High Energy Analysis at KamLAND and Application to Dark Matter Search

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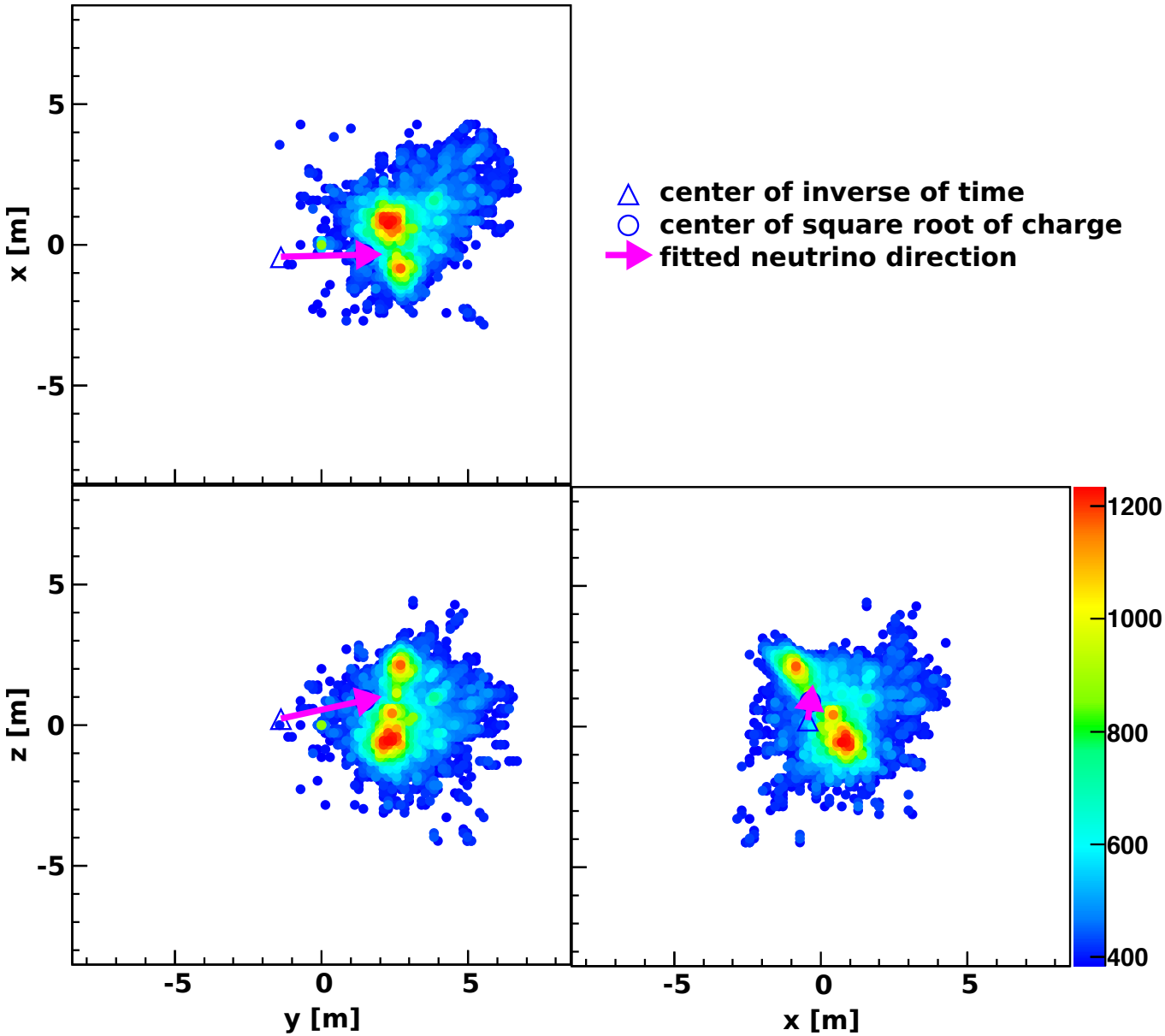
Overview

Test Hellgartner on T2K events (Data)

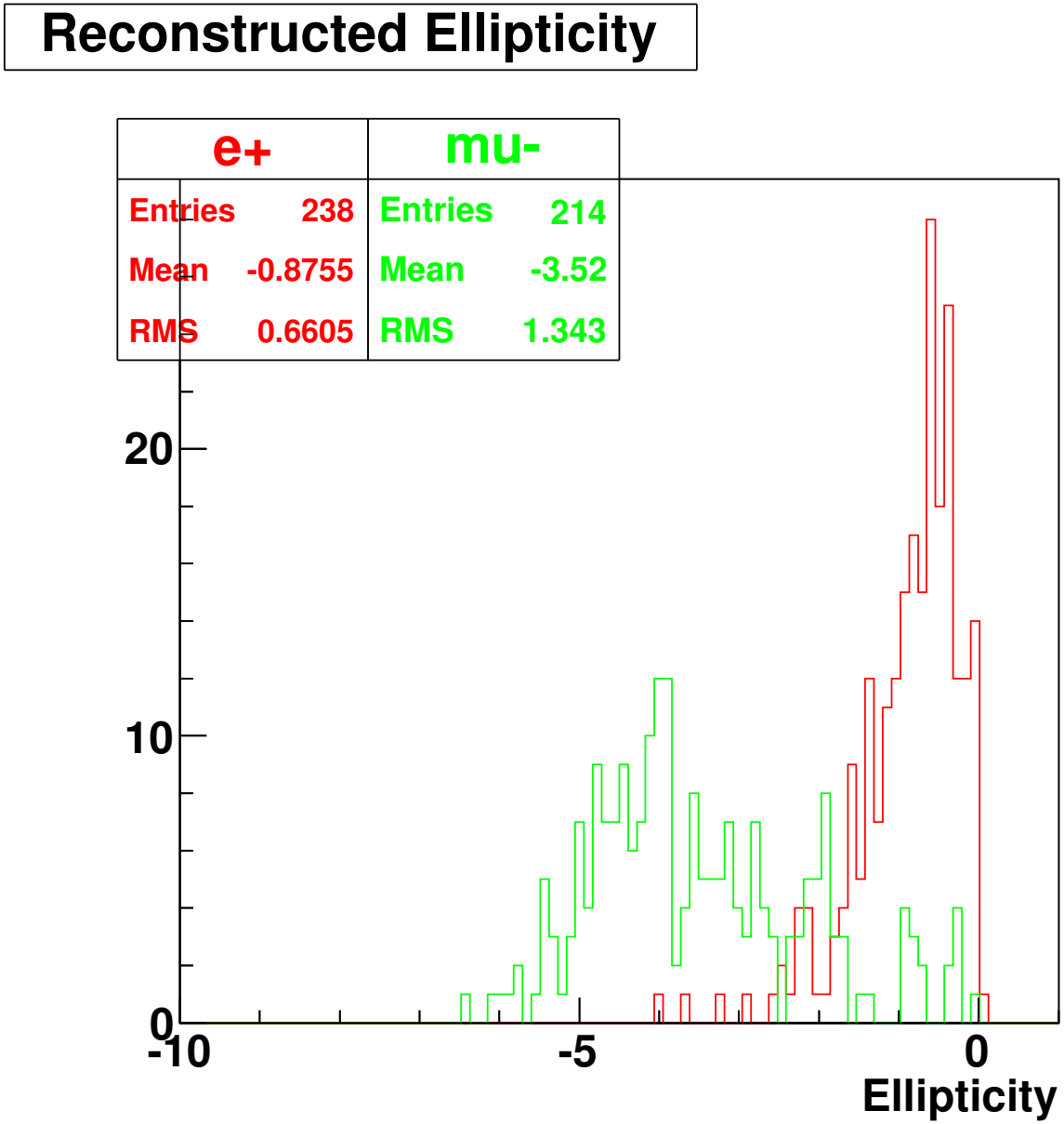
$E_{\text{reconstructed}} = 363\,\text{MeV}$



Lepton discrimination algorithm

Explanation is here.

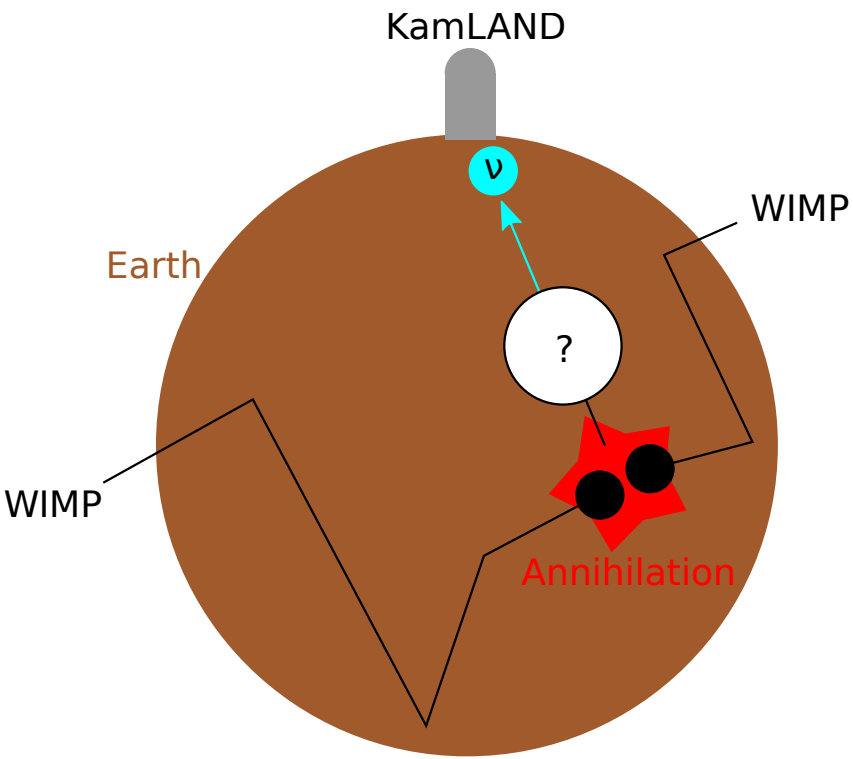
Test lepton discrimination (MC)



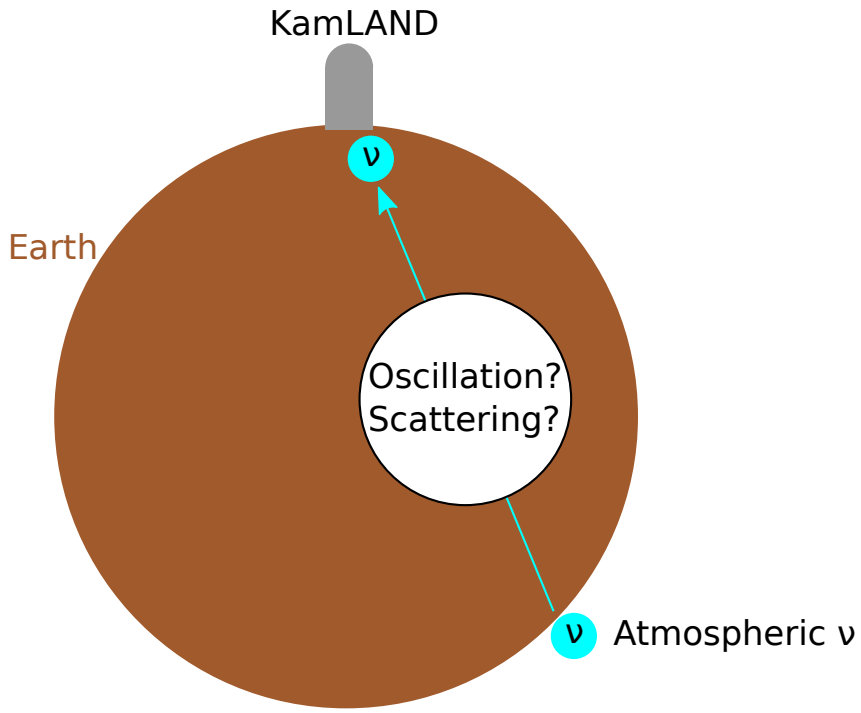
Analysis on Dark Matter Search

Dark matter detection scheme

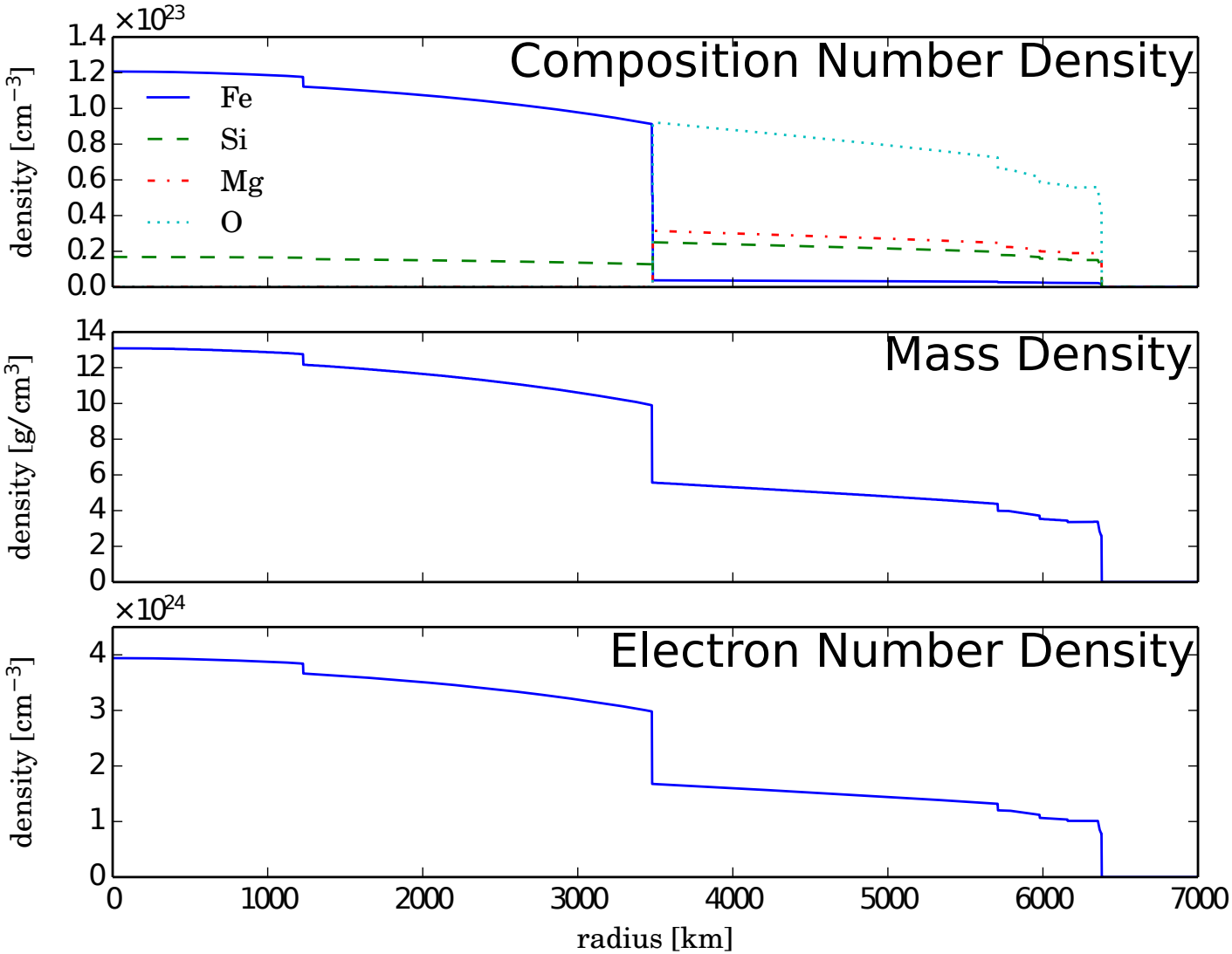
Signal: Dark matter (WIMP) annihilation induced ν



Background: atmospheric ν



Earth Model (PREM)



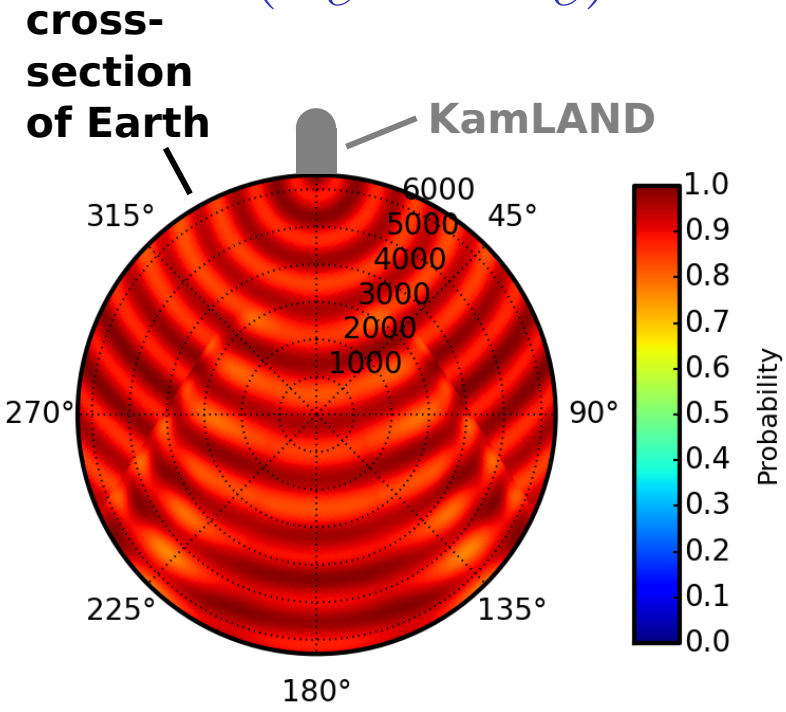
Neutrino Oscillation Parameters

(normal hierarchy, PDG 2014)

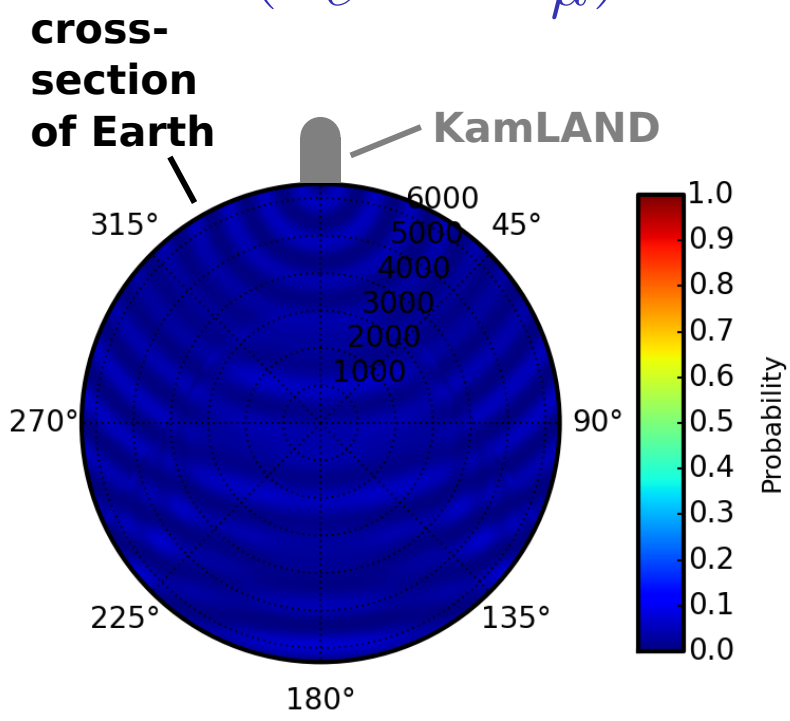
- $\sin^2(2\theta_{12}) = 0.846 \pm 0.021$
  $\implies \theta_{12} = 33.45^\circ$
- $\sin^2(2\theta_{13}) = (9.3 \pm 0.8) \times 10^{-2}$
  $\implies \theta_{13} = 8.88^\circ$
- $\sin^2(2\theta_{23}) = 0.999^{+0.001}_{-0.018}$
  $\implies \theta_{23} = 44.09^\circ$
- $\Delta m^2_{21} = 7.53 \pm 0.18 \times 10^{-5}\,\text{eV}$
- $\Delta m^2_{31} = 2.52 \pm 0.06 \times 10^{-3}\,\text{eV}$

1 GeV ν_e oscillation probability $P(\nu_e \to \nu_x)$ from inside Earth to KamLAND

$P(\nu_e \to \nu_e)$

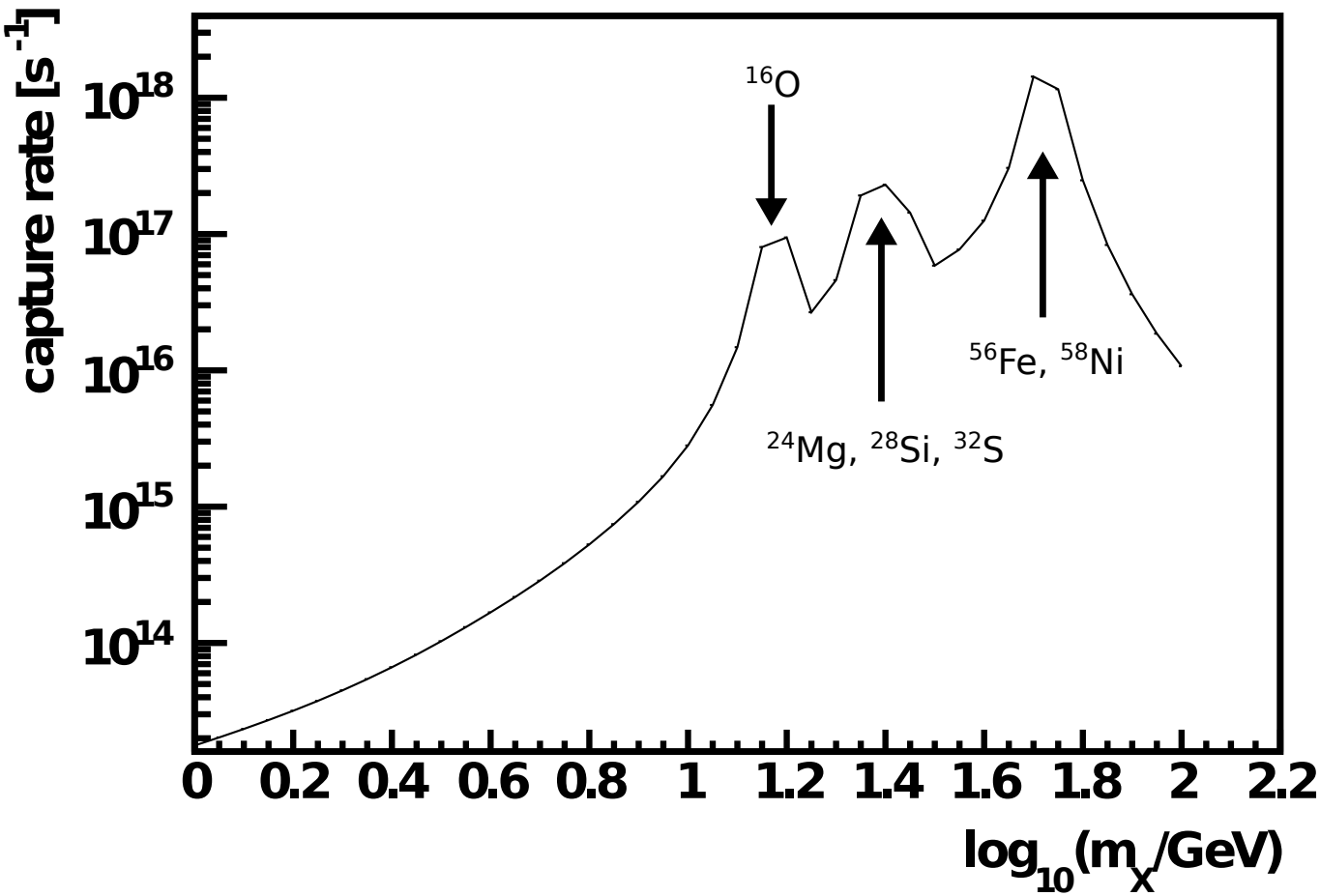


$P(\nu_e \to \nu_\mu)$



Dark matter capture in Earth vs mass m_x

(Spin-independent cross-section $\sigma_{\rm SI} = 1 \times 10^{-40}\,{\rm cm}^2$)



Data Selection

- Runs: 1330 to 12 475
- Total Live Time: 3671 days
- Selection Criteria:
  - Outer detector PMT hits < 5 (want fully contained events)
  - $E_{\text{reconstructed}} >= 1\,\text{GeV}$