ZH analysis with Higgs to hadron & Z invisible at FCC-ee detector performance studies

IDEA physics and software meeting

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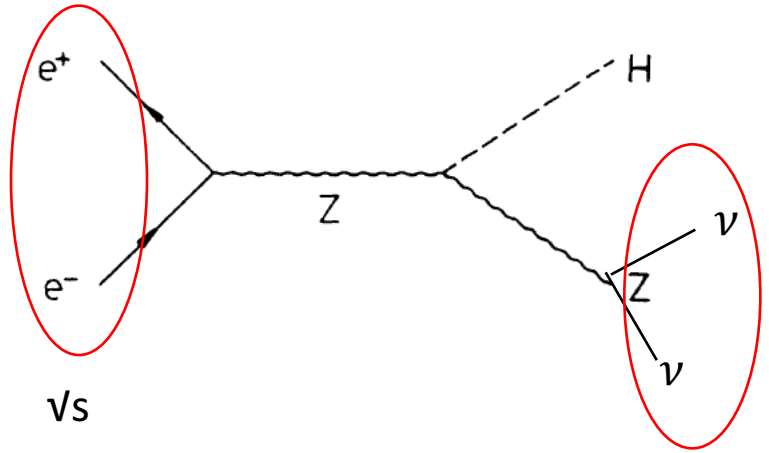
Overview

Aim: study which detector design maximizes expected precision for H → gg, bb, cc , ss final states ?

Signal: e+ e- → Z H → $\nu\,\nu$ + Jets



Signal extraction: peak at Higgs mass (reconstructed from jets), recoil mass distribution around Z peak **. Peak width dominated by detector resolution**.

Need: Precise energy measurement and excellent resolution

Monte Carlo Campaign:

- Center of mass energy 240 GeV, luminosity 5 ab^{-1}
- nominal Higgs mass 125.00 GeV
- Signal generated by Pythia (100 K events)
- IDEA detector response modelled with Delphes => **with different IDEA detector configurations**

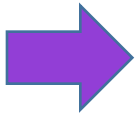
Signal samples:

- ZH(bb)
- ZH(cc)
- ZH(gg)
- ZH(qq)

HCAL Energy Resolution

1- HCAL energy resolution:

$$\frac{\sigma}{E} = \frac{s}{\sqrt{E}} \oplus \frac{b}{E} \oplus c$$



Resolution improves with energy

- **S** : is the stochastic or "sampling" term, related to statistic fluctuations in the signal.
- **b** : is the "noise" term, related to electronics noise, pileup, etc. => Not present in current IDEA base Delphes card
- **C** : is the "constant" term, related to imperfections, non-uniformities, channel-by-channel calibration uncertainties, leakage, dead material.

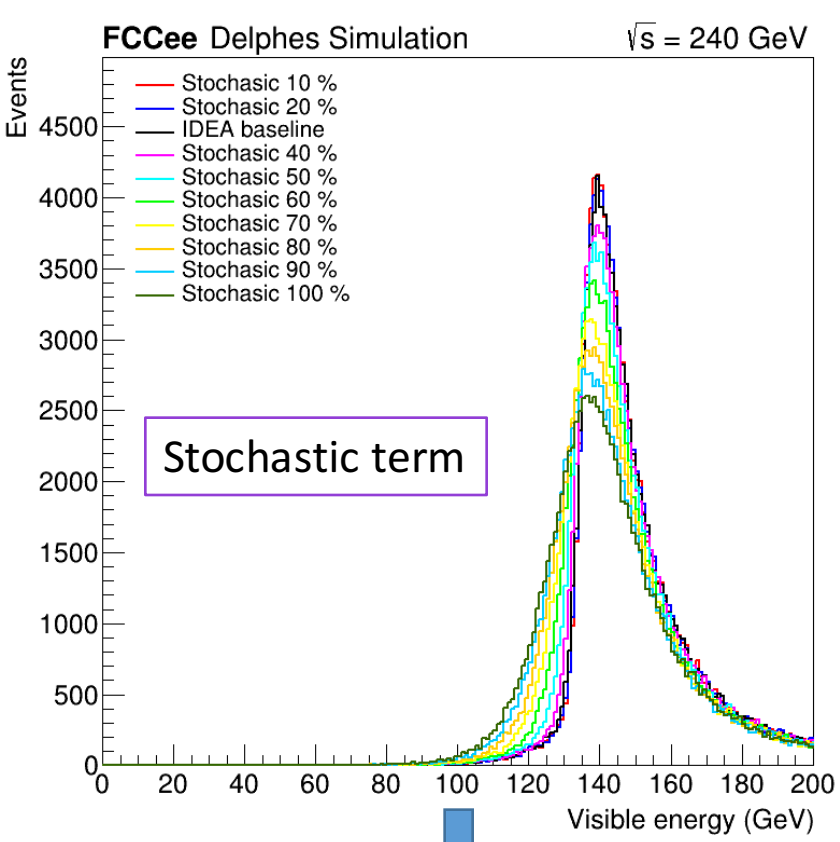
In IDEA Base Delphes card: **Stochastic term 30% , constant term 1% , No noise term.**

- **Goal:** Study the effect of tuning those terms in the visible energy.
- Producing ZH (gg, bb, qq, cc) samples with different values of energy resolution terms.

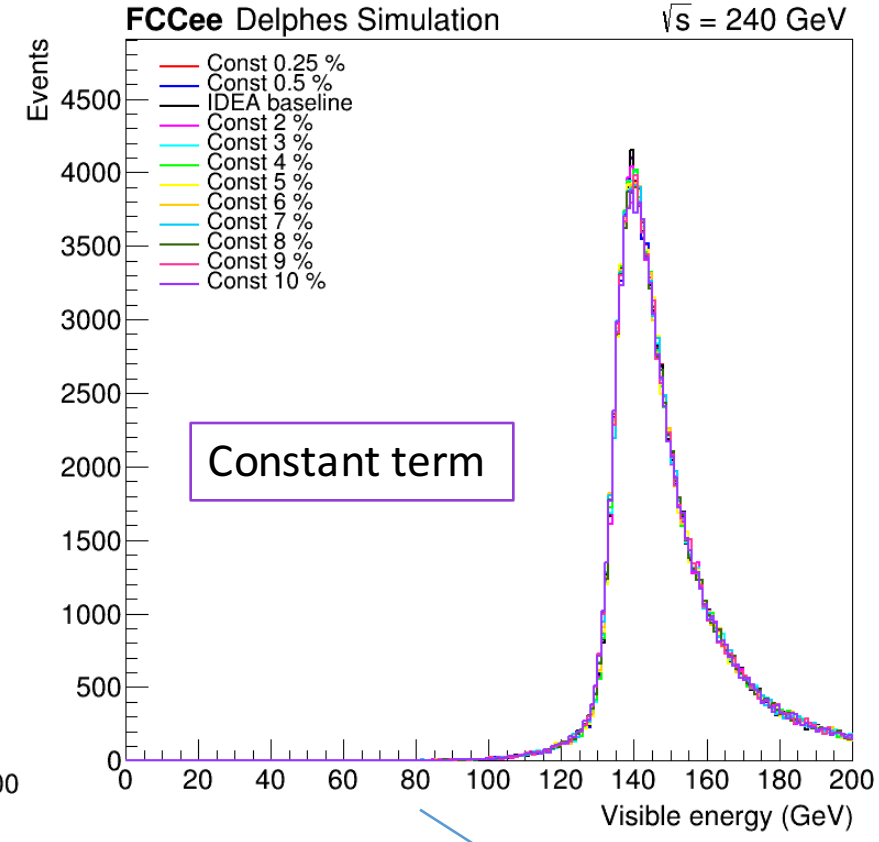
Analysis

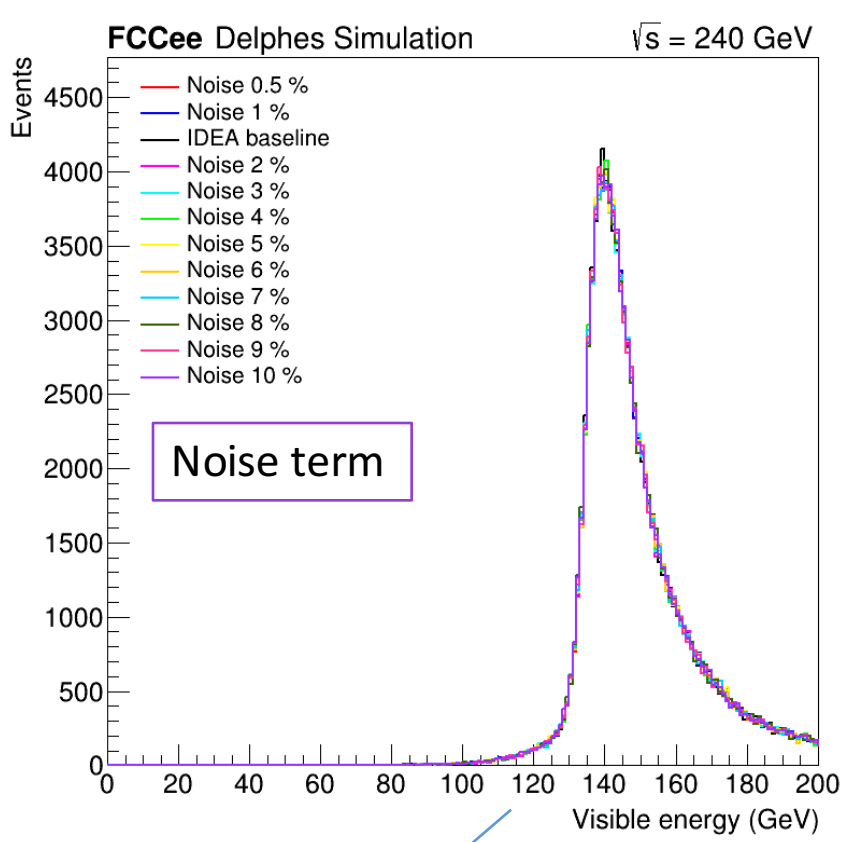
- ZH(gg) signal sample.

- Distribution of PF candidates visible energy



Main contributor



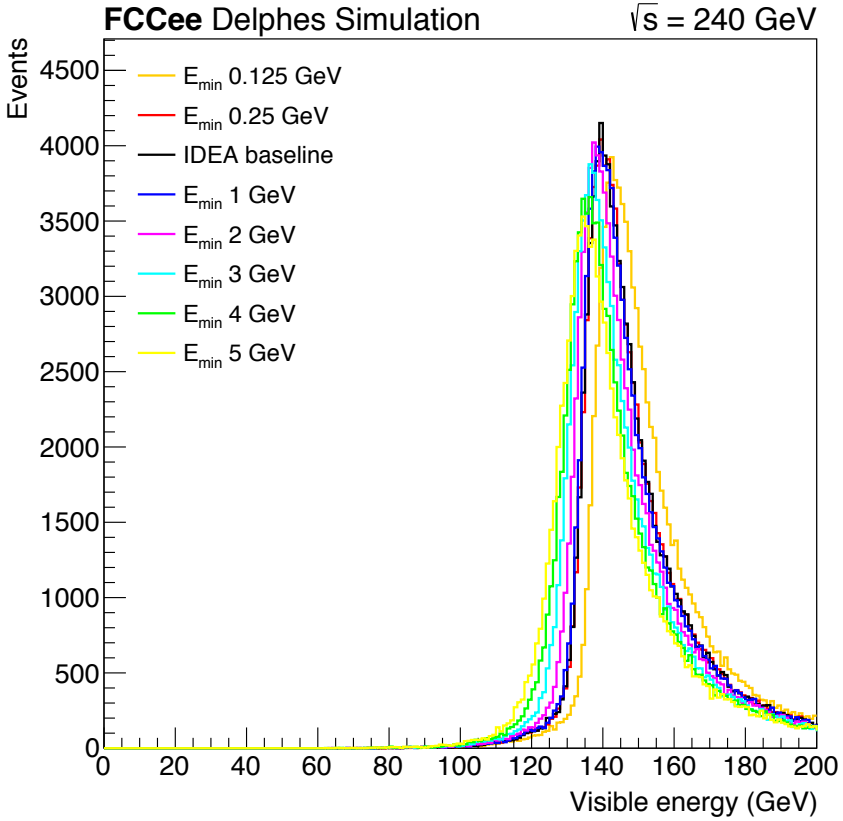


Adding the values with smaller steps

Analysis

2- Energy minimum :

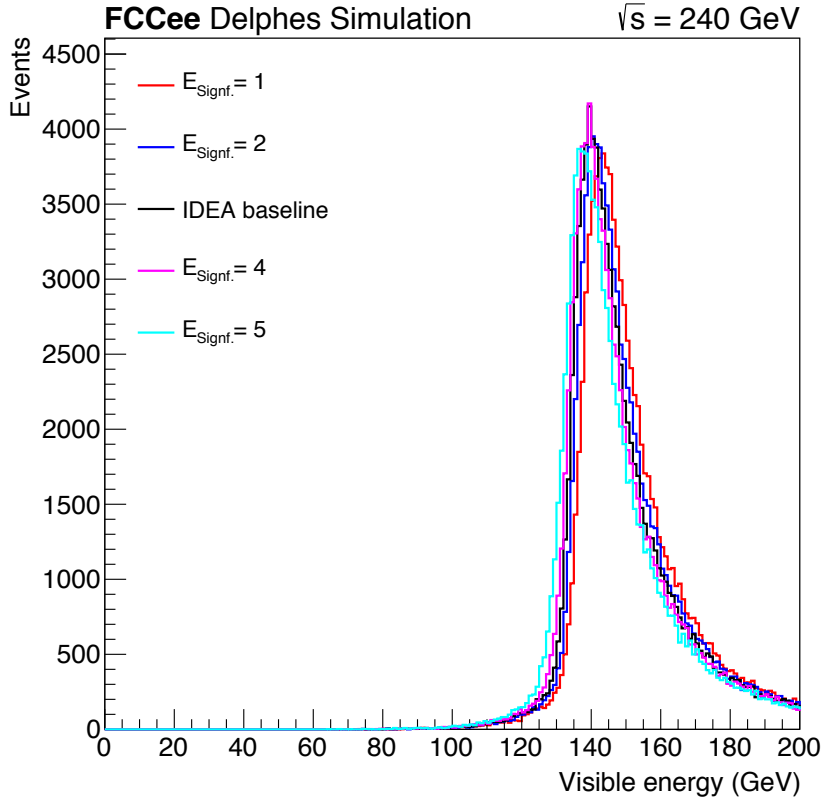
In IDEA Base card : Energy min = 0.5 GeV



Adding low values

2- Energy Significance :

In IDEA Base card : Energy Sig. = 3



Ongoing /Next step

1- Understanding the source of the tail in the distributions

2- From the curves, get the relation between the resolution and different tuning parameters.

3- Tune Delphes HCAL energy resolution parameters and include Noise term.

4- Tune the minimum energy threshold.

5- study calorimeter granularity impact (visible mass vs visible energy)