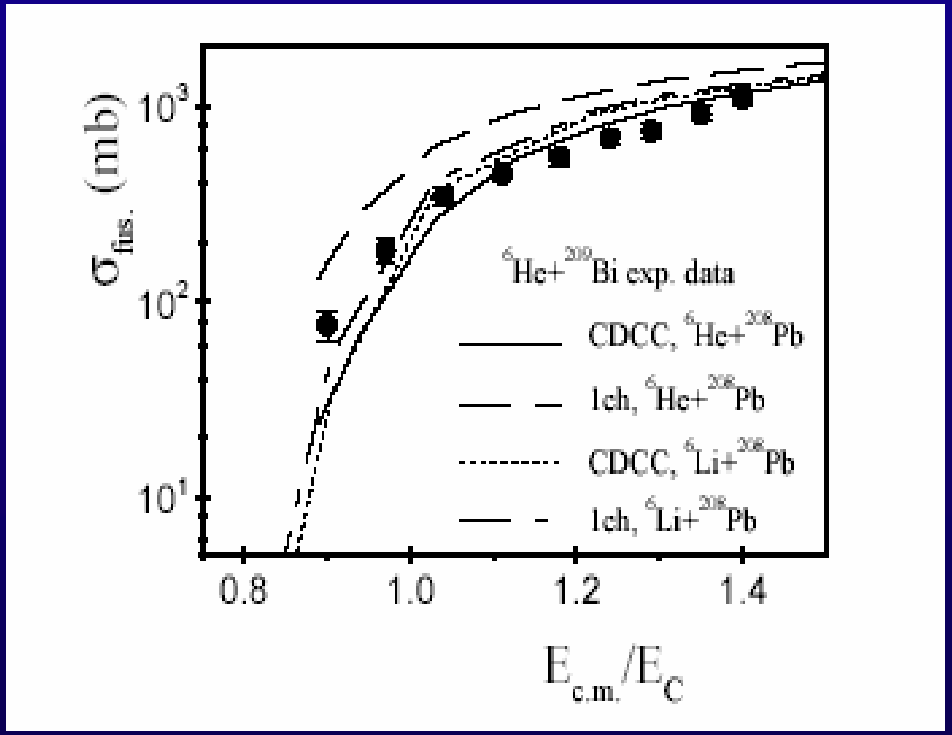
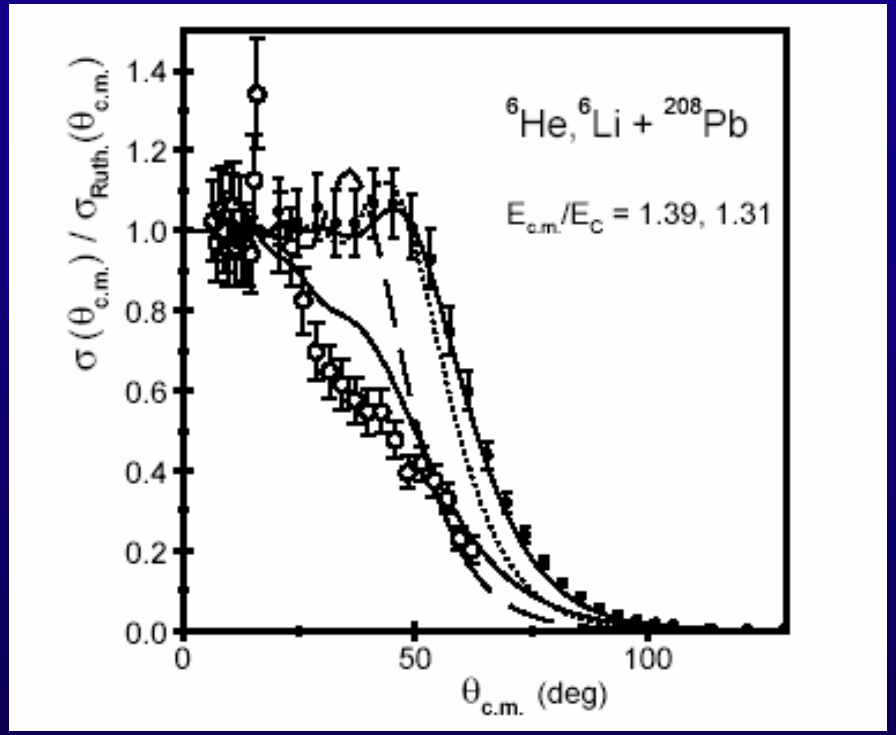
elastic and breakup measurements

$^{6}He + ^{209}Bi$
$^{6}He, ^{6}Li + ^{208}Pb$

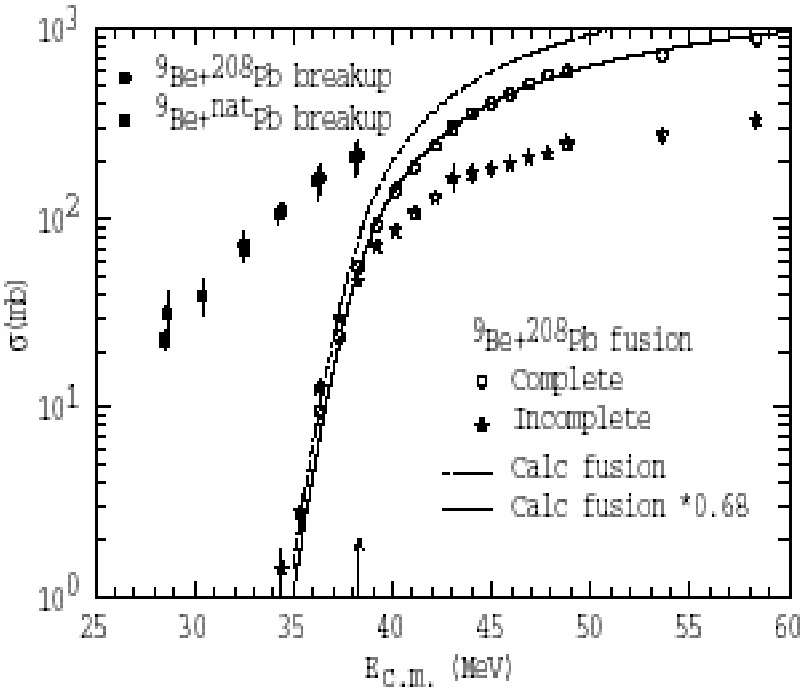


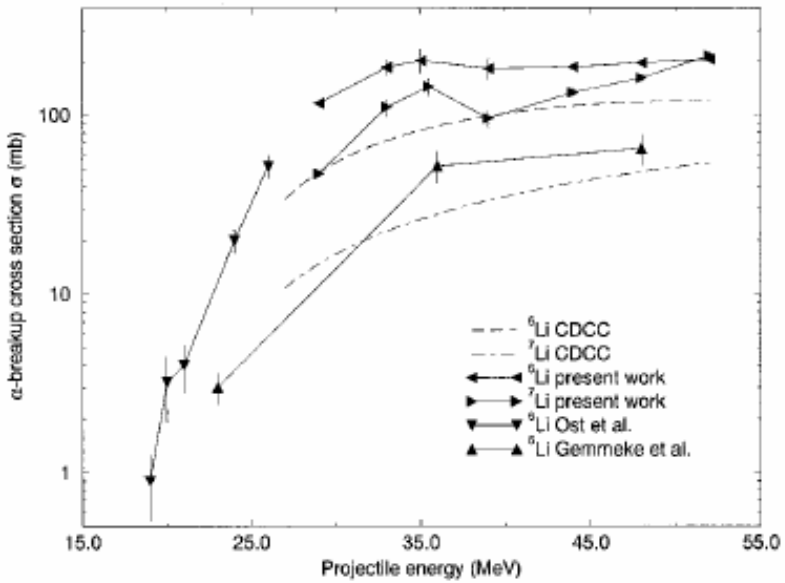


K. Rusek et al.
PRC 67 (2003) 41604

$^{9}Be + ^{208}Pb$

D.J. Hinde et al.
PRL 89 (2002) 272701



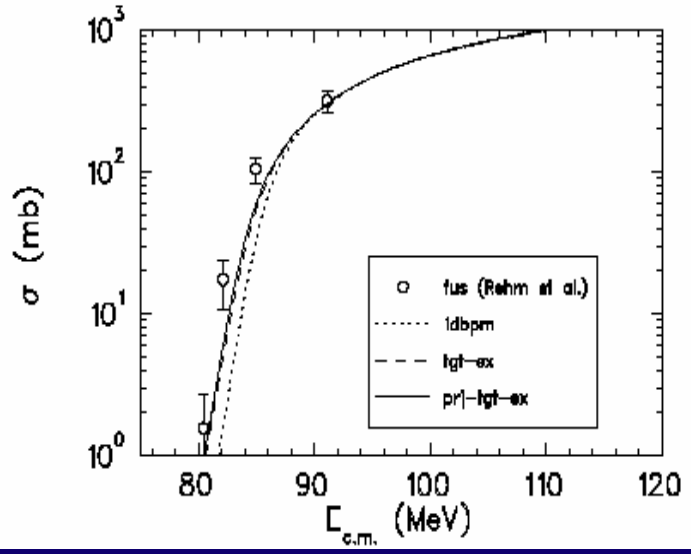


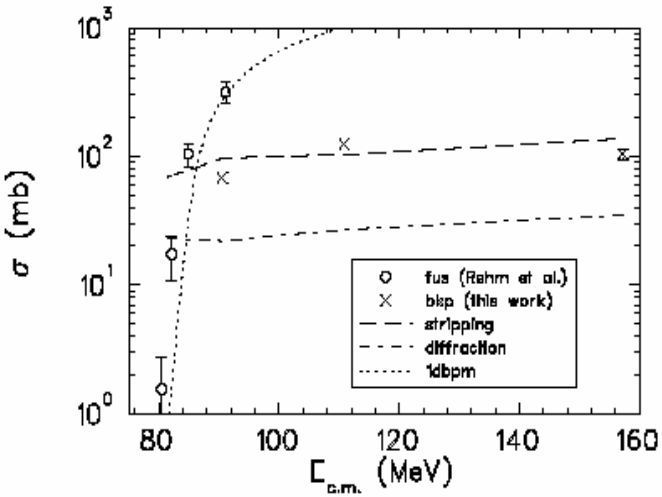
$^{6,7}Li + ^{208}Pb$

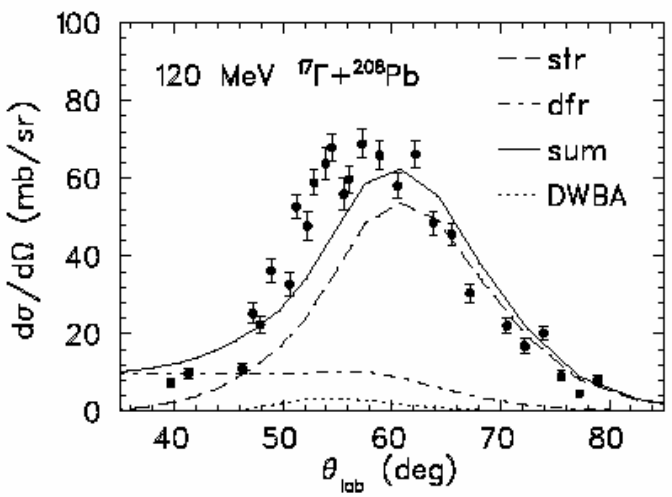
G.R. Kelly et al.
PRC 63 (2000) 24601

$^{17}F+^{208}Pb$

J.F. Liang et al.
PRC 67 (2003) 44603







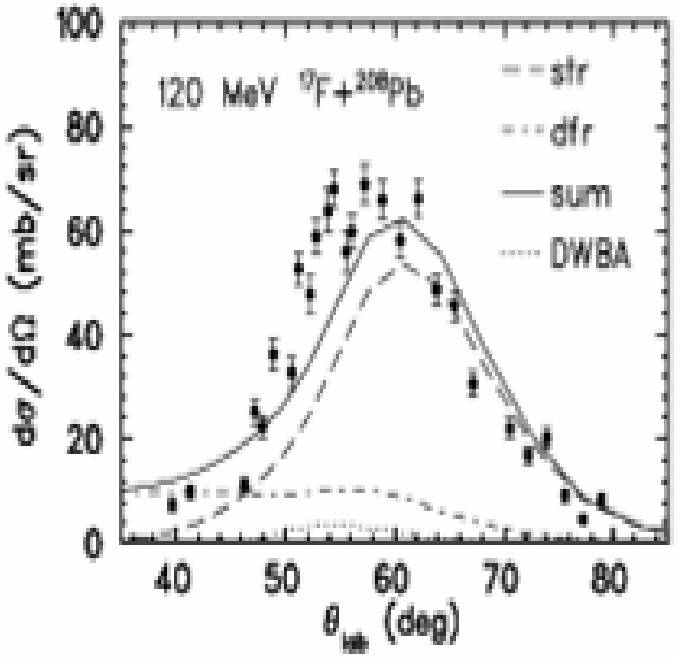


FIG. 3. Angular distribution of oxygen produced from 120 MeV ^{17}F+^{208}Pb. The calculated stripping and diffraction breakup are shown by the dashed and dash-dotted curves, respectively. The solid curve is for the sum of the two. The results of one-step DWBA transfer calculations are shown by the dotted curve.

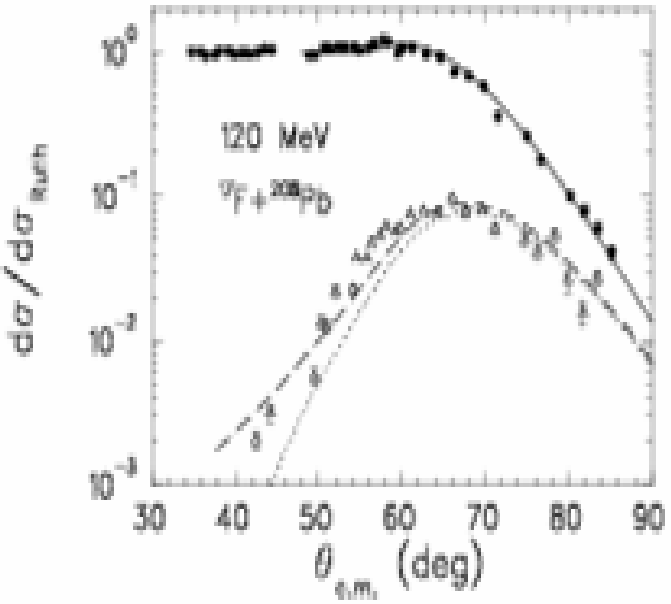
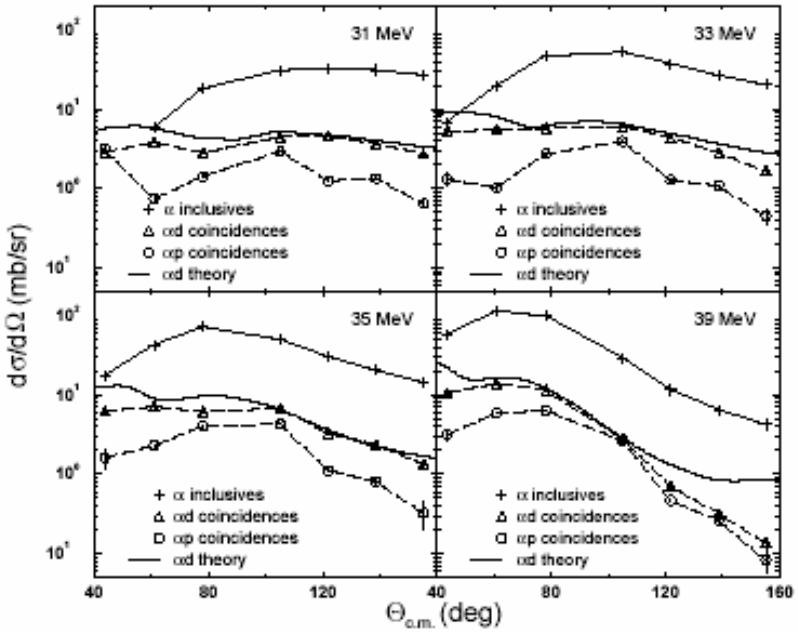


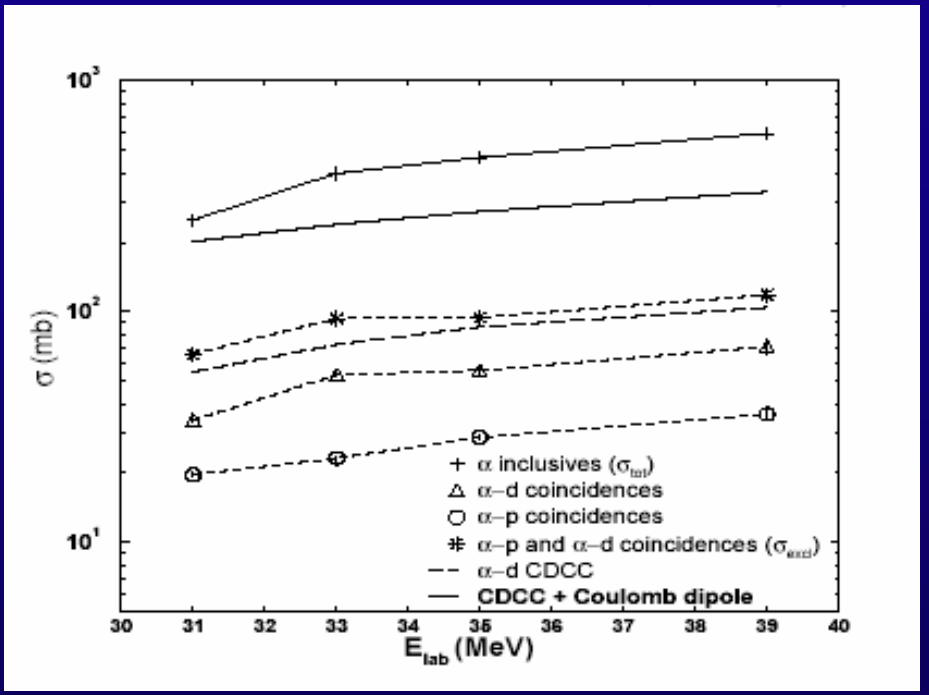
FIG. 4. Angular distribution of elastic scattering (filled circles) in 120 MeV ^{17}F+^{208}Pb. The result of an optical model fit to the data is shown by the solid curve. The angular distribution of oxygen produced in the same reaction is presented for comparison (open triangles). The calculated stripping is shown by the dotted curve and the sum of stripping and diffraction breakup is shown by the dashed curve.

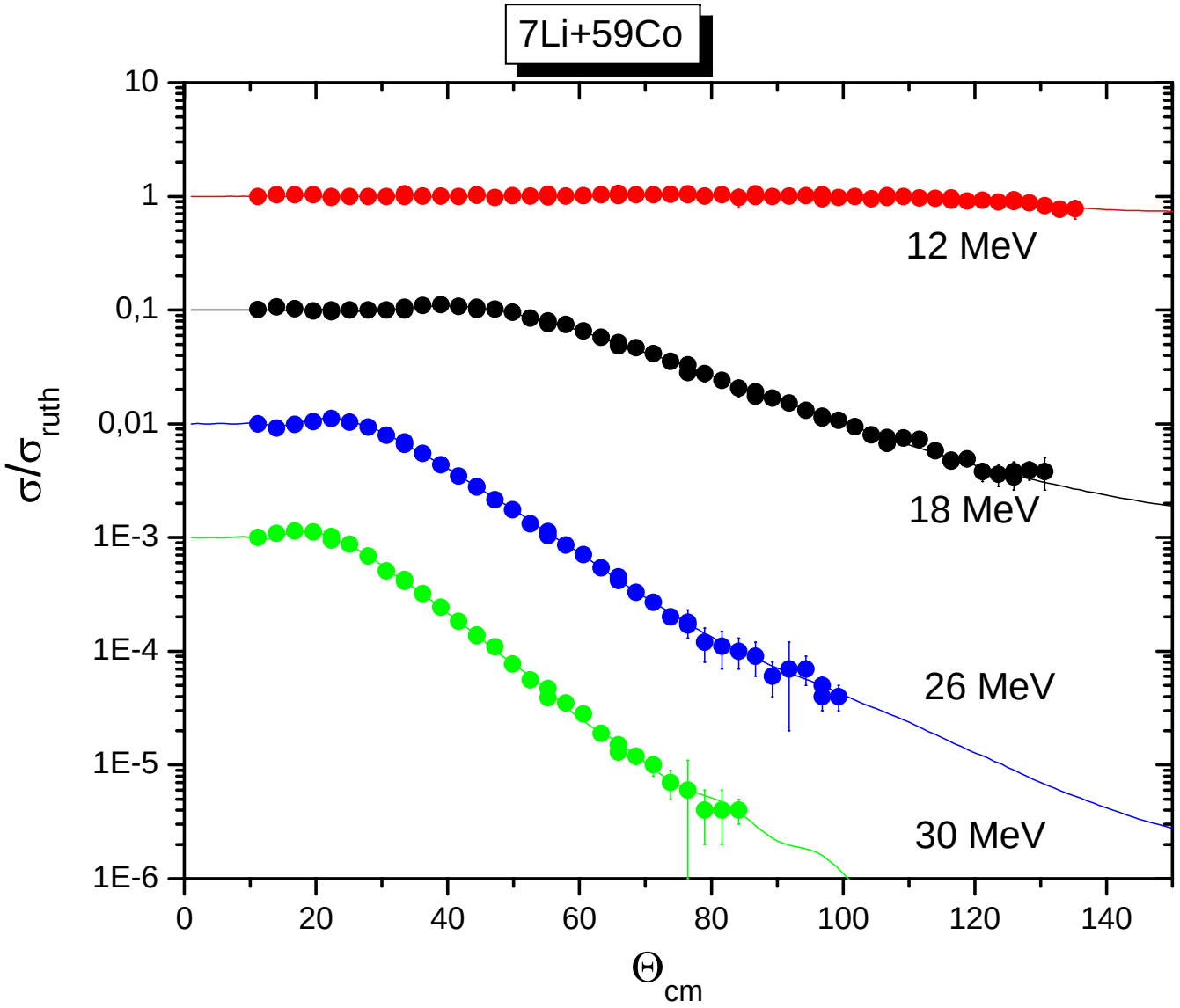
or large cross sections calculated in one-step single-nucleon

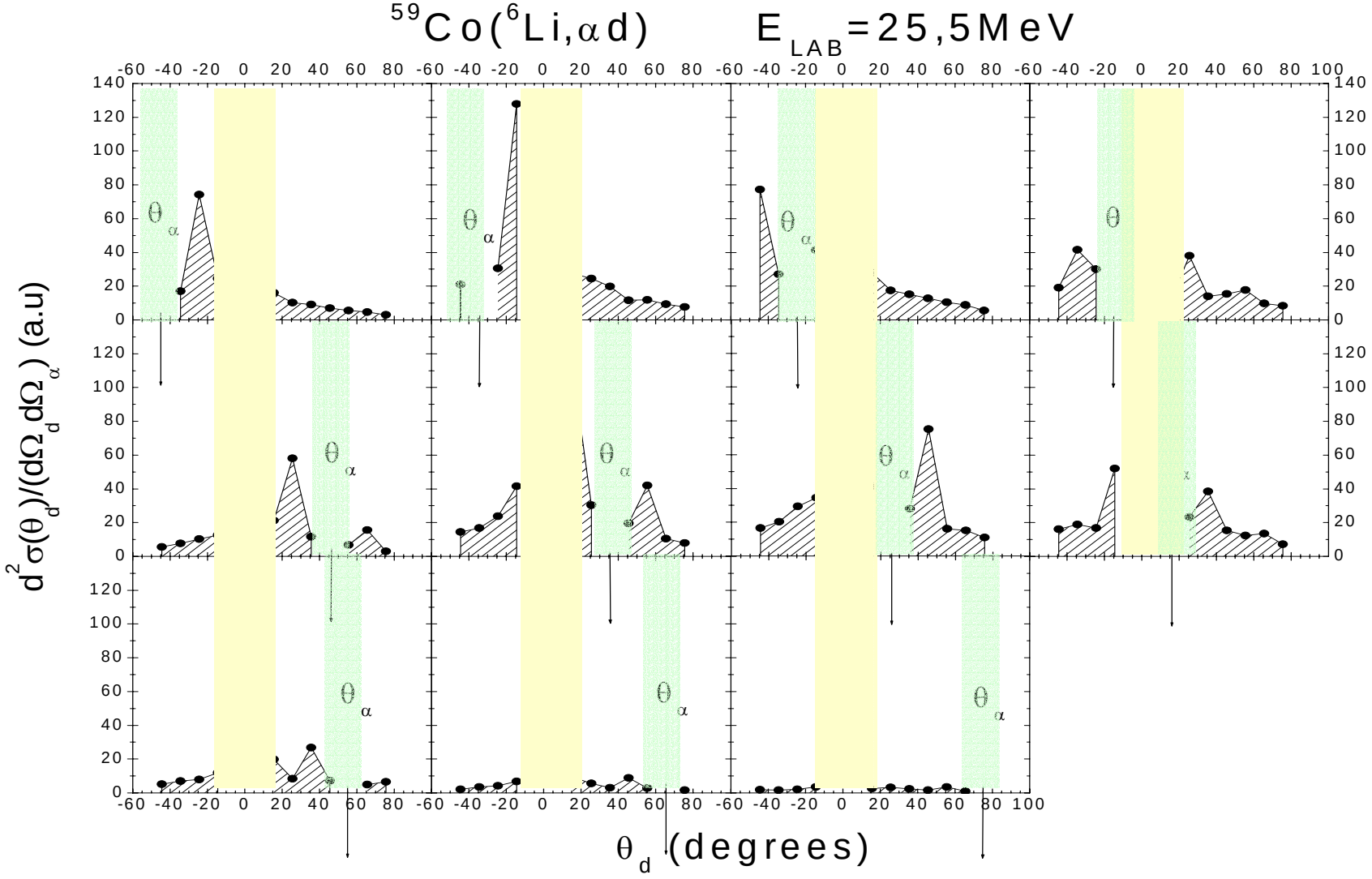
$^{6}Li + ^{208}Pb$

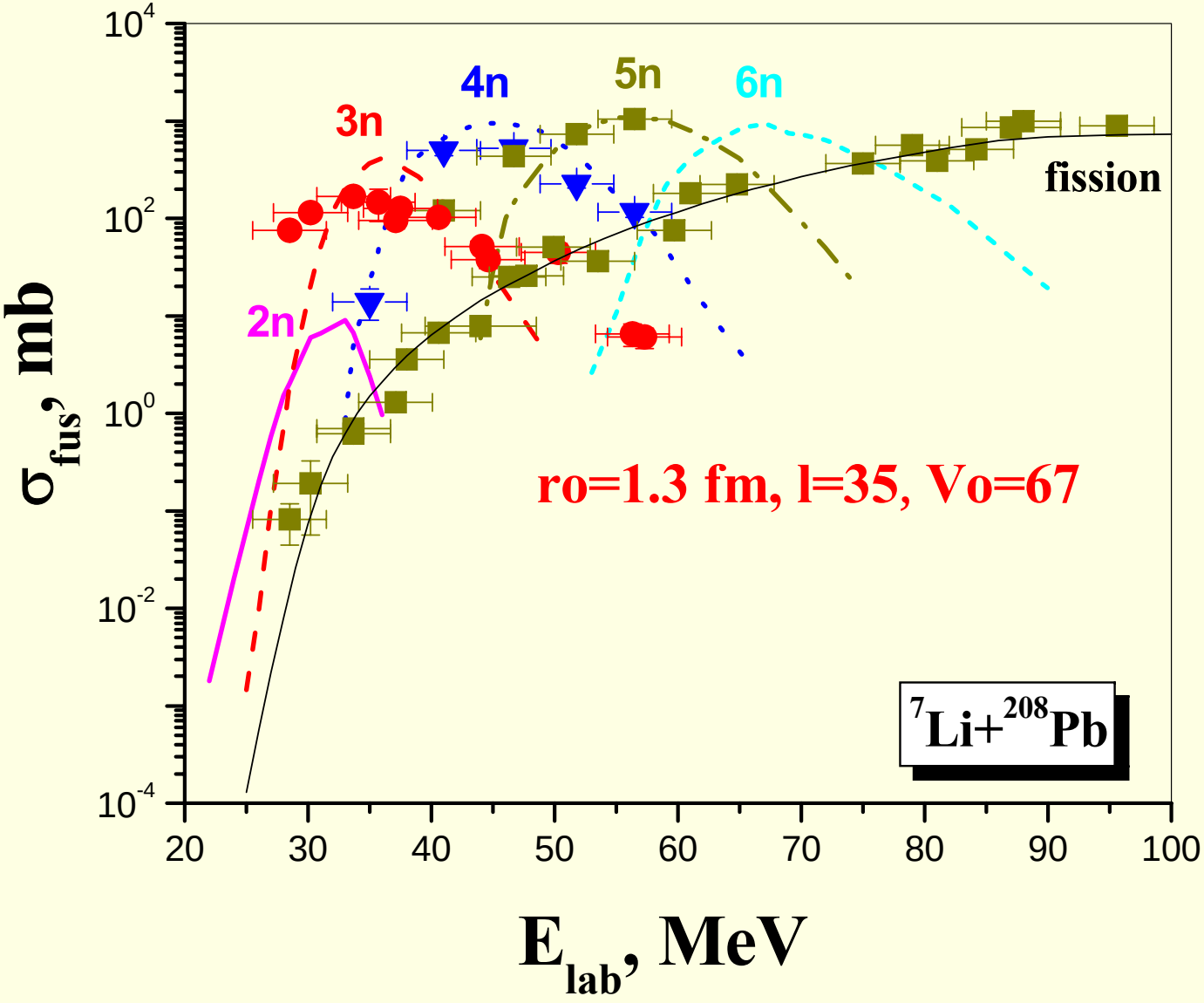
C.Signorini et al.
PRC 67 (2003) 44607






7Li+59Co
10
1
0,1
0,01
1E-3
1E-4
1E-5
1E-6
σ/σruth
12 MeV
18 MeV
26 MeV
30 MeV
0
20
40
60
80
100
120
140
Θcm


$^{59}Co(^{6}Li,\alpha d)$ $E_{LAB}=25,5MeV$
$d^2\sigma(\theta_d)/(d\Omega_d\, d\Omega_\alpha)$ (a.u)
θ_d (degrees)
θ_α


10^4
10^2
10^0
10^{-2}
10^{-4}
σ_{fus}, mb
2n
3n
4n
5n
6n
fission
ro=1.3 fm, l=35, Vo=67
^{7}Li+^{208}Pb
20
30
40
50
60
70
80
90
100
E_{lab}, MeV

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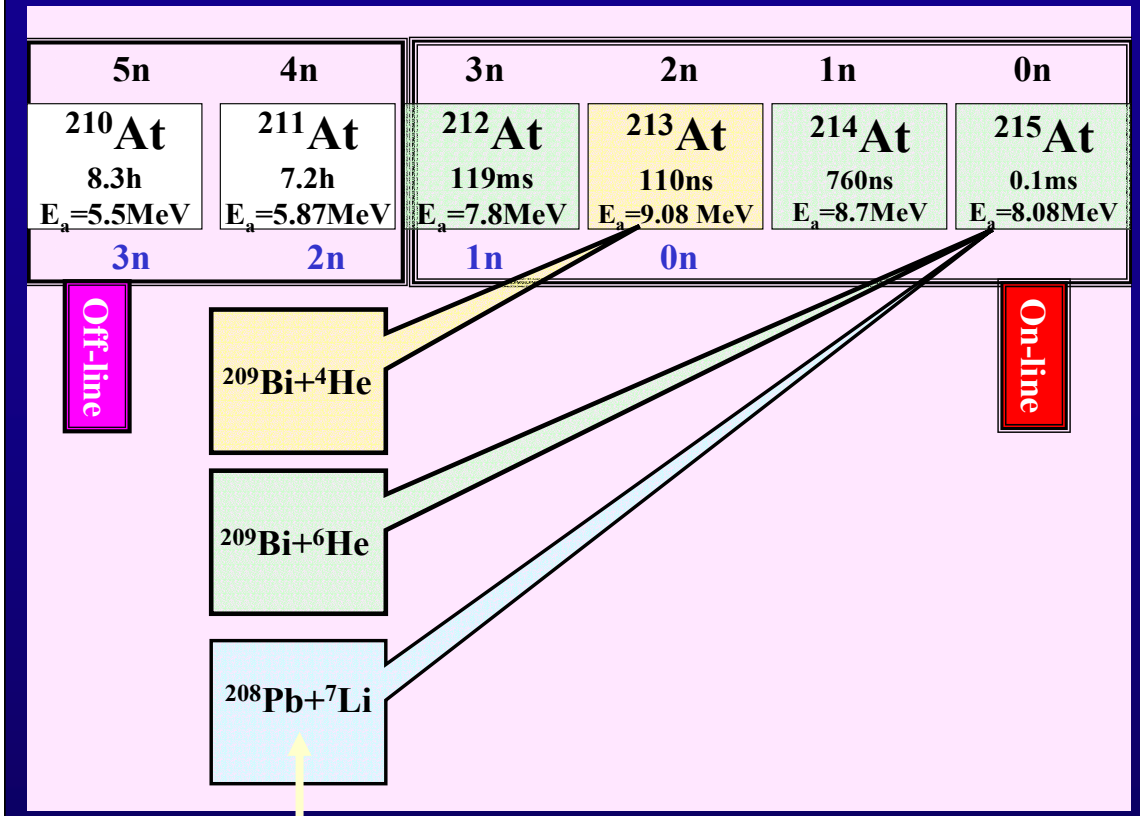

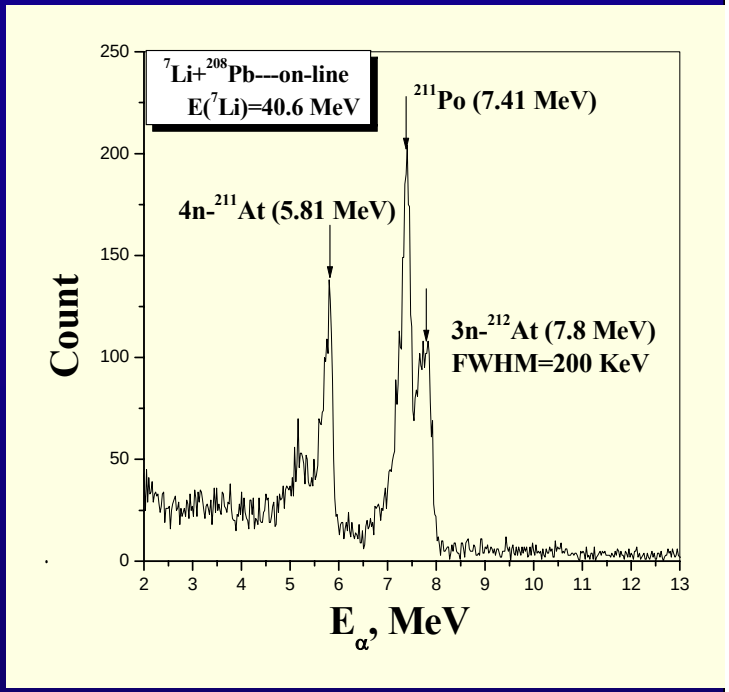

TRIGGER: det de neutrons

xn	Evaporation residue	$T_{1/2}$	E_α (MeV), Table of Isotopes	E_α(MeV) Experimental
0n	^{213}At	125 ns	9.08	--
1n	^{212}At	314 ms	7.68	--
2n	^{211}At	7.21 h	5.87 7.28 (^{211}Po 516 ms)	5.9 ($T_{1/2}$=7.34h) 7.43 (^{211}Po)
3n	^{210}At	8.1 h	5.36 - 5.52 5.3 (^{210}Po 138.4d)	5.36 ($T_{1/2}$=8.44h) 5.33 (^{210}Po)
4n	^{209}At	5.41 h	5.65 4.979 (^{209}Po 103 yr)	

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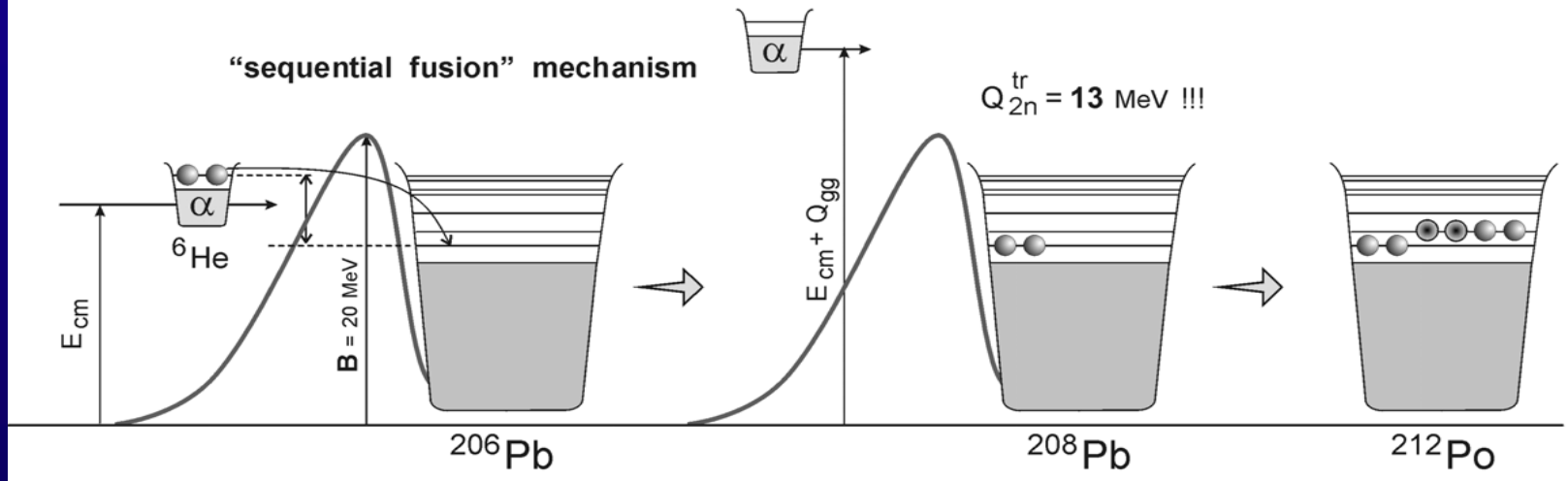
Sub-barrier fusion of weekly bound nuclei: proposal for a new experiment

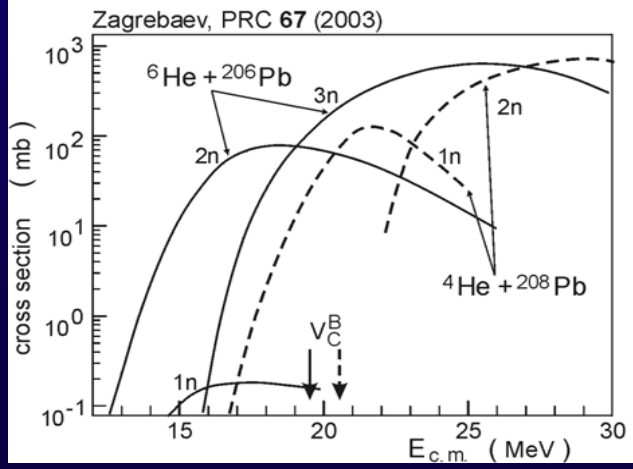
$^{6}He + ^{206}Pb \rightarrow ^{212}Po$, $E_{cm} = 15$ MeV, $\sigma_{fus} \sim 10$ mb

$^{4}He + ^{208}Pb \rightarrow ^{212}Po$, $E_{cm} = 15$ MeV, $\sigma_{fus} \sim 0.01$ mb

$V_C^B = 20$ MeV

"sequential fusion" mechanism



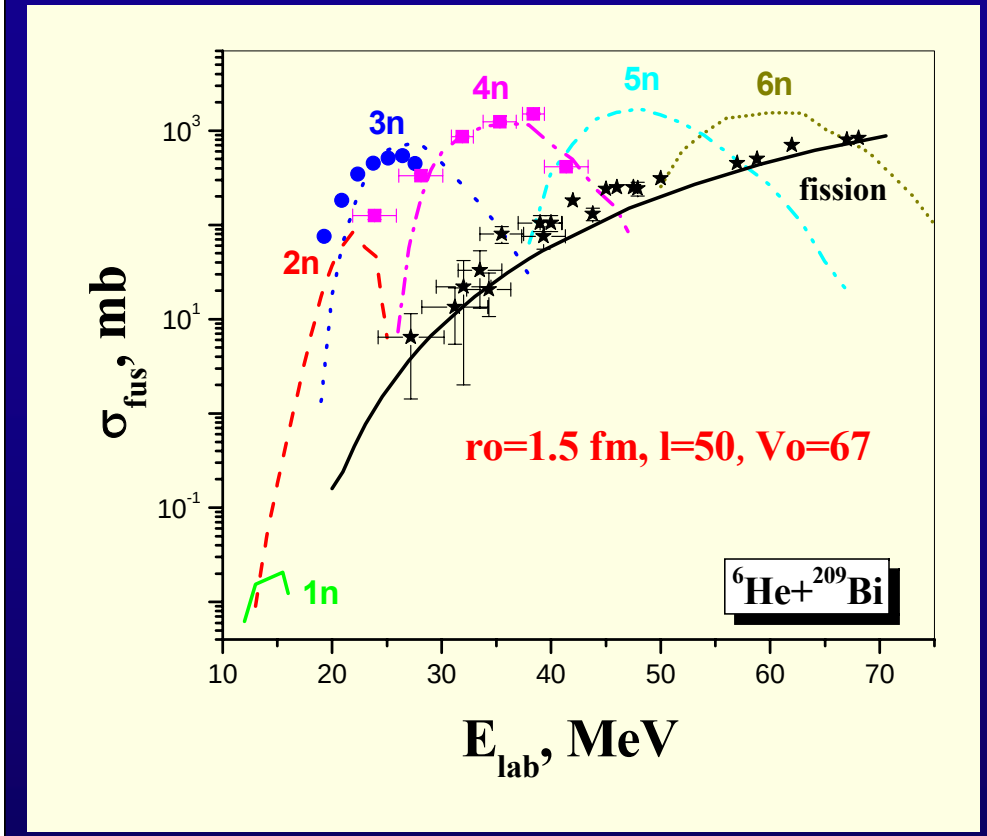


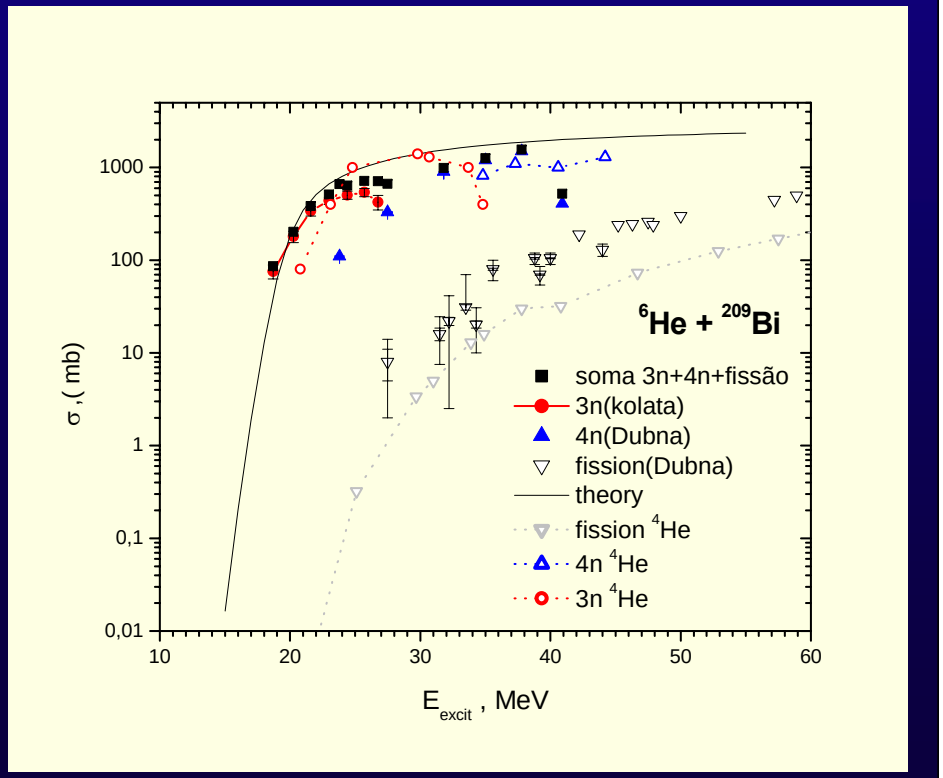
$^{6}He + ^{206}Pb \rightarrow ^{212}Po^{*}(19\ MeV) \xrightarrow{2n} ^{210}Po(g.s., T_{\alpha} = 138\ d)$
off-line detecting

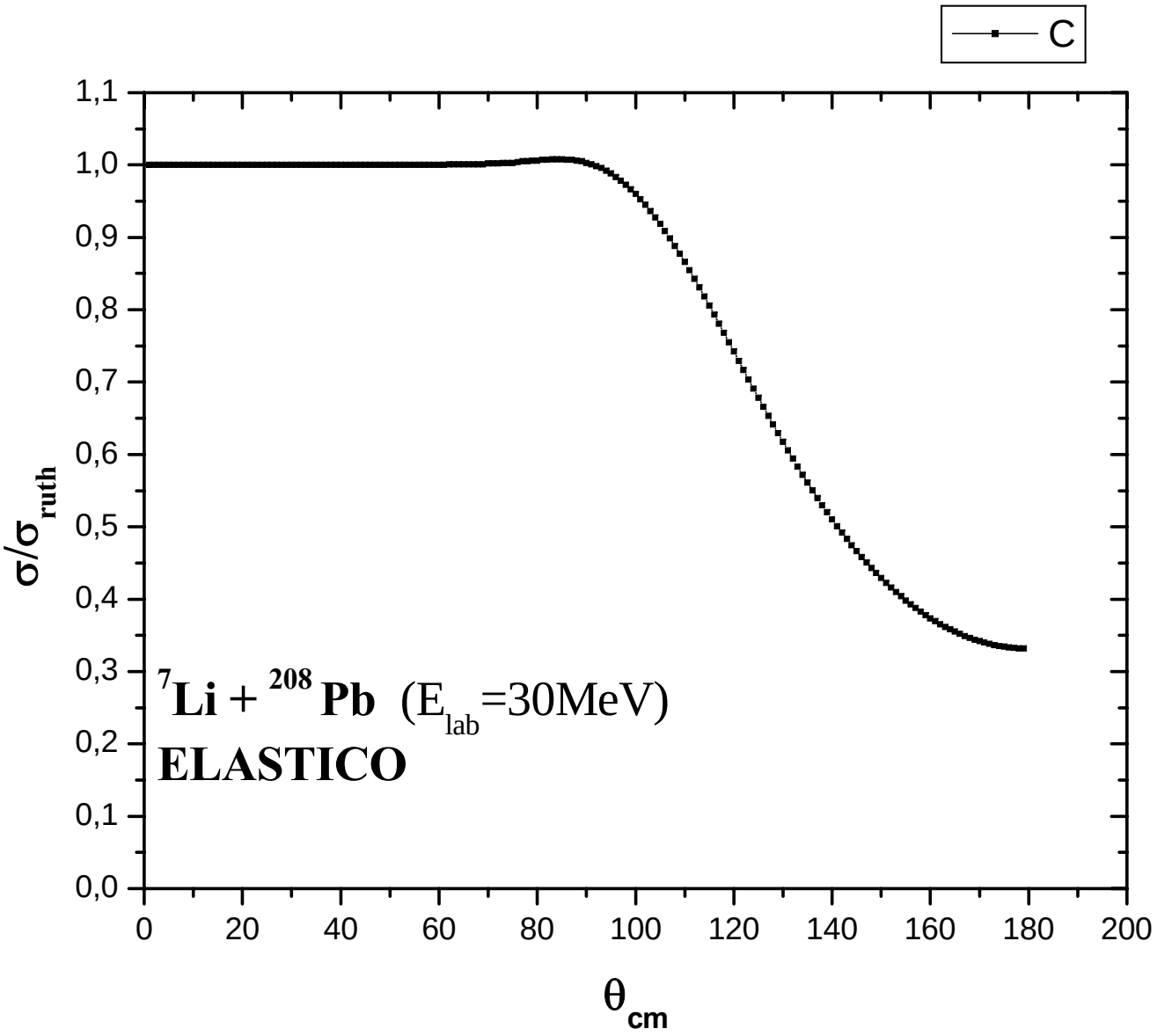
$^{4}He + ^{208}Pb \rightarrow ^{212}Po^{*}(6\ MeV) \xrightarrow{1n} ^{211}Po(g.s., T_{\alpha} = 0.5\ s)$
pulsed beam

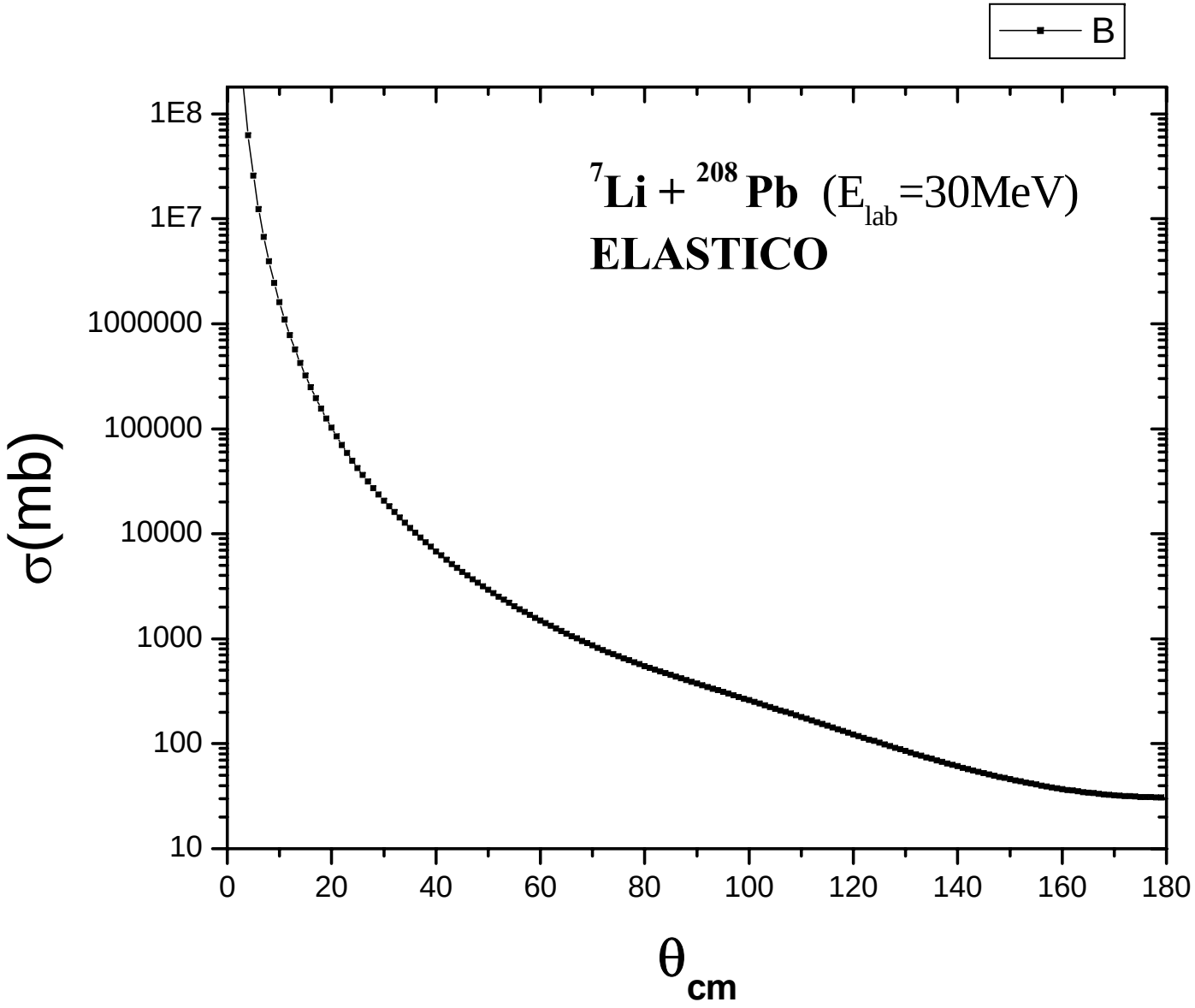
xn	Evaporation residue	$T_{1/2}$	E_α (MeV), Table of Isotopes
0n	^{214}Po	163.7 μs	7.787
1n	^{213}Po	4 μs	8.375
2n	^{212}Po	45s	11.65
3n	^{211}Po	25.2s	7.27
4n	^{210}Po	138.38d	5.304

α-decay characteristics of the 214-xnPo residual nuclei.


1n
2n
3n
4n
5n
6n
fission
ro=1.5 fm, l=50, Vo=67
^{6}He+^{209}Bi
σ_{fus}, mb
E_{lab}, MeV


^{6}He + ^{209}Bi
soma 3n+4n+fissão
3n(kolata)
4n(Dubna)
fission(Dubna)
theory
fission ^{4}He
4n ^{4}He
3n ^{4}He
σ ,(mb)
E_{excit} , MeV


C
1,1
1,0
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0,0
σ/σruth
0
20
40
60
80
100
120
140
160
180
200
θcm
7Li + 208Pb (Elab=30MeV)
ELASTICO


B
^{7}Li + ^{208}Pb (E$_{lab}$=30MeV)
ELASTICO
σ(mb)
θ$_{cm}$
1E8
1E7
1000000
100000
10000
1000
100
10
0
20
40
60
80
100
120
140
160
180

$Y = \sigma N_a N_f$

$\sigma = 10 - 10^{-2}$ mb (calc. $\sigma \sim 1.0$ mb)

$N_a = 200\ \mu g/cm^2$

$N_f = 10$ e.nA

} Y = 13 cont. /hora

Y=1000 cont. → 3 dias

NECESSIDADE MÍNIMA : 8 ENERGIAS (/ sistema)→

Request : E-65

25 days of ^{6,7} Li beam

using the 15B scattering chamber and neutron wall.

Request : E-64

30 days of ^{6}He beam

using the superconducting solenoid and neutron wall, at the 45B beam-line.