

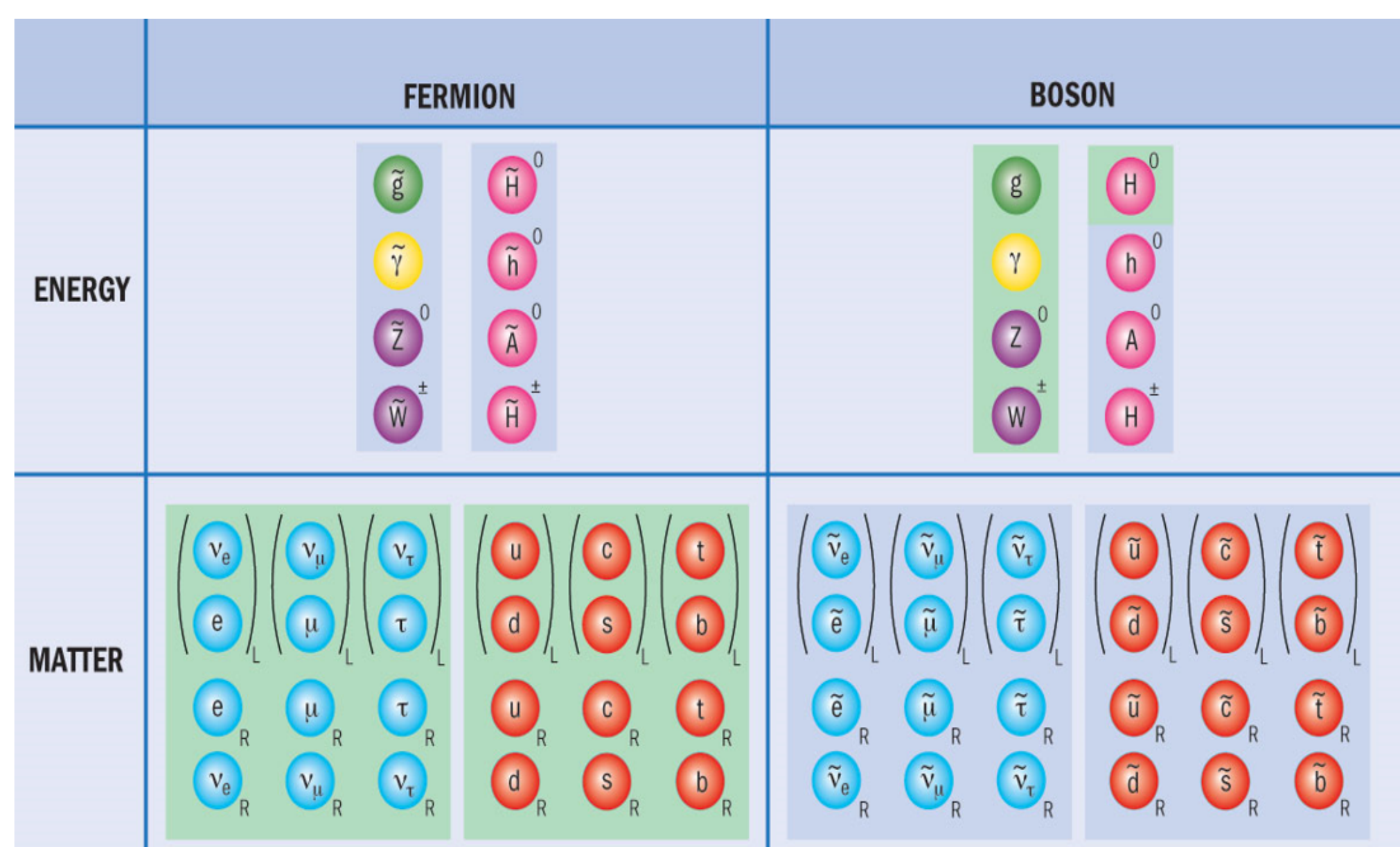
## SUPERSYMMETRIC MODELS

Supersymmetry (SUSY) is a space-time symmetry which relates fermions and bosons. It predicts superpartners for every known particle with identical quantum numbers except the spin which differs by 1/2 and thus offers a solution to several open problems of the standard model (SM).

As no superpartners with SM mass has been observed, SUSY must be broken. The Minimal Supersymmetric Standard Model (MSSM) with the most general SUSY breaking potential adds more than 100 new parameters.

To decrease the number of parameters, specific SUSY breaking scenarios are considered assuming that spontaneous symmetry breaking in a hidden sector is mediated by some interaction to the visible sector.

When the mediators are gauge interactions, we arrive to Gauge Mediated Supersymmetry Breaking models (GMSB, 5 parameters) or to its generalization, General Gauge Mediation (GGM, 8 parameters).

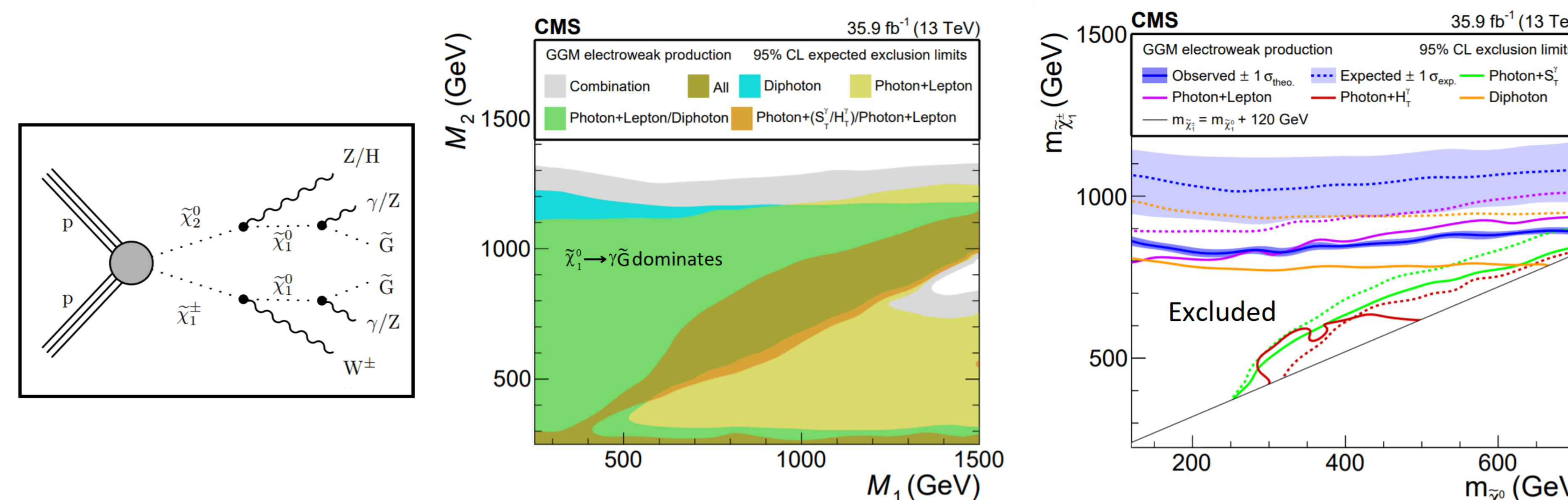


## GGM COMBINATION

Four analyses looking for photon + MET signature ( $\gamma\gamma + MET, \gamma + MET + \text{lepton}, EW \gamma + MET, \text{strong } \gamma + MET + HT$ ) combined, using additional physics object vetoes to remove potential selection overlaps. [1]

Simplified model results interpreted in a full SUSY model, GGM, and limits are derived on the model parameters as well as on the physical SUSY particle masses.

Combination improves sensitivity on sparticle masses by about 100 GeV. Observed mass limits are worse than expected due to an excess in the  $\gamma\gamma + MET$  (JHEP 06 (2019) 143A) analysis. The lightest chargino mass  $> 890$  GeV and the gluino mass  $> 1950$  GeV.



## R-PARITY CONSERVING GMSB

R-parity is a multiplicative quantum number that is +1 for known particles and -1 for their superpartners. In most models, R-parity conservation (RPC) is assumed to suppress baryon and lepton number violating processes. This implies that SUSY particles are produced in pairs, and the lightest supersymmetric particle (LSP) is stable, and if neutral, a good dark matter candidate.

In GMSB / GGM with RPC, the LSP is the gravitino (with a mass  $< 1$  GeV) and the Next-to-LSP (NLSP) is typically a neutralino (sometimes mass-degenerate with a chargino) and can decay as:

$$\tilde{\chi}_0 \rightarrow \tilde{G} + \gamma/Z/H \quad (\tilde{\chi}^\pm \rightarrow \tilde{G} + W^\pm)$$

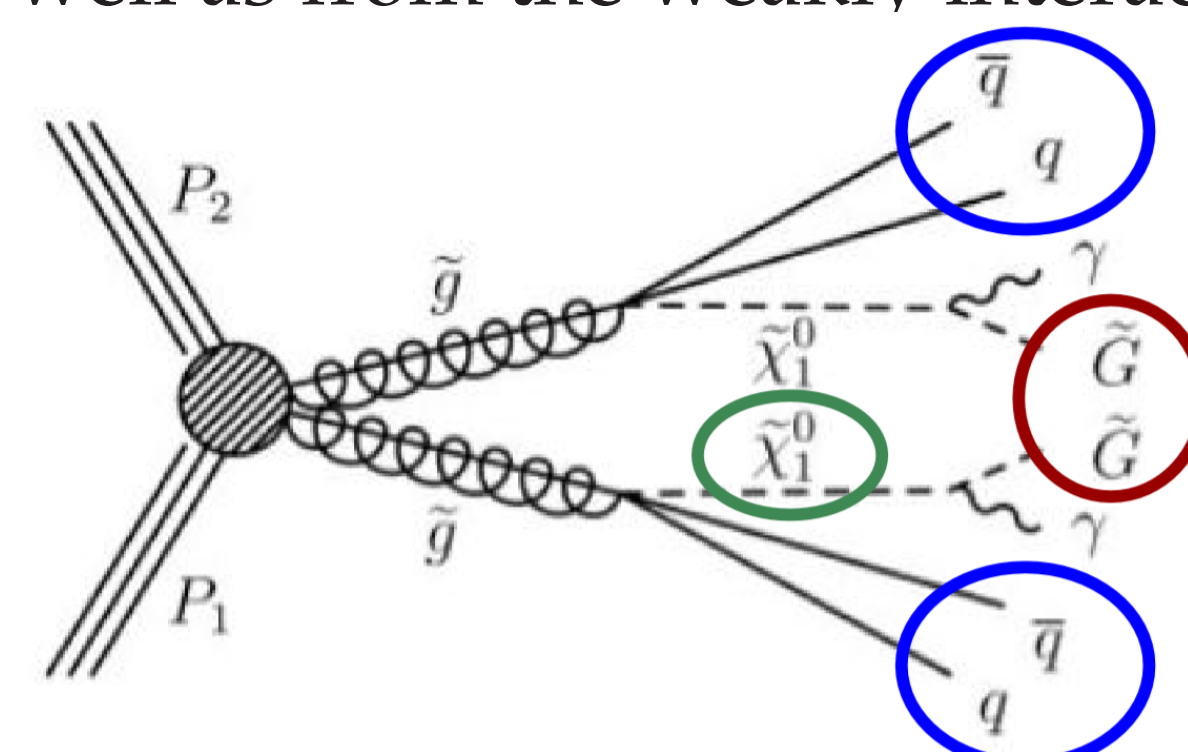
Results are interpreted in simplified models that consider only a single SUSY process with its cross-section ( $\sigma$ ), decay branching ratio ( $BR$ ) and the masses of the SUSY particles considered as model parameters. Results on  $\sigma \cdot BR$  are then derived that can later be reinterpreted in specific models.

## EXPERIMENTAL OBSERVABLES

**Missing Transverse Momentum (MET):** momentum imbalance of all observed physics objects. It originates from neutrinos and (jet) momentum mismeasurements in the SM, as well as from the weakly interacting LSP in SUSY models.

**Hadronic Activity (HT):** scalar sum of jet transverse momenta. Large HT can come from the final state jets in strong SUSY production.

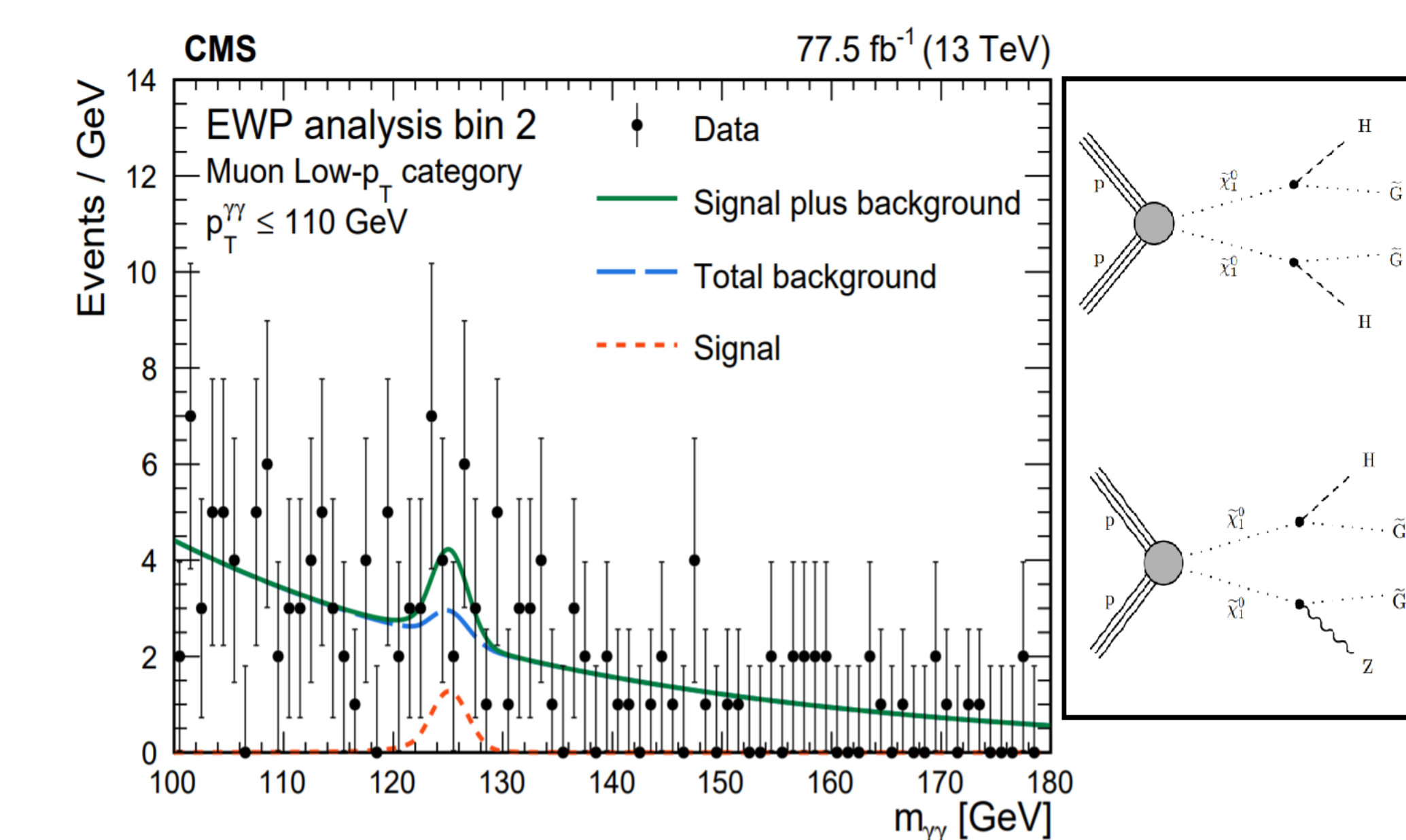
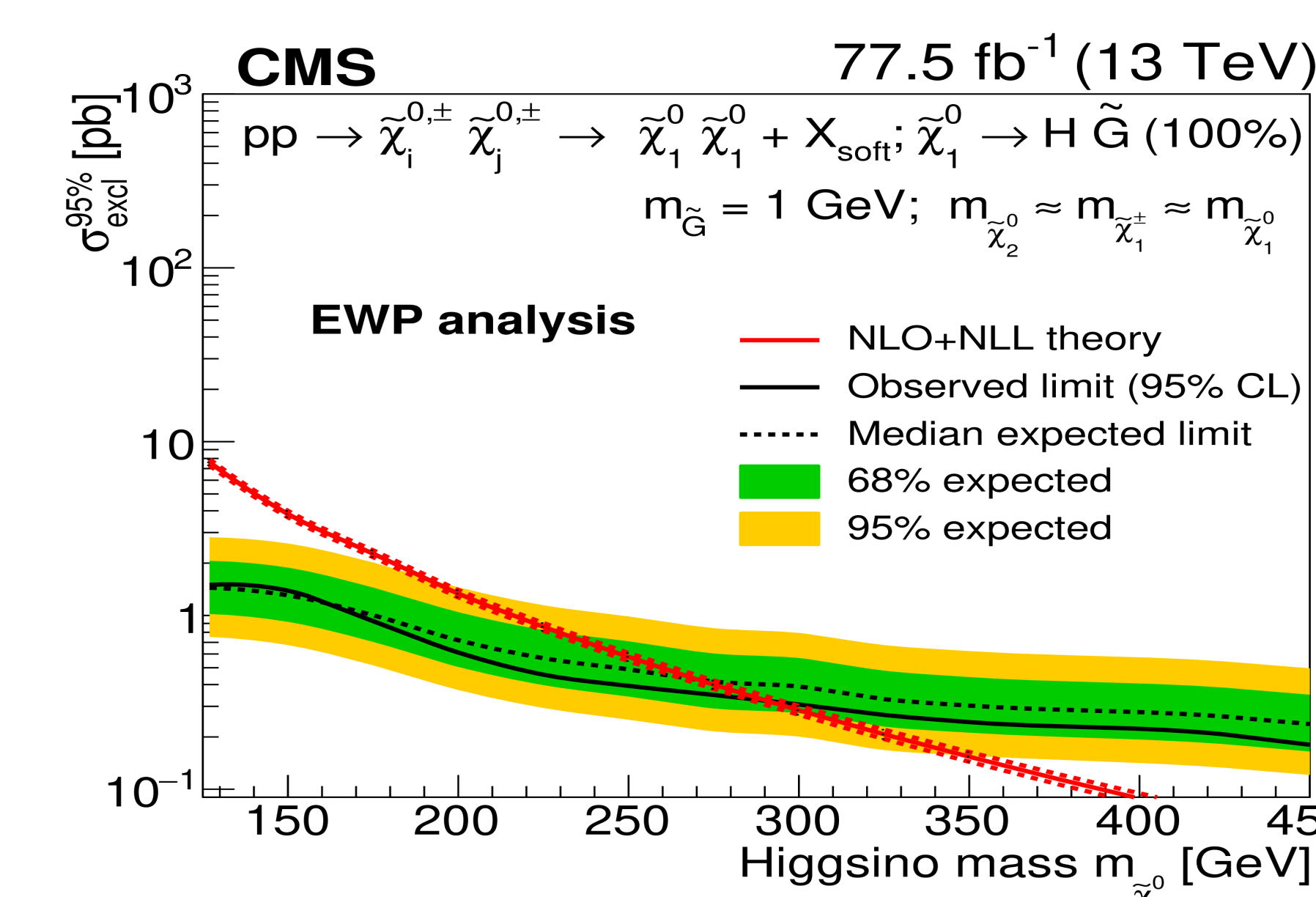
**Reconstructed Photon-MET system:** Its transverse energy sum and transverse mass characterise the NLSP kinematics.



## $H \rightarrow \gamma\gamma$ FROM NEUTRALINO

Search for an excess of Higgs boson production over the SM expectation originating from neutralino decay  $\tilde{\chi}_1^0 \rightarrow H + \tilde{G}$  in the  $H \rightarrow \gamma\gamma$  final state. [2]

No additional SUSY signal observed. The result interpreted in a GMSB motivated simplified model leads the constraint: Higgsino mass  $> 290$  GeV.



**Combined fit of SUSY signal + SM background**  
**Total SM background:** side-band fit to diphoton mass distribution + SM Higgs production from simulation  
**SUSY signal:** combined fit - SM background; consistent with no SUSY

## REFERENCES

- [1] Combined search for supersymmetry with photons in proton-proton collisions at  $\sqrt{s}=13$  TeV arXiv: 1908.08500
- [2] Search for supersymmetry using Higgs boson to diphoton decays at  $\sqrt{s}=13$  TeV arXiv: 1908.08500

## SUMMARY

Searches address a large area of the GMSB (GGM) MSSM parameter space. Results so far are consistent with SM (largest excess at  $2.4\sigma$  level observed in the  $\gamma\gamma + MET$  search). In the absence of a discovery, constraints are provided on SUSY model parameters and sparticle masses. Looking forward to more LHC data to reach the so far hidden corners of SUSY parameter space.