

PACE version : 4.20

In LISE++ package v.9.6.31

from 23-May-2013

Transmission probability for a one-dimensional barrier (O.T.)

Classical (use it above the barrier)
 Quantum-mechanical [D.Hill & J.Wheeler, PhysRev 89(1953) 1105]

1. R_fusion value has been used to calculate partial waves L in QM mode, in order to avoid “classical” subroutines in at energies below the barrier.

However this assumption gives some serious jumps (it will be shown later), and the code has been modified to avoid this problem, coming back above the barrier to the classical solution in QM mode.

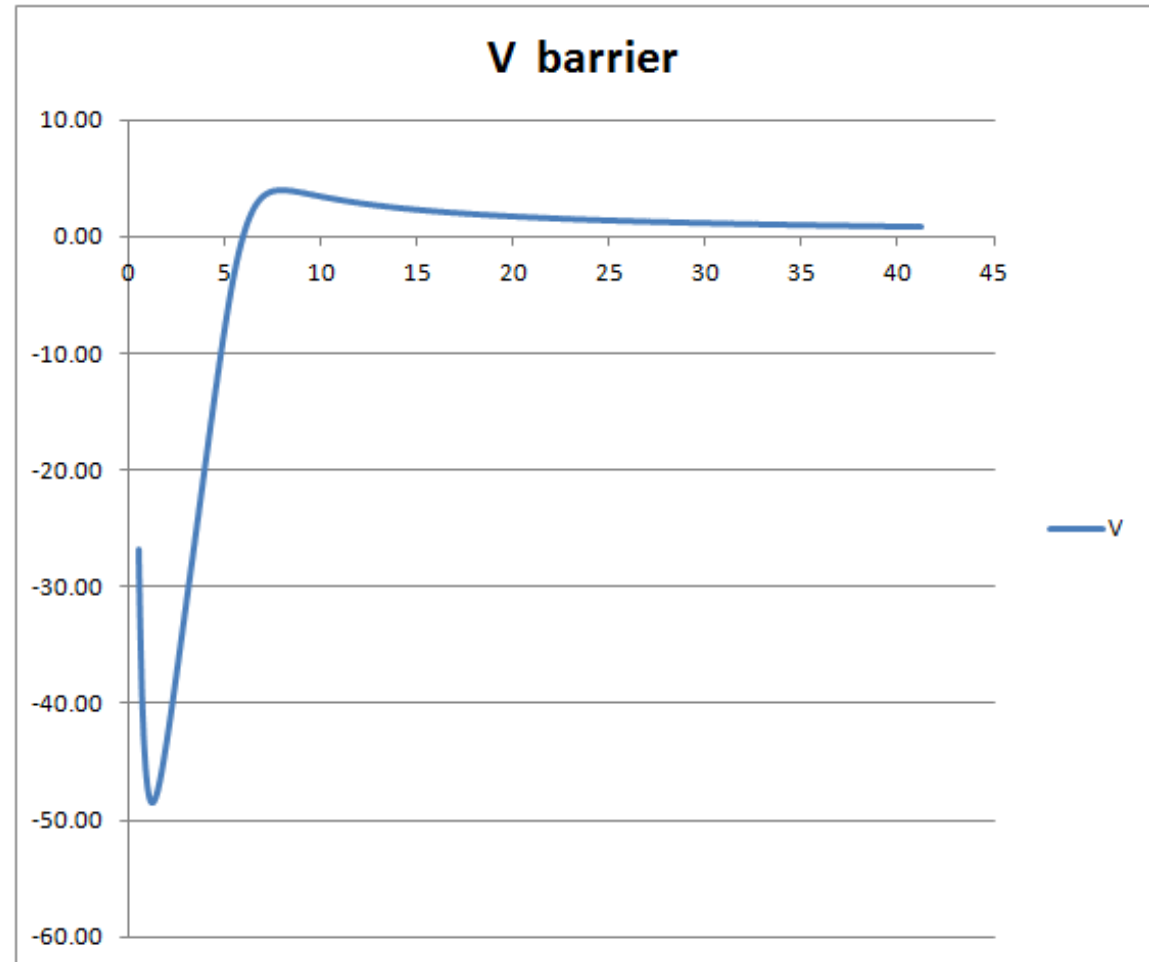
2. Default value of AGRAZ which was equal to 4, now set to 2

All examples in this presentation were done for the combination



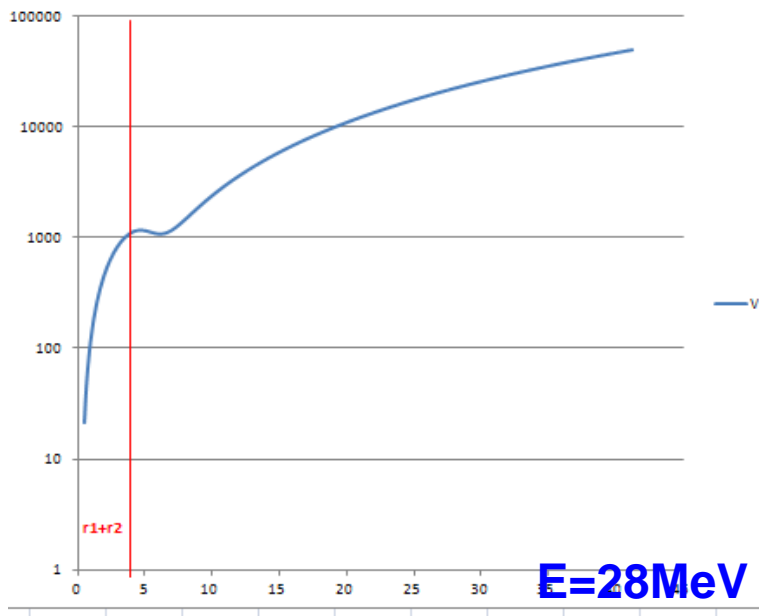
Bass subroutine

R1	1.914 fm
R2	2.088 fm
A1	10
A2	12
Z1	4
Z2	6

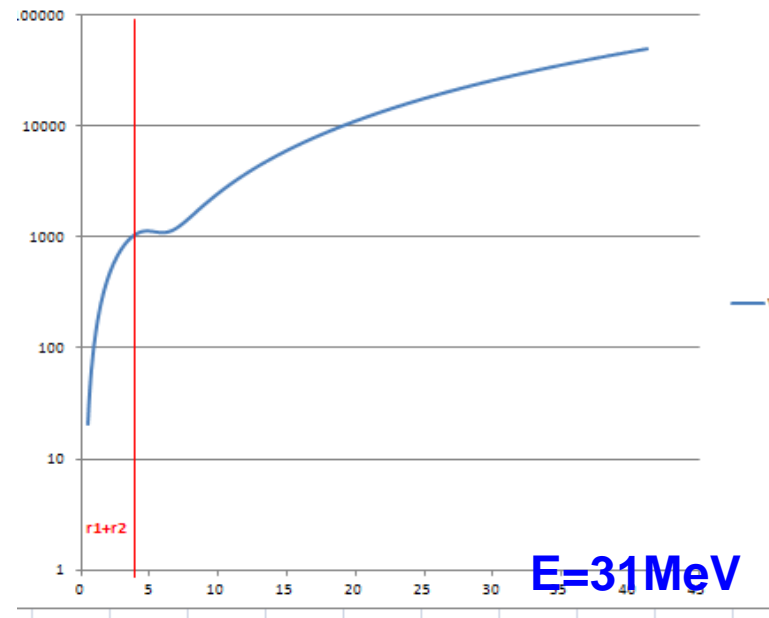


Bass Subroutine

Cross Section

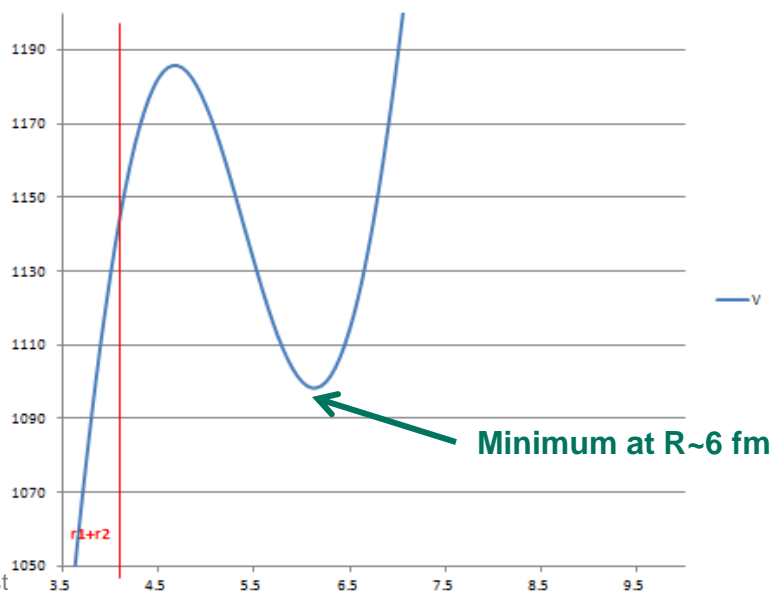


Cross Section

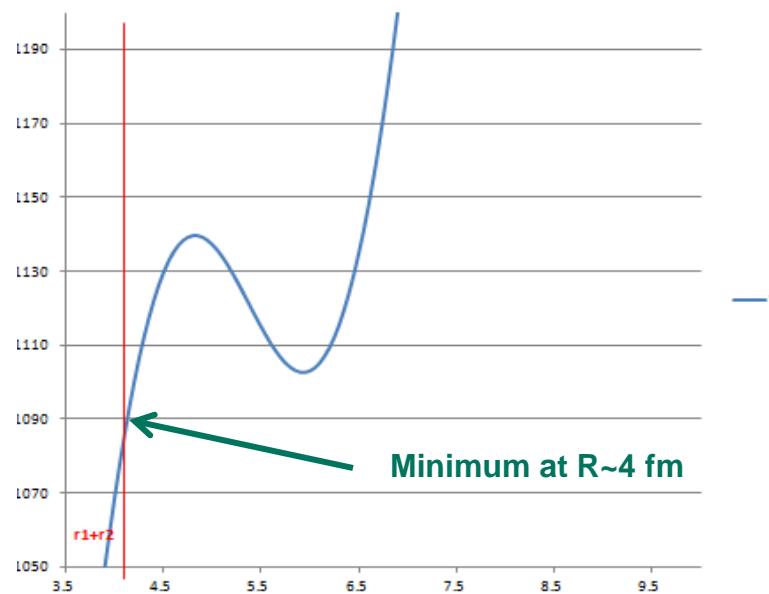


Search for minimum CS

Fusion Cross Section (Bass's approach)



Fusion Cross Section (Bass's approach)

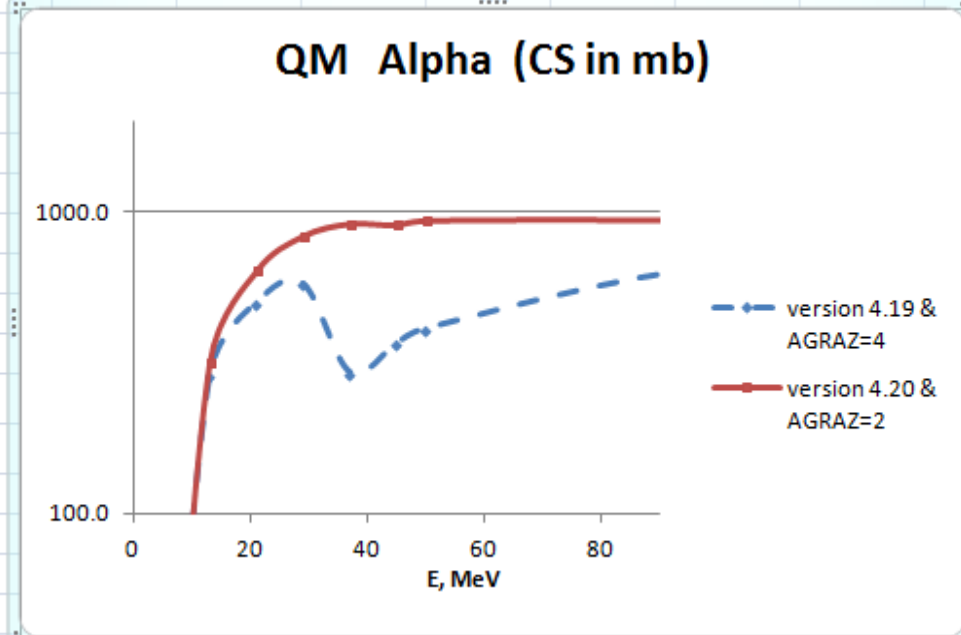
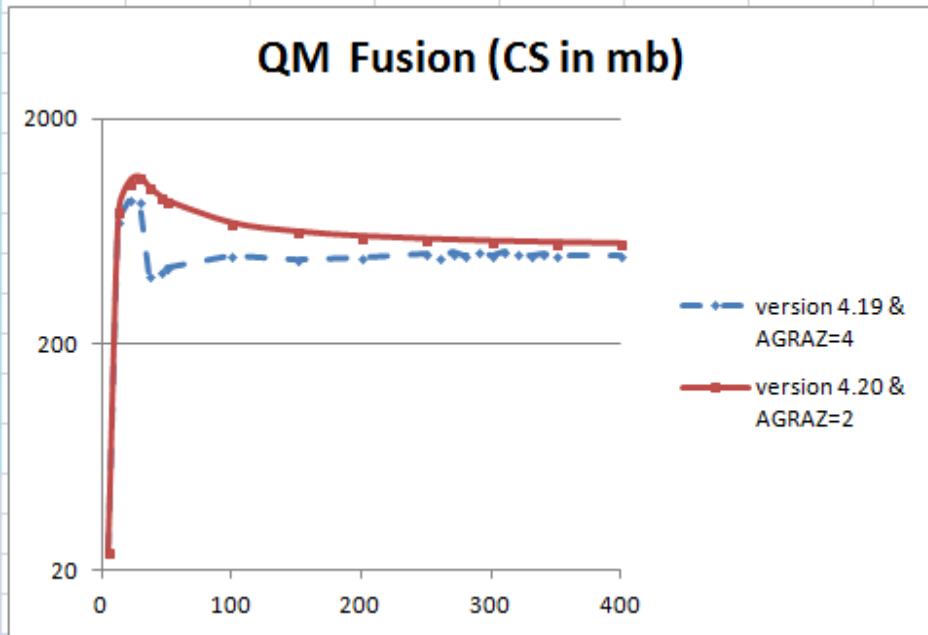
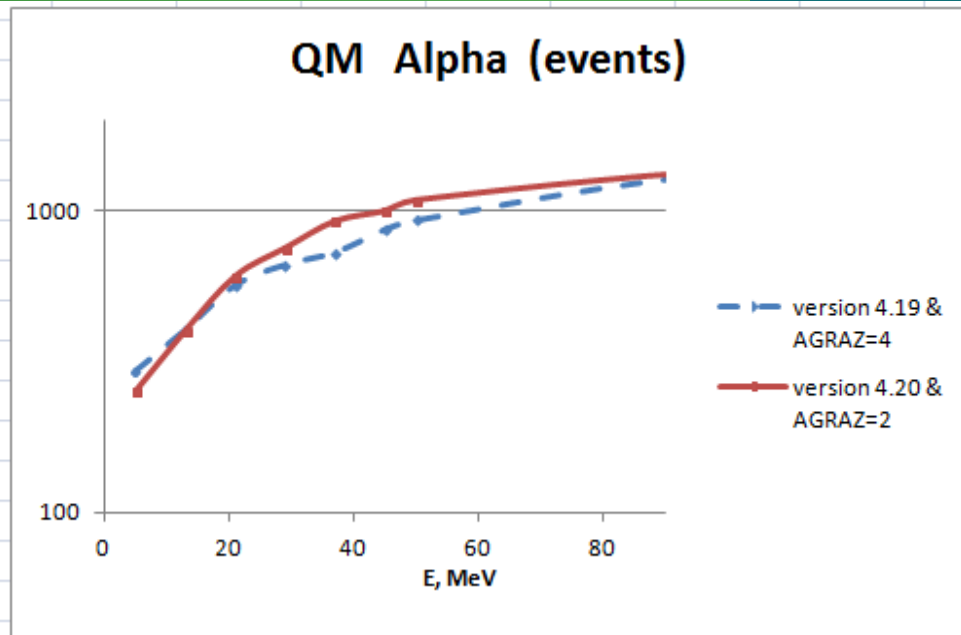
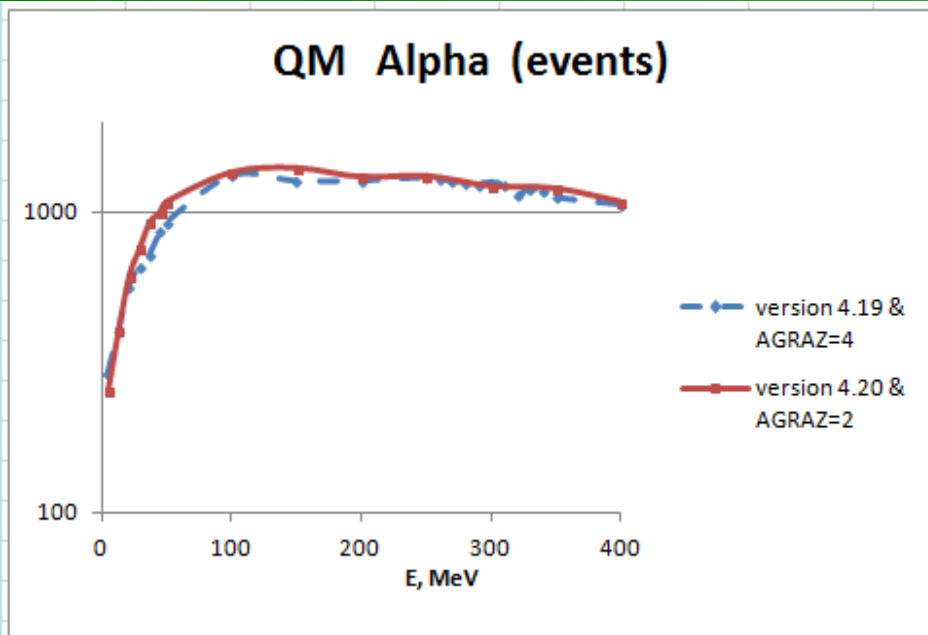


	mb	mb	mb	events	mb		1000 event	mb	mb	events	mb
Elab	Fusion	Bass	Fission	Alpha	Alpha		Elab	Fusion	Fission	Alpha	Alpha
5	24.3	23.6	0	295	7.2		5	24.3		255	6.2
13	710	777	0	405	287.6		13	776		404	313.5
21	880	1040	0	568	499.8		21	1040		609	633.4
29	868	1100	0	663	575.5		29	1100		753	828.3
37	403	986	0	729	293.8		37	986		923	910.1
45	423	903	0	867	366.7		45	903		997	900.3
50	441	864	0	931	410.6		50	863		1082	933.8
100	494	690	2.47	1331	657.5		100	689	9.65	1355	933.6
150	477	631.5	14.8	1277	609.1		150	631	23.4	1401	884.0
200	487	602	36.5	1281	623.8		200	602	47	1308	787.4
250	508	585	68.6	1312	666.5		250	585	70.2	1319	771.6
260	489	582	72.4	1307	639.1		300	573	100	1220	699.1
270	511	580	82.8	1273	650.5		350	565	145	1199	677.4
280	493	578	90.7	1271	626.6		400	559	170	1084	606.0
290	514	575.4	97.7	1250	642.5						
300	497	573	91	1264	628.2						
310	516	571.5	102	1238	638.8						
320	503	570	110	1146	576.4						
330	496	568	121	1202	596.2						
340	509	567	140	1188	604.7						
350	494	565	139	1125	555.8						
400	497	559	171	1065	529.3						

AGRAZ=4
version 4.19

AGRAZ=2
version 4.20

See the next slide for figures with these data



LISE++ partner site



<http://nrv.jinr.ru/nrv/webnrv/fusion/>

$\psi^{(+)}(r, \xi) = \sum_n \psi_n(r) \phi_n(\xi)$

NRV: Fusion (Channel coupling)

Fusion of $^{10}\text{Be} + ^{12}\text{C}$

[Calculate evaporation residue cross section](#)

Input data

projectile: ^{10}Be	target: ^{12}C
$r_0 (R) = 1.22 (2.63) \text{ fm}$	$r_0 (R) = 1.160 (2.66) \text{ fm}$
No excitations	Rotation
	$E_2 = 0.082 \text{ MeV}$
	$\beta_2 = 0.300$
	$\beta_4 = 0.100$
	Levels = 5

Potential parameters

type: WS volume $V_0 = -105.0 \text{ MeV}$ $r_0 (R) = 1.120 (4.977) \text{ fm}$ $a = 0.750 \text{ fm}$
 Coulomb $r_0 (R) = 1.120 (4.977) \text{ fm}$

Potential Energy

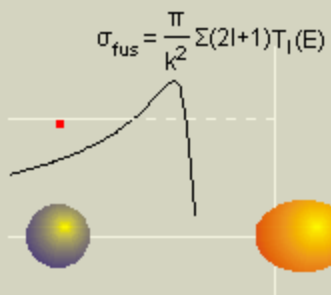
Fusion Cross Section

Click on a plot to process it

LISE++ partner site



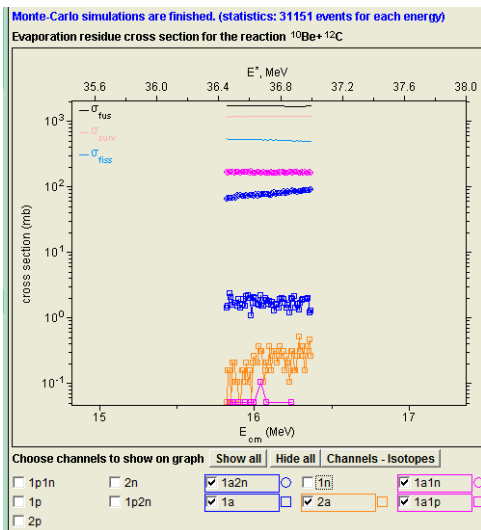
<http://nrv.jinr.ru/nrv/webnrv/fusion/>



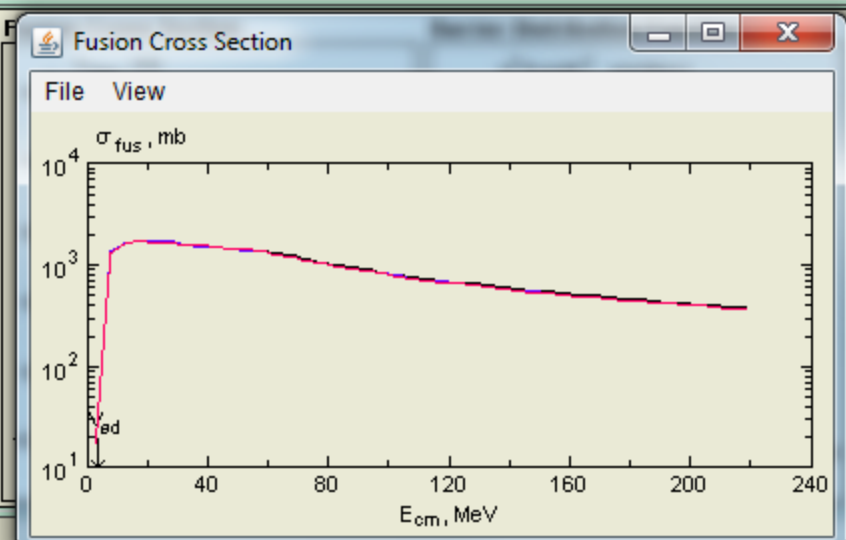
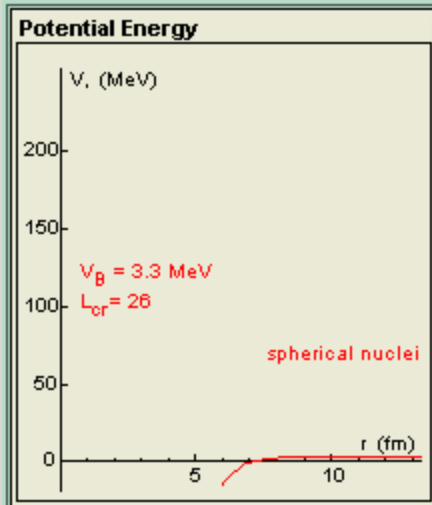
NRV: Fusion (Empirical model)

Fusion of $^{10}\text{Be} + ^{12}\text{C}$

Calculate evaporation residue cross section



Input data		Derived data
projectile: ^{10}Be	target: ^{12}C	$V_C^B(\text{spherical}) = 3.389 \text{ fm}$
$r_0 (R) = 1.220 (2.63) \text{ fm}$	$r_0 (R) = 1.160 (2.66) \text{ fm}$	$R_C^B = 9.380 \text{ fm}$
$\lambda = 2$	$\lambda = 2$	$hw = 1.19 \text{ MeV}$
$C = 8.85 \text{ MeV fm}^{-2}$	$C = 4.50 \text{ MeV fm}^{-2}$	$L_{or} = 26$
Potential parameters type: WS volume $V_0 = -105.0 \text{ MeV}$ $r_0 (R) = 1.120 (4.977) \text{ fm}$ $a = 0.750 \text{ fm}$ Coulomb $r_0 (R) = 1.120 (4.977) \text{ fm}$		$E_{or} = 59.3 \text{ MeV}$
		dynamic deformation:
		$V^B(\text{saddle}) = 3.38 \text{ MeV}$
		$R(\text{saddle}) = 9.362 \text{ fm}$
		$\beta(\text{saddle}) = 0.080$
		Barrier = 4.05 MeV



PACE4 - [QM3_10Be_12C.in]

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Projectile	Target	Compound
A = 10 N = 6	A = 12 N = 6	A = 22 N = 12
Z = 4 Be	Z = 6 C	Z = 10 Ne
Spin (gs) = 0	Spin (gs) = 0	
ME (MeV) = 12.607 DB	ME (MeV) = 0.000 DB	ME (MeV) = -8.025 DB

QCN = 0 Q value of reaction [MeV]. If == 0 it is calculated from mass tables.

Beam Energy (MeV)
Elab = 3 Batch Mode

EXPSIG = 0 experimental fusion cross section if known. TL-S from optical model shifted to reproduce this value if inputted, preserving the L-diffuseness. if == 0 Bass model (PRL 1977) fusion cross section being used.

JCMAX = 0 Maximum J to be used during calculations. (if 0 it is taken from optical model routine)

AGRAZ = 0 To bypass input channel optical model routine (TLOM) specify L-diffuseness of fusion cross section. If == 0 diffuseness will be set to 0.5 which is essentially sharp cutoff.

ELOSS = 0 energy loss of beam thru full target width. (total dE) energies will be distributed between Ebeam & Ebeam-Eloss

LMINN = 0 Lowest partial wave L in calculation. Partial waves from L=0 to LMINN excluded, enabling low-L non-fusion window in reaction calculation.

Transmission probability for a one-dimensional barrier (O.T.)
 Classical (use it above the barrier)
 Quantum-mechanical [D.Hill & J.Wheeler, PhysRev 89(1953) 1105] ?

h_omega = 3 Curvature parameter of the parabolic potential describing the barrier (default value 3 MeV) (only for Quantum-Mechanical mode)

Note: If you are running at high bombarding energies for which the grazing angular momentum is above 75 hbar, it is recommended to input AGRAZ > 0, and to specify an arbitrary value for EXPSIG (or 0 = Bass) which corresponds to a fusion cross section with a limiting L-value around 80. This will give you all the evaporation residue data and the fission probabilities you need. For J>80 all nuclei will fission anyway, and you will run out of dimension if you try.

Set "0" to run TLOM model
To obtain this diffuseness parameter

So, for this reaction at 30 MeV the Diffuseness parameter is equal to 0.7 from TLOM!

In version 4.19 AGRAZ default value was set to 4.0

In version 4.20 new default value is 2.0

Please, use the same parameters in input files if you compare different PACE2, PACE3, PACE4 versions!