Seperation of H$\rightarrow$ZZ$\rightarrow$4l from the SM ZZ$\rightarrow$4l background

Using multivariate analysis on angular distributions, a work in progress

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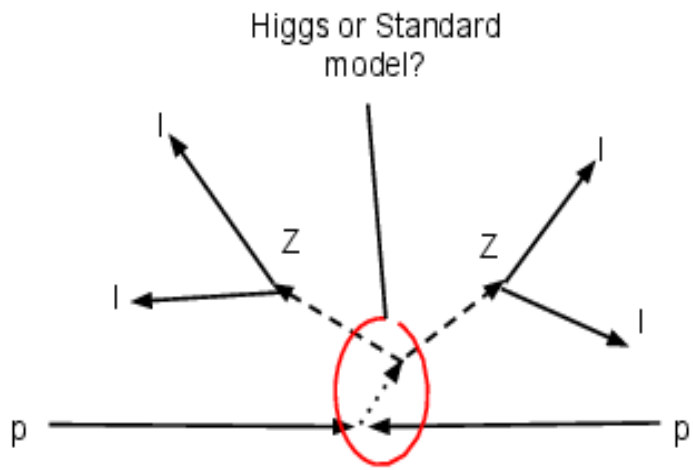
Leptonic ZZ decay of Higgs

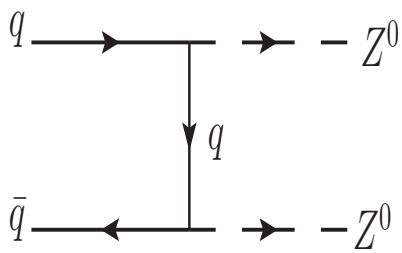
Normal selection cannot distinguish H$\rightarrow$ZZ from SM ZZ.
In light of recent progress, a Higgs mass of $\sim$125GeV will be used throughout the presentation.

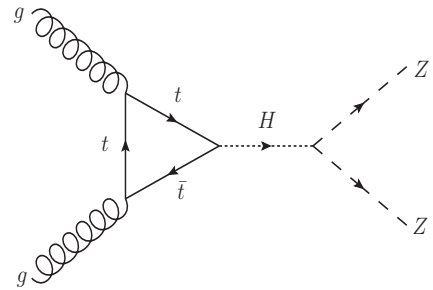
- Some relevant numbers from the ATLAS experiment:
- $\sigma_{H\rightarrow ZZ\rightarrow 2l2l} = 4.6fb$.
- Processed amount of data : 4.8 fb^{-1}.
- Acceptance and efficiency reduces expected number of events.
- Number of candidates, winter 2011: 3.
- $\sigma_{ZZ\rightarrow 2l2l} = 92fb$ (All masses) and $\sim$3fb ($M_{ZZ} \sim 125$GeV).



ZZ production modes

Observing ZZ dibosons can we say anything of the probability of these being SM-like or Higgs-like?





- SM ZZ production
- Total angular momentum $\neq 0$ in general.

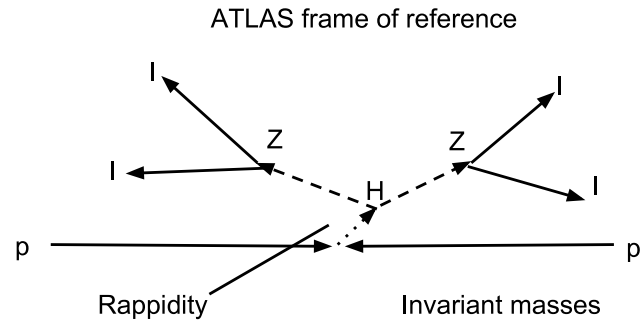
- Higgs ZZ decay channel
- Total angular momentum = 0
- Cross section of gg fusion (shown) is around 10 times that of VBF

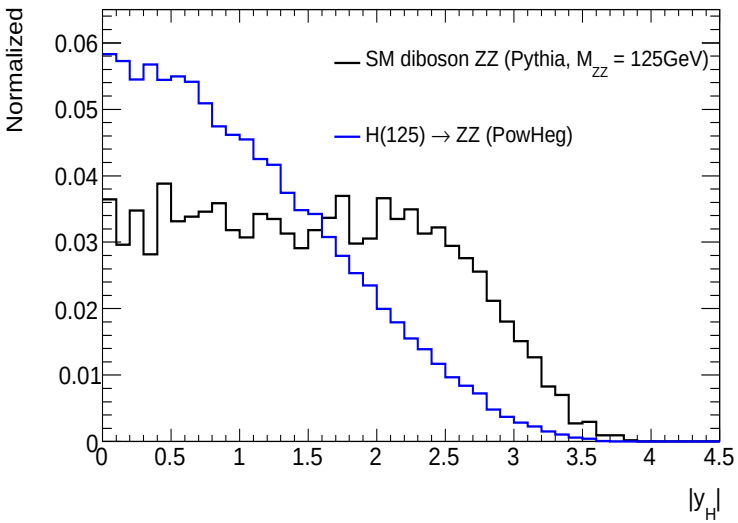
- Different leading order Feynman diagrams gives insight into differences
- Variables used for seperation should express differences in spin effects of the two event types.

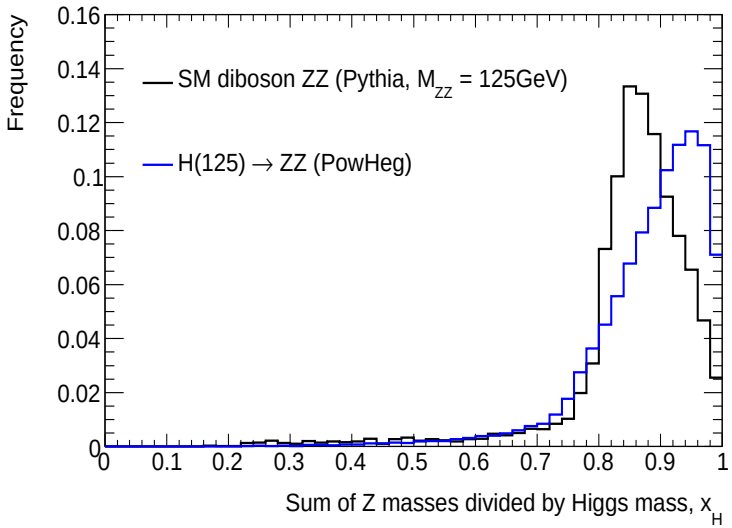
Seperation variables

Variables used in detector frame of reference.

- Rappidity of Higgs candidate.
- Amount of Higgs mass contributing to the sum of the two Z masses : $x_H = \frac{M_{l0l1}+M_{l2l3}}{M_{l0l1l2l3}}$



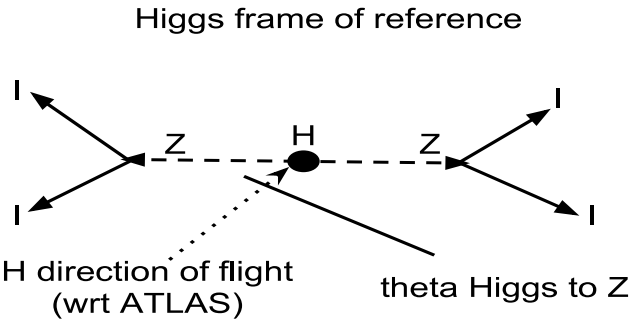


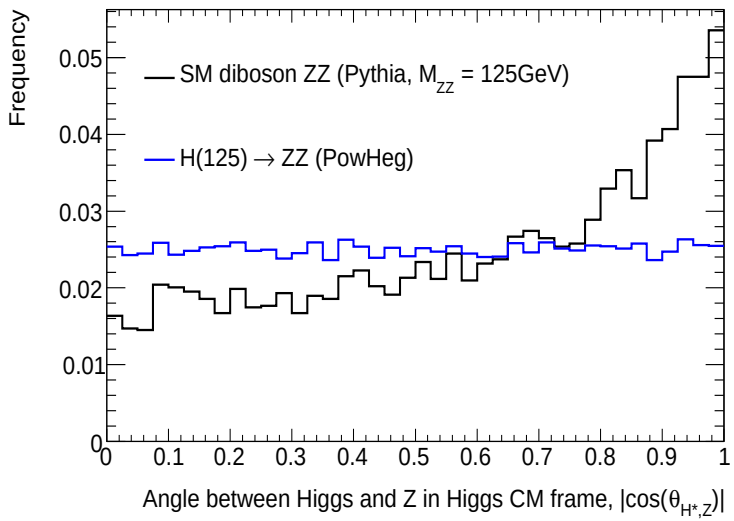


Seperation variables

Variables used in Higgs frame of reference.

- Angle between one Z boson and higgs direction of flight (taken from detector frame)

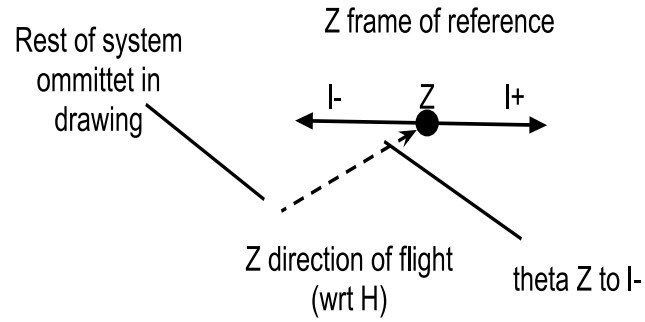


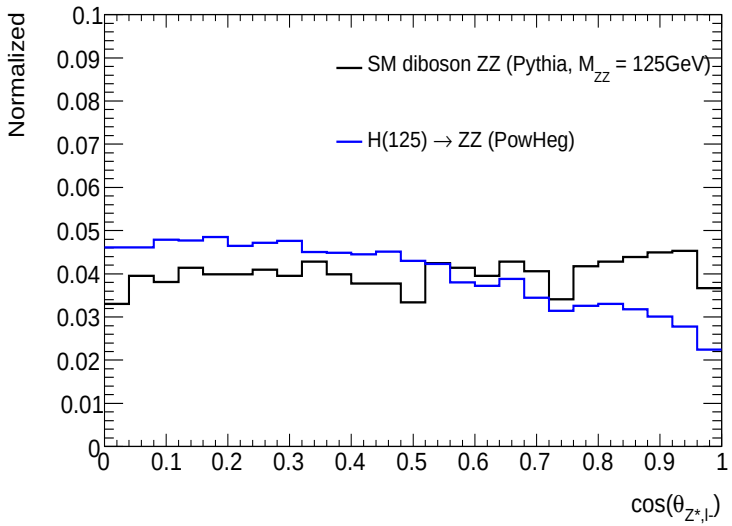


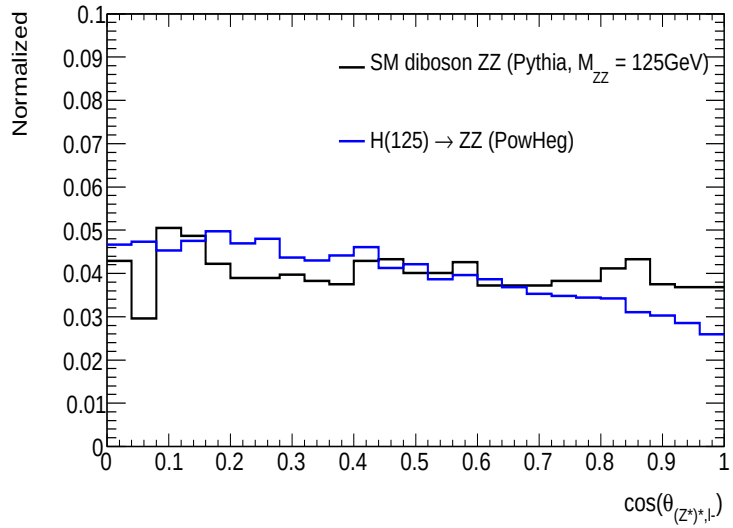
Seperation variables

Variables used in Z-boson frame of reference.

- Angle between negatively charged lepton and Z direction of flight (taken from Higgs frame)

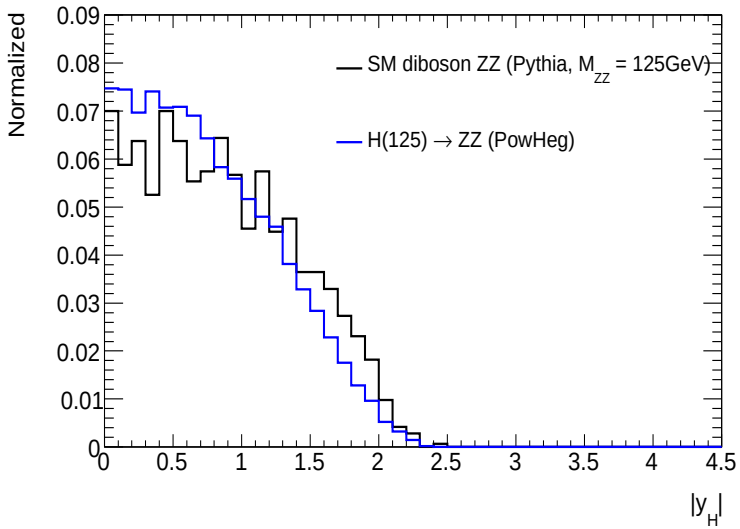


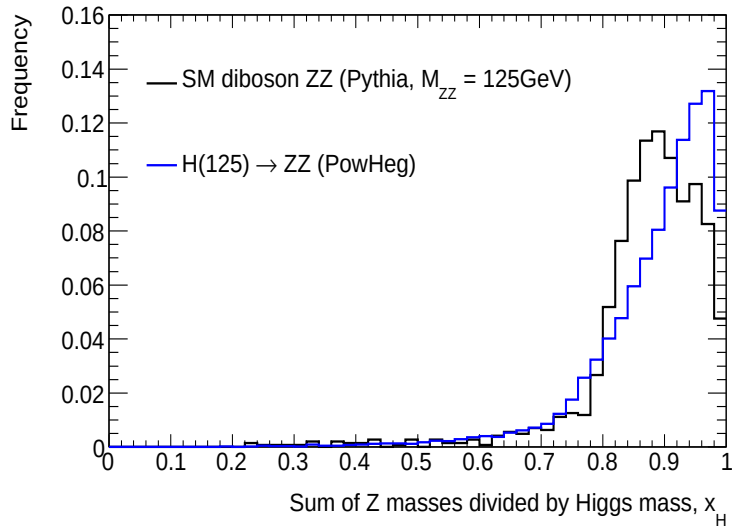


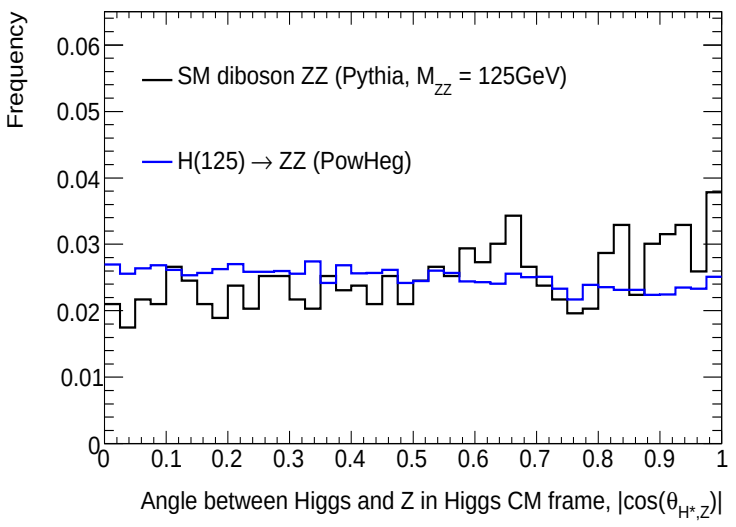


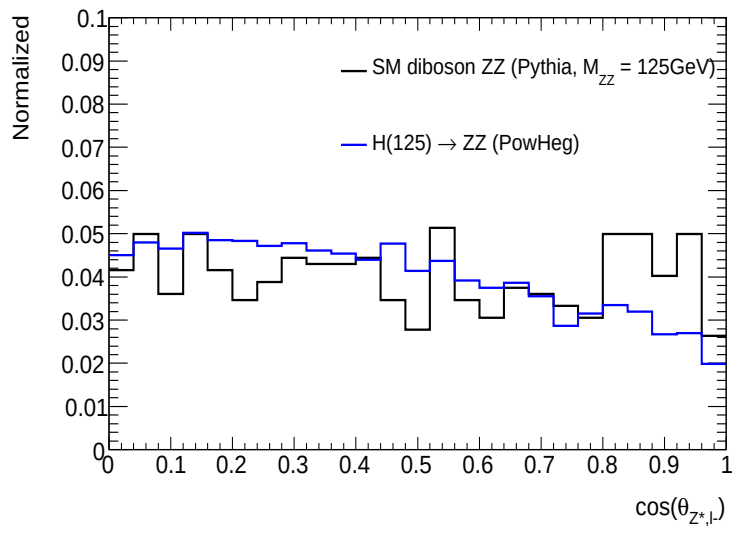
Bad news

Even ATLAS has a finite fiducial volume.



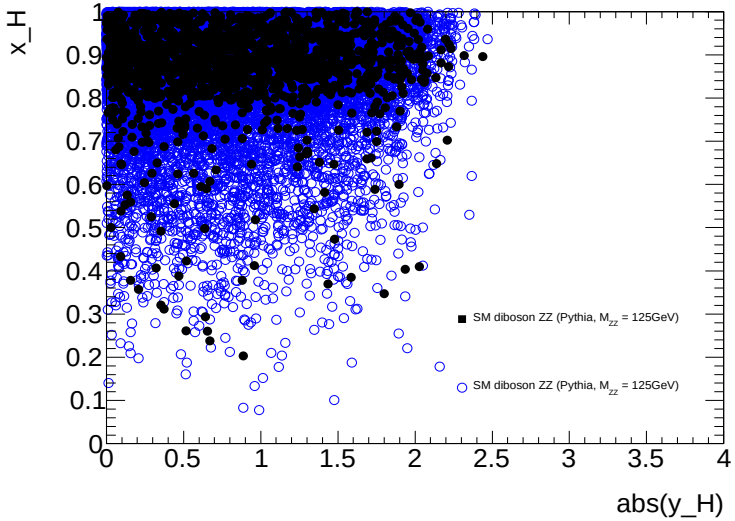


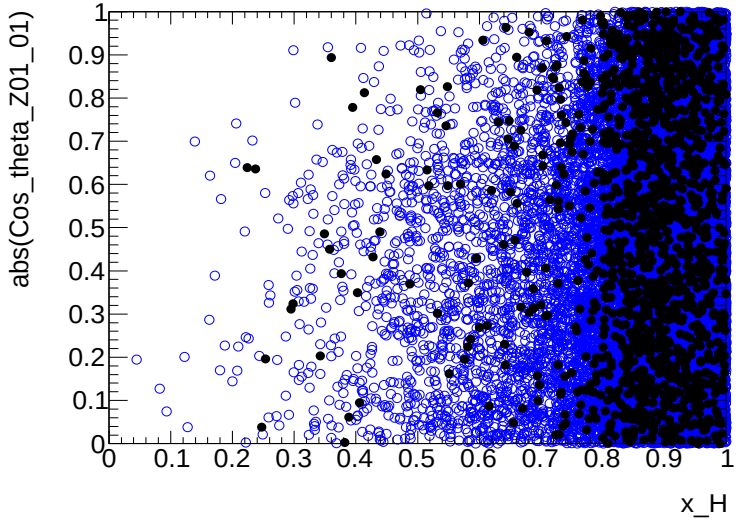


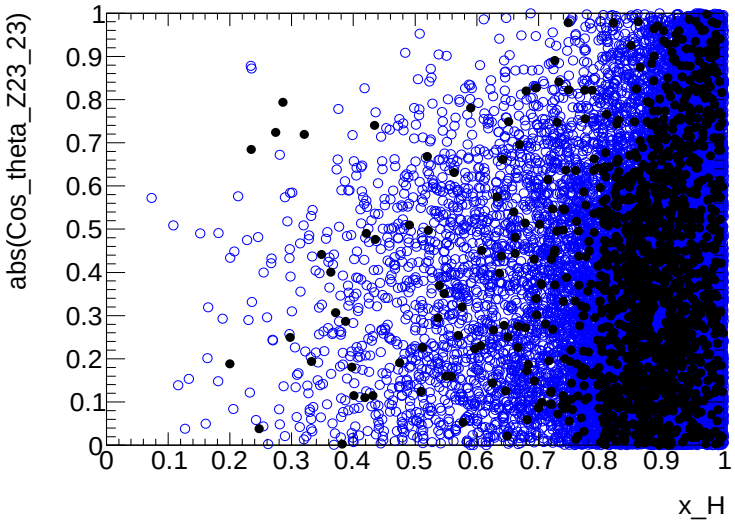


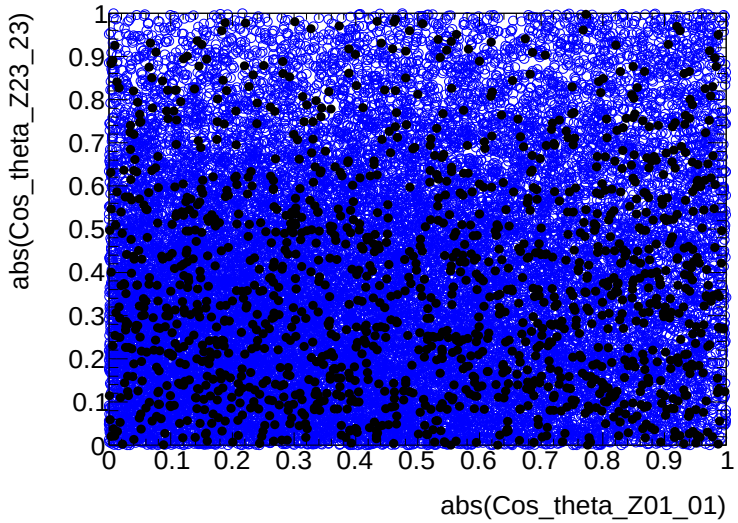
Good news

1D projections of variables does not present the full power of seperation.
Moreover the analysis is mostly sensitive to measured angles and not momenta.



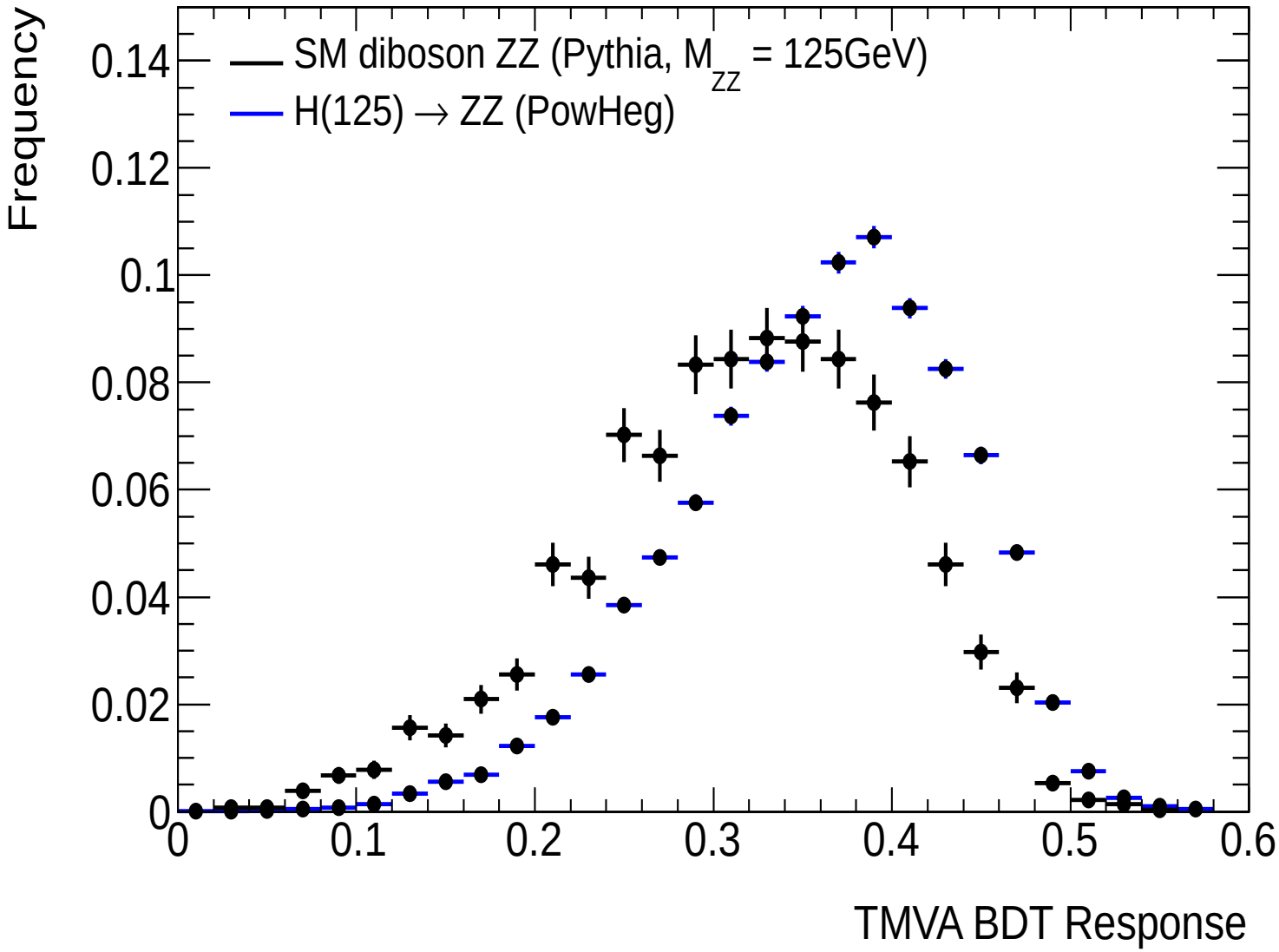






Results

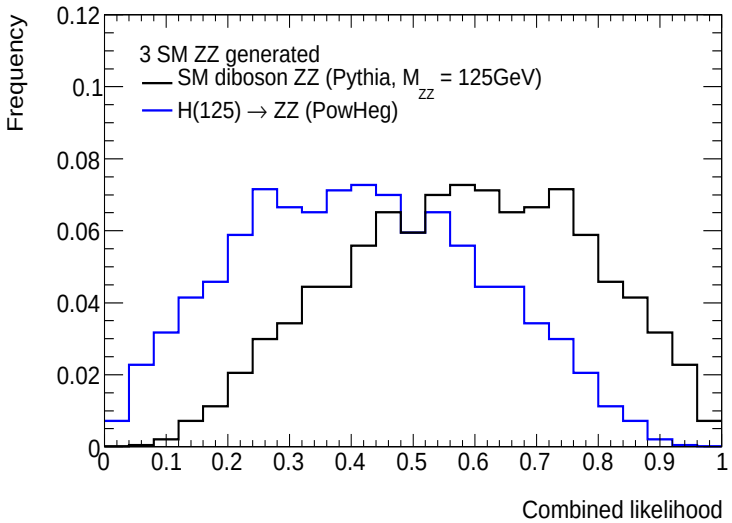
Using variables as input in a boosted decision tree we get the final distribution:

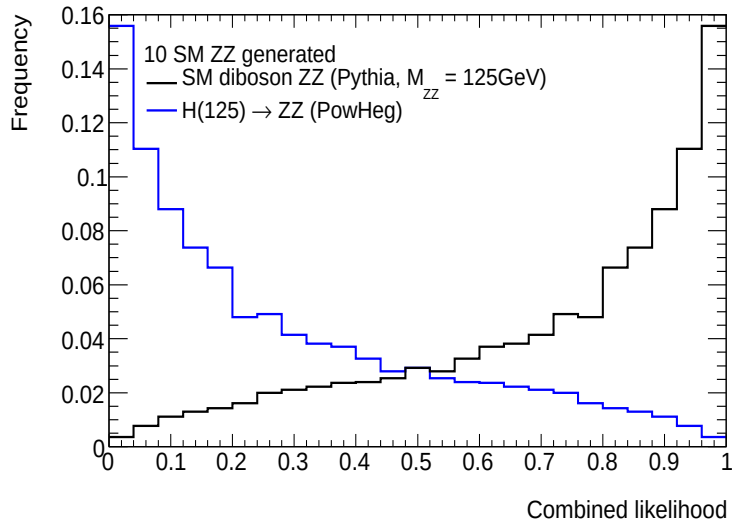


Conclusion + Outlook

Eventhough poorly, it is possible to seperate a potential Higgs signal from the standard model diboson background.

- Cut based seperation would yield zero seperation.
- Better statistics of the SM ZZ background could lead to better training.
- Stability of result should be checked using VBF and different generators.





Backup slides