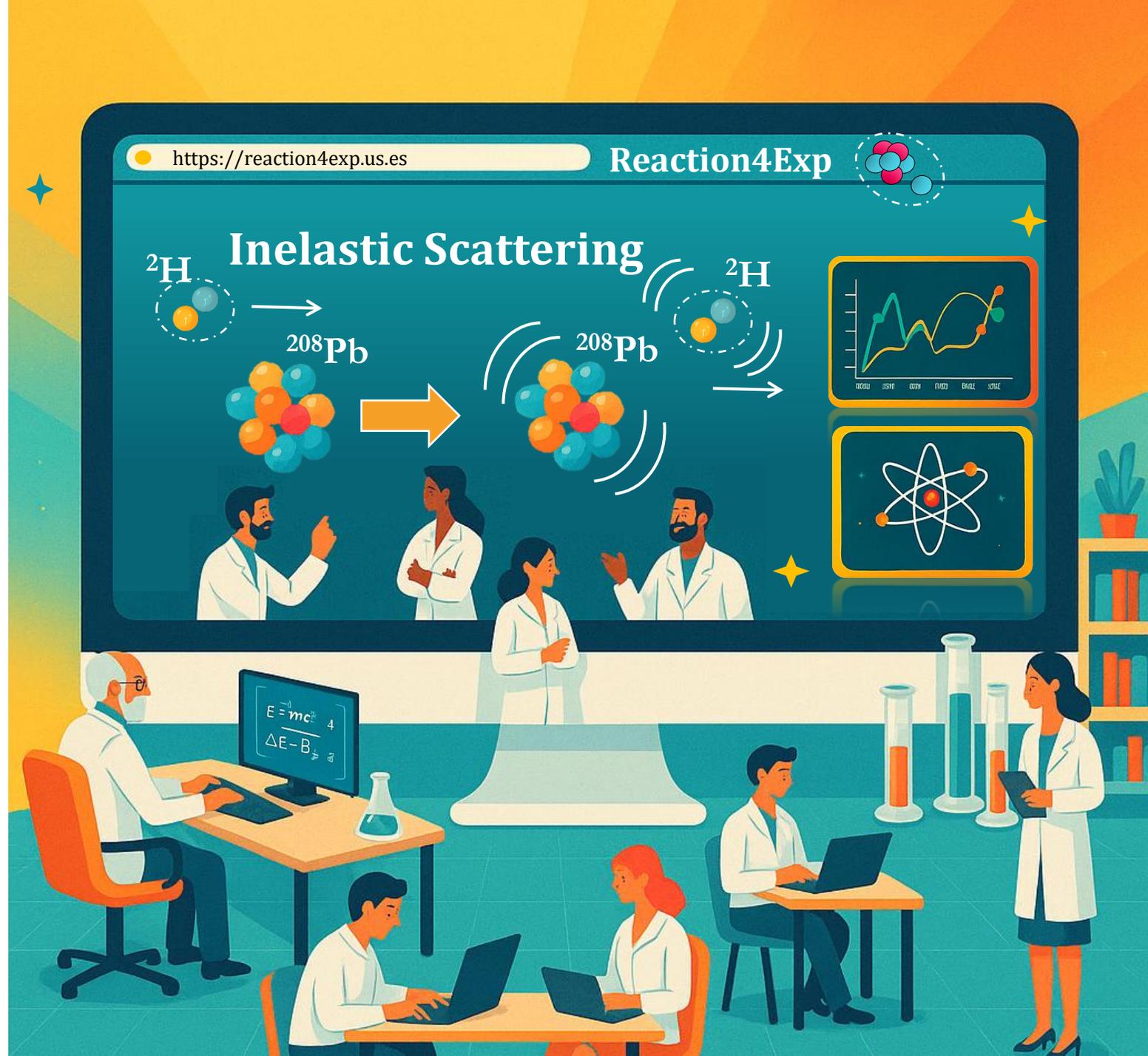


Do you know how to use Reaction4Exp platform?

Carla Tatiana Muñoz Chimbo



Content



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Access and general options

Customize styles plot, download results, external input.

2

Optical Model (FRESCO) and Classical

Potential generator / SPP2.

3

Inelastic Scattering - FRESCO

Rotational Model / Deformations.

4

Transfer reactions - FRESCO

Q-value, prior and post interaction.

5

Coulomb break up - EPM

Discrete and continuous distribution.



Welcome to Reaction4Exp!

Virtual access Infraestructure - University of Seville

CARLA TATTANA MUÑOZ CHIMBO

Theo4Exp

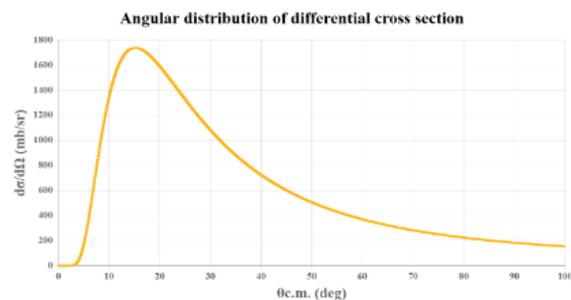
EURO-LABS

Contact us



Start your calculation

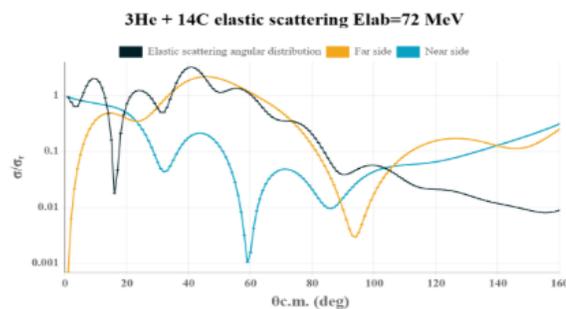
Select the type of nuclear reaction and explore results



Coulomb break up

Semiclassical calculations - EPM

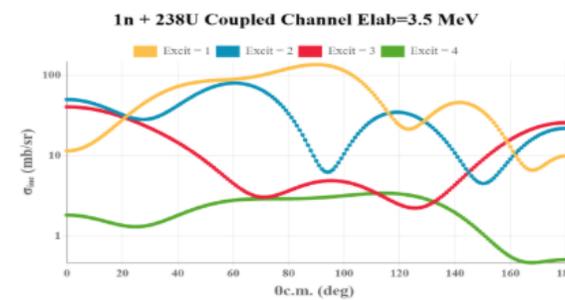
• Angular distribution of cross section



Elastic scattering

Classical and Optical Model FRESKO

• Generate potential SYSOP and SPP2



Inelastic scattering

Coupled channels method and DWBA approximation - FRESKO

• Generate potential SYSOP

<https://reaction4exp.us.es>

Access

<https://iam-eurolabs.ijclab.in2p3.fr/login>



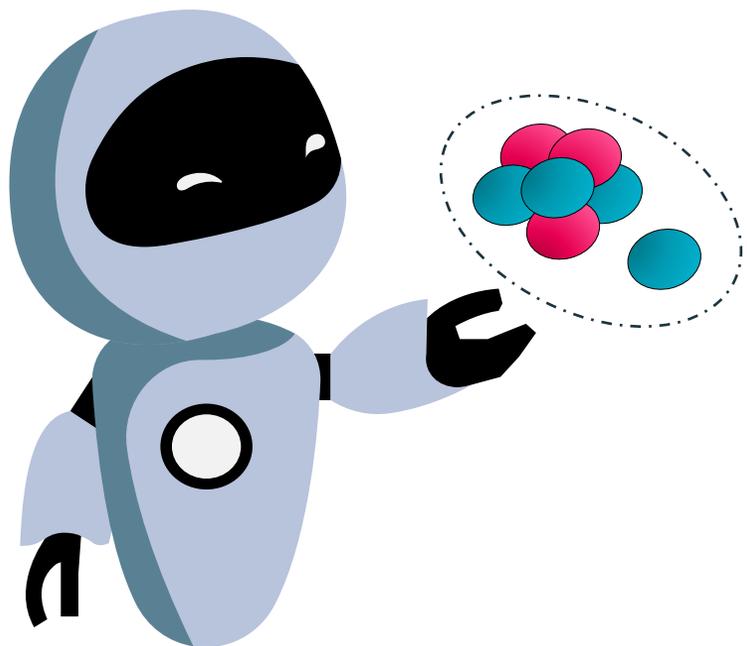
1. Choose eduGain or Orcid for identification



2. EduGain: Look for your institution



3. Use your institutional username and password



General Options

Reaction data, potentials, results, plot options

Reaction information

${}^4\text{He} + {}^{13}\text{C}$ at $E_{\text{lab}} = 72 \text{ MeV}$

- Projectile and target data
- Potentials
- Integration parameters

	Reaction	Potentials	Integration Parameters	
	Nucleus	A	J	Parity
Projectile	He <input type="text"/>	3 <input type="text"/>	0 <input type="text"/>	+1 <input type="text"/>
Target	C <input type="text"/>	14 <input type="text"/>	0 <input type="text"/>	+1 <input type="text"/>
	<input checked="" type="radio"/> Lab	<input type="radio"/> CM		
E (MeV)	72 <input type="text"/>	59,284 <input type="text"/>		

Reaction information

${}^4\text{He} + {}^{13}\text{C}$ at $E_{\text{lab}} = 72 \text{ MeV}$

- Projectile and target data
- **Potentials**
- Integration parameters

Potential options:

- Fresco format
- Global potential generator.
- Only available in elastic reactions (SPP2, external potential)

ReactionPotentialsIntegration Parameters

A_p and A_t for radii conversion

$R_0 = r_0(A_p^{1/3} + A_t^{1/3})$ A_p A_t

In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Generate potential←

Coulomb potential

r_c (fm) Switch off Coulomb

Nuclear potential

Type	Shape	V_0 (MeV)	r_0 (fm)	a_0 (fm)	W_0 (MeV)	r_1 (fm)	a_1 (fm)
Volume. central poten	Woods-Saxon	150	0,3	0,86	3,8	1,66	0,469

+🔄SPP2

FRESCO Potential

${}^4\text{He} + {}^{13}\text{C}$ at $Elab = 72\text{ MeV}$

- Radii conversion
- Coulomb potential
- Nuclear potential
 - V_0, W_0 : Real and imaginary widths. (negative signs are automatically applied)
 - r_0, r_i : real and imaginary reduced radius.
 - a_0, a_i : Real and imaginary diffuseness.

A_p and A_t for radii conversion

$$R_0 = r_0(A_p^{1/3} + A_t^{1/3})$$

A_p

3

A_t

14

In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Coulomb potential

r_c (fm)

0,65

Switch off
Coulomb

FRESCO Potential

${}^4\text{He} + {}^{13}\text{C}$ at $Elab = 72\text{ MeV}$

- Radii conversion
- Coulomb potential
- **Nuclear potential**
 - V_0, W_0 : Real and imaginary widths. (negative signs are automatically applied)
 - r_0, r_i : real and imaginary reduced radius.
 - a_0, a_i : Real and imaginary diffuseness.

Nuclear potential

Type	Shape	$V_0(\text{MeV})$
Volume, central poten	Woods-Saxon	150

Potential parameters

- A_0

Volume, central potential

- Surface, central potential
- Spin-orbit for projectile
- Spin-orbit for target

Woods-Saxon

- WS squared
- Gaussian
- Yukawa
- Exponential
- Reid soft core for T=0, central part
- Reid soft core for T=1, central part
- Read Complex

FRESCO Potential

${}^4\text{He} + {}^{13}\text{C}$ at $Elab = 72 \text{ MeV}$

- Radii conversion
- Coulomb potential
- **Nuclear potential**
 - V_0, W_0 : Real and imaginary widths. (negative signs are automatically applied)
 - r_0, r_i : real and imaginary reduced radius.
 - a_0, a_i : Real and imaginary diffuseness.

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$	$W_0(\text{MeV})$	$r_i(\text{fm})$	$a_i(\text{fm})$
Volume, central poten ▾	Woods-Saxon ▾	150	0,3	0,86	3,8	1,66	0,469

Reaction information

${}^4\text{He} + {}^{13}\text{C}$ at $E_{\text{lab}} = 72 \text{ MeV}$

- Projectile and target data
- Potentials
- **Integration parameters**

Reaction

Potentials

Integration Parameters

Radial grid (fm):

step (h)

0,07

Matching
radius

20

Total angular momentum:

min

0

max

40

Angular range (degrees):

min

1

max

180

step

1

Integration parameters

- **Radial step (h)** It has to be chosen smaller than the diffuseness of the potentials and than the characteristic wavelength of the projectile. A simple criterion is to set $hk \leq 0.2$, where k is the wave numbers associated with the kinetic energy ($k = \sqrt{2 E_{\text{cm}} \mu} / \hbar$).
- **Matching radius** (for $R > R_{\text{MATCH}}$ asymptotic behaviour is assumed)

CALCULATE

Reaction information

${}^4\text{He} + {}^{13}\text{C}$ at $E_{\text{lab}} = 72 \text{ MeV}$

- Projectile and target data
- Potentials
- **Integration parameters**

Reaction

Potentials

Integration Parameters 

Radial grid (fm):

$k = 3.34 \text{ fm}^{-1}$

step (h)

0,07

Matching

radius

20

Total angular momentum:

min

0

max

40

Angular range (degrees):

min

1

max

180

step

1

Warning! Reduce h, the integration step has to be $hk \leq 0.2$

Integration parameters

- **Radial step (h)** It has to be chosen smaller than the diffuseness of the potentials and than the characteristic wavelength of the projectile. A simple criterion is to set $hk \leq 0.2$, where k is the wave numbers associated with the kinetic energy ($k = \sqrt{2 E_{\text{cm}} \mu} / \hbar$).
- **Matching radius** (for $R > R_{\text{MATCH}}$ asymptotic behaviour is assumed)

CALCULATE

**Warning! Reduce h,
the integration step
must be $hk \leq 0.2$**

Useful
information 

Results

- Plot visualization
- Data in Fresco format
- Save input file (generated by FRESCO in Reaction4Exp) -> Simplifies future data entry (external input)
- Save detailed output -> provides additional information for expert users.

Optical Model Calculation By FRESCO

$^3\text{He} + ^{14}\text{C}$ Elastic scattering, $E_{\text{lab}} = 72 \text{ MeV}$

Save input file

Save output file

OM Elastic scattering angular distribution (FORT.201)

Plot

Data

Fusion(absorption), reaction and inelastic cross section (FORT.56)

Plot

Data

Potentials (FORT.34)

Plot

Data

Elastic S-matrix (FORT.7)

Plot

Data

Results

- Plot visualization
- Data in Fresco format
- Save input file (generated by FRESKO in Reaction4Exp) -> Simplifies future data entry (external input)
- Save detailed output -> provides additional information for expert users.

Reaction **Potentials** **Integration Parameters**

	Nucleus	A	J	Parity
Projectile	He <input type="text"/>	3 <input type="text"/>	0 <input type="text"/>	+1 <input type="text"/>
Target	C <input type="text"/>	14 <input type="text"/>	0 <input type="text"/>	+1 <input type="text"/>

Lab CM

E (MeV)

Reactions parameters

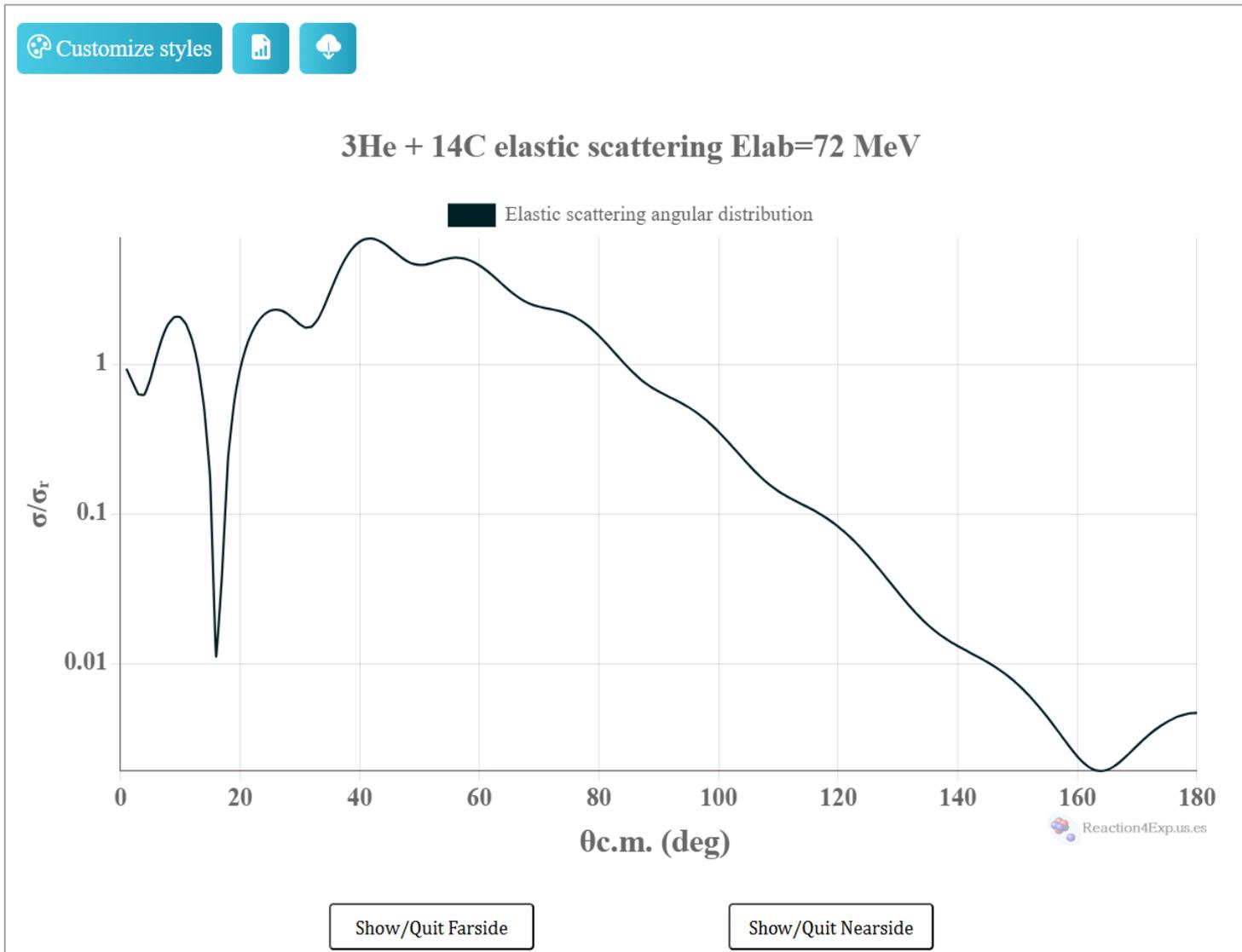
- **E_{lab}**: Incident laboratory energy.
- **J**: projectile and target angular momentum.

CALCULATE

Upload input from external file

You can upload a previously generated input file to automatically fill in the form fields.

Upload input Elastic_3He+14C_72MeV.in



Download

Plot Options

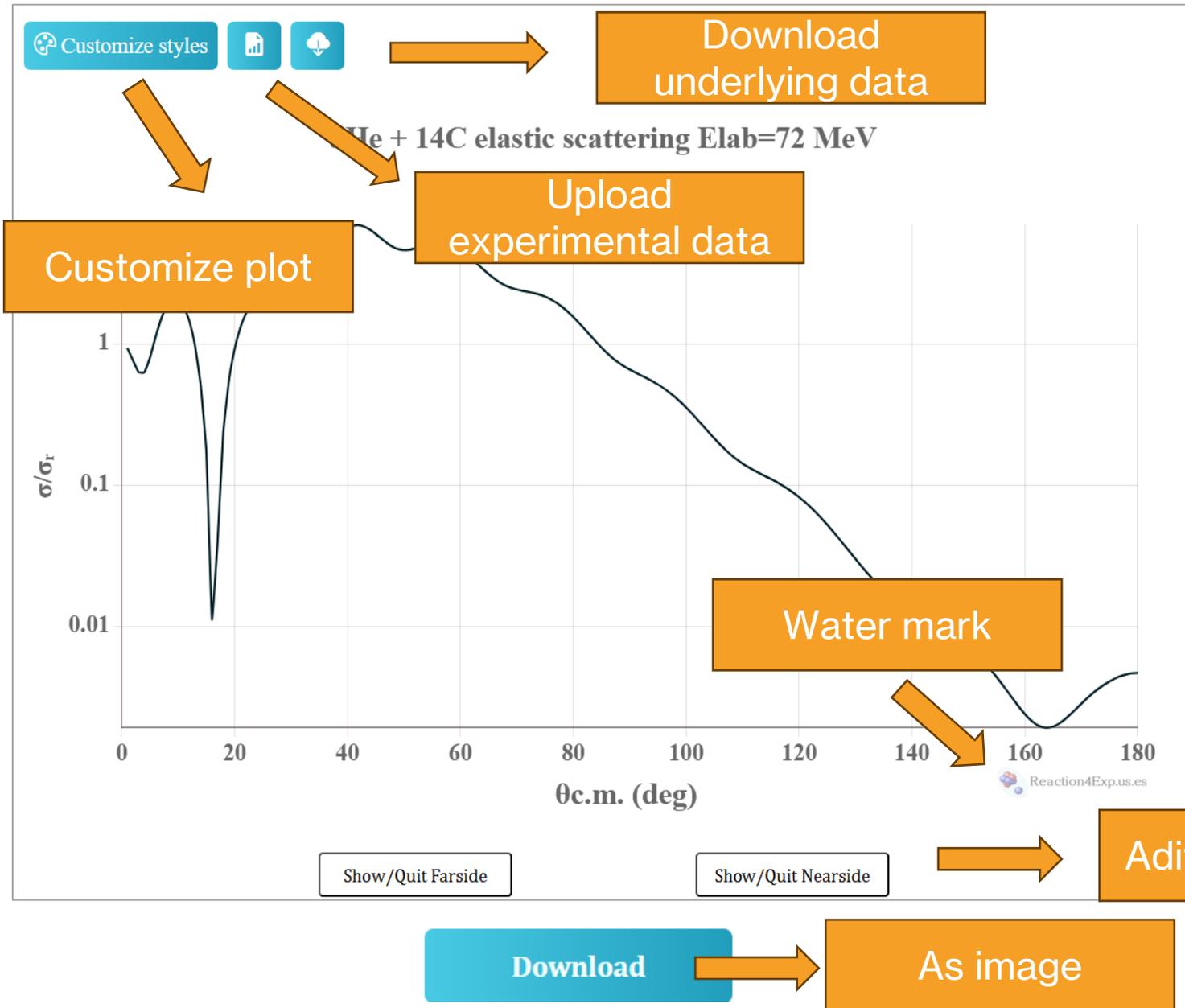
Customize plot appearance
(axes, labels, colors)

Compare with experimental
data

Download plot as image (.png)

Download underlying data (.txt)

Additional options (e.g.:
farside/nearside components)



Plot Options

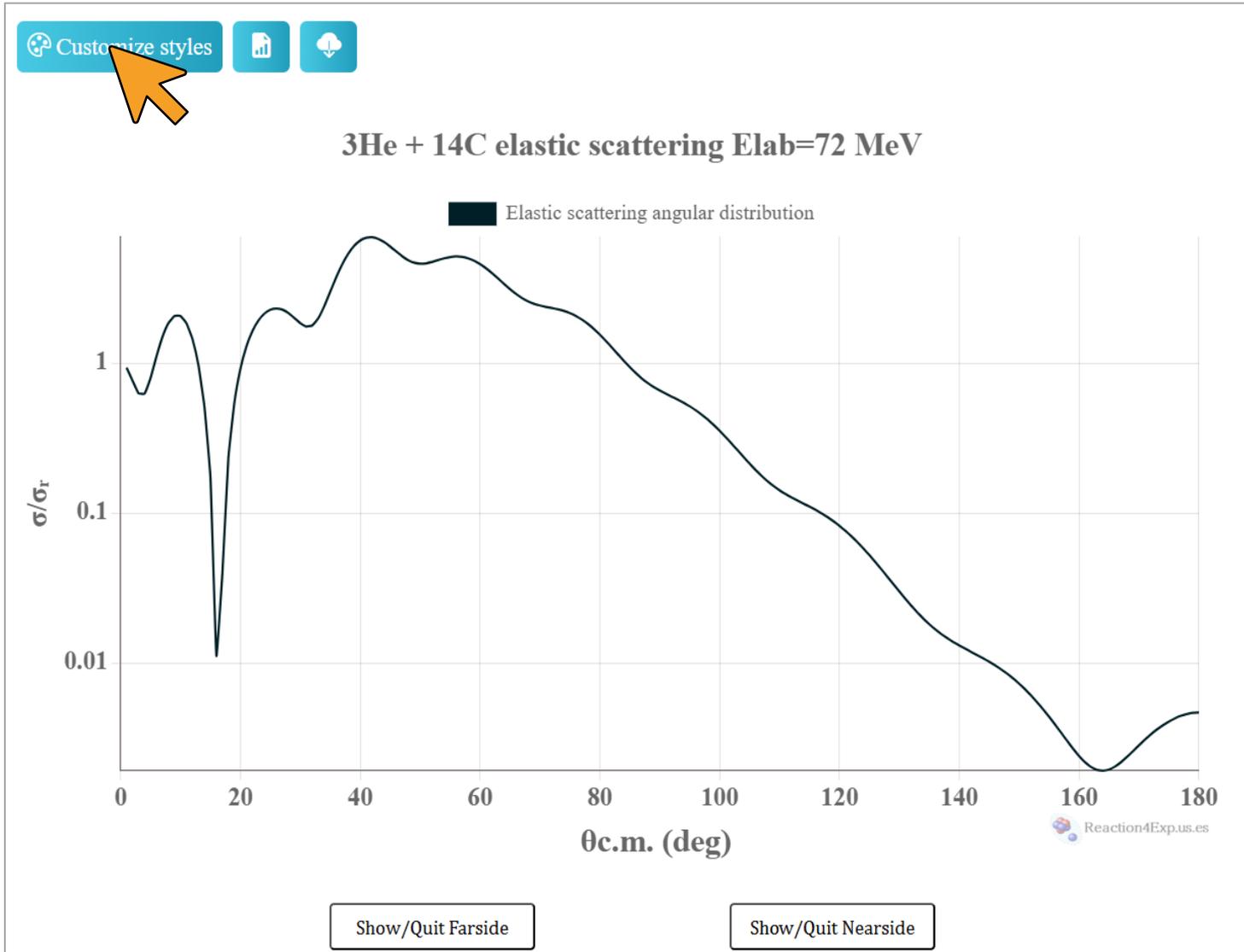
Customize plot appearance
(axes, labels, colors)

Compare with experimental
data

Download plot as image (.png)

Download underlying data (.txt)

Additional options (e.g.:
farside/nearside components)



Customize
plot
appearance



Title

Legend

Axis

Plot

Text



Position

Top

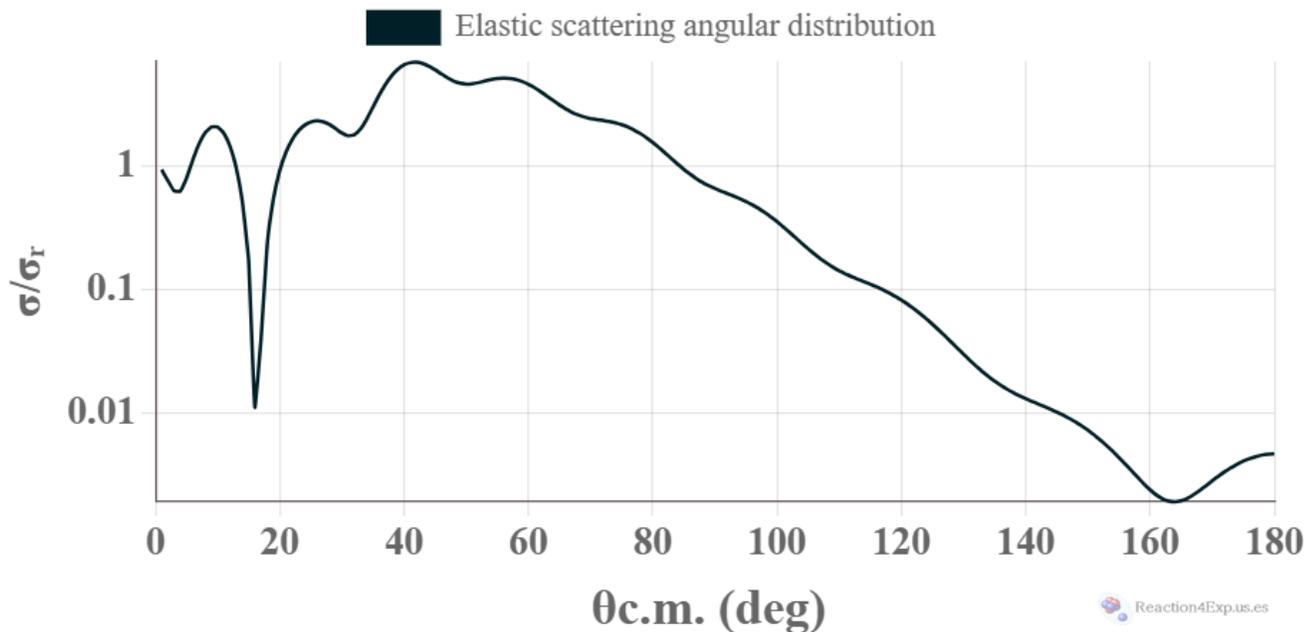
Size

25

Color



3He + 14C elastic scattering Elab=72 MeV



Customize plot appearance

1. **Title:** show/hide, position, font size, color.
2. **Legend:** show/hide position, size.
3. **Axis:** min/max (XY), grid display, logarithmic scale.
4. **Style settings:** axis title size, ticks size, line thickness, line color.



Title

Legend

Axis

Plot

Text Elastic scattering angular distribution



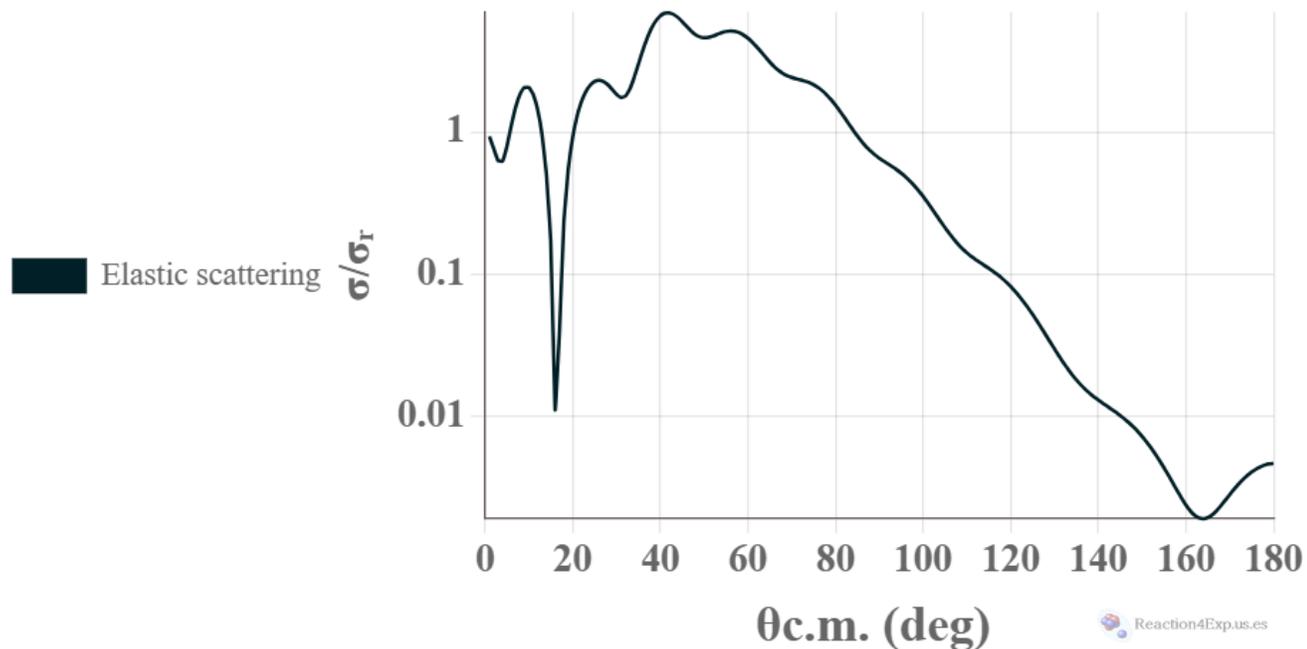
Position

Left

Size

18

3He + 14C elastic scattering Elab=72 MeV



Customize plot appearance

1. Title: show/hide , position, font size, color.
2. **Legend:** show/hide position, size.
3. Axis: min/max (XY), grid display, logarithmic scale.
4. Style settings: axis title size, ticks size, line thickness, line color.



Title

Legend

Axis

Plot

Min

Max

Grid

Scale

X axis:

0,00

100



Logaritmico X

Y axis:

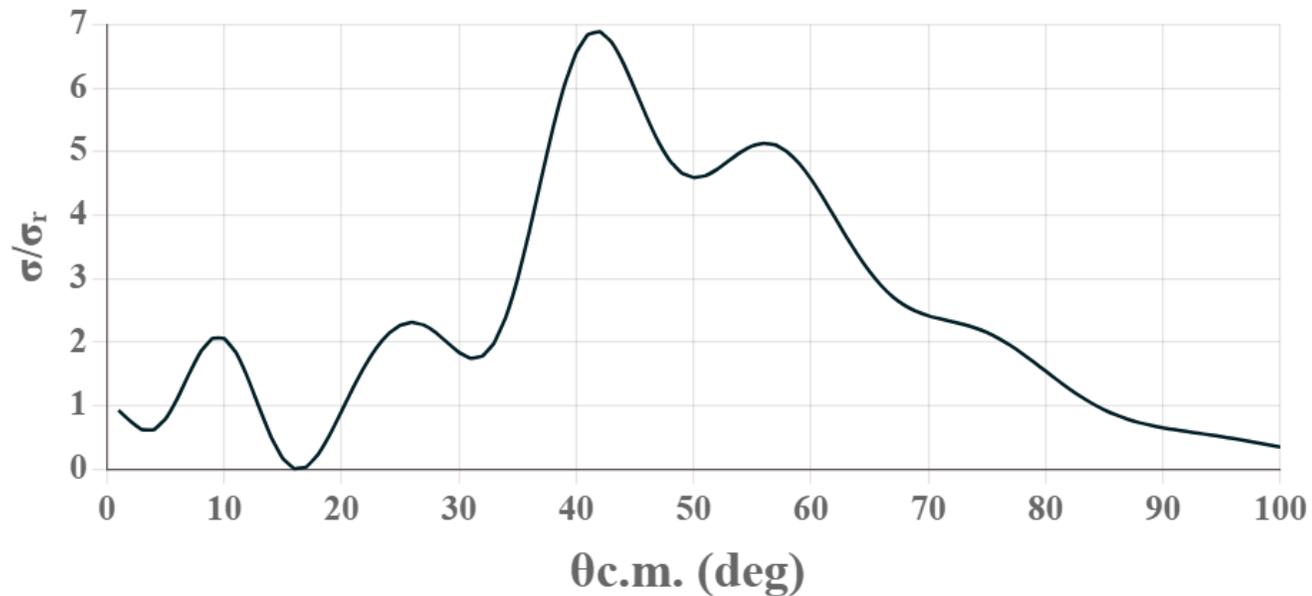
0,00

7



Logaritmico Y

3He + 14C elastic scattering Elab=72 MeV



■ Elastic scattering angular distribution

Reaction4Expus.es

Customize plot appearance

1. Title: show/hide , position, font size, color.
2. Legend: show/hide position, size.
3. **Axis:** min/max (XY), grid display, logarithmic scale.
4. Style settings: axis title size, ticks size, line thickness, line color.



Title

Legend

Axis

Plot

Titles Axis

Size

Ticks

X

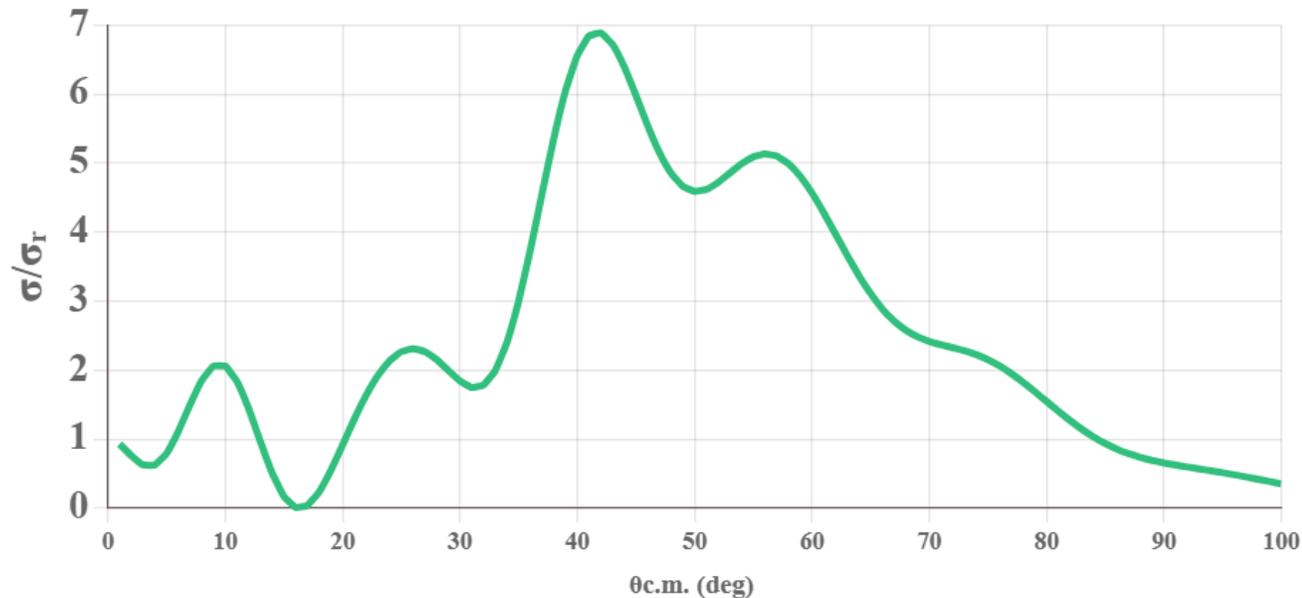
Line thickness:

Y

Absolute value



3He + 14C elastic scattering Elab=72 MeV



 Elastic scattering angular distribution

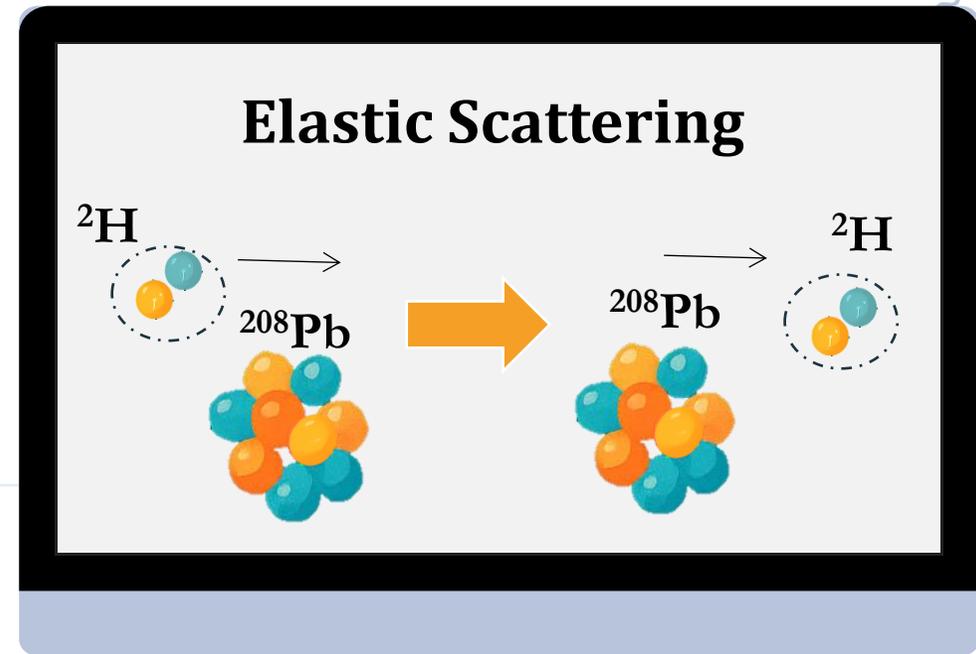
 Reaction4Exp.us.es

Customize plot appearance

1. Title: show/hide , position, font size, color.
2. Legend: show/hide position, size.
3. Axis: min/max (XY), grid display, logarithmic scale.
4. **Style settings:** axis title size, ticks size, line thickness, line color.

2

Optical Model and Classical



Potential generator / SPP2



ELASTIC SCATTERING

Optical Model

Classical Model

Reaction

Potentials

Integration Parameters

	Nucleus	A	J	Parity
Projectile	<input type="text" value="Select"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="+1"/>
Target	<input type="text" value="Select"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="+1"/>

Lab CM

<https://reaction4exp.us.es/elastic>

Optical potential

${}^4\text{He} + {}^{13}\text{C}$ at $E_{\text{lab}} = 72 \text{ MeV}$

Reaction data

Potentials

ELASTIC SCATTERING

Optical ModelClassical Model

ReactionPotentialsIntegration Parameters

	Nucleus	A	J	Parity
Projectile	He	3	0	+1
Target	C	14	0	+1

Lab CM

E (MeV)	72	59,294
---------	----	--------

Optical ModelClassical Model

ReactionPotentialsIntegration Parameters

A_p and A_t for radii conversion

$$R_0 = r_0(A_p^{1/3} + A_t^{1/3}) \quad A_p \text{ } 3 \quad A_t \text{ } 14$$

In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Generate potential ←

Coulomb potential

r_c (fm) Switch off Coulomb

Nuclear potential

Type	Shape	V_0 (MeV)	r_0 (fm)	a_0 (fm)	W_0 (MeV)	r_1 (fm)	a_1 (fm)
Volume. centr	Woods-Saxo	150	0.3	0.86	3.8	1.66	0.469

+ 📄 sPP2 ←

Global potential generator

Developed by Danyang Pang, with TWOFNR frontend (Jeffrey A. Tostevin)

- It requires you to provide information about the projectile, the target, and the energy.
- Suggest potential type based on provided data.
- Calculate potentials across wide energy ranges.

Generate potential



${}^4\text{He} + {}^{13}\text{C}$ at $E_{\text{lab}} = 72 \text{ MeV}$

Generate potential

Name of potential

CGP08



 Target range Z=20-82, A=40-209, Elab=30-217

Generate

Global potential generator

Particle	Potential Name	Cite	Ap (proj.m for R)	Range Z	Range A	Range E
Neutron	Becchetti Greenless	Phys. Rev. 182,1190 (1969)	0	20-92	4-238	10-50
	Koning Delaroche	Nucl. Phys. A713, 231 (2003)	0	13-83	27-209	0-200
	CH89	Phys. Rep. 201,57 (1991)	0	20-83	40-209	10-26
	Watson	Phys Rev, 1969		3-8	6-16	10-50
Proton	Becchetti Greenless	Phys. Rev. 182,1190 (1969)	0	20-92	40-238	10-50
	Koning Delaroche	Nucl. Phys. A713, 231 (2003)	0	13-83	27-209	0-200
	CH89	Phys. Rep. 201,57 (1991)	0	20-83	40-209	10-26
	Watson	Phys Rev, 1969	0	3-8	6-16	10-50
Deuteron	Perey Perey	Phys. Rev. 132,755 (1963)	0	20-82	40-208	11-27
	An Cai	Phys. Rev. C73, 054605 (2006)	0	6-92	12-238	1-200
	Daehnick	Phys.Rev.C21,2253(1980)	0	13-90	27-238	11,8-90
Tritium	CGP08	PHYS.REV.C79,024615(2009)	0	20-82	40-209	30-217
³He	CGP08	PHYS.REV.C79,024615(2009)	0	20-82	40-209	30-217
⁴He	Nolte	PRC 36(1987)1312	0	6-40	12-90	80
	Avrigneanu	Phys. Rev. C49,2136 (1994)	0	8-96	16-250	1-73
⁶Li	Cook	Nucl.Phys.A388 (1982),153	0	12-82	24-208	13-156
⁷Li	Cook	Nucl.Phys.A388 (1982),153	0	12-82	24-208	13-156
Heavy nuclei	Akyuz Winther	Proc.Enr.Fer.Int.Sch. Phys.,1979,491	ap	?	?	?

SPP2 São Paulo potential and Brazilian nuclear potential

<https://reaction4exp.us.es/spp2>

REACTION4EXP CARLA TATIANA MUÑOZ CHIMBO

VIRTUAL ACCESS INFRASTRUCTURE - UNIVERSITY OF SEVILLE

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São Paulo Potential And Brazilian Nuclear Potential - REGINA

The REGINA code calculates the São Paulo potential version 2 (SPP2) and the Brazilian nuclear potential (BNP), using nuclear densities and distributions for a large variety of nuclei. With theoretical and experimental densities for the calculations.

	Nucleus		Mass		Density	
	Projectile	Target	Theoretical	Experimental	Theoretical	Experimental
	<input type="text" value="Select"/>	<input type="text" value="Select"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="radio"/>	<input type="radio"/>
	<input type="text" value="Select"/>	<input type="text" value="Select"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="radio"/>	<input type="radio"/>
	<input checked="" type="radio"/> Lab	<input type="radio"/> CM				
E (MeV)	<input type="text"/>	<input type="text"/>				

Advanced options

Parameters					
Rmax	<input type="text" value="25"/>	Steps	<input type="text" value="0,01"/>	Lmax	<input type="text" value="50"/>
Escalar factor for real and imaginary part					
N _R	<input type="text" value="1"/>	N _I	<input type="text" value="1"/>		
Select potential:	<input checked="" type="button" value="SPP2"/>	<input type="button" value="BNP"/>			

Computer Physics Communications
Volume 267, October 2021, 108061

São Paulo potential version 2 (SPP2) and Brazilian nuclear potential (BNP) ☆, ☆☆

L.C. Chamon ^a, B.V. Carlson ^b, L.R. Gasques ^a

Show more

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<https://doi.org/10.1016/j.cpc.2021.108061> Get rights and content Full text access

Abstract

The REGINA code calculates the São Paulo potential version 2 (SPP2) and the Brazilian nuclear potential (BNP). The code also provides nuclear densities obtained from the Dirac-Hartree-Bogoliubov model, which are used to calculate the nuclear potentials. Elastic scattering cross sections are obtained within the context of the optical model, with different options for the real and imaginary parts of the optical potential. In this manuscript, we provide a summary of the theoretical framework and information about the use of the code.

SPP2 São Paulo potential and Brazilian nuclear potential

${}^4\text{He} + {}^{13}\text{C}$ at $E_{\text{lab}} = 72 \text{ MeV}$

Volume, cent ▾

Read Com ▾

Elegir archivo

No se ha selecci...o ningún archivo



Density

Theoretical Experimental

${}^3\text{He}$ No data available

${}^{14}\text{C}$ No data available

Advanced options

Parameters

Rmax Steps Lmax

Escalar factor for real and imaginary part

N_R N_I

Select potential:

SPP2

BNP

Generate and upload 

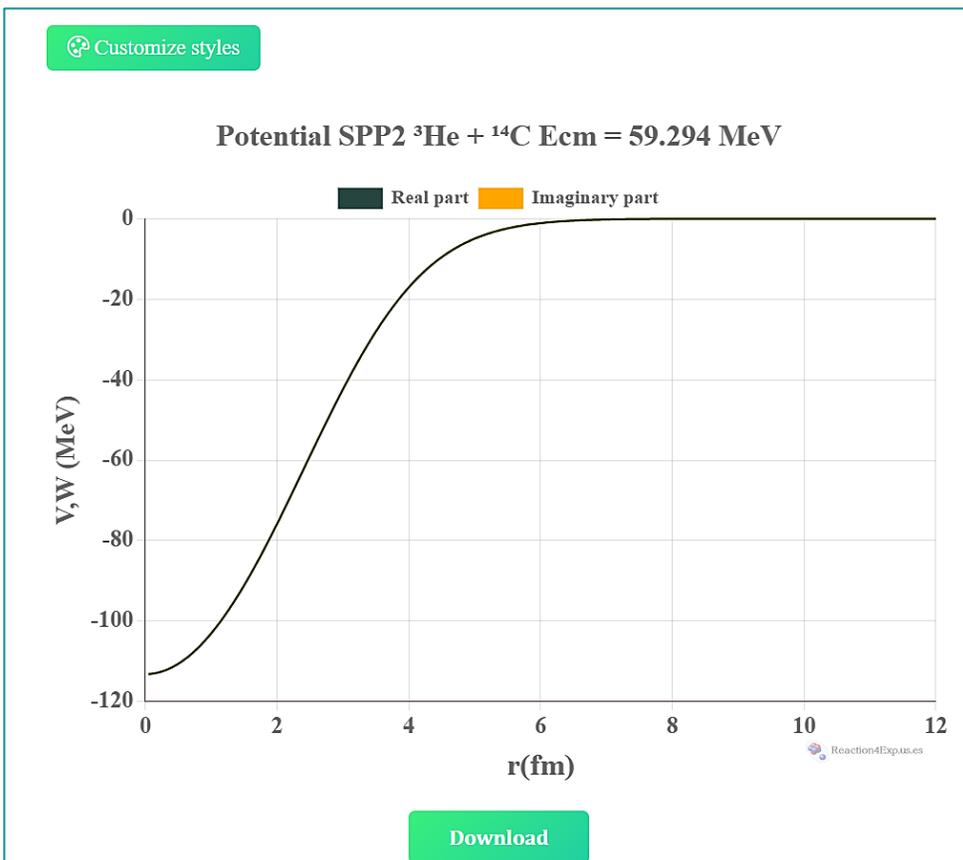
Results

- Plot visualization
- Download data as .txt
- Download regina output





Plot visualization



Data as .txt

```
SPP2 potential
502 0.050 0.050
-0.1131475E+03 -0.1131475E+03
-0.1130701E+03 -0.1130701E+03
-0.1129412E+03 -0.1129412E+03
-0.1127607E+03 -0.1127607E+03
-0.1125289E+03 -0.1125289E+03
-0.1122459E+03 -0.1122459E+03
-0.1119118E+03 -0.1119118E+03
-0.1115268E+03 -0.1115268E+03
-0.1110912E+03 -0.1110912E+03
-0.1106053E+03 -0.1106053E+03
-0.1100692E+03 -0.1100692E+03
-0.1094835E+03 -0.1094835E+03
-0.1088484E+03 -0.1088484E+03
-0.1081645E+03 -0.1081645E+03
-0.1074321E+03 -0.1074321E+03
-0.1066518E+03 -0.1066518E+03
-0.1058241E+03 -0.1058241E+03
-0.1049497E+03 -0.1049497E+03
-0.1040225E+03 -0.1040225E+03
```

Regina output

```
Calculation of the energy independent Brazilian nuclear potential (BNP) and
the velocity-dependent Sao Paulo potential version 2 (SPP2).

Theoretical distributions or charge densities are used
instead of those from the original SPP systematics.

Projectile: A = 3 Z = 2
Target: A = 14 Z = 6

Ecm = 59.29 MeV

Projectile densities from the density.dat file

Target distributions from the distribution.dat file

Deformation lengths
Neutron: delta2 = -0.003 delta4 = -0.003
Proton: delta2 = -0.006 delta4 = -0.004
Nucleon: delta2 = -0.005 delta4 = -0.003

Parameter values for the deformed Fermi function
Neutron: rho0 = 0.1009 R0 = 2.369 a = 0.490 beta2 = -0.001 beta4 = -0.000
Proton: rho0 = 0.0739 R0 = 2.472 a = 0.418 beta2 = -0.003 beta4 = 0.000
Nucleon: rho0 = 0.1817 R0 = 2.368 a = 0.467 beta2 = -0.001 beta4 = -0.001

Parameter values for the spherical Fermi function
Neutron: rho0 = 0.1019 R0 = 2.358 a = 0.491
Proton: rho0 = 0.0755 R0 = 2.450 a = 0.420
Nucleon: rho0 = 0.1841 R0 = 2.354 a = 0.469

Proton and neutron distributions, and charge and matter densities:

projectile target
r rop ron roc rom rop r
0.00 0.2659E+00 0.8078E-01 0.1391E+00 0.2064E+00 0.8820E-01 0.98
```

External potential

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$	$W_0(\text{MeV})$	$r_i(\text{fm})$	$a_i(\text{fm})$
Volume. central potent ▾	Read Complex ▾						
	 SPP2						

Elegir archivo No se ha selecci...o ningún archivo

Read external potential

The file must have the following format:

1. First line: a comment
2. Second line: three values - NPOINTS, RSTEP and RFIRST - which define the radial grid.
3. Next NPOINTS lines: each line contains two columns, the real and imaginary parts of the potential, sampled at intervals of RSTEP starting from $r=\text{RFIRST}$.

Optical Model Calculation By FRESKO

$^3\text{He} + ^{14}\text{C}$ Elastic scattering, $E_{\text{lab}} = 72 \text{ MeV}$

Save input file

Save output file

OM Elastic scattering angular distribution (FORT.201)

Plot

Data

Fusion(absorption), reaction and inelastic cross section (FORT.56)

Plot

Data

Potentials (FORT.34)

Plot

Data

Elastic S-matrix (FORT.7)

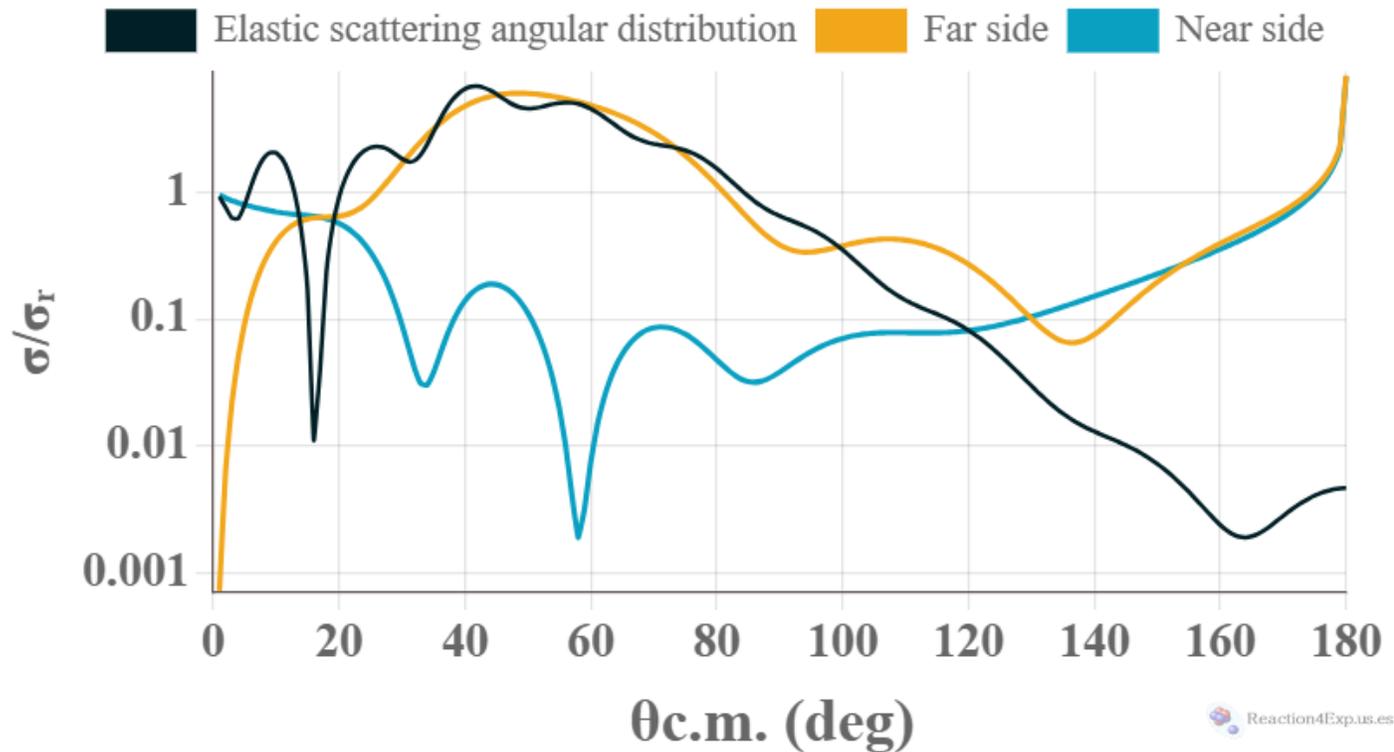
Plot

Data

Optical Model Results

- OM elastic scattering angular distribution (fort.201)
- Fusion (absorption), reaction and inelastic cross section (fort.56)
- Potentials (fort.34)
- Elastic S-matrix (Fort.7)

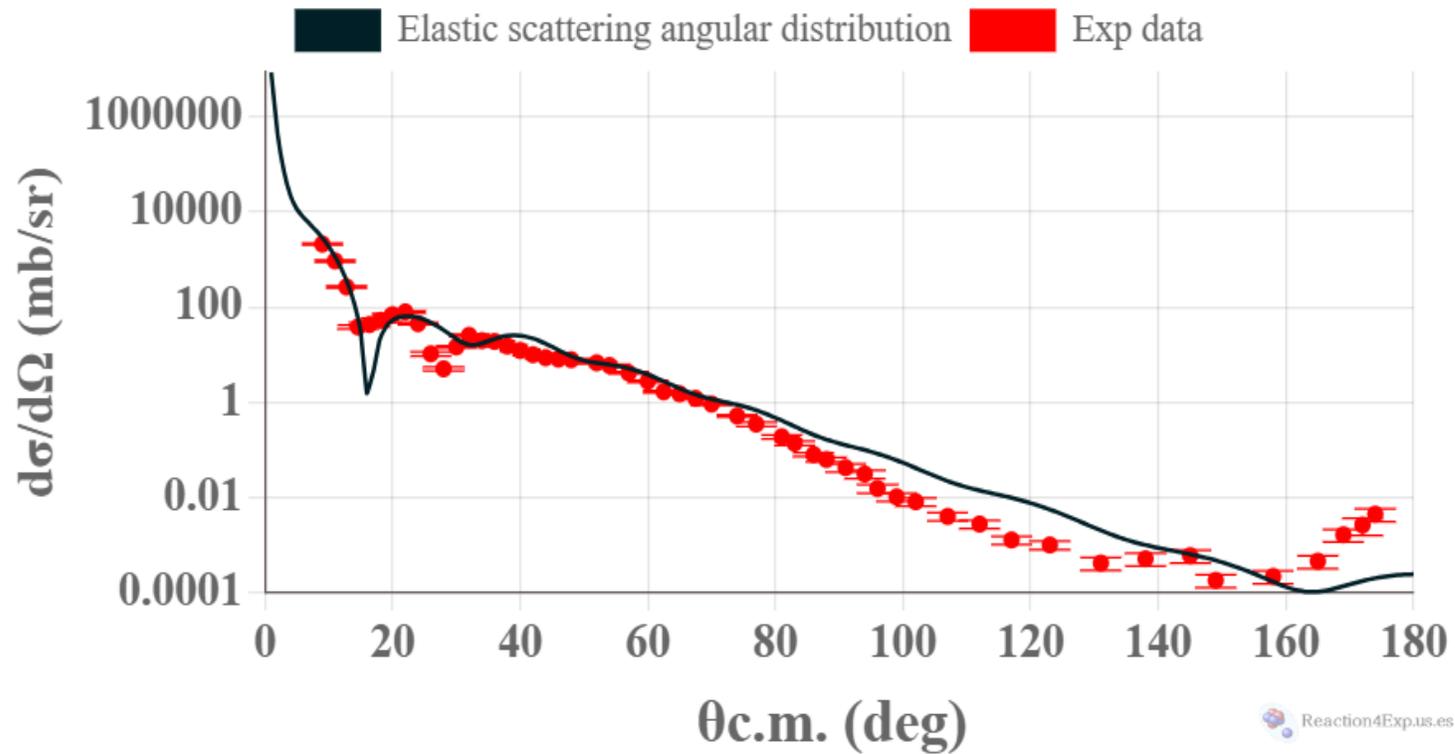
3He + 14C elastic scattering Elab=72 MeV



Optical Model Results

- **OM elastic scattering angular distribution (fort.201)**
 - Far and near side
- Fusion (absorption), reaction and inelastic cross section (fort.56)
- Potentials (fort.34)
- Elastic S-matrix (Fort.7)

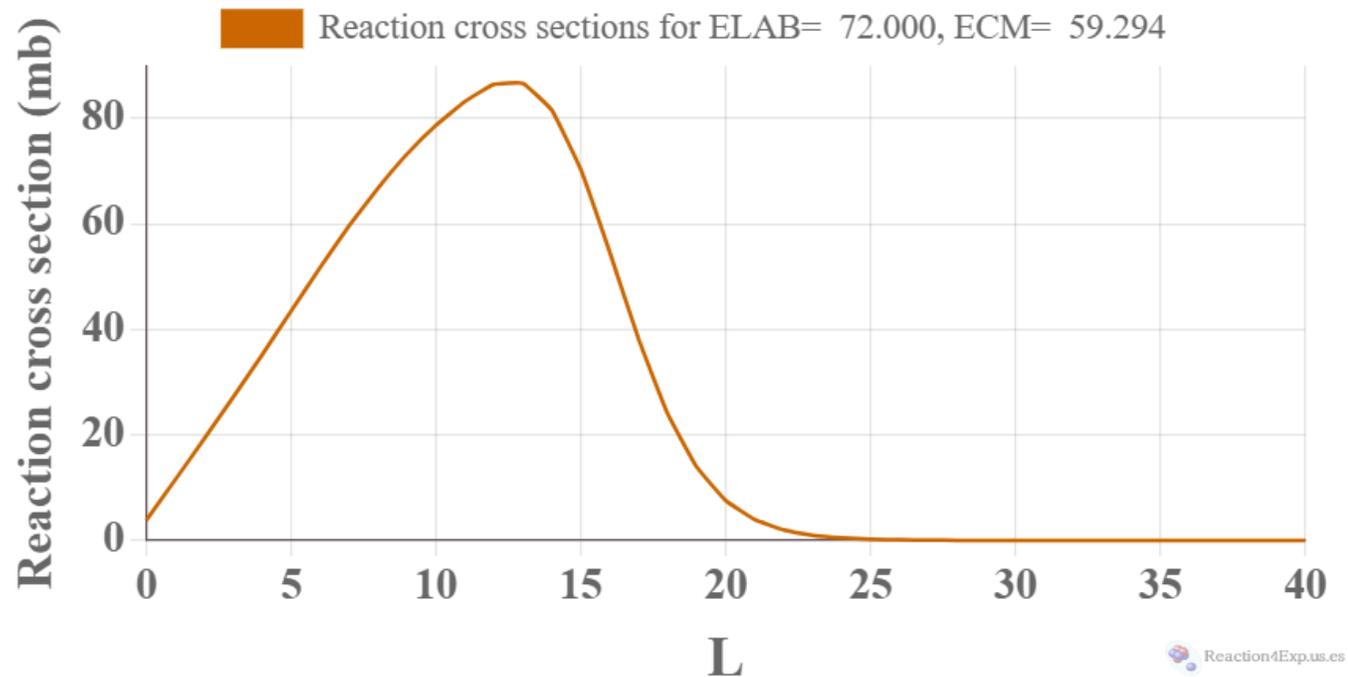
$^3\text{He} + ^{14}\text{C}$ elastic scattering $E_{\text{lab}}=72 \text{ MeV}$



Optical Model Results

- **OM elastic scattering angular distribution (fort.201)**
 - Absolute value (plot options).
 - Comparison with experimental data.
- Fusion (absorption), reaction and inelastic cross section (fort.56)
- Potentials (fort.34)
- Elastic S-matrix (Fort.7)

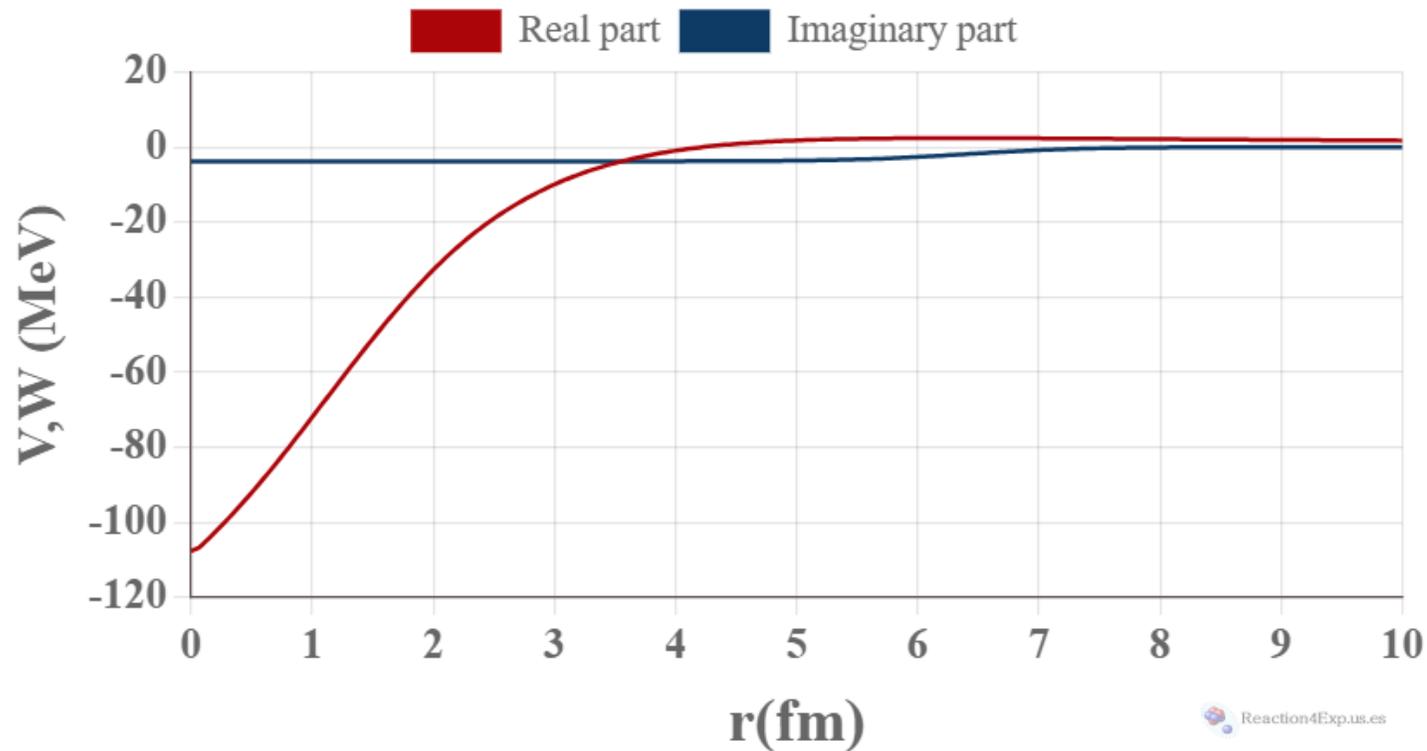
Reaction cross sections for ELAB= 72.000, ECM= 59.294



Optical Model Results

- OM elastic scattering angular distribution (fort.201)
- **Fusion (absorption), reaction and inelastic cross section (fort.56)**
- Potentials (fort.34)
- Elastic S-matrix (Fort.7)

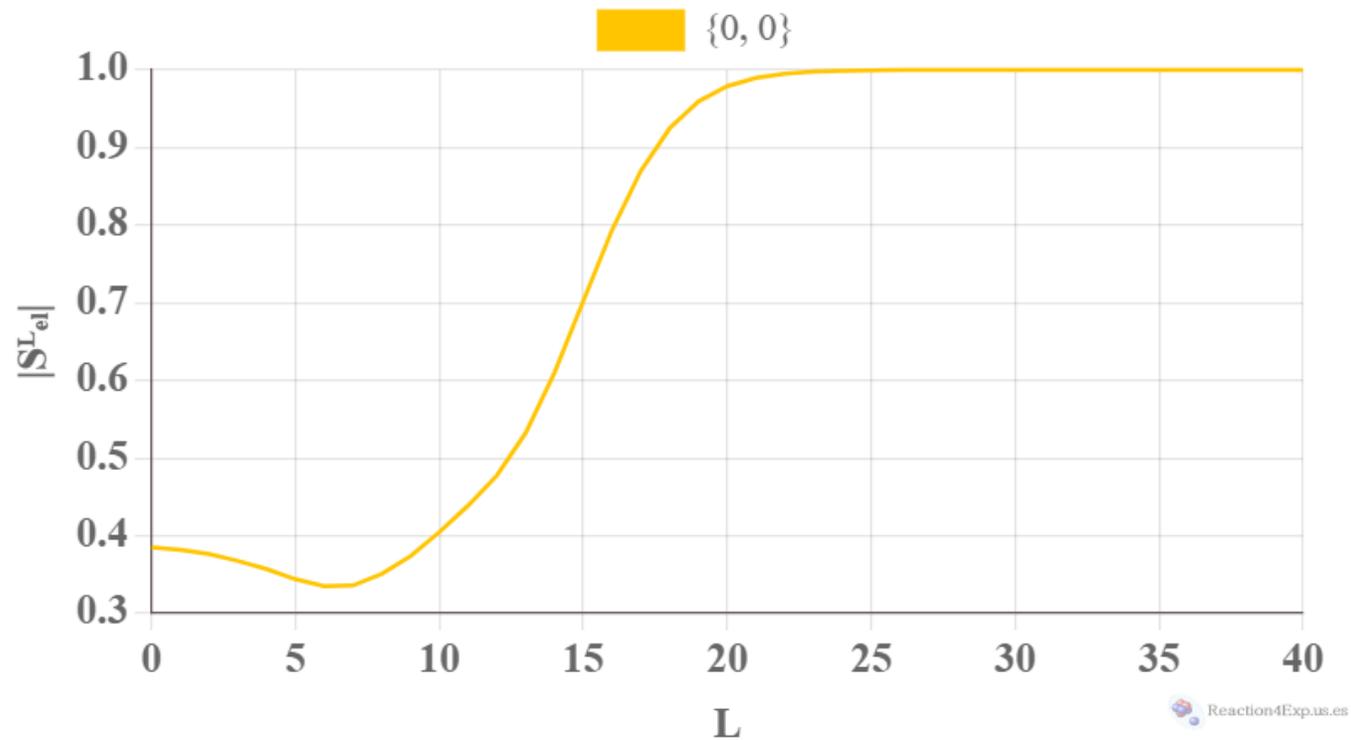
Optical Potential



Optical Model Results

- OM elastic scattering angular distribution (fort.201)
- Fusion (absorption), reaction and inelastic cross section (fort.56)
- **Potentials (fort.34)**
- Elastic S-matrix (Fort.7)

$^3\text{He} + ^{14}\text{C}$ elastic scattering $E_{\text{lab}}=72$ MeV



Optical Model Results

- OM elastic scattering angular distribution (fort.201)
- Fusion (absorption), reaction and inelastic cross section (fort.56)
- Potentials (fort.34)
- **Elastic S-matrix (Fort.7)**

Classical

Reaction data

ELASTIC SCATTERING

Optical ModelClassical Model

ReactionPotentials

	Nucleus	A	J	Parity
Projectile	<input type="text" value="He"/>	<input type="text" value="3"/>	<input type="text" value="0"/>	<input type="text" value="+1"/>
Target	<input type="text" value="C"/>	<input type="text" value="14"/>	<input type="text" value="0"/>	<input type="text" value="+1"/>
	<input checked="" type="radio"/> Lab	<input type="radio"/> CM		
E (MeV)	<input type="text" value="72"/>	<input type="text" value="59,294"/>		

Potentials

ReactionPotentials

A_p and A_t for radii conversion

$$R_0 = r_0(A_p^{1/3} + A_t^{1/3})$$

A_p A_t

In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Generate potential

Coulomb potential

r_c (fm) Switch off Coulomb

Nuclear potential

Type	Shape	V_0 (MeV)	r_0 (fm)	a_0 (fm)	W_0 (MeV)	r_i (fm)	a_i (fm)
<input type="text" value="Volume, c"/>	<input type="text" value="Woods-Sε"/>	<input type="text" value="150"/>	<input type="text" value="0,3"/>	<input type="text" value="0,86"/>	<input type="text" value="3,8"/>	<input type="text" value="1,66"/>	<input type="text" value="0,469"/>

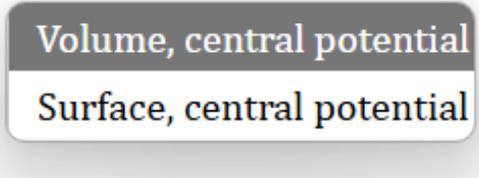
+

Classical potential

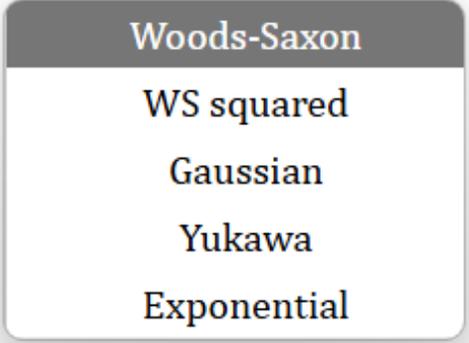
- Coulomb potential
- Nuclear potential
- Global Potential generator

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$	$W_0(\text{MeV})$	$r_i(\text{fm})$	$a_i(\text{fm})$
Volume, central poten 	Woods-Saxon 	150	0,3	0,86	3,8	1,66	0,469

- Volume, central potential
- Surface, central potential



- Woods-Saxon
- WS squared
- Gaussian
- Yukawa
- Exponential

Classical Model Calculation

$^3\text{He} + ^{14}\text{C}$ Elastic scattering, $E_{\text{lab}} = 72 \text{ MeV}$

Save input file

Turning points

Plot

Data

Deflection function

Plot

Data

Survival probability

Plot

Data

Trajectories

B min: B max:

154 plots

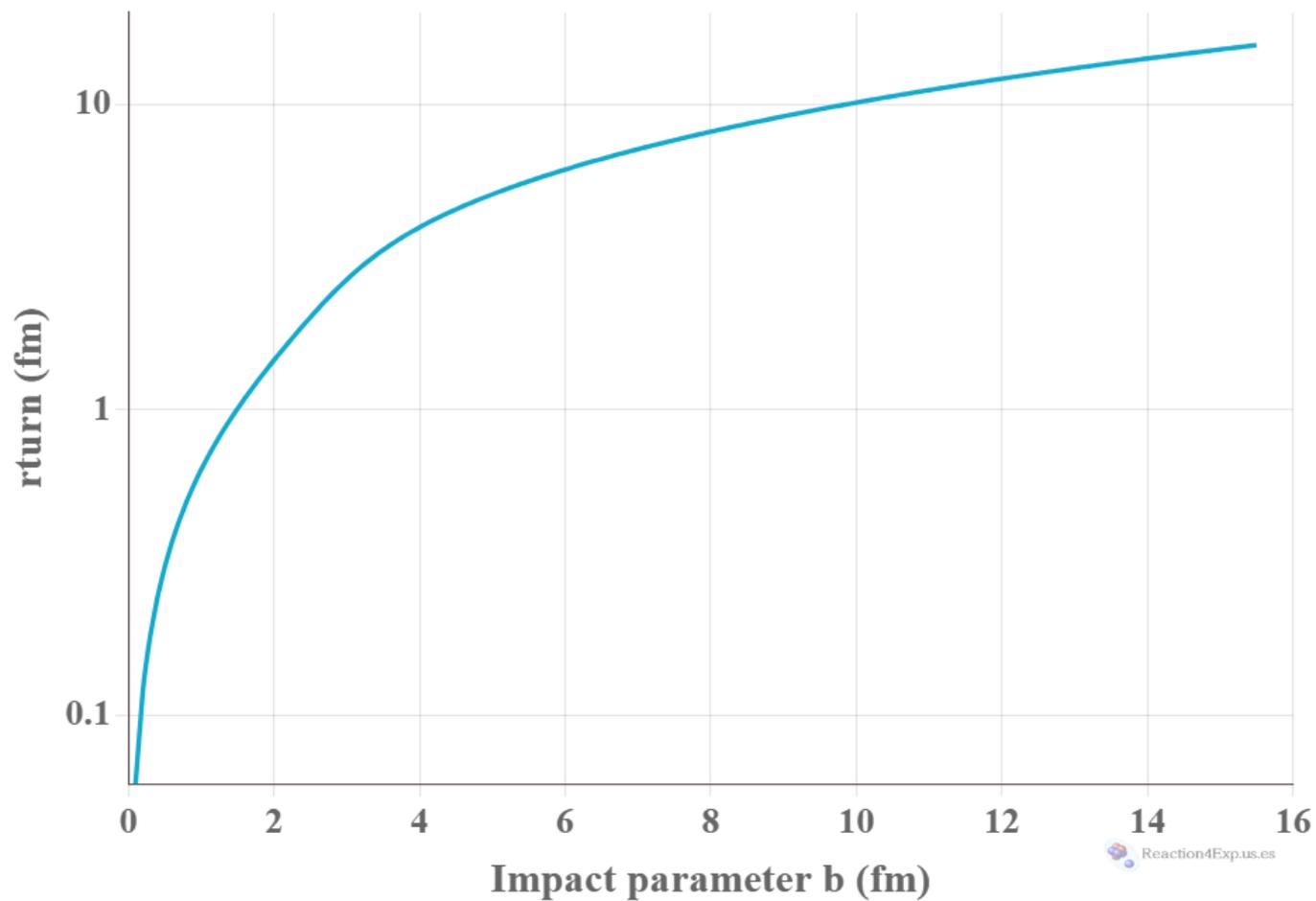
Plot

Data

Classical Results

- Turning points
- Deflection function
- Survival probability
- Trajectories (select range B)

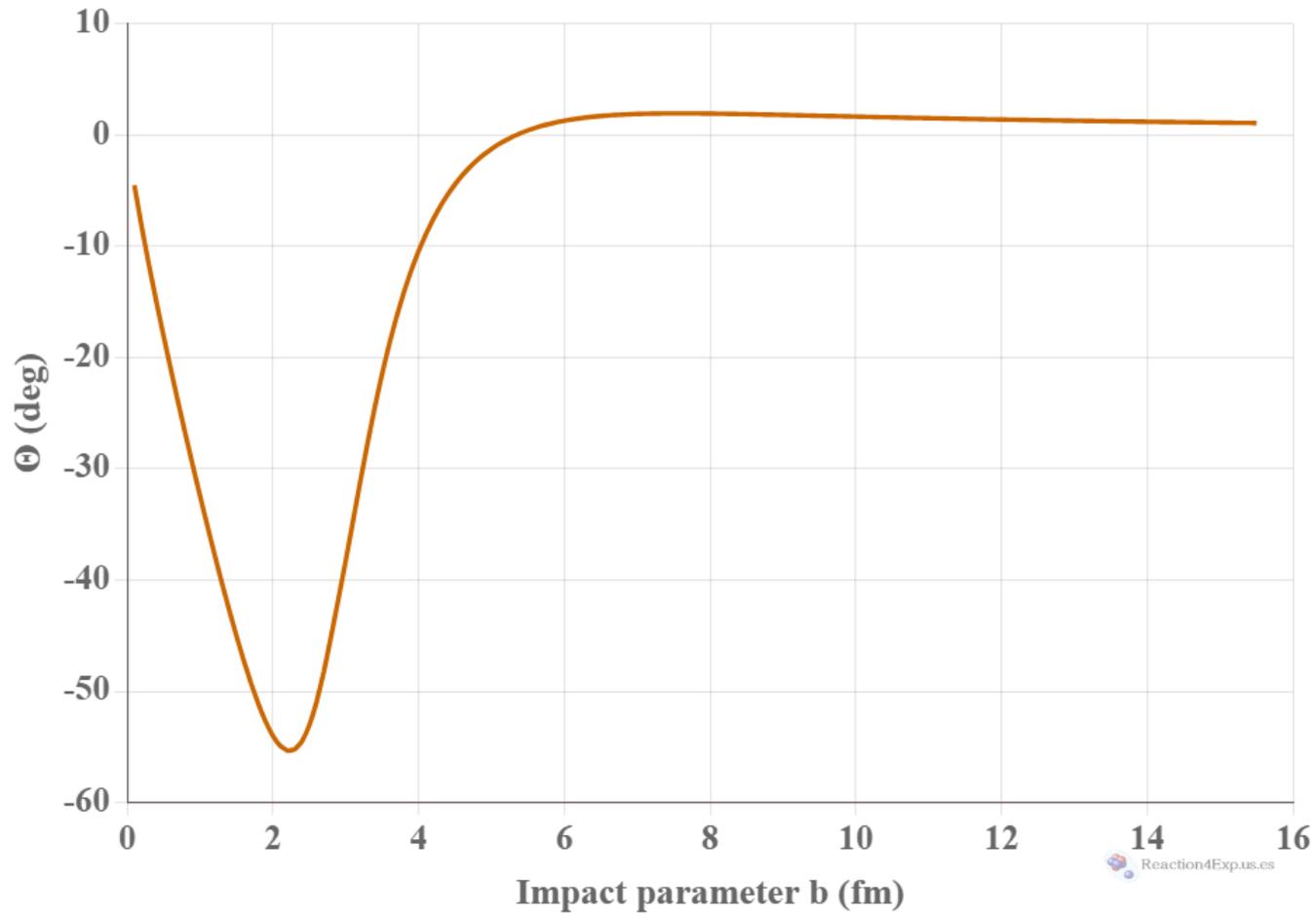
Turning points for ${}^3\text{He}+{}^{14}\text{C}$ at 72MeV



Classical Results

- **Turning points**
- Deflection function
- Survival probability
- Trajectories (select range B)

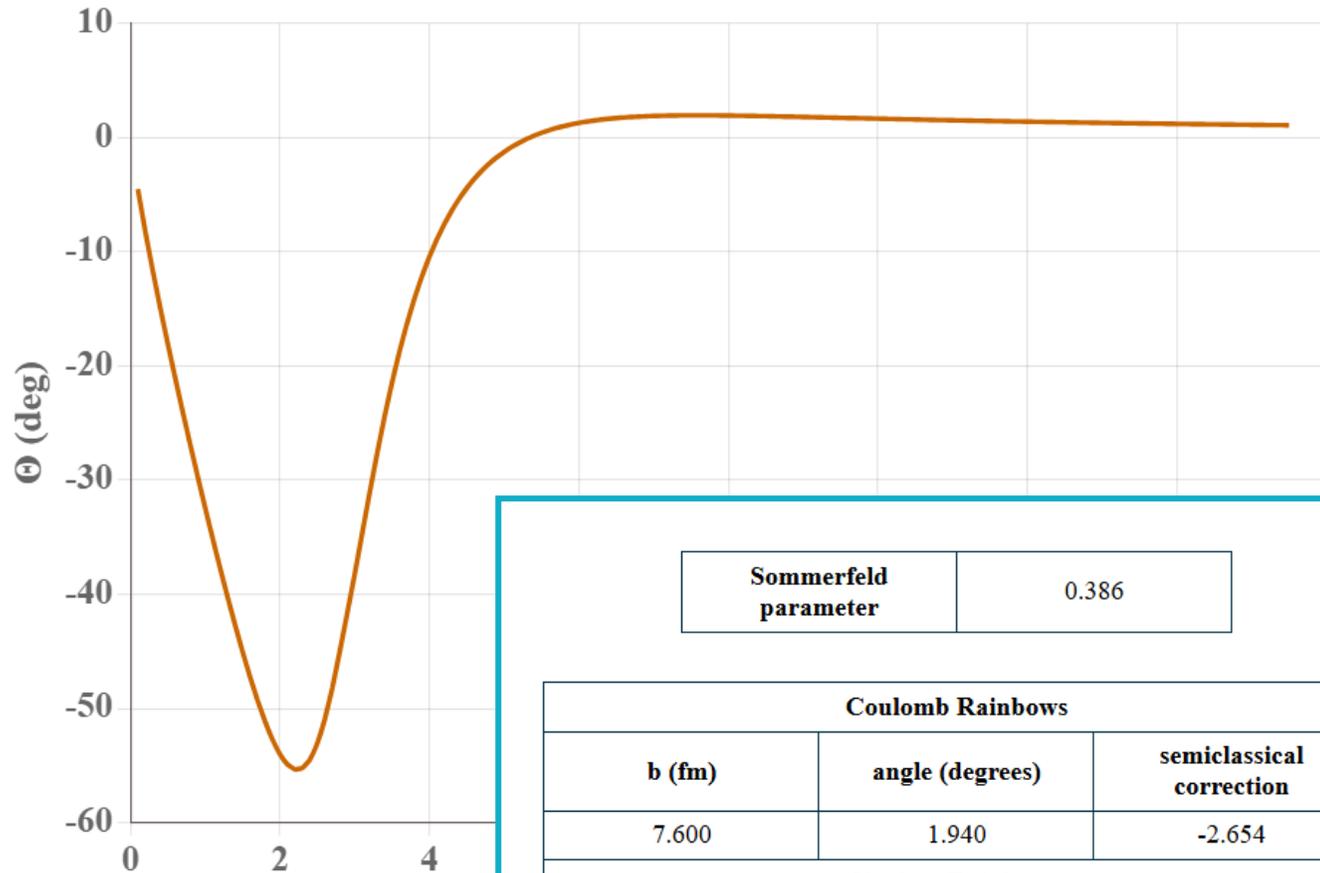
Deflection function for $^3\text{He}+^{14}\text{C}$ at 72MeV



Classical Results

- Turning points
- **Deflection function**
 - **Sommerfeld parameter**
 - **Coulomb and nuclear rainbow**
- Survival probability
- Trajectories (select range B)

Deflection function for $3\text{He}+^{14}\text{C}$ at 72MeV



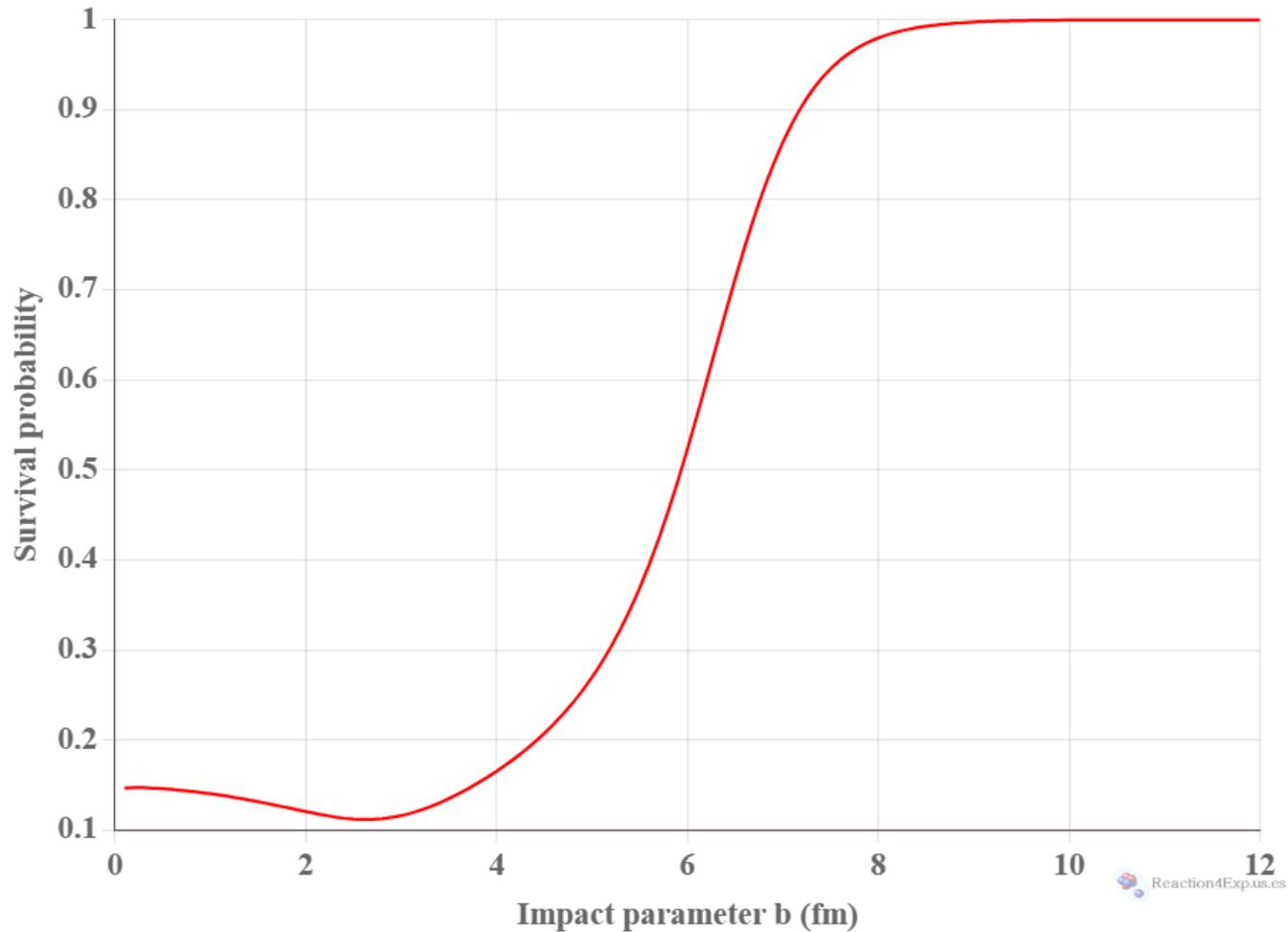
Sommerfeld parameter	0.386
----------------------	-------

Coulomb Rainbows		
b (fm)	angle (degrees)	semiclassical correction
7.600	1.940	-2.654
Nuclear Rainbows		
b (fm)	angle (degrees)	semiclassical correction
2.200	-55.336	-27.085

Classical Results

- Turning points
- **Deflection function**
 - Sommerfeld parameter
 - Coulomb and nuclear rainbow
- Survival probability
- Trajectories (select range B)

Survival probability for $^3\text{He}+^{14}\text{C}$ at 72MeV



Classical Results

- Turning points
- Deflection function
- **Survival probability**
- Trajectories (select range B)



Title

Axis

Impact Parameter

b min

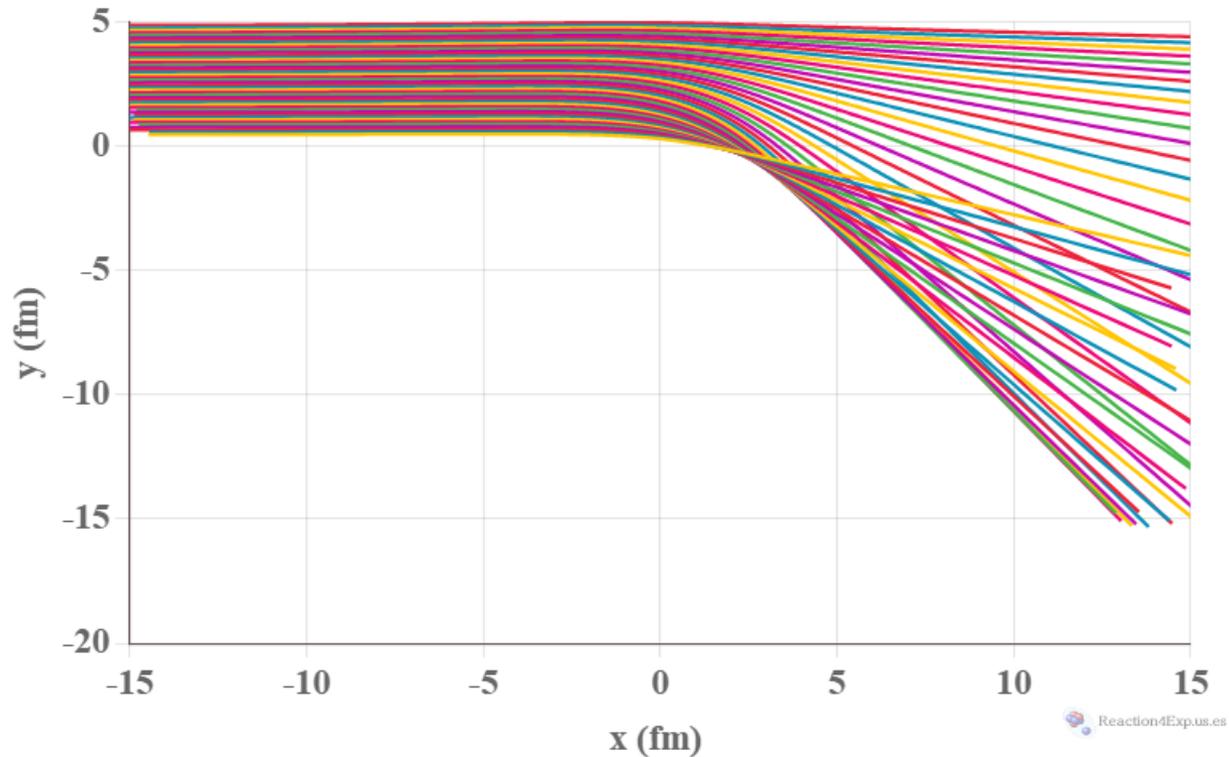
0,5

b max

5

Plot

Trajectories for $3\text{He}+^{14}\text{C}$ at 72MeV



Classical Results

- Turning points
- Deflection function
- Survival probability
- **Trajectories (select range B)**

3

Rotational model for Inelastic scattering



Deformations



Rotational Model For Inelastic Scattering - Coupled Channels And DWBA

Reaction

Potentials

Integration Parameters

Projectile

Target

Nucleus

A

Nucleus

A

Select ▾

Select ▾

Spin

Parity

E(MeV)

Spin

Parity

E(MeV)

https://reaction4exp.us.es/cc_fresco/fresco_cc.php

Inelastic scattering

$^{64}\text{Zn}(^{16}\text{O}, ^{16}\text{O})^{64}\text{Zn}^*(2^+) \text{ at } E_{\text{lab}} = 44 \text{ MeV}$

- Projectile and target data
- Potentials
- Integration parameters

Defined excited states for projectile and target.

Choose calculation method:

- Coupled-Channels (CC)
- DWBA (1st order approximation)

Reaction			Potentials			Integration Parameters		
Projectile			Target					
Nucleus	A		Nucleus	A				
<input type="text" value="O"/>	<input type="text" value="16"/>		<input type="text" value="Zn"/>	<input type="text" value="64"/>				
Spin	Parity	E(MeV)	Spin	Parity	E(MeV)			
<input type="text" value="0"/>	<input type="text" value="+1"/>	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="+1"/>	<input type="text" value="0"/>			
			<input type="text" value="2"/>	<input type="text" value="+1"/>	<input type="text" value="0,992"/>			
			<input type="text" value="-"/>					
			<input type="text" value="+"/>					
Elab (MeV)	<input type="text" value="44"/>							
			Select the calculation model:					
			<input type="text" value="CC"/>			<input type="text" value="DWBA"/>		

Inelastic scattering: coupling potential

- **Coulomb excitation** -> electric reduced matrix elements

$$V_{if}^C(\mathbf{R}) = \sum_{\lambda > 0} \frac{4\pi}{2\lambda + 1} \frac{Z_t e}{R^{\lambda+1}} \langle f; I_f M_f | M(E\lambda, \mu) | i; I_i M_i \rangle Y_{\lambda\mu}(\hat{R})$$

$$\langle I_f || M(E\lambda) || I_i \rangle = \sqrt{(2I_i + 1) B(E\lambda; I_i \rightarrow I_f)}$$

- **Nuclear excitation** -> deformation lengths

$$V_{if}^N(\mathbf{R}) = -\frac{dV_0}{dR} \sum_{\lambda} \langle f; I_f M_f | \hat{\delta}_{\lambda\mu} | i; I_i M_i \rangle Y_{\lambda\mu}(\hat{R})$$

Rotor model

$$\langle K I_f || M(E\lambda) || K I_i \rangle = \sqrt{2I_i + 1} \langle f I_i K \lambda 0 | I_f K \rangle \mathbf{M}_n(\mathbf{E}_\lambda)$$

$$\langle K I_f || \hat{\delta}_{\lambda\mu} || K I_i \rangle = \sqrt{2I_i + 1} \langle f I_i K \lambda 0 | I_f K \rangle \delta_\lambda$$

Inelastic scattering

$^{64}\text{Zn}(^{16}\text{O}, ^{16}\text{O})^{64}\text{Zn}^*(2^+)$ at $E_{\text{lab}} = 44 \text{ MeV}$

- Projectile and target data
- Potentials
- Integration parameters

Reaction
Potentials
Integration Parameters

A_p and A_t for radii conversion

$$R_0 = r_0(A_p^{1/3} + A_t^{1/3})$$

A_p A_t

In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Generate potential

Coulomb potential

r_c **Deformation** ←

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$	$W_0(\text{MeV})$	$r_1(\text{fm})$	$a_1(\text{fm})$
Volume, ϵ	Woods-Si	<input type="text" value="0"/>	<input type="text" value="1.25"/>	<input type="text" value="0.65"/>	<input type="text" value="0"/>	<input type="text" value="1.25"/>	<input type="text" value="0.65"/>

Deformation ←

Within the rotational model excitations are interpreted in terms of the deformation of the charge or mass distribution of the nucleus.

- Coulomb deformation: Intrinsic reduced matrix elements in units of $e \cdot fm^k$

$$M_n(E_\lambda) = \pm \frac{\sqrt{B(E_\lambda; I_i \rightarrow I_f)}}{\langle f I_i K \lambda 0 | I_f K \rangle}$$

- Nuclear deformation: lengths in units of fm

$$\delta_\lambda = \beta_\lambda R$$

Inelastic scattering

$^{64}\text{Zn}(^{16}\text{O}, ^{16}\text{O})^{64}\text{Zn}^*(2^+)$ at $E_{\text{lab}} = 44 \text{ MeV}$

- Projectile and target data
- **Potentials**
- Integration parameters

Coulomb potential

r_c **Deformation**

Deformation

Projectile

Target

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$	$W_0(\text{MeV})$	$r_1(\text{fm})$	$a_1(\text{fm})$
Volume	Woods-	45,69	1,25	0,559	12,09	1,25	0,563

Deformation

	δ_2	δ_3	δ_4
Projectile	<input type="text" value="0"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Target	<input type="text" value="1,25"/>	<input type="text" value="0,411"/>	<input type="text" value="0"/>

Real + img deformation separately

There is one deformation for all nuclear potentials.

Within the rotational model excitations are interpreted in terms of the deformation of the charge or mass distribution of the nucleus.

- Coulomb deformation: Intrinsic reduced matrix elements in units of $e \cdot fm^k$

$$M_n(E_\lambda) = \pm \frac{\sqrt{B(E_\lambda; I_i \rightarrow I_f)}}{\langle f I_i K \lambda 0 | I_f K \rangle}$$

- Nuclear deformation: lengths in units of fm

$$\delta_\lambda = \beta_\lambda R$$

Inelastic scattering

$^{64}\text{Zn}(^{16}\text{O}, ^{16}\text{O})^{64}\text{Zn}^*(2^+)$ at $E_{\text{lab}} = 44 \text{ MeV}$

- Projectile and target data
- Potentials
- Integration parameters

Reaction

Potentials

Integration
Parameters

Radial grid (fm):

step
(h)

0,04

matching
radius

50

Total angular
momentum:

min

0

max

300

Angular range
(degrees):

min

0

max

180

step

0,1

Integration parameters

- **Radial step (h)** It has to be chosen smaller than the diffuseness of the potentials and than the characteristic wavelength of the projectile. A simple criterion is to set $hk \leq 0.2$, where k is the wave numbers associated with the kinetic energy ($k = \sqrt{2 E_{\text{cm}} \mu} / \hbar$).
- **Matching radius** (for $R > R_{\text{MATCH}}$ asymptotic behaviour is assumed)

CALCULATE

Coupled Channels Calculation - FRESCO

$^{16}\text{O} + ^{64}\text{Zn}$ Inelastic scattering, $E_{\text{lab}} = 44 \text{ MeV}$

Save input file

Save output file

OM Elastic angular distribution (FORT.201)

Plot

Data

Inelastic angular distribution (FORT.16)

Plot

Data

Absorption, reaction and inelastic cross section (FORT.56)

Plot

Data

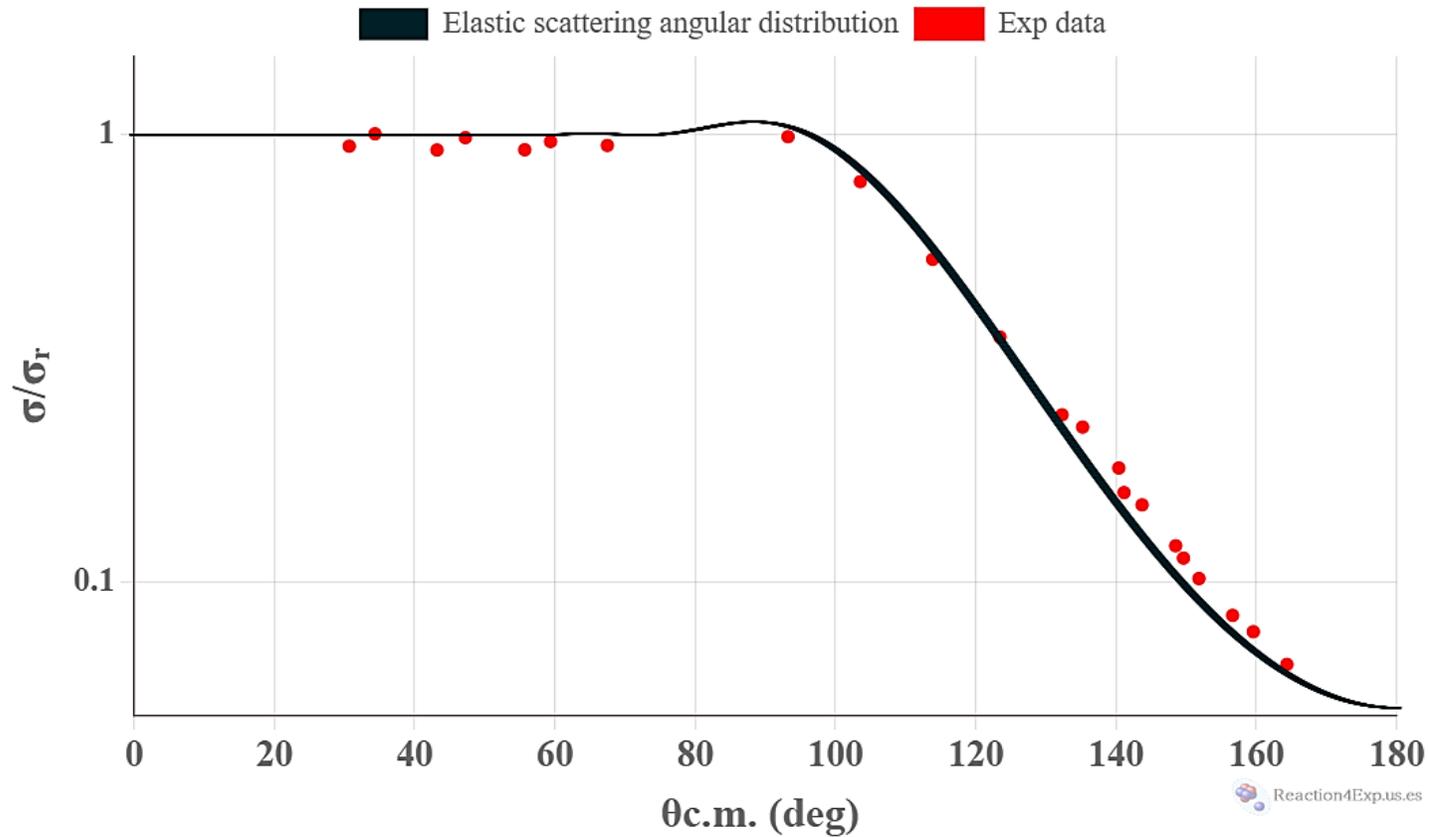
Total cross section for all states (FORT.13)

Table

Rotational model for Inelastic scattering Results

- OM elastic scattering angular distribution (fort.201)
- Inelastic scattering angular distribution (fort.16)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)

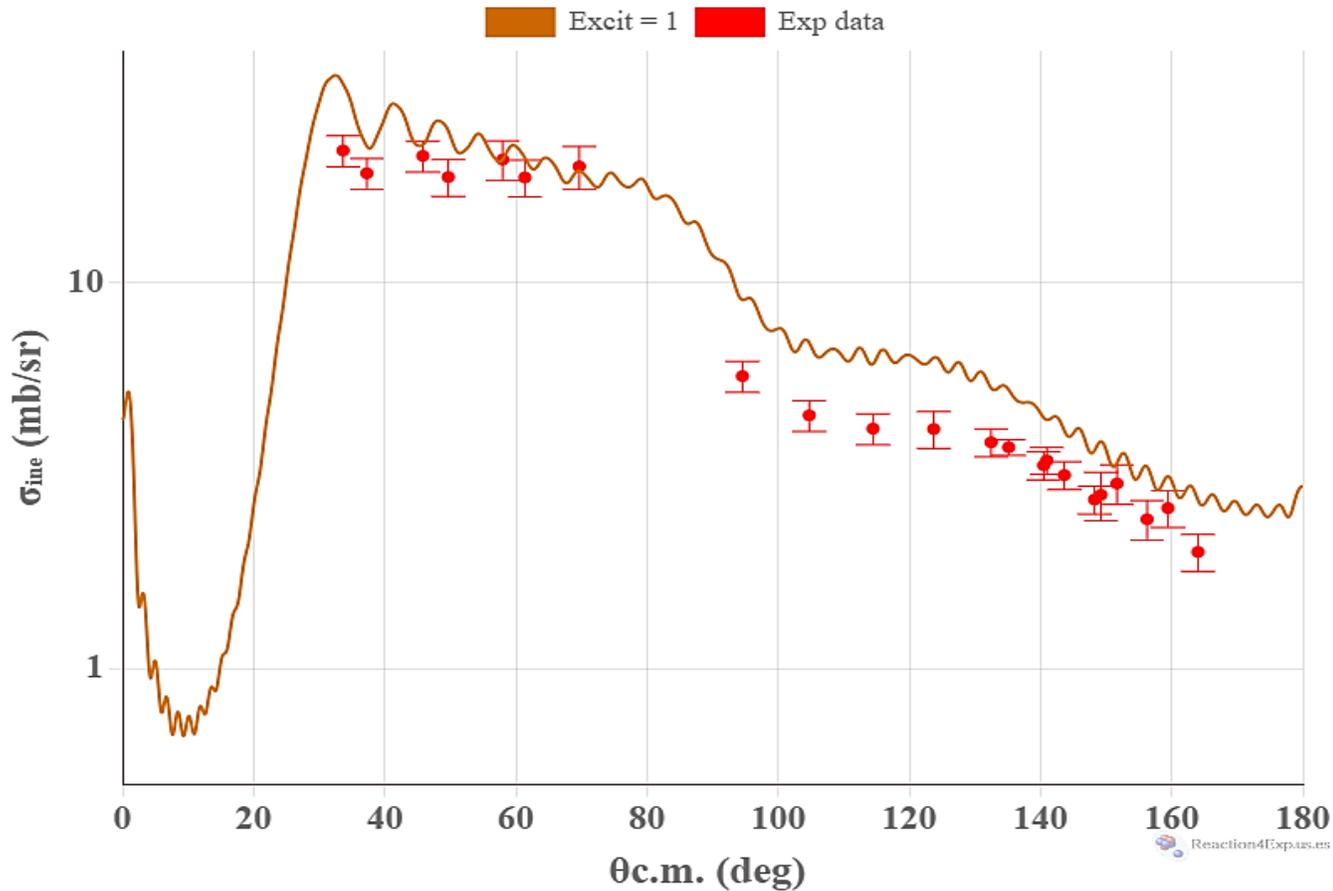
16O + 64Zn Coupled Channel Elab=44 MeV



Rotational model for Inelastic scattering Results

- **OM elastic scattering angular distribution (fort.201)**
- Inelastic scattering angular distribution (fort.16)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)

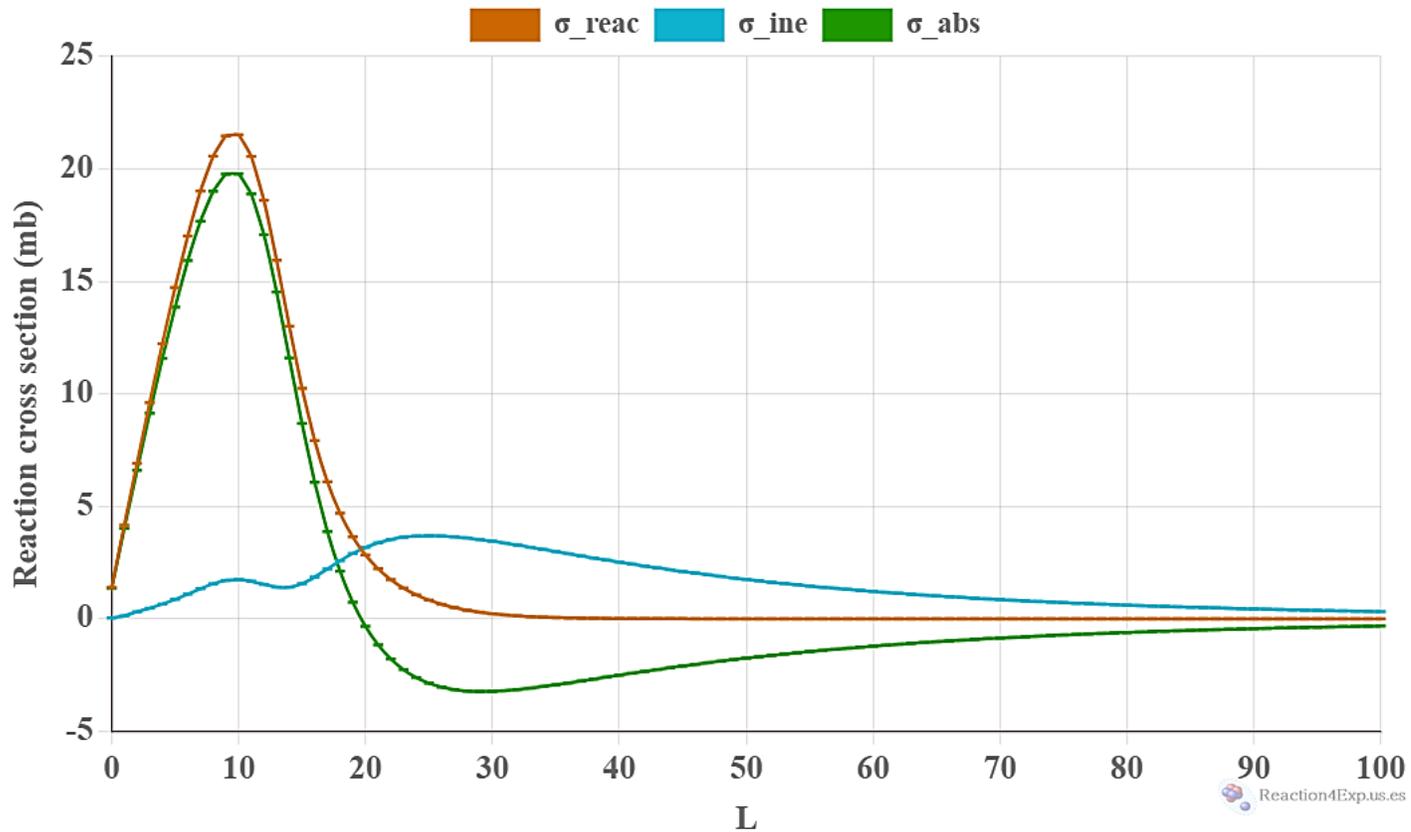
16O + 64Zn Coupled Channel Elab=44 MeV



Rotational model for Inelastic scattering Results

- OM elastic scattering angular distribution (fort.201)
- **Inelastic scattering angular distribution (fort.16)**
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)

Reaction cross sections for ELAB= 44.000, ECM= 35.200



Rotational model for Inelastic scattering Results

- OM elastic scattering angular distribution (fort.201)
- Inelastic scattering angular distribution (fort.16)
- **Absorption, reaction and inelastic cross section (fort.56)**
- Total cross section for all states (fort.13)

Integrated cross section $^{16}\text{O} + ^{64}\text{Zn}$ Coupled Channels, $E_{\text{lab}} = 44 \text{ MeV}$

Reaction cross section (mb)	262.16
Absorption cross section (mb)	105.60659

Projectile			Target			Integrated cross section (mb)
J	Parity	E (MeV)	J	Parity	E (MeV)	
0	1	0	2	1	0.992	156.56

Rotational model for Inelastic scattering Results

- OM elastic scattering angular distribution (fort.201)
- Inelastic scattering angular distribution (fort.16)
- Absorption, reaction and inelastic cross section (fort.56)
- **Total cross section for all states (fort.13)**

Transfer Reactions DWBA

Transfer $^{56}\text{Fe} (d, p) ^{57}\text{Fe}$

The diagram illustrates a transfer reaction. On the left, a deuteron (d), represented by two spheres (one blue, one orange), approaches a ^{56}Fe nucleus, which is a cluster of 26 blue and 30 orange spheres. A large blue arrow points to the right, where a proton (p), represented by a single blue sphere, is shown being ejected from the nucleus. The remaining nucleus is ^{57}Fe , consisting of 26 blue and 31 orange spheres.

REACTION4EXP
UNIVERSITY OF SEVILLE

EURO-LABS UNIVERSIDAD DE SEVILLA 1505

Transfer Reactions - FRESKO

Reaction Potentials Integration Parameters

Incoming (initial)

	Nucleus	A	Spin	Parity	E(MeV)
Projectile	Sele	<input type="text"/>	<input type="text"/>	+1	0
Target	Sele	<input type="text"/>	<input type="text"/>	+1	0
Elab	<input type="text"/>				

Q-value, post and prior interaction



Transfer Reactions - FRESCO

Reaction

Potentials

Integration Parameters

Incoming (initial)

	Nucleus	A	Spin	Parity	E(MeV)
Projectile	Select ▾	<input type="text"/>	<input type="text"/>	+1 ▾	<input type="text" value="0"/>
Target	Select ▾	<input type="text"/>	<input type="text"/>	+1 ▾	<input type="text" value="0"/>

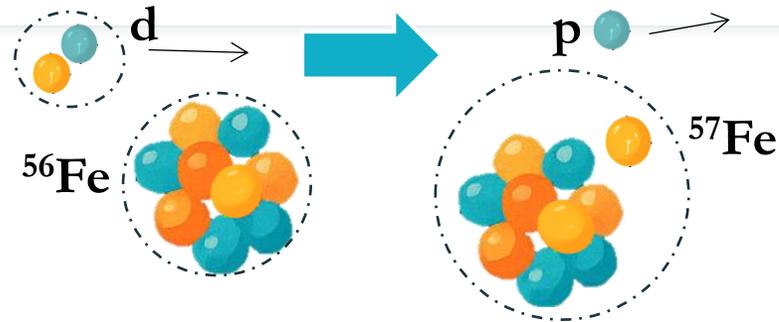
Outgoing (final)

	Nucleus	A	Spin	Parity	E(MeV)
Projectile	Select ▾	<input type="text"/>	<input type="text"/>	+1 ▾	<input type="text" value="0"/>
Target	Select ▾	<input type="text"/>	<input type="text"/>	+1 ▾	<input type="text" value="0"/>

<https://reaction4exp.us.es/transfer>

Initial and final partition

$^{56}\text{Fe} (d, p) ^{57}\text{Fe}$ at $E_{\text{lab}} = 12\text{MeV}$

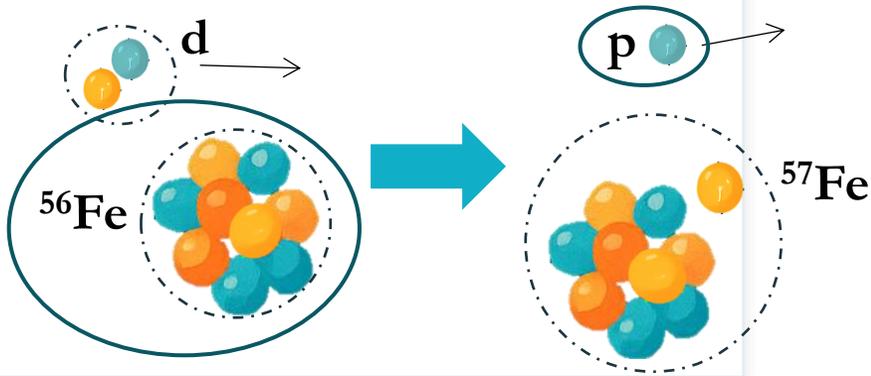


Reaction						Potentials						Integration Parameters							
Incoming (initial)						Outgoing (final)													
	Nucleus	A	Spin	Parity	E(MeV)		Nucleus	A	Spin	Parity	E(MeV)								
Projectile	H	2	1,0	+1	0	Projectile	H	1,0078	0,5	+1	0								
Target	Fe	55,934	0,0	+1	0	Target	Fe	56,935	0,5	-1	0								
Elab (MeV)	12					Q-value	5,422												

Automatic calculation of Q-value

Potentials

- Entrance Channel
- Exit channel
- Core-core
- Bound state: Entrance channel
- Bound State: Exit channel



$$\underbrace{a}_{b+x} + A \rightarrow b + \underbrace{x + A}_B$$

$$\langle \chi_f \Phi_{xA} | V_{bx} + \underbrace{U_{bA}}_{\text{Core-Core}} - U_{bB} | \Phi_{bx} \chi_i \rangle$$

Entrance Channel

Exit Channel

Core-Core

Bound State:
Entrance Channel

Bound State: Exit
Channel

$p + {}^{56}\text{Fe}$

Use same entrance channel potential.

Use same exit channel potential.

Radii conversion and Coulomb potential

$$R_0 = r_0(A_p^{1/3} + A_t^{1/3})$$

A_p

A_t

r_c

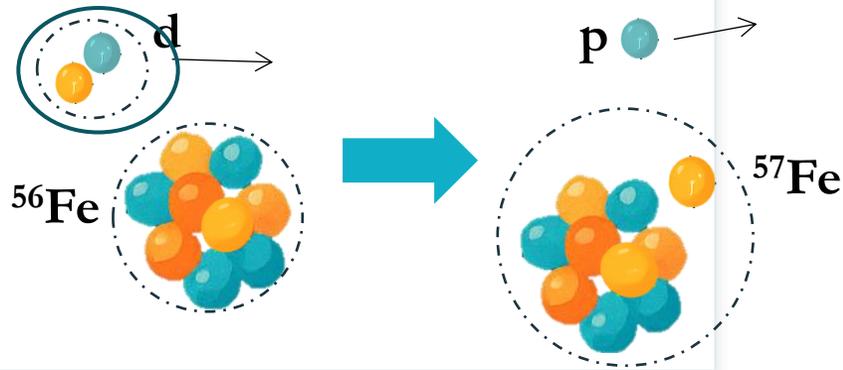
In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$	$W_0(\text{MeV})$	$r_i(\text{fm})$	$a_i(\text{fm})$
Volum	Woods	47,9	1,25	0,65	<input type="text"/>	<input type="text"/>	<input type="text"/>
-	Surfac	<input type="text"/>	<input type="text"/>	<input type="text"/>	11,5	1,25	0,47

Potentials

- Entrance Channel
- Exit channel
- Core-core
- **Bound state: Entrance channel**
- Bound State: Exit channel



$$\underbrace{a}_{b+x} + A \rightarrow b + \underbrace{x + A}_B$$

$$\langle \chi_f \Phi_{xA} | \underbrace{V_{bx}}_{\text{circled}} + U_{bA} - U_{bB} | \Phi_{bx} \chi_i \rangle$$

Entrance Channel Exit Channel Core-Core **Bound State: Entrance Channel** Bound State: Exit Channel

p + n

Radii conversion and Coulomb potential

$$R_0 = r_0(A_p^{1/3} + A_t^{1/3})$$

A_p

A_t

r_c

In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$
Volume, ce	Gaussian	72,15	<input type="text"/>	1,484

+

Transferred particle bound state

n	<input type="text" value="1"/>
l	<input type="text" value="0"/>
sn	<input type="text" value="0,5"/>
j	<input type="text" value="0,5"/>

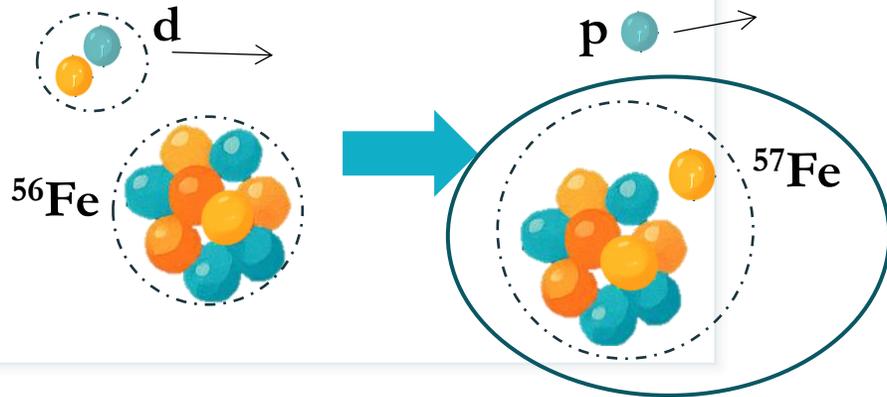
be (MeV)

a

Spectroscopic amplitude

Potentials

- Entrance Channel
- Exit channel
- Core-core
- Bound state: Entrance channel
- **Bound State: Exit channel**



$$\underbrace{a}_{b+x} + A \rightarrow b + \underbrace{x + A}_B$$

$$\langle \chi_f \Phi_{xA} | \underbrace{V_{bx}}_{\text{circled}} + U_{bA} - U_{bB} | \Phi_{bx} \chi_i \rangle$$

Entrance Channel

Exit Channel

Core-Core

Bound State:
Entrance Channel

Bound State: Exit
Channel

$n + {}^{56}\text{Fe}$

Radii conversion and Coulomb potential

$$R_0 = r_0(A_p^{1/3} + A_t^{1/3})$$

A_p

A_t

r_c

In most nucleon-nucleus reactions, ap in the radius conversion formula is typically zero. In nucleus-nucleus reactions, ap and at represents the mass numbers (A) of the involved elements.

Nuclear potential

Type	Shape	V_0 (MeV)	r_0 (fm)	a_0 (fm)
Volume, ce	Woods-Sax	65	1,25	0,65

+

Transferred particle bound state

n	<input type="text" value="2"/>
l	<input type="text" value="1"/>
sn	<input type="text" value="0,5"/>
j	<input type="text" value="0,5"/>

be (MeV)

a

Spectroscopic
amplitude

Integration parameters

- **Non local kernels:** Describe the spatial overlap between channels. Kernel width, center and mesh settings
- Post and Prior interaction

$$V_{\text{post}} = V_{\text{p-n}} + \underbrace{U_{\text{p-56Fe}} - U_{\text{p-57Fe}}}_{\text{remnant}}$$

$$V_{\text{prior}} = V_{\text{n-56Fe}} + \underbrace{U_{\text{p-56Fe}} - U_{\text{d-56Fe}}}_{\text{remnant}}$$

$^{56}\text{Fe} (\text{d}, \text{p}) ^{57}\text{Fe}$ at $E_{\text{lab}} = 12\text{MeV}$

Reaction

Potentials

Integration Parameters

Radial grid (fm): step (h) rmatch

Non-local kernels rintp hnl rnl centre

Total angular momentum: min max Stop at absent

Angular range (degrees): min max step

Select interaction:

POST

PRIOR

Post $\simeq V_{\text{p+n}}$

Transfer Calculation - FRESCO

$^{56}\text{Fe}(^2\text{H}, ^1\text{H})^{57}\text{Fe}$ Elab=12 MeV

Save input file

Save output file

OM Elastic angular distribution (FORT.201)

Plot

Data

Transfer angular distribution (FORT.202)

Plot

Data

Absorption, reaction and inelastic cross section (FORT.56)

Plot

Data

Total cross section for all states (FORT.13)

Table

Potentials (FORT.34)

Plot

Recommendations

NON-LOCAL WIDTH IS GREATER THAN 2.70 FM., CENTRATION -0.15, after 0.01 secs.

RNL: non-local width > 2.70 cf: 4.00 fm: OK

CENTRE: centration ~ -0.15 cf: -0.40 fm

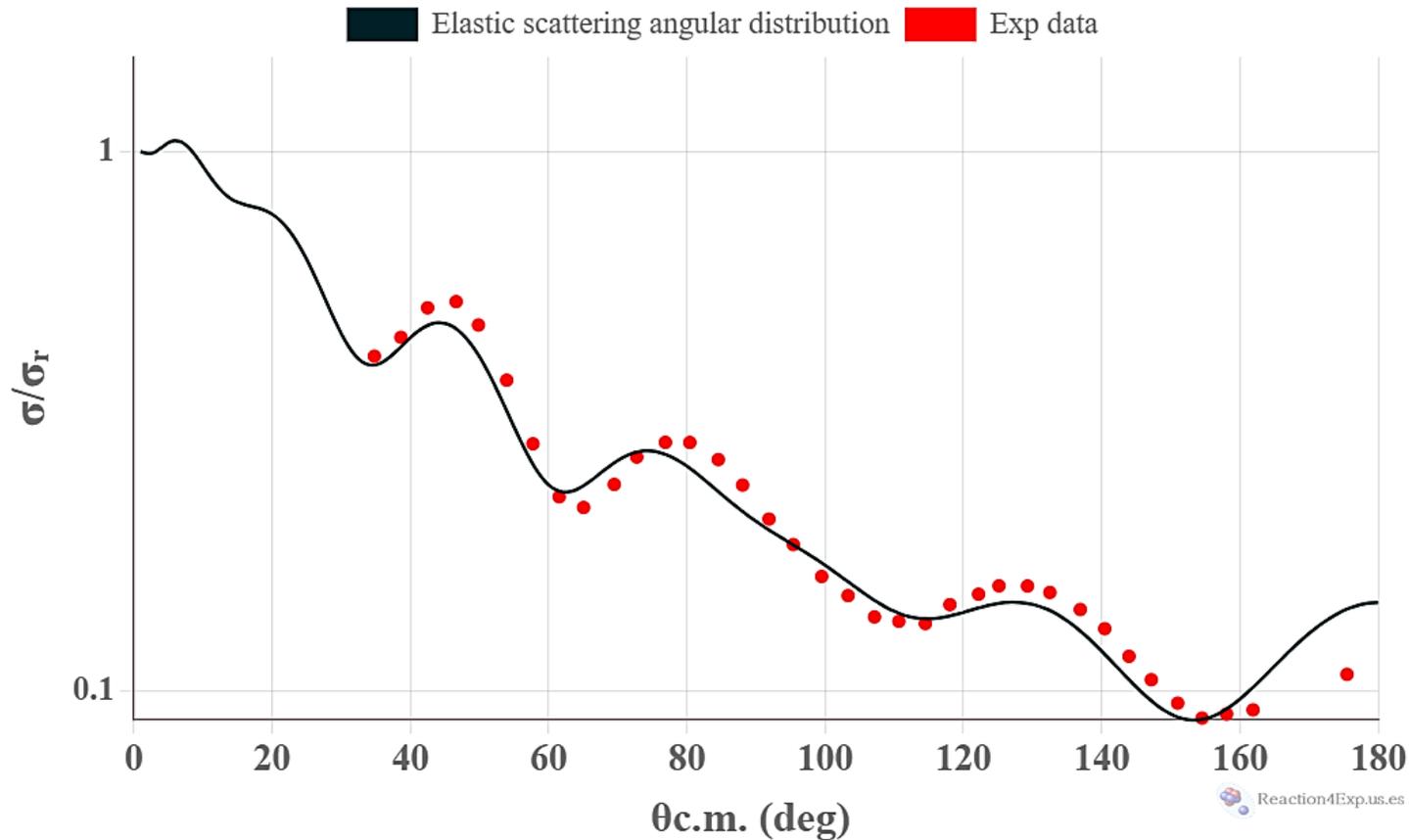


Transfer DWBA Results

- OM elastic angular distribution (fort.201)
- Transfer angular distribution (fort.202)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)
- Potentials (fort.34)

FRESCO verifies that the non-local kernel is wide and centered to obtain numerically reliable results.

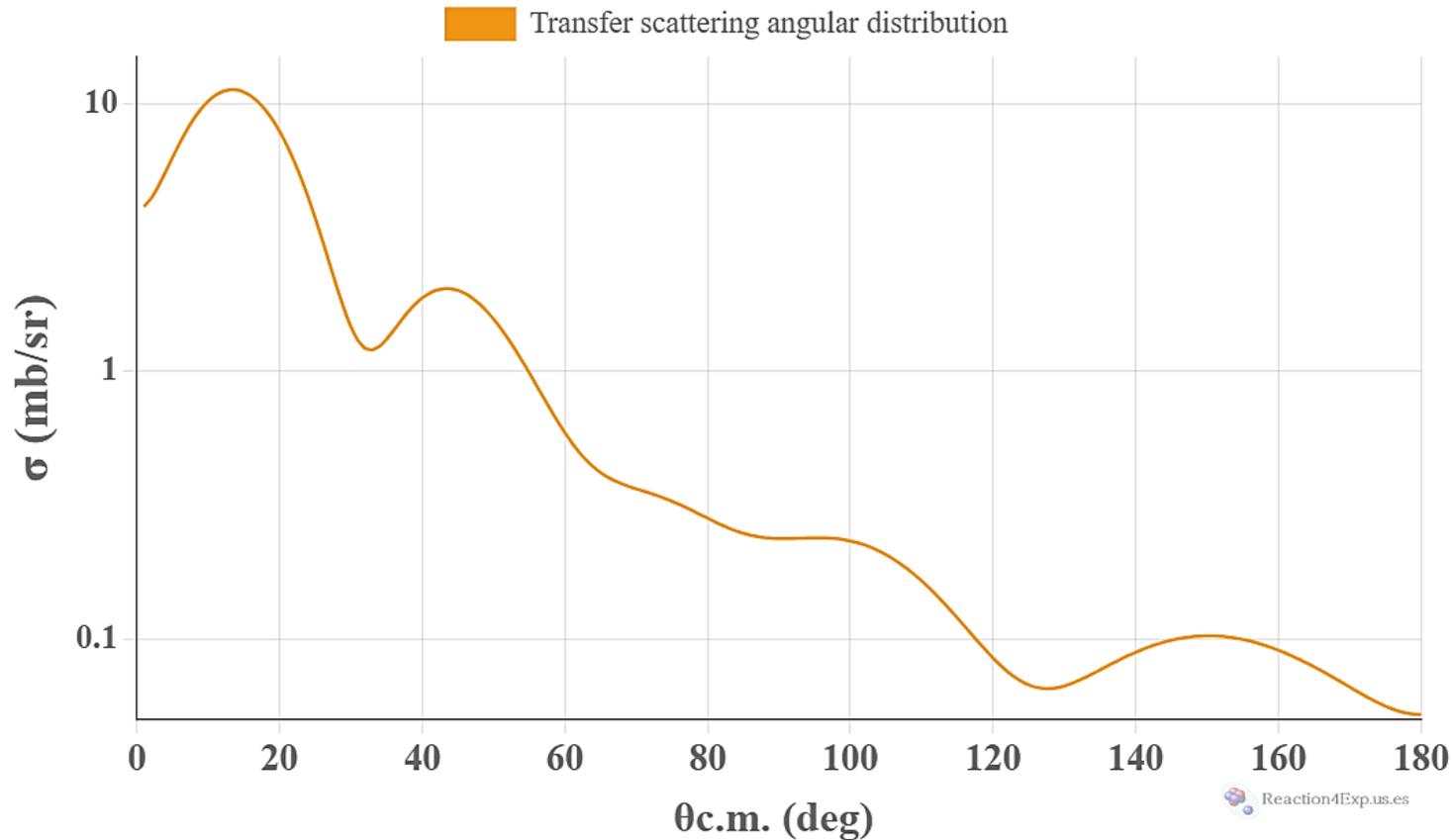
Entrance channel $2\text{H} + {}^{56}\text{Fe}$ $E_{\text{lab}}=12$ MeV



Transfer DWBA Results

- **OM elastic angular distribution (fort.201)**
- Transfer angular distribution (fort.202)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)
- Potentials (fort.34)

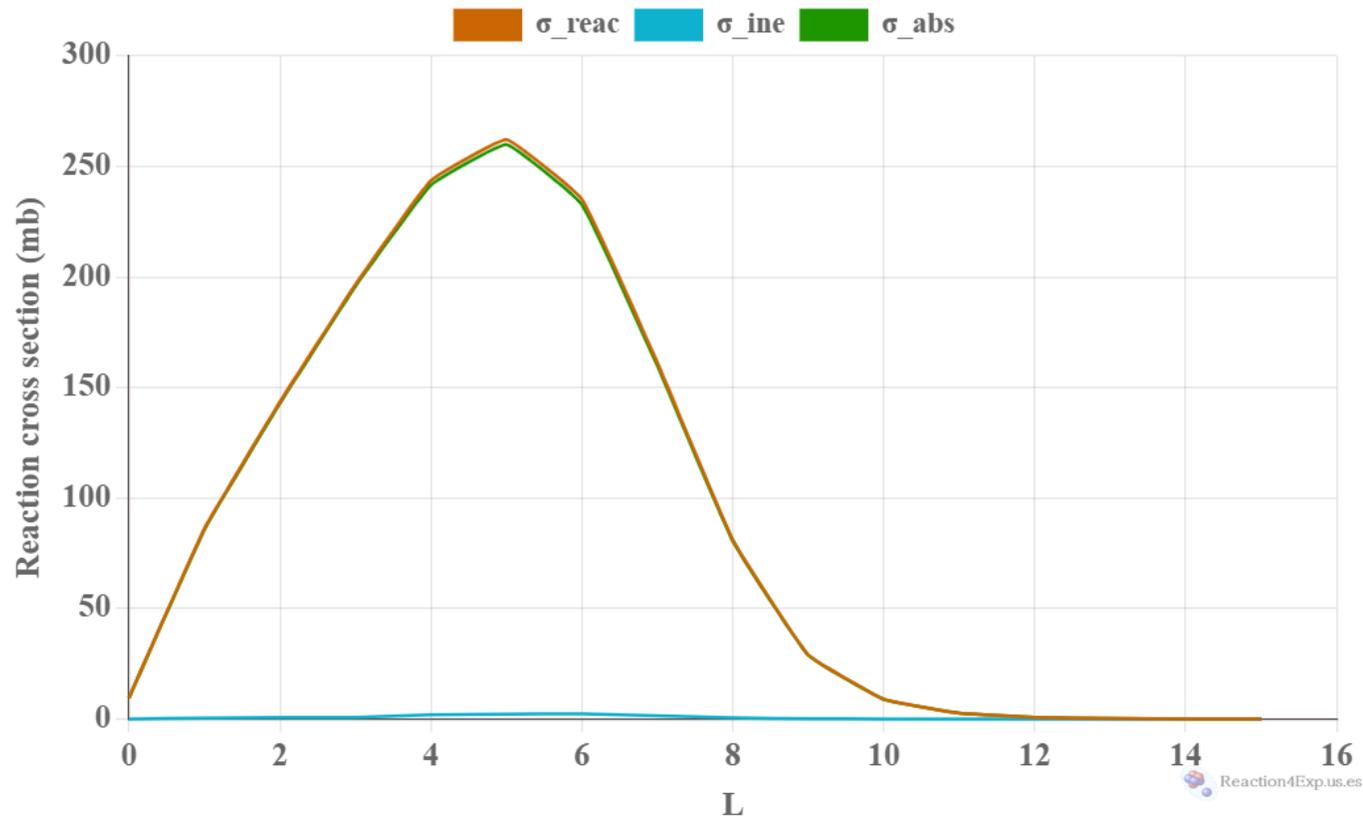
Exit channel $1\text{H} + {}^{57}\text{Fe}$ Elab=12 MeV



Transfer DWBA Results

- OM elastic angular distribution (fort.201)
- **Transfer angular distribution (fort.202)**
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)
- Potentials (fort.34)

Reaction cross sections for ELAB= 12.000, ECM= 11.583



Transfer DWBA Results

- OM elastic angular distribution (fort.201)
- Transfer angular distribution (fort.202)
- **Absorption, reaction and inelastic cross section (fort.56)**
- Total cross section for all states (fort.13)
- Potentials (fort.34)

Integrated cross section $^{56}\text{Fe}(^2\text{H},^1\text{H})^{57}\text{Fe}$ Elab=12 MeV

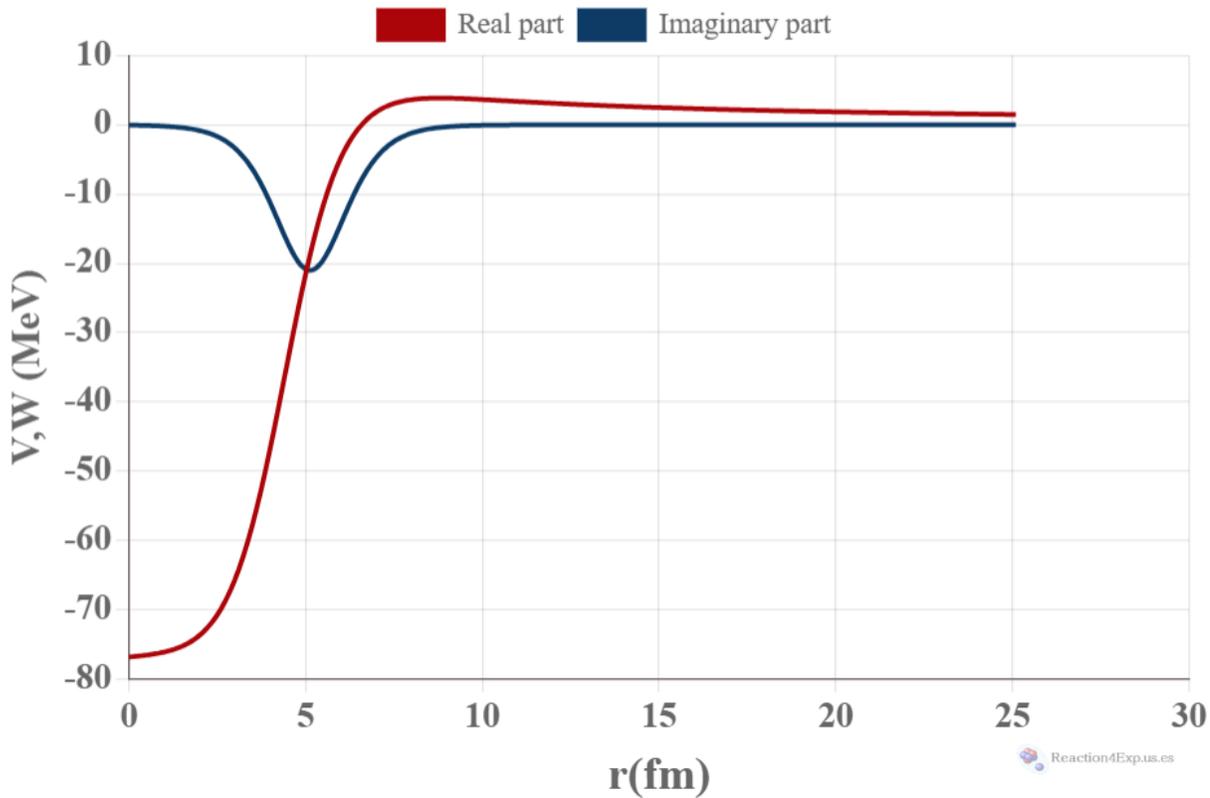
Reaction cross section (mb)	1460.8
Absorbtion cross section (mb)	1450.22275

Projectile			Target			Integrated cross section (mb)
J	Parity	E (MeV)	J	Parity	E (MeV)	
0.5	1	0	0.5	-1	0	10.621

Transfer DWBA Results

- OM elastic angular distribution (fort.201)
- Transfer angular distribution (fort.202)
- Absorption, reaction and inelastic cross section (fort.56)
- **Total cross section for all states (fort.13)**
- Potentials (fort.34)

Optical potential $d + {}^{56}\text{Fe}$ Elab = 12 MeV



☞ Potentials
Entrance $d + {}^{56}\text{Fe}$
Exit $p + {}^{57}\text{Fe}$
Core-core $p + {}^{56}\text{Fe}$
Bound state - Entrance $n + p$
Bound state - Exit $n + {}^{56}\text{Fe}$

Transfer DWBA Results

- OM elastic angular distribution (fort.201)
- Transfer angular distribution (fort.202)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)
- **Potentials (fort.34)**

5

Coulomb Breakup Semiclassical equivalent photon method (EPM)



Discrete and continuous distribution



COULOMB BREAKUP

Equivalent Photon Model (EPM)

This program calculate differential Coulomb break up cross sections from external transition probabilities, both in angle and energy. Multipolarities included are dipole and quadrupole for electric transitions and only dipole for magnetic transitions. The results are presented in .dat format and graphically displayed. As output, it provides: the angular distribution of cross section, the energy distribution of cross section and the probability distribution.

Projectile and target

Projectile

Select ▾

A

Energy (MeV)

Separation Energy

Target

Select ▾

A

<https://reaction4exp.us.es/epm>

Coulomb breakup EPM: Discrete distribution

Projectile and target

Disttype

Projectile

Target

Lab Energy (MeV) Transition

Grid

thmin thmax nth thgr

Ex B(Ex;i→f)

Upload input from external file

You can upload a previously generated input file to automatically fill in the form fields.

Upload input Discrete 11Be+197Au_29_7MeV.in

- **Transition:** E1, E2 and M1
- Ex : Excitation energy of the final state (MeV)
- $B(Ex; i \rightarrow f)$: Transition probability

Coulomb breakup EPM: Continuous distribution

- **Transition:** E1, E2 and M1
- **Electric transition probability:** File with two columns – energy grid from $ermin$ to $ermax$ (relative to neutron separation threshold) and dB/dE .

Projectile and target

Disttype	<input type="text" value="Continuous"/>		
Projectile	<input type="text" value="Li"/>	<input type="text" value="11"/>	Separation Energy (MeV) <input type="text" value="0,38"/>
Target	<input type="text" value="Zn"/>	<input type="text" value="64"/>	
Lab Energy (MeV)	<input type="text" value="22,5"/>		Transition <input type="text" value="E1"/>

Grid

thmin	<input type="text" value="0,1"/>	thmax	<input type="text" value="180"/>	nth	<input type="text" value="1800"/>	thgr	<input type="text" value="180"/>
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Electric transition probability

Experimental.dat

ermin	<input type="text" value="0,1"/>	ermax	<input type="text" value="7"/>	ner	<input type="text" value="1000"/>
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Coulomb Break Up By EPM

$^{11}\text{Be} + ^{197}\text{Au}$ Elab= 31.9 MeV

Save input file

Angular distribution of
cross section:

Plot

Data

Energy distribution of
cross section:

Plot

Data

Probability
distribution:

Plot

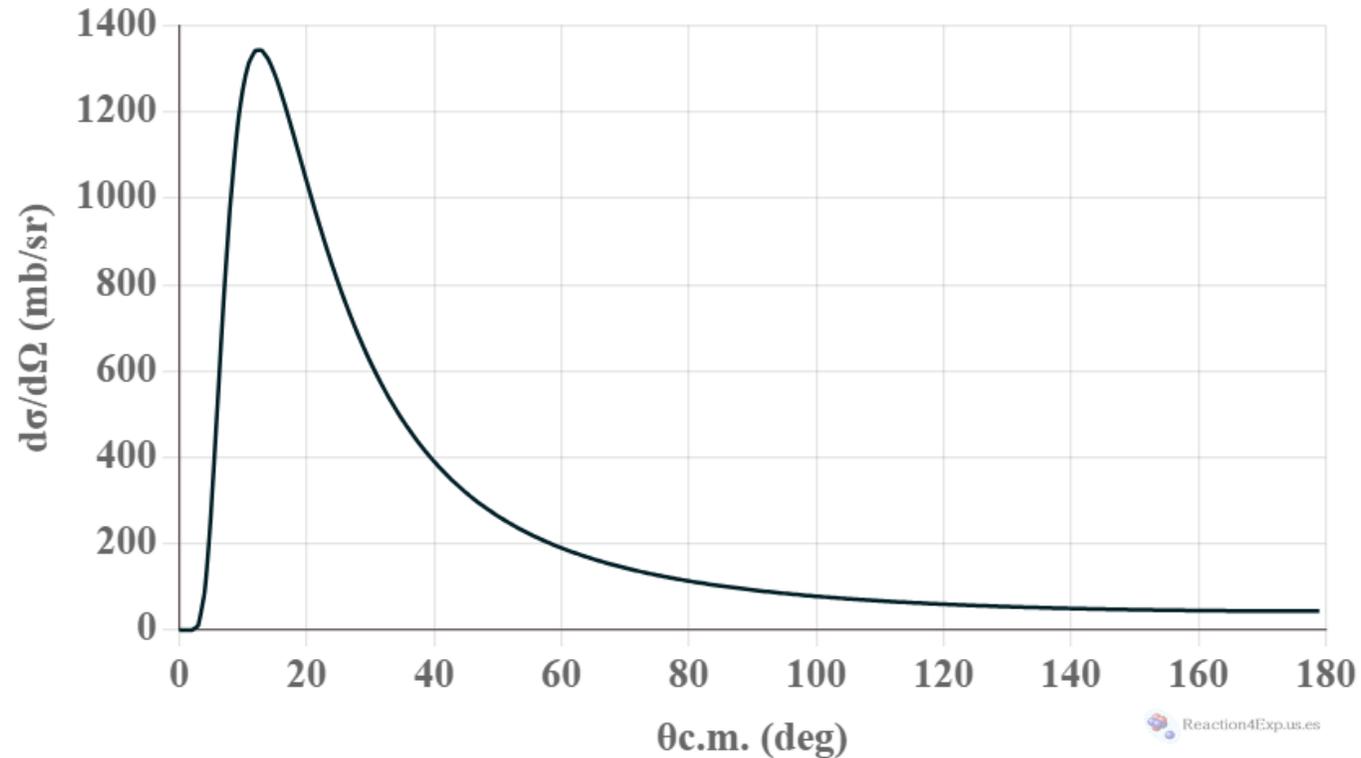
Data

EPM Results

- Angular distribution of cross section
- Energy distribution of cross section and total cross section
- Probability distribution

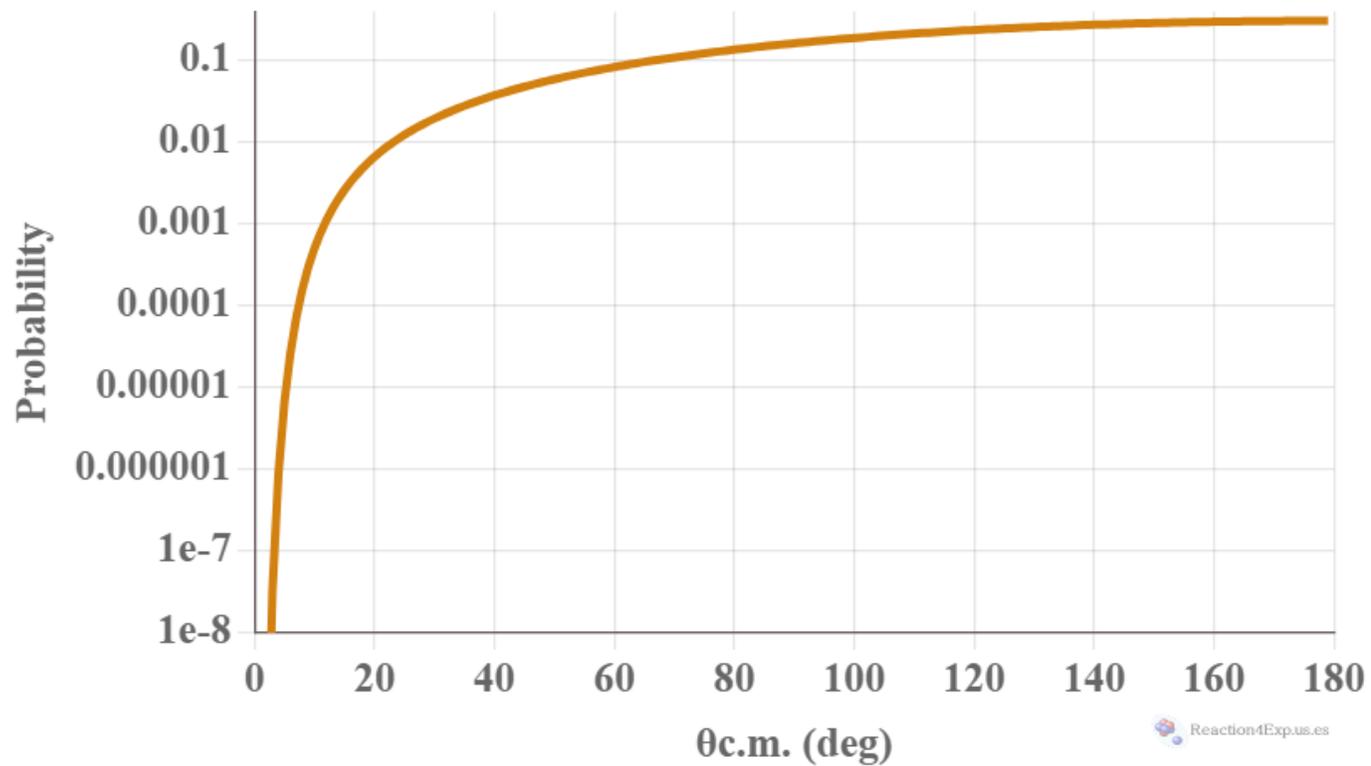
EPM Results

Angular distribution of differential cross section



- **Angular distribution of cross section**
- Probability distribution
- Energy distribution of cross section and total cross section

Probability distribution



EPM Results

- Angular distribution of cross section
- **Probability distribution**
- Energy distribution of cross section and total cross section

Discrete -> Total cross section

Continuous -> Energy distribution of cross section

Energy cross section $^{11}\text{Be} + ^{197}\text{Au}$ Elab = 31.9 MeV

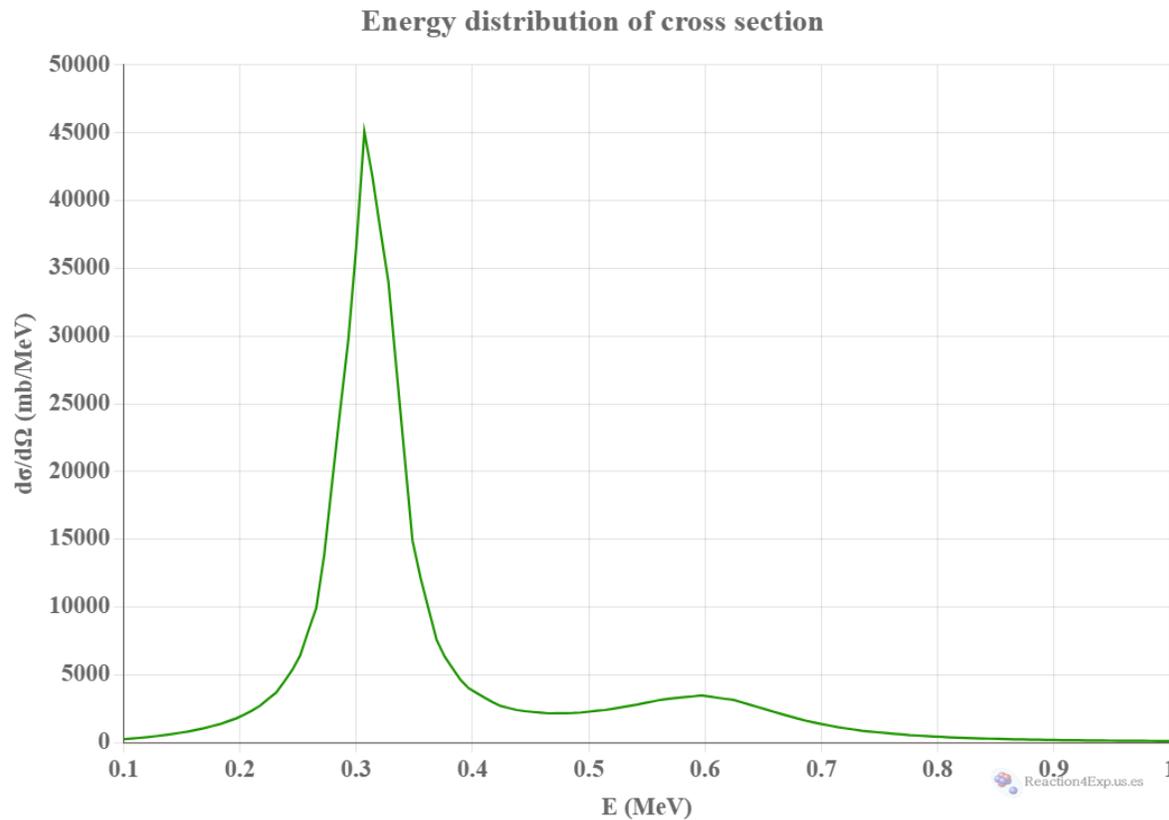
Transition	E(MeV)	σ (mb)
E1	0.32	2344.678

EPM Results

- Angular distribution of cross section
- Probability distribution
- Energy distribution of cross section and **total cross section**

Continuous -> Energy distribution of cross section:

Example: $^{11}\text{Li} + ^{64}\text{Zn}$ at $E_{\text{lab}} = 22,5 \text{ MeV}$



EPM Results

- Angular distribution of cross section
- Probability distribution
- **Energy distribution of cross section** and total cross section

Additional information



More information about the programs:

At the bottom of each program's web page, you will find a description, user manuals and additional resources. You can also visit the main page:

<https://institucional.us.es/theo4exp/reaction4exp.html>



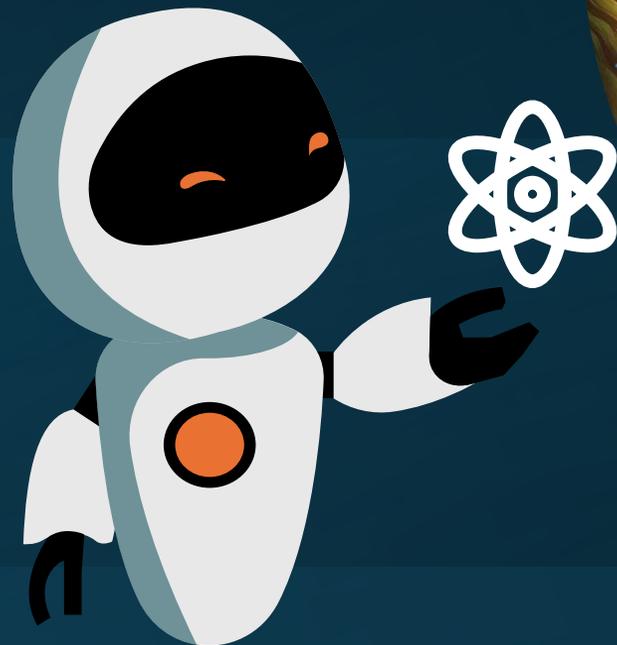
How do you cite reaction4exp results?

You can find the citation on the results page of each program.

The results obtained should be cited as follows:

This work has made use of the Virtual Access facility Theo4Exp funded by the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101057511.

Surprise:
CDCC in
development



Thanks!

May Reaction4Exp be your trusted sidekick in all your nuclear reaction calculations.

