ν_e Disappearance in Miniboone

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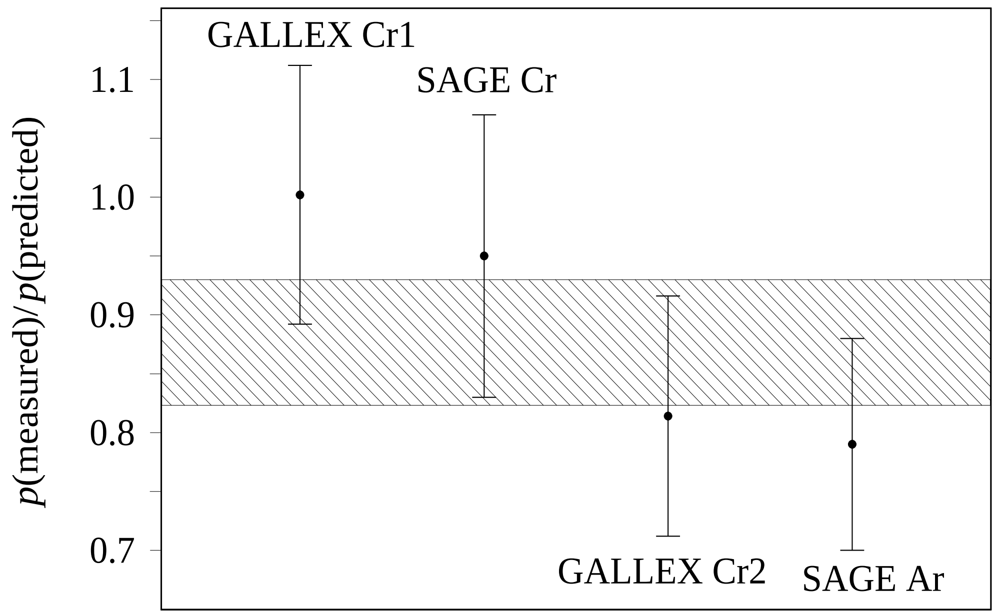
Padova University and INFN

Torino - 17 December 2007

Gallium radioactive source experiments



$R \equiv$ wheighted average value of the ratio of measured and predicted ^{71}Ge production rates (p) :

$$R \equiv \frac{\text{p(measured)}}{\text{p(predicted)}} = 0.88 \pm 0.05(1\sigma)$$

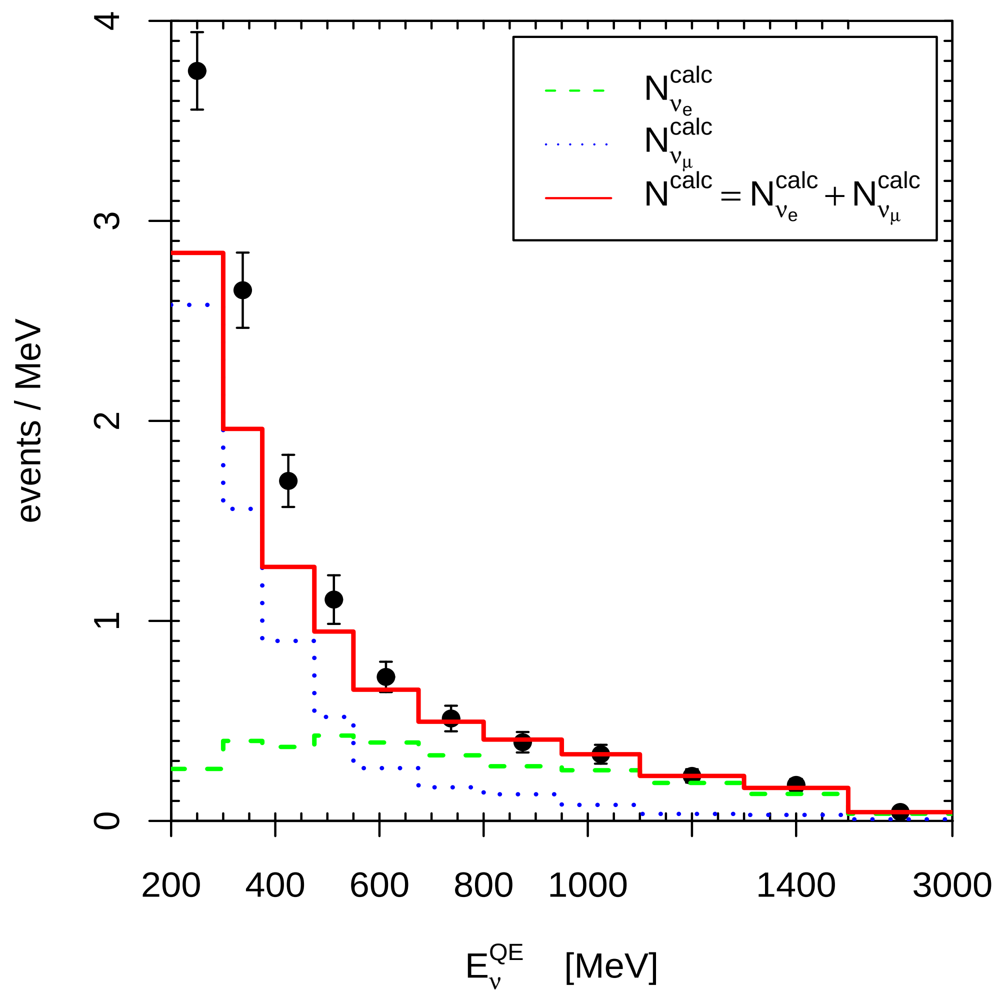
nucl-ex/0512041

Ga radioactive source exp. results may be interpreted as an indication of the disappearance of ν_e due to active-sterile oscillations!

hep-ph/0610352 Carlo Giunti & ML

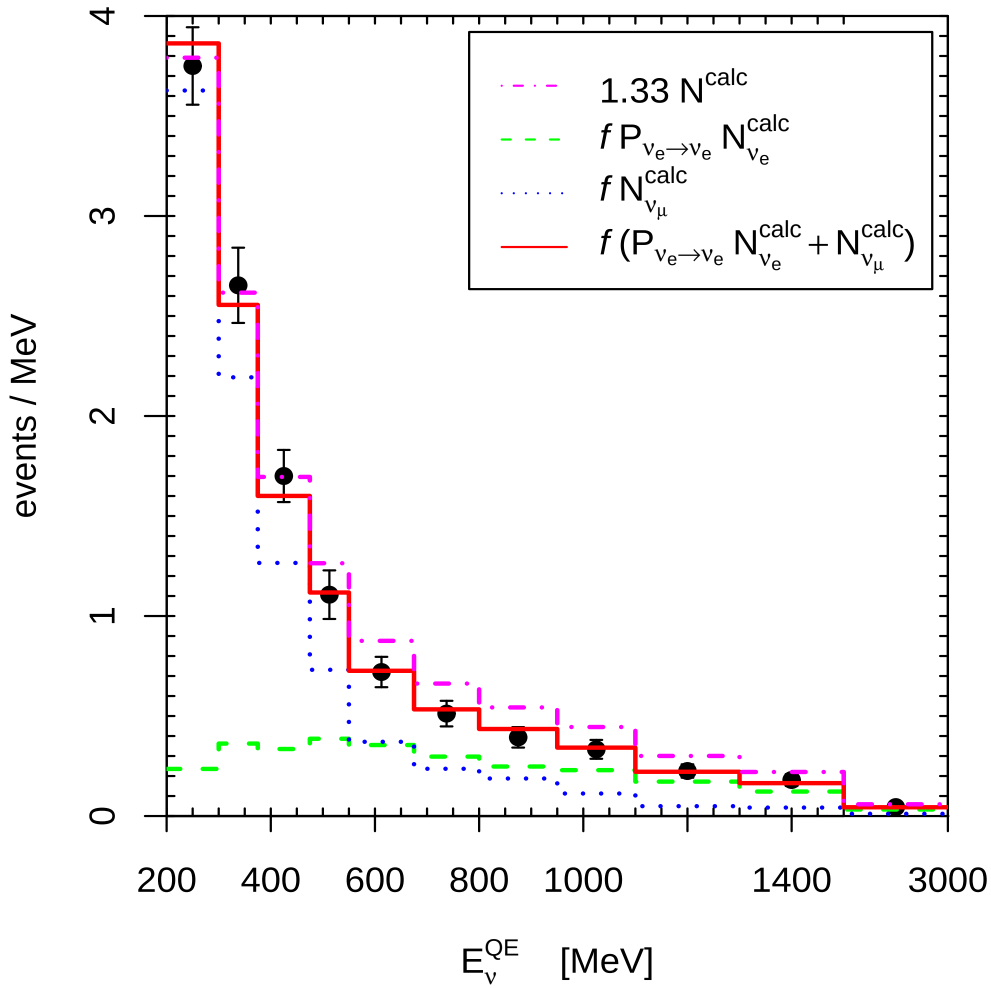
arXiv:0711.4222 Mario A. Acero, Carlo Giunti & ML .

Miniboone data : Low Energy Excess or ...



R.Tayle : Miniboone talk at LP07

ν_e Disappearance in Miniboone



0707.4593.v2 C.Giunti & ML

N.B. constant $P_{\nu_e \to \nu_e} \leftrightarrow \Delta m^2 \gtrsim 20\,\mathrm{eV}^2$

Baic idea: a renormalization of the absolute event rate $\equiv \phi \otimes \sigma(\mathrm{M_A})$ by a constant factor f with a simultaneous disappearance of the ν_e in the beam with a constant $P_{\nu_e \to \nu_e}$.

This hypothesis is allowed by the large error on the absolute event rate.

j	Energy Range [MeV]	$N^{\text{calc}}_{\nu_e,j}$	$N^{\text{calc}}_{\nu_\mu,j}$	N^{calc}_{j}	N^{meas}_{j}
1	$200-300$	26	258	284	375
2	$300-375$	30	117	147	199
3	$375-475$	37	90	127	170
4	$475-550$	32	39	71	83
5	$550-675$	49	33	82	90
6	$675-800$	41	21	62	64
7	$800-950$	41	20	61	59
8	$950-1100$	38	12	50	50
9	$1100-1300$	38	7	45	45
10	$1300-1500$	27	6	33	36
11	$1500-3000$	54	12	66	67

Table 1: $N^{\text{calc}}_{\nu_e,j}$: number of expected ν_e-induced events ; $N^{\text{calc}}_{\nu_\mu,j}$: number of expected ν_μ-induced events ; N^{calc}_{j}: total number of expected events ; N^{meas}_{j}: measured number of events .

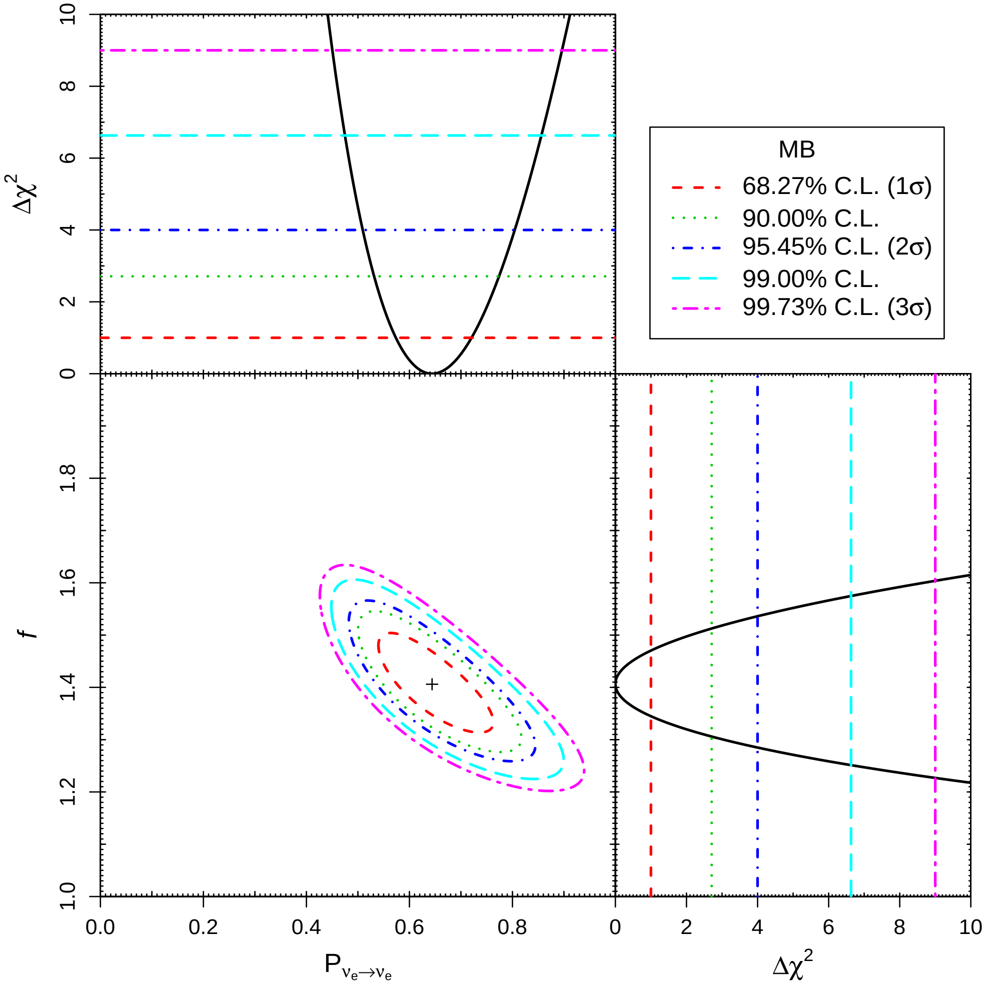
Under this hypothesis, the theoretical number of events in the jth energy bin is given by

$$N^{\text{the}}_{j} = f\left(P_{\nu_e\to\nu_e} N^{\text{calc}}_{\nu_e,j} + N^{\text{calc}}_{\nu_\mu,j}\right) \,,$$

We tested the ν_e-disappearance hypothesis with the Pearson's chi-square

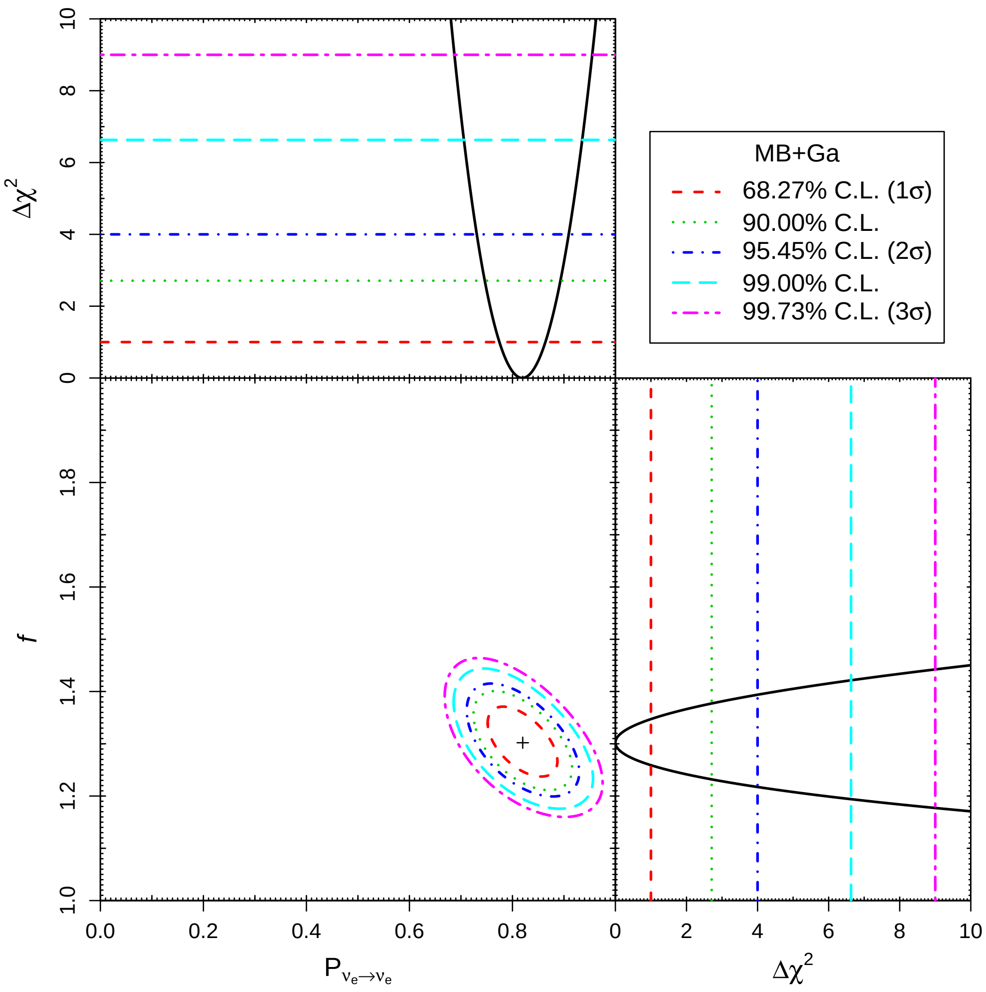
$$\chi^2_{\text{MB}} = \sum_{j=1}^{11} \frac{\left(N^{\text{the}}_{j} - N^{\text{meas}}_{j}\right)^2}{N^{\text{the}}_{j}} \,,$$

Fit to Miniboone data



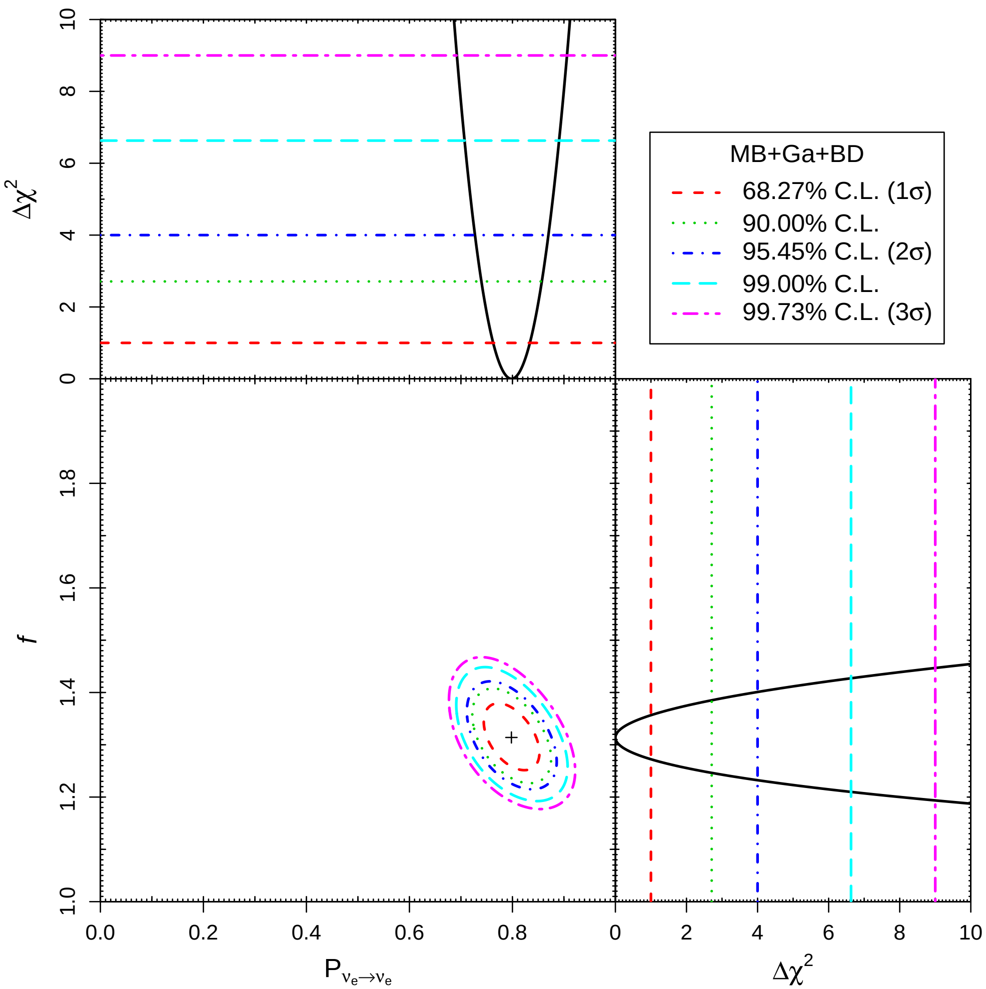
$$\chi^2_{\rm MB} = 2.31/(9\,{\rm dof}) \qquad gof = 98.6\% \qquad P_{\nu_e\to\nu_e} = 0.64^{+0.08}_{-0.07} \qquad f = 1.41 \pm 0.06$$

Fit to Miniboone + Gallium data



$$\chi^2_{\mathrm{MB+Ga}} = 8.48/(10\,\mathrm{dof}) \quad gof = 58.2\% \qquad P_{\nu_e\to\nu_e} = 0.82 \pm 0.04 \quad f = 1.31^{+0.04}_{-0.05}$$

Fit to Miniboone + Gallium + Beam Dump data



$$\chi^2_{\mathrm{MB+Ga+BD}} = 9.11/(11\,\mathrm{dof}) \quad gof = 61.2\% \quad P_{\nu_e \to \nu_e} = 0.80^{+0.03}_{-0.04} \quad f = 1.32 \pm 0.04$$

Possible Interpretations of the results

We have considered here an old indication in favor of ν_e disappearance found from the analysis of the results of Beam-Dump (BD) experiments : $\sin^2 2\vartheta = 0.48 \pm 0.10 \pm 0.05$ for the large squared-mass difference $\Delta m^2 = 377 \pm 27 \pm 7$ eV^2

[G. Conforto Nuovo Cim. A103 (1990) 751] .

In this case, the average ν_e survival probability is

$$P^{\text{BD}}_{\nu_e \to \nu_e} = 0.76 \pm 0.06 \,. \quad (1)$$

The large disappearance of ν_e found in this study may be due to oscillations into sterile neutrinos $\nu_e \to \nu_s$ with $\Delta m^2 \gtrsim 20\,\text{eV}^2$, since

- $\nu_e \to \nu_\mu$ transitions are restricted by the results of CCFR , KARMEN , NOMAD and MINIBOONE ;
- $\nu_e \to \nu_\tau$ transitions are limited by the results of CHORUS and NOMAD .

Comparison with SBL reactor limits : Bugey 2 detectors

B. Achkar et al. / Nuclear Physics B 434 (1995) 503–532 527

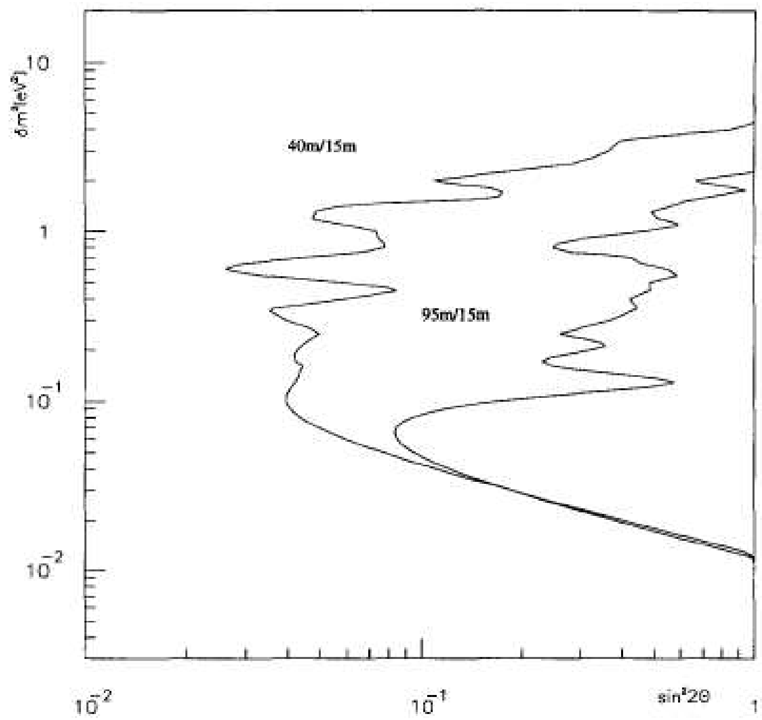


Fig. 16. 90% C.L. exclusion contours obtained from the ratios of the positron energy spectra measured at 40/15 and 95/15 meters.

2 detectors Bugey 90 % C.L. (raster scan) limits do not exclude active-sterile mixing with $\delta m^2 > 5\,\mathrm{eV}^2$

Bugey : high δm^2 limit

530 *B. Achkar et al. / Nuclear Physics B 434 (1995) 503–532*

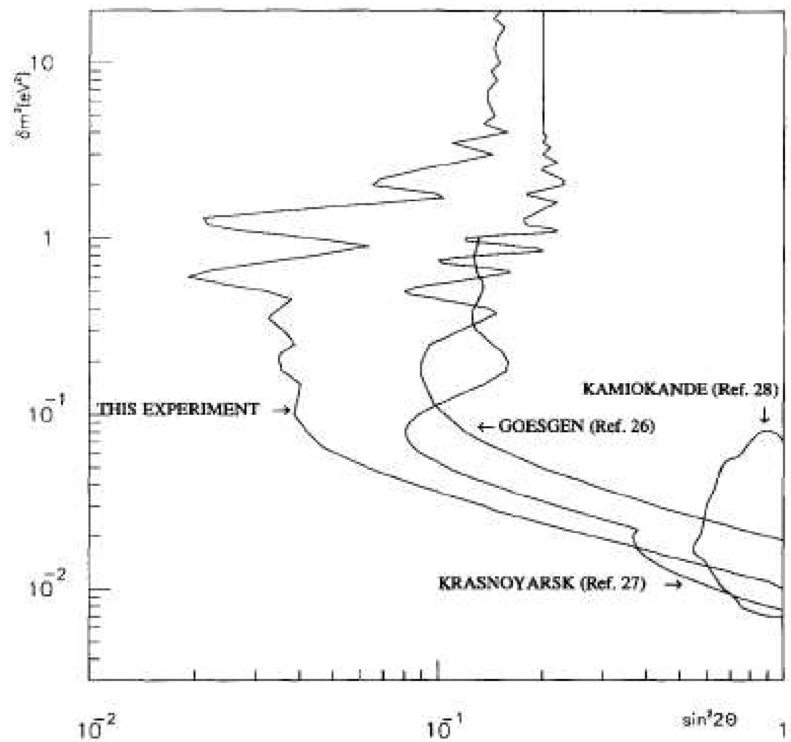


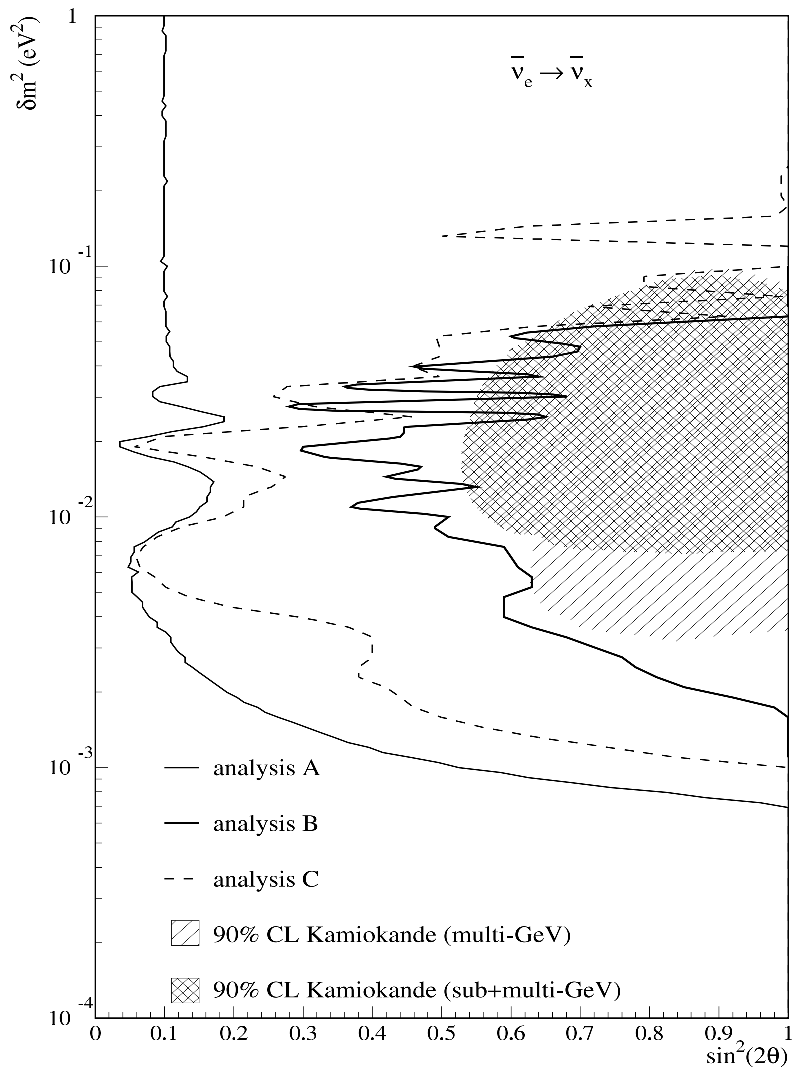
Fig. 18. The 90% C.L. exclusion contour obtained from the positron energy spectra measured at 40, 15 and 95 meters. Also shown is the hitherto excluded area in earlier reactor experiments with the region for a possible ν_e–ν_μ oscillation put forward by the KAMIOKANDE collaboration.

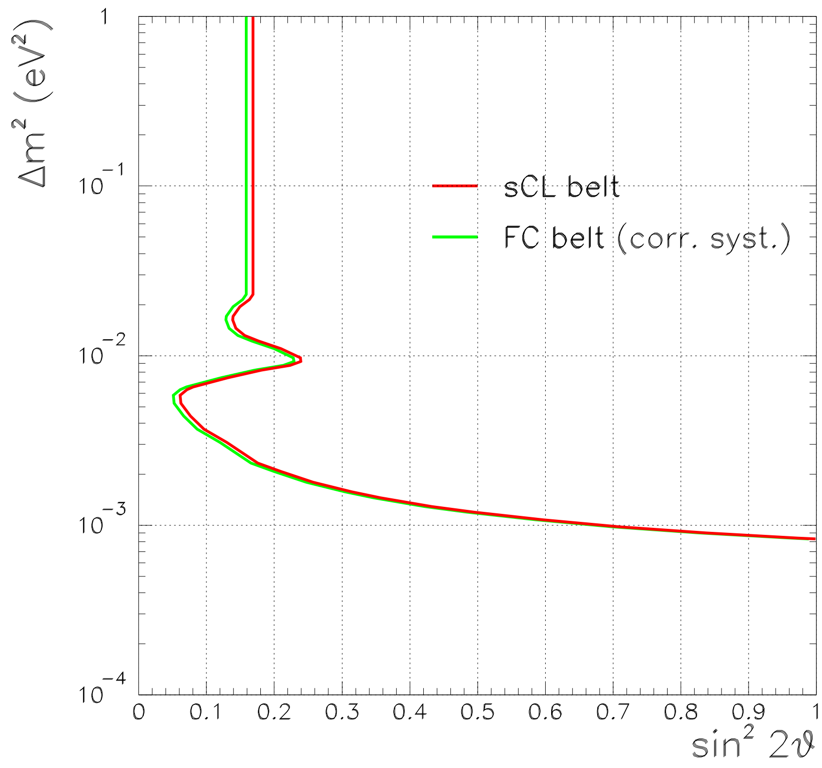
Bugey 90 % C.L. high δm^2 (raster scan) limit do not exclude active-sterile mixing with $\sin^2 2\theta \lesssim 0.15$ if the neutrino flux is **known with 2.8 % error**

Reactors Exp. : Errors on the Normalization

	KAMLAND	CHOOZ	BUGEY
References	TAUP 2007	hep-ex/0301017	NPB434(1995)
Total reactor related	3.43 %	0.94 %	2.8 %
Cross section	0.20 %	1.90 %	0.20 %
Total detector related	2.24 %	1.67 %	4.14 %
Combined	4.10 %	2.70 %	5.00 %

CHOOZ high δm^2 limits





$90\% C.L.$ limit : $\sin^2 2\theta < 0.1$

FC limit: $\sin^2 2\theta < 0.16$

hep-ex/0301017

ν_e versus $\bar{\nu}_e$ data tension

Taken the Bugey error as a reference value (5% error on $P_{\bar{\nu}_e \to \bar{\nu}_e}$) we face 2 possibilities

(3% is the error on $P^{\text{MB+Ga+BD}}_{\nu_e \to \nu_e}$) :

- The error in $\bar{\nu}_e$ data may be $> 5\%$ and therefore
  $(P^{\text{MB+Ga+BD}}_{\nu_e \to \nu_e} - P_{\bar{\nu}_e \to \bar{\nu}_e}) < 4\sigma$.
- The error in $\bar{\nu}_e$ data is $< 5\%$ and therefore
  $(P^{\text{MB+Ga+BD}}_{\nu_e \to \nu_e} - P_{\bar{\nu}_e \to \bar{\nu}_e}) > 4\sigma$.
  This possibility seems to need new physics that violates CPT.

In hep-th/0610252 R.Casalbuoni showed as the infinite component wave Majorana equation [E.Majorana Nuovo Cimento 9 (1932) 335], were **no negative energy solutions are presents**, violates CPT !!!

MAJORANA NEUTRINO THEORY 1937

Majorana, E.;

Symmetrical Theory of Electrons and Positrons

Nuovo Cim. 14 (1937) 171

Abstracts

A new method of quantization is proposed which allows Dirac's theory of the positron to be built up in such a form that there is complete symmetry between the positive and negative charge throughout the formalism of the theory, while in Dirac's original form this symmetry applied only to the results of the theory, which had to be obtained by using ambiguous mathematical operations such as subtraction of infinities.

It is also claimed that

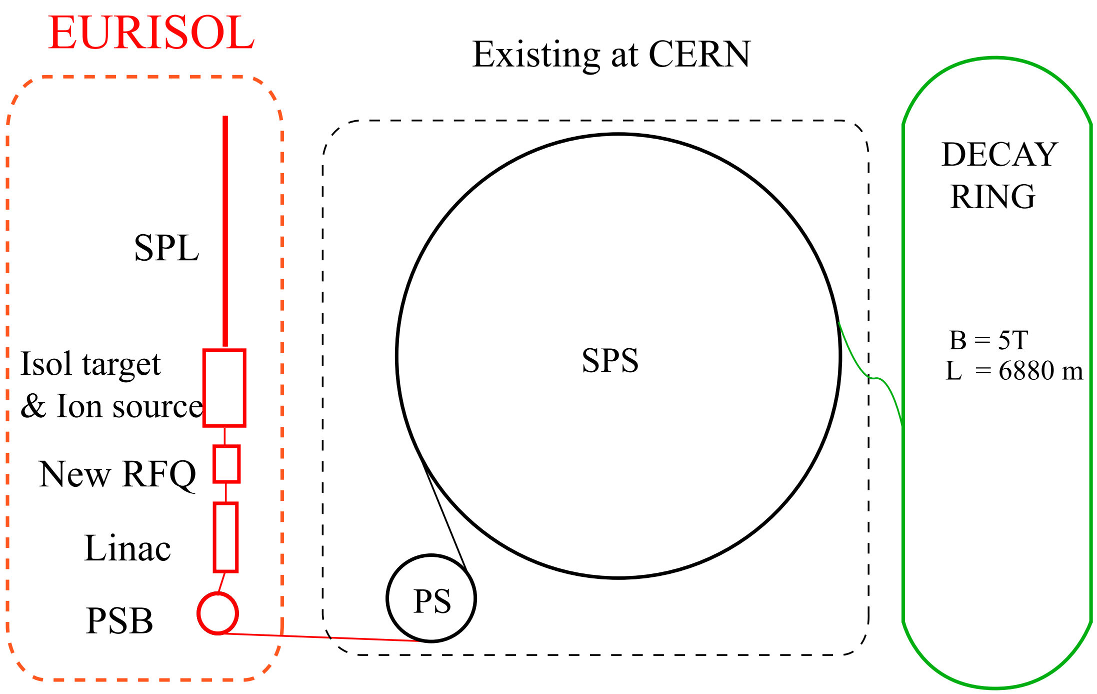
the new method of quantization is capable of describing a neutral particle

without states of negative kinetic energy

and without introducing a "mirror image" like the positron.

(Science Abstracts. 1937, 4685. R. P.).

Future SBL experimental CPT tests with β beams



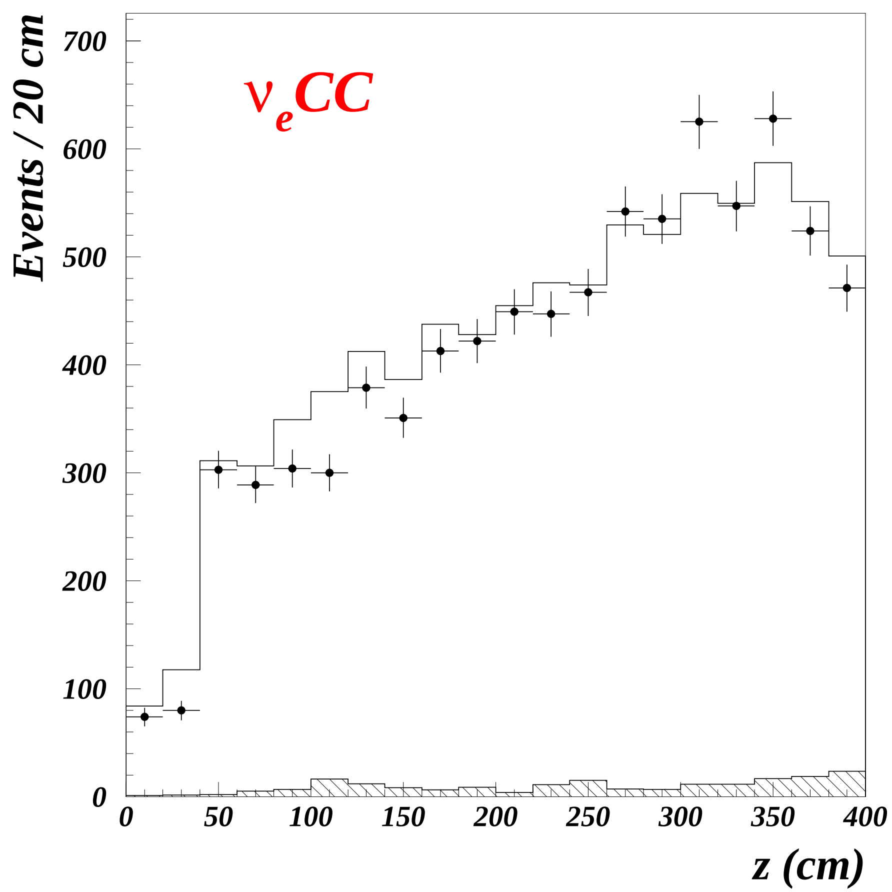
Future SBL Beta-Beam experiments [P.Zucchelli PLB 532 (2002) 166]
with a pure ν_e or $\bar{\nu}_e$ beam from nuclear decay of accelerated ions have the potentiality to check the possible SBL disappearance of ν_e and $\bar{\nu}_e$ with high accuracy .

... if they are roses they'll flower...

... GOOD LUCK to Majorana ν physics !!!

Backup slides

NOMAD ν_e measurement

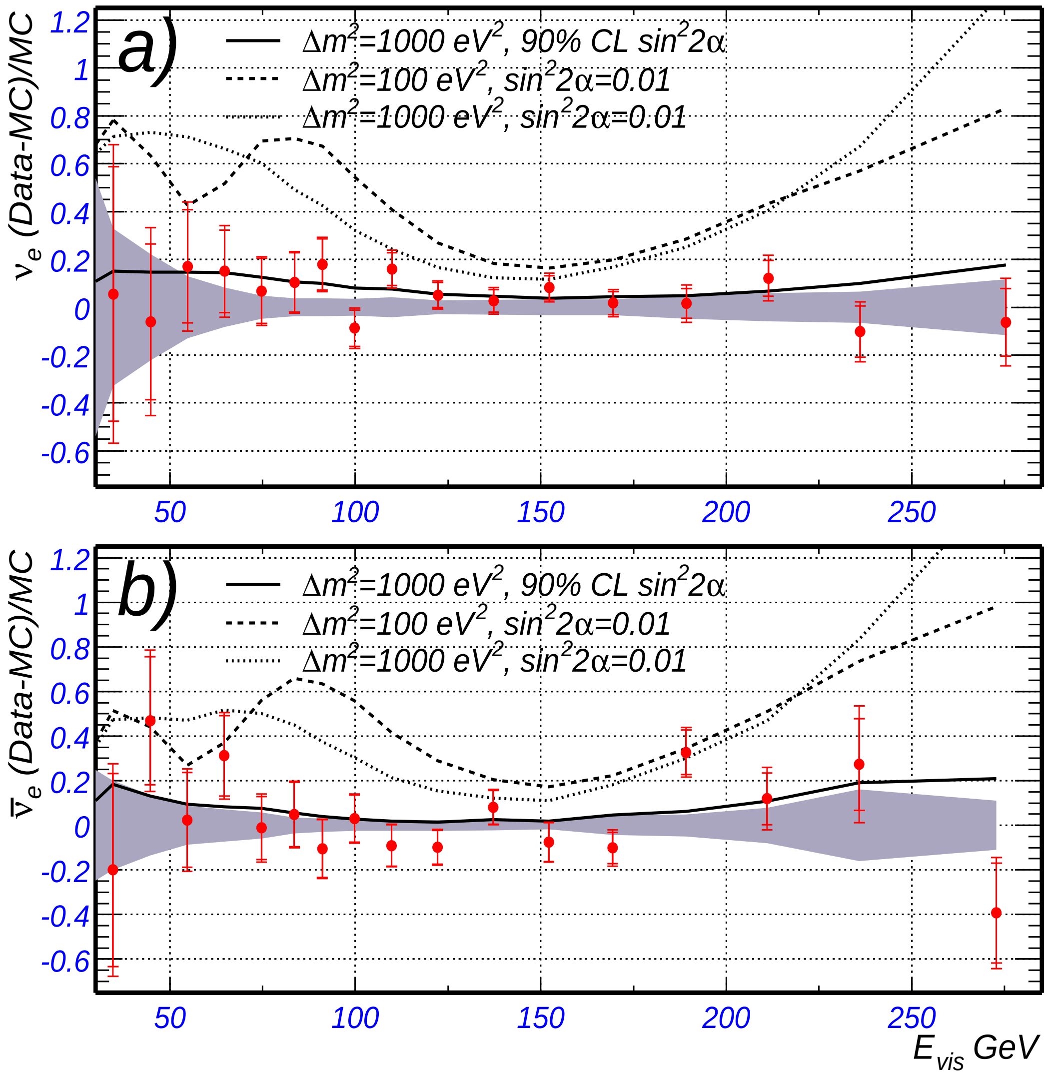


Before [$z_{VTX} > 184\,\mathrm{cm}$] cut : observed = 7969 ; predicted = 8329

(4% absolute normalization error) $\Rightarrow 1\sigma$ deficit

hep-ex/0306037

NUTEV ν_e , $\bar{\nu}_e$ measurements



hep-ex/0203018