

Homework #2 - Statistics and Data Analysis - Probability Distributions

1. A certain isotope has an lifetime of 1 year. If you have 1 mole of this isotope, what is the activity of the sample, in counts per second?
2. If you have beam collisions at a rate of 1 MHz on average, and they occur in 20 ns time intervals, then use the Poisson probability formula to determine
 - a) the probability of seeing at least one collision in a particular time interval, and
 - b) the average rate (in Hz) for seeing two collisions or more at a time.
3. Your new particle detector turns out to be not that efficient: it only gives you a “hit” one out of every five times a particle passes through it. If 1000 particles pass through it, what is the mean and rms spread of the number of hits you might observe?
4. Show that the distribution of the sum of two gaussian-distributed variables is itself gaussian, and determine the width (σ) of the resulting distribution.
5. After years of work on CDF, you get a background-free measurement of the top quark production rate where you have 100 top quark events. If you want to get a measurement which is three times more precise (statistically, anyway), how many events do you need?
6. Show that the uncertainty on the estimate of the rms of a gaussian distribution of N events with width σ is given by $\sigma/\sqrt{2N}$ using the propagation of errors formula.