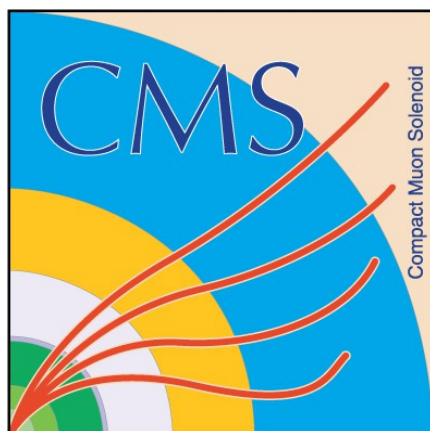


Latest Results from CMS

Enrique Palencia Cortezón
(on behalf of the CMS Collaboration)

Universidad de Oviedo



**TOP2016: 9th International
Workshop on Top Quark
Physics**

September 19, 2016

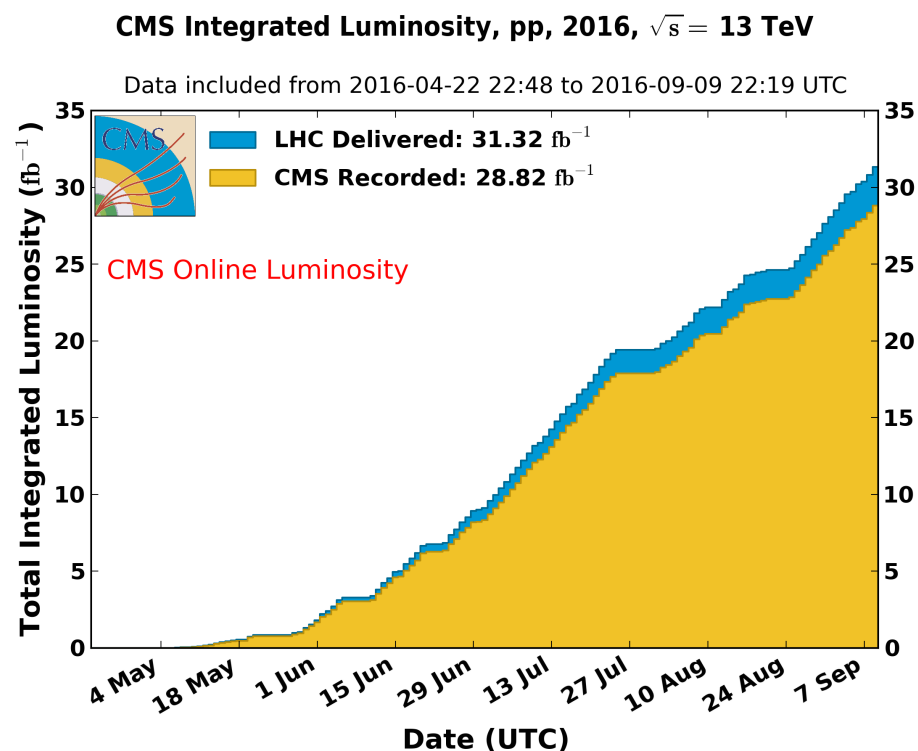
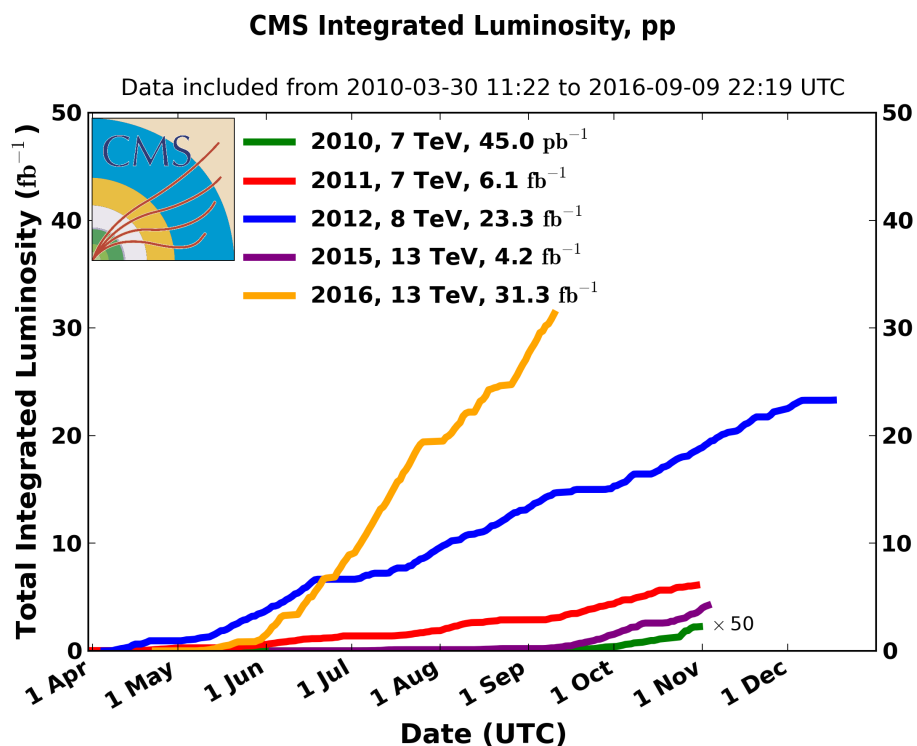


Outline

- **CMS** has released almost **100 new results** during this summer
 - **SM** measurements: exploiting the improvement in the detectors and analysis techniques and providing more precise results
 - **Searches** for Supersymmetry and Exotica: exploring the new energy domain
- Can't cover all new analyses ==> personal (and biased) selection
 - Prioritized new 13 TeV results
 - Tried to avoid overlap of the results to be shown during the week
 - Apologies in advanced for the omissions
- CMS results: <http://cms-results.web.cern.ch/cms-results/public-results/publications/>
- I will focus on results not on methodology

LHC Performance

Superb performance, exceeding the most optimistic estimate



Dataset used for Summer16

- 2015: ~ 3 fb⁻¹
- 2016: ~ 13 fb⁻¹

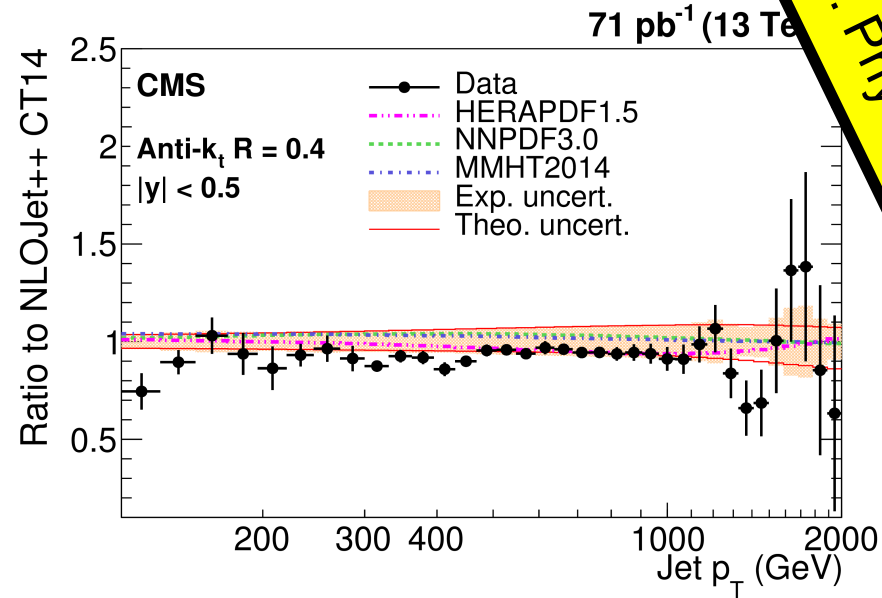
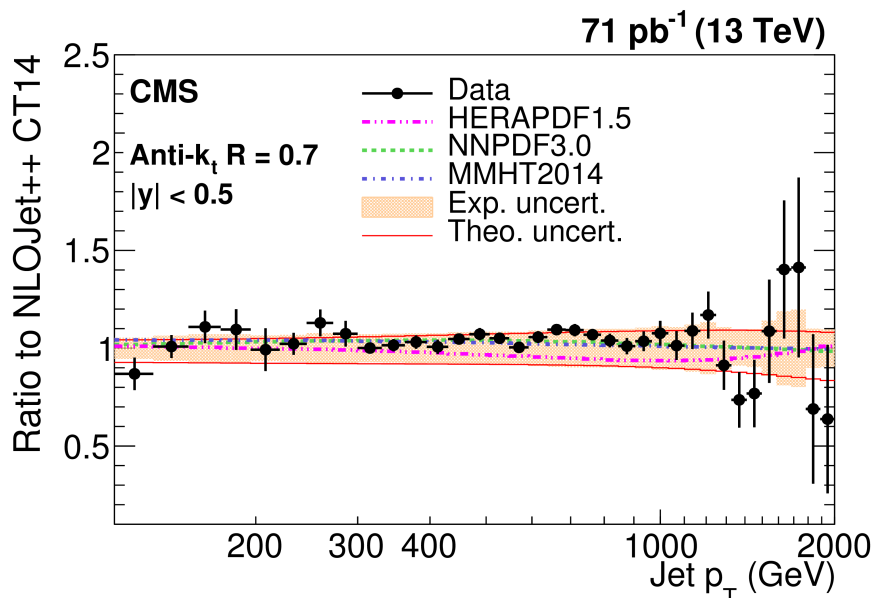
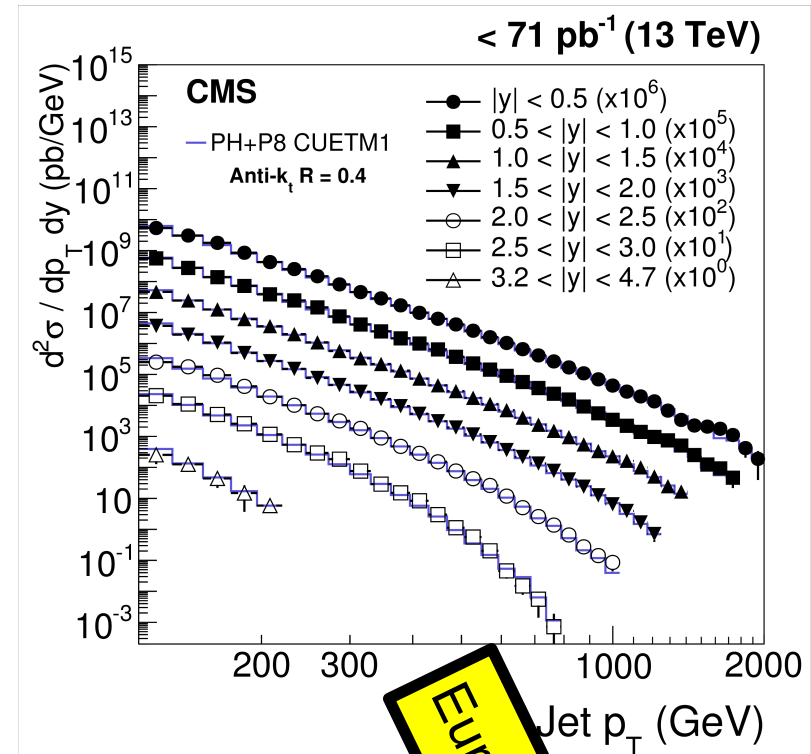
Without the high luminosity and outstanding performance of the accelerator chain, the results shown here would just not be possible

SM Physics

CMS-PAS-SMP-15-012	Measurement of the differential cross sections for pairs of Z bosons produced in association with jets in pp collisions at $\sqrt{s} = 8$ TeV
CMS-PAS-SMP-16-012	Search for anomalous couplings in semileptonic WW and WZ decays at $\sqrt{s} = 13$ TeV
CMS-PAS-SMP-16-009	Measurement of the differential Drell-Yan cross section in proton-proton collisions at $\sqrt{s} = 13$ TeV
CMS-PAS-SMP-16-005	Measurement of the differential cross section for the production of a W ($\rightarrow \mu\nu$) boson in association with jets at $\sqrt{s} = 13$ TeV
CMS-PAS-SMP-16-004	Measurement of the production cross section for $pp \rightarrow Z\gamma \rightarrow \nu\bar{\nu}\gamma$ at $\sqrt{s} = 13$ TeV at CMS
CMS-PAS-SMP-15-009	Measurement of associated Z + charm production in pp collisions at $\sqrt{s} = 8$ TeV
CMS-PAS-SMP-15-001	Combination of results from the ATLAS and CMS experiments on anomalous triple gauge couplings from ZZ production in pp collisions at a center-of-mass energy of 7 TeV at the LHC
CMS-PAS-SMP-15-002	Measurements of ϕ^* differential cross sections for Drell-Yan events in pp collisions at $\sqrt{s} = 8$ TeV
CMS-SMP-14-012	Measurement of the transverse momentum spectra of weak vector bosons produced in proton-proton collisions at $\sqrt{s} = 8$ TeV
CMS-PAS-SMP-16-006	Measurement of the W^+W^- cross section in pp collisions at $\sqrt{s} = 13$ TeV
CMS-PAS-SMP-15-003	Measurement of jet charge observables in dijet events at $\sqrt{s} = 8$ TeV

Inclusive Jet Cross Section

- Double-differential cross-section for inclusive jets with $R=0.7$ and 0.4
- Compared to Powheg + Pythia8, NLOJet++ + NP and LO MC
- Agreement with NLO is in general better than LO
- Slightly different behaviour observed between the two jet radii

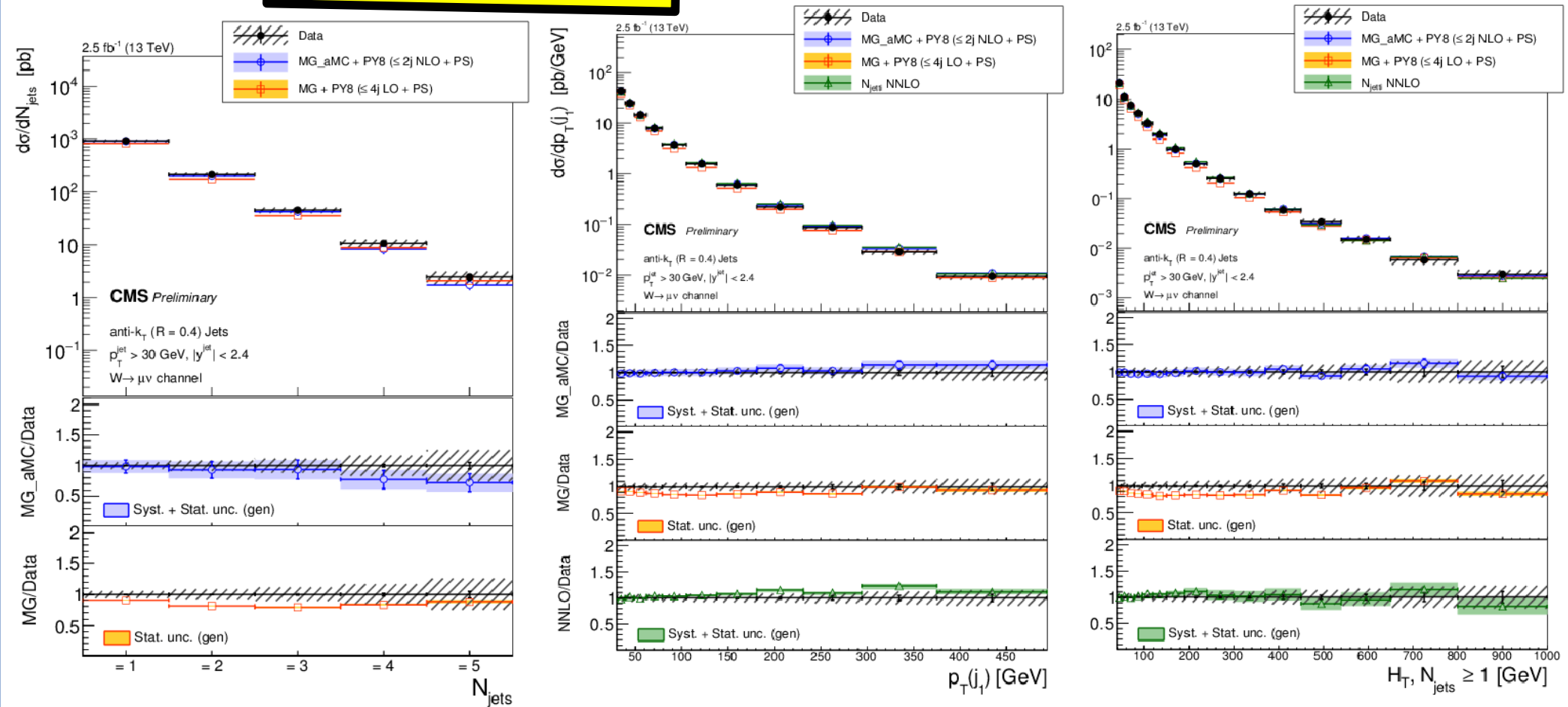


Eur. Phys. J. C 76 (2016) 451

$W(\mu\nu)+\text{Jets}$ Differential Cross Section (2.5 fb^{-1})

- Reported as a function of #Jets, jet p_T , jet η , and H_T for different jet multiplicities
- Compared with predictions that include multileg LO and NLO matrix element calculations interfaced with parton showers and a NNLO calculation for W+1 jet

CMS-PAS-SMP-16-005



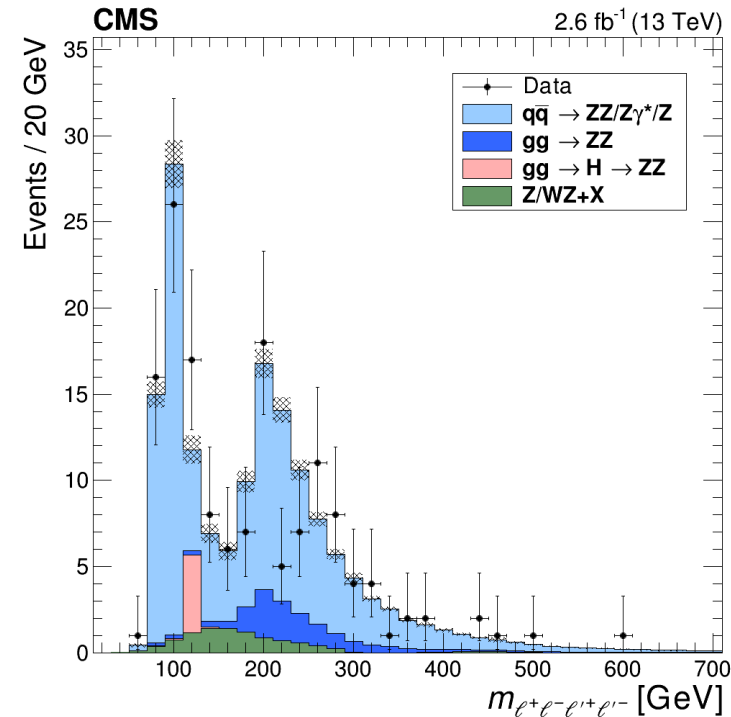
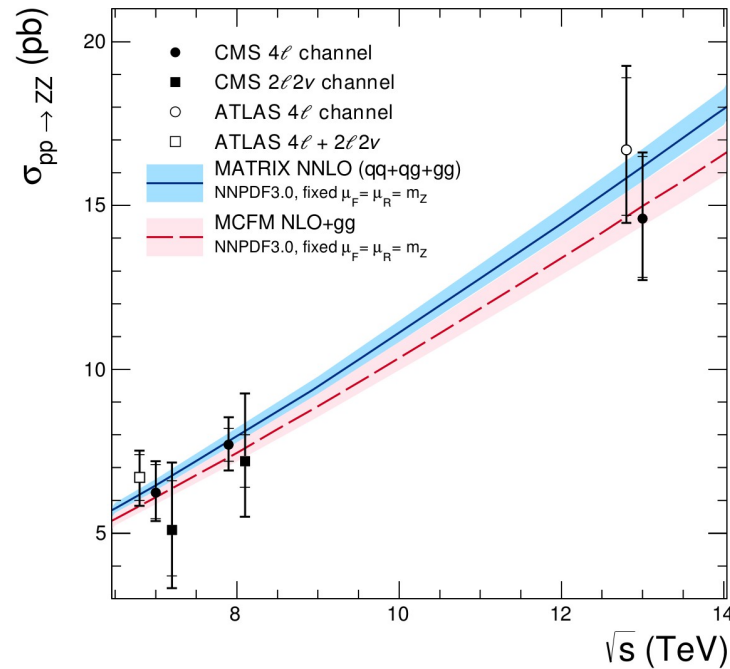
ZZ ($\rightarrow \ell^+ \ell^- \ell'^+ \ell'^-$) Production (2.6 fb^{-1})

● Selection: 4 OS leptons ($e^+e^-e^+e^-$,

$e^+e^-\mu^+\mu^-$, $\mu^+\mu^-\mu^+\mu^-$)

CMS-PAS-SMP-16-001

arXiv:1607.08834



$$\sigma(pp \rightarrow ZZ) = 14.6^{+1.9}_{-1.8} \text{ (stat)} \text{ }^{+0.5}_{-0.3} \text{ (syst)} \pm 0.2 \text{ (theory)} \pm 0.4 \text{ (lumi)} \text{ pb}$$

● 14% precision, statistically limited

● Consistent with NNLO prediction: $15.0^{+0.7}_{-0.6} \pm 0.2 \text{ pb}$

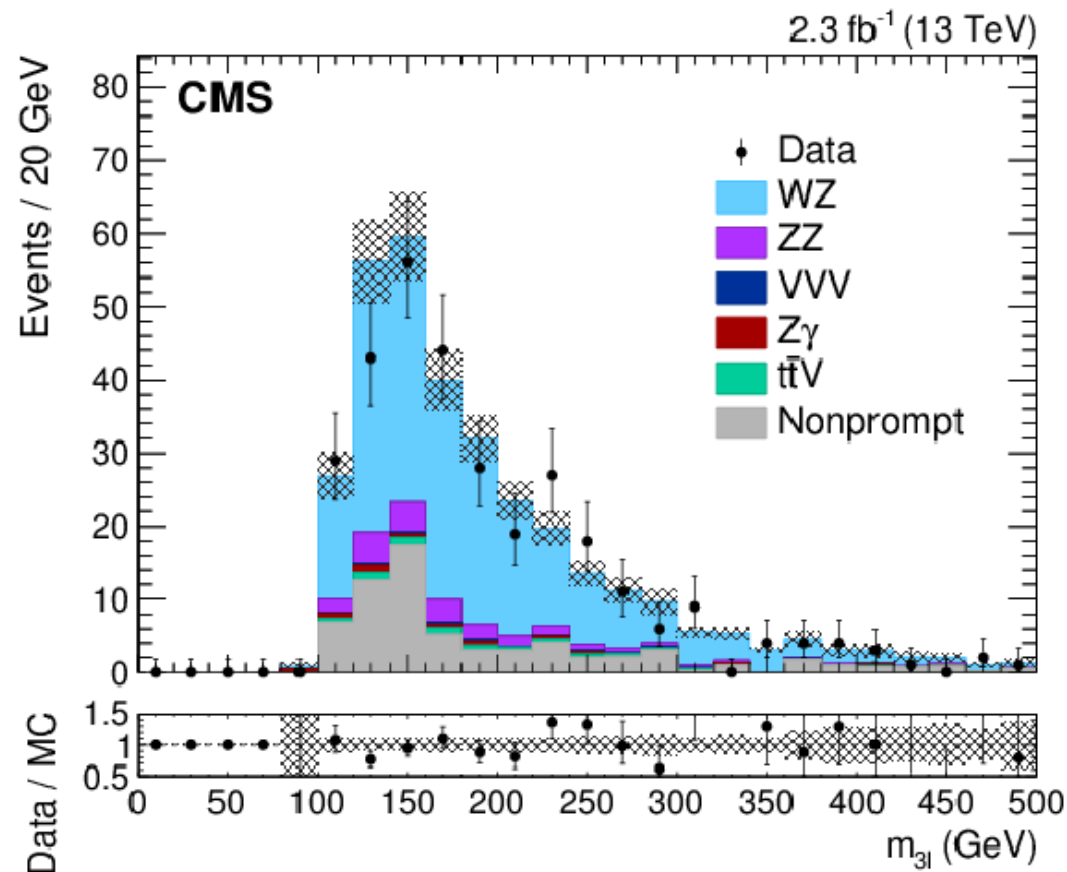
$WZ (\rightarrow \ell^+ \ell^- \ell'^+ \nu)$ Production (2.3 fb^{-1})

● Selection: 3 leptons ($e^+e^- \mu^\pm, \mu^\pm \mu^\mp e^\pm$)

● Fake background measured from data (main systematic)

CMS-PAS-SMP-16-002

arXiv:1607.06943



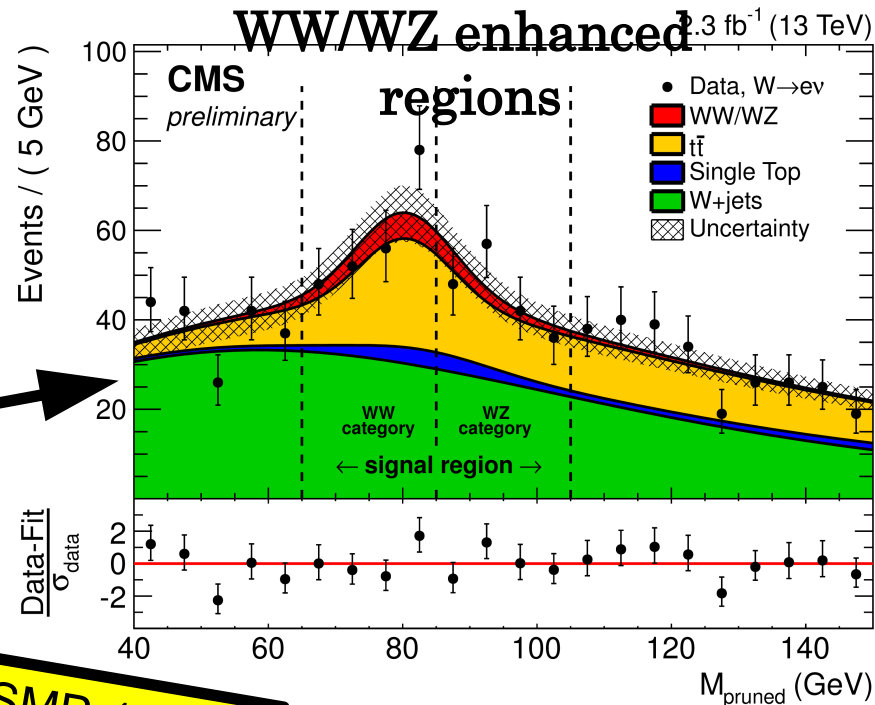
$$\sigma(pp \rightarrow WZ) = 39.9 \pm 3.2 \text{ (stat)}_{-3.1}^{+2.9} \text{ (syst)} \pm 0.4 \text{ (theo)} \pm 1.3 \text{ (lumi)} \text{ pb}$$

● Dominated by systematic uncertainties

● Consistent with NNLO prediction: $50.0_{-1.0}^{+1.1}$ (scale) pb

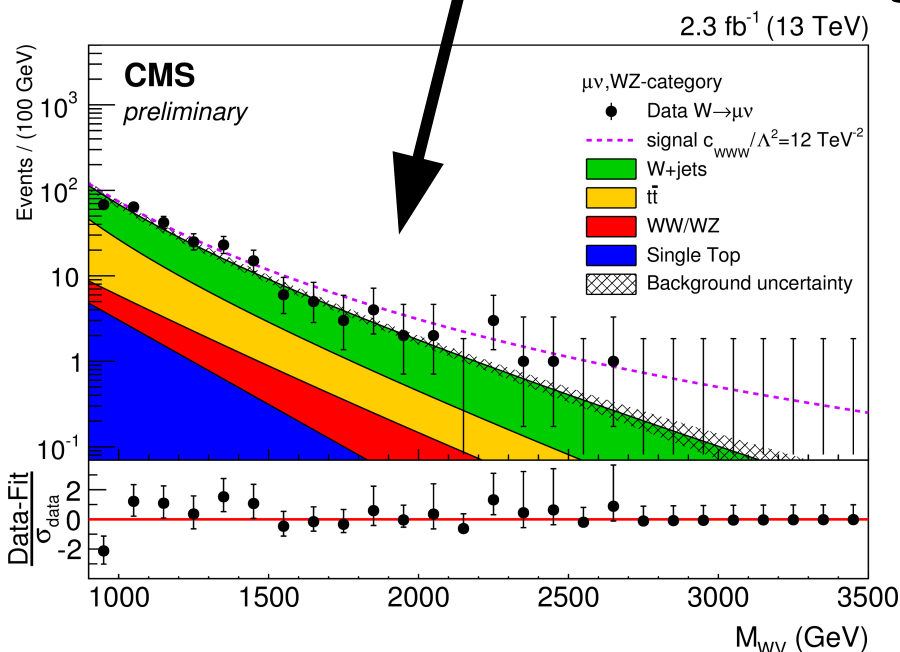
Anomalous Couplings in WW, WZ (2.3 fb^{-1})

- Constrain additional operators that would lead to anomalous WW γ or WWZ couplings
- Events with one W boson decaying leptonically and one W or Z boson decaying hadronically
- Use pruned mass (merged jet) for bkg evaluation and WW mass for aQGC



CMS-PAS-SMP-16-012

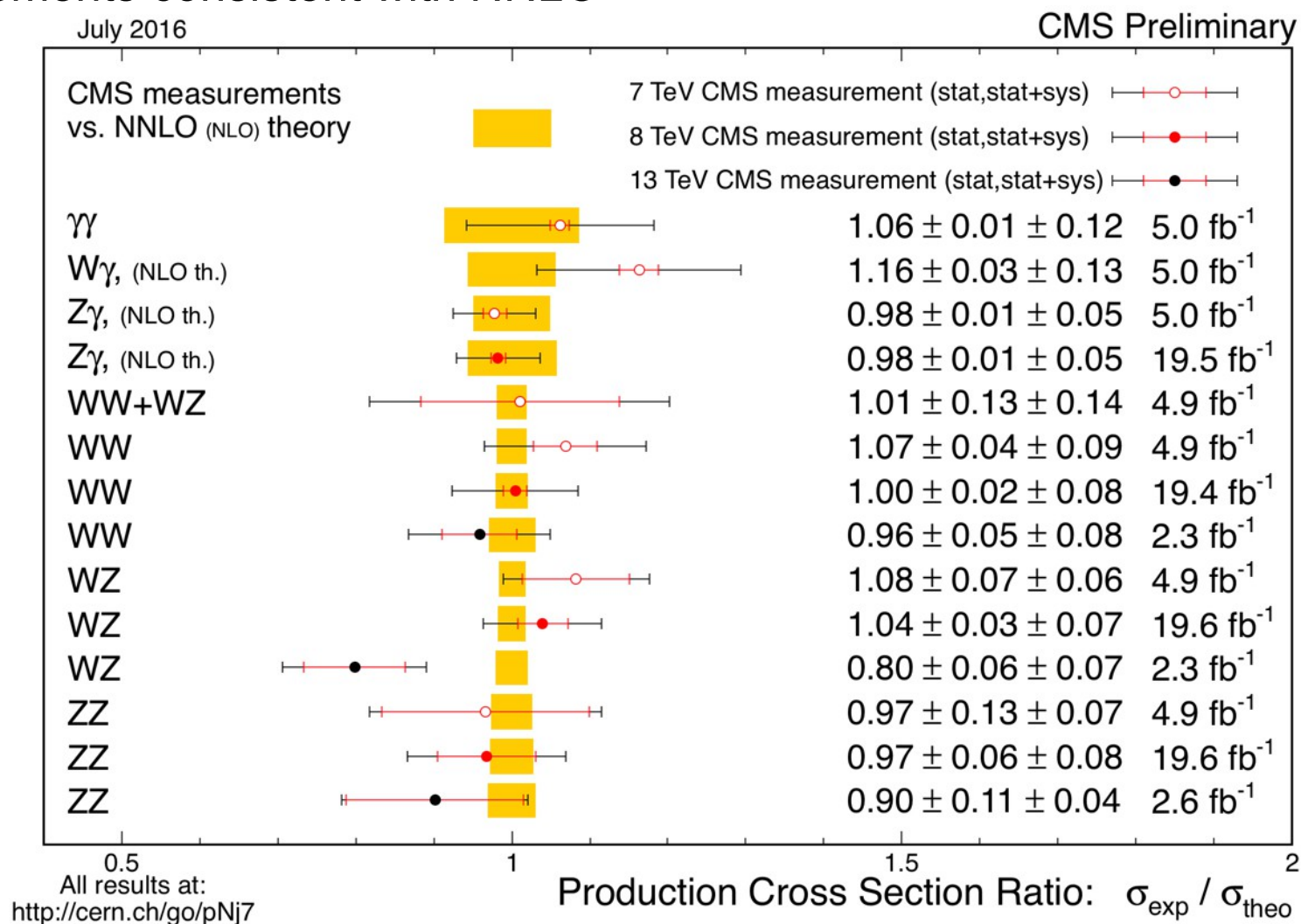
- Limits in agreement with SM expectations



	aTGC	expected limit	observed limit
EFT param.	$\frac{c_{WWW}}{\Lambda^2}$ (TeV^{-2})	[-8.73, 8.70]	[-9.46, 9.42]
	$\frac{c_W}{\Lambda^2}$ (TeV^{-2})	[-11.7, 11.1]	[-12.6, 12.0]
	$\frac{c_B}{\Lambda^2}$ (TeV^{-2})	[-54.9, 53.3]	[-56.1, 55.4]
Vertex param.	λ	[-0.036, 0.036]	[-0.039, 0.039]
	Δg_1^Z	[-0.066, 0.064]	[-0.067, 0.066]
	$\Delta \kappa_Z$	[-0.038, 0.040]	[-0.040, 0.041]

SM Summary

- Final precise 8TeV diboson cross sections, differential cross sections
- New 13 TeV cross section, starting to go differential
- Measurements consistent with NNLO



Top Physics

CMS-PAS-TOP-16-017	Measurement of the top pair-production in association with a W or Z boson in pp collisions at 13 TeV
CMS-PAS-TOP-16-016	Search for standard model production of four top quarks in proton-proton collisions at 13 TeV
CMS-PAS-TOP-12-039	Search for associated production of a Z boson with a single top quark and for tZ flavour-changing interactions in pp collisions at $\sqrt{s} = 8$ TeV
CMS-PAS-TOP-16-007	Measurement of particle level differential $t\bar{t}$ cross sections in the dilepton channel at $\sqrt{s} = 13$ TeV
CMS-PAS-TOP-15-008	Measurement of the top-quark mass in the dileptonic $t\bar{t}$ decay channel using the $M_{b\ell}$, M_{T2} , and $M_{b\ell\nu}$ observables
CMS-PAS-TOP-14-013	Measurement of double differential cross sections for top quark pair production in pp collisions at $\sqrt{s} = 8$ TeV
CMS-PAS-TOP-16-010	Measurement of the cross section ratio $\sigma_{t\bar{t}b\bar{b}} / \sigma_{t\bar{t}jj}$ using dilepton final states in pp collisions at $\sqrt{s} = 13$ TeV
CMS-PAS-TOP-16-006	A measurement of the inclusive $t\bar{t}$ production cross section in proton-proton collisions at $\sqrt{s} = 13$ TeV using events with one isolated charged lepton and at least one jet
CMS-PAS-TOP-15-006	Measurement of the differential production cross section for top-quark pairs as a function of jet multiplicity in the lepton+jets final state at $\sqrt{s} = 8$ TeV with the CMS detector
CMS-TOP-12-042	Measurement of the differential cross sections for top quark pair production as a function of kinematic event variables in pp collisions at $\sqrt{s} = 7$ and 8 TeV
CMS-PAS-TOP-16-015	First measurement of the top quark pair production cross section in proton-proton collisions at $\sqrt{s} = 5.02$ TeV
CMS-PAS-TOP-16-013	Measurement of the $t\bar{t}$ production cross section at 13 TeV in the all-jets final state

 Dedicated talks during the week ==> **Not shown here**

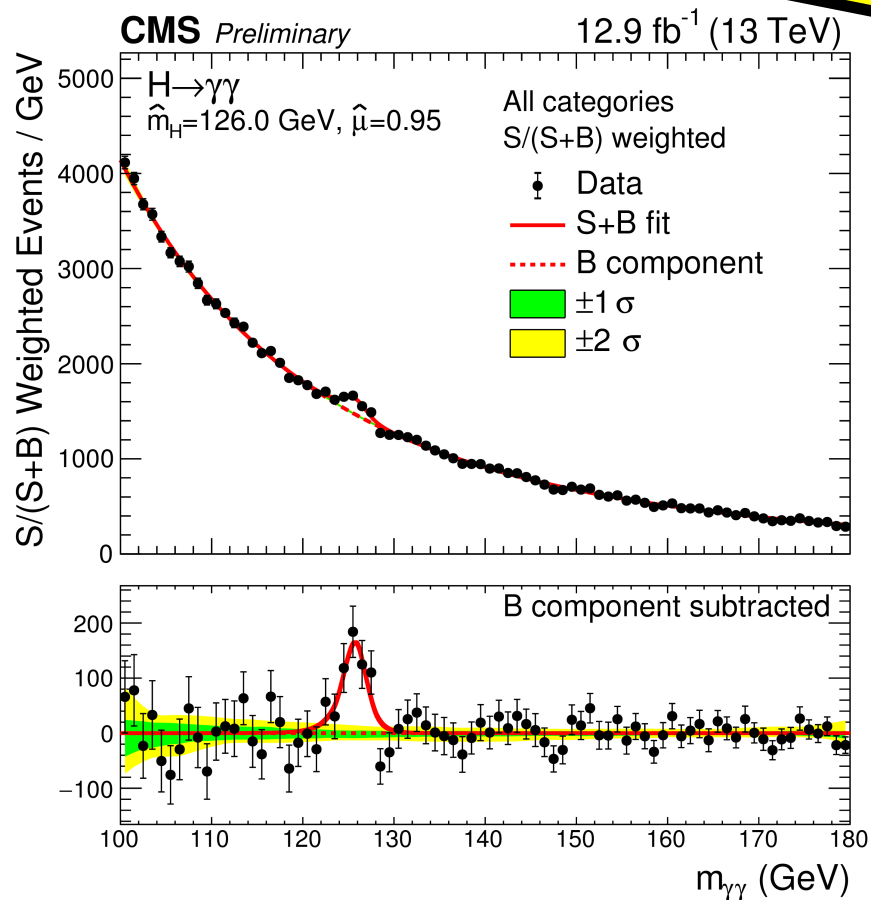
Higgs Physics

CMS-PAS-HIG-16-026	Search for non-resonant pair production of Higgs bosons in the $b\bar{b}b\bar{b}$ final state with 13 TeV CMS data
CMS-PAS-HIG-16-030	Search for $H^+ \rightarrow c\bar{b}$ in lepton+jets channel using top quark pair events
CMS-PAS-HIG-16-032	Search for $H(b\bar{b})H(\gamma\gamma)$ decays at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-024	Search for Higgs boson pair production in the $b\bar{b}l\nu l\nu$ final state at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-022	Search for associated production of Higgs bosons and top quarks in multilepton final states at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-020	Updated measurements of Higgs boson production in the diphoton decay channel at $\sqrt{s} = 13$ TeV in pp collisions at CMS.
CMS-PAS-HIG-16-023	Search for high mass Higgs to WW with fully leptonic decays using 2015 data
CMS-PAS-HIG-16-029	Search for resonant Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ final state using 2016 data
CMS-PAS-HIG-16-028	Search for non-resonant Higgs boson pair production in the $b\bar{b}\tau^+\tau^-$ final state using 2016 data
CMS-PAS-HIG-16-025	Search for a narrow heavy resonance decaying to bottom quark-antiquark pairs at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-033	Measurements of properties of the Higgs boson and search for an additional resonance in the four-lepton final state at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-019	Search for $H \rightarrow b\bar{b}$ in association with a single top quark as a test of Higgs boson couplings at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-027	Search for charged Higgs bosons in WZ decays at 13 TeV
CMS-PAS-HIG-16-016	Searches for invisible Higgs boson decays with the CMS detector
CMS-PAS-HIG-15-003	First results on Higgs to WW at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-006	Search for a neutral MSSM Higgs boson decaying into $\tau\tau$ at 13 TeV
CMS-PAS-HIG-16-003	Search for the standard model Higgs boson produced through vector boson fusion and decaying to $b\bar{b}$ with proton-proton collisions at $\sqrt{s} = 13$ TeV
CMS-PAS-HIG-16-005	Search for lepton flavour violating decays of the Higgs boson in the $\mu\tau$ final state at 13 TeV

Higgs Rediscovery (12.9 fb^{-1})

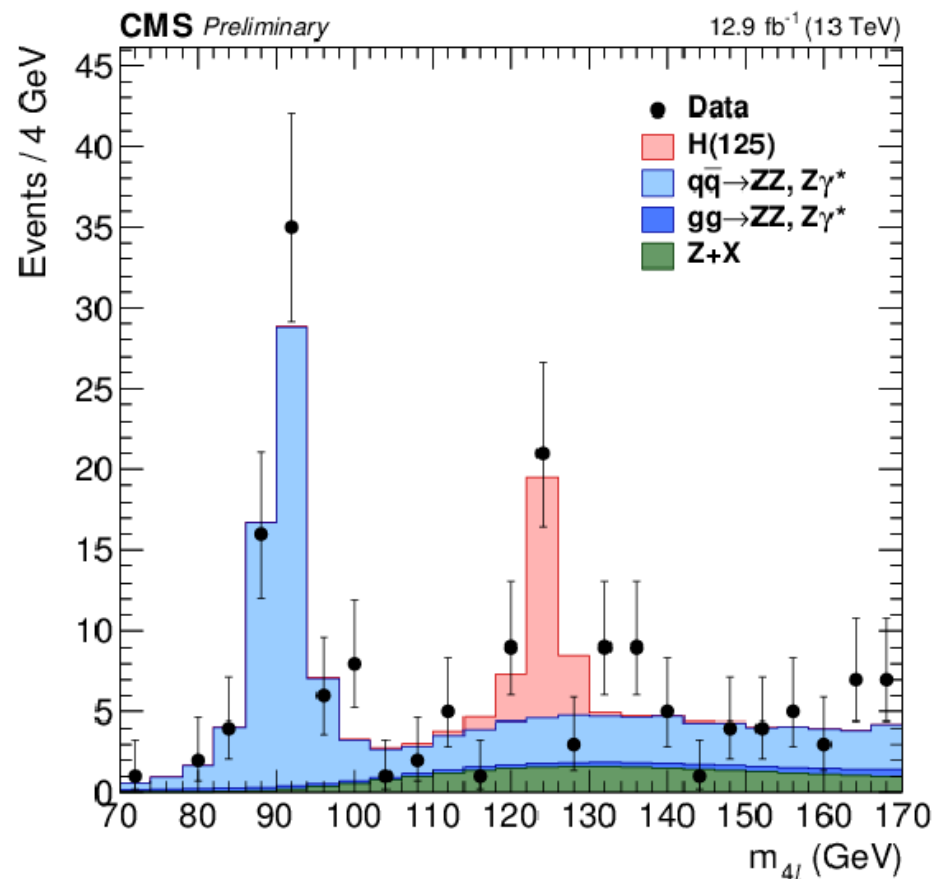
CMS-PAS-HIG-16-020

$H \rightarrow \gamma\gamma$



CMS-PAS-HIG-16-033

$H \rightarrow ZZ \rightarrow \ell^+ \ell^- \ell'^+ \ell'^-$



● Signal clear already by eye!!!

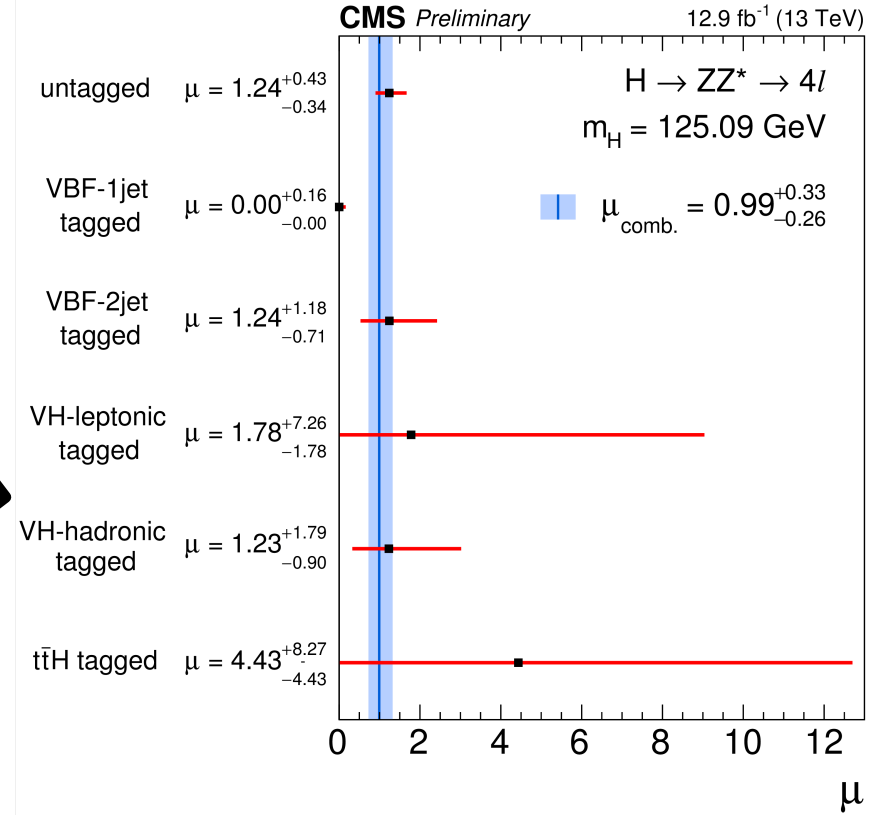
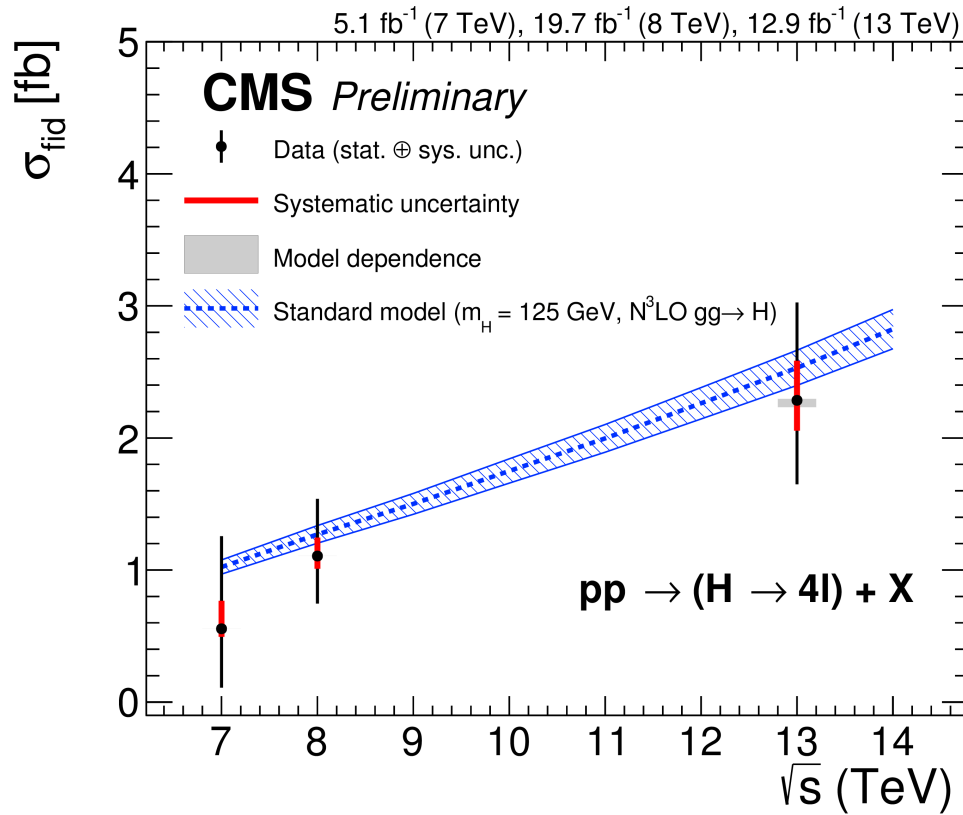
● Well beyond 5 sigma each channel!

Higgs Cross Section: $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \ell'^+ \ell'^-$ (12.9 fb^{-1})

• No tension in signal strength between channels

$$\mu = \sigma / \sigma_{SM} = 0.99^{+0.33}_{-0.26}$$

CMS-PAS-HIG-16-033



• Fiducial cross section compatible with SM

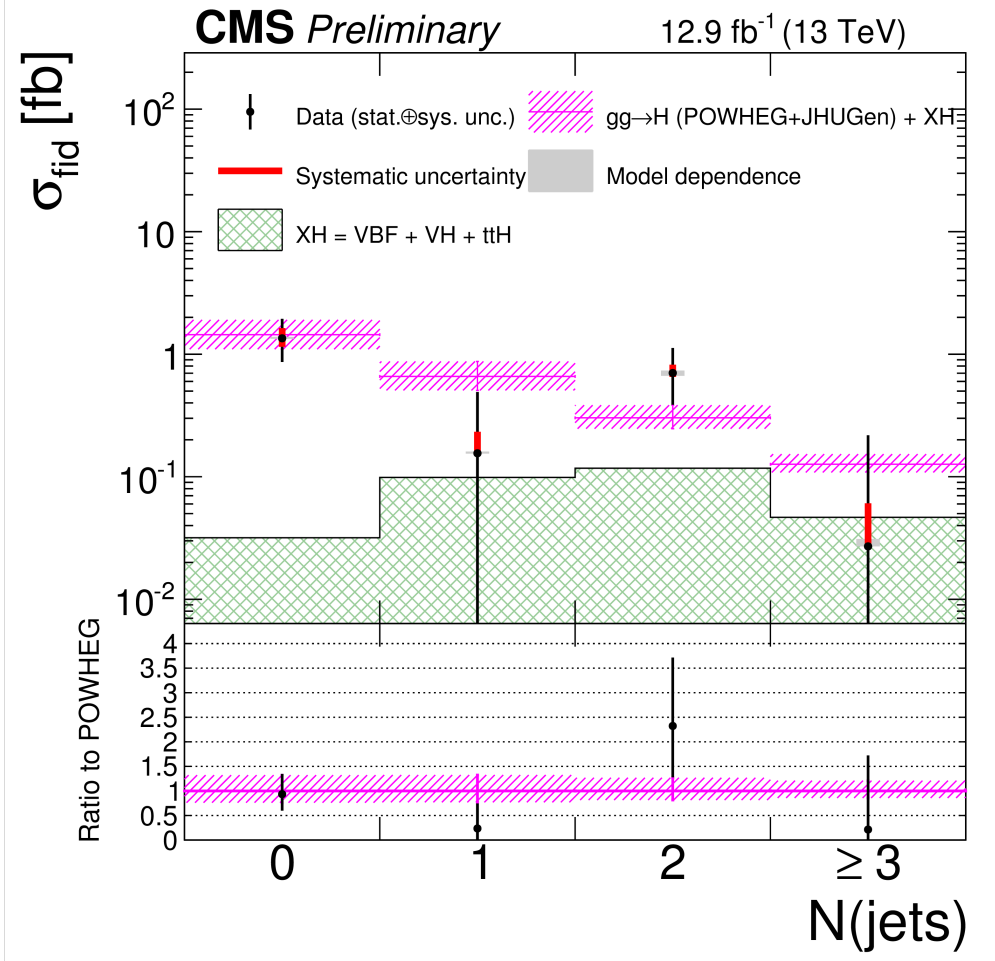
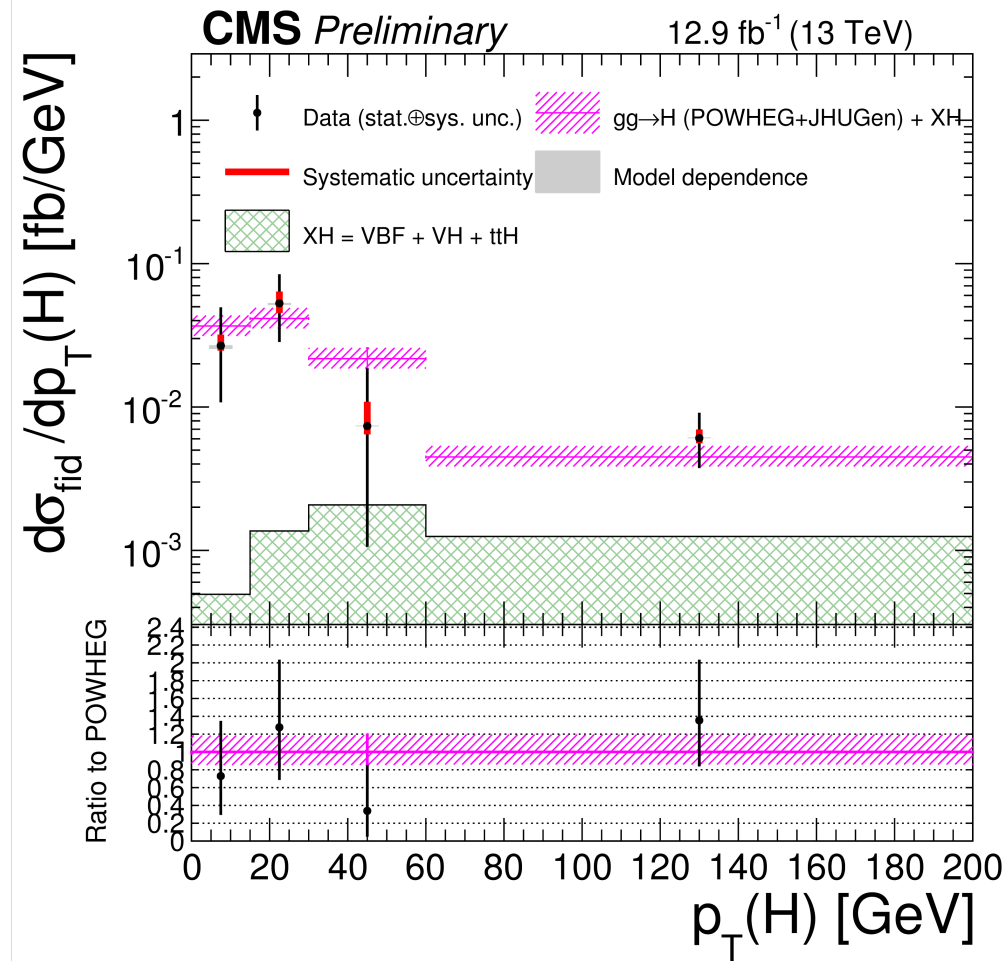
$$\sigma_{\text{fid.}}^{\text{SM}} = 2.53 \pm 0.13 \text{ fb}$$

$$\sigma_{\text{fid.}} = 2.29^{+0.74}_{-0.64} (\text{stat.})^{+0.30}_{-0.23} (\text{sys.})^{+0.01}_{-0.05} (\text{model dep.}) \text{ fb}$$

Higgs Cross Section: $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \ell'^+ \ell'^-$ (12.9 fb^{-1})

CMS-PAS-HIG-16-033

Differential cross sections as a function of the Higgs p_T and #jets are provided



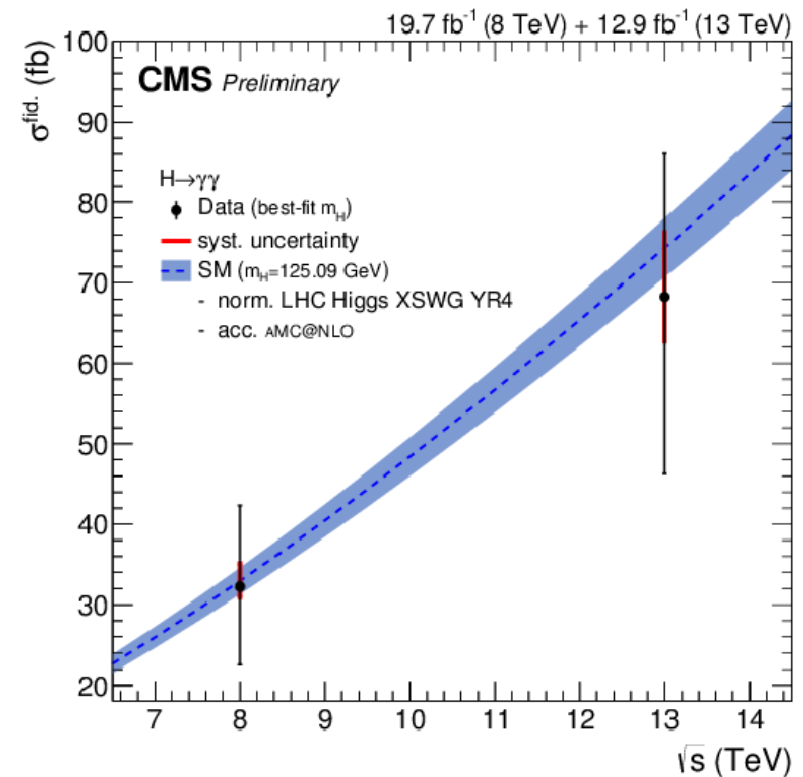
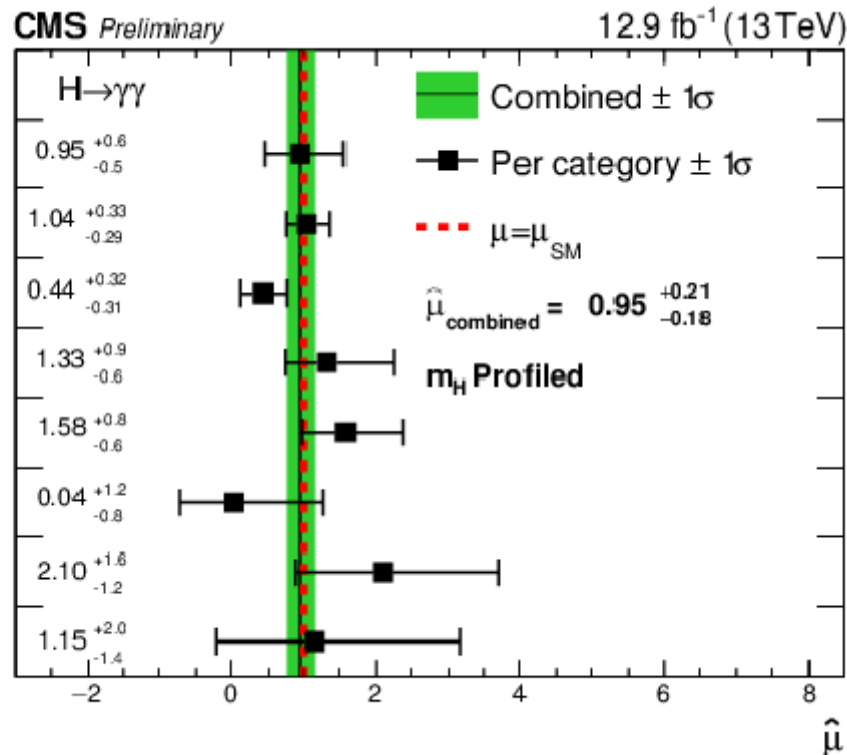
With more luminosity, these distributions will become more and more important

Higgs Cross Section: $H \rightarrow \gamma\gamma$ (12.9 fb^{-1})

CMS-PAS-HIG-16-020

$\hat{\mu} = 0.95 \pm 0.20 = 0.95 \pm 0.17 \text{ (stat.) } \begin{matrix} +0.10 \\ -0.07 \end{matrix} \text{ (syst.) } \begin{matrix} +0.08 \\ -0.05 \end{matrix} \text{ (theo.)}$

$\sigma^{\text{fid}} = 69_{-22}^{+16} \text{ (stat.) } \begin{matrix} +8 \\ -6 \end{matrix} \text{ (syst.) fb, (SM: } \sigma^{\text{fid}} = 73.8 \pm 3.8 \text{ fb)}$



Higgs Properties: $H \rightarrow ZZ \rightarrow \ell^+ \ell^- \ell'^+ \ell'^-$ (12.9 fb^{-1})

Higgs mass

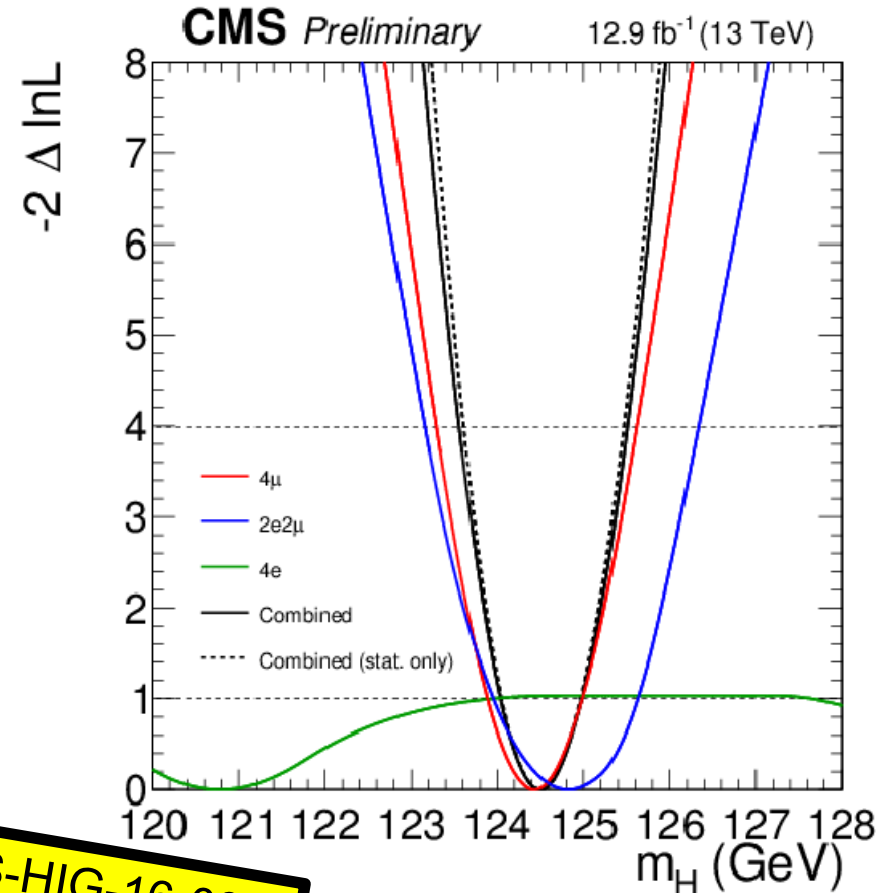
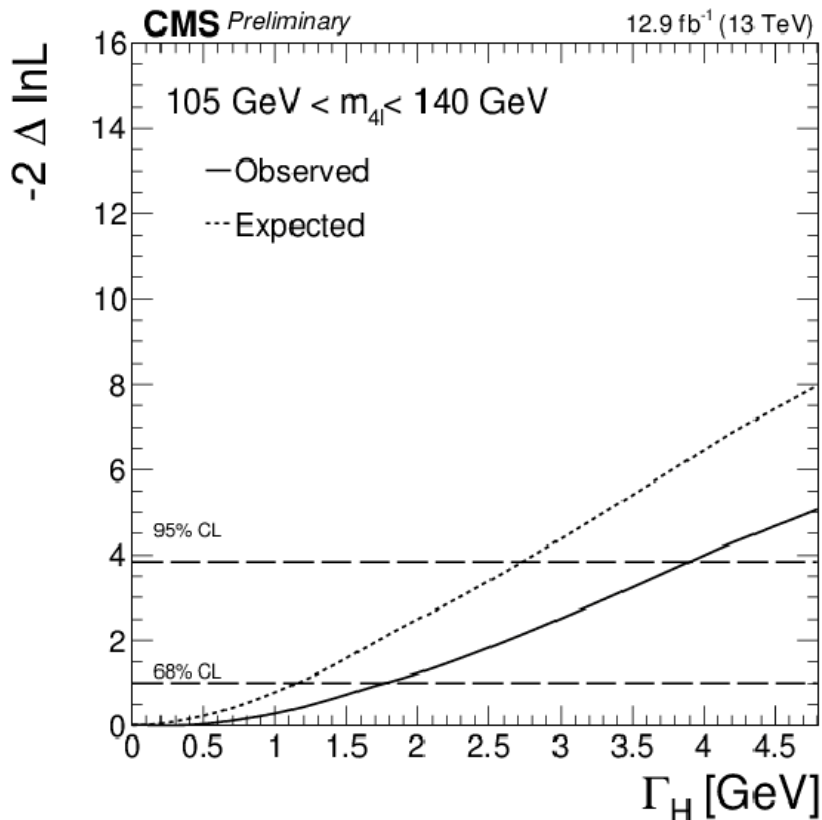
- comparable with Run I combined result

$$m_H = 125.09 \pm 0.21 \text{ (stat)} \pm 0.11 \text{ (syst)} \text{ GeV}$$

$$m_H = 124.50^{+0.48}_{-0.46} \text{ GeV}$$

Higgs width is indirectly constrained to be

$$\Gamma_H < 41 \text{ MeV} (<32 \text{ MeV expected})$$



CMS-PAS-HIG-16-033

- No anomalies wrt 0+ hypothesis

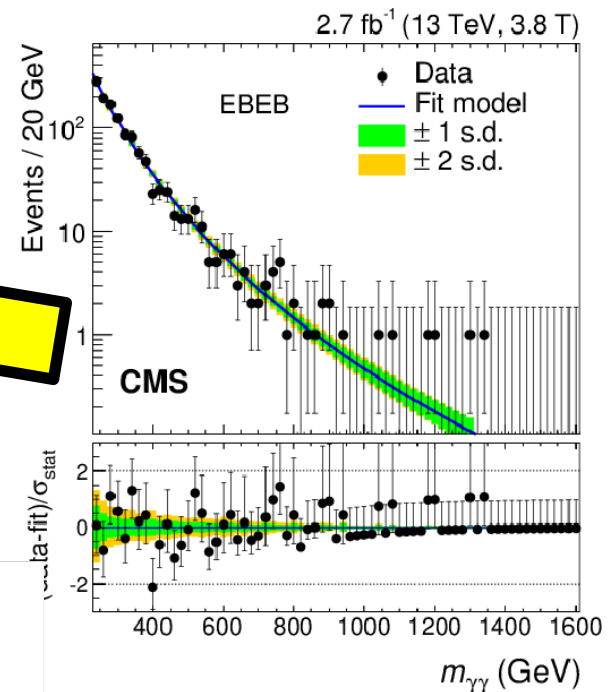
Exotica Searches

CMS-PAS-EXO-14-007	Enhanced scope of a Phase 2 CMS detector for the study of exotic physics signatures at the HL-LHC
CMS-PAS-EXO-16-031	Search for a high-mass resonance decaying into a dilepton final state in 13 fb^{-1} of pp collisions at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-038	Search for dark matter in $Z \rightarrow B_s^0 B_s^{0*}$ events using 12.9 fb^{-1} of 2016 data
CMS-PAS-EXO-16-039	Search for excited leptons in the $EE\gamma$ final state at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-037	Search for dark matter in final states with an energetic jet, or a hadronically decaying W or Z boson using 12.9 fb^{-1} of data at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-040	Search for new physics in a boosted hadronic monoton final state using 12.9 fb^{-1} of $\sqrt{s} = 13 \text{ TeV}$ data
CMS-PAS-EXO-16-043	Search for pair-production of first generation scalar leptoquarks in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ with 2.6 fb^{-1}
CMS-PAS-EXO-16-036	Search for heavy stable charged particles with 12.9 fb^{-1} of 2016 data
CMS-PAS-EXO-16-035	Search for high-mass resonances in $Z(q\bar{q})\gamma$ final state in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ with 12.9 fb^{-1}
CMS-PAS-EXO-16-026	Search for heavy composite Majorana neutrinos produced in association with a lepton and decaying into a same-flavour lepton plus two quarks at $\sqrt{s} = 13 \text{ TeV}$ with the CMS detector
CMS-PAS-EXO-16-025	Search for high-mass resonances in the $Z(q\bar{q})\gamma$ final state at $\sqrt{s} = 8 \text{ TeV}$
CMS-PAS-EXO-16-023	Search for the third-generation scalar leptoquarks and heavy right-handed neutrinos in $\tau\tau\mu\mu$ final states in pp collisions at 13 TeV
CMS-PAS-EXO-16-027	Search for resonant production of high mass photon pairs using 12.9 fb^{-1} of proton-proton collisions at $\sqrt{s} = 13 \text{ TeV}$ and combined interpretation of searches at 8 and 13 TeV
CMS-PAS-EXO-16-022	Search for narrow resonances decaying to dijets in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ using 12.9 fb^{-1}
CMS-PAS-EXO-16-029	Search for dark matter and graviton produced in association with a photon in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ with an integrated luminosity of 12.9 fb^{-1}
CMS-PAS-EXO-16-027	Search for displaced leptons in the $e\mu$ channel
CMS-PAS-EXO-16-025	Search for dark matter in association with a top quark pair at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-034	Search for high-mass resonances in $Z\gamma \rightarrow e^+e^-\gamma/\mu^+\mu^-\gamma$ final states in proton-proton collisions at $\sqrt{s} = 13 \text{ TeV}$ with 12.9 fb^{-1}
CMS-PAS-EXO-16-010	Search for dark matter and unparticles in events with a Z boson and missing transverse momentum in proton-proton collisions at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-015	Search for excited quarks in the $\gamma + \text{jet}$ final state in proton-proton collisions at $\sqrt{s} = 13 \text{ TeV}$
CMS-EXO-13-001	Search for new phenomena in events with high jet multiplicity and low missing transverse momentum in proton-proton collisions at $\sqrt{s} = 8 \text{ TeV}$
CMS-PAS-EXO-16-012	Search for dark matter in association with a Higgs boson decaying into a pair of bottom quarks at $\sqrt{s} = 13 \text{ TeV}$ with the CMS detector
CMS-PAS-EXO-16-030	Search for light vector resonances decaying to quarks at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-020	Search for high-mass resonances in $Z(q\bar{q})\gamma$ final state in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ with 2.7 fb^{-1}
CMS-PAS-EXO-16-008	Search for new physics with high-mass τ lepton pairs in pp collisions at $\sqrt{s} = 13 \text{ TeV}$ with the CMS detector
CMS-PAS-EXO-16-017	Search for dark matter in association with a boosted top quark in the hadronic final state at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-014	Search for dark matter and large extra dimensions in the $\gamma + B_s^{0*}$ final state in pp collisions at $\sqrt{s} = 13 \text{ TeV}$
CMS-PAS-EXO-16-016	Search for heavy neutrinos and third-generation leptoquarks in final states with two hadronically decaying τ leptons and two jets in proton-proton collisions at $\sqrt{s} = 13 \text{ TeV}$

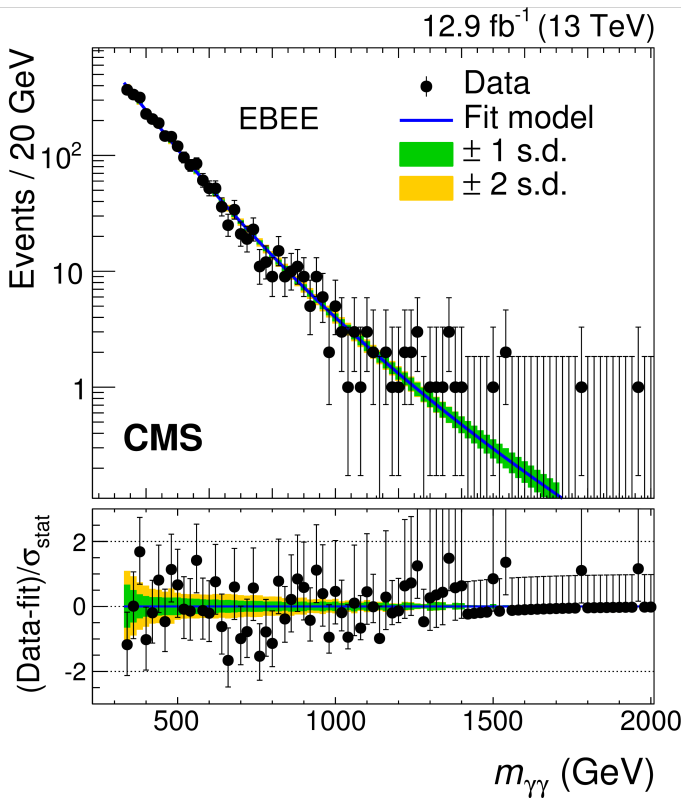
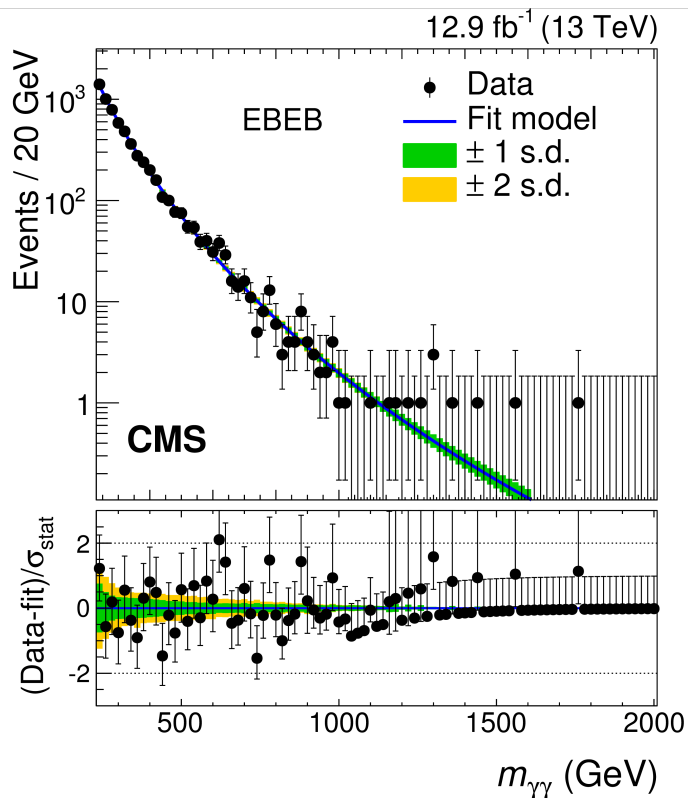
Diphoton Resonances

Small excess around 750 GeV in 2015 data

Phys. Rev. Lett. 117 (2016) 051802



2016 analysis: straight reload of 2015 analysis

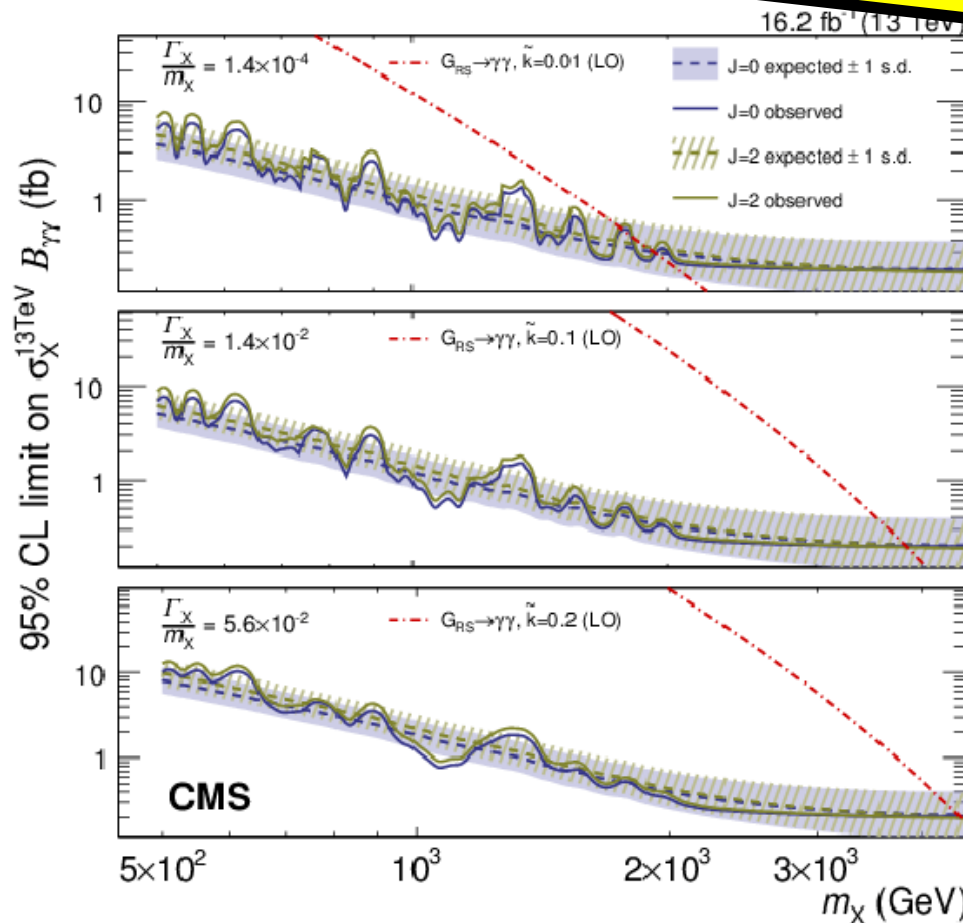
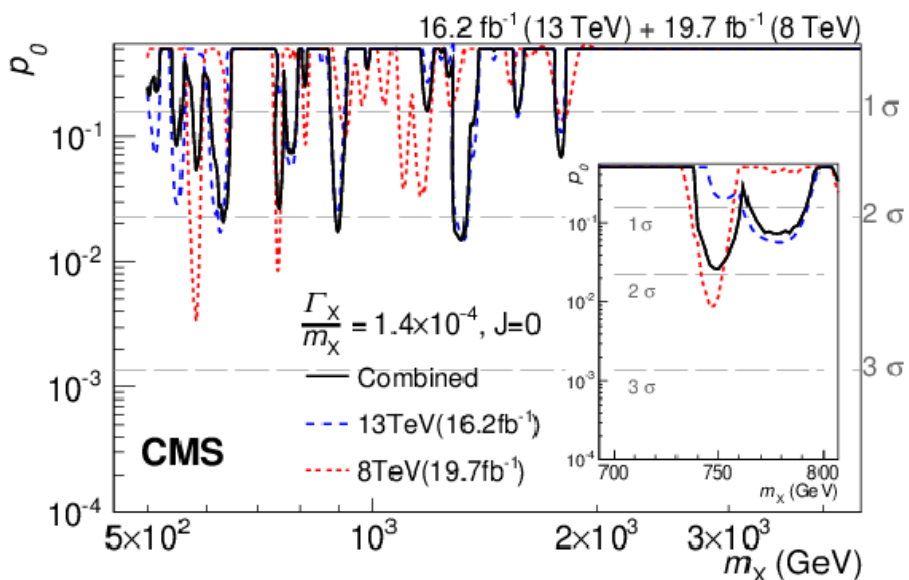
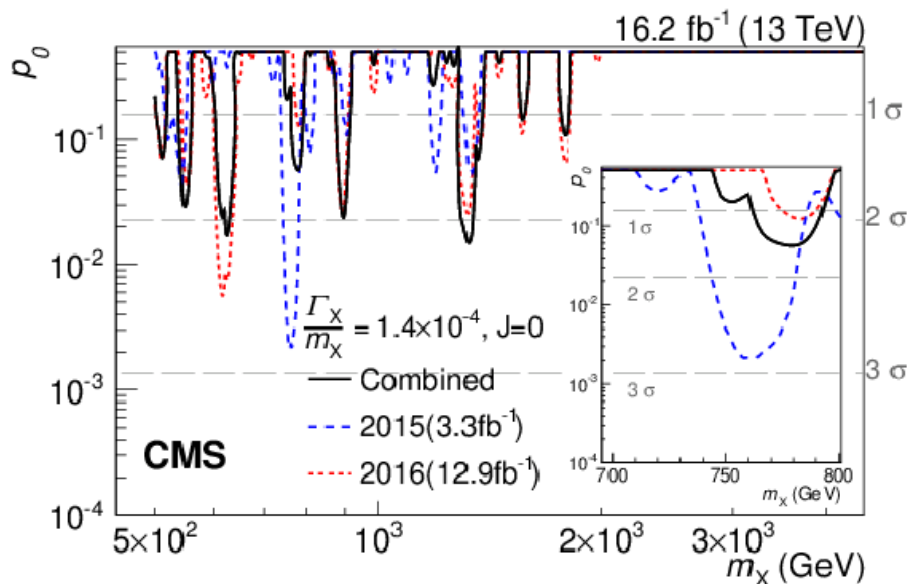


CMS-PAS-EXO-16-027
arXiv:1609.02507

Diphoton Resonances (12.9 fb^{-1})

CMS-PAS-EXO-16-027
arXiv:1609.02507

Small excess observed before is **not confirmed**

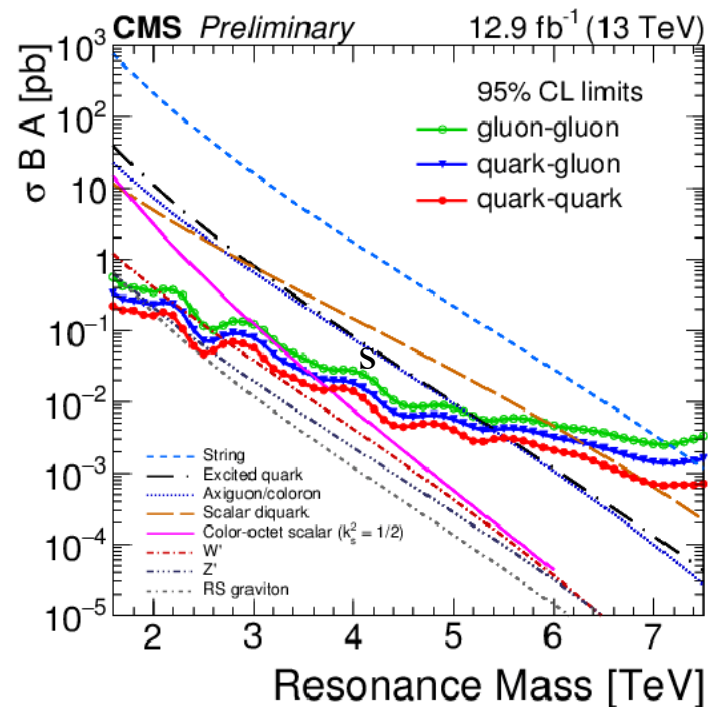
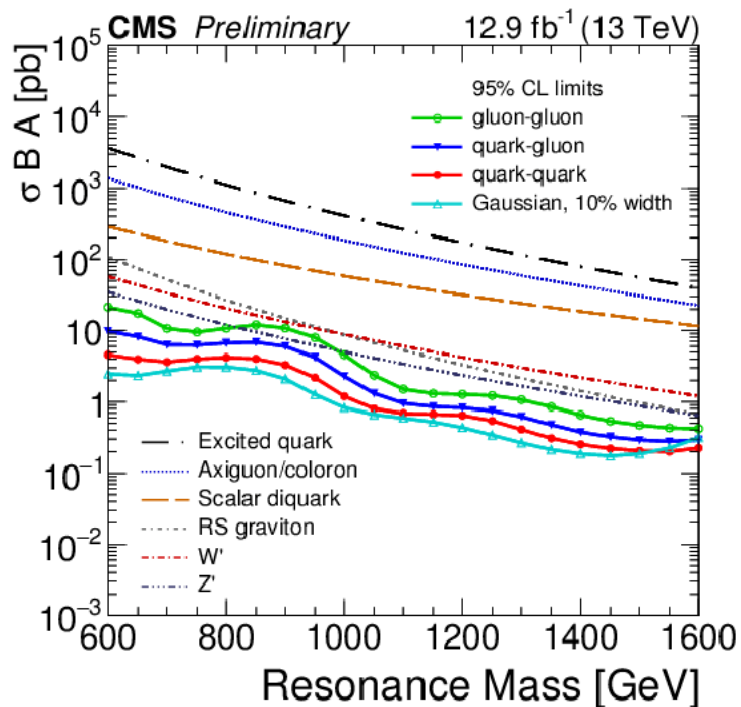
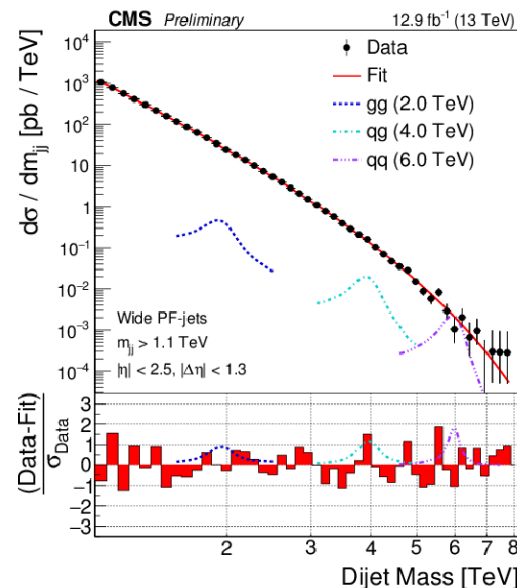
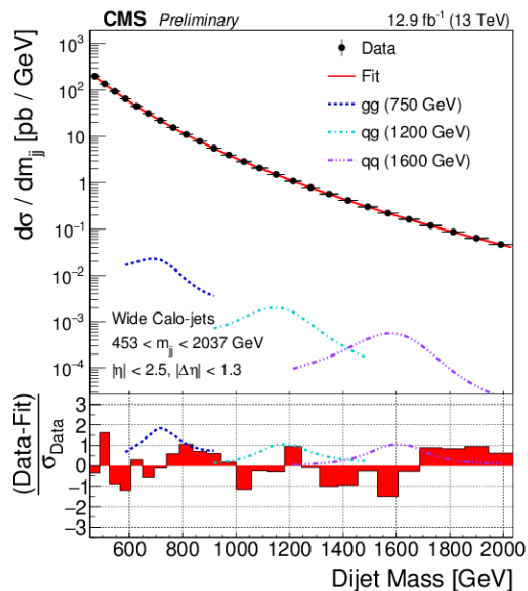


Most stringent limits on Randall-Sundrum
Gravitons: from 1.95 to 4.45 TeV for coupling
parameters between 0.01 and 0.2

Dijet Resonances (12.9 fb^{-1})

Dedicated low and high mass channels

CMS-PAS-EXO-16-032

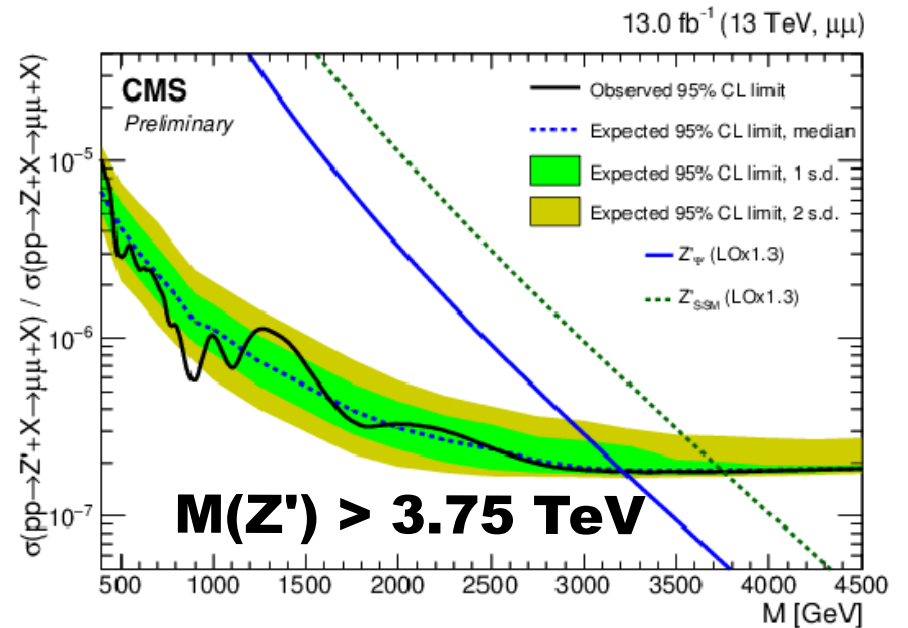
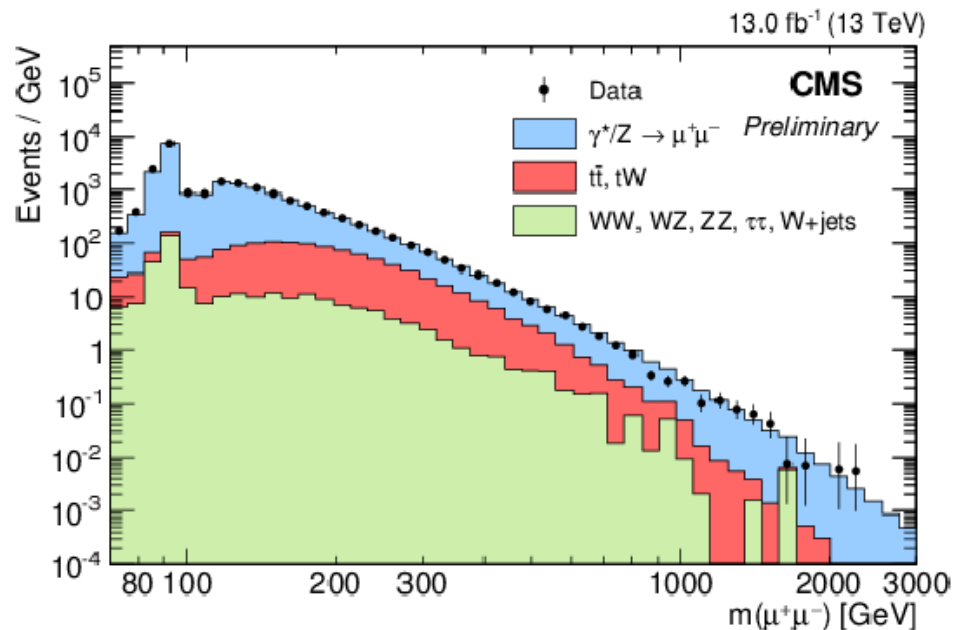
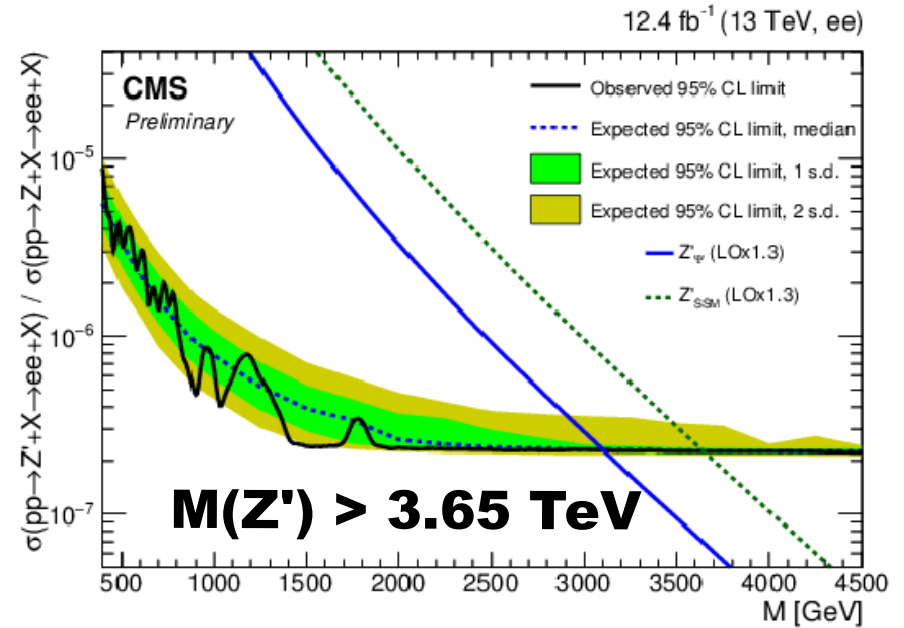
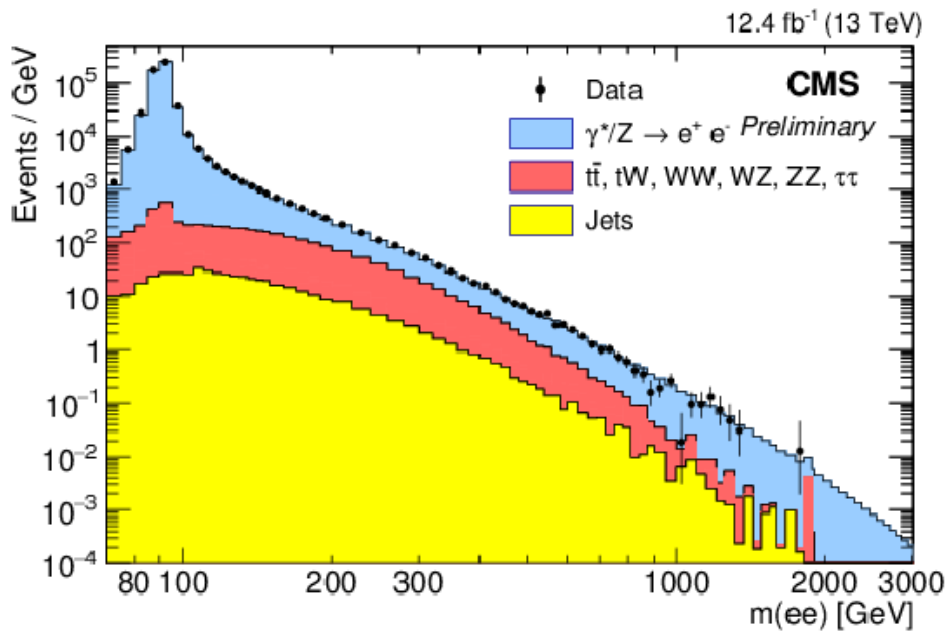


Strongest limit: STRING resonances excluded up to 7.4 TeV

Dilepton Resonances (12.9 fb^{-1})

CMS-PAS-EXO-16-031

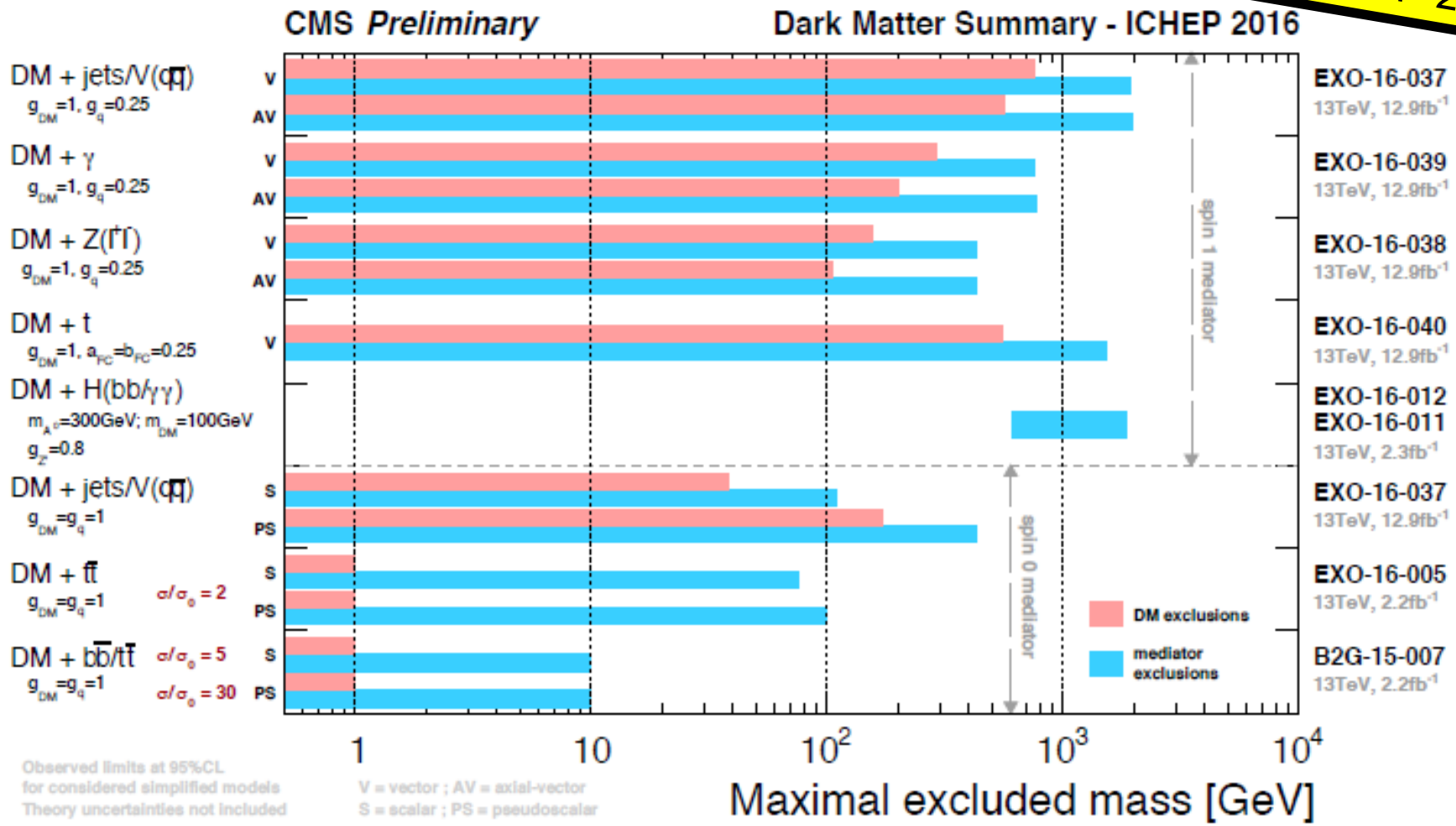
Opposite sign dilepton events: very clean signature



Dark Matter Searches

- Search in imbalance transverse momentum of mono-object (t, V, jet, photon, Z, H,...)

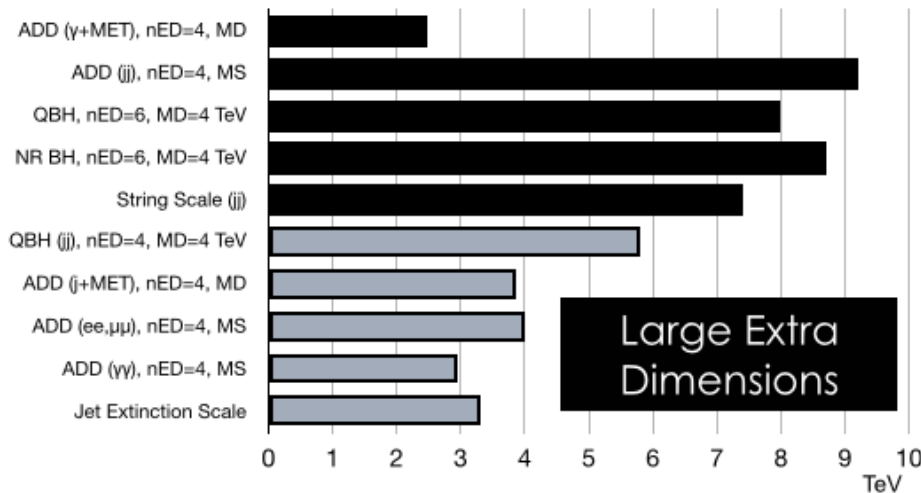
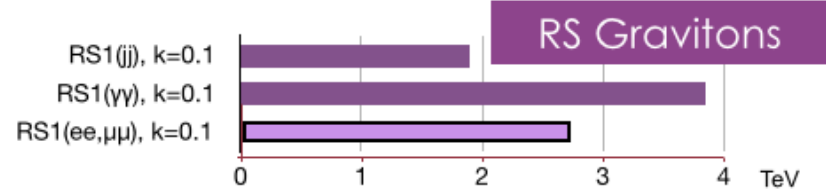
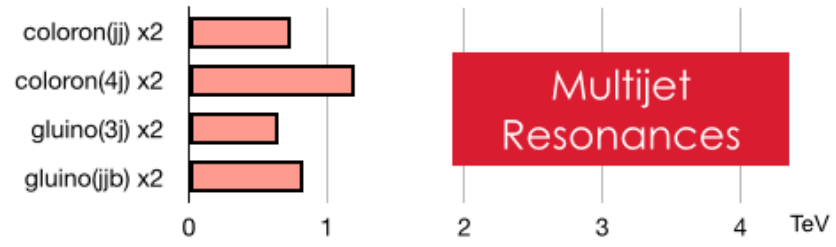
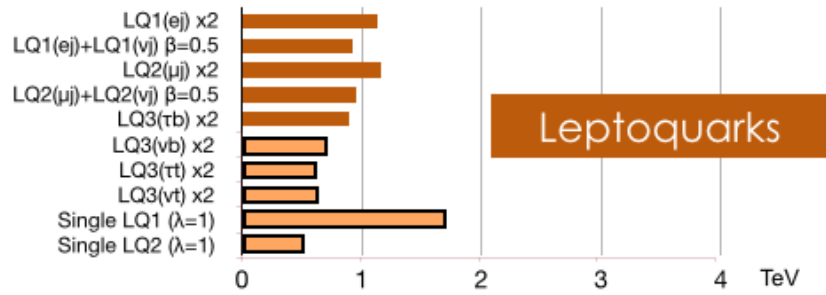
CMS-DP-2016-057



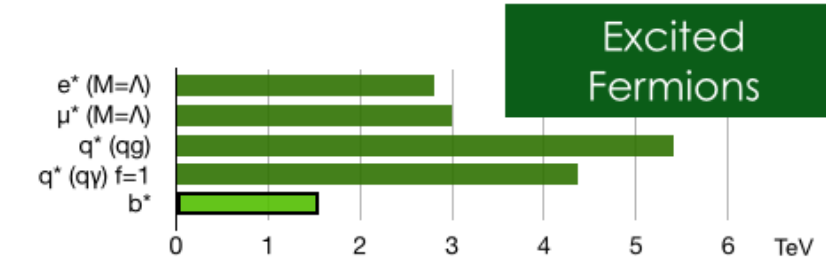
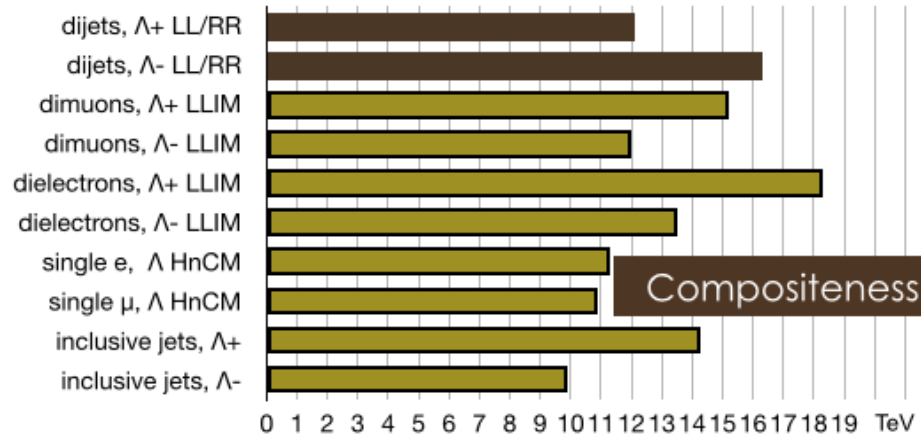
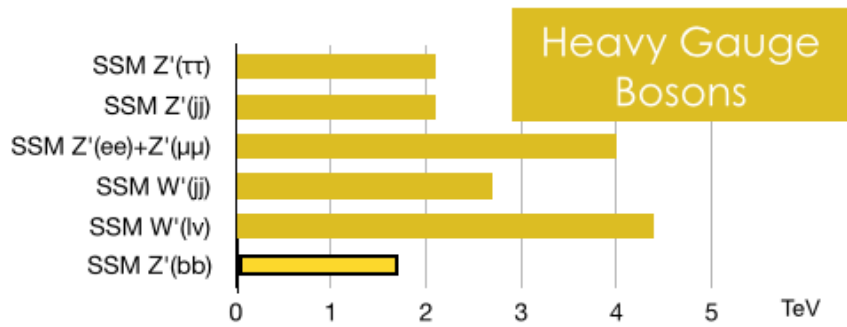
- Max and min limits on mediator search (blue) and decaying to DM (red)

Summary of Exotica Limits

13 TeV 8 TeV



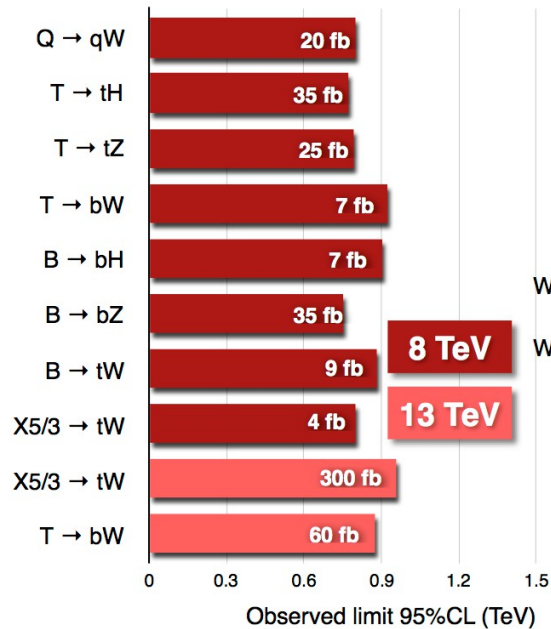
CMS Preliminary



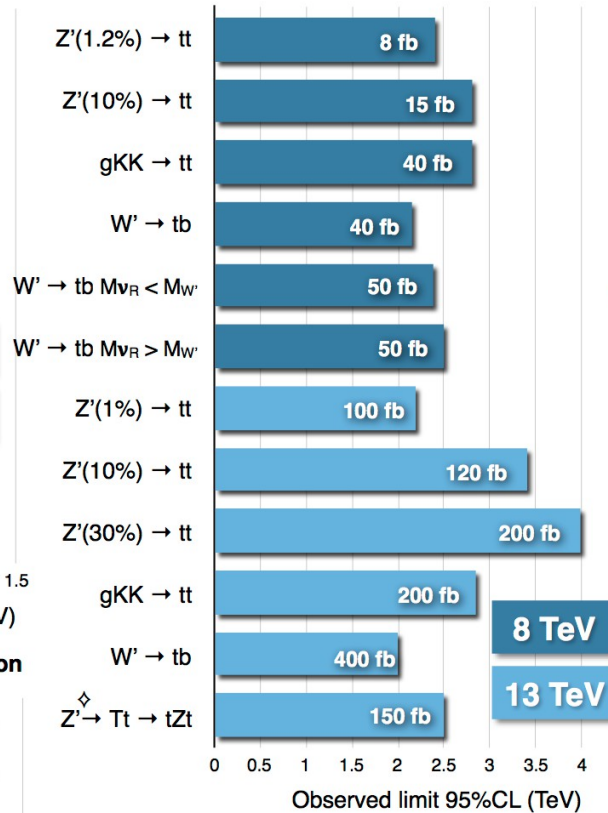
CMS Exotica Physics Group Summary – ICHP, 2016

Summary of B2G

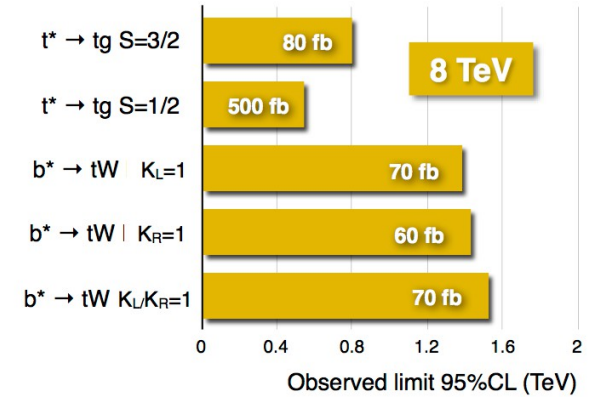
Vector-like quark pair production



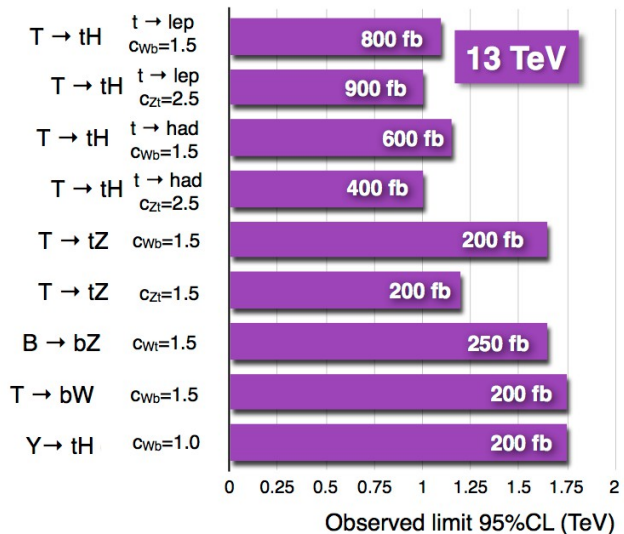
Resonances to heavy quarks



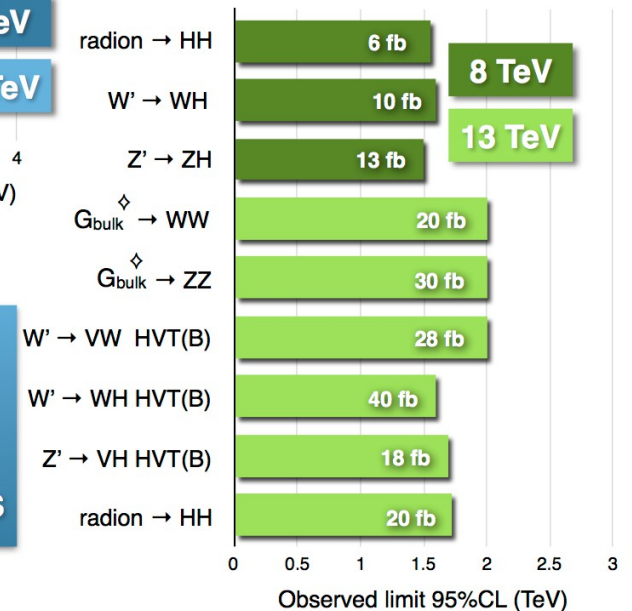
Excited quarks



Vector-like quark single production



Resonances to dibosons



B2G
new physics
searches with
heavy SM particles

◊model-independent

Supersymmetry Searches

CMS-PAS-SUS-16-025	Search for new physics in the compressed mass spectra scenario using events with two soft opposite-sign leptons and missing transverse momentum at 13 TeV
CMS-PAS-SUS-16-028	Search for direct top squark pair production in the single lepton final state at $\sqrt{s} = 13$ TeV
CMS-PAS-SUS-16-021	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
CMS-PAS-SUS-16-029	Search for direct top squark pair production in the fully hadronic final state in proton-proton collisions at $\sqrt{s} = 13$ TeV corresponding to an integrated luminosity of 12.9 fb^{-1}
CMS-PAS-SUS-16-026	Search for electroweak production of charginos and neutralinos in the WH final state at 13 TeV
CMS-PAS-SUS-16-024	Search for electroweak SUSY production in multilepton final states in 12.9 fb^{-1} of pp collision data at $\sqrt{s} = 13$ TeV
CMS-PAS-SUS-16-022	Search for supersymmetry with multileptons in 13 TeV data
CMS-PAS-SUS-16-016	An inclusive search for new phenomena in final states with one or more jets and missing transverse momentum at $\sqrt{s} = 13$ TeV with the α_T variable
CMS-PAS-SUS-16-015	Search for new physics in the all-hadronic final state with the M_{T2} variable
CMS-PAS-SUS-16-014	Search for supersymmetry in events with jets and missing transverse momentum in proton-proton collisions at 13 TeV
CMS-PAS-SUS-16-012	Search for supersymmetry in events with a Higgs decaying to two photons using the razor variables
CMS-PAS-SUS-16-013	Search for R -parity-violating SUSY in final states with zero or one lepton and large multiplicity of jets and b-tagged jets
CMS-PAS-SUS-16-019	Search for supersymmetry in events with one lepton and multiple jets in proton-proton collisions at $\sqrt{s} = 13$ TeV in 2016
CMS-PAS-SUS-16-030	Search for supersymmetry in the all-hadronic final state using top quark tagging in pp collisions at $\sqrt{s} = 13$ TeV
CMS-PAS-SUS-16-020	Search for SUSY in same-sign dilepton events with 12.9 fb^{-1} of pp collision data at 13 TeV
CMS-PAS-SUS-16-023	Search for supersymmetry in final states with at least one photon and E_T^{miss} in pp collisions at $\sqrt{s} = 13$ TeV
CMS-PAS-SUS-16-011	Search for new physics in the one soft lepton final state using 2015 data at $\sqrt{s} = 13$ TeV
CMS-PAS-SUS-14-020	Search for R -parity violating supersymmetry with displaced vertices

Gluino decays to $qq/bb/tt+LSP$

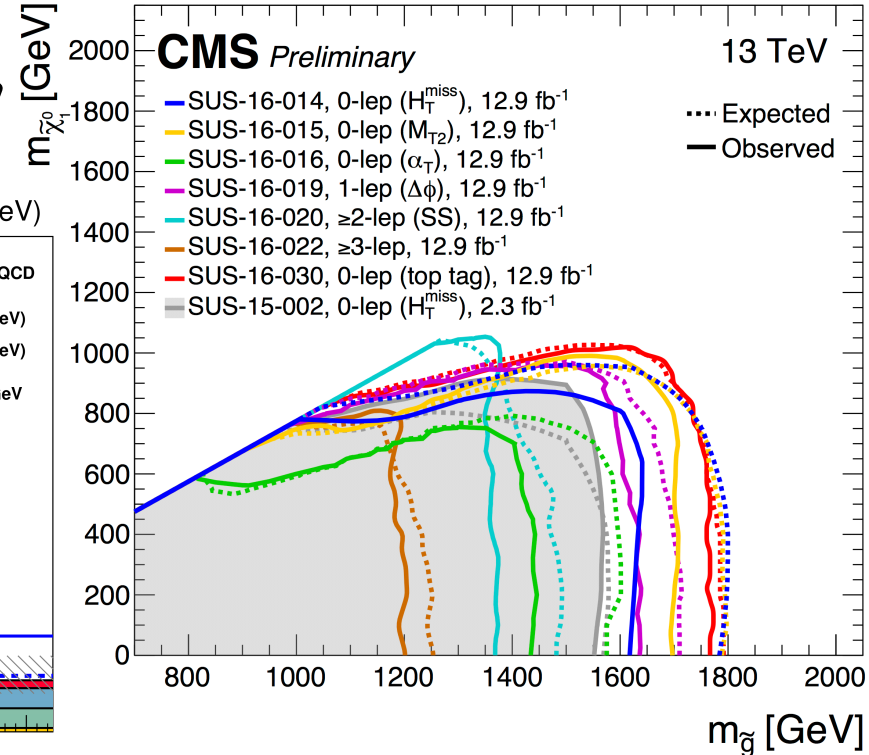
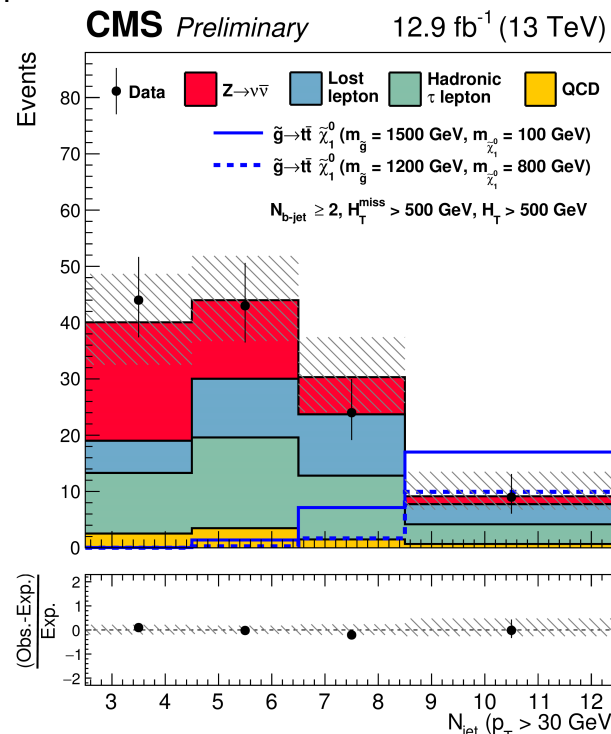
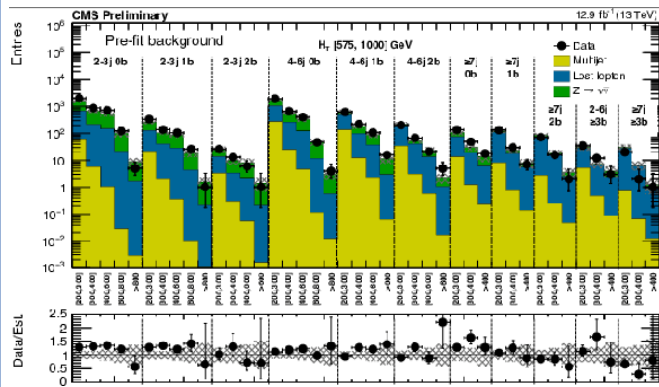
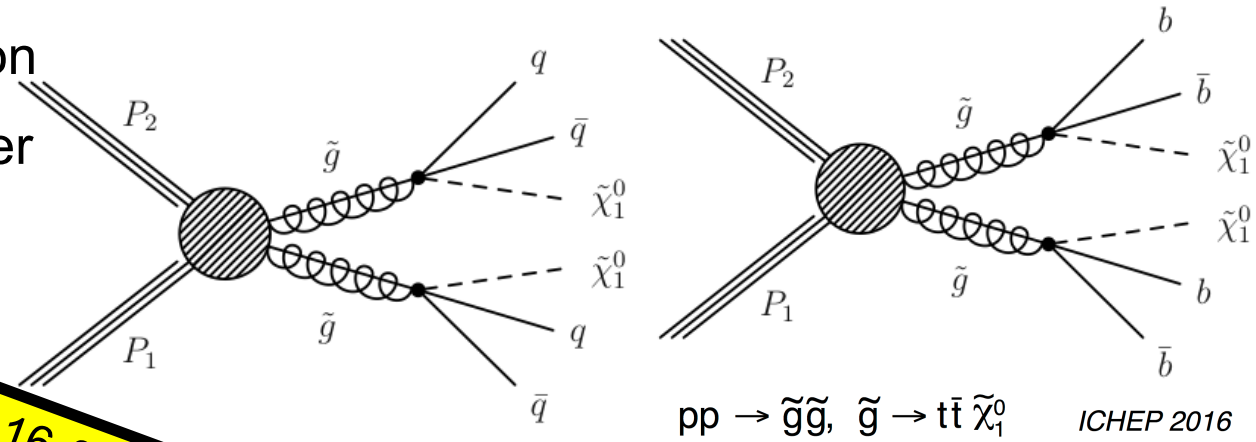
● Gluinos: highest SUSY production cross section, give access to other sparticles via decay chains

CMS-PAS-SUS-16-014, 015, 016

● Hadronic search

■ Key variables: M_{T2} , or missing H_T ,

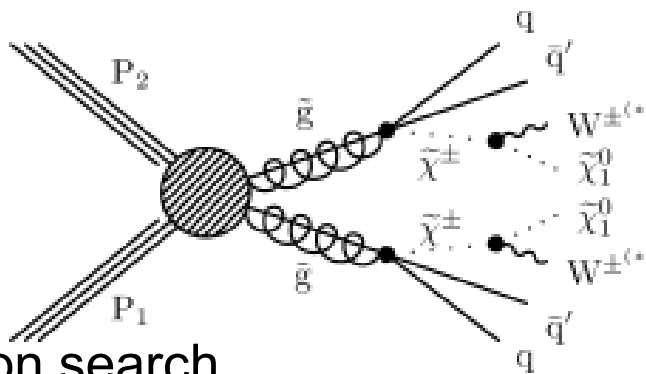
binned in #jets, #b-jets, H_T



Glauino Production / Chargino

● Decay chains in gluino production via a chargino and a W^*

CMS-PAS-SUS-16-014, 019, 020, 022



● Same sign dilepton search

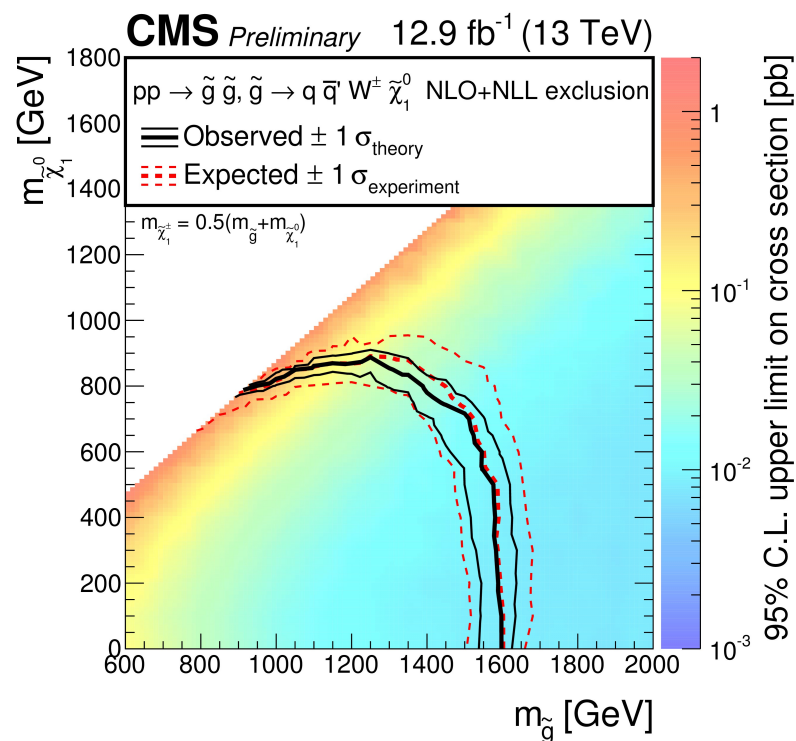
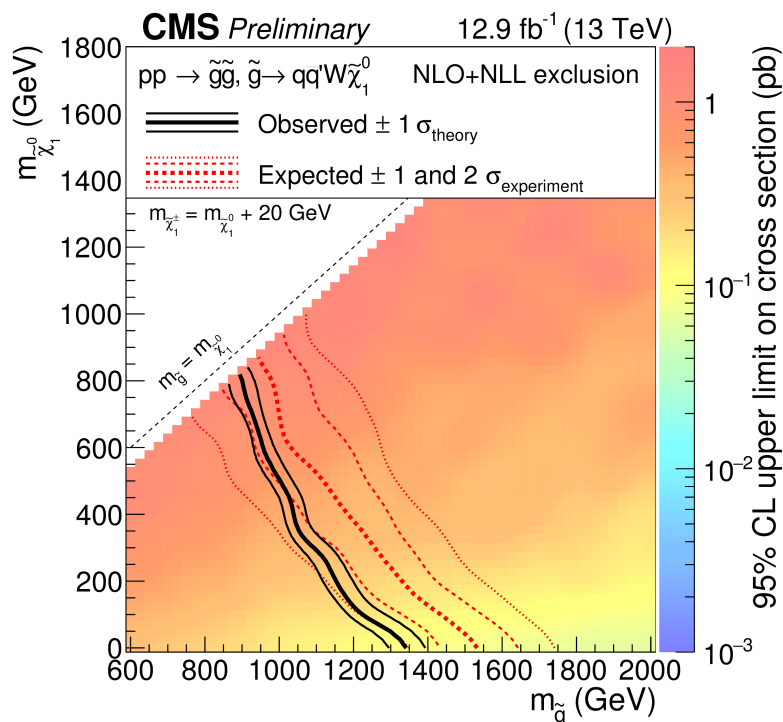
- Small SM backgrounds (multi-boson, fake leptons)

- Binned in $p_T(l)$, m_T , MET, H_T , #jets

● Single lepton search

- 1 lepton, jets, no b-jets

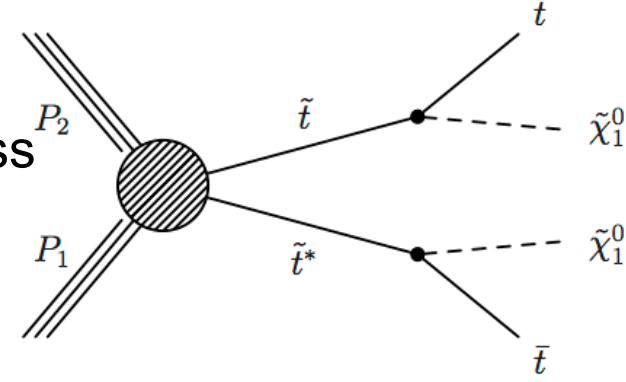
- H_T , MET, $W p_T$, $\Delta\phi(W, \text{lepton})$



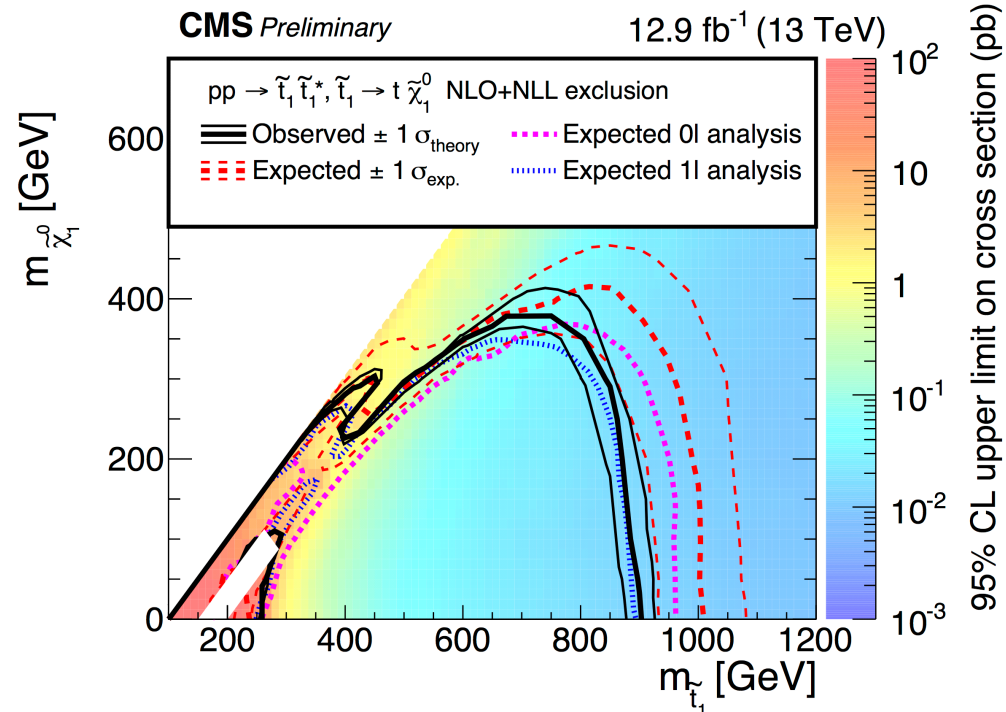
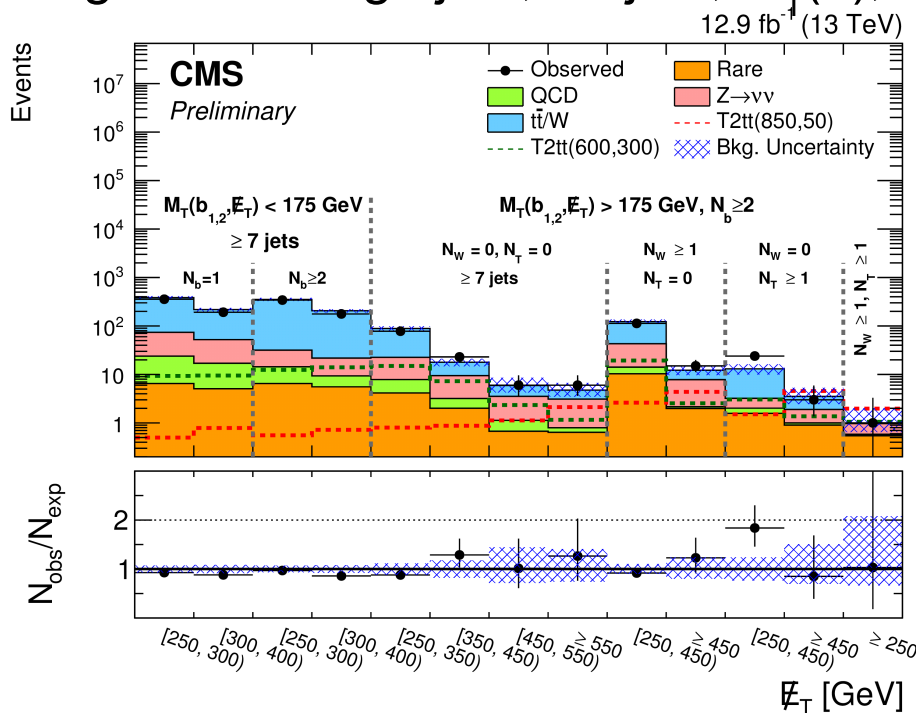
Top Squarks

CMS-PAS-SUS-16-025, 029

- Low-mass top squarks required for natural models
- Favored decay via t^* and LSP: final states classified according to W decay mode
- Event topology: $WbWb+\text{MET}$ (0l, 1l, 2l, τ)
- Approaches SM $t\bar{t}$ signature for $\Delta m \approx m(t)$ and low LSP mass



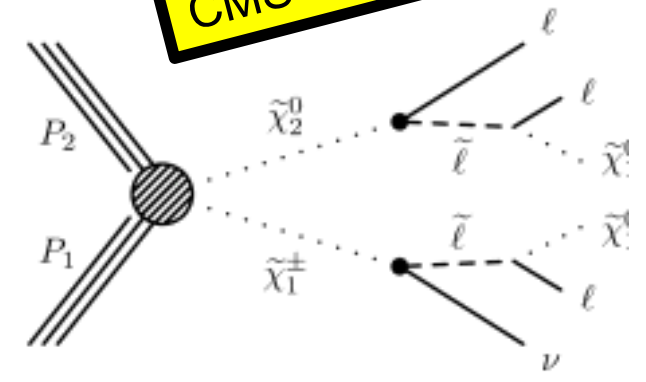
- Hadronic search
- Optimizations for low and high Δm
- High Δm : using #jets, #b-jets, $m_T(b)$, and MET; #tops and #Ws from jet substructure



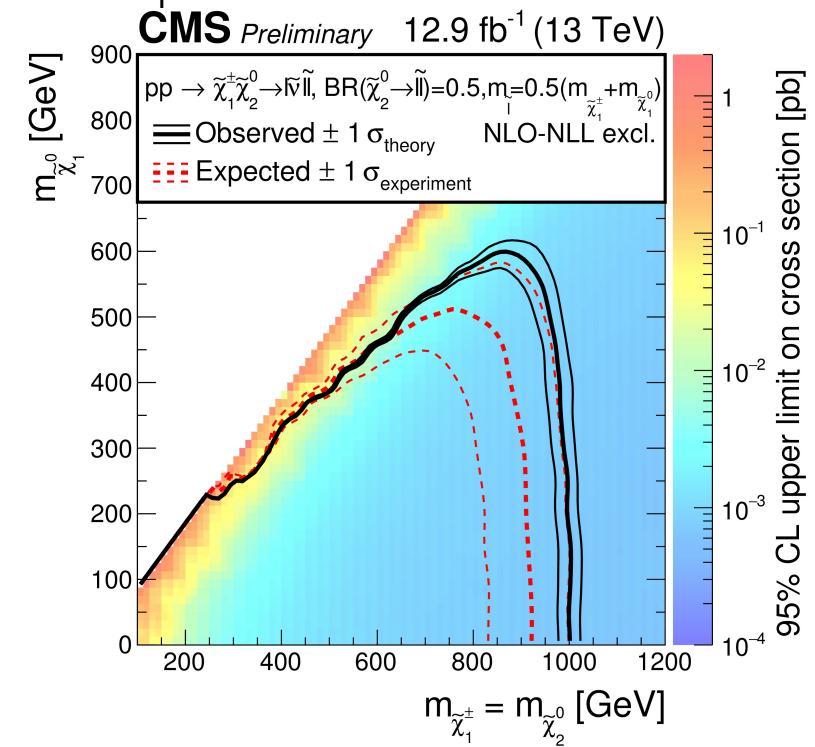
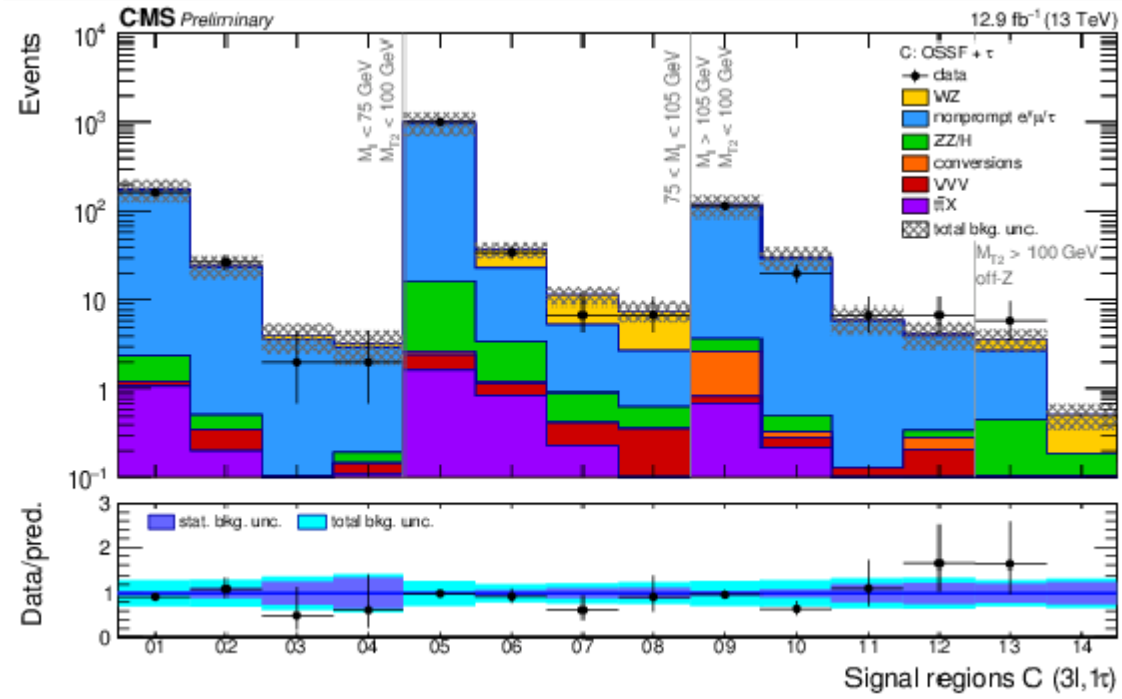
Electroweak Production

CMS-PAS-SUS-16-024

- Direct production of “electroweakino” pairs
 - Decays via sleptons/sneutrinos
 - Using benchmarks to illustrate different scenarios (depend on mixings and nature of lightest slepton)



- Multilepton searches
 - 3 (or 4) leptons (includes combinations with 1 or 2 hadronically decaying taus)
 - SRs binned in flavour&charge combination, MET, $m(\ell\ell)/p_T(\ell\ell)$



Summary

- **Very successful operation of the LHC** and the CMS experiment in 2016
- Exploration of the new energy regime of 13 TeV has started
 - And CMS was able to cope with PU levels close to twice the design
- **CMS has a very comprehensive physics program:** released almost 100 new results during this Summer with great coverage over the full spectrum
 - New 13 TeV SM measurements confirm 8 TeV results with impressive precision
 - New era in Higgs precision physics, Higgs re-discovered, ttH, H->bb
 - Broad scan of different scenarios for physics BSM model have been performed, e.g. in SUSY: limits up to ~1.9 TeV (gluinos) and ~900 GeV (top squarks)
- So far, **no significant deviation with respect to the SM** has been observed
- The performance of the Accelerator complex makes us confident that **it will be possible to exploit the full physics reach of the LHC**
 - So we will keep testing the SM in all its corners!

**Thank you
for your
attention!**

<http://cms-results.web.cern.ch/cms-results/public-results/publications/>

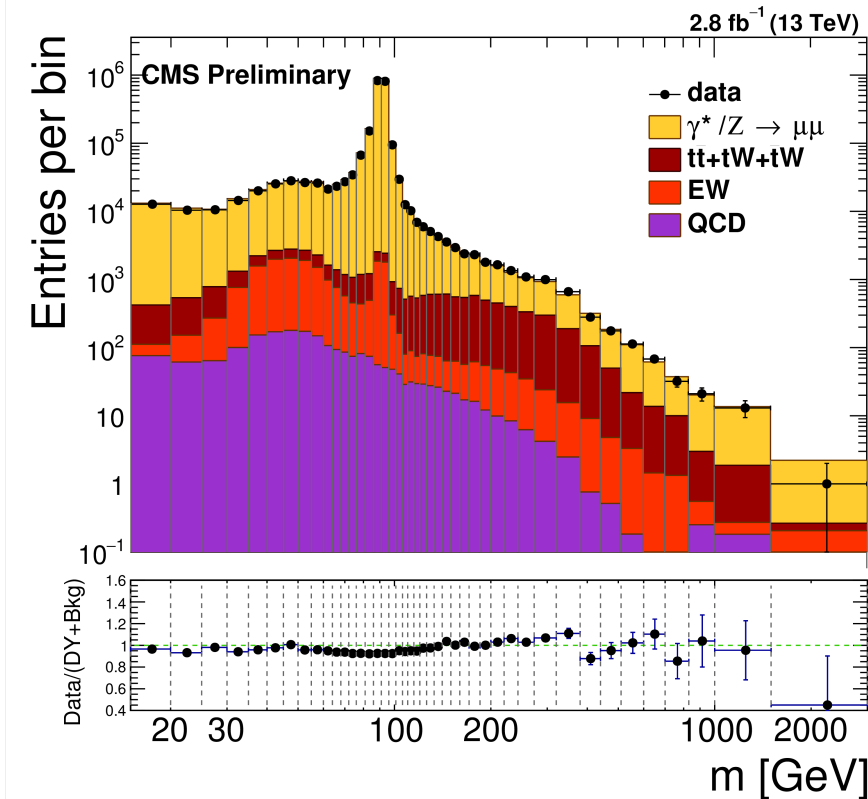
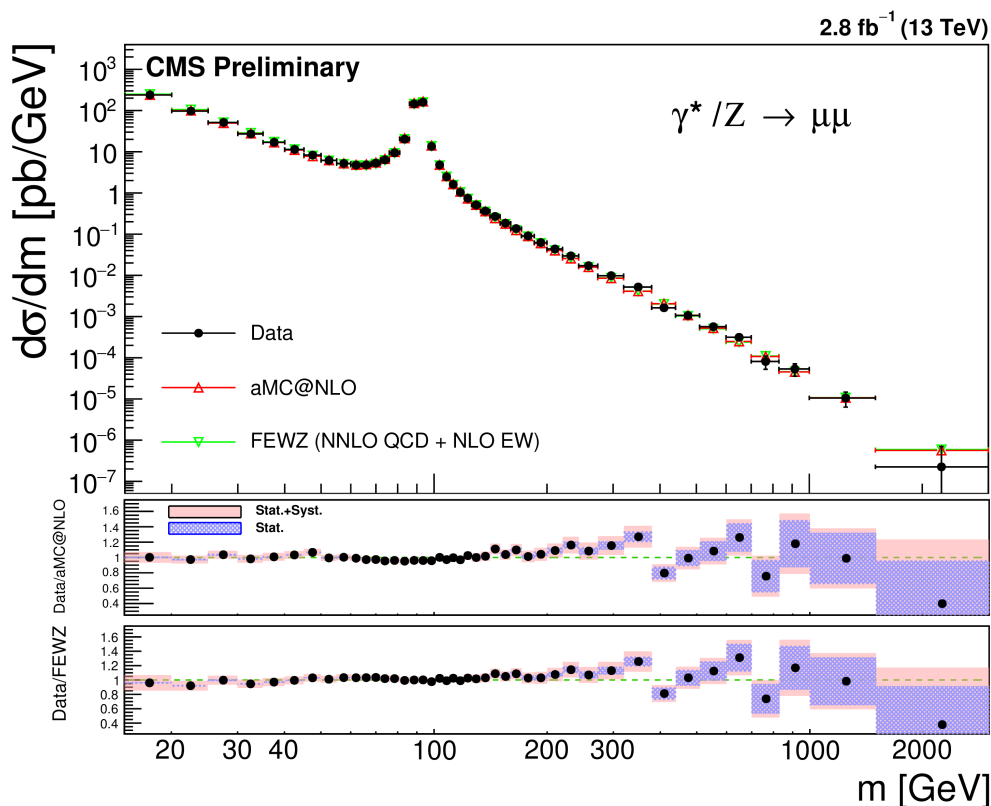
Back-up

Slides

Differential DY ($Z \rightarrow \mu\mu$) Cross Section (2.8 fb^{-1})

- Dimuon invariant mass range from 15 to 3000 GeV
- Results are corrected to the full phase space
- ISR Effects also taken into account

CMS-PAS-SMP-16-009



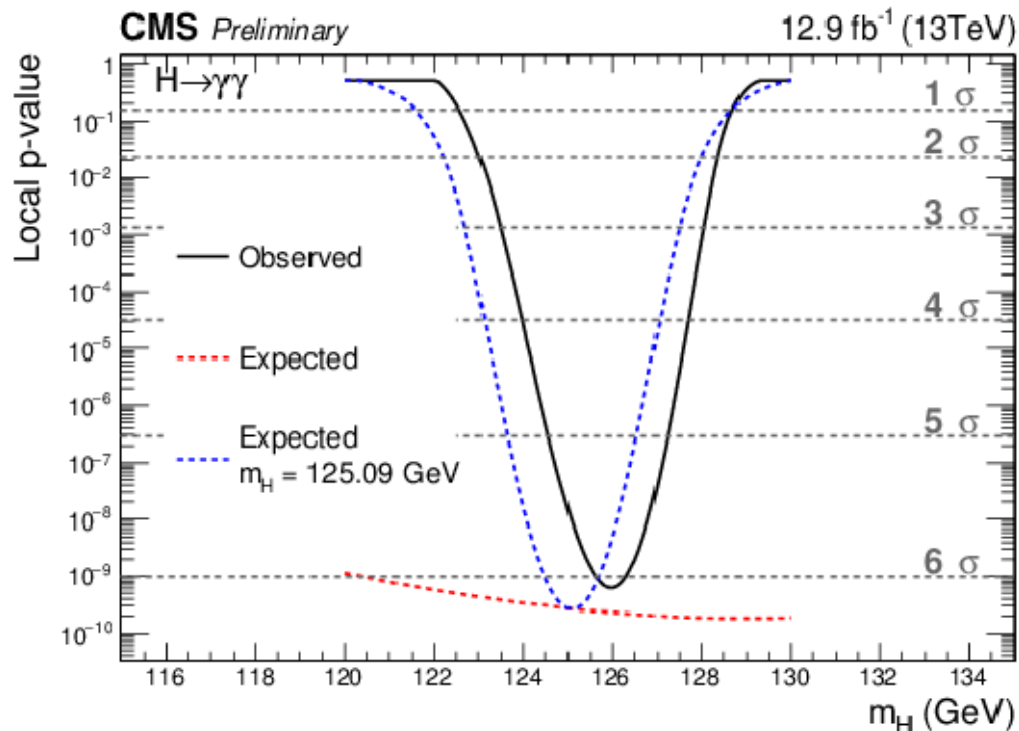
- Data are compared to NLO and NNLO predictions
- Results in good agreement with the SM

Higgs Rediscovery (12.9 fb^{-1})

CMS-PAS-HIG-16-020

$H \rightarrow \gamma\gamma$

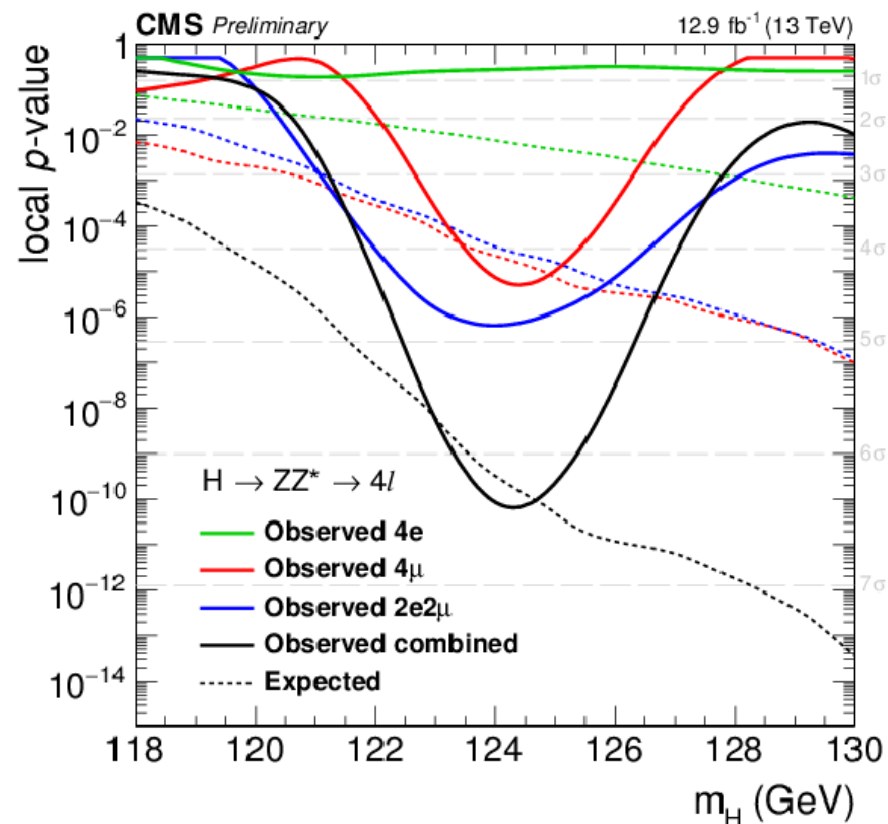
- Obs (exp) significance for $m_H = 125.09$ GeV is 5.6σ (6.2σ)
- Max obs. sign. of 6.1σ for $m_H = 126.0$ GeV



CMS-PAS-HIG-16-033

$H \rightarrow ZZ \rightarrow \ell^+\ell^-\ell^+\ell^-$

- Obs (exp) significance for $m_H = 125.09$ GeV is 6.2σ (6.5σ)



Well beyond 5 sigma each channel