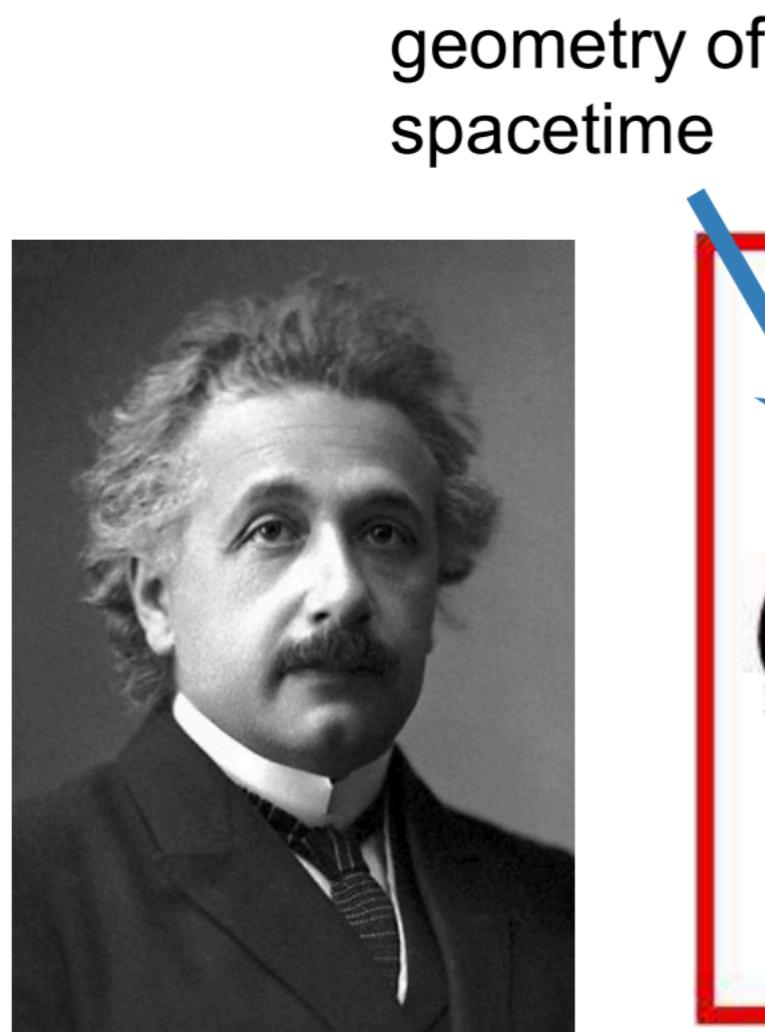


Searching For Gravitational Waves

Gravity

There is a limiting speed in Nature, the speed of light (1905)



geometry of
spacetime

stress-
energy
tensor

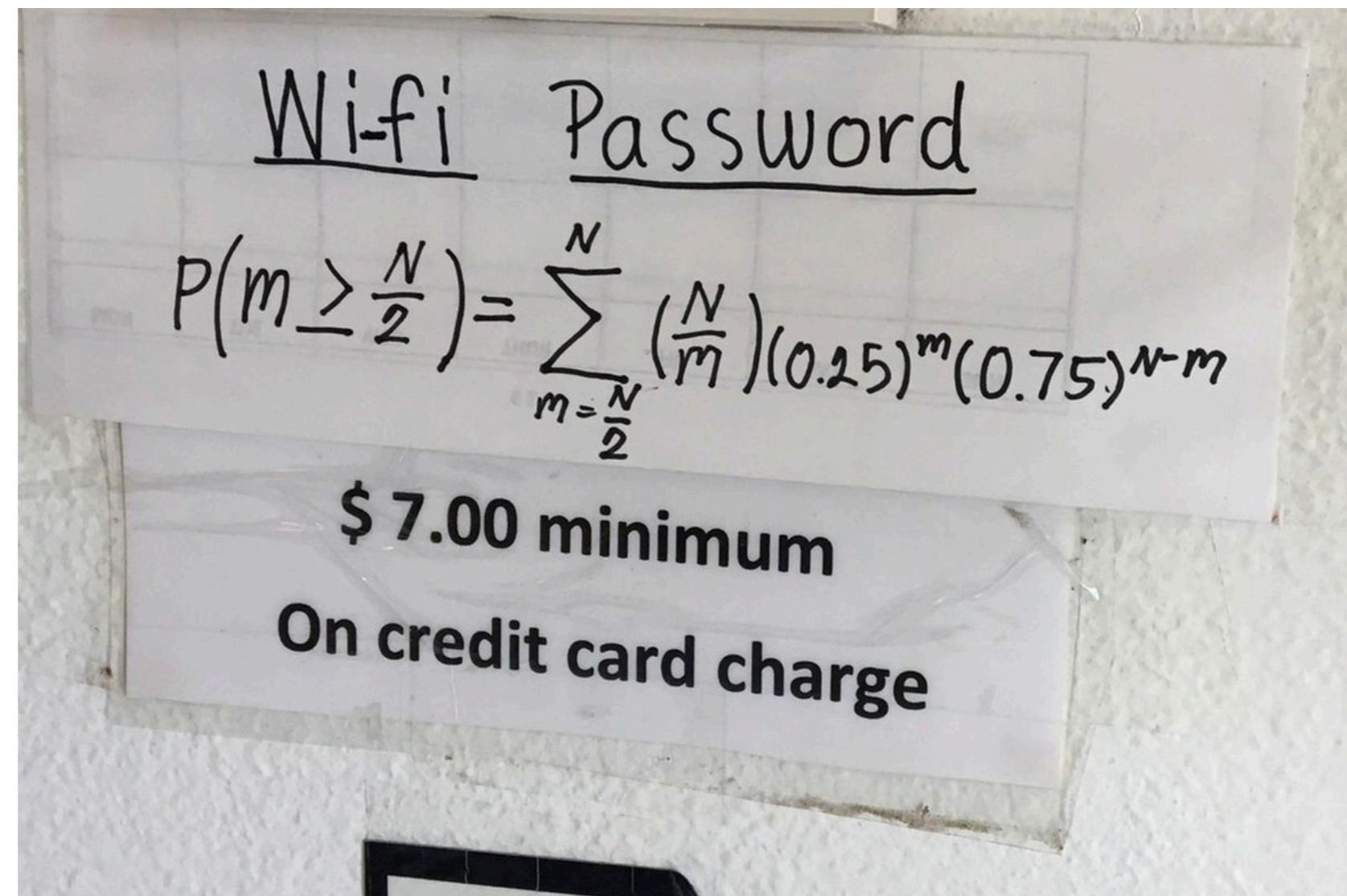
$$G_{\alpha\beta} = -\frac{8\pi G}{c^4} T_{\alpha\beta}$$

Gravity: manifestation of spacetime curvature (1915)

Slides

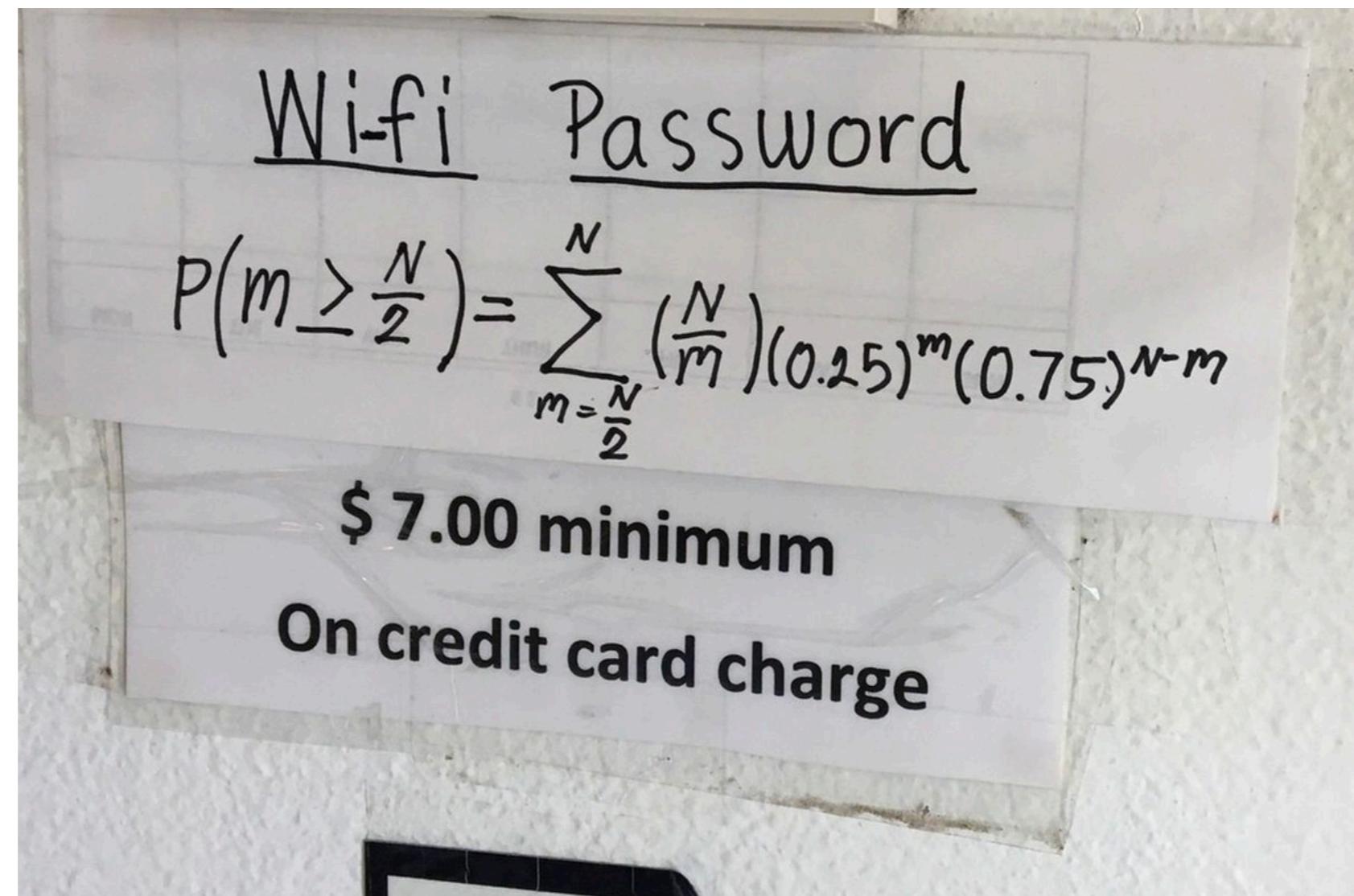
- See this link for animations:
- [https://www.dropbox.com/s/44ew35qlz89xono/
PCH Lecture2 LigoAnims 8S50.pptx?dl=0](https://www.dropbox.com/s/44ew35qlz89xono/PCH_Lecture2_LigoAnims_8S50.pptx?dl=0)

Whats the password?



Hint: We are at a coffee shop?

Whats the password?



Hint: We are at a coffee shop?
Binomial(Buy No Meal)

Binomial Distribution

Given a coin with a probability p for heads what is the probability of k heads in n tosses

$$\binom{n}{k} (1 - p)^{n-k} p^k$$

Number of possible
heads combinations

Probaility of $n-k$
tails

Probaility of
 k heads

Binomial is the foundation of all statistics

$$E[f(x)] = np$$

$$V[f(x)] = np(1 - p)$$

- Function summary

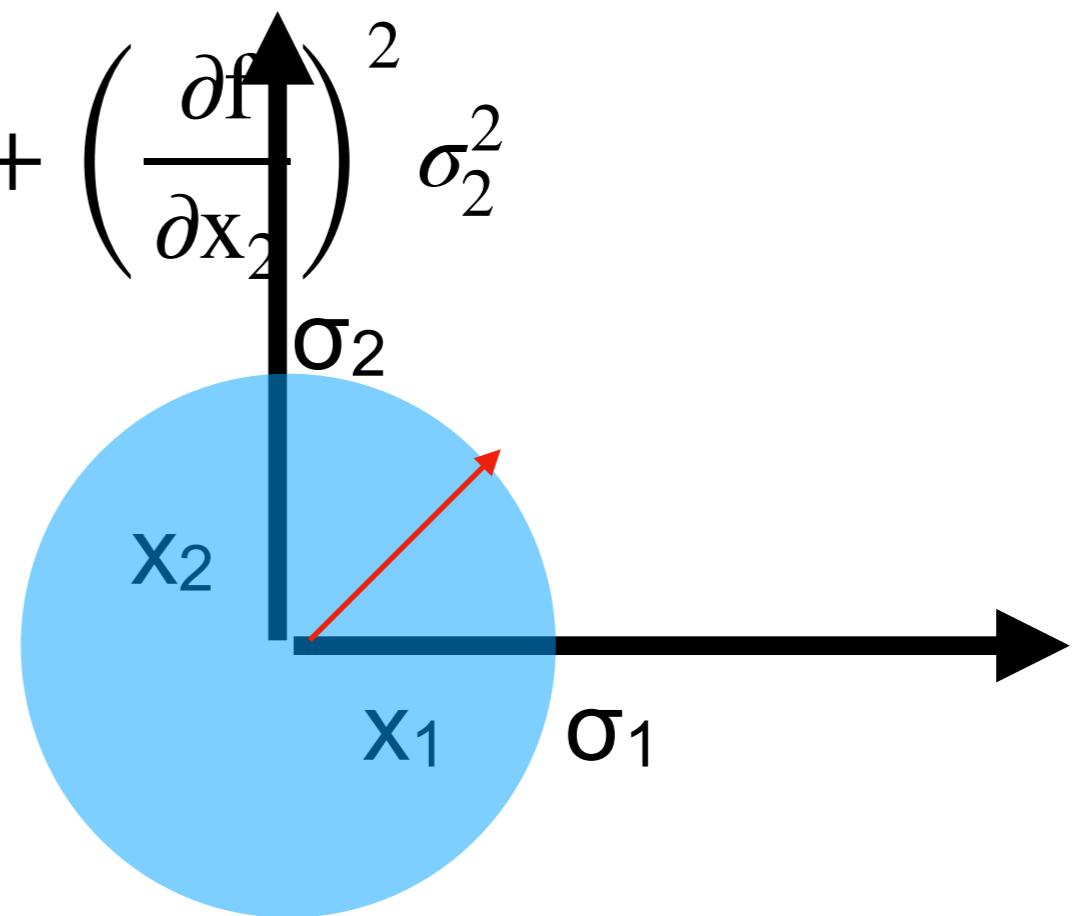
Error Propagation

- An important element of variance is that it propagates
 - Take $f(x)$
 - What is the variance of $f(x)$ given x
- Take: $f(x + \sigma) \approx f(x) + \sigma \frac{df}{dx}$
- $\text{VAR}[f(x)] = \sigma^2 \left(\frac{df}{dx} \right)^2$

What if you have two unc?

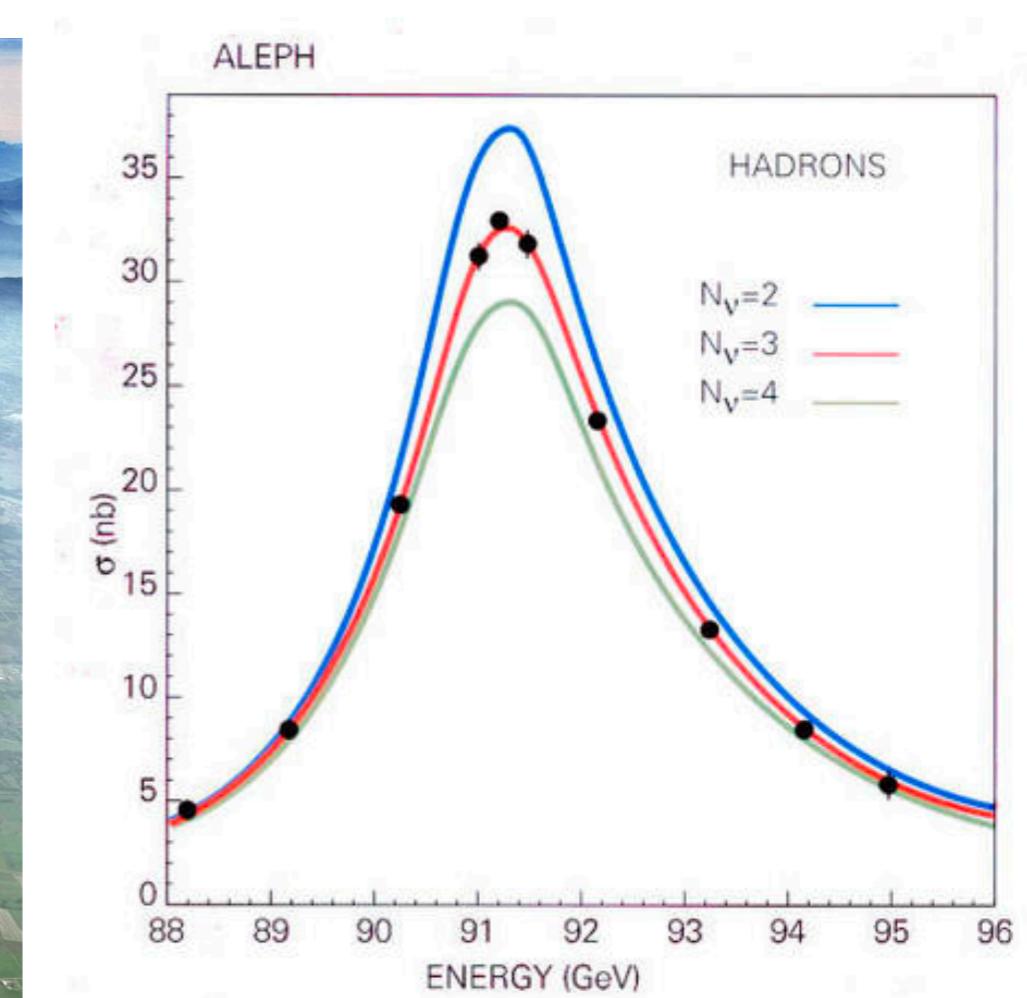
- Now consider another function:
- $f(x_1, x_2)$ where x_1 and x_2 are independent variables
- In this case we treat the total uncertainty as the sum
- Since they are independent we can visualize as a circle

- Take: $\text{VAR}[f(x_1, x_2)] = \left(\frac{\partial f}{\partial x_1}\right)^2 \sigma_1^2 + \left(\frac{\partial f}{\partial x_2}\right)^2 \sigma_2^2$



Dealing with uncertainties

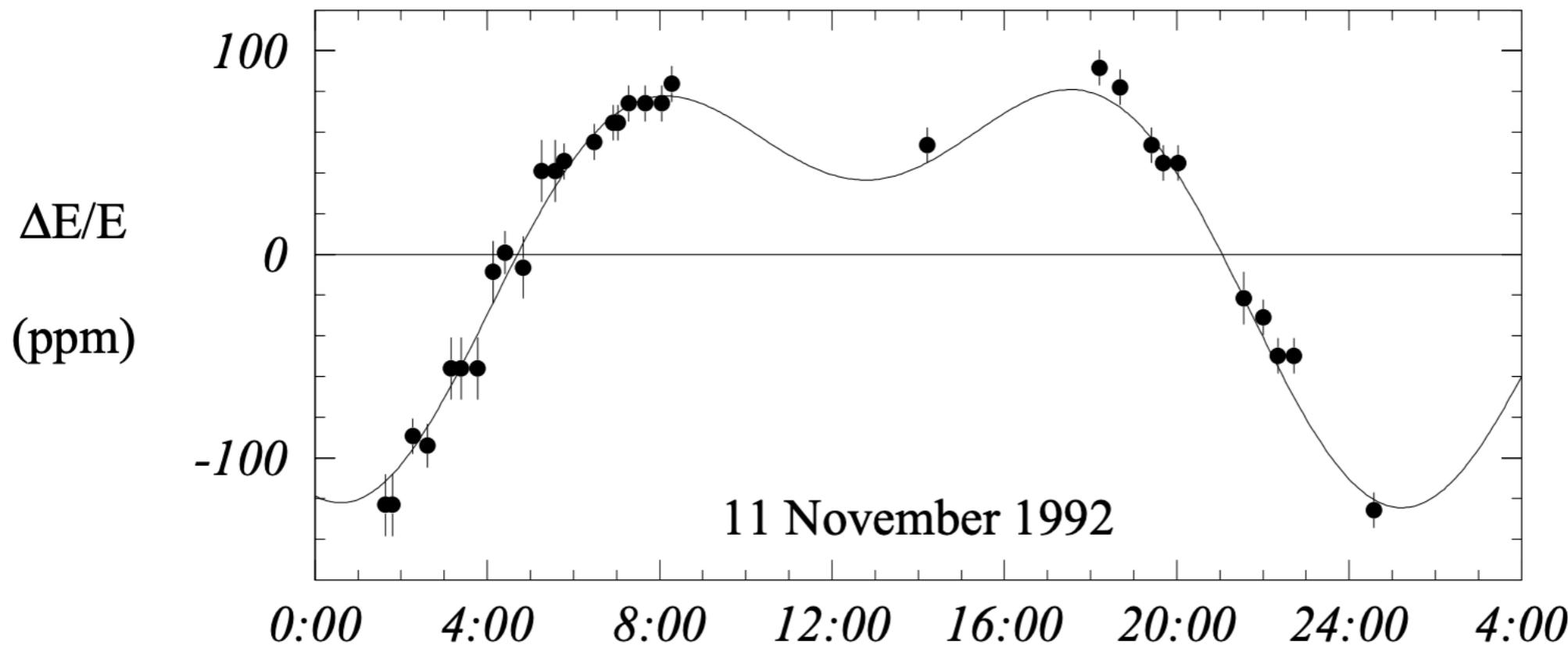
LEP: Large Electron-Positron Collider



Collider was used to
measure rates of collisions
(and all their properties)
Precisely

Func with Unceratinties

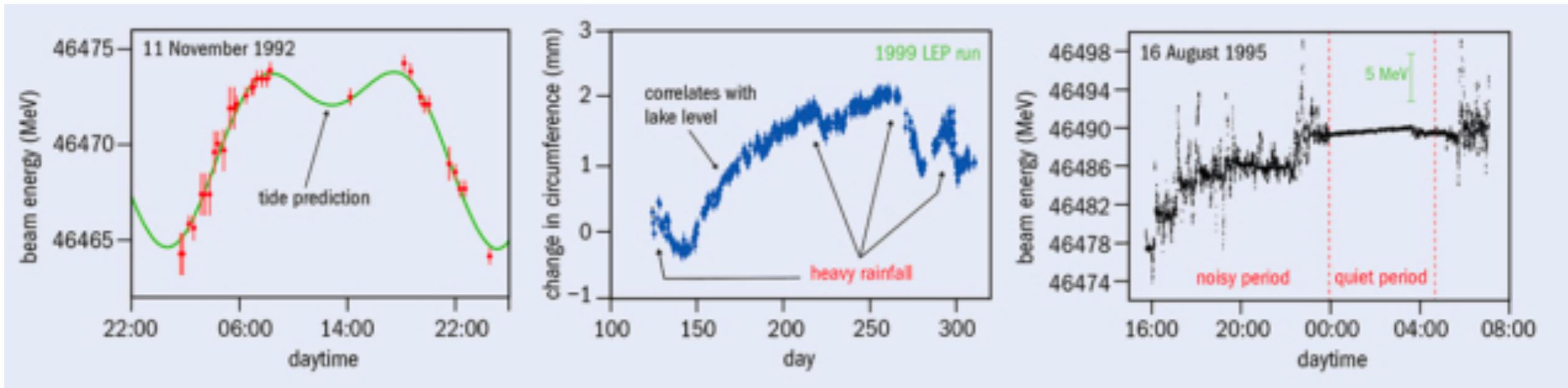
How precise is this?



Any guesses whats causing this?

Paper of this plot

Lots of Uncertainties



- The collider would change parameters due to :
 - The water level in the nearby lake
 - The TGV train schedule
 - The orbits of the moon

Questions?