INTERNATIONAL ATOMIC ENERGY AGENCY
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION

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H4.SMR 346/26

SCHOOL ON
NON-ACCELERATOR PHYSICS
25 April - 6 May 1988

SOLAR NEUTRINOS, NEUTRINO OSCILLATIONS (2)

by

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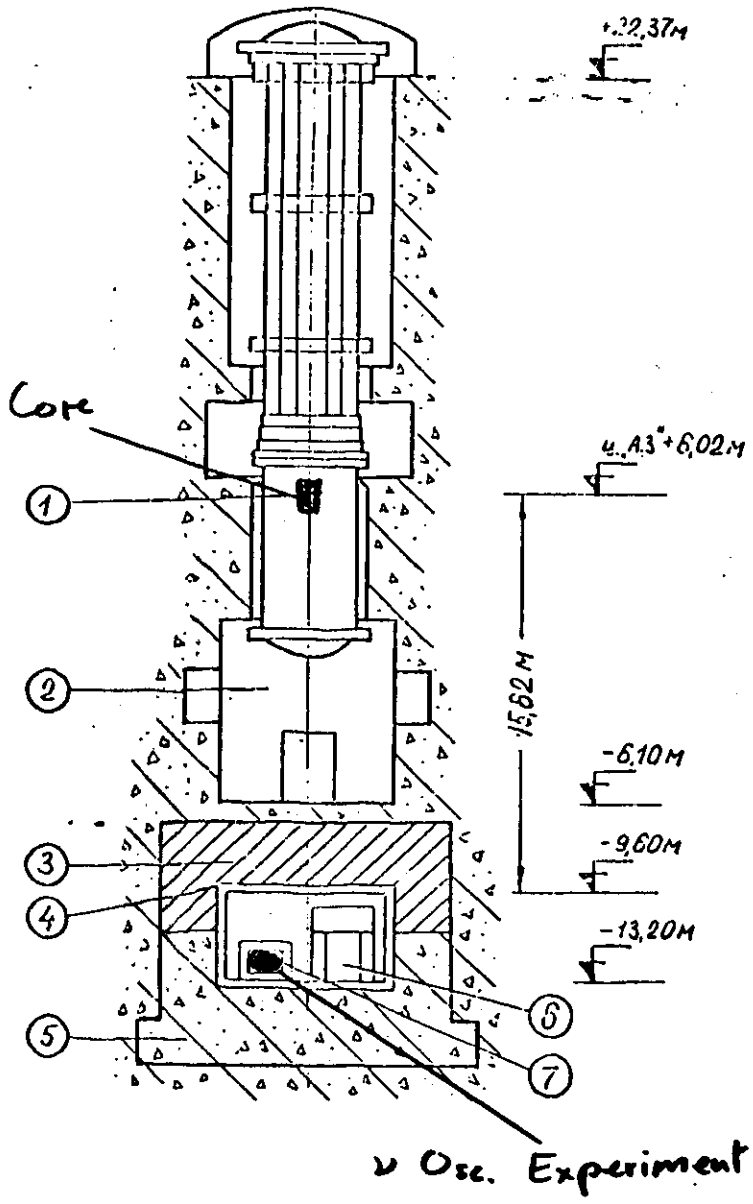


Fig. 2

Rovno

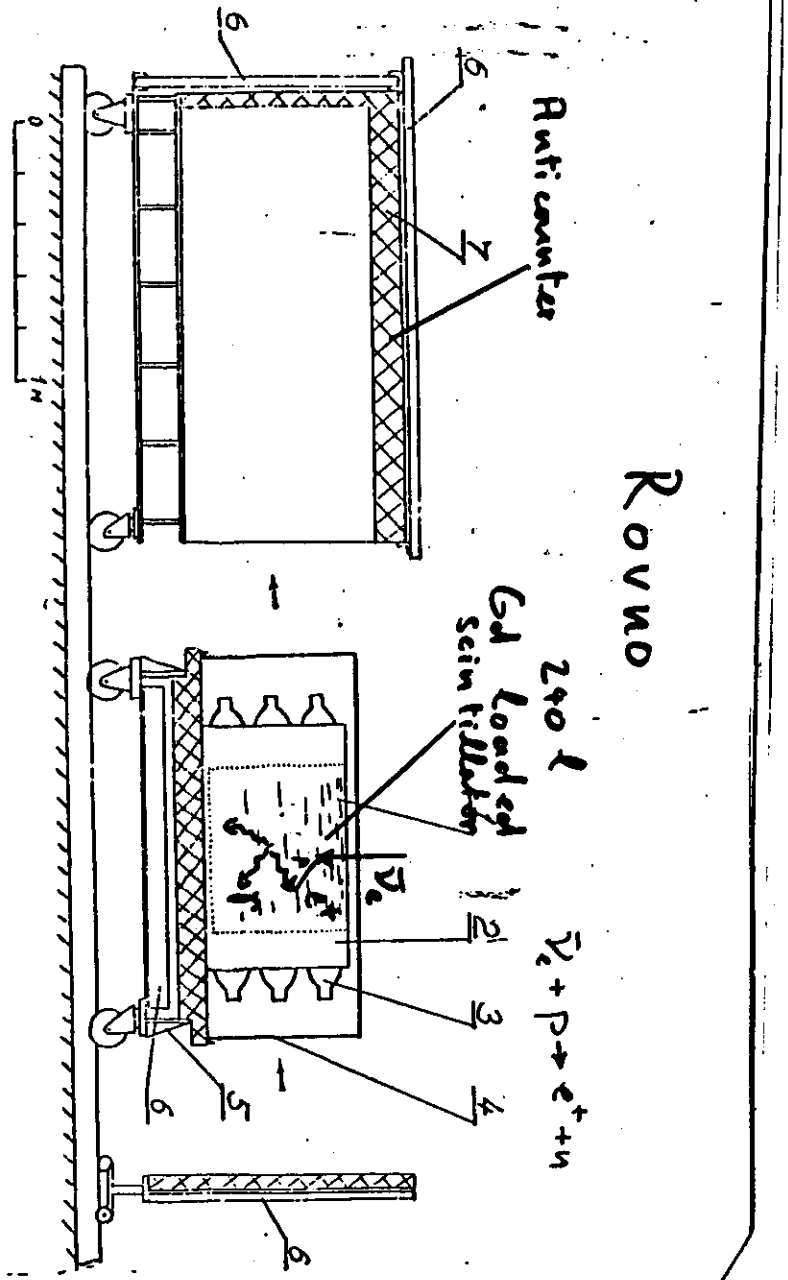


Fig. 3

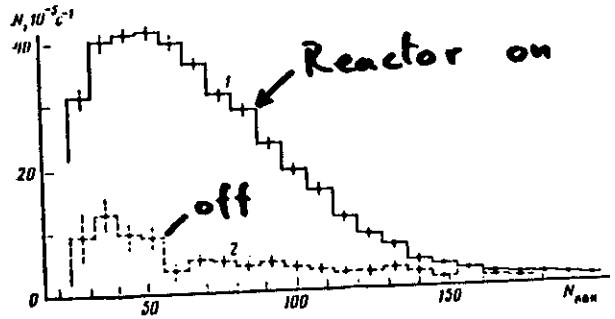
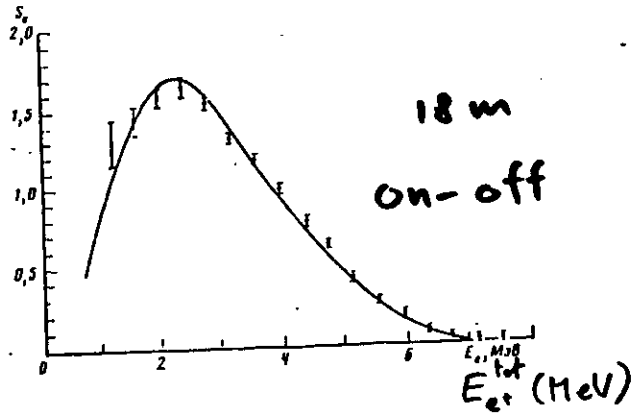
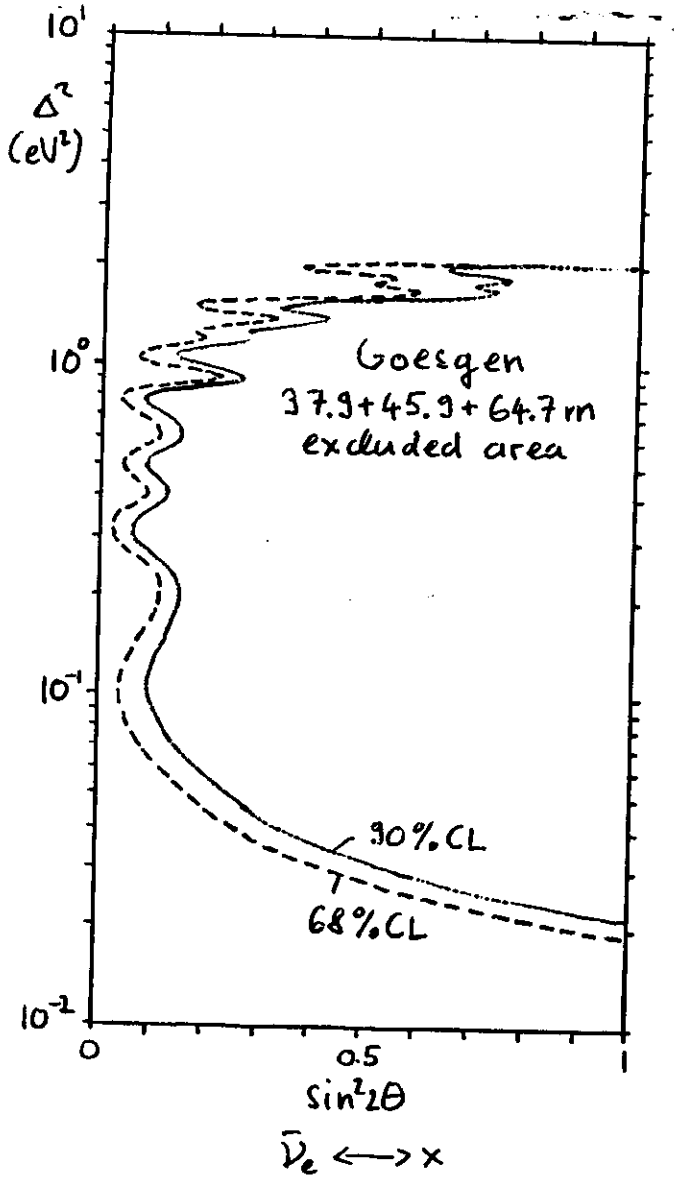
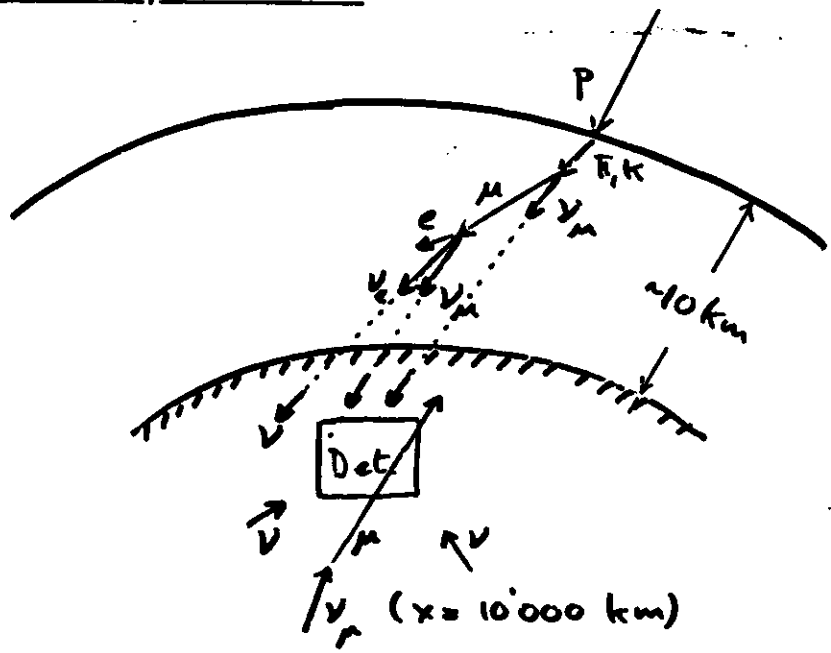


Рис. 7. Спектры, измеренные в эксперименте 3С: *1* – реактор работает (эффект+ +фон); *2* – реактор остановлен (фон). Фон случайных совпадений вычтен





Atmospheric ν's

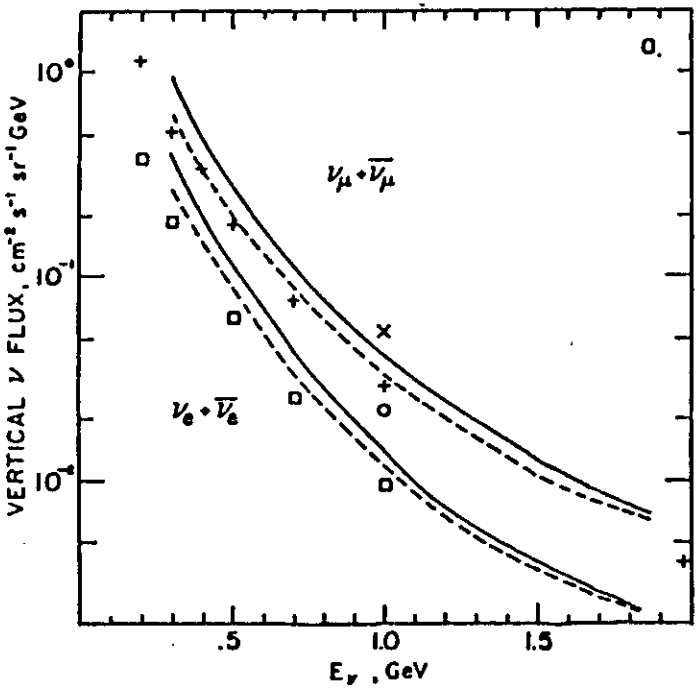


To study ν oscillations:

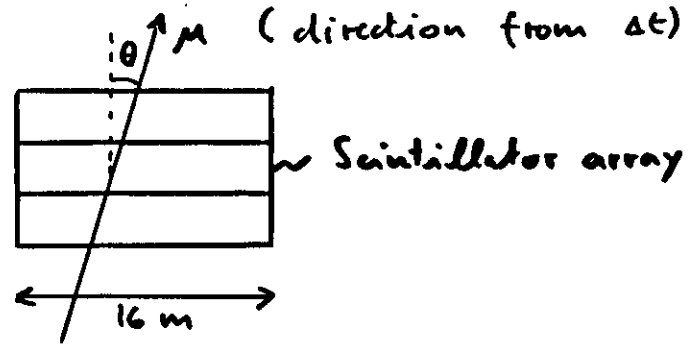
1) $\nu_\mu \leftrightarrow x$: through going μ's: $\frac{\mu(\uparrow)}{\mu(\downarrow)}$

2) $\nu_\mu \leftrightarrow x$, $\nu_\mu \leftrightarrow \nu_e$: contained ν events

Gaisser et al.



Baksan (850 mwe)

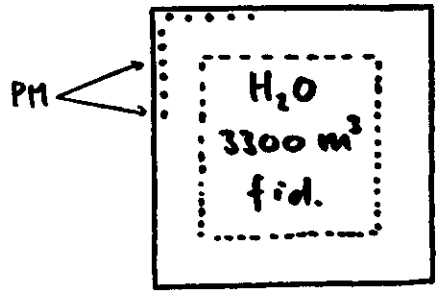


8300 h of data : 21 μ(↑) with $\theta < 50°$

Expected (no $\nu_\mu \leftrightarrow x$) : 22.2

$\Rightarrow$ $\Delta m^2 \gtrsim 6 \cdot 10^{-3} eV^2$ $\sin^2 2\theta = 1$
$\sin^2 2\theta < 0.86$ Δm^2 large (68% CL)

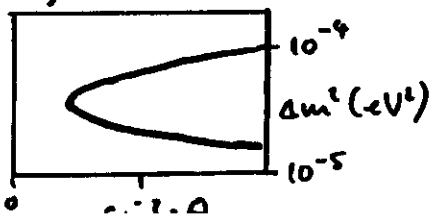
IMB (1700 mwe)



420 d:
401 contained events ($E > 0.2$ GeV)
305 single prong

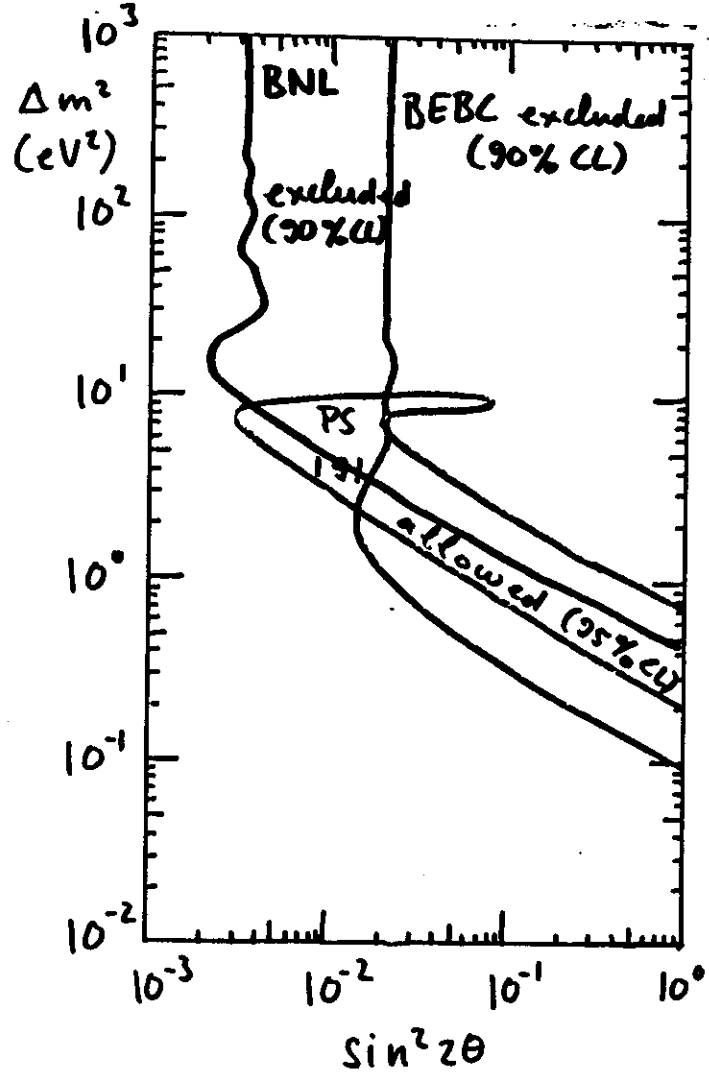
$\frac{\uparrow \frac{1}{5}\Omega}{\downarrow \frac{1}{5}\Omega} = \frac{25 \text{ events}}{25 \text{ events}}$

No e-μ discrimination !



$\nu_\mu \to x$

Baksan, 68% CL



$\nu_\mu \leftrightarrow \nu_e$

2.87 kt·year:

	Data		ν Monte Carlo	
	total	μ-decay	total	μ- decay
Single ring	190	60	250	110
μ-like	85	52	144	104
e-like	105	8	106	6.5
Multi ring	87	34	86	37
Total	277	94	336	147

⇒ Oscillations $\nu_\mu \leftrightarrow x$? $\Delta m^2 = 10^{-2}$ eV!

$\nu_\mu \leftrightarrow \nu_e$?

Requires large mixings

Analysis in progress

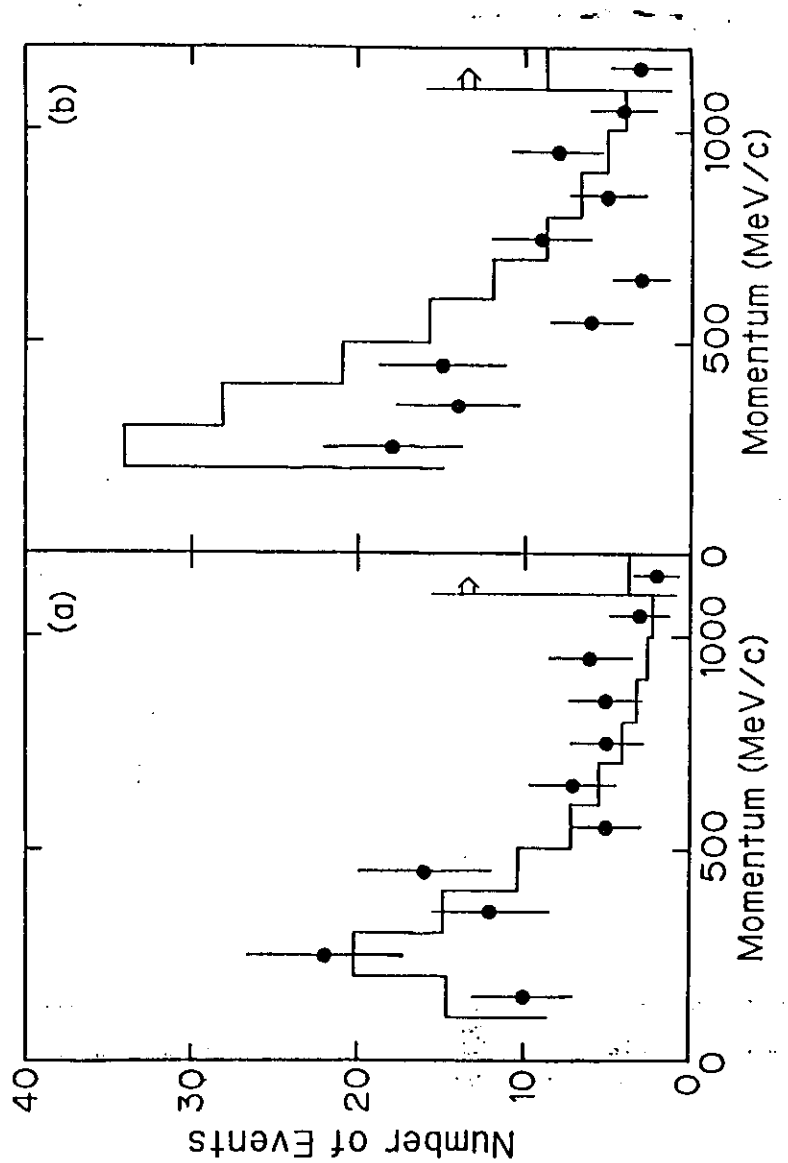


Fig. 1

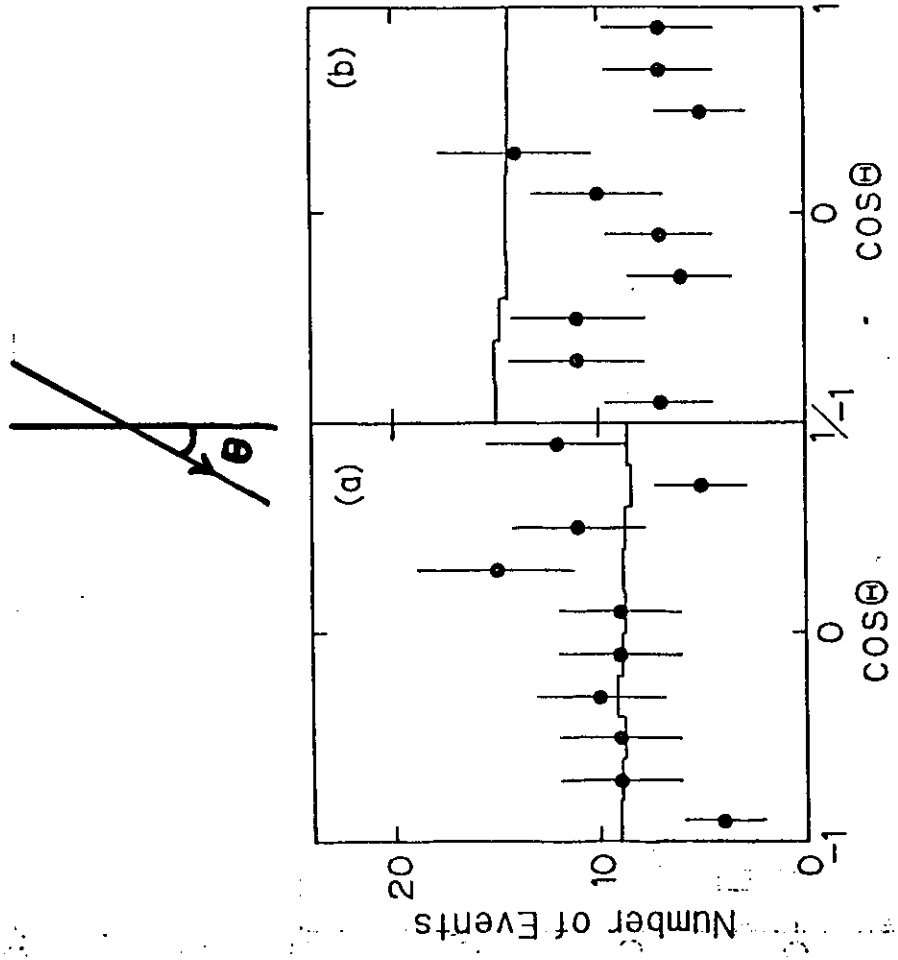


Fig. 2

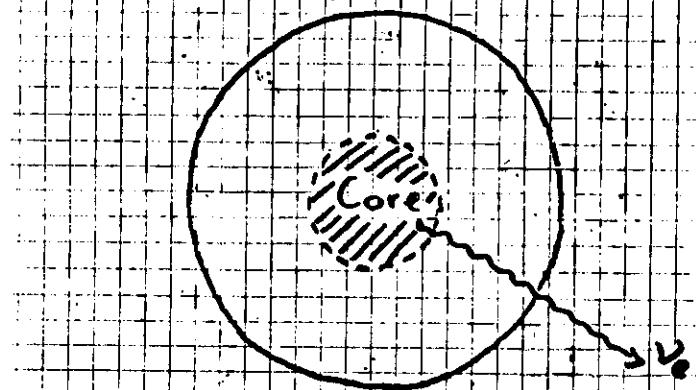
Fréjus: Analysis in progress

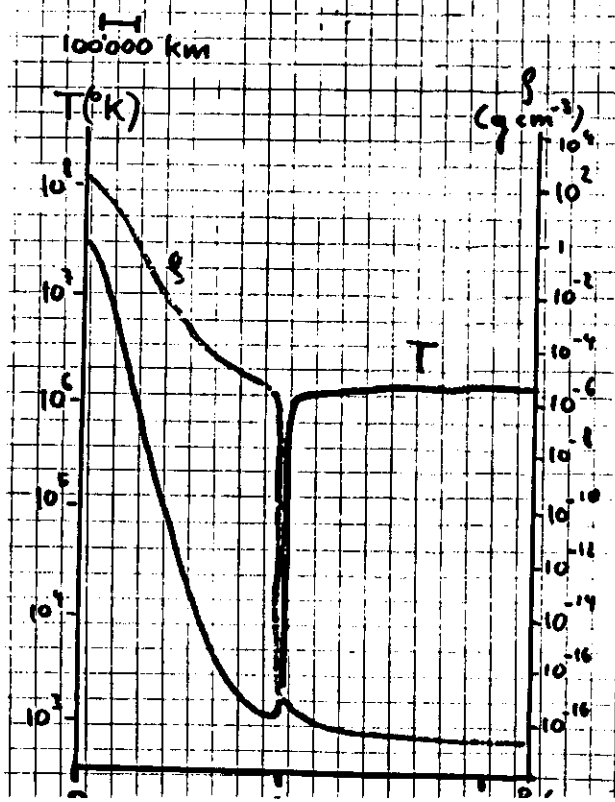
Preliminary:

$$\left(\frac{e}{\mu}\right)_{meas} = 0.57 \pm 0.15$$

$$\left(\frac{e}{\mu}\right)_{calc} = 0.43 \pm 0.05$$

Sun ⊙ ($x = 1.5 \cdot 10^{11}$ m)





Fuel burning in the core:

1) pp chain, 98.5 % of ⊙ energy

$2e^- + 4p \rightarrow {}^4He + 2\nu_e + Q$

$Q = 26.7$ MeV

2) CNO-cycle, 1.5 % of ⊙ energy

p-p chain

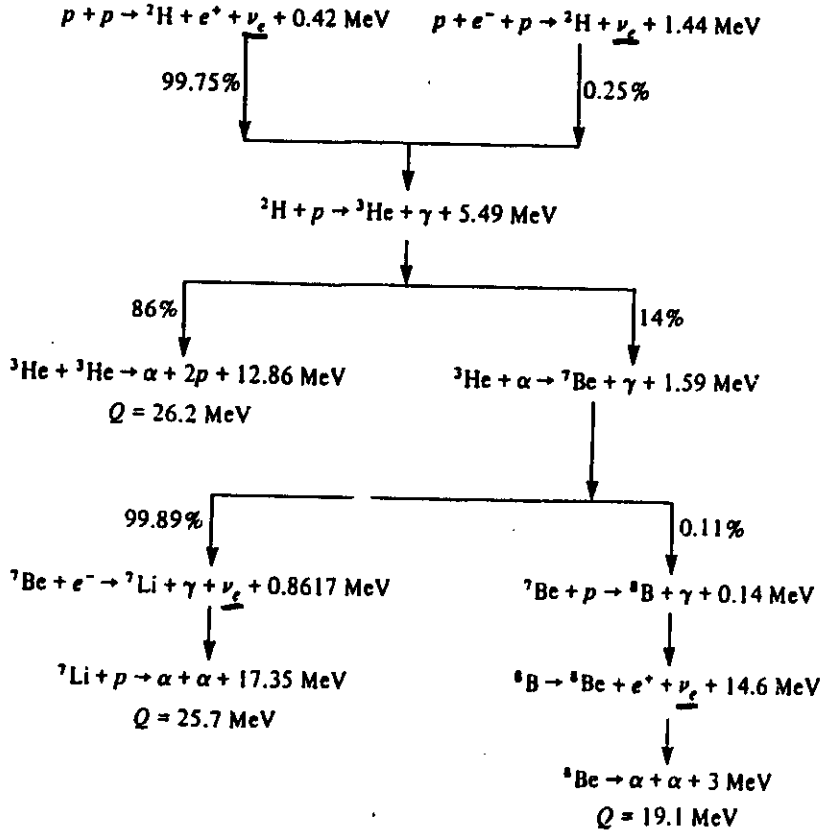
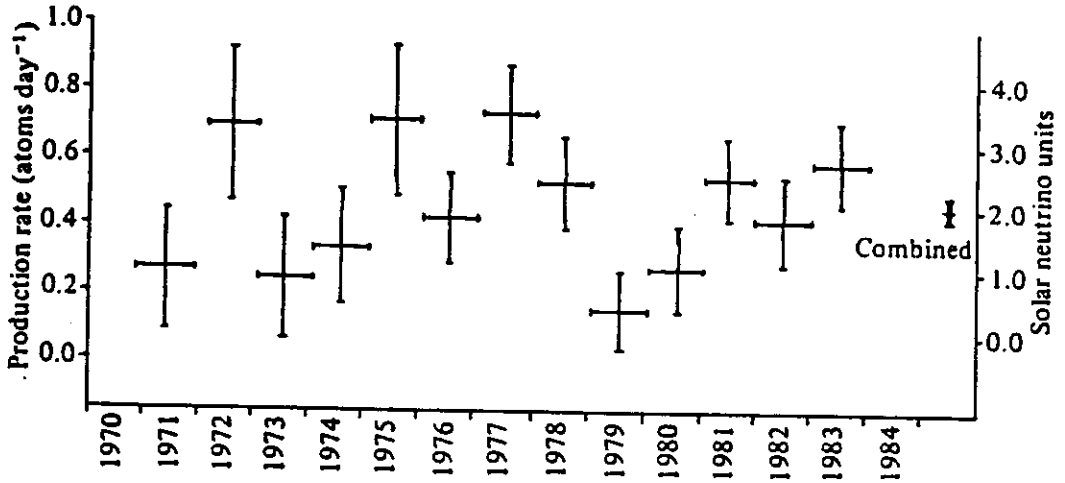
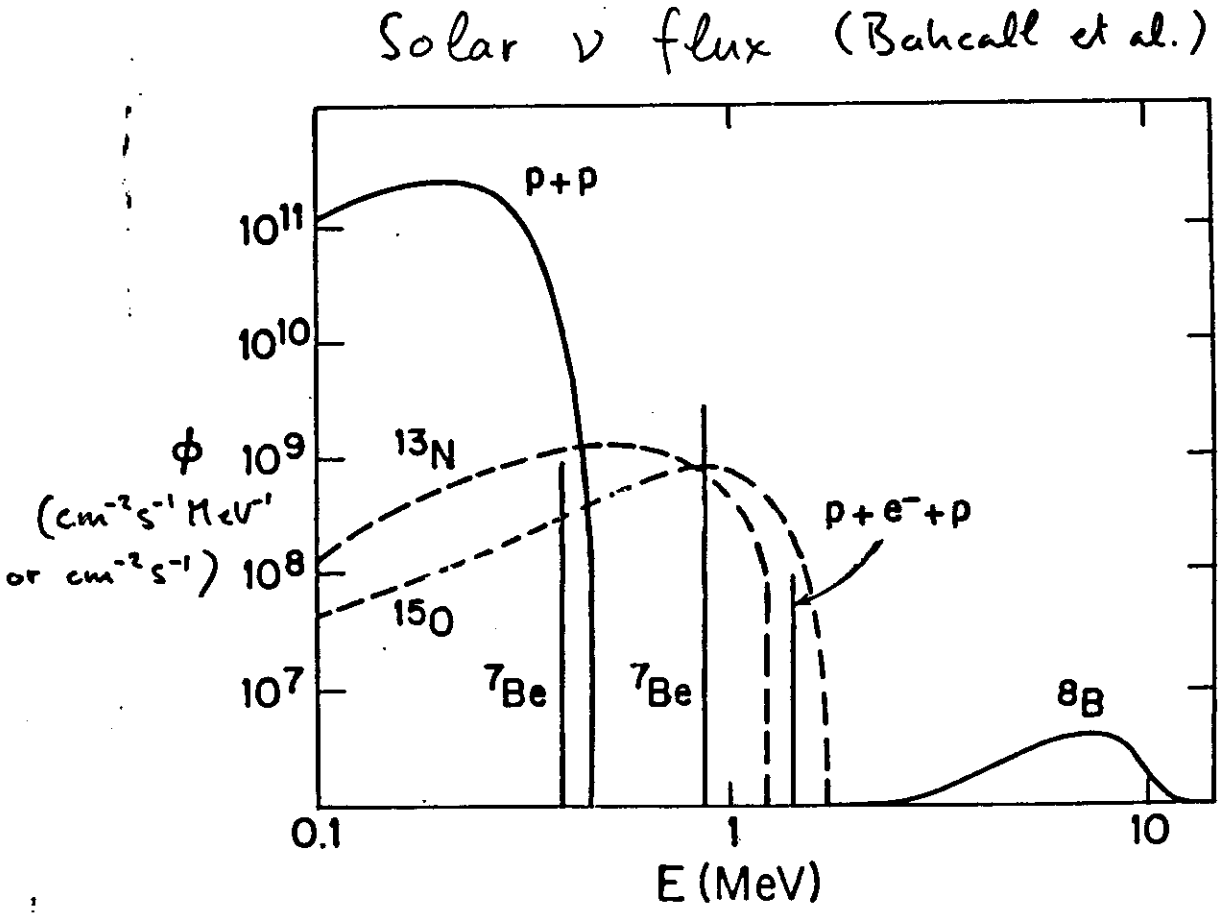


Figure 5.22. Yearly averages of the ^{37}Ar production rate observed in the chlorine solar neutrino experiment.





1) Davis et al., Homestake Gold Mine (4400 m.w.e.)

$$\nu_e + {}^{37}Cl \longrightarrow {}^{37}Ar + e^-$$

$$EC \hookrightarrow {}^{37}Cl + \nu_e + \{\text{X-rays}\}\{\text{Auger}\} \quad (T_{1/2} = 35\,d)$$

Detector: 615 t C_2Cl_4 tank ($2.2 \cdot 10^{30}$ ^{37}Cl)

Periodically (30 d) inject 0.2 cc Ar, purge with He to remove Ar. After separation, fill proportional counter with Ar, look for ^{37}Ar decay:

Measure: 0.46 ± 0.04 atom$\cdot d^{-1}$

Cosmic bkgd: 0.08 ± 0.03 atom$\cdot d^{-1}$

$\Rightarrow$ 0.38 ± 0.05 atom$\cdot d^{-1}$

$\equiv \langle \sigma\phi \rangle_{exp} = 2.0 \pm 0.3$ SNU

(1 SNU $\equiv$ 1 capture$\cdot s^{-1} \cdot (10^{36}$ atom$)^{-1}$)

$\nu_e \leftrightarrow \nu_x$ with $\theta \approx 45°$?

MSW ?

Bahcall et al:

	$\langle \sigma\phi \rangle_{calc}$
p p	0
p<p	0.23
^{7}Be	1.0
^{8}B	5.0
^{13}N	0.08
^{15}O	0.26

$\Rightarrow$ $\langle \sigma\phi \rangle_{th.} = 6.6 \pm 2.3$ SNU