

Update on Higgs mass

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Higgs/Top Performance meeting - May 13 2024



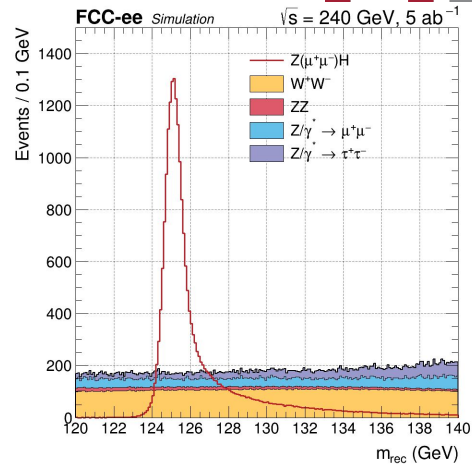


Recap Higgs Mass at 240 GeV

Higgs mass extracted from fitting recoil distribution

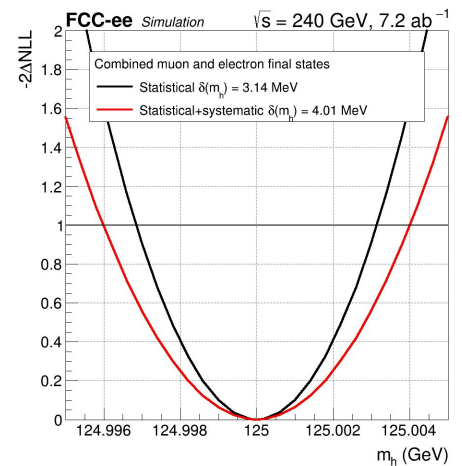
$$M_{recoil}^2 = (\sqrt{s} - E_{l\bar{l}})^2 - p_{l\bar{l}}^2 = s - 2E_{l\bar{l}}\sqrt{s} + m_{l\bar{l}}^2$$

- Muon and electron final states
- Tight event selection (follow closely the ZH cross-section selection)
- Categorize in central and forward regions to probe different material budget
 - In total 3 categories: central, forward, central+forward



Simultaneous fit over all the 6 categories (2 flavor, 3 angular categories)

- Statistical only: 3.14 MeV
- Stat+Syst: 4.01 MeV

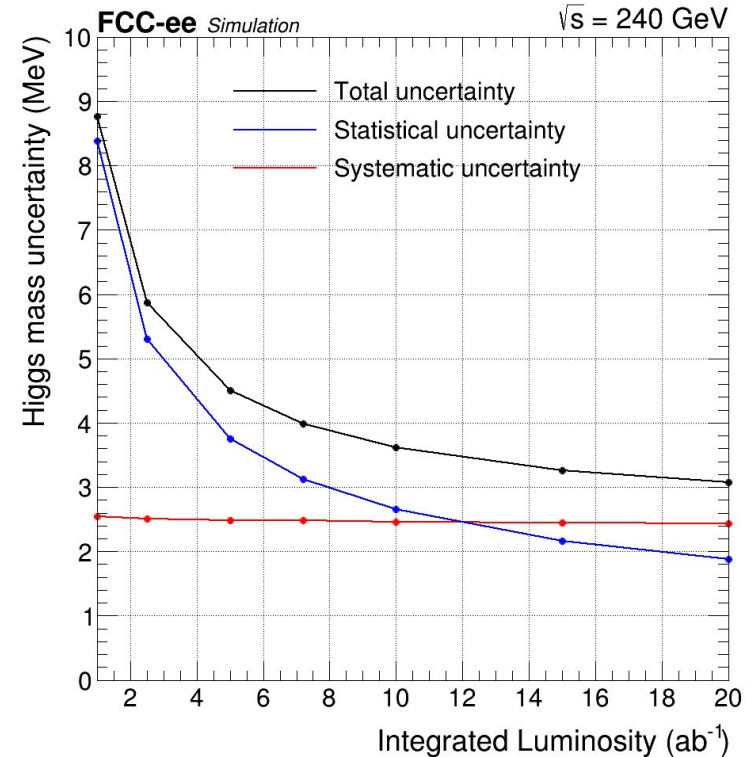




Uncertainty vs. Integrated Luminosity

With 7.2 ab^{-1} , the analysis is statistically limited

Systematics become dominant over 12 ab^{-1}





Looking at 365 GeV

Reloading the analysis at 365 GeV

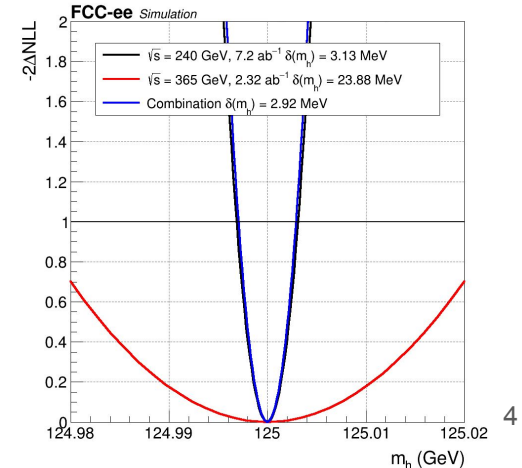
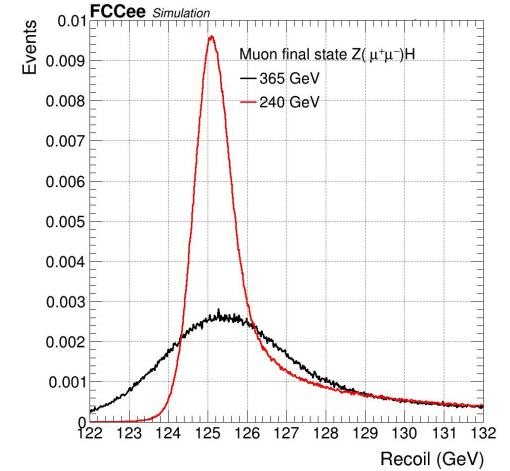
- ZH system more boosted, therefore slightly alter the kinematic cuts
 - $p_T(Z)$ [20, 70] GeV \rightarrow $p_T(Z)$ [50, 150] GeV
- Use same angular categorization, muons and electrons
- Some optimization of the cuts still needed

Results:

- 365 GeV only: 24 MeV uncertainty on Higgs mass
- Combined with 240 GeV brings it down from **3.13 MeV to 2.92 MeV**

Minor impact of 365 GeV

- Reduced statistics
- Broadened recoil distribution





Understanding differences between 240 and 365

Beam energy spread

- 240 GeV BES = 0.185% → 222 MeV spread per beam
- 365 GeV BES = 0.221% → 403 MeV spread per beam
- **Limited by the machine**

Initial State Radiation

- At 365 the system is more boosted
- Higher ISR broadens the recoil distribution due to reduced \sqrt{s}
- **ISR recovery with forward photon tagging? (investigating)**

$$M_{recoil}^2 = (\sqrt{s} - E_{l\bar{l}})^2 - p_{l\bar{l}}^2 = s - 2E_{l\bar{l}}\sqrt{s} + m_{l\bar{l}}^2$$

Lepton momentum resolution

- At 365 GeV, leptons have higher momenta → higher resolution
 - 240 GeV → 80 MeV per muon
 - 365 GeV → 150 MeV per muon
- **Detector requirements? But less dominant effect**

