

Do you know how to use Reaction4Exp platform?

Carla Tatiana Muñoz Chimbo



Inelastic Scattering

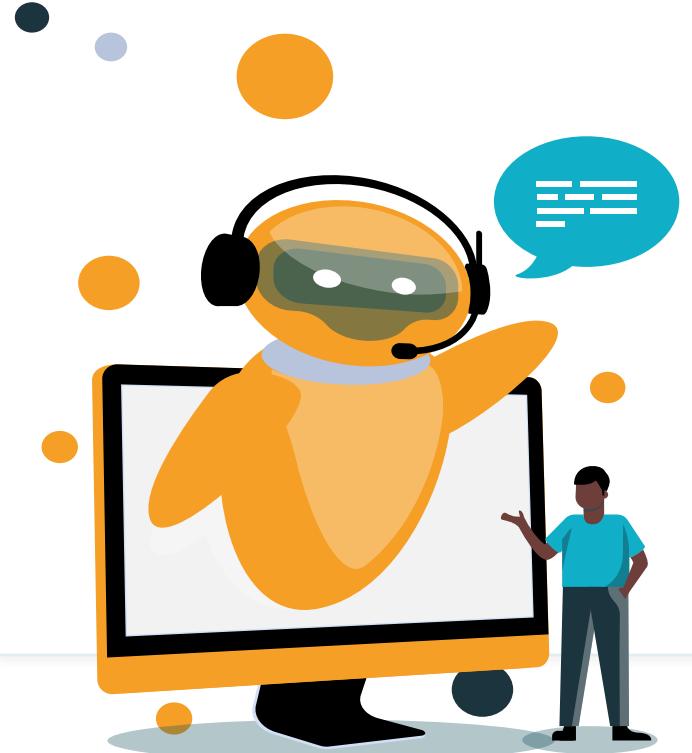
${}^2\text{H} \rightarrow {}^{208}\text{Pb}$

Reaction4Exp

https://reaction4exp.us.es

DEUTON 208Pb CERN FAIR EAGLE SIME

Content



- 1 Access and general options**
Customize styles plot, download results, external input.
- 2 Optical Model and Classical**
Potential generator / SPP2.
- 3 Inelastic Scattering**
Rotational Model / Deformations.
- 4 Transfer reactions**
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 TATIANA MUÑOZ CHIMBO

Theo4Exp

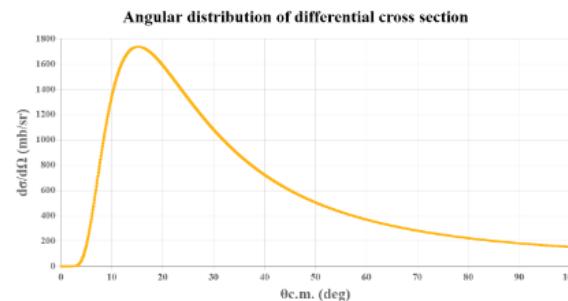
EURO-LABS

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Start your calculation

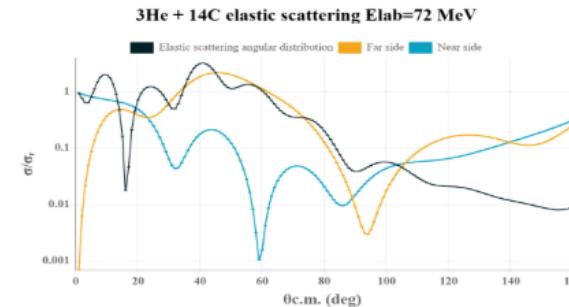
Select the type of nuclear reaction and explore results



Coulomb break up

Semiclassical calculations - EPM

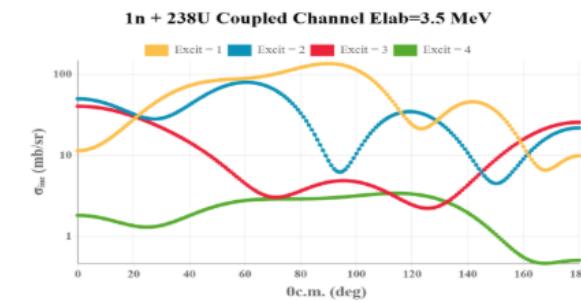
- Angular distribution of cross section



Elastic scattering

Classical and Optical Model FRESCO

- Generate potential SYSOP and SPP2



Inelastic scattering

Coupled channels method and DWBA approximation - FRESCO

- Generate potential SYSOP

<https://reaction4exp.us.es>

Access

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



Welcome to **EURO-LABS SSO**

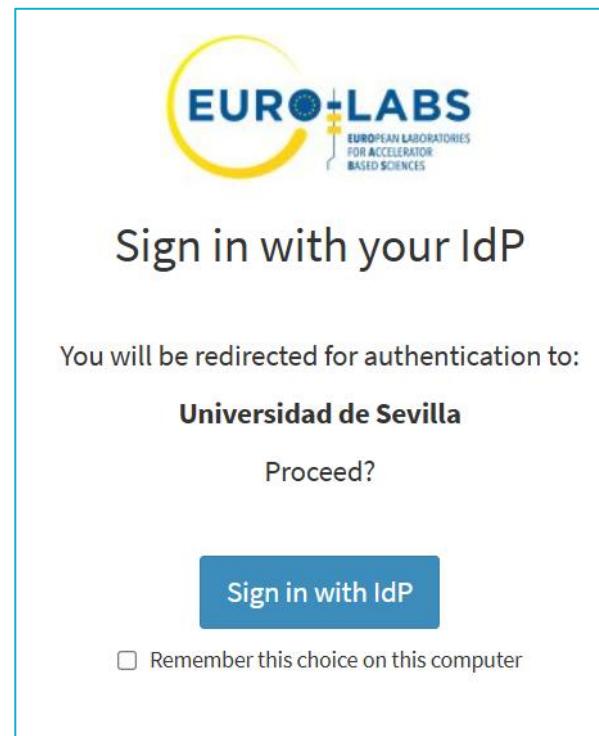
Sign in with

ORCID 

eduGAIN 

Local credentials

1. Choose eduGain or Orcid for identification



Sign in with your IdP

You will be redirected for authentication to:

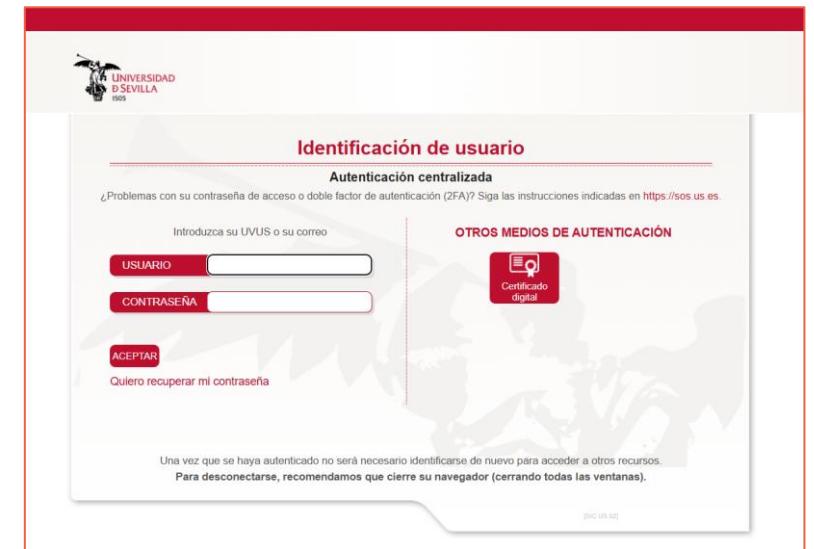
Universidad de Sevilla

Proceed?

Remember this choice on this computer

[Sign in with IdP](#)

2. EduGain: Look for your institution



Identificación de usuario

Autenticación centralizada

Problemas con su contraseña de acceso o doble factor de autenticación (2FA)? Siga las instrucciones indicadas en <https://sos.us.es>.

Introduzca su UVUS o su correo

USUARIO

CONTRASEÑA

ACEPTAR

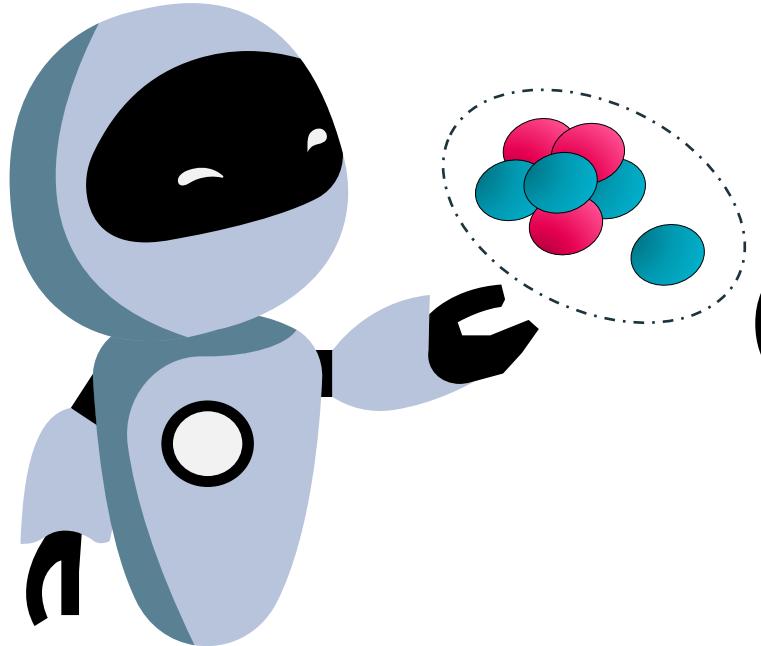
Quiero recuperar mi contraseña

OTROS MEDIOS DE AUTENTIFICACIÓN

Certificado digital

Una vez que se haya autenticado no será necesario identificarse de nuevo para acceder a otros recursos.
Para desconectarse, recomendamos que cierre su navegador (cerrando todas las ventanas).

3. Use your institutional username and password



General Options

Reaction form, 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
Projectile	Nucleus	A	J
	He	3	0
Target	C	14	0
	+1	+1	+1
E (MeV)	72	59,294	
	Lab	CM	

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)

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 (fm) Switch off Coulomb

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

+  SPP2 ←

FRESCO Potential

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

${}^4He + {}^{13}C$ at $E_{lab} = 72$ 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 (MeV)
Volume, central poten	Woods-Saxon	150
Volume, central potential	WS squared	
Surface, central potential	Gaussian	
Spin-orbit for projectile	Yukawa	
Spin-orbit for target	Exponential	
• A	Reid soft core for T=0, central part	
	Reid soft core for T=1, central part	
	Read Complex	

Potential pair

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

• A

FRESCO Potential

${}^4He + {}^{13}C$ at $E_{lab} = 72$ 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 (MeV)	r_0 (fm)	a_0 (fm)	W_0 (MeV)	r_i (fm)	a_i (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)

Matching radius

Total angular momentum:

min

max

Angular range (degrees):

min

max

step

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 ($k = \sqrt{2 E_{\text{cm}} \mu / h}$).
- **Matching radius** (for $R > \text{RMATCH}$ 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

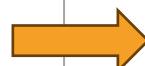
Warning! Reduce h, the integration step has to be $hk \leq 0.2$

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 ($k = \sqrt{2 E_{\text{cm}} \mu / h}$).
- **Matching radius** (for $R > \text{RMATCH}$ asymptotic behaviour is assumed)

CALCULATE

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, Elab= 72 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 FRESCO in Reaction4Exp) -> Simplifies future data entry (external input)
- Save detailed output -> provides additional information for expert users.

ReactionPotentialsIntegration Parameters

	Nucleus	A	J	Parity
Projectile	He	3	0	+1
Target	C	14	0	+1
E (MeV)	72	59,294		

Reactions parameters

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

CALCULATE

Upload input from external file

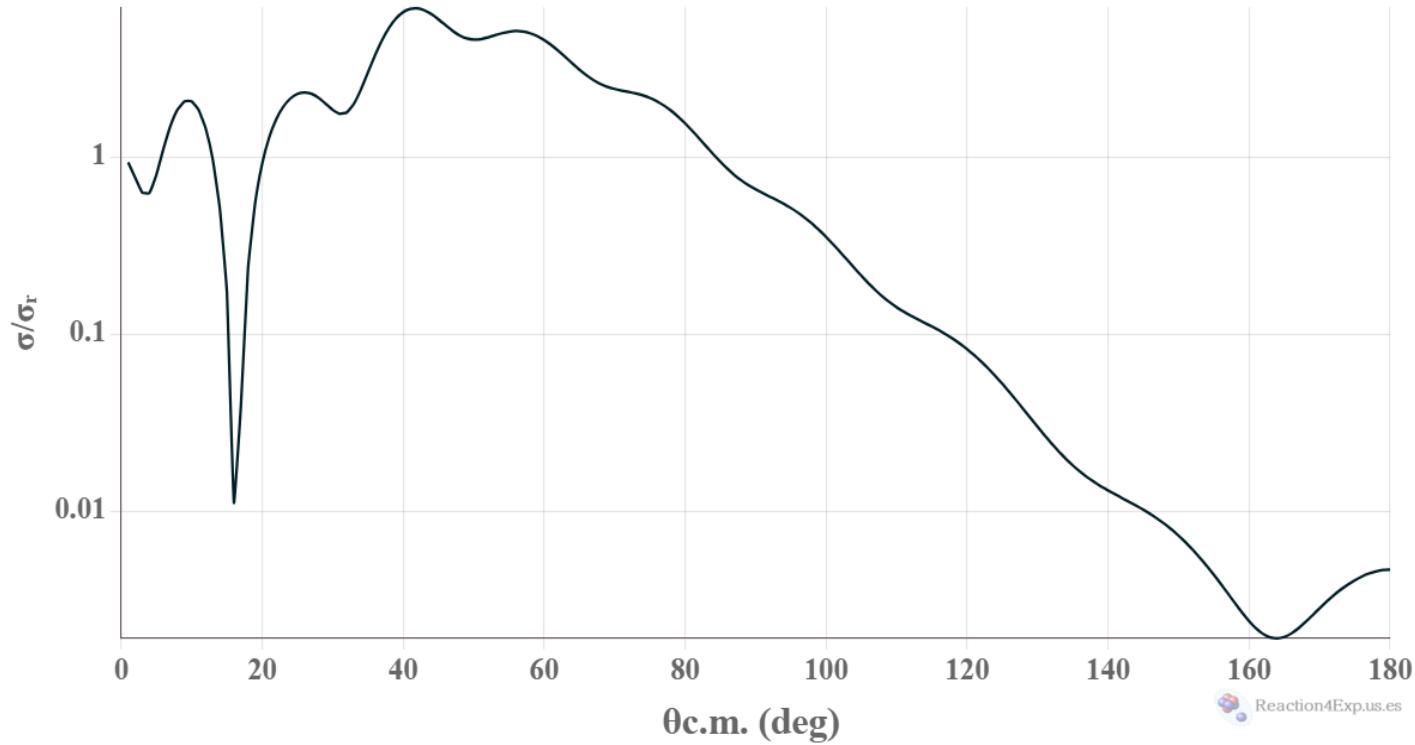
You can upload a previously generated input file to automatically fill in the form fields.

Upload input Elastic_3He+14C_72MeV.in

[Customize styles](#)

3He + 14C elastic scattering Elab=72 MeV

Elastic scattering angular distribution

[Show/Quit Farside](#)[Show/Quit Nearside](#)[Download](#)

Plot Options

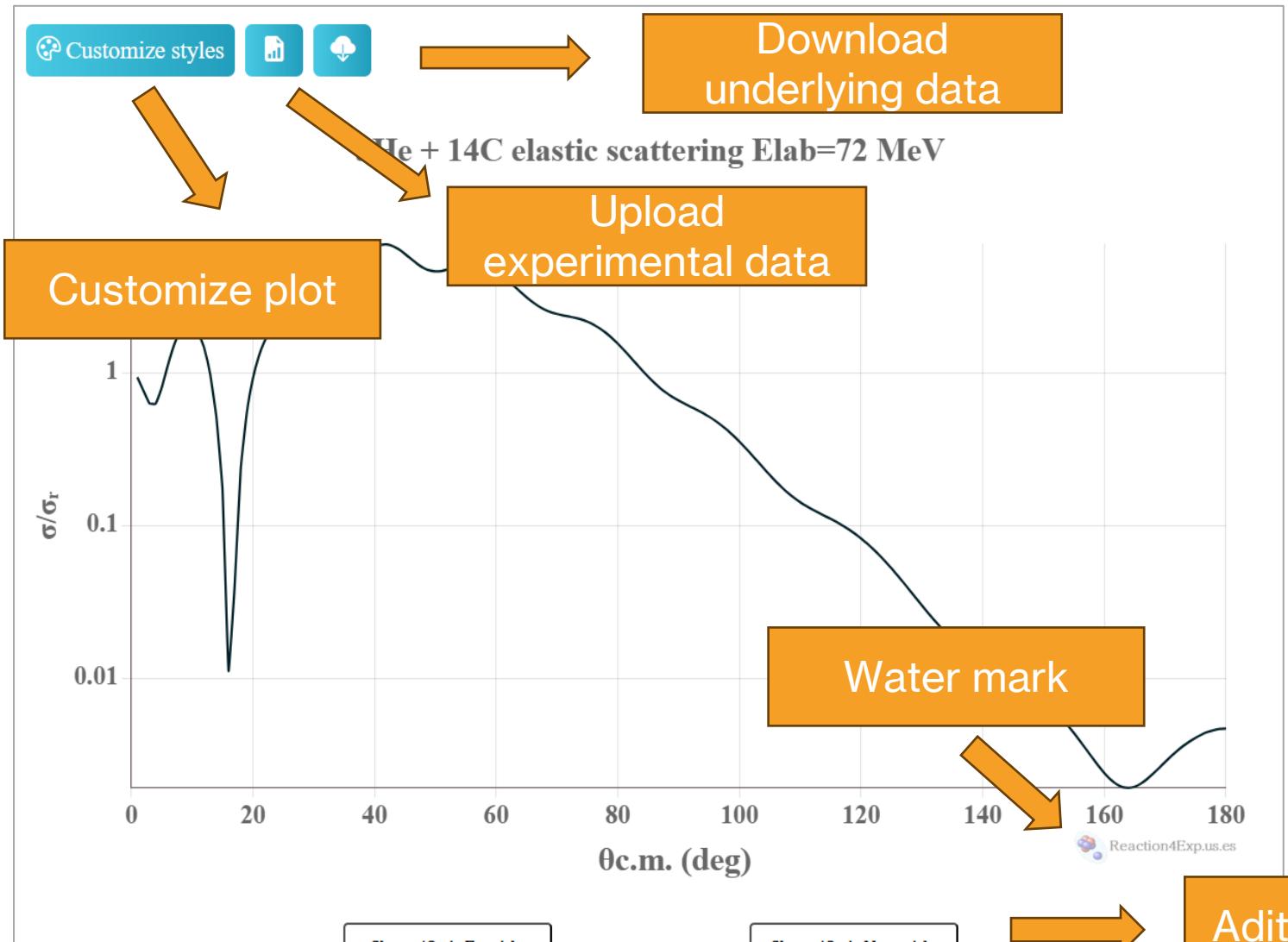
Customize plot appearance
(axes, labels, colors)

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)

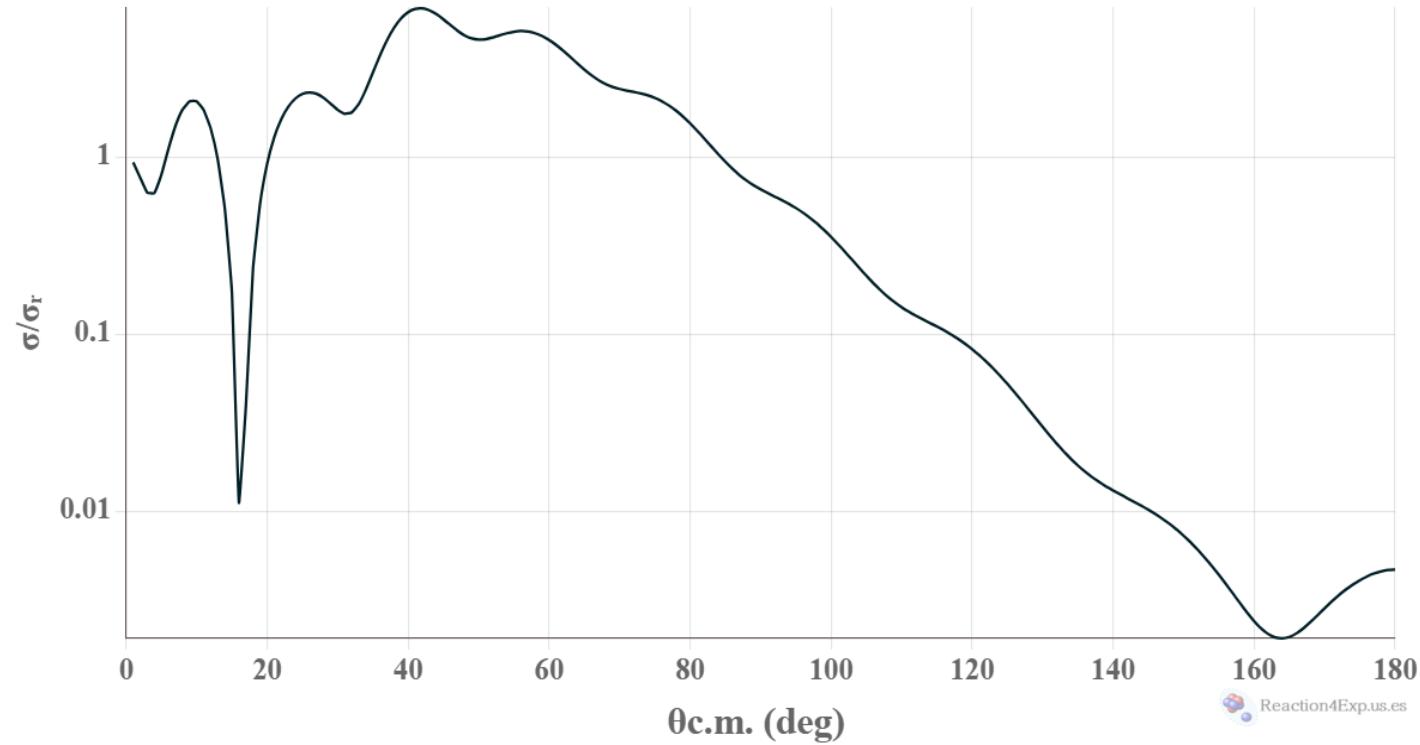
Download underlying data (.txt)

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

 Customize styles

3He + 14C elastic scattering Elab=72 MeV

Elastic scattering angular distribution



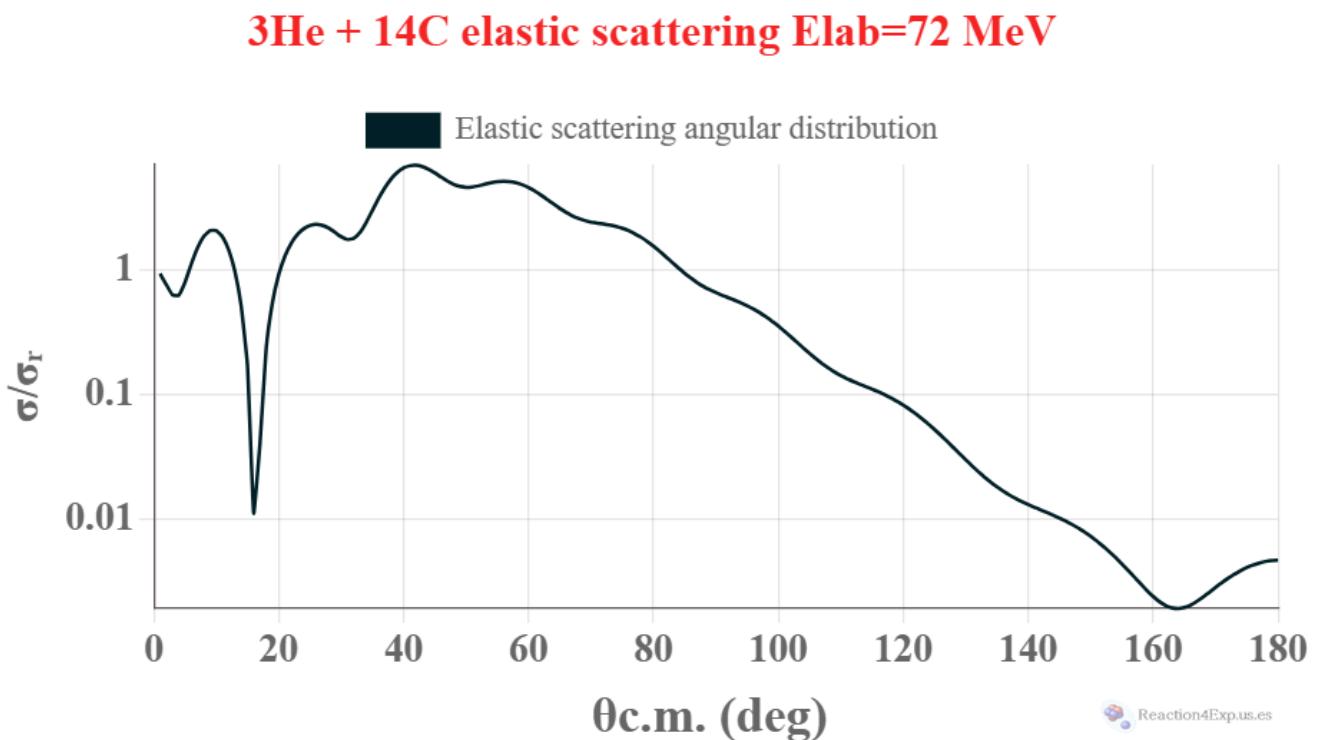
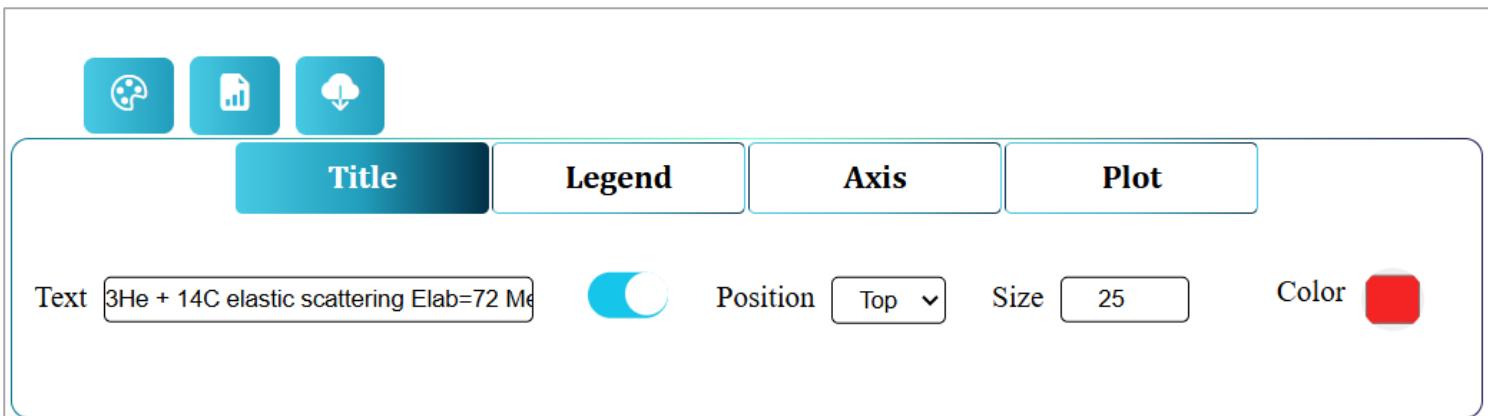
Show/Quit Farside

Show/Quit Nearside

Download

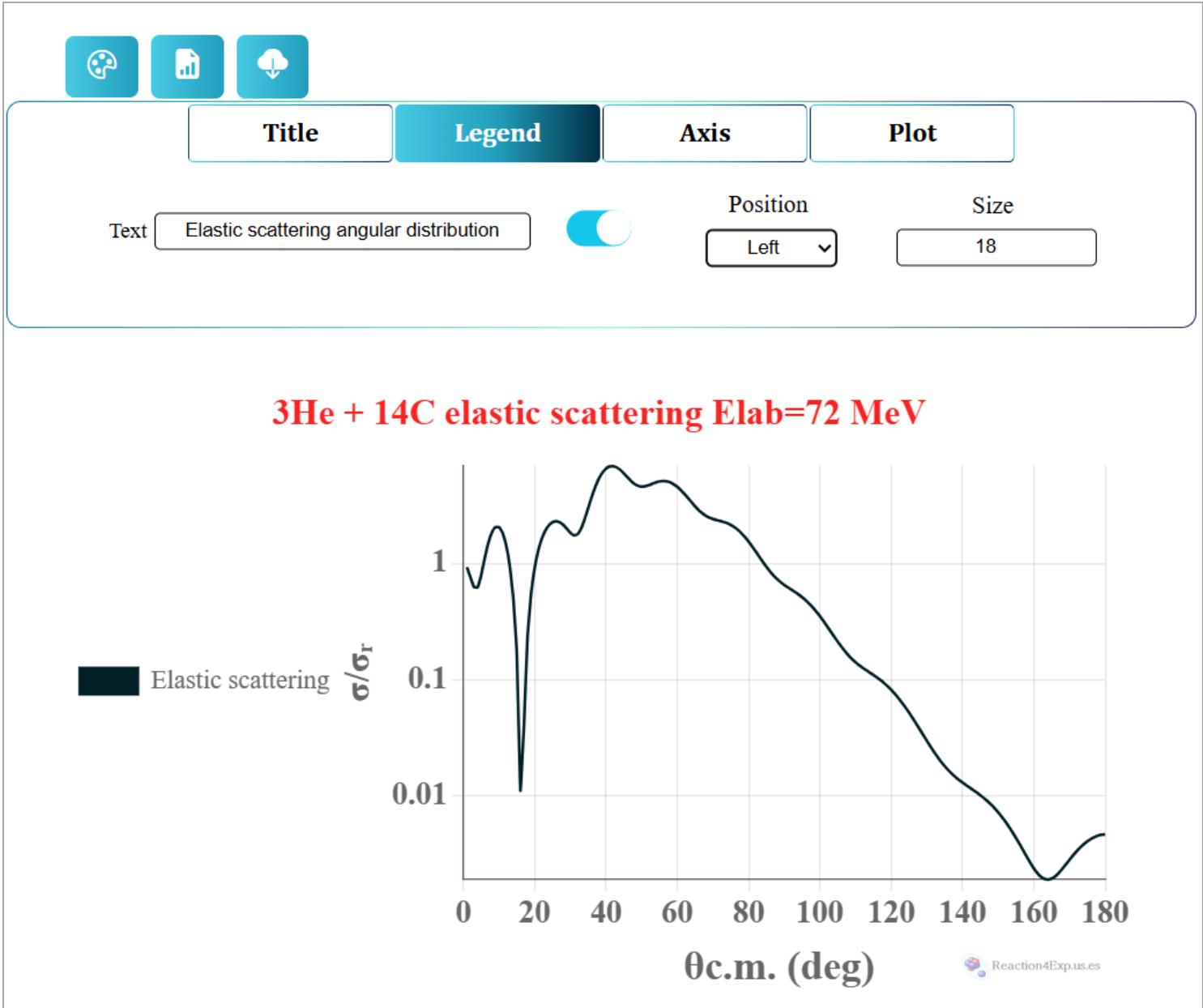


Customize plot appearance



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.



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



Logarithmic X

Y axis:

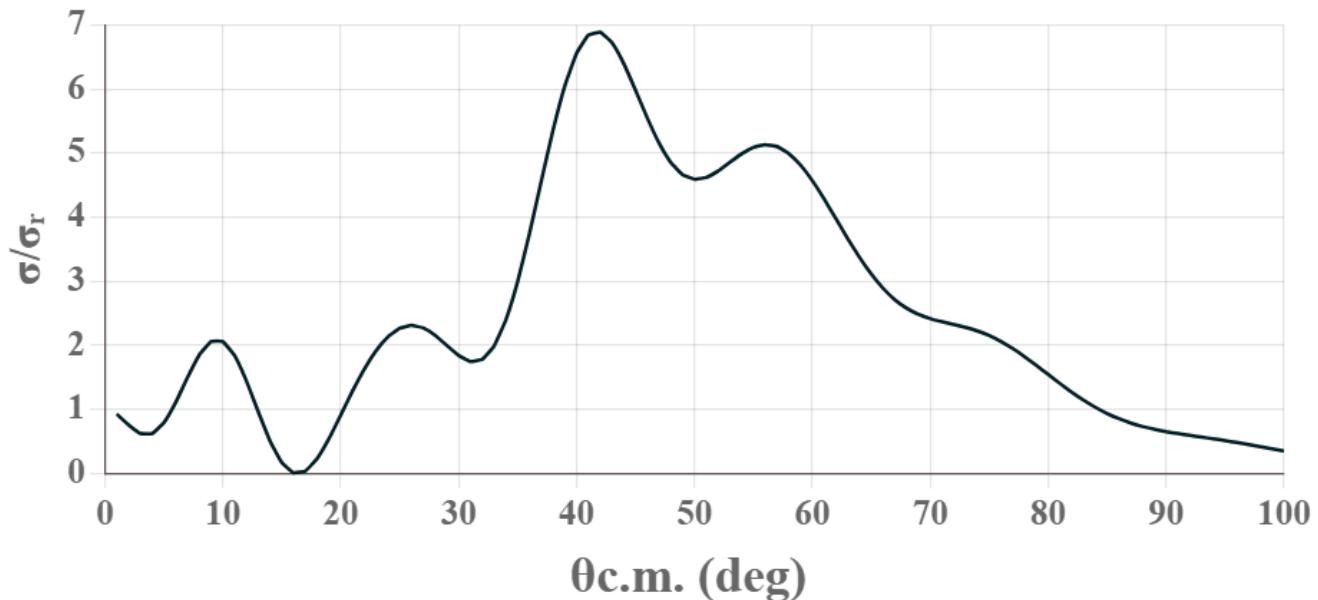
0,00

7



Logarithmic Y

3He + 14C elastic scattering Elab=72 MeV

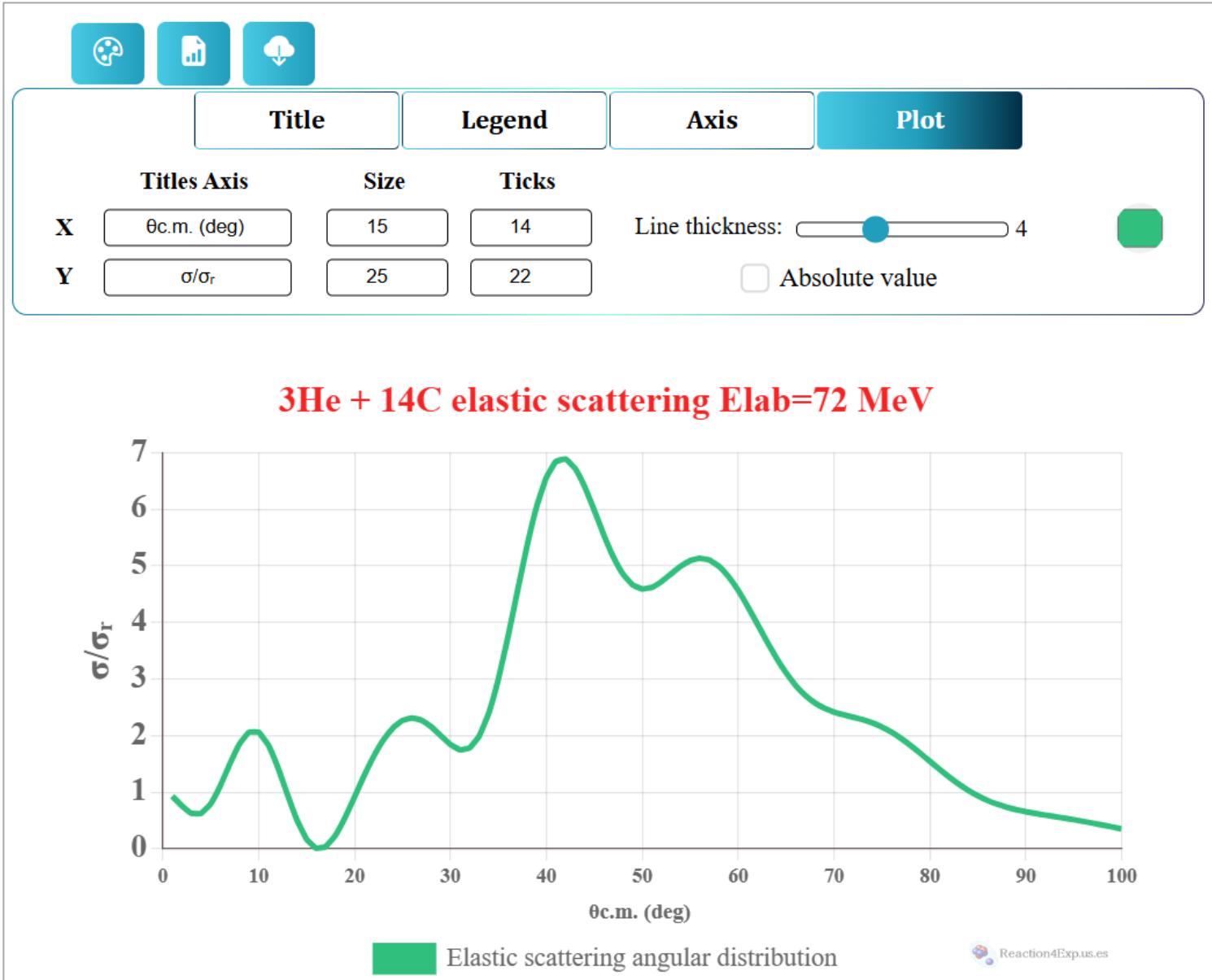


Elastic scattering angular distribution

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.



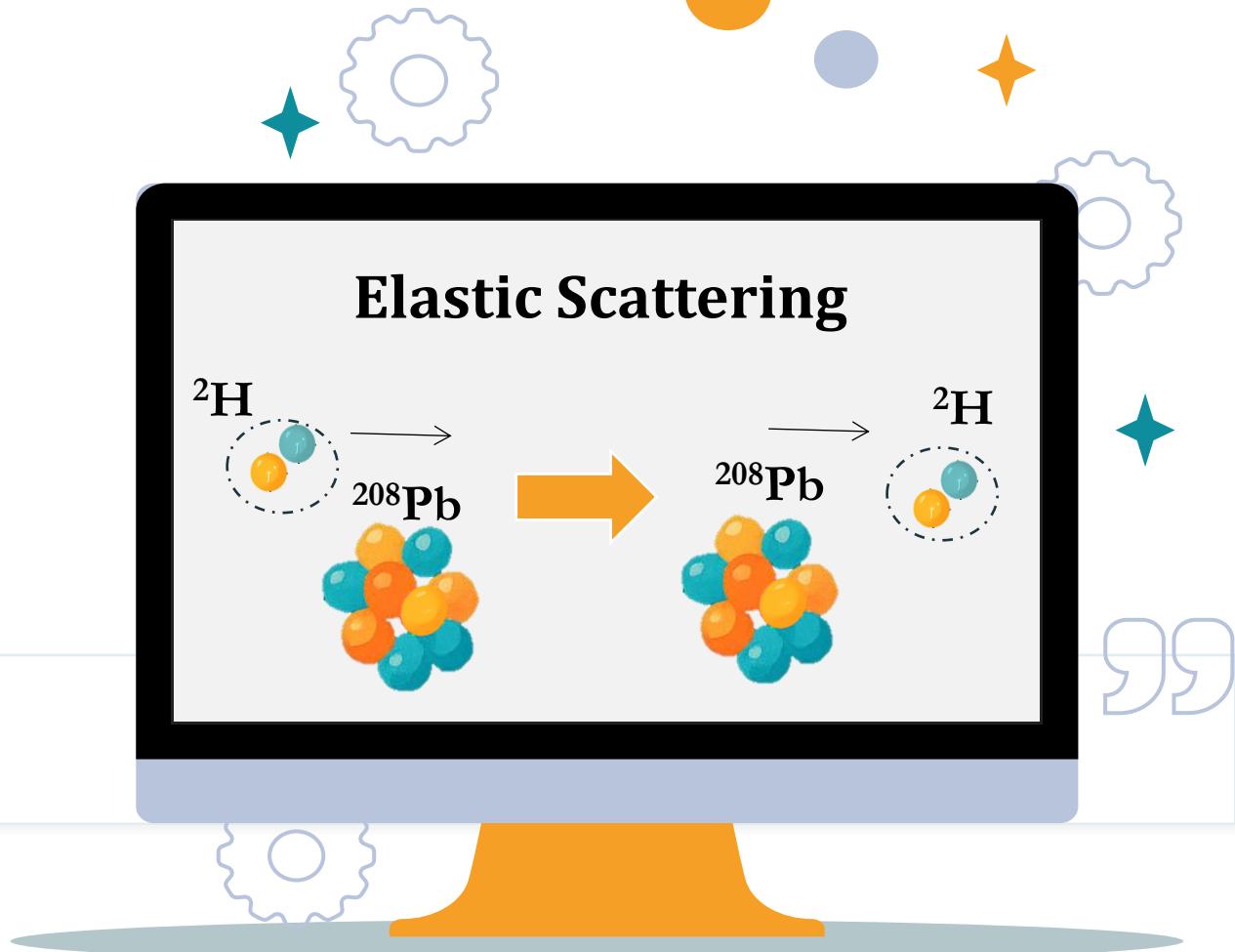
Customize plot appearance

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



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CARLA TATIANA MUÑOZ CHIMBO ↗

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ELASTIC SCATTERING

Optical Model

Classical Model

Reaction

Potentials

Integration Parameters

Nucleus

A

J

Parity

Projectile

Select ▾

+1 ▾

Target

Select ▾

+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

ELASTIC SCATTERING

Optical Model Classical Model

Reaction Potentials Integration Parameters

	Nucleus	A	J	Parity
Projectile	He	3	0	+1
Target	C	14	0	+1
	Lab	CM		
E (MeV)	72	59,294		

Potentials

Optical Model Classical Model

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

Generate potential

Coulomb potential

r_c (fm) Switch off Coulomb

Nuclear potential

Type	Shape	$V_0(\text{MeV})$	$r_0(\text{fm})$	$a_0(\text{fm})$	$W_0(\text{MeV})$	$r_1(\text{fm})$	$a_1(\text{fm})$
Volume. centr	Woods-Saxo	150	0,3	0.86	3.8	1,66	0,469

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

(i) 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
³ He	CGP08	PHYS.REV.C79,024615(2009)	0	20-82	40-209	30-217
⁴ He	Nolte	PRC 36(1987)1312	0	6-40	12-90	80
	Avrigeanu	Phys. Rev. C49,2136 (1994)	0	8-96	16-250	1-73
⁶ Li	Cook	Nucl.Phys.A388 (1982),153	0	12-82	24-208	13-156
⁷ Li	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>

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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**

Theoretical Experimental

Projectile: Select Mass: Density: Theoretical Experimental

Target: Select Mass: Density: Theoretical Experimental

Lab CM

E (MeV): MeV MeV

Parameters

Rmax: 25 Steps: 0,01 Lmax: 50

Escalar factor for real and imaginary part

N_R: 1 N_I: 1

Select potential: **SPP2** **BNP**

Advanced options

ELSEVIER COMPUTER PHYSICS COMMUNICATIONS

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>

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

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

Volume, cent Read Com

Elegir archivo No se ha seleccionado ningún archivo

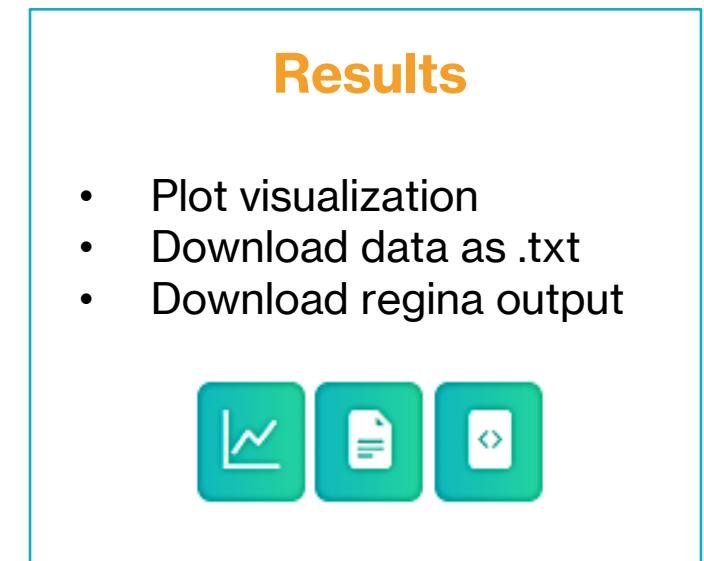


Density
Theoretical Experimental
 ${}^3\text{He}$ No data available 
 ${}^{14}\text{C}$  No data available

Parameters
Rmax 25 Steps 0,05 Lmax 50
Escalar factor for real and imaginary part
N_R 1 N_I 1
Select potential: **SPP2** **BNP**

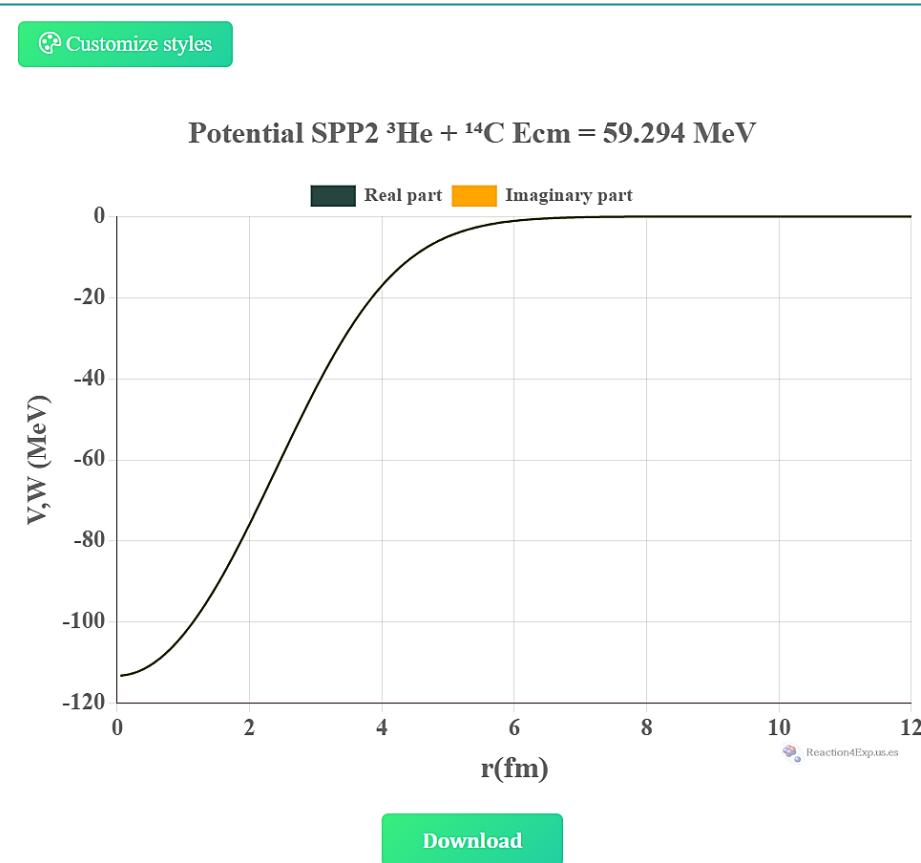
Advanced options

Generate and upload 





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	
-0.1042205E+03	-0.1042205E+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	re
0.00	0.2659E+00	0.8078E-01	0.1391E+00	0.2064E+00	0.8820E-01	0.984

External potential

Nuclear potential

Type

Shape

V_0 (MeV)

r_0 (fm)

a_0 (fm)

W_0 (MeV)

r_i (fm)

a_i (fm)

Volume, central potent ▾

Read Complex ▾

Elegir archivo

No se ha selecci...o ningún archivo



SPP2

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 $r=RFIRST$.

Optical Model Results

Optical Model Calculation By FRESCO

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

[Save input file](#) [Save output file](#)

OM Elastic scattering angular distribution (FORT.201) [Plot](#) [Data](#)

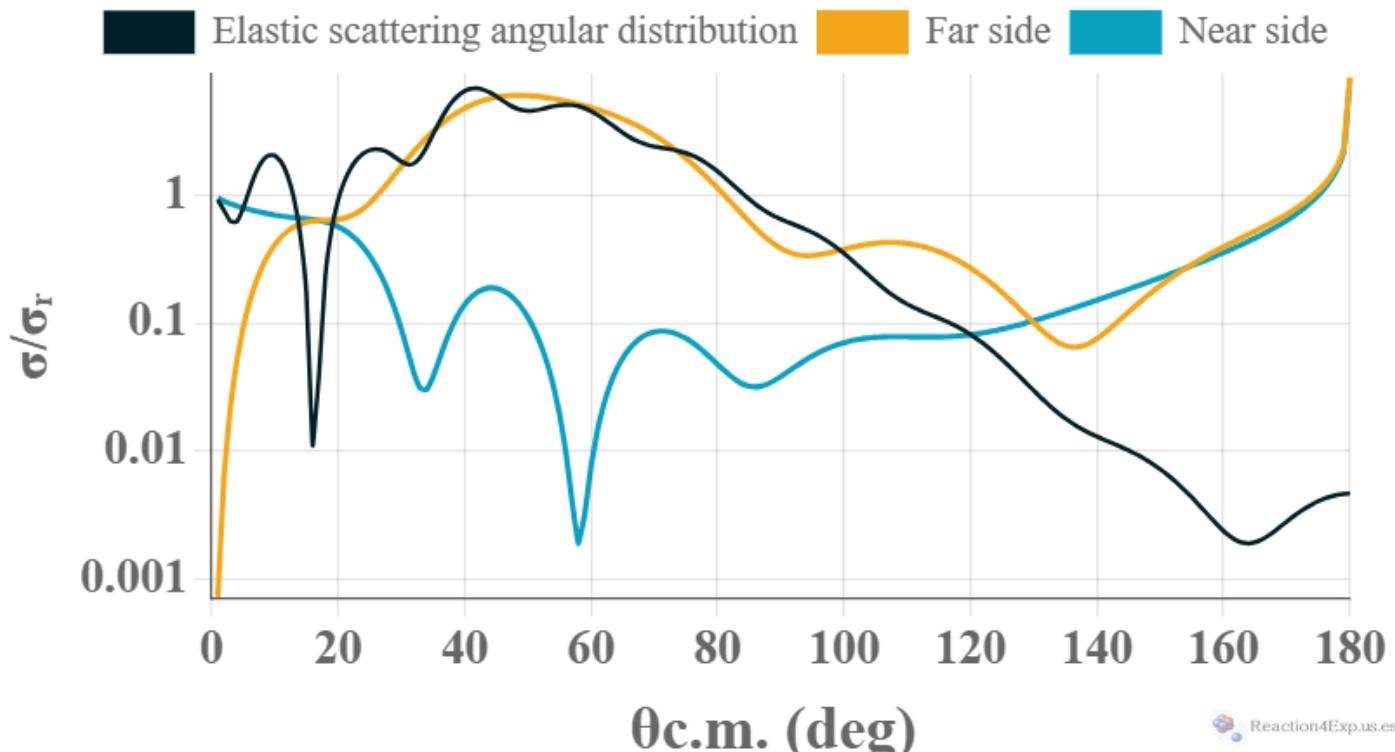
Fusion(absorption), reaction and inelastic cross section (FORT.56) [Plot](#) [Data](#)

Potentials (FORT.34) [Plot](#) [Data](#)

Elastic S-matrix (FORT.7) [Plot](#) [Data](#)

- 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 Elab=72 MeV



Show/Quit Farside

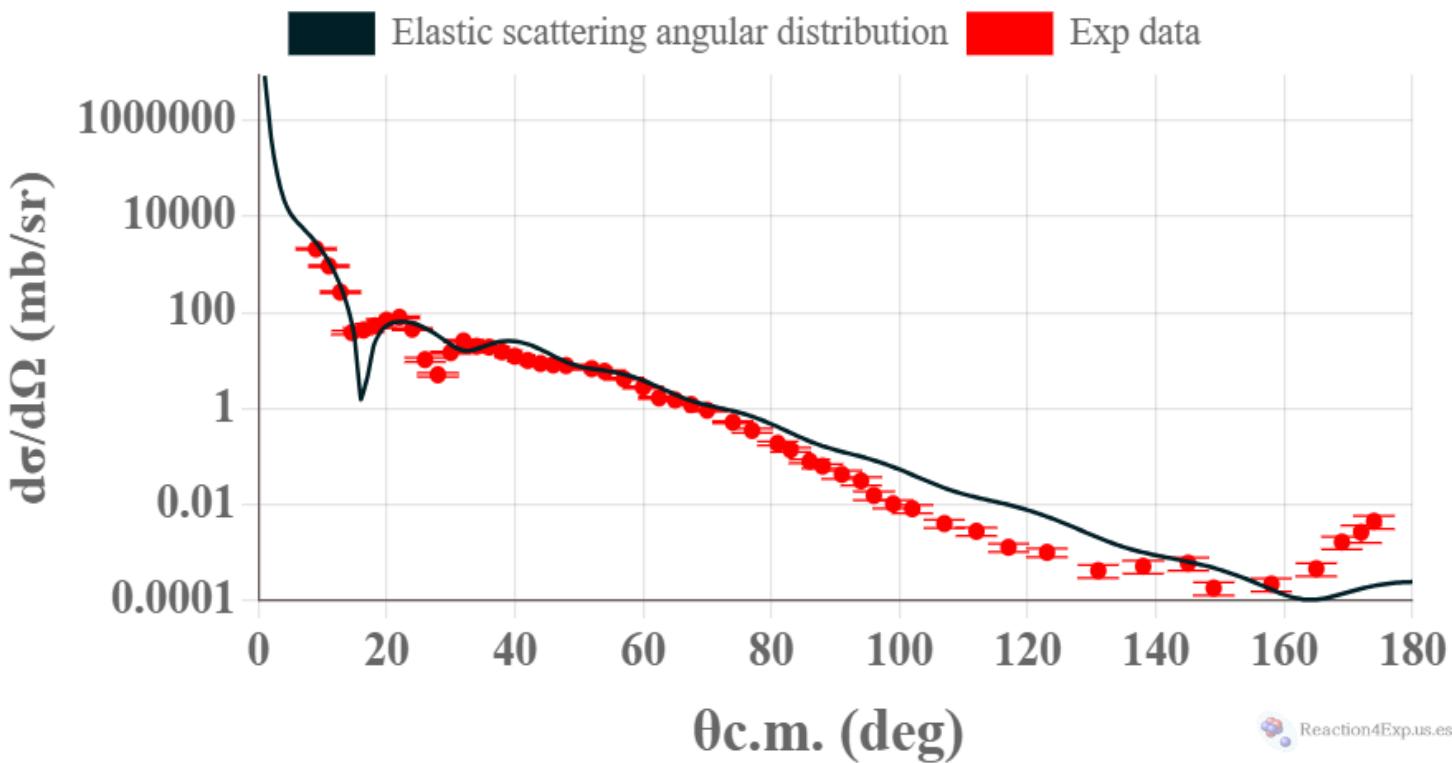
Show/Quit Nearside

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)

Optical Model Results

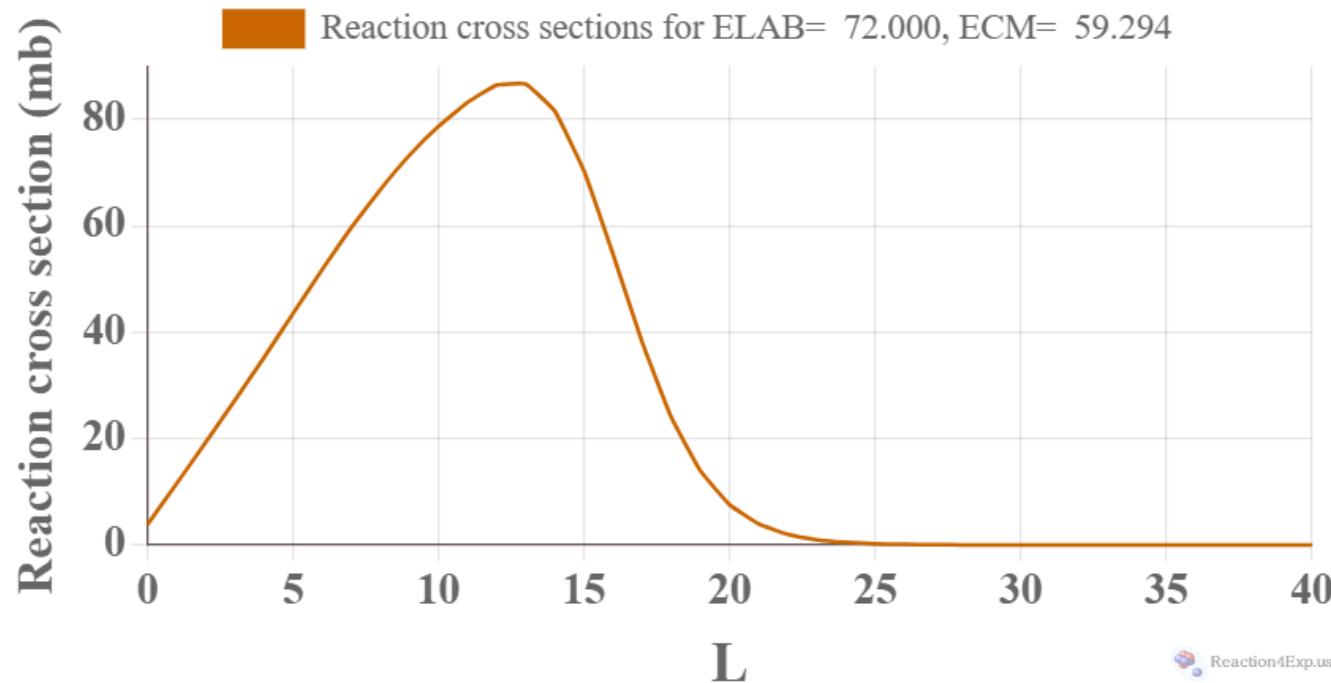
$^3\text{He} + ^{14}\text{C}$ elastic scattering Elab=72 MeV



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

Optical Model Results

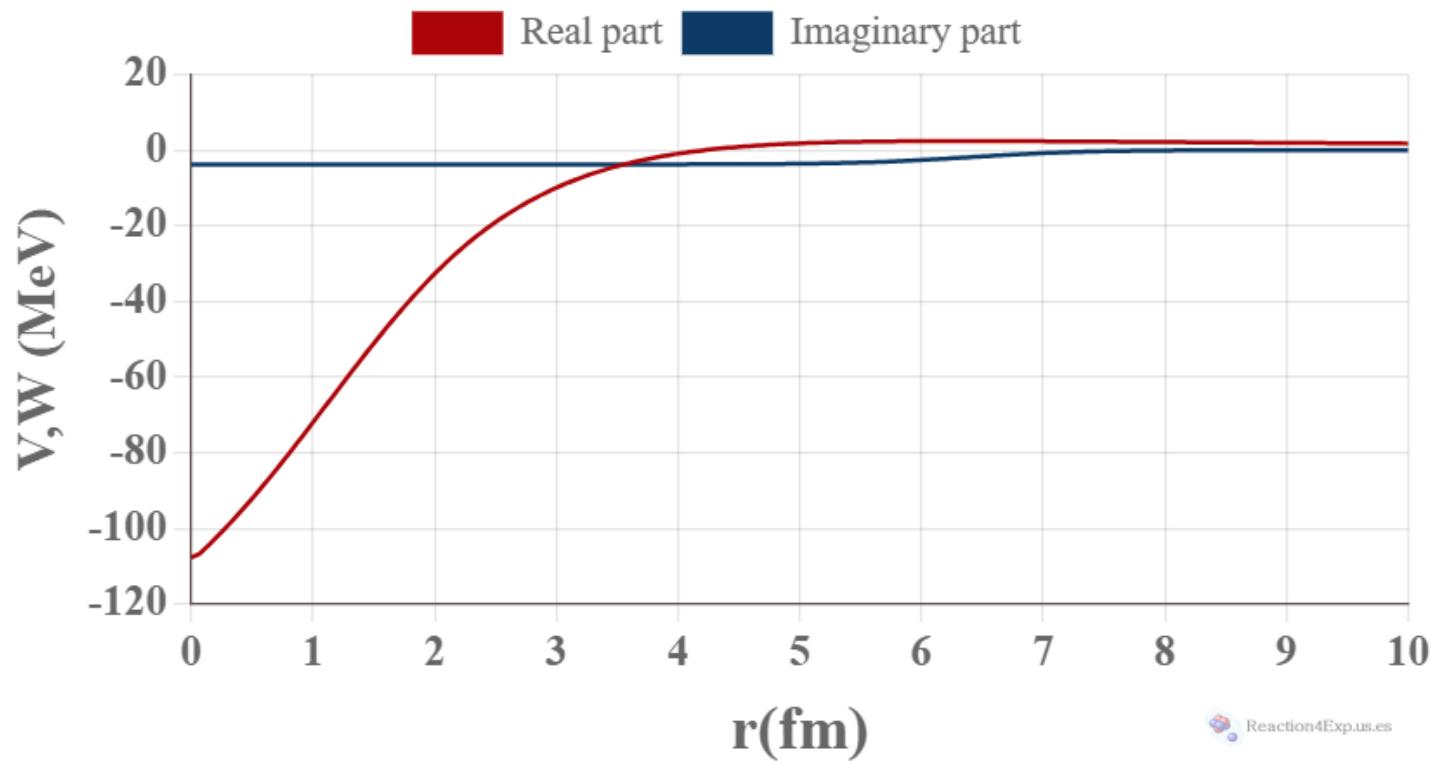
Reaction cross sections for ELAB= 72.000, ECM= 59.294



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

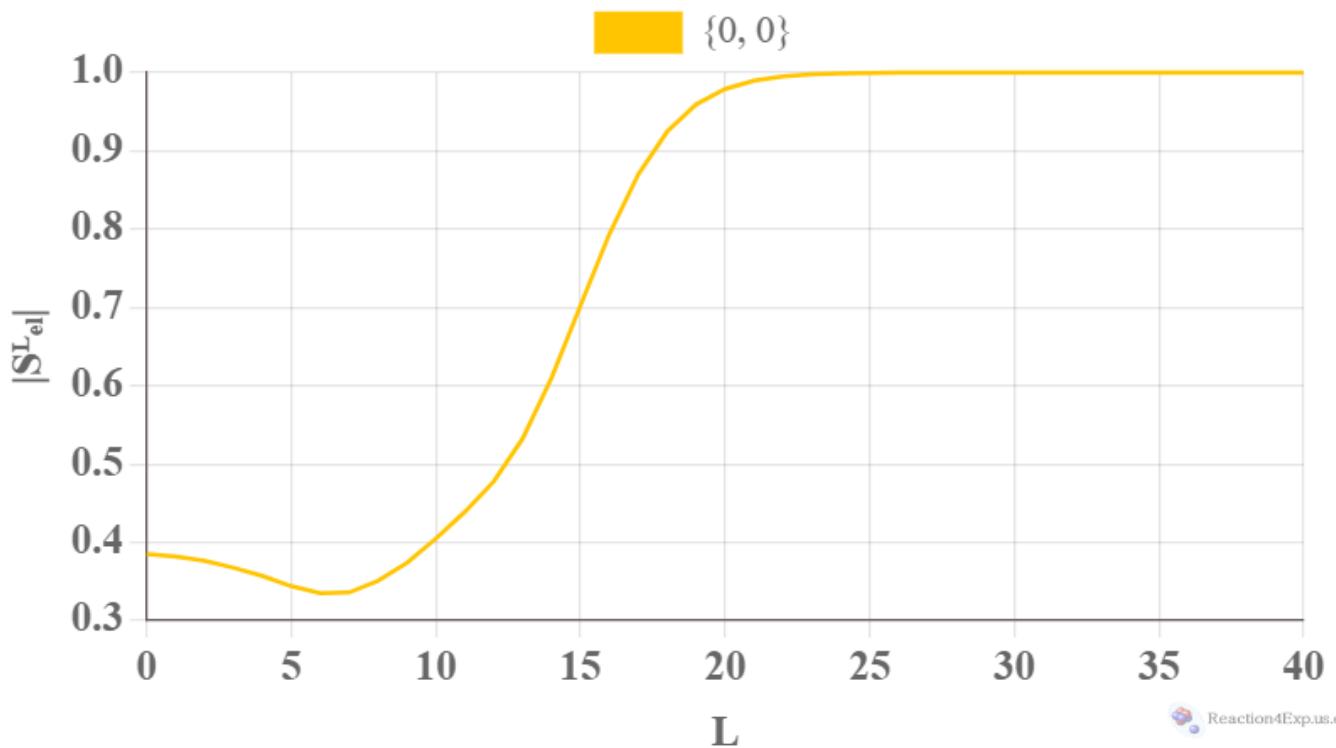
Optical Model Results

Optical Potential



Optical Model Results

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



- 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 Model Classical Model

Reaction Potentials

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

Lab CM

E (MeV) 72 59,294

Potentials

Reaction Potentials

A_p and A_t for radii conversion

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

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

Generate potential

Coulomb potential

r_c (fm) 0,65 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)
Volume, c	Woods-Saxon	150	0,3	0,86	3,8	1,66	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, Elab= 72 MeV

Save input file

Turning points

Plot

Data

Deflection function

Plot

Data

Survival probability

Plot

Data

Trajectories

B min: 0,10

B max: 15,50

154 plots

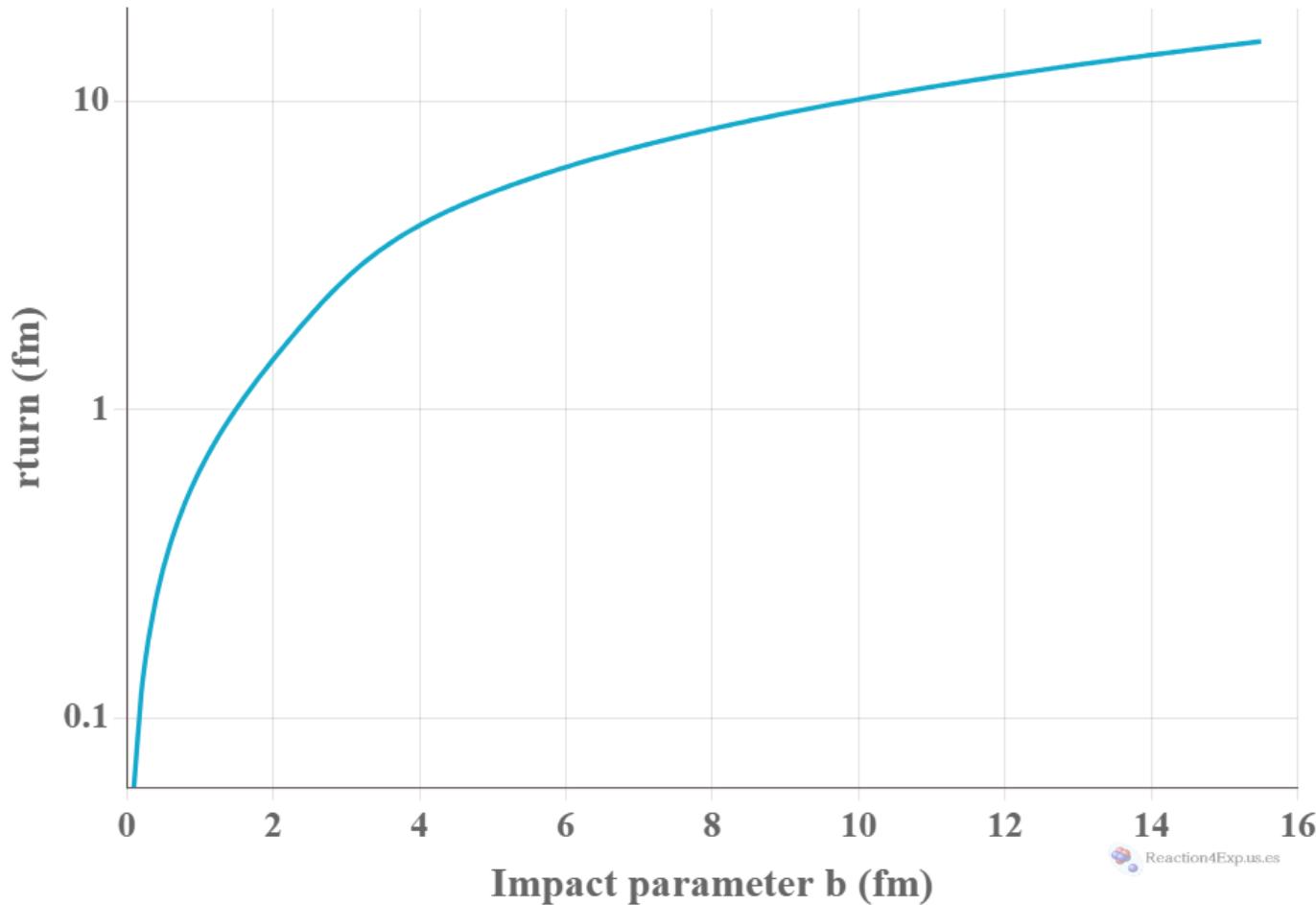
Plot

Data

Classical Results

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

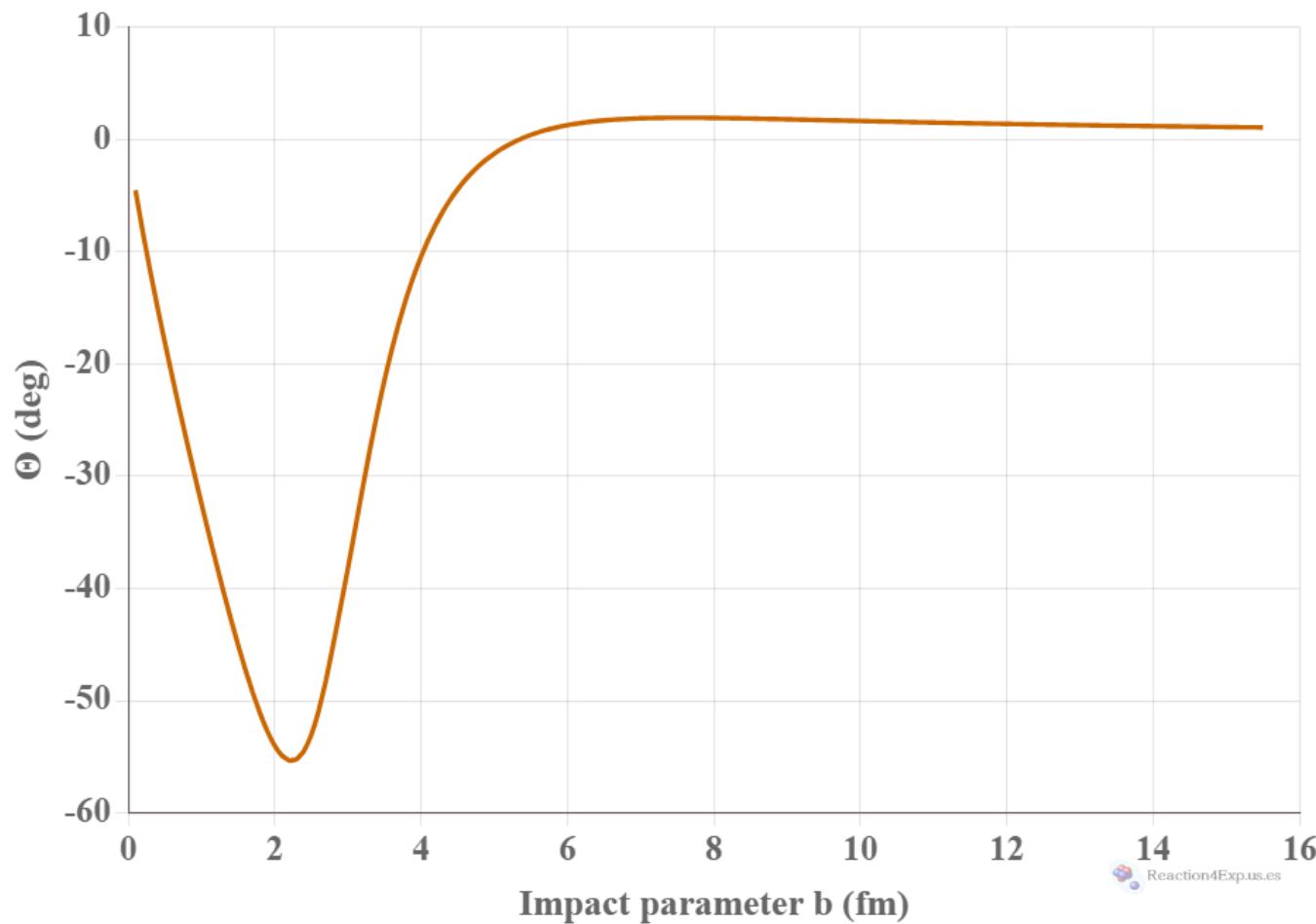
Turning points for ${}^3\text{He} + {}^{14}\text{C}$ at 72MeV



Classical Results

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

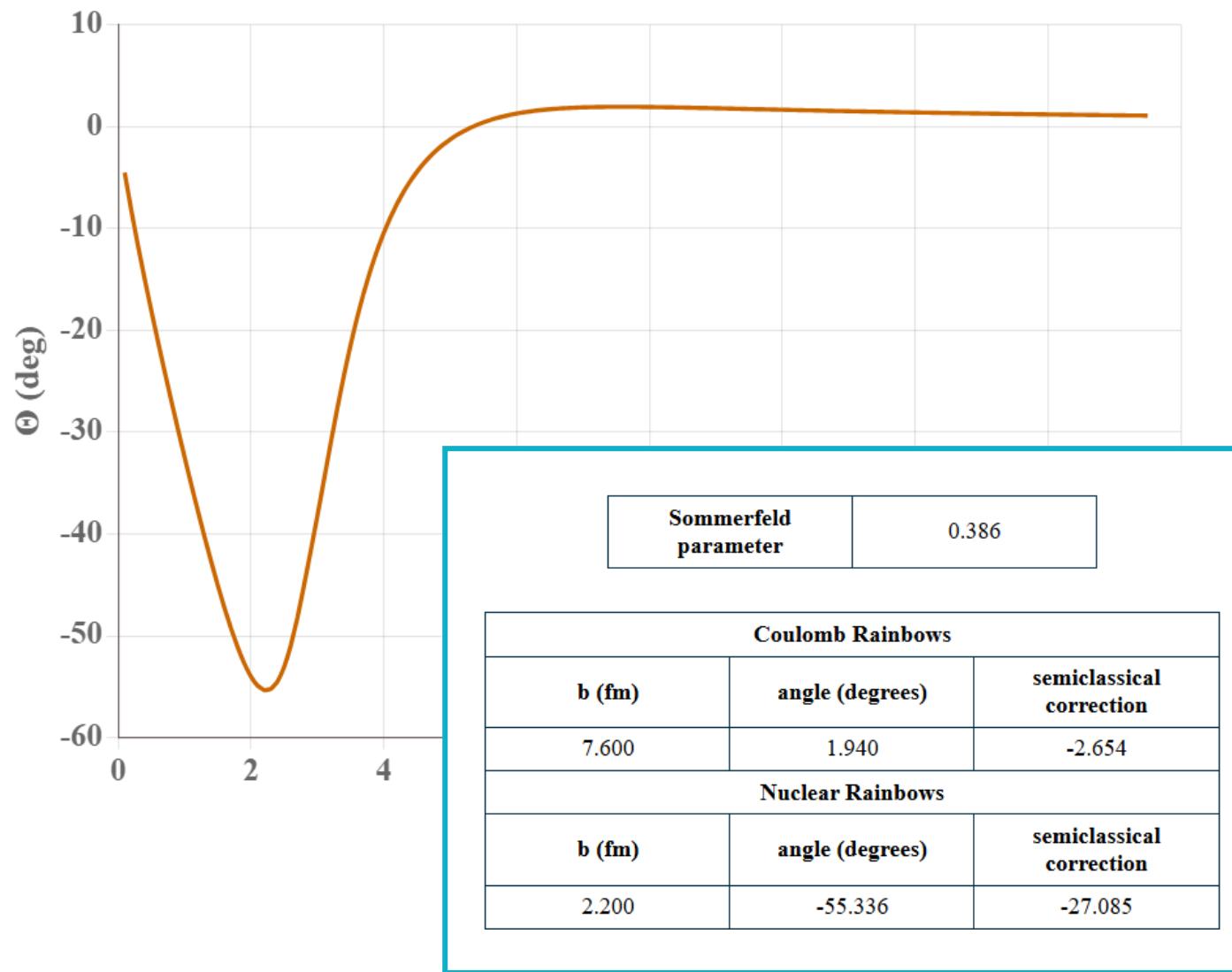
Deflection function for ${}^3\text{He} + {}^{14}\text{C}$ at 72MeV



Classical Results

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

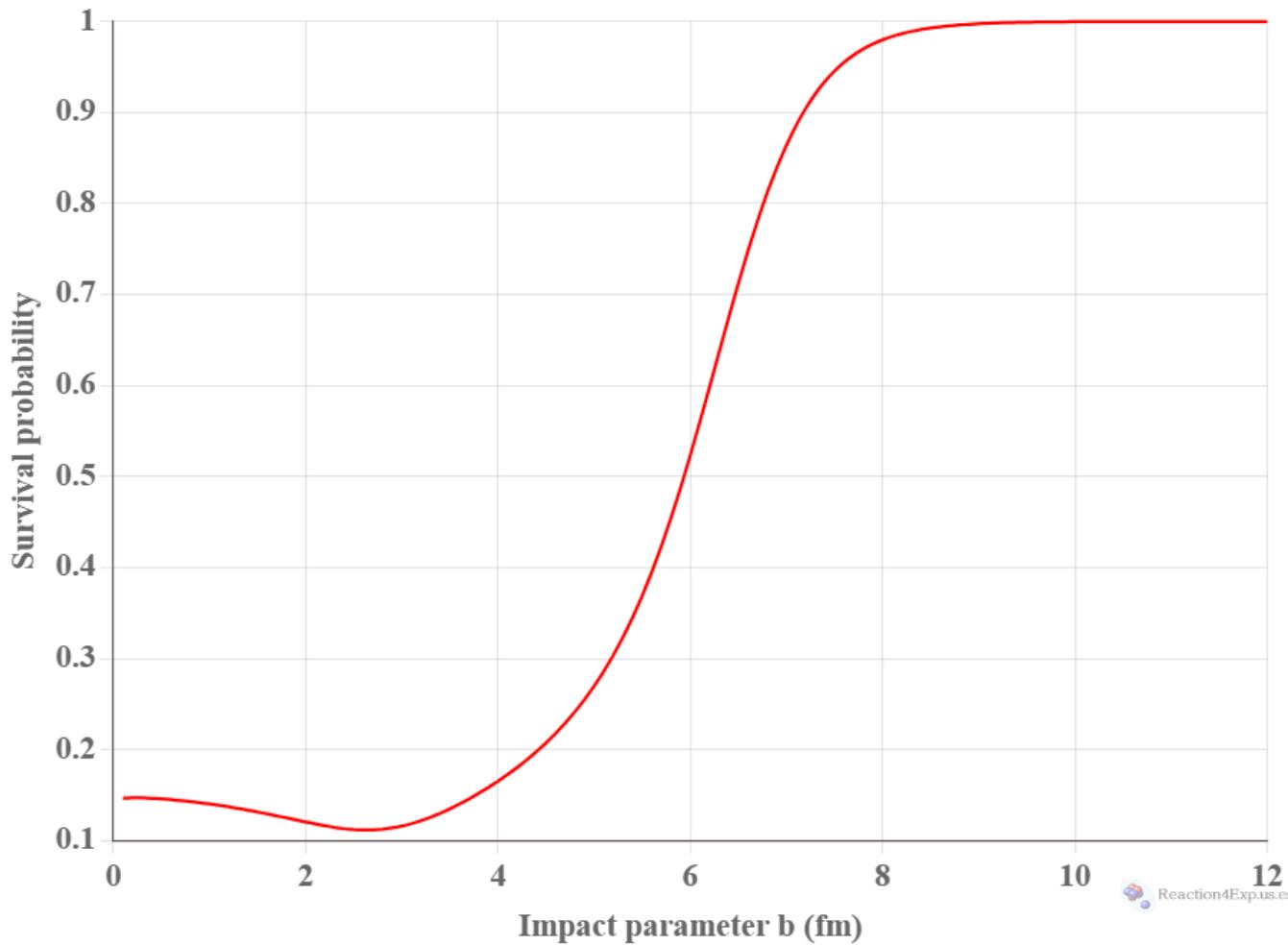
Deflection function for ${}^3\text{He} + {}^{14}\text{C}$ at 72MeV



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

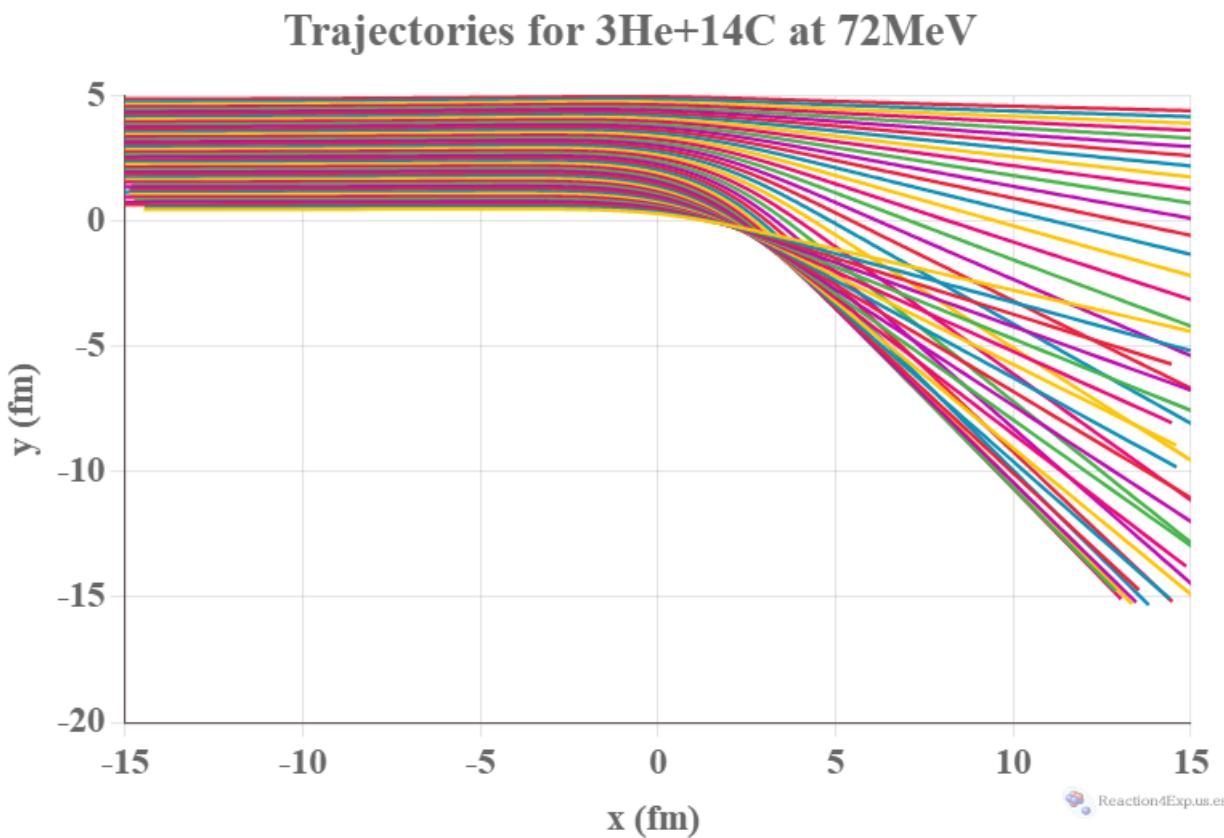
Impact Parameter

b min 0,5

b max 5

Plot

Classical Results



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

Rotational model for Inelastic scattering

Deformations





Rotational Model For Inelastic Scattering - Coupled Channels And DWBA

Reaction

Potentials

Integration Parameters

Projectile

Nucleus

A

Select ▾

Target

Nucleus

A

Select ▾

Spin

Parity

E(MeV)

Spin

Parity

E(MeV)

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

Inelastic scattering

$^{64}\text{Zn}(^{16}\text{O}, ^{16}\text{O})^{64}\text{Zn}^*(2^+)$ 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		
Nucleus	A	Target
O	16	Zn
Spin	Parity	E(MeV)
0	+1	0
Elab (MeV) 44		
Select the calculation model: CC DWBA		

Inelastic scattering: coupling potential

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

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

- **Nuclear excitation** -> deformation lengths

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

Rotor model

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

Inelastic scattering

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

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	<input type="text"/>	A_t					
In most nucleon-nucleus reactions, a_p in the radius conversion formula is typically zero. In nucleus-nucleus reactions, a_p and a_t represents the mass numbers (A) of the involved elements.							
Generate potential							
Coulomb potential							
r_c	<input type="text" value="1.2"/>	Deformation					
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, ϵ	Woods-Saxon	<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							

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

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 $e \cdot fm^k$

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

- 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 $E_{\text{lab}} = 44 \text{ MeV}$

Coulomb potential

r_c	1,25	Deformation	
Deformation	M_2	M_3	M_4
Projectile	0	0	0
Target	40,98	0	0

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	0	0	0
Target	1,25	0,411	0

Real + img deformation separately

+ There is one deformation for all nuclear potentials.

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

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 $e \cdot fm^k$

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

- 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) <input type="text" value="0.04"/>	matching radius <input type="text" value="50"/>
Total angular momentum:	min <input type="text" value="0"/>	max <input type="text" value="300"/>
Angular range (degrees):	min <input type="text" value="0"/>	max <input type="text" value="180"/> step <input type="text" value="0.1"/>
Integration parameters		
<ul style="list-style-type: none">• 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 $R > \text{RMATCH}$ asymptotic behaviour is assumed)		
CALCULATE		

Coupled Channels Calculation - FRESCO

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

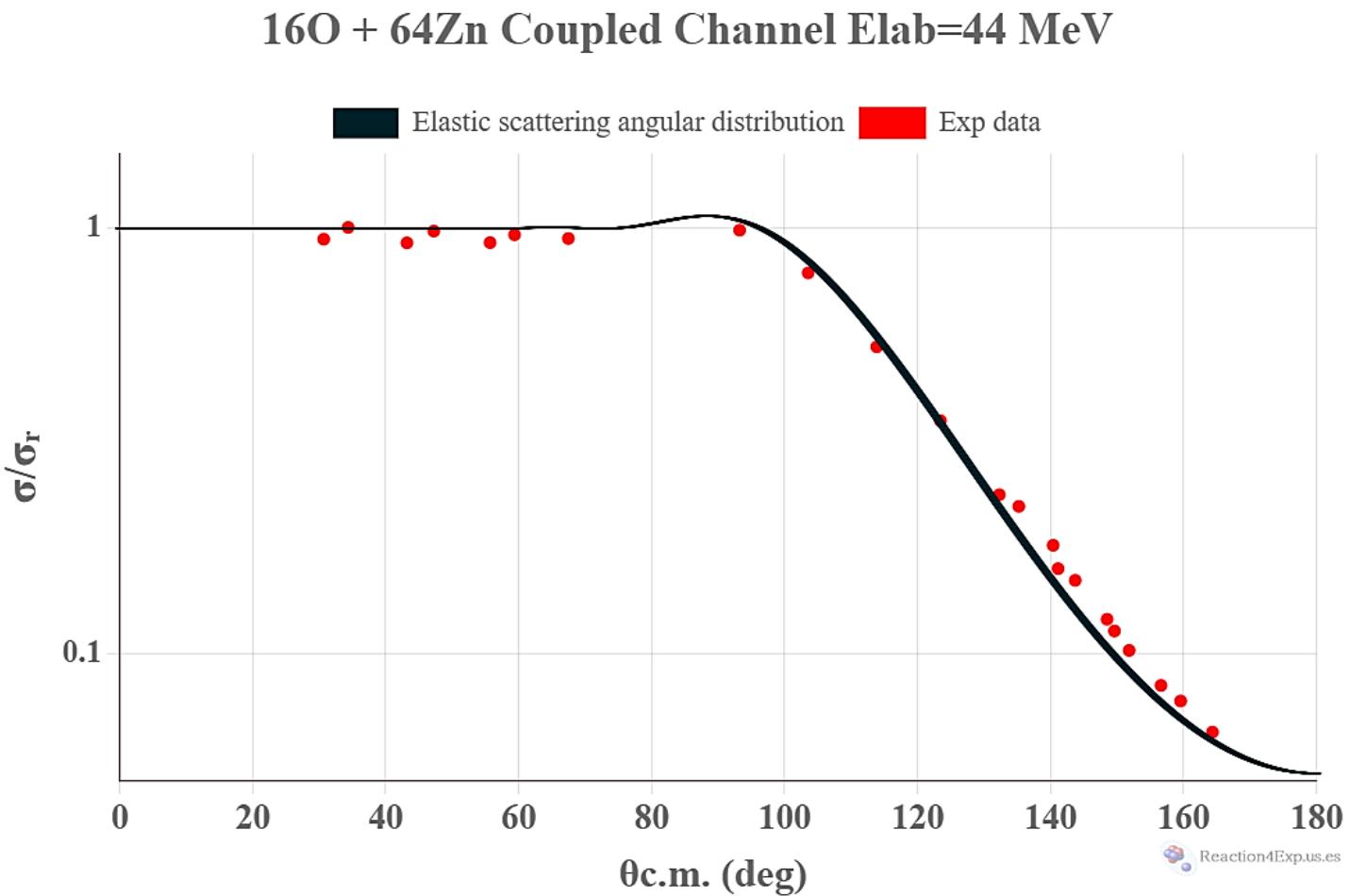
Total cross section for all states (FORT.13)

Table

Rotational model for Inelastic scattering Results

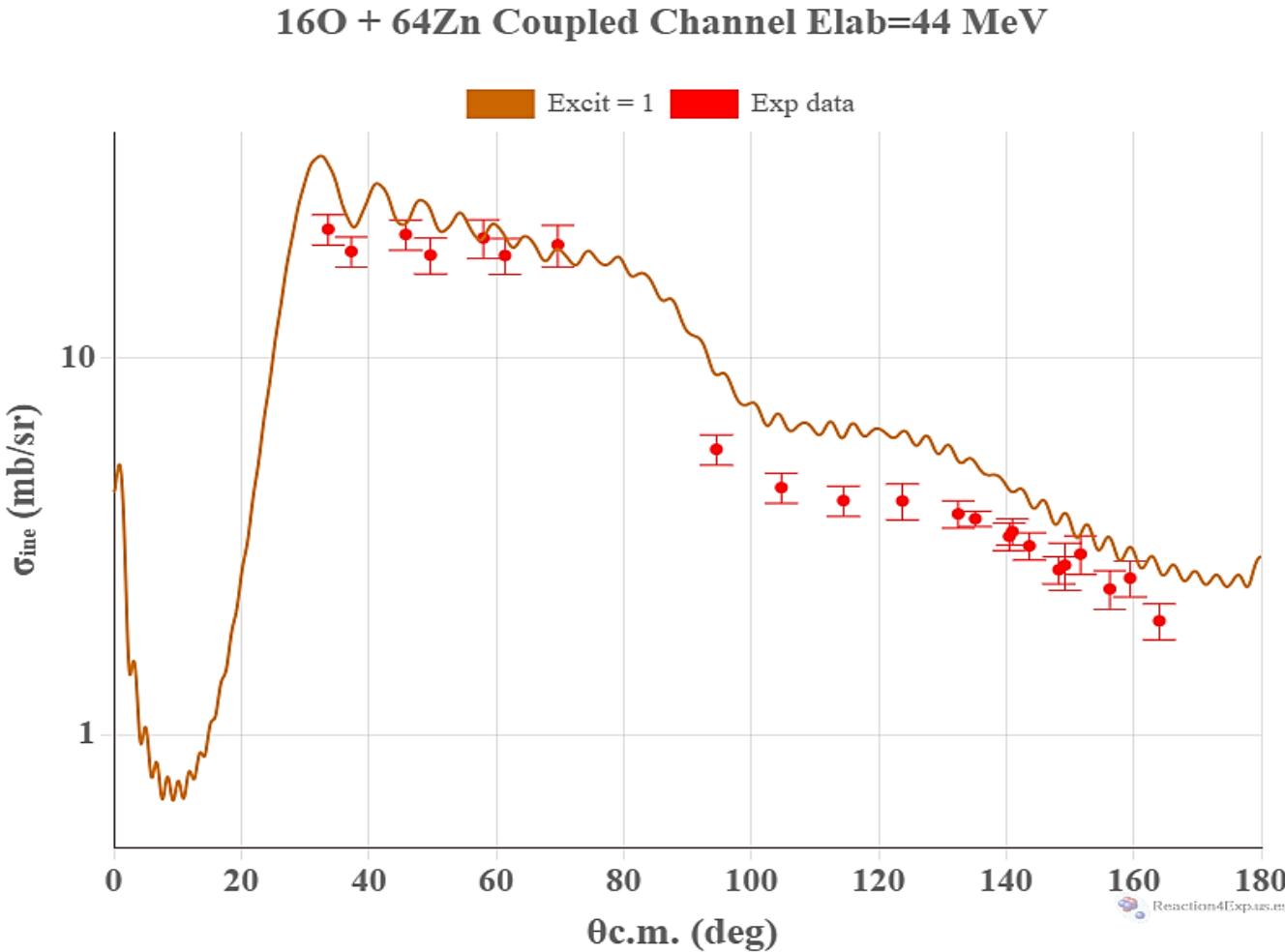
- OM elastic scattering angular distribution (fort.201)
- Inelastic scattering angular distribution (fort.16)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)

Rotational model for Inelastic scattering Results



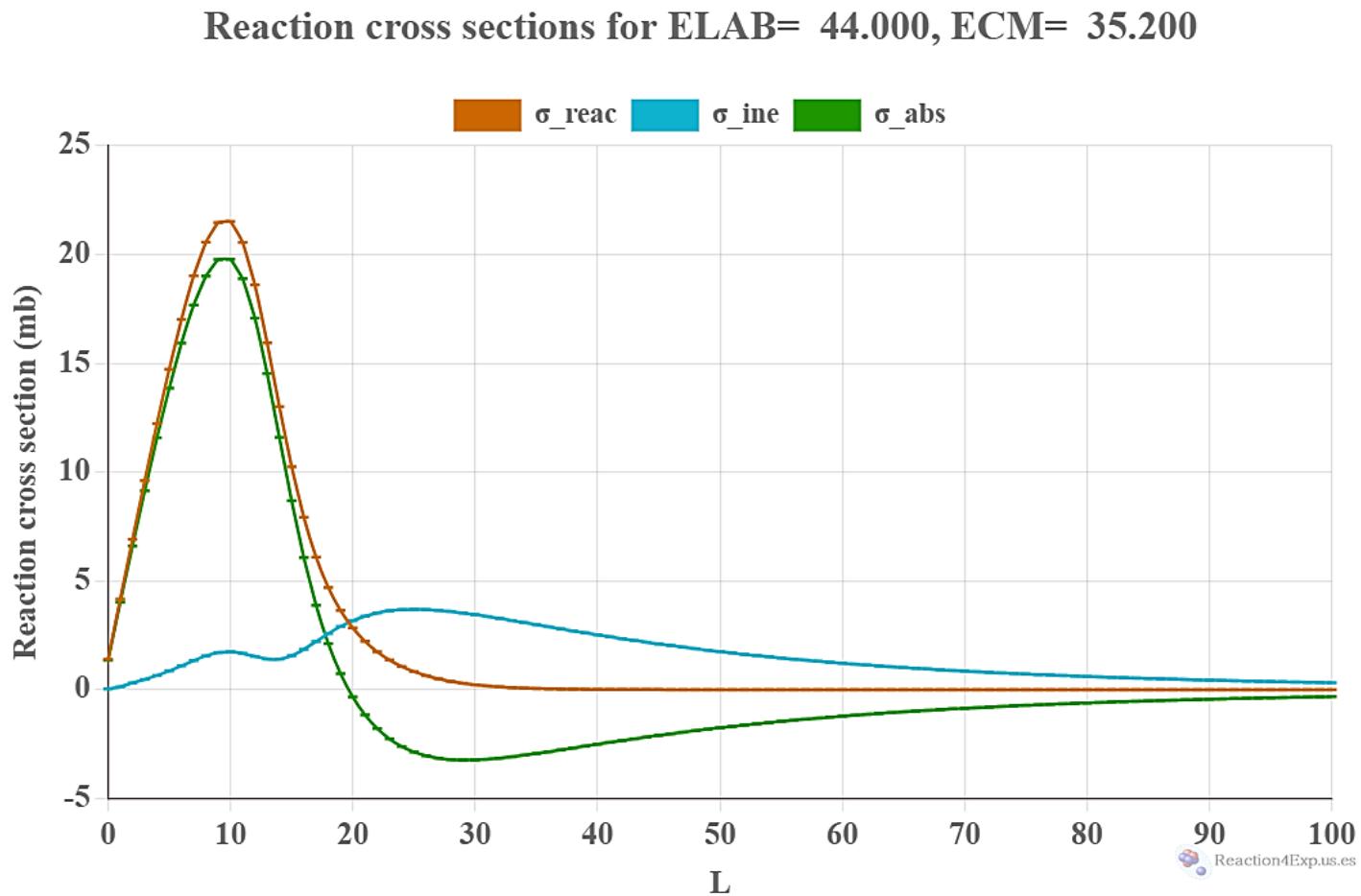
- OM elastic scattering angular distribution (fort.201)
- Inelastic scattering angular distribution (fort.16)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)

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)

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, Elab= 44 MeV

Reaction cross section (mb)	262.16
Absorbtion 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

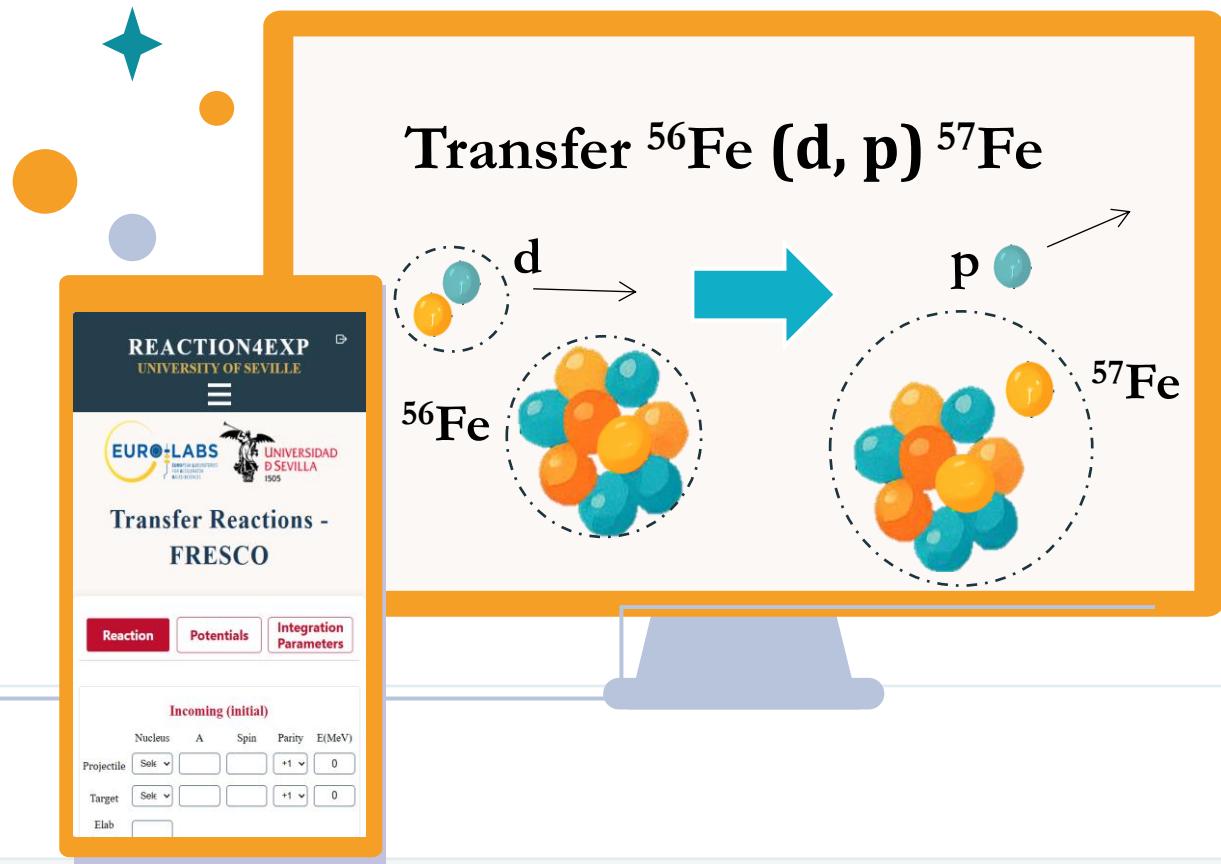
Rotational model for Inelastic scattering Results

- 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)**

4

Transfer Reactions DWBA

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 ▾	0
Target	Select ▾	<input type="text"/>	<input type="text"/>	+1 ▾	0

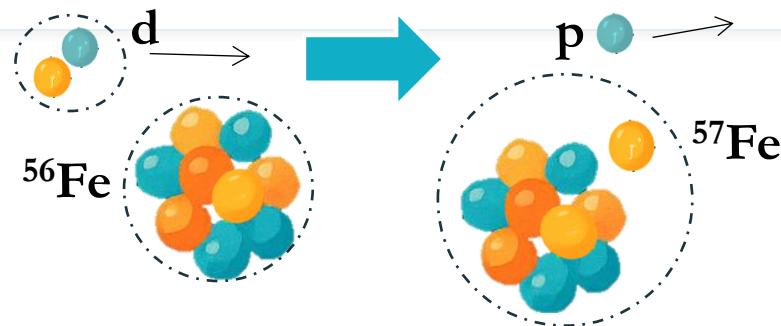
Outgoing (final)

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

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

Initial and final partition

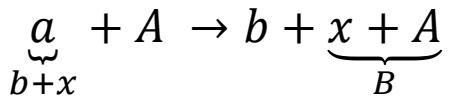
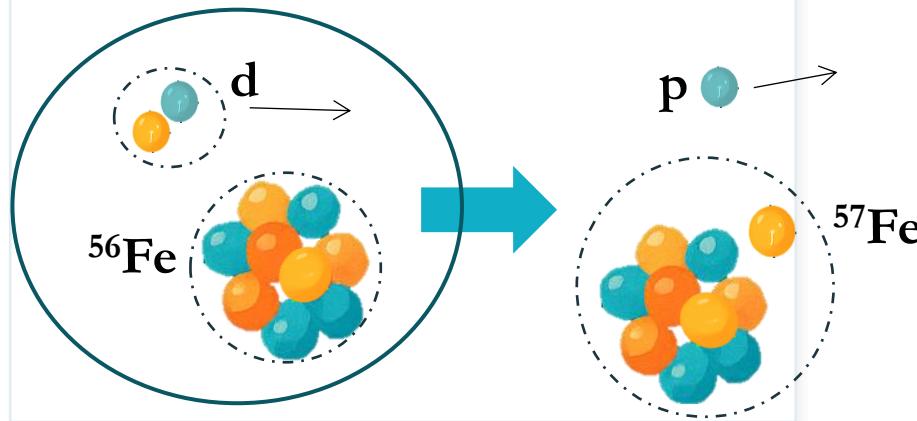
$^{56}\text{Fe} (\text{d}, \text{p}) ^{57}\text{Fe}$ at Elab = 12MeV



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					Aumatic calculation of Q-value	

Potentials

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



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

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

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

Radii conversion and Coulomb potential

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

A_p	<input type="text"/>
A_t	56
r_c	1,15

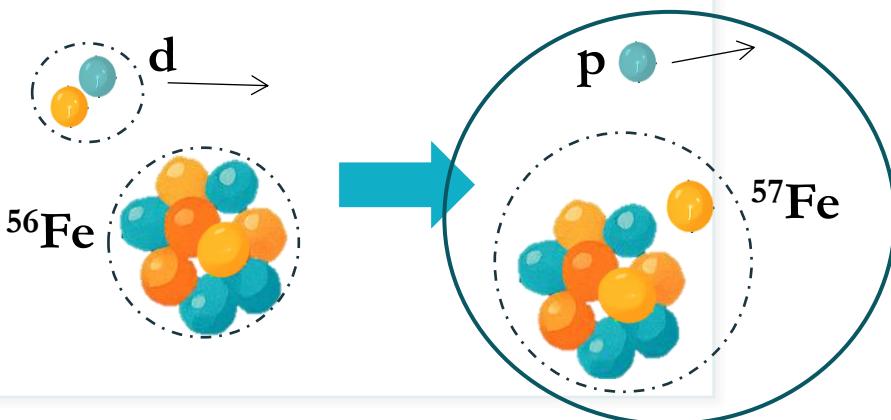
In most nucleon-nucleus reactions, a_p in the radius conversion formula is typically zero. In nucleus-nucleus reactions, a_p and a_t represents the mass numbers (A) of the involved elements.

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	90	1,15	0,81			
-	Surfac				21	1,34	0,68
+							

Potentials

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



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

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

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

p + ^{57}Fe

Radii conversion and Coulomb potential

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

A_p

A_t

r_c

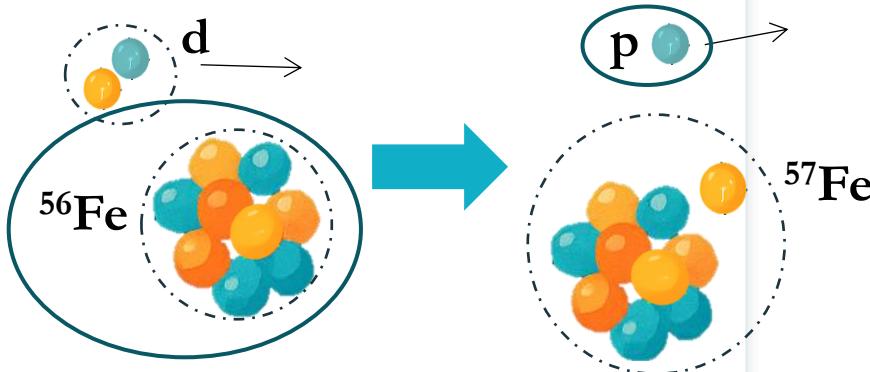
In most nucleon-nucleus reactions, a_p in the radius conversion formula is typically zero. In nucleus-nucleus reactions, a_p and a_t represents the mass numbers (A) of the involved elements.

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			
-	Surfac				11,5	1,25	0,47
+							

Potentials

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



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

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

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

p + ^{56}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

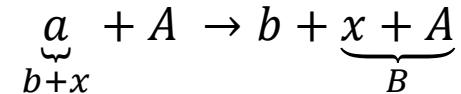
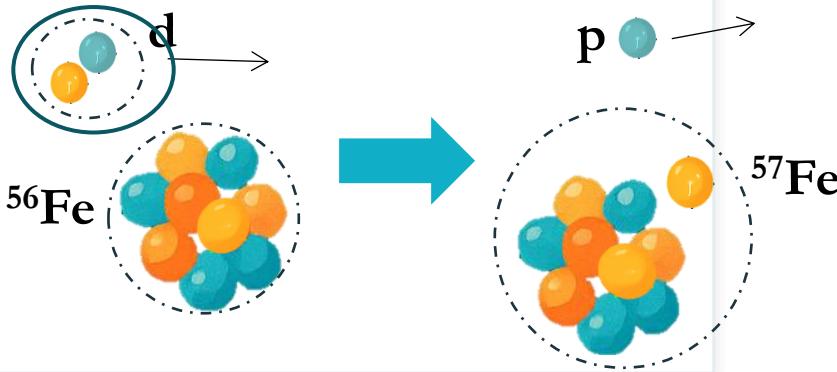
In most nucleon-nucleus reactions, *ap* in the radius conversion formula is typically zero. In nucleus-nucleus reactions, *ap* and *at* represents the mass numbers (A) of the involved elements.

Nuclear potential

Type	Shape	V ₀ (MeV)	r ₀ (fm)	a ₀ (fm)	W ₀ (MeV)	r _i (fm)	a _i (fm)
Volum	Woods	47,9	1,25	0,65			
-	Surfac				11,5	1,25	0,47

Potentials

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



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

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, ce1	Gaussian	72,15		1,484



Transferred particle bound state

n

$be (\text{MeV})$

l

a

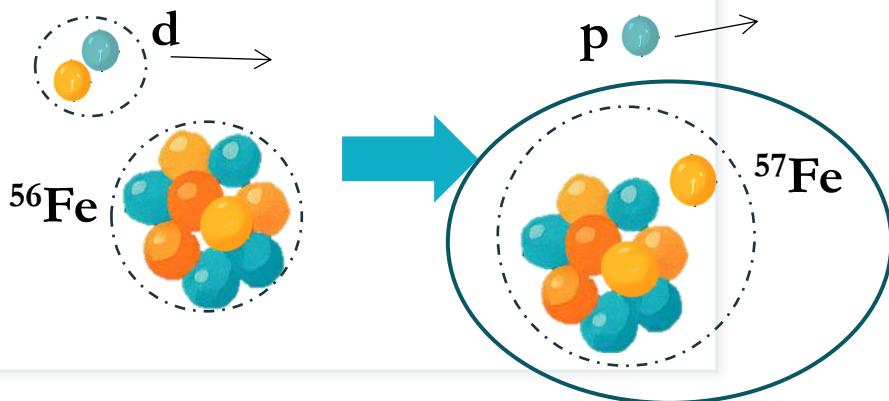
sn

j

Spectroscopic amplitude

Potentials

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



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

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

[Entrance Channel](#) [Exit Channel](#) [Core-Core](#) [Bound State: Entrance Channel](#) [Bound State: Exit Channel](#)

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

Radius conversion and Coulomb potential

A_p

A_t 56

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

r_c 1

In most nucleon-nucleus reactions, a_p in the radius conversion formula is typically zero. In nucleus-nucleus reactions, a_p and a_t 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, ce1	Woods-Sax	65	1,25	0,65

+

Transferred particle bound state

n 2

$be(\text{MeV})$ 7,646

l 1

a 0,9

sn 0,5

j 0,5

Spectroscopic amplitude

Integration parameters

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

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

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

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

Angular range (degrees): min max step

Select interaction:

POST

PRIOR

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

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

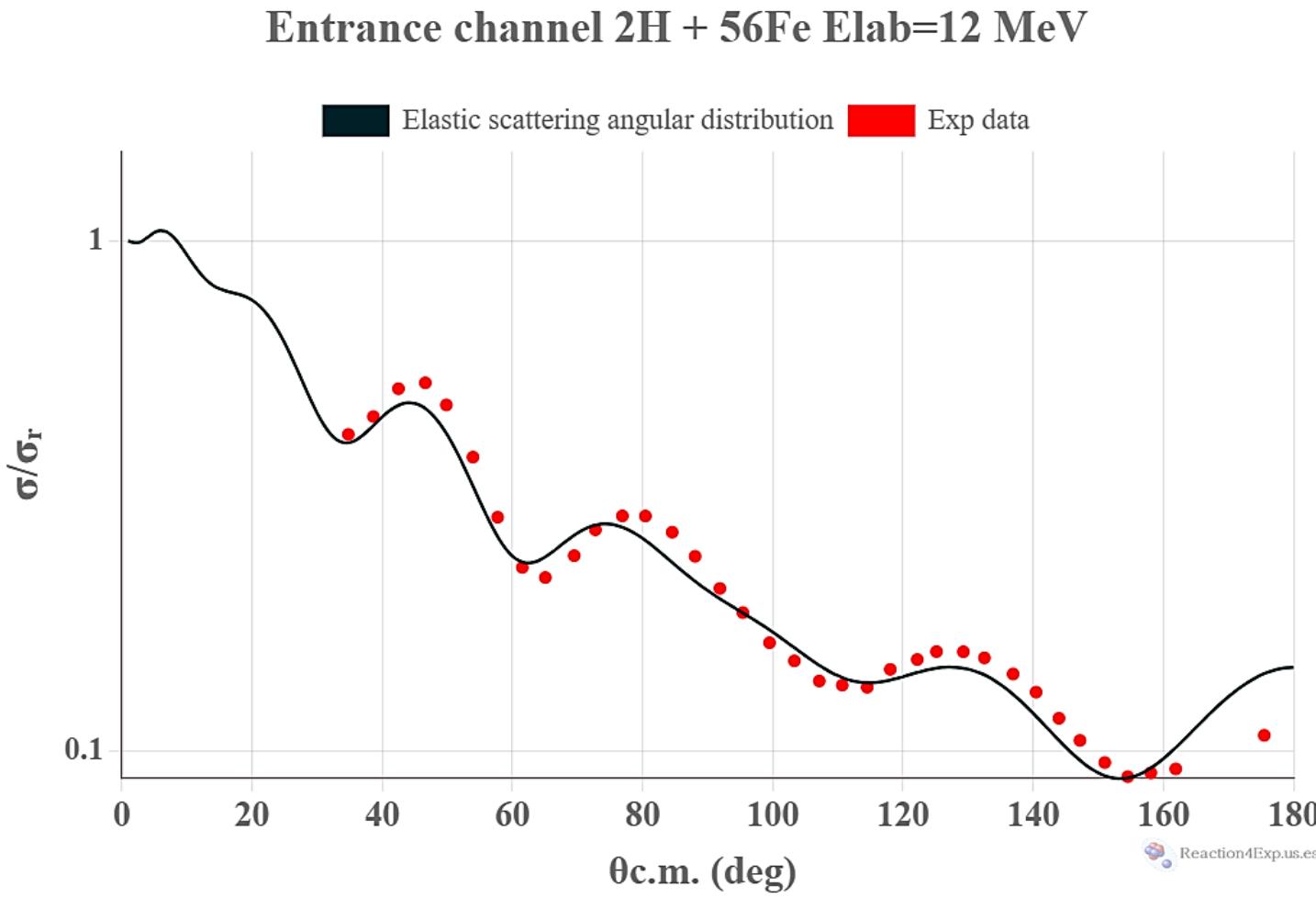
Transfer DWBA Results

- 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.

Transfer DWBA Results

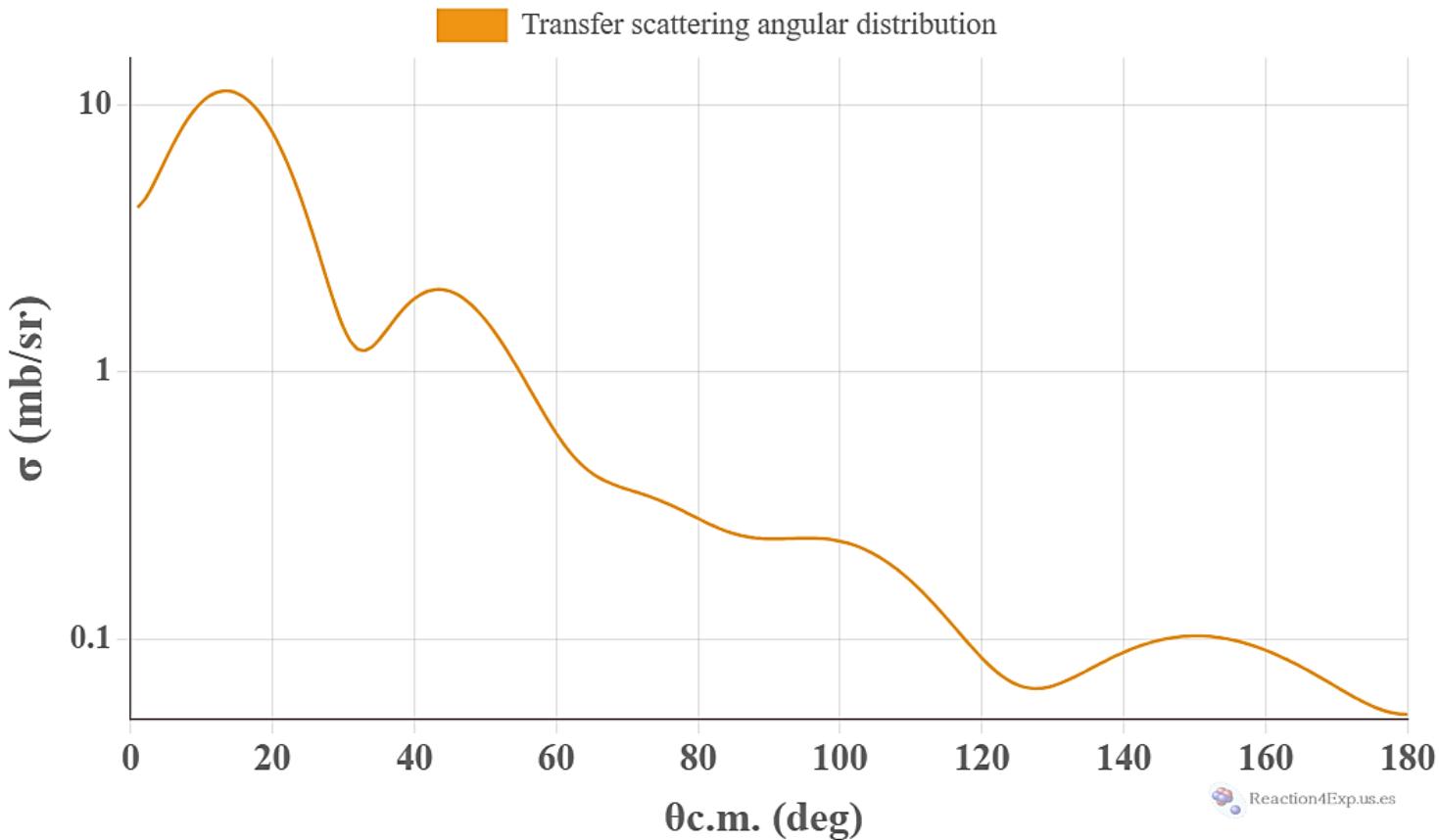
- OM elastic angular distribution (fort.201)
- Transfer angular distribution (fort.202)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)
- Potentials (fort.34)



Transfer DWBA Results

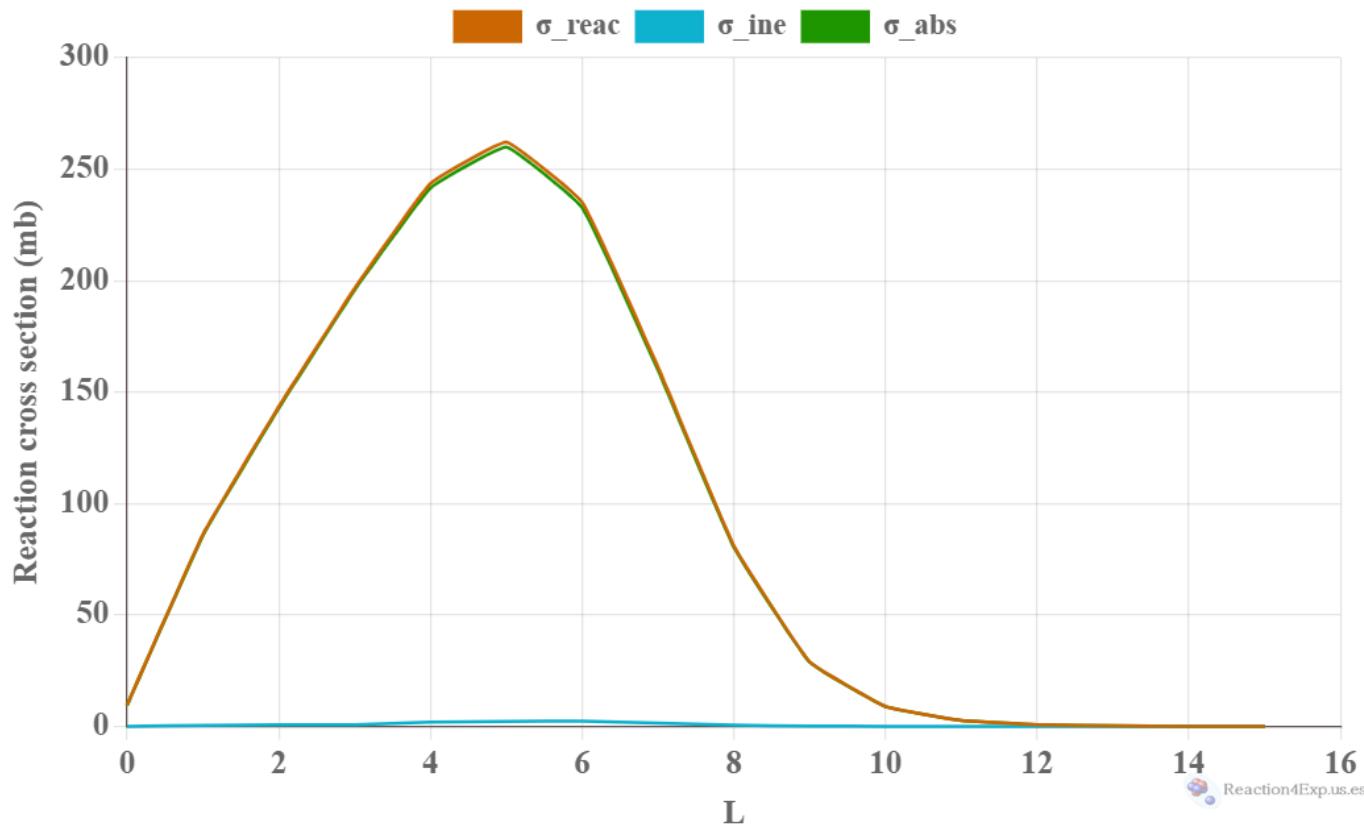
- OM elastic angular distribution (fort.201)
- **Transfer angular distribution (fort.202)**
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)
- Potentials (fort.34)

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



Transfer DWBA Results

Reaction cross sections for ELAB= 12.000, ECM= 11.583



- 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)

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

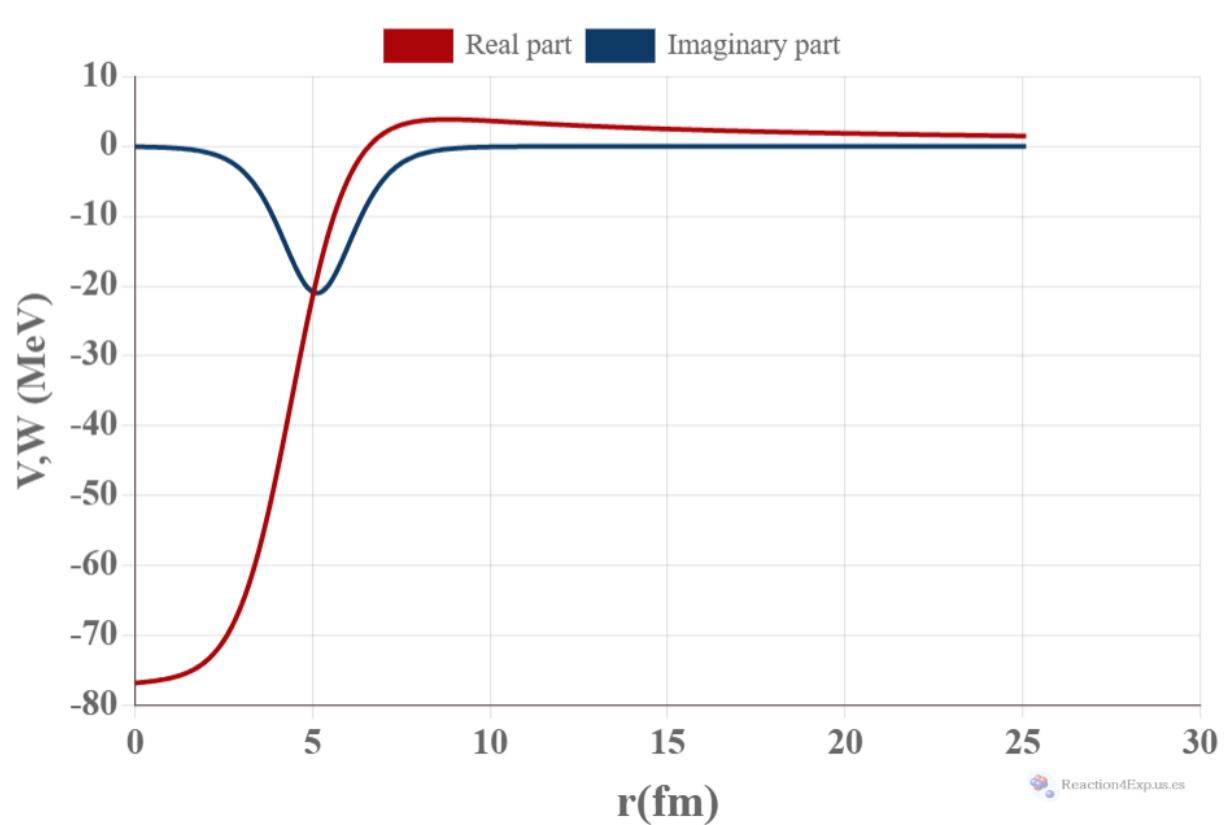
Reaction cross section (mb)	1460.8
Absorbtion cross section (mb)	1450.22275

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

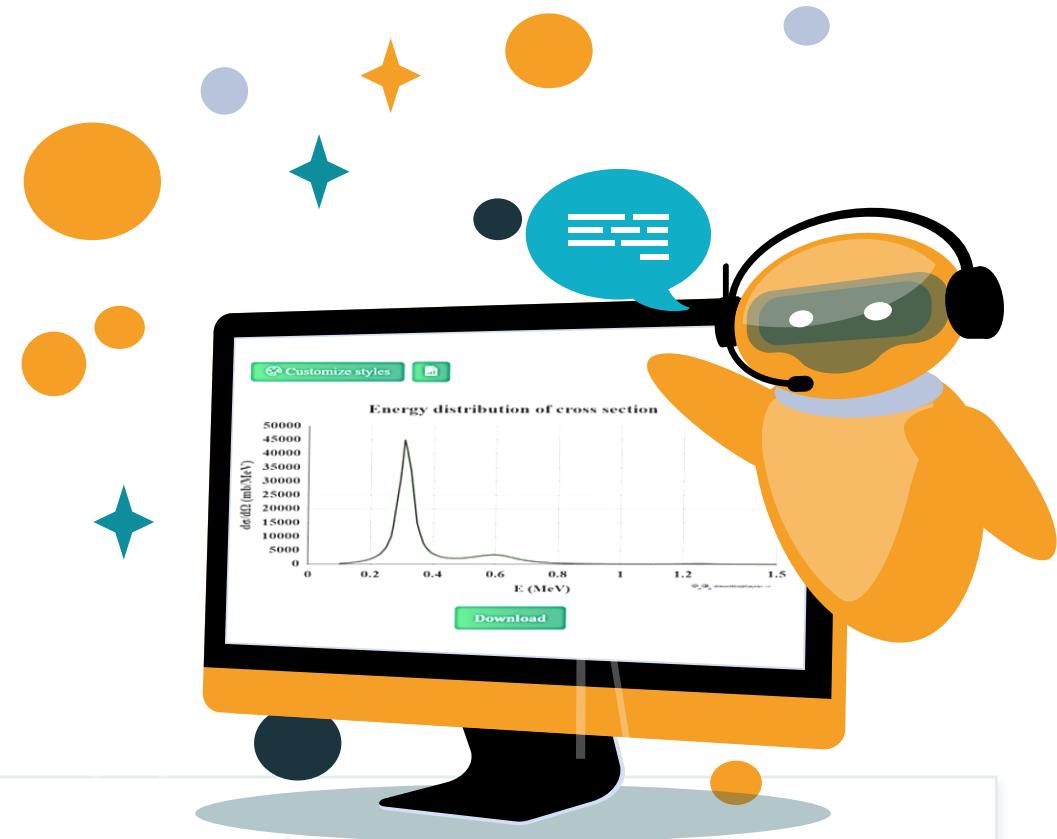
- OM elastic angular distribution (fort.201)
- Transfer angular distribution (fort.202)
- Absorption, reaction and inelastic cross section (fort.56)
- Total cross section for all states (fort.13)
- **Potentials (fort.34)**

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



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	Discrete	
Projectile	Be	11
Target	Au	197
Lab Energy (MeV)	31,9	
Transition	E1	

Grid

thmin	0,01	thmax	180,	nth	181	thgr	180
Ex	0,32	B(Ex;i→f)	0,11				

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

Distype	Continuous	Separation Energy (MeV)	0,38
Projectile	Li	11	
Target	Zn	64	
Lab (MeV)	Energy	22,5	Transition
			E1

Grid

thmin 0,1 thmax 180 nth 180c thgr 180

Electric transition probability

Elegir archivo Experimental.dat

ermin 0,1 ermax 7 ner 1000

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

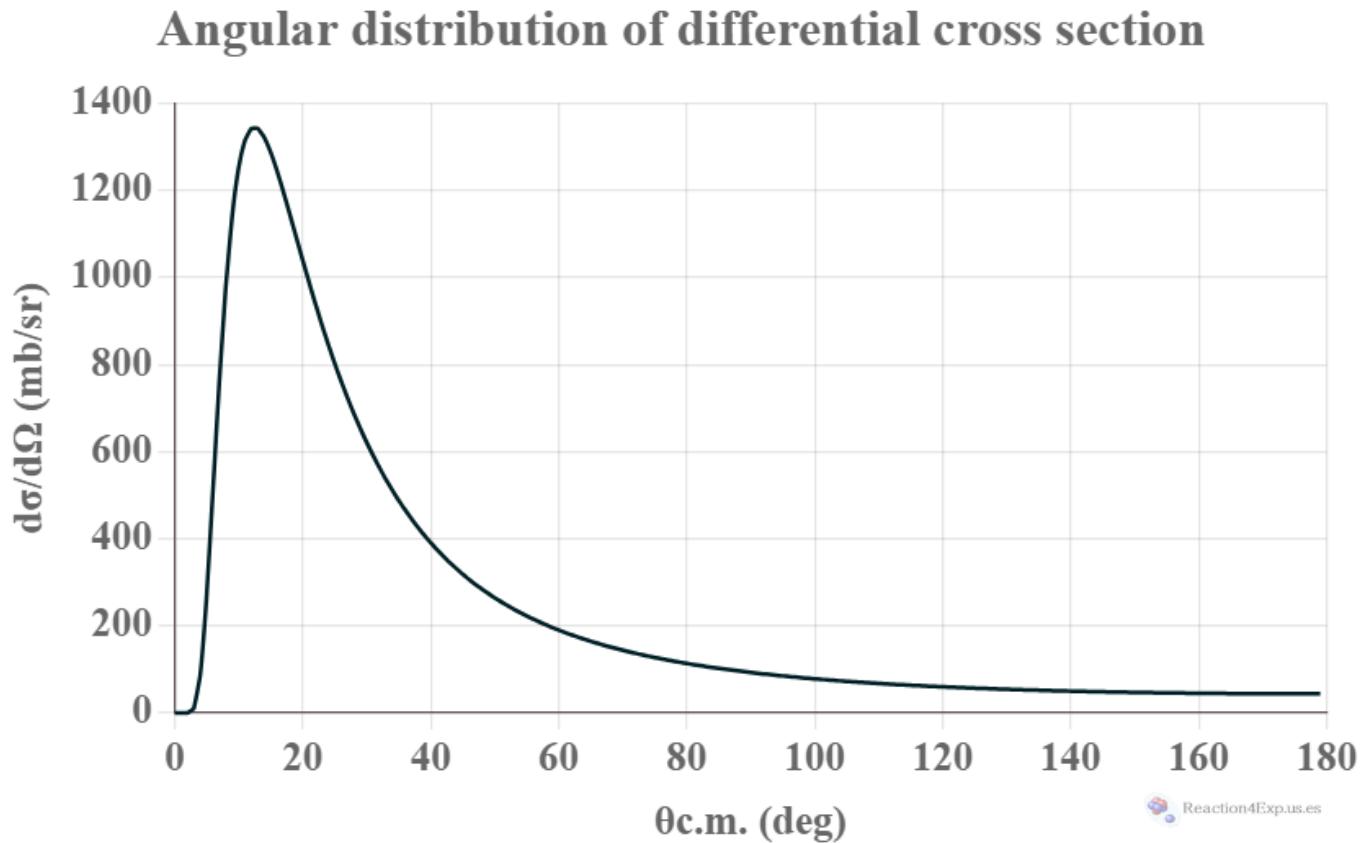
Data

EPM Results

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

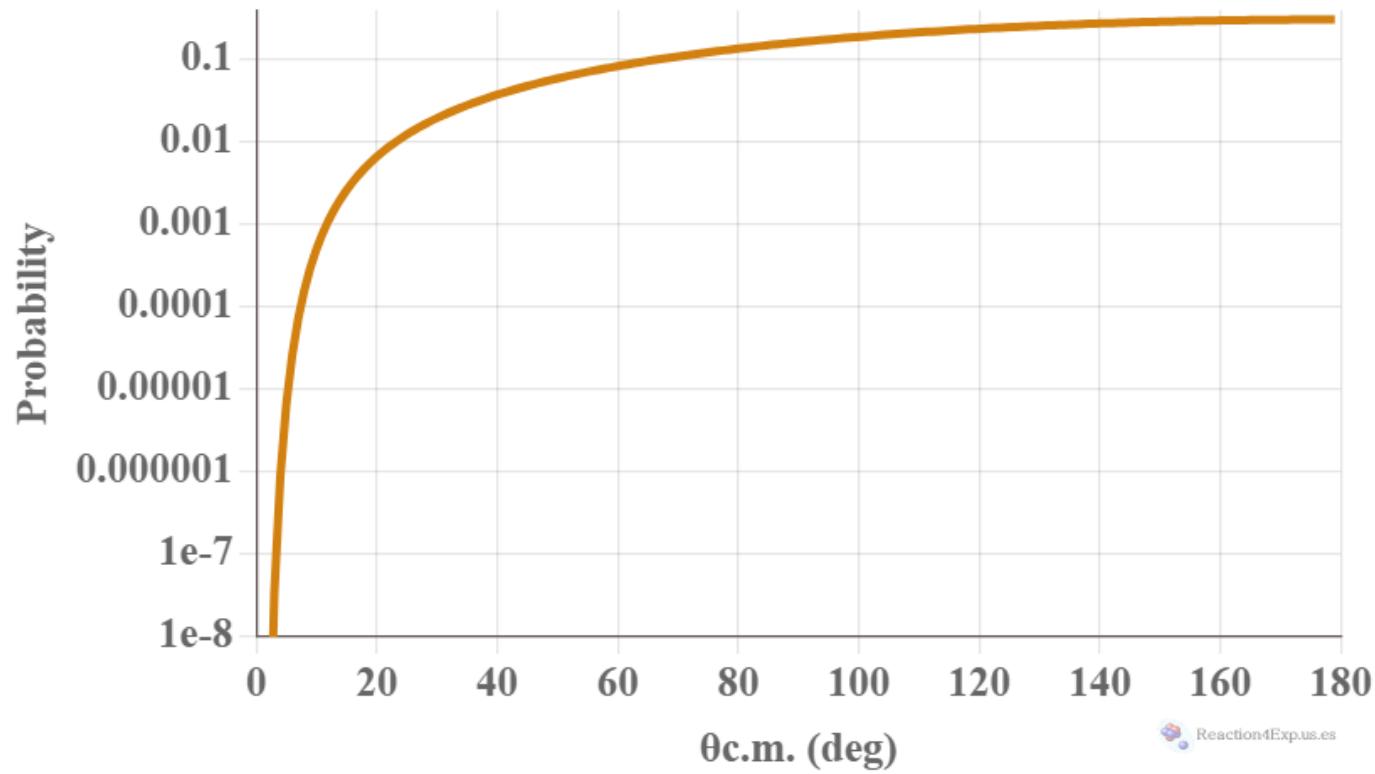
EPM Results

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



EPM Results

Probability distribution



Discrete -> Total cross section

Continuous -> Energy distribution of cross section

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

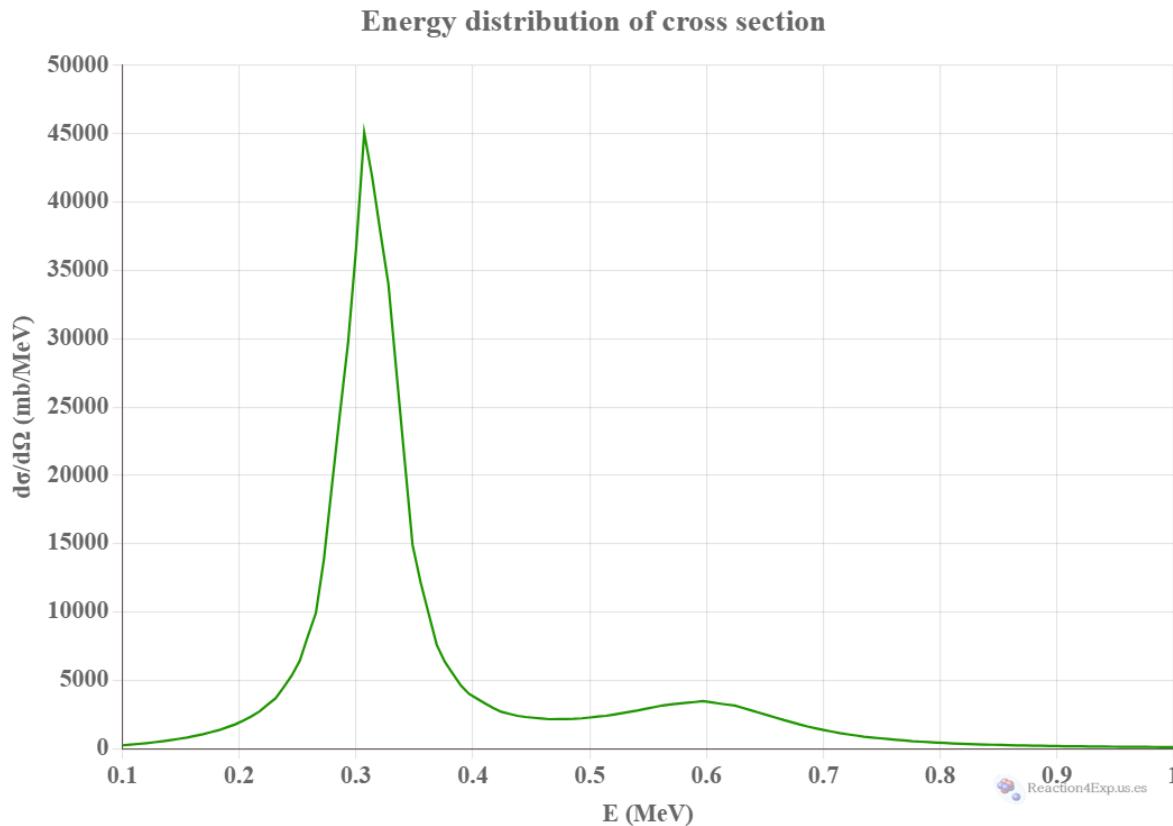
Transition	E(MeV)	σ (mb)
E1	0.32	2344.678

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>



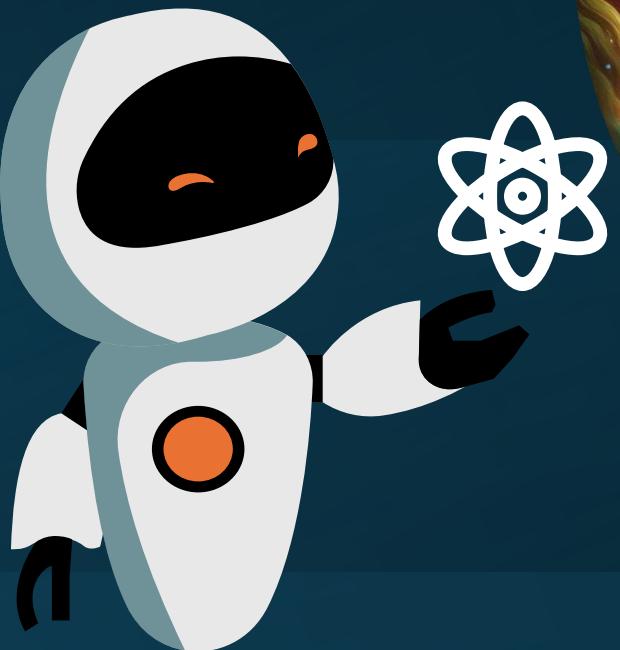
How do you cite reaction4exp results?

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 trusty sidekick in all your nuclear reaction calculations.

