STATISTICS AND MEASUREMENTS

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ALICE Masterclass
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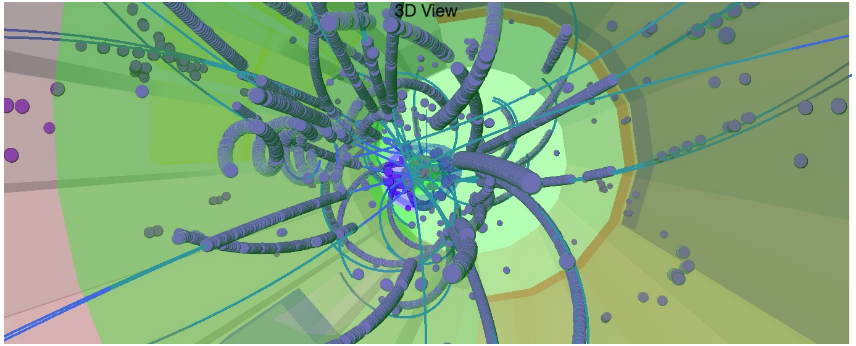
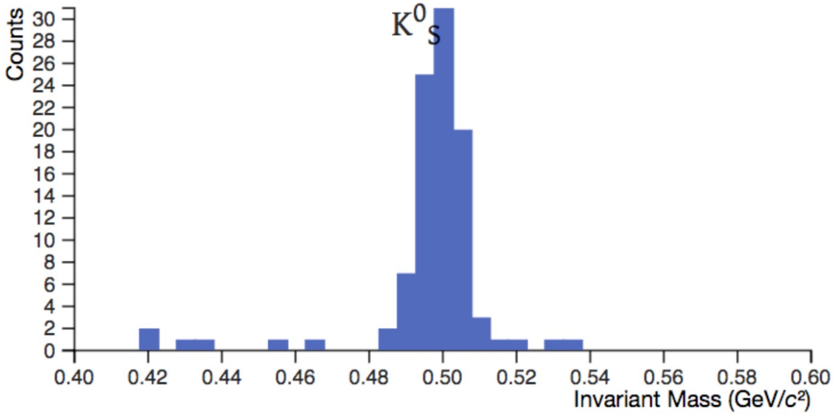
The Detector

- Data is collected by the detector
  - Little points are left in the detector where the particle deposited energy (only charged particles)
  - An algorithm is used to reconstruct a “track”
  - The bending of the track with the time of flight or the exact amount of energy lost can be used to identify the particle (mass, momentum, charge)



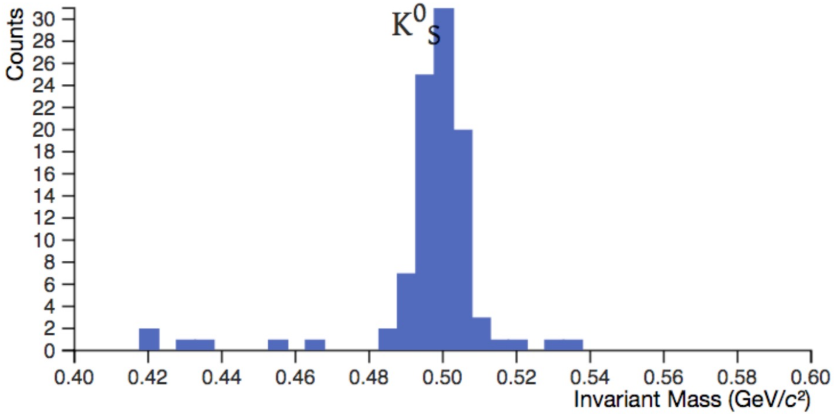
Identifying V0s

- The specific decay chain can be used to identify candidate decaying particles
- Decay products must originate close to each other
- Through energy and momentum conservation one can reconstruct which kind of particle this could be



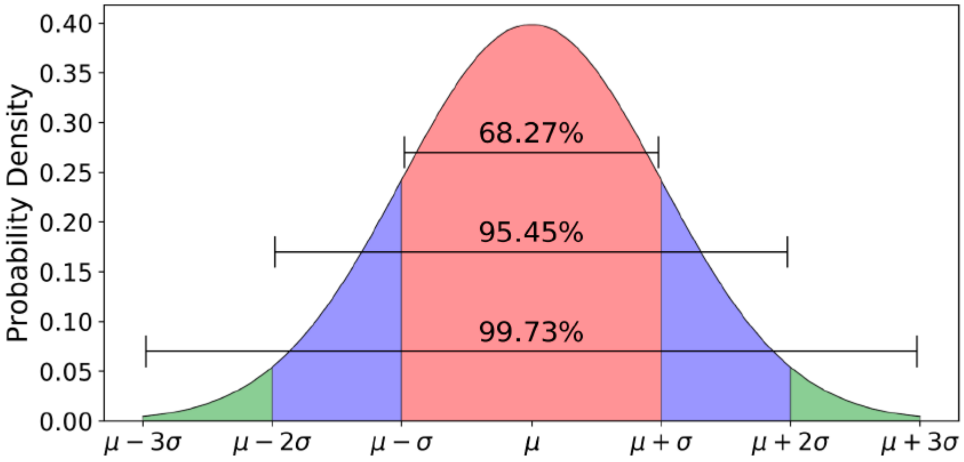
Counting how many particles

- We want to know how many particles were created in the collision
- How can we do that?
  - Are all of the particles actually from dacays?



Normal distribution

- There can be a background of “fake” particles
- We expect, from quite general principles, that the actual signal should have a normal distribution
  - which has 2 parameters when normalized to an area of 1.



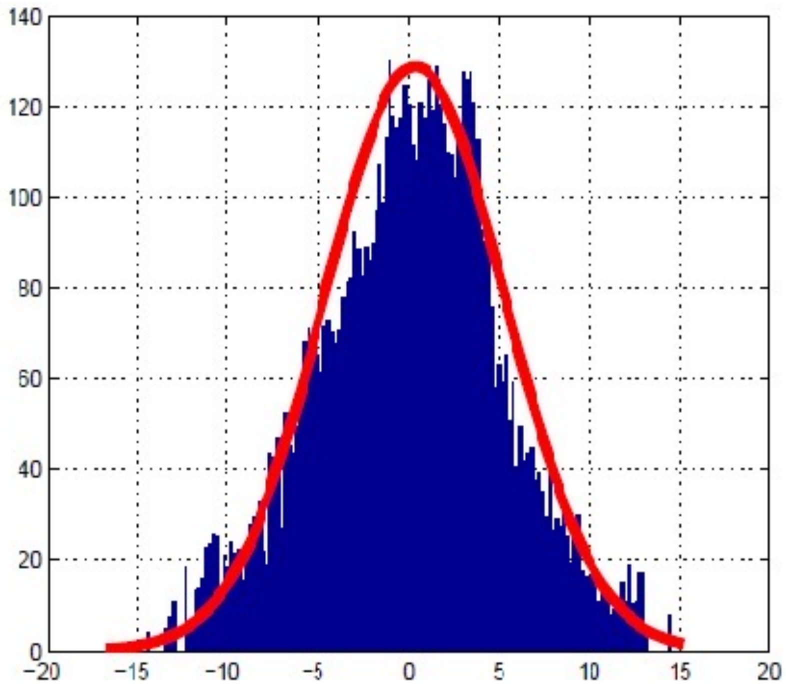
$$P(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Fitting to a normal distribution

- One can fit the signal to a normal distribution
  - Fitting finds the parameters that reduces the sum of the square of the distance of the function to the data points

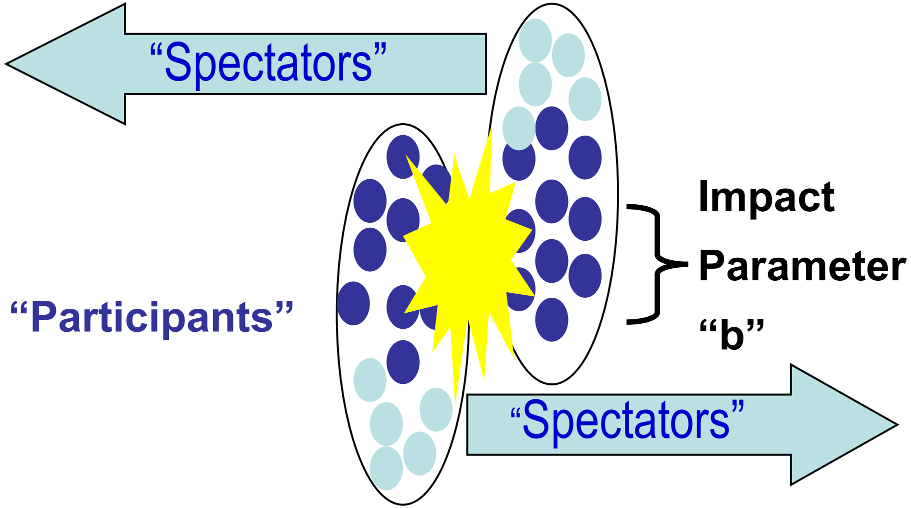
$$\chi^2(a_1,\ldots,a_m) = \sum_{i=1}^{n}\left(\frac{y_i - f(x_i;a_1,\ldots,a_m)}{\sigma_i}\right)^2$$

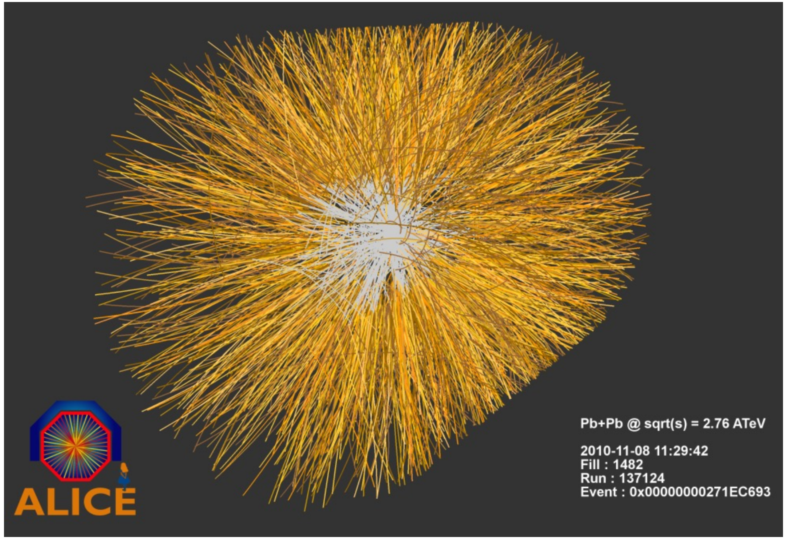
  - $a_{1,}\ldots,a_m$ are parameters
  - y_i is the value of a data point
  - σ_i is the uncertainty of each data point



A heavy-ion event

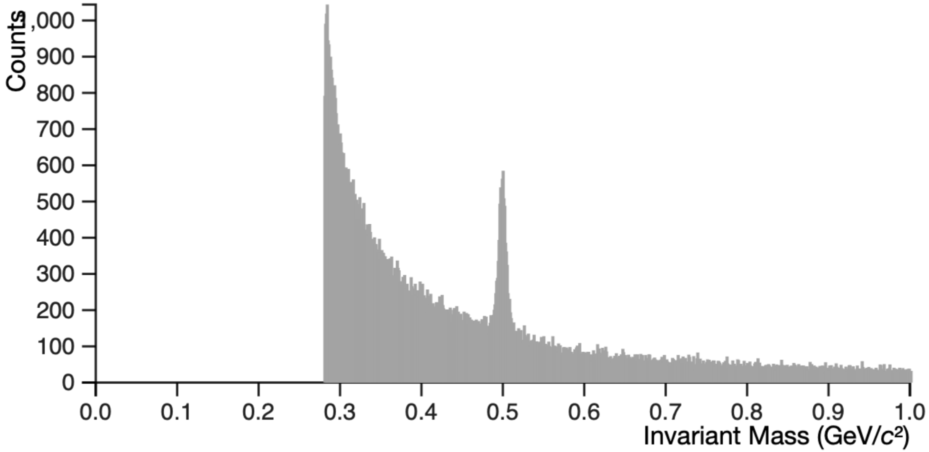
- When lead ions are collided, many more particles are created
- For a central collision (head on hit) more than 20000 particles are created
- This give a high chance of matching particles that were not from a decay





Invariant mass distribution

- Invariant mass distribution for kaons looks like the following
  - Why?
- How can we count the particles now?



How to count

- Fit both the signal and background together
- Use the signal fit to compute the number of particles
- This requires the background to be some smooth function underneath the signal
  - In the exercise a second order polynomial is used: $y=ax^2+bx+c$