Digitization of figures with unusual scale.

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There are two figures with the unusual scale in an article V.I.Yurevich,V.A.Nikolaev,R.M.Yakovlev,

J,FCY/L,13,(2),382,2016 :

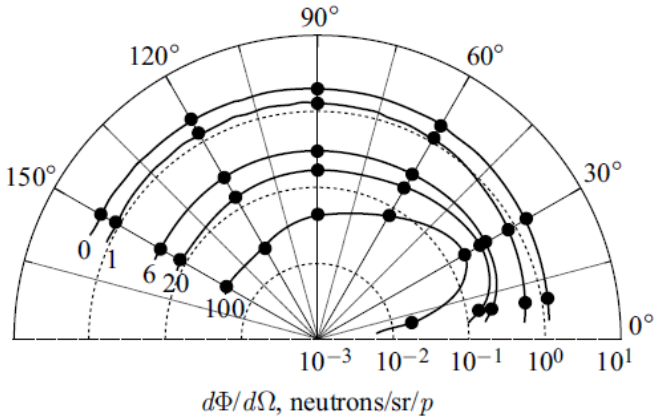


Fig. 3. Angular distributions of neutrons for different energy groups obtained for a proton energy of 0.99 GeV: the points — the experimental data; the curves — the polynomial fits; the numbers — the minimal neutron energy in MeV

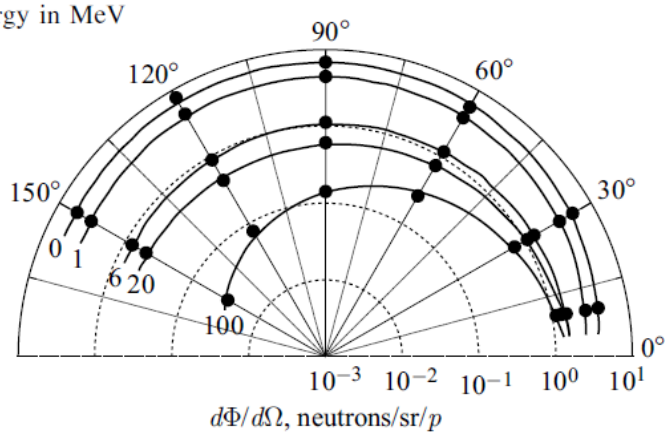


Fig. 4. The same as in Fig. 3 for a proton energy of 3.65 GeV

The neutrons were obtained via spallation reaction in lead irradiated by protons and were used as incident neutrons for Th-232(n,fission) reaction cross-section measurement.

For the spectrum average cross section it’s important to know the incident spectrum.

Request for the data was sent to the author, but reply has not received.

So, the digitization is only one way to obtain the data of the incident spectra in such case.

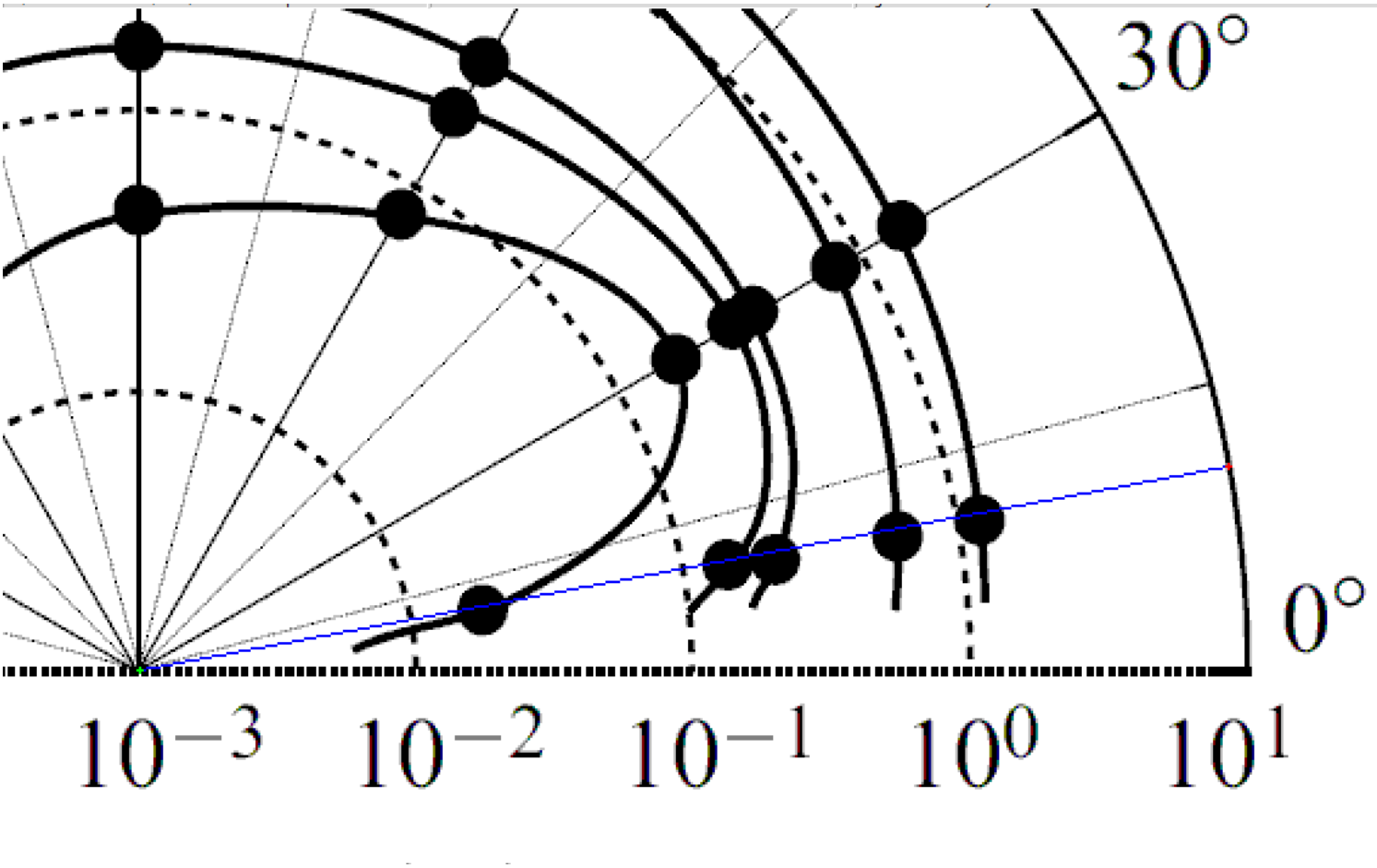
But existing EXFOR digitizers do not let us to use such ring scale.

Fortunately, the angle values 30,60,90,120,150 degrees are given on these figures, excluding one angle, which was visually supposed by compiler as 10 degrees.

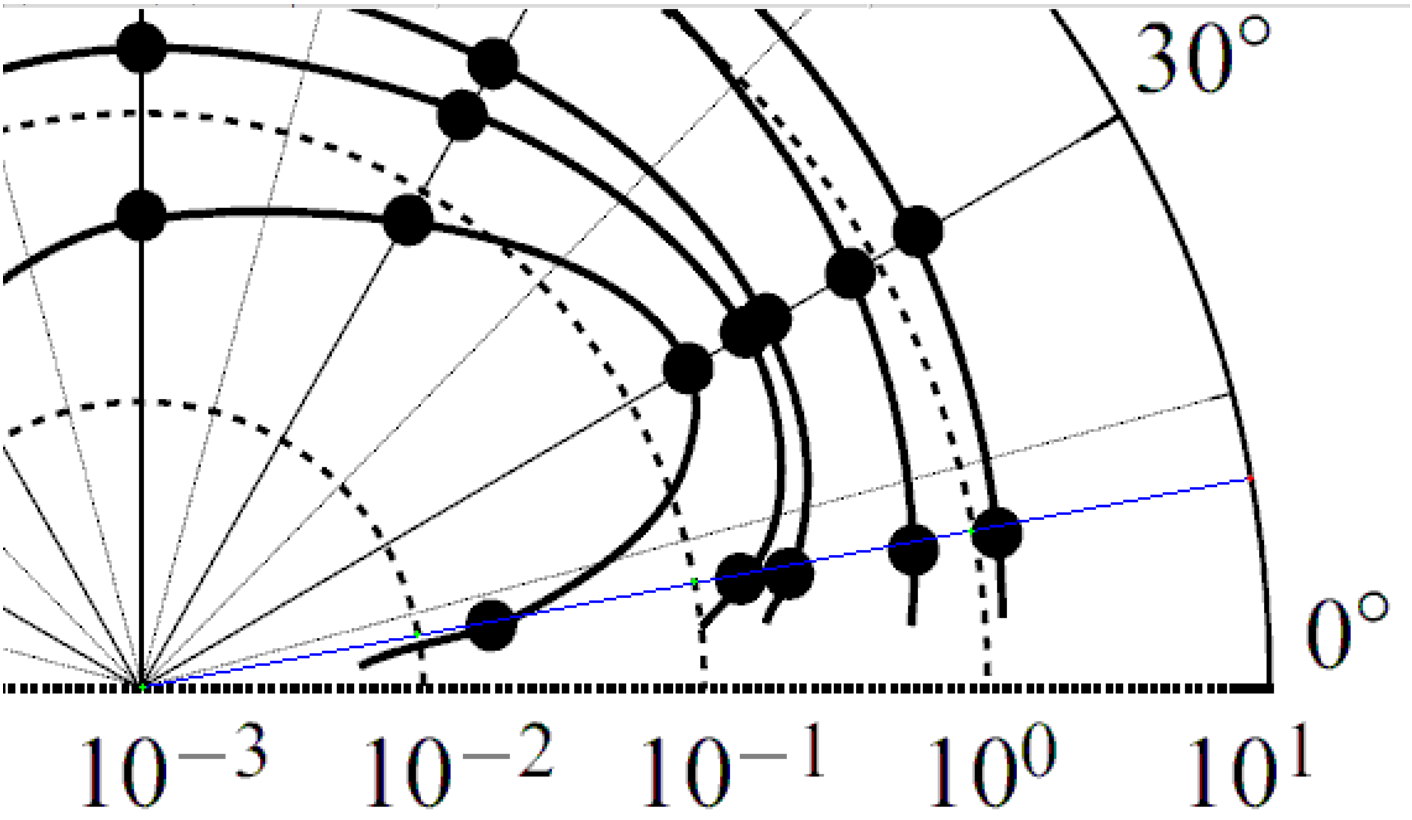
This angle (~10 deg) could be also calculated using the digitized values from this plot.

The plot was digitized step by step:

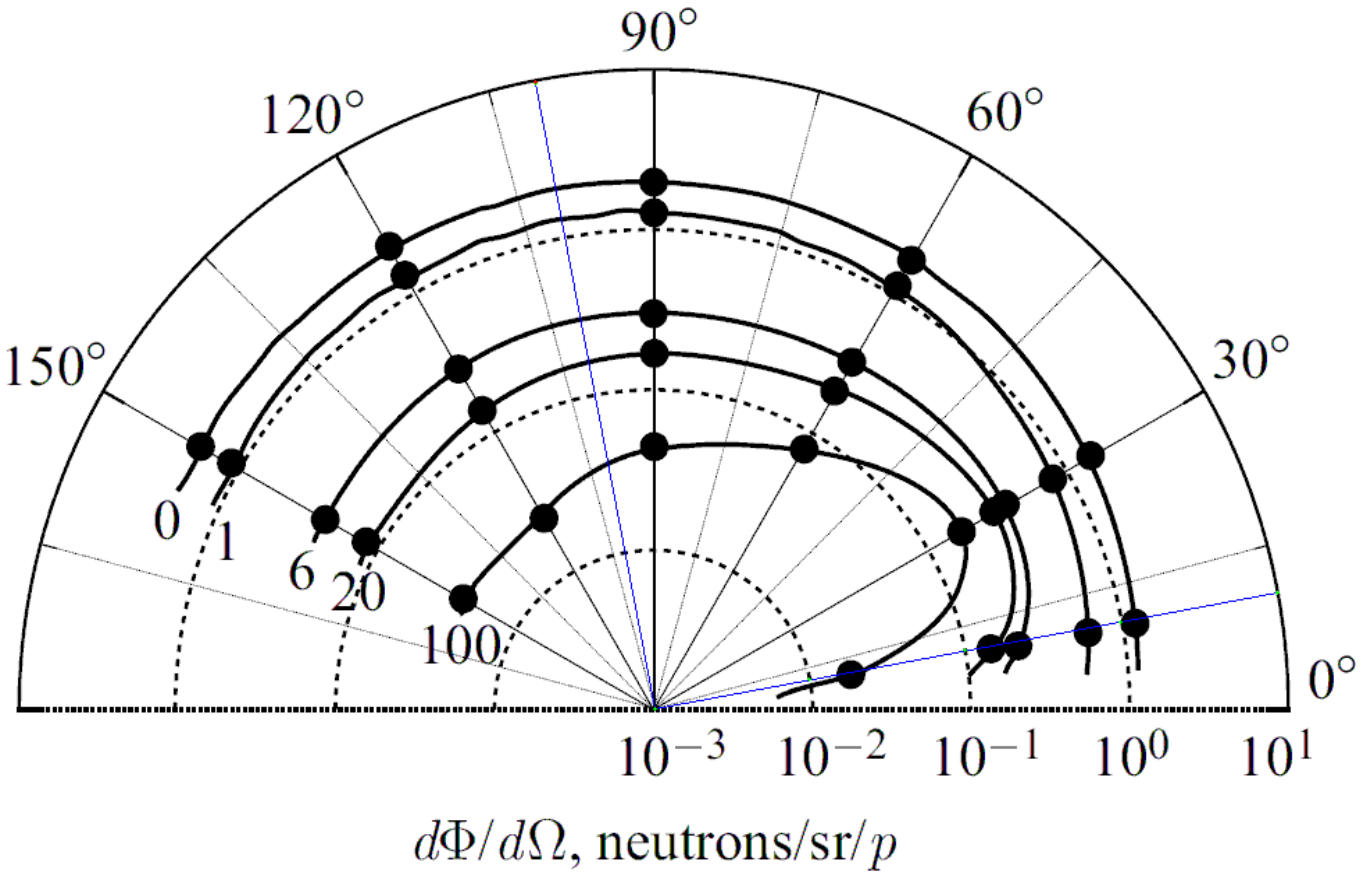
1) Scale X line definition



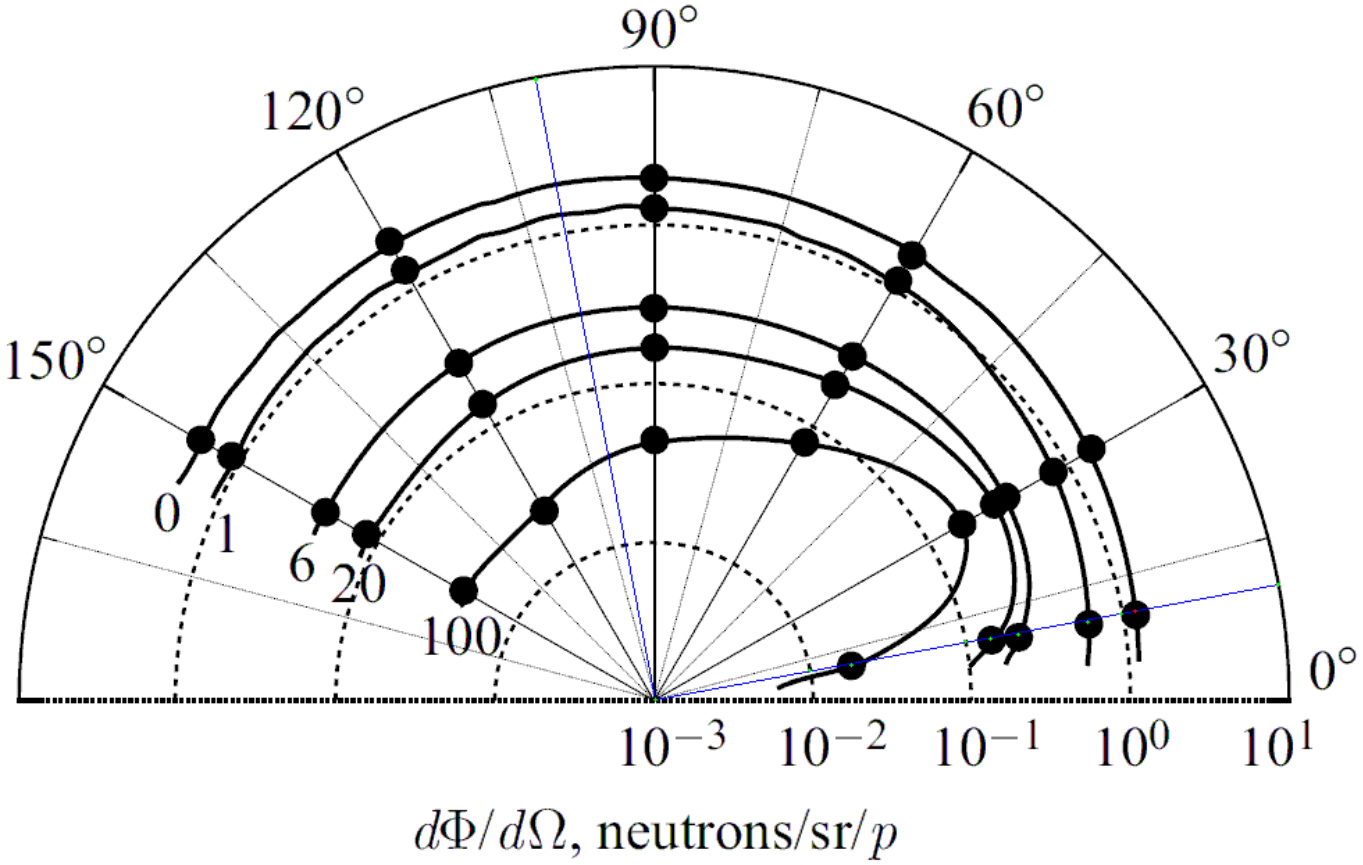
2) X scale ticks values definition



3) Scale Y is defined as arbitrary scale at ~90 degrees to scale X:



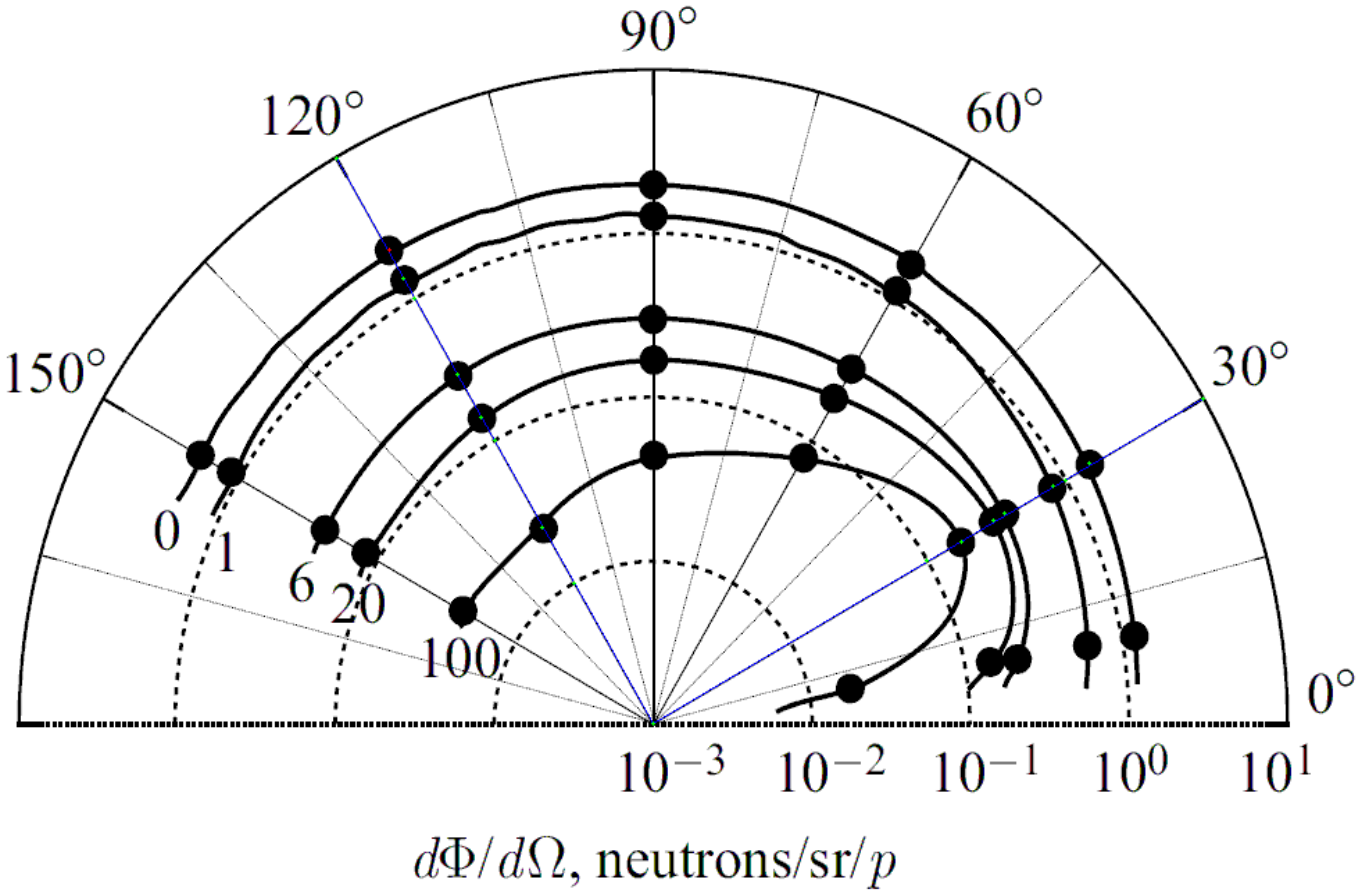
4) digitization of data points on defined scale X:



5) Processing and obtaining results for 5 points for 10degrees angle as X – values:
   0.18461E-01
   0.14381
   0.21618
   0.60223
   1.2173
   with digitization error 1.752% and quantization error 0.891%.

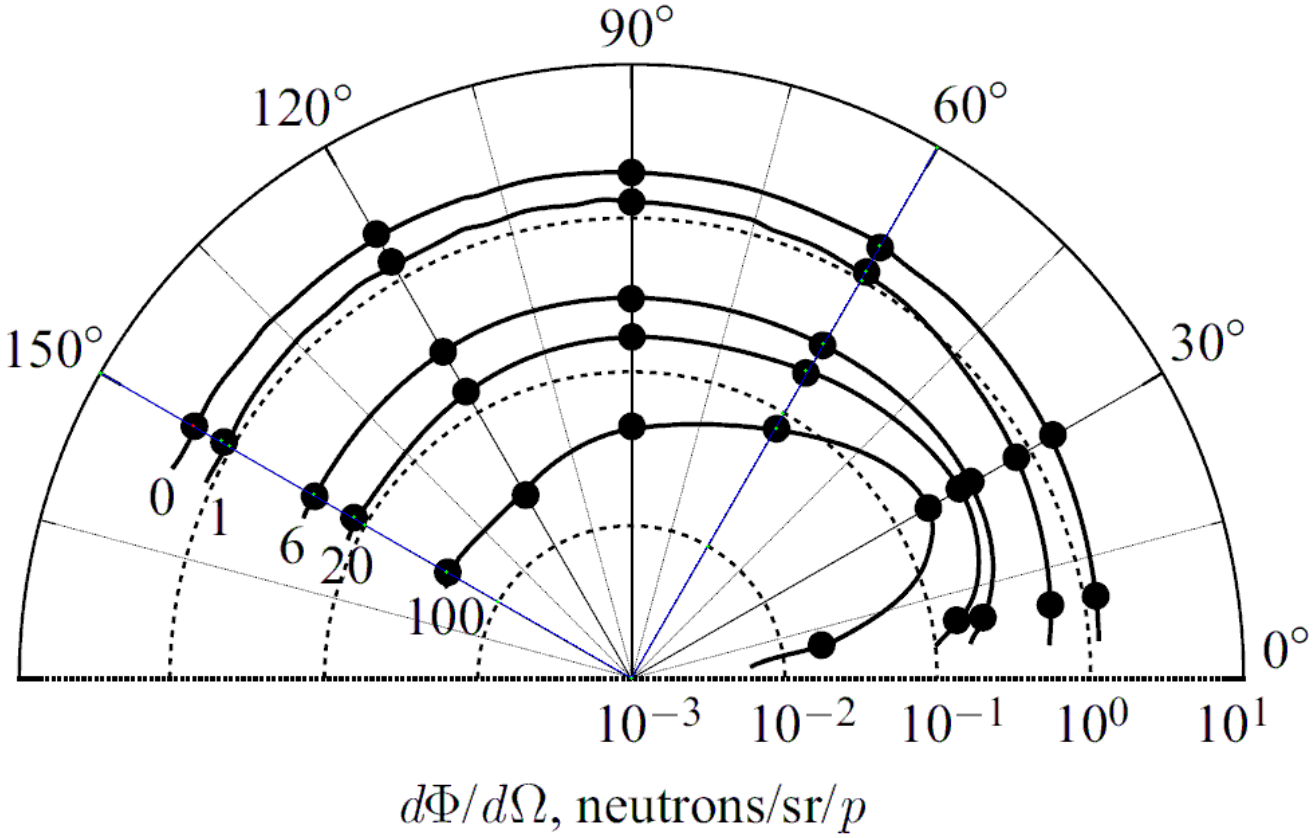
The same steps 1)-5) were repeated for other angles:

- 30 / 120deg (digitization error 0.81 / 1.14 % and quantization error 1.010 / 1.005%) :



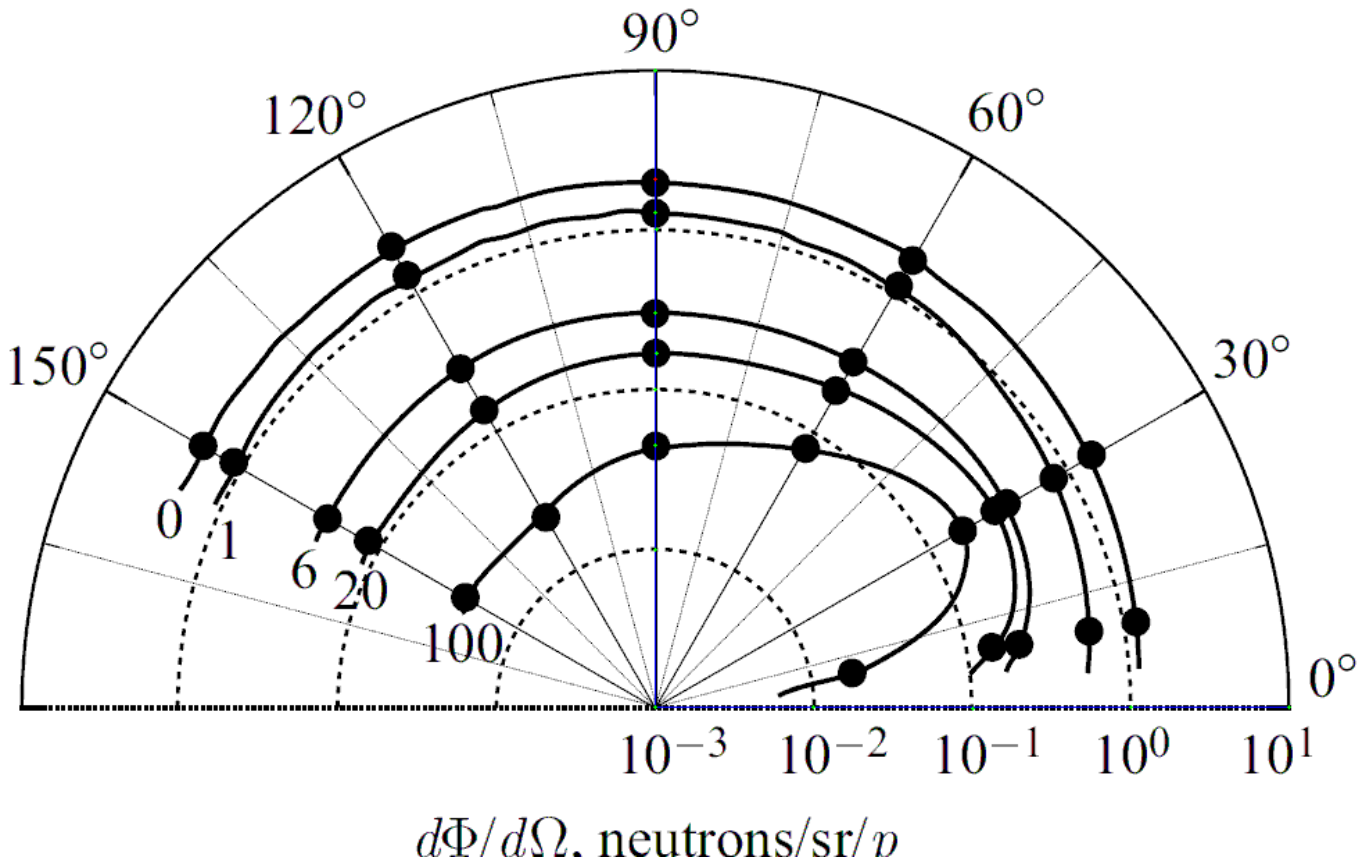
For 30 degrees (scale X values):
0.17600
0.30557
0.36941
0.82311
1.5211
For 120 degrees (scale Y values):
0.024657
0.14720
0.29486
1.4058
2.2041

- 60 / 150 deg (digitization error 0.91/1.31% and quantization error 1.74/1.77%) :



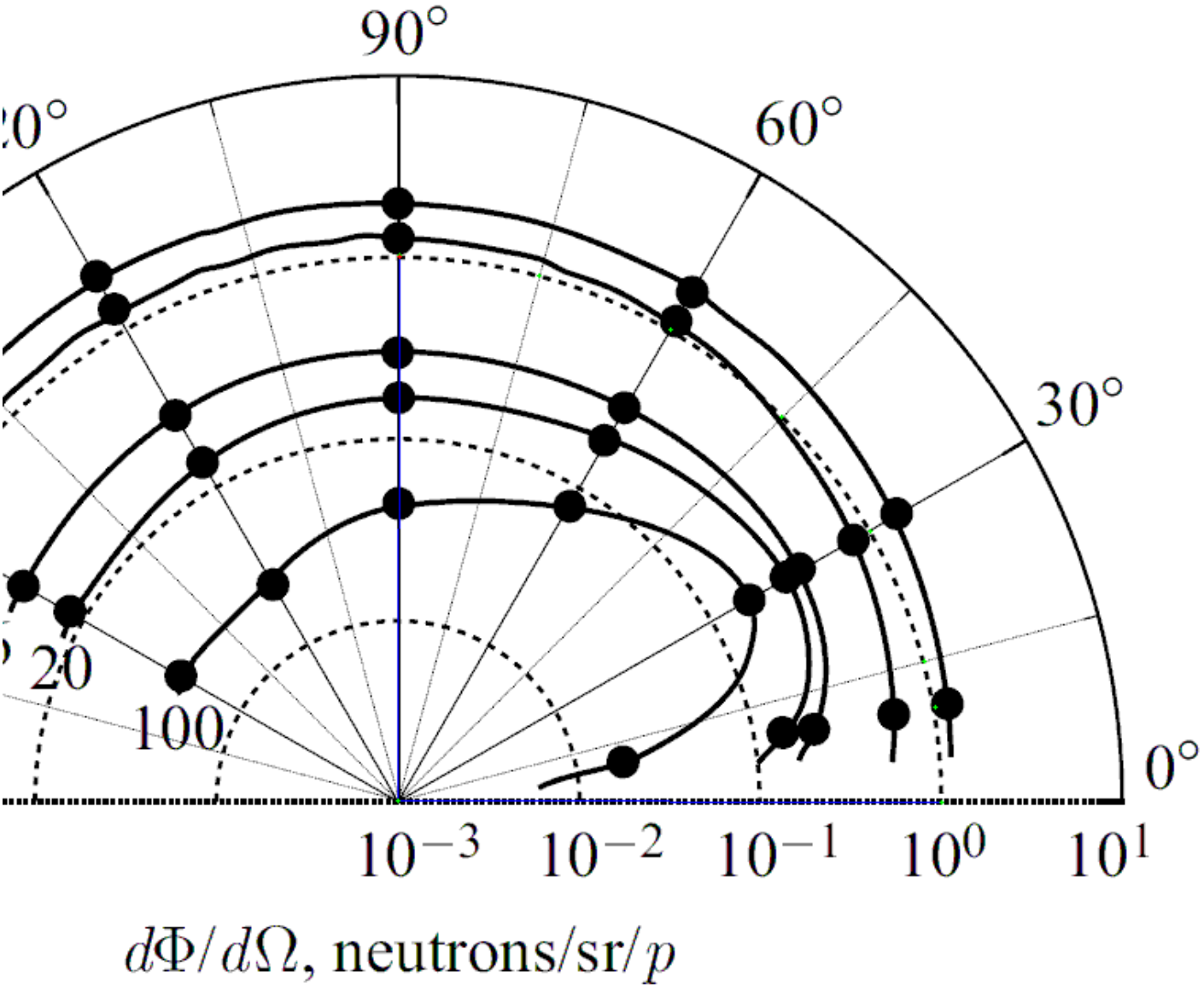
For 60 degrees (scale X values)
0.077729
0.20510
0.33114
1.1701
1.8015
For 150 degrees (scale Y values)
0.023999
0.12119
0.24301
1.2149
1.9593

- 90deg (digitization error 0.987% and quantization error 0.872%):



For 90 deg (scale Y values):
0.04489
0.1689
0.3023
1.283
2.077

Digitization of un-known angle (visually ~10 degrees)



Coordinates X and Y obtained for 7points using the linear scales.

0.98783 0.17438
0.96717 0.25862
0.86735 0.49670
0.70348 0.70553
0.49893 0.86482
0.25666 0.96295
0.42500E-05 0.99709

ARCCOS and ARCSIN were applied for these values.

Angle by ARCCOS	Angle by ARCSIN	Average	Real angle	Deviation
8.95251	10.04767	9.50009	**? ~10**	
14.72952	14.9958	14.86266	15	0.13734
29.863	29.79702	29.83001	30	0.16999
45.3161	44.89514	45.10562	45	0.10562
60.10123	59.89252	59.99688	60	0.00312
75.16614	74.39249	74.77931	75	0.22069
90.04541	85.67134	87.85837	90	2.14163

Result of angular distributions for 5 energy groups for proton energy 0.99 GeV:

Minimal neutron energy, MeV	Angle, degree	dF/dAngle, n/sr/p
100	10	0.018461
20	10	0.14381
6	10	0.21618
1	10	0.60223
0	10	1.2173
100	30	0.17600
20	30	0.30557
6	30	0.36941
1	30	0.82311
0	30	1.5211
100	60	0.077729
20	60	0.20510
6	60	0.33114
1	60	1.1701
0	60	1.8015
100	90	0.04489
20	90	0.1689
6	90	0.3023
1	90	1.283
0	90	2.077
100	120	0.024657
20	120	0.14720
6	120	0.29486
1	120	1.4058
0	120	2.2041
100	150	0.023999
20	150	0.12119
6	150	0.24301
1	150	1.2149
0	150	1.9593

Result of angular distributions for 5 energy groups for proton energy 3.65 GeV:

Minimal neutron energy, MeV	Angle, degree	dF/dAngle, n/sr/p
100	10	1.1172
20	10	1.3155
6	10	1.5491
1	10	2.7254
0	10	4.0723
100	30	0.68427
20	30	1.0857
6	30	1.3832
1	30	3.2828
0	30	5.1338
100	60	0.26276
20	60	0.75260
6	60	1.2519
1	60	3.9584
0	60	5.8628
100	90	0.13535
20	90	0.59162
6	90	1.1421
1	90	4.5187
0	90	7.0058
100	120	0.077282
20	120	0.45931
6	120	0.92146
1	120	4.5519
0	120	7.8347
100	150	0.030170
20	150	0.49283
6	150	0.81303
1	150	3.4405
0	150	5.7329