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Inclusive SUSY searches with the CMS detector

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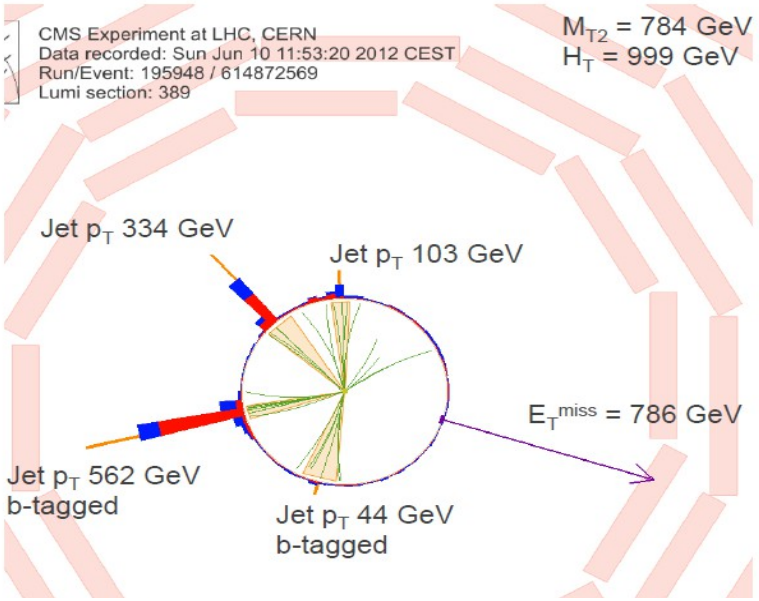
on behalf of the CMS collaboration

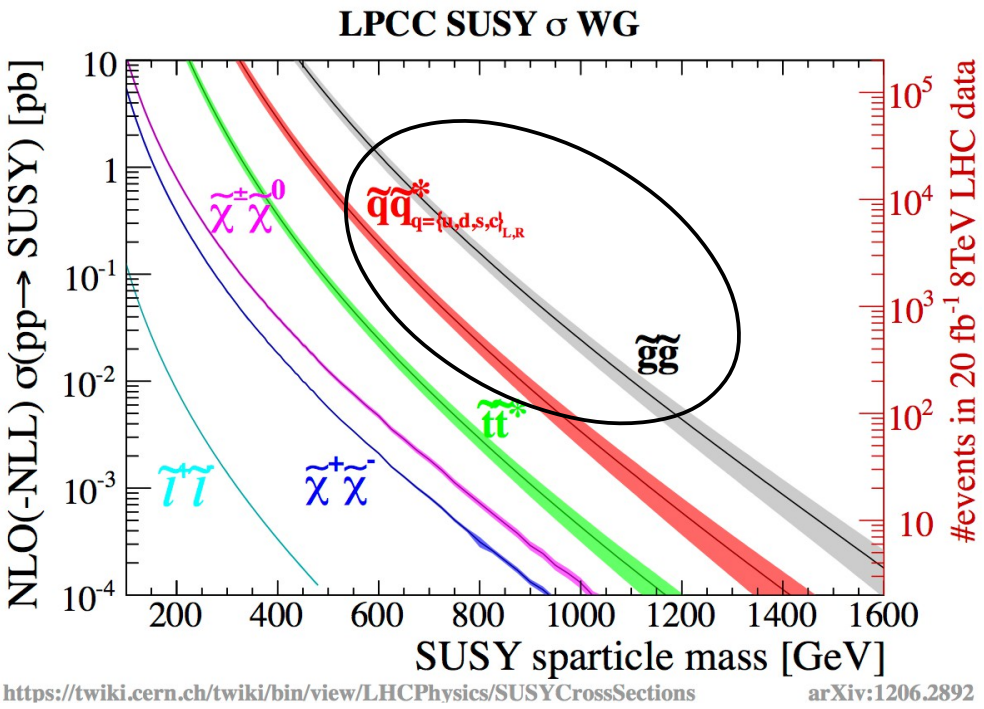
Inclusive SUSY Searches

- In this talk: searches for gluino and squark production by strong force.

- « inclusive »: analyses trying to cover as many SUSY signatures as possible.

- Study events in fully hadronic channels, with large hadronic activity and genuine momentum imbalance.





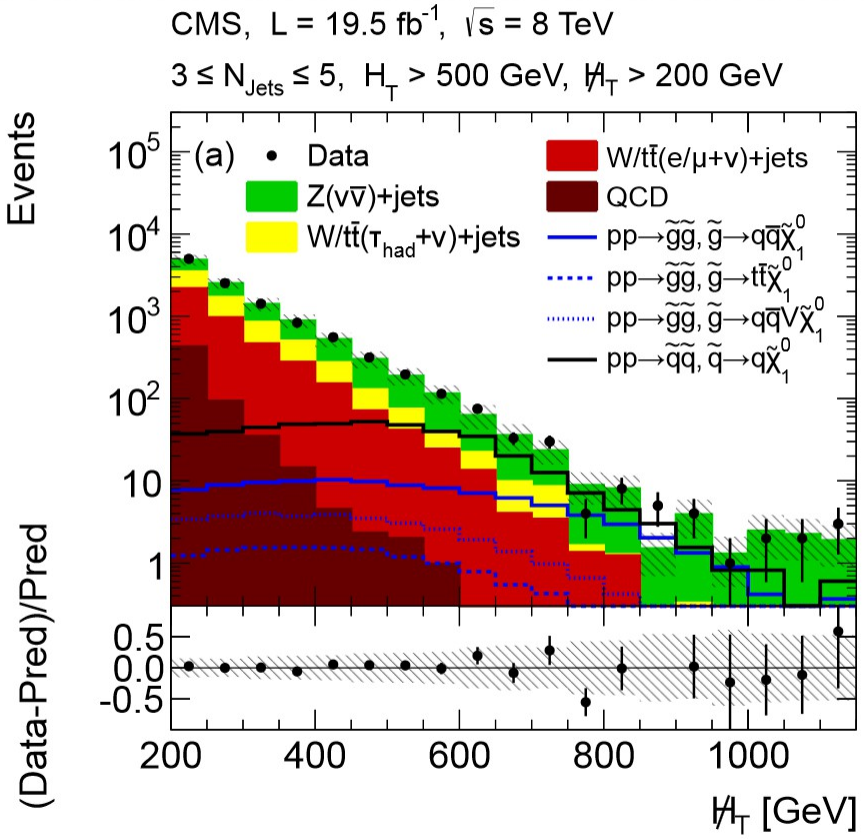
- HT+MHT analysis
- MT2 analysis
- AlphaT analysis
- Razor analysis

HT+MHT search

- CMS-PAS-SUS-13-012, JHEP 1406, 055 (2014).

- Selection :
  - 3 jets with pt > 50 GeV
  - HT > 500 GeV
  - MHT > 200 GeV
  - DeltaPhi(jet, MHT) > 0.5,0.5,0.3
  - Veto isolated e/mu, pt > 10 GeV

- Data driven methods are used to estimate each background.
  - muon+jet control sample is used to estimate W and ttbar background.
  - γ+jets events are used for the Z background estimation.
  - « Rebalance and smear » method is used to estimate the QCD.

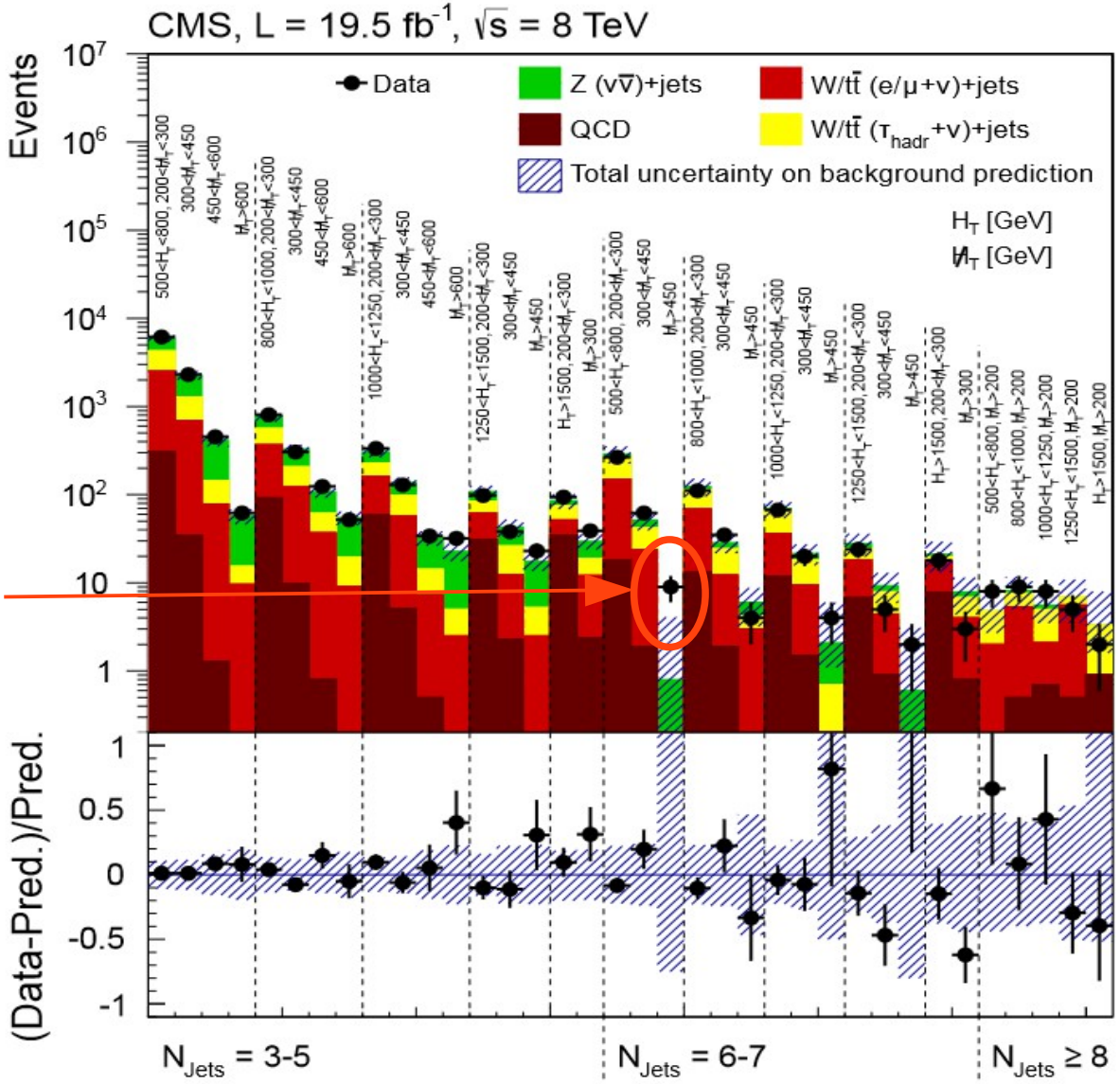


HT+MHT: search bins and results

- Inclusive analysis of 36 search regions, binned in Njets, HT and MHT.

- Data shows no significant excess.

- N bkg = 0.8 ± 1.8
- N data = 9
  - p local ~ 0.004 → 2.7σ
  - p global ~ 0.11 → 1.2σ

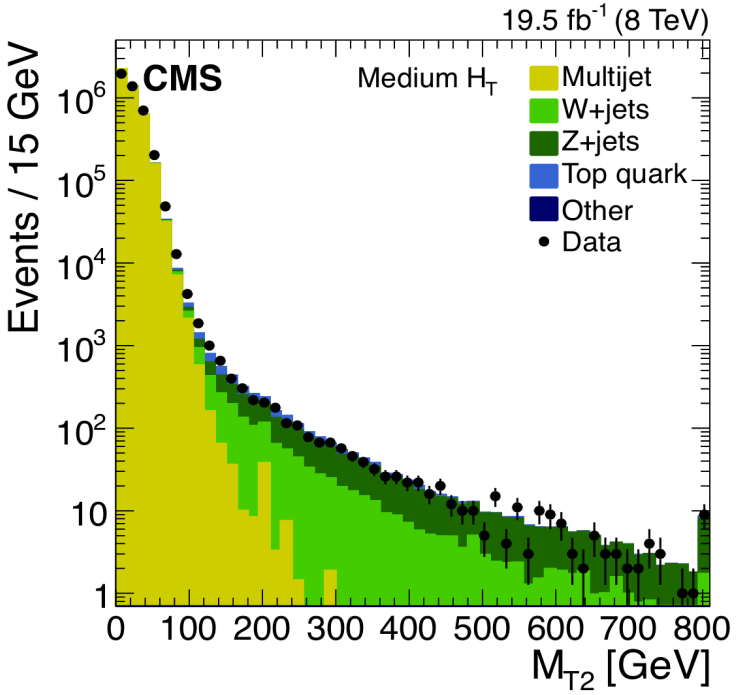


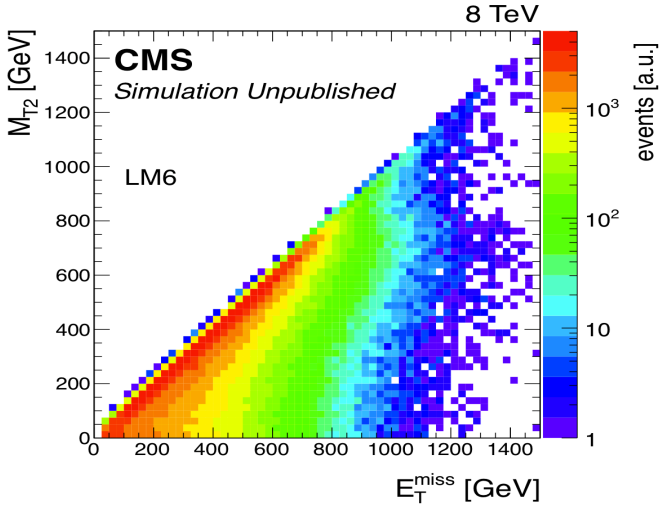
MT2 search

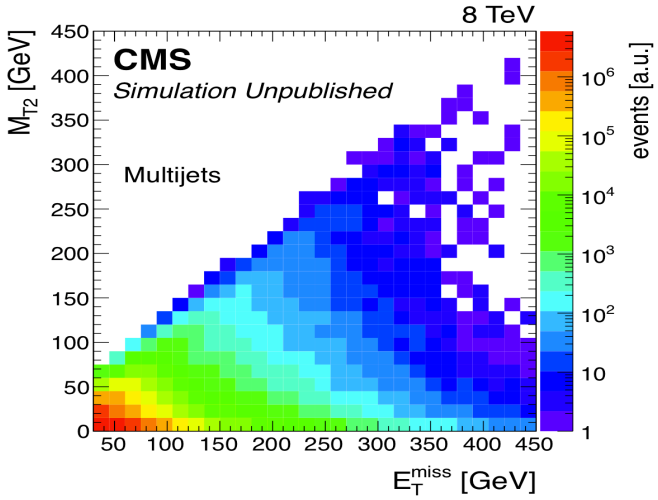
- CMS-PAS-SUS-13-019, JHEP 05, 078 (2015).
- MT2 is a generalization of the transverse mass MT for the case of 2 decay chains with 2 unobserved particles:

$$M_{T2}(m_{\tilde{\chi}}) = \min_{\vec{p}_T^{\tilde{\chi}(1)} + \vec{p}_T^{\tilde{\chi}(2)} = \vec{p}_T^{\,\text{miss}}} \left[\max\left(M_T^{(1)}, M_T^{(2)} \right) \right]$$

- Sensitive variable to genuine MET:
- QCD high met events are mainly at low MT2, contrary to SUSY events.





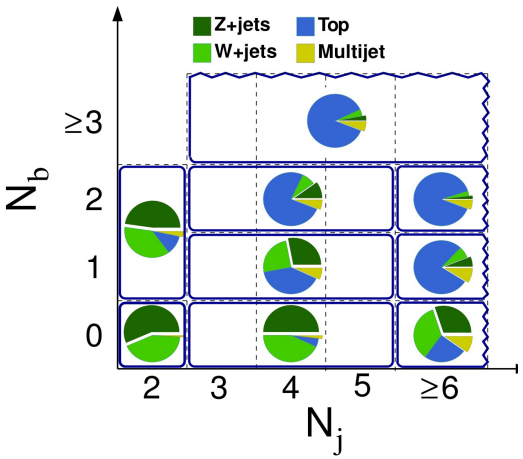


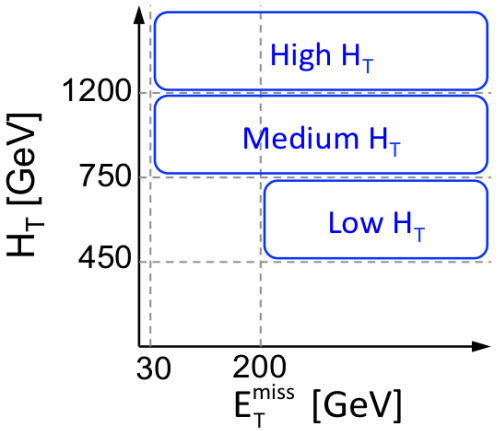
MT2: search bins and results

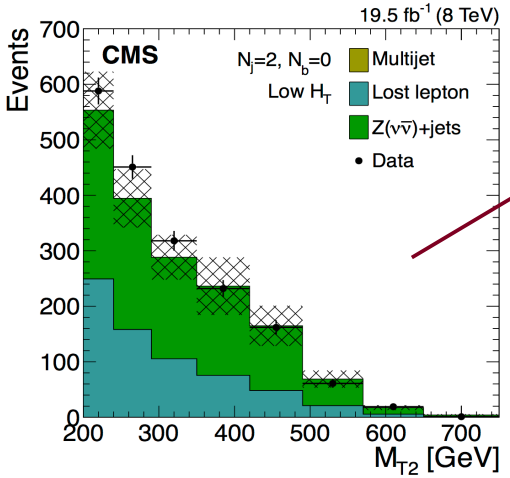
- Selection:
- Veto e/mu/tau, pt 10/10/20 GeV
- Leading 2 jets with pt>100 GeV
- DeltaPhi(jets,MET)>0.3

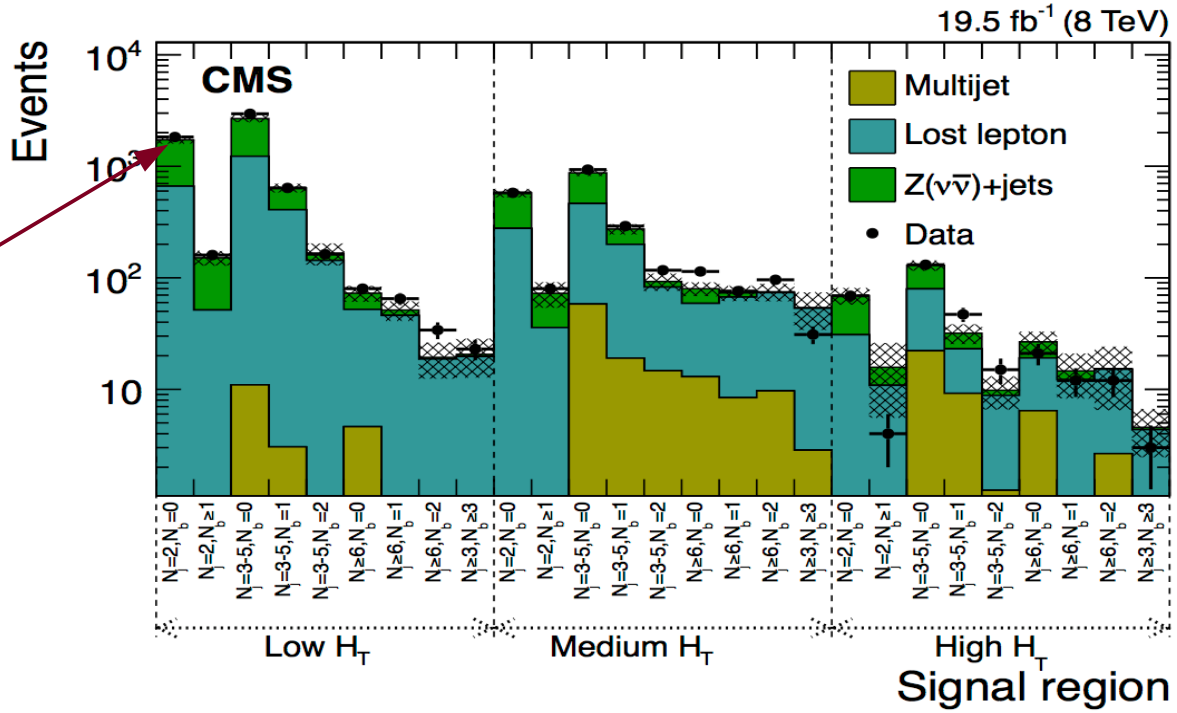
- Search binned in HT, Nb, Njets and MT2.

- No significant excess observed.







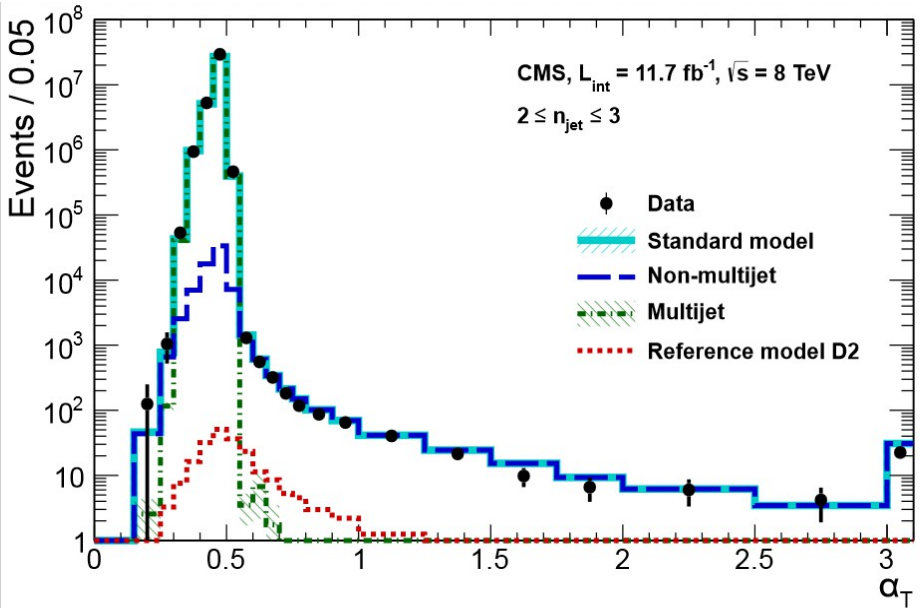


AlphaT search

- CMS-PAS-SUS-12-028, EPJC 73, 2568 (2013).

- Inclusive search based on kinematic variable alphaT:
  - Cluster jets into 2 pseudo-jets
  - $\alpha_{\mathrm{T}} = \dfrac{E_{\mathrm{T}}^{j_2}}{M_{\mathrm{T}}(j_1, j_2)}$

- Basic idea :
  - alphaT=0.5: perfect dijet event
  - alphaT<0.5: events with mismeasured jets
  - alphaT>0.5: events with genuine MET
  - ➢ Very effective discriminant against QCD background.



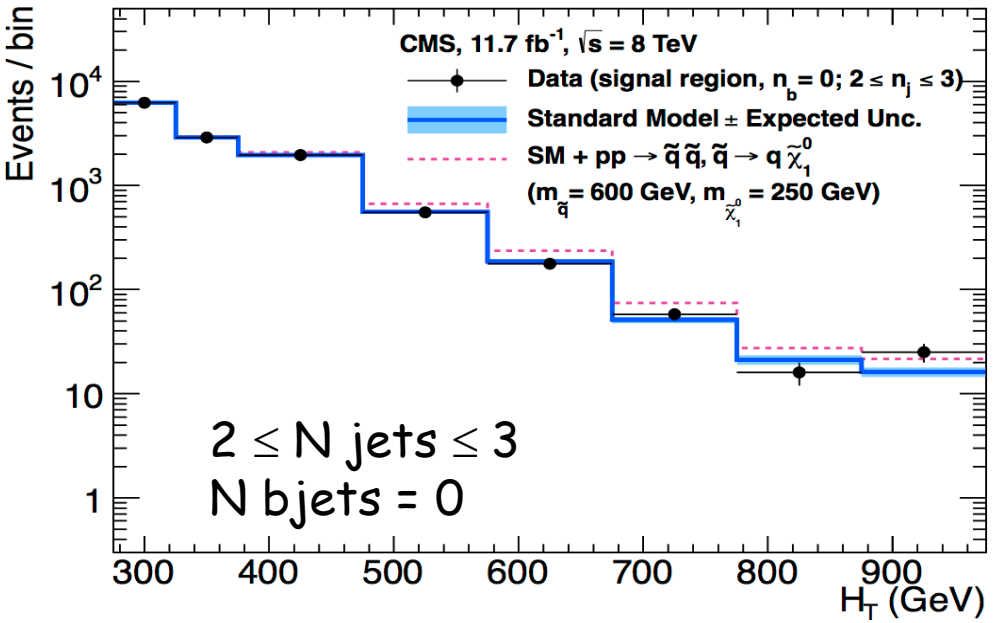
- Selection:
- HT > 275 GeV
- At least 2 jets, pt> 100 GeV
- alphaT > 0.55
- Veto isolated e/mu/photon

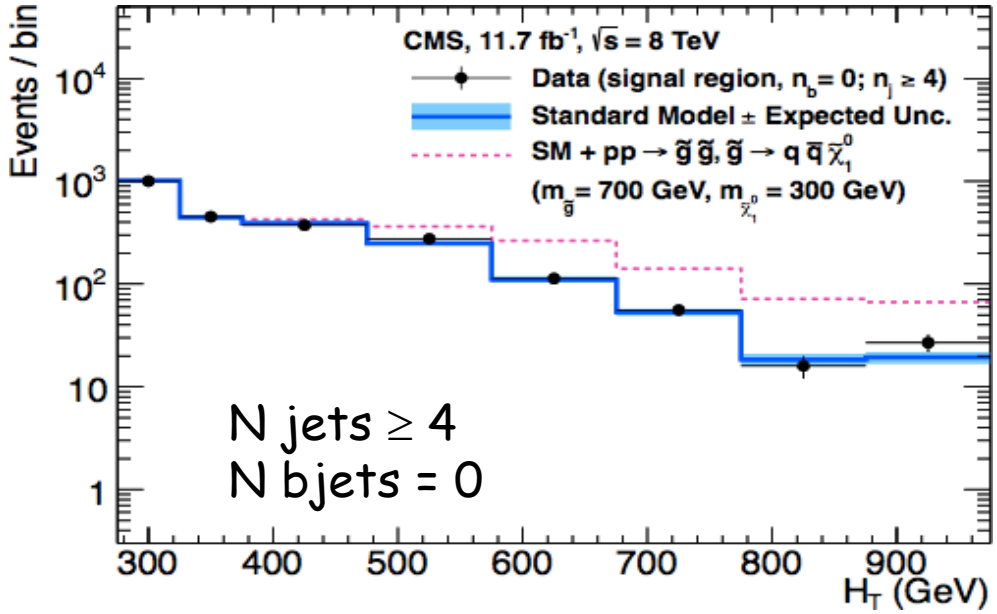
alphaT: search bins and results

- Search is binned in :
  - HT
  - N jets = 2-3, ≥4
  - N bjets = 0, 1, 2, 3, ≥4

- Data driven background estimates from muon+jets, di-muons+jets and photon+jets control samples, using transfer factors.

- All results are compatible with SM expectation.



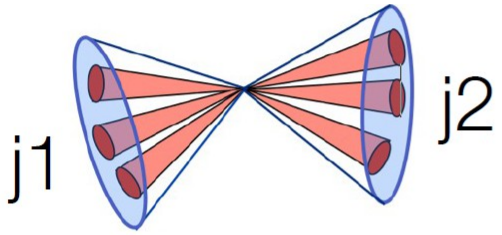


Razor search

- CMS-PAS-SUS-13-004, PRD 91, 052018 (2015).

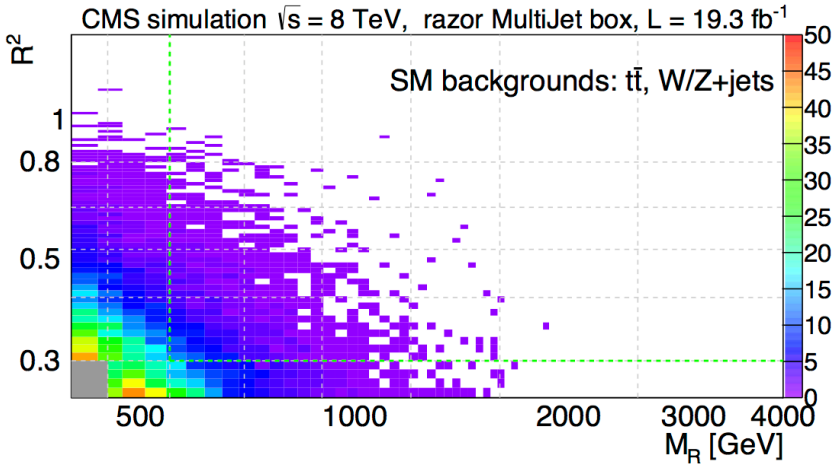
- Compute MR and R2 from the mega jets and the MET.
- MR broadly peaks at the caracteristic mass scale: $\frac{M_{\tilde{q}}^2 - M_{\tilde{\chi}}^2}{M_{\tilde{q}}}$

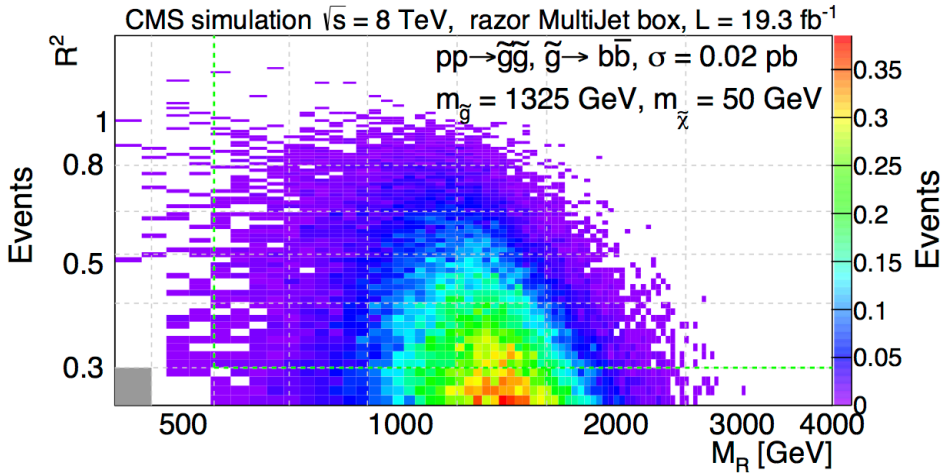
- Categorized events into « boxes » by lepton content, and jet and bjet multiplicities.



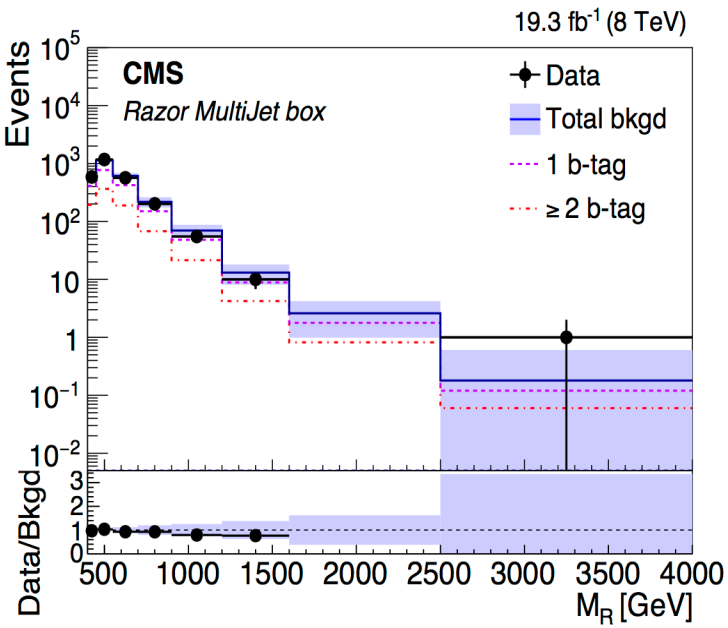
$$M_R = \sqrt{(|\vec{p}^{j1}| + |\vec{p}^{j2}|)^2 - (p_z^{j1} + p_z^{j2})^2}$$

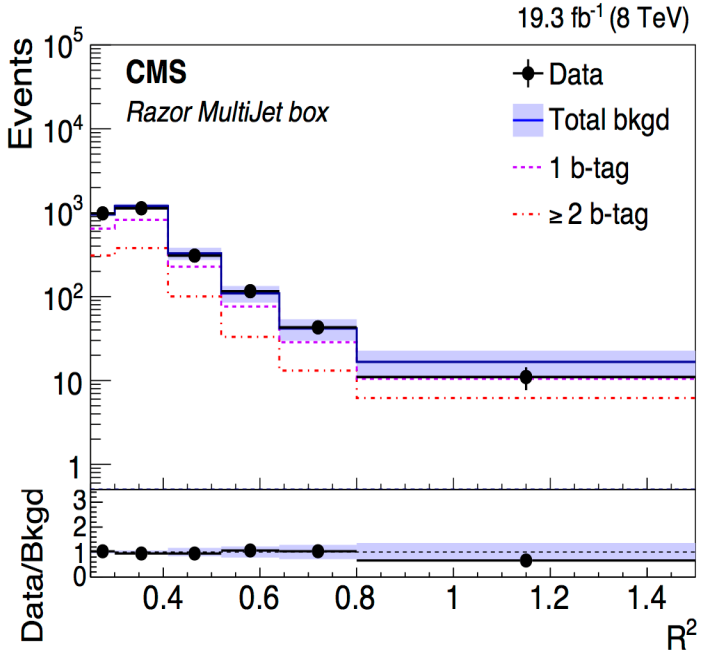
$$R \equiv \frac{M_T^R}{M_R} \qquad M_T^R \equiv \sqrt{\frac{E_T^{\rm miss}(p_T^{j1} + p_T^{j2}) - \vec{E}_T^{\rm miss}\cdot(\vec{p}_T^{j1} + \vec{p}_T^{j2})}{2}}$$





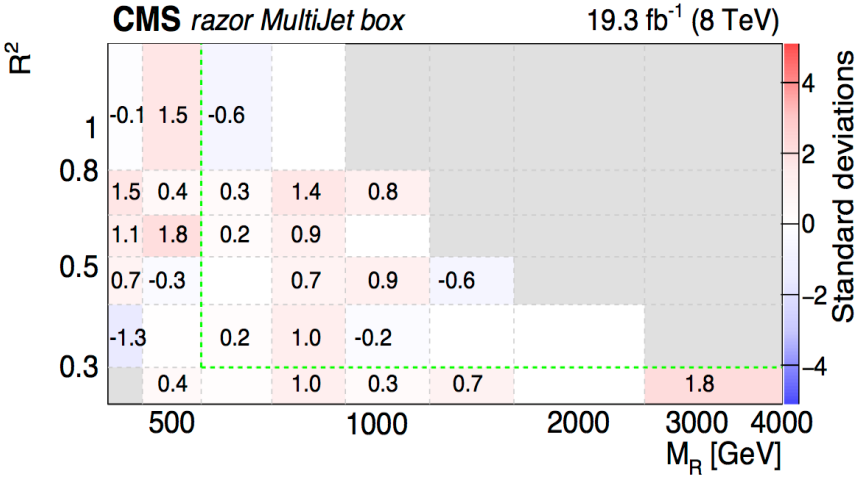
Razor: results





- 2d analytic shape is fit in a background enriched sideband and extrapolated.

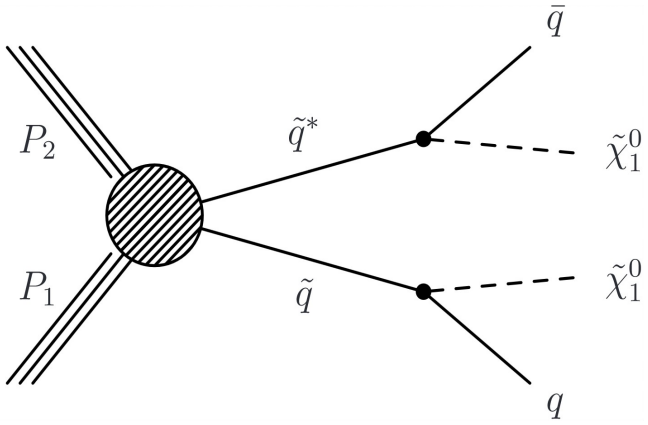
- Agreement is quantified between prediction and data as a two-sided p-value, expressed as a number of standard deviations for a gaussian.



Simplified Model Interpretation

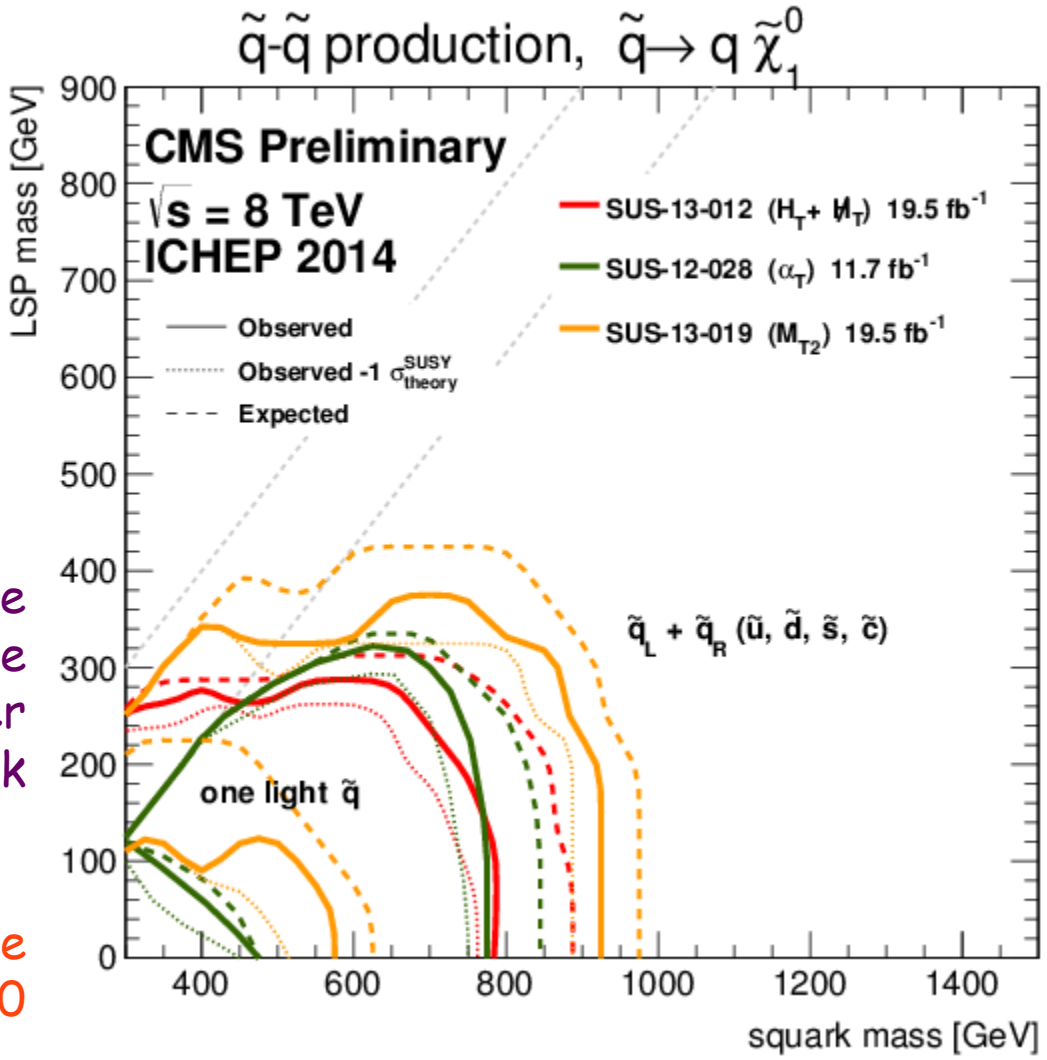
Squark pairs

- Direct pair production.
- T2qq simplified model.



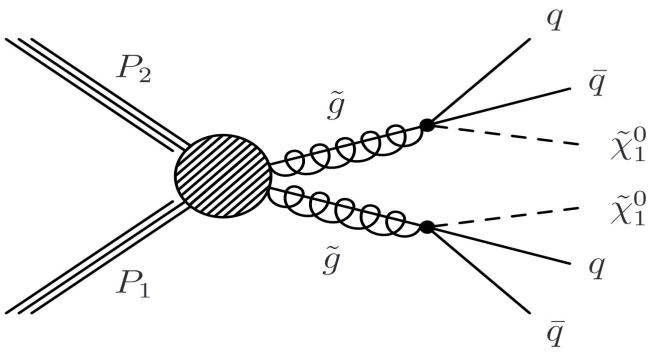
- 2 scenarios: one assumes that the first 2 generations of squark are degenerate and light; the other that only one light-flavour squark is kinematically accessible.

- Squark masses below 875 GeV are excluded for LSP mass below 200 GeV.

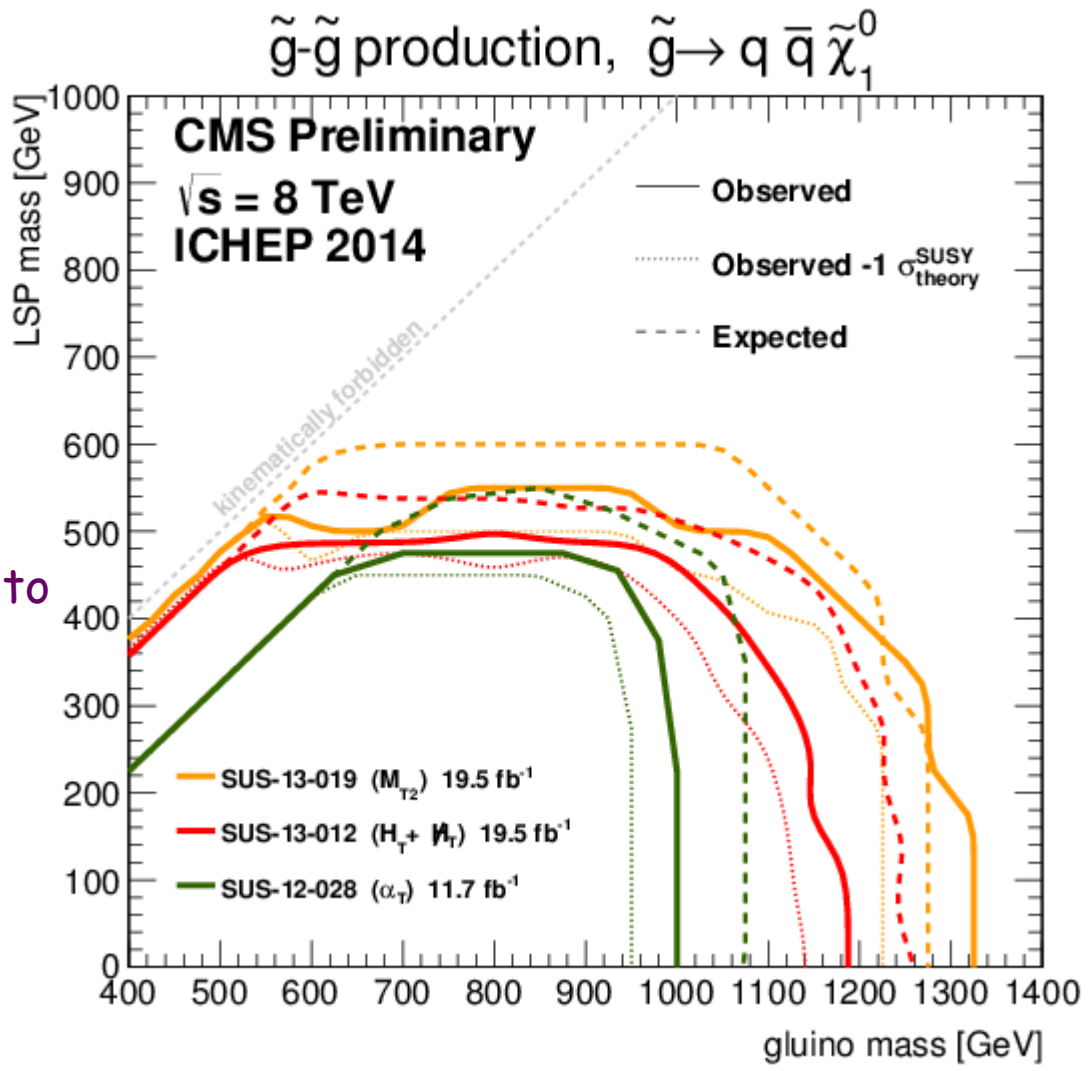


Gluino pair production

- Gluino mediated production.
- T1qqqq simplified model.

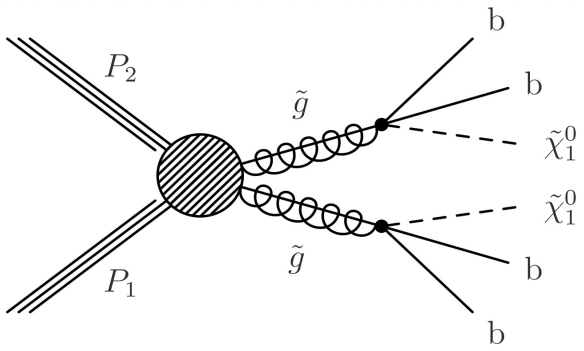


- Gluino masses excluded up to 1225 GeV for m(LSP) = 0 GeV.

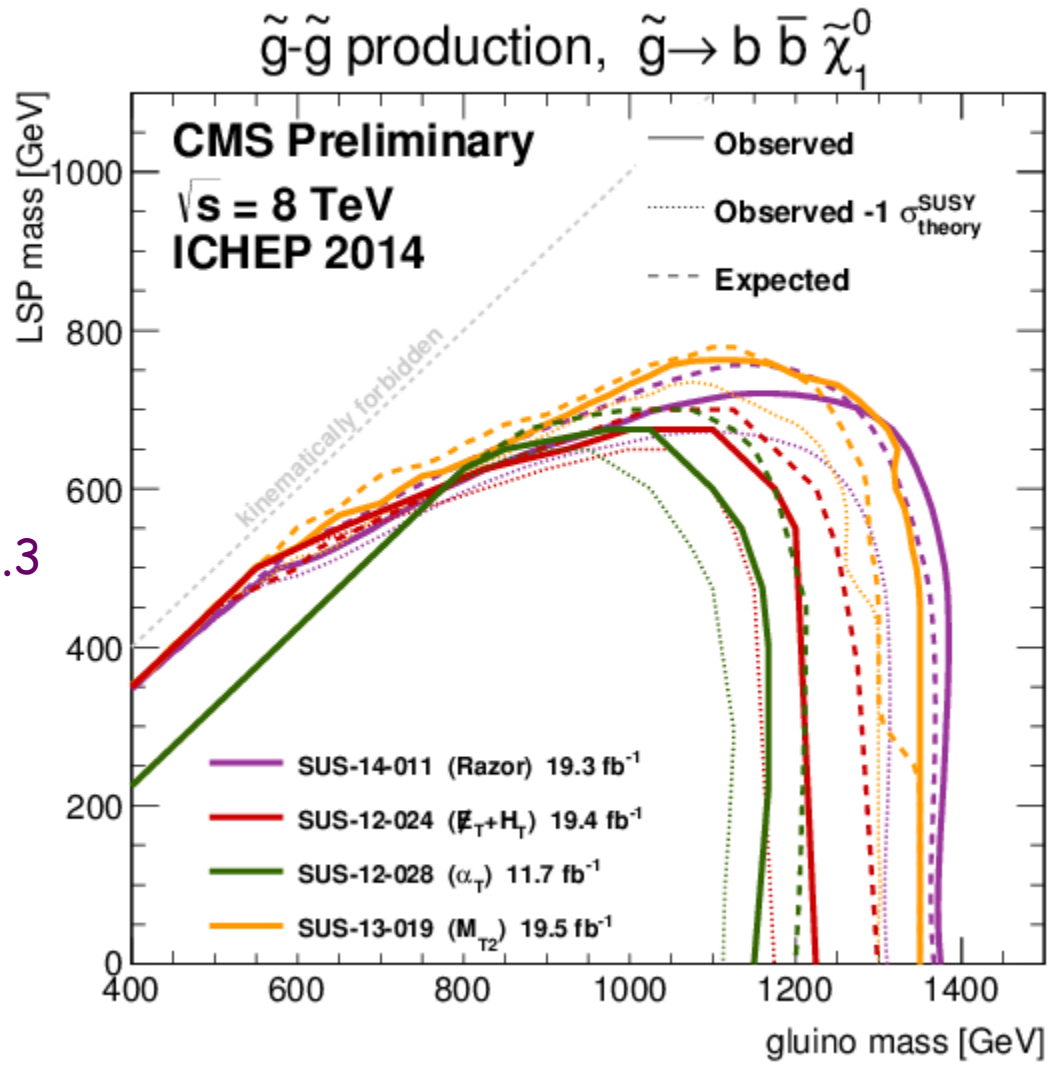


T1bbbb

- Simplified model T1bbbb.

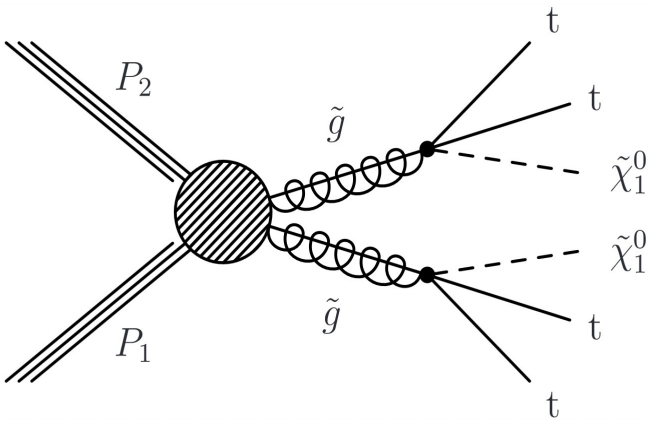


- Gluino masses excluded up to 1.3 TeV for m(LSP) = 0 GeV.

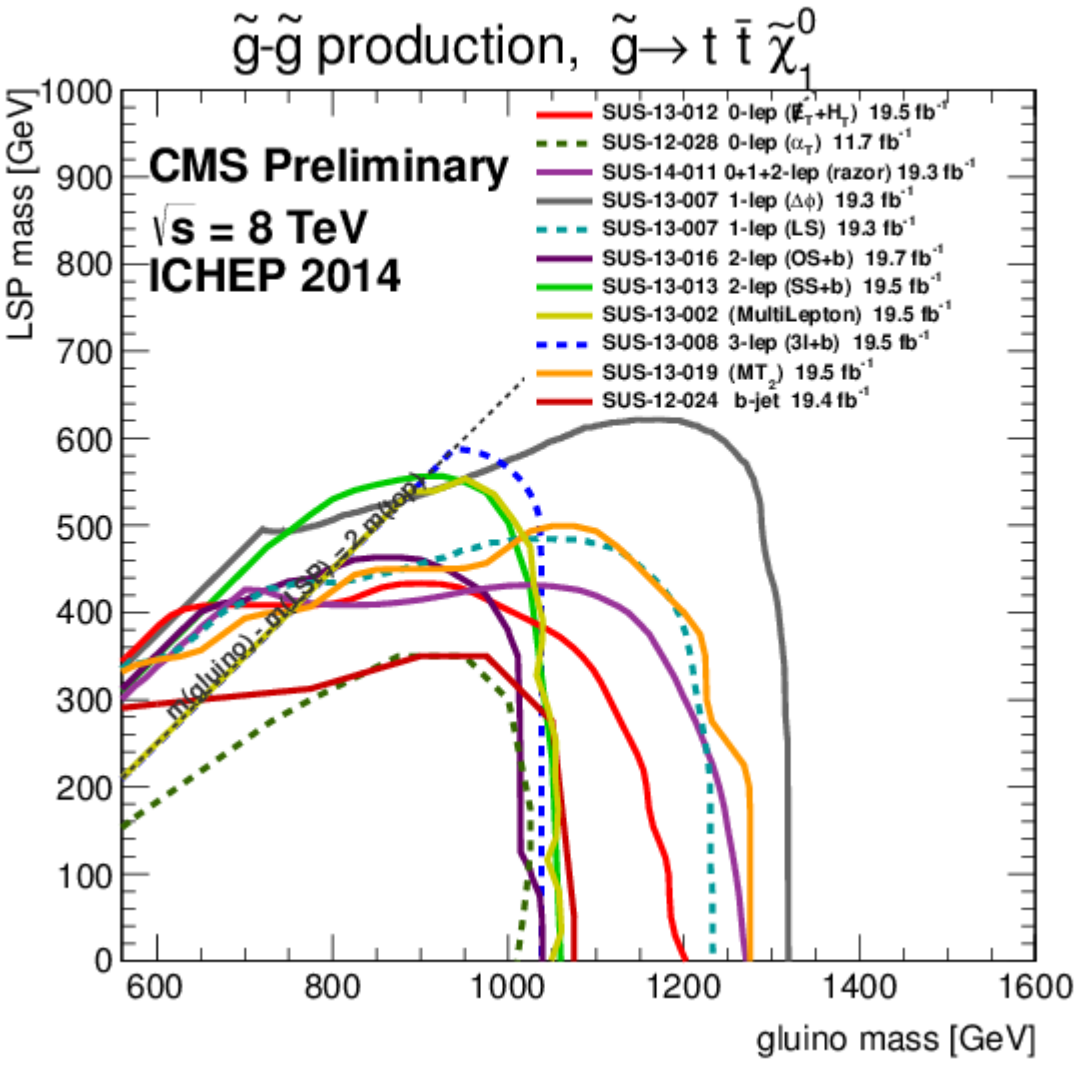


T1tttt

- Simplified model T1tttt.



- Inclusive analyses give also competitive results for T1tttt and other specific susy signal.
- cf 3rd generation talk by Javier Duarte.



Conclusion

- CMS has developed a nice set of inclusive SUSY searches.
- Inclusive SUSY analyses are an effective way to cover a large range of theory parameter space.
- No significant excesses observed in 8 TeV data.
- Stay tuned for 13 TeV results !

BACK UP

SLIDES