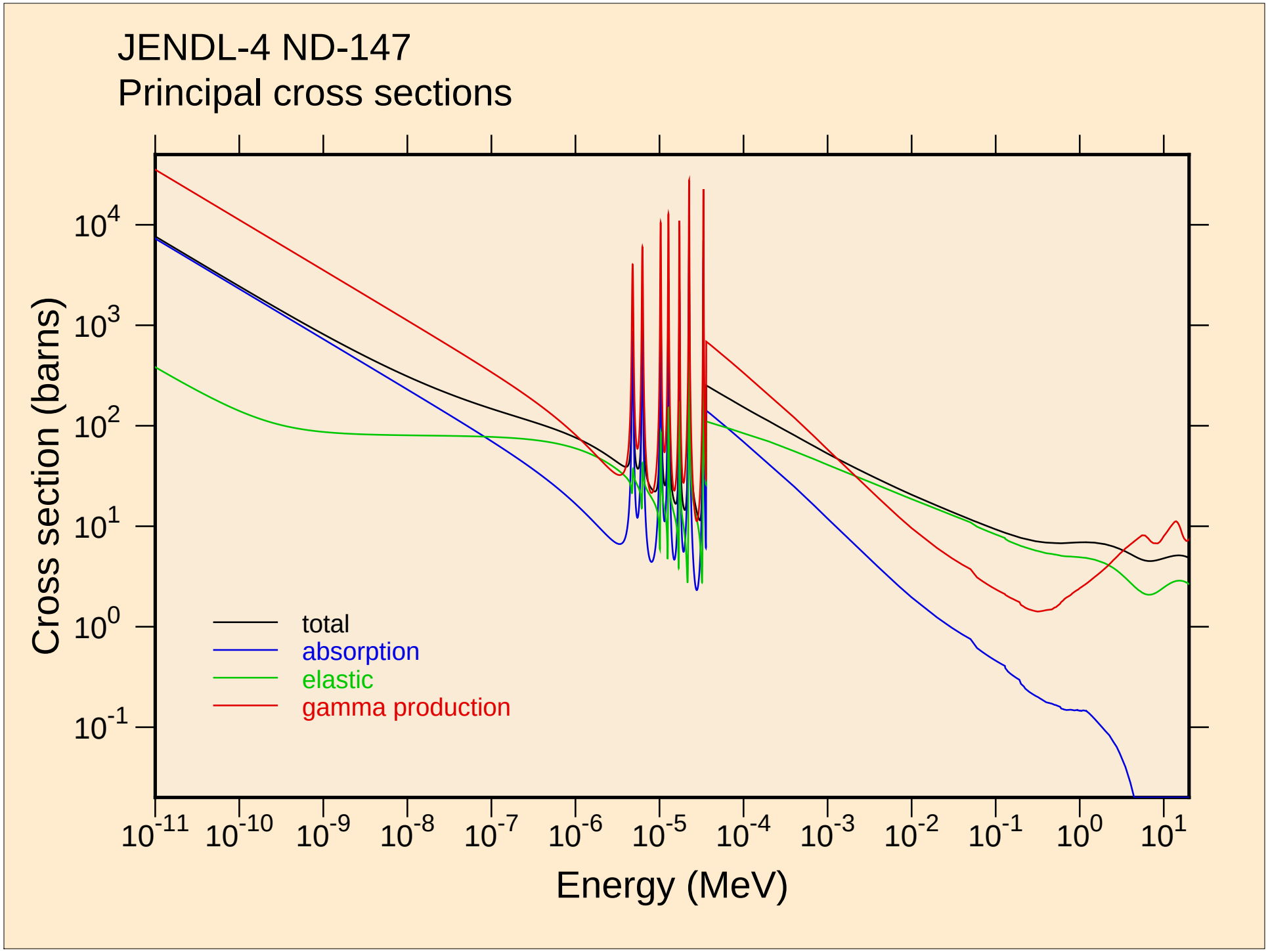
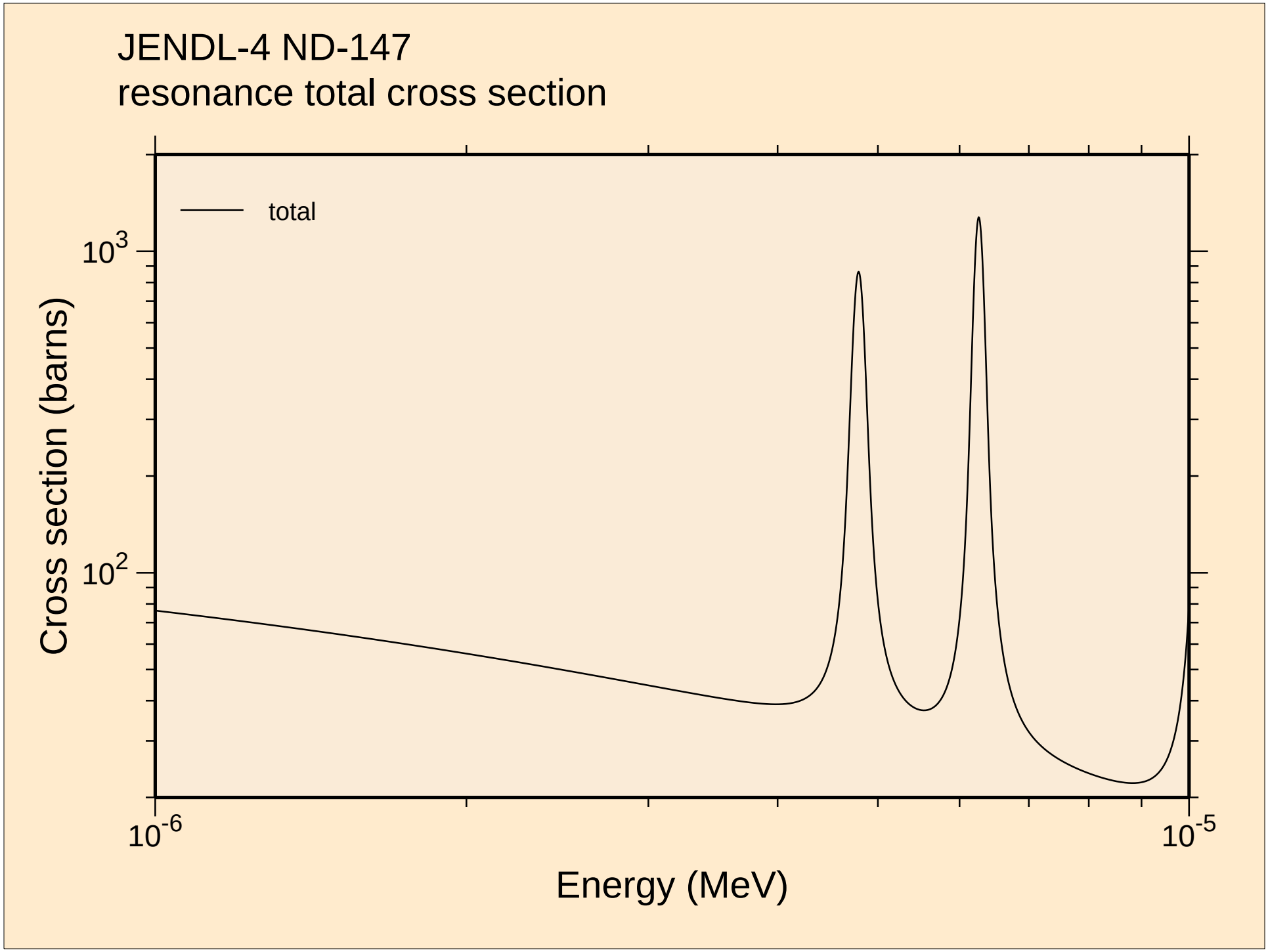
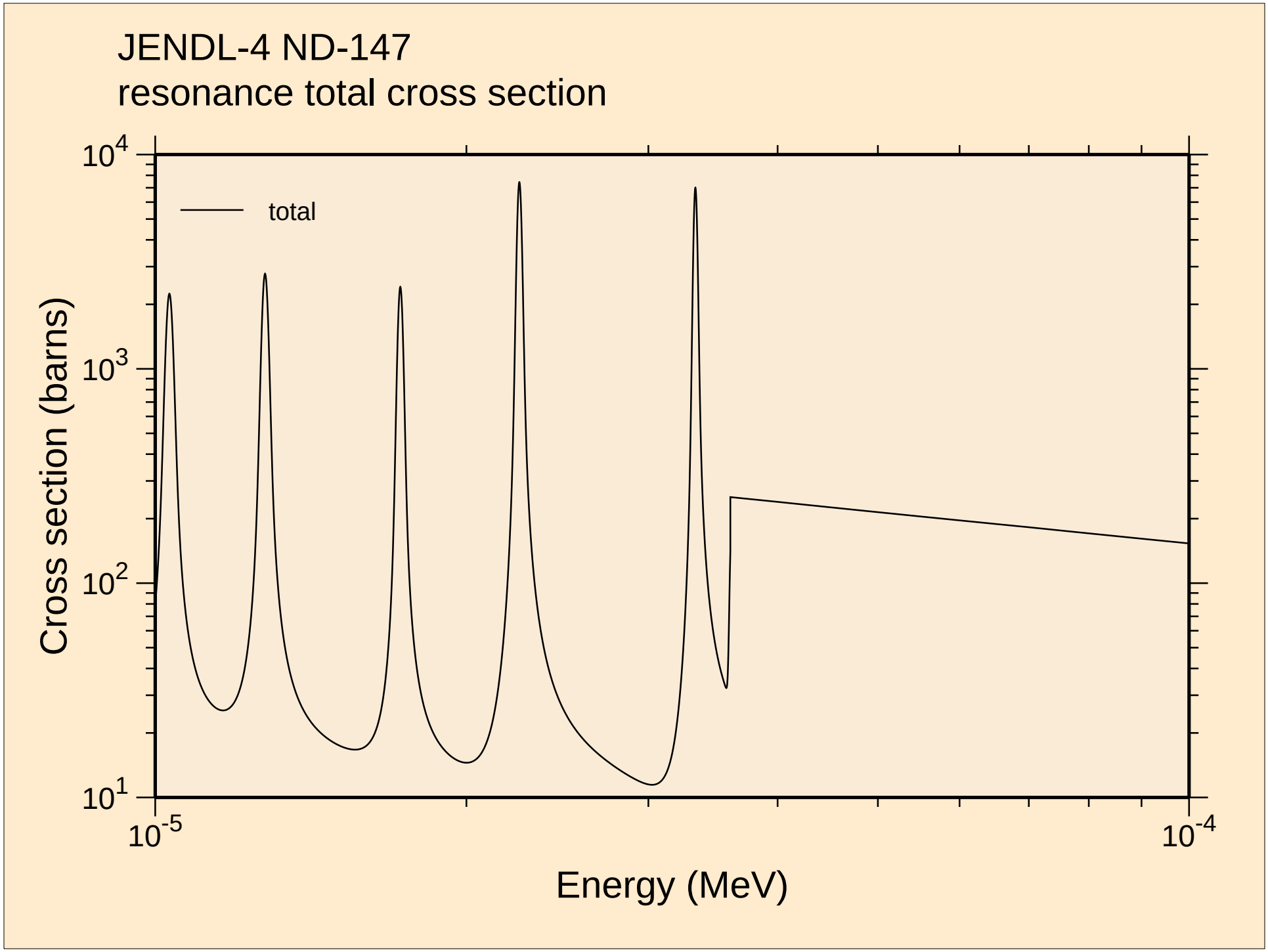
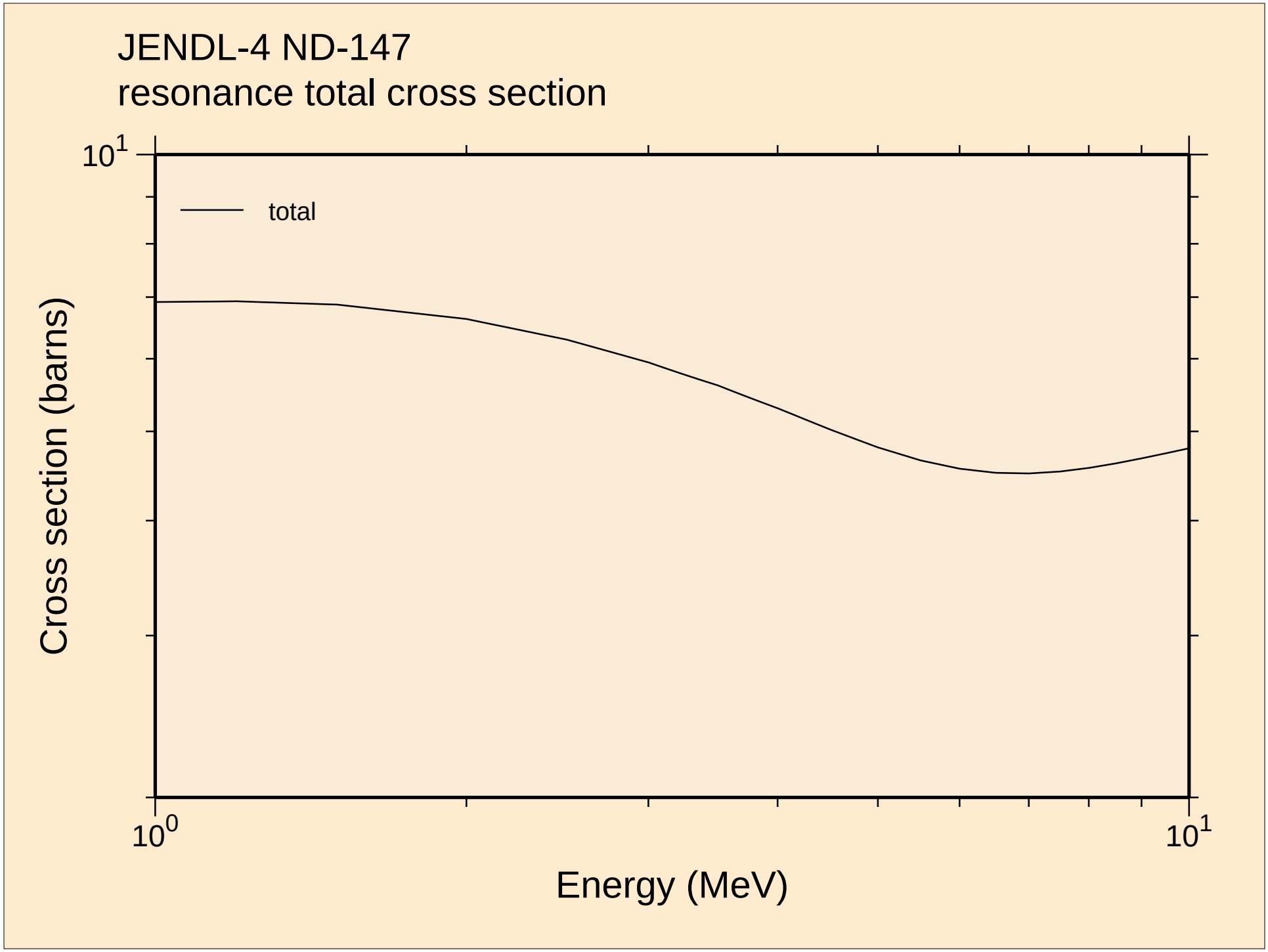
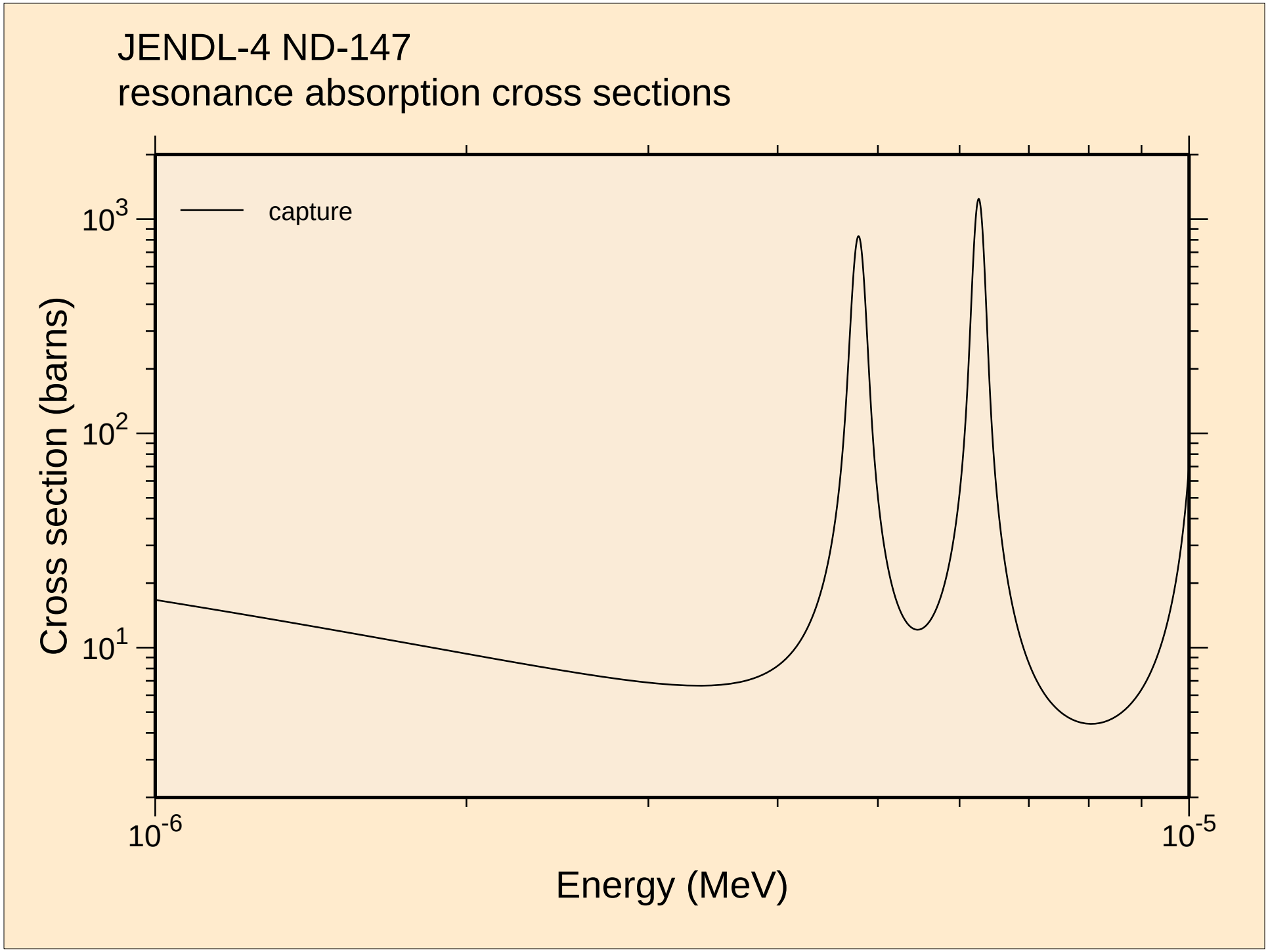
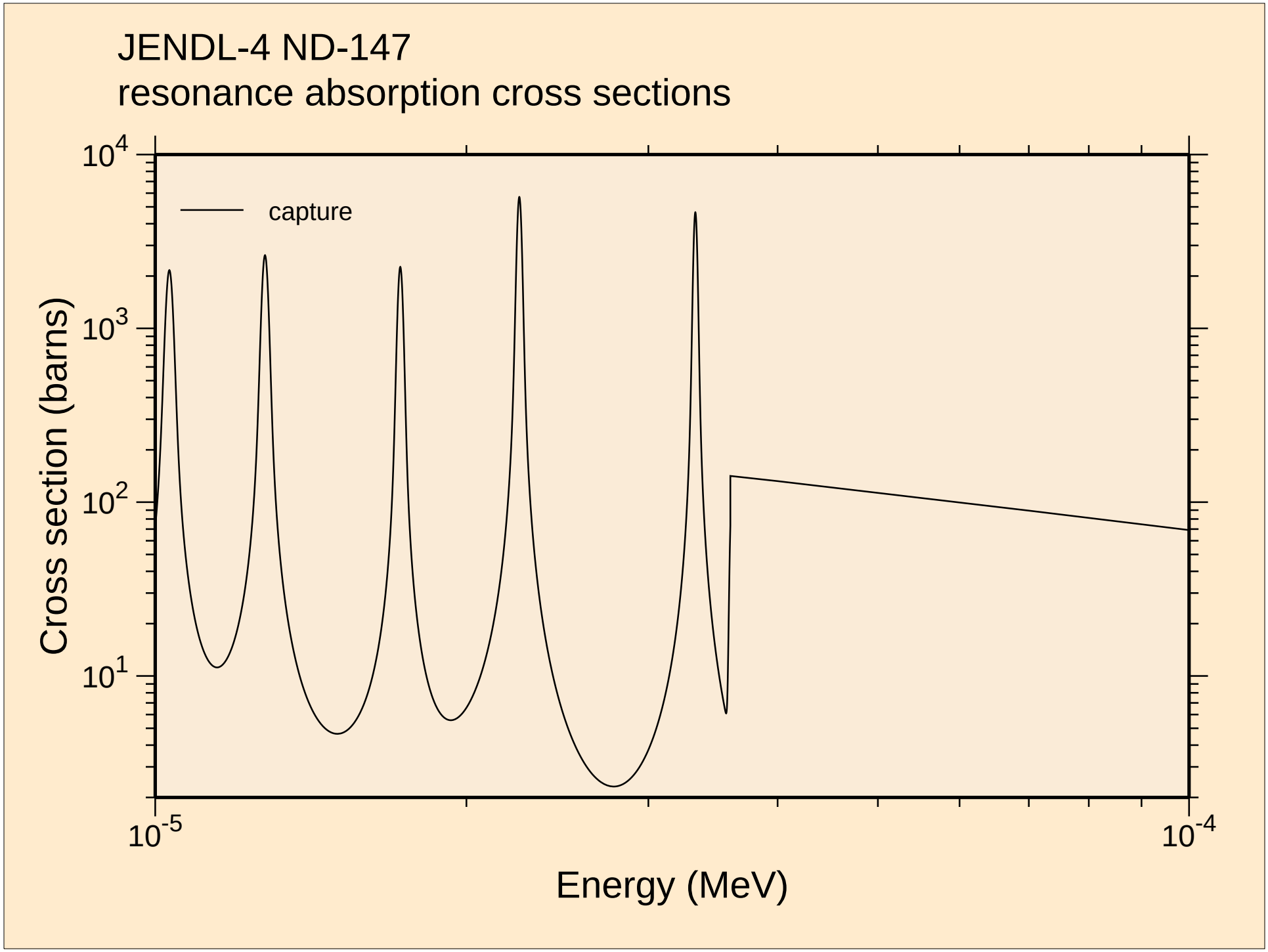

JENDL-4 ND-147
Principal cross sections
Cross section (barns)
Energy (MeV)
total
absorption
elastic
gamma production

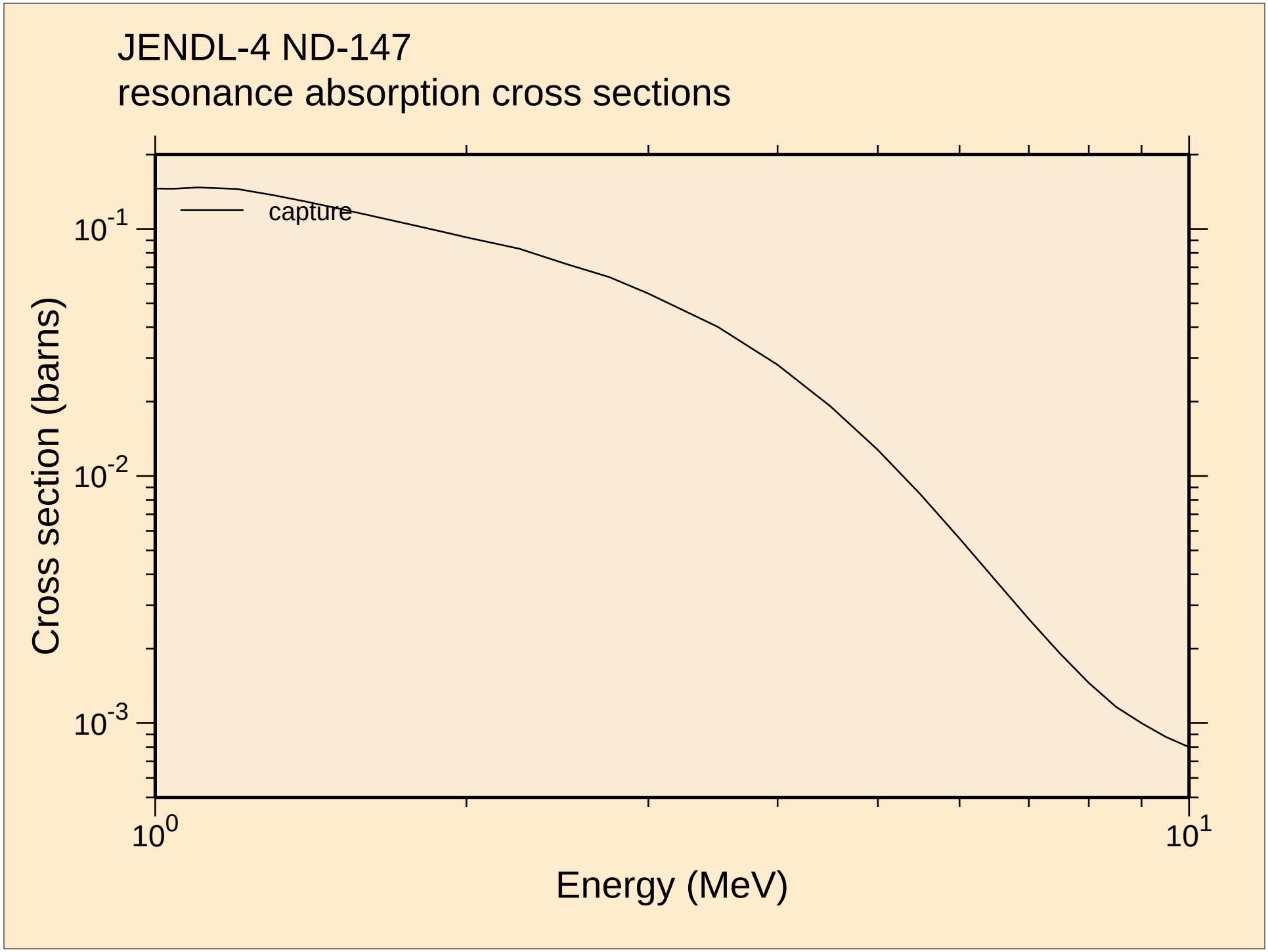

JENDL-4 ND-147
resonance total cross section
total
Cross section (barns)
10^3
10^2
10^{-6}
10^{-5}
Energy (MeV)

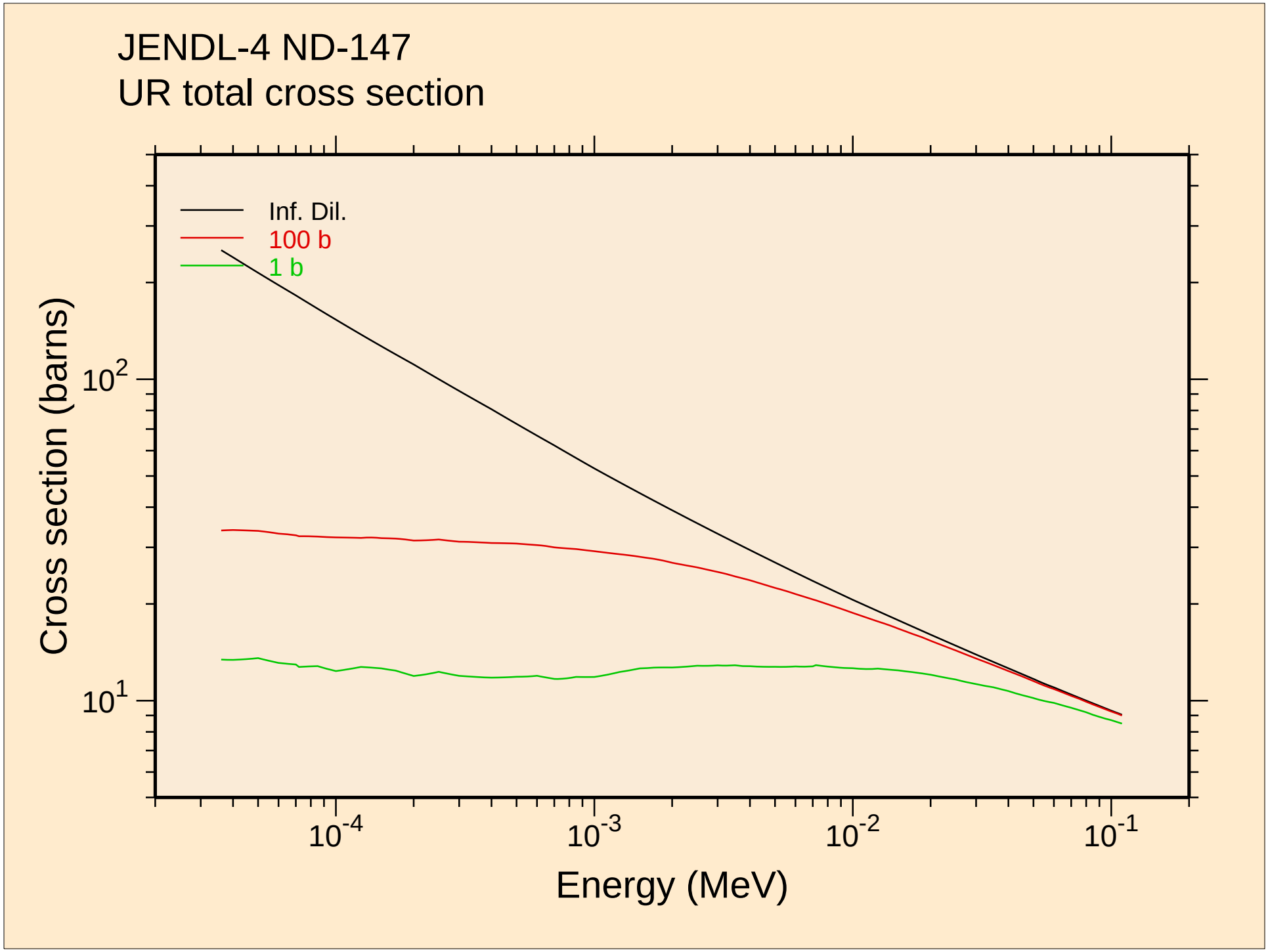

JENDL-4 ND-147
resonance total cross section
total
Cross section (barns)
Energy (MeV)
10^4
10^3
10^2
10^1
10^-5
10^-4

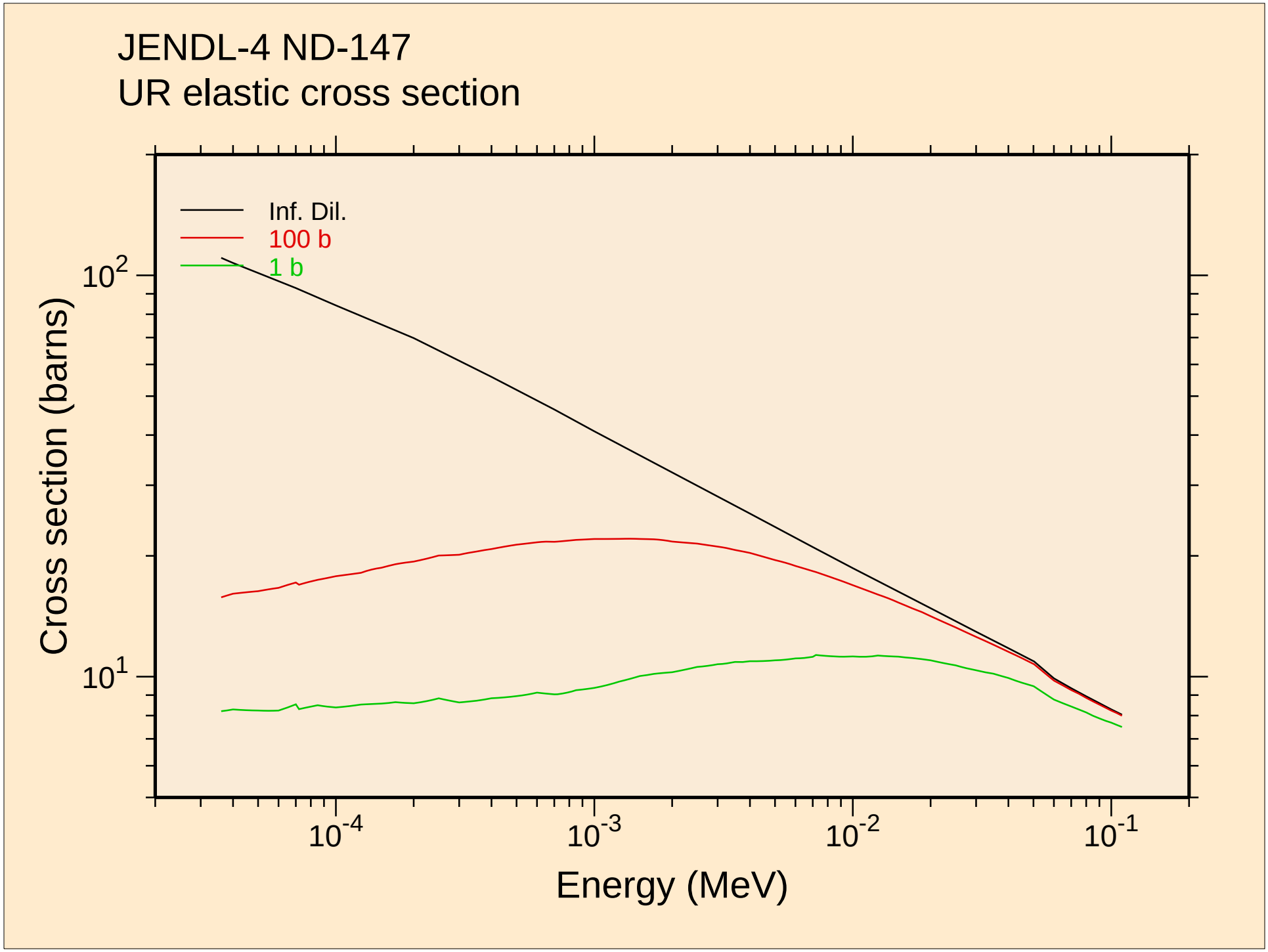

JENDL-4 ND-147
resonance total cross section
total
Cross section (barns)
Energy (MeV)
10^1
10^0
10^1

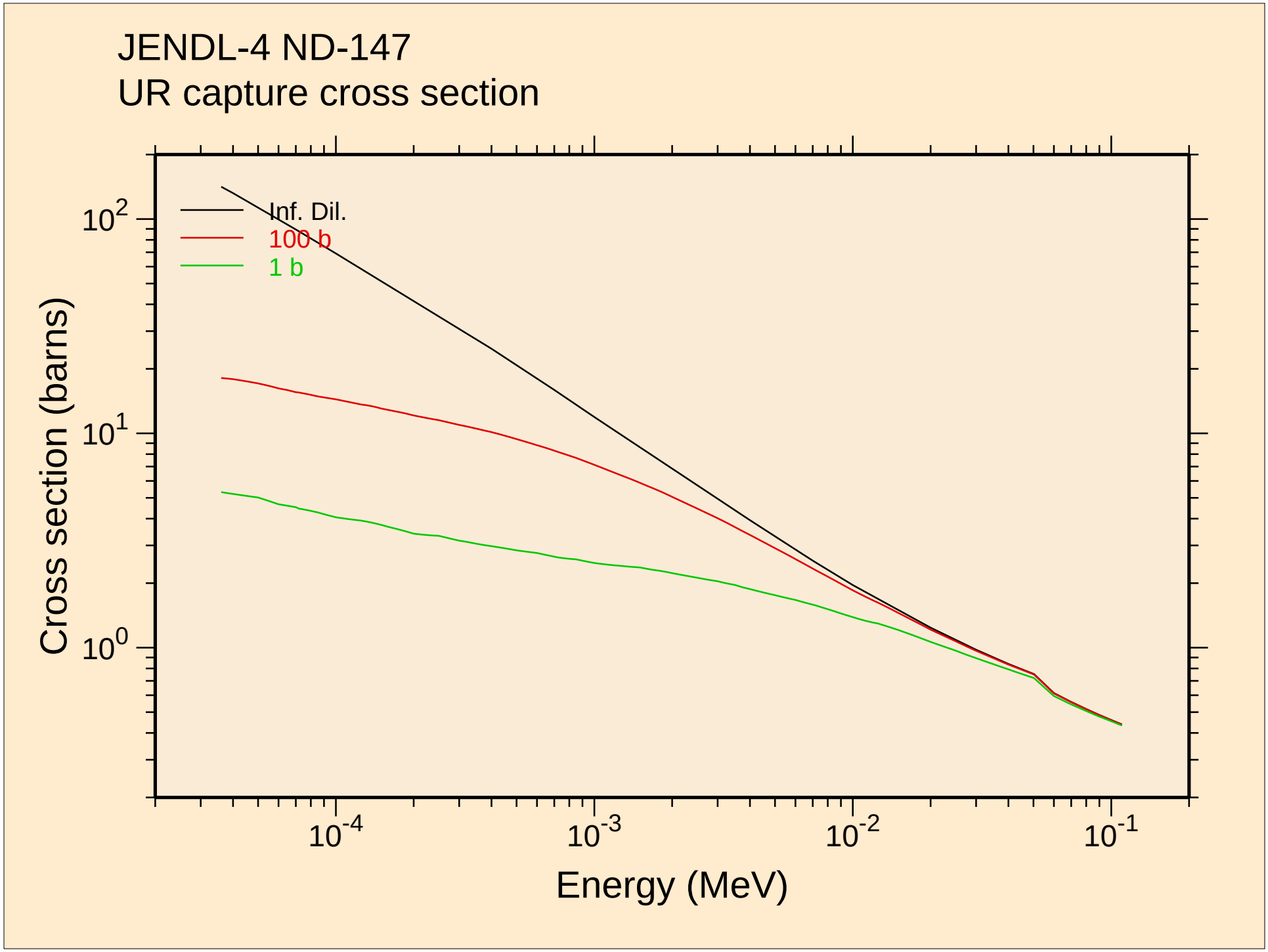

JENDL-4 ND-147
resonance absorption cross sections
capture
Cross section (barns)
10^3
10^2
10^1
10^{-6}
10^{-5}
Energy (MeV)

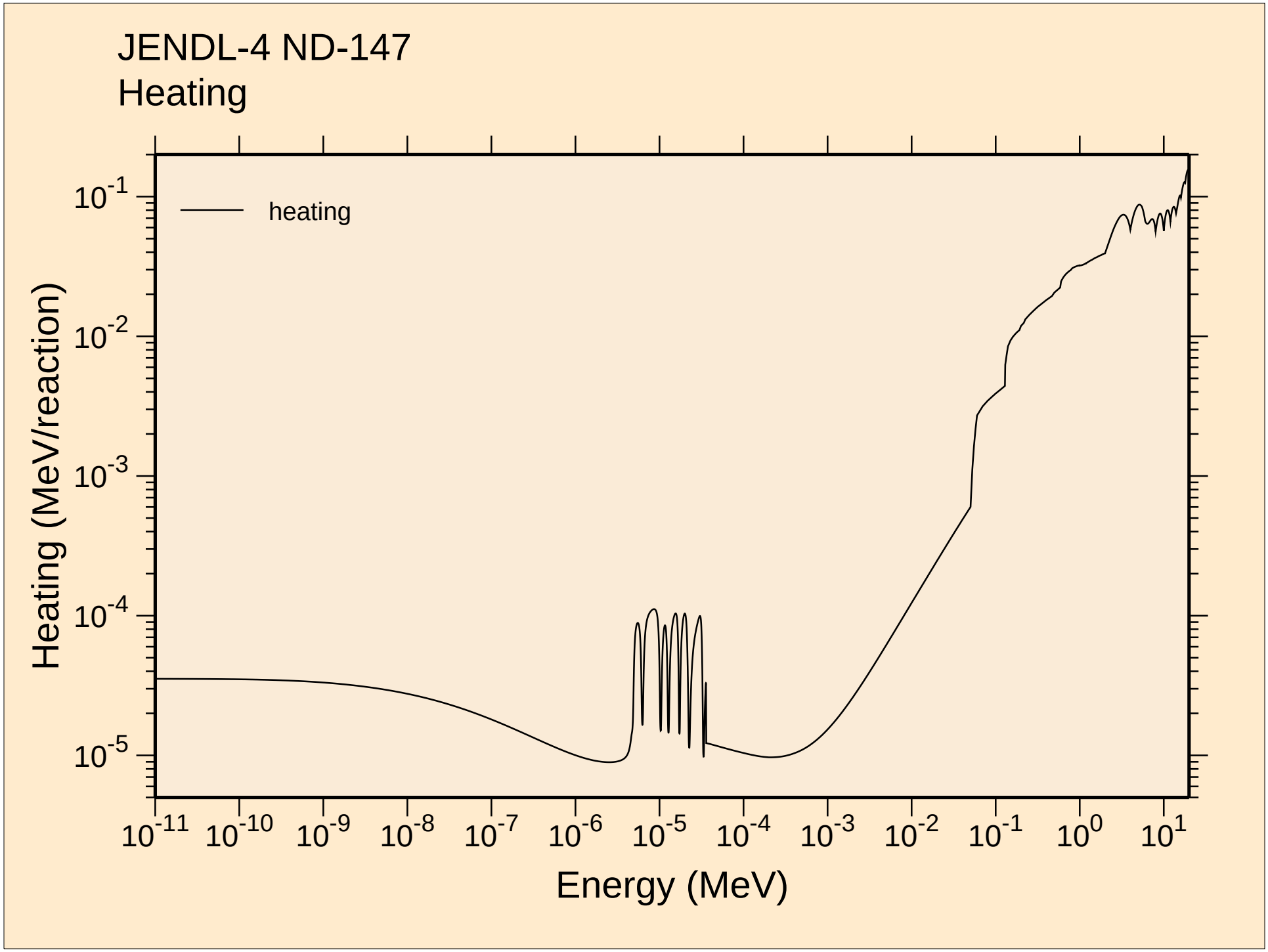

JENDL-4 ND-147
resonance absorption cross sections
capture
Cross section (barns)
10^4
10^3
10^2
10^1
10^{-5}
10^{-4}
Energy (MeV)

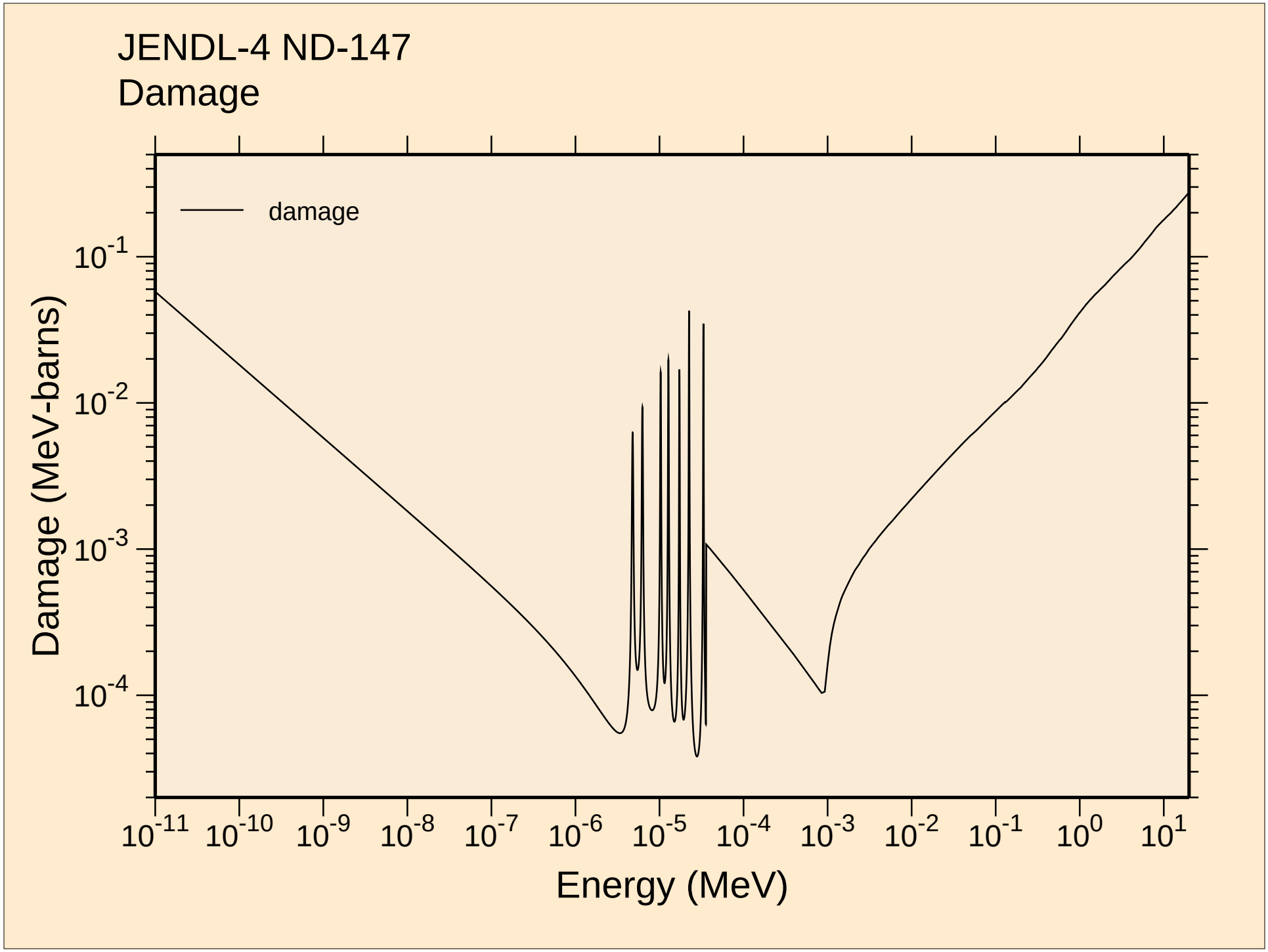

JENDL-4 ND-147
resonance absorption cross sections
capture
Cross section (barns)
10-1
10-2
10-3
100
101
Energy (MeV)

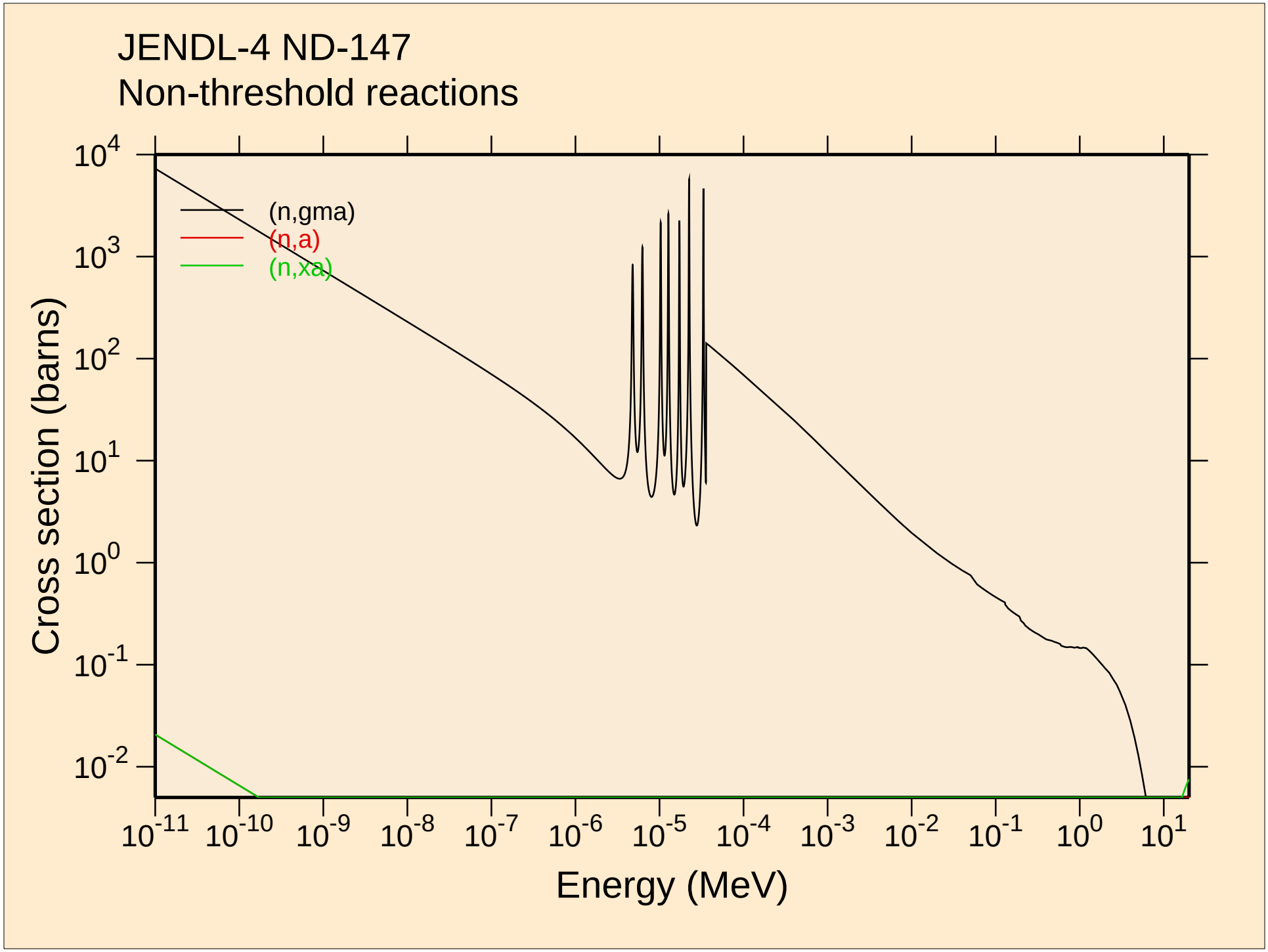

JENDL-4 ND-147
UR total cross section
Inf. Dil.
100 b
1 b
Cross section (barns)
10^2
10^1
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Energy (MeV)

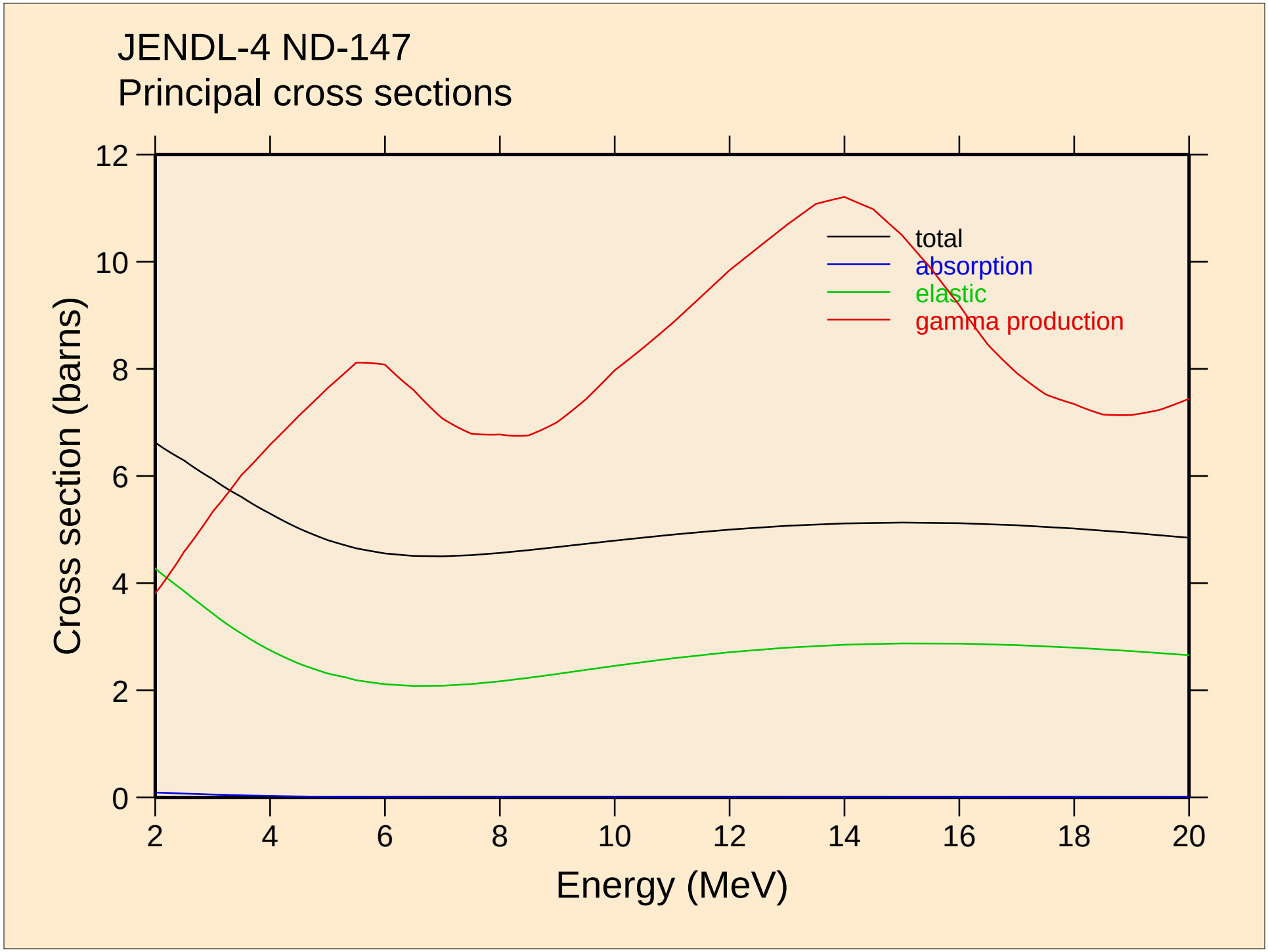

JENDL-4 ND-147
UR elastic cross section
Inf. Dil.
100 b
1 b
Cross section (barns)
10^2
10^1
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Energy (MeV)

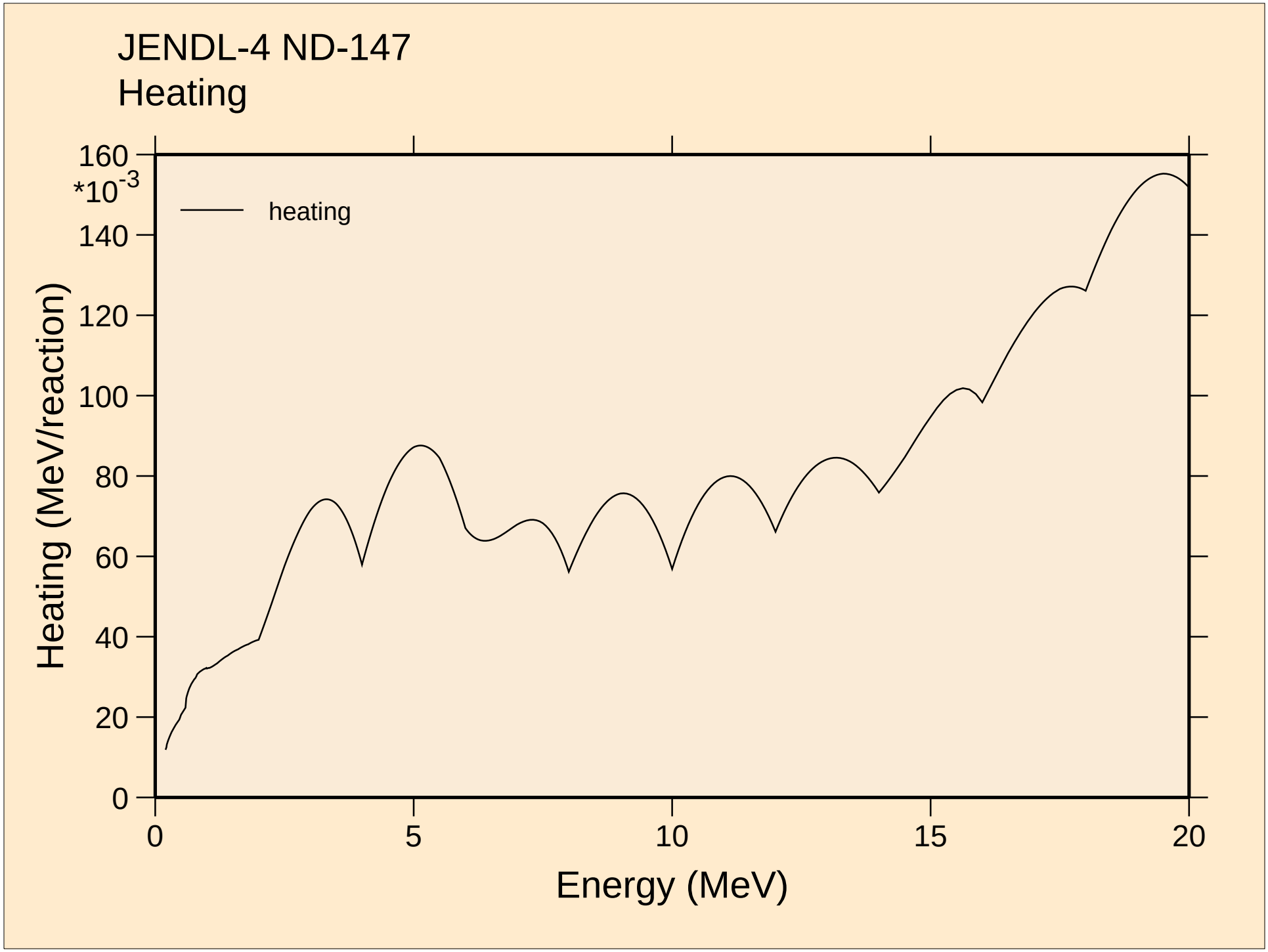

JENDL-4 ND-147
UR capture cross section
Inf. Dil.
100 b
1 b
Cross section (barns)
10^2
10^1
10^0
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Energy (MeV)

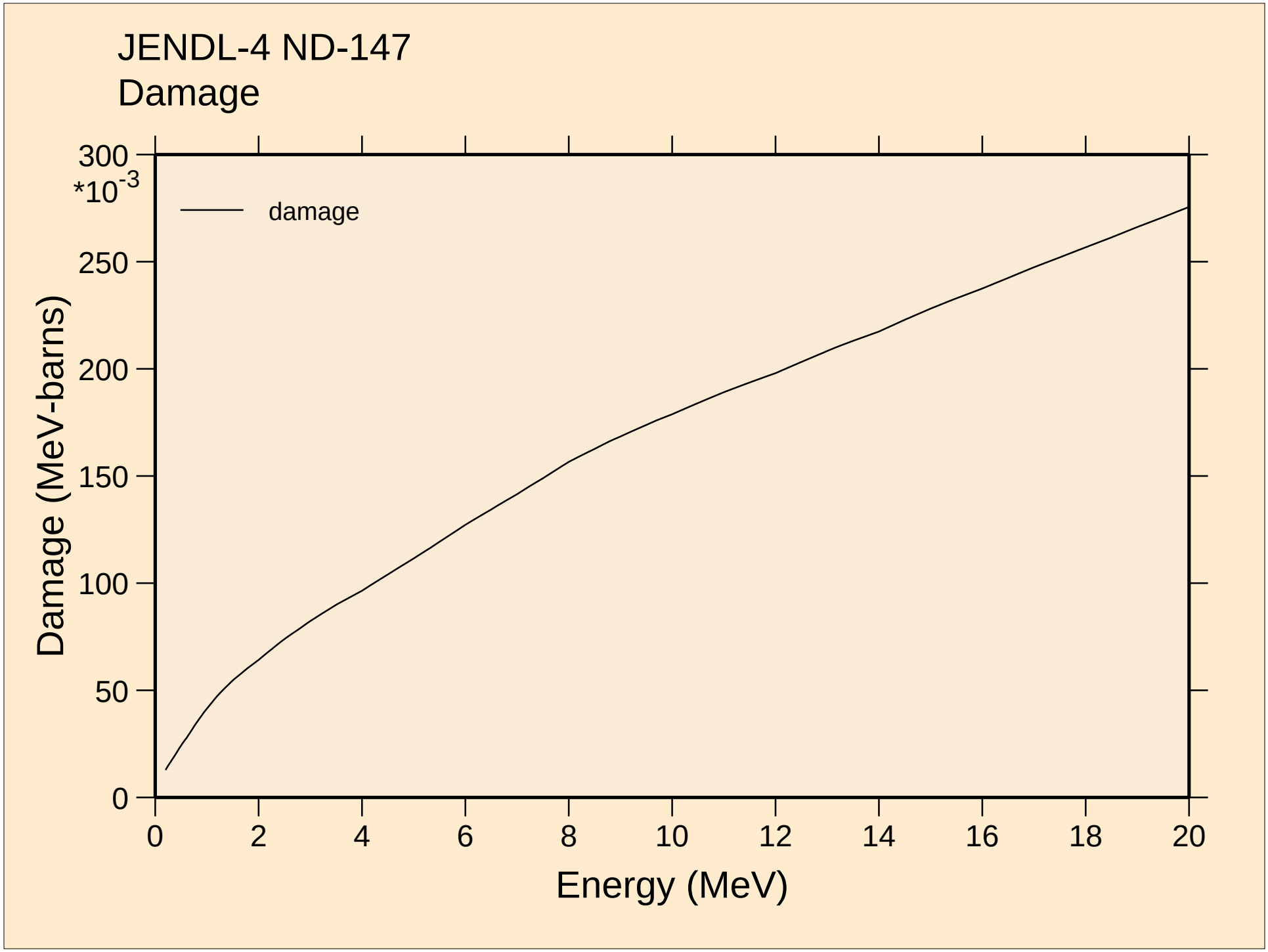

JENDL-4 ND-147
Heating
heating
Heating (MeV/reaction)
Energy (MeV)
10^-1
10^-2
10^-3
10^-4
10^-5
10^-11
10^-10
10^-9
10^-8
10^-7
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
10^0
10^1

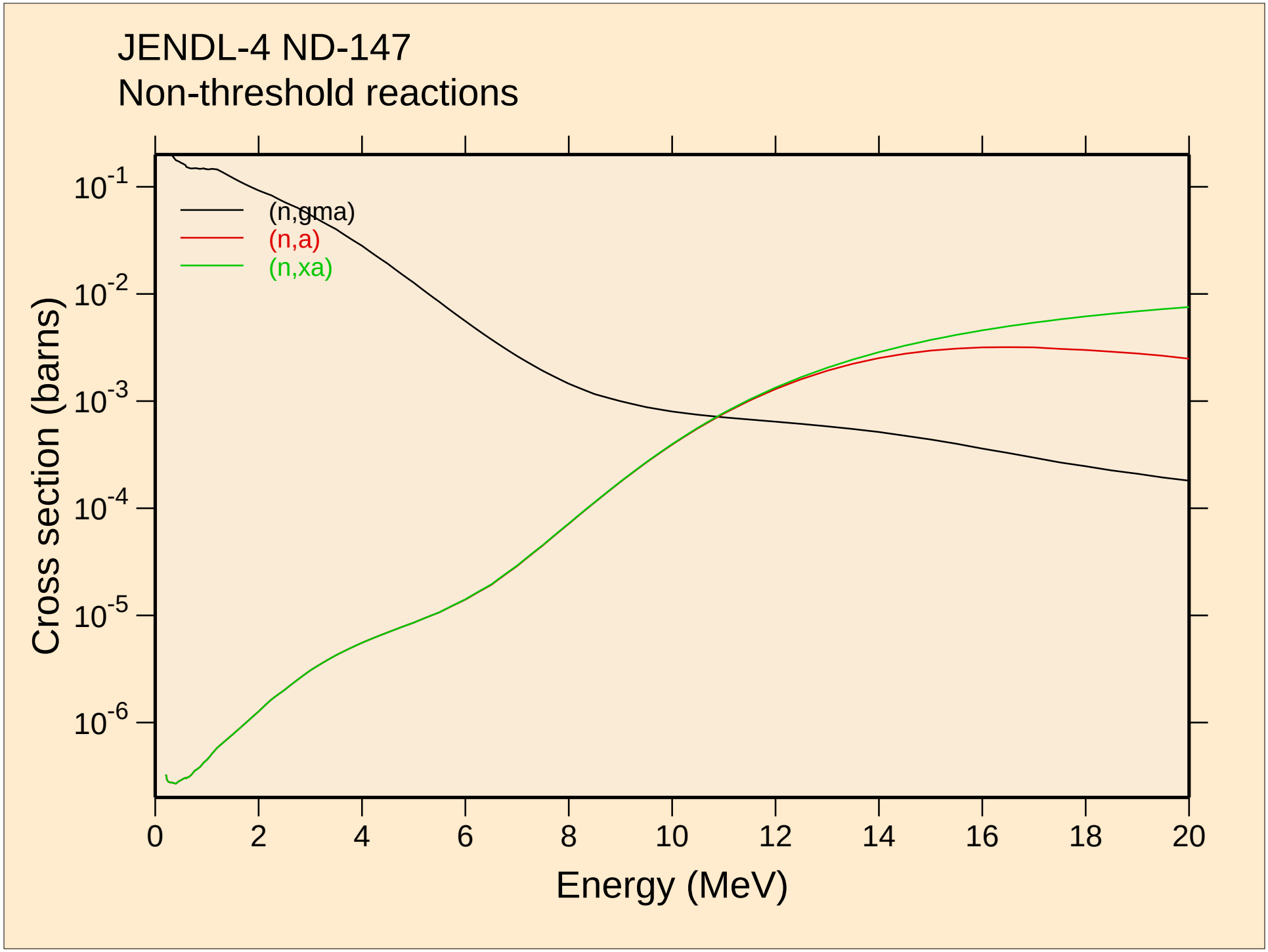

JENDL-4 ND-147
Damage
damage
Damage (MeV-barns)
Energy (MeV)
10^-1
10^-2
10^-3
10^-4
10^-11
10^-10
10^-9
10^-8
10^-7
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
10^0
10^1

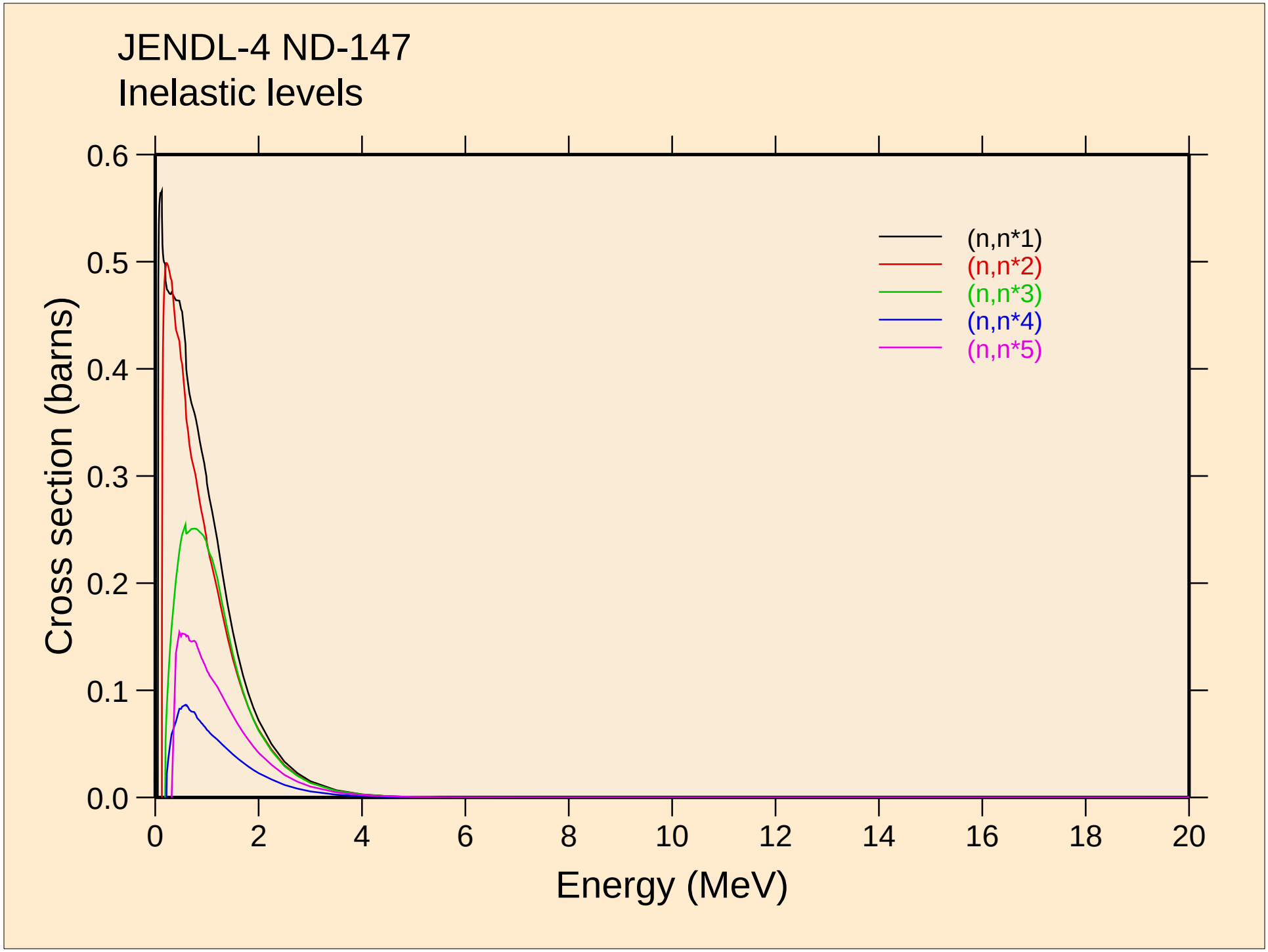

JENDL-4 ND-147
Non-threshold reactions
(n,gma)
(n,a)
(n,xa)
Cross section (barns)
Energy (MeV)
10^4
10^3
10^2
10^1
10^0
10^-1
10^-2
10^-11
10^-10
10^-9
10^-8
10^-7
10^-6
10^-5
10^-4
10^-3
10^-2
10^-1
10^0
10^1

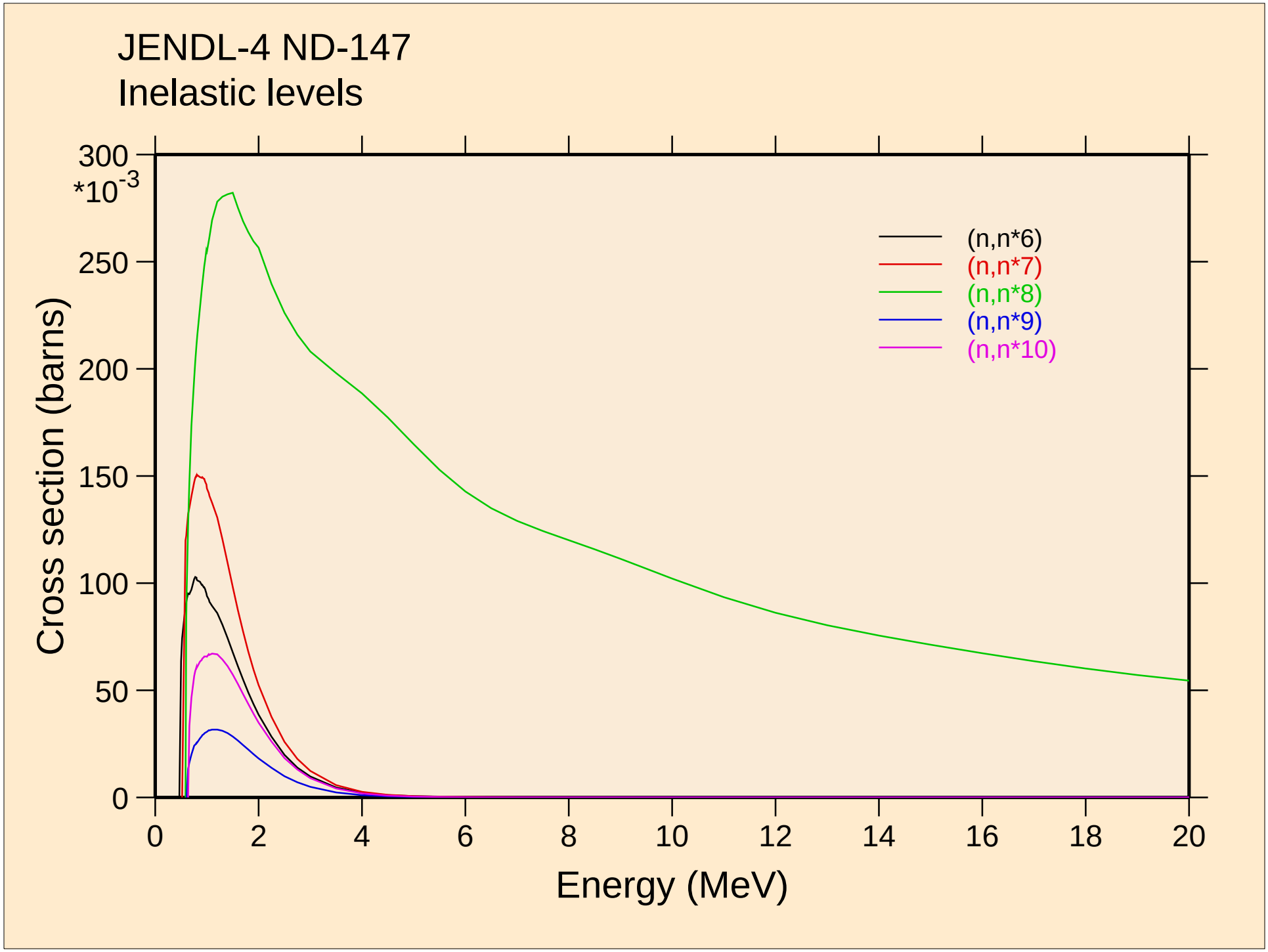

JENDL-4 ND-147
Principal cross sections
Cross section (barns)
Energy (MeV)
total
absorption
elastic
gamma production
0
2
4
6
8
10
12
2
4
6
8
10
12
14
16
18
20

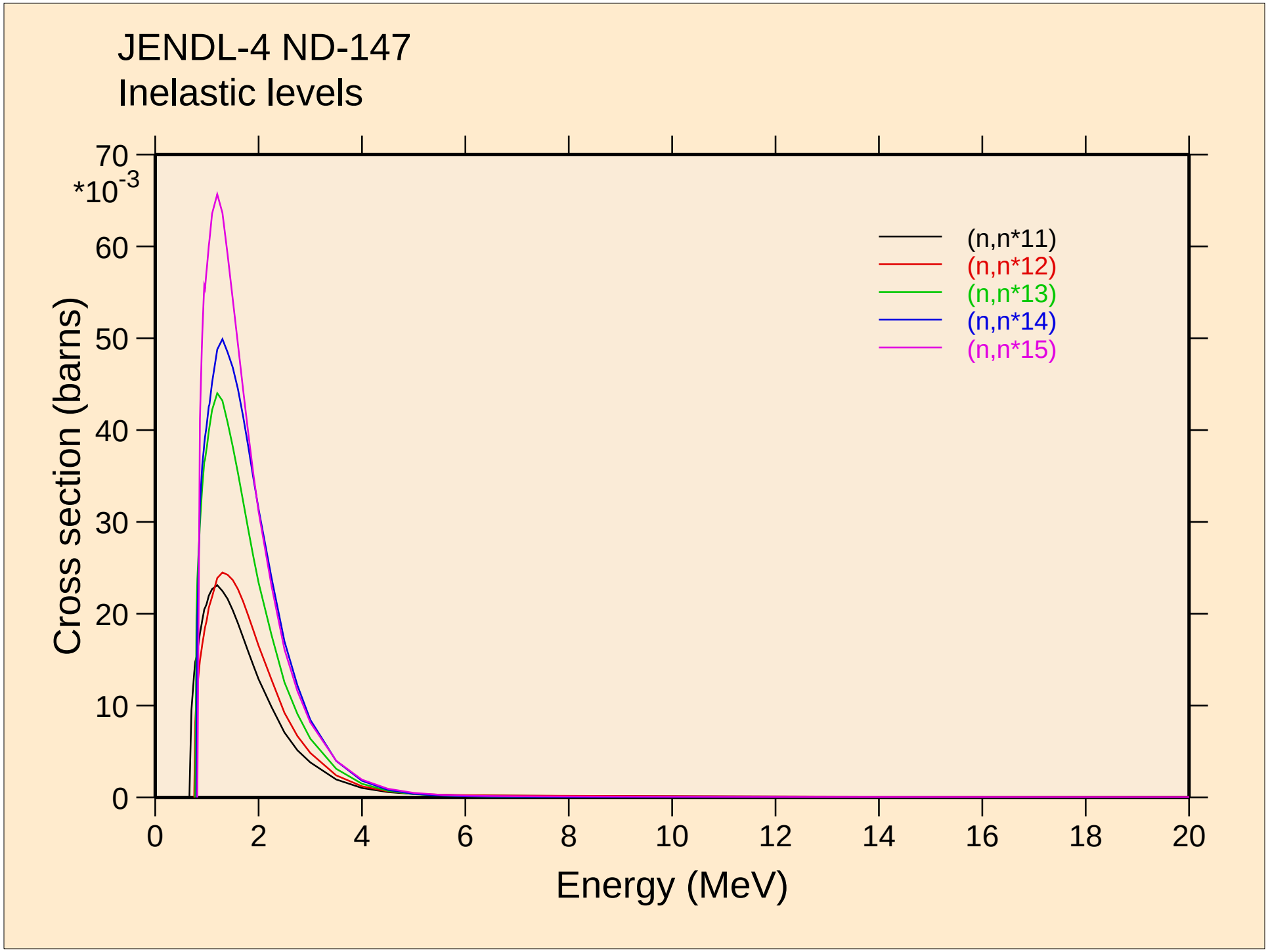

JENDL-4 ND-147
Heating
heating
*10-3
160
140
120
100
80
60
40
20
0
Heating (MeV/reaction)
0
5
10
15
20
Energy (MeV)

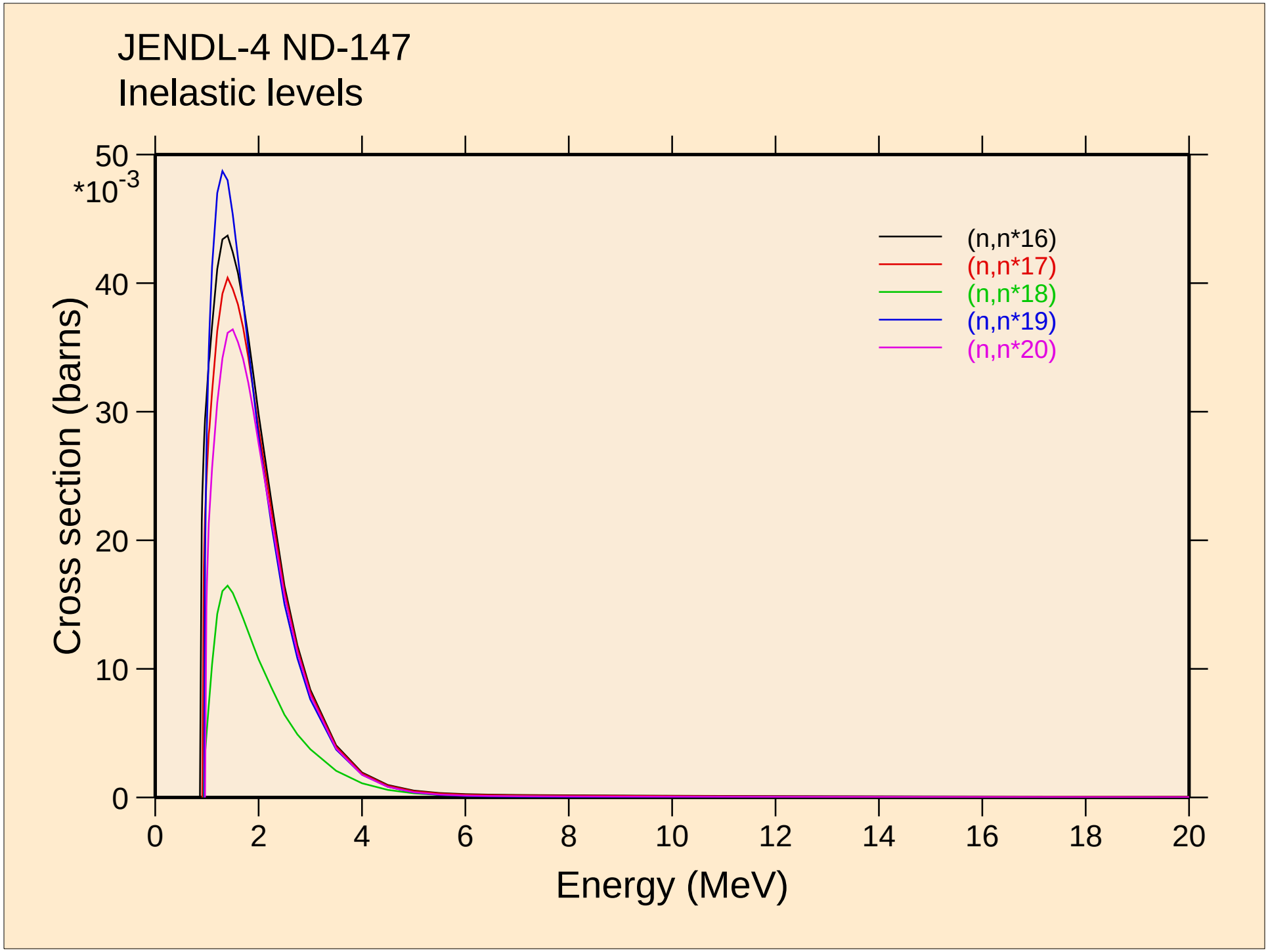

JENDL-4 ND-147
Damage
damage
Damage (MeV-barns)
*10-3
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)

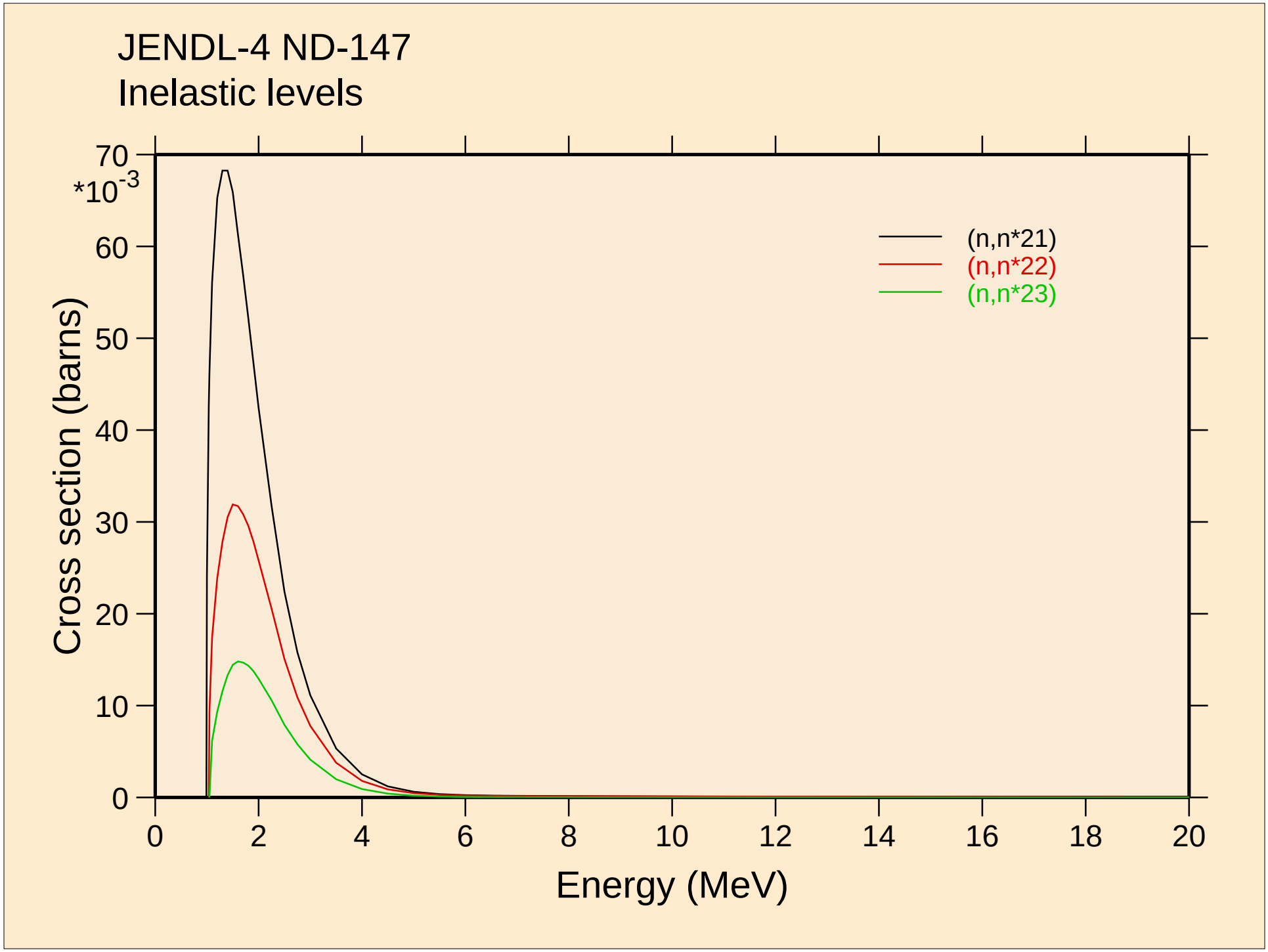

JENDL-4 ND-147
Non-threshold reactions
(n,gma)
(n,a)
(n,xa)
Cross section (barns)
10-1
10-2
10-3
10-4
10-5
10-6
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)

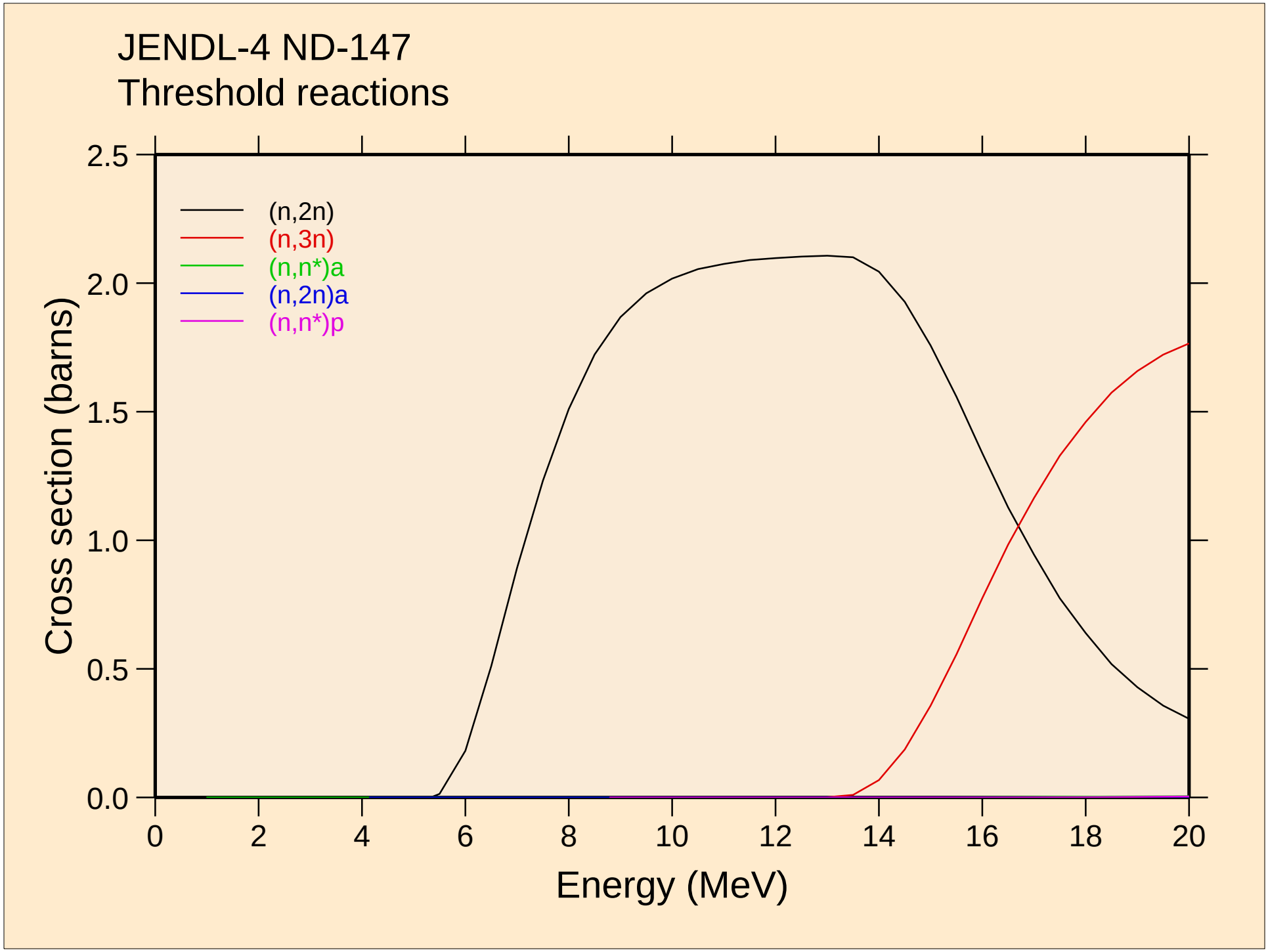

JENDL-4 ND-147
Inelastic levels
Cross section (barns)
Energy (MeV)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
2
4
6
8
10
12
14
16
18
20
(n,n*1)
(n,n*2)
(n,n*3)
(n,n*4)
(n,n*5)

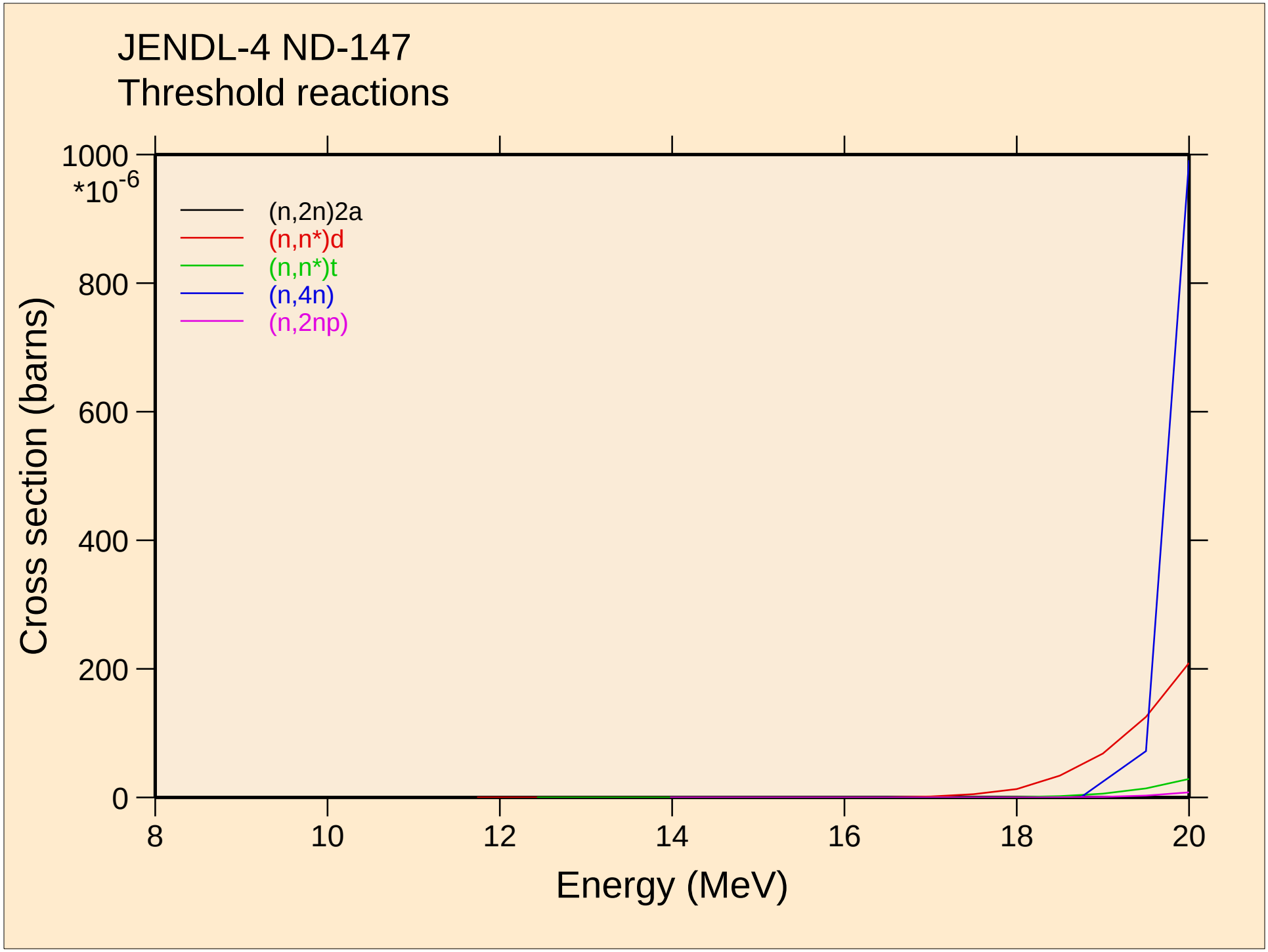

JENDL-4 ND-147
Inelastic levels
Cross section (barns)
*10^-3
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)
(n,n*6)
(n,n*7)
(n,n*8)
(n,n*9)
(n,n*10)

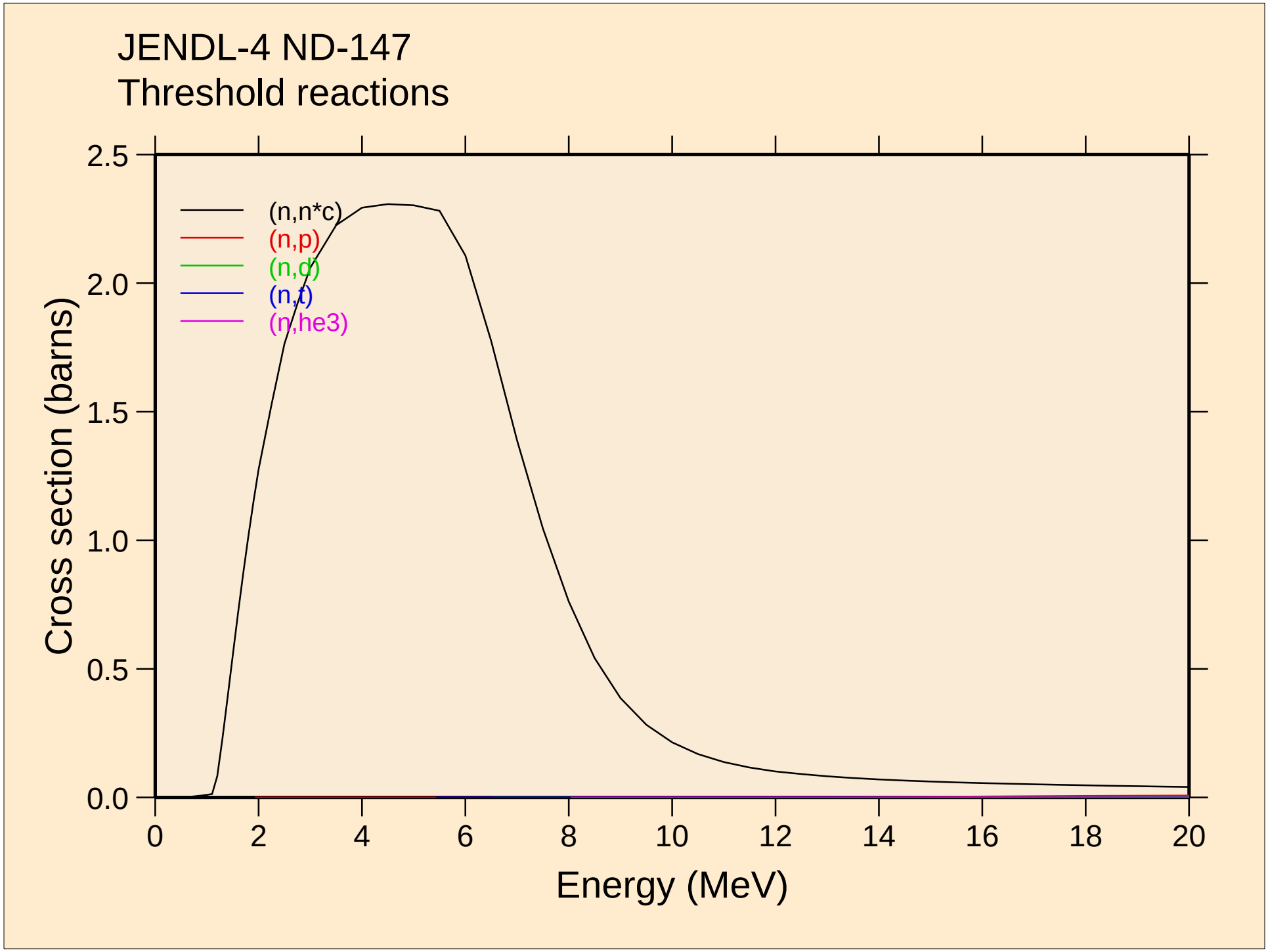

JENDL-4 ND-147
Inelastic levels
Cross section (barns)
*10^-3
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)
(n,n*11)
(n,n*12)
(n,n*13)
(n,n*14)
(n,n*15)

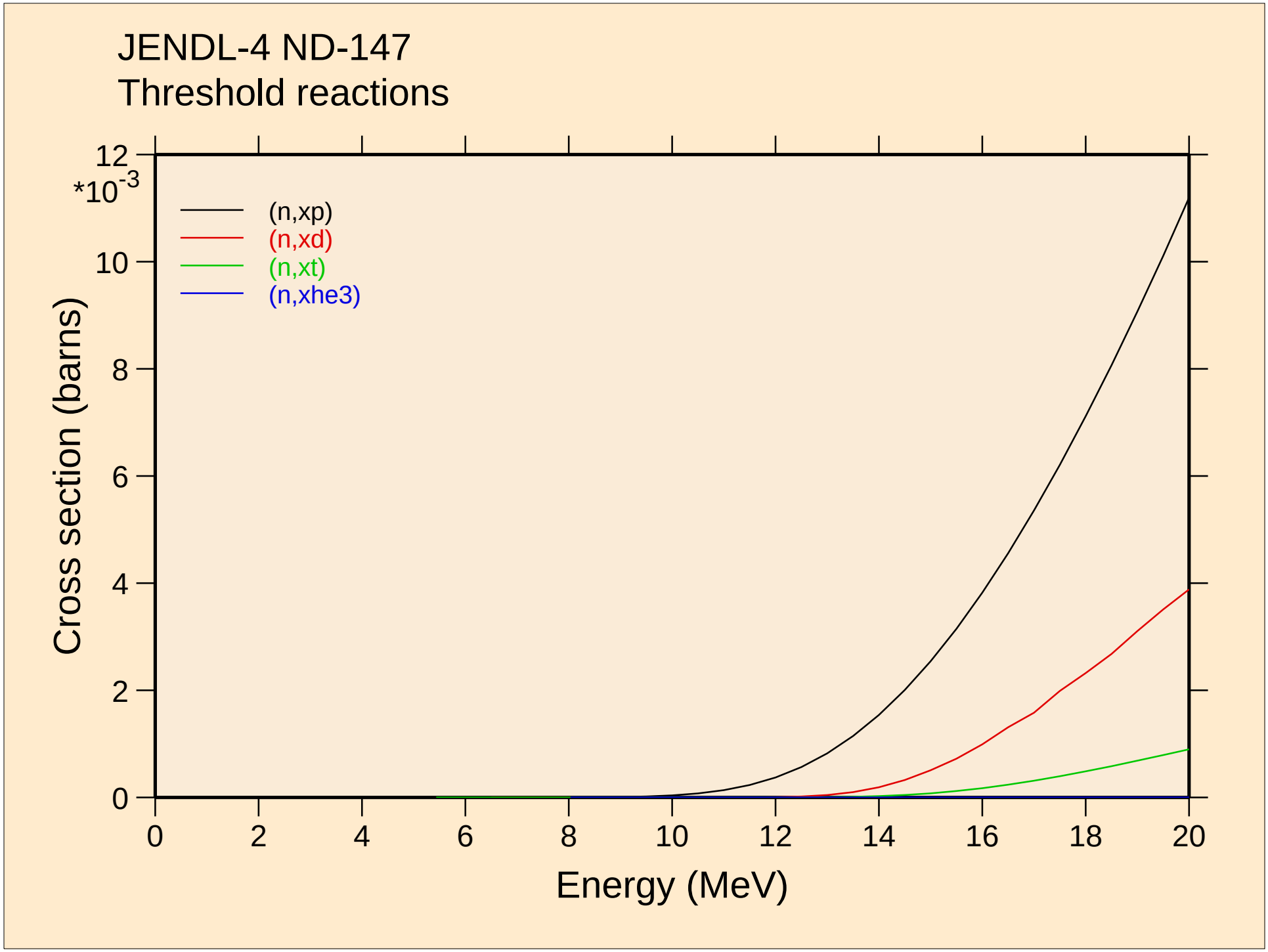

JENDL-4 ND-147
Inelastic levels
Cross section (barns)
*10^-3
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)
(n,n*16)
(n,n*17)
(n,n*18)
(n,n*19)
(n,n*20)

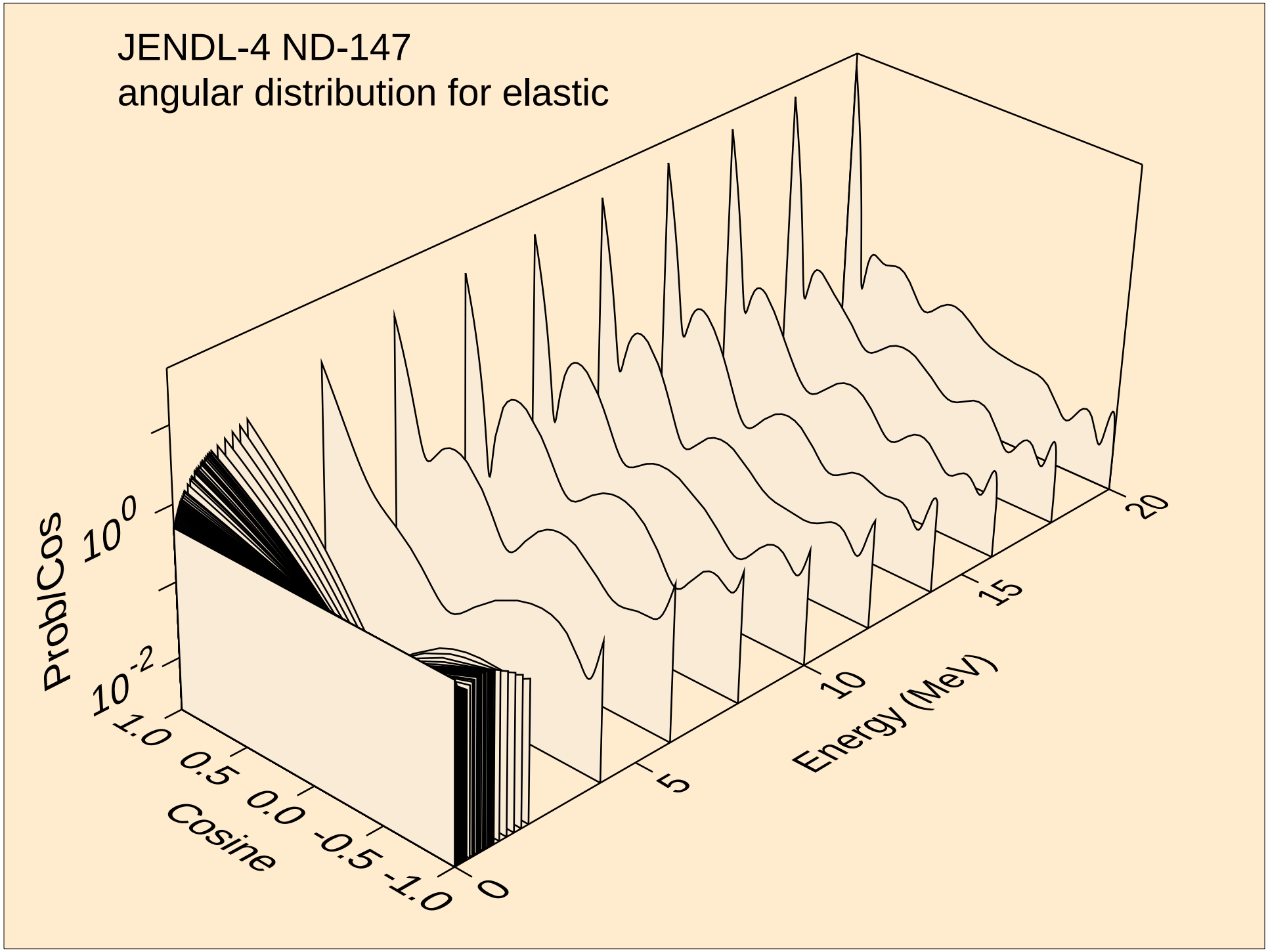

JENDL-4 ND-147
Inelastic levels
*10-3
70
60
50
40
30
20
10
0
Cross section (barns)
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)
(n,n*21)
(n,n*22)
(n,n*23)

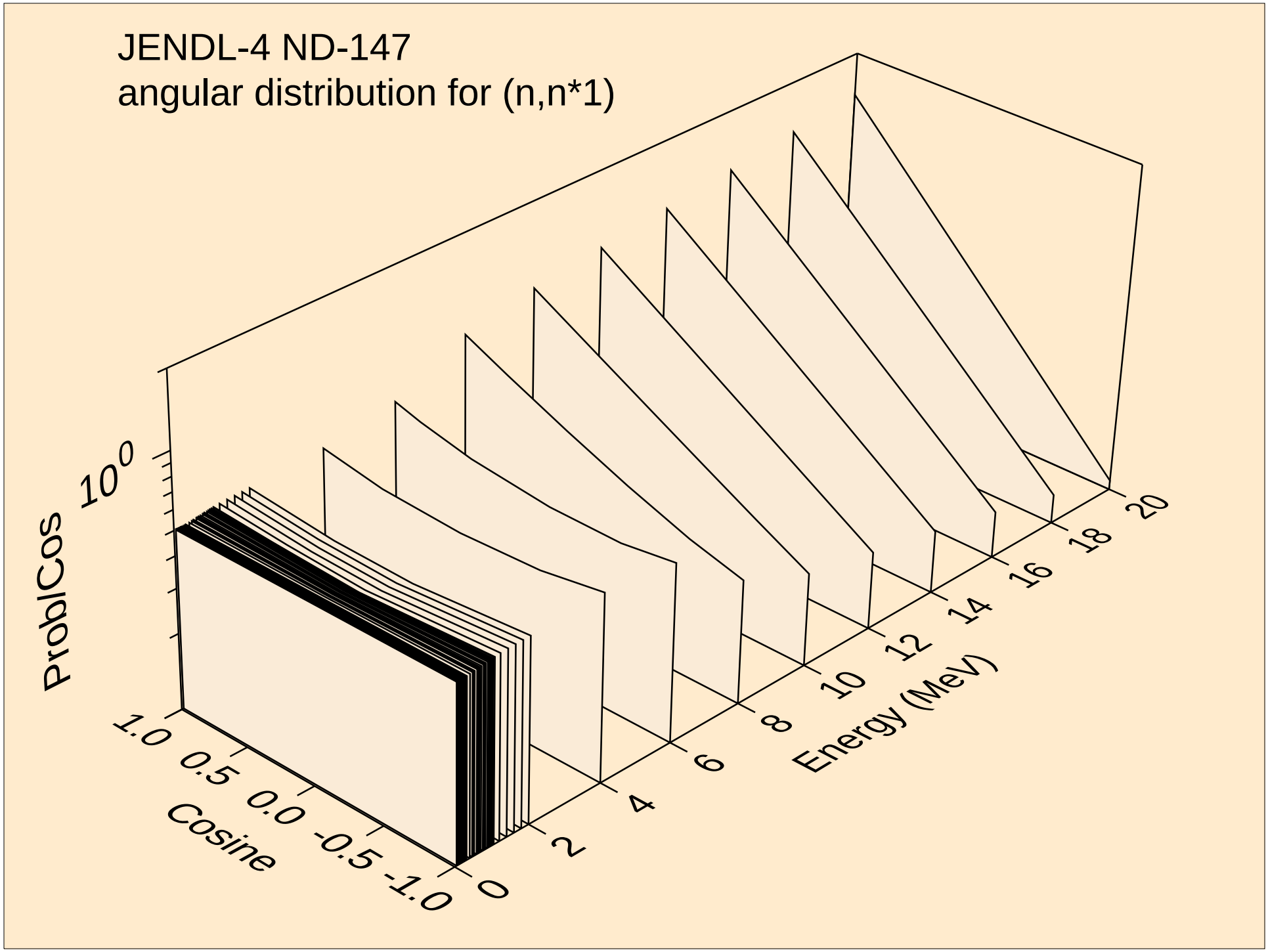

JENDL-4 ND-147
Threshold reactions
(n,2n)
(n,3n)
(n,n*)a
(n,2n)a
(n,n*)p
Cross section (barns)
Energy (MeV)
0.0
0.5
1.0
1.5
2.0
2.5
0
2
4
6
8
10
12
14
16
18
20

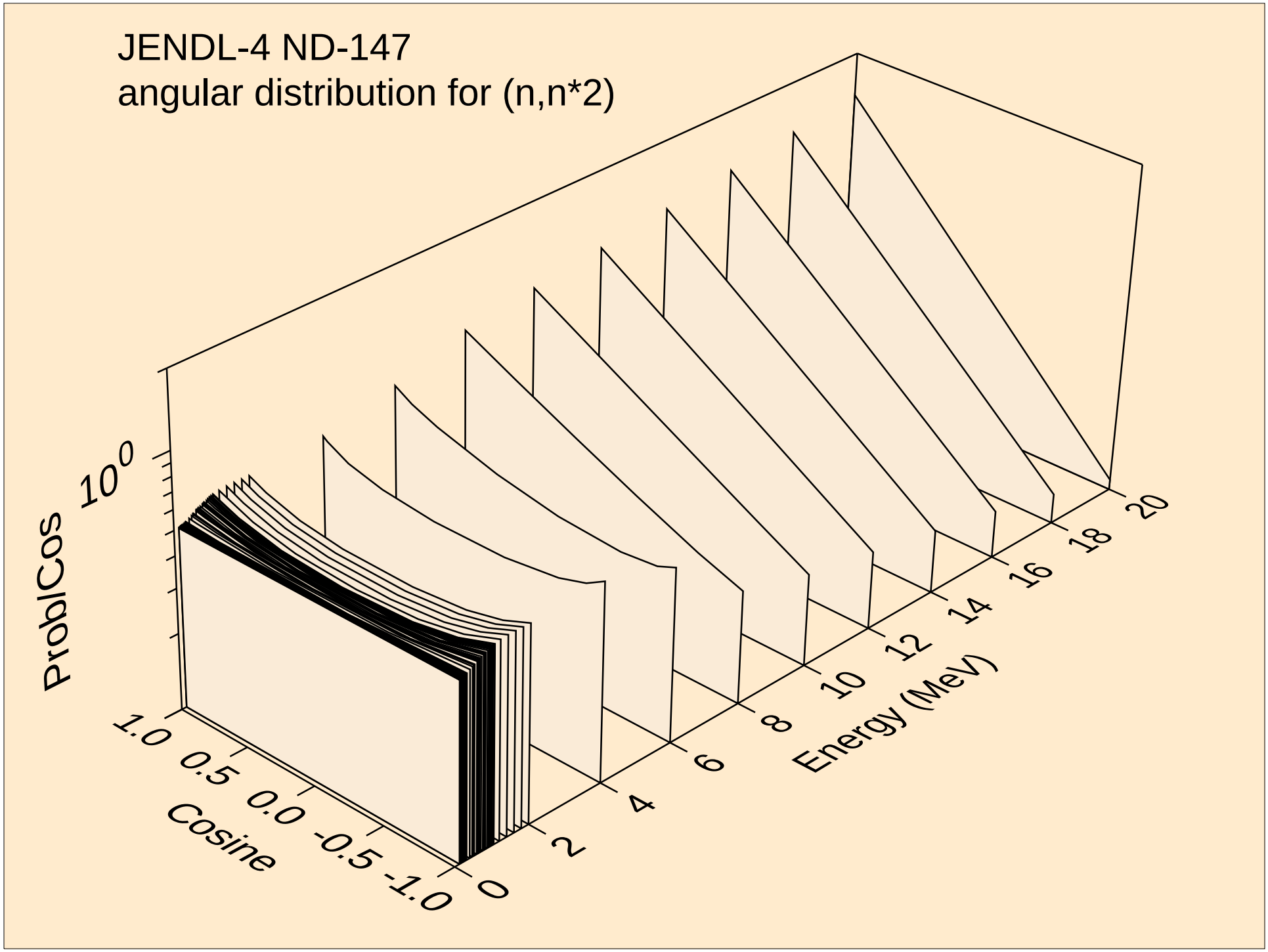

JENDL-4 ND-147
Threshold reactions
1000
*10-6
800
600
400
200
0
Cross section (barns)
(n,2n)2a
(n,n*)d
(n,n*)t
(n,4n)
(n,2np)
8
10
12
14
16
18
20
Energy (MeV)

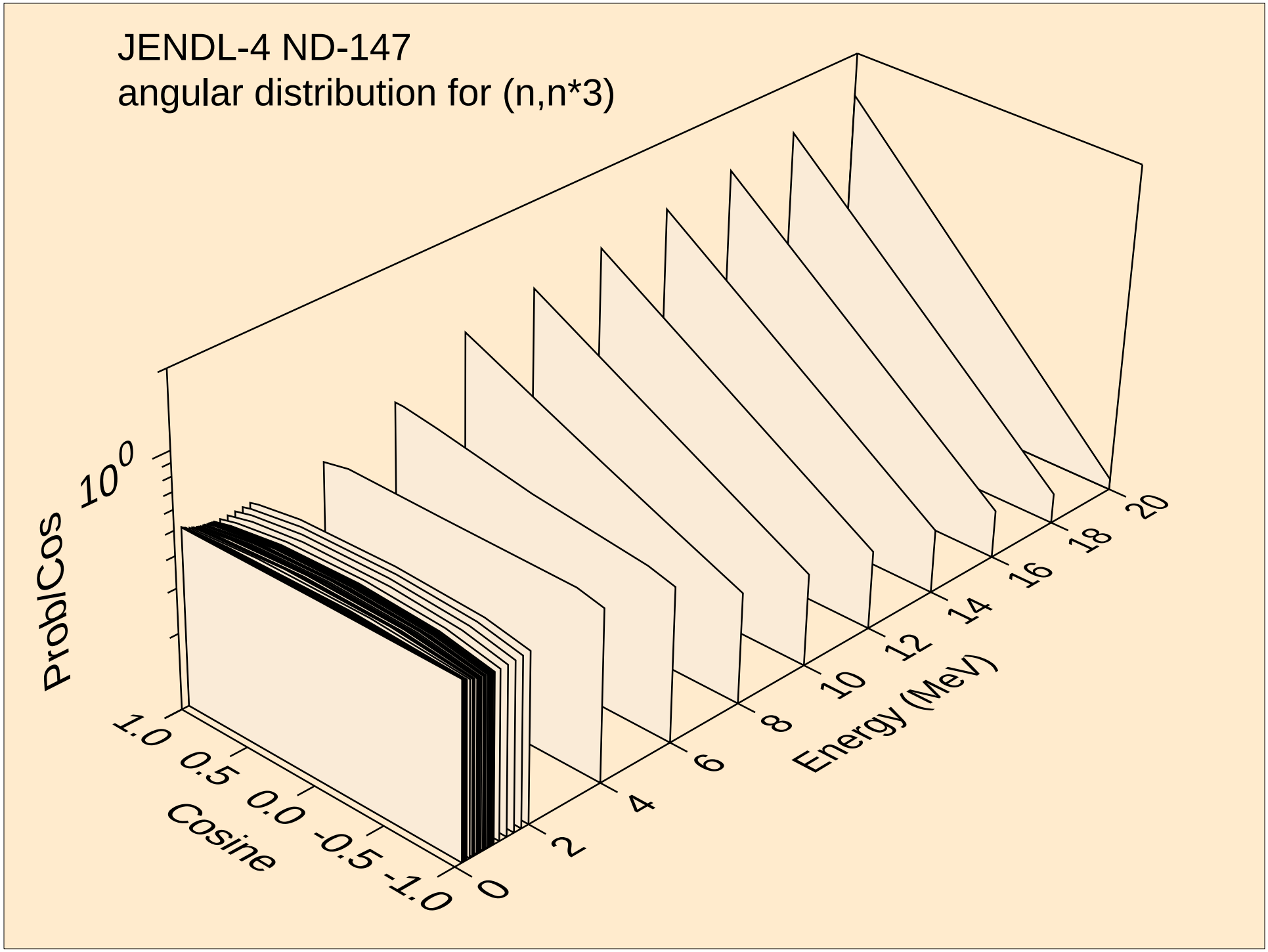

JENDL-4 ND-147
Threshold reactions
(n,n*c)
(n,p)
(n,d)
(n,t)
(n,he3)
Cross section (barns)
Energy (MeV)
0.0
0.5
1.0
1.5
2.0
2.5
0
2
4
6
8
10
12
14
16
18
20

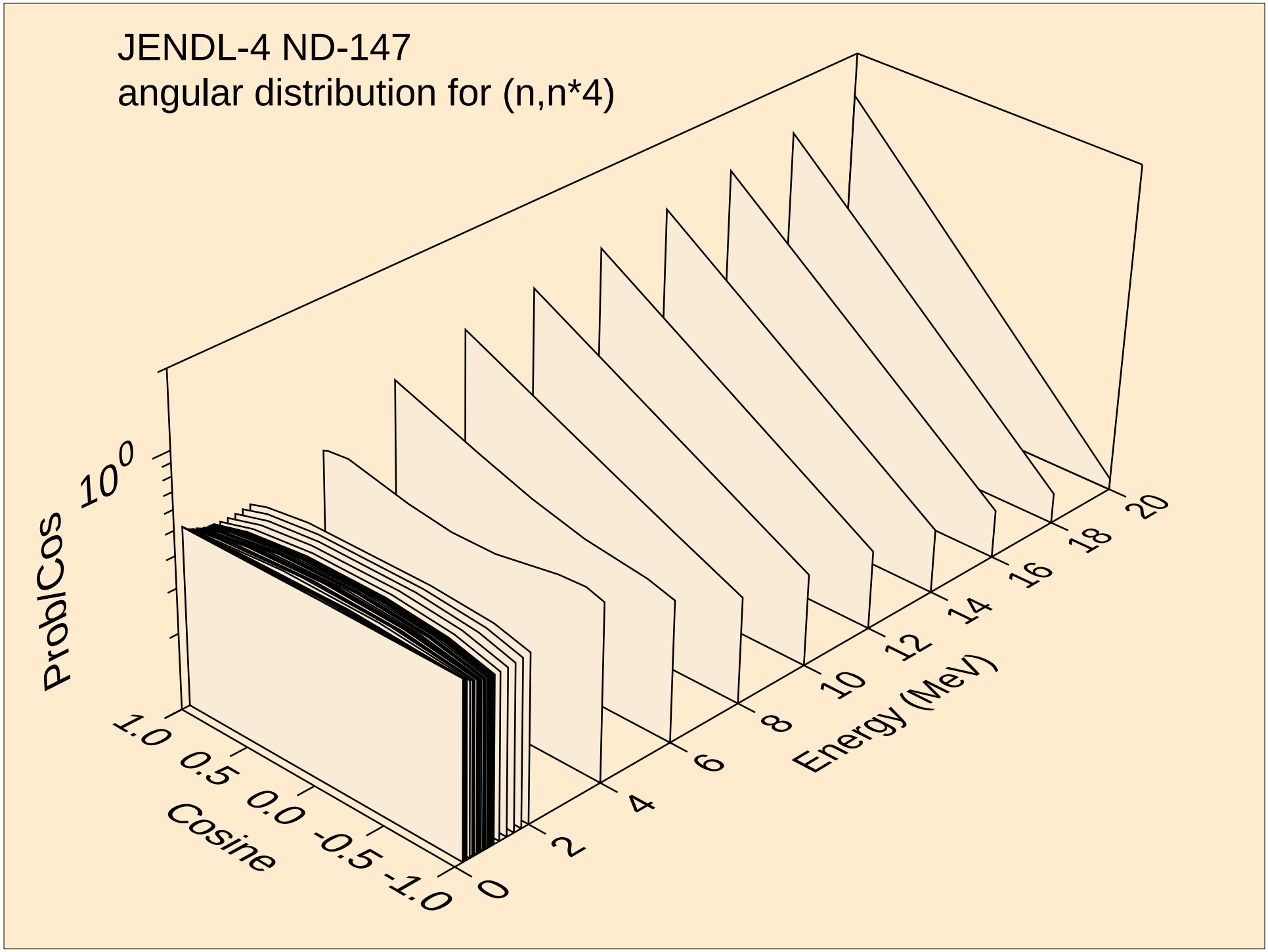

JENDL-4 ND-147
Threshold reactions
*10-3
12
10
8
6
4
2
0
Cross section (barns)
(n,xp)
(n,xd)
(n,xt)
(n,xhe3)
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)

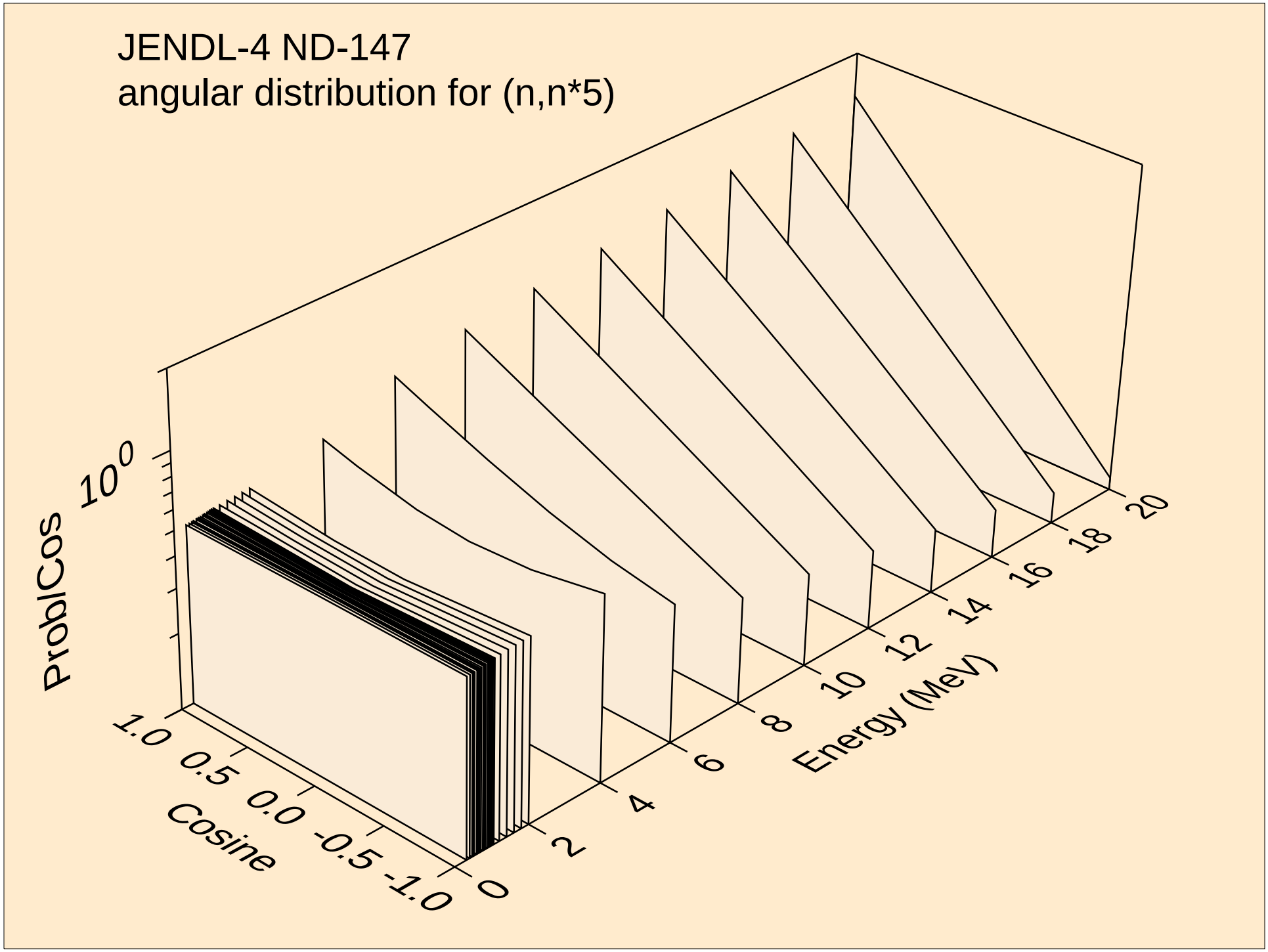

JENDL-4 ND-147
angular distribution for elastic
ProblCos
10^0
10^{-2}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
Energy (MeV)

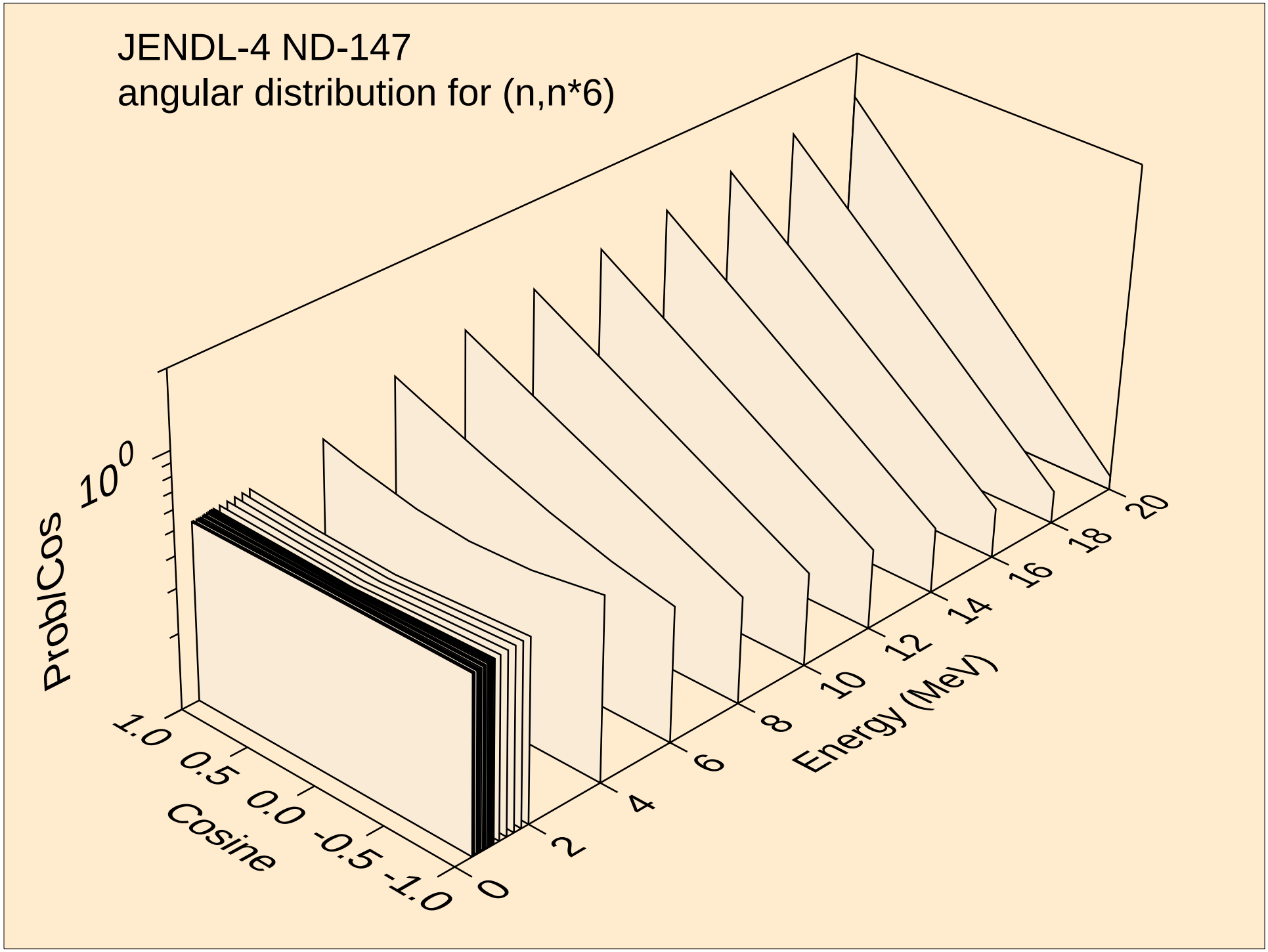

JENDL-4 ND-147
angular distribution for (n,n*1)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

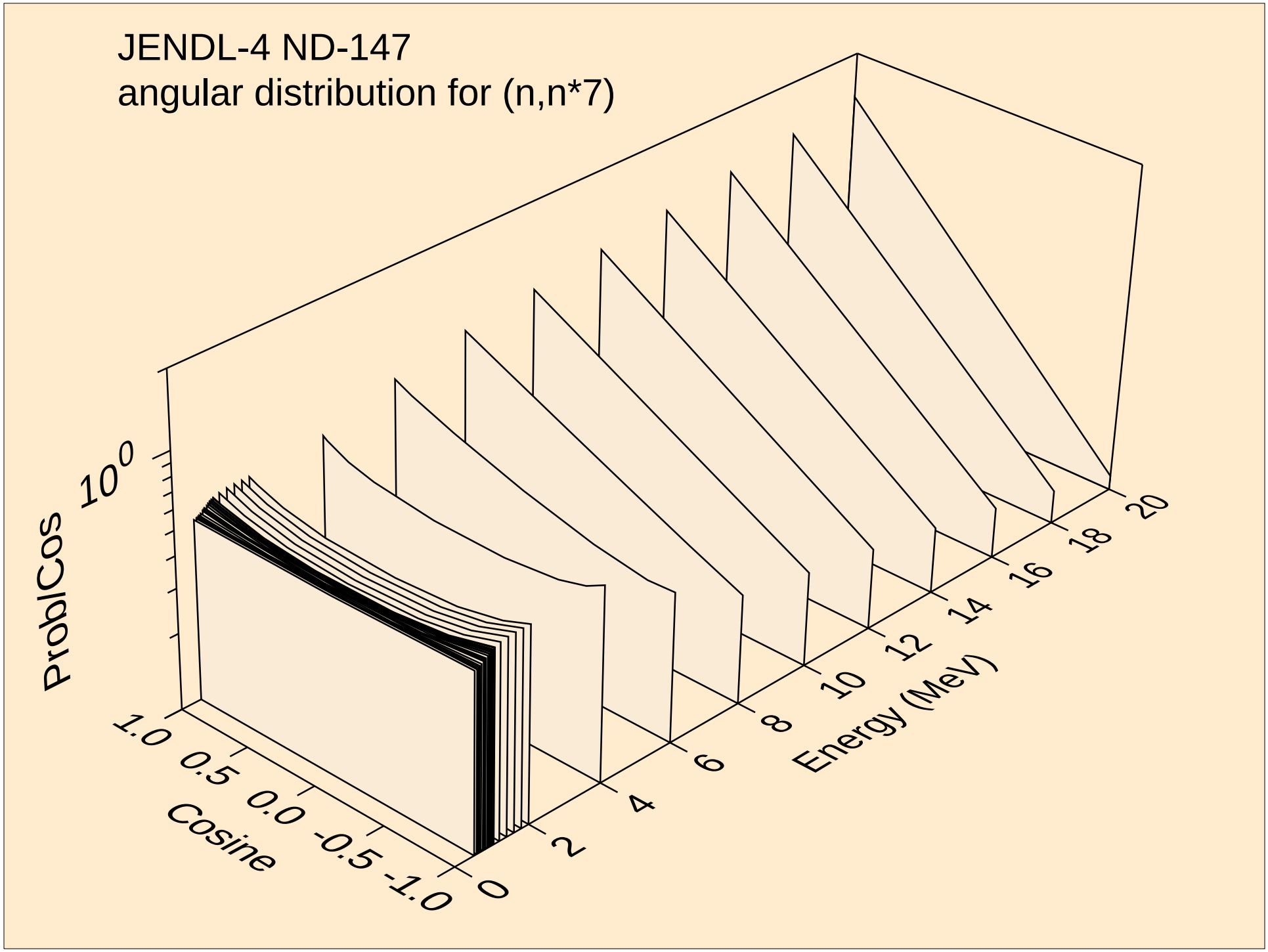

JENDL-4 ND-147
angular distribution for (n,n*2)
ProblCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

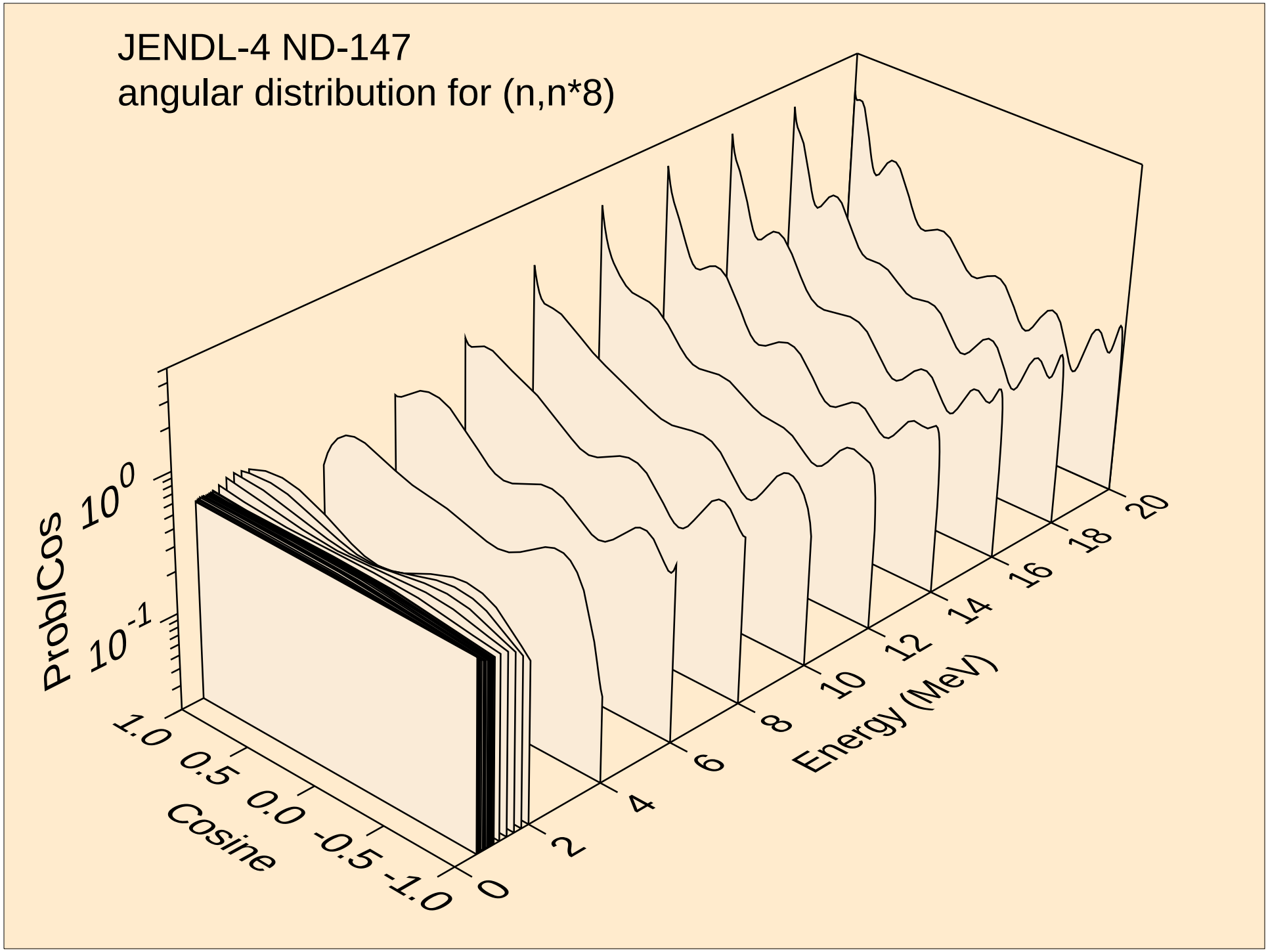

JENDL-4 ND-147
angular distribution for (n,n*3)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

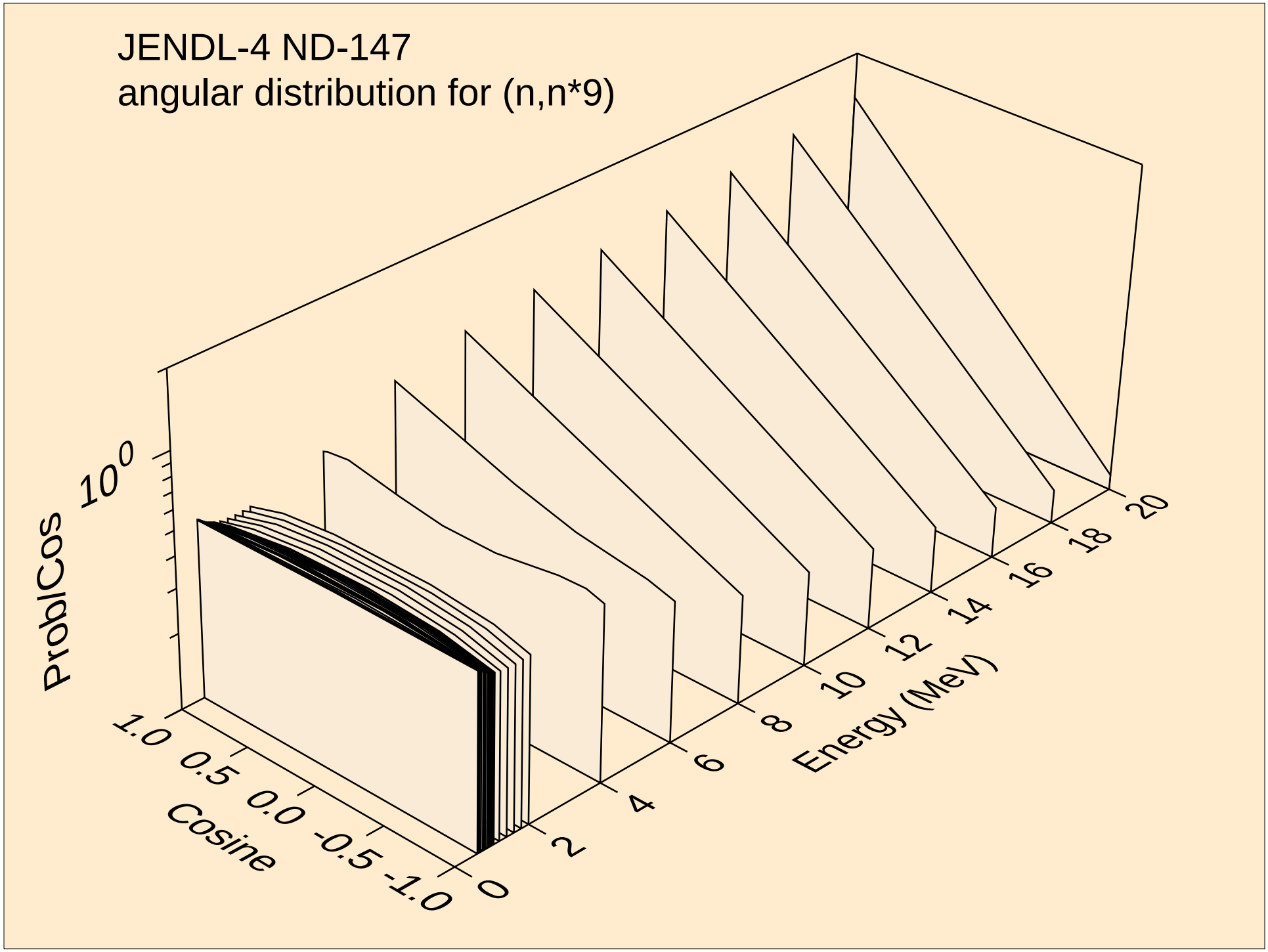

JENDL-4 ND-147
angular distribution for (n,n*4)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

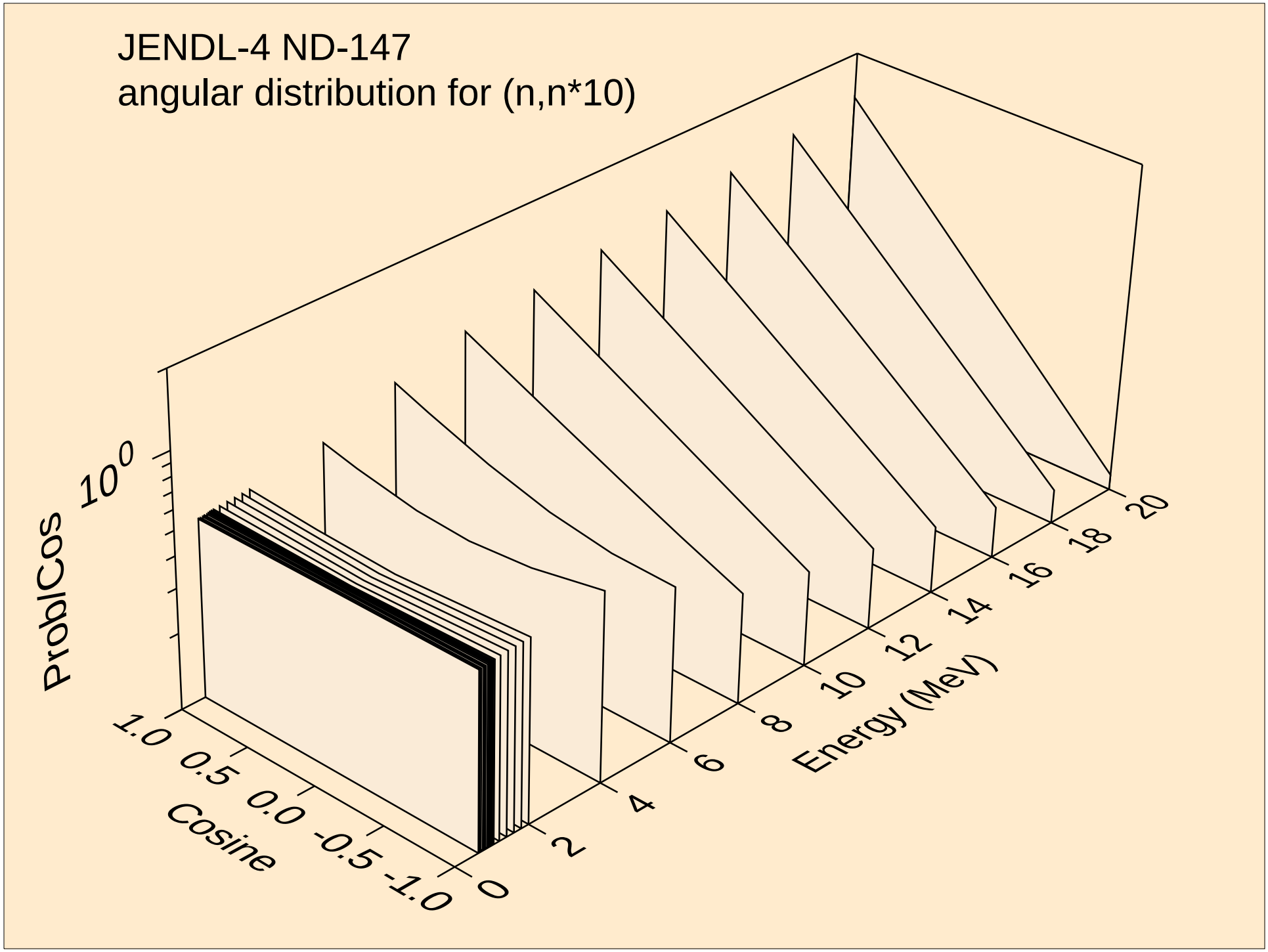

JENDL-4 ND-147
angular distribution for (n,n*5)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

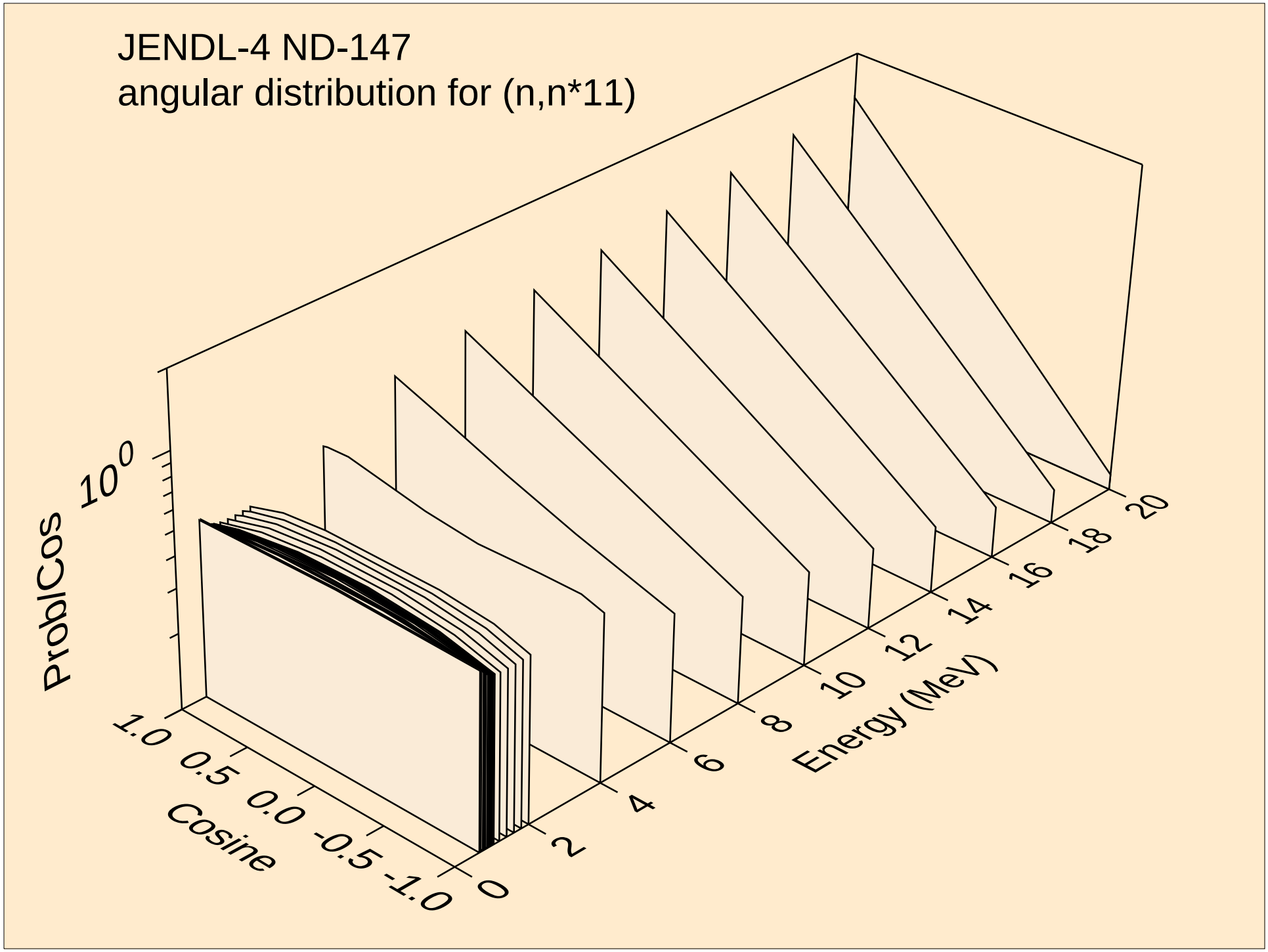

JENDL-4 ND-147
angular distribution for (n,n*6)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

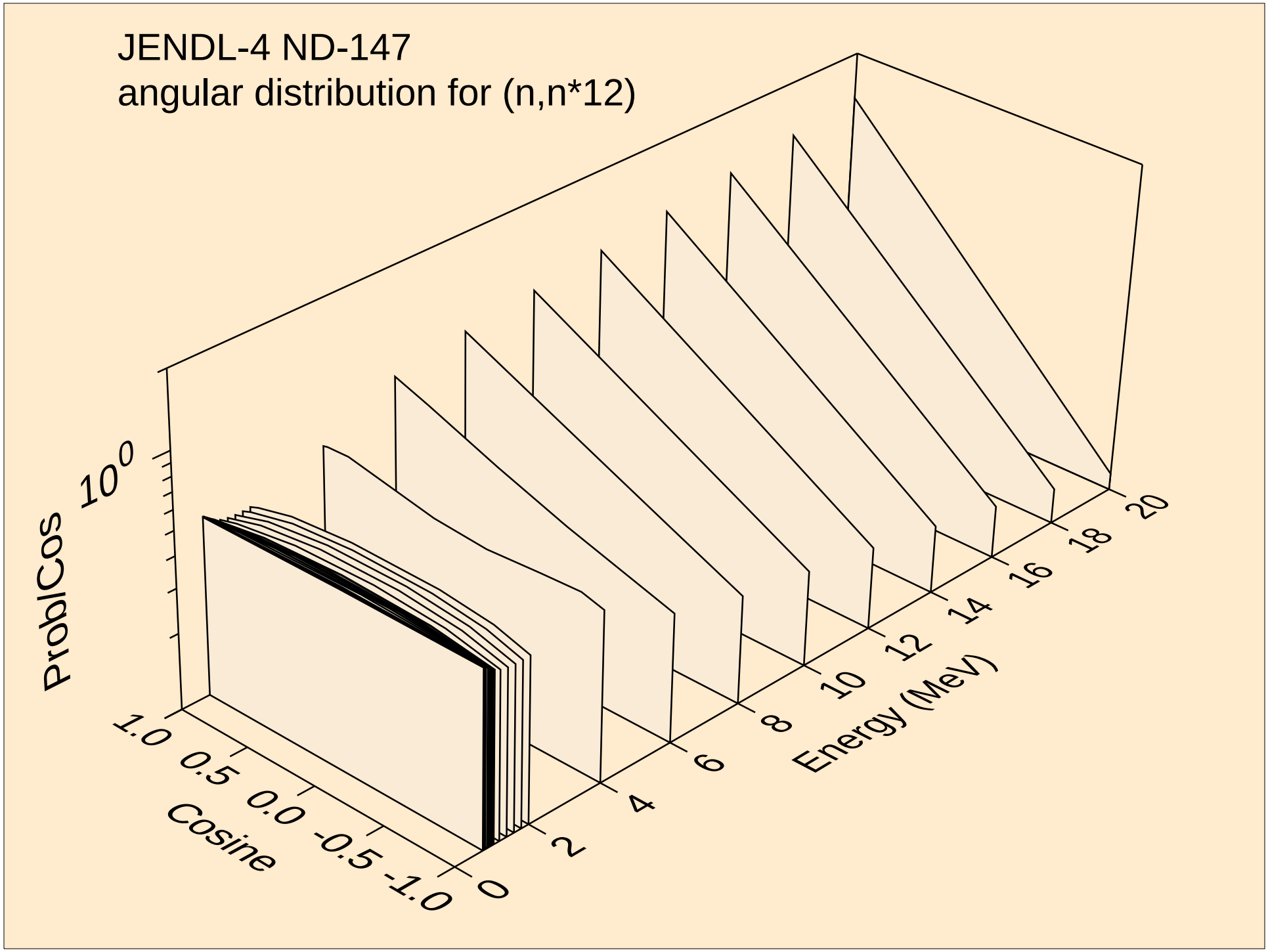

JENDL-4 ND-147
angular distribution for (n,n*7)
ProblCos
10^0
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)

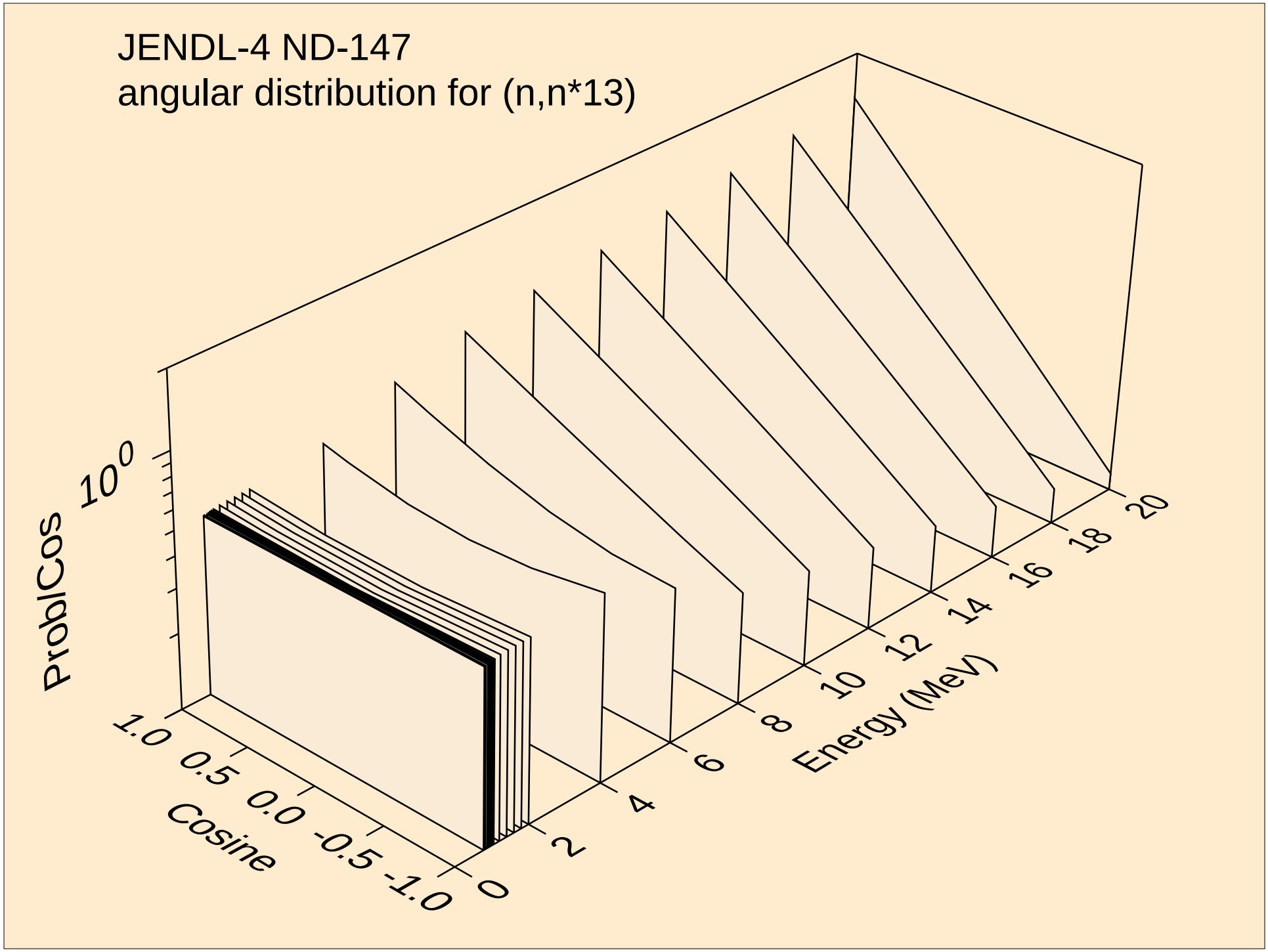

JENDL-4 ND-147
angular distribution for (n,n*8)
ProbCos
10^0
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)

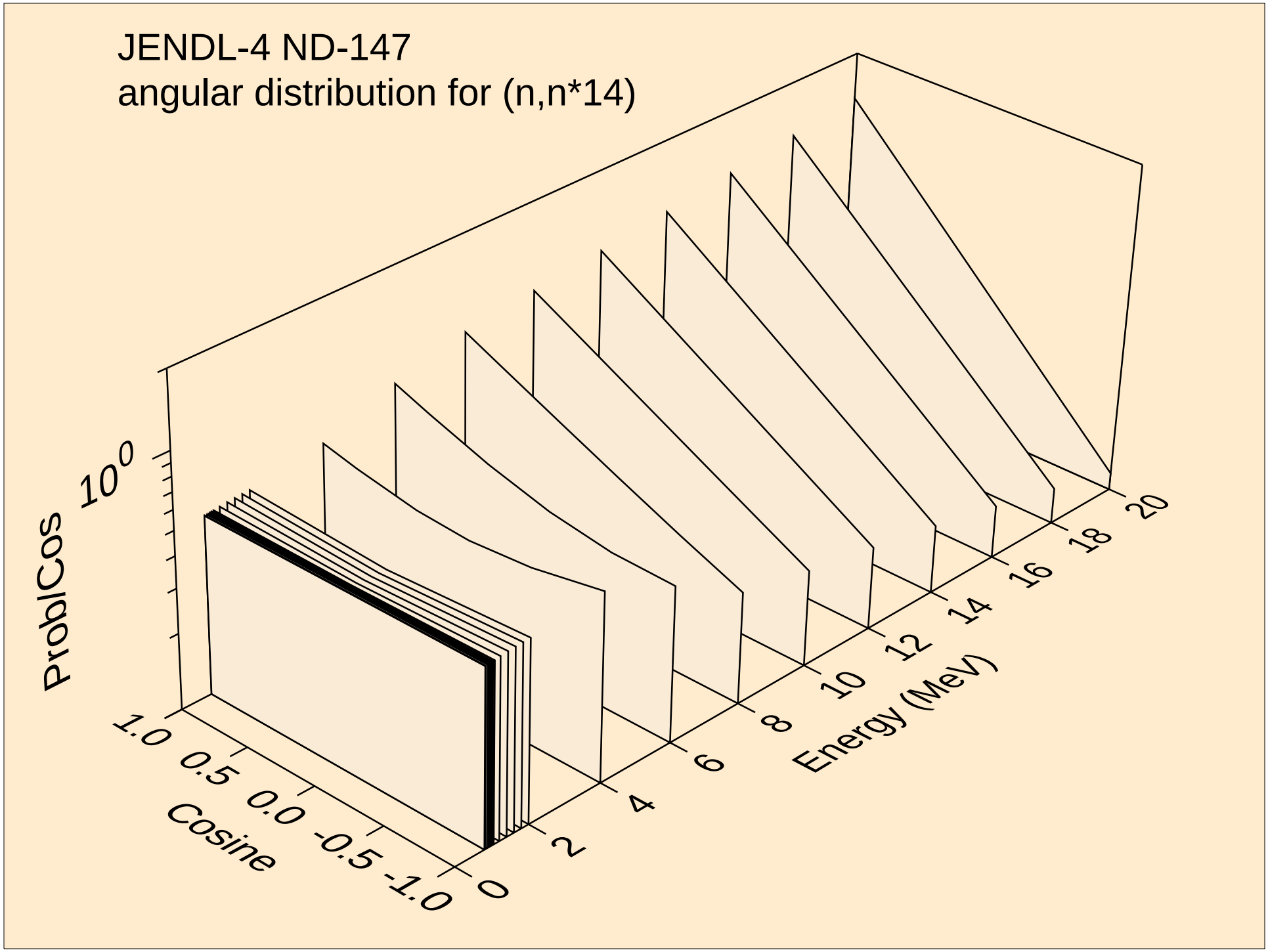

JENDL-4 ND-147
angular distribution for (n,n*9)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

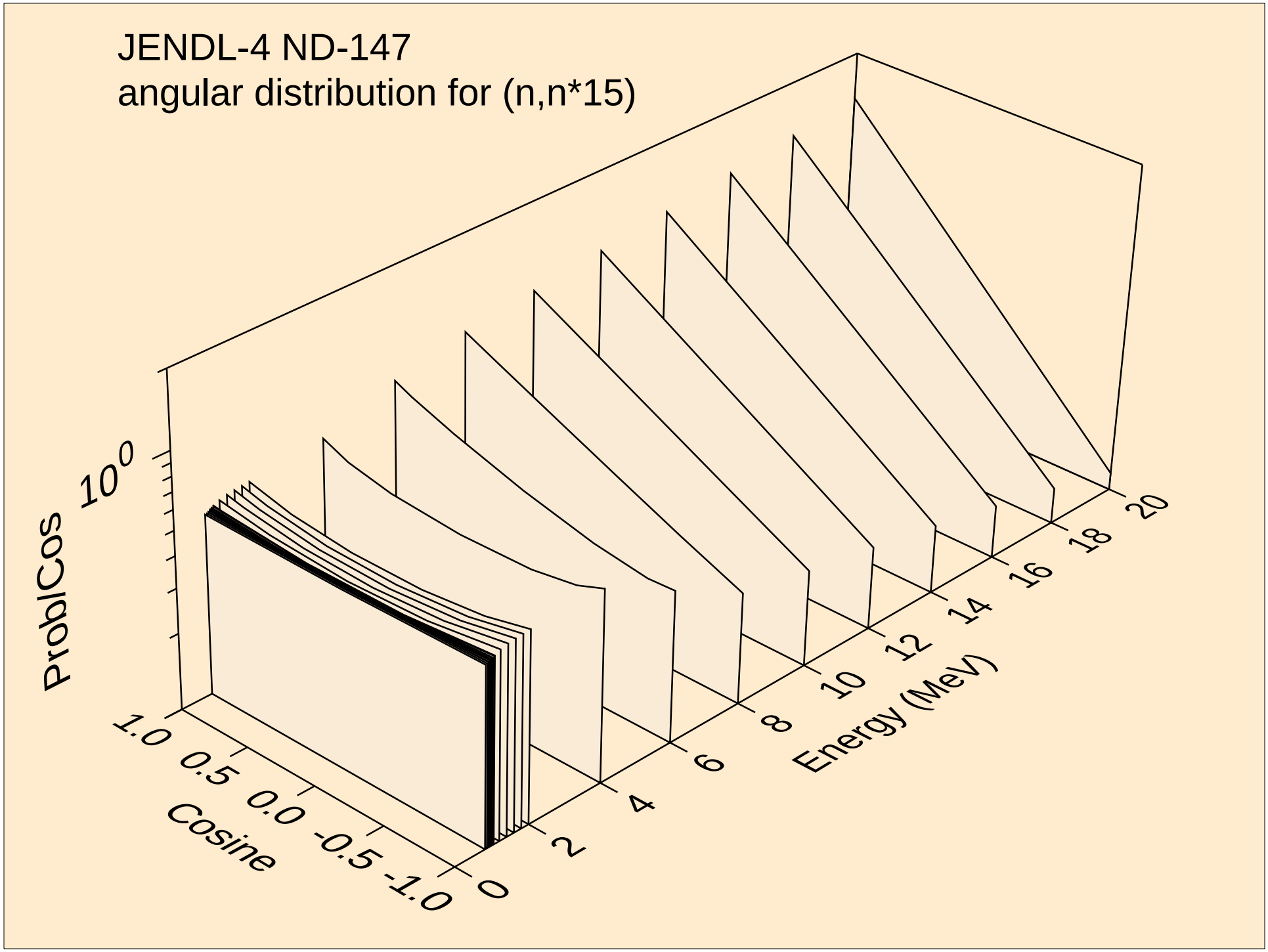

JENDL-4 ND-147
angular distribution for (n,n*10)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

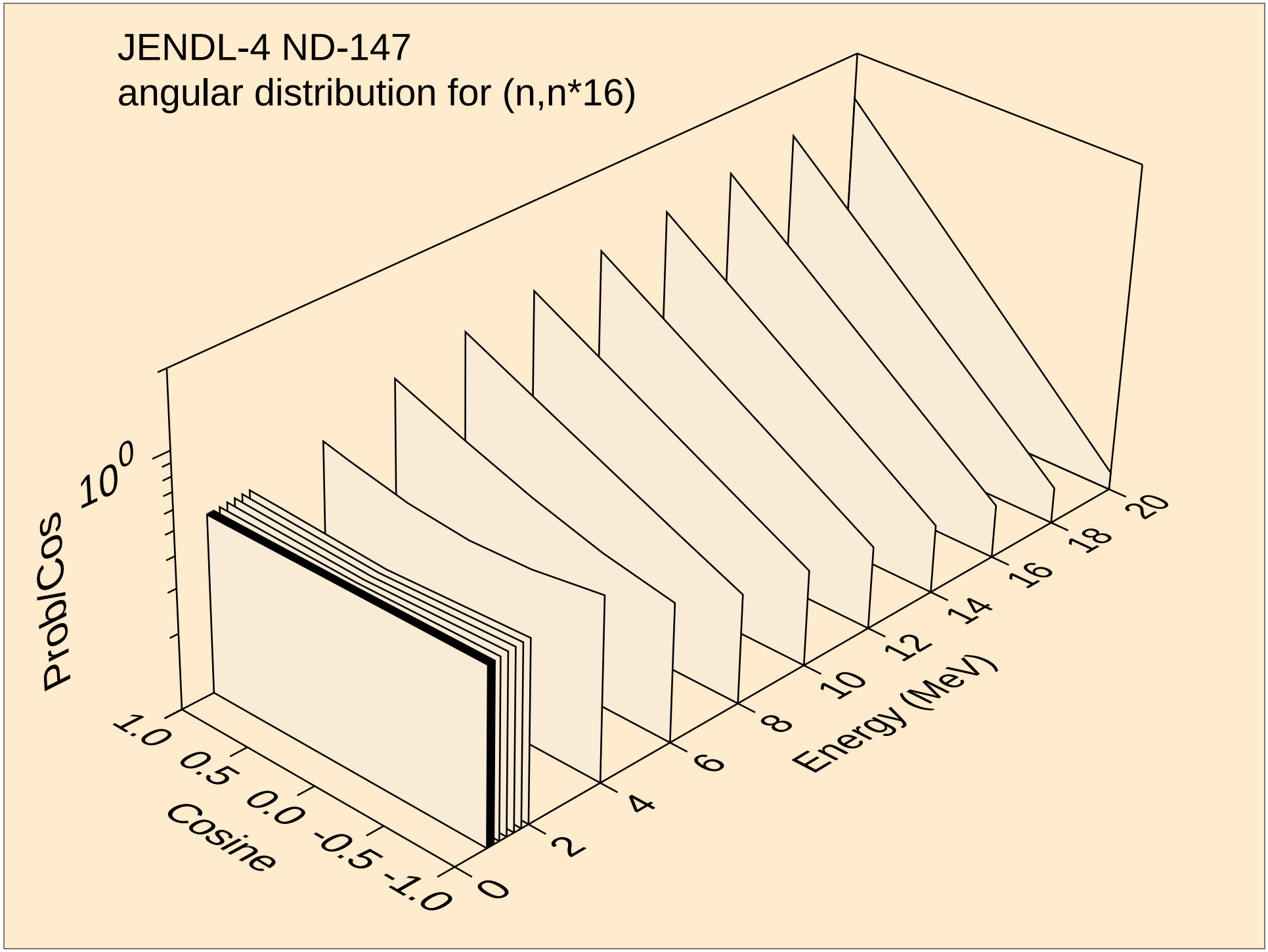

JENDL-4 ND-147
angular distribution for (n,n*11)
ProblCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

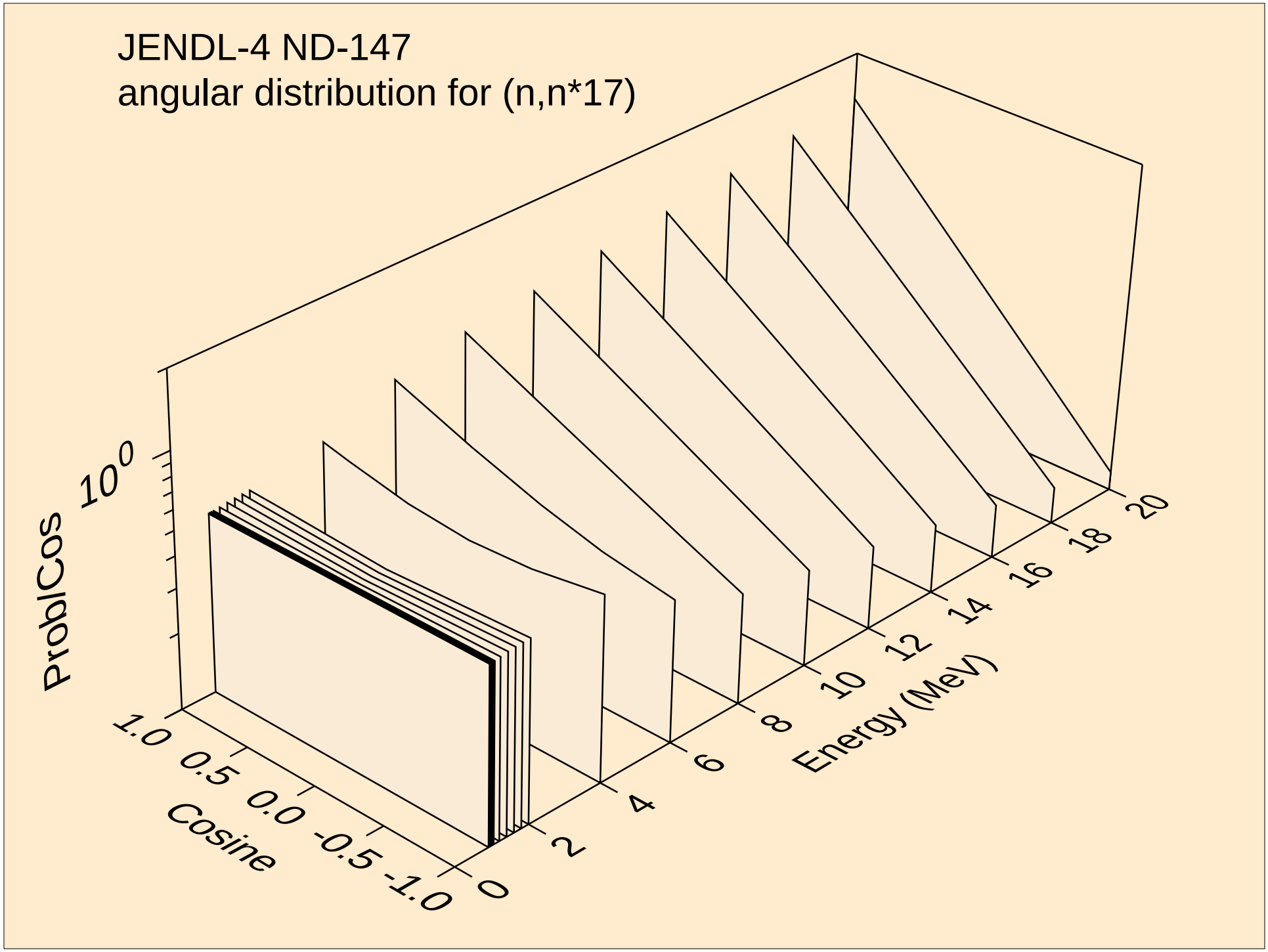

JENDL-4 ND-147
angular distribution for (n,n*12)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

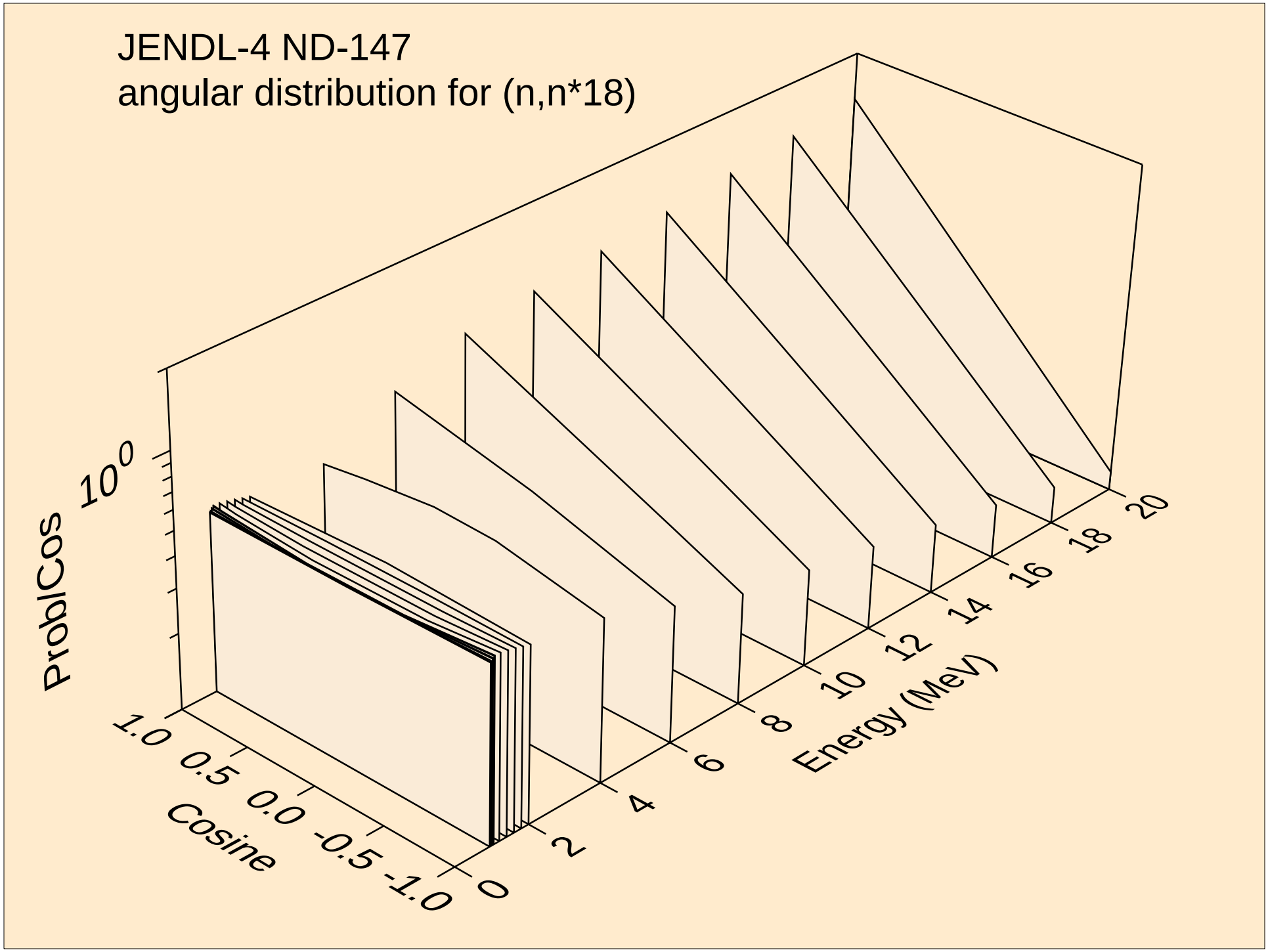

JENDL-4 ND-147
angular distribution for (n,n*13)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

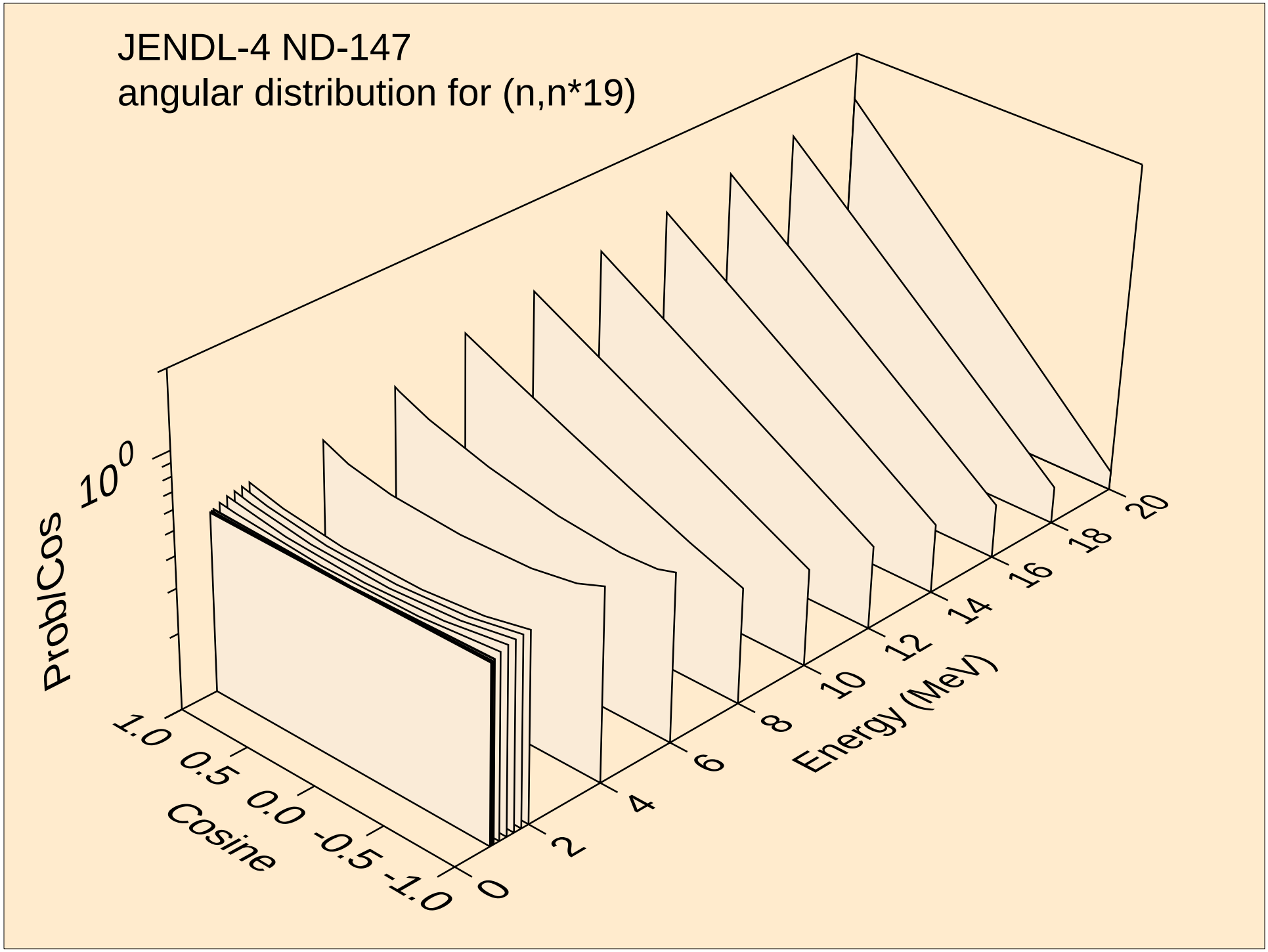

JENDL-4 ND-147
angular distribution for (n,n*14)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

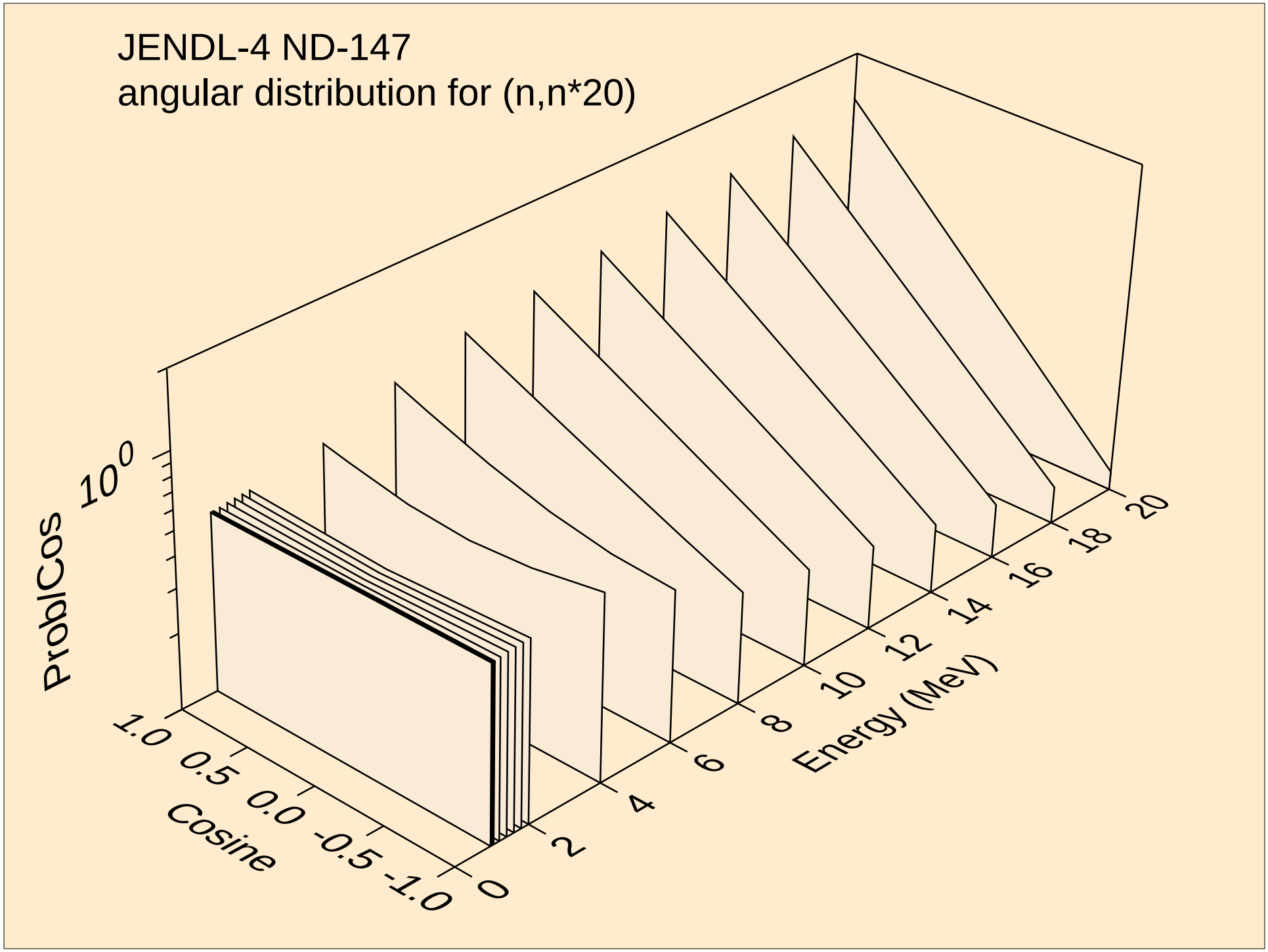

JENDL-4 ND-147
angular distribution for (n,n*15)
ProblCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

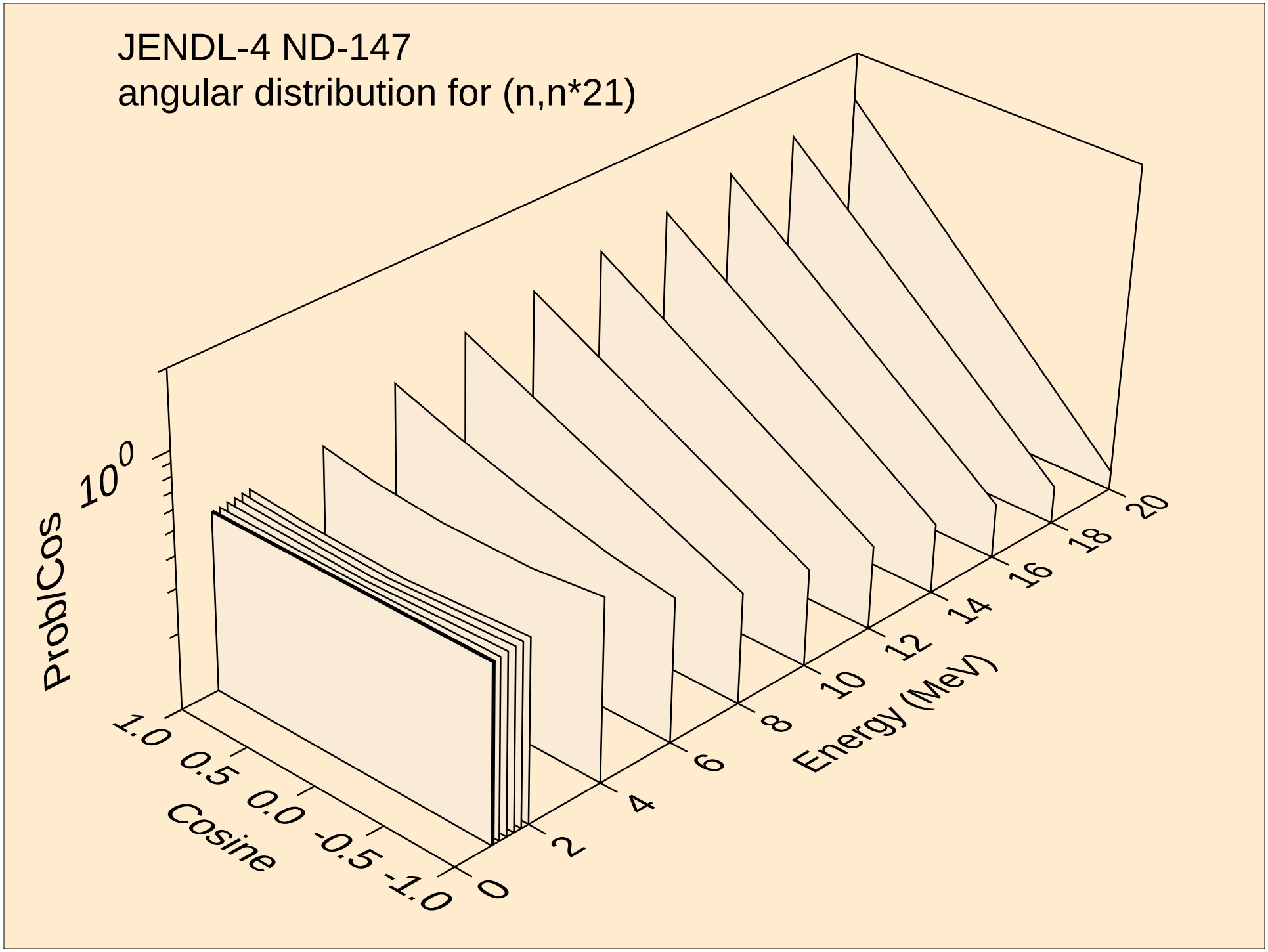

JENDL-4 ND-147
angular distribution for (n,n*16)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

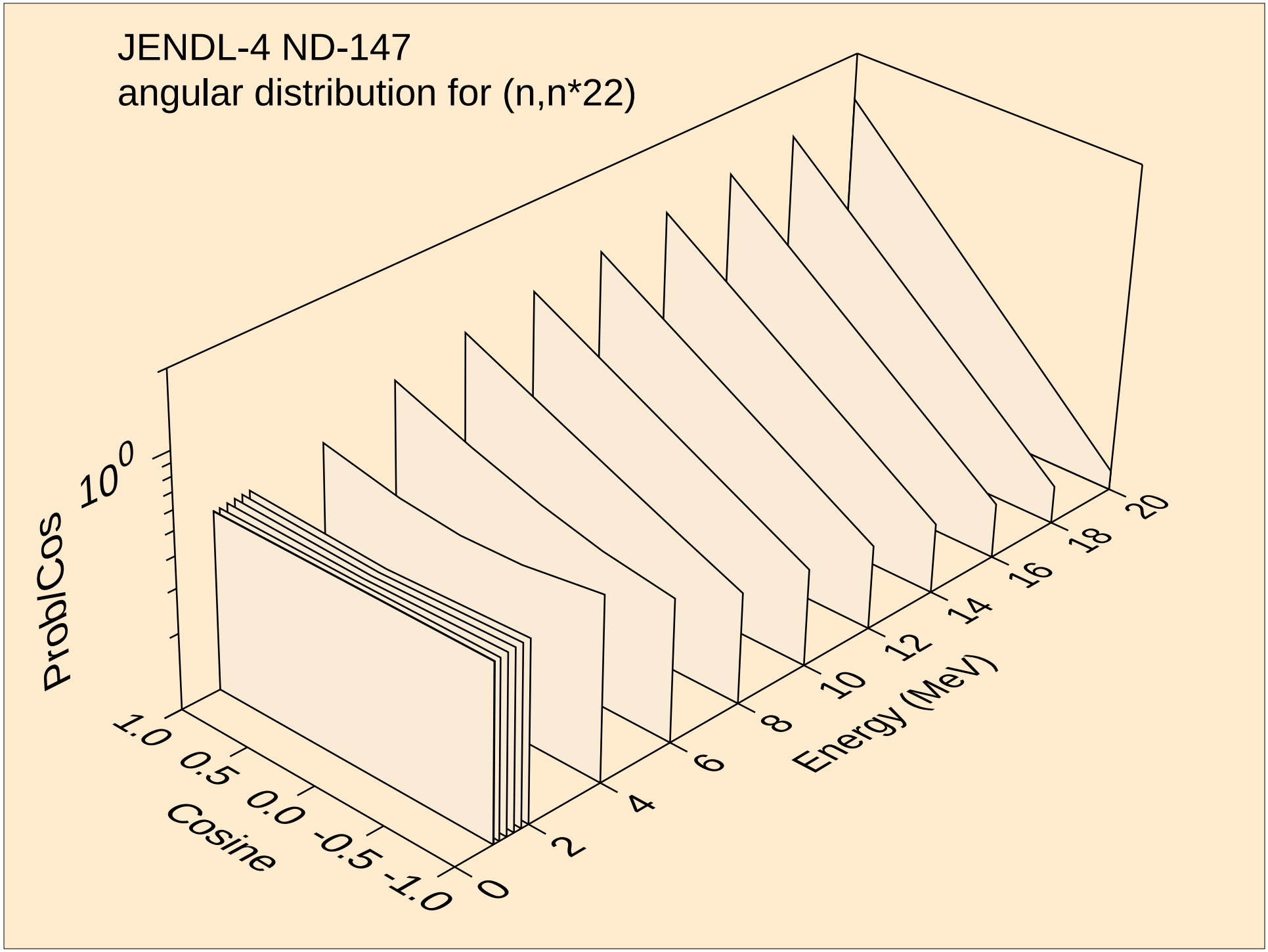

JENDL-4 ND-147
angular distribution for (n,n*17)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

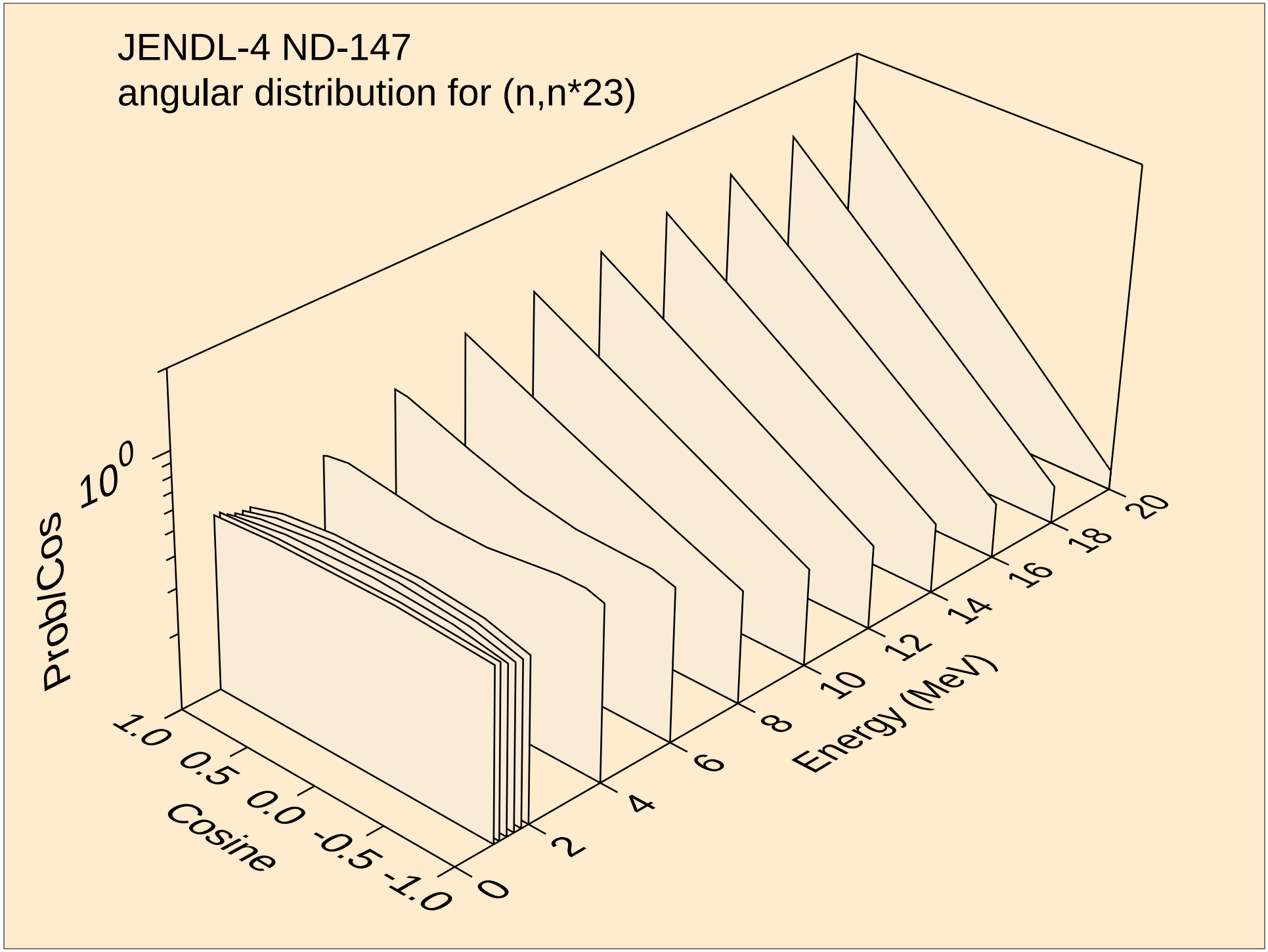

JENDL-4 ND-147
angular distribution for (n,n*18)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

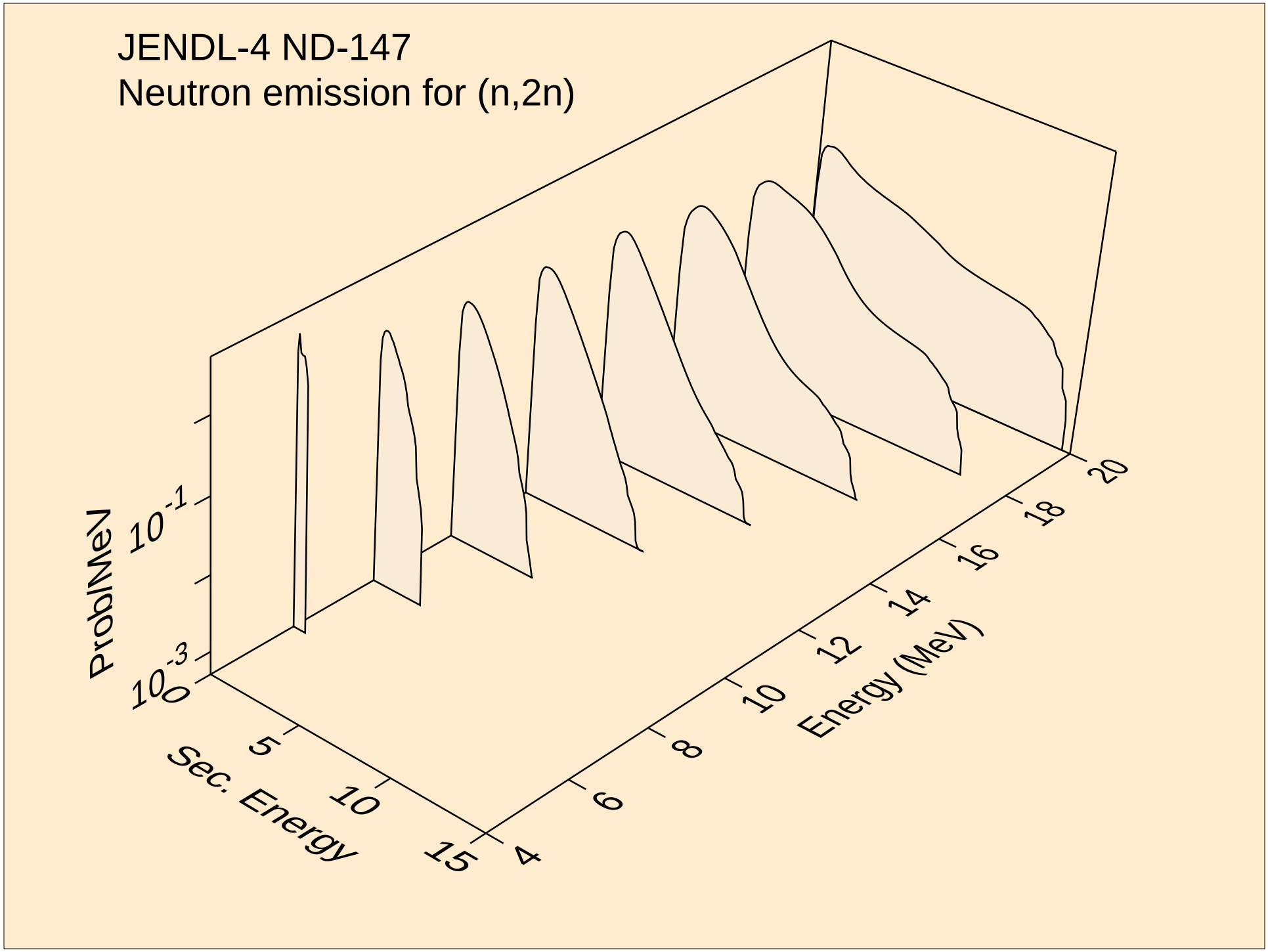

JENDL-4 ND-147
angular distribution for (n,n*19)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

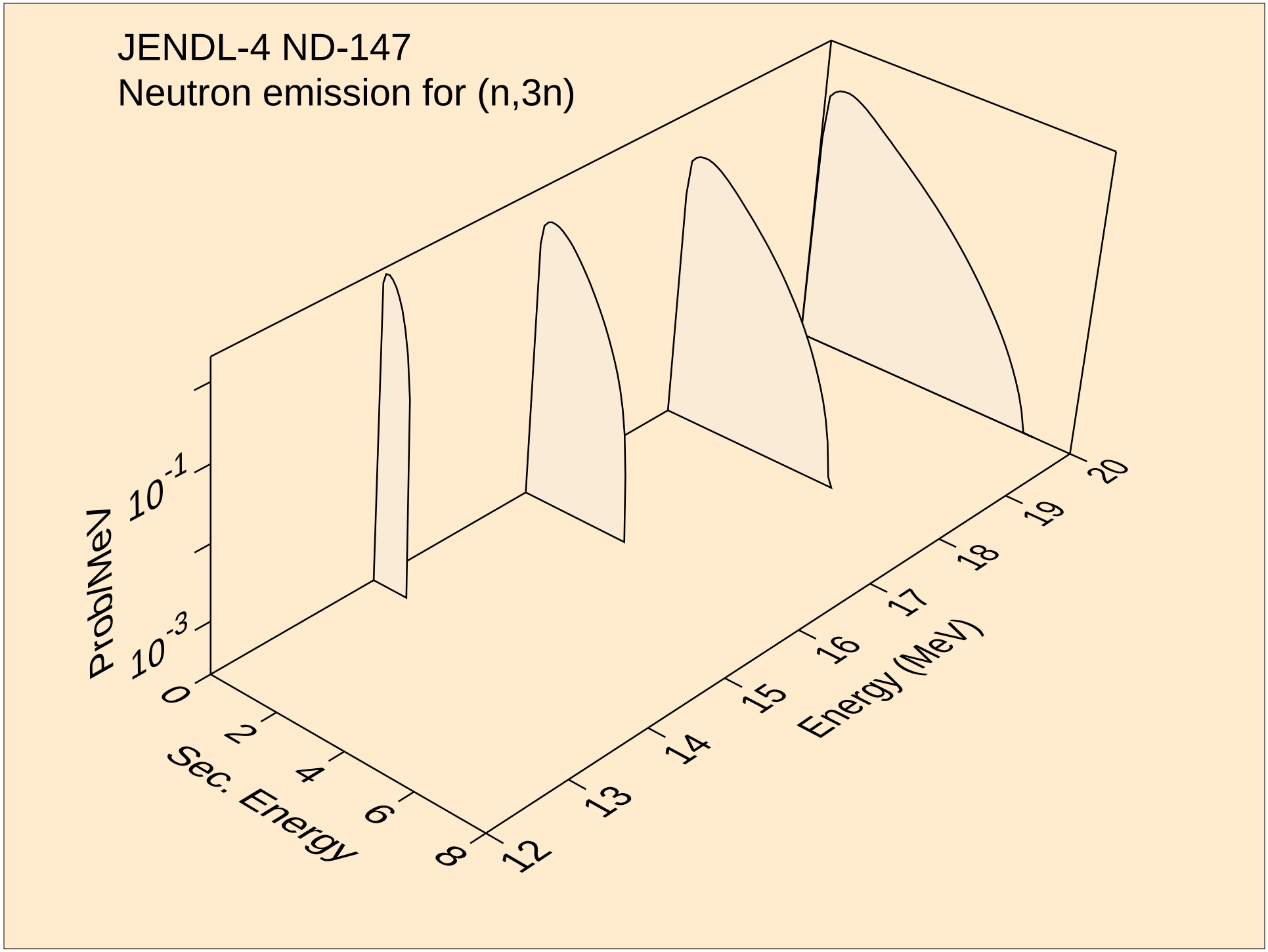

JENDL-4 ND-147
angular distribution for (n,n*20)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

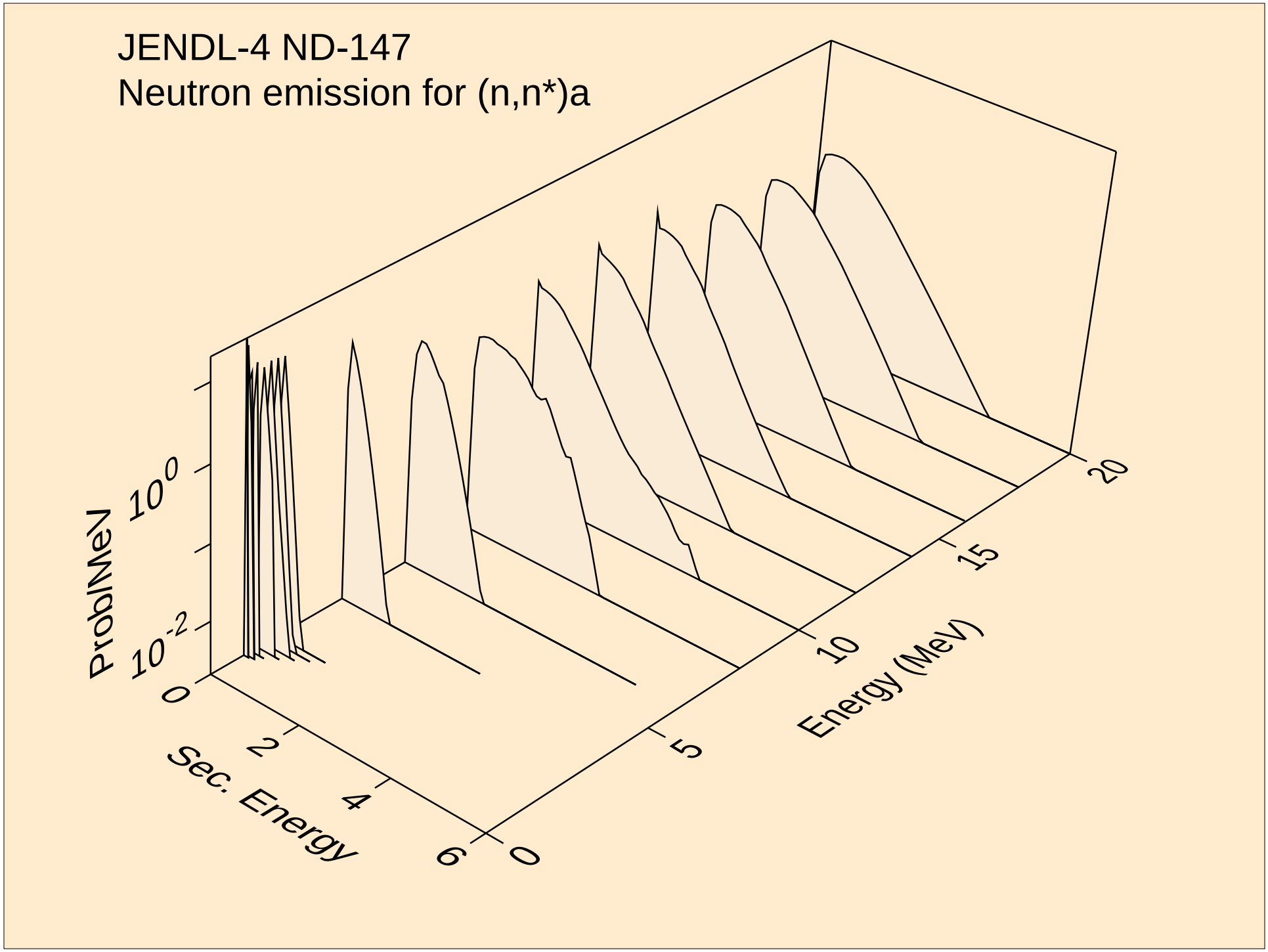

JENDL-4 ND-147
angular distribution for (n,n*21)
ProbCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

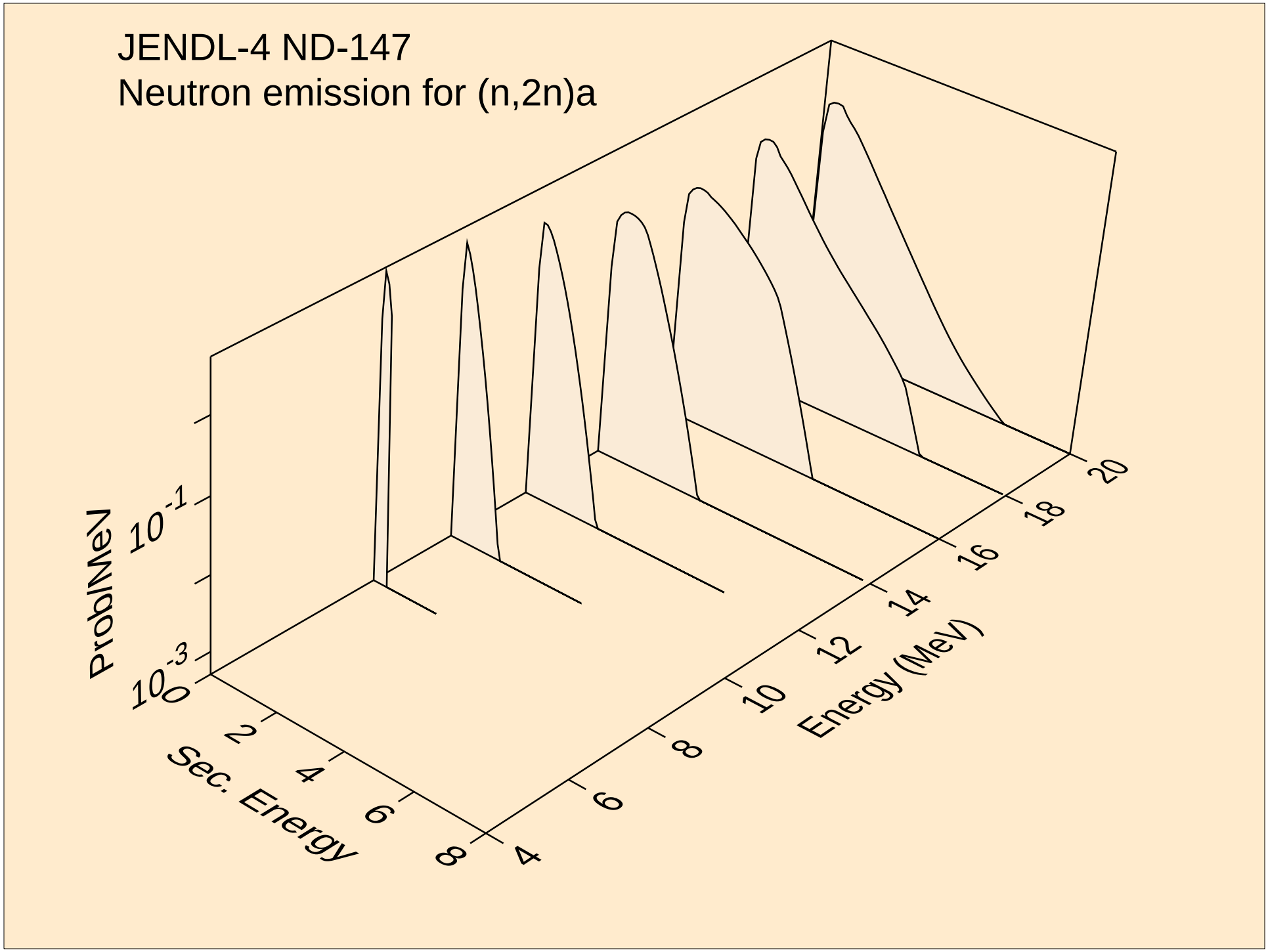

JENDL-4 ND-147
angular distribution for (n,n*22)
ProblCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20

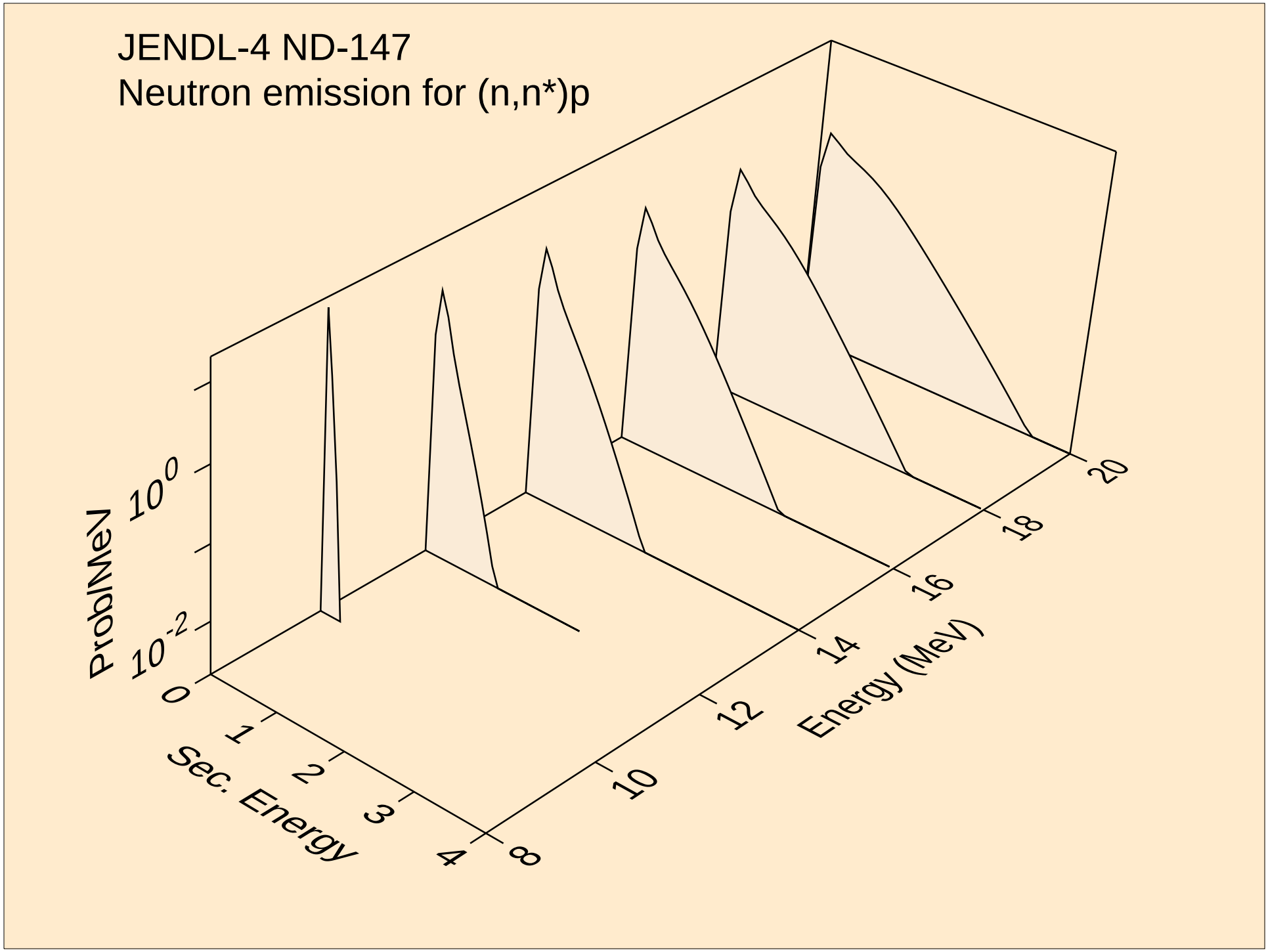

JENDL-4 ND-147
angular distribution for (n,n*23)
ProblCos
10^0
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
2
4
6
8
10
12
14
16
18
20


JENDL-4 ND-147
Neutron emission for (n,2n)
Prob/MeV
10^{-1}
10^{-3}
0
5
10
15
Sec. Energy
4
6
8
10
12
14
16
18
20
Energy (MeV)

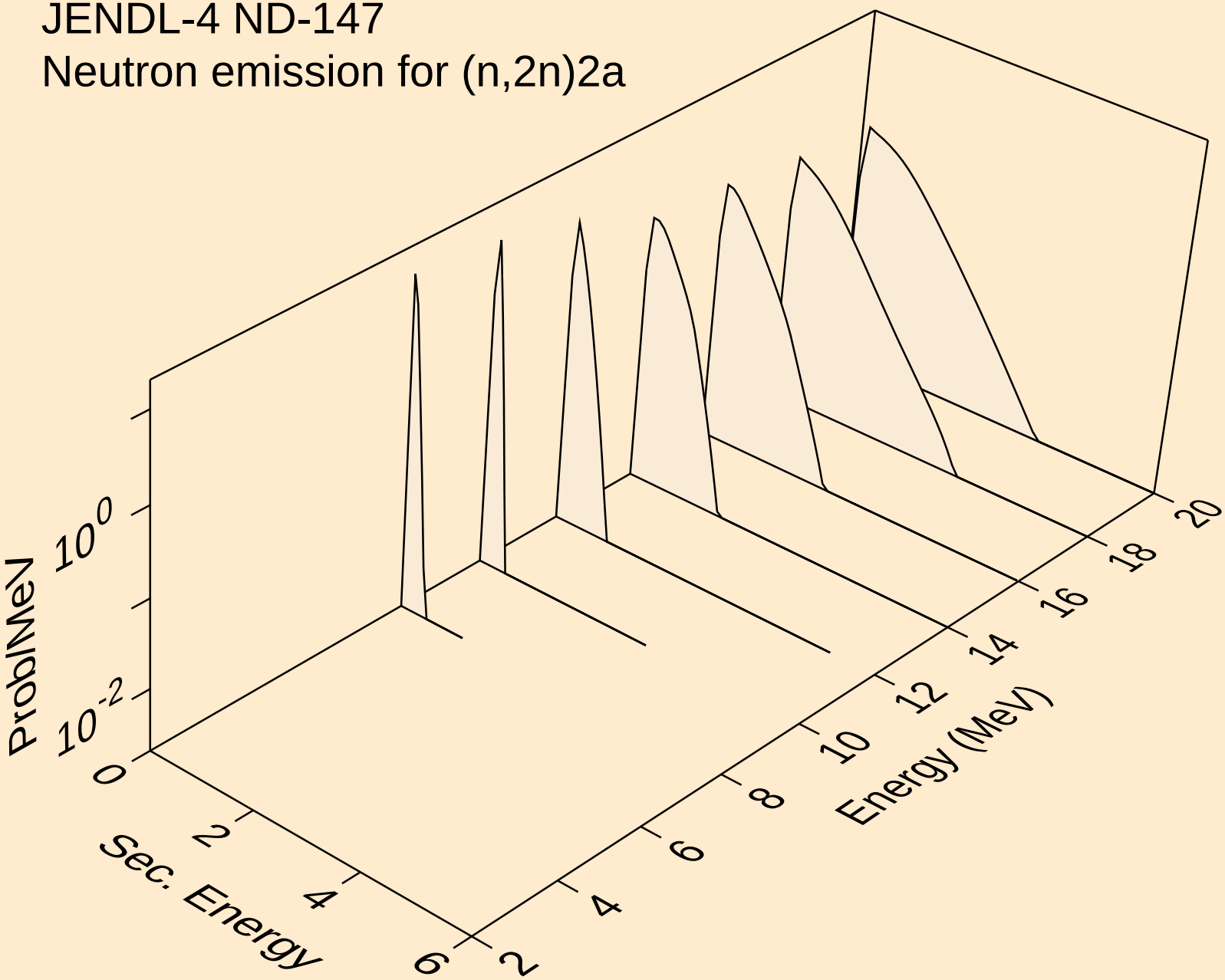

JENDL-4 ND-147
Neutron emission for (n,3n)
Prob/MeV
10-1
10-3
0
2
4
6
8
Sec. Energy
12
13
14
15
16
17
18
19
20
Energy (MeV)

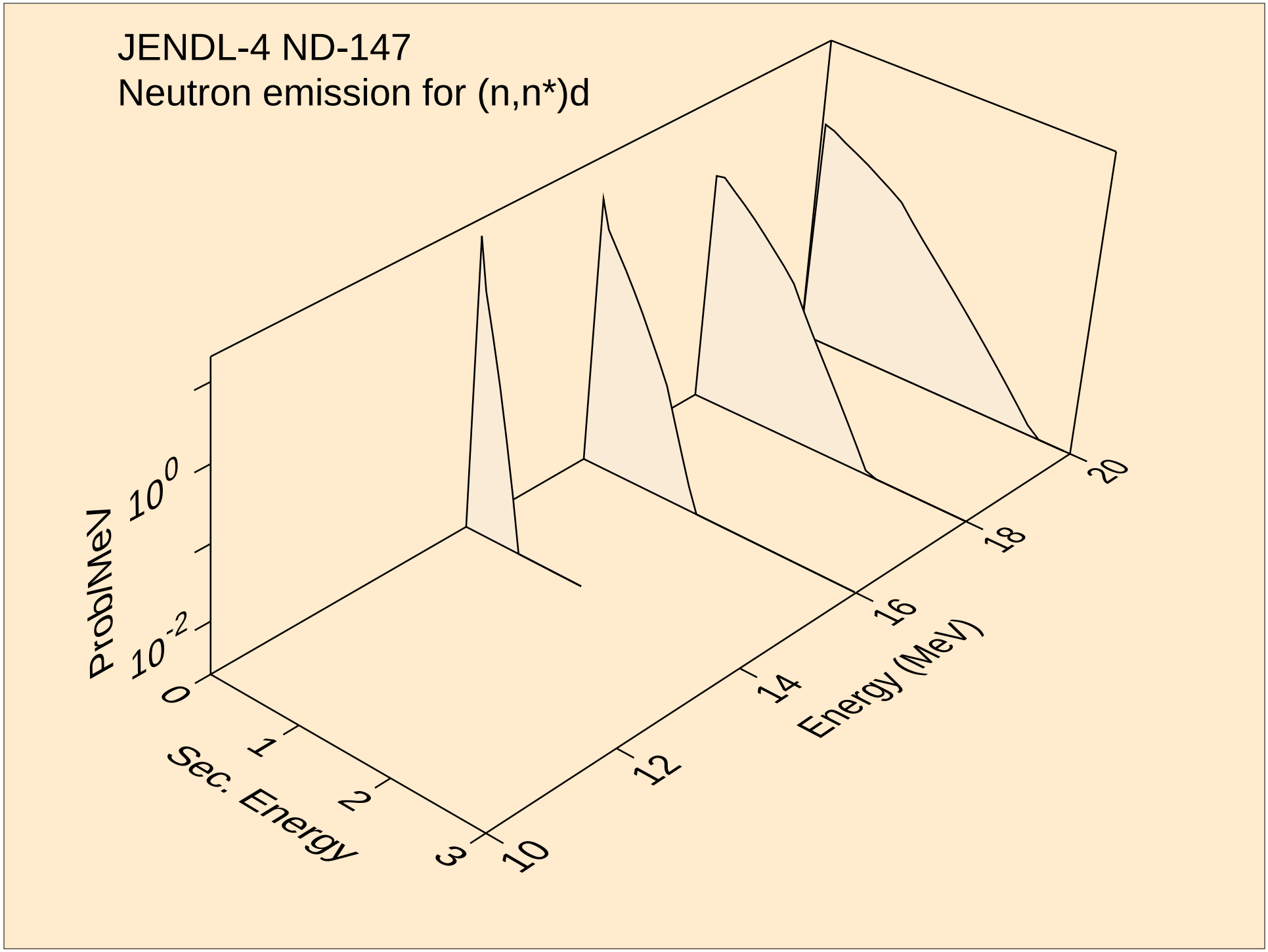

JENDL-4 ND-147
Neutron emission for (n,n*)a
Prob/MeV
10^0
10^{-2}
0
2
4
6
Sec. Energy
0
5
10
15
20
Energy (MeV)


JENDL-4 ND-147
Neutron emission for (n,2n)a
Prob/MeV
10^{-1}
10^{-3}
0
2
4
6
8
Sec. Energy
4
6
8
10
12
14
16
18
20
Energy (MeV)

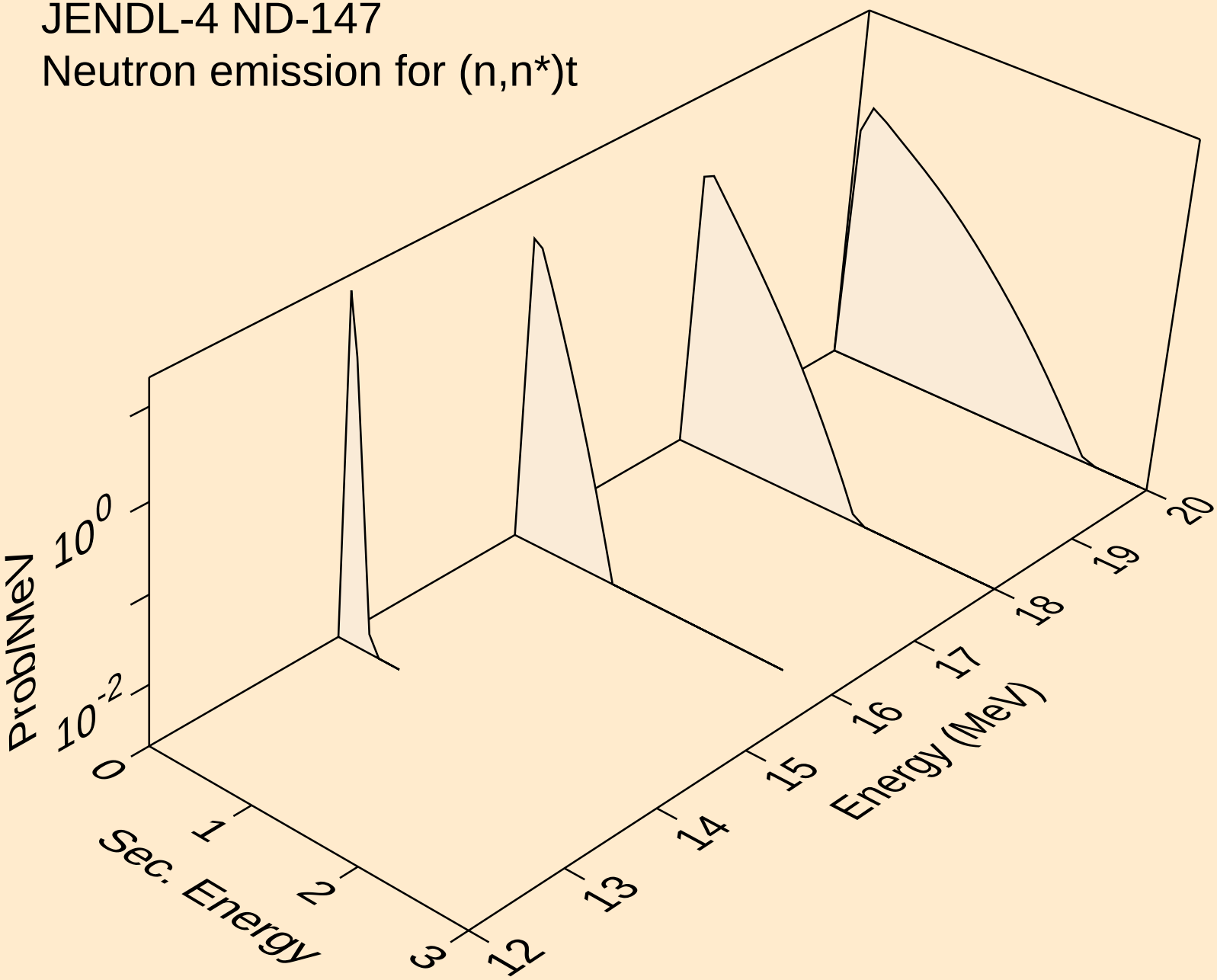

JENDL-4 ND-147
Neutron emission for (n,n*)p
Prob/MeV
10^0
10^{-2}
0
1
2
3
4
Sec. Energy
8
10
12
14
16
18
20
Energy (MeV)

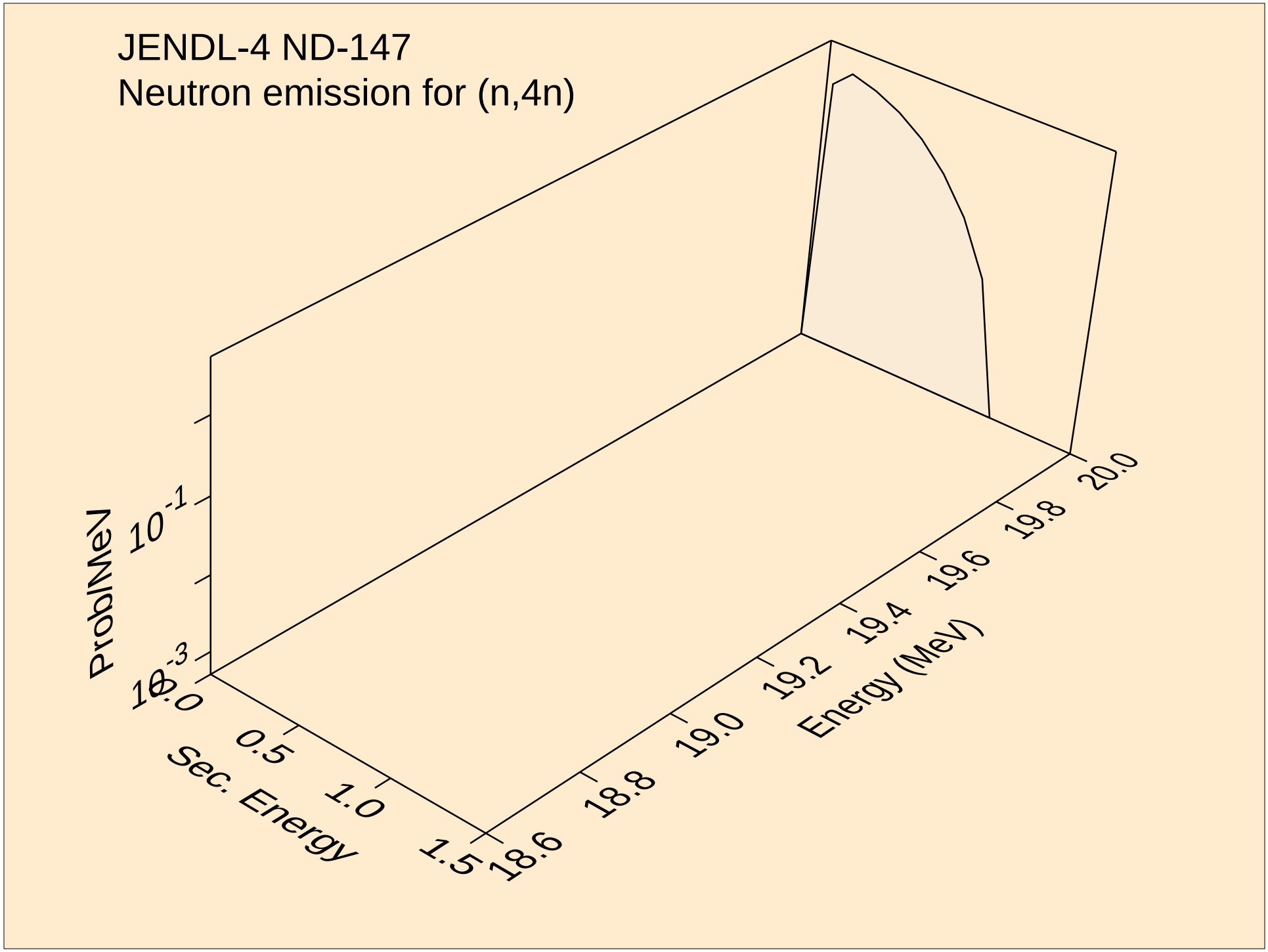
JENDL-4 ND-147
Neutron emission for (n,2n)2a

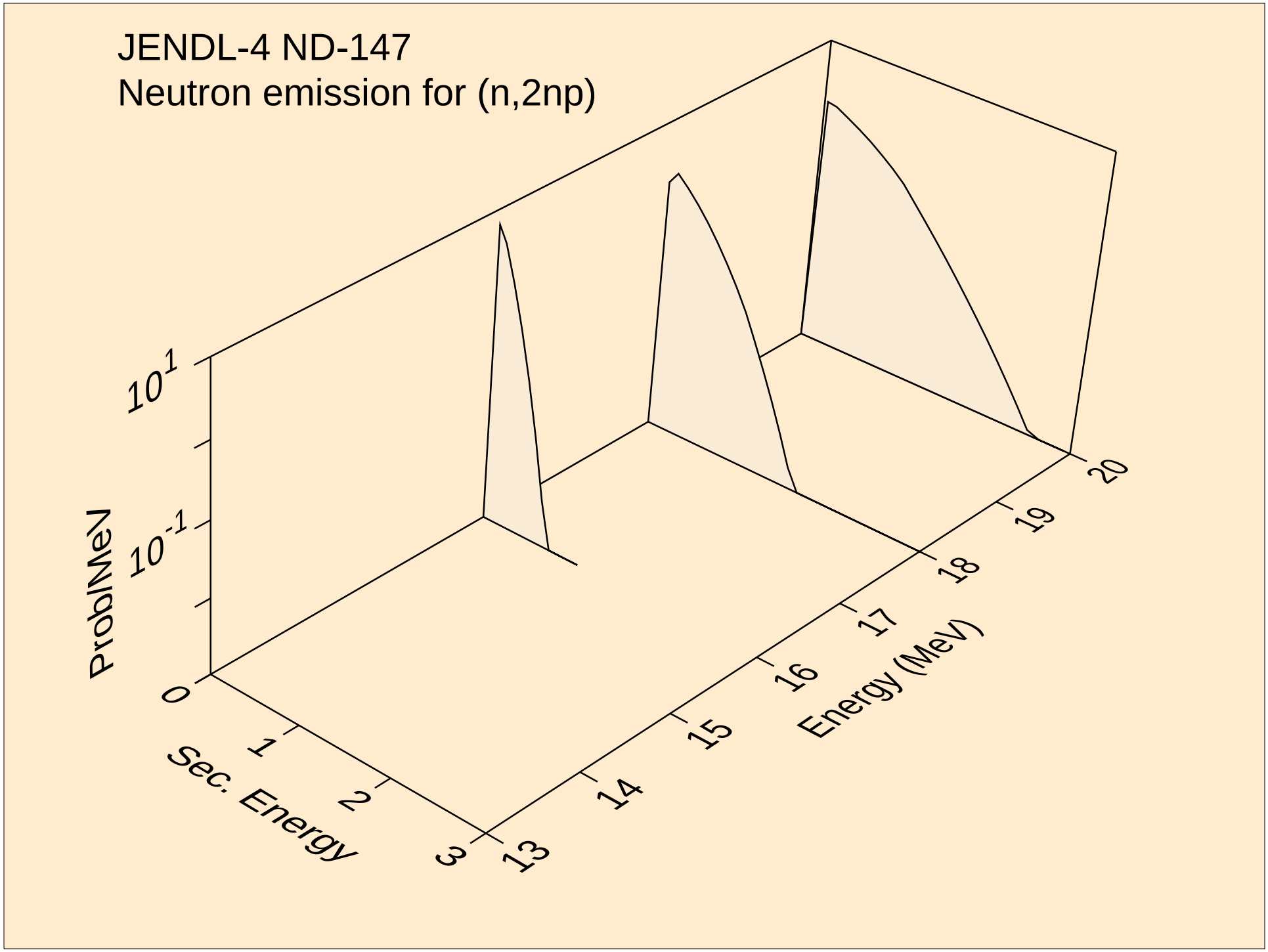


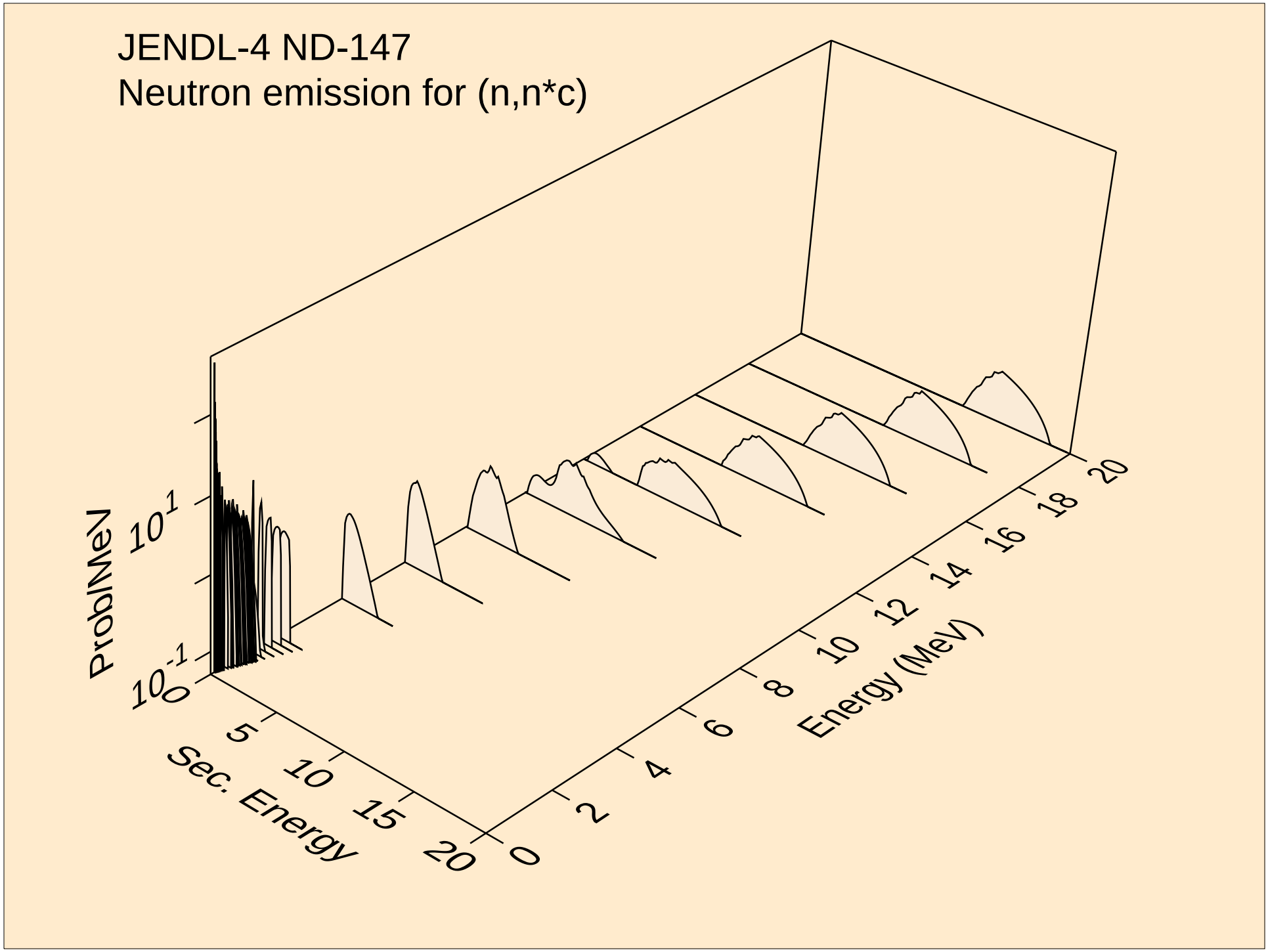

JENDL-4 ND-147
Neutron emission for (n,n*)d
Prob/MeV
10^0
10^{-2}
0
1
2
3
Sec. Energy
10
12
14
16
18
20
Energy (MeV)

JENDL-4 ND-147
Neutron emission for (n,n*)t

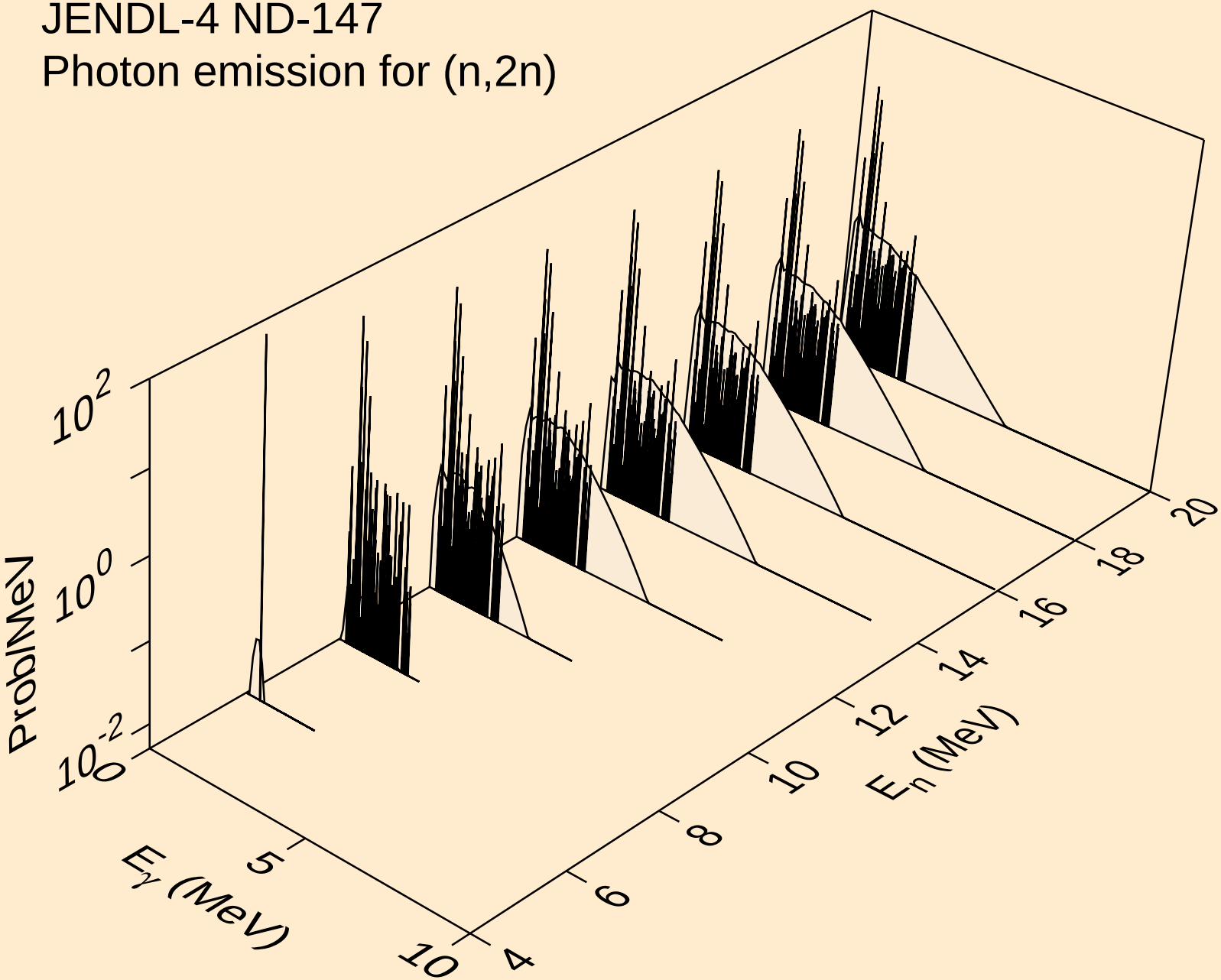



JENDL-4 ND-147
Neutron emission for (n,4n)
Prob/MeV
10-1
10-3
0.0
0.5
1.0
1.5
Sec. Energy
18.6
18.8
19.0
19.2
19.4
19.6
19.8
20.0
Energy (MeV)

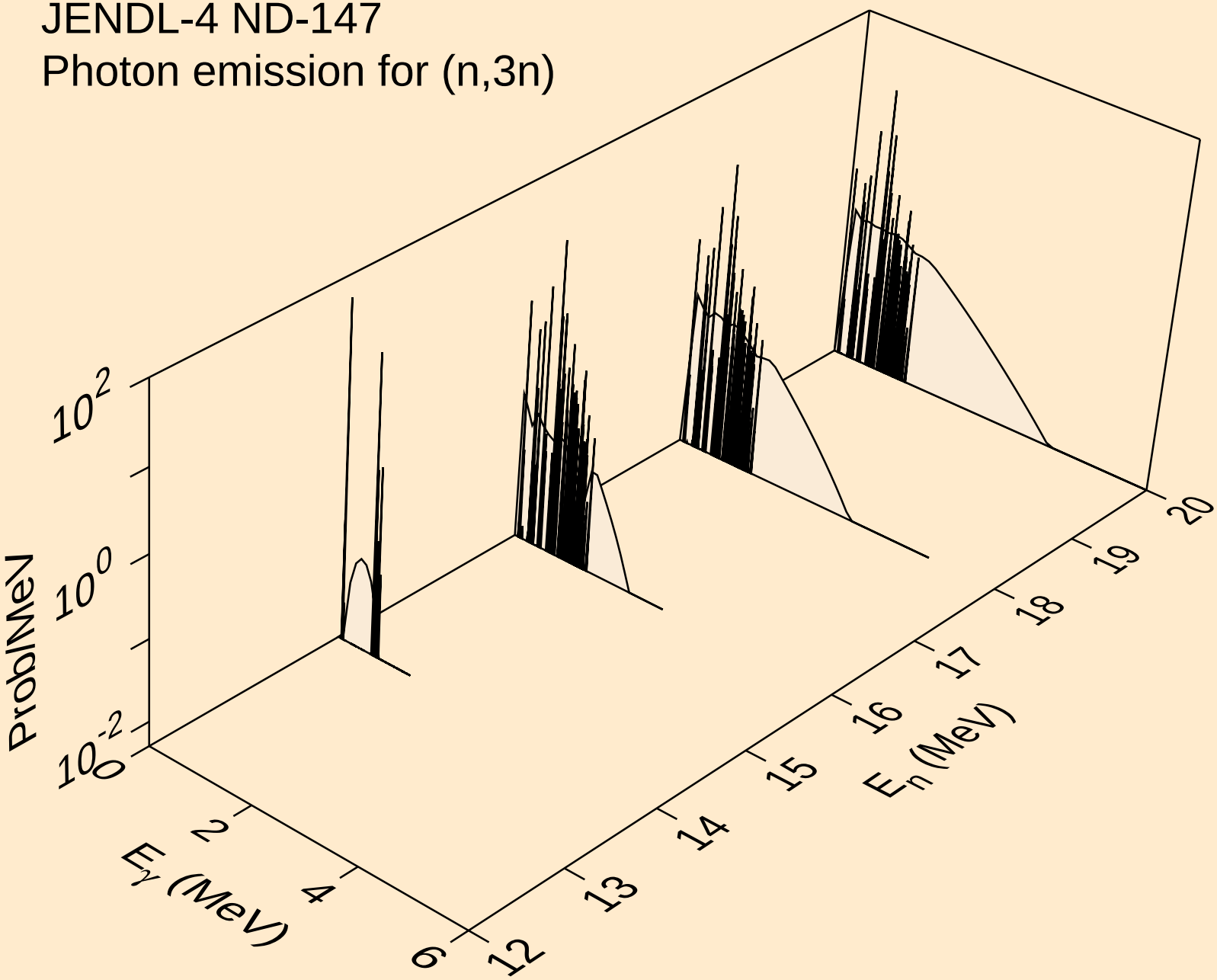

JENDL-4 ND-147
Neutron emission for (n,2np)
Prob/MeV
10^{1}
10^{-1}
0
Sec. Energy
1
2
3
Energy (MeV)
13
14
15
16
17
18
19
20


JENDL-4 ND-147
Neutron emission for (n,n*c)
Prob/MeV
10^{1}
10^{-1}
0
5
10
15
20
Sec. Energy
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)

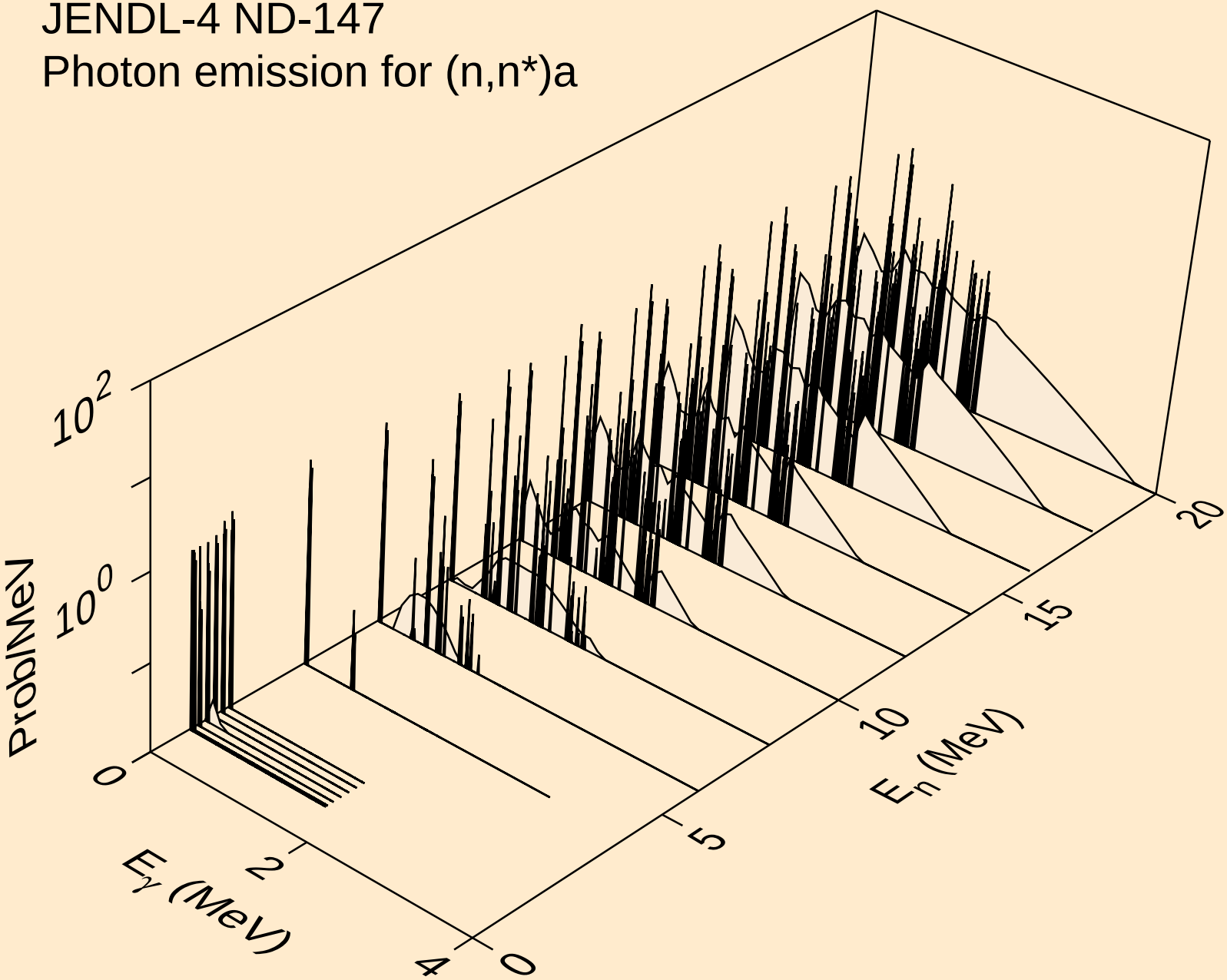
JENDL-4 ND-147
Photon emission for (n,2n)



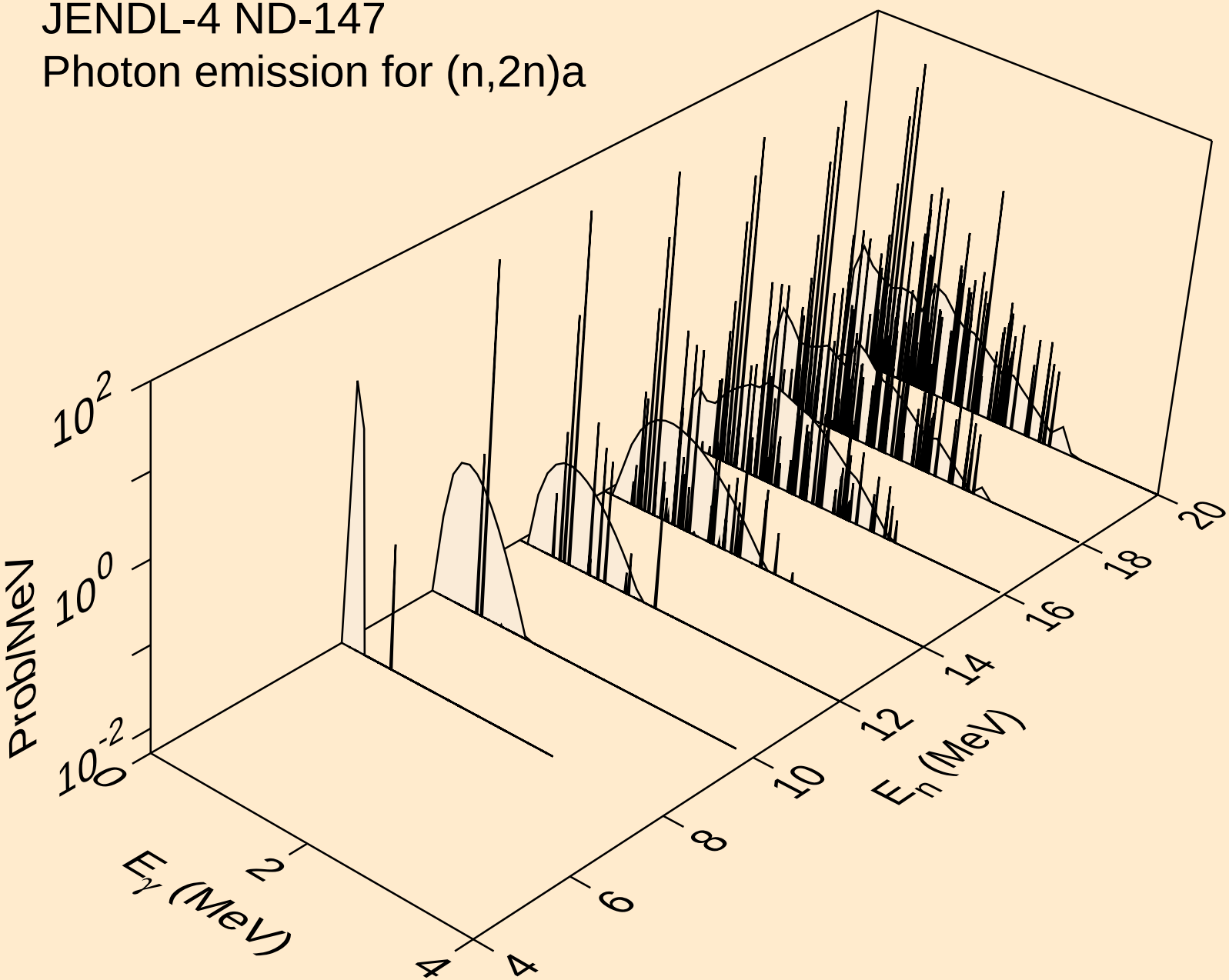
JENDL-4 ND-147
Photon emission for (n,3n)



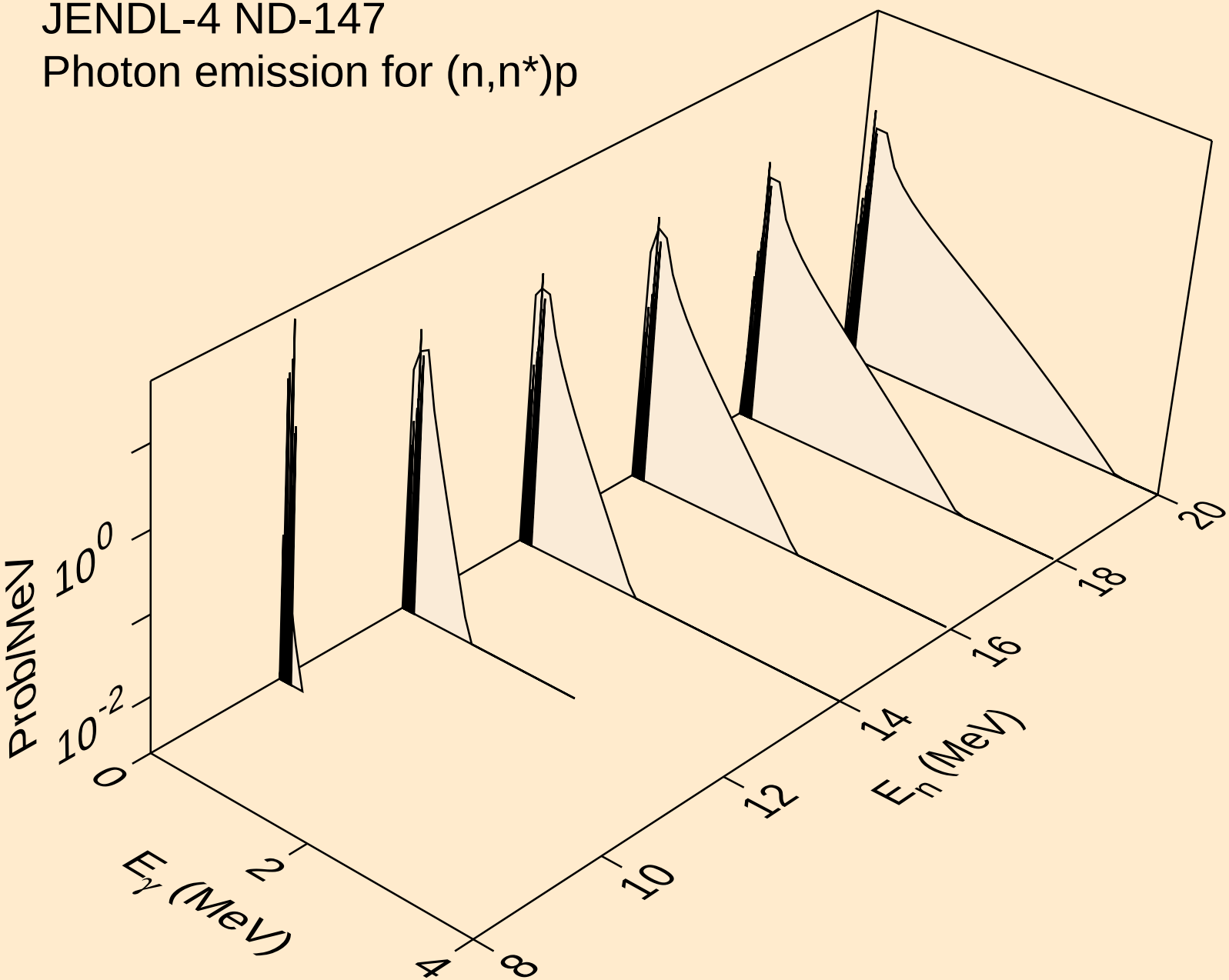
JENDL-4 ND-147
Photon emission for (n,n*)a



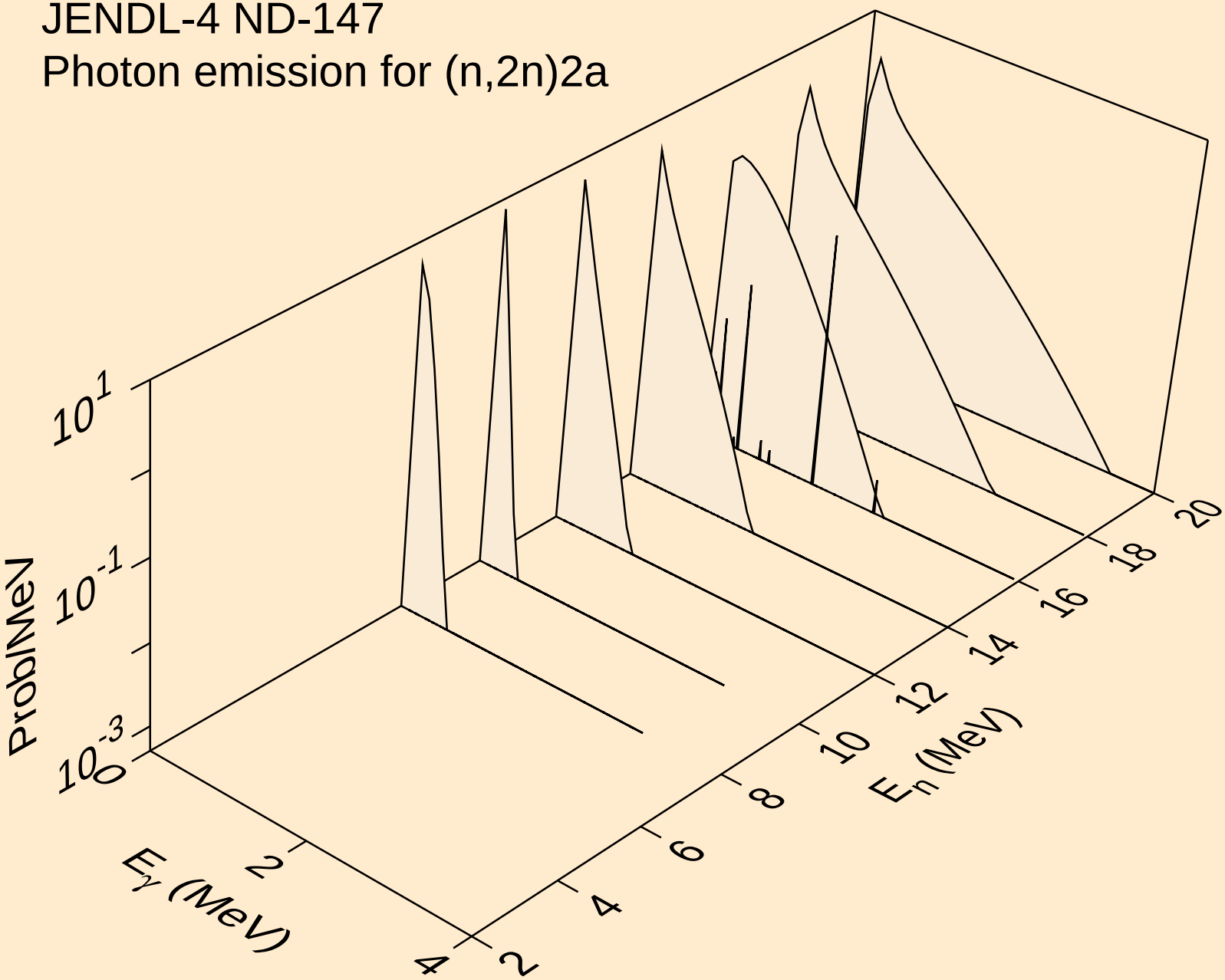
JENDL-4 ND-147
Photon emission for (n,2n)a



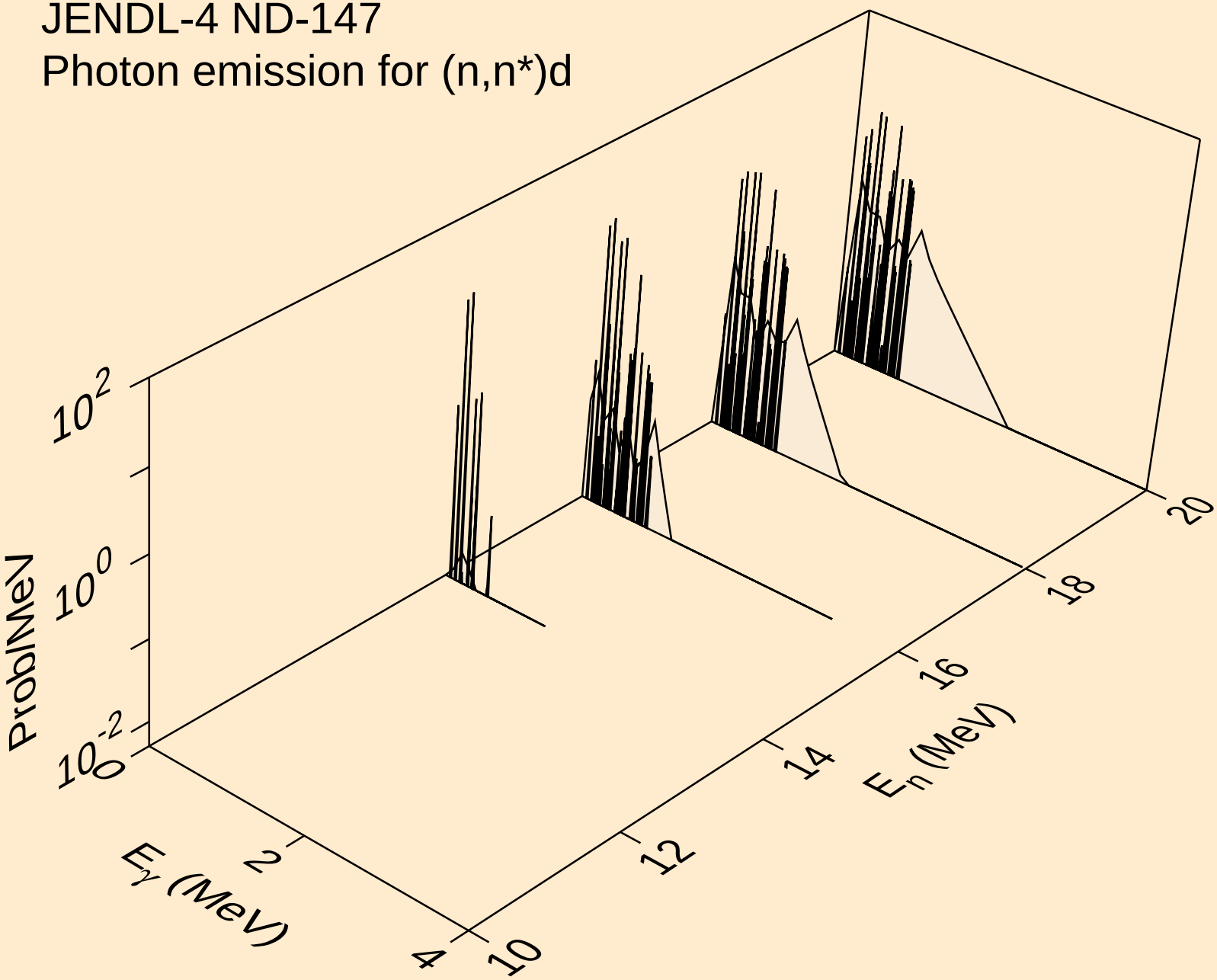
JENDL-4 ND-147
Photon emission for (n,n*)p



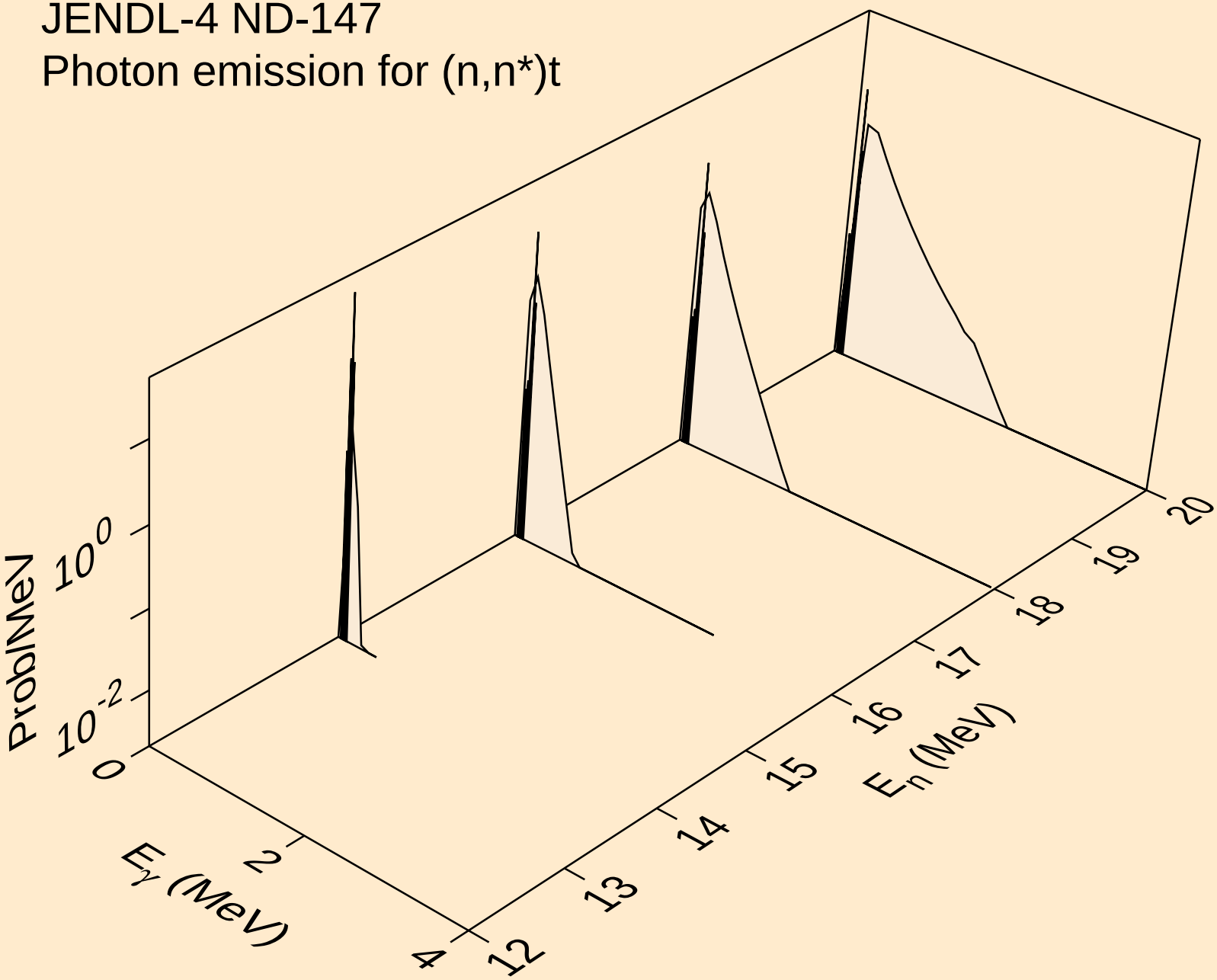
JENDL-4 ND-147
Photon emission for (n,2n)2a



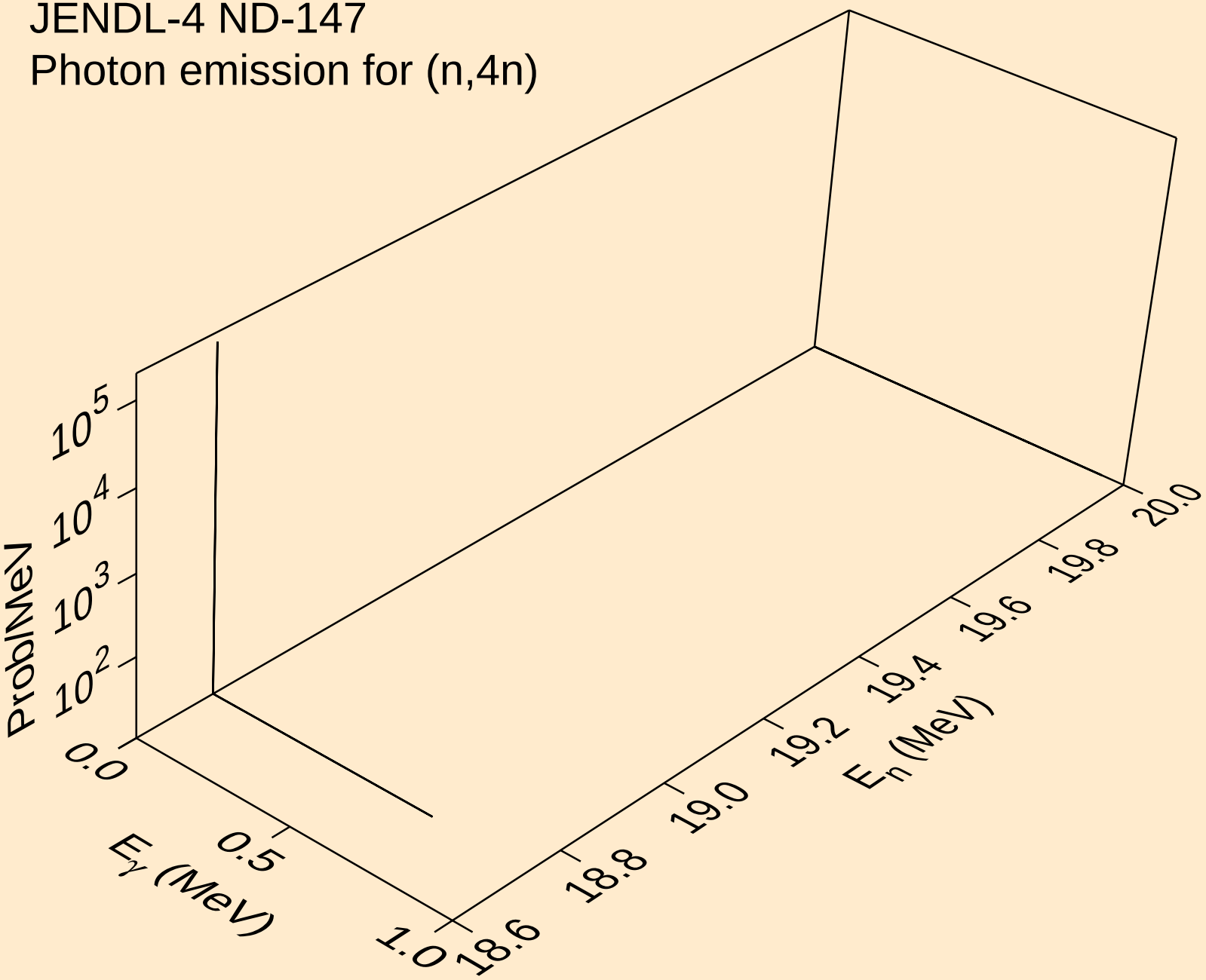
JENDL-4 ND-147
Photon emission for (n,n*)d



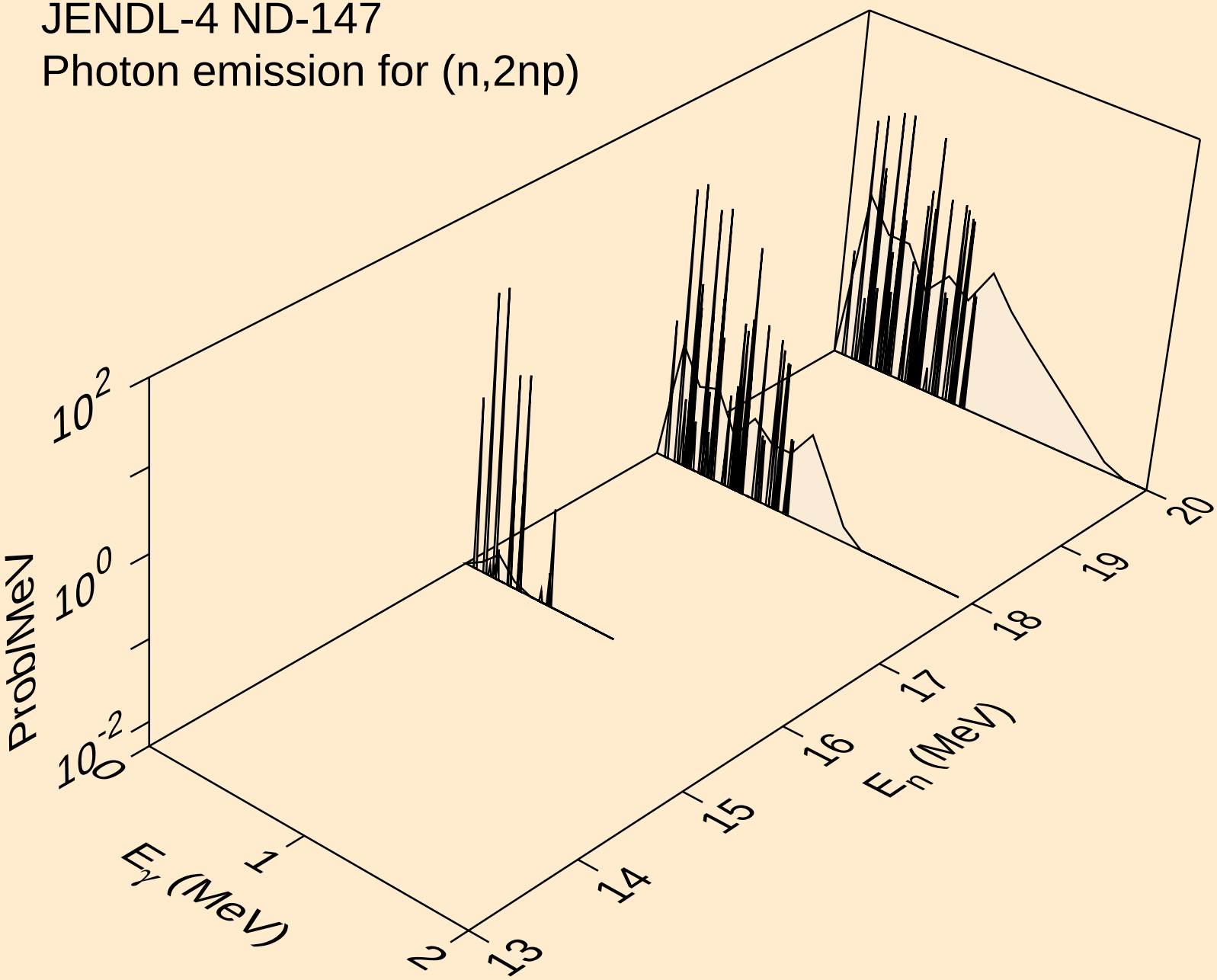
JENDL-4 ND-147
Photon emission for (n,n*)t



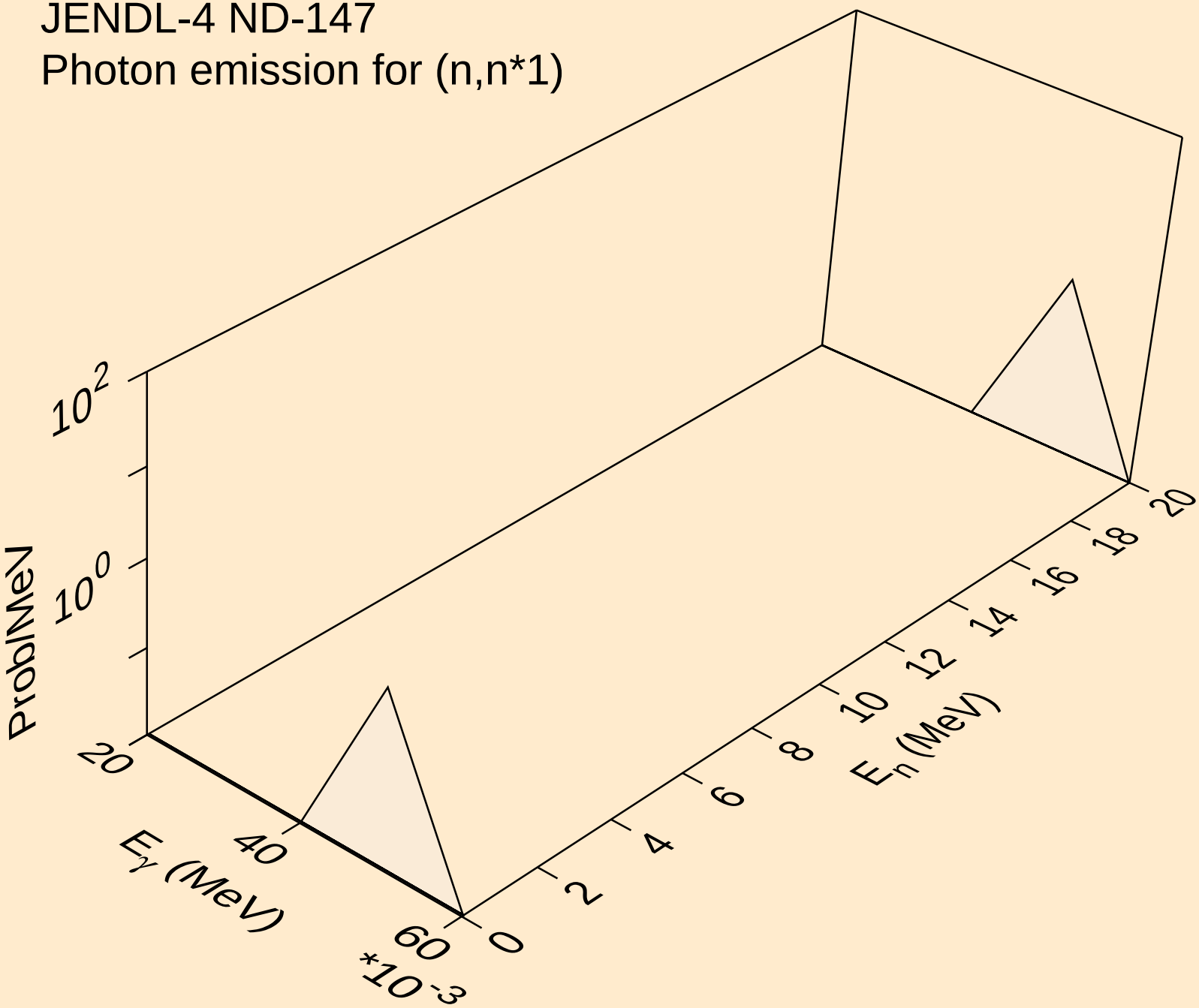
JENDL-4 ND-147
Photon emission for (n,4n)

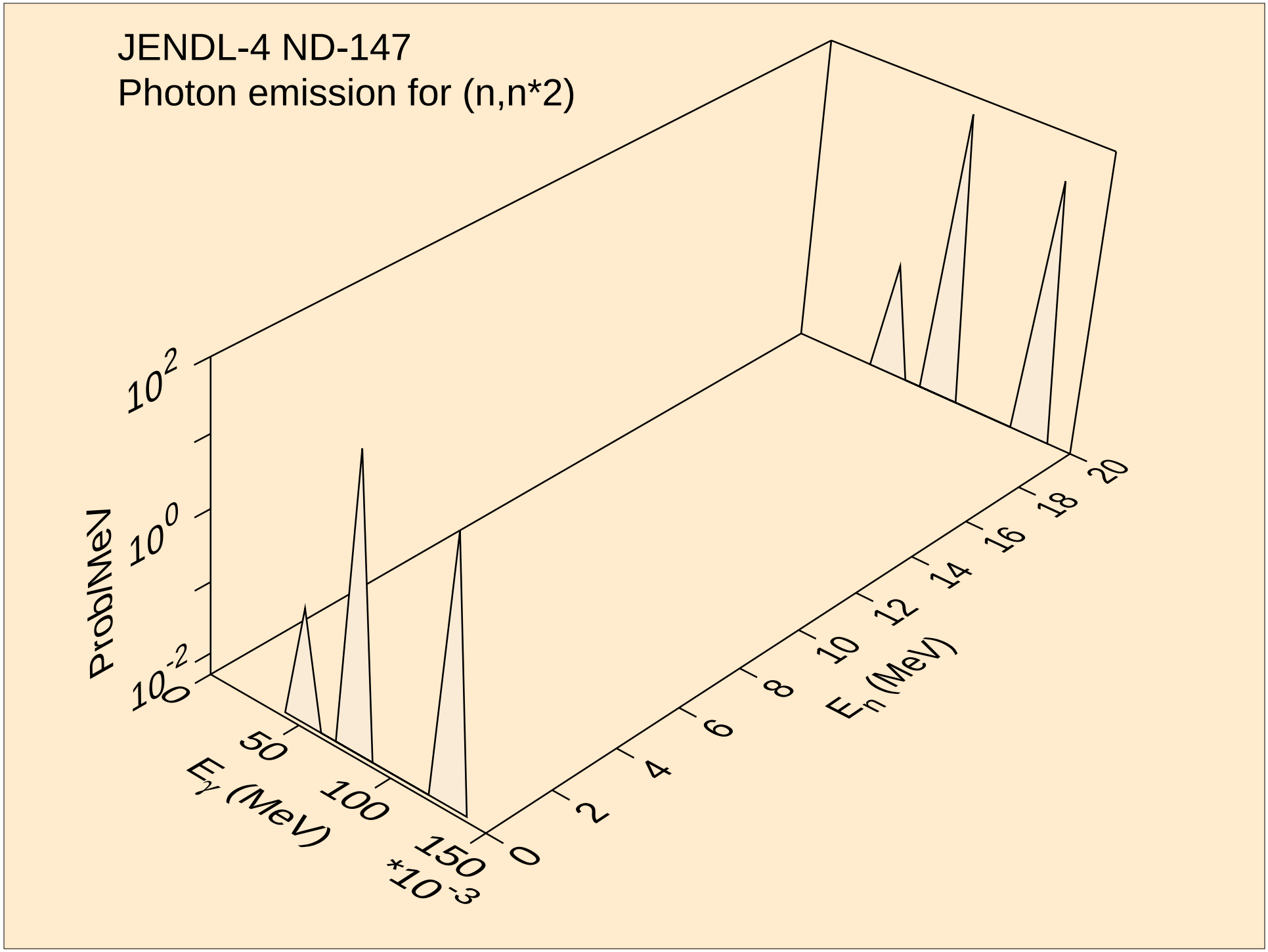


JENDL-4 ND-147
Photon emission for (n,2np)

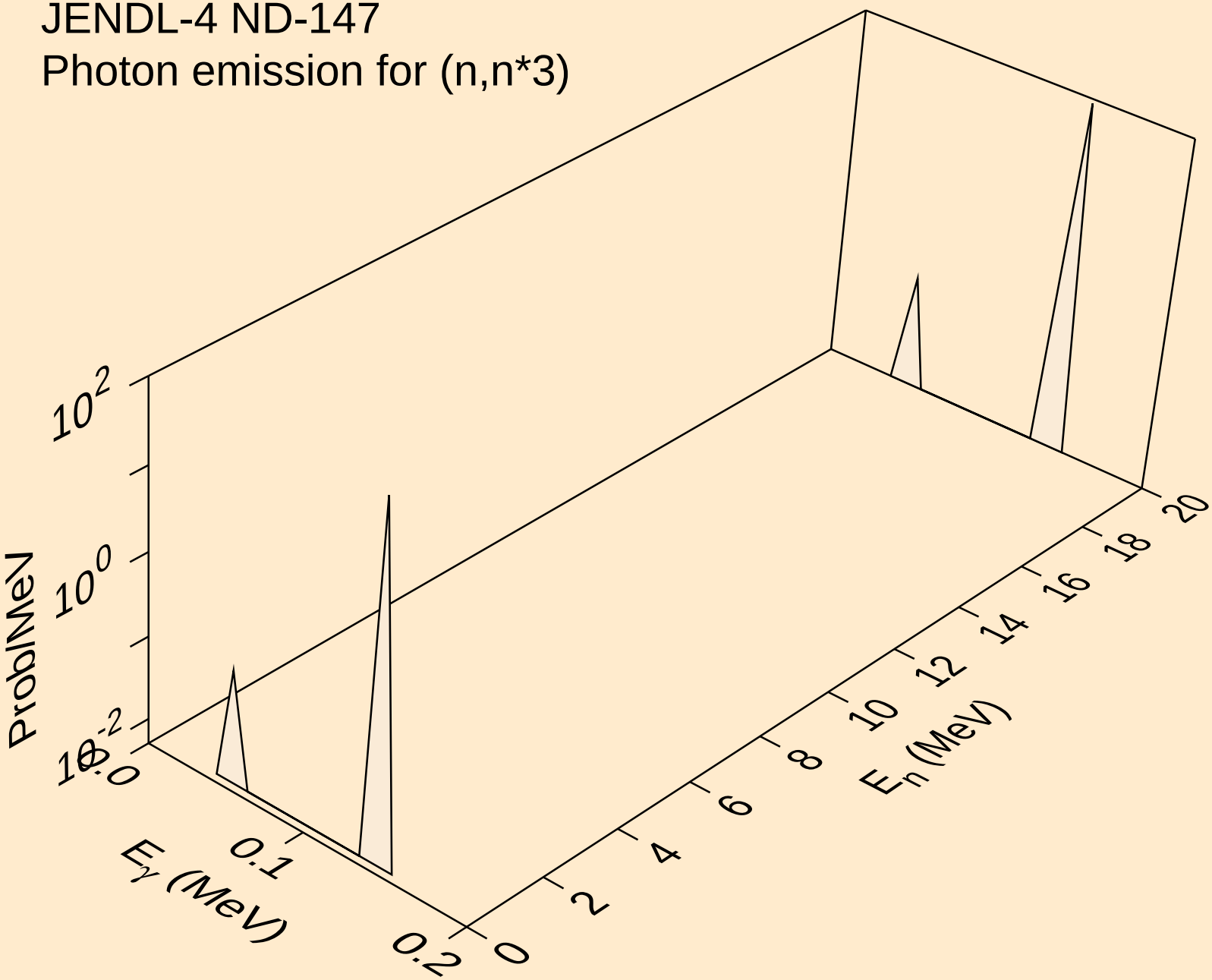


JENDL-4 ND-147
Photon emission for (n,n*1)

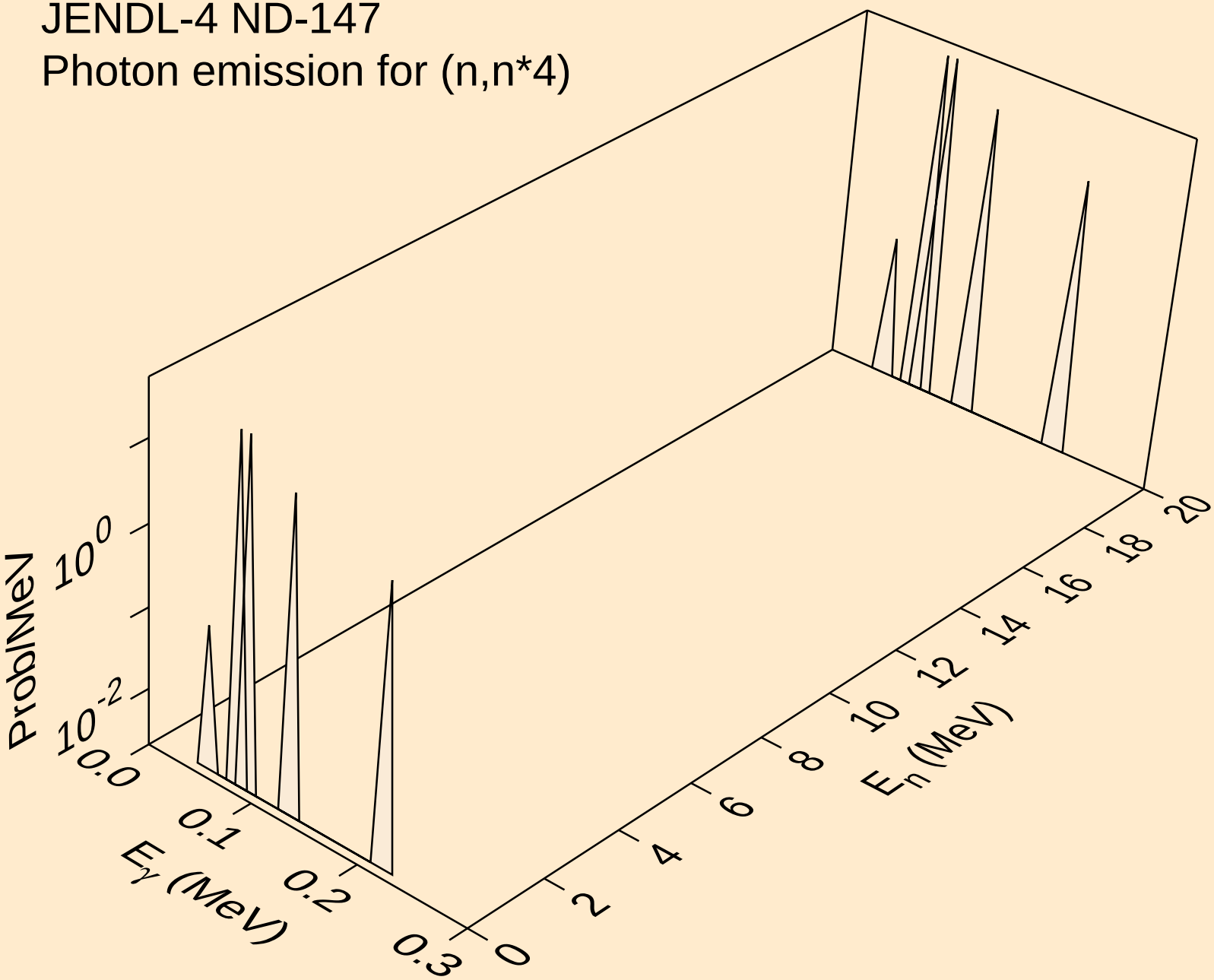



JENDL-4 ND-147
Photon emission for (n,n*2)
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
50
100
150
E_γ (MeV)
$*10^{-3}$
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)

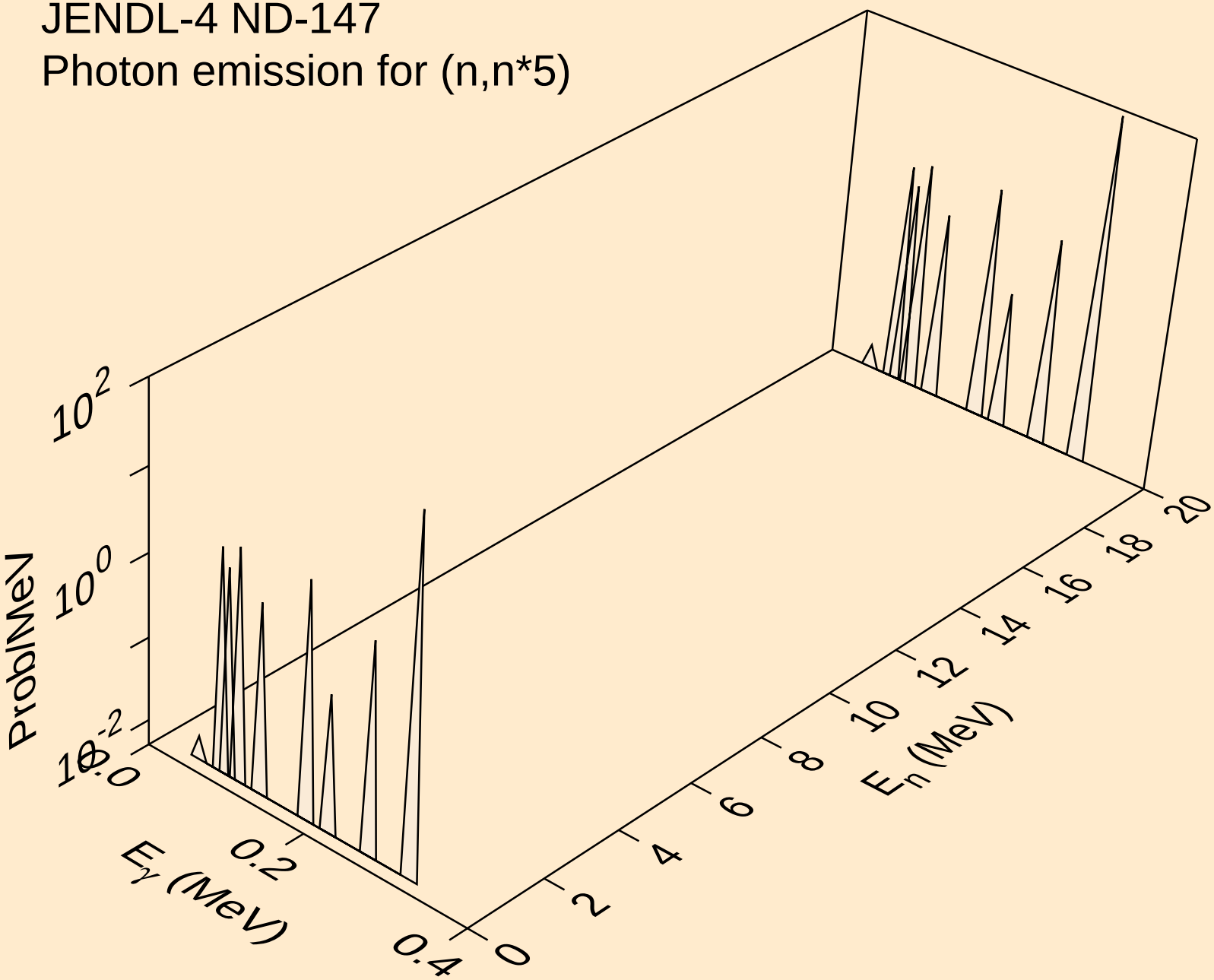
JENDL-4 ND-147
Photon emission for (n,n*3)



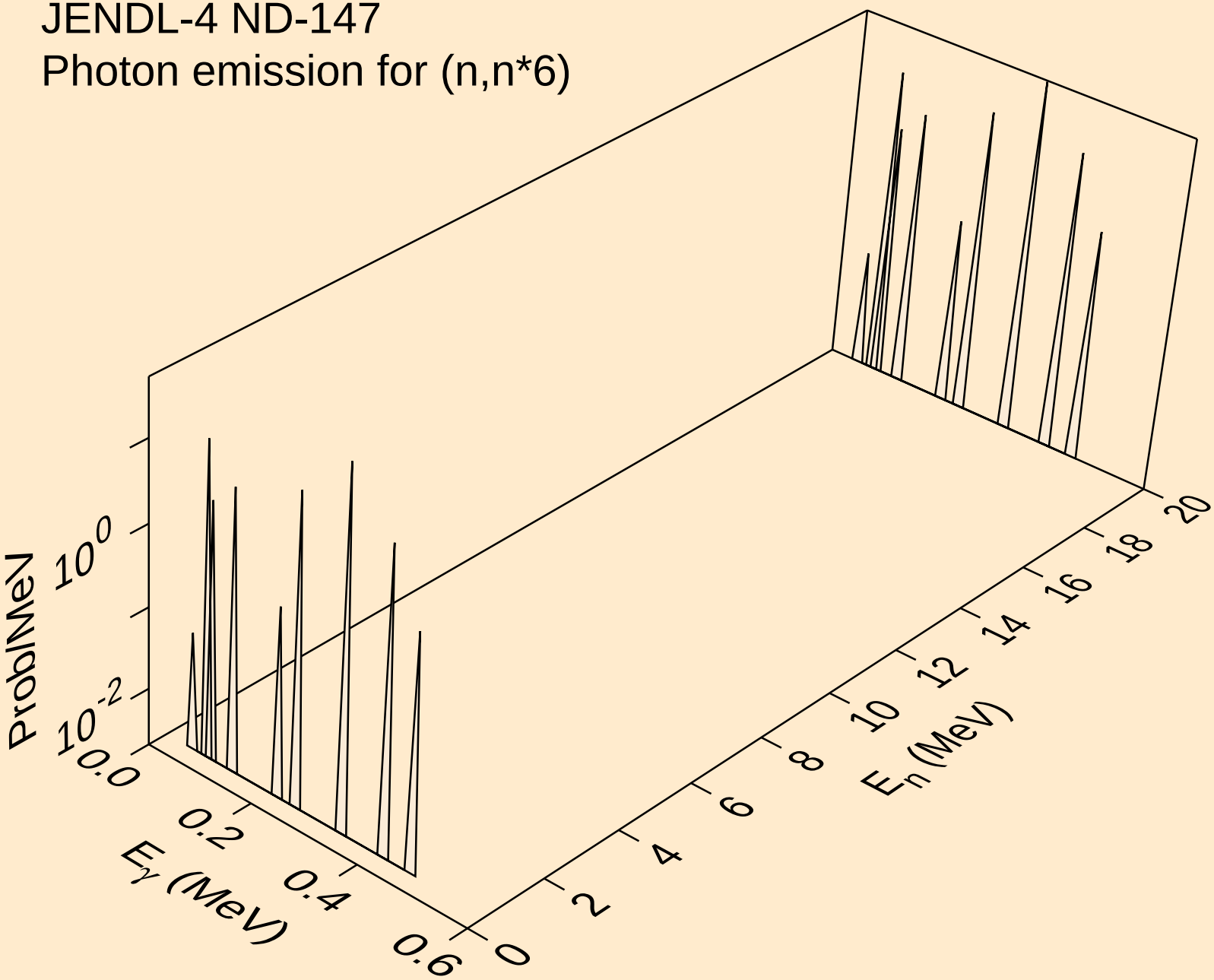
JENDL-4 ND-147
Photon emission for (n,n*4)

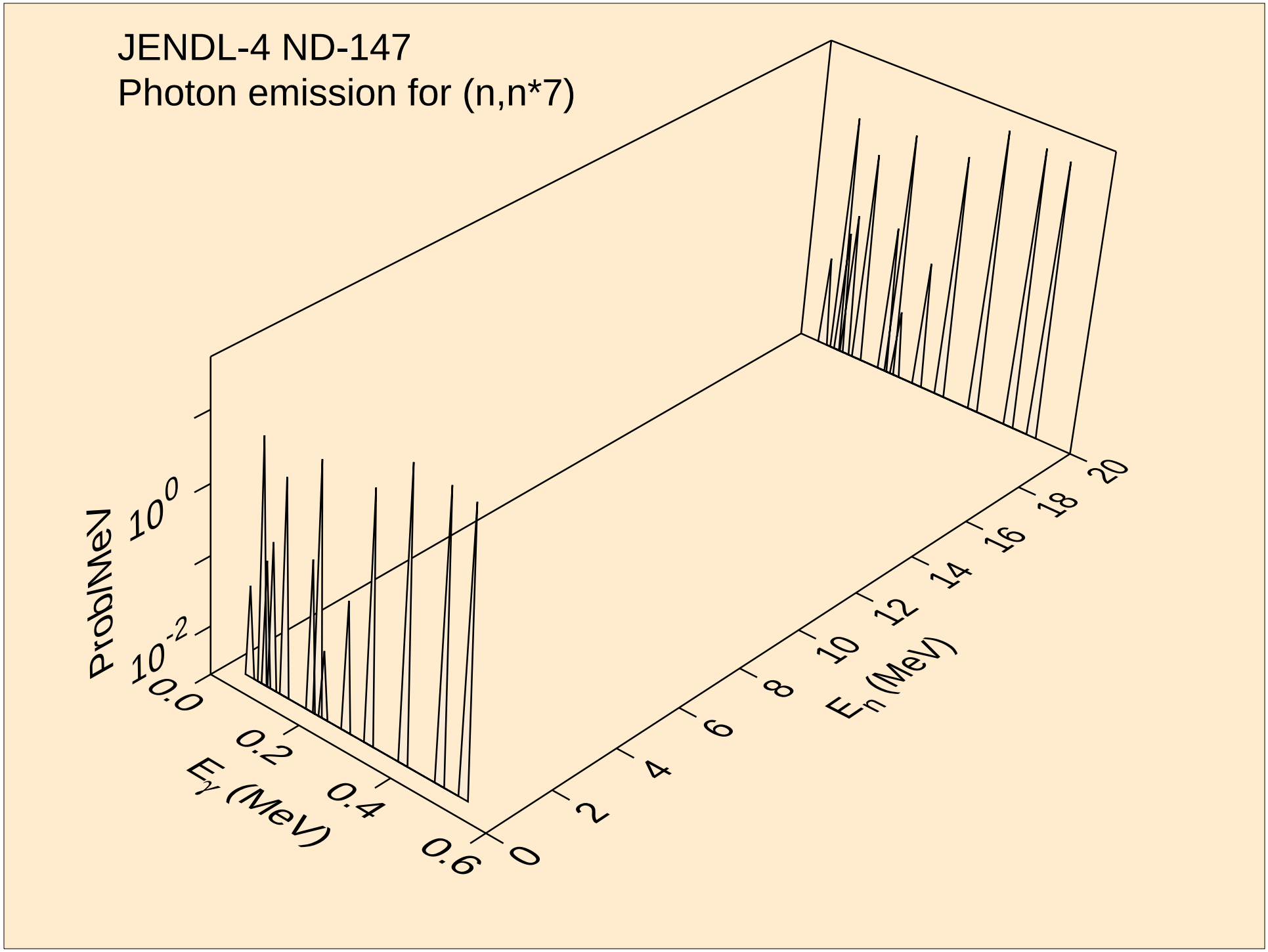


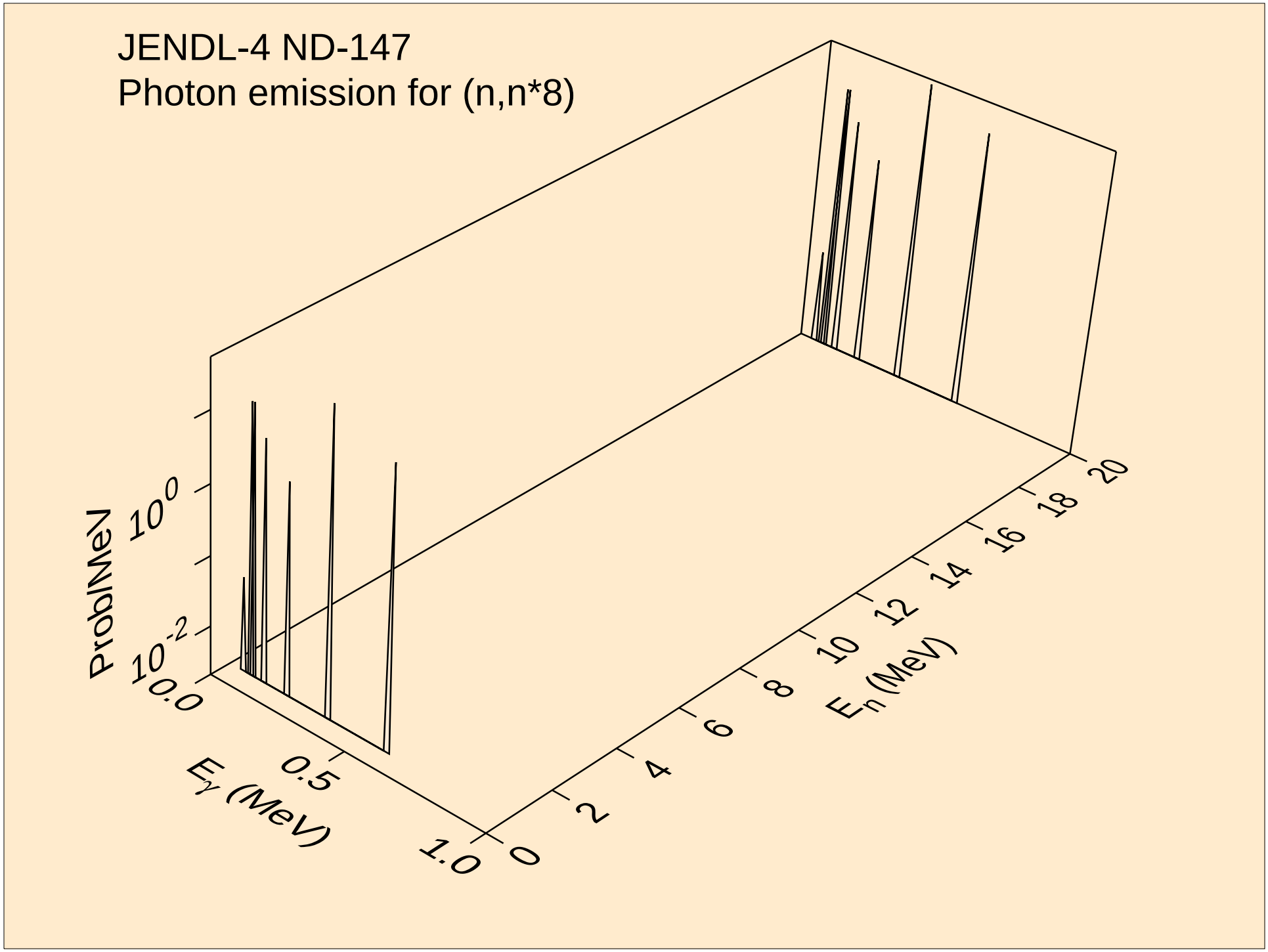
JENDL-4 ND-147
Photon emission for (n,n*5)

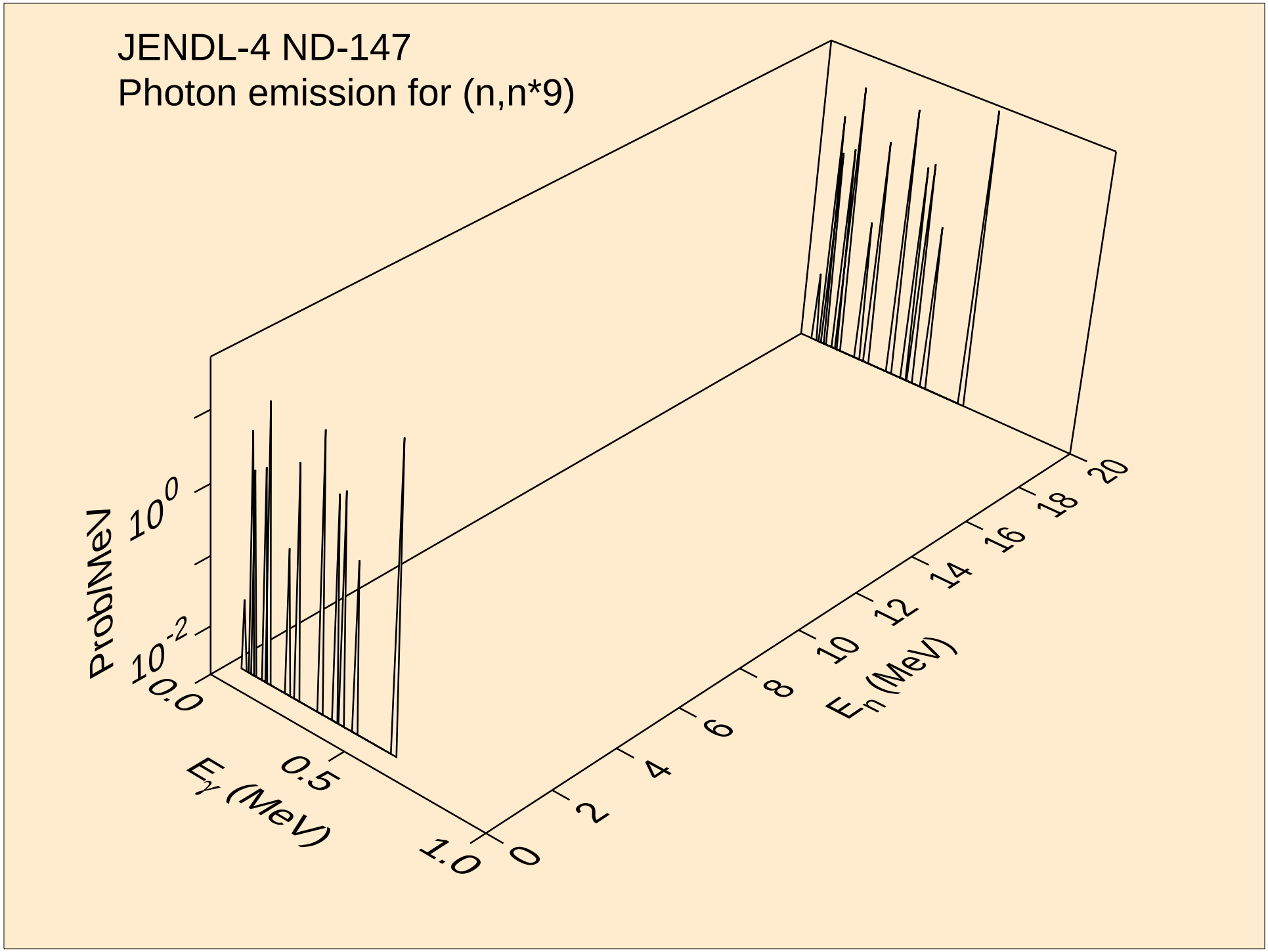


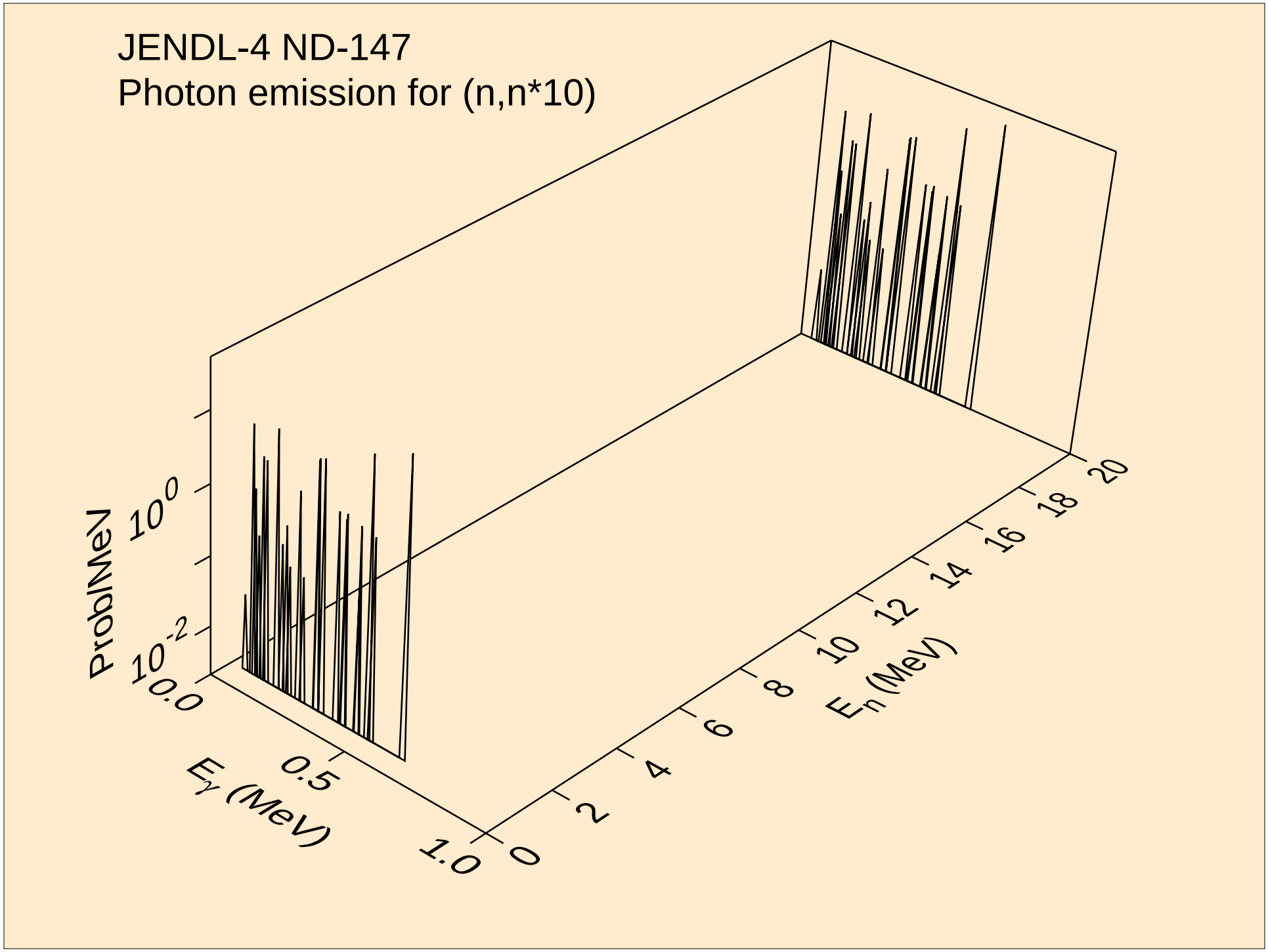
JENDL-4 ND-147
Photon emission for (n,n*6)



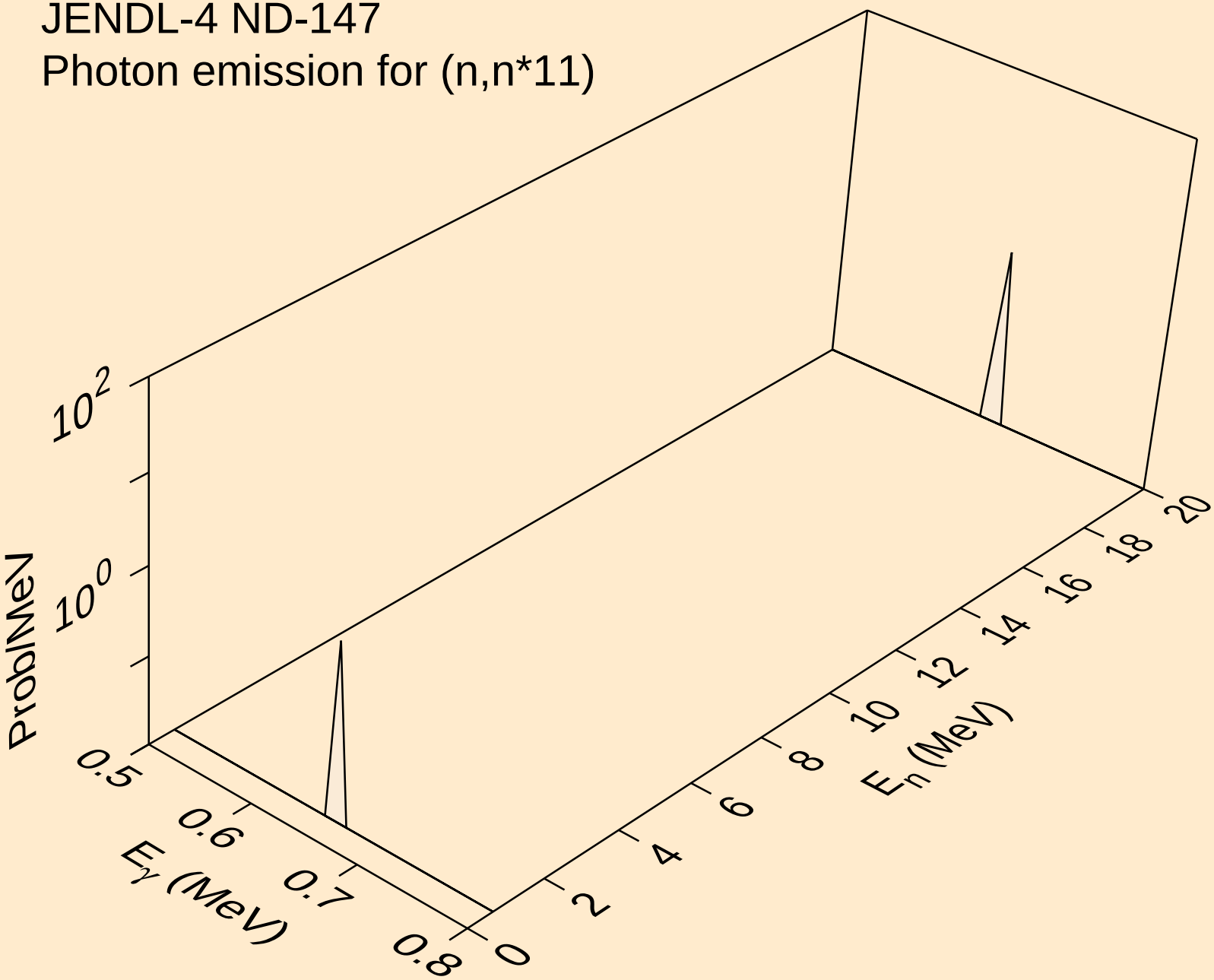

JENDL-4 ND-147
Photon emission for (n,n*7)
Prob/MeV
10^0
10^{-2}
0.0
0.2
0.4
0.6
E_γ (MeV)
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)


JENDL-4 ND-147
Photon emission for (n,n*8)
Prob/MeV
10^0
10^{-2}
0.0
0.5
1.0
E_γ (MeV)
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)

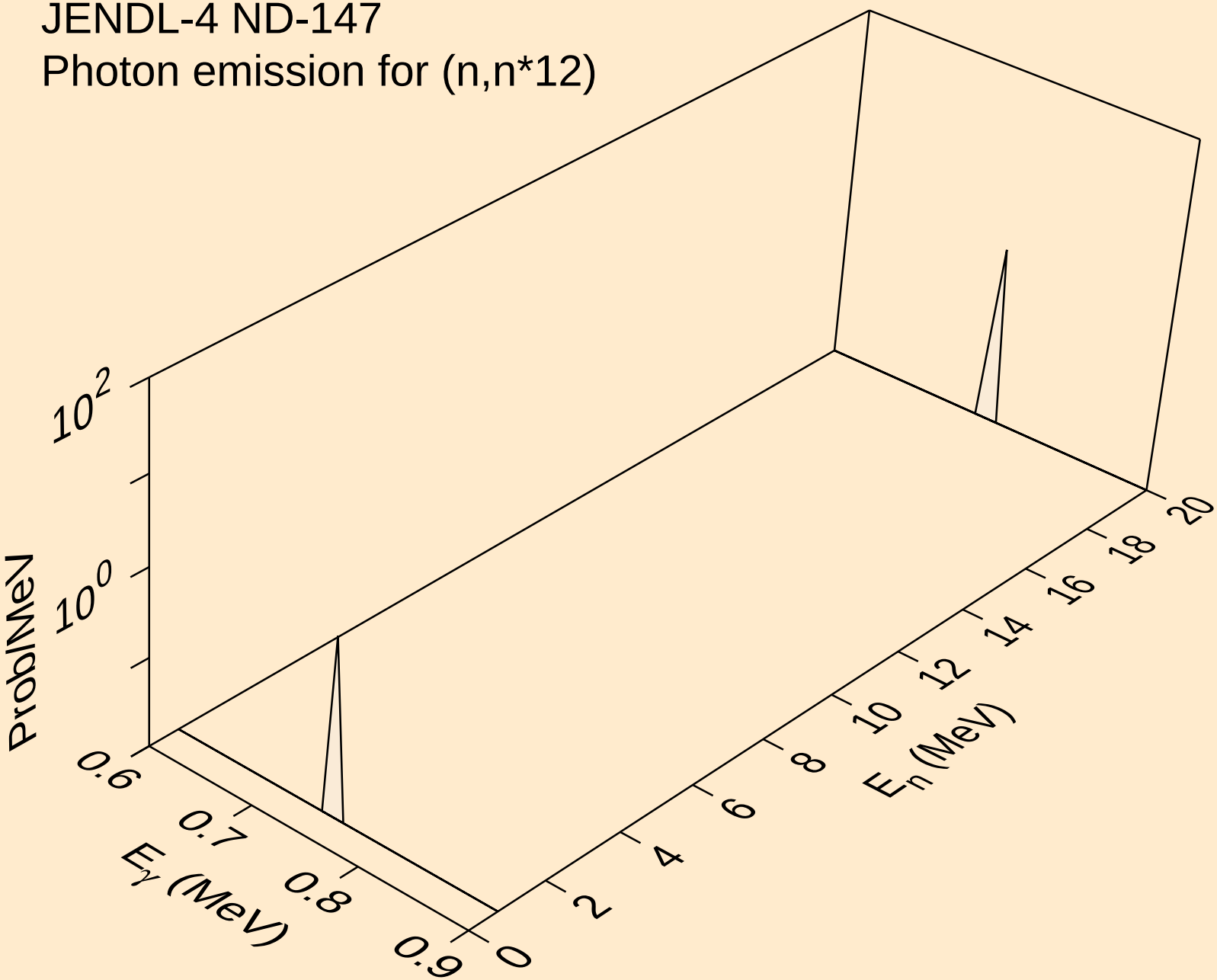

JENDL-4 ND-147
Photon emission for (n,n*9)
Prob/MeV
10^0
10^{-2}
0.0
0.5
1.0
E_γ (MeV)
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)


JENDL-4 ND-147
Photon emission for (n,n*10)
Prob/MeV
10^0
10^{-2}
0.0
0.5
1.0
E_γ (MeV)
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)

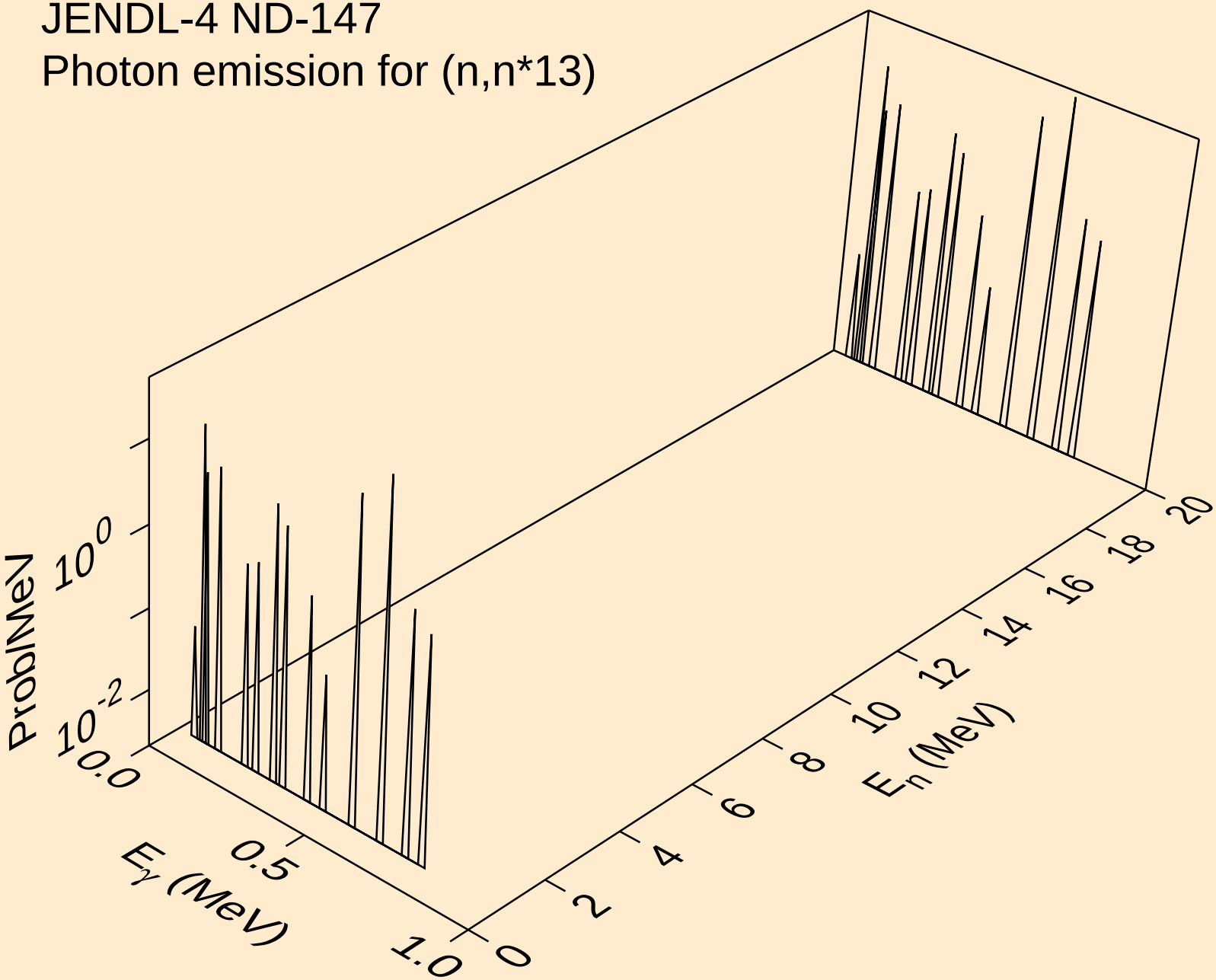
JENDL-4 ND-147
Photon emission for (n,n*11)

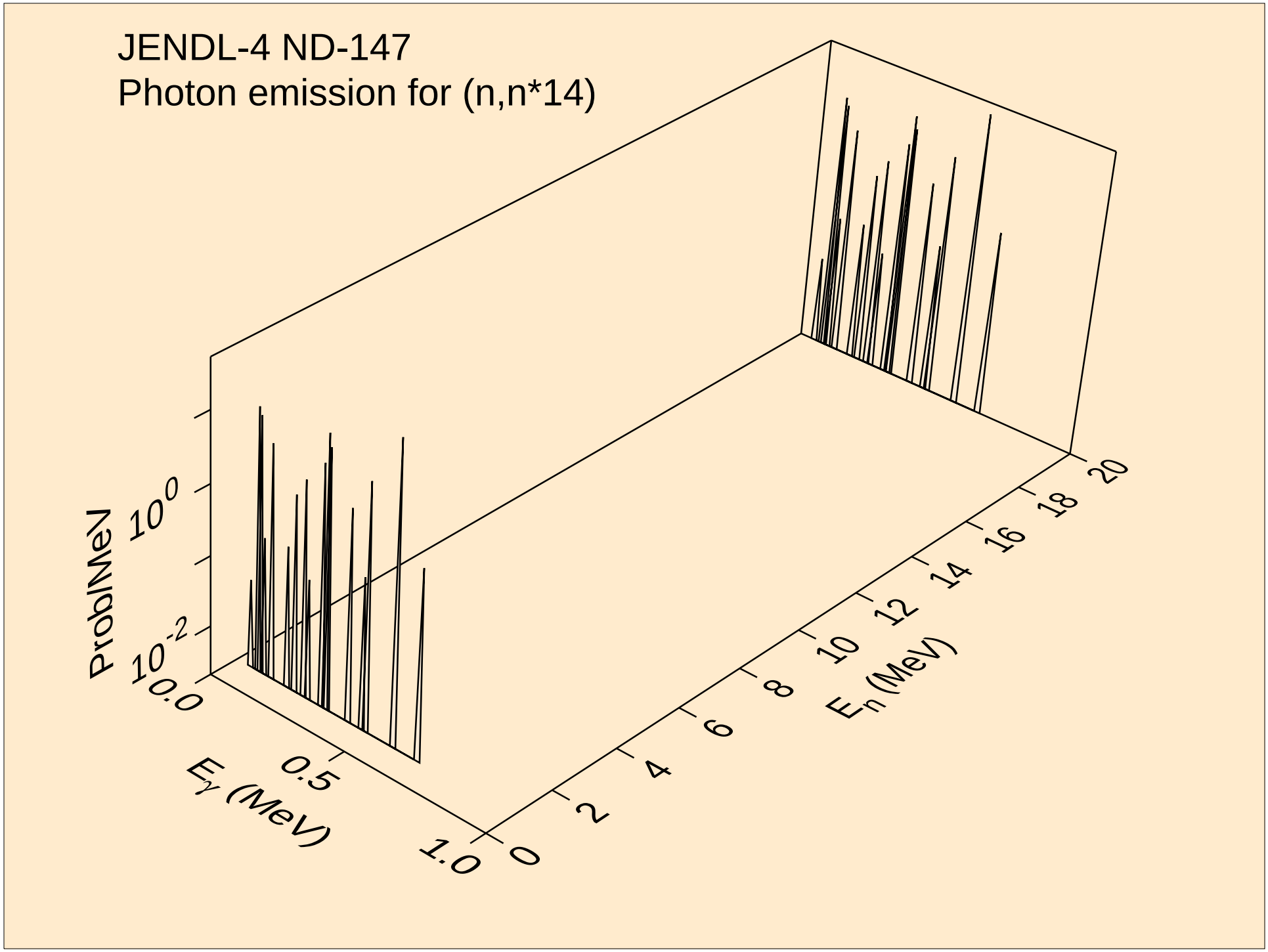


JENDL-4 ND-147
Photon emission for (n,n*12)

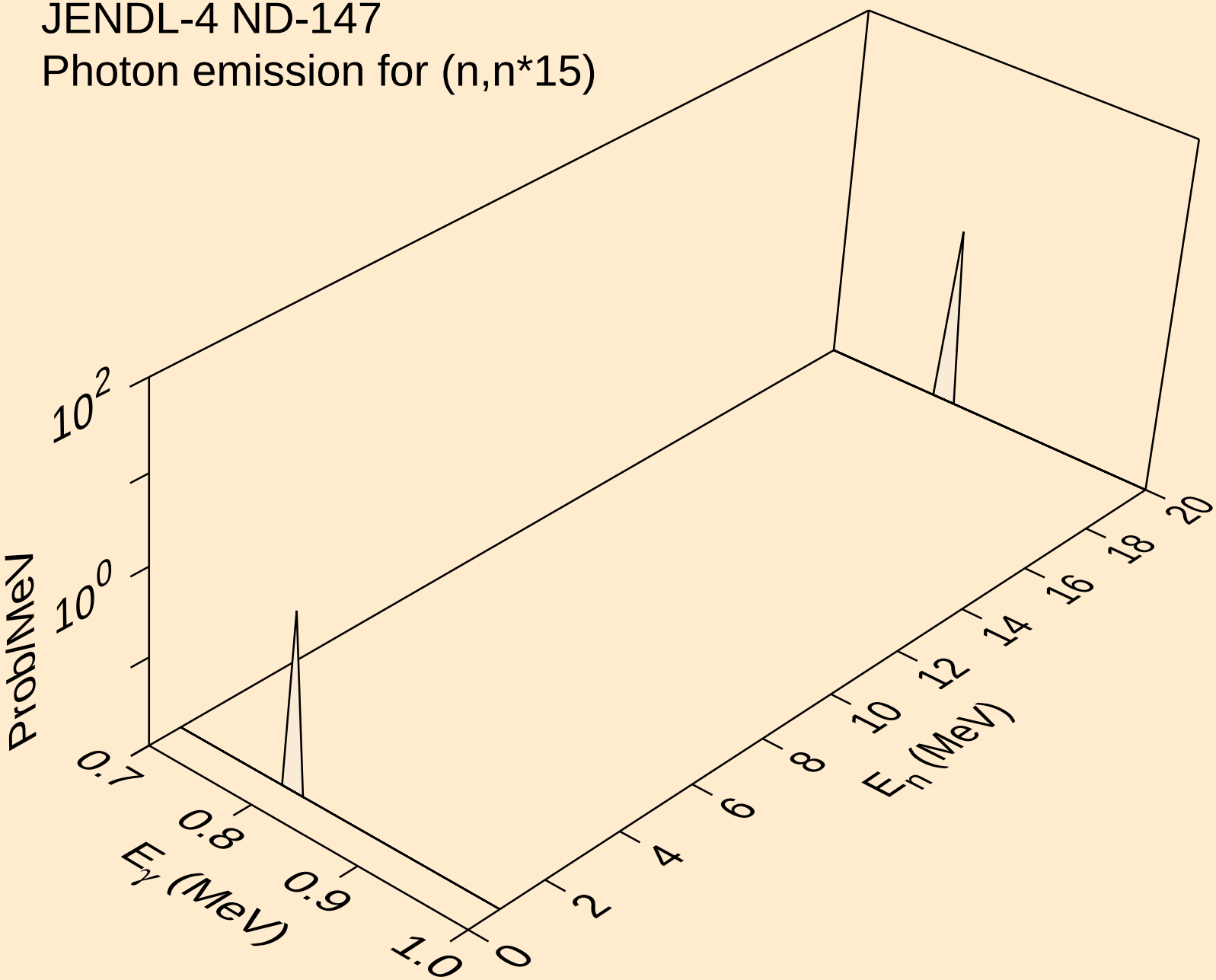


JENDL-4 ND-147
Photon emission for (n,n*13)

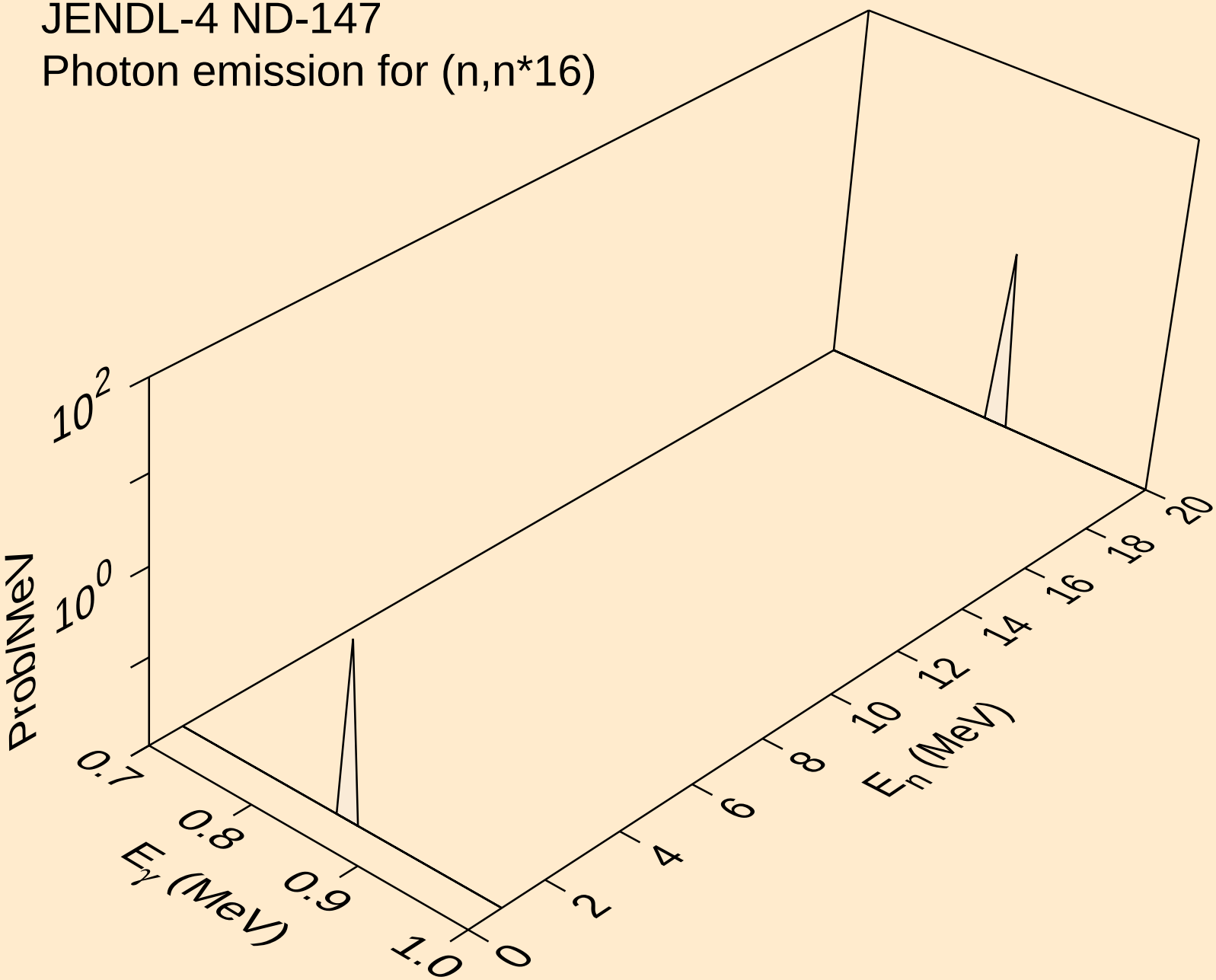



JENDL-4 ND-147
Photon emission for (n,n*14)
Prob/MeV
10^0
10^{-2}
0.0
0.5
1.0
E_γ (MeV)
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)

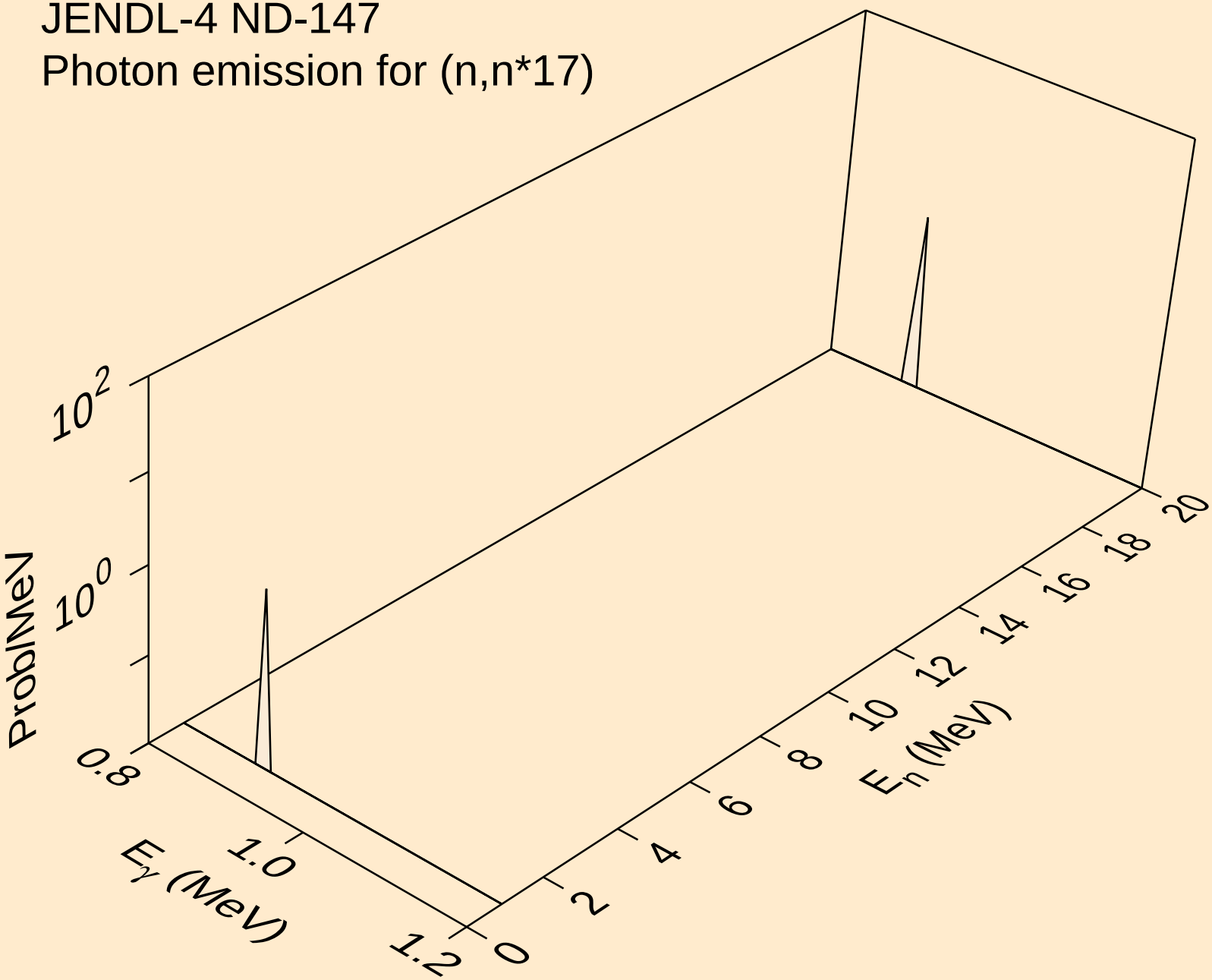
JENDL-4 ND-147
Photon emission for (n,n*15)



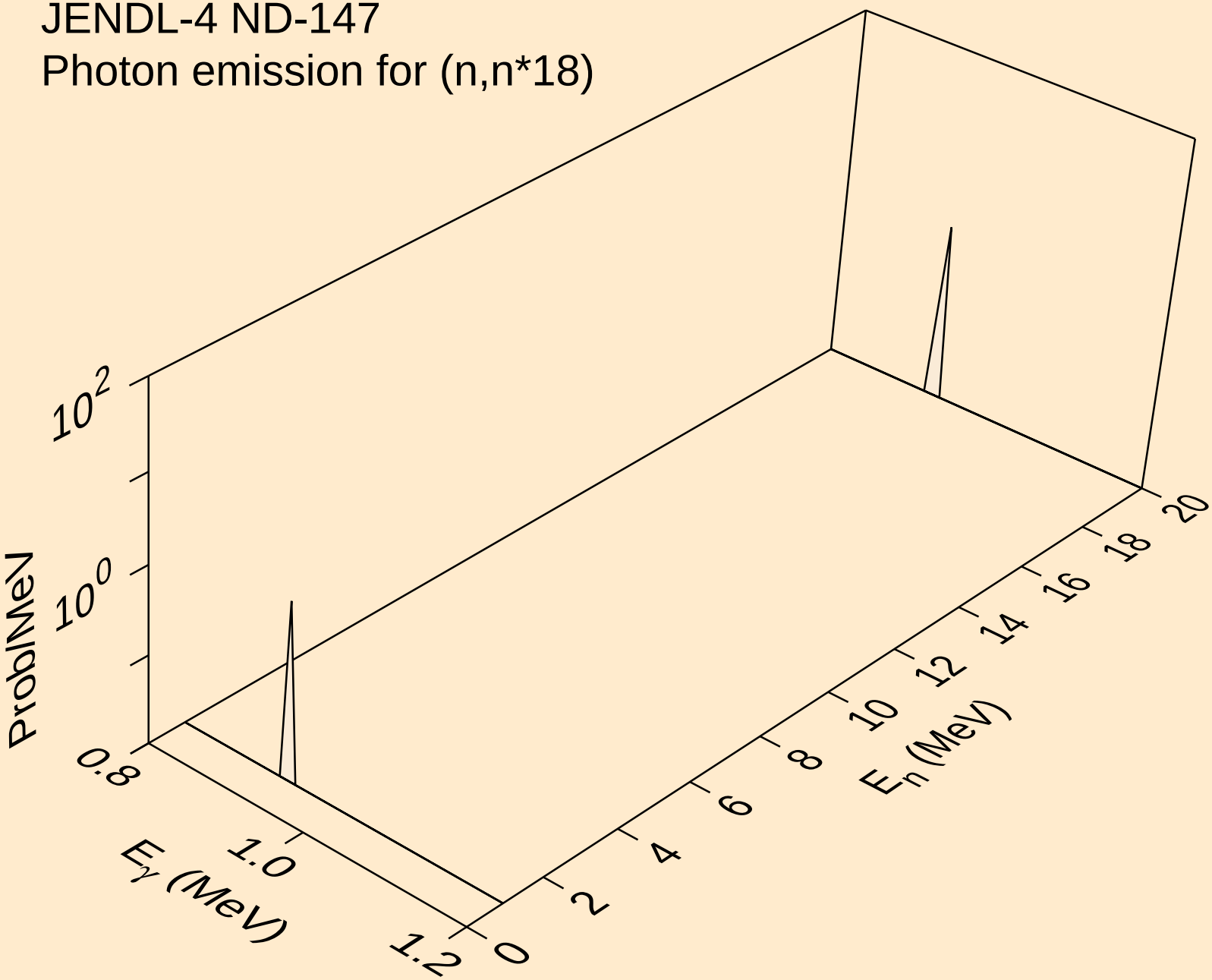
JENDL-4 ND-147
Photon emission for (n,n*16)



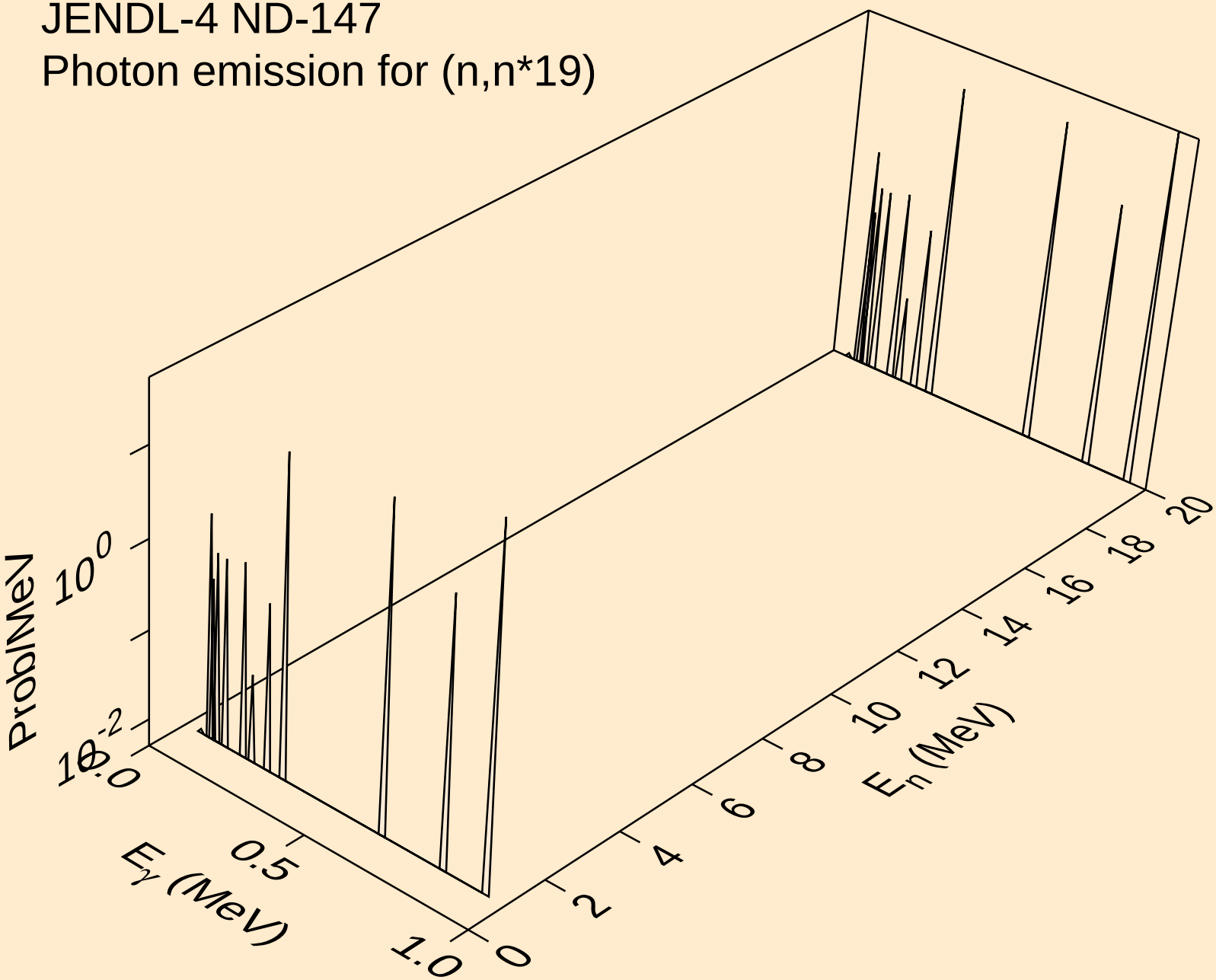
JENDL-4 ND-147
Photon emission for (n,n*17)

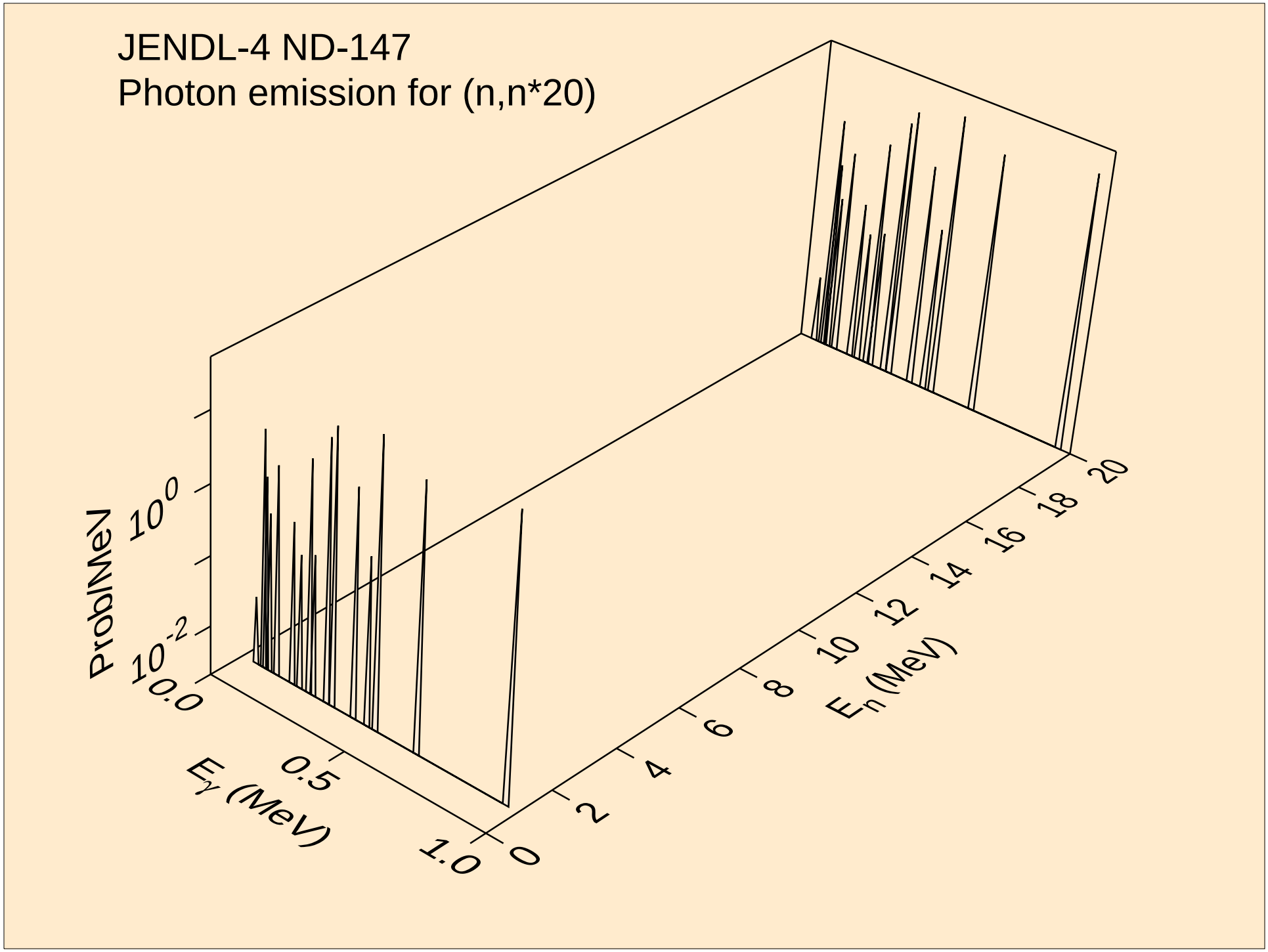


JENDL-4 ND-147
Photon emission for (n,n*18)

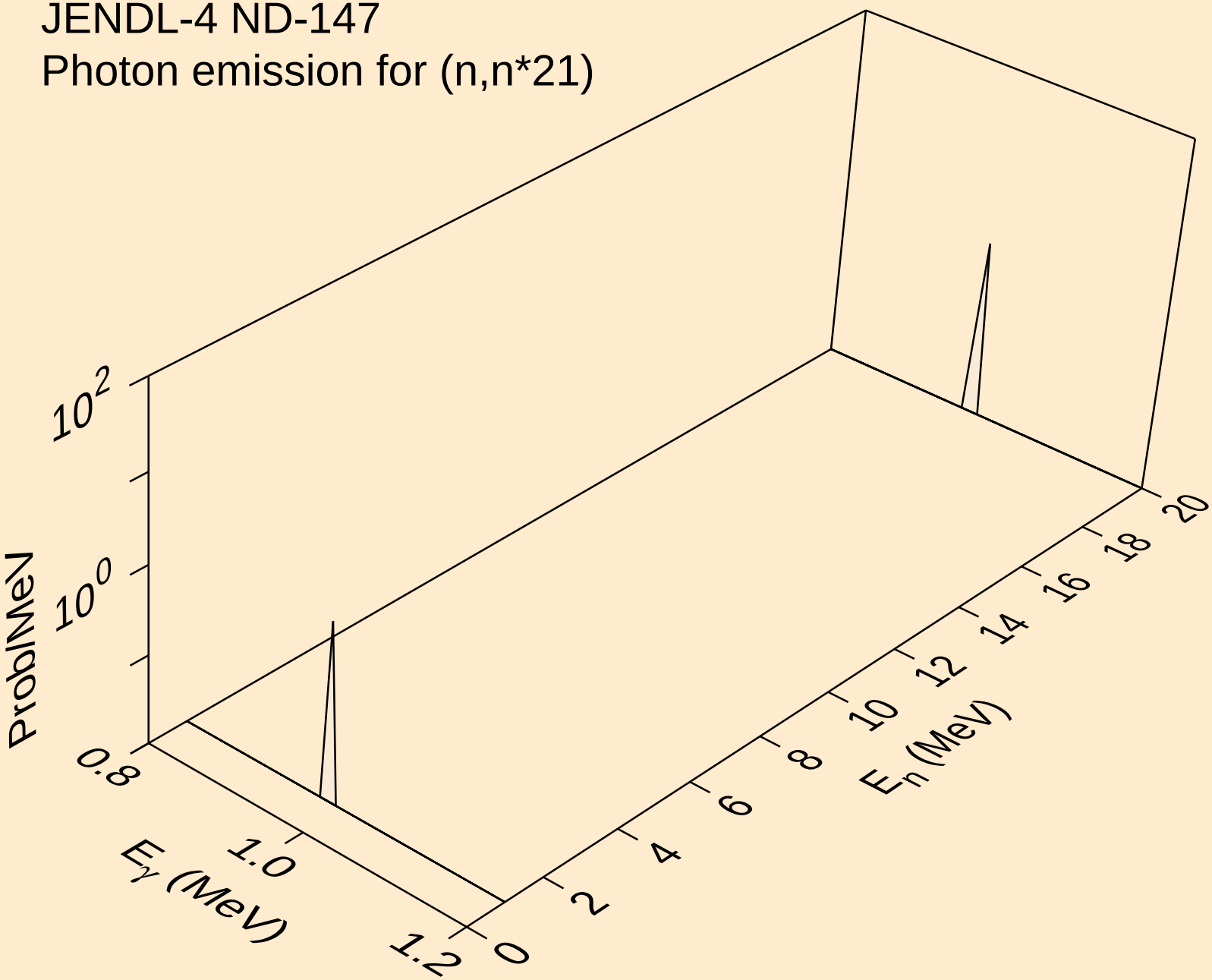


JENDL-4 ND-147
Photon emission for (n,n*19)

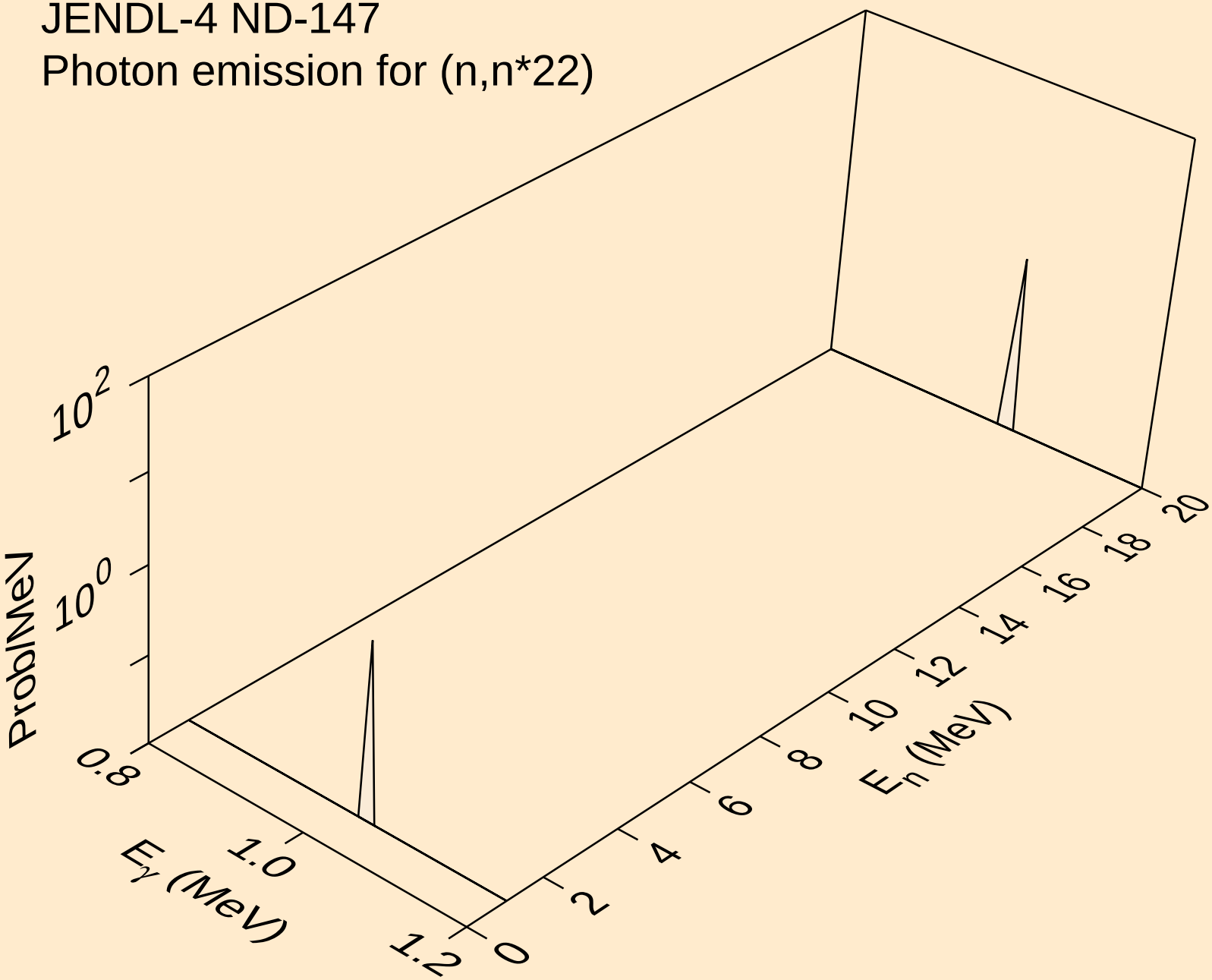


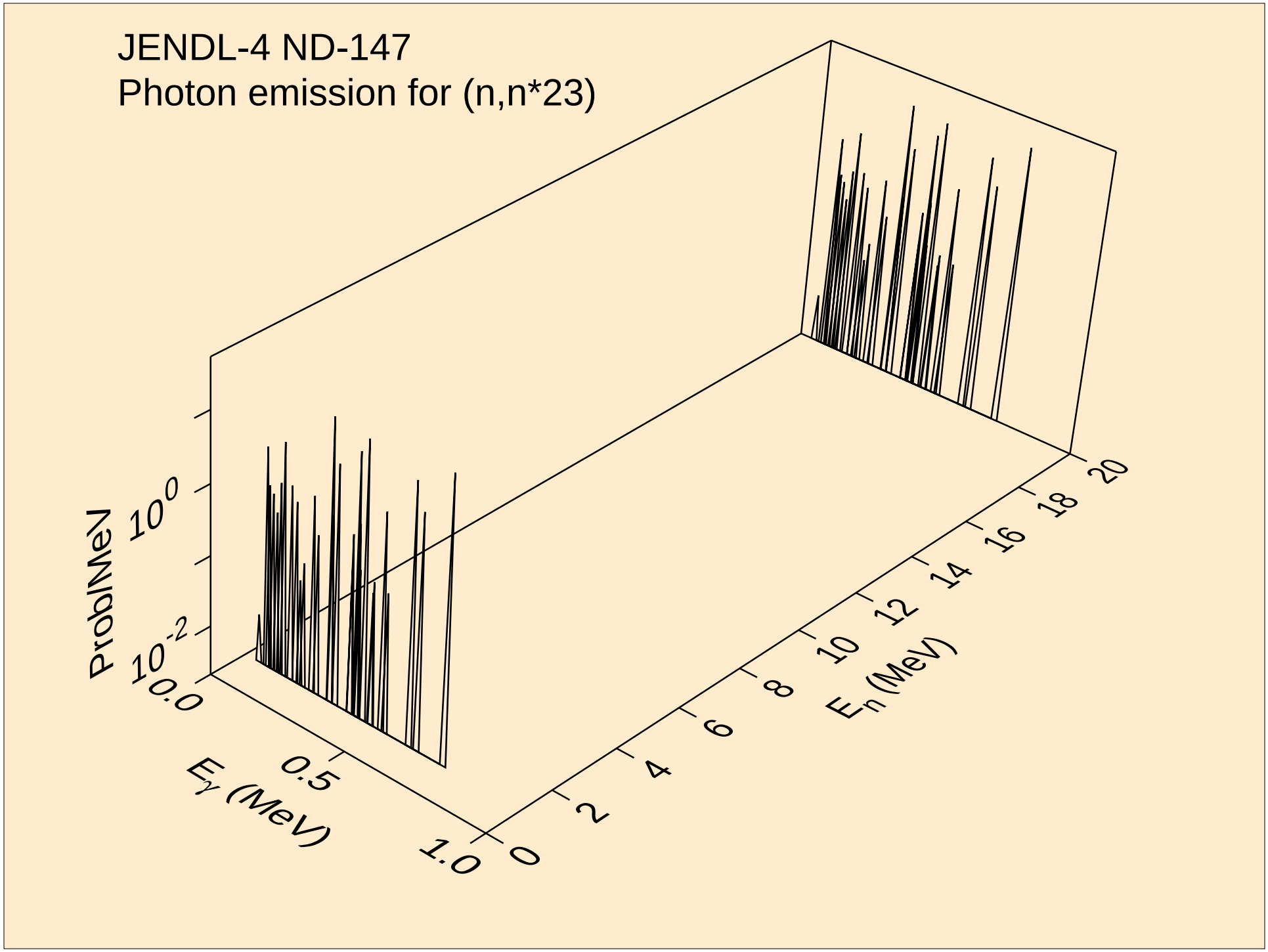

JENDL-4 ND-147
Photon emission for (n,n*20)
Prob/MeV
10^0
10^{-2}
0.0
0.5
1.0
E_γ (MeV)
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)

JENDL-4 ND-147
Photon emission for (n,n*21)

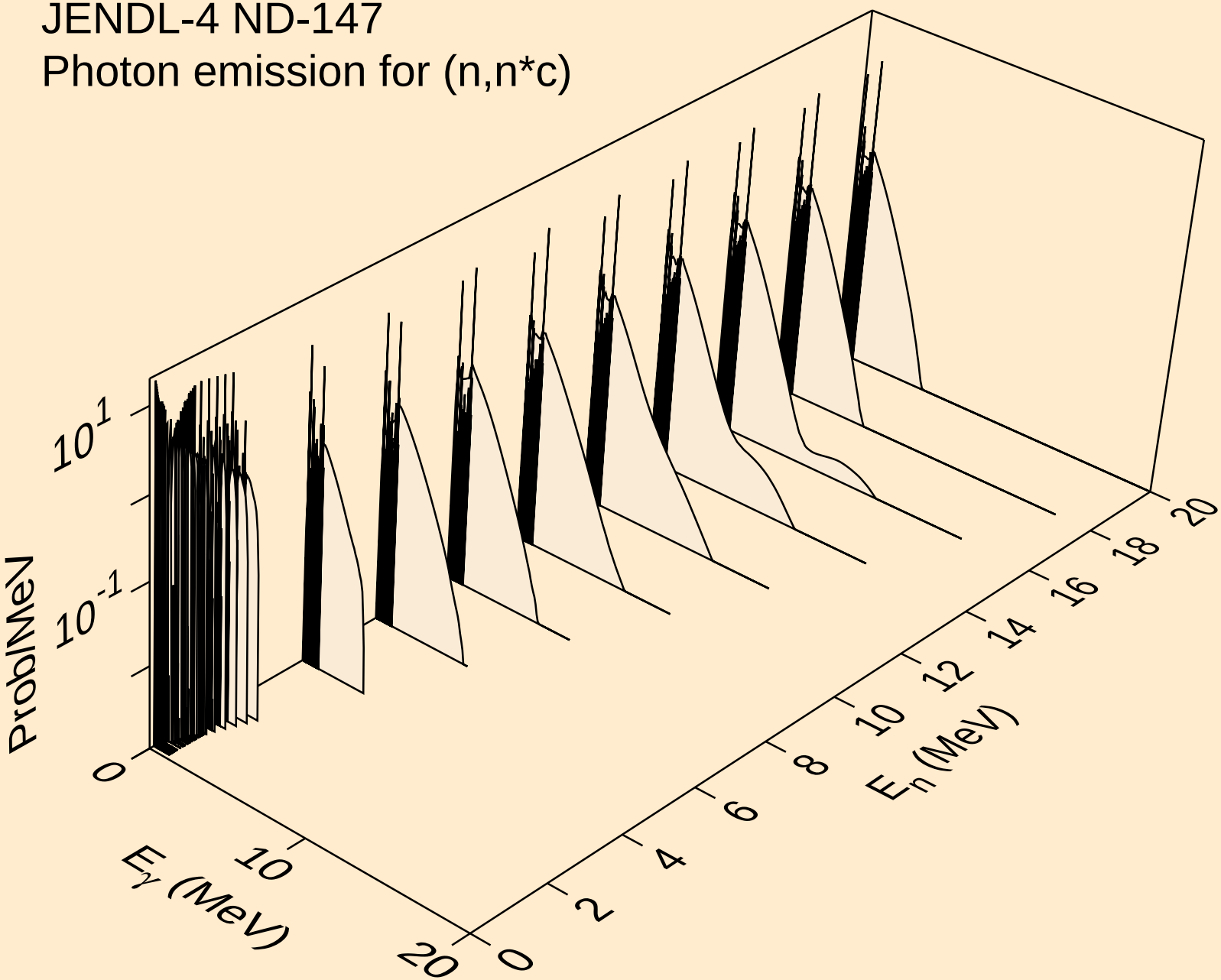


JENDL-4 ND-147
Photon emission for (n,n*22)

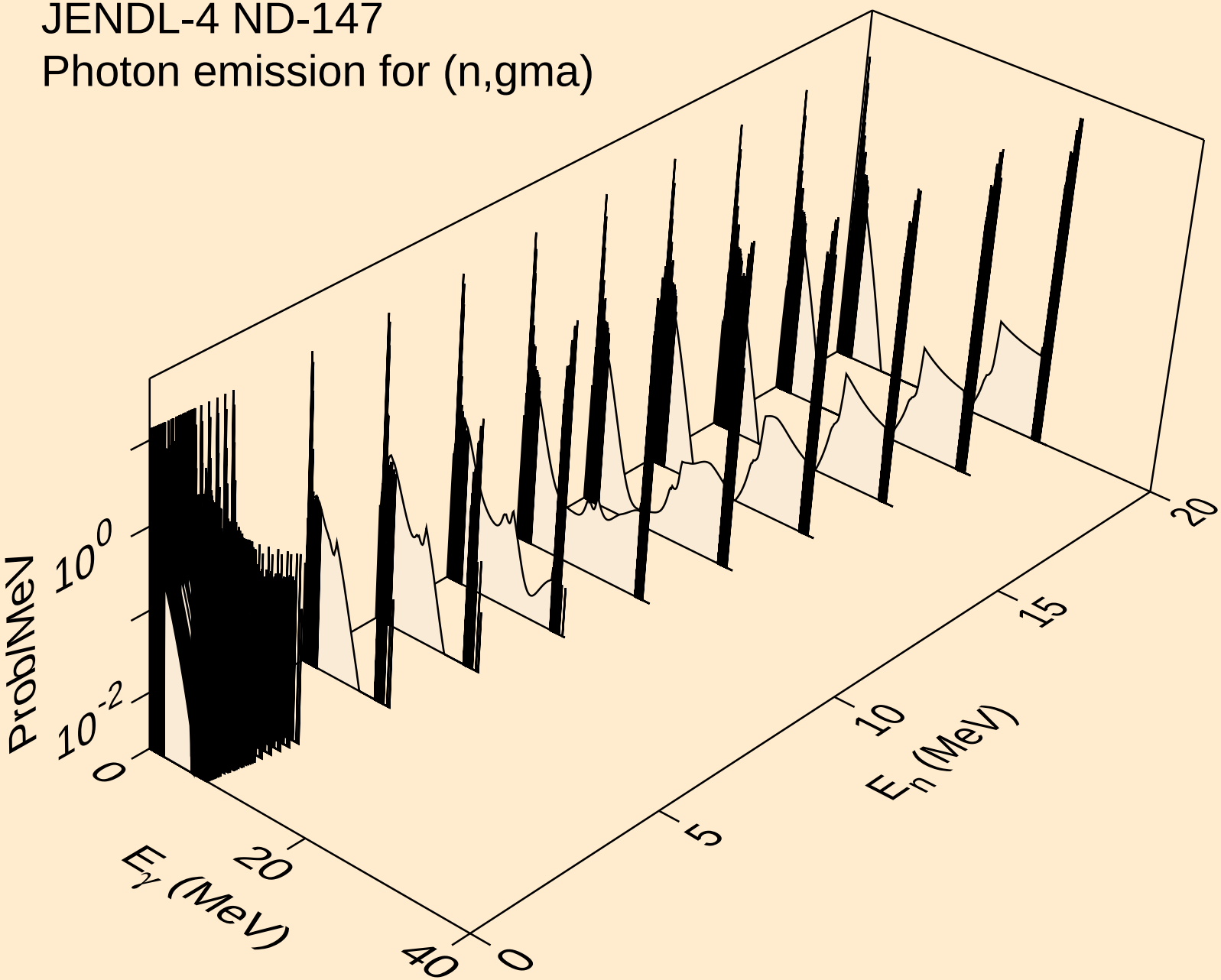


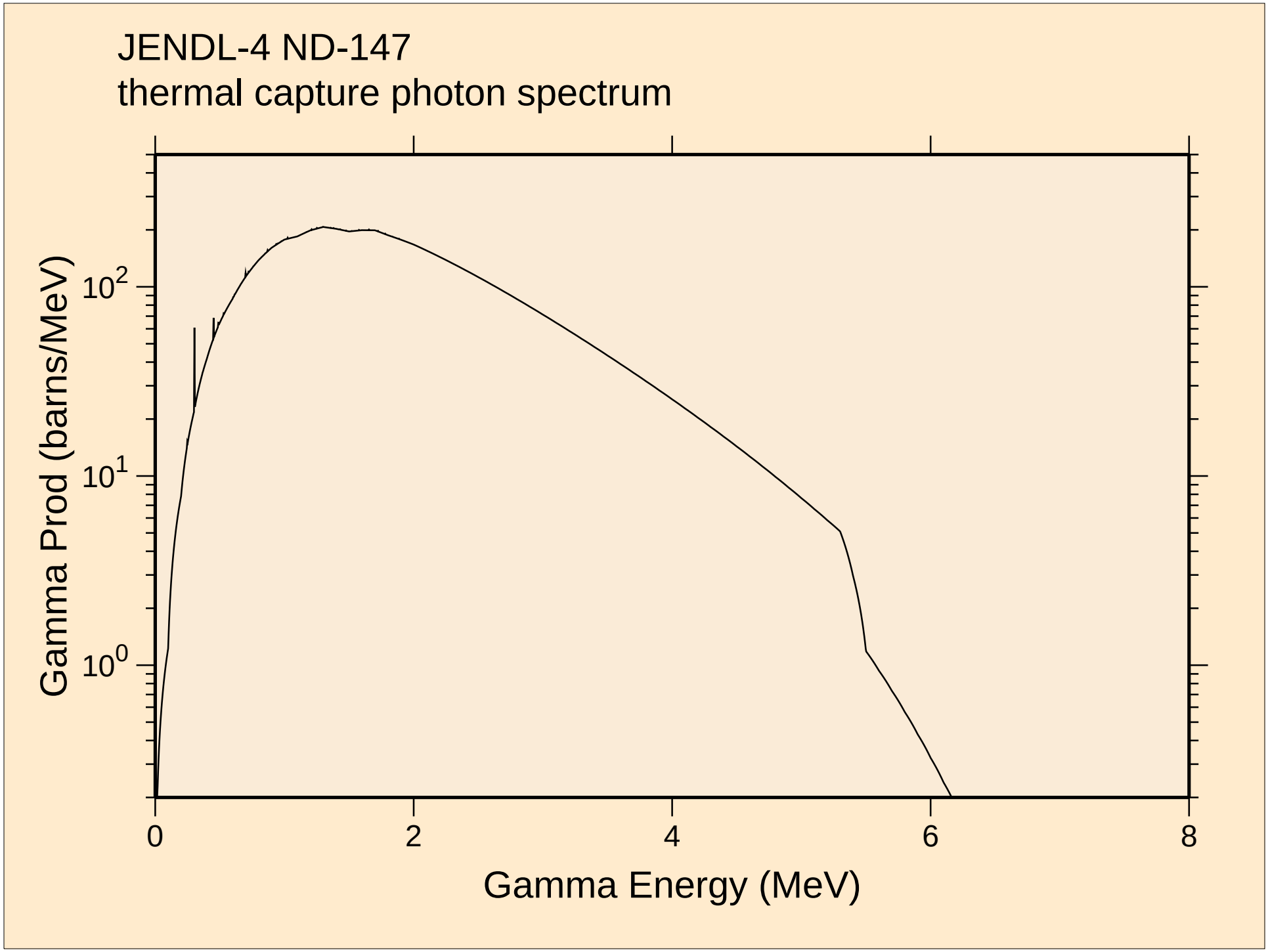

JENDL-4 ND-147
Photon emission for (n,n*23)
Prob/MeV
10^0
10^{-2}
0.0
0.5
1.0
E_γ (MeV)
0
2
4
6
8
10
12
14
16
18
20
E_n (MeV)

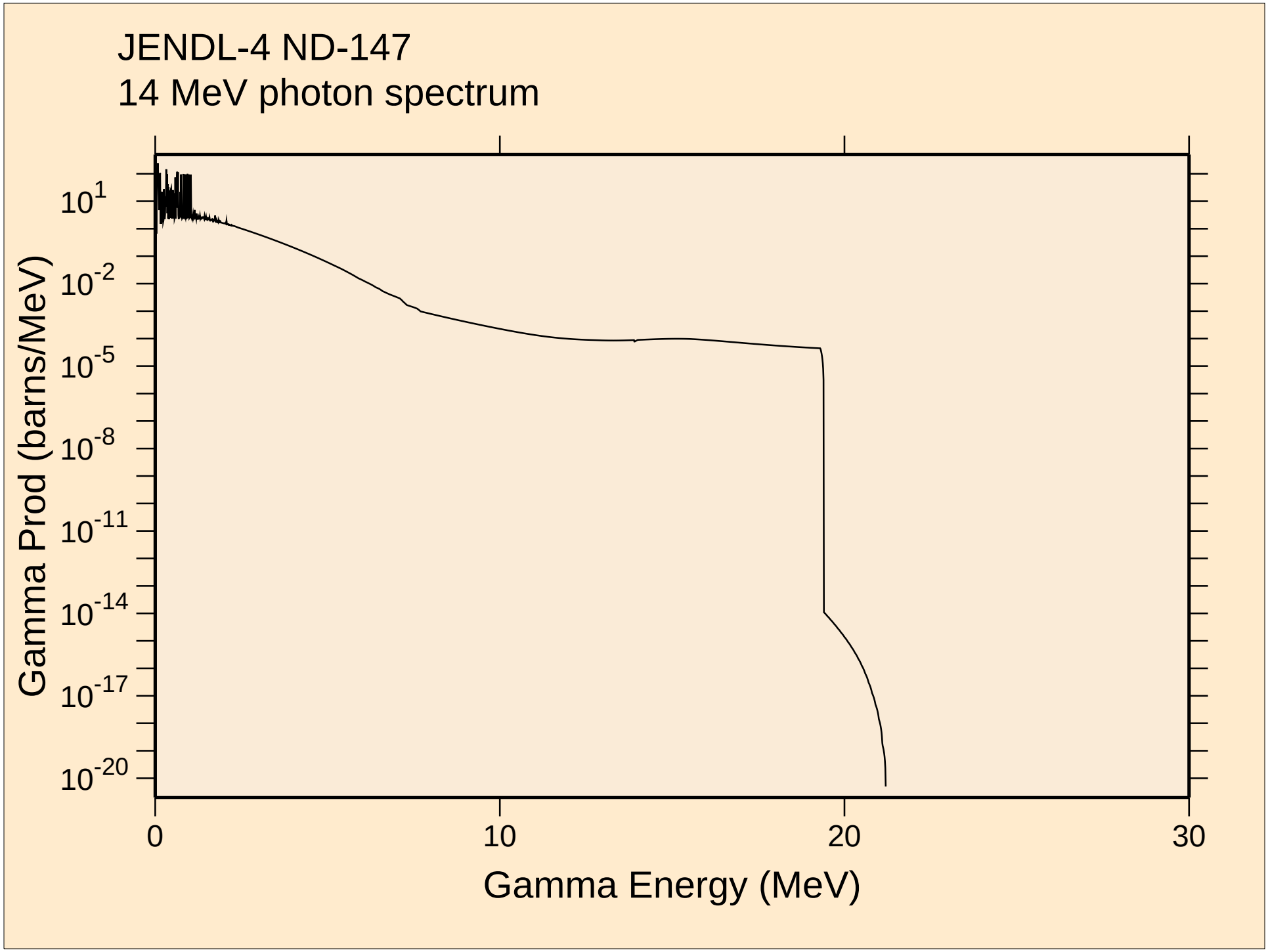
JENDL-4 ND-147
Photon emission for (n,n*c)

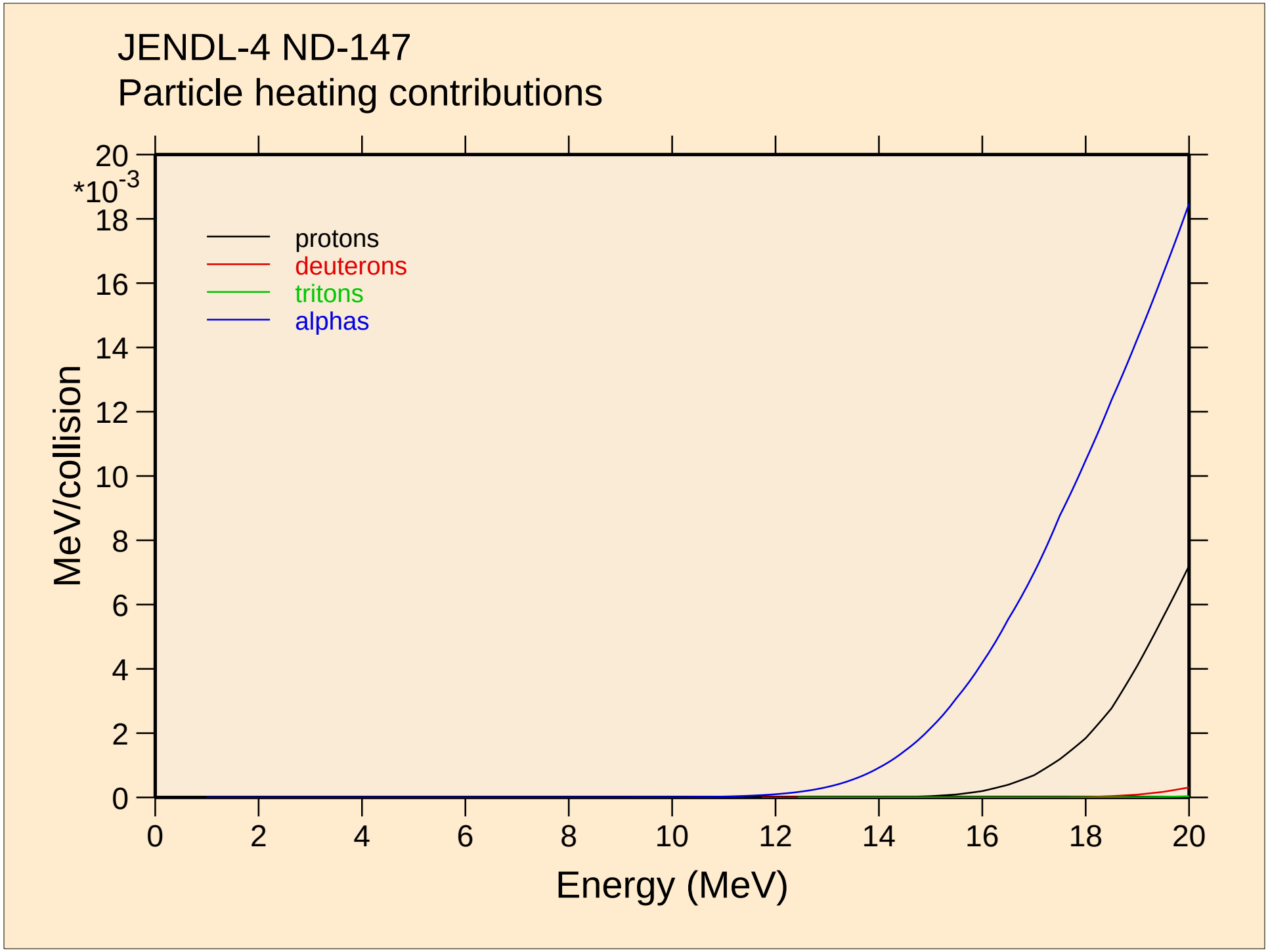


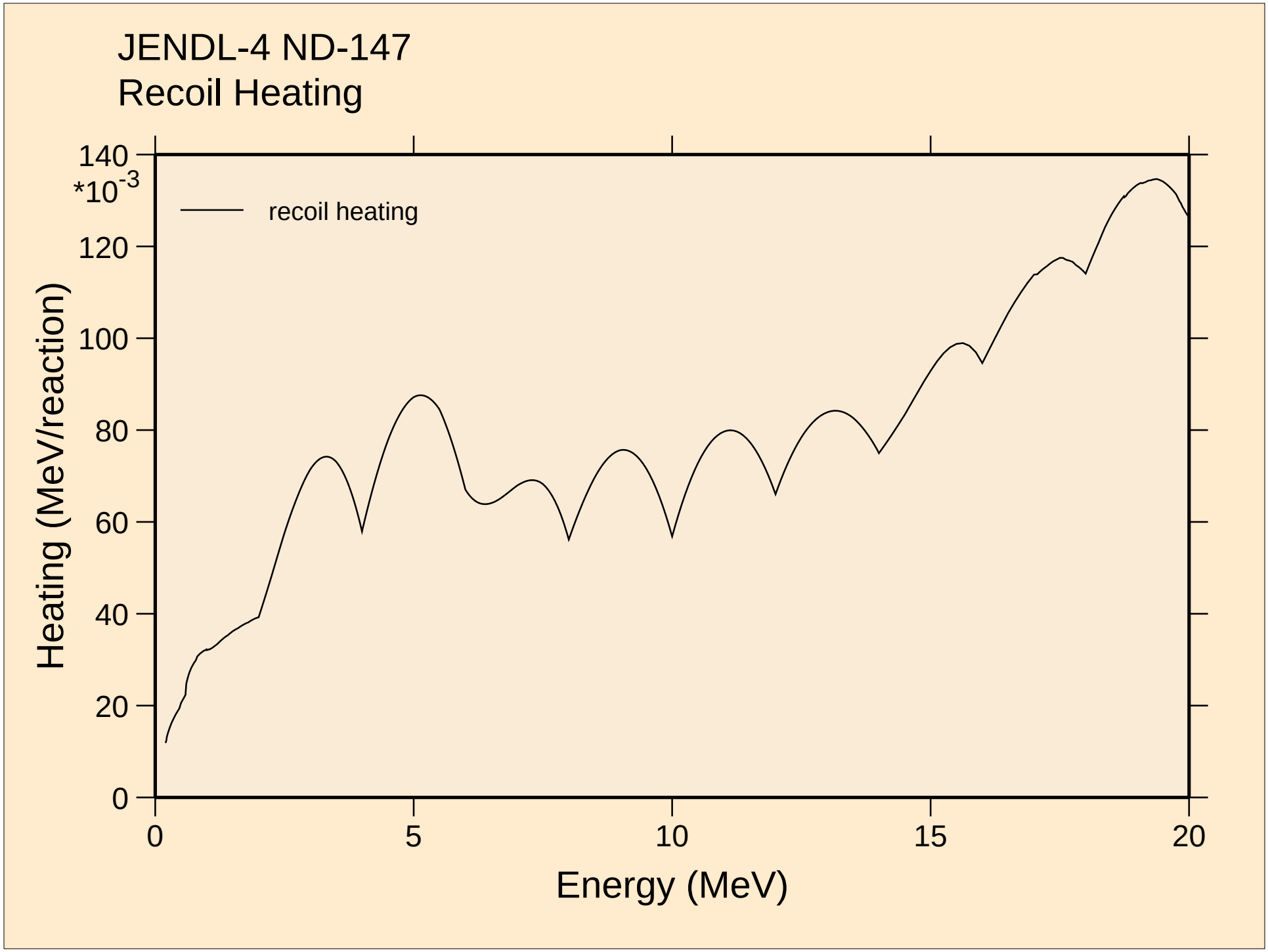
JENDL-4 ND-147
Photon emission for (n,gma)

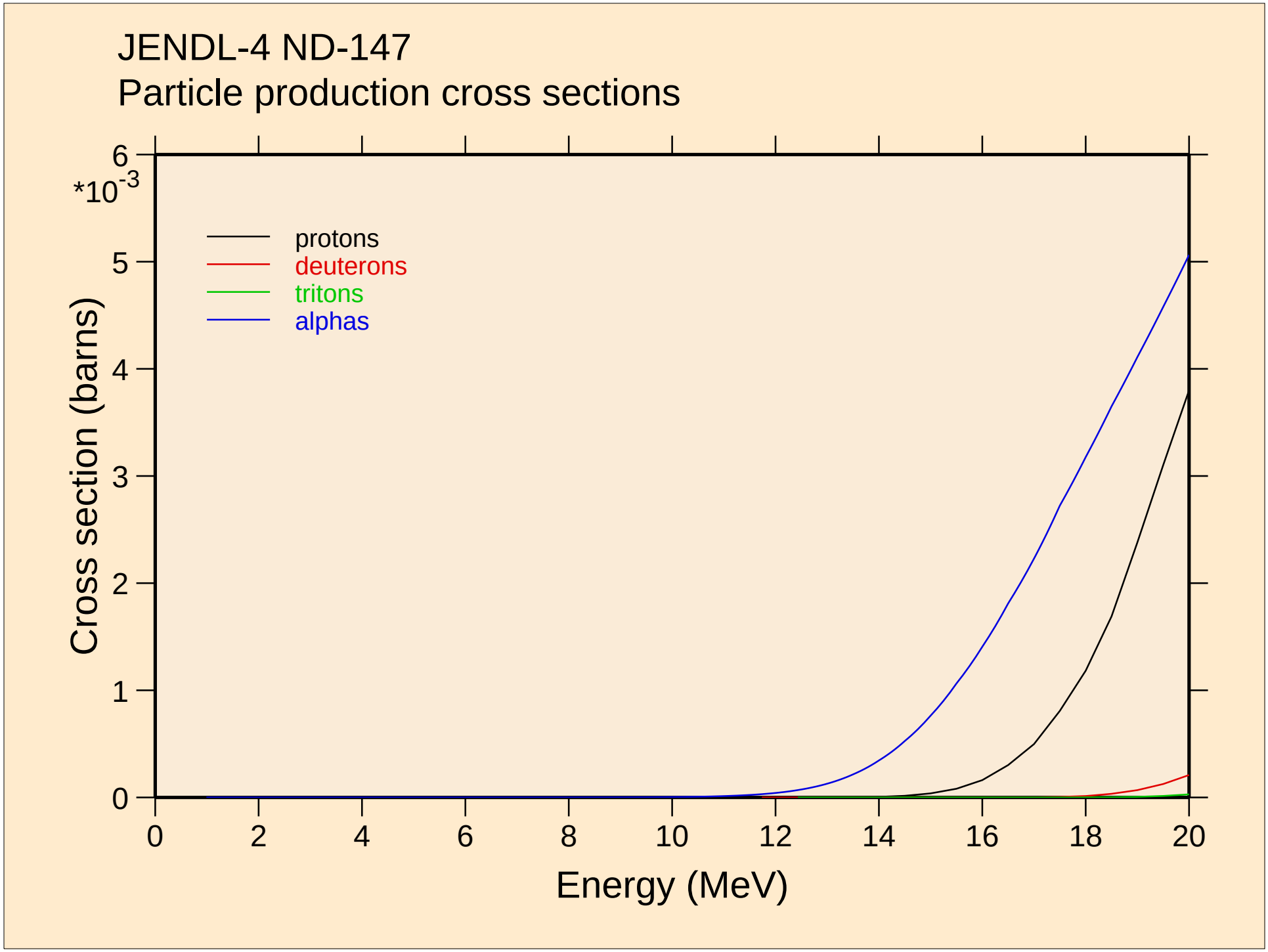


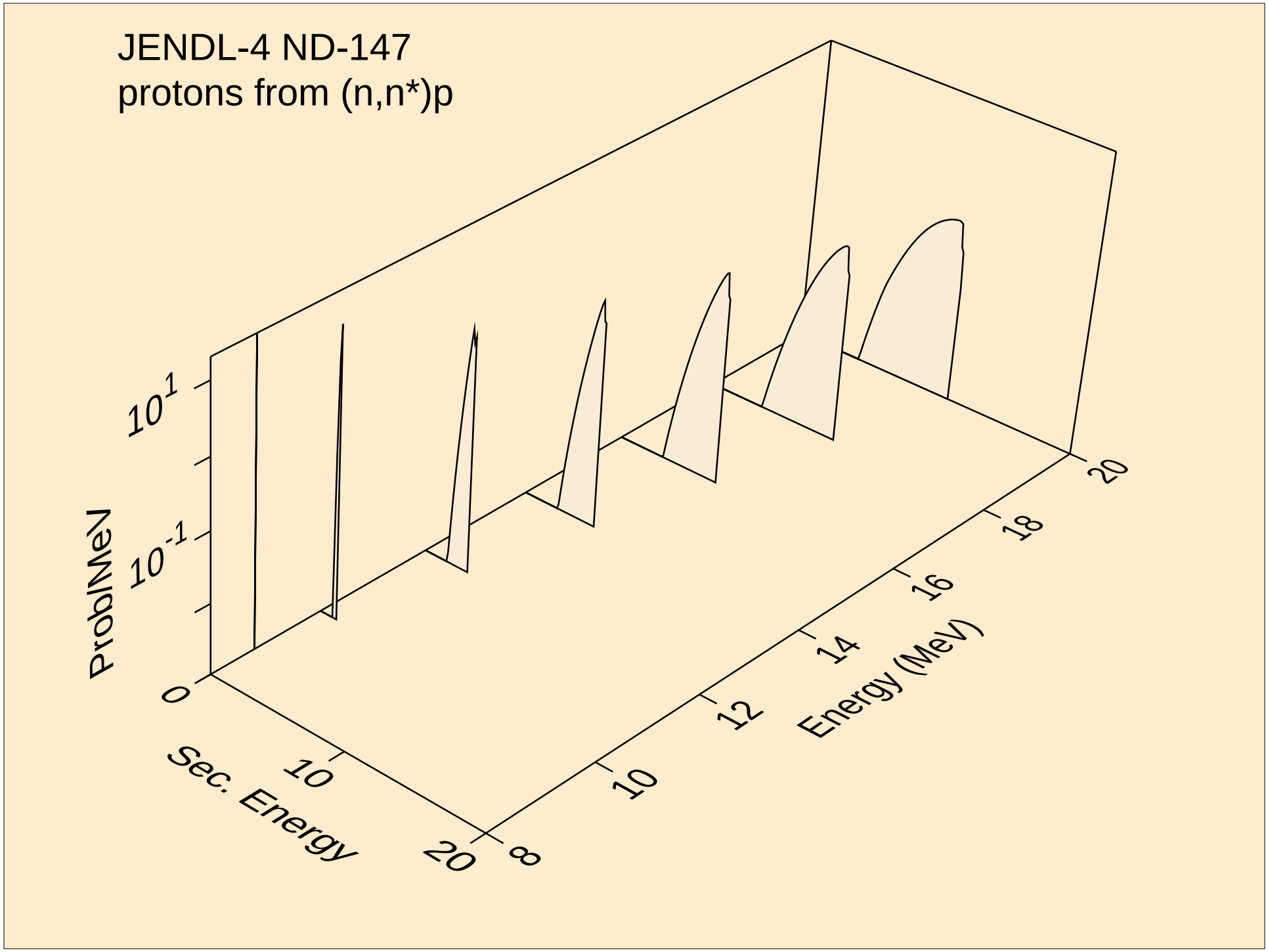

JENDL-4 ND-147
thermal capture photon spectrum
Gamma Prod (barns/MeV)
10^2
10^1
10^0
0
2
4
6
8
Gamma Energy (MeV)

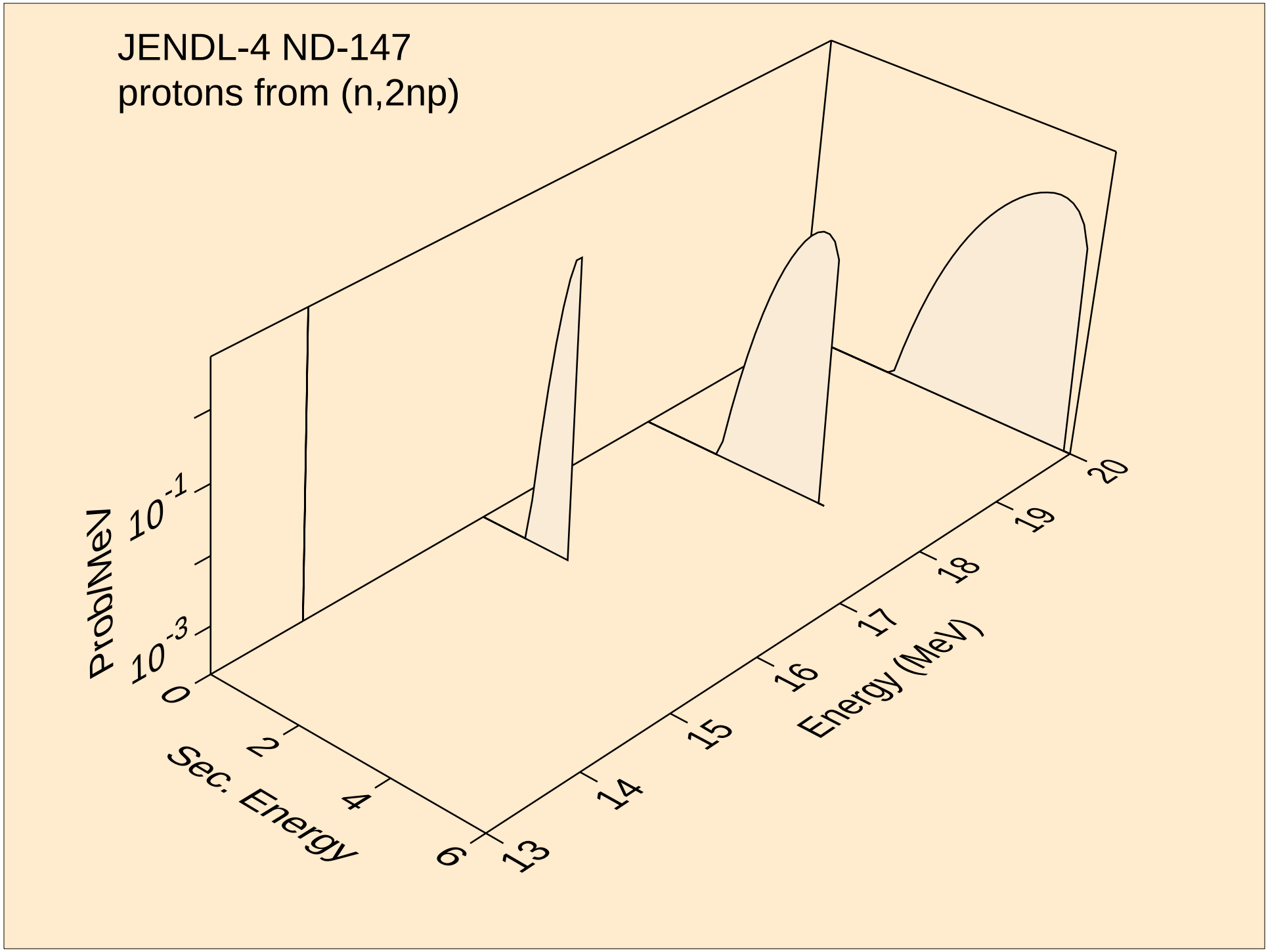

JENDL-4 ND-147
14 MeV photon spectrum
Gamma Prod (barns/MeV)
10^1
10^-2
10^-5
10^-8
10^-11
10^-14
10^-17
10^-20
0
10
20
30
Gamma Energy (MeV)

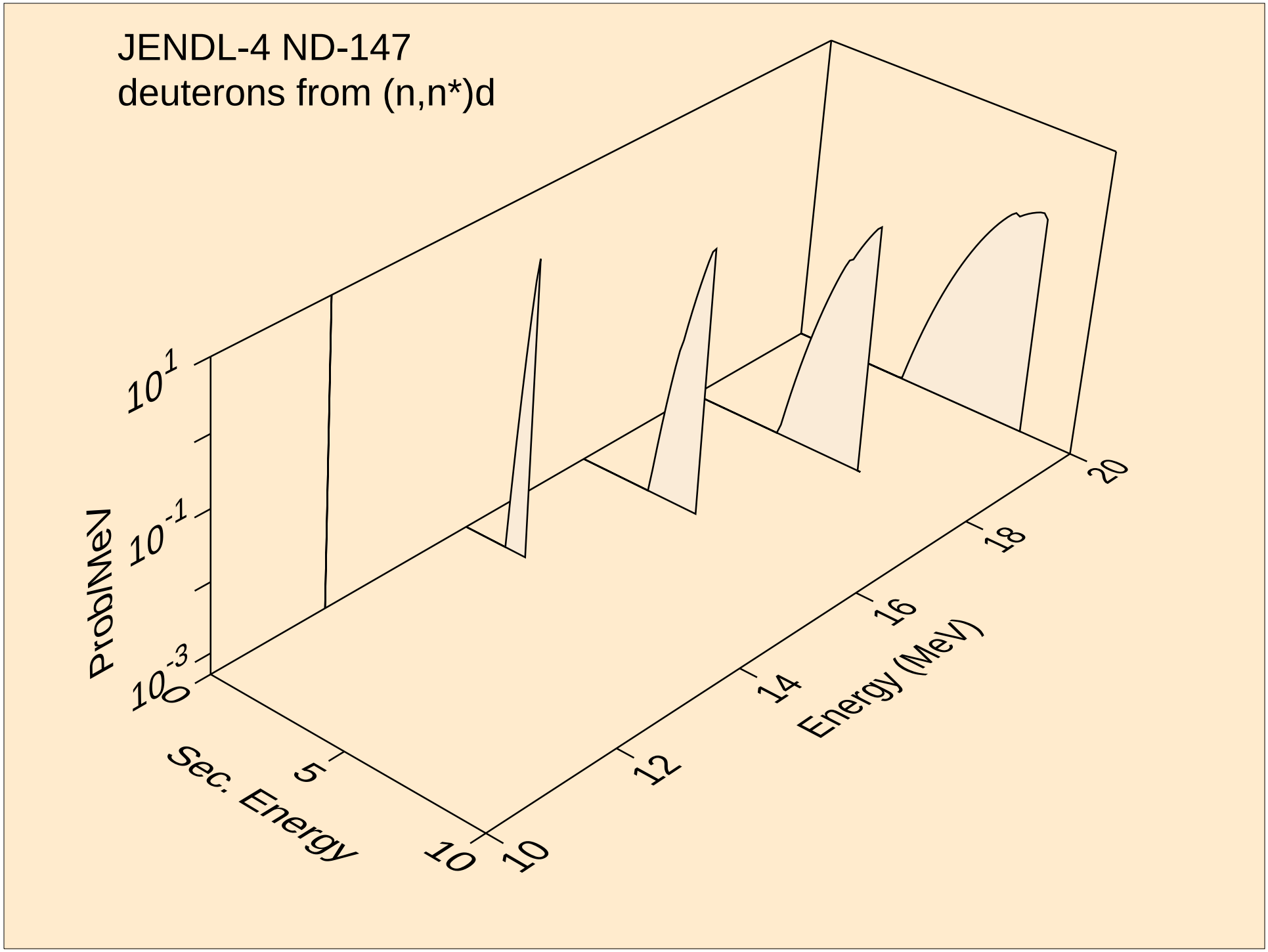

JENDL-4 ND-147
Particle heating contributions
*10-3
MeV/collision
Energy (MeV)
protons
deuterons
tritons
alphas
0
2
4
6
8
10
12
14
16
18
20

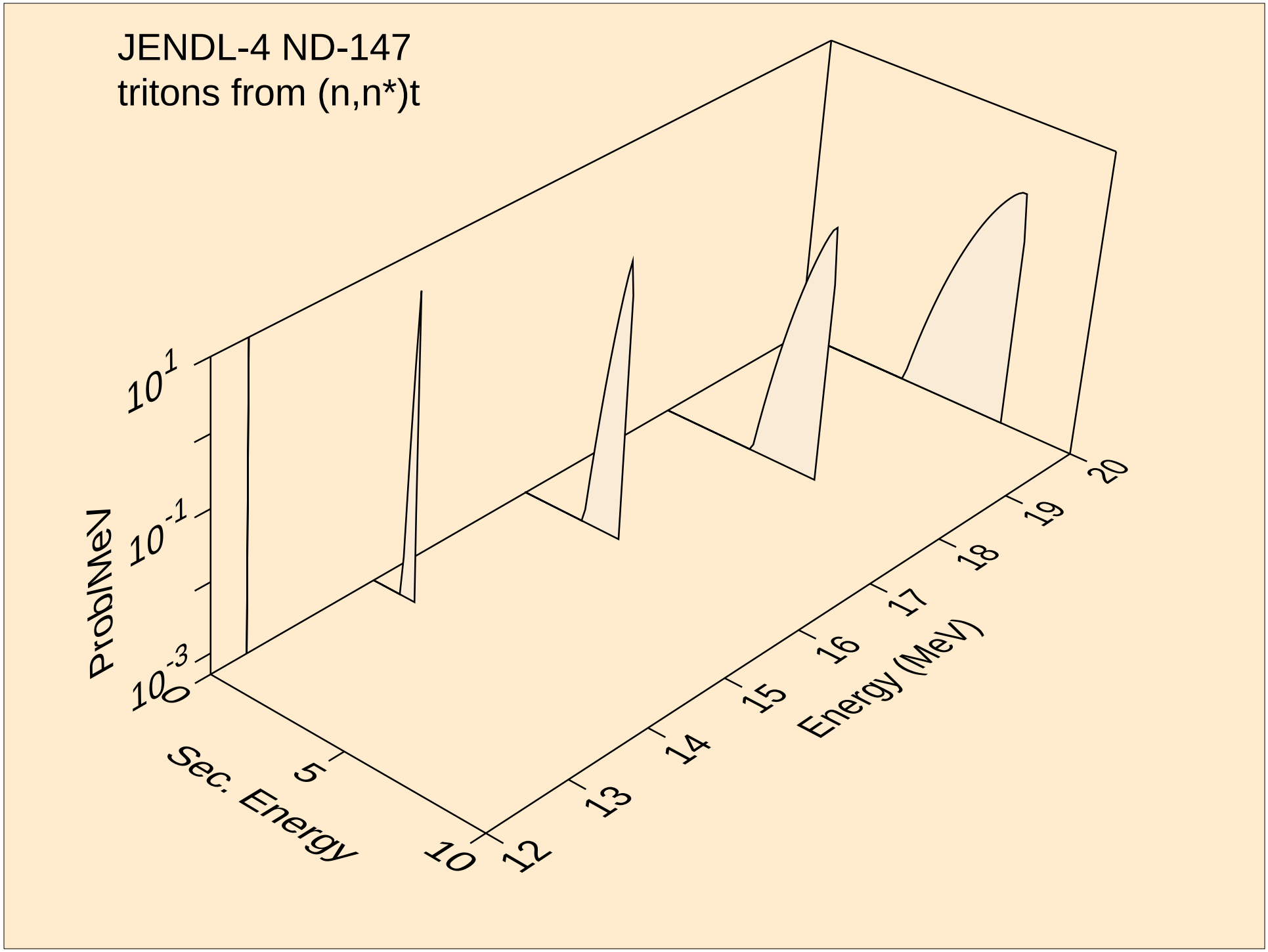

JENDL-4 ND-147
Recoil Heating
recoil heating
Heating (MeV/reaction)
*10^-3
140
120
100
80
60
40
20
0
0
5
10
15
20
Energy (MeV)

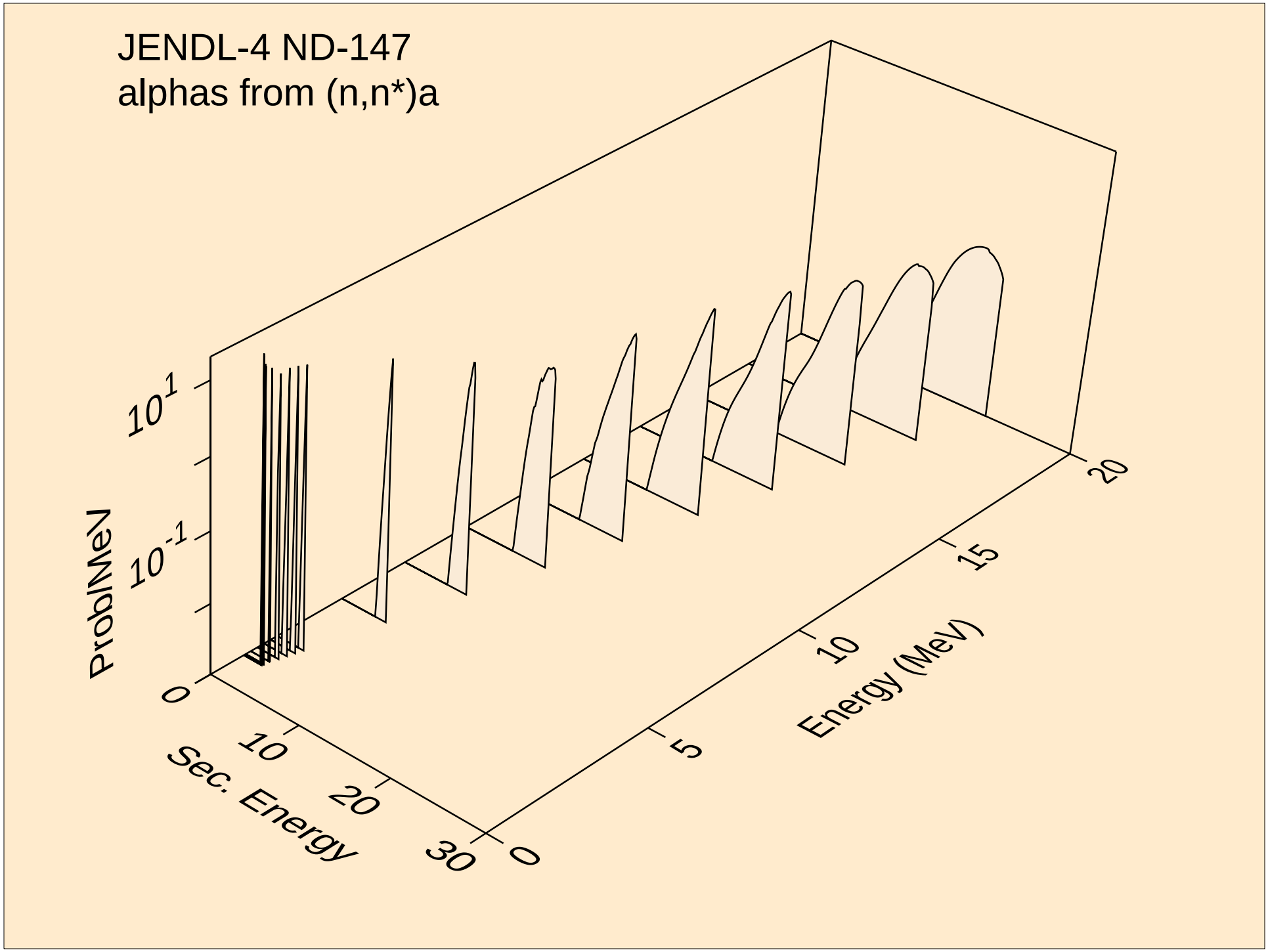

JENDL-4 ND-147
Particle production cross sections
*10-3
6
5
4
3
2
1
0
Cross section (barns)
protons
deuterons
tritons
alphas
0
2
4
6
8
10
12
14
16
18
20
Energy (MeV)

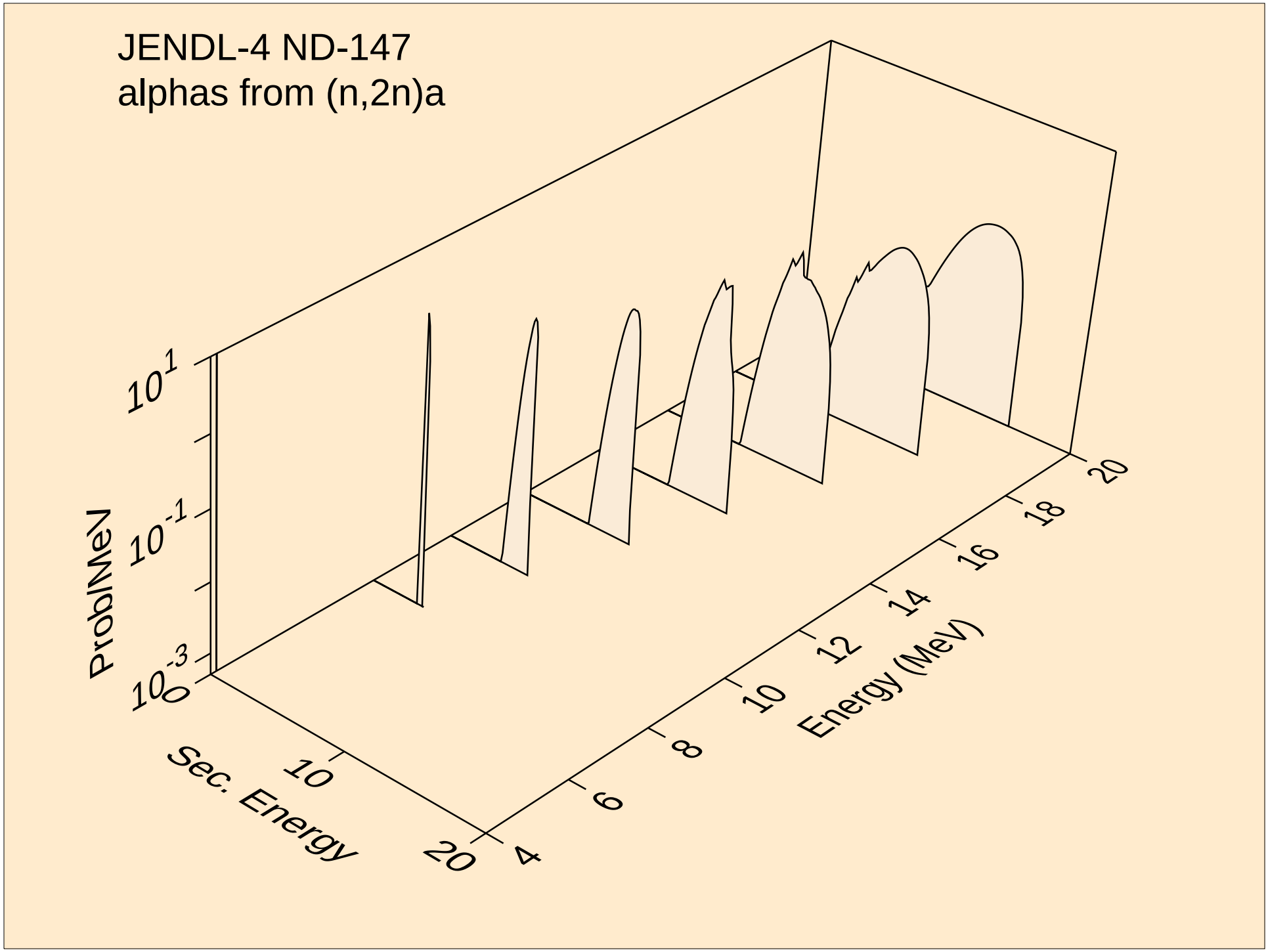

JENDL-4 ND-147
protons from (n,n*)p
Prob/MeV
10^1
10^-1
0
Sec. Energy
10
20
8
10
12
14
16
18
20
Energy (MeV)

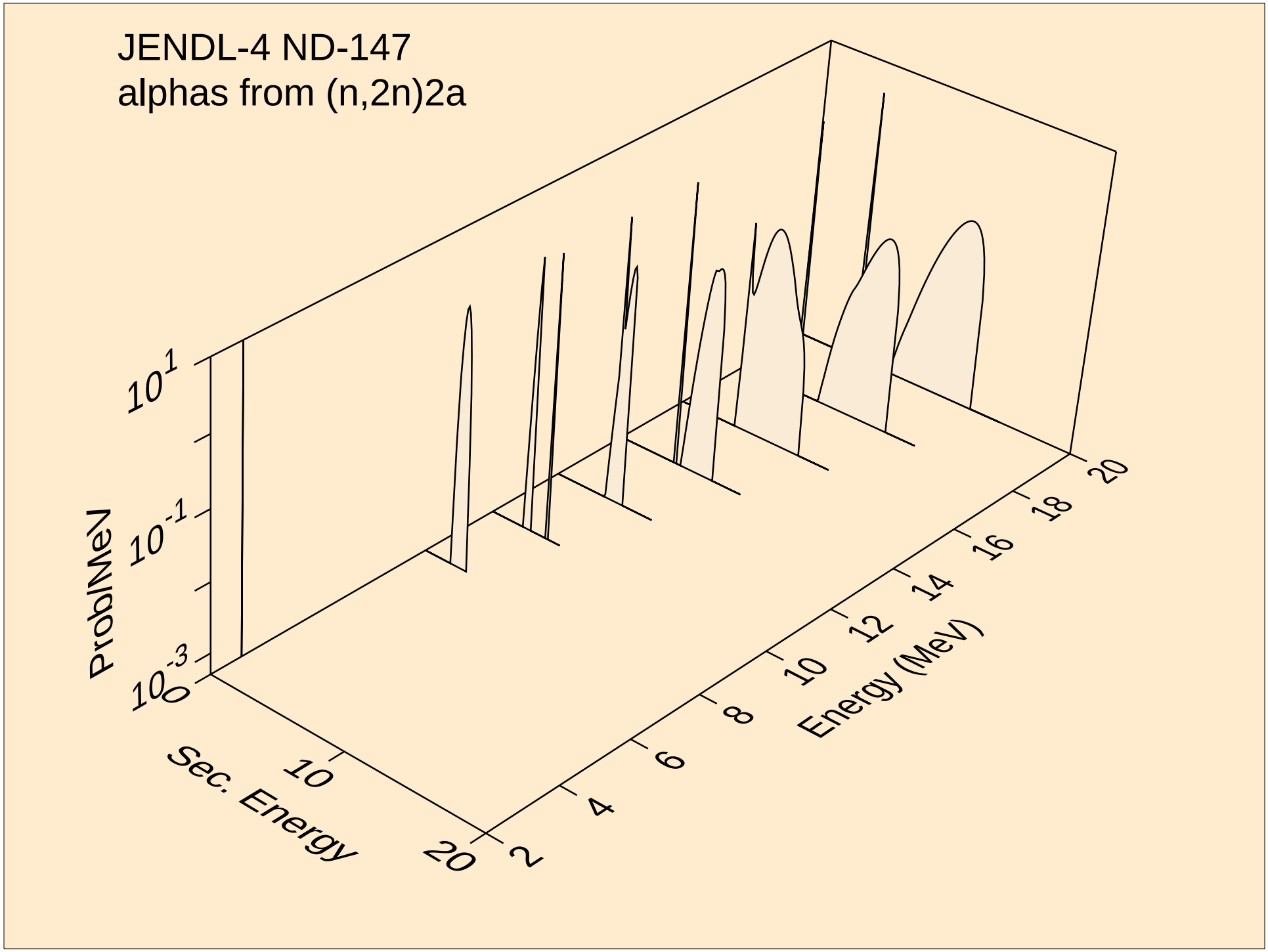

JENDL-4 ND-147
protons from (n,2np)
Prob/MeV
10^-1
10^-3
0
2
4
6
Sec. Energy
13
14
15
16
17
18
19
20
Energy (MeV)


JENDL-4 ND-147
deuterons from (n,n*)d
Prob/MeV
10^1
10^-1
10^-3
Sec. Energy
0
5
10
Energy (MeV)
10
12
14
16
18
20


JENDL-4 ND-147
tritons from (n,n*)t
Prob/MeV
10^{1}
10^{-1}
10^{-3}
Sec. Energy
0
5
10
Energy (MeV)
12
13
14
15
16
17
18
19
20


JENDL-4 ND-147
alphas from (n,n*)a
Prob/MeV
10^{1}
10^{-1}
0
10
20
30
Sec. Energy
0
5
10
15
20
Energy (MeV)


JENDL-4 ND-147
alphas from (n,2n)a
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
10
20
Sec. Energy
4
6
8
10
12
14
16
18
20
Energy (MeV)


JENDL-4 ND-147
alphas from (n,2n)2a
Prob/MeV
10^{1}
10^{-1}
10^{-3}
Sec. Energy
0
10
20
Energy (MeV)
2
4
6
8
10
12
14
16
18
20