MiniBooNE

H. Ray

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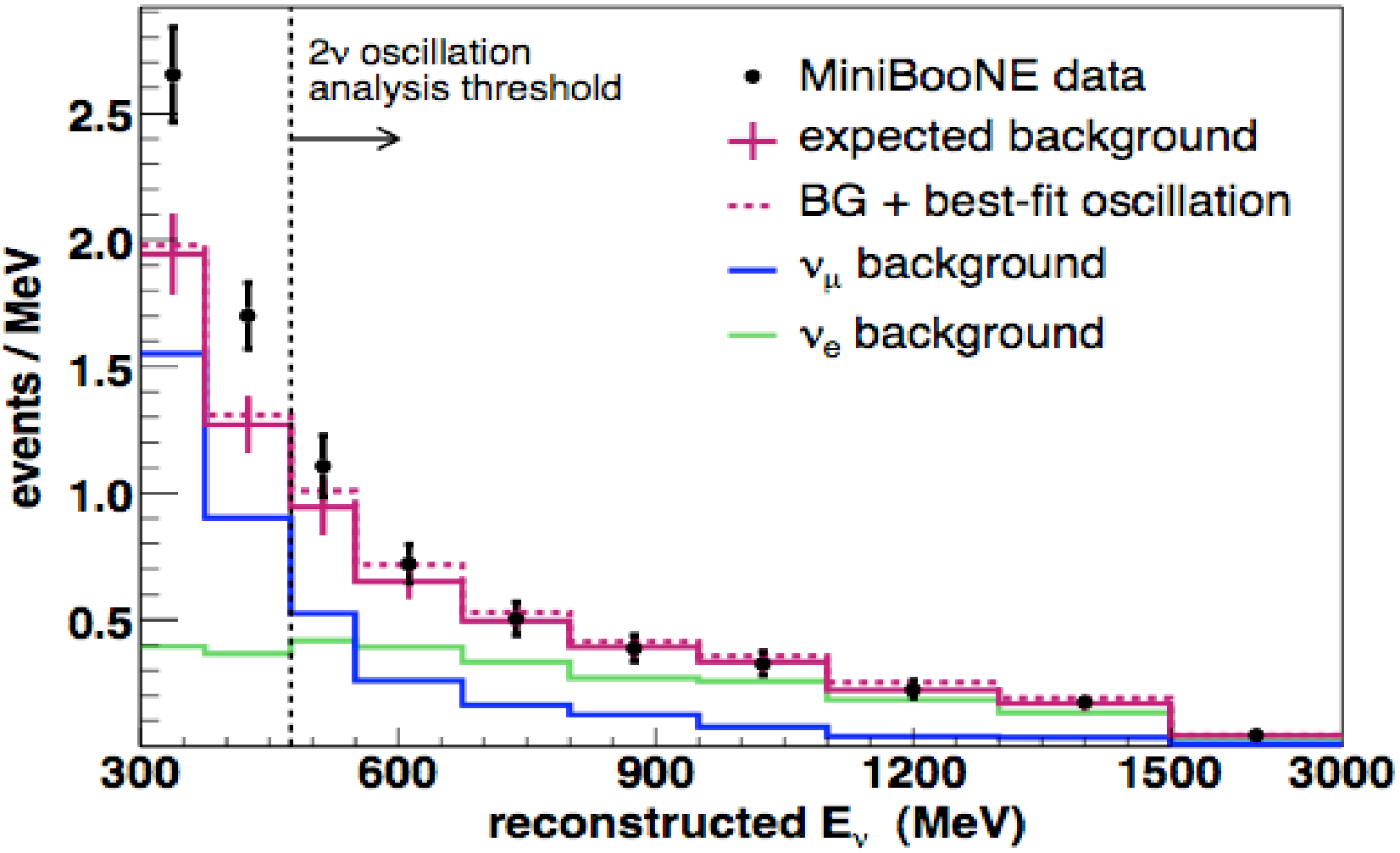
MiniBooNE Results



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Beyond the Standard Model

- **Works in progress**
  - $\Rightarrow$Extra-dimensions fit

Beyond the Standard Model

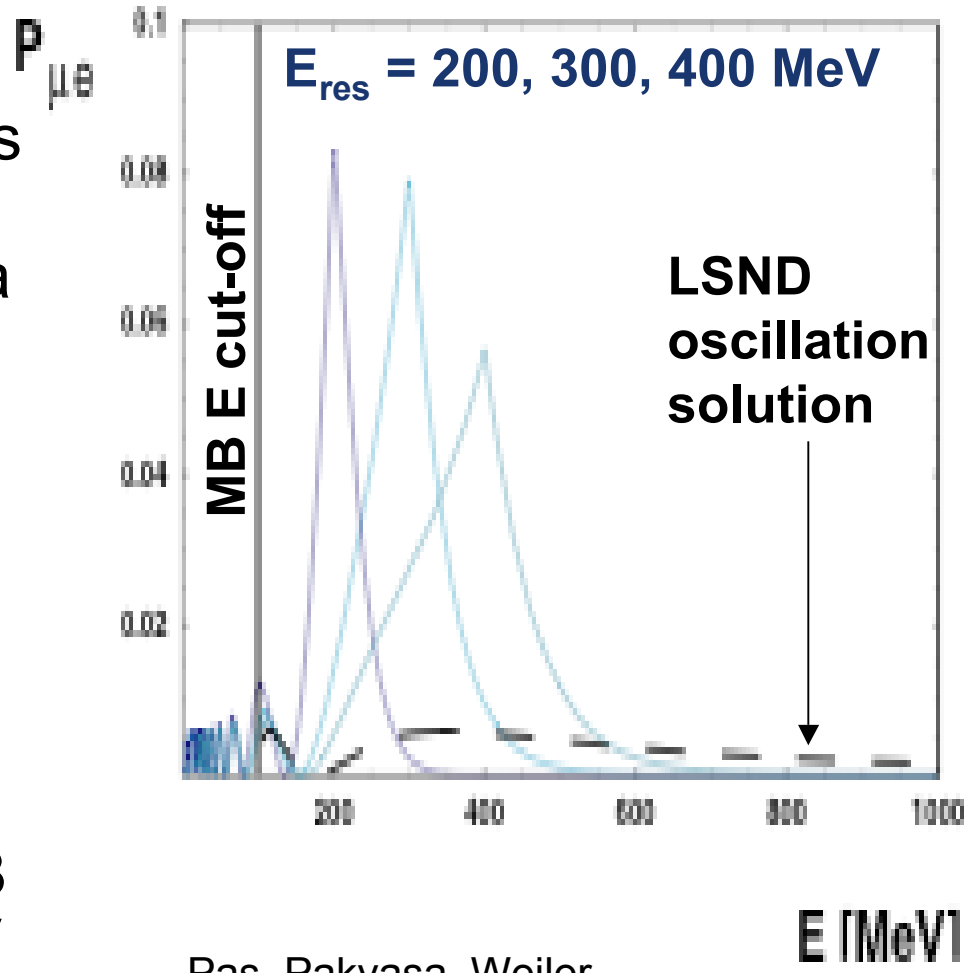
- **Works in progress**
  - ⇒Extra-dimensions fit

- **Meaty Subjects**
  - ⇒Lorentz violation studies
  - ⇒3+2/Sterile neutrino scenarios

Extra-Dimensions

Y. Liu

- New resonance in active-sterile oscillations which comes from theories with large extra dimensions
- Resonance of 30 - 400 MeV = explain all neutrino data, including LSND, in a consistent 4 neutrino model
- Predicted (2005) no MB signal above ~700 MeV



Pas, Pakvasa, Weiler
Phys. Rev D 72, 095017 (2005)

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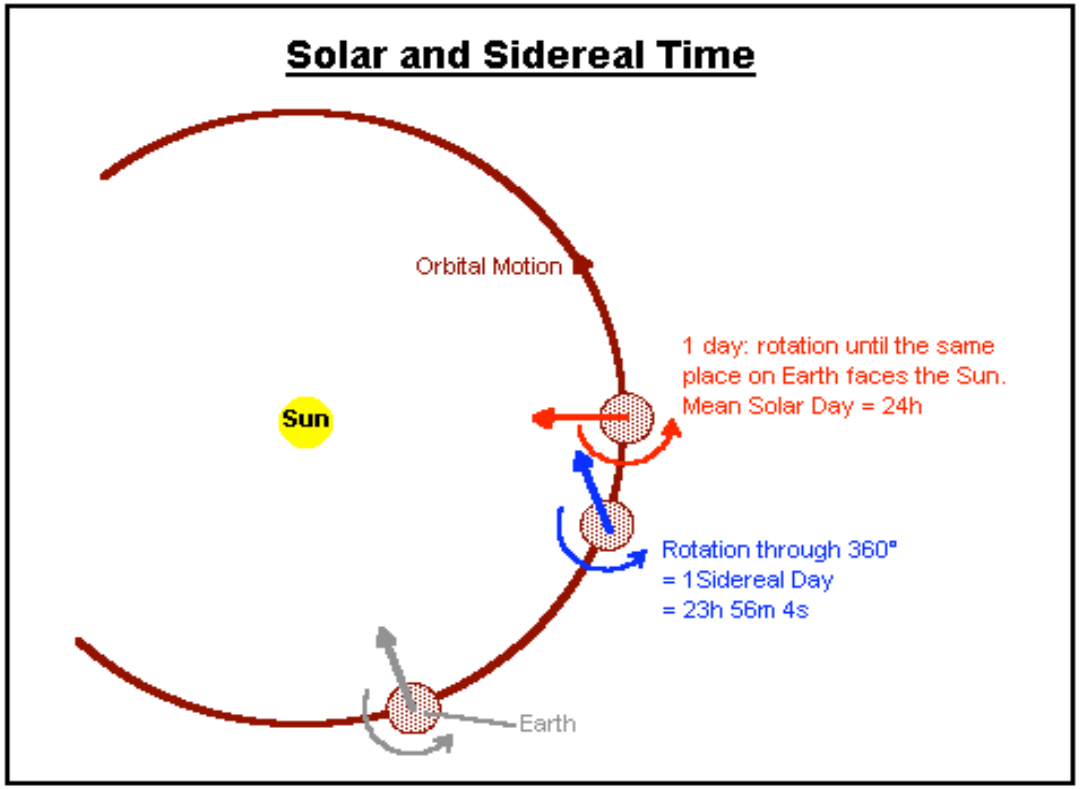
Lorentz Violation

T. Katori

- Search for sidereal variation in LSND data
  - ⇒Not statistically significant, but doesn't rule out LV
  - ⇒ PRD 72, 076004 (2005)



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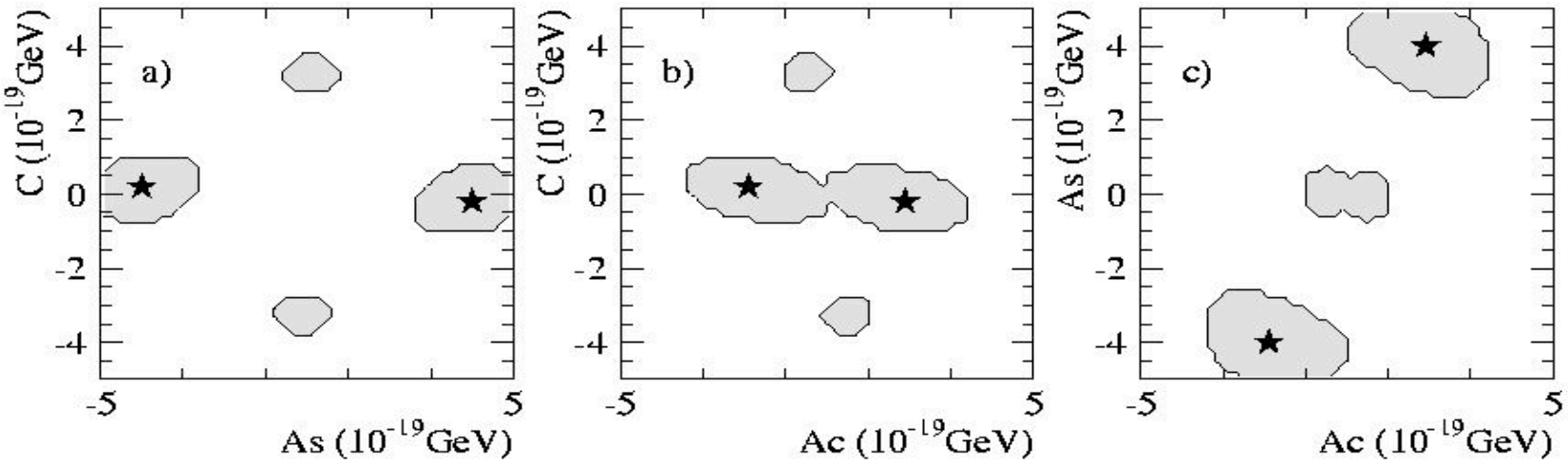
Lorentz Violation

T. Katori

- Fit to short baseline Standard Model Extension (SME)
  - ⇒Fit for 1, 3, 5 parameter combinations

Ex : 3 parameter fit



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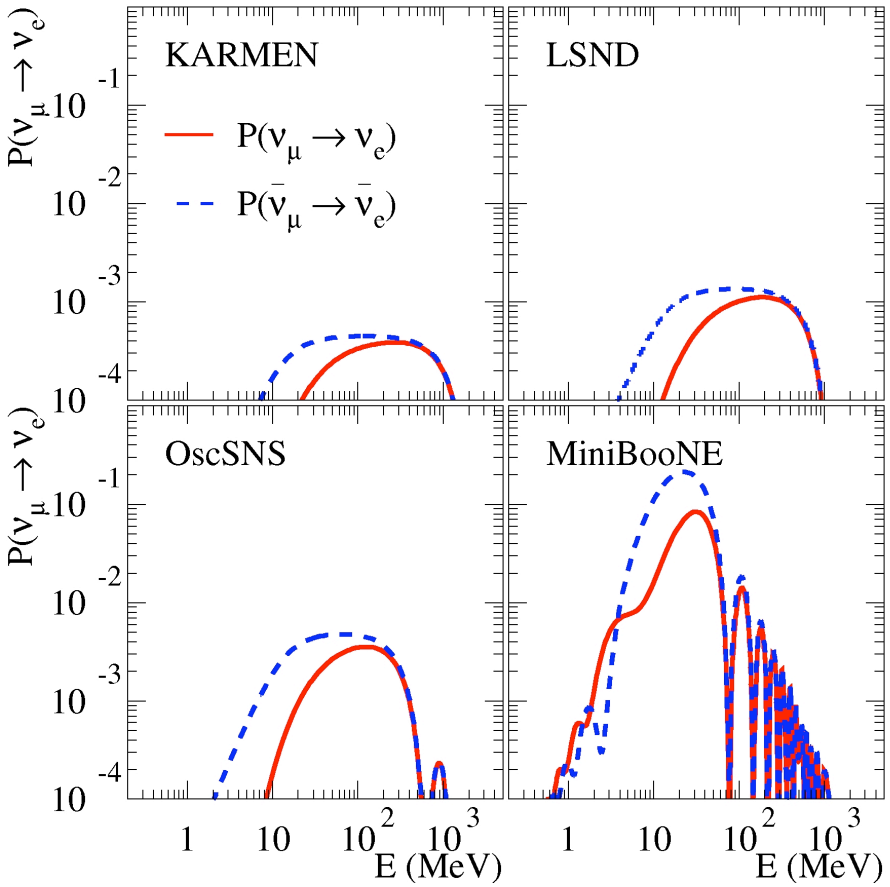
Lorentz Violation

- Use SME to construct global model of oscillations

- **Tandem model**
  - ⇒ PRD 74 105009 (2006)
  - ⇒3 parameters : CPT-odd, CPT-even, mass terms
  - ⇒Explains atm, KamLAND, LSND
  - ⇒Predicts low E signal for MB



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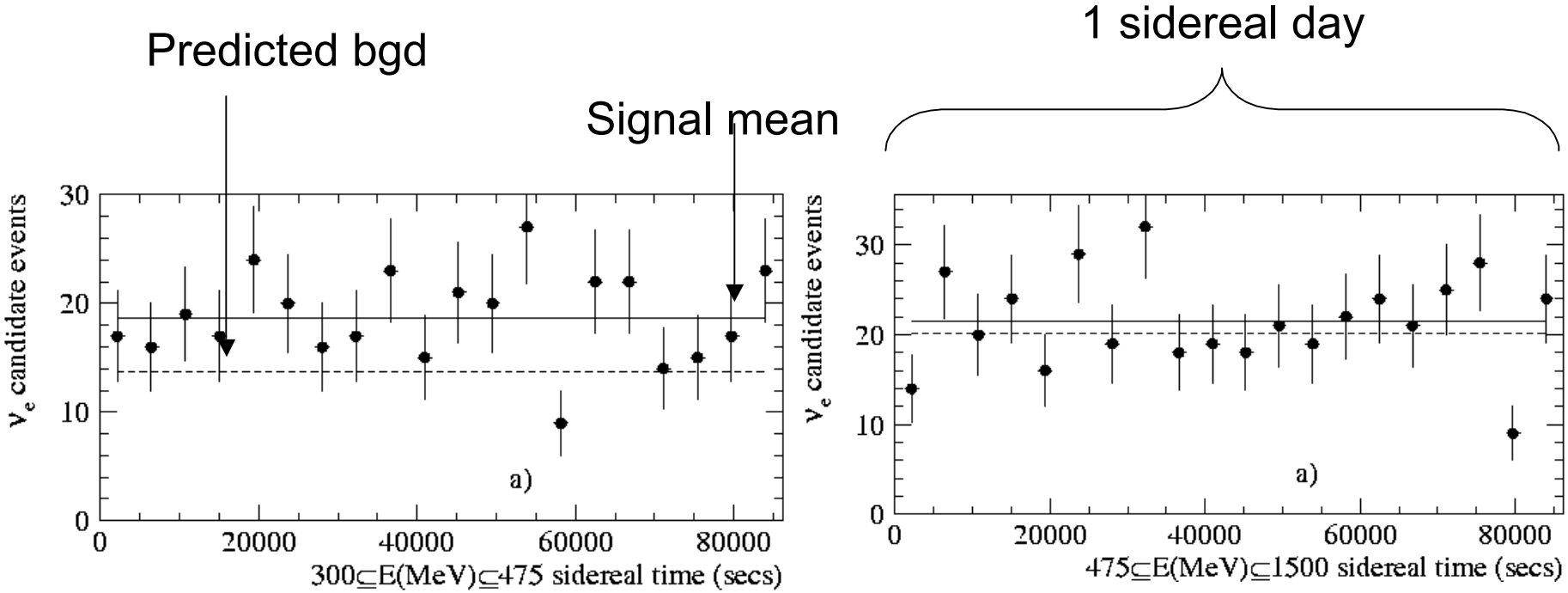
Lorentz Violation

- Perform sidereal test for MB



χ^2 = 79.5/73 (P=28%)

χ^2 = 77.2/84 (P=69%)

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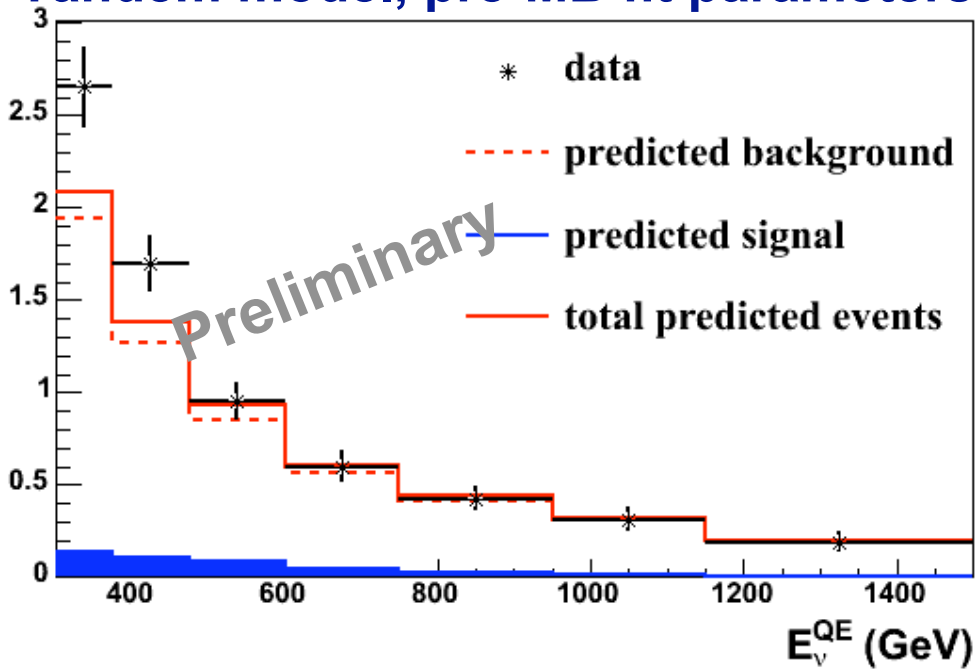
Lorentz Violation

- Fit Tandem model to MB public data
  - ⇒Fit using params found from pre-MB fit
  - ⇒Re-tune model, re-fit MB

Tandem model, pre-MB fit parameters



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3+n Sterile Neutrino Fits

G. Karagiorgi

- Perform a combined analysis of short baseline expts to constrain sterile oscillation parameters
  - ⇒SBL : LSND, KARMEN, NOMAD, MB, CCFR, CDHS, CHOOZ, Bugey, atm constraint

- Study compatibility of null SBL results with MiniBooNE and LSND in a 3+n sterile neutrino hypothesis

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3+n Sterile Neutrino Fits

- Assumptions
  - $\Rightarrow m_1 \approx m_2 \approx m_3 \approx 0$
  - $\Rightarrow$n independent mass splittings
  - $\Rightarrow$2n mixing parameters (U)
  - $\Rightarrow$n -1 CPV phases
  - $\Rightarrow$Masses between 0.1 and 100 eV^2 (LSND)
  - $\Rightarrow$Atm and solar data constrain the Us

- Use full MB data (300 - 3000 MeV)
  - Allow $\nu_\mu \rightarrow \nu_e$ osc, and ν_μ, ν_e bgd dis

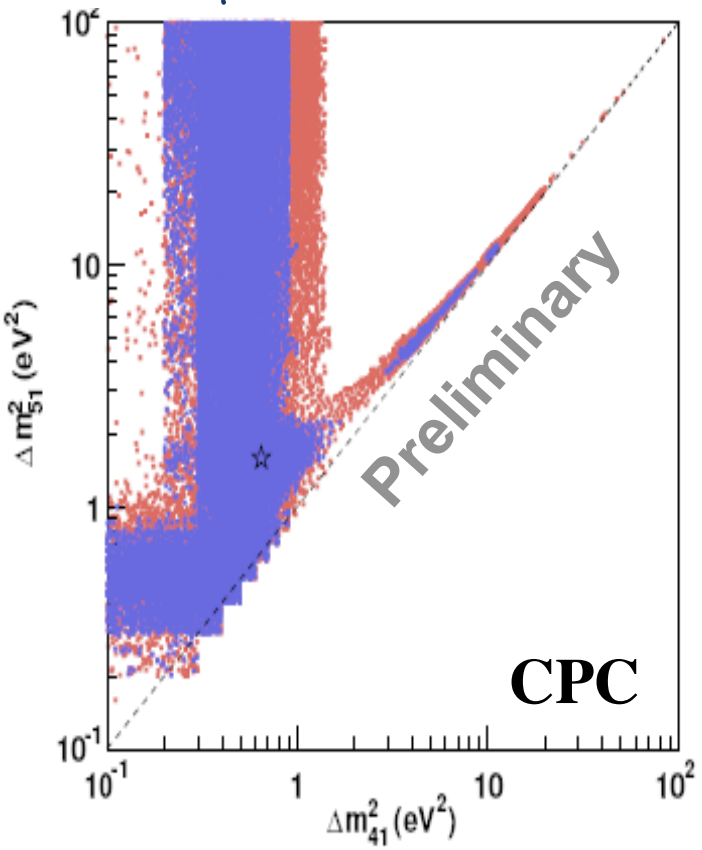
3+n Sterile Neutrino Fits

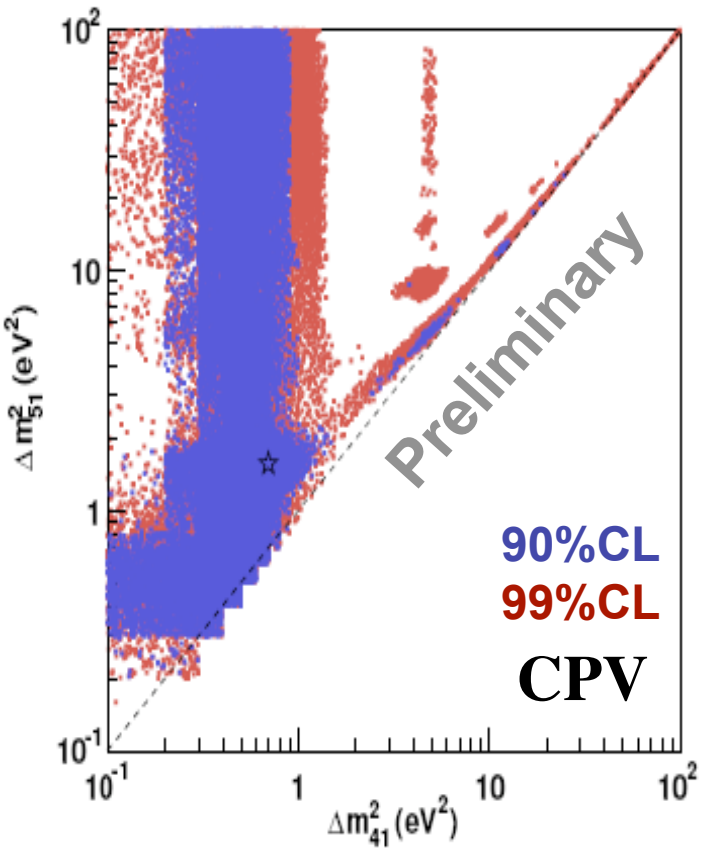
- 3+1 already excluded from previous studies
  - ⇒M. Sorel, et al. hep-ph/0305255 (no MB data)
  - ⇒M. Maltoni, T. Schwetz. hep-ph/0705.0107 (w/MB)

- 3+2 = 2 analyses
  - ⇒Appearance only experiments
  - ⇒Appearance + Disappearance experiments
    - MB with $\nu_\mu \rightarrow \nu_e$ oscillations
    - $\nu_\mu \rightarrow \nu_e$, ν_μ, ν_e background disappearance

Appearance Expt : KARMEN, MB, LSND, NOMAD

MB : $\nu_\mu \rightarrow \nu_e$





χ^2/ndf = 52.6/52

χ^2 prob = 45%

χ^2/ndf = 52.3/51

χ^2 prob = 42%

$\varphi_{54} = 1.07\ \pi$

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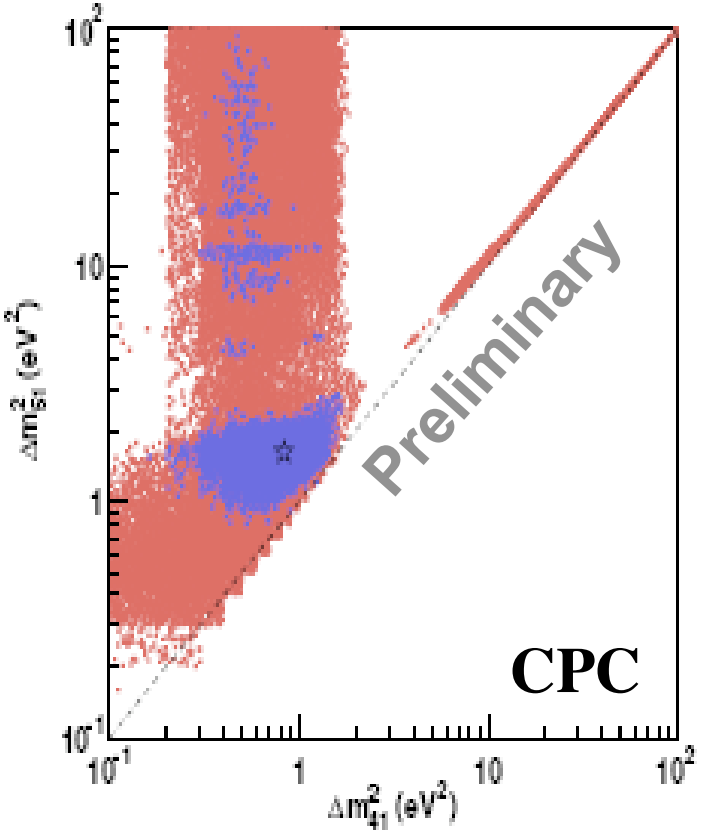
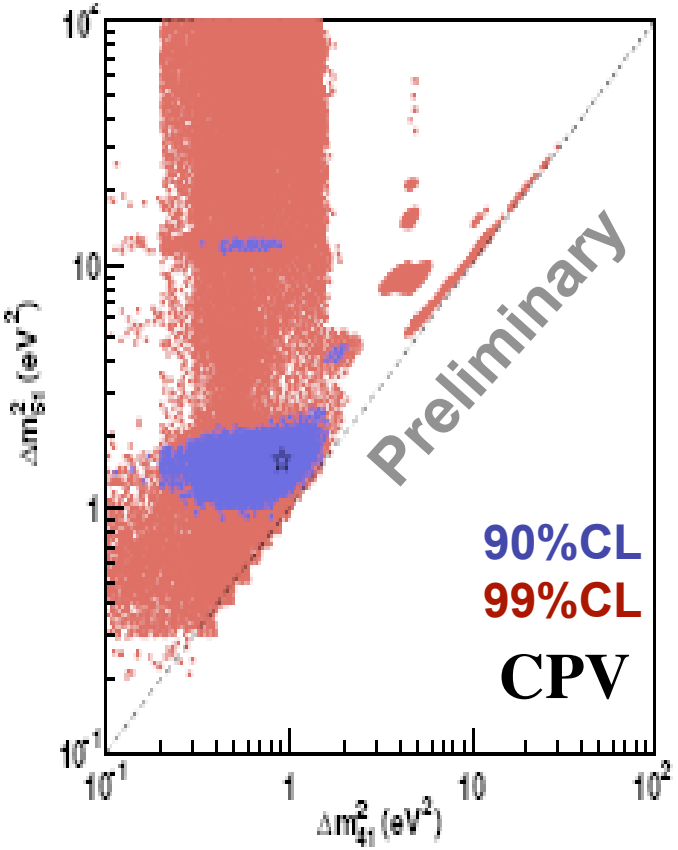
Appearance Expt : KARMEN, MB, LSND, NOMAD

MB : $\nu_\mu \rightarrow \nu_e, \nu_\mu, \nu_e$ bgd disappearance





χ^2/ndf = 50.1/48

χ^2 prob = 39%

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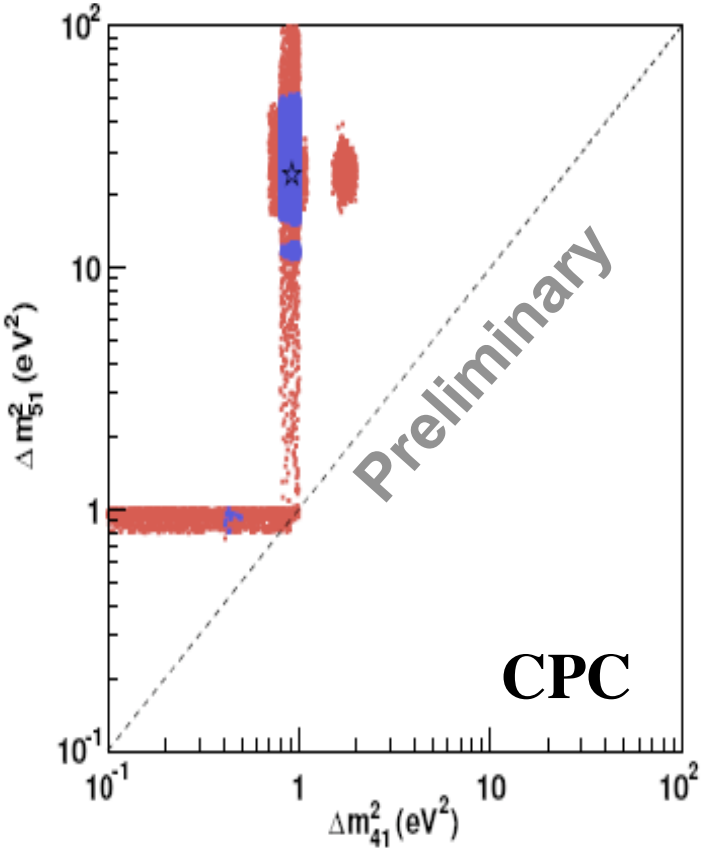
χ^2/ndf = 48.8/47

χ^2 prob = 40%

$\varphi_{54} = 1.12\ \pi$

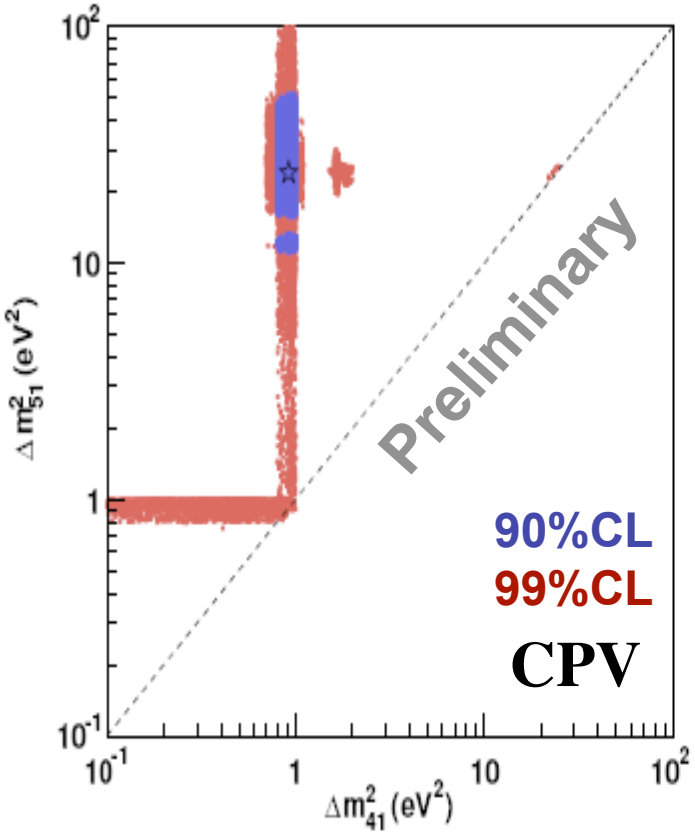
Combined Analysis : All experiments

MB : $\nu_\mu \rightarrow \nu_e$



χ^2/ndf = 147.9/157

χ^2 prob = 69%



χ^2/ndf = 146.7/156

χ^2 prob = 69%

$\varphi_{54} = 1.74\ \pi$

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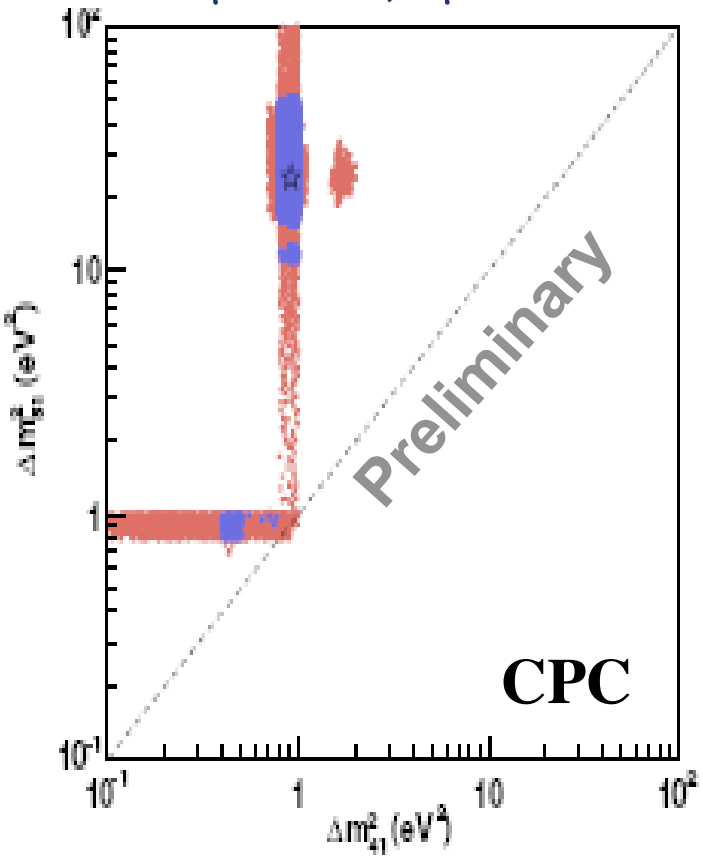
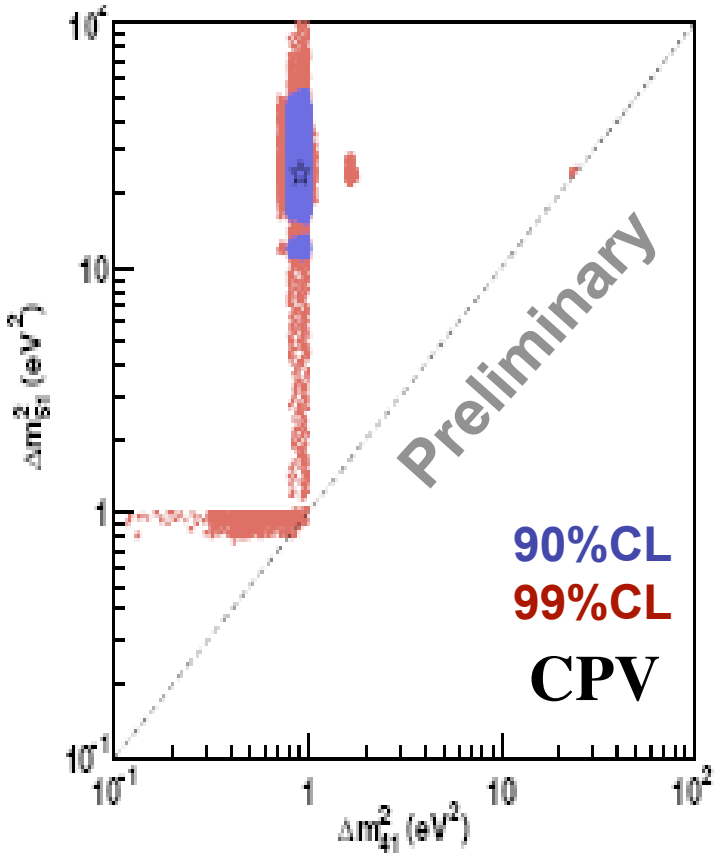
Combined Analysis : All experiments

MB : $\nu_\mu \rightarrow \nu_e, \nu_\mu, \nu_e$ bgd disappearance





χ^2/ndf = 147.9/157

χ^2 prob = 69%

χ^2/ndf = 146.8/156

χ^2 prob = 69%

$\varphi_{54} = 1.72\ \pi$

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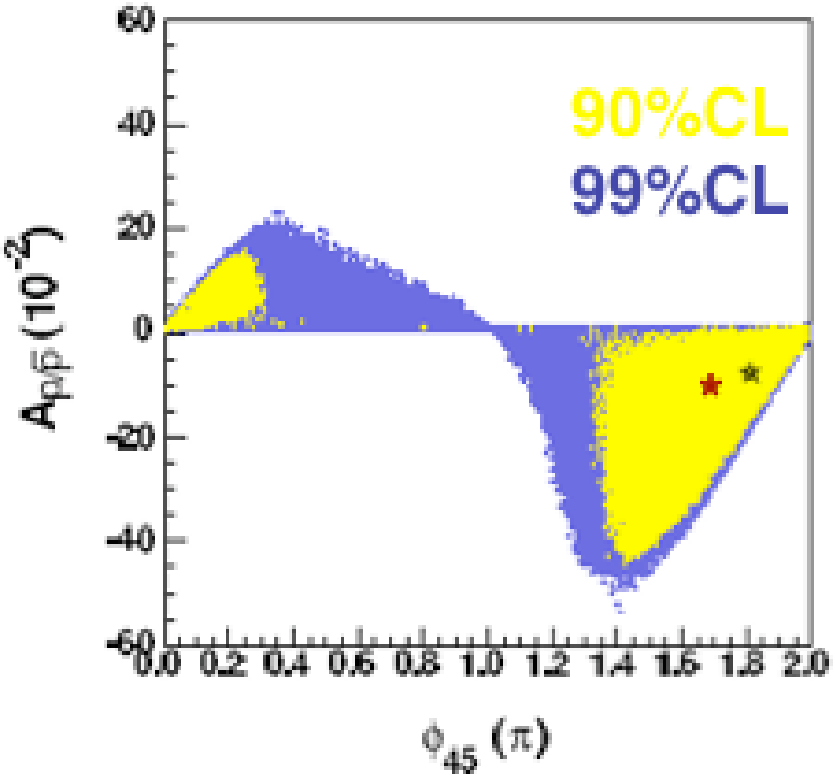
3+n Sterile Neutrino Fits

- Allowed regions in 3+2 analysis
- No preference for CPC vs CPV

CPV Tests in Anti-Nu Mode

- MB asymmetry prediction based on 3+2 best fit model for CPV combined analysis



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$$A_{P/\bar{P}} = \frac{P_{MB} - \bar{P}_{MB}}{P_{MB} + \bar{P}_{MB}} = -12\%$$

$$P_{MB} = 0.08\%$$

$$\bar{P}_{MB} = 0.10\%$$

$$\phi_{45} = 1.72\pi$$

Asymmetry significance ≈1σ

6x10^{20} POT in ν

6x10^{20} POT in anti-ν mode

Current collected data

7x10^{20} POT in ν mode

2.4x10^{20} POT in anti-ν mode

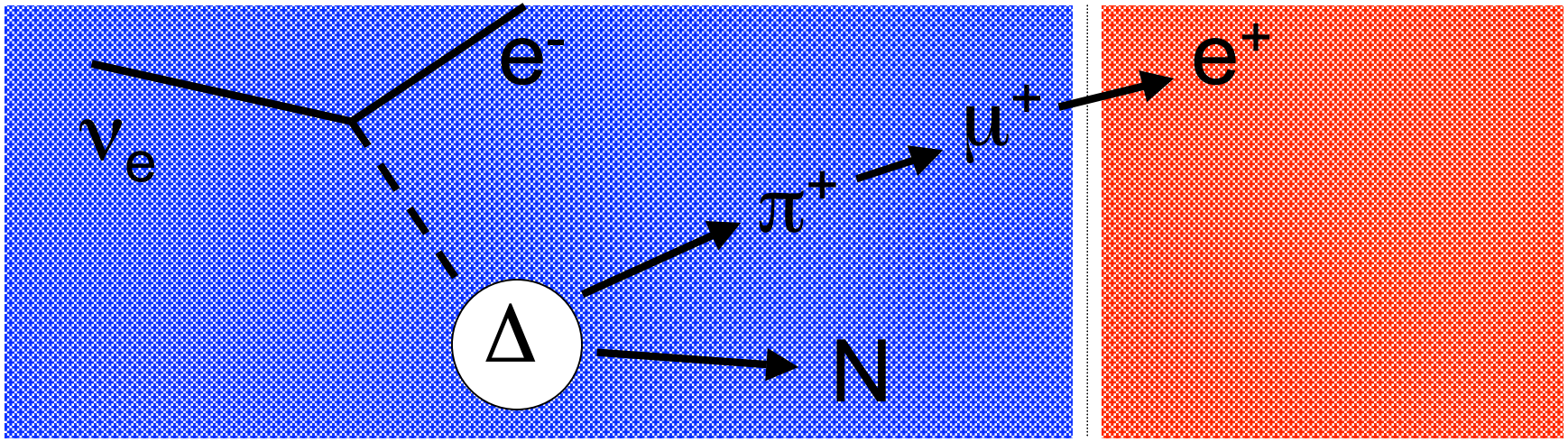
Looking Ahead

- Expect pre-prints/publications of 3+2, Lorentz Violation, and Extra-Dimension analyses by the end of the year

- Many other important analyses & world first measurements (SM & BSM) to be coming!

Backup Slides

$CC\pi^+$



- Few overlapping systematics with published CCQE analysis; will improve overall limit
- Different backgrounds from CCQE analysis

  $\Rightarrow$Provide more information to understand low E region

3+n Sterile Neutrino Fits

- Start with ν_μ, ν_e unoscillated signal predictions

- Generate model parameters via Markov chain importance sampling