SEARCH FOR NEW PHYSICS WITH A Z BOSON, JETS, AND E_T^{miss} AT CMS

arXiv:1204.3774

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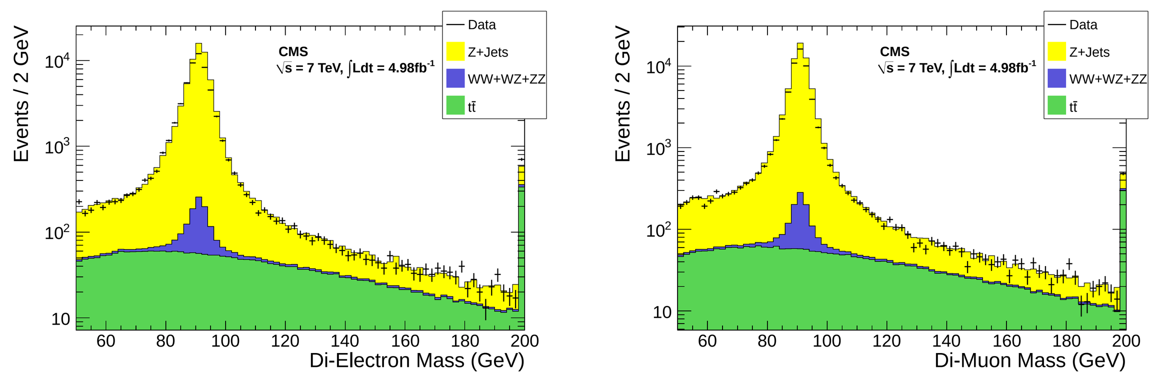
INTRODUCTION

- **Search for physics beyond the standard model** (BSM) with $Z \to \ell^+\ell^-$ ($\ell = e, \mu$), jets, and missing transverse energy (E_T^{miss})
- $\int\mathcal{L} = 4.98$ fb^{-1}, $\sqrt{s} = 7$ TeV data collected by the CMS experiment at the LHC
- **Backgrounds:**
- **Z + jets** predicted from E_T^{miss} templates
- **$t\bar{t}$** predicted from opposite flavor ($e\mu$) events
- **Diboson** backgrounds taken from MC



E_T^{miss} TEMPLATES METHOD

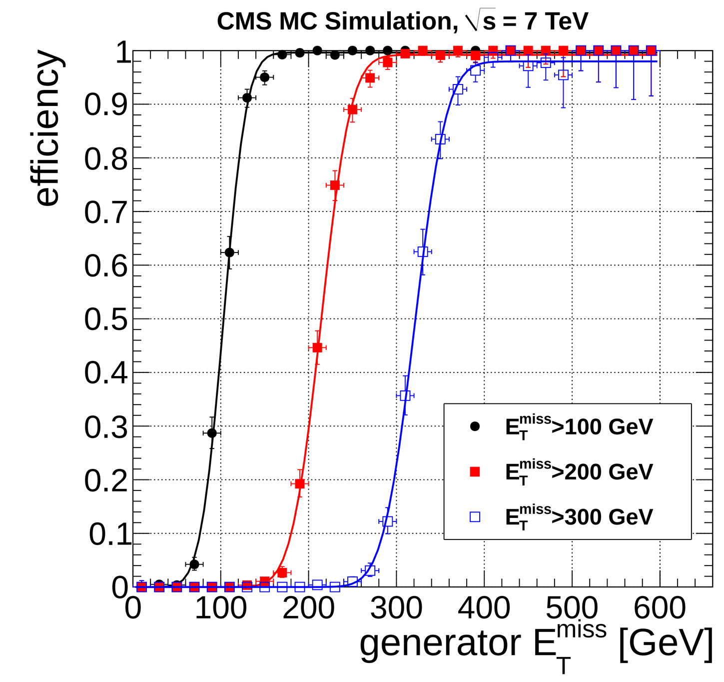
- **Data-driven** technique
- **γ + jets** control sample used to predict E_T^{miss} in Z + jets
- **Fake E_T^{miss}** from jet mismeasurement is parameterized by N_{jets} and scalar sum of jet p_T (H_T)
- **Templates:** plot E_T^{miss} in γ + jets events binned in N_{jets} and H_T, normalized to unity
- **Prediction** of E_T^{miss} in Z + jets is formed by summing the templates which correspond to the N_{jets} and H_T in each Z + jets event
- In both γ + jets and Z + jets, the hadronic system recoils against the boson
- Can also use QCD as a control sample after correcting for the hadronic recoil effect

OPP. FLAVOR BACKGROUNDS

- **Flavor symmetric** backgrounds have equal rates of opposite flavor (OF) and same flavor leptons:
  $N(e\mu) = N(ee) + N(\mu\mu)$
- **OF data** control sample: data-driven
- These backgrounds include $t\bar{t}$ (dominant), single top (tW), WW, and $Z \to \tau\tau$
- **Decrease statistical uncertainty:** remove dilepton mass cut and scale the yield by ratio of events inside the Z mass window to the total (MC: 0.16 ± 0.01)
- The difference in identification efficiency between electrons and muons is corrected for by scaling the OF yield by the ratio of these efficiencies : $R_{\mu e} = 1.07 \pm 0.07$

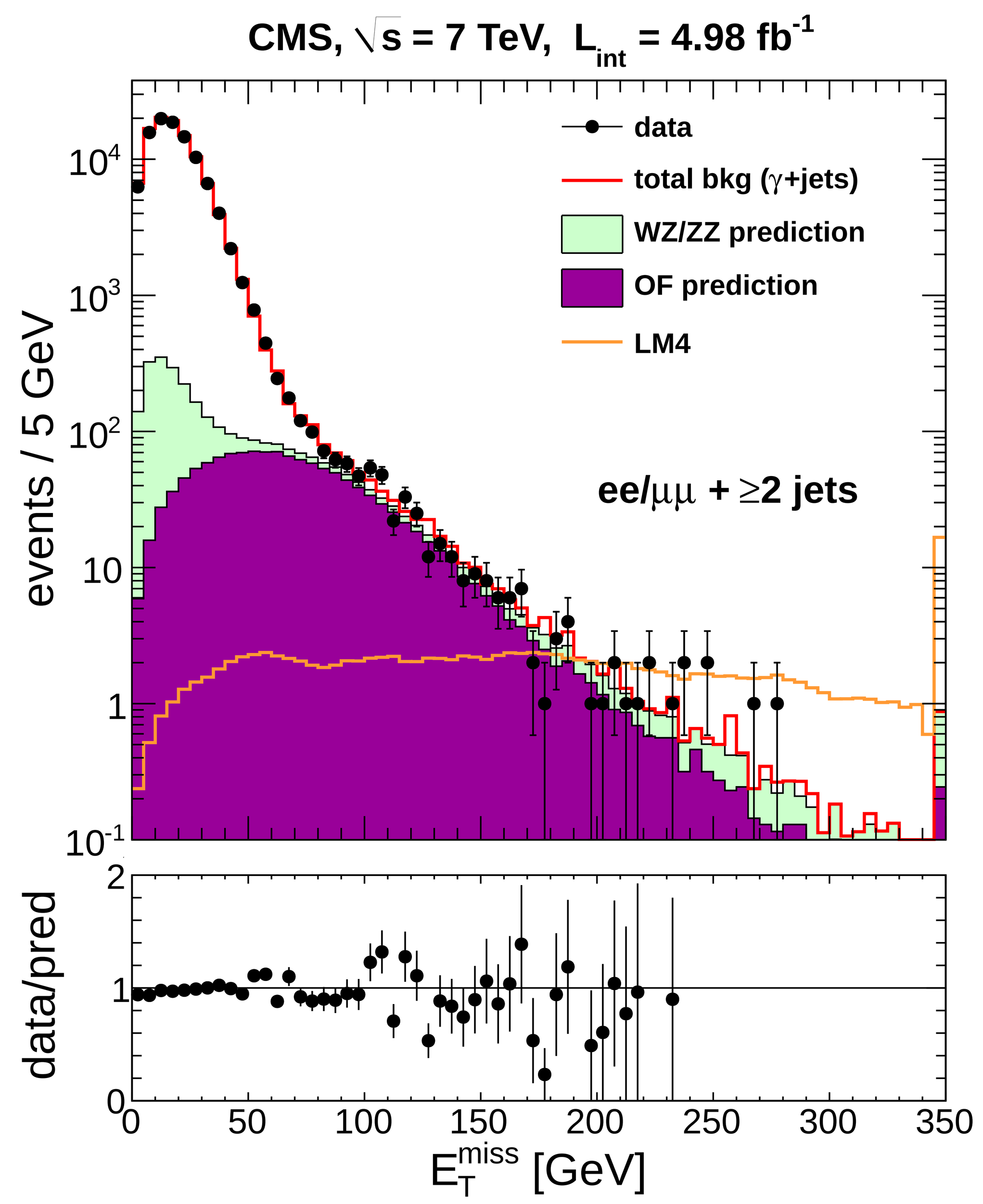
MODEL TESTING

- **Constrain** arbitrary new physics models using efficiencies for all objects
- Provide approximate efficiencies for lepton identification and isolation
- Parameterize the E_T^{miss} response: error function



RESULTS

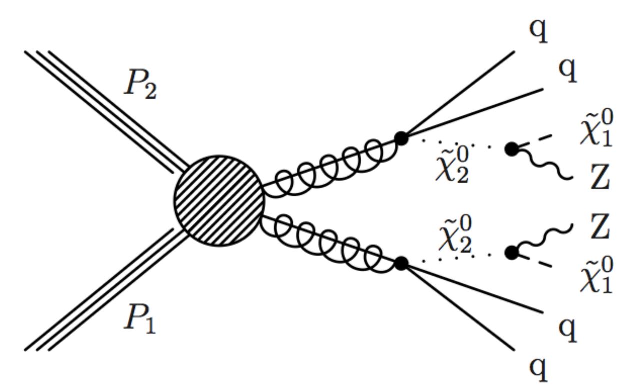
- **Signal regions** are formed by applying E_T^{miss} cuts as shown in the table
- **Expected sensitivity** mostly from $E_T^{miss} > 100$, 200, and 300 GeV; lower E_T^{miss} cuts are shown as a validation of the background predictions.
- The results shown here are for **$N_{jets} \geq 2$**; see the paper (arXiv:1204.3774) for $N_{jets} \geq 3$
- Uncertainties include both statistical and systematic contributions.
- For the observed yield (data), the first (second) number in parentheses is the yield in the ee ($\mu\mu$) final state.
- Background predictions agree with data; no evidence for new physics
- Calculate model independent upper limits (UL) on new physics contributions
- We show yields for two example cMSSM model points (LM4 and LM8)

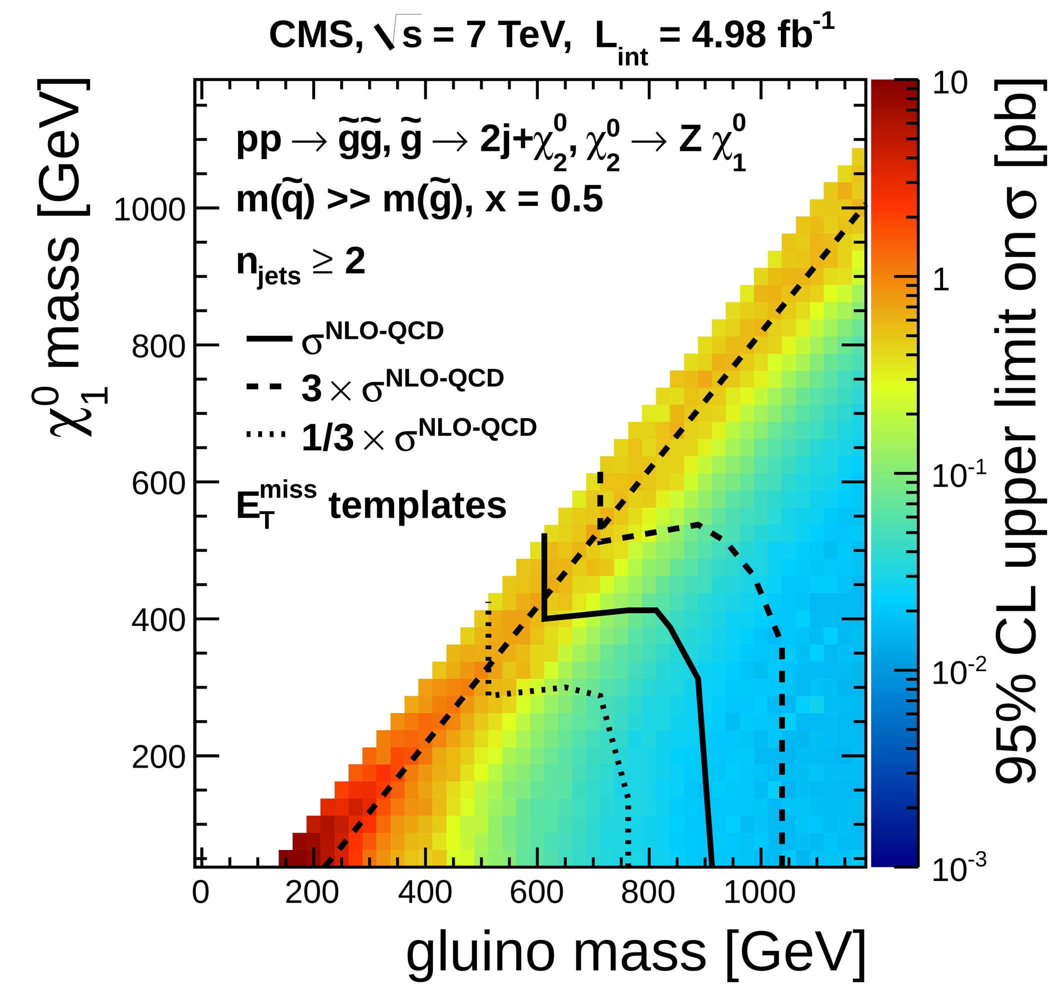


	E_T^{miss}> 30 GeV	E_T^{miss}> 60 GeV	E_T^{miss}> 100 GeV	E_T^{miss}> 200 GeV	E_T^{miss}> 300 GeV
Z bkg	15070 ± 4825	484 ± 156	36 ± 12	2.4 ± 0.9	0.4 ± 0.3
OF bkg	1116 ± 101	680 ± 62	227 ± 21	11 ± 3.2	1.6 ± 0.6
VZ bkg	269 ± 135	84 ± 42	35 ± 17	5.3 ± 2.7	1.2 ± 0.7
Total bkg	16455 ± 4828	1249 ± 174	297 ± 30	19 ± 4.3	3.2 ± 1.0
Data	16483 (8243,8240)	1169 (615,554)	290 (142,148)	14 (8,6)	0
Observed UL	9504	300	57	8.3	3.0
Expected UL	9478	349	60	11	4.6
LM4	120 ± 7.0	108 ± 6.7	93 ± 6.6	53 ± 7.3	24 ± 6.2
LM8	52 ± 3.2	46 ± 3.0	37 ± 2.8	21 ± 2.8	9.1 ± 2.3

INTERPRETATION

- Final states with **Z bosons** are predicted in many models of BSM physics, such as supersymmetry (SUSY).
- **Gauge structure of SUSY:** the decay $\tilde{\chi}_2^0 \to \tilde{\chi}_1^0 Z$, where $\tilde{\chi}^0$ are neutralinos, can become a favored channel in SUSY parameter space where the neutralinos have a large Higgsino or neutral Wino component.
- We interpret our results in **simplified model scans (SMS)** which represent decay chains of new particles
- The diagram showns a gluino which decays to two quarks and a heavy neutralino ($\tilde{\chi}_2^0$)
- The $\tilde{\chi}_2^0$ then decays to a Z and the LSP ($\tilde{\chi}_1^0$), which is only seen as E_T^{miss}
- We provide **efficiencies** for each scan point: may be used to validate efficiency models and applied to other new physics scenarios.
- We also provide cross section ULs, as shown on the right





MORE TO COME...

The analysis described can be tailored to search for electroweak production of new physics (e.g. $\tilde{\chi}_2^0$ direct production) by the addition of the following cuts: a veto on any b jets significantly suppresses $t\bar{t}$ background, a third lepton veto decreases the diboson background, and a dijet mass requirement can be used to select jets which originate from the decay of a W or Z boson.