attributed to the p-p neutrinos,other important contributions are made by neutrinos from ^{7}Be(34 SNU) and ^{8}B(14 SNU). Since the number of p-p neutrinos produced in the sun is fixed by the solar luminosity, the Ga-Ge experiment should prove crucial in choosing between the solar model and particle physics solutions to the solar neutrino problem. Two experiences are in preparation; The GGNT Gallium-Germanium neutrino telescope built in the baksan Valley of the Northern Gaucass, USSR (soviet-American Gallium Experiment :S.A.G.E) and the Gallex at Gran Sasso (Italie)(European - American Experiment).

I) ILL EXPERIMENT REANALYSIS :

In the spring of 1990, it was annouced that the operating power of the high-flux reactor of institut laue langevin (ILL), Grenoble, FRANCE, had been incorrectly reported since its earliest days of operation. One impact of this is that the ILL reactor was operated at 1.095 times it's rated full power (57 MW thermal). It also affects the results of experiment conduced by a collaboration from caltech, Munich, and ISN-GRENOBLE wich searched for neutrino oscillations at ILL reactor in early 1980. THe expected yield of that experiment as reported by kwon et al. (ref.3) should now be increased by 9.5%.

The possible implications of neutrino oscillations resulting from the wrong normalisation applied in the analysis of Ref.3 stimulated the present reanalysis of that experiment.

Other normalisation factors :

In addition , other constants wich are used to normalise the inverse beta decay spectrum one measures near a fissining reactor, have changed since 1980.

-First, there have been refinements in the determination of the antineutrino source spectrum that one expects from a reactor. In the case of the ILL reactor, about 93% of the neutrino are from fission of U235. The neutrino spectrum used to find the expected yield in ref 2 was that couverted from the measured beta spectrum from the reactor by schreckenbach et al.(ref.4). An improved spectrum done in a similar manner at ILL was published later (ref.5) wich, if applied to ILL neutrino oscillations analysis, enhances the normalisation of the yield by nearly 5%

Other corrections are connected with the inverse beta decay cross section. In ref.3, there was no attempt to corret for proton recoil, weak magnetism (ref.6) , and other effects that were account for in subsequent neutrino oscillations experiments. Also, the neutron lifetime used the earlier work was 926s and now is 616± 3s, wich boosts the cross section by ~ 5%

All the changes above result in an estimated net increase in the normalisation of the ILL experiment of ≈ **20%.** What is the source of this difference between experiment and theory ? One plausible reason for the difference is that there was mistakes or wrong assumptions made when calculating the pedicted yield or limitations in the monte-carlo code employed.

II) Purpose of present simulation studies

The purpose of the present work is to repeat the simulation studies of the ILL detector response to positrons using a completely different Monte carlo code. The resulting response functions (fig.1) are then used to calculate the expected yield from the ILL experiment taking into account the local neutron efficiencies at each point of the detector. This yield is normalised to solide angle and the reactor power in order to compare to the experimental data. This is done first assuming no oscillations taking place (fig.2) and then again with a two-state neutrino oscillations probability function incorporated. This probability function is parameterised by the mixing angle and the difference of the square of the masses associated with two mass eigenstates.

Theorical Positron spectrum :

The expected positron yield $Y(Ee+, L, \Delta m^2, \theta)$ per Mev and hour is given by :

$$Y(Ee^+, L, \Delta m^2, \theta) = N_p.\mathcal{E}_n(tc) \int\int \phi\,(E\vartheta_e, \Delta_{12}^2, \theta, L')\, R\,(E_{e^+}, E'_e+).\sigma(E^-_{\vartheta_e})$$

$$X\, N_F\, X\, A(PSD)\;\; h(L,L')\; dE'e+dl'$$

were $Ee^+ = E_\upsilon - 1.8O4$

$$\phi\,(E\vartheta_e, \Delta_{12}^2, \theta, L') = \frac{S\,(E^-_{\vartheta_e})}{4\eta L'^2}\left[1 - \frac{1}{2}\sin^2 2\theta\, \sin^2 1.27\,\frac{\Delta_{12}^2 L'}{E^-_{\vartheta_e}}\right]$$

NF : Number of Fissions/ hour
A(PSD) : .98 PSD Acceptance

$\varepsilon_n(tc = 200\mu s) = .1914$ neutron efficiency in the time window of 200µs.

The expected spectrum for the no-oscillations case is shown in the (fig.2)

Systematic errors affecting the positron spectrum are summarizd as follows :

(1) the uncertainty of in the normalisation of the intensity the
(2) The uncertainty in the neutron detection efficiency : 6,5%.
(3) Power reactor 1%
(4) The uncertainty of neutron efficiency stabilily : 1,5%
(5) The uncertainty of rejection criteria : 1.5%
(6) The uncertainty on the number of protons : 1.5%
(7) The uncertainty on the cross-section : 2%
(8) The uncertainty on the energy release per fission : 1.5 %

Thus, there is a resulting total systematic error of 8.87% which is essentially energy independant.

$$\sigma_{tot} =(\sigma_{stat}^2 + \sigma_{syst}^2)^{1/2} = 9.538$$

III) **Results and discussion** :

The ratio of the experimental to expected integral positron yield for Ee+> 1 Mev is found to be :

$$R = \frac{\int Y_{exp} (Ee^+)\, dEe^+}{\int Y_{th} (Ee^+,L,0,0)\, dEe^+} = .832 \qquad \pm 0.035 \text{ (Statiscal)}$$

$$\pm 0{,}0887 \text{ (Systematic)}$$

In order to test the compatibility of a certain oscillations hypothesis $(\Delta m^2, \theta)$ with the measurement, the folowing χ^2 square expressions was defined :

$$\chi_F^2 = \frac{1}{16}\sum_{i=1}^{16} \frac{(R^{-1}Y_{exp}(E_e^+) - Y_{th}(E_e^+, L, \Delta,\theta))^2}{\sigma_i^2(stati)}$$

$$\chi_N^2 = \frac{(R - 1)^2}{\sigma_{syst}^2 + \sigma_{stat}^2\,)}$$

$$\chi_S^2 = \chi_N^2 + \chi_F^2$$

$$R = \frac{\int Y_{exp}\,(Ee^{+})\,dEe^{+}}{\int Y_{th}\,(Ee^{+},L,\Delta,\Theta)\,dEe^{+}}$$

To determine the confidence level we calculate the distributions of $\chi^2{}_F$, $\chi^2{}_N$, and $\chi^2{}_S$ for many simulated experimental spectra by scattering the individual data points according to a Gaussian distribution with variance given by σ_i(statist).

- Therfore we define a $\chi^2{}_N$, $\chi^2{}_f$ and $\chi^2{}_s$ corresponding to 68%, 90% and 95.4%,(fig.3-4-5)for $\chi^2{}_N$, (fig.6-7-8)for $\chi^2{}_F$, (fig.9-10-11)for $\chi^2{}_S$.

The minimum of $\chi^2{}_s$ is obtained for $\Delta m^2 = 2.23ev^2$, $\sin^2 2\theta = 0.31$

$$\chi^2_S(2.23,\ 0.31) = 0.45$$

In conclusion, the reanalysis of ILL experiment shows a depletion of 20% in the neutrino flux. An interpretation of this integrated counting difference between the experimental and the expected spectra (fig.12) by simple two-neutrino oscillations scheme exclude the no oscillations case at 2 σ level (fig.11). The parameters of neutrino oscillations deduced from this reanalysis are : $\mathbf{\sin^2 2\theta = 0.31}$, $\mathbf{\Delta m^2 = 2.23ev^2}$ (fig.12).

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Ref.2 K.S.Hirata et al. , Phys.rev D38 : 488(1988)
Phys.Rev.Lett 63: 16(1989)
Ref.3 H-kwon et al. Phys.rev 24D ,1097(1981
Ref.4 K-schrekenbach Phys.lett 99B 251(1981)
Ref.5 K-schrekenbach Phys.lett 99B 251(1981)
Ref.6 P-Vogel Phys.Rev 29D 1918(1984)
S-A-fayans,Sov-J-Nucl-Phys,42(4)

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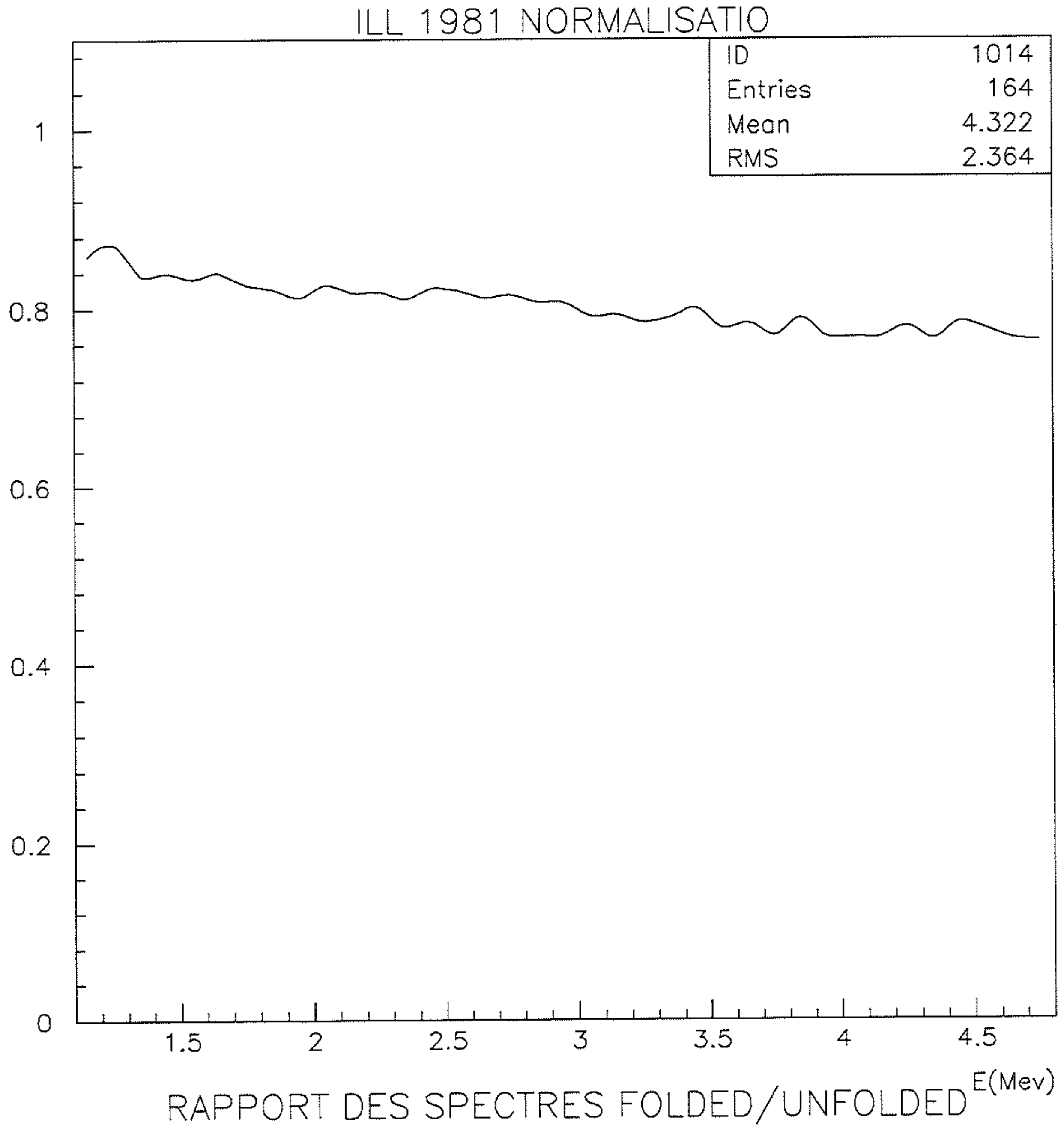
ILL 1981 NORMALISATIO
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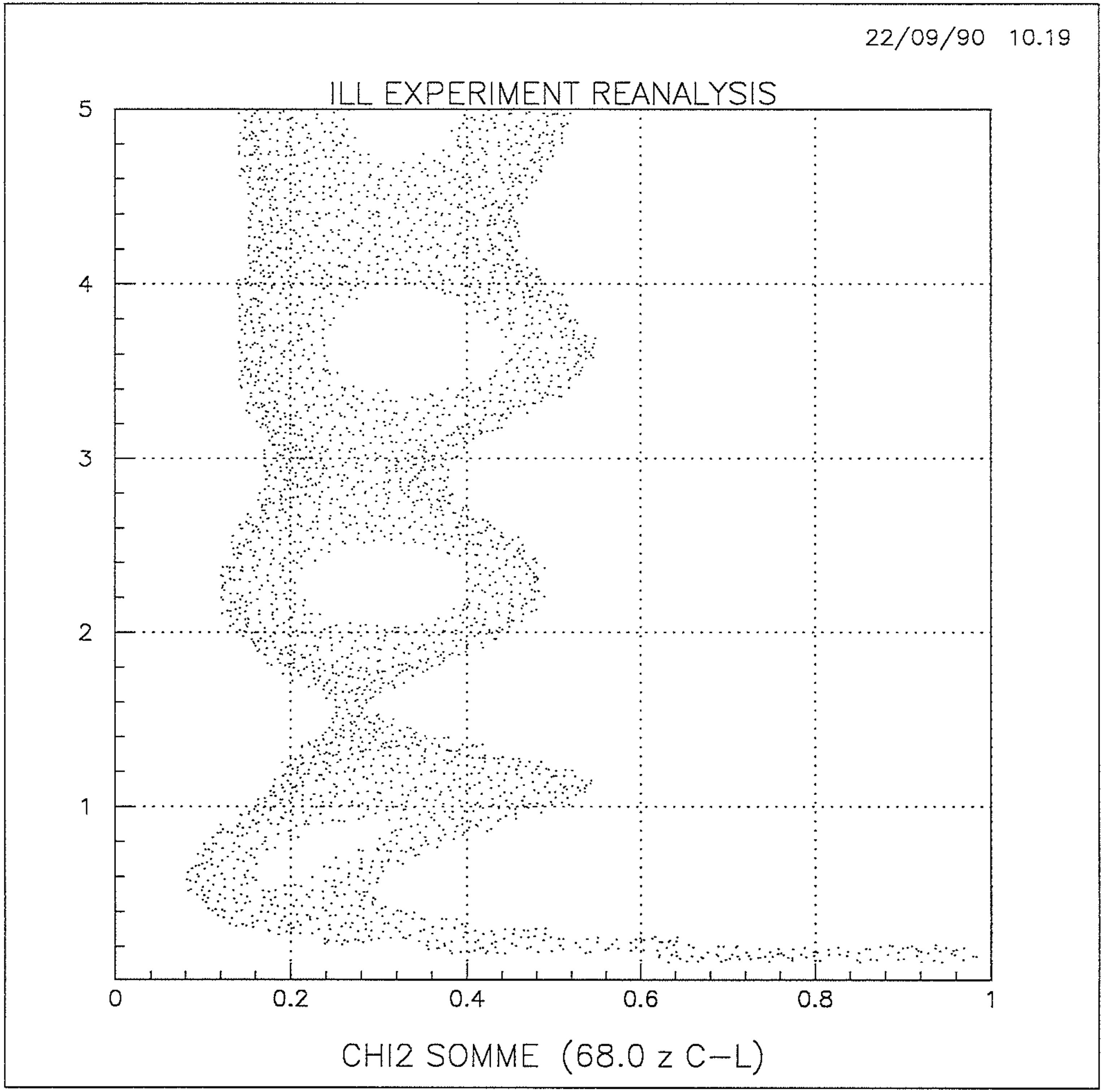
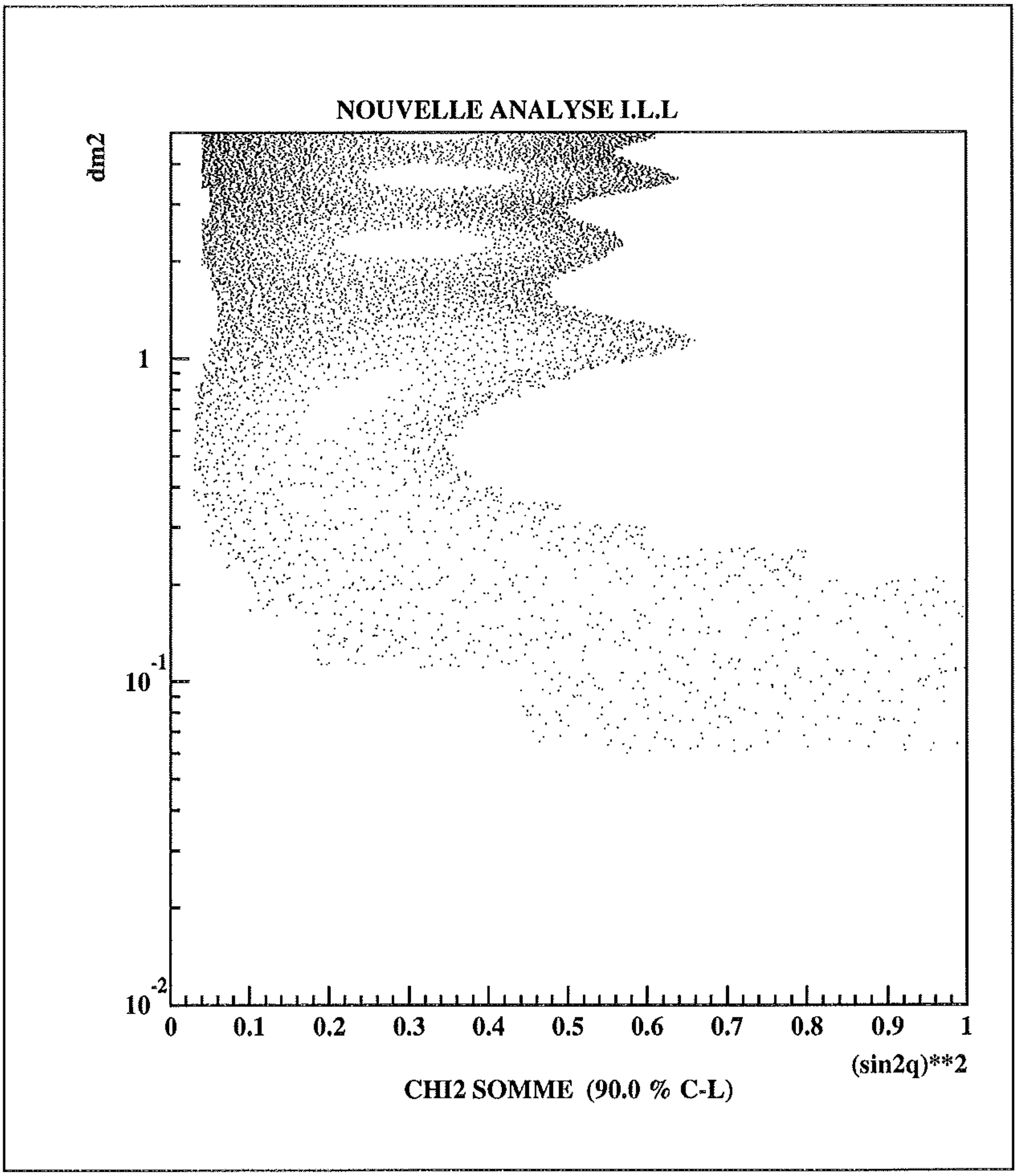
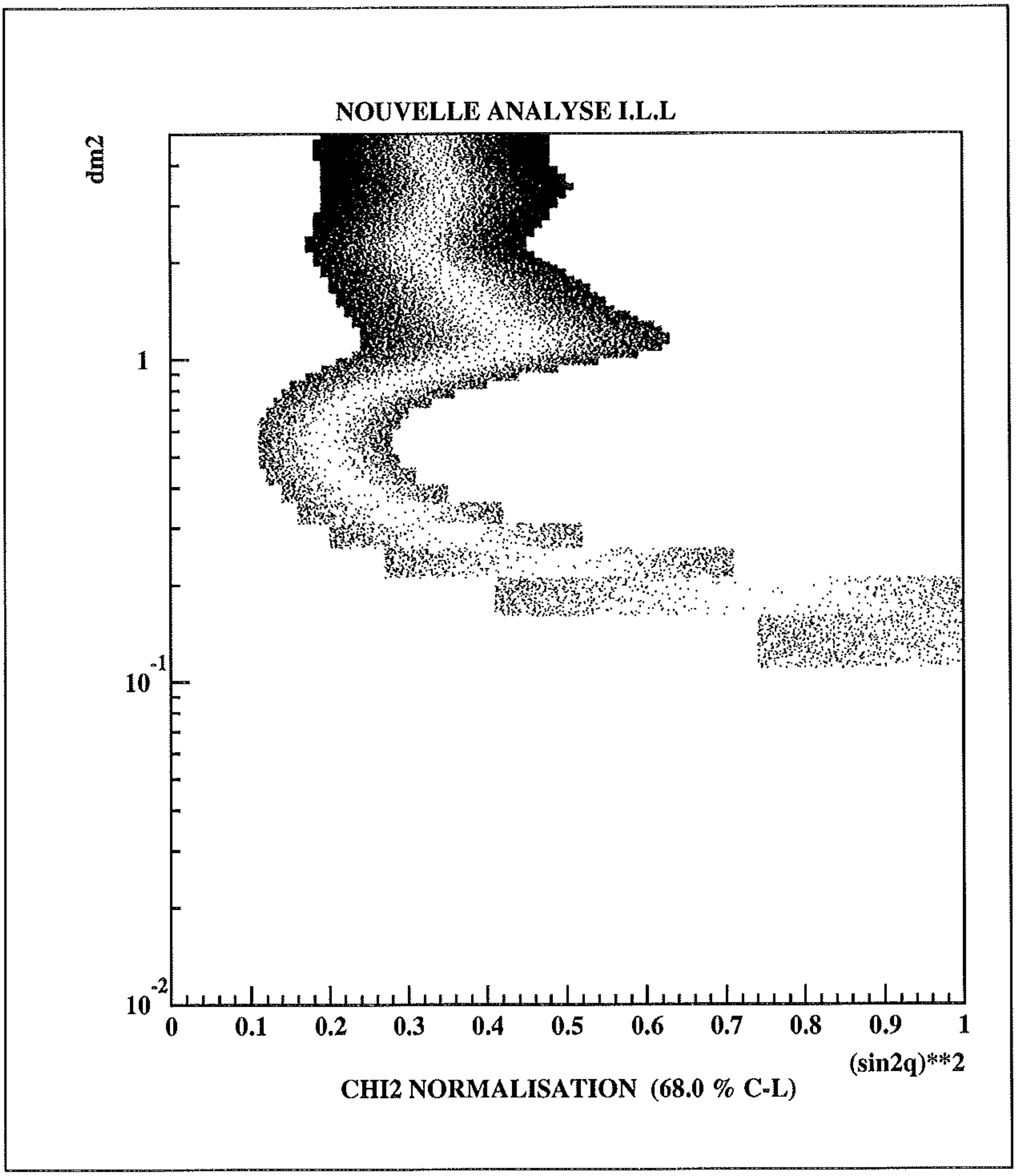
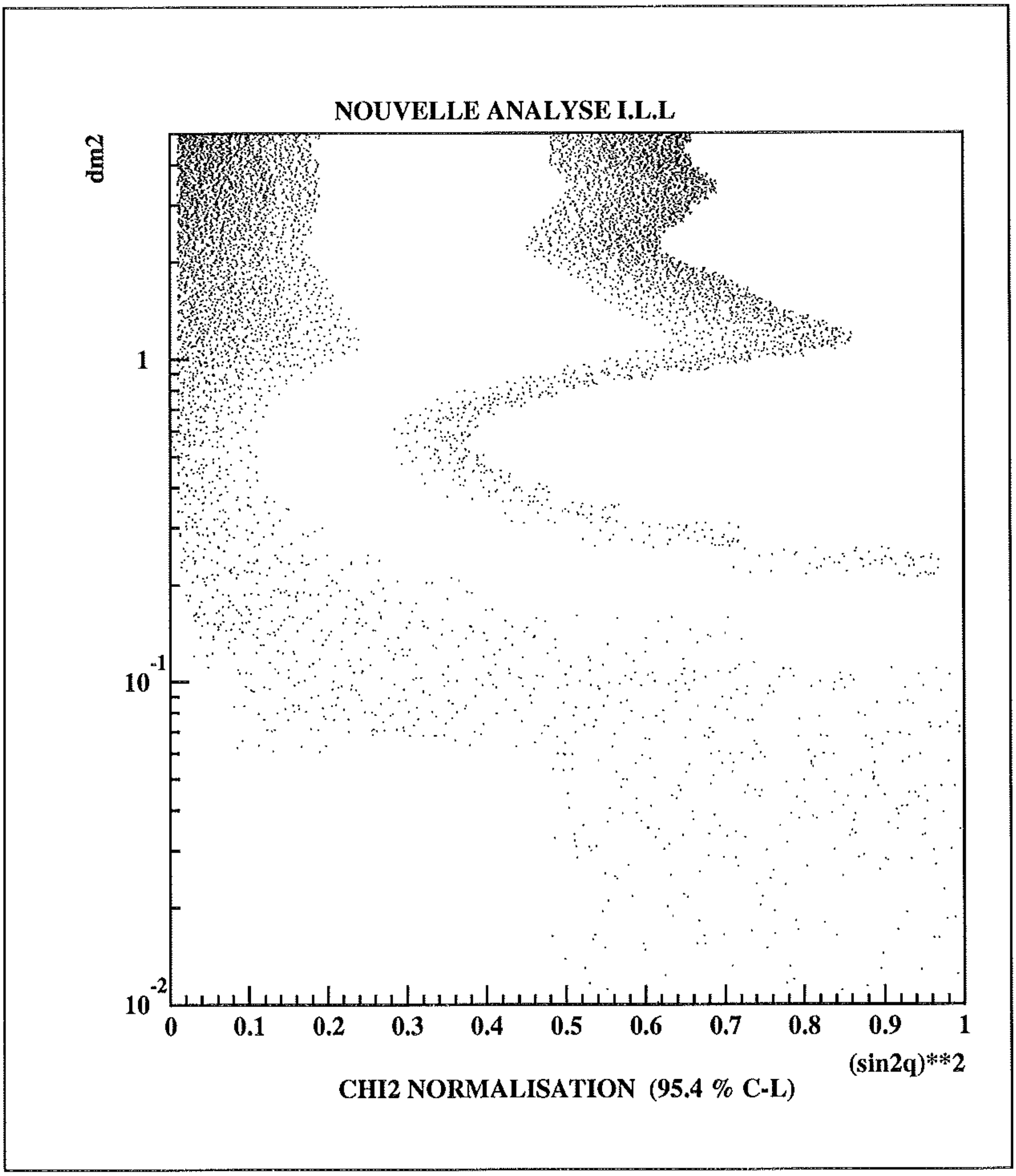
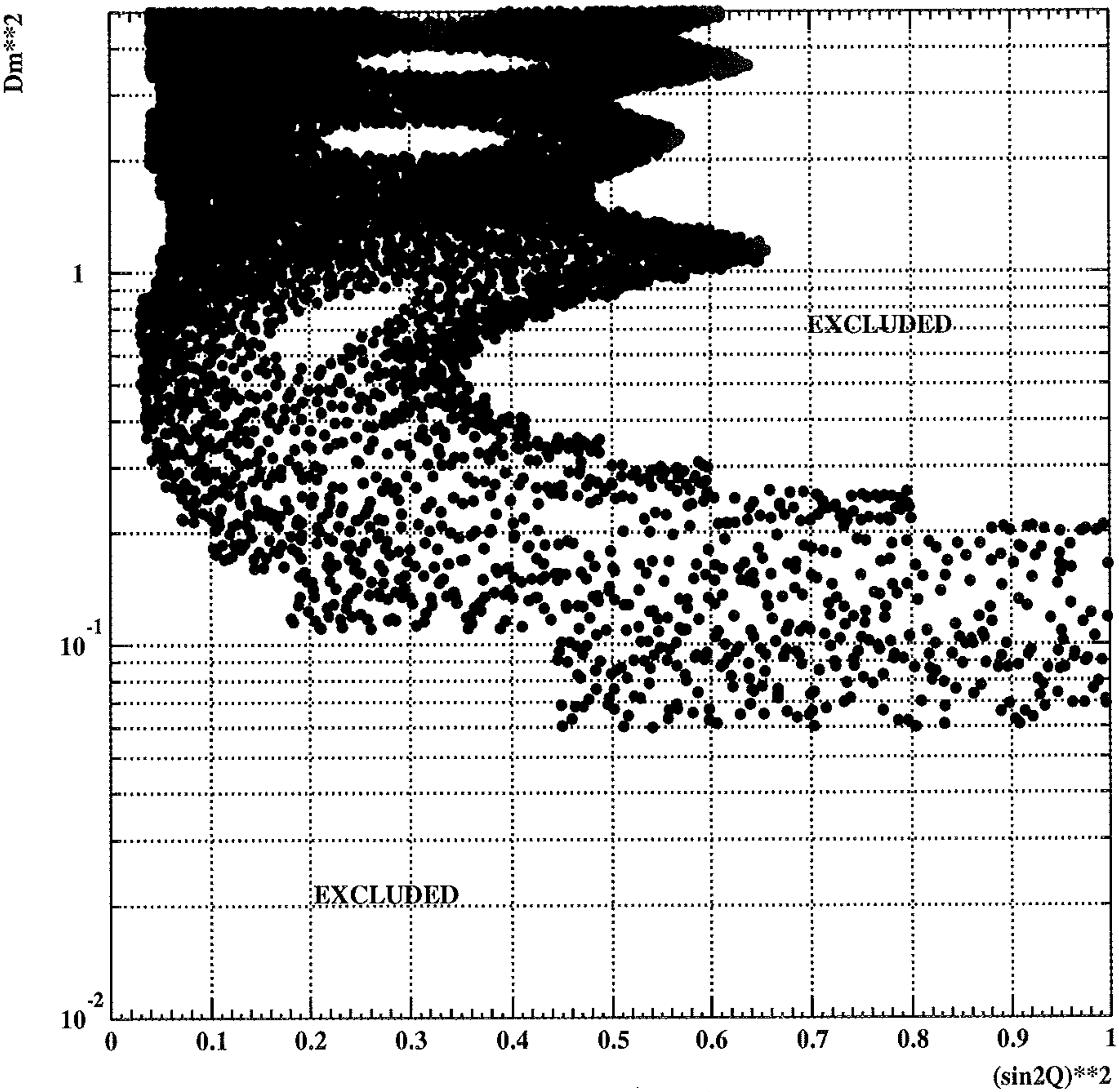
Entries 164
Mean 4.322
RMS 2.364
1
0.8
0.6
0.4
0.2
0
1.5
2
2.5
3
3.5
4
4.5
E(Mev)
RAPPORT DES SPECTRES FOLDED/UNFOLDED


22/09/90 10.19
ILL EXPERIMENT REANALYSIS
5
4
3
2
1
0
0.2
0.4
0.6
0.8
1
CHI2 SOMME (68.0 z C–L)

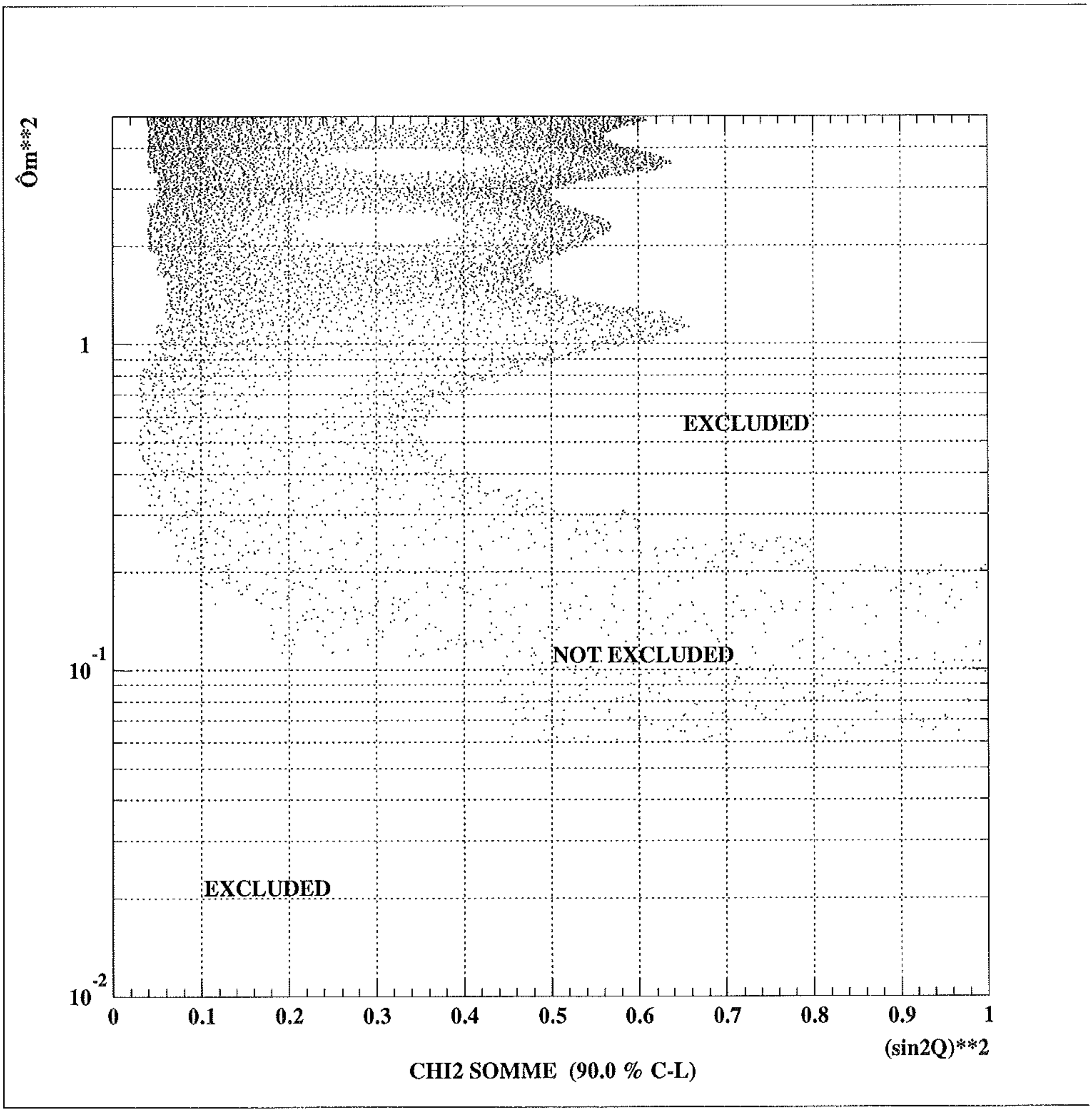

NOUVELLE ANALYSE I.L.L
dm2
1
10^{-1}
10^{-2}
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
(sin2q)**2
CHI2 SOMME (90.0 % C-L)

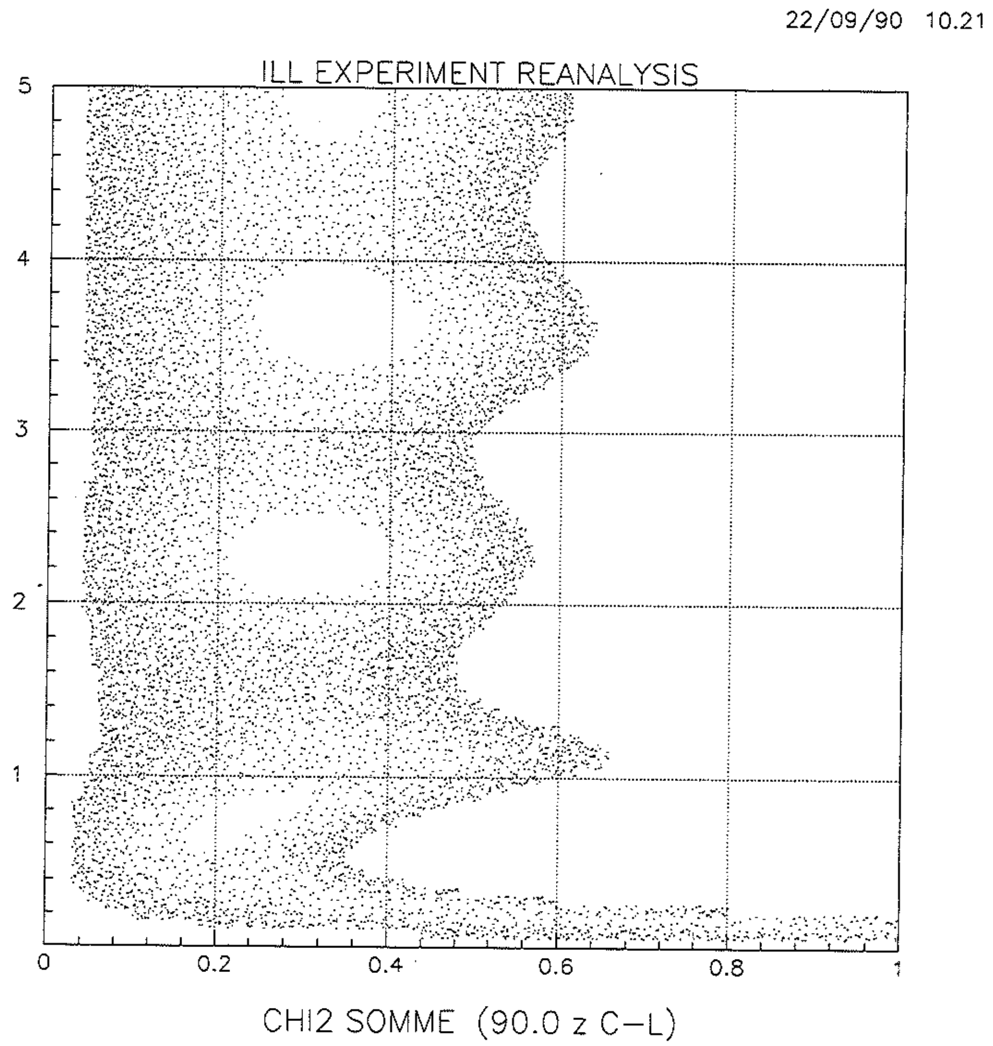

NOUVELLE ANALYSE I.L.L
dm2
1
10^-1
10^-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
(sin2q)**2
CHI2 NORMALISATION (68.0 % C-L)

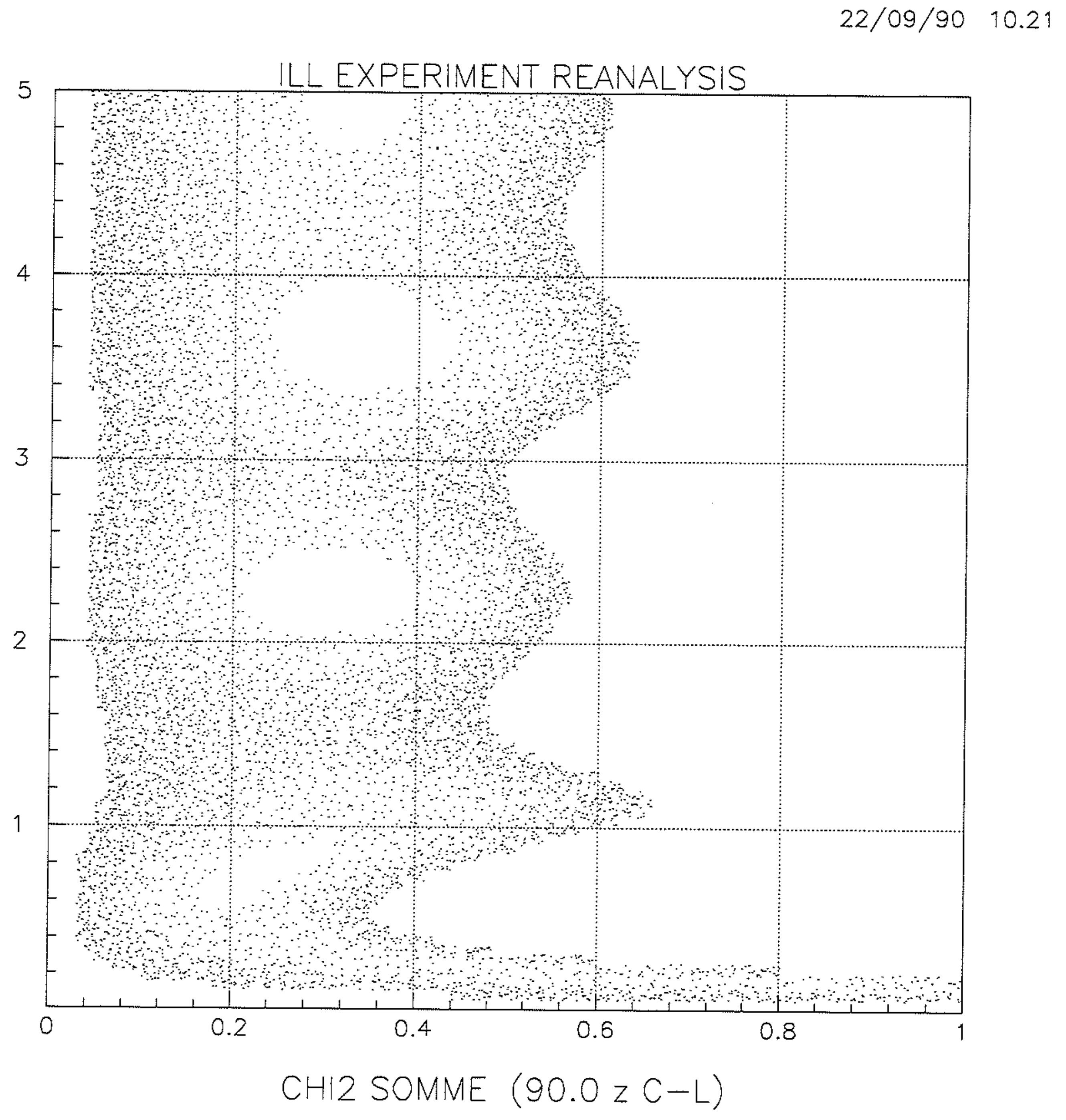

NOUVELLE ANALYSE I.L.L
dm2
1
10^{-1}
10^{-2}
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
(sin2q)**2
CHI2 NORMALISATION (95.4 % C-L)



CHI2 SOMME (90.0 % C-L)


Ôm**2
1
10-1
10-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
(sin2Q)**2
EXCLUDED
NOT EXCLUDED
EXCLUDED
CHI2 SOMME (90.0 % C-L)


22/09/90 10.21
ILL EXPERIMENT REANALYSIS
5
4
3
2
1
0
0.2
0.4
0.6
0.8
1
CHI2 SOMME (90.0 z C–L)


22/09/90 10.21
ILL EXPERIMENT REANALYSIS
5
4
3
2
1
0
0.2
0.4
0.6
0.8
1
CHI2 SOMME (90.0 z C–L)

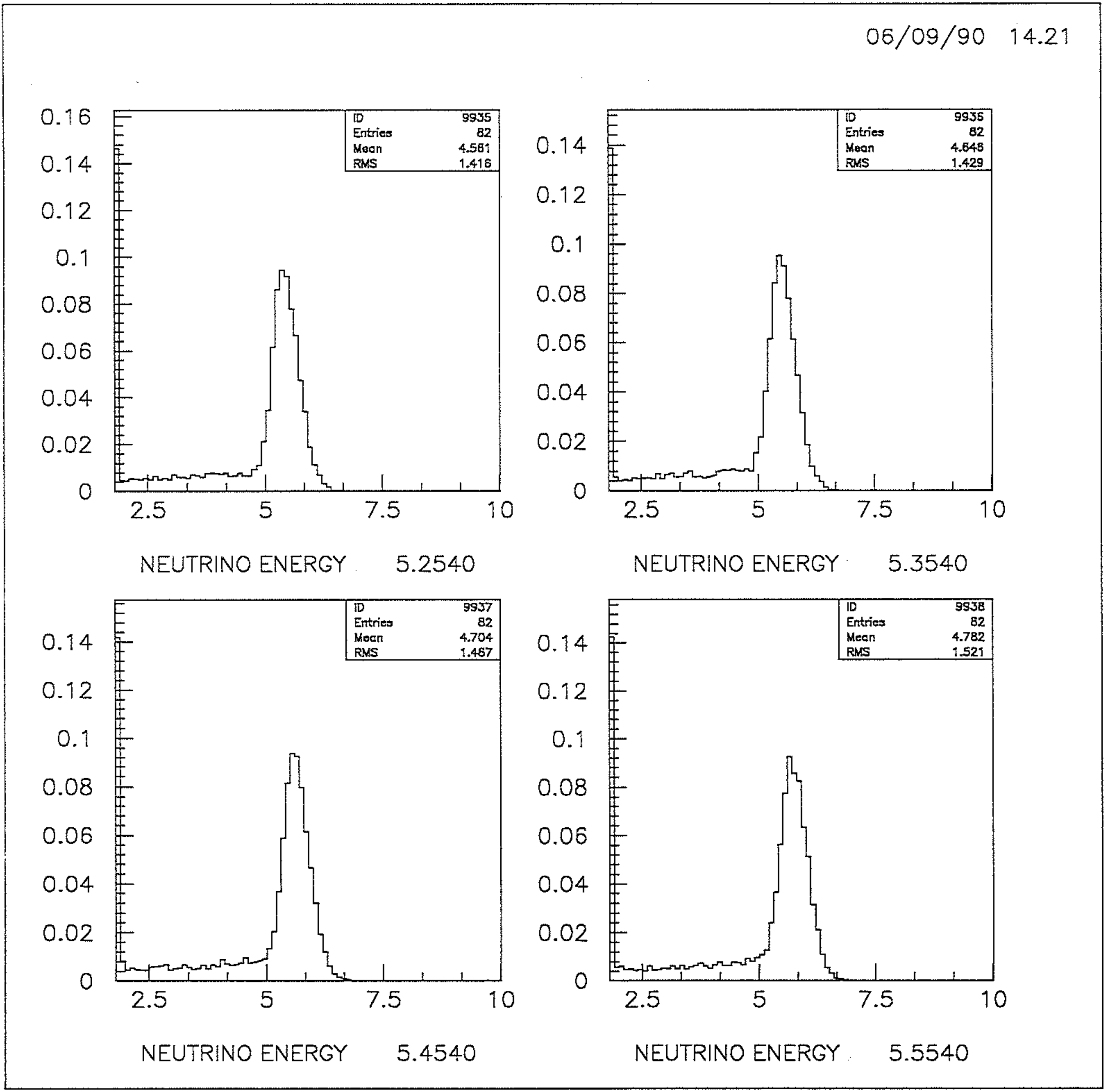


fig 1: $R(E_{e^+}, E'_{e^+})$: Energy response of the Detector to monoenergetic positrons.

Effects Included :

- **Positrons escape effects**
- **Positrons annihilation**
- **Positron Bremsstrahlung**
- **Wall corrections : Lucite walls of each scintillator cell also acts as neutrino target**
- **Energy resolution : 18%**

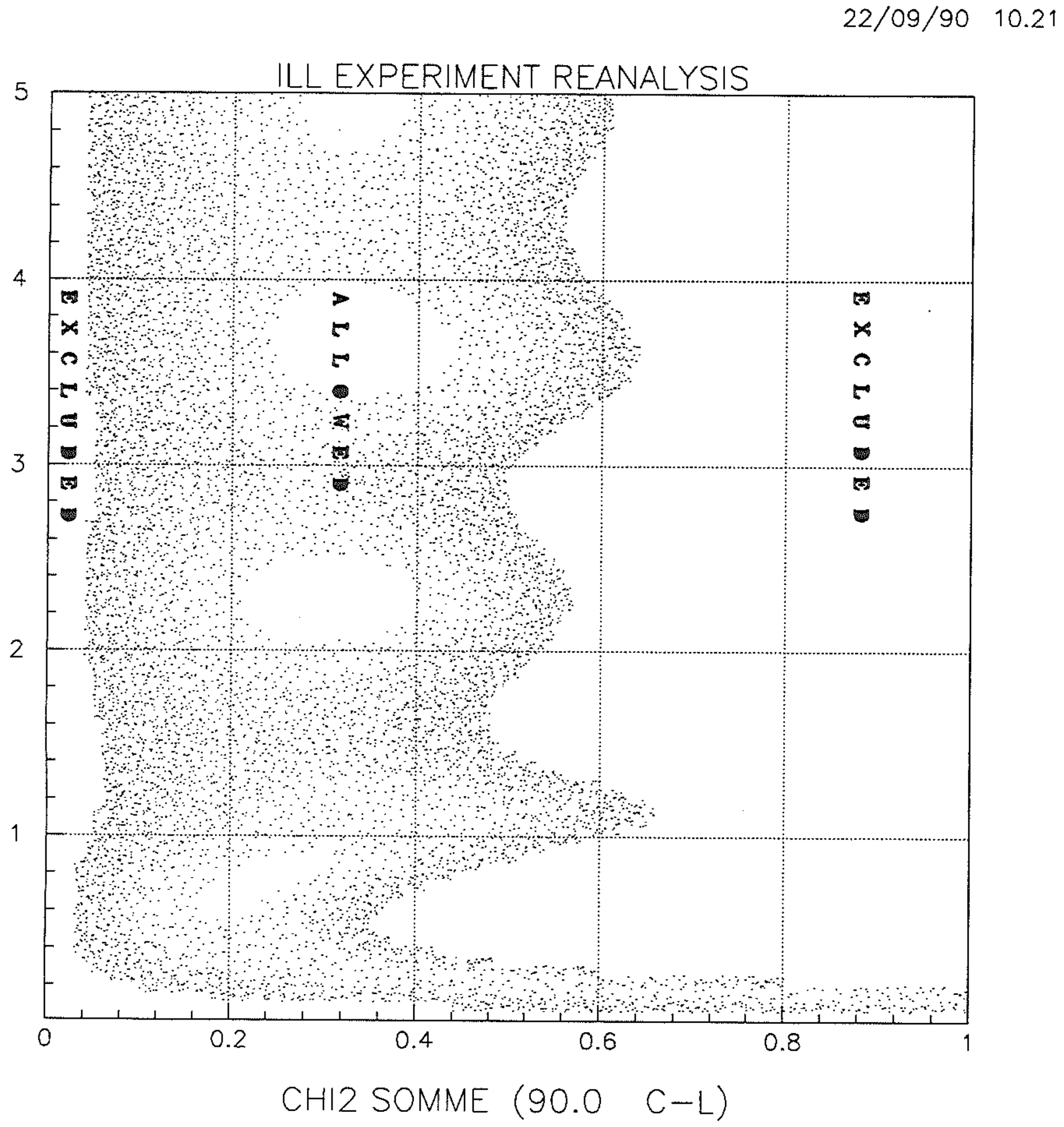


fig.10: **Combined probability Contours** :Limits on the neutrino oscillations parameters Δ^2_{12} versus $\sin^2 2\theta$ given by $\chi^2_F + \chi^2_N = \chi^2_S$ based on the combined probability on the shape and the normalisation of the ratio,of the experimental to the theoritical spectra for 90% C-L. Regions to the right of Contour are excluded. The set of parameters($\Delta^2_{12} = 0$, $\sin^2 2\theta = 0$) corresponding to the no-oscillation case is excluded.