

Solar Neutrinos in Super-Kamiokande-I



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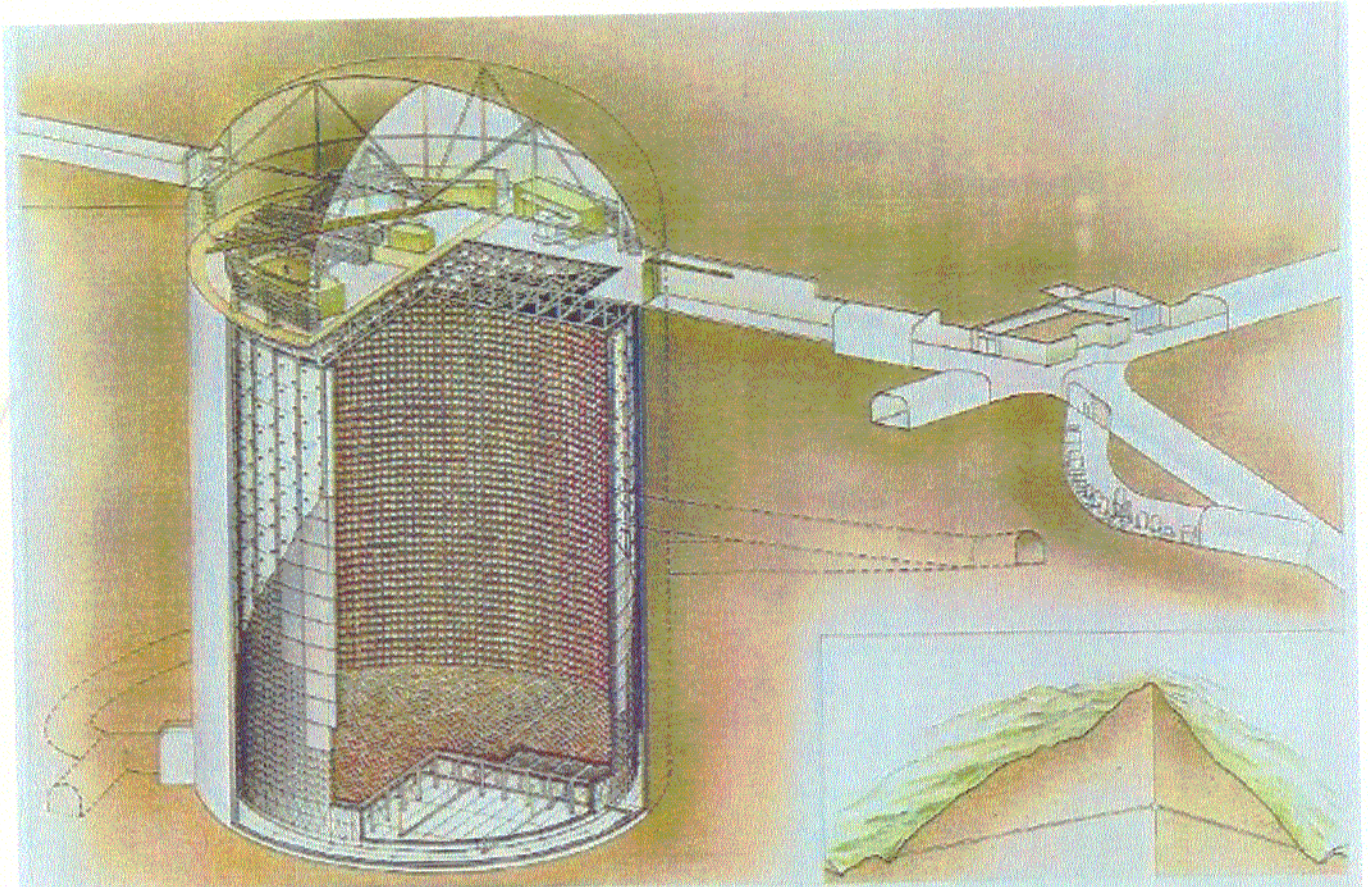
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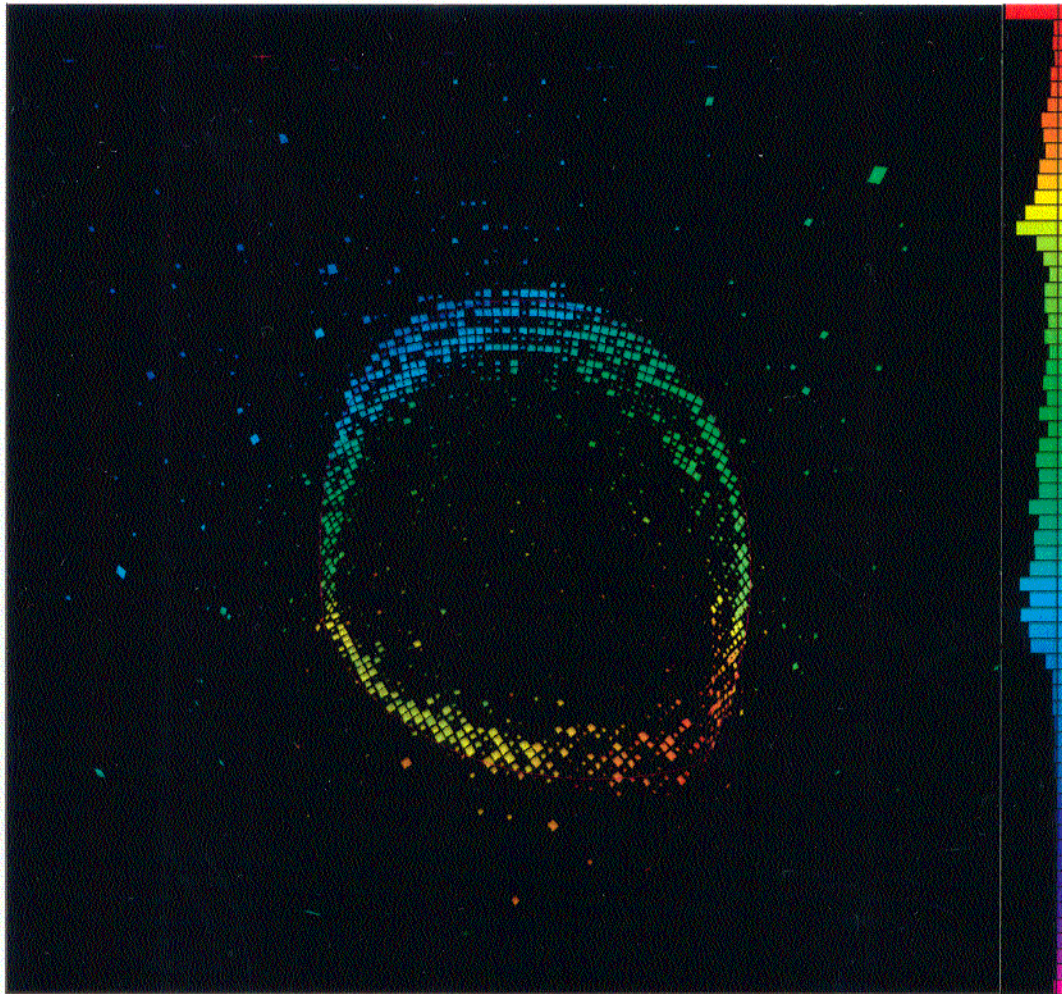
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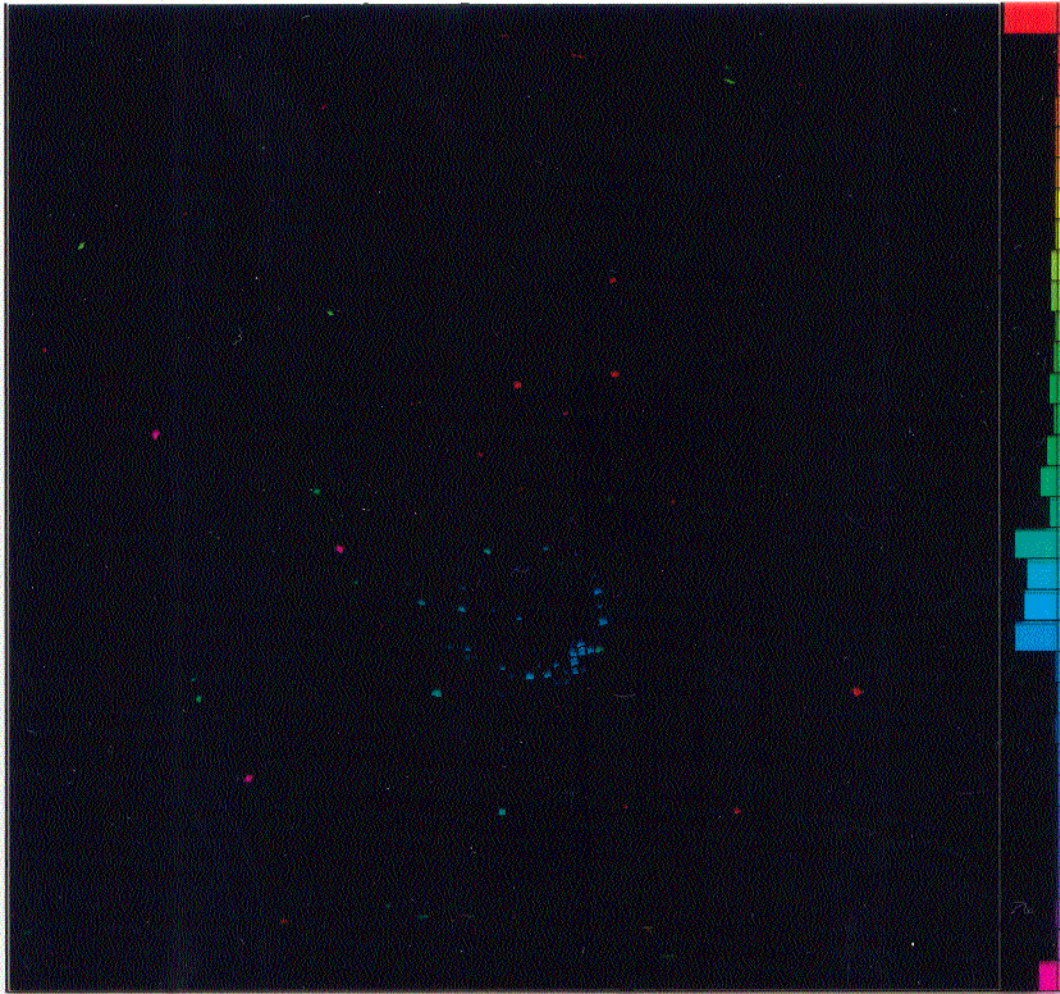


SUPERKAMIOKANDE 1999 (1997) KEK COSMIC RAY RESEARCH UNIVERSITY OF TOKYO

NIKKEN SENKEI

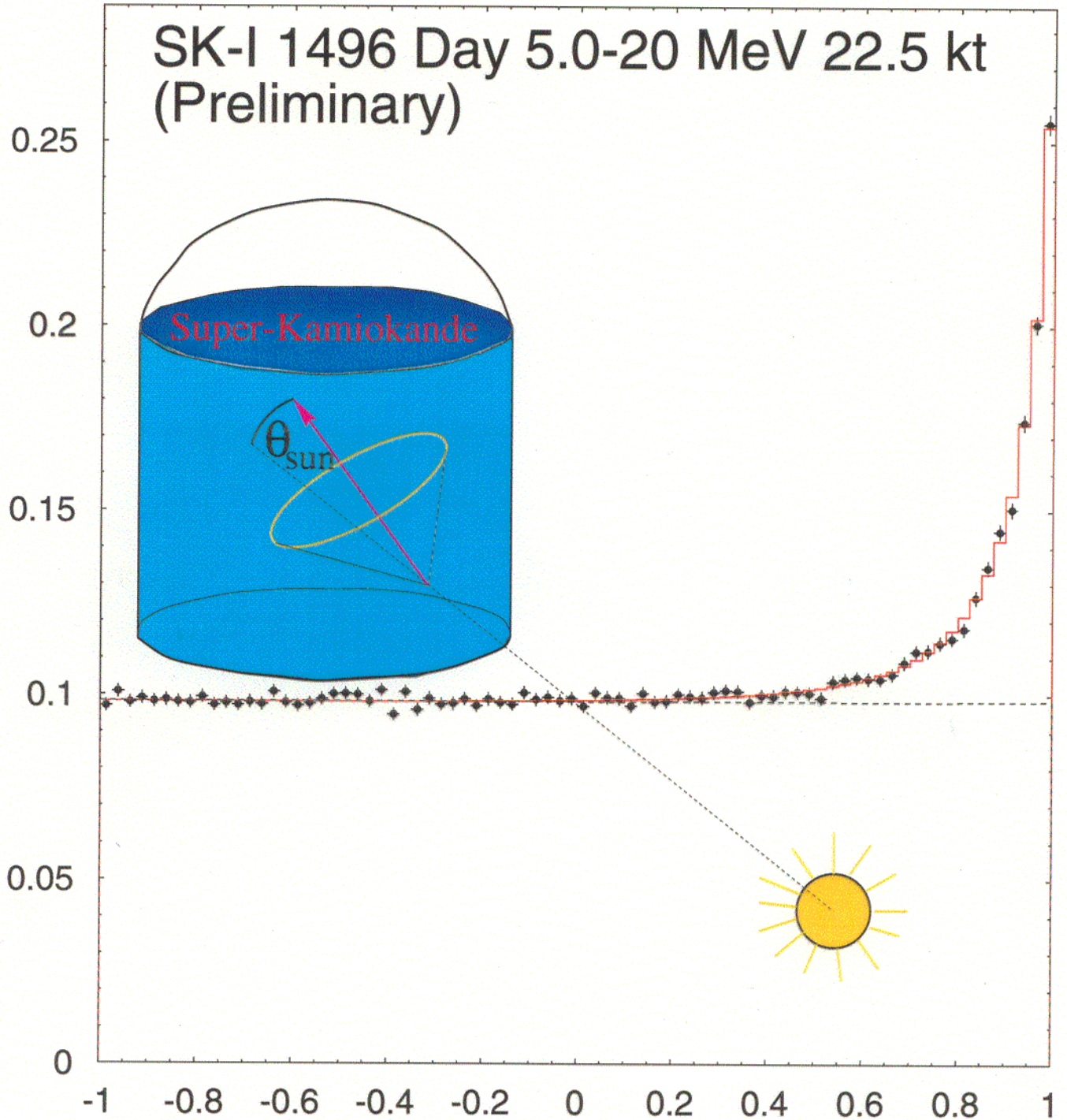


A 603 MeV Muon From An
Atmospheric Neutrino Interaction

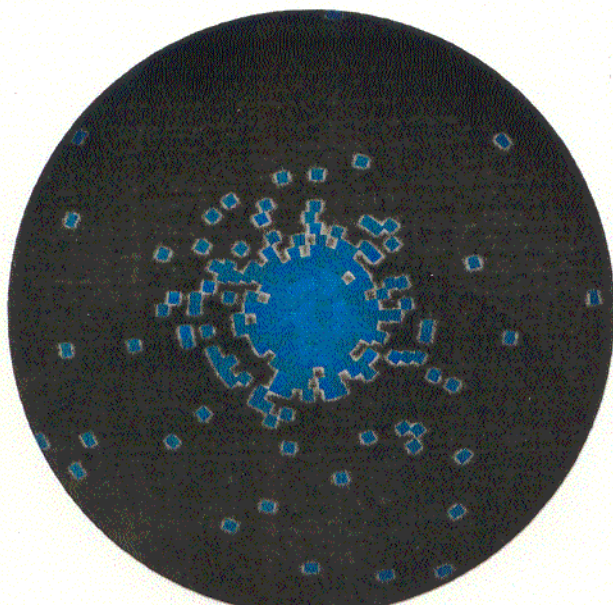
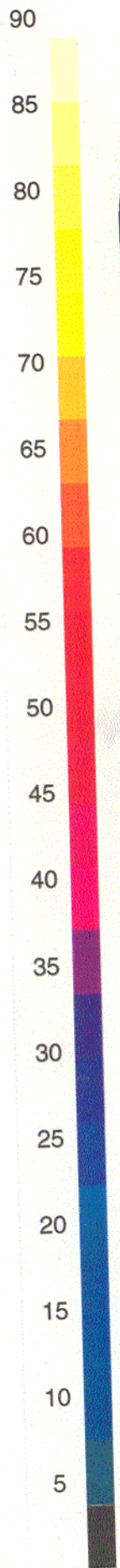


A 12.5 MeV Solar Neutrino Event

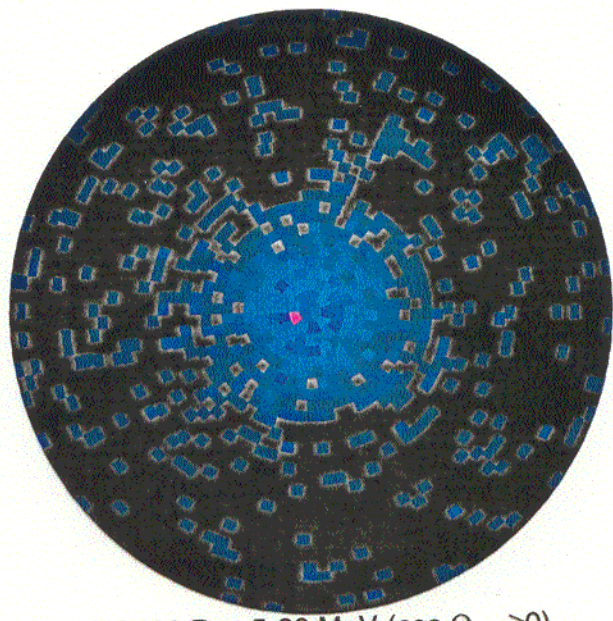
Solar Peak > 5 MeV



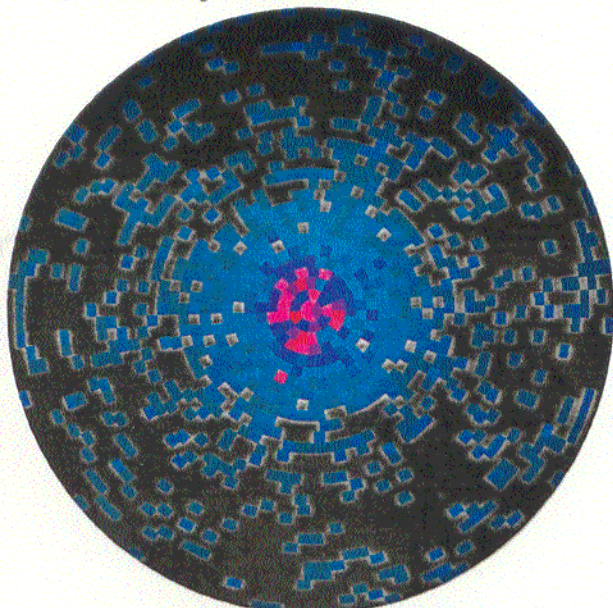
SK reached its design threshold!



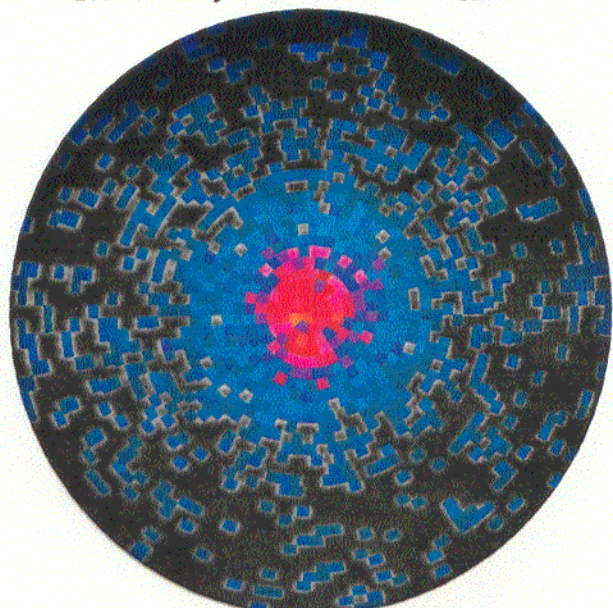
SK 200 Day 6.5-20 MeV ($\cos \Theta_{\text{Sun}} \geq 0$)



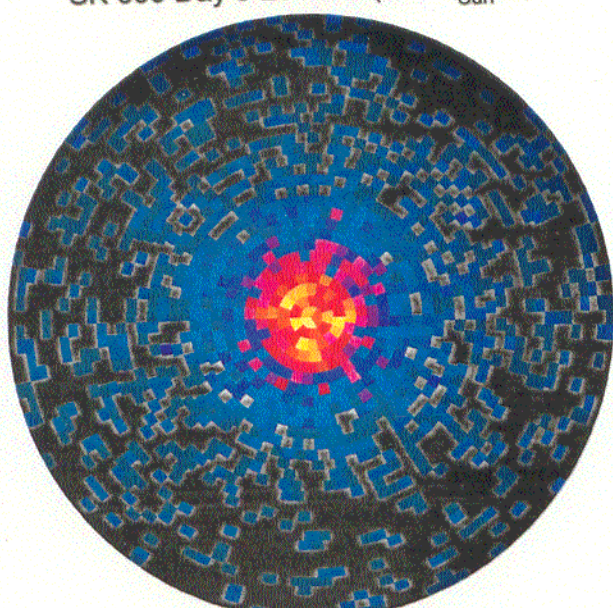
SK 400 Day 5-20 MeV ($\cos \Theta_{\text{Sun}} \geq 0$)



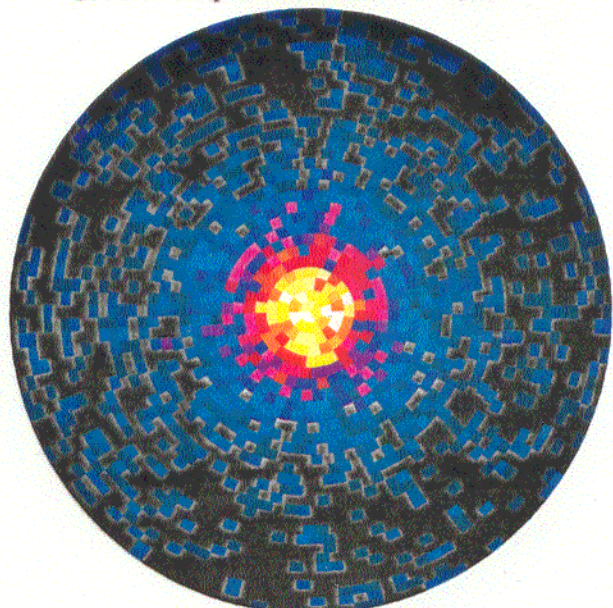
SK 600 Day 5-20 MeV ($\cos \Theta_{\text{Sun}} \geq 0$)



SK 800 Day 5-20 MeV ($\cos \Theta_{\text{Sun}} \geq 0$)



SK 1000 Day 5-20 MeV ($\cos \Theta_{\text{Sun}} \geq 0$)



SK 1258 Day 5-20 MeV ($\cos \Theta_{\text{Sun}} \geq 0$)

(1 pixel=2.6msrad)

Neutrino Rate

1496 Day Final Sample:

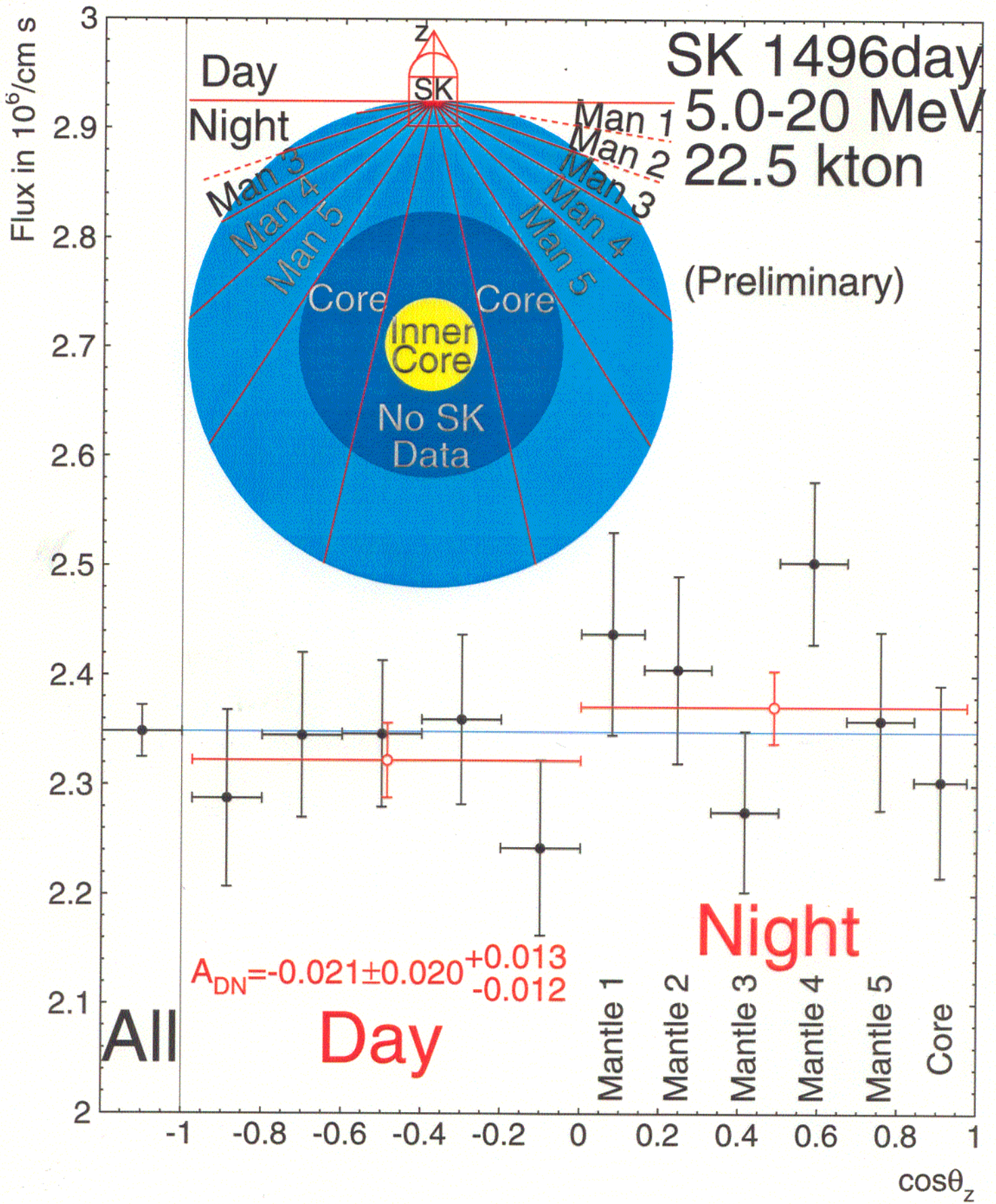
- 287,000 events
- 22,400 solar neutrino events

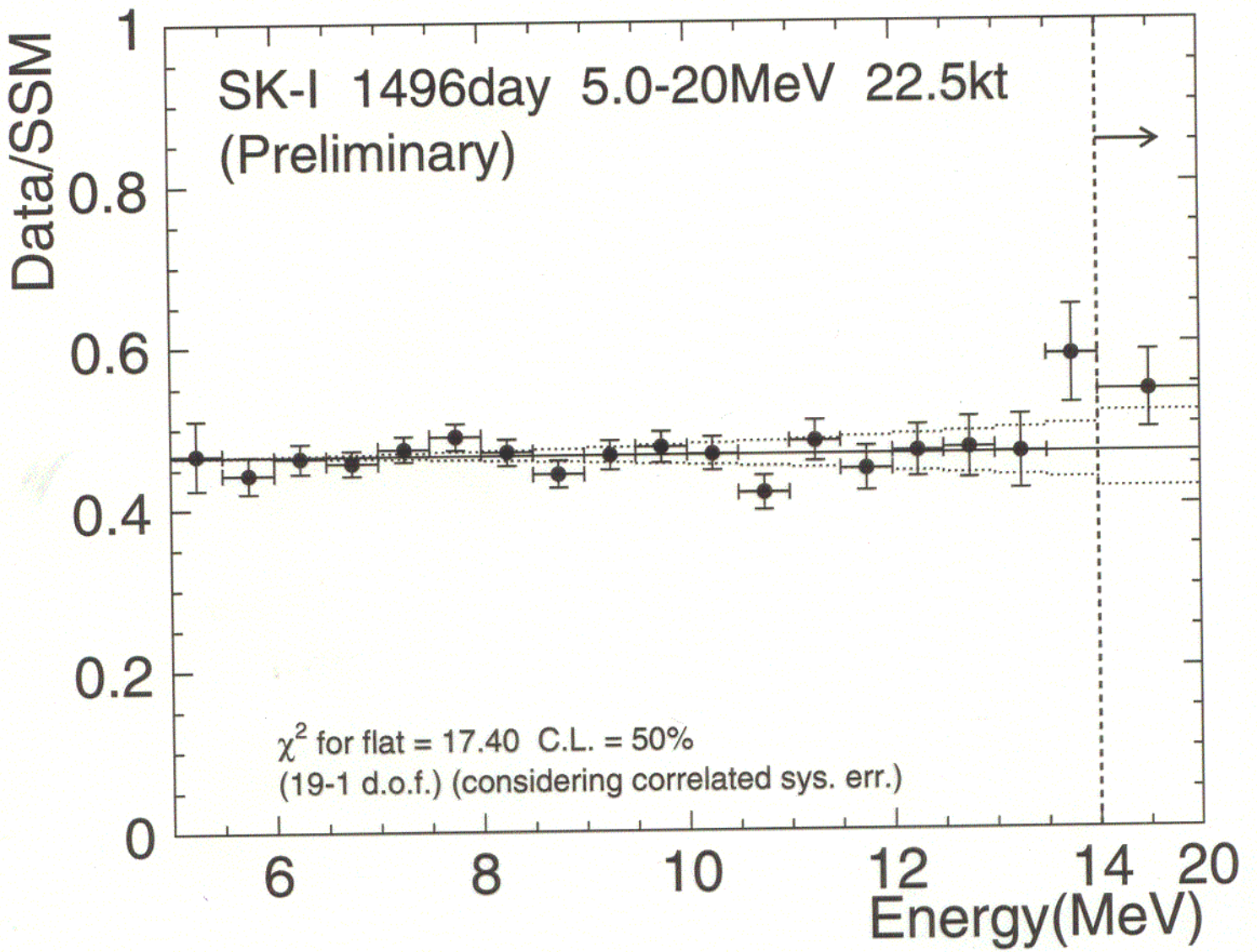
Expect:

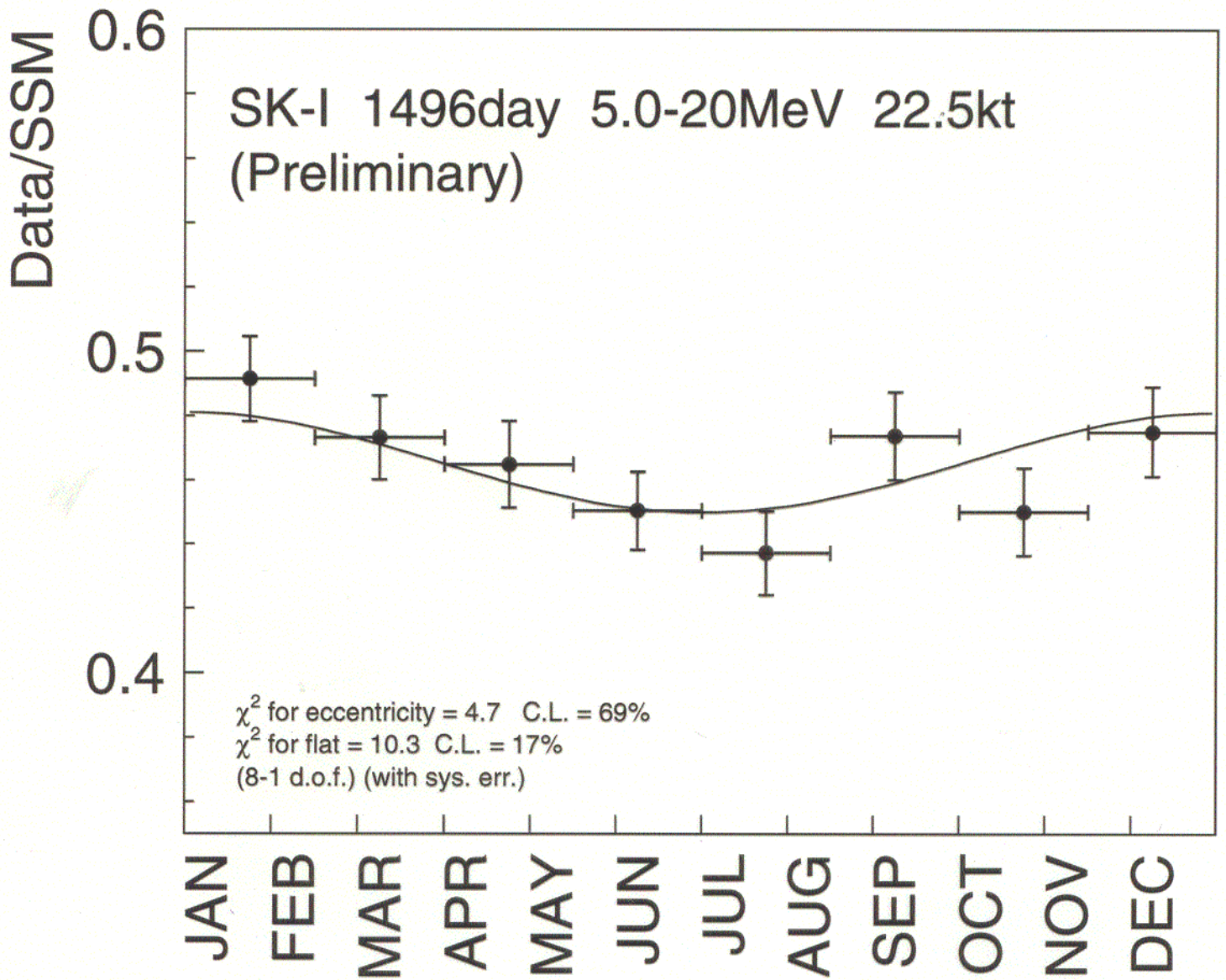
- 48,200 solar neutrino events (from SSM)
- 16,700 e -type solar neutrino events (from SNO)
- about 5,700 μ/τ -type solar neutrino events!

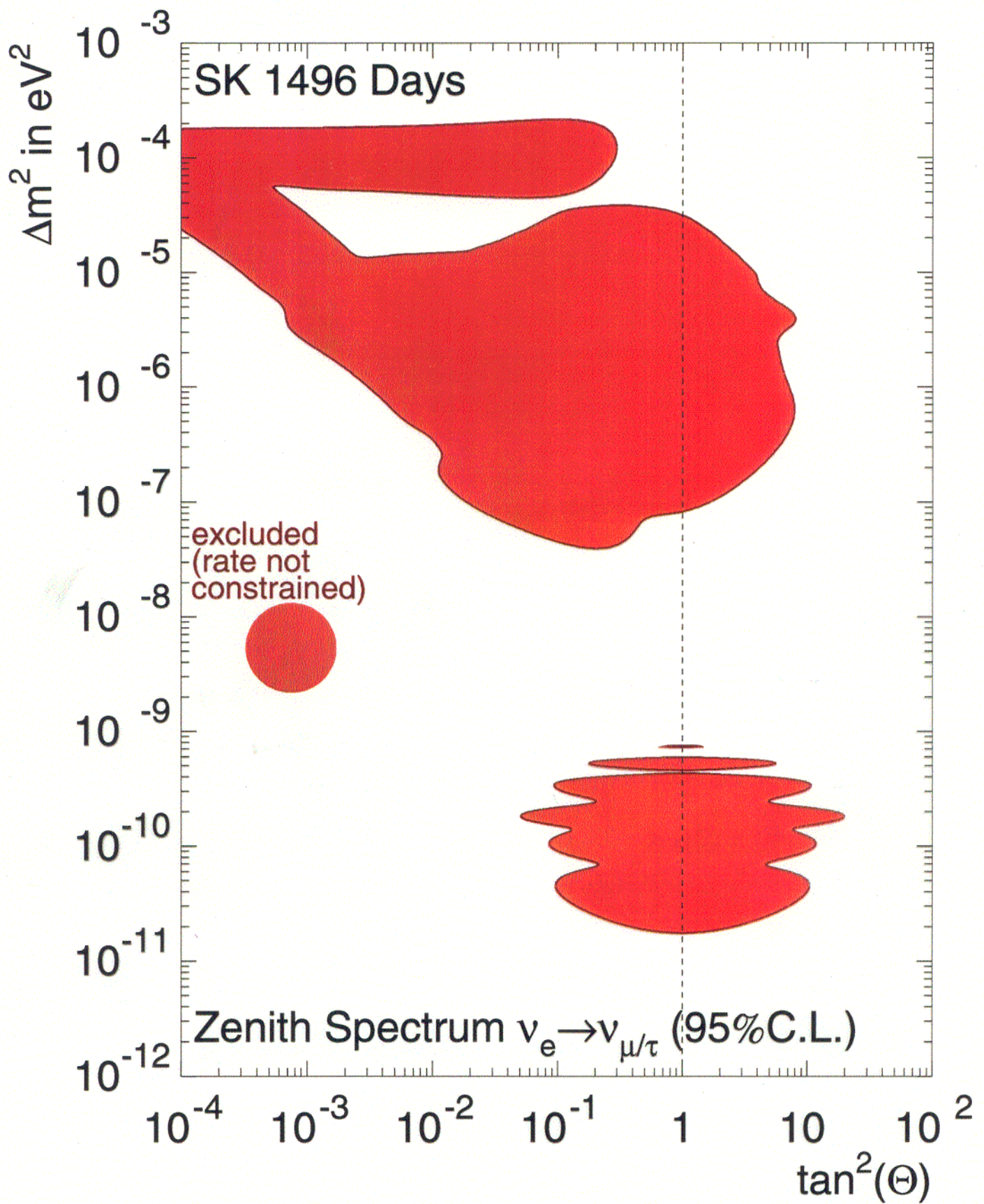
Flux:

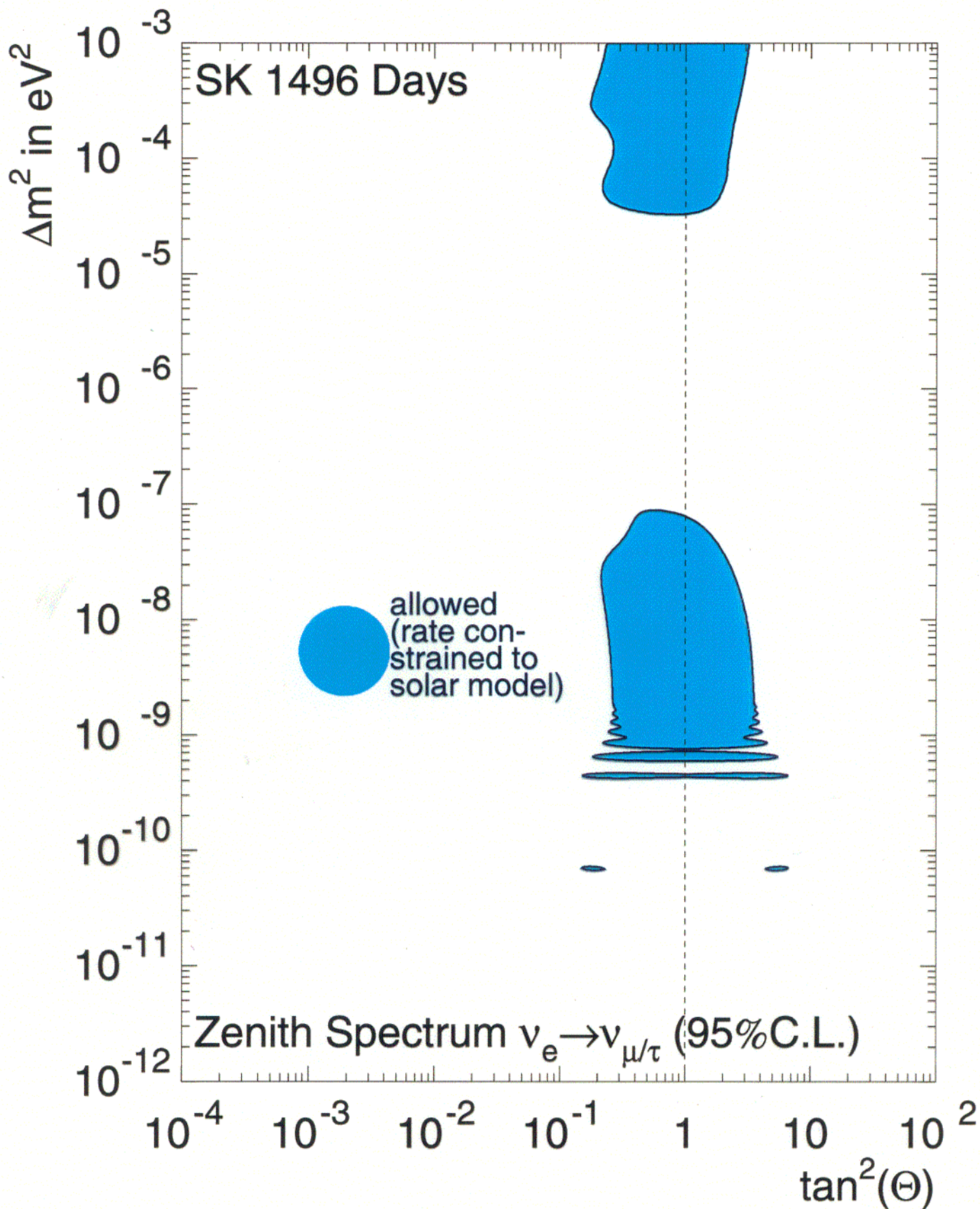
- flux is
 $2.35 \pm 0.02(\text{stat.}) \pm 0.08(\text{sys.}) \times 10^6 / \text{cm}^2 \cdot \text{s}$
- or $0.465 \pm 0.005(\text{stat.})_{-0.015}^{+0.016}(\text{sys.}) \times \text{SSM}$

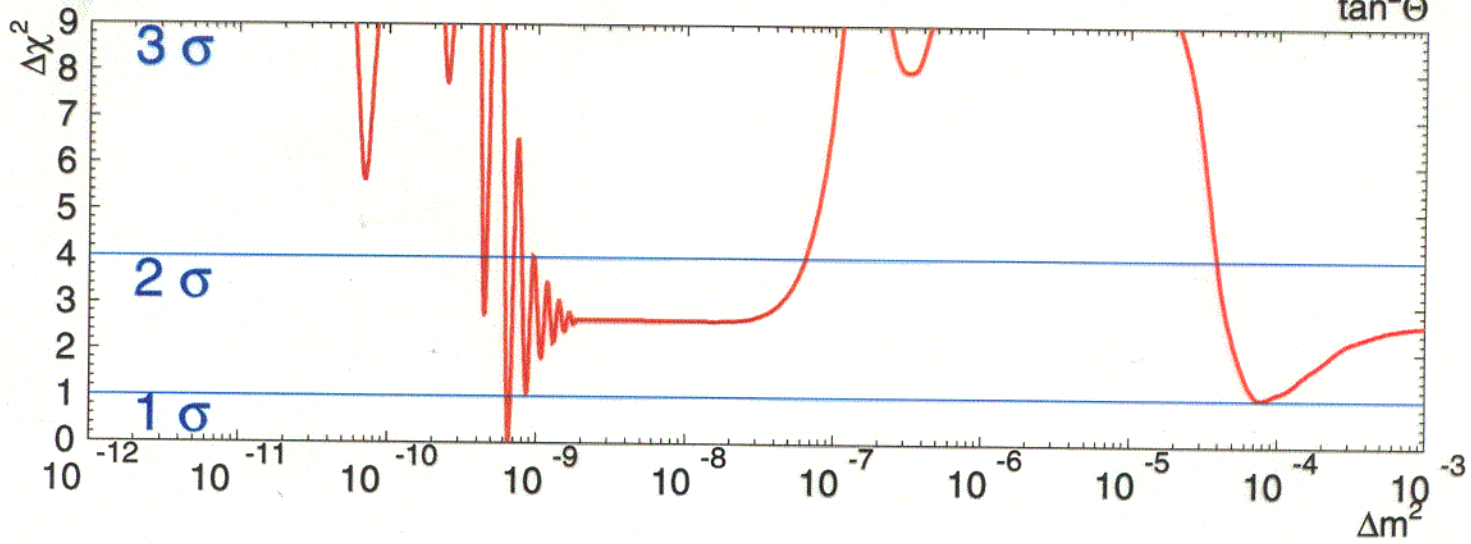
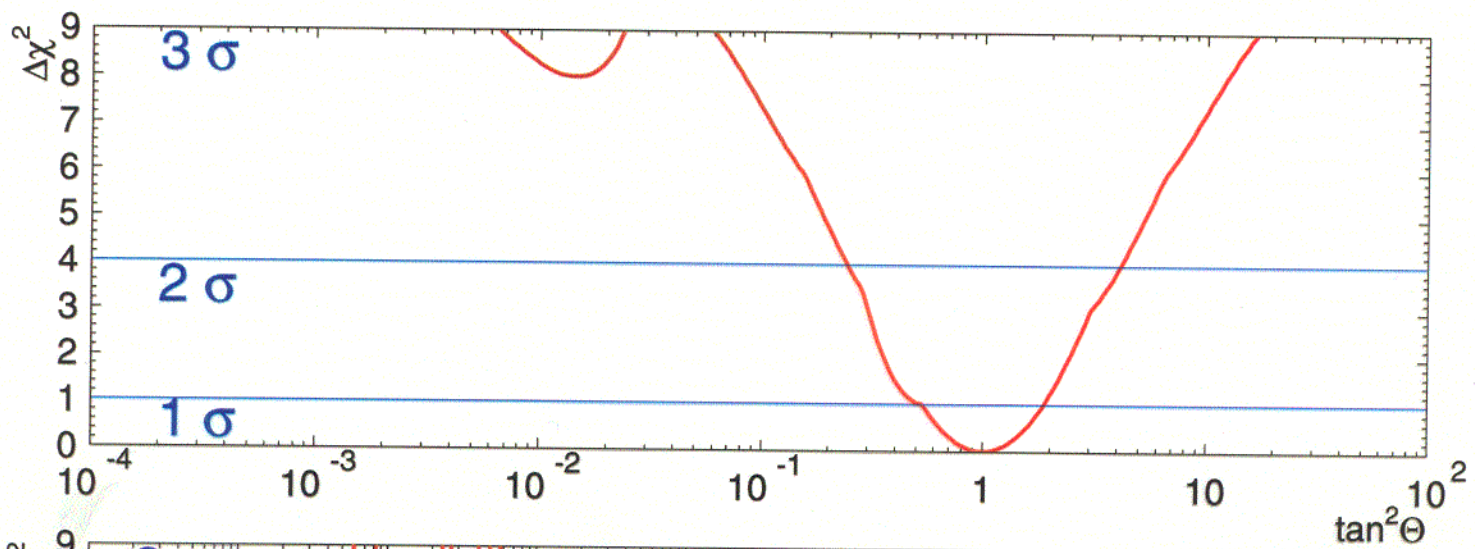


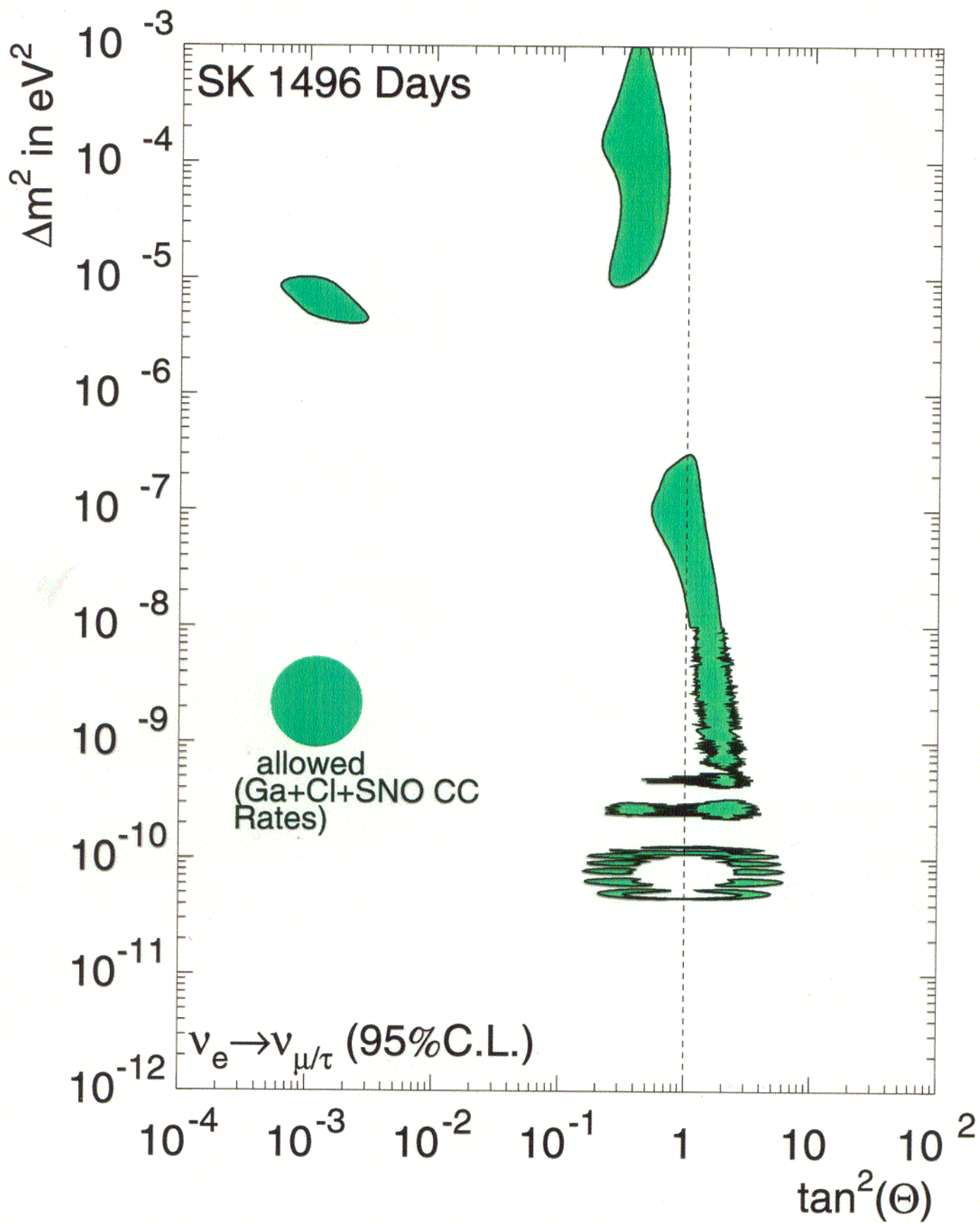


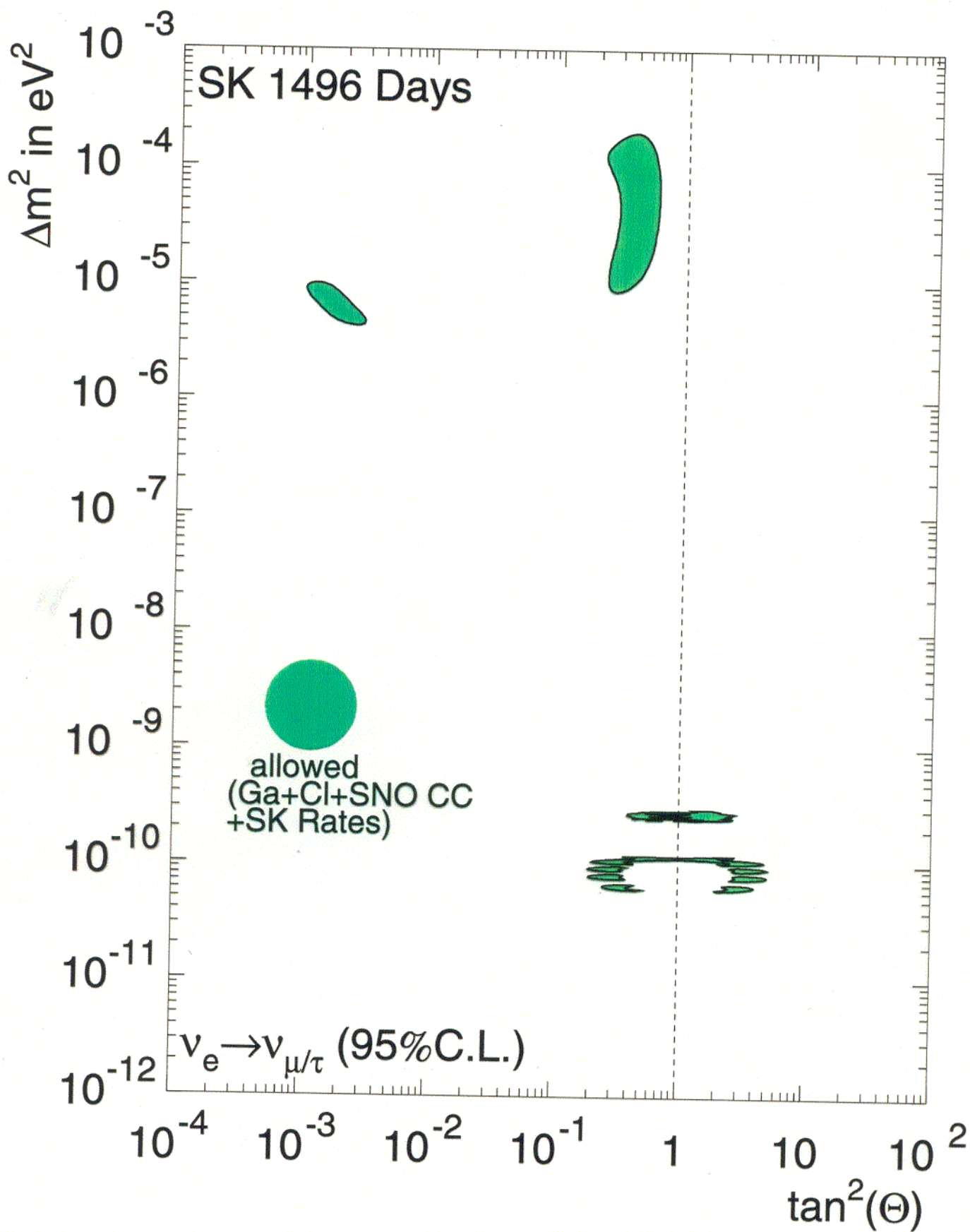


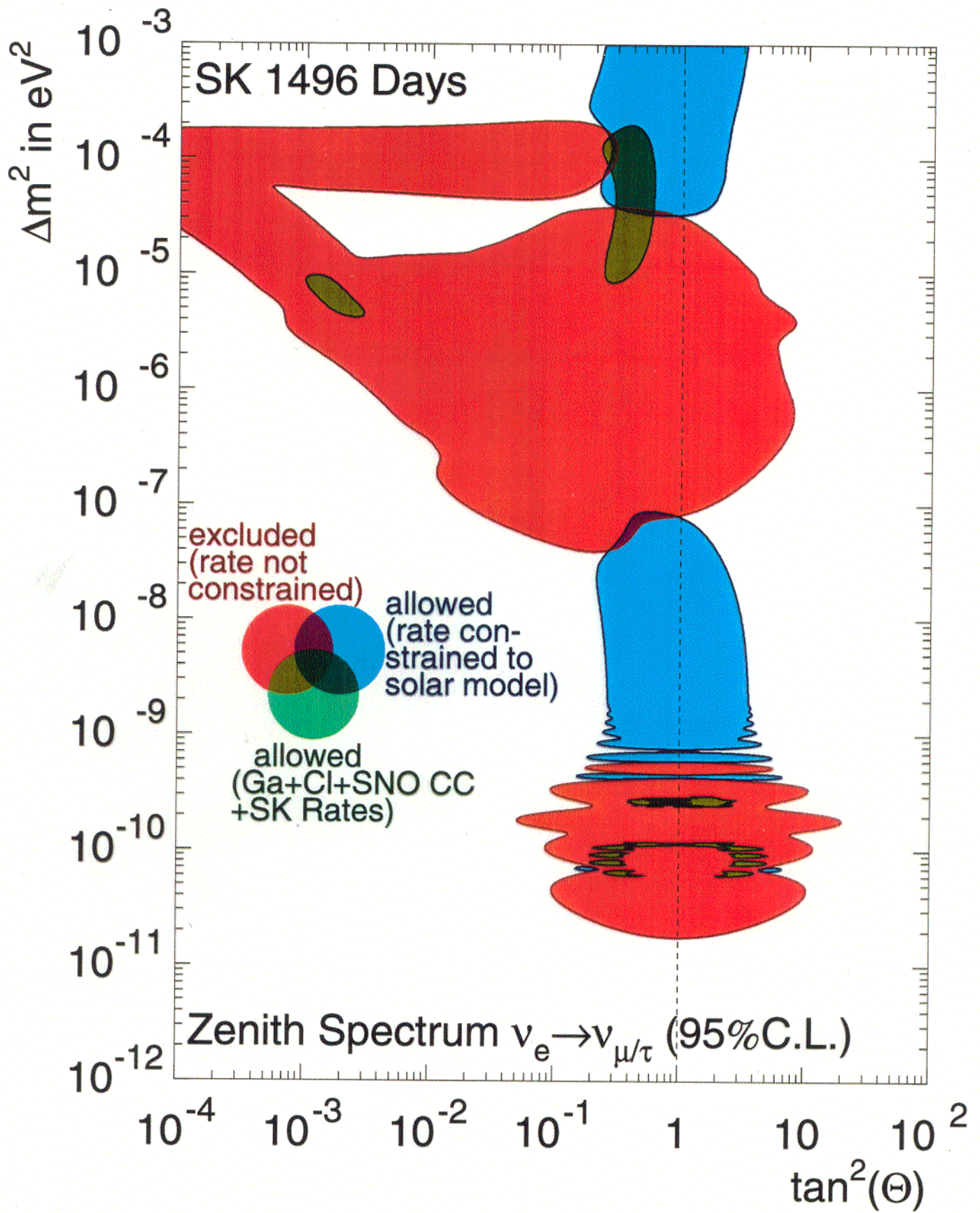


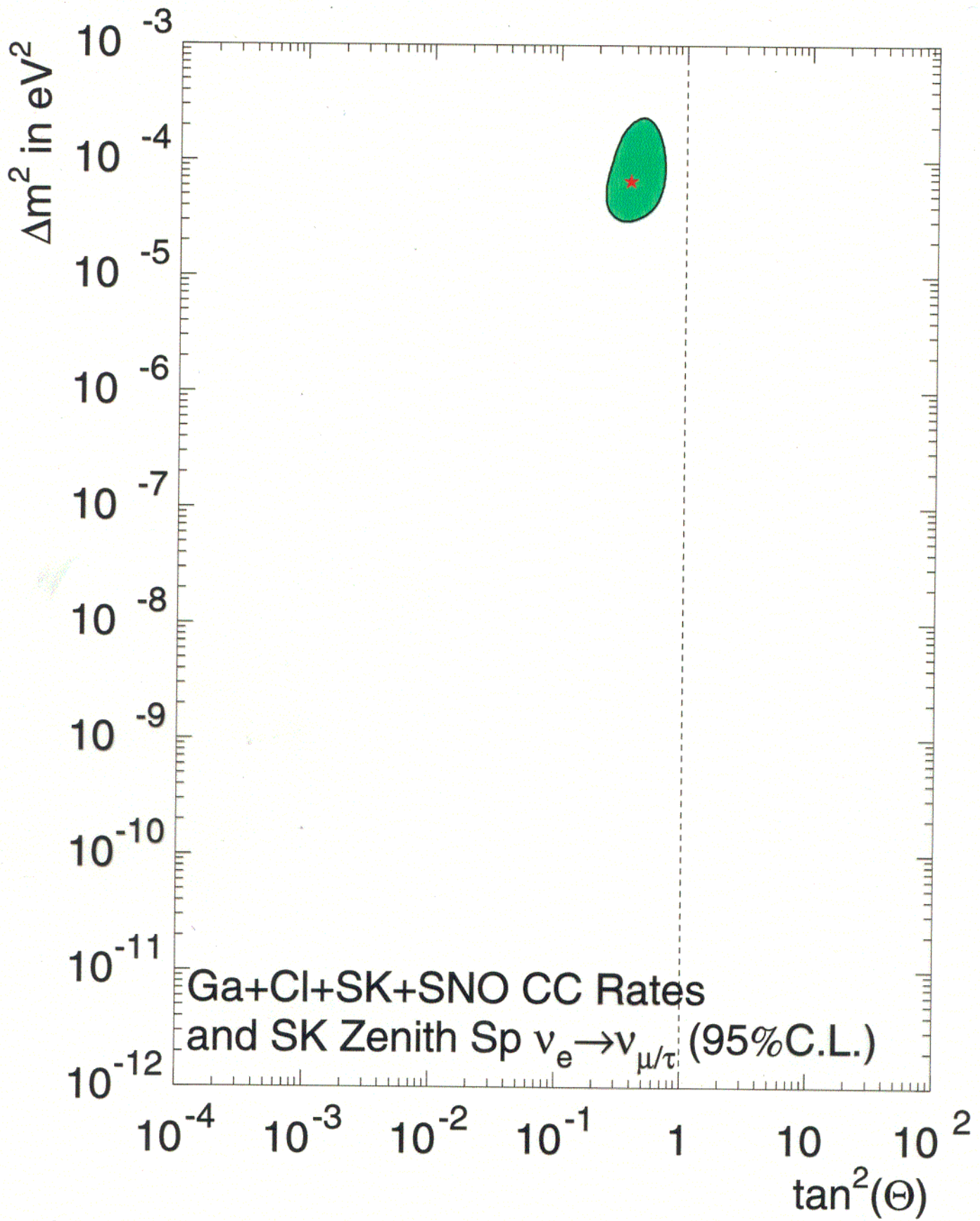


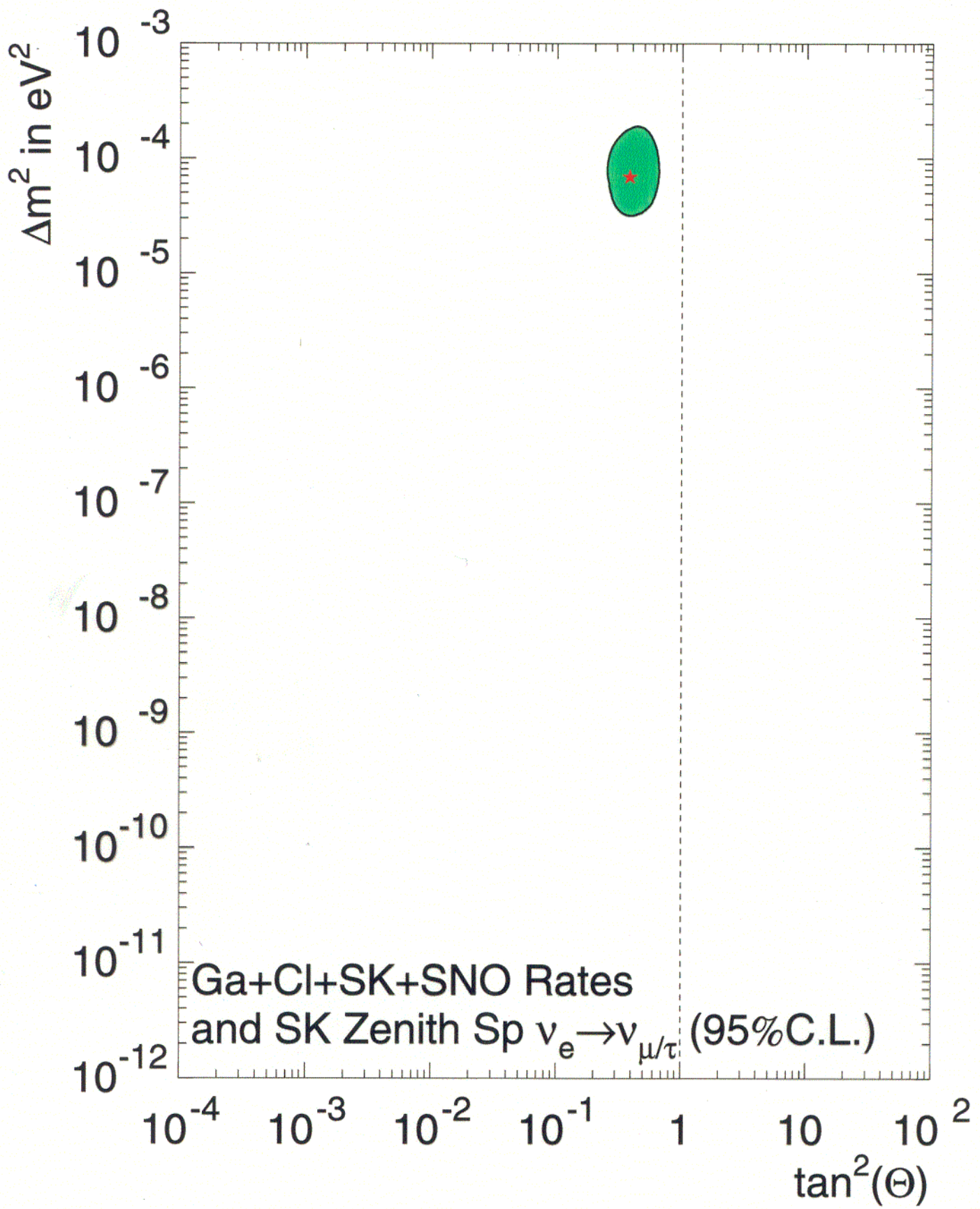


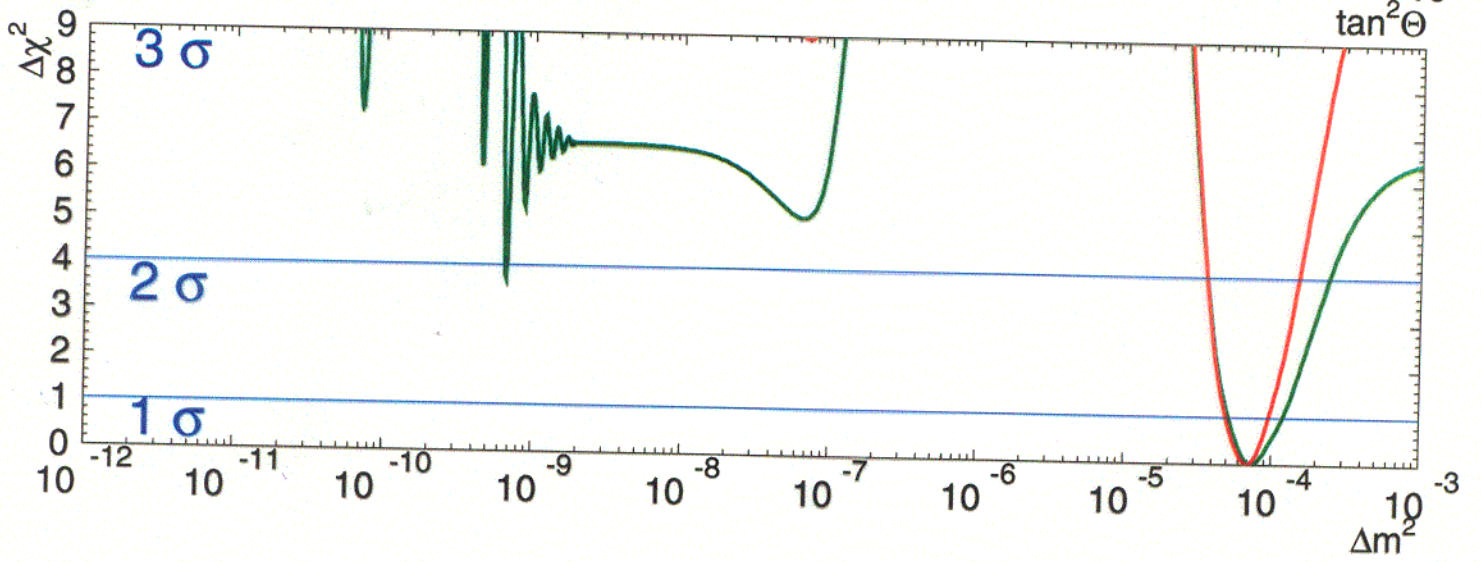
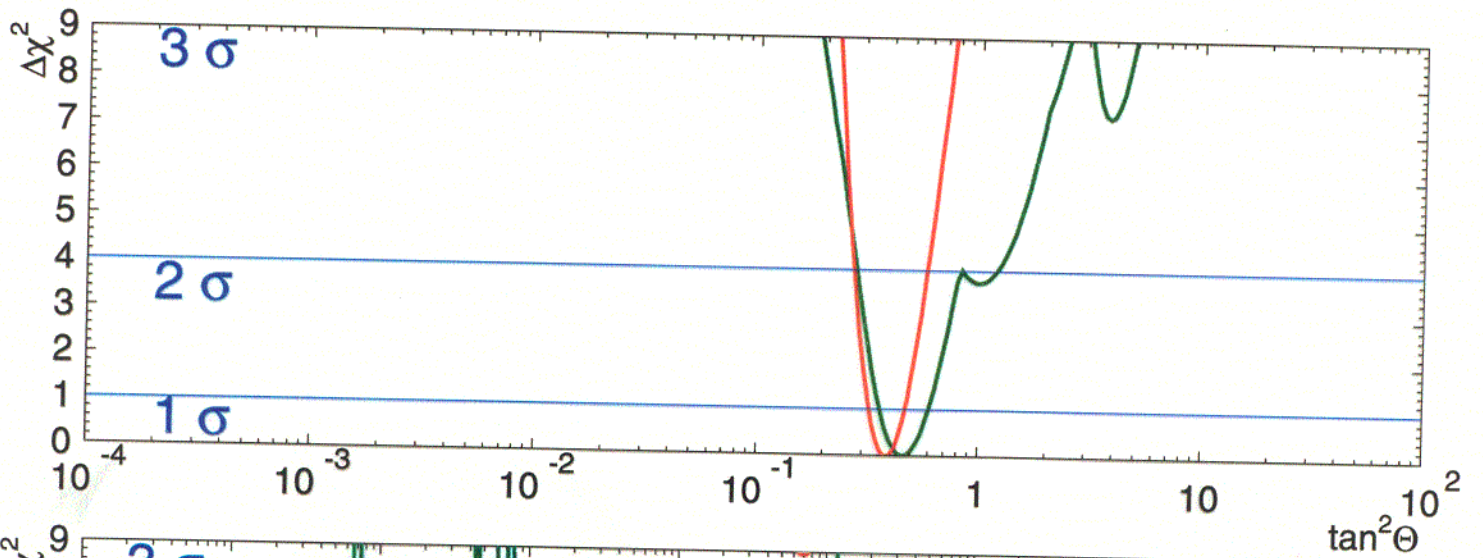












Summary and Outlook

So, where do we stand with Super-K's solar neutrinos?

→ For active species, we have entirely excluded both the Small Mixing Angle MSW oscillation region and the "Just-So" vacuum oscillation regions at the 95% confidence level.

→ We've uniquely selected large mixing, and it appears that the LMA region is where to look for oscillations. KamLAND will do this within the next two years.

→ Oscillations into a purely sterile neutrino are completely ruled out at the 95% level everywhere in phase space.

What's Next?

Within the next year or so, we will be publishing new results on:

→ Supernova Relic Neutrinos

→ $\bar{\nu}_e$'s from the Sun

→ Neutrino Magnetic Moment

→ Galactic Supernova Rate

Super-K will be back online by January 1st, 2003. We look forward to continuing our high-statistics solar observations, with a number of enhancements, through an entire solar cycle.

Observing a Galactic Supernova

| Version of the Detector | Number of Inverse β 's (at 10 kpc) | Number of ^{16}O Events (at 10 kpc) | Number of Elastic Scatters (at 10 kpc) |
|-------------------------|--|--|--|
| SK-I/III | 8,000 | 700 | 300 |
| SK-II | 7,200 | 310 | 240 |

How will Super-Kamiokande-II's supernova response compare to that of the world's other existing detectors, either **under construction (in blue)**, or **running (in green)**?

Total number of SN events at 10 kpc

Super-K — 7,750

SNO — ~1,000

KamLAND — ~500

Borexino — ~200

LVD — ~200

What Does the Future Hold?

