BNL-101580-2014-TECH

RHIC/PG/37;BNL-101580-2013-IR

Why Multiple Events / Bunch Crossing Is Not A Problem

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March 1984

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RHIC-PG-37

WHY MULTIPLE EVENTS PER BUNCH CROSSING IS NOT A PROBLEM

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March 1, 1984

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3/1/84

Multiple Events per Crossing ?

Say we have $L = 1.0 \times 10^{27}/cm^2/sec$ for gold and $L = 1.1 \times 10^{30}/cm^2/sec$ for carbon (gold-gold and carbon-carbon). The total reaction cross sections (geometric) are $\frac{\pi}{100} 1.25^2 (A_1^{1/3} + A_2^{1/3})^2$ barn. This gives 1.03 barns for $^{12}C + ^{12}C$ and 6.65 barns for $^{197}Au + ^{197}Au$. The beam makes 78197 orbits/second. Thus on the average, there are

$$N/\text{crossing} = \frac{L \cdot \sigma}{(\#\text{ orbits/second})(\#\text{ crossings/orbit})} \quad \text{events per crossing.}$$

We always have 57 crossings/orbit ie bunches. Then for carbon-carbon, there are 0.254 events/crossing and for gold-gold there are 0.00149 events/crossing, on the average.

A normalized Poisson distribution has the form $P_{\bar{n}}(n) = \frac{e^{-(\bar{n})} (\bar{n})^n}{n!}$ $n = 0, 1, 2, \ldots$ where n is the number of events and $\bar{n}$ is the mean, given above. The variance equals the mean. The following table results for our two cases.

	C–C $L = 1.1 \times 10^{30}$	Au–Au $L = 1.0 \times 10^{27}$
n	$P_{\bar{n}}(n) = P_{.254}(n)$	$P_{\bar{n}}(n) = P_{.00149}(n)$
0	.776	.9985
1	.197	.001488
2	.0250	$1.11 \ 10^{-6}$
3	.00212	$5.51 \ 10^{-10}$
4	.000135	$2.05 \ 10^{-13}$
5	.00000683	$6.11 \ 10^{-17}$
6	$2.89 \ 10^{-7}$	$1.52 \ 10^{-20}$
7	$1.05 \ 10^{-8}$	$3.23 \ 10^{-24}$
8	$3.33 \ 10^{-10}$	$6.02 \ 10^{-28}$

The gold numbers are just fine.

The carbon numbers for 2-4 events per crossing are perhaps unacceptable. If we lower the luminosity by a factor of ten, we get 0.0254 events/crossing, and the table becomes

C-C

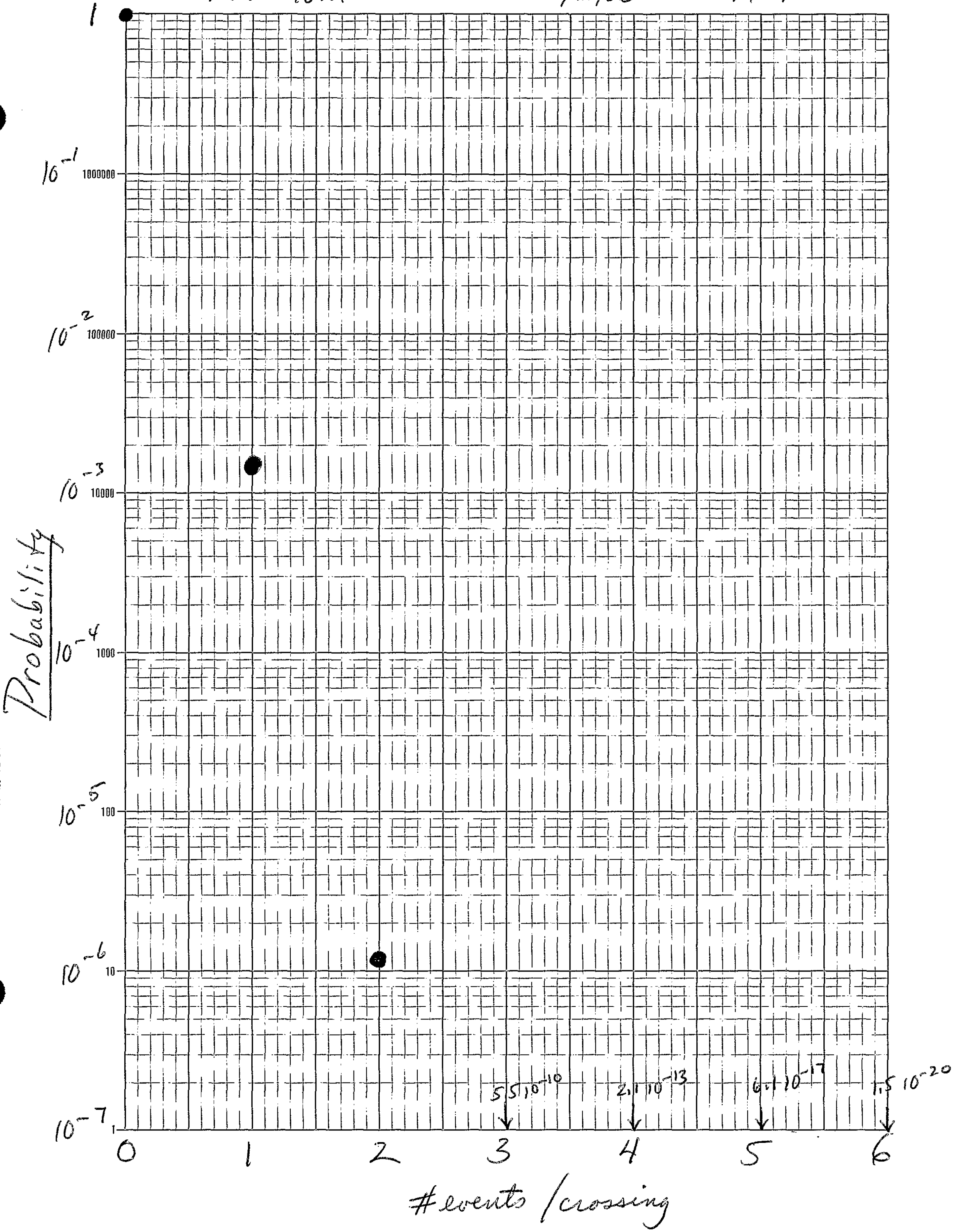
n	$P_{.0254}(n)$
0	.9749
1	.02476
2	.000314
3	$2.66\ 10^{-6}$
4	$1.69\ 10^{-8}$
5	$8.59\ 10^{-11}$
6	$3.64\ 10^{-13}$
7	$1.32\ 10^{-15}$
8	$4.19\ 10^{-18}$

low $L = 1.1\ 10^{29}$ /cm²/sec

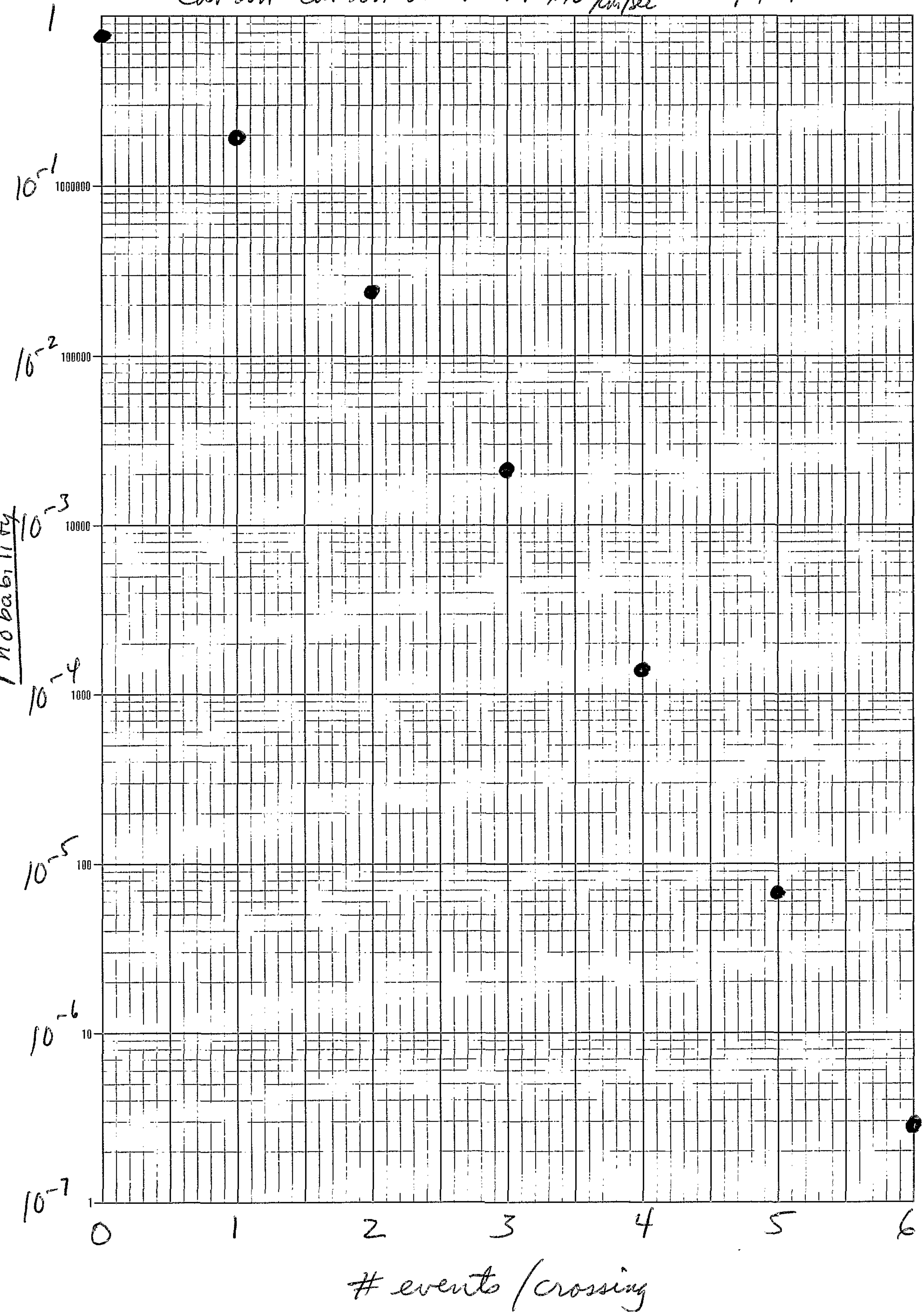
Arguing even half the cross section goes to fragmentation and thus events with little or no central rapidity activity, these values should be quite acceptable.

BOTTOM LINE : THIS AIN'T NO PROBLEM!

MODEL Gold-Gold $L = 1 \times 10^{27}/cm^2/sec$ DATE 3/1/84



MODEL Carbon-Carbon at $L = 1.1 \times 10^{30}/cm^2/sec$ DATE 3/1/84



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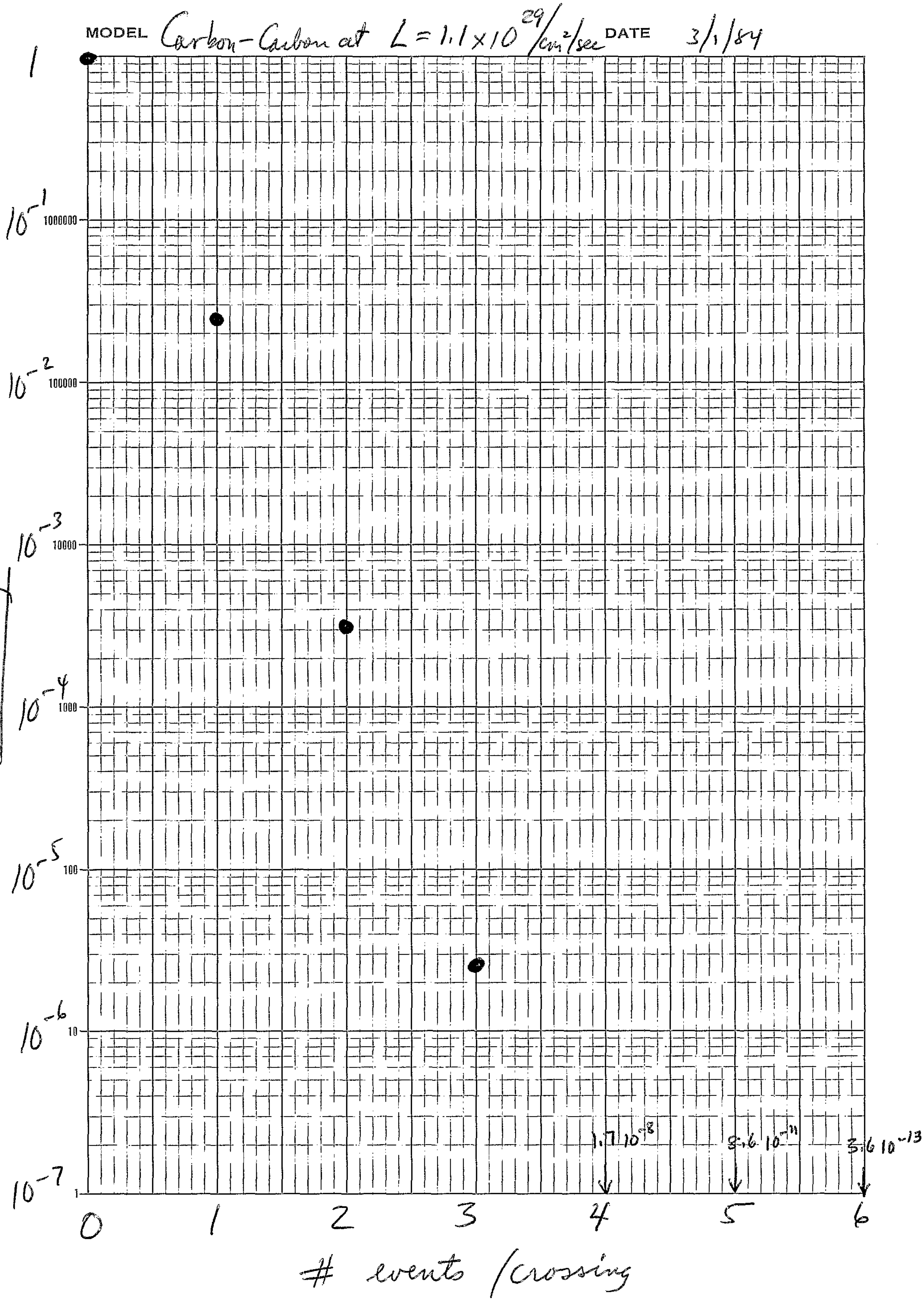
MODEL Carbon-Carbon at L = 1.1×10^29/cm²/sec DATE 3/1/84
1
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
1000000
100000
10000
1000
100
10
1
Probability
1.7 10^-8
8.6 10^-11
3.6 10^-13
0
1
2
3
4
5
6
events /crossing