RECENT RESULTS FROM CMS

Suyong Choi (Korea University)

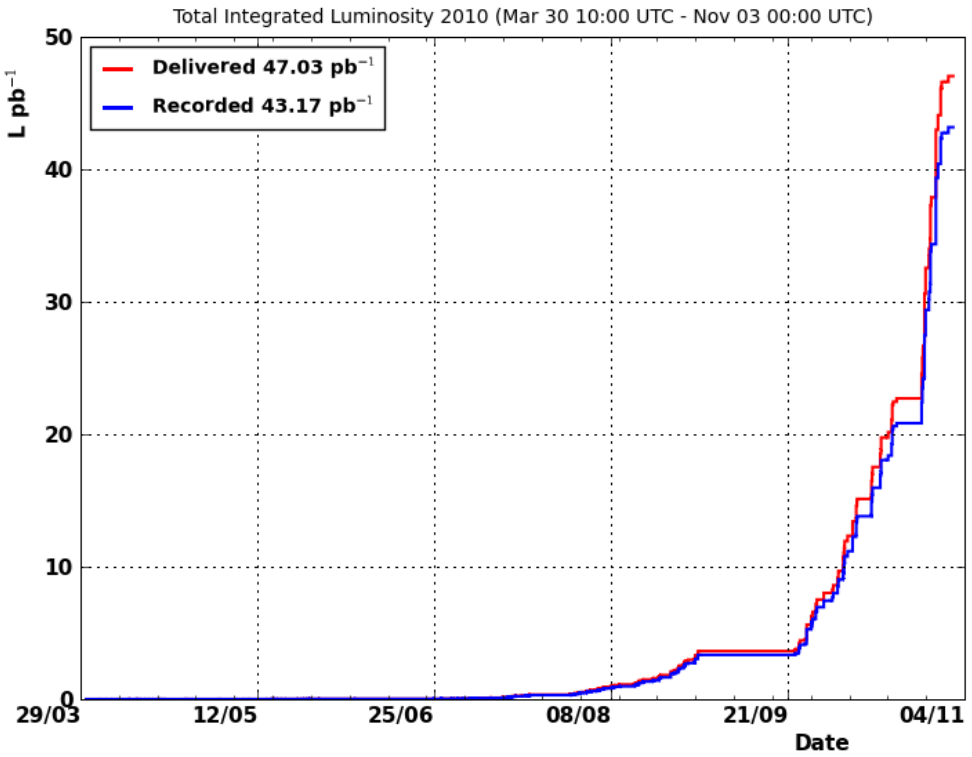
CONTENTS

- LHC 7 TeV Run
- Results
- Summary and Outlook

STATUS OF LHC

- In 2010, LHC ran with $\sqrt{s} = 7$ TeV
- Instantaneous luminosity of 2×10^{32} reached
  - Number of protons in a bunch almost targeted design
- Atlas and CMS collected 35~45 pb-1 each in 2010
- New results already exceed that of Tevatron

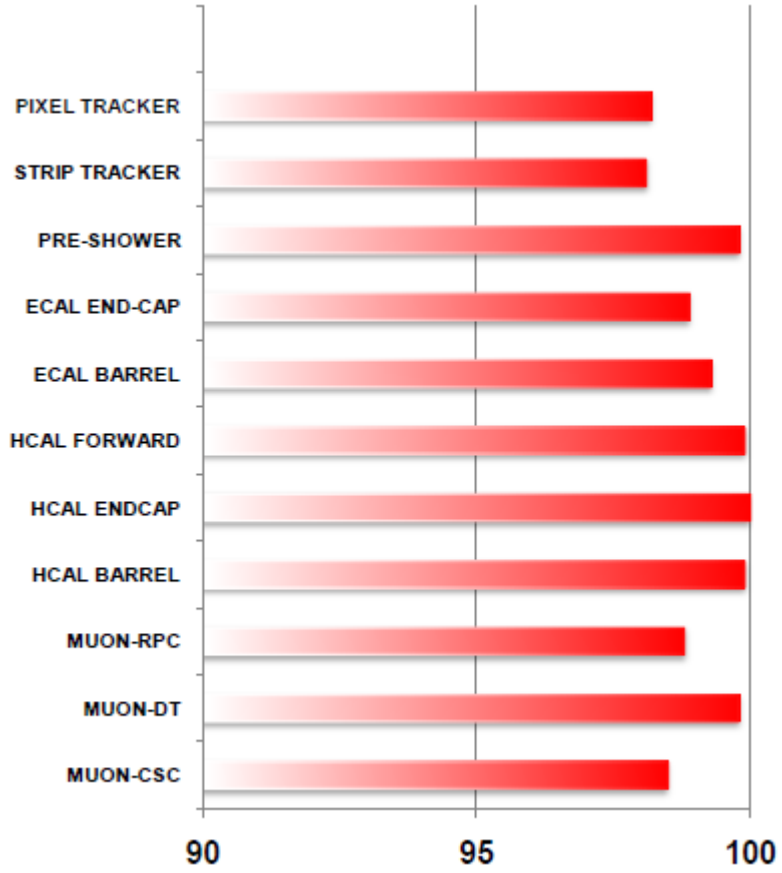
INTEGRATED LUMINOSITY AT CMS



- Peak instantaneous luminosity: 2×10^{32} cm^{-2}s^{-1}

CMS STATUS

- Over 95% efficiency for all detectors
- Data taking efficiency 92%
- 85% usable data by all analyses



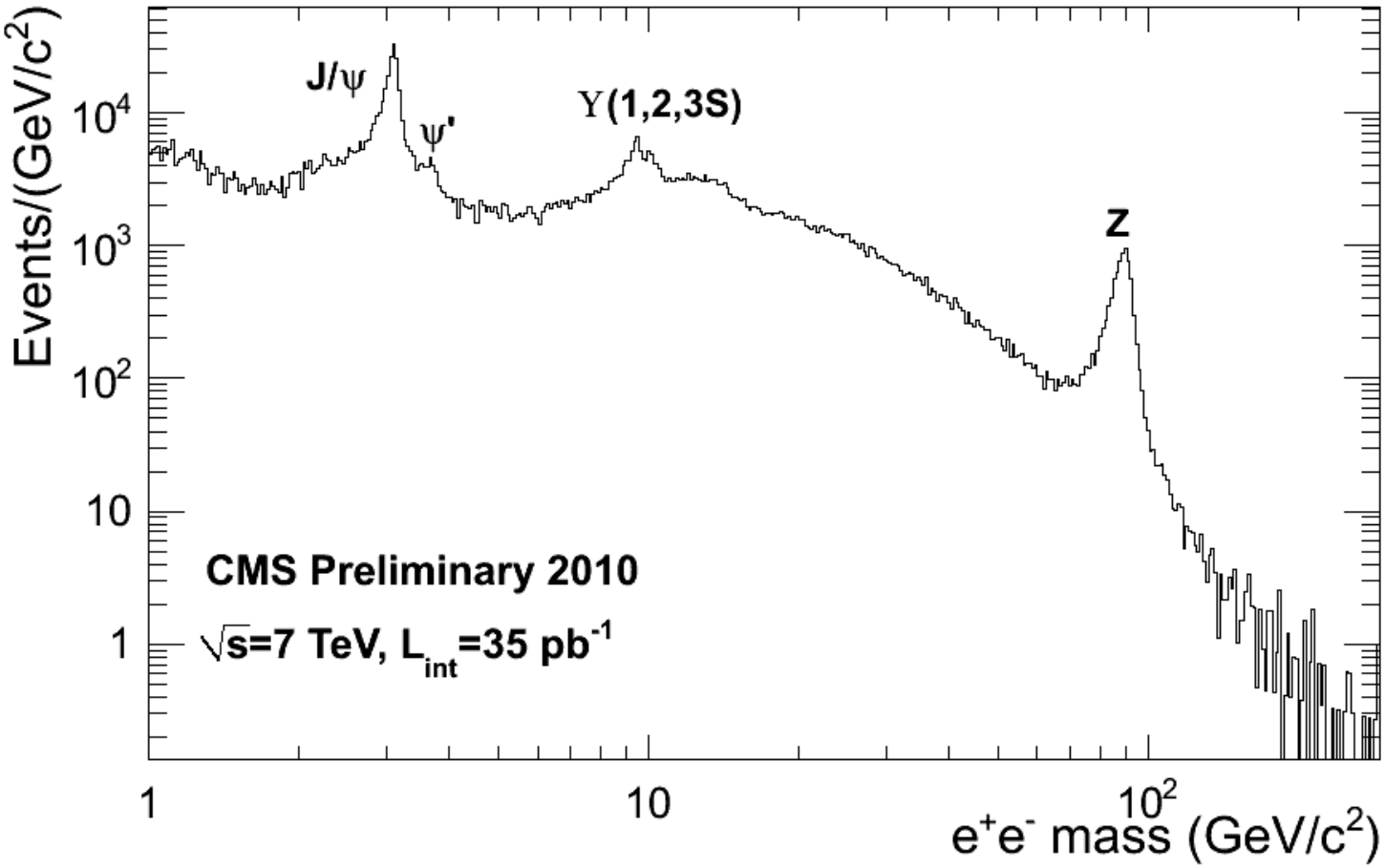
GOALS FOR ~10 PB^{-1}

- Detector and operations
  - Understand and optimize performance
  - Calibration issues
  - Data taking and processing
- Physics
  - QCD and W/Z backgrounds
  - Rediscovery of SM at 7 TeV: W, Z, onia, top, V+jets
  - Physics searches with jets: dijet resonances, compositeness
- Addressed in 2010 summer

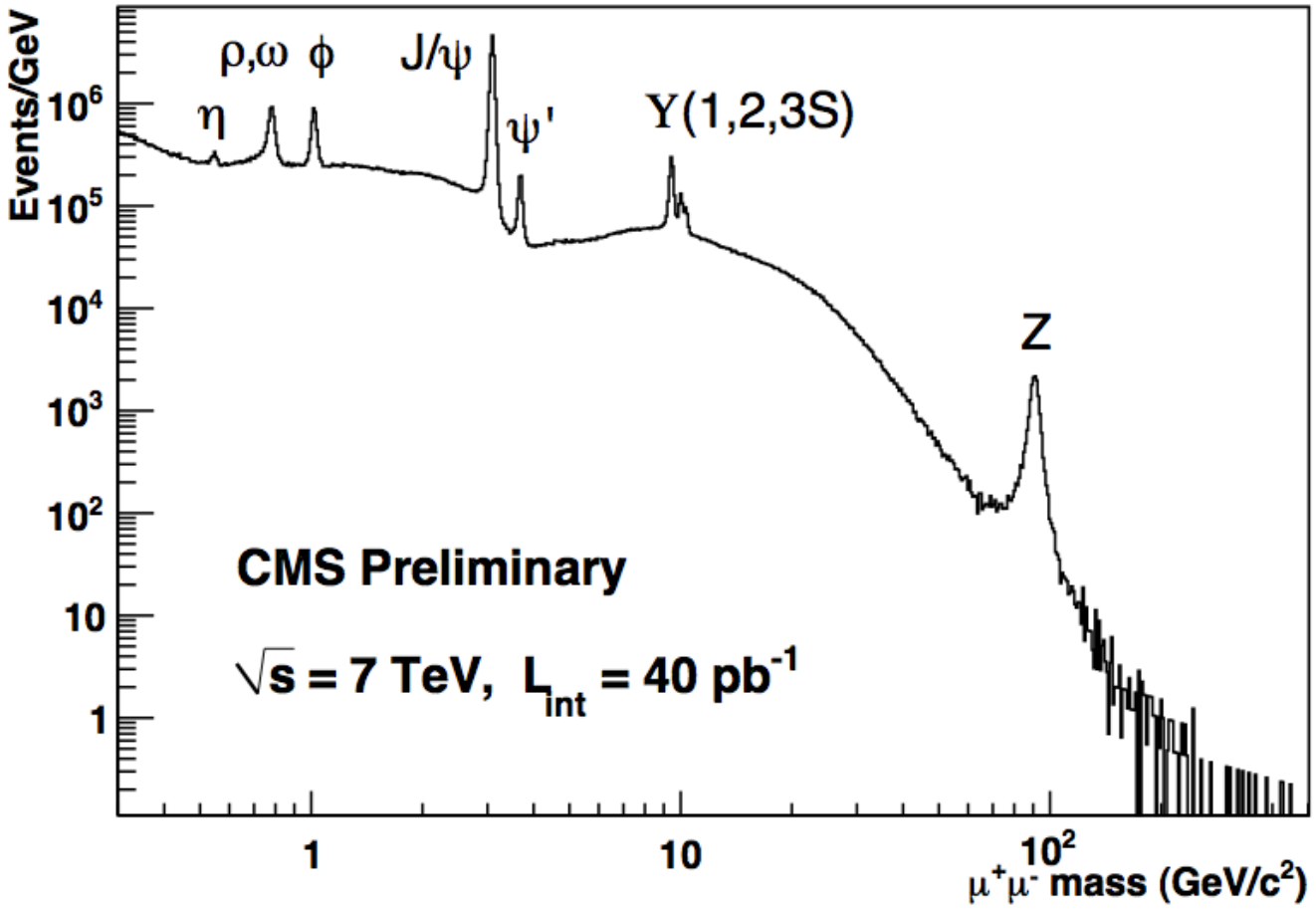
GOALS FOR THE FULL 2010 DATA

- More Precise SM measurements
- Top pair production
- SUSY searches
- TeV resonances – Z', RS gravitons
- Foundations for Higgs searches in 2011

RESONANCES IN DIELECTRON MASS SPECTRA



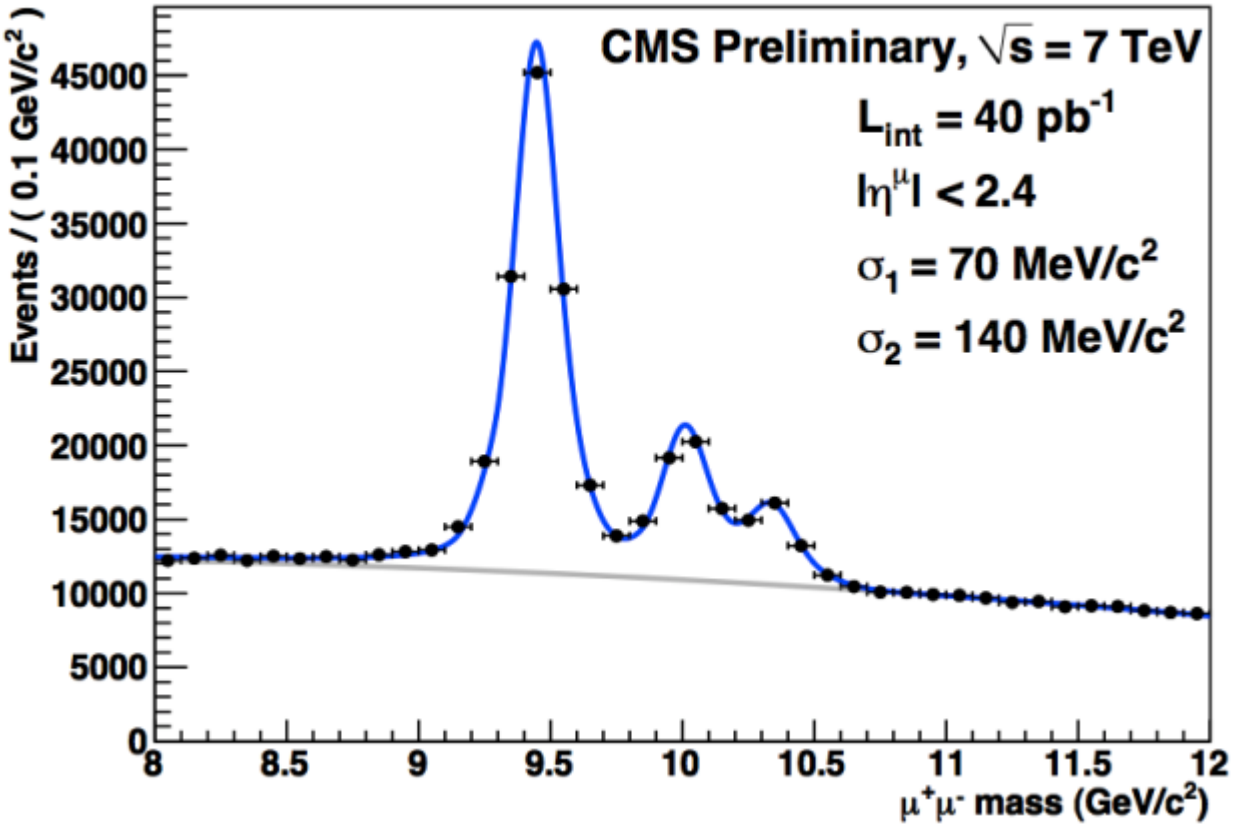
RESONANCES IN DIMUON MASS SPECTRA



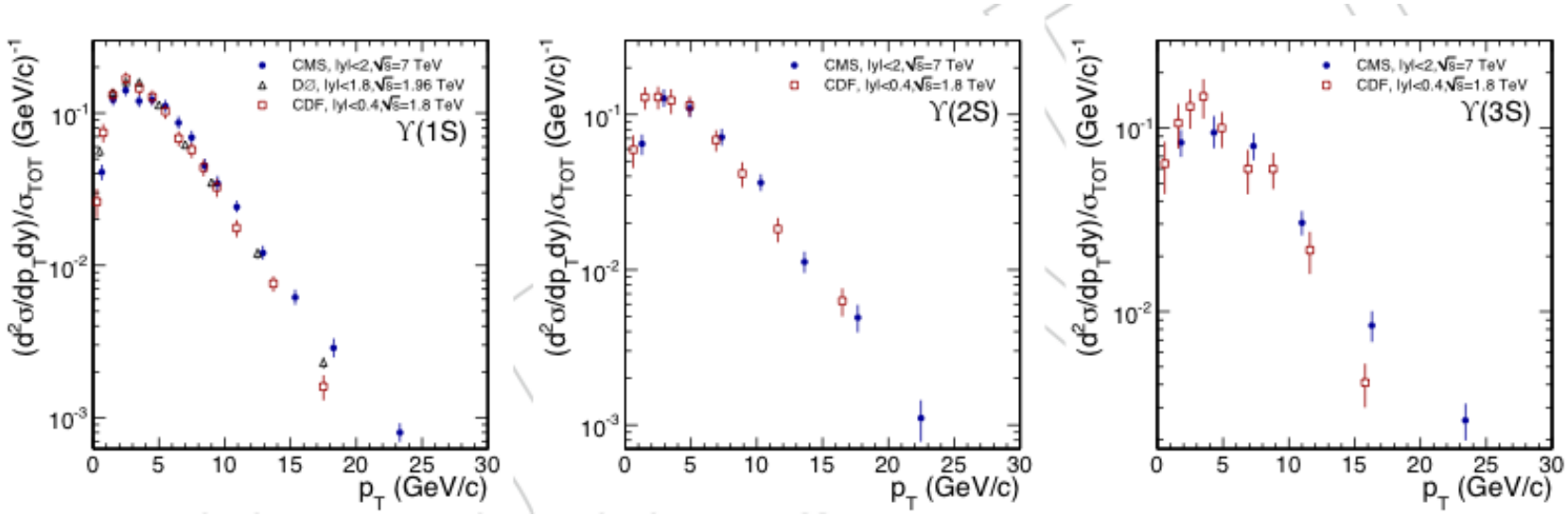
KOREAN CONTRIBUTIONS TO CMS ANALYSES IN 2010

- Contributed directly to the following analyses
  - Inclusive and differential J/ψ and b production
  - $t\bar{t}$ production cross section in dilepton channel
  - SUSY Trilepton
  - $W' \rightarrow e\nu$ Search
  - Doubly charged Higgs search
  - Azimuthal correlations of charged hadrons in Pb+Pb
  - RS Graviton -> ZZ
  - Some results are not public yet

Υ PRODUCTION



UNPOLARIZED ϒ PRODUCTION

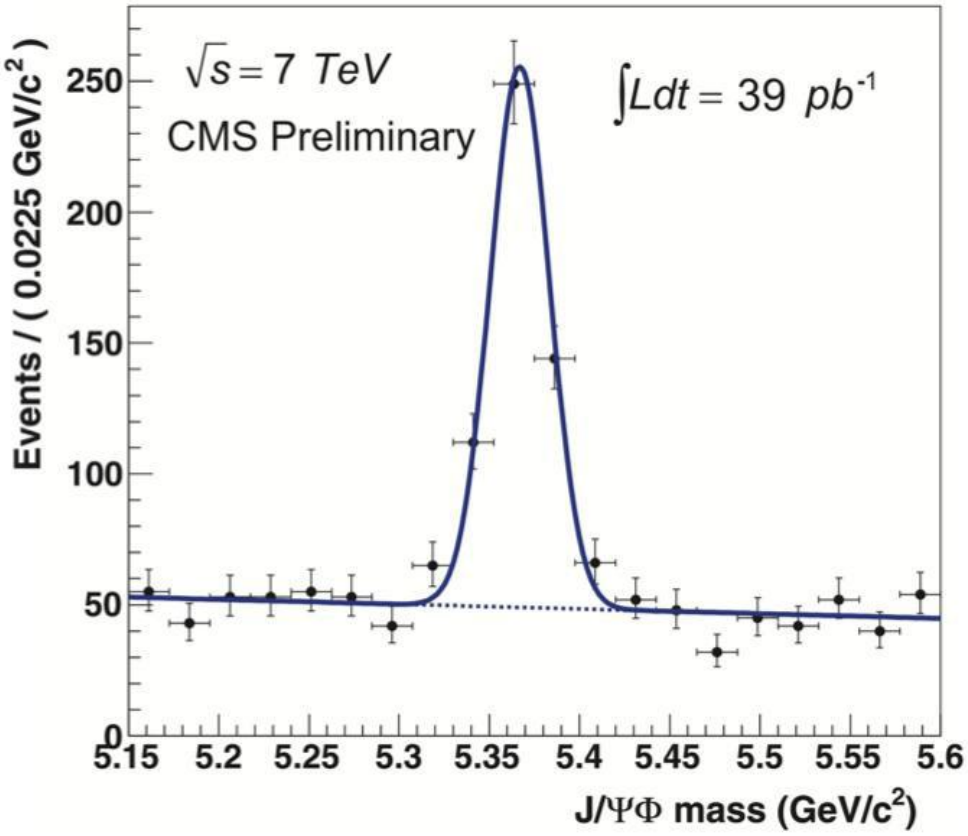


$$\sigma(pp \to \Upsilon(1S)X) \cdot \mathcal{B}(\Upsilon(1S) \to \mu^+\mu^-) = (7.49 \pm 0.13(\text{stat.})^{+0.67}_{-0.49}(\text{syst.}) \pm 0.82(\text{lumi.}))\ \text{nb},$$

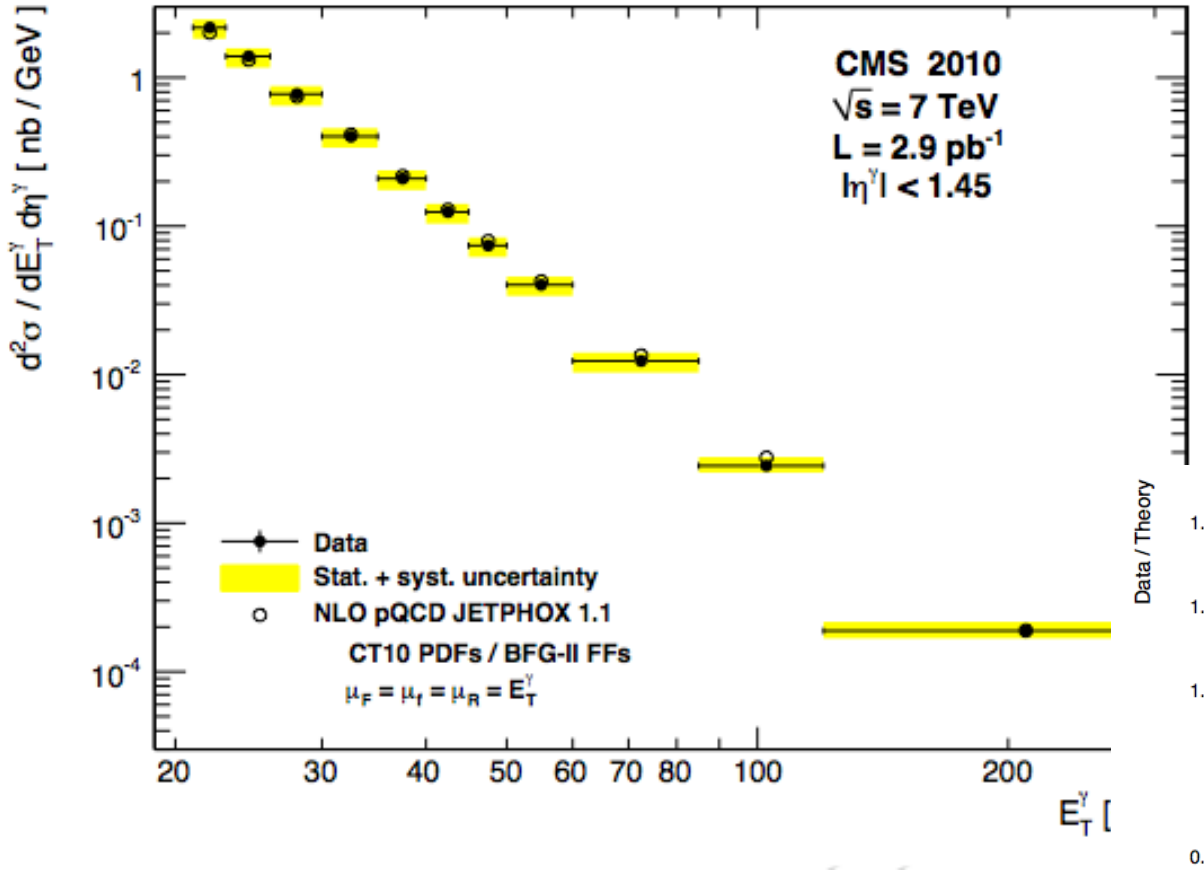
$$\sigma(pp \to \Upsilon(2S)X) \cdot \mathcal{B}(\Upsilon(2S) \to \mu^+\mu^-) = (1.93 \pm 0.08(\text{stat.})^{+0.19}_{-0.14}(\text{syst.}) \pm 0.21(\text{lumi.}))\ \text{nb},$$

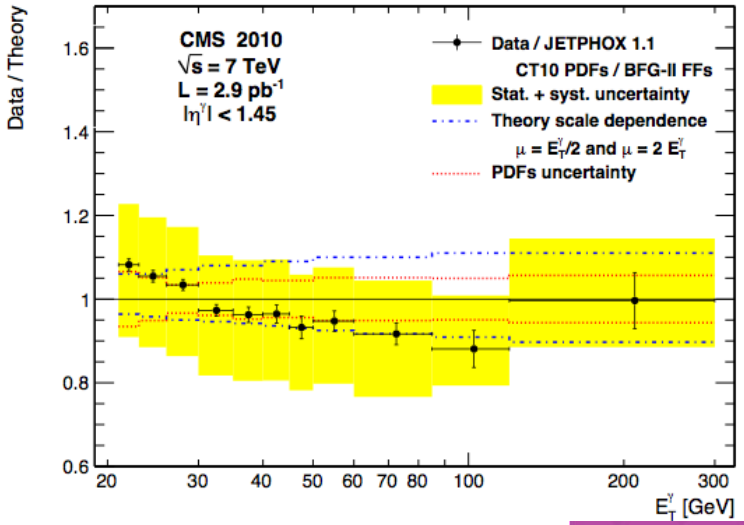
$$\sigma(pp \to \Upsilon(3S)X) \cdot \mathcal{B}(\Upsilon(3S) \to \mu^+\mu^-) = (1.04 \pm 0.07(\text{stat.})^{+0.12}_{-0.09}(\text{syst.}) \pm 0.11(\text{lumi.}))\ \text{nb}.$$

$B_s \rightarrow J/\psi\phi$

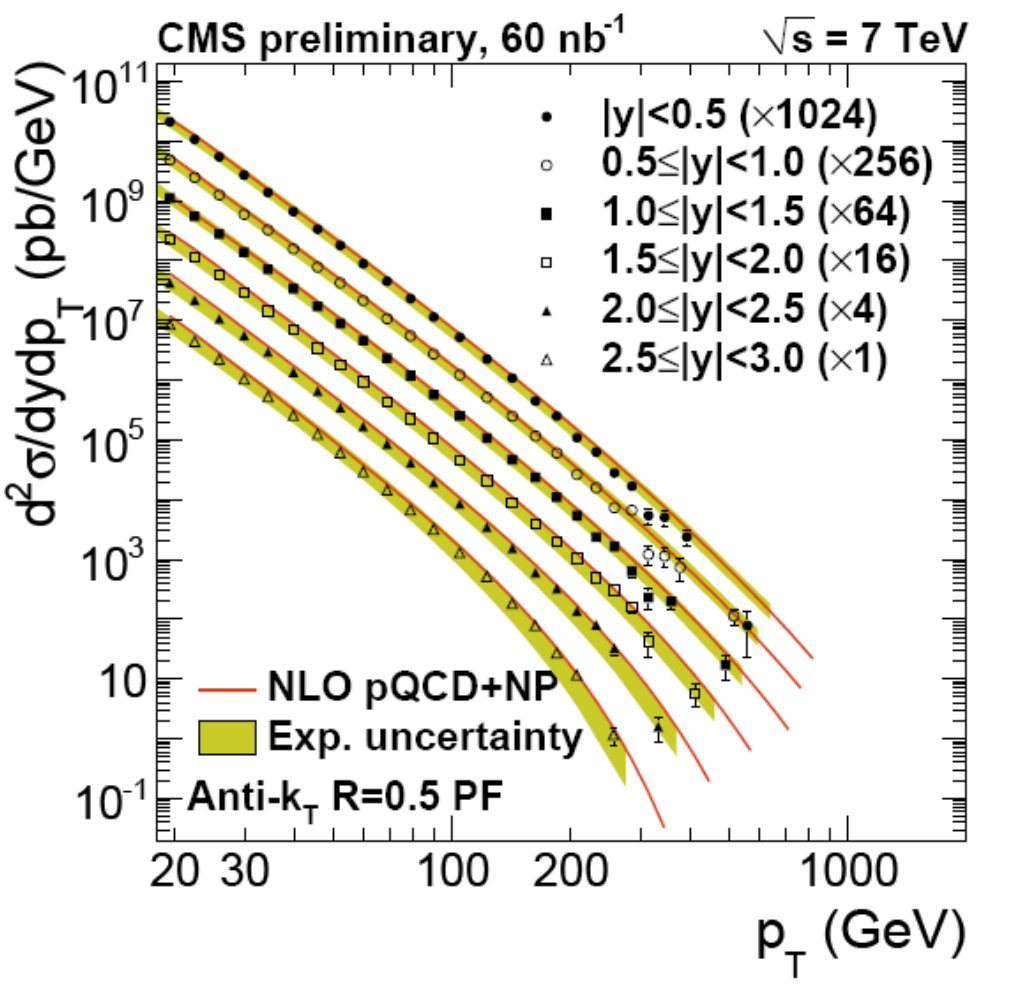


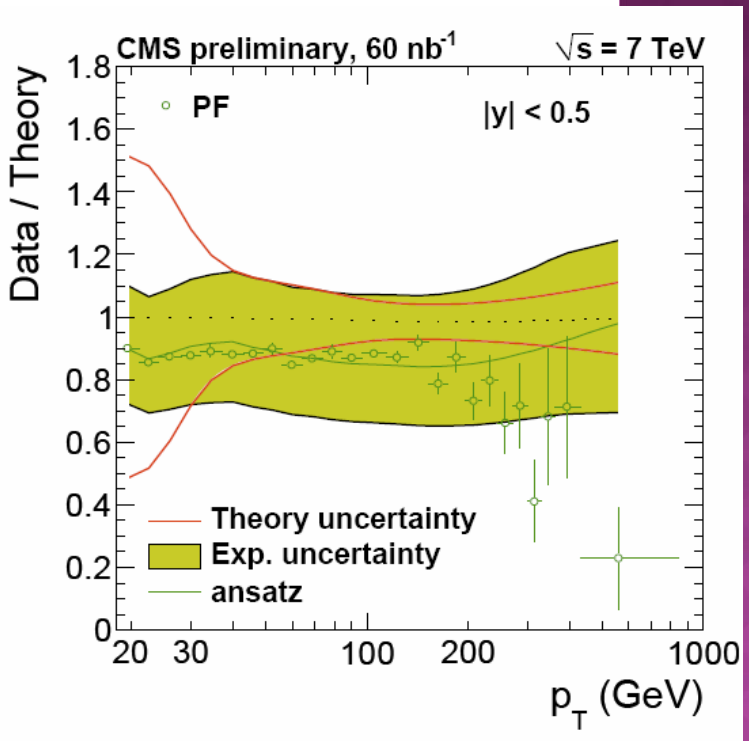
ISOLATED PHOTON PRODUCTION



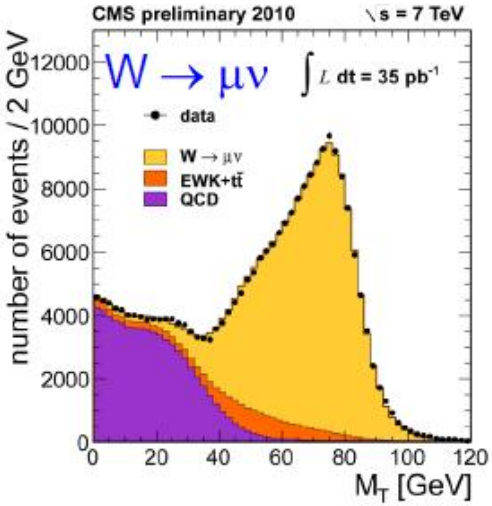


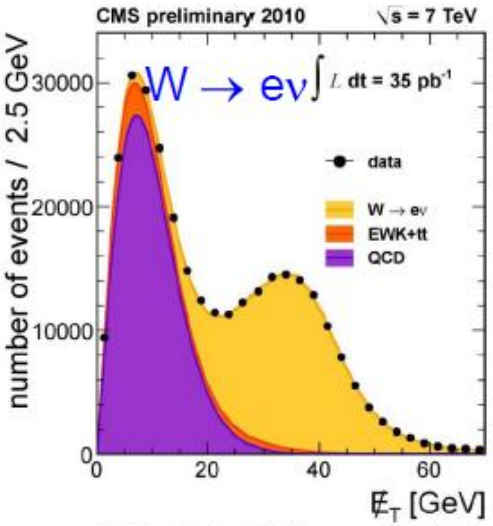
JETS

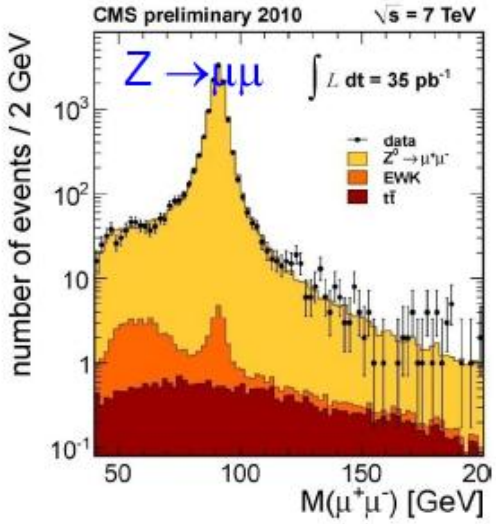

CMS preliminary, 60 nb^{-1}
$\sqrt{s}$ = 7 TeV
|y|<0.5 (×1024)
0.5≤|y|<1.0 (×256)
1.0≤|y|<1.5 (×64)
1.5≤|y|<2.0 (×16)
2.0≤|y|<2.5 (×4)
2.5≤|y|<3.0 (×1)
NLO pQCD+NP
Exp. uncertainty
Anti-k$_T$ R=0.5 PF
$d^2\sigma/dydp_T$ (pb/GeV)
p_T (GeV)

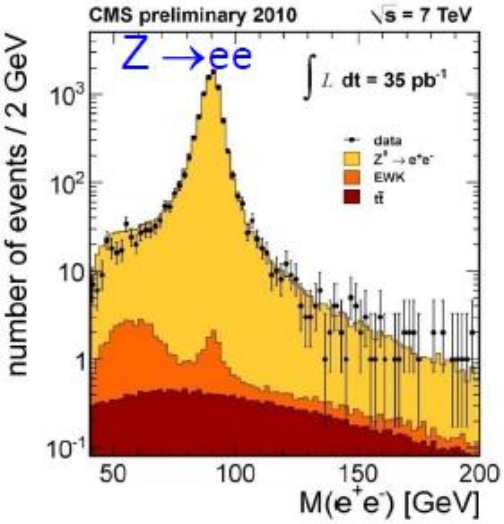

CMS preliminary, 60 nb^{-1}
$\sqrt{s}$ = 7 TeV
PF
|y| < 0.5
Theory uncertainty
Exp. uncertainty
ansatz
Data / Theory
p_T (GeV)

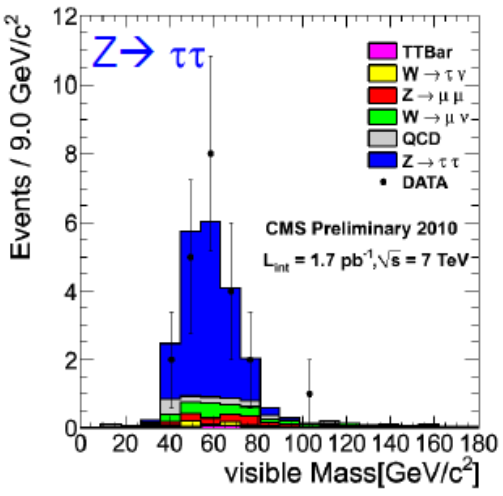
W AND Z BOSONS AT CMS



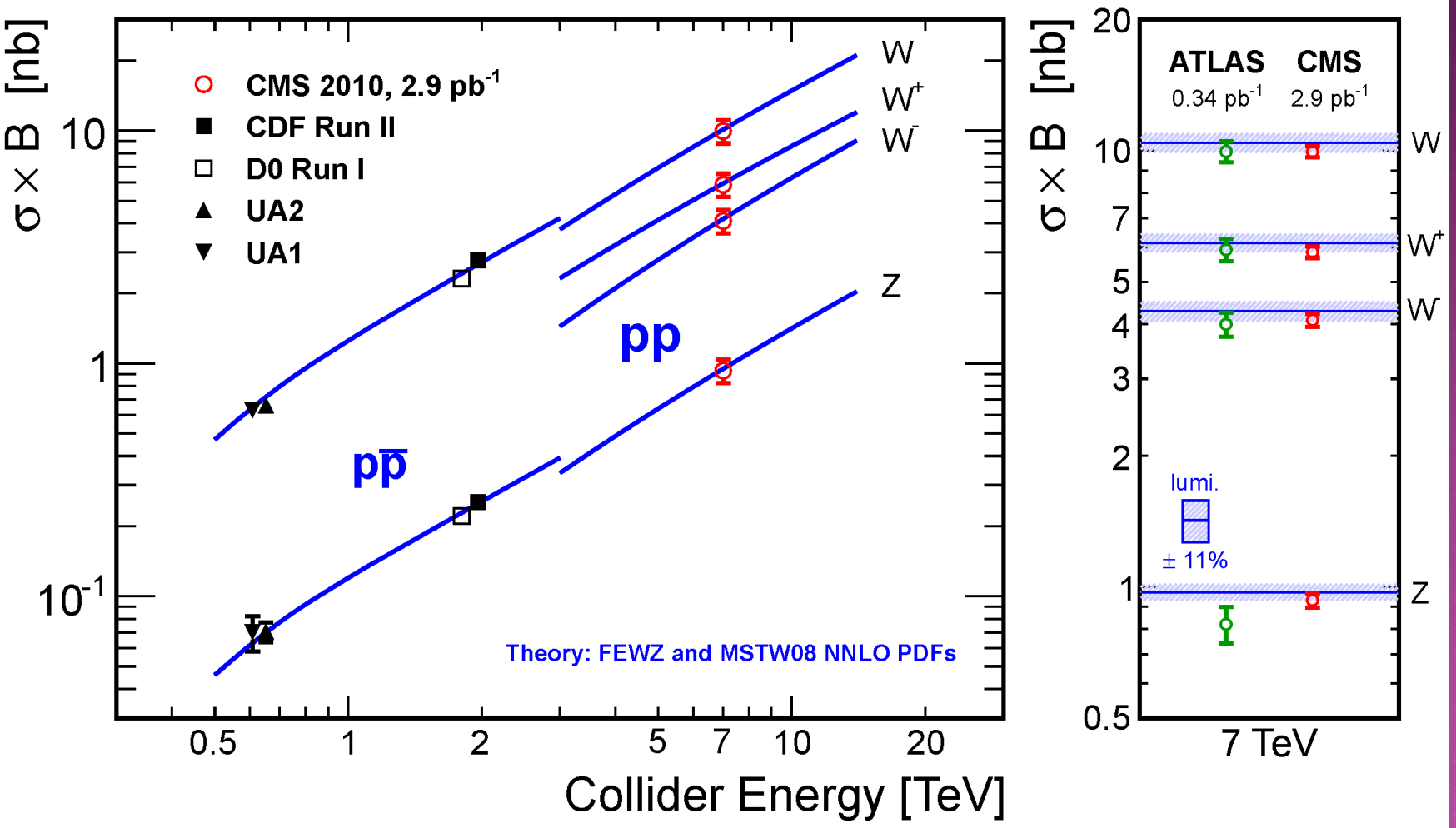




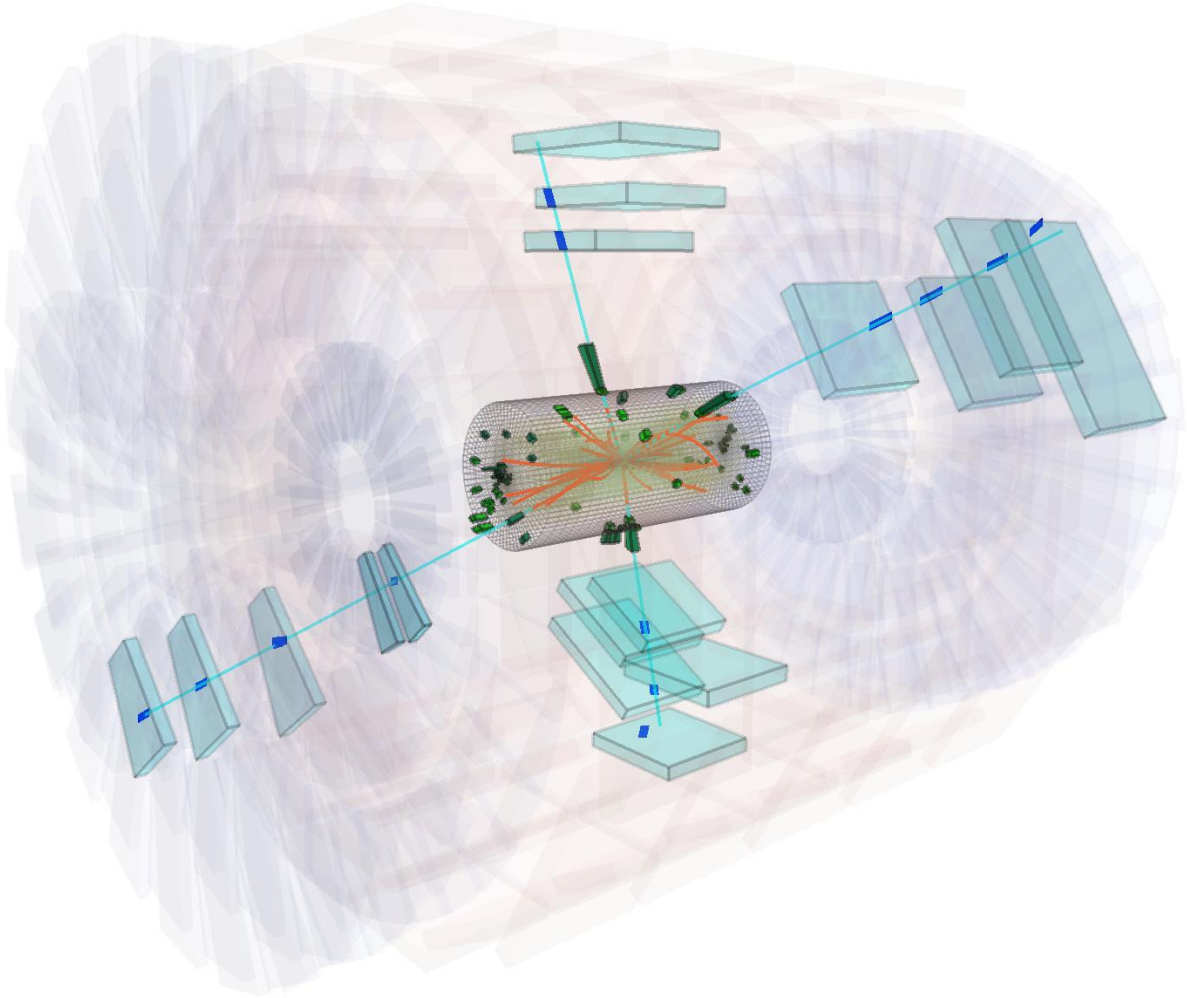




W CROSS SECTIONS

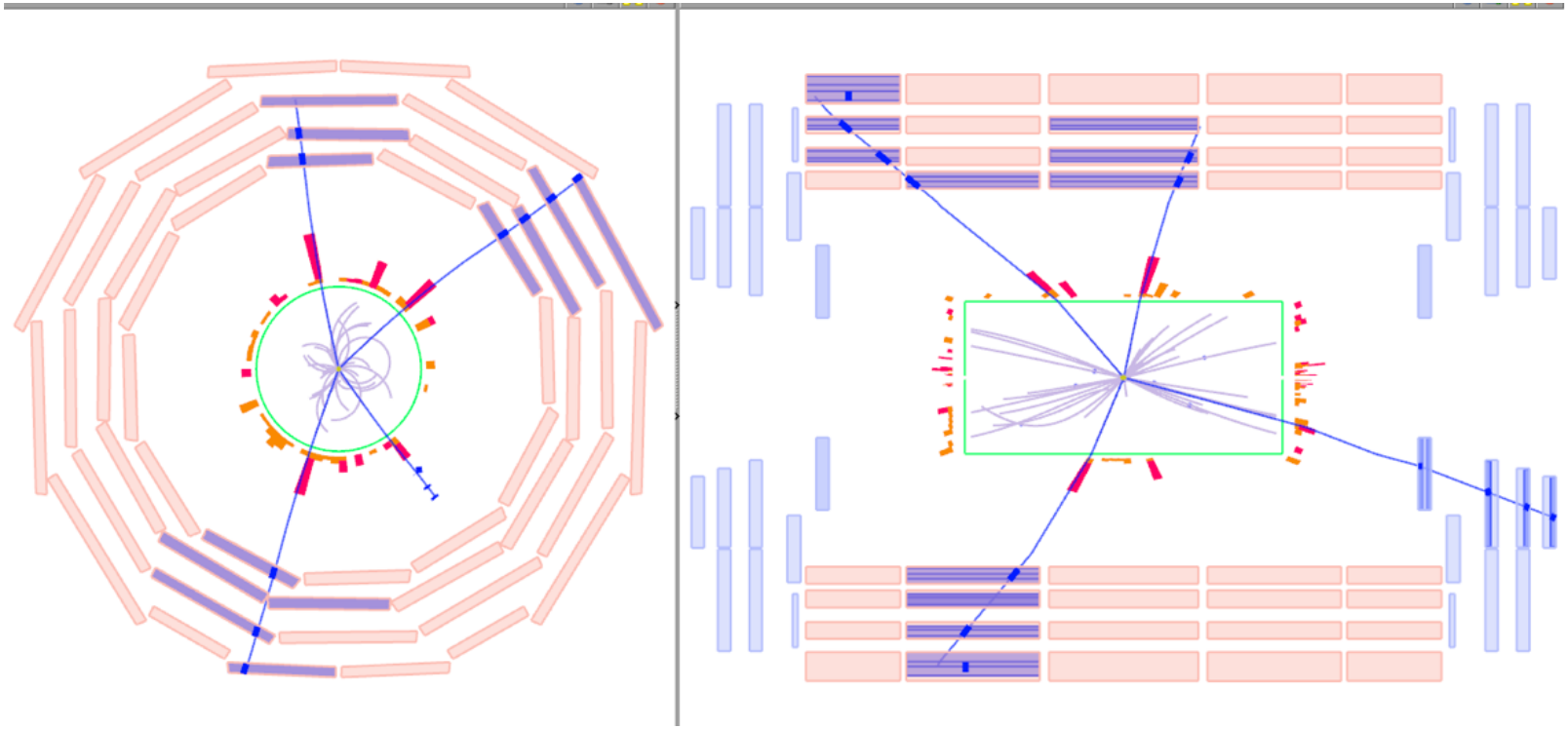


ZZ CANDIDATE

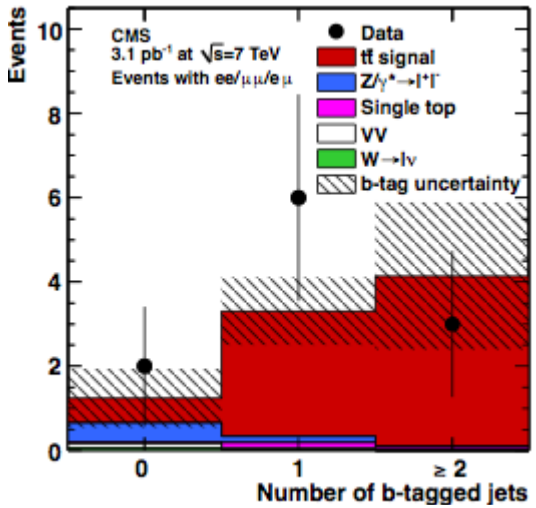


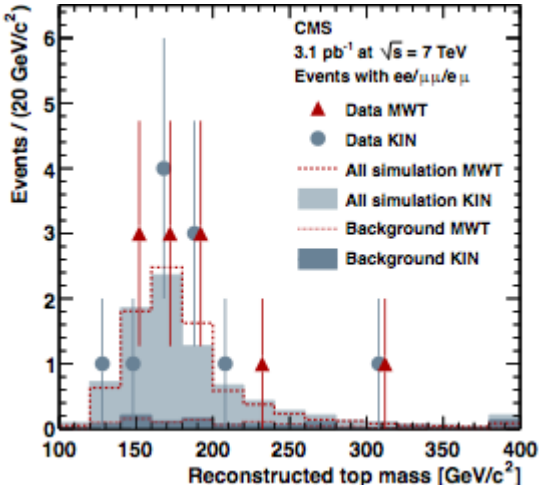
CMS ZZ CANDIDATE

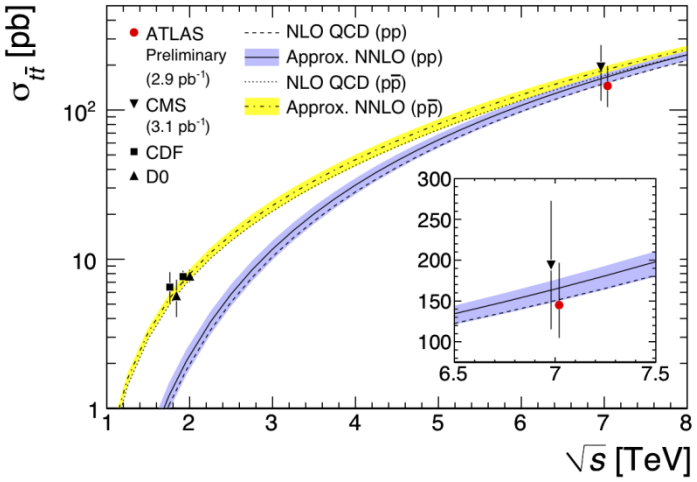
- Invariant mass of 4 muon 201 GeV



TOP CROSS SECTION







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

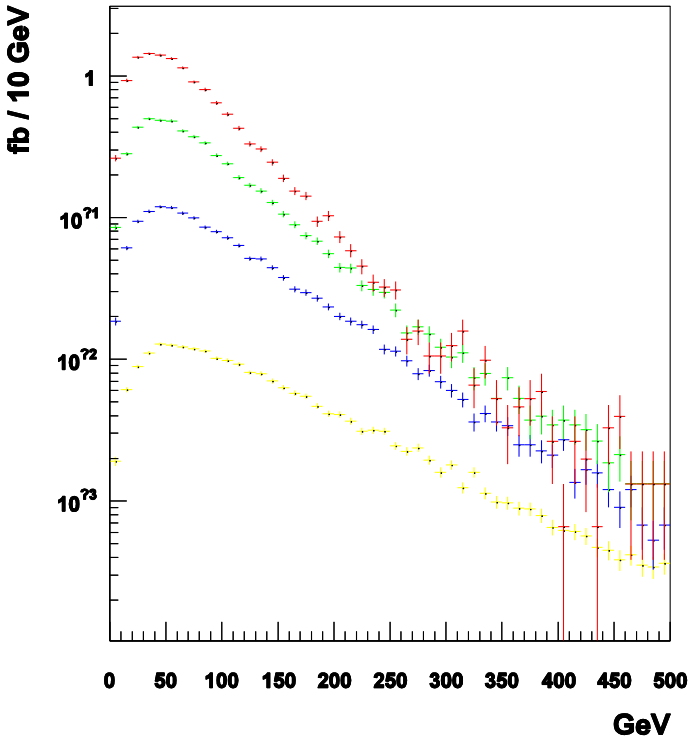
TOP ANALYSES

- Ttbar dilepton cross section with 35 pb-1 result coming soon with contribution from Korean group
- Next step is to measure $M(t\bar{t})$ spectrum by summer
  - Aiming for unfolded measurement
  - Resonances
  - Rise in the large mass area
- Search for like-sign top pair
  - Recently proposed at CMS by our group
  - uu→tt via intermediate particle
  - Z' exchange implemented in MadGraph
  - Can use MT2 for reconstructing neutrino momenta

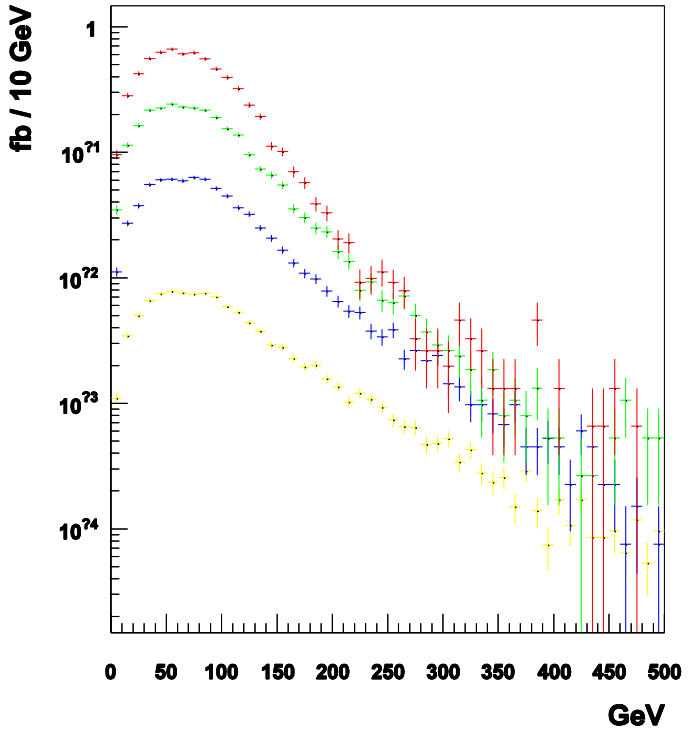
$uu \rightarrow tt \rightarrow \mu^+\mu^+ b\bar{b} + MET$

- $M_{Z'} = 200,300,500,1000\ GeV$

Muon pt



MET

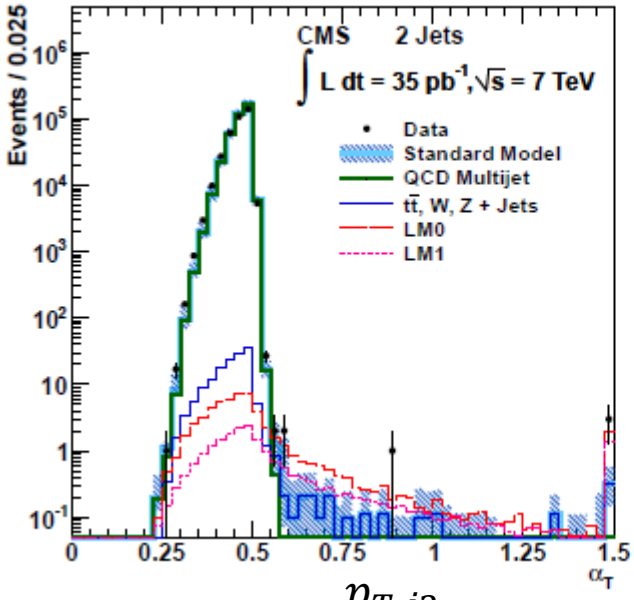


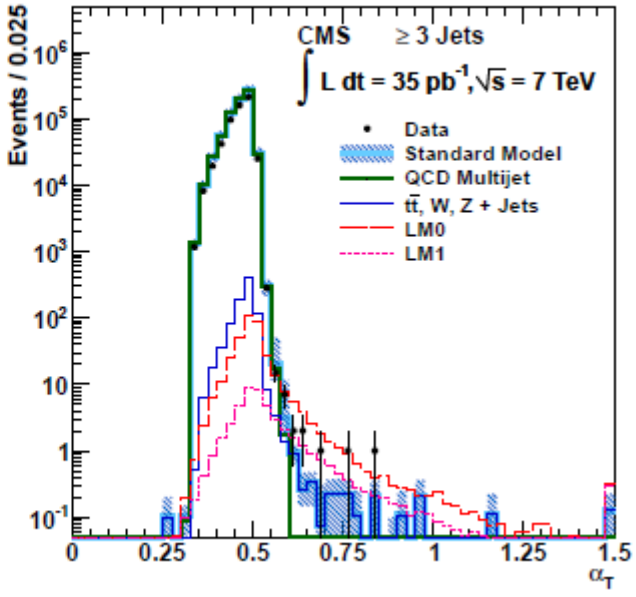
SUSY SEARCHES

SQUARKS AND GLUINOS SEARCHES IN JETS + MET

- Selection
  - Veto events with leptons or photons
  - Select on H_T = Scalar sum of p_T of jets
  - Select Second jet E_T

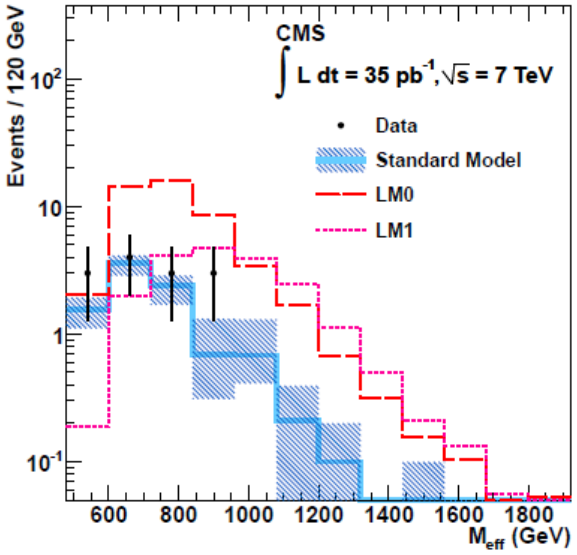
α_T=0.5 for back-to-back dijet event
α_T<0.5 for imbalance in back-to-back dijet event

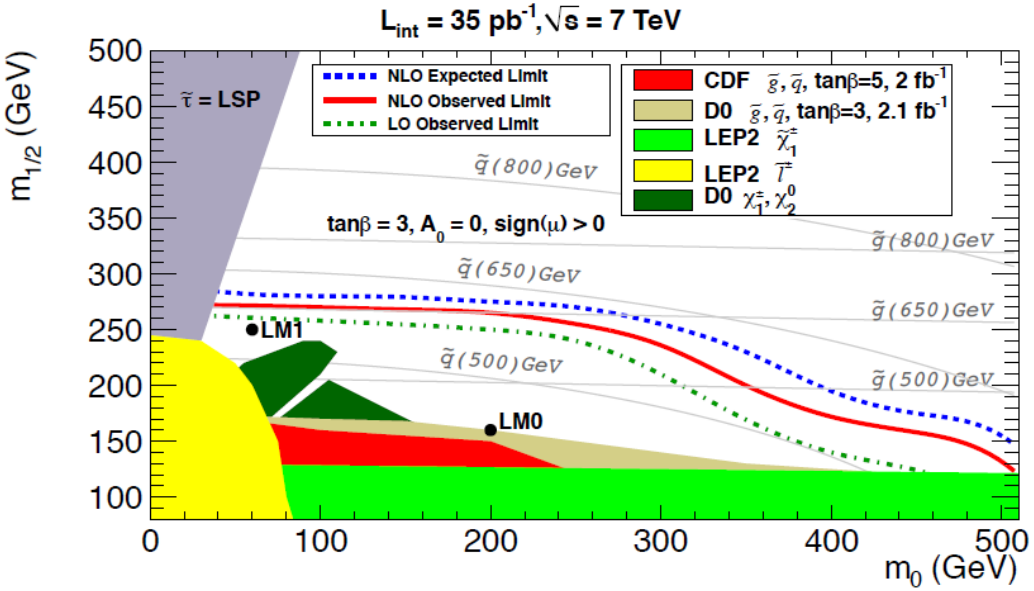




$$\alpha_T = \frac{p_{T,j2}}{M_T(jets)}$$

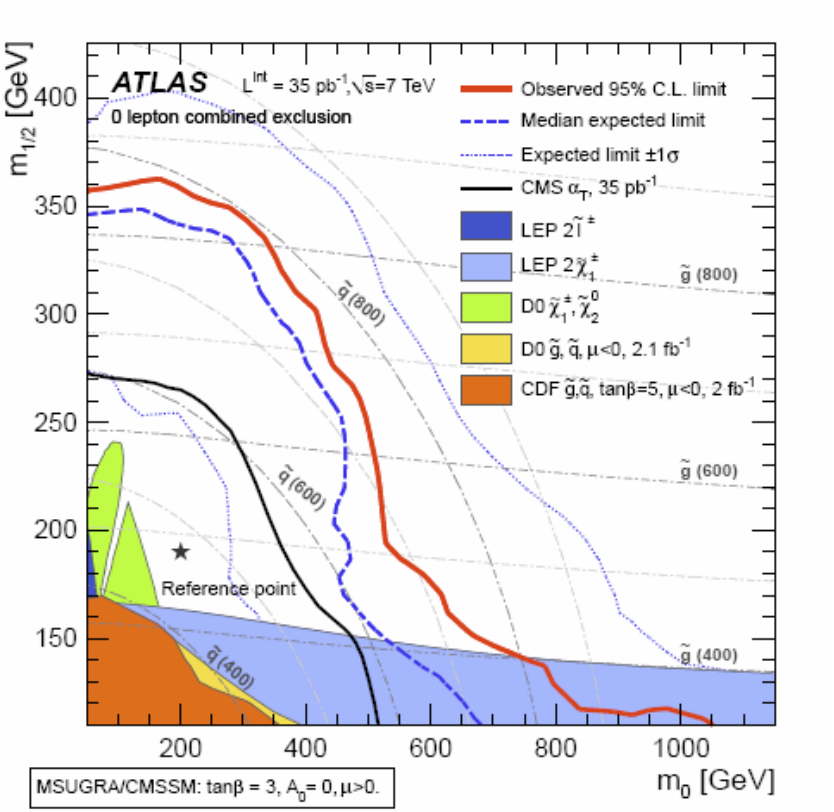
SQUARK AND GLUINO SEARCHES (ARXIV:1101.1628)





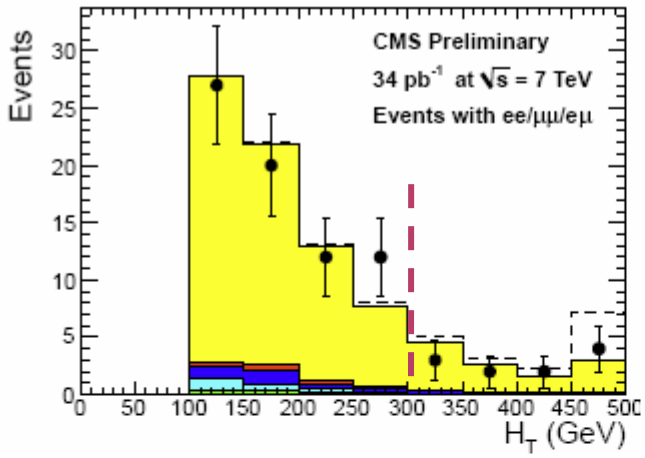
- Large portion of SUSY space excluded
  - Squark and gluino masses >500 GeV – Model dependent
  - LM0, LM1, SPS1a excluded

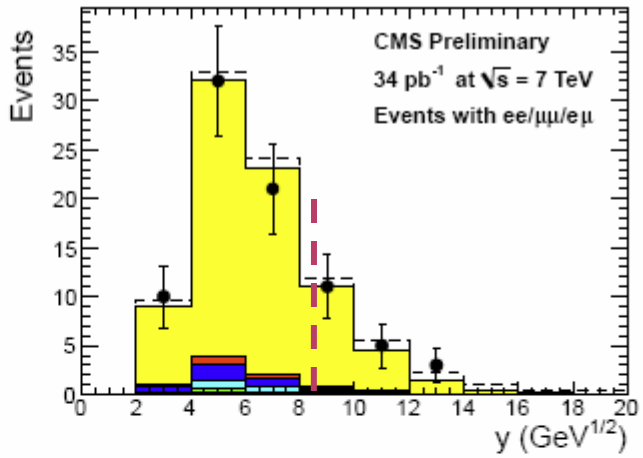
ATLAS JET+MET RESULT (ARXIV:1102.5290)

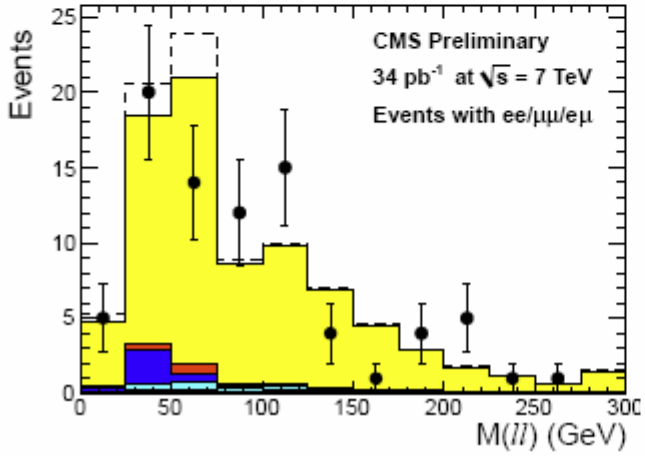


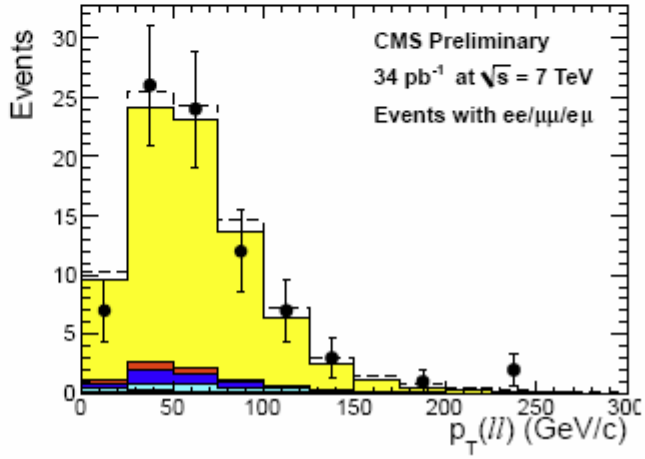
- Power of analysis depends on scenarios

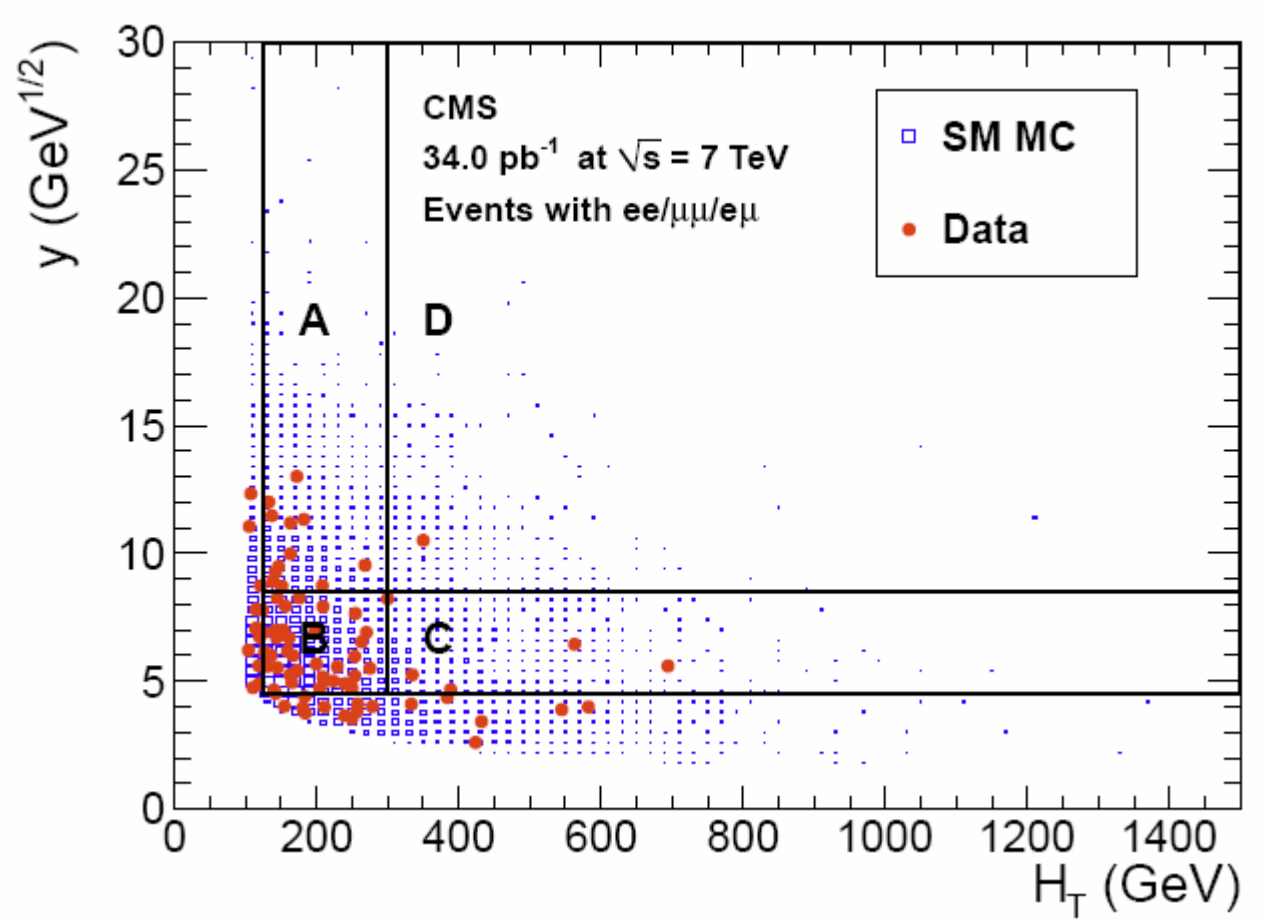
GENERIC SEARCHES IN OPPOSITE SIGNED DILEPTON + 2 JETS + MET



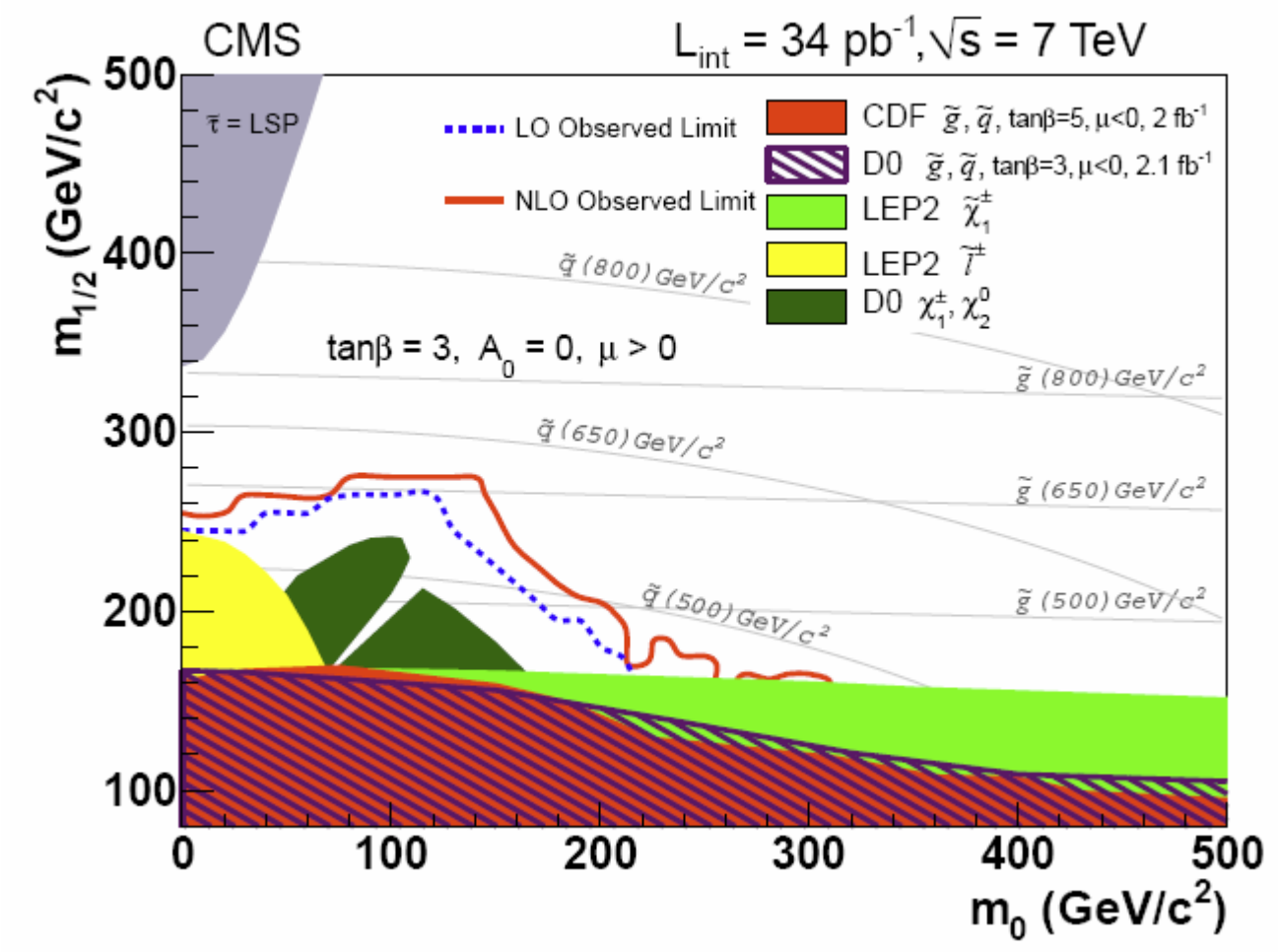







CMS
34.0 pb-1 at √s = 7 TeV
Events with ee/μμ/eμ
SM MC
Data
A
B
C
D
y (GeV1/2)
HT (GeV)
0
5
10
15
20
25
30
0
200
400
600
800
1000
1200
1400

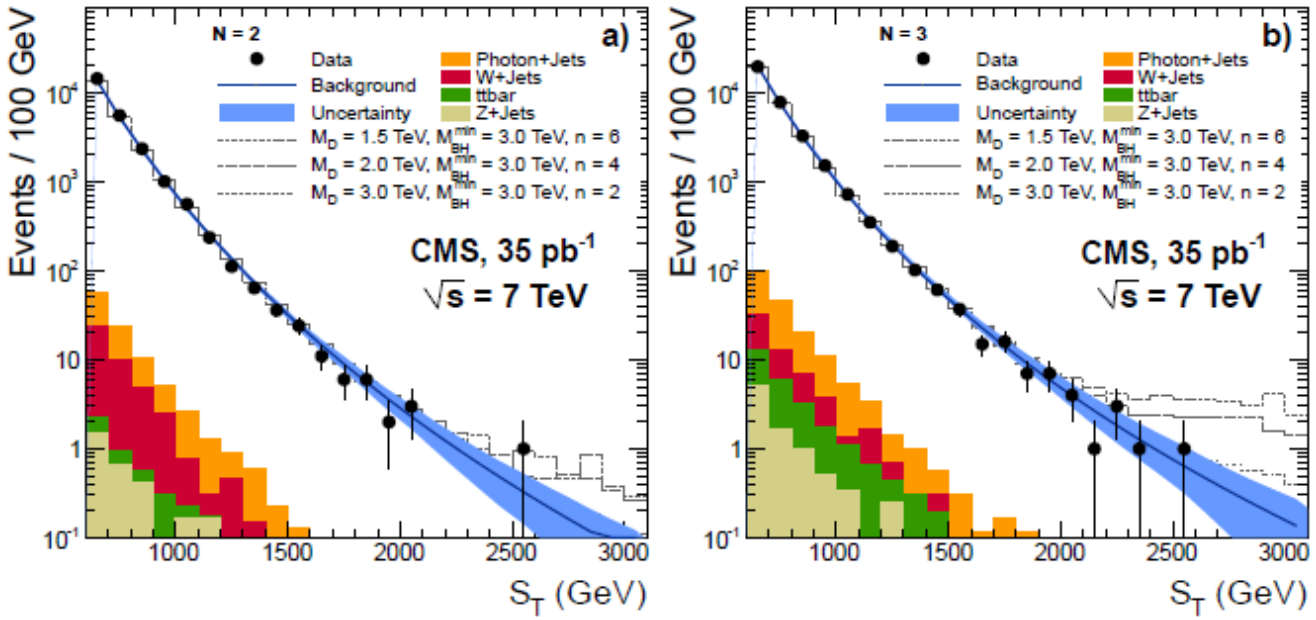
SUSY SEARCH IN OPPOSITE SIGNED DILEPTONS (ARXIV:1103.1348)



EXOTICA SEARCHES

ADD BLACKHOLE SEARCH

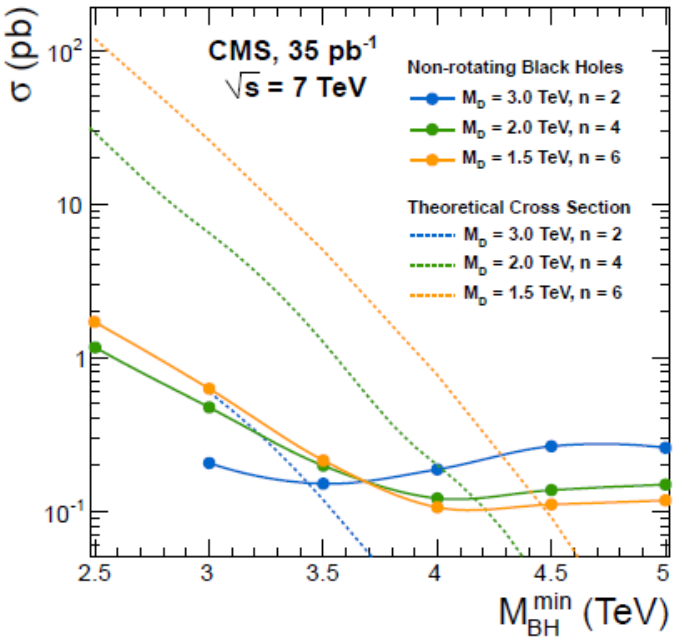
- S_T : scalar sum p_T of all jets and leptons
  - N indicates number of objects

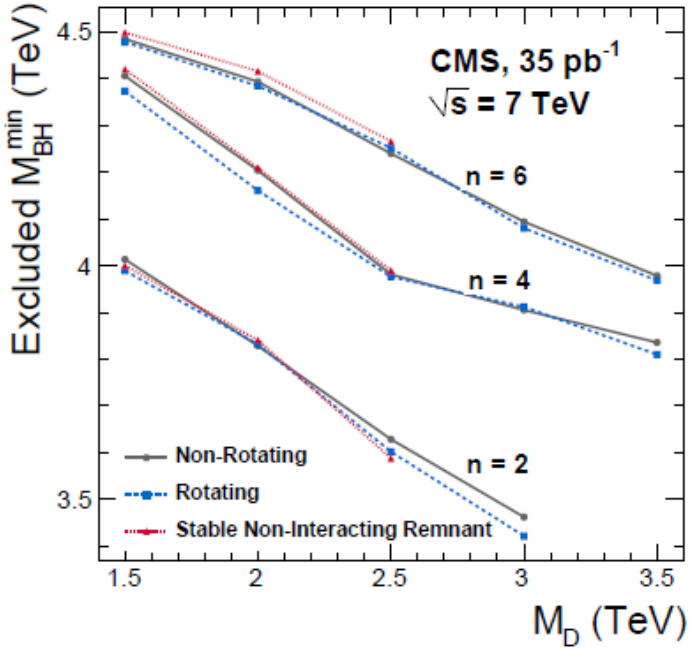


  - Simulation – BlackMax, PYTHIA 6.4

ADD BLACKHOLE

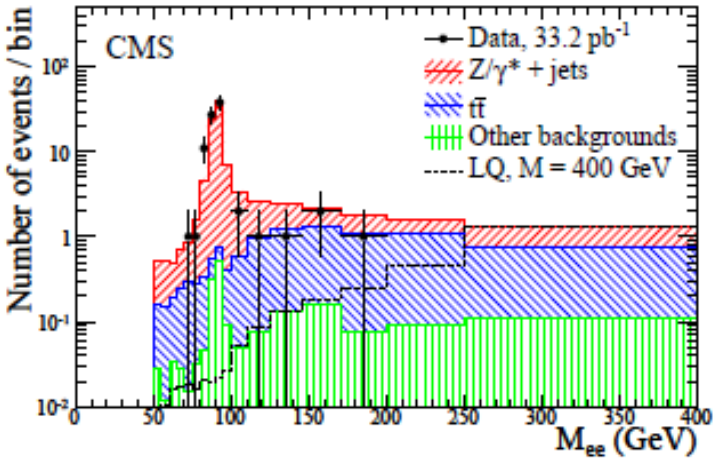
- Minimum BH mass 3.5~4.5 TeV excluded for M_D up to 3.5 TeV

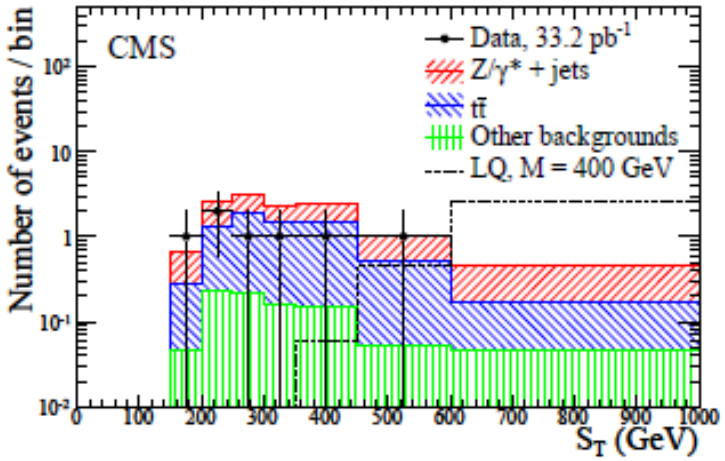




1ST GENERATION LEPTOQUARKS

- Pair produced LQ decaying into 2 electrons + ≥2 jets
  - S_T = scalar sum of p_T of 2 electrons, 2 jets

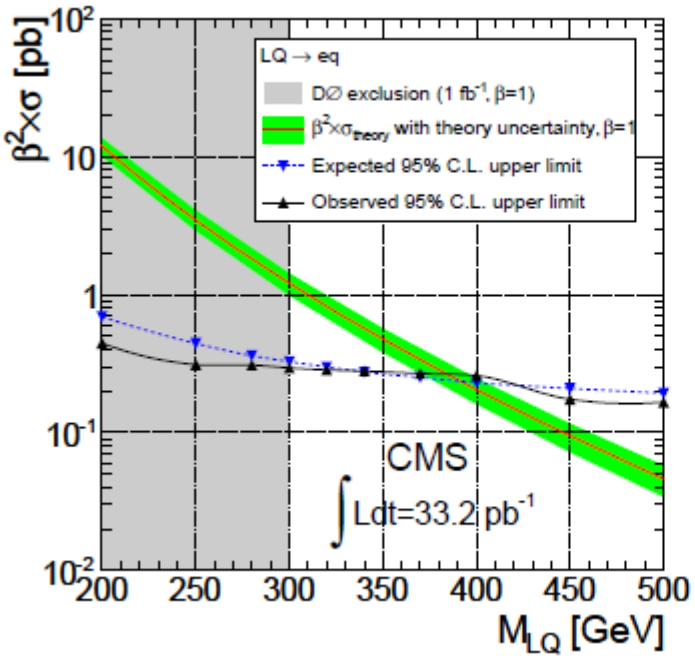


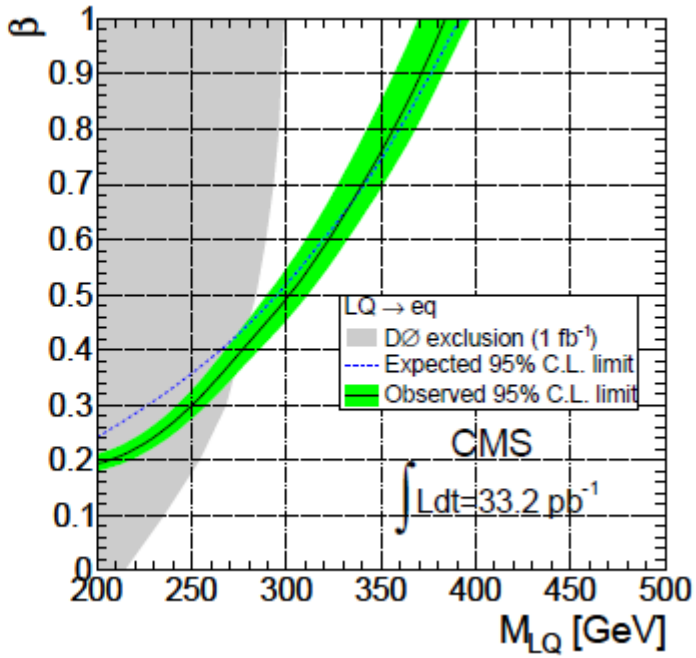


  - Optimized cuts placed on M_{ee} and S_T for some M_{LQ} hypothesis

1ST GENERATION LQ SEARCH AT CMS

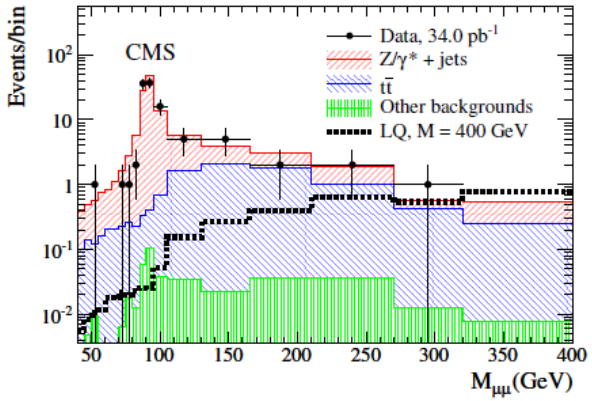
- M_{LQ}>384 for β=1
  - β: fraction of LQ decaying into charged lepton+quark

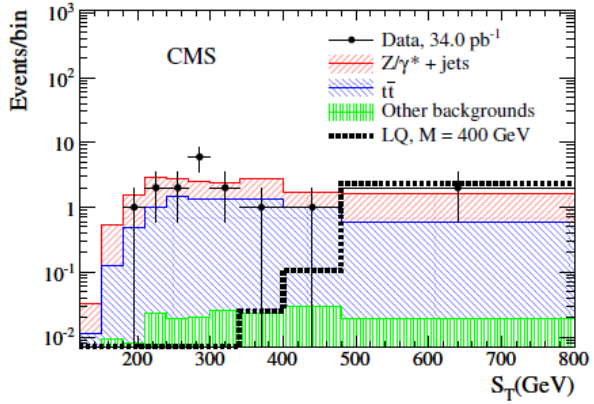




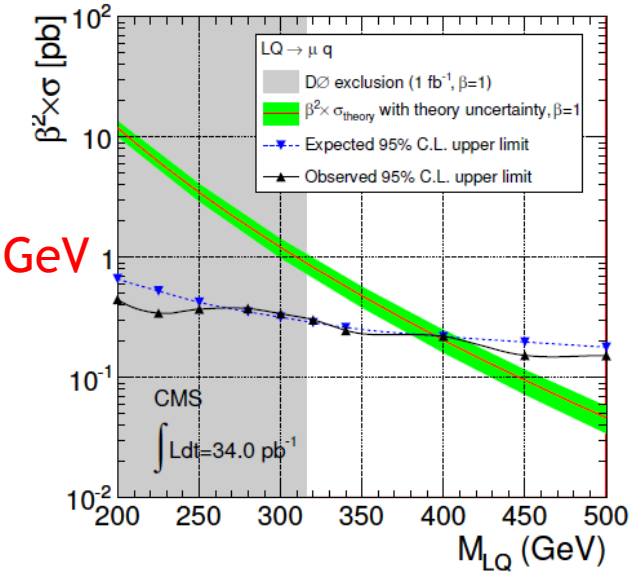
2ND GENERATION LQ SEARCHES

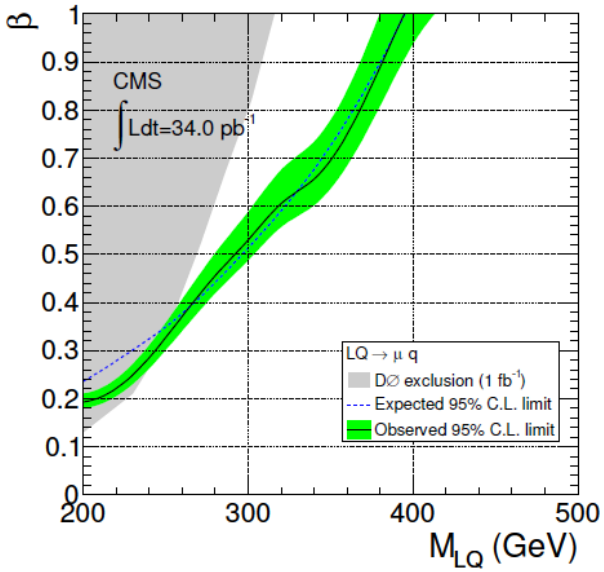
- 2μ+2jets final state





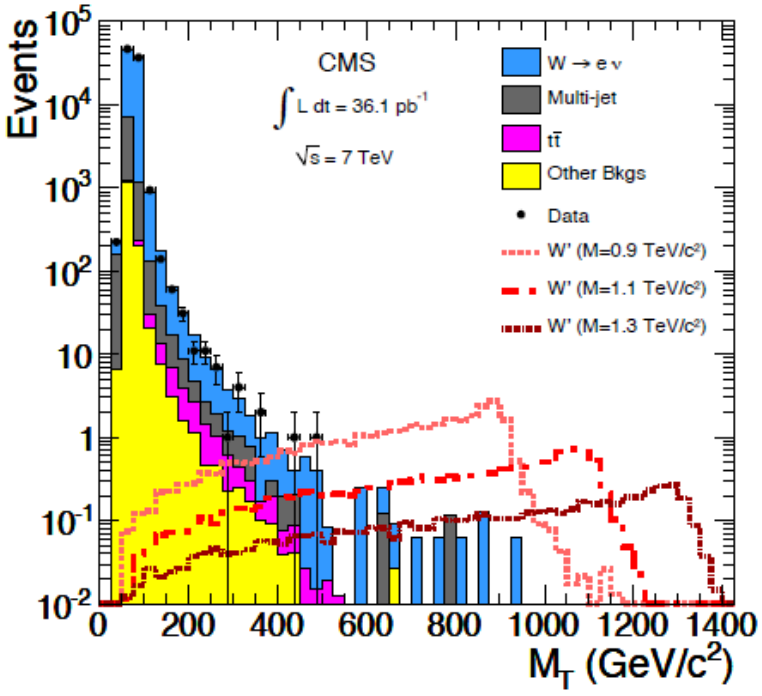
M_{LQ}>394 GeV

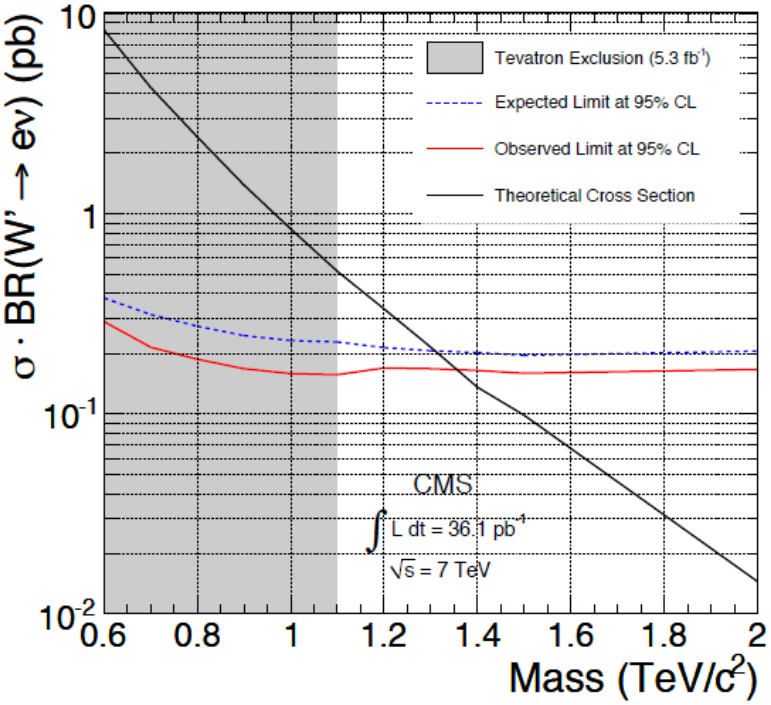




$W' \rightarrow e\nu$ SEARCH

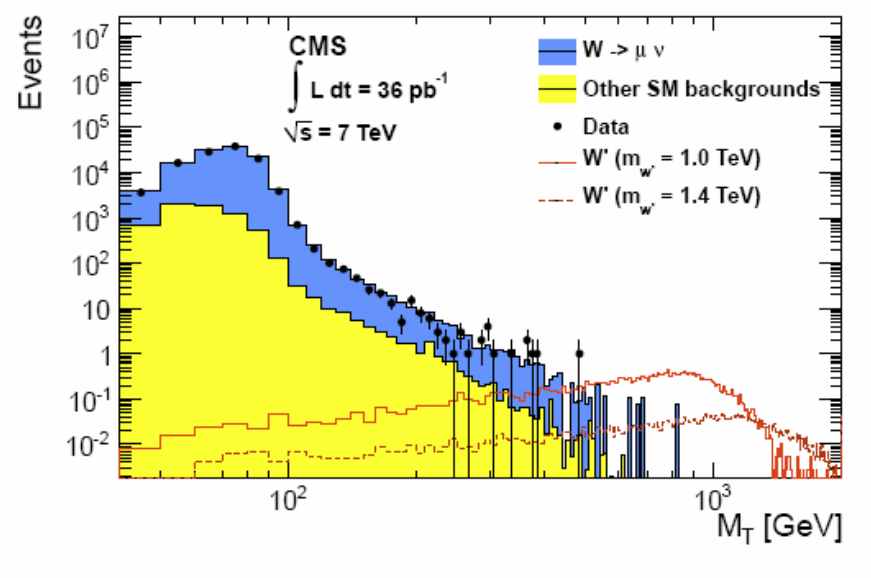
- $M_{W'}$>1.36 TeV

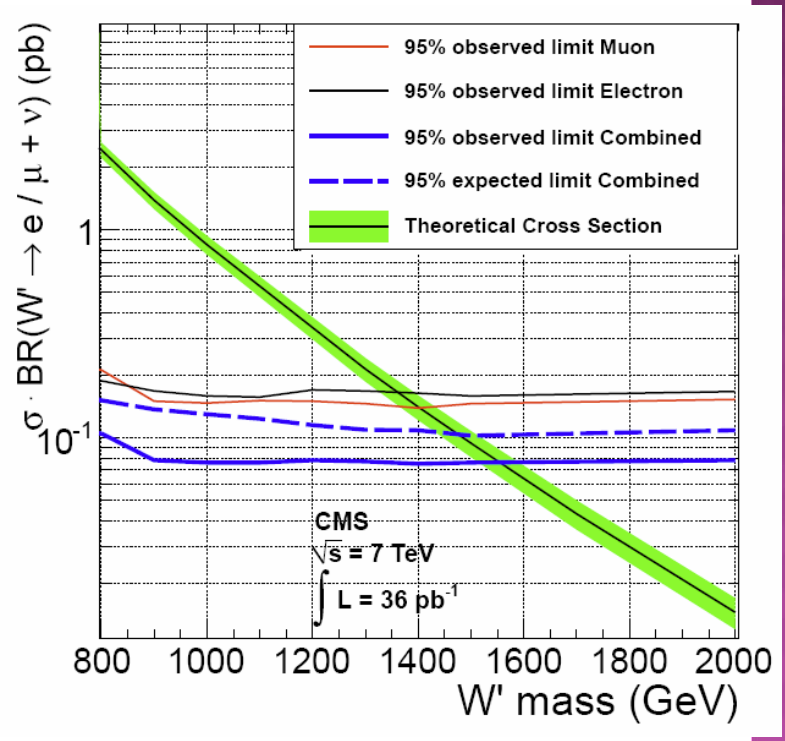




W' IN MUON CHANNEL (ARXIV:1103.0030)

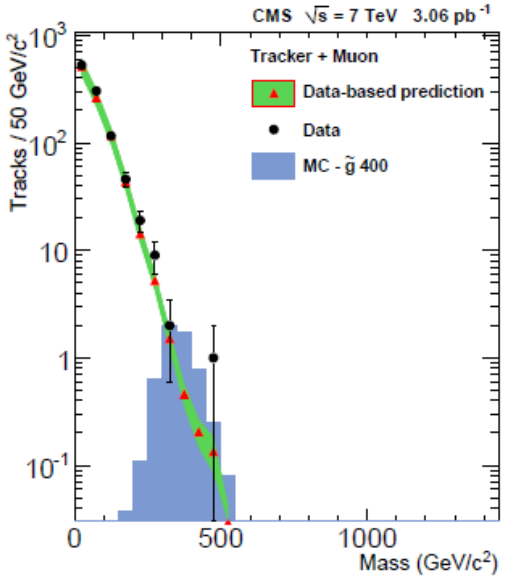
- $M_{W'}$>1.4 TeV
- Combined limit 1.58 TeV

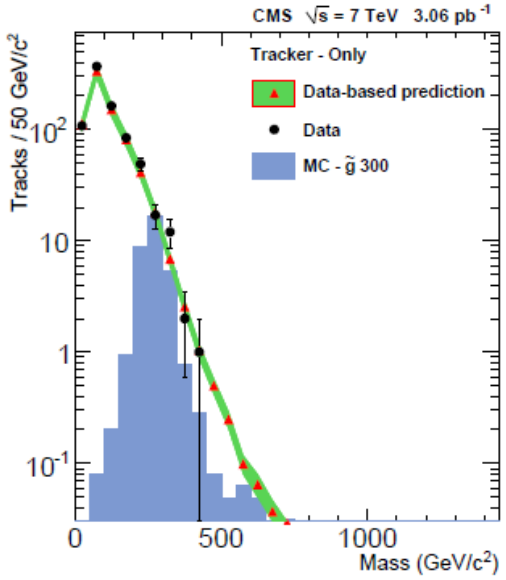




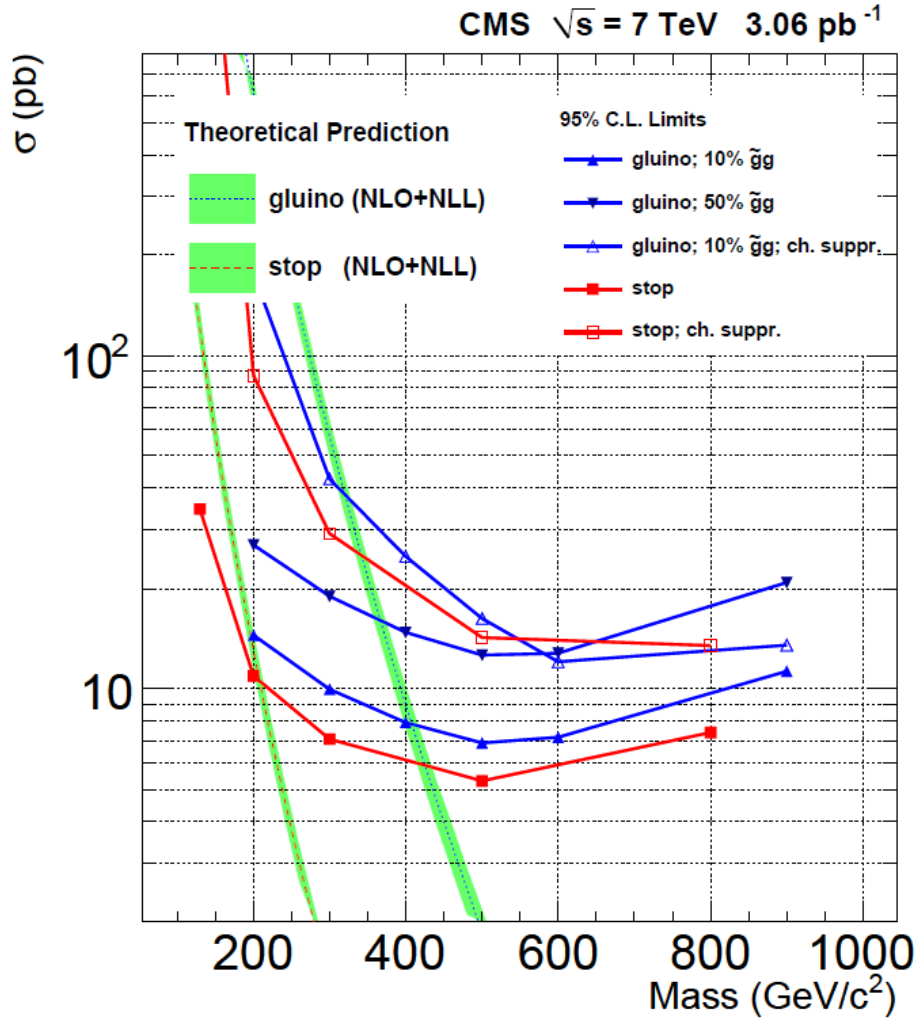
HEAVY STABLE CHARGED PARTICLE

- Long-lived strongly interacting particles
  - Gluinos, stops forming R-hadron in matter
  - Strongly ionizing, but R-hadron can interact with matter strongly – may not reach muon detectors
- Selection on ionization variables





HEAVY STABLE CHARGED PARTICLE

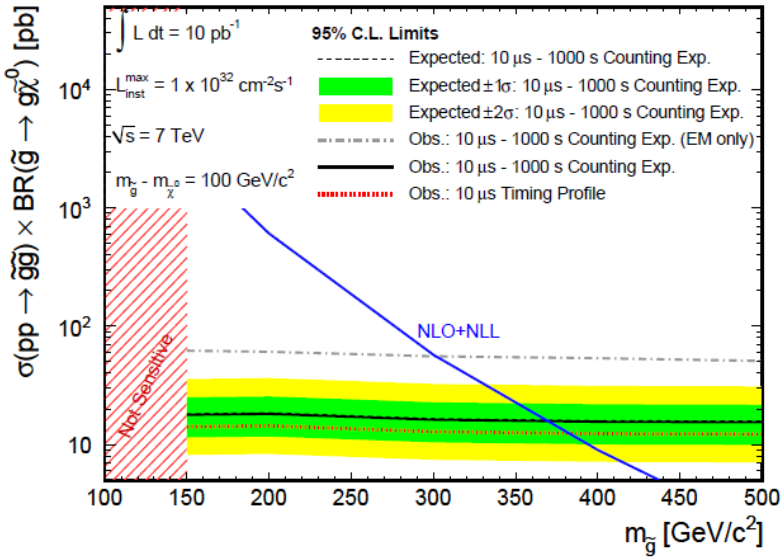


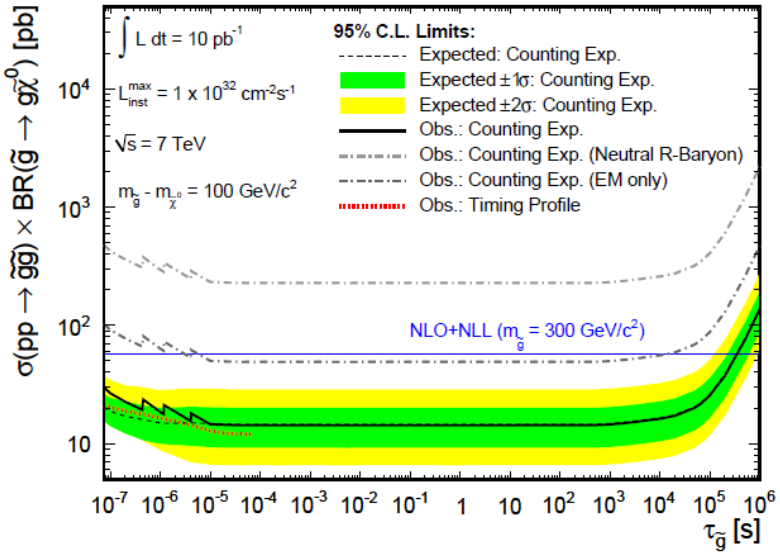
STOPPED GLUINOS

- Split SUSY scenario
- Similar to earlier scenario except the particle is very slow and stops in the detector
- Lifetime can be as long as 1000s
- Signature: jet-like energy deposit out of time with beam collision
  - Special trigger and simulation

STOPPED GLUINO SEARCHES

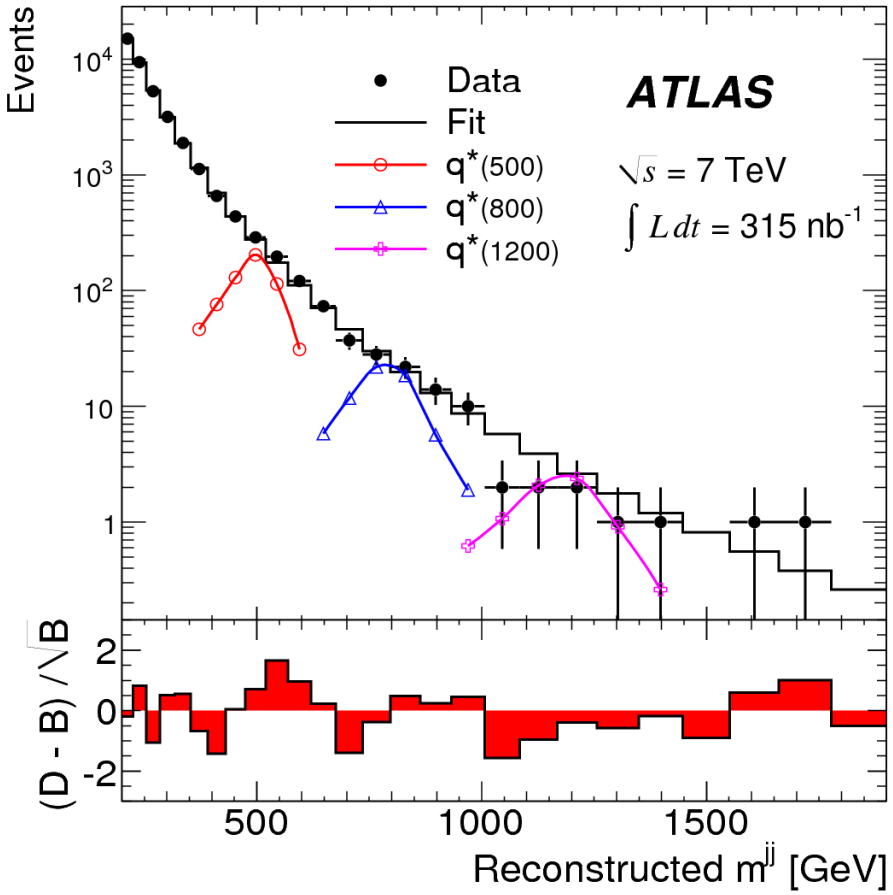
- $m_{\tilde{g}} > 382\ GeV$



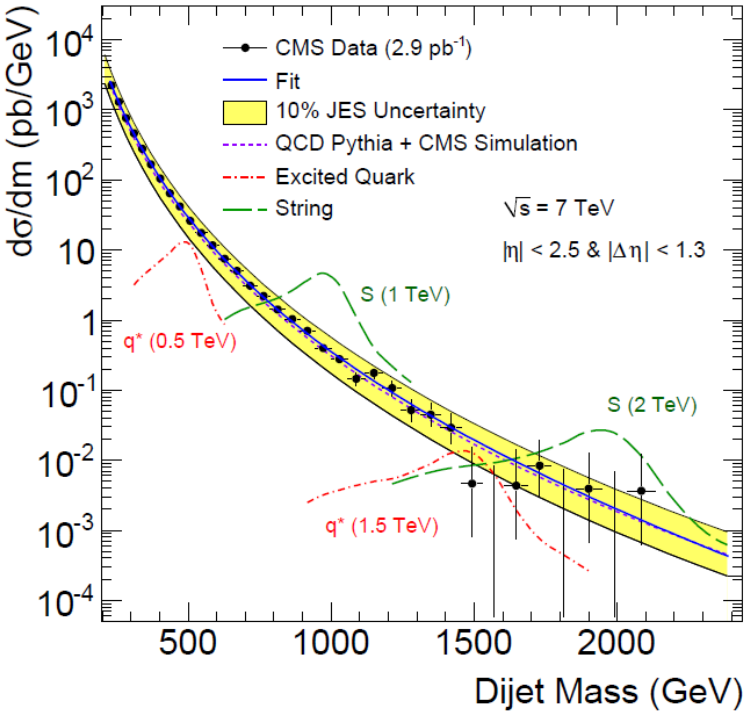


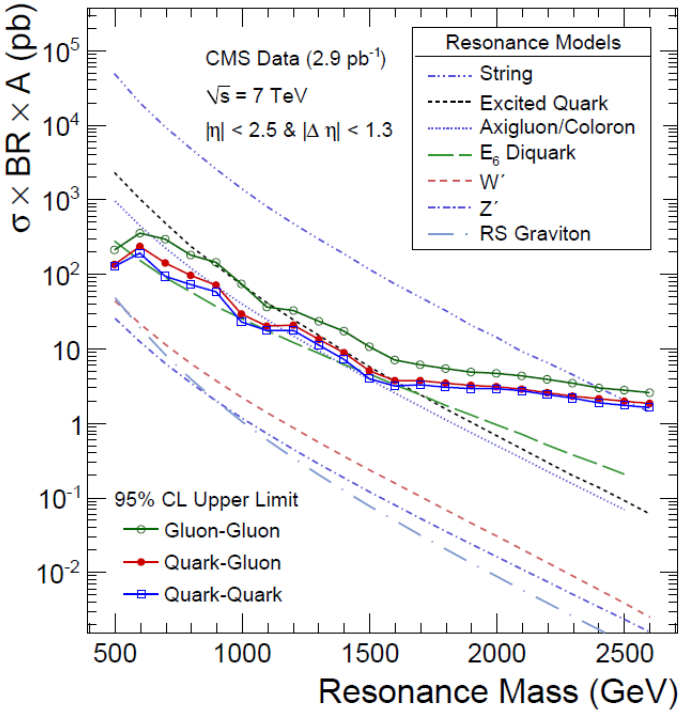
DIJET RESONANCES

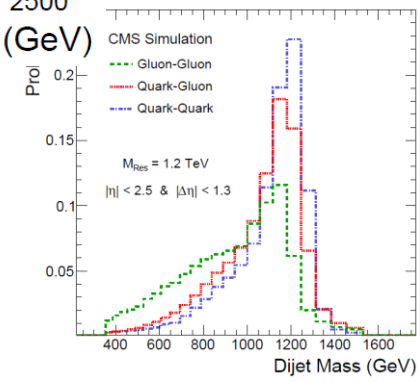
- Excludes at 95% CL $m_{q^*} < 1.26$ TeV



DIJET RESONANCES

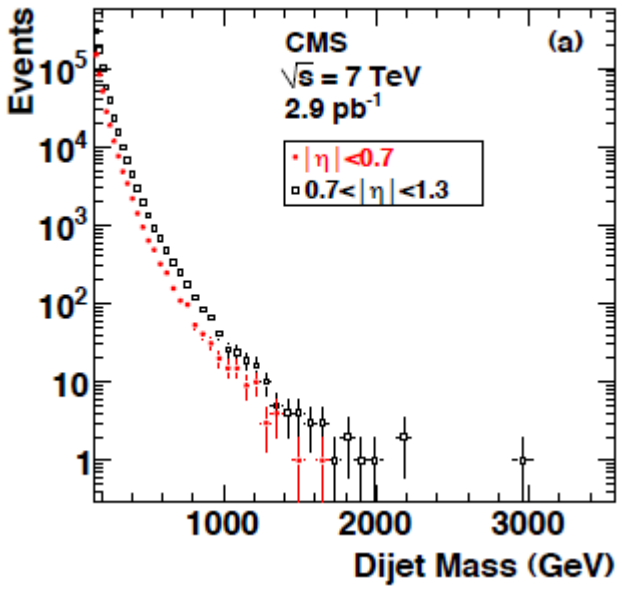


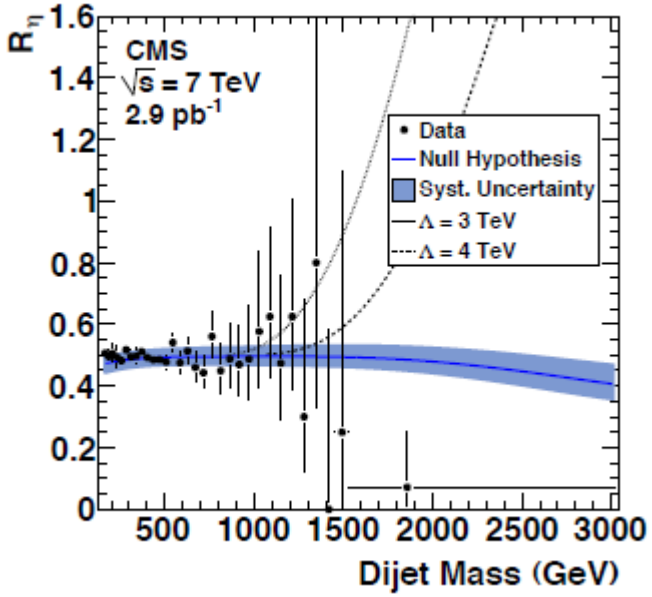




QUARK COMPOSITENESS

- Contact interaction scale Λ>4 TeV

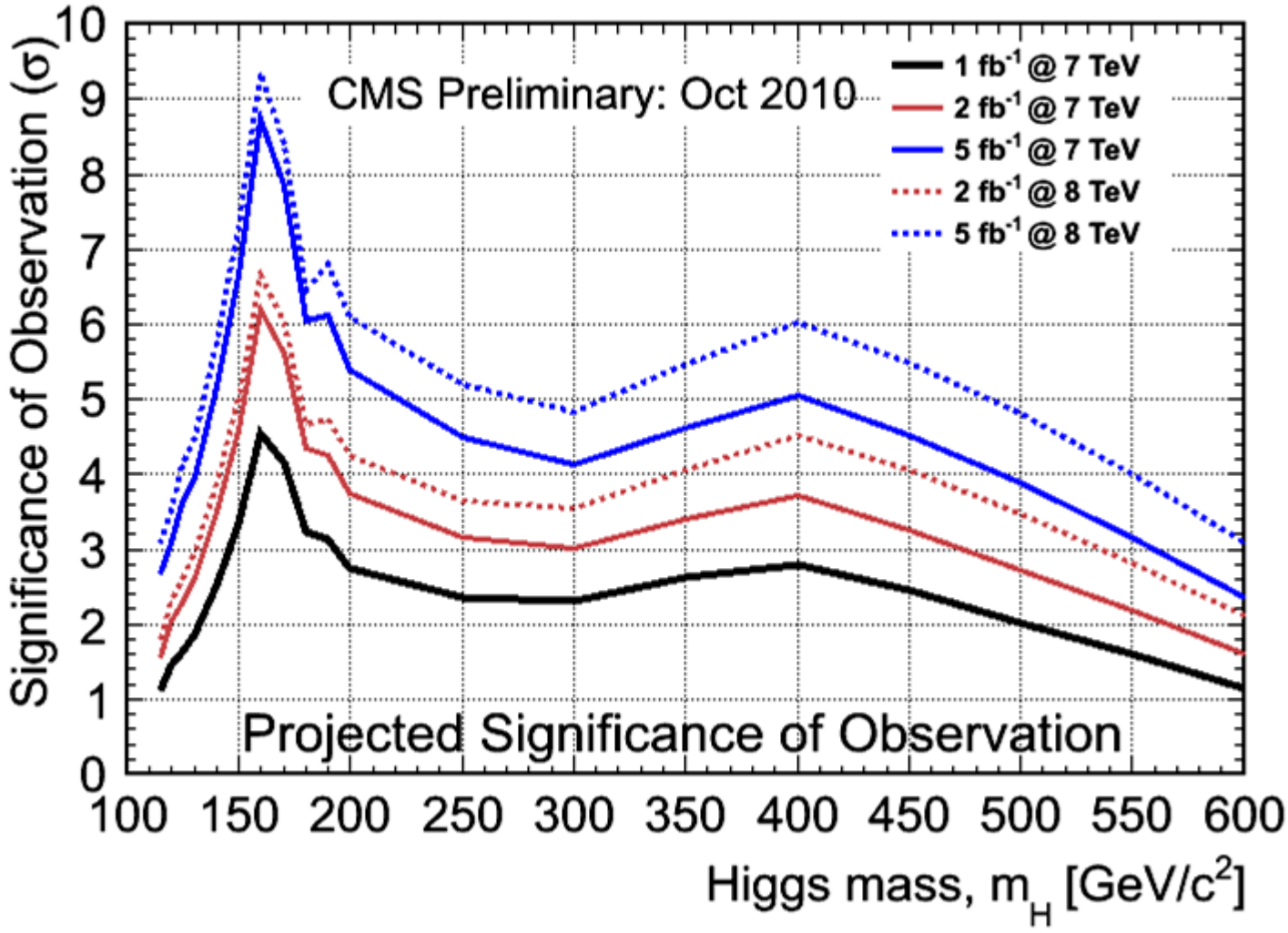




SUMMARY OF CHAMONIX WORKSHOP

- 2011~2012 will run with 7 TeV
  - 8 TeV run deemed risky
  - Instantaneous luminosity will be increased 5 times during that time
  - By 2011 – 1 fb^{-1}
  - By 2012 – 5 fb^{-1}
  - Shutdown end of 2012 - 19 months needed to fix LHC

HIGGS SENSITIVITY



SUMMARY AND OUTLOOK

- Detector and accelerator is performing well and our understanding is improving
- Exciting results and more new results with 35 pb^{-1} will be released soon in time for the Moriond conference
- Expect > x10 data by summer
- Check for latest updates https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResults