

Experimental hands-on session

Flavour physics at LHC School

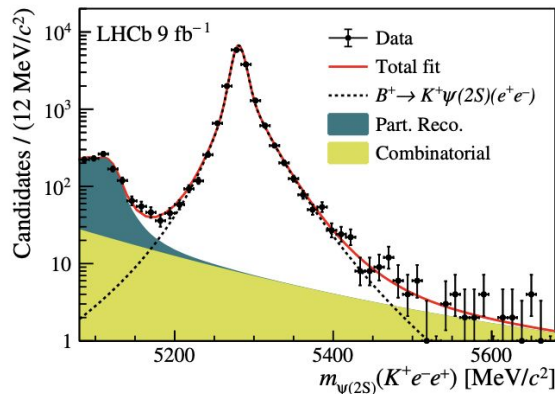
CERN, 26th-30th May 2025

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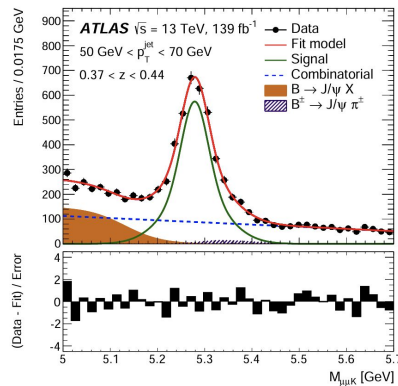
Click [HERE](#) to start the Binder session that we will use for the tutorial!
It should take few minutes to load...

What you will do in this tutorial

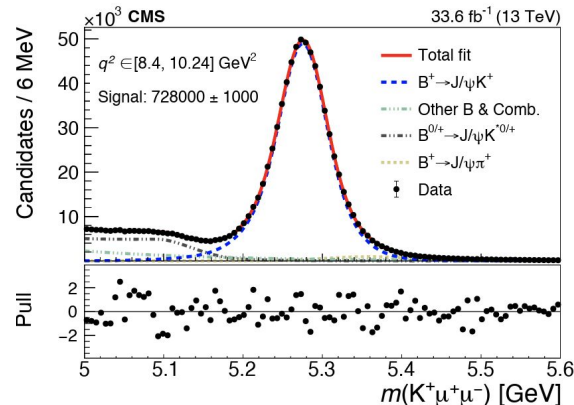
- Use pre-generated datasets to perform fit using different frameworks: **iminuit**, **RooFit**, **zfit**
 - **Signal + combinatorial background (datasets/dataset.cvs)**
 - **Signal + combinatorial bkg + partially reconstructed bkg (datasets/partreco_dataset1.cvs)**



<https://inspirehep.net/literature/2918595>



<https://inspirehep.net/literature/1913061>



<https://inspirehep.net/literature/2747130>

- Learn how to apply constraints on fit parameters and incorporate weights in the likelihood
- Play with different fit models
- Throw generation of toy datasets to perform studies on fit goodness, evaluate systematics

iminuit, RooFit, zfit... which one *fits* best?

- iminuit: Jupyter-friendly Python interface for the Minuit2 C++ library maintained by CERN's ROOT team
 - Ideal for fits with tight control on function and minimization
 - References: <https://scikit-hep.org/iminuit/>
- RooFit: C++ based framework integrated in ROOT
 - Ideal for complex models in a ROOT-based workflow
 - References: <https://root.cern/manual/roofit/>
- zfit: modern python based fitting framework, inspired by RooFit and based on TensorFlow
 - Ideal for complex models, still growing
 - References: <https://zfit.readthedocs.io/en/stable/>

The logo for iminuit features the word "iminuit" in a lowercase, sans-serif font. The letter "i" is red, and the letter "u" is blue with a dashed line forming a loop above it, resembling a particle detector track.The logo for ROOT consists of a circular icon on the left containing a blue square root symbol. To the right of the icon, the word "ROOT" is written in a large, bold, sans-serif font, with "Data Analysis Framework" in a smaller font below it.The logo for zfit features the word "zfit" in a lowercase, sans-serif font. The letter "z" is orange, and the letters "fit" are black. A red line is drawn over the letters, starting from the top of the "z", curving over the "f", and ending at the top of the "t", resembling a particle detector track.

Outline

1. **ML_exercise/ml_fit.ipynb** (iminuit, ~1.5h)
 - a. familiarise with the dataset (Task 0), perform fit with simple model and plot the result (Task 1)
 - b. repeat the fit separately for files in datasets/dataset[1-5].cvs (Task 2)
 - c. apply constraint on a fit parameter (Task 3)
 - d. compare different methods for uncertainty estimation for a weighted likelihood fit (Task 4)
2. **ML_exercise/ml_roofit.ipynb** (roofit, ~1h)
 - a. build simple fit model, perform fit and plot the result
 - b. generate some toys and check for bias in parameter estimations
 - c. evaluate pulls and plot distribution
 - d. build more complex model to include part reco bkg and apply constraints on fit parameters
3. **ML_exercise/Systematics_zfit.ipynb** (zfit, ~15min)
 - a. evaluate systematics on fit model

More details on each task are provided in the notebook!

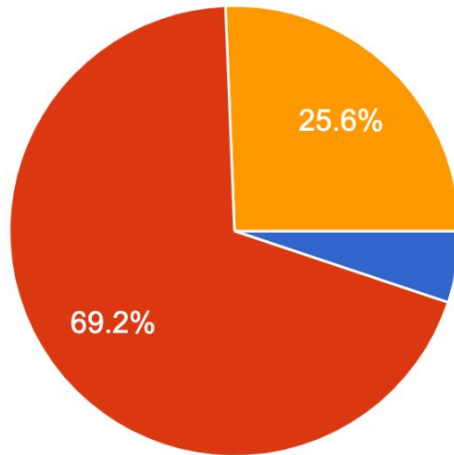
Practical information

- You will find some empty cells where you will write your own code
 - cells with solution available with one click
- At the end of the tutorial, if you want to use the results, **don't forget to download your jupyter notebook!**
- Partially inspired by G. Cowan tutorial
(<https://www.pp.rhul.ac.uk/~cowan/stat/exercises/fitting/>)

Now let's start

What is FCN?

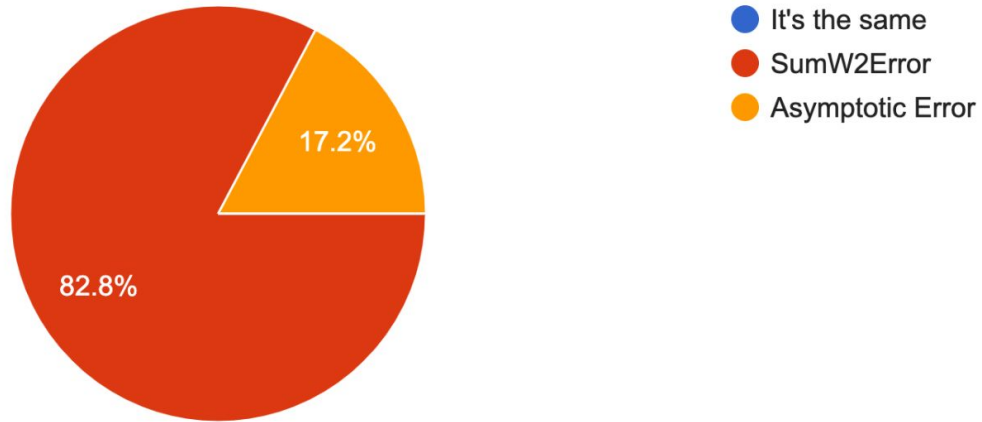
39 responses



- Numerical cost function
- Function to be minimized
- Function characterization number

What is better to use in the weighted fit in RooFit the SumW2Error or the AsymptoticError? If you have never used RooFit you may skip it

29 responses



Without running it, will this fit converge? `x = ROOT.RooRealVar("x", "x", -10, 10) mean = ROOT.RooRealVar("mean", "mean", 0, -1, 1) sigma = ...erate(ROOT.RooArgSet(x), 1000) model.fitTo(data)`
40 responses

