

# Atmospheric tau neutrinos

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May 9, 2011

with Janet Conrad, André de Gouvêa and Joshua Spitz (arXiv:1008.2984)

# Why atmospheric neutrinos?

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- ▶ Large range of  $L/E$

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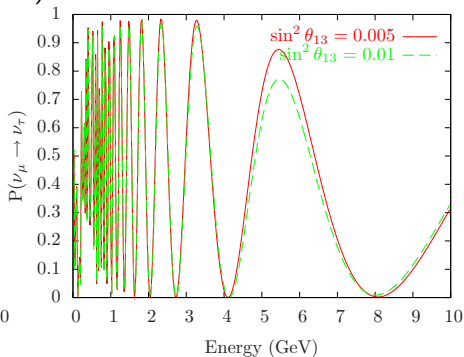
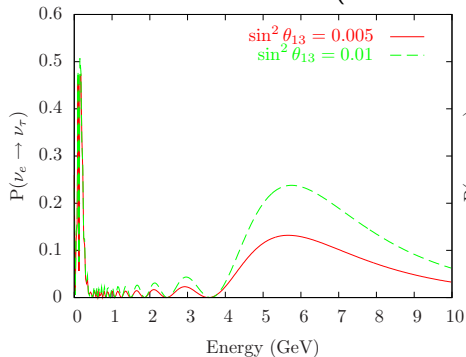
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Why LArTPC?

- ▶ Good energy and angular resolution

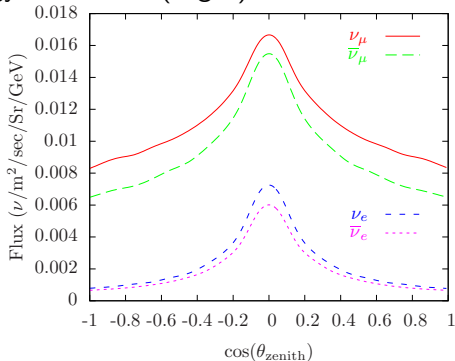
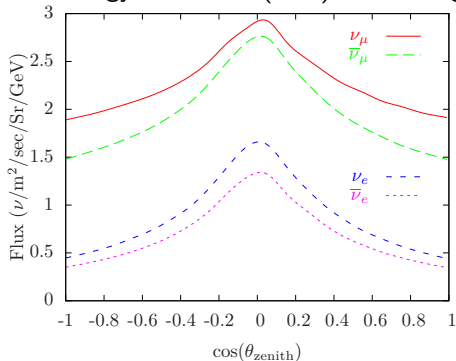
# Oscillation probabilities

For current best fit values ( $L=8000$  km)



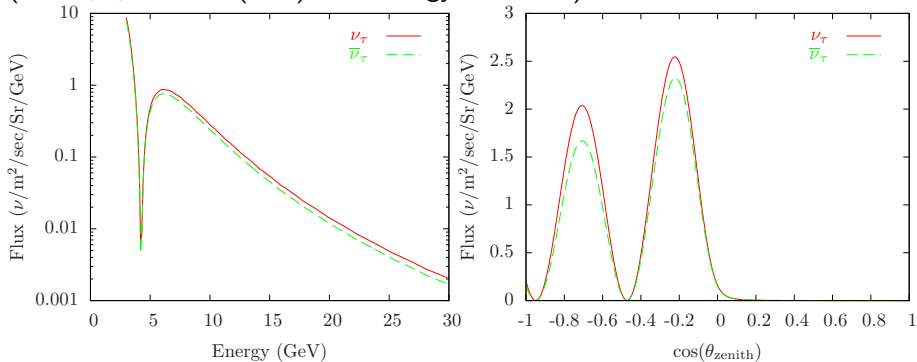
# Atmospheric flux

for Energy = 5 GeV (Left) and Energy = 30 GeV (Right)



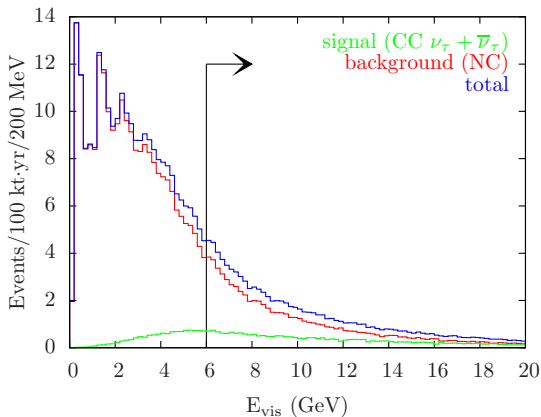
# $\nu_\tau$ flux

$\nu_\tau$  flux for current best fit values  
( $\cos\theta_{\text{zenith}} = -0.4$  (Left) and Energy = 5 GeV)



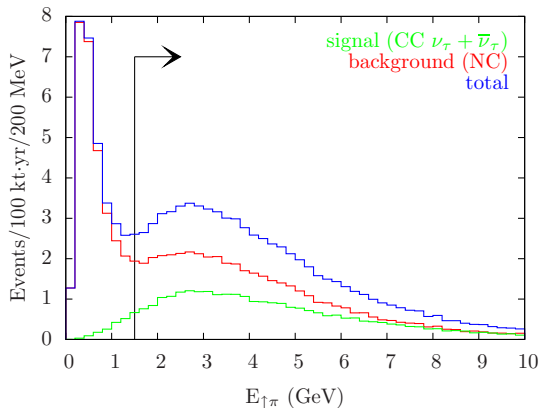


# A lot of background ...



Events with atleast one charged pion.

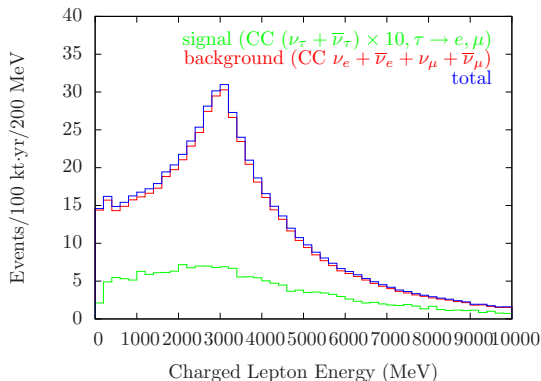
... but all we need is simple cuts



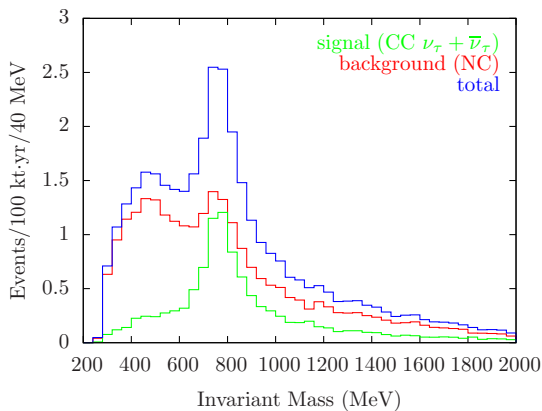
Events with atleast one charged pion.

# Contrary to naive expectations

charged leptons are not very useful



# Invariant mass distribution does not add much



# Results:

- ▶  $E_{\text{vis}} > 6 \text{ GeV}$
- ▶  $E_{\uparrow\pi} > 1.5 \text{ GeV}$
- ▶  $\cos \theta_{\text{zenith}} < -0.2$

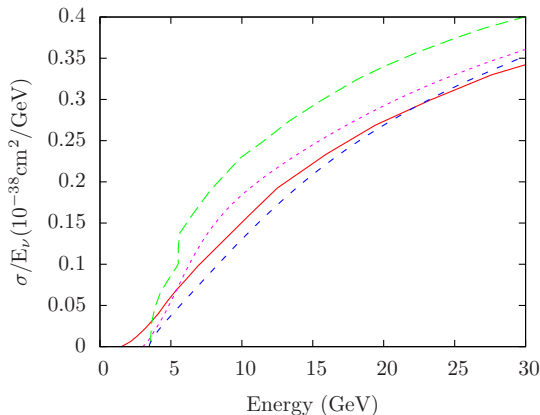
## Results:

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## Results:

- ▶ Total CC  $\nu_{\tau}$  interactions  $\sim 80$
- ▶  $\nu_{\tau}$ s after cuts  $\sim 30$  (with a background of  $\sim 45$  events)
- ▶ we can disfavor  $\nu_{\mu} \leftrightarrow \nu_{\tau}$  at 4.3 sigma (with an exposure of 100 kt-yr)

## What does that mean?



Paschos et al. (**long-dashed**), Kretzer et al. (**solid**) and Hagiwara et al. (**short-dashed**). The Nuance (**dotted**) cross section prediction for an argon target is also shown.

## What does that mean?

Model	$\nu_\tau$ events	$\bar{\nu}_\tau$ events	Total
NuTeV	56.9	24.9	81.7
Kretzer et al.	37.7	17.5	55.2
Hagiwara et al.	33.7	18.5	52.3
Paschos et al.	65.2	29.6	94.8
Nuance	54.1	23.1	77.2

Hagiwara et.al. hep-ph/0305324

kretzer el.al. hep-ph/0208187

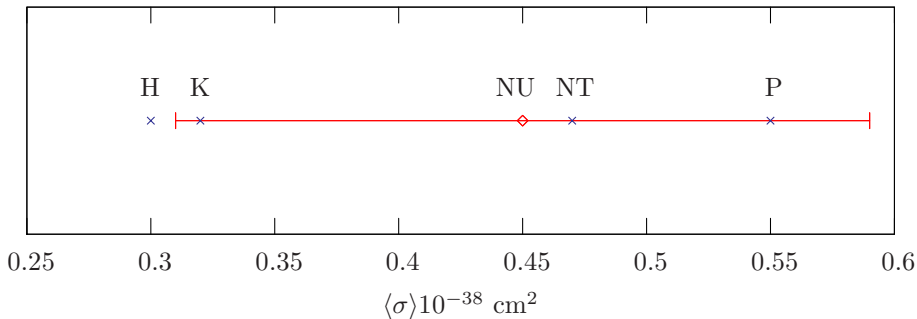
(Nuance) Bodek et.al. hep-ex/0203009

(NuTeV) hep-ex/0307005

Paschos et.al. hep-ph/0107261



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H - Hagiwara et.al. hep-ph/0305324

K - kretzer et.al. hep-ph/0208187

NU - (Nuance) Bodek et.al. hep-ex/0203009

NT - (NuTeV) hep-ex/0307005

P - Paschos et.al. hep-ph/0107261