Higgs recoil mass in FCCAnalyses

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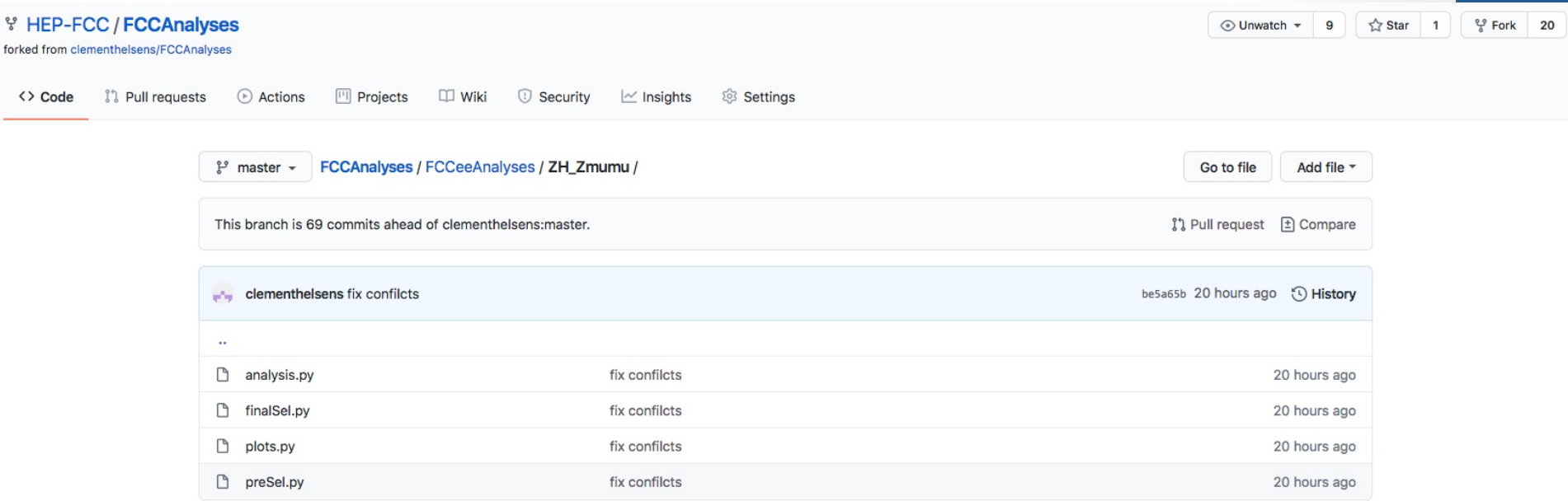
Common software?

- FCCAnalyses
  - Is a common tool for analyzing large amount of data using RootDataFrame and produce flat ntuple
  - Is composed of a library of C++ analysers and python configurations
    - C++ analysers are developed in common
    - Python code specific to the analysis to define the analysers, output variables, input samples
  - Use those flat ntuples
    - To produce final variables for analysis, for MVA training, and for plotting
    - To run decay selector for flavour physics
  - Is a-priori transparent to the input format

- EDM4Hep
  - EDM4Hep is the common event data model
  - Is the only supported input format at the moment but this can evolve
  - Will be used for the very long term for any simulation (so better to start using it now!)



- Aim at having always the same structure inside an analysis

Generalities

Each analysis is hosted in a single directory, for example `FCCeeAnalyses/ZH_Zmumu/` and contains the same kind of files, please use the same naming convention for all analysis.

1. `analysis.py` : This class that is used to define the list of analysers and filters to run on as well as the output variables.
2. `preSel.py` : This configuration file is used to define how to run the `analysis.py` . It contains the list of samples, the number of CPUs, the fraction of the original sample to process and the base directory for the yaml files (that contains the informations about the samples). This will run the `analysis.py` with a common code `bin/runDataFrame.py` (this last file is common to all analyses and should not be touched).
3. `finalSel.py` : This configuration file contains the final selections and it runs over the locally produced flat ntuples from the `preSel.py` . It contains a link to the `procDict.json` for getting cross section etc...(this might be removed later to include everything in the yaml, closer to the sample), the list of processes, the number of CPU, the cut list, and the variables (that will be both written in a `TTree` and in the form of `TH1` properly normalised to an integrated luminosity of 1pb-1.
4. `plots.py` : This configuration files is used to select the final selections from running `finalSel.py` to plot. Informations about how to merge processes, write some extra text, normalise to a given integrated luminosity etc... For the moment it is possible to only plot one signal at the time, but several backgrounds.

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Delphes FCCee Physic events tmp (IDEA with Track Covariance)

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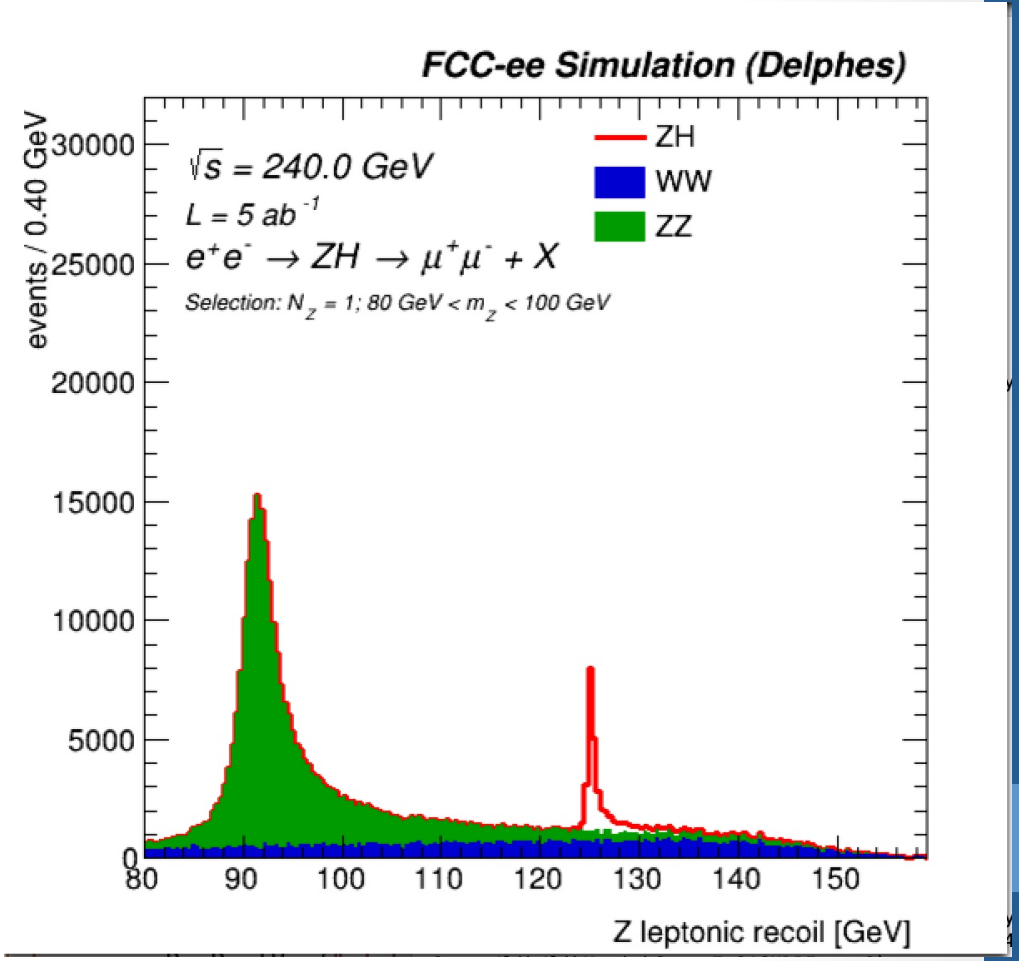
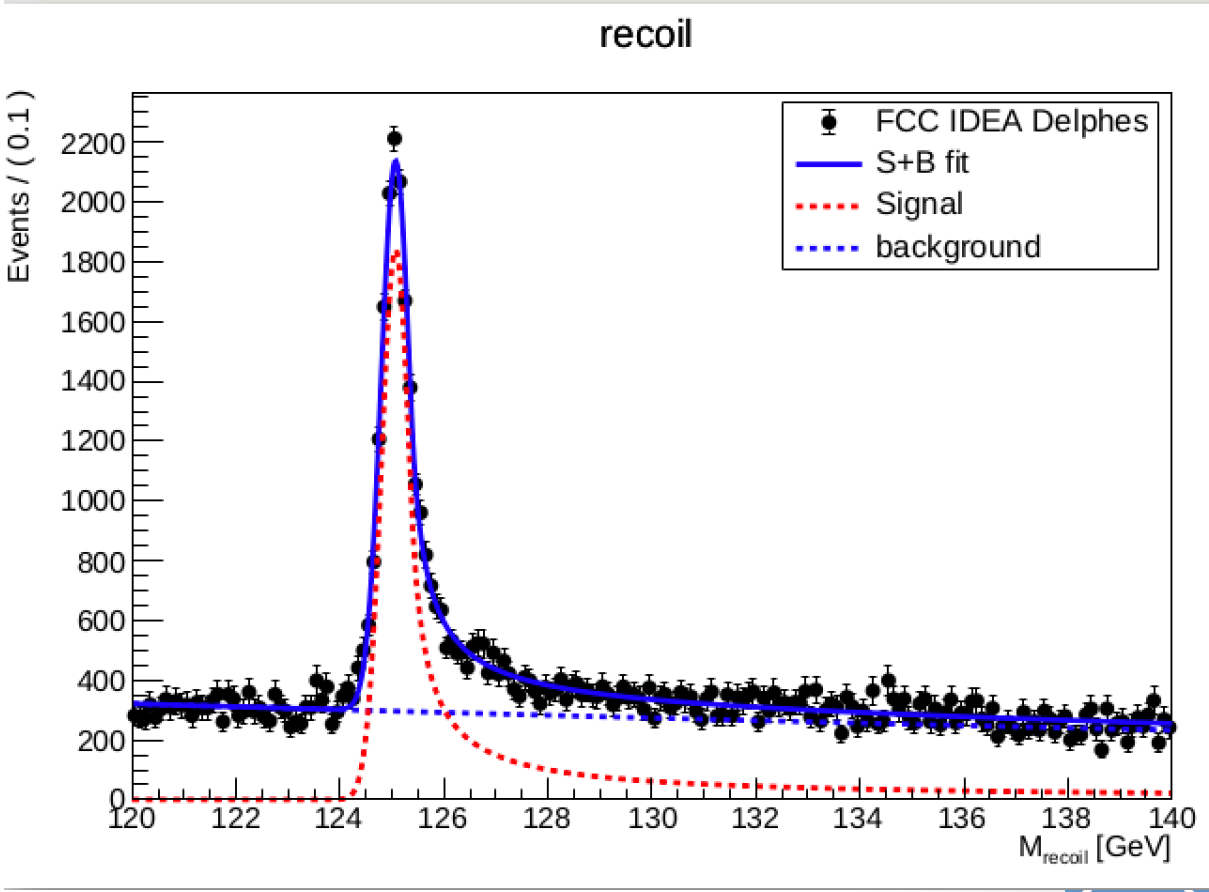
NO	NAME	NEVENTS	NWEIGHTS	NFILES	NBAD	NEOS	SIZE (GB)	OUTPUT PATH	MAIN PROCESS	FINAL STATES	CROSS SECTION (PB)	K-FACTOR	MATCHING EFF
35	p8_ee_ZH_ecm240	9,920,000	0	992	0	992	90.31	/eos/experiment/fcc/ee/generation/DelphesEvents/fcc_tmp /p8_ee_ZH_ecm240/	ZH ecm=240GeV	inclusive decays	0.201037	1.0	1.0
36	p8_ee_ZZ_ecm240	9,980,000	0	998	0	998	67.76	/eos/experiment/fcc/ee/generation/DelphesEvents/fcc_tmp /p8_ee_ZZ_ecm240/	ZZ ecm=240GeV	inclusive decays	1.35899	1.0	1.0
37	p8_ee_WW_ecm240	10,000,000	0	1000	0	1000	65.44	/eos/experiment/fcc/ee/generation/DelphesEvents/fcc_tmp /p8_ee_WW_ecm240/	WW ecm=240GeV	inclusive decays	16.4385	1.0	1.0

- Used the common delphes IDEA track covariance samples I produced
- Processed them through FCCAnalyses machinery with a Z->mumu selection
- And within very little time make this recoil plot



- Then fit the recoil with custom roofit code (this part has to be written by analysers)
- Fitted mass:
  - 125.07 +/- 0.00357 GeV

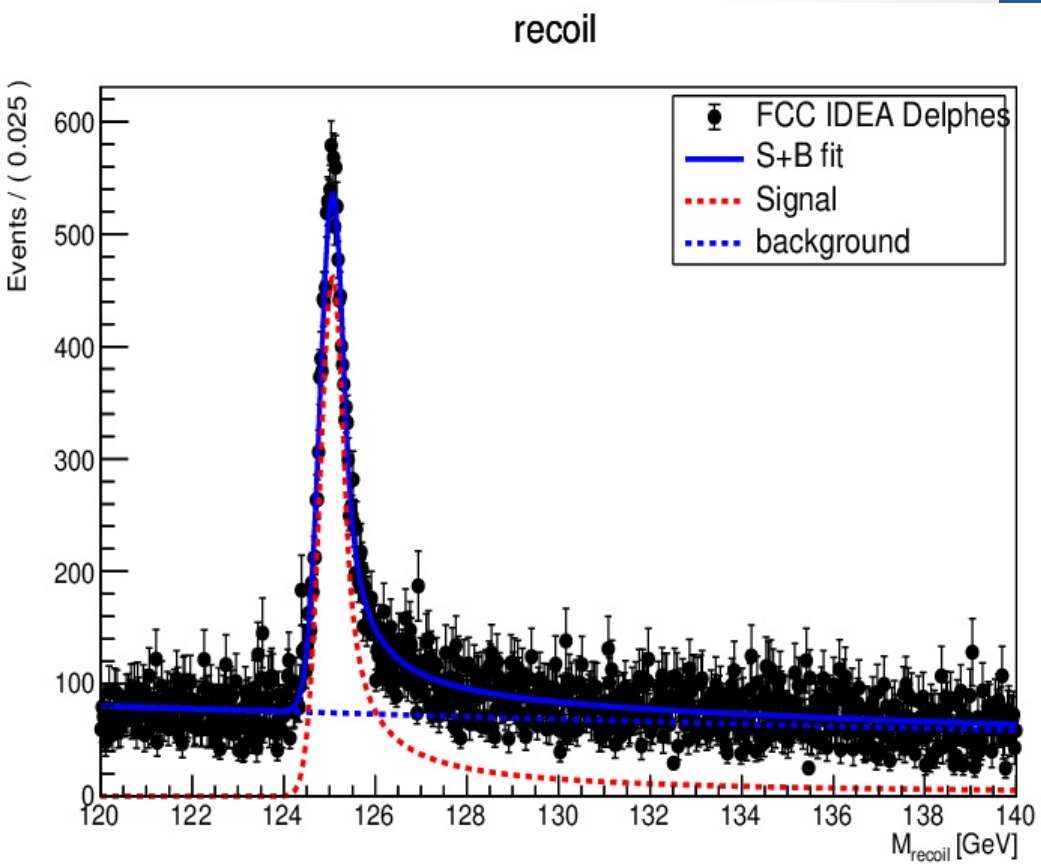


Summary

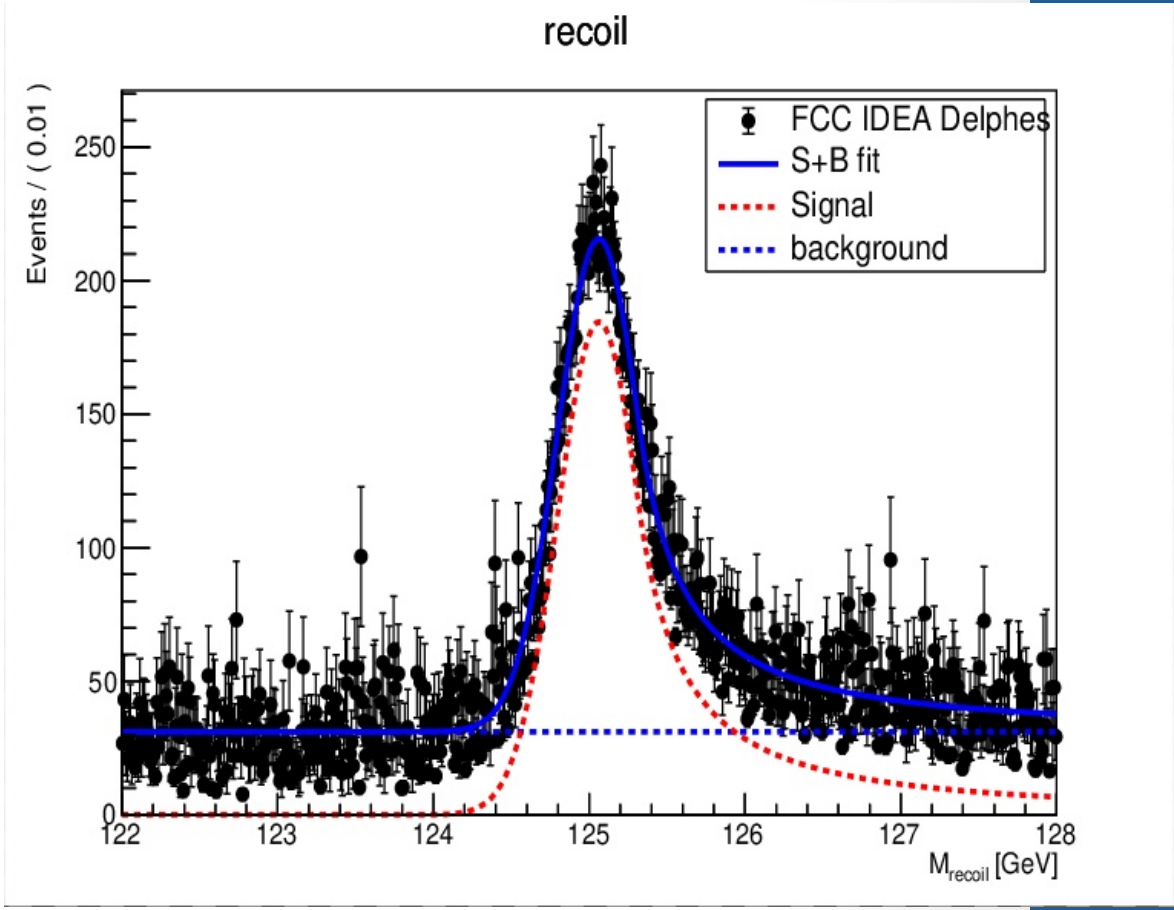
- I am not pretending taking over this analysis but:
  - It took me a few hours to achieve a result from event generation to analyzing them
  - I do not see a reason why the common tools can not be used here, and right now
- Next obvious steps could be
  - to look at the hadronic channel
    - Preliminary jet clustering has been implemented in FCCAnalyses to allow more flexibility
  - use the same framework for higgs width
  - Study different detector response

Follow up

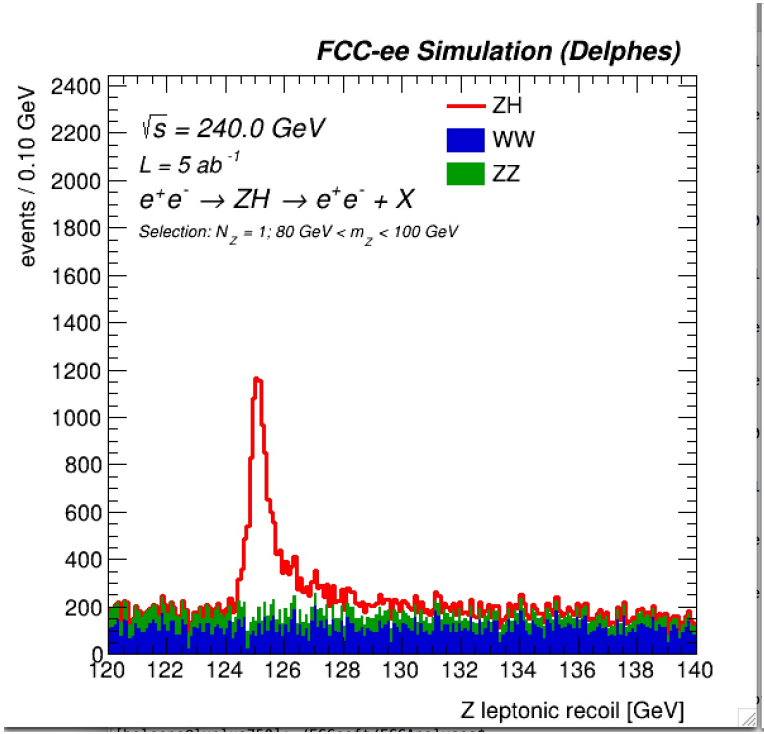
- 25Mev bins
- Fitted mass:
  - 125.07 +/- 0.00403 GeV

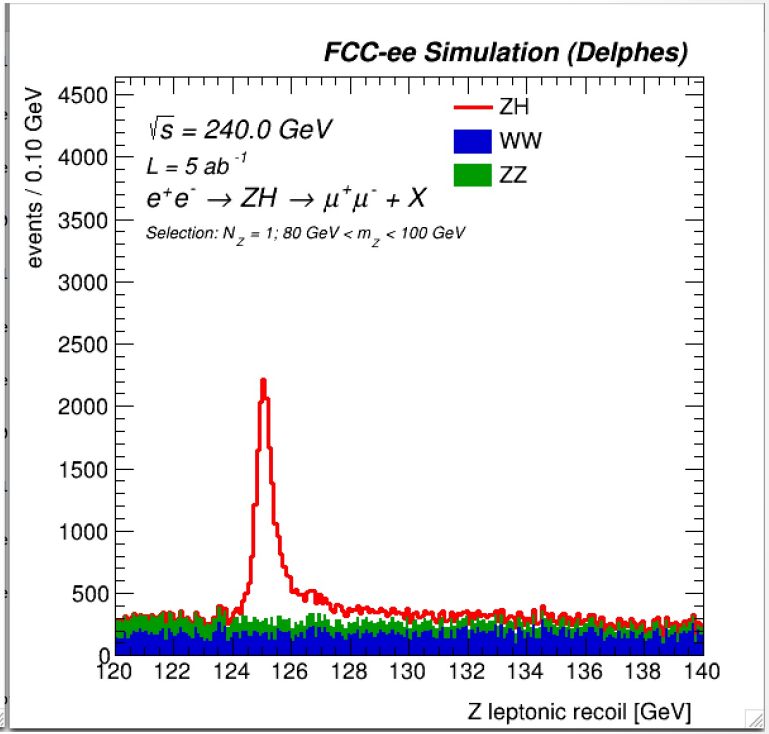


- 100MeV bins
- Fitted mass:
  - 125.07 +/- 0.00460 GeV



Electron channel





Less statistics in the electron channel because of a bug found in the electron to reconstructed particle association in edm4hep (need to move to new implementation)

- Electron channel
- 25Mev bins
- Fitted mass:
  - 125.1 +/- 0.00628 GeV