



Search for MSSM Higgs by Tau-Tau decay at the CMS Experiment

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MSSM Higgs

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tt fusion :



 $\sigma(pp \to \Phi + X)$ [pb]

H

 $\rightarrow H^+ \bar{t} b$

 M_{Φ} [GeV]

 $\sqrt{s} = 14 \text{ TeV}$ $\tan \beta = 30$

 $qq \rightarrow \Phi$

 $b\bar{b}\Phi$..

 $aa\Phi$

 $W\Phi$

 $Z\Phi$

tīΦ

- The MSSM light Higgs presents an attractive early data target
- We will look at both gluonfusion and quark-associated production mechanisms





The decay to a pair of tau leptons offers a cleaner and more distinguishable channel than b decay.

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I am focussing on the further decay to electron and tau jet. The overall branching ratio for this process is $\sim 2.4\%$.

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Current Results

- Recent results from Tevatron have started to push exclusior limits down to tan $\beta = 30$
- With sufficient data, this analysis (combined with other tau-tau channels) should be able to close the gap between Tevatron and LEP data
- Results presented are for the maximal mixing model
- We consider
 - Mass points 115, 160 GeV
 - tan β = 15, 20, 30, 40



For 10TeV, M_{H} =115GeV, tan β =30 Event rate (e+t) ~ **20 / pb**⁻¹

Where not specified, plots correspond to M=115GeV and tan β = 30

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CMS Fireworks Event Display



- Selections optimised
 - individually, by distribution
 - all together, using — Python/ROOT/ MINUIT
- This data is for 10TeV, re-running this analysis for **7TeV** is not yet complete

 distribution all together, using Python/ROOT/ 	Signal Samples	Events	Intlumi /pb
MINUIT • This data is for 10TeV , re-running this analysis for 7TeV is not yet	 Higgs (bb) * (115Ge (160Ge)) Higgs (gluon-gluon)*(115Ge) (160Ge) 	V) 200k eV) 200k eV) 200k eV) 200k eV) 200k	3800 11400 7800 36800 ^(tap $\beta = 30$)
complete	Backgrounds Samples		(tan p = 50)
	QCD (with >0 electrons) * Photon+Jet ~ W+jet(s) ^ TTbar +jet(s) ^ Z+jet(s) ^ Zbb ^ Zcc ^	65M 500k 10M 1M 1M 150k 250k	6+ 4+ 240 2600 330 3500 3500
₽ python ™	ordon.ball@cern.ch GPG 0x324543E5 * PYTHIA 6 ~ PYTHIA 8 ^ MadGraph	CMS Su	mmer08
CMSSW 2.2.13, ROOT 5.22, Python 2.6.4	+ Multiple Bins		6



Electrons

• Events triggered with a single, isolated electron trigger

- HLT_IsoEle15

- Use good, offline electrons
- Built from both a GSF* track and a ECAL cluster
- Select electrons within the tracker acceptance (η<2.4) and P_t > 15GeV
- Electron Identification cut
- Isolated in both tracker and ECAL
 - Cone size 0.4 in η,φ

*Gaussian Sum Filter, a track reconstruction method designed to handle bremstrahlung events

gordon.ball@cern.ch GPG 0x324543E5 Multivariate Electron ID ("robust") from CMS eq working group. Variables such as HCAL/ECAL, deposit shape, E/p and track extrapolated $_7$ position





Tau Jets

- Use "Particle Flow"* Taus
- Select taus within the tracker acceptance (η<2.4) with P_t > 20GeV
- Must be non-colinear with the selected electron(s)
- Leading track at least 5GeV
- Isolated in both tracker and ECAL
 - Cone size 0.5 in η,ϕ
- Passes electron-rejection cuts[^]



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*This is an algorithm intended to reconstruct the entire detector in one pass, classifying each track and deposit only once.

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[^]This is another MVA intended to identify electrons faking taus. This is based on the Particle Flow electron pre-ID decision and HCAL/track pt. ⁸



Electron-Tau Pairs

- Build all possible electron-tau pairs
 - where $\Delta R > 0.7$
- Require opposite charge
 q_{ec} x q_{tal} < 0
 - reduces losses due to badly counted tracks
- Require $\Delta \Phi_{\text{dectau}} > 1.5$
 - this eliminates a lot of QCD and W background
- Require M_{tdec,MET} < 25 GeV
 - this is sensitive to higher higgs masses but useful in this region to remove W and TTbar background gordon.bal gordon.bal





Jets and B-Tagging

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- Use simple calorimeter jets, since energy resolution is not important
- For the associated production channel, we can look for b-jets to eliminate backgrounds
- Tag b-jets by looking at the impact parameter significance of the 2rd best track in the jet
- Although the signal should usually contain 2 b-jets, most of the time we do not find a second
- Requiring exactly one b-tag significantly reduces tt-bar background
- Requiring no more than two jets, in tracker and E_t>15GeV further reduces this background
 - But this is sensitive to pileup







Results

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At **10TeV** with **200pb⁻¹** of data

Signal (115 GeV)	17.8 ± 1.0 evts
Signal (160 GeV)	11.9 ± 0.5 evts
Background	22.8 ± 2.2 evts

Selection efficiency is 0.5% (of e+T events)

Data required for 3σ exclusion

115 GeV	129 ± 16 pb ⁻¹
160 GeV	291 ± 31 pb ⁻¹

(Systematic errors not included)





Conclusions

- With a 1 fb⁻¹ of data, we can significantly advance the current exclusion limits with this channel alone
- This analysis will be combined with other tau-tau channels to improve reach
- The limits will however worsen when recalculated with 7TeV Monte-Carlo data
- Many of the ideas for this analysis will be commissioned by looking at Z→TT events in early data



Expected exclusion limits for electron+tau channel only, without systematic uncertainities and with 10TeV data.

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Other Work



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Pygoscelis – a grid copying GUI

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Overview Web Tools – Production and Site Monitoring



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DAS – CMS Data Aggregation Service

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