CMS Results on SUSY and Higgs searches and EW physics

A short* selection of the latest Moriond presentations



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March 21, 2011



* Very short

SUSY searches at CMS





SUSY searches at CMS



CMS search strategy:



olepton

SUSY searches at CMS



CMS search strategy:

 q_{\bullet} Perform generic searches m₄ \rightarrow Focus on simple signatures that are common to several scenarios (MET from LSPs, m^B high- E_T jets and leptons from long decay chains) P Backgrounds Cannot yet rely on MC Measured in data \rightarrow Data-driven techniques

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lepton

Hadronic search with α_T



otherwise

 α_T can be used to supress the background a_{10}

- At least two jets with $E_T > 50$ GeV and $|\eta| < 3$
- Leading jet with $|\eta| < 2.5$ and $E_{\tau}^{j_1} > 100$ GeV
- Veto on isolated e^{\pm}, μ^{\pm} and photons
- $H_T = \sum E_T^{jets} > 350 \text{ GeV}$



Inclusive Background estimation



 $R_{\alpha_{T}} = \frac{\text{Events passing the } \alpha_{T} \text{ requirement}}{\text{Events failing the } \alpha_{T} \text{ requirement}}$

• $\alpha_T > 0.51$ dominated by QCD multijet BG $\rightarrow \not{E}_T$ originates mostly from energy

mismeasurements

• $\alpha_T > 0.55$ dominated by EW background

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- \rightarrow Genuine E_T .
- ightarrow Constant value of $R_{lpha_{ au}}$

• The background for the signal region can then be estimated with the double ratio: $\frac{R_{\alpha T}(HT300 \text{ GeV})}{R_{\alpha T}(HT250 \text{ GeV})} = \frac{R_{\alpha T}(HT350 \text{ GeV})}{R_{\alpha T}(HT300 \text{ GeV})}$

- \bullet Yields an estimation of $9.4^{+4.8}_{-4.0}(\mbox{stat.})\pm1.0(\mbox{syst.})$
- 13 events are observed in data \rightarrow No excess observed

Interpretation in the CMSSM

• To facilitate the comparison with previous experiments, exclusion limits in the CMSSM are set

- $tan\beta = 3 A_0 = 0 \mu > 0$
- Excluded region at Tevatron significantly extended



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Interpretation in the CMSSM



Same-sign dilepton search

• Isolated same-sign lepton signature is essentially absent in the Standard Model



the backgrounds in these regions.



Same-sign dilepton search

• In the high- p_T^{lepton} region, the dominant background arises from $t\bar{t}$ events, with one isolated lepton from W decay (*real*) and one brom a b decay (*fake*), expected to be less isolated.



• Rellso quantifies the isolation:

 $\label{eq:Rellso} \text{Rellso} = \frac{\text{Scalar sum of track momenta and calorimeter energy in} \Delta R^{\text{lepton}} < 0.3}{\text{transverse momentum of the lepton}}$

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- Tight-to-Loose lepton ID probability from multi-jet sample
- \rightarrow Tight cuts involve Rellso< 0.1 (high isolation)
- \rightarrow Loose cuts involve Rellso< 0.4



#events with two SS2L, one real && isolated and one fake, where the fake satisfies the loose Rellso cut.



#events where the fake lepton satisfies the tight Reliso cut.

#events where the fake leton does not satisfy the tight Rellso cut.

• Key assumption: $\epsilon_{T|L}$ is universal

i.e. it is the same for all jets in all samples

• A fake-lepton-enriched sample is considered and $\epsilon_{T/L}$ is measured.

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• $\epsilon_{T/L}$ can now be used to estimate the background

Two different methods to estimate the $t\bar{t}$ contribution:

- Tight-to-Loose lepton ID probability from multi-jet sample
- \rightarrow Tight cuts involve Rellso< 0.1 (high isolation)
- \rightarrow Loose cuts involve Rellso< 0.4



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Two different methods to estimate the $t\bar{t}$ contribution:

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- \rightarrow Loose cuts involve Rellso< 0.4



- Data-driven approach
- Different techniques provide consistent predictions in overlapping regions.

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Results

• No excess of events over the background expectation is seen.

Tabl	e 2: Data and	Monte Carlo y	reids summa	rized for all a	nalyses.	
Search Region	ee	μμ	еµ	total	95% C.L. UL Yield]
Lepton Trigger		\sim		∇D]
$E_T > 80 \text{GeV}$	<pre></pre>			\sim		
MC	0.05	0.07	0.23	0.35	(7.3 for LM0)	
BG predicted	0.23 ± 0.35	0.23 ± 0.26	0.74 ± 0.55	1.2 ± 0.8		
observed	0	0	0	0	3.1	
$H_T > 200 \text{ GeV}$			\sim			
MC	0.04	0.10	0.17	0.32	(9.6 for LM0)	
BG predicted	0.71 ± 0.58	0.01 ± 0.24	0.25 ± 0.27	0.97 ± 0.74		Additional cuts fo
observed	0	0	1	1	4.4	HT trigger:
H_T Trigger						
$Low-p_T$						
MC	0.05	0.16	0.21	0.41	(9.1 for LM0)	🚤 HT>300 GeV
BG predicted	0.10 ± 0.07	0.30 ± 0.13	0.40 ± 0.18	0.80 ± 0.31		MFT>30 GeV
observed	1	0	0	1	4.5	
	ετ	μτ	ττ	total	95% C.L. UL Yield	
au enriched]
MC	0.36	0.47	0.08	0.91	(2.0 for LM0)	
BG predicted	0.10 ± 0.10	0.17 ± 0.14	0.02 ± 0.01	0.29 ± 0.17	Į	
observed	0	0	0	0	3.4	MET>50 GeV

Table 2: Data and Monte Carlo yields summarized for all analyses.

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Interpretation within the CMSSM

- Exclusion contour in the $m_0 m_{1/2}$ plane for the CMSSM
- A significant improvement over the Tevatron results is obtained



$pp \rightarrow W \rightarrow \ell \nu$ charge asymmetry

• The production of W bosons at the LHC

is sensitive to the structure of the proton and can therefore be used to constrain the PDFs.

• A prevalence of *W*⁺ over *W*⁻ should be expected due to the higher content of u quarks





$pp \rightarrow W \rightarrow \ell \nu$ charge asymmetry

• The charge asymmetry is defined as:

$$\mathcal{A}(\eta) = \frac{\frac{d\sigma}{d\eta_{\ell}}(W^{+} \to l^{+}\nu_{\ell}) - \frac{d\sigma}{d\eta_{\ell}}(W^{-} \to l^{-}\nu_{\ell})}{\frac{d\sigma}{d\eta_{\ell}}(W^{+} \to l^{+}\nu_{\ell}) + \frac{d\sigma}{d\eta_{\ell}}(W^{-} \to l^{-}\nu_{\ell})}$$

• Measured for muons and electrons
• The signal is extracted from the

QCD and EW background in bins of η



Results



• A good agreement beween ℓ and μ is observed

• This provides the first constraints on the PDF from LHC physics

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Results

• The preliminary addition of the CMS *W* charge assymetry data in NNPDF2.1 shows a reduced uncertainty on sea quarks



Neutral MSSM Higgs Boson $\rightarrow \tau \bar{\tau}$

- In the MSSM, one has 2 Higgs doublets:
- This leads to 5 physical Higgs Bosons after EWK breaking:



• At Born level, MSSM is described by 2 parameters: $tan\beta$ and m_A





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$\tau^+\tau^-$ Mass reconstruction



- Likelihood Fit of the momenta of visible decay products and of the neutrino.
- The mass spectra show no evidence of the presence of a Higgs boson signal

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 \mapsto A 95% C.L. upper level bound on the $\sigma_{\phi} \cdot B_{\tau\tau}$ can be set as a function of the Higgs mass

$\tau^+\tau^-$ Mass reconstruction

• Figure: Expected one- and two- σ deviation ranges (blue bands) and observed (red line) 95% C.L. upper limits on $\sigma_{\phi} \cdot B_{\tau\tau}$



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$\tau^+\tau^-$ Mass reconstruction

• Figure: Region of the parameter space of $tan\beta$ vs. m_A excluded at 95% C.L. in the context of the MSSM m_h^{max} scenario. hep-ph 1101.0593v2



• The exclusion region in $tan\beta$ is extended with respect to the Tevatron experiments, especially for values of $m_A > 140$ GeV².

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