m_H from the ZH threshold cross section

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WW threshold lineshape

arXiv:1703.01626
arXiv:1909.12245

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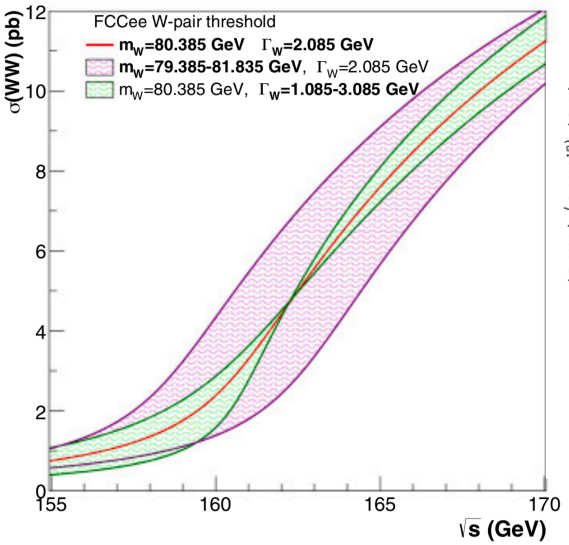
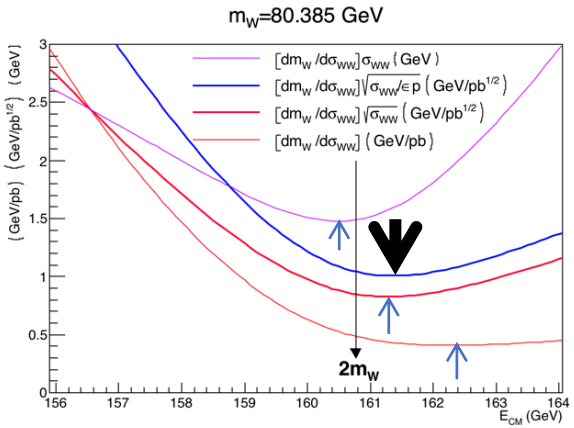
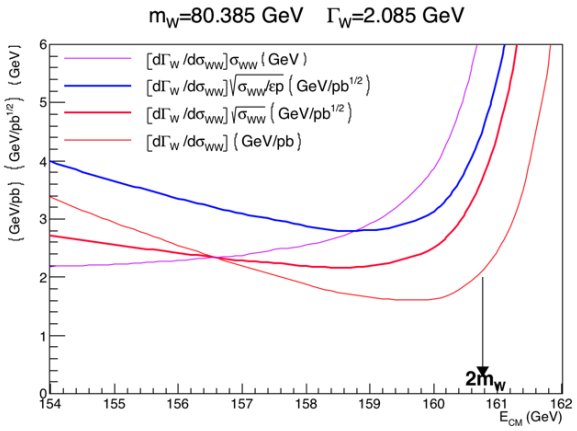




5/ab**@157.3** GeV
+7/ab@**162.6** GeV

Δm_W=0.5 MeV **$\Delta\Gamma_W$=1.2 MeV**

$(dm_W/d\sigma_{WW})_{min}$=0.5MeV/fb



need syst control on :

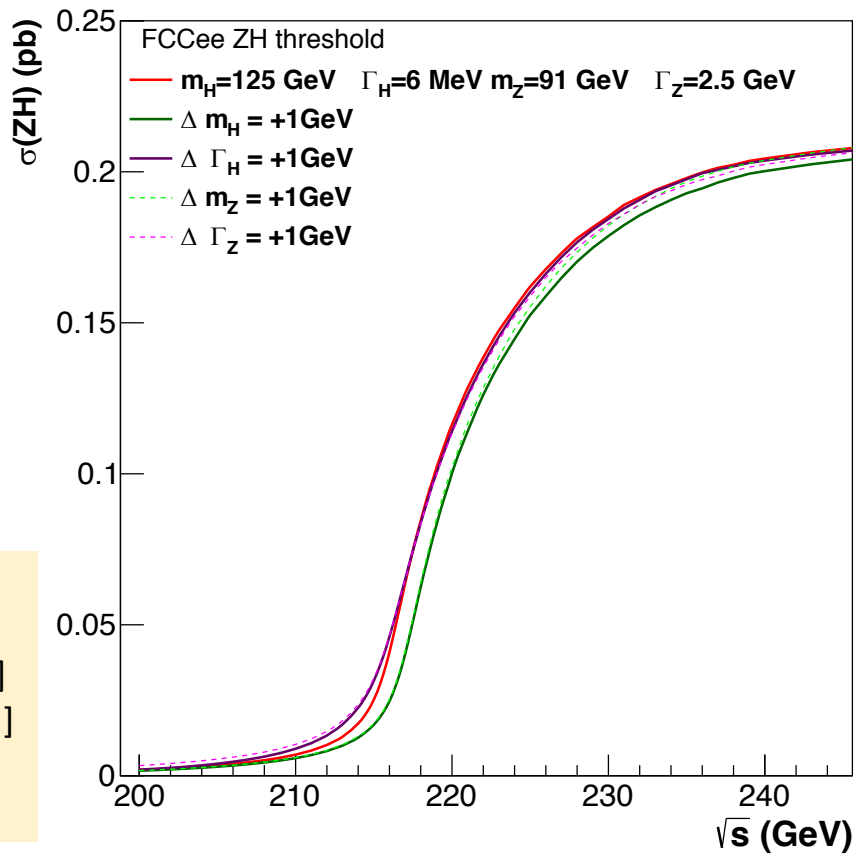
- ΔE(beam)<0.5 MeV (**6x10^{-6}**)
- Δε/ε, ΔL/L < **2 10^{-4}**
- $\Delta\sigma_B$<1 fb (2 **10^{-3}**)

Can we do something similar for mH ?

ZH cross section at threshold

```
                      MG5_aMC_v2_6_7
MadGraph5_aMC@NLO       *
#*                                  *
#*    run as ./bin/mg5_aMC  filename                *
#*                                  *
#*************************************
set default_unset_couplings 99
set group_subprocesses Auto
set ignore_six_quark_processes False
set loop_optimized_output True
set loop_color_flows False
set gauge unitary
set complex_mass_scheme False
set max_npoint_for_channel 0
import model sm
define p = g u c d s u~ c~ d~ s~
define j = g u c d s u~ c~ d~ s~
define l+ = e+ mu+
define l- = e- mu-
define vl = ve vm vt
define vl~ = ve~ vm~ vt~
generate  e+ e- > z h , z > all all , h > all all
```

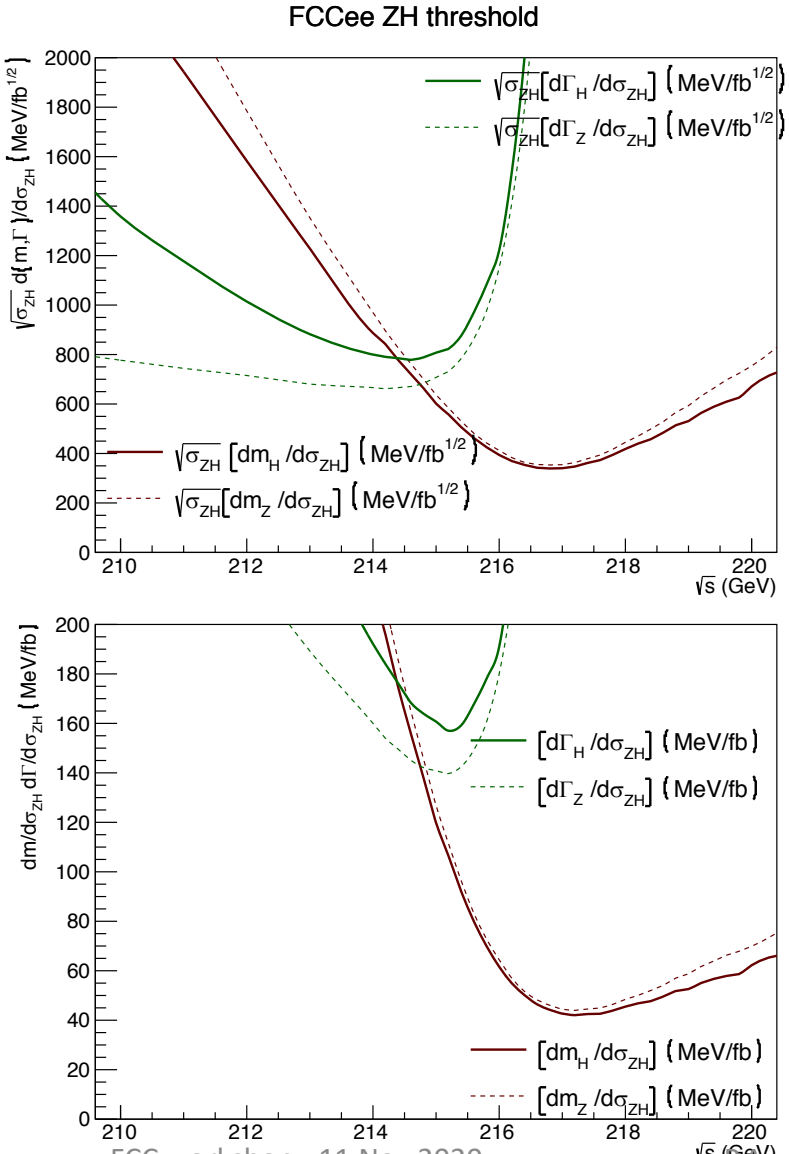
```
launch
 madspin=OFF
 set mh scan1:[125, … ]
 set wh scan1:[6e-3, … ]
 set mz scan1:[91,…]
 set wz scan1:[2.5,…]
```



.. and run with different E_{CM}s from 200 to 240 GeV

For $\Gamma_{H,Z}$ variations couplings are kept "fixed"

Differential ZH cross section



Optimal data-taking point for min Δm_H(stat)
Is $E_{CM} \simeq m_Z + m_H + 0.6 \sim 217$ GeV

$\sqrt{\sigma_{ZH}}(dm_H/d\sigma_{ZH})_{min}$=350 MeV/$\sqrt{fb}$

With 5/ab ⇒ Δm_H(stat) = 5 MeV
Not including $Q=\sqrt{\sum \varepsilon_i p_i}$ (over all channels)

$(dm_H/d\sigma_{ZH})$=40 MeV/fb

need syst control on :

- ΔE(beam)<5 MeV (**5x10^{-5}**)
- $\Delta\varepsilon/\varepsilon$, $\Delta L/L <$ **10^{-3}**
- $\Delta\sigma_B$<0.1 fb (~**10^{-3}**)

Taking some /ab at $E_{CM} \simeq$214-215GeV (off shell)
should be sensitive to $\Delta\Gamma_H \simeq$40 MeV

⟹ *not very interesting*

Summary

- Very first look at extracting m_H from the ZH threshold **σ** (as m_w from σ_{WW})
- Not-as-good sensitivity /ab (1→10 MeV/ /√ab)
  - Lower ZH cross section
  - Less sharp σ rise in ZH
- With 2-5/ab **@217 GeV** could obtain **Δ**m_H(stat) = 6-10 MeV
- Could be combined with similar **Δ**m_H from ZH kinematic (recoil) methods @240 GeV