Gallium and Reactor Neutrino Anomalies

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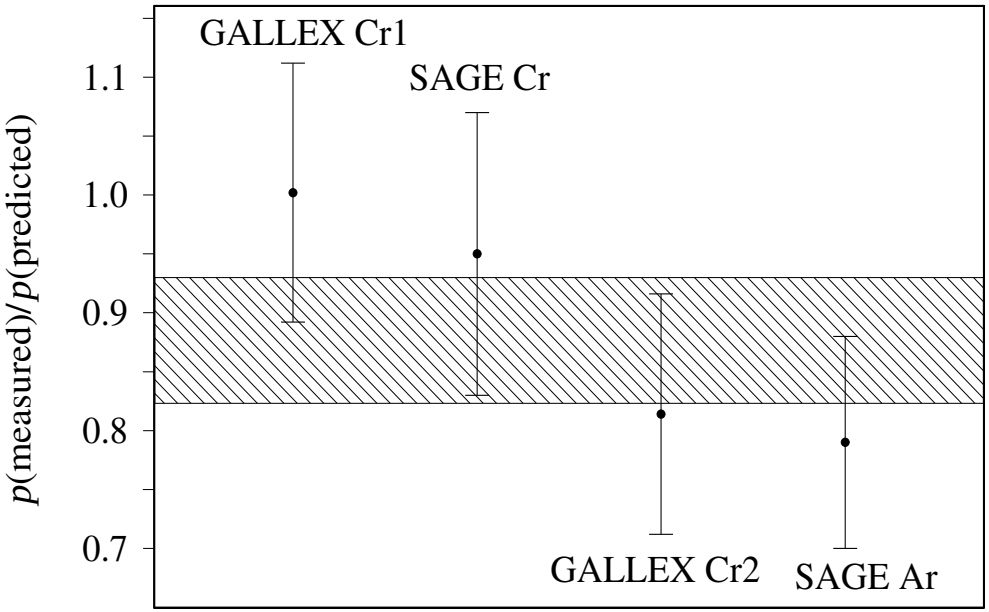
work in collaboration with Mario A. Acero and Carlo Giunti

Active-Sterile ν mixing ?

- Charged massive spin 1/2 particles can have only a Dirac mass term
- According to Majorana neutral massive spin 1/2 particles can coincide with their antiparticles having a Majorana mass term.
- Non-SM right-handed neutral particles can have both Dirac and Majorana mass terms.
- If these non-SM right-handed neutral particles are light (sterile neutrinos ν_s) can mix with ordinary active neutrinos.
- The observable effect is a disappearance of active neutrinos.
- We focus on Gallium (ν_e) and Reactors ($\overline{\nu}_e$) disappearance.

Gallium radioactive source experiments



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

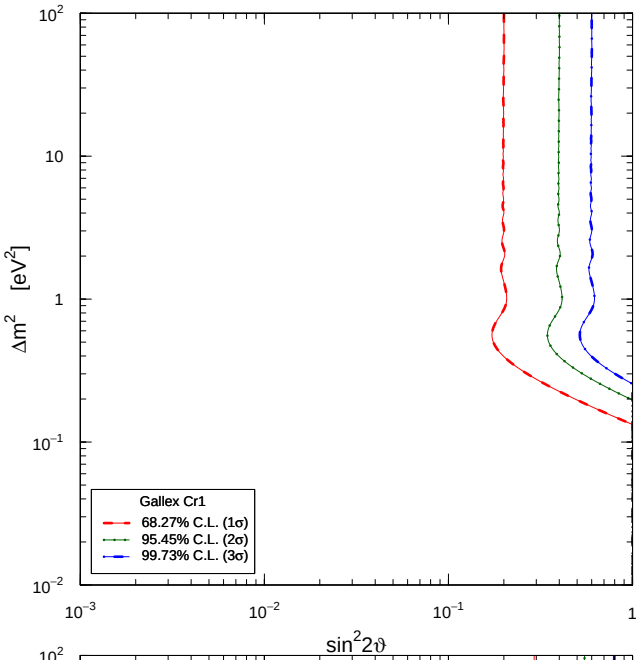
$$R \equiv \frac{\mathrm{p(measured)}}{\mathrm{p(predicted)}} = 0.88 \pm 0.05(1\sigma)$$

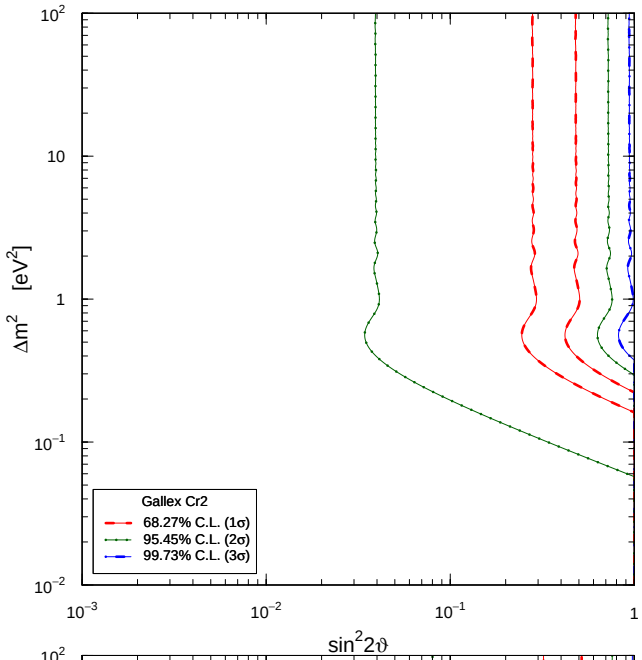
nucl-ex/0512041

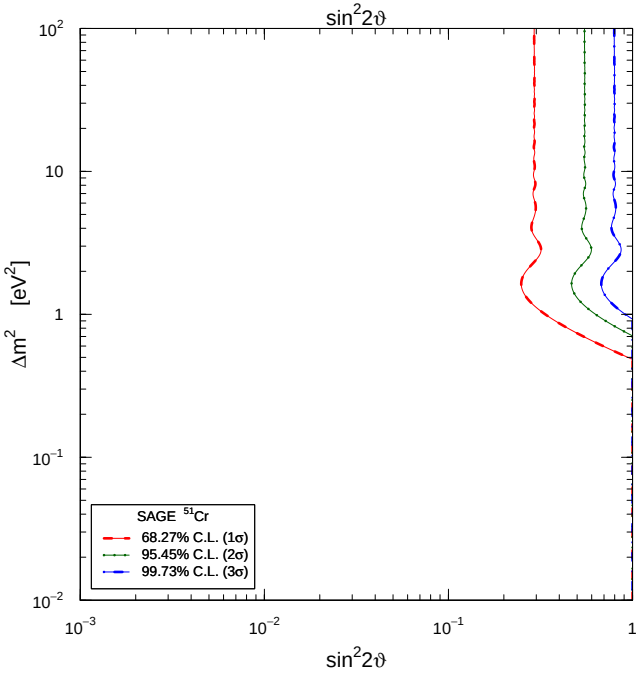
Ga radioactive source exp. results may be interpreted as an indication of the disappearance of ν_e due to active-sterile oscillations!

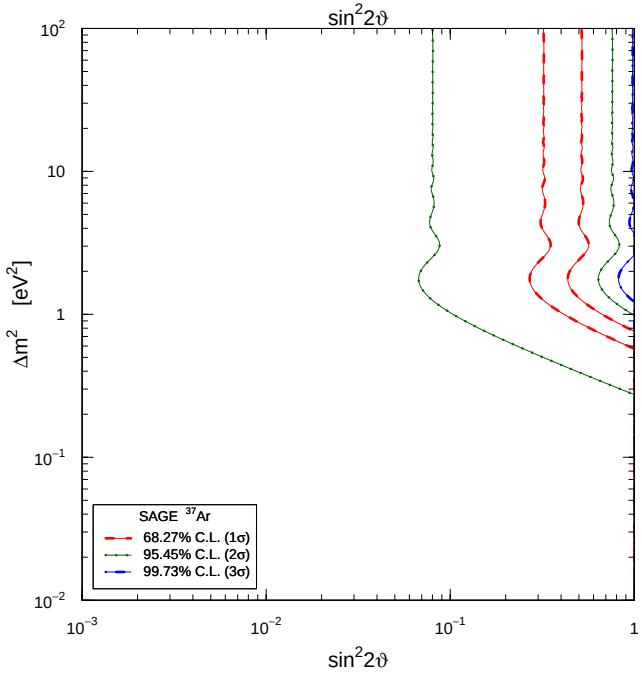
hep-ph/0610352 Carlo Giunti & ML .

Gallium anomaly : individual fits

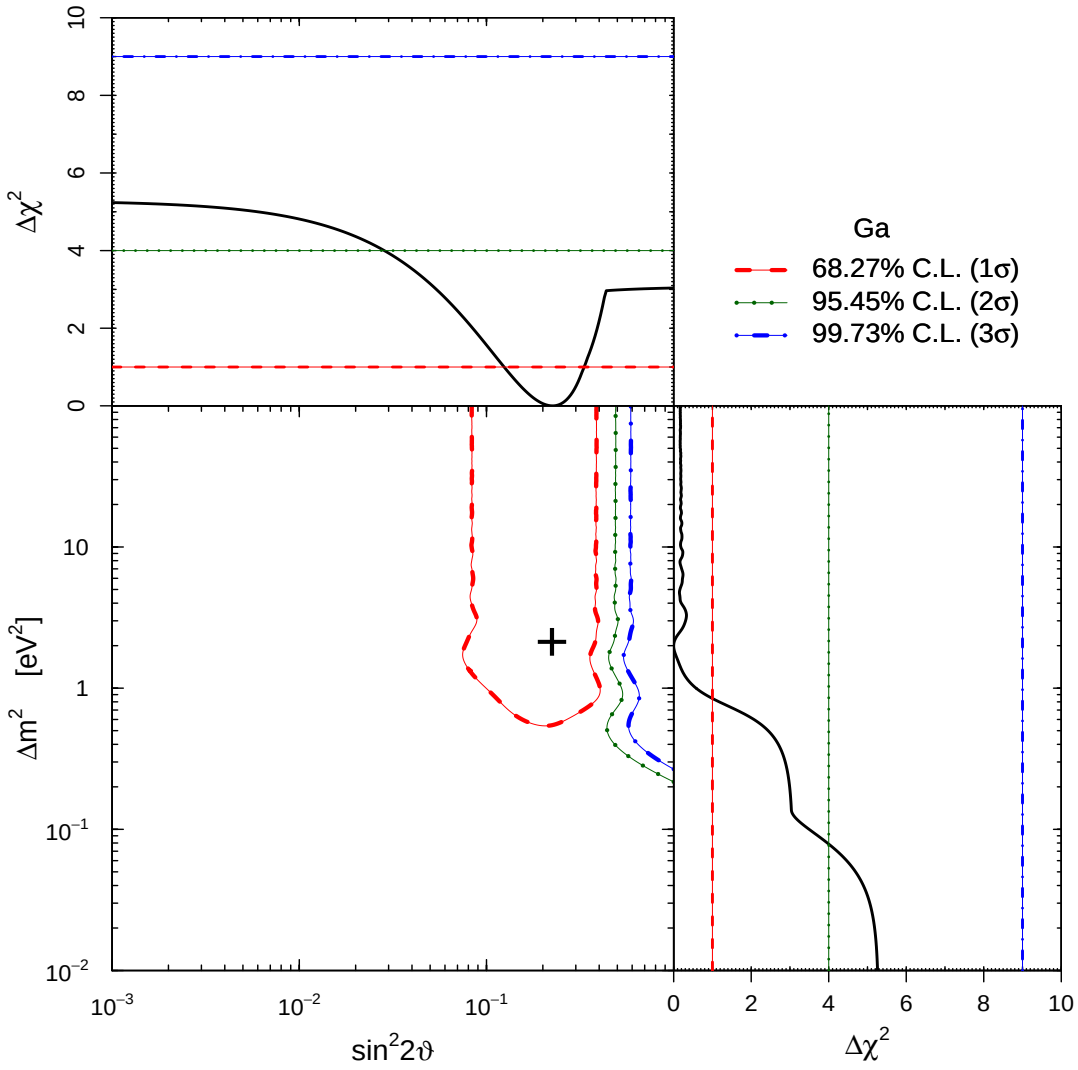






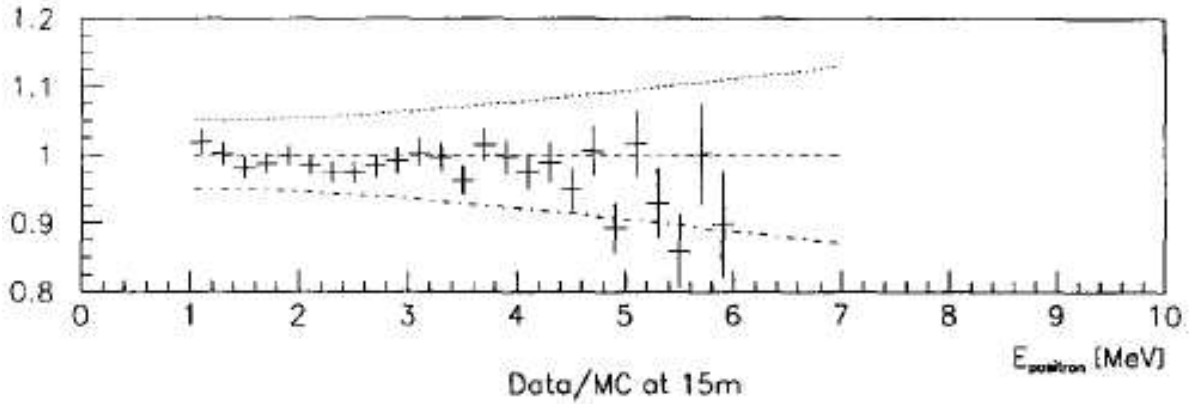


Gallium anomaly : combined fit

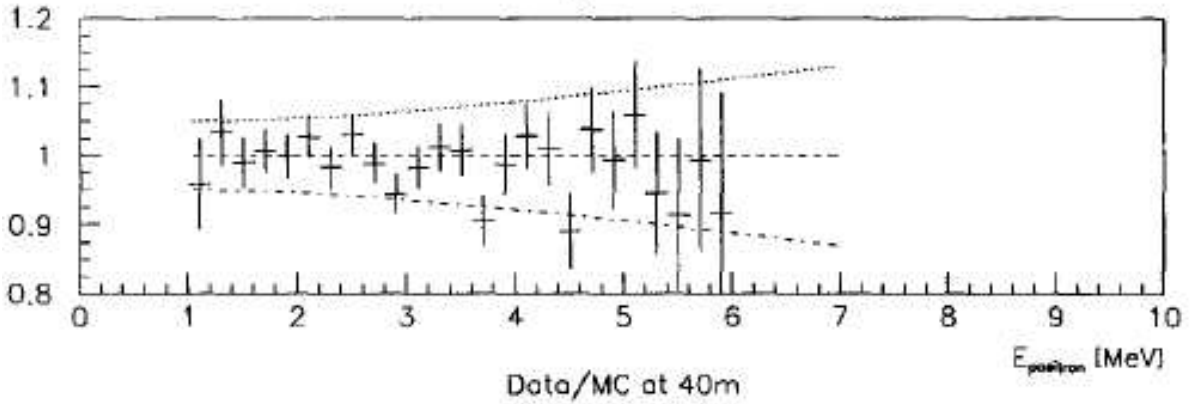


$\chi^2_{\rm min} = 2.91/(2\,{\rm dof})$ $\quad GoF = 23\%$ $\quad \sin^2(2\theta)_{bf} = 0.22$ $\quad \Delta m^2_{bf} = 1.98\,eV^2$

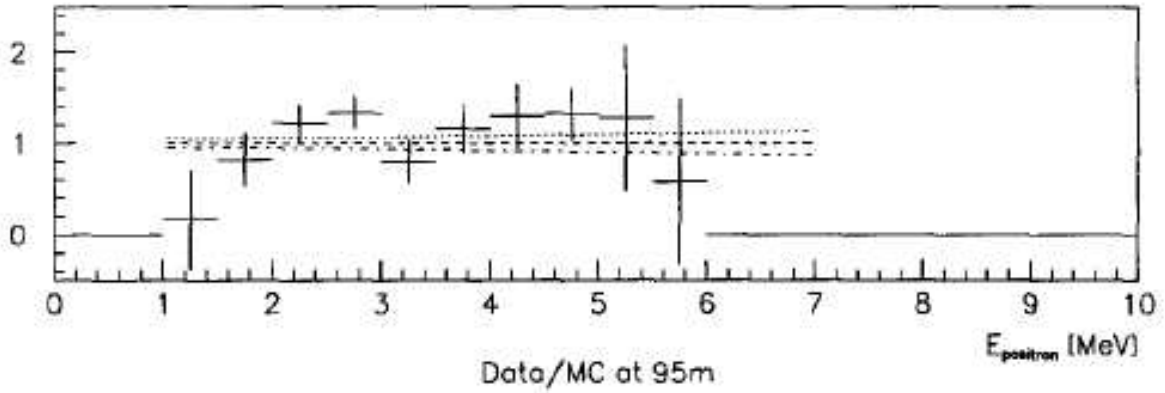
Bugey reactor data at 15 m , 45 m and 90 m



Data/MC at 15m

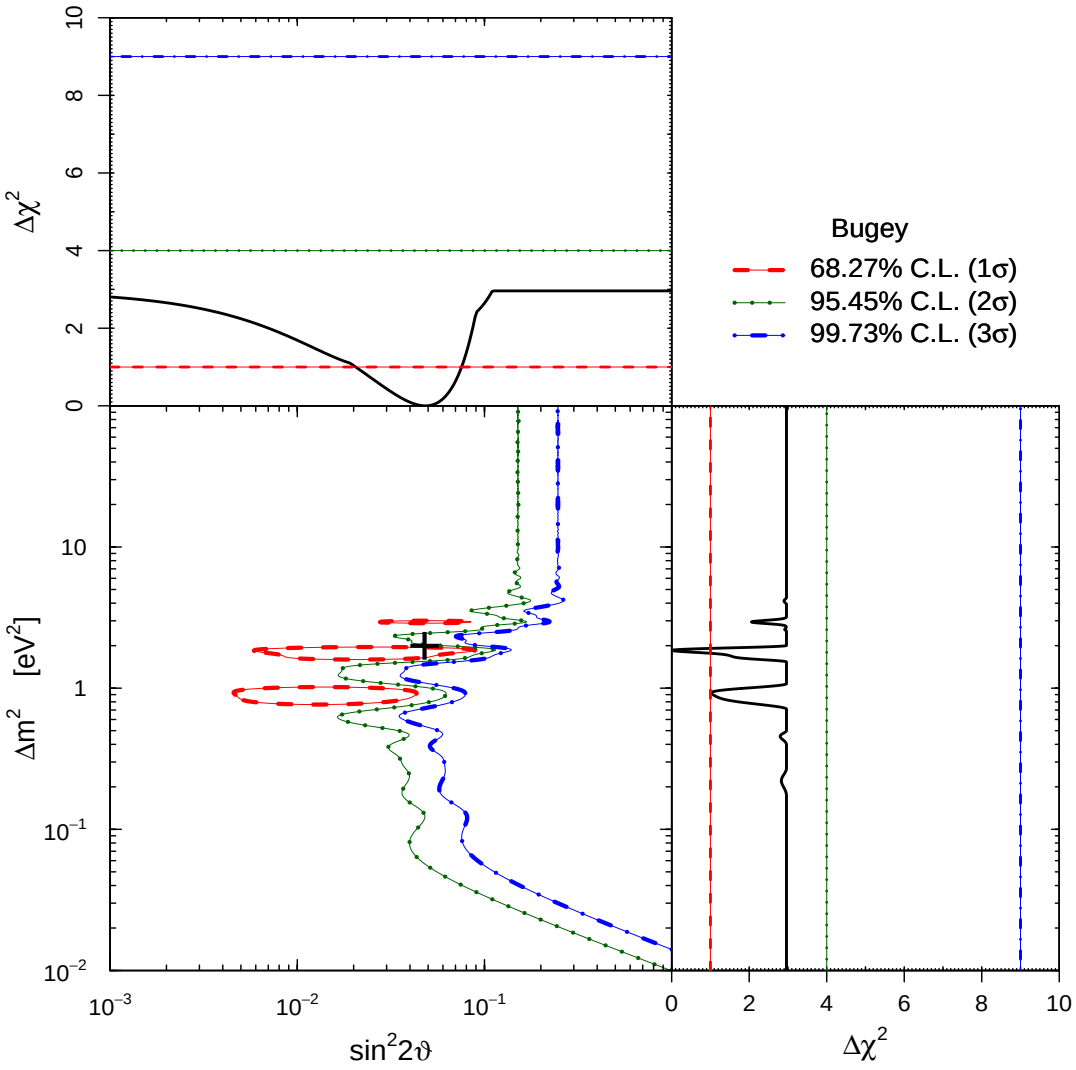


Data/MC at 40m



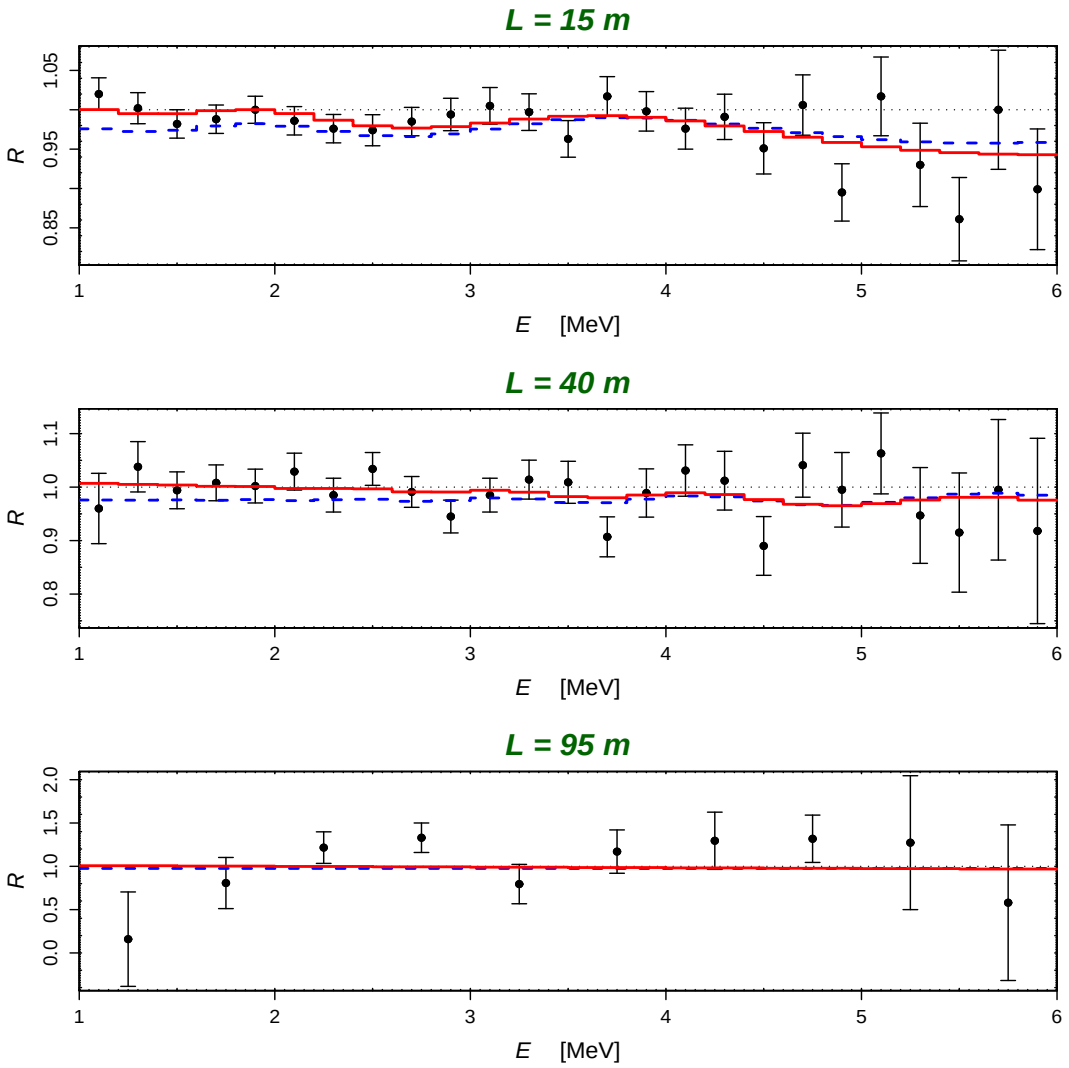
Data/MC at 95m

Fit to Bugey data

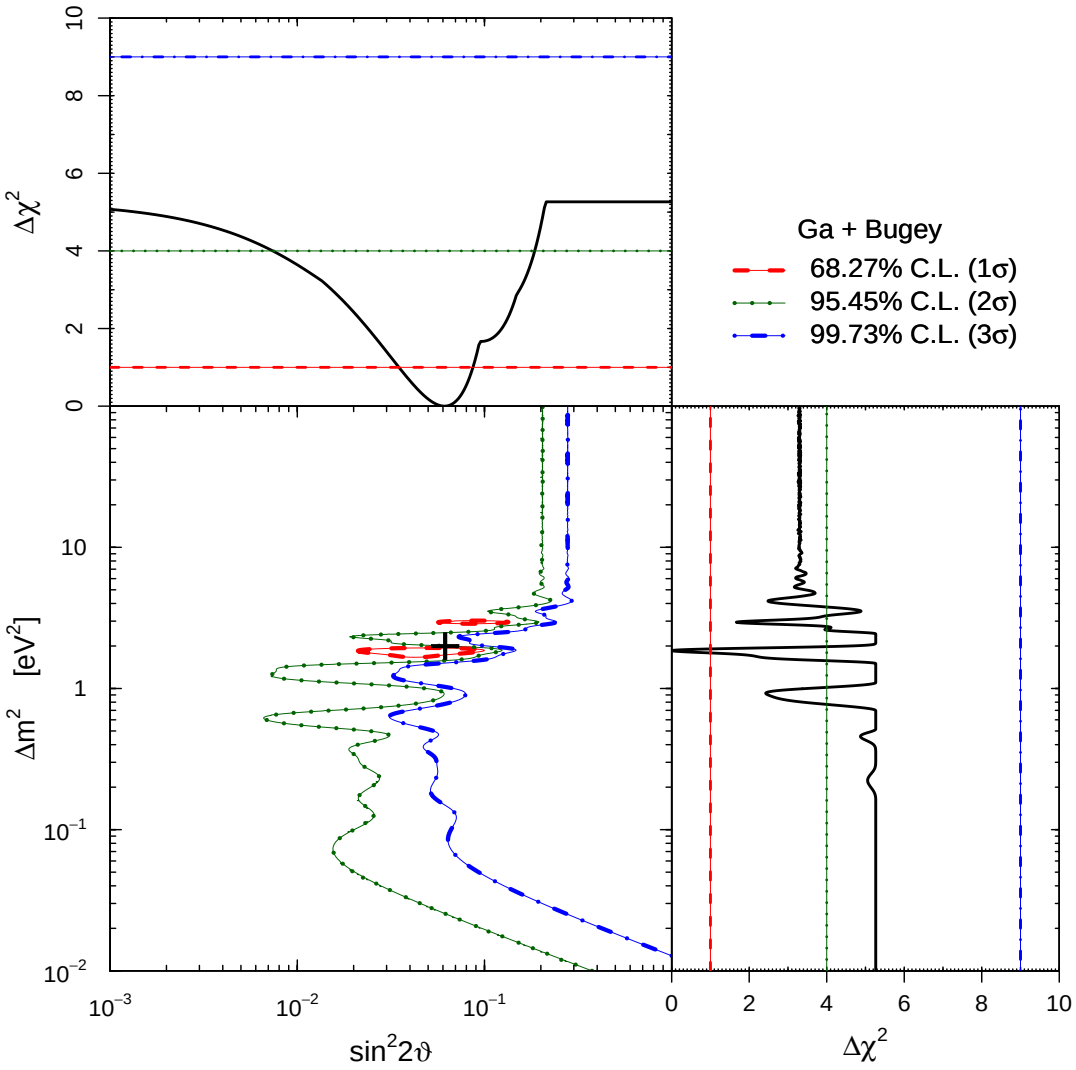


$\chi^2_{\rm min} = 47.97/(53\,{\rm dof})$ $\quad GoF = 67\%$ $\qquad \sin^2(2\theta)_{bf} = 0.048$ $\quad \Delta m^2_{bf} = 1.85\,eV^2$

Best fit of Bugey data

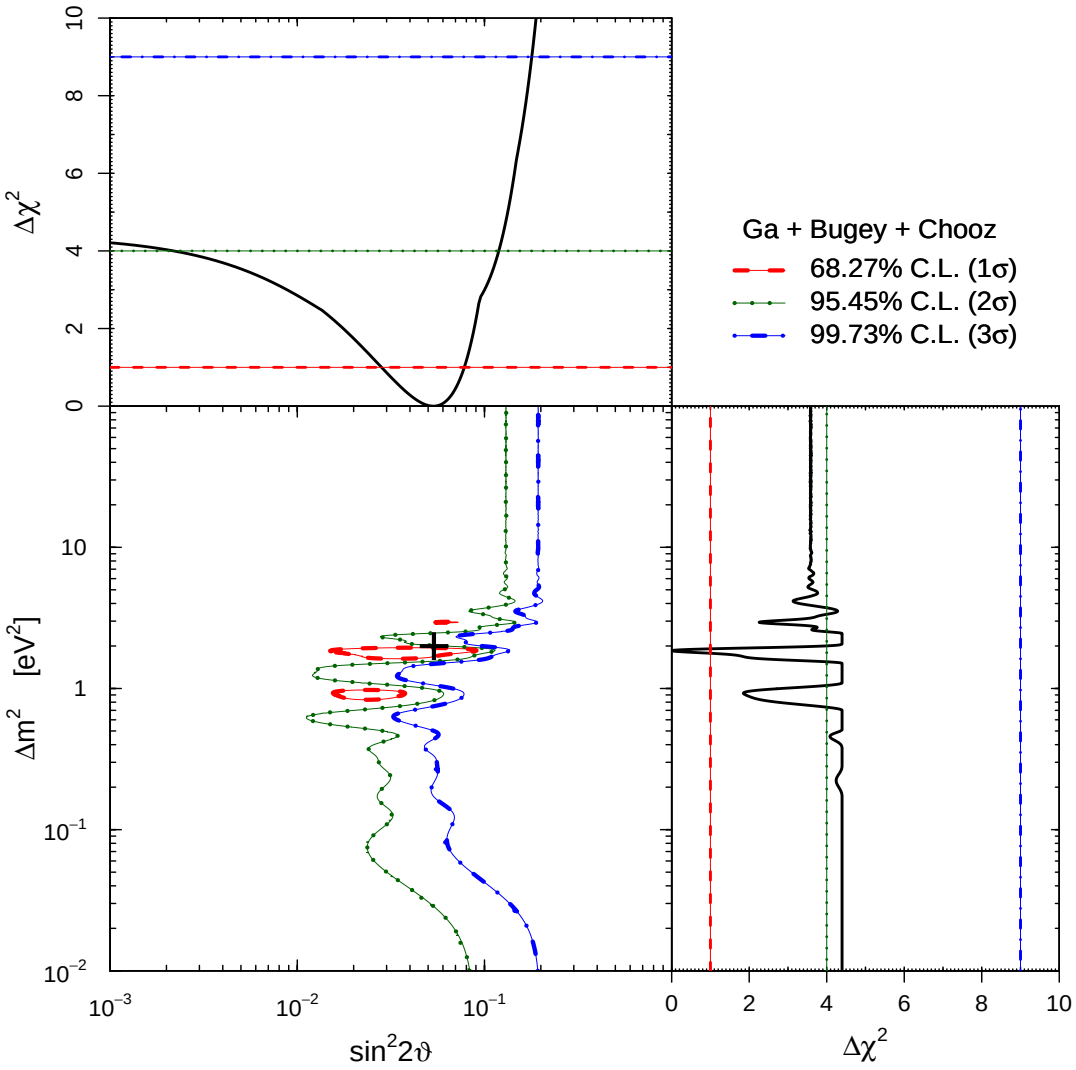


Combined fit to Gallium & Bugey data



$\chi^2_{\rm min} = 53.87/(57\,{\rm dof})$ $\quad GoF = 59\%$ $\qquad \sin^2(2\theta)_{bf} = 0.062$ $\quad \Delta m^2_{bf} = 1.85\,eV^2$

Combined fit to Gallium Bugey & Chooz data



$\chi^2_{\rm min} = 54.80/(58\,{\rm dof})$ $GoF = 60\%$ $\sin^2(2\theta)_{bf} = 0.054$ $\Delta m^2_{bf} = 1.85\,eV^2$

Summary of results compared with No Osc. hypothesis

		Ga	Bu	Ga+Bu	Bu+Ch	Ga+Ch	Ga+Bu+Ch
No Osc.	χ^2_{min}	8.19	50.94	59.13	51.00	8.26	59.19
	NDF	4	55	59	56	5	60
	GoF	0.085	0.63	0.47	0.66	0.14	0.51
Osc.	χ^2_{min}	2.91	47.97	53.87	48.63	6.60	54.80
	NDF	2	53	57	54	3	58
	GoF	0.23	0.67	0.59	0.68	0.086	0.60
	$\sin^2 2\vartheta_{\text{bf}}$	0.22	0.048	0.062	0.041	0.08	0.054
	Δm^2_{bf} [eV^2]	1.98	1.85	1.85	1.85	1.72	1.85
PG	$\Delta\chi^2_{\text{min}}$			2.98	0.59	3.63	3.85
	NDF			2	1	1	3
	GoF			0.23	0.44	0.057	0.28

arXiv:0711.4222

Active-Sterile ν mixing !

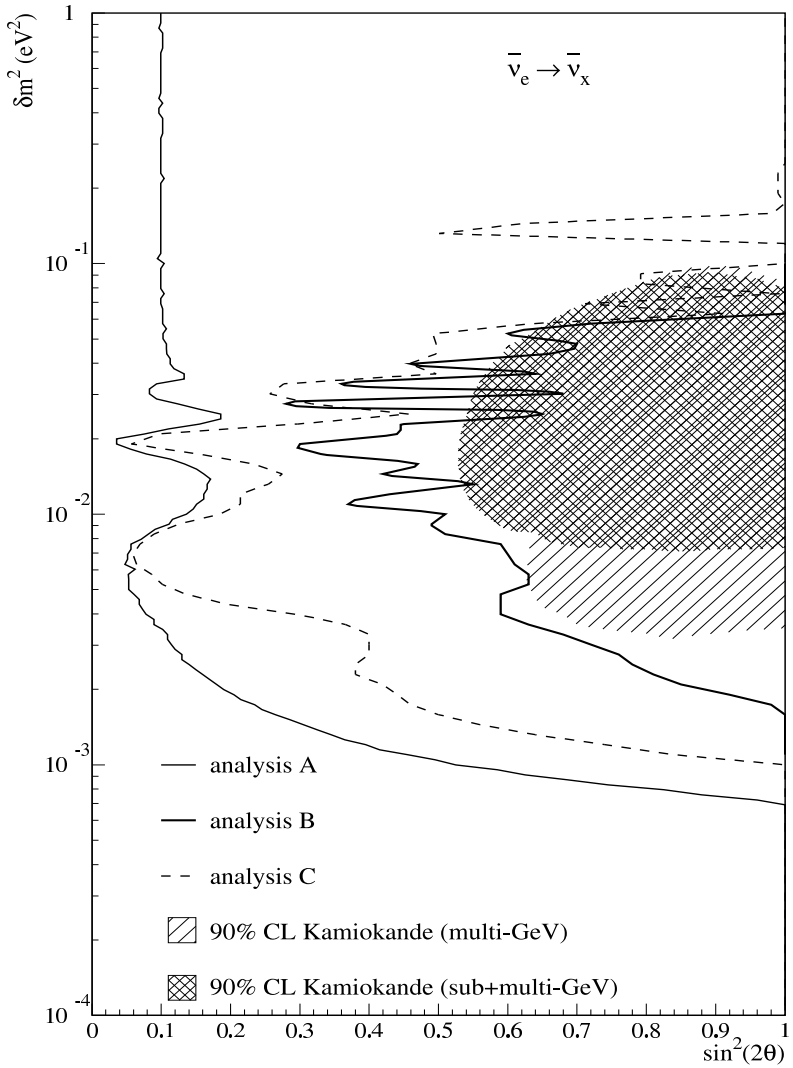
- A hint in favor of short-baseline neutrino oscillations generated by $\Delta m^2 \gtrsim 0.1\,\text{eV}^2$ is extremely interesting.
- This squared-mass difference is too large to be compatible with the three-neutrino mixing scheme inferred from the observation of neutrino oscillations in solar, very-long-baseline reactor, atmospheric and long-baseline accelerator experiments, in which there are only two independent squared-mass differences, $\Delta m^2_{\text{SOL}} \approx 8 \times 10^{-5}\,\text{eV}^2$ and $\Delta m^2_{\text{ATM}} \approx 3 \times 10^{-3}\,\text{eV}^2$.
- Our results indicate the possible existence of at least one light sterile neutrino ν_s.
- Future experiments which are well suited for fi nding small $\overset{(-)}{\nu}_e \longrightarrow \overset{(-)}{\nu}_s$ transitions are those with a source producing a $\overset{(-)}{\nu}_e$ flux which is known with high accuracy.
- Beta-Beam experiments which have a pure ν_e or $\bar{\nu}_e$ beam from nuclear decay, Neutrino Factory experiments in which the beam is composed of ν_e and $\bar{\nu}_\mu$, from μ^+ decay, or $\bar{\nu}_e$ and ν_μ, from μ^- decay.

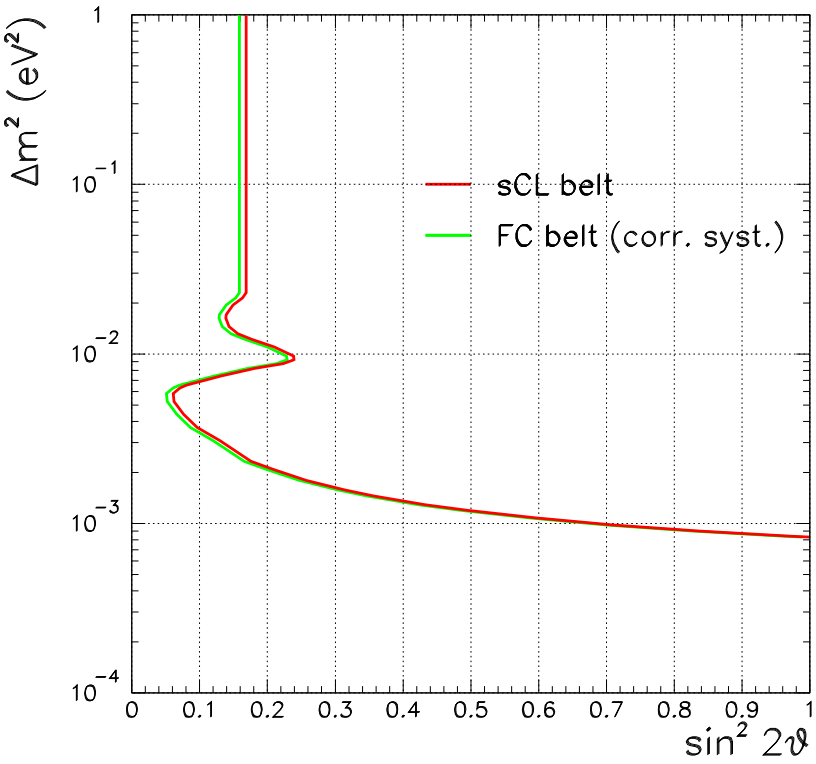
Se son rose fioriranno ...

... GOOD LUCK to MAJORANA ν PHYSICS !!!

Backup slides

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