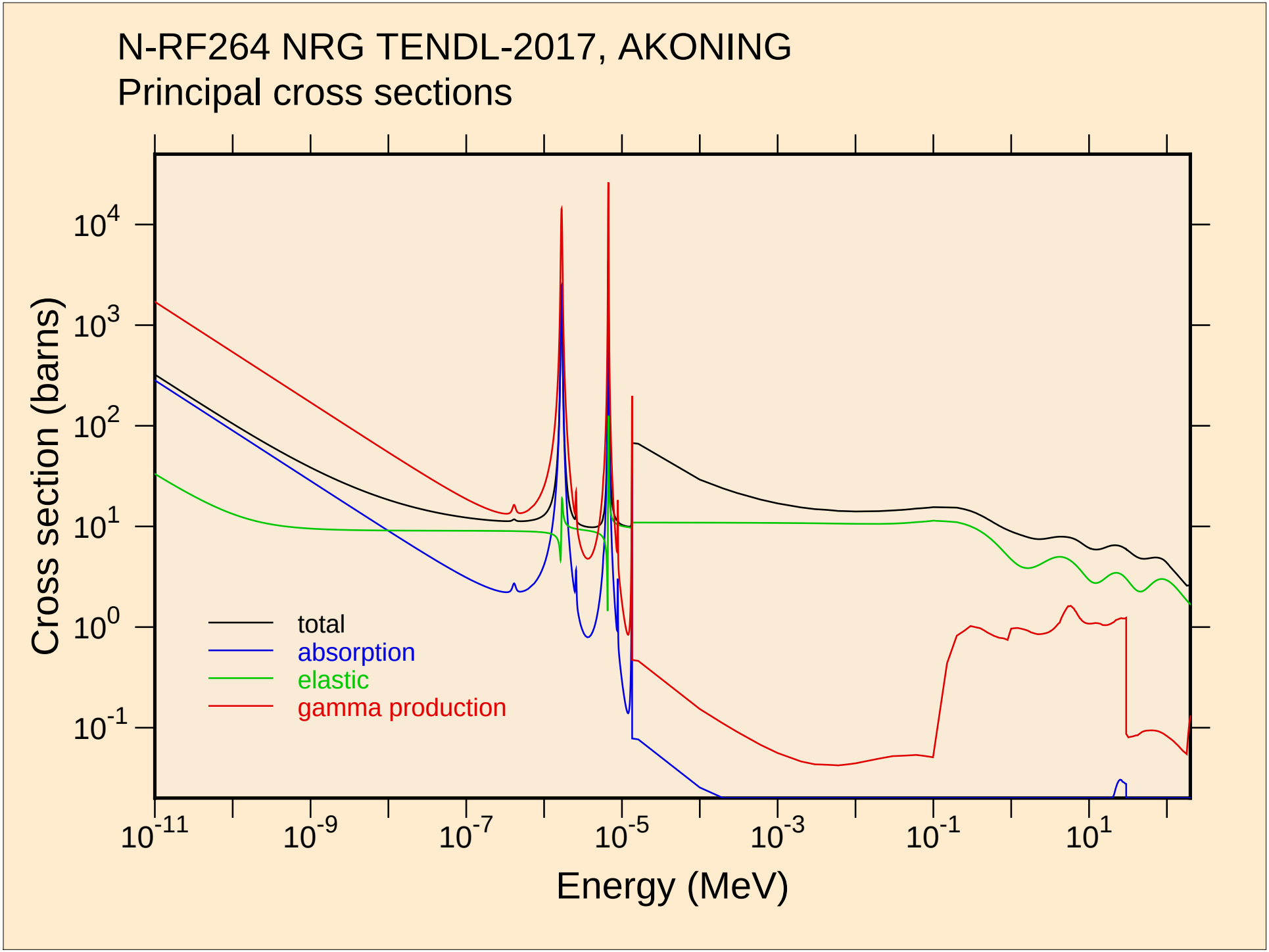
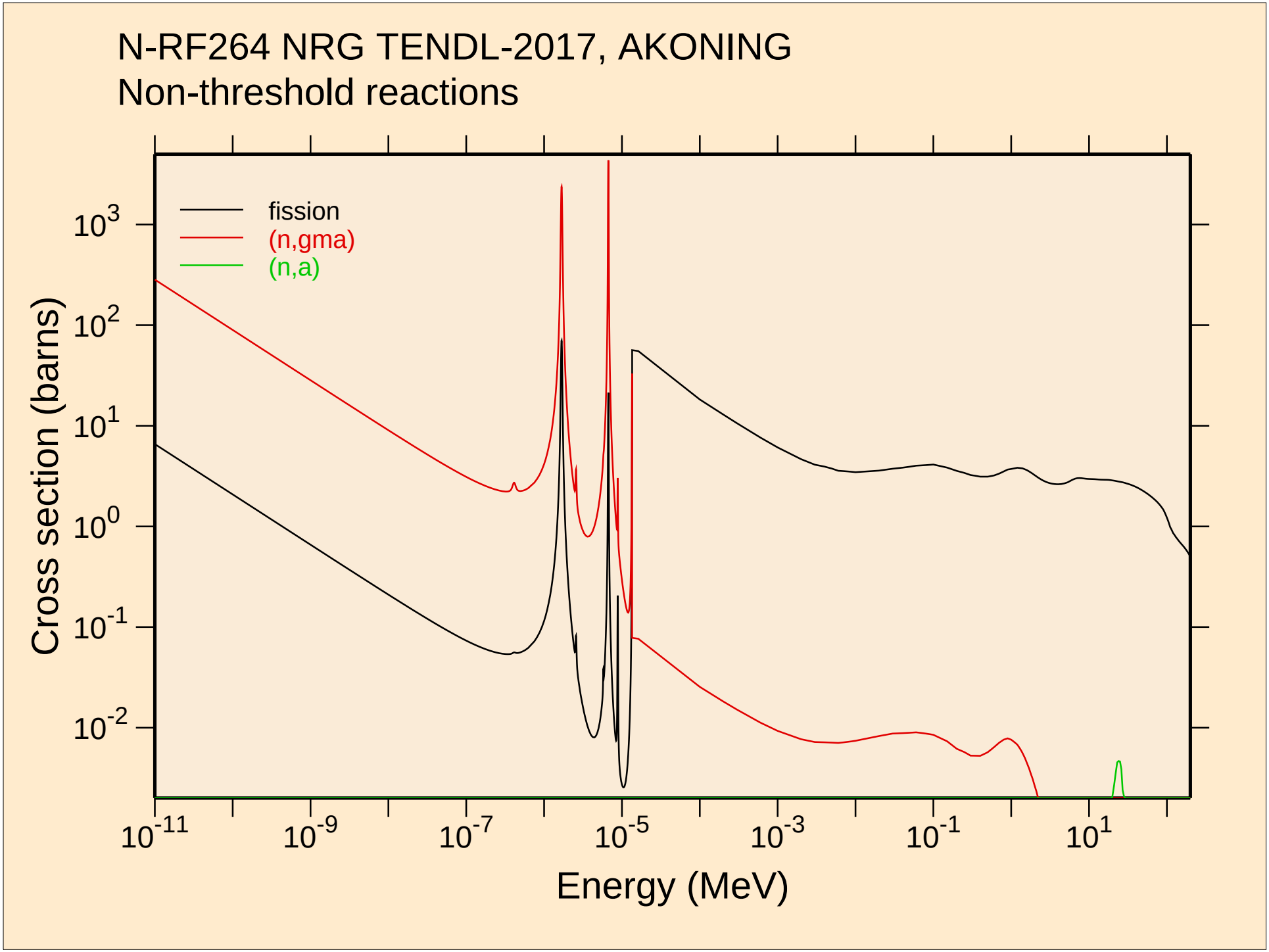
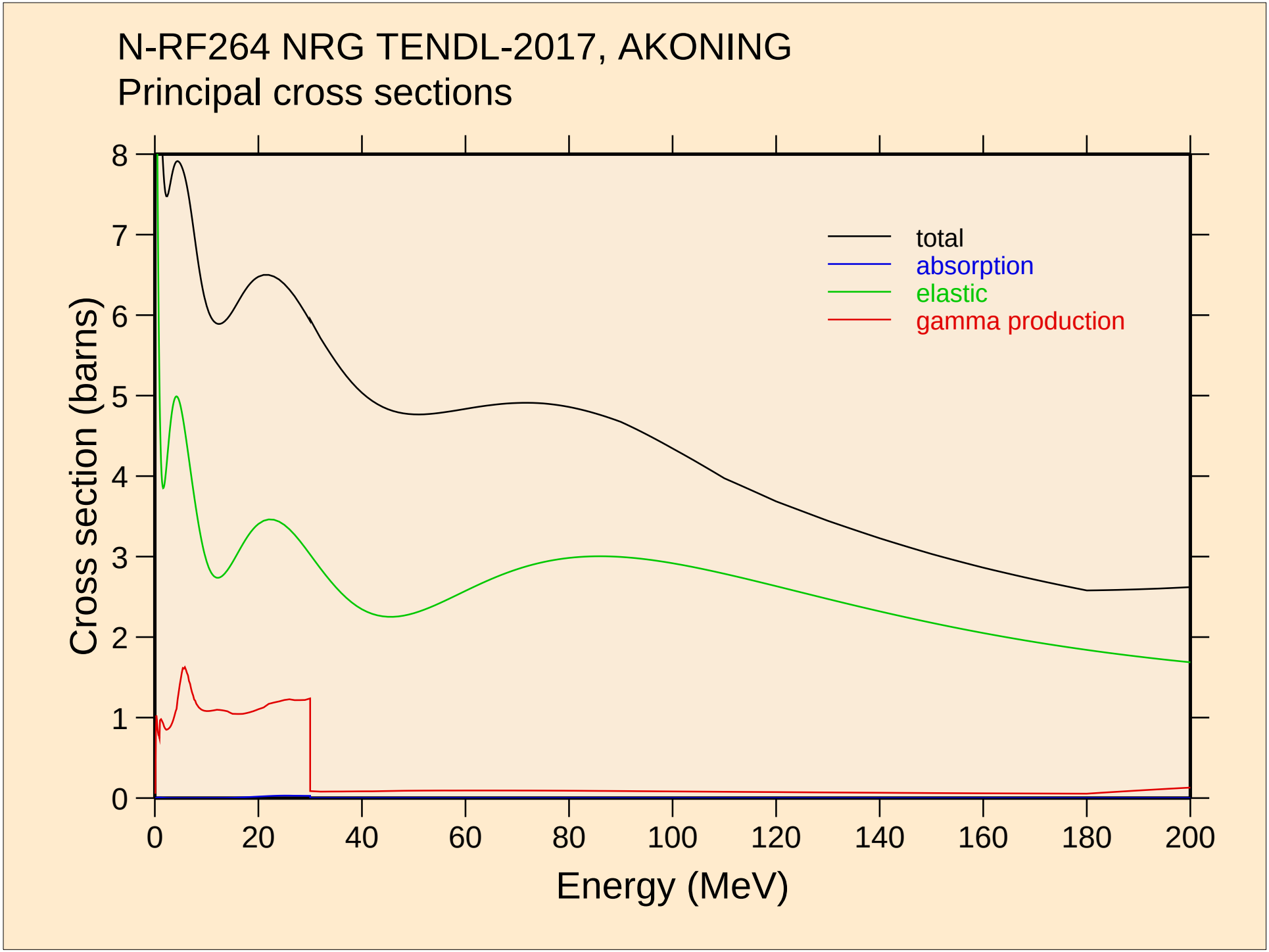
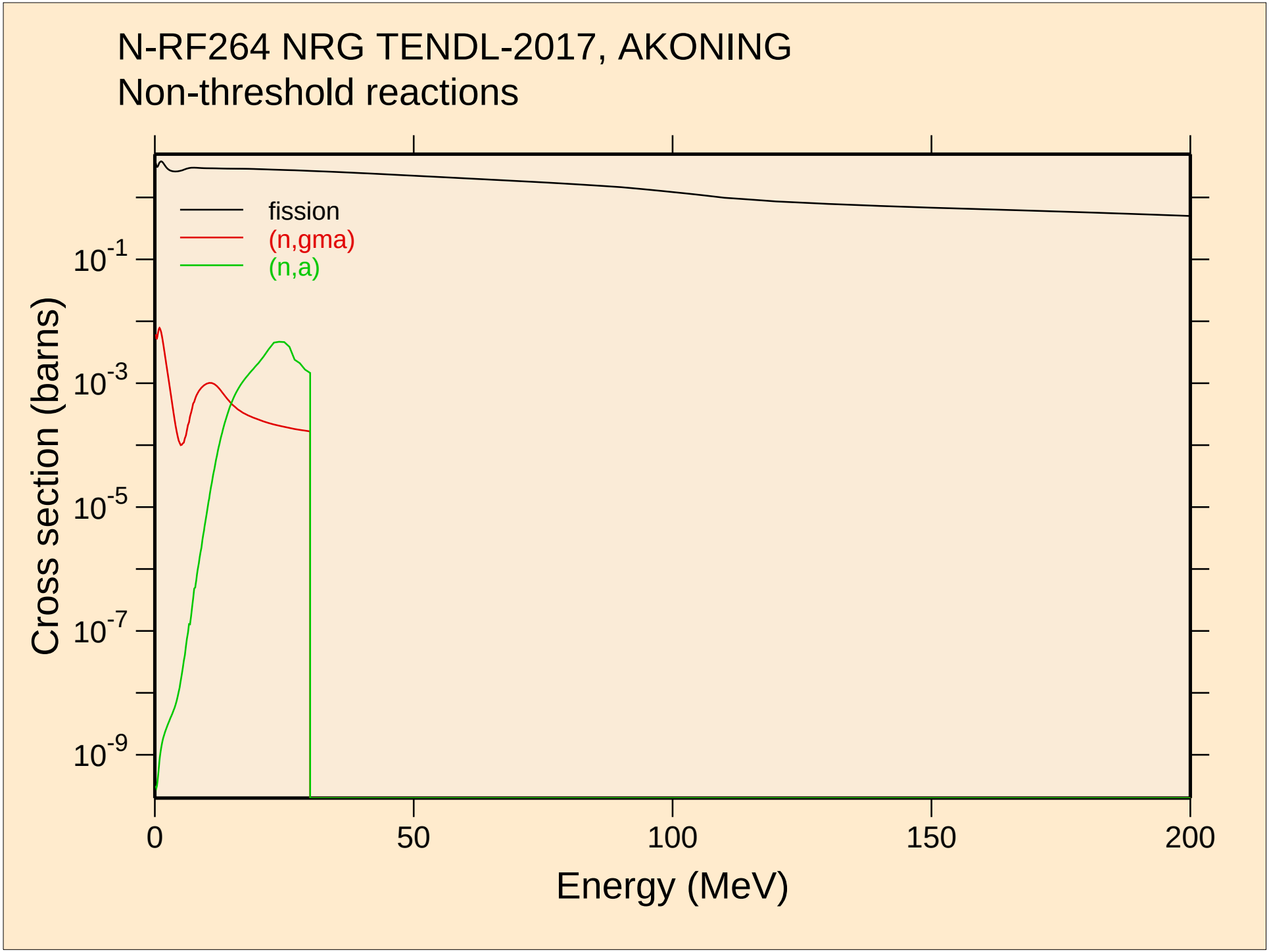
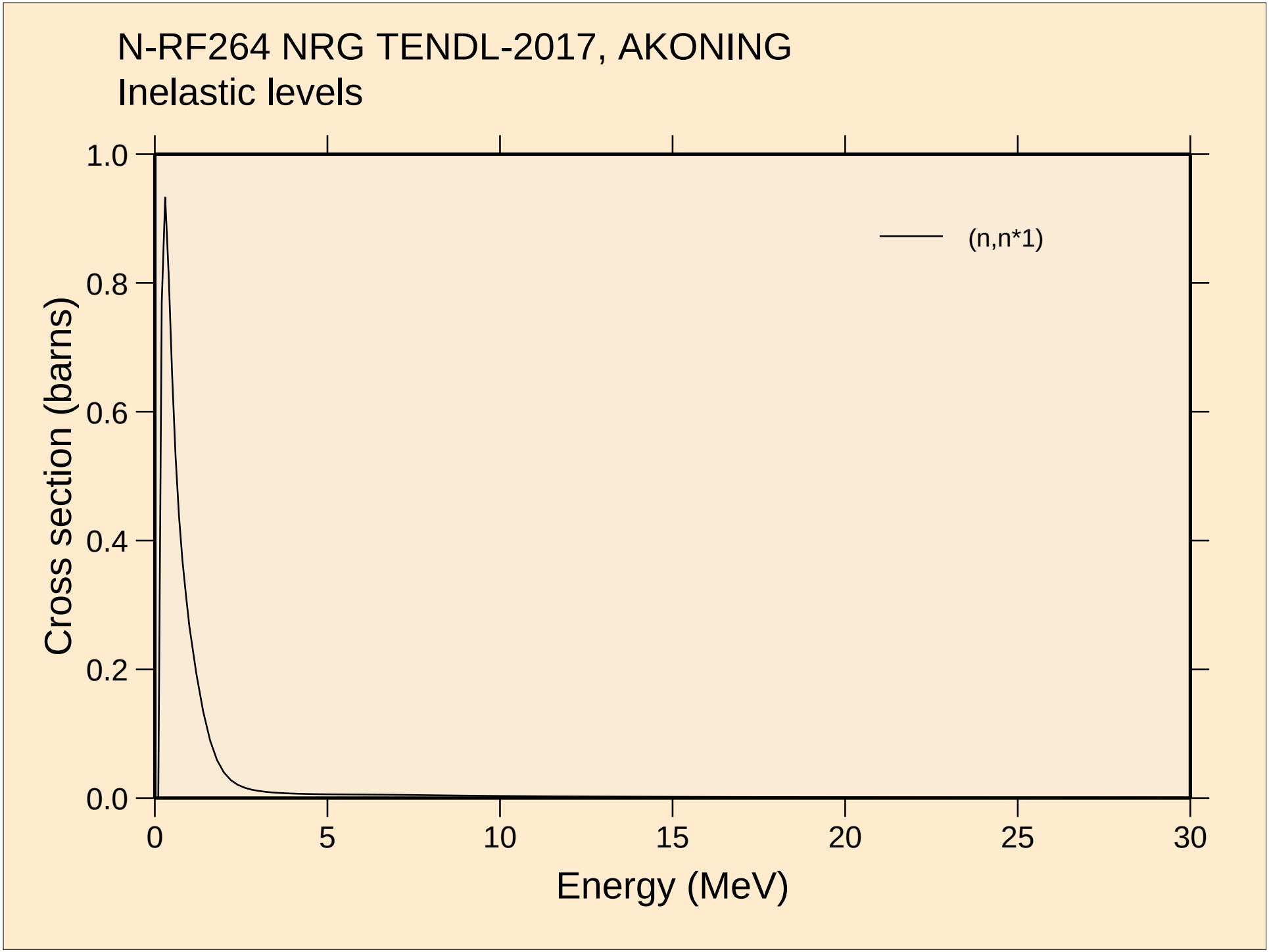
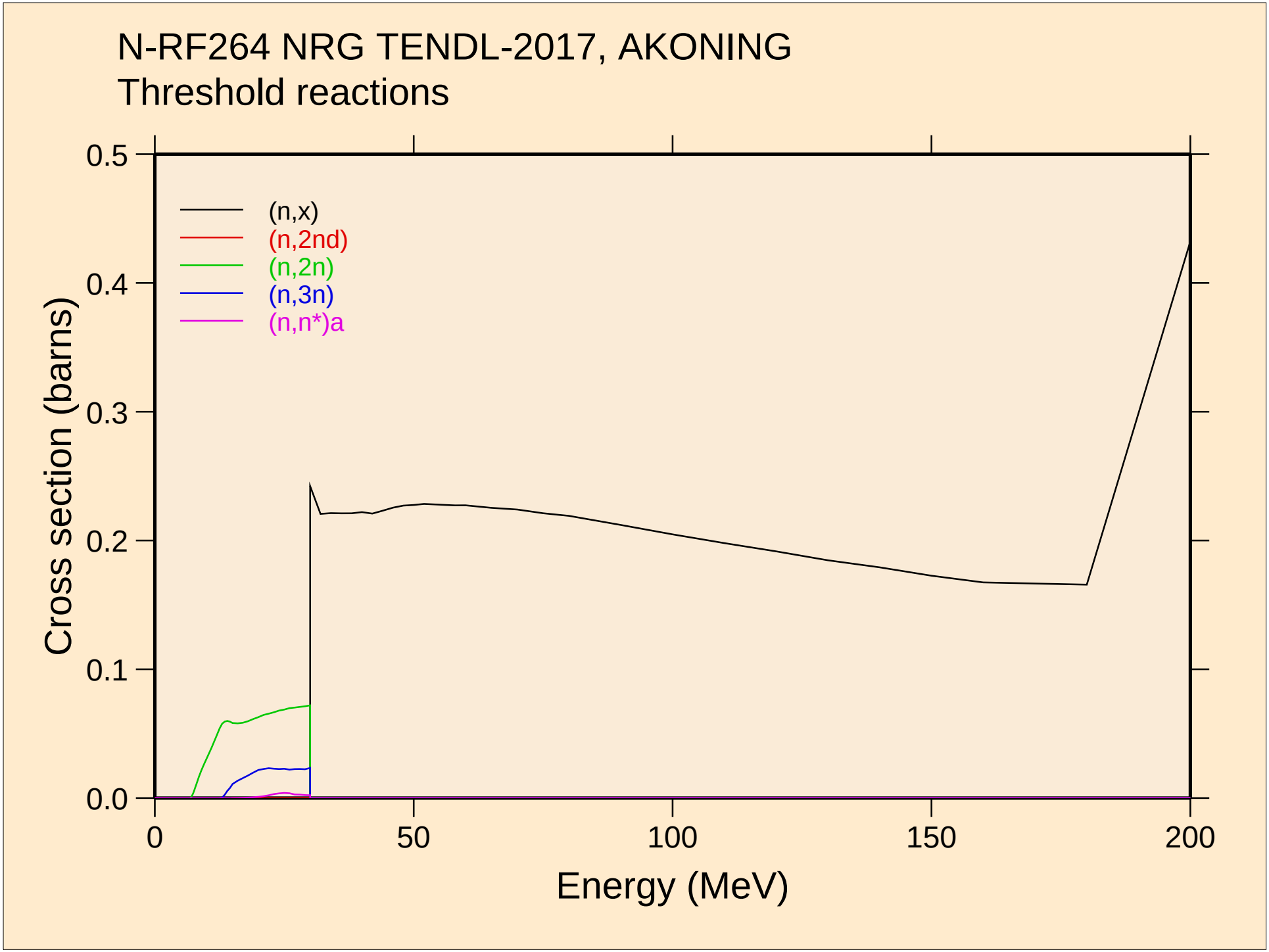

N-RF264 NRG TENDL-2017, AKONING
Principal cross sections
Cross section (barns)
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
total
absorption
elastic
gamma production
10^{-11}
10^{-9}
10^{-7}
10^{-5}
10^{-3}
10^{-1}
10^{1}
Energy (MeV)

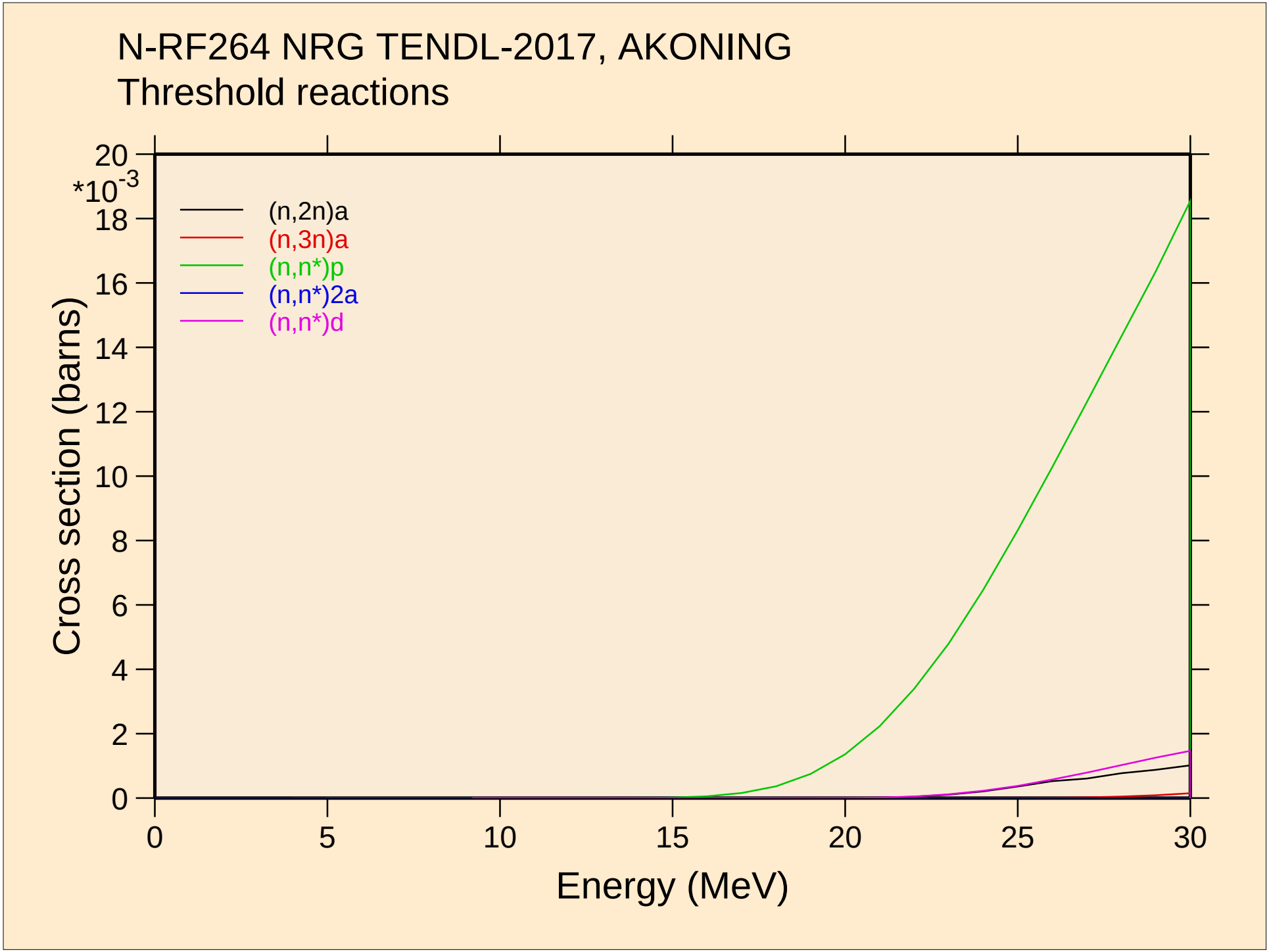

N-RF264 NRG TENDL-2017, AKONING
Non-threshold reactions
fission
(n,gma)
(n,a)
Cross section (barns)
10^3
10^2
10^1
10^0
10^-1
10^-2
10^-11
10^-9
10^-7
10^-5
10^-3
10^-1
10^1
Energy (MeV)

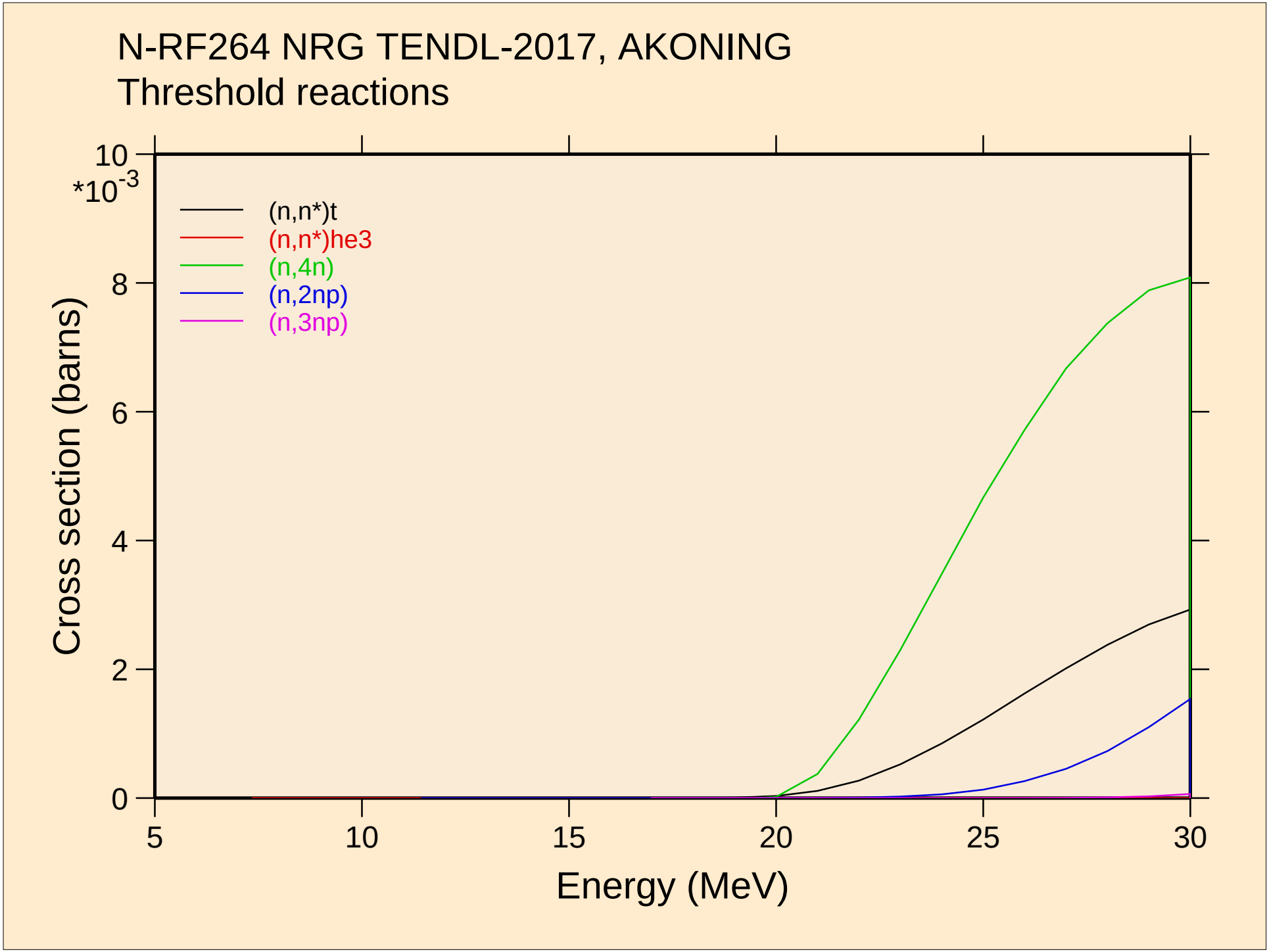

N-RF264 NRG TENDL-2017, AKONING
Principal cross sections
Cross section (barns)
Energy (MeV)
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140
160
180
200
total
absorption
elastic
gamma production

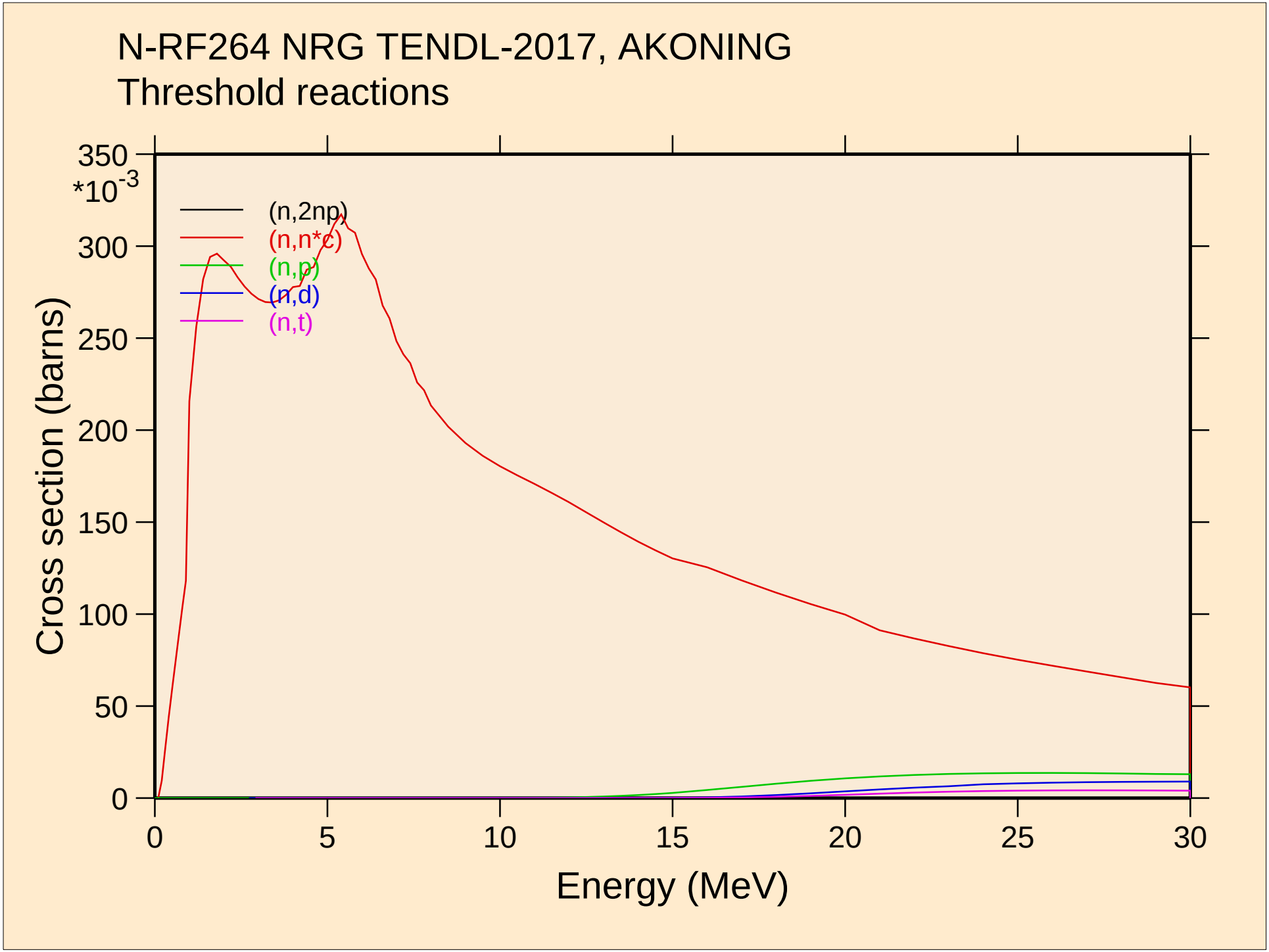

N-RF264 NRG TENDL-2017, AKONING
Non-threshold reactions
fission
(n,gma)
(n,a)
Cross section (barns)
10-1
10-3
10-5
10-7
10-9
0
50
100
150
200
Energy (MeV)

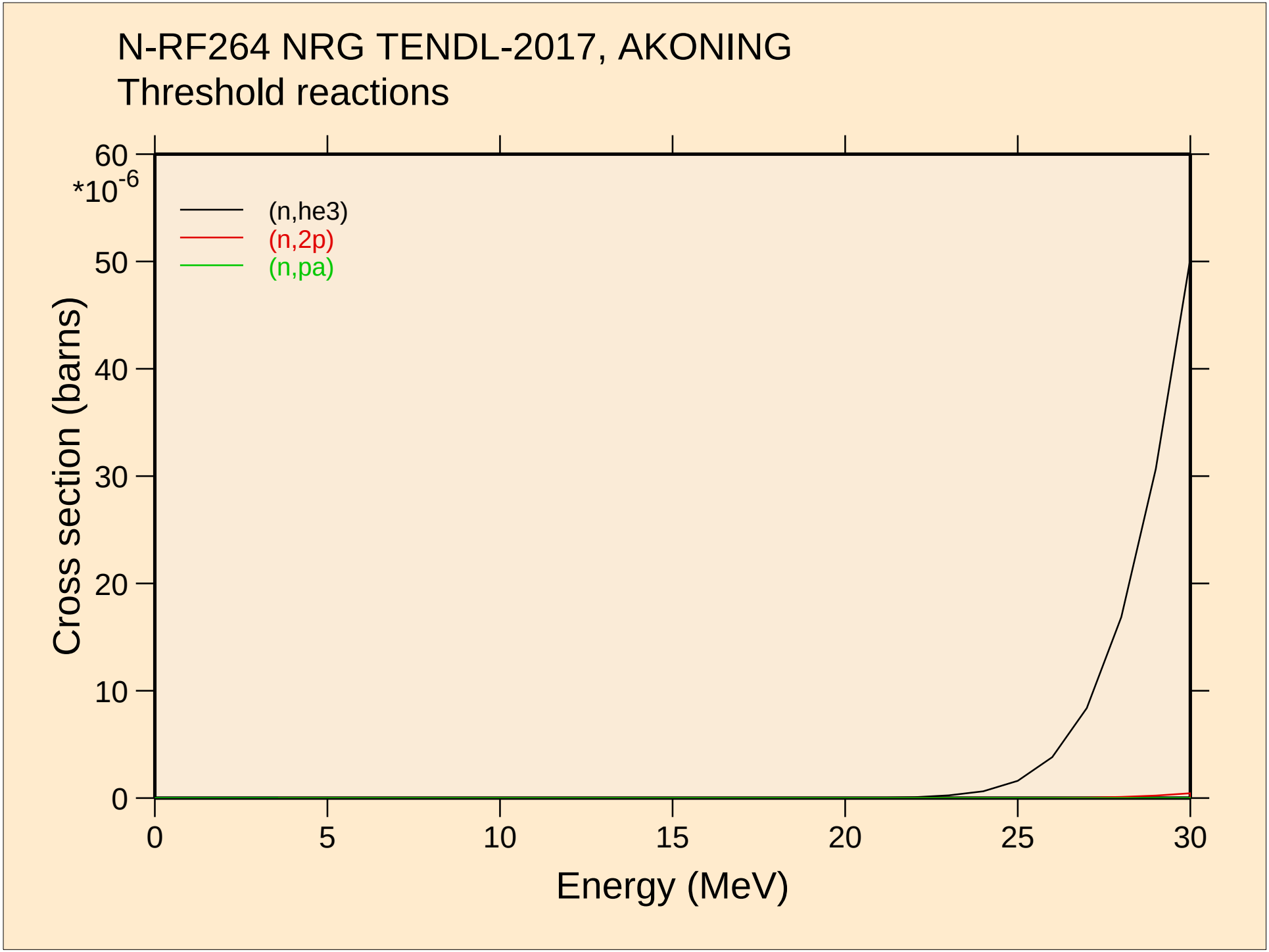

N-RF264 NRG TENDL-2017, AKONING
Inelastic levels
(n,n*1)
Cross section (barns)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
Energy (MeV)

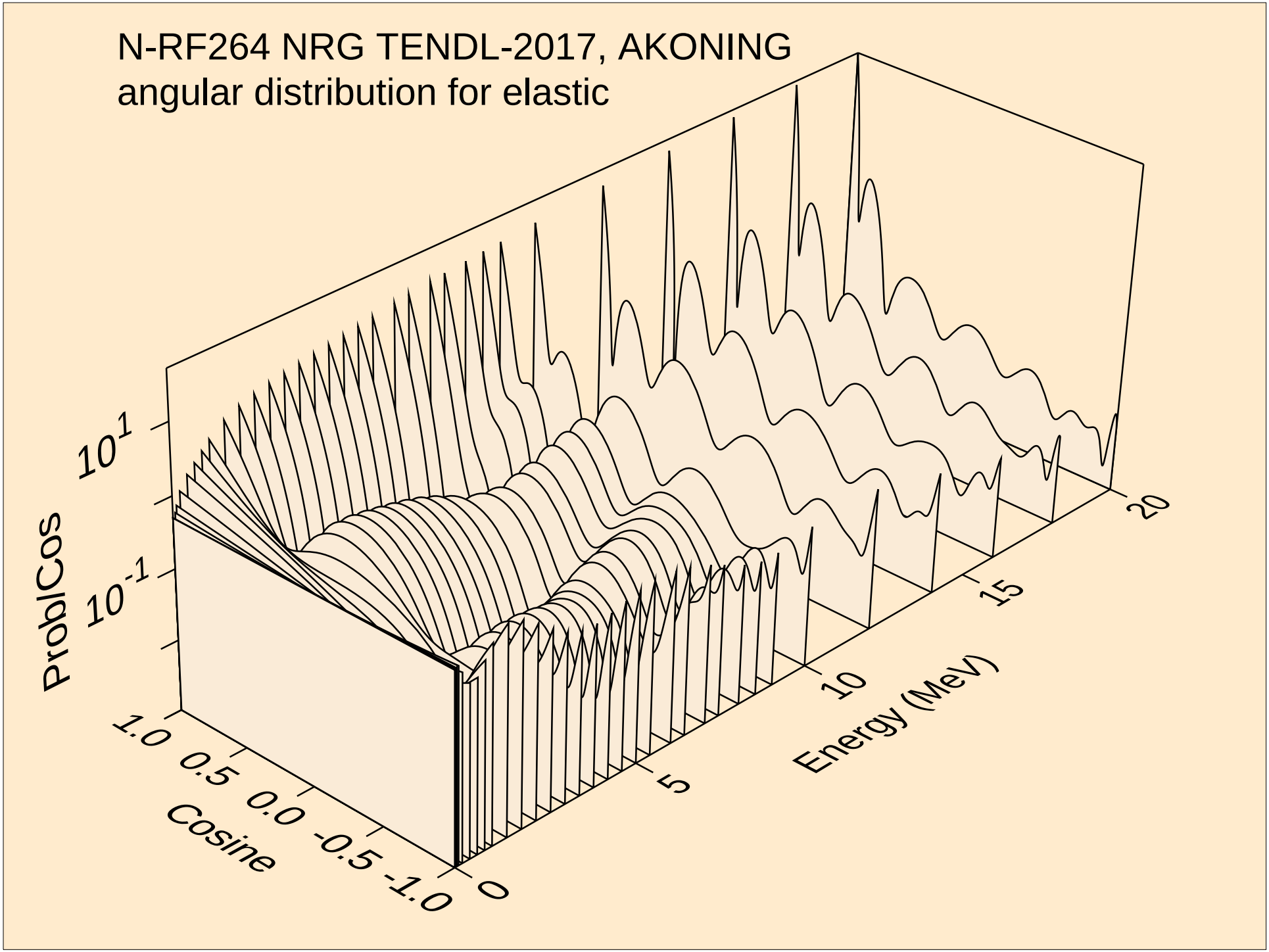

N-RF264 NRG TENDL-2017, AKONING
Threshold reactions
(n,x)
(n,2nd)
(n,2n)
(n,3n)
(n,n*)a
Cross section (barns)
0.0
0.1
0.2
0.3
0.4
0.5
0
50
100
150
200
Energy (MeV)

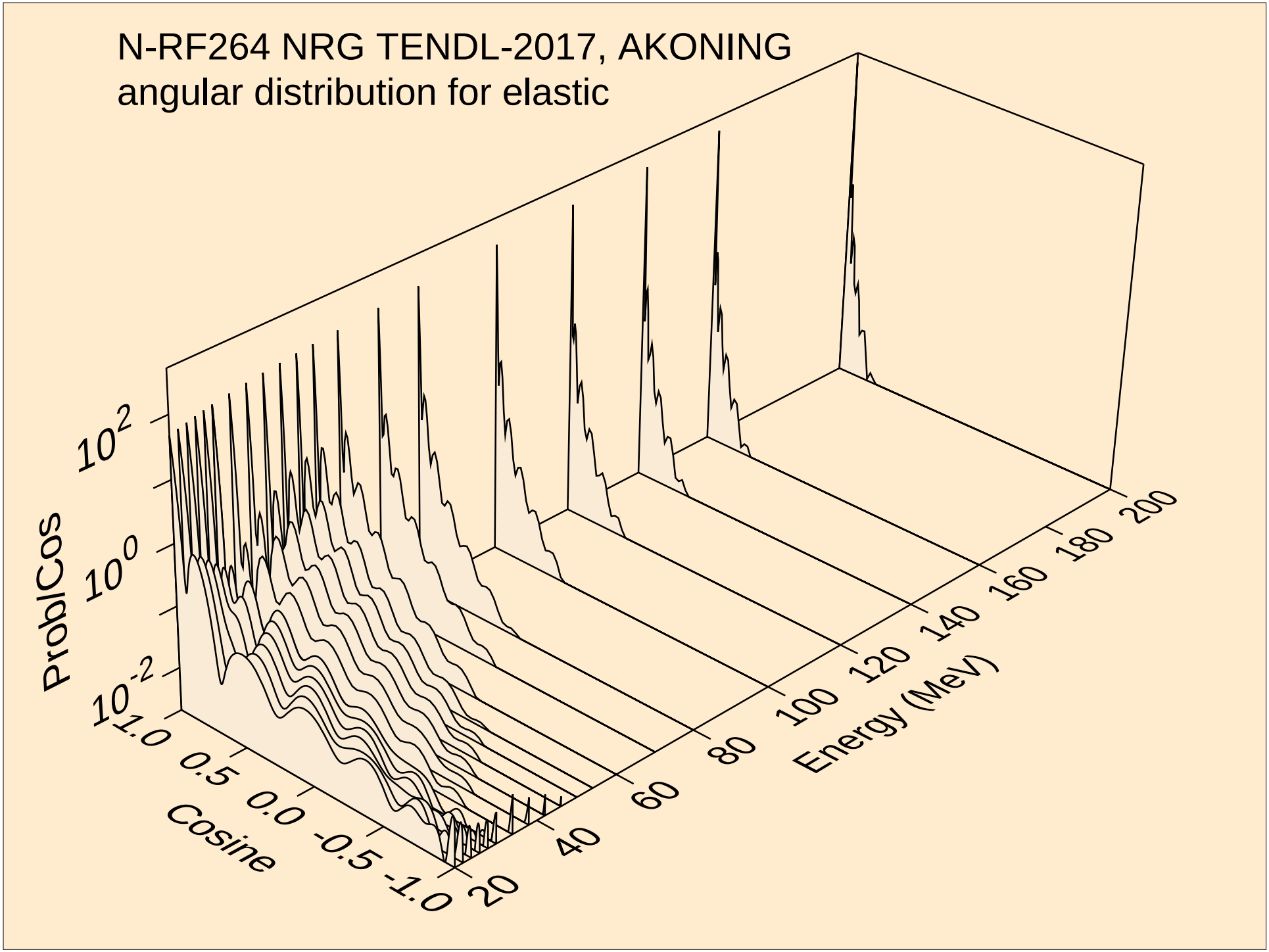

N-RF264 NRG TENDL-2017, AKONING
Threshold reactions
*10-3
Cross section (barns)
Energy (MeV)
(n,2n)a
(n,3n)a
(n,n*)p
(n,n*)2a
(n,n*)d
0
2
4
6
8
10
12
14
16
18
20
0
5
10
15
20
25
30

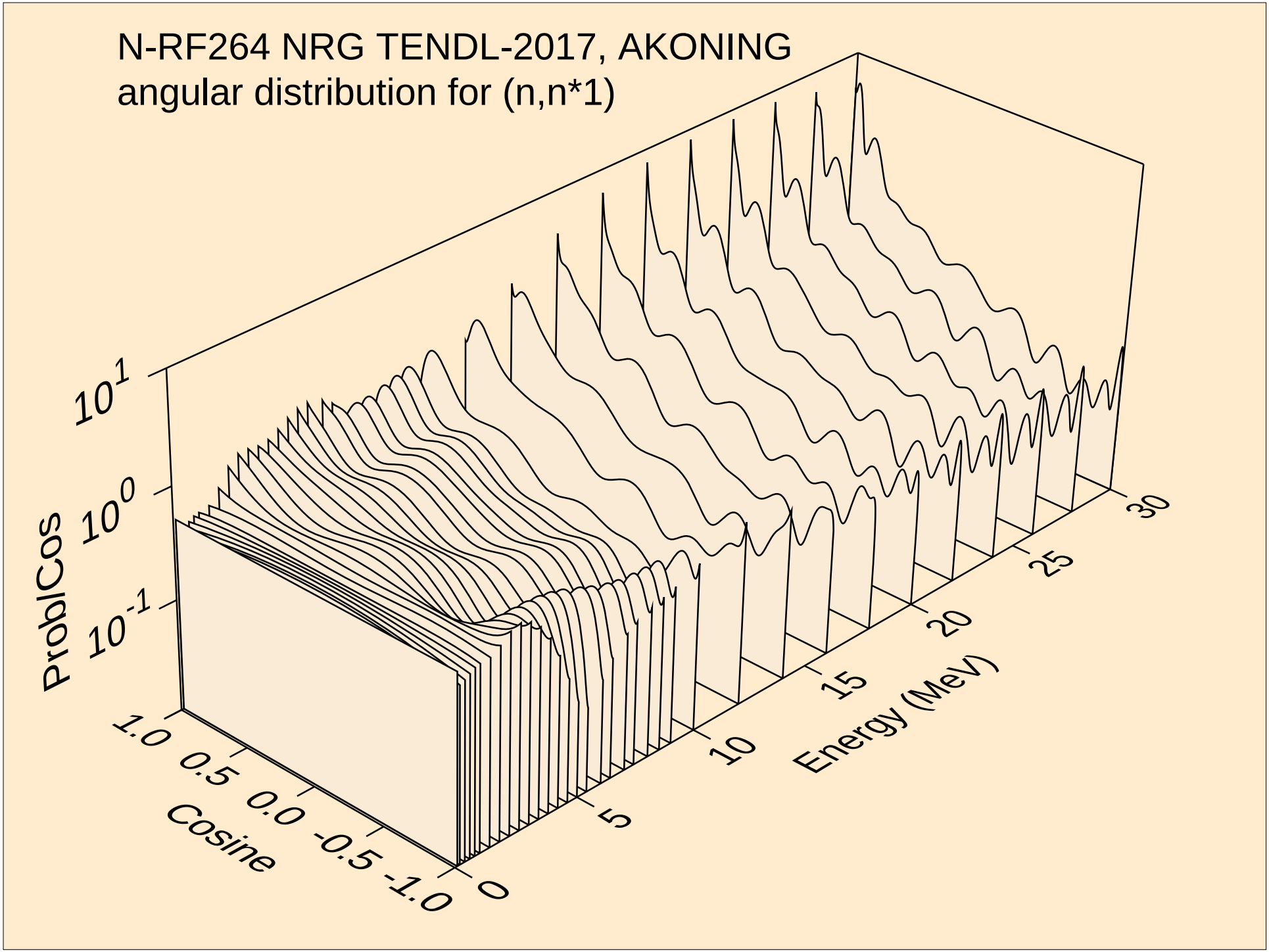

N-RF264 NRG TENDL-2017, AKONING
Threshold reactions
10
*10-3
8
6
4
2
0
Cross section (barns)
(n,n*)t
(n,n*)he3
(n,4n)
(n,2np)
(n,3np)
5
10
15
20
25
30
Energy (MeV)

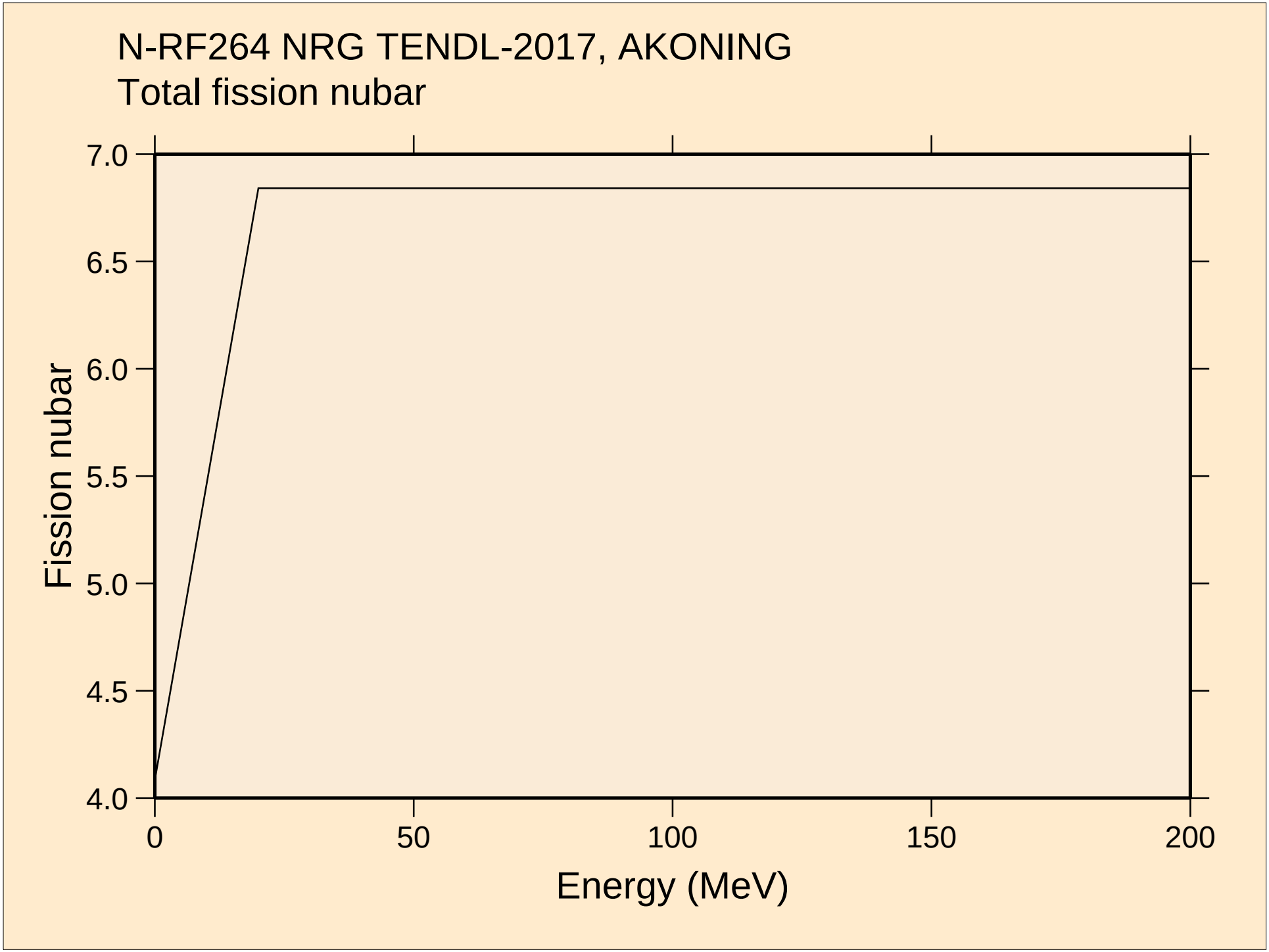

N-RF264 NRG TENDL-2017, AKONING
Threshold reactions
*10-3
350
300
250
200
150
100
50
0
Cross section (barns)
(n,2np)
(n,n*c)
(n,p)
(n,d)
(n,t)
0
5
10
15
20
25
30
Energy (MeV)

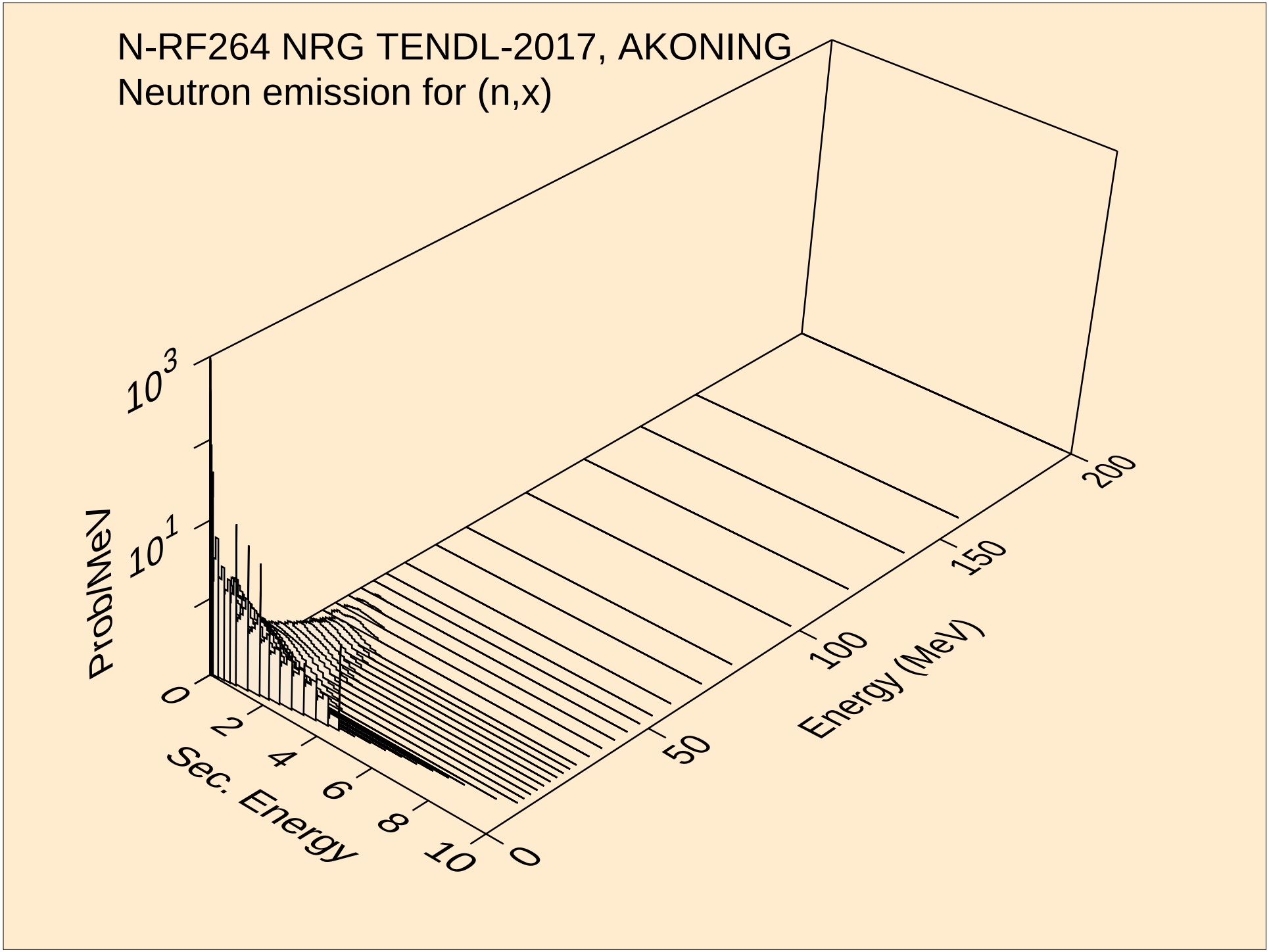

N-RF264 NRG TENDL-2017, AKONING
Threshold reactions
*10-6
60
50
40
30
20
10
0
(n,he3)
(n,2p)
(n,pa)
Cross section (barns)
0
5
10
15
20
25
30
Energy (MeV)

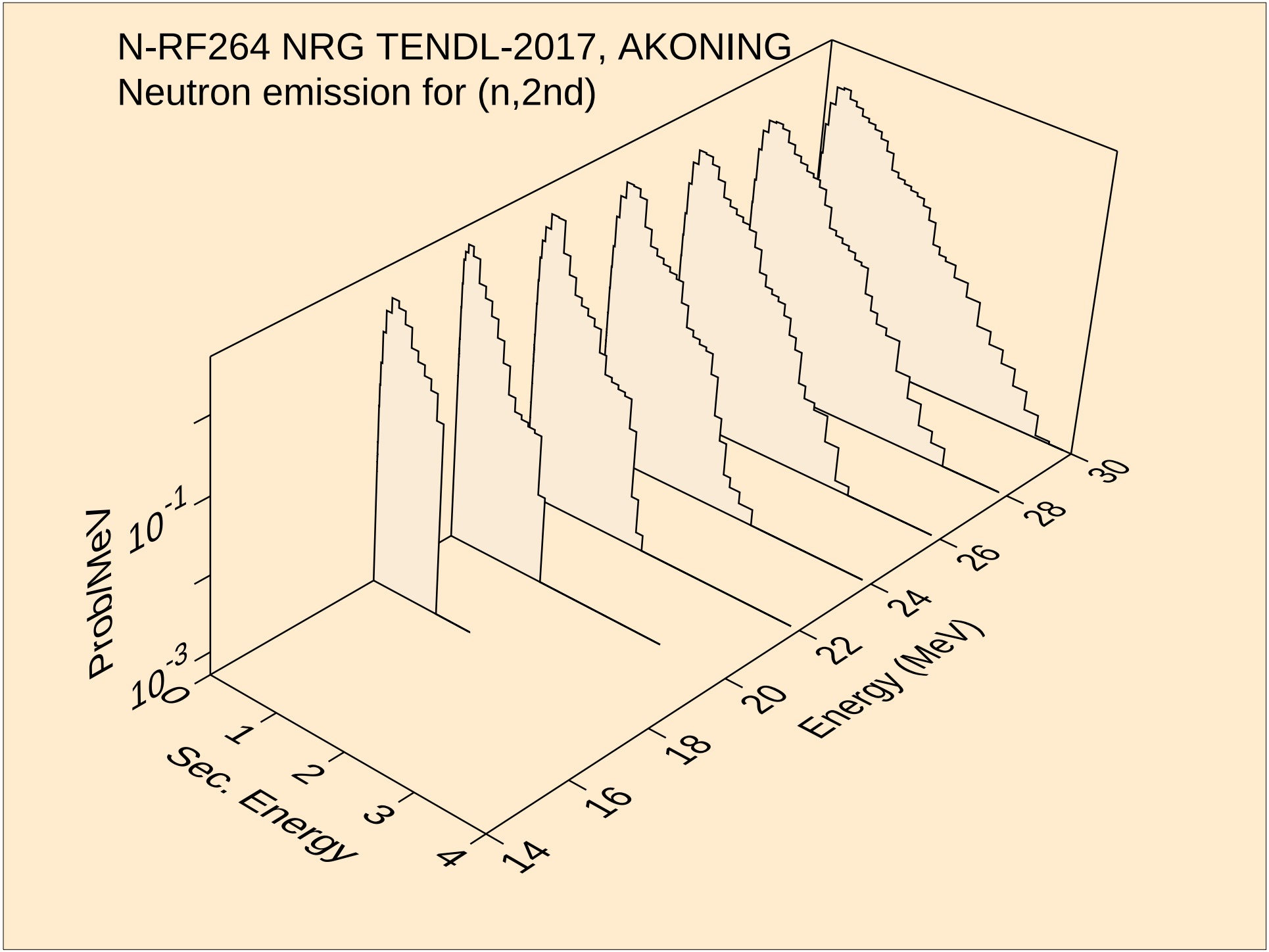

N-RF264 NRG TENDL-2017, AKONING
angular distribution for elastic
ProbCos
10^{1}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
Energy (MeV)

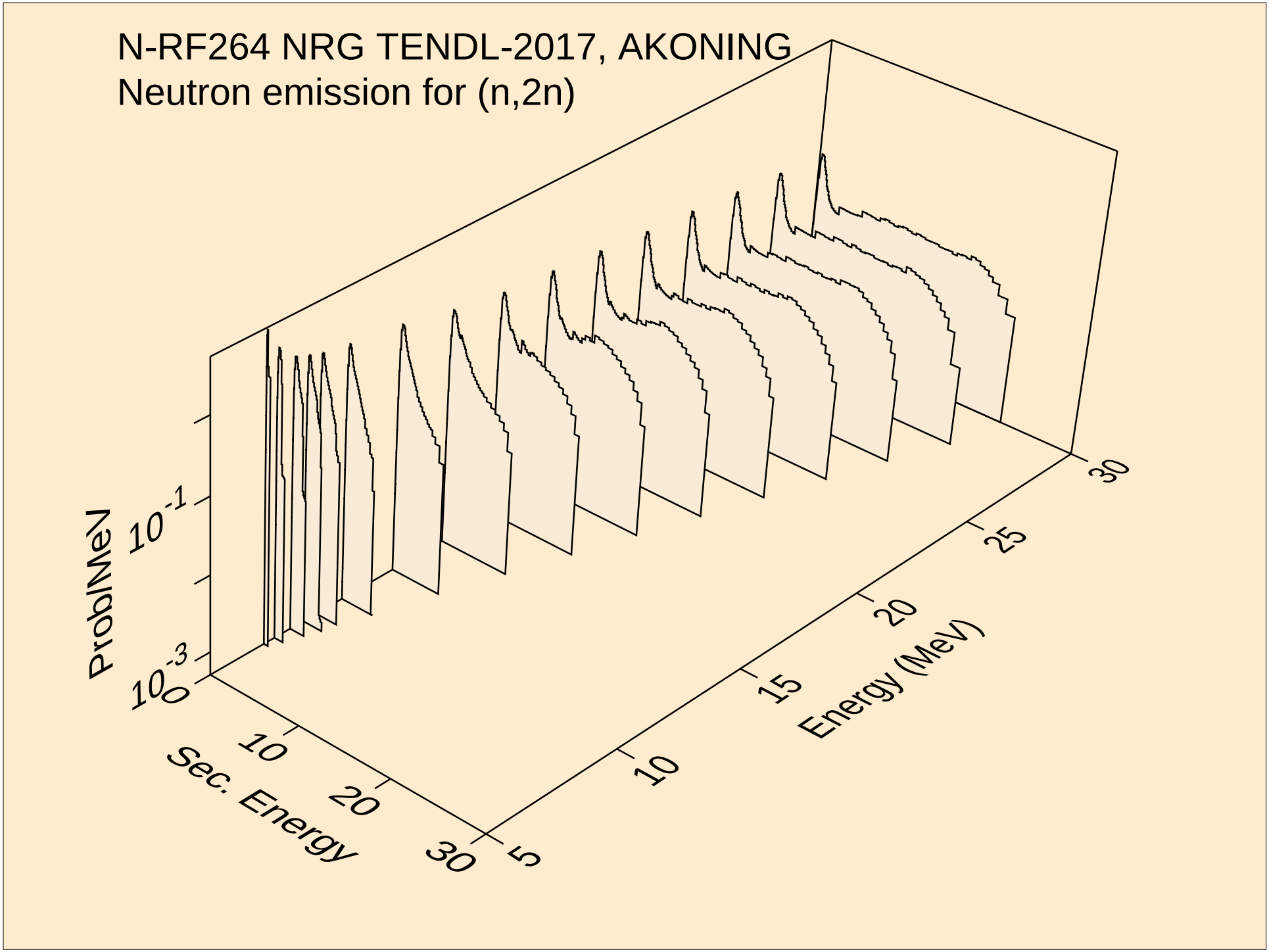

N-RF264 NRG TENDL-2017, AKONING
angular distribution for elastic
ProbCos
10^{2}
10^{0}
10^{-2}
Cosine
1.0
0.5
0.0
-0.5
-1.0
Energy (MeV)
20
40
60
80
100
120
140
160
180
200

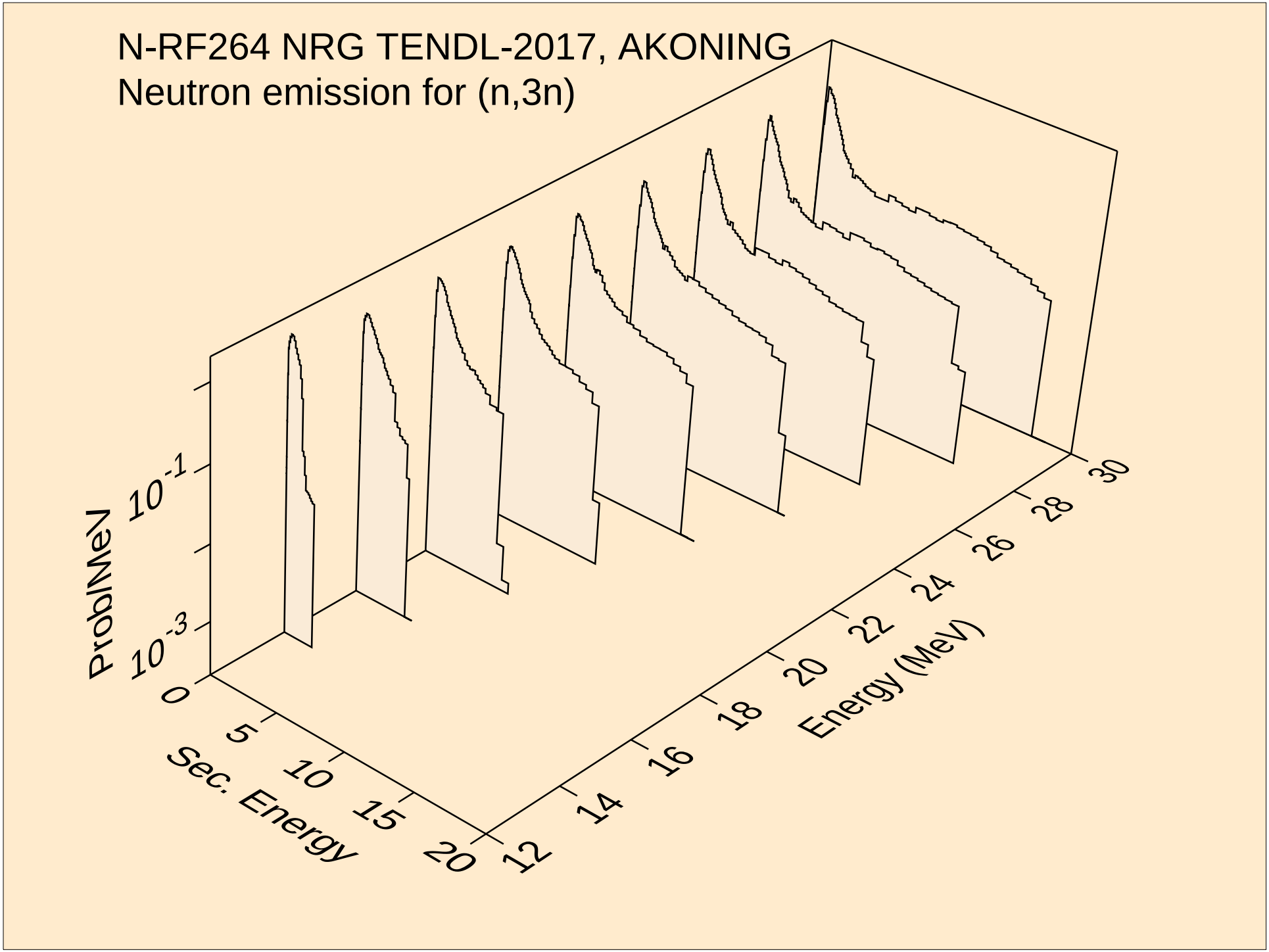

N-RF264 NRG TENDL-2017, AKONING
angular distribution for (n,n*1)
ProbCos
10^{1}
10^{0}
10^{-1}
1.0
0.5
0.0
-0.5
-1.0
Cosine
0
5
10
15
20
25
30
Energy (MeV)

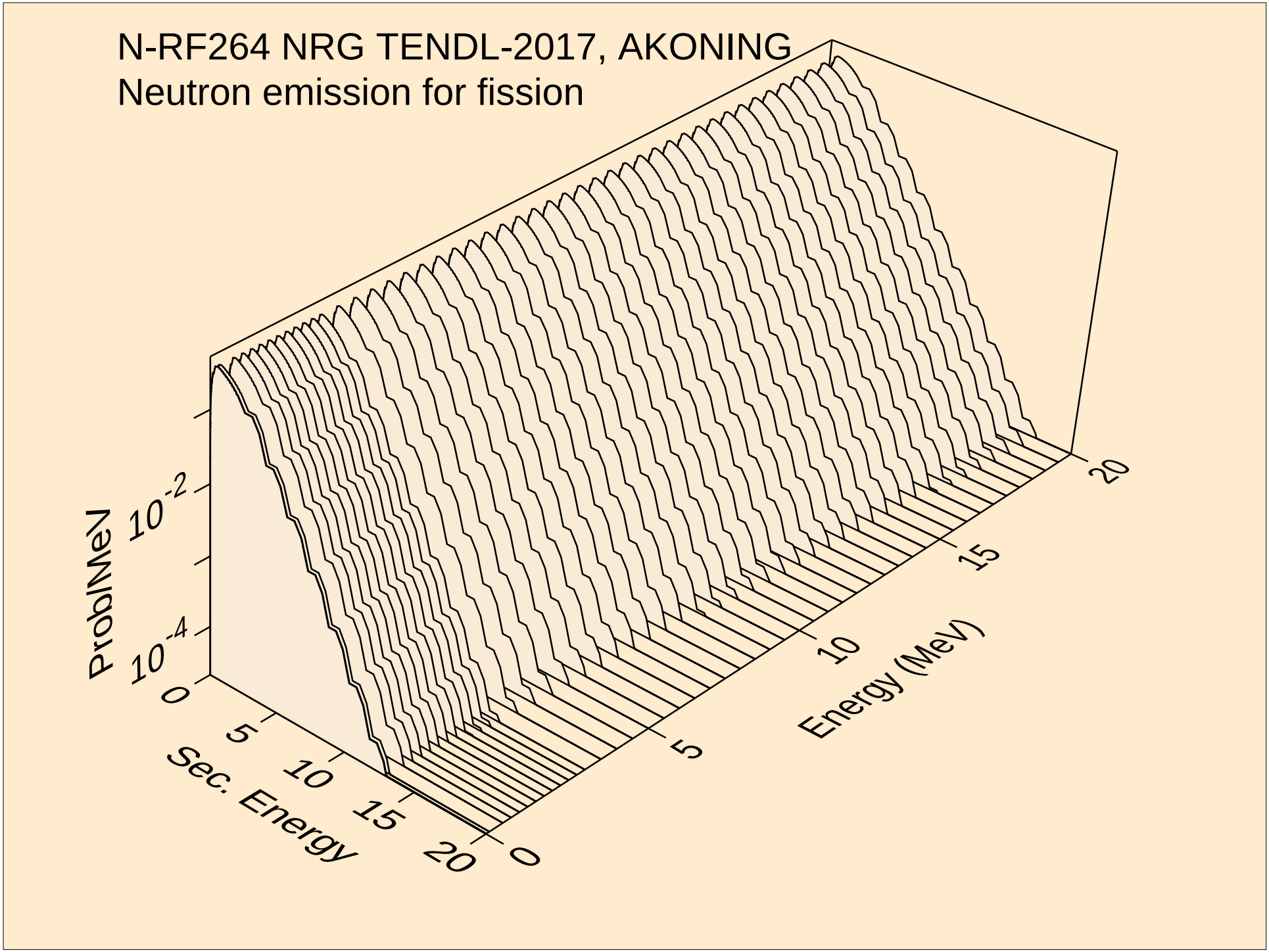

N-RF264 NRG TENDL-2017, AKONING
Total fission nubar
Fission nubar
7.0
6.5
6.0
5.5
5.0
4.5
4.0
0
50
100
150
200
Energy (MeV)

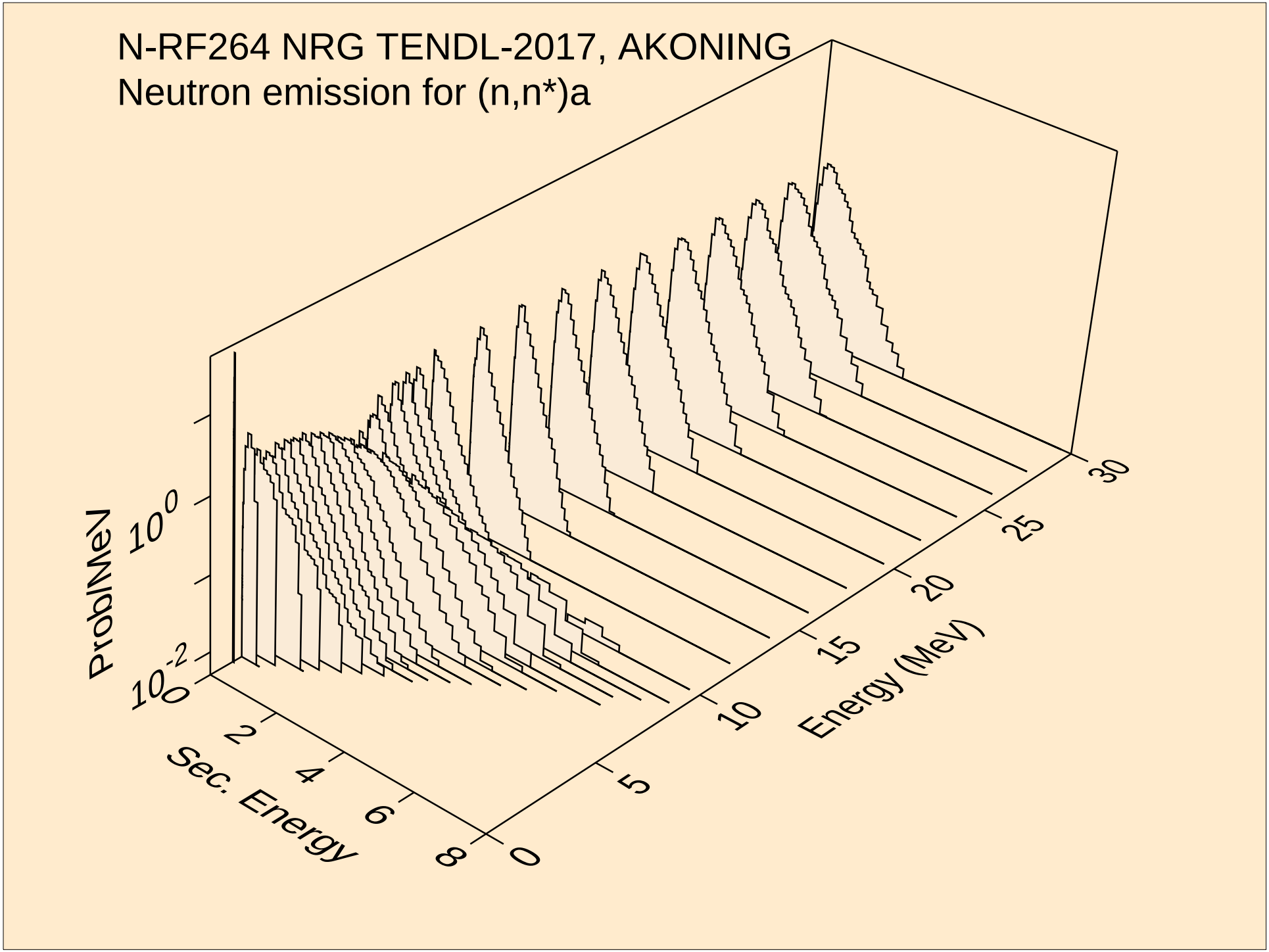

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,x)
Prob/MeV
10^3
10^1
0
2
4
6
8
10
Sec. Energy
0
50
100
150
200
Energy (MeV)

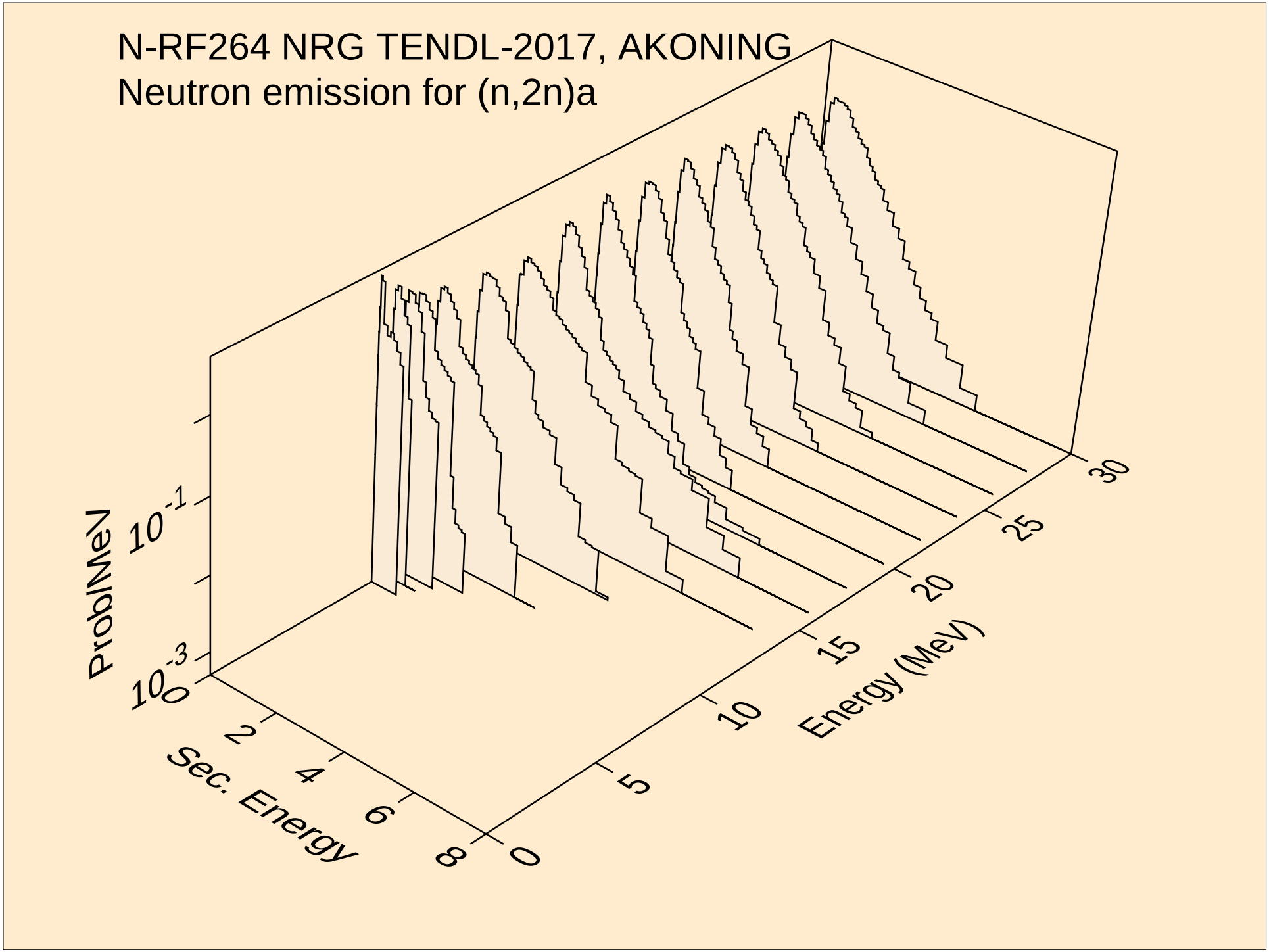

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,2nd)
Prob/MeV
10-1
10-3
0
Sec. Energy
1
2
3
4
14
16
18
20
22
24
26
28
30
Energy (MeV)

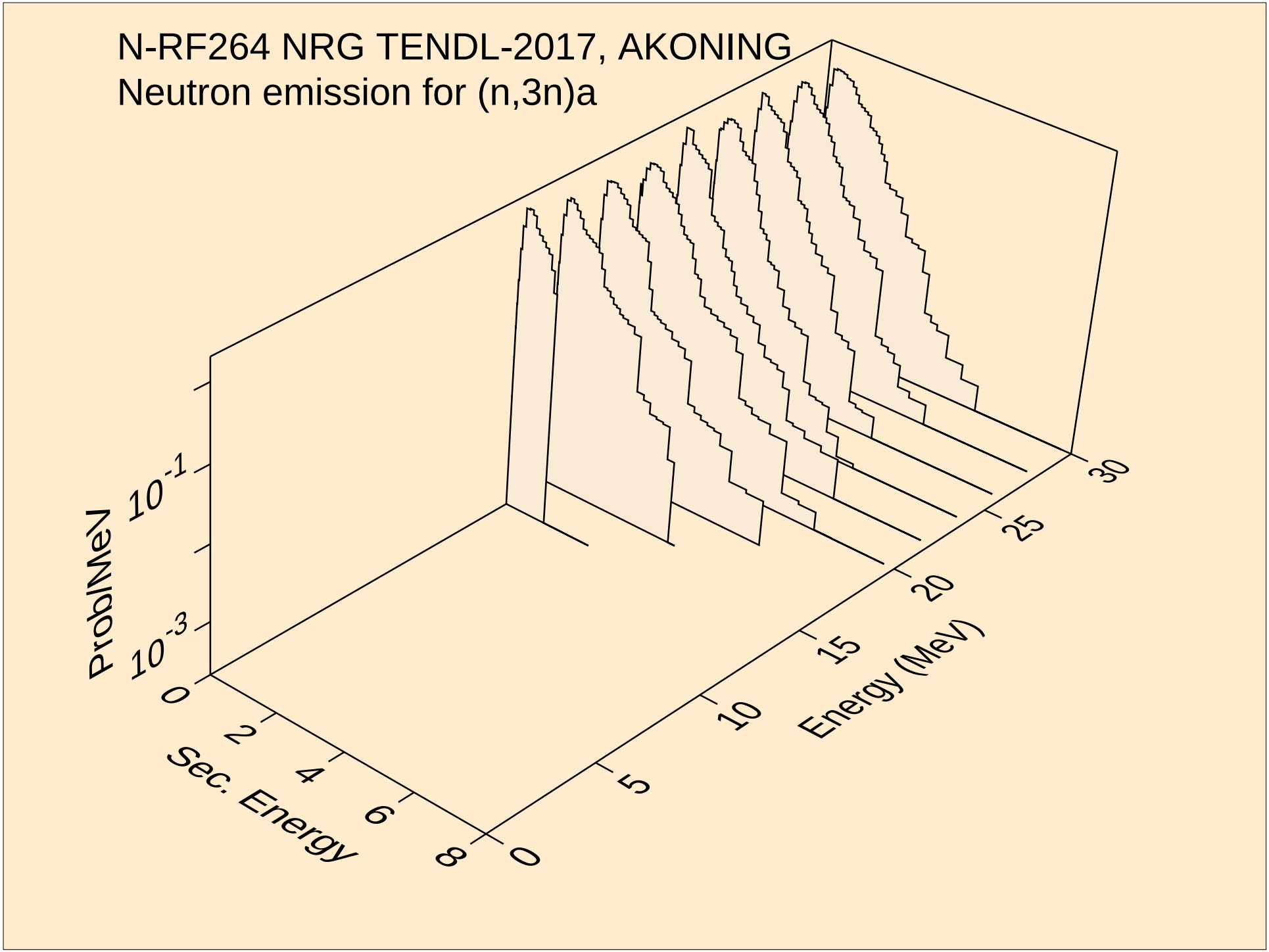

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,2n)
Prob/MeV
10-1
10-3
0
10
20
30
Sec. Energy
5
10
15
20
25
30
Energy (MeV)

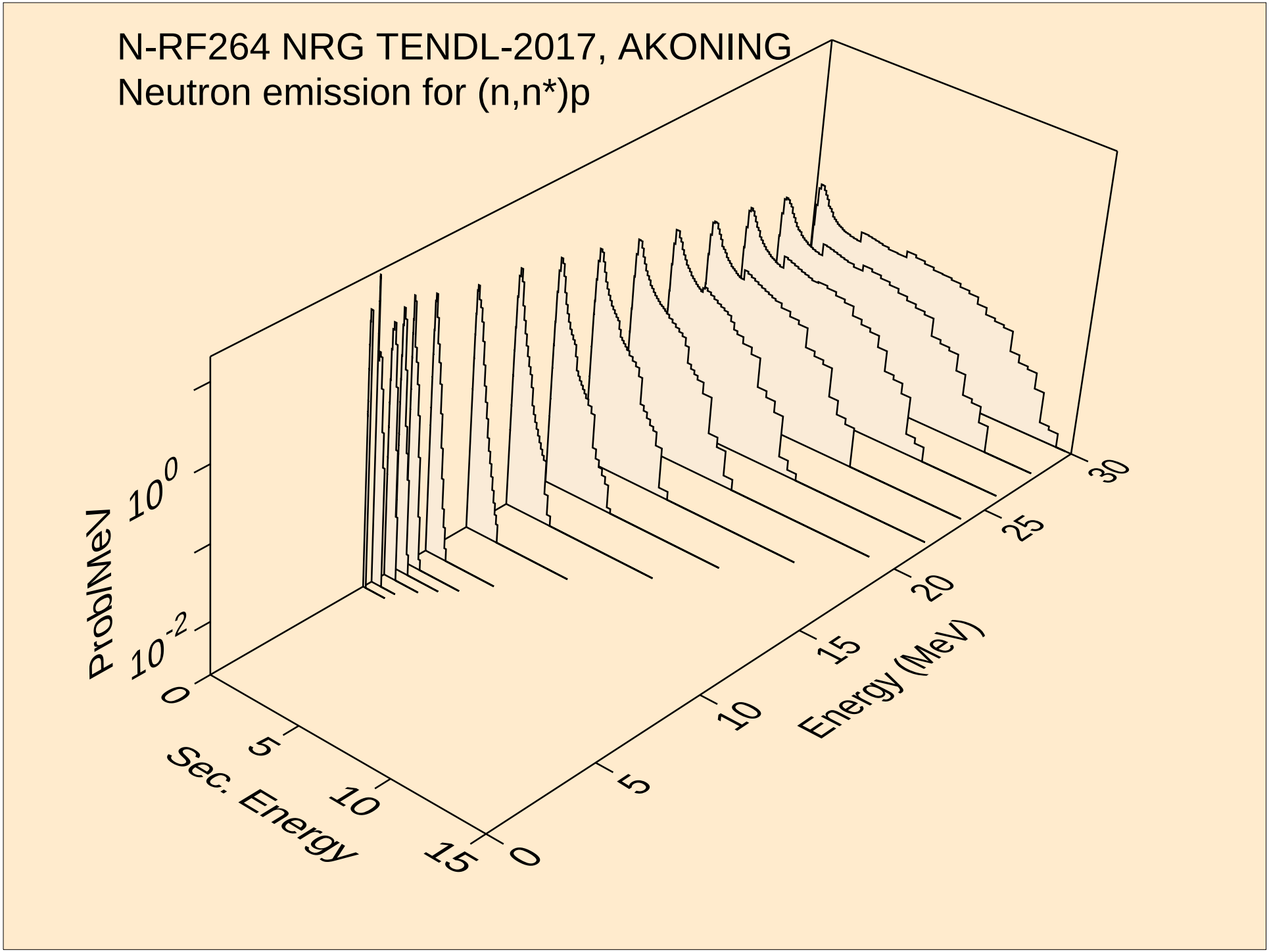

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,3n)
Prob/MeV
10-1
10-3
0
5
10
15
20
Sec. Energy
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

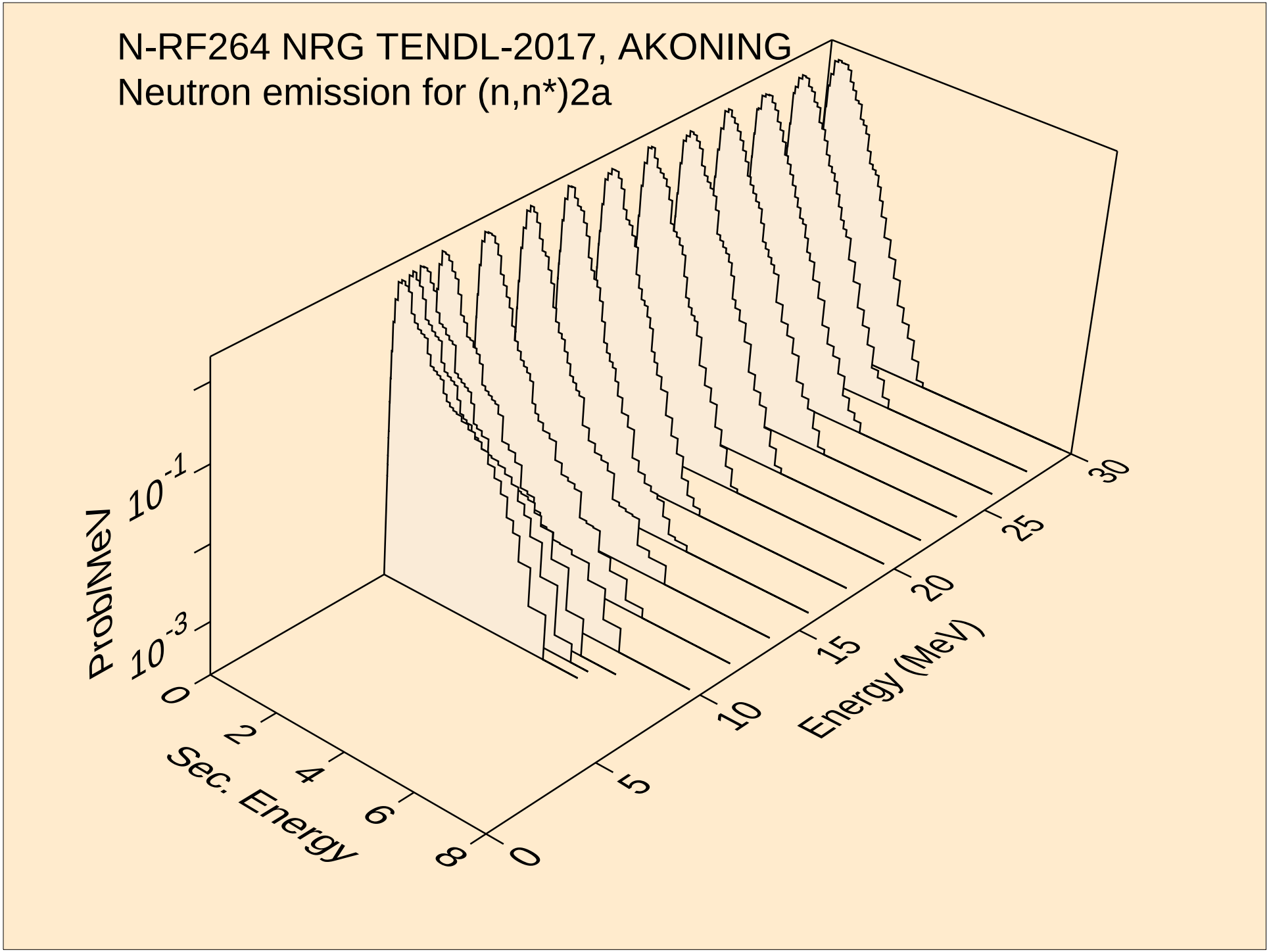

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for fission
Prob/MeV
10-2
10-4
0
5
10
15
20
Sec. Energy
0
5
10
15
20
Energy (MeV)

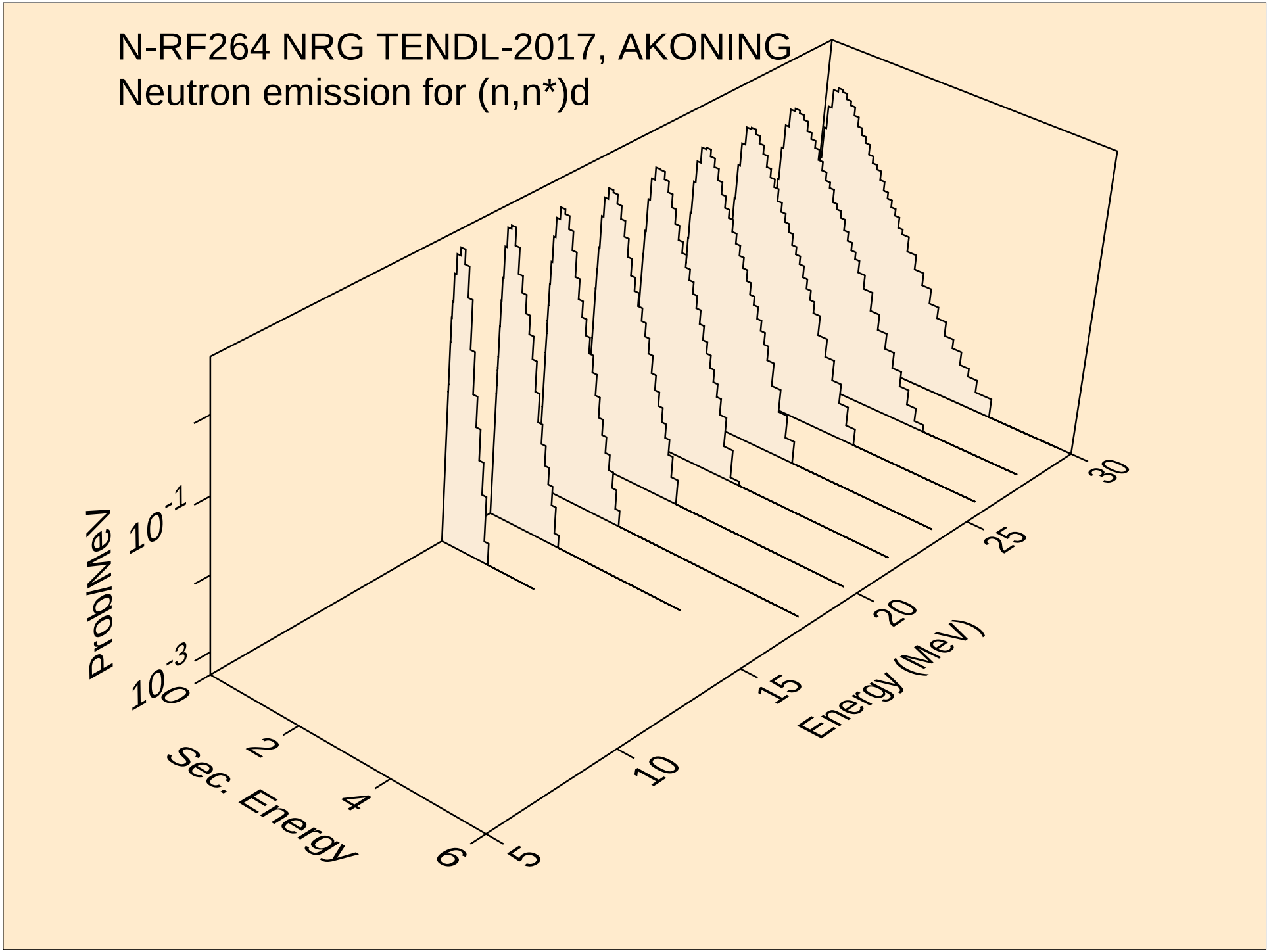

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,n*)a
Prob/MeV
10^0
10^-2
0
2
4
6
8
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

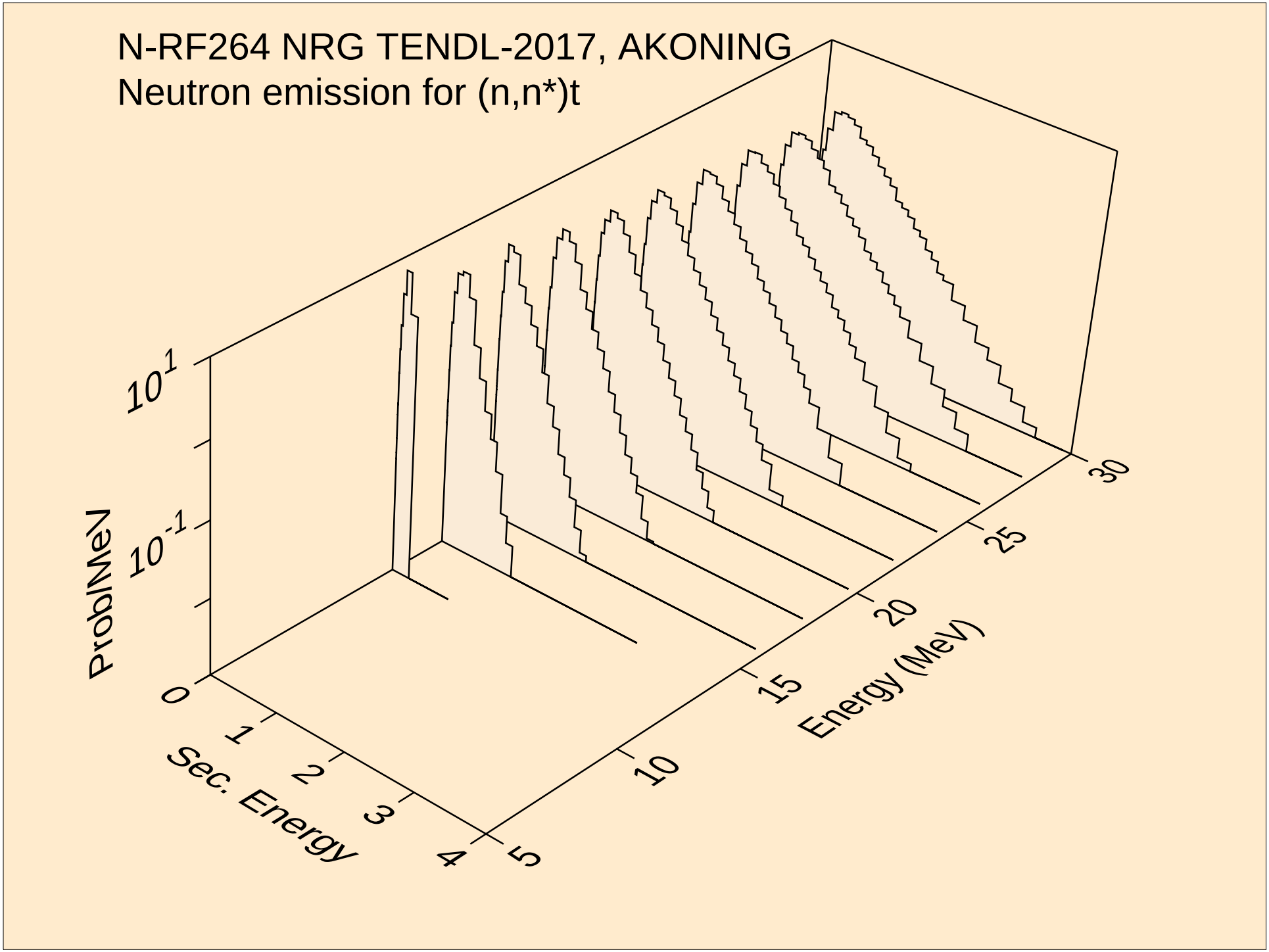

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,2n)a
Prob/MeV
10-1
10-3
0
2
4
6
8
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

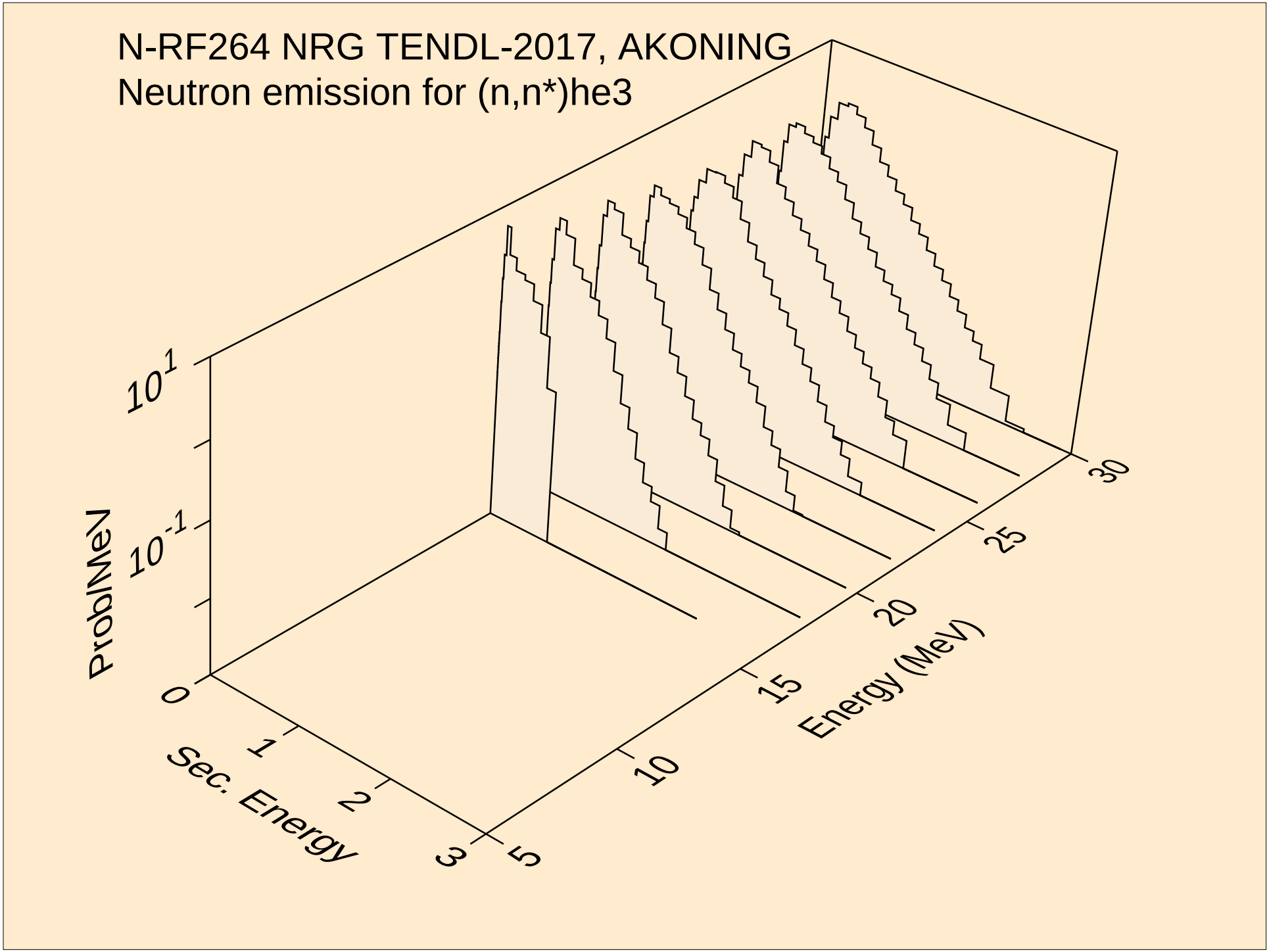

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,3n)a
Prob/MeV
10-1
10-3
0
2
4
6
8
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

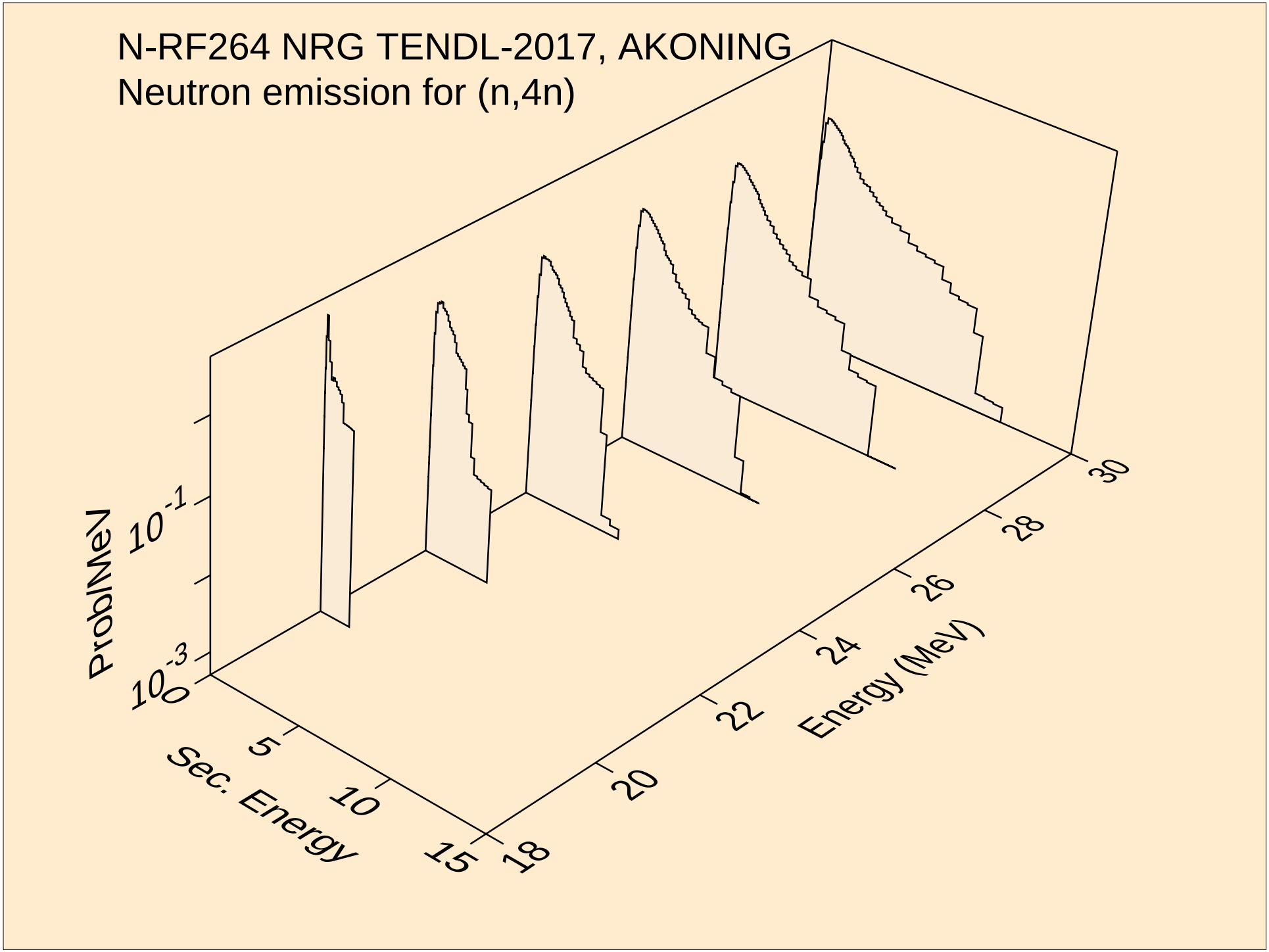

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,n*)p
Prob/MeV
10^0
10^-2
0
5
10
15
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

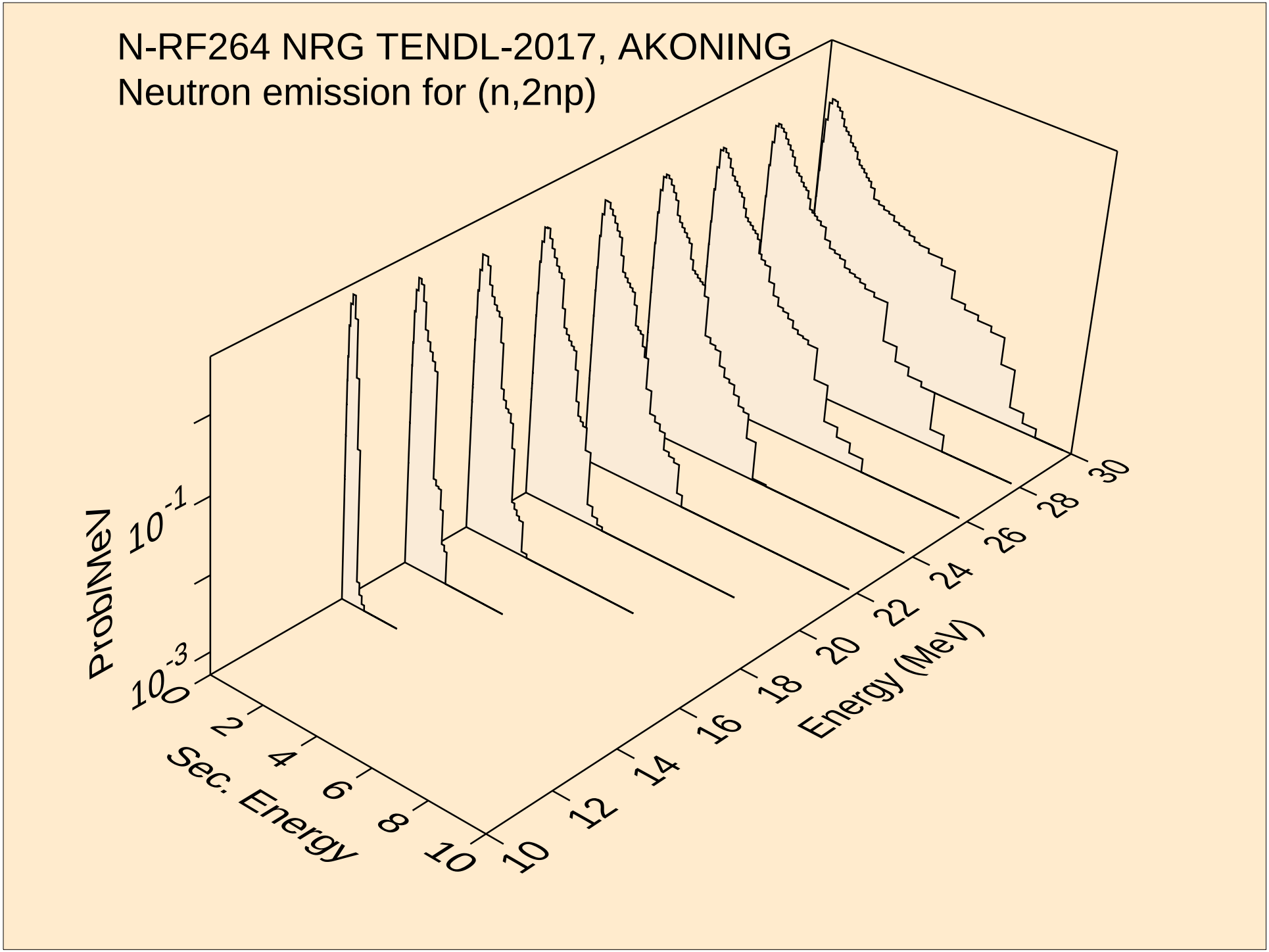

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,n*)2a
Prob/MeV
10-1
10-3
0
2
4
6
8
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

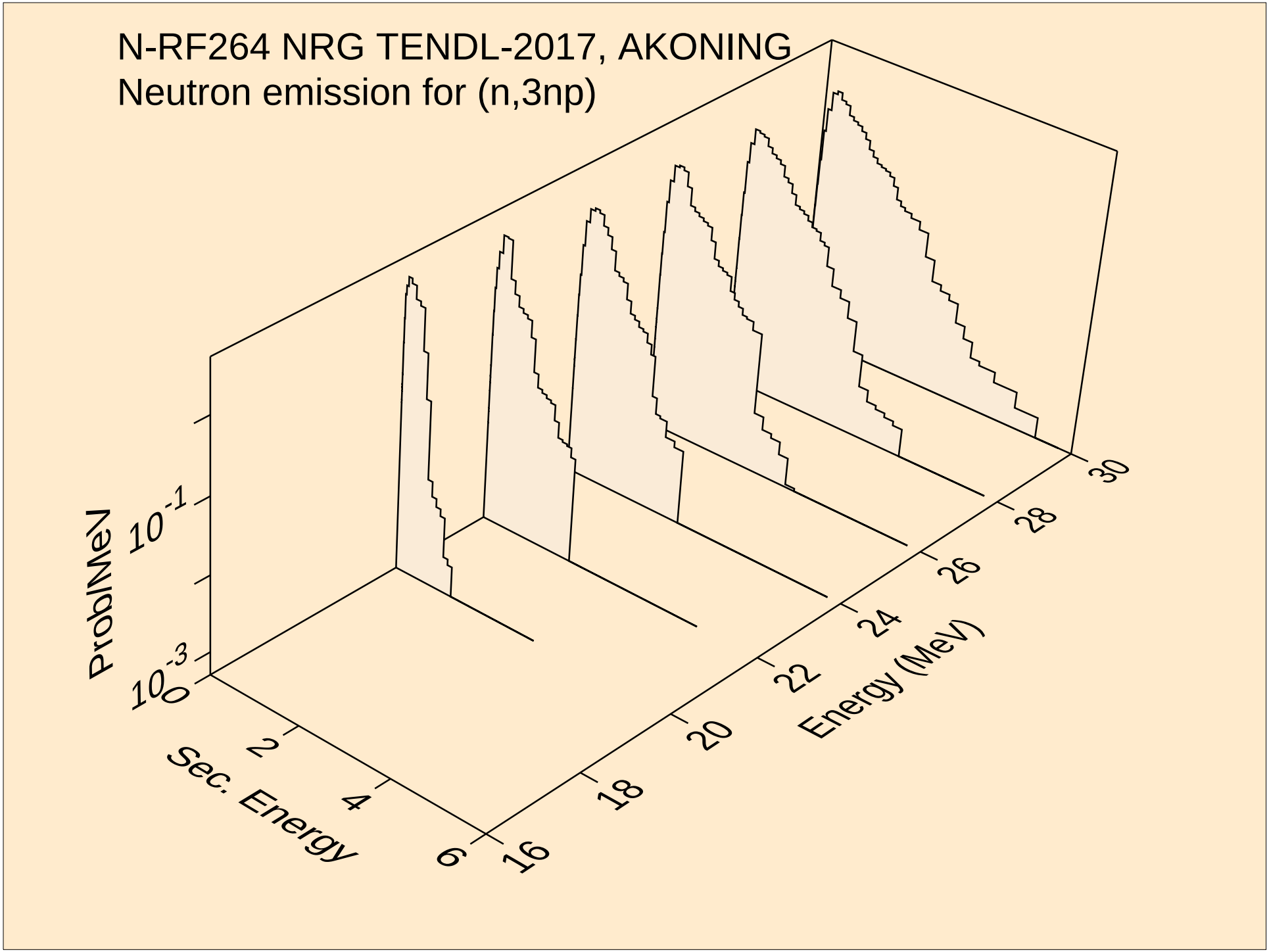

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,n*)d
Prob/MeV
10-1
10-3
0
2
4
6
Sec. Energy
5
10
15
20
25
30
Energy (MeV)

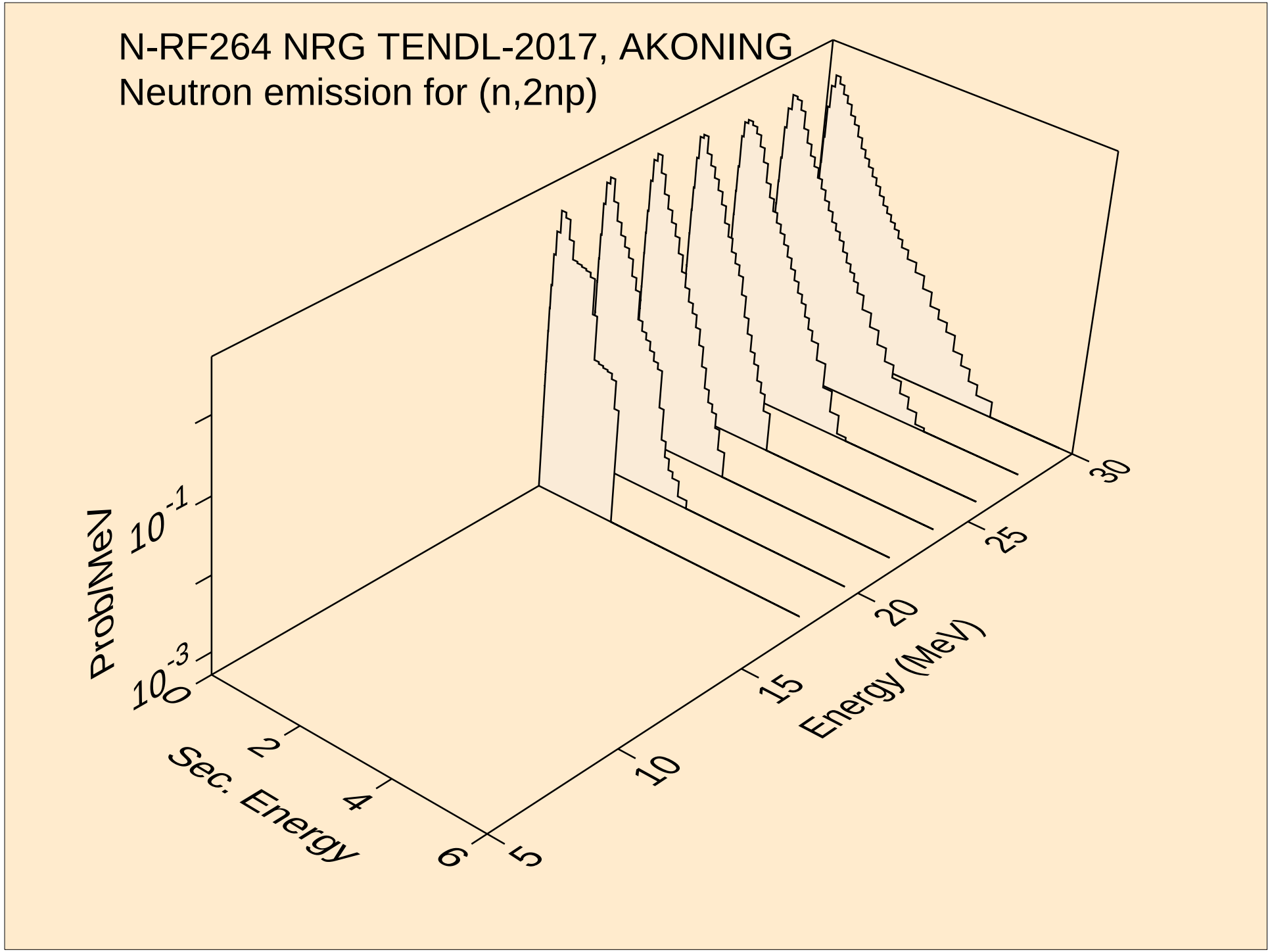

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,n*)t
Prob/MeV
10^{1}
10^{-1}
0
1
2
3
4
5
Sec. Energy
10
15
20
25
30
Energy (MeV)

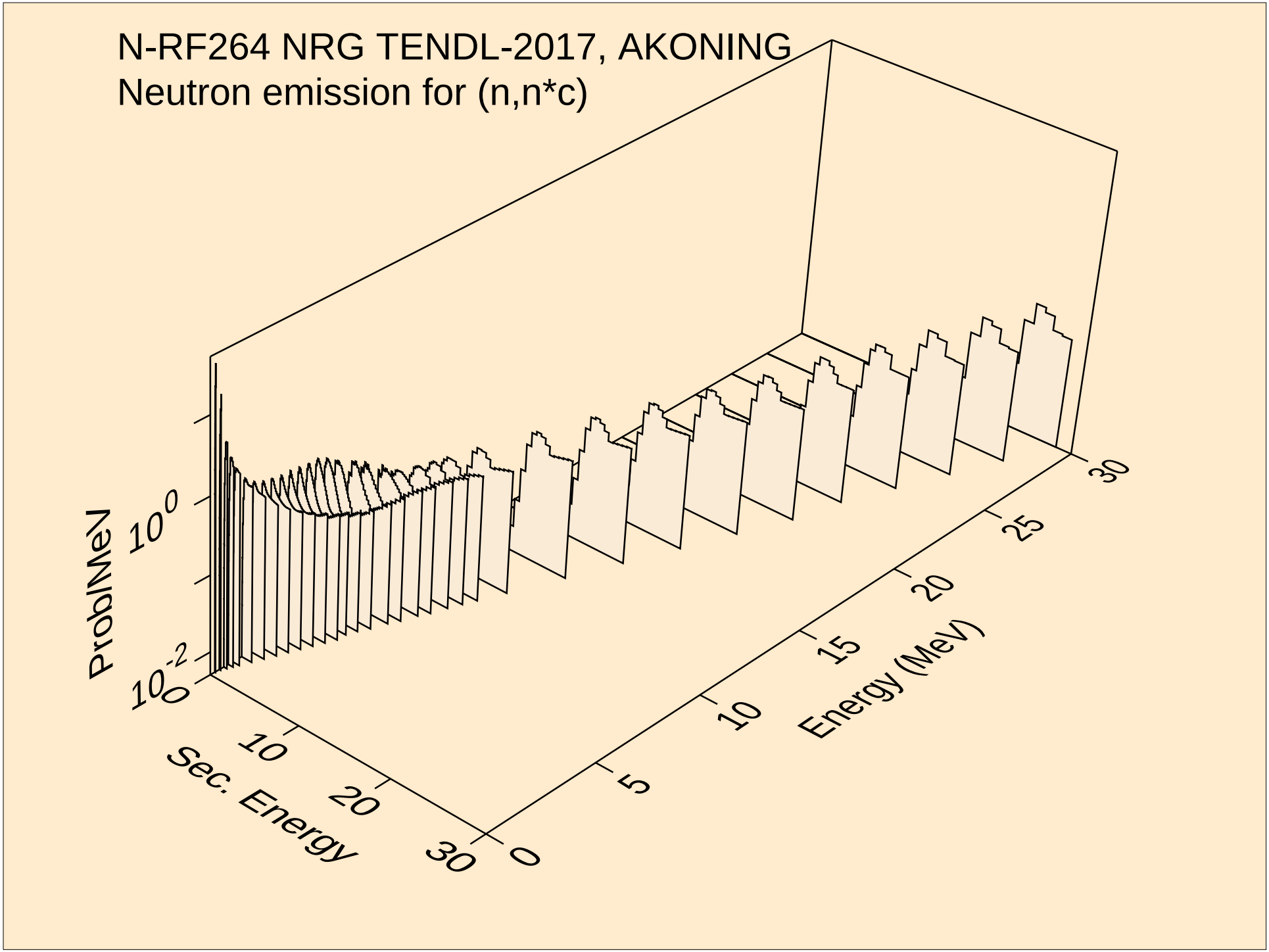

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,n*)he3
Prob/MeV
10^{1}
10^{-1}
0
1
2
3
Sec. Energy
5
10
15
20
25
30
Energy (MeV)

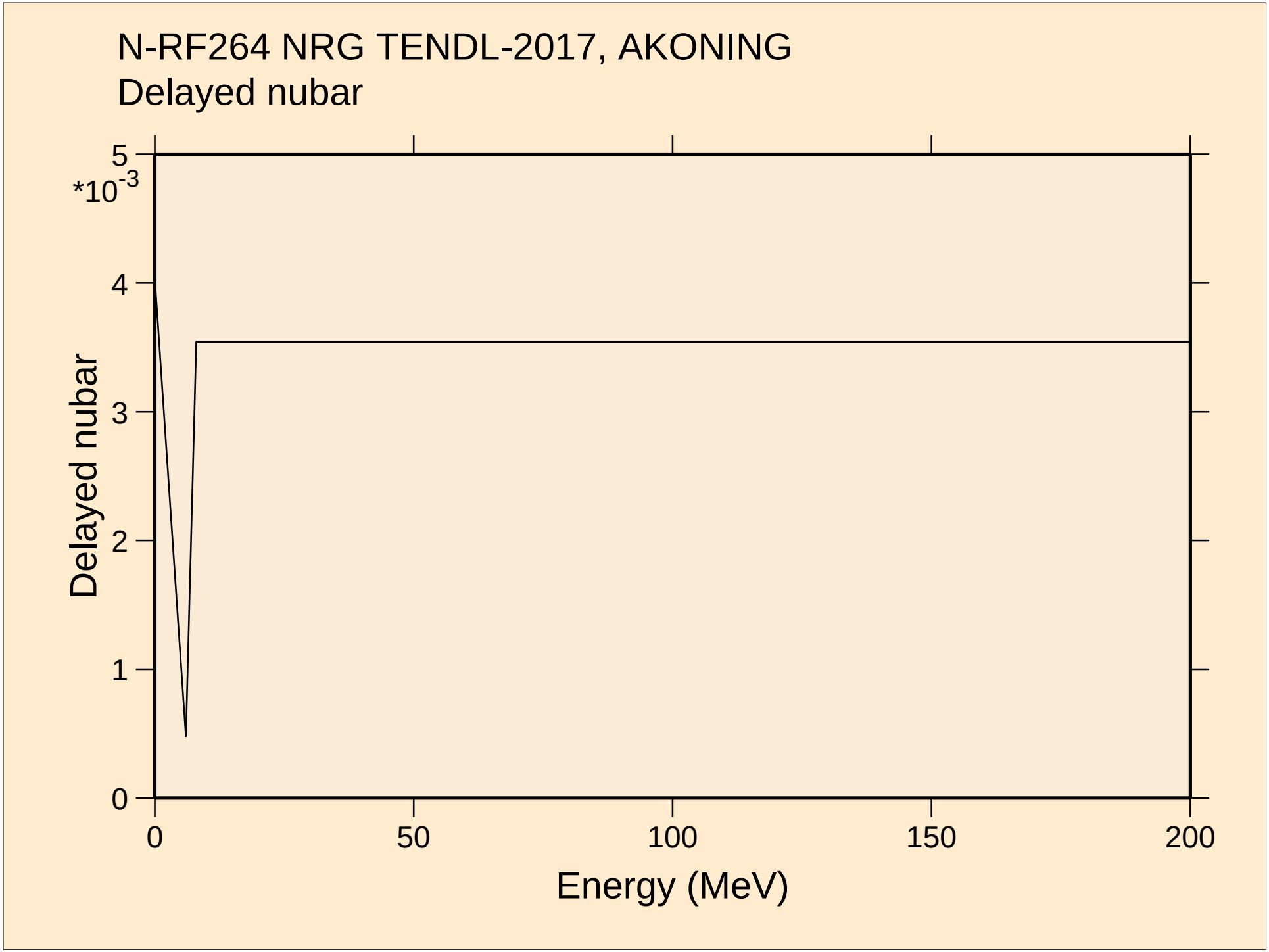

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,4n)
Prob/MeV
10-1
10-3
0
5
10
15
18
Sec. Energy
20
22
24
26
28
30
Energy (MeV)

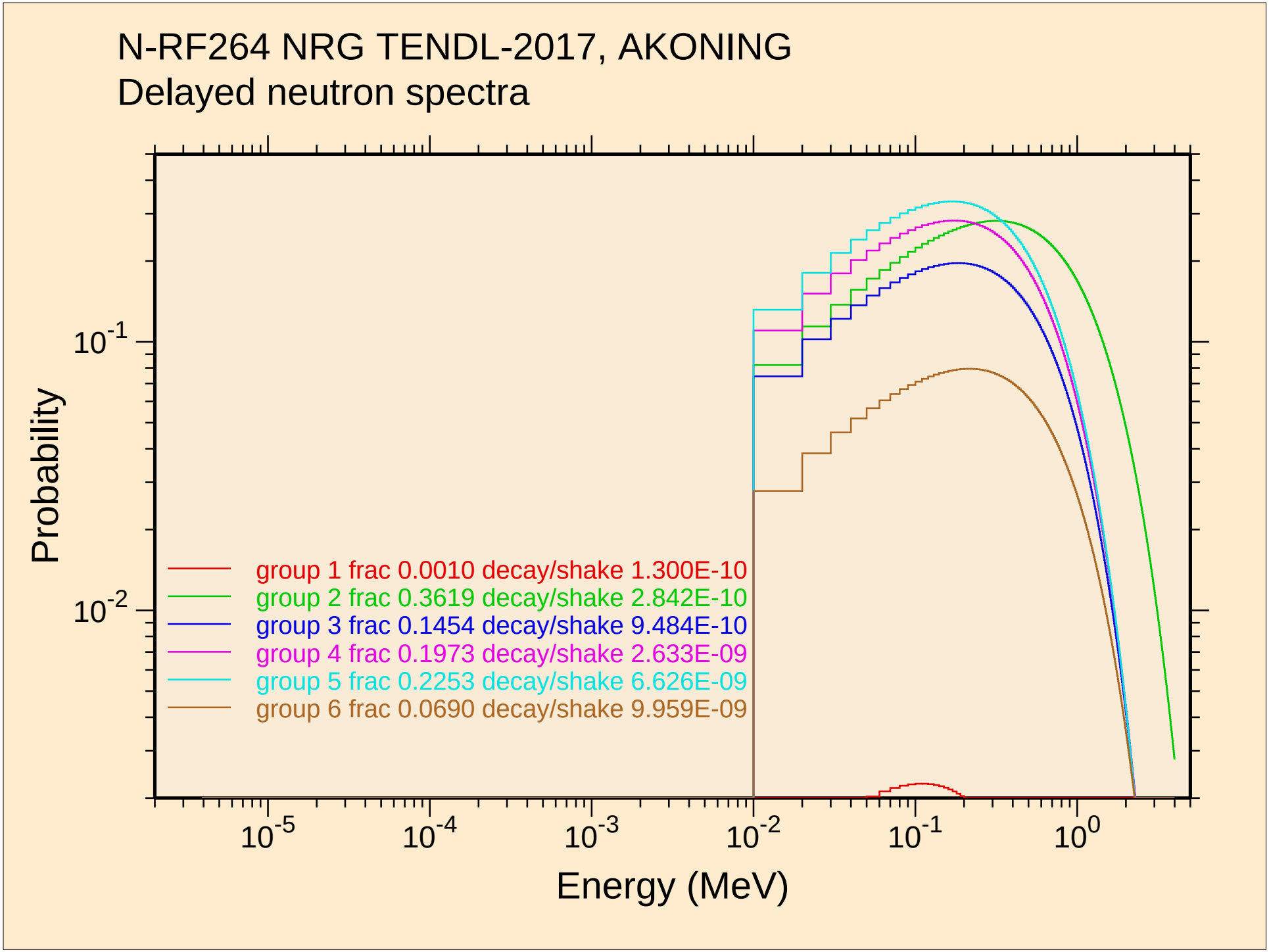

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,2np)
Prob/MeV
10-1
10-3
0
2
4
6
8
10
Sec. Energy
10
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

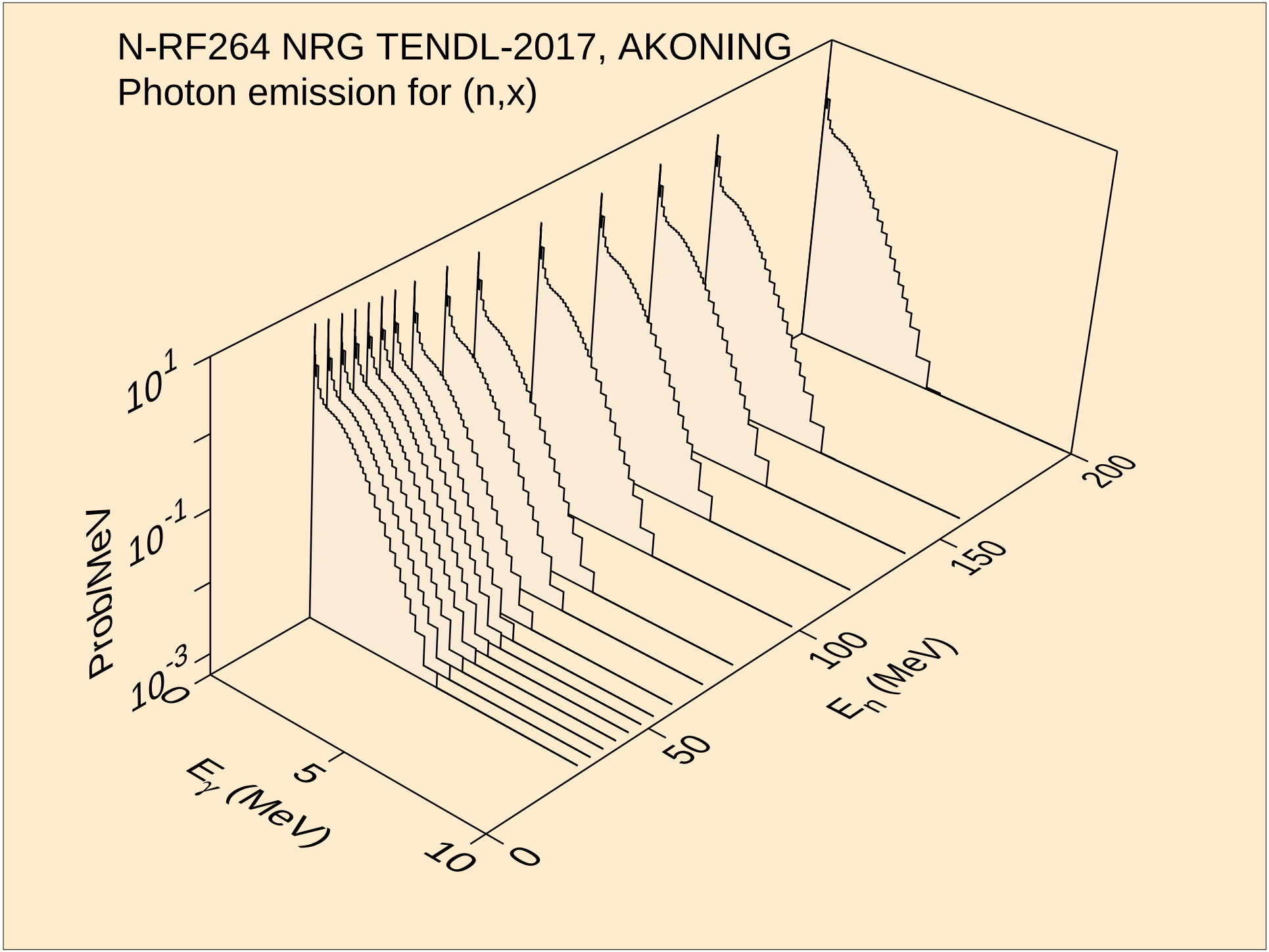

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,3np)
Prob/MeV
10-1
10-3
0
2
4
6
Sec. Energy
16
18
20
22
24
26
28
30
Energy (MeV)

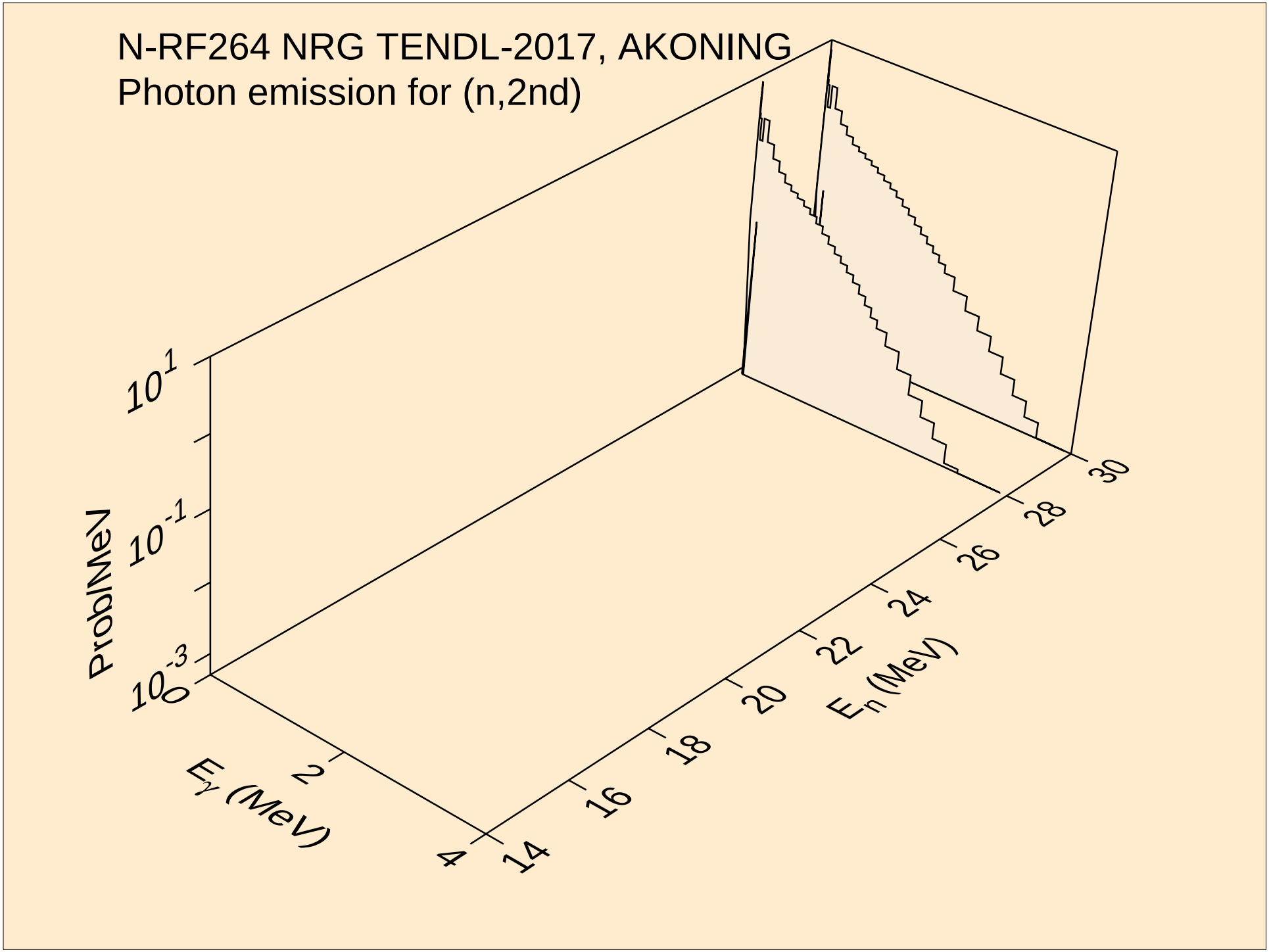

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,2np)
Prob/MeV
10-1
10-3
0
2
4
6
Sec. Energy
5
10
15
20
25
30
Energy (MeV)

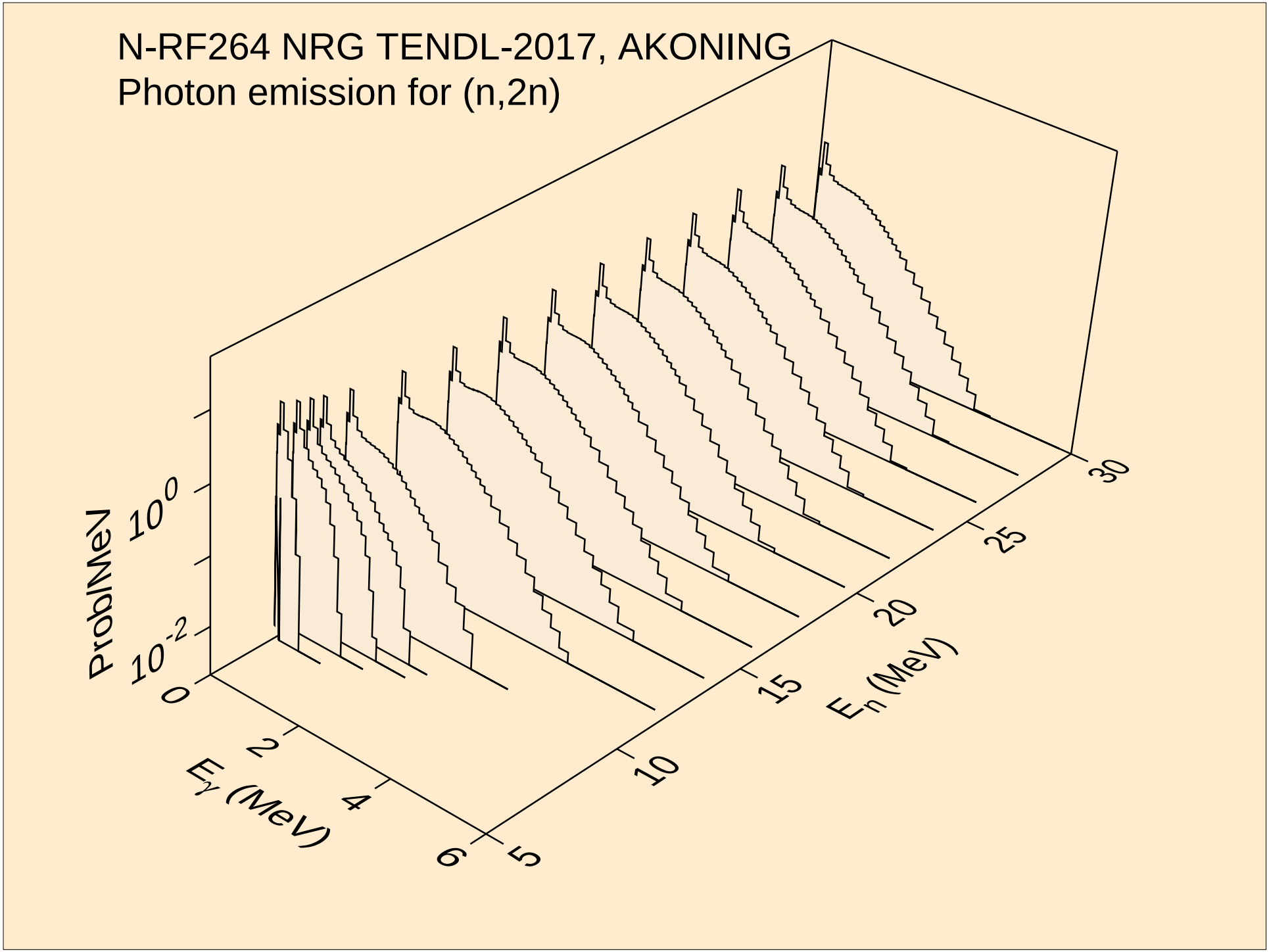

N-RF264 NRG TENDL-2017, AKONING
Neutron emission for (n,n*c)
Prob/MeV
10^{0}
10^{-2}
0
10
20
30
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

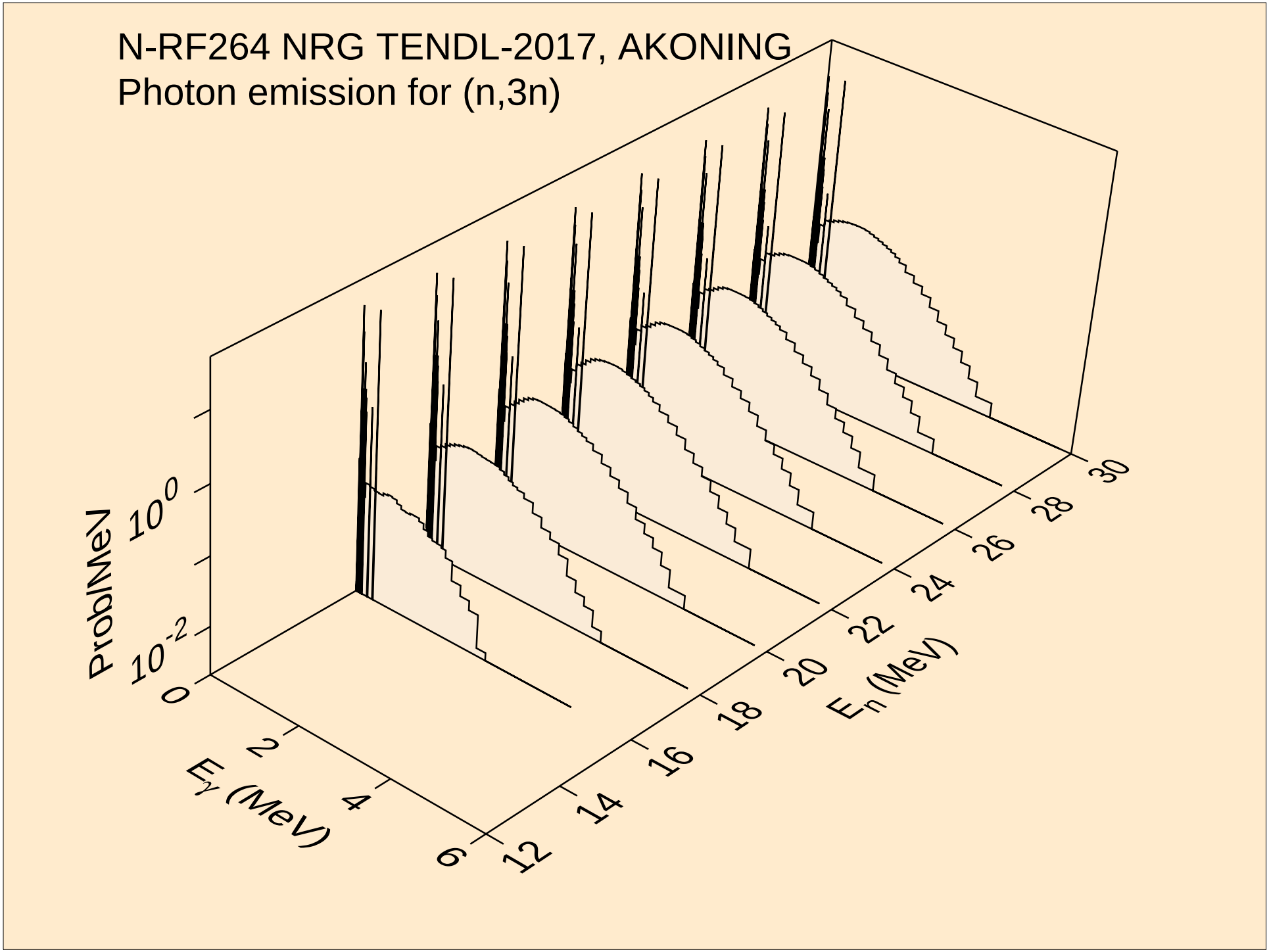

N-RF264 NRG TENDL-2017, AKONING
Delayed nubar
*10-3
5
4
3
2
1
0
Delayed nubar
0
50
100
150
200
Energy (MeV)

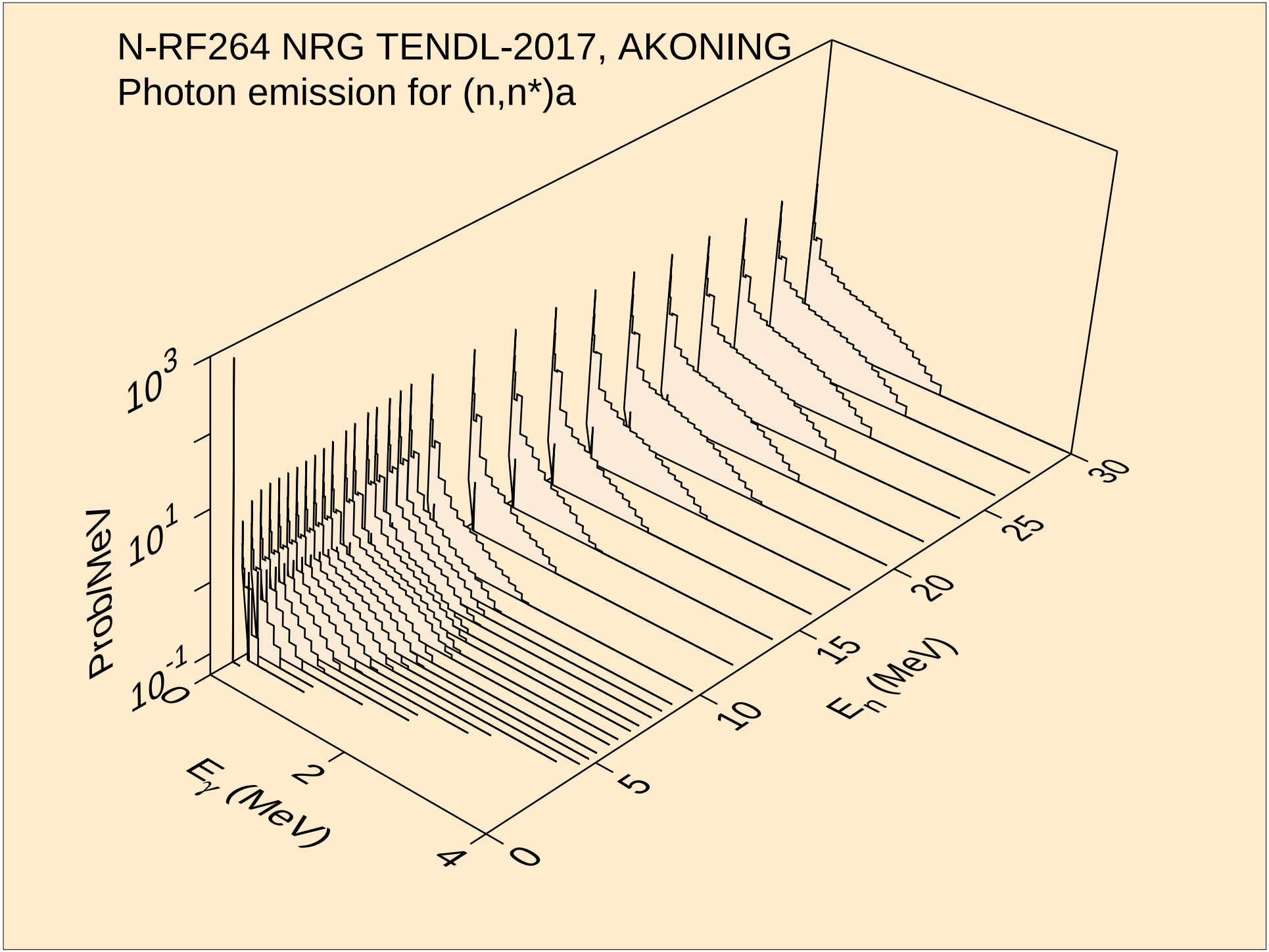

N-RF264 NRG TENDL-2017, AKONING
Delayed neutron spectra
Probability
10^{-1}
10^{-2}
group 1 frac 0.0010 decay/shake 1.300E-10
group 2 frac 0.3619 decay/shake 2.842E-10
group 3 frac 0.1454 decay/shake 9.484E-10
group 4 frac 0.1973 decay/shake 2.633E-09
group 5 frac 0.2253 decay/shake 6.626E-09
group 6 frac 0.0690 decay/shake 9.959E-09
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Energy (MeV)

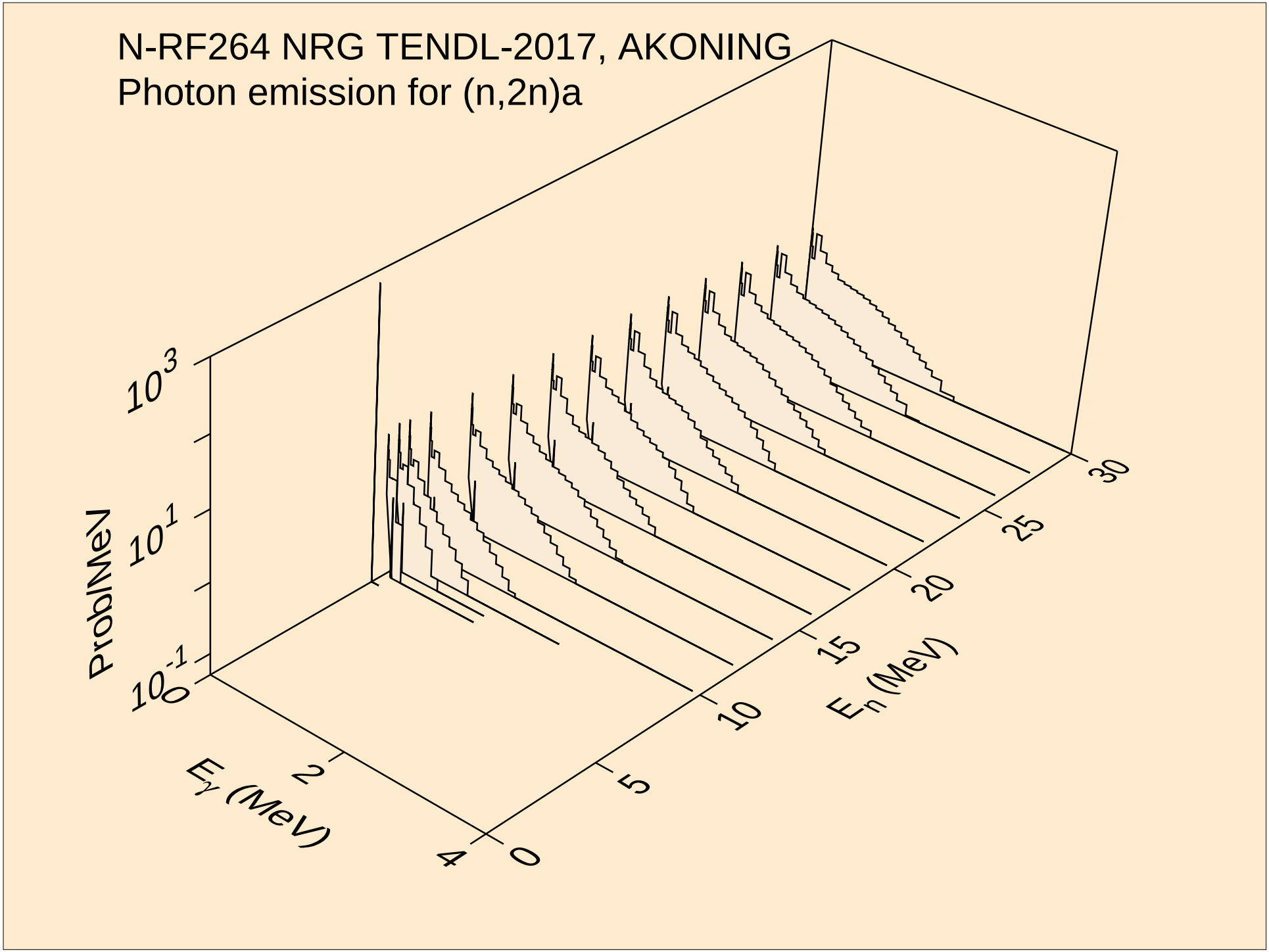

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,x)
Prob/MeV
10^{1}
10^{-1}
10^{-3}
E_γ (MeV)
0
5
10
E_n (MeV)
0
50
100
150
200

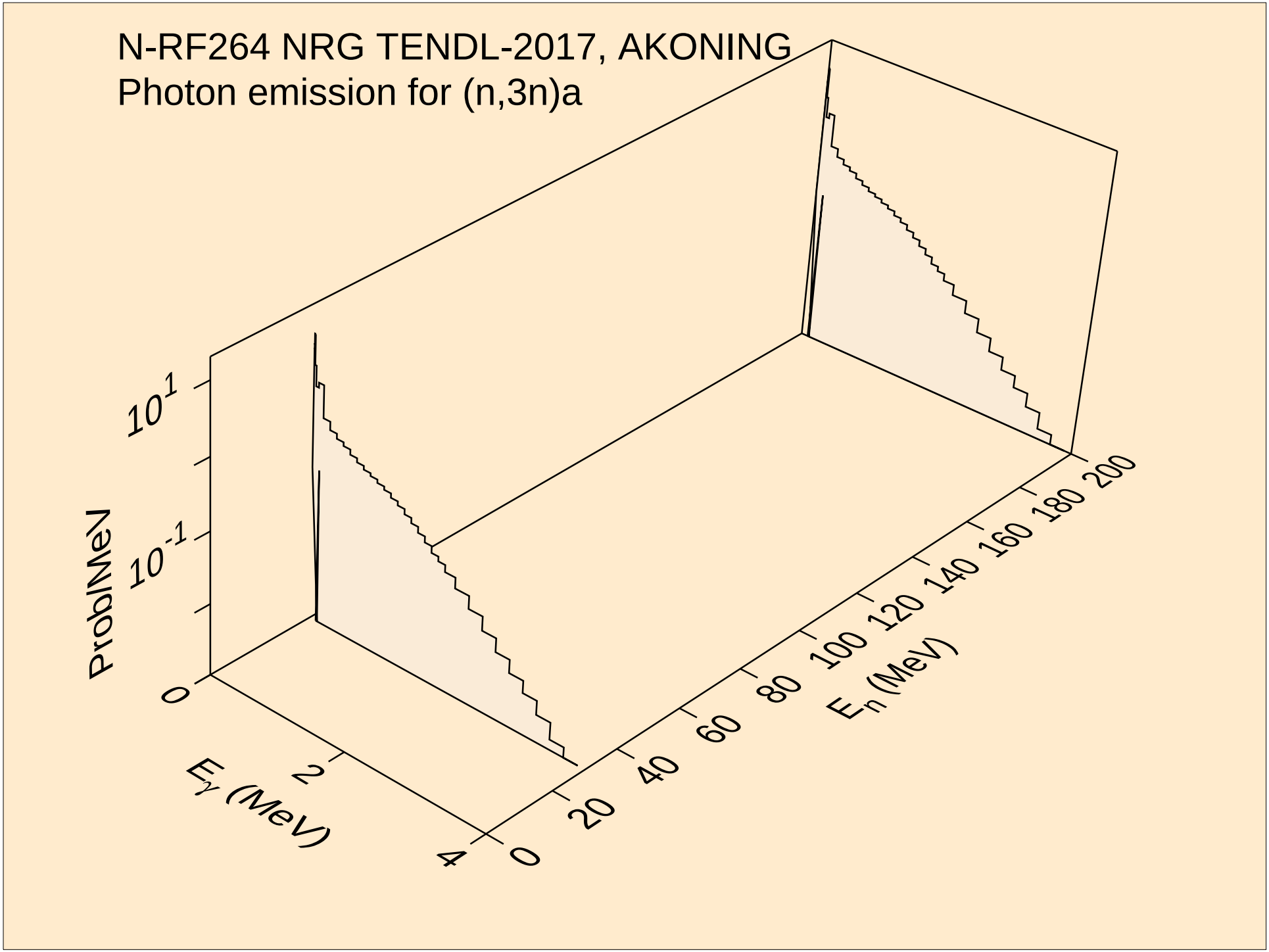

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,2nd)
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
2
4
E_γ (MeV)
14
16
18
20
22
24
26
28
30
E_n (MeV)

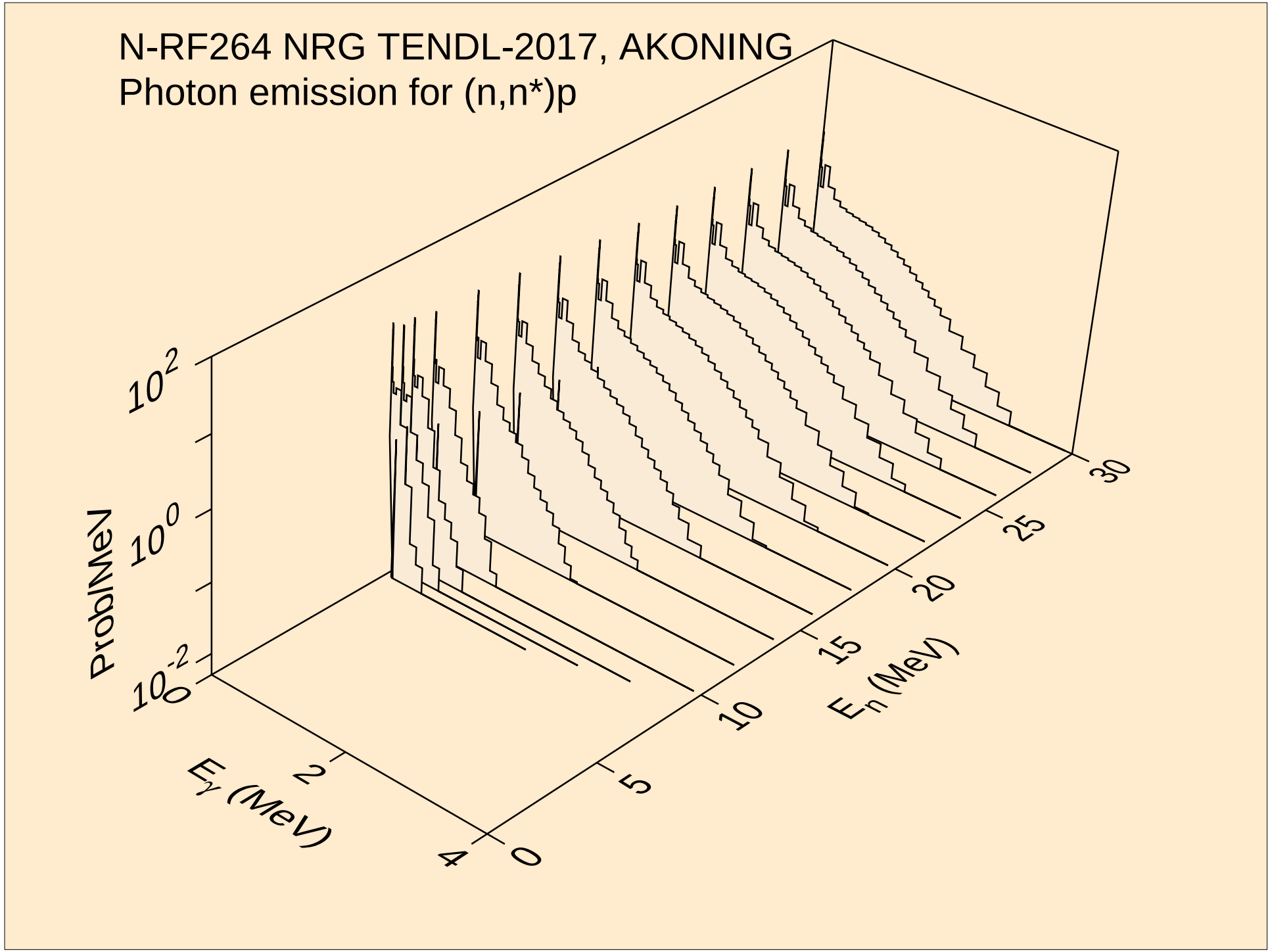

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,2n)
Prob/MeV
10^{0}
10^{-2}
0
2
4
6
E_γ (MeV)
5
10
15
20
25
30
E_n (MeV)

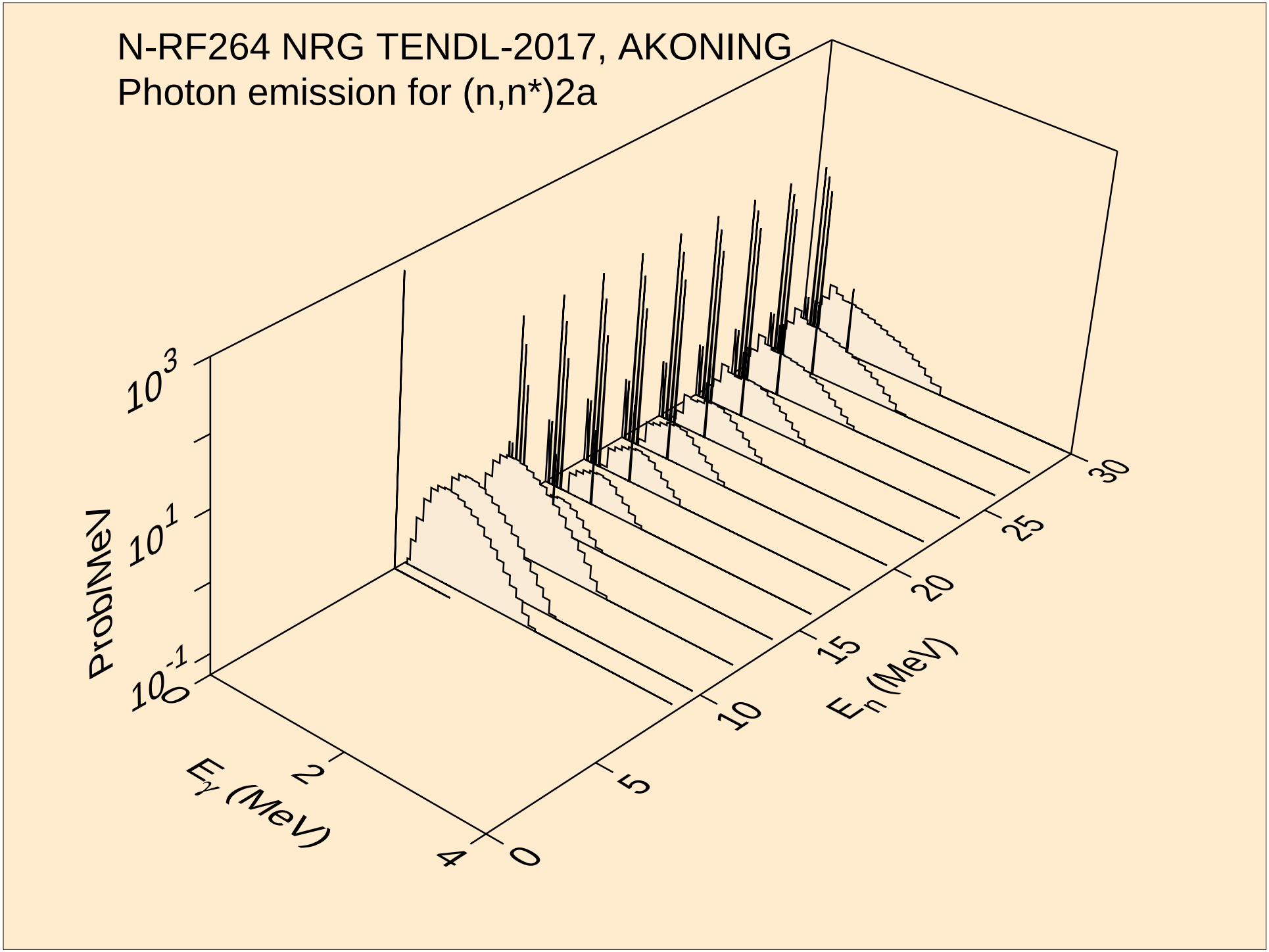

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,3n)
Prob/MeV
10^{0}
10^{-2}
0
2
4
6
E_γ (MeV)
12
14
16
18
20
22
24
26
28
30
E_n (MeV)

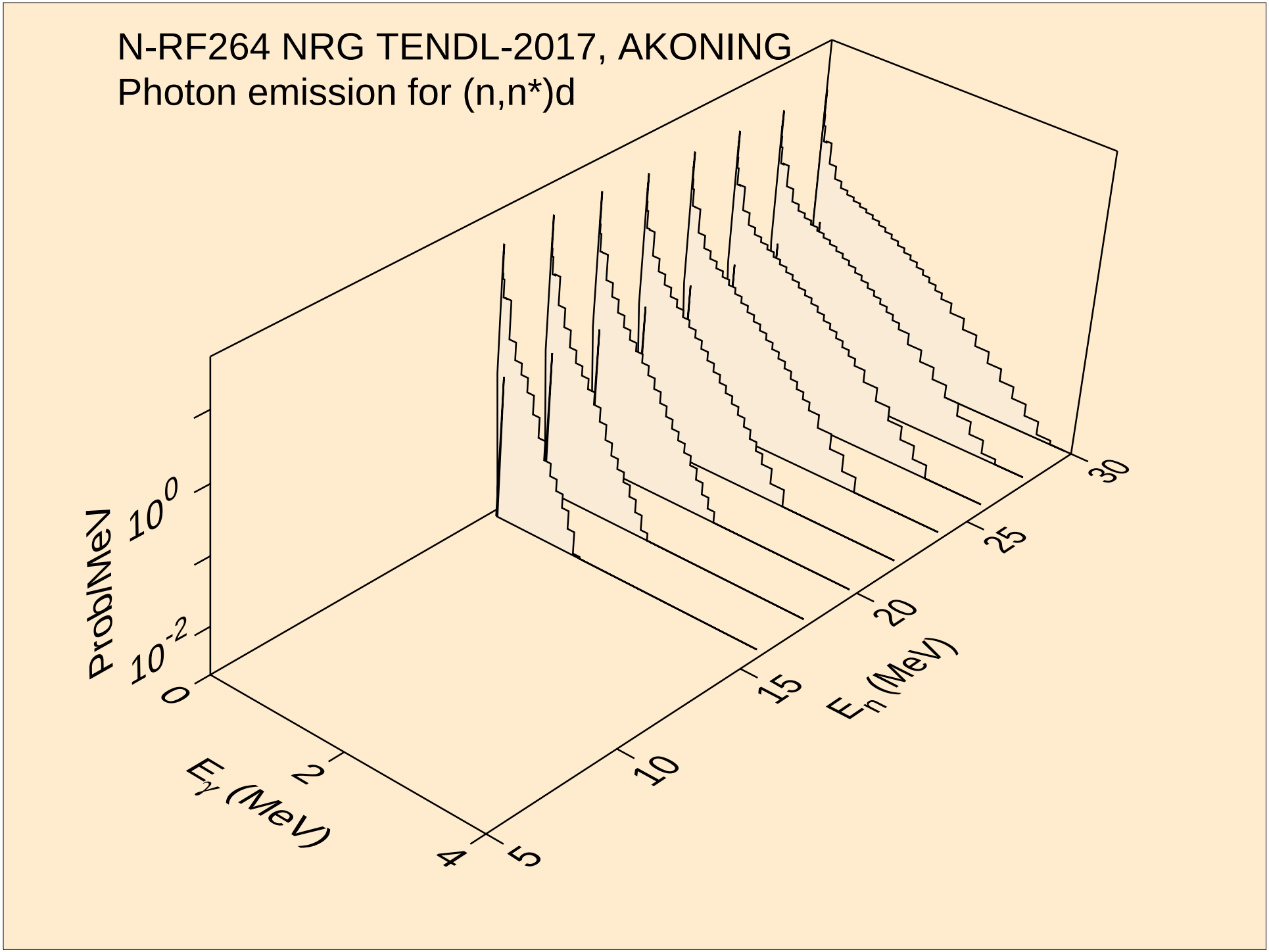

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,n*)a
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

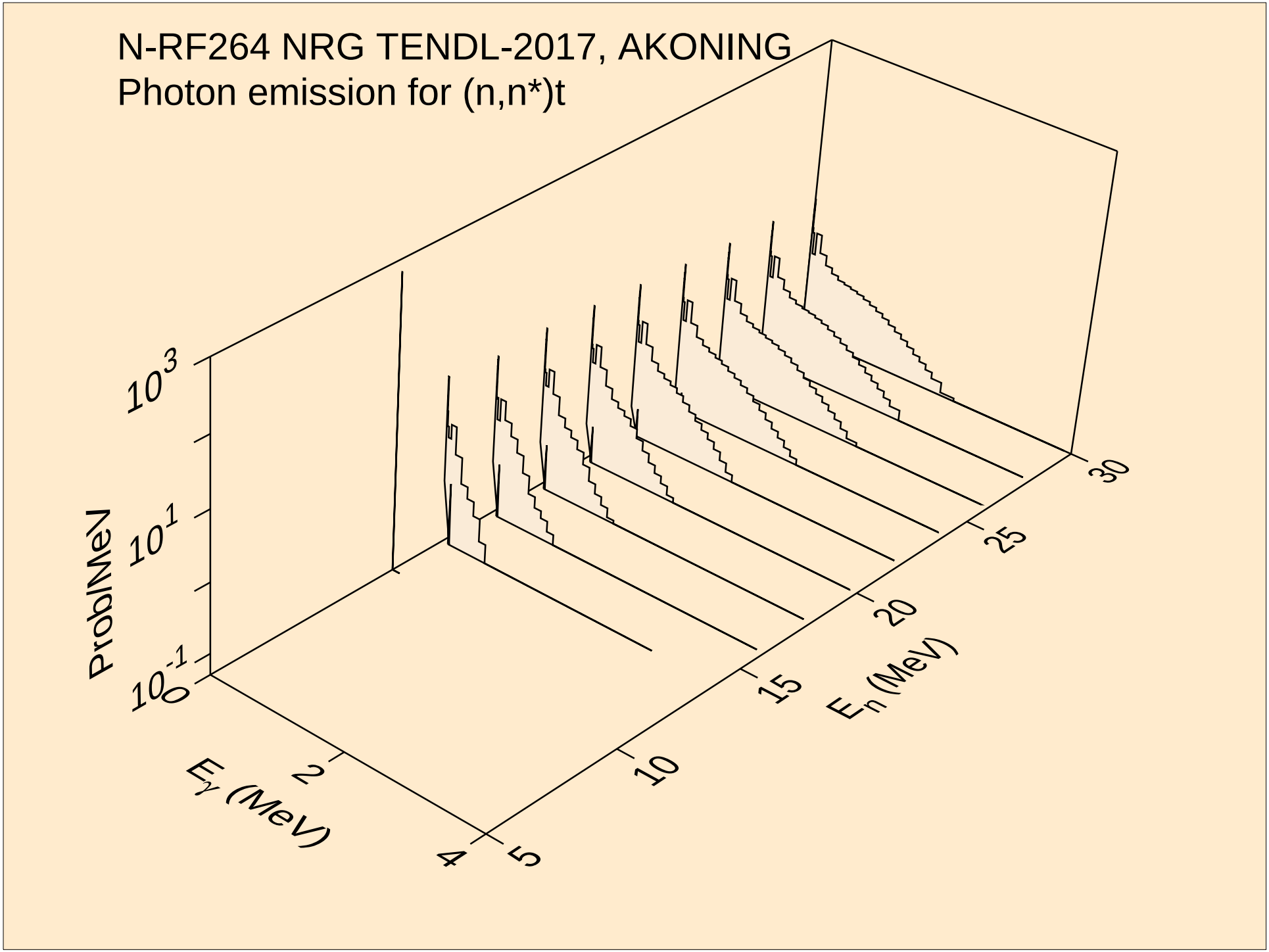

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,2n)a
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

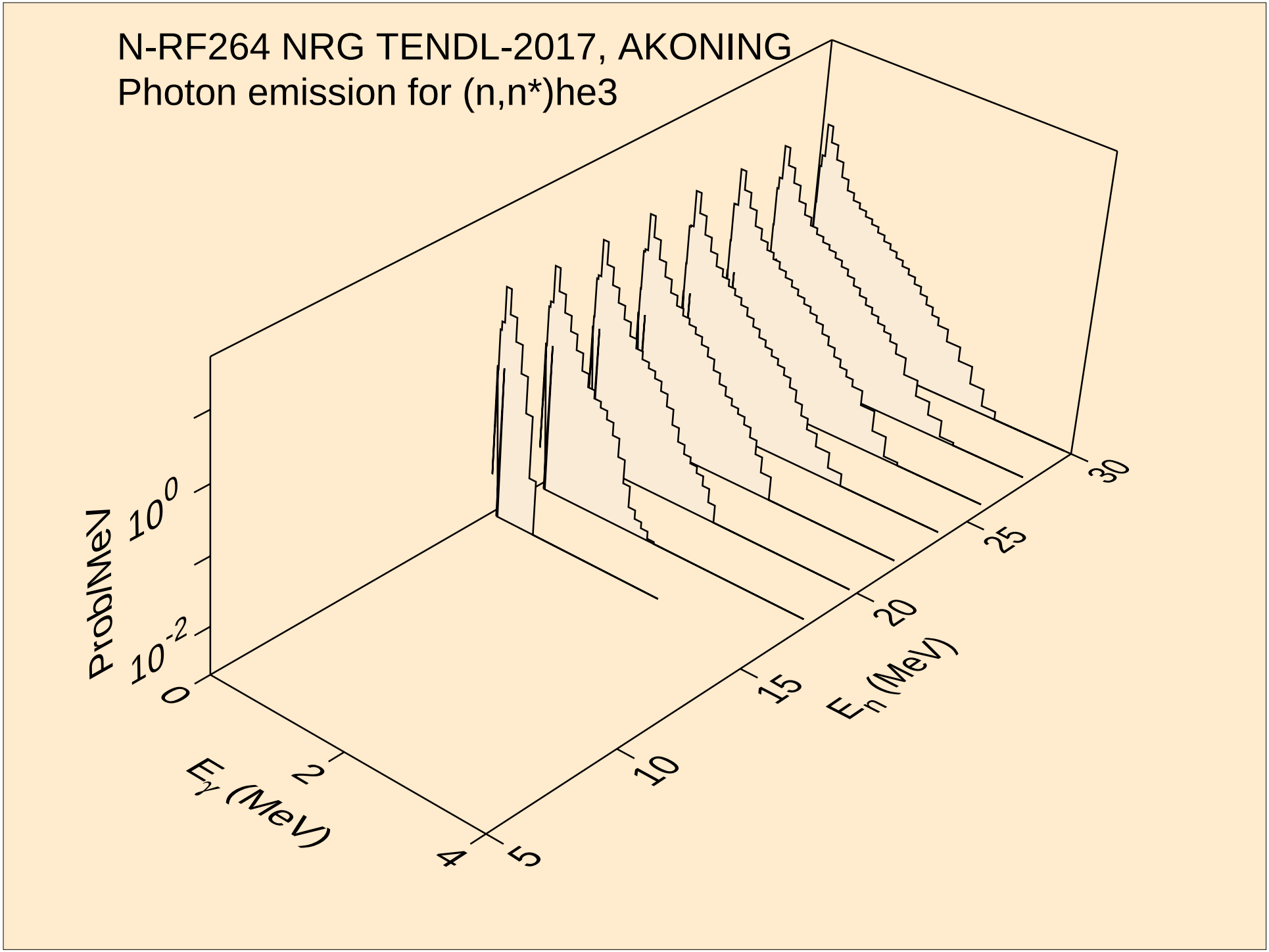

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,3n)a
Prob/MeV
10^{1}
10^{-1}
0
2
4
E_γ (MeV)
0
20
40
60
80
100
120
140
160
180
200
E_n (MeV)

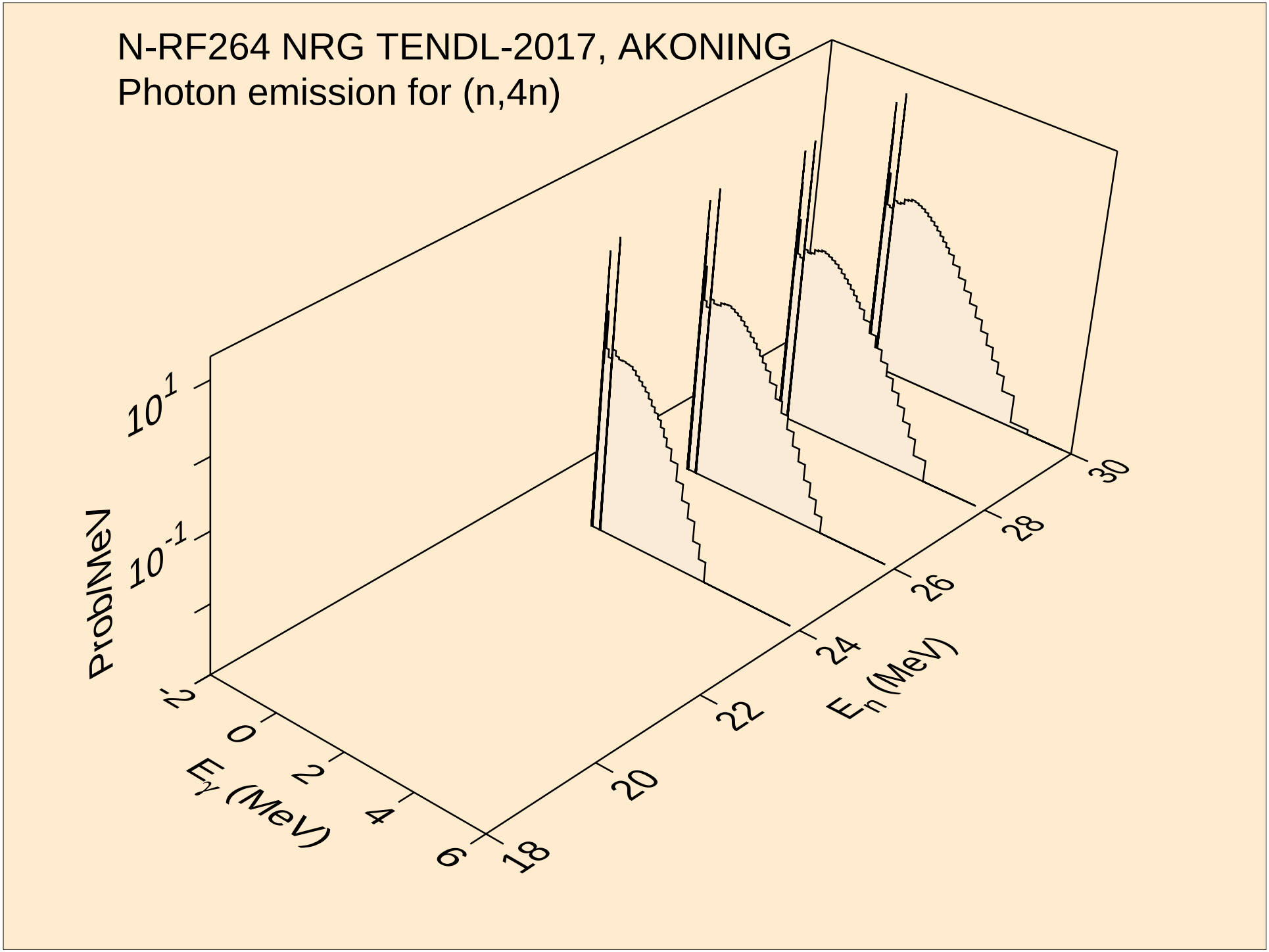

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,n*)p
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
2
4
E_γ (MeV)
0
5
10
15
20
25
30
E_n (MeV)

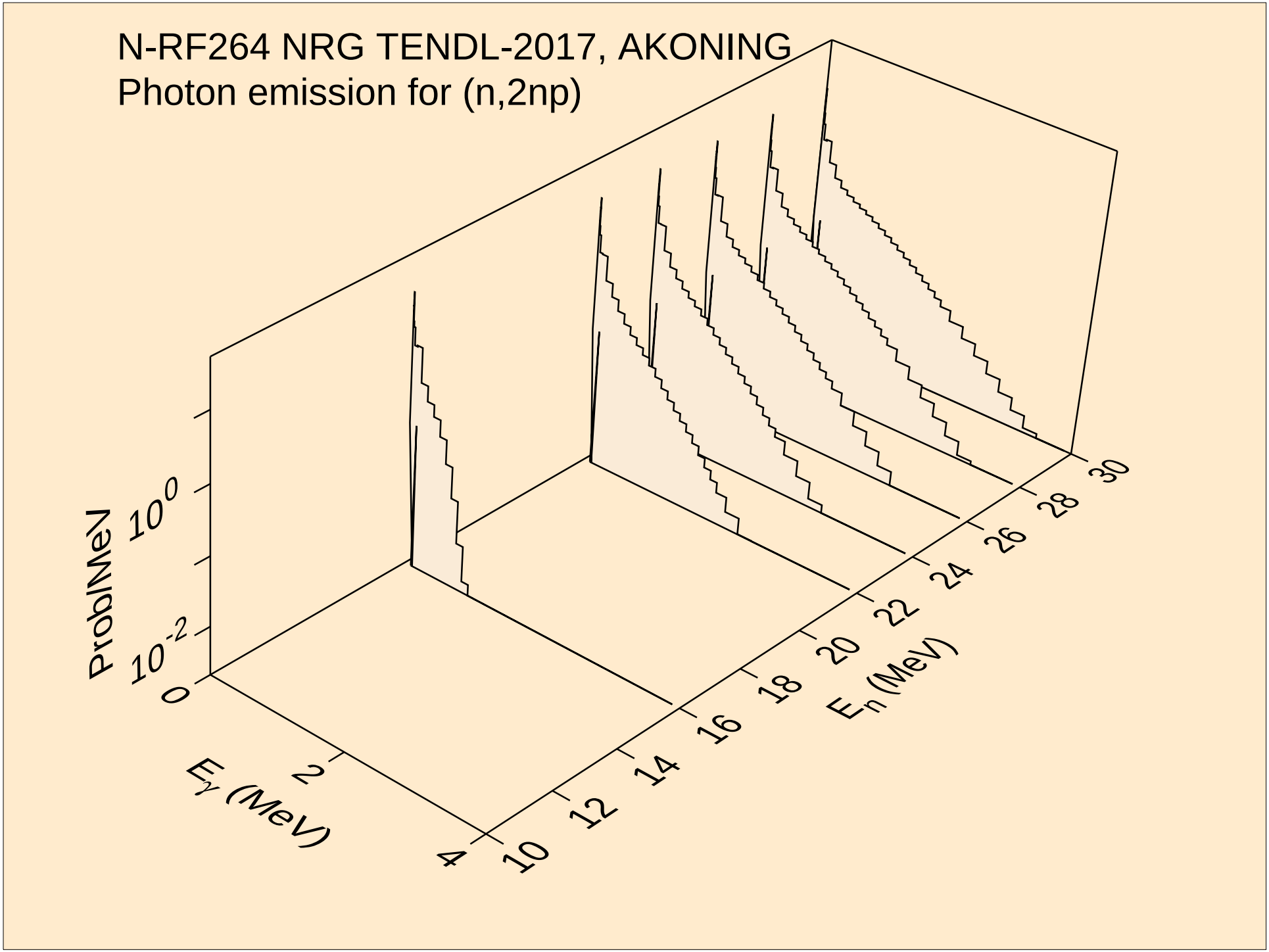

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,n*)2a
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

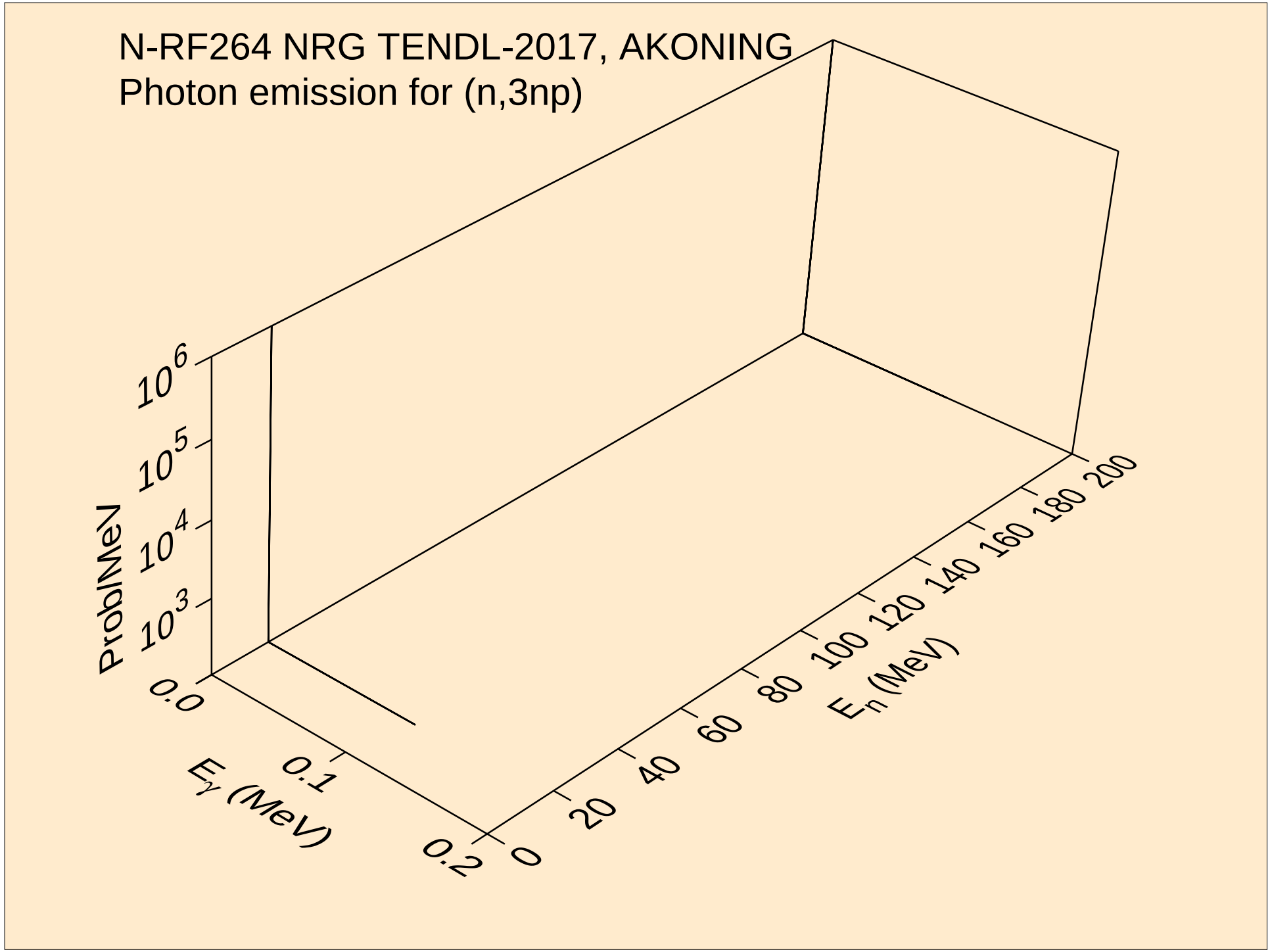

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,n*)d
Prob/MeV
10^0
10^-2
0
2
4
E_γ (MeV)
10
15
20
25
30
E_n (MeV)

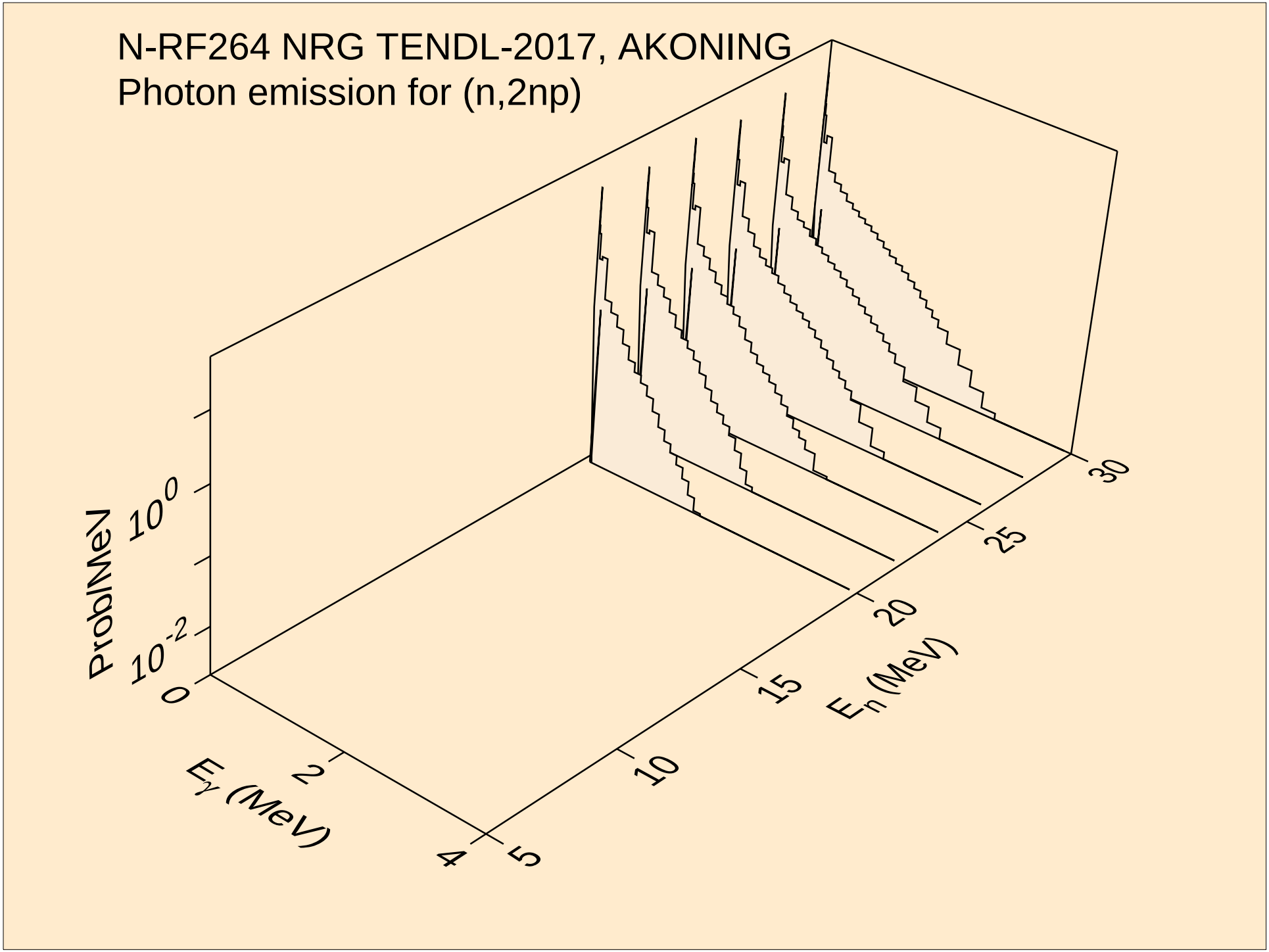

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,n*)t
Prob/MeV
10^{3}
10^{1}
10^{-1}
0
E_γ (MeV)
2
4
5
10
15
20
25
30
E_n (MeV)

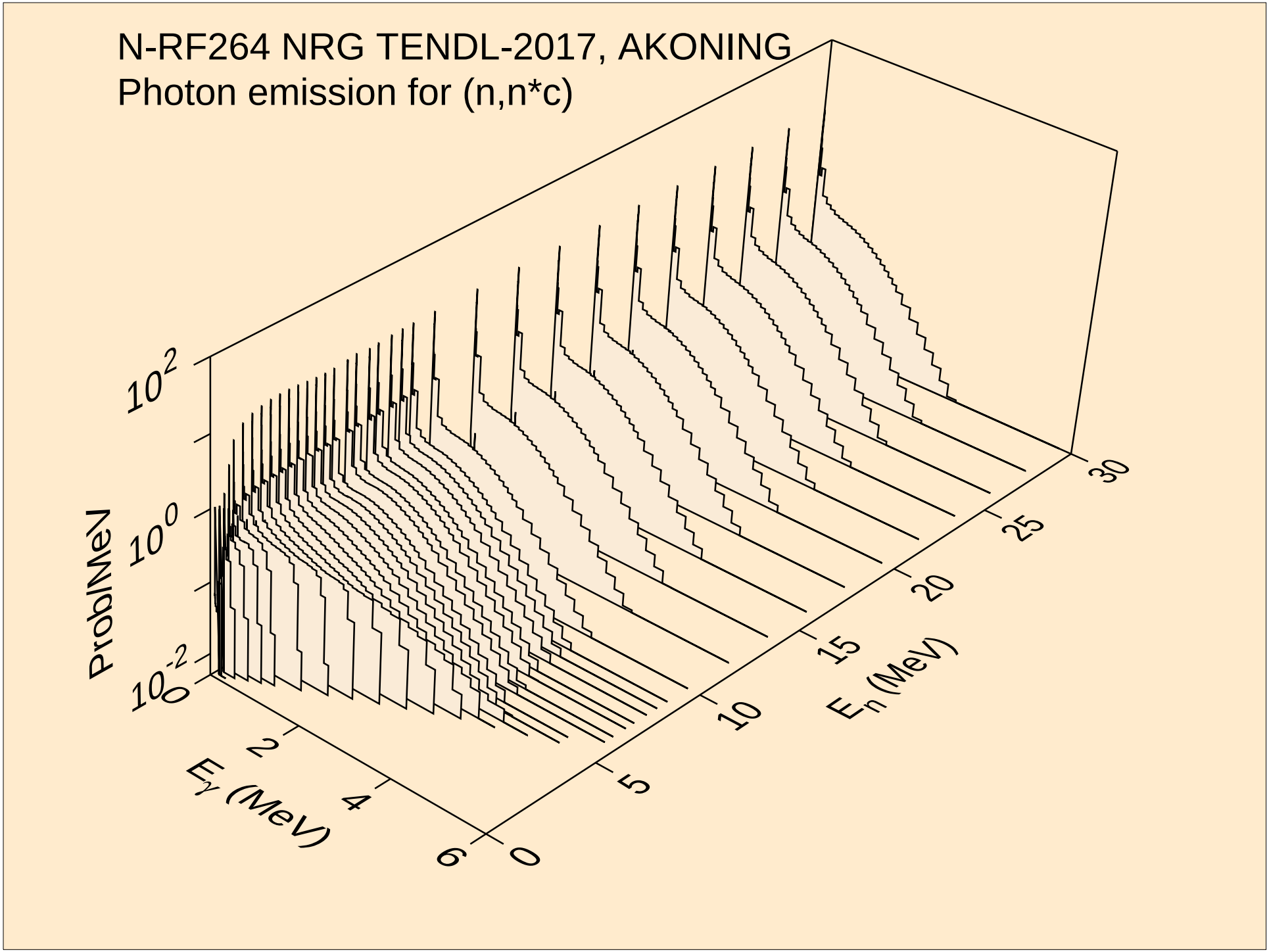

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,n*)he3
Prob/MeV
10^0
10^-2
0
2
4
E_γ (MeV)
10
15
20
25
30
E_n (MeV)

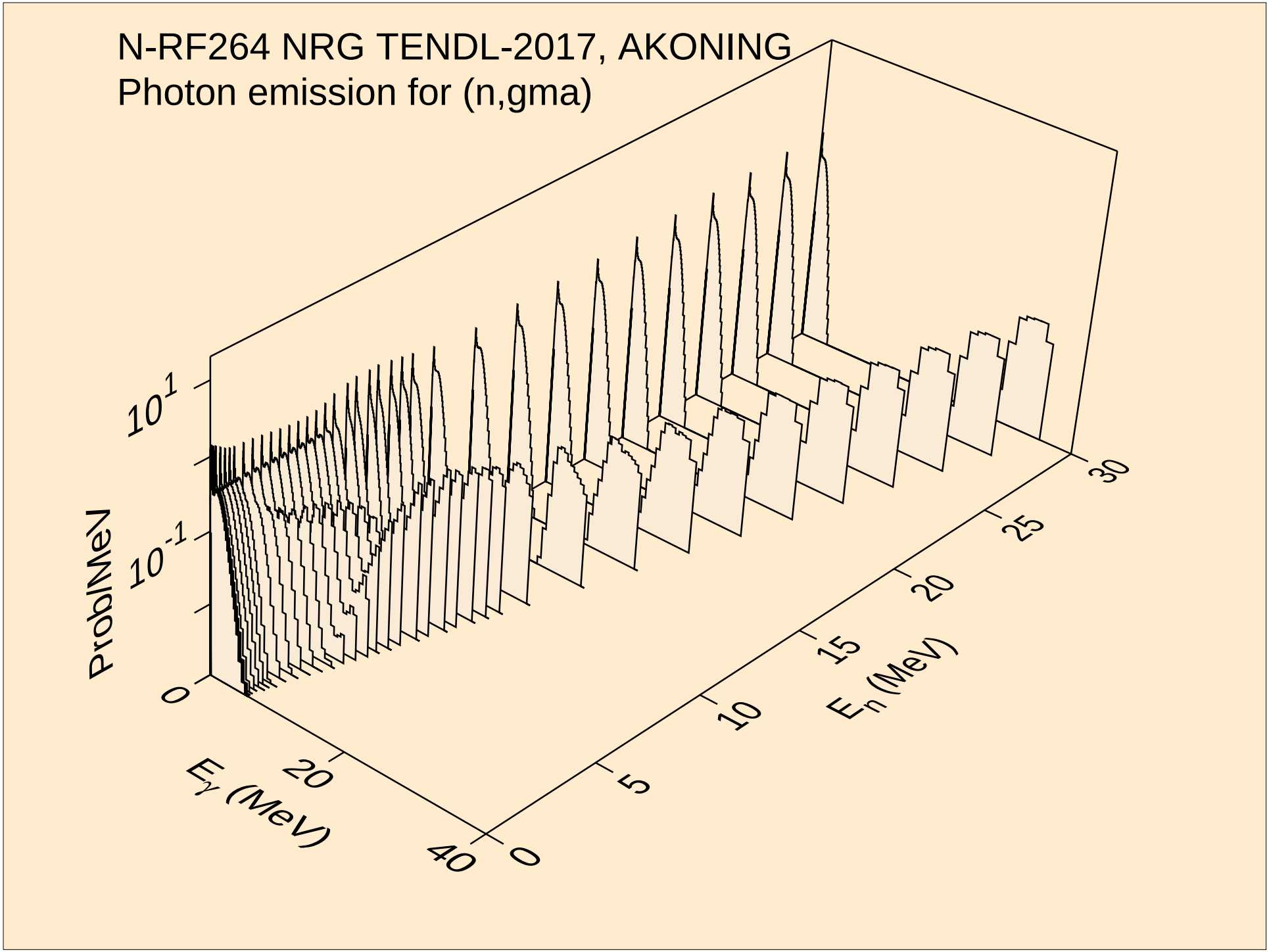

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,4n)
Prob/MeV
10^{1}
10^{-1}
-2
0
2
4
6
E_γ (MeV)
18
20
22
24
26
28
30
E_n (MeV)

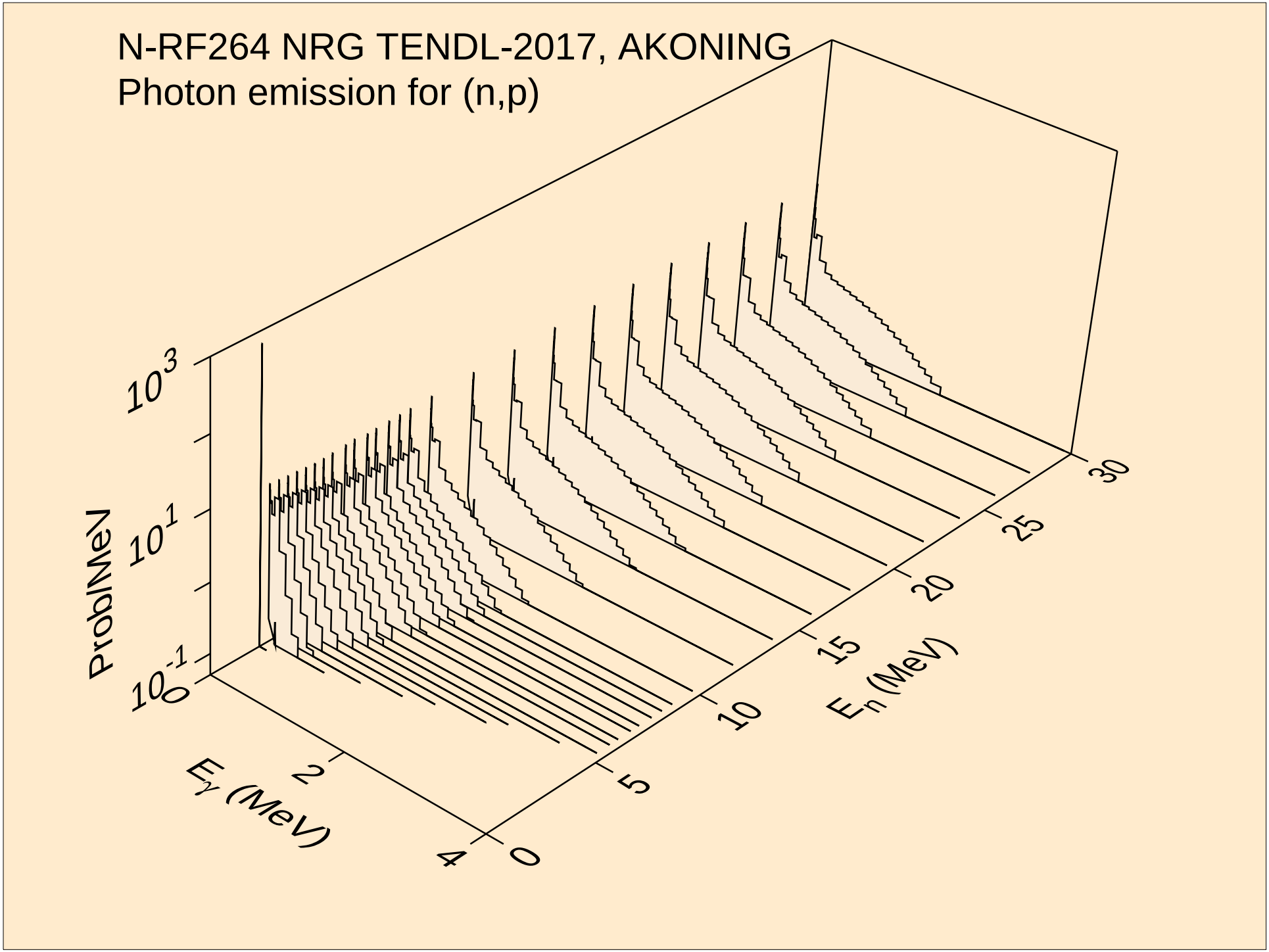

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,2np)
Prob/MeV
10^{0}
10^{-2}
0
2
4
E_γ (MeV)
10
12
14
16
18
20
22
24
26
28
30
E_n (MeV)

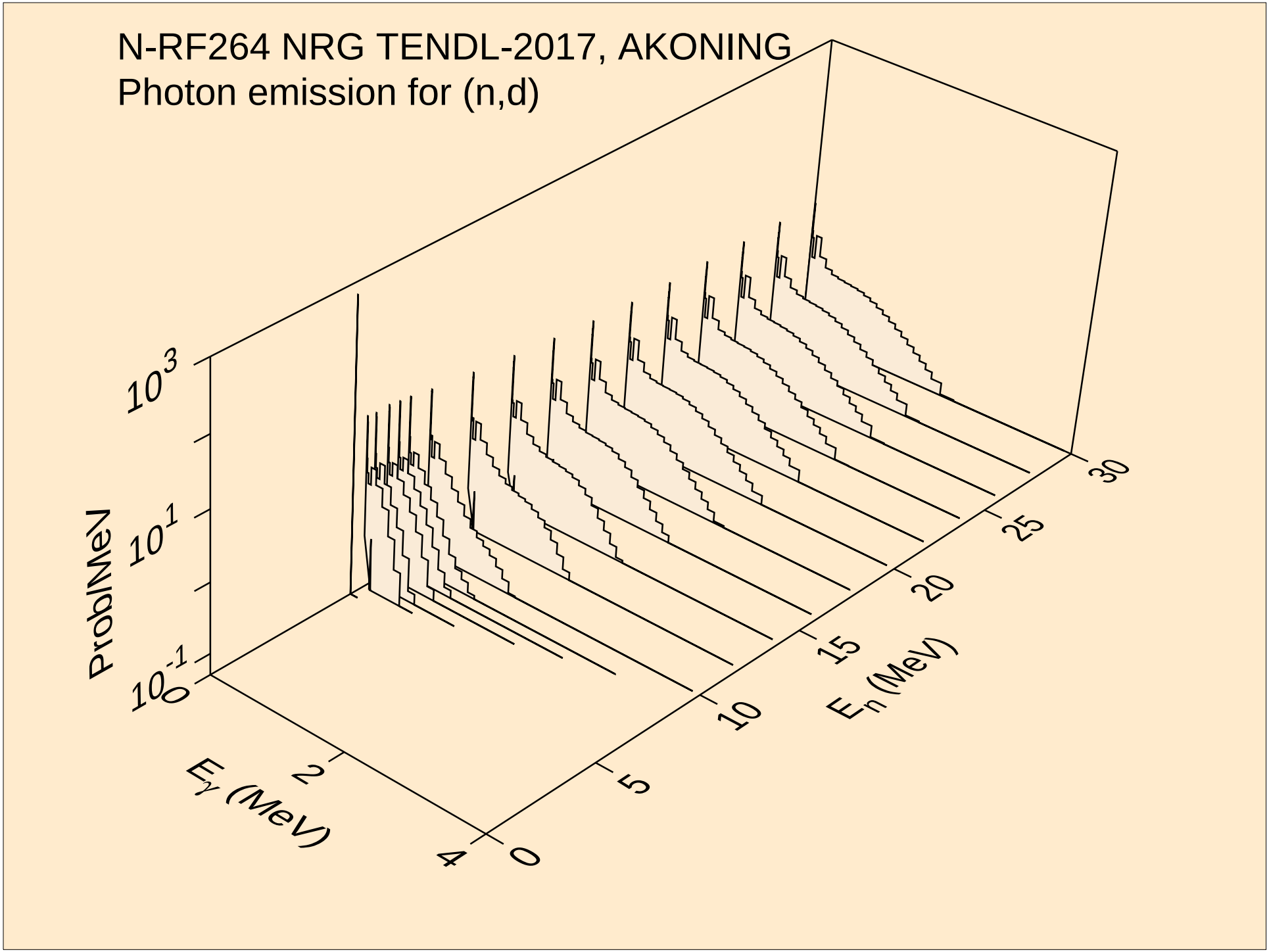

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,3np)
Prob/MeV
10^6
10^5
10^4
10^3
0.0
0.1
0.2
E_γ (MeV)
0
20
40
60
80
100
120
140
160
180
200
E_n (MeV)

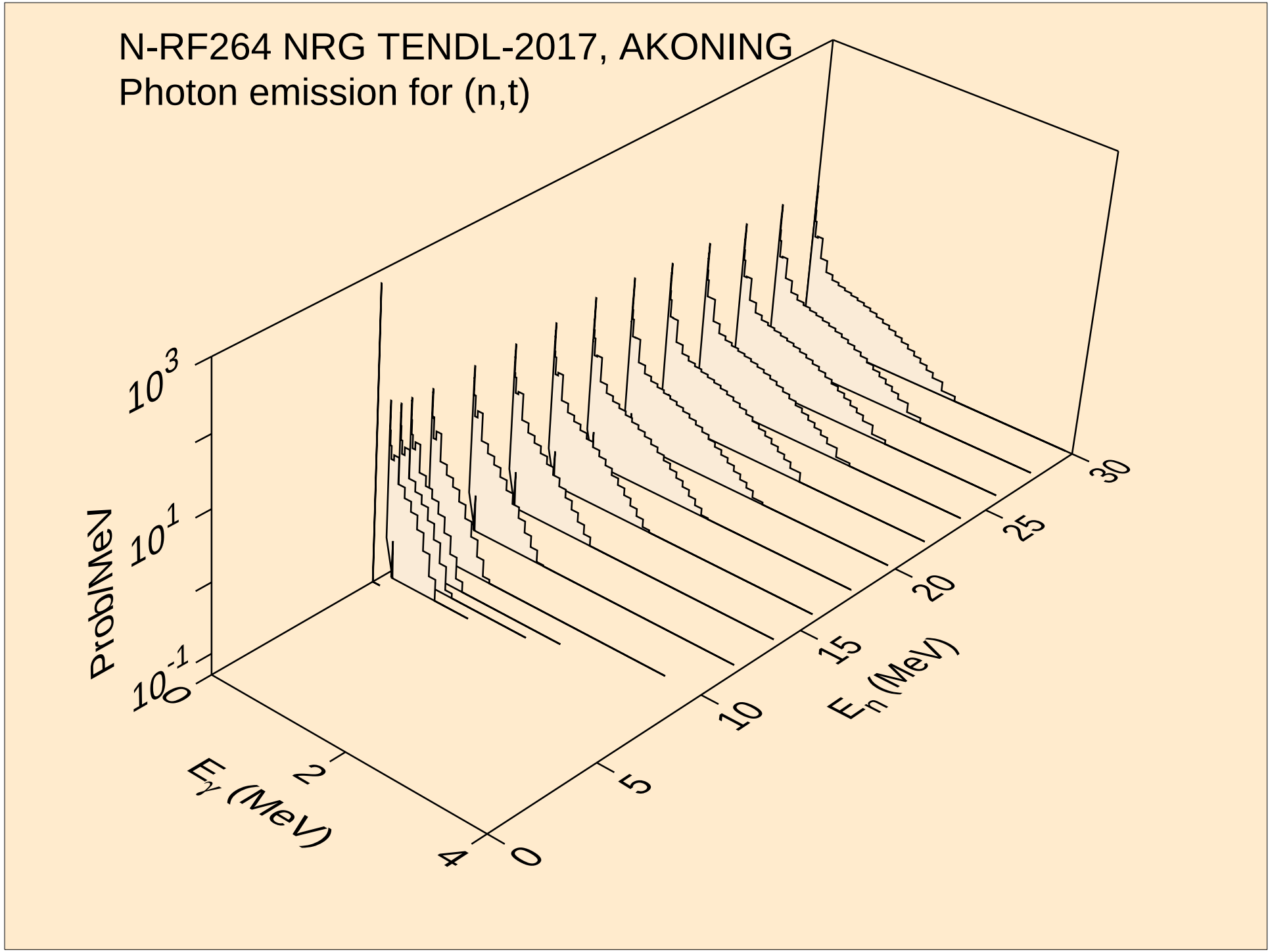

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,2np)
Prob/MeV
10^{0}
10^{-2}
0
E_γ (MeV)
2
4
5
10
15
20
25
30
E_n (MeV)

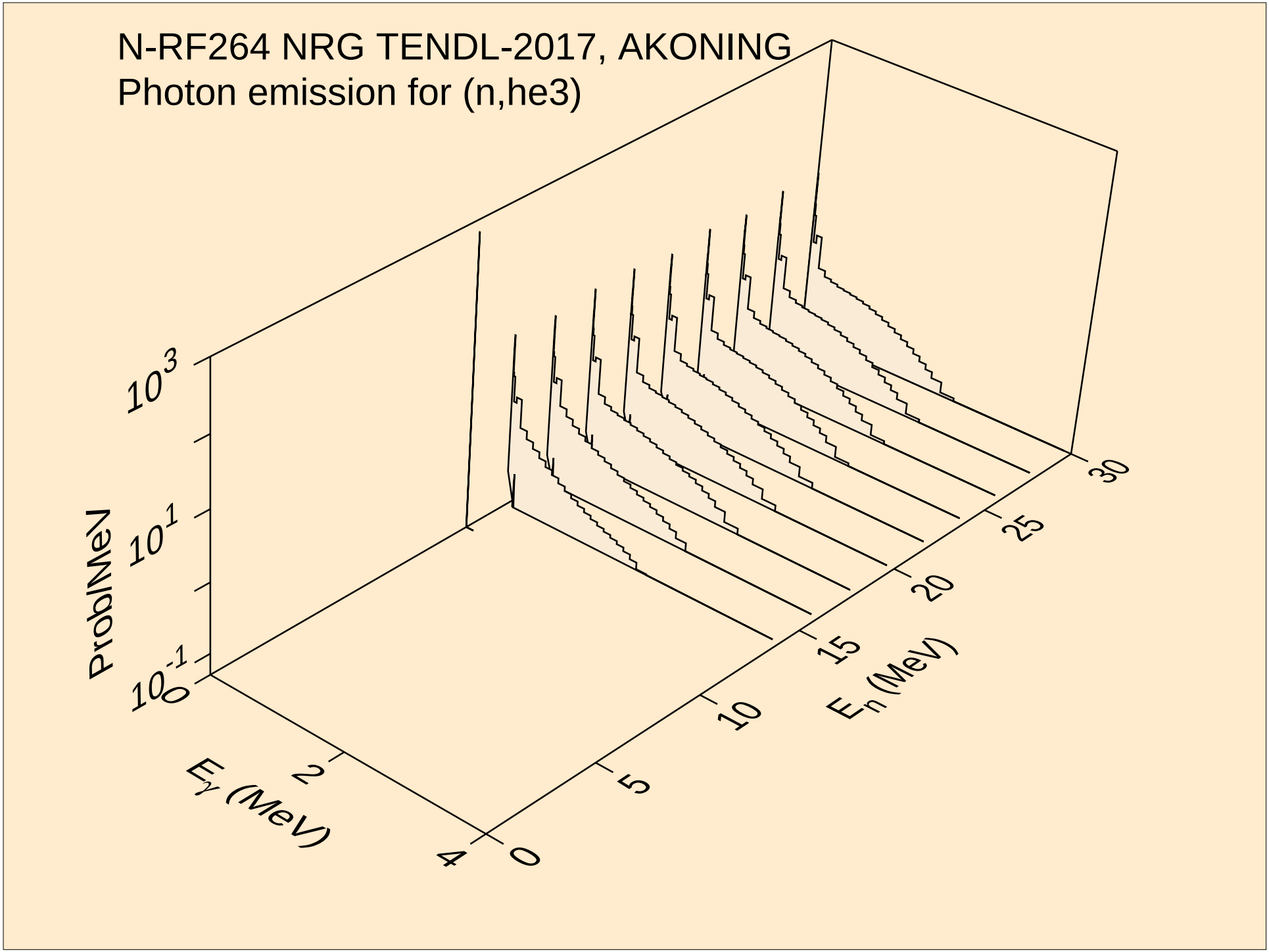

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,n*c)
Prob/MeV
10^{2}
10^{0}
10^{-2}
E_γ (MeV)
0
2
4
6
E_n (MeV)
0
5
10
15
20
25
30

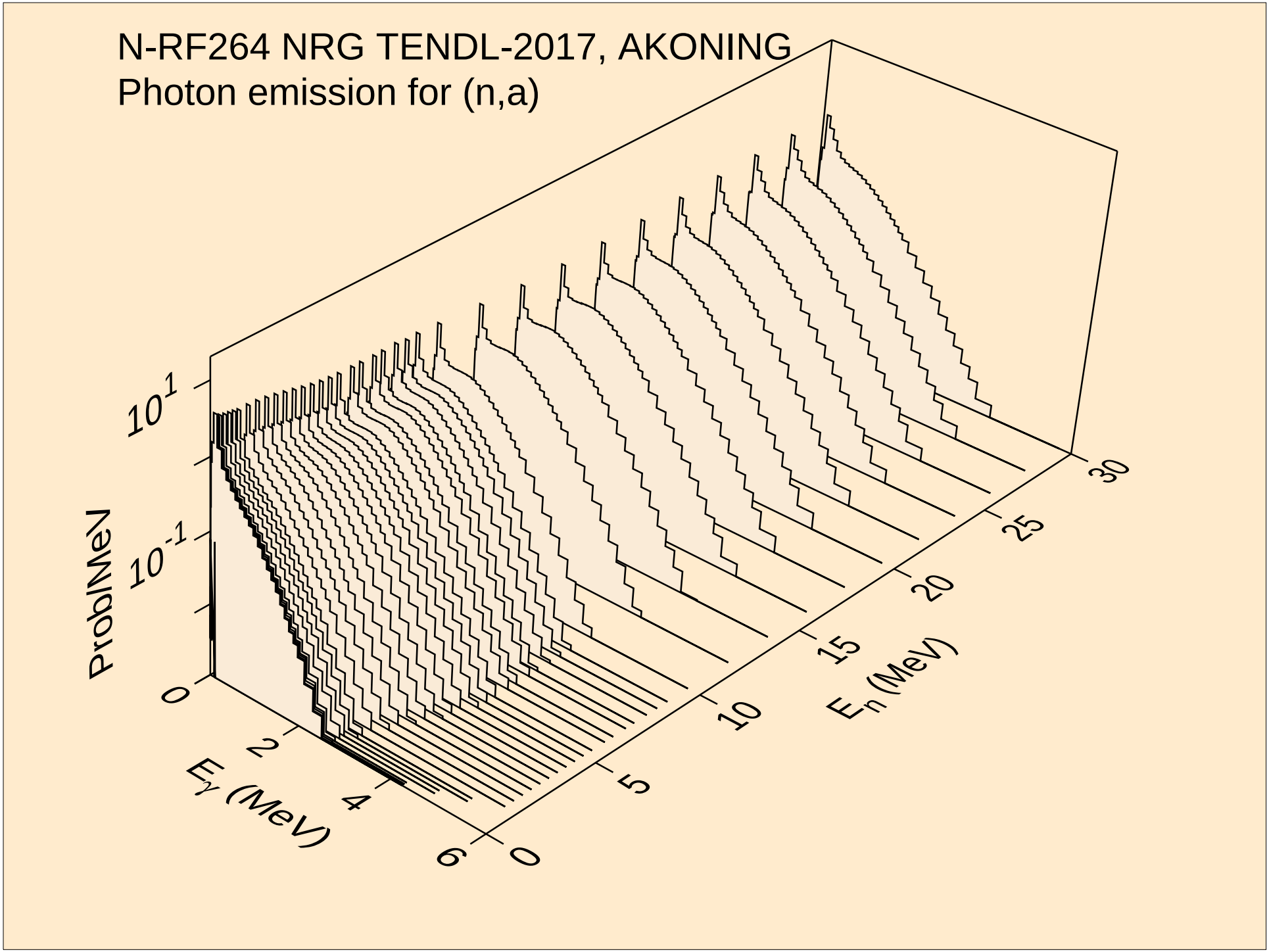

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,gma)
Prob/MeV
10^{1}
10^{-1}
0
E_γ (MeV)
20
40
0
5
10
15
20
25
30
E_n (MeV)

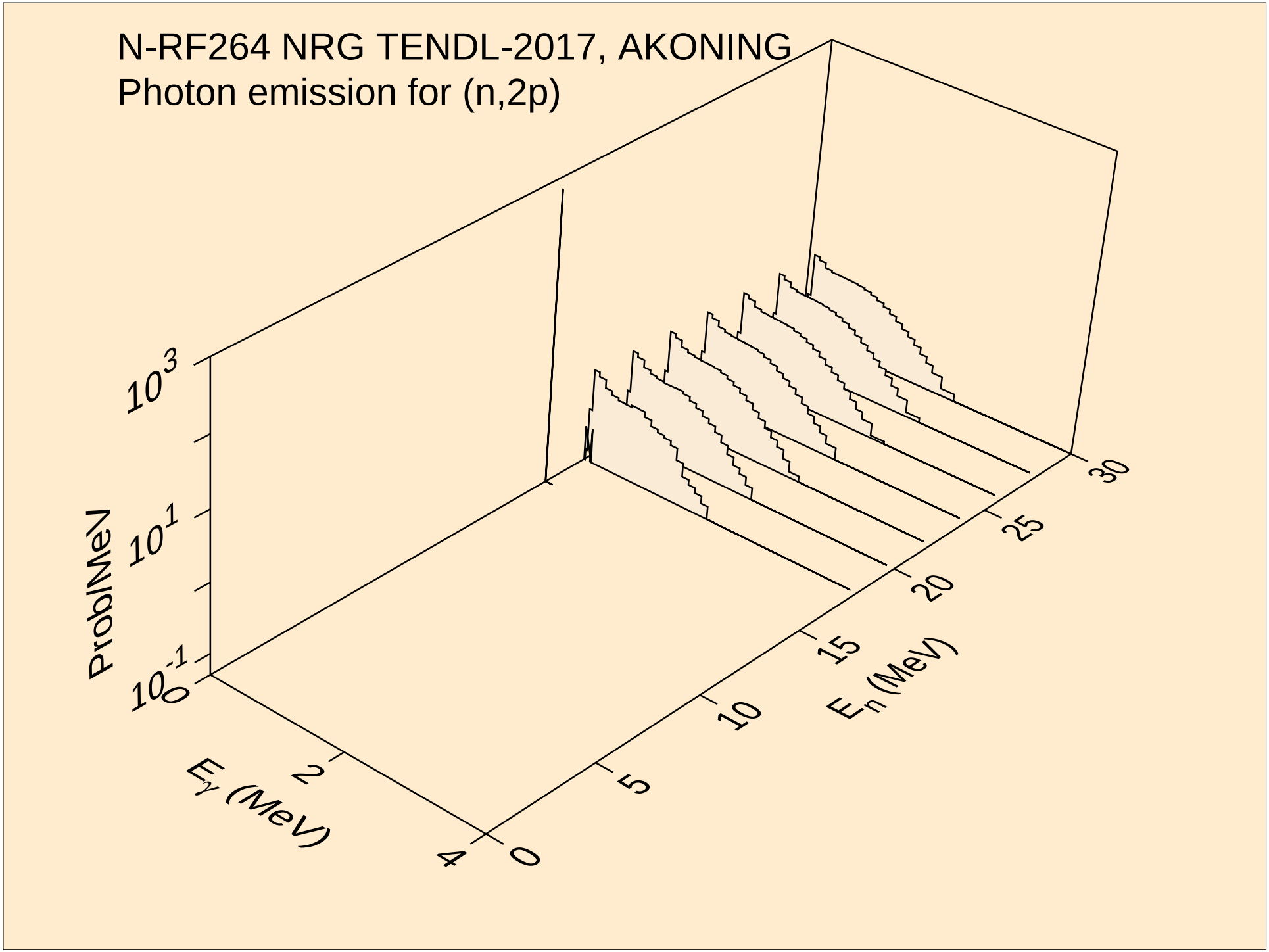

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,p)
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

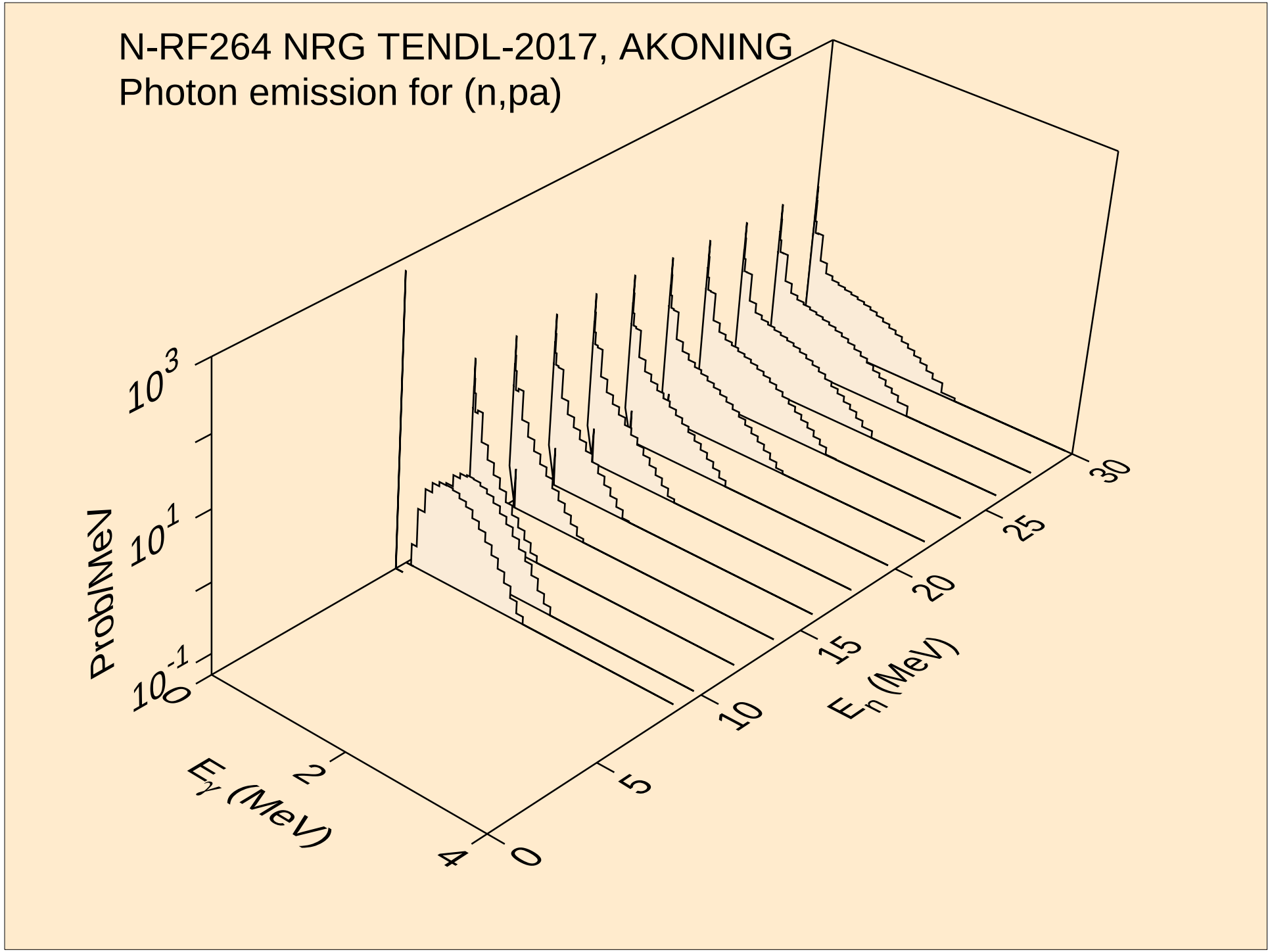

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,d)
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

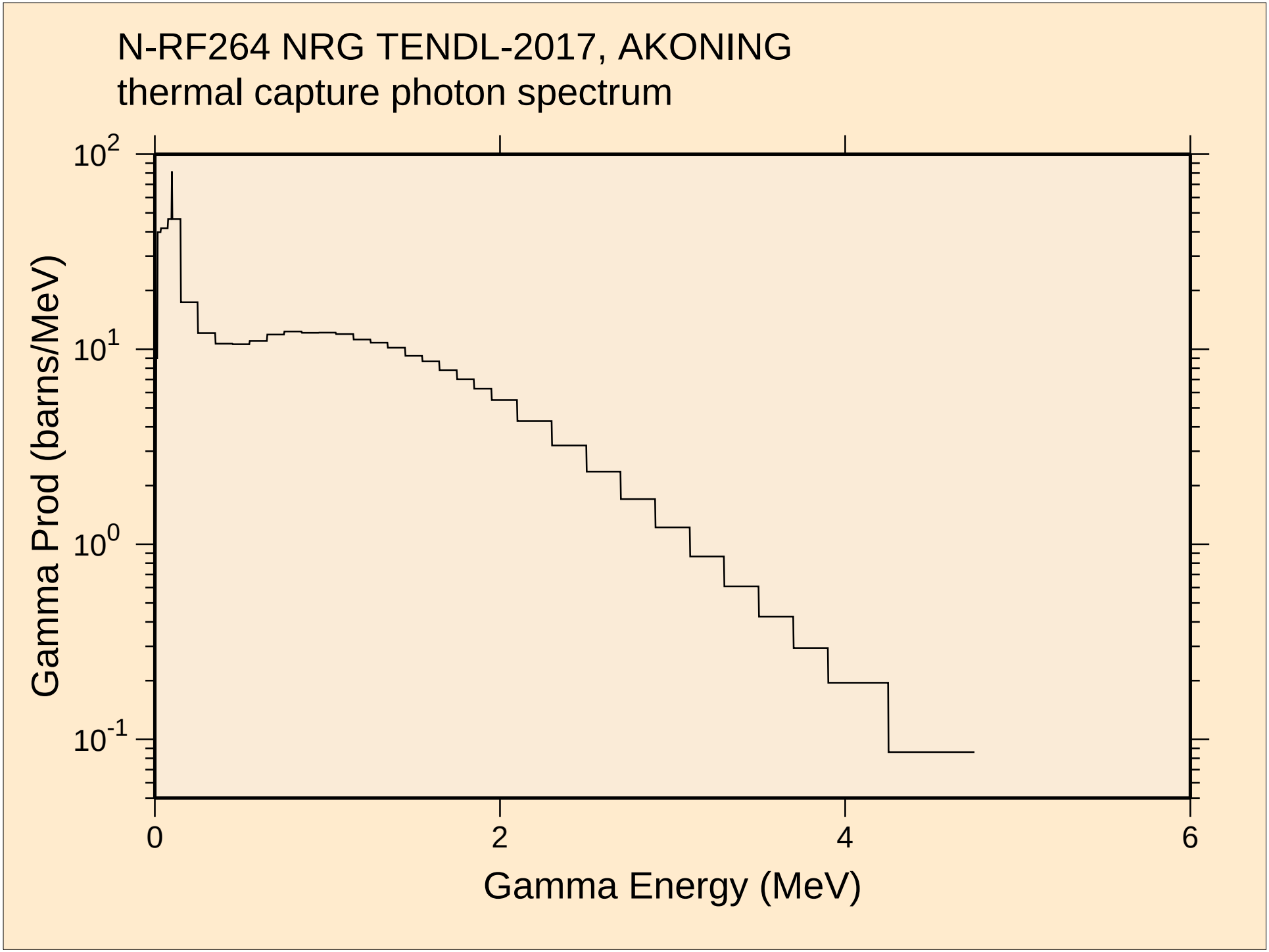

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,t)
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

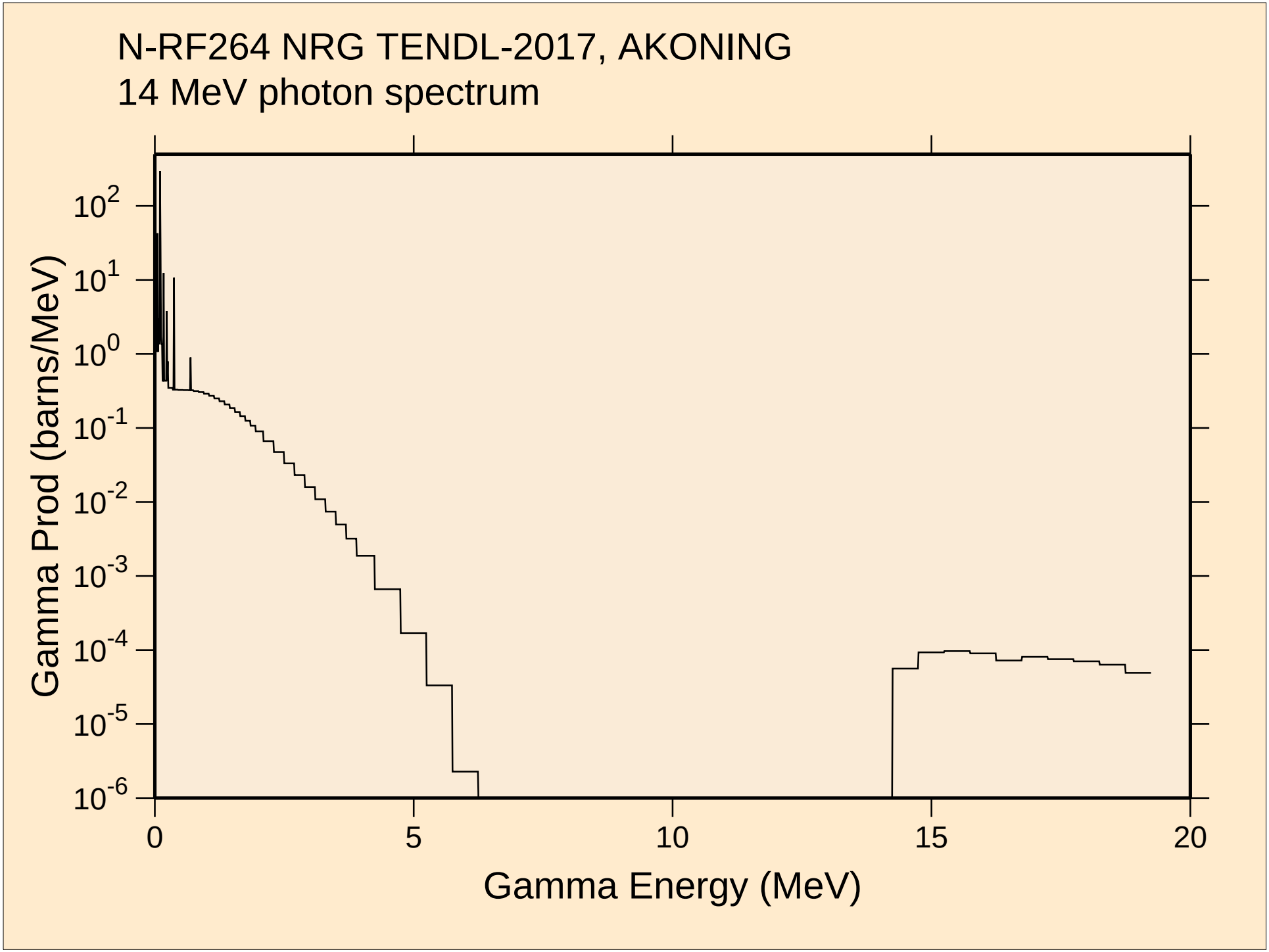

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,he3)
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

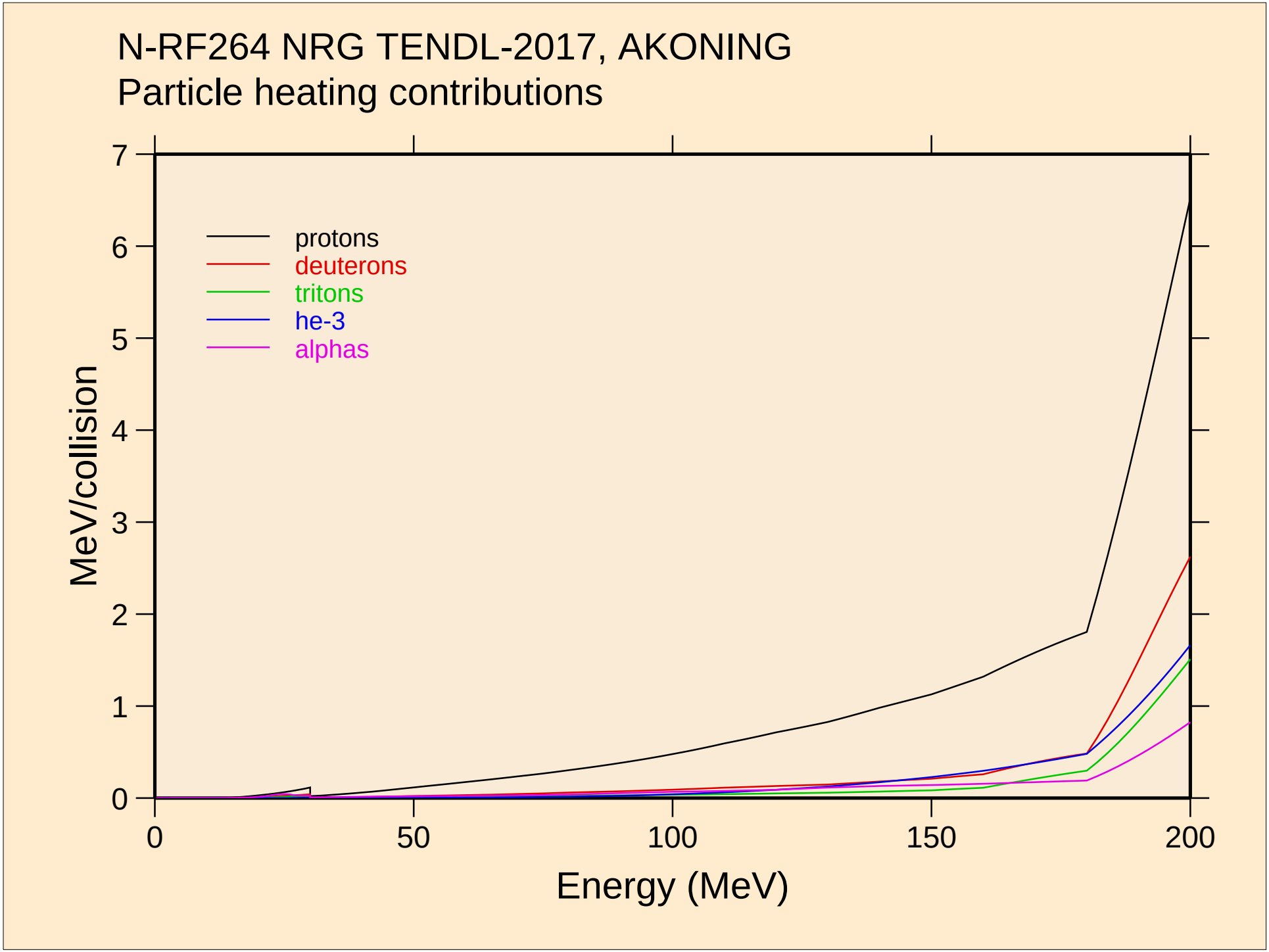

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,a)
Prob/MeV
10^{1}
10^{-1}
0
2
4
6
E_γ (MeV)
0
5
10
15
20
25
30
E_n (MeV)

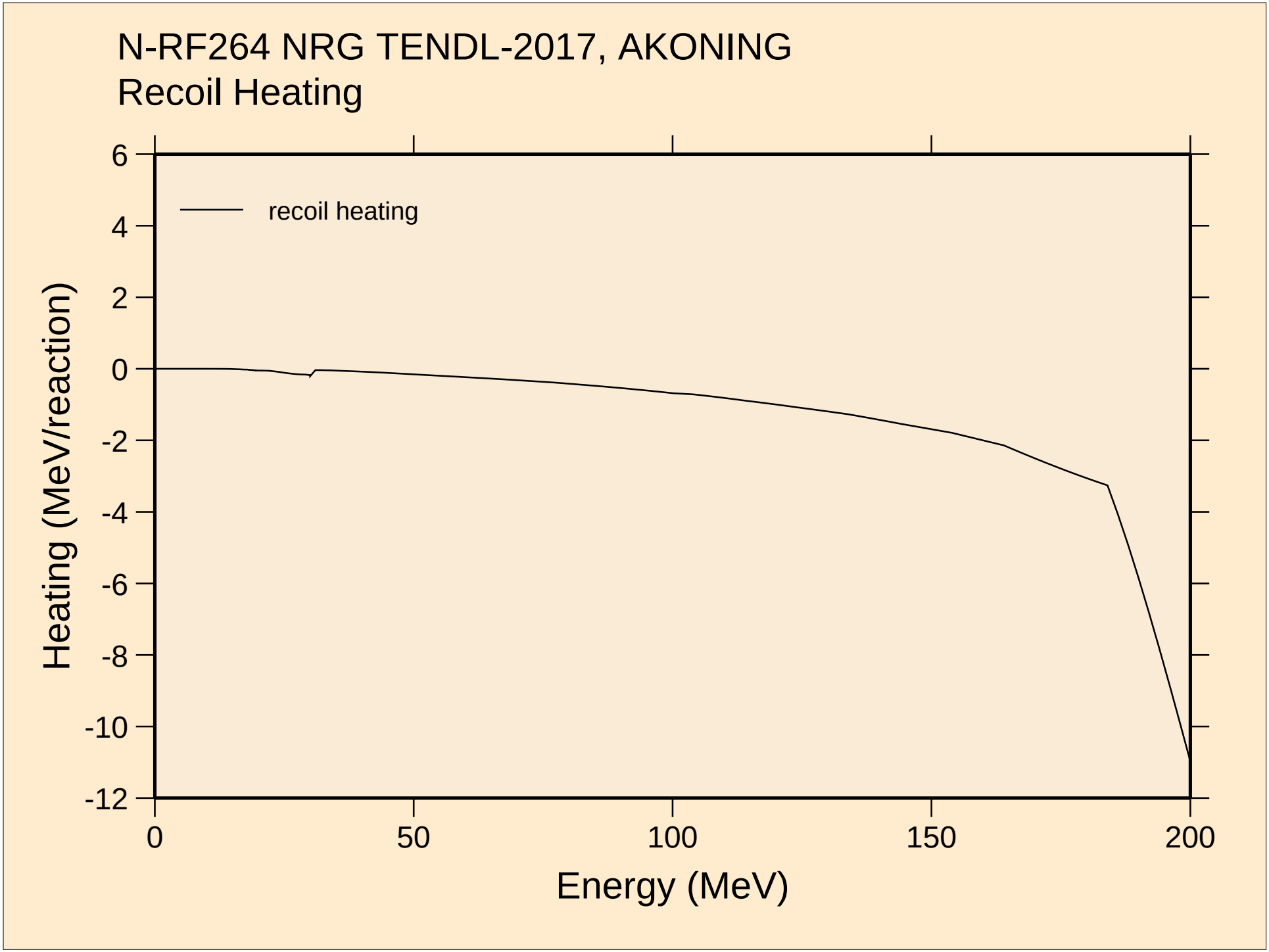

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,2p)
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

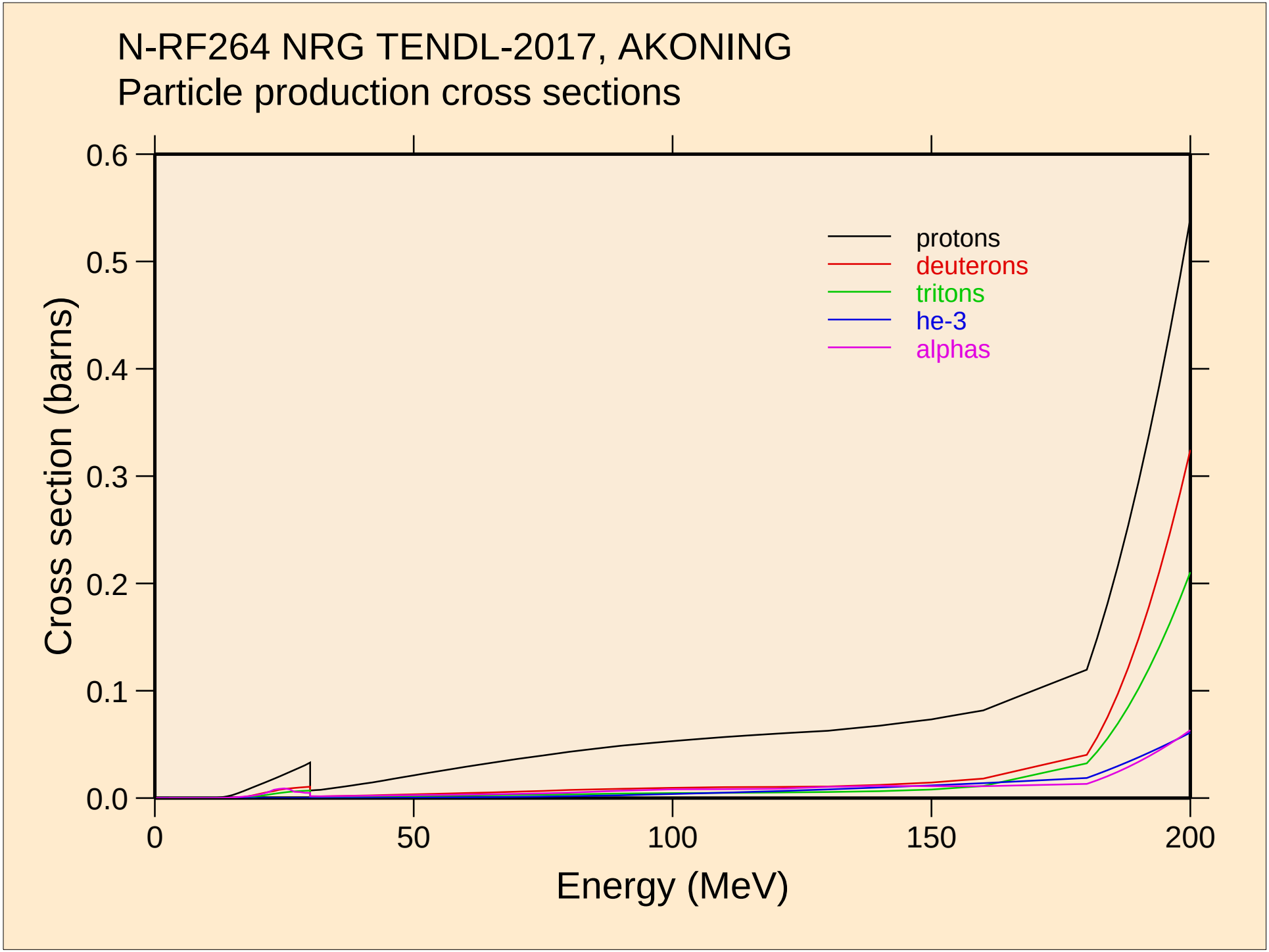

N-RF264 NRG TENDL-2017, AKONING
Photon emission for (n,pa)
Prob/MeV
10^{3}
10^{1}
10^{-1}
E_γ (MeV)
0
2
4
E_n (MeV)
0
5
10
15
20
25
30

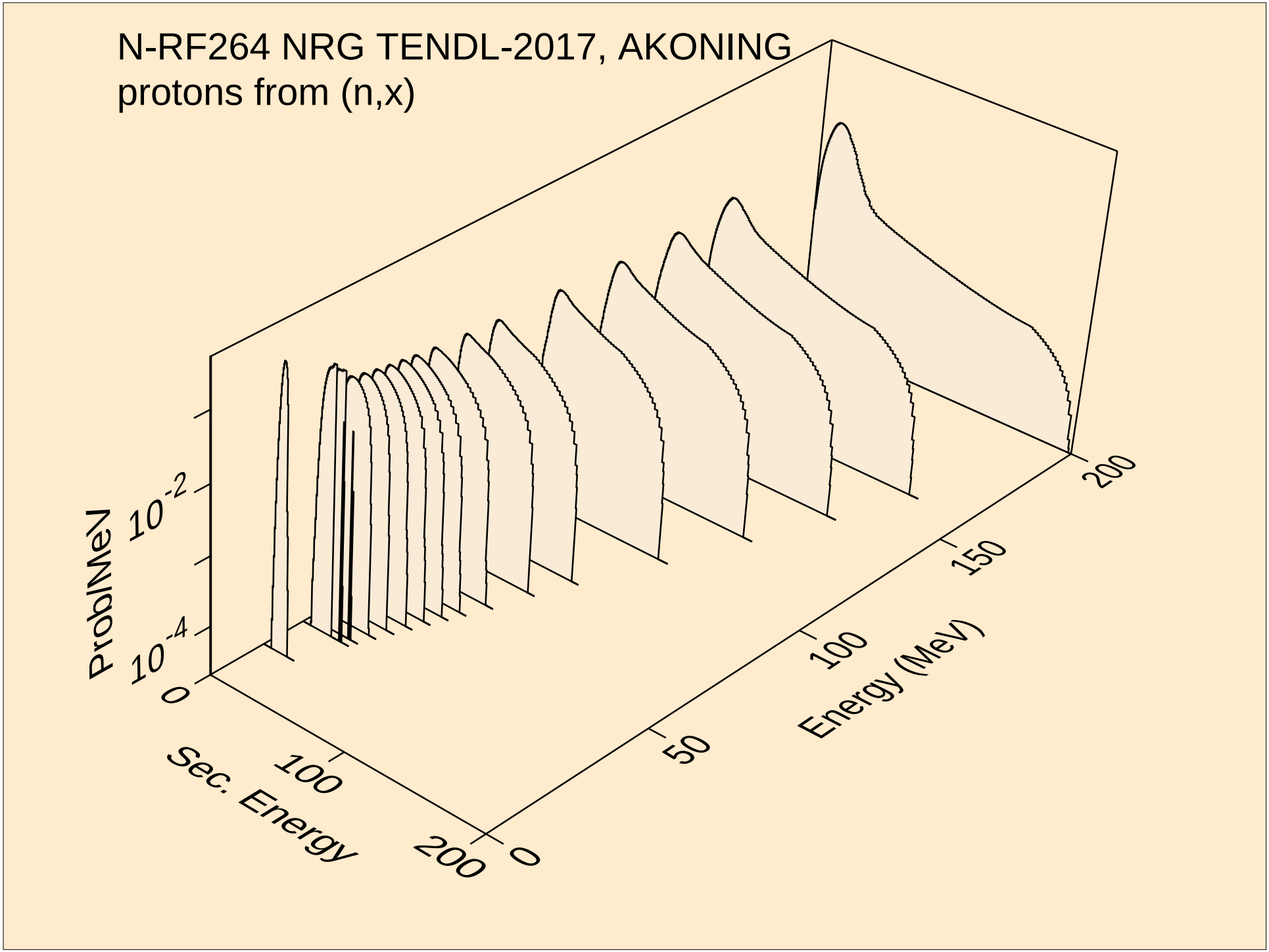

N-RF264 NRG TENDL-2017, AKONING
thermal capture photon spectrum
Gamma Prod (barns/MeV)
10^2
10^1
10^0
10^-1
0
2
4
6
Gamma Energy (MeV)

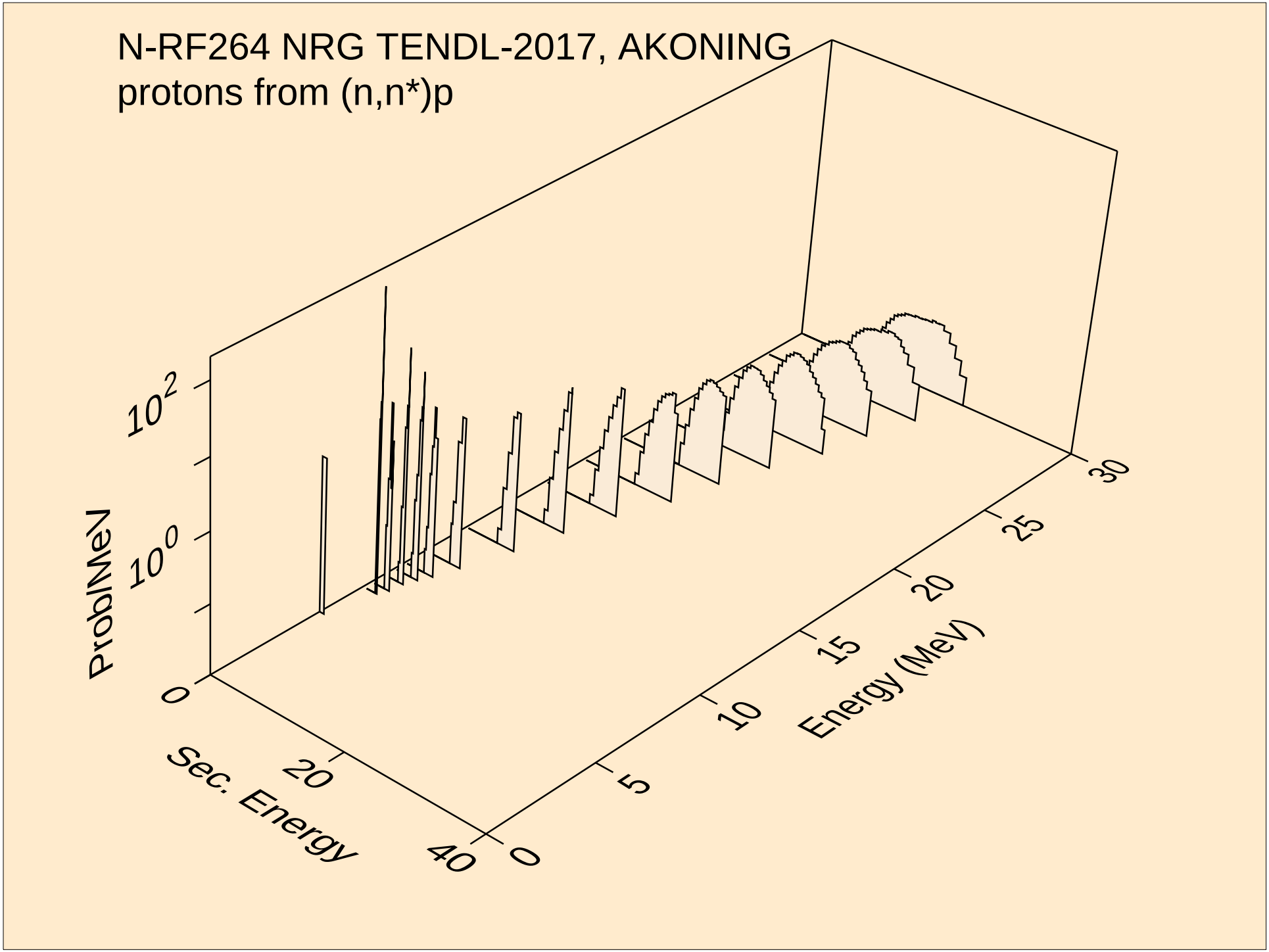

N-RF264 NRG TENDL-2017, AKONING
14 MeV photon spectrum
Gamma Prod (barns/MeV)
10^2
10^1
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
0
5
10
15
20
Gamma Energy (MeV)

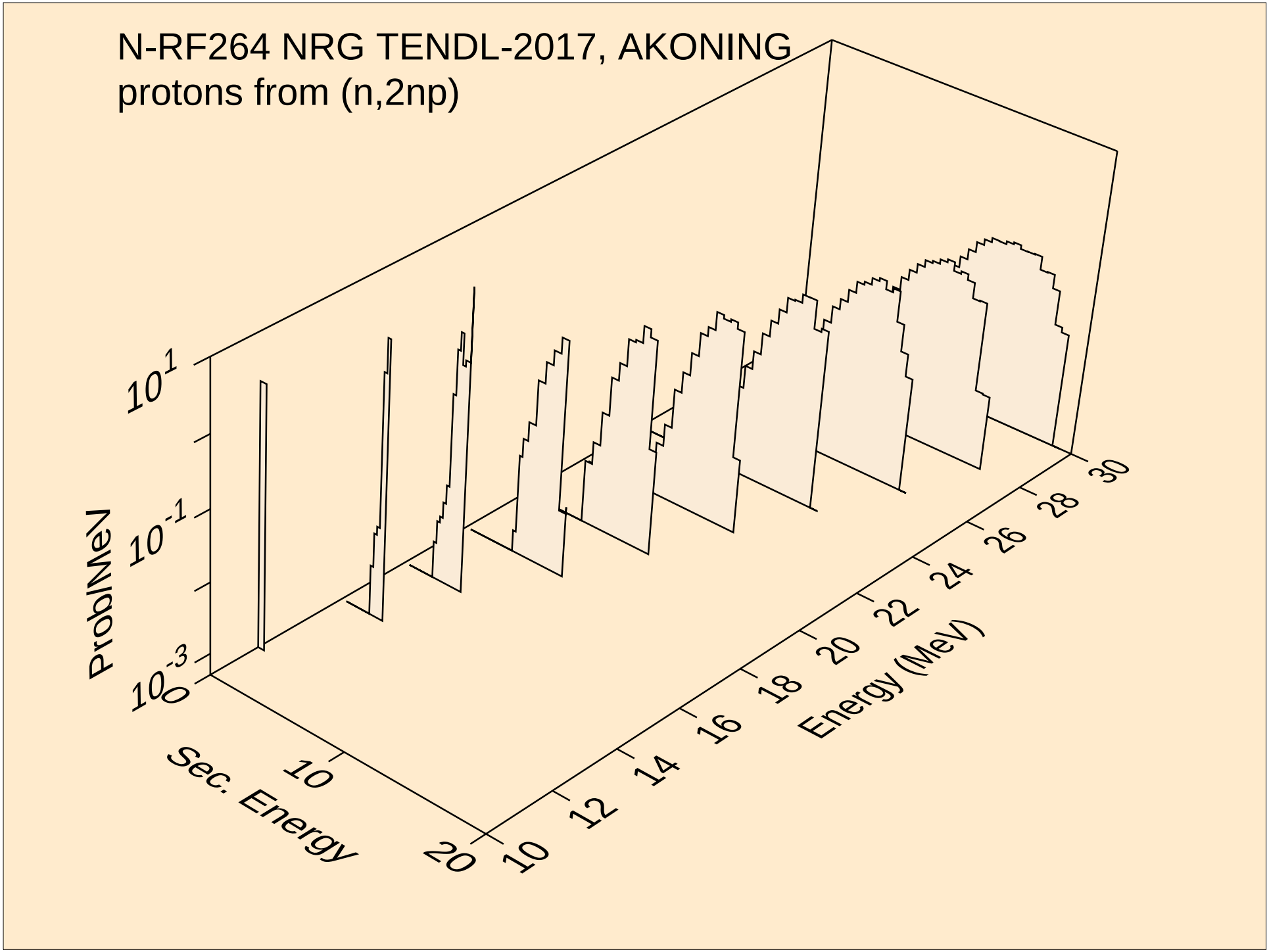

N-RF264 NRG TENDL-2017, AKONING
Particle heating contributions
protons
deuterons
tritons
he-3
alphas
MeV/collision
Energy (MeV)
0
1
2
3
4
5
6
7
0
50
100
150
200

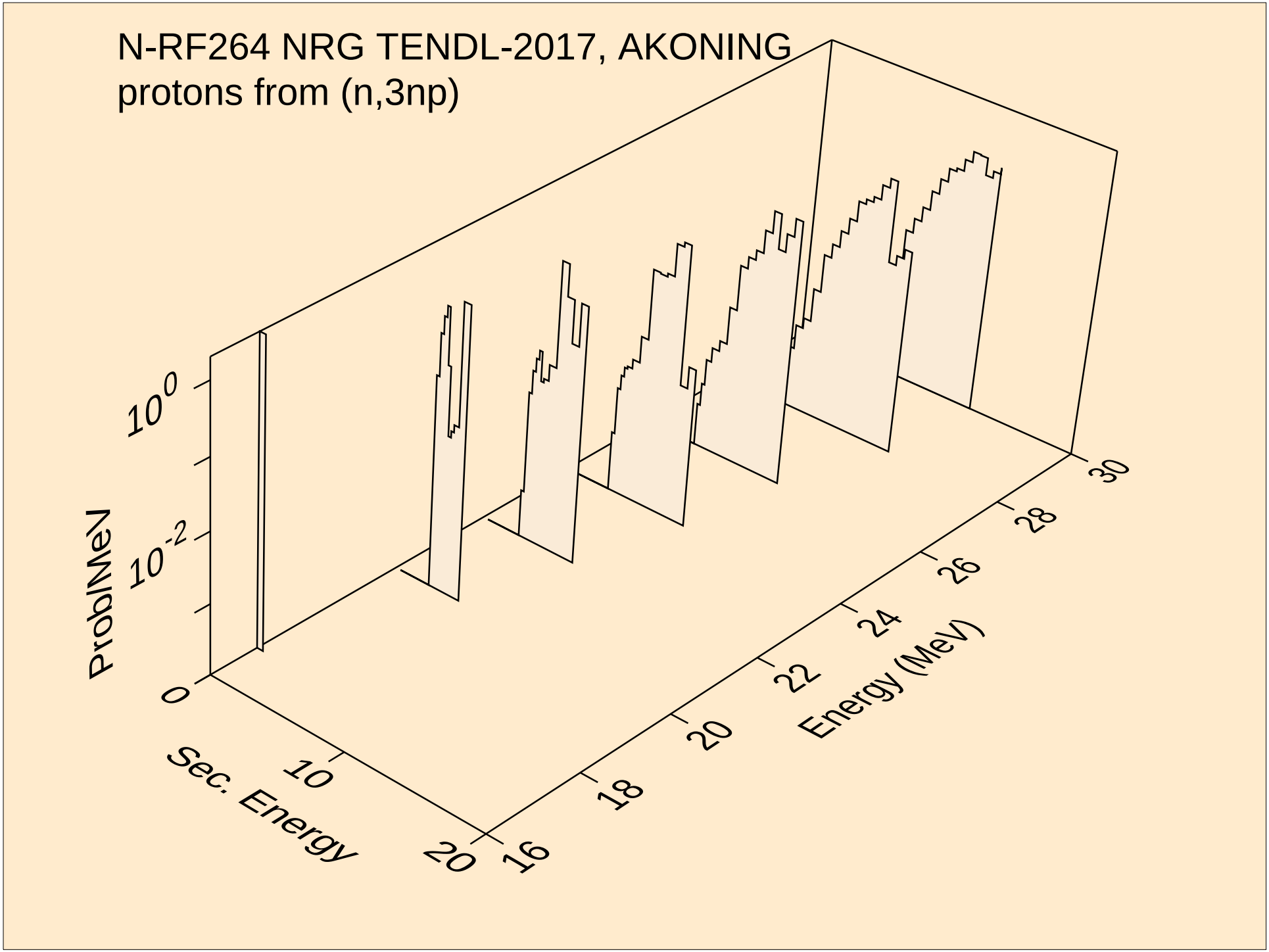

N-RF264 NRG TENDL-2017, AKONING
Recoil Heating
recoil heating
Heating (MeV/reaction)
6
4
2
0
-2
-4
-6
-8
-10
-12
0
50
100
150
200
Energy (MeV)

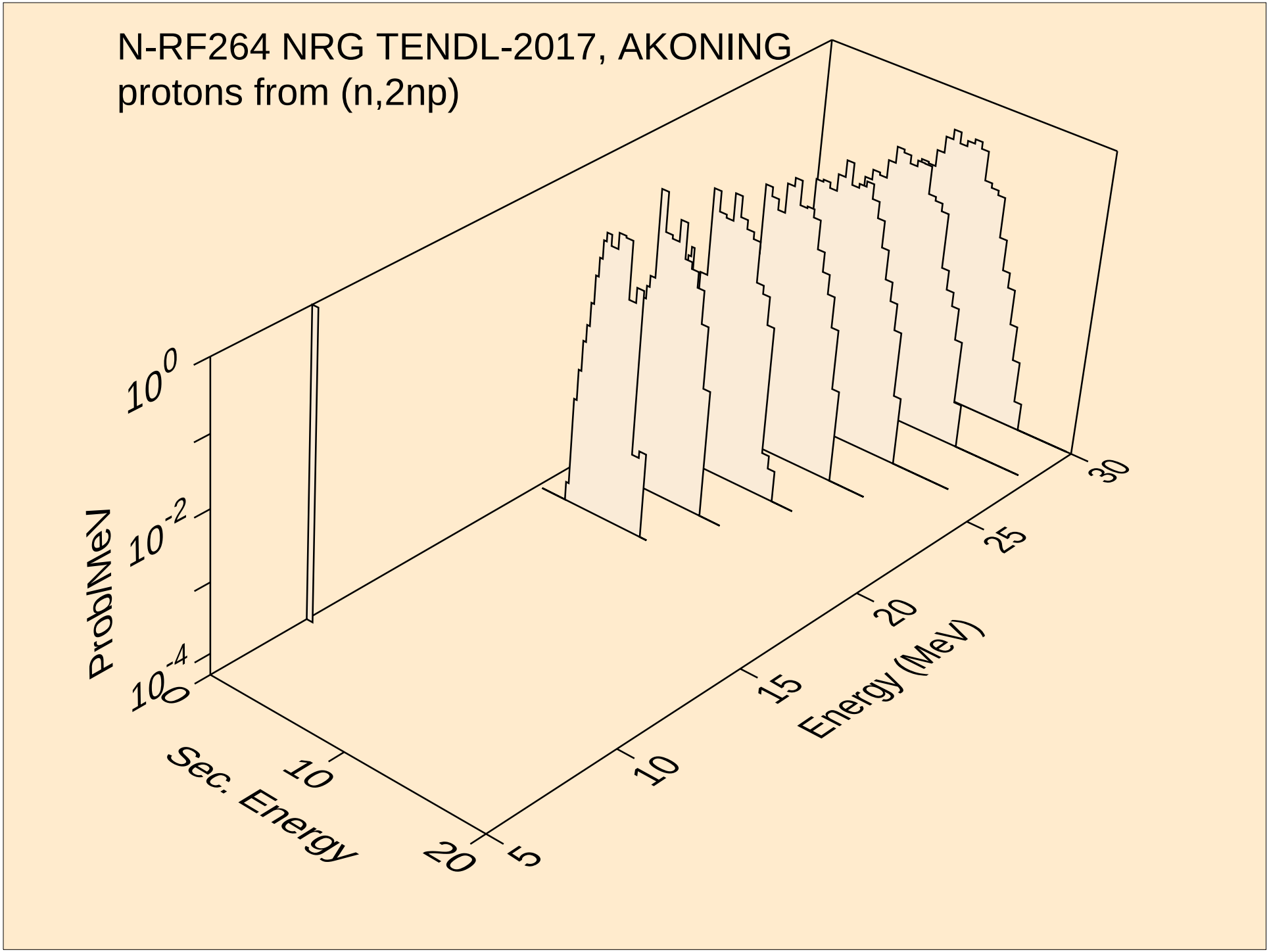

N-RF264 NRG TENDL-2017, AKONING
Particle production cross sections
Cross section (barns)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0
50
100
150
200
Energy (MeV)
protons
deuterons
tritons
he-3
alphas

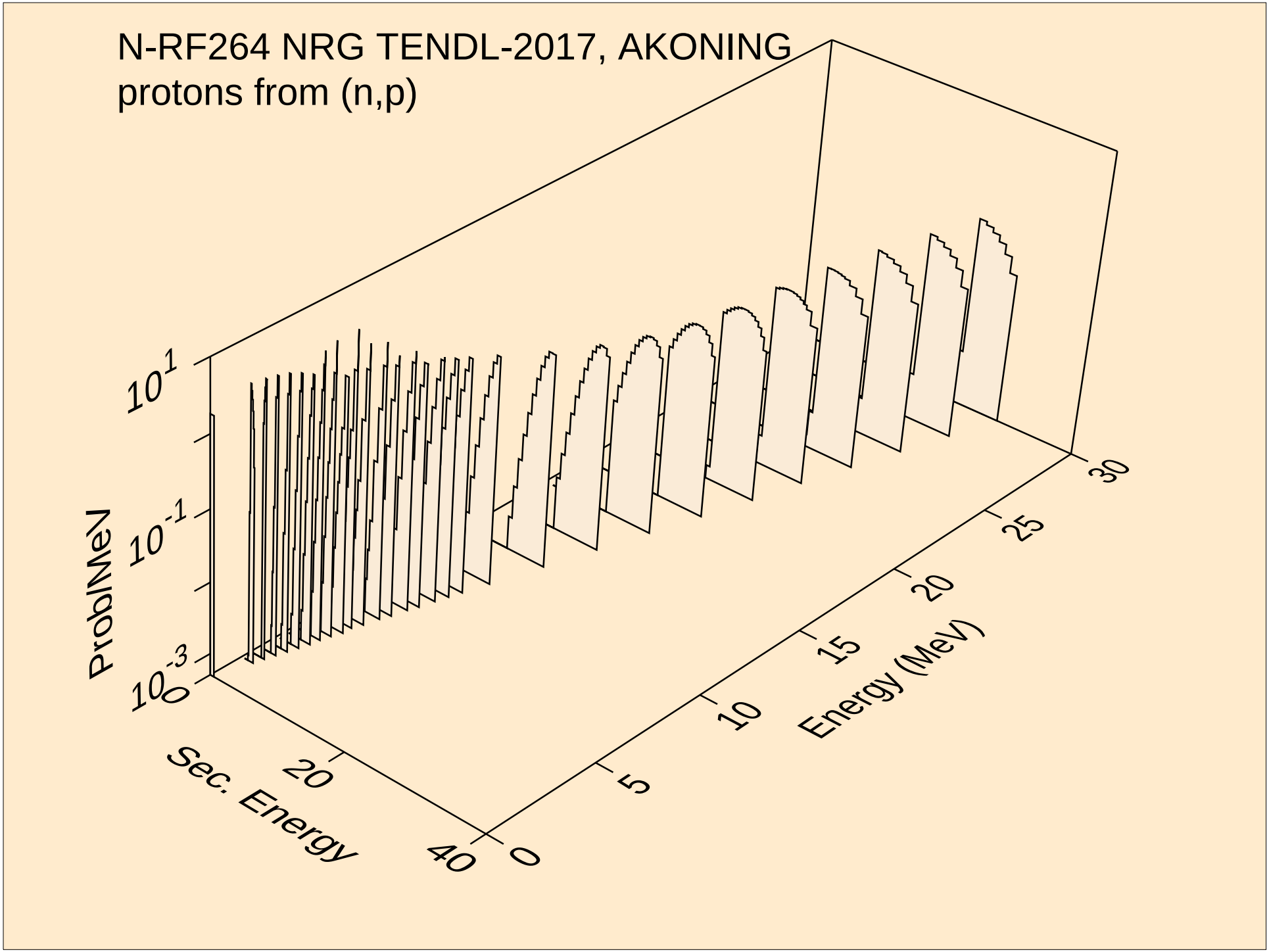

N-RF264 NRG TENDL-2017, AKONING
protons from (n,x)
Prob/MeV
10-2
10-4
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

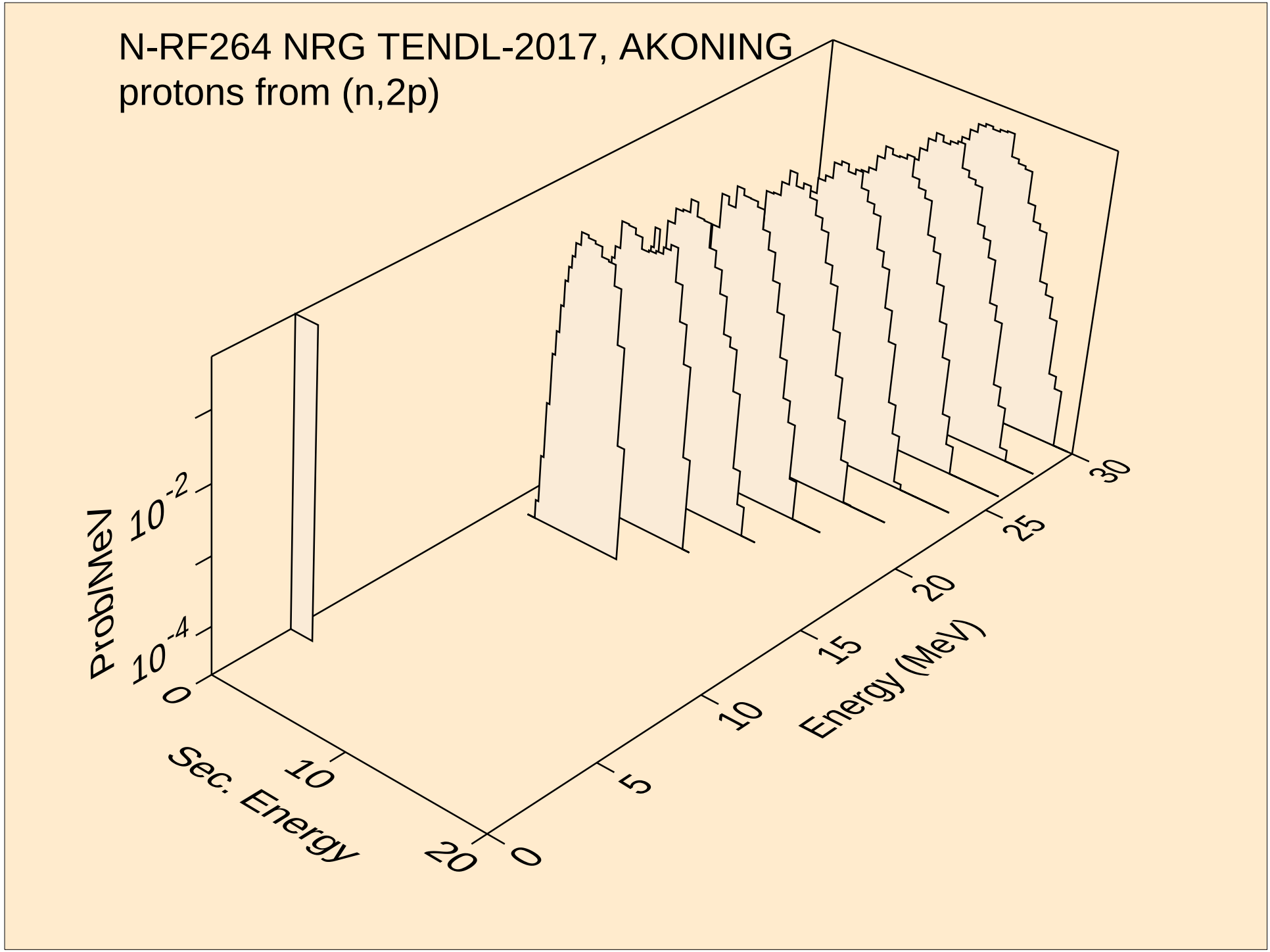

N-RF264 NRG TENDL-2017, AKONING
protons from (n,n*)p
Prob/MeV
10^2
10^0
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

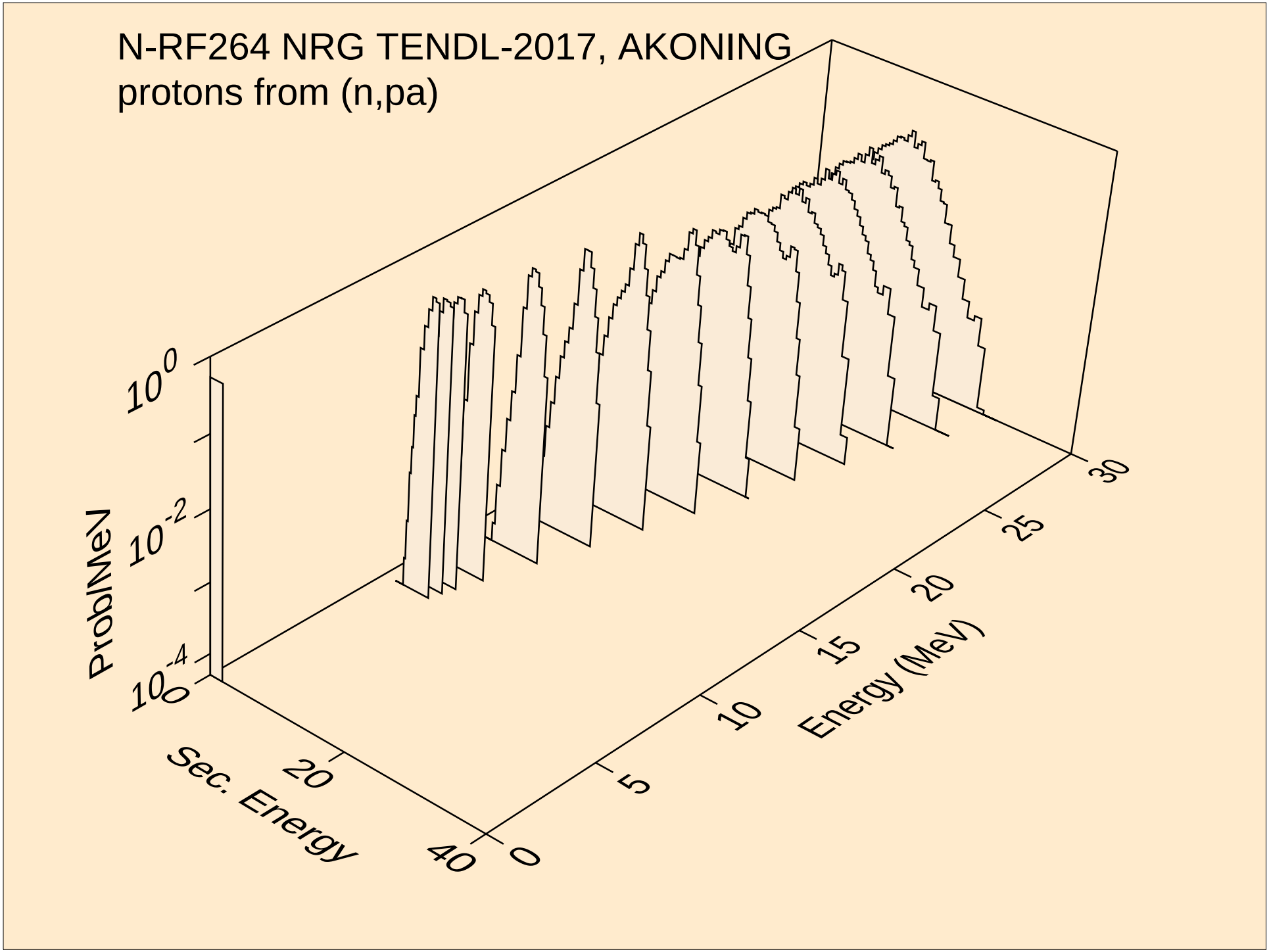

N-RF264 NRG TENDL-2017, AKONING
protons from (n,2np)
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
10
20
Sec. Energy
10
12
14
16
18
20
22
24
26
28
30
Energy (MeV)

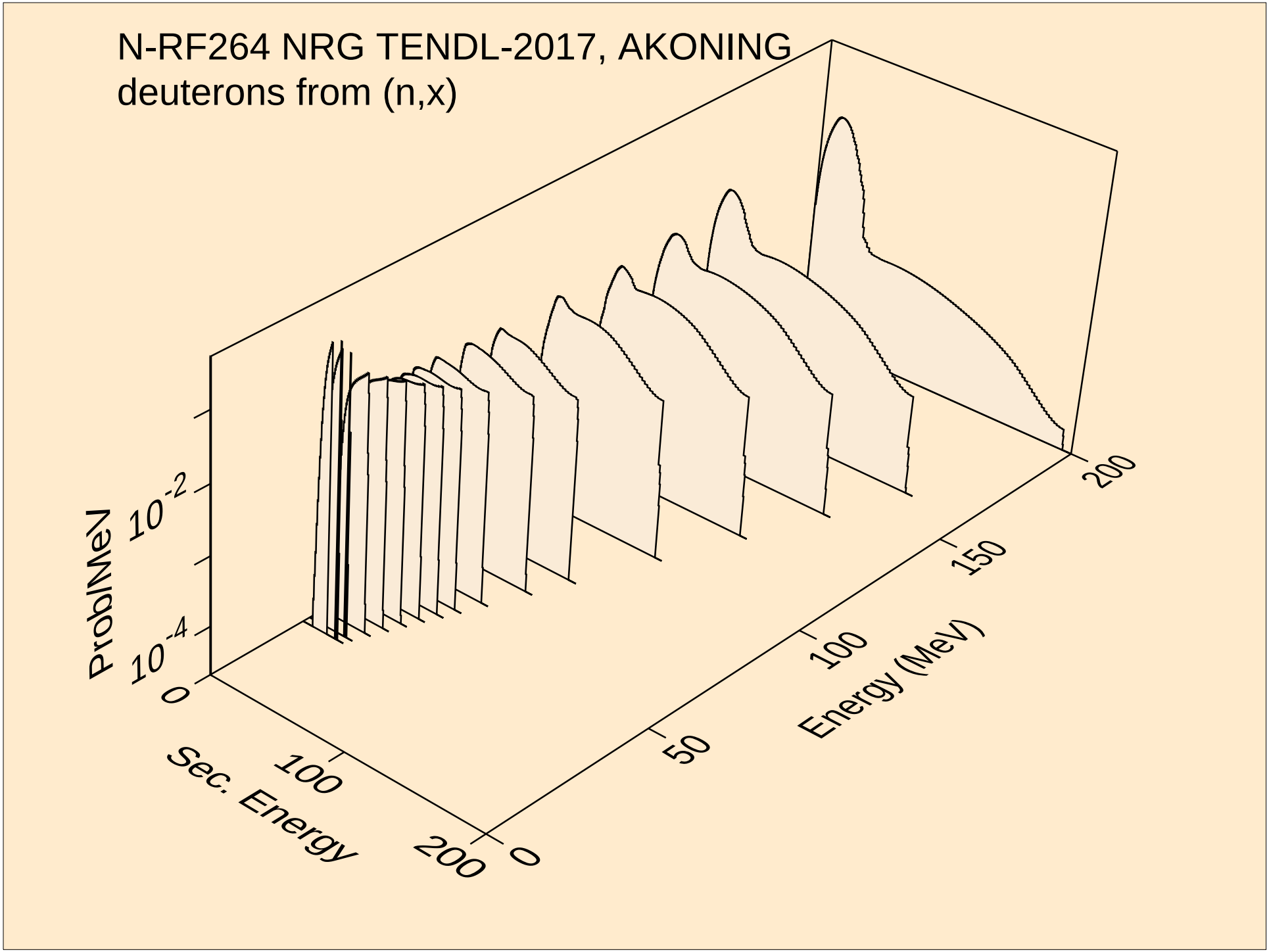

N-RF264 NRG TENDL-2017, AKONING
protons from (n,3np)
Prob/MeV
10^{0}
10^{-2}
0
Sec. Energy
10
20
16
18
20
22
24
26
28
30
Energy (MeV)

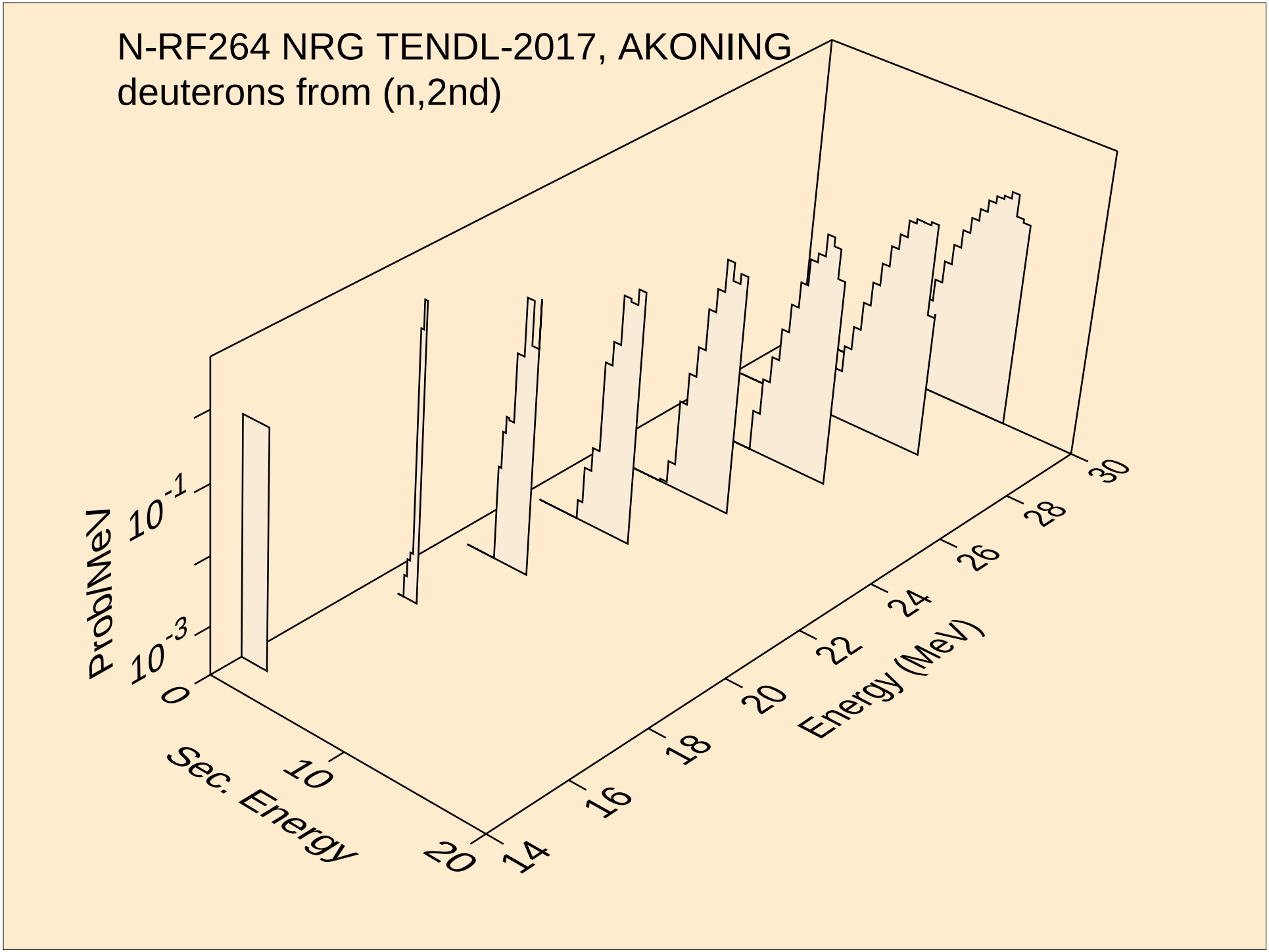

N-RF264 NRG TENDL-2017, AKONING
protons from (n,2np)
Prob/MeV
10^0
10^-2
10^-4
0
10
20
Sec. Energy
5
10
15
20
25
30
Energy (MeV)

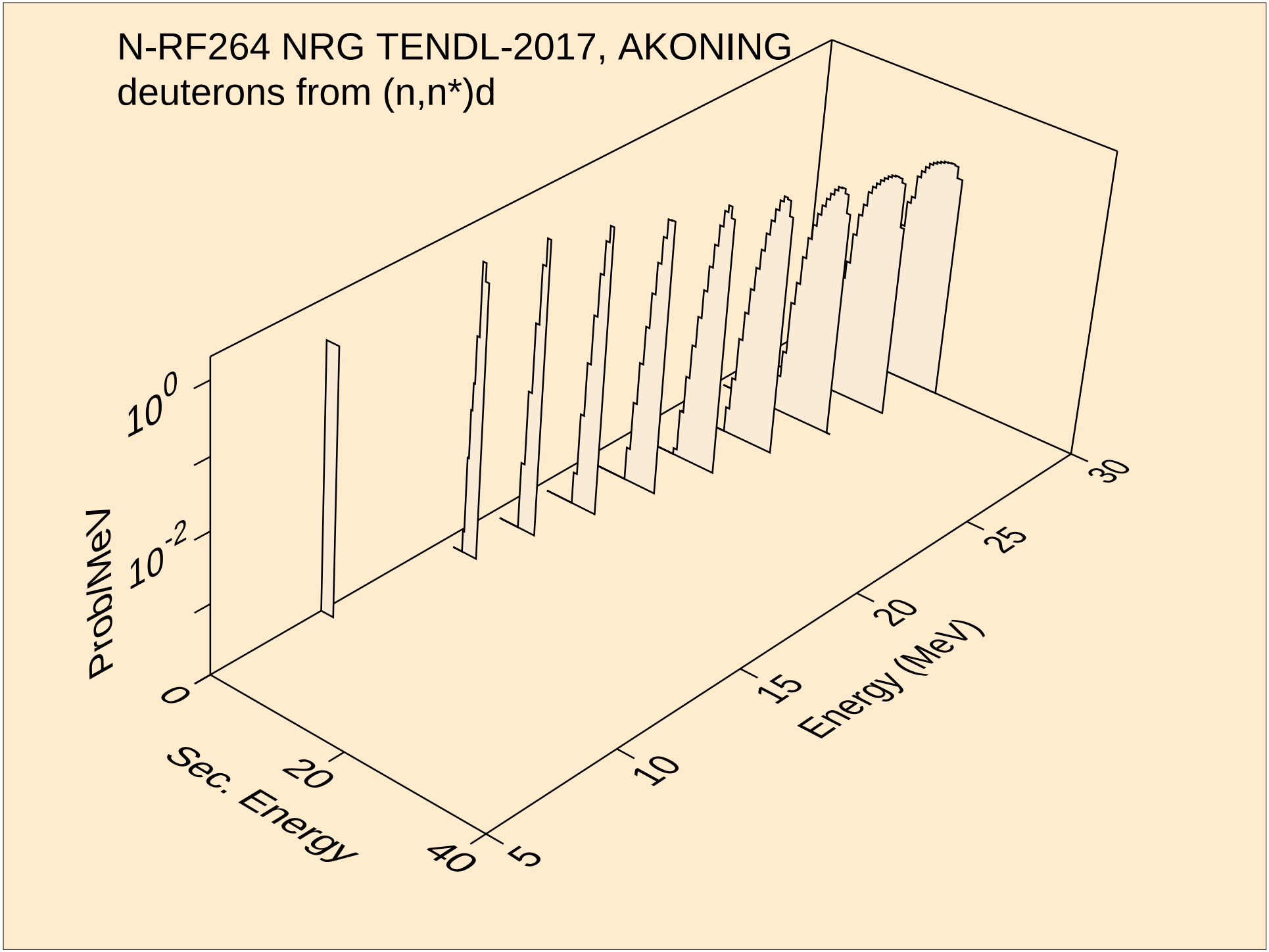

N-RF264 NRG TENDL-2017, AKONING
protons from (n,p)
Prob/MeV
10^1
10^-1
10^-3
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

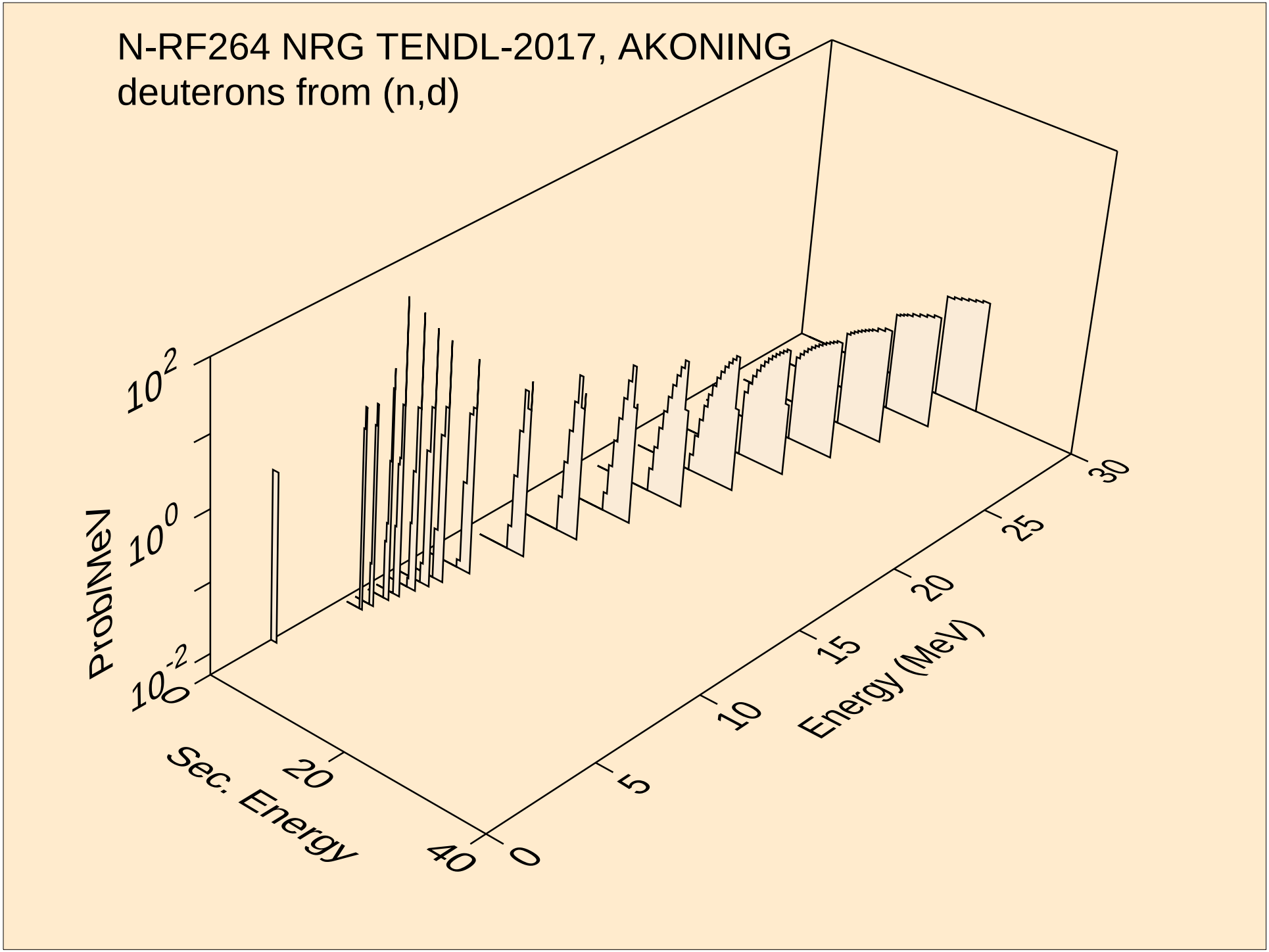

N-RF264 NRG TENDL-2017, AKONING
protons from (n,2p)
Prob/MeV
10-2
10-4
0
Sec. Energy
10
20
0
5
10
15
20
25
30
Energy (MeV)

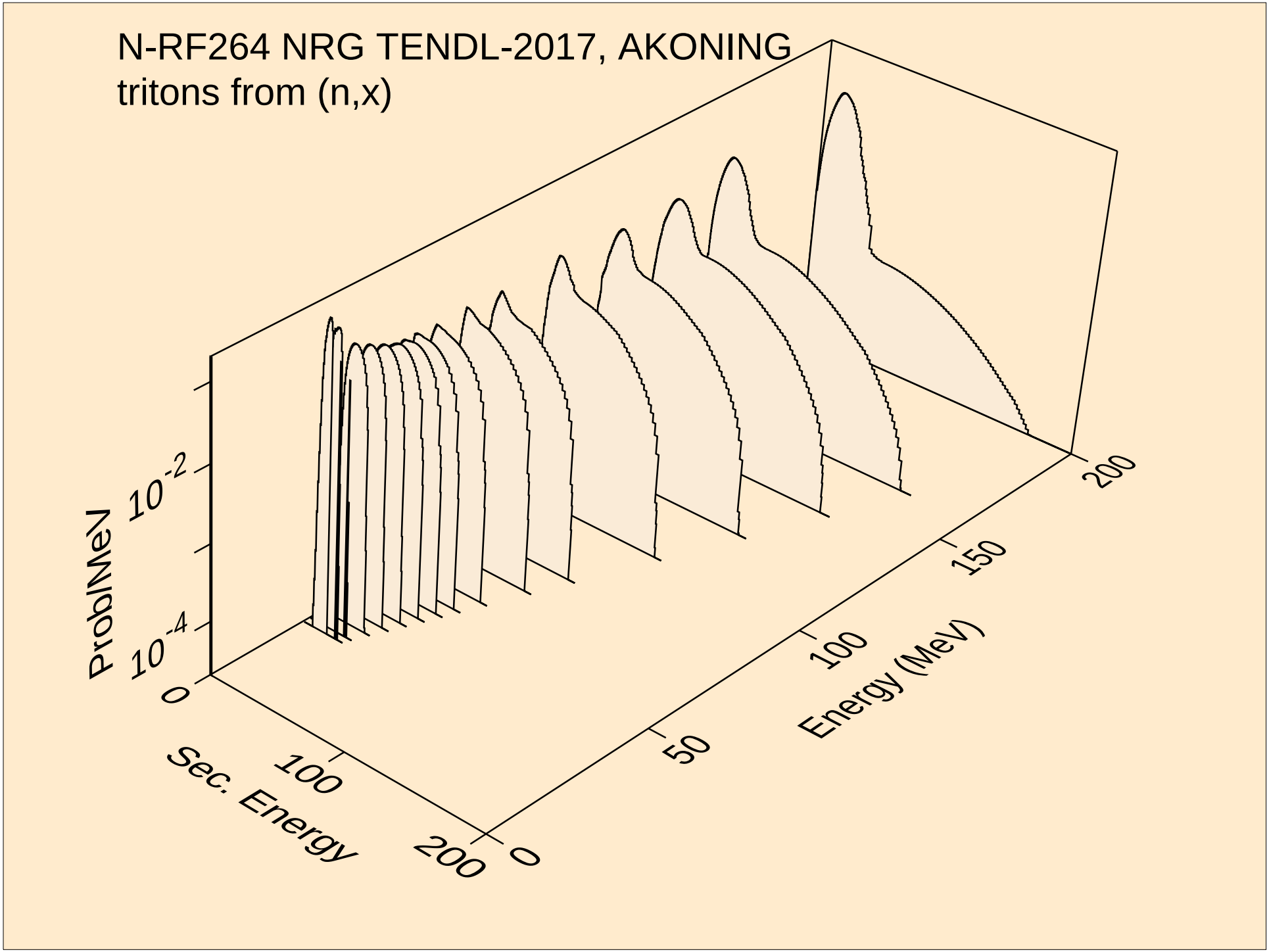

N-RF264 NRG TENDL-2017, AKONING
protons from (n,pa)
Prob/MeV
10^0
10^-2
10^-4
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

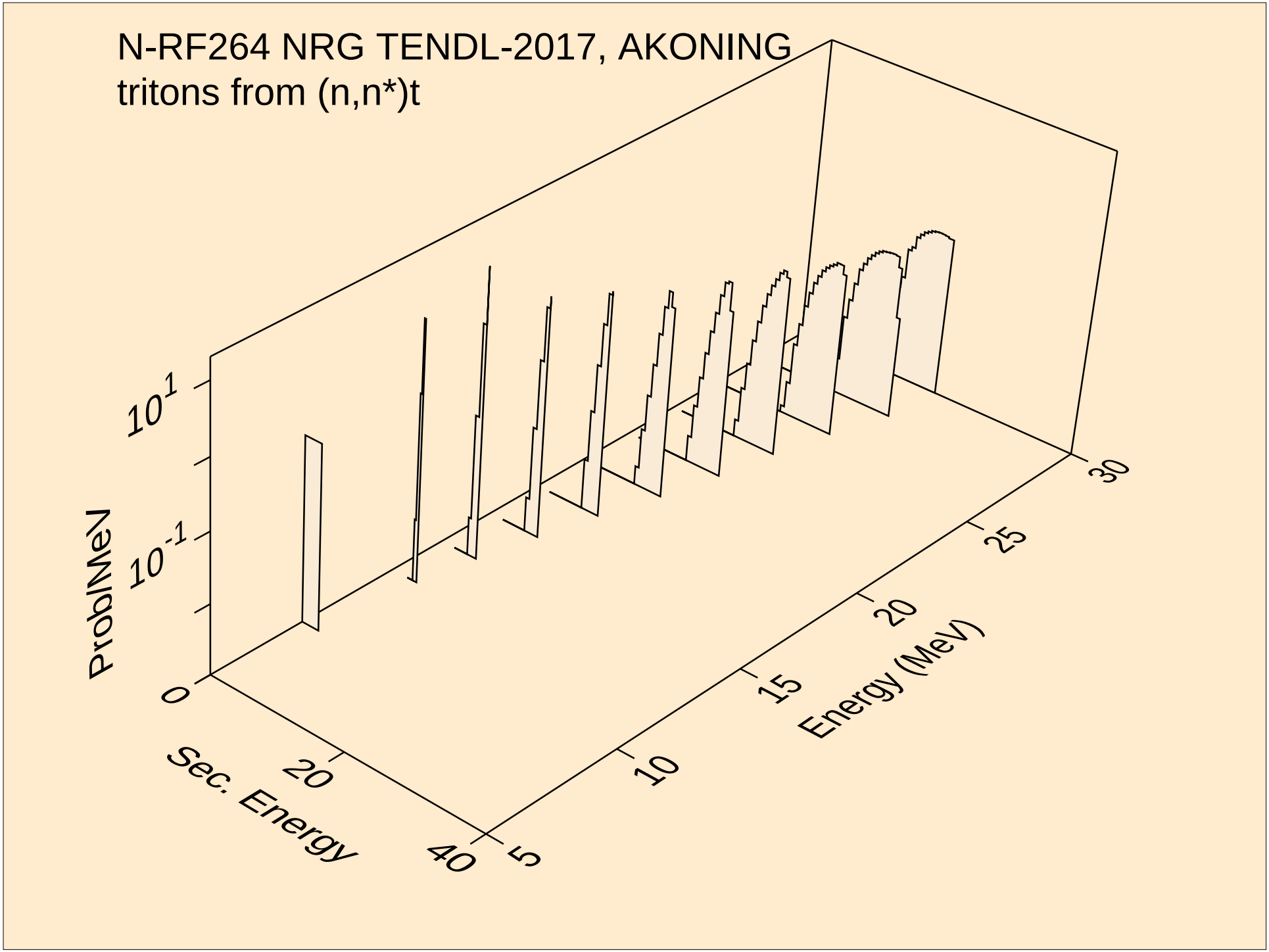

N-RF264 NRG TENDL-2017, AKONING
deuterons from (n,x)
Prob/MeV
10-2
10-4
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

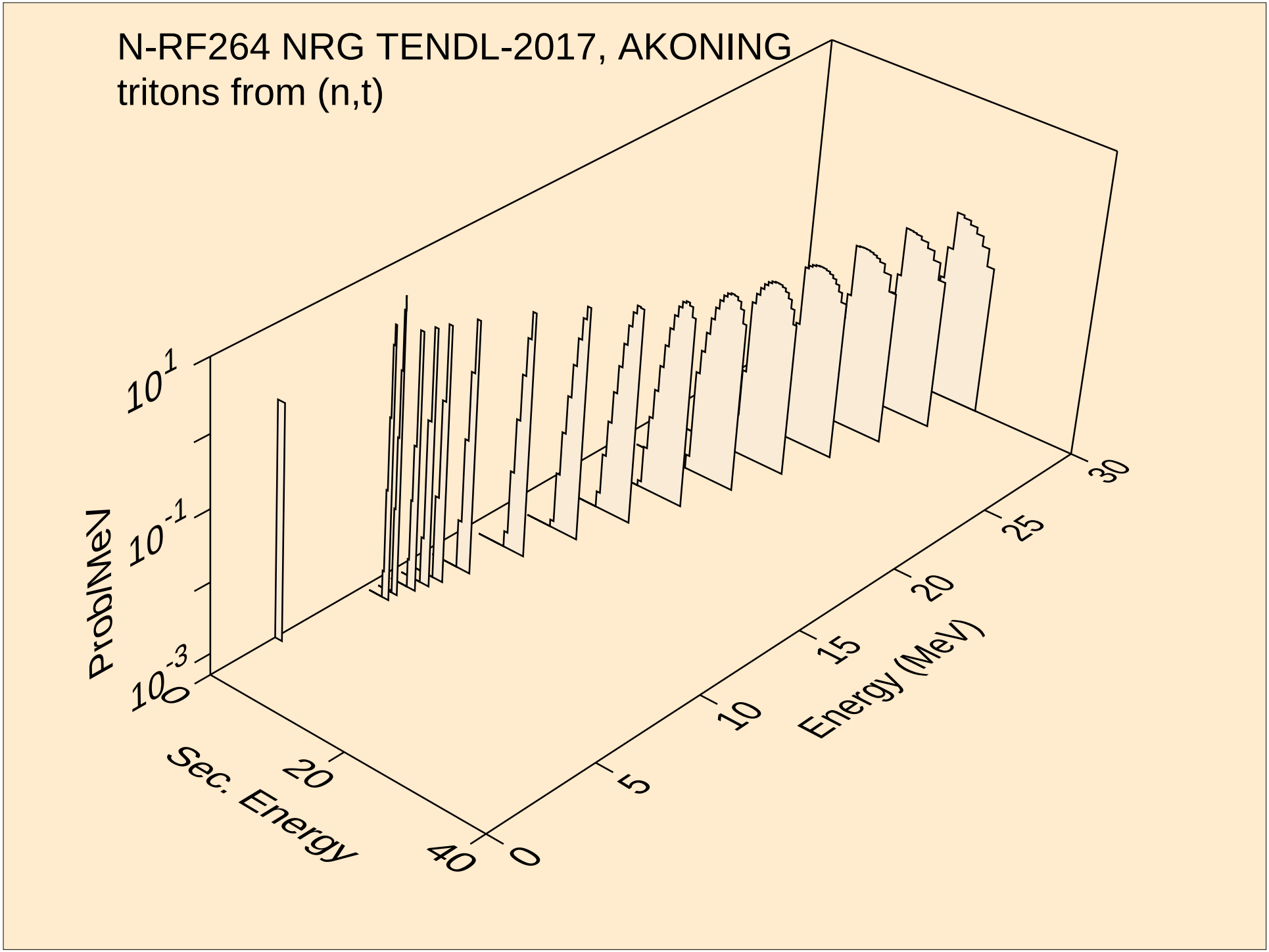

N-RF264 NRG TENDL-2017, AKONING
deuterons from (n,2nd)
Prob/MeV
10-1
10-3
0
Sec. Energy
10
20
14
16
18
20
22
24
26
28
30
Energy (MeV)

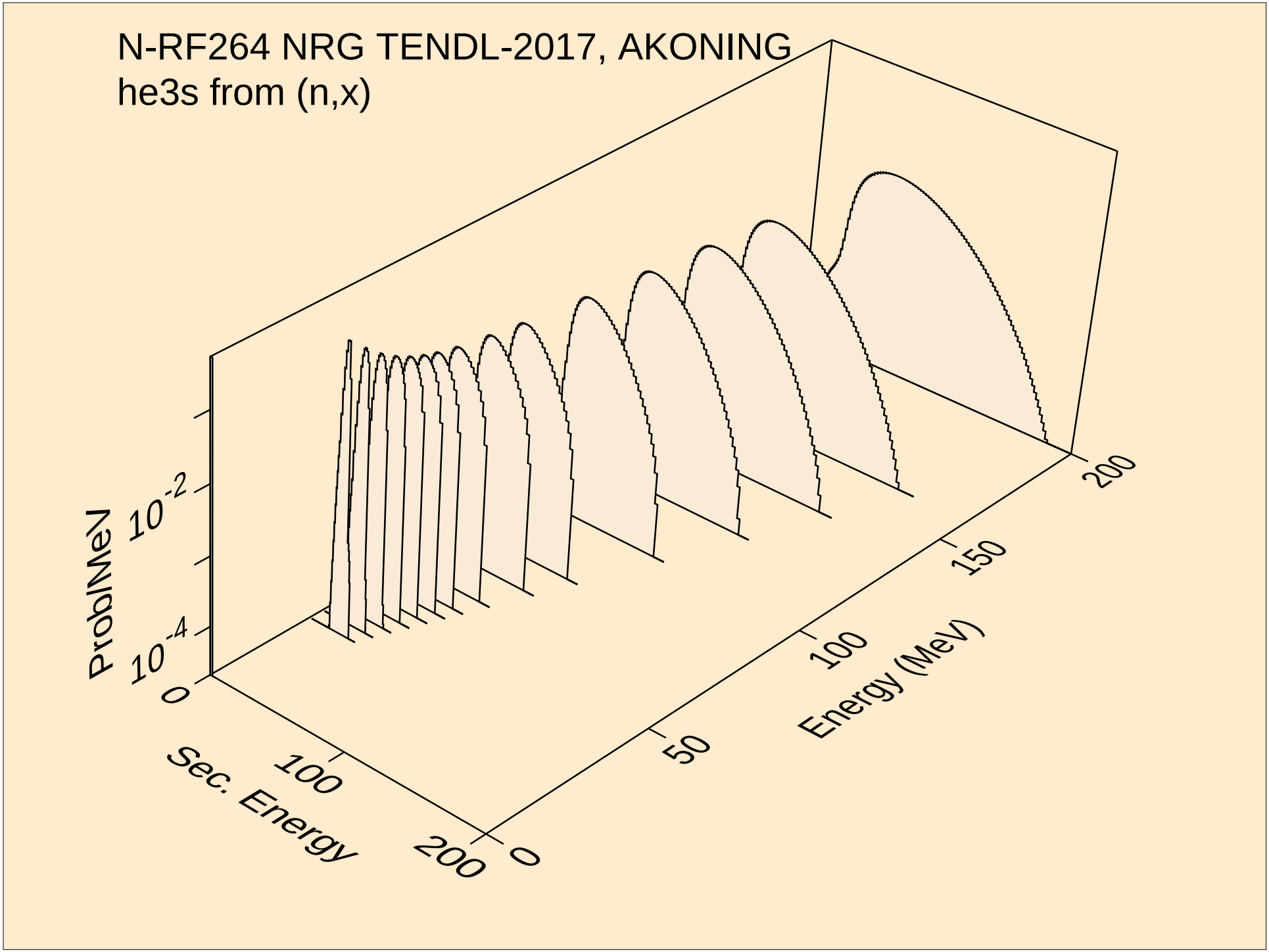

N-RF264 NRG TENDL-2017, AKONING
deuterons from (n,n*)d
Prob/MeV
10^0
10^-2
0
Sec. Energy
20
40
5
10
15
20
25
30
Energy (MeV)

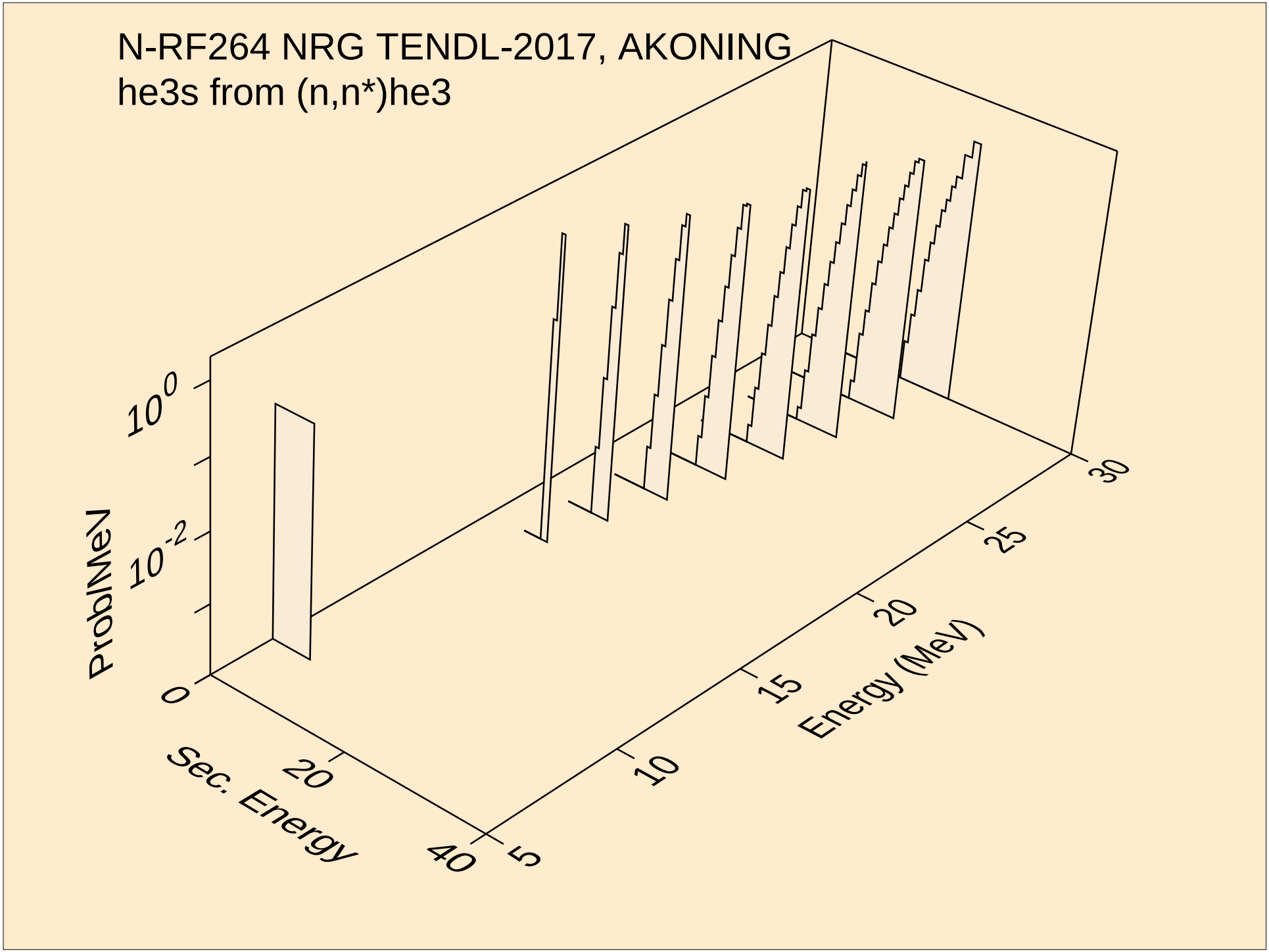

N-RF264 NRG TENDL-2017, AKONING
deuterons from (n,d)
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

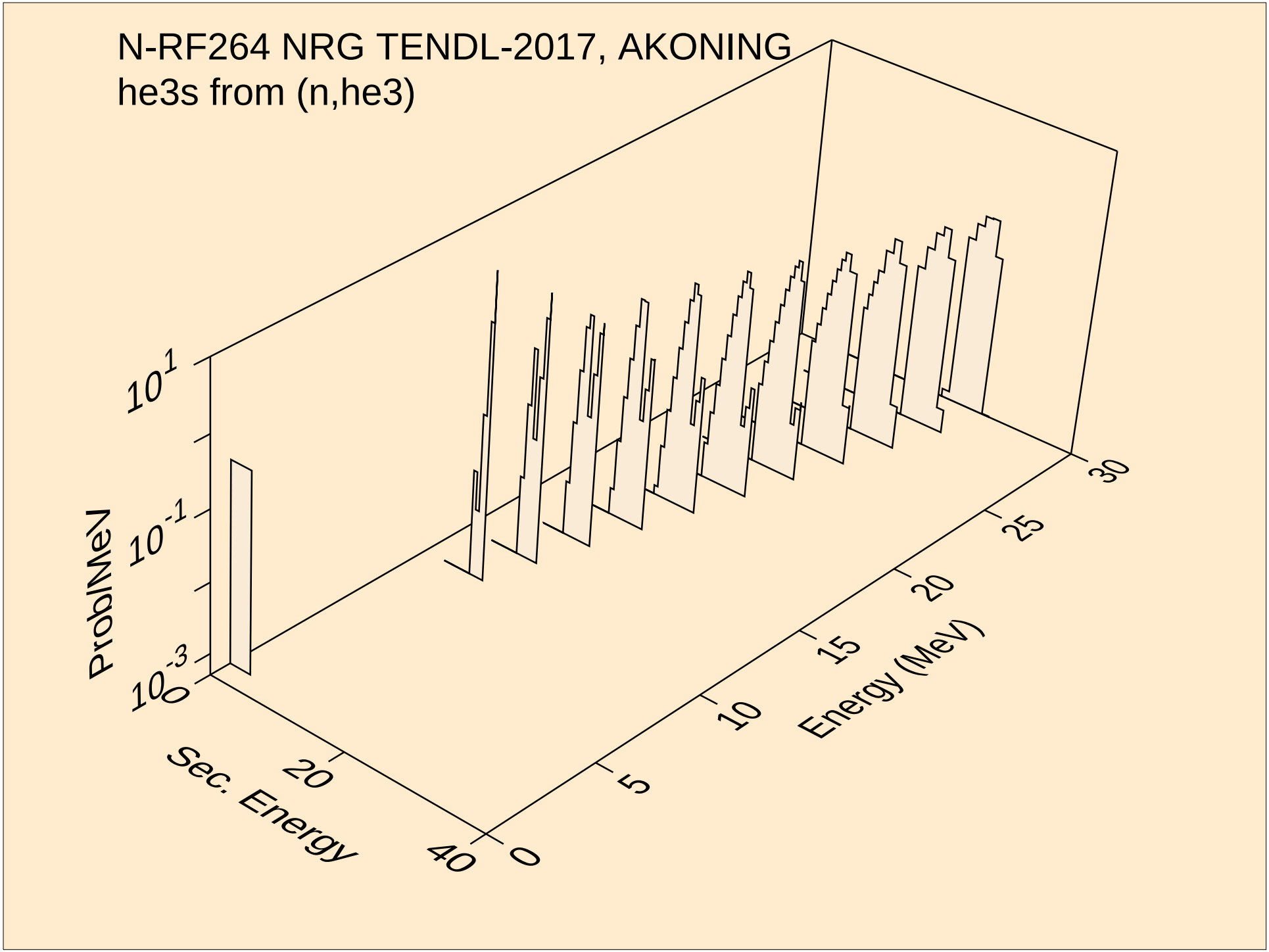

N-RF264 NRG TENDL-2017, AKONING
tritons from (n,x)
Prob/MeV
10-2
10-4
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

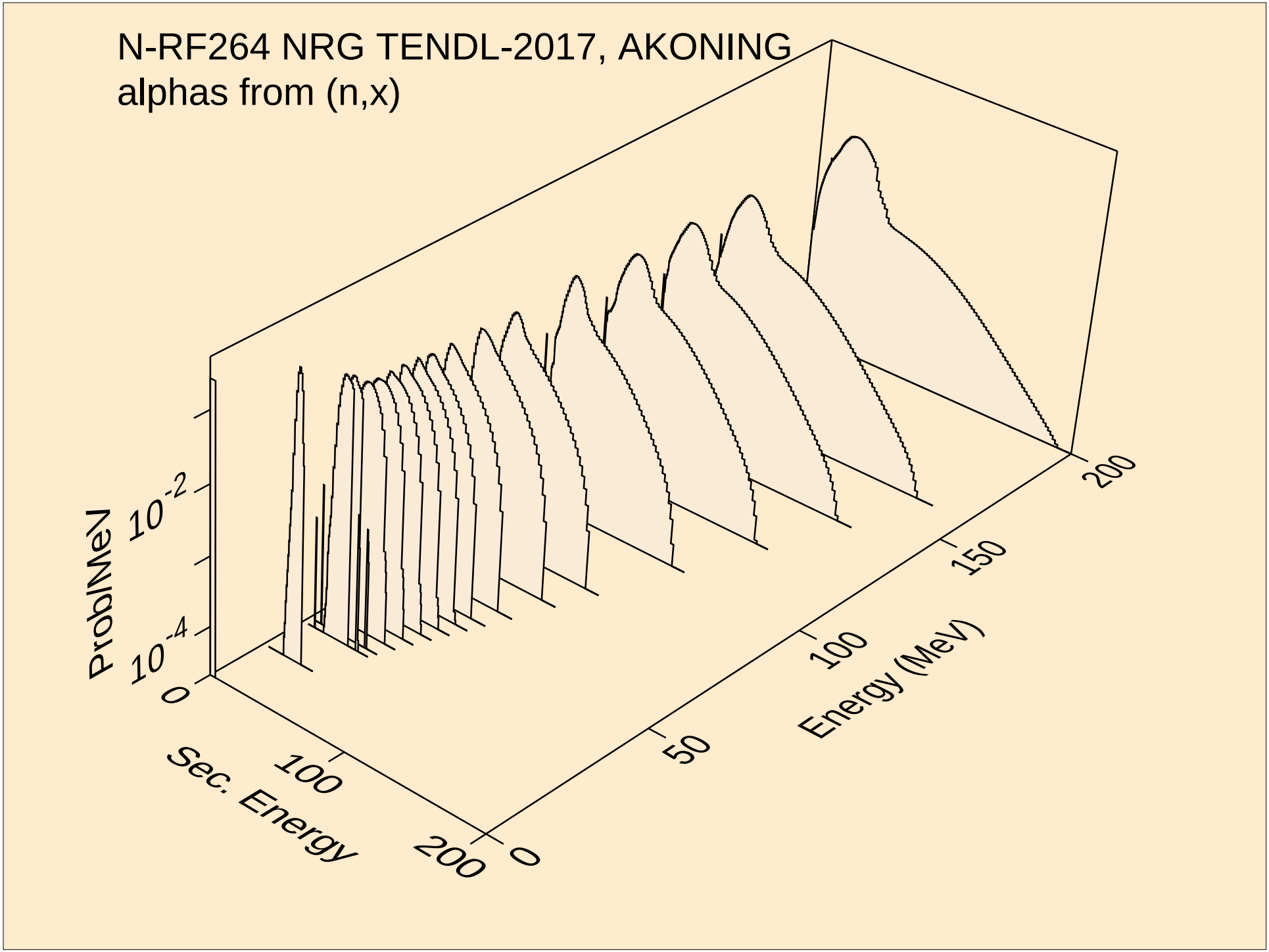

N-RF264 NRG TENDL-2017, AKONING
tritons from (n,n*)t
Prob/MeV
10^1
10^-1
0
Sec. Energy
20
40
5
10
15
Energy (MeV)
20
25
30

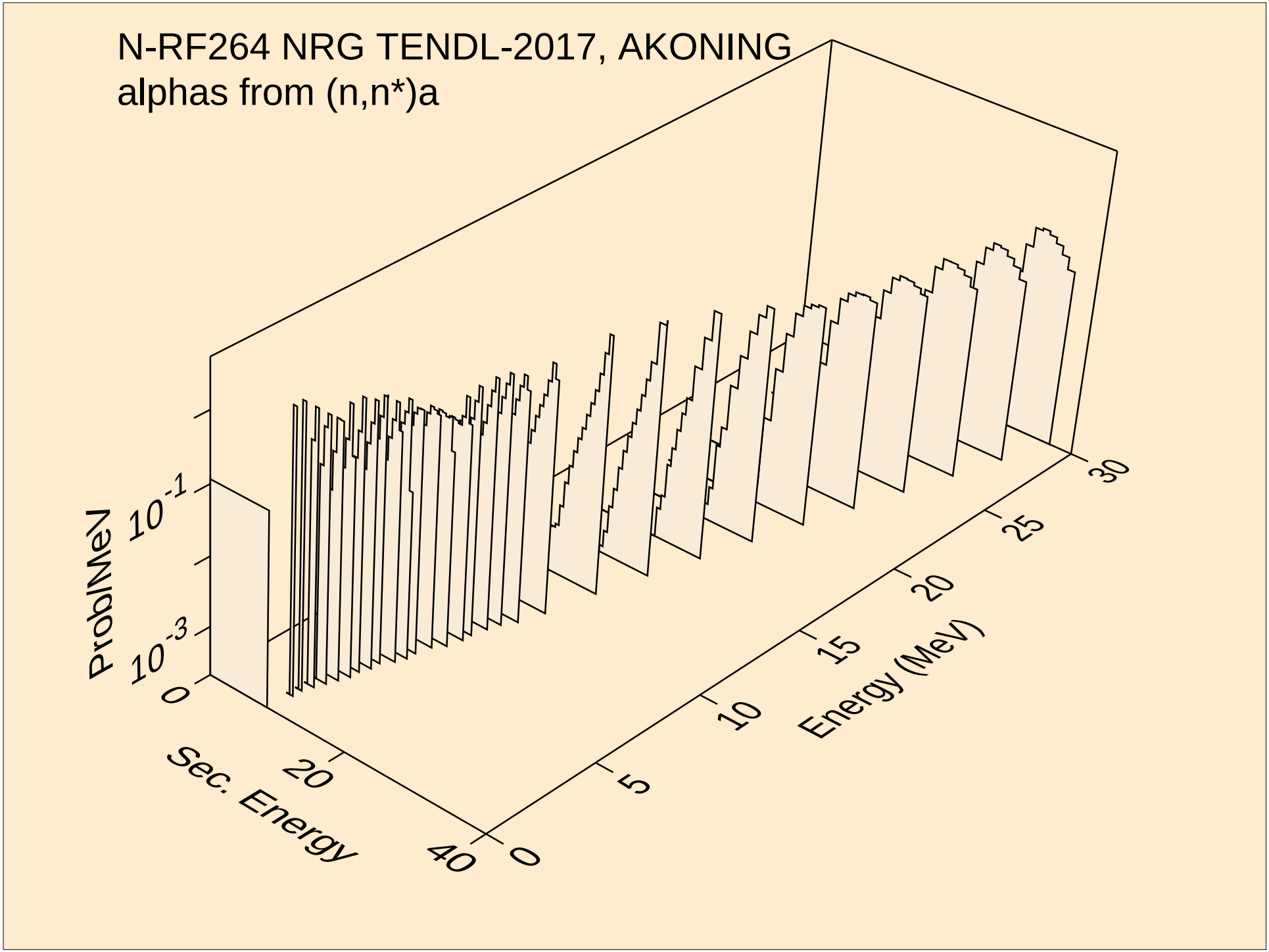

N-RF264 NRG TENDL-2017, AKONING
tritons from (n,t)
Prob/MeV
10^{1}
10^{-1}
10^{-3}
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

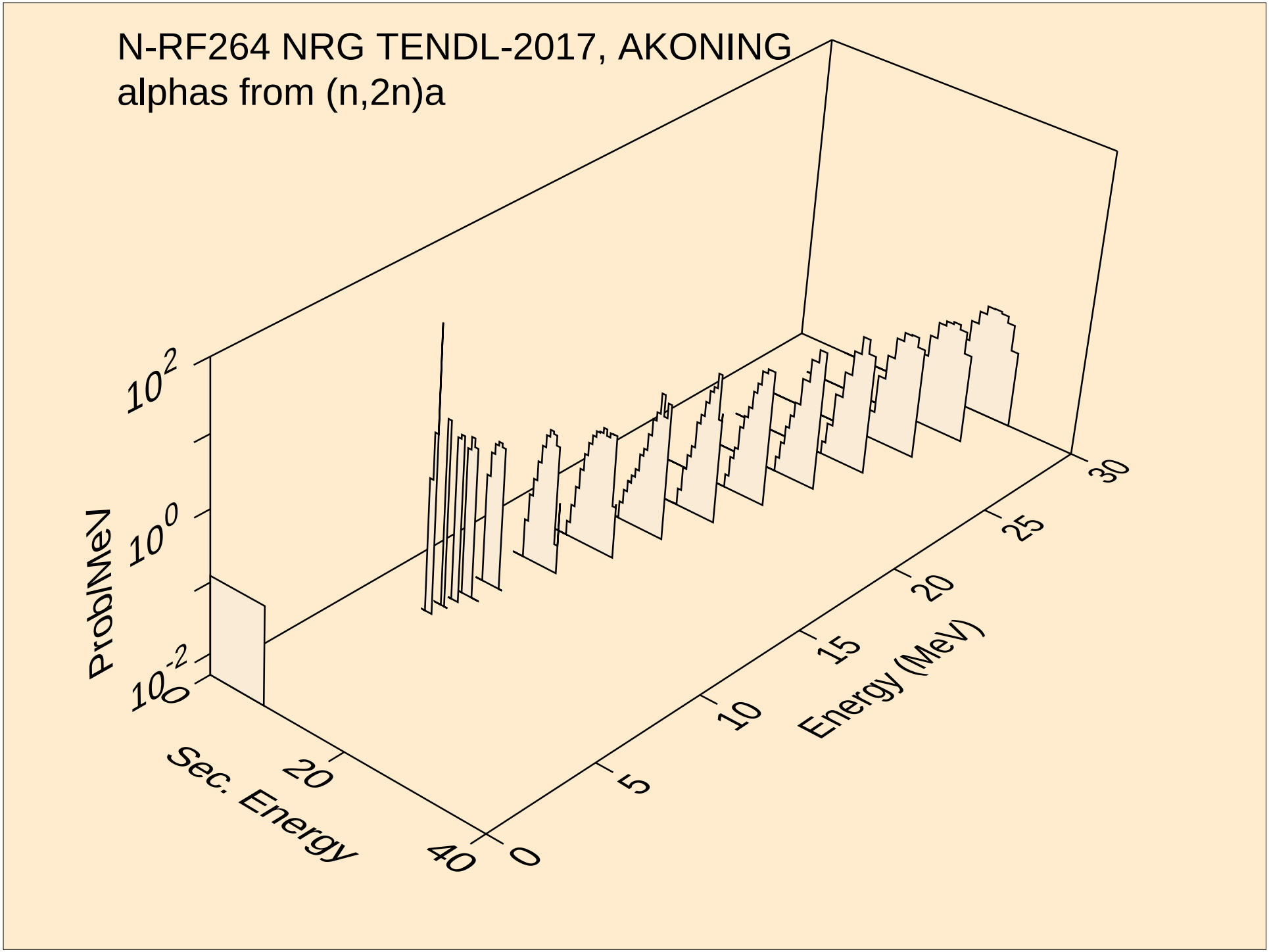

N-RF264 NRG TENDL-2017, AKONING
he3s from (n,x)
Prob/MeV
10-2
10-4
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

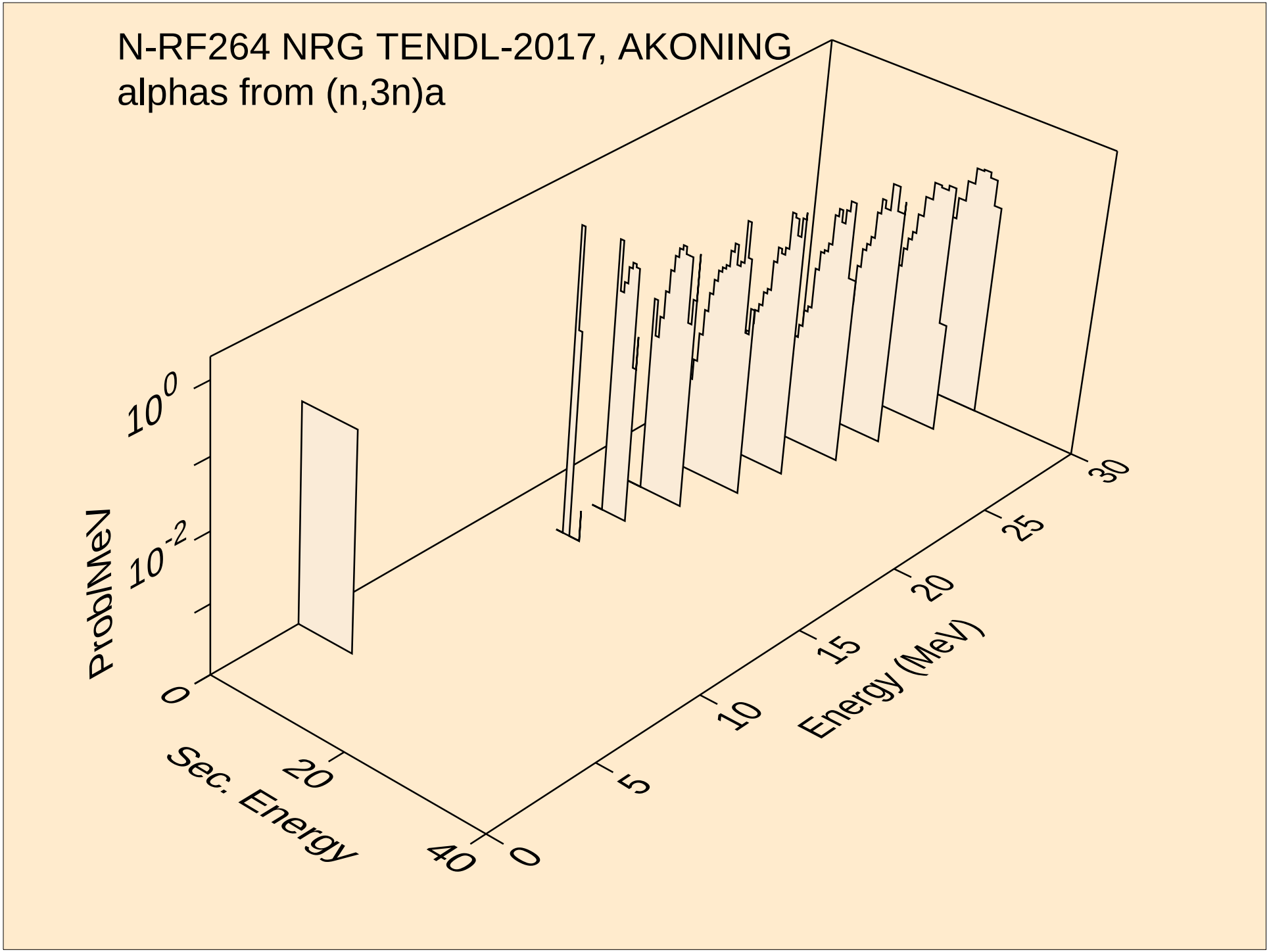

N-RF264 NRG TENDL-2017, AKONING
he3s from (n,n*)he3
Prob/MeV
10^0
10^-2
0
Sec. Energy
20
40
5
10
15
20
25
30
Energy (MeV)

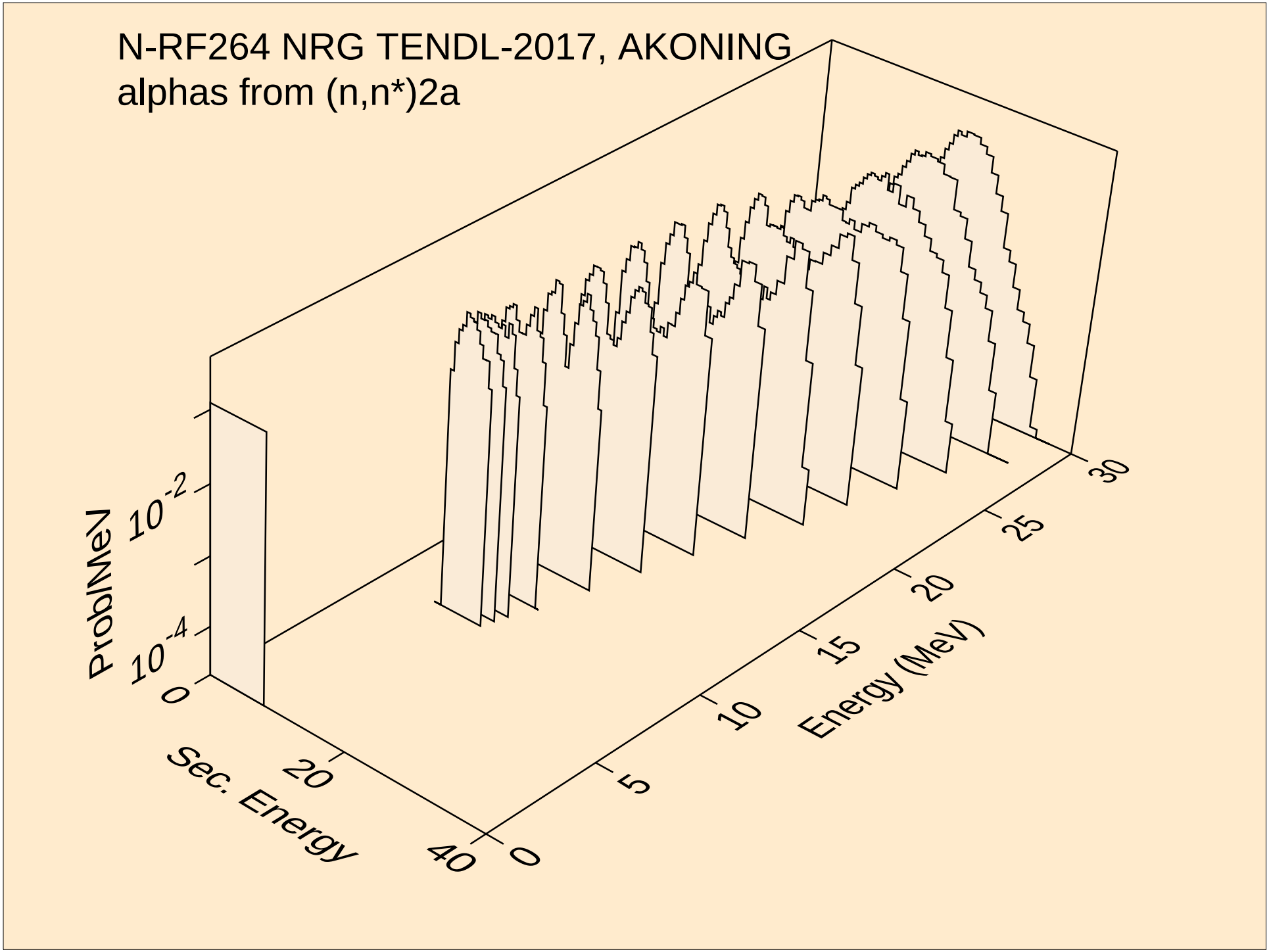

N-RF264 NRG TENDL-2017, AKONING
he3s from (n,he3)
Prob/MeV
10^1
10^-1
10^-3
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)

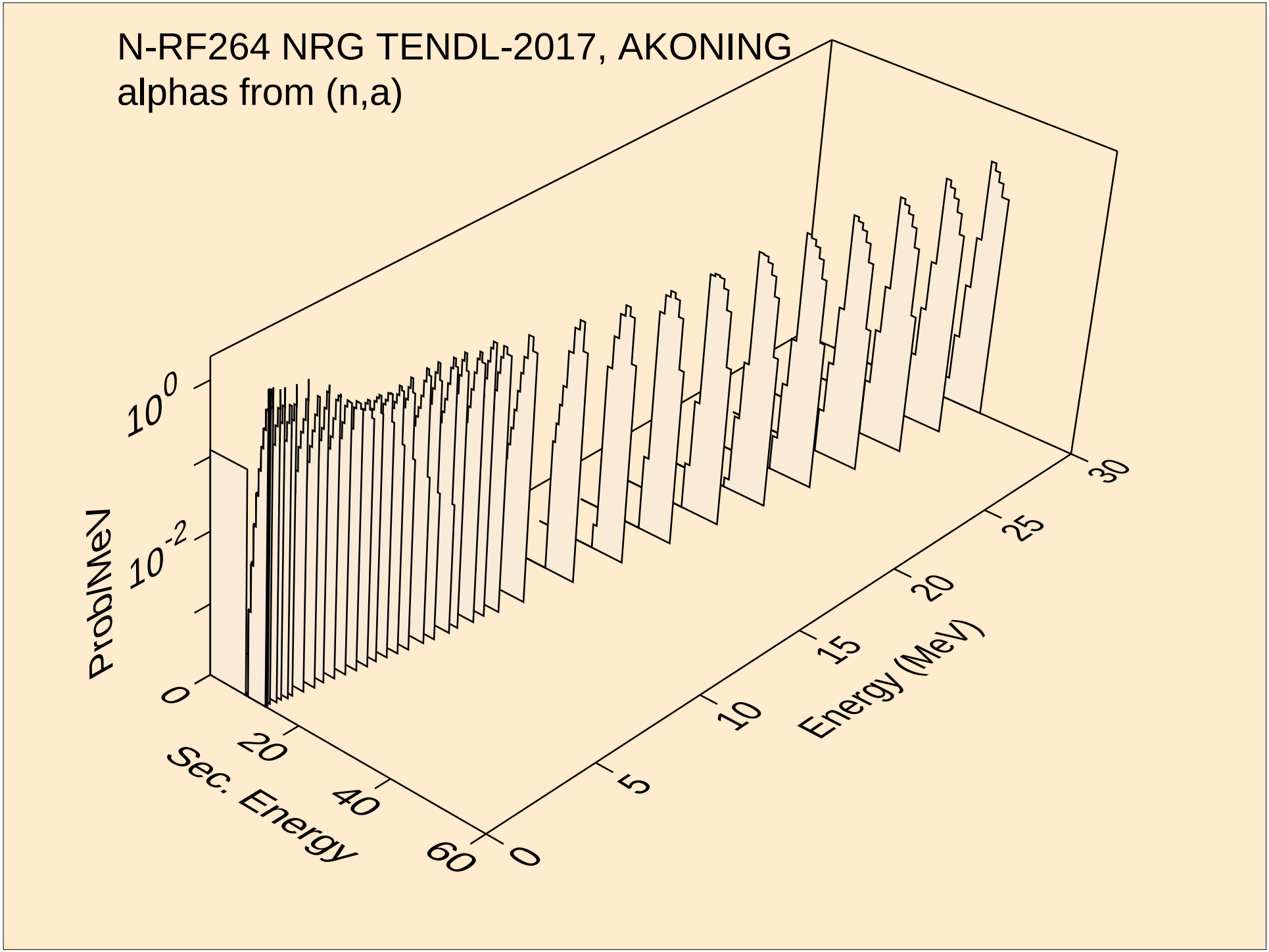

N-RF264 NRG TENDL-2017, AKONING
alphas from (n,x)
Prob/MeV
10-2
10-4
0
Sec. Energy
100
200
0
50
100
150
200
Energy (MeV)

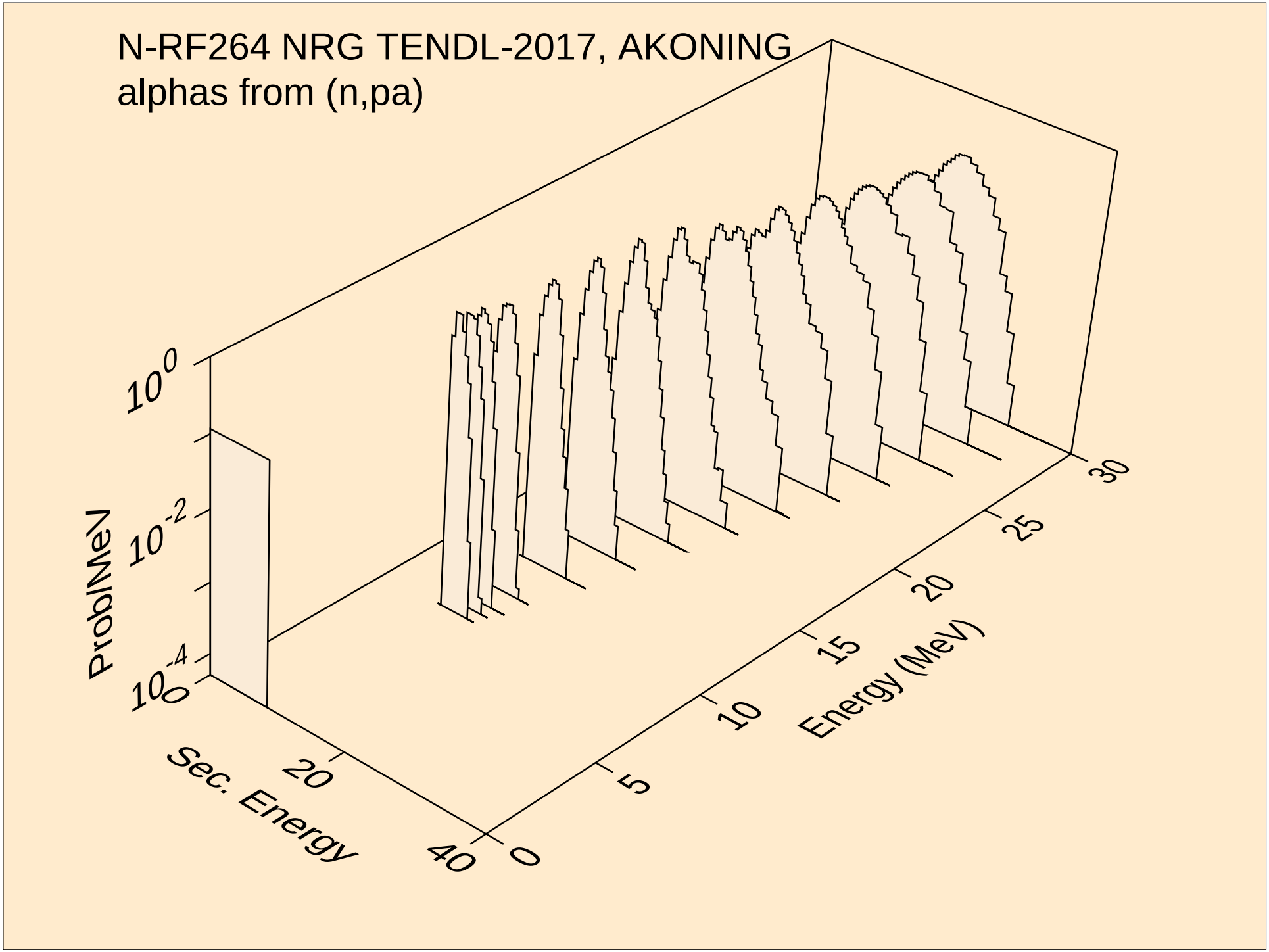

N-RF264 NRG TENDL-2017, AKONING
alphas from (n,n*)a
Prob/MeV
10-1
10-3
0
Sec. Energy
20
40
0
5
10
15
20
25
30
Energy (MeV)


N-RF264 NRG TENDL-2017, AKONING
alphas from (n,2n)a
Prob/MeV
10^{2}
10^{0}
10^{-2}
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)


N-RF264 NRG TENDL-2017, AKONING
alphas from (n,3n)a
Prob/MeV
10^0
10^-2
0
Sec. Energy
20
40
0
5
10
15
Energy (MeV)
20
25
30


N-RF264 NRG TENDL-2017, AKONING
alphas from (n,n*)2a
Prob/MeV
10-2
10-4
0
Sec. Energy
20
40
0
5
10
15
20
25
30
Energy (MeV)


N-RF264 NRG TENDL-2017, AKONING
alphas from (n,a)
Prob/MeV
10^0
10^-2
0
Sec. Energy
20
40
60
0
5
10
15
20
25
30
Energy (MeV)


N-RF264 NRG TENDL-2017, AKONING
alphas from (n,pa)
Prob/MeV
10^{0}
10^{-2}
10^{-4}
0
20
40
Sec. Energy
0
5
10
15
20
25
30
Energy (MeV)