

Why Multiple Events / Bunch Crossing Is Not A Problem

G. R. Young

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Collider Accelerator Department
Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

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WHY MULTIPLE EVENTS
PER BUNCH CROSSING
IS NOT A PROBLEM

Glenn Young

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Brookhaven National Laboratory

1
3/1/84

Multiple Events per Crossing ?

Say we have $L = 1.0 \times 10^{27} \text{ /cm}^2\text{/sec}$ for gold and $L = 1.1 \times 10^{30} \text{ /cm}^2\text{/sec}$ for carbon (gold-gold and carbon-carbon). The total reaction cross sections (geometric) are $\frac{\pi}{100} 1.25^2 (A_1^{1/3} + A_2^{1/3})^2$ barns. This gives 1.03 barns for $^{12}\text{C} + ^{12}\text{C}$ and 6.65 barns for $^{197}\text{Au} + ^{197}\text{Au}$. 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 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 $P_{\bar{n}}(n) = \frac{e^{-\bar{n}} (\bar{n})^n}{n!}$ $n = 0, 1, 2, \dots$ 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	$P_{\bar{n}}(n) = P_{0.254}(n)$	$P_{\bar{n}}(n) = P_{0.00149}(n)$
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}

2
3/1/84

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		low L = $1.1 \cdot 10^{29}$ /cm ² /sec
n	$P_{0.0254}(n)$	
0	.9749	
1	.02476	
2	.000314	
3	$2.66 \cdot 10^{-6}$	
4	$1.69 \cdot 10^{-8}$	
5	$8.59 \cdot 10^{-11}$	
6	$3.64 \cdot 10^{-13}$	
7	$1.32 \cdot 10^{-15}$	
8	$4.19 \cdot 10^{-18}$	

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 $L = 1 \times 10^{27} \text{ km}^2/\text{sec}$ 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}

Probability

#events / crossing

5.5×10^{-10}

2.1×10^{-13}

6.1×10^{-17}

1.5×10^{-20}

0

1

2

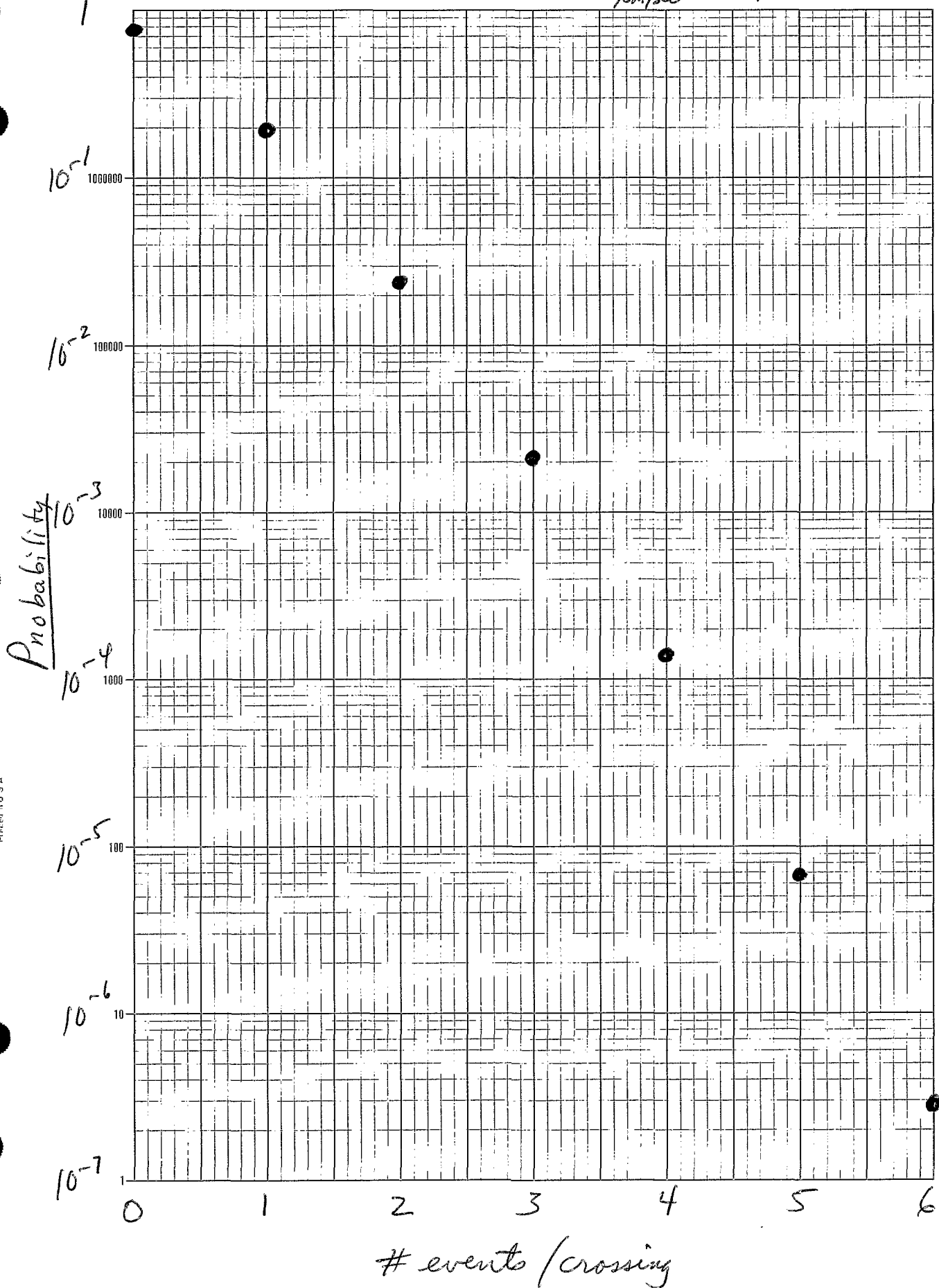
3

4

5

6

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



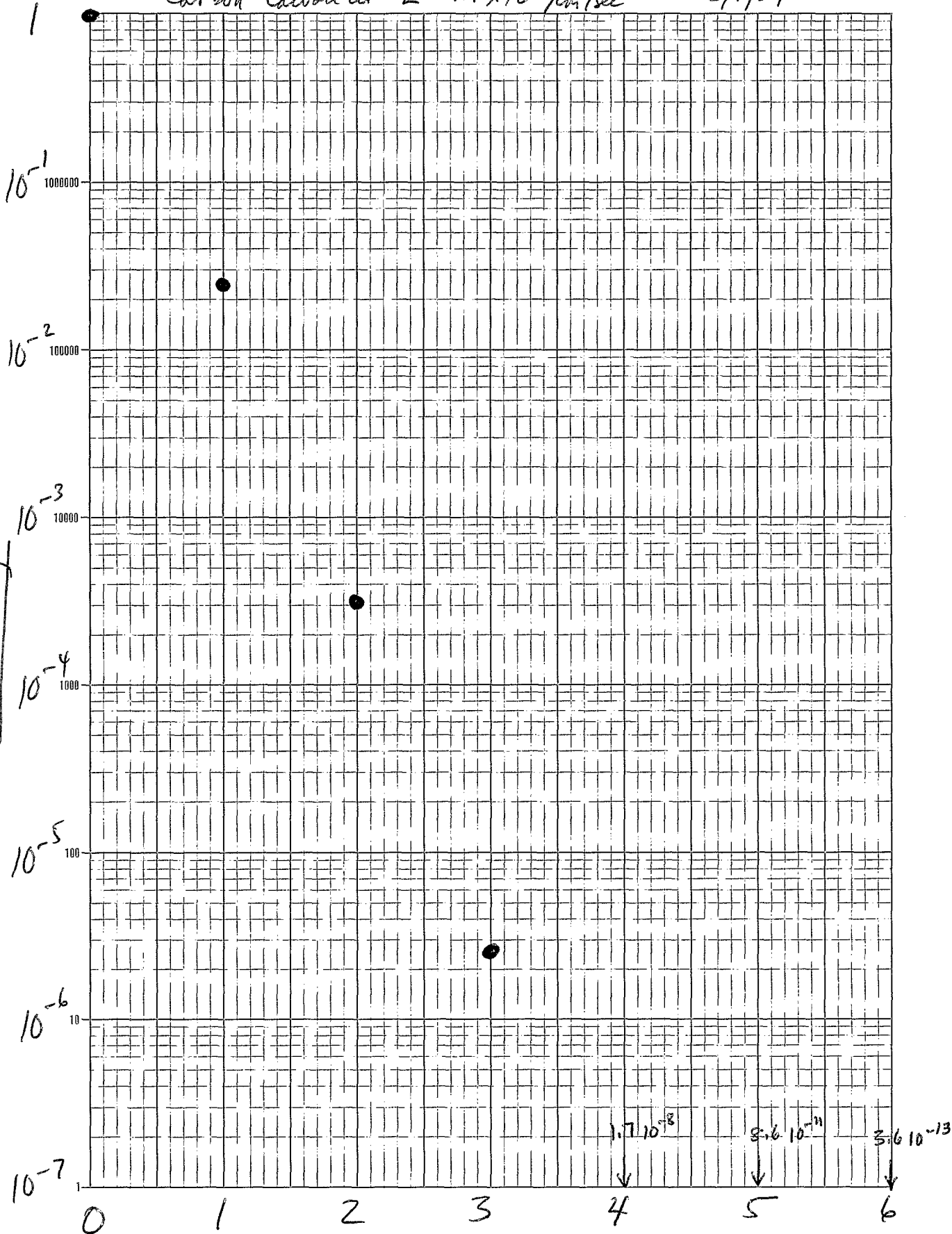
MODEL

Carbon-Carbon at $L = 1.1 \times 10^{29} / \text{cm}^2 / \text{sec}$

DATE

3/1/84

Probability



events / crossing