

“All the Nu’s
that’s fit to
print”

The Neutrino Nu’s

Late Edition

Today, mostly sunny, light winds, high 69. Tonight, increasing clouds, spotty showers late, low 56. Tomorrow, clouds, a little sun, milder, high 73. Weather map is on Page B14.

VOL. CLVIII . . No. 54,457

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NEW YORK, WEDNESDAY, OCTOBER 8, 2008

\$1.50

Neutrinos Exhibit Quantum-Mechanical Oscillations



Neutrinos are probes for new physics beyond SM, no longer an “anomaly,” a “problem,” or an “effect”

U.S. Japan, Europe each building their own facilities

By ADAM NAGOURNEY

Senators John McCain and Barack Obama debated for 90 minutes on Tuesday night before a nation in economic crisis, each

Mr. Obama placed the blame for the financial crisis on deregulation and the lack of fiscal discipline under President Bush

Experiments still pushing for CP Violation in Neutrinos

By ERIC SCHMITT

WASHINGTON — An investigation by the military has concluded that American airstrikes

the raid, and the American military, under Gen. David D. McKiernan, the top American

MEASUREMENTS FROM THE SUN, COSMIC RAYS, ACCELERATORS, —REACTORS Mixing like quarks, implications beyond Standard Model

By EDMUND L. ANDREWS and MICHAEL M. GRYNBAUM

WASHINGTON — The promise of lower interest rates and new federal efforts to stem the financial crisis failed to dispel the fear gripping Wall Street on Tuesday.

Stocks rose at the session's opening but soon began to fall, and the selling intensified during the afternoon, even after Ben S. Bernanke, the chairman of the Federal Reserve, all but pledged to cut interest rates by the end of the month. The Dow Jones industrial average plunged 508 points, or 5.1 percent, extending a slide of months that has erased a third of its value in a year. In the last five trading days alone, the Dow has lost 1,400 points.

With the flow of credit still tight, investors have fixated on the threat of a serious recession despite the increasingly urgent attempts by policy makers to buttress the markets. Deepening problems in the European banking industry have compounded fears of a worldwide downturn.

“The Fed is just plugging holes in the dam and the water keeps rushing over,” said Michael T. Darda, chief economist at the research firm MKM Partners.

strongest indication to date that the Fed will cut rates.

Fed policy makers are scheduled to meet on Oct. 28 and 29, and investors had already been betting that the central bank would reduce the overnight federal funds rate by as much as one-half of a percent, to 1.5 percent. But many analysts predict the Fed may act before the next meeting, given the sprawling nature of the credit crisis.

In its latest tactic, the Fed announced on Tuesday morning a new program to buy up parts of the short-term financing market to unlock the flow of credit to businesses. The program, which is expected to begin soon, was the latest and potentially biggest in a series of unprecedented ef-

Continued on Page A23

Dow Industrials

Neutrinos Don't Decay or Decohere

NEUTRINO CHRONICLE

ATMOSPHERIC NU

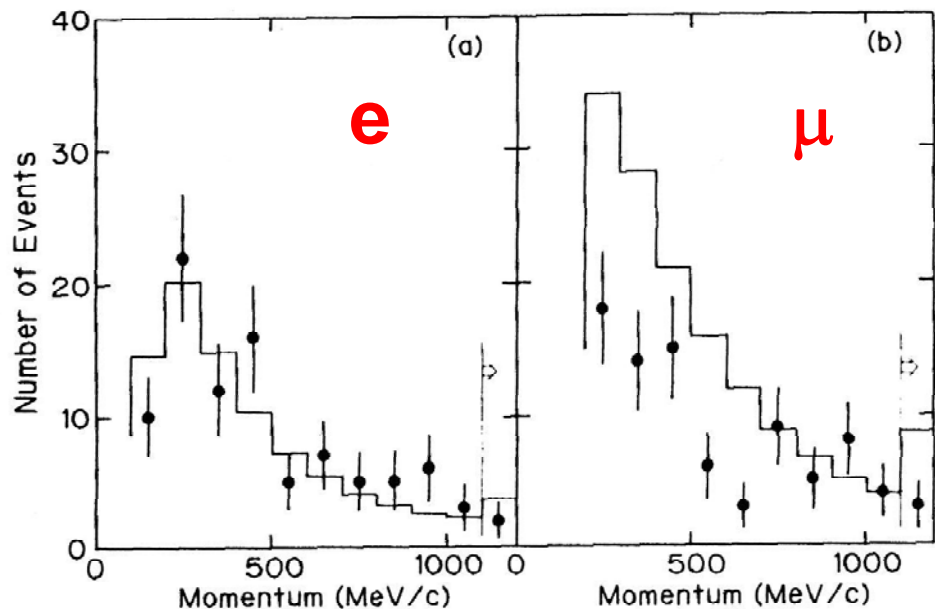
EXPERIMENTAL STUDY OF THE ATMOSPHERIC NEUTRINO FLUX: "ANOMALY"

KAMIOKANDE-II Collaboration (K.S. Hirata *et al.*), Phys.Lett.B205:416,1988

■ And who is to blame depends on whom you ask

MORE CAPITOL ACTION
Houston's apartment safety measure gets some help, while efforts to expand CHIP are at risk. **STORIES ON PAGES B1, B2**

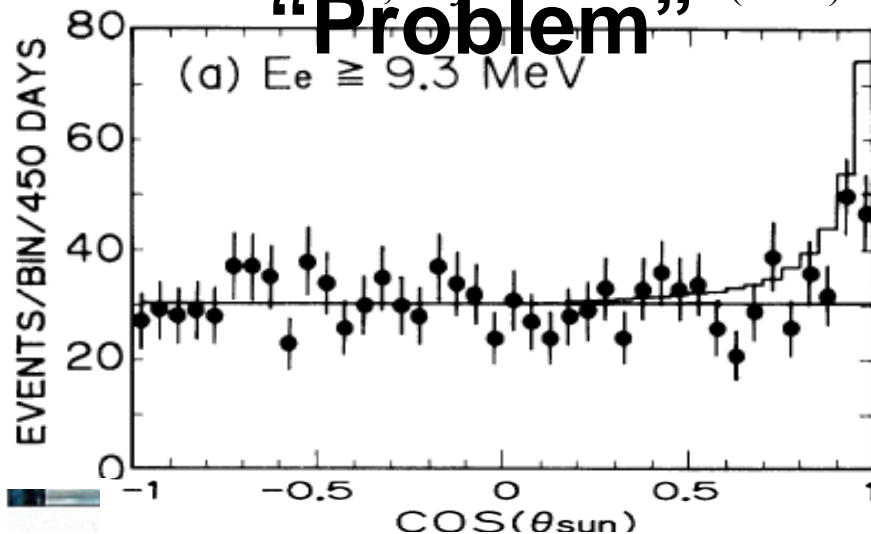
"We did spend five days asking meaningless, pointless questions about butterflies, cold remedies and Christmas trees when we could have



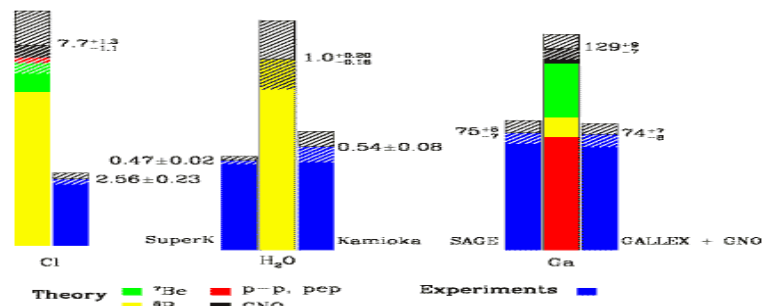
Solar Neutrino

K.S.Hirata et al., Phys. Rev. Lett, 63(1989) 16

"Problem"

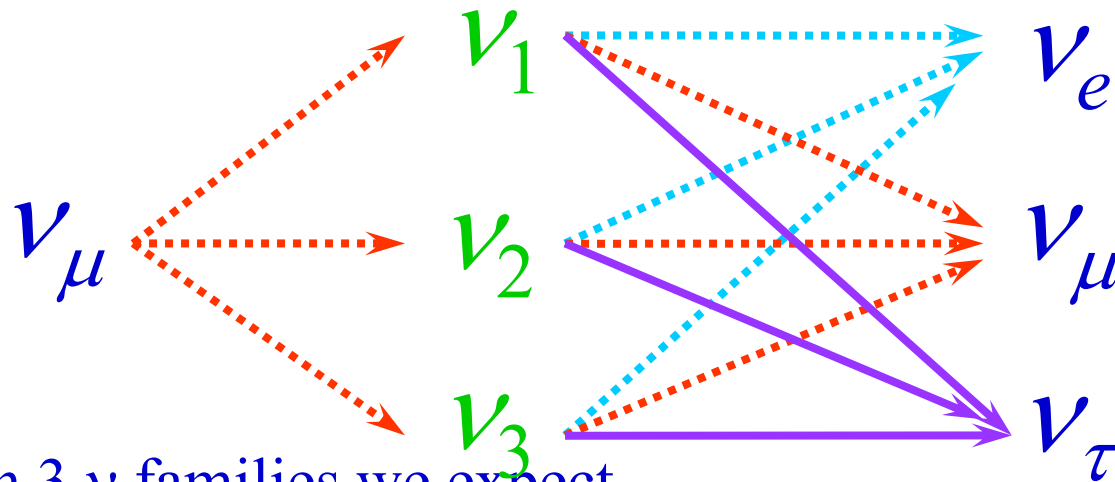


Total Rates: Standard Model vs. Experiment
Bahcall-Pinsonneault 2000



Neutrinos: 3 Slit Experiment

- The ν_τ discovered $\Rightarrow \geq 3$ lepton flavors must exist
(K. Kodama *et al.*, *Phys. Lett.* **B504** 218 (2001))
- Measurements of Z^0 boson resonance $\Rightarrow N_\nu = 2.983 \pm 0.009$
[S. Eidelman *et al.*, *Phys. Lett.* **B592**, 1 (2004)]



- With 3 ν families we expect
 - ❖ 3 mixing probabilities between flavor $i \rightarrow j$
 - ❖ 2 distinct mass splittings $(\Delta m^2)_{ij}$

ν Mixing Orthodoxy

- PMNS: a 3×3 unitary transformation to mass states:

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = \begin{pmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta} \\ -s_{12}c_{23} - c_{12}s_{23}s_{13} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta} & s_{23}c_{13} \\ s_{12}s_{23} - c_{12}c_{23}s_{13}e^{i\delta} & -c_{12}s_{23} - s_{12}c_{23}s_{13}e^{i\delta} & c_{23}c_{13} \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

$c_{ij} \equiv \cos\theta_{ij} \quad s_{ij} \equiv \sin\theta_{ij}$

$\sin\theta_{\text{solar}} < 0.62$
(Smirnov, hep/0309299)

Is this *non-zero*???
 Large enough to measure
~~CP~~ in $\nu_\mu \rightarrow \nu_e$

Is the mixing angle truly *maximal*???

- In the quarks, matrix has phase $\delta \neq 0$ responsible for CP.

$$P(\nu_\mu \rightarrow \nu_\tau) = \sin^2 2\theta \sin^2 \left(1.27 \frac{\Delta m^2 L}{E_\nu} \right)$$

The Japan Times



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水
TODAY

NATIONAL
Greenhouse goal
Environment Minister Tetsuo Saito suggests that Japan might adopt 15 percent as its target for greenhouse gas cuts for 2020.
Page 2

WORLD
Hispanic appeal
U.S. President Barack Obama taps U.S. Circuit Judge Sonia Sotomayor for the Supreme Court, officials say, making her the first Hispanic in history picked to wear the robes of a justice.
Page 5

BUSINESS
Future looks bright
Shimizu aims to grow its share of the global solar panel market to 10 percent by 2014, up from less than 1 percent now.
Page 7

MARKET DATA
MARKET INDEXES

Tuesday Close	Change
Nikkei 225	8,110.84 ↓ 34.19
Dow*	8,277.32 UNCH
Haneda*	1,882.01 UNCH

TERMINATION EXERCISE
Tuesday 5 p.m.
NY 84.6647 ○ 34

Super Kamiokande Exp't Observes Zenith Angle-Dependent Loss of ν_μ not

See **V** Test for **e** same: Page 5

North Korea reportedly tested two more short-range missiles Tuesday, thumping its nose at global powers just hours after the U.S. Security Council condemned the regime's provocative nuclear test.

Fyonyang also warned ships to stay away from waters off its western coast this week, a sign the country may be gearing up for more missile tests, South Korea's coast guard said.

North Korea appeared to be displaying its might a day after conducting an atomic test in the northeast that the U.S. Security Council condemned as a "clear violation" of a 2006 resolution banning the regime from developing its nuclear program.

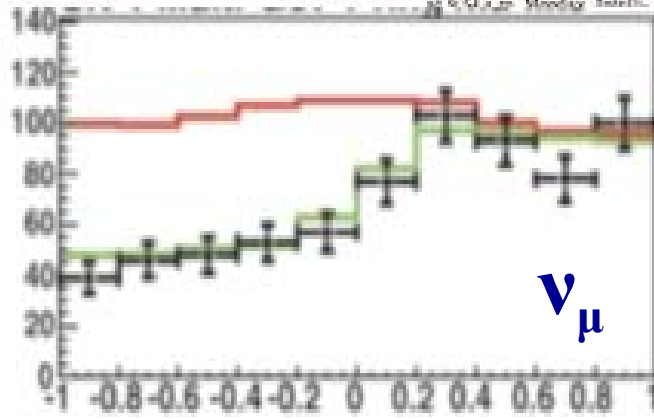
France called for new sanctions, while the U.S. and Japan pushed for strong action against North Korea for testing a bomb that Russian officials said was comparable in power to those that obliterated Hiroshima and Nagasaki during World War II. However, many questioned

whether new punishment would have any effect on a nation already penalized by numerous sanctions and clearly dismissive of the Security Council's jurisdiction.

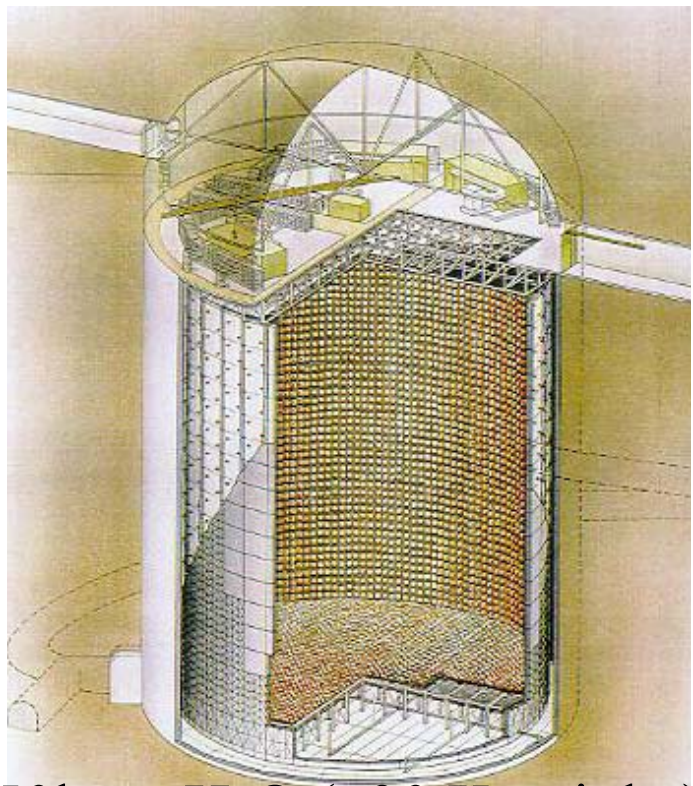
Monday's nuclear test appeared to catch the world by surprise, but South Korea's spy chief told lawmakers Beijing and Washington knew Fyonyang was planning a test some 20 to 25 minutes before it was carried out, said Choi Kyu-Ha, an aide to lawmaker Park Young-Sun.

Russia said the test went off at 8:54 a.m. Monday, adding

Events/bin



$\cos \theta_{zenith}$



50kton H₂O (x30 Kamioka)
SK-I - ('96-'00) and SK-III ('03 --) 11100 PMTs,
SK-II (2000-2003), 5200 PMTs

First expt showing dynamic loss of ν 's

Masashi Hata and Jun Horigo

The government Tuesday welcomed the U.N. Security Council's quick opposition to North Korea's nuclear test but continued to scramble for a fresh response to Pyongyang's latest provocation.

Prime Minister Taro Aso and U.S. President Barack Obama agreed during a phone conference in the morning that Pyongyang's nuclear test was "a serious threat to the peace and stability of Northeast Asia and the international community," and that a swift adoption of a U.N. resolution against the recalcitrant state is necessary.

They also confirmed that Japan, the U.S. and South Korea will cooperate more closely over North Korea and stressed the importance of coordinating with China and Russia.

Chief Cabinet Secretary Takero Kawamura said the government plans to hold phone conferences with the Chinese and Russian leaders. He said he had not received word of whether Japan would draft a U.N. resolution but refused to rule out the possibility.

"I have not received a clear report on whether Japan will draft the resolution or not," Kawamura said. "But considering that we asked for a Security Council meeting, I believe that Japan is fully capable of playing a 5/38 role in the discussion."

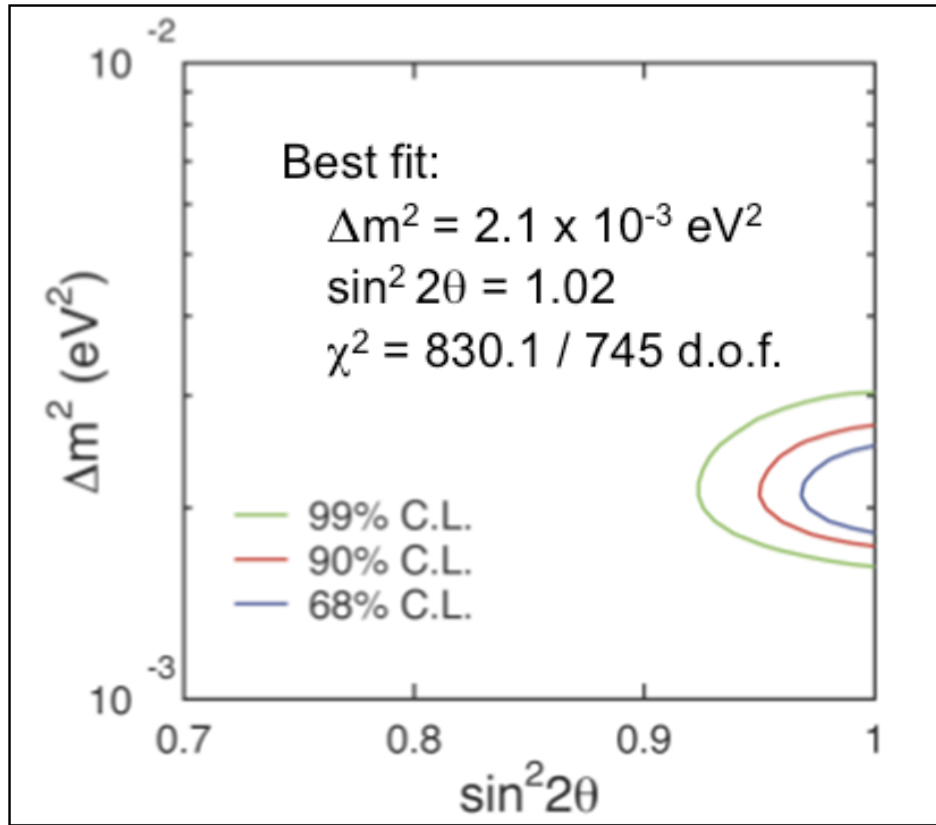
Hiroshima

A digital counter on the "peace clock" monument at Hiroshima.

In the fifth year since the clock was established by a peace group in August 2005, the digital counter was changed to one from 900 — the number of

tests since the clock debuted. The monument was produced and donated to the museum on the 56th anniversary of the Hiroshima bombing.

Super-K zenith angle analysis



- Containment and $\cos \theta_\nu$ are best measured quantities
- Effect ‘turns on’ near horizon
- Many oscillations across Earth diameter

$$\sin^2 2\theta_{23} > 0.94 \text{ (90\% C.L.)}$$

SK I+II L/E Analysis

Datasets

SK-I FC/PC μ -like: 1489 days

SK-II FC/PC μ -like: 799 days

Use only event categories with good L/E resolution:

Partially-contained muons

Fully-contained muons

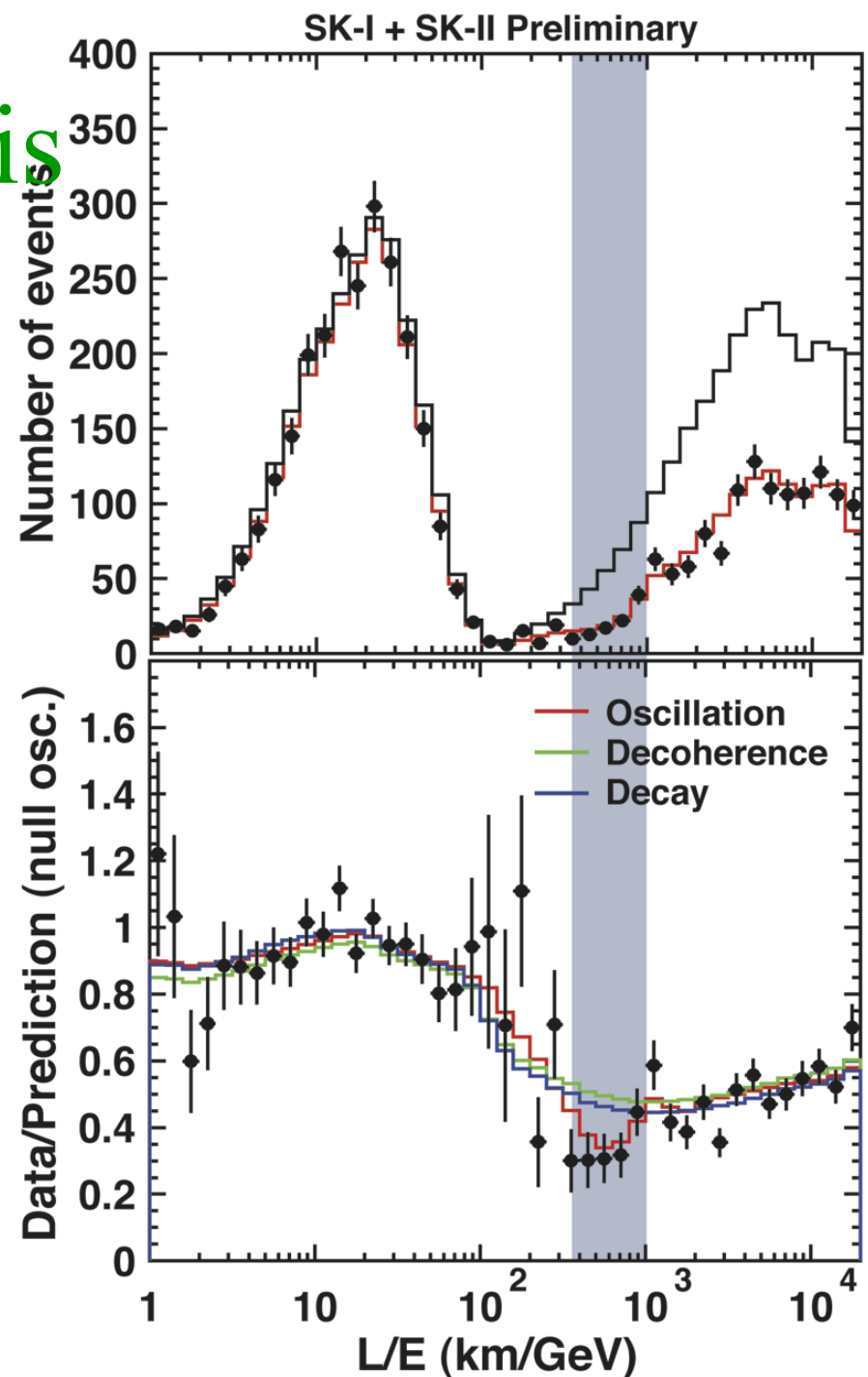
χ^2 fit to 43 bins of $\log_{10}(L/E)$

with 29 systematic error terms

Compare against:

Neutrino decoherence (5.0σ)

Neutrino decay (4.1σ)



Long Baseline Times

75¢ DESIGNATED AREAS INC.

latimes.com

COLUMN ONE

Exp'ts
in U.S.
Japan,
Europe

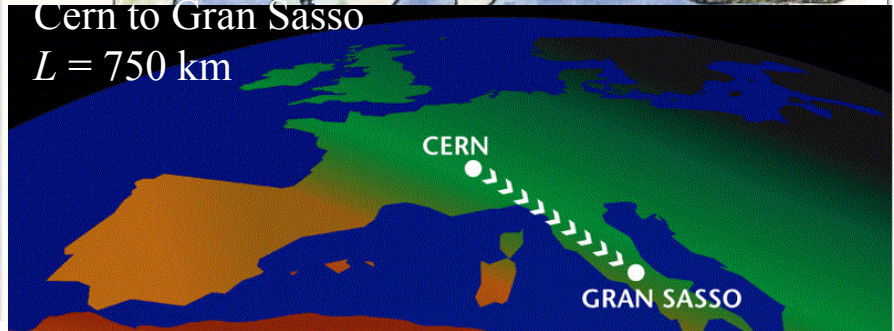
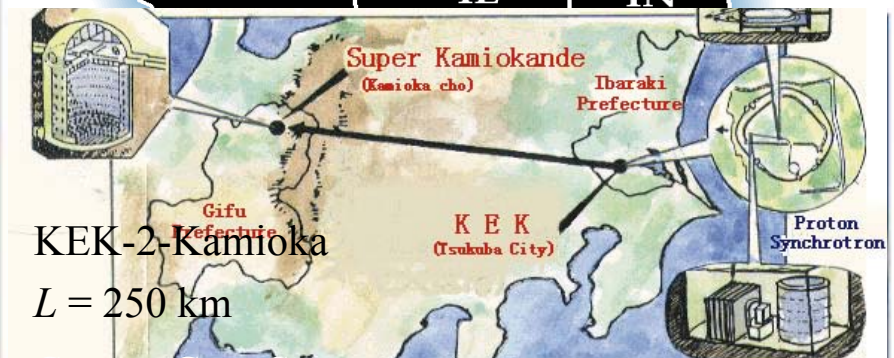
MINOS:
200

scientists, 23
universities &
laboratories

Hiba Qassir dreams of making movies. She's ambitious and precocious enough. At 18, she's taught herself how to edit video and sound on a computer, and has her sights set on directing gripping social and psychological dramas.

But if the movie business doesn't work out, that's OK. She has other dreams: perhaps to become a cop or a pilot. Or maybe a suicide bomber.

"Martyrdom is the shortest way to heaven, and the history



Reproduce Atmospheric Effect With Controlled Accelerator Beam

"Thank
Goodness Earth
is Round" – A.
Zichichi

Fire chiefs in tinder-dry Southern California, faced with lean budgets while more people squeeze into the region, are starting to rethink long-standing policies on ordering mass evacuations in a wildfire, debating whether it may be wiser in some situations to let residents stay and defend their homes.

"We don't have enough resources to put an engine at every house in harm's way," said Ventura County Fire Chief Bob Roper. "We figure, if people are going to stay, maybe they can become part of the solution."

Borrowing from tactics used in Australia for nearly two decades, top officials from fire

Freeman, chairman of Fire-scope.

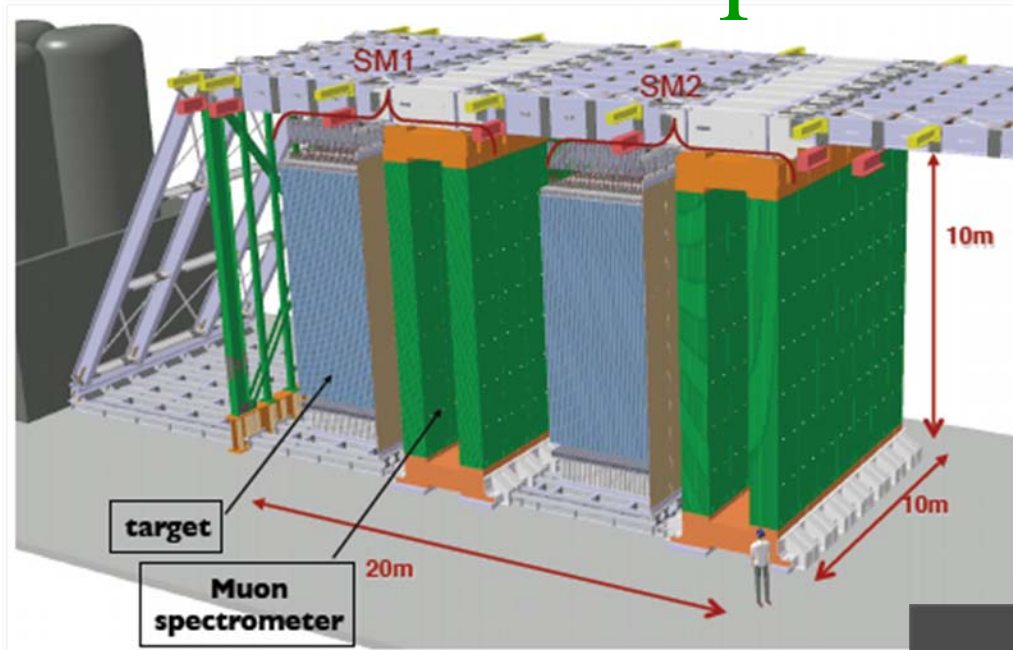
Roper acknowledges that building consensus for the program will be difficult and could take several years. But he hopes that eventually the entire state will follow stay-and-defend guidelines.

"This is a paradigm shift," he said. "We can't do it overnight."

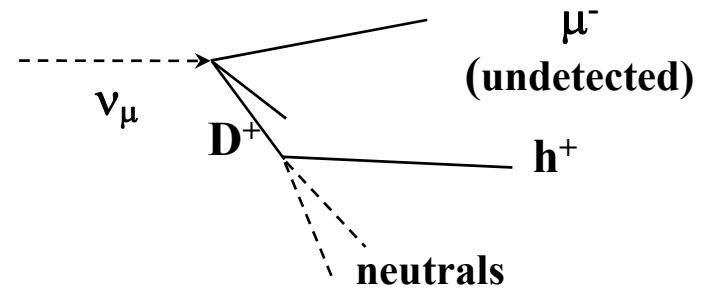
Roper has been holding [See Wildfires, Page A13]

Near Detector
measures flux
Far Detector
observes
oscillations

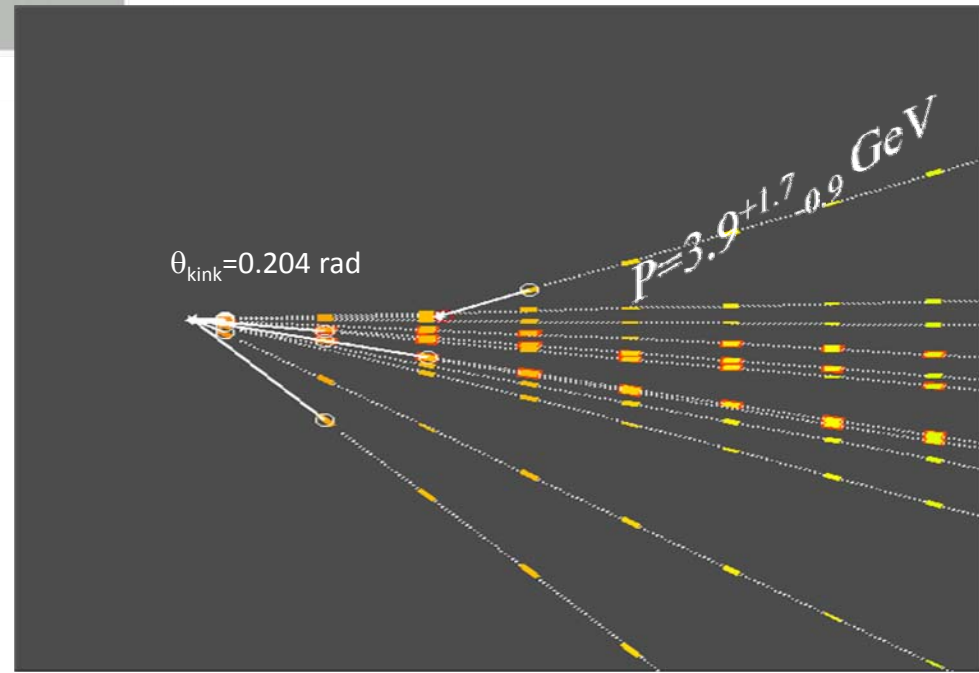
Opera

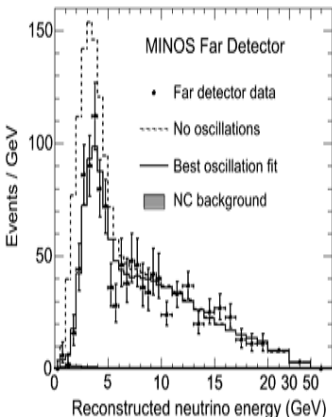


- Total target mass 1.2 kton
- 2 super modules:
 - Spectrometer: 22 RPC planes in B field (1.5T), 6 Drift tube planes
 - Target: 27 lead emulsion brick walls, alternated with scintillator planes



- Recorded $\sim 2 \times 10^{19}$ POT 2008
- After 5 year exposure
 - 22.5×10^{19} POT
 - 10-15 ν_τ (depending on Δm^2)
 - fewer than 1 BG





Tribune photo by Alex Garcia
"We all thought we were going to be rich," Fernando Chavarin says of the agave craze.

Energy-dependent deficit of neutrinos

"Where did they go?" — *Pier Oddone*
 By *Oscar Avila*
 Tribune foreign correspondent

AHUALULCO, Mexico — Te-

MINOS Experiment: Neutrinos do Oscillate

By **Phillip Rosenthal**

Tragedy struck after a series of mysterious "unintentional dis-ruptions," a Federal Emergency Management Agency spokeswoman called it—stemmed from a FEMA contractor's installation of the state's Emergency Alert System satellite receiver in Springfield as part of a nationwide upgrade.

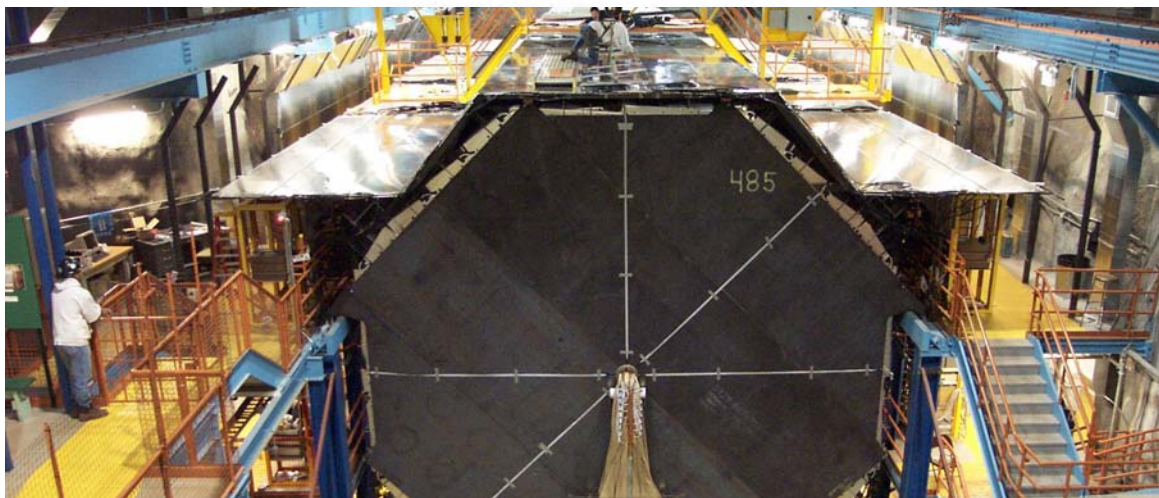
Rather than President Bush's "unintentional dis-ruptions," a Federal Emergency Management Agency spokeswoman called it—stemmed from a FEMA contractor's installation of the state's Emergency Alert System satellite receiver in Springfield as part of a nationwide upgrade.

Everything from local public safety to music stations in Richmond, Va., and Cleveland. While the interrupted morning drive-time broadcasts proved the Illinois system worked, the fact that what's known as an Emergency Action Notification, or EAN—the highest level of EAS alert, indicating an emergency message is coming from the White House—could be relayed mistakenly to

advertently picked up a closed-circuit test between receivers in Richmond, Va., and Cleveland. While the interrupted morning drive-time broadcasts proved the Illinois system worked, the fact that what's known as an Emergency Action Notification, or EAN—the highest level of EAS alert, indicating an emergency message is coming from the White House—could be relayed mistakenly to

override stations was a bit of a jolt, sending engineers scrambling at the affected outlets throughout Illinois and in adjacent media markets such as St. Louis. Compounding the error, an actual presidential code, minus any audio explanation, was sent rather than a lesser alert or a notification of a systems test of

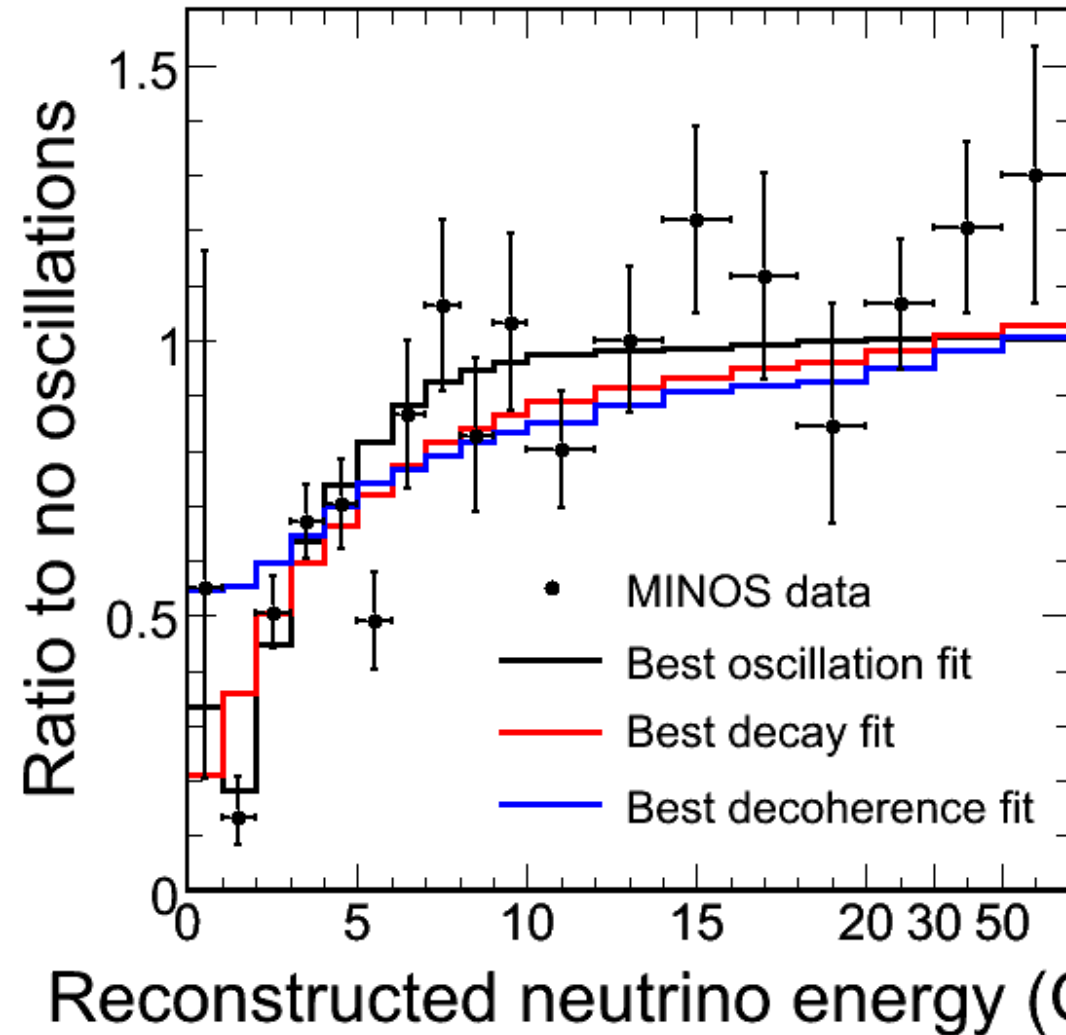
PLEASE SEE EMERGENCY, PAGE 18



World's most precise oscillation

Neutrino Physics transitions from discovery to precision measurements.

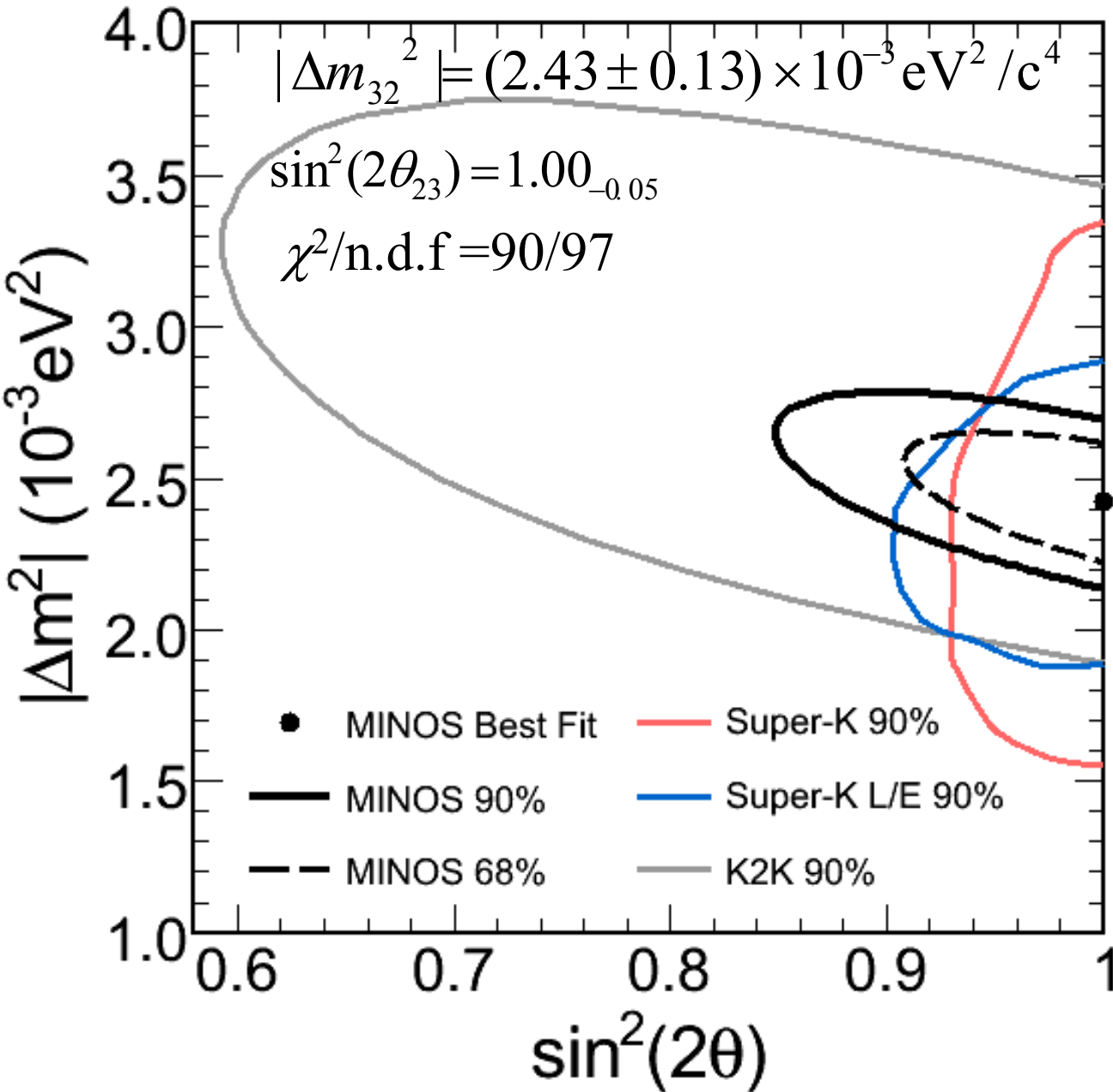
MINOS Measures ν_μ Disappearance



Observed 848 events

Expect 1060 ± 60
events if no oscillations

- Neutrino decay
 - ❖ V. Barger et al., Phys. Rev. Lett. 82 2640, 1999
 - ❖ Disfavored at 3.7σ
- Quantum decoherence of neutrino wave packets
 - ❖ G. L. Fogli et al., Phys. Rev. D67 093006, 2003
 - ❖ Disfavored at 5.7σ



MINOS
 Oscillation
 Hypothesis
 Fit

“Fair
and
Balanced”

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SCIENCE
Updated: 4-04-06 11:58am ET


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Physicists Lose Some Neutrinos, Gain Some Information


Monday, April 03, 2006
By Sara Goudarzi

 LIVE SCIENCE.

Somewhere between Illinois and Minnesota, the federal government lost some **neutrinos**.

No matter. These invisible **elementary particles** are ubiquitous in the universe.

PHOTOS

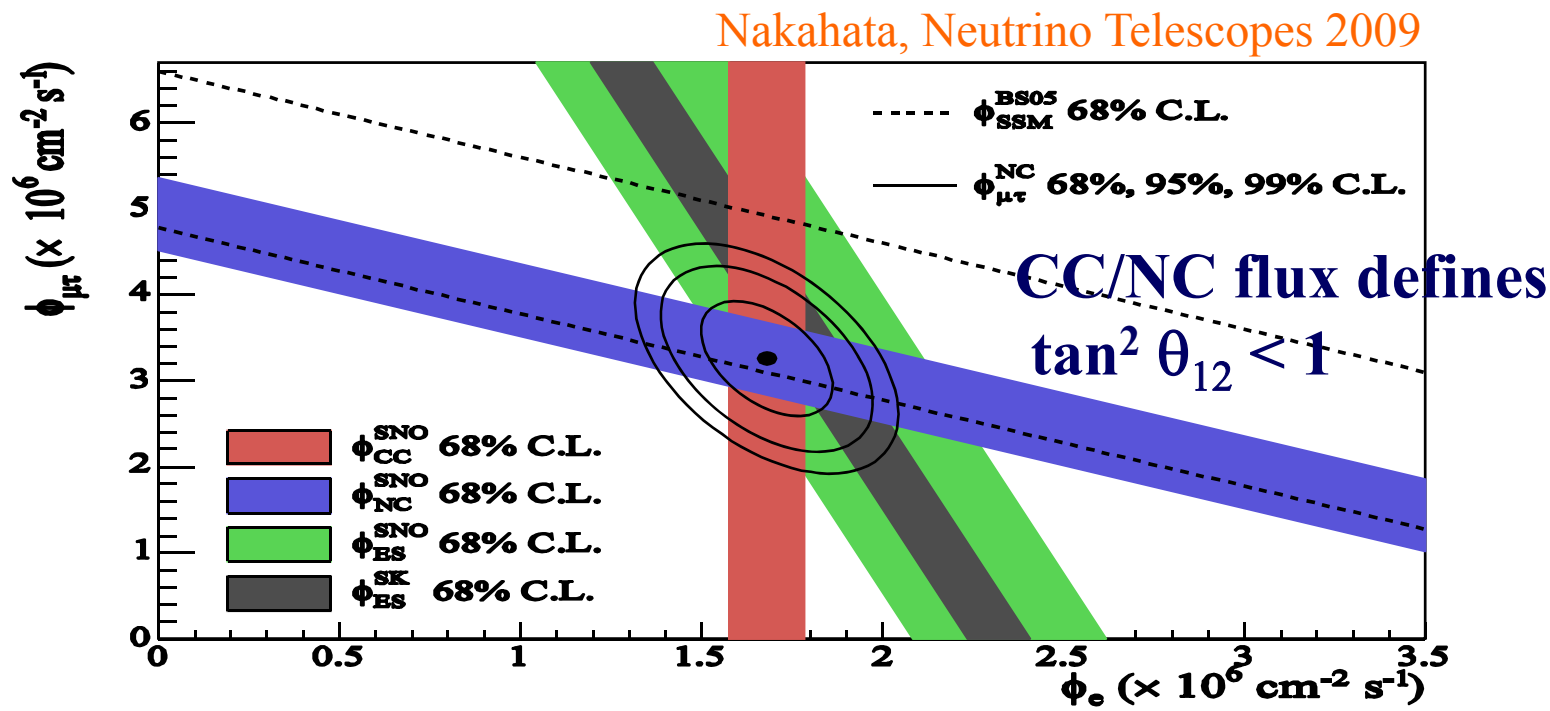


Click image to enlarge

GAZETTE EXCLUSIVE

LMA is solution, Sun shines on

Data favor MSW effect, suggests mass hierarchy $m_1 > m_2$



SLOW START

After 30 yrs, KamLAND and SNO weigh in

GAZETTE QUEBEC BUREAU

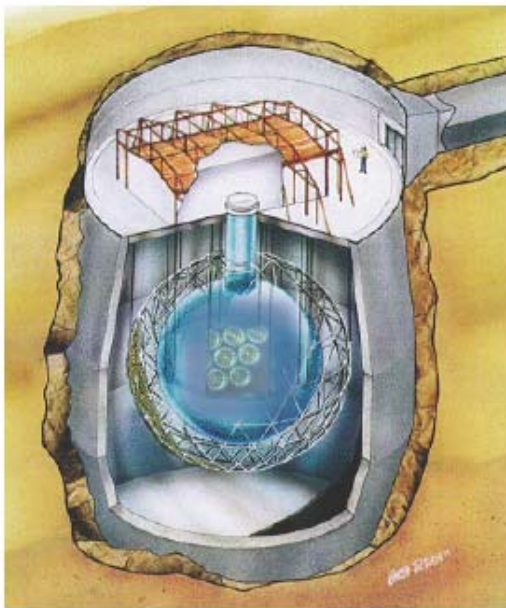
QUEBEC - The province's new enhanced driver's licences, which will act as official identification for crossing the border into the United States, are proving to be a tough sell.

In the first 3 1/2 months of the program only 11,000 enhanced licences - which have computer identity chips that can be read by border guards - have been issued, The Gazette has learned.

For the enhanced licence program to reach even about

SNO Phase III

ICHEP08



Three ways to see Solar neutrinos:

$$\nu_x + e^- \rightarrow \nu_x + e^- \quad (\text{Elastic scattering})$$

$$\nu_e + d \rightarrow p + p + e^- \quad (\text{Charged Current})$$

$$\nu_x + d \rightarrow p + n + \nu_x \quad (\text{Neutral Current})$$

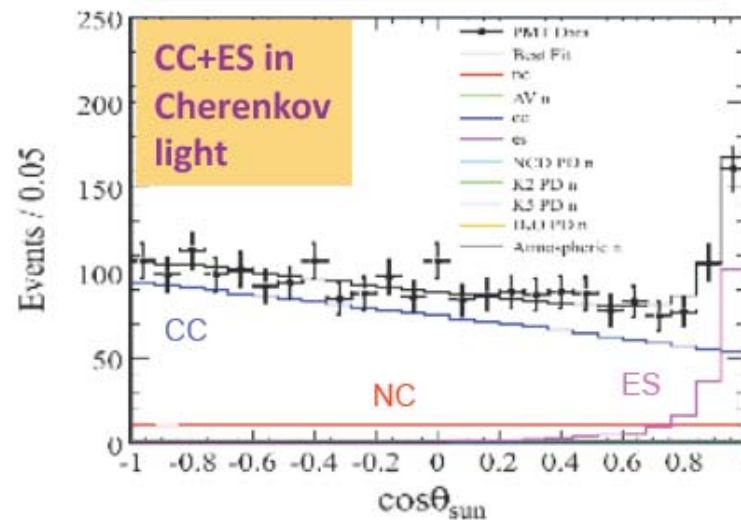
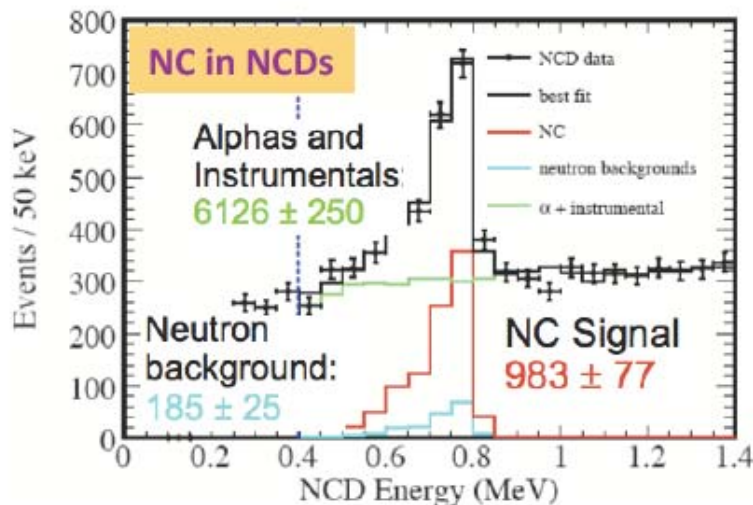
Three ways to see neutron:

$$n + d \rightarrow t + \gamma + 6.25 \text{ MeV} \quad (\text{Pure D}_2\text{O})$$

$$n + {}^{35}\text{Cl} \rightarrow {}^{36}\text{Cl} + \gamma + 8.6 \text{ MeV} \quad (\text{Salt})$$

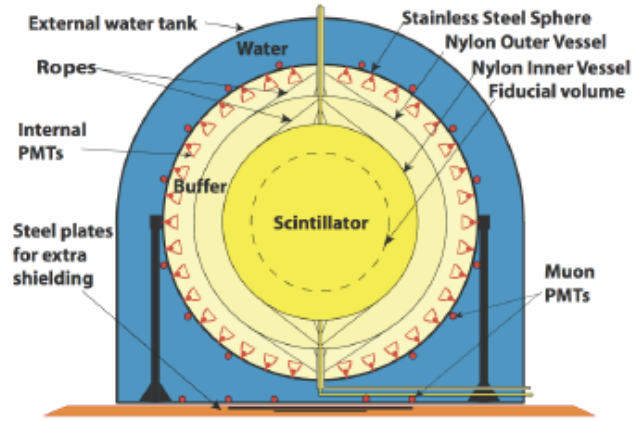
$$n + {}^3\text{He} \rightarrow p + t + 0.76 \text{ MeV} \quad ({}^3\text{He Counter})$$

NCDs break the correlation between CC and NC
Have different systematic errors



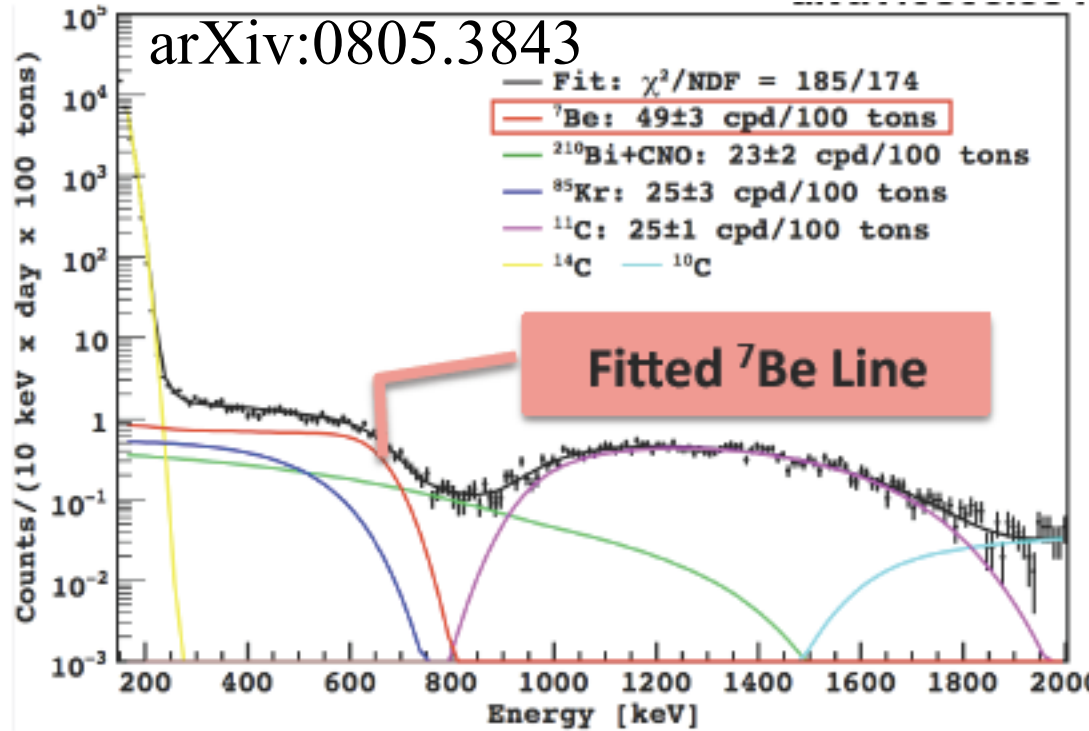
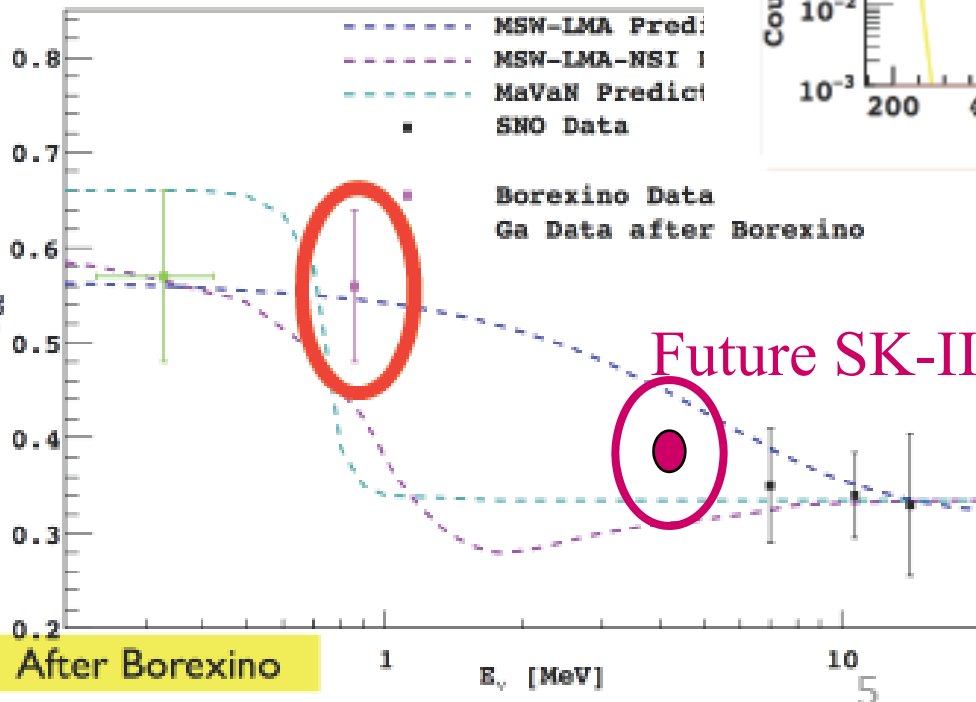
Can now fit separately

7



Uses ~300 tons of liquid scintillator to measure low energy Solar neutrinos.

Solar Neutrino Survival Probability



Borexino Data

49 ± 3 (stat) ± 4 (sys)

No Osc: 75 ± 4

MSW LMA

48 ± 4

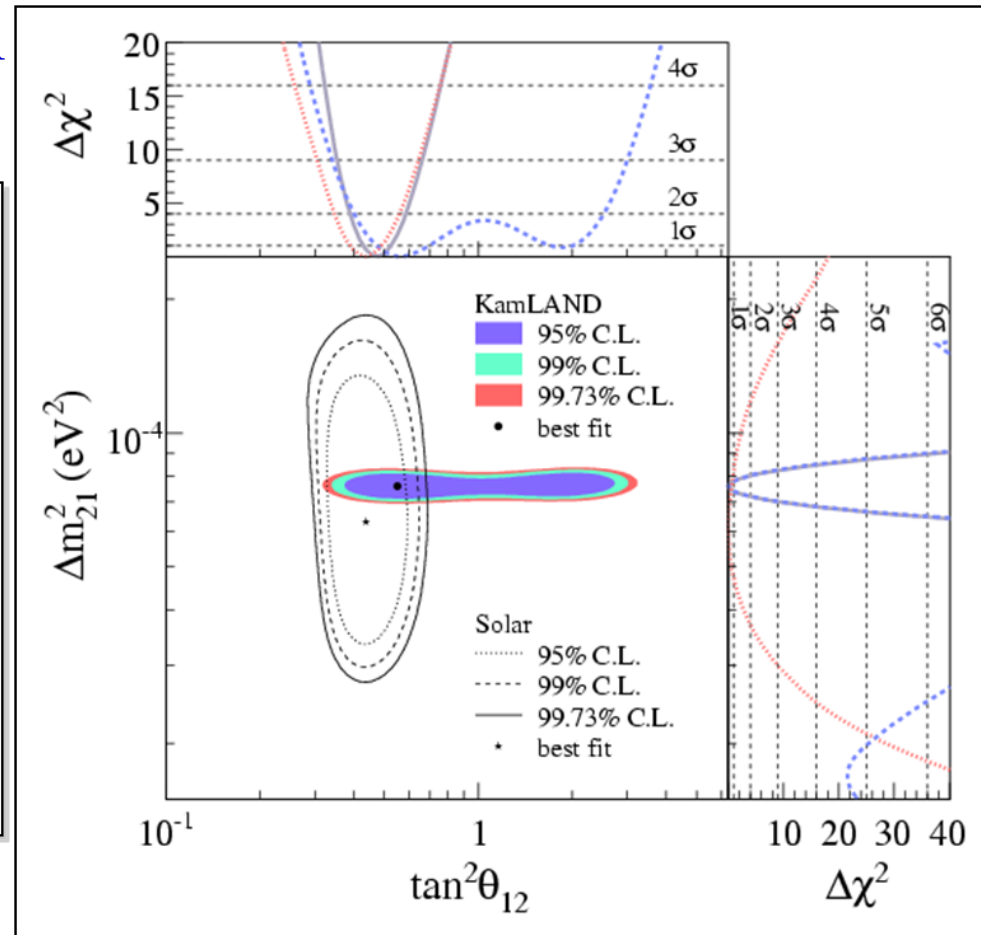
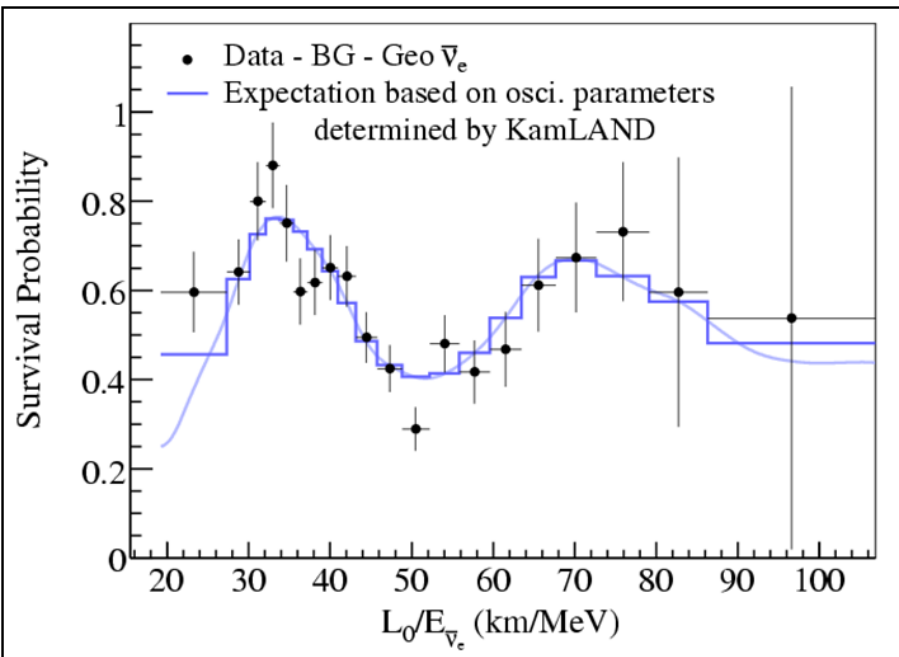
θ_{12} : KamLAND

Electron antineutrino disappearance from 55 nuclear reactors around Japan

Phys.Rev.Lett.100:221803,2008

KamLAND: $\tan^2 \theta_{12} = 0.56^{+0.10}_{-0.07}$ (stat.) $^{+0.10}_{-0.06}$ (syst.)

KamLAND+Solar: $\tan^2 \theta_{12} = 0.47^{+0.06}_{-0.05}$



SterileTribune

Wednesday • 50¢



MAY 27, 2009 • MINNEAPOLIS • ST. PAUL • "WHAT EXERCISE IS TO THE BODY, EMPLOYMENT IS TO THE MIND AND MORALS." THOREAU

N. KOREA TESTS MORE MISSILES

North Korea lashed out at the United States and reportedly launched three more short-range missiles. A3



Did LSND result at $\Delta m^2 \sim 1 \text{ eV}^2$ imply a 4th mass state?

• With the cancer growing and chemo to resume today, the teen was allowed to go home, despite county objections.

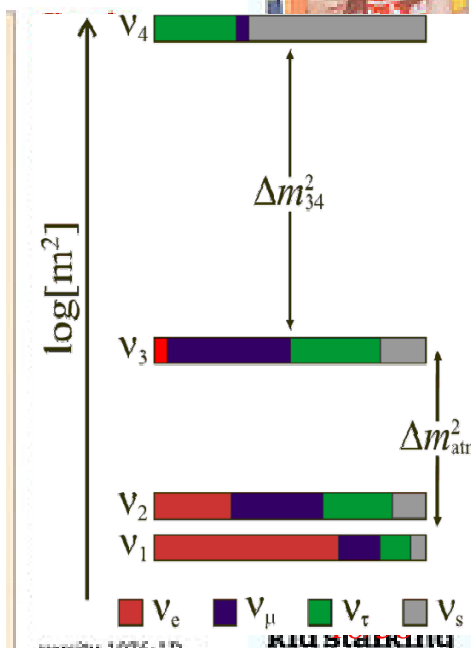
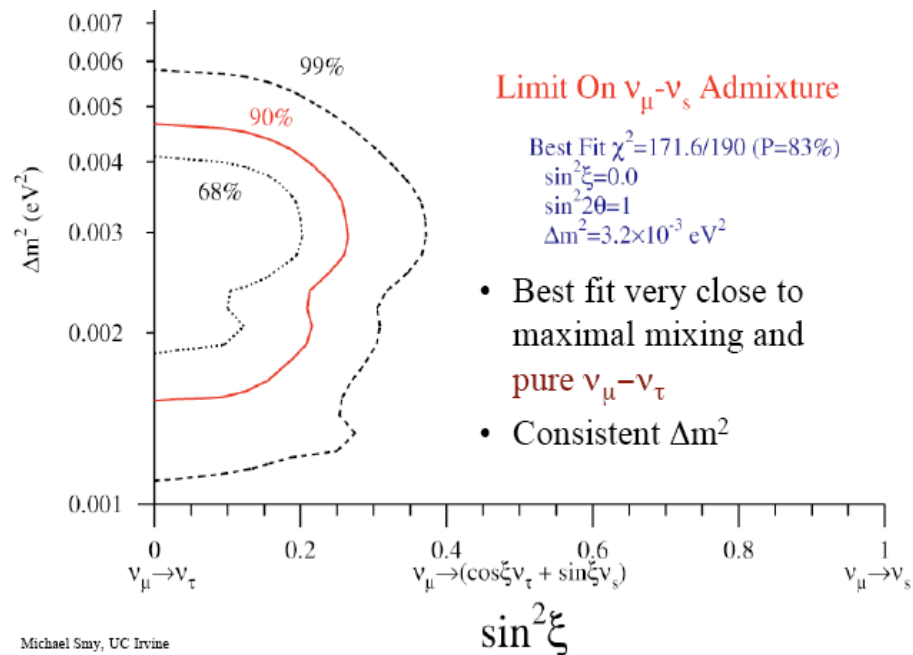
By JENNA BOSS and JACKIE CROSSBY
Star Tribune staff writers

NEW ULM, MINN. - Inside a Brown County courtroom Tuesday, Judge John Rosenberg looked directly at the parents of cancer-stricken Daniel Hauser and asked them both a blunt question.

"Do you believe that chemotherapy is necessary to save Daniel's life?"

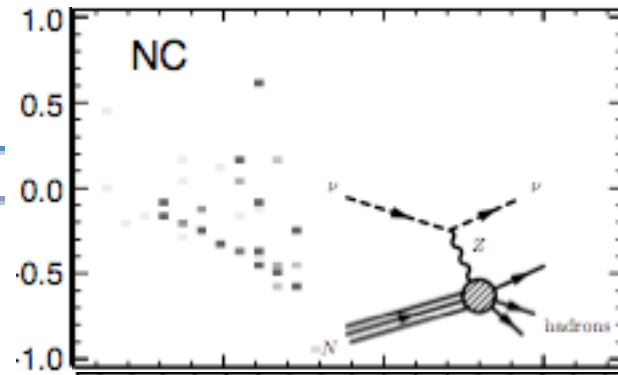
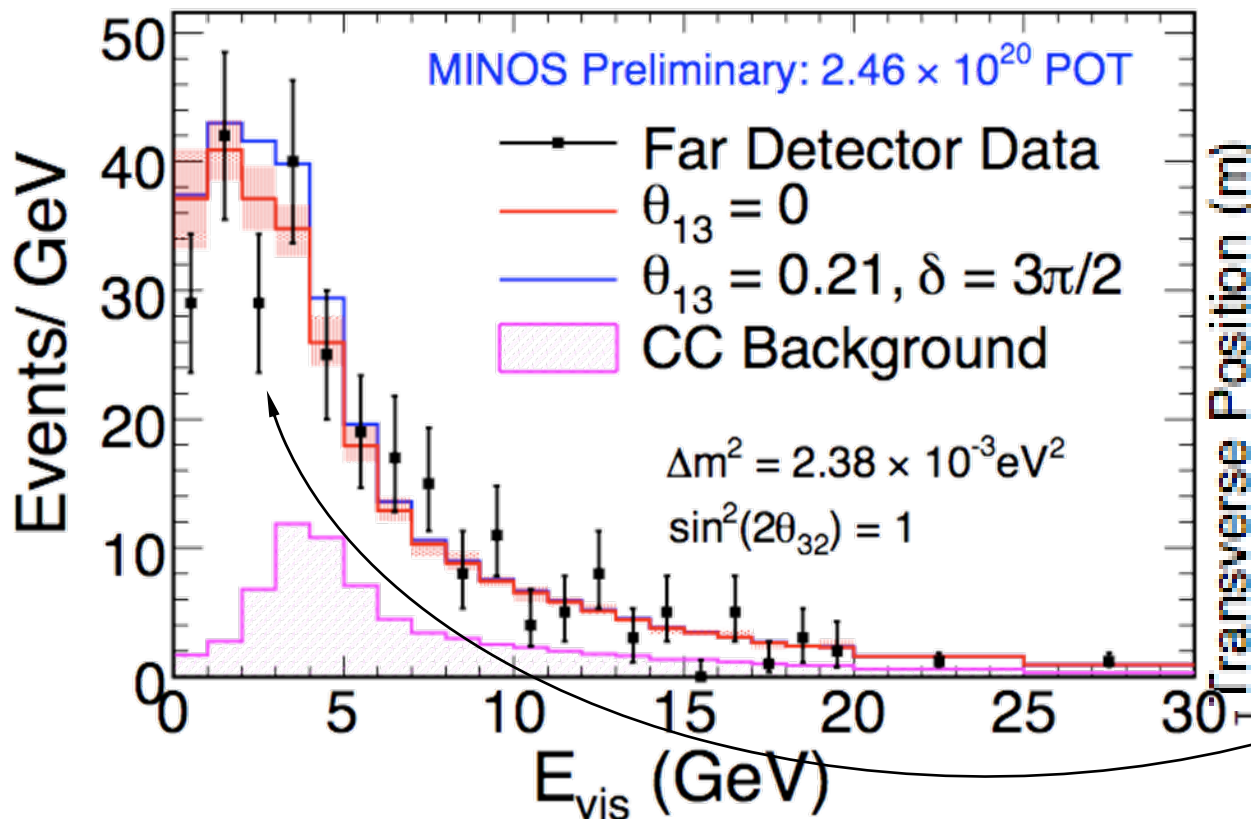
Colleen Hauser, the 13-year-old boy's mother, grabbed some tissues. "Yes, I do," she said. So did Anthony Hauser, Daniel's father.

the supreme court nomination NEW STATES IN OSC EXPTS?



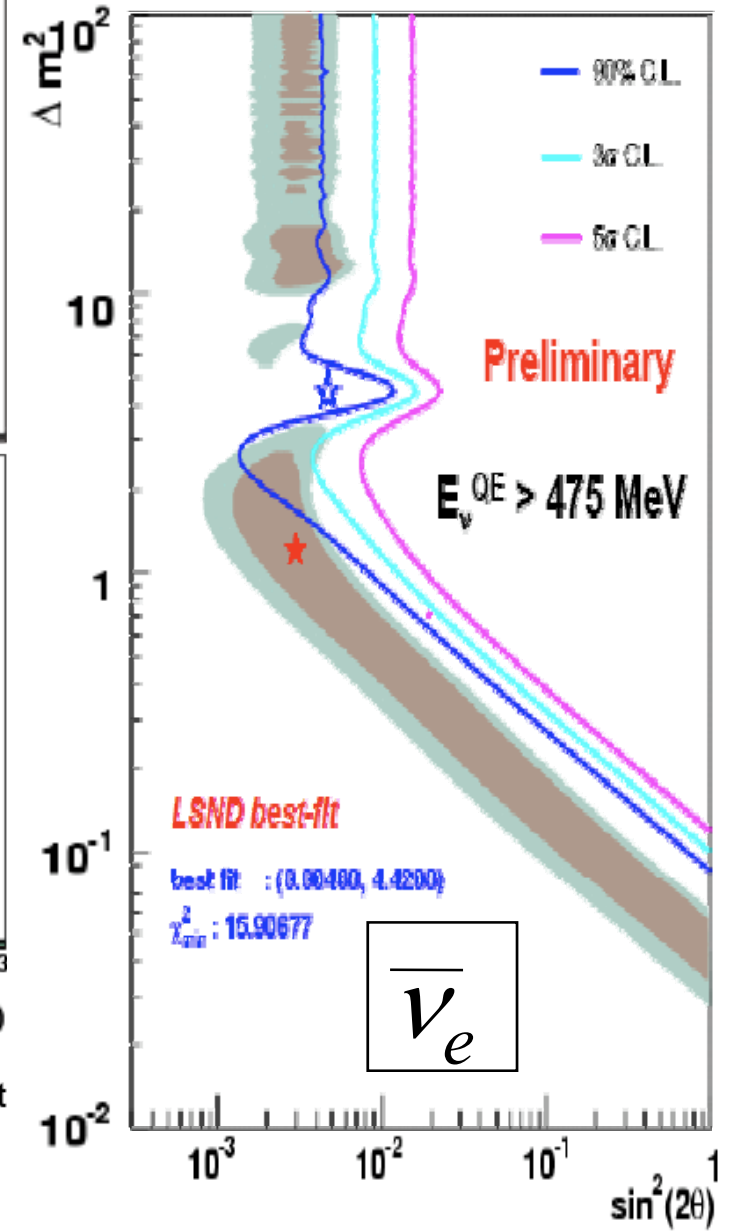
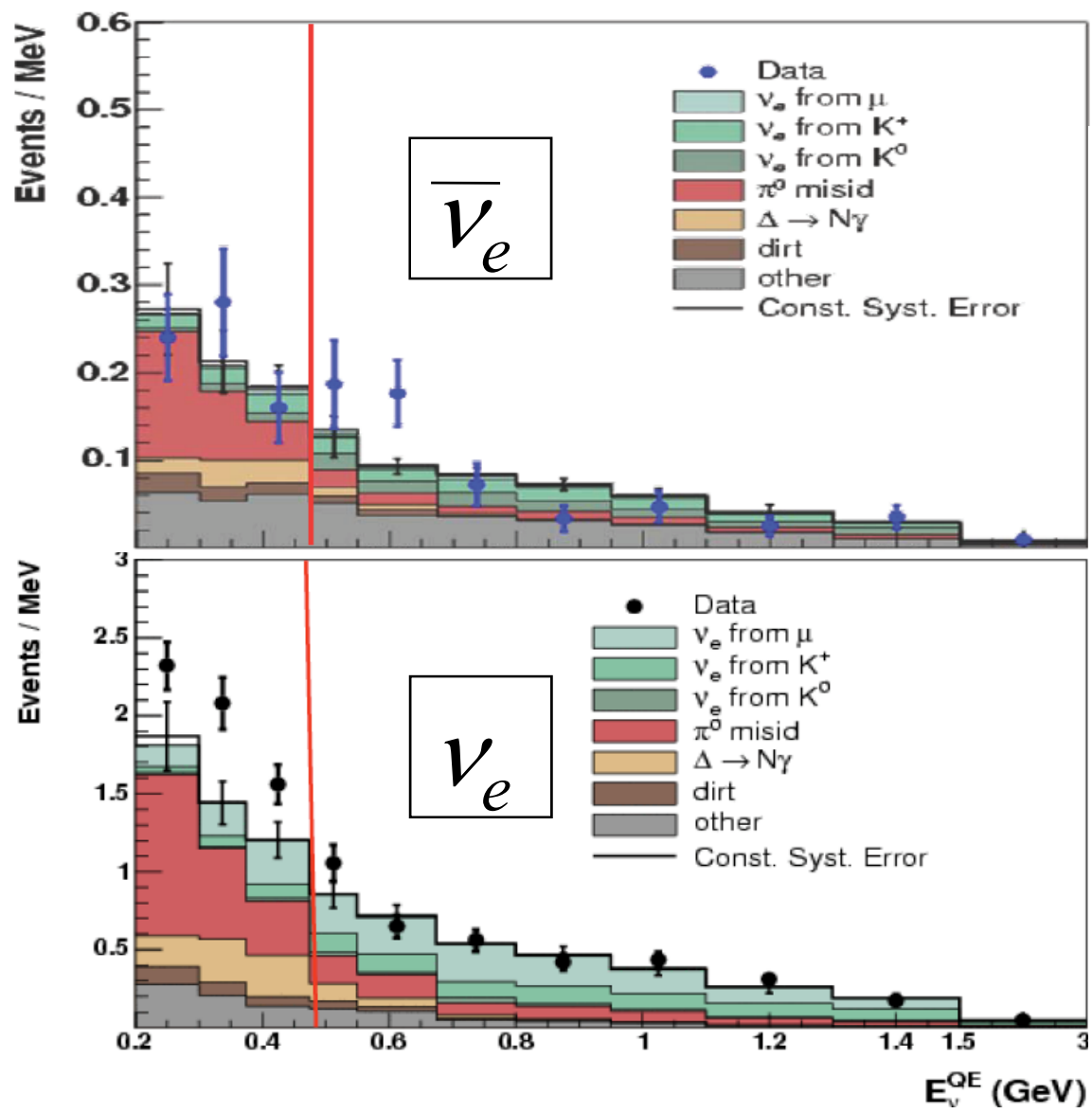
$\nu_\mu \rightarrow \nu_{\text{sterile}}$ Oscillations?

- Charged current – identifies flavor of interacting ν_μ
- Neutral current – inclusive, all “active” ν flavors interact



A $\nu_\mu \rightarrow \nu_{\text{sterile}}$ oscillation would result in a deficit of NC events at the Far Detector

MiniBooNE



A. A. Aguilar-Arevalo et al., Phys. Rev. Lett. 98, 231801 (2007);
 A. A. Aguilar-Arevalo et al., arXiv: 0812.2243, submitted to Phys. Rev. Lett

The CP-Violating Globe

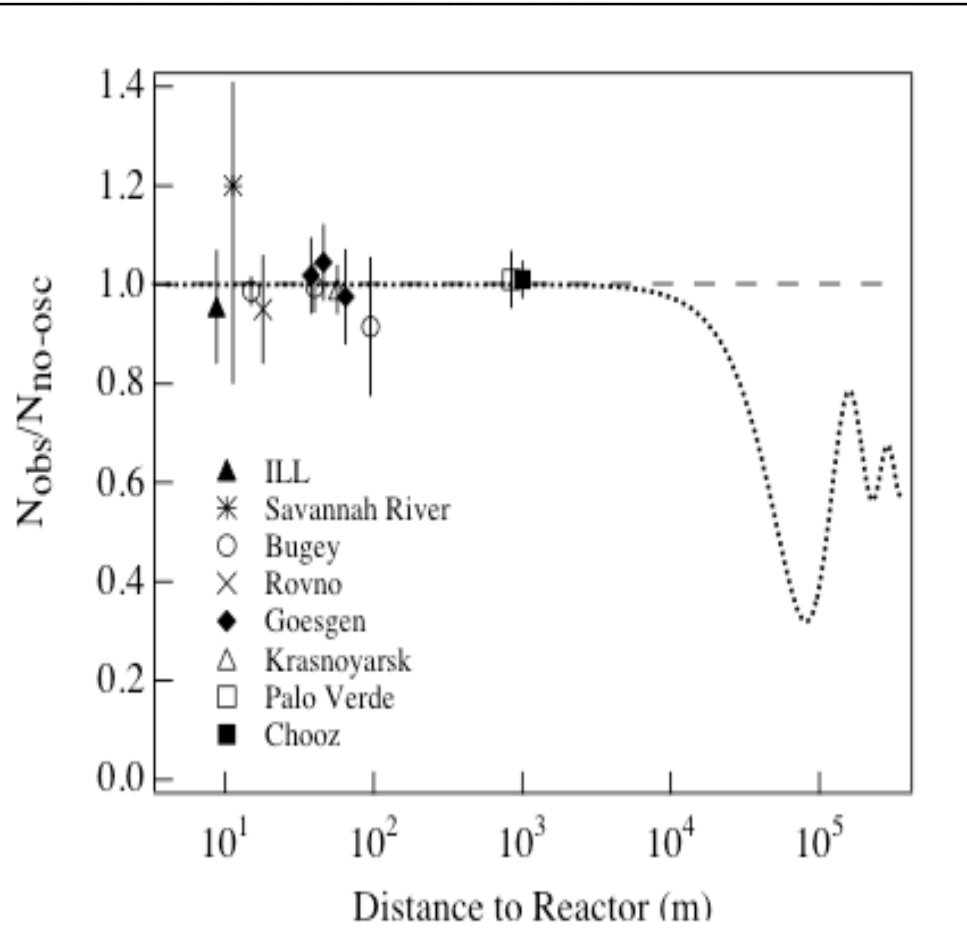
WEDNESDAY, MAY 27, 2009

No hint of rarest transition $\nu_{\mu} \rightarrow \nu_{\tau}$

Must find $\theta_{13} > 0$ to study CP Violation

WASHINGTON — Introducing Sonia Sotomayor yesterday as his first Supreme Court nominee, President Obama relished telling her up-from-poverty life story and highlighting her history-making ethnic roots. But he stressed that he picked her because of her intellect, judicial experience, and her determination "to approach decisions without any particular ideology or agenda."

Obama, however, was quickly challenged by critics who contended she was picked more for her personal story — and her gender and ethnicity — than her legal credentials. They buttressed their contention by noting that she recently joined a three-judge panel that ruled unanimously against white firefighters in a case that centers on racial disparity.



Search for θ_{13} via reactors (disappearance) or accelerators (appearance)

prime Court yesterday, selecting a woman who is a product of both New York City public housing and Ivy League universities, and who would become the first Hispanic and third female to serve on the high court.

Calling the 54-year-old Sotomayor "an inspiring woman," Obama praised her three-decade career as a corporate litigator, prosecutor, and federal appellate judge. But in his first chance to shape the closely divided high court, Obama also said her real-life experience filled his desire for a justice who has "a sense of compassion, an understanding of how the world works and how ordinary people live."

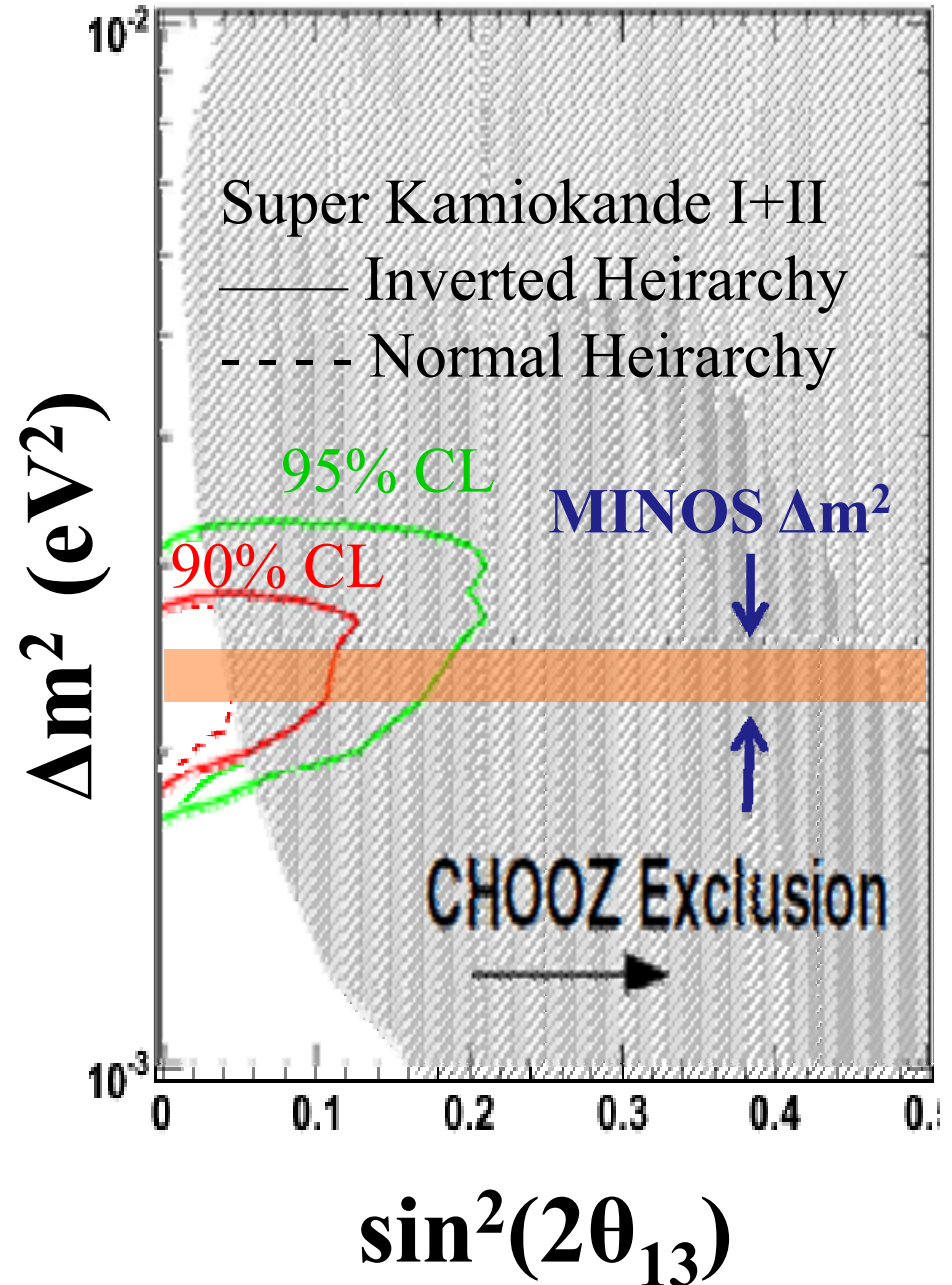
The president cited Sotomayor's humble upbringing, including her father's death when she was 9 years old, and the distance that would have affected her

θ_{13}

As yet, no
observation
CHOOZ reactor
experiment

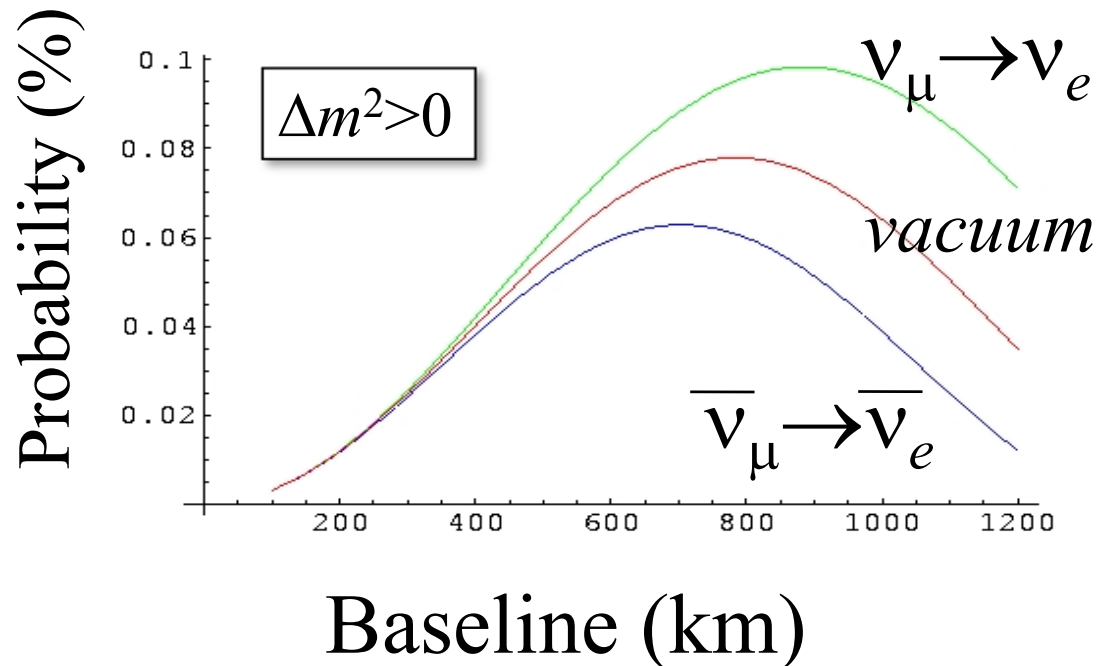
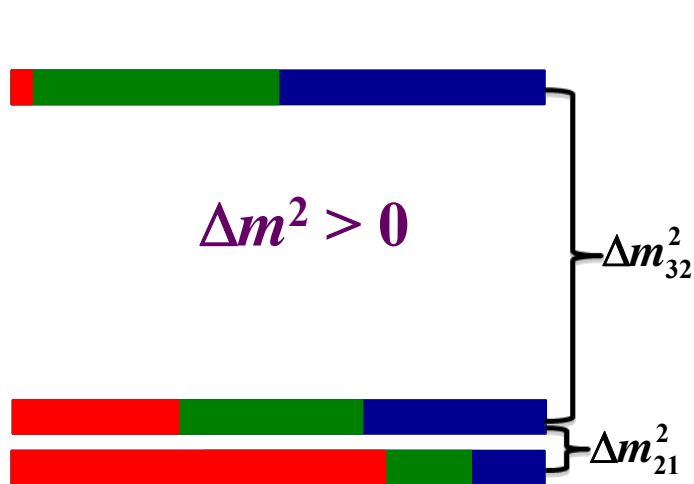
$$\sin^2(2\theta_{13}) < 0.15^\dagger$$

Eur.Phys.Journal
C27:331-374, 2003

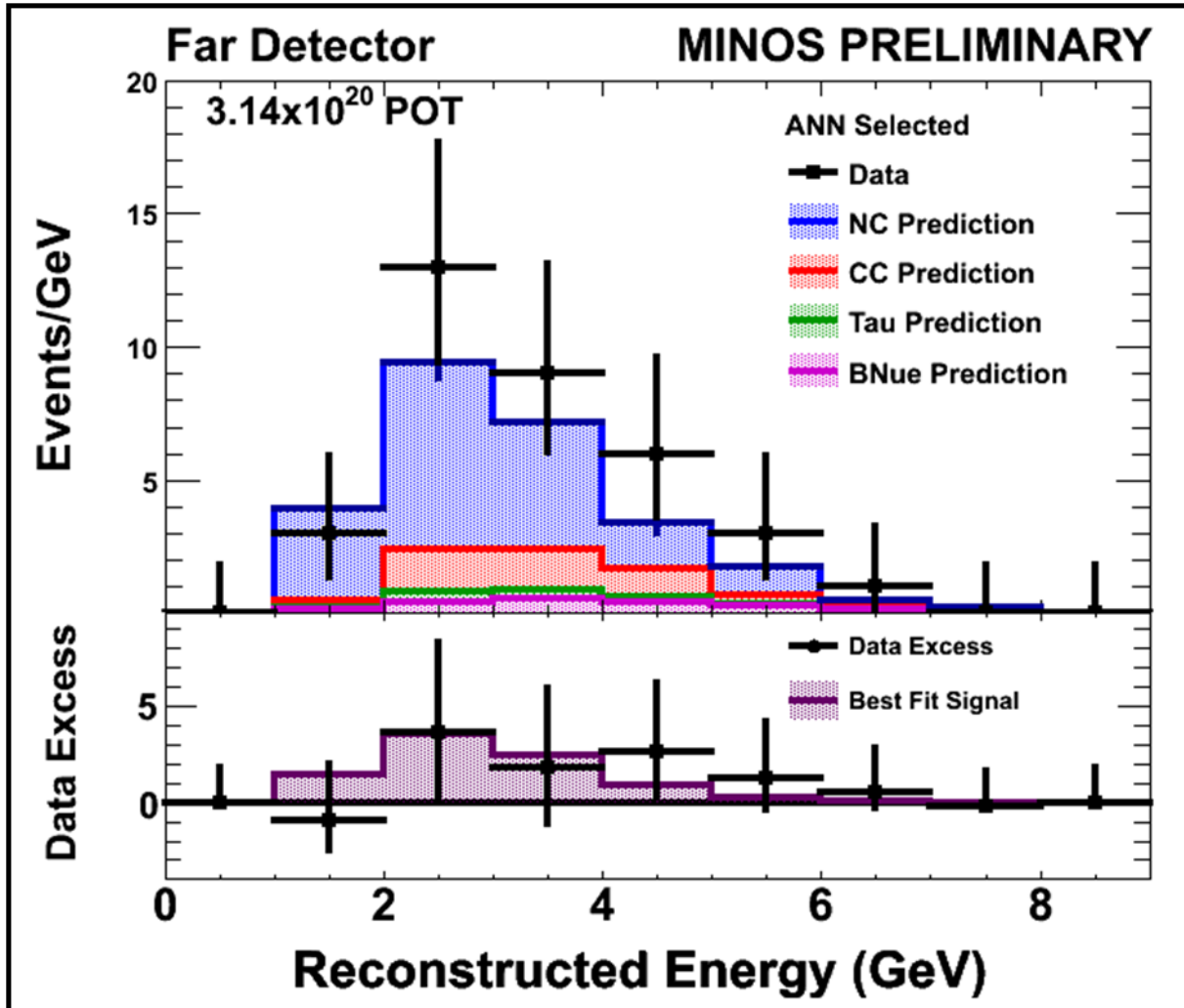


$$\begin{aligned}
P(\nu_\mu \rightarrow \nu_e) \approx & \underbrace{\sin^2(2\theta_{13}) \sin^2(\theta_{23}) \sin^2\left(1.27 \Delta m_{31}^2 \frac{L}{E}\right)}_{\text{atm } \Delta m^2} \\
& + \underbrace{\sin^2(2\theta_{12}) \cos^2(\theta_{23}) \sin^2\left(1.27 \Delta m_{21}^2 \frac{L}{E}\right)}_{\text{solar } \Delta m^2} \\
& + \underbrace{\sin(2\theta_{13}) \sin(2\theta_{23}) \sin(2\theta_{12}) \times}_{\text{atm } \Delta m^2} \\
& \sin\left(1.27 \Delta m_{31}^2 \frac{L}{E}\right) \sin\left(1.27 \Delta m_{21}^2 \frac{L}{E}\right) \cos\left(1.27 \Delta m_{32}^2 \frac{L}{E} \pm \delta_{CP}\right)
\end{aligned}$$

thanks to P. Vahle (William & Mary) for correct equation



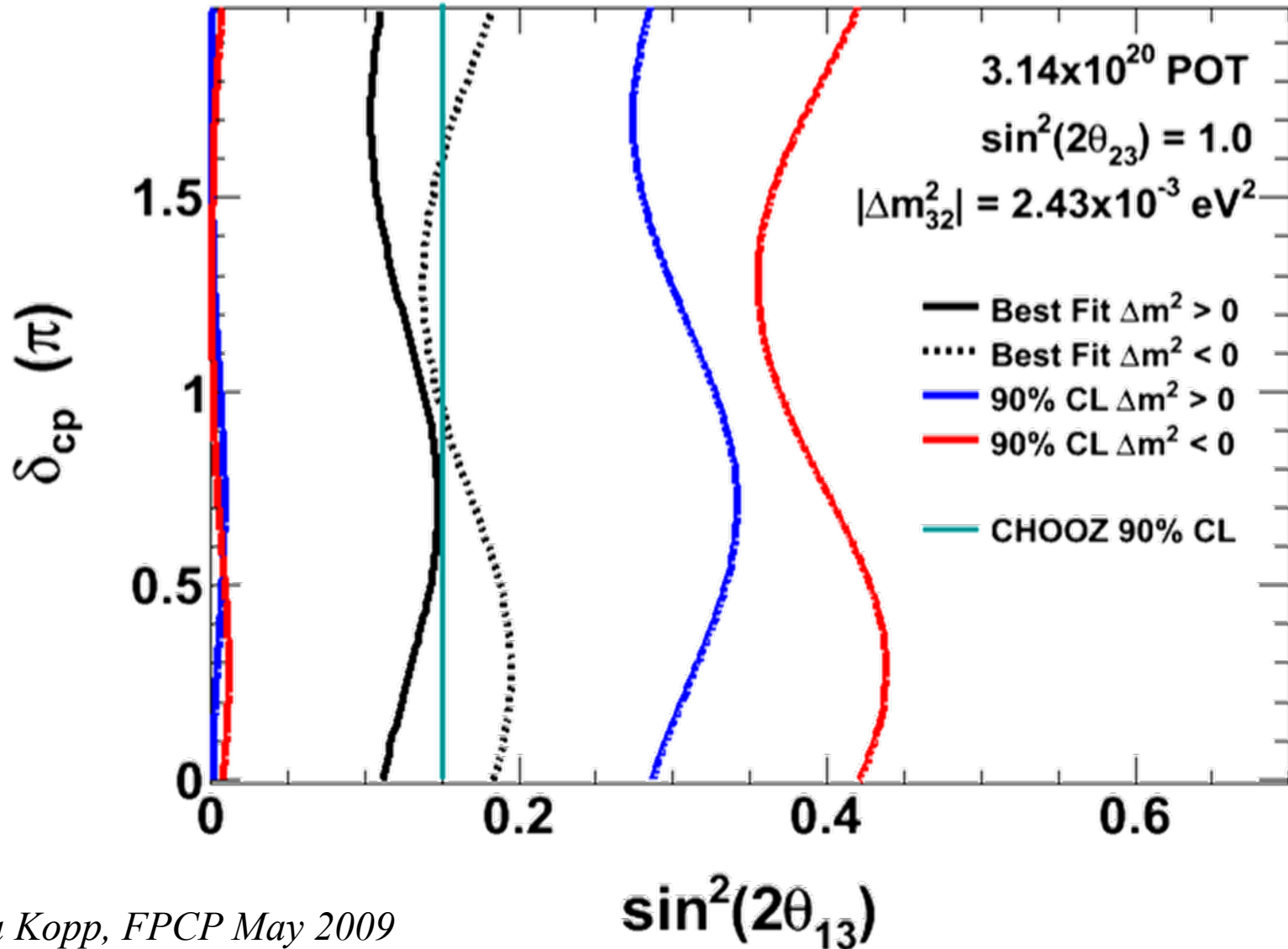
MINOS ν_e Appearance



- Expected background $27 \pm 5(\text{stat}) \pm 2(\text{syst})$ (mis-reconstructed showers, beam ν_e)
- Observed:
35 events
- Observed is 1.5σ over bckgd. expectation

**Will integrate
~8 x 10²⁰ POT
as of June 15!**

MINOS ν_e Appearance



“All the Nu’s
that’s fit to
print”

The Neutrino Nu’s

Late Edition

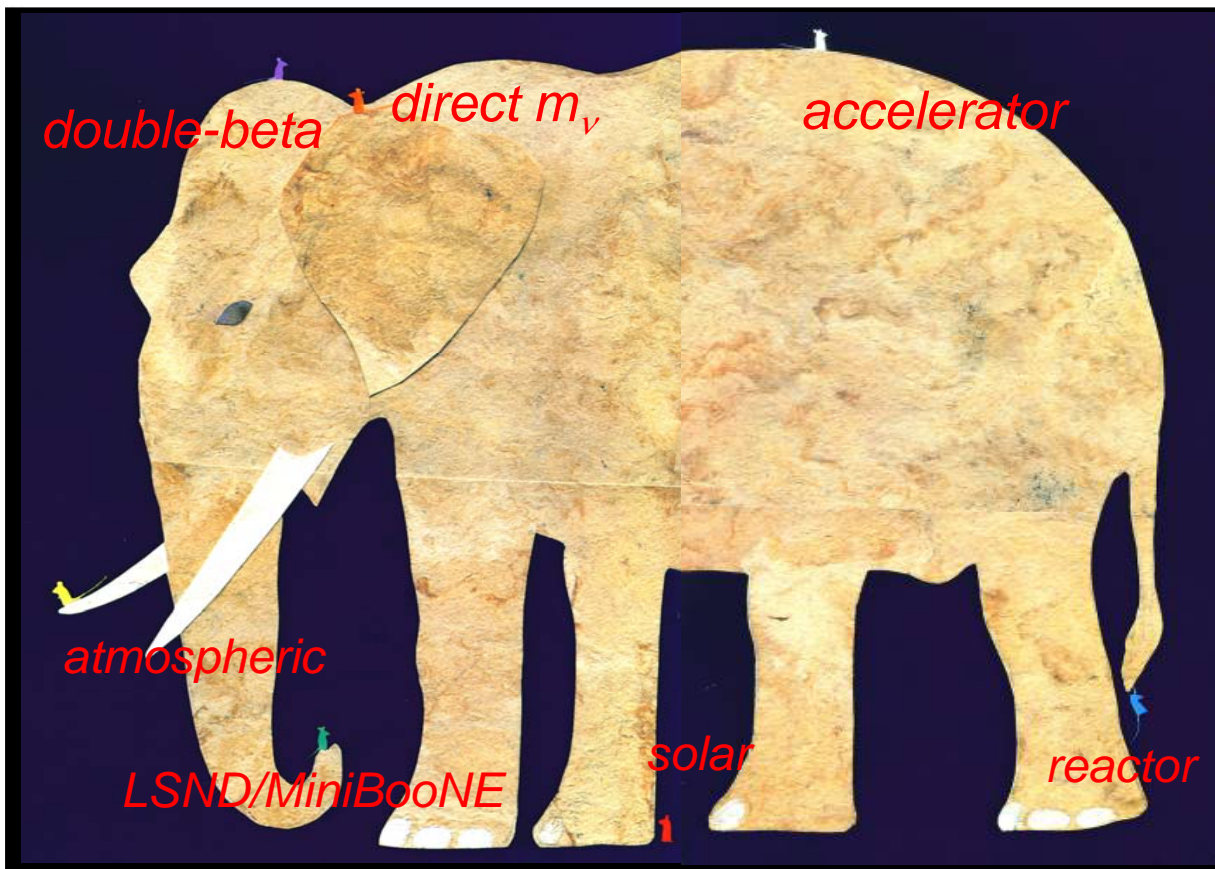
Today, mostly sunny, light winds, high 69. Tonight, increasing clouds, spotty showers late, low 56. Tomorrow, clouds, a little sun, milder, high 73. Weather map is on Page B14.

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\$1.50



CAN NEUTRINO CP EXPLAIN BARYON ASYMMETRY?

*Mixing like quarks, implications
beyond Standard Model*

By EDMUND L. ANDREWS and MICHAEL M. GRYNBAUM

WASHINGTON — The promise of lower interest rates and new federal efforts to stem the financial crisis failed to dispel the fear gripping Wall Street on Tuesday.

Stocks rose at the session's opening but soon began to fall, and the selling intensified during the afternoon, even after Ben S. Bernanke, the chairman of the Federal Reserve, all but pledged to cut interest rates by the end of the month. The Dow Jones industrial average plunged 508 points, or 5.1 percent, extending a slide of months that has erased a third of its value in a year. In the last five trading days alone, the Dow has lost 1,400 points.

With the flow of credit still tight, investors have fixated on the threat of a serious recession despite the increasingly urgent attempts by policy makers to buttress the markets. Deepening problems in the European banking industry have compounded fears of a worldwide downturn.

"The Fed is just plugging holes in the dam and the water keeps rushing over," said Michael T. Darda, chief economist at the research firm MKM Partners.

strongest indication to date that the Fed will cut rates.

Fed policy makers are scheduled to meet on Oct. 28 and 29, and investors had already been betting that the central bank would reduce the overnight federal funds rate by as much as one-half of a percent, to 1.5 percent. But many analysts predict the Fed may act before the next meeting, given the sprawling nature of the credit crisis.

In its latest tactic, the Fed announced on Tuesday morning a new program to buy up parts of the short-term financing market to unlock the flow of credit to businesses. The program, which is expected to begin soon, was the latest and potentially biggest in a series of unprecedented ef-

Continued on Page A23

World-Wide Effort to Interpret Nu Disappearance, Mass

By ADAM NAGOURNEY

Senators John McCain and Barack Obama debated for 90 minutes on Tuesday night before a nation in economic crisis, each

Mr. Obama placed the blame for the financial crisis on deregulation and the lack of fiscal discipline under President Bush

Experiments still pushing for CP Violation in Neutrinos

By ERIC SCHMITT

WASHINGTON — An investigation by the military has concluded that American airstrikes

the raid, and the American military, under Gen. David D. McKiernan, the top American

*Apologies to T_2 ,
 $\beta\beta_{0\nu}$, VHE
cosmic*

ANITA LIMITS GZK NEUTRINOS

Protons make energetic nu's on CMB

ANITA-I balloon flew for 35 days, data analysis is now complete

The California Supreme Court's decision Tuesday to uphold Proposition 8 and existing same-sex marriages left in place all rights for California's gays and lesbians except access to the label "marriage," but it provided little protection from future ballot measures that could cost gays and other minorities more rights, lawyers and scholars said Tuesday.

In a 6-1 ruling, the court said the November ballot measure that restored a ban on same-sex marriage was a limited constitutional amendment, not a wholesale revision that would have required a two-thirds vote of the Legislature to be placed before voters.

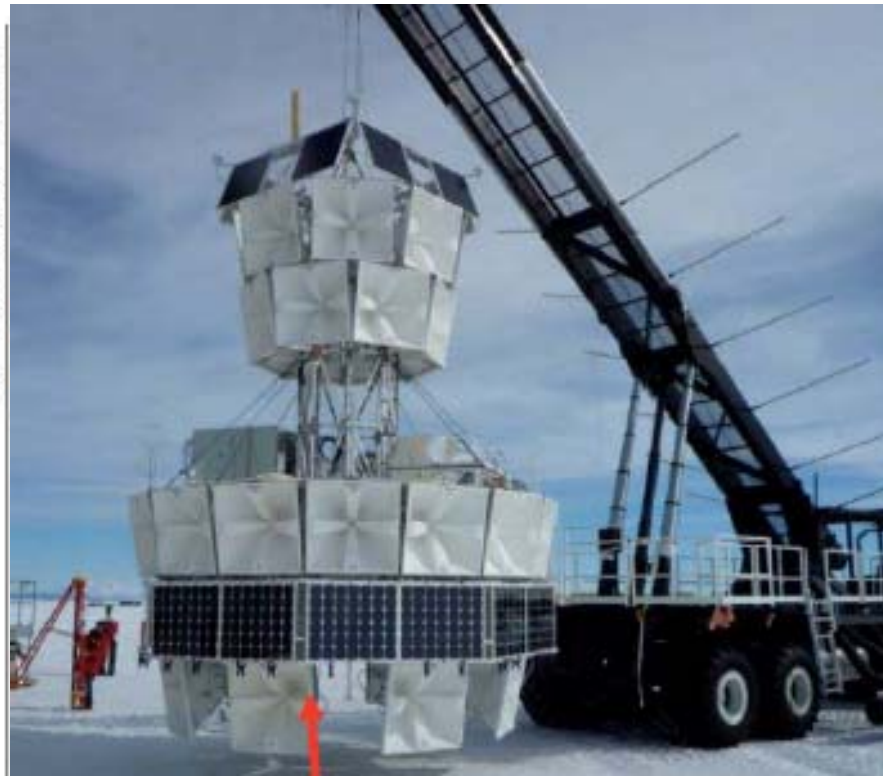
tutional right," George wrote.

UC Berkeley constitutional law professor Goodwin Liu said the ruling shows "the court continues to be very deferential to the processes of direct democracy in California."

In a separate, concurring opinion, Associate Justice Kathryn Mickle Werdegar noted some rights married couples have that domestic partners do not, and suggested that the state now has the duty "to eliminate the remaining important differences."

She agreed with the majority. [See Ruling, Page A12]

ANITA-II flight has even better live time, X5-10 GZK sensitivity



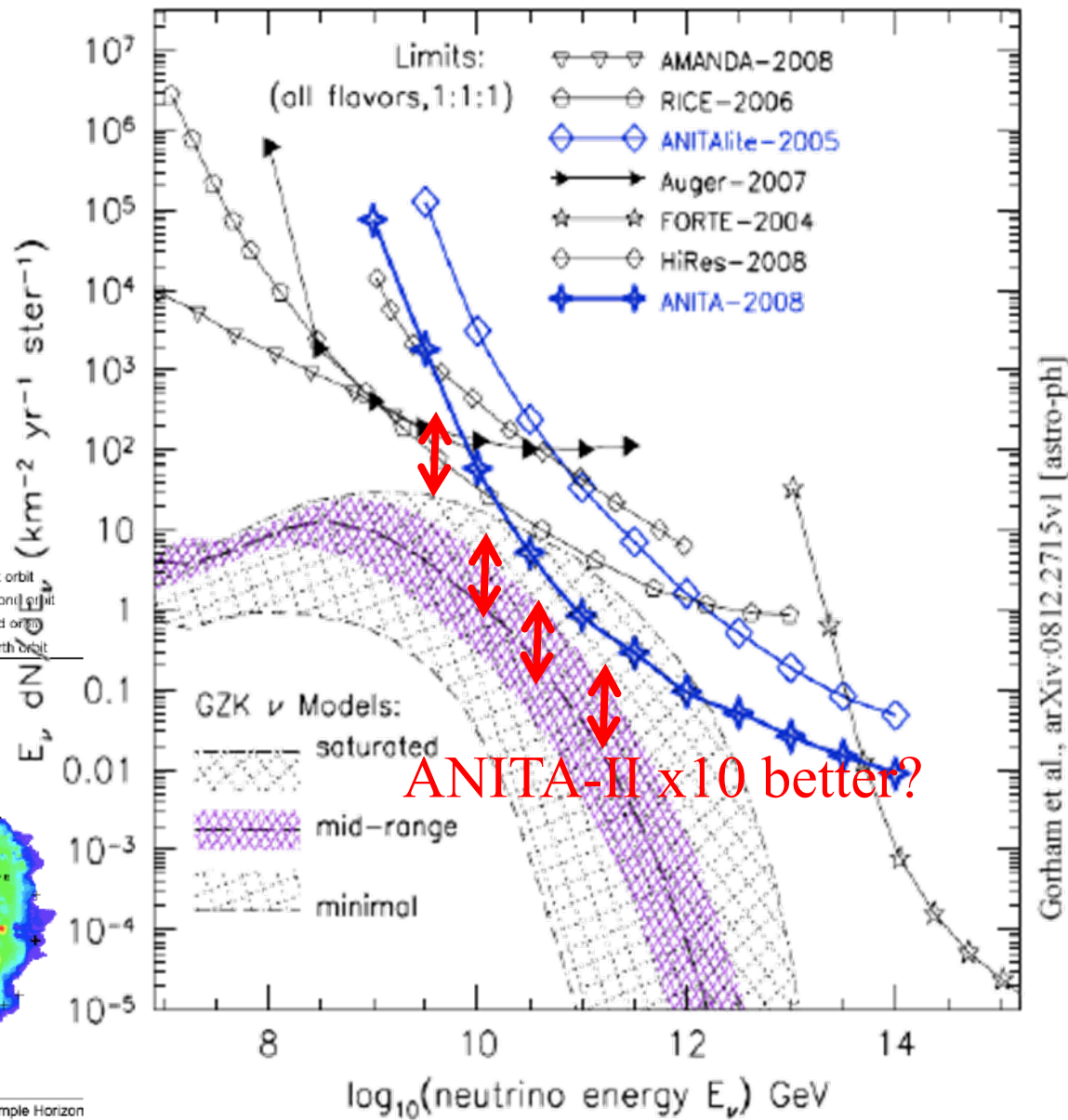
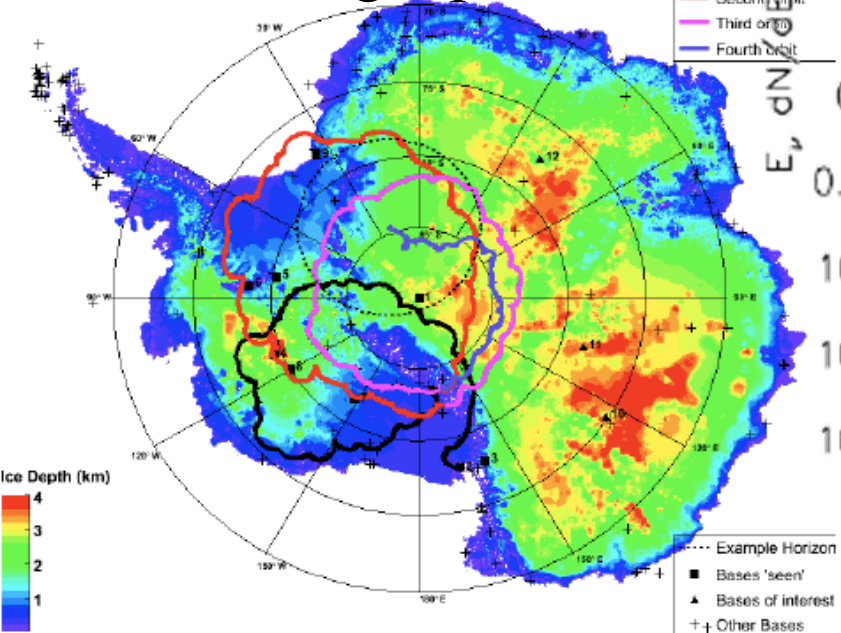
Cherenkov emission in radio band from particle shower in ice

mayor to the Supreme Court on Tuesday, President Obama tapped a veteran jurist whose humble upbringing and moderate-to-liberal record is unlikely to trigger an ideological battle in the Senate.

Sotomayor, 54, would be the first Latino on the court. Legal experts said that her narrowly written opinions resembled those of the justice she would replace, David H. Souter. She has not ruled squarely on controversial issues such as gay rights or abortion.

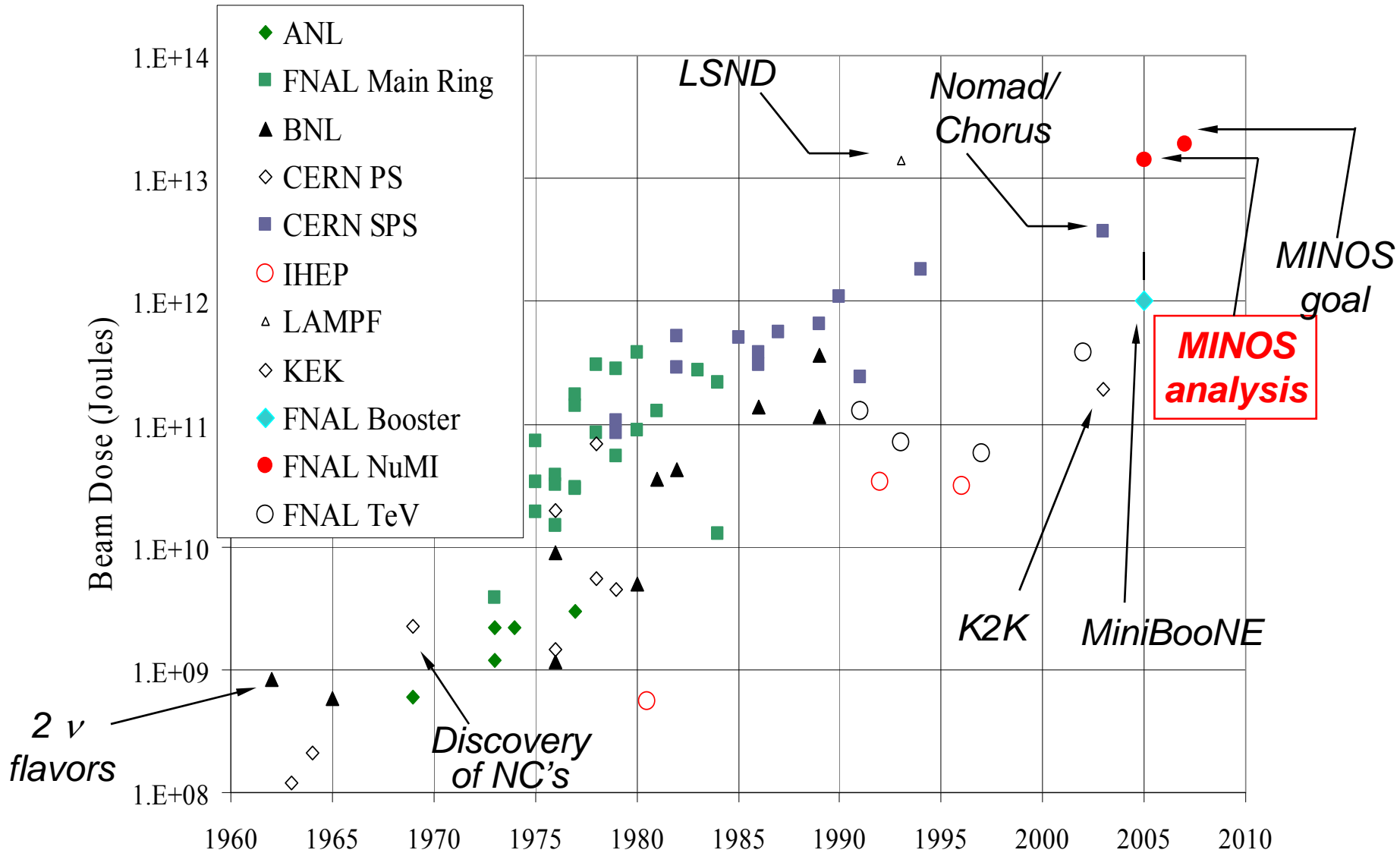
Standing with Sotomayor by his side in the East Room of the White House, Obama said, "I have decided to nominate an inspiring woman who I believe

ANITA-I flight path



AMANDA & ICE CUBE

Moore's Law for Neutrinos?



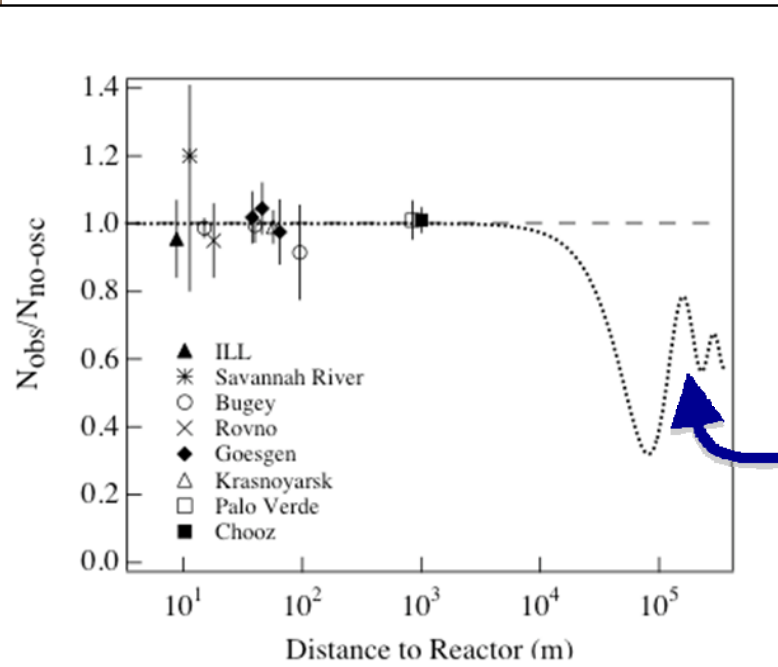
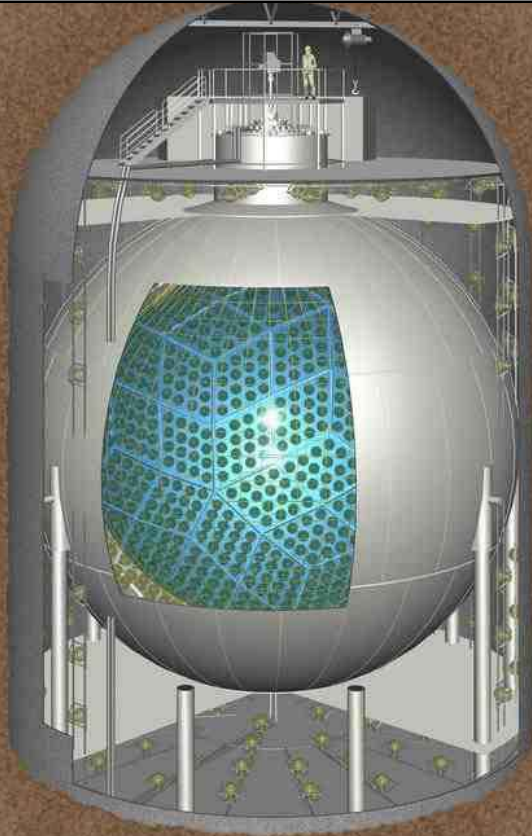
θ_{12} : KamLAND

Liquid Scintillator Detector



Experimental strategy: electron antineutrino disappearance from 55 nuclear reactors around Japan

$$P(\bar{\nu}_e \rightarrow \bar{\nu}_e); \cos^4 \theta_{13} \left(1 - \sin^2(2\theta_{12}) \sin^2 \frac{\Delta m_{12}^2 L}{4E} \right) + \sin^4 \theta_{13}$$



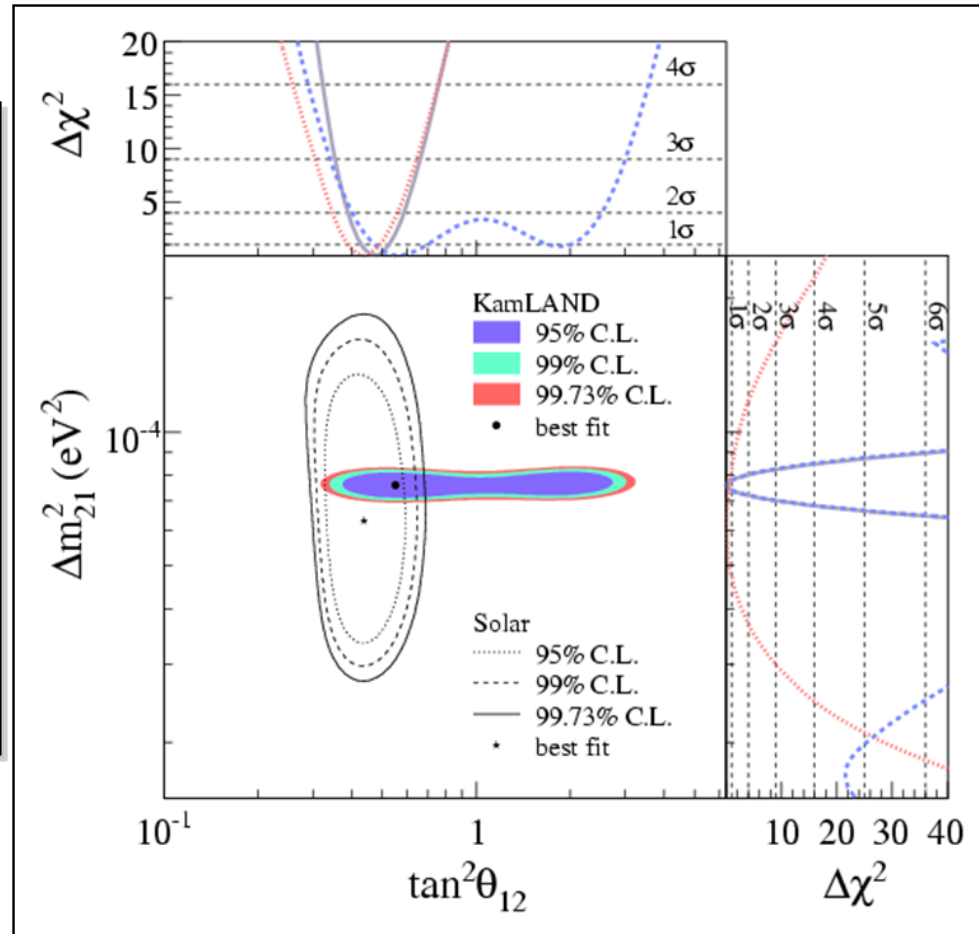
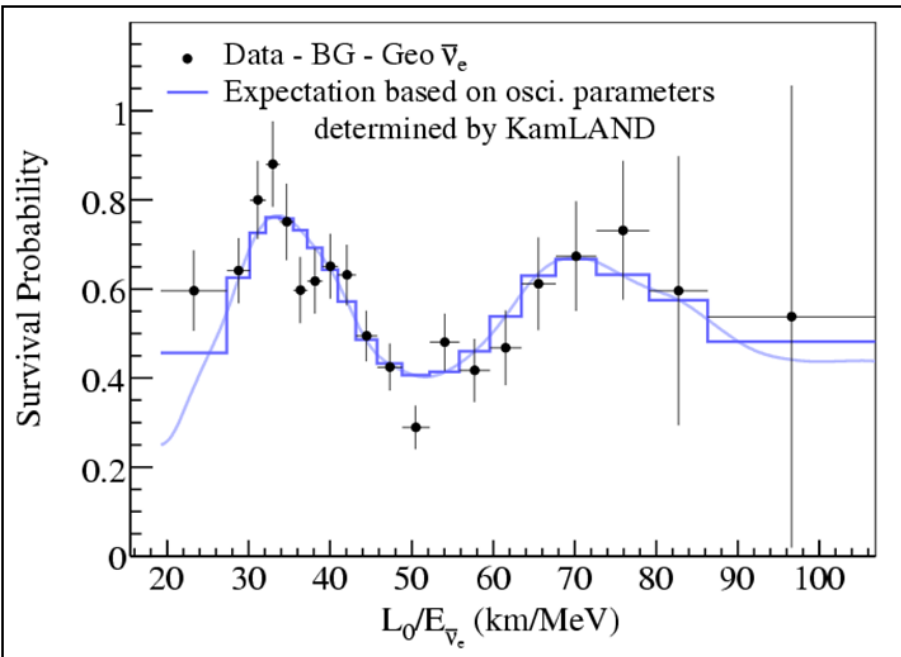
$\langle L \rangle = 180 \text{ km}$
 $\langle E \rangle = 4 \text{ MeV}$

KamLAND

KamLAND: $\tan^2 \theta_{12} = 0.56^{+0.10}_{-0.07}$ (stat.) $^{+0.10}_{-0.06}$ (syst.)

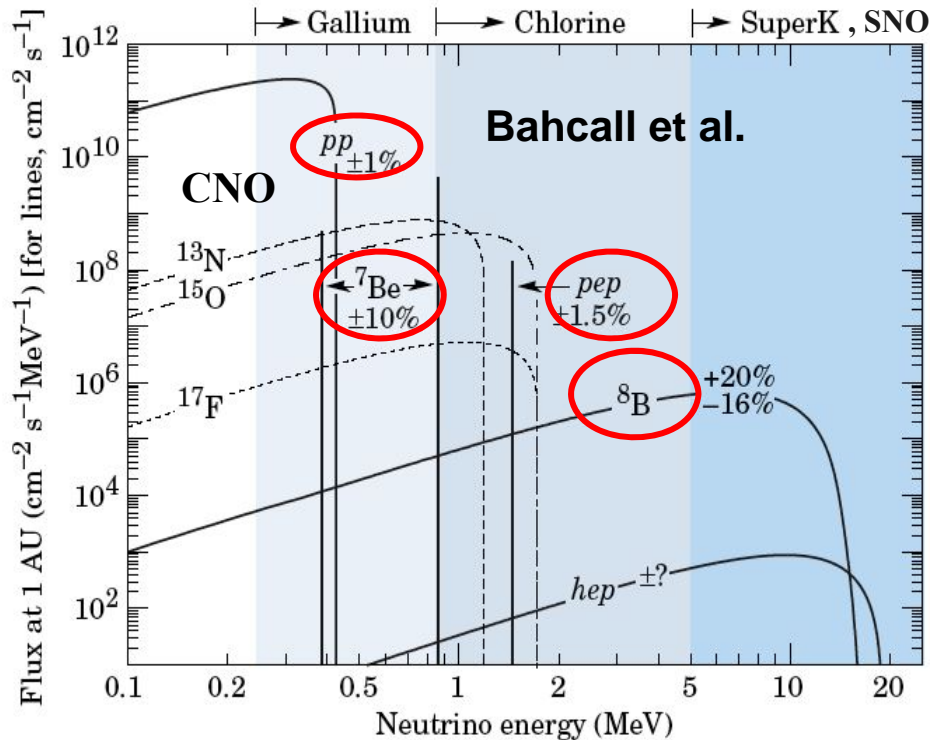
KamLAND+Solar: $\tan^2 \theta_{12} = 0.47^{+0.06}_{-0.05}$

Phys.Rev.Lett.100:221803,2008

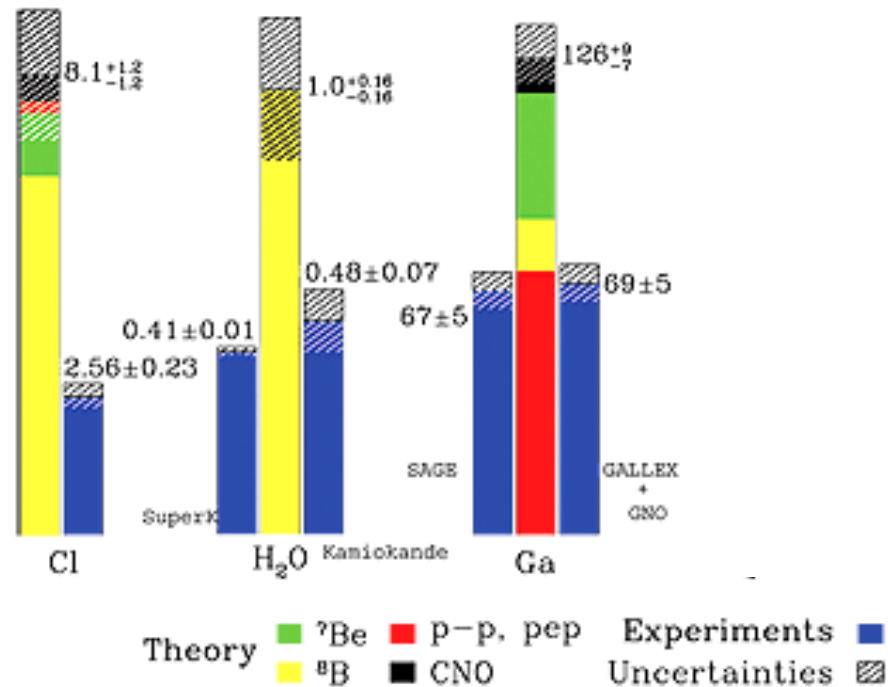


Solar Nu's Pre-2000

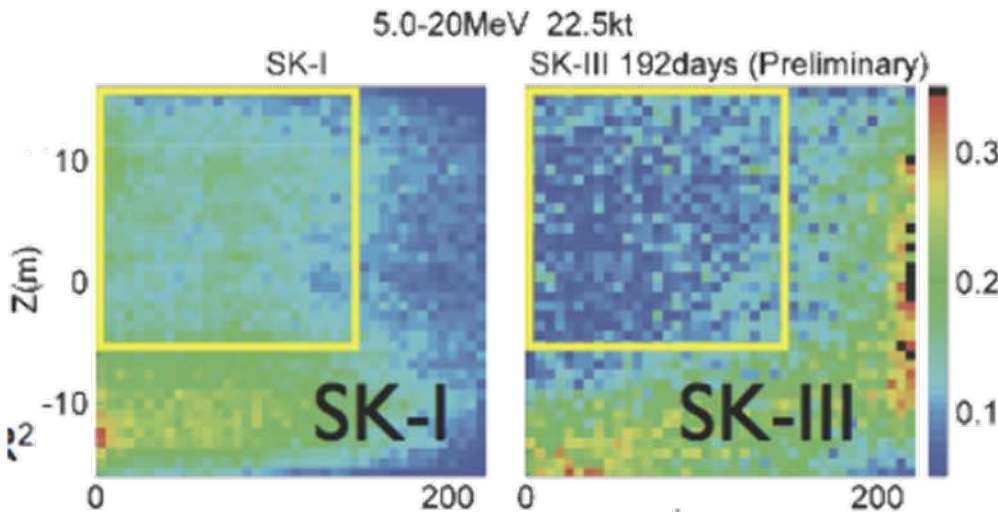
Solar Model Flux Calculations



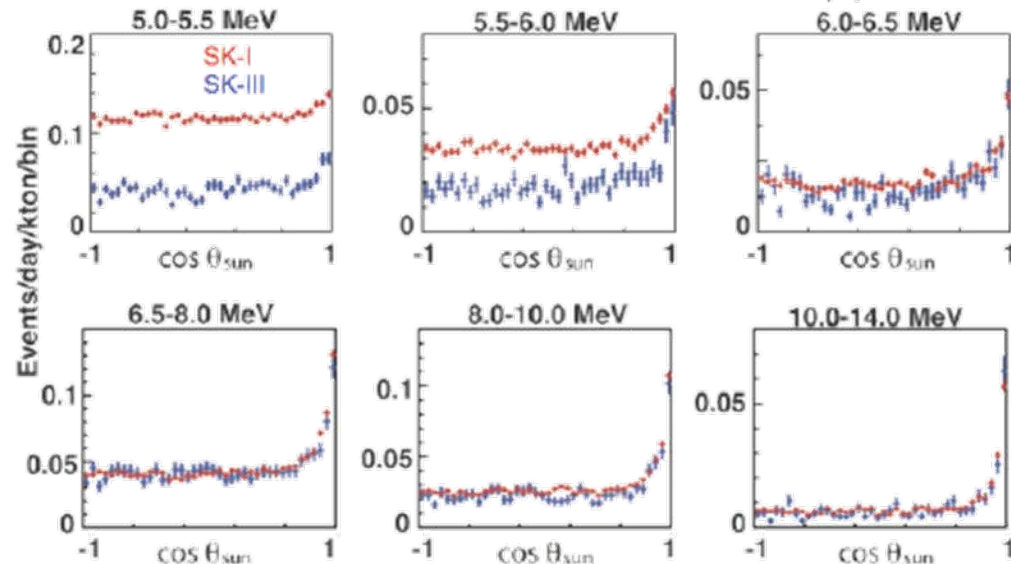
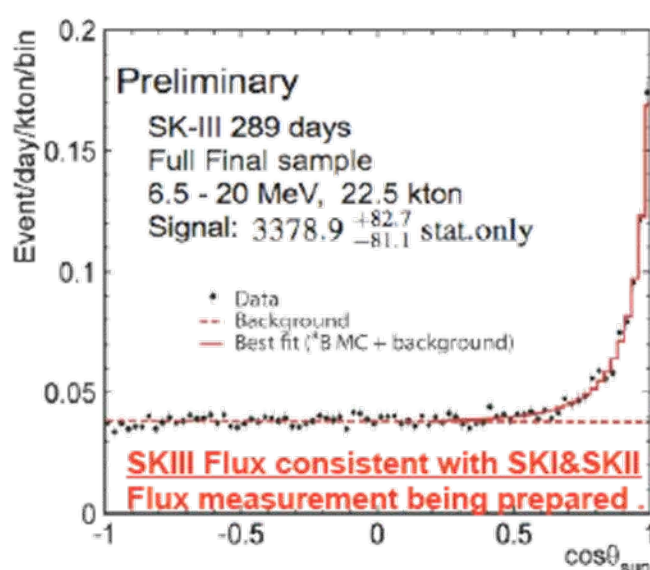
Previous Experiments Sensitive Mainly to Electron Neutrinos



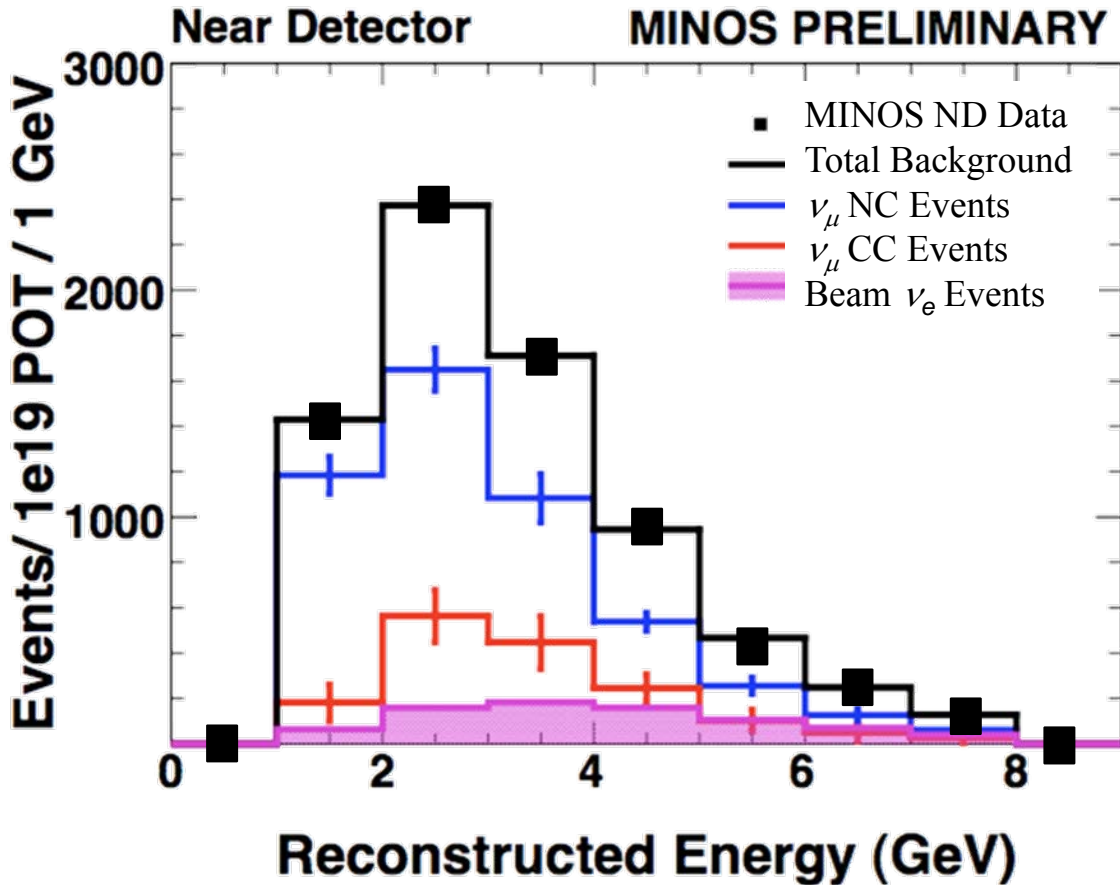
SUPER-K III Solar results and plans



- Goal: see upturn in probability predicted by LMA (~10% effect in SK)
- Lower radon backgrounds, reduce threshold to 4.0 MeV



Measuring the Backgrounds



- Our beam is 94% ν_μ , 5% $\bar{\nu}_\mu$, and $\sim 1\%$ ν_e .
 - ◆ $\pi \rightarrow \mu \nu_\mu \rightarrow e \nu_\mu \nu_\mu \nu_e$
 - ◆ $K \rightarrow \pi e \nu_e$
- Oscillations $\nu_\mu \rightarrow \nu_e$ would be excess ν_e rate over beam and instrumental backgrounds.

Alternatives for ν_μ Disappearance

“Neutrinos actually decay to lighter states”

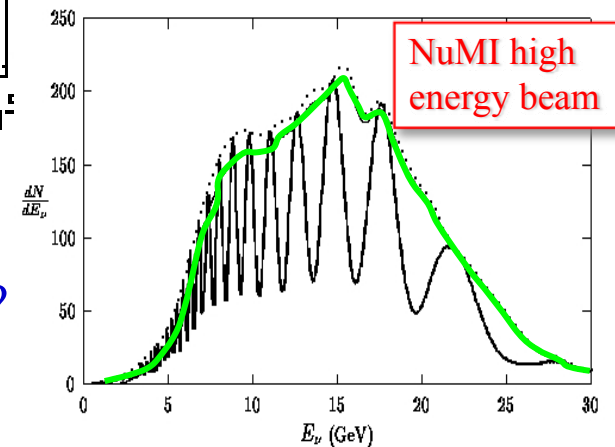
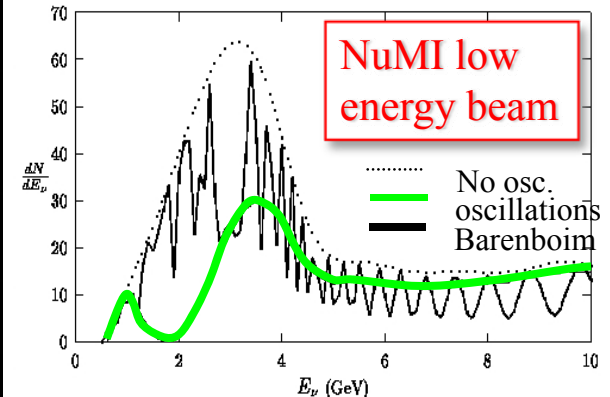
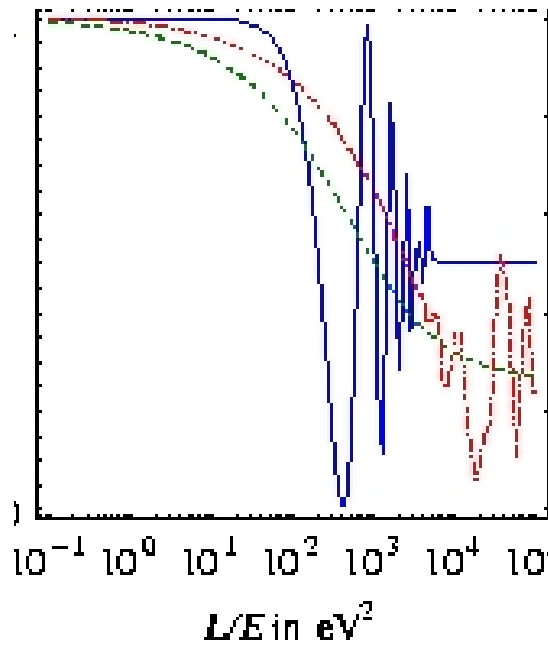
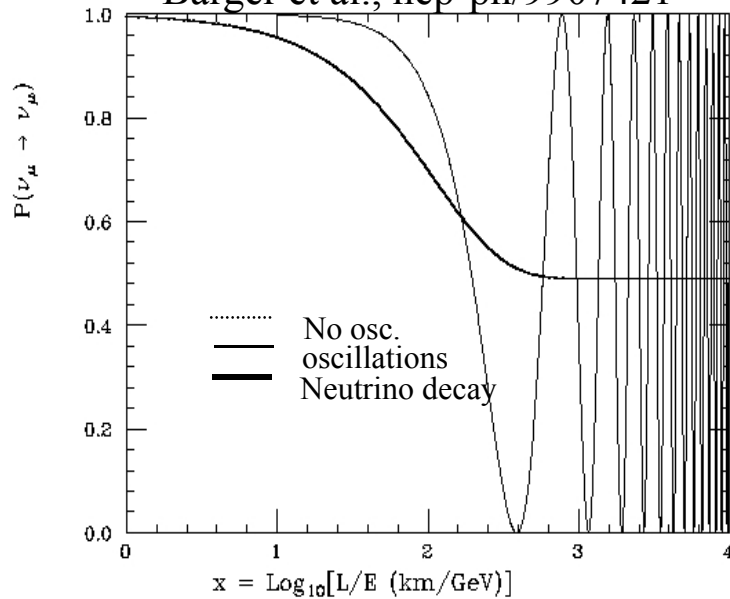
“Neutrinos propagating in Extra Dimensions”

“SuperK effect is combination of Δm^2 (solar) and Δm^2 (LSND)”

Barger et al., hep-ph/9907421

Barbieri et al., hep-ph/9907421

Barenboim et al., hep-ph/0009247



- All of these models modify expected L/E_ν shape.
- Other models will surely come along in coming years?