Searches for heavy resonances at the LHC

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For the ATLAS and CMS collaborations,

XXII International Workshop on Deep Inelastic Scattering and Related Subjects,

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Outline

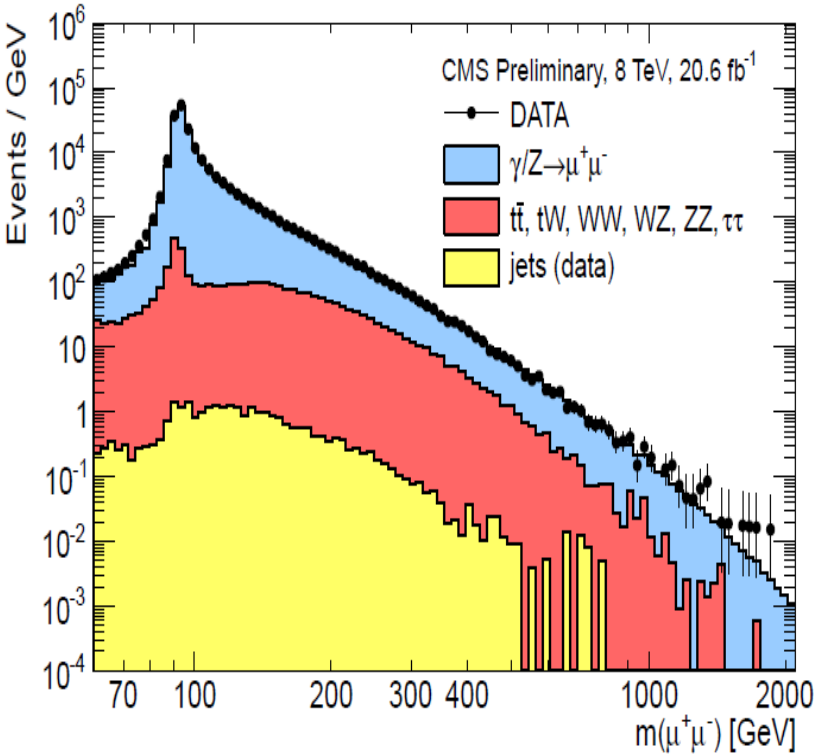
- Looking for signatures of new physics:
  - Heavy resonances in di-lepton and lepton+MET channels
  - Excited quarks in γ+jets final state
  - Lepto-quarks in b+τ and top+τ channels
- Mostly focusing on the most recent results.
- Other parallel talks focusing new physics aspects:
  - Resonant di-boson production (Matthias Mozer)
  - Vector-like quarks, ttbar resonances (Thomas Peiffer)
  - Dark matter (Arely Cortes Gonzalez)
  - Model independent search in multi-leptons, excited leptons, heavy neutrinos (Olya Igonkina)
  - SUSY resonances, RPV SUSY and long-lived particles (Sofia Vallecorsa, yesterday morning)

Search for di-lepton resonances

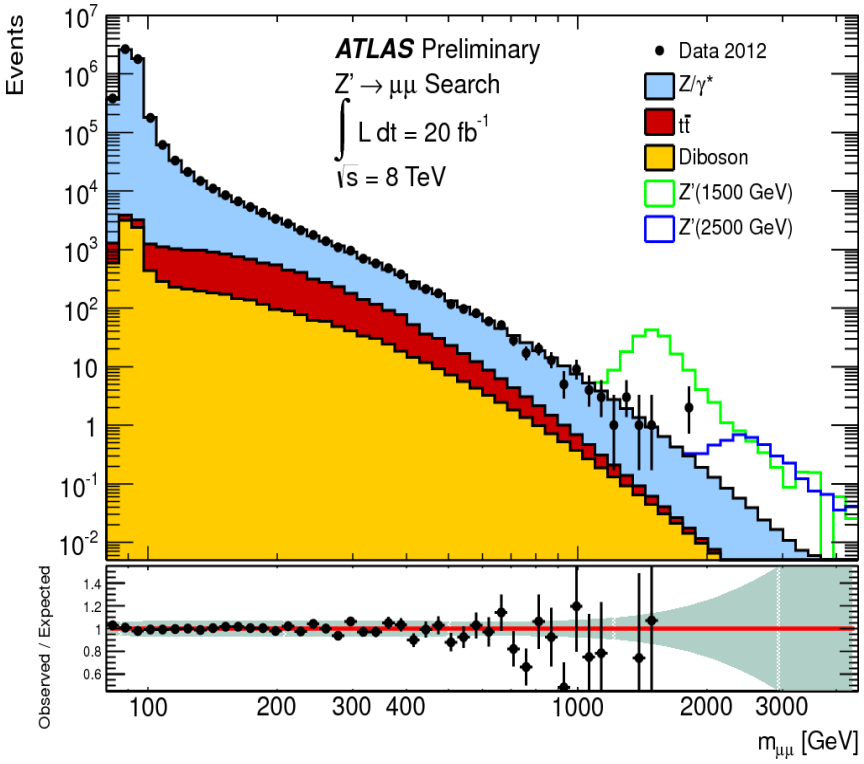
Searches for heavy resonances (di-lepton)

- Selection CMS(ATLAS): E_T>35 GeV (40 and 30), |η|<1.442(1.37), 1.56(1.52)<|η|<2.5(2.47), p_T^{μ} >45 (25) GeV, |η|<2.1(2.4), Isolation criteria.
- Data consistent with the Standard Model prediction.

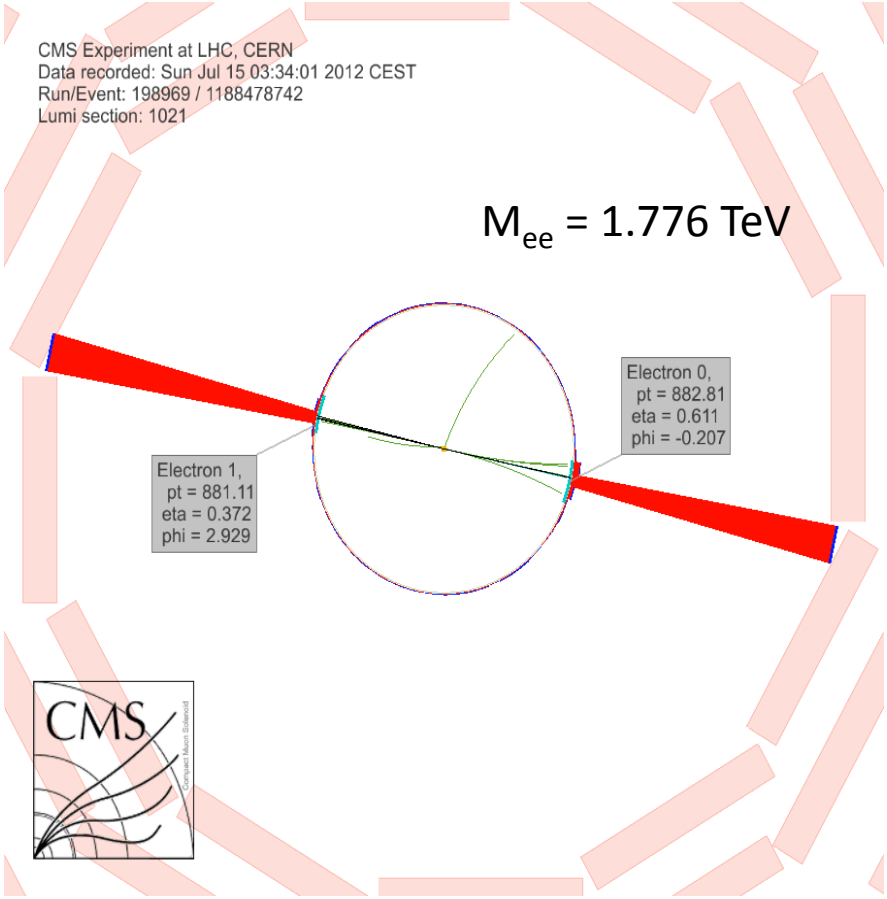
CMS-PAS-EXO-12-061

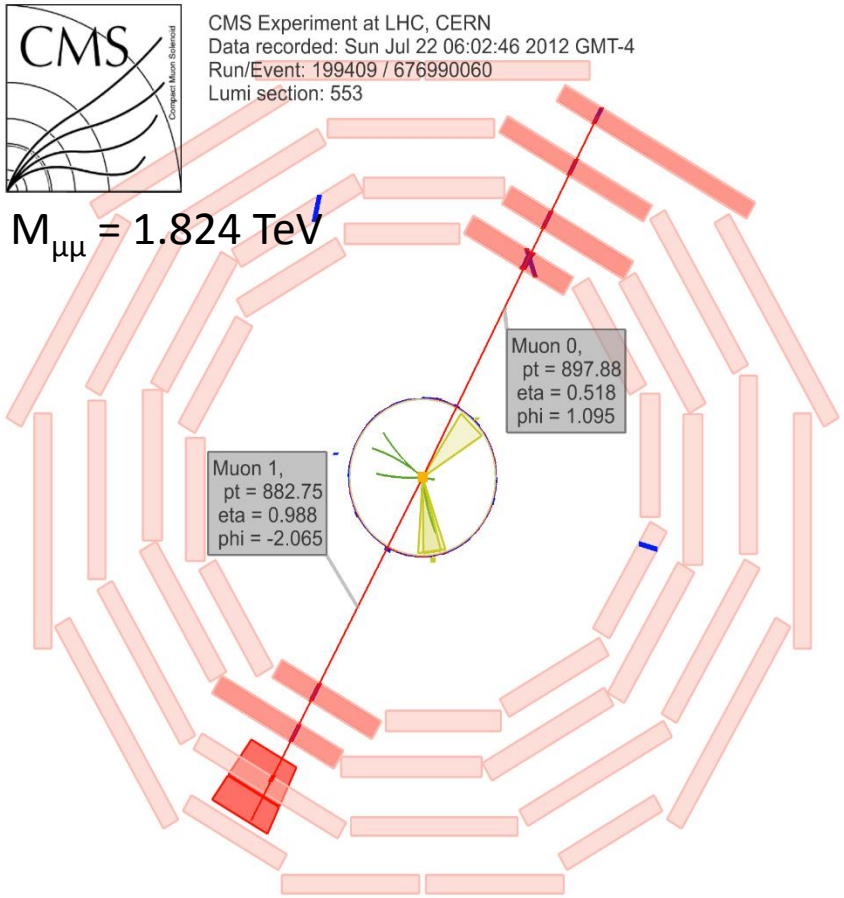


ATLAS-CONF-2013-017



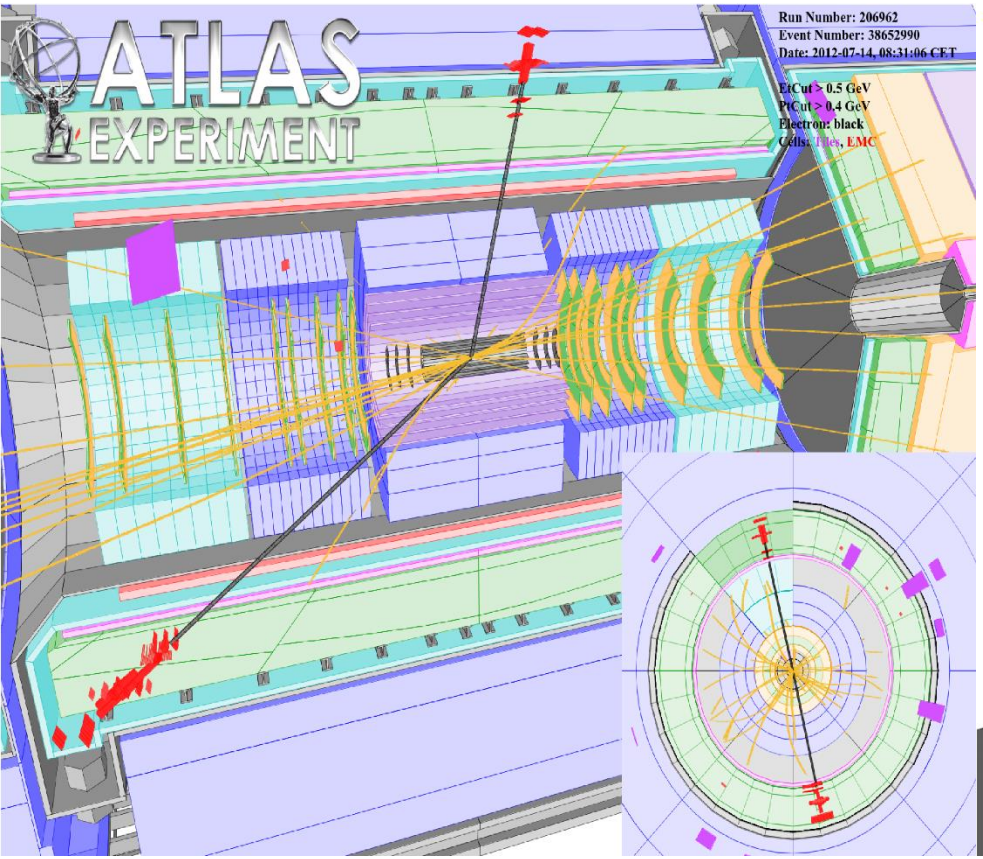
Some event displays (di-lepton) CMS



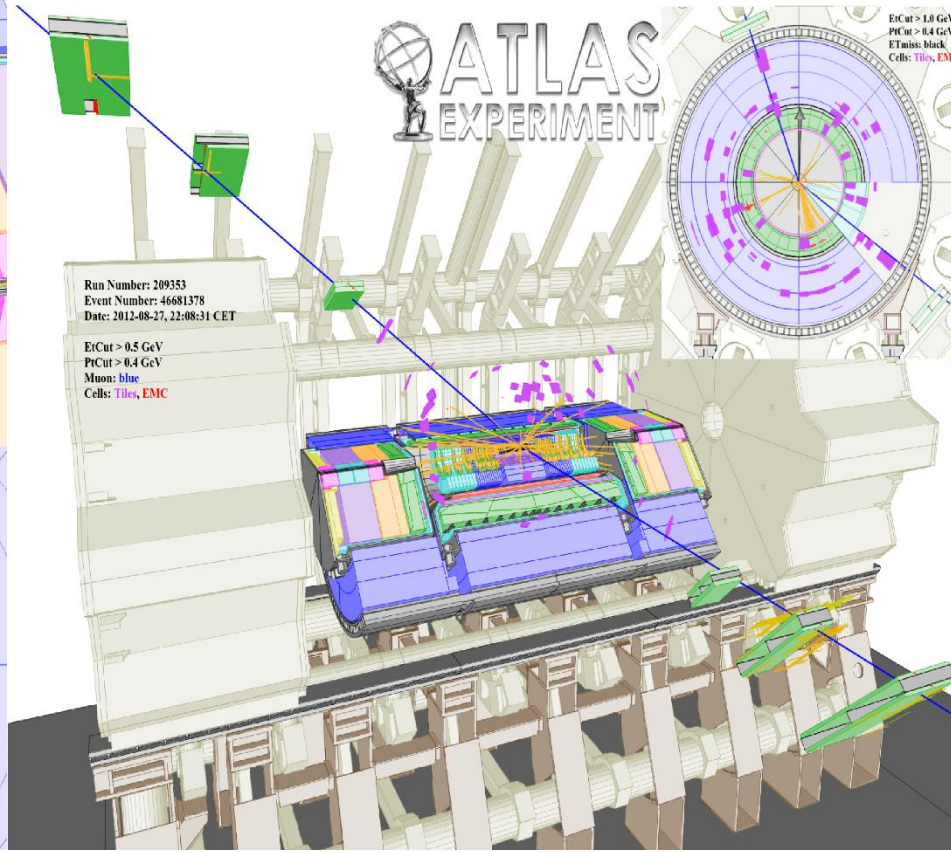


Some event displays (di-lepton) ATLAS

M_{ee} = 1.541 TeV



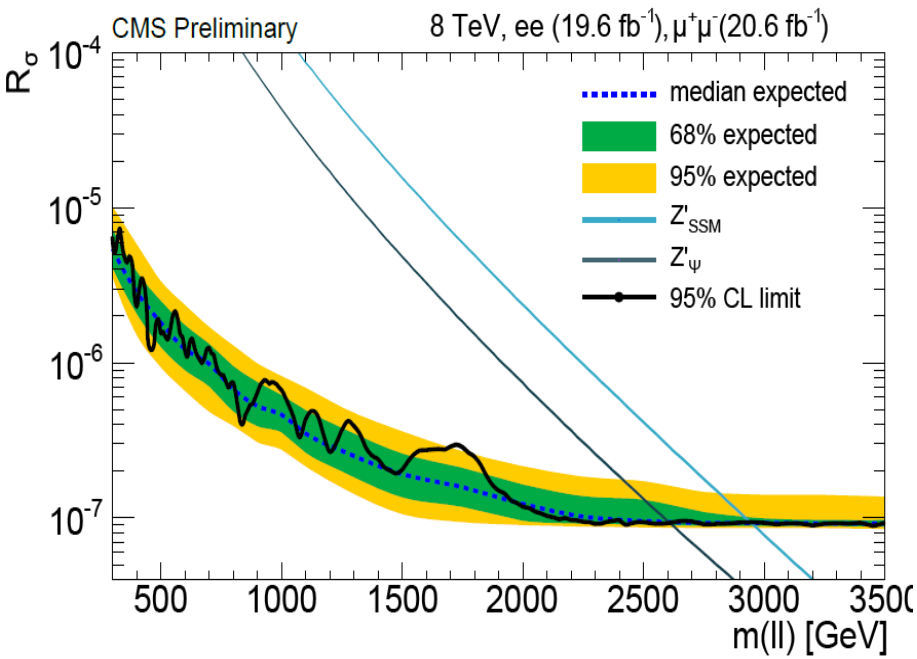
$M_{\mu\mu}$ = 1.844 TeV

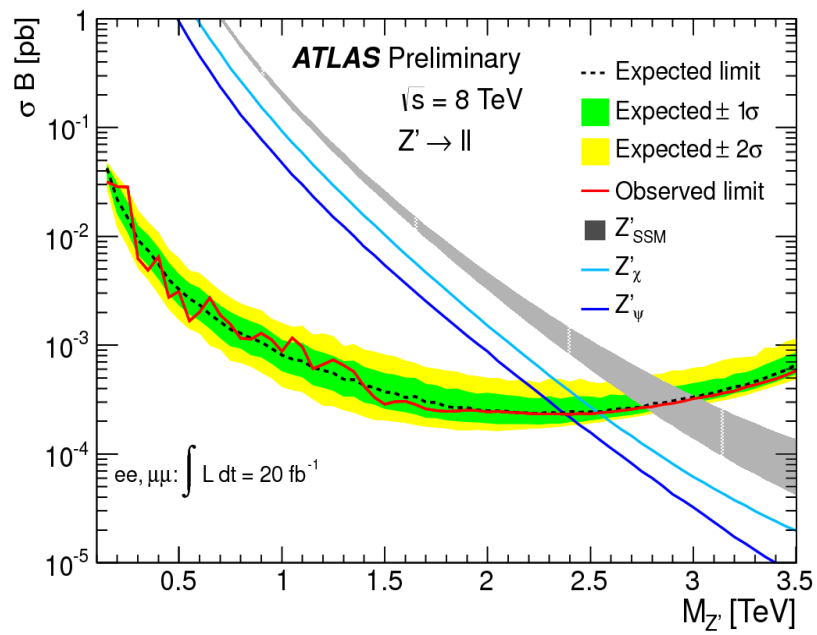


Limit plots (Z')

- Limits at 95% confidence level:
  - $M(Z'_{SSM}) > 2.96$ TeV (CMS) & 2.86 TeV (ATLAS)
  - $M(Z'_{\psi}) > 2.60$ TeV (CMS) & 2.38 TeV (ATLAS)

$$R_\sigma = \frac{\sigma(pp \to Z' + X \to \ell\ell + X)}{\sigma(pp \to Z + X \to \ell\ell + X)}$$



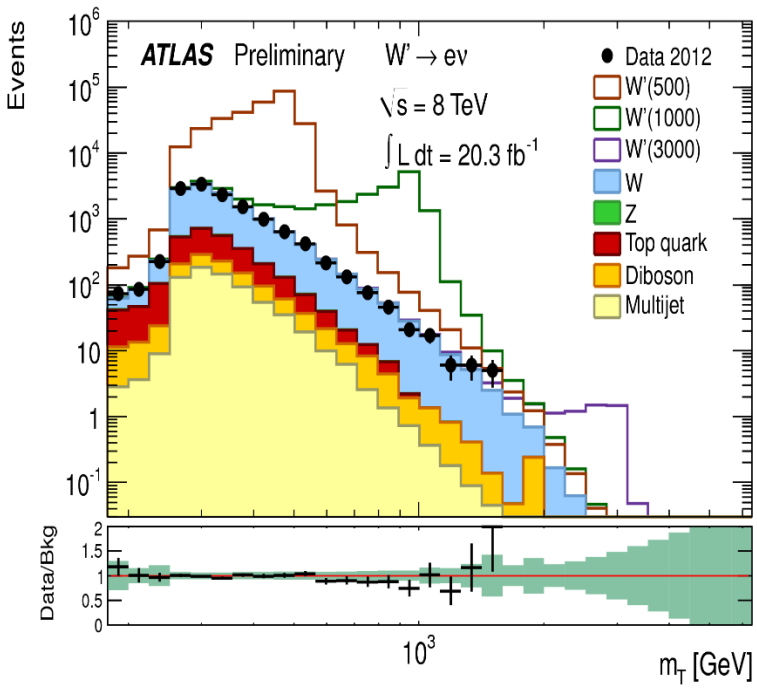


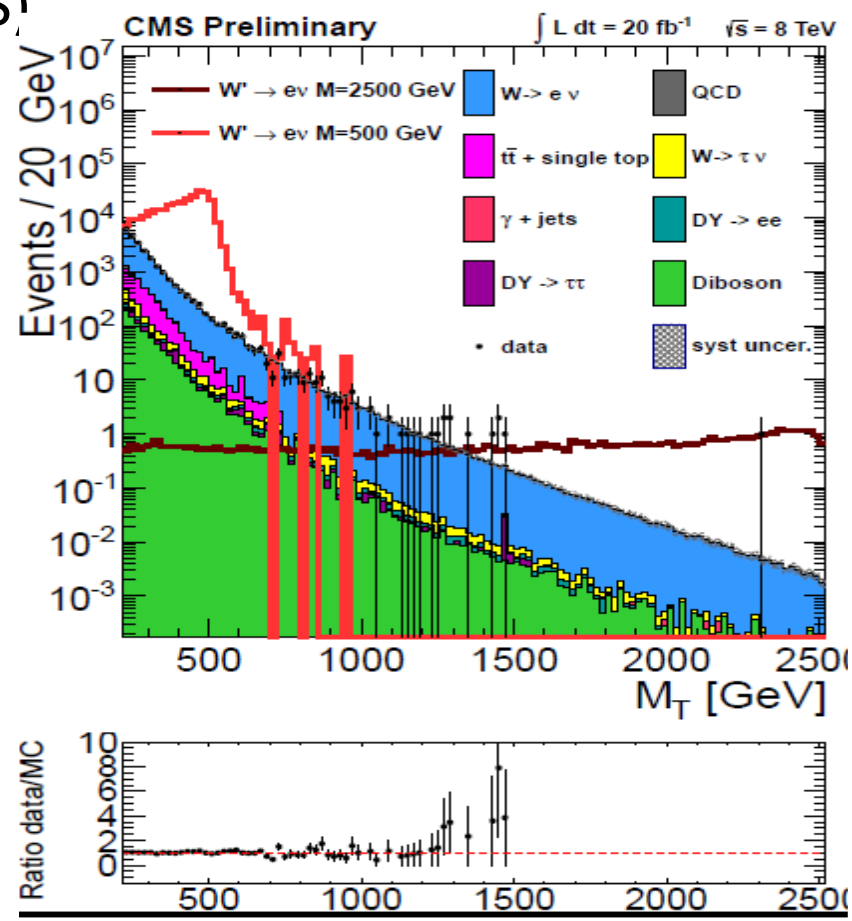
Search for resonances in lepton+MET final state

lepton+MET final state

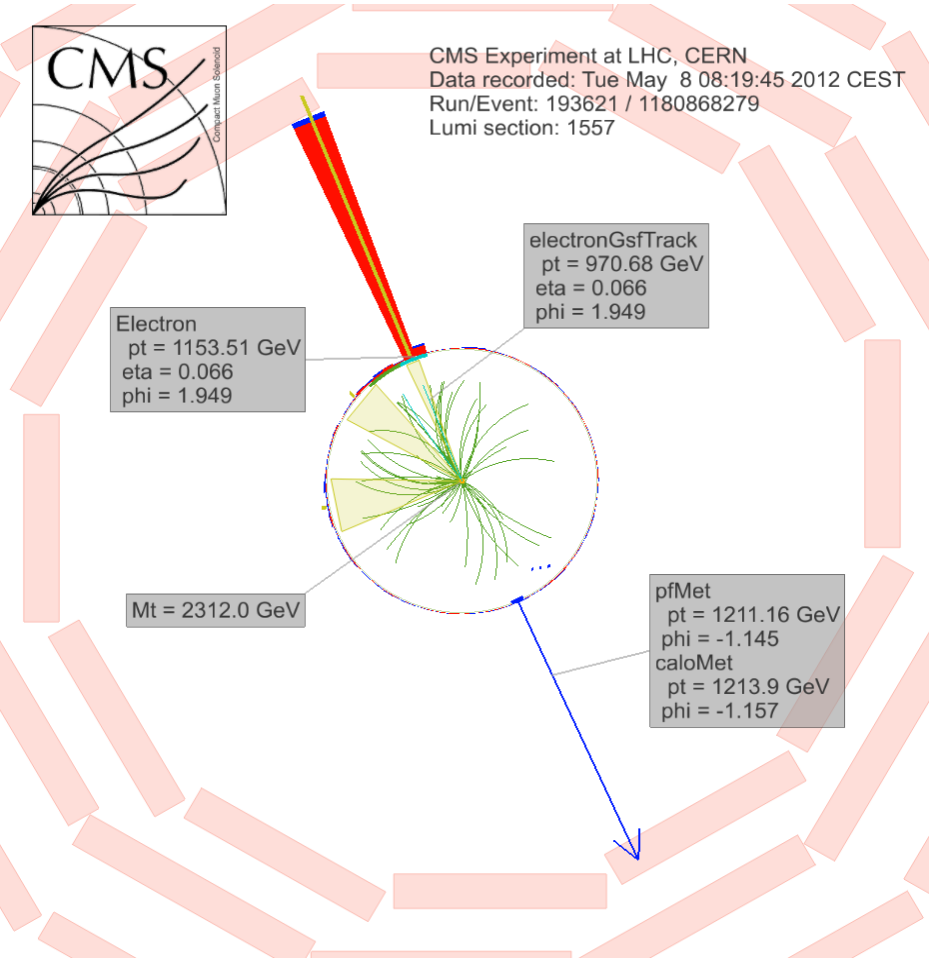
- Bump hunt in m_T spectrum.
- E_t^{ele} > 100 (125) GeV CMS (ATLAS)
- p_T^{μ} > 45 GeV

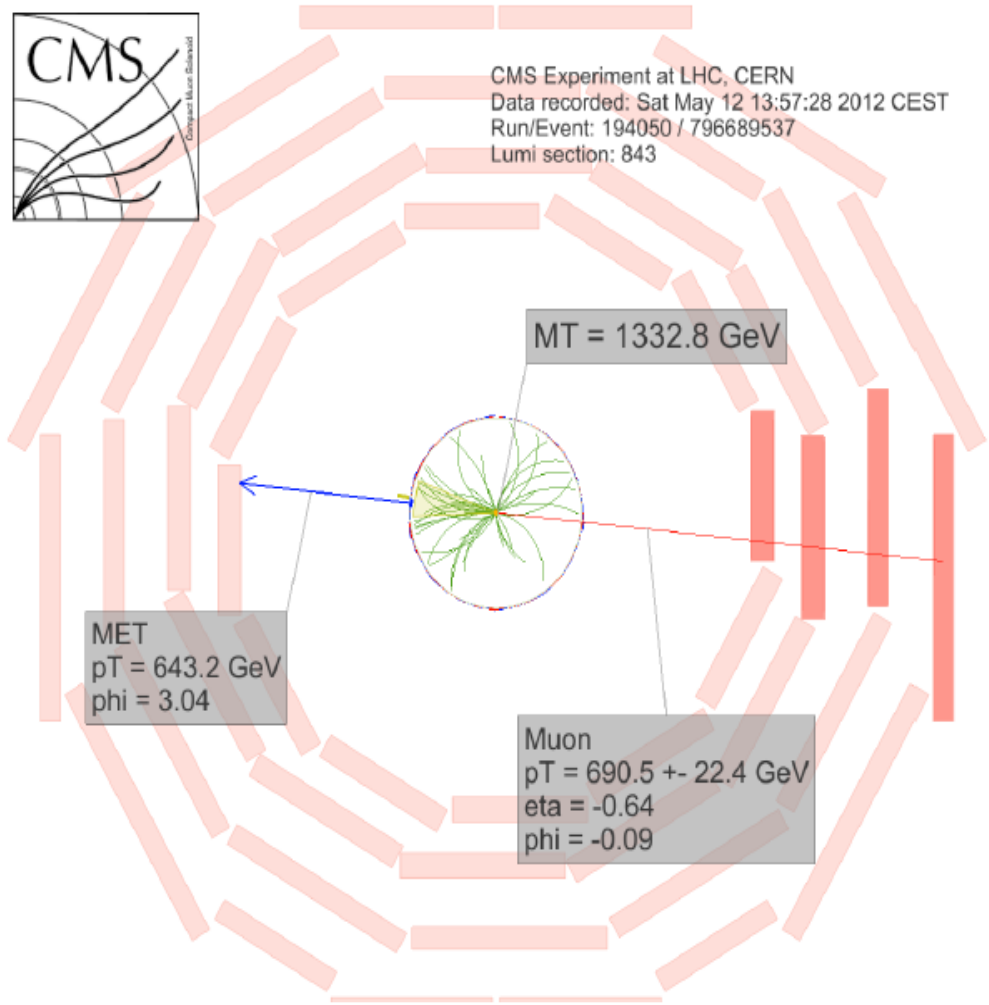
$$m_T = \sqrt{2 p_T E_T^{miss} (1 - \cos \varphi_{\ell\nu})},$$





Some event displays (lepton+MET)

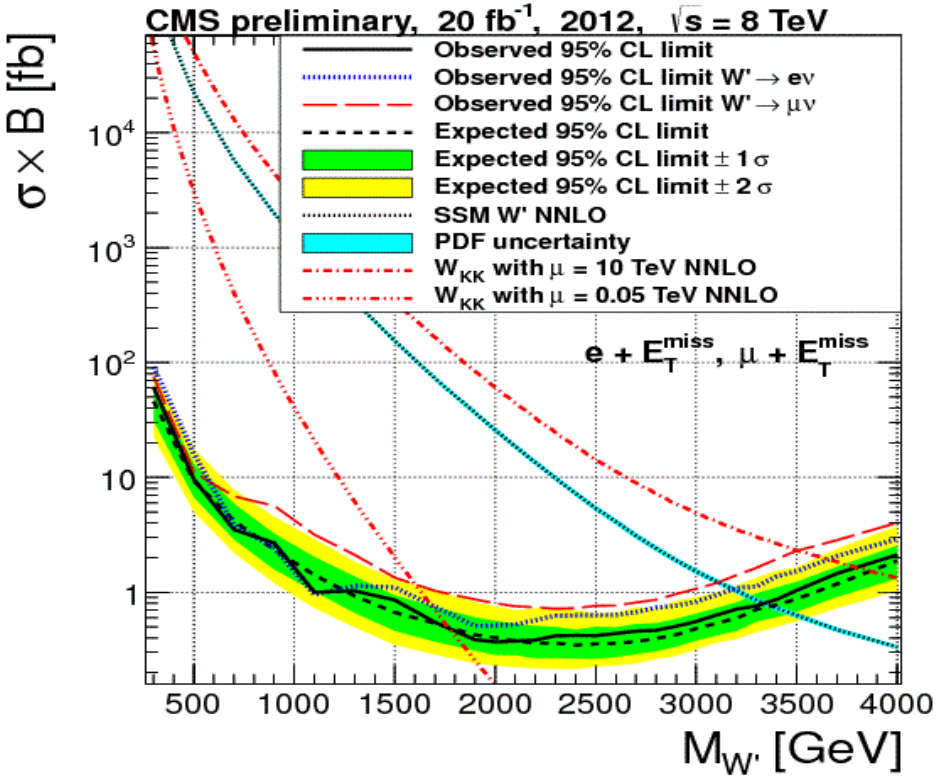




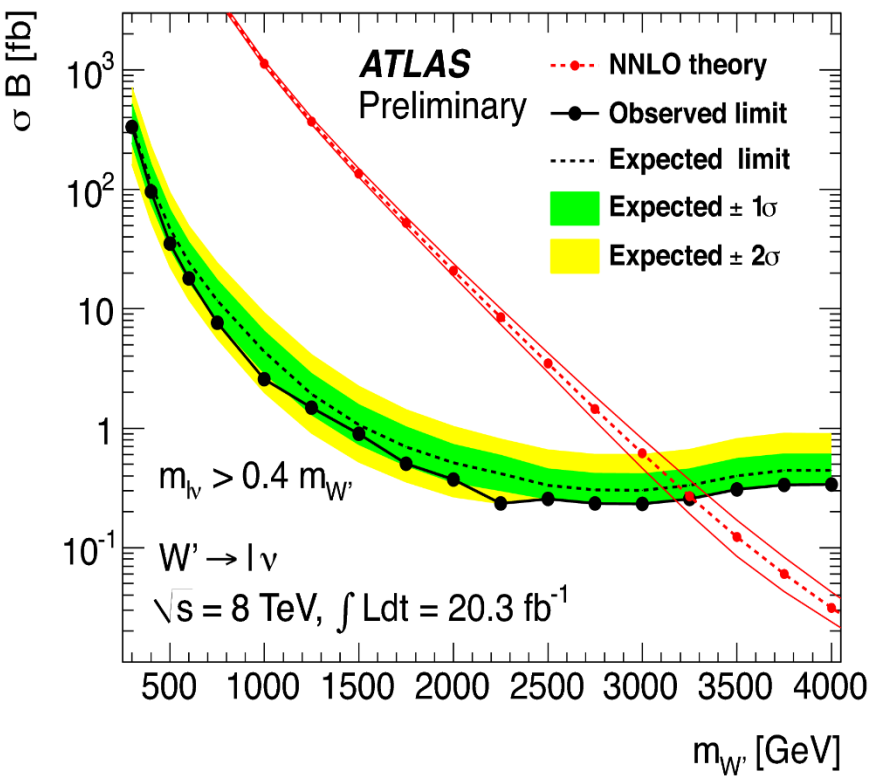
Limit plots (W')

- CMS (ATLAS) excluded SM-like W‘ mass < 3.35 (3.27) TeV at 95% confidence level.

CMS-PAS-EXO-12-060

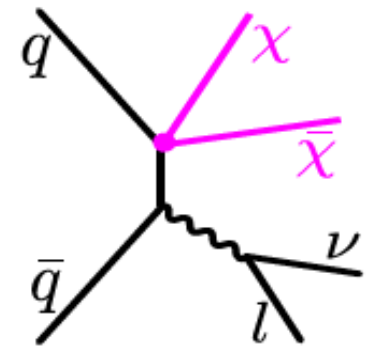


ATLAS-CONF-2014-017

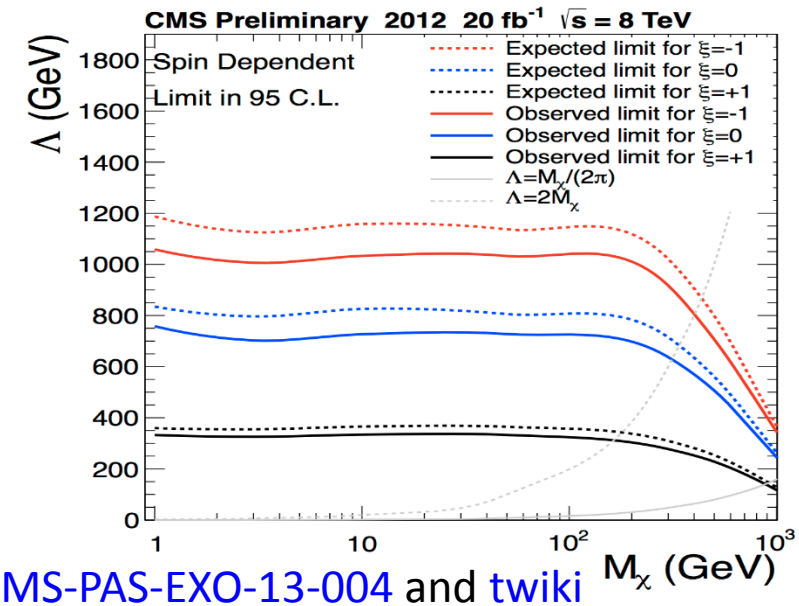


DM interpretation

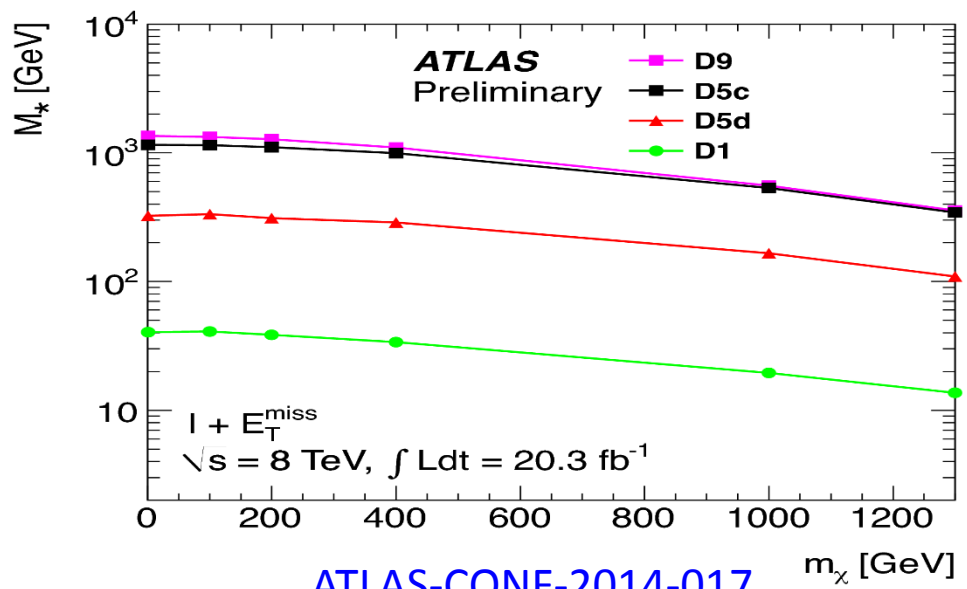
- Production of DM particles recoiling against W decaying leptonically.
- Complements the search for DM in mono-photon and jet channels.



arXiv : 1208.4361



CMS-PAS-EXO-13-004 and twiki



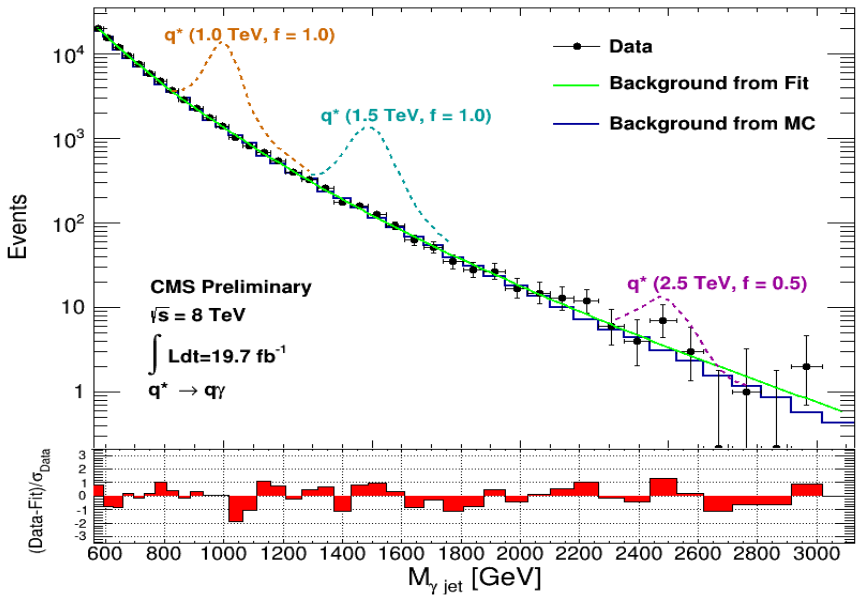
ATLAS-CONF-2014-017

Search for resonances in γ + jets final state

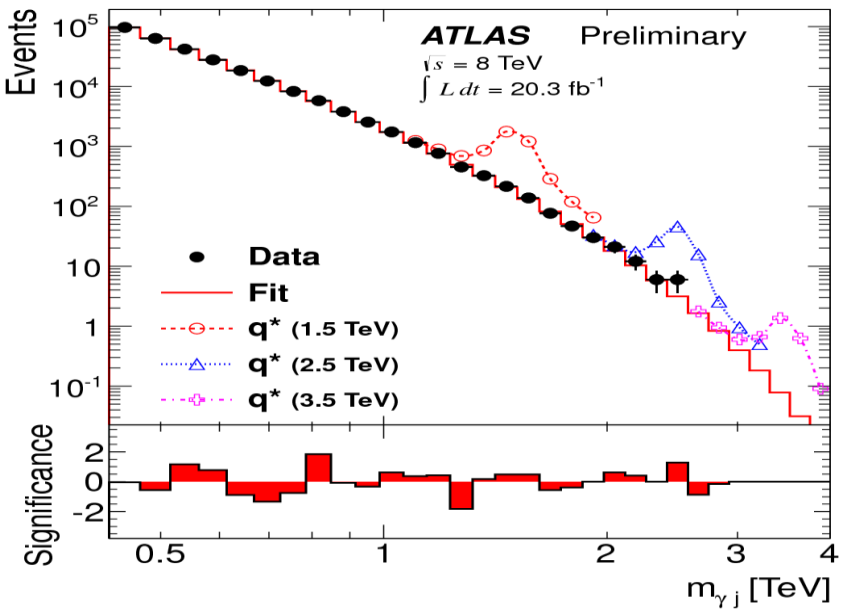
γ+jets final state

- Search for excited quarks decaying to γ + jets.
- Event selection CMS (ATLAS) : $p_T^{\gamma} > 170$ (125) GeV; $\eta^{\gamma} < 1.44$ (1.37); $\eta^{j} < 3.0$ (2.8); $\Delta\eta^{\gamma,j} < 2.0$ (1.6)
- No significant excess is observed. $f(x \equiv m_{\gamma j}/\sqrt{s}) = p_1(1-x)^{p_2} x^{-(p_3+p_4 \ln x)}$.

CMS-PAS-EXO-13-003

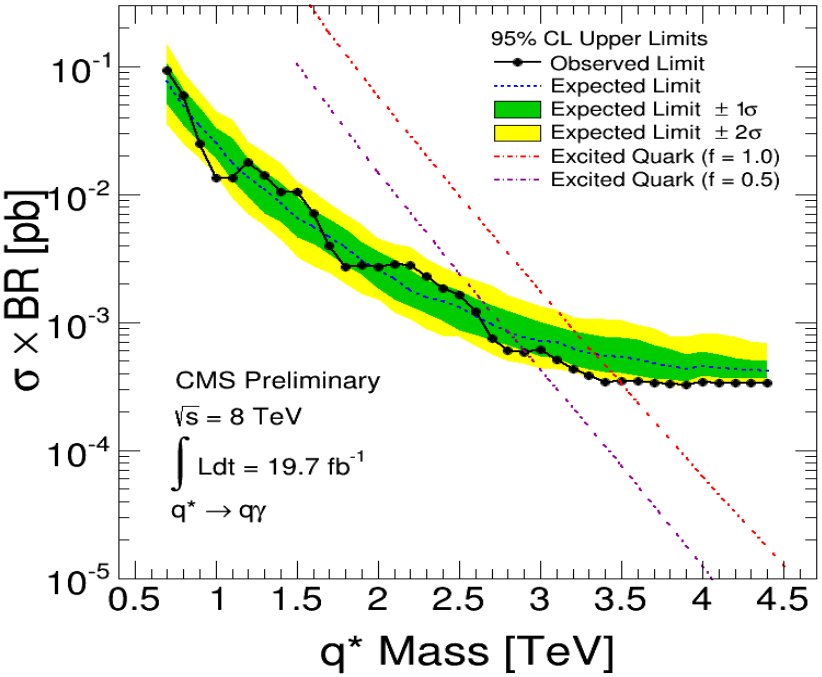


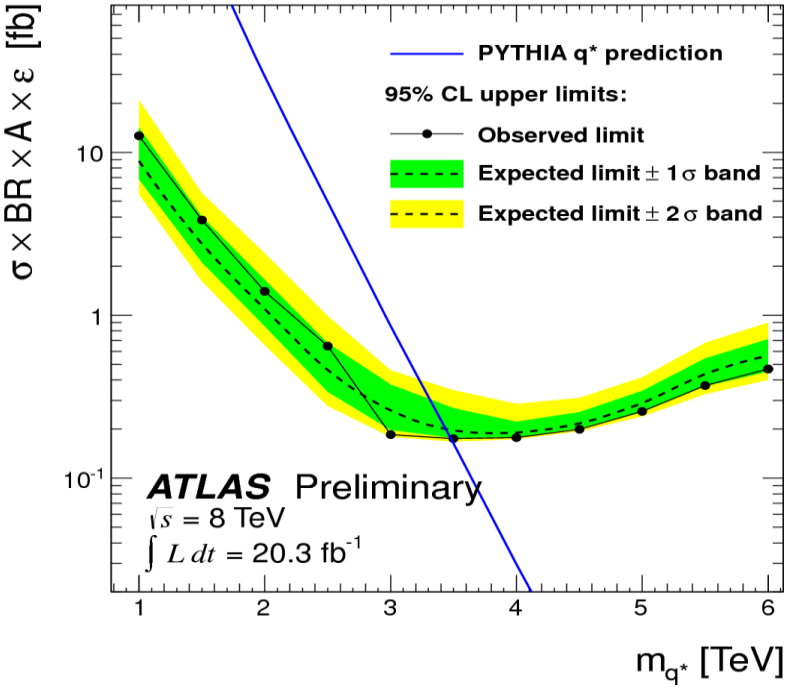
PLB 728, 562 (2013)



Limit plots (q*)

- Both CMS and ATLAS exclude excited quark mass < 3.5 TeV @ 95% CL.

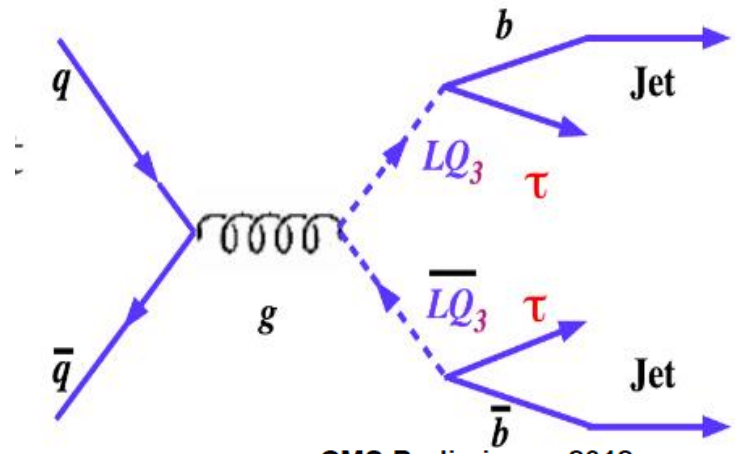


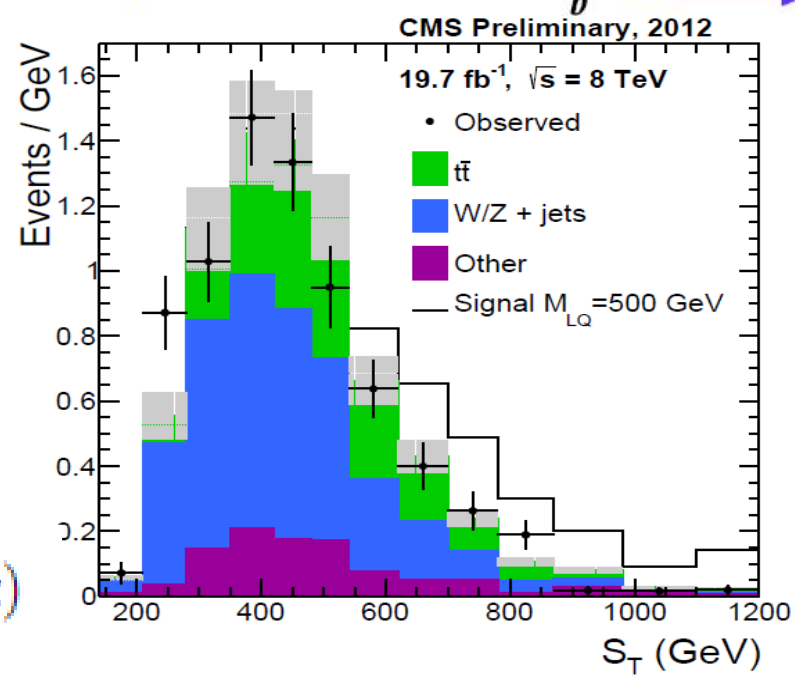


Search for lepto-quarks in b+τ and top+τ final states

b+τ final state

- Search for the pair production of heavy scalar particles.
- Assumption: 100% branching fraction for the lepto-quark decay to τ and b-quark.
- $M(\tau_h, \text{Jet}) > 250$ GeV, $p_T^{\tau} > 50$ GeV
-

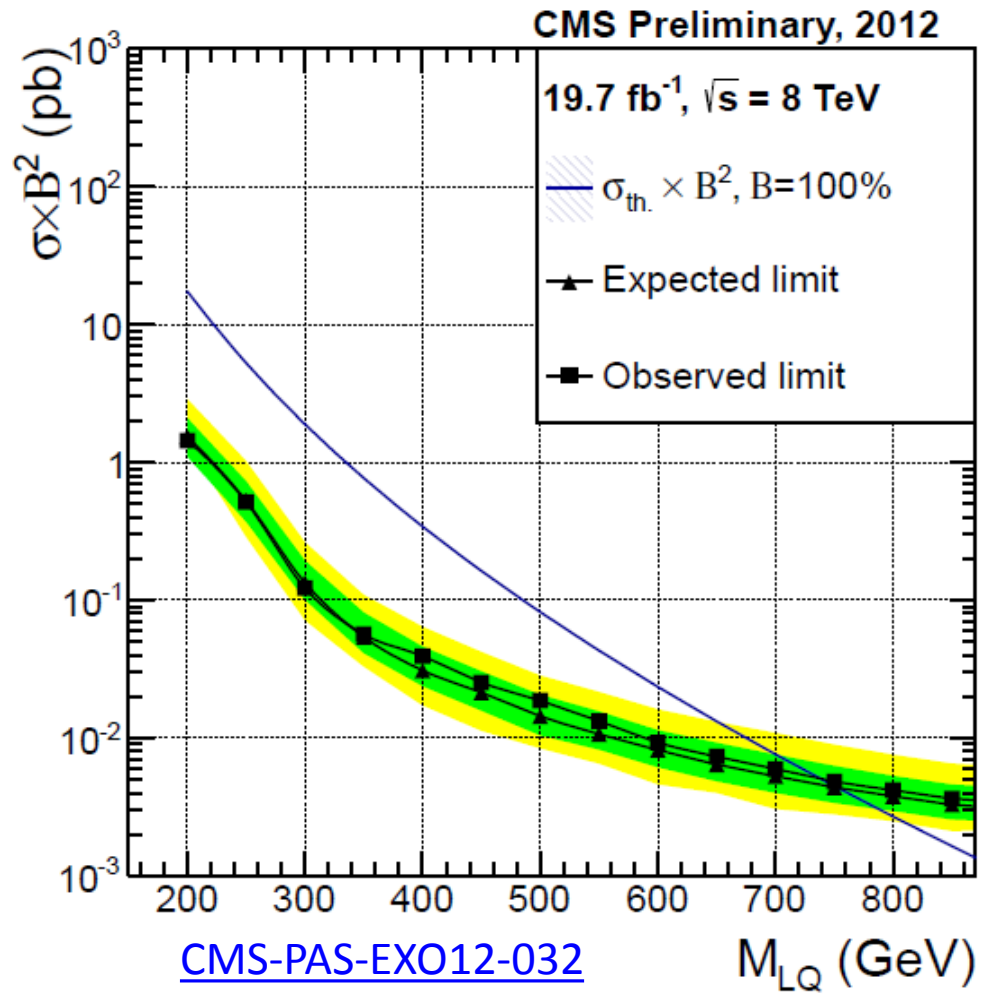




$$S_T^{(LQ)} = p_T(\ell) + p_T(\tau_h) + p_T(\text{b-jet}) + p_T(\text{jet})$$

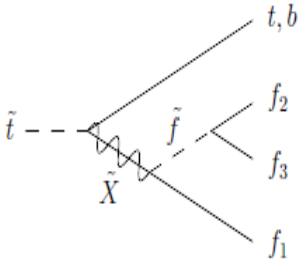
Limit on M_{LQ}

- LQ3 masses below 740 GeV are excluded at 95% confidence level.
- Previous limit on LQ3 mass from ATLAS and CMS was around 540 GeV for 7 TeV dataset.



CMS-PAS-EXO12-032

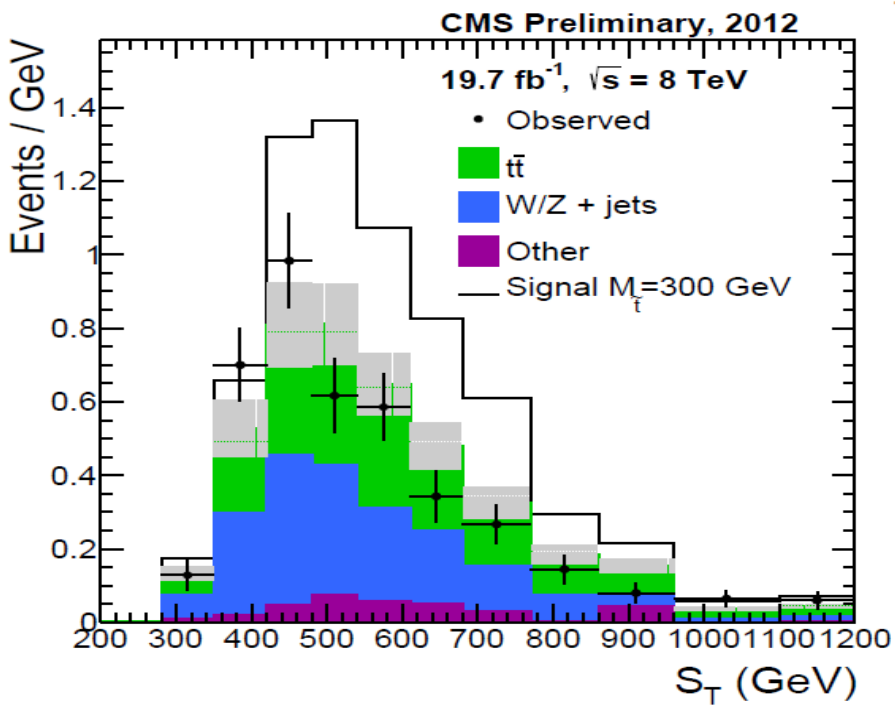
Limit on RPV stop

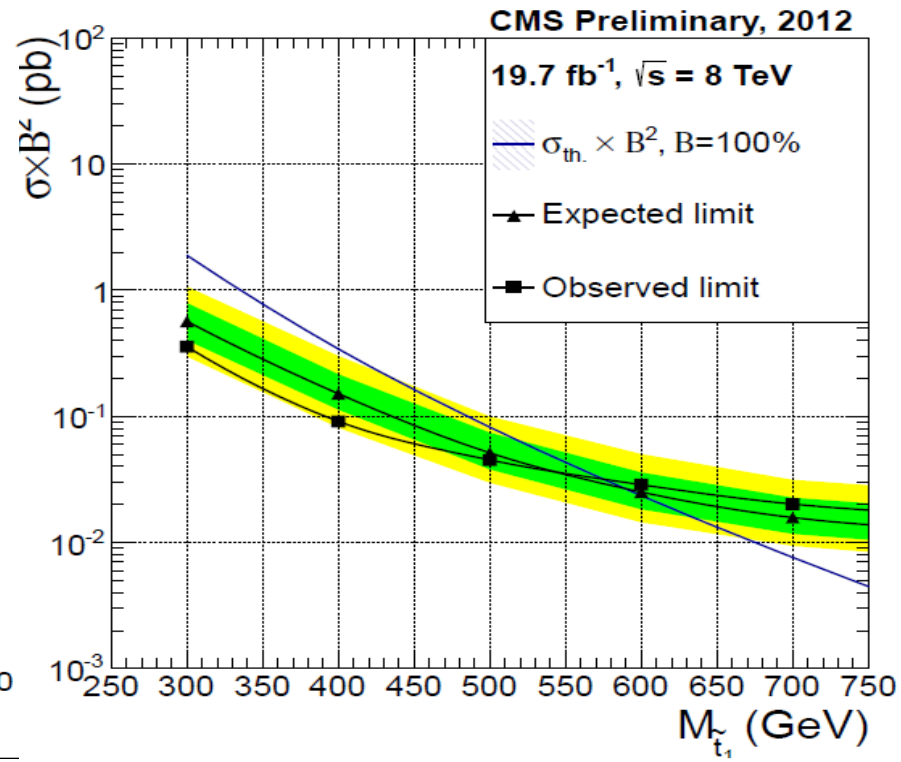


- The limit on LQ3 directly constrains the production of supersymmetric top partners.

arXiv:1209.0764

- Stop quarks in this model with masses below 576 GeV are excluded at the 95% confidence level.

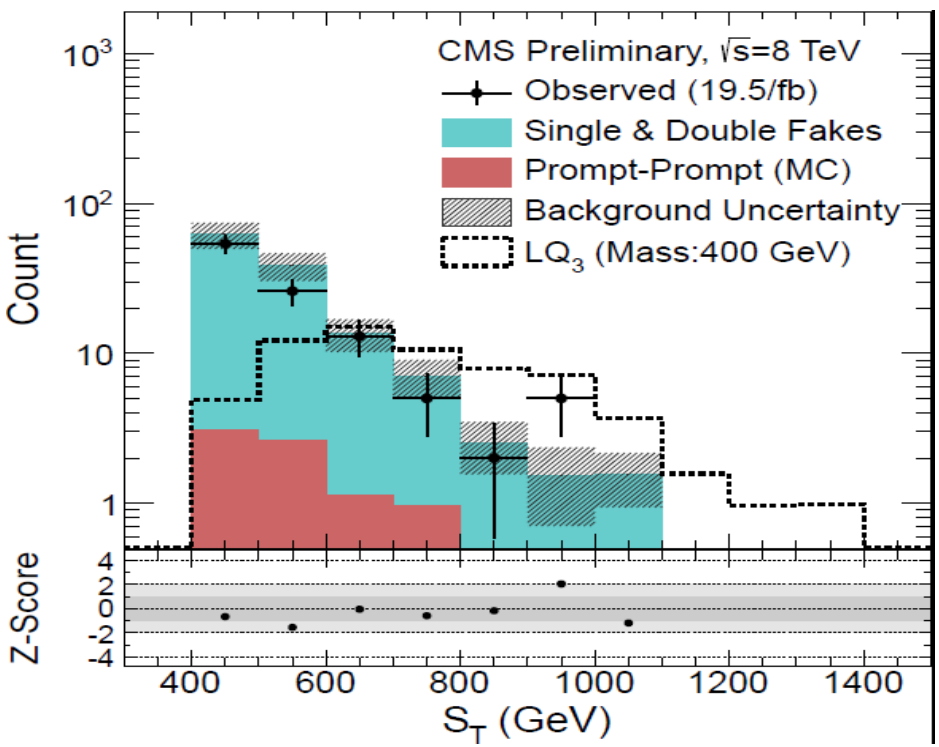


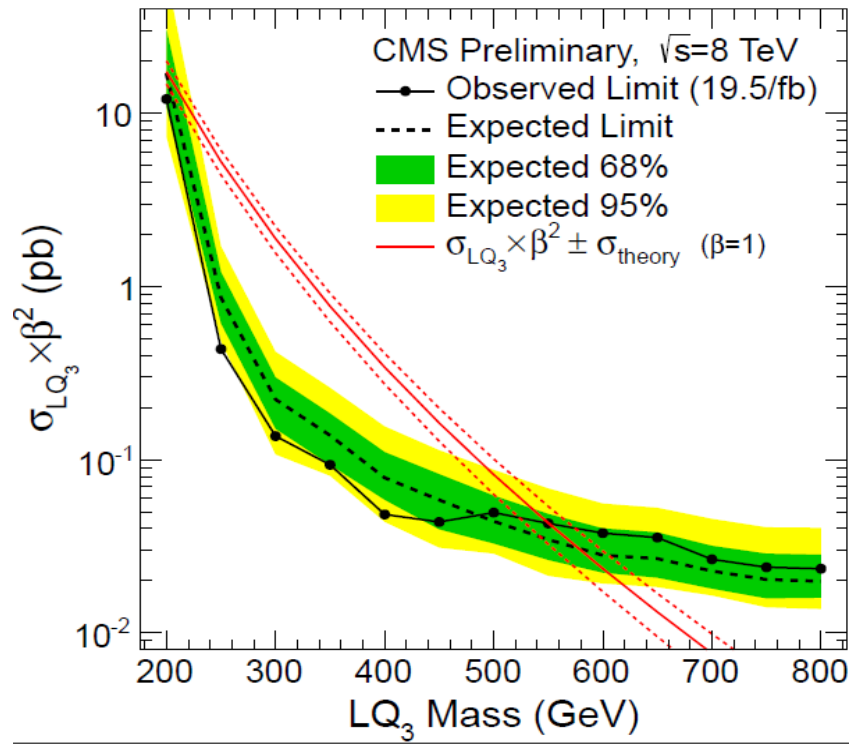


LQ3 searches in top+τ final state

- Same sign $\mu\tau_h$ pair, $S_T > 400$ GeV, $M_T(\mu,MET)>40$ GeV.
- The existence of pair produced LQ3s up to a mass of 550 GeV are excluded at 95% confidence level.

CMS-PAS-EXO-12-030





Conclusion

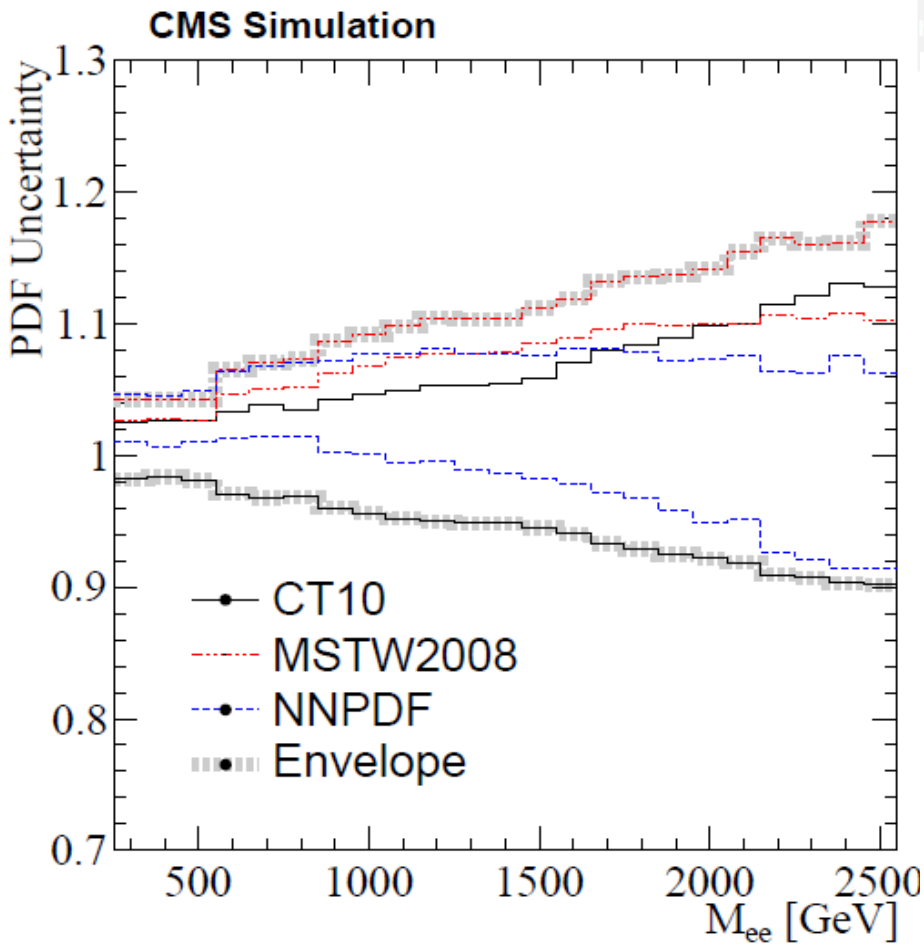
- A handful of the recent search analysis results are presented from CMS and ATLAS collaboration.
- No significant deviation form the Standard Models are found, limits are placed.
- Constraining several models will help us to search for new physics in LHC Run II, stay tuned.
- All the public results are listed in:
  - CMS: https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsEXO
  - ATLAS:

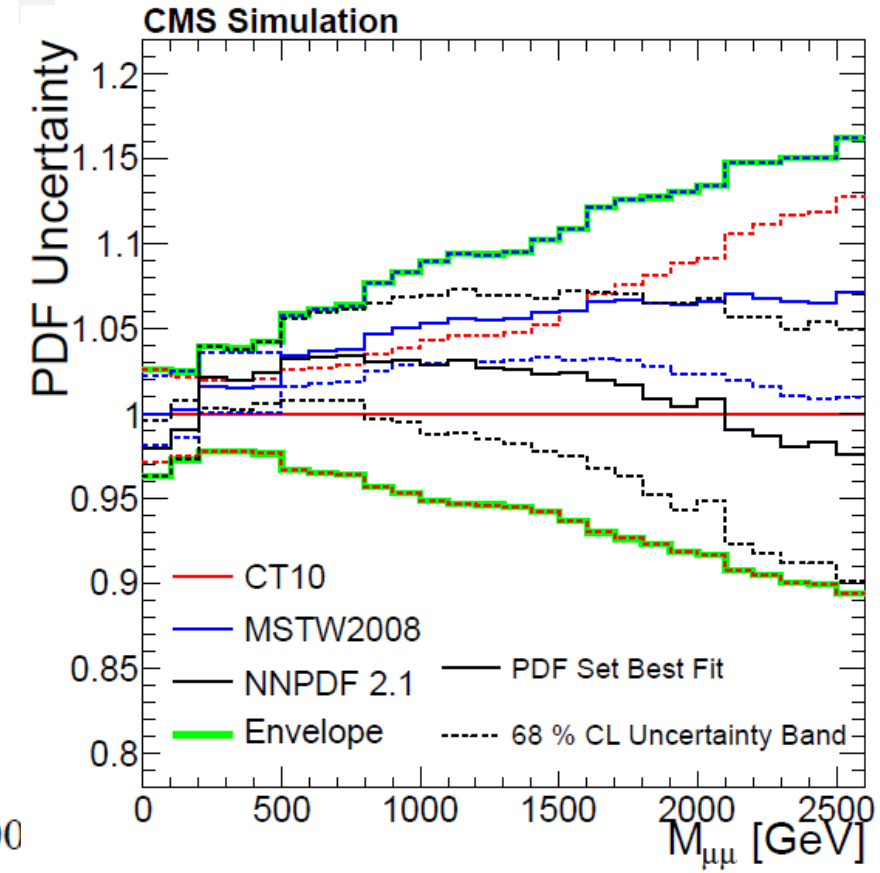
https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ExoticsPublicResults

Thank you!

Back-up slides

Effect of PDF





All CMS limit together