GNO: Status Report

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GNO Collaboration

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subjects

- Short introduction
- Update of GNO results
- Situation at Gran Sasso Laboratory
- Comments on gallium experiments

Motivations: **Measure the solar neutrinos interaction rate, with a low energy threshold,with an accuracy of 5 SNU, over 1 solar cycle.**

The interaction

$^{71}Ga(\nu_e,e)^{71}Ge$ $(E_{thr} = 233$ keV)

EC $\tau = 16.5$ d → ^{71}Ga

ν Signal Composition: (BP00 SSM)

pp + pep	73 SNU	(55 %)
^{7}Be	35 SNU	(27 %)
CNO	8 SNU	(8 %)
^{8}B	13 SNU	(10 %)
Tot	129 SNU $^{+9}_{-7}$ 1σ	

Expected Signal (SSM)

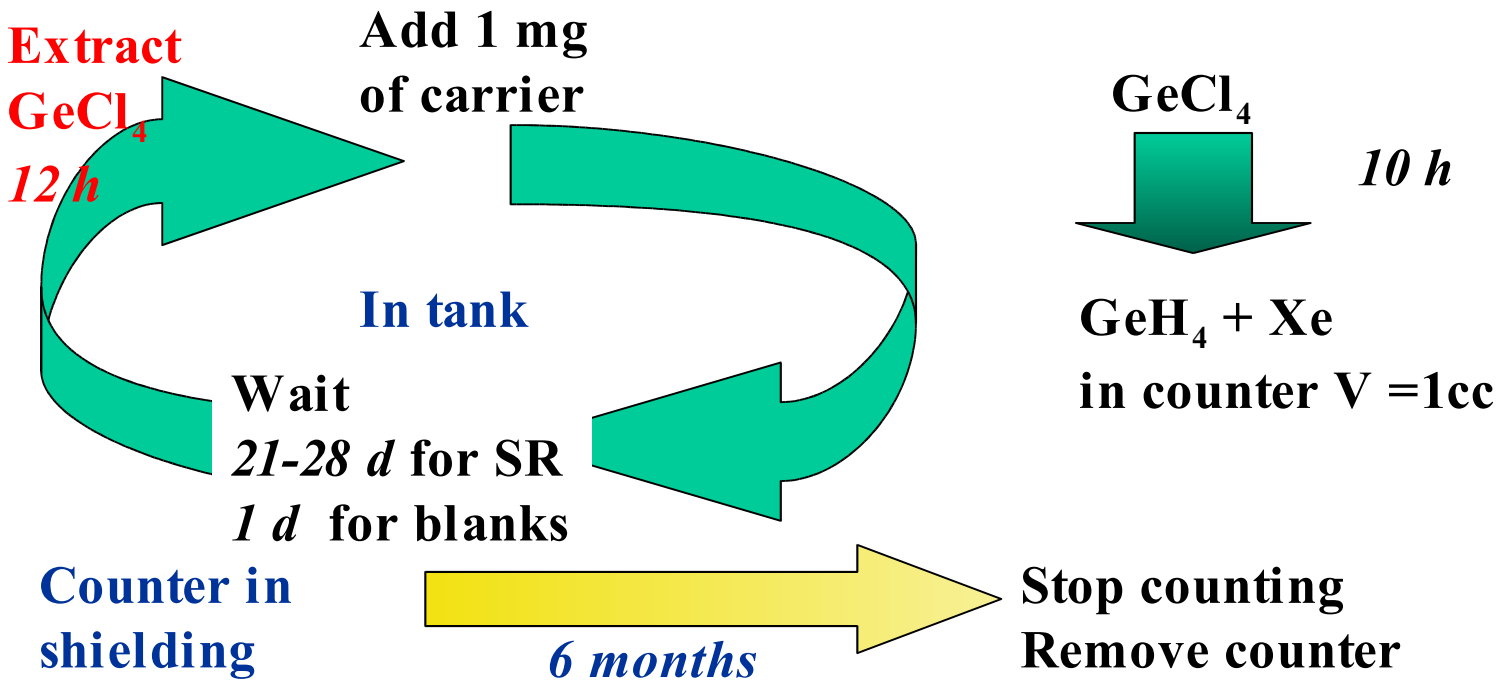
1.2 ν int. per day, but due to decay during exposure + ineff., 9 ^{71}Ge decay detected per extraction (28 days exposure)

Technique

Radiochemical - Target: 30 t of ^{nat}Ga
(12 t of ^{71}Ga) in 100 t of Ga_3Cl acid sol.

Detector description and operation

See f.i. PL B490(2000)16
PL B314(1993)445



GALLEX

1986 - 1990 — **Construction of the detector**

May 1991 – May 1992 — **GALLEX I data taking** (PL B285 (1992) 376, PL B285 (1992) 390)
15 Solar runs, 5 Blanks

83.4 ± 19 SNU

Jun 1994 – Oct 1994 — **1st ^{51}Cr source experiment** (PL B342 (1995) 440)

Oct 1995 – Feb 1996 — **2nd source ^{51}Cr experiment** (PL B420 (1998) 114)

Feb. 1997 — **End of Solar Data Taking** (PL B447 (1999) 127)

GALLEX Final Result

1594 days – 65 runs: **77.5 ± 7.7 SNU**

Feb 1997 – Apr 1997 — **Test of the detector with ^{71}As** (PL B436 (1998) 158)
Extraction efficiency 100%

Apr 1998 – Now — **Start of GNO data taking**

Improvements

Many improvements resulting in a reduction of a factor of ≈ 2 in the systematic error

Item	Gallex	GNO
Target size	0.8%	0.8%
Chemical yield	2.0%	2.0%
Counting efficiency (active vol determination)	4.0%	**2.2%**
Pulse shape cuts	2.0%	**1.3%***
Event sel. (others)	0.3%	0.6%
Side reactions	1.2 SNU	1.2 SNU
Rn-cut inefficiency	1.2 SNU	**0.5 SNU**
^{68}Ge contamination	$^{+1.8\ SNU}_{-2.6\ SNU}$	-

* Neural network analysis

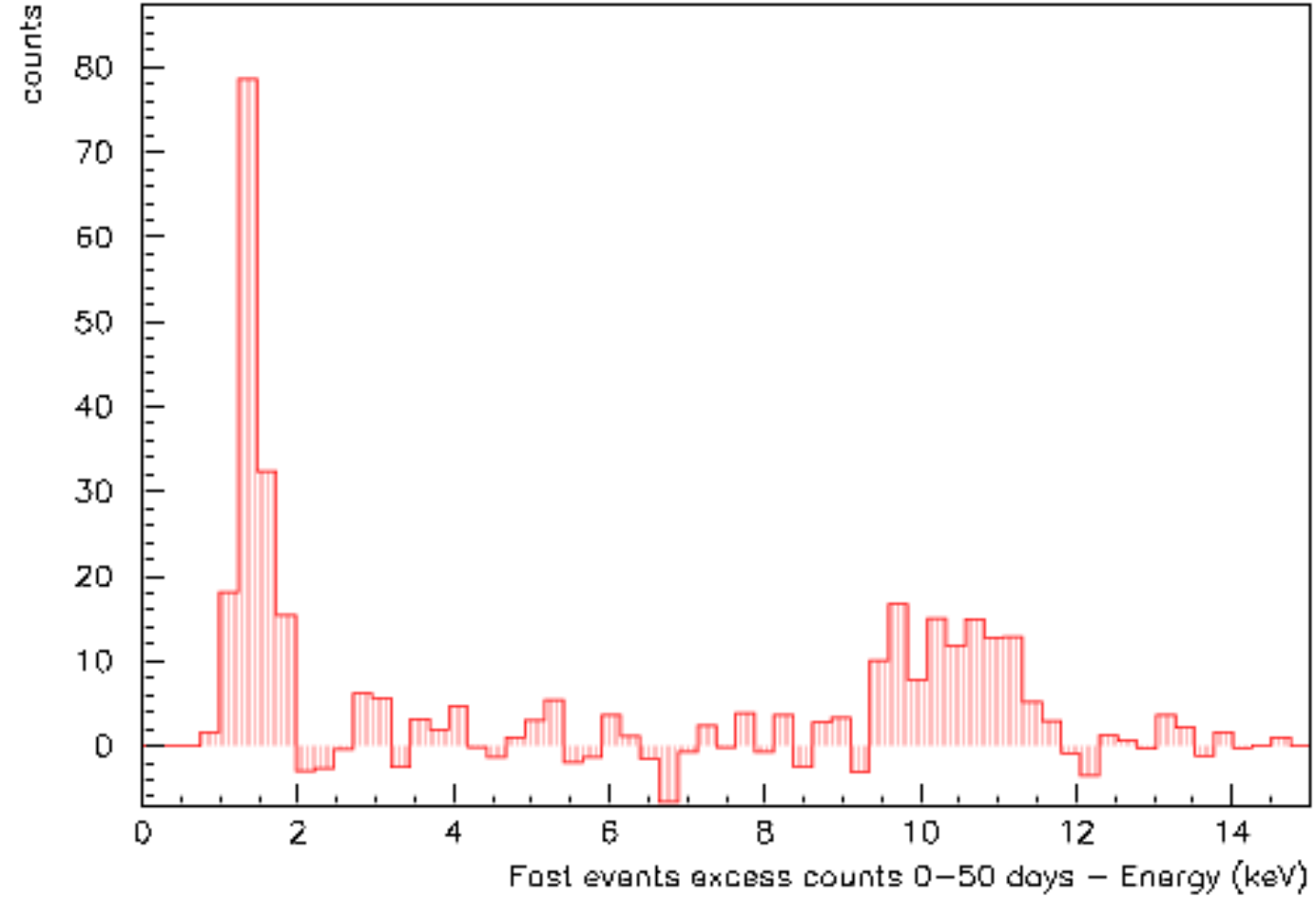
GNO – Results

completed	**58 solar runs**	**1713 days**
blanks	**12**	

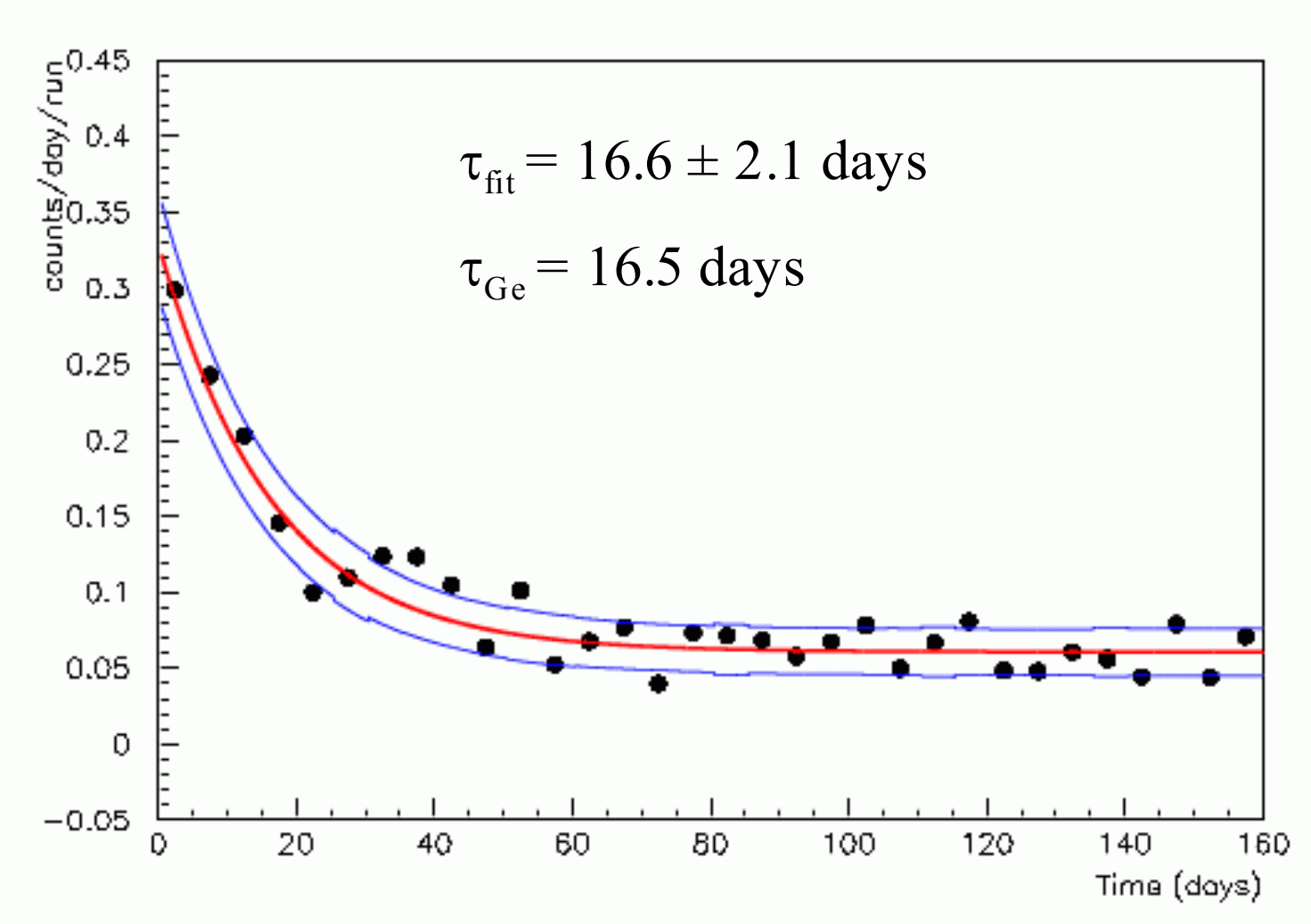
GNO (31/08/2003)	**62.9 ± 5.4 ± 2.5 SNU**
	(L 68. ± 9. K 60. ± 7.)
GALLEX	$77.5 \pm 6.2\ ^{+4.3}_{-4.7}$ SNU
GALLEX+GNO	**69.3 ± 4.1 ± 3.6 SNU**

Further minor improvements expected in a short time (analysis of counter calibration data…)

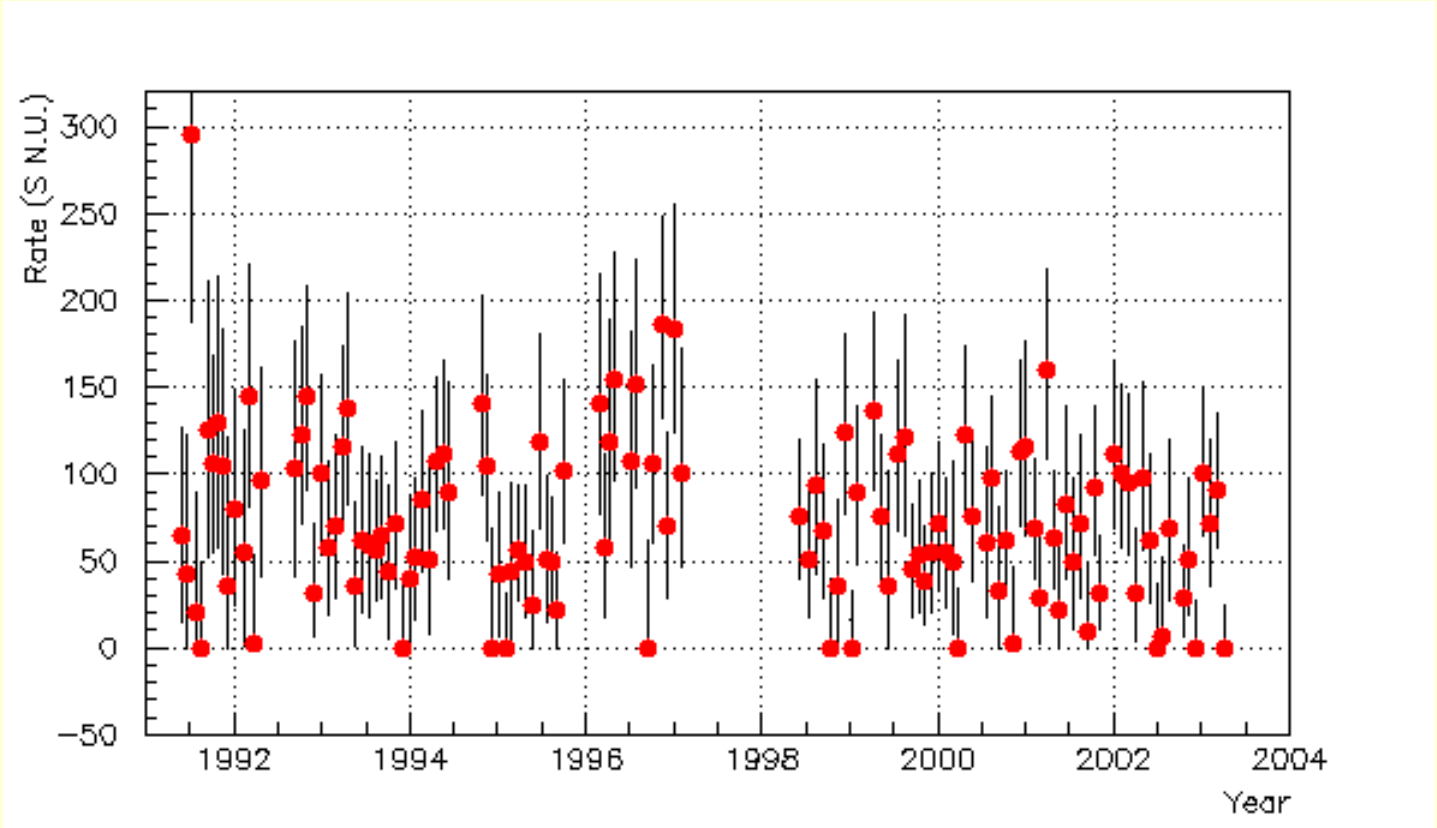
GNO – Energy distribution



Time distribution



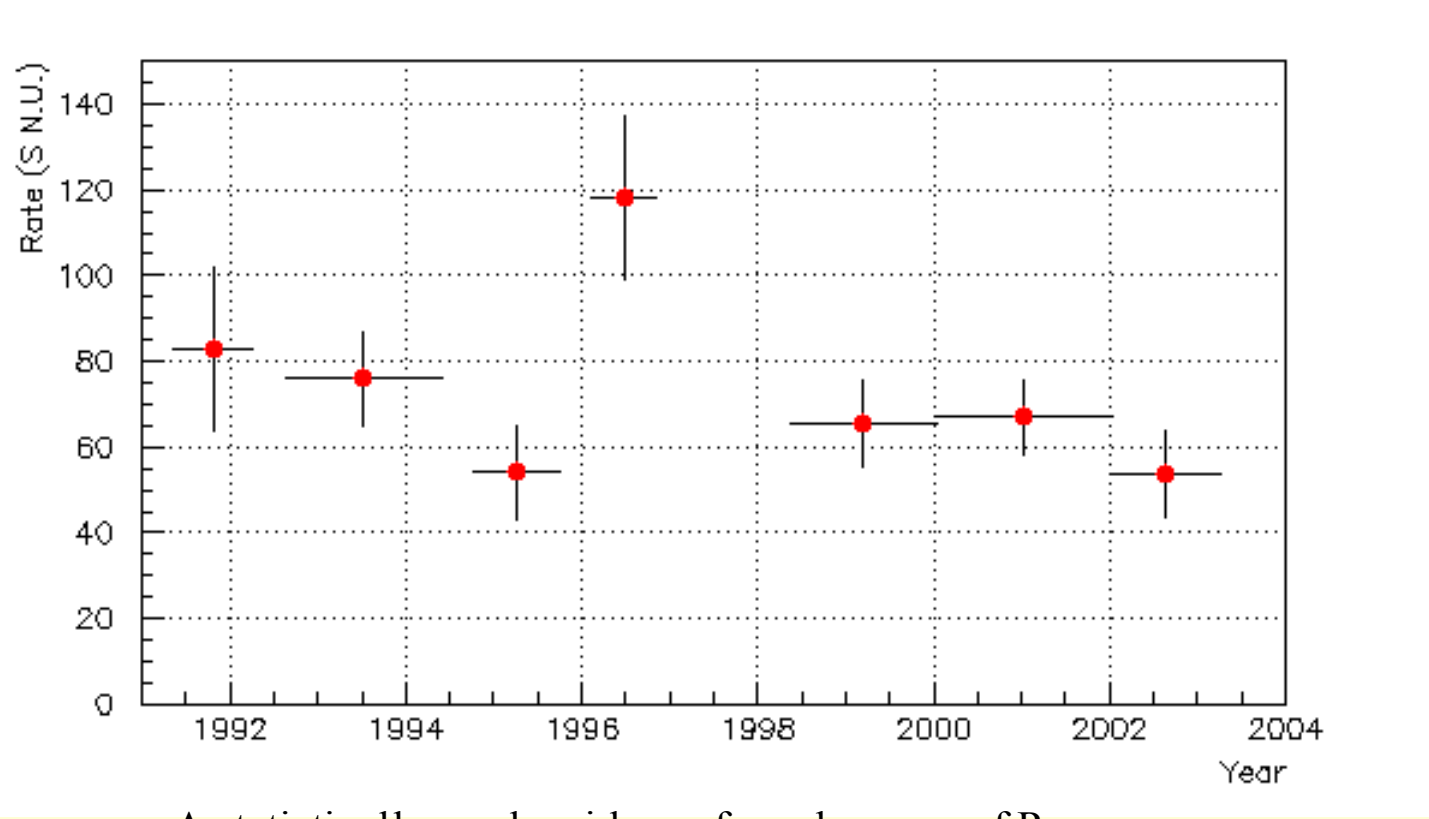
GALLEX - GNO
Davis plot



GALLEX
65 solar runs

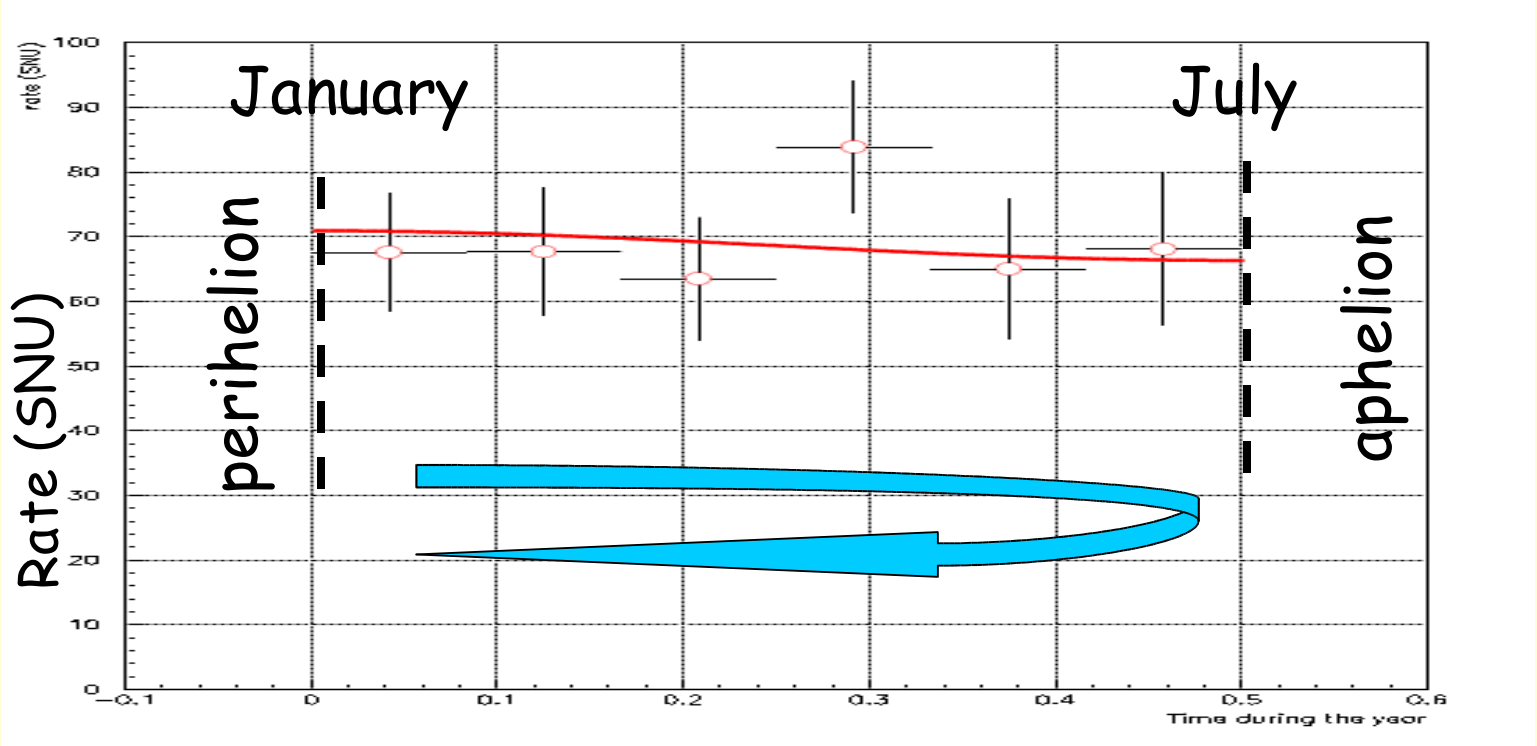
GNO
58 solar runs

GALLEX – GNO



A statistically weak evidence for a decrease of R
Further checks planned

GALLEX +GNO
Seasonal variations



Flat: χ^2= 2.7 (5 d.o.f.), g.o.f.: 75%

Elliptical: χ^2= 3.0 (5 d.o.f.), g.o.f.: 70%

GALLEX +GNO
Seasonal variations

Winter-Summer (statistical error only):

GNO only (58 SRs):

Winter (32 SR): $58.7^{+7.1}_{-6.8}$ SNU

Summer (26 SR): $69.0^{+8.8}_{-8.3}$ SNU

W-S: -10 ± 11 SNU

GNO + Gallex (123 SRs):

Winter (66 SR): $66.5^{+5.6}_{-5.4}$ SNU

Summer (57 SR): $74.1^{+6.4}_{-6.2}$ SNU

W-S: -7.6 ± 9 SNU

The situation at LNGS

In one word:

A very difficult situation:

main risks: judiciary attachment of the hall A

(see situation of Hall C)

water spill leakege close to GNO main building

….

We are not allowed to operate the experiment since April

No clear date for restarting the experiment

Therefore:

it is better to consider GNO as a concluded experiment

Comments and conclusions

Gallium radiochemical experiments have demonstrated to be reliable

At present, the only existing technique to measure the low energy part of the neutrino spectrum

Output of the measurement:

R_{Ga} with a given sampling frequency

Number of events essentially defined by mass

$R_{Ga} = 2.9 10^{-2}$ evt.s/(ton. ^{nat}Ga x SNU x day)

N evt.s = R x τ (1.- exp(-T/τ))

Some flexibility on T (2- 4 weeks)

Comments and conclusions (cont.)

Achievable accuracies:

3 years of running; 4 weeks runs; 60% efficency; 70 SNU signal

Systematic error: 2.5 SNU (GNO); not large improvements possible

	30 tons (GNO)	80 tons (available gallium)	160 tons
Det.evt.s	195	519	1040
Total accuracy	7 SNU	4 SNU	3 SNU

Comments and conclusions (cont.ed)

From the rate (assumption: no time variations)

Oscillations: p-p ν no matter effect

^{8}B strongly affected by matter effect

Then : consistency check

Fluxes:

R_{Ga} is essential to evaluate

(without or with the luminosity constraint)

p-p and CNO (^{7}Be) fluxes

e.g. with 4 SNU error and lum. constr.

CNO flux limited to be less than 2 x SSM

Note: present central value of GNO is at the border of the physical region

Comments and Conclusions (cont.ed)

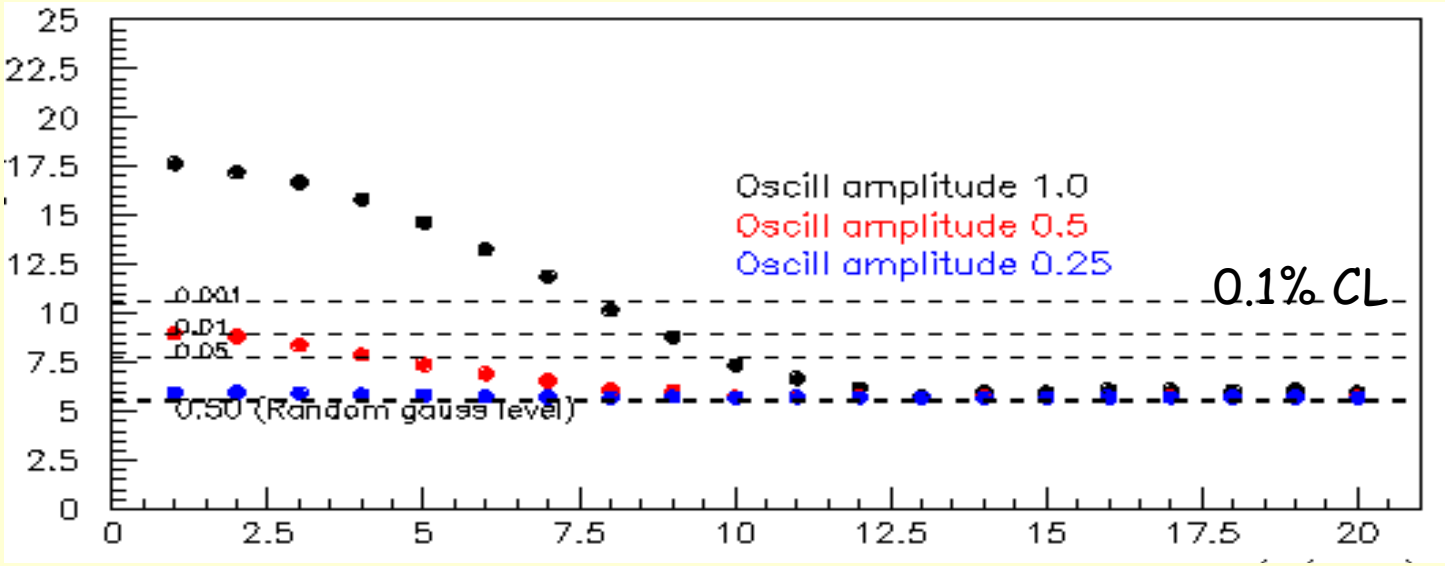
Time Variations:

See also the Caldwell talk

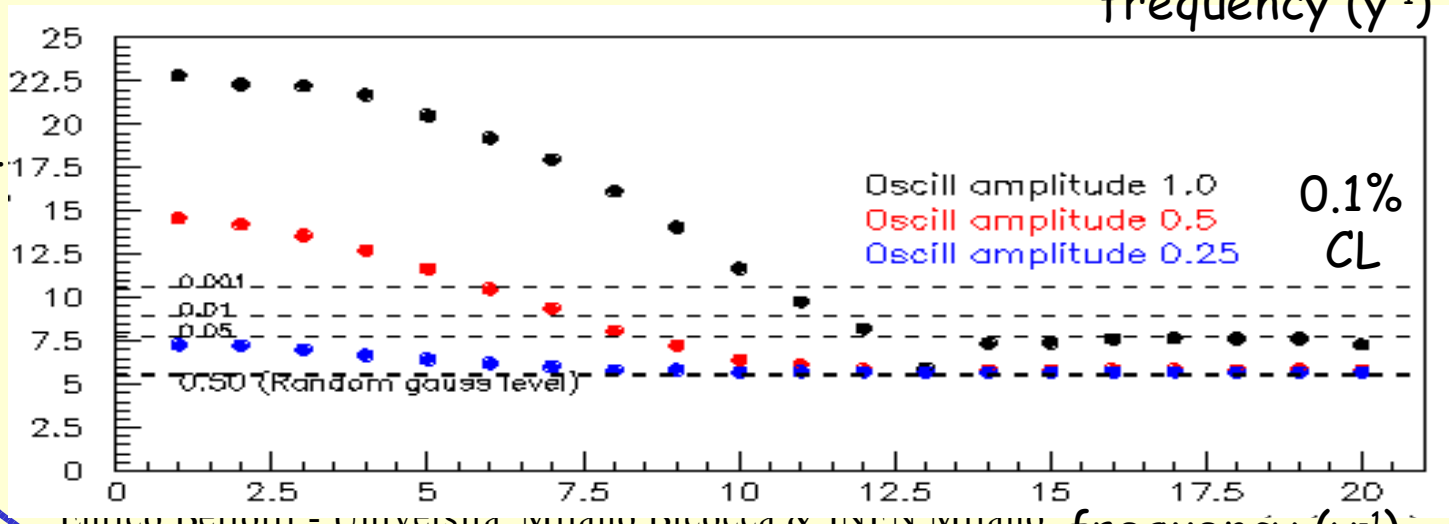
sensitivity

Lomb-Scargle analysis

L.-S. time series analysis of 58 simulated GNO-like



40 SNU error on single sun



25 SNU error on single sun

ν ^{71}Ga cross sections

Cross sections are needed to compute fluxes from rate

At low energy (< 410 keV) only g.s.-g.s.transitions are present; cross sections evaluated from ^{71}Ge E.C.

good accuracy (2.3% at 1 σ)

At the ^{7}Be energies, the first two excited state (at 175 and 500 keV) must be considered; BGT estimated from p,n reactions;

estimated accuracy –3% +5%

Direct measurement desirable

Cross sections/2

Experimental situations

Two GALLEX and one SAGE calibrations,

R(meas./comp.) = 0.91±0.07

Improvements are well possible

Final accuracy 5% or better = theoretical accuracy

Corrections to g.s.-e.s. only or to g.s.-g.s.cross sections?

A Gallium experiment with a reasonable (100 tons?) mass would be of high scientific interest for neutrino and solar physics