



Search for $t\bar{t}$ resonances below 1 TeV in lepton + jets events in pp collisions at $\sqrt{s} = 8$ TeV

CMS PAS B2G-12-006

Sébastien Brochet

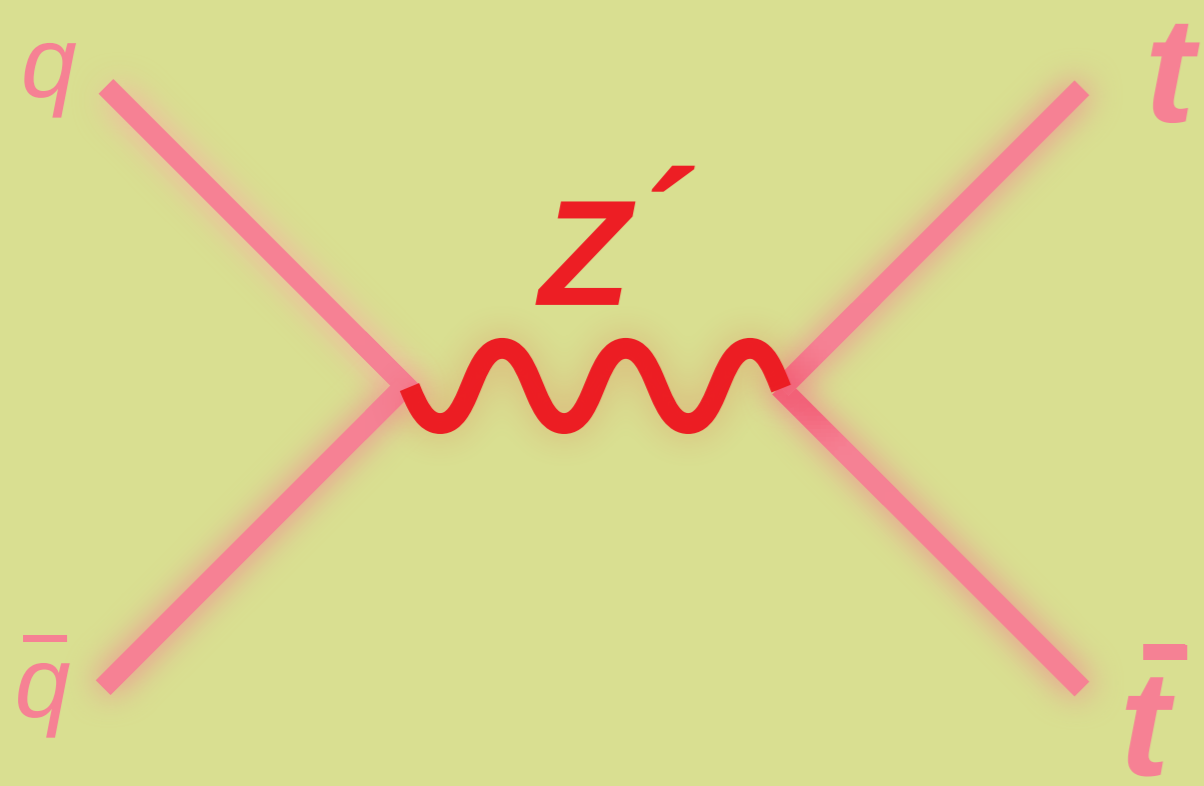
on behalf of the CMS collaboration

Institut de Physique Nucléaire de Lyon (CNRS / IN2P3, Université Lyon 1)



I. Introduction

- Top quark: probe for beyond the standard model (SM) theories because of its large mass.
- Several models like Topcolor Z' , pseudo-scalar Higgs boson or Kaluza-Klein gluons predict the existence of heavy particles decaying into $t\bar{t}$.



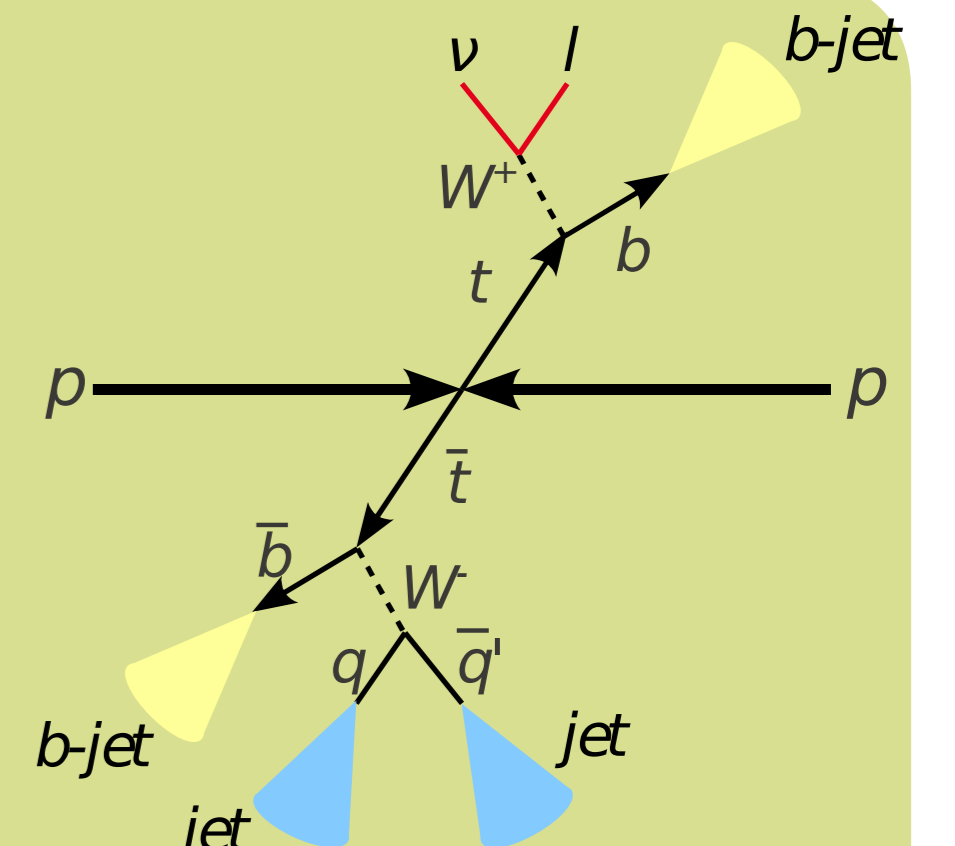
- Model independent search for $t\bar{t}$ resonances in the semi-leptonic channel (one top to bjj and one to $b\bar{\nu}$)
- We consider here only events where the top quarks are **resolved**. Another analysis is devoted exclusively to events where top quarks are boosted.

II. Signal

- Two particular models are considered:
 - Generic spin 1 Z' boson** [1]: width and cross-sections **independent** of the resonance mass. Narrow (1%) and wide (10%) resonances are generated.
 - Kaluza-Klein partner of the SM gluon** [2]: width and cross-sections are **fixed** by the resonance mass.
- Signal is generated for $M=0.5, 0.75, 1, 1.25, 1.5$ and 2 TeV

III. Selection

- Selection optimized for **non-boosted** top pairs:
 - Exactly one **isolated** lepton (muon or electron)
 - At least **4** jets
 - E_t^{miss} cut to remove multijet background
 - At least **1** b-tagged jet



Events categorized in 4 categories	Muon	1 b-jet
	Electron	≥ 2 b-jets

IV. The $t\bar{t}$ event reconstruction

- First, the lepton and the E_t^{miss} are assigned to the leptonic leg of the $t\bar{t}$ event, where E_t^{miss} is interpreted as the transverse component of the momentum of the neutrino. Neutrino p_z is reconstructed using W mass constraint.
- For events with more than four jets, a χ^2 algorithm is used in order to choose the four jets coming from the $t\bar{t}$ decay.

$$\chi^2 = \chi_{m_{\text{top}}}^2 + \chi_{m_{\text{top}}}^2 + \chi_{m_W}^2 + \chi_{p_z}^2$$

where $\chi_x^2 = (x_{\text{meas}} - x_{\text{MC}})^2 / \sigma_{\text{MC}}^2$

V. Number of signal event extraction

- Number of signal event extracted with a maximum likelihood fit of the $M_{t\bar{t}}$ distribution in all the considered categories, with a fit range from 550 GeV to 2 TeV.
- Two categories in the likelihood formula: **background** and **signal**

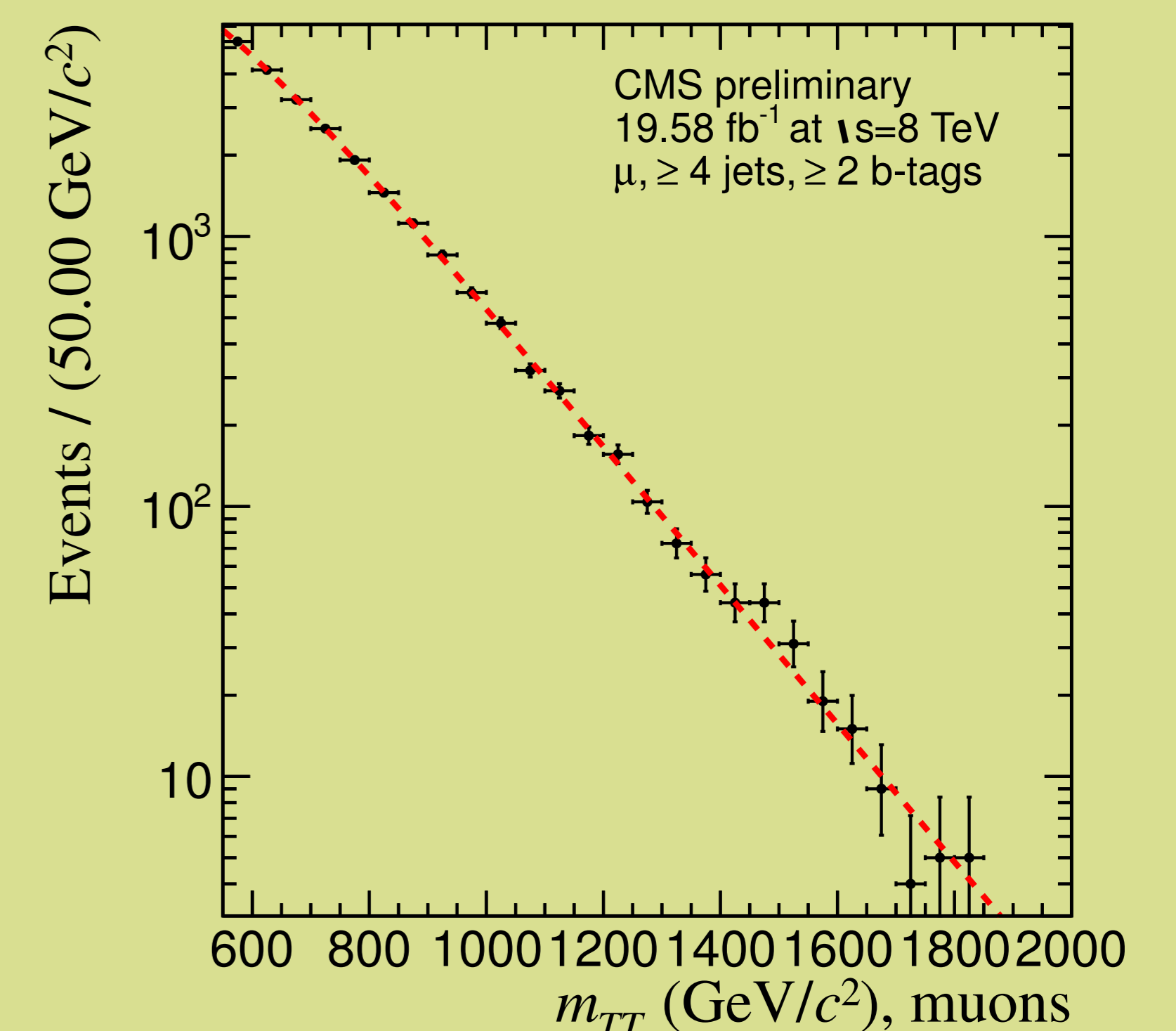
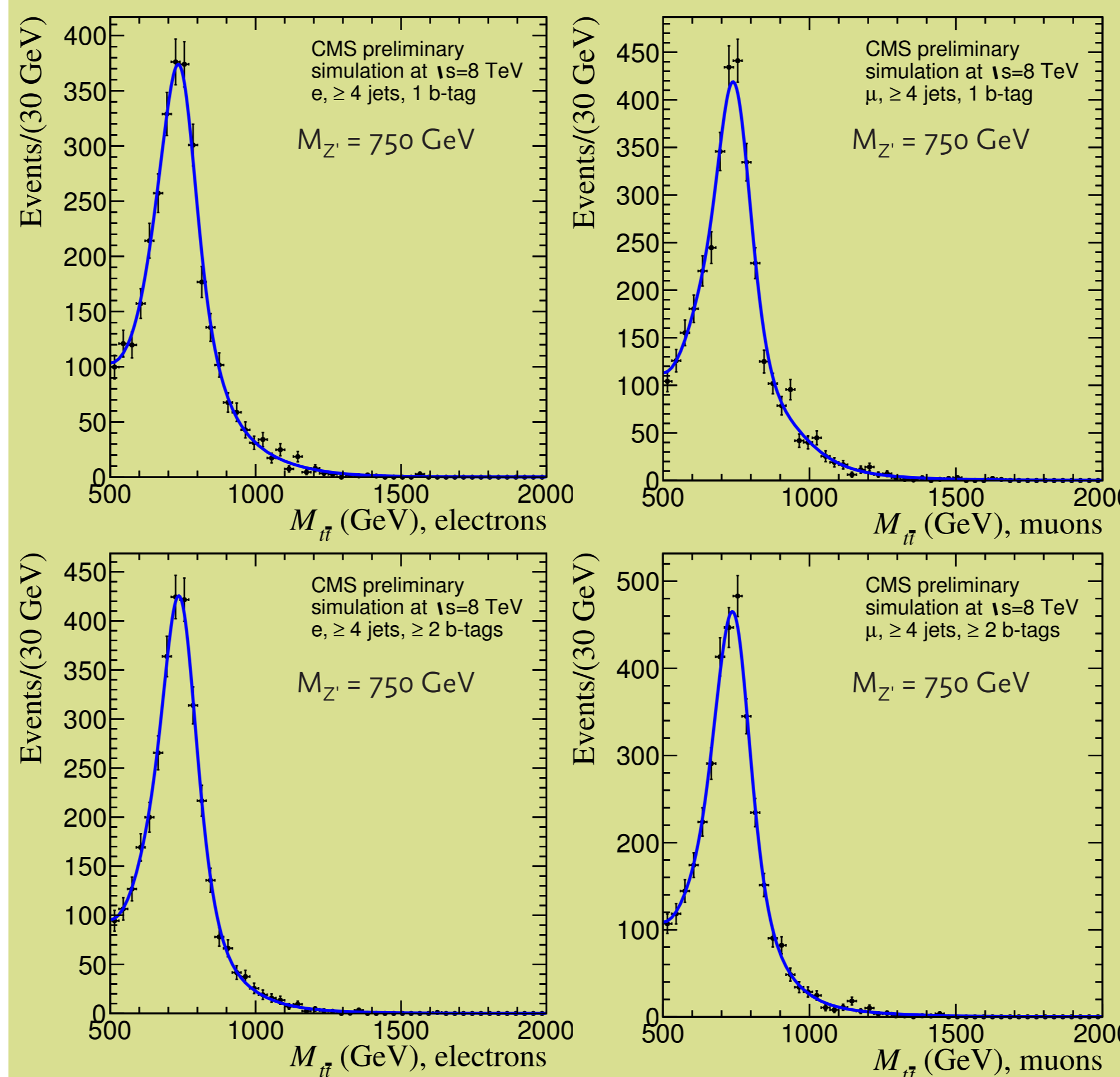
V.1 Signal parametrization

- Signal parametrization derived from simulation, using a gaussian kernel estimation.

V.2 Background parametrization

- A **data driven approach** is used to parametrize the background functional form.

$$\frac{d\sigma}{dm_{t\bar{t}}} = \frac{(1 - m/\sqrt{s})^{c_1}}{(m/\sqrt{s})^{c_2 + c_3 \ln m/\sqrt{s}}}$$



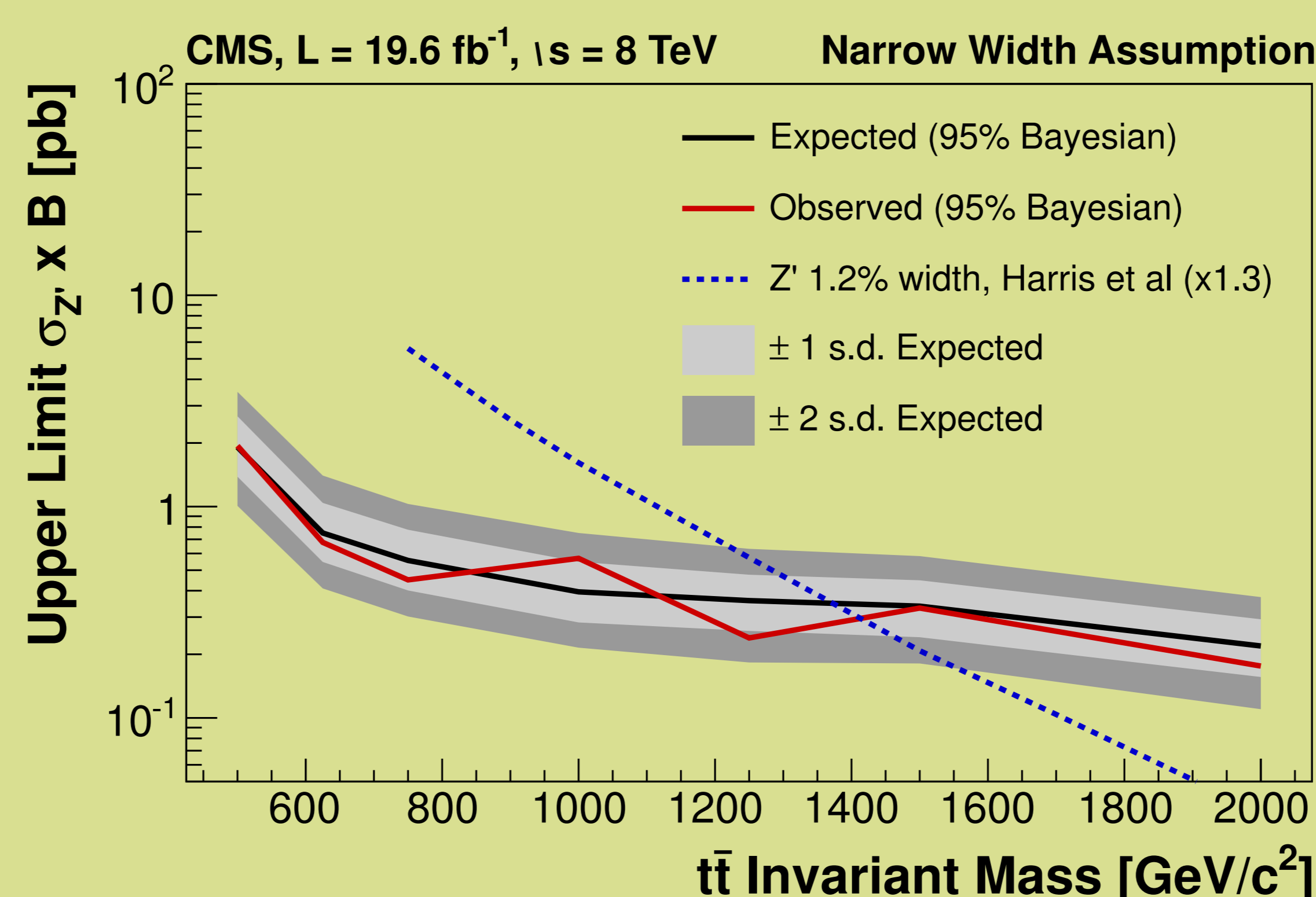
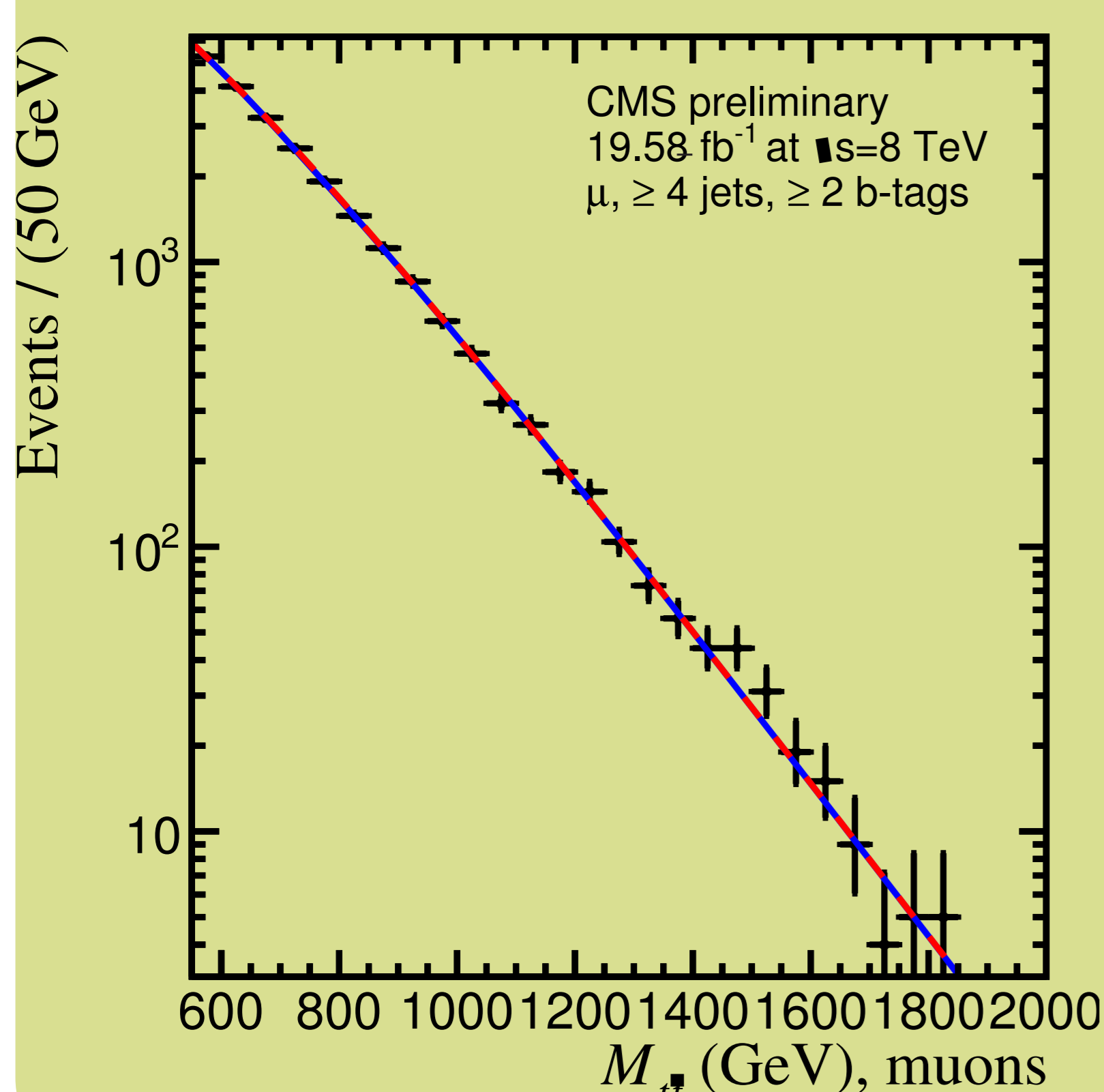
VI. Systematic uncertainties

- Affecting normalization
 - Luminosity, lepton trigger and identification
- Affecting normalization and shape
 - Jet energy correction and resolution
 - Pile-up reweighting
 - Background and signal PDF choice

VII. Results

- During the fit, the signal PDF is fixed, and the background PDF is left floating.
- Resulting cross-sections are compatible with 0 for every signal point. We proceed to set limit.

- A Bayesian statistical method (MCMC) is used to compute expected and observed limits for each signal point.
- Statistical uncertainties are treated like nuisance parameters.



VIII. Conclusion

- Results from a model-independent search for heavy resonances decaying to $t\bar{t}$, using a data sample corresponding to an integrated luminosity of **19.6 fb⁻¹**
- No evidence of signal is found, therefore limits are set on the production of non-SM particles.
- Analysis combined with a boosted analysis to improve sensibility over the whole mass range:**
 - Topcolor Z' bosons with a width of 1.2% (10%) are excluded below **2.10** TeV (**2.68** TeV).
 - Kaluza-Klein excitations of a gluon with masses below **2.54** TeV are excluded.

[1] R. M. Harris and S. Jain, "Cross Sections for Leptophobic Topcolor Z decaying to top-antitop", *Eur. Phys. J. C* **72** (2012) 2072
 [2] K. Agashe et al., "LHC Signals from Warped Extra Dimensions", *Phys. Rev. D* **77** (2008) 015003