CMS SUSY Searches at 13 TeV

LHC Seminar
9TH February 2016

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On behalf of the CMS Collaboration

ETH Institute for Particle Physics

ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

The Standard Model: not quite everything

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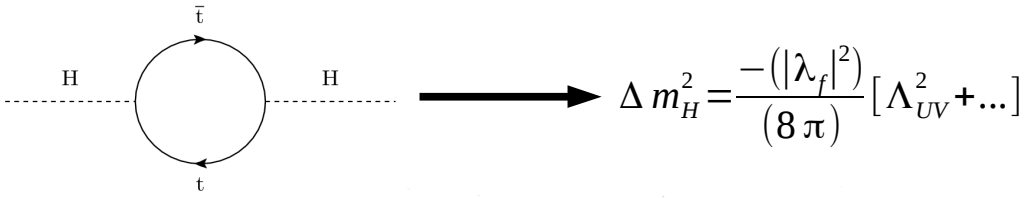
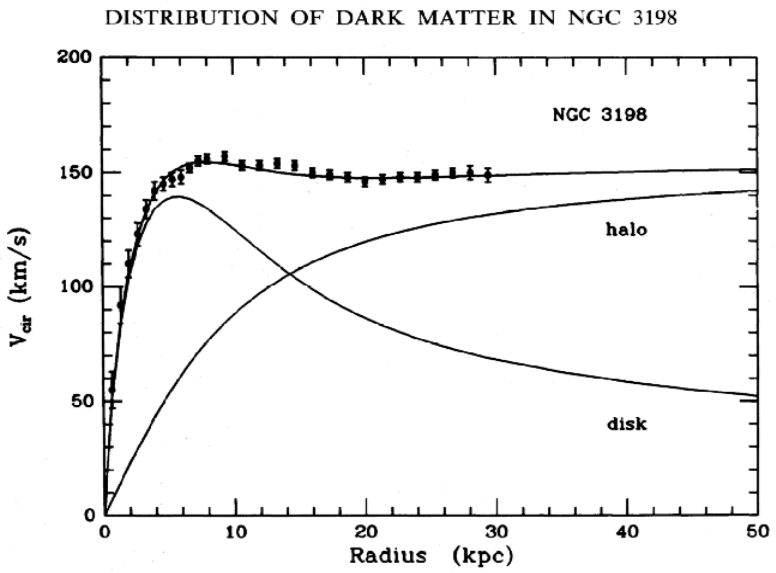
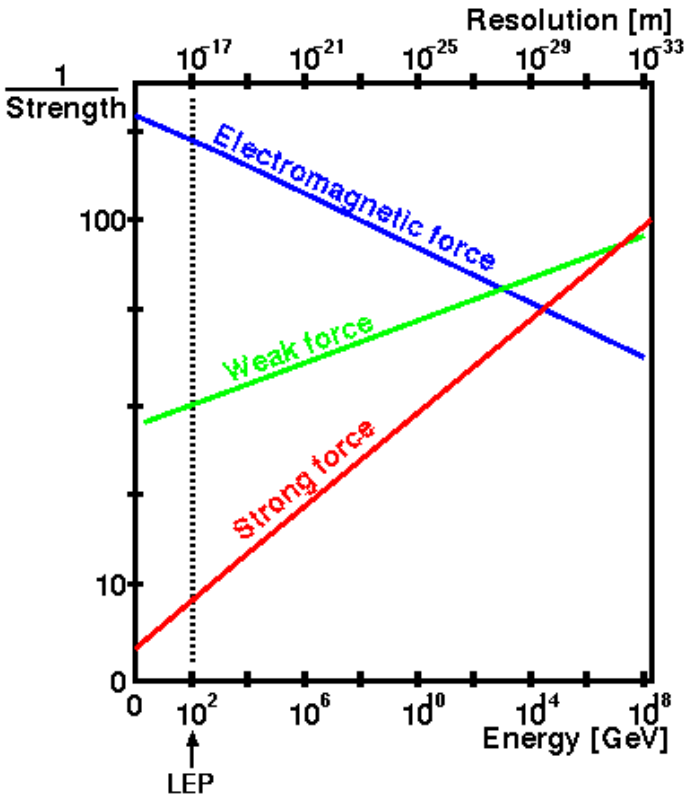
- The Standard Model of Particles even if extremely successful cannot explain everything
  - **The hierarchy problem** → stability of the Higgs mass under quantum corrections
  - **The problem of dark matter** → gravitational effects observed but not a "candidate"
  - **Impossibility to achieve Grand Unification** → not converging couplings at Λ_{GUT}



$$\Delta m_H^2 = \frac{-(|\lambda_f|^2)}{(8\pi)}[\Lambda_{UV}^2 + \ldots]$$





Supersymmetry: elegant and gorgeous*

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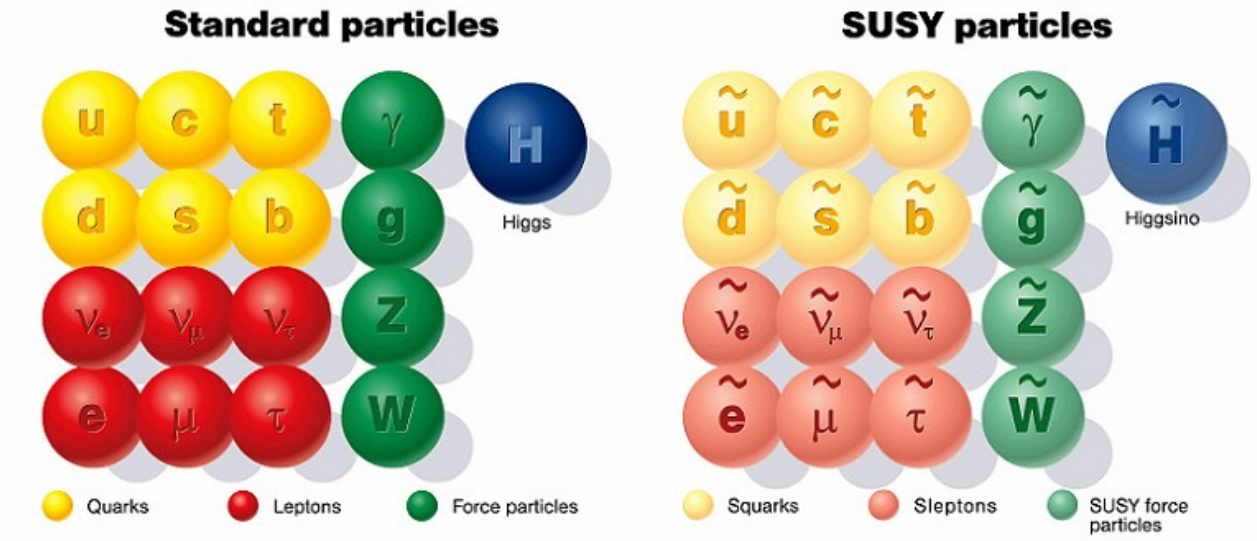
- Supersymmetry imposes a new fundamental symmetry between fermions and bosons
- The new super-partners can solve the aforementioned problems
  - **Δm_H compensated by boson loops** → if gluino, stop, higgsino masses are at the ~ TeV scale
  - **Provides dark matter candidates** → linear combinations of electroweak and Higgs SUSY partners
  - **Leads to unification** → running couplings coincident at Λ_{GUT}



* Quoting Marcela Carena (ICHEP14, Plenary Talk)

Supersymmetry: is anybody there?

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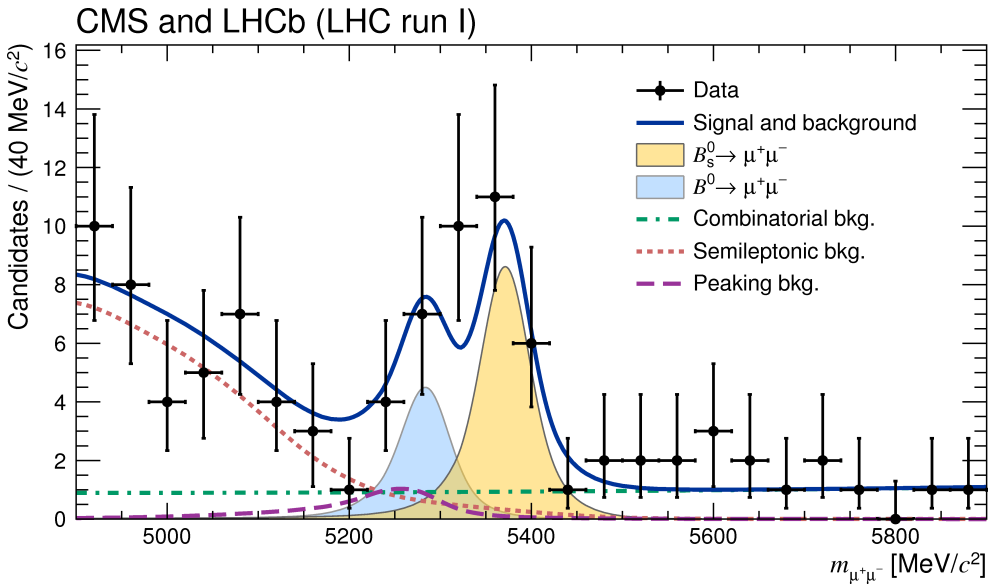
- No evidence of SUSY particles nor SM deviation have been found at the LHC
- Rare decays with high sensitivity to new particles through quantum corrections measured
  - $B_S \rightarrow \mu\mu$ in good agreement with the Standard Model prediction → ???
- After Run I we know there is a new 125 GeV scalar particle exists: the Higgs boson
  - This is important since since it requires $\Delta m_H \sim 34$ GeV $\quad m^2_{\text{Higgs}} \approx m^2_Z \left[1 + \frac{3m_t^2}{2\pi^2 m_Z^2} \log(m_{\text{stop}}/m_{\text{top}})\right]$
  - This implies stops to have maximal mixing or to be very heavy → some tension with naturalness



Still in a valid range

Supersymmetry: Hiding from us?

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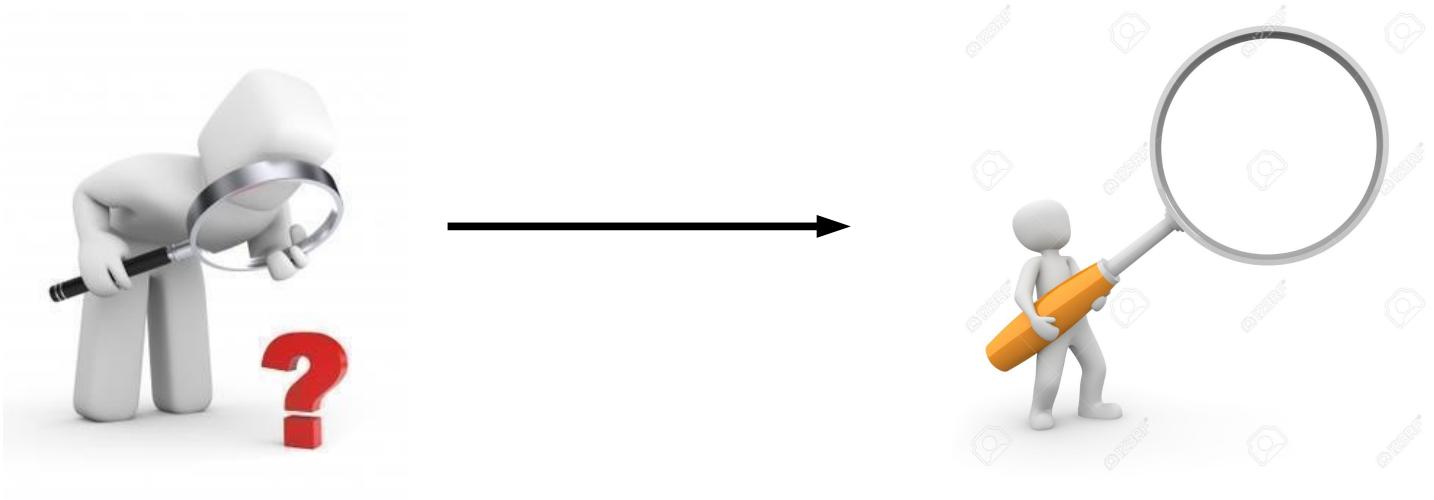
- Very ambitious SUSY search programs have been carried out at the LHC during Run 1
- However SUSY might be hard to find … it might be hiding
  - SUSY particles too heavy for 8 TeV? Cross sections very small at LHC, hardly produced?
  - Very compressed spectra leading to very difficult experimental signatures
  - Stealth SUSY: so long decays that spectrum of produced particles is very soft
  - R-Parity Violation: again complicated signatures with no momentum imbalance
- The 13 TeV data will provide insight on these searches → **we're back with a better tool**



SUSY experimental signatures

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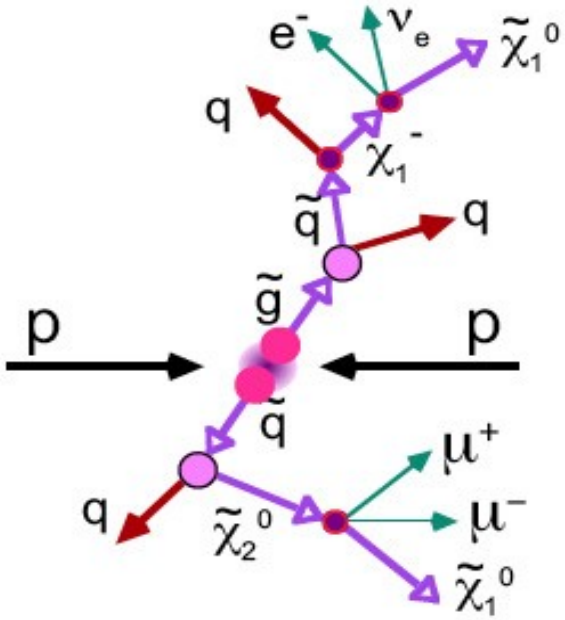
- At the LHC we are looking for pair production of SUSY particles in the hard interaction
- SUSY particles assumed to be heavy → long decay chains expected including SM particles
  - As a result typical SUSY signatures contain usually many jets in the event
- Also if **R-parity** is conserved the lightest neutralino (LSP) is stable and escapes detection
  - Leaving a large amount of **Missing Transverse Energy** in the event



A "typical" SUSY event

High Jet multiplicity

High MET → $|-\Sigma \overrightarrow{pT}(\text{particle})|$

High HT → $\Sigma\, |\overrightarrow{pT}(\text{jets})|$

High MHT → $|\Sigma \overrightarrow{pT}(\text{jets})|$

SUSY Interpretations: Simplified Models

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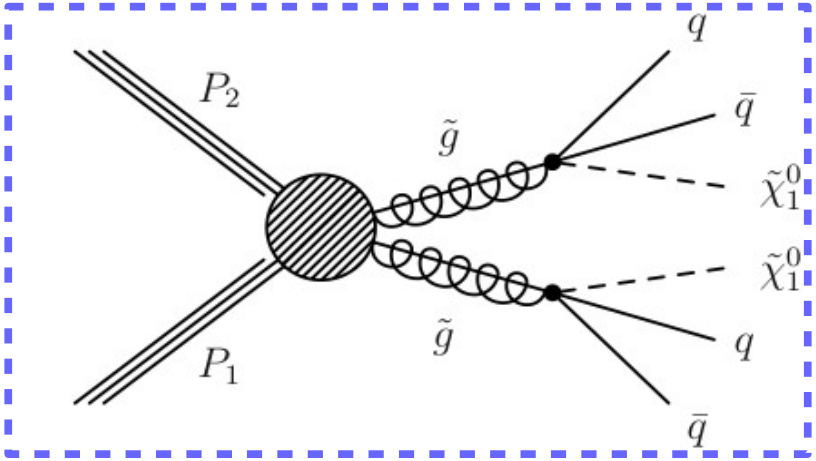
- Most of SUSY interpretations are performed using Simplified Models of Supersymmetry*
  - This approach puts more emphasis on the experimental signature leaving aside the model details
- Hard interaction producing two SUSY particles (fully decoupled from other particles)
- A single decay chain is implemented producing a given and fixed topology
- However the masses of the SUSY particles are scanned usually in 2 dimensions
- Upper limits are set on the **cross-section x branching ratio** of the given process



* Interpretations in full models are also provided: mSUGRA, pMSSM, etc

SUSY searches at the LHC: Run 1

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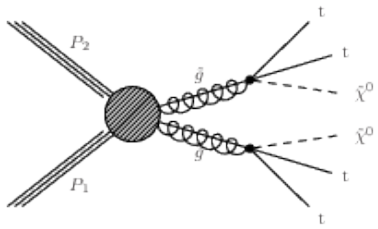
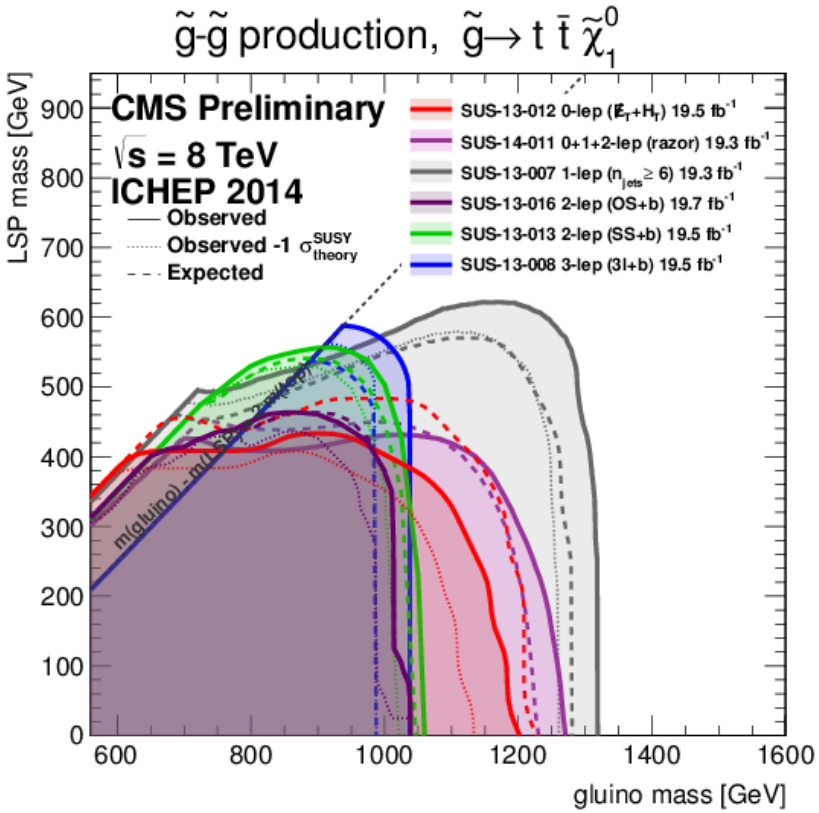
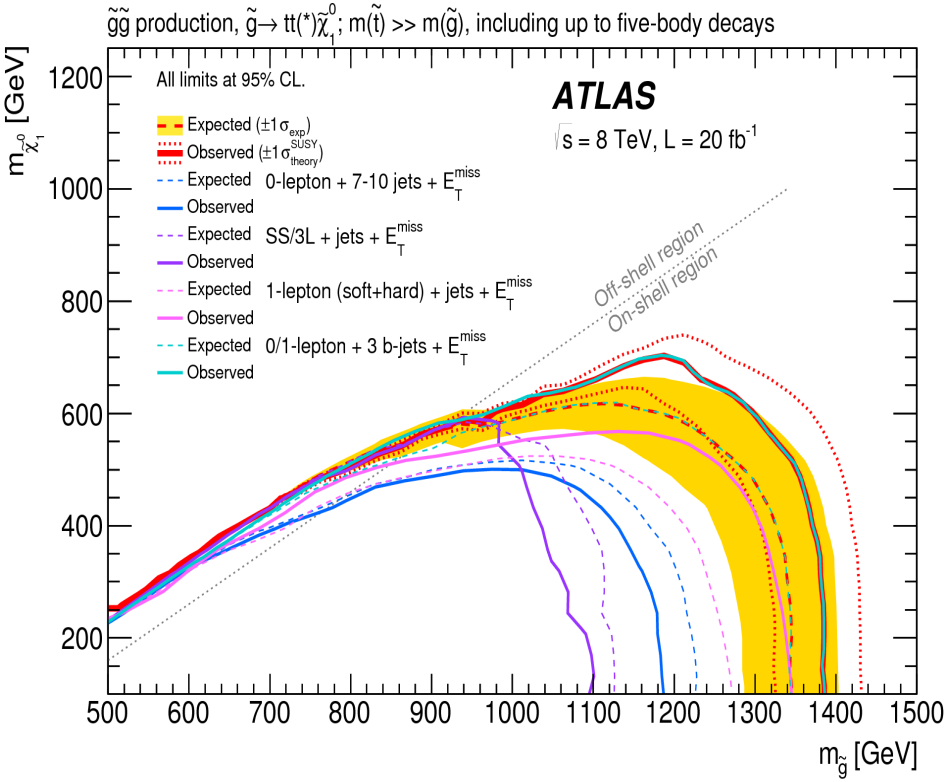
- A huge amount of searches seeking all kind of different topologies
- **Gluino mass** has been probed up to ~ 1300 GeV in different topologies







SUSY searches at the LHC: Run 1

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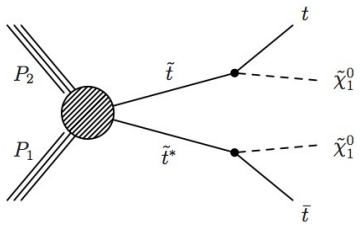
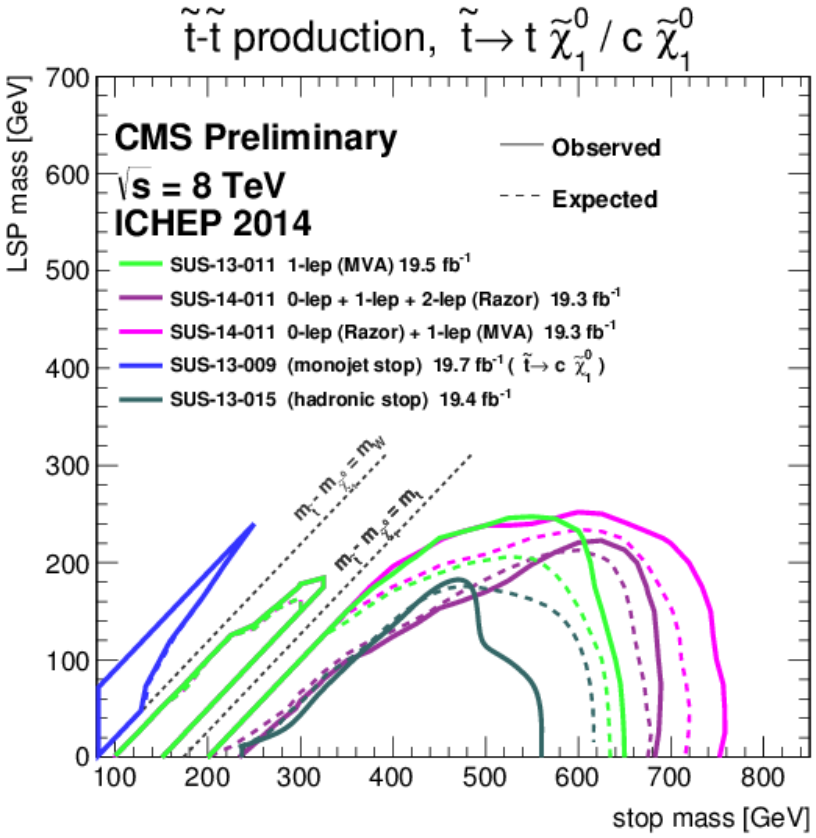
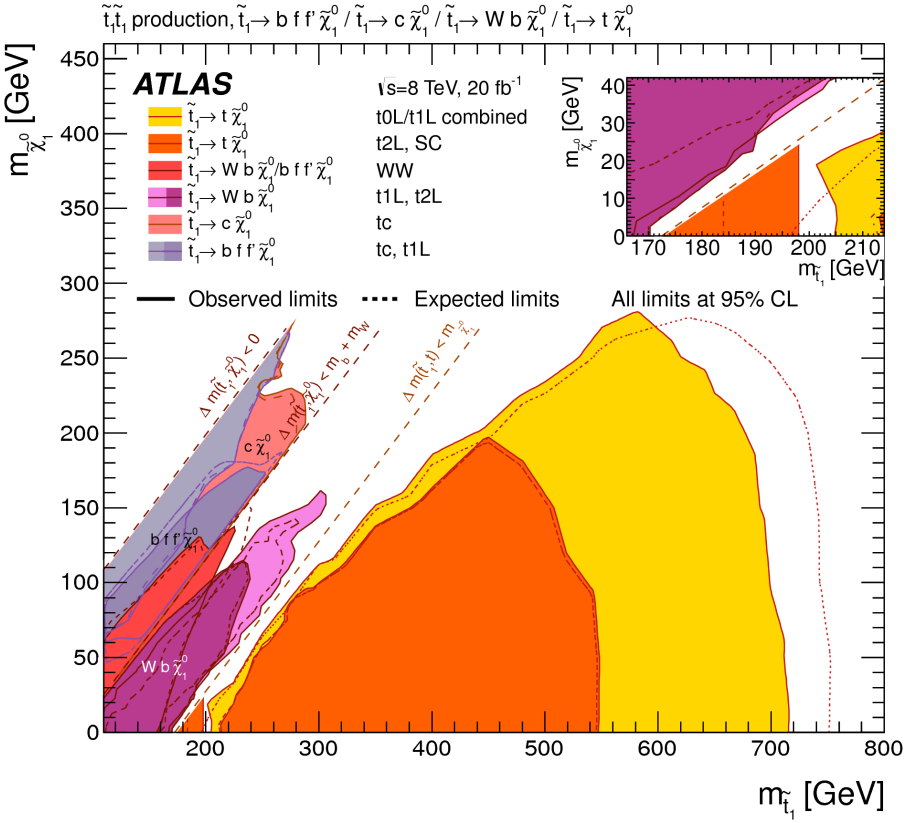


- **stop masses** have been also probed up to ~ **750 GeV**





- But also upper limits on light squarks, s-bottoms, neutralinos/charginos, s-leptons, RPV SUSY

CMS, a wonderful detector

The CMS detector at the LHC

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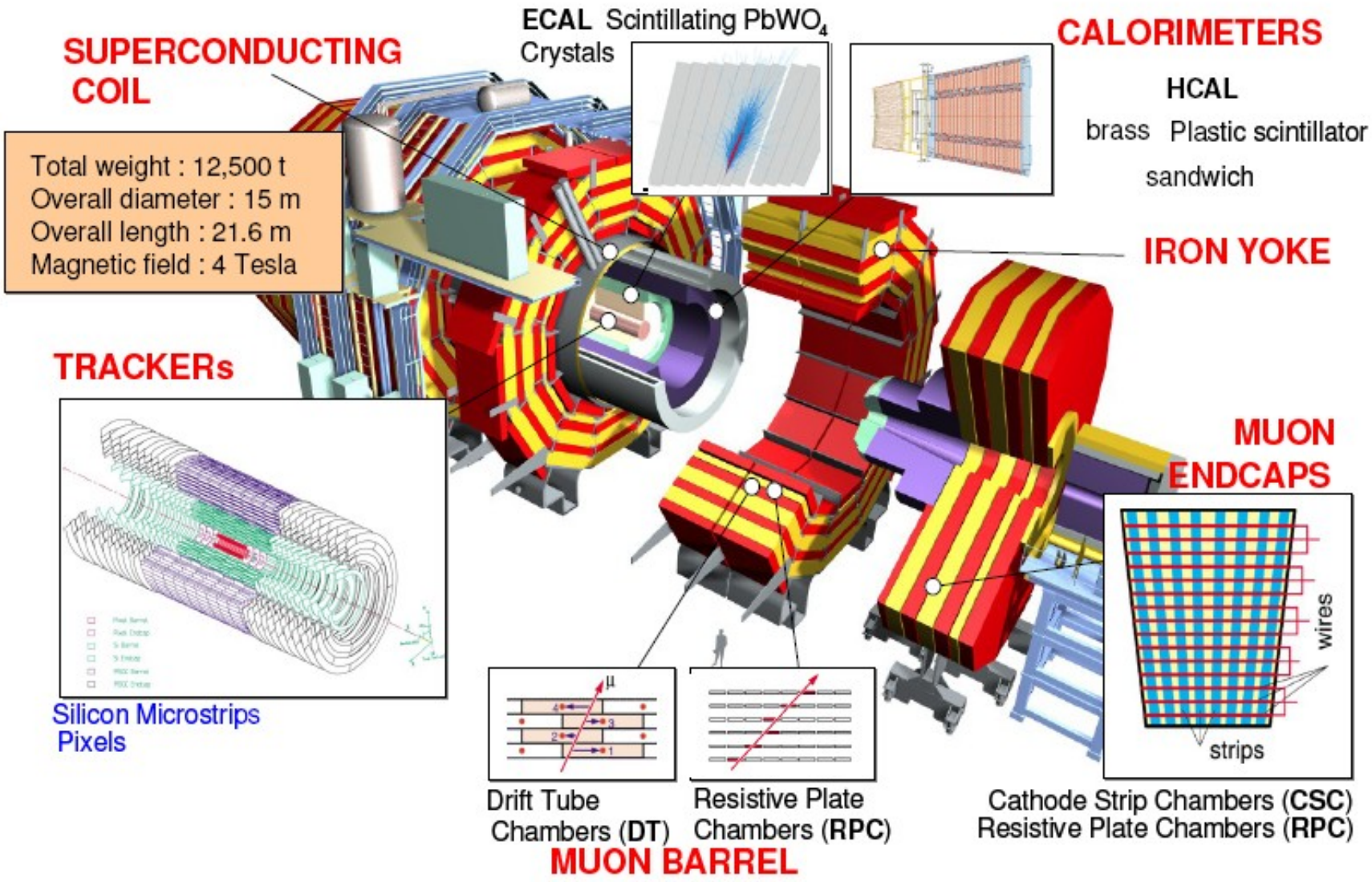

The CMS detector at the LHC

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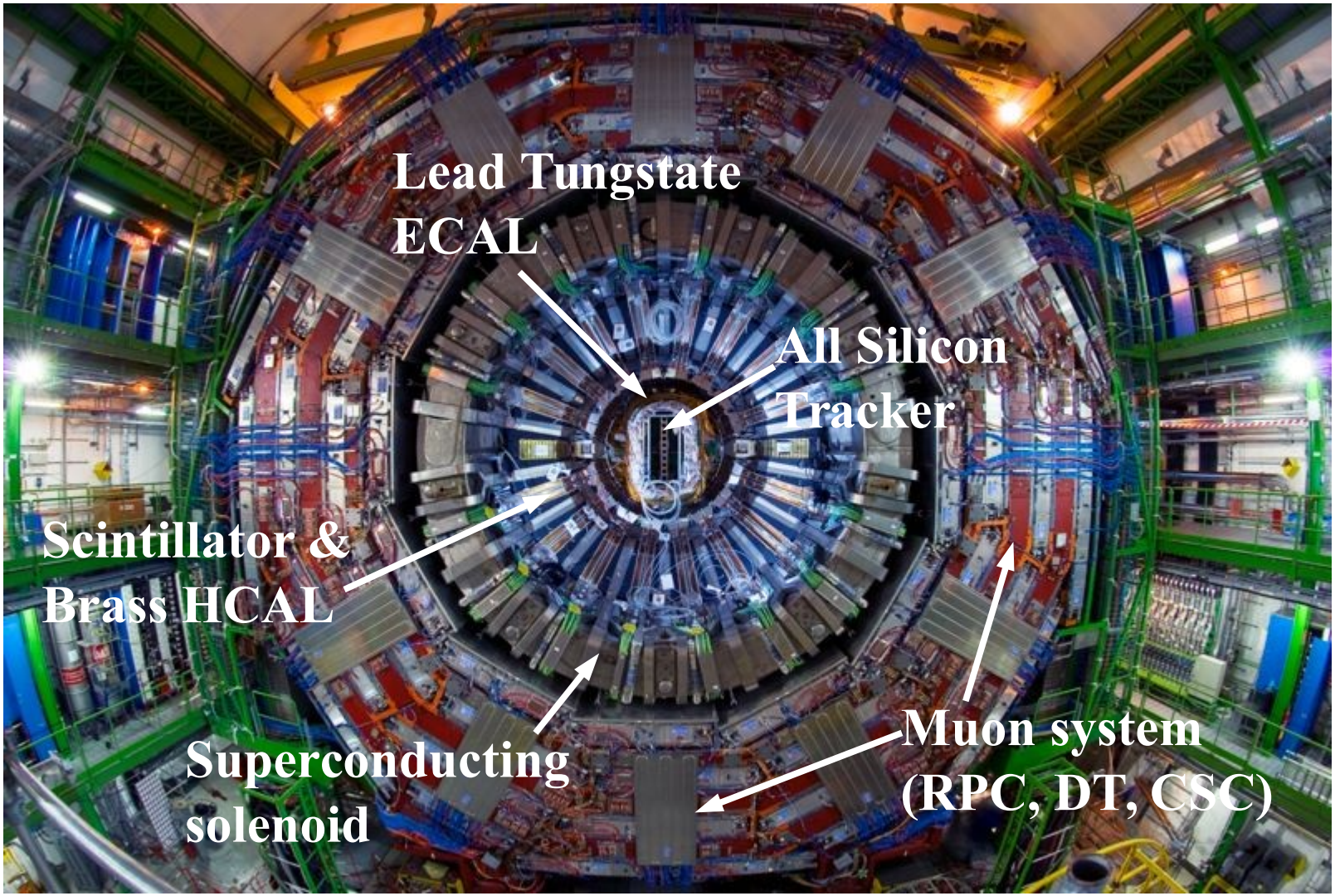

LHC/CMS performance in 2015

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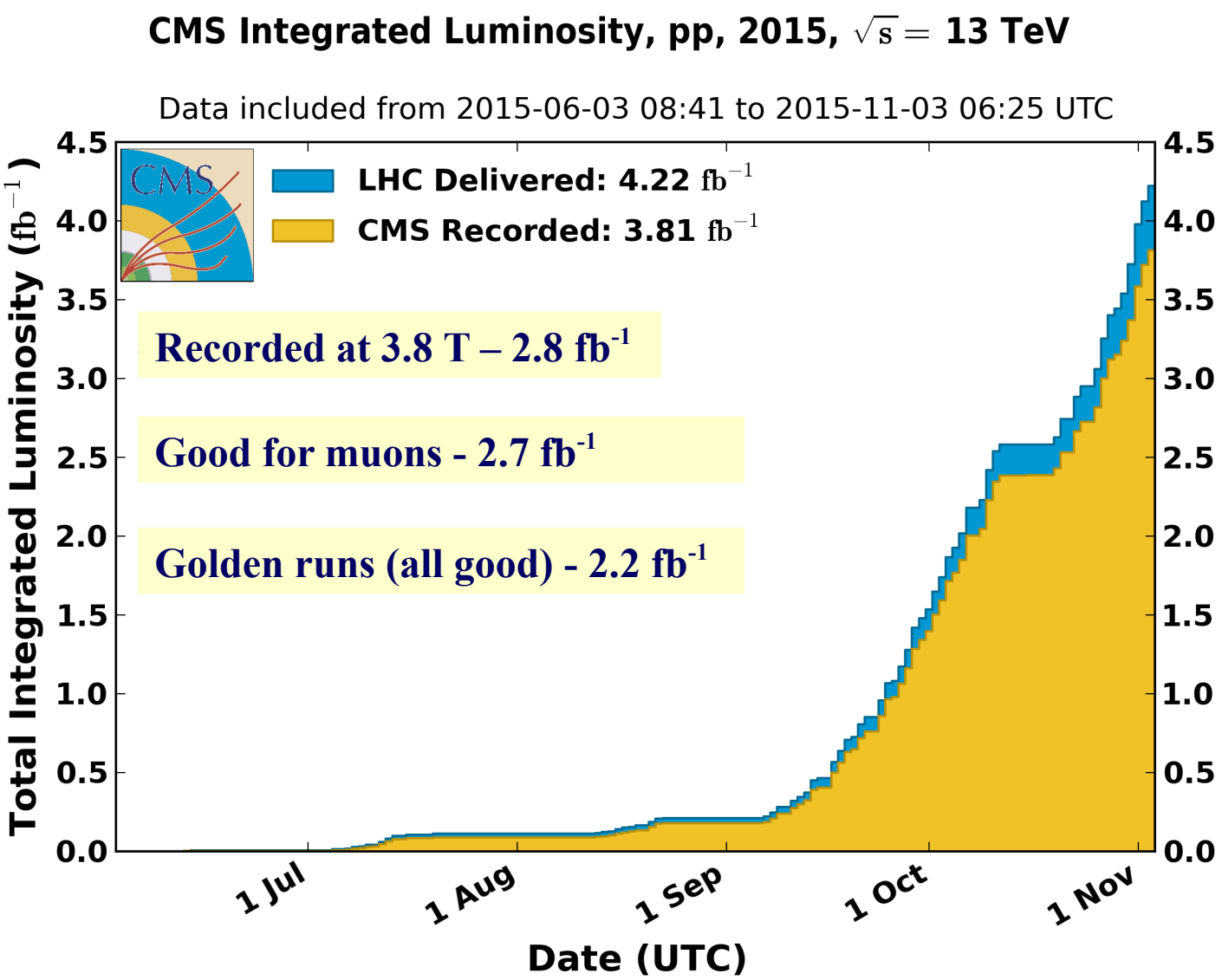

Triggers at 13 TeV

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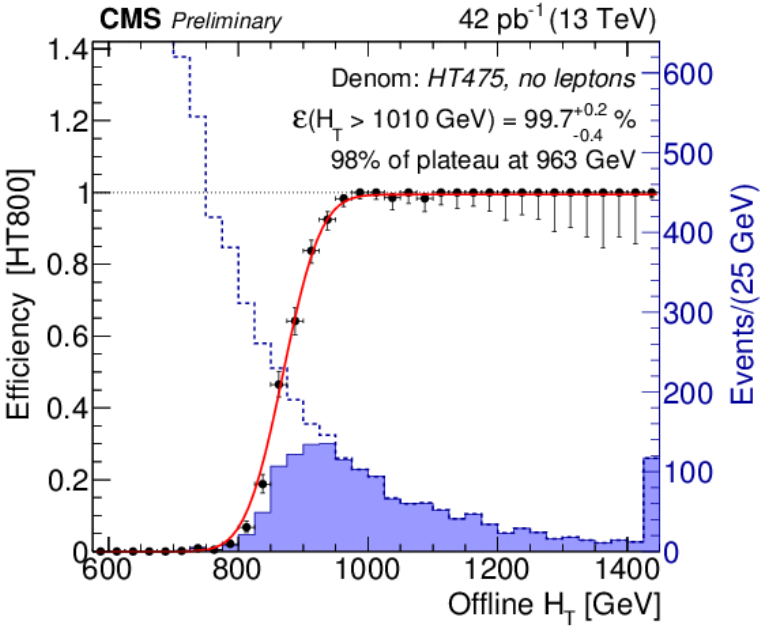
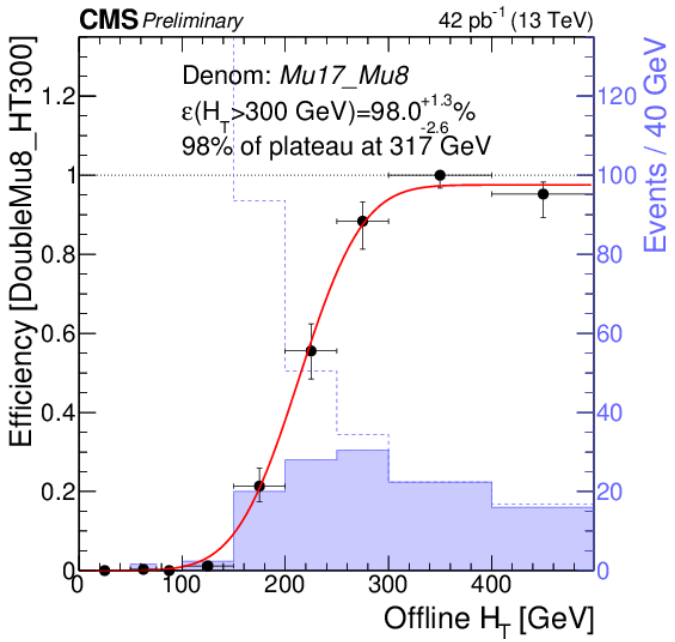
- Upgraded L1 trigger logic including better pile-up rejection and improved algorithms
- HLT reconstruction also improved with a simplified version of the iterative tracking
- Efficiency above **95%** for most trigger paths including MET, jets, single/double lepton
- All these improvements allowed to keep trigger thresholds close to 8 TeV in most cases

HT > 800 trigger



HT > 300 + Double Mu trigger



Physics objects at 13 TeV: jets and sums

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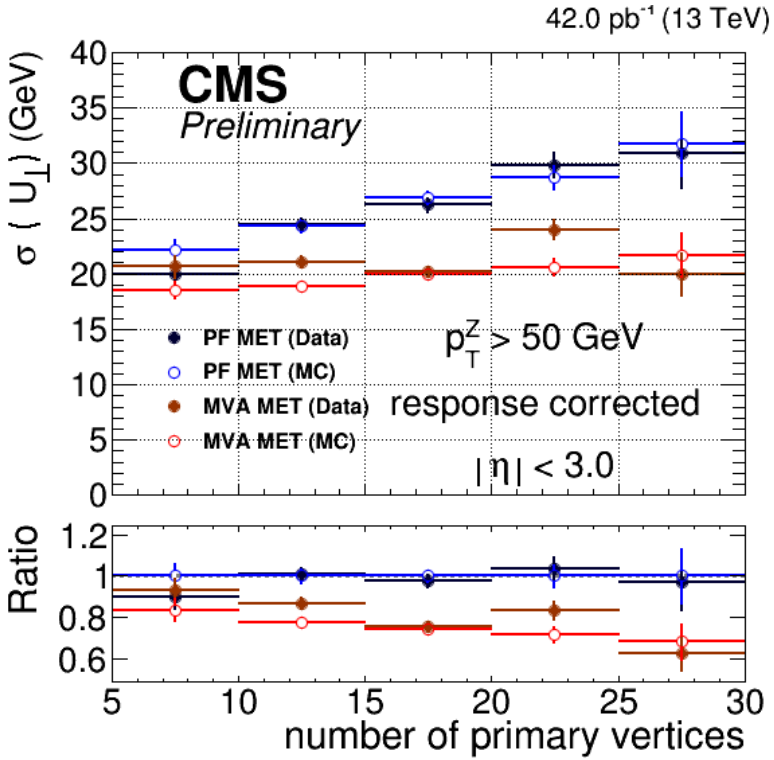
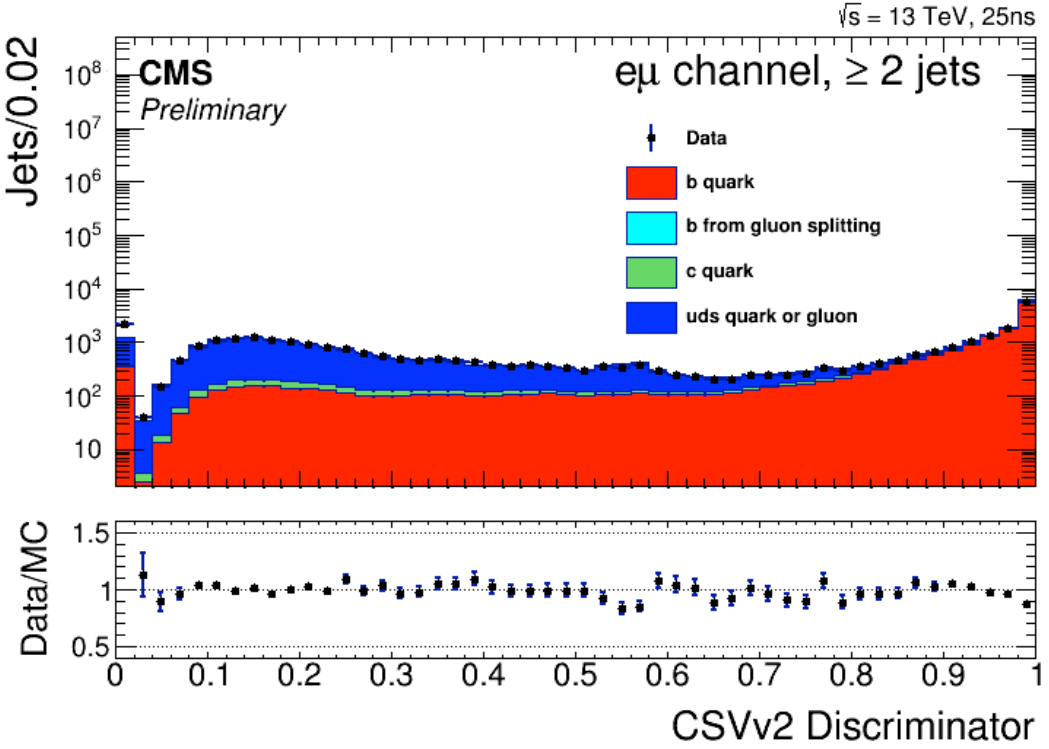
- Very good performance of jet reco and jet sum objects (MET, MHT) both at 50 and 25 ns
- Full chain of Jet Energy Corrections (L1L2L3Residual) extracted from collected data
- Detailed studies on MET resolution and response, dependency with pile-up, etc, etc
- Also new and improved b-tagging discriminators deployed for the 13 TeV data taken





Physics objects at 13 TeV: leptons-photons

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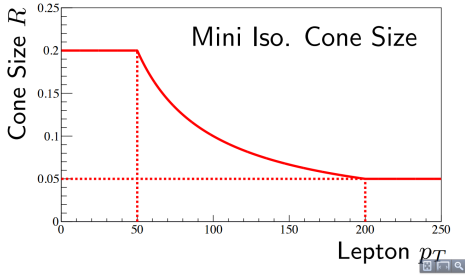
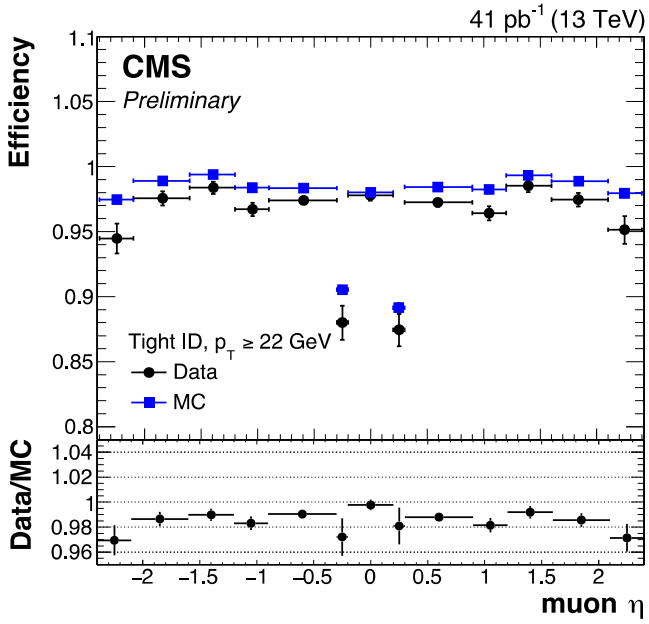
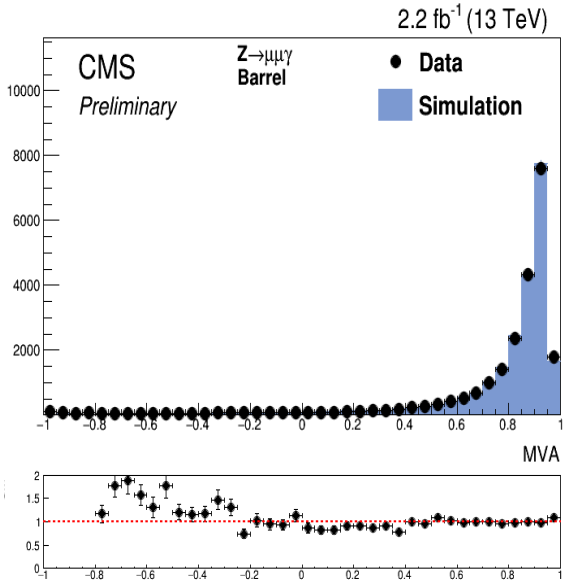
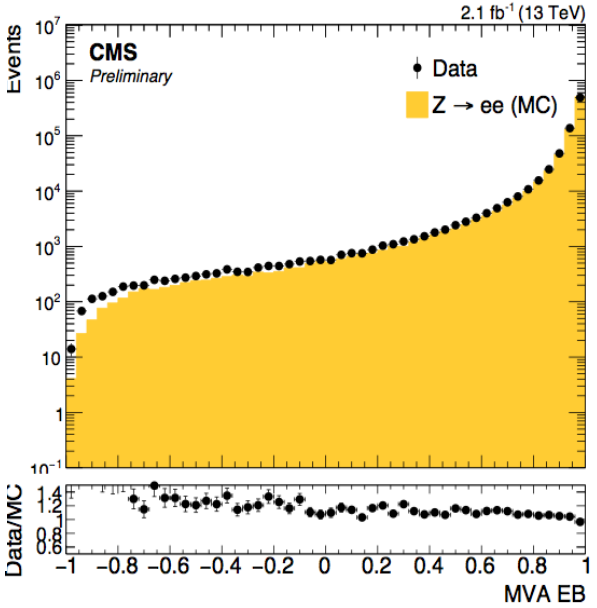
- New and improved identification algorithms for muons, electrons and photons
- Combining cut-based and multivariate discriminators to improve ID efficiency
- Extended use of mini-isolation → isolation cone ΔR dependent on pT of the lepton



Nice performance for very boosted systems







Excellent physics performance

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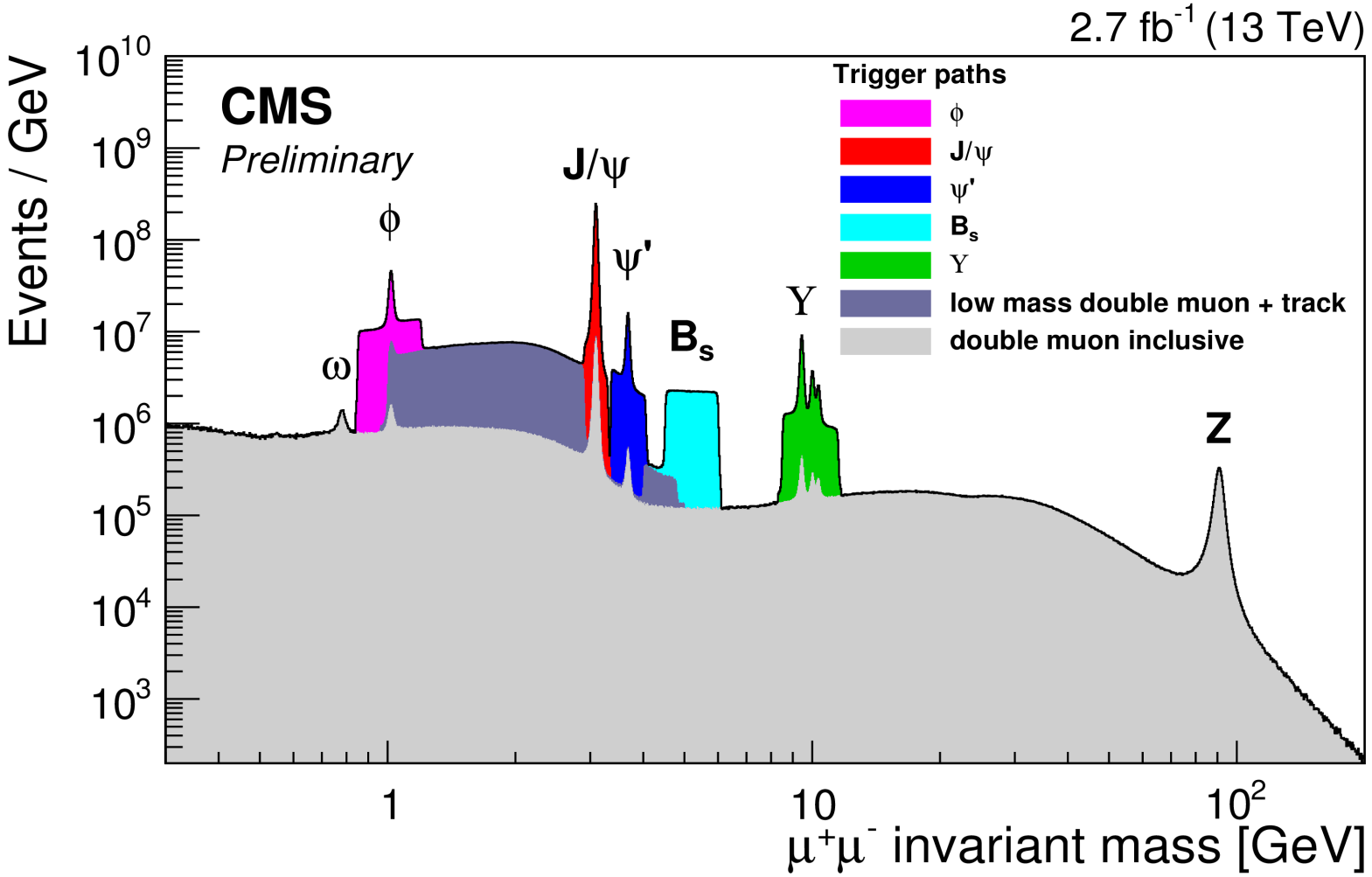
- Di-muon resonances decaying into pairs of muons
- Excellent muon reconstruction and resolution over a wide range of momentum



SUSY searches at 13 TeV

SUSY at 13 TeV in CMS

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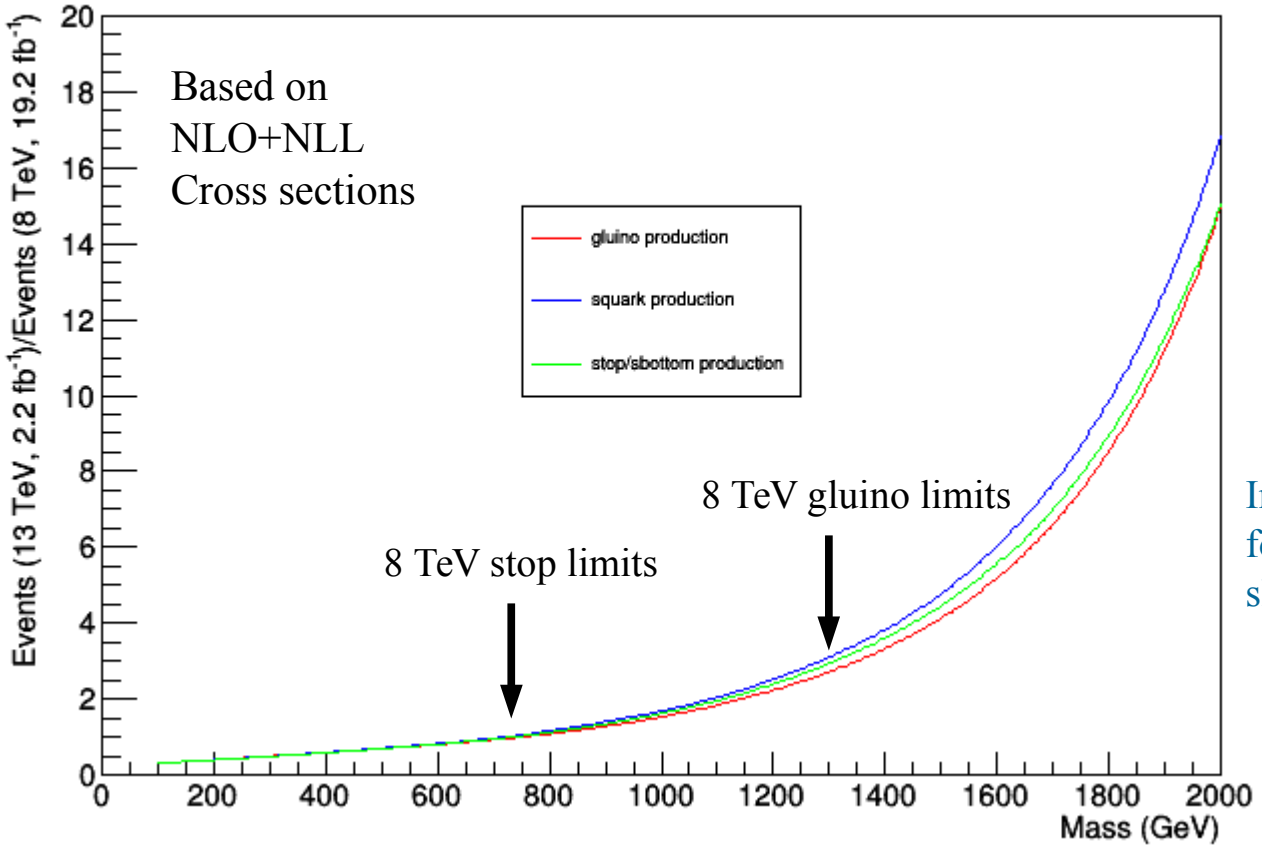
- In the year 2015 a total of 2.2 fb^{-1} were collected by CMS at a center of mass of 13 TeV
- Two competing effects: cross section increase due to CME and luminosity ratio
- What can we expect at 13 TeV compared to the 8 TeV in terms of SUSY production?



Increased sensitivity is expected for gluino-gluino production and slightly for stop-stop production

https://twiki.cern.ch/twiki/bin/view/LHCPhysics/SUSYCrossSections#SUSY_Cross_Sections_using_8_TeV

SUSY searches at 13 TeV: overview

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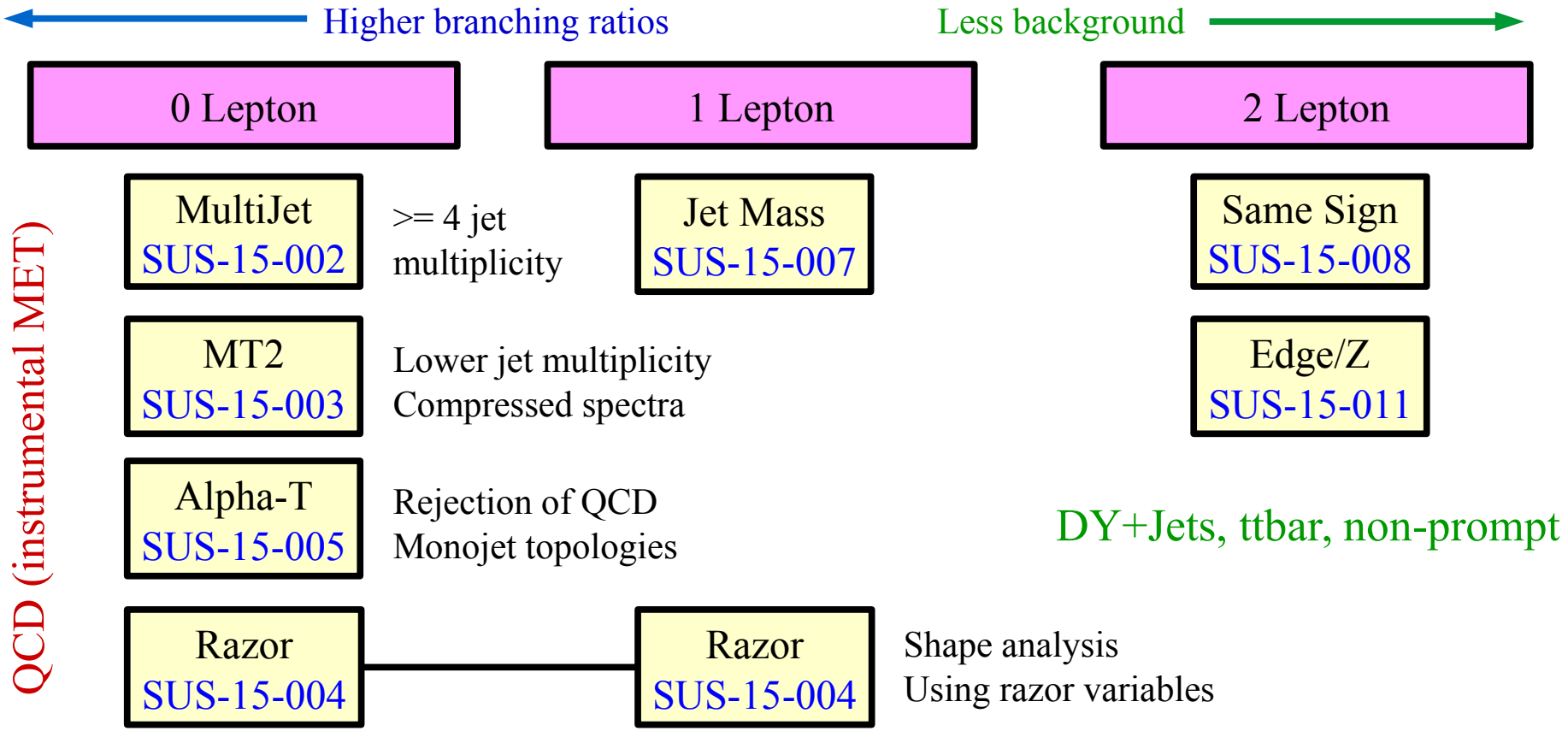
- Full set of analysis covering different final states and using 2.2 fb^{-1} collected at 13 TeV
- Most of them targeting the direct production of gluino pairs decaying into several topologies
- All of them including a large variety of different signal regions to increase sensitivity



All-hadronic searches

Multijet + MET search

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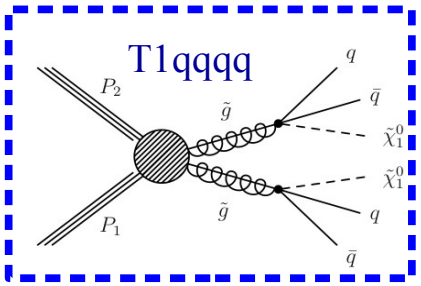
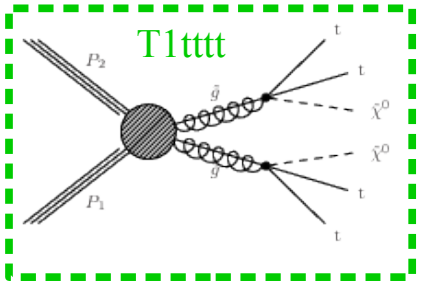
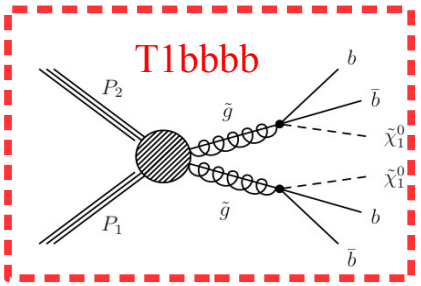
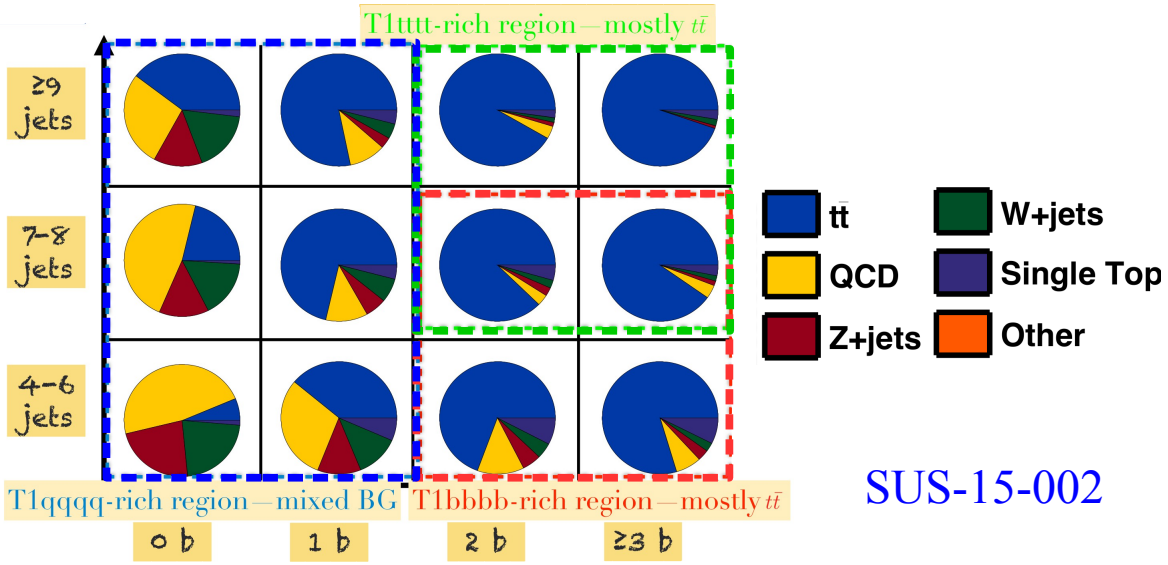
- Inclusive search binned in HT, MHT, #jets and #b-jets targeting gluino production







- Most important backgrounds coming from QCD events with instrumental MET
- Events with real MET like Z(νν)+jets, taus, W+jets and top-pair production (with lost lepton)



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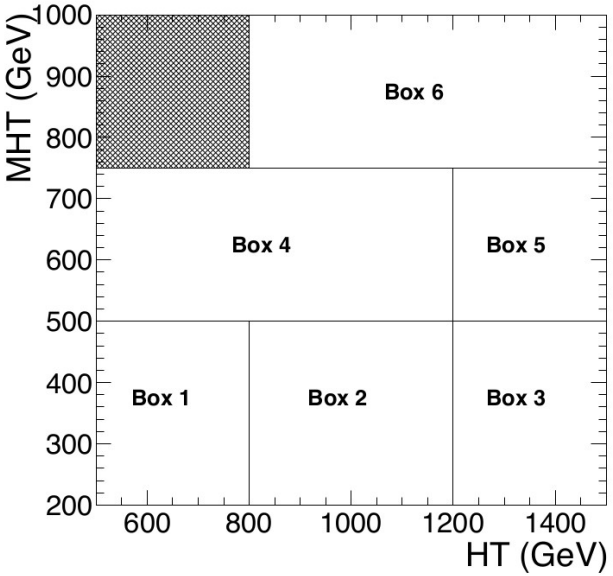

Background prediction

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- QCD estimated from a low $\Delta\varphi_{min}$ control region (min angle between jets and MHT vector)
  - In QCD events with instrumental MET usually MHT is aligned with one of the jets
  - This variable will be used by many other all-hadronic searches as it will be shown later
- Z(νν) + jets → estimated from a γ+jets sample subtracting the photon from the event
  - Correction factors extracted from data and MC to account for differences
- W + jets and top pair production with lost lepton is predicted from the lost lepton probability
  - Which is measured in a 1 lepton control sample and then applied to the signal region

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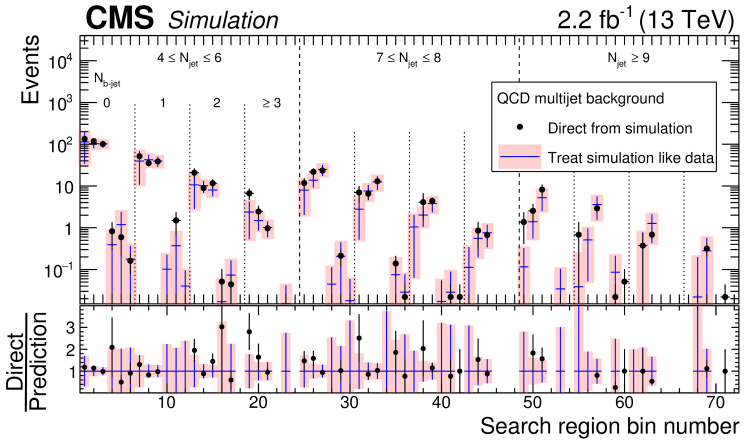
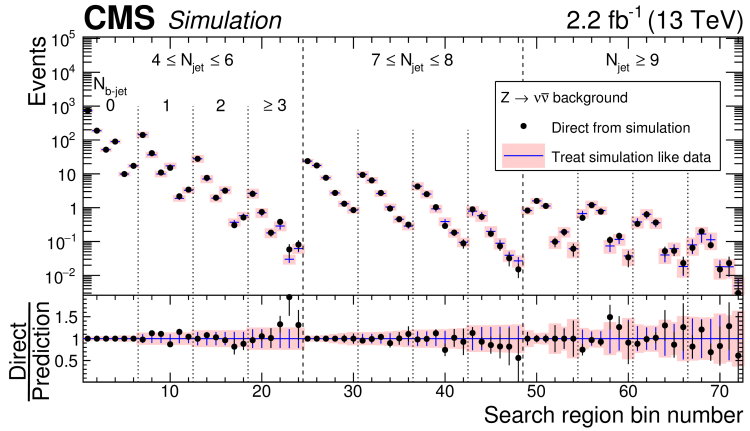
- Hadronic tau leptons are finally estimated from W→ μ + neutrino control region





Multijet + MET search: results

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- Good agreement seen between observation and Standard Model background predictions

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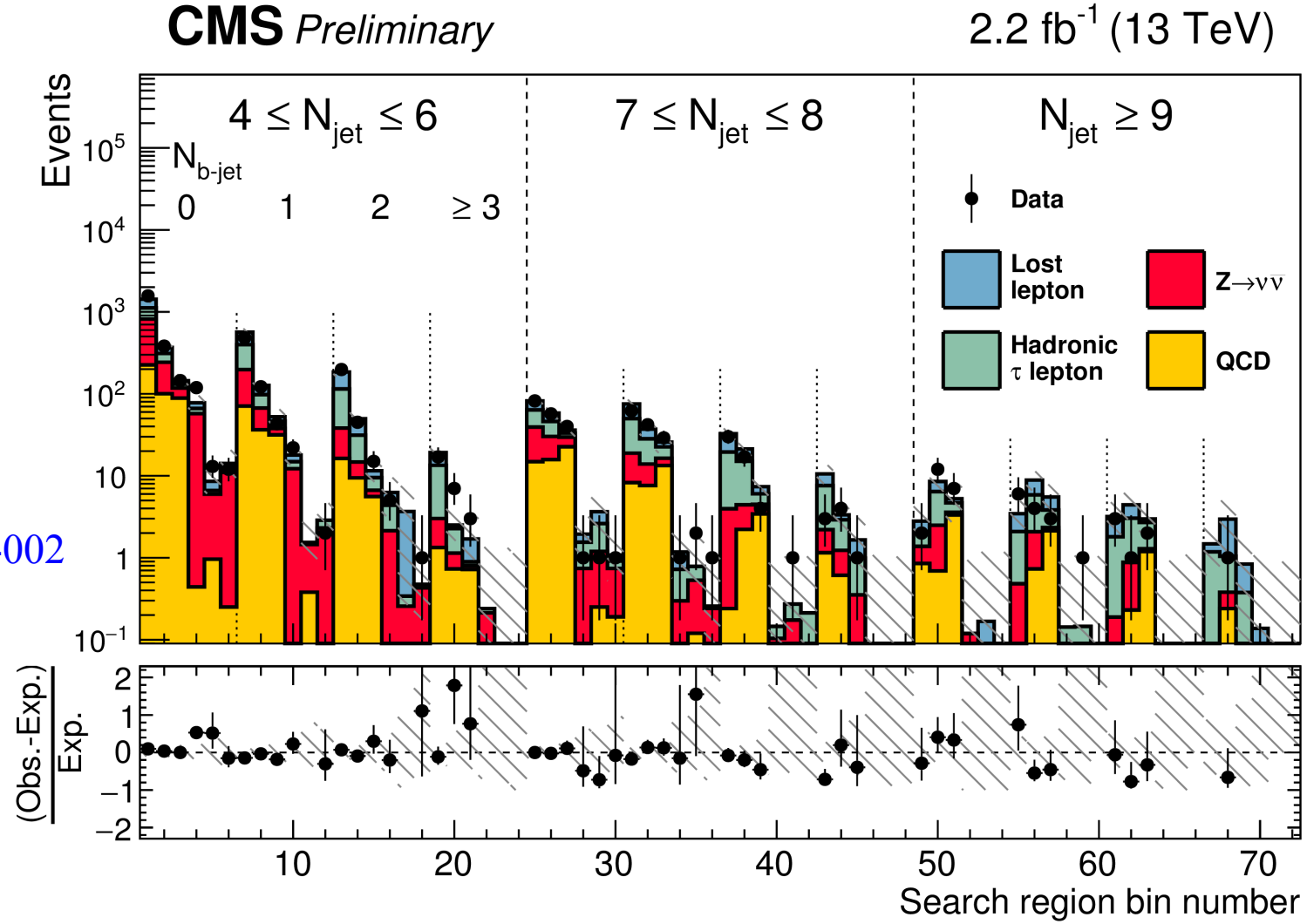

Upper limits on Simplified Models

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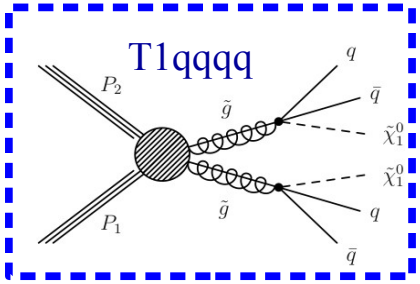
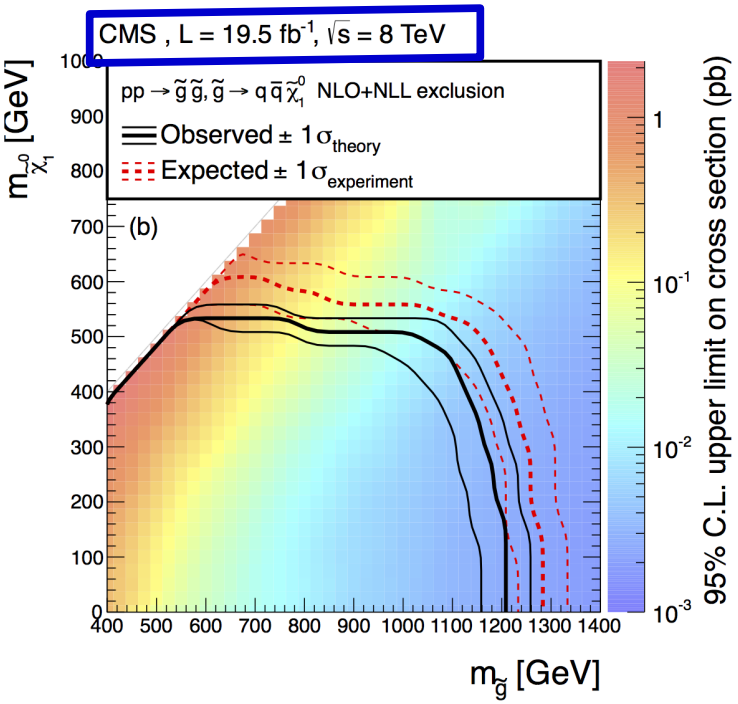
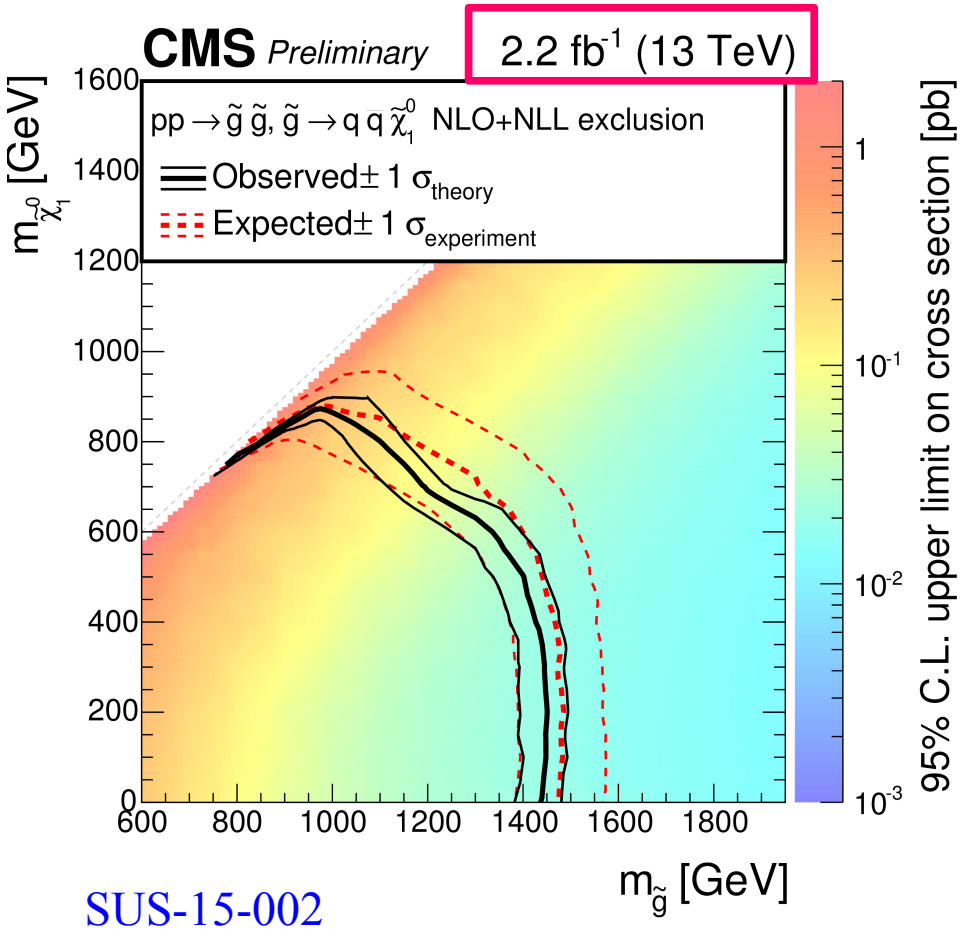
- Upper limits are set on the T1qqqq SMS pushing the limit on the gluino mass about ~ 100 GeV





8 TeV result



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Upper limits on Simplified Models

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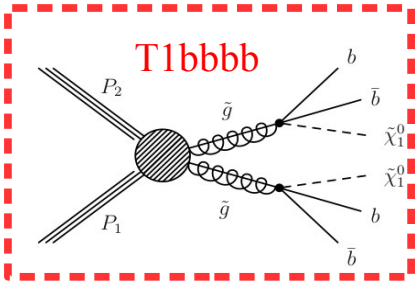
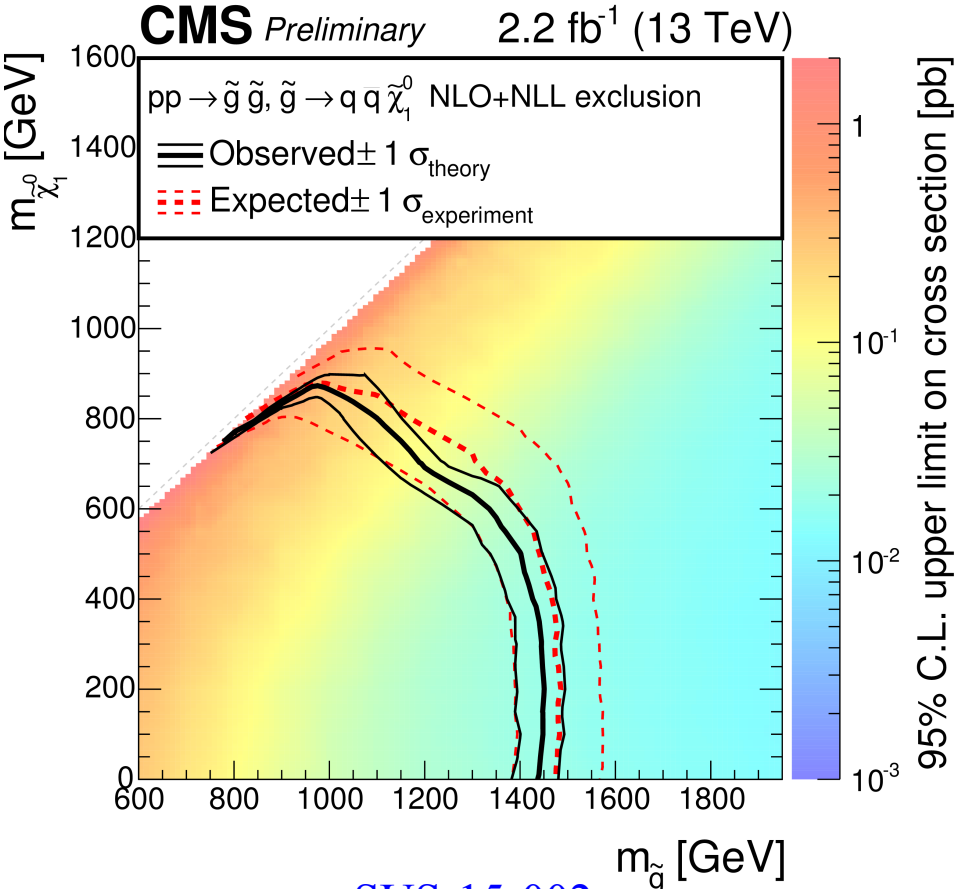
- New Upper limit set on the T1bbbb SMS with this analysis reaching 1400 GeV in gluino mass





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Upper limits on Simplified Models

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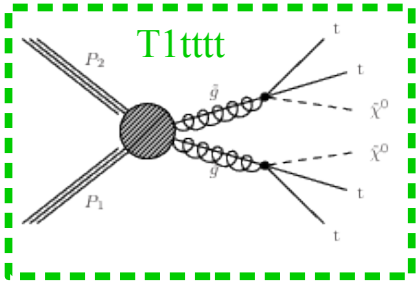
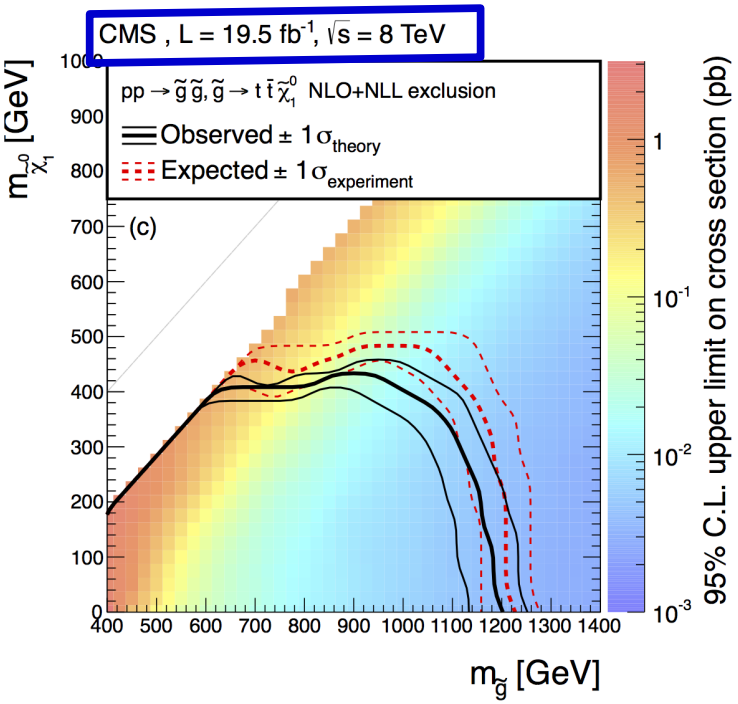
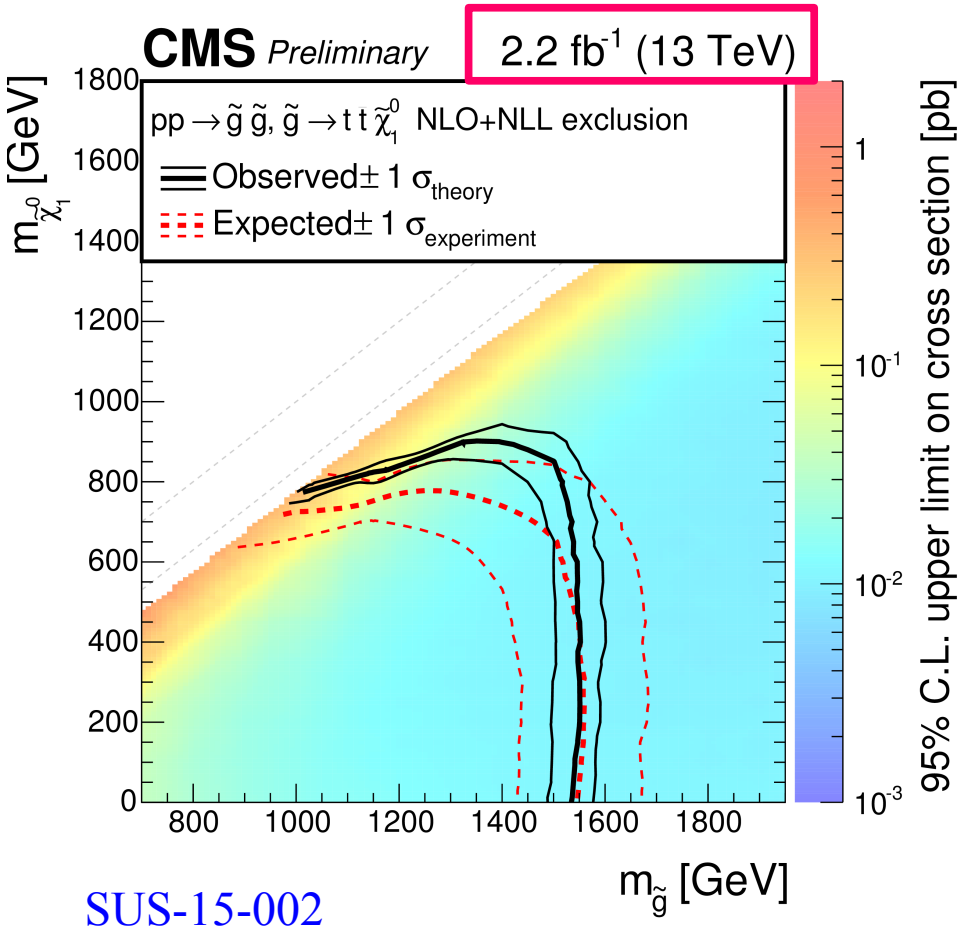
- Upper limits are set on the T1tttt SMS pushing the limit on the gluino mass about ~ 300 GeV





8 TeV result



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All-hadronic analysis MT2

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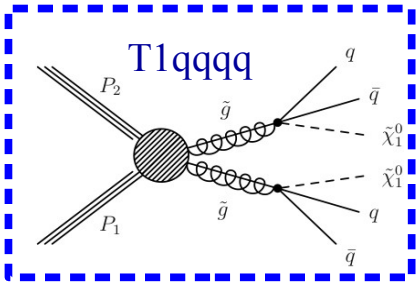
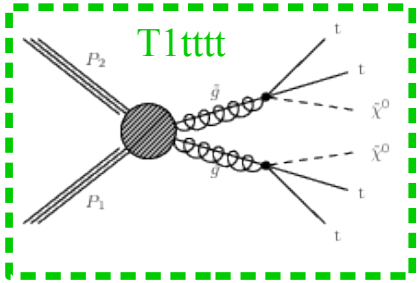
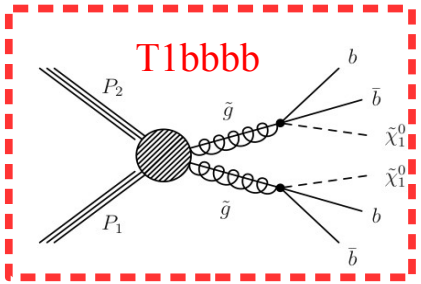
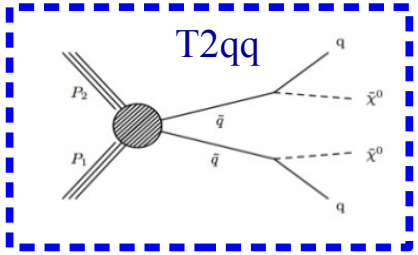
- Inclusive search using the MT2 variable and targeting mainly gluino production

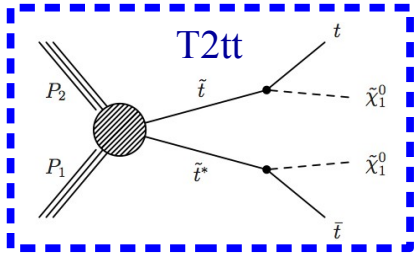






- Leptons and photons are vetoed and signal regions are asked to contain more than 1 jet
  - Signal regions are requested to have $\Delta\Phi_{min}$>0.3 and then binned in HT, # of jets and b-jets and MT2
- A new category is also included with only 1 jet and very low HT (HT > 200)
  - This new category targets to improve the sensitivity of the analysis to models like T2qq or T2tt
  - Particularly in those regions with very compressed spectra



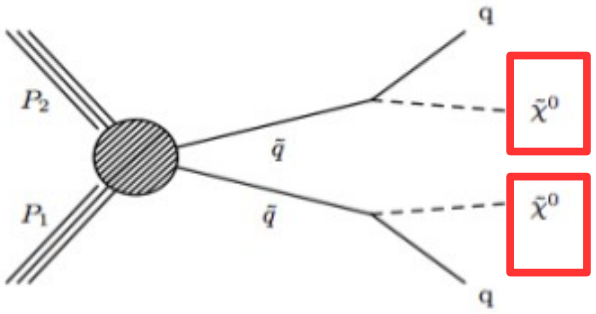


SUS-15-003

MT2 and $\Delta\Phi_{min}$

ETH Institute for Particle Physics

- MT2 is a generalization of the transverse mass for a system with 2 invisible particles
  - This variable has a cut-off at the mass of the produced particles
  - In practice jets are merged into 2 "pseudo-jets" to apply the definition
  - SM processes and more in particular multijet QCD events have very low values of MT2



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

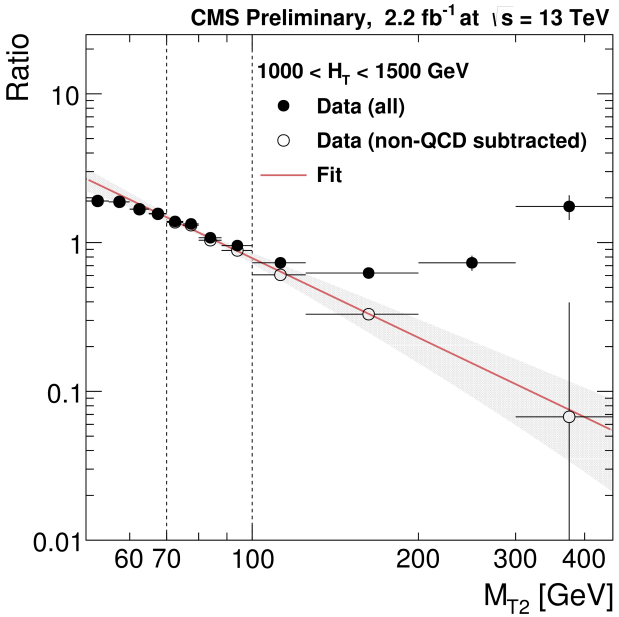
SUS-15-003

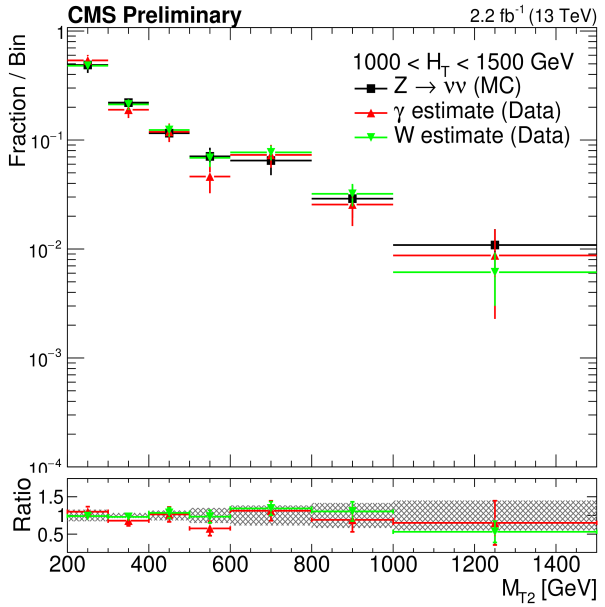
- The analysis also uses $\Delta\Phi_{min}$ which is the minimum angle between a jet and the MET vector
  - QCD events contain instrumental MET originating from jet mismeasurements
  - Events where the MET is pointing in the same direction as a jet are likely to be QCD

Background prediction

ETH Institute for Particle Physics

- The main backgrounds are QCD, Z(νν)+jets, and top-pair production or W+jets with lost lepton
- QCD is estimated by extrapolating the ratio $\#\Delta\Phi_{min}>0.3/\#\Delta\Phi_{min}<0.3$ at low MT2 to high MT2
  - The extrapolated ratio is multiplied to the yields in the QCD enriched region ($\Delta\Phi_{min}<0.3$) at high MT2





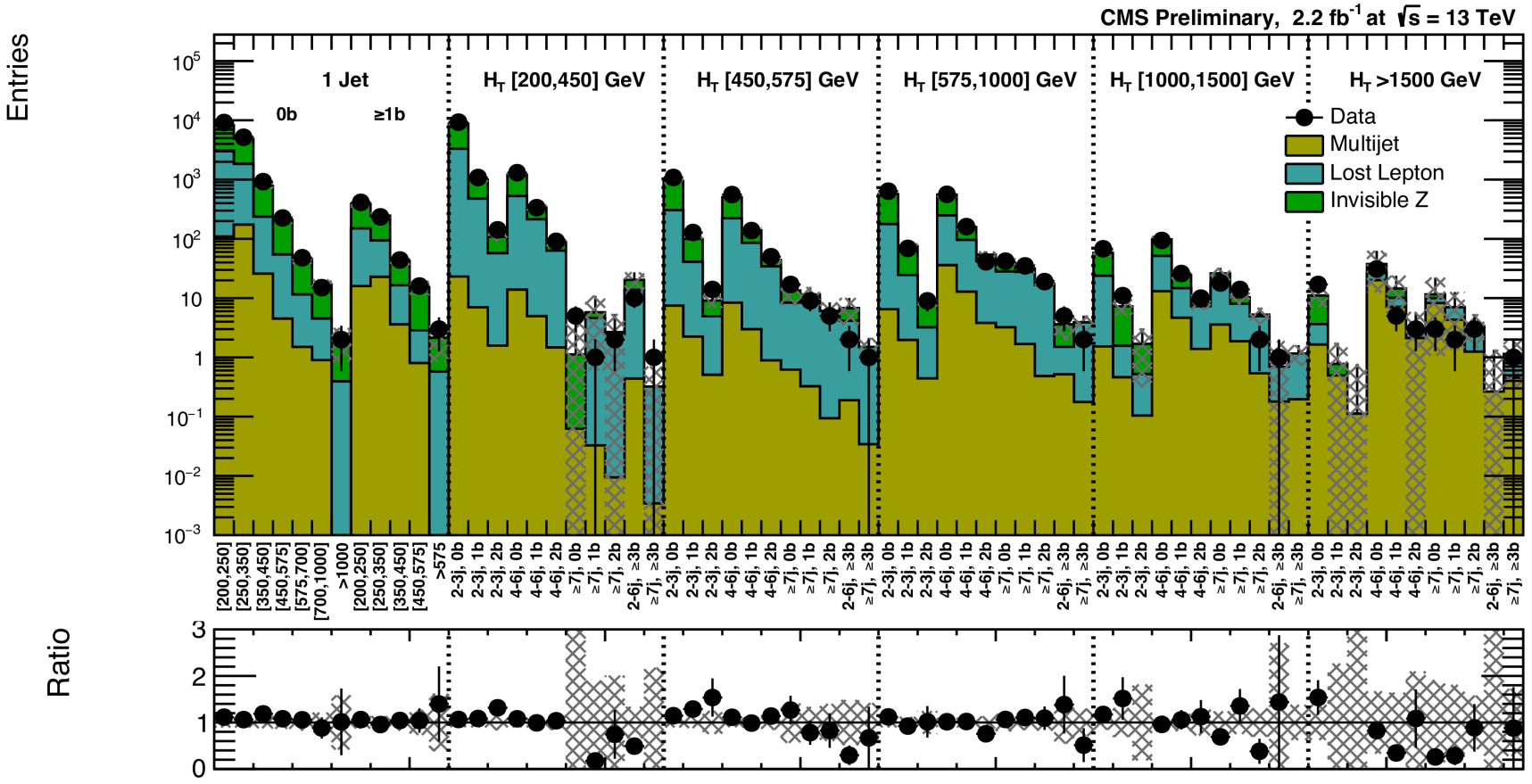
SUS-15-003

- The Z(νν) + Jets contribution is estimated from a γ+Jets control region and MC transfer factors
- Ttbar and W+jets also estimated from a control region with 1 lepton and MC transfer factors

All-hadronic analysis MT2: Results

ETH Institute for Particle Physics

- Observations in the different signal regions are found to be compatible with SM predictions

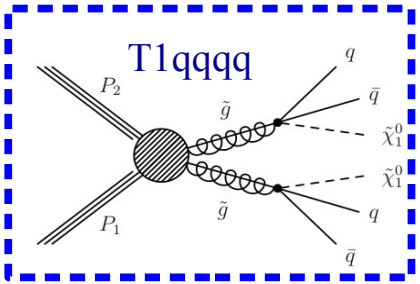


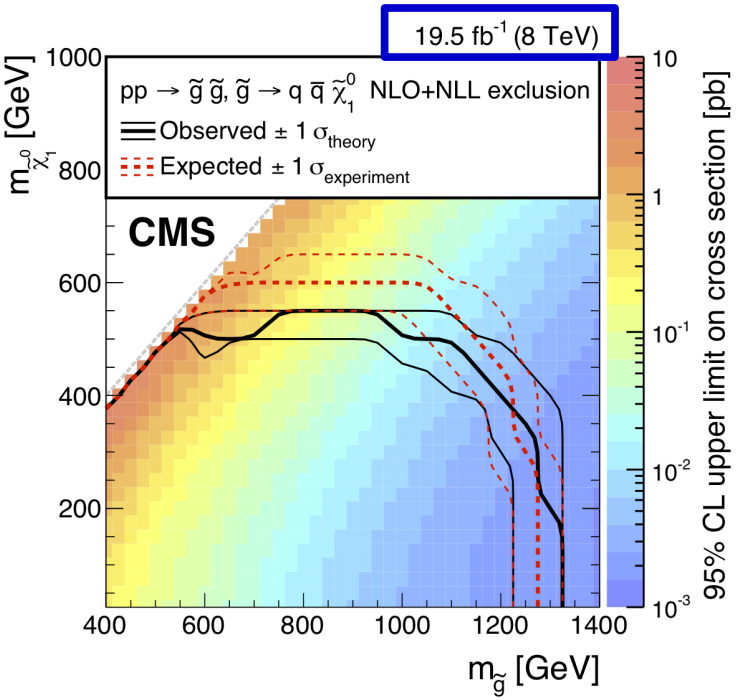
SUS-15-003

Upper limits on Simplified Models

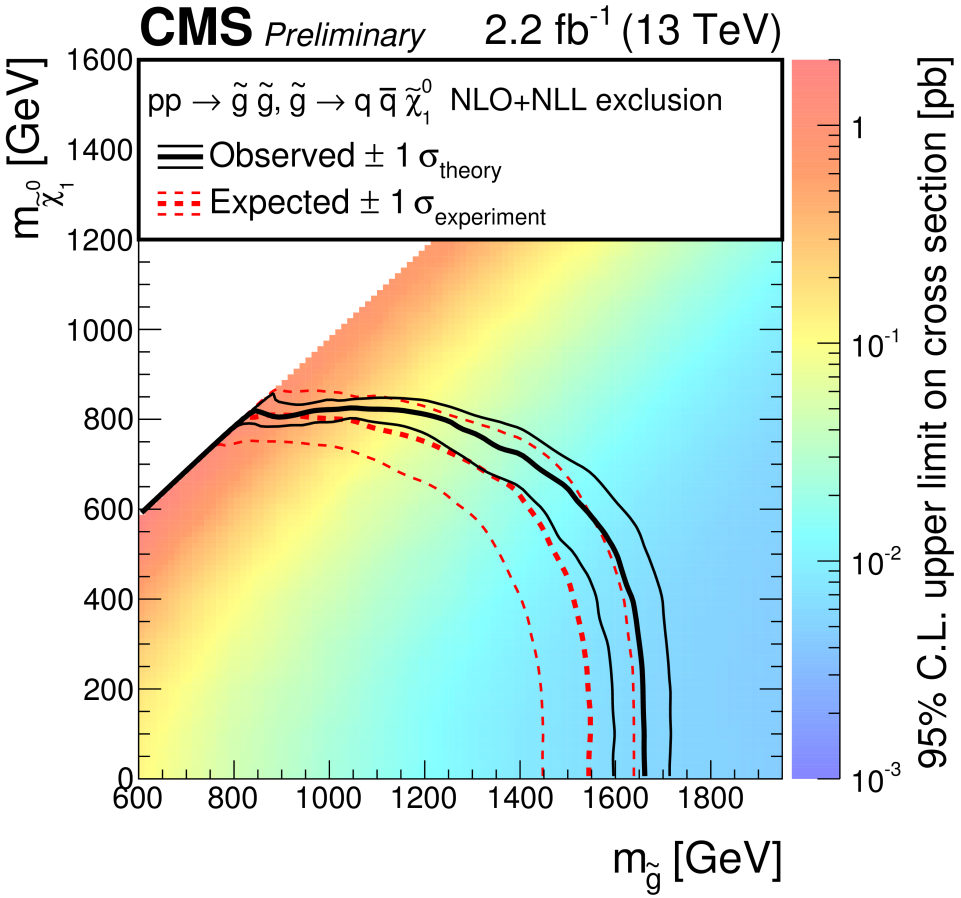
ETH Institute for Particle Physics

- Upper limits are set on the T1qqqq SMS pushing the limit on the gluino mass about ~ 300 GeV





8 TeV result

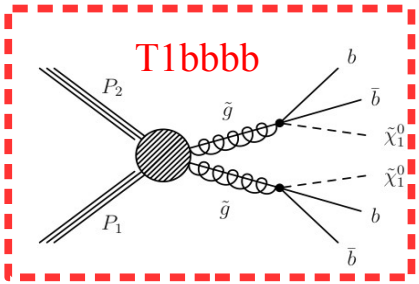


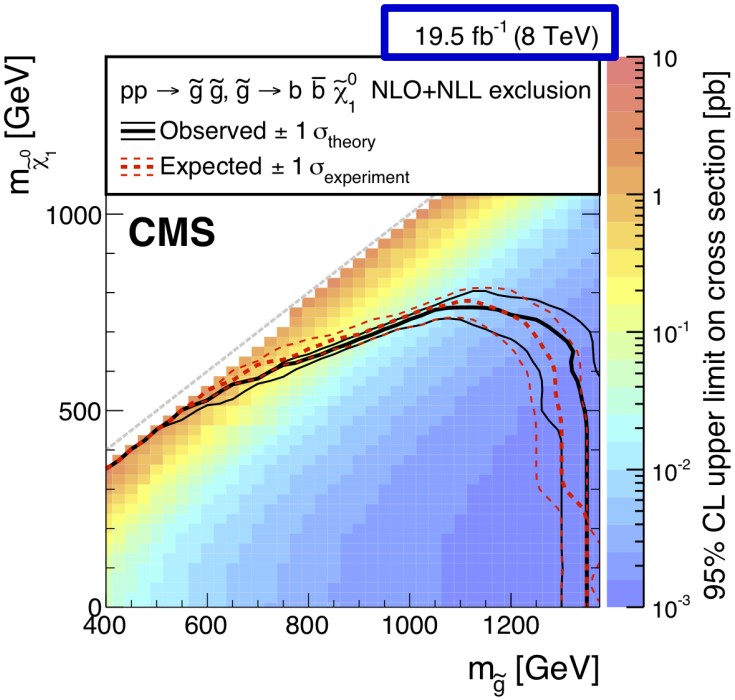
SUS-15-003

Upper limits on Simplified Models

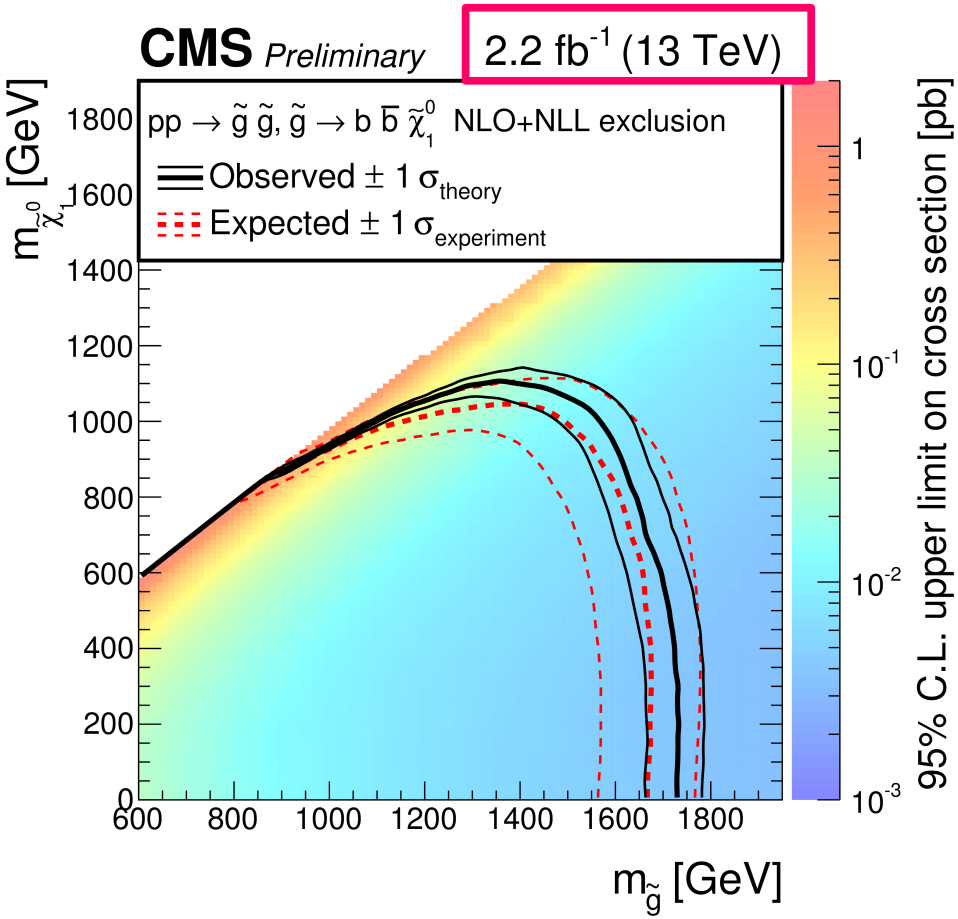
ETH Institute for Particle Physics

- Upper limits are set on the T1bbbb SMS pushing the limit on the gluino mass about ~ 300 GeV





8 TeV result

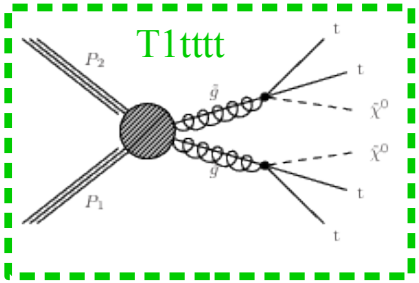


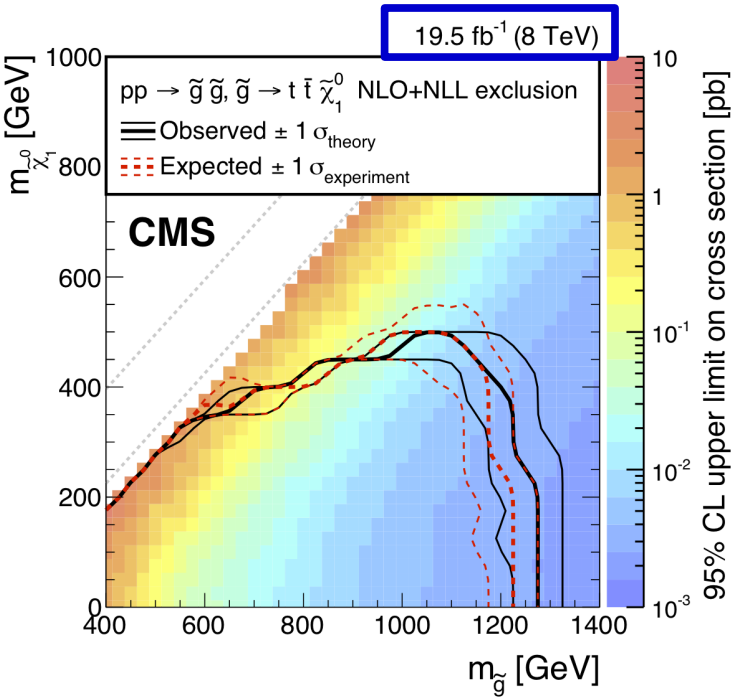
SUS-15-003

Upper limits on Simplified Models

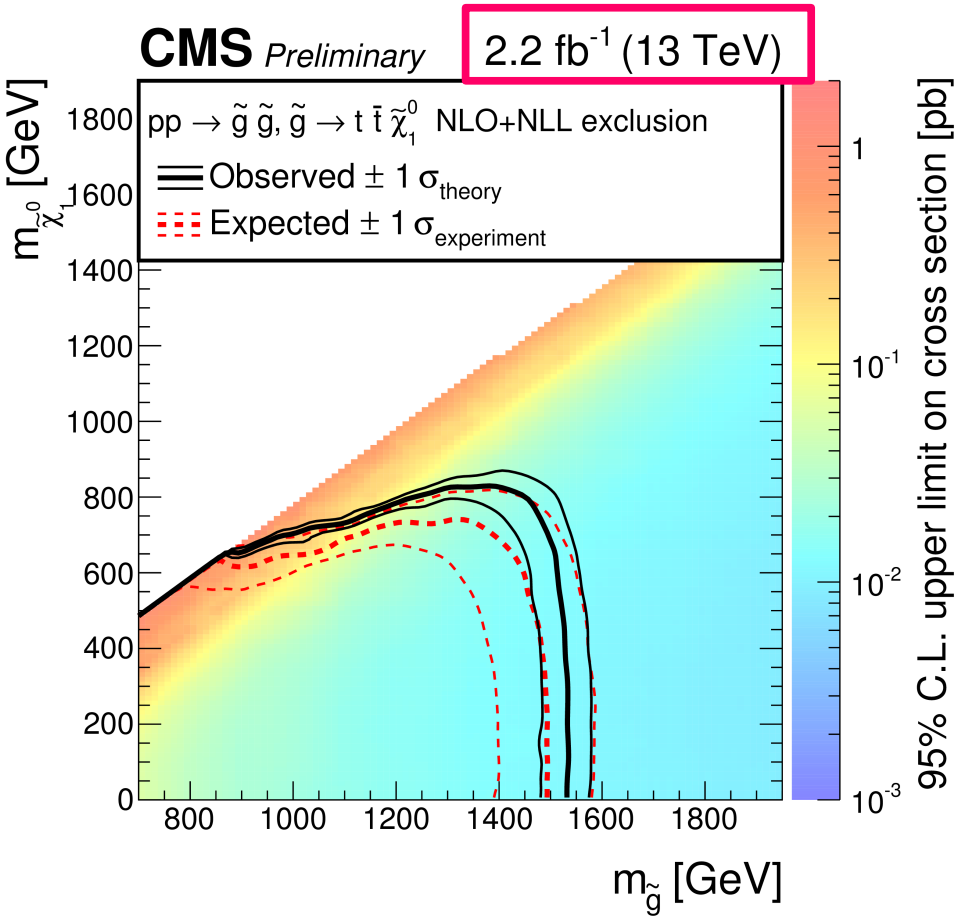
ETH Institute for Particle Physics

- Upper limits are set on the T1tttt SMS pushing the limit on the gluino mass about ~ 300 GeV





8 TeV result

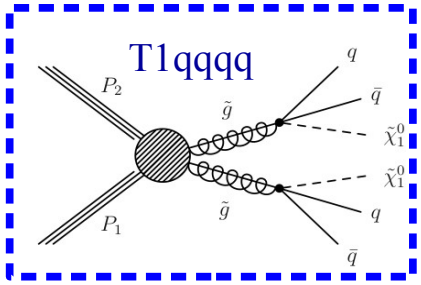


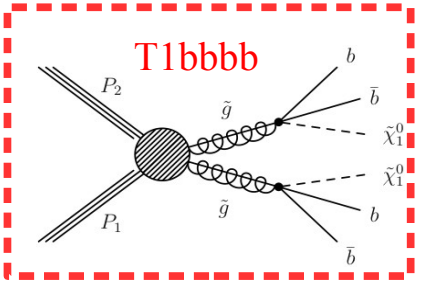
SUS-15-003

All-hadronic analysis using α-T

ETH Institute for Particle Physics

- Pure hadronic search using the α-T and $\Delta\varphi^*_{min}$ variables to strongly reduce the amount of QCD
- The analysis targets SUSY models with gluinos decaying into light quarks/bottoms and LSP





SUS-15-005

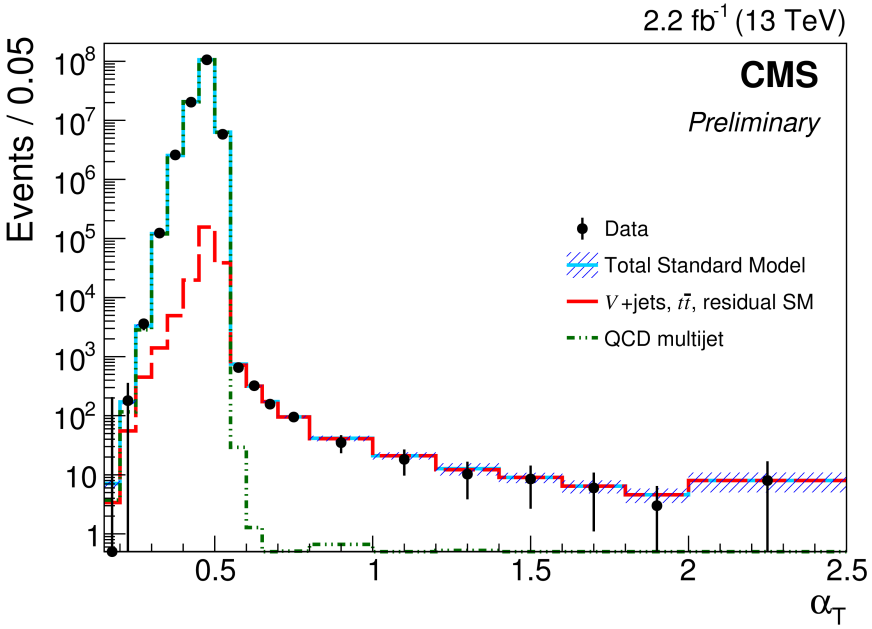
- The analysis defines 3 different categories of signal regions attending to the two leading jets
  - **Symmetric jet selection**: 2 leading jets with Pt > 100 GeV
  - **Asymmetric jet selection**: leading jet with Pt > 100 GeV and sub-leading Pt > 40 GeV
  - **Mono-jet category**: leading jet with Pt > 100 GeV and sub-leading Pt < 40 GeV (compressed spectra)
- Additional binning according to HT, number of jets and number of b-jets
- Varying α-T cuts for different HT bins and additional $\Delta\varphi^*_{min}$ and MHT/MET cuts

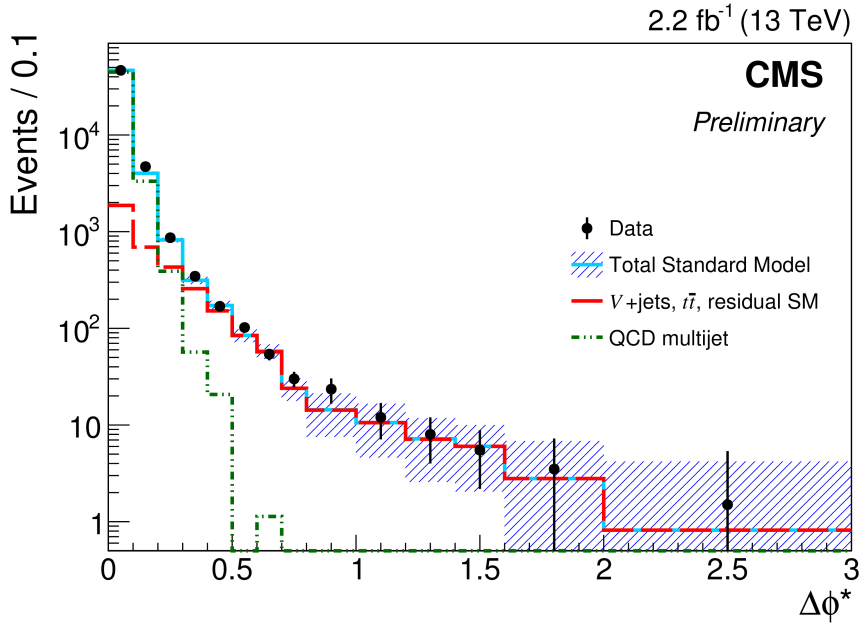
α-T and $\Delta\varphi^*_{min}$ variables: QCD killers

ETH Institute for Particle Physics

- The α-T variable is defined as the transverse momentum of the second jet over mT
  - In events with multi-jet topology, jets are merged into a leading and sub-leading jet
  - The α-T variable gets values < 0.5 for QCD events (with a back-to-back jet topology)
- $\Delta\varphi^*_{min}$ is defined as the min. angle between a jet and the MHT vector formed by the rest
  - Small values of this angle indicate a deficit of energy in the direction of the jets

SUS-15-005





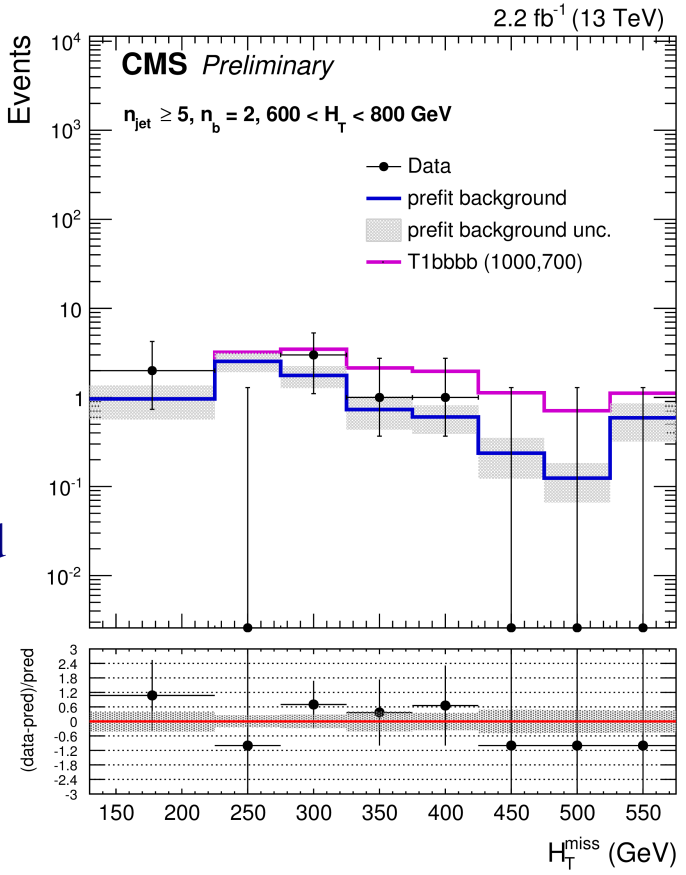
Background prediction

ETH Institute for Particle Physics

- SM background are estimated from **control regions and Monte Carlo transfer factors**
  - Predictions are validated using additional control regions (validation regions)

SUS-15-005

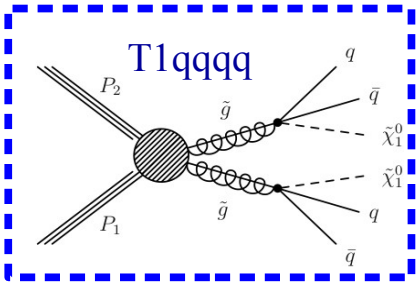
- QCD from a QCD enriched control region where MHT/MET is inverted
- Other backgrounds with real MET:
  - W+Jets, DY+Jets ($Z \rightarrow \upsilon\upsilon$ + Jets), top pair production
  - Extracted from Control Regions with:
    - γ + Jets, μ + Jets and $\mu\mu$ + Jets
- Systematic studies performed on validation regions
- Yields in control/signal regions and transfer factors fitted
  - To get the final background prediction
- Good agreement between observation/prediction

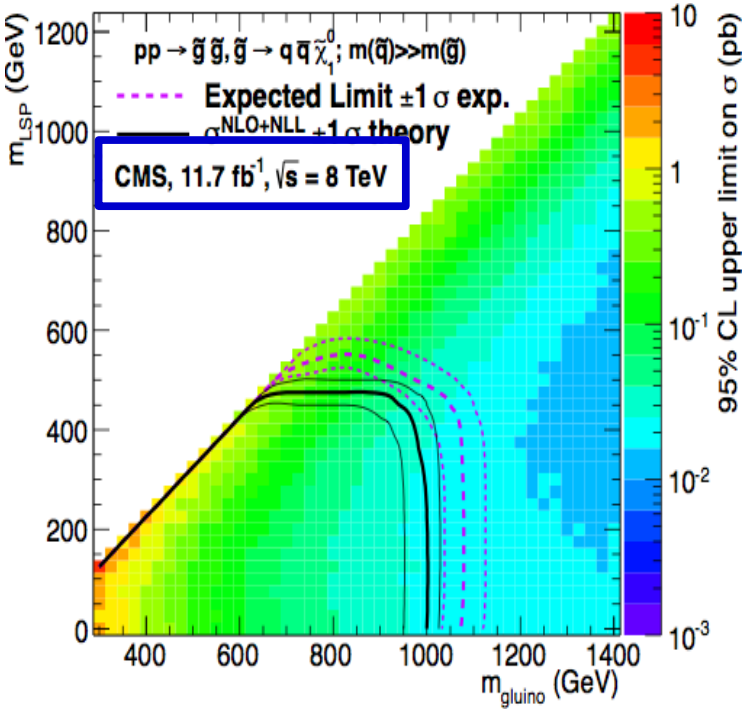


Upper limits on Simplified Models

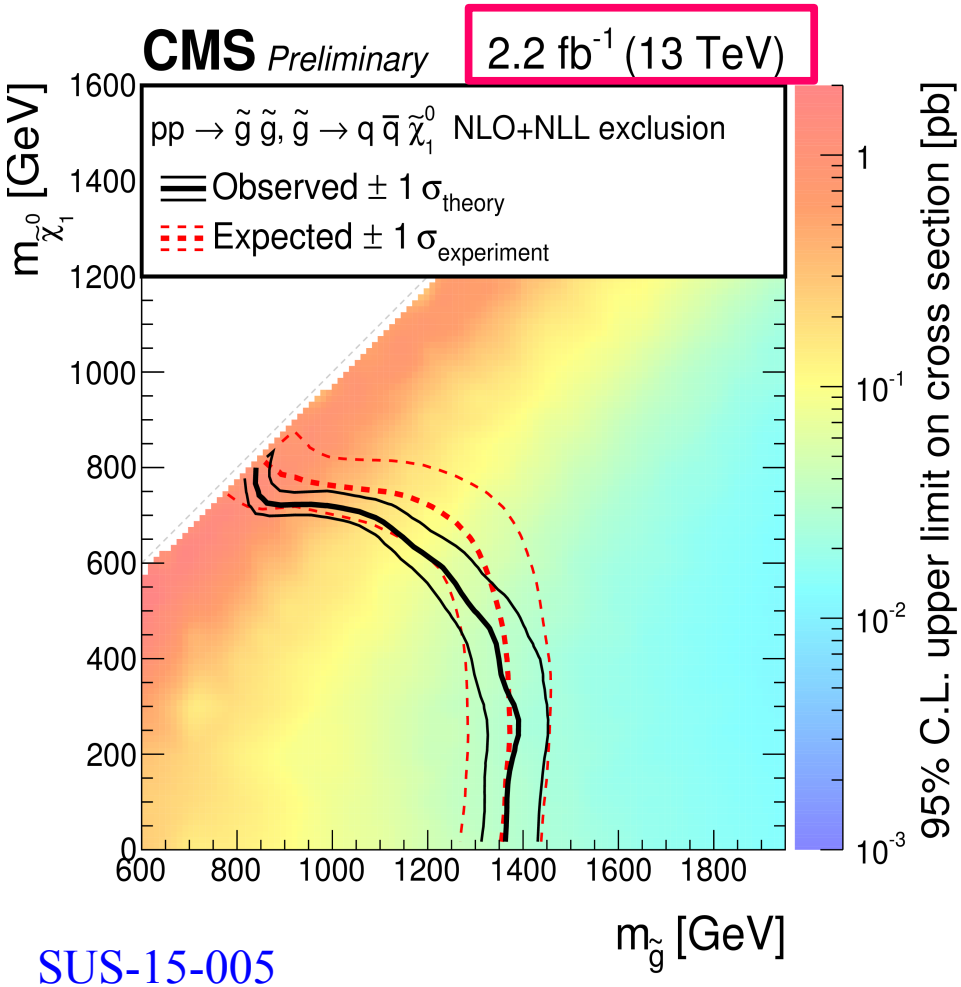
ETH Institute for Particle Physics

- Upper limits are set on the T1qqqq SMS pushing the limit on the gluino mass about ~ 400 GeV





8 TeV result

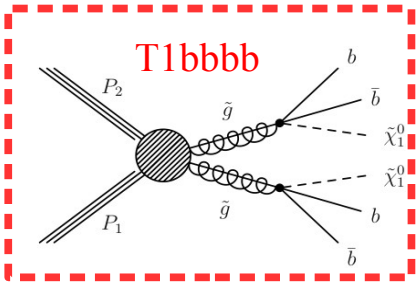


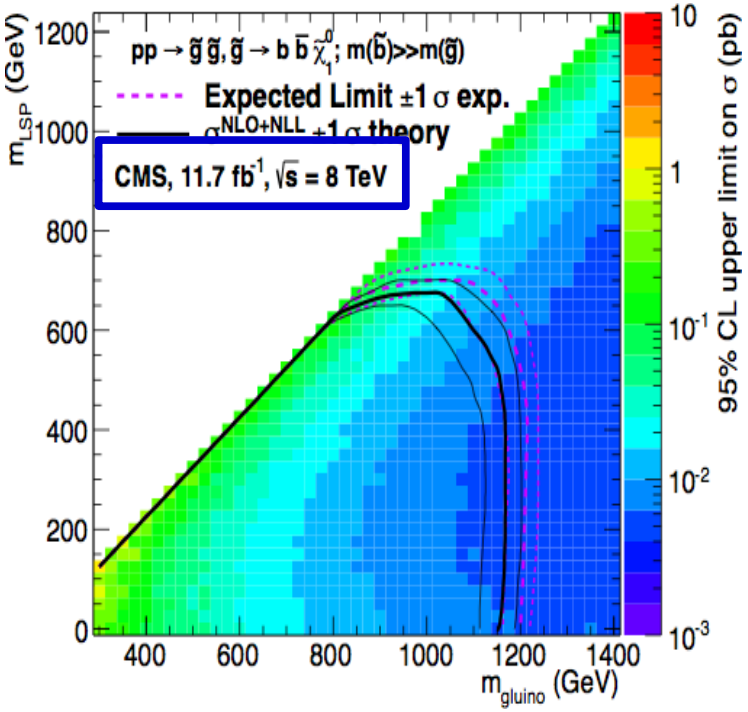
SUS-15-005

Upper limits on Simplified Models

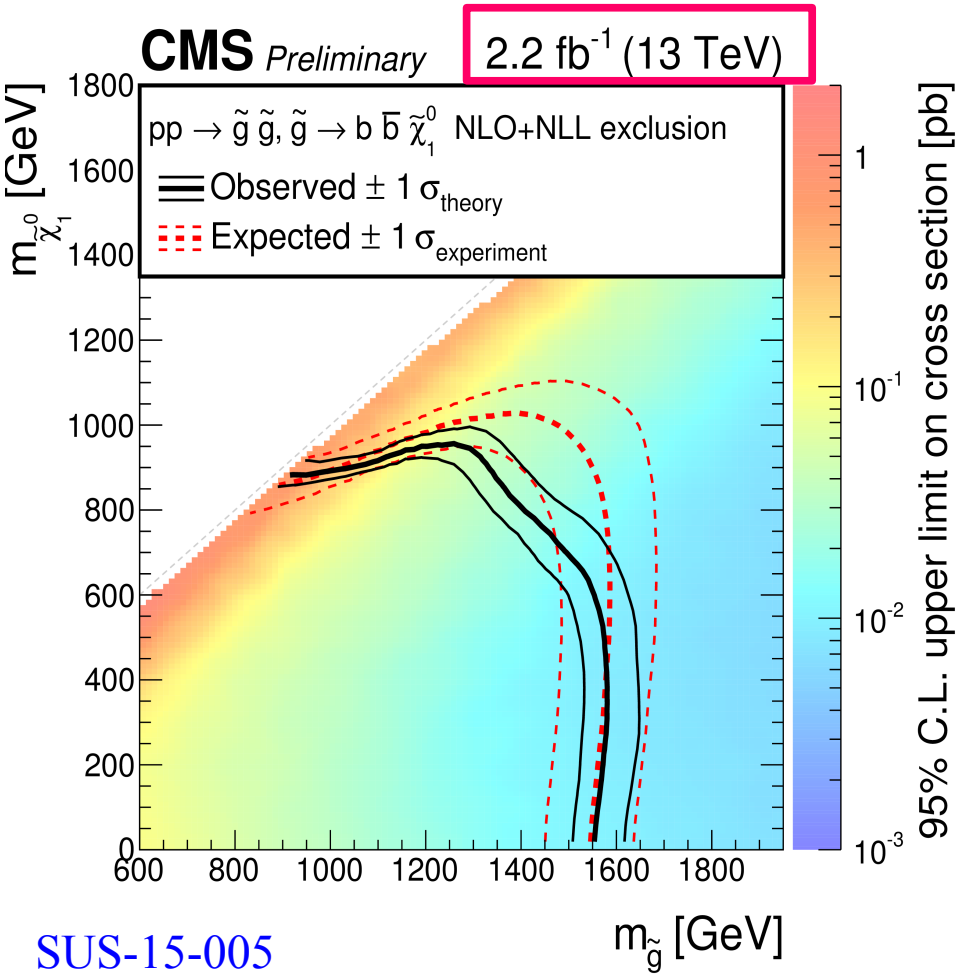
ETH Institute for Particle Physics

- Upper limits are set on the T1bbbb SMS pushing the limit on the gluino mass about ~ 400 GeV





8 TeV result

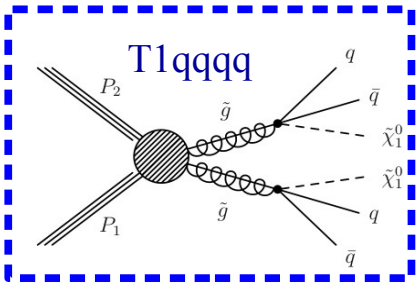


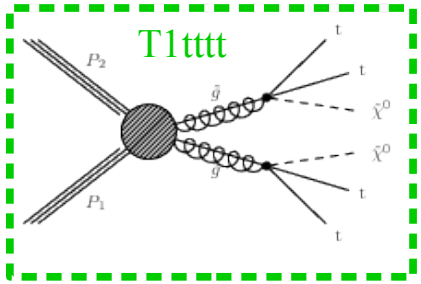
SUS-15-005

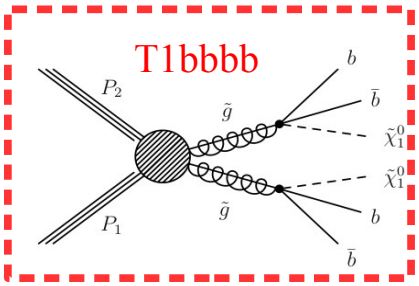
Razor analysis

ETH Institute for Particle Physics

- Razor analysis is a combined 0 lepton and 1 lepton search using the **razor variables**
- The analysis targets also the T1qqqq and T1bbbb SMS and the T1tttt (also in the 1 lepton)







- Therefore three different categories with different base-line selections, all binned in #b-jets
  - **1 muon + multijet** →one muon with pt > 25 GeV and at least 4 jets wit pt > 40 GeV
  - **1 electron + multijet** → one electron with pt > 25 GeV and at least 4 jets with pt > 40 GeV
  - **Multijet** → at least 4 jets with pt > 40 GeV and >= 2 jets with 80 GeV
- In order to reduce the SM background a cut on the transverse mass of the lepton is performed
- In the multijet case, jets are grouped in 2 megajets and cut $\Delta\varphi < 2.8$ (angle between megajets)
  - Strongly reduces the amount of background

SUS-15-004

The Razor variables

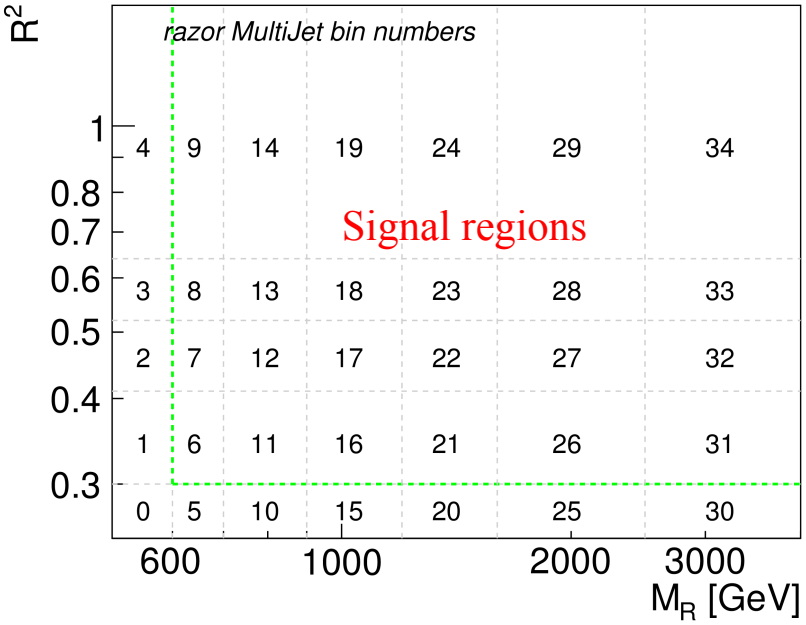
ETH Institute for Particle Physics

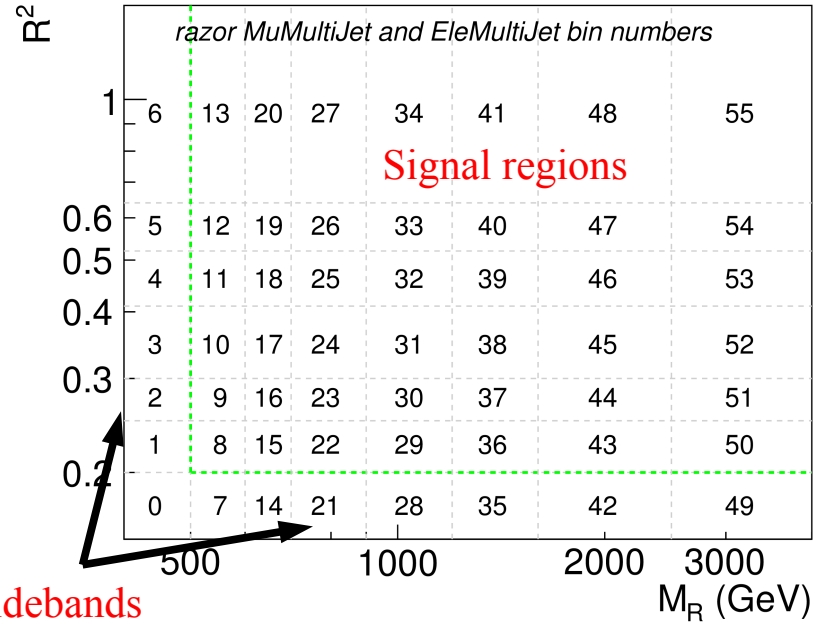
- A shape analysis performed in the plane of two kinematic variables denoted MR and R^2
- This variables correspond to the mass and transverse energy flow of pair-produced particles
- In a decay: $\tilde{q} \rightarrow q + LSP$ MR peaks at $(M(\tilde{q})-M(q))/M(\tilde{q})$ and R^2 is related to the MET

$$M_R \equiv \sqrt{(P_{j_1} + P_{j_2})^2 - (p_z^{j_1} + p_z^{j_2})^2} \qquad M_T^R \equiv \sqrt{\frac{E_T^{miss}(p_T^{j1} + p_T^{j2}) - \vec{p}_T^{miss} \cdot (\vec{p}_T^{j1} + \vec{p}_T^{j2})}{2}} \qquad R^2 \equiv \left(\frac{M_T^R}{M_R}\right)^2$$

- Many control (sidebands) and signal regions are defined in the MR and R^2 plane

SUS-15-004

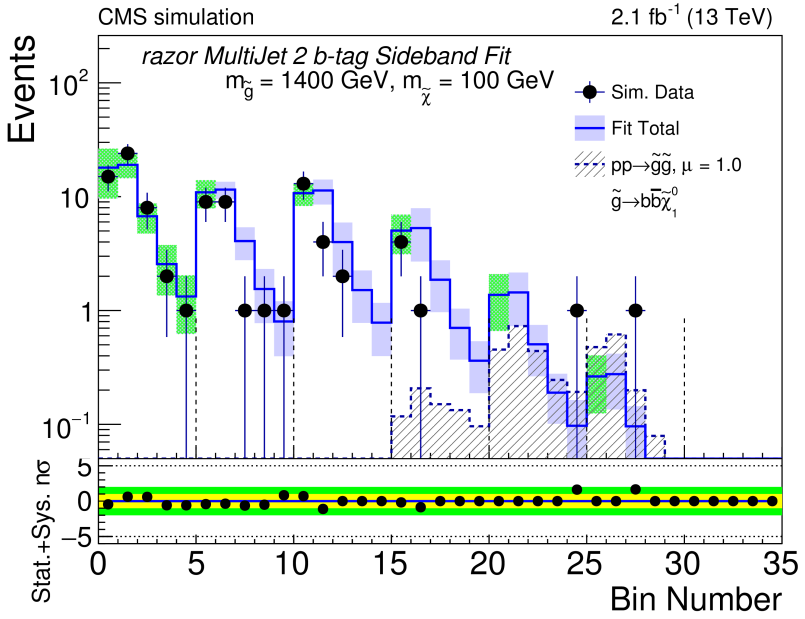


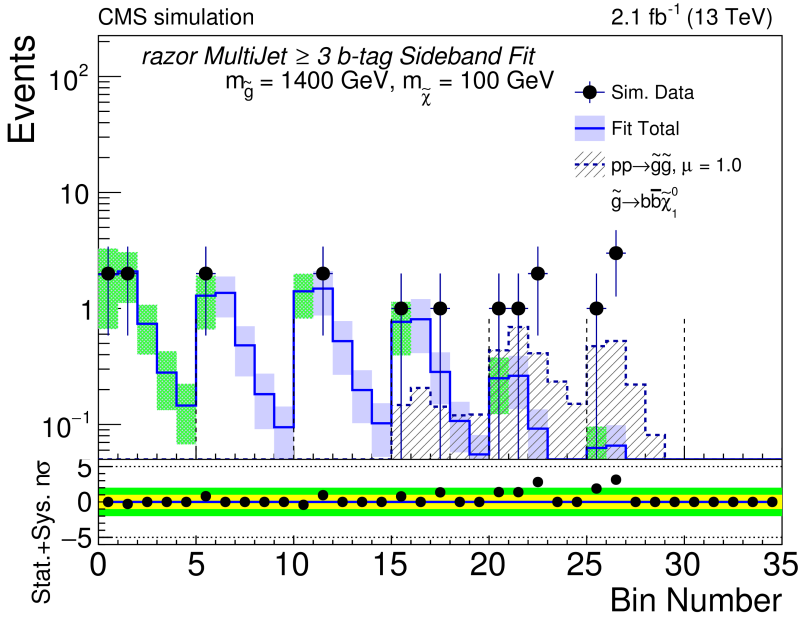


Background estimation

ETH Institute for Particle Physics

- Main backgrounds are QCD (instrumental MET) , top-pair production, W+jets and DY+jets
- 2D analytical functions modeling MR/R2 are validated in control regions for every background
- A total final fit is performed in the sidebands and extrapolated to the signal regions





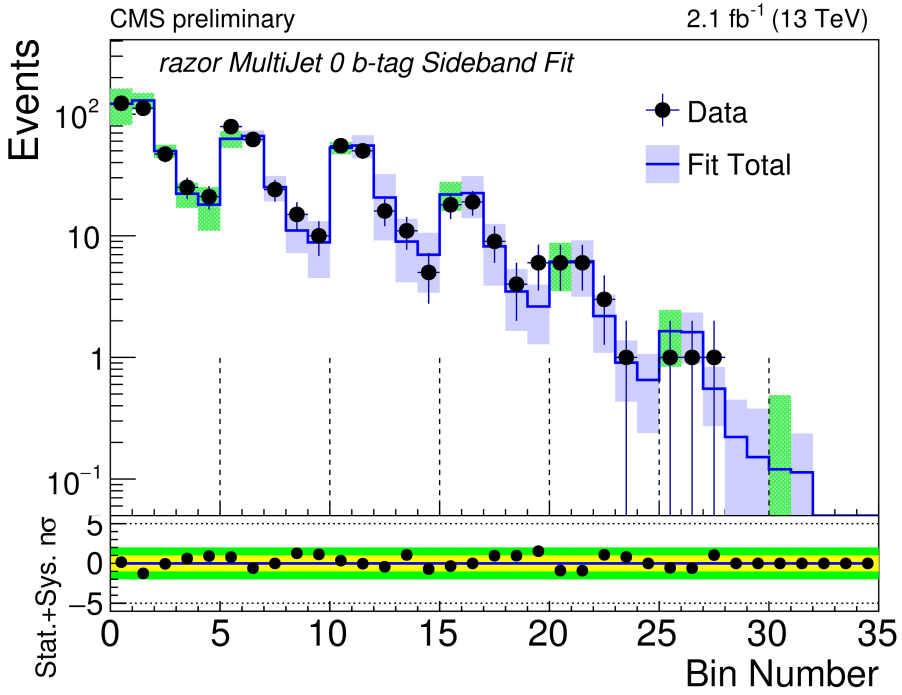
SUS-15-004

Razor analysis: results

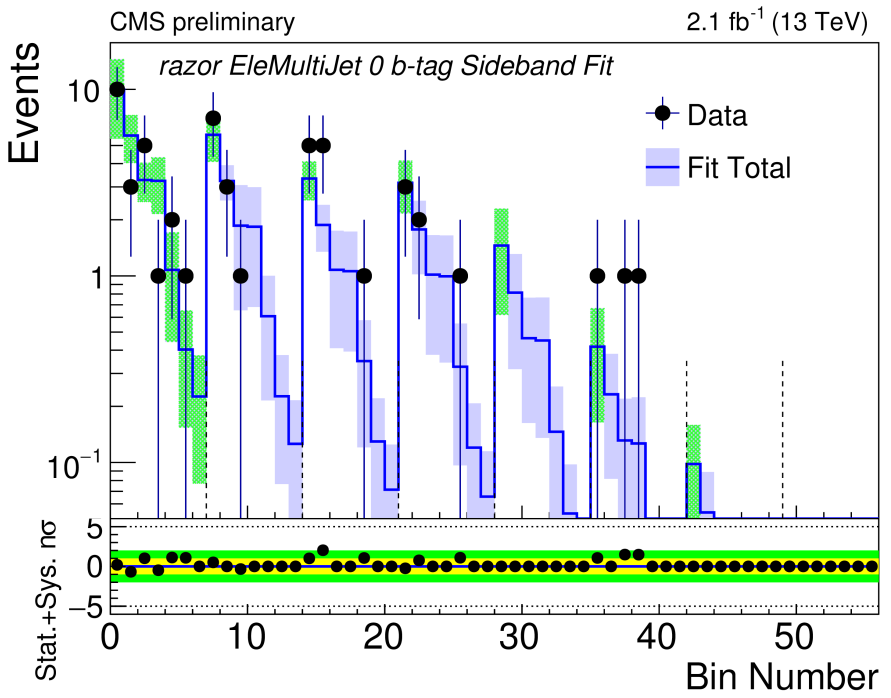
ETH Institute for Particle Physics

- Very good agreement found between the observation and the prediction in all signal regions

Multijet with 0 b-tag



Electron + multijet with 0 b-tag

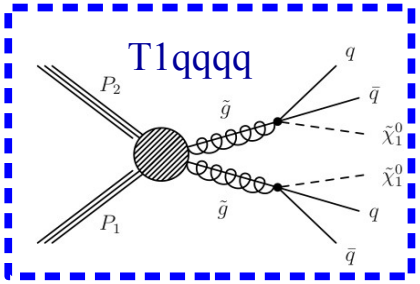


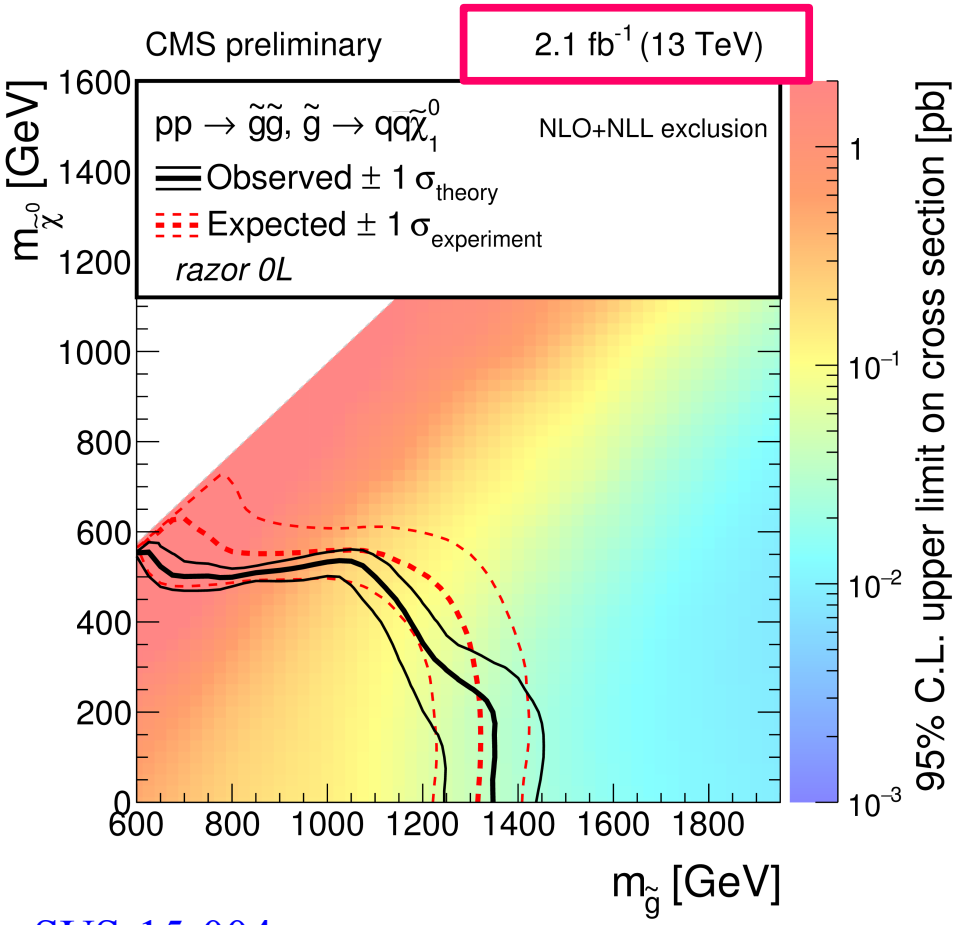
SUS-15-004

Upper limits on Simplified Models

ETH Institute for Particle Physics

- First upper limits on the T1qqqq SMS reaching gluino masses up to ~ 1300 GeV



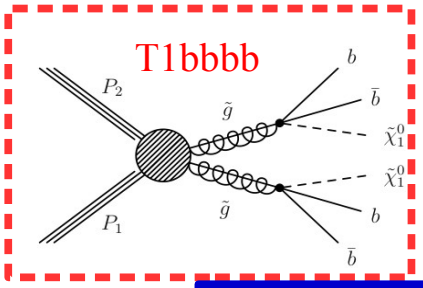


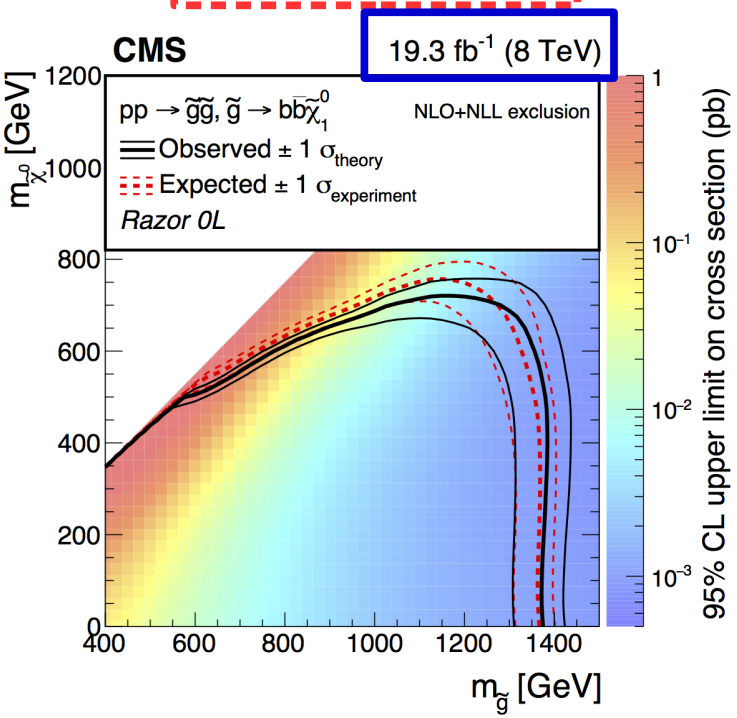
SUS-15-004

Upper limits on Simplified Models

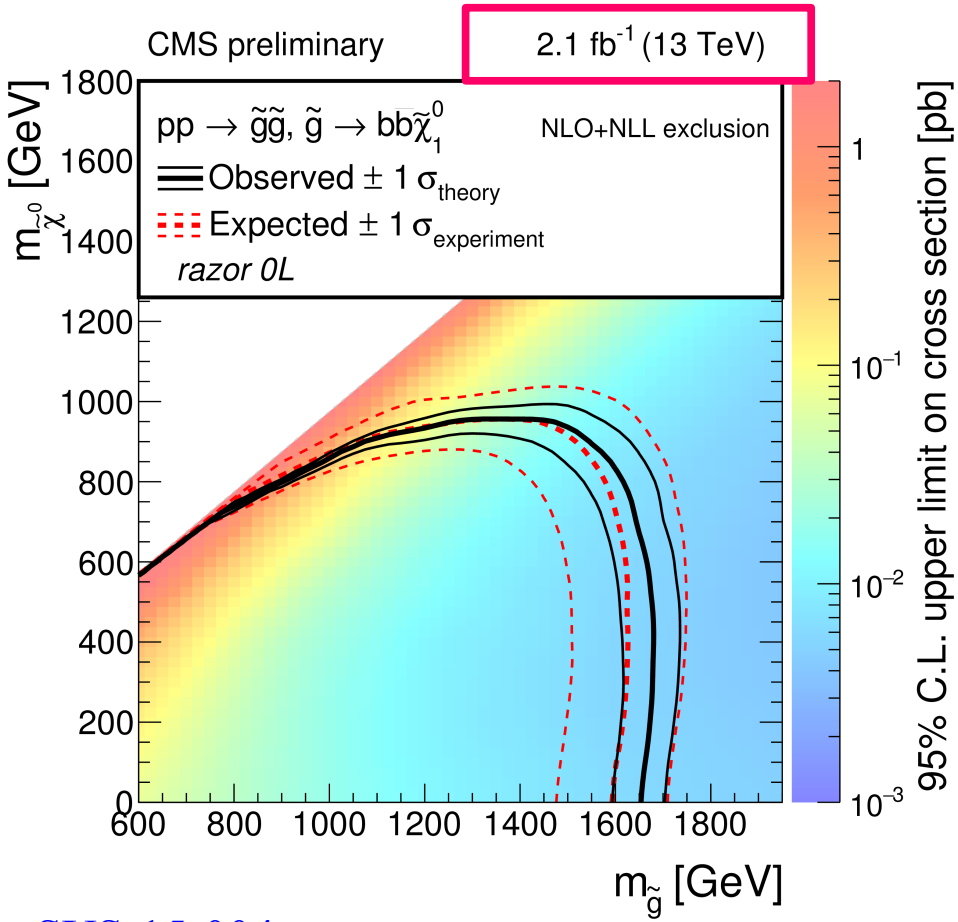
ETH Institute for Particle Physics

- Upper limits are set on the T1bbbb SMS pushing the limit on the gluino mass about ~ 300 GeV





8 TeV result

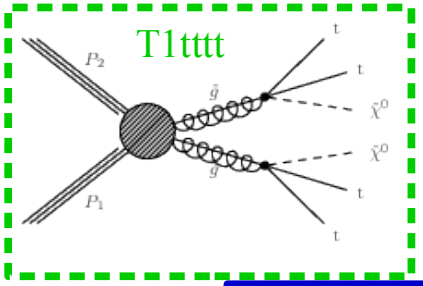


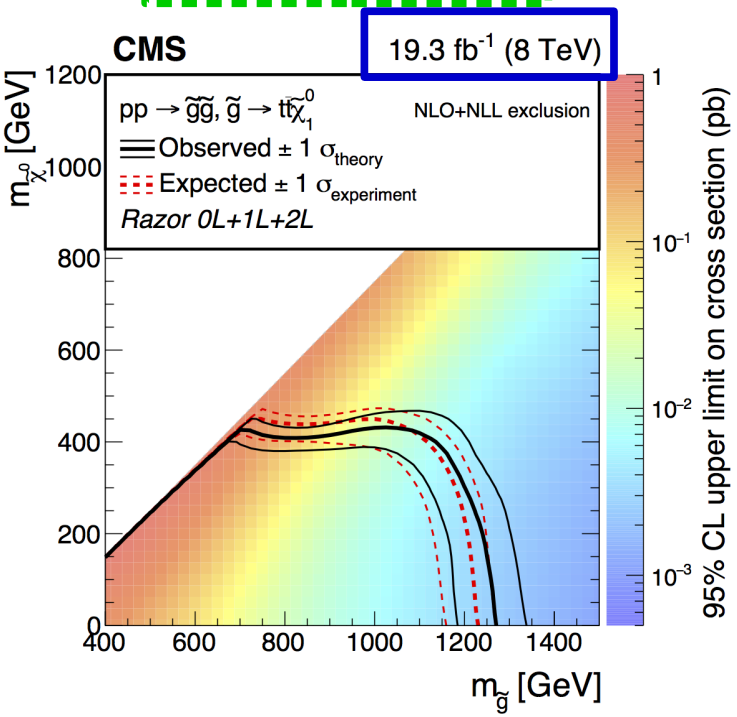
SUS-15-004

Upper limits on Simplified Models

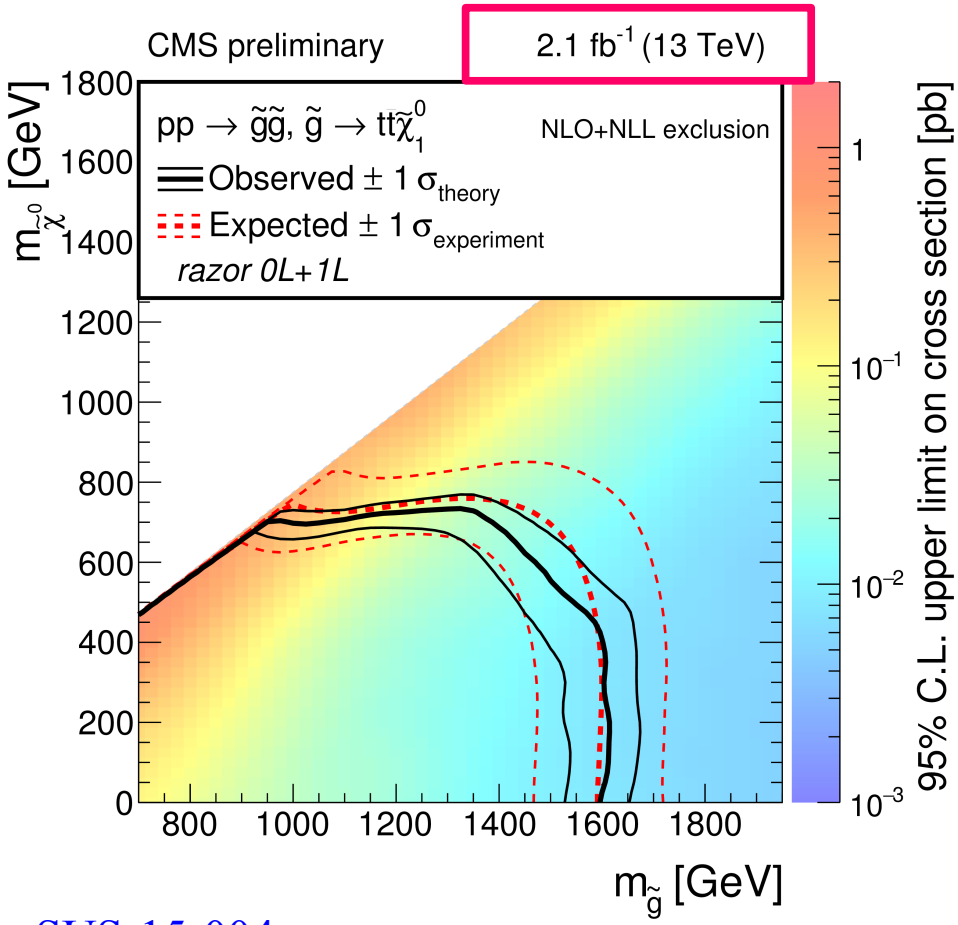
ETH Institute for Particle Physics

- Upper limits are set on the T1tttt SMS pushing the limit on the gluino mass about ~ 400 GeV



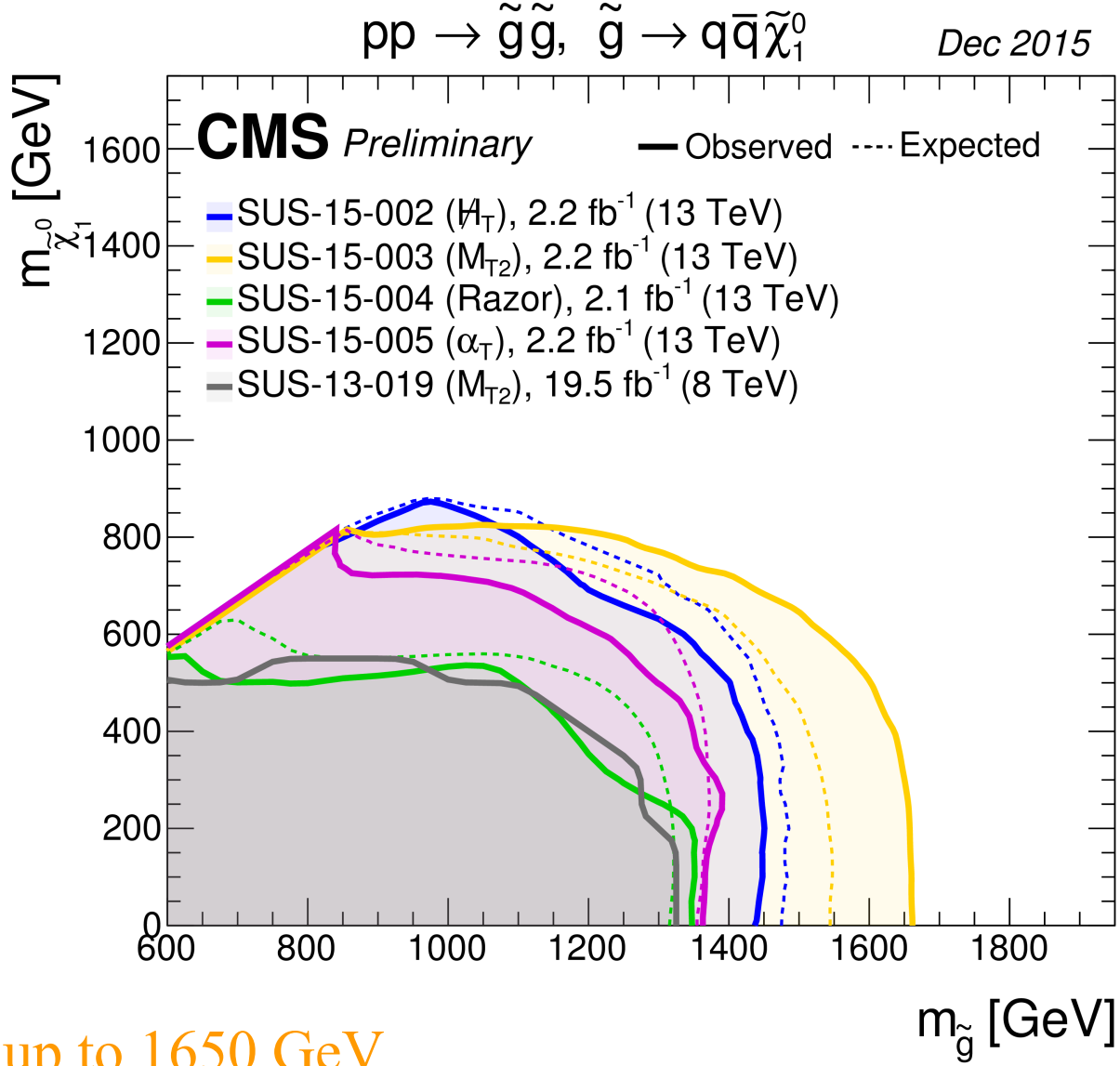


8 TeV result



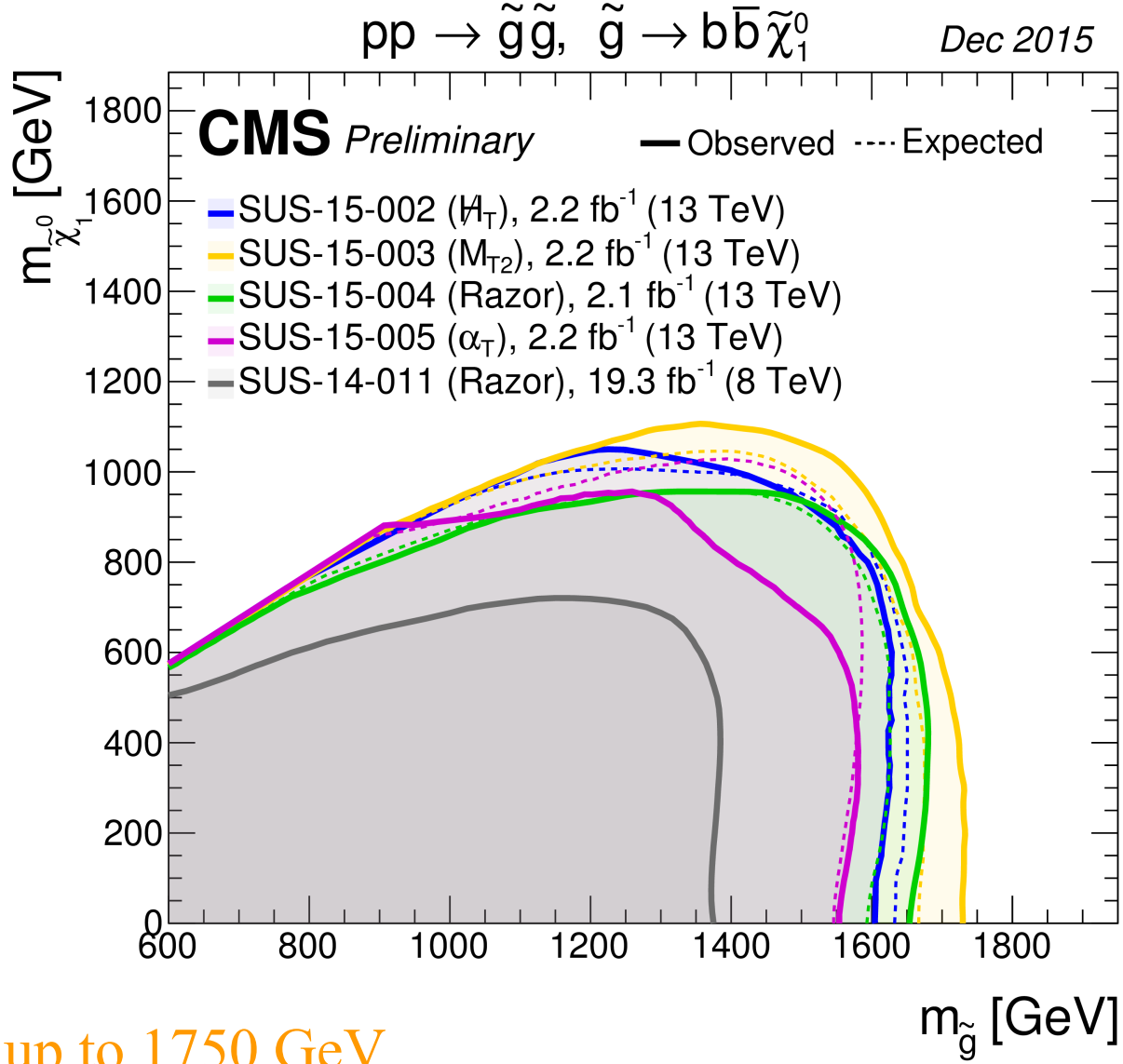
SUS-15-004

T1qqqq topology (all-hadronic): summary



Reaching up to 1650 GeV

T1bbbb topology (all-hadronic): summary



Reaching up to 1750 GeV

Search with one lepton

1 Lepton sum of FatJet masses

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- Search for SUSY with 1 lepton, jets and MET in a boosted regime and using two variables:
  - Mj = Sum of the Fat-Jet masses in the event
  - MT = transverse mass between the lepton and the MET vector

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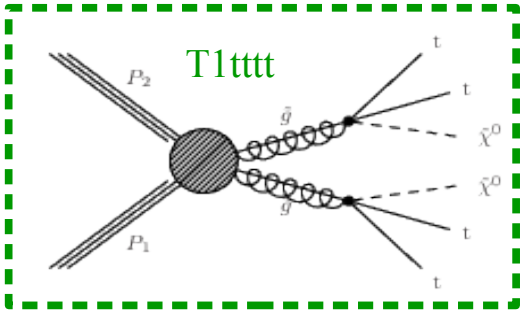
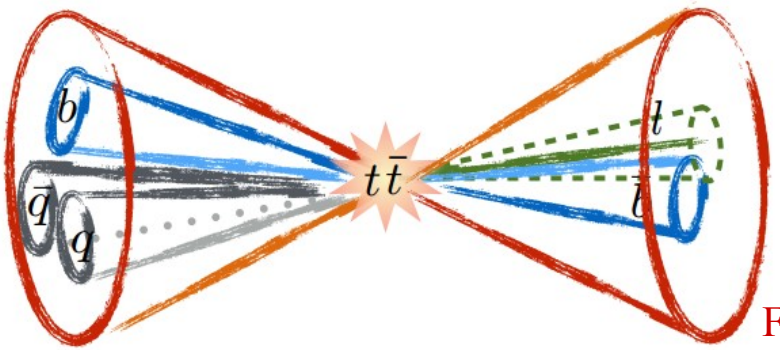
- Targeting gluino production decaying to boosted tops and LSP through off-shell stop



Fat-jet: jet with R=1.2 instead of the regular 0.4



- Baseline selection asking for HT>500 GeV, MET > 200 GeV, #jets >=7, #b-jets >=2

FatJet masses: heavy objects

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- Large Mj is characteristic of decays of heavy objects producing very boosted particles (jets)
- In SM events this can occur mainly because of accidental jet overlap and ISR jets

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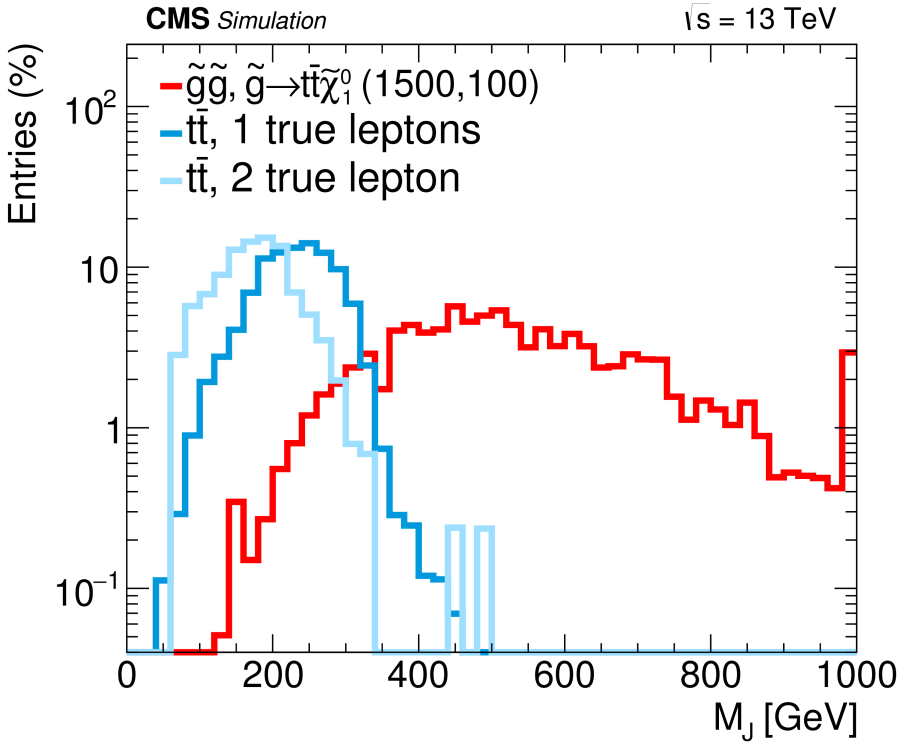
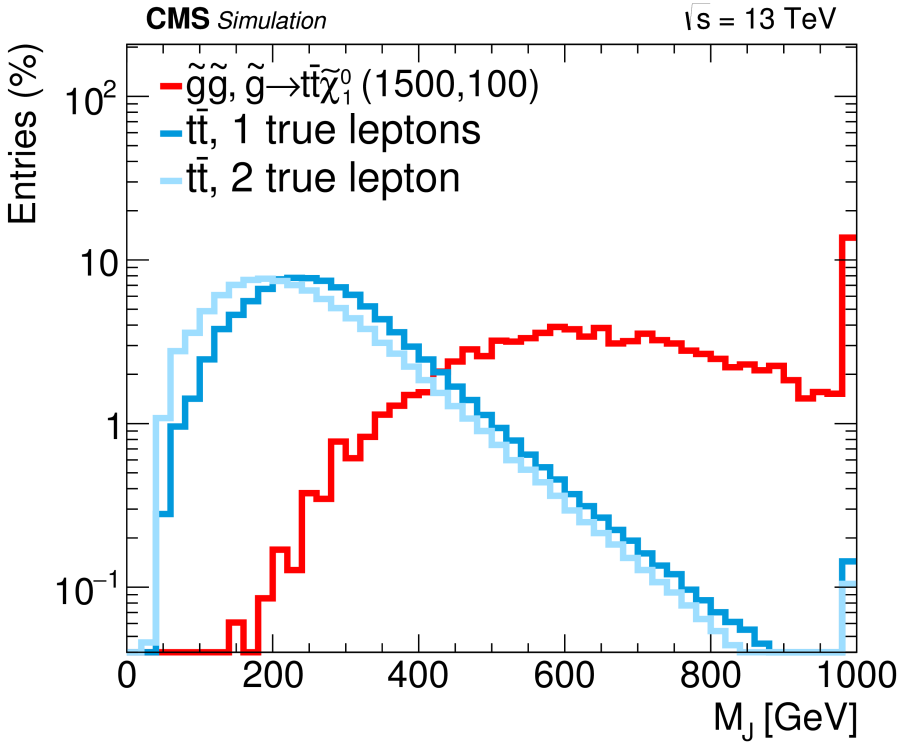
No ISR jet



ISR jet



Background prediction: mT vs. MJ

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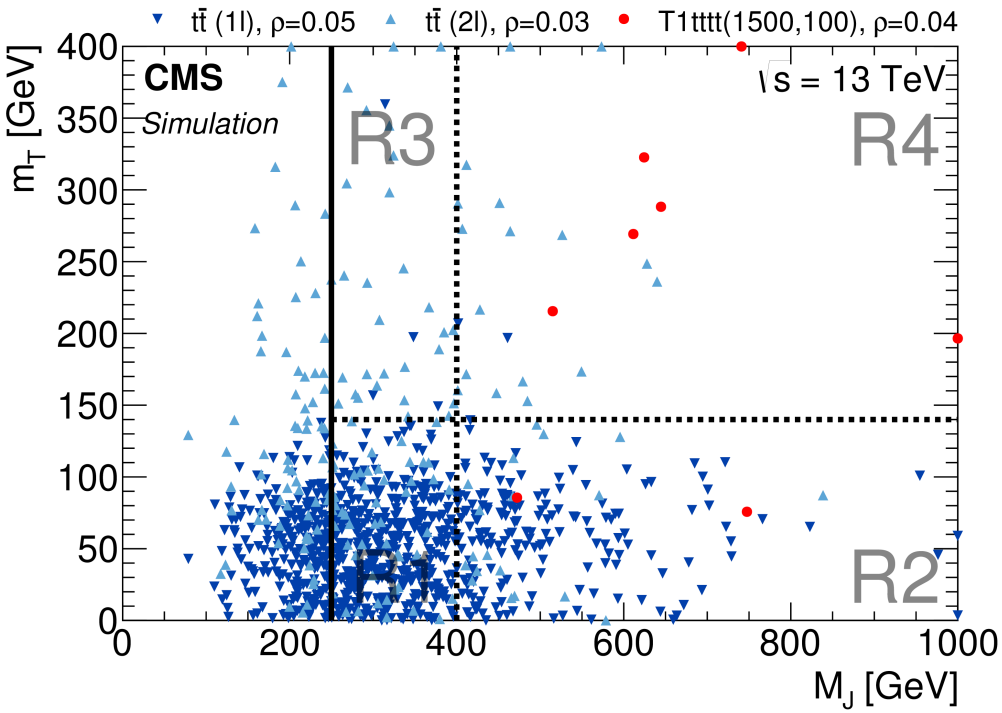
- Background is mainly dominated by top pair production both with 1 and 2 leptons
- ABCD method implemented in the Mj and mT plane in bins of MET, #jets and #b-jets
- Mj and mT are approximately uncorrelated variables → differences corrected using MC

$$\hat{N}^{Data}_{R4,MET,N_{jets},N_b} = \underbrace{N^{Data}_{R2,MET,N_{jets},N_b}\left(\frac{N_{R3}}{N_{R1}}\right)^{Data}_{MET,N_b}}_{\text{ABCD Prediction (Data)}} \times \underbrace{\left(\frac{N_{R4}}{N_{R2}}\right)^{MC}_{MET,N_{jets},Nb} \cdot \left(\frac{N_{R1}}{N_{R3}}\right)^{MC}_{MET,N_b}}_{\kappa \text{ factor (MC)}}$$



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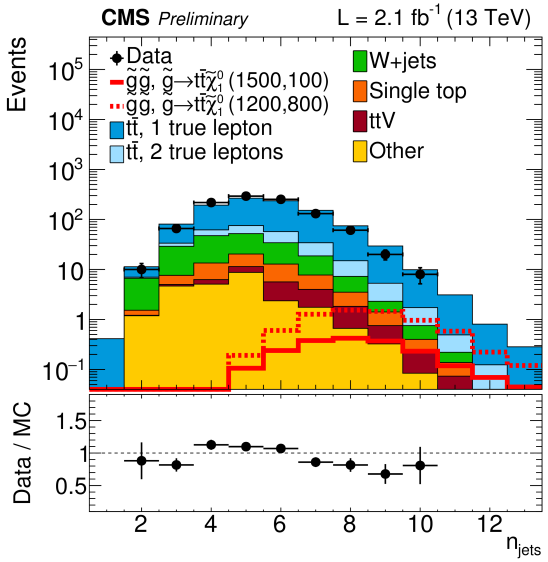

Upper limits on Simplified Model

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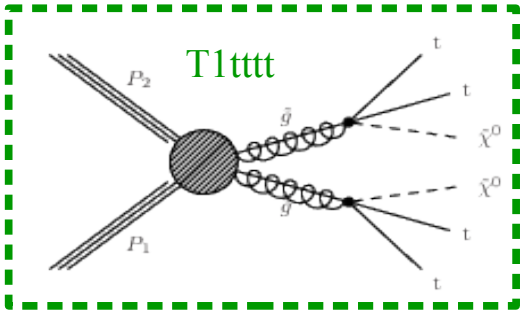
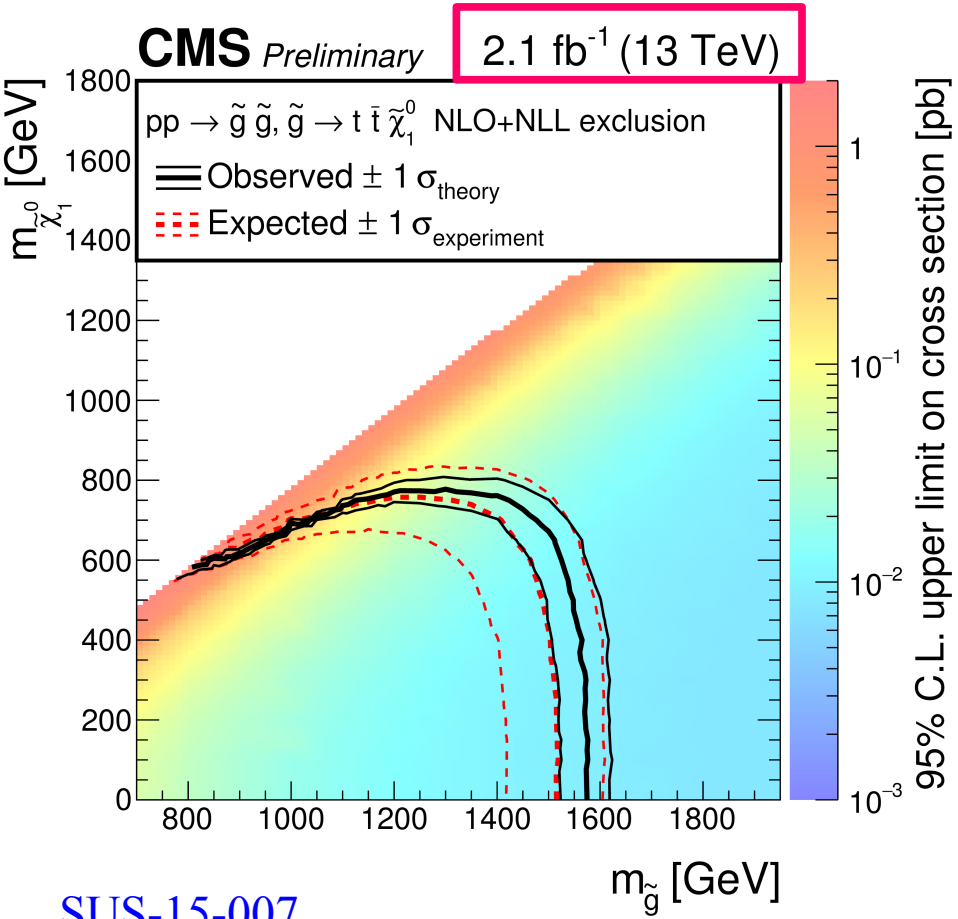
- Good agreement is found between observations and background predictions
- Upper limit in the range 1500-1600 GeV for the gluino mass





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Searches with two leptons

Same Sign Leptons

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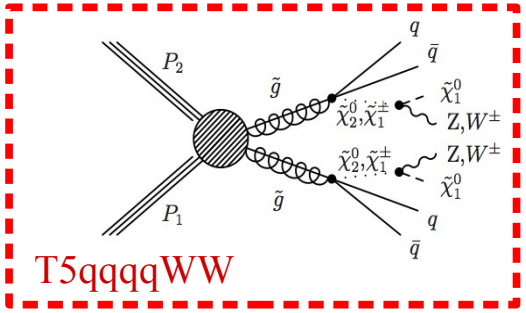
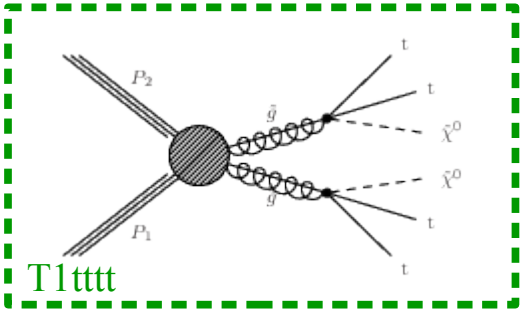
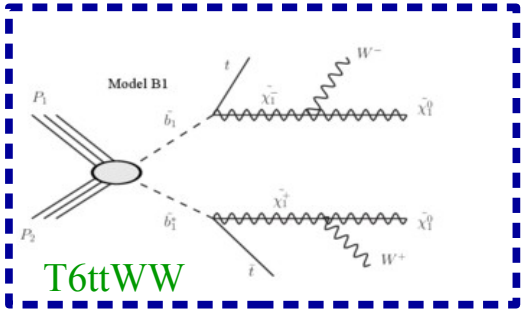
- Targeting production of Same Sign leptons in SUSY decay chains with gluinos and squarks

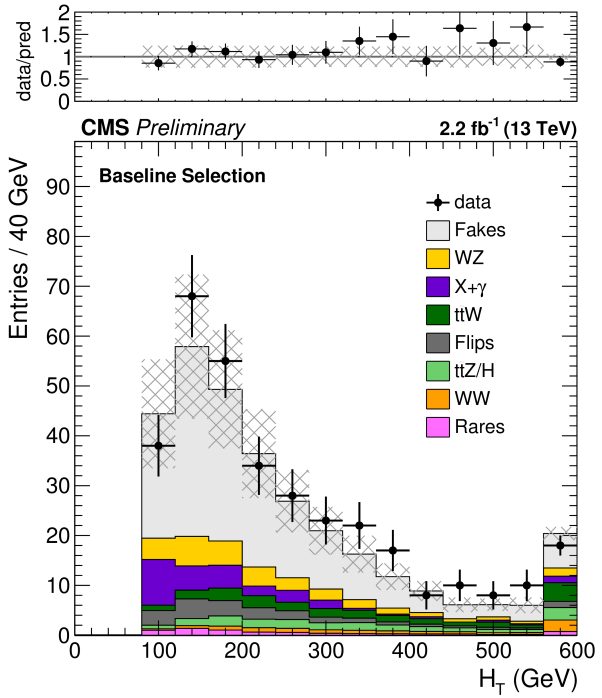


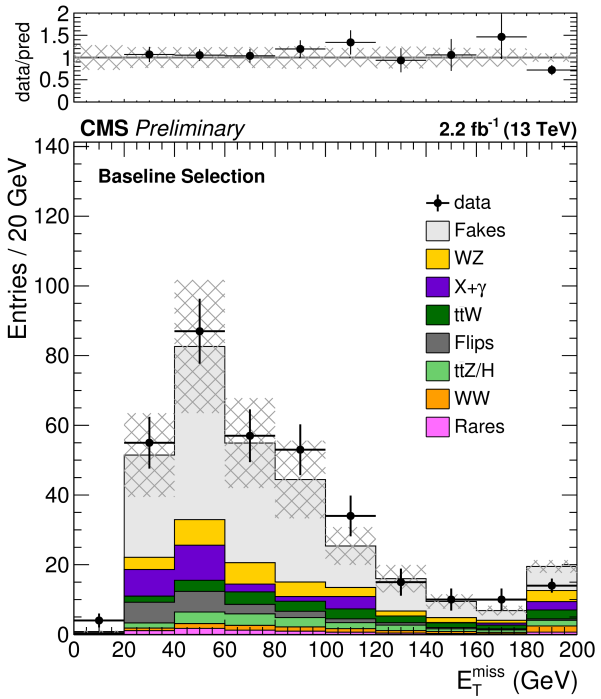




- Binned in regions of HT, MET, Mt_{min} and number of b-jets

SUS-15-008





3 lepton categories

High-High:
both pt > 25 GeV

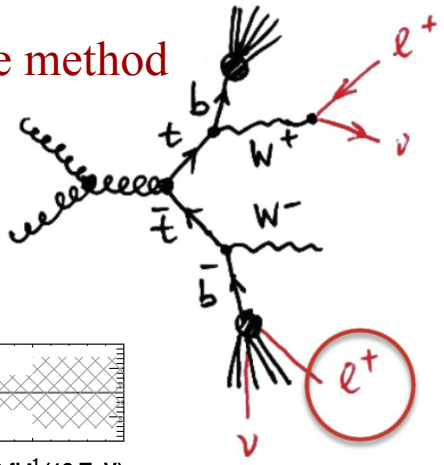
Low-High:
pt > 15 GeV and pt < 25 GeV
pt > 25 GeV

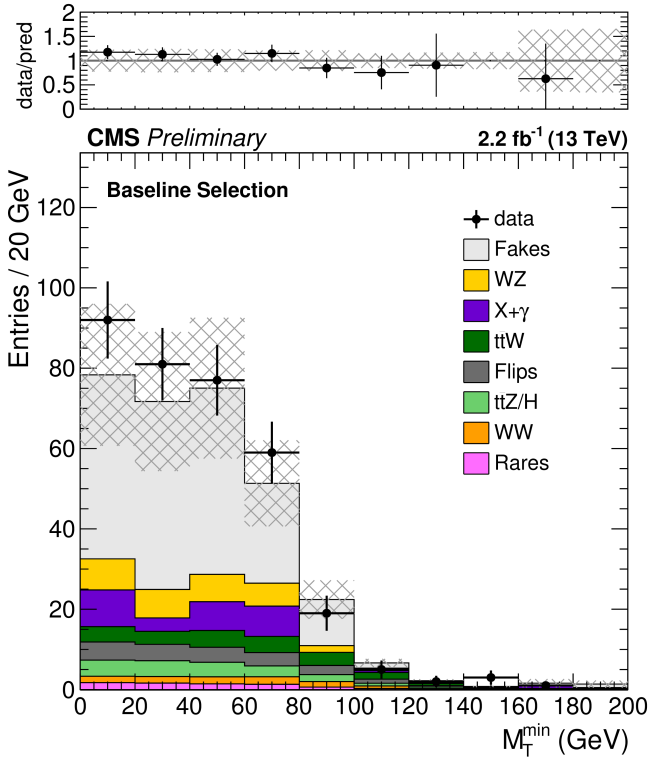
Low-Low:
pt > 15 GeV and pt < 25 GeV

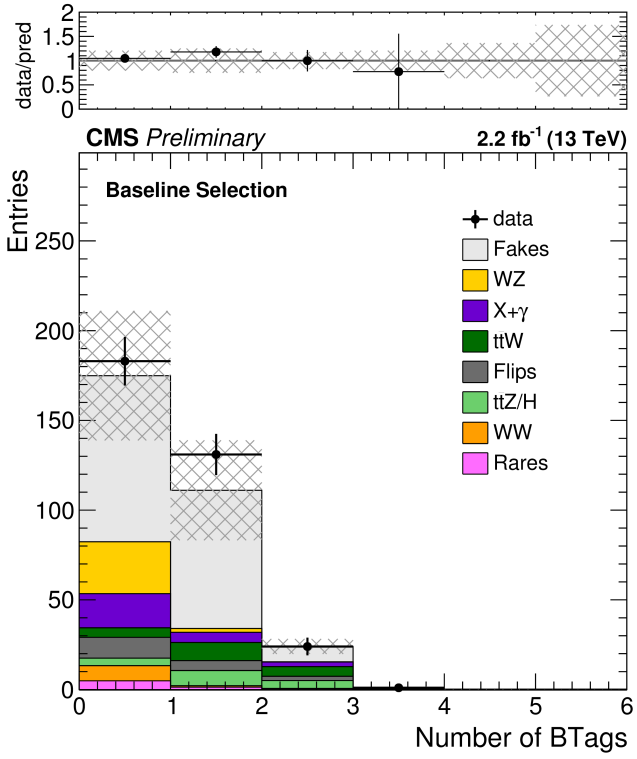
Background prediction

ETH Institute for Particle Physics

- Standard model produces very few same sign lepton backgrounds:
  - Fake leptons (not necessarily non-prompt-leptons) → tight-to-loose method
  - Charge flipping for electrons → measured in DY Control Region
  - Rare SM backgrounds TTZ, TTW → from MC, WZ from data CR







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Same Sign Leptons: results

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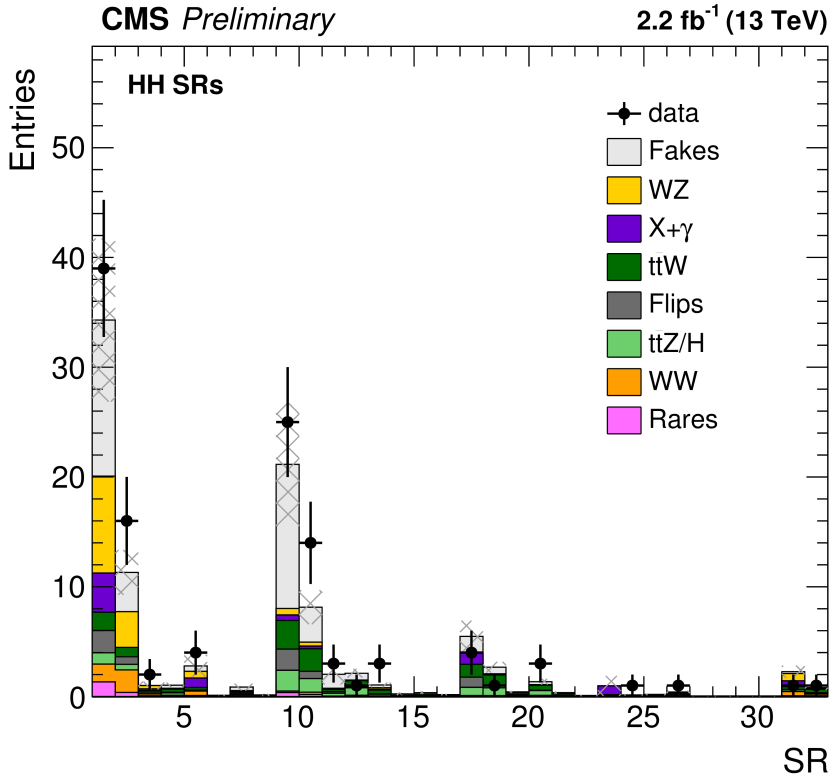
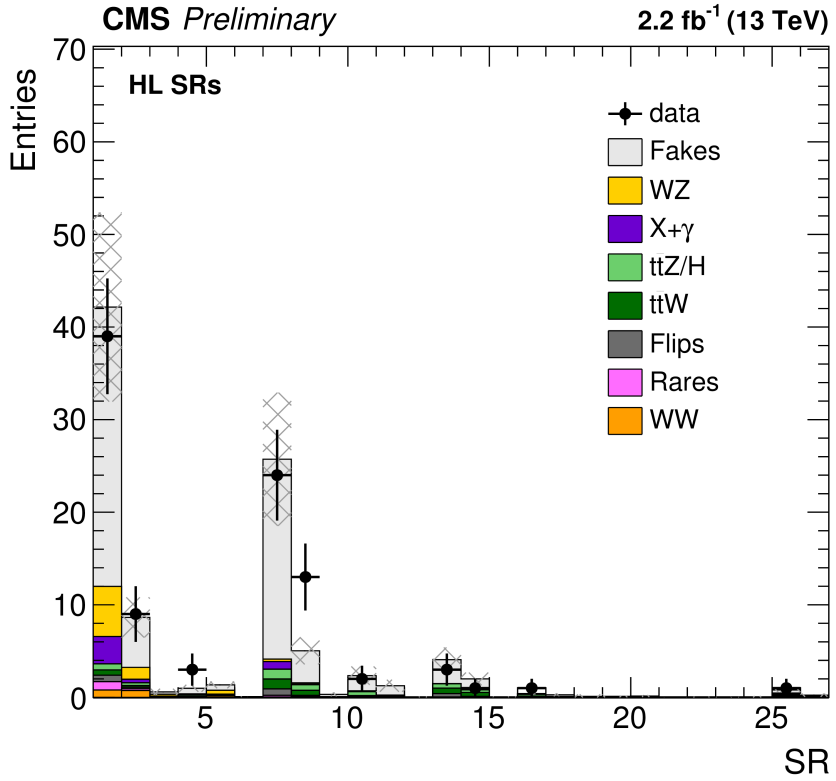
- Good agreement is found between observation and SM prediction in all categories





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Same Sign Leptons: limits on T1tttt

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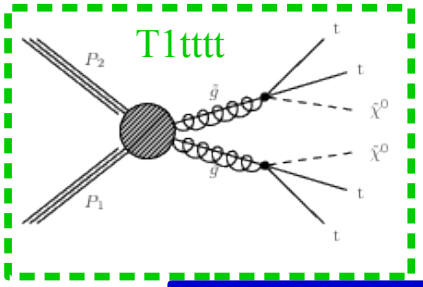
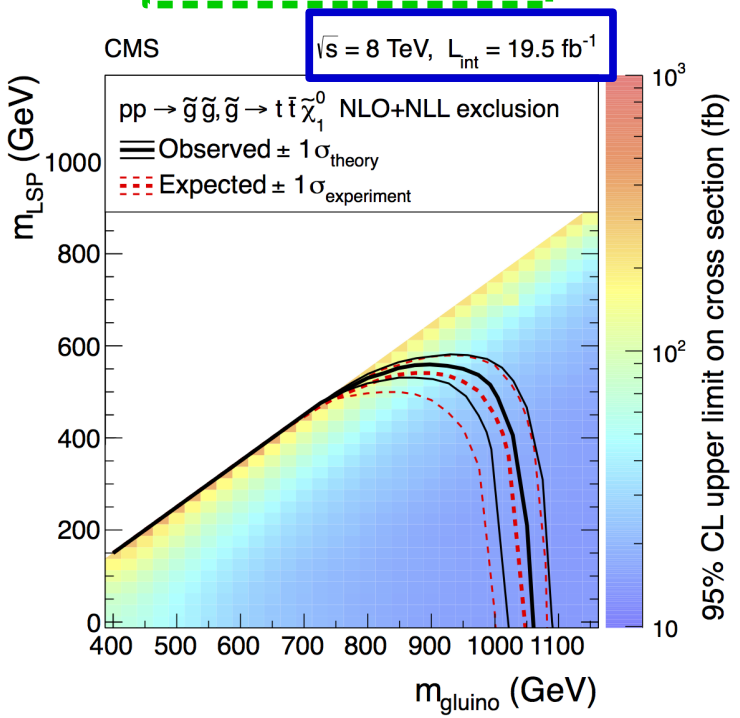
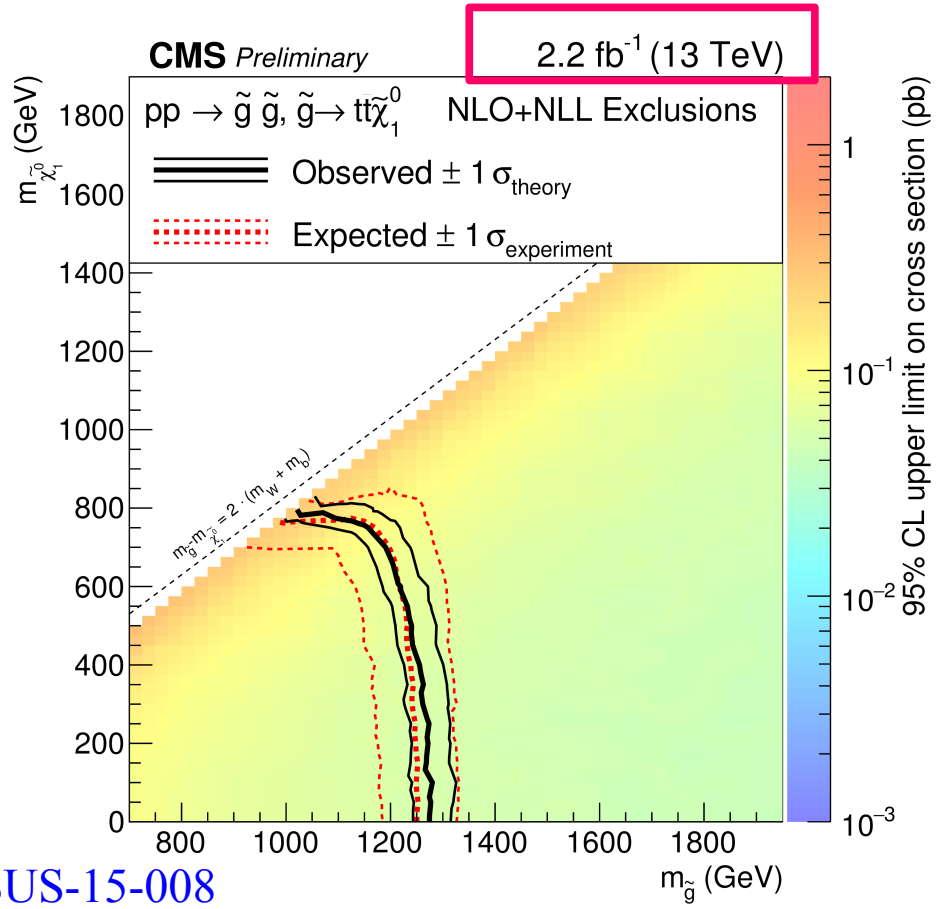
- Upper limits on gluino masses for the T1tttt model are pushed ~ 200 GeV





8 TeV results



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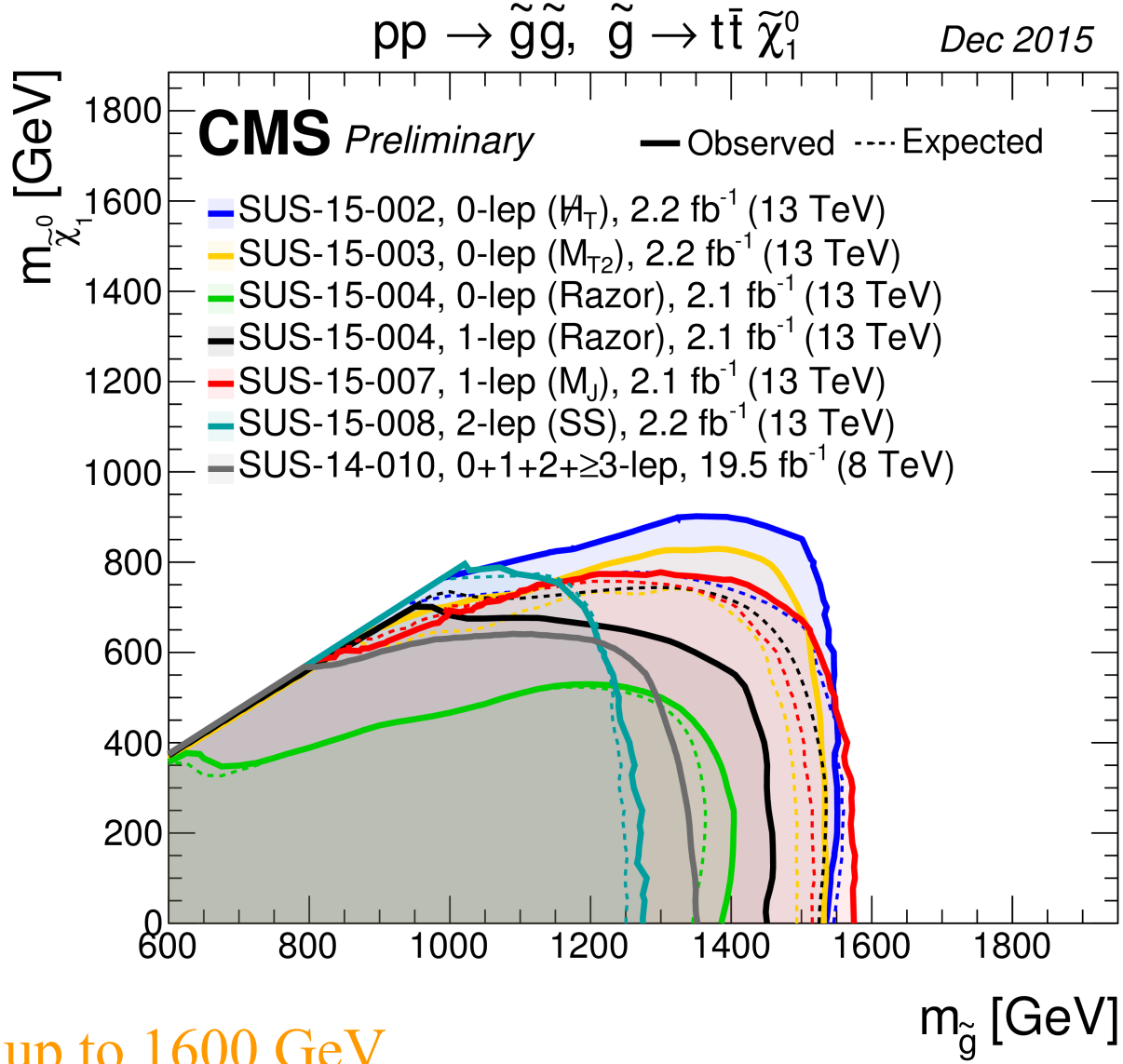
T1tttt topology: summary



Reaching up to 1600 GeV

Opposite-sign leptons: The EdgeZ analysis

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- SUSY decay chains can lead to opposite sign same flavor leptons in the final state
- Decays involving an on-shell Z boson will produce an excess on the Z peak invariant mass
  - Search for an excess of events in the tails of the MET distribution (traditional SUSY-like)
- Off-shell Z boson or slepton decays lead to a characteristic "edge" shape
  - Search for this structure in the invariant mass distribution (bump hunting-like)

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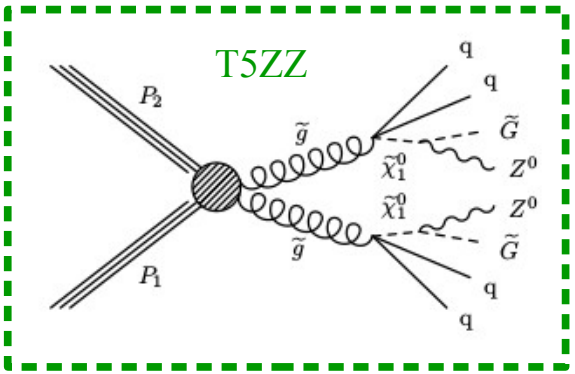

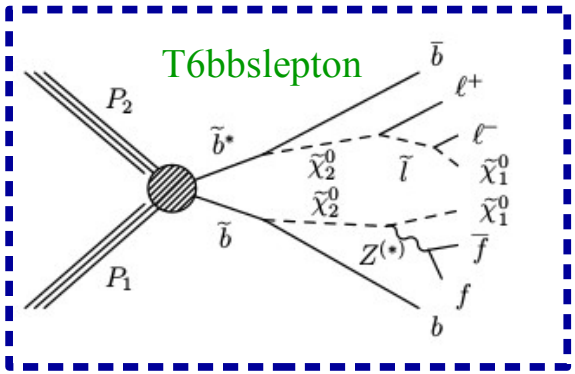

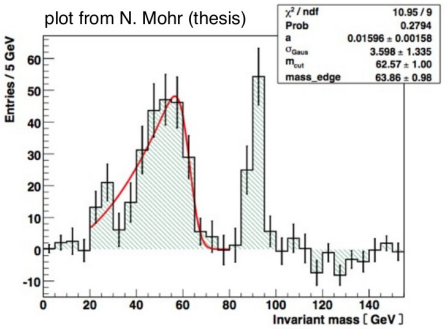

All possible mass endpoints calculated in CMS IN 2006/012, L.Pape, e.g. for a 3-body: $M_{ll}^{max} = M_X - M_0$

- CMS observed a 2.6 sigma deviation in the off-Z region at 8 TeV
- ATLAS reported 3 sigma in the on-Z region at 8 TeV and 2.2 in the same region at 13 TeV

Opposite-sign leptons at 13 TeV

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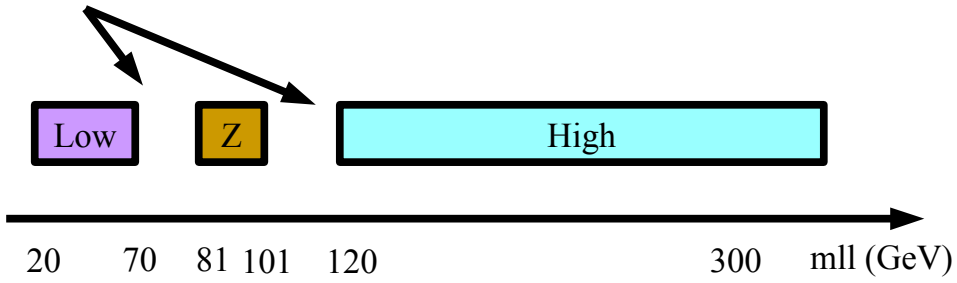
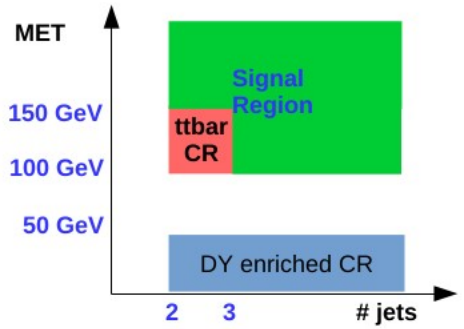
- Tha analysis has been repeated at 13 TeV only in its cut & count version
- The signal regions for the off-Z search have been kept unchanged with respect to 8 TeV
  - However new b-tagged exclusive regions were defined to explore the b-tag dependency
  - New signal regions covering the holes in the invariant mass have been also added





- The on-Z search extended by adding much higher granularity on jet multiplicity and MET
  - **Signal A**: 2-3 jets and HT > 400 with and without b-tagging + binning in MET
  - **Signal B**: >= 4 jets with and without b-tagging + binning in MET

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  - A new region as similar as possible to the **ATLAS region** has been also defined
    - HT + pT(lep1) + pT(lep2) > 600, MET > 225 GeV, $\Delta\varphi$(MET, jets) > 0.4

Background prediction & results

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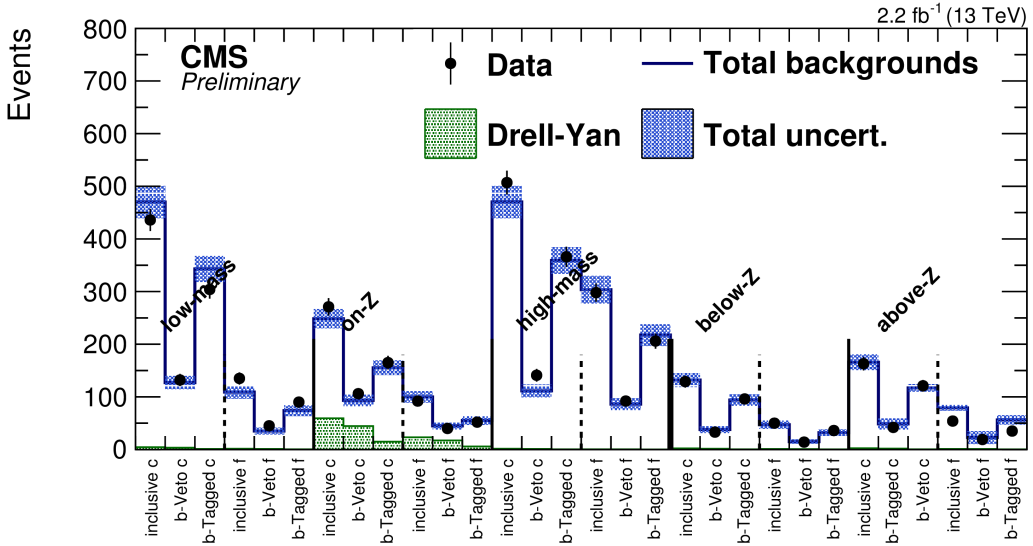
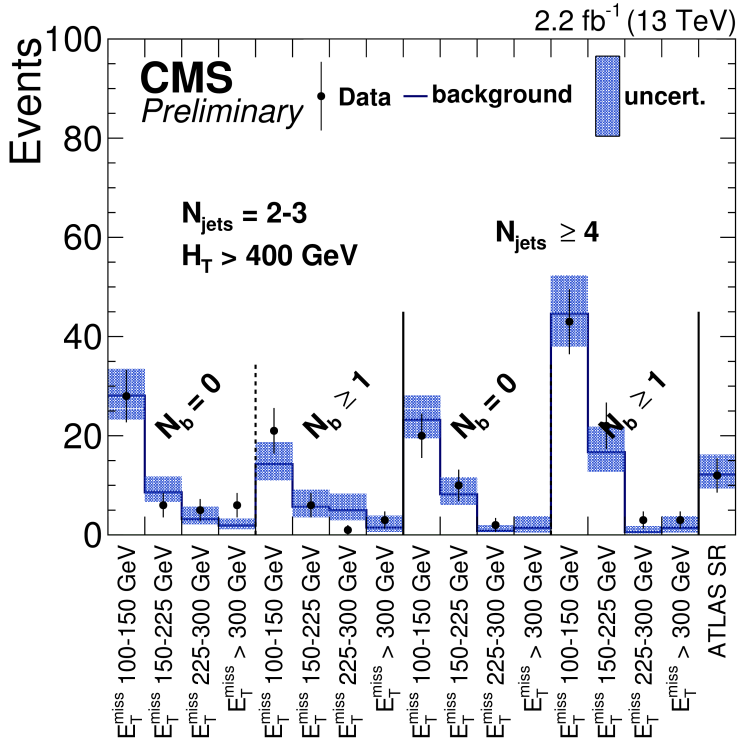
- The main SM backgrounds: top-pair production (real MET) and DY+jets (instrumental MET)
  - Top-pair production → Extracted from eμ events after correcting for efficiency differences
  - DY + Jets → Measure instrumental MET shape in a γ + jets control sample with a similar MET origin
- Good agreement between prediction and observation for all signal regions





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Edge Signal Regions

on-Z Signal Region

A closer look to the edge region

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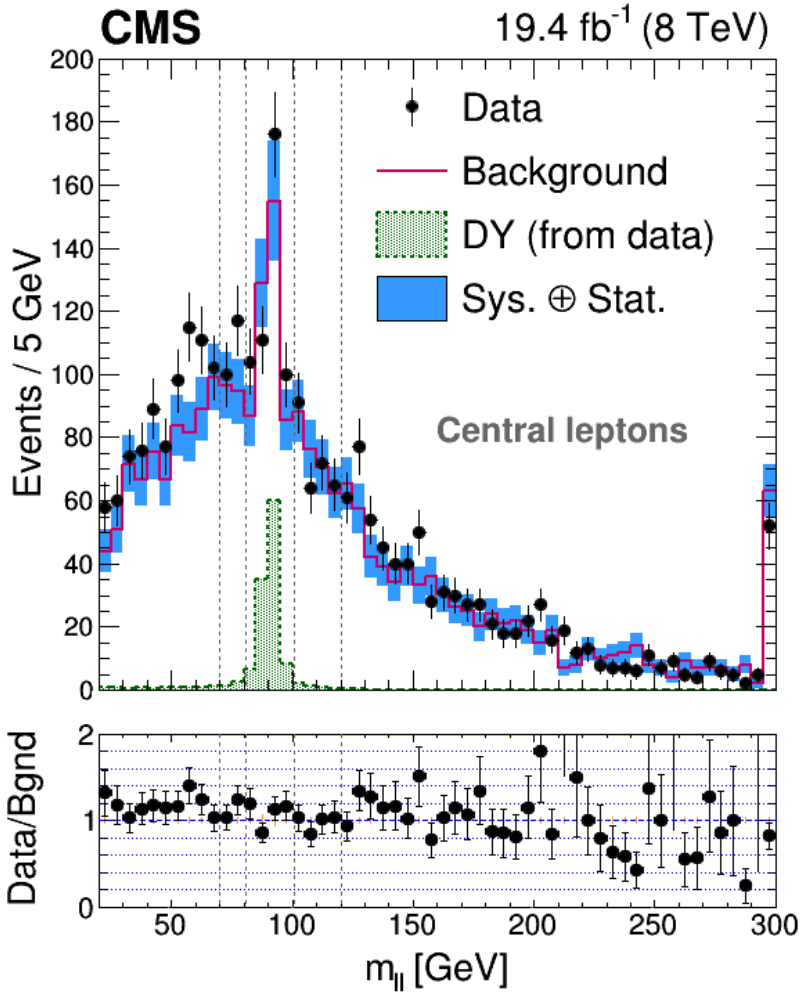
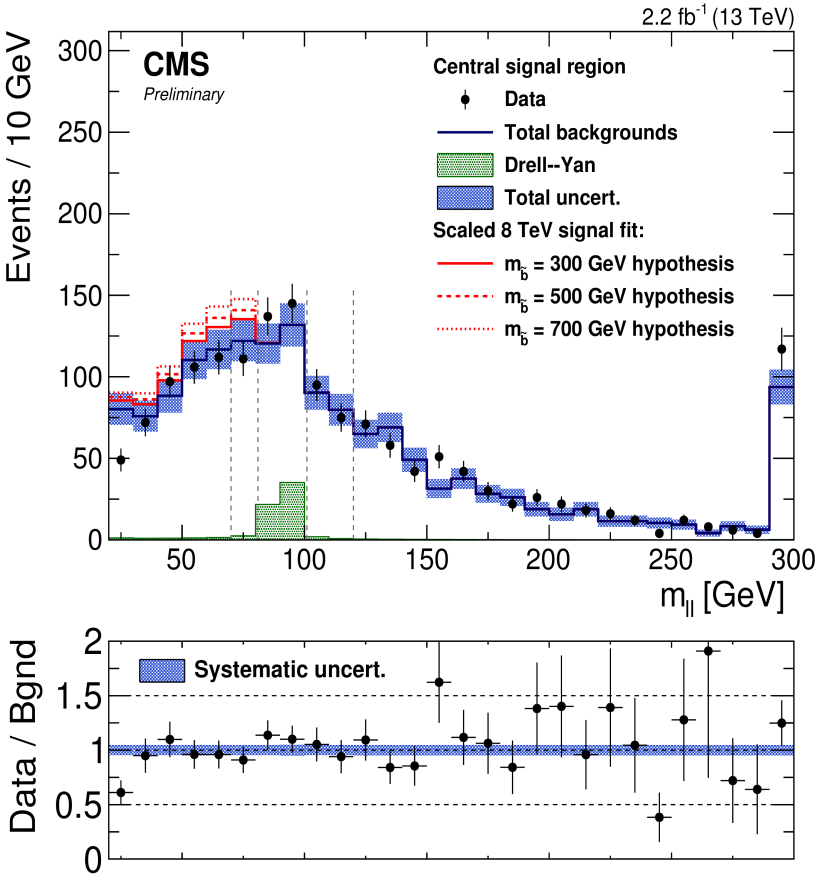
- Good agreement is observed in the classic edge region (also in the region with > 0 b-tags)
- **13 TeV data disfavors the signal hypothesis although it is on the limit of sensitivity**





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A closer look to the ATLAS region

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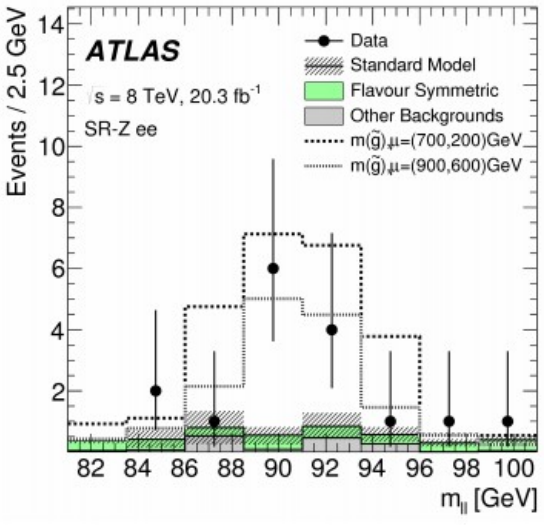
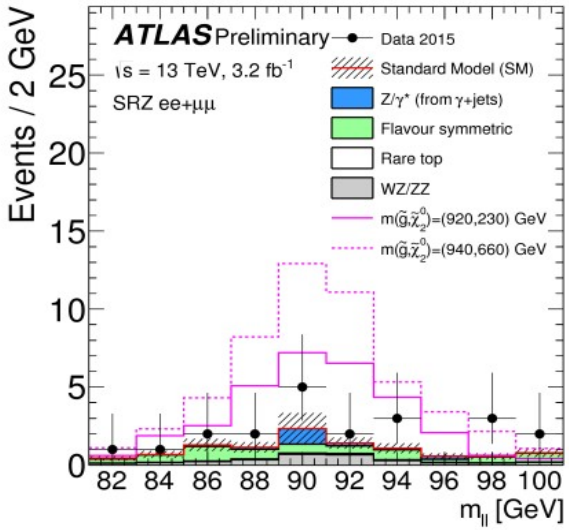
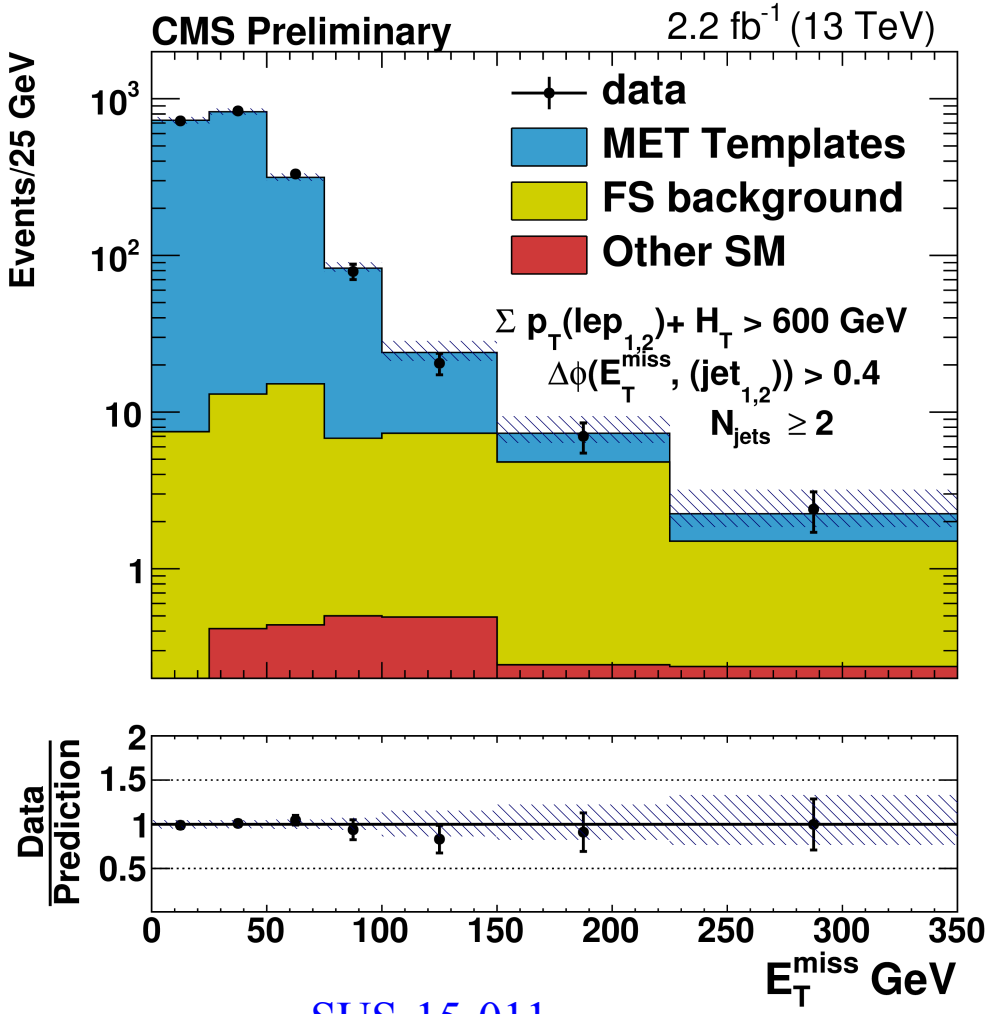
- CMS does not observe any excess in the so called "ATLAS" region







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Upper limits on Simplified Models

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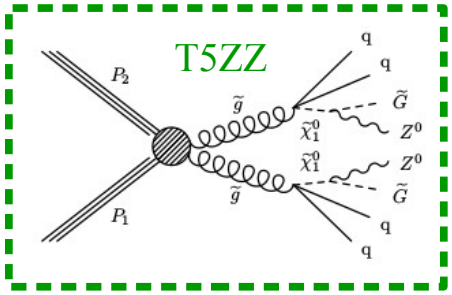
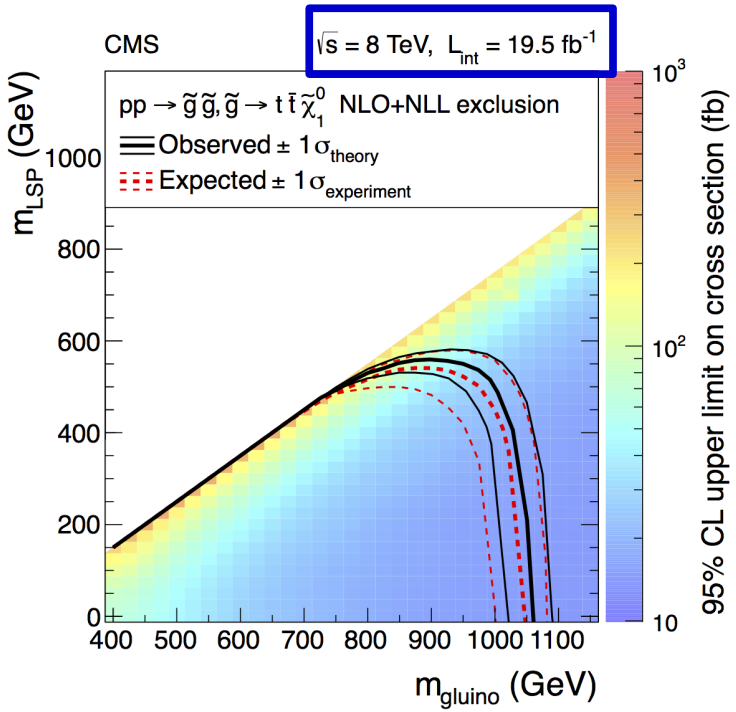
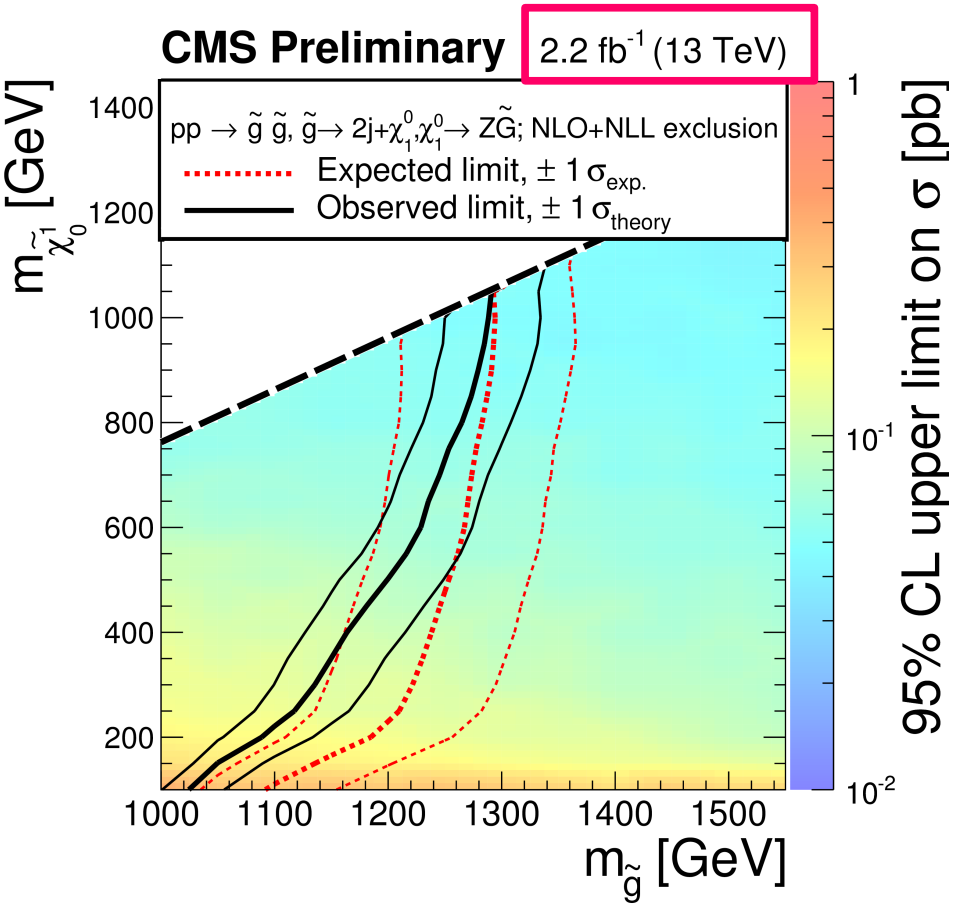
- Upper limits on gluino masses for the T5ZZ model are pushed ~ 100 GeV



Mass of gravitino is set to 0



8 TeV result



SUS-15-011

Summary & outlook

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- CMS collected 2.2 fb^{-1} of data in 2015 with a new center of mass energy of 13 TeV
- A complete set of SUSY analysis covering different topologies have been deployed by CMS
- Given the current amount of data most of them targeting mainly gluino production
- A good agreement between observation and prediction has been observed in all cases
- Upper limits on gluino mass has been pushed forward about ~ 300 GeV (for low LSP mass)
- The "Edge-Z" analysis has been also repeated to crosscheck the previous results
  - However 13 TeV results on the Edge region (2.6 sigma an 8 TeV) disfavor the signal hypothesis
  - CMS does not see any excess in the region where ATLAS saw 3.0 and 2.2 sigma excesses
- However this was only the first chunk of results with the first 2.2 fb^{-1} at 13 TeV
  - Many more results will be coming by the time of Moriond
  - And of course many more results will be coming with the new data of 2016

Stay tuned!

Thank you for the attention!

Questions???