

Higgs Production and Decays at LHC

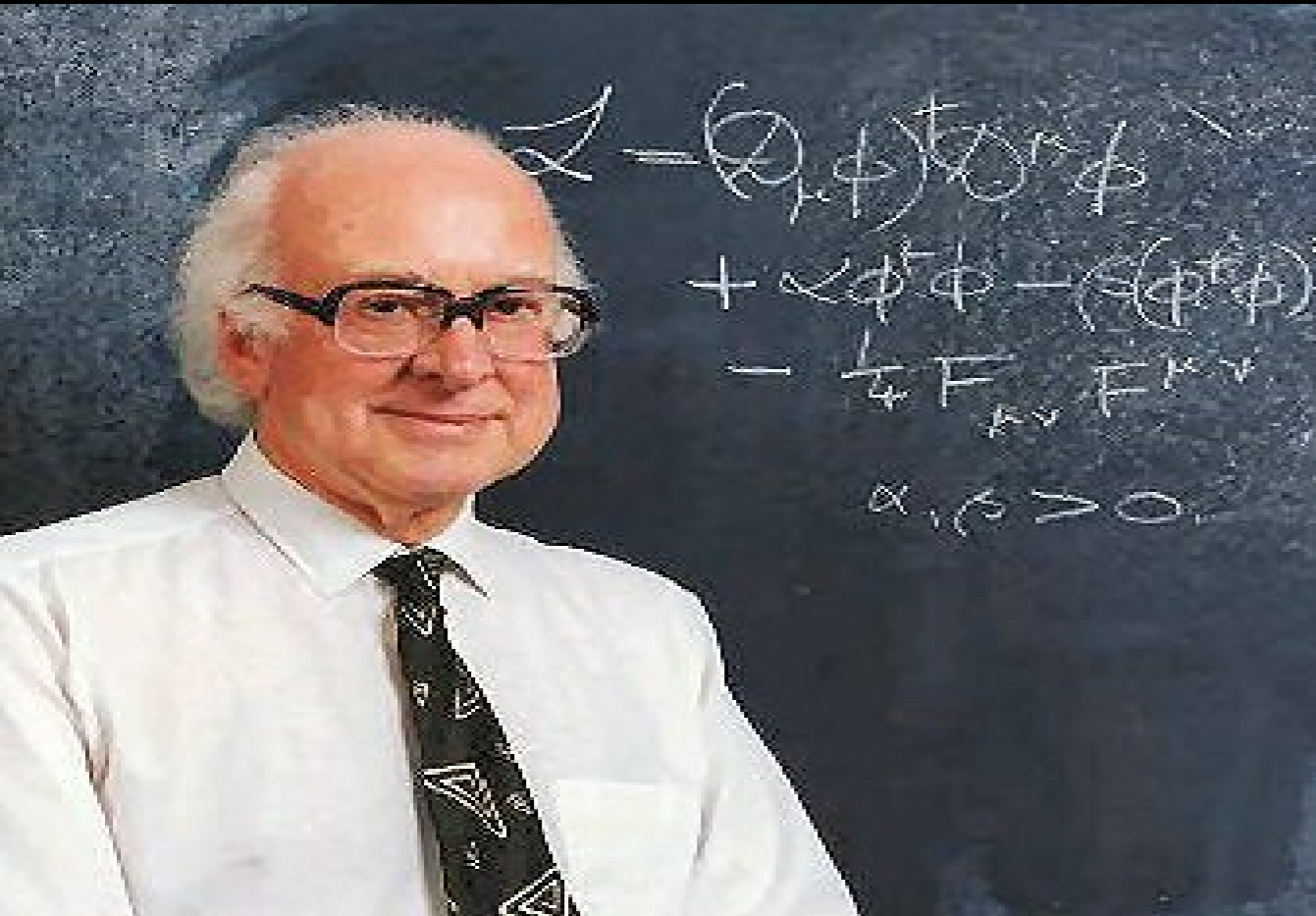
One Day Workshop on LHC Physics
with Emphasis on Higgs

Maryam Zeinali

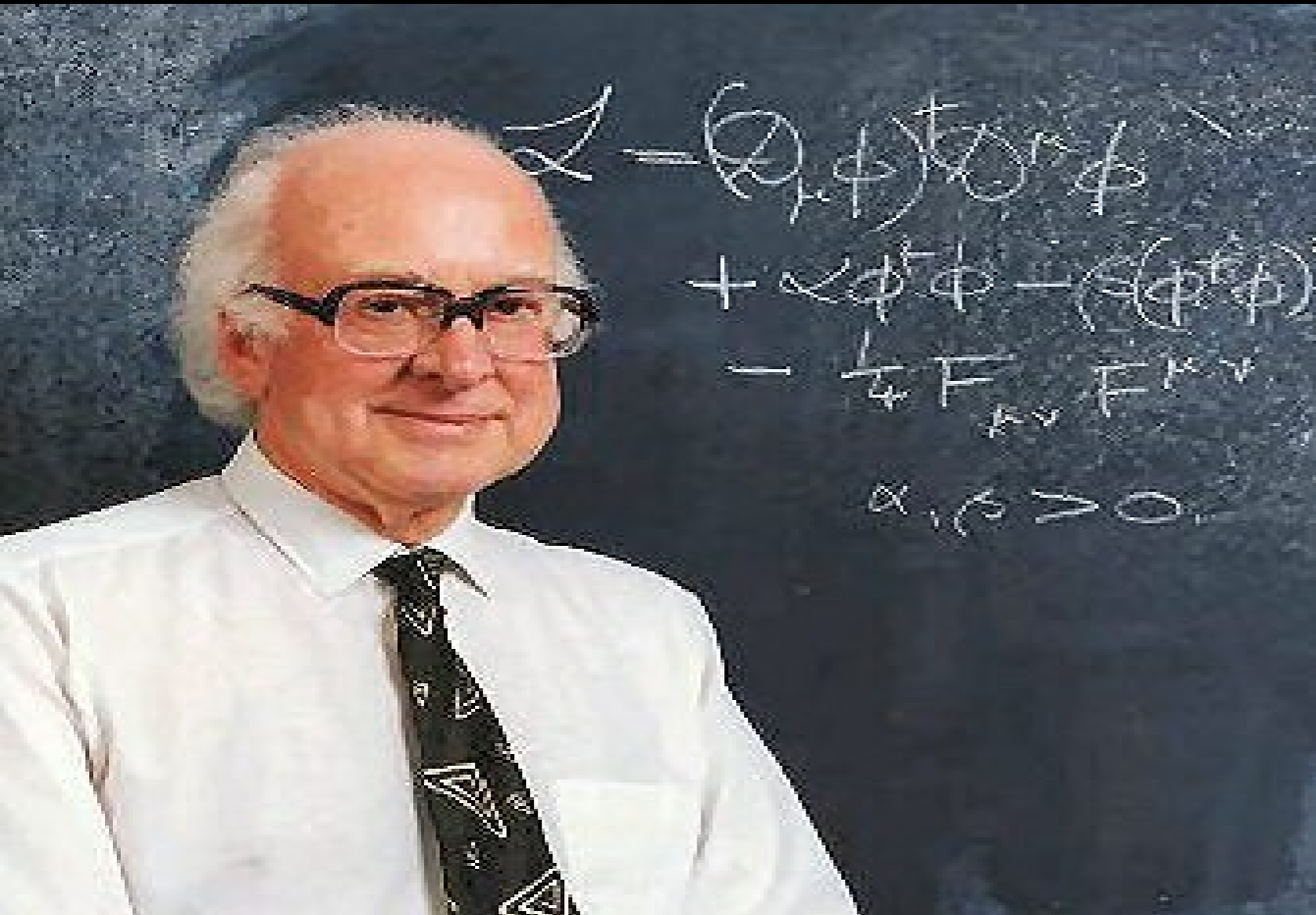
School of Particles and Accelerators

Wednesday, 11 July 2012

And now Higgs shows up...



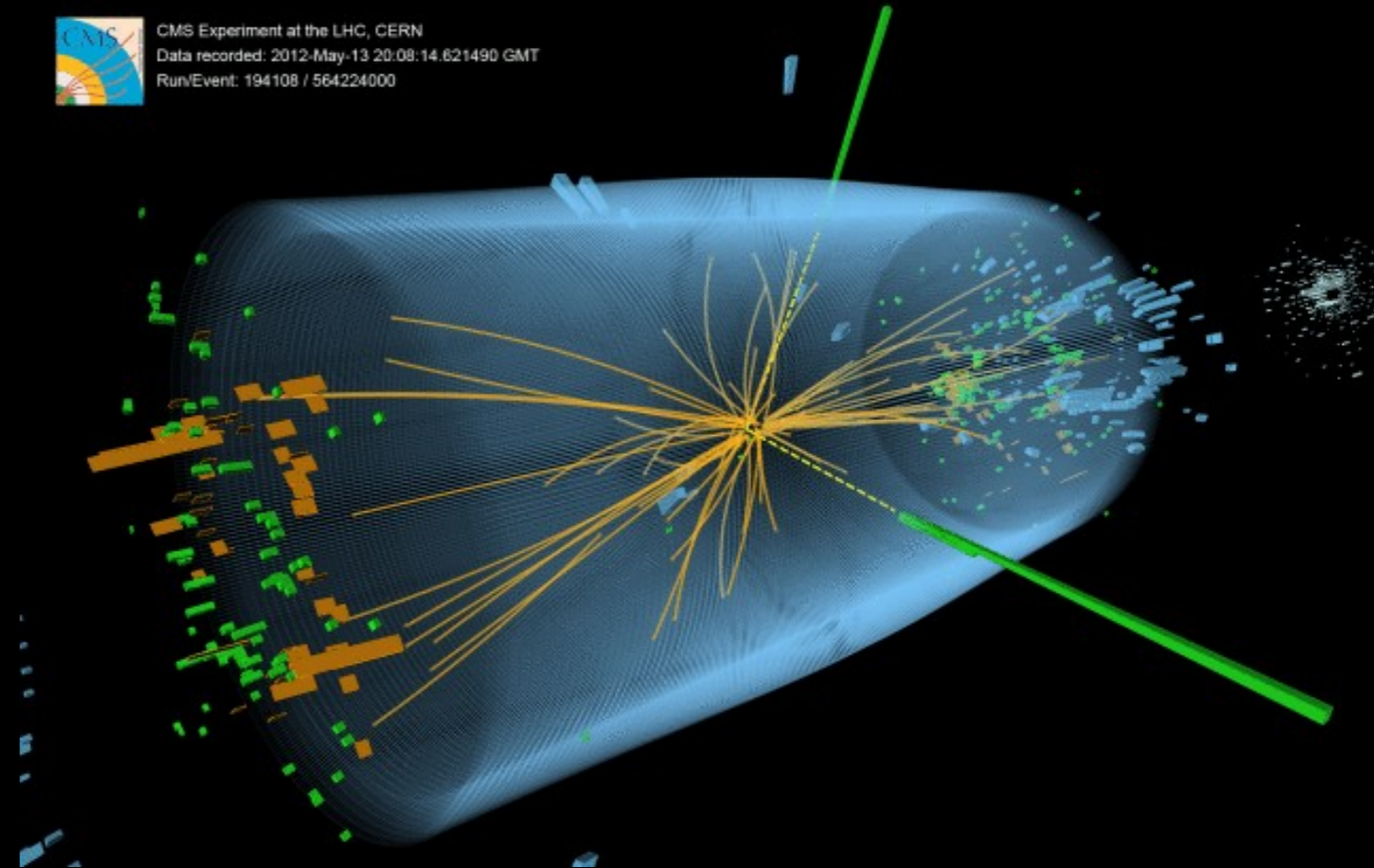
And now Higgs shows up...



A real Higgs candidate!



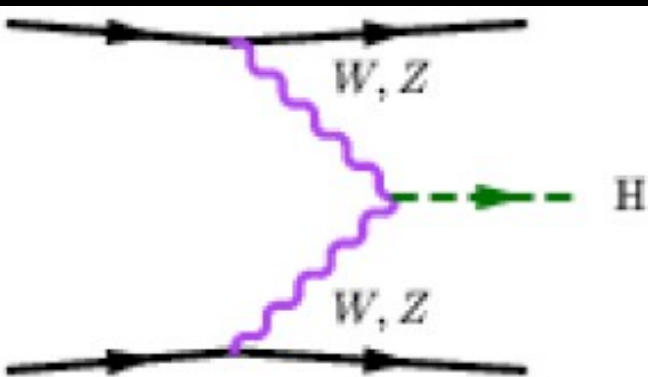
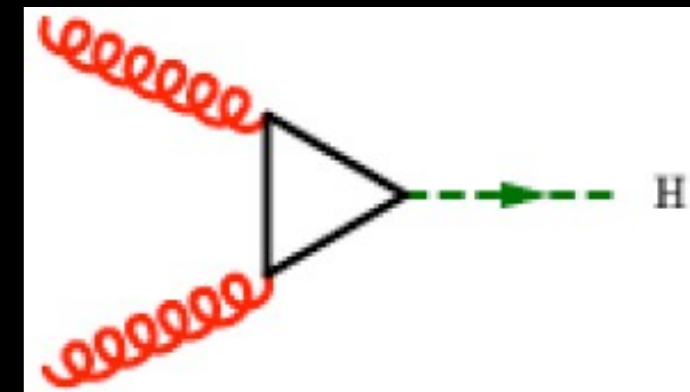
CMS Experiment at the LHC, CERN
Data recorded: 2012-May-13 20:08:14.621490 GMT
Run/Event: 194108 / 564224000



Higgs Production Channels:

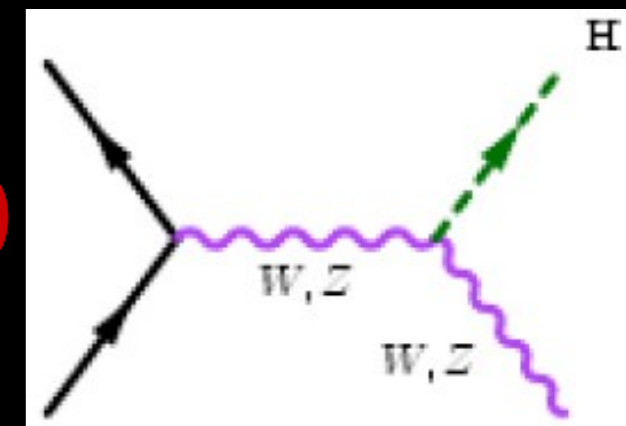
- **gluon fusion($gg \rightarrow H$)**

- ◆ Largest rate over whole mass range
- ◆ Proportional to the top Yukawa coupling



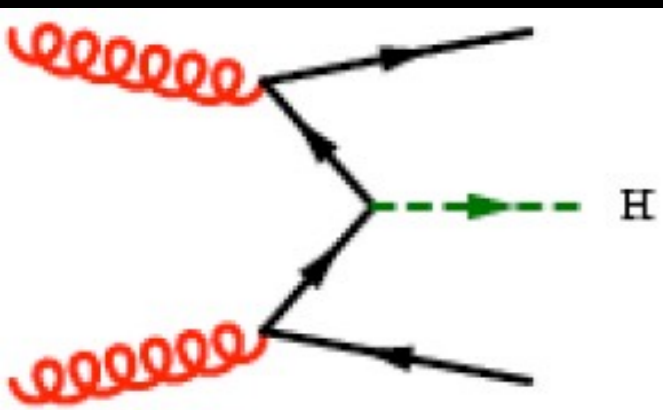
- **weak-boson fusion($qq \rightarrow qqH$)**

- ◆ Next largest rate over whole mass range
- ◆ Proportional to the WWH/ZZH coupling



- **Higgs-strahlung($qq \rightarrow W/ZH$)**

- ◆ Third largest rate
- ◆ Proportional to the WWH/ZZH coupling



- **$tt\bar{t}$ associated($gg \rightarrow ttH$)**

- ◆ Same initial state as in gluon fusion
- ◆ Proportional to the top Yukawa coupling

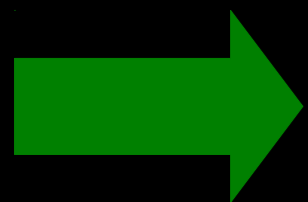
Higgs Production Channels:

● gluon fusion is the most dominant production channel due to the Parton Distribution Functions(PDF)

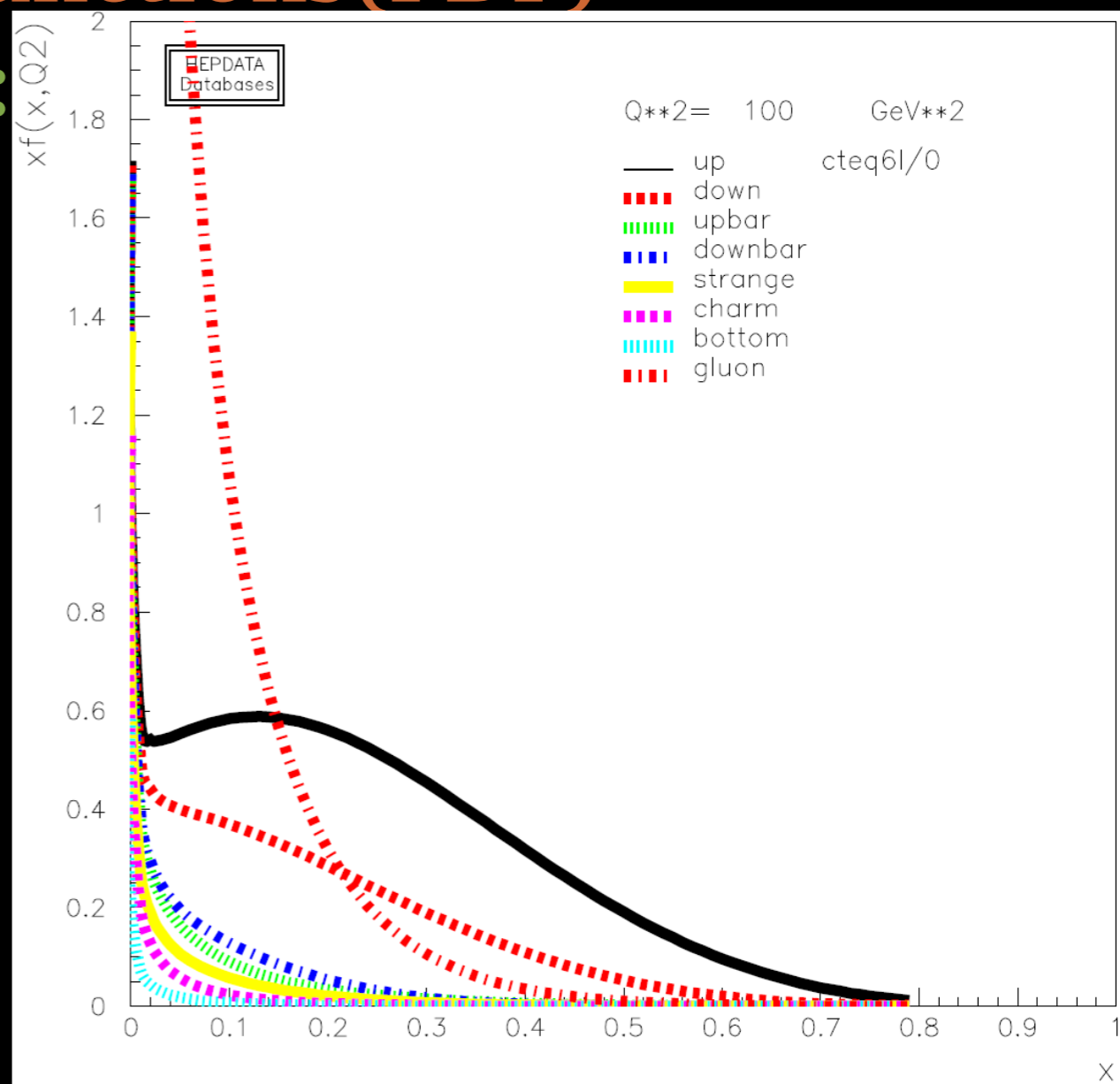
● For a Higgs boson production:

$$x = \sqrt{\hat{s}} / \sqrt{s}$$

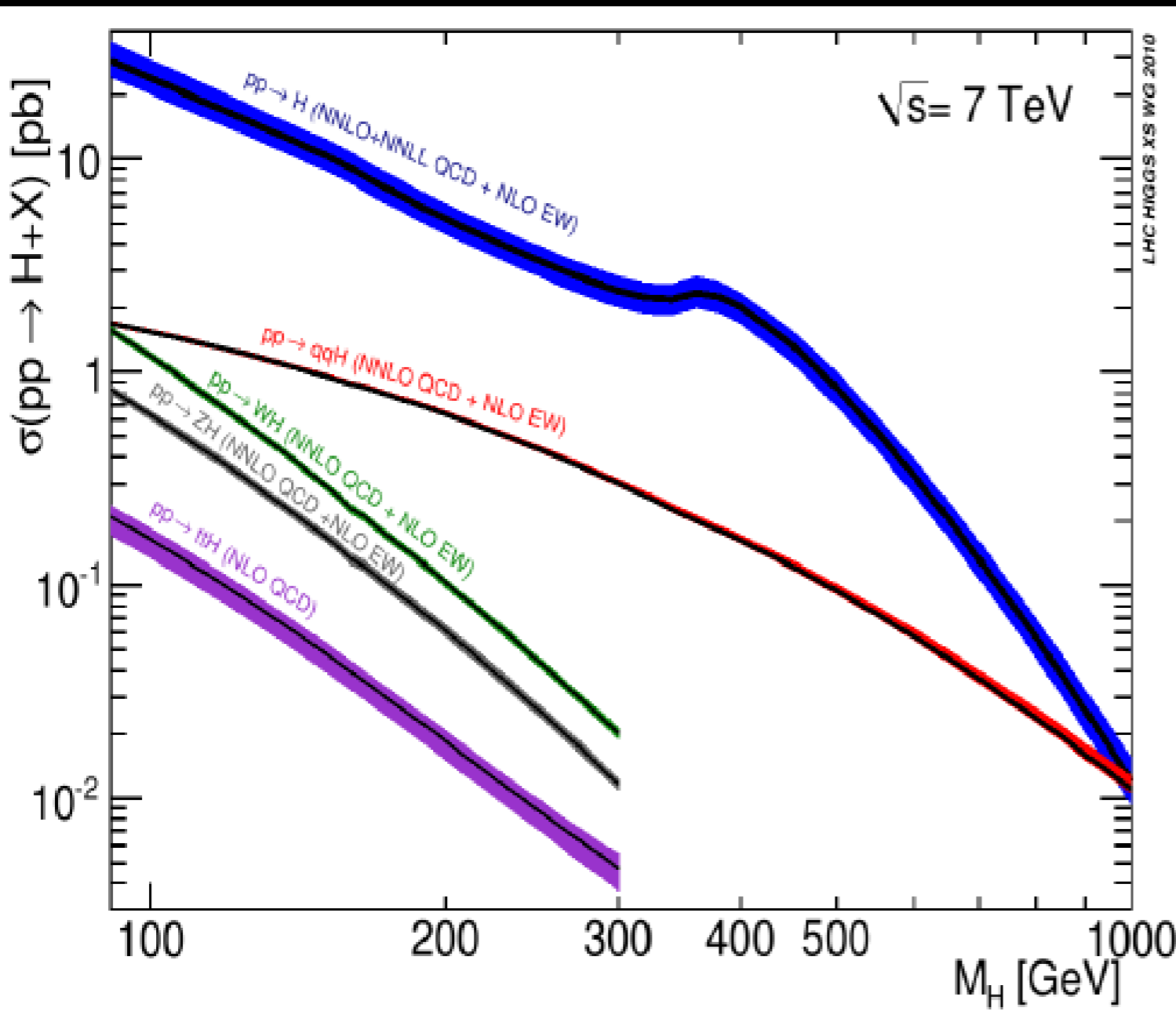
$$\sqrt{\hat{s}} = 125 \text{ GeV} ; \sqrt{s} = 7000 \text{ GeV}$$



$$x = 0.018$$



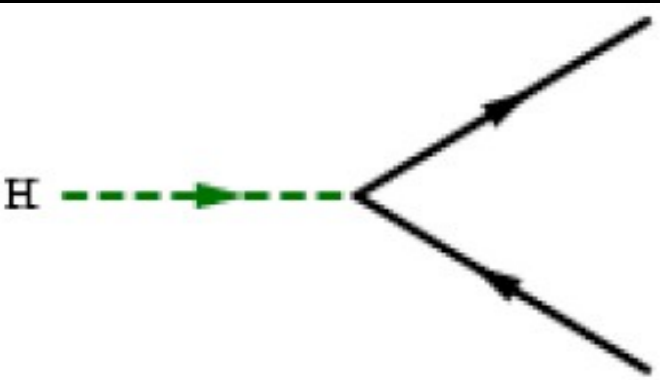
Higgs Production Cross-Sections:



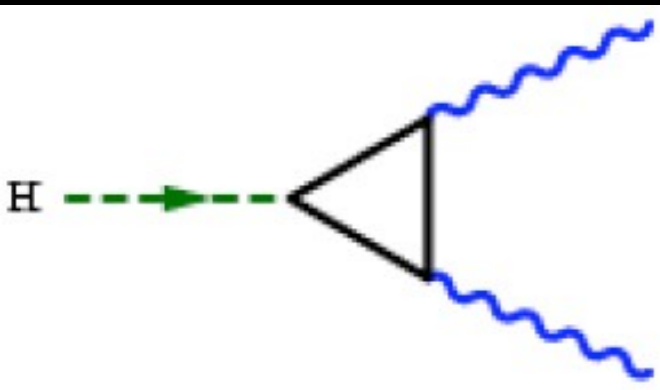
A Higgs boson with mass 125 GeV is produced by:

- gluon fusion
◆ 15 pb
- weak-boson fusion
◆ 1.5 pb
- Higgs-strahlung $(qq \rightarrow WH)$
◆ 0.8 pb
- Higgs-strahlung $(qq \rightarrow ZH)$
◆ 0.6 pb
- $tt\bar{t}$ associated
◆ 0.1 pb

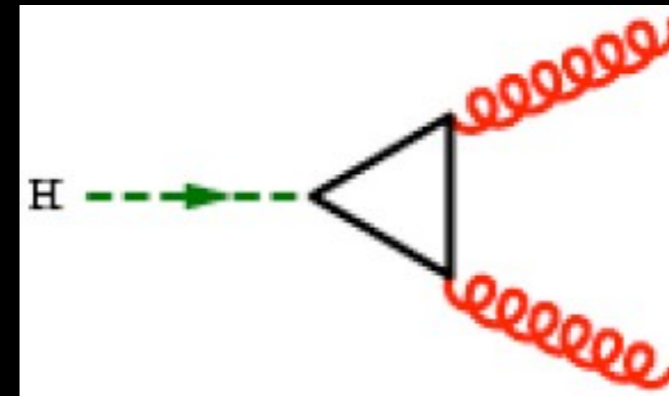
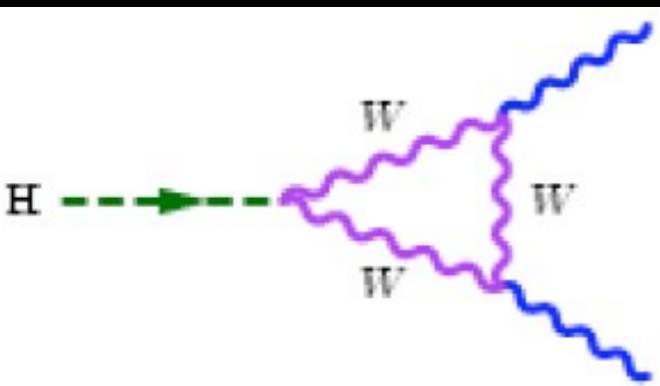
Higgs Decay Channels:



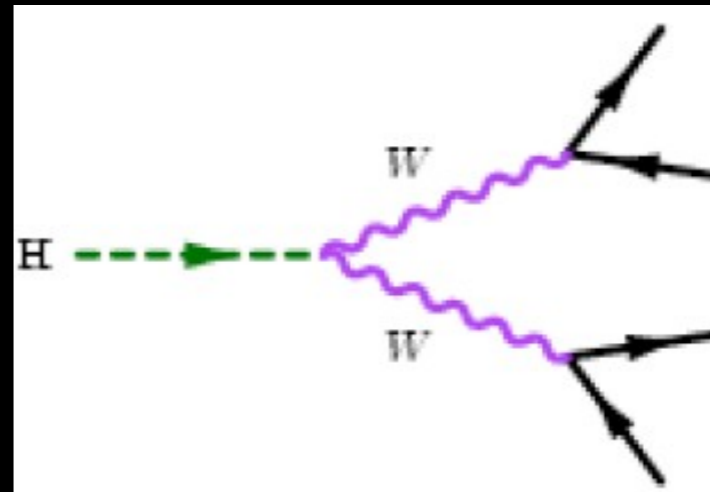
- $H \rightarrow b\bar{b}$
- $H \rightarrow t\bar{t}$
- $H \rightarrow c\bar{c}$



- $H \rightarrow \gamma\gamma$

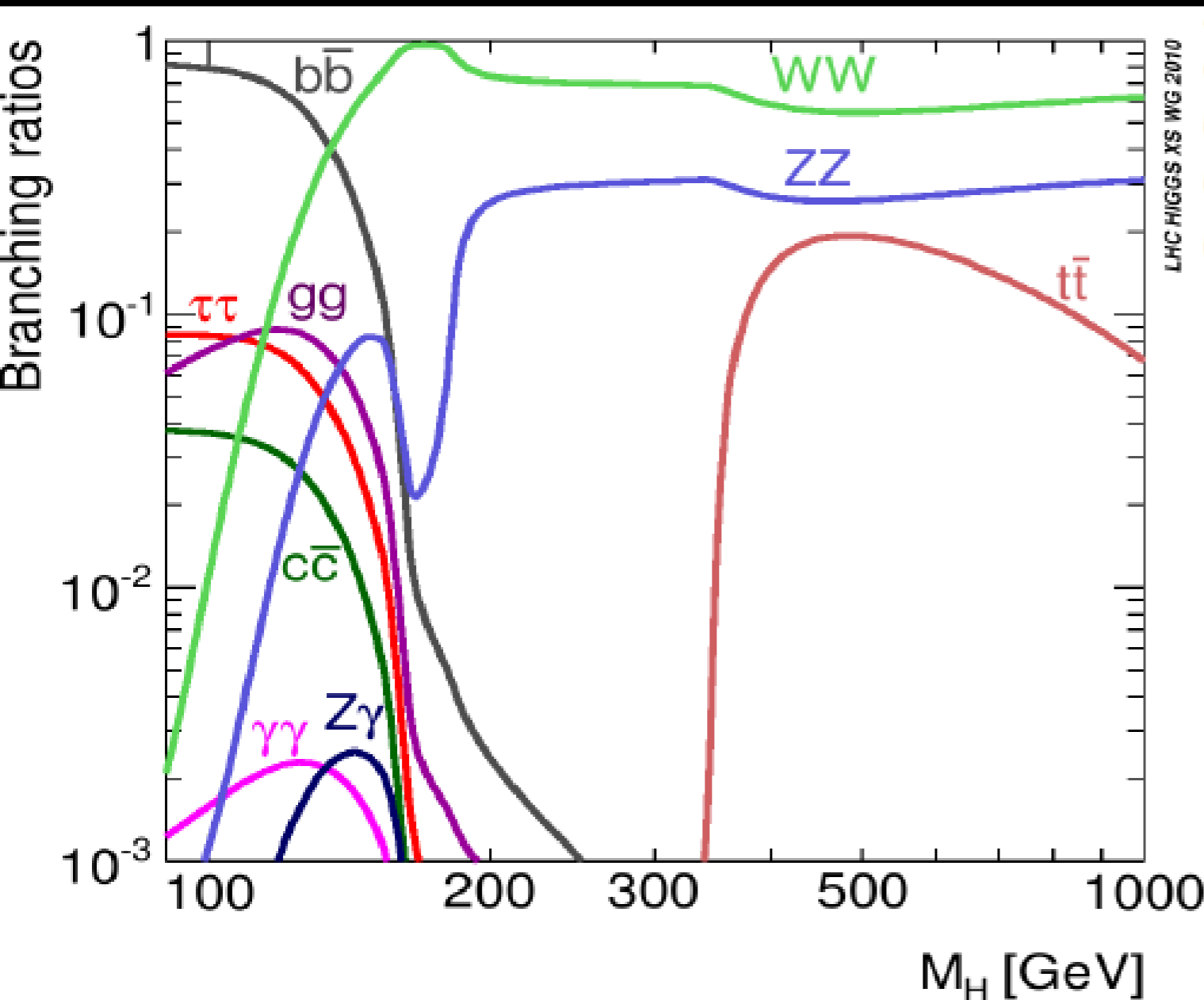


- $H \rightarrow gg$



- $H \rightarrow WW$
- $H \rightarrow ZZ$

Higgs branching ratios:



● Most probable Higgs decay modes depend on the Higgs boson mass

● For a light Higgs:

- ◆ $H \rightarrow b\bar{b}$ & $H \rightarrow gg$ are dominant but contain lots of QCD backgrounds
- ◆ $H \rightarrow \gamma\gamma$ provides a clean signature
- ◆ ECAL has a high resolution

● For a heavy Higgs:

- ◆ $H \rightarrow WW$ & $H \rightarrow ZZ$ and $H \rightarrow t\bar{t}$ are dominant channels
- ◆ Studying these modes, a heavy Higgs with a mass greater than 140 GeV has already been excluded