Trilepton channel at LM1

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Discovery of SuperSymmetry

- $\tilde{\chi}_1^{\pm}$, $\tilde{\chi}_{1,2}^{o}$ being among the lightest SUSY particles are likely to be produced more easily in all models.
- 2- or 3-body decay of $\tilde{\chi}_2^{o}$ to leptons $\Longrightarrow$ kinematic upper limit of dilepton invariant mass $\Longrightarrow$ first signature of SUSY: observation of sharp edge in mass distribution.

Pure Trilepton Channel

- $\mathrm{pp} \rightarrow \tilde{\chi}_2^{\mathrm{o}} \tilde{\chi}_1^{\pm}$ is a DY(weak) process.
  Signal in leptonic decay modes$\Rightarrow$
  3leptons + missing energy +*no hadronic activity in central region*.
- Background is much less compared to other channels!
- Inclusive di-lepton and trilepton channels are also being studied in CMS.

Motivation of present study

- The trilepton (e, μ) channel has been studied at $tan\beta = 2$: CMS Note/1997-007, J.Phys.G: Nucl.Part.Phys. 28 (2002)469.
- With increasing $tan\beta$, production of 3rd generation particles are enhanced.
- Can we still observe the *pure trileptons* in e, μ channel at high/moderate $tan\beta$?
- We study τs in near future.

Numbers at LM1, a low-mass point, with mSUGRA

- $m_0 = 60$ GeV/c^2, $m_{1/2} = 250$ GeV/c^2,
  $tan\beta = 10$, $A_o = 0$, μ : +ve,
  $m_t = 175$ GeV/c^2

- Mass spectrum, GeV/c^2
  $M_{\tilde{g}} : 611$, $M_{\tilde{q}_L} : 560$, $M_{\tilde{q}_R} : 540$,
  $M_h : 113$,
  $M_{\tilde{e}_L} : 189$, $M_{\tilde{e}_R} : 119$,
  $M_{\tilde{\nu}_\tau} : 168$, $M_{\tilde{\tau}_1} : 111$, $M_{\tilde{\tau}_2} : 192$,
  $M_{\chi_1^0} : 95$, $M_{\chi_2^0} : 180$,
  $M_{\chi_1^\pm} : 178$

Production at LM1

- Total SUSY rate at LM1 ~ 52 pb.
- Total branching ratios:

$\tilde{\chi}_1^{\pm} \to \ell^{\pm}\tilde{\nu}_L$: 36%

$\tilde{\chi}_2^0 \to \ell\tilde{\ell}_R$: 11%, $\tilde{\tau}_1\tau$: 46%

- The direct production cross-section:

$\sigma(q\bar{q} \to \tilde{\chi}_2^0\tilde{\chi}_1^+) = 1.07$ pb.

- Exclusive trilepton production cross-section:

$\sigma(3\ell^{\pm} + \not{\mathrm{E}}_{\mathrm{t}}) = 0.1361$ pb ~ 136 fb.

Other SUSY points compatible with WMAP data

- LM6 (post-LEP benchmark point C'):

$m_0 = 85$ GeV, $m_{1/2} = 400$ GeV, tanβ=10

  - Total branching ratios:

  $\tilde{\chi}_1^{\pm} \to \tilde{\chi}_1^0 \ell\nu$: 54%

  $\tilde{\chi}_2^0 \to \tilde{\tau}_{1,2}\tau$: 18%, $\quad \tilde{\ell}_{L,R}\ell$: 14%

- SPS4 (Snowmass point):

$m_0 = 400$ GeV, $m_{1/2} = 300$ GeV, tanβ=50

Backgrounds

SM processes	SUSY internal
WZ	$\tilde{q}\tilde{q},\ \tilde{g}\tilde{g},\ \tilde{q}\tilde{g}$
ZZ	$\tilde{g}\tilde{\chi},\ \tilde{q}\tilde{\chi}$
$t\bar{t}$	$\tilde{\ell}\tilde{\ell}$
Wtb	$\tilde{\chi}_i\tilde{\chi}_j$
$Zb\bar{b}$	
$b\bar{b}$	

- Leptonic branching modes to be considered.
- Jet-veto requirement reduces several backgrounds by large factors.

$WZ,\ ZZ \rightarrow$ leptons: potential backgrounds.

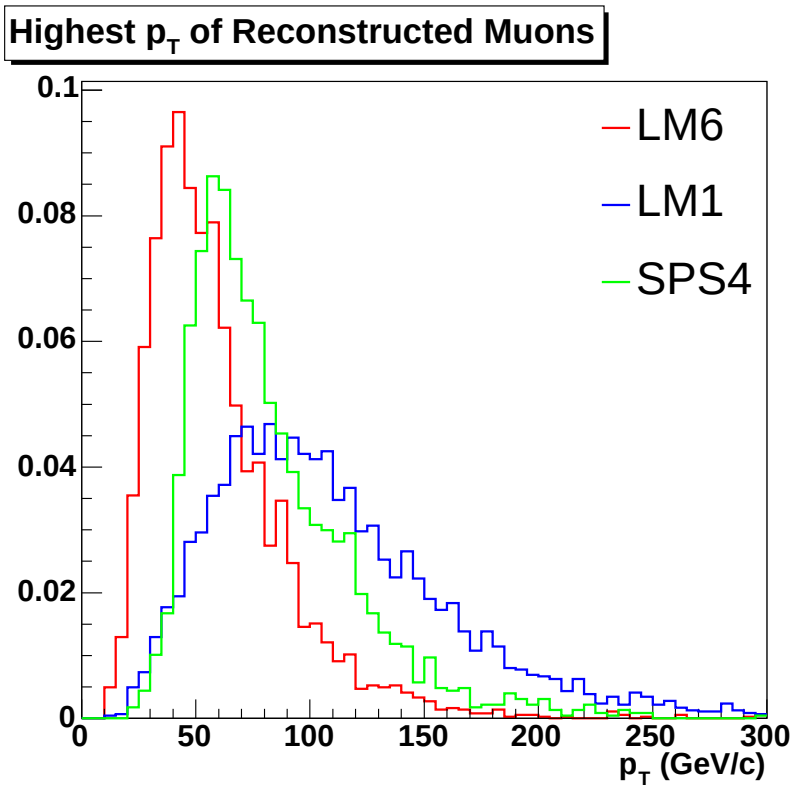
Status of trilepton channel analysis

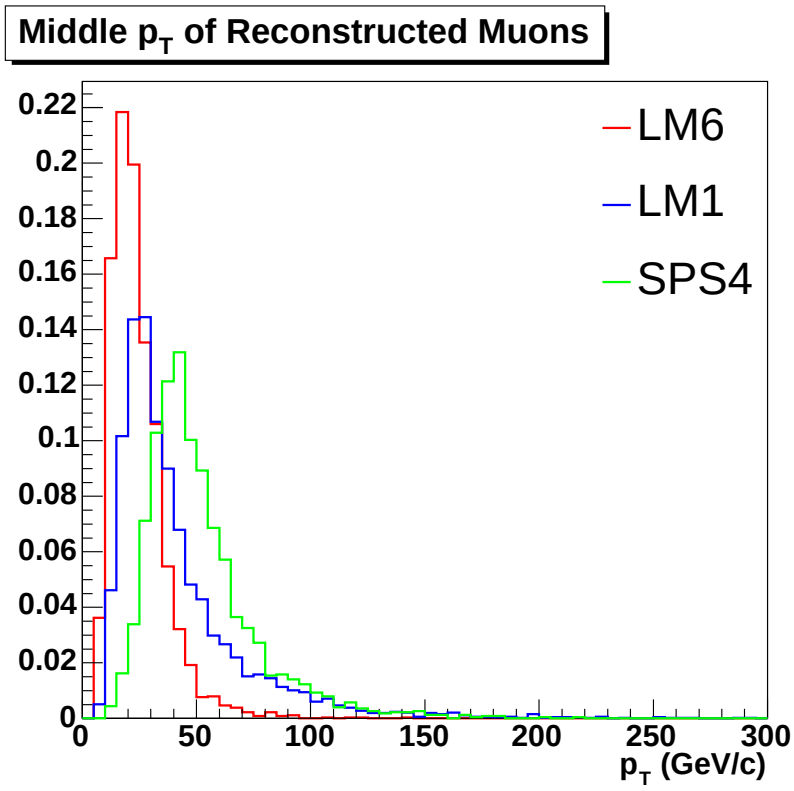
- Local DSTs made at 3 SUSY points.
  Studied MET, lepton momenta,...
- Used DC04 samples with leptons in final states.
  $\mathrm{t\bar{t}} \rightarrow \ell\ell + \mathrm{X}$ with ORCA-813.
  $\mathrm{WZ} \rightarrow \mathrm{leptonic}$, ...
- Had troubles transitioning to newer versions; problems with data access.

Status continued

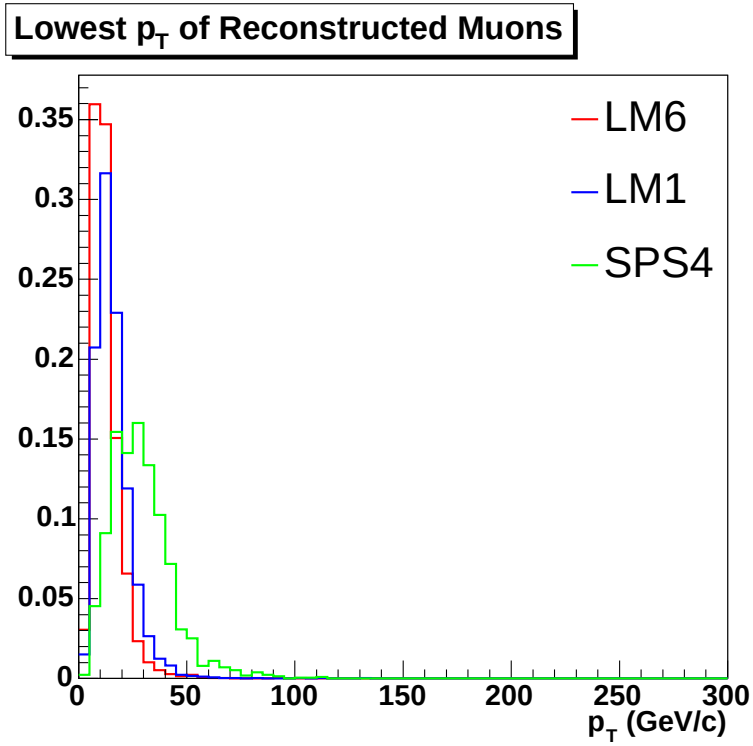
- Recently read LM1 DST (low statistics). High statistics study made for inclusive channel (talk by Chiorboli).
- Cut based analysis based on root tree: under progress.
- Famos has been tried for Muons (examples, CMKIN ntuples,..).

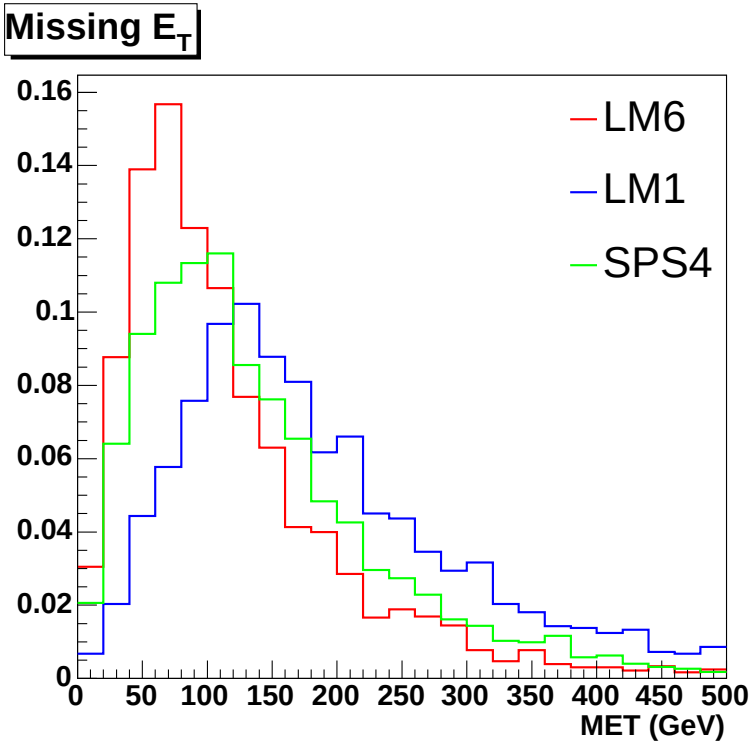
Highest p_T Muons at SUSY points





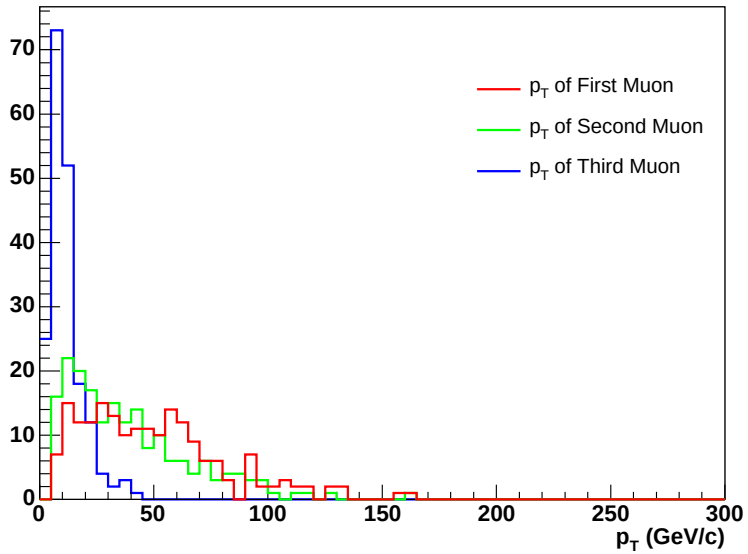
3rd highest p_T Muon and MET at SUSY points



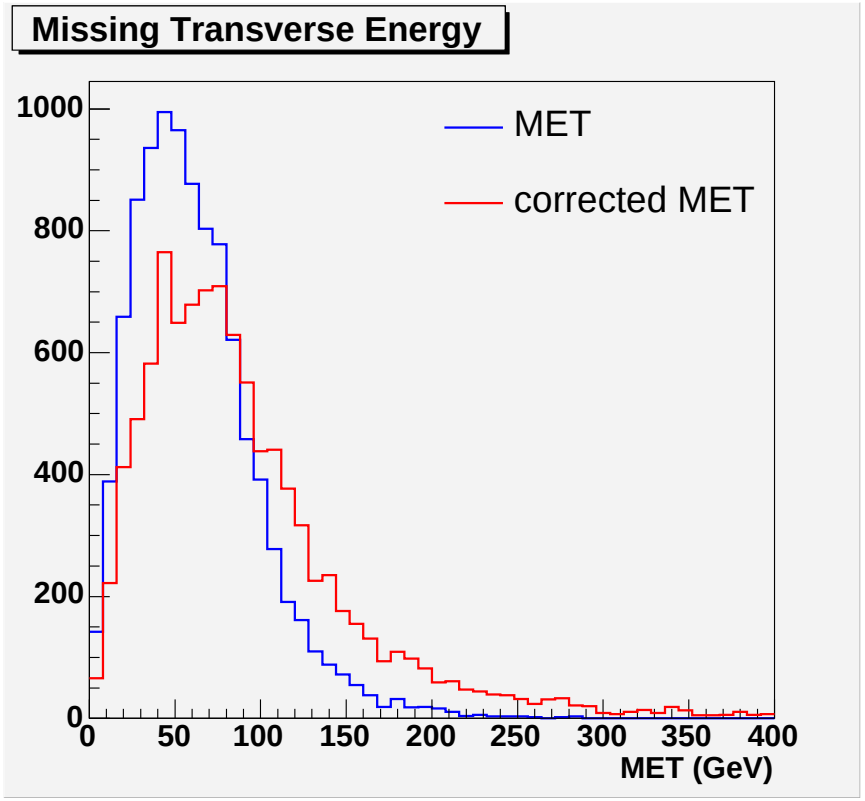


Lepton momenta, MET in ttbar sample

p_T of reconstructed muons



Missing Transverse Energy



Studies needed for PTDR

- Detailed study of WZ, ZZ and $\mathrm{t\bar{t}}$ backgrounds.
- Systematics: jet veto, MET, lepton-id, fake rate.
- Variation of signal and background rates wrt PDF; K-factors.
- Parameter scan with FAMOS.

Conclusion

- Need to collate all groups looking at similar process to strengthen effort.
- Lot more work needed before PTDR.