LHC: recent results and status

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Contents

- LHC
- Higgs
- Top
- Summary

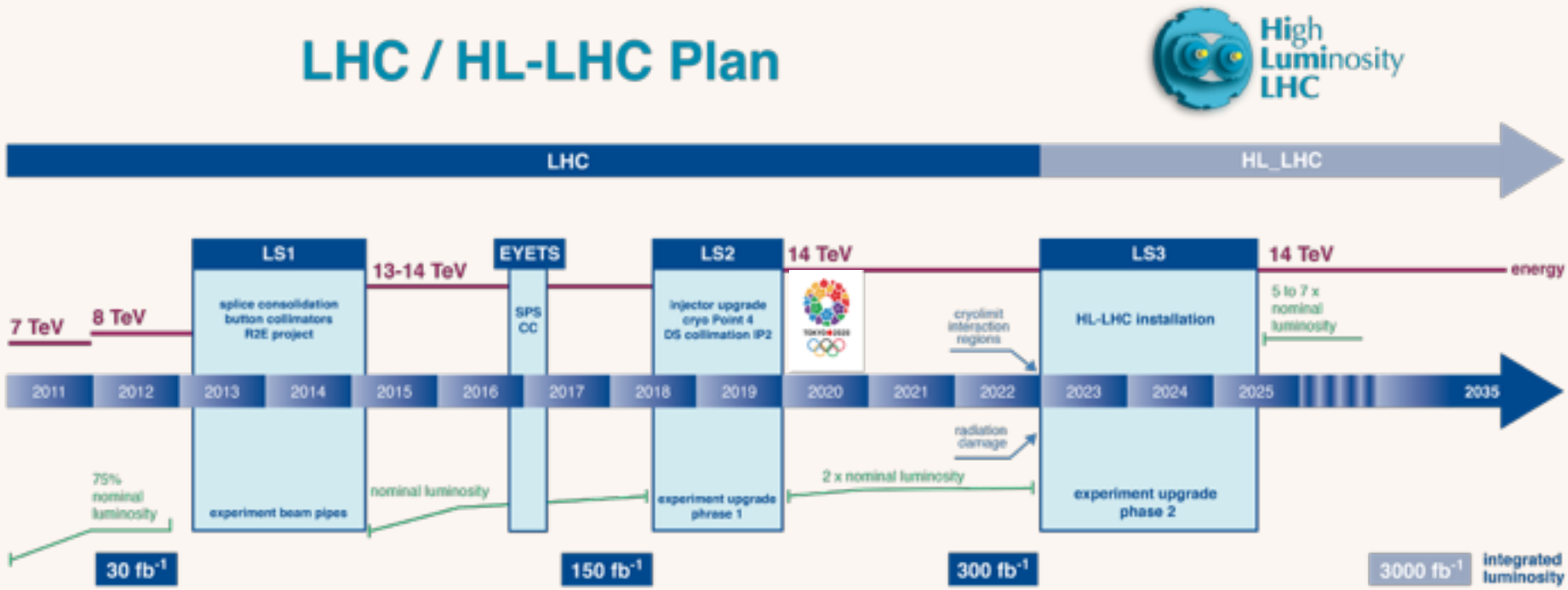
High Energy Beam…

- Commissioning of high energy beam (6.5TeV) was originally scheduled on Mar./25…

- "An intermittent short circuit to ground in one of the machine's magnet circuits was identified on 21 March and is under investigation."

- A delay of between a few days and several weeks.

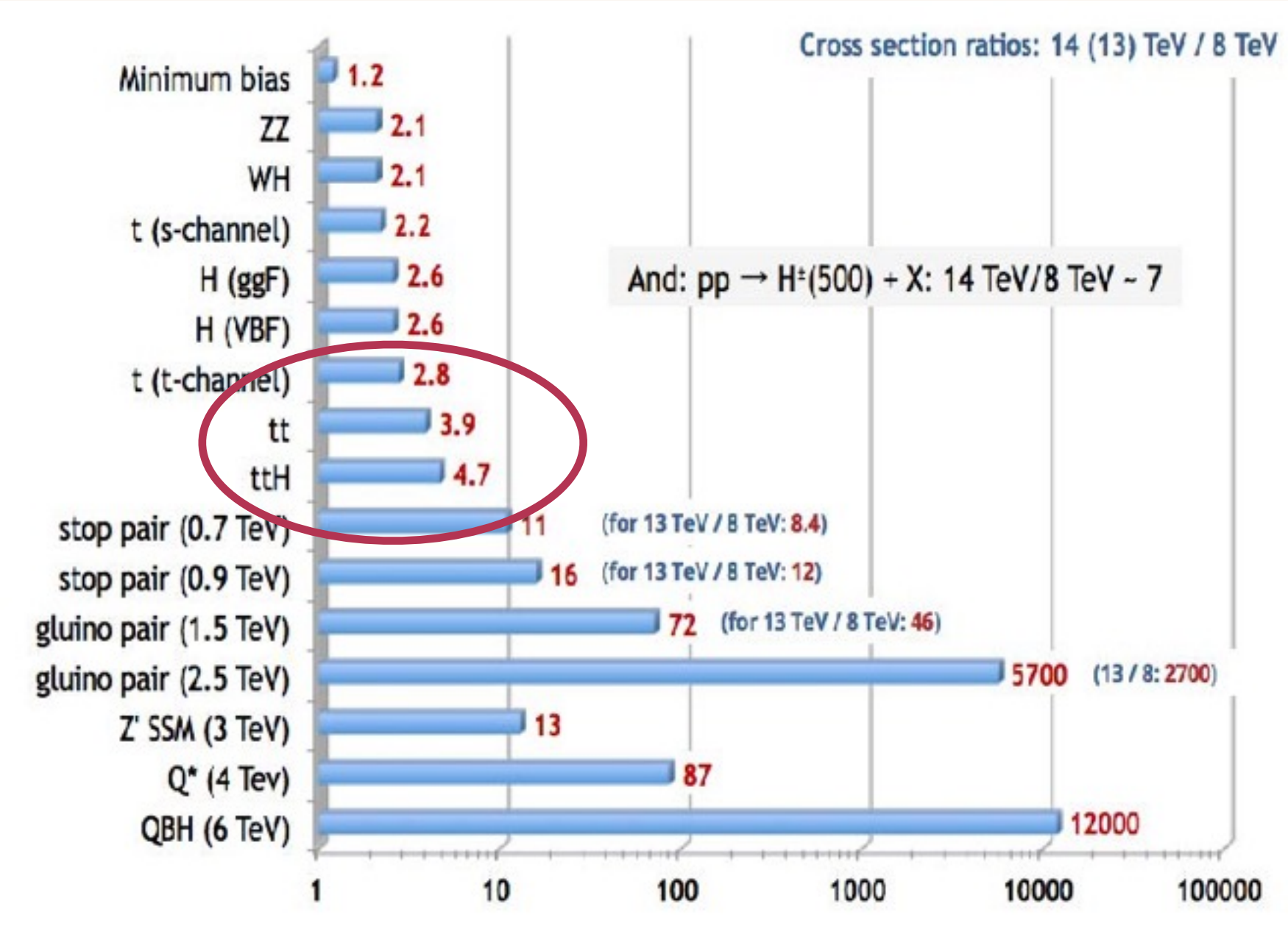
Near and Far Future



7-8TeV		13-14TeV	14TeV	14TeV
0.75 10^{34} cm^{-2} s^{-1}		1.5 10^{34} cm^{-2} s^{-1}	1.7-2.2 10^{34} cm^{-2} s^{-1}	5.0 10^{34} cm^{-2} s^{-1}
50 ns	Now	25 ns	25 ns	25 ns
pile up ~20		pile up ~40	pile up ~60	pile up ~140
25fb^{-1}		100fb^{-1}/~3years	300fb^{-1}/~3years	3000fb^{-1}/~10years

Long and rough (at least, not easy) road

Pros - High Collision Energy



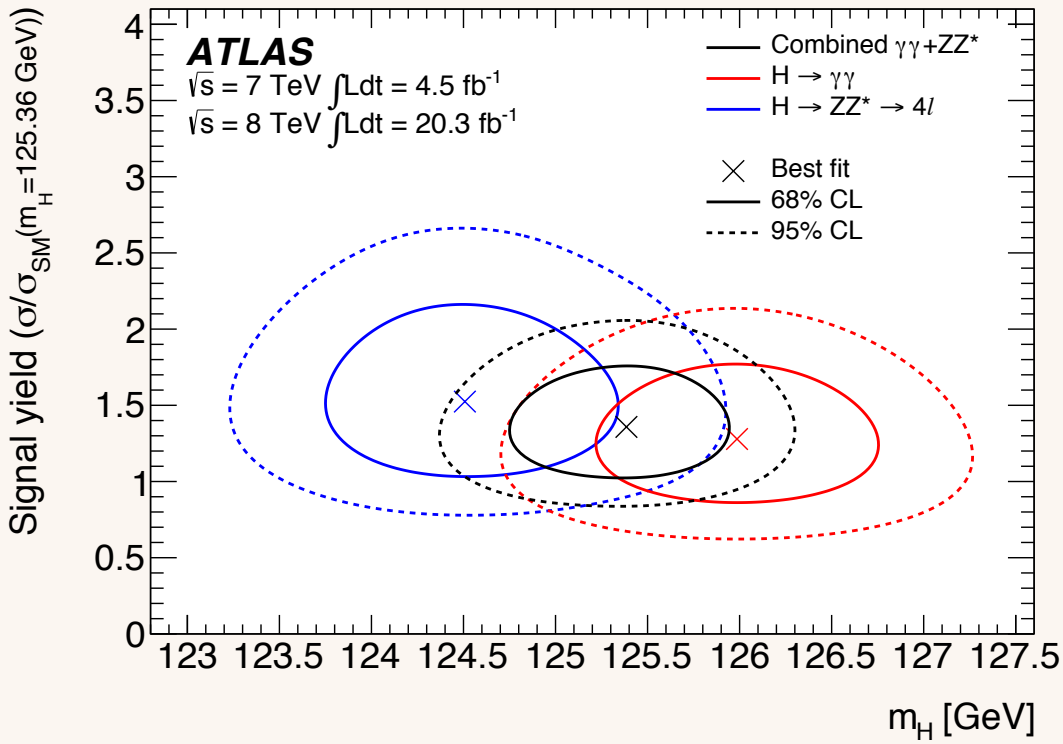
Cons - Pile-up events & Huge data

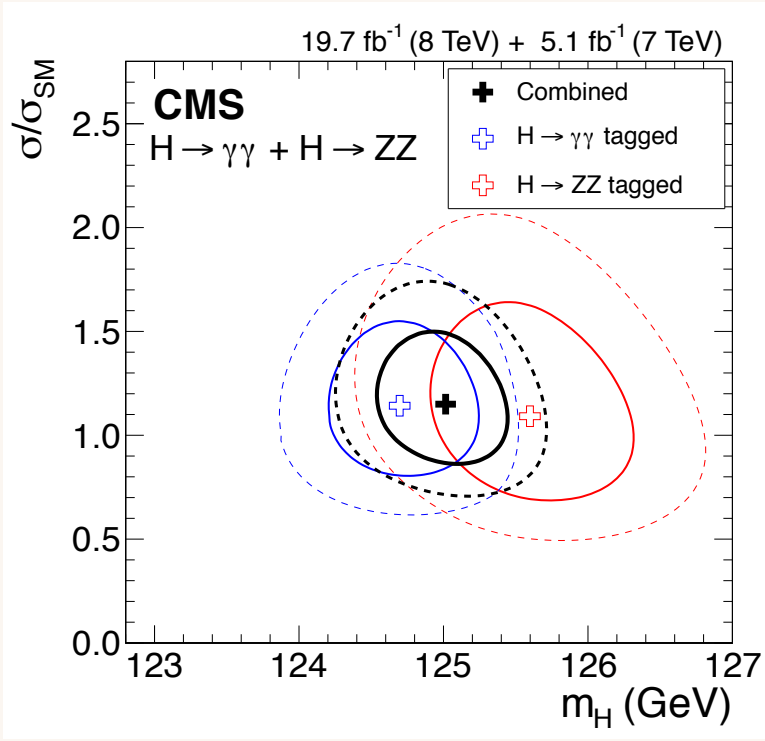
- Large number of pile-up events:
  Averaged number of pile-up events
  - Run1@8TeV, ~20
  - Run-2@14TeV, ~40-60
  - HL-LHC, ~140

  -> Detector upgrade is essential.
- Large data size requires computing resources:
  … storage, CPU and network.

Higgs - Mass and signal yield

- From the H→γγ and H→ZZ*→4l channels,



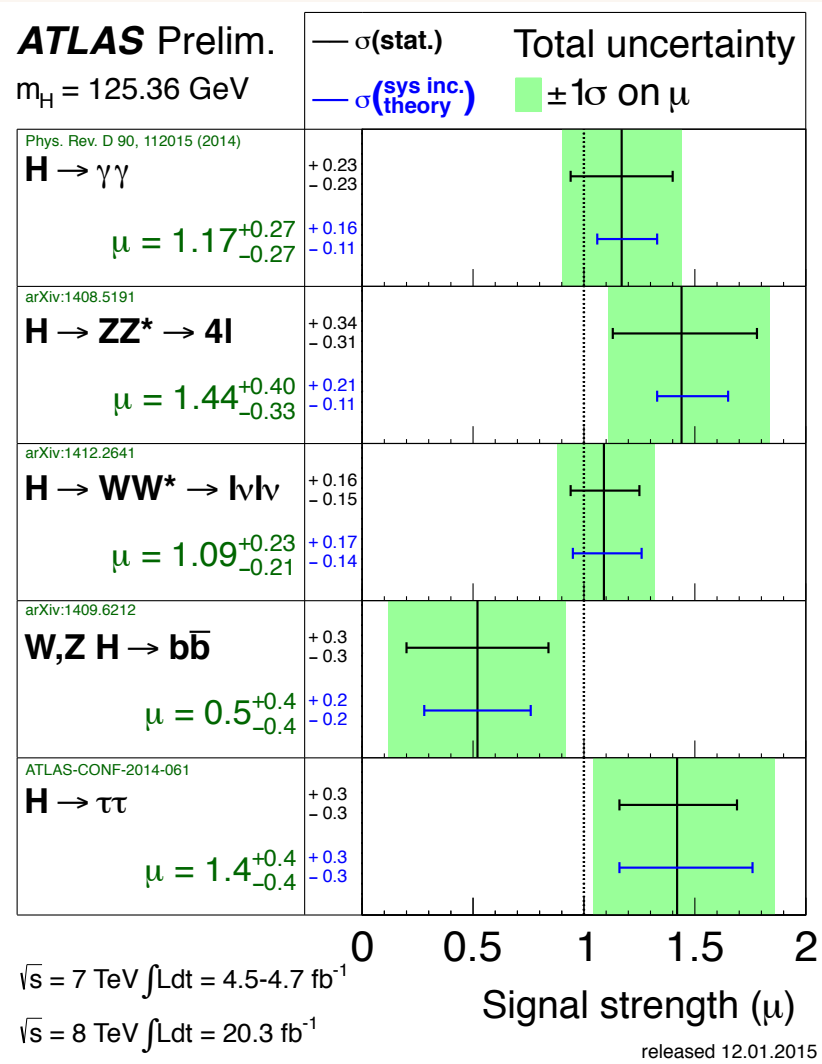


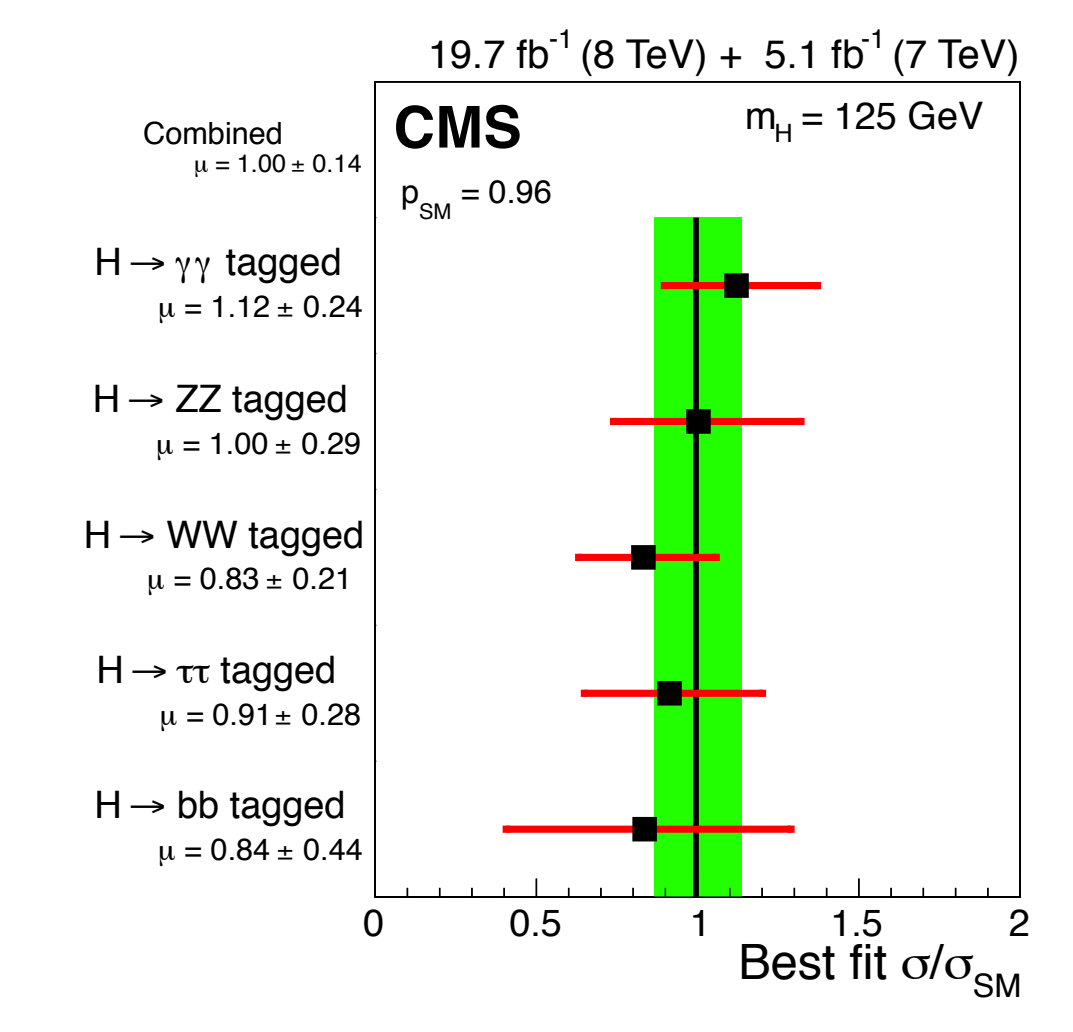
ATLAS: 125.36±0.37(stat.)±0.18(syst.) GeV

CMS: 125.02±0.27(stat.)±0.15(syst.) GeV

Higgs - Signal yield

- Signal yields for each decay channel



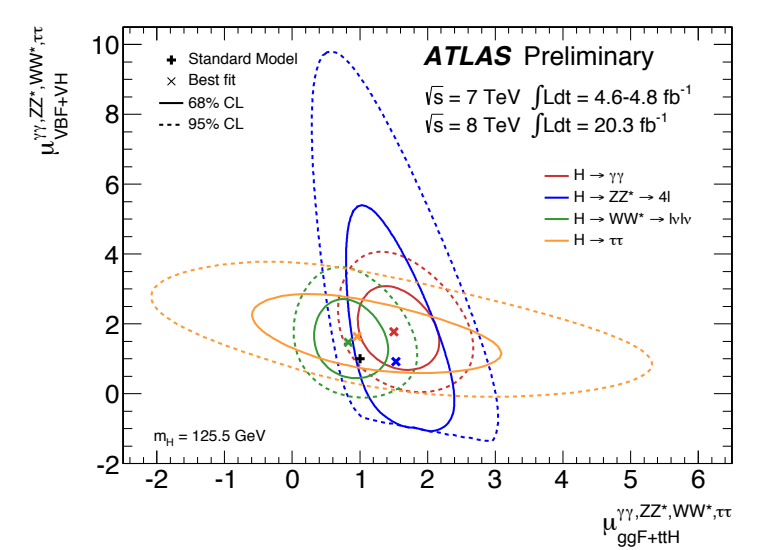


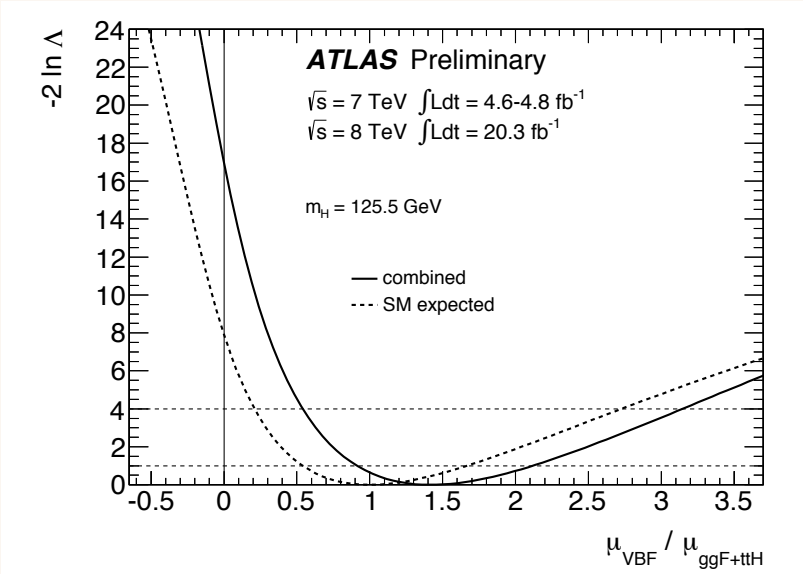
Higgs - VBF production process

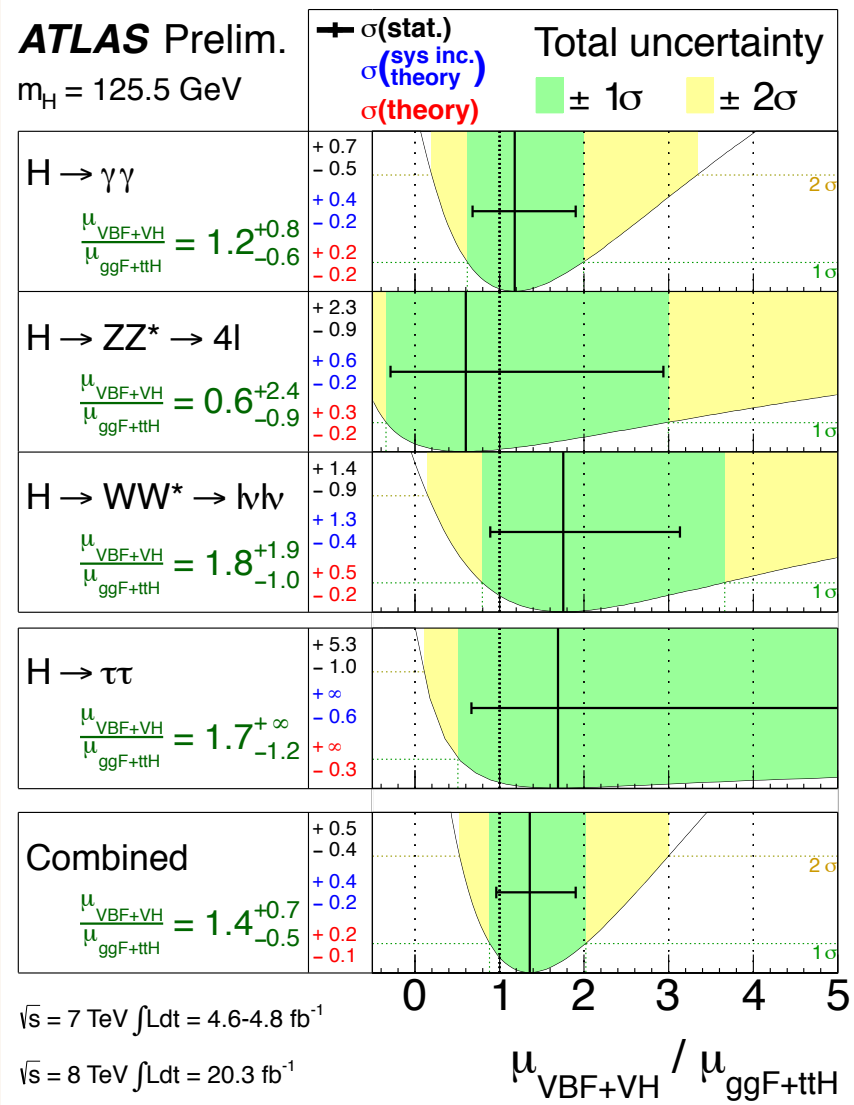
- D. Rainwater and D. Zeppenfeld, JHEP 9712 (1997) 005, "Searching for $H \to \gamma\gamma$ in weak boson fusion at the LHC "
- D. Rainwater, D. Zeppenfeld and K. Hagiwara, Phys.Rev. D59 (1998) 014037, "Searching for $H \to \tau^+\tau^-$ in weak boson fusion at the CERN LHC"
- D. Rainwater and D. Zeppenfeld, Phys.Rev. D60 (1999) 113004, Erratum-ibid. D61 (2000) 099901, "Observing $H \to W^*W^* \to e^\pm\mu^\mp$ missing p_T in weak boson fusion with dual forward jet tagging at the CERN LHC"

Higgs - VBF production process

- ATLAS: 4.1 σ evidence

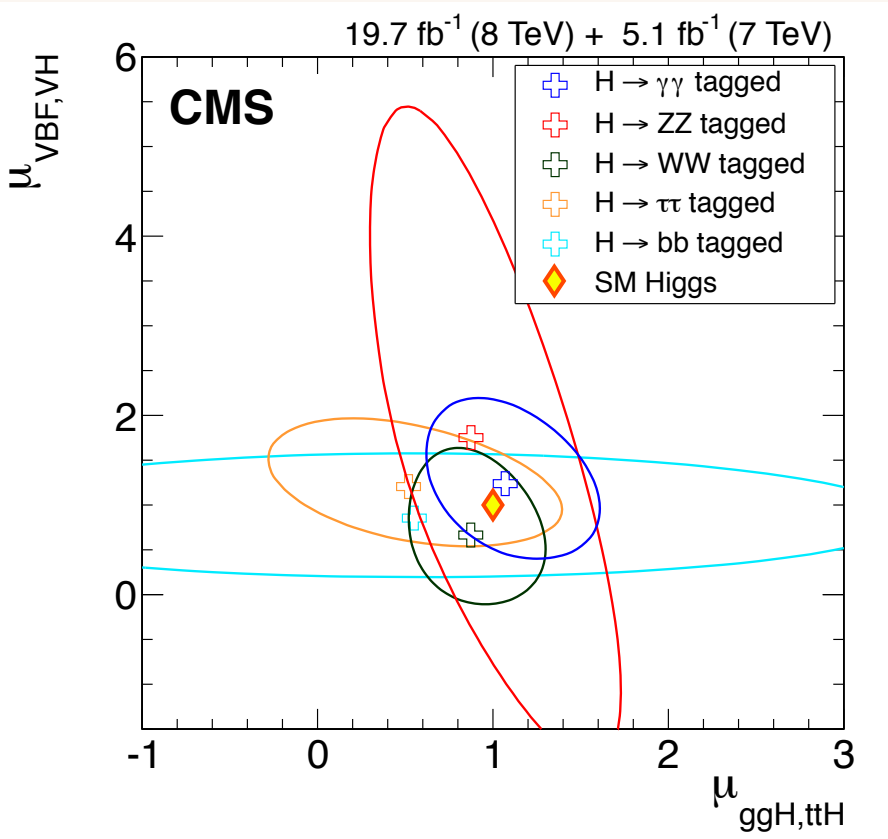


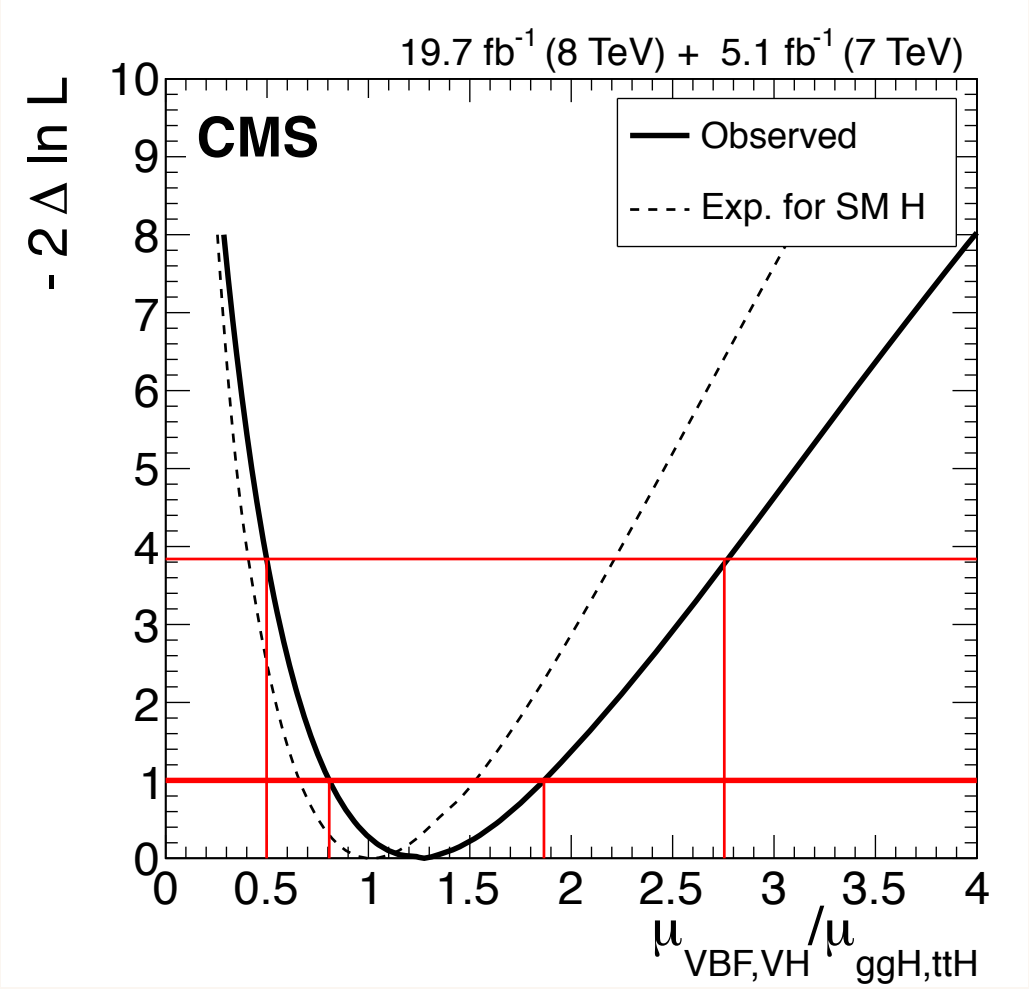




Higgs - VBF production process

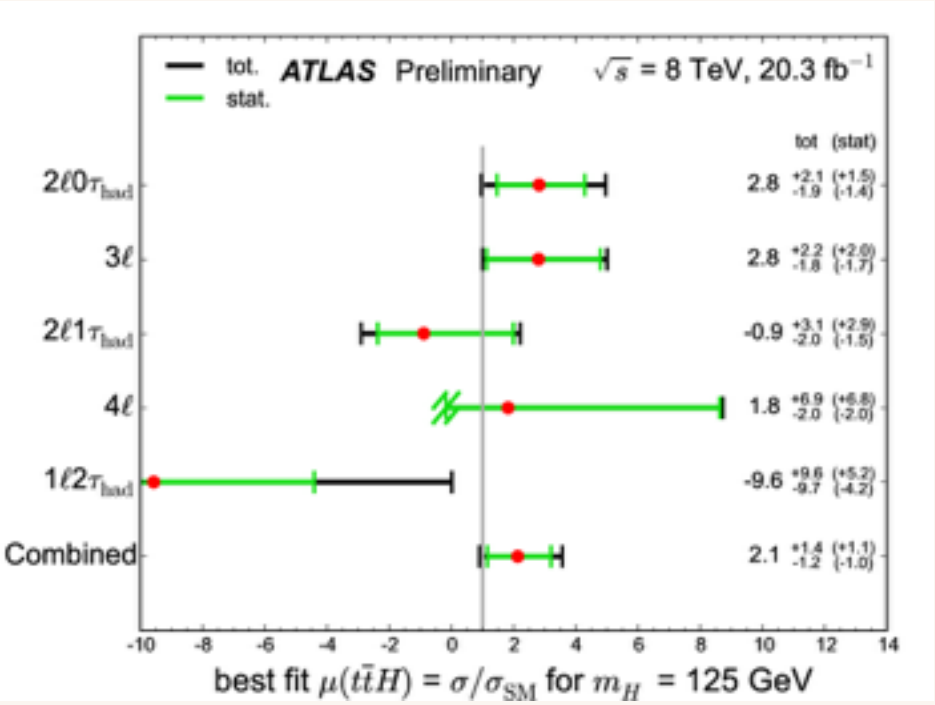
- CMS

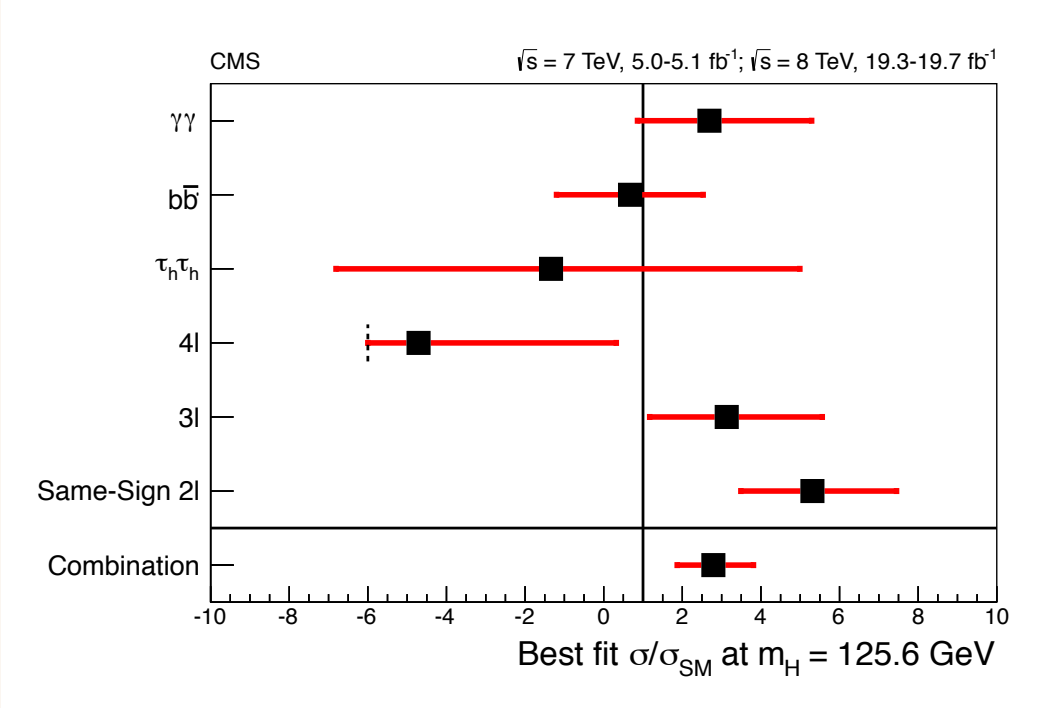




Higgs - ttH

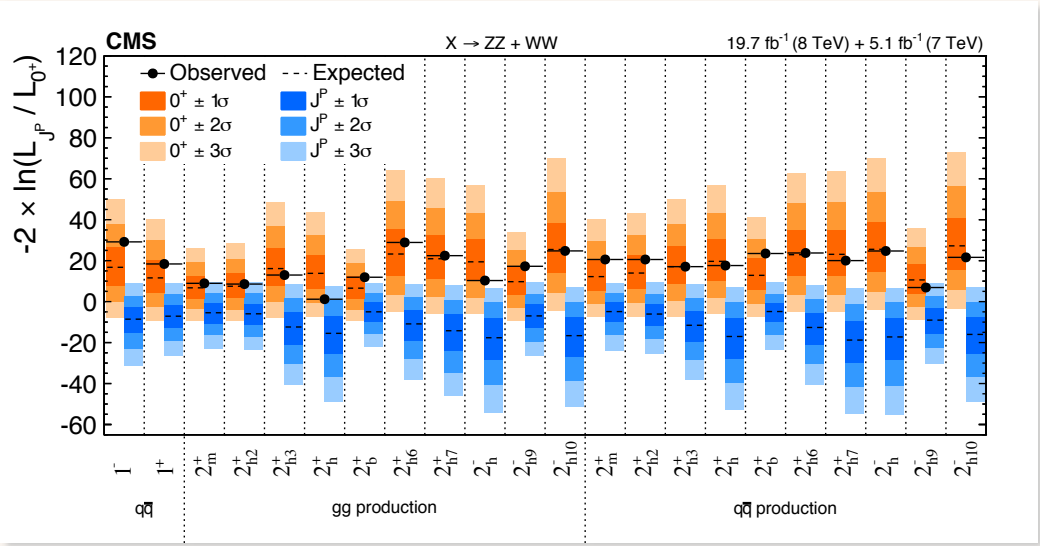
- Important channel, but not enough statistics yet

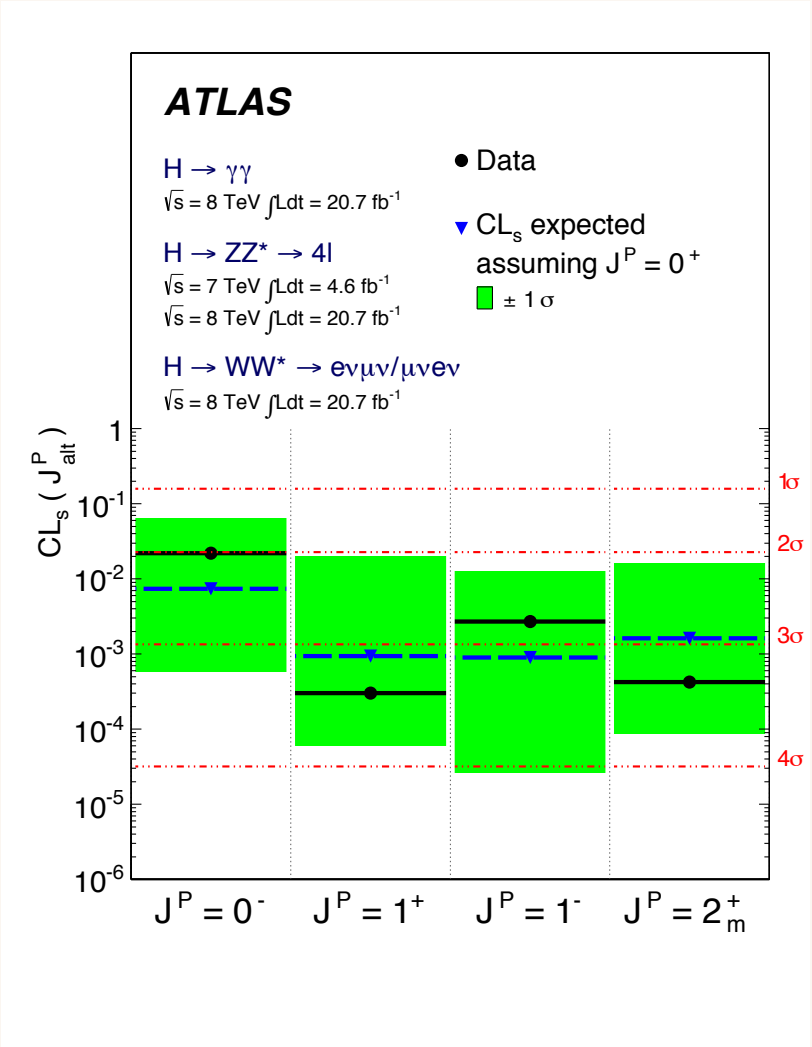




Higgs - Spin/CP

- Pure 0^-, $2^\pm$, 2^+ are excluded.
- CP mixing and CP violation.





Top - Charge asymmetry

- ATLAS: tt-bar di-lepton, 4.6fb^{-1}

  A_C^{ll} = 0.024±0.015(stat.)±0.009(syst.)

  A_C^{tt} = 0.021±0.025(stat.)±0.017(syst.)

  NLO QCD + EW corrections

  A_C^{ll} = 0.0070±0.0003(scale)

  A_C^{tt} = 0.0123±0.0005(scale)

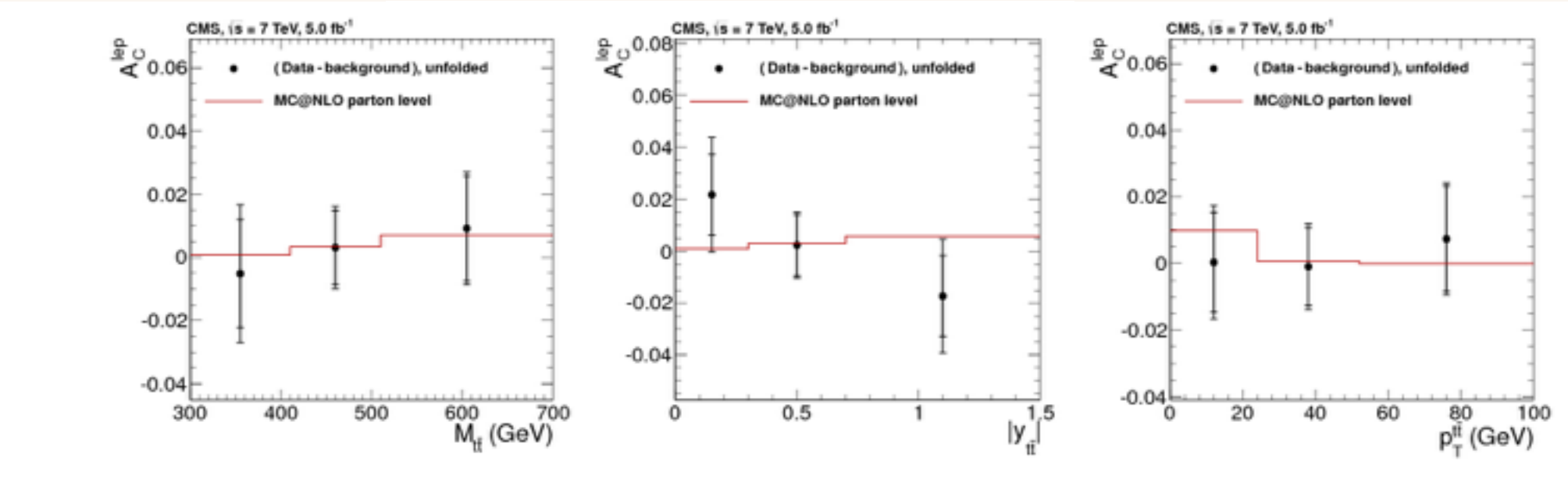
- CMS: tt-bar di-lepton, 5fb^{-1}

  A_C^{ll} = 0.009±0.010(stat.)±0.006(syst.)

  A_C^{tt} = -0.010±0.017(stat.)±0.008(syst.)

Top - Charge asymmetry

- CMS measures differential A_C^{ll} vs. m(tt), Y(tt) and p_T(tt)



Summary & Prospect

- A SM Higgs boson was discovered by LHC experiments with 7/8 TeV pp collisions. That provided experimentalists many tasks:
  - Detailed studies of Higgs properties
  - Search for other Higgs
- New data taking at high collision energy will begin really soon and provide us enormous amount of data.
- I think that new idea on physics is essential to analyze high energy data.