Search for supersymmetry in hadronic final states with M_{T2}

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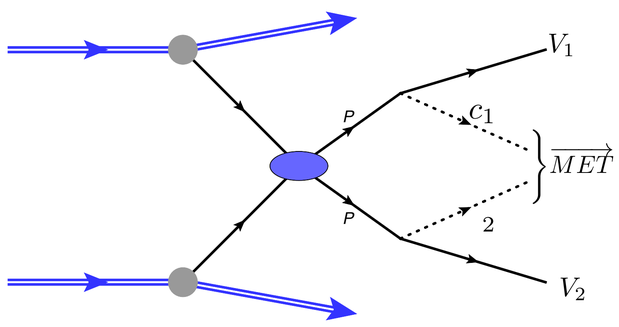
We present the results of a search for physics beyond the Standard Model (BSM) using data of 1.1 fb^{-1} integrated luminosity collected by the CMS experiment at the LHC. Fully hadronic final states were selected based on the "stransverse" mass variable M_{T2} and interpreted in various models of supersymmetry (SUSY). Two complementary analyses were performed targeting different areas of the SUSY phase space. All backgrounds were estimated using both simulation and data-driven methods. As no excess of events over the expected background was observed exclusion limits were derived.

Definition of M_{T2}

Generalization of transverse mass M_T in case of **two** decay chains with each an unobserved particle [1]

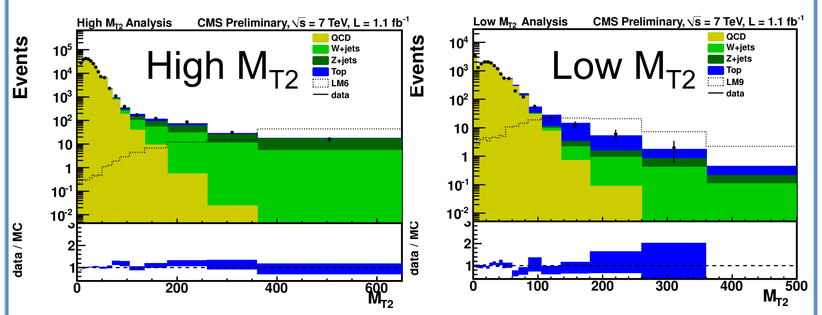
$$M_{T2}(m_c) = \min_{\vec{p}_T^{\,c(1)}+\vec{p}_T^{\,c(2)}=\vec{p}_T^{\,miss}} \left[\max\left(m_T^{(1)}, m_T^{(2)} \right) \right]$$

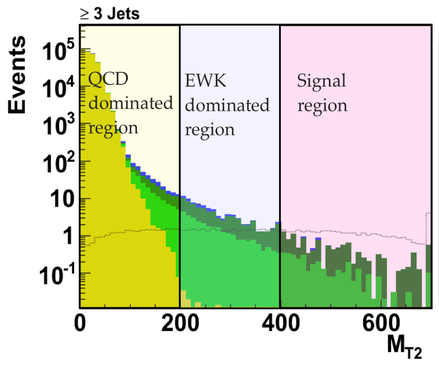


Here M_{T2} purely **discovery variable** [2]

Divide jets into two “pseudojets” using a **hemisphere** algorithm

Background Estimation Strategy





EWK/top estimation from adjacent **control region**

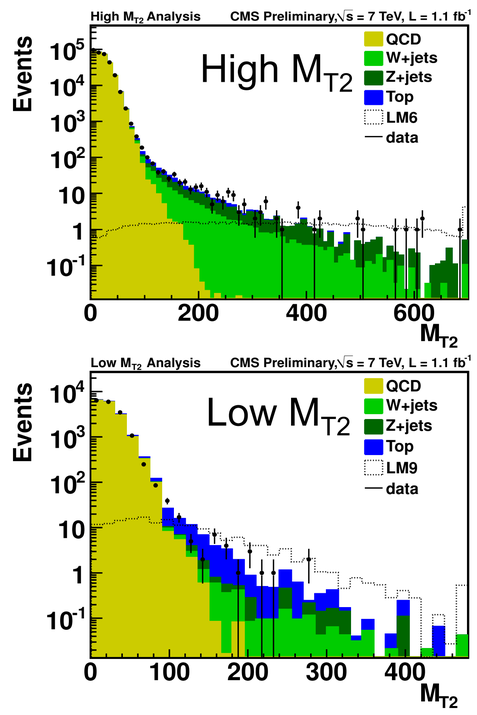
Prediction from data in control region scaled by MC ratio

Translate uncertainties via MC ratio

EWK / Top control regions:
Low M_{T2}: 100 GeV < M_{T2} < 150 GeV
High M_{T2}: 200 GeV < M_{T2} < 400 GeV

Results

	SM-MC	Data	Final background estimate
High M_{T2}	10.6	12	12.6 ± 1.3 (stat) ± 3.5 (syst)
Low M_{T2}	14.3	19	10.6 ± 1.9 (stat) ± 4.8 (syst)



Advantages of M_{T2}

Assuming zero masses and no initial state radiation (ISR):

$$M_{T2}^2 = 2p_T^{(1)}p_T^{(2)}(1+\cos\phi_{1,2})$$

M_{T2} ≈ MET for symmetric systems, i.e. for $p_T^{(1)} = p_T^{(2)}$

M_{T2} = 0 GeV for back-to-back systems

→ M_{T2} is **robust against jet energy mismeasurements**:

M_{T2} ≈ 0 GeV for mismeasurement along one of the two visible systems

M_{T2} < MET for asymmetric mismeasurement

QCD estimation

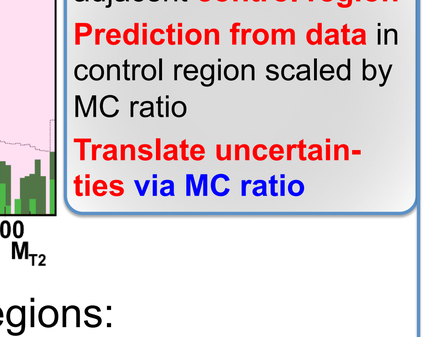
Factorization method

$$r(M_{T2}) = \frac{N(\min\Delta\phi(\text{jets,MET}) \geq 0.3)}{N(\min\Delta\phi(\text{jets,MET}) \leq 0.2)} = e^{a-b\cdot M_{T2}} + c$$

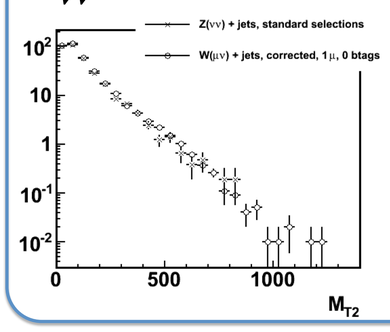
Fit data in QCD dominated region:

$M_{T2} \subseteq (50,80)$ GeV

c = value of exponential at M_{T2} = 200 GeV



$Z_{\nu\nu}$ estimation



Use **$W_{\mu\nu}$ data**

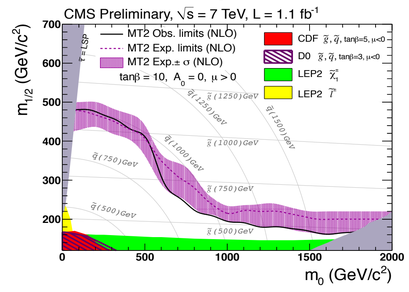
$$N_{Z\nu\nu}(est.) = \frac{R_{Z/W}}{\varepsilon_{acc}\cdot\varepsilon_{reco/iso}} N_{W\mu\nu}$$

Exclusions

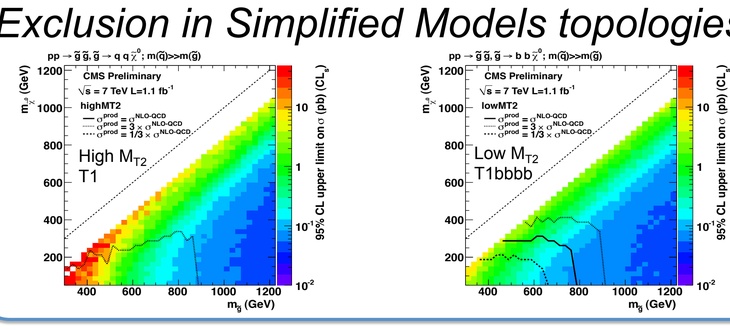
Model independent limit

	Limit on σ × BR (pb) observed	expected
High M_{T2}	0.010	0.011
Low M_{T2}	0.020	0.014

Exclusion in cMSSM plane



Exclusion in Simplified Models topologies



Analysis Strategy

High M_{T2}	Low M_{T2}
# jets ≥ 3 H_T > 600 GeV M_{T2} > 400 GeV	# jets ≥ 4 # b-tags ≥ 1 H_T > 650 GeV M_{T2} > 150 GeV
Sensitive to low m_0, high $m_{1/2}$	Sensitive to high m_0, low $m_{1/2}$

Event Selection

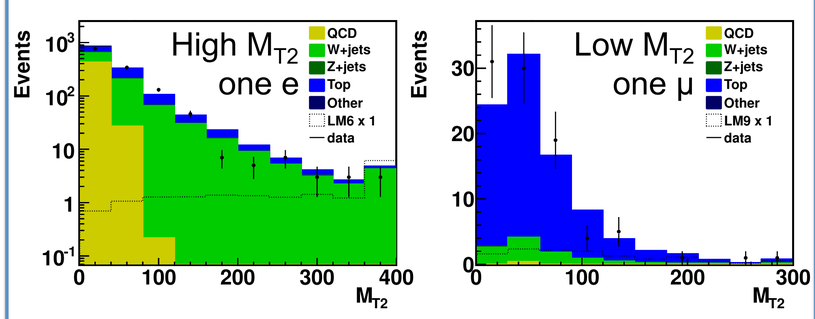
- jets with p_T > 20 GeV, |η| < 2.4
- Lepton (e,μ) veto
- MET tail cleaning cuts (e.g. noise)
- minΔφ(MET, any jet) > 0.3
- |MHT – MET| < 70 GeV
- H_T triggers for selecting data

W/Top estimation

Leptons lost due to acceptance, isolation or identification

$$N_{e,\mu}^{pass\ veto} = (N_{e,\mu}^{reco} - N_{e,\mu}^{bg})\frac{1-\varepsilon_{e,\mu}}{\varepsilon_{e,\mu}}$$

ε_l: **probability** of $W_{l\nu}$ to be reconstructed



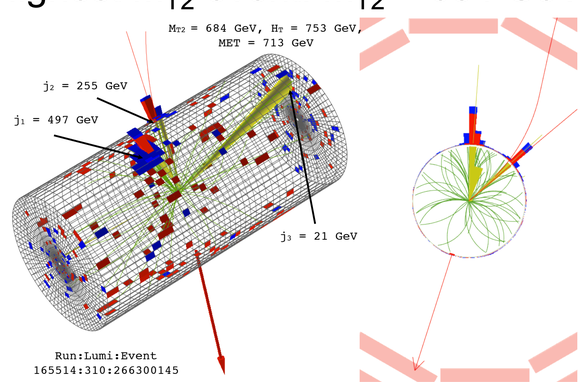
Hadronic tau decays

Well modelled in Monte Carlo
→ **Verified $W_{l\nu}$ kinematics** with muons

Summary

- **Search for BSM physics** in hadronic final states performed:
  1.1 fb^{-1} at **$\sqrt{s}$ = 7 TeV** with CMS
- **Two analysis strategies** to probe a large phase space
- **Tail of the M_{T2} distributions sensitive** to possible SUSY signal
- **No excess observed**, limits set.

Highest M_{T2} event: M_{T2} = 684 GeV



References: [1] C.G. Lester, J.D. Summers, Phys.Lett. B463 (1999) 99 [hep-ph/9906349]; [2]: A. Barr, C. Gwenlan, arXiv:0907.2713 [hep-ph/09072713]
Bibliography: CMS PAS SUS-11-005