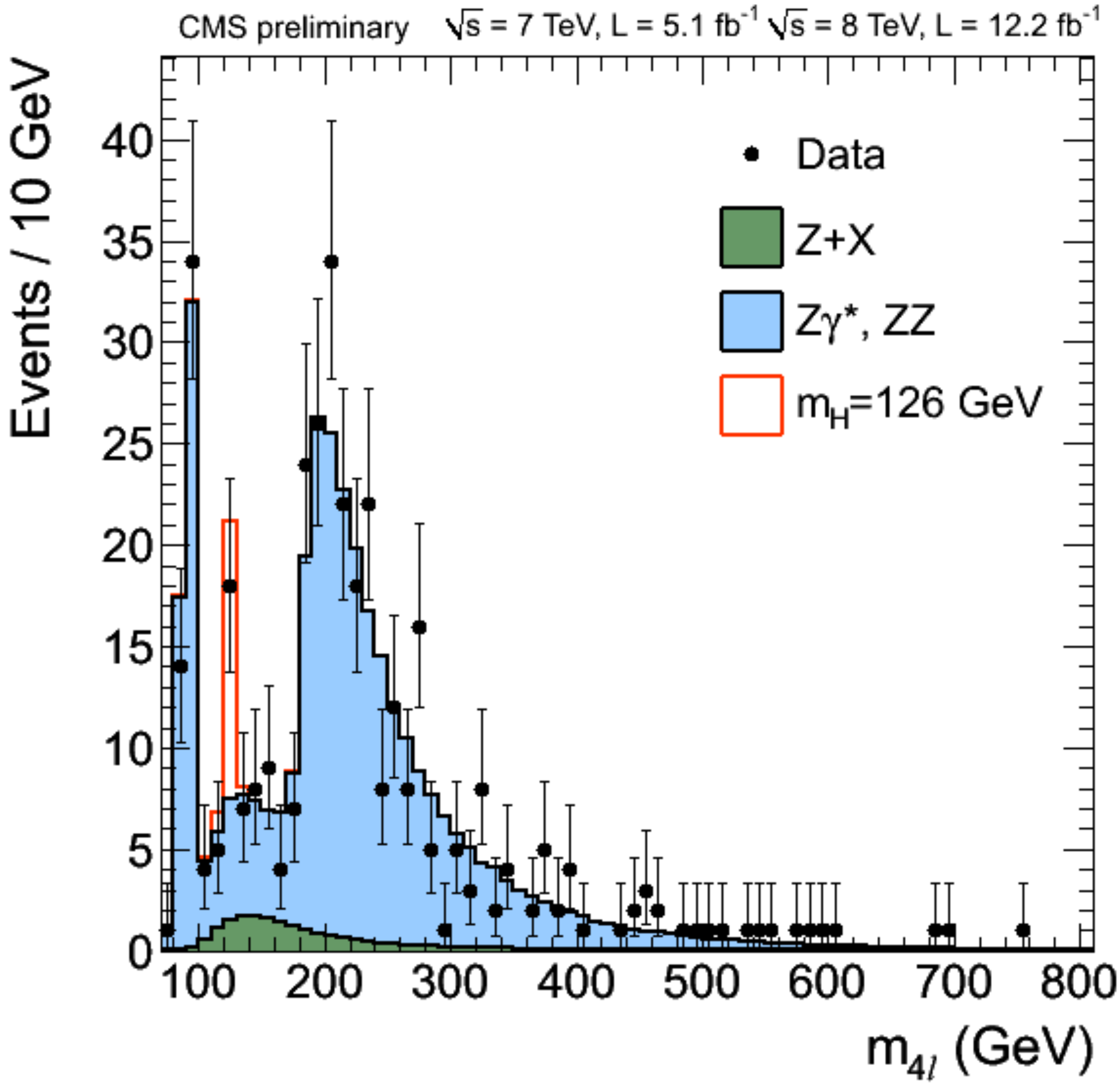
Counting and Binomial Distribution I

- Suppose random variable X = 1 (event in a particular bin of histogram) and X=0 (event not in bin)
- Let μ be probability that a particular event lies in a bin
  - This is coin tossing problem with μ probability of heads
- If a random variable takes just two values with probability μ (for 1) and $1-\mu$ (for 0), then
- **Average of X** = $\{0.\,(1-\mu) + 1.\,\mu\}/\{(1-\mu) + \mu\}$ = $\boldsymbol{\mu}$
- **Average of $(X-\mu)^2$** = $\{(-\mu)^2.\,(1-\mu) + (1-\mu)^2\,.\,\mu\}$

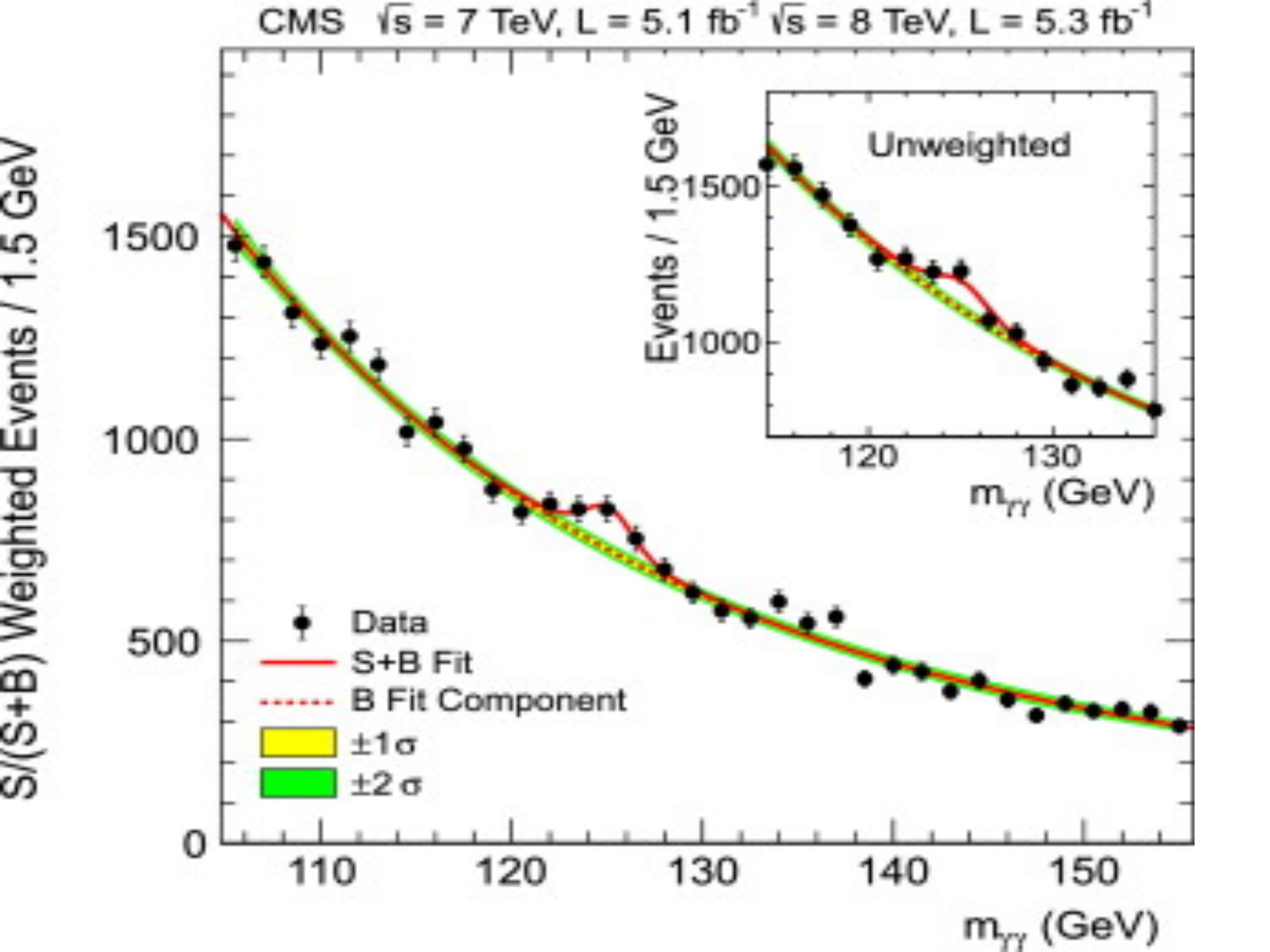
  = $\mathbf{(1-\mu)\,\mu}$

Counting and Binomial Distribution II

- Now in our application μ is tiny
- So Average of X = Average of $(X-\mu)^2 = \mu$
- i.e. standard deviation of X is square root of mean
- If we have a sum of random variables with a binomial distribution
- $O = \sum_{i=1}^{N} X_i$
- Then O has **mean Nμ** and **standard deviation = $\sqrt{N}\,\sqrt{\mu}$ = $\sqrt{\text{mean}}$**



Here is a histogram with 140 bins. We have a random variable for each bin.
There is an excess of events in bin from 125 to 130 GeV


CMS √s = 7 TeV, L = 5.1 fb^{-1} √s = 8 TeV, L = 5.3 fb^{-1}
S/(S+B) Weighted Events / 1.5 GeV
$m_{\gamma\gamma}$ (GeV)
Unweighted
Events / 1.5 GeV
$m_{\gamma\gamma}$ (GeV)
Data
S+B Fit
B Fit Component
±1σ
±2σ

Comments

- Note some measurements have a small signal but a small background
- Others have a larger signal but also a larger background
- If you have signal N_S and background $N_{B,}$ then statistical error is $\surd(N_S + N_B)$ and one needs
- $\surd(N_S + N_B)$ much smaller than N_S which is harder than $\surd N_S$ much smaller than N_S
- Typically one quotes "systematic errors" as well. These reflect model-based uncertainties in analysis and will not decrease like sqrt of total event sample