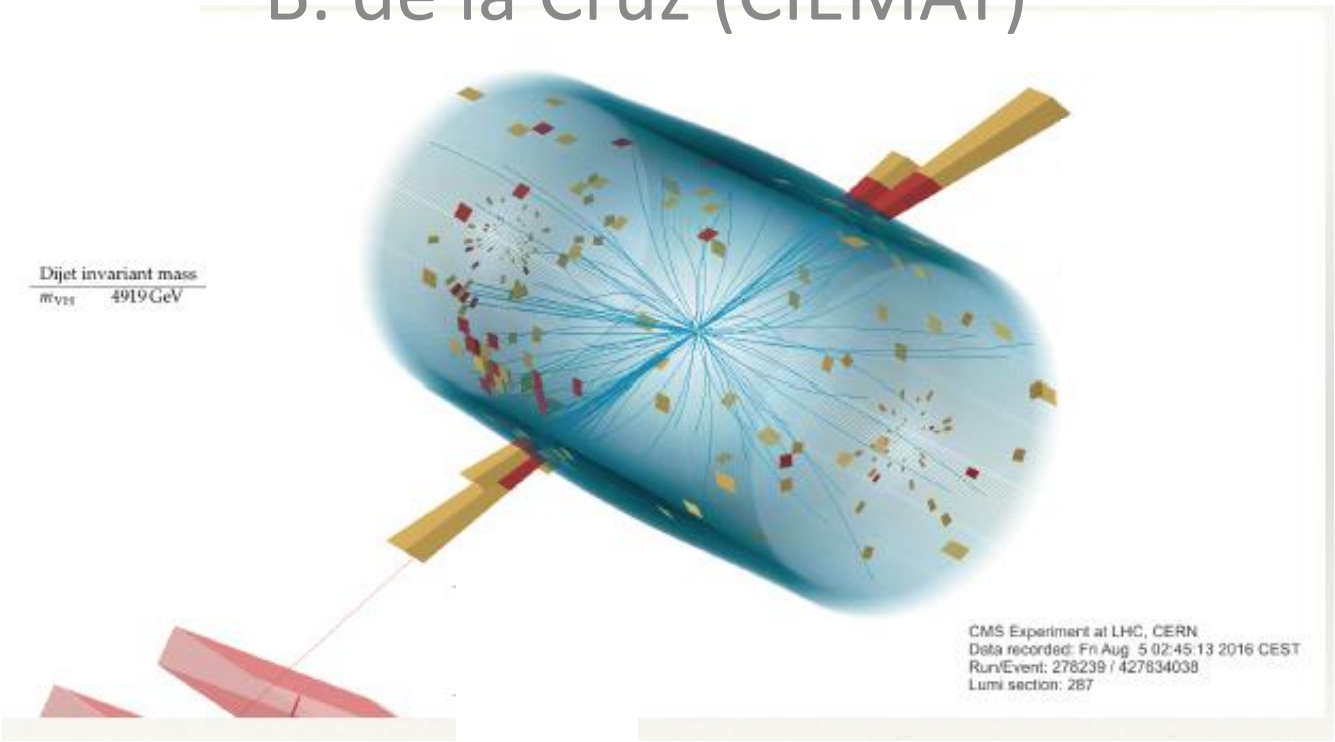
Searches for new vector bosons at LHC

B. de la Cruz (CIEMAT)



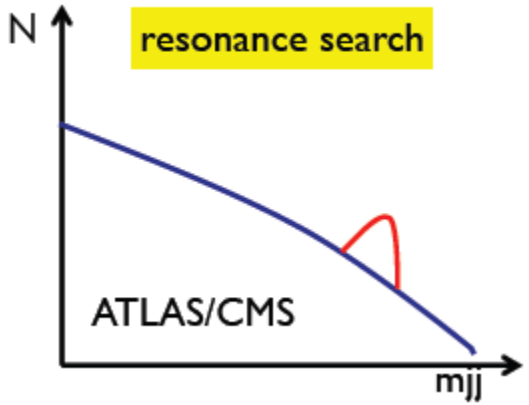
Red LHC – IFT (Madrid)

9th May 17

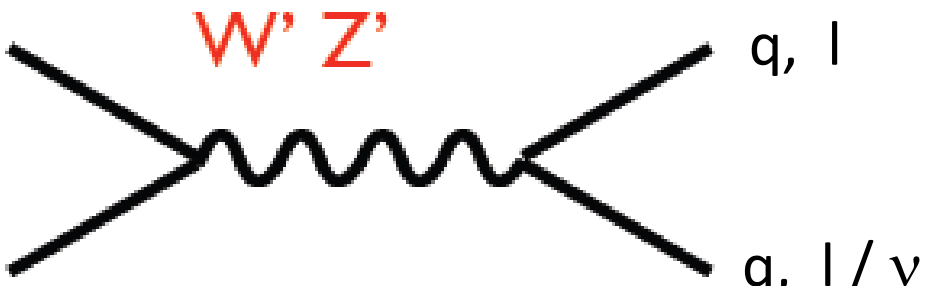
Search for new bosons

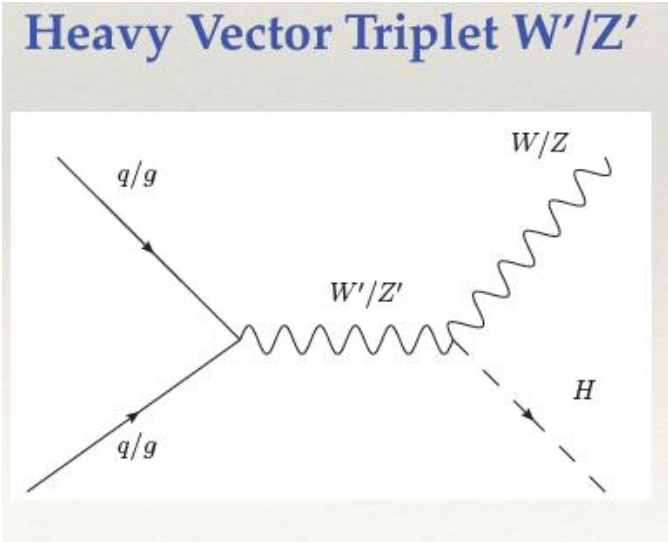
New physics search aims at:

- Highest energies/masses → region in phase space in the kinematical limit, basically free of SM background → "easy" bump hunting search, though control region?
- Highest statistics → Precision knowledge of background sensitive to small deviations from predictions .



New (vector) bosons not a neccessary ingredient to extend SM into a more general theory, but many models predict their existance. ➔ Look for them!

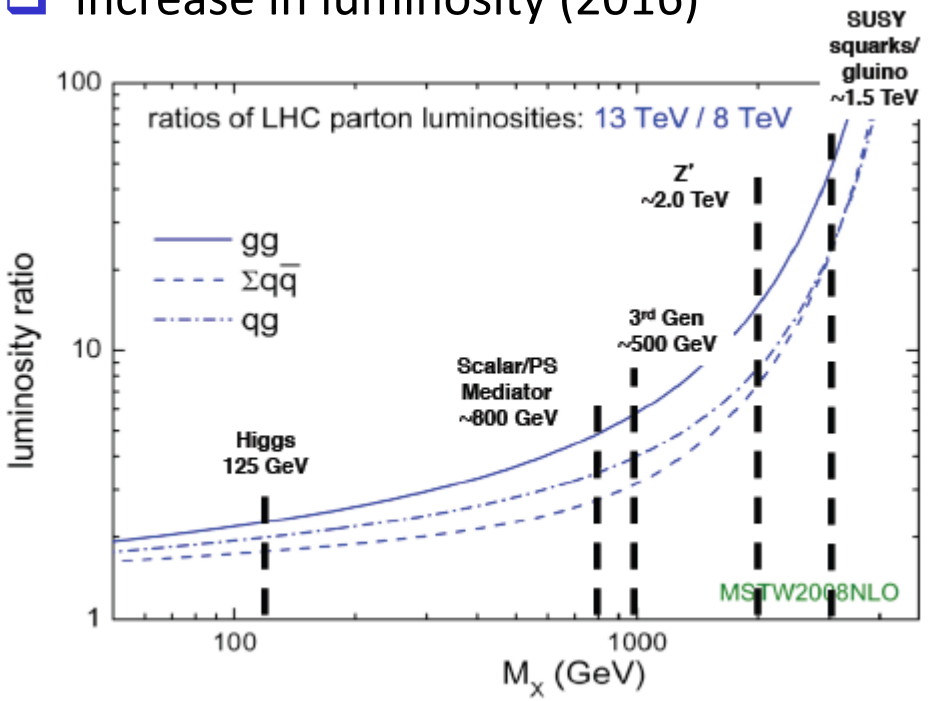


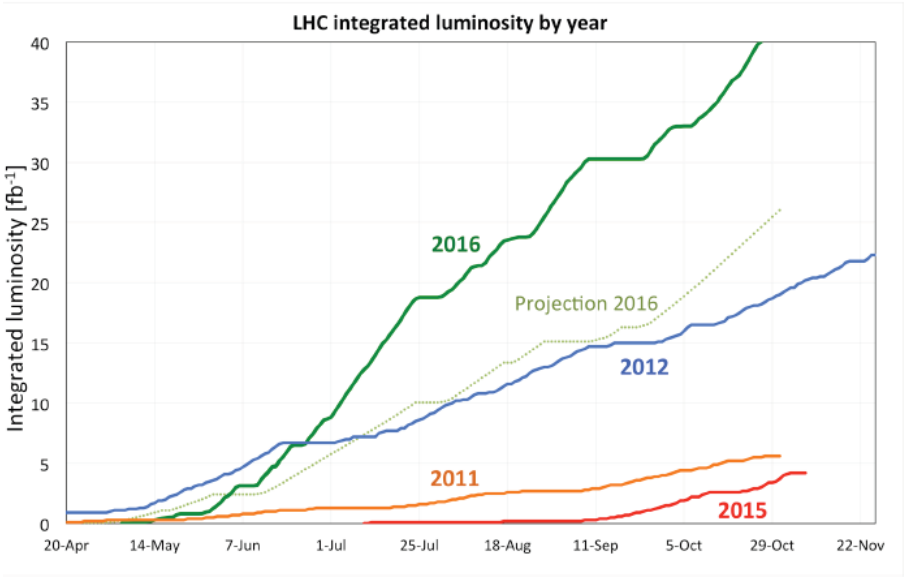


Search for new bosons

Search for new boson resonances profit from

- increase in collision energy relative to Run I, 8 to 13 TeV (2015) ➔ increase in parton luminosities, push high mass limit.
- increase in luminosity (2016)



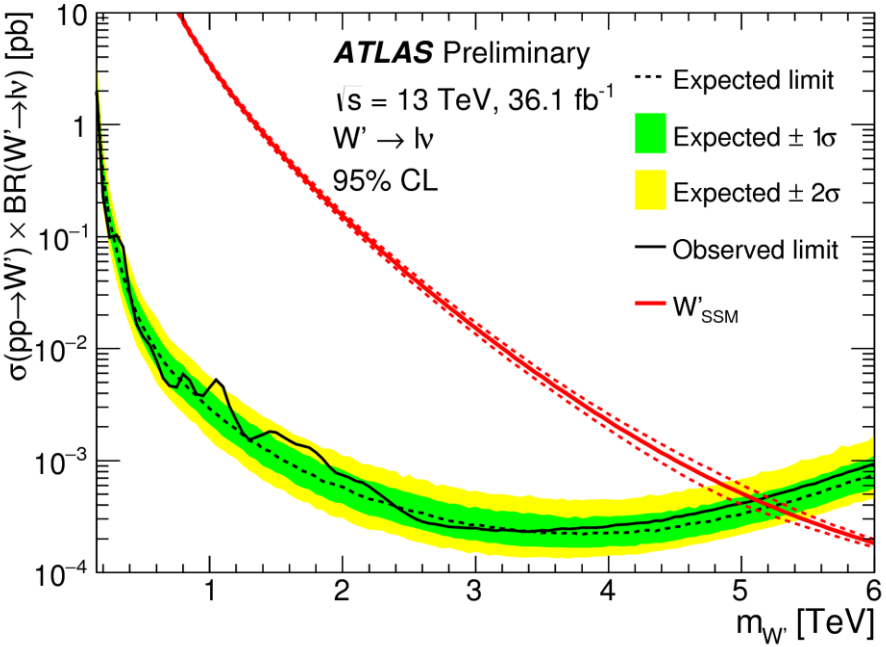


- No signals found in Run1 nor in Run2.
- Limits set on cross section observed, interpreted in given models as limits on signal parameters (mass, couplings, decay fractions, widths, …)

Dileptons: l (l/ν) l=e,μ,τ

- Discriminating variable: reconstructed mass (ll,lν)
- Experimental issues: μ high-p_T (alignment, showers), e energy scale, τ reconst.
- Syst. uncertainty: Backgd normalization (MC), lepton high p_T assignment (scale, resolution)
- Models: SSM, HVT W'/Z' (w/wo interference with SM processes), width ∝ M, broad non-resonant signals

ATLAS-CONF-2017-016



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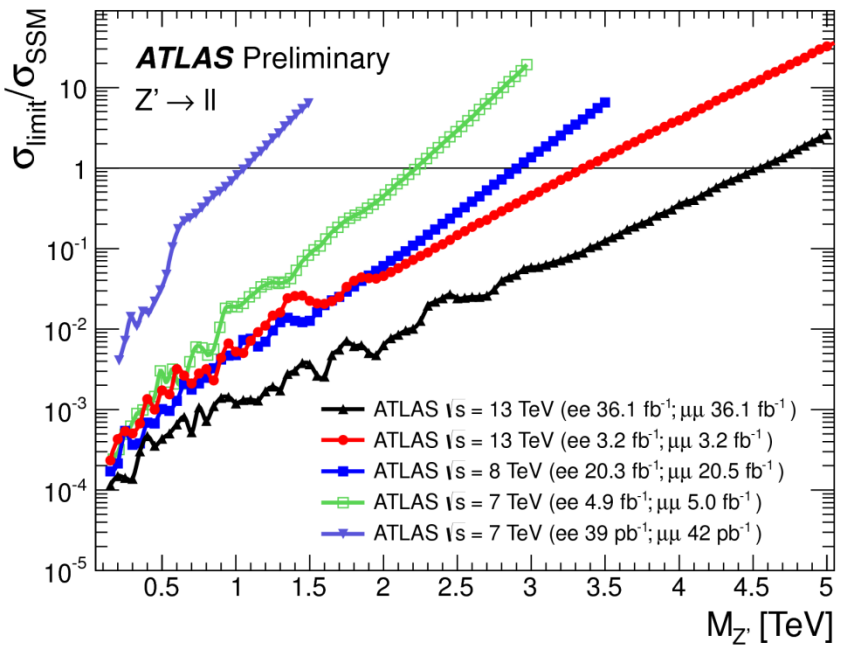
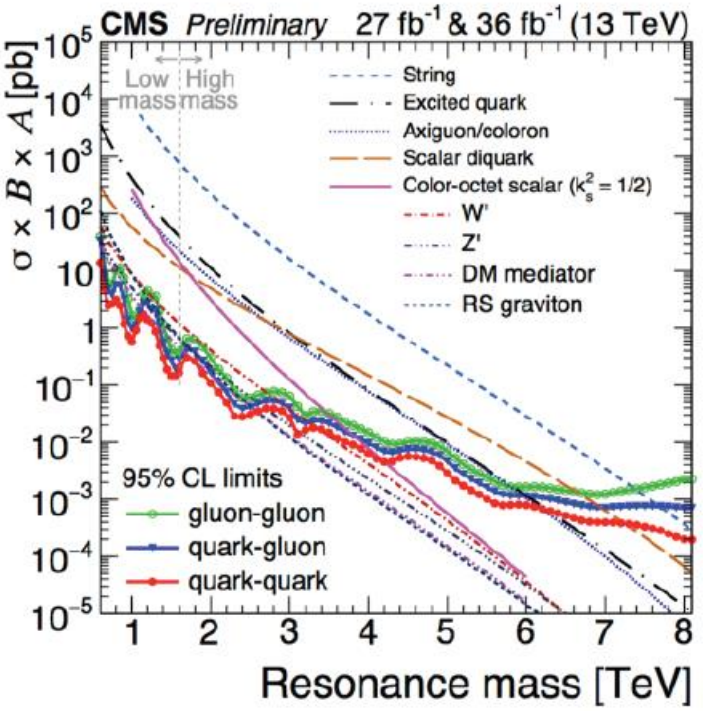


W'→τν: 1. TeV < M < 3.3 TeV using 2.3 fb^{-1} at 13 TeV (CMS EXO-16-006)

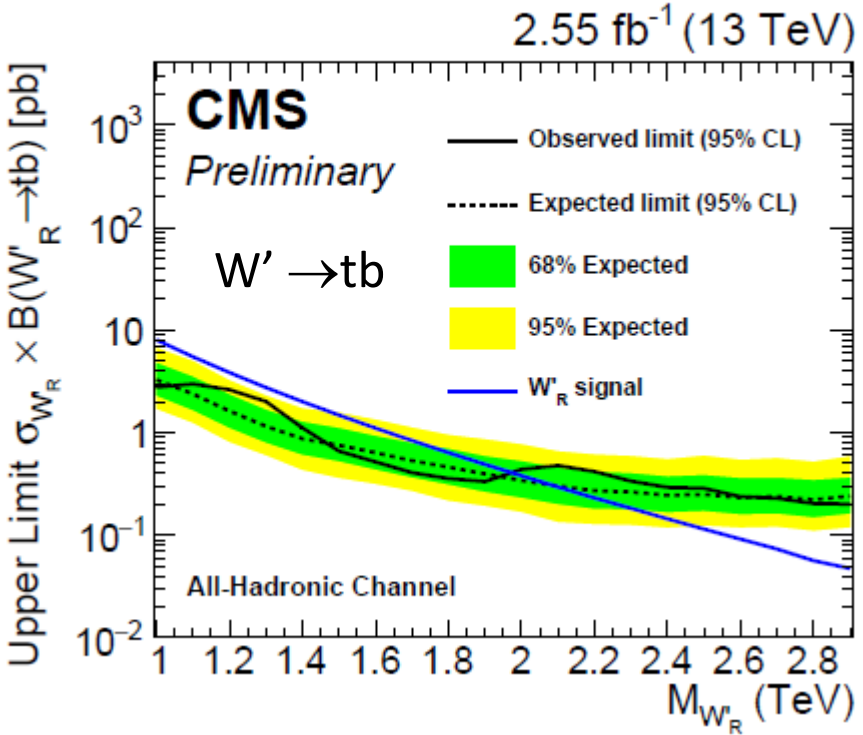
Dijets: qq (incl. tt, tb)

- Discriminating variables: dijet mass, angular variables
- Experimental issues: background fit, boosted (merged) jets tools.
- Theoretical issues: narrow width approx, Generic resonance interpretation (gaussian signal shape).
- Syst uncertainty: Jet energy scale and resolution, top quark tagging
- Models: SSM or leptophobic, HVT W'/Z', interference with SM processes

CMS EXO-16-056



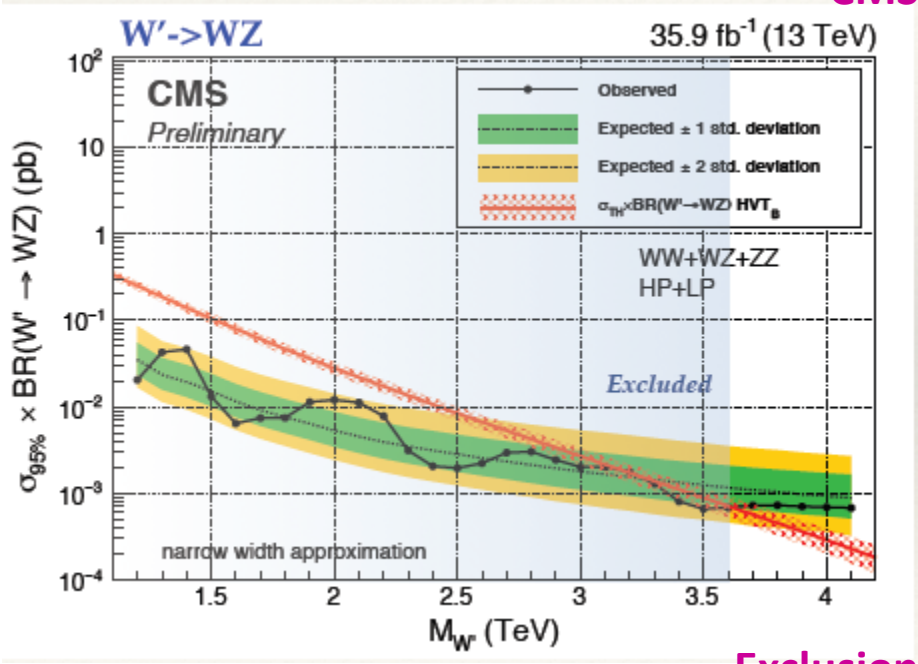
CMS B2G-16-009

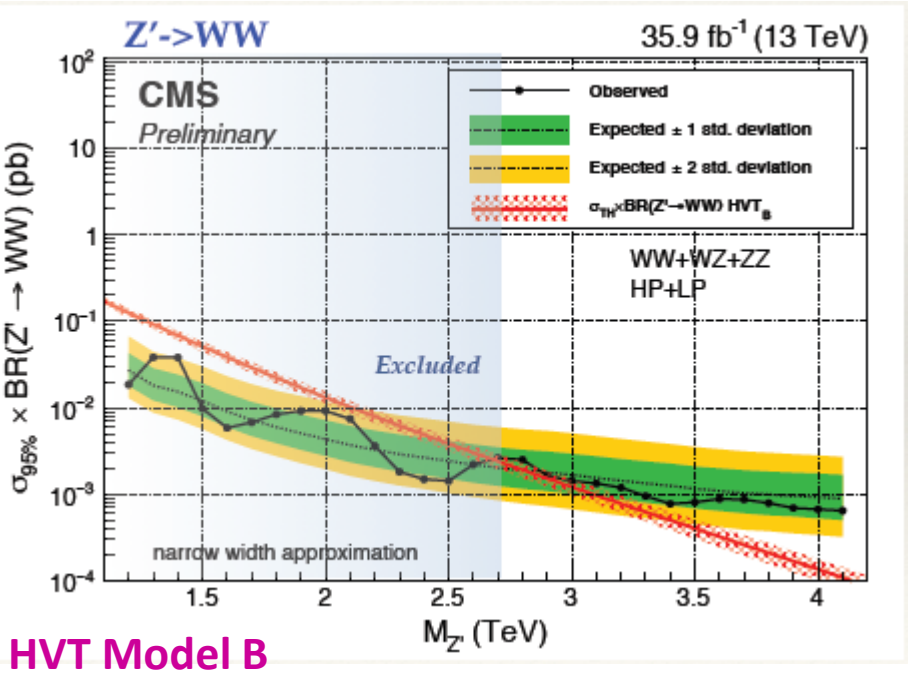


Dibosons: W, Z, H, γ (VV, Vγ, VH)

- Discriminating variables: reconstructed V/H-jets (diboson) mass, leptonic mass
- Experimental issues: dedicated algorithms for boosted jets, V-jets tagging variables, backgrounds from data (control/validating/signal regions), then fit
- Syst uncertainty: tagging efficiencies (hadronic), jets energy scale & resolution
- Models: SSM, HVT W'/Z', (w/wo interference SM processes)

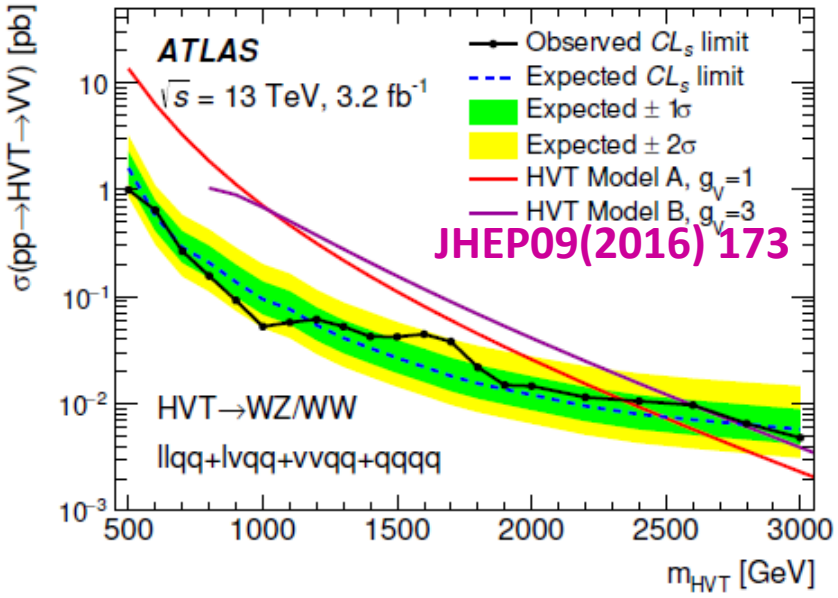
CMS B2G-17-001



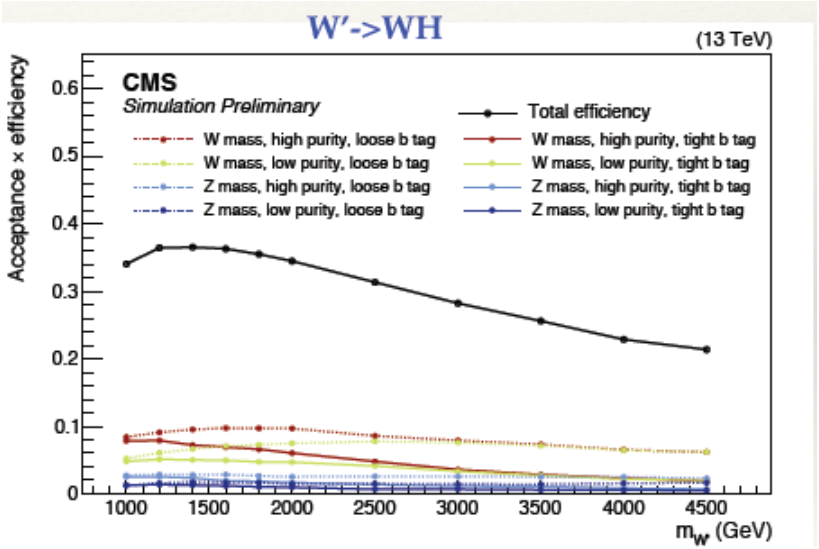


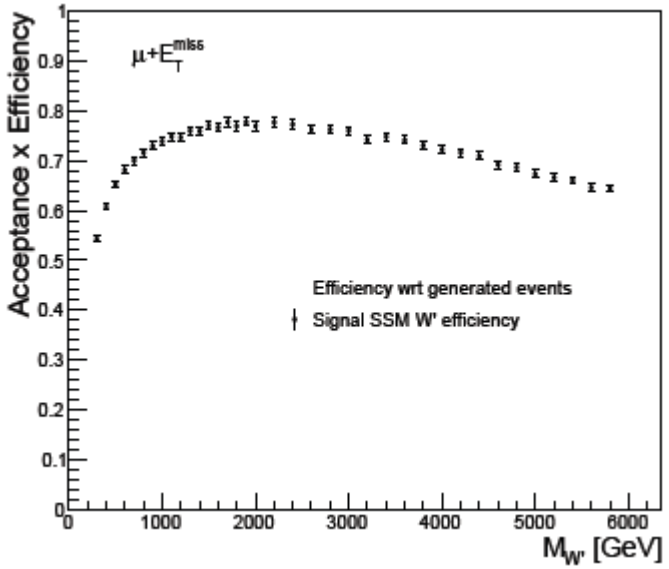
Exclusion in HVT Model B

Dibosons: W, Z, H, γ (VV, Vγ, VH)



Revisit search for low mass resonances (~100-300 GeV)

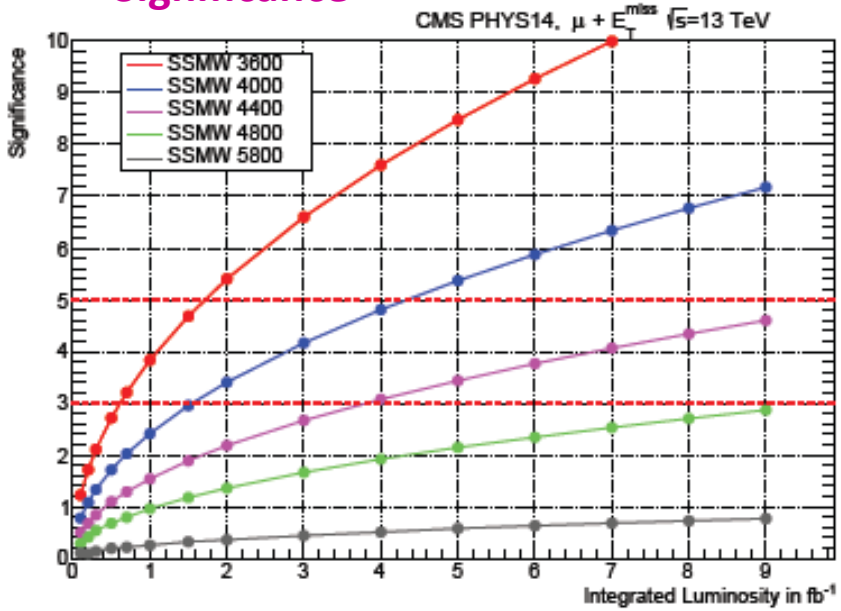


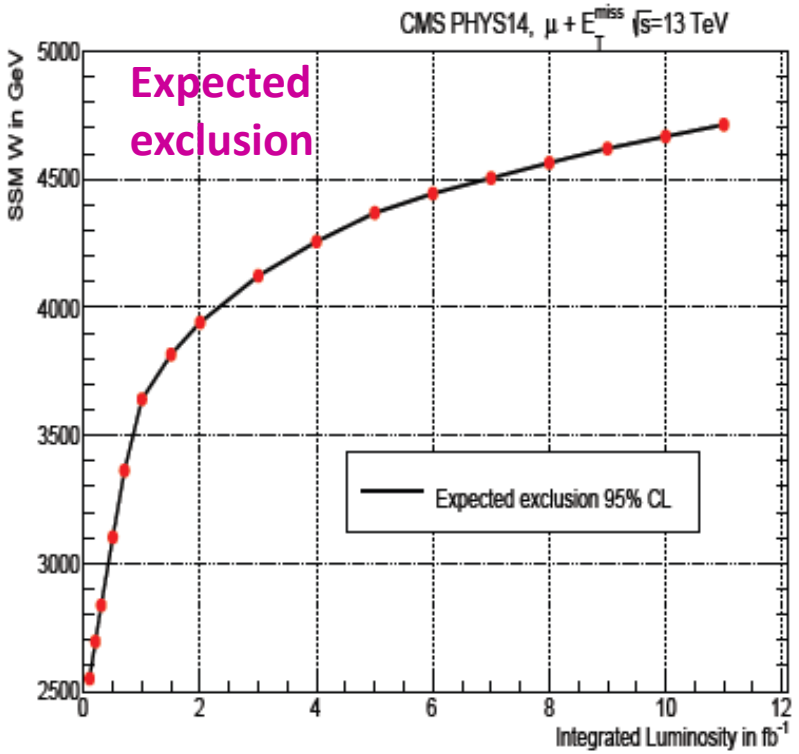


Sensitivity in leptonic modes better than in bosonic/hadronic ones

Looking ahead

Observation Significance





Sensitivity to an 0bservation/Exclusion of a new signal saturates with increasing luminosity.

~40 fb^{-1} high quality data during 2015+16 ➔ Expecting ≥120 fb^{-1} by the end 2018

- No more significant jump in energy or luminosity: our tools must be smarter
- How to continue our exploration for New Physics, testing as much of parameters space and leaving no holes behind?

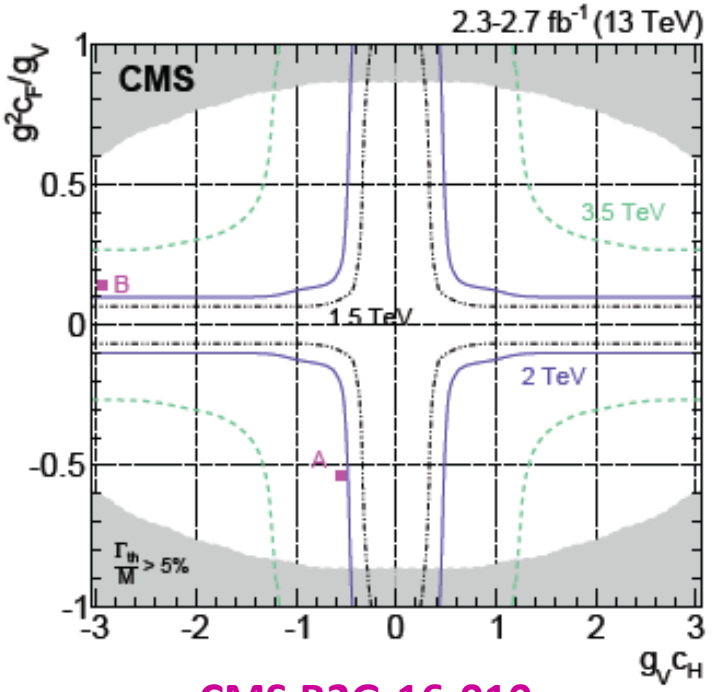
Looking ahead

- Systematically study mass limits for varying couplings, BF, or other phase space parameters.
- Combine different analysis or decay channels, to improve sensitivity to a given model and strengthen the search for New Physics more systematically.

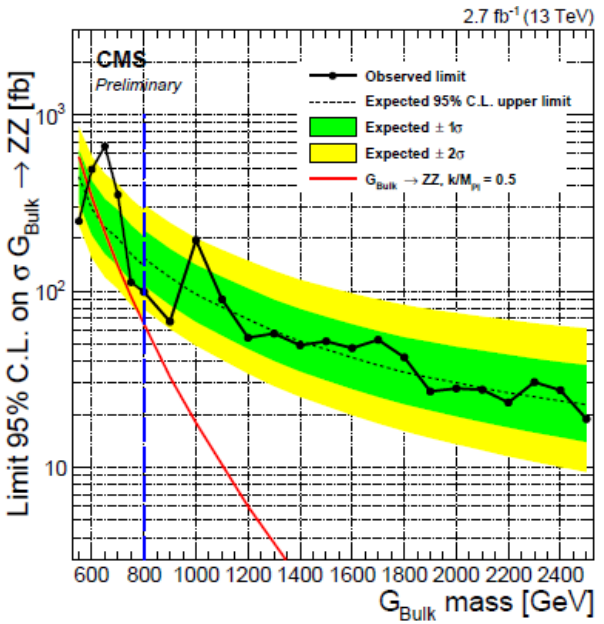
1612.09159

- Obtain model independent limits , based on experimental signatures, making generic assumptions (eg. kinematics)
- Release/relax some cuts in selections to allow non-standard new signals (eg. balanced kinematics in dileptons), look for corners never looked at before (VX),…

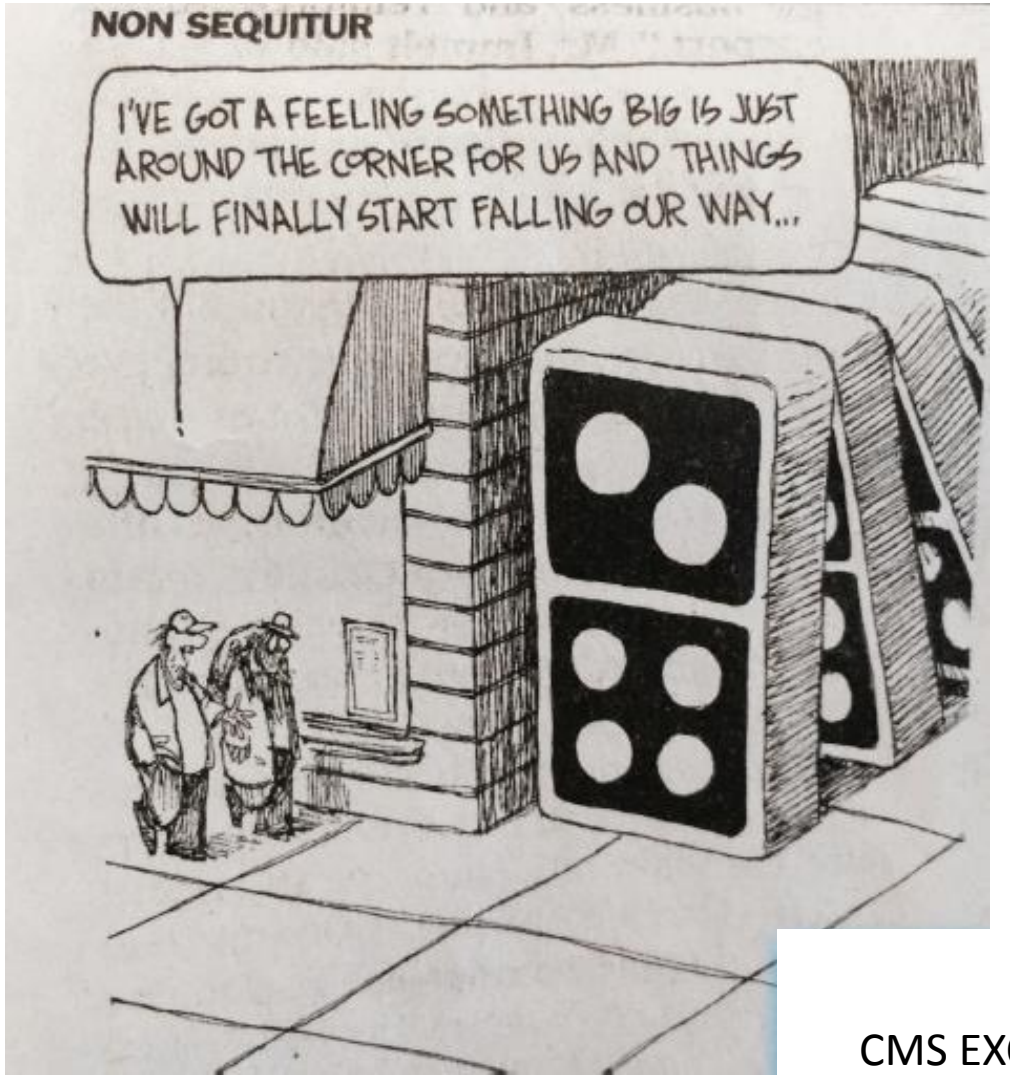
arXiV 1612.09159



CMS B2G-16-010



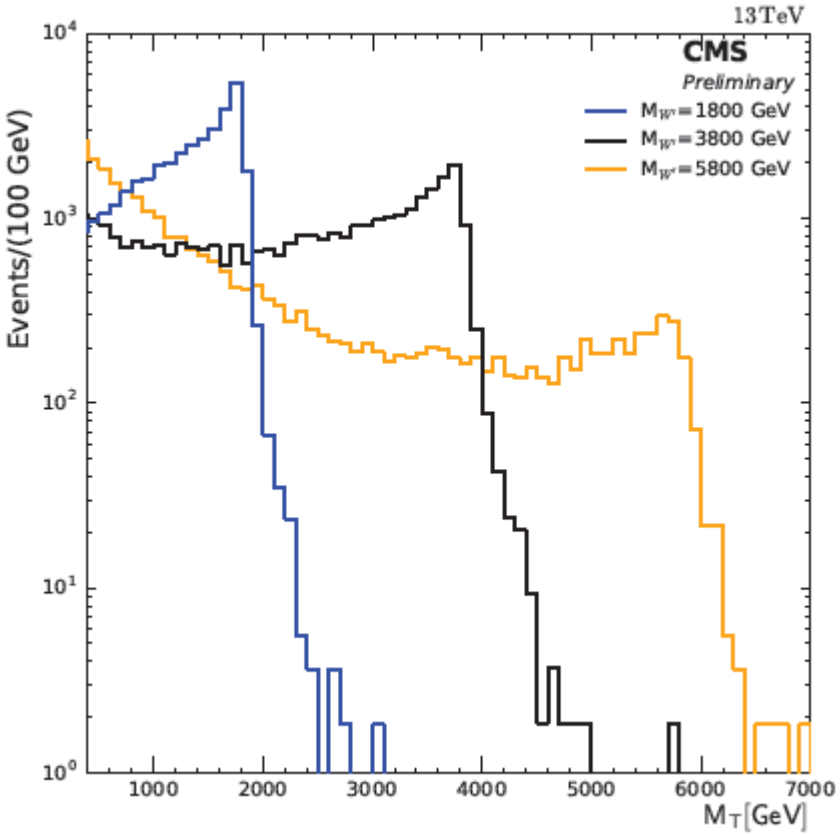
Talking about corners….

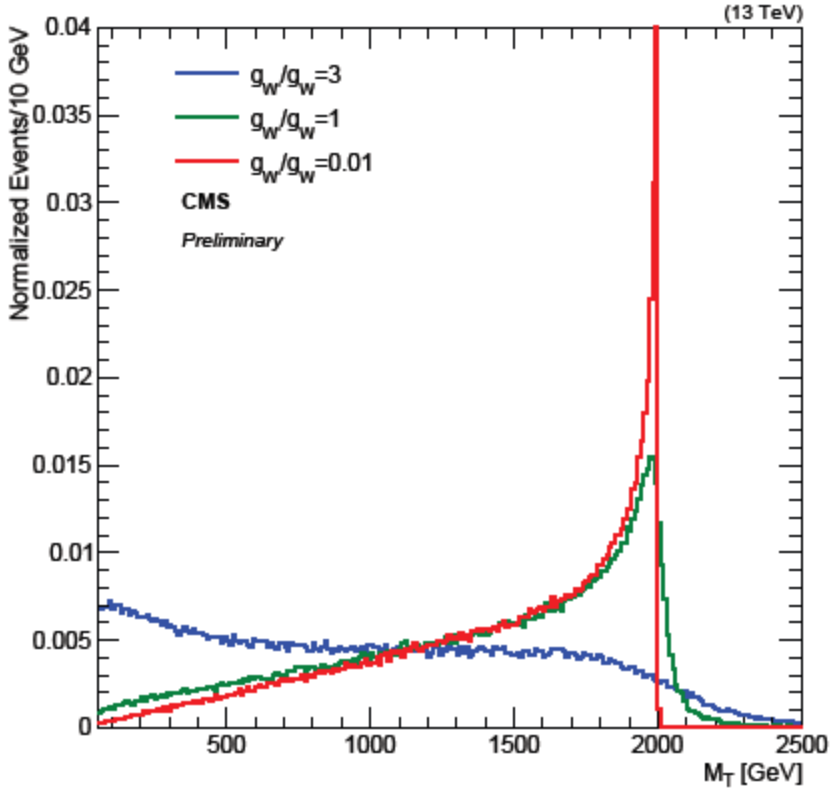


G. Landsberg
CMS EXOtica Workshp (Dec. 2016)

Thank you!

Dileptons: l (l/ν) l=e,μ,τ





MT for a 2 TeV SSM W' signal, for different coupling values