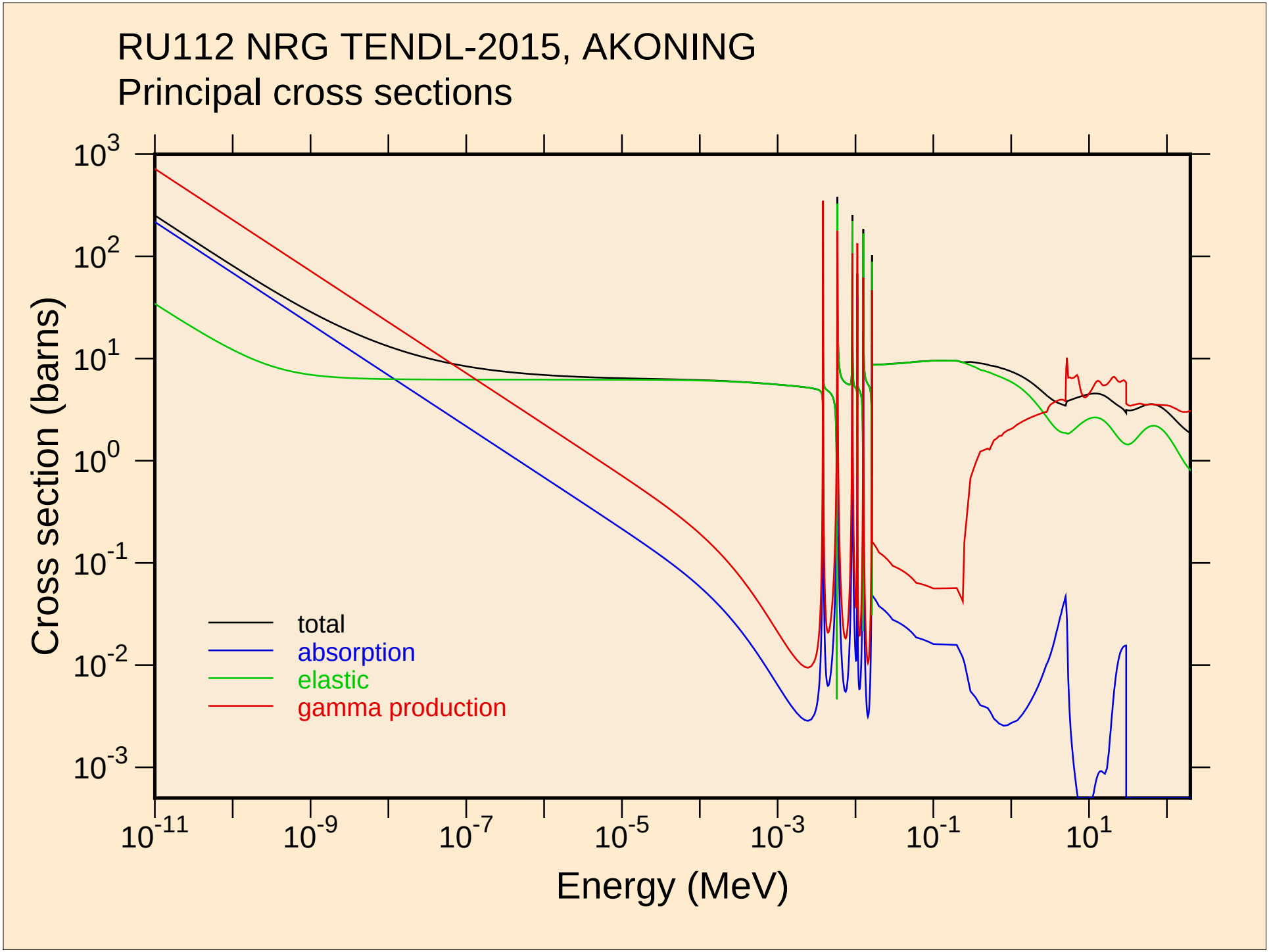
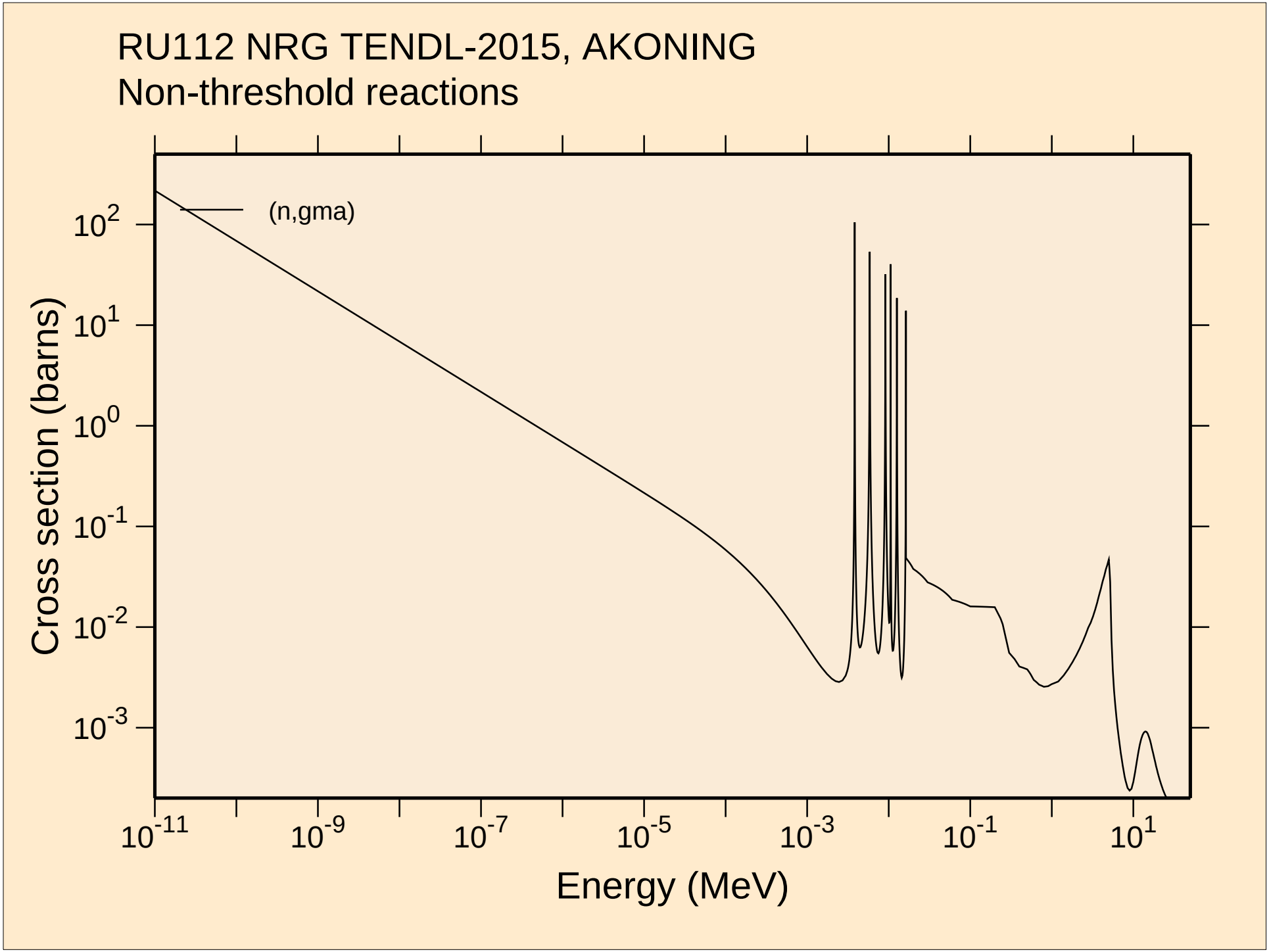
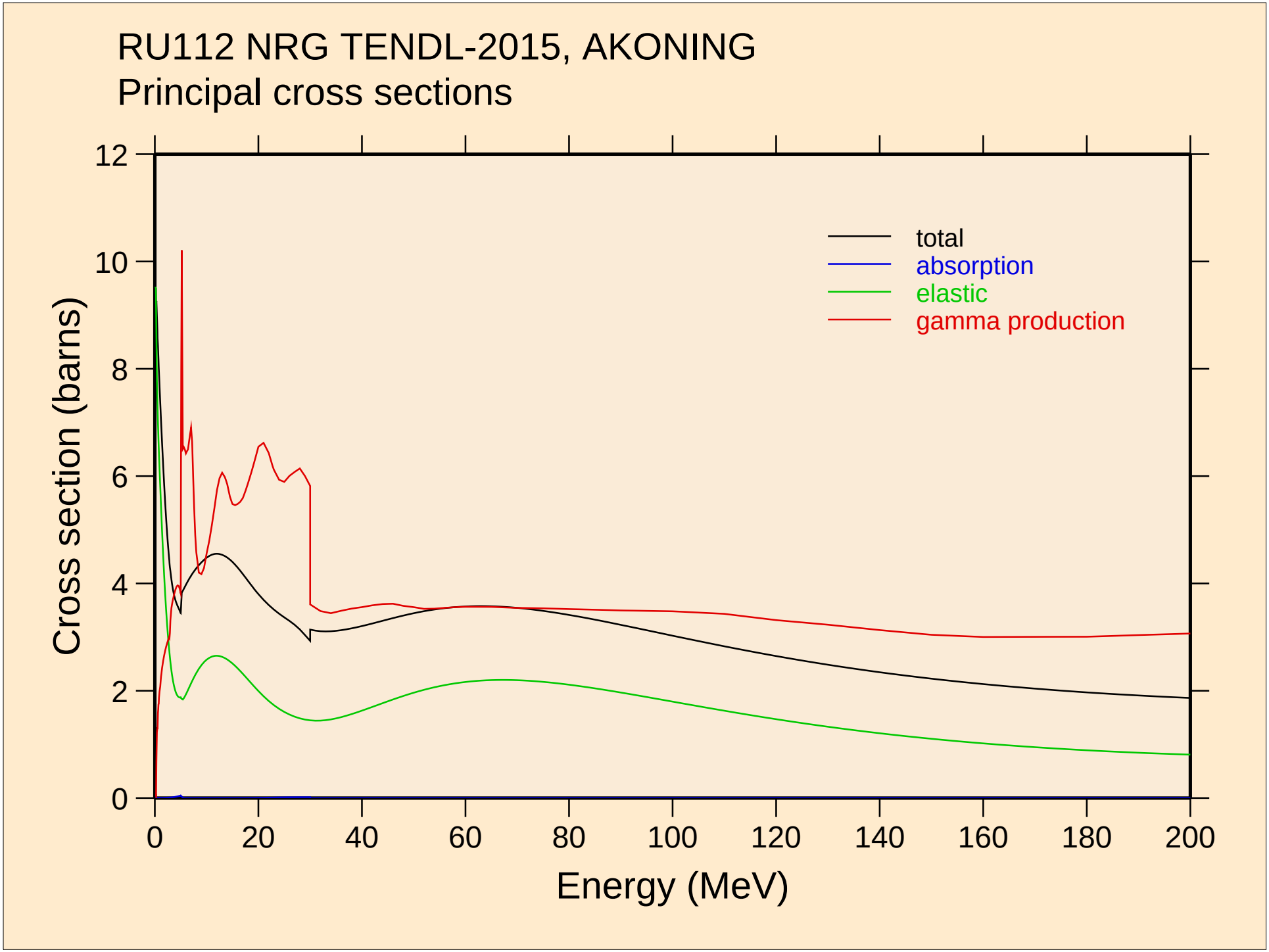
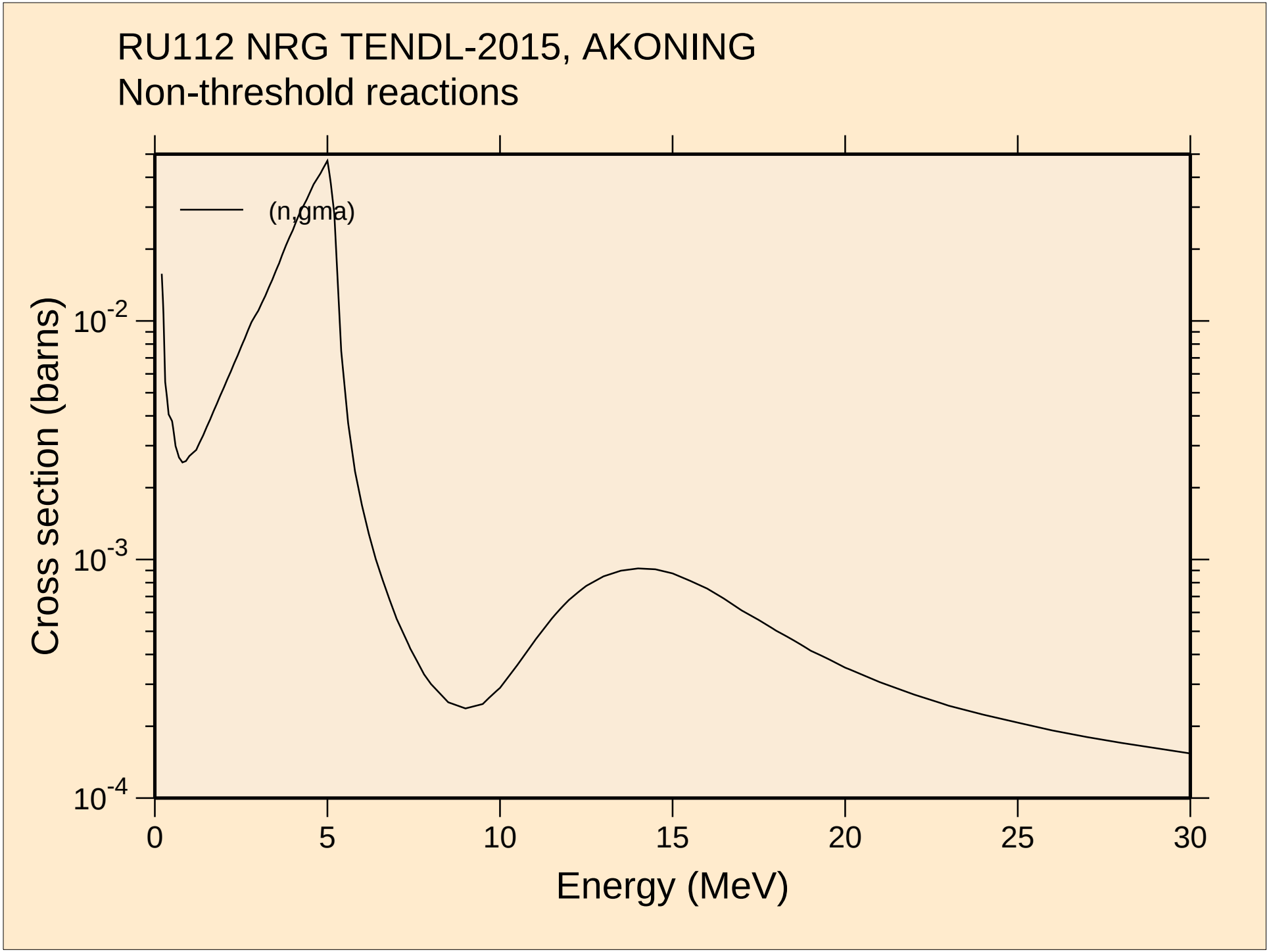
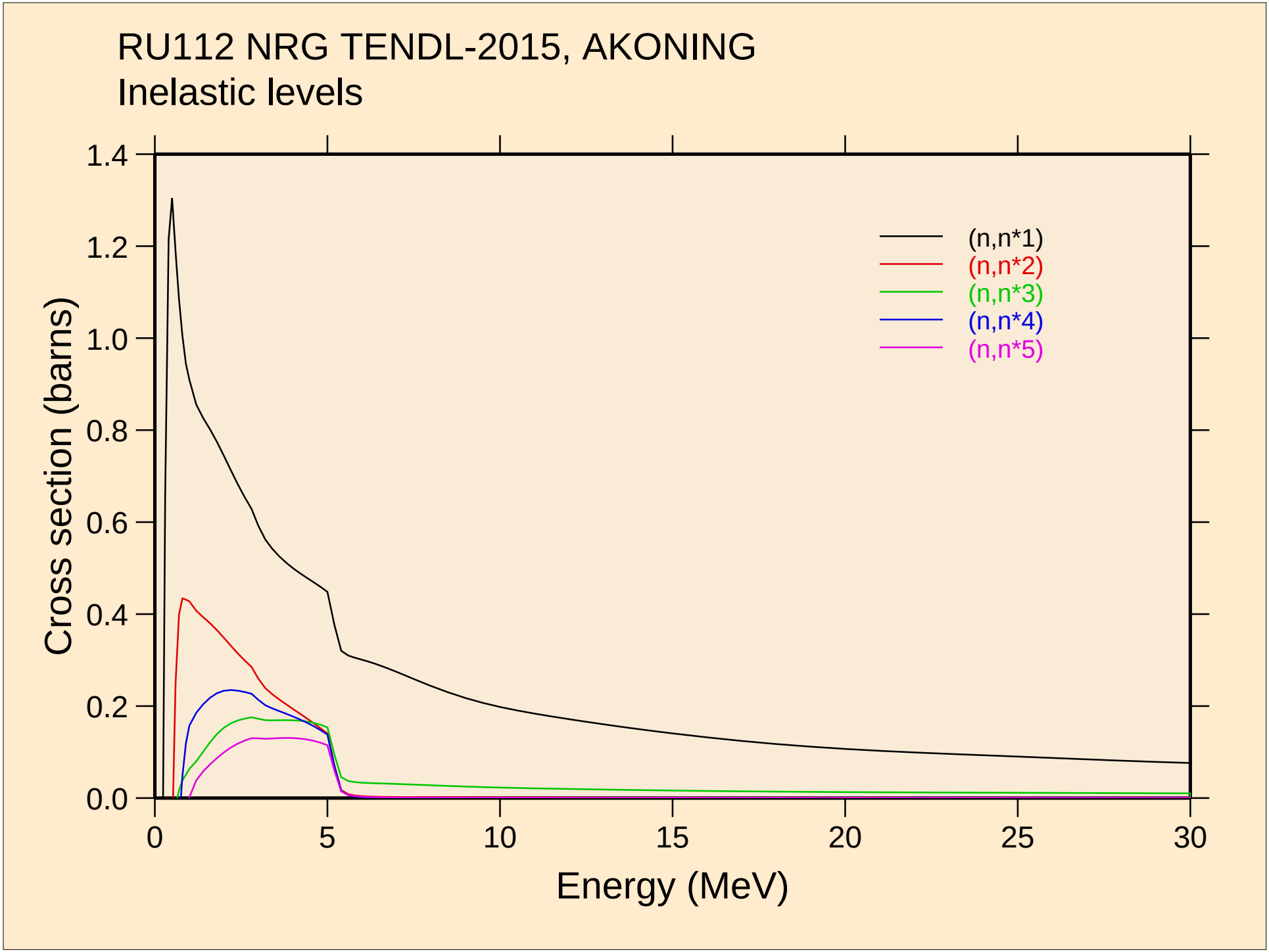
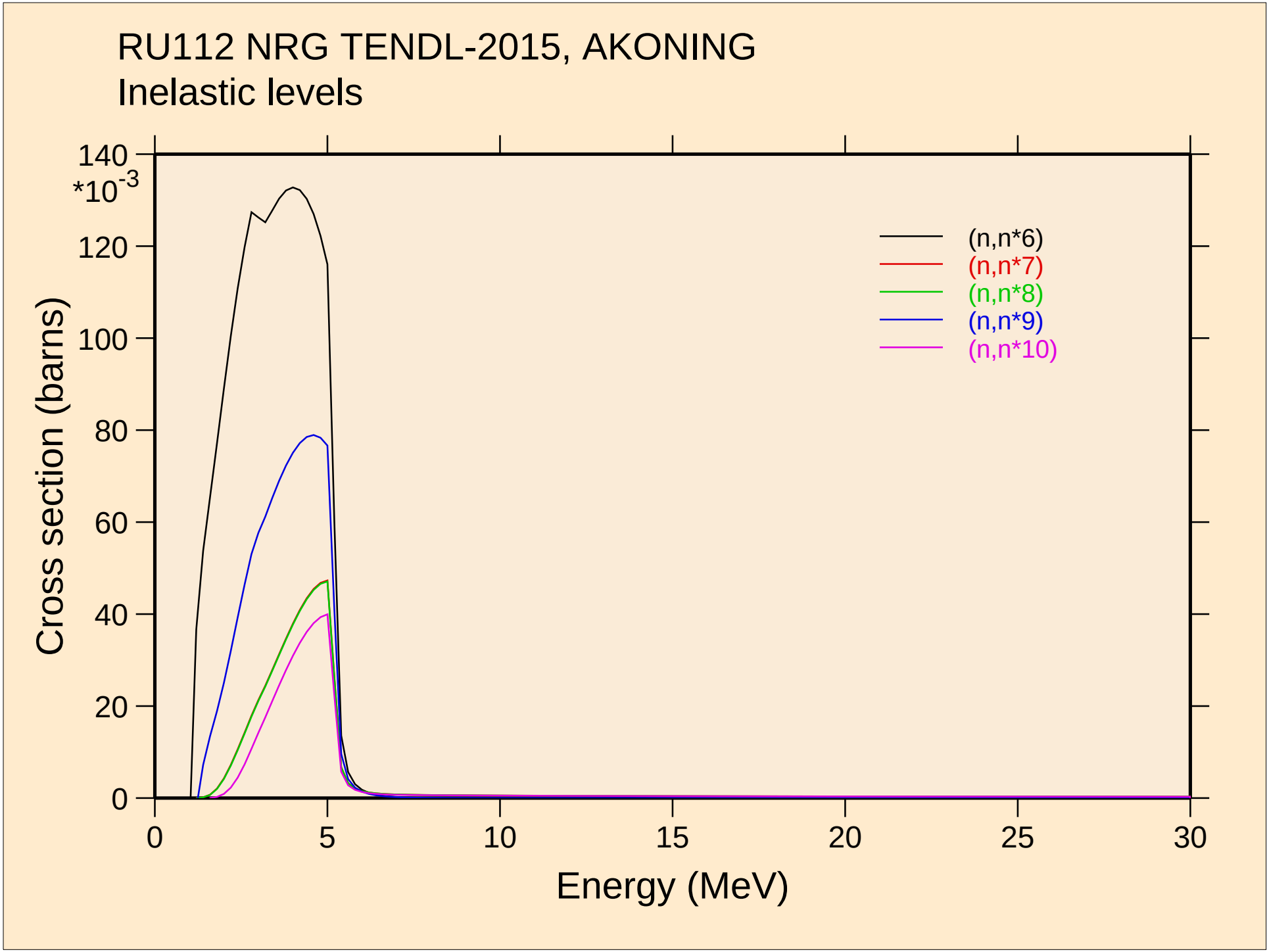

RU112 NRG TENDL-2015, AKONING
Principal cross sections
Cross section (barns)
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
total
absorption
elastic
gamma production
10^{-11}
10^{-9}
10^{-7}
10^{-5}
10^{-3}
10^{-1}
10^{1}
Energy (MeV)

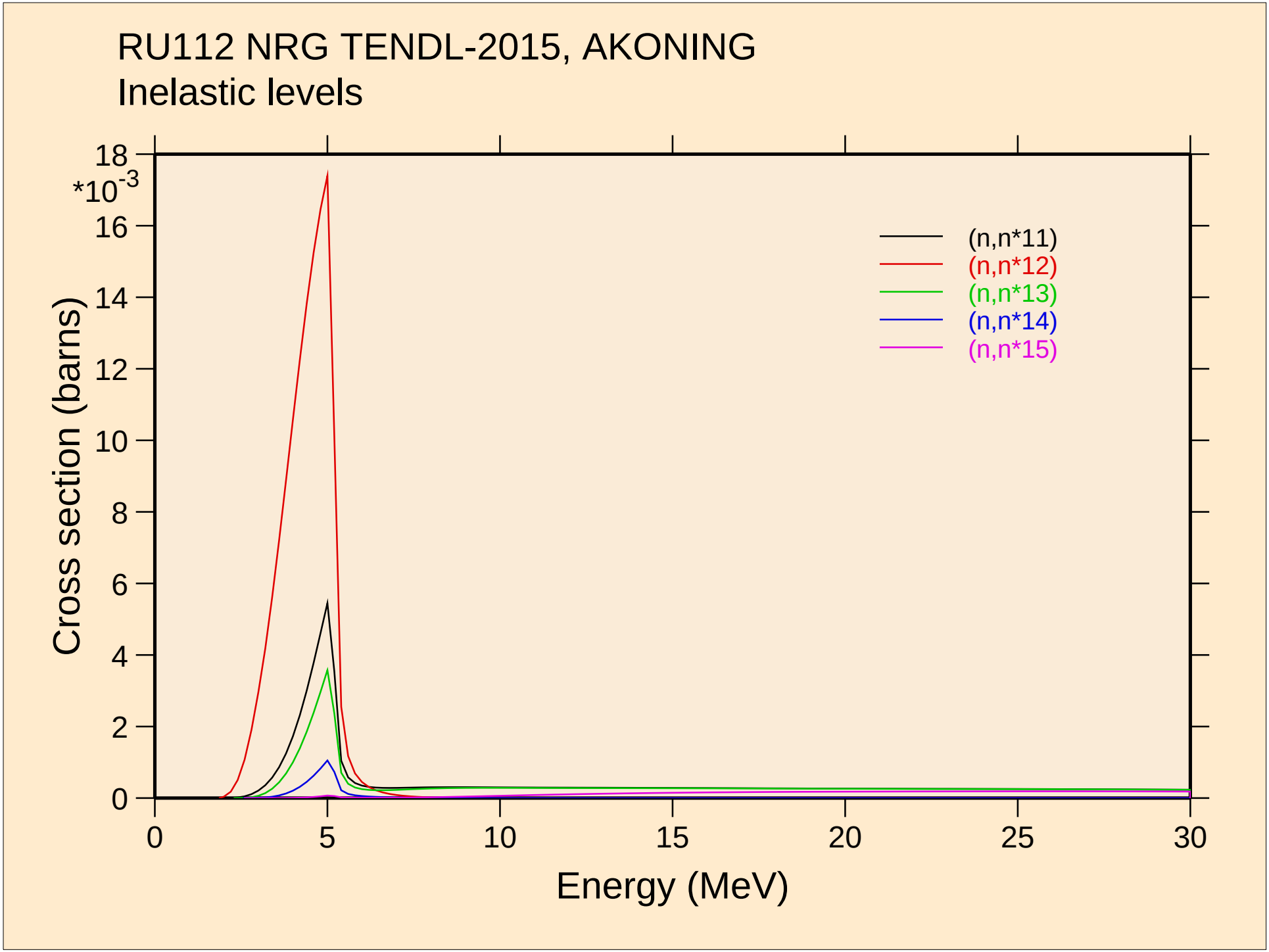

RU112 NRG TENDL-2015, AKONING
Non-threshold reactions
(n,gma)
Cross section (barns)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-11
10^-9
10^-7
10^-5
10^-3
10^-1
10^1
Energy (MeV)

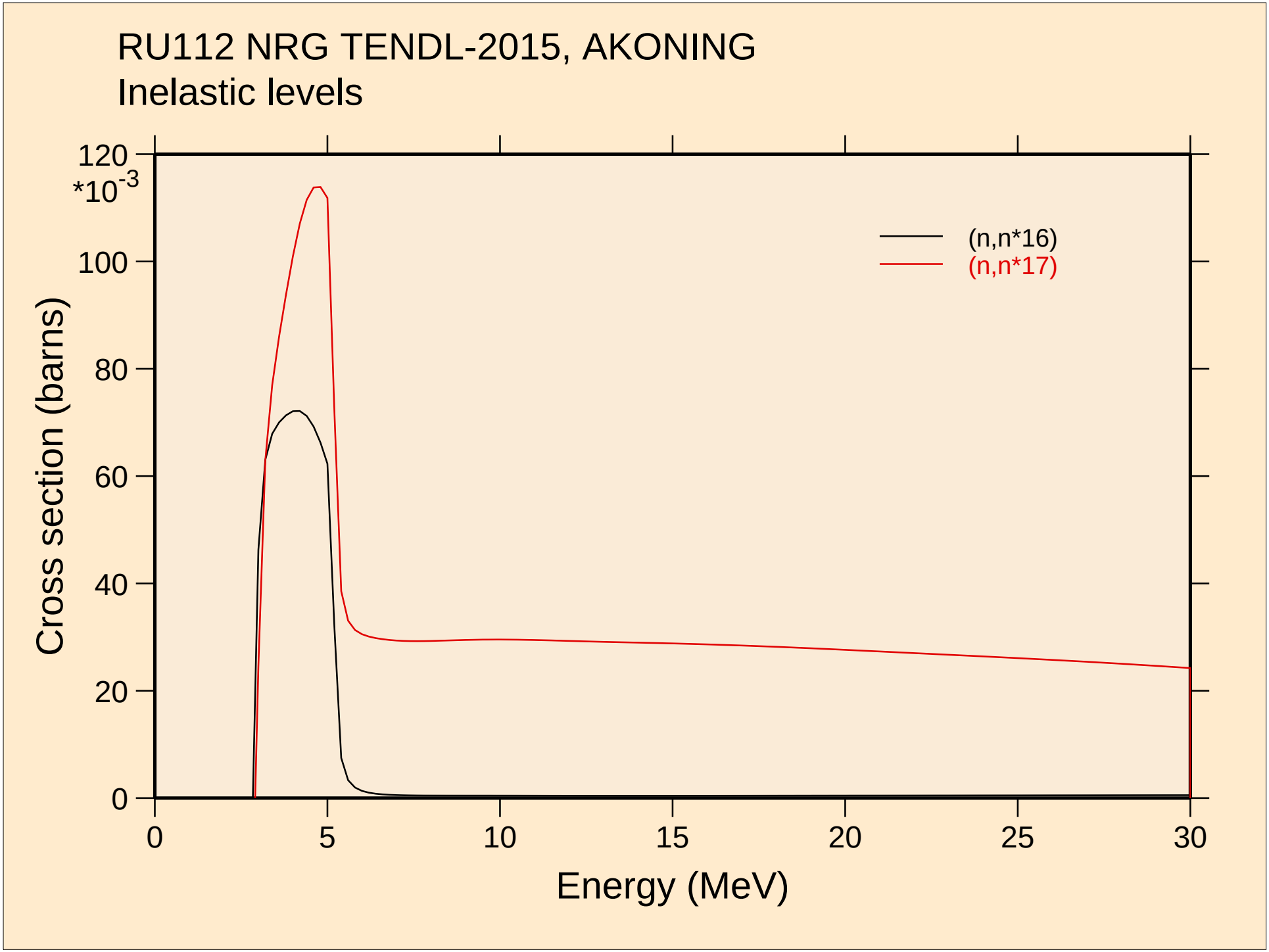

RU112 NRG TENDL-2015, AKONING
Principal cross sections
Cross section (barns)
Energy (MeV)
0
2
4
6
8
10
12
0
20
40
60
80
100
120
140
160
180
200
total
absorption
elastic
gamma production

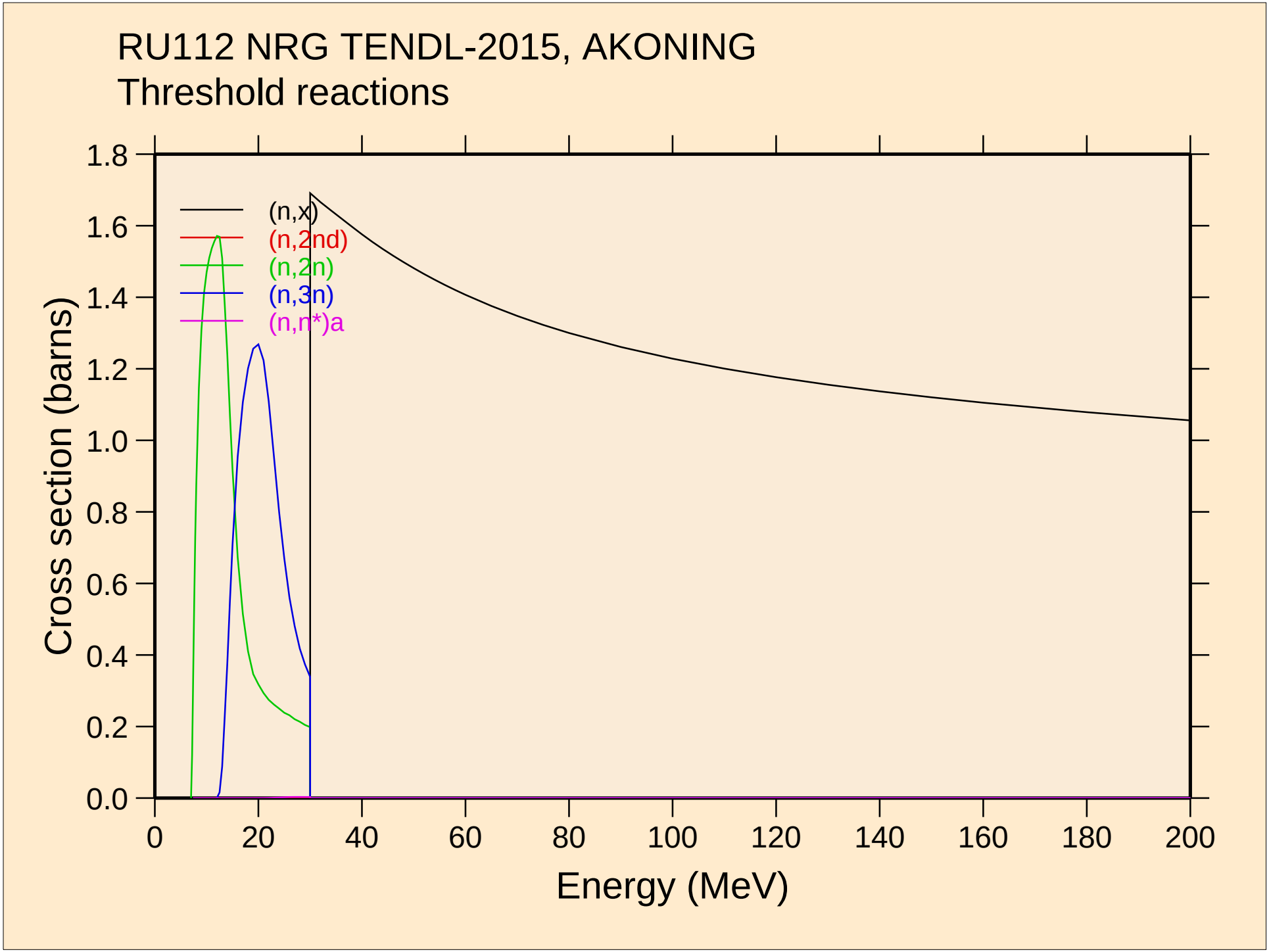

RU112 NRG TENDL-2015, AKONING
Non-threshold reactions
(n,gma)
Cross section (barns)
10-2
10-3
10-4
0
5
10
15
20
25
30
Energy (MeV)

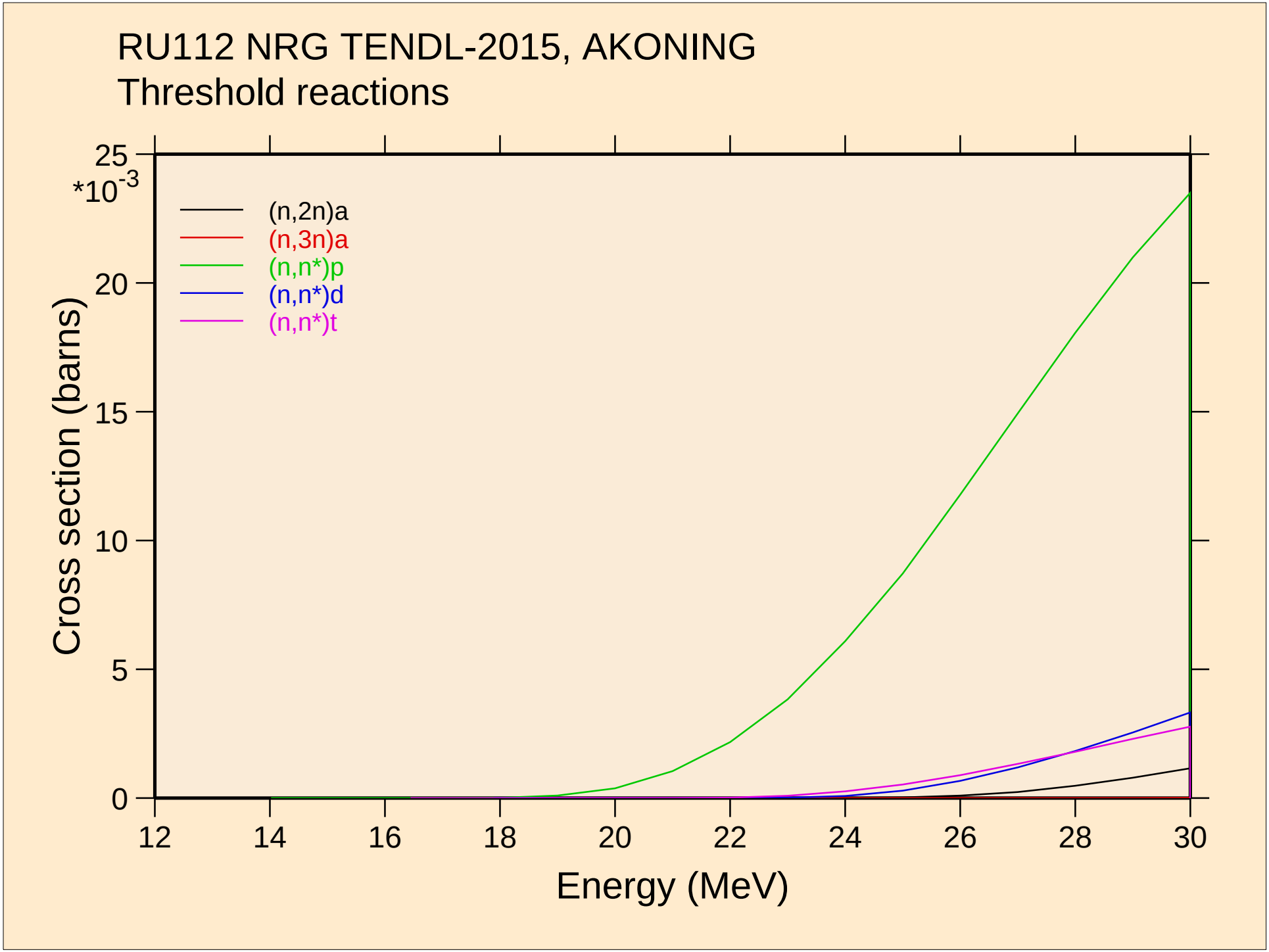

RU112 NRG TENDL-2015, AKONING
Inelastic levels
Cross section (barns)
Energy (MeV)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
0
5
10
15
20
25
30
(n,n*1)
(n,n*2)
(n,n*3)
(n,n*4)
(n,n*5)

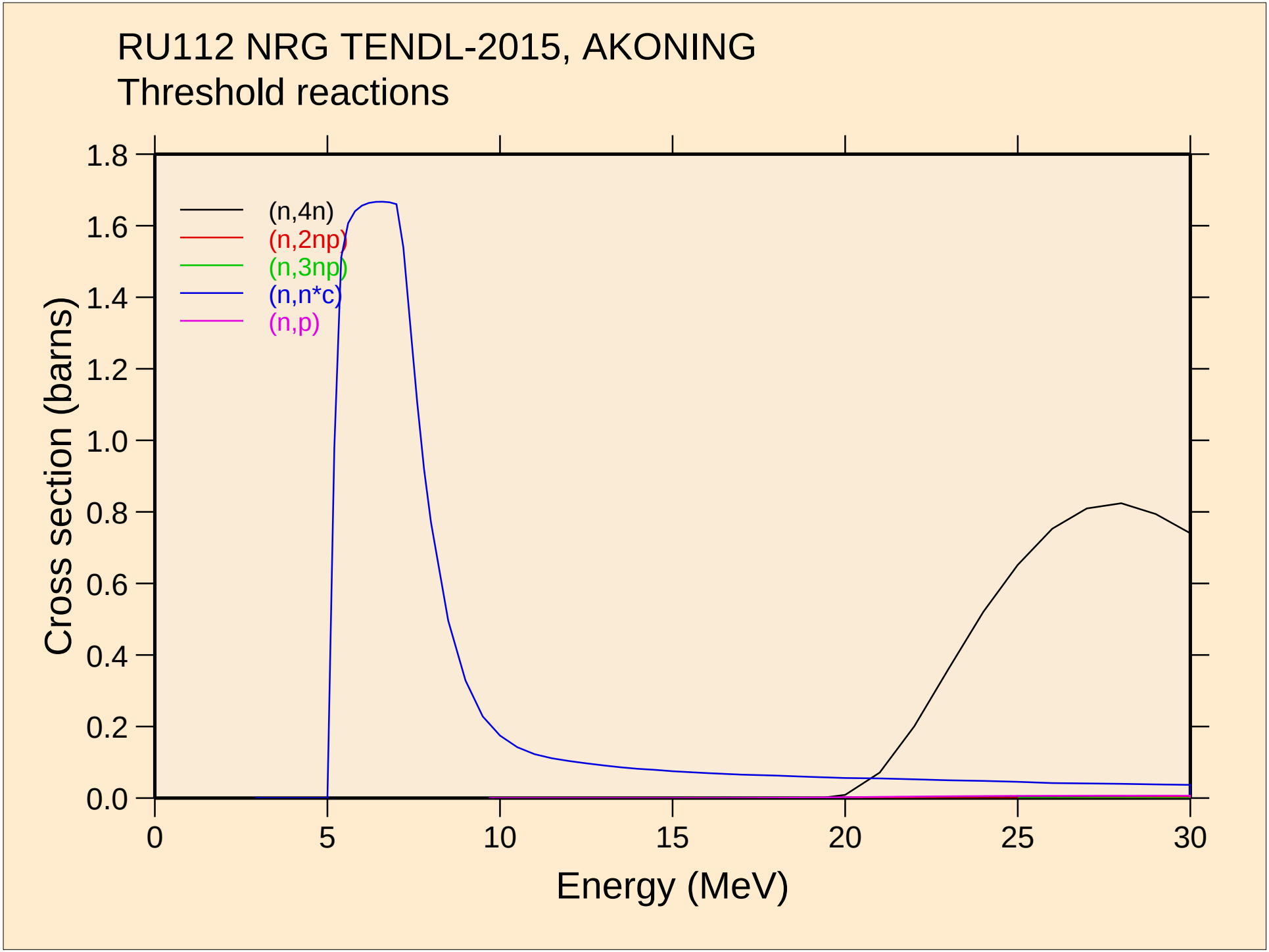

RU112 NRG TENDL-2015, AKONING
Inelastic levels
140
*10-3
120
100
80
60
40
20
0
Cross section (barns)
0
5
10
15
20
25
30
Energy (MeV)
(n,n*6)
(n,n*7)
(n,n*8)
(n,n*9)
(n,n*10)

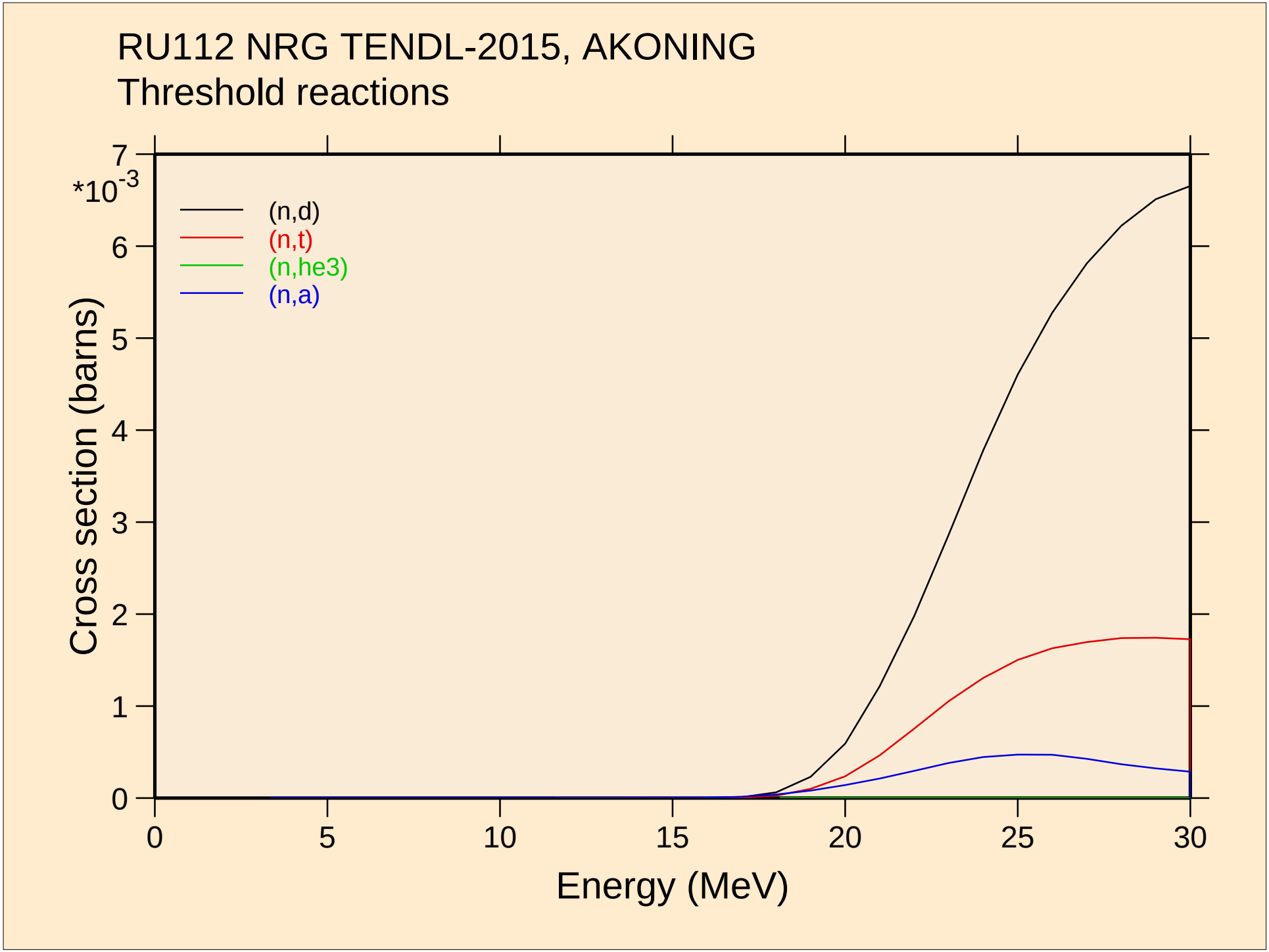

RU112 NRG TENDL-2015, AKONING
Inelastic levels
Cross section (barns)
*10-3
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Energy (MeV)
(n,n*11)
(n,n*12)
(n,n*13)
(n,n*14)
(n,n*15)

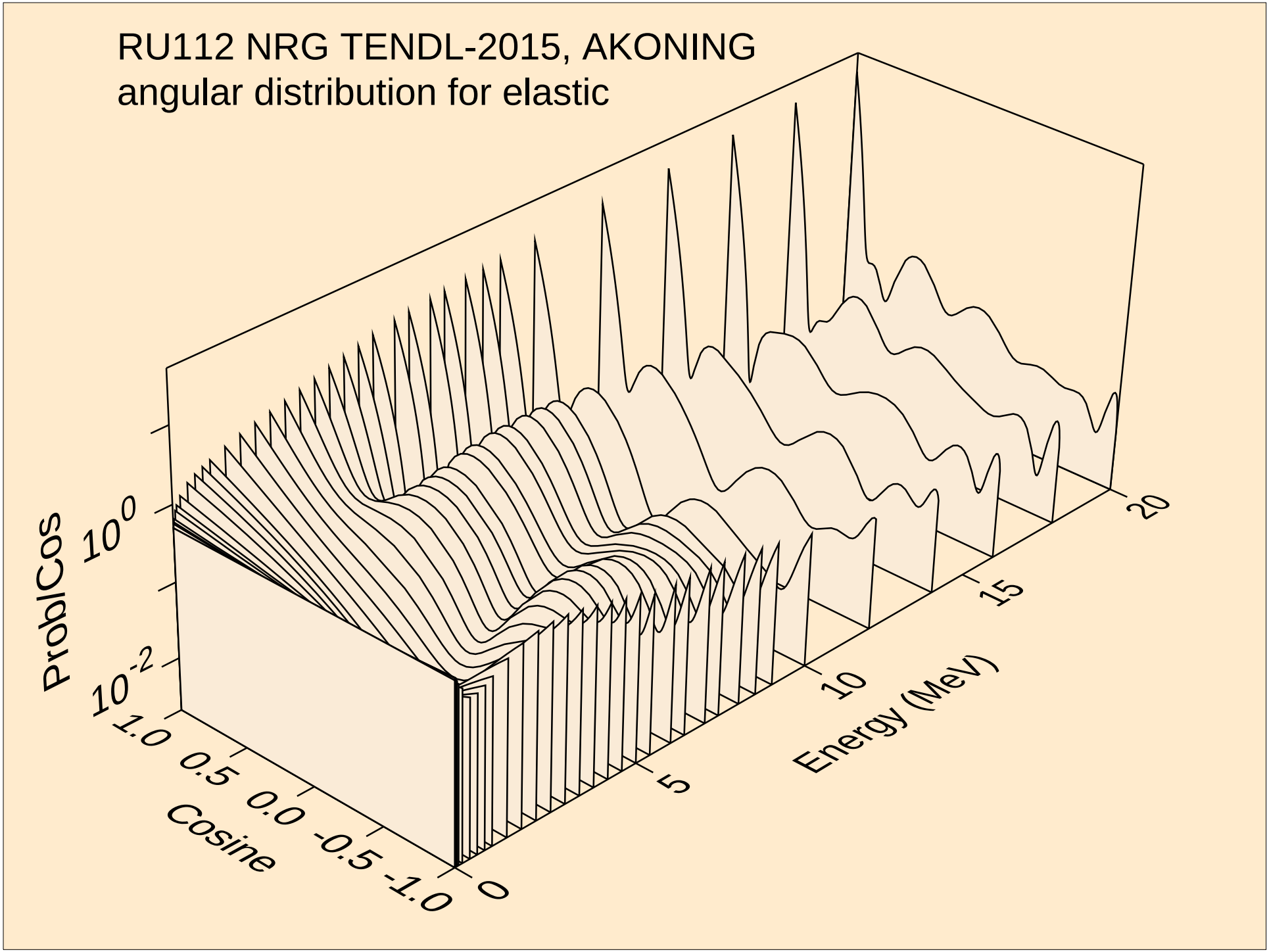

RU112 NRG TENDL-2015, AKONING
Inelastic levels
120
*10-3
100
80
60
40
20
0
Cross section (barns)
0
5
10
15
20
25
30
Energy (MeV)
(n,n*16)
(n,n*17)

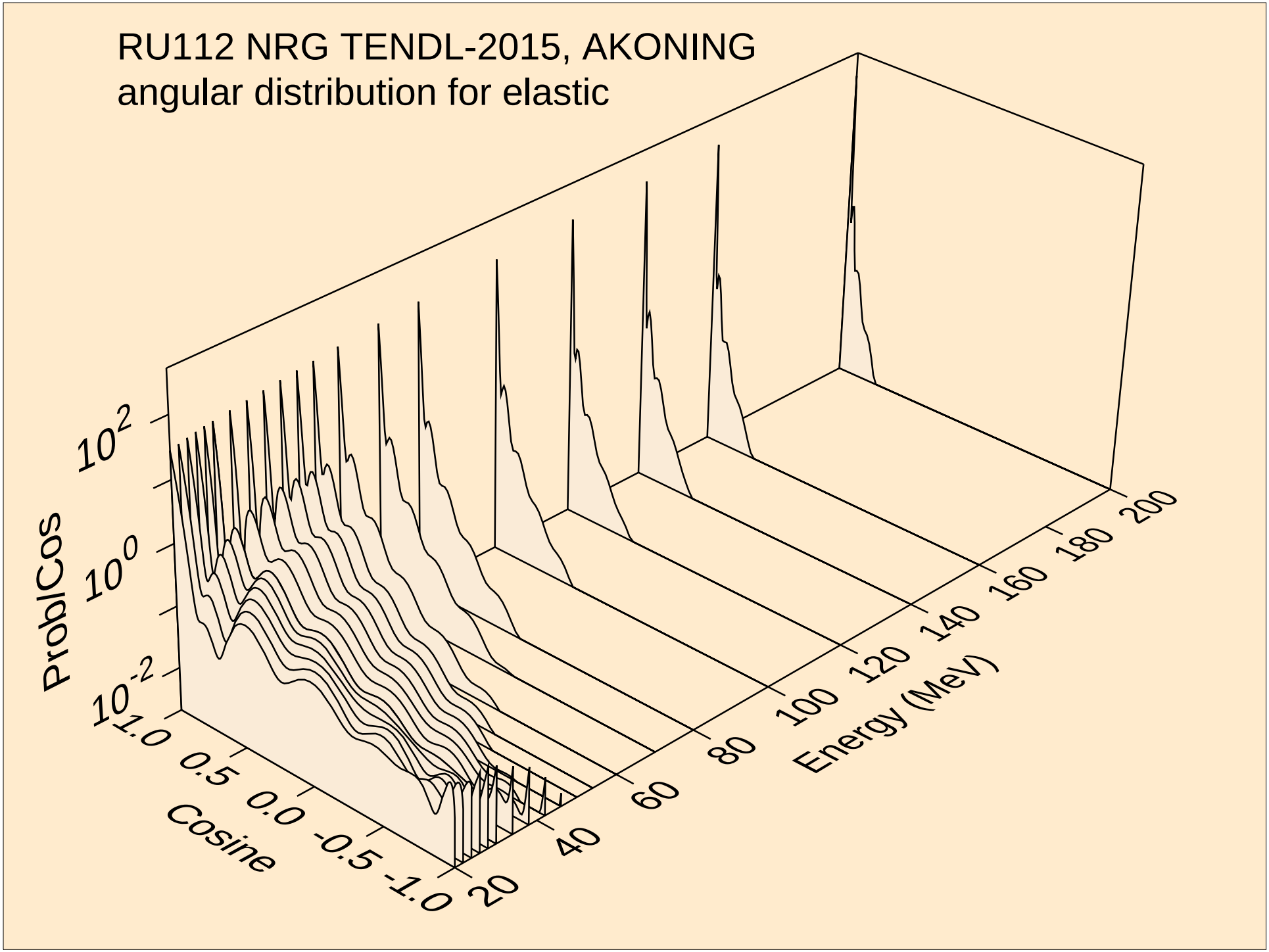

RU112 NRG TENDL-2015, AKONING
Threshold reactions
Cross section (barns)
Energy (MeV)
(n,x)
(n,2nd)
(n,2n)
(n,3n)
(n,n*)a
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0
20
40
60
80
100
120
140
160
180
200

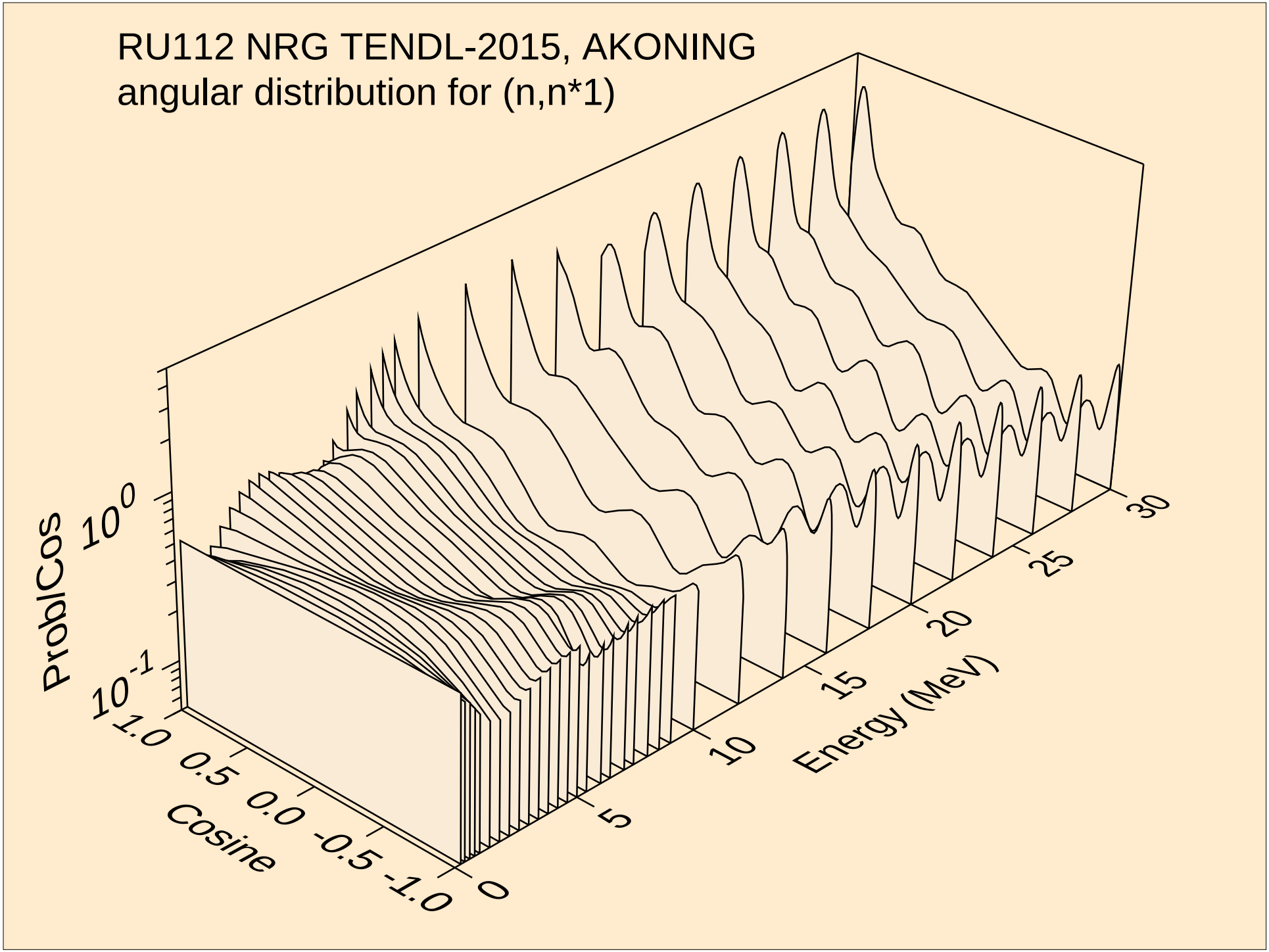

RU112 NRG TENDL-2015, AKONING
Threshold reactions
*10-3
25
20
15
10
5
0
Cross section (barns)
(n,2n)a
(n,3n)a
(n,n*)p
(n,n*)d
(n,n*)t
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

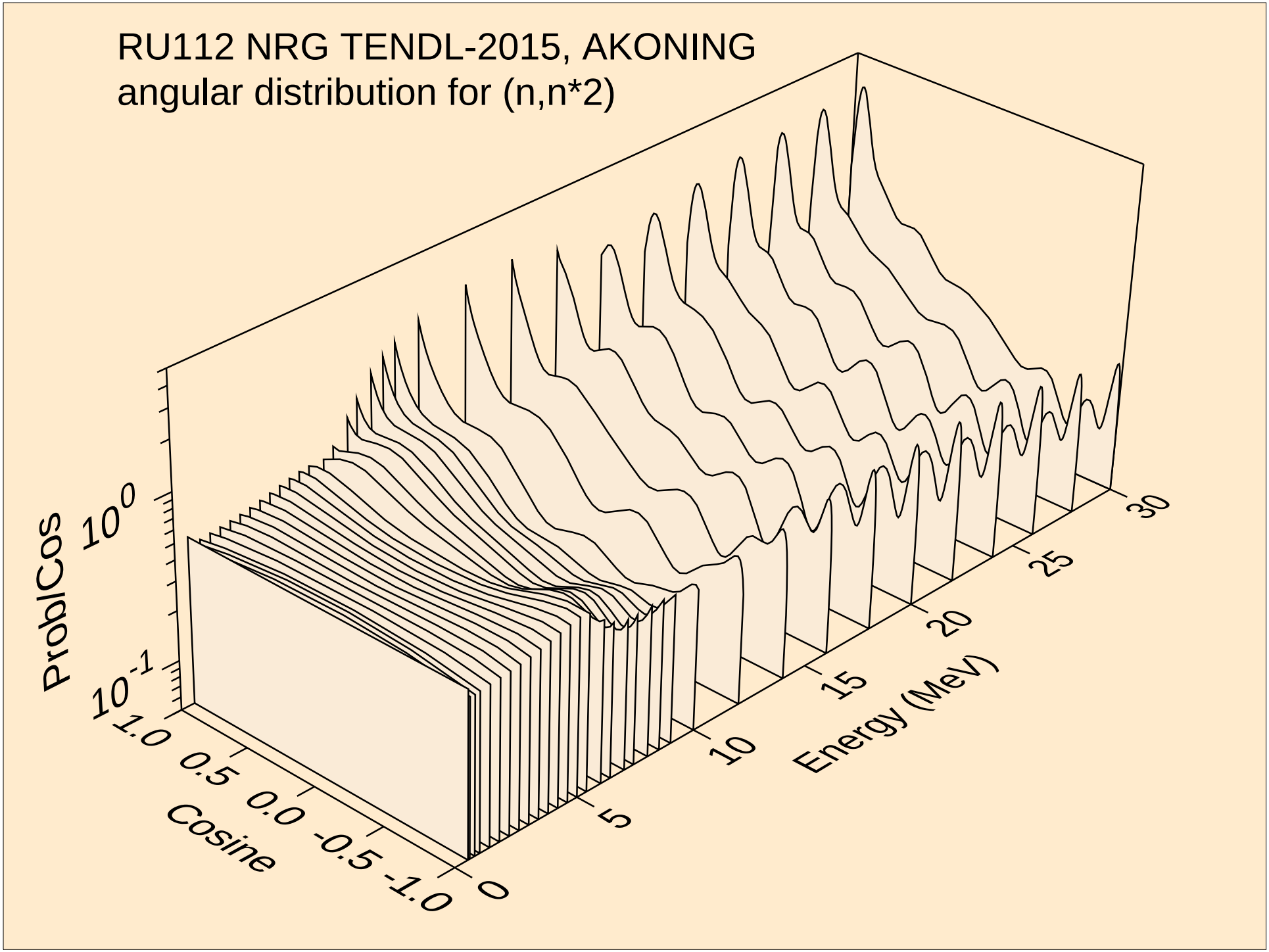

RU112 NRG TENDL-2015, AKONING
Threshold reactions
(n,4n)
(n,2np)
(n,3np)
(n,n*c)
(n,p)
Cross section (barns)
Energy (MeV)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0
5
10
15
20
25
30

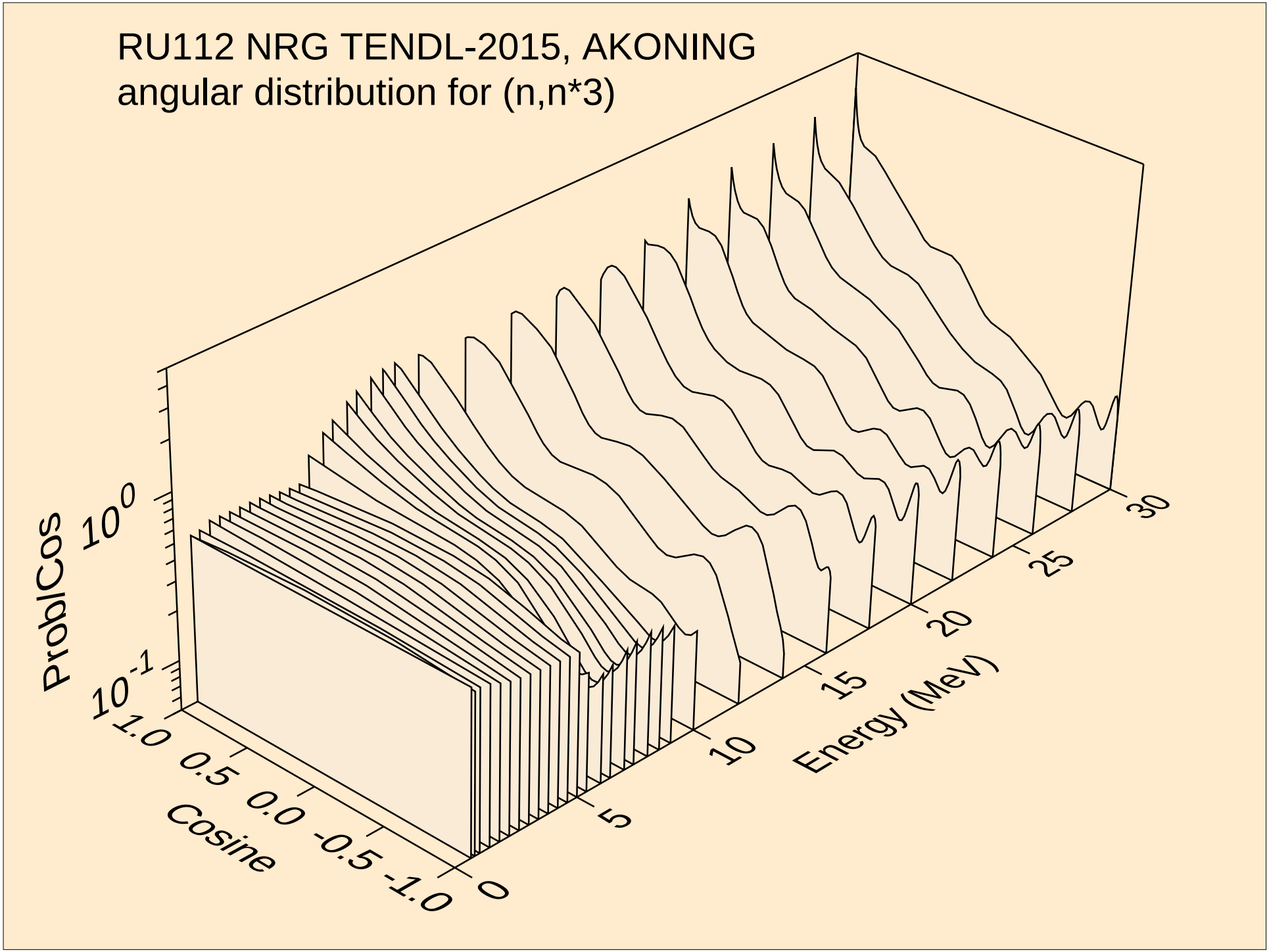

RU112 NRG TENDL-2015, AKONING
Threshold reactions
*10-3
Cross section (barns)
(n,d)
(n,t)
(n,he3)
(n,a)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
30
Energy (MeV)

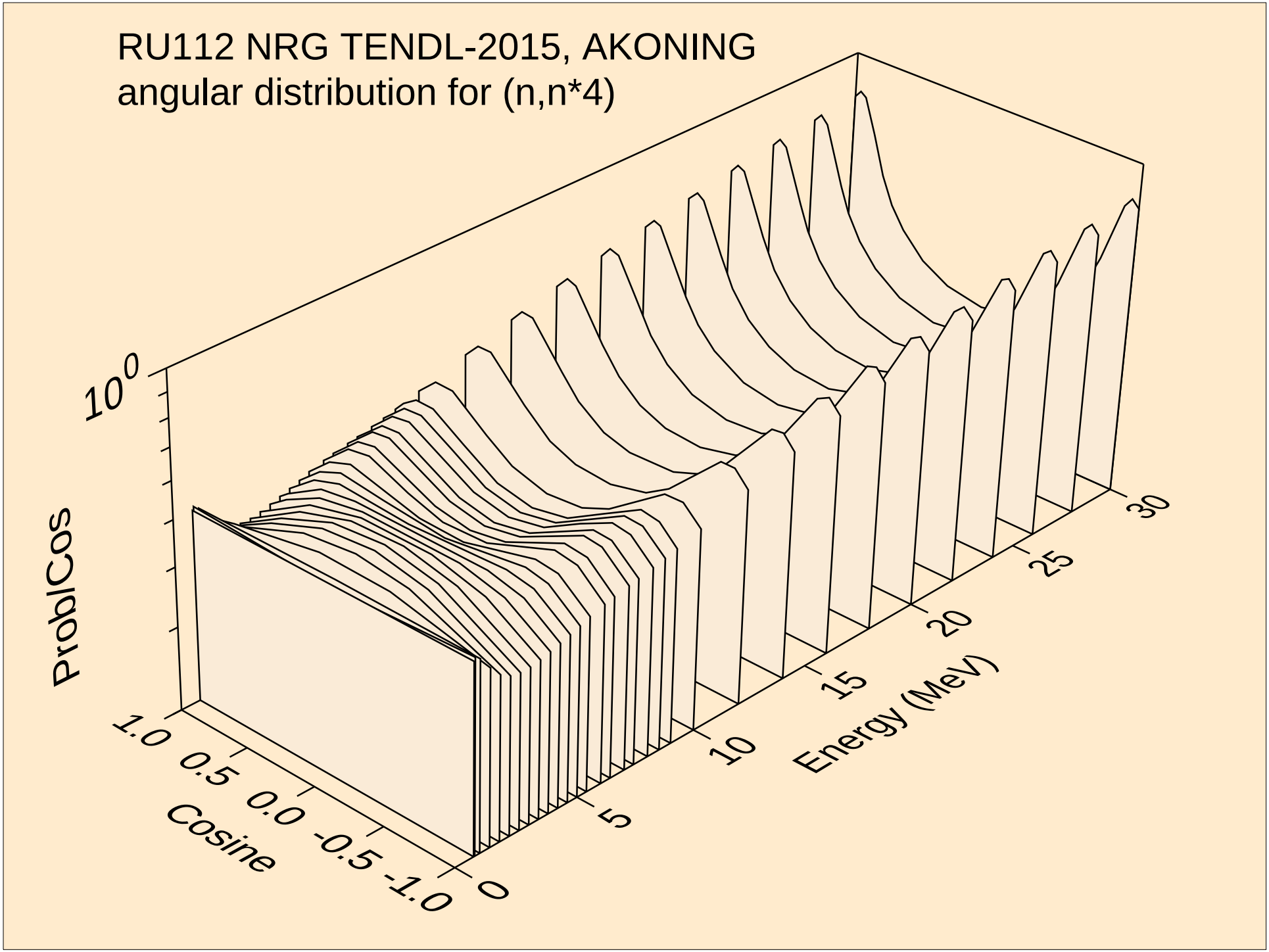

RU112 NRG TENDL-2015, AKONING
angular distribution for elastic
ProbCos
10^{0}
10^{-2}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
Energy (MeV)

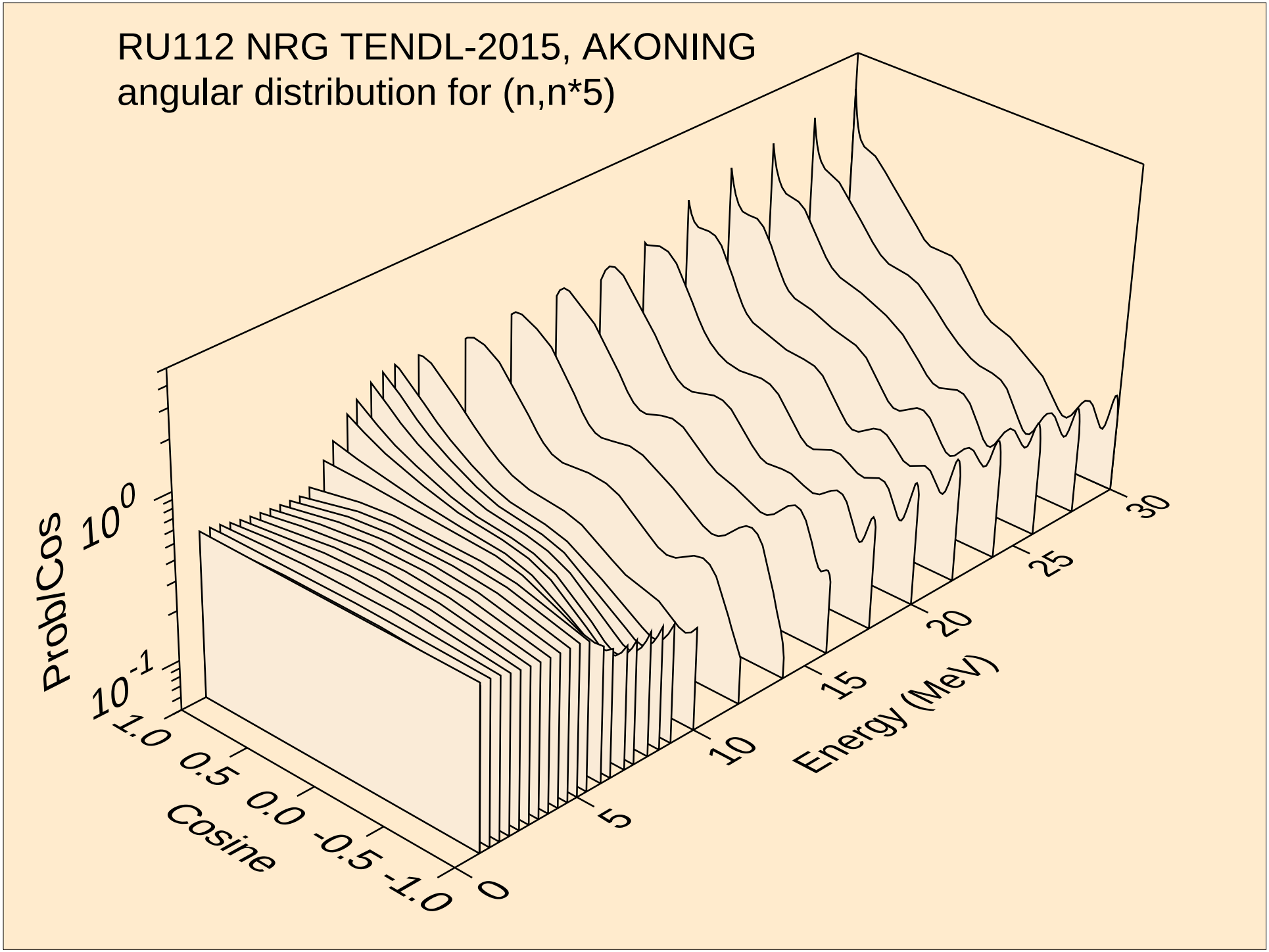

RU112 NRG TENDL-2015, AKONING
angular distribution for elastic
ProbICos
10^{2}
10^{0}
10^{-2}
1.0
0.5
0.0
-0.5
-1.0
Cosine
20
40
60
80
100
120
140
160
180
200
Energy (MeV)

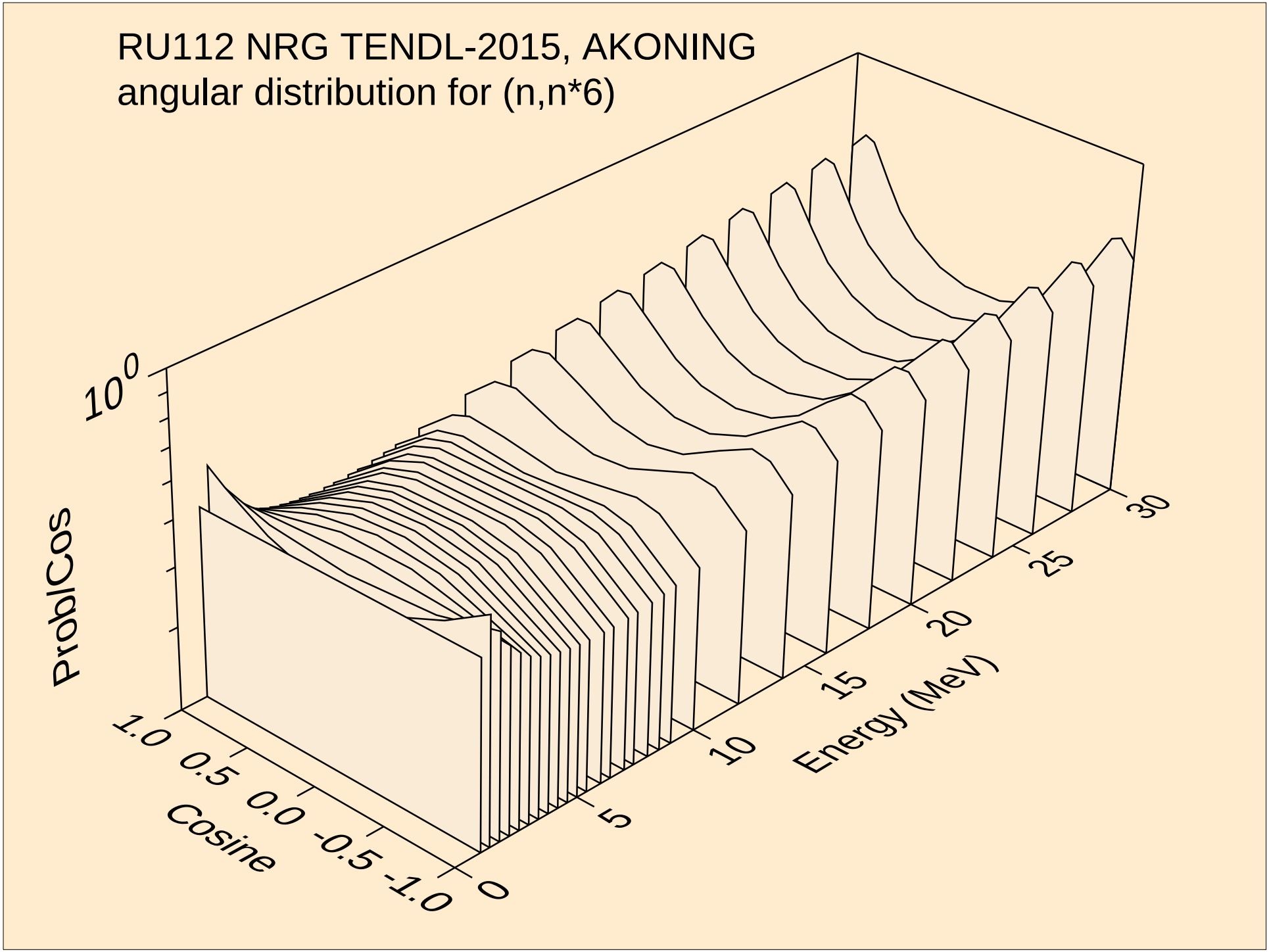

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*1)
ProbCos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

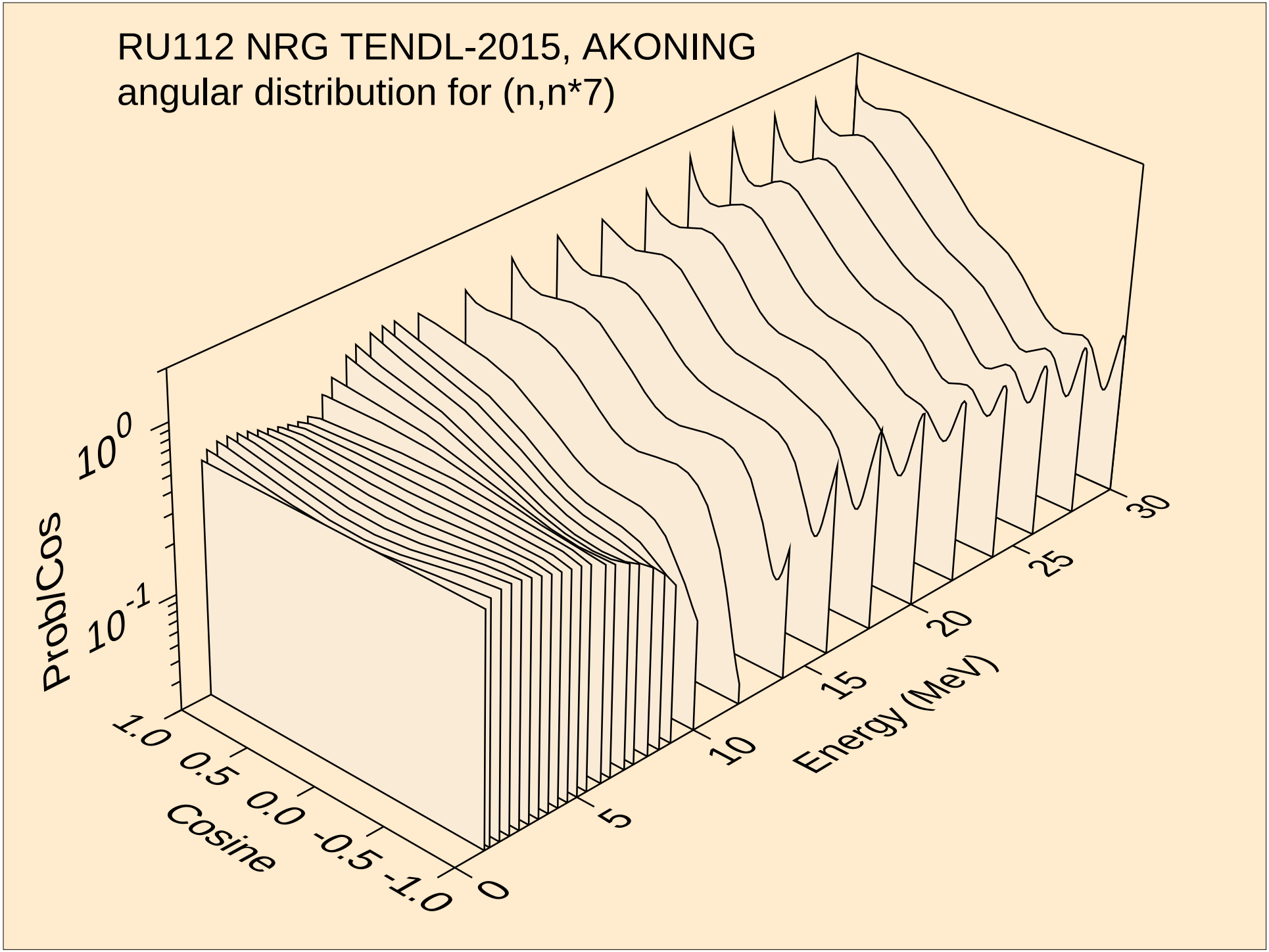

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*2)
ProbCos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

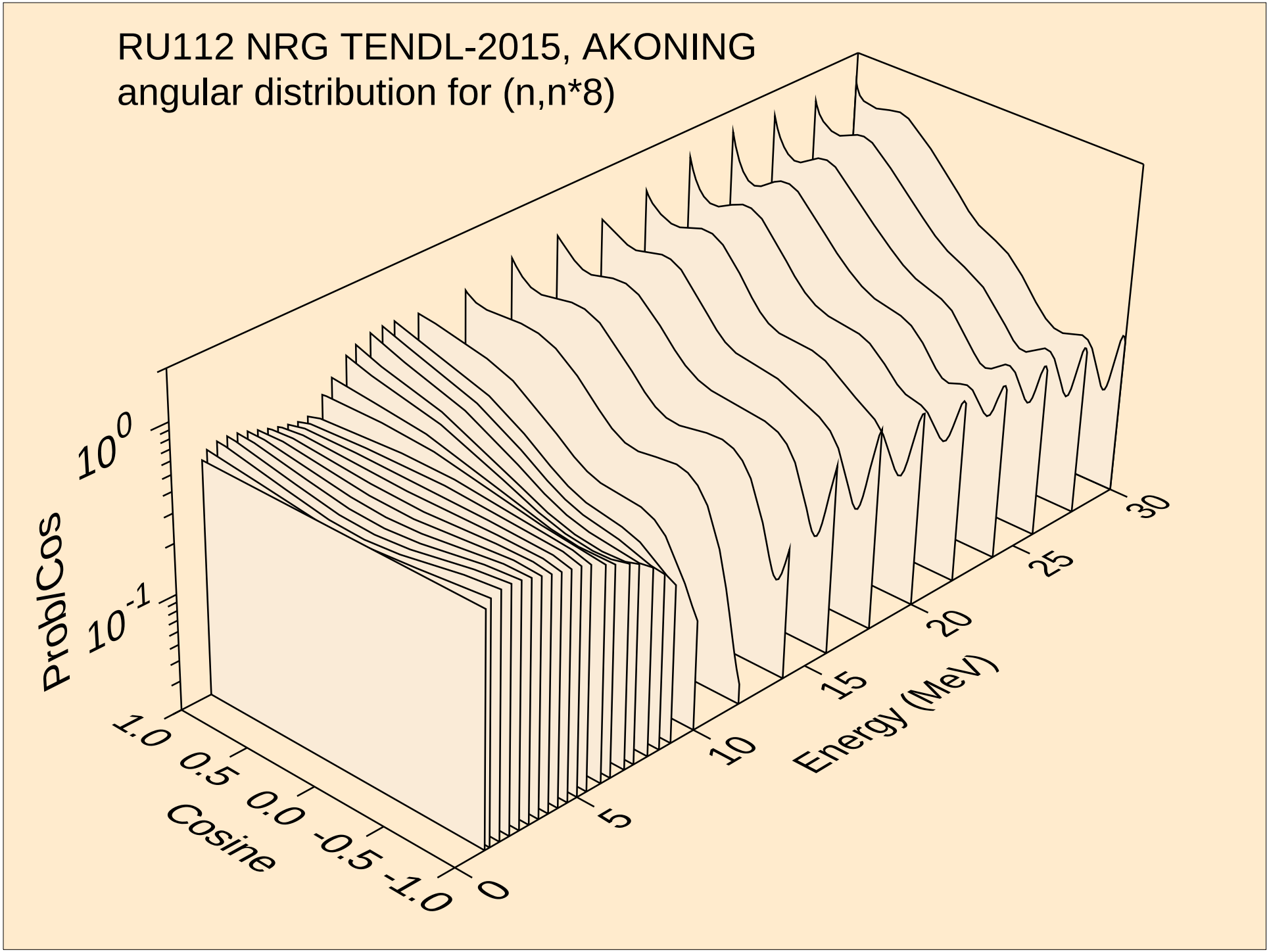

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*3)
ProbCos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

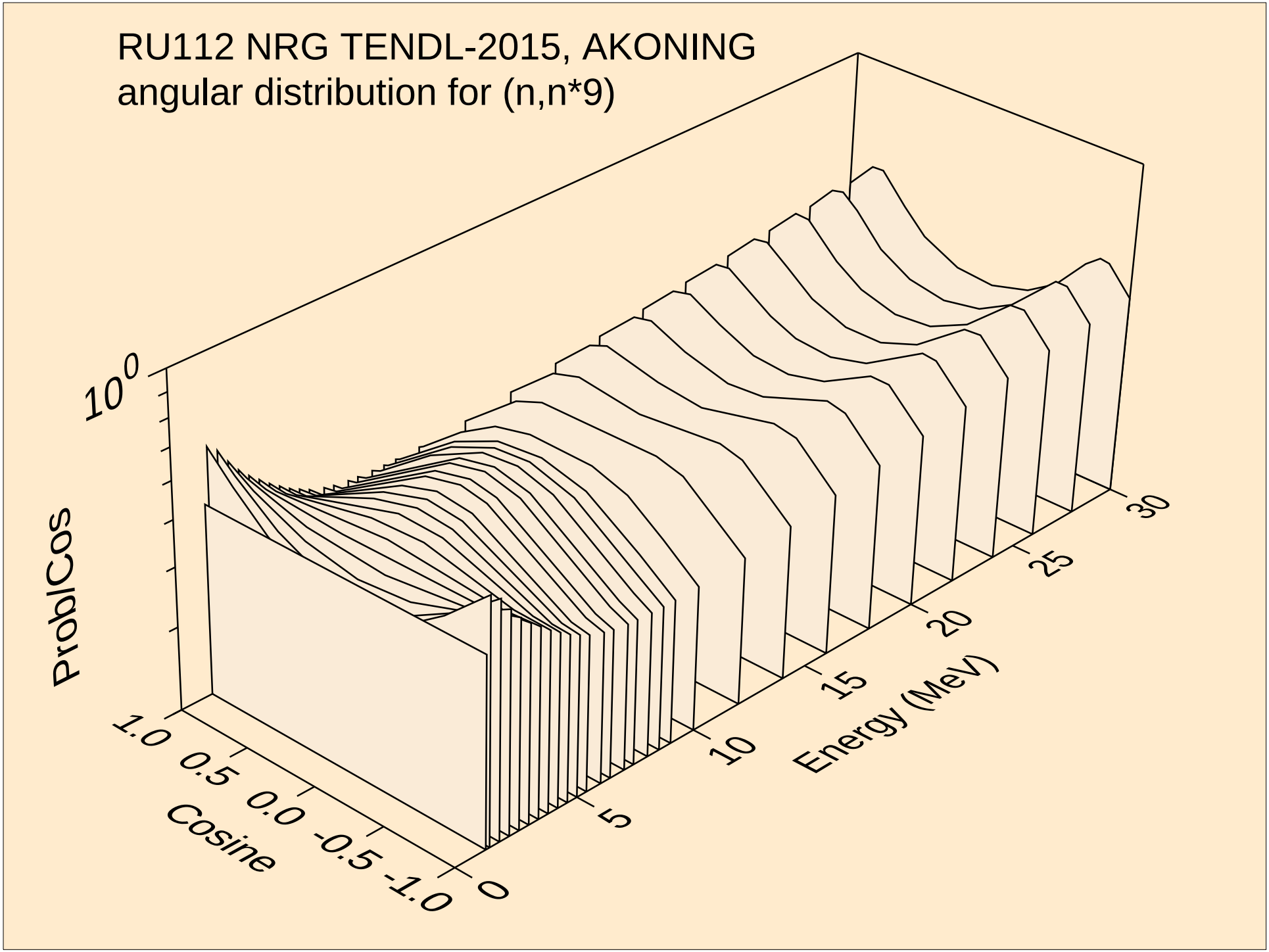

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*4)
10^0
ProbICos
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

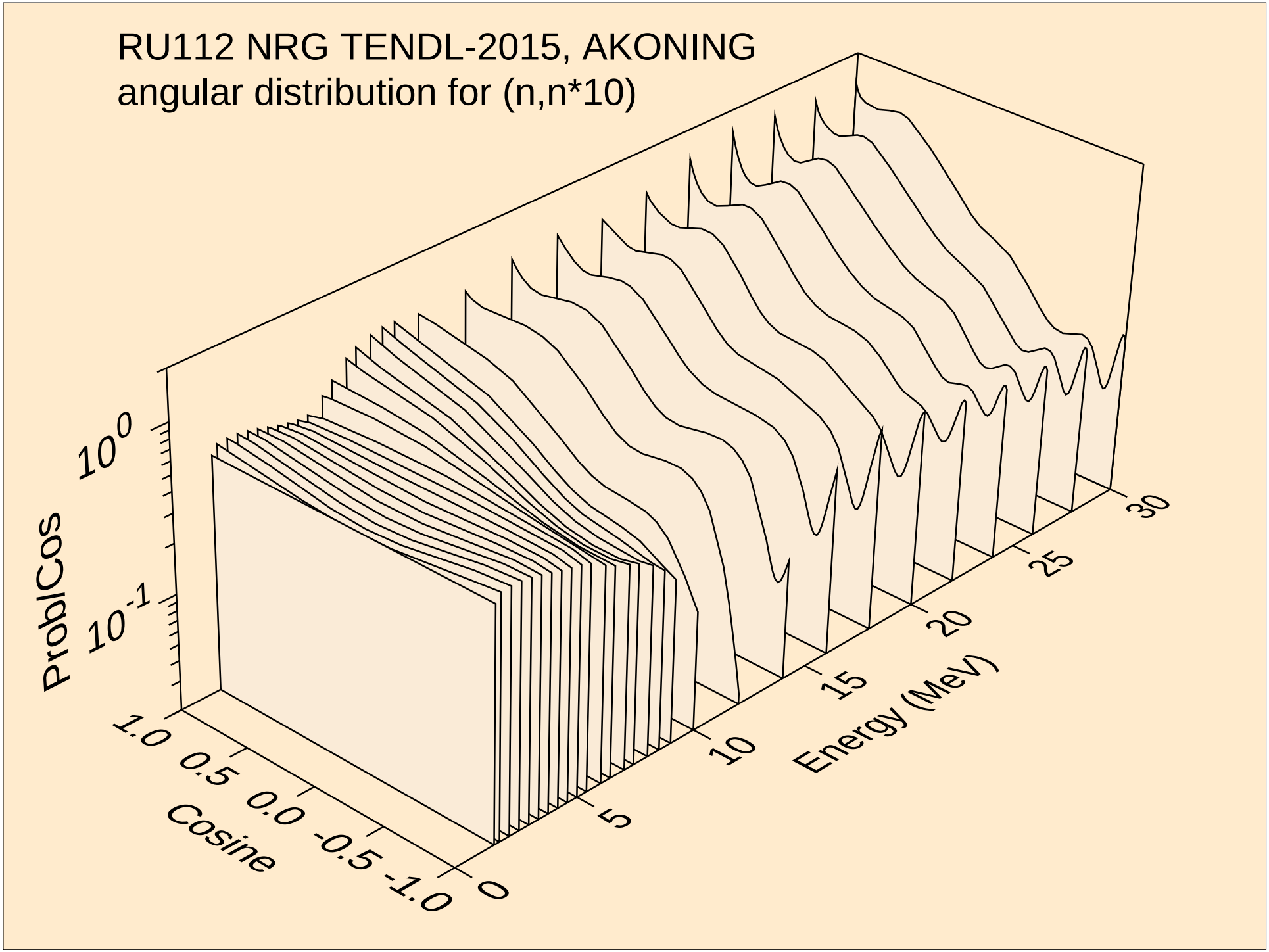

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*5)
ProbICos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

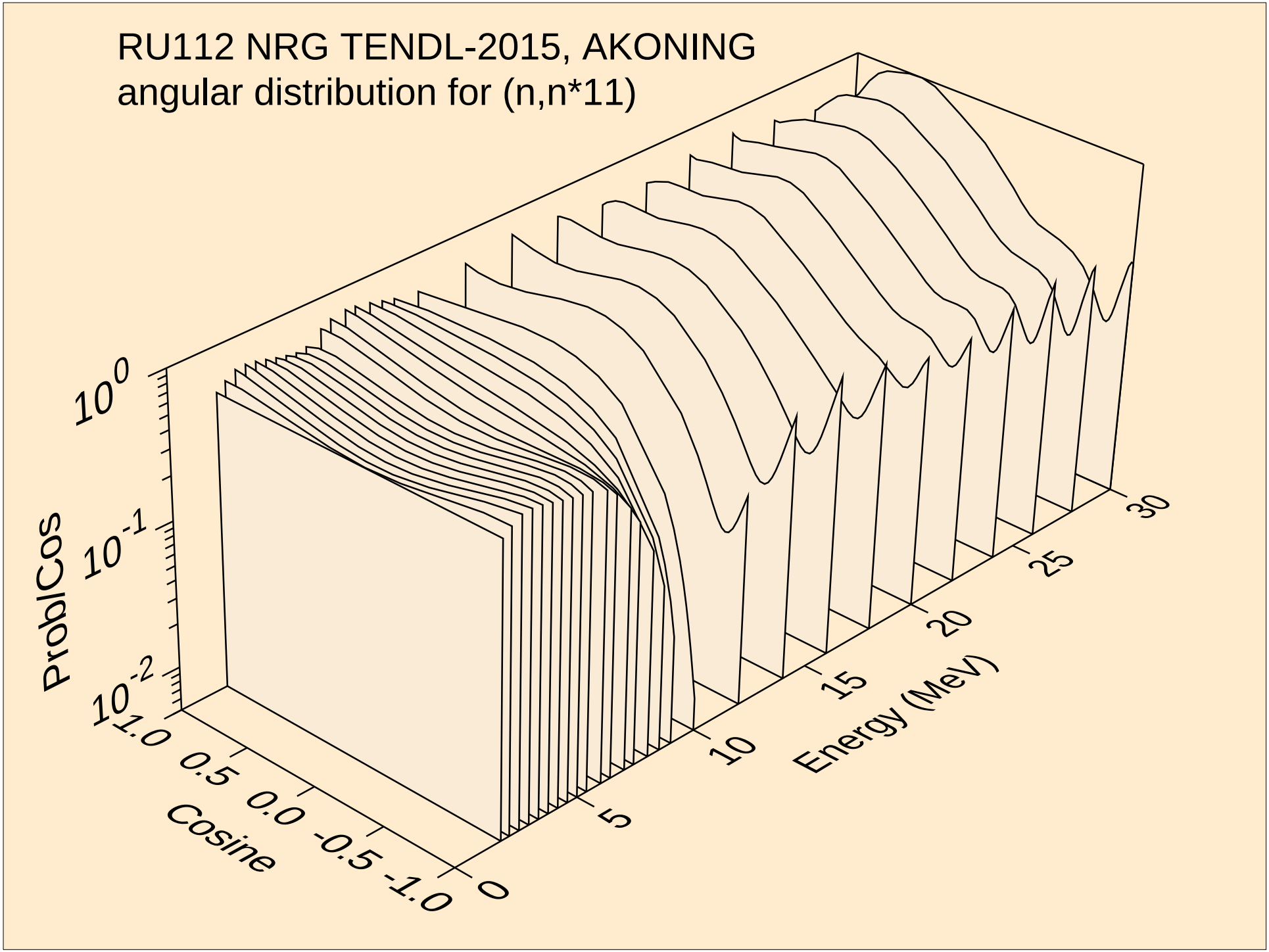

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*6)
10^0
ProbICos
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

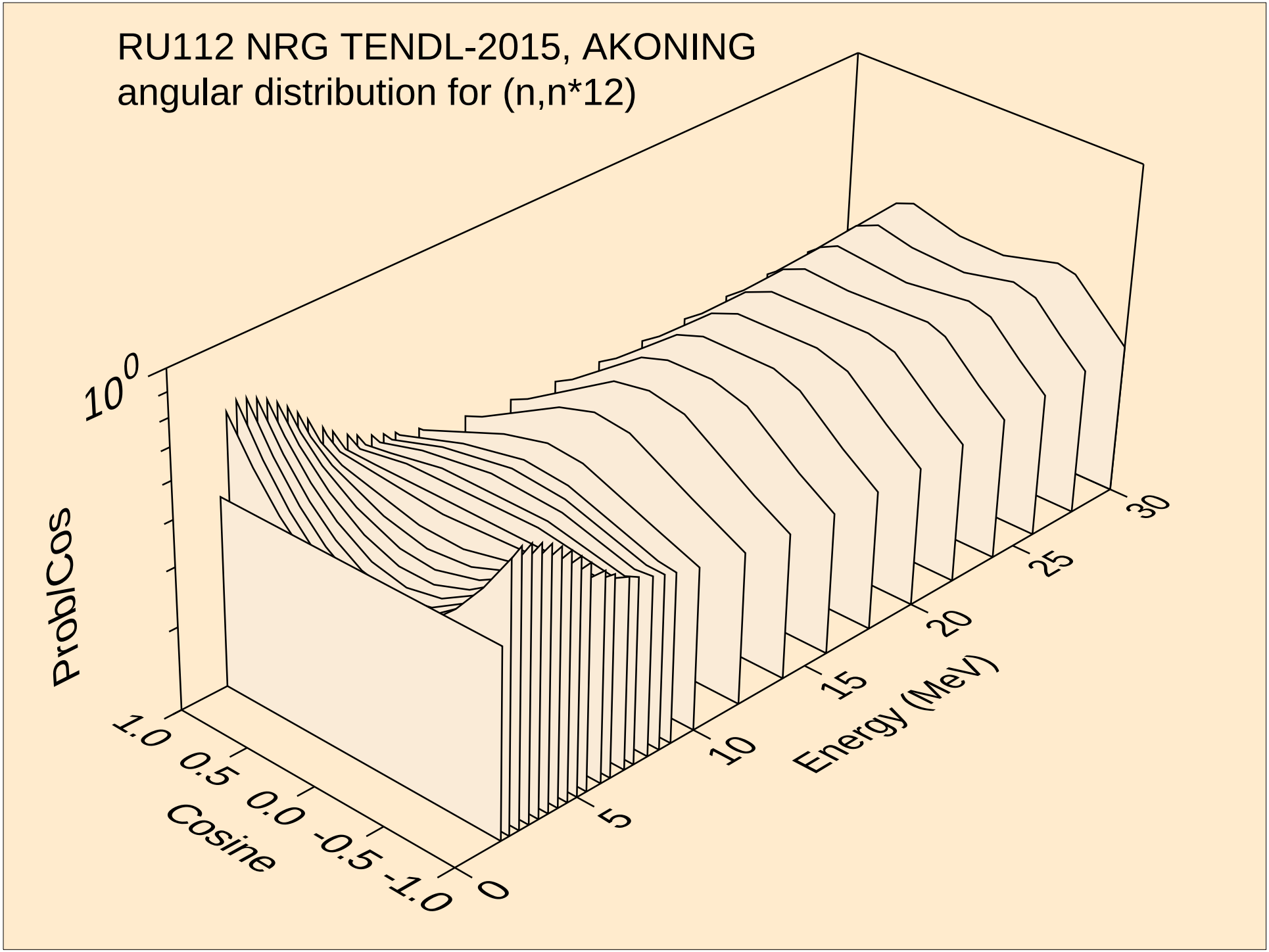

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*7)
ProbICos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

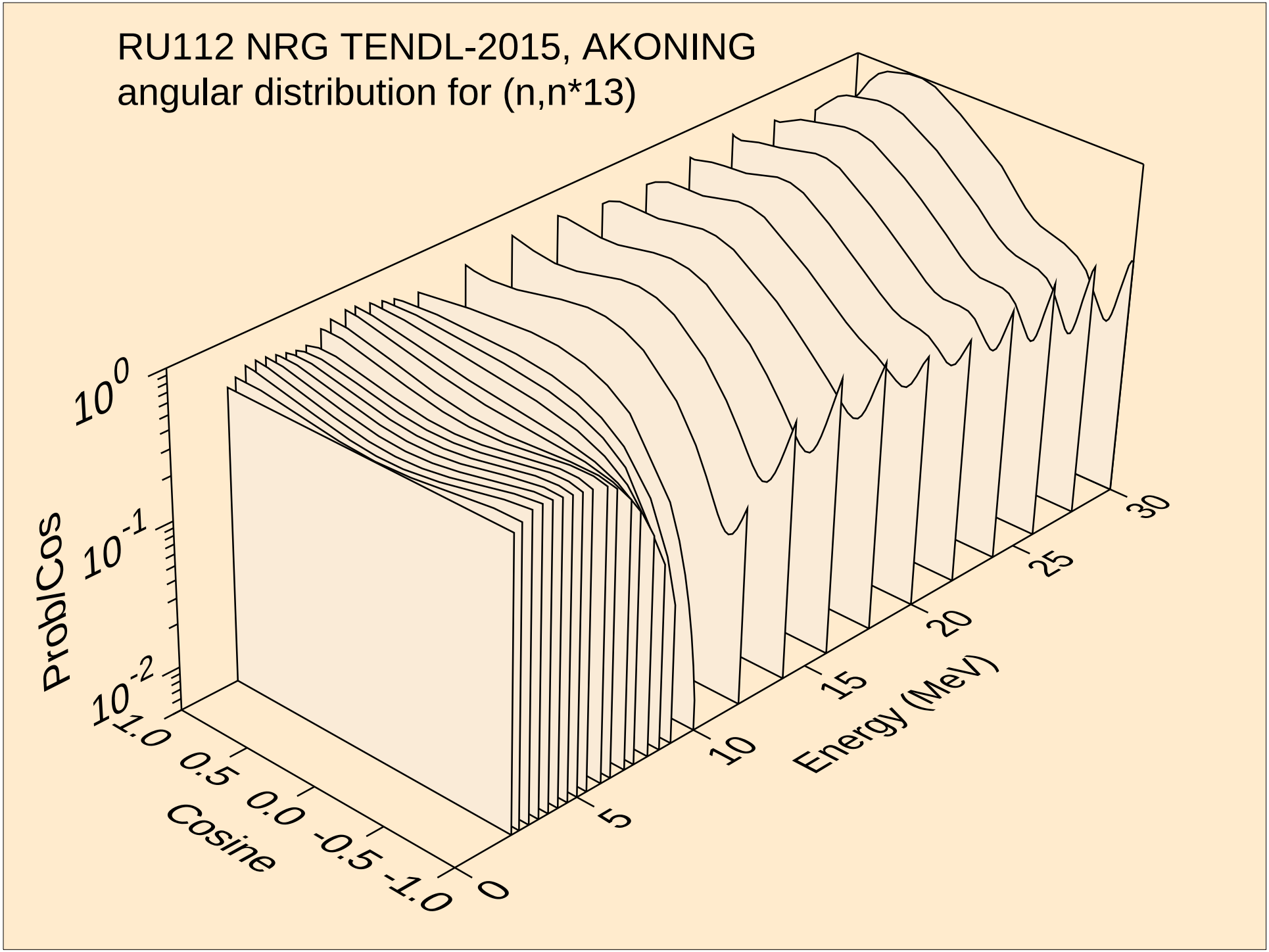

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*8)
ProbCos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

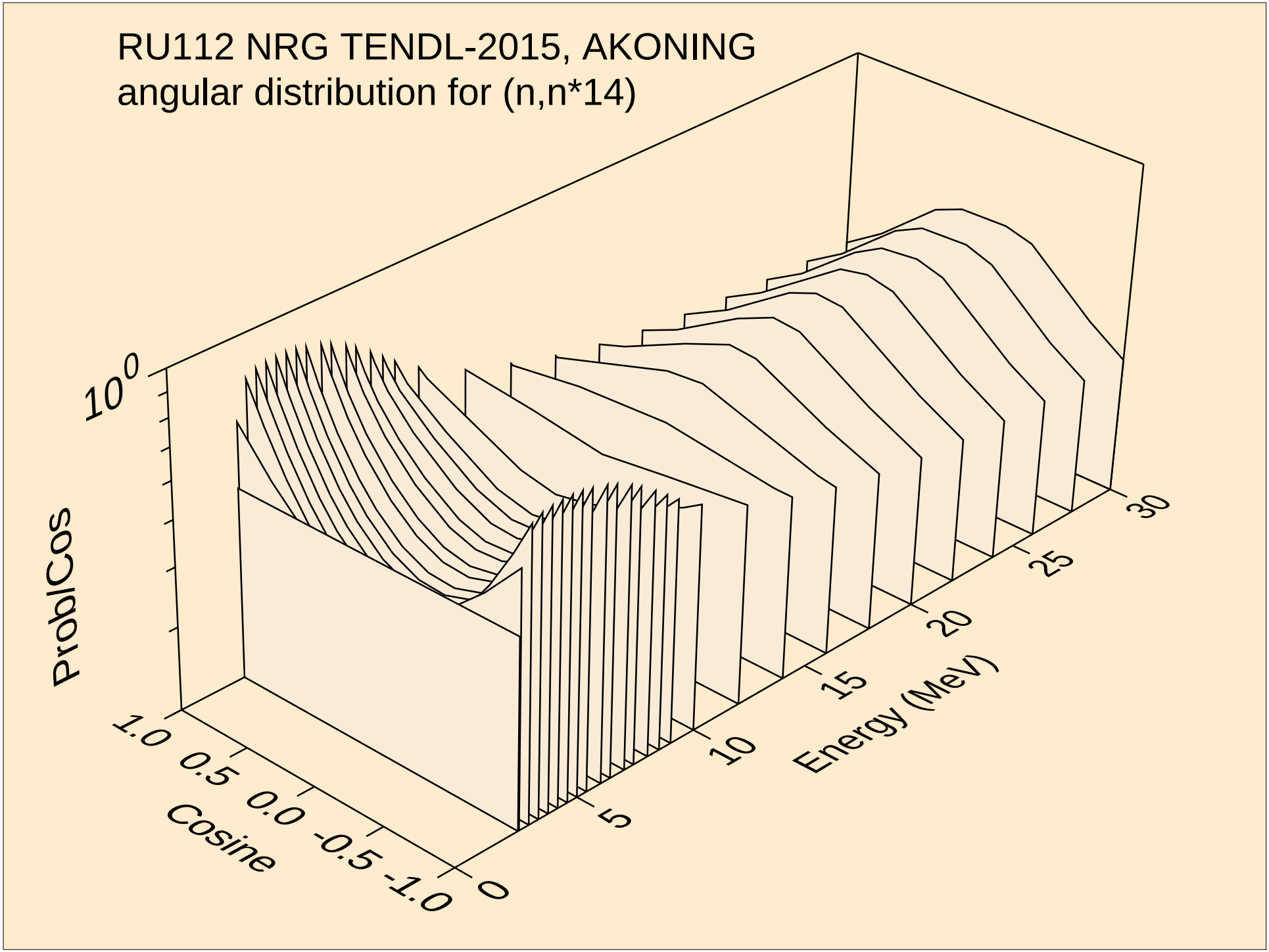

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*9)
ProbICos
10^0
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

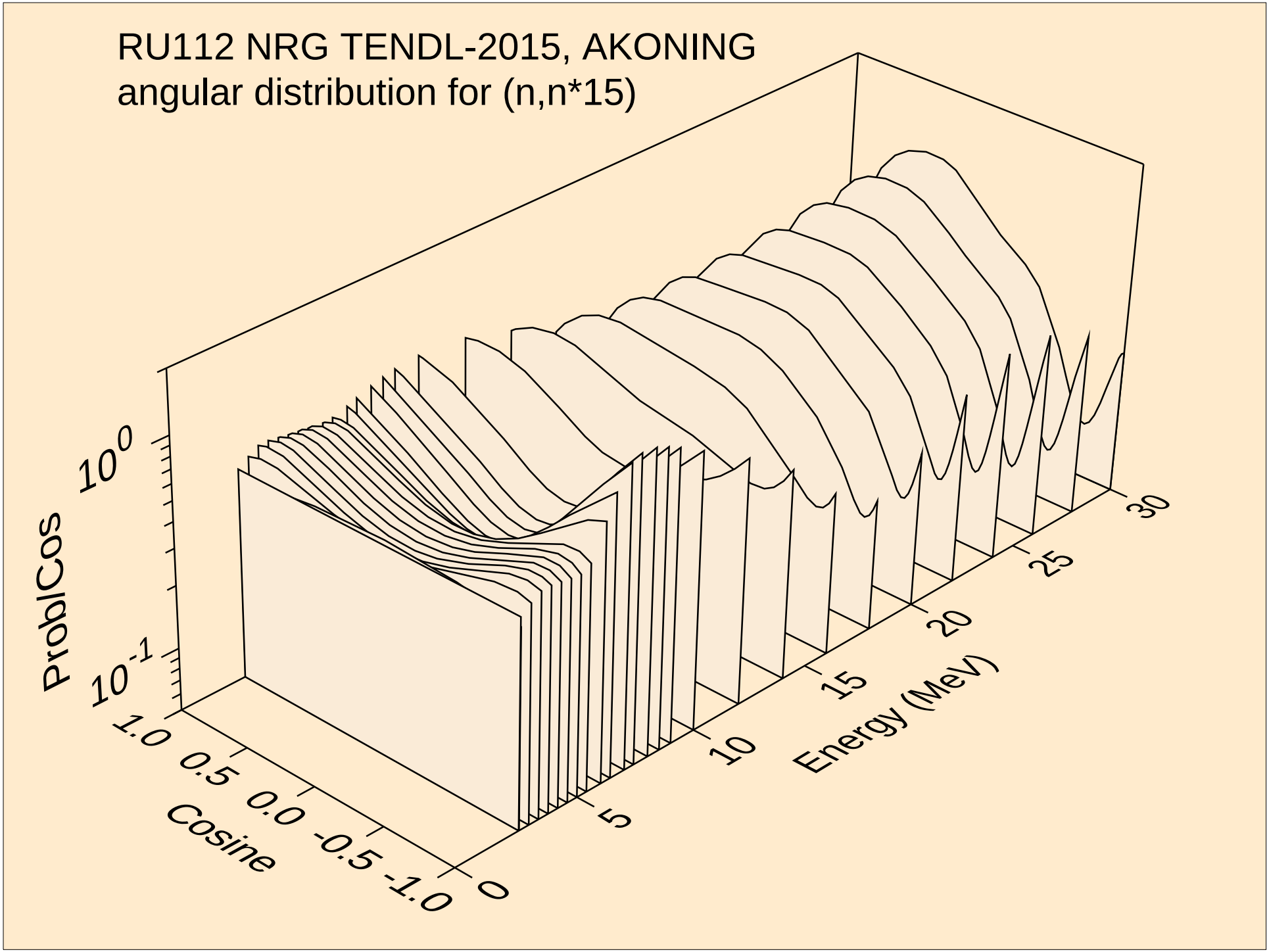

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*10)
ProbCos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

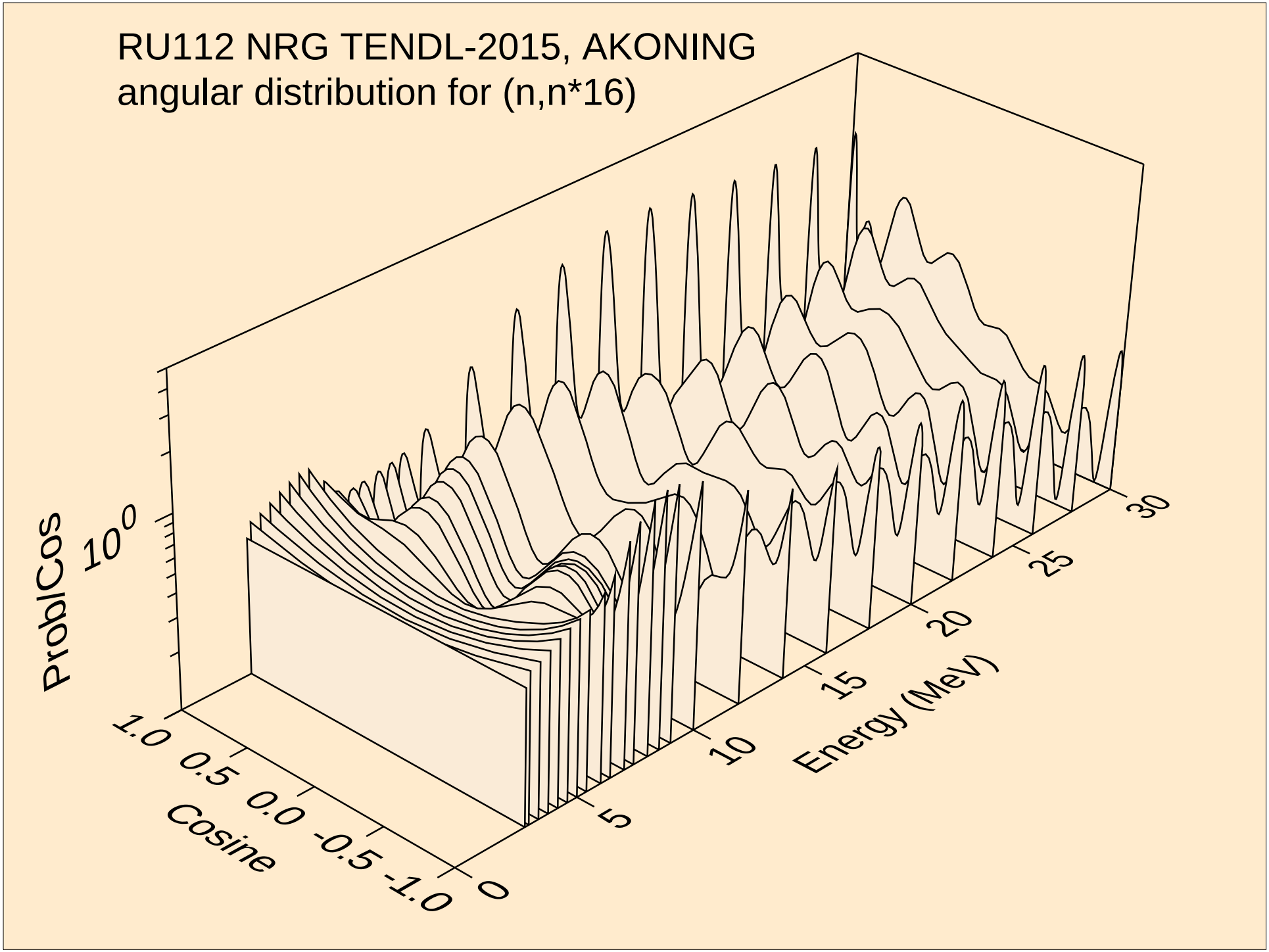

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*11)
ProbCos
10^{0}
10^{-1}
10^{-2}
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
5
10
15
20
25
30

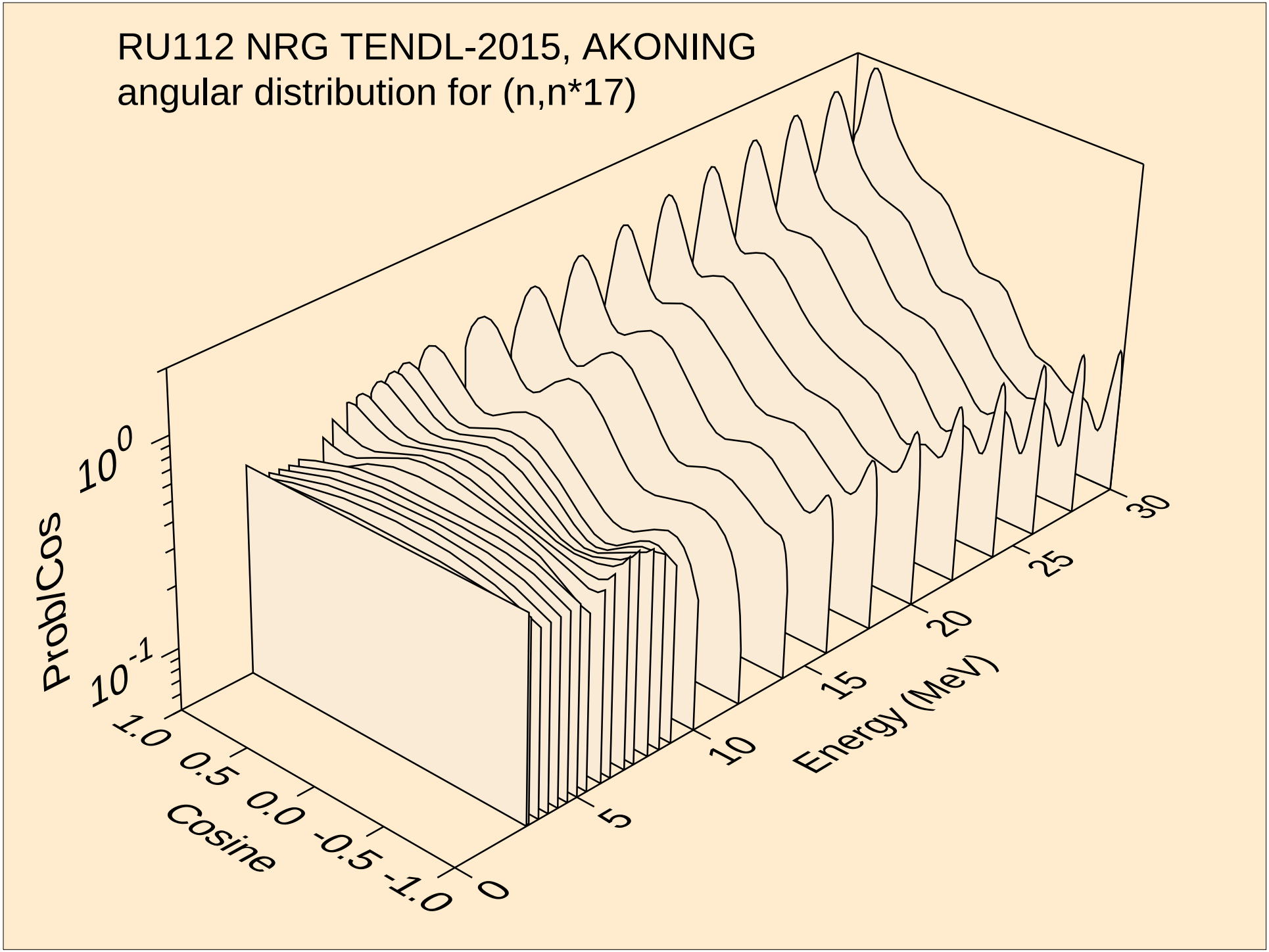

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*12)
10^0
ProbICos
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

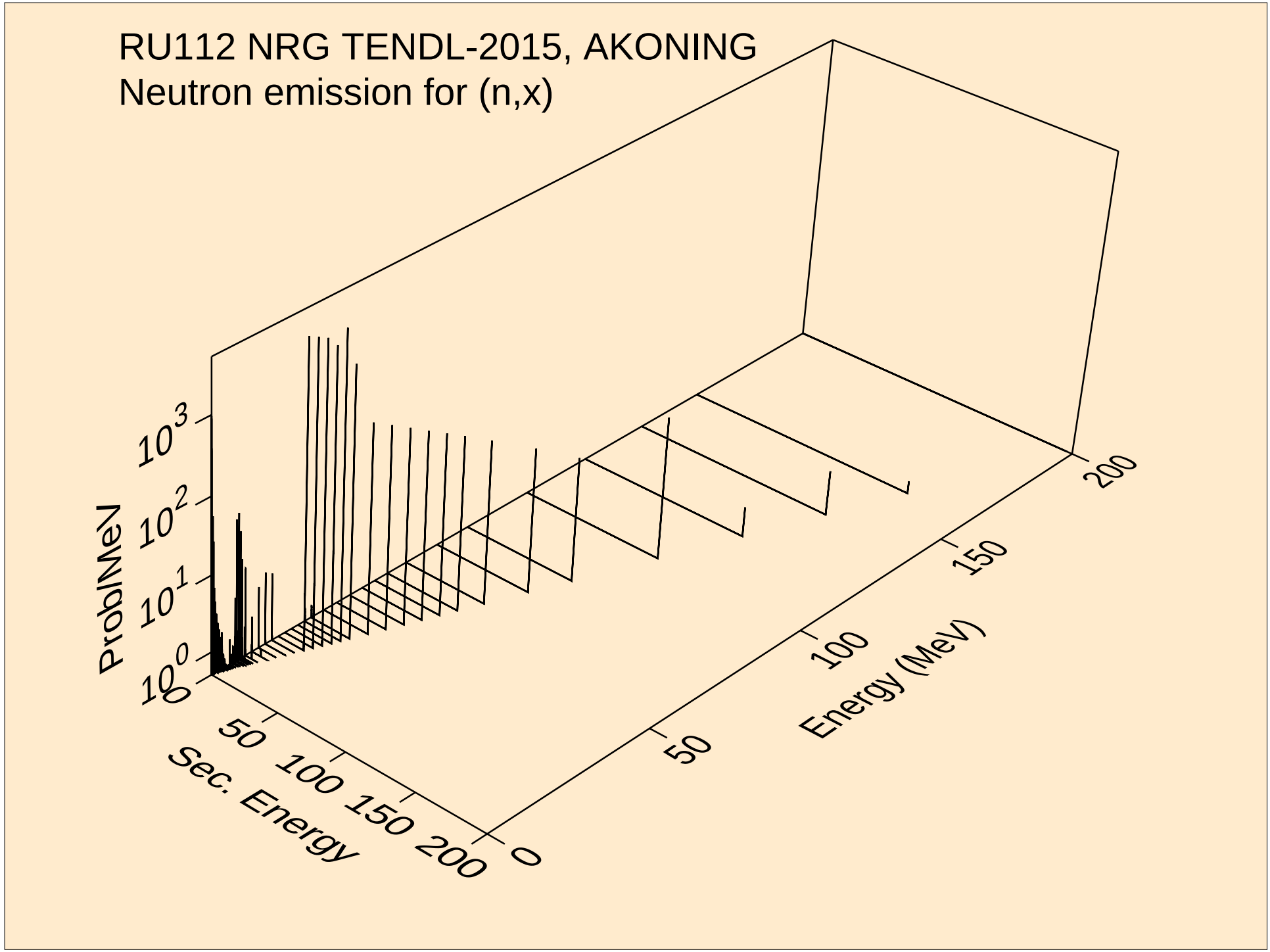

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*13)
ProbCos
10^{0}
10^{-1}
10^{-2}
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
0
5
10
15
20
25
30

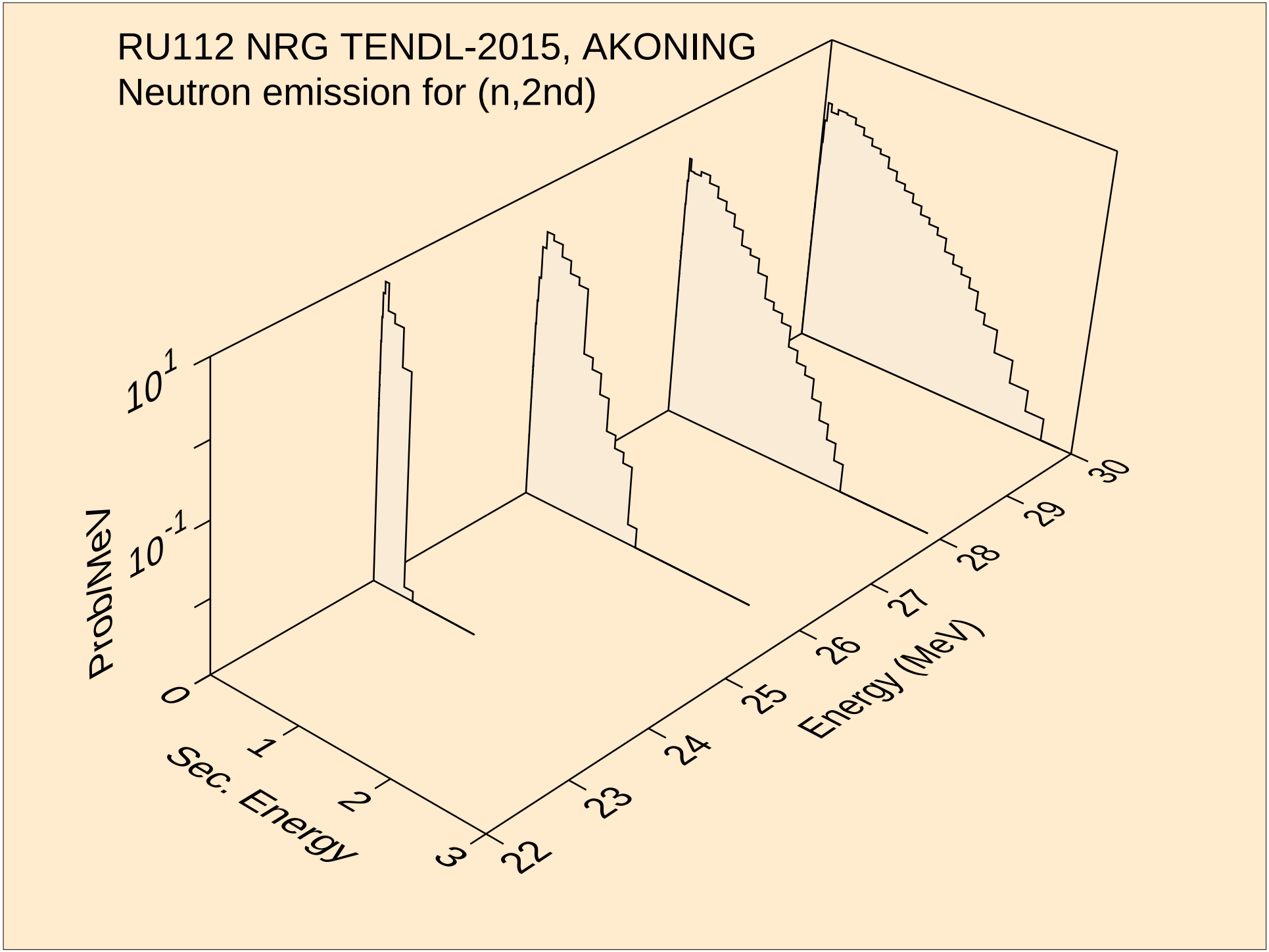

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*14)
ProbICos
10^0
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

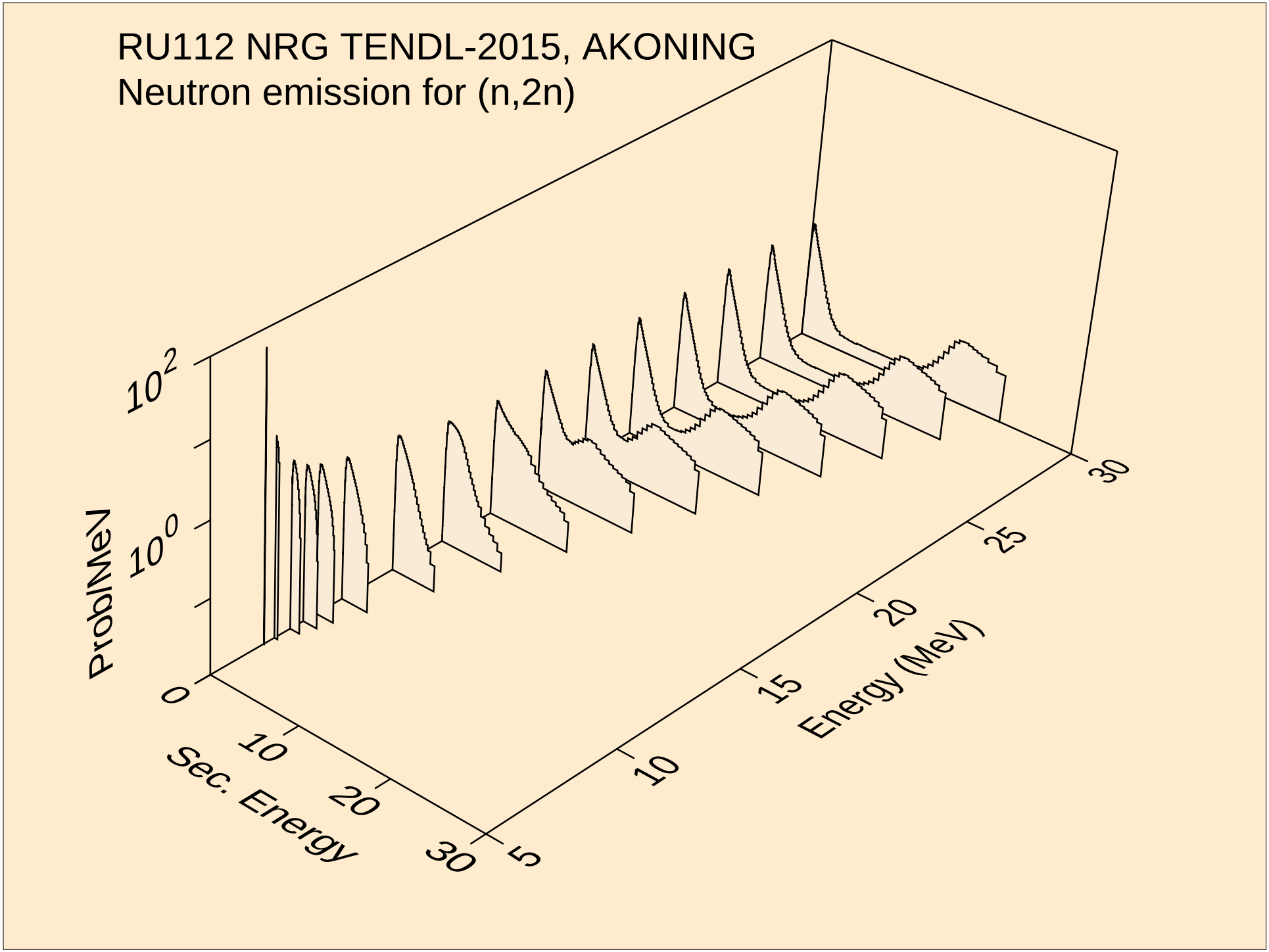

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*15)
ProbCos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

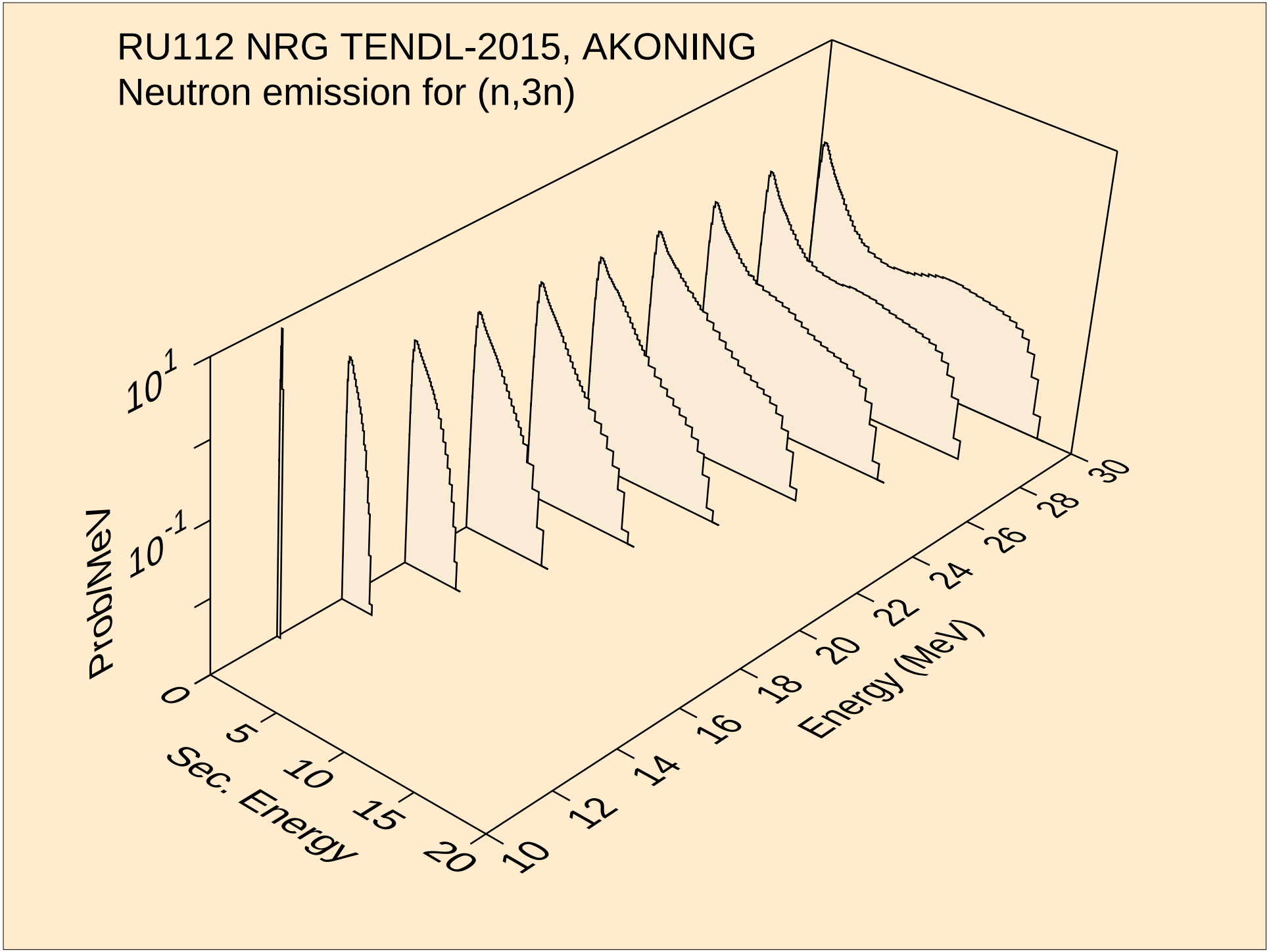

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*16)
ProbICos
10^0
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

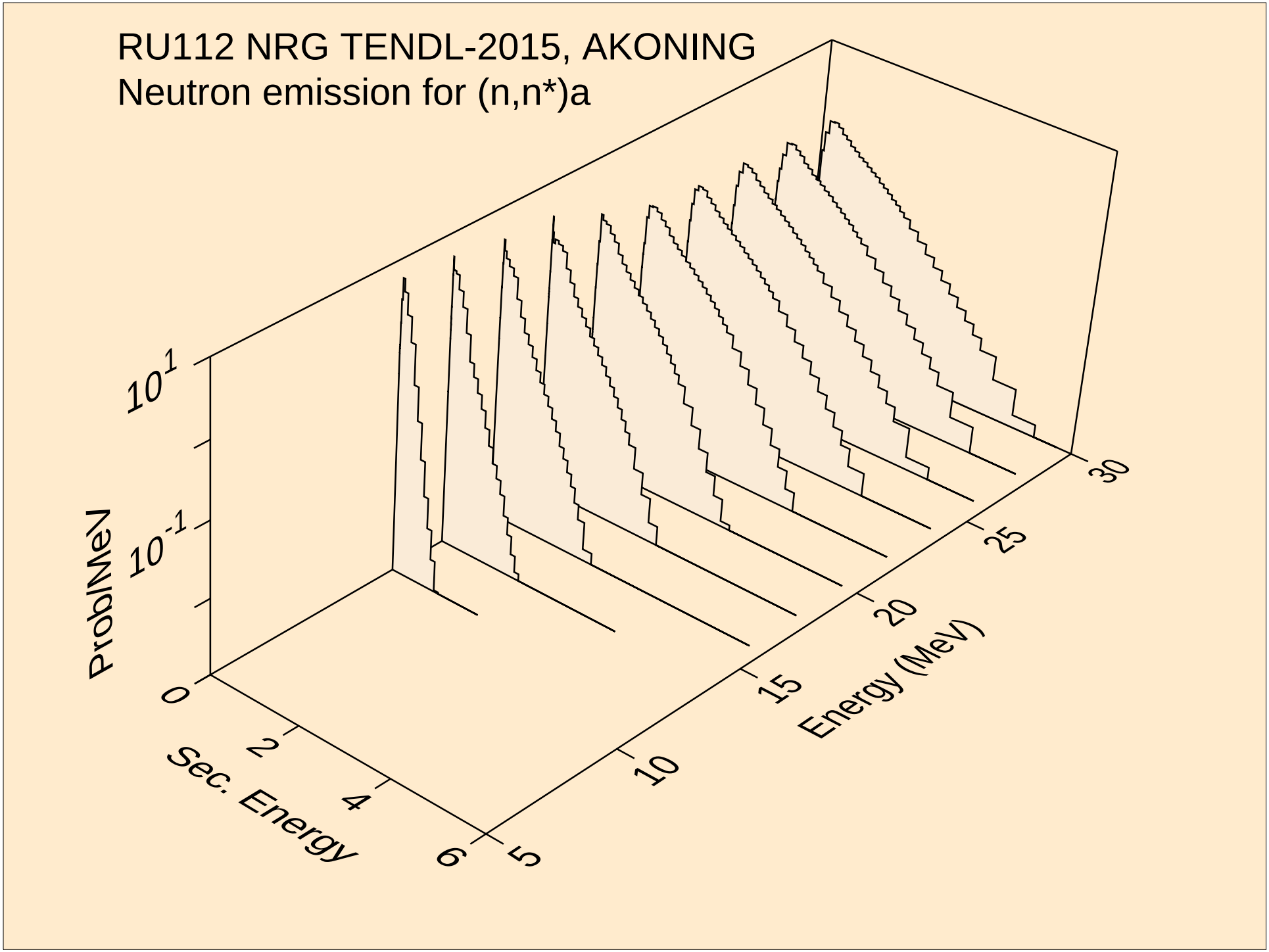

RU112 NRG TENDL-2015, AKONING
angular distribution for (n,n*17)
ProbCos
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

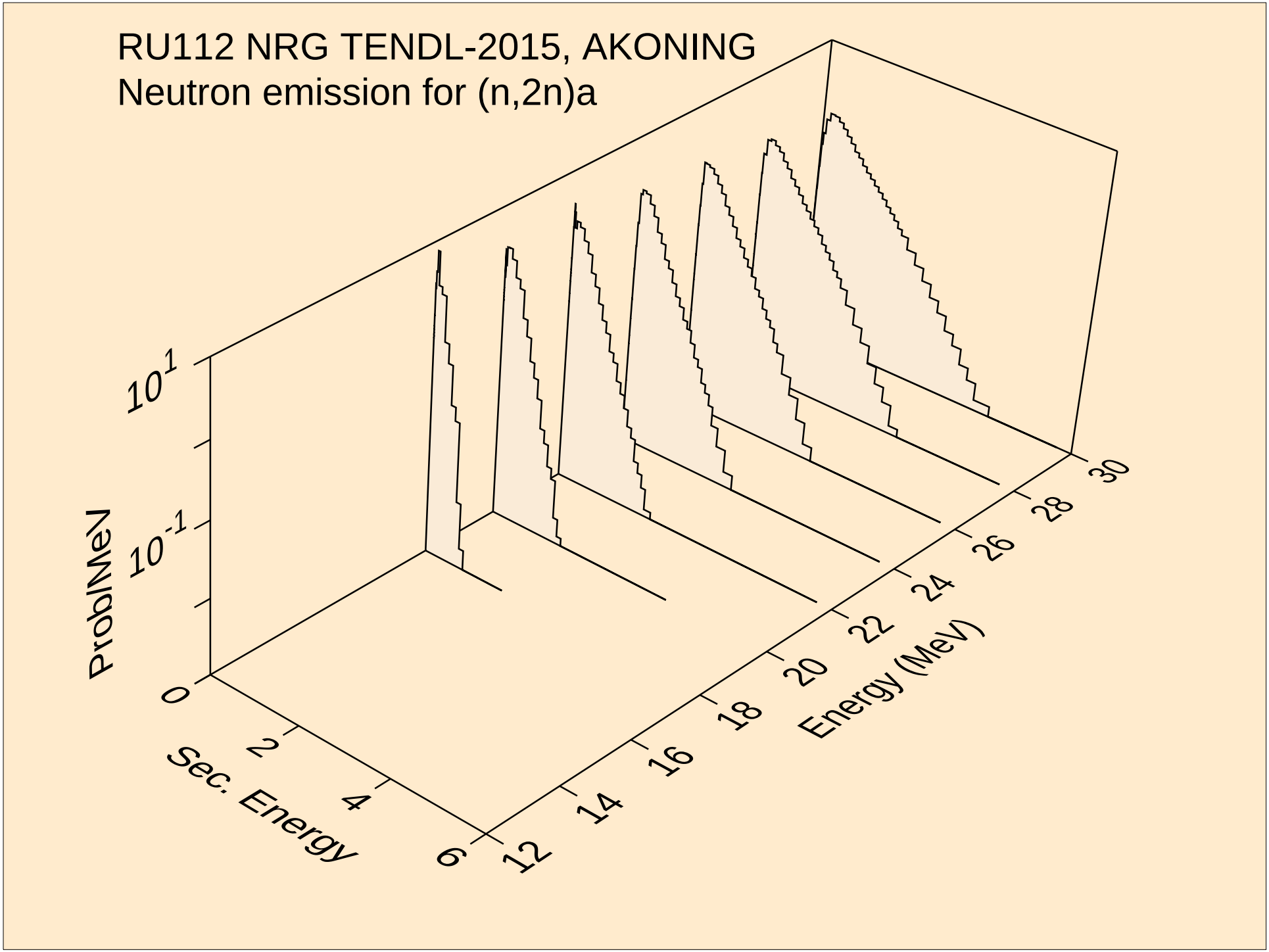

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,x)
Prob/MeV
10^3
10^2
10^1
10^0
Sec. Energy
50
100
150
200
0
50
100
150
200
Energy (MeV)

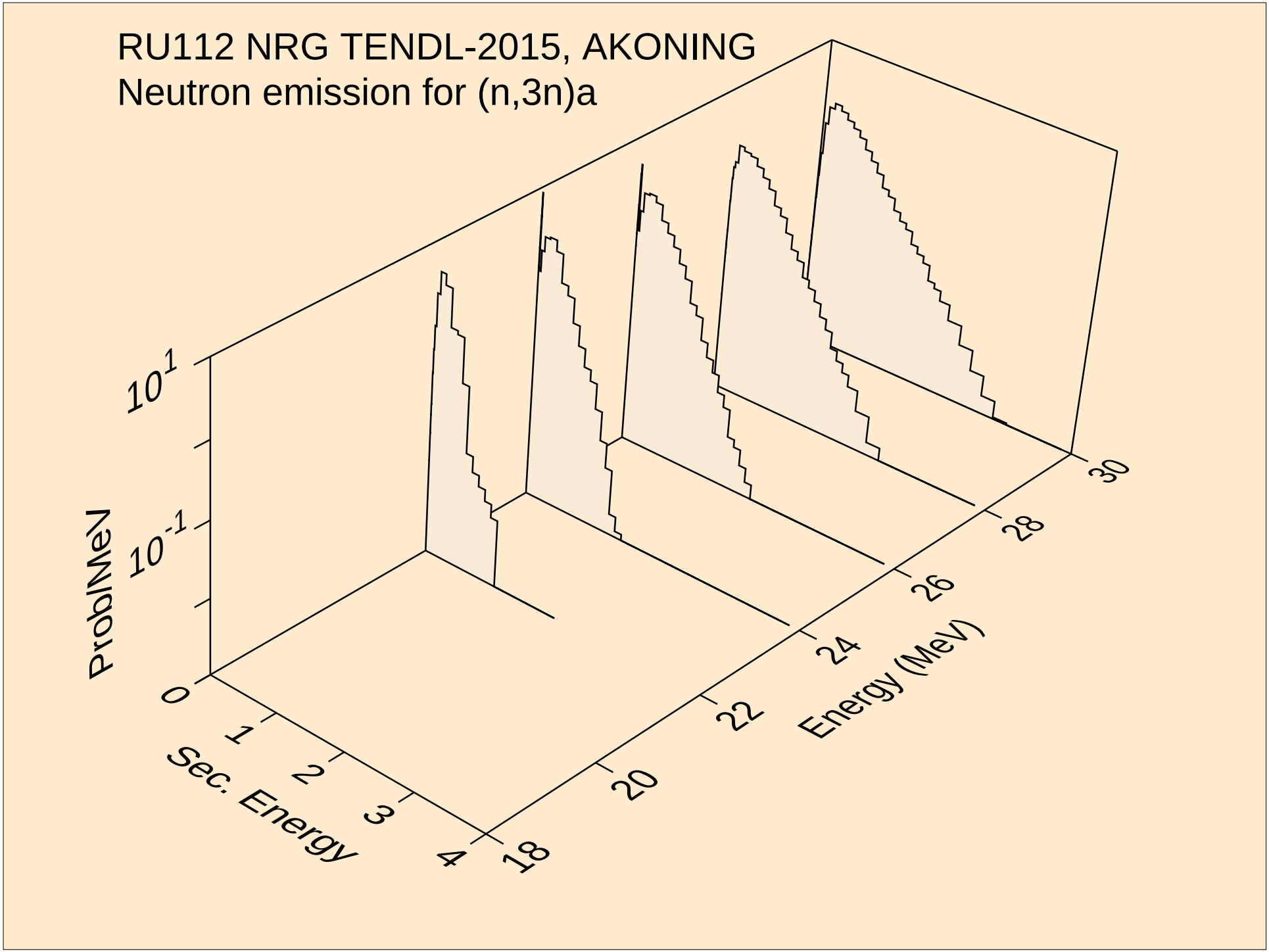

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,2nd)
Prob/MeV
10^{1}
10^{-1}
0
1
2
3
Sec. Energy
22
23
24
25
26
27
28
29
30
Energy (MeV)

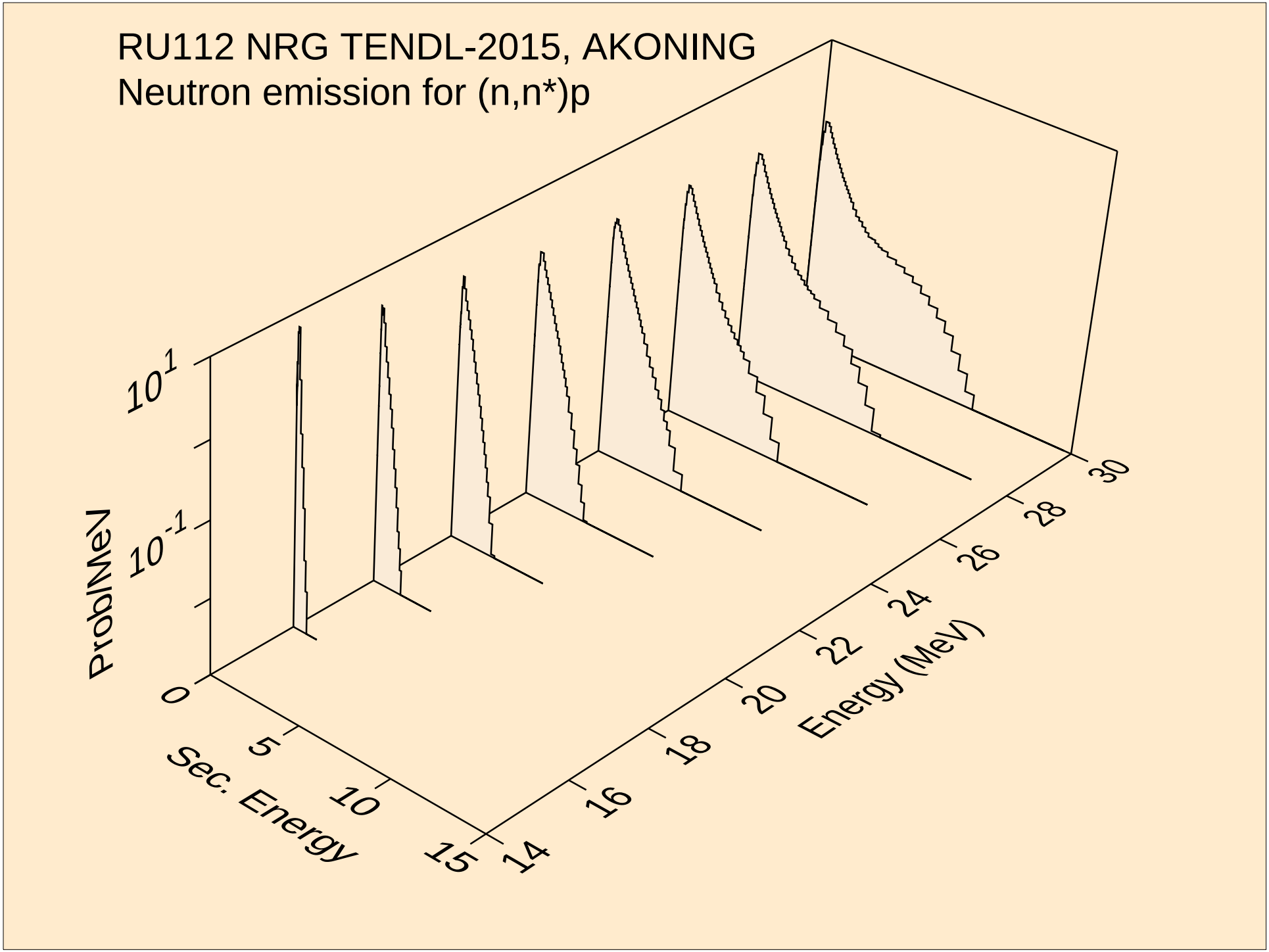

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,2n)
Prob/MeV
10^2
10^0
0
Sec. Energy
10
20
30
5
10
15
20
25
30
Energy (MeV)

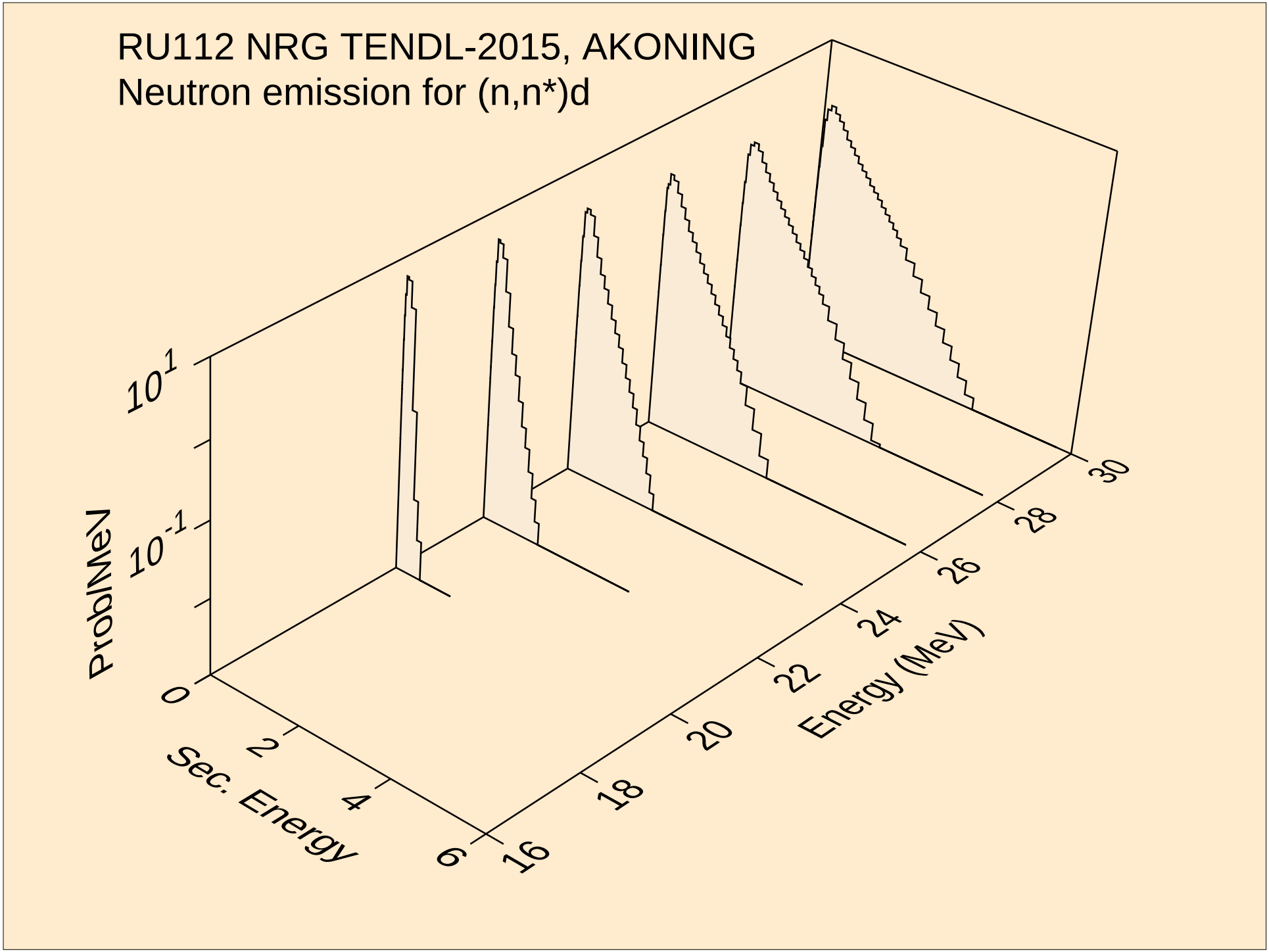

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,3n)
Prob/MeV
10^{1}
10^{-1}
0
5
10
15
20
Sec. Energy
10
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

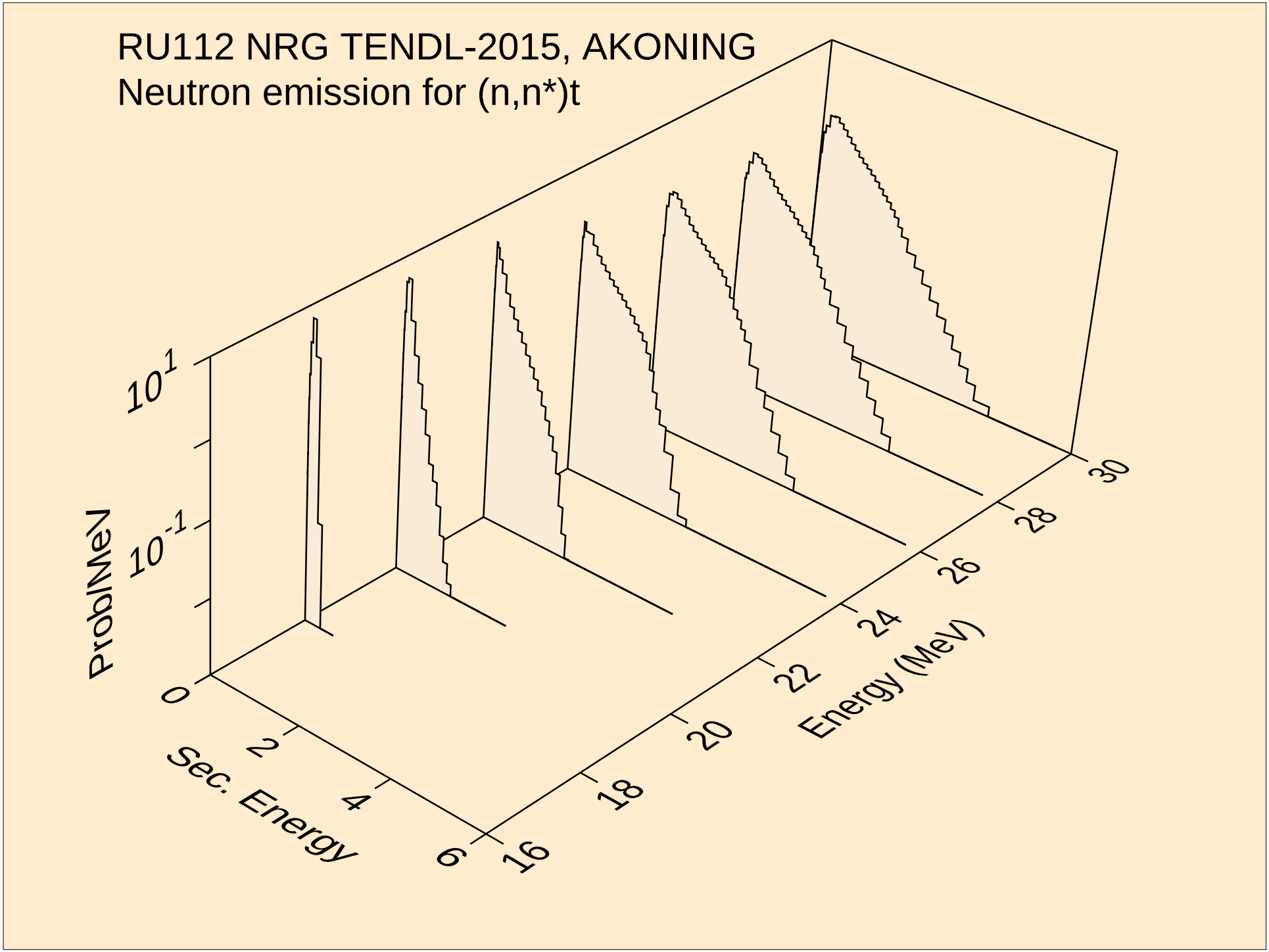

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,n*)a
Prob/MeV
10^1
10^-1
0
2
4
6
Sec. Energy
5
10
15
20
25
30
Energy (MeV)

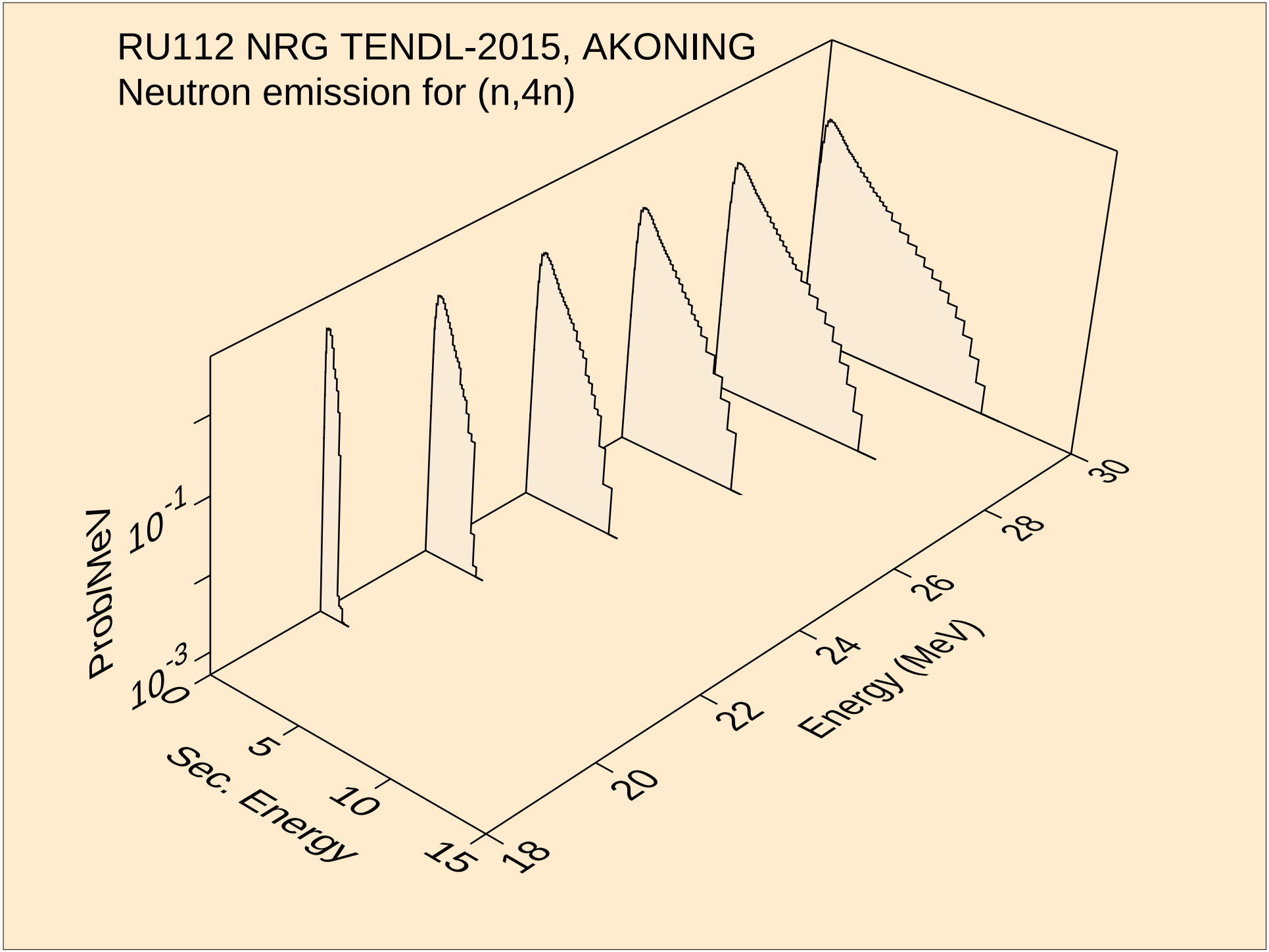

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,2n)a
Prob/MeV
10^1
10^-1
0
Sec. Energy
2
4
6
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

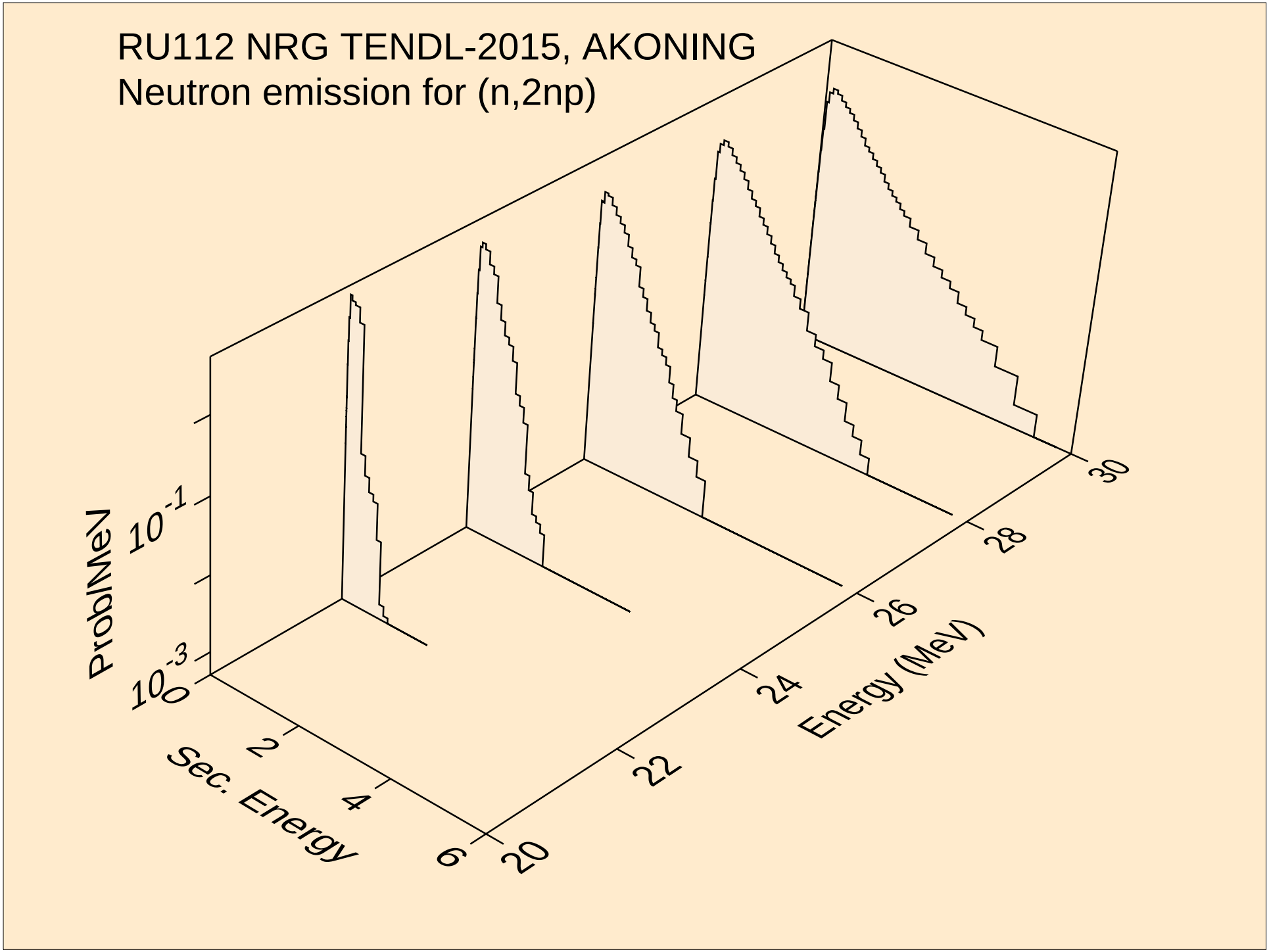

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,3n)a
Prob/MeV
10^{1}
10^{-1}
0
1
2
3
4
Sec. Energy
18
20
22
24
26
28
30
Energy (MeV)

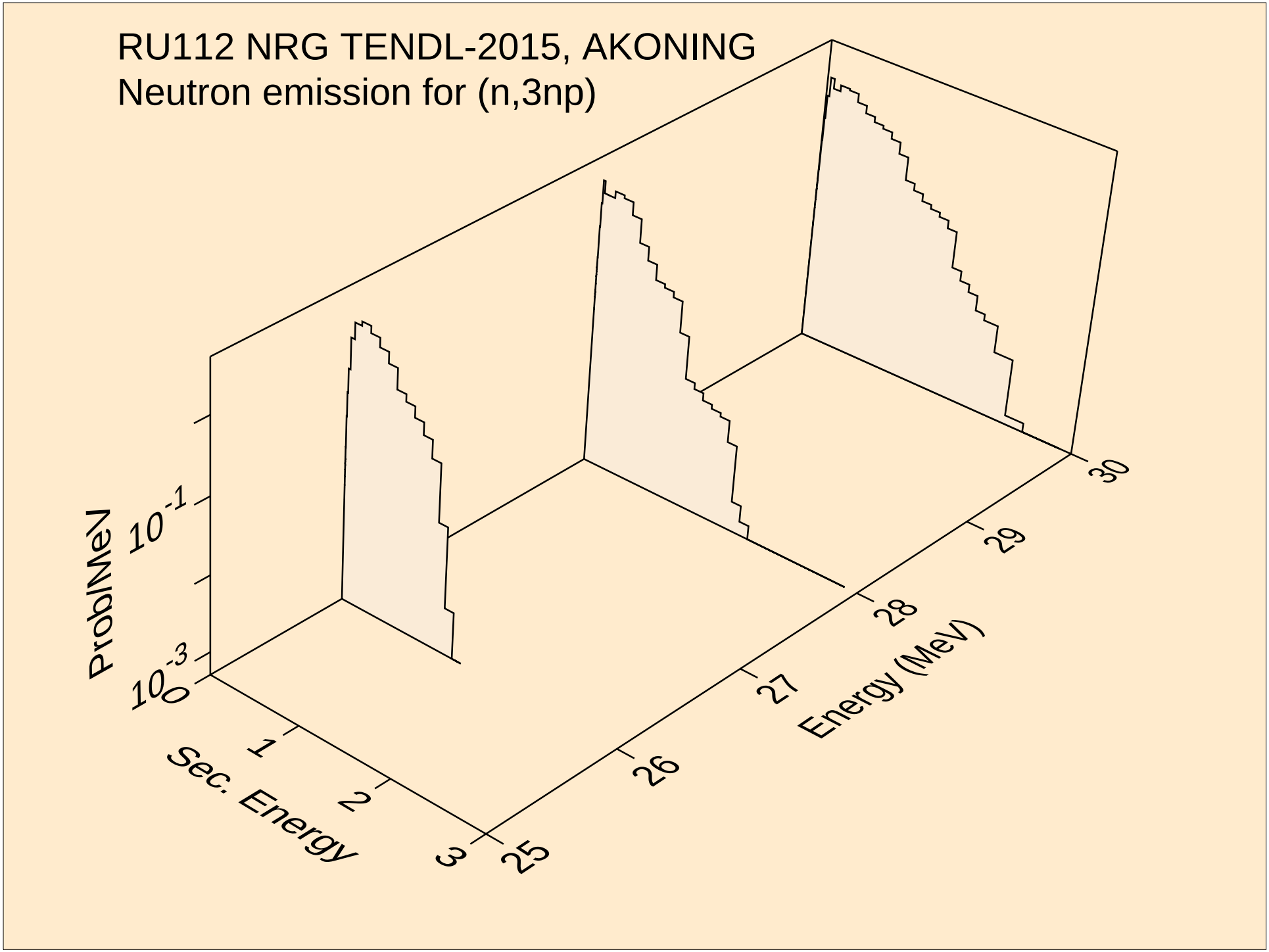

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,n*)p
Prob/MeV
10^{1}
10^{-1}
0
Sec. Energy
5
10
15
14
16
18
20
22
24
26
28
30
Energy (MeV)

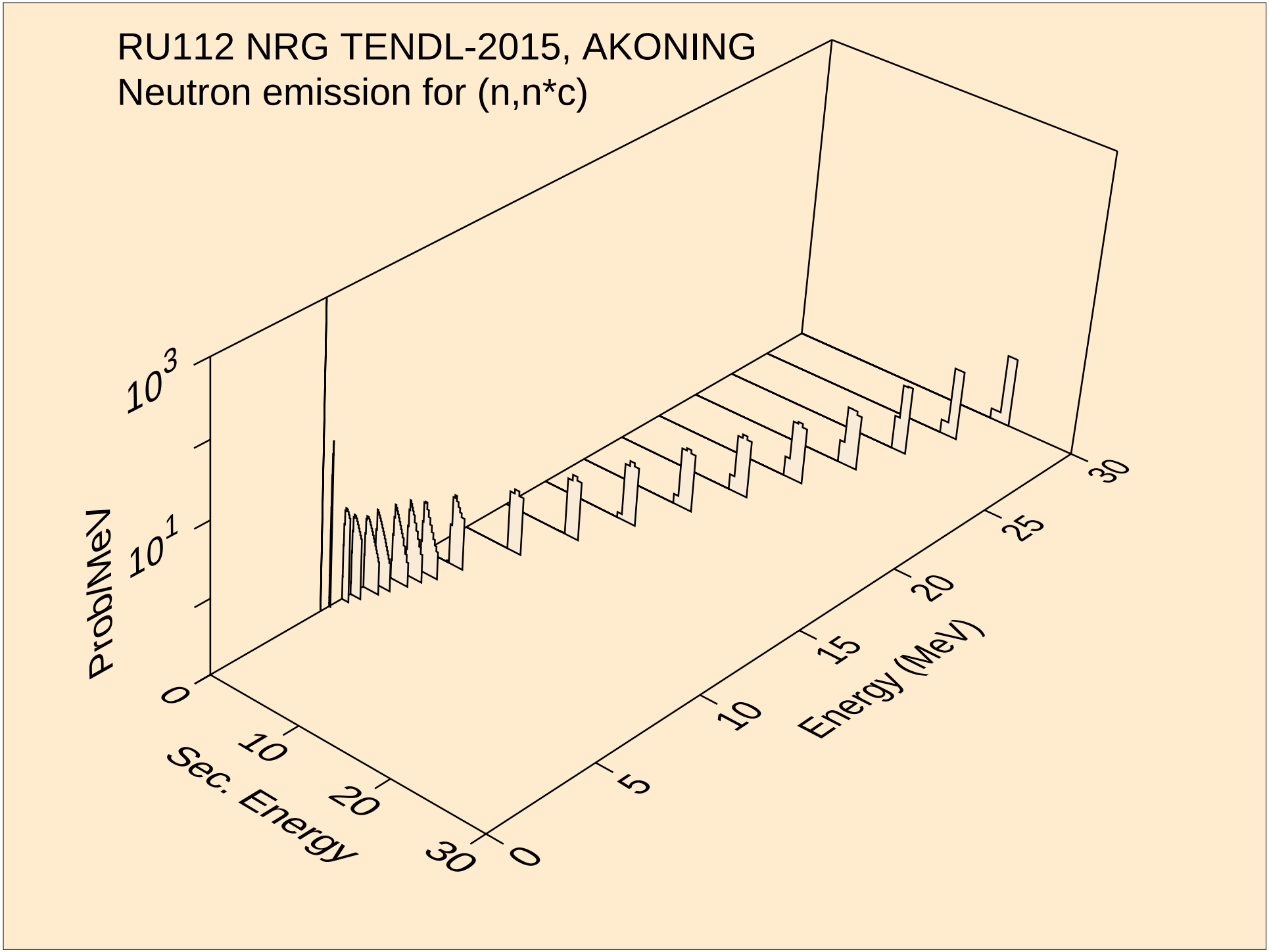

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,n*)d
Prob/MeV
10^{1}
10^{-1}
0
2
4
6
Sec. Energy
16
18
20
22
24
26
28
30
Energy (MeV)

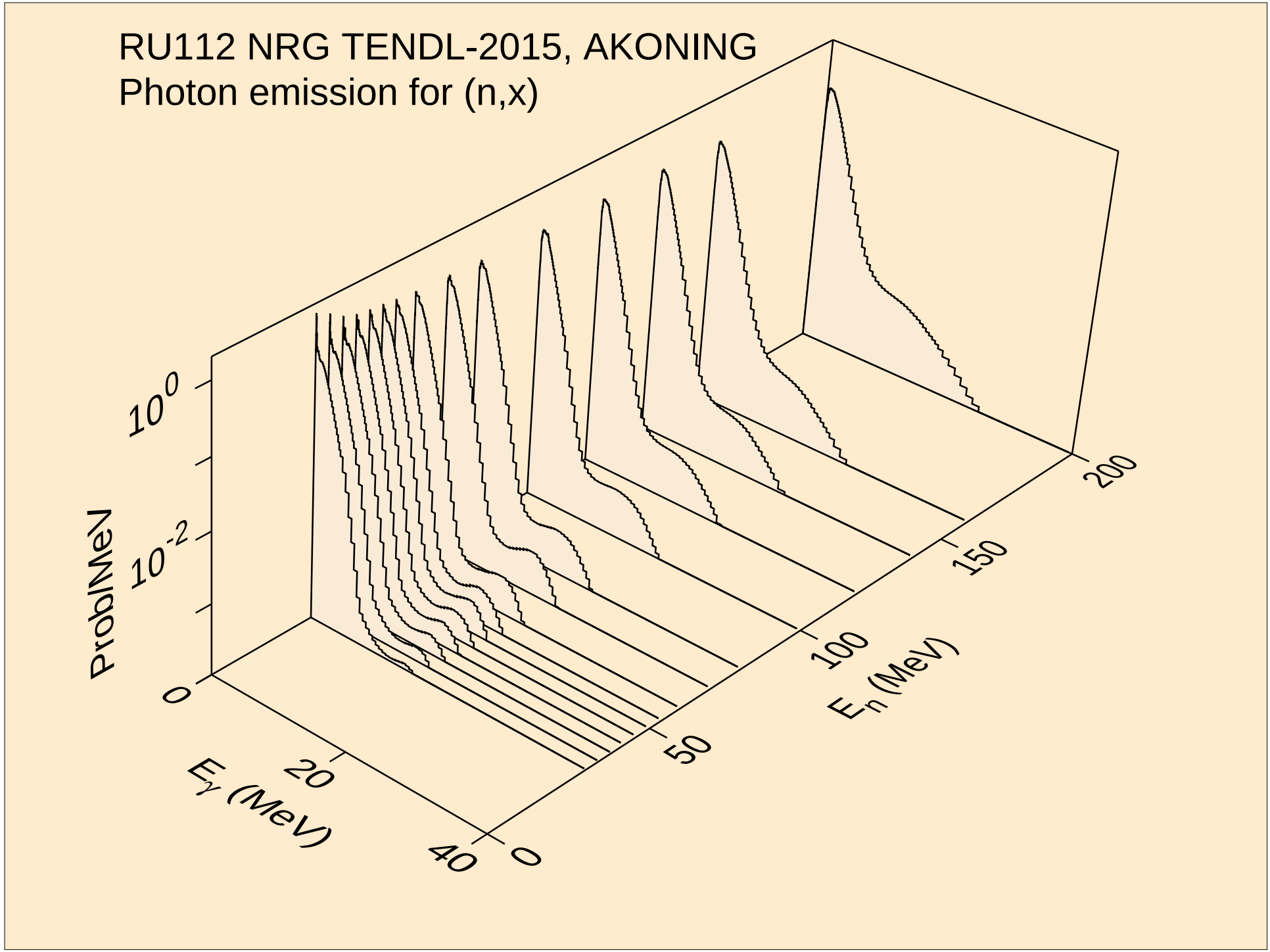

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,n*)t
Prob/MeV
10^1
10^-1
0
2
4
6
Sec. Energy
16
18
20
22
24
26
28
30
Energy (MeV)

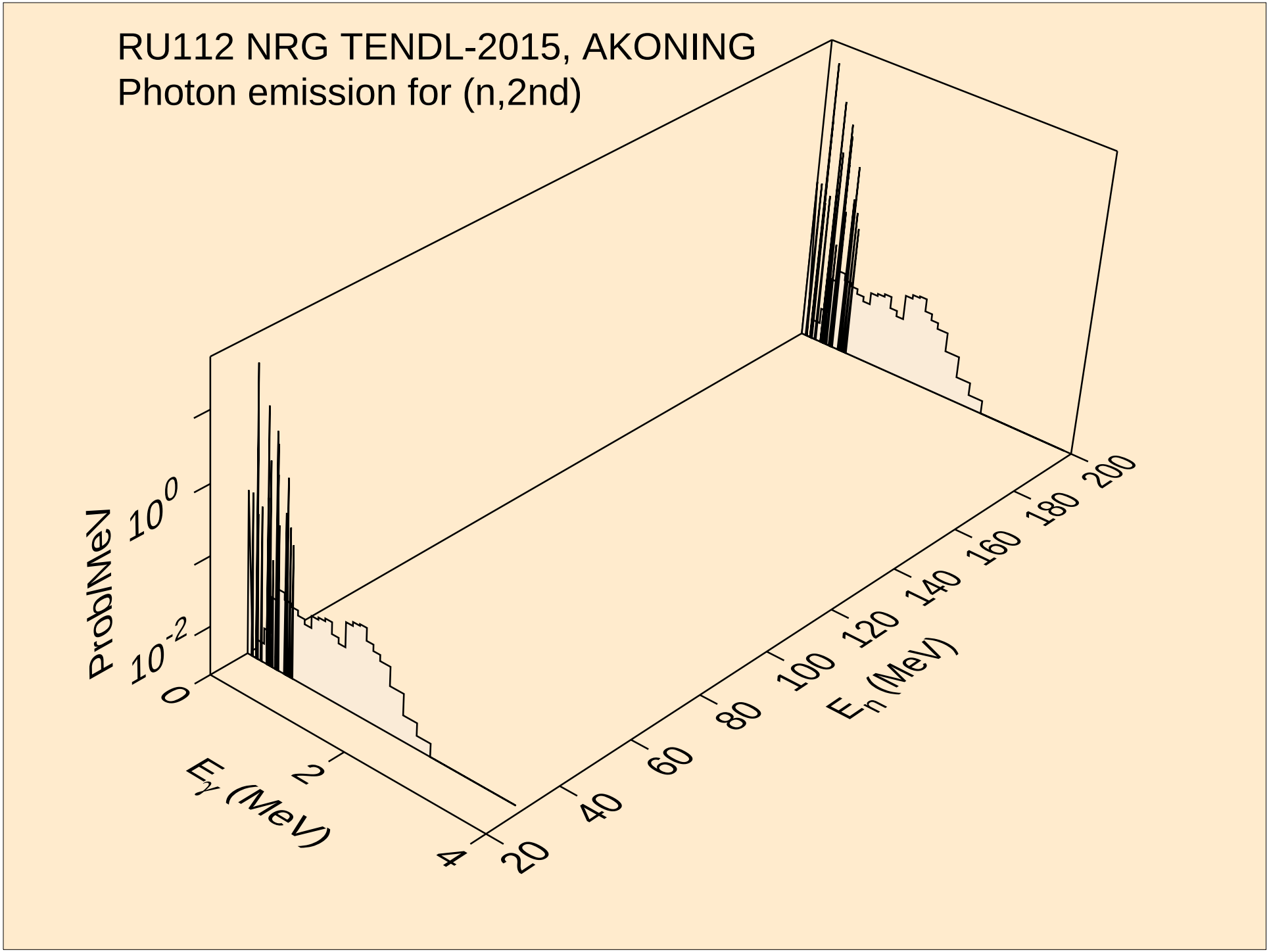

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,4n)
Prob/MeV
10-1
10-3
0
5
10
15
18
Sec. Energy
20
22
24
26
28
30
Energy (MeV)

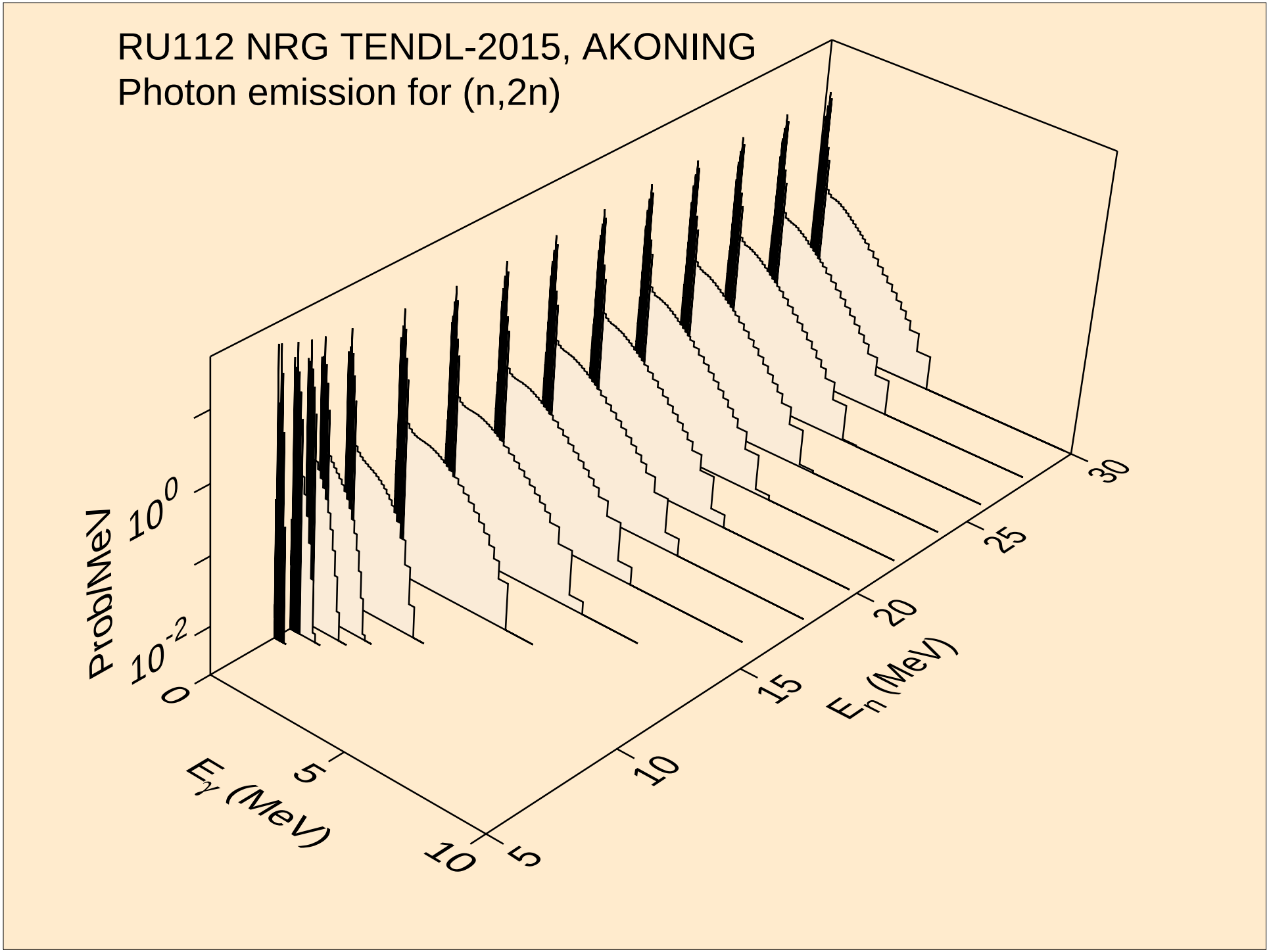

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,2np)
Prob/MeV
10-1
10-3
0
2
4
6
Sec. Energy
20
22
24
26
28
30
Energy (MeV)

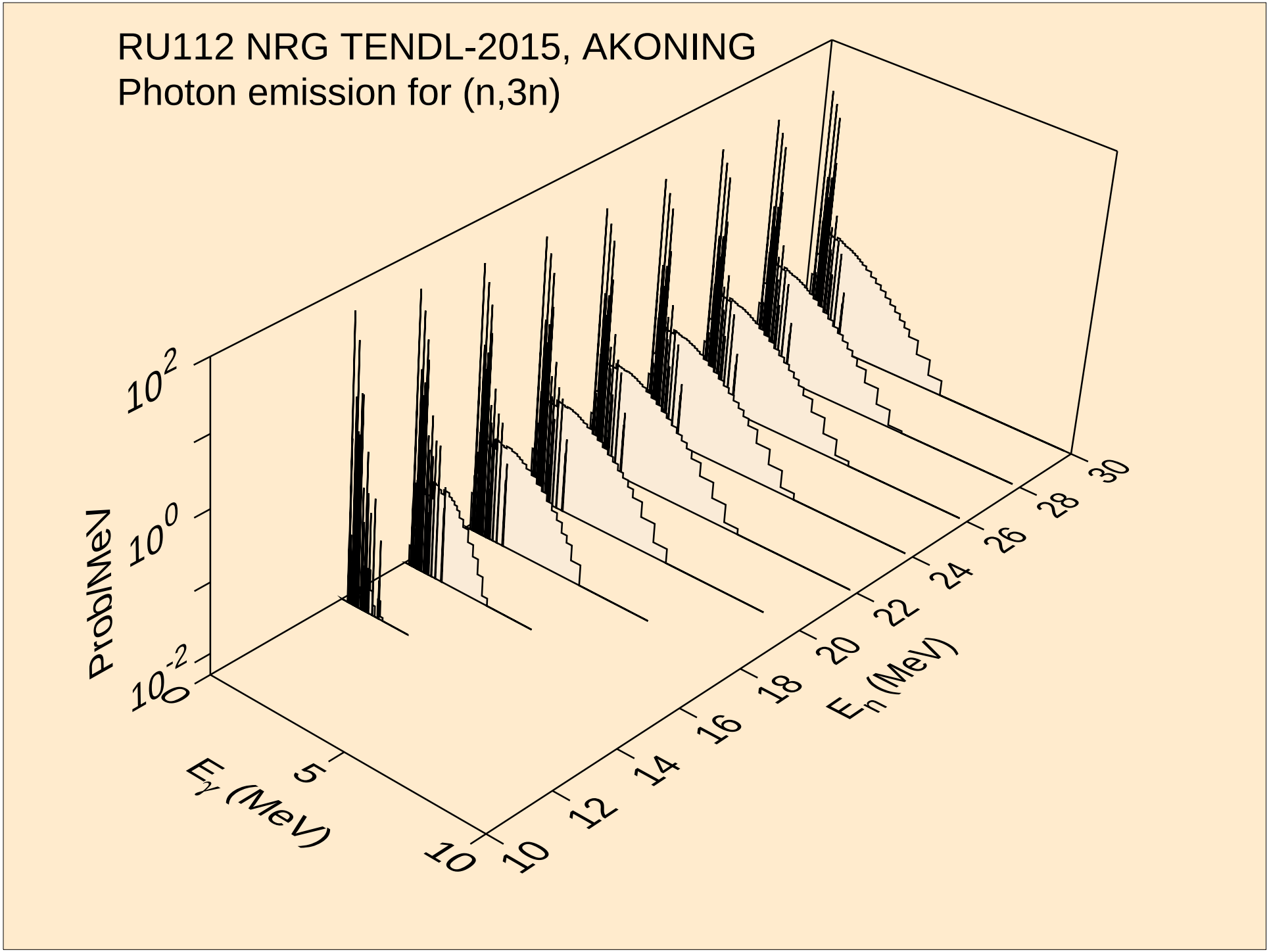

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,3np)
Prob/MeV
10-1
10-3
0
1
2
3
Sec. Energy
25
26
27
28
29
30
Energy (MeV)

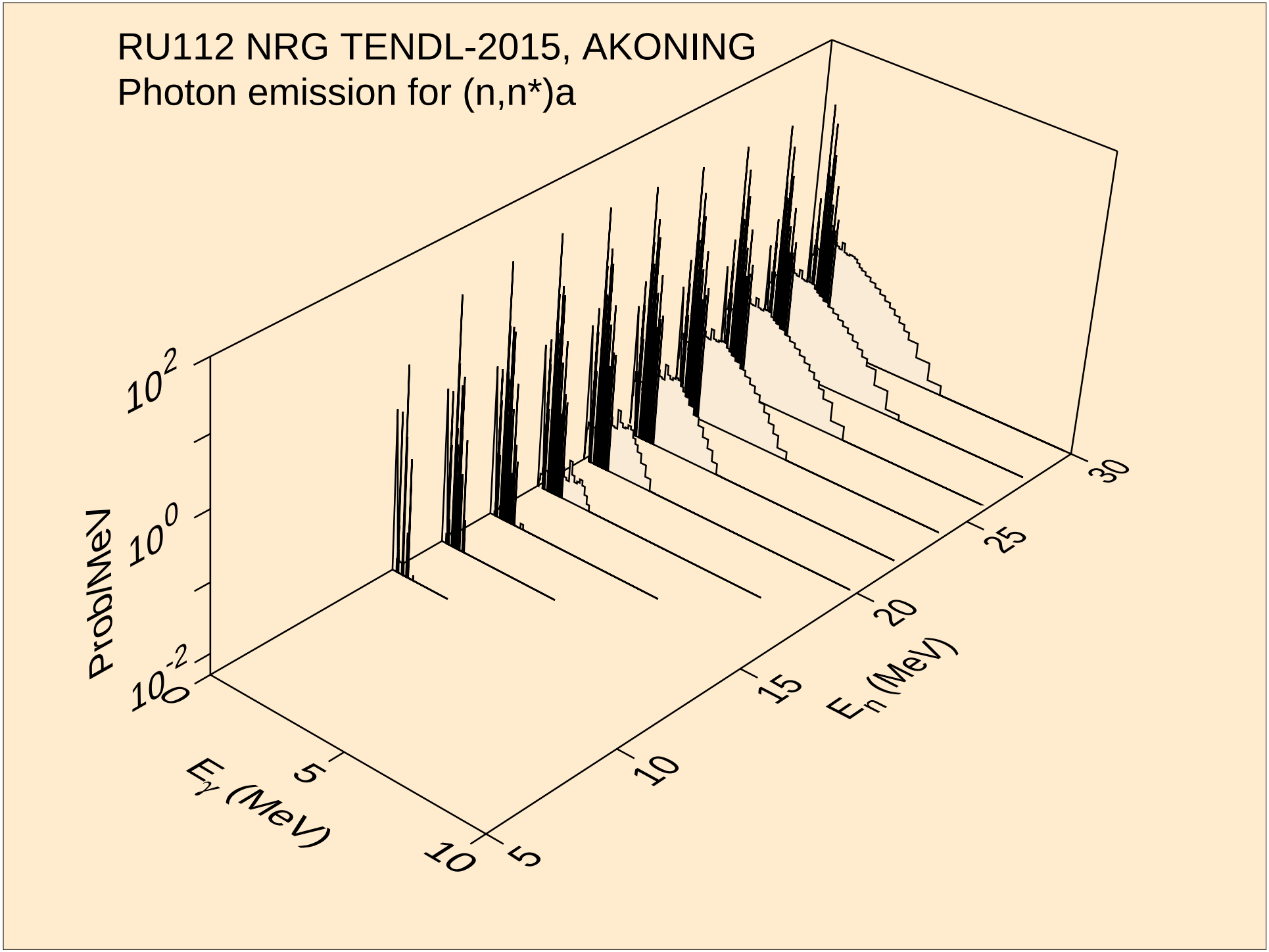

RU112 NRG TENDL-2015, AKONING
Neutron emission for (n,n*c)
Prob/MeV
10^3
10^1
0
10
20
30
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

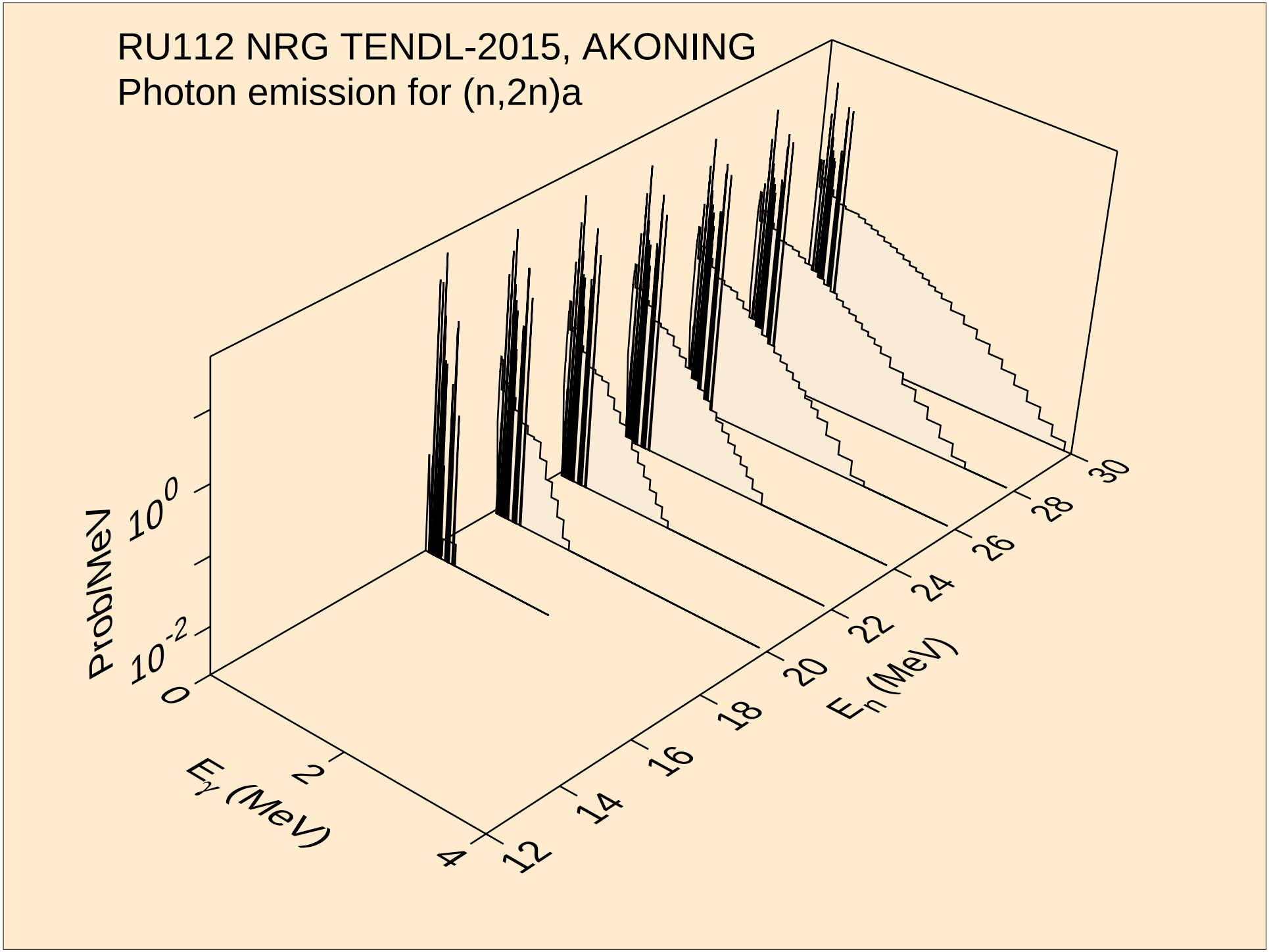

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,x)
Prob/MeV
10^{0}
10^{-2}
0
20
40
E_γ (MeV)
0
50
100
150
200
E_n (MeV)

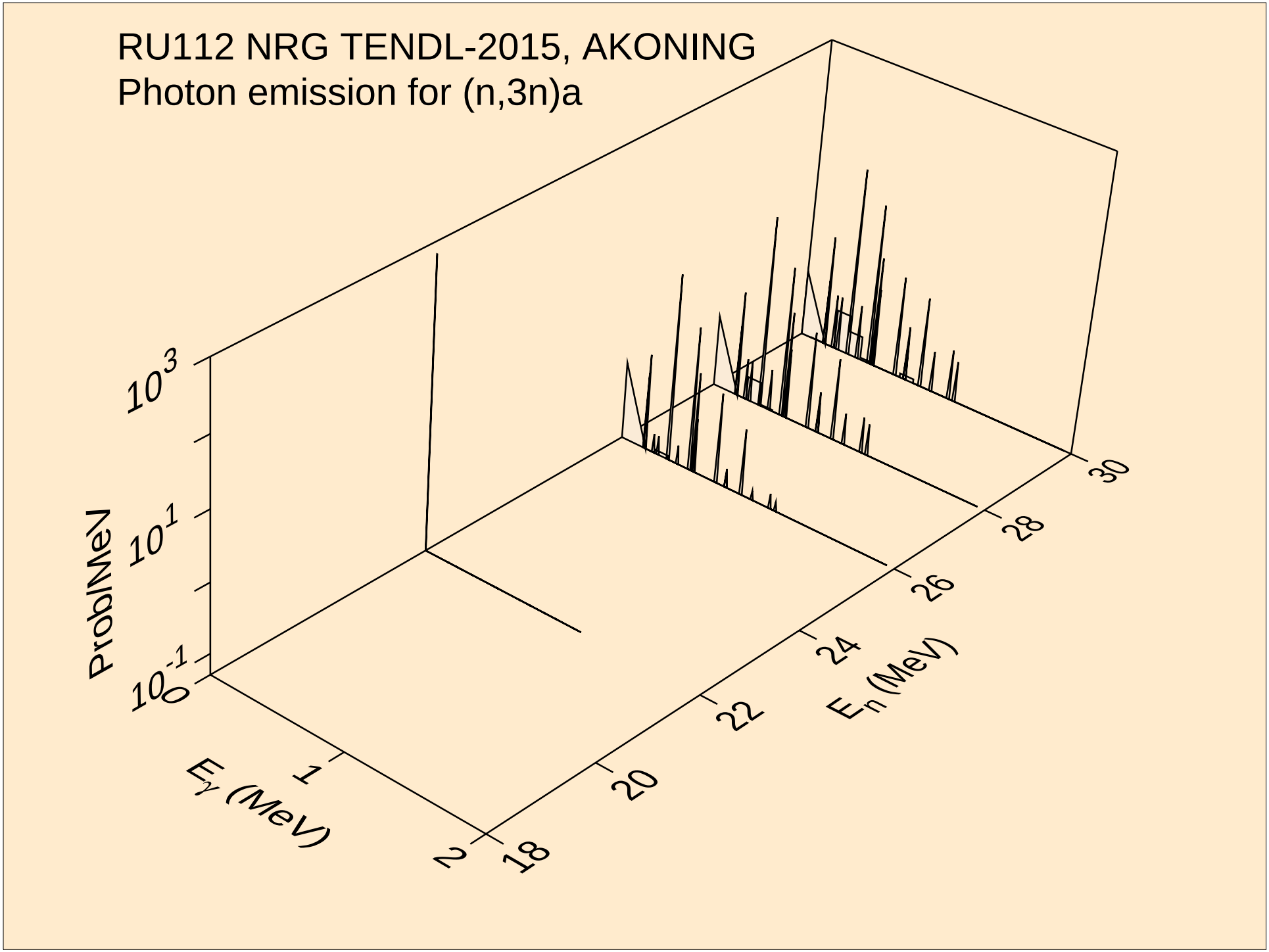

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,2nd)
Prob/MeV
10^{0}
10^{-2}
0
2
4
E_γ (MeV)
20
40
60
80
100
120
140
160
180
200
E_n (MeV)

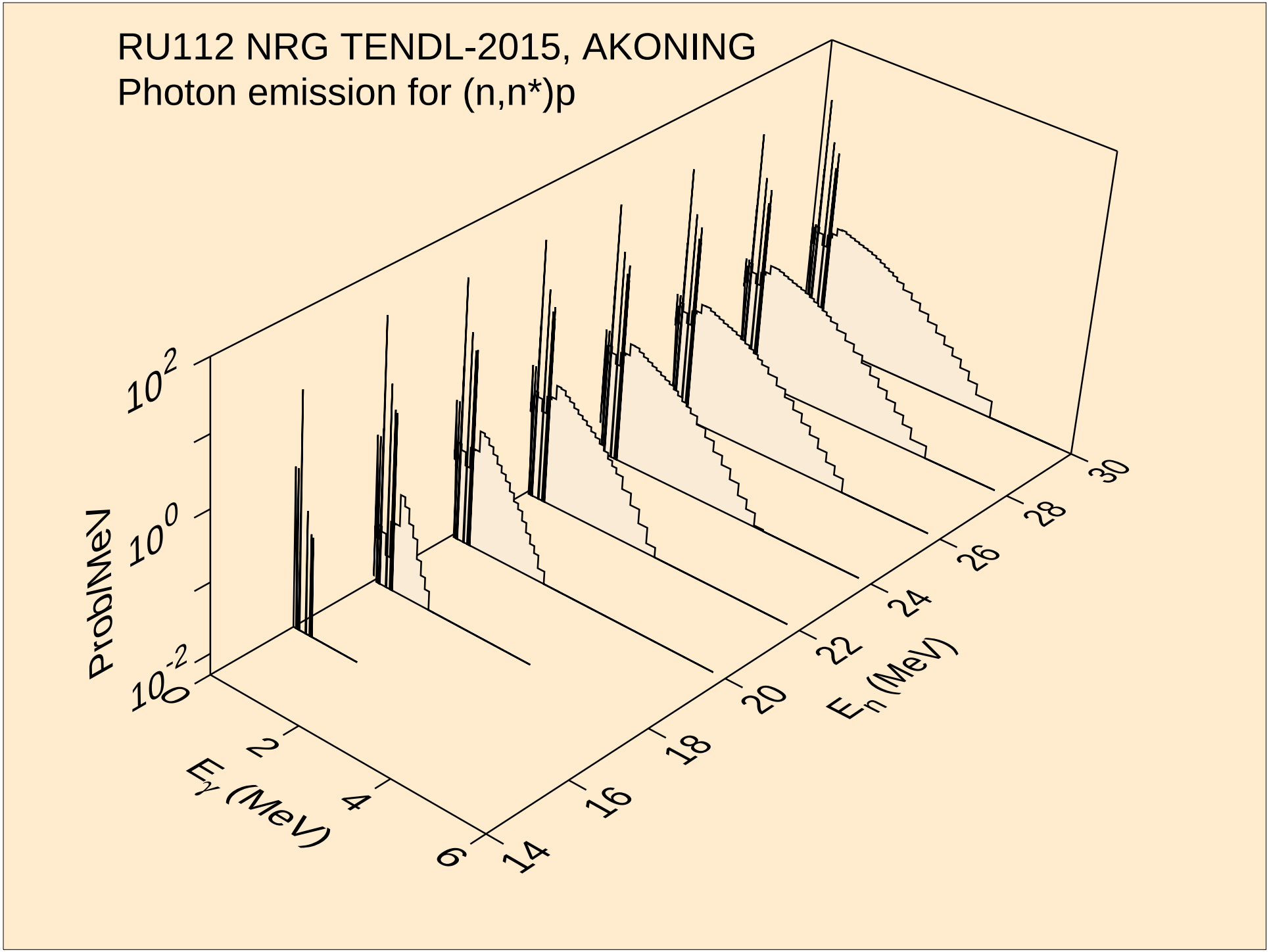

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,2n)
Prob/MeV
10^0
10^-2
0
5
10
E_γ (MeV)
5
10
15
20
25
30
E_n (MeV)

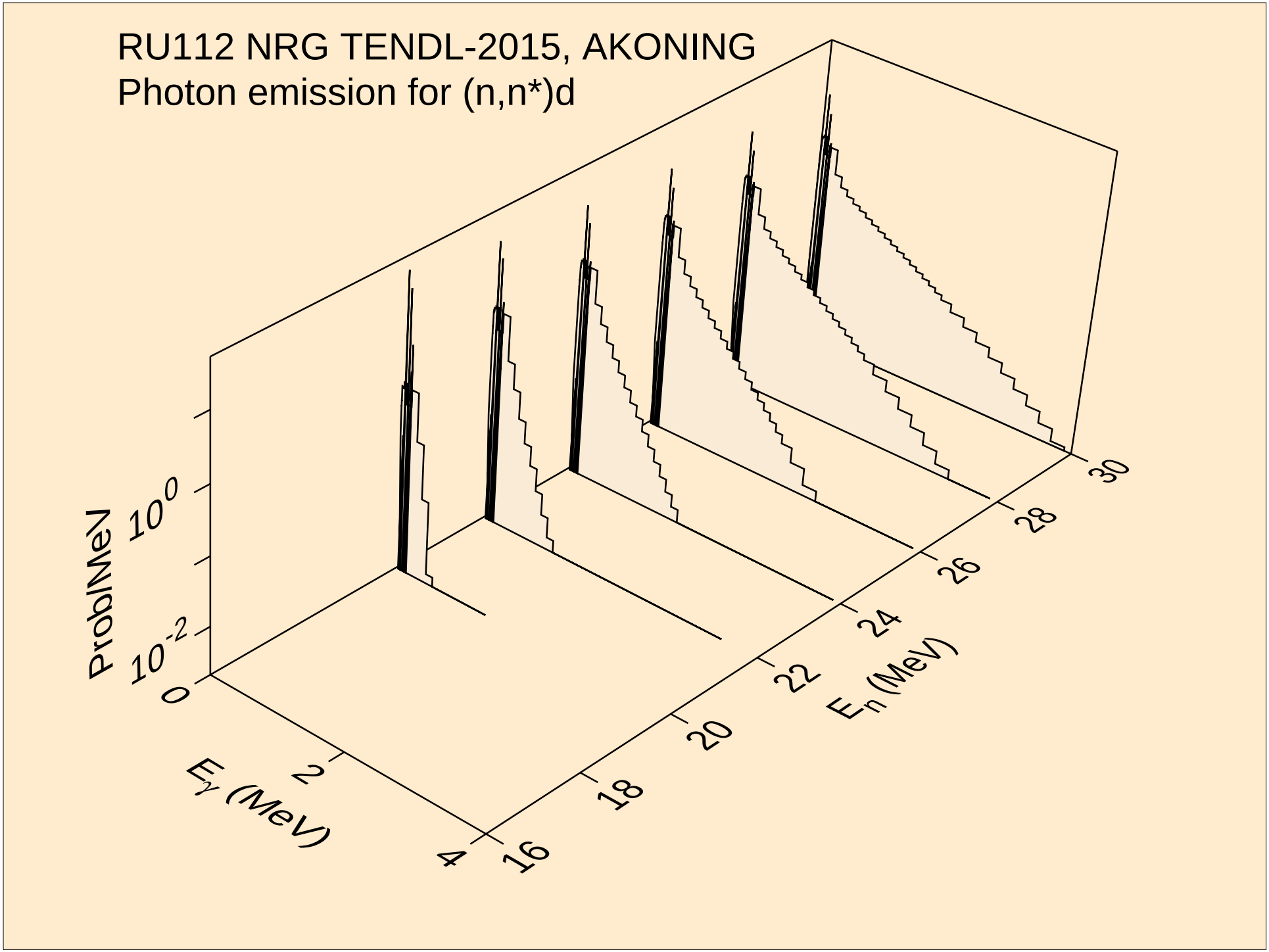

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,3n)
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
5
10
E_γ (MeV)
10
12
14
16
18
20
22
24
26
28
30
E_n (MeV)

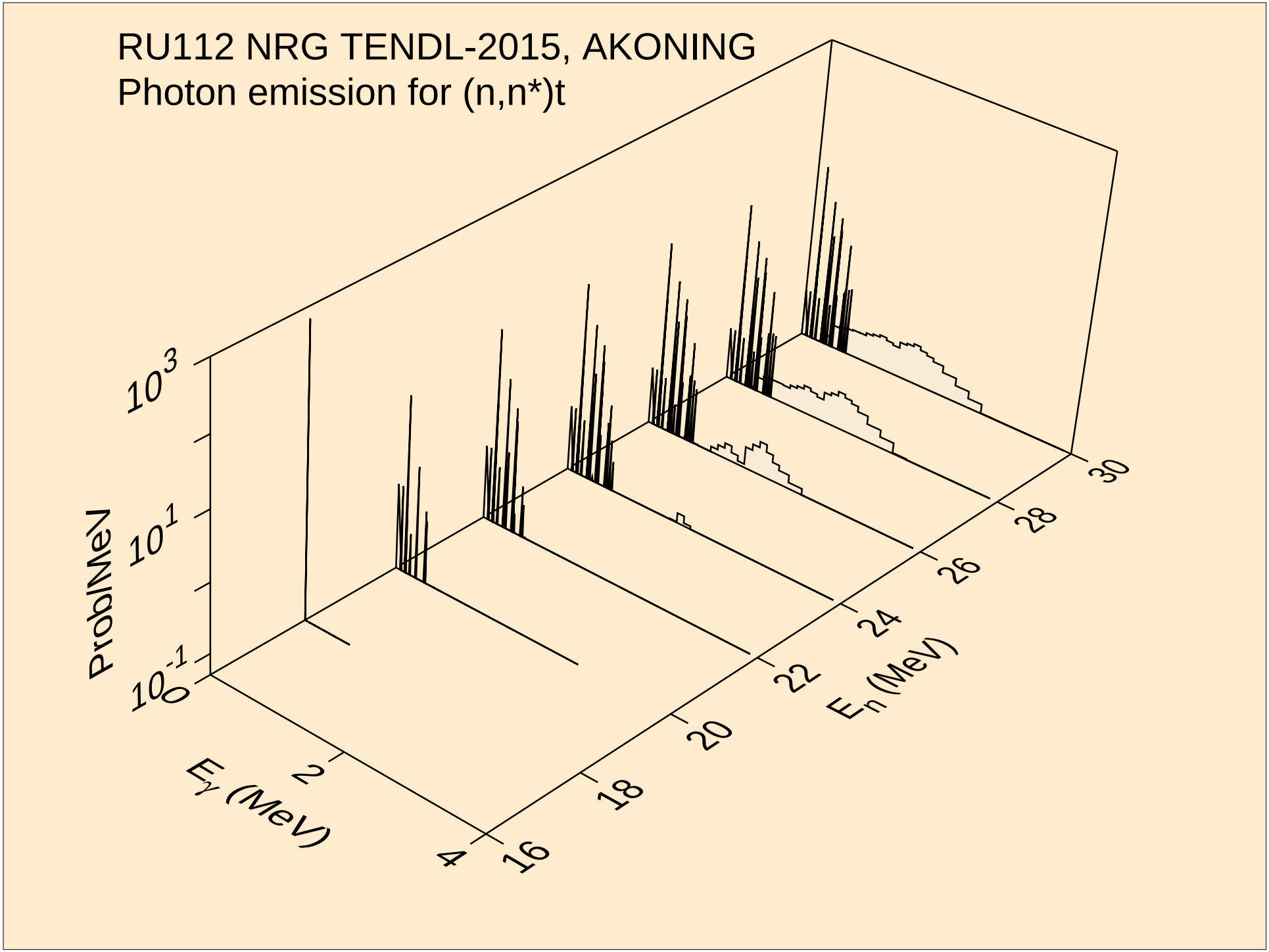

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,n*)a
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
5
10
E_γ (MeV)
5
10
15
20
25
30
E_n (MeV)

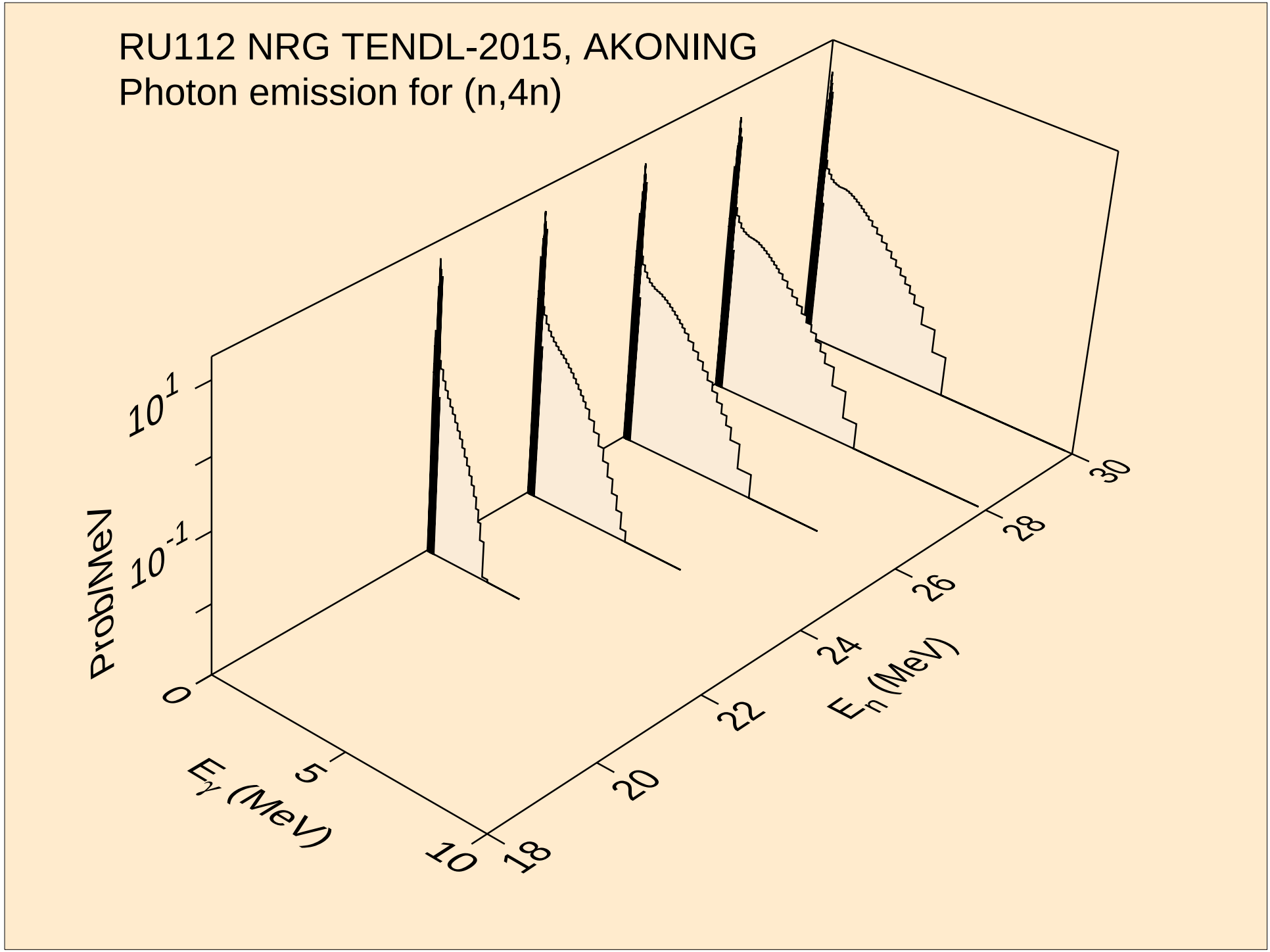

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,2n)a
Prob/MeV
10^0
10^-2
0
2
4
E_γ (MeV)
12
14
16
18
20
22
24
26
28
30
E_n (MeV)

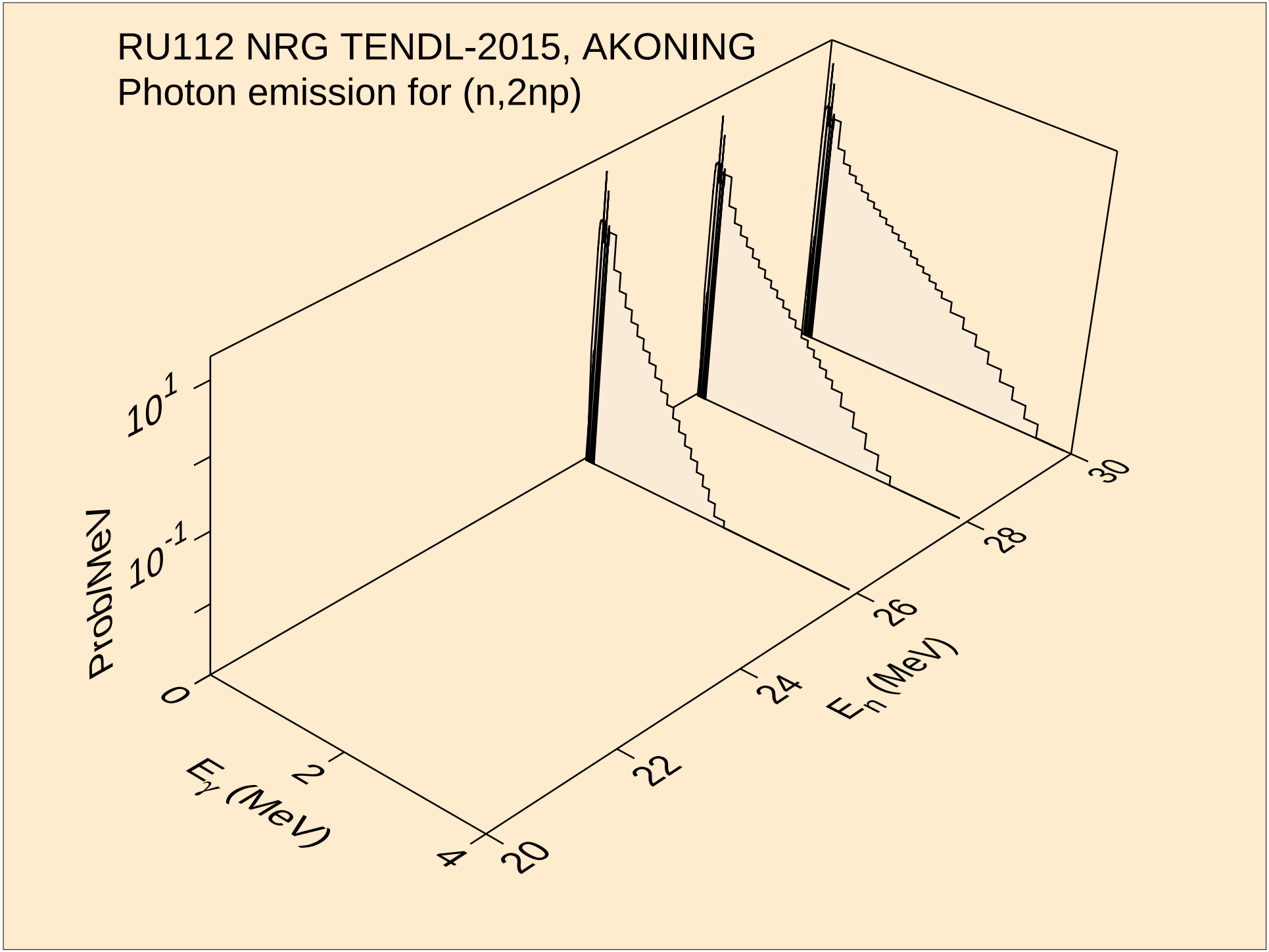

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,3n)a
Prob/MeV
10^{3}
10^{1}
10^{-1}
0
1
2
E_γ (MeV)
18
20
22
24
26
28
30
E_n (MeV)

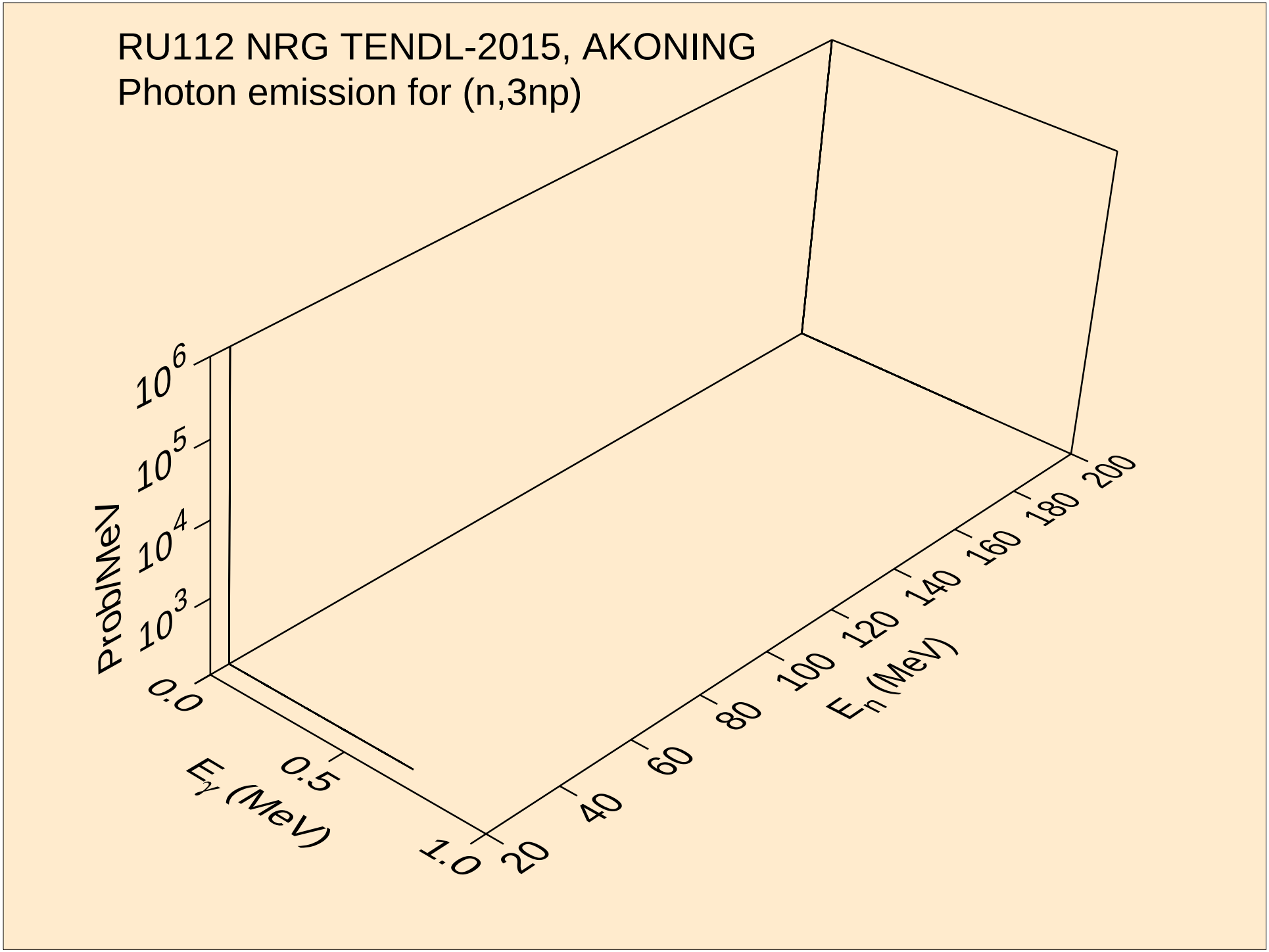

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,n*)p
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
2
4
6
E_γ (MeV)
14
16
18
20
22
24
26
28
30
E_n (MeV)

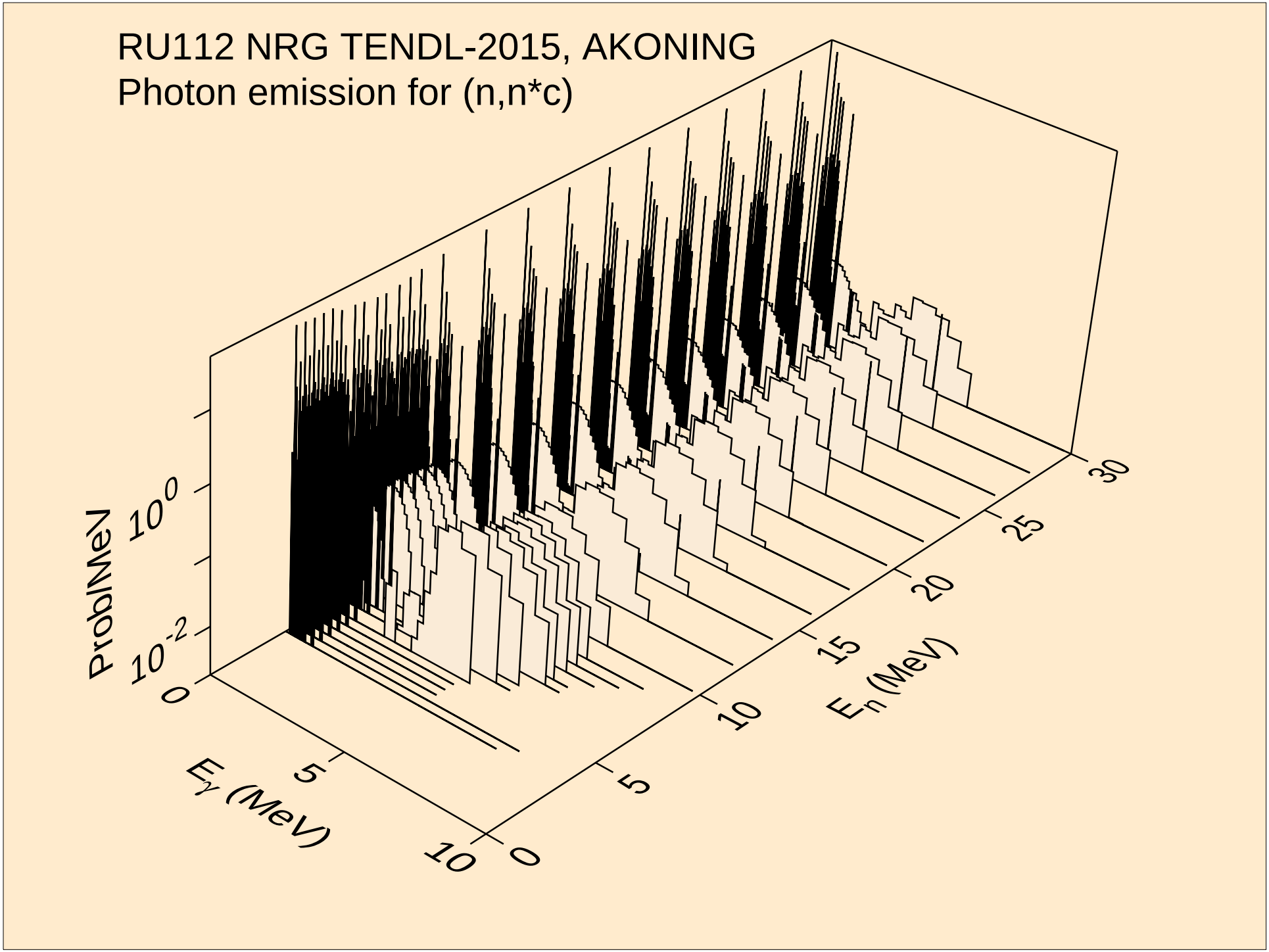

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,n*)d
Prob/MeV
10^0
10^-2
0
2
4
E_γ (MeV)
16
18
20
22
24
26
28
30
E_n (MeV)

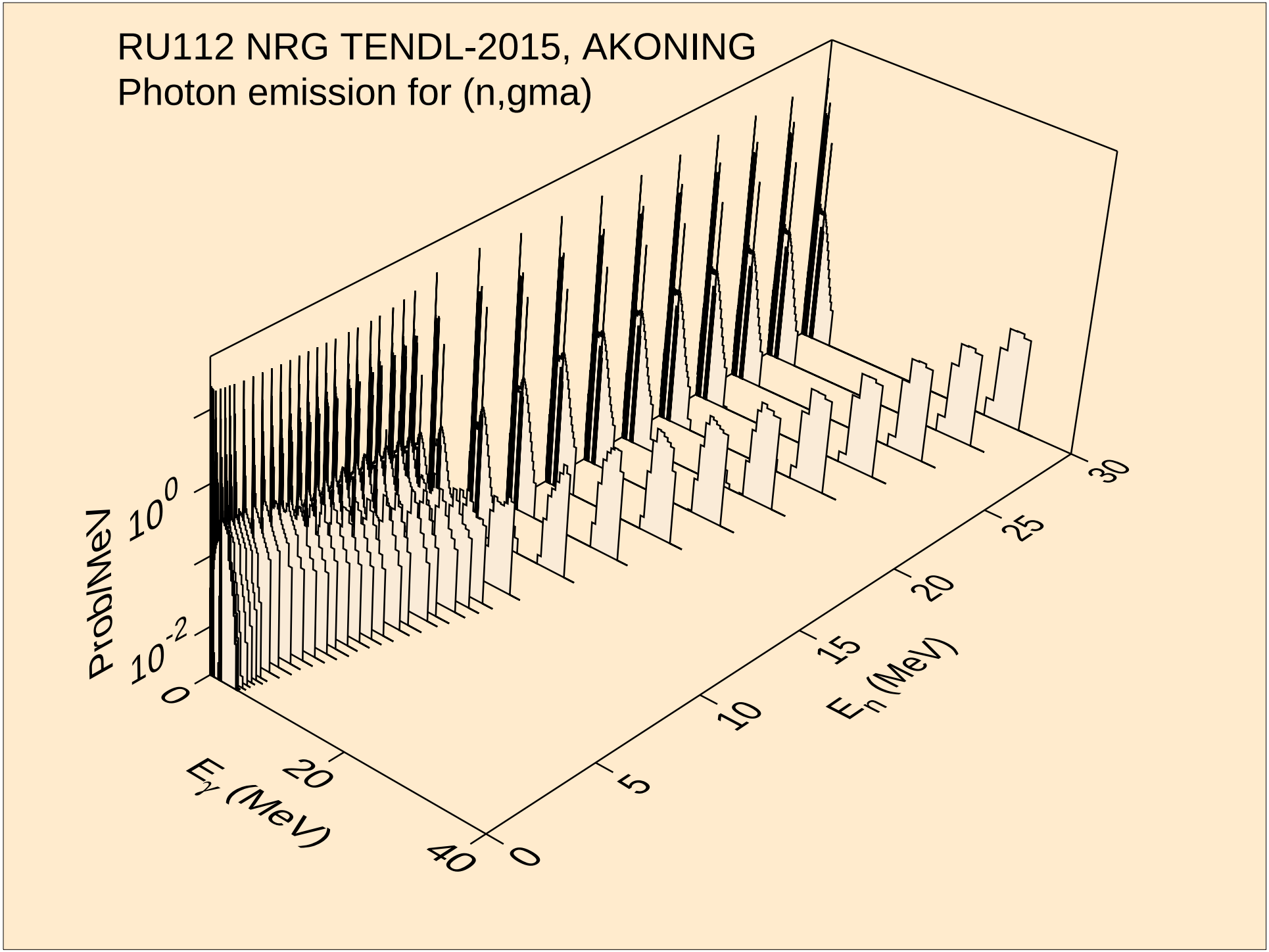

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,n*)t
Prob/MeV
10^{3}
10^{1}
10^{-1}
0
2
4
E_γ (MeV)
16
18
20
22
24
26
28
30
E_n (MeV)

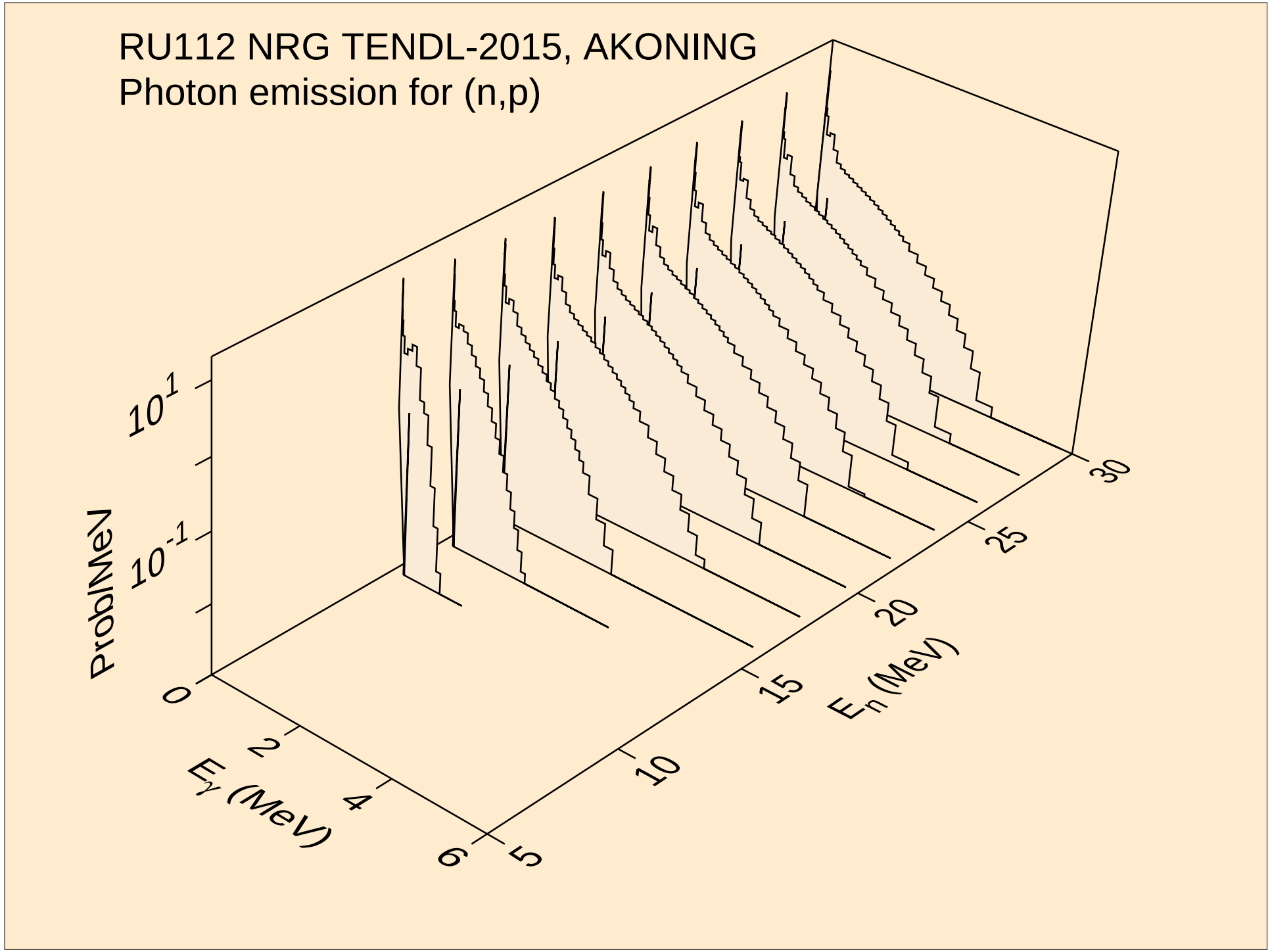

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,4n)
Prob/MeV
10^{1}
10^{-1}
0
5
10
E_γ (MeV)
18
20
22
24
26
28
30
E_n (MeV)

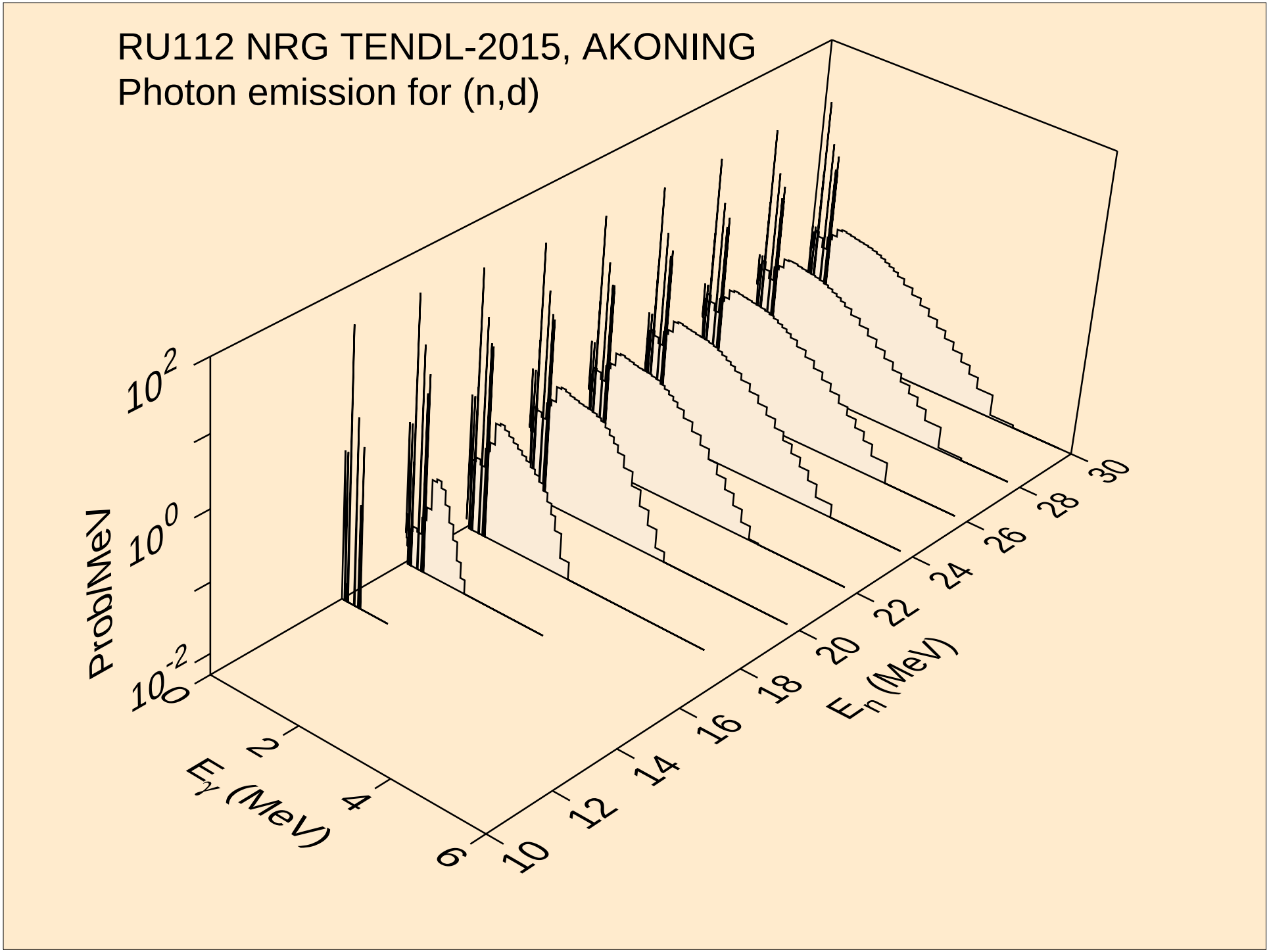

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,2np)
Prob/MeV
10^1
10^-1
0
2
4
E_γ (MeV)
20
22
24
26
28
30
E_n (MeV)

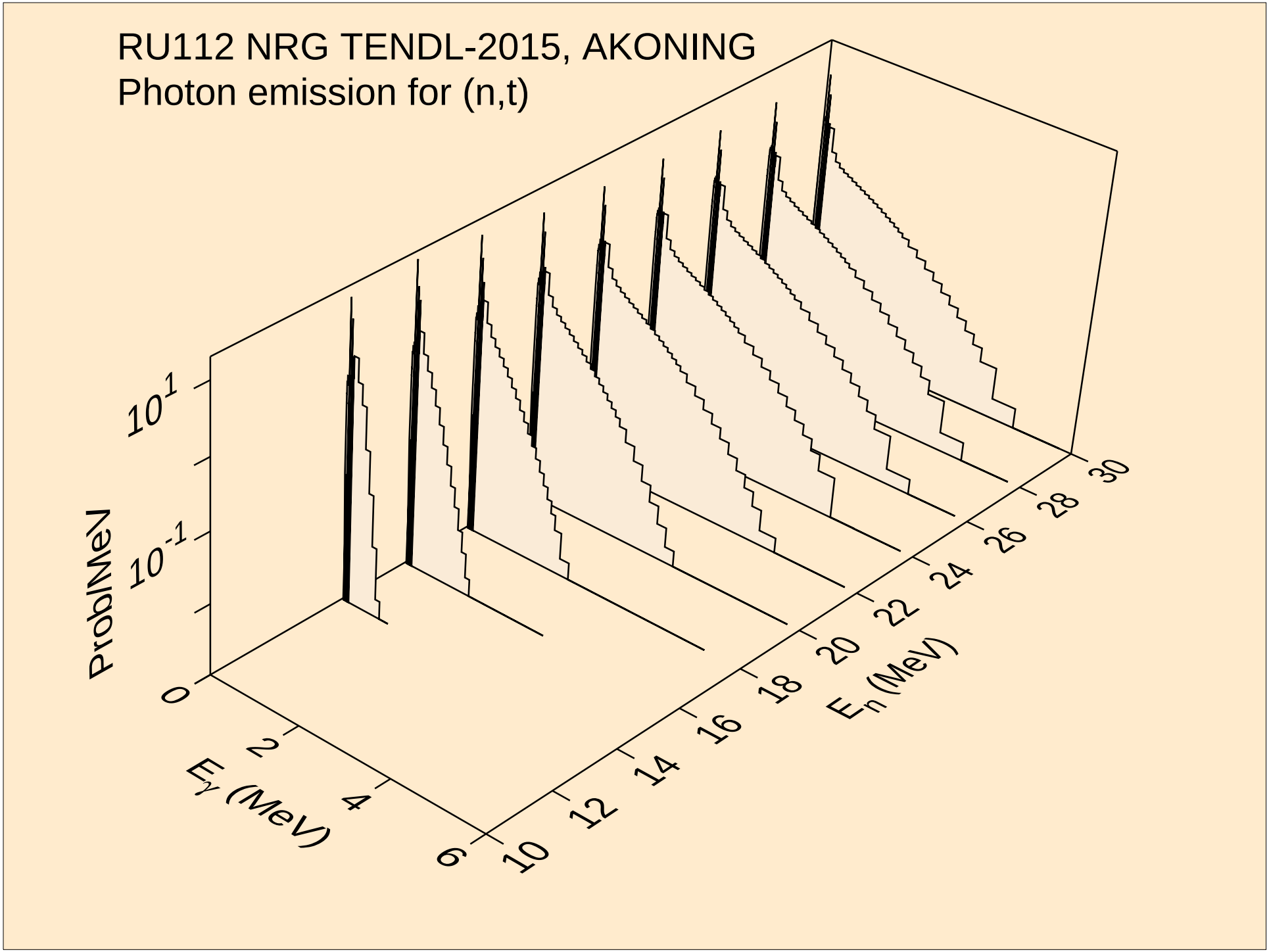

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,3np)
Prob/MeV
10^6
10^5
10^4
10^3
0.0
0.5
1.0
E_γ (MeV)
20
40
60
80
100
120
140
160
180
200
E_n (MeV)

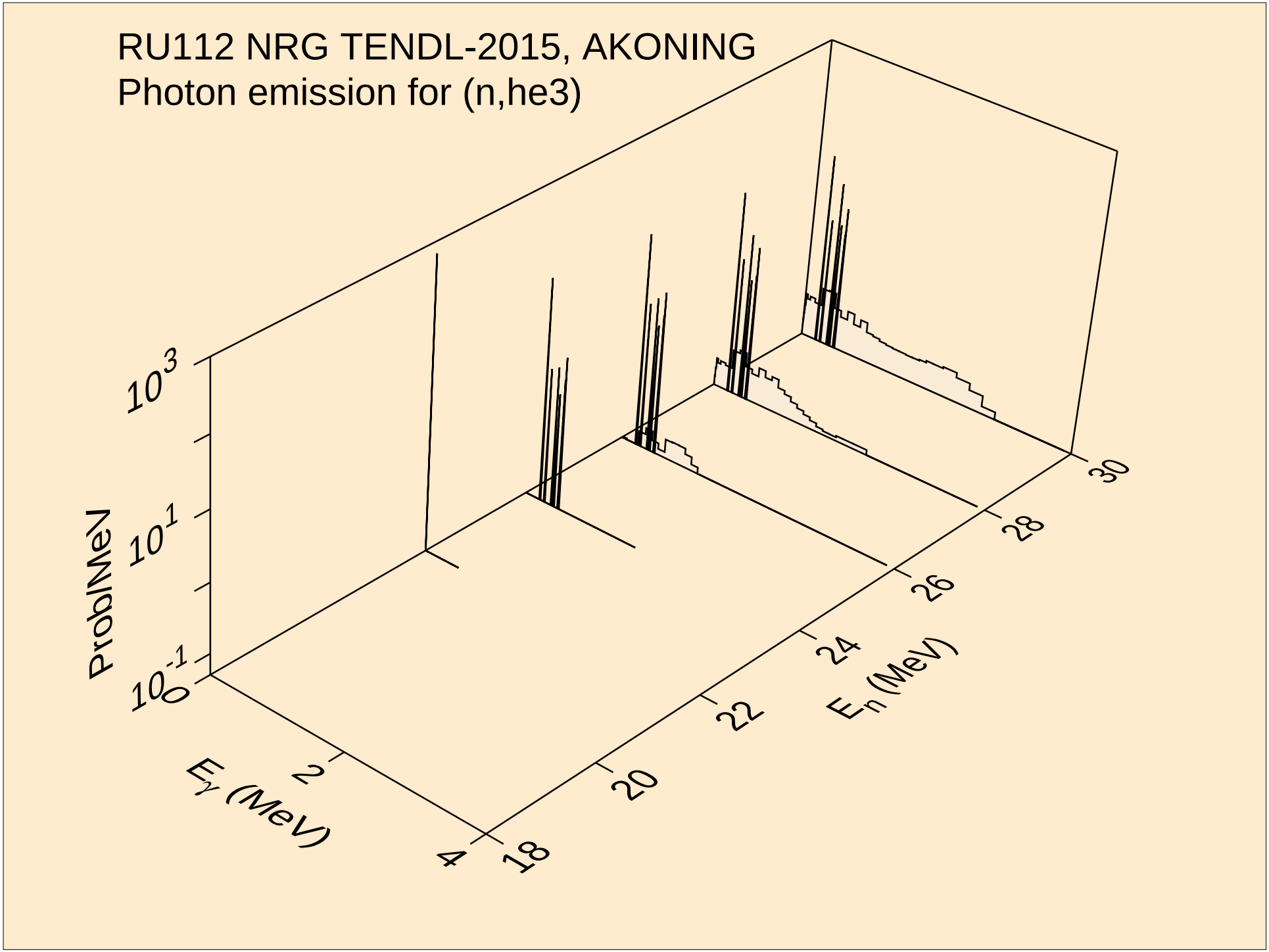

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,n*c)
Prob/MeV
10^0
10^-2
0
5
10
E_γ (MeV)
0
5
10
15
20
25
30
E_n (MeV)

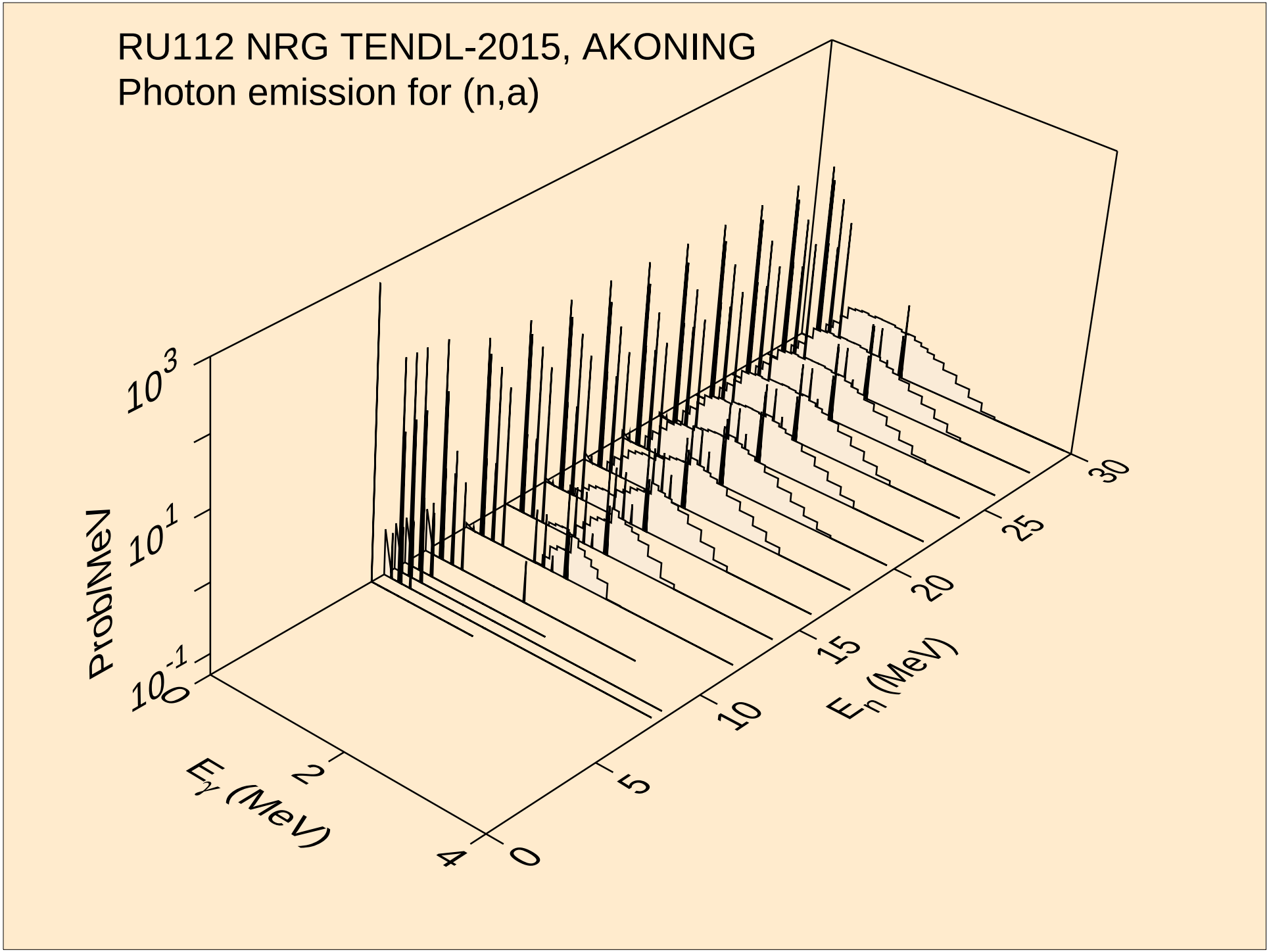

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,gma)
Prob/MeV
10^0
10^-2
0
20
40
Eγ (MeV)
0
5
10
15
20
25
30
En (MeV)

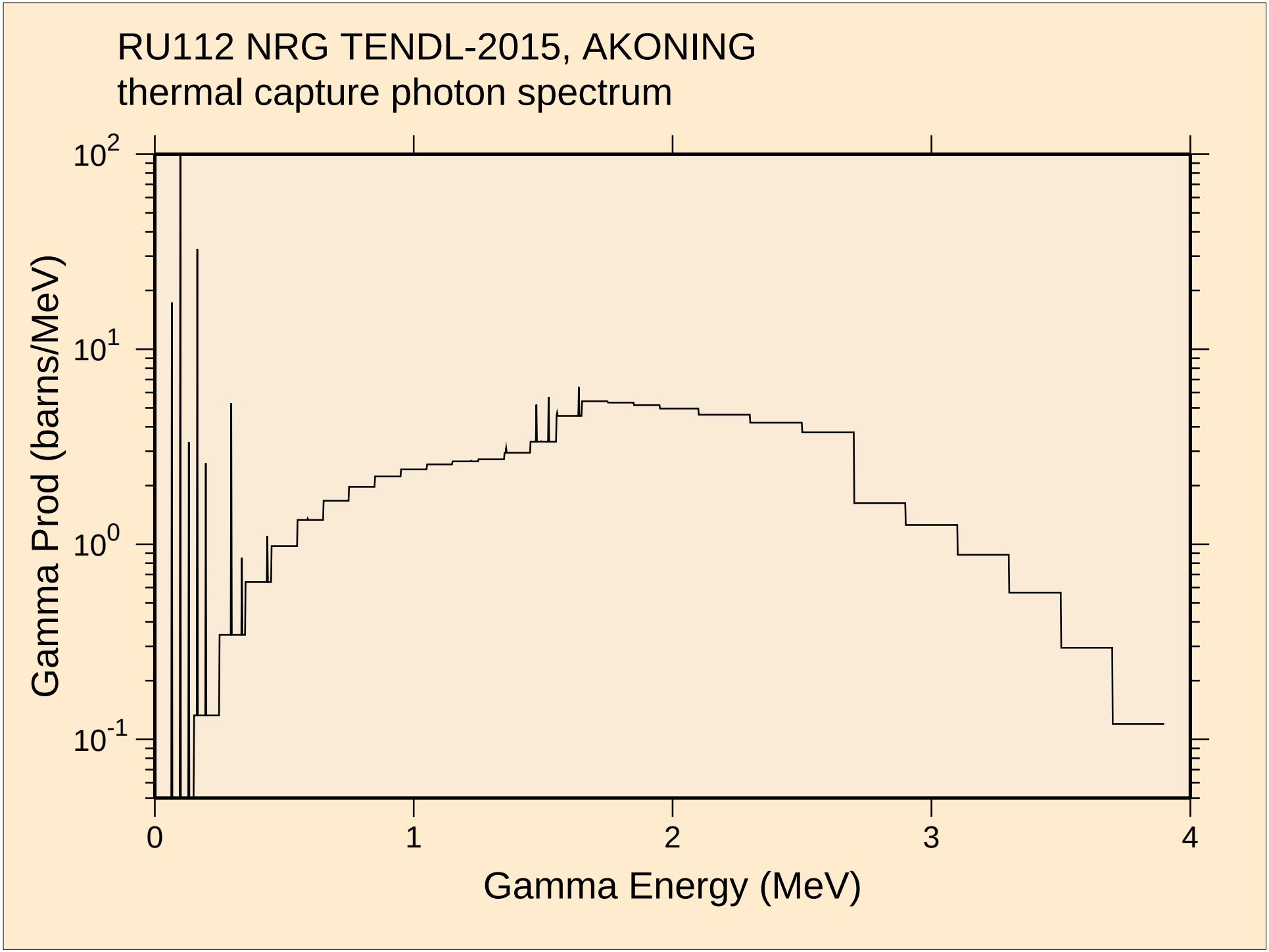

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,p)
Prob/MeV
10^{1}
10^{-1}
0
2
4
6
E_γ (MeV)
5
10
15
20
25
30
E_n (MeV)

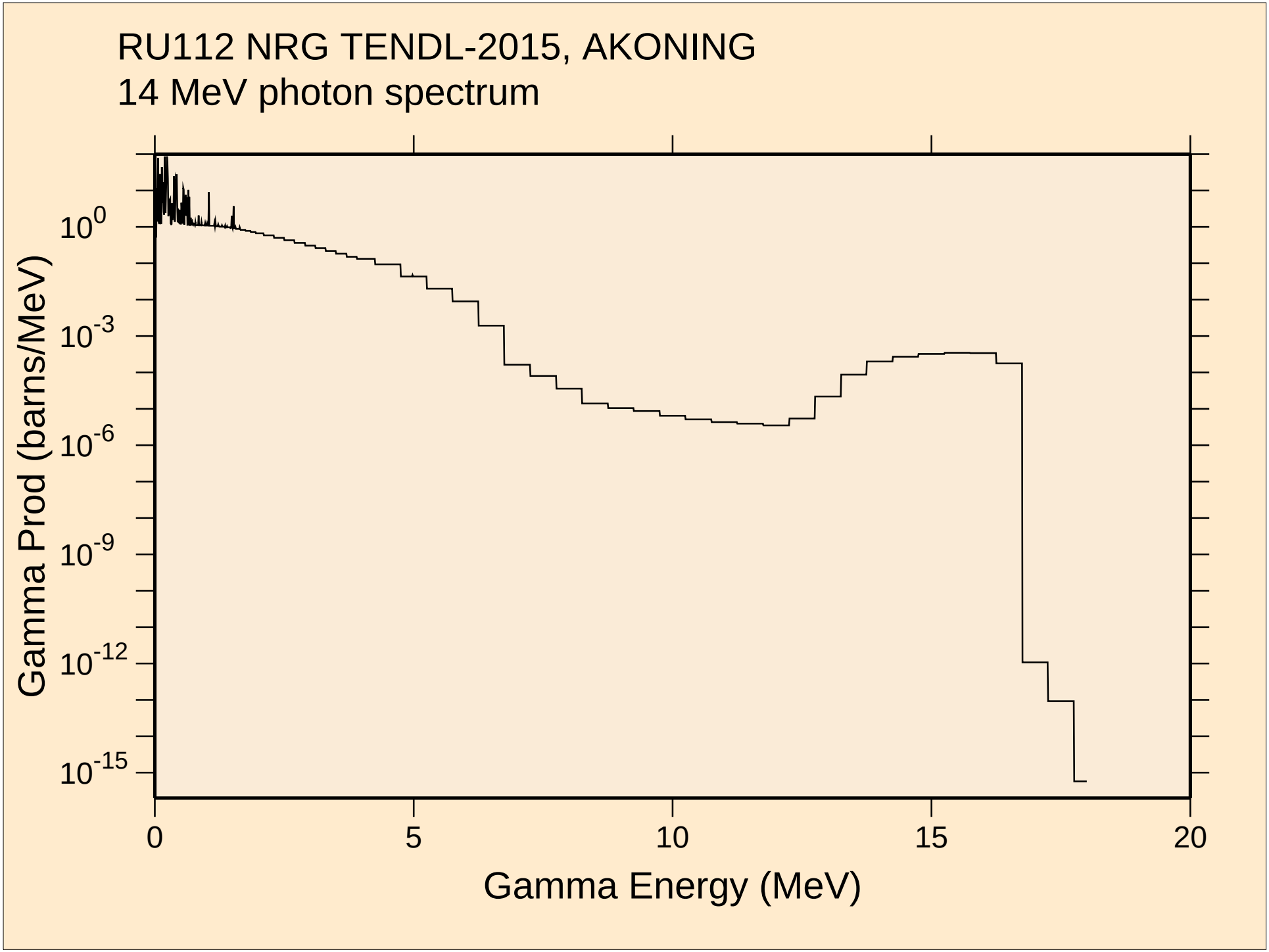

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,d)
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
2
4
6
E_γ (MeV)
10
12
14
16
18
20
22
24
26
28
30
E_n (MeV)

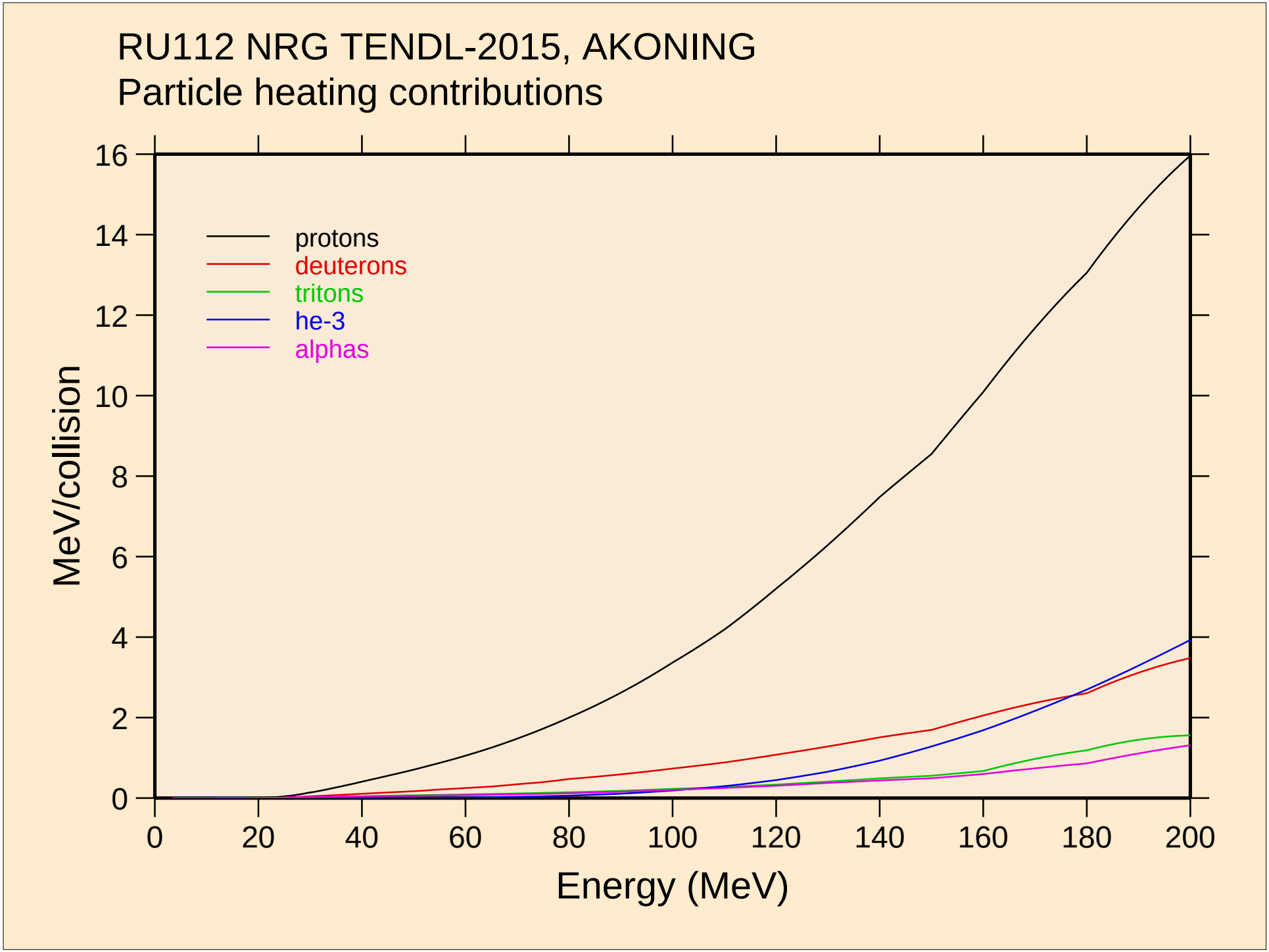

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,t)
Prob/MeV
10^{1}
10^{-1}
0
2
4
6
E_γ (MeV)
10
12
14
16
18
20
22
24
26
28
30
E_n (MeV)

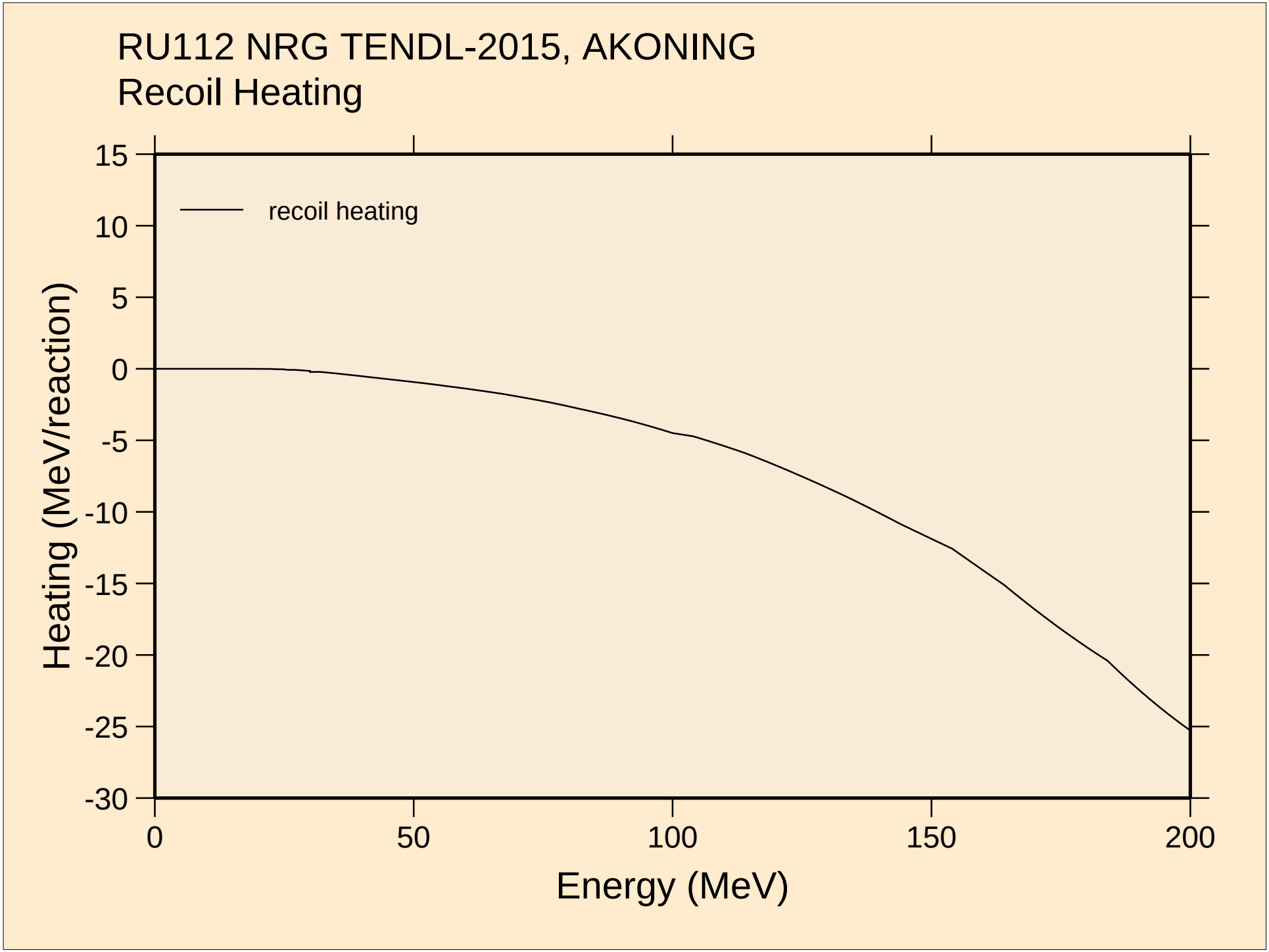

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,he3)
Prob/MeV
10^{3}
10^{1}
10^{-1}
0
2
4
E_γ (MeV)
18
20
22
24
26
28
30
E_n (MeV)

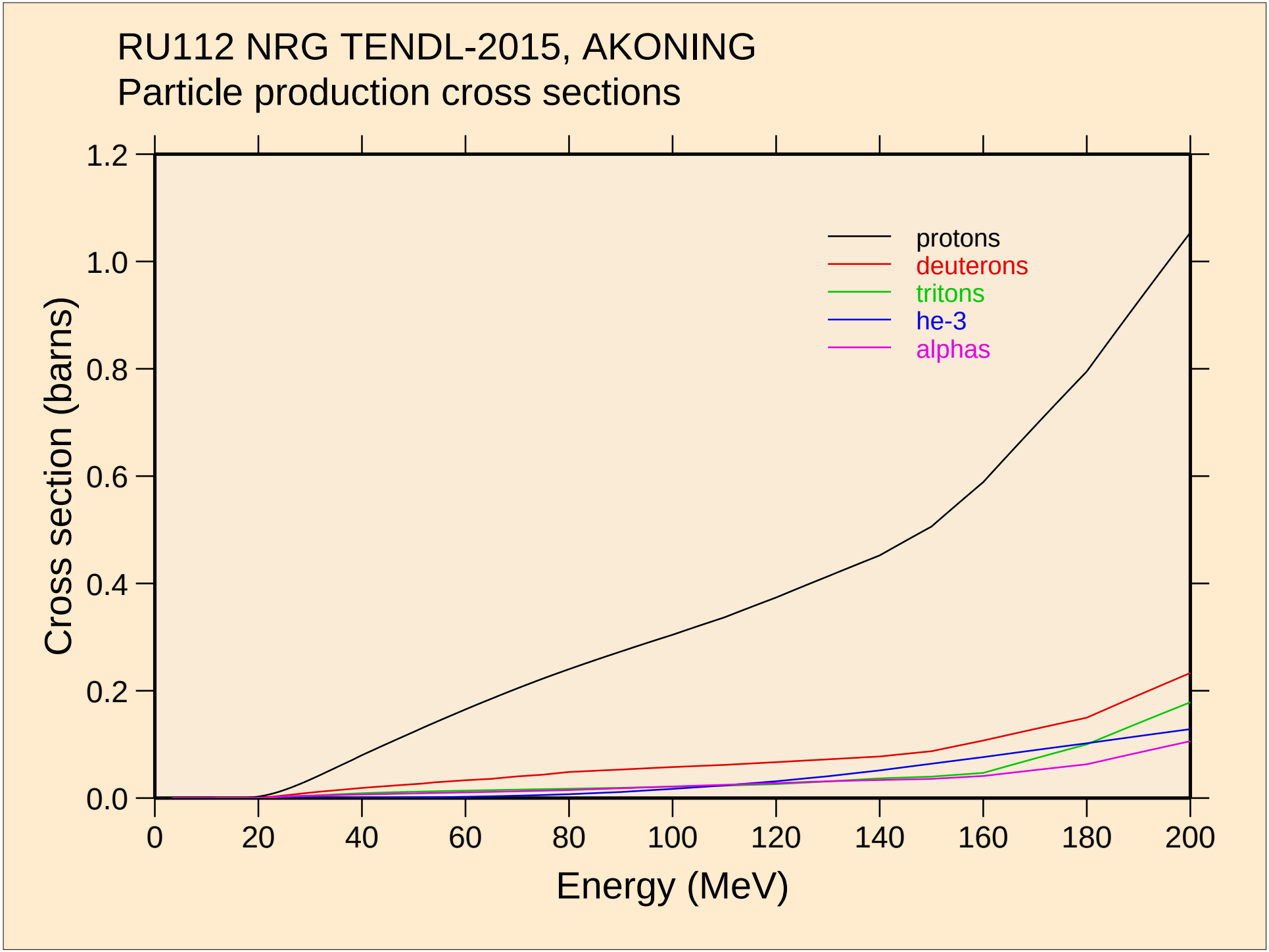

RU112 NRG TENDL-2015, AKONING
Photon emission for (n,a)
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

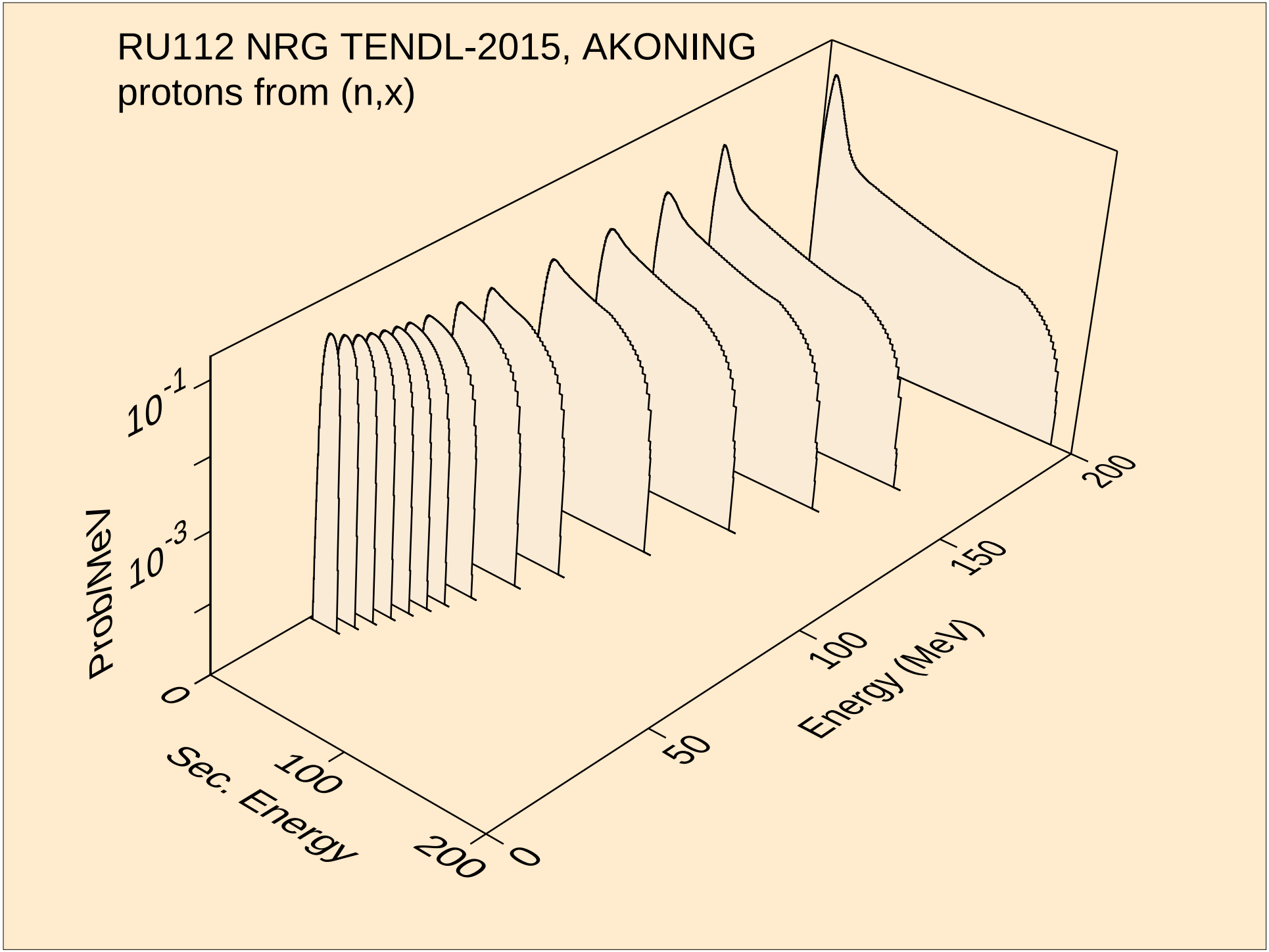

RU112 NRG TENDL-2015, AKONING
thermal capture photon spectrum
Gamma Prod (barns/MeV)
10^2
10^1
10^0
10^{-1}
0
1
2
3
4
Gamma Energy (MeV)

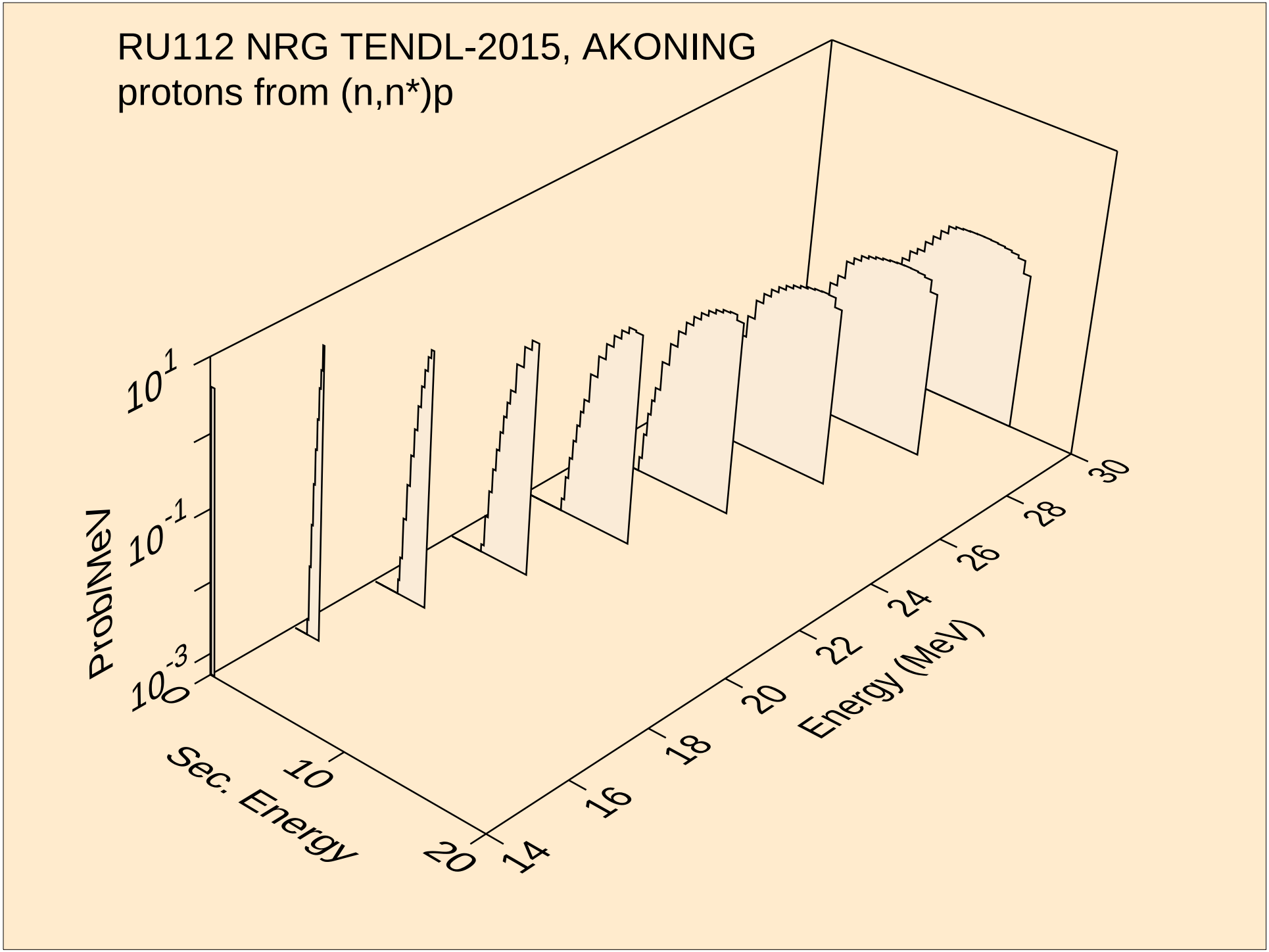

RU112 NRG TENDL-2015, AKONING
14 MeV photon spectrum
Gamma Prod (barns/MeV)
10^0
10^-3
10^-6
10^-9
10^-12
10^-15
0
5
10
15
20
Gamma Energy (MeV)

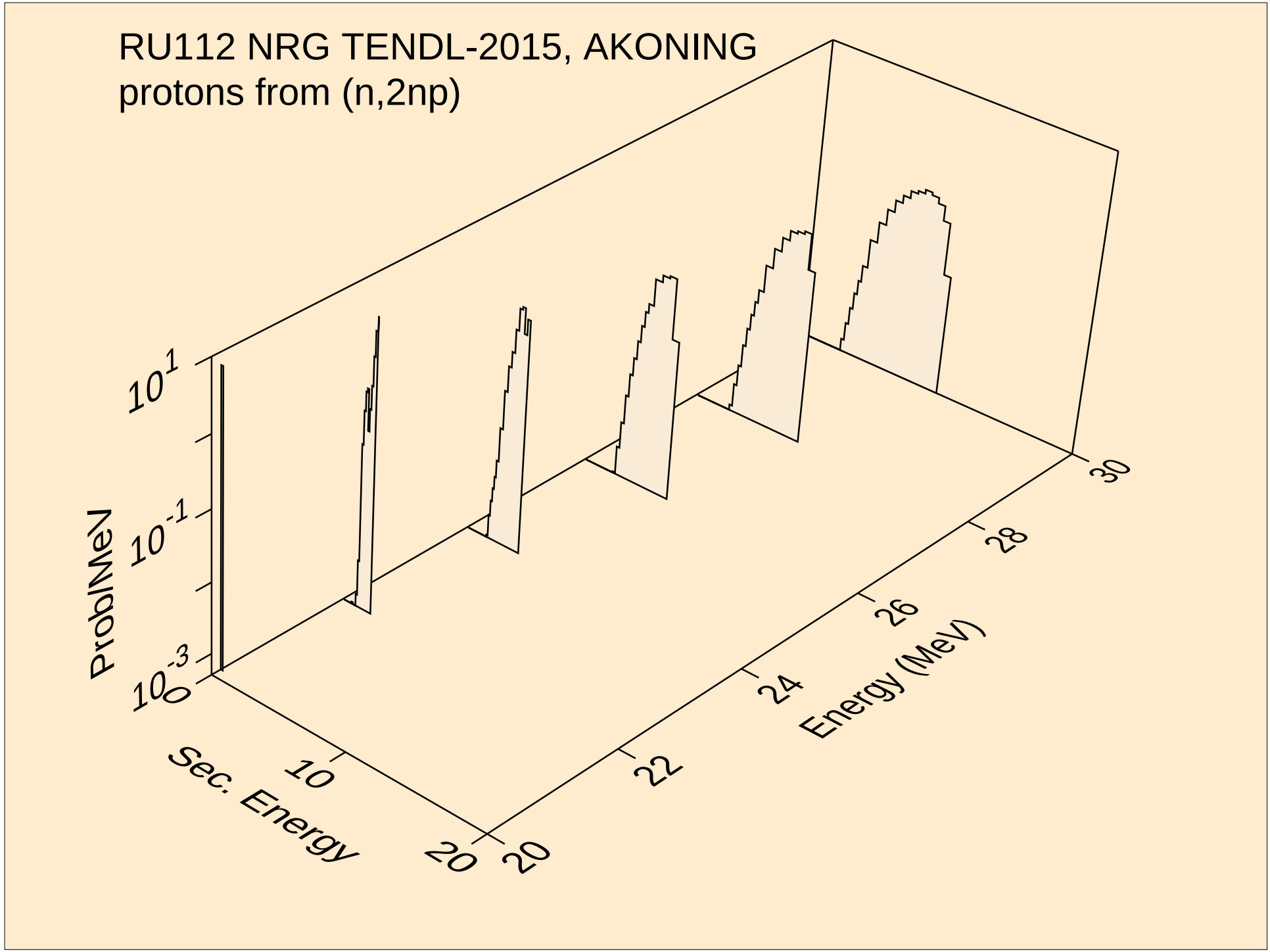

RU112 NRG TENDL-2015, AKONING
Particle heating contributions
protons
deuterons
tritons
he-3
alphas
MeV/collision
Energy (MeV)
0
2
4
6
8
10
12
14
16
0
20
40
60
80
100
120
140
160
180
200

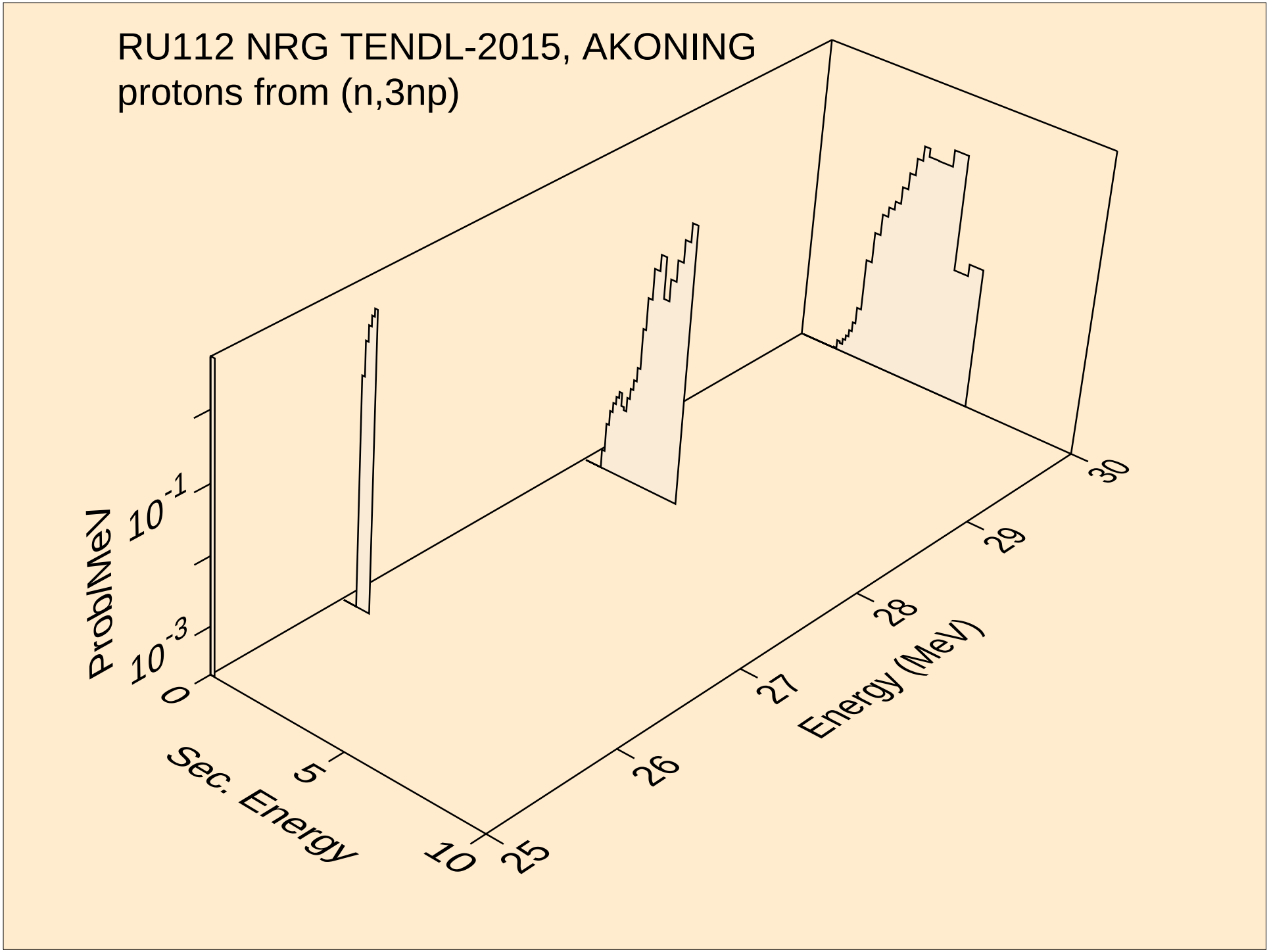

RU112 NRG TENDL-2015, AKONING
Recoil Heating
recoil heating
Heating (MeV/reaction)
15
10
5
0
-5
-10
-15
-20
-25
-30
0
50
100
150
200
Energy (MeV)

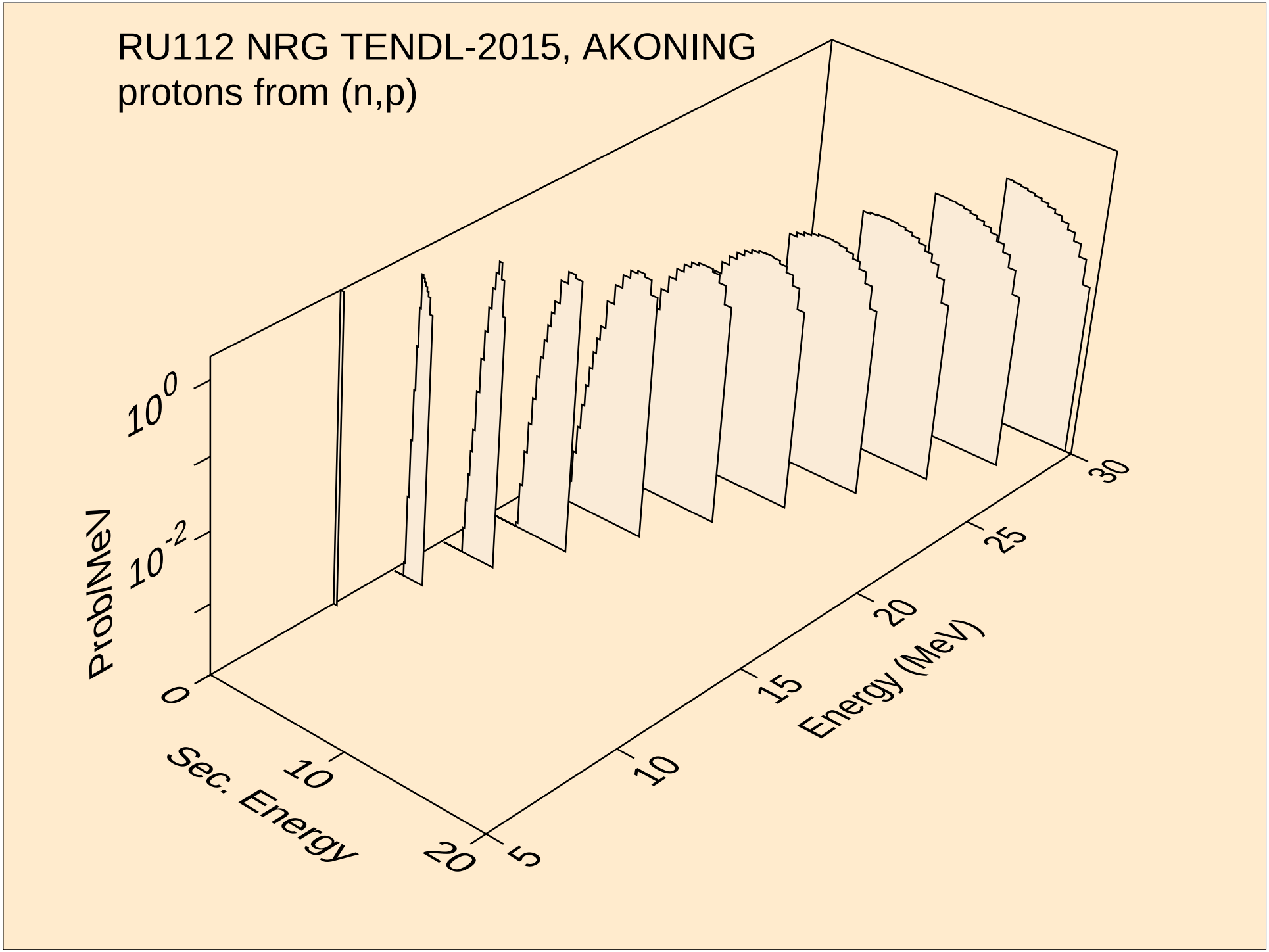

RU112 NRG TENDL-2015, AKONING
Particle production cross sections
Cross section (barns)
Energy (MeV)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
0
20
40
60
80
100
120
140
160
180
200
protons
deuterons
tritons
he-3
alphas

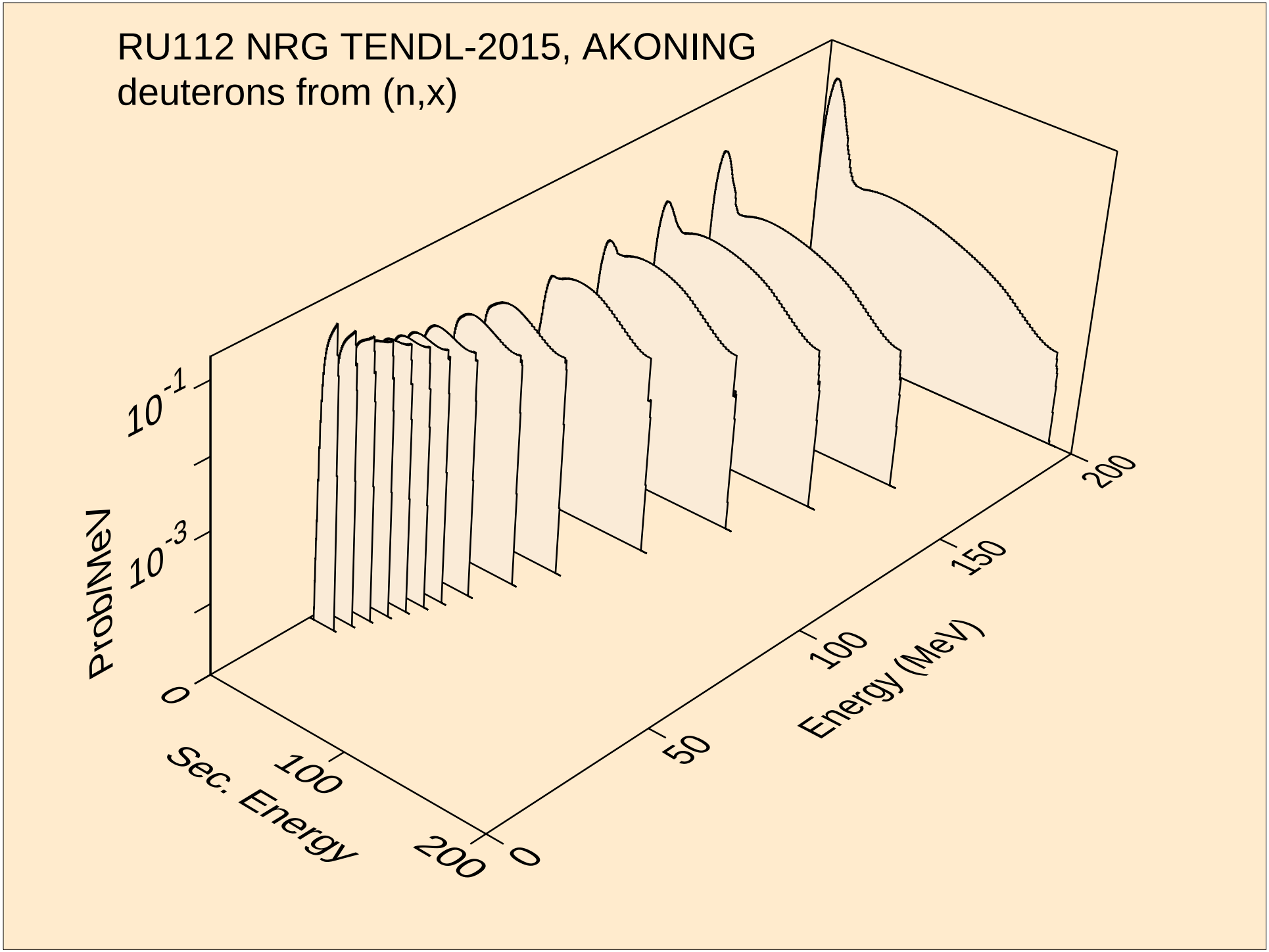

RU112 NRG TENDL-2015, AKONING
protons from (n,x)
Prob/MeV
10-1
10-3
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

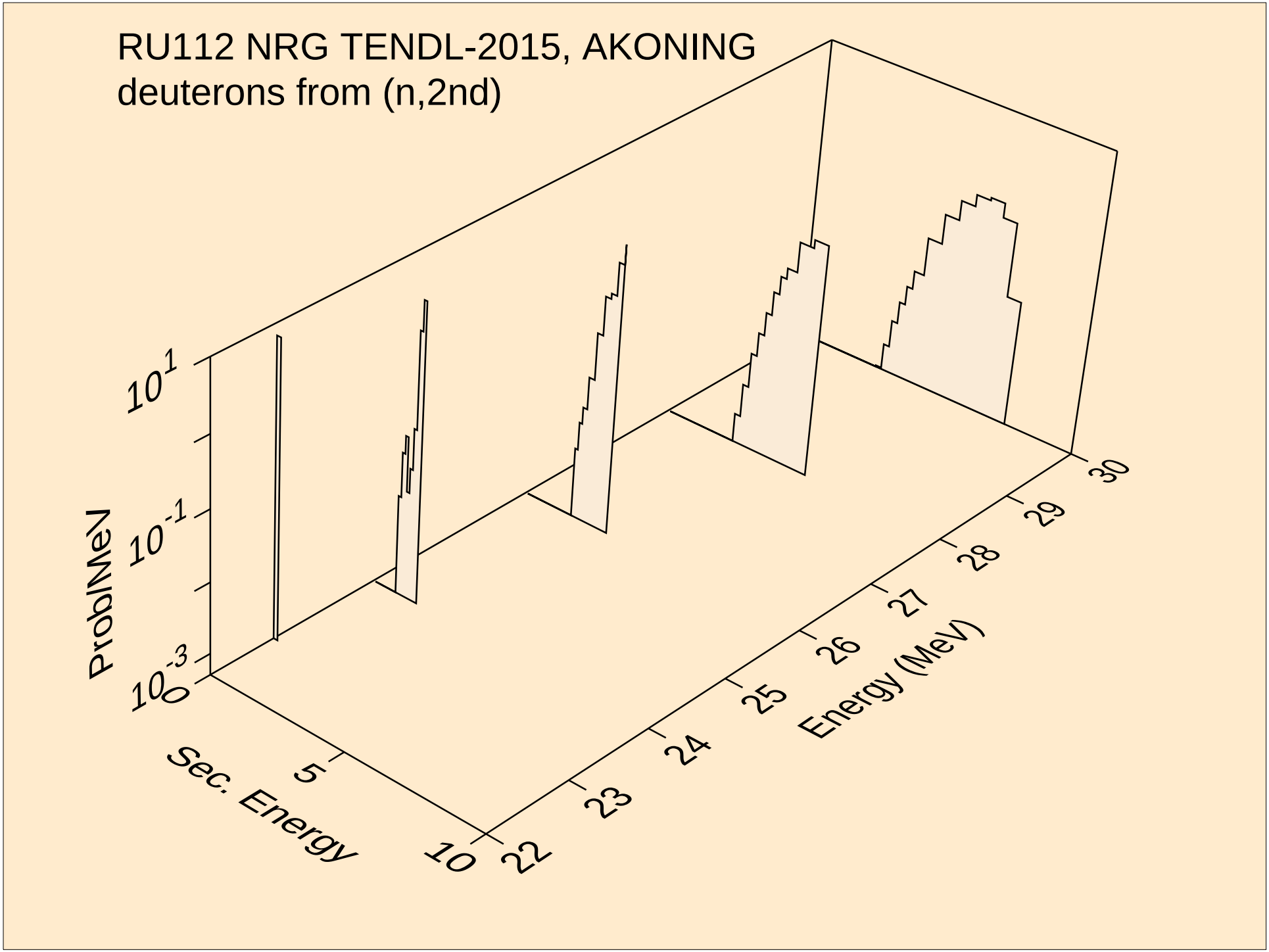

RU112 NRG TENDL-2015, AKONING
protons from (n,n*)p
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
10
20
Sec. Energy
14
16
18
20
22
24
26
28
30
Energy (MeV)

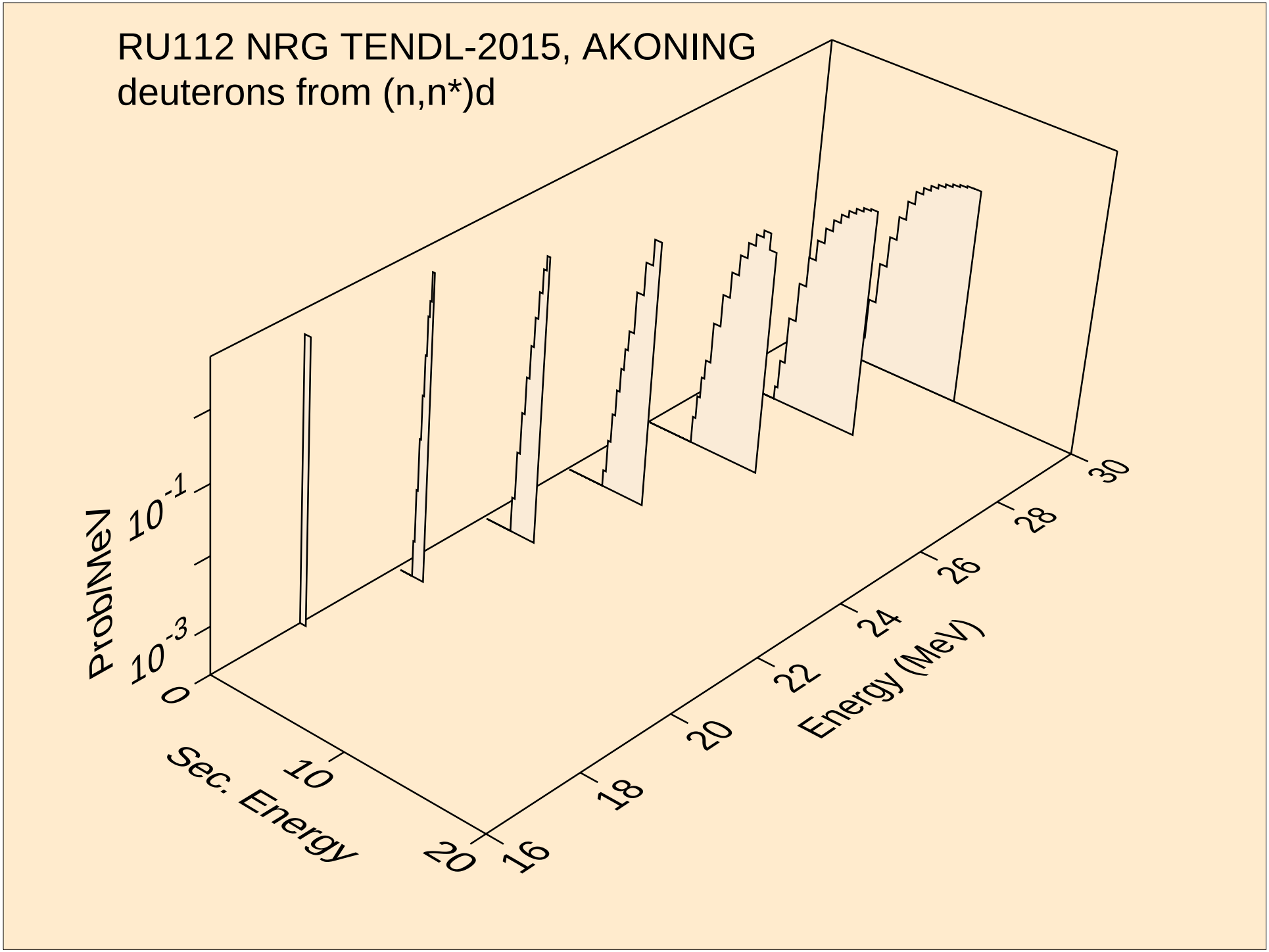

RU112 NRG TENDL-2015, AKONING
protons from (n,2np)
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
10
20
Sec. Energy
20
22
24
26
28
30
Energy (MeV)

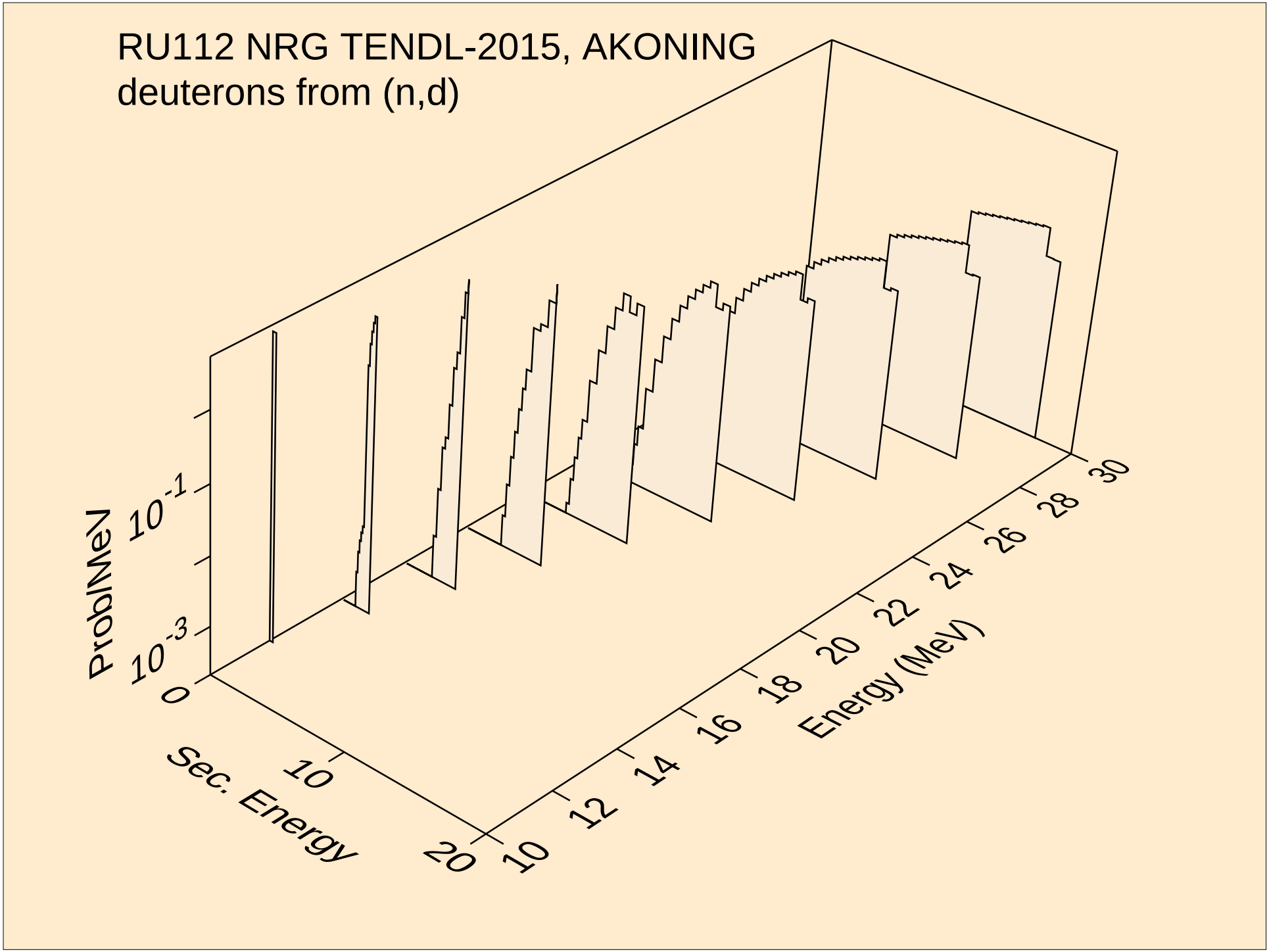

RU112 NRG TENDL-2015, AKONING
protons from (n,3np)
Prob/MeV
10-1
10-3
0
Sec. Energy
5
10
25
26
27
28
29
30
Energy (MeV)

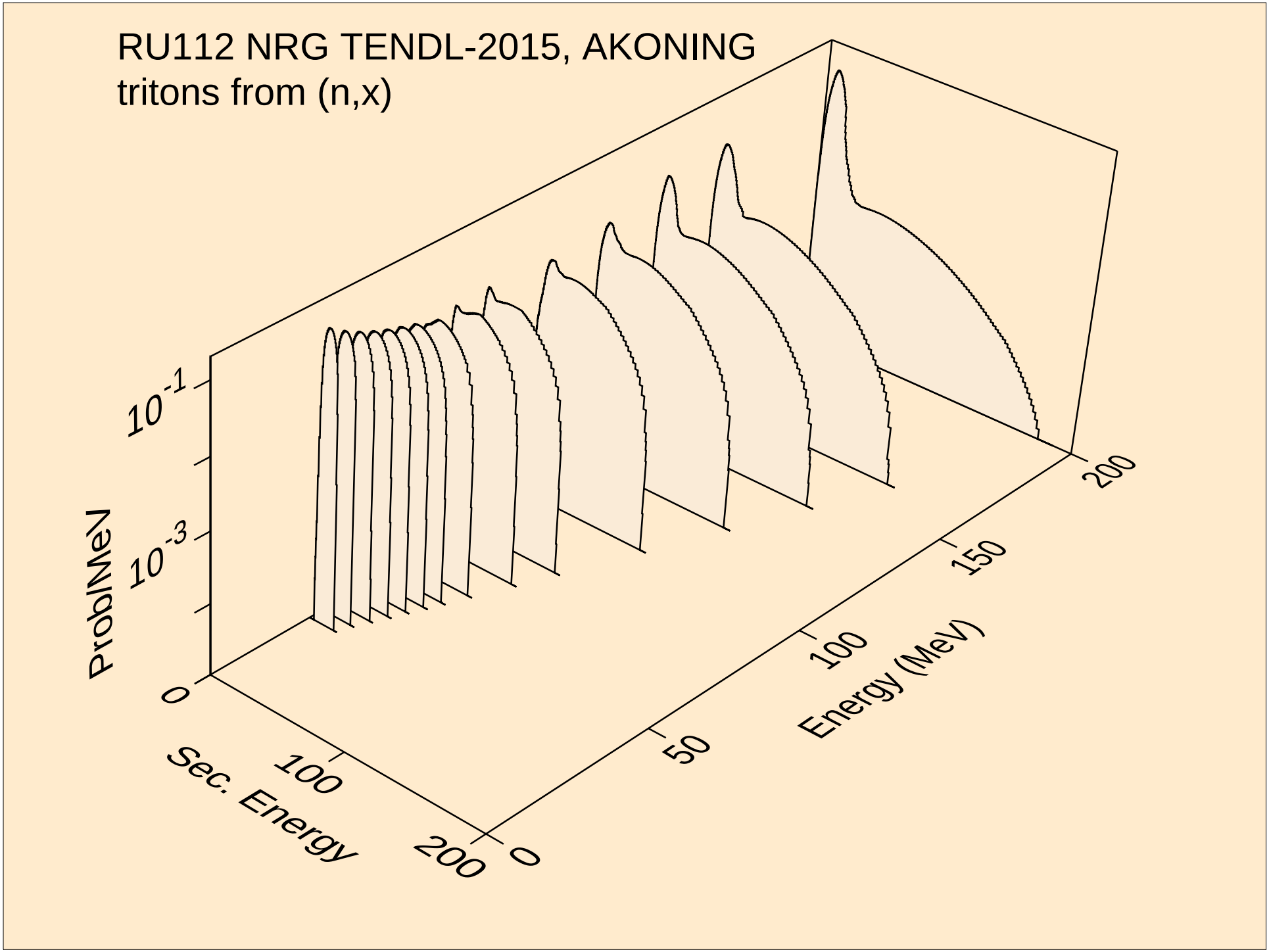

RU112 NRG TENDL-2015, AKONING
protons from (n,p)
Prob/MeV
10^{0}
10^{-2}
0
Sec. Energy
10
20
5
10
15
20
25
30
Energy (MeV)

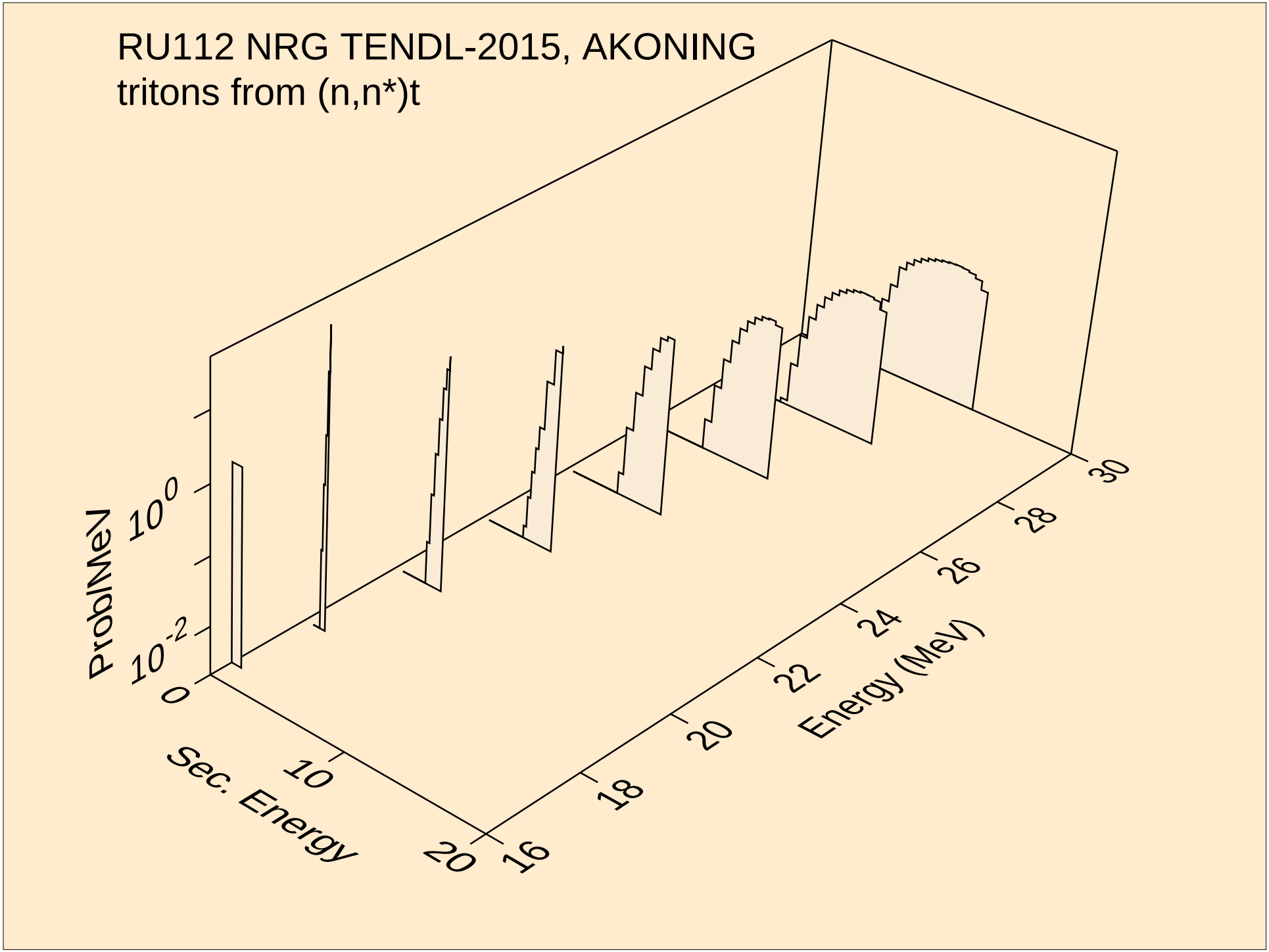

RU112 NRG TENDL-2015, AKONING
deuterons from (n,x)
Prob/MeV
10-1
10-3
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

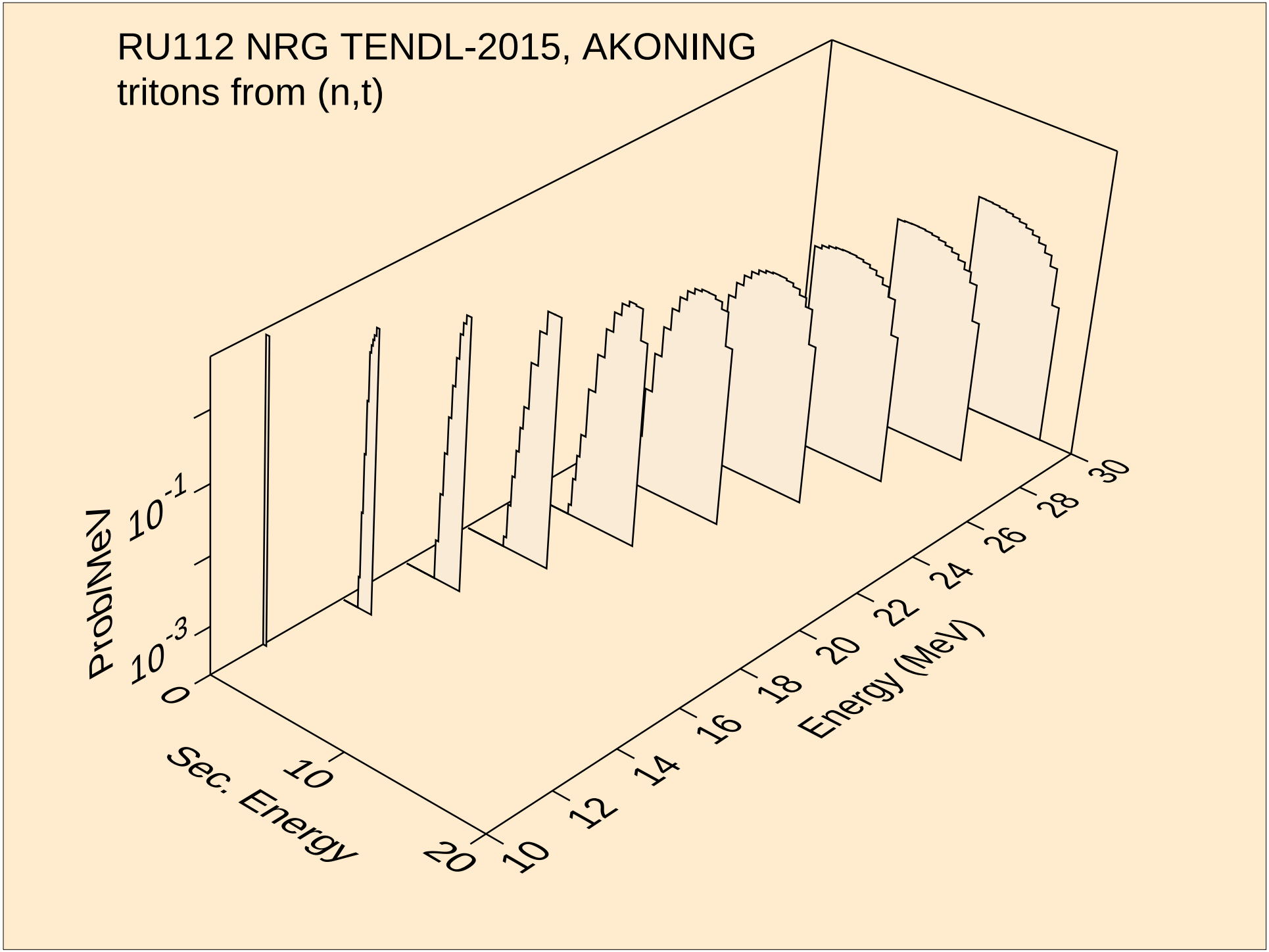

RU112 NRG TENDL-2015, AKONING
deuterons from (n,2nd)
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
Sec. Energy
5
10
22
23
24
25
26
27
28
29
30
Energy (MeV)

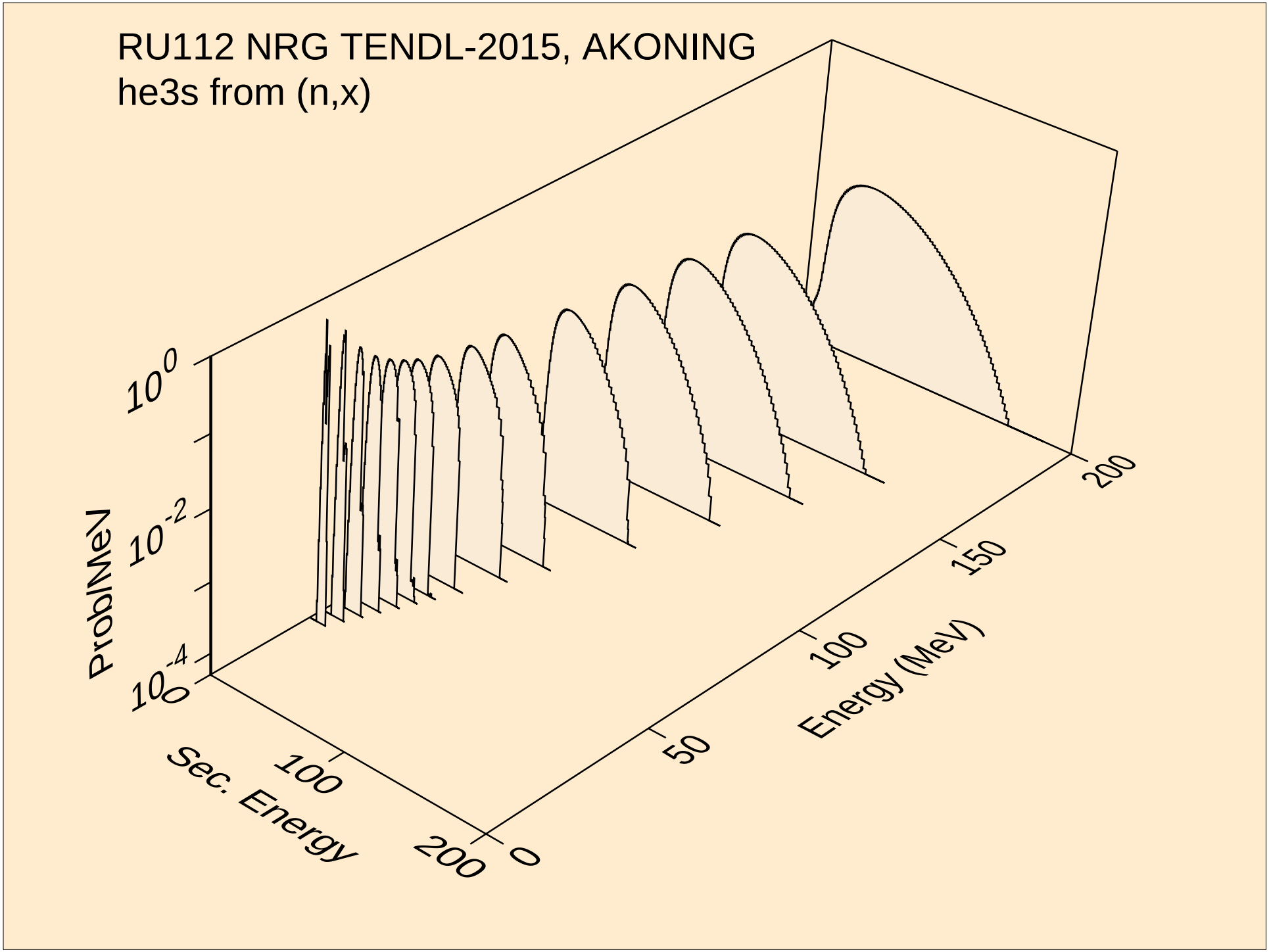

RU112 NRG TENDL-2015, AKONING
deuterons from (n,n*)d
Prob/MeV
10^-1
10^-3
0
Sec. Energy
10
20
16
18
20
22
24
26
28
30
Energy (MeV)

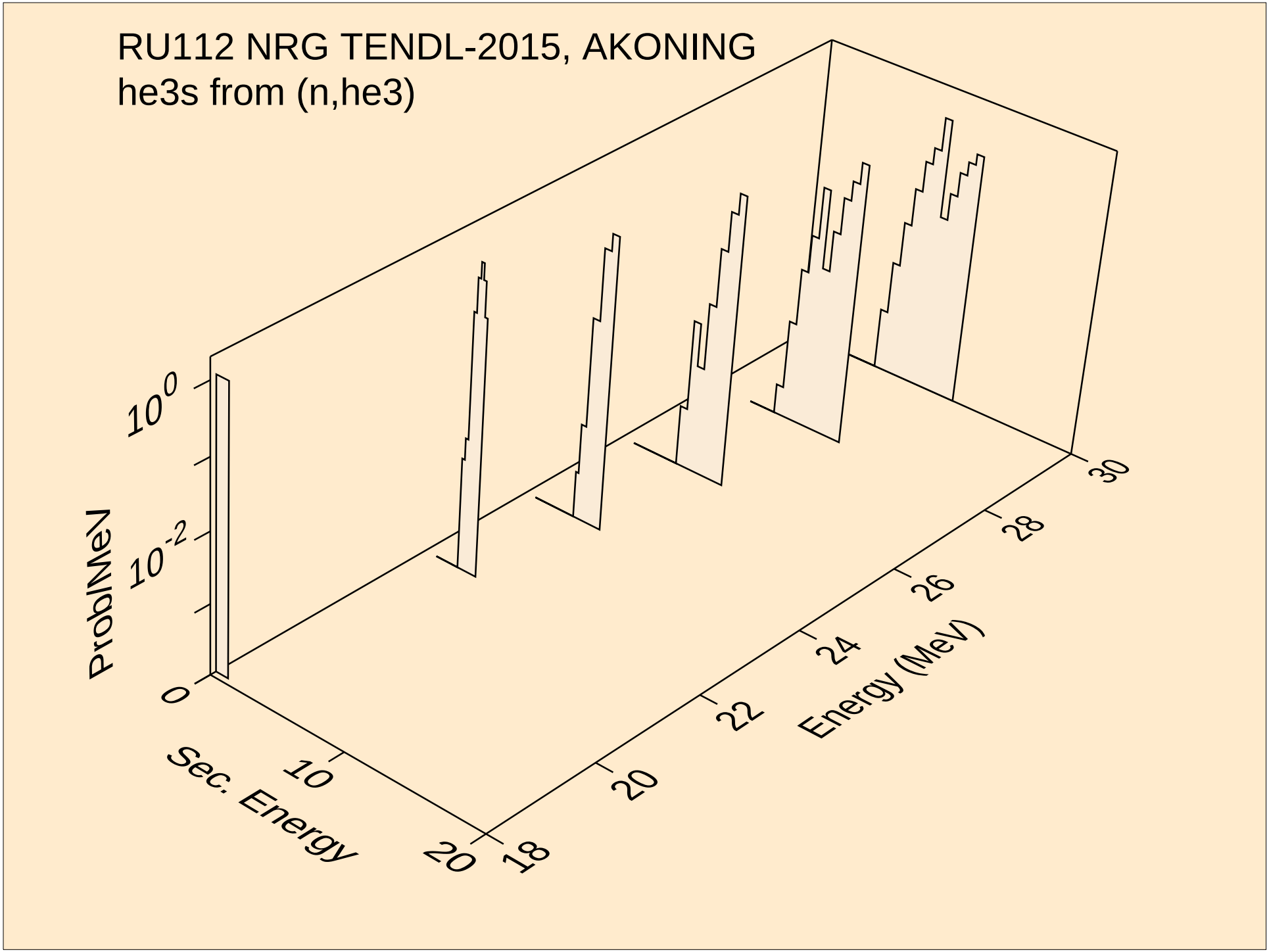

RU112 NRG TENDL-2015, AKONING
deuterons from (n,d)
Prob/MeV
10-1
10-3
0
Sec. Energy
10
20
10
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

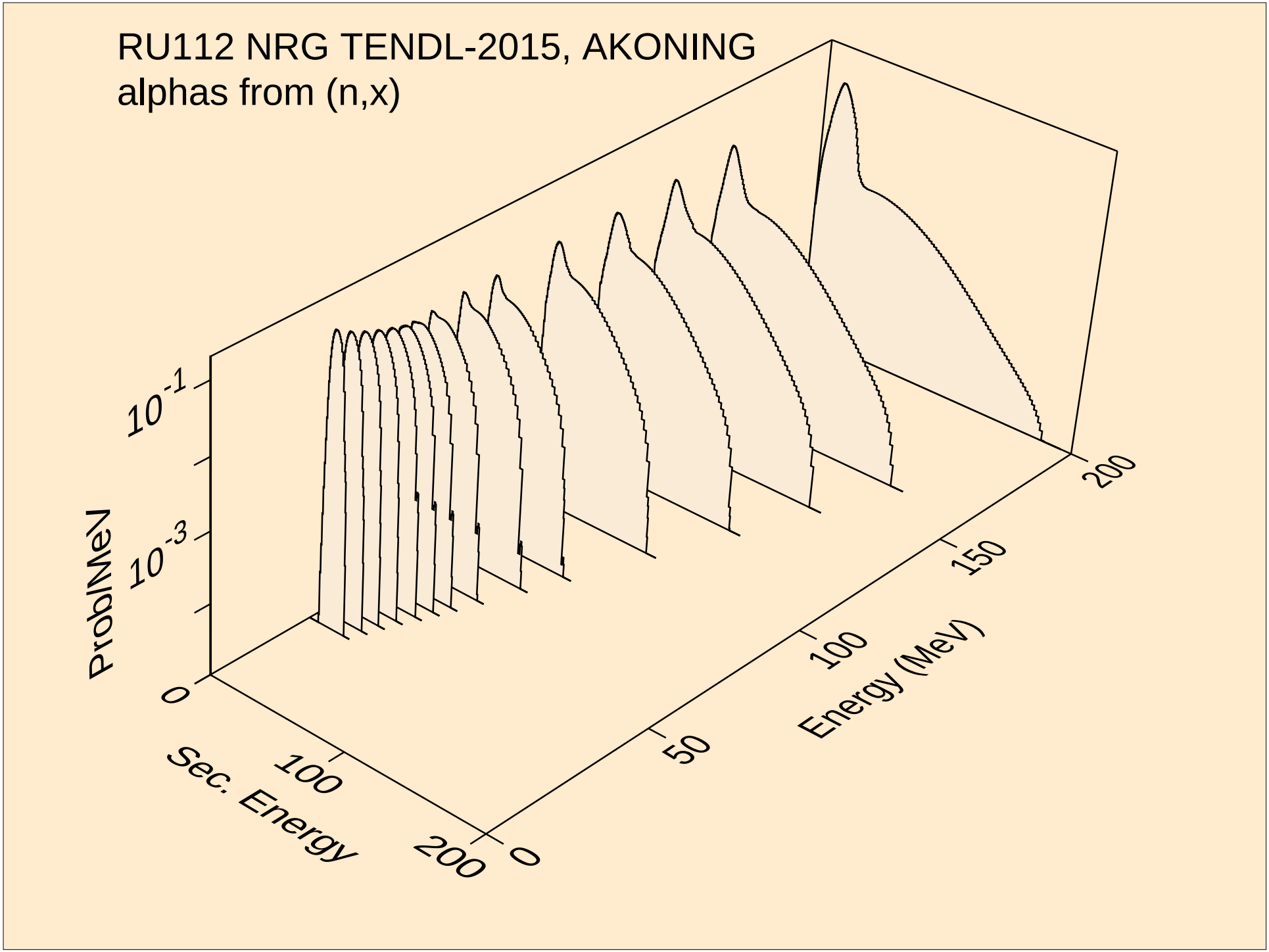

RU112 NRG TENDL-2015, AKONING
tritons from (n,x)
Prob/MeV
10-1
10-3
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

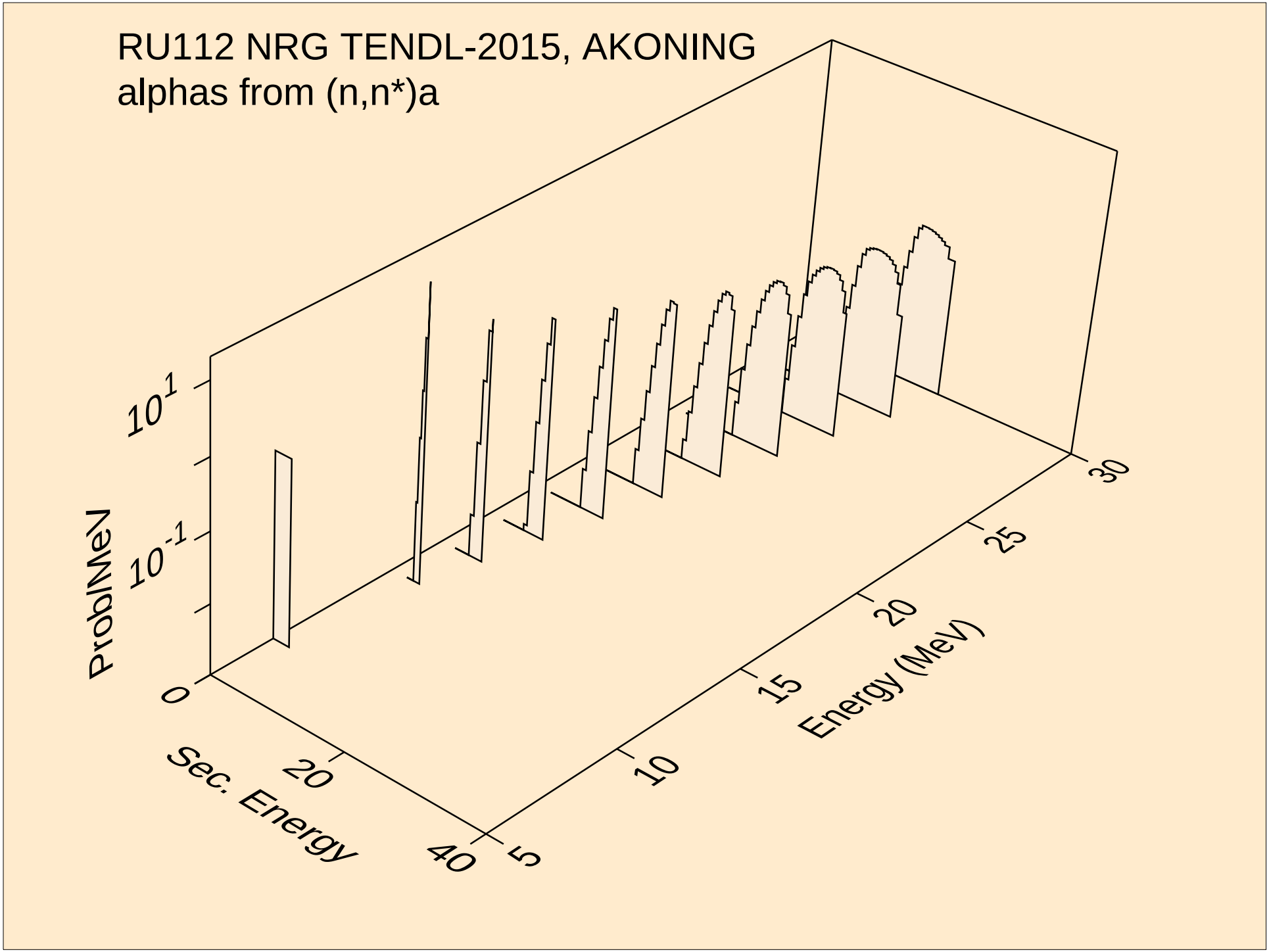

RU112 NRG TENDL-2015, AKONING
tritons from (n,n*)t
Prob/MeV
10^{0}
10^{-2}
0
Sec. Energy
10
20
16
18
20
22
24
26
28
30
Energy (MeV)

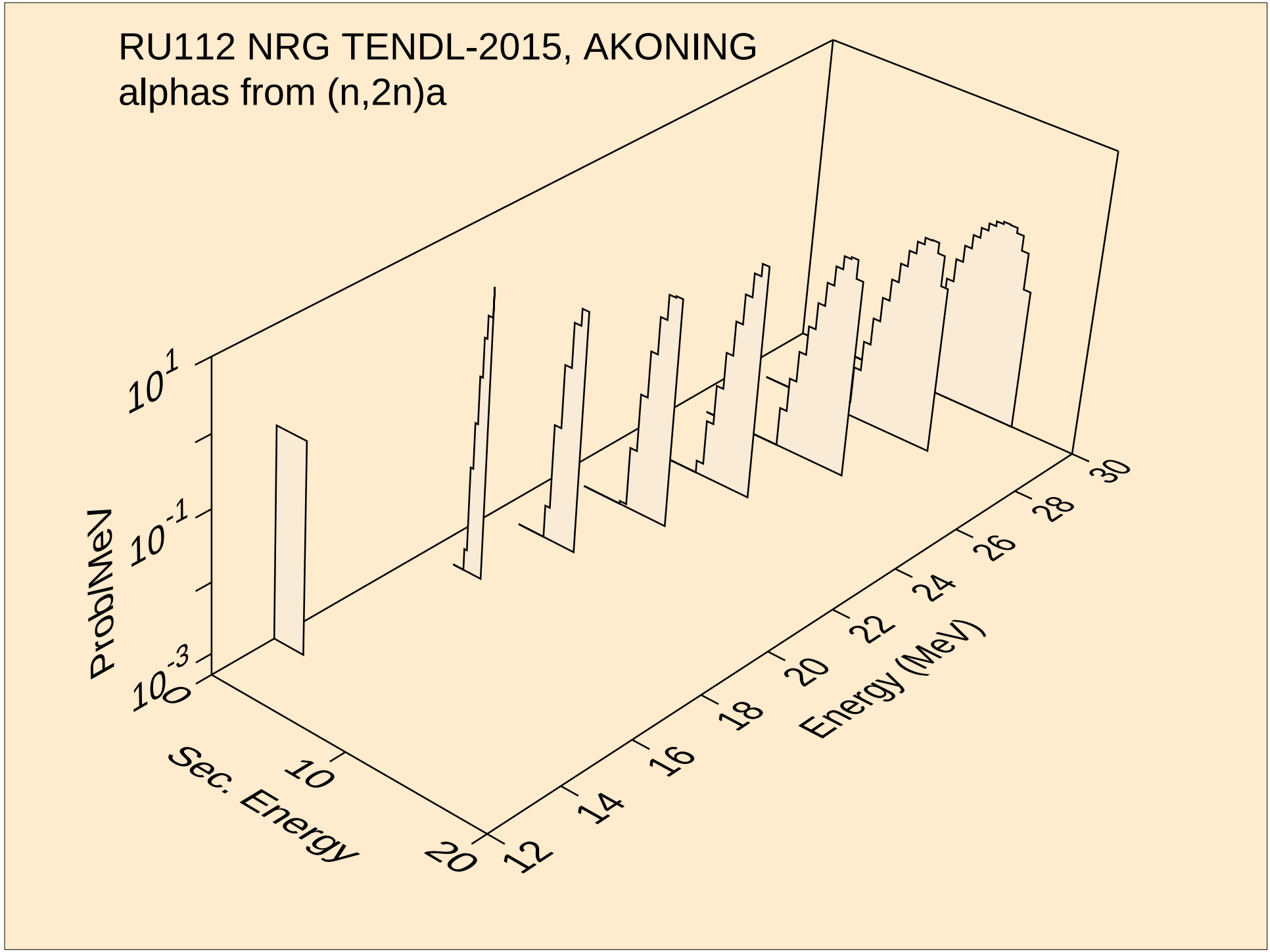

RU112 NRG TENDL-2015, AKONING
tritons from (n,t)
Prob/MeV
10^-1
10^-3
0
Sec. Energy
10
20
10
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

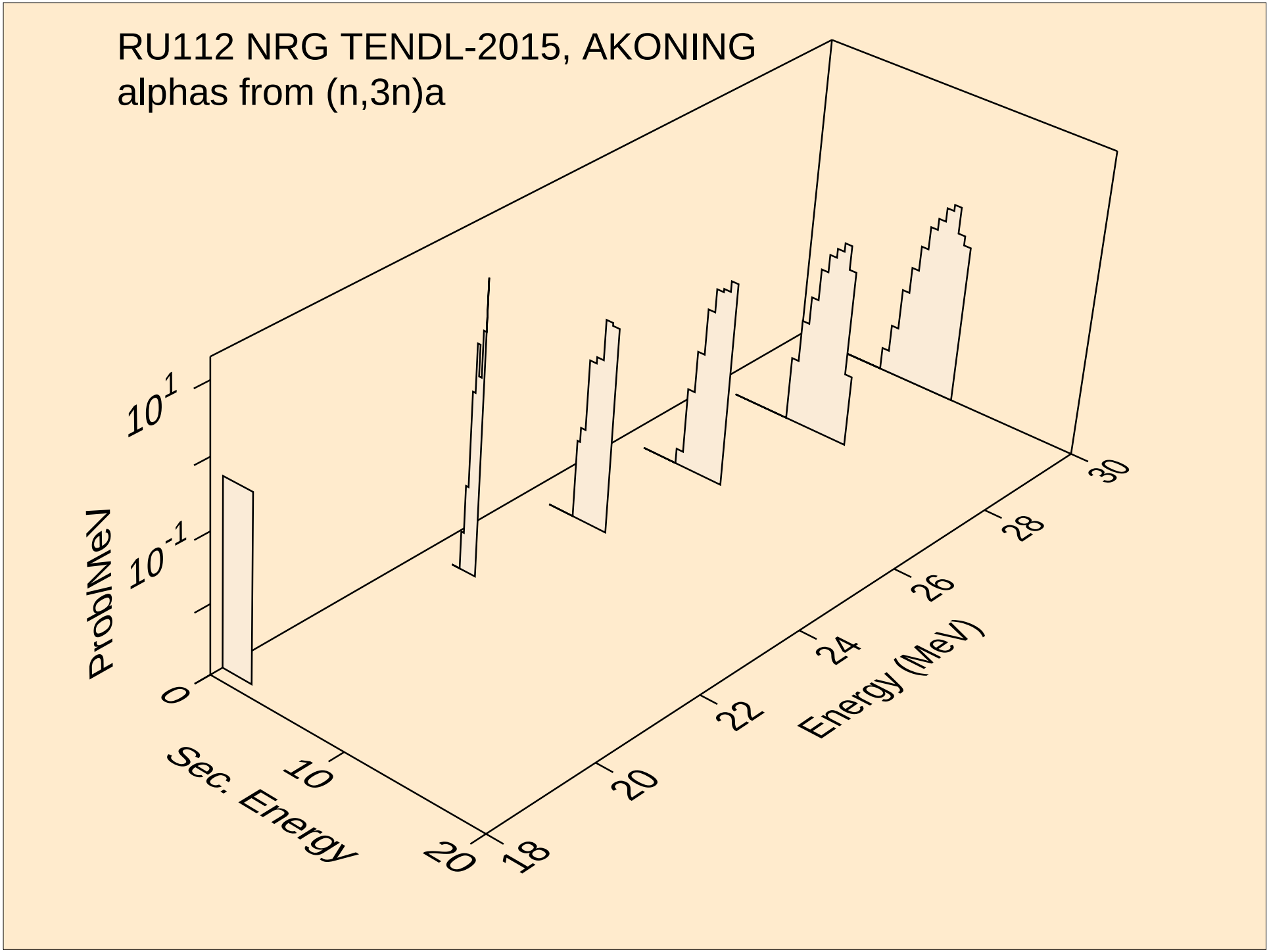

RU112 NRG TENDL-2015, AKONING
he3s from (n,x)
Prob/MeV
10^0
10^-2
10^-4
0
100
200
Sec. Energy
0
50
100
150
200
Energy (MeV)

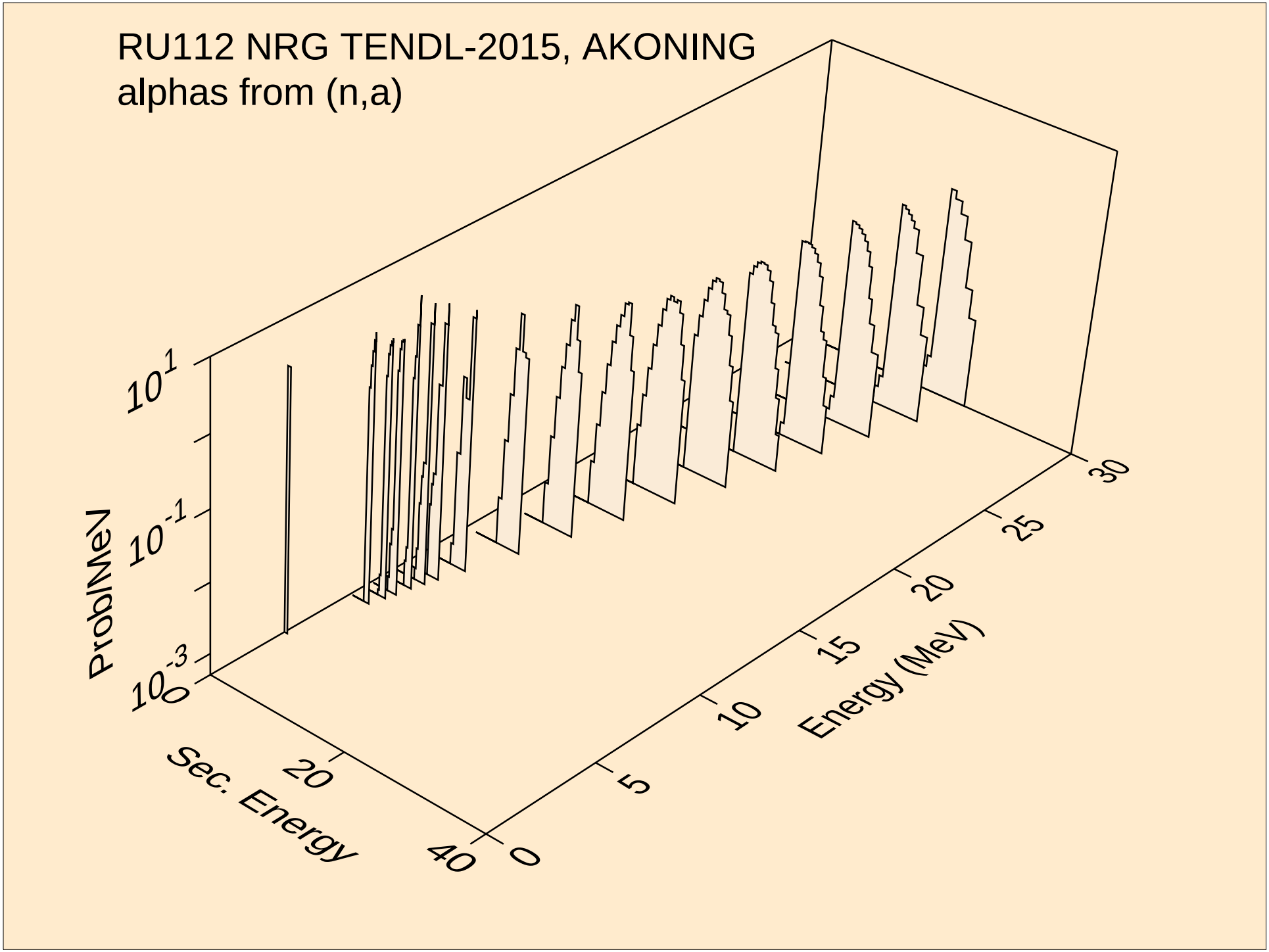

RU112 NRG TENDL-2015, AKONING
he3s from (n,he3)
Prob/MeV
10^0
10^-2
0
Sec. Energy
10
20
18
20
22
24
26
28
30
Energy (MeV)


RU112 NRG TENDL-2015, AKONING
alphas from (n,x)
Prob/MeV
10-1
10-3
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)


RU112 NRG TENDL-2015, AKONING
alphas from (n,n*)a
Prob/MeV
10^1
10^-1
0
Sec. Energy
20
40
5
10
15
20
25
30
Energy (MeV)


RU112 NRG TENDL-2015, AKONING
alphas from (n,2n)a
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
10
20
Sec. Energy
12
14
16
18
20
22
24
26
28
30
Energy (MeV)


RU112 NRG TENDL-2015, AKONING
alphas from (n,3n)a
Prob/MeV
10^{1}
10^{-1}
0
Sec. Energy
10
20
18
20
22
24
26
28
30
Energy (MeV)


RU112 NRG TENDL-2015, AKONING
alphas from (n,a)
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)