Xenon (Xe)

1. Recommended electron collision cross sections [1]

The following cross section set was compiled so that it can reproduce the drift velocity, the ND_L and the Townsend's ionization coefficient measured in Xe gas by the two-term Boltzmann code.

(1) Elastic momentum transfer cross section

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
0.00000	131.00000	0.42000	1.55000	2.80000	15.00000
0.00100	123.00000	0.44000	1.38000	3.00000	17.00000
0.00250	113.00000	0.46000	1.25000	3.30000	19.50000
0.00500	99.00000	0.48000	1.14000	3.60000	22.30000
0.01000	84.30000	0.50000	1.04200	4.00000	25.20000
0.02000	67.10000	0.54000	0.90000	4.40000	28.00000
0.03000	55.70000	0.58000	0.75000	4.80000	30.80000
0.04000	47.20000	0.62000	0.64000	5.20000	31.40000
0.05000	40.80000	0.70000	0.55000	5.60000	31.60000
0.06000	35.33000	0.74000	0.54000	6.00000	30.20000
0.08000	27.84000	0.78000	0.55000	6.50000	27.50000
0.10000	22.60000	0.80000	0.56000	7.00000	25.50000
0.12000	18.10000	0.84000	0.58000	7.40000	23.50000
0.14000	14.66000	0.88000	0.63000	7.80000	21.80000
0.16000	11.97000	0.92000	0.73000	8.40000	19.50000
0.18000	9.86000	0.96000	0.92000	9.00000	17.00000
0.20000	8.18000	1.00000	1.10000	10.00000	14.00000
0.22000	6.82000	1.10000	1.60000	12.00000	10.10000
0.24000	5.73000	1.20000	2.21000	14.00000	7.70000
0.26000	4.83000	1.30000	2.77000	20.00000	5.20000
0.28000	4.10300	1.40000	3.38000	25.00000	5.00000
0.30000	3.50400	1.60000	4.68000	30.00000	4.80000
0.32000	3.01000	1.80000	5.98000	35.00000	4.55000
0.34000	2.60000	2.00000	7.47000	40.00000	4.20000
0.36000	2.26000	2.20000	9.20000	50.00000	3.60000
0.38000	1.98000	2.40000	11.05000	100.00000	2.40000
0.40000	1.74000	2.60000	12.90000		

(2) Electronic excitation cross section 1, Threshold = 8.315 eV, Energy loss = 8.315 eV

Energy (eV)	Cross section(A_2)	Energy (eV)	Cross section(A_2)
8.31500	0.00000	9.52000	0.01790
8.35000	0.00552	9.55000	0.03320
8.40000	0.01010	9.59000	0.02280
8.50000	0.00420	9.63000	0.03410
8.60000	0.00540	9.68000	0.02520
8.70000	0.00840	9.73000	0.02210
8.80000	0.01220	9.78000	0.02240
8.90000	0.01810	9.83000	0.02760
9.00000	0.02280	9.90000	0.03250
9.07000	0.02440	9.94000	0.03110
9.20000	0.01760	10.00000	0.03310
9.25000	0.01660	10.25000	0.04080
9.30000	0.01700	10.50000	0.04510
9.35000	0.01800	10.75000	0.04860
9.40000	0.01760	11.00000	0.05420

11.50000	0.07320	22.00000	0.03360
12.00000	0.09120	25.00000	0.02160
12.50000	0.10400	30.00000	0.01120
13.00000	0.11200	35.00000	0.00804
14.00000	0.11400	40.00000	0.00660
15.00000	0.10600	50.00000	0.00540
16.00000	0.09480	60.00000	0.00480
17.50000	0.07680	80.00000	0.00420
20.00000	0.04680	100.00000	0.00384

(3) Electronic excitation cross section 2, Threshold = 8.437 eV, Energy loss = 8.437 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
8.43700	0.00000	13.00000	0.17500
8.50000	0.00115	14.00000	0.21500
8.60000	0.00720	15.00000	0.25300
8.70000	0.01300	16.00000	0.28600
8.80000	0.02020	17.50000	0.31600
8.90000	0.02880	20.00000	0.33400
9.00000	0.04180	22.00000	0.33800
9.10000	0.05330	25.00000	0.34200
9.20000	0.04610	30.00000	0.35200
9.30000	0.04460	32.00000	0.35500
9.40000	0.04610	35.00000	0.37000
9.50000	0.04900	40.00000	0.41000
9.60000	0.05180	45.00000	0.43000
9.70000	0.05620	50.00000	0.44200
9.80000	0.05900	55.00000	0.44000
9.90000	0.06190	60.00000	0.43400
10.00000	0.06770	70.00000	0.39000
10.50000	0.08400	80.00000	0.34100
11.00000	0.10100	100.0000	0.27000
12.00000	0.13700		

(4) Electronic excitation cross section 3, Threshold = 9.447 eV, Energy loss = 9.447 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
9.44700	0.00000	12.00000	0.05160
9.52000	0.00408	12.50000	0.05700
9.55000	0.00756	13.00000	0.06000
9.59000	0.00516	14.00000	0.06120
9.63000	0.00780	15.00000	0.05760
9.68000	0.00576	16.00000	0.05400
9.73000	0.00504	18.00000	0.04320
9.78000	0.00516	20.00000	0.03540
9.83000	0.00780	22.00000	0.02700
9.90000	0.00924	25.00000	0.02040
9.94000	0.00888	30.00000	0.01340
10.00000	0.01020	35.00000	0.00912
10.25000	0.01660	40.00000	0.00756
10.50000	0.02200	50.00000	0.00588
10.75000	0.02590	60.00000	0.00528
11.00000	0.03120	80.00000	0.00468
11.50000	0.04320	100.0000	0.00408

(5) Electron excitation cross section 4, Threshold = 9.570 eV, Energy loss = 9.570 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
9.57000	0.00000	15.00000	0.32000
9.60000	0.02020	16.00000	0.32200
9.62000	0.02590	18.00000	0.29600
9.70000	0.01440	20.00000	0.27600
9.80000	0.01750	21.00000	0.27800
9.90000	0.02300	22.00000	0.28700
10.00000	0.02880	25.00000	0.35000
10.50000	0.05500	27.00000	0.42000
11.00000	0.08500	30.00000	0.48000
11.50000	0.11700	32.00000	0.50000
12.00000	0.15200	35.00000	0.51000
12.50000	0.19100	40.00000	0.49000
13.00000	0.23200	50.00000	0.42000
13.50000	0.26700	60.00000	0.37000
14.00000	0.29400	80.00000	0.30000
14.50000	0.31200	100.0000	0.25000

(6) Electronic excitation cross section 5, Threshold = 9.686 eV, Energy loss = 9.686 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
9.68600	0.00000	16.00000	0.17400
10.00000	0.01000	17.00000	0.16000
10.20000	0.01800	18.00000	0.14600
10.50000	0.02800	20.00000	0.12600
10.70000	0.03500	22.00000	0.12500
11.00000	0.04600	25.00000	0.13500
11.50000	0.06600	30.00000	0.16700
12.00000	0.09000	32.00000	0.17300
12.50000	0.11200	35.00000	0.17700
13.00000	0.13500	40.00000	0.17000
13.50000	0.15600	50.00000	0.15000
14.00000	0.17100	60.00000	0.13200
14.50000	0.17800	80.00000	0.10300
15.00000	0.18000	100.0000	0.08400

(7) Electronic excitation cross section 6, Threshold = 9.789 eV, Energy loss = 9.789 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
9.78900	0.00000	16.00000	0.08100
10.00000	0.00400	17.00000	0.07800
10.20000	0.00800	18.00000	0.07500
10.50000	0.01500	20.00000	0.06700
10.70000	0.02000	22.00000	0.06400
11.00000	0.02700	25.00000	0.06600
11.50000	0.03900	30.00000	0.07900
12.00000	0.04900	32.00000	0.08200
12.50000	0.05900	35.00000	0.08400
13.00000	0.06800	40.00000	0.08200
13.50000	0.07500	50.00000	0.07400
14.00000	0.07900	60.00000	0.06600
14.50000	0.08200	80.00000	0.05300
15.00000	0.08300	100.0000	0.04400

(8) Electronic excitation cross section 7, Threshold = 9.891 eV, Energy loss = 9.891 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)

9.89100	0.00000	15.00000	0.69700
10.00000	0.01700	15.50000	0.67700
10.20000	0.05600	16.00000	0.65200
10.50000	0.12000	18.00000	0.56000
10.70000	0.16000	20.00000	0.49400
11.00000	0.22500	22.00000	0.45000
11.20000	0.27500	25.00000	0.43000
11.50000	0.34700	30.00000	0.45000
12.00000	0.47200	35.00000	0.43000
12.50000	0.59700	40.00000	0.40000
13.00000	0.67200	50.00000	0.34000
13.50000	0.71000	60.00000	0.29600
14.00000	0.72000	80.00000	0.24000
14.50000	0.71200	100.0000	0.20000

(9) Electronic excitation cross section 8, Threshold = 10.039 eV, Energy loss = 10.039 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
10.03900	0.00000	15.50000	0.15100
10.20000	0.00600	16.00000	0.14400
10.50000	0.01700	18.00000	0.11800
10.70000	0.02500	20.00000	0.10200
11.00000	0.03800	22.00000	0.09700
11.20000	0.04600	25.00000	0.09300
11.50000	0.05800	30.00000	0.08900
12.00000	0.08000	35.00000	0.08600
12.50000	0.10100	40.00000	0.08000
13.00000	0.12300	50.00000	0.06900
13.50000	0.14100	60.00000	0.05800
14.00000	0.15300	80.00000	0.04600
14.50000	0.15700	100.00000	0.03800
15.00000	0.15500		

(10) Electronic excitation cross section 9, Threshold = 10.158 eV, Energy loss = 10.158 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
10.15800	0.00000	15.50000	0.10400
10.20000	0.00100	16.00000	0.10000
10.50000	0.00900	18.00000	0.07500
10.70000	0.01600	20.00000	0.05900
11.00000	0.02500	22.00000	0.04800
11.20000	0.03100	25.00000	0.04000
11.50000	0.04100	30.00000	0.03300
12.00000	0.05700	35.00000	0.02900
12.50000	0.07300	40.00000	0.02600
13.00000	0.08700	50.00000	0.02200
13.50000	0.09900	60.00000	0.01900
14.00000	0.10600	80.00000	0.01500
14.50000	0.10800	100.00000	0.01270
15.00000	0.10700		

(11) Electronic excitation cross section 10, Threshold = 10.220 eV, Energy loss = 10.220 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
10.22000	0.00000	11.00000	0.01200
10.50000	0.00300	11.20000	0.01500
10.70000	0.00700	11.50000	0.02100

12.00000	0.02750	22.00000	0.04400
12.50000	0.03460	25.00000	0.05100
13.00000	0.03900	28.00000	0.05900
13.50000	0.04200	30.00000	0.06100
14.00000	0.04400	35.00000	0.06300
14.50000	0.04530	40.00000	0.05900
15.00000	0.04600	50.00000	0.05000
15.50000	0.04600	60.00000	0.04400
16.00000	0.04600	80.00000	0.03500
18.00000	0.04300	100.00000	0.02900
20.00000	0.04300		

(12) Electronic excitation cross section 11, Threshold = 10.401 eV, Energy loss = 10.401 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
10.40100	0.00000	16.00000	0.31500
10.60000	0.01800	18.00000	0.34500
11.00000	0.05500	20.00000	0.37000
11.20000	0.07600	22.00000	0.39000
11.50000	0.10200	25.00000	0.44000
12.00000	0.14800	30.00000	0.60000
12.50000	0.18500	32.00000	0.64000
13.00000	0.21600	35.00000	0.67000
13.50000	0.24000	40.00000	0.66000
14.00000	0.25900	50.00000	0.60000
14.50000	0.27700	60.00000	0.53000
15.00000	0.29000	80.00000	0.43000
15.50000	0.30400	100.00000	0.36000

(13) Electronic excitation cross section 12, Threshold = 10.562 eV, Energy loss = 10.562 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
10.56200	0.00000	18.00000	0.10100
10.60000	0.00300	20.00000	0.11000
11.00000	0.01350	22.00000	0.11900
11.20000	0.01880	25.00000	0.13400
11.50000	0.02700	27.00000	0.14400
12.00000	0.04200	30.00000	0.15300
12.50000	0.05550	32.00000	0.15500
13.00000	0.06750	35.00000	0.15300
13.50000	0.07580	40.00000	0.14700
14.00000	0.08250	50.00000	0.12800
14.50000	0.08780	60.00000	0.11100
15.00000	0.09000	80.00000	0.08850
15.50000	0.09300	100.00000	0.07500
16.00000	0.09450		

(14) Electronic excitation cross section 13, Threshold = 11.259 eV, Energy loss = 11.259 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
11.25900	0.00000	14.50000	0.00885
11.50000	0.00105	15.00000	0.01020
12.00000	0.00255	15.50000	0.01130
12.50000	0.00405	16.00000	0.01220
13.00000	0.00525	18.00000	0.01580
13.50000	0.00645	20.00000	0.01860
14.00000	0.00750	22.00000	0.02060

25.00000	0.02280	50.00000	0.02400
30.00000	0.02450	60.00000	0.02340
35.00000	0.02520	80.00000	0.02100
40.00000	0.02510	100.00000	0.01910

(15) Electronic excitation cross section 14, Threshold = 11.580 eV, Energy loss = 11.580 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
11.58000	0.00000	20.00000	0.01050
12.00000	0.00090	22.00000	0.01130
12.50000	0.00195	25.00000	0.01220
13.00000	0.00300	30.00000	0.01280
13.50000	0.00390	35.00000	0.01280
14.00000	0.00495	40.00000	0.01260
14.50000	0.00585	50.00000	0.01230
15.00000	0.00660	60.00000	0.01140
15.50000	0.00705	80.00000	0.01020
16.00000	0.00765	100.00000	0.00915
18.00000	0.00930		

(16) Ionization cross section, Threshold = 12.130 eV, Energy loss = 12.130 eV

Energy(eV)	Cross section(A_2)	Energy(eV)	Cross section(A_2)
12.13000	0.00000[2]	31.00000	4.02000
12.50000	0.10500	32.00000	4.11000
13.00000	0.24700	33.00000	4.21000
13.50000	0.40900	34.00000	4.28000
14.00000	0.57000	35.00000	4.36000
14.50000	0.75100	36.00000	4.43000
15.00000	0.93100	37.00000	4.48000
15.50000	1.09000	38.00000	4.55000
16.00000	1.25000	39.00000	4.61000
17.00000	1.56000	40.00000	4.66000
18.00000	1.82000	45.00000	4.87000
19.00000	2.06000	50.00000	5.09000
20.00000	2.30000	55.00000	5.23000
21.00000	2.54000	60.00000	5.34000
22.00000	2.76000	65.00000	5.40000
23.00000	2.96000	70.00000	5.46000
24.00000	3.14000	75.00000	5.50000
25.00000	3.29000	80.00000	5.51000
26.00000	3.41000	85.00000	5.60000
27.00000	3.55000	90.00000	5.63000
28.00000	3.70000	95.00000	5.69000
29.00000	3.82000	100.00000	5.76000
30.00000	3.92000		

[1] T. Hashimoto and Y. Nakamura, Papers of Gas Discharge Technical Committee ED-90-61 (Japan:IEE) (1990)
[2] D. Mather et al., Phys. Rev. A, **35** (1987) 1033 -

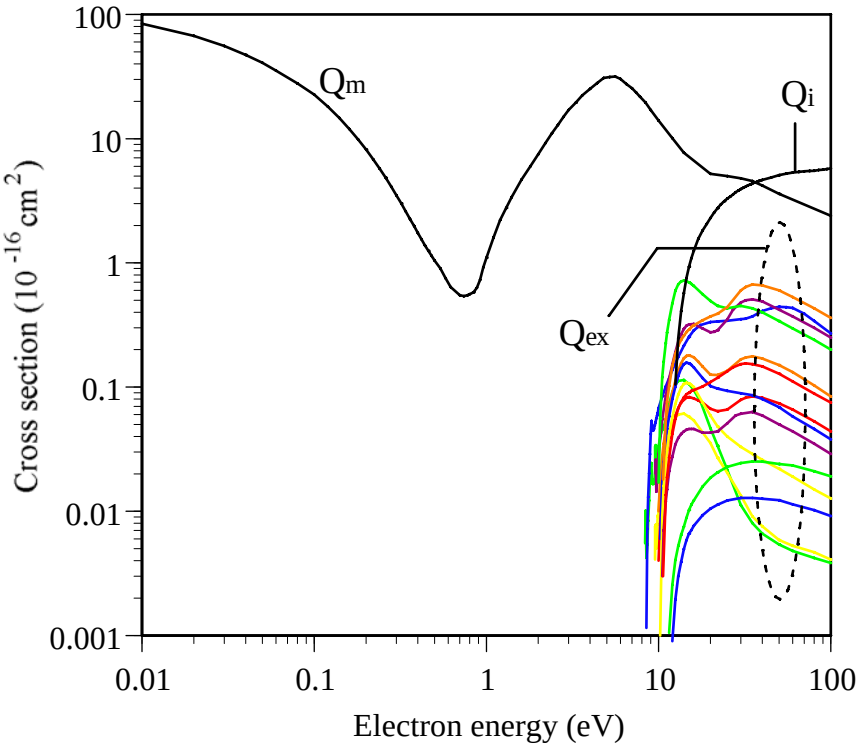

Fig.1 Recommended cross sections for Xe

2. Related electron swarm data

(1) Electron drift velocity, W, in Xe

E/N (Td)	W (10^6 cm/s)		E/N (Td)	W (10^6 cm/s)	
0.0031	0.0126[3]		0.092	0.82	
0.0045	0.0188		0.10		0.823
0.0061	0.0250		0.11	0.89	
0.0077	0.0292		0.12	0.90	0.856
0.0092	0.037		0.14		0.886
0.012	0.047		0.16	0.97	
0.014	0.054		0.17		0.918
0.016	0.062		0.19	0.97	
0.018	0.059		0.2		0.947
0.022	0.087		0.25	1.01	0.979
0.024	0.101		0.3	1.11	1.029
0.028	0.128		0.39	1.13	
0.03		0.163[1]	0.4		1.089
0.031	0.163		0.46	1.10	
0.035		0.234	0.5		1.133
0.037	0.256		0.6		1.184
0.04		0.318	0.65	1.25	
0.043	0.41		0.7		1.208
0.045		0.397	0.8		1.257
0.047	0.45		0.92	1.31	
0.05	0.50	0.479	1.		1.301
0.055	0.60		1.2	1.46	1.350
0.06		0.623	1.4		1.395
0.062	0.70		1.5	1.53	
0.07	0.73	0.708	1.7		1.462
0.08		0.762	1.8	1.57	

2.	1.523	10.	6.324
2.2	1.64	12.	7.417
2.5	1.685	14.	8.593
2.7	1.76	17.	10.39
3.	1.783	20.	12.57
3.2	1.86	25.	15.48
3.5	1.986	30.	18.07
4.	2.221	35.	21.34
5.	2.905	40.	24.09
6.	3.503	50.	28.79
7.	4.237	60.	34.58
8.	4.910		

[3] J. L. Pack et al., *Phys. Rev*. **127** (1962) 2084 - 2089

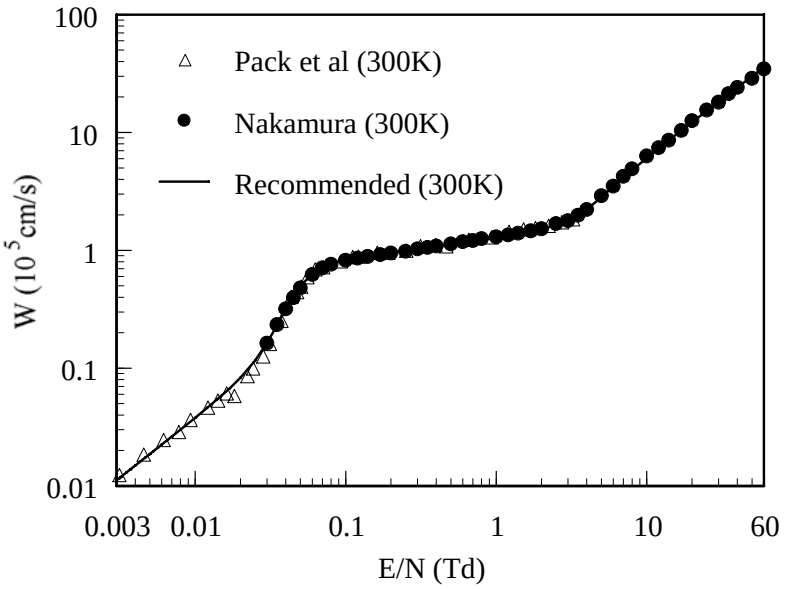

Fig. 2 Electron drift velocity in Xe

(2) Product of longitudinal diffusion coefficient and gas number density, ND_L, in Xe

E/N (Td)	ND_L (10^{22} $cm^{-1}s^{-1}$)	E/N (Td)	ND_L (10^{22} $cm^{-1}s^{-1}$)
0.03	2.231[1]	0.35	0.7626
0.035	3.651	0.4	0.7158
0.04	5.246	0.5	0.6384
0.045	5.694	0.6	0.6000
0.05	5.143	0.7	0.5535
0.06	3.932	0.8	0.5240
0.07	2.780	1.	0.4837
0.08	2.157	1.2	0.4532
0.1	1.583	1.4	0.4067
0.12	1.334	1.7	0.3919
0.14	1.216	2.	0.3831
0.17	1.041	2.5	0.4204
0.2	0.998	3.	0.5083
0.25	0.9214	3.5	0.6865
0.3	0.7871	4.	0.8766

5.	1.2140	20.	1.5420
6.	1.3670	25.	1.5110
7.	1.3920	30.	1.5710
8.	1.4270	35.	1.5420
10.	1.5300	40.	1.5990
12.	1.5730	50.	1.6050
14.	1.5660	60.	1.5490
17.	1.5960		

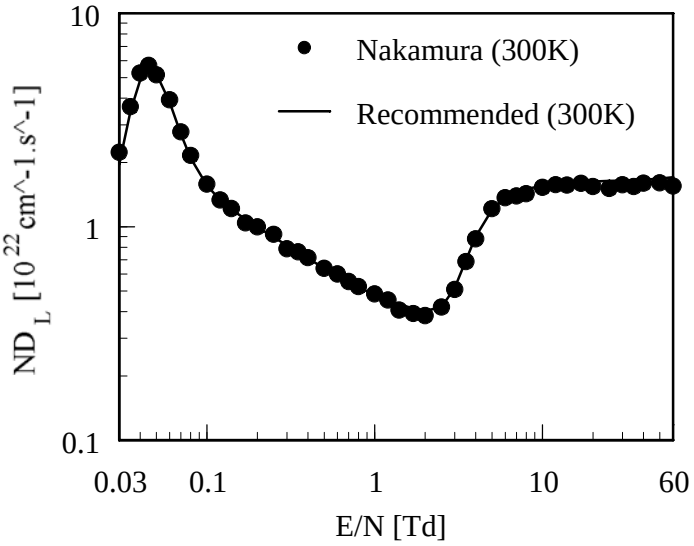

Fig.3 ND_L in Xe

(3) Ratio of ionization coefficient to gas number density, α/N, in Xe

E/N (Td)	α/N (10^{-19} cm^2)	E/N (Td)	α/N (10^{-19} cm^2)
22.60	0.0054[4]	113.0	7.0
25.42	0.0102	127.1	9.6
28.25	0.0181	141.2	12.5
31.1	0.030	169.5	18.8
33.9	0.048	197.7	26.0
39.6	0.109	226.0	34
45.2	0.215	254.2	42
50.9	0.38	282.5	51
56.5	0.62	339.	68
62.2	0.92	396.	85
70.6	1.51	452.	103
79.1	2.27	509.	121
90.4	3.6	565.	140
101.7	5.1		

[4] A. A. Kruithof, Physica **7** (1940) 519-540

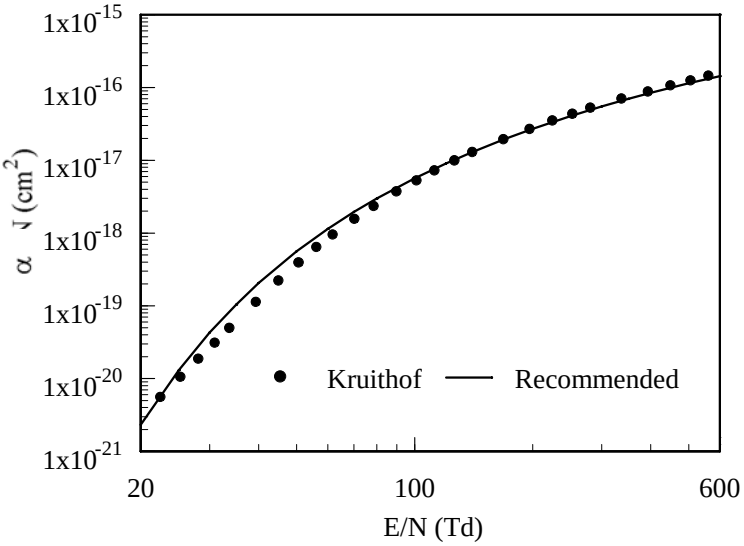
1x10-15
1x10-16
1x10-17
1x10-18
1x10-19
1x10-20
1x10-21
α N (cm2)
Kruithof
Recommended
20
100
600
E/N (Td)

Fig.4 α/N in Xe