Searches for strong production of supersymmetry in CMS

Tamás Álmos VÁMI[1] for the CMS Collaboration

[1]Hungarian Academy of Sciences, Wigner RCP

Corfu2018 Workshop

Need for New Physics

We know that the SM cannot be the final theory

It does not explain the matter/antimatter asymmetry

It does not give any candidate on Dark Matter

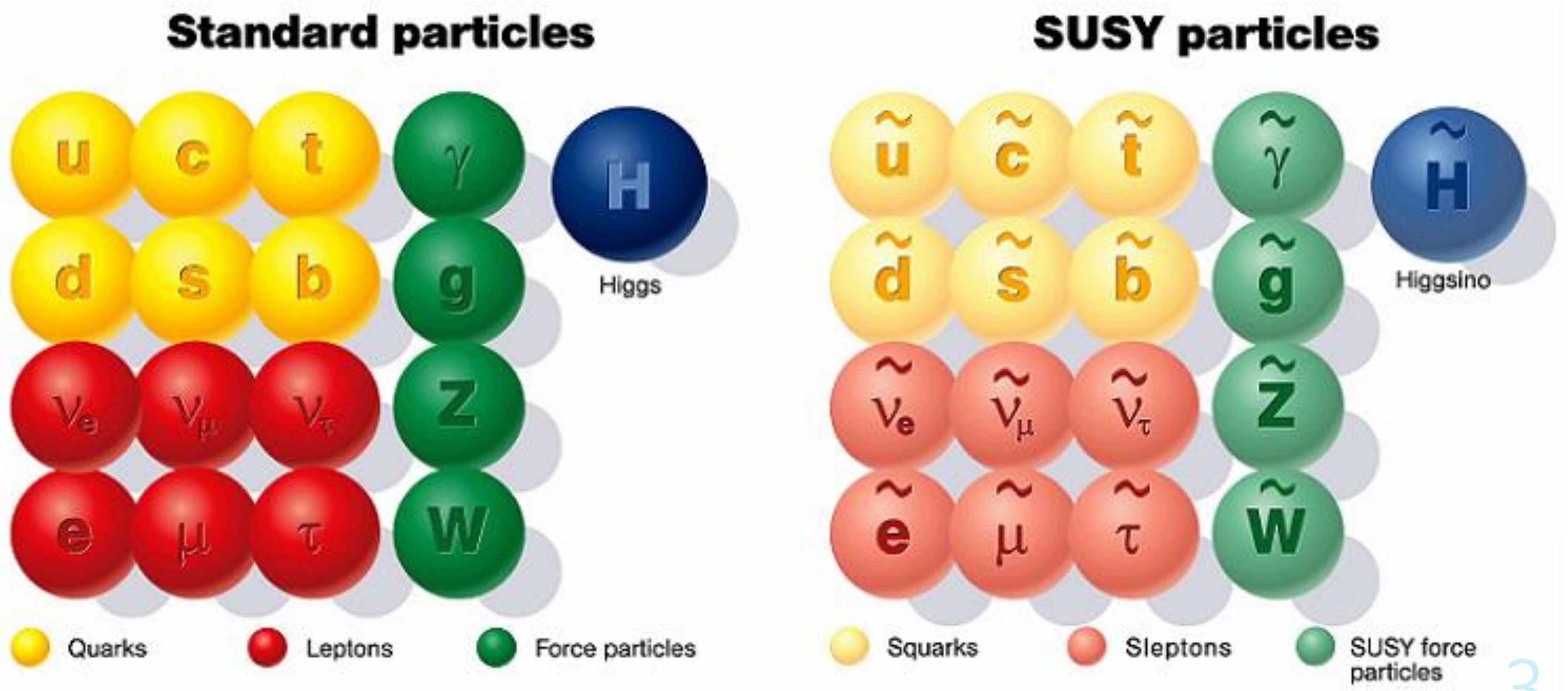
It does not give any reason why the mass of the Higgs is so low wrt the Planck mass

Unification of the electroweak and the strong interaction is not possible with it

A possible solution: supersymmetry

Extending the SM with the superpartners of its particles seems to solve these problems theoretically

Superpartners of the SM fermions are bosons while the SM bosons become fermions



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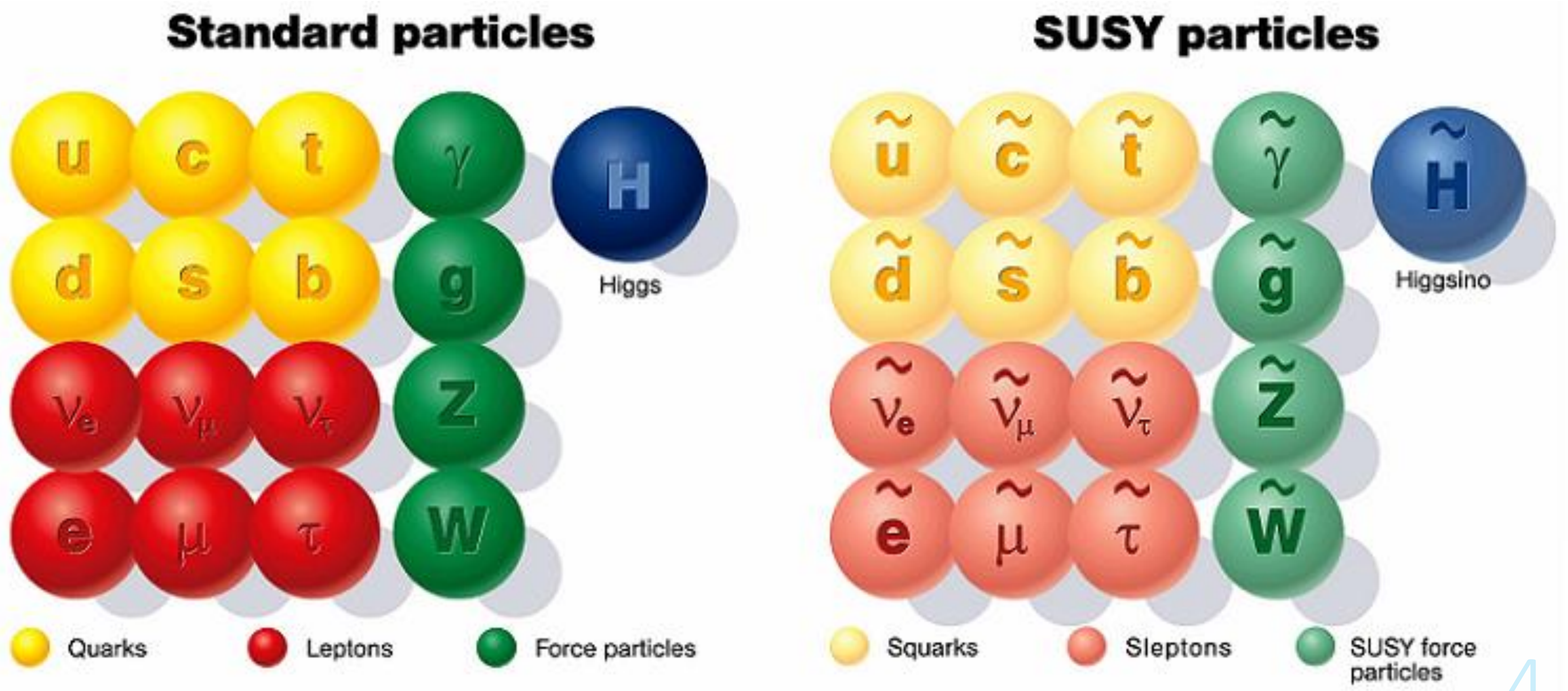
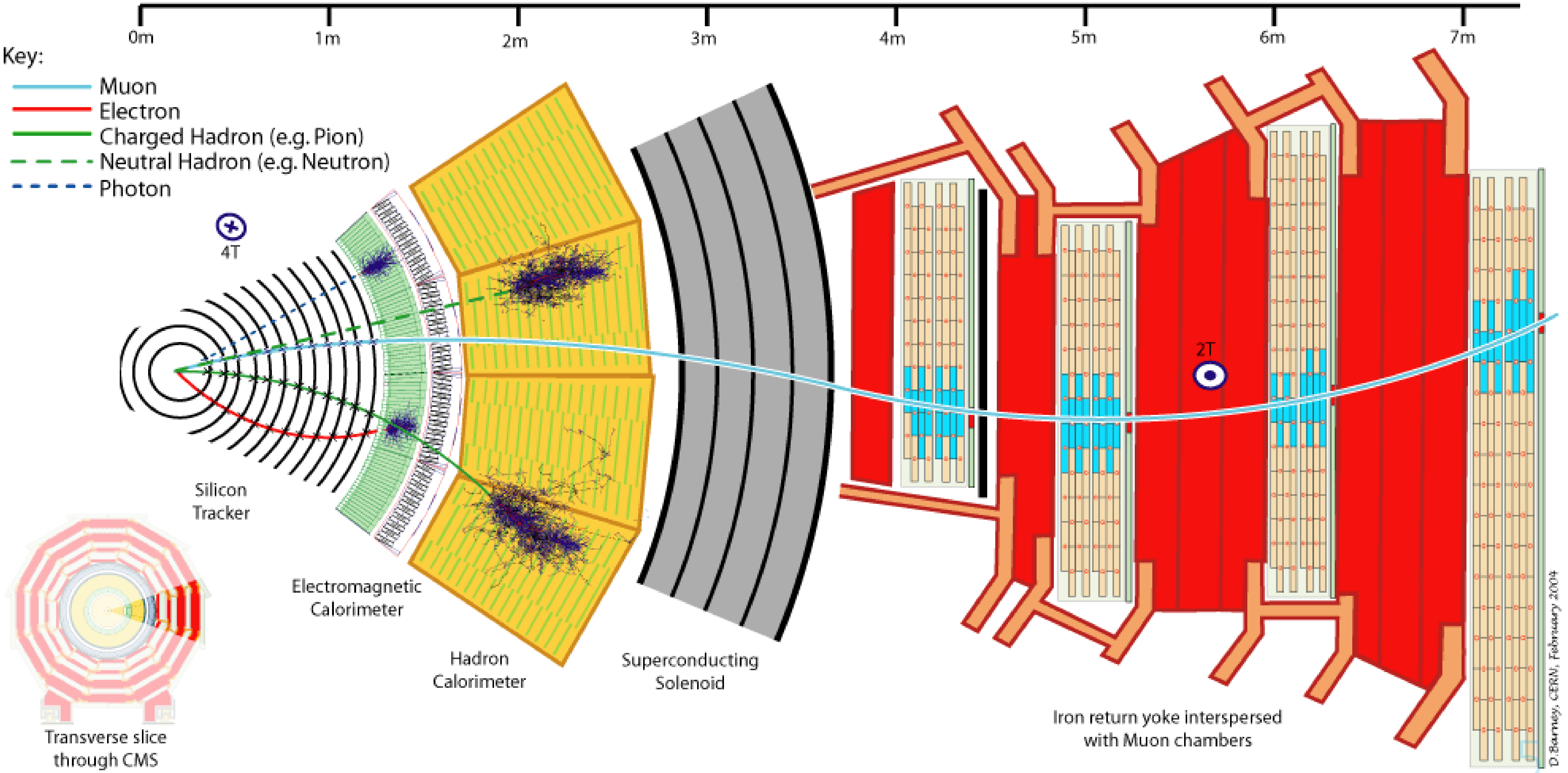
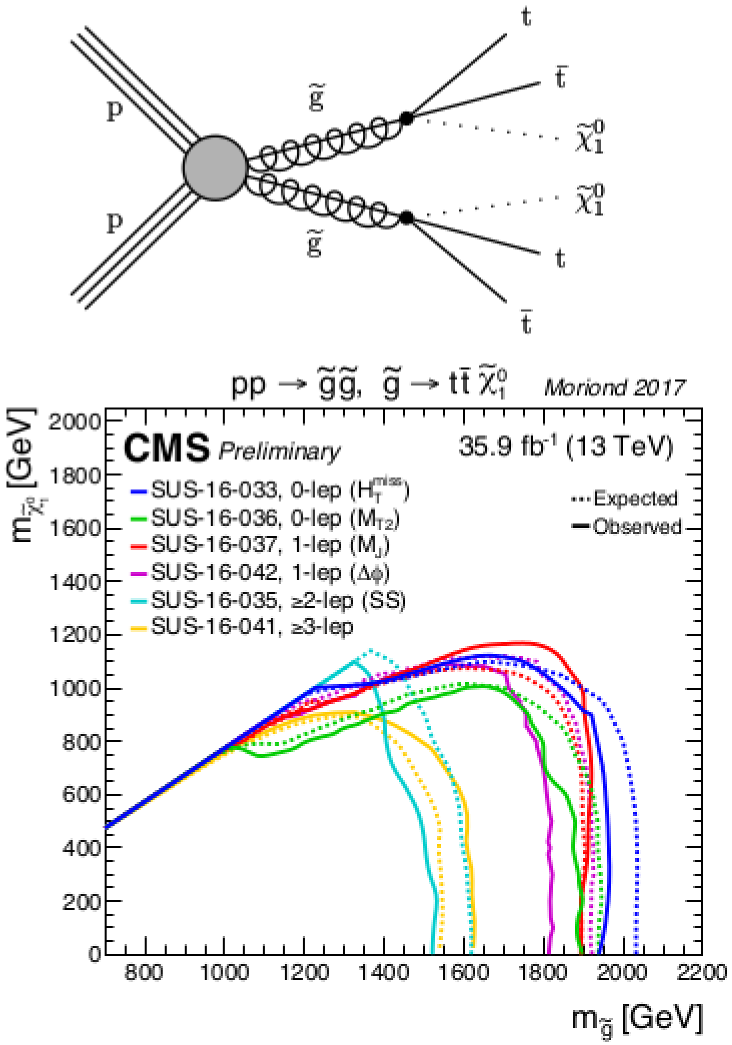
In this talk searches for strong production SUSY on data from the CMS detector in 2016 will be presented (35.9 fb^{-1})

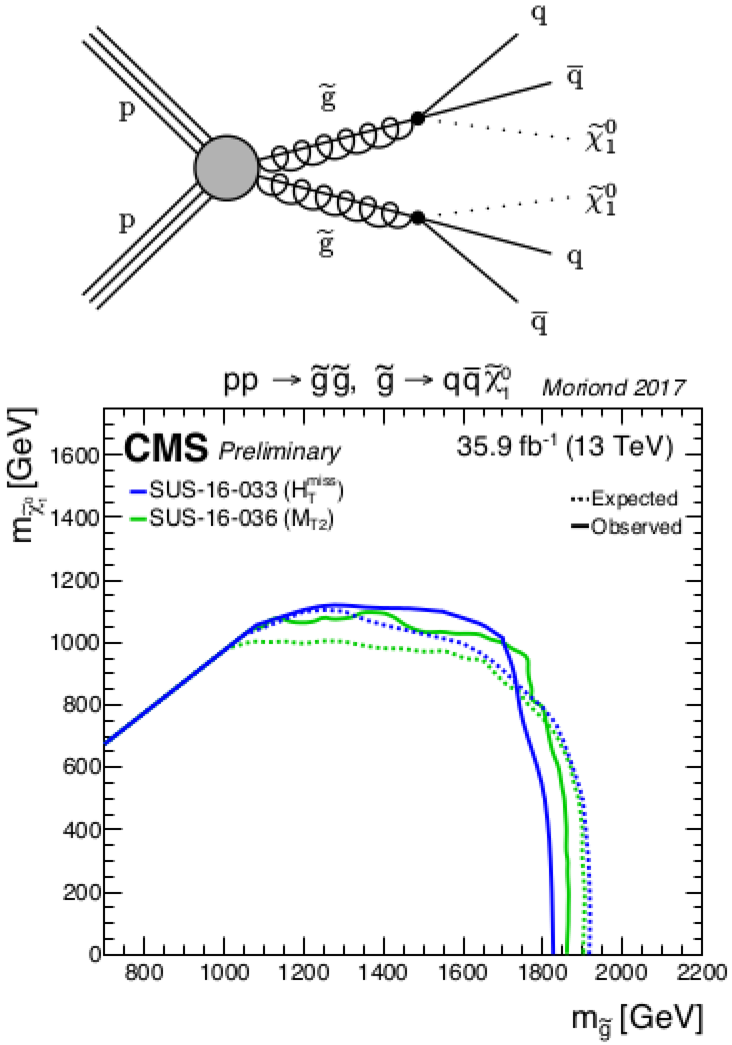


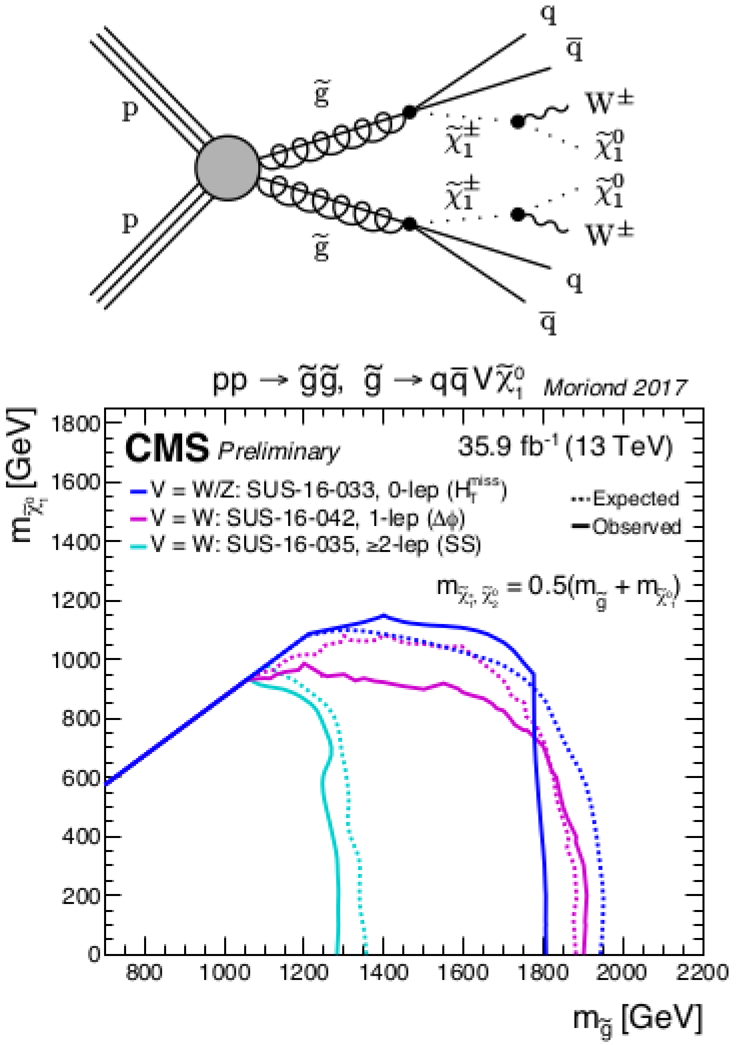
The detector: Compact Muon Solenoid



Results from Moriond: gluino searches

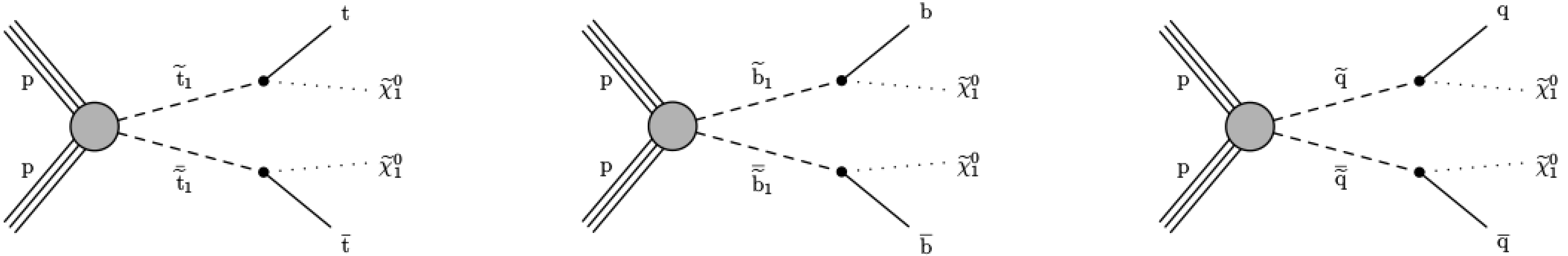


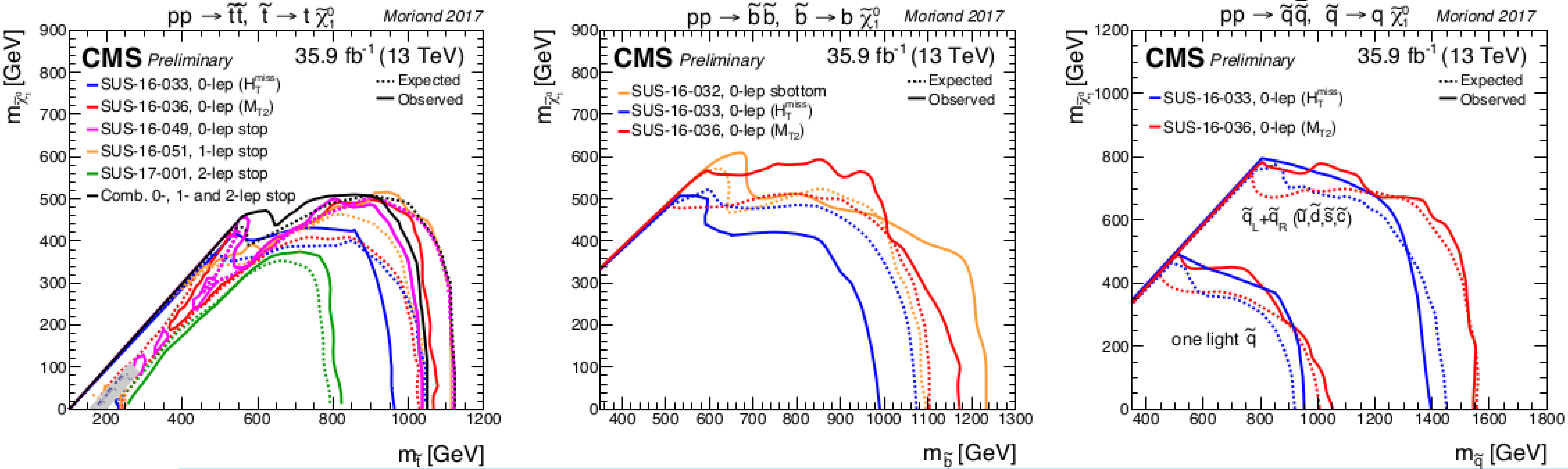




Limits upto ~1.9 TeV in various final states as long as the event has high missing energy

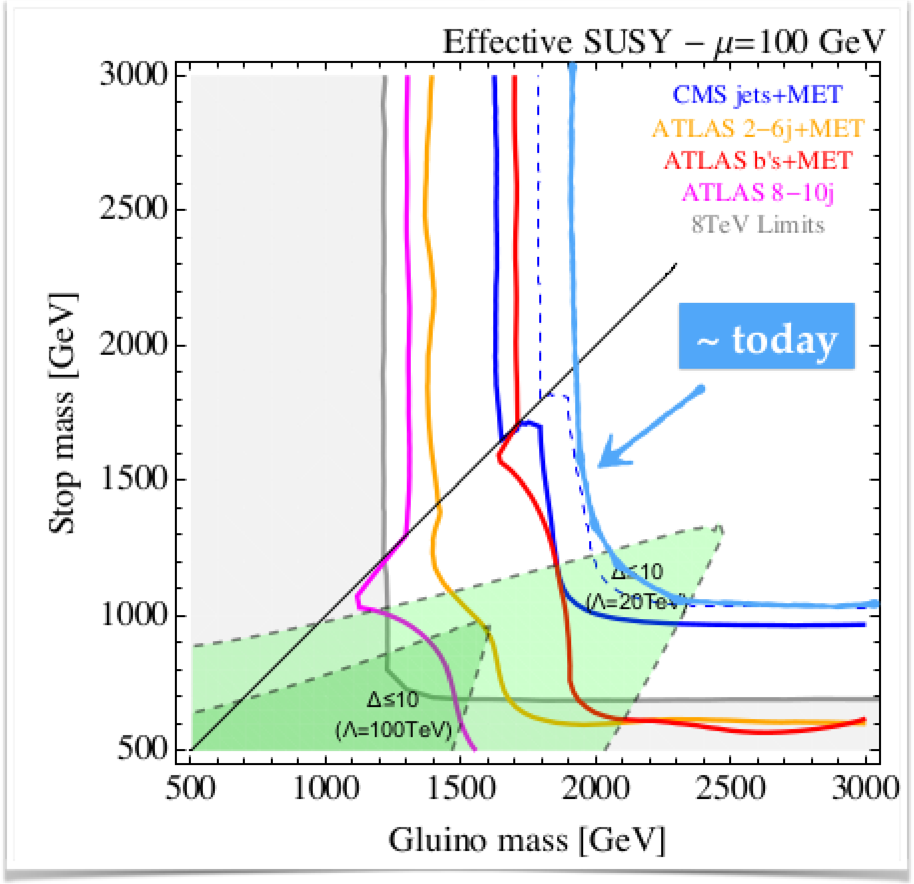
Results from Moriond: squark searches





Limits upto ~1.1 TeV in various final states

How to move forward?



Natural SUSY with high MET

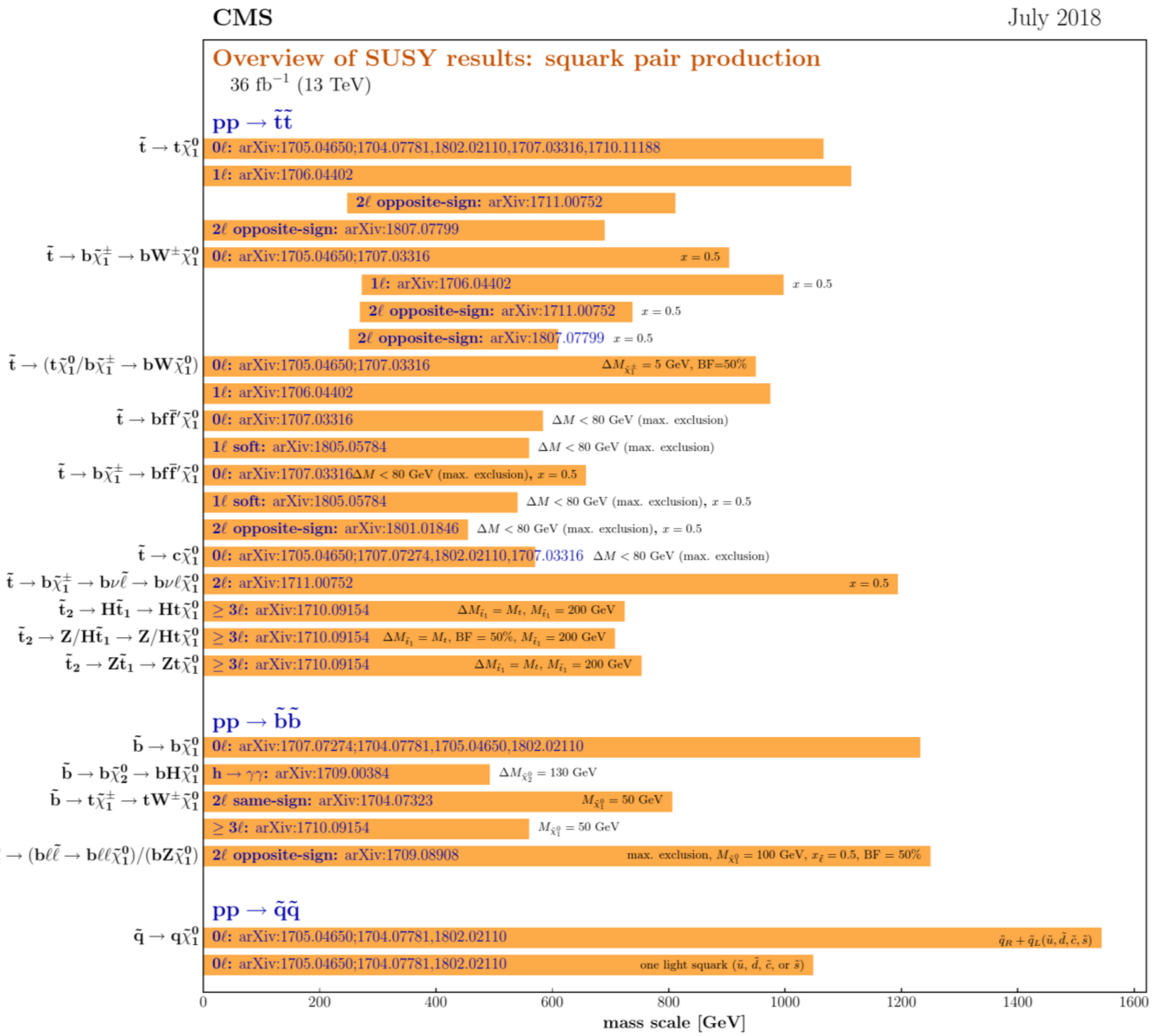
From Ana Ovcharova from ICHEP, based on arXiv:1610.08059

Based on the plot on the left there is very little unexplored phase space for Natural SUSY with high missing energy

Low missing energy states are still unexplored

Possible models include Split SUSY (long lived particles), RPV SUSY (no MET) or Compressed SUSY

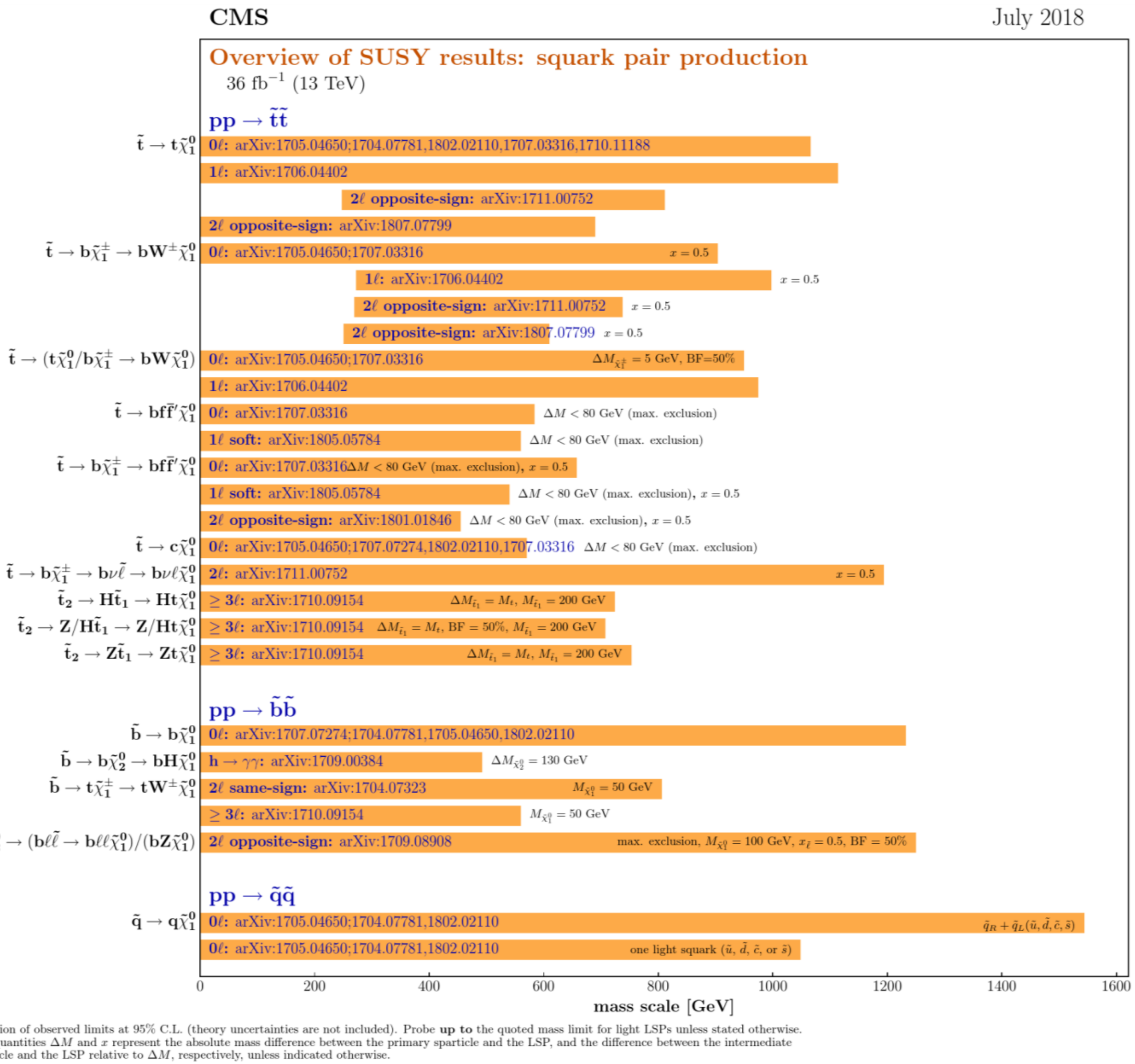
Where do we stand?

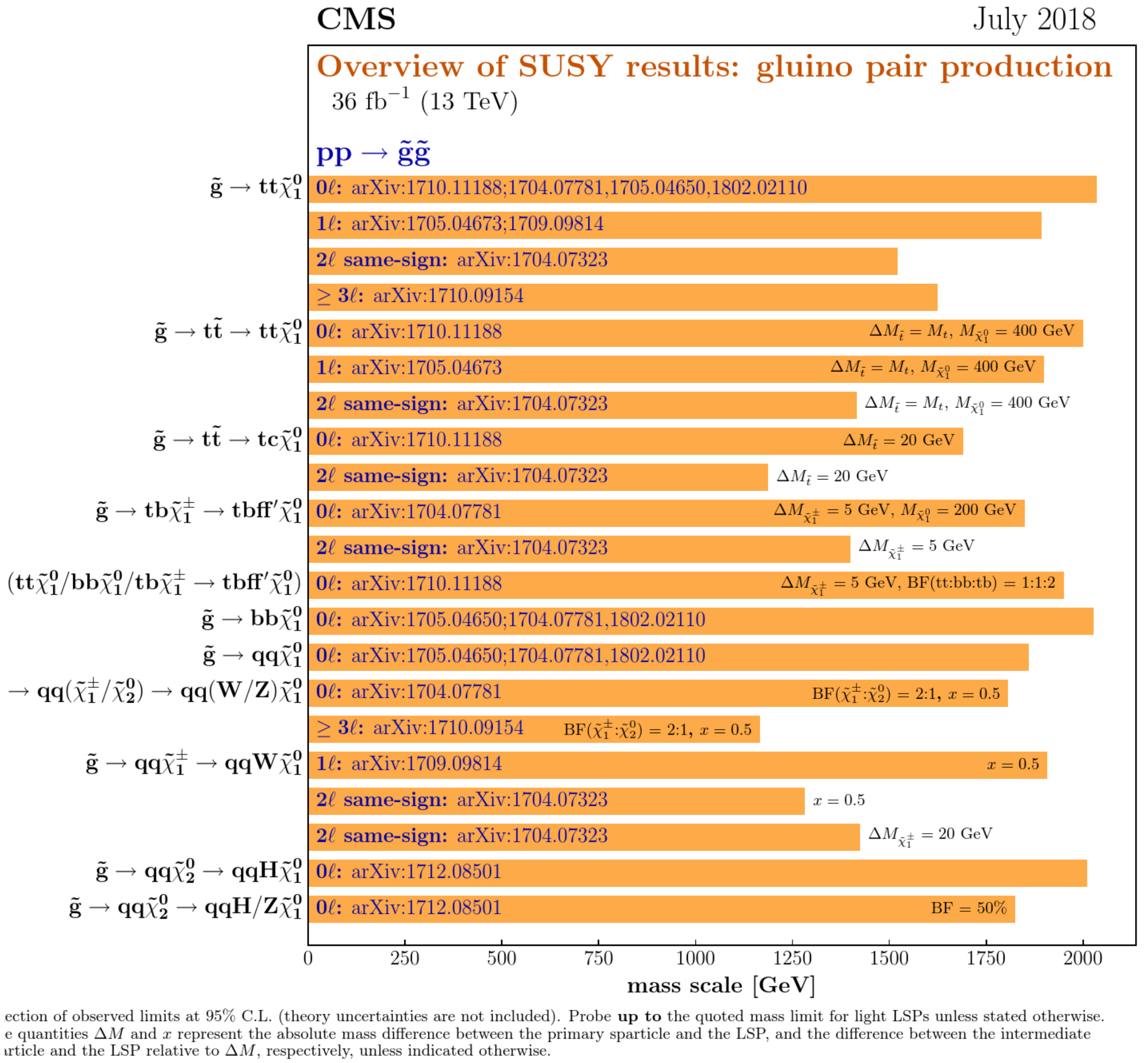


ion of observed limits at 95% C.L. (theory uncertainties are not included). Probe **up to** the quoted mass limit for light LSPs unless stated otherwise. uantities ΔM and x represent the absolute mass difference between the primary sparticle and the LSP, and the difference between the intermediate cle and the LSP relative to ΔM, respectively, unless indicated otherwise.

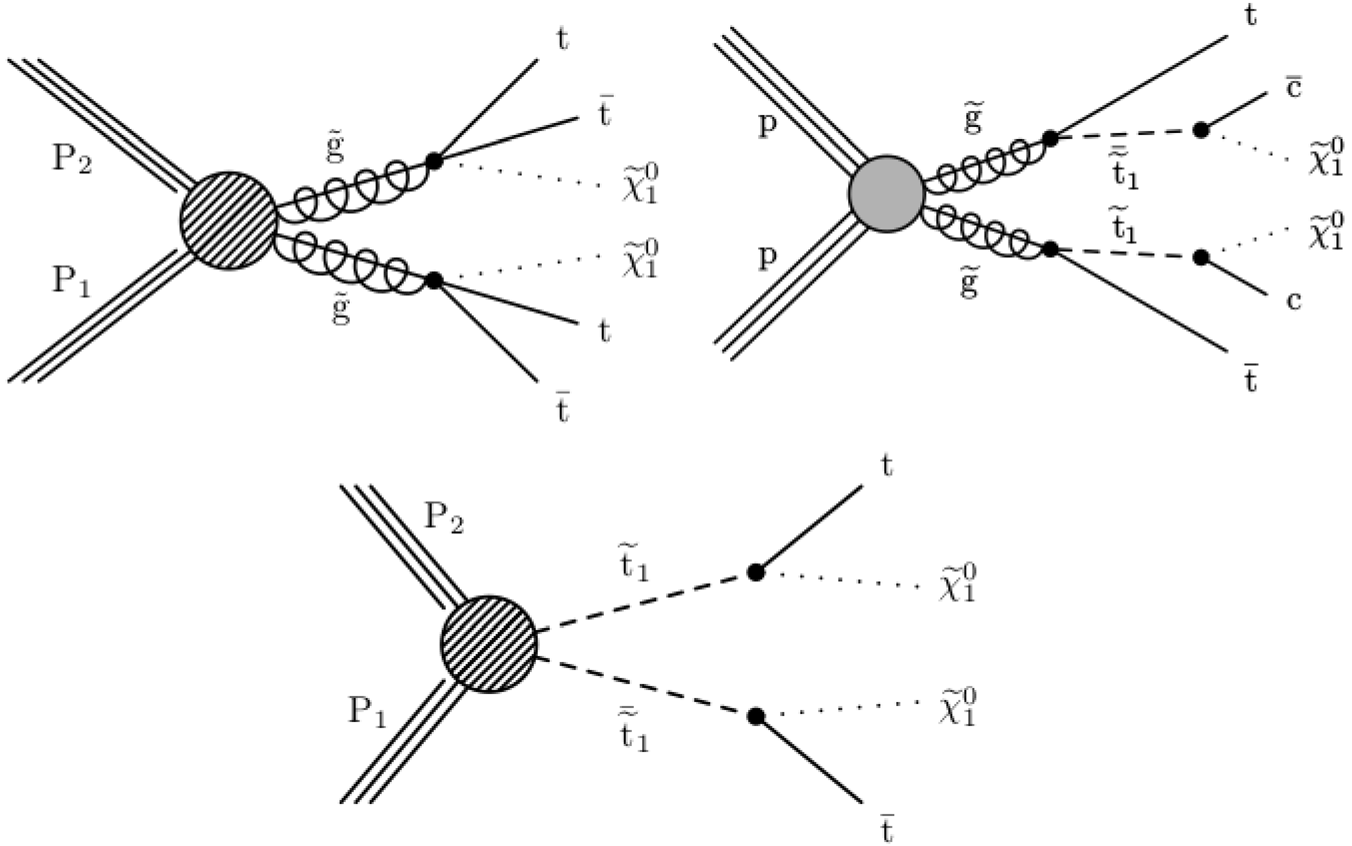
Where do we stand?

Best achieved is with 0 lepton with final states with jets and missing transverse momentum





Latest results: Inclusive SUSY with Razor



(left) Gluino pair production decaying to two top quarks and the LSP

(middle) Gluino pair production decaying to a top quark and a low mass top squark, which subsequently decays to a charm quark and the LSP

(right) Top squark pair production decaying to a top quark and the LSP

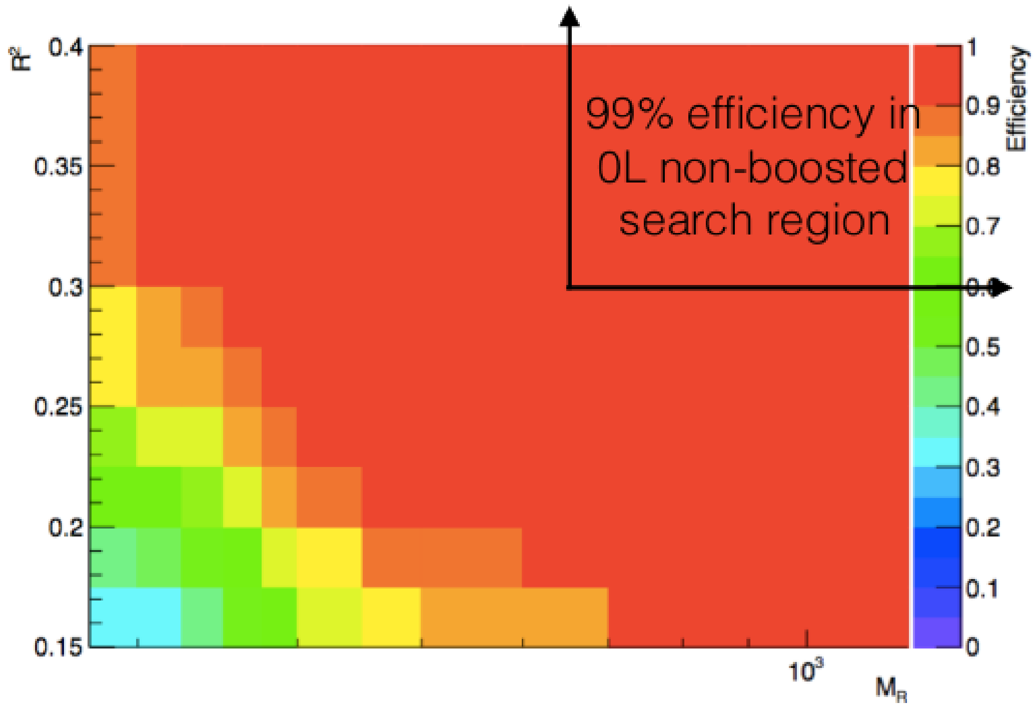
Event categorization

Events are categorized according to the presence of jets consistent with high-transverse momentum hadronically decaying W bosons or top quarks, the number of leptons, jets, and b-tagged jets identified

The search is performed in bins of the razor variables M_R and R^2 .

$$M_R = \sqrt{(|p^{j_1}| + |p^{j_2}|)^2 - \left(\mathrm{p}_z^{j_1} + \mathrm{p}_z^{j_2}\right)^2}$$

$$M_T^R = \sqrt{\frac{E_T^{miss}\left(p_T^{j_1} + p_T^{j_2}\right) - \vec{p}_T^{\,miss}\,(\overrightarrow{\vec{p}_T^{j_1} + \vec{p}_T^{j_2}})}{2}}$$



$$R = \frac{M_T^R}{M_R}$$

where j_1 and j_2 refers to the megajets

Background modeling

The main background is coming from W($l\nu$)+jets, Z($\nu\bar{\nu}$)+jets, $t\bar{t}$ and QCD multijet production

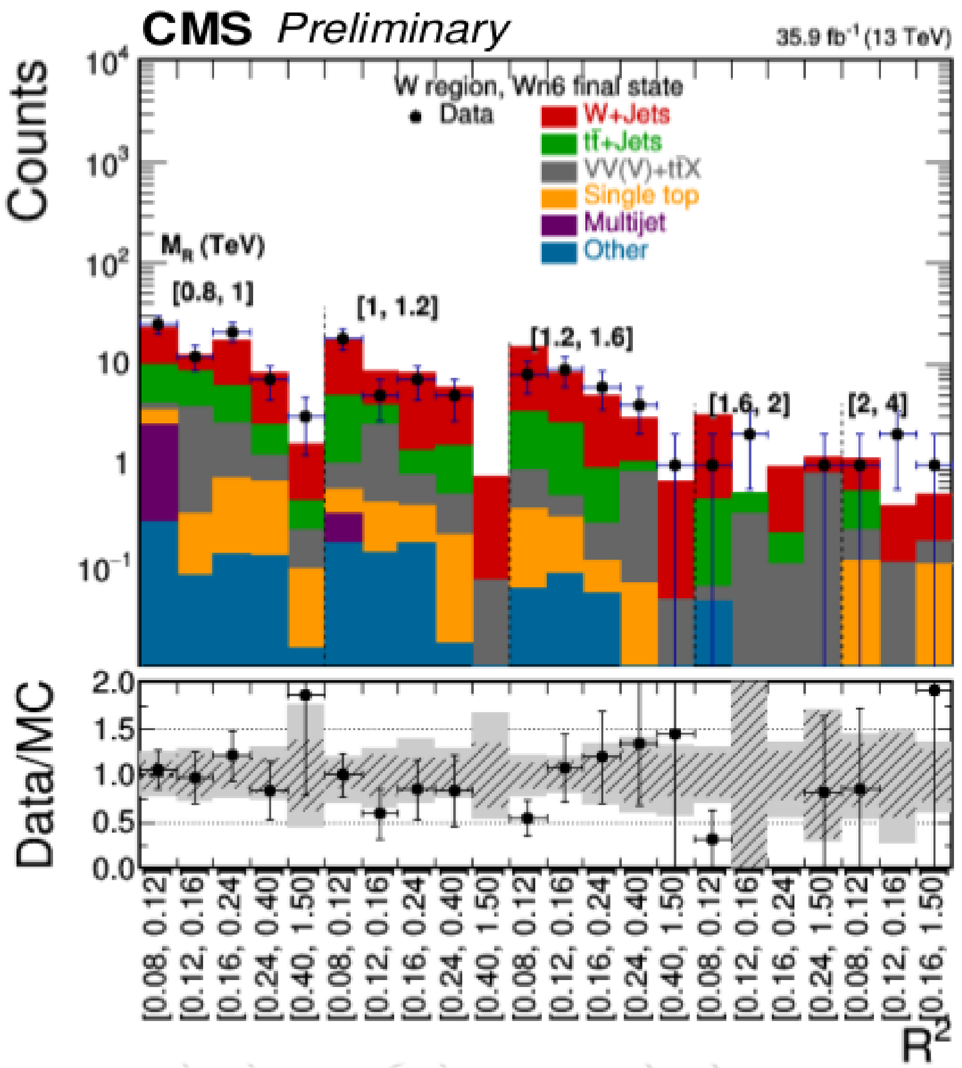
In case of zero b-tagged jets W($l\nu$)+jets, Z($\nu\bar{\nu}$)+jets while for more b-tagged jets the $t\bar{t}$ is dominant

The background prediction strategy uses control regions to isolate each background process, address any deficiencies of the MC simulation in a data driven way, and estimate systematic uncertainties in the expected event yields.

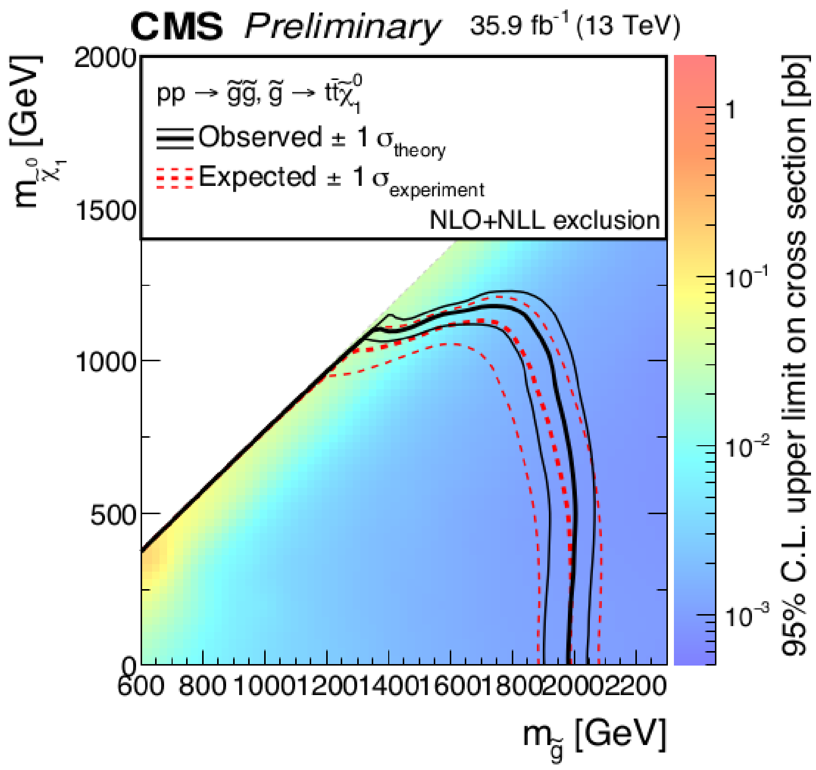
Background modeling

The M_R -R^2 distribution in the W+jets control regions of the boosted Wnj45 category.

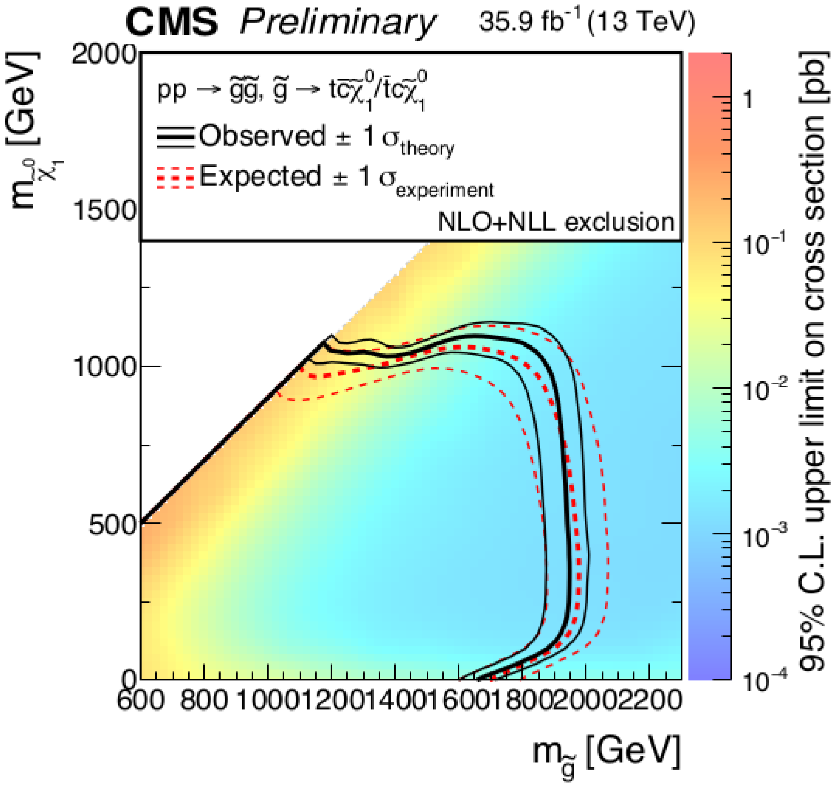
The ratio of data to the MC simulation prediction is shown on the bottom inset, with the statistical uncertainty expressed through the data point error bars and the systematic uncertainty of the background prediction represented by the shaded region.



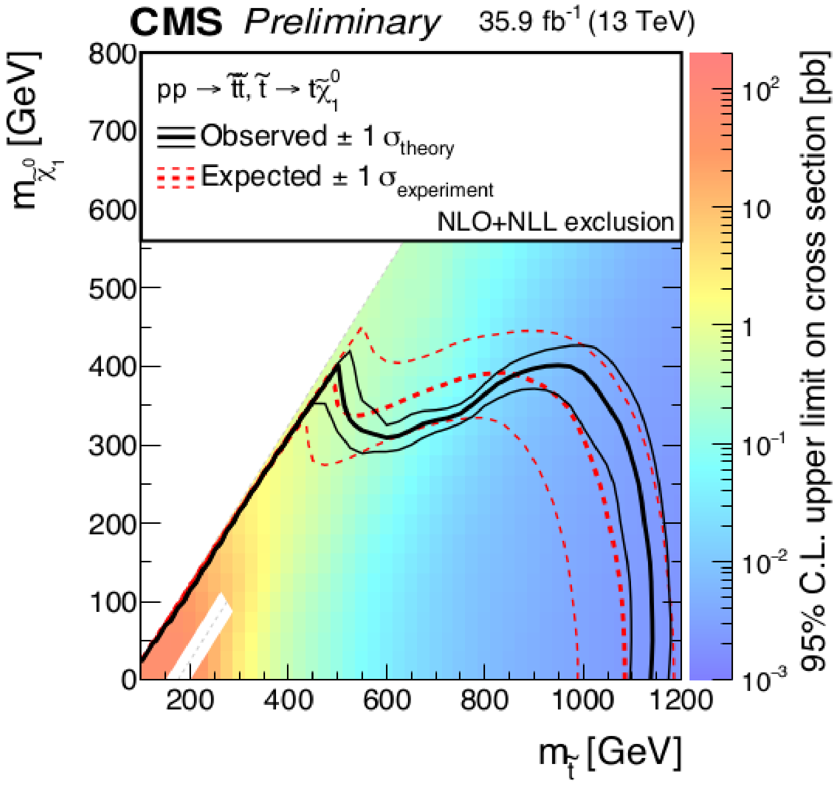
Results



Pair-produced gluinos decaying to top quarks.



Gluinos decaying to a top and a charm quark.



Pair-produced squarks decaying to top quarks.

Conclusion

There is very little phase space left for Natural SUSY, new models and techniques are developed.

New great result is presented: An inclusive search for supersymmetry in one lepton and fully hadronic final states using the razor variables and boosted object tagging techniques was presented based on data from 2016 with 35.9 fb^{-1}. The combination of both boosted and resolved event categories gave better exclusion limits for rarer processes.

Data are observed to be consistent with the SM expectation. Limits on the gluino mass extend to 2.0 TeV while limits on stop masses reach 1.14 TeV.

References

https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsSUS

CMS PAPER SUS-16-017