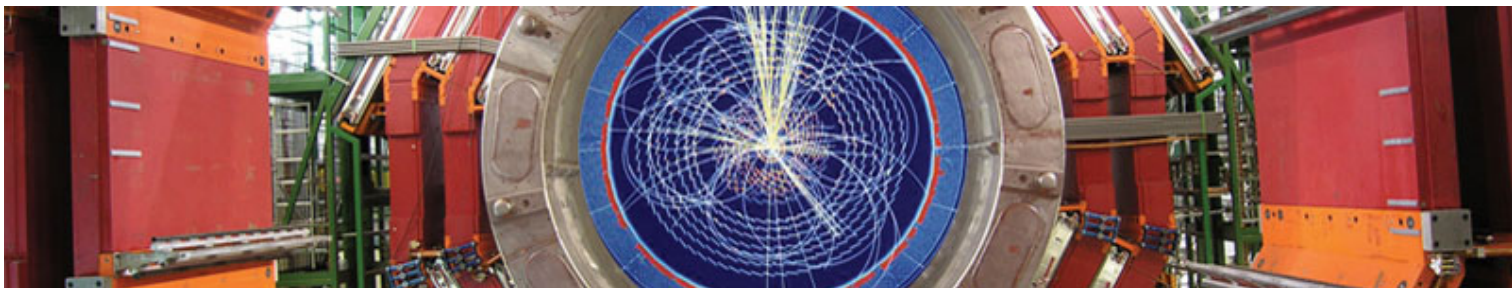


New Results in CMS

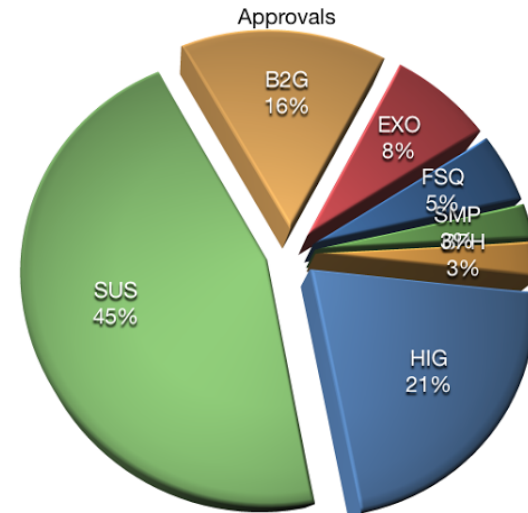


Hwidong Yoo
Seoul National University

1st KR-LHC TH-EXP cross seminar, April 4th 2017

New Results at Moriond

- Totally 38 new results: 29 for Moriond EWK and 9 for Moriond QCD
 - EXO: 4
 - Top: 0
 - FSQ: 2
 - Higgs: 7
 - B-physics: 1
 - B2G: 5
 - SUSY: 17
 - SMP: 2
- ICHEP2016: ~90 new results
 - Significant needs by diphoton access issue
 - But certainly CMS is slowing down and establishing new strategy for the preparation of 100 /fb era



New Results at Moriond

- EXO

- <http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/EXO/index.html>
- CMS-PAS-EXO-16-003: Inclusive search for new particles decaying to displaced jets at 13 TeV
- CMS-PAS-EXO-17-006: Search for evidence of Type-III seesaw mechanism in multilepton final states at 13 TeV
- CMS-PAS-EXO-16-056: Search for dijet resonances at 13 TeV
- CMS-PAS-EXO-14-016: a Model Unspecific Search for New Physics at 8 TeV

- FSQ

- <http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/FSQ/index.html>
- CMS-PAS-FSQ-16-009: Measurement of double parton scattering in same-sign WW production at 13 TeV
- CMS-PAS-FSQ-17-001: Very forward inclusive jet cross section in p+Pb at 5.02 TeV

New Results at Moriond

- Higgs

- <http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/HIG/index.html>
- CMS-PAS-HIG-17-002: Search for pair production of Higgs bosons in the two tau leptons and two bottom quarks final state at 13 TeV
- CMS-PAS-HIG-17-011: Constraints on anomalous Higgs boson couplings in production and decay $H \rightarrow 4l$
- CMS-PAS-HIG-17-004: Search for Higgs boson production in association with top quarks in multiparton final state at 13 TeV
- CMS-PAS-HIG-16-041: Measurements of properties of the Higgs boson in the four-lepton final state at 13 TeV
- CMS-PAS-HIG-17-003: Search for the associated production of a Higgs boson with a top quark pair in final states with a tau lepton at 13 TeV
- CMS-PAS-HIG-17-006: Search for resonant and non-resonant Higgs boson pair production in the $b\bar{b}l\nu l\nu$ final state at 13 TeV
- CMS-PAS-HIG-17-015: Measurement of differential fiducial cross sections for Higgs boson production in the diphoton decay channel at 13 TeV

New Results at Moriond

- B2G

- <http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/B2G/index.html>
- CMS-PAS-B2G-17-001: Search for massive resonance decaying into WW, WZ, ZZ, qW and qZ in the dijet final state at 13 TeV
- CMS-PAS-B2G-17-002: Search for heavy resonances decaying into a vector boson and a Higgs boson in hadronic final states
- CMS-PAS-B2G-16-019: Search for heavy vector-like quarks decaying to same-sign dileptons
- CMS-PAS-B2G-17-007: Search for single production of a vector-like T quark decaying to a Z boson and a top quark at 13 TeV
- CMS-PAS-B2G-17-010: Search for heavy resonances decaying to a top and bottom quark in the lepton+jets final state at 13 TeV

New Results at Moriond

- B-physics
 - <http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/BPH/index.html>
 - CMS-PAS-BPH-15-009: Measurement of the P1 and P'5 angular parameters of the decay $B^0 \rightarrow K^{*0} \mu^+ \mu^-$ at 8 TeV
- SMP
 - <http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/SMP/index.html>
 - CMS-PAS-SMP-16-017: Measurement of the $pp \rightarrow ZZ$ production cross section, $Z \rightarrow 4l$ branching fraction and constraints on anomalous triple gauge couplings at 13 TeV
 - CMS-PAS-SMP-16-014: Measurements of inclusive 2-jet, 3-jet and 4-jet azimuthal correlations at 13 TeV

New Results at Moriond

- SUSY

- <http://cms-results.web.cern.ch/cms-results/public-results/preliminary-results/SUS/index.html>

Strong SUSY

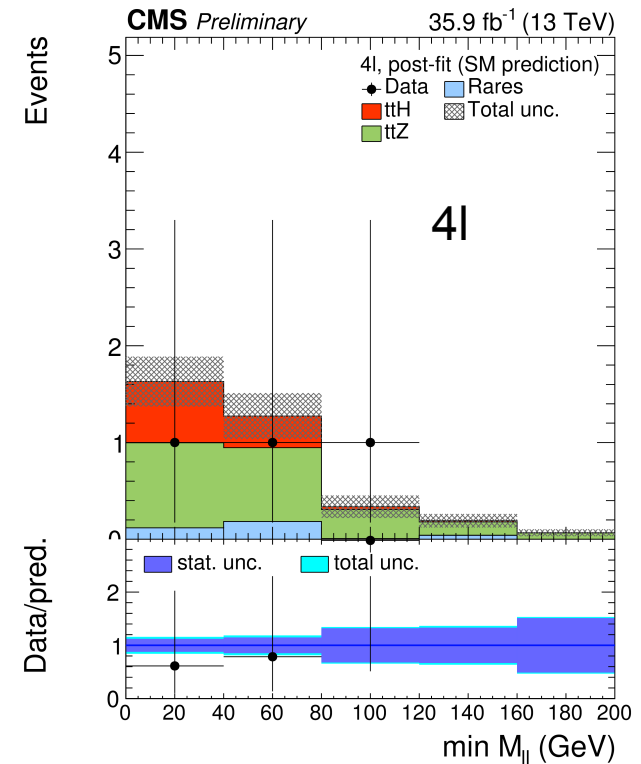
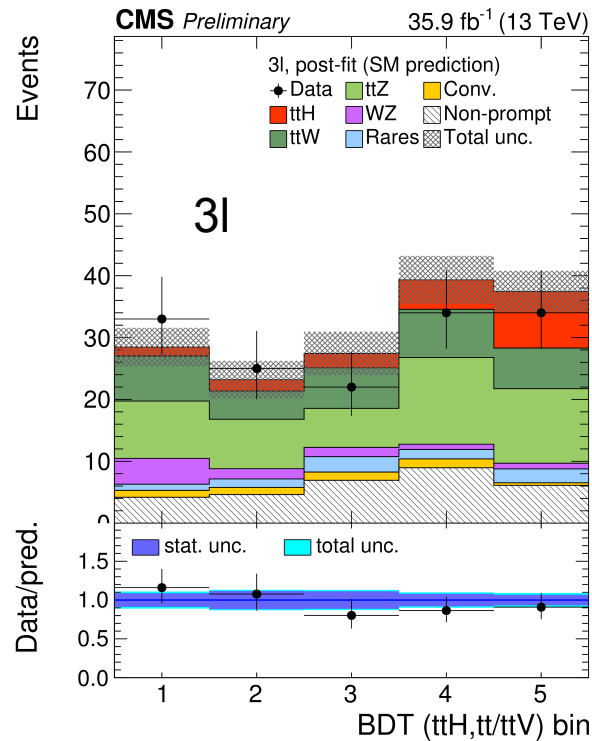
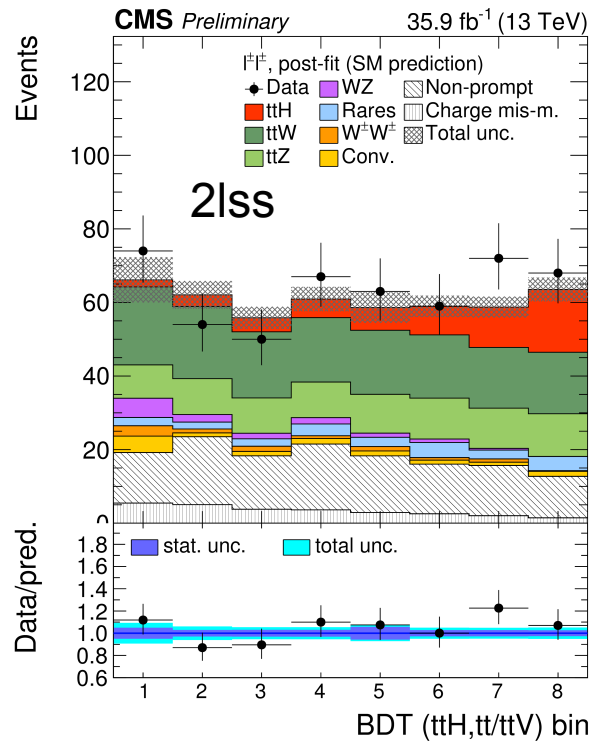
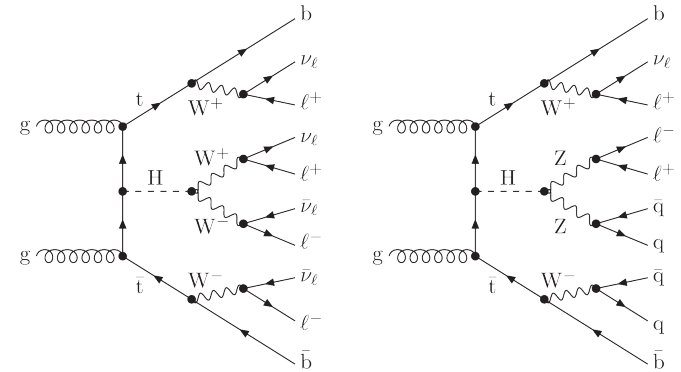

All hadronic +MET Search for supersymmetry in multijet events with missing transverse momentum in pp collisions at 13 TeV SUS-16-033 Search for new physics in the all hadronic final state with the MT2 variable SUS-16-036 Search for direct production of bottom and top squark pairs in pp collisions at $\sqrt{s}=13$ TeV SUS-16-032 Search for direct top squark pair production in the all-hadronic final state in pp collisions at $\sqrt{s}=13$ TeV SUS-16-049
1 l +MET Search for supersymmetry in pp collisions at $\sqrt{s}=13$ TeV in the single-lepton final state using the sum of masses of large-radius jets SUS-16-037 Search for supersymmetry in events with one lepton and multiple jets in pp collisions at $\sqrt{s}=13$ TeV with 2016 data SUS-16-042 Search for top squark pair production in the single lepton final state in pp collisions at $\sqrt{s}=13$ TeV SUS-16-051
2 opp. sign l +MET Search for new physics in final states with two opposite-sign, same-flavor leptons, jets, and missing transverse momentum in pp collisions at $\sqrt{s}=13$ TeV SUS-16-034 Search for direct stop pair production in the dilepton final state at $\sqrt{s}=13$ TeV SUS-17-001
2 same sign l / ≥ 3 l +MET Search for beyond the standard model physics in events with two leptons of the same sign, missing transverse momentum, and jets in pp collisions at $\sqrt{s}=13$ TeV SUS-16-035 Search for new physics with multileptons and jets in 35.9 fb ⁻¹ of pp collision data at $\sqrt{s}=13$ TeV SUS-16-041
Photon(s) +MET Search for Excess Higgs production in diphoton final states using the razor variables at $\sqrt{s}=13$ TeV SUS-16-048 Search for supersymmetry in events with at least one photon, missing transverse momentum, and large transverse event activity in pp collisions at 13 TeV SUS-16-047 Search for GMSB supersymmetry in events with at least one photon and missing transverse momentum in pp collisions at $\sqrt{s}=13$ TeV SUS-16-046

(Mostly) EWK SUSY

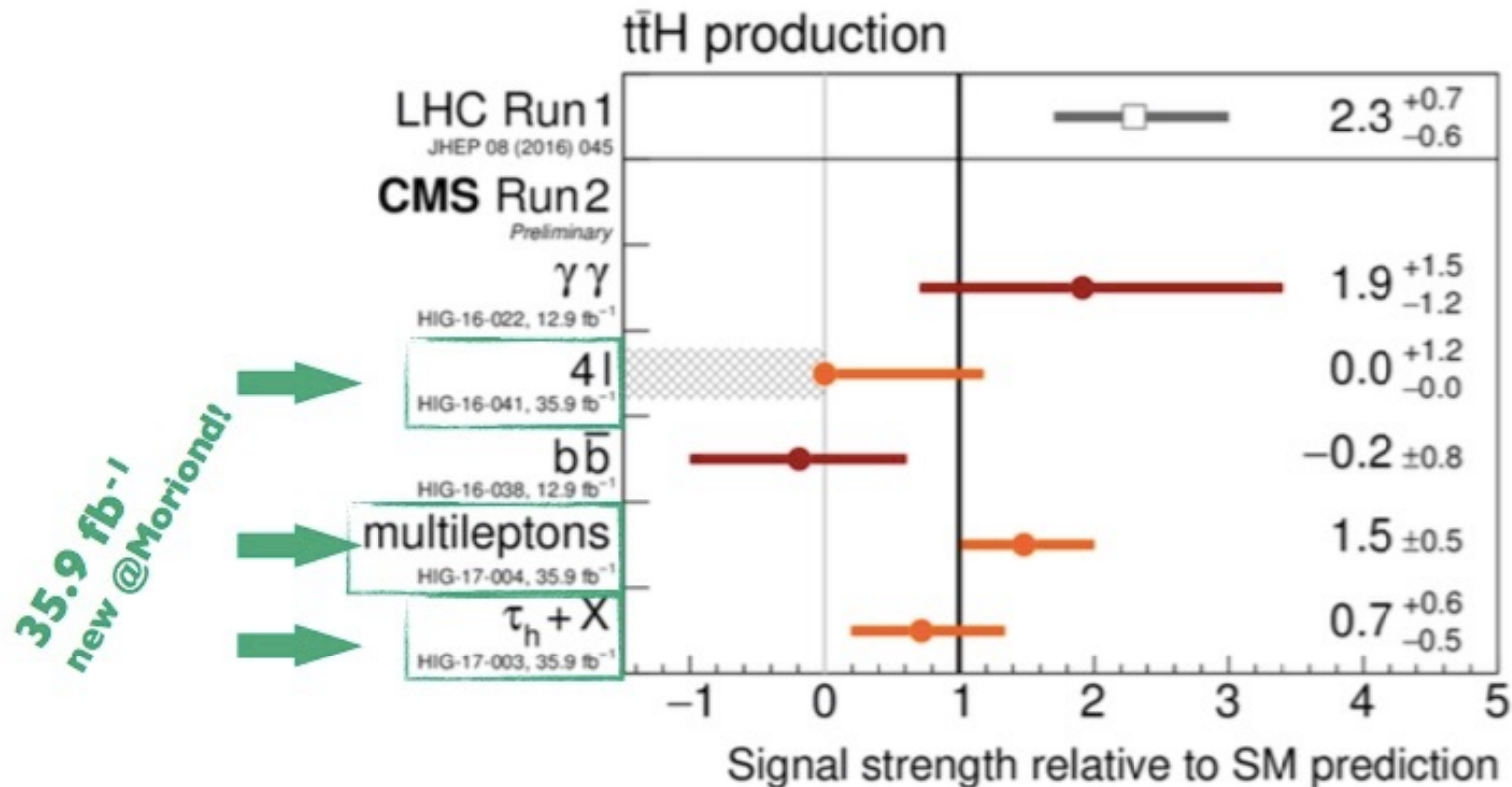
Search for electroweak production of charginos and neutralinos in multilepton final states in pp collision data at $\sqrt{s}=13$ TeV SUS-16-039 Search for new physics in events with two low momentum opposite-sign leptons and missing transverse energy at $\sqrt{s}=13$ TeV SUS-16-048 Search for the pair production of Higgsinos in pp collisions at $\sqrt{s}=13$ TeV in final states with Higgs bosons and large missing transverse momentum SUS-16-044 Search for electroweak production of charginos and neutralinos in the WH final state in pp collisions at $\sqrt{s}=13$ TeV SUS-16-043
--

Higgs Highlights: ttH Search (1)

- Signal categories in multilepton ch
 - 2lss and 3l: use 2 kinematic BDTs against ttbar & ttW/Z
 - 3l: ME likelihood ratio for ttW/Z separation
 - 4l: counting experiment



Higgs Highlights: ttH Search (2)

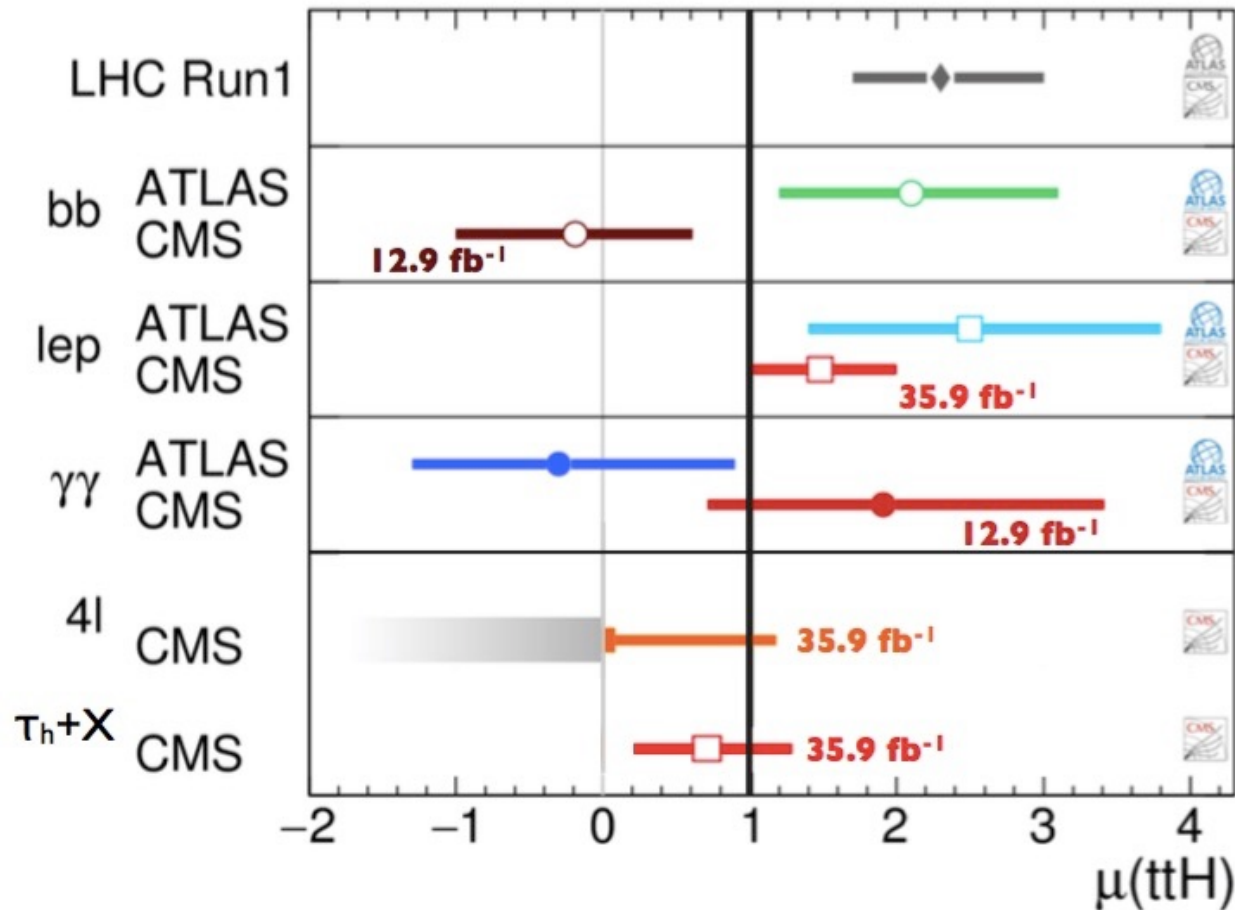


→

ttH, multilepton final states (electrons, muons):		
significance	3.3σ (observed)	2.5σ (expected)
ttH, semi-hadronic H→ττ		
significance	3.3σ (observed)	2.5σ (expected)

Higgs Highlights: ttH Search (3)

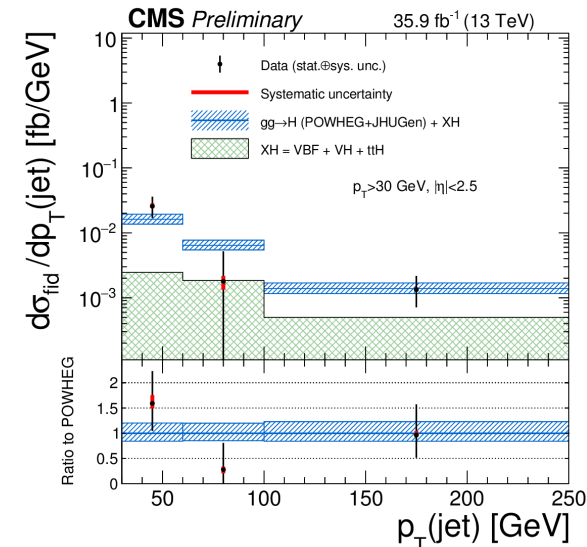
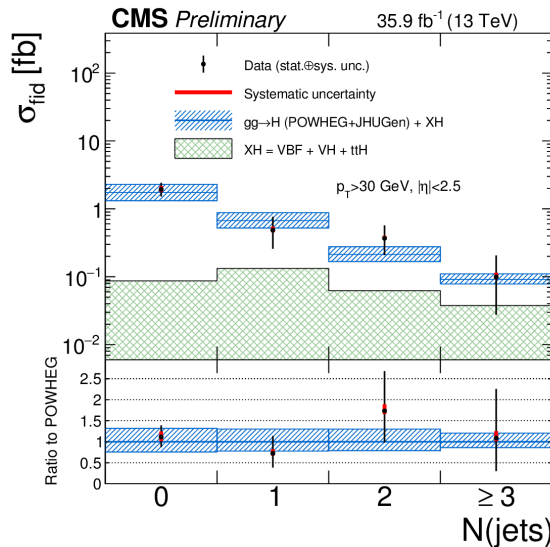
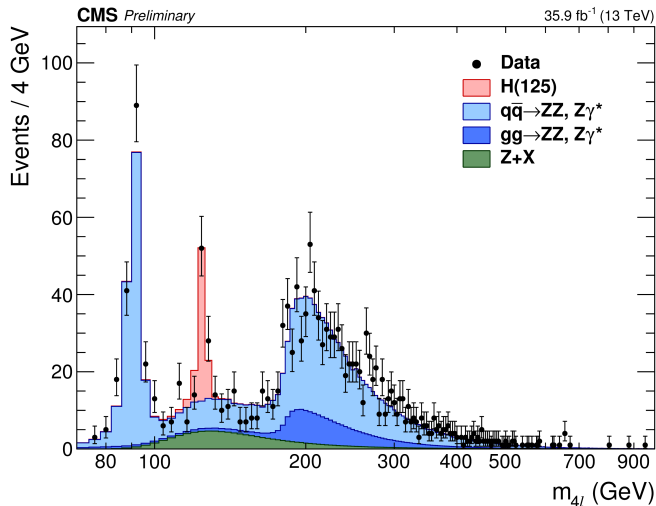
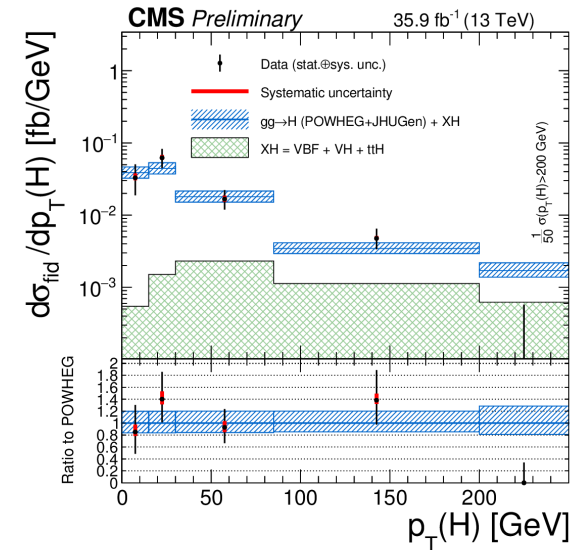
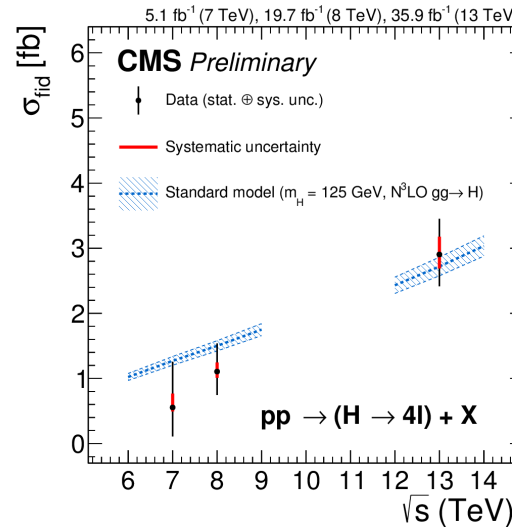
- ATLAS + CMS



Higgs Highlights: $H \rightarrow 4l$ Measurements

- Differential cross section measurements of $p_T(H)$, $N(\text{jets})$, $p_T(\text{jet})$

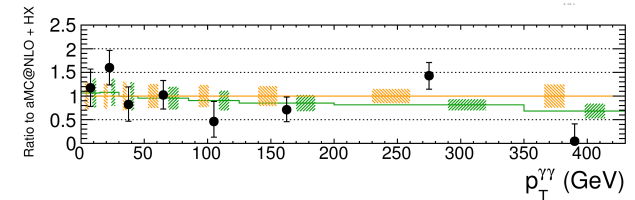
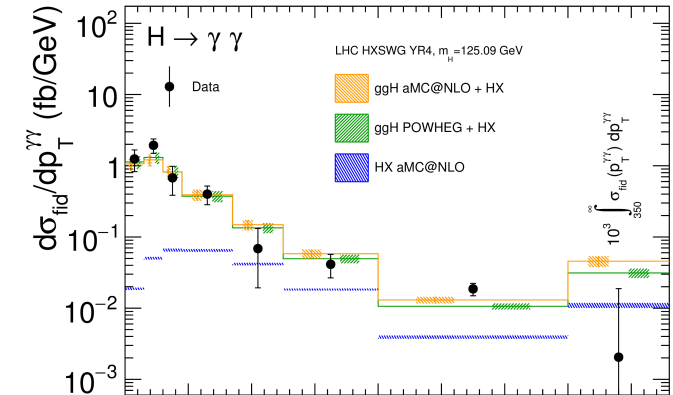
$$\sigma_{\text{fid.}} = 2.90_{-0.44}^{+0.48}(\text{stat.})_{-0.22}^{+0.27}(\text{sys.}) \text{ fb}$$



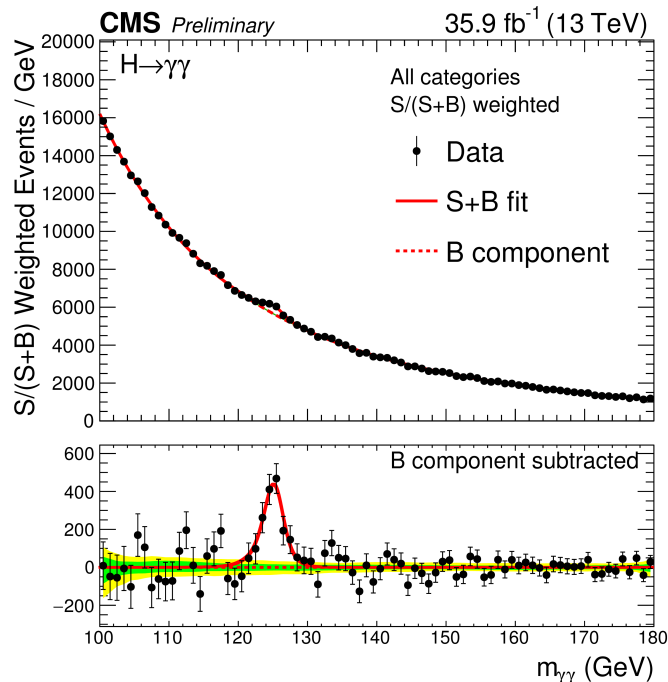
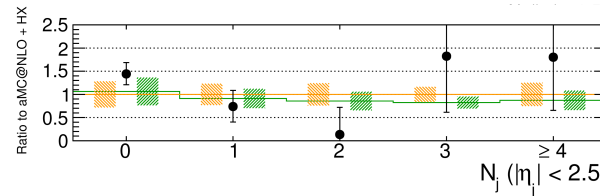
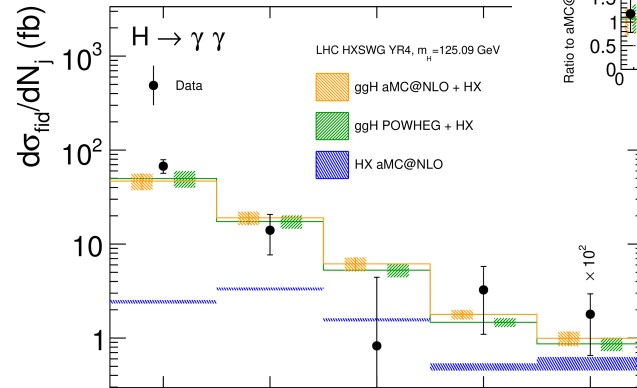
Higgs Highlights: $H \rightarrow \gamma\gamma$ Measurements

- Differential cross section measurements of p_T (H) and N (jets)

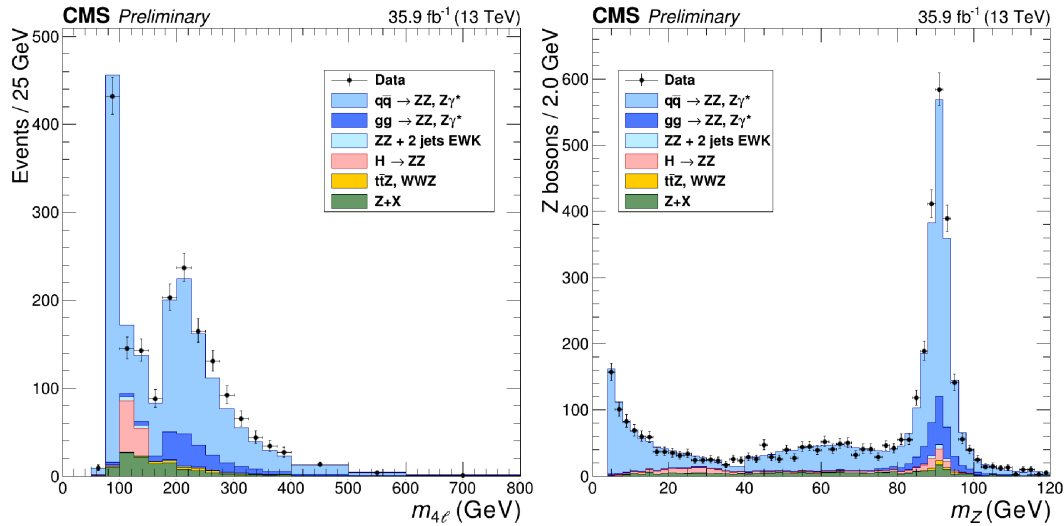
CMS Preliminary 35.9 fb⁻¹ (13 TeV)



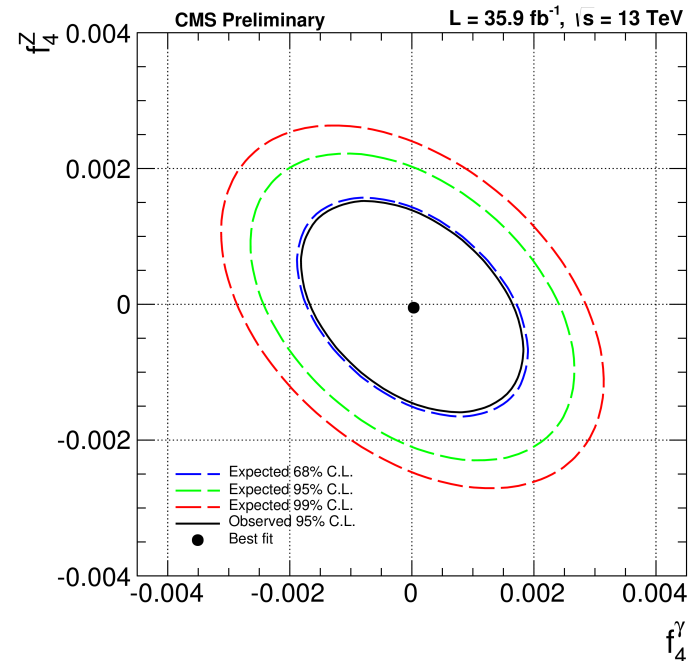
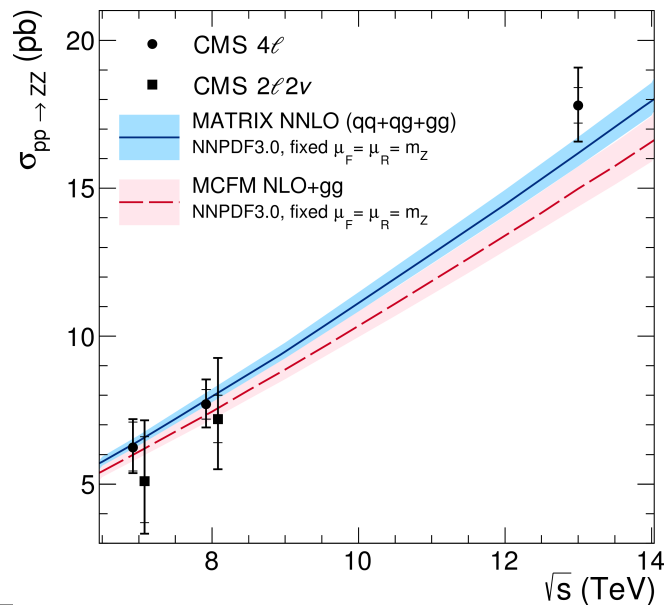
CMS Preliminary 35.9 fb⁻¹



SMP Highlights: $ZZ \rightarrow 4\ell$ Measurements

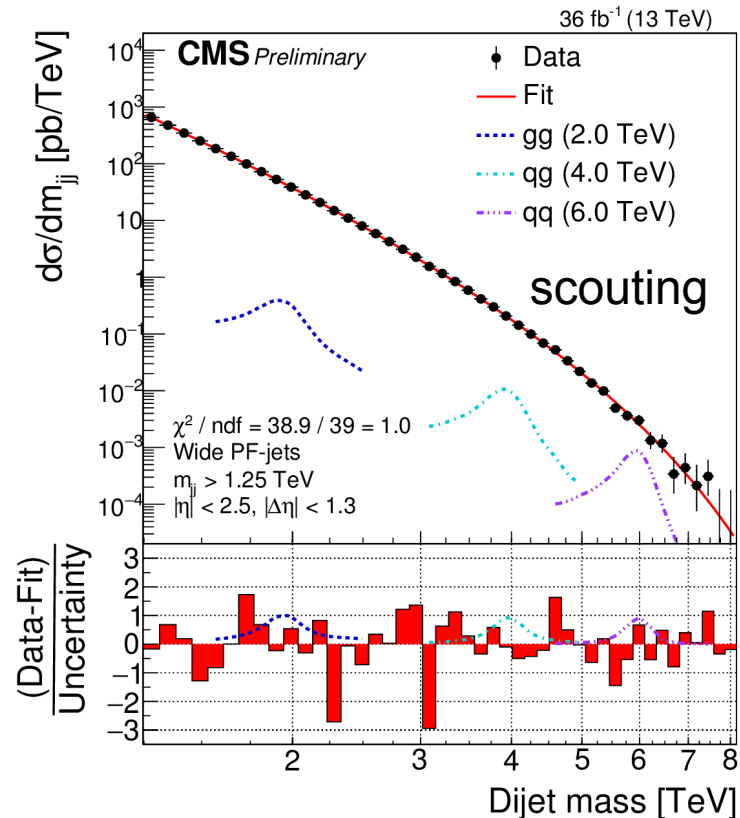
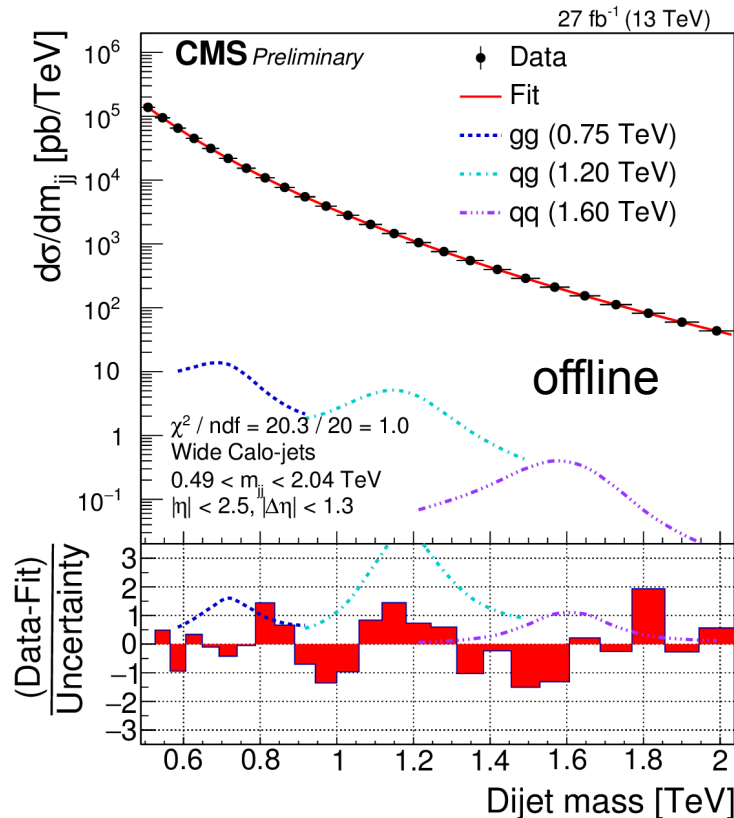
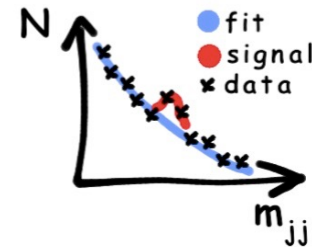


Including searches for anomalous triple gauge couplings
(CP-violating/conserving f_4/f_5 Z/ γ parameters for anomalous ZZZ and $ZZ\gamma$ couplings)

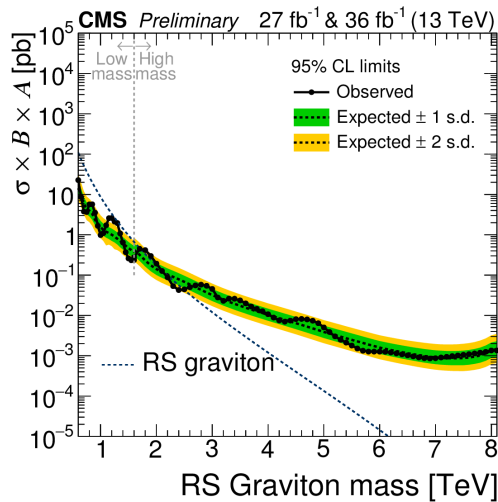
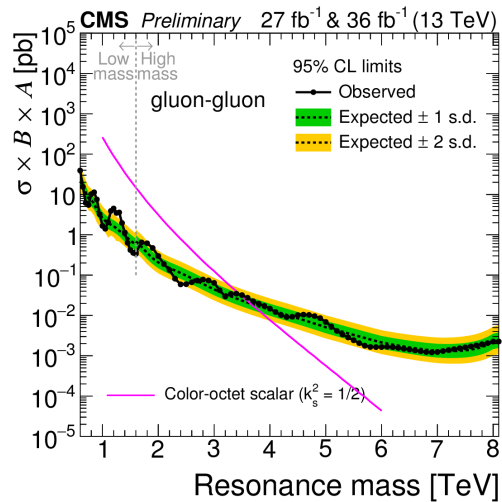
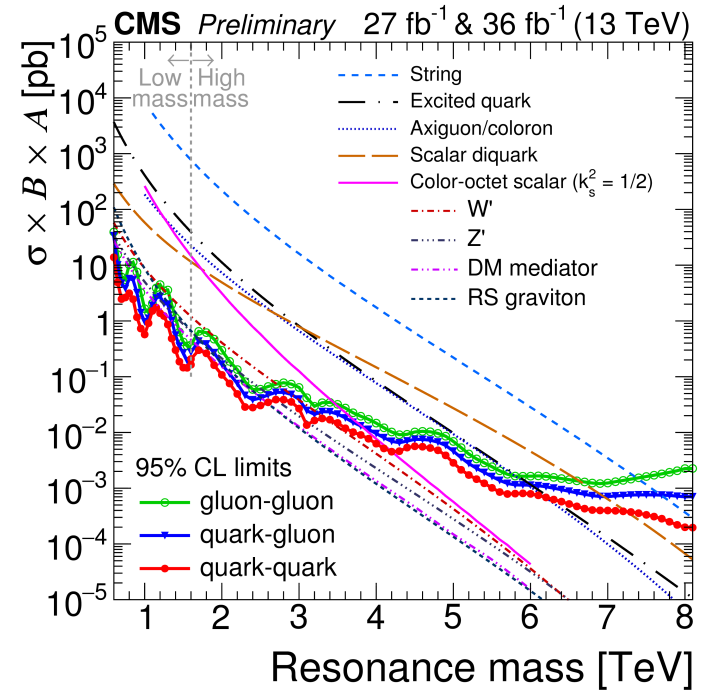
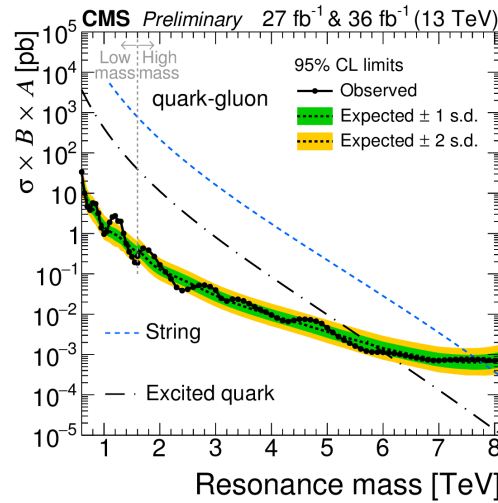
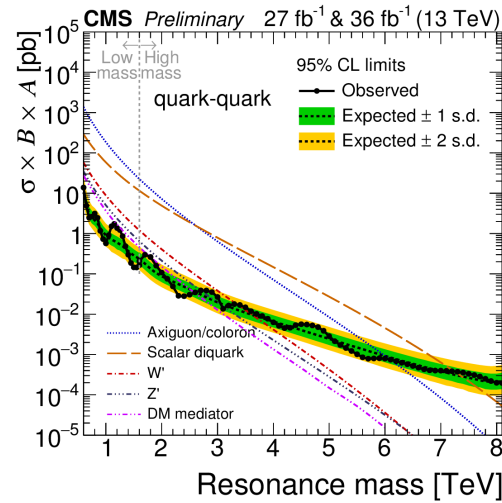


EXO Highlights: Dijet Search (1)

- searches often performed as a **bump hunt** using **functional forms** to describe the backgrounds:



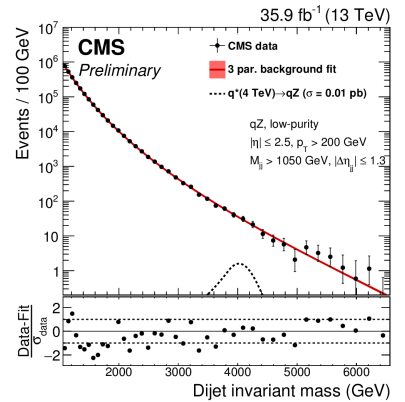
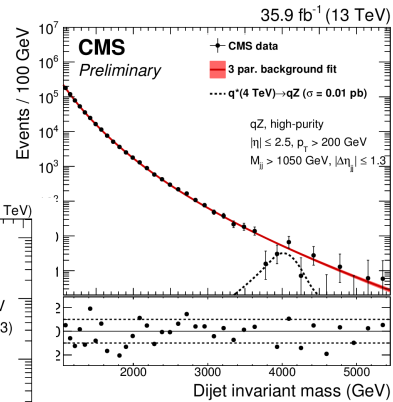
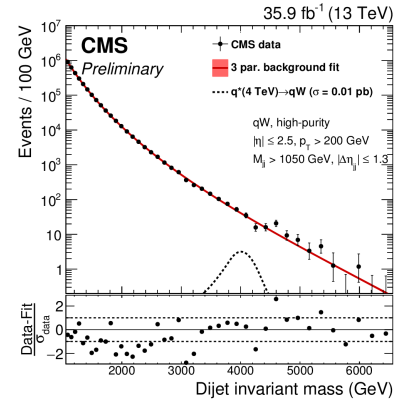
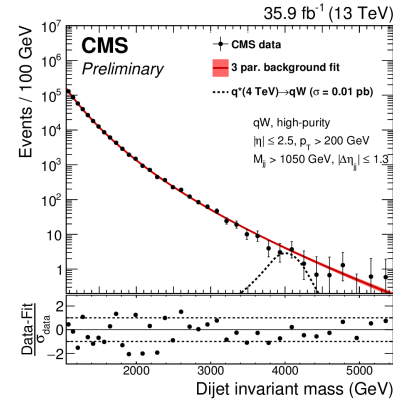
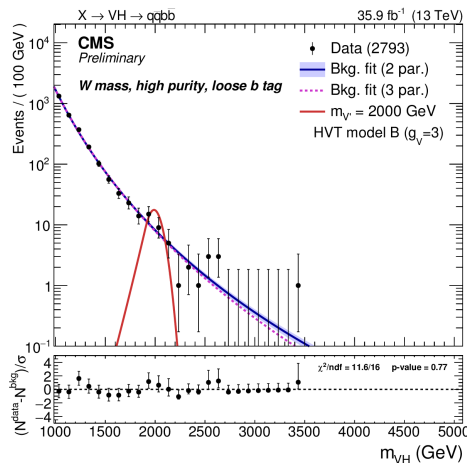
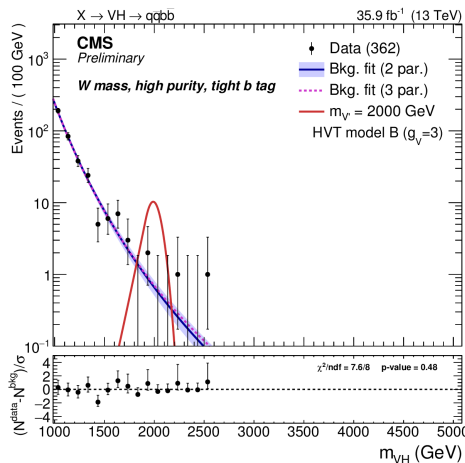
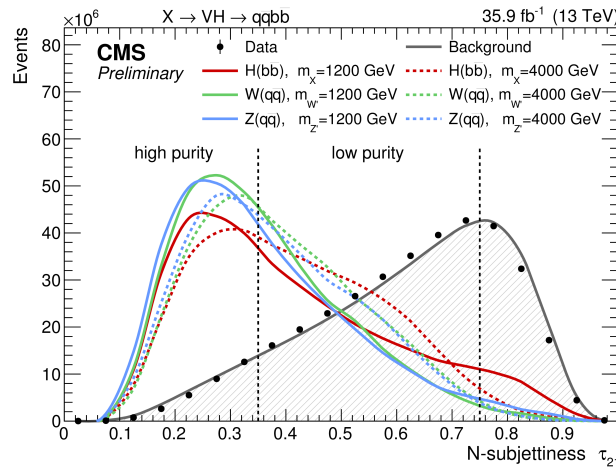
EXO Highlights: Dijet Search (2)



B2G Highlights: Diboson Search (1)

► two diboson analyses with all-hadronic final states presented at Moriond:

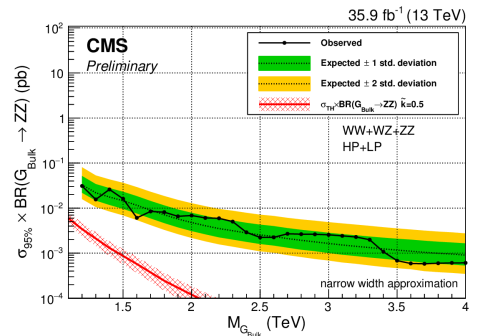
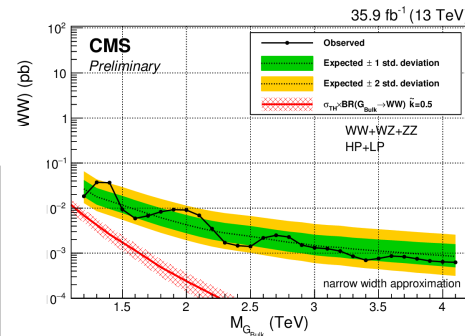
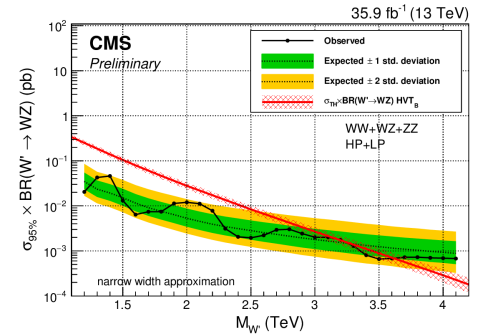
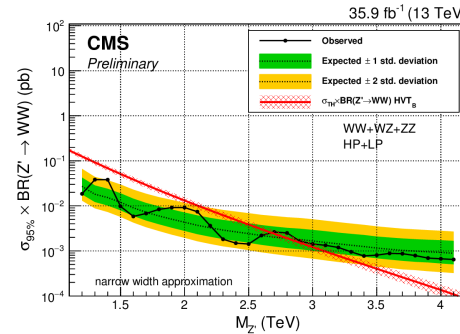
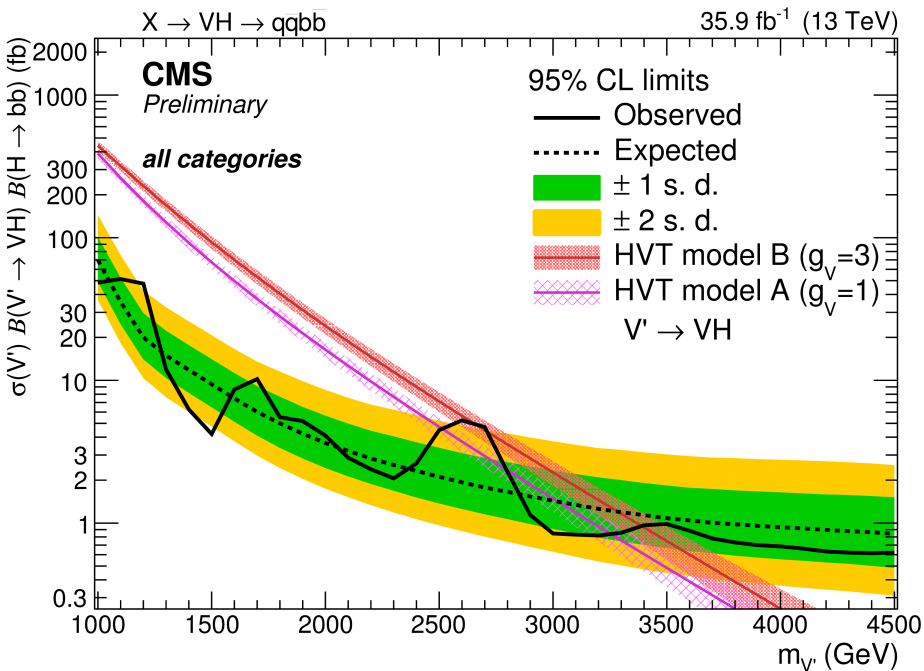
- qV/VV ($V = W, Z$), $V \rightarrow qq$
- $VH \rightarrow qq bb$



B2G Highlights: Diboson Search (2)

➤ two **diboson** analyses with **all-hadronic final states** presented at Moriond:

- qV/VV ($V = W, Z$), $V \rightarrow qq$
- $VH \rightarrow qq\,bb$



Summary

- CMS shows a lot of interesting new results at Moriond 2017
- There are a lot of on-going physics program in CMS for spring and summer conferences

Back Up

Higgs Highlights: ttH Search (tau)

- Signal categories in tautau channel

- $3l + 1 \tau_h$: use 2 kinematic BDTs against ttbar & ttW/Z
- $2lss + 1 \tau_h$: ME likelihood ratio for ttW/Z separation
- $1l + 2 \tau_h$: BDT for ttbar separation

