Cross section combination

BAT tutorial

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Cross section combination tutorial

Webpage of the tutorial:
http://www.mppmu.mpg.de/bat/?page=tutorials&name=combination

5 steps

To create the project:
./CreateProject.sh ProjectName ModelName

Step 1

Cross section measurement in two channels: electron and muon

Number of events is proportional to the cross section:

$$\lambda = L \cdot \varepsilon \cdot \sigma$$

λ - number of expected events

σ - cross section, physical parameter

L - luminosity, ε - efficiency - constants

Statistical model: Poisson distribution $p(N|\lambda) = e^{-\lambda} \lambda^N / N!$

Estimate λ from N, propagate uncertainty to σ $\sigma = \sigma(\lambda)$

STEP 2

Combination of two channels:

$$p(N_e, N_\mu|\lambda) = p(N_e|\lambda) \cdot p(\lambda|N_\mu|\lambda) = e^{-\lambda}\, \lambda^{N}_{e} / N_e! \cdot e^{-\lambda}\, \lambda^{N}_{\mu} / N_\mu!$$

STEP 3

Including systematic uncertainties:

If efficiencies are known with an uncertainty

- variation: vary efficiency up and down and re-run analysis
- include uncertainty as a **nuisance parameter**

  -> replace constant with a parameter

$$\varepsilon \rightarrow \varepsilon + \delta\varepsilon \cdot \Delta\varepsilon$$

$\delta\varepsilon$ - nuisance parameter

$\Delta\varepsilon$ - shift

Assume Gaussian prior probability

Assume efficiency for electrons and muons independent

STEP 4

Including correlated systematic uncertainties

- common uncertainty for both channels: luminosity
- again, replace constant with a parameter

$$L \rightarrow L + \delta L \cdot \Delta L$$

Assume Gaussian prior probability

Assume uncertainty for electrons and muons the same

STEP 5

High and low statistics

Assume larger statistics
Assume 0 observed events - limit setting