Requirements on very Forward Tagging (Work in Progress)

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CLIC 09: Physics and Detectors

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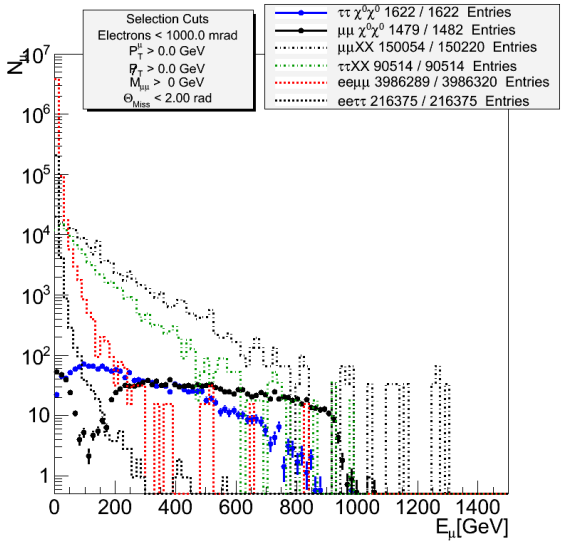
- Selection Cuts and Forward Tagging
- Summary and Conclusions

SuSy Signal

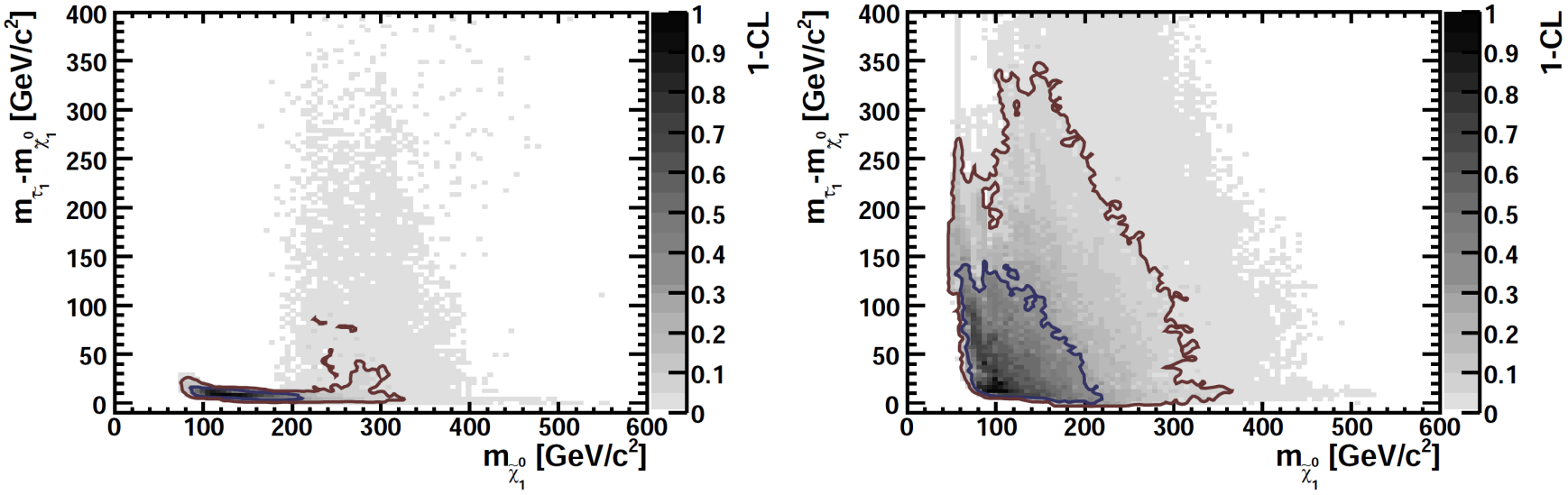


- SuSy Point K'
- Masses
  - Neutralino (LSP): 554 GeV
  - $\tilde{\tau}_1$ (σ ≈ 1.4 nb) 896 GeV
  - $\tilde{\mu}_R$ (σ ≈ 0.9 nb) 1109 GeV
- Sleptons decay into Neutralino and lepton
- Signature: 2 Muons/Taus and Missing Energy
- Use Endpoints of lepton Energy Distribution to extract mass
- For Simulation:
  - Luminosity Spectrum
  - Full Detector Simulation
  - Reconstruction

Mass Splitting between Sleptons and Neutralino

Constrained MSSM: Large Mass splitting only for larger Neutralino Masses

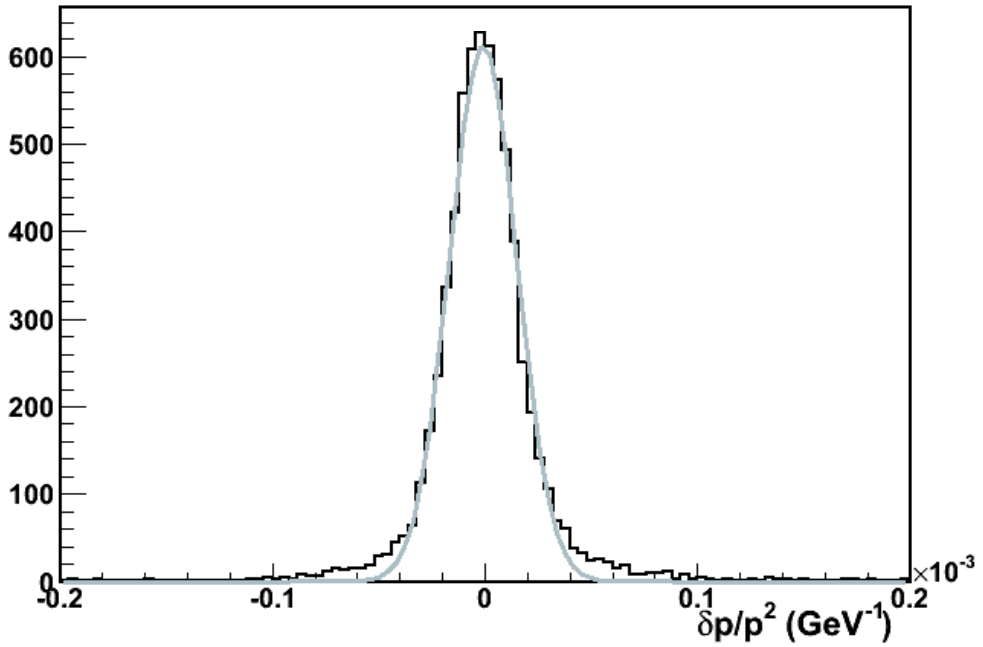
Non Universal Higgs Mass: Large Mass splitting possible for any Neutralino Mass



Buchmueller et al. : http://arxiv.org/abs/0907.5568v1

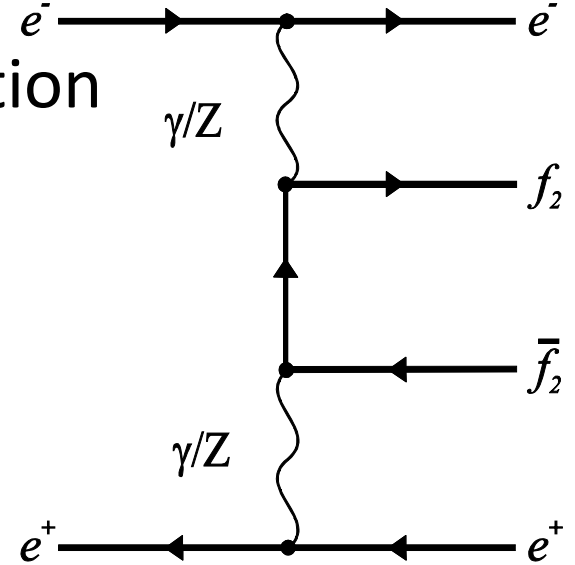
Muon Measurement

- Good Muon ID
- Good Momentum Resolution from Tracking for CLIC_ILD
  - $\sigma \approx 1.7 * 10^{-5}$



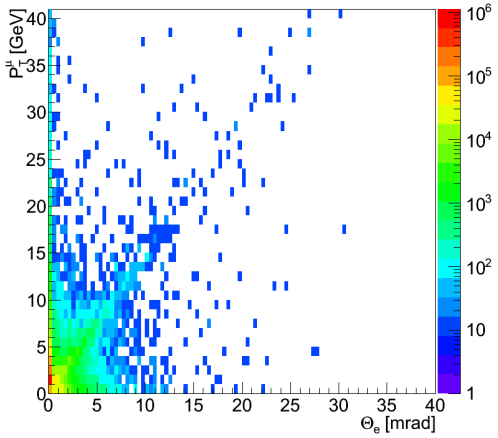
Two Photon Background

- $ee \to ee\tau\tau$ σ ≈ 280nb
- $ee \to ee\mu\mu$ σ ≈ 4700nb
- Electrons at very small angles
- These events only at generator Level
  - Without full Detector simulation
- No Luminosity Spectrum

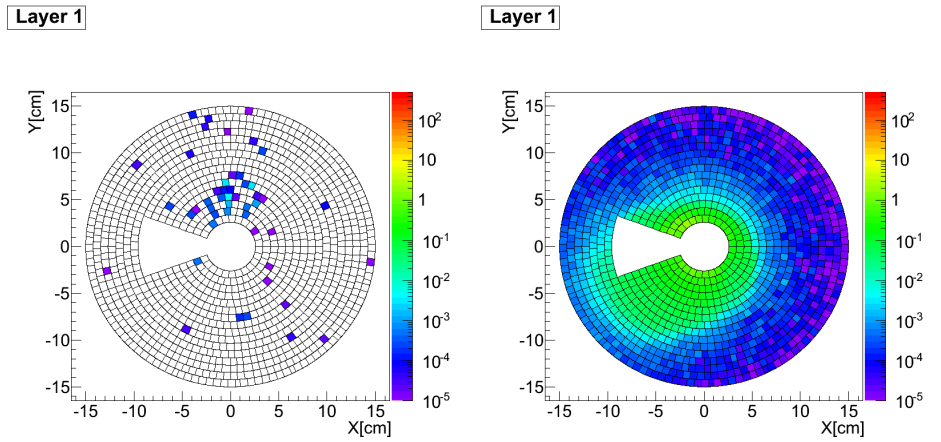


Very Forward Tagging (BeamCal)

- Tag Electrons with angles above ≈ 10 mrad
- Smaller angle to tag electrons → less stringent Pt cuts
- Electron veto removes Background only
- Large background from incoherent Pairs



PT for Muons and Angles of Electrons for eeμμ



1.5 TeV Electron @ 19mrad vs.
1 BX incoherent pair BG
(Animated in PPT)

Standard Model Background

- Inclusive Production
  - $ee \to \tau\tau\nu\nu$ (σ ≈ 105nb)
  - $ee \to \mu\mu\nu\nu$ (σ ≈ 130nb)
  - Luminosity Spectrum
  - Full Detector Simulation and Reconstruction

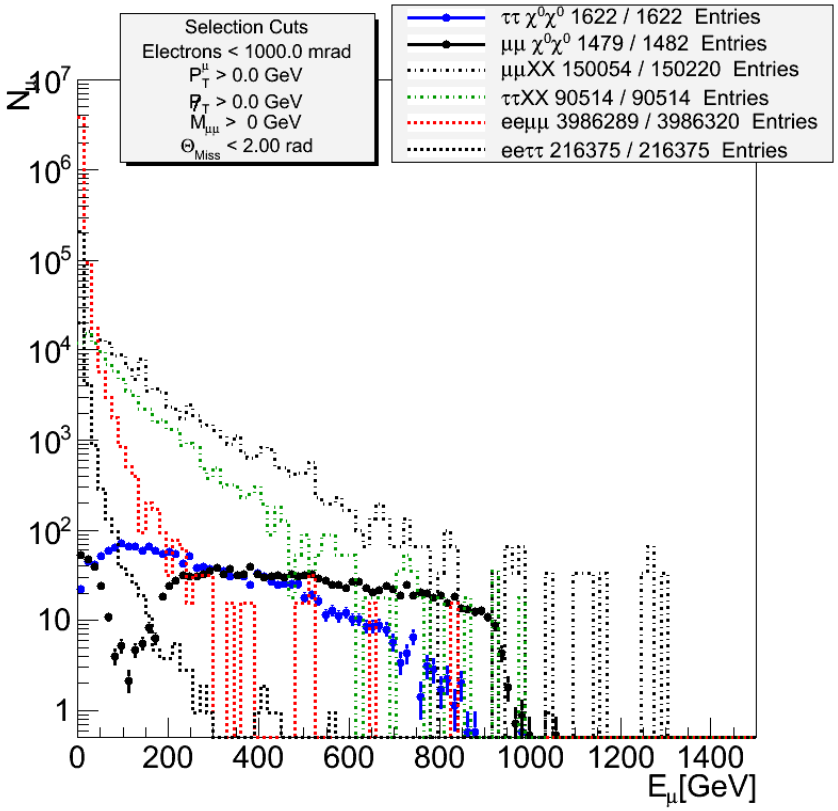
Monte Carlo Samples

Process	Cross Section @ 3TeV	Simulated Events	"Accepted" Events
$\tilde{\mu}_R\tilde{\mu}_R$	0.9 fb	5000	740
$\tilde{\tau}_1\tilde{\tau}_1$	1.4 fb	5000	811
$\tau\tau\nu\nu$	105 fb	5886	45257
$\mu\mu\nu\nu$	130 fb	3963	75110
$ee\mu\mu$	4700 fb	300000	1993160
$ee\tau\tau$	280 fb	300000	108187

- "Accepted" Events
  - Integrated Luminosity 1/ab
  - 2 Muon/Tau with $\theta > 10^o$
  - Tau Tagging Efficiency 100%

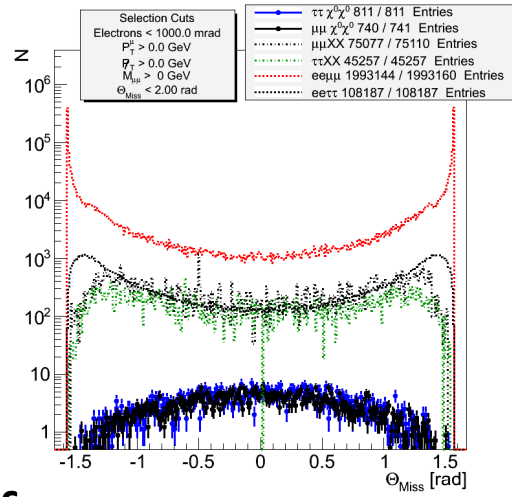
Muon Energy Spectrum

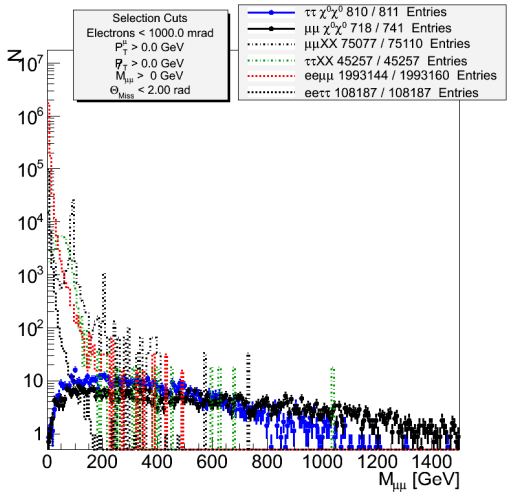
- Use Endpoints of Energy distribution to extract Slepton and Neutralino Masses
- Substantial Background Reduction needed
- Very challenging for lower Endpoint
- (Smuon peak at E=0 caused by tracking (Reco) problem)

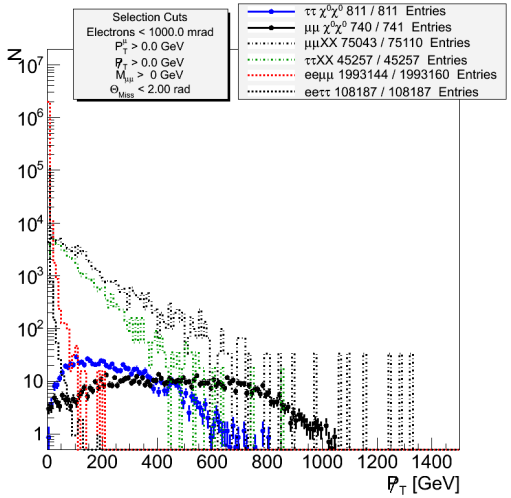


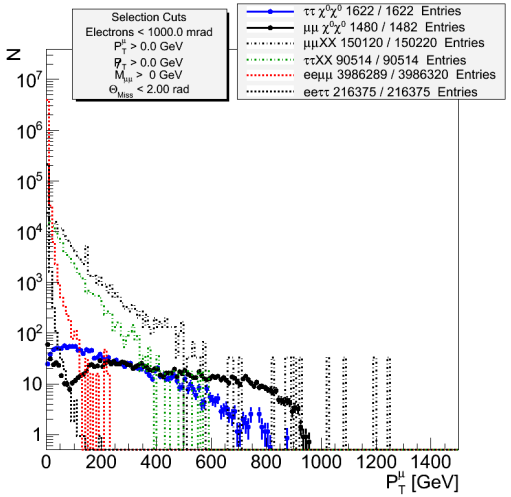
Selection Cuts

- Theta of Missing Energy
- Invariant Mass of Di-Muon System
- Missing Transverse Momentum
- Transverse Momentum of Muons
- Angle of Electrons in eeμμ/ττ
- Have to be careful not to bias Energy distribution through cuts



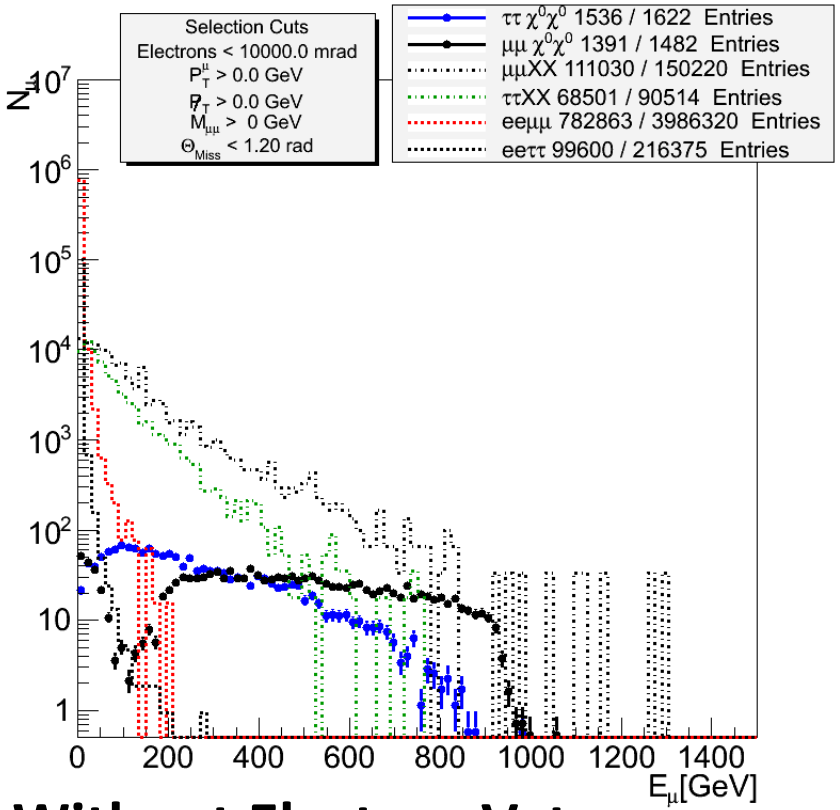




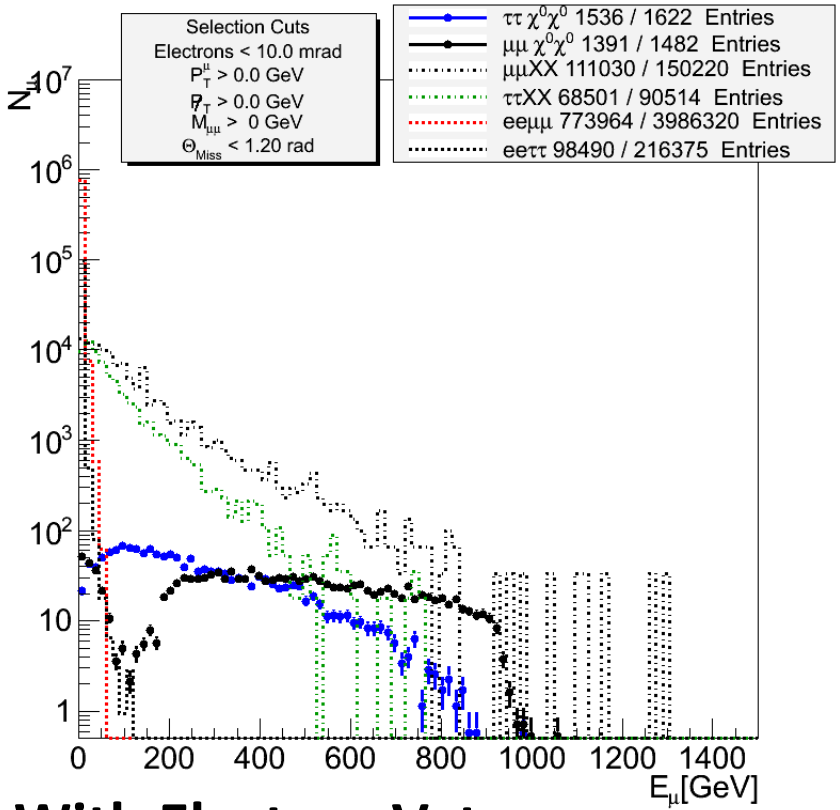


Only |Theta Miss| < 1.2 rad

- Removes almost all high energetic Muons down to 200 GeV without elec. Veto
- Down to 100 GeV with the electron Veto



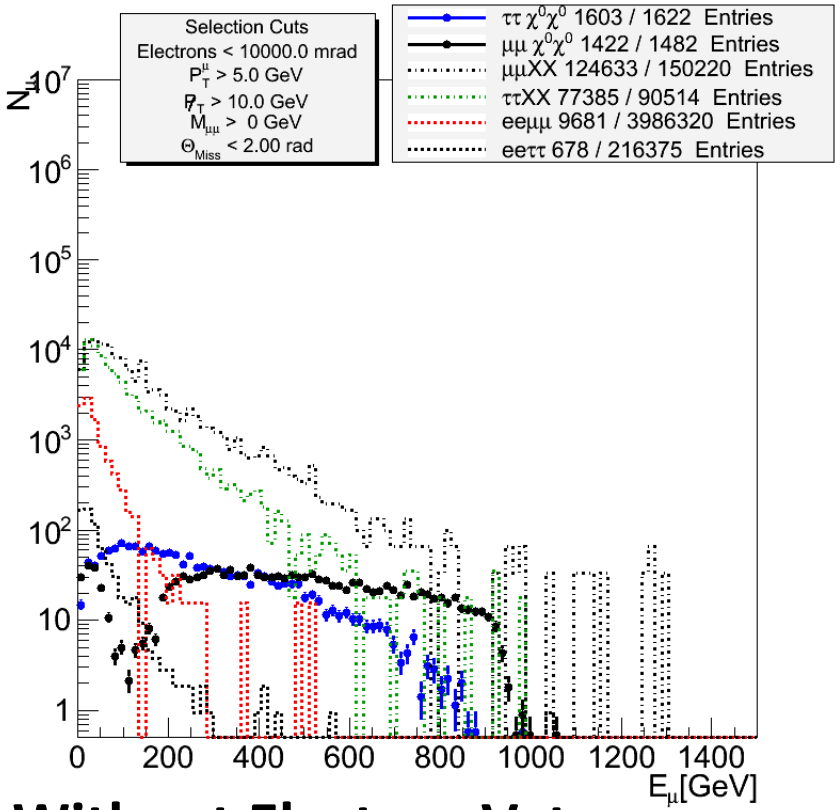
Without Electron Veto



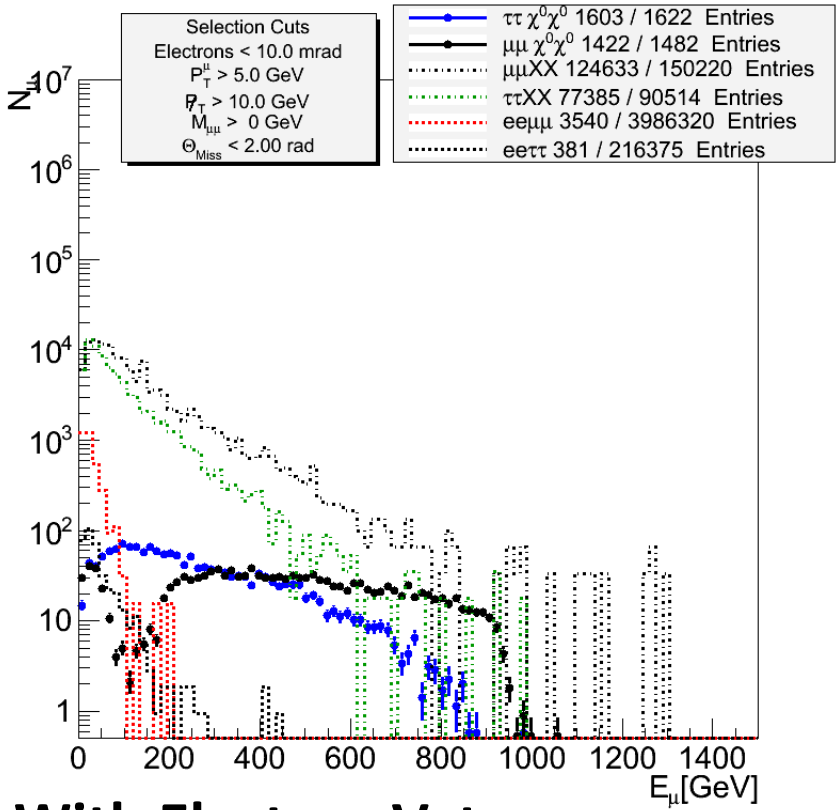
With Electron Veto

Only Pt > 5 GeV and Ptmiss > 10 GeV

- Decreases low energy Muons by 3 orders of magnitude
- Another factor 3 with electron veto



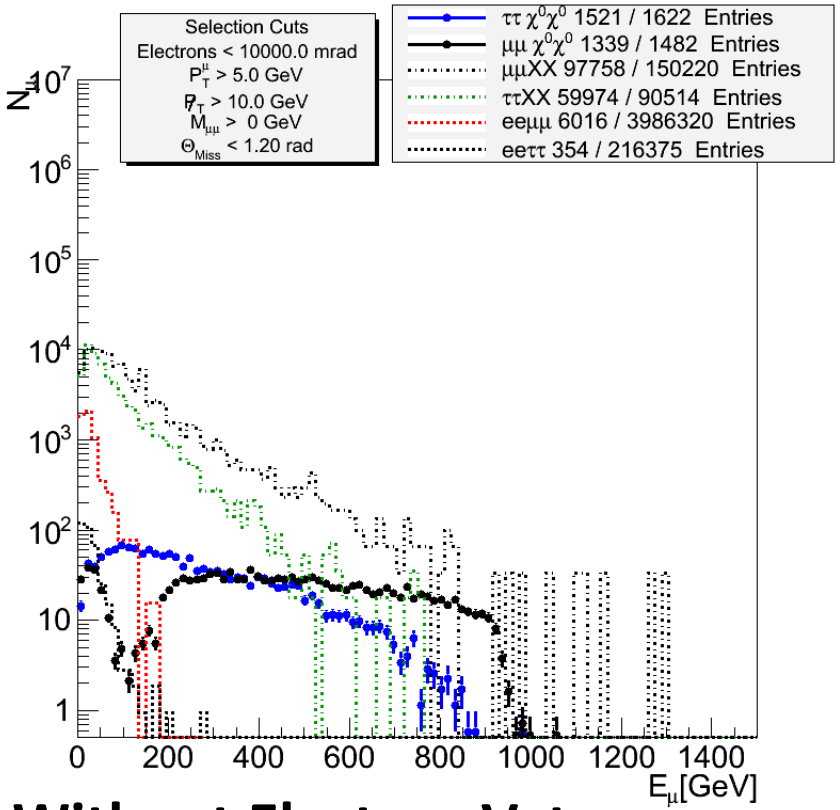
Without Electron Veto



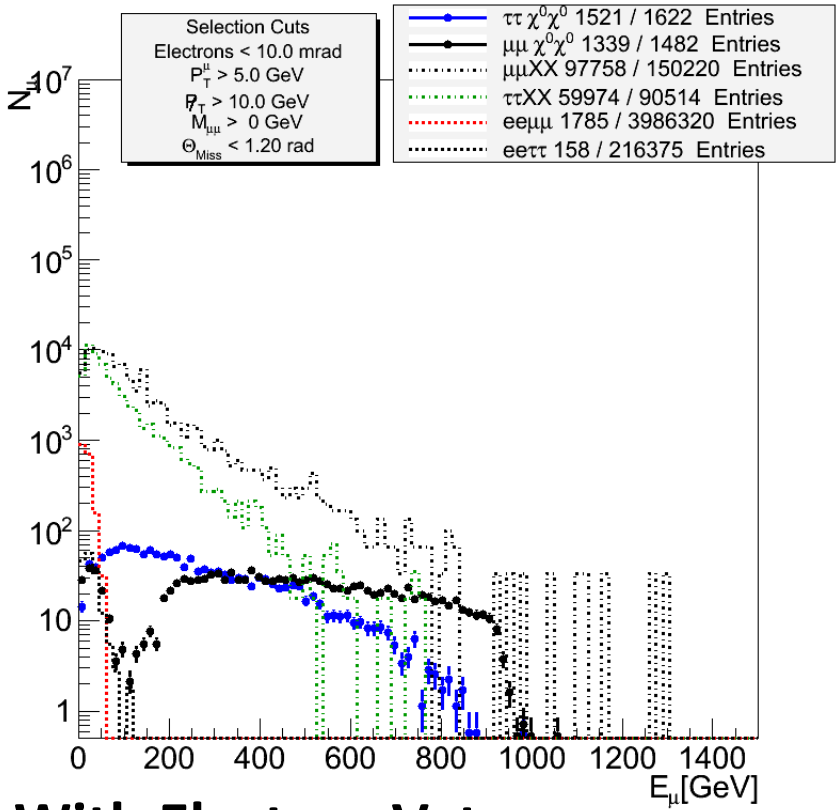
With Electron Veto

Combined PT and Theta Miss cuts

- eeττ and eeμμ Background suppressed by three order of magnitude
- Electron Veto adds another factor 3
- lower edge of Smuon Signal free of eeμμ BG



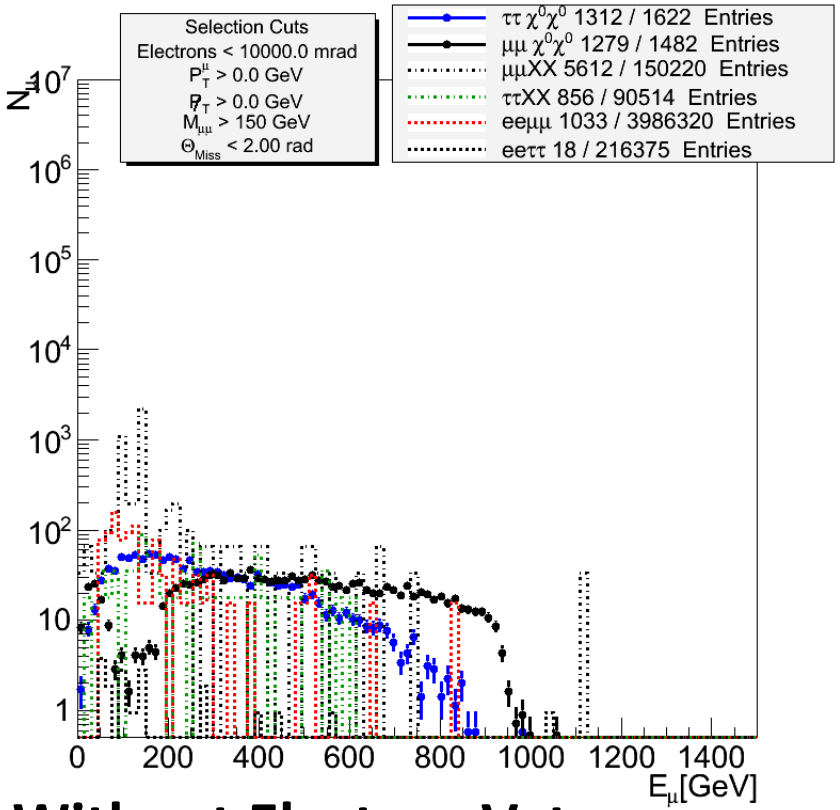
Without Electron Veto



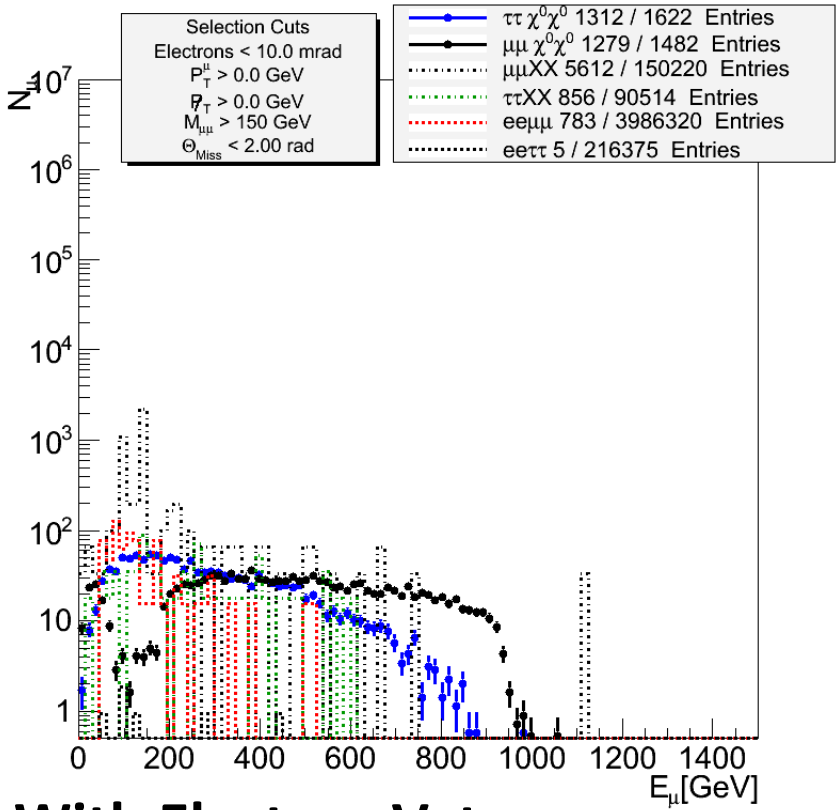
With Electron Veto

Only Mμμ > 150 GeV

- Decreases low energy Muons by 3 order of magnitude
- Large reduction of SM BG
- Affects lower edge for Stau Signal



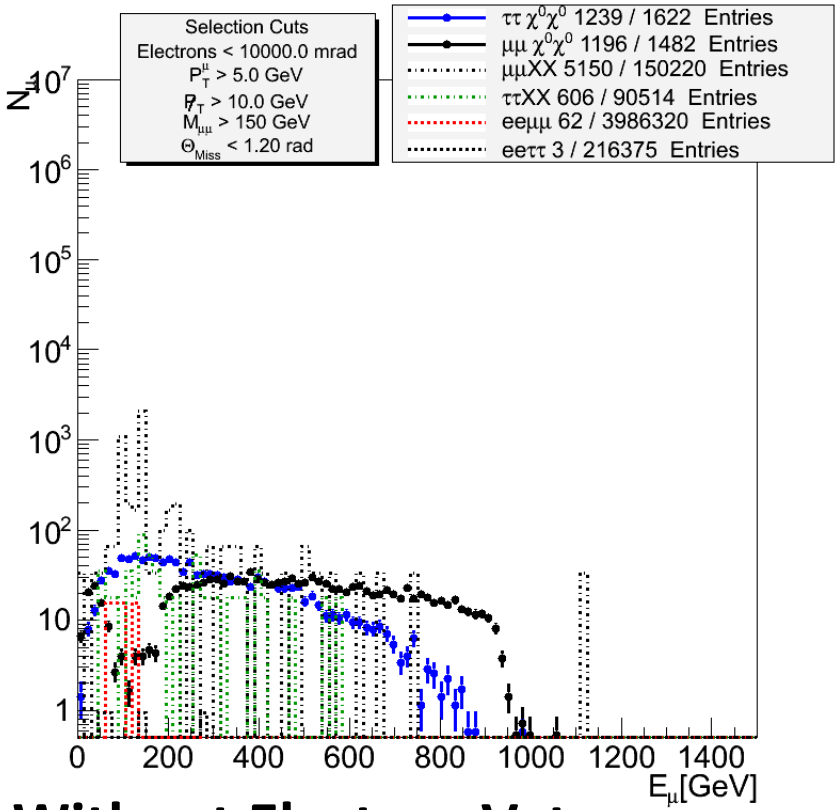
Without Electron Veto



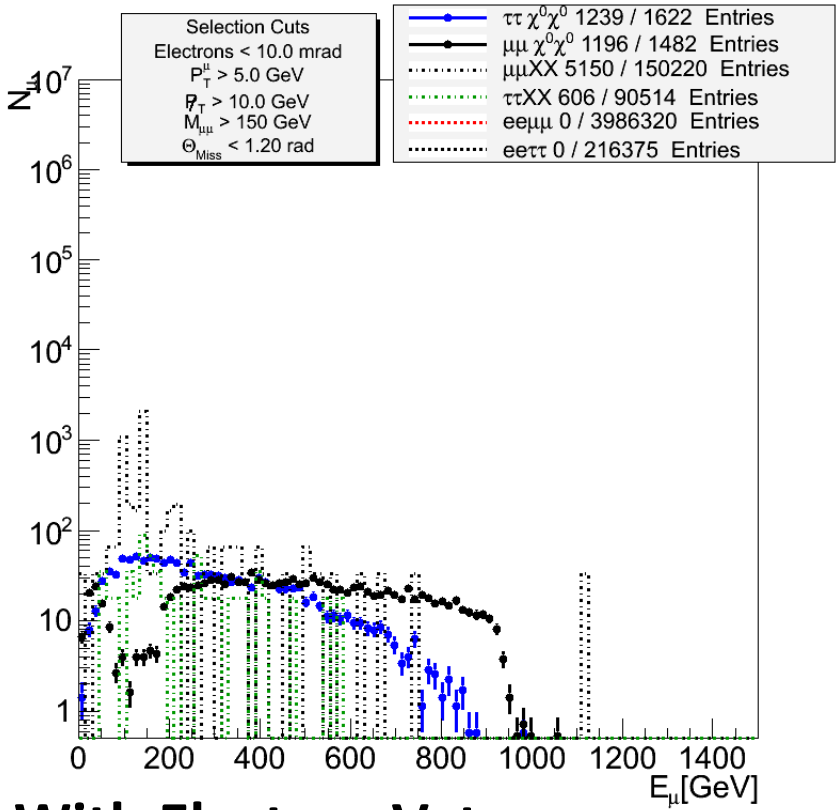
With Electron Veto

All Cuts Combined

- 2 photon background completely removed
- SM background still too high



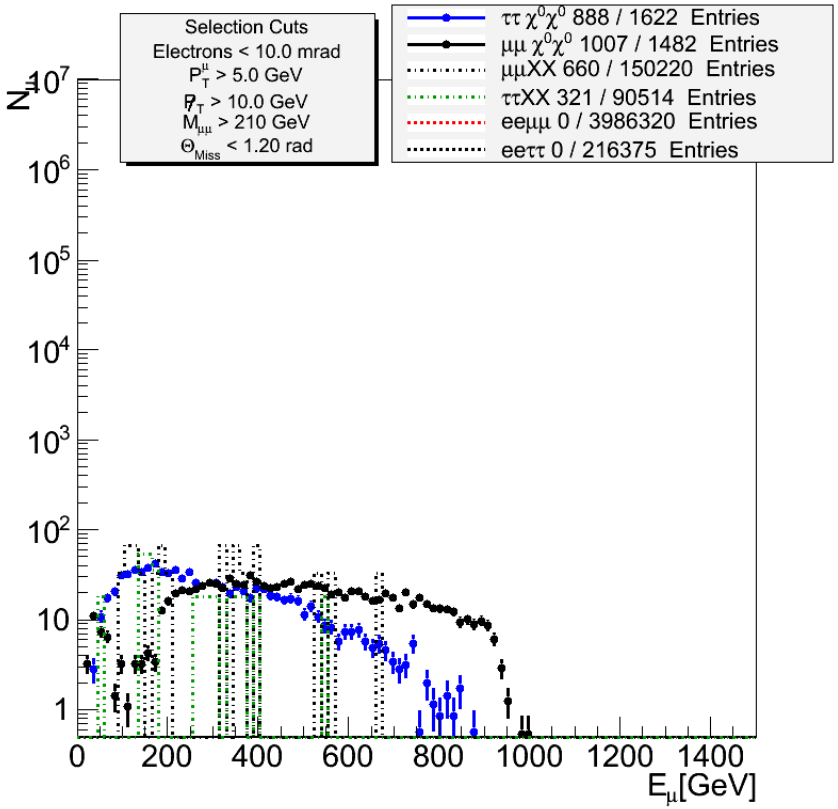
Without Electron Veto



With Electron Veto

Removing SM Background

- Cuts
  - Angle of Missing Momentum
  - Pt cuts
  - Invariant Mass > 210 GeV
  - Thrust > 0.98
- Large Impact on lower end of Energy Spectrum for Stau Signal



Summary and Conclusions

- Slepton Production at 3TeV CLIC in SuSy Benchmark Point K' studied
- Compared Cuts with and without Electron Veto
- Electron Tagging useful to remove some of the higher energetic lepton background
- Further Studies are needed to determine more exact requirements on very forward tagging
  - Impact of Cuts on Slepton Mass measurement
  - Smaller Mass Splitting between Sleptons and Neutralinos
- Better Cuts on SM Background