25. Search for a Heavy Neutral Particle Decaying into eμ, eτ, μτ in pp Collisions at sqrt(s) = 7 TeV with ATLAS

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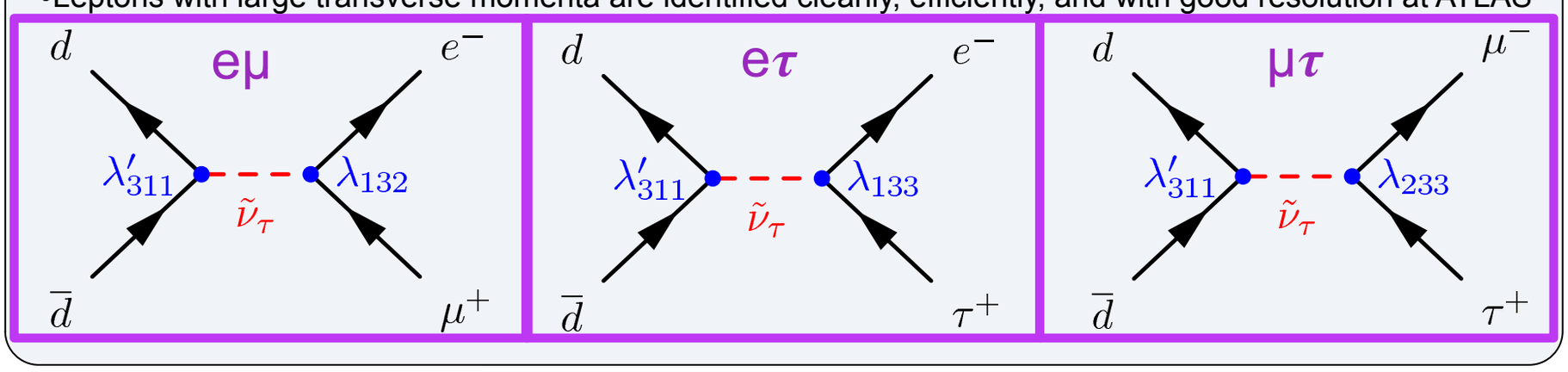
Motivation

- In the Standard Model, Lepton Flavor Violating (LFV) decays are forbidden, *but*....
  - -Neutrino oscillations show that lepton flavor conservation is not absolute
  - -LFV has not been observed among charged leptons (yet)
  - -LFV is permitted in several extensions of the standard model (LFV Leptoquarks,Models with additional gauge symmetries, etc.)
- This poster focuses on an **RPV SUSY** model where a **tau-sneutrino** has LFV couplings
- R-Parity is introduced in many Supersymmetric models to explain the stability of the proton, but there is no experimental evidence that demands R-parity conservation as the explanation
- Leptons with large transverse momenta are identified cleanly, efficiently, and with good resolution at ATLAS

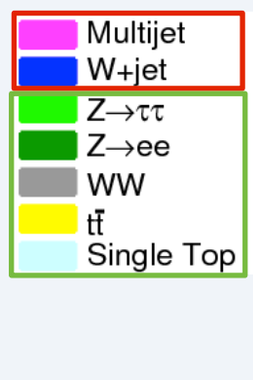


Backgrounds

Background events fall into 2 categories:

Instrumental (data driven estimations):
QCD Multijet
W+jet

Well-Modeled (taken from MC)
Z→ττ
Z→ll
WW/WZ/ZZ
ttbar
Single top



Event Selection

- **Muons:**
  - P_T > 25 GeV, |η| < 2.5
  - Isolated (track+calorimeter)
- **Electrons:**
  - P_T > 25 GeV, |η| < 2.47
  - Isolated (track+calorimeter)
- **Taus:**
  - Single track hadronic
  - Medium boosted decision tree discriminant against jets
- **Event level:**
  - Single lepton (e/μ) trigger
  - 1 LFV Pair
  - Opposite charge
  - No extra leptons (isolated or not)
  - Δϕ(leptons) > 2.7

W+jet/QCD Estimation

- **W+jet estimation:**
  - 1 real lepton from the W
  - 1 lepton misidentified from jet
  - Mis-ID rate is poorly modeled
  - Normalize W+jet to data in a control region where E_T^{Miss} > 30 GeV
  - The shape of the mass distribution is taken from the Monte Carlo simulation
- **QCD multijet estimation**
  - Probability that a jet is mis-identified as a lepton is independent of charge (within 10% uncertainty)
  - A "same sign" sample is constructed with same criteria, except the charge requirement is inverted
  - The "same sign" QCD is found by subtracting other MC and W+jet backgrounds from data in same sign sample
  - Use "same sign" QCD distribution for opposite sign

Systematics

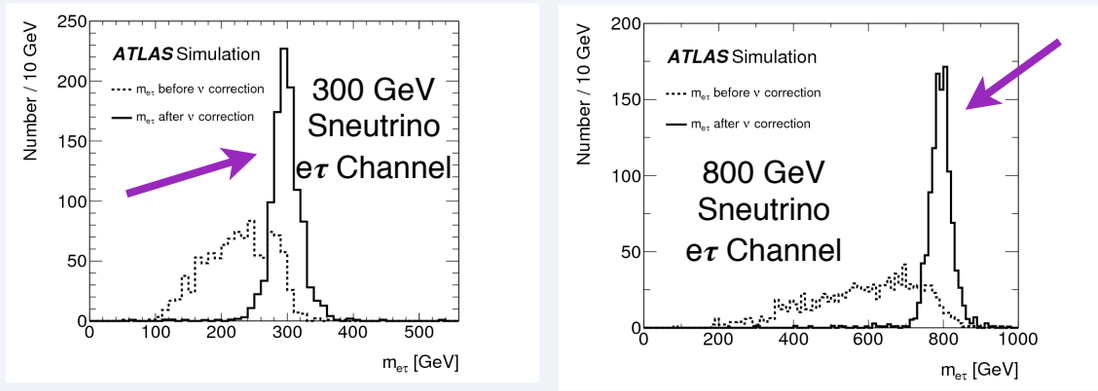
Dominant Sources: cross-sections of background processes, luminosity; lepton trigger, reconstruction, identification, and energy scale/resolution

	$m_{\ell\ell'} > 200$ GeV		
Process	$N_{e\mu}$	$N_{e\tau_{\rm had}}$	$N_{\mu\tau_{\rm had}}$
$Z/\gamma^* \to \tau\tau$	8 ± 1	24 ± 3	28 ± 4
$Z/\gamma^* \to ee$		44 ± 3	
$Z/\gamma^* \to \mu\mu$			29 ± 3
$t\bar{t}$	251 ± 30	90 ± 15	70 ± 13
Diboson	71 ± 8	26 ± 3	24 ± 3
Single top quark	39 ± 4	10 ± 2	8 ± 1
W+jets	90 ± 40	370 ± 80	470 ± 110
multijet	6 ± 2	150 ± 50	24 ± 18
Total background	460 ± 60	720 ± 80	650 ± 90
Data	498	795	699

Event Yields and uncertainties for M > 200 GeV

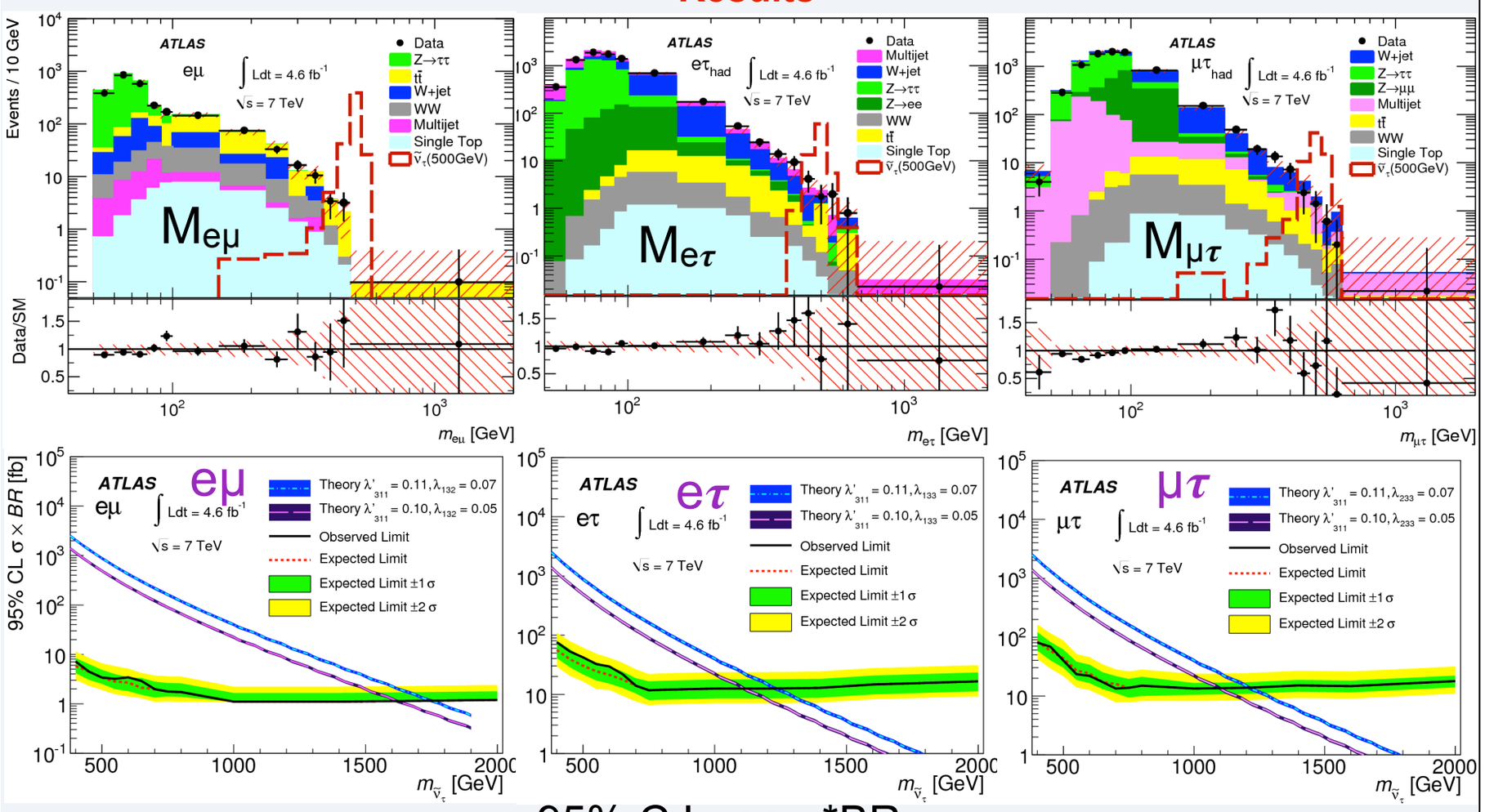
Collinear Neutrino Approximation

- In the eτ and μτ channels the neutrino from the hadronic τ is missing
- *But* the neutrino and remnant hadronic τ are highly boosted in the same direction → Can reconstruct Narrow Resonance!
- Take $P_{T\nu}$, ϕ_ν from E_T^{Miss} and assume $\eta_\nu = \eta_{\tau\ \text{hadronic}}$→Full 4-vector!



Signal Samples Before (dashed) and after (solid) neutrino correction

Results



95% C.L. on σ*BR

Data Samples

2011 ATLAS data: Sqrt(s) = 7 TeV
Totaling 4.6 fb^{-1}
MC: Pythia (W/Z),MC@NLO (top)
Powheg (ttbar),Herwig (WW)

Reference

[1] ATLAS Collaboration, "Search for a heavy narrow resonance decaying to e mu, e tau, or mu tau with the ATLAS detector in sqrt(s)=7 TeV pp collisions at the LHC," Phys. Lett. B 723, 15 (2013), arXiv:1212.1272.