Lab Guide for the
Sensitivity and Exclusion Limits for DM & ν Experiments Course

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Topics

- *A brief overview of the most popular distributions in particle physics.*
- *Frequentist confidence intervals: 90% central, upper and lower limits.*
- *Principle of maximum likelihood.*
- *Hypothesis testing, significance, type I and II errors, and p-value.*
- *On-Off experiments with Poissonian counting: Reactor neutrino experiments*
- *Sensitivity and exclusion limits using Monte Carlo simulations.*

Recommended Bibliography

Probability and Statistics in Particle Physics, A. Frodesen, O. Skjeggestad; Columbia. [**pdf**]

Introduction to Statistics and Data Analysis for Physicists. Bohm y Zech. [**pdf**]

Tentative Agenda

[14:00 to 14:30 hs] A brief overview of the most popular and fundamental distributions useful in particle physics: binomial, Poisson, Gaussian, and chi-squared. We will focus on their relationship using simple Python code lines to visualize the different regimes where one becomes another.

[14:30 to 15:30 hs] The frequentist recipe to set confidence intervals, central intervals, and lower and upper limits. We will work on the case of a Poissonian random variable, as usual in particle physics, to learn how to set a 90% upper limit in a counting experiment.

[30 minutes] Break

[16:00 to 16:30 hs] The Likelihood: construction and meaning. The Likelihood as a tool for establishing 68%, and 95% confidence intervals. Principle of maximum likelihood to get the most representative value of a distribution.

[16:30 to 17:30 hs] A general overview of hypothesis testing, significance, type I and II errores. p-value: What is and what is not. The use of hypothesis testing in particle physics. Discovering new physics.

[17:30 to 18:30 hs] Creating an ON-OFF neutrino experiment by Monte Carlo simulation. Setting exclusion limits for beyond standard model scenarios.