Highlights from LIP/CMS results

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Apr. 22, 2012

- **Top physics: x-section, mass, taus, R**
- **Higgs: photons, taus**
- **SUSY: scalar top**

CMS Experiment at LHC, CERN
Data recorded: Thu Apr 5 05:47:32 2012 CEST
Run/Event: 190401 / 12545076
Lumi section: 75
Orbit/Crossing: 19465645 / 1347

Introduction

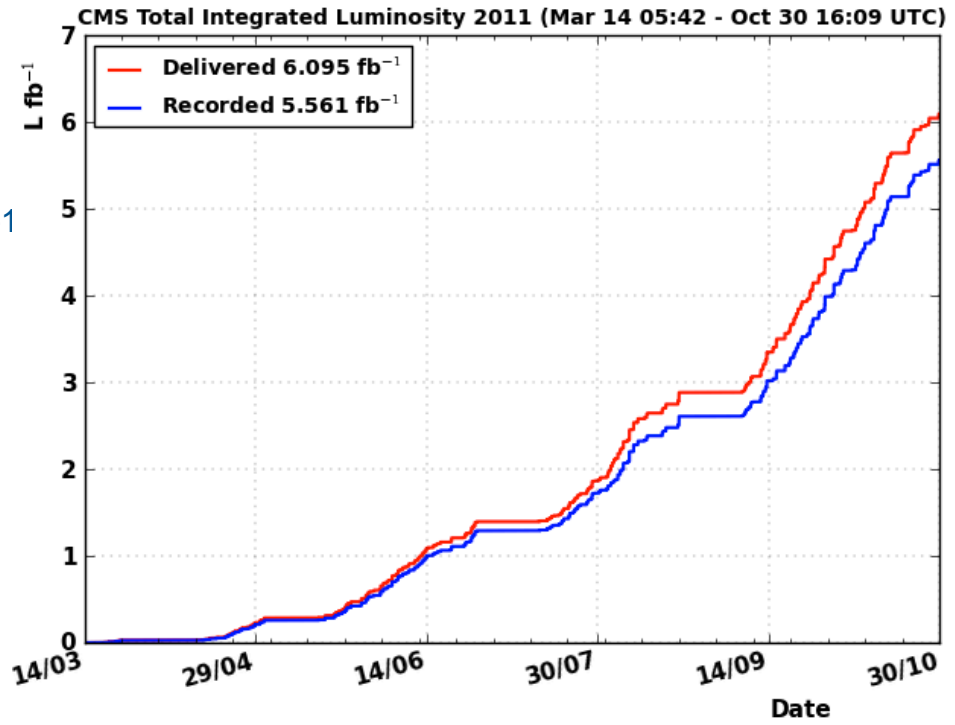
- What happened since last ``Jornadas" in 2010?
- LHC started well
- LIP/CMS group had an active involvement in physics analyses
- Results in 2010/2011

Disclaimer:

- Current allocation of time is short
- Please refer to the individual presentations
- In addition to Jornadas (every 2 years), we'd welcome more frequent scientific discussion

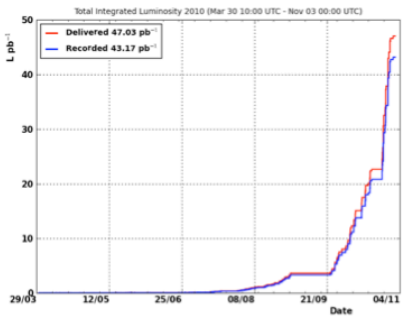
LHC operation in 2011

- Record inst. luminosity: $3.54 \times 10^{33} cm^{-2} sec^{-1}$
- Recorded 5.5/fb in 2011
- Excellent performance
- This year ~15/fb at 8TeV



LHC operation in 2010

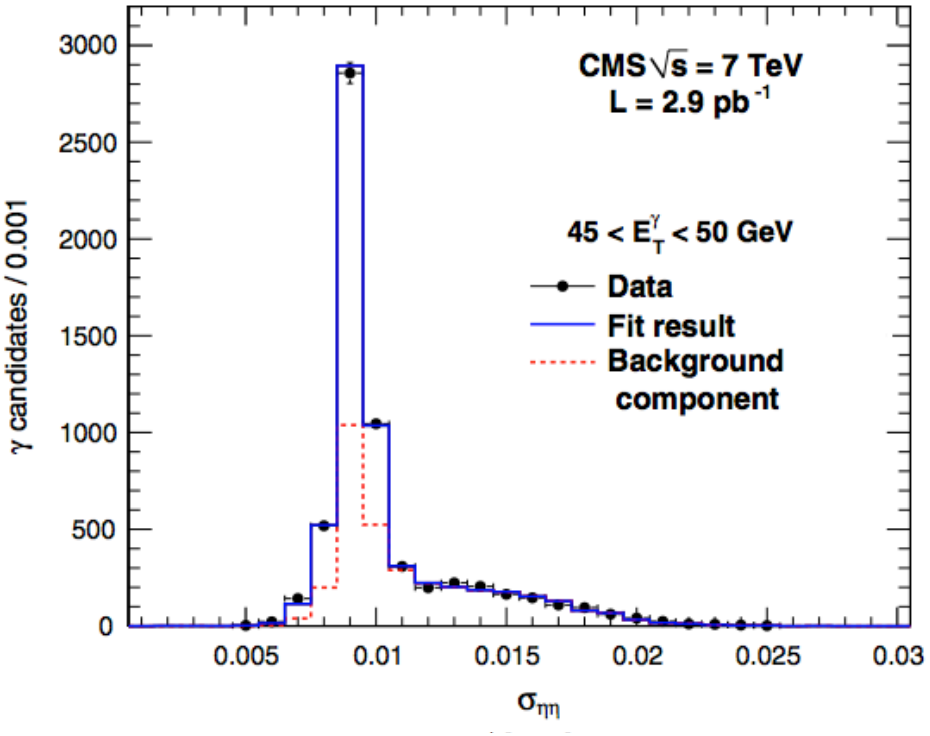
- Reached peak luminosity of $2 \times 10^{32} cm^{-2} sec^{-1}$
- Collected 36/pb in 2010 run
- Run in 2011 (may also continue in 2012)
- There will be large datasets available
- LHC is a complicated machine and there may/will be problems

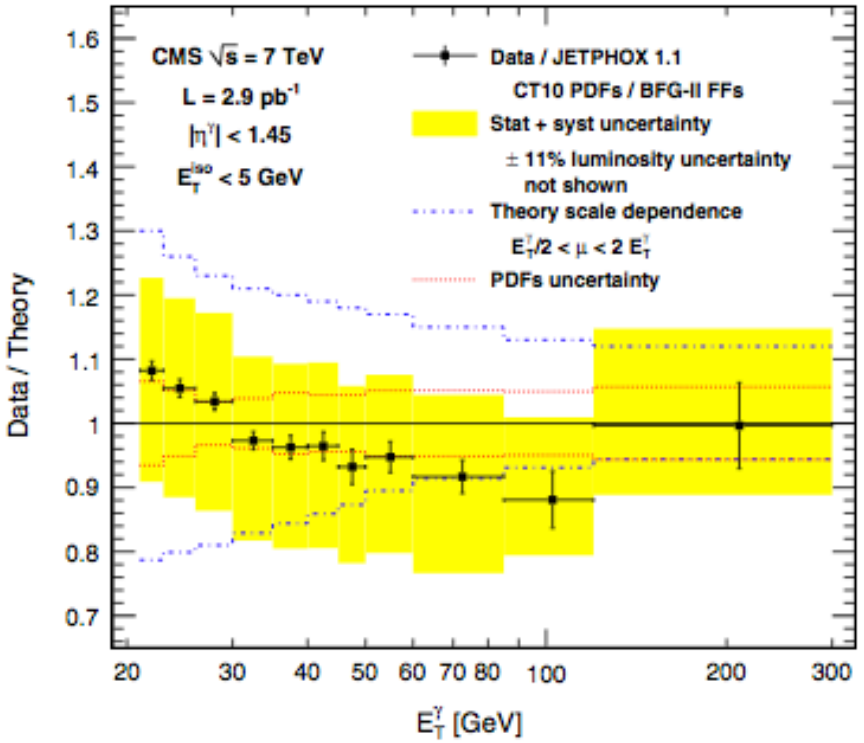


Photons

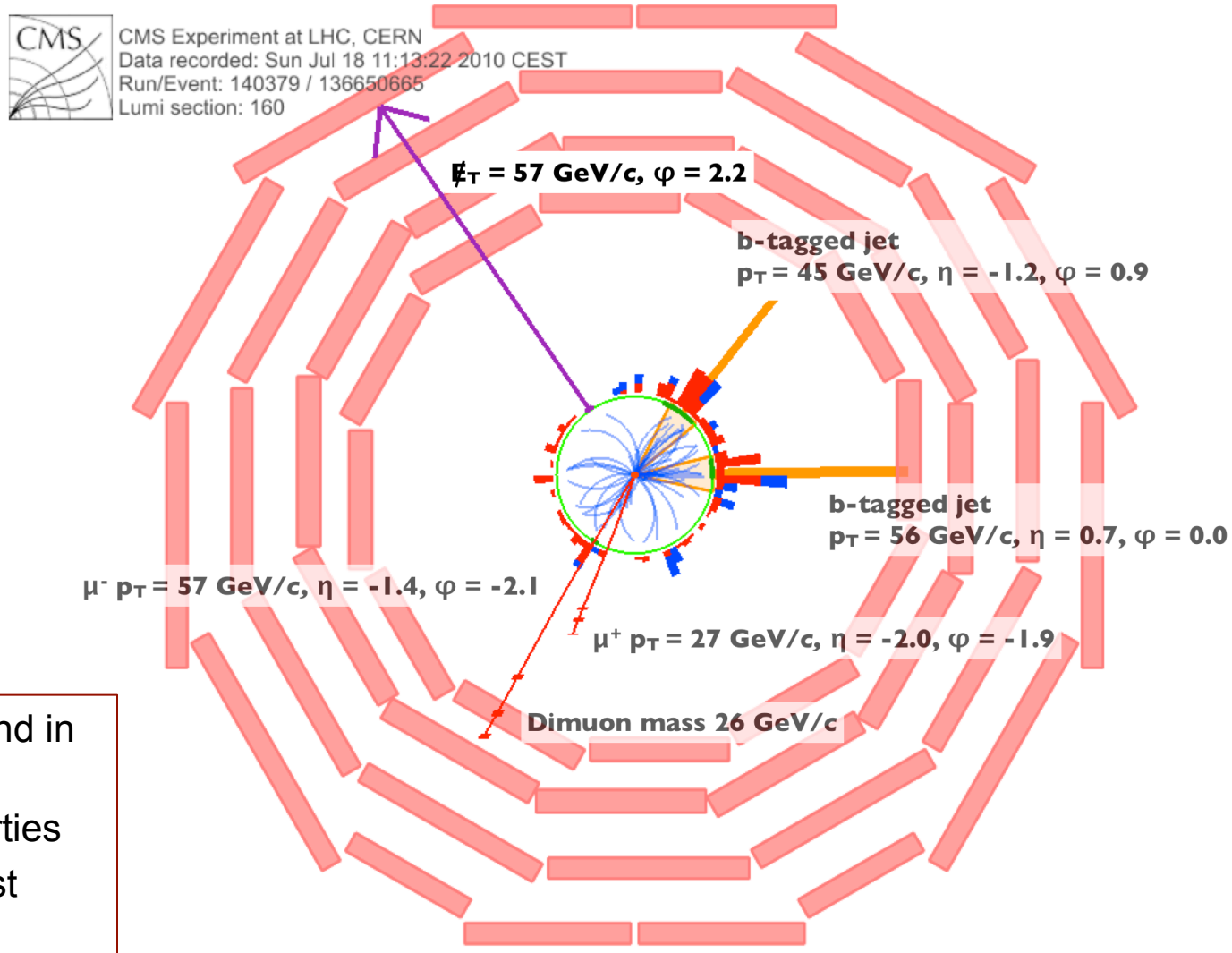
- First measurement of the inclusive photon cross section in early LHC data

CMS PAS QCD-10-019 (2.9/pb)
Phys.Rev.Lett. 106 (2011) 082001





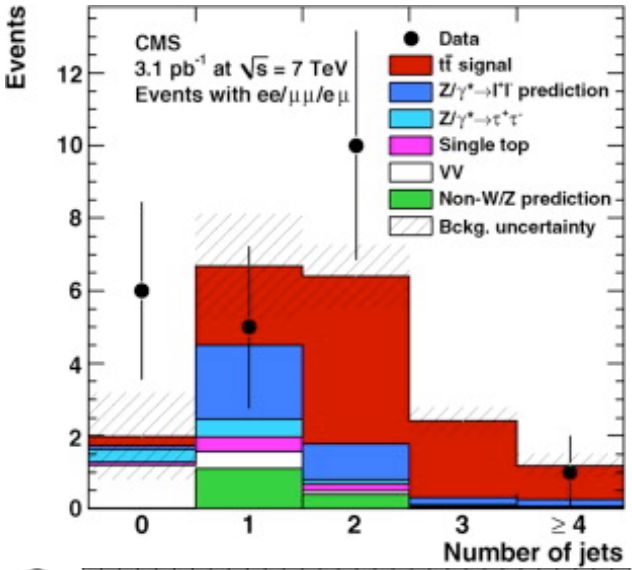
Top quark production

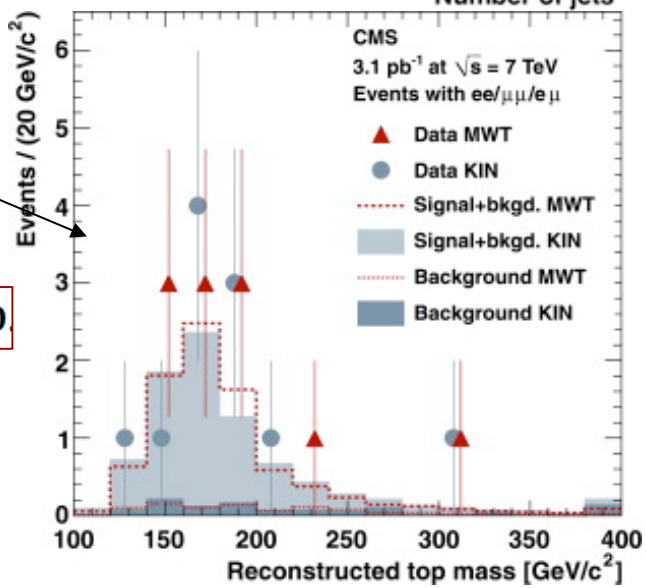


- Dominant background in BSM searches
- Measure Top properties
- Discriminator against ttbar background

Top cross section

- First measurement of the top quark pair production cross section at the LHC
  - Select events in dilepton final state
  - careful evaluation of backgrounds from data
- First attempt to reconstruct the top mass





$$\sigma(pp \to t\bar{t} + X) = 194 \pm 72(stat.) \pm 24(syst.) \pm 21(lumi.)\ pb$$

CMS PAS TOP-10-001 (3.1/pb)
Phys. Lett. B 695 (2011) 424

Top quark cross section

JHEP

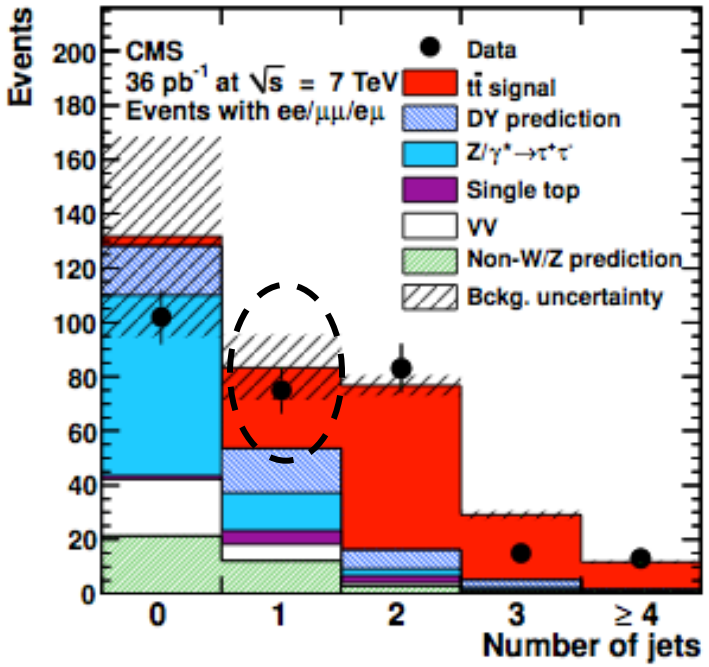
Published for SISSA by Springer

Received: May 28, 2011
Accepted: June 16, 2011
Published: July 11, 2011

JHEP07(2011)049

Measurement of the $t\bar{t}$ production cross section and the top quark mass in the dilepton channel in pp collisions at $\sqrt{s} = 7$ TeV

- Updated measurement:
  - Revisited cut optimization in full 2010 dataset, added N_{jet}=1 bin



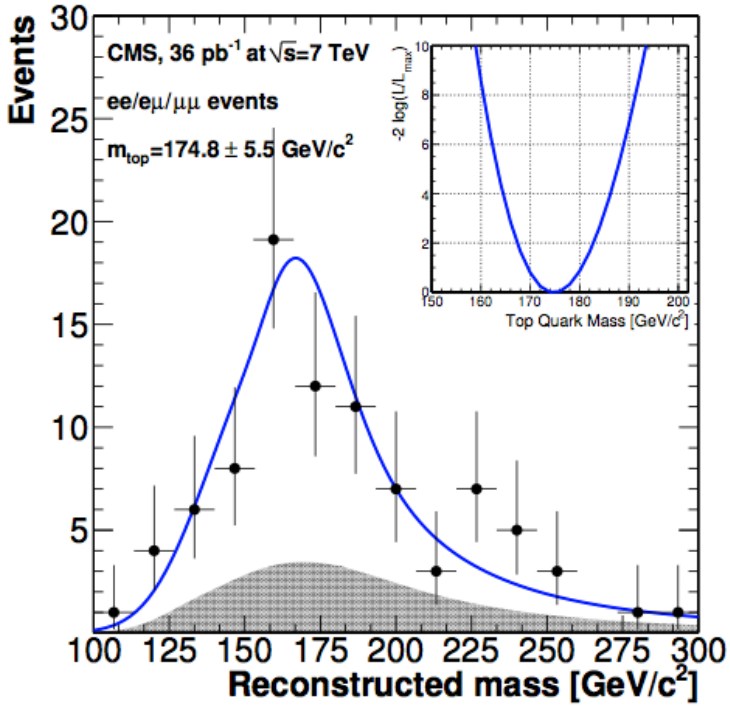
$$\sigma_{t\bar{t}} = 168 \pm 18\,(\text{stat.}) \pm 14\,(\text{syst.}) \pm 7\,(\text{lumi.})\ \text{pb}$$

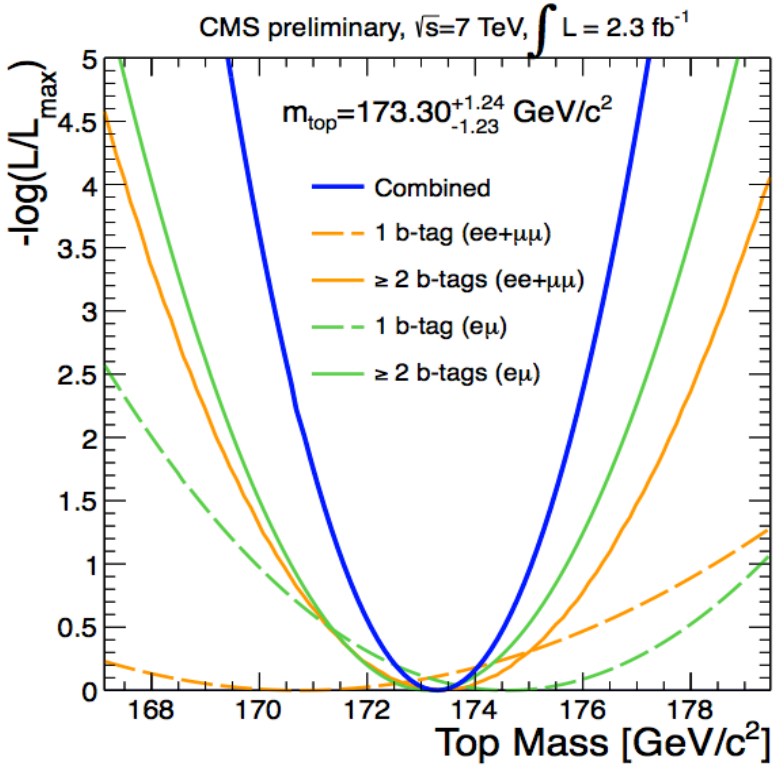
CMS PAS TOP-11-002 (36/pb)
JHEP 07(2011)049

Top quark mass measurement

- First LHC measurement of the top quark mass
  - Dilepton final state
  - Full kinematical reconstruction method
  - Also used m_{top} to understand JES/MET

CMS PAS TOP-10-006
JHEP 07(2011)049 (36/pb)
CMS PAS TOP-11-016 (2.3/fb)





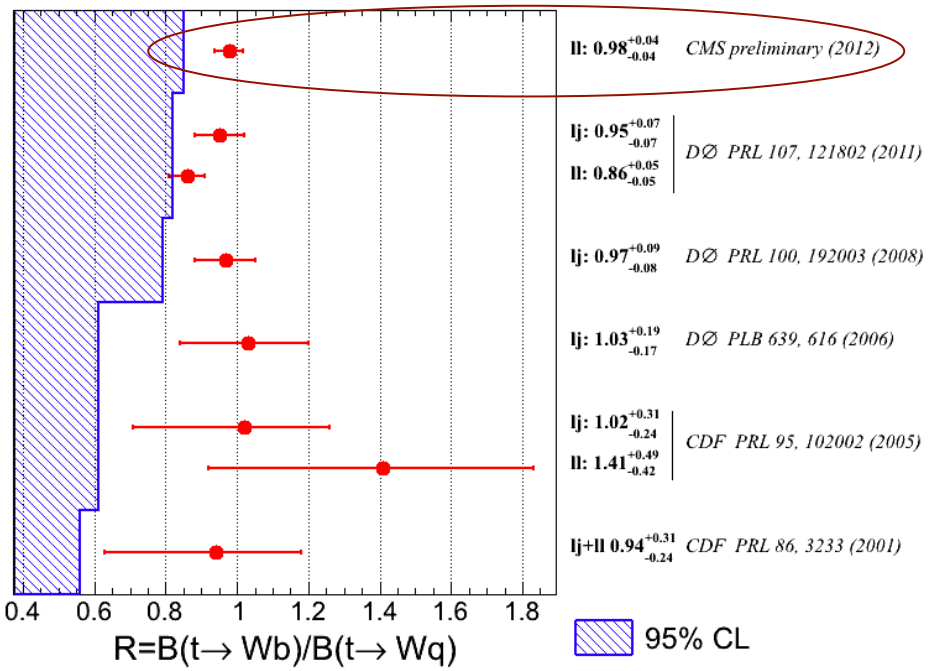
$$m_{\mathrm{top}} = 173.3 \pm 1.2(\mathrm{stat.})^{+2.5}_{-2.6}(\mathrm{syst.})\ \mathrm{GeV}/c^2$$

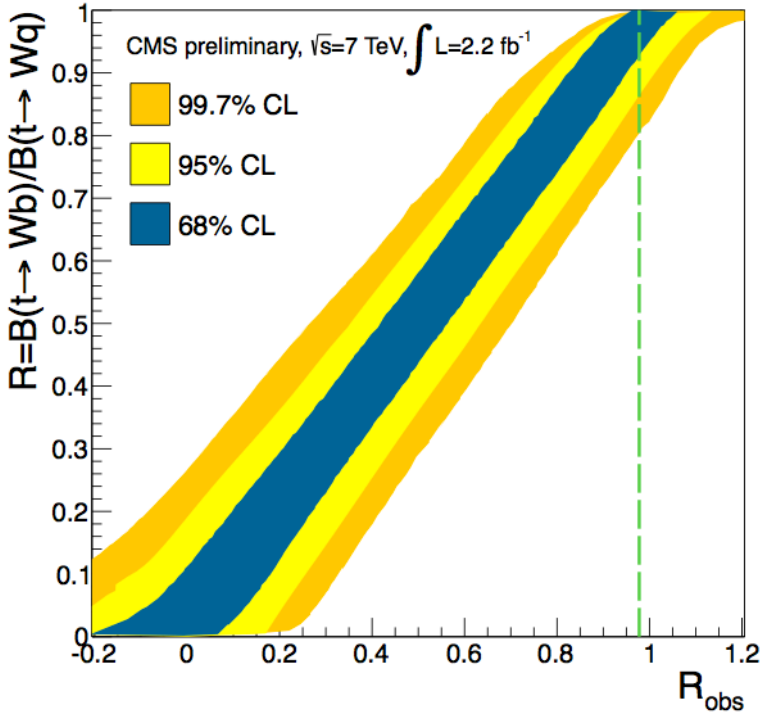
Single most precise measurement in dilepton channel

R=B(t→Wb)/B(t→Wq)

- First measurement at the LHC
  - Determine heavy-flavor content of ttbar events
  - Use dilepton final state
  - Fully data-driven method
- R=0.98±0.04 (stat.⊕syst.)

N.Cim.B: arXiv:1010.2994
CMS PAS TOP-11-029 (2.2/fb)

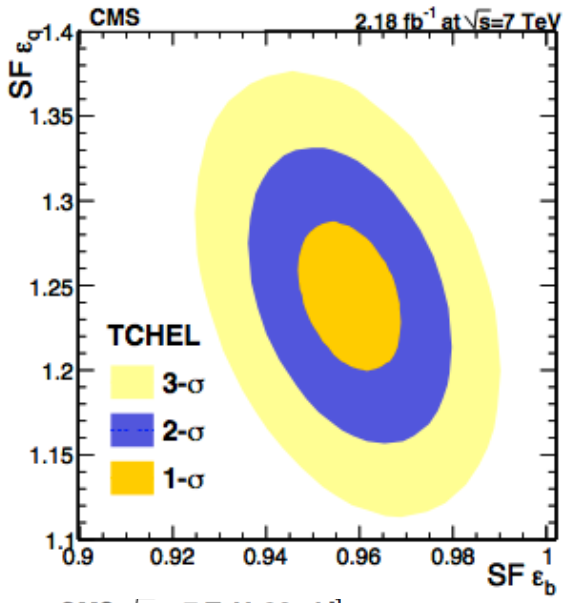




Physics objects

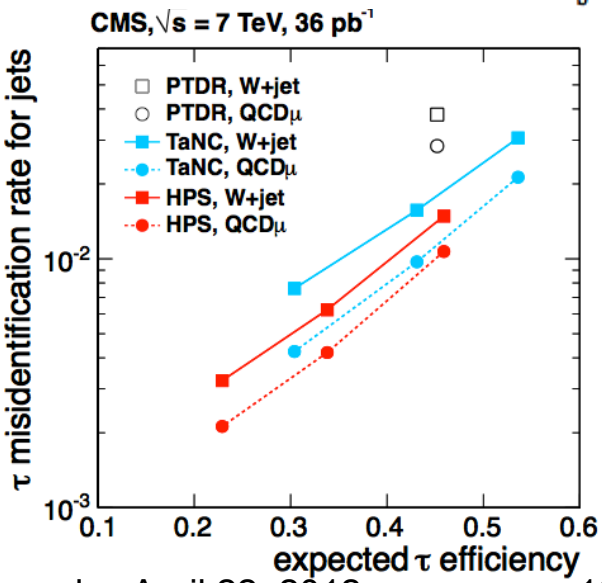
- B-tagging efficiency in ttbar events

CMS PAS BTV-11-001
CMS PAS BTV-11-003



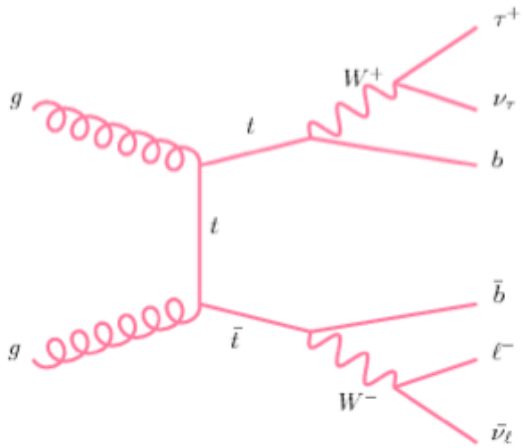
- Tau identification: fake rate/efficiencies

CMS PAS TAU-11-001
JINST 7 (2012) P01001



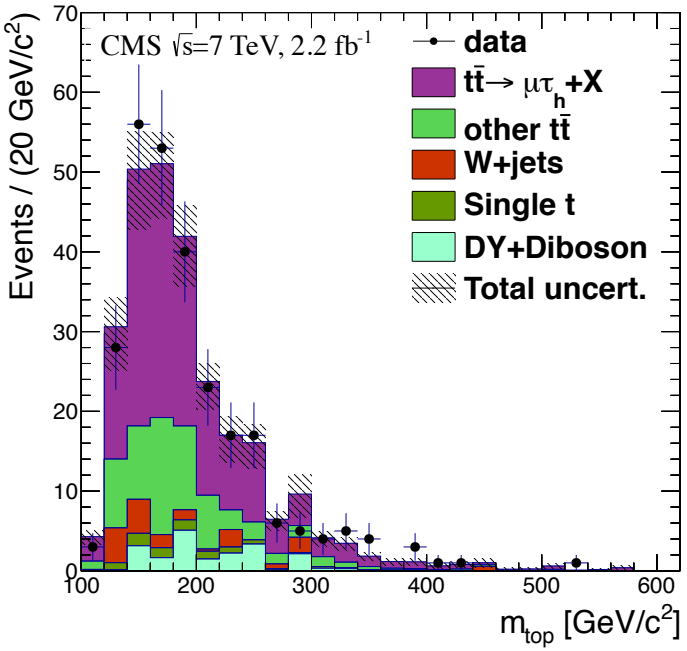
Taus in Top decays

- First ttbar cross section measurement explicitly including taus at the LHC
  - Not well studied at the Tevatron
  - Involves only 3rd generation quarks/leptons
  - Sensitive to New Physics



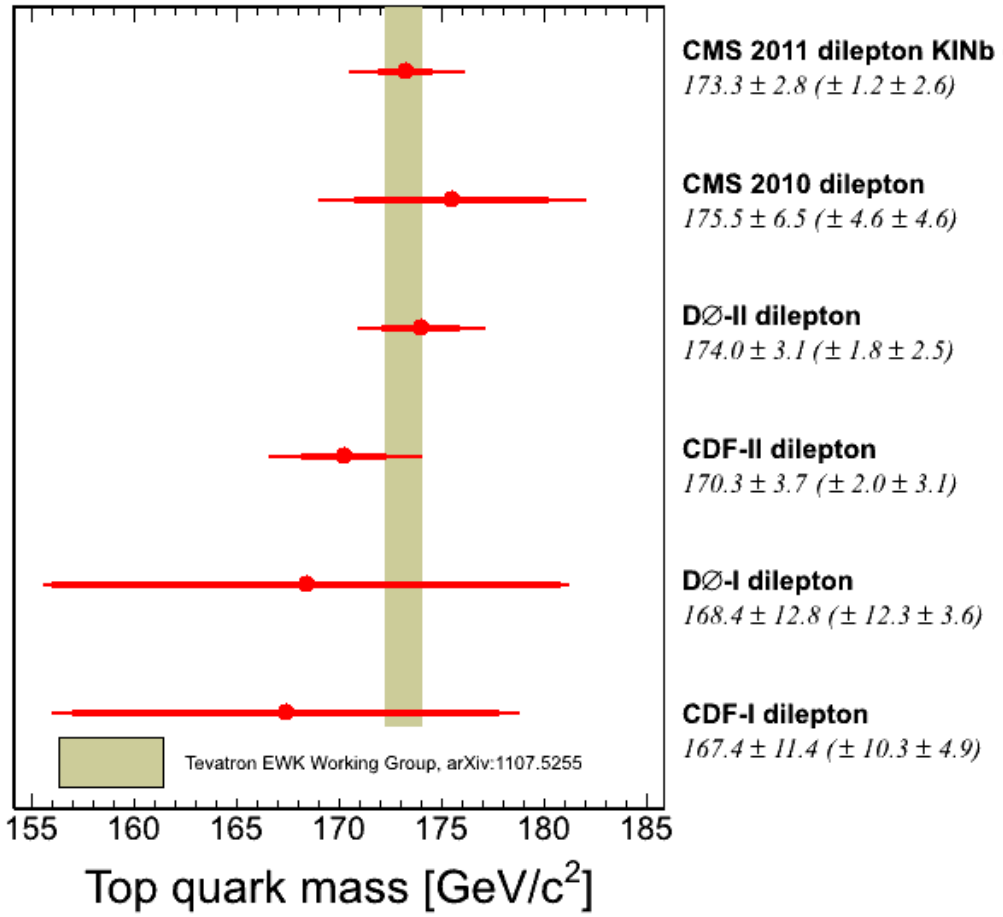
- Reconstruct top quark mass

$$\sigma_{t\bar{t}} = 143 \pm 14(\text{stat.}) \pm 22(\text{syst.}) \pm 3(\text{lumi.})\ \text{pb}$$

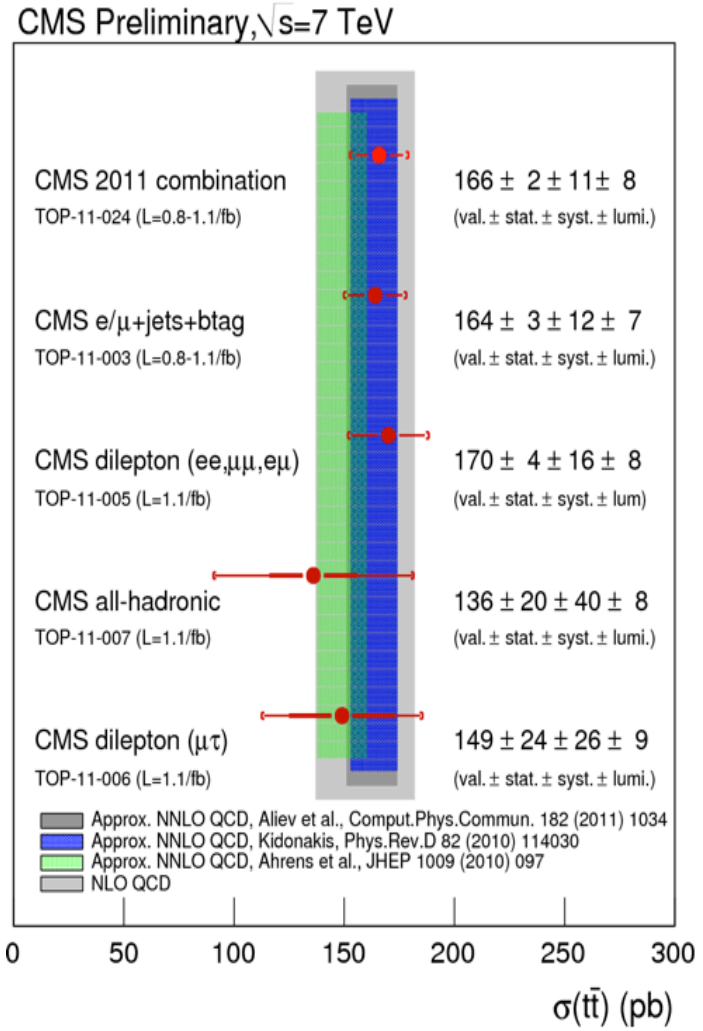


CMS PAS TOP-11-006 (1.1/fb)
arXiv:1203.6810 (2.2/fb): subm. to PRD

Mass and cross section comparison



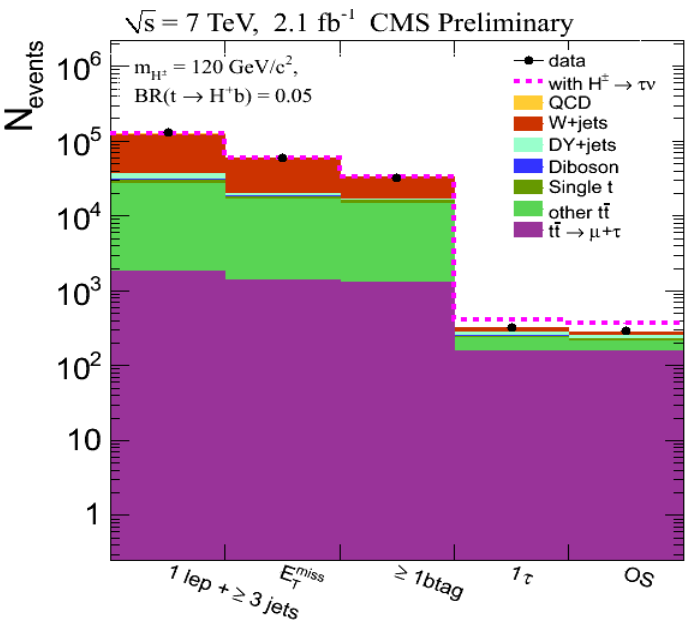
CMS TOP-11-024

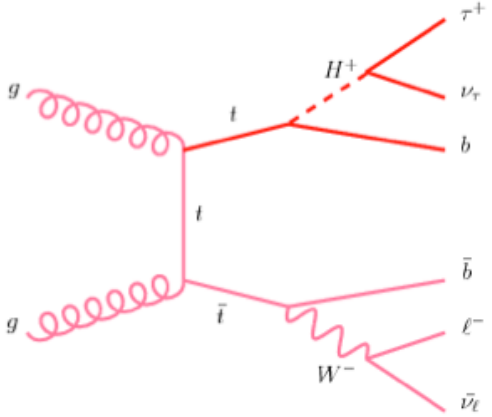


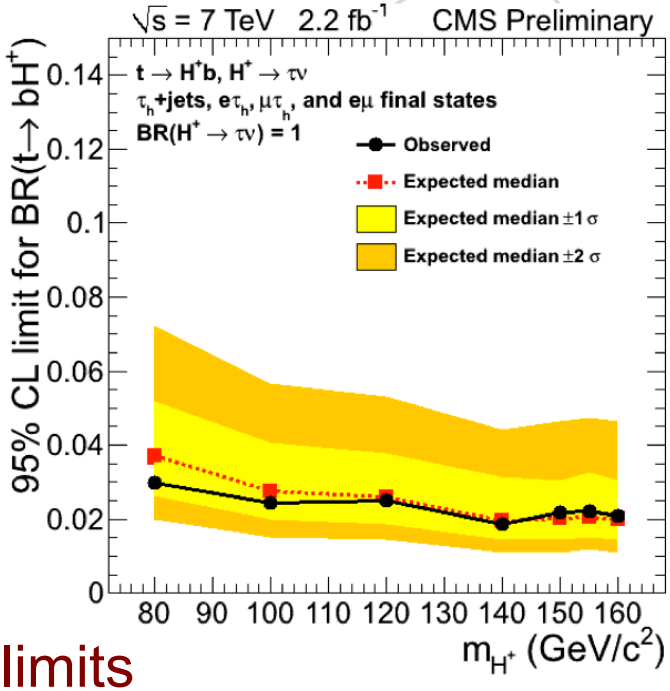
MSSM charged Higgs

- If anomalous production in ttbar decays there may be a contribution from charged Higgs
- Careful determination of backgrounds with data

PAS HIG-11-002 (36/pb)
PAS HIG-11-008 (1.1/fb)
PAS HIG-11-019 (2.2/fb, TBS)





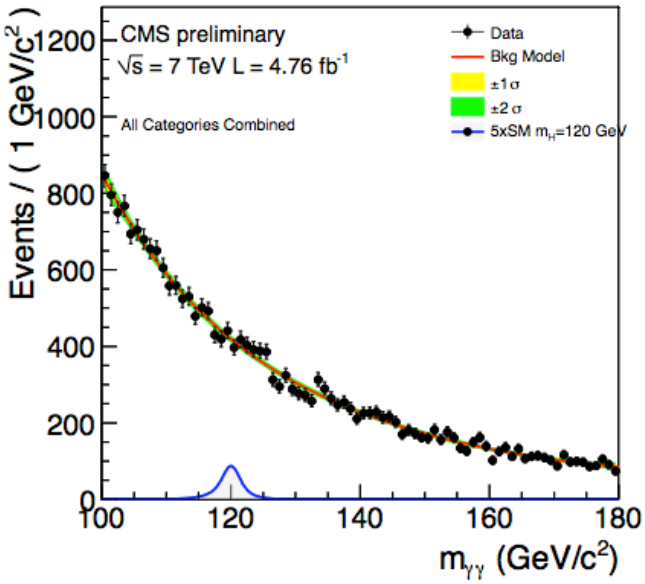


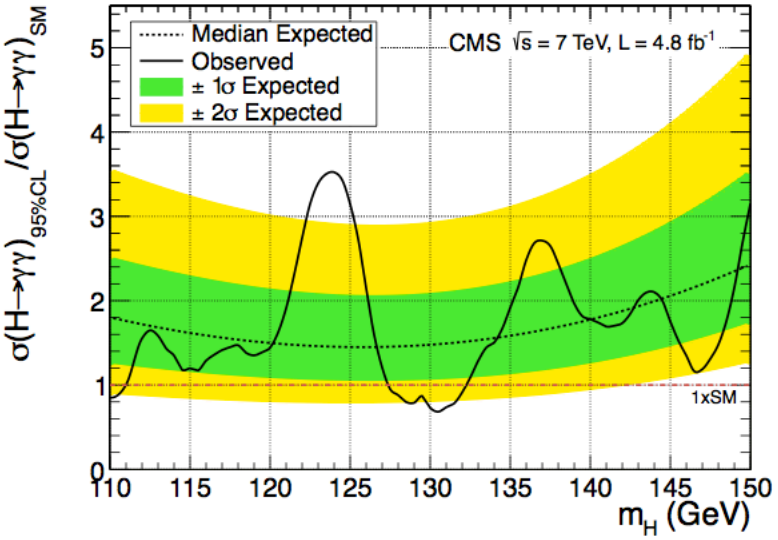
Yields in agreement with expectations ⇒ set limits

$80 < m_{H^+} < 160$ GeV. $BR(t \to H^+ b) < 2 - 3\%$

Higgs to photons

- Golden channel for low mass Higgs search
- It is not easy
- Signature: two high p_T isolated photons
- Look for bump
- Region of interest: M_H=115-140 GeV/c^2

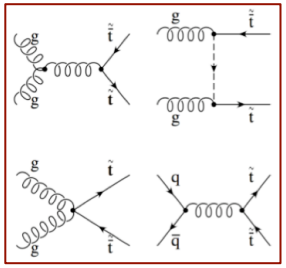


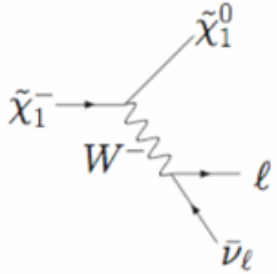


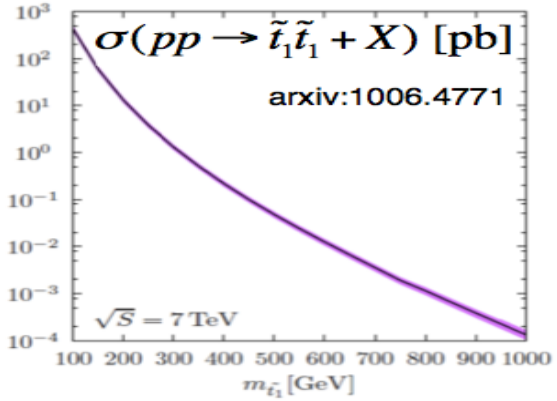
CMS PAS HIG-11-010 (1.1/fb)
CMS PAS HIG-11-021 (1.7/fb)
CMS PAS HIG-11-030 (4.8/fb)
Phys. Lett. B, 710 (2012) 403
CMS PAS HIG-12-001 (4.8/fb)

SUSY: Scalar top quark

- SUSY is one plausible extension of the SM
- Due to the heavy top quark, mass splitting between $\tilde{t}_1$ and $\tilde{t}_2$ can be large, such that the lighter stop $\tilde{t}_1$ can be even lighter than the top quark
- Similar signature as in ttbar:







- Light stop:

$$m_{\tilde{t}_1} \lesssim m_t \qquad \tilde{t}_1 \to b + \tilde{\chi}_1^{\pm} \to b + \tilde{\chi}_1^0 + \nu + \ell$$

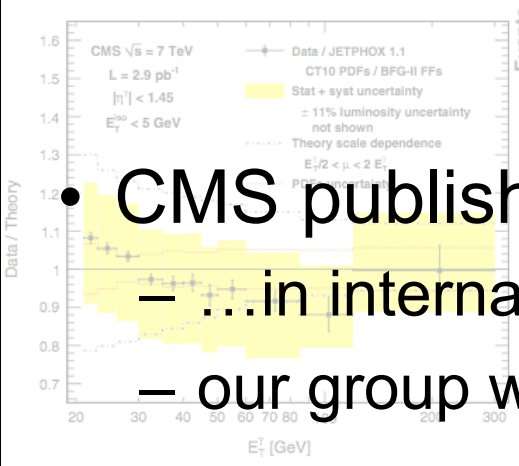
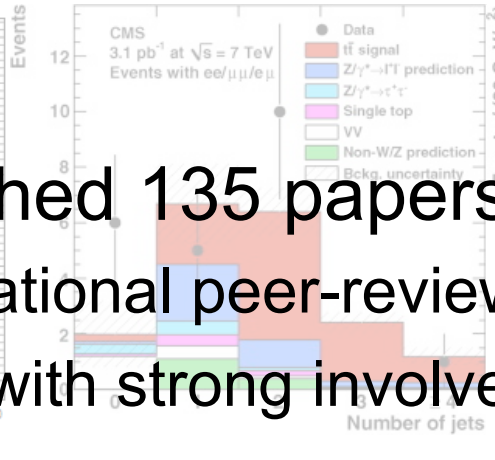
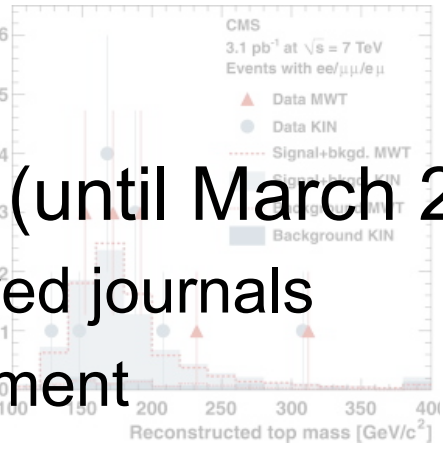
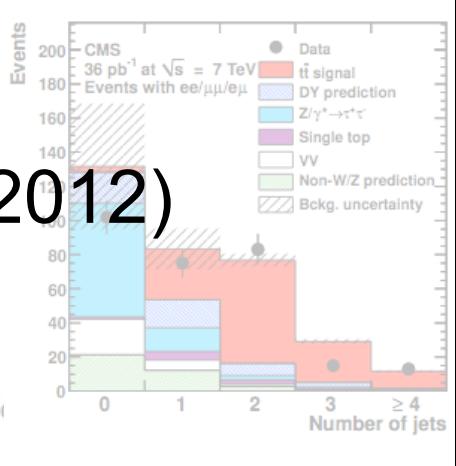
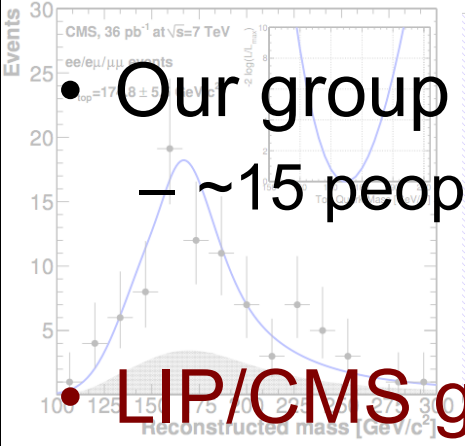
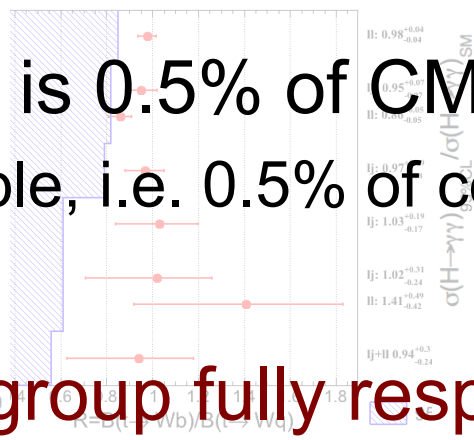
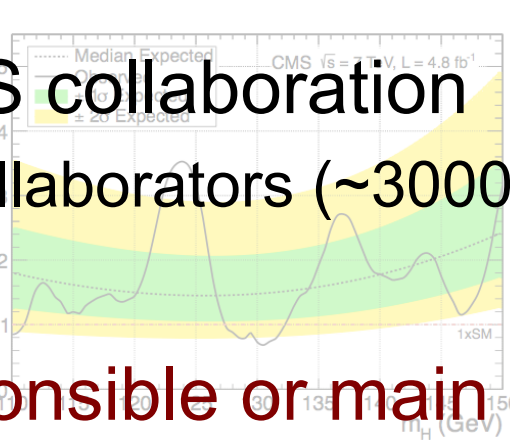
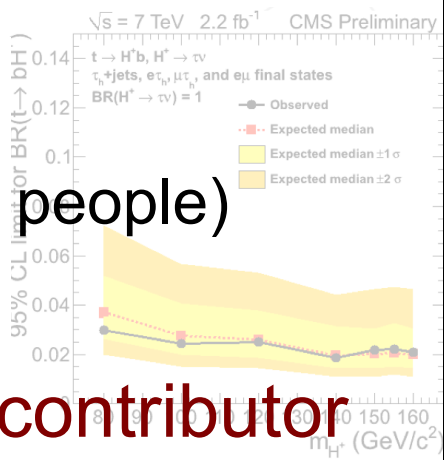
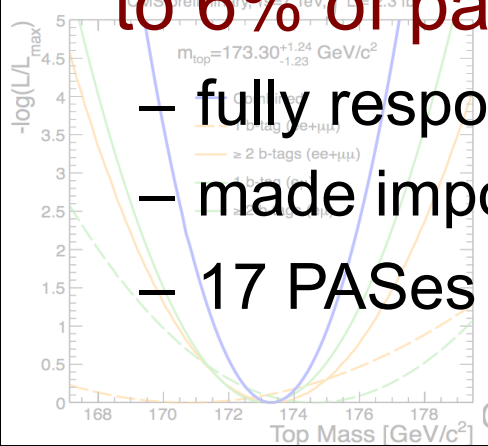
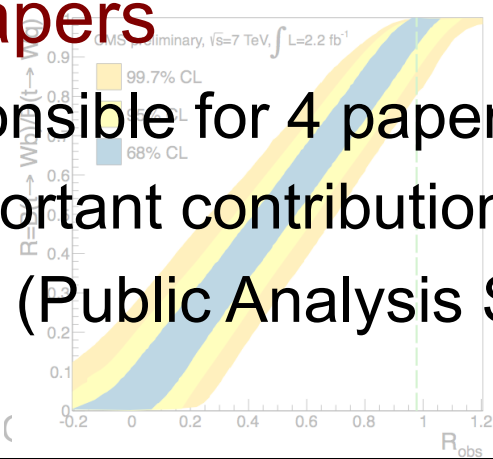
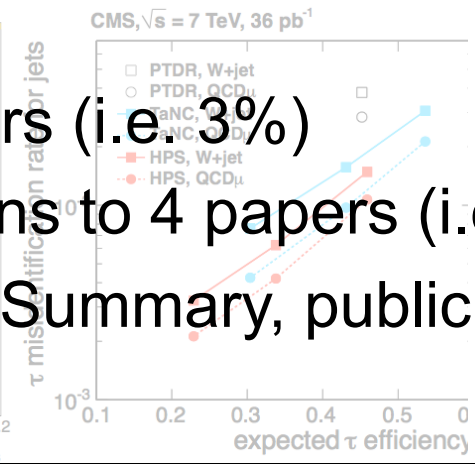
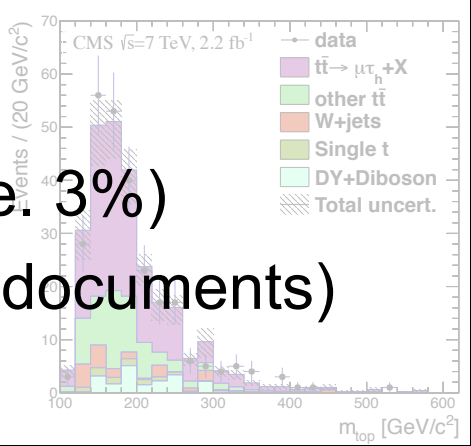
- Heavy stop:

$$\tilde{t} \to t\tilde{\chi}^0$$

- Final state: 1lepton+MET +2jets+2b
- limitations due to small xsec, large ttbar background

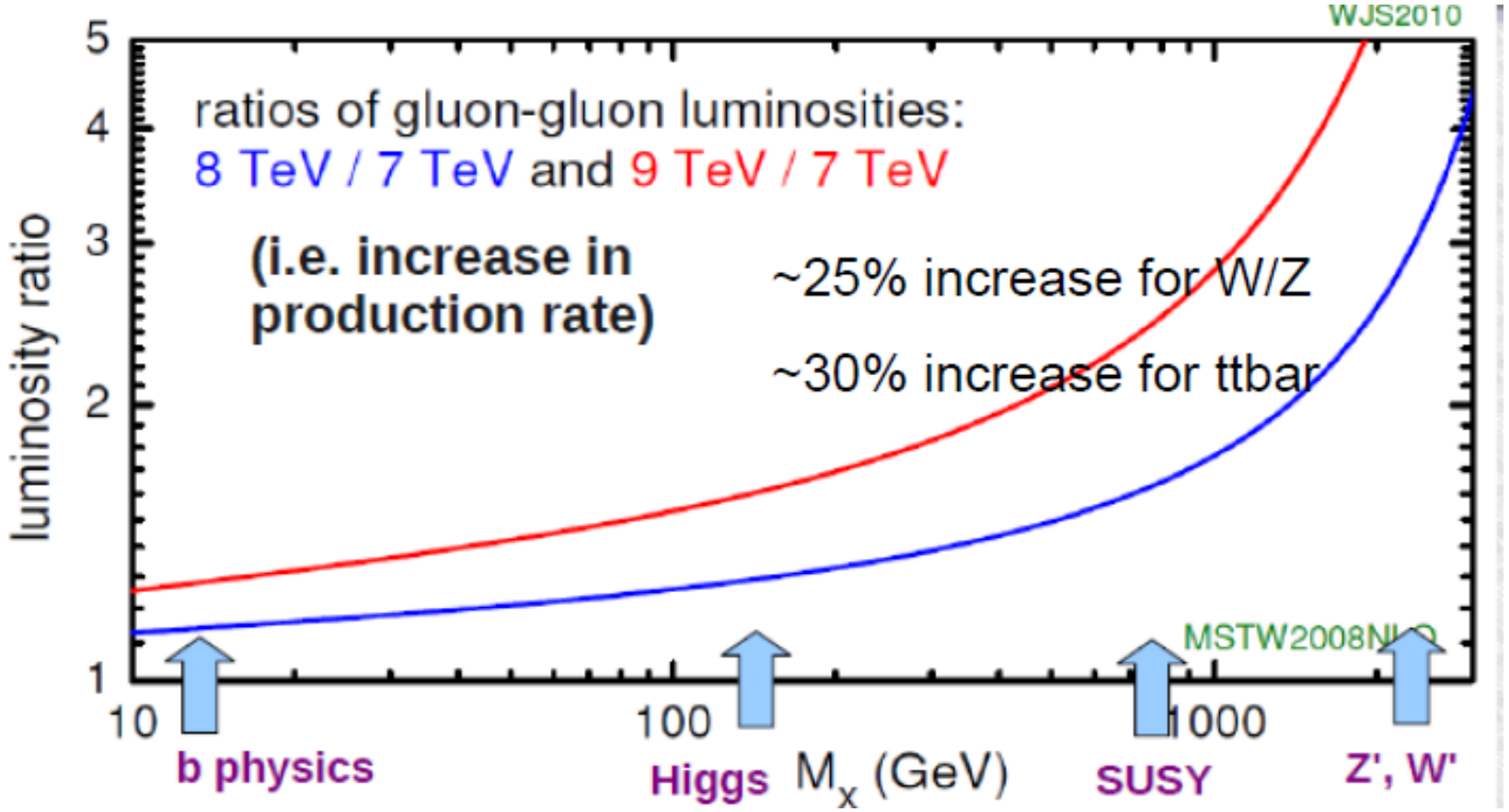
$$\tilde{t}\tilde{t} \to t\bar{t}\,\chi^0\chi^0 \qquad \tilde{t}\tilde{t} \to b\bar{b}\,\chi^+\chi^- \to b\bar{b}W^+W^-\chi^0\chi^0$$

- CMS published 135 papers (until March 2012)
  - …in international peer-reviewed journals
  - our group with strong involvement
- Our group is 0.5% of CMS collaboration
  - ~15 people, i.e. 0.5% of collaborators (~3000 people)
- LIP/CMS group fully responsible or main contributor to 6% of papers
  - fully responsible for 4 papers (i.e.3%)
  - made important contributions to 4 papers (i.e. 3%)
  - 17 PASes (Public Analysis Summary, public documents)

Outlook for 2012

- New beam energies will require re-rediscoveries of SM
- Increased discovery potential at 8 TeV



Summary

- Very positive start of operation at the LHC
- Good performance of detector/accelerator

- Strong (intense?) involvement in physics analyses
  - Early data: Inclusive photon cross section
  - Top quark: cross section, mass, taus, R
  - Higgs: SM (photons), MSSM (taus)
  - SUSY: scalar top
- This year: larger dataset, aim at discoveries (?)

The people