UPDATE ON THE ZH RECOIL ANALYSIS

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INFN

OUTLINE

STATUS OF THE HIGGS RECOIL ANALYSIS

Update on the work we are doing

- Add the systematic uncertainties to the template fit
- Obtaining the NLL curve as a function of the Higgs masses
- Make the analysis with larger statistics samples **centrally produced**

SYSTEMATIC UNCERTAINTIES ON THE SHAPE

Systematic on the shape of signal and background histograms implemented in combine

shapes * * shapes.root $CHANNEL/$PROCESS/nominal $CHANNEL/$PROCESS/$SYSTEMATIC

→ Combine look for Up/Down systematic templates for a given process

→ Macro to smear histograms by 1σ is ready and is being validated on reduced samples

NLL VS MH

Use the Higgs mass as a Parameter Of Interest (POI) in combine instead of the signal strength μ

Check the signal shape dependence on the Higgs Mass.

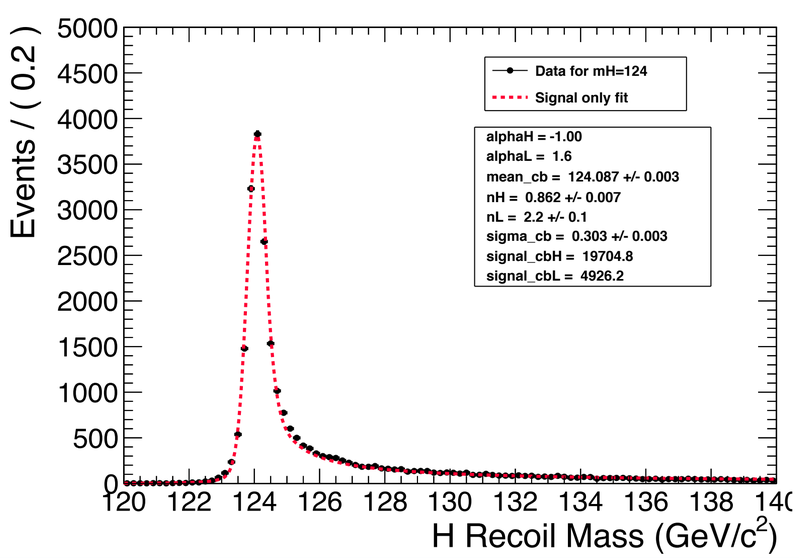
Simulation of 100 000 signal events using different Higgs masses: 124, 125, 126 GeV

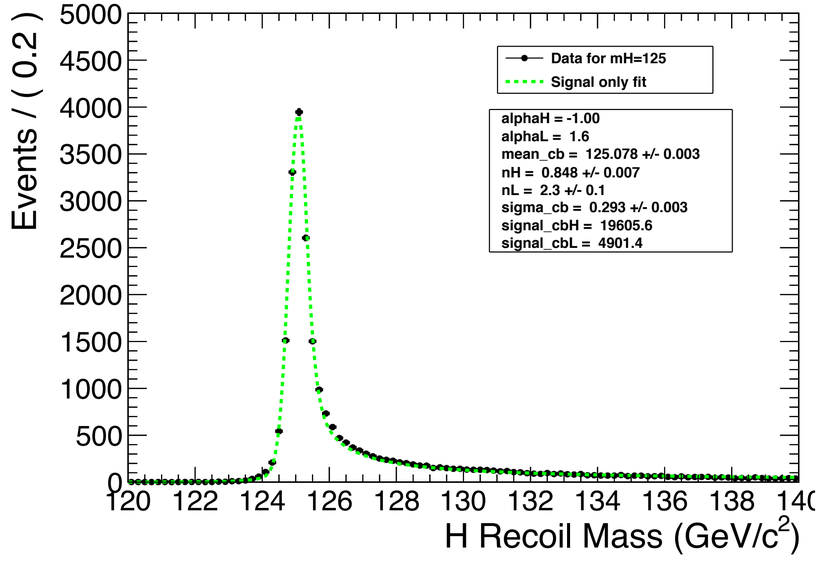
Histograms are fitted with a double sided crystal ball

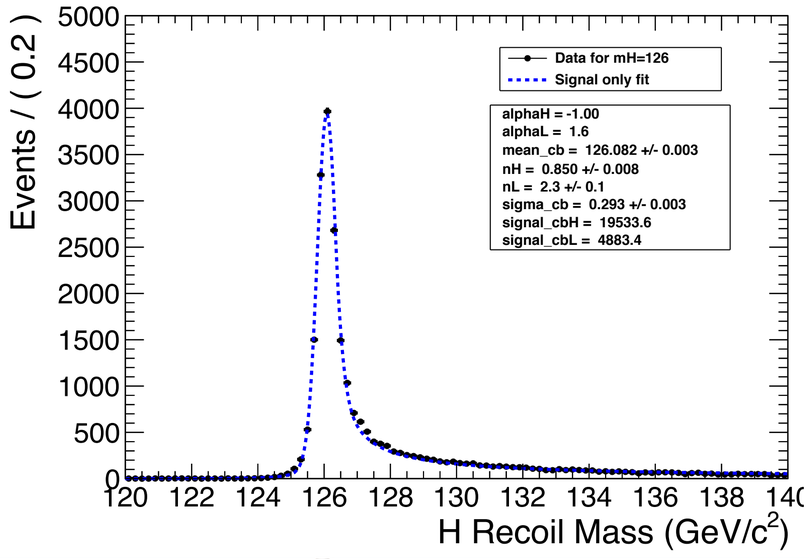
No evident difference in shape is observed

→ Assume for the time being that the signal shape has NO dependence on the Higgs

→ Thorough check is needed: one might have to introduce a dependence of the signal shape







NLL VS MH

Assuming NO shape dependency for the signal samples but only a dependency of the cross-section on the Higgs mass:

→ Signal yields are obtained for Higgs mass in a range $[120 \div 130]$ using the cross section calculated in Pythia8

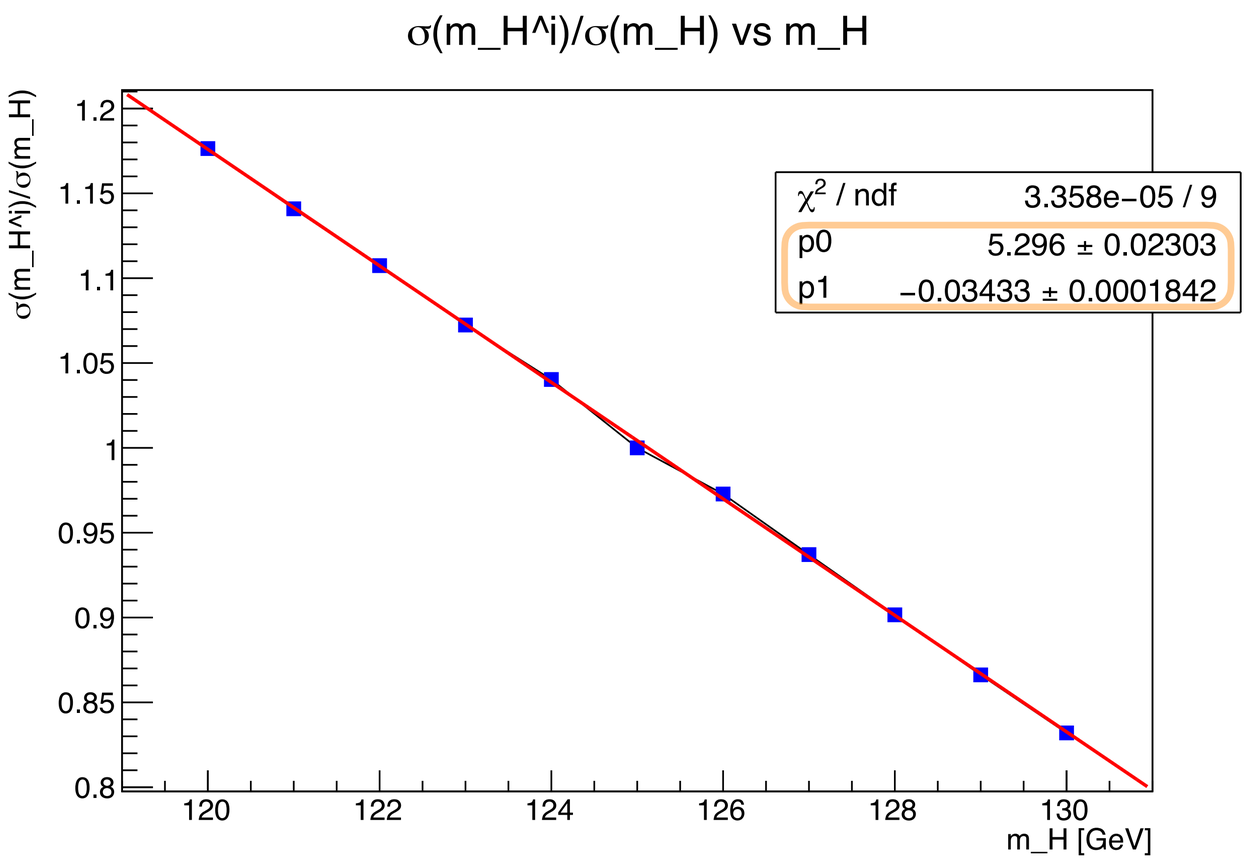
Higgs Mass	Estimated Cross-section	Delta [mb]	HZ yield $\in [120 \div 130]$
M_H=120	7.678×10^{-12} mb	$\pm 9.61 \times 10^{-15}$	19580
M_H=121	7.446×10^{-12} mb	$\pm 9.339 \times 10^{-15}$	25333
M_H=122	7.227×10^{-12} mb	$\pm 9.054 \times 10^{-15}$	24297
M_H=123	6.999×10^{-12} mb	$\pm 8.743 \times 10^{-15}$	22990
M_H=124	6.789×10^{-12} mb	$\pm 8.348 \times 10^{-15}$	22005
M_H=125	6.5262×10^{-12} mb	$\pm 8.049 \times 10^{-15}$	20627
M_H=126	6.349×10^{-12} mb	$\pm 7.805 \times 10^{-15}$	19905
M_H=127	6.116×10^{-12} mb	$\pm 7.508 \times 10^{-15}$	18230
M_H=128	5.884×10^{-12}	$\pm 7.237 \times 10^{-15}$	16371
M_H=129	5.653×10^{-12}	$\pm 6.962 \times 10^{-15}$	14508
M_H=130	5.430×10^{-12} mb	$\pm 6.697 \times 10^{-15}$	8431

Estimated cross sections x BR

$\sigma_{HZ} \cdot BR(Z \to \mu\mu)$

NLL VS MH

Define $\frac{\sigma_{HZ}(m_H^i)}{\sigma_{HZ}(m_H)}$ + fit



Fit obtained using a 1st order polynomial

p0 and p1 are the fit parameters that we introduced in combine to add the POI to the analysis

NLL vs MH:

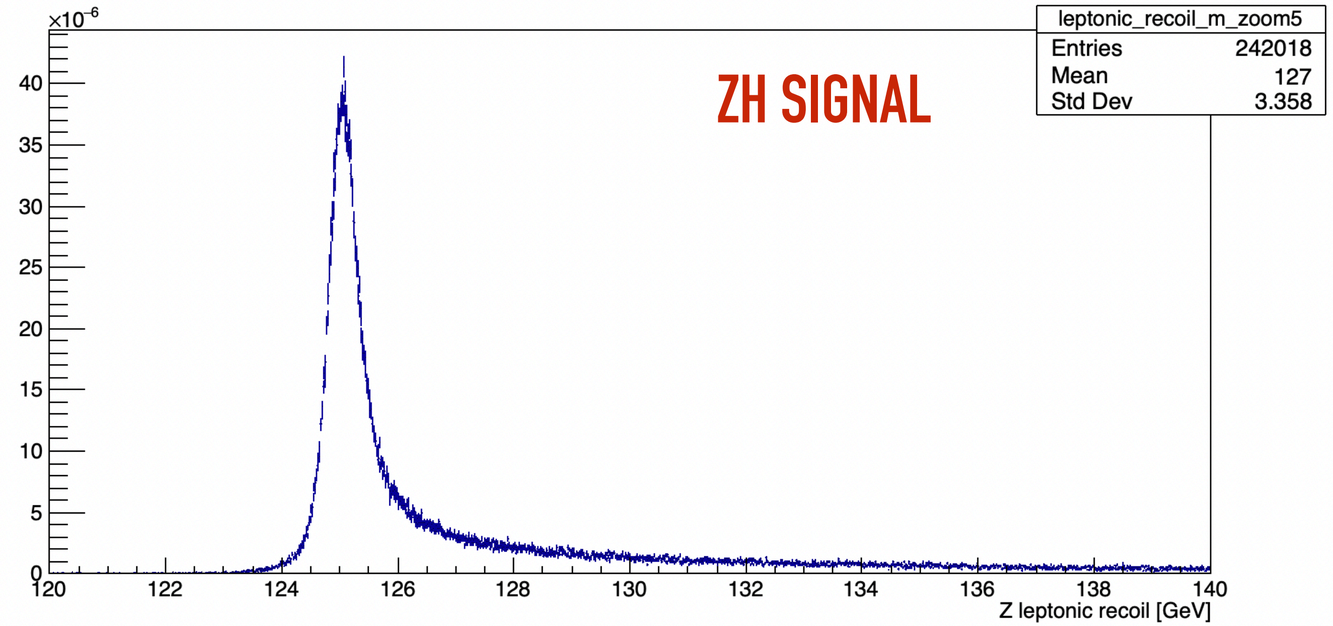
Preliminary results obtained (need to be cross-checked)

EDM4HEP

Analysis of the samples centrally produced in the EDM4HEP output is now working (thanks to Patrizia's instructions)

→ need to perform some checks and thorough validation

http://fcc-physics-events.web.cern.ch/fcc-physics-events/Delphesevents_fccee_tmp.php



CONCLUSIONS

The software for the combine template analysis with shape uncertainty and MH as a POI is READY and is being cross-checked and validated

TO DO NEXT:

- Use the histograms obtained with the FCCAnalyser software in combine
- Adding all the systematic uncertainties
  - Particular focus on the effect of
    - the beam energy spread
    - the uniform magnetic field: how does the fit changes if $\overrightarrow{B}$ is increased to 3T instead of 2T?

THANK YOU