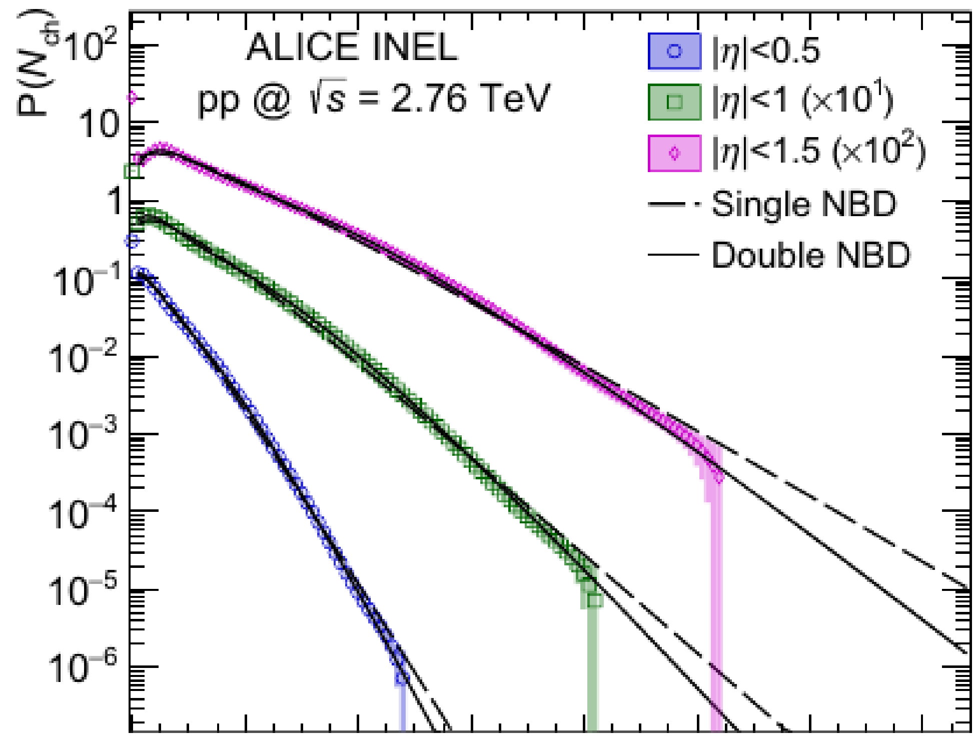
Modern Particle Physics Experiments

The probability

Many aspects of particle physics are of stochastic nature:

- final state properties in particle collisions:
  - number of particles
  - type of particles
  - particle fourmomenta



https://arxiv.org/abs/1509.07541

Probability distributions are given by the differential cross sections, e.g.

$$\frac{d\sigma}{dN}=\ldots,\quad \frac{d\sigma}{dp_T}=\ldots,\quad \frac{d\sigma}{dp_{T\,\eta}}=\ldots$$

The probability

Probability distributions are given by the differential cross sections:

$$\frac{d\sigma}{dN}=\ldots,\quad \frac{d\sigma}{dp_T}=\ldots,\quad \frac{d\sigma}{dp_T}=\ldots,\quad \frac{d\sigma}{d\eta}=\ldots$$

Probability distribution has to correctly normalized:

$$p(\eta)=\frac{1}{\sigma_{tot}}\frac{d\sigma}{d\eta}$$

total cross section – normalization constant

differential cross section – the distribution shape

Task 1: electron spectrum from μ decay

Plot the probability distribution for the electron energy for electrons from muon decay.

- the differential decay width section is as follows:

$$\frac{d\Gamma}{dE_e} = \frac{G_F^2}{4\pi^3} m_\mu^2 E_e^2 \left(1 - \frac{4E_e}{3m_\mu}\right)$$

- the total decay width is as follows:

$$\Gamma_\mu = \frac{G_F^2 m_\mu^5}{192\pi^3}$$

Materials

Review articles of probability and statistics on PDG portal:

- *The Review of Particle Physics*

Python packages:

- *Scikit-HEP Project*