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SEARCH FOR RESONANT TTBAR PRODUCTION

in lepton+jets events in CMS

US LHC Users Organization Annual Meeting 2012

Samvel Khalatyan @ UIC University of Illinois at Chicago

on behalf of **CMS** collaboration

INTRODUCTION

Many **B**eyond the **S**tandard **M**odel (BSM) theories predict heavy resonances that decays into ttbar:

extended gauge theories, colorons, axigluons, Kaluza-Klein excitations of gluon

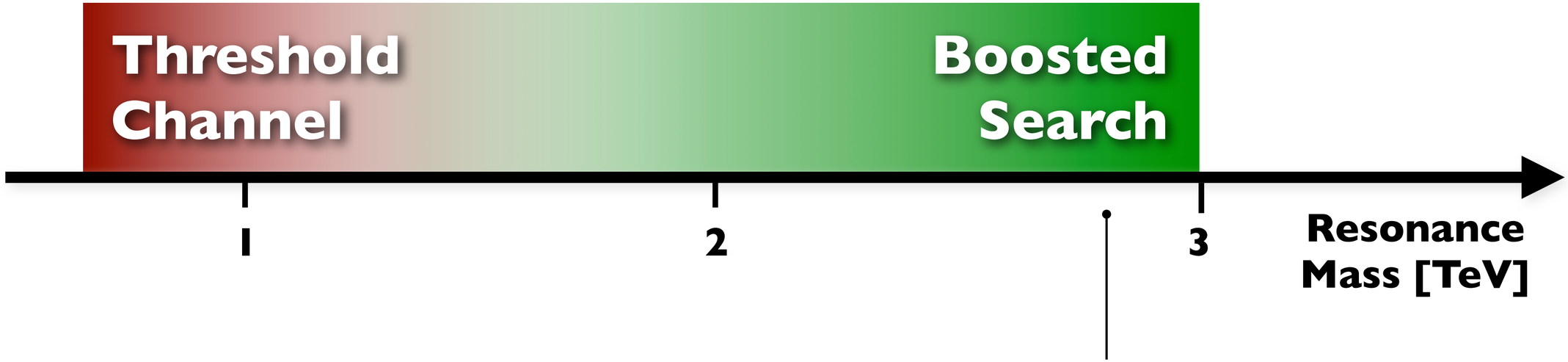
Results on search for such resonances in lepton+jets channel in **CMS** experiment using 2011 data are presented

arXiv 1209.4397

LEPTON+JETS CHANNELS

Definition

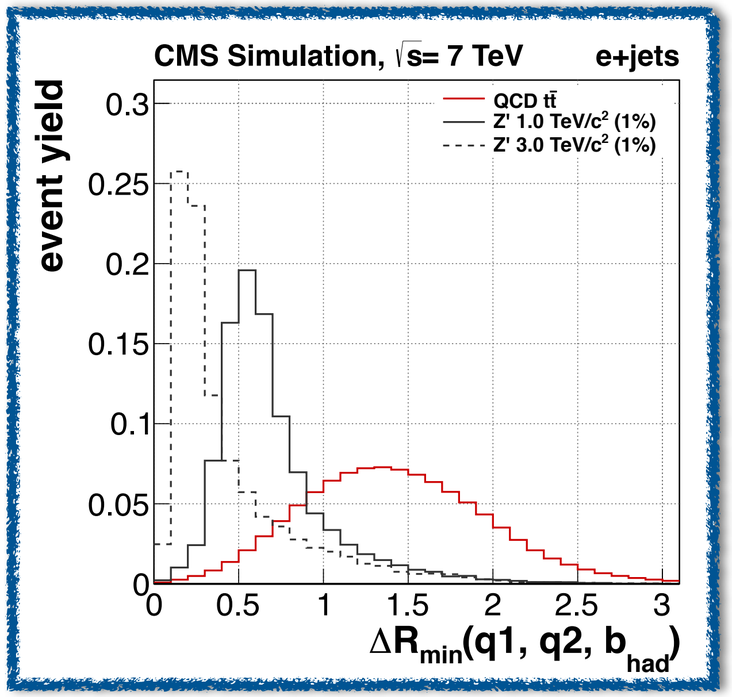
we can resolve all decay products because of low resonance mass, can impose the isolation requirement to lepton and require all jets in final state to be reconstructed

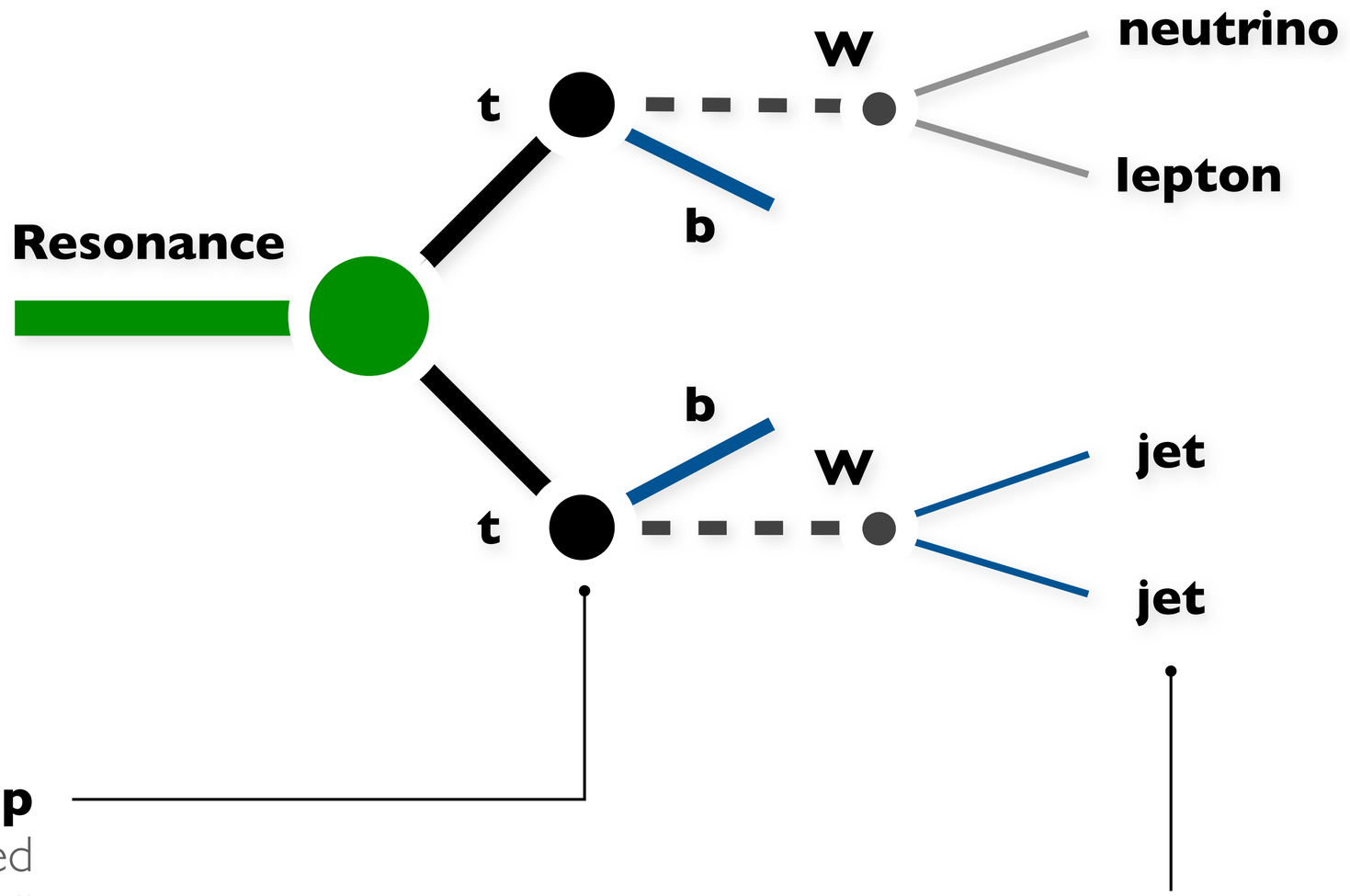


Compromise

because of high resonance mass we can not impose lepton isolation requirement and have to drop the multiplicity requirement of reconstructed jets

BOOSTED SIGNATURE





Boosted Top

the top quarks is expected to be boosted and its decay product may **not** be well isolated from each other; this can result in fewer jets being reconstructed

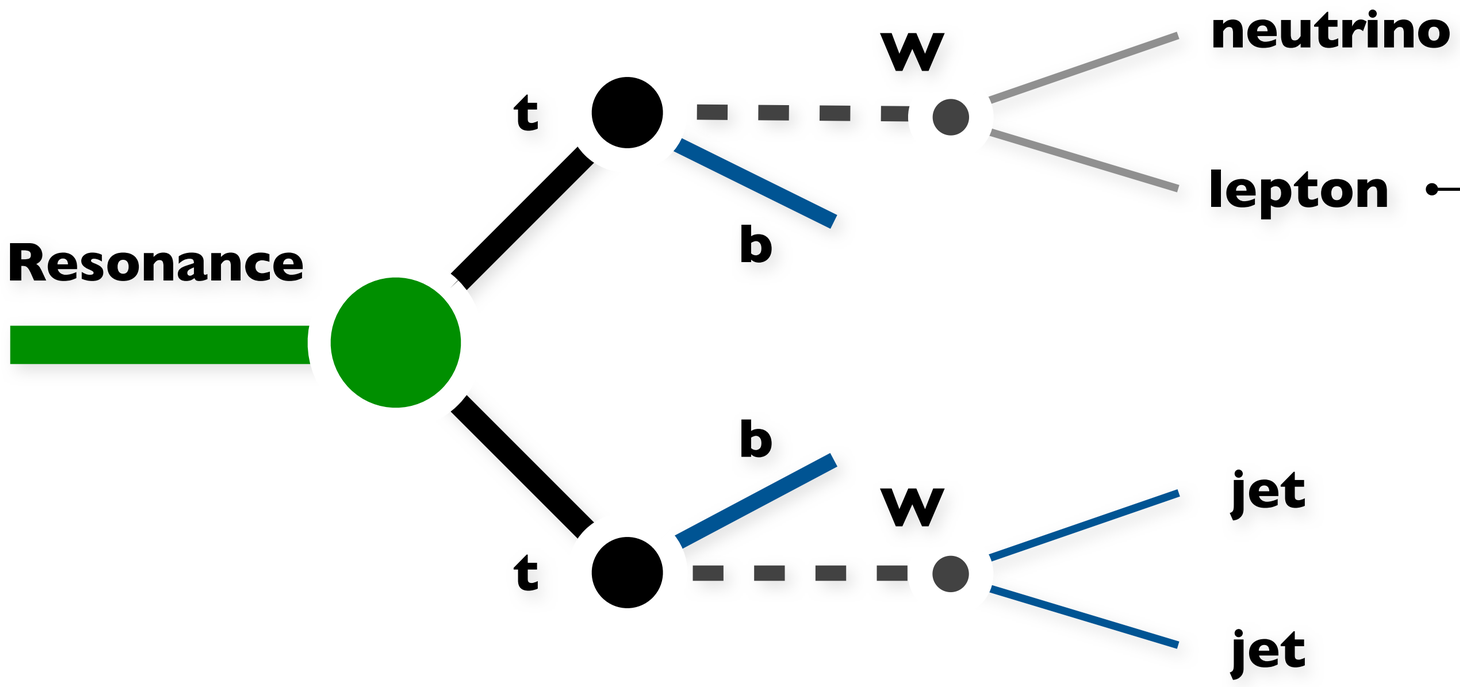
Jets Reconstruction

the analysis uses jets that are reconstructed with anti-kT algorithm with R = 0.5

BOOSTED SIGNATURE

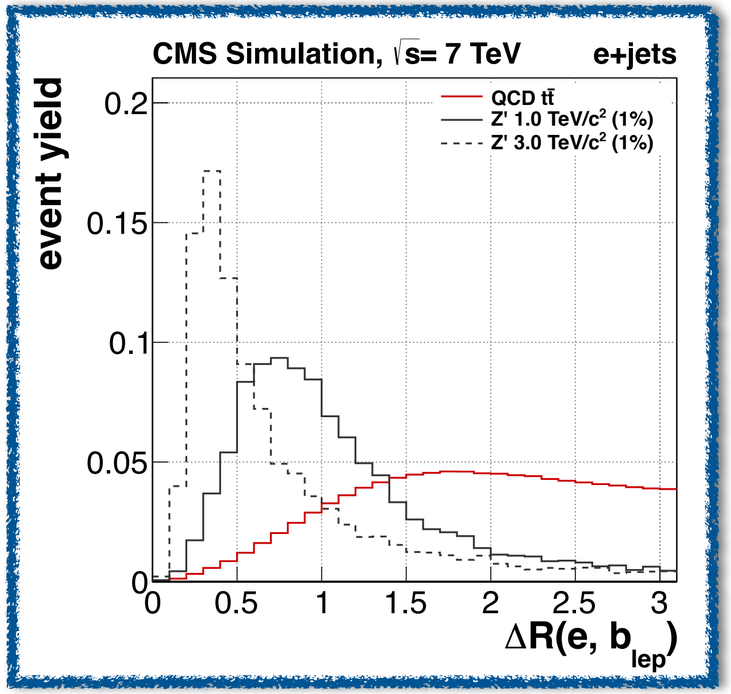
Undetected

neutrino escapes the detector **undetected** and can be only approximately reconstructed using missing transverse energy



Isolation

our analysis searches for either muon or electron; because of boosted nature of the top quark, lepton may **not** be isolated



BOOSTED SELECTION

Orthogonality
keep electron+jets and muon+jets channels orthogonal to each other and exclude di-lepton events

Energetic Lepton
no isolation requirement is applied; electron (muon) pT is above 70 (42) GeV

One reconstructed lepton
Veto second lepton
Two and more jets
QCD multijet suppression cuts

Simulated Backgrounds
topological cuts are exclusively designed to reduce QCD multijet background up to levels of few percent

Boosted Top
decay products can be highly boosted and be merged during the reconstruction

BOOSTED RECONSTRUCTION

Neutrino

assume W boson decay on shell and interpret Missing Transverse Energy as neutrino transverse four momentum, then reconstruct neutrino longitudinal component of momentum

Reconstruct Neutrino
Permute jets assignments
Choose best jets assignment

Jets Assignment

jets are assigned either to leptonically decaying top, hadronically decaying top, or neither of the two; at least one jet should be assigned to each top

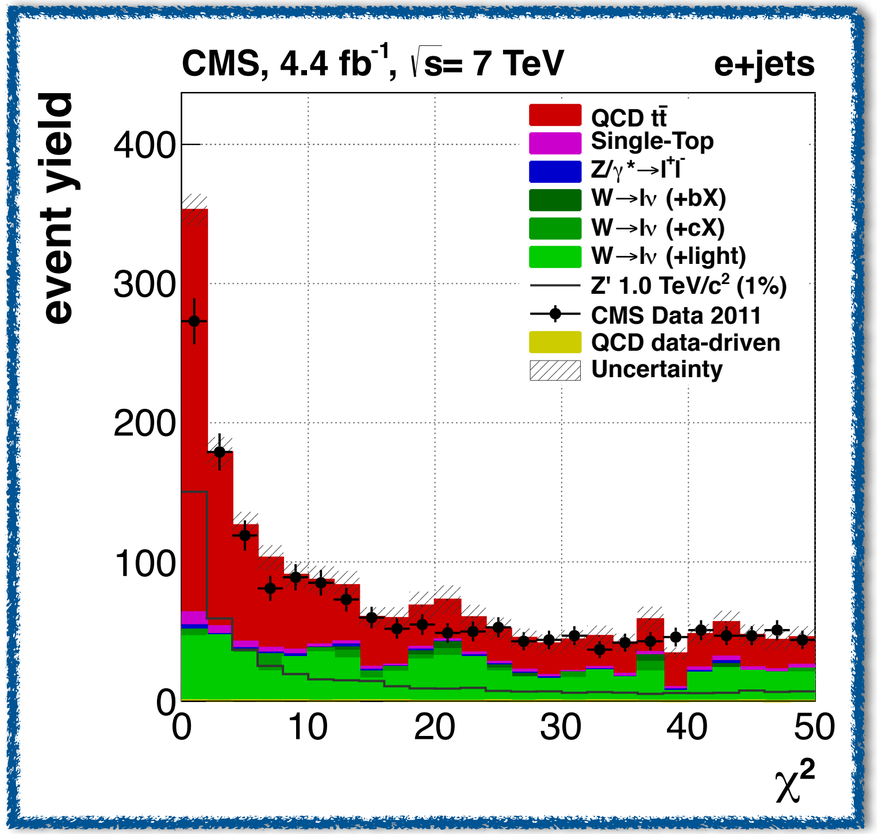
Chi2 Algorithm

for each jets assignment build

$$\chi^2 = \left[\frac{M_{lep} - \bar{M}_{lep}}{\sigma_{M_{lep}}}\right]^2 + \left[\frac{M_{had} - \bar{M}_{had}}{\sigma_{M_{had}}}\right]^2$$

and choose the one that has the lowest value of Chi2; parameters are extracted from simulations

BOOSTED RECONSTRUCTION



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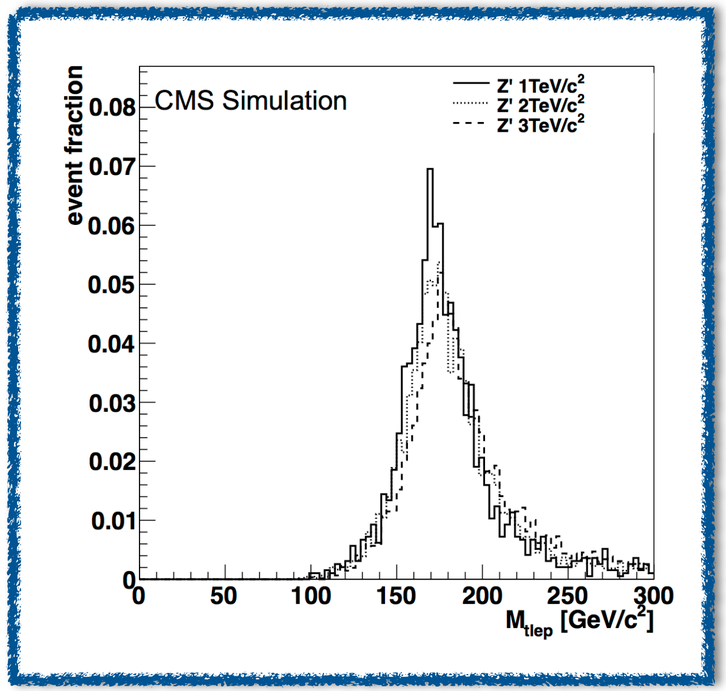
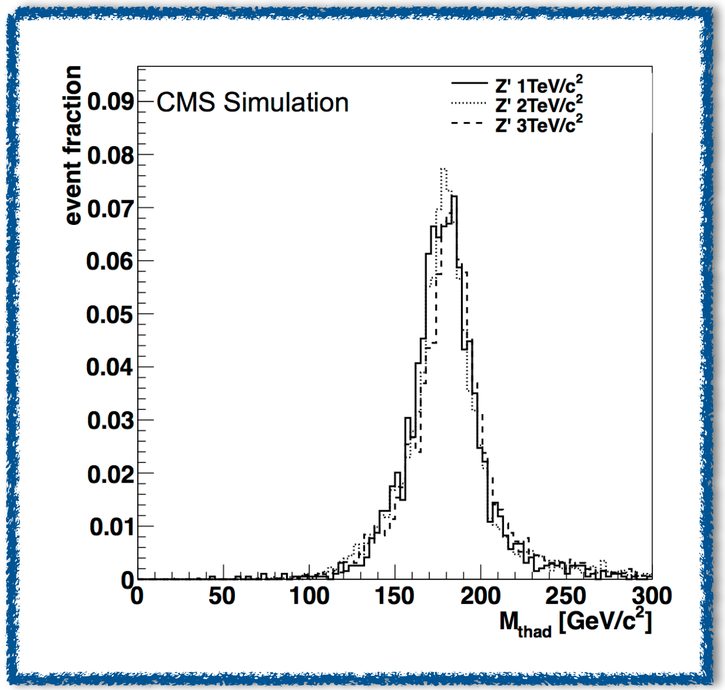
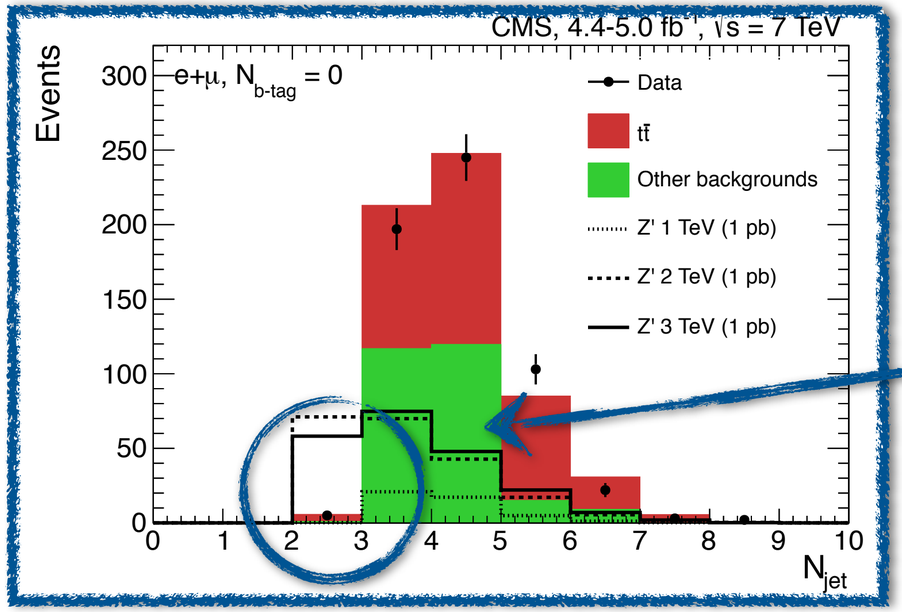




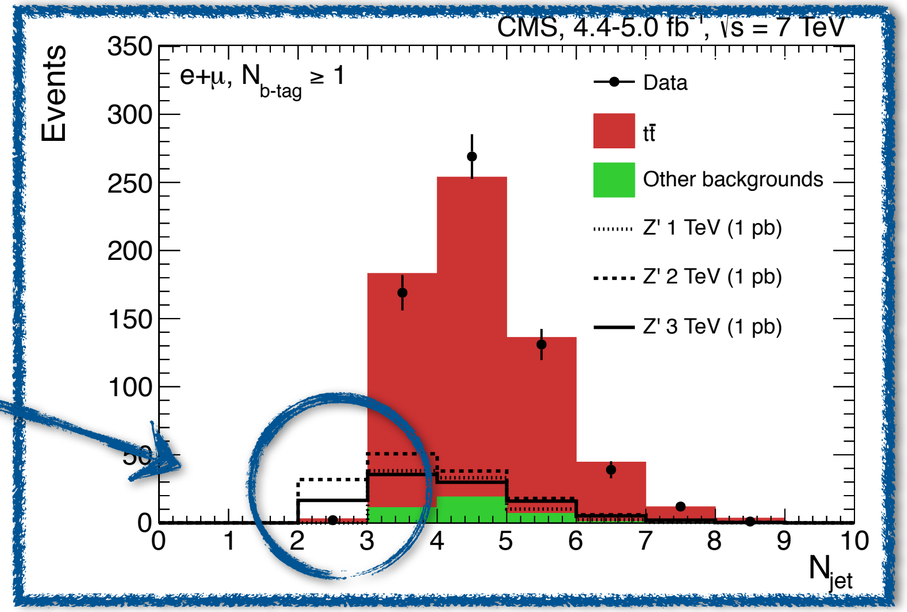
Suppress Backgrounds

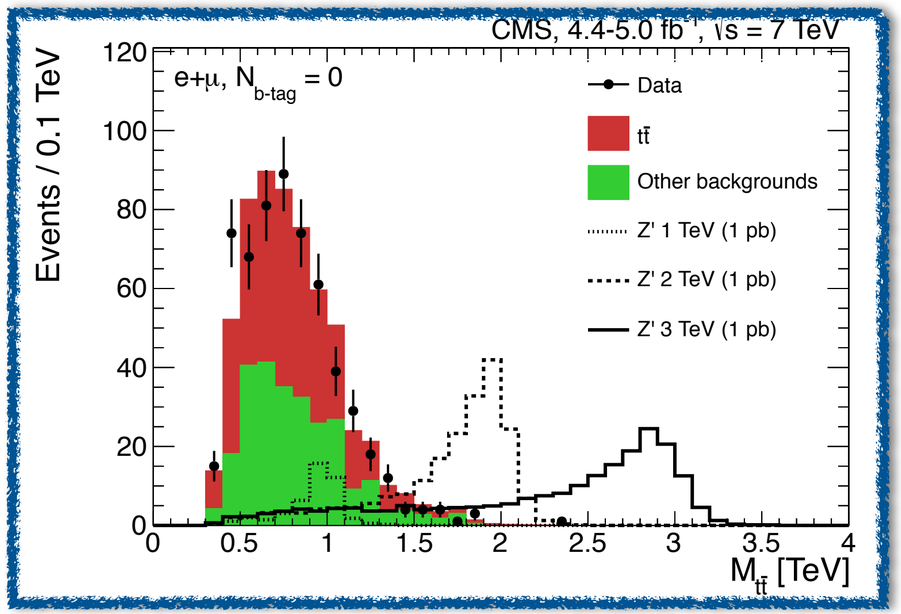
cut on Chi2 to reduce backgrounds; less than 1% of QCD multijet background is left after full selection and Chi2 cut

BOOSTED DATA/MC COMPARISON

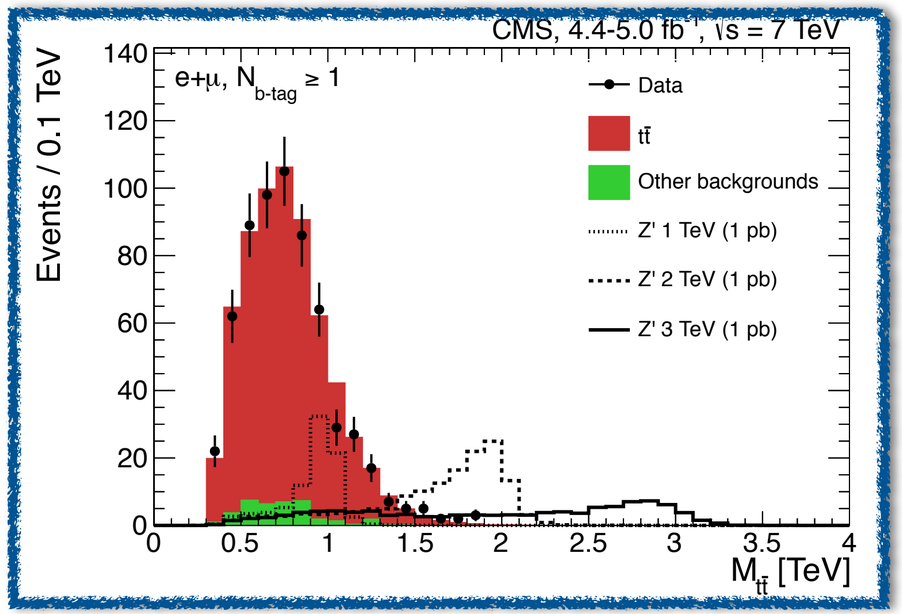


Almost no background in jet multiplicity two jets bin

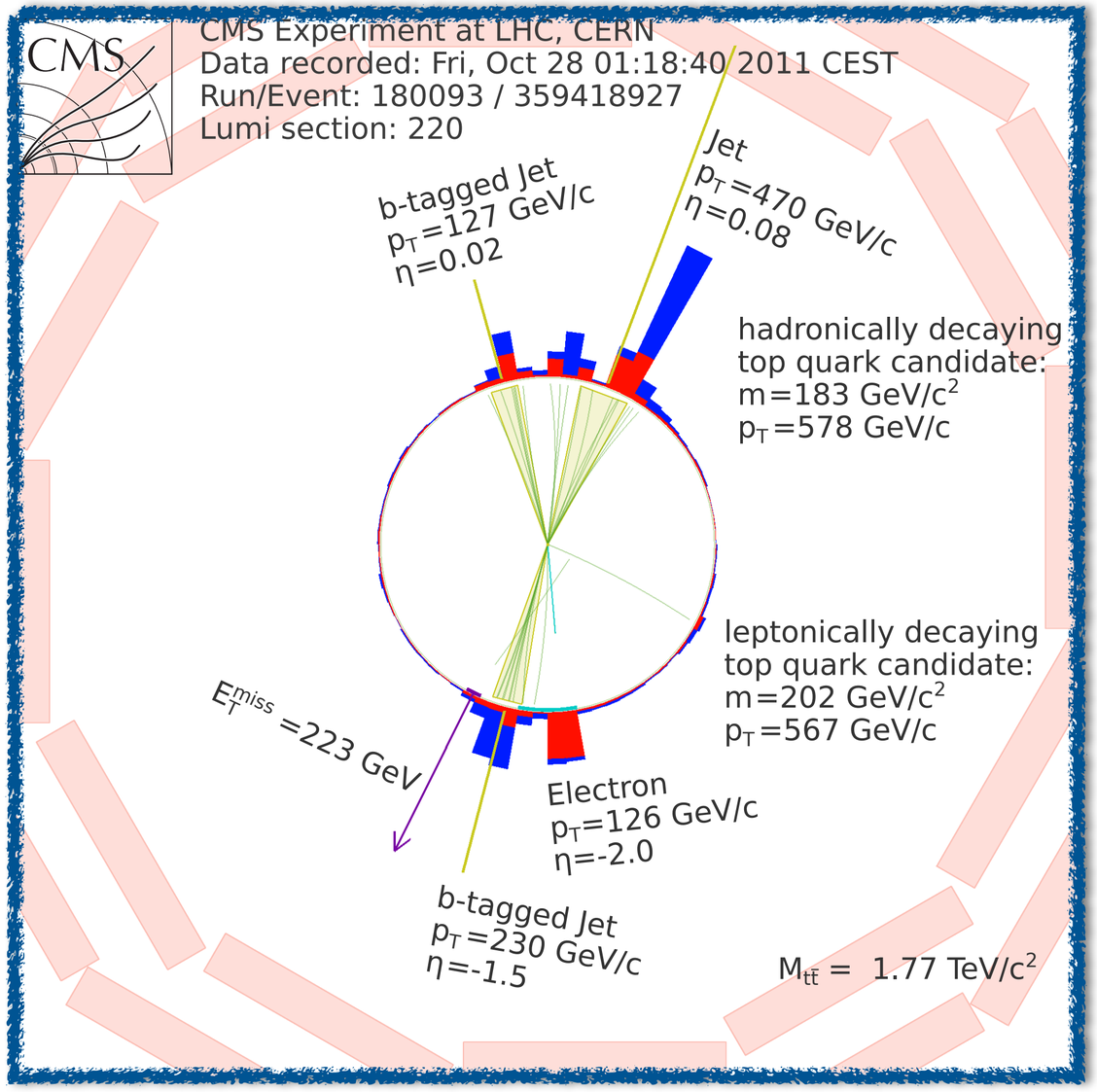


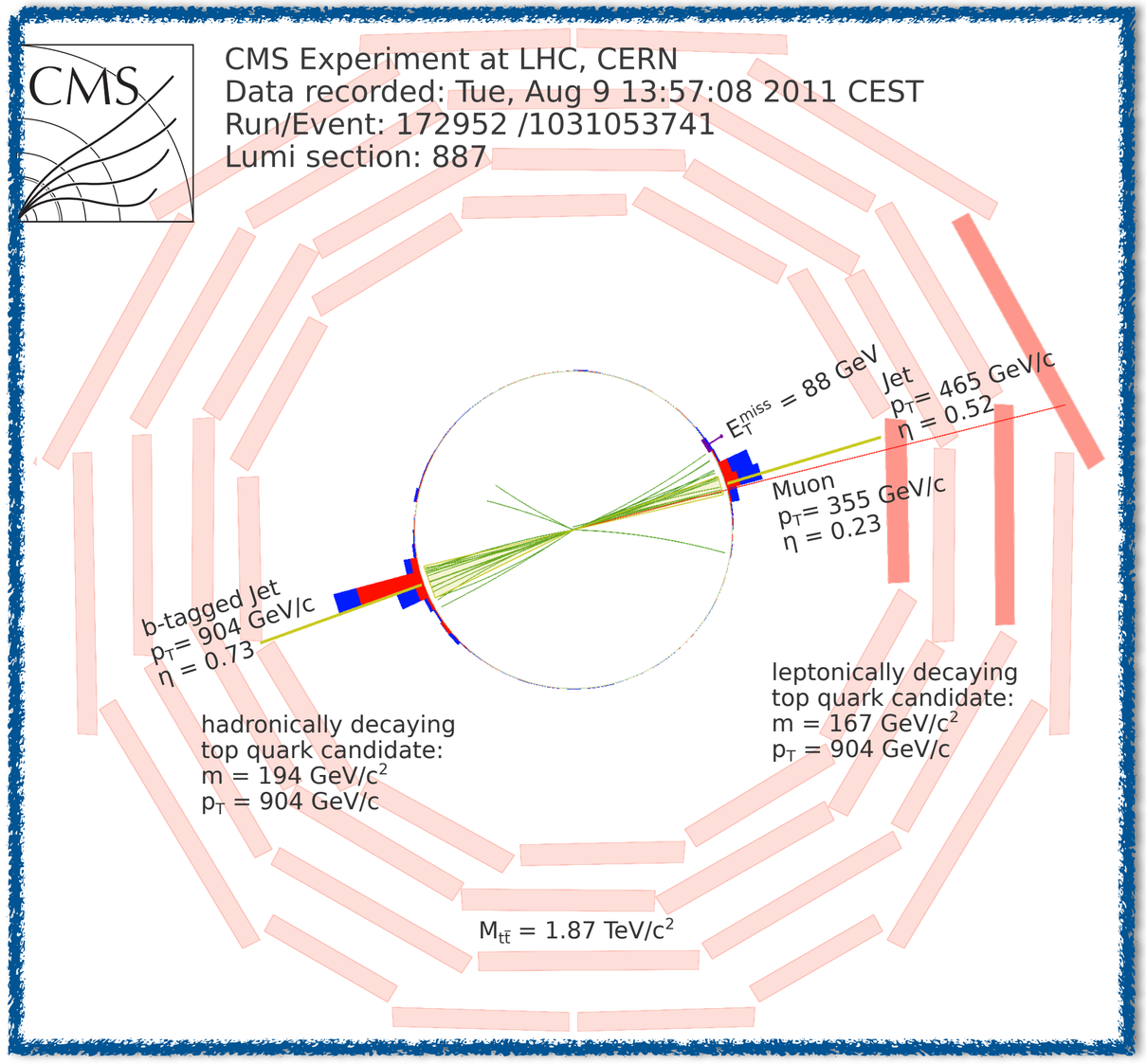


Reconstructed resonance mass distribution is used in limit setting procedure



BOOSTED EVENT DISPLAY





THRESHOLD ANALYSIS

Orthogonality
remove events from di-lepton channel and separate electron+jets and muon+jets channels

One **isolated** lepton
Veto second lepton
Three or more jets
Missing Transverse Energy cut
Resonance Reconstruction

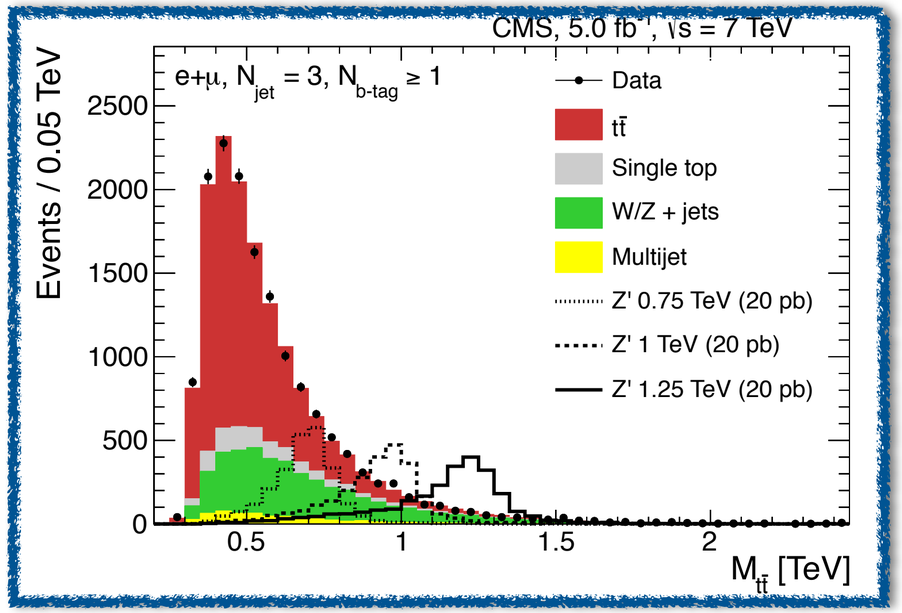
Soft Lepton
lepton is required to be isolated; electron (muon) pT is above 30 (20) GeV

Soft Top
decay products are expected to be well separated in space and be reconstructed as separate objects

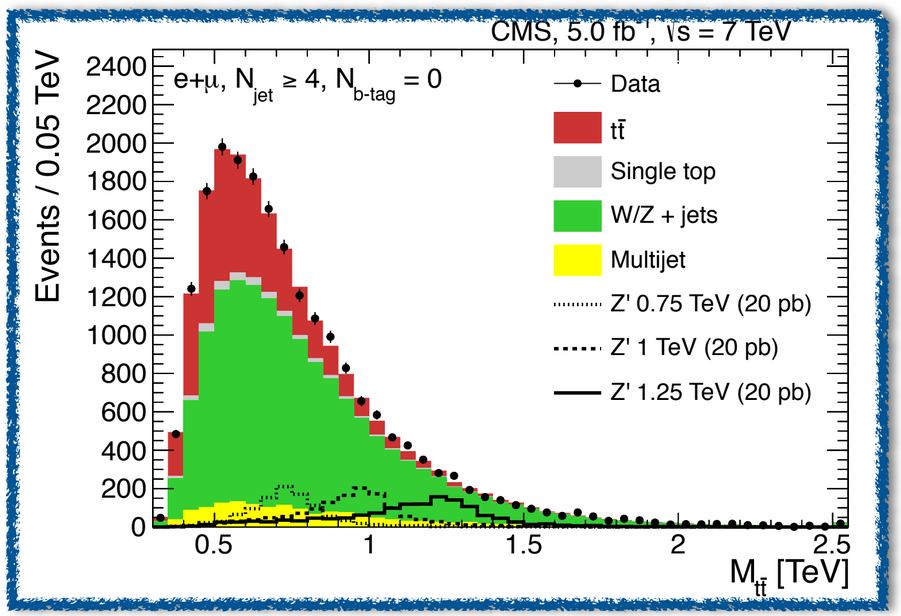
QCD multijet background
Missing Transverse Energy cut is used to suppress the QCD multijet background

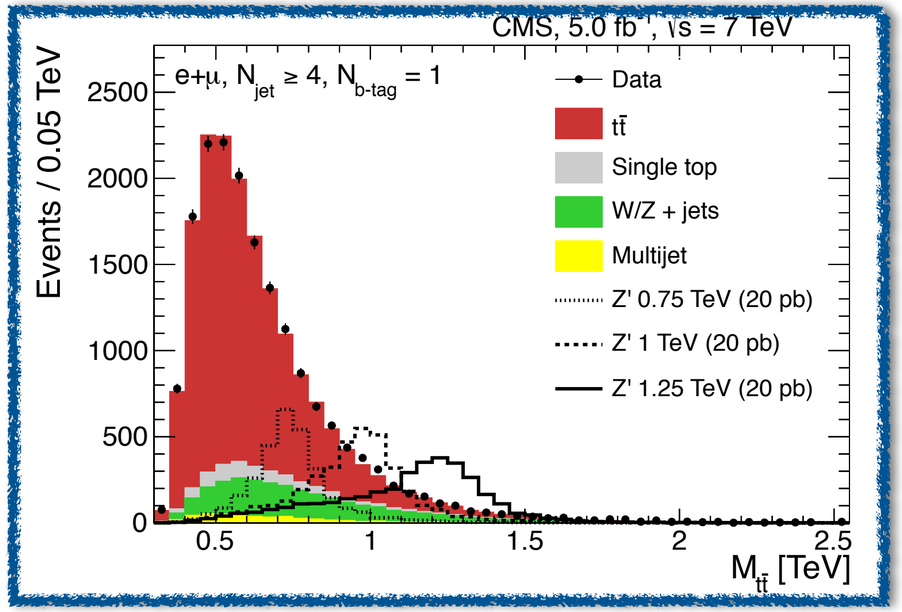
Jets Assignment
Reconstruction is similar to boosted analysis; Chi2 has additional terms: hadronic W mass, ttbar pT, etc.

THRESHOLD DATA/MC COMPARISON



Good data/MC agreement in a full range of reconstructed resonance mass





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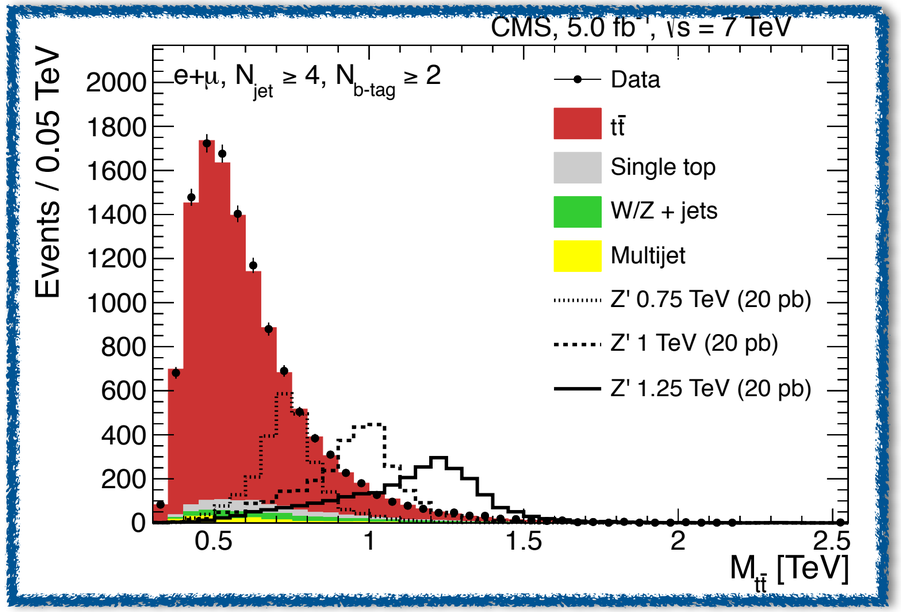
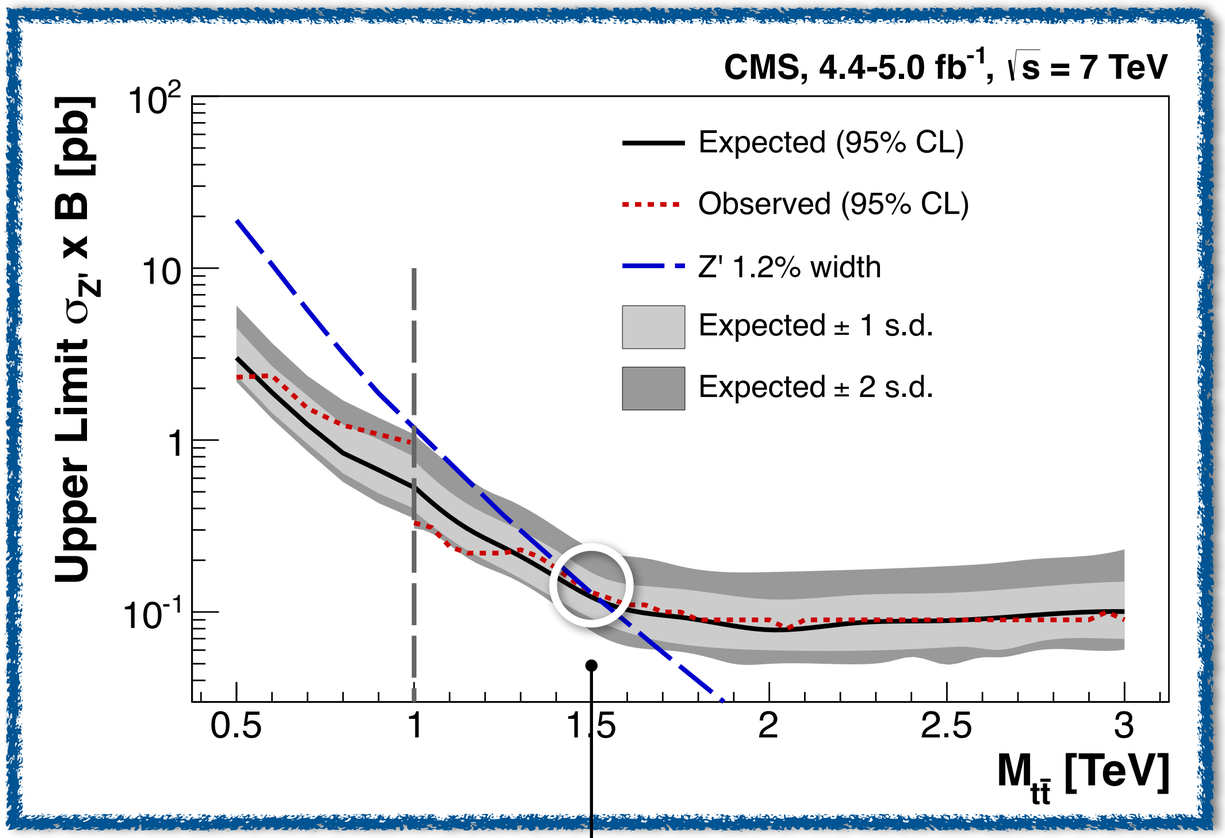
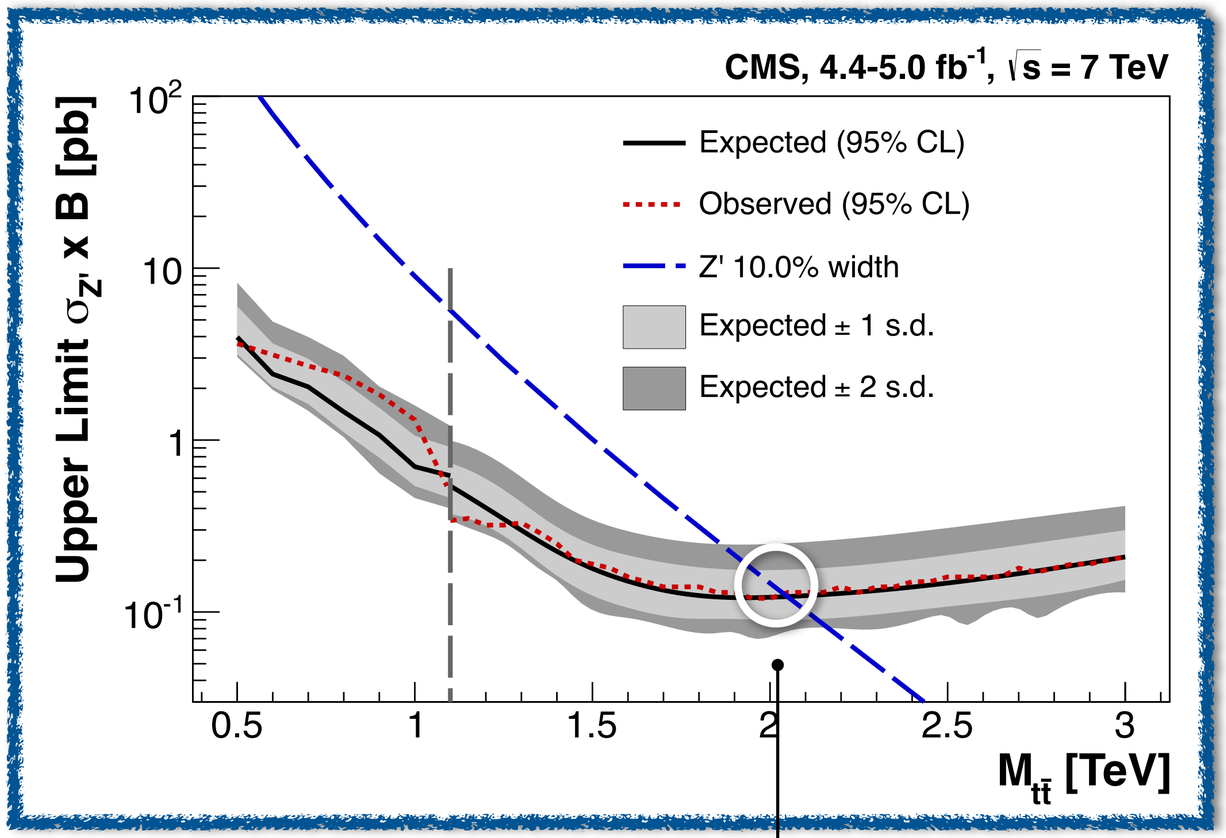


COMBINATION: **CLS** LIMITS



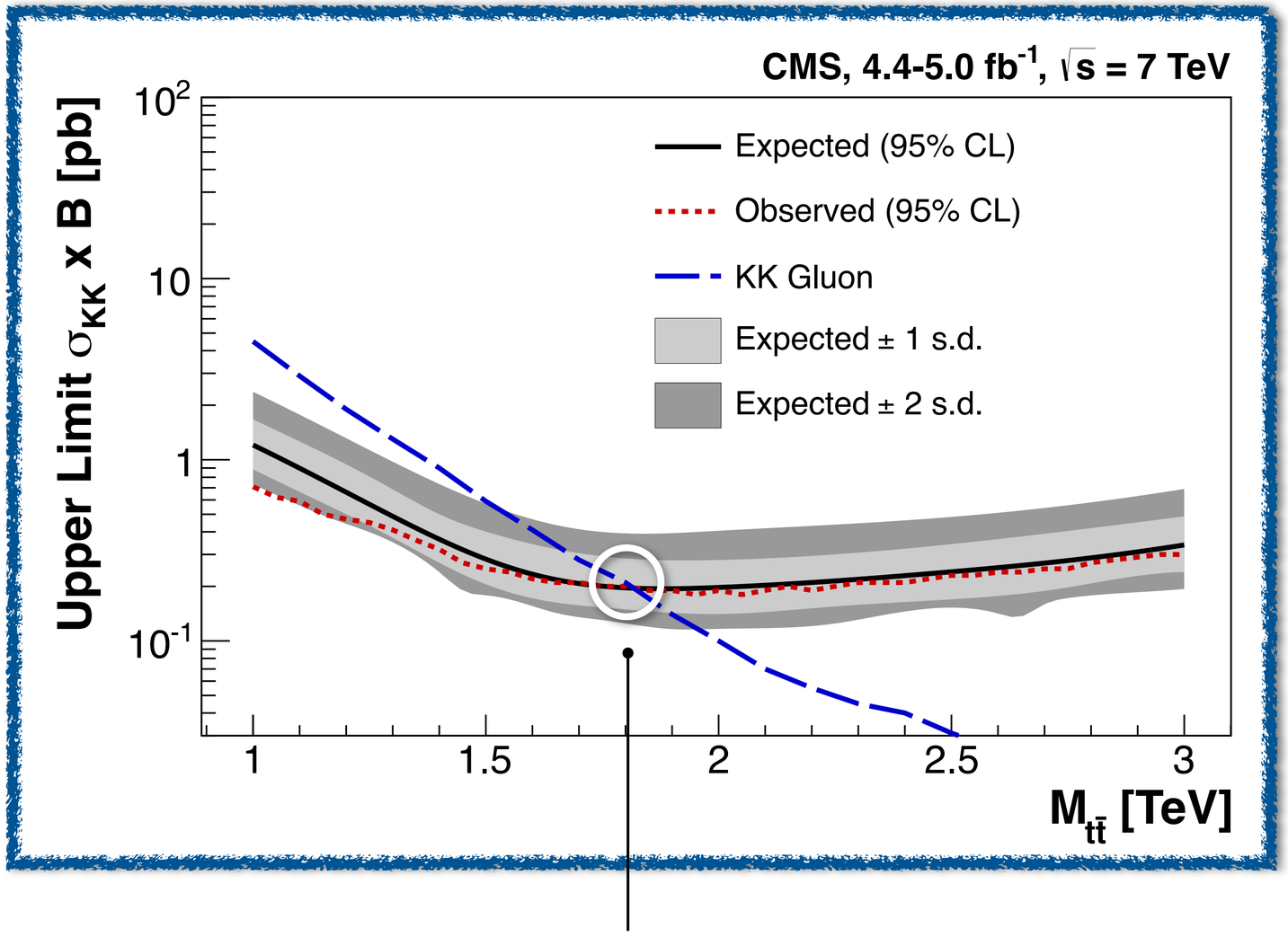


Excluded Mass Region

narrow Z` mass < 1.5 TeV

wide Z` mass < 2.0 TeV

COMBINATION: **CLS** LIMITS



Excluded Mass Region

KK excitations of a gluon < 1.8 TeV

SUMMARY

- New search for BSM resonances was shown
  arXiv 1209.4397
- Search is done in lepton+jets boosted and threshold channel
- Boosted analysis used non-isolated leptons
- No evidence of such resonances is observed in 2011 data
- Exclusion limits are set on resonance mass and production cross-section for different theories