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Why Multiple Events / Bunch Crossing Is Not A Problem

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DISCLAIMER

WHY MULTIPLE EVENTS PER BUNCH CROSSING IS NOT A PROBLEM

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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 $\frac{\pi\ 1.25^2}{100}(A_1^{1/3}+A_2^{1/3})^2$ 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

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

We always have 57 crossings/orbit i.e 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	$3.33\ 10^{-10}$	$6.02\ 10^{-28}$

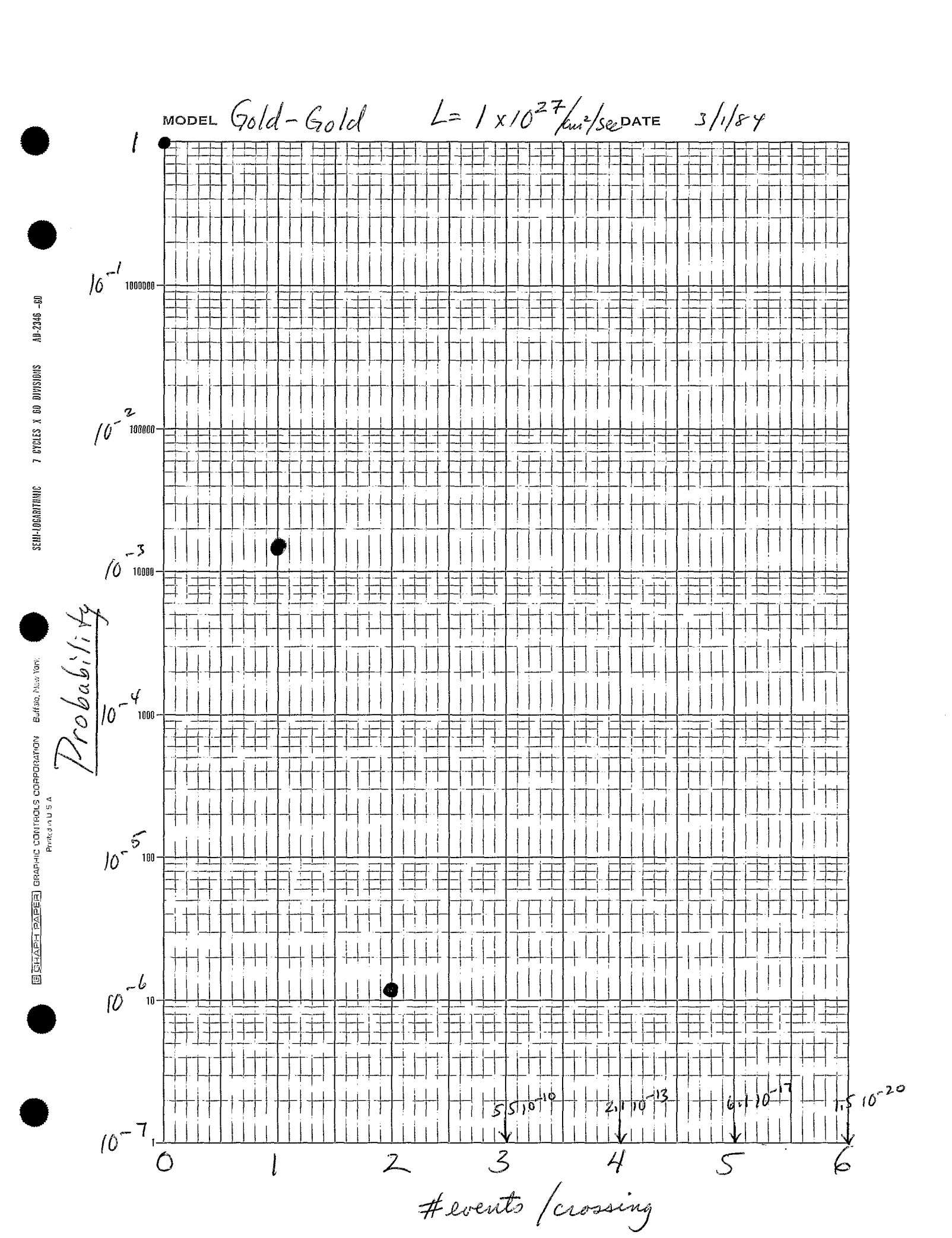
The gold numbers are just fine.

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

n	$P_{.0254}(n)$ C-C low $L = 1.1\ 10^{29}/cm^2/sec$
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	$4.19\ 10^{-18}$

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 x 10^27 /cm^2/sec DATE 3/1/84
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10^-1 1000000
10^-2 100000
10^-3 10000
10^-4 1000
10^-5 100
10^-6 10
10^-7 1
Probability
5.5 10^-10
2.1 10^-13
6.1 10^-17
1.5 10^-20
0
1
2
3
4
5
6
#events / crossing
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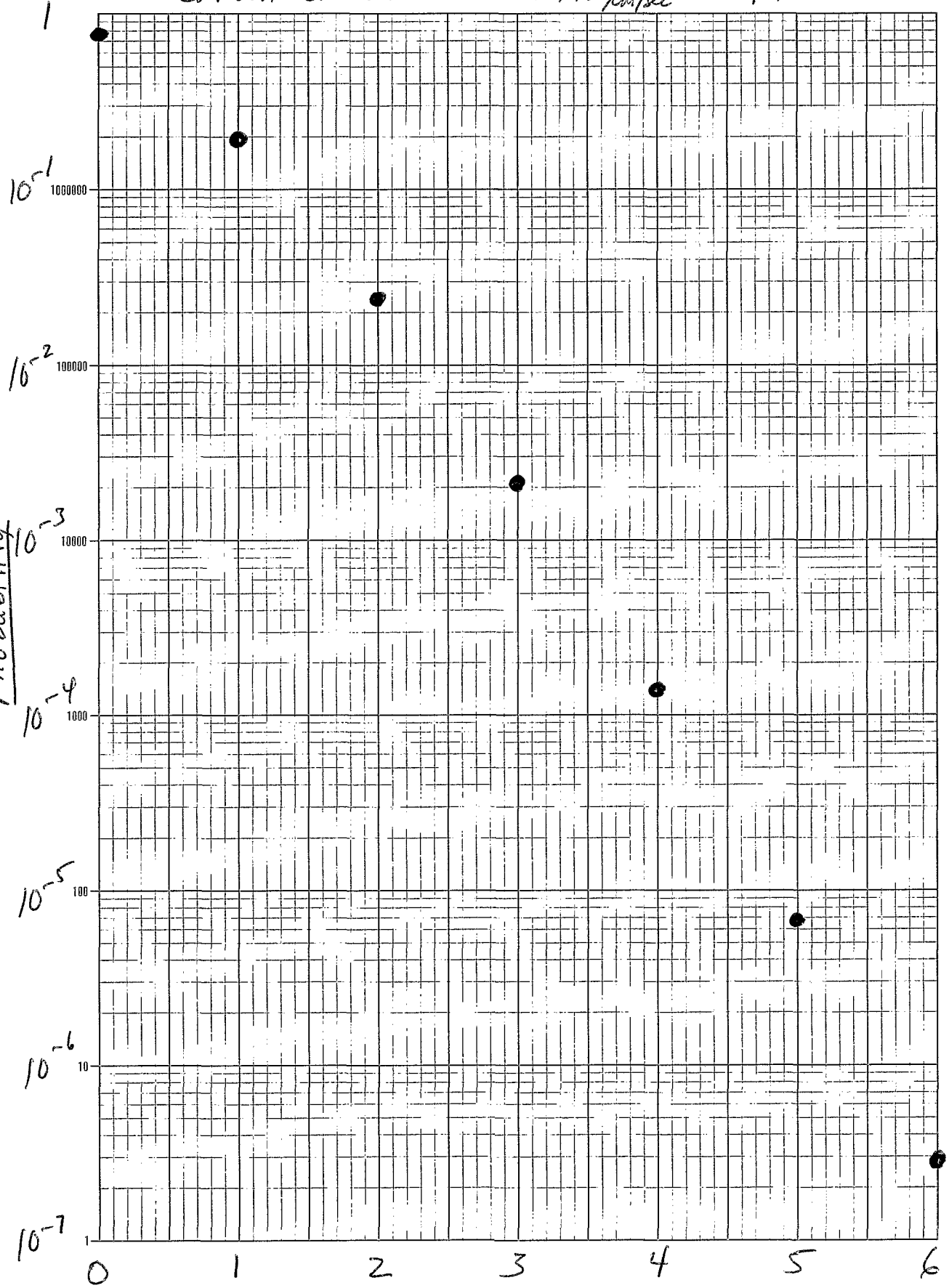
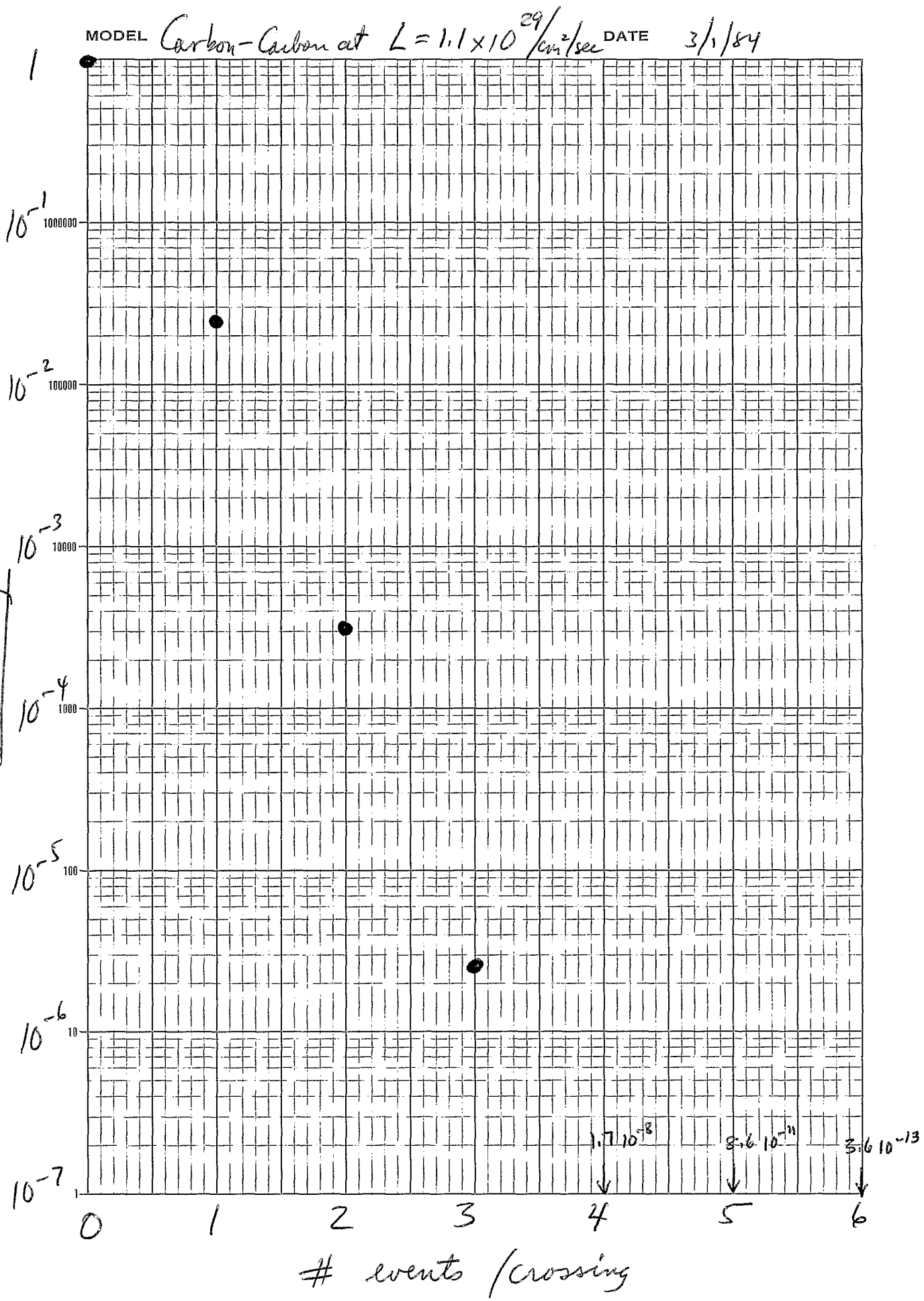
MODEL Carbon-Carbon at $L = 1.1 \times 10^{30}$ /cm²/sec DATE 3/1/84




MODEL Carbon-Carbon at $L = 1.1 \times 10^{29}/cm^2/sec$ DATE 3/1/84
1
10^{-1} 1000000
10^{-2} 100000
10^{-3} 10000
10^{-4} 1000
10^{-5} 100
10^{-6} 10
10^{-7} 1
Probability
$1.7\ 10^{-8}$
$8.6\ 10^{-11}$
$5.6\ 10^{-13}$
0 1 2 3 4 5 6
events / crossing
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