Oscar Saavedra

Torino University, Italy

LAY OUT

- LSD at Mt. Blanc
- On-line Burst detection by LSD at Mt. Blanc
- IMB, K-II and BST SN-neutrino detection time
- Correllations between LSD - K-II and BST
- Correllations between LSD – IMB and GW antennas
- Conclusions

Liquid Scintillator Detector (LSD)

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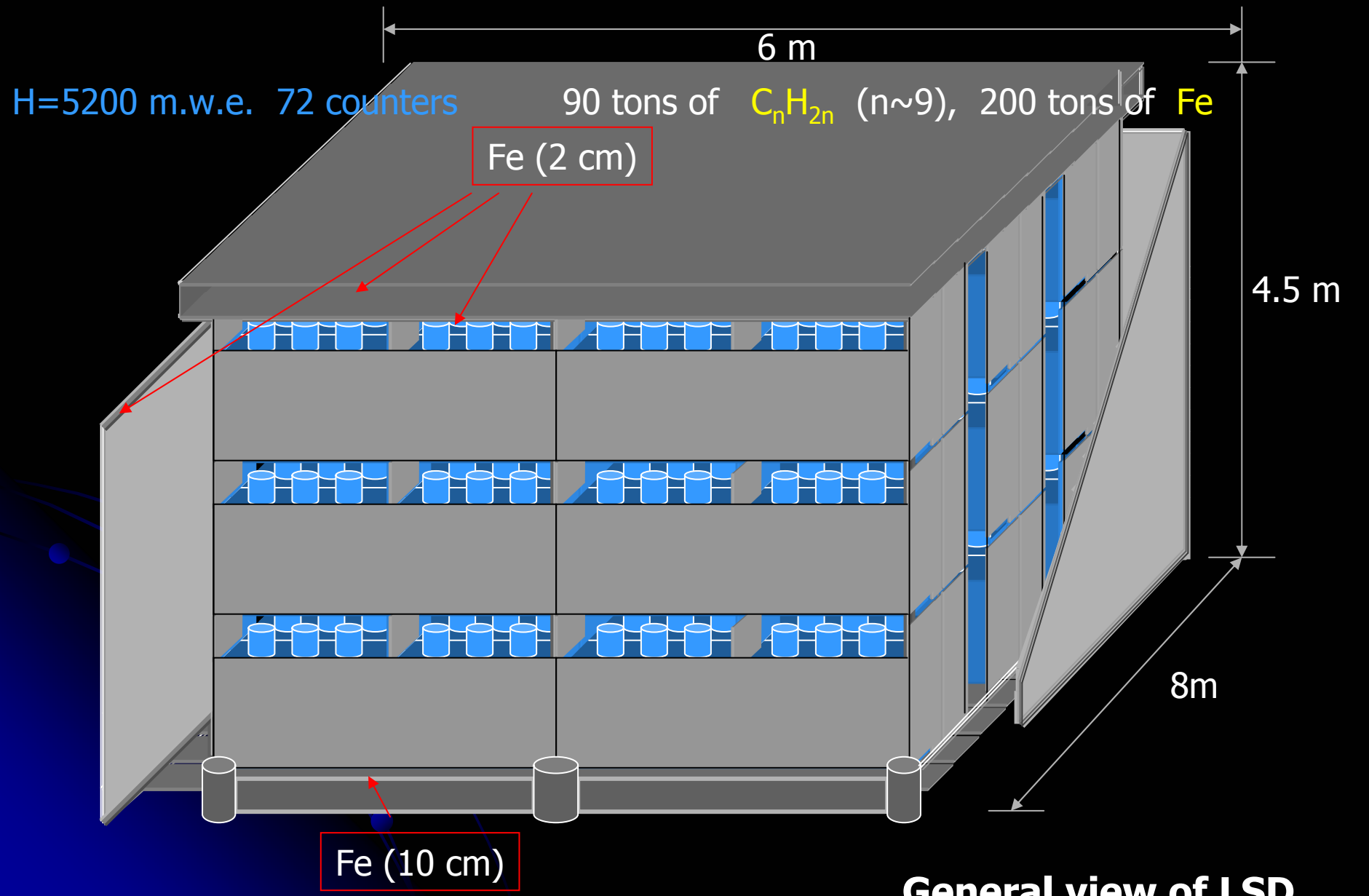
Liquid Scintillator Detector (LSD)



General view of LSD

General idea

Detection of e^+ from the reaction $\tilde{\nu}_e + p \rightarrow e^+ + n$

that has a large $\tilde{\nu}_e$-p cross section.

$\sigma_{\tilde{\nu}_e p} \sim 9.3 E^2_{e^+} \cdot 10^{-44}\ см^2$ $\qquad E_{e^+} >> 0.5\ MeV$

It was shown for the first time by G.T.Zatsepin, O.G.Ryazhskaya, A.E.Chudakov (1973):

$$n + p \rightarrow d + \gamma \quad E_\gamma = 2.2\ MeV$$

with τ~180 – 200 μs.

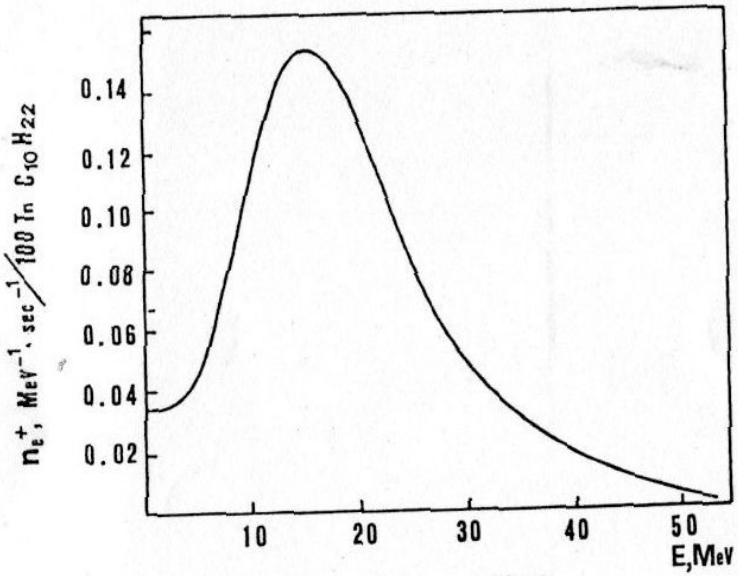


Fig.3

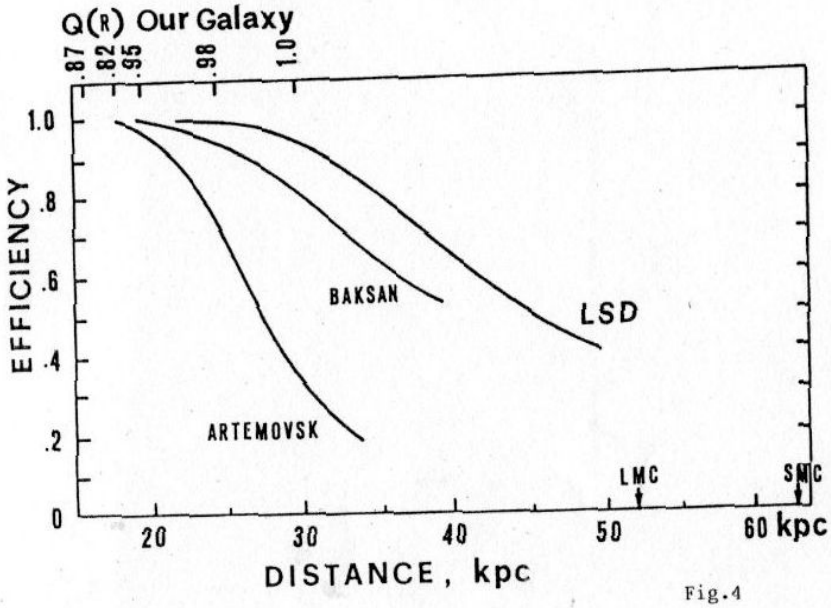


Fig.4

Finally, if the collapse occurs within our Galaxy, a large ammount of information on the dynamics of the collapse and on the physical conditions inside the pre-supernova core can be obtained by observing not only the $\bar{\nu}_e$ through reaction (1), but also the ν_e through the elastic scattering reaction $\nu_e + e^- \rightarrow \nu_e + e^-$, which however produces a lower number of interactions in the detector. The signature of the electron neutrinos is given in LSD by pulses above the high energy threshold of 7 MeV, without any low energy delayed pulse. In this way, since ν_e are emitted as early as the neutronization stage of the collapse, the initial phases of the development of a collapsing star can be study.

4. Solar neutrinos

Since in our apparatus the local radioactivity background from the surrounding rock has been reduced to very low counting rates, we are checking the possibility to detect high energy solar neutrinos from the ^{10}B decay in the Sun, through the elastic scattering reaction with the electrons of our detector.

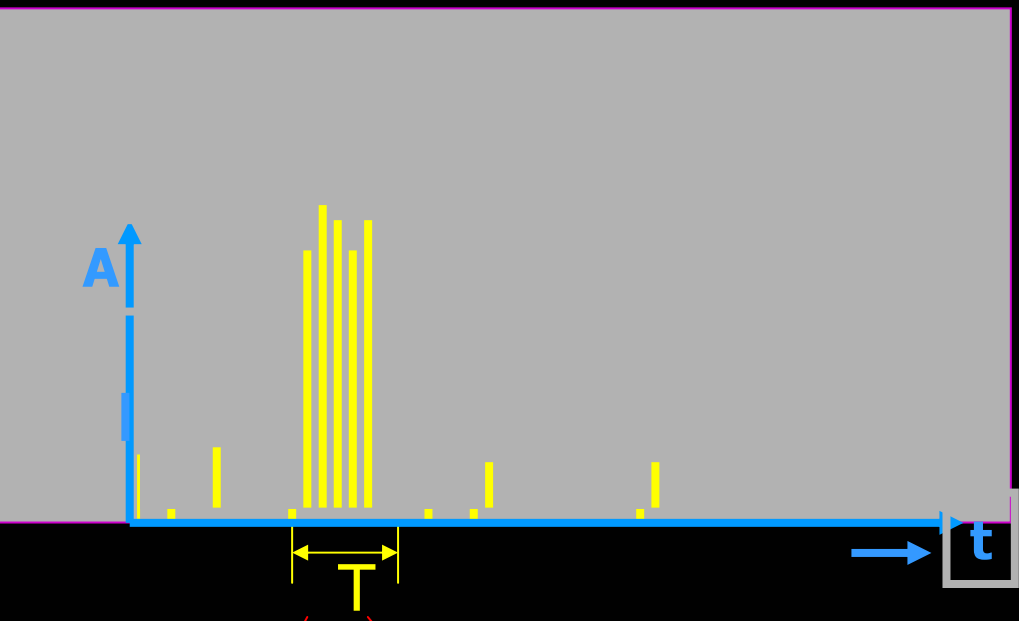
By using the present limit flux of solar neutrinos observed in the Brookhaven detector, and taking into account that the energy threshold in our apparatus can be set at 5 MeV, the number of detectable electrons from solar neutrinos is $\sim$ 0.3/day.

5. Atmospheric neutrinos

At low energy range, $10 \leq E_\nu \leq 700$ MeV, no experimental information is at present available for the atmospheric neutrino spectrum; also the theoretical predictions are not well defined in this region, even if some calculations have been recently made for energies $\gtrsim$ 200 MeV to estimate the neutrino background in proton decay experiments in underground laboratories. However, new efforts are in progress, Gaisser[7], to predict the neutrino spectrum at low energies.

With our LSD experiment we intend to directly measure the $\bar{\nu}_e$ atmospheric neutrinos above an energy threshold of $\gtrsim$10 MeV through reaction (1). By measuring inside the fiducial volume of LSD both the energy of the contained e^+ and the associate γ-pulse from neutron capture, we'll obtain a direct experimental measure of the $\bar{\nu}_e$ atmospheric spectrum, with a very clear signature that makes such events easily distinguishable from any other type of neutrino interactions. At a threshold of 10 MeV, the total number of atmospheric neutrino interactions has been estimated to be of the order of a few tens per year.

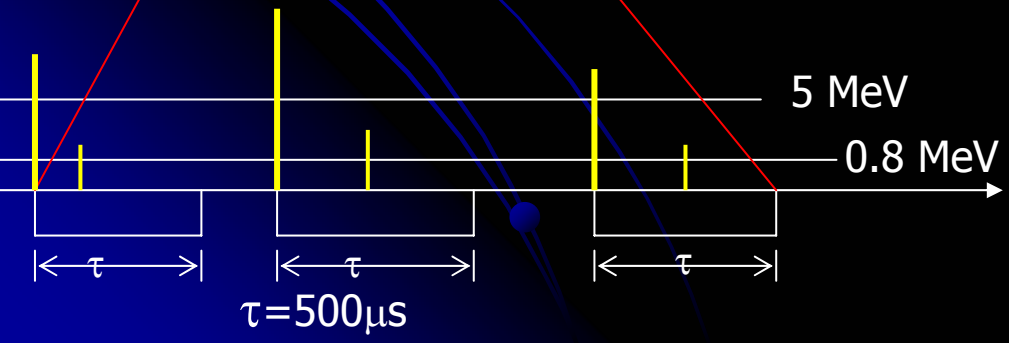
How can the neutrino burst be identified ?



The detection of the burst of N impulses in short time interval T

$$\tilde{\nu}_e + p \rightarrow e^+ + n$$

$$N \sim \frac{1}{4\pi R^2} \cdot \sum_i \int_{E_{thr}}^{\infty} I_{\nu_i}(E_{\nu_i}) \cdot \sigma(E_{\nu_i}) dE \cdot M$$



If R ~ 10 kpc

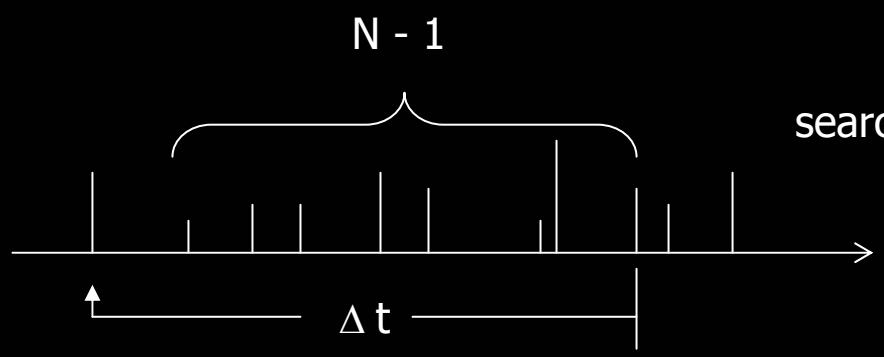
N_{int} ~ 50 in LSD

Δt ~ 5-20 sec

E_e+ < 50 MeV

ON-LINE:

search for cluster of pulses in real-time



N > 2

1 ms < Δ t < 600 sec

$$F_{imit} = f \sum_{n=N-1}^{\infty} P(n, \Delta t) = f \sum_{n=N-1}^{\infty} \frac{e^{-f\Delta t} \left(f\Delta t\right)^n}{n!}$$

if F_{imit} < 1/10 day ⟶ print-out

Conditions:
- Only 1 pulse/N_{tank}
- E < 60 MeV

OFF-LINE

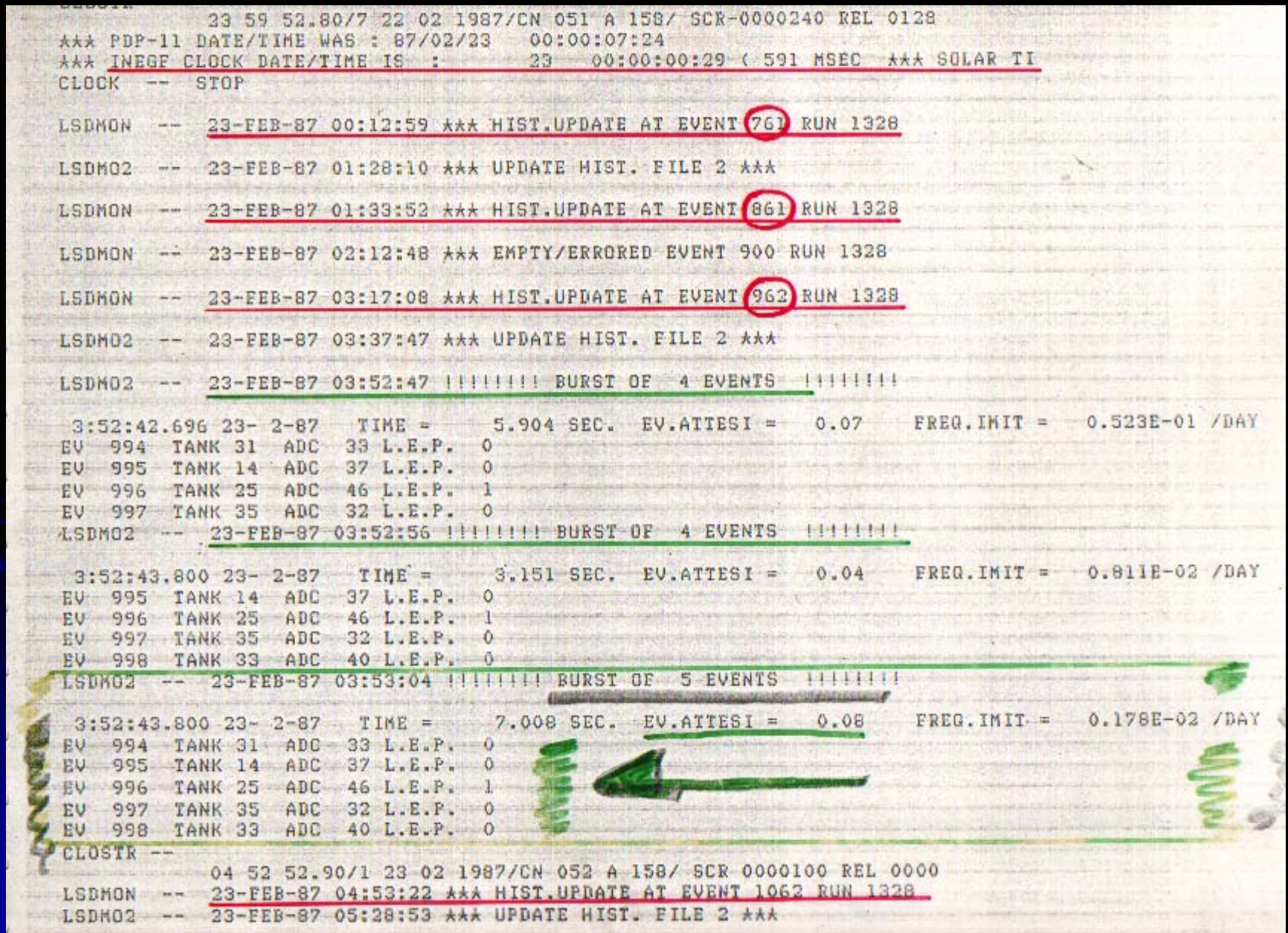
Avoid some noise, uniform distribution, scape muons, etc } < 0.1 %

Phase A

On-line Burst detection by LSD at Mt. Blanc

February 23, 1987
2 h 52 min.

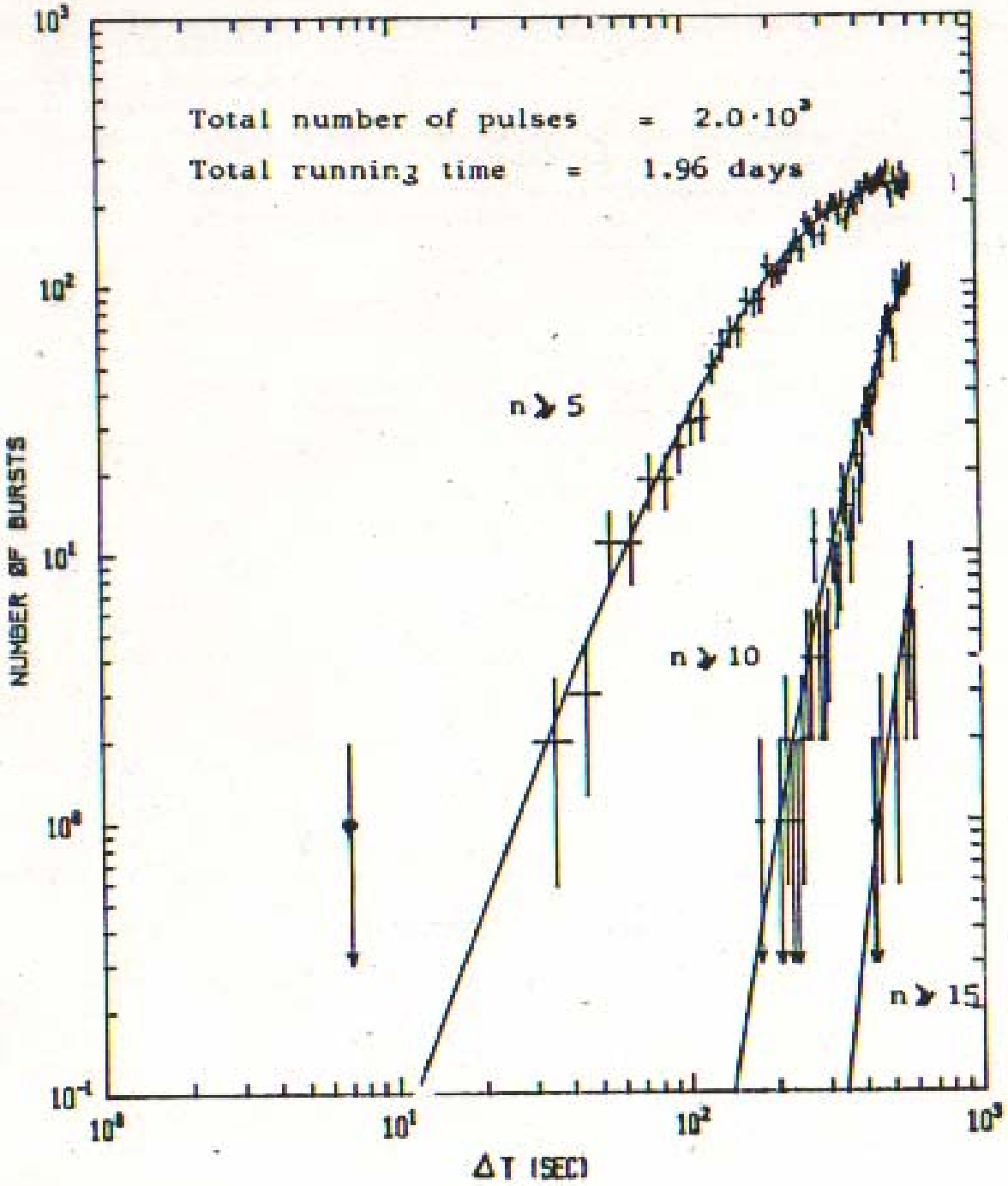
On line print of five pulses on 23 February 1987 at 3 hr, 52 min, IT
Detected at Mt. Blanc LSD experiment



```
            23 59 52.80/7 22 02 1987/CN 051 A 158/ SCR-0000240 REL 0128
*** PDP-11 DATE/TIME WAS : 87/02/23   00:00:07:24
*** INEGF CLOCK DATE/TIME IS  :       23   00:00:00:29 ( 591 MSEC  *** SOLAR TI
CLOCK  --  STOP

LSDMON  --  23-FEB-87 00:12:59 *** HIST.UPDATE AT EVENT 761 RUN 1328

LSDMO2  --  23-FEB-87 01:28:10 *** UPDATE HIST. FILE 2 ***

LSDMON  --  23-FEB-87 01:33:52 *** HIST.UPDATE AT EVENT 861 RUN 1328

LSDMON  --  23-FEB-87 02:12:48 *** EMPTY/ERRORED EVENT 900 RUN 1328

LSDMON  --  23-FEB-87 03:17:08 *** HIST.UPDATE AT EVENT 962 RUN 1328

LSDMO2  --  23-FEB-87 03:37:47 *** UPDATE HIST. FILE 2 ***

LSDMO2  --  23-FEB-87 03:52:47 !!!!!!!! BURST OF  4 EVENTS  !!!!!!!!

 3:52:42.696 23- 2-87   TIME =     5.904 SEC.  EV.ATTESI =   0.07    FREQ.IMIT =   0.523E-01 /DAY
EV  994  TANK 31  ADC  33 L.E.P.  0
EV  995  TANK 14  ADC  37 L.E.P.  0
EV  996  TANK 25  ADC  46 L.E.P.  1
EV  997  TANK 35  ADC  32 L.E.P.  0
LSDMO2  --  23-FEB-87 03:52:56 !!!!!!!! BURST OF  4 EVENTS  !!!!!!!!

 3:52:43.800 23- 2-87   TIME =     3.151 SEC.  EV.ATTESI =   0.04    FREQ.IMIT =   0.811E-02 /DAY
EV  995  TANK 14  ADC  37 L.E.P.  0
EV  996  TANK 25  ADC  46 L.E.P.  1
EV  997  TANK 35  ADC  32 L.E.P.  0
EV  998  TANK 33  ADC  40 L.E.P.  0
LSDMO2  --  23-FEB-87 03:53:04 !!!!!!!! BURST OF  5 EVENTS  !!!!!!!!

 3:52:43.800 23- 2-87   TIME =     7.008 SEC.  EV.ATTESI =   0.08    FREQ.IMIT =   0.178E-02 /DAY
EV  994  TANK 31  ADC  33 L.E.P.  0
EV  995  TANK 14  ADC  37 L.E.P.  0
EV  996  TANK 25  ADC  46 L.E.P.  1
EV  997  TANK 35  ADC  32 L.E.P.  0
EV  998  TANK 33  ADC  40 L.E.P.  0
CLOSTR --
            04 52 52.90/1 23 02 1987/CN 052 A 158/ SCR 0000100 REL 0000
LSDMON  --  23-FEB-87 04:53:22 *** HIST.UPDATE AT EVENT 1062 RUN 1328
LSDMO2  --  23-FEB-87 05:28:53 *** UPDATE HIST. FILE 2 ***
```

Number of bursts as function of their duration ΔT (sec) for Multiplicities $n \geq 5$, ≥ 10 and ≥ 15

f=0.012 events/sec



Telex from
S. Cristiani from
ESO, Chile

27/02/1987

prot. 84/28.2.87

27/82 23.27 ♦
224379 COSMOT I
~~27.82.87~~
TLX NO 612

ATT. O. SAAVEDRA

FROM.: S. CRISTIANI

SORRY FOR THE DELAY.
MORE DETAILED INFORMATION ABOUT THE SN 1887 A

1) THE DISCOVERY WAS MADE ON FEB 24.23, BUT, FROM PREVIOUS PLATES,
IT HAS STARTED RISING BETWEEN FEB 22 AND FEB 23.443.

2) TYPE OF THE SN IS ALMOST CERTAINLY II AND THE PROGENITOR COULD
BE A MASSIVE STAR, SANDULEAK -69. 202, OF ABOUT 12.2 V MAGNITUDE.

3) LUMINOSITY STILL TO BE COMPUTED IN DETAIL. AT PRESENT DATA
ABOUT BOLOMETRIC LUMINOSITY ARE NOT AVAILABLE. AT PRESENT THE SN
IS ABOUT 4.2 MAGNITUDE V.

4) APPROXIMATE DISTANCE = 52 KPC

MORE RELEVANT INFORMATION IN THE NEXT DAYS. PLEASE KEEP ME
INFORMED ABOUT YOUR OBSERVATIONS.
CORDIALMENTE,

STEFANO
240881 ESOGO CL♦
224379 COSMOT JMMMM

Circular No. 4332
I. A. U.

2/28/1987

TELEX ETELEX TELEX ETELEX TELEX

0025+
0257103206842
NA
0025+
0257103206842+
~~28/02 14.37~~
ASTROGRAM CAM
*
224379 COSMOT I

TO DIRECTOR

IN THE MONT BLANC NEUTRINO OBSERVATORY ~~A SIGNAL HAS BEEN DETECTED~~ ON FEB.23RD AT 2:58 UT. THE NEUTRINO TELESCOPE, RUNNING SINCE OCT. 1984, AT 5000 M.W.E. UNDERGROUND, IN COLLABORATION BETWEEN OUR ISTITUTO DI COSMOGEOFISICA CNR, TORINO (ITALY) AND ACADEMY OF SCIENCES OF USSR MOSCOW (ZATSEPIN GROUP), CONSISTS OF 90 TONS OF LIQUID SCINTILLATOR IN 72 COUNTERS SHIELDED WITH 200 TONS OF FE SLABS.
THE RECORDED SIGNAL IS MADE BY 5 PULSES, ABOVE THE 7 MEV ENERGY THRESHOLD, DURING 7 SEC. THIS IS IN AGREEMENT WITH THE PREDICTIONS OF COLLAPSING FE-CORES STANDARD MODELS AT 50 KPC FARAWAY, BOTH IN ENERGY AND IN TIME DURATION.
THE PROBABILITY OF A RANDOM COINCIDENCE WITH SUPERNOVA SN 1987 A IS 1 ABOUT EVERY 10000 YEARS.
DETAILS WILL BE SEND SOON BY TELEFAX (PLEASE, LET US KNOW YOUR NUMBER).
BEST WISHES

CARLO CASTAGNOLI
DIRECTOR OF ISTITUTO COSMOGEOFISICA
TORINO - ITALY

*
ASTROGRAM CAM

224379 COSMOT IMMMM

Events, detected by LSD

February,23, 1987 (SN 1987 A)

# of event	Time, UT±2ms	Energy, MeV
1	2:52:36,79	6,2 – 7
2	40,65	5,8 – 8
3	41,01	7,8 –11
4	42,70	7,0 – 7
5	43,80	6,8 – 9
1	7:36:00,54	8
2	7:36:18,88	9

Phase B

IMB, K-II and BST SN-neutrino detection time

$\Delta t = \pm 50\ ms$

$\Delta t = \pm 60 sec$

$\Delta t = +2$ sec
-54sec

Table I: Summary of IMB Events

Event Time	Relative Time	Cosine from SN	Angle from SN	Energy (MeV)
7:35:41.374	0.000	0.172	80±10	38±7
7:35:41.786	0.412	0.720	44±15	37±7
7:35:42.024	0.650	0.563	56±20	28±6
7:35:42.515	1.141	0.414	65±20	39±7
7:35:42.936	1.562	0.843	33±15	36±9
7:35:44.058	2.684	0.610	52±10	36±6
7:35:46.384	5.010	0.738	42±20	19±5
7:35:46.956	5.582	-0.246	104±20	22±5

Table II: Summary of Kamioka Events

Event Time	Relative Time	Cosine from SN	Angle from SN	Energy (MeV)
7:35:35	0.000	0.951	18.±18.	20.0±2.9
7:35:35	0.107	0.966	15.±27.	13.5±3.2
7:35:35	0.303	-.309	108.±32.	7.5±2.0
7:35:35	0.324	0.342	70.±30.	9.2±2.7
7:35:36	0.507	-.707	135.±23.	12.8±2.9
7:35:36	0.686	0.375	68.±77.	6.3±1.7
7:35:37	1.541	0.848	32.±16.	35.4±8.0
7:35:37	1.728	0.866	30.±18.	21.0±4.2
7:35:37	1.915	0.788	38.±22.	19.8±3.2
7:35:44	9.219	-.530	122.±30.	8.6±2.7
7:35:45	10.433	0.656	49.±26.	13.0±2.6
7:35:47	12.439	-.017	91.±39.	8.9±1.9

Table III: Summary of Baksan Events

Event Time	Relative Time	Energy (MeV)	Internal or External
7:36:11.818	0.000	12±2.4	Internal
7:36:12.253	0.435	18±3.6	Internal
7:36:13.528	1.710	23.3±4.7	External
7:36:19.505	7.687	17±3.4	External
7:36:20.917	9.099	20.1±4.0	External

Mt. Blanc – LSD events

$\Delta t = \pm 2 ms$

7 hr 36 min. 005s 9.0 MeV tank 2
7 hr 36 min. 18.9s 6.4 MeV tank 14
Europhys. Lett. ***3****,1315,1987*

OFF LINE

U.T.

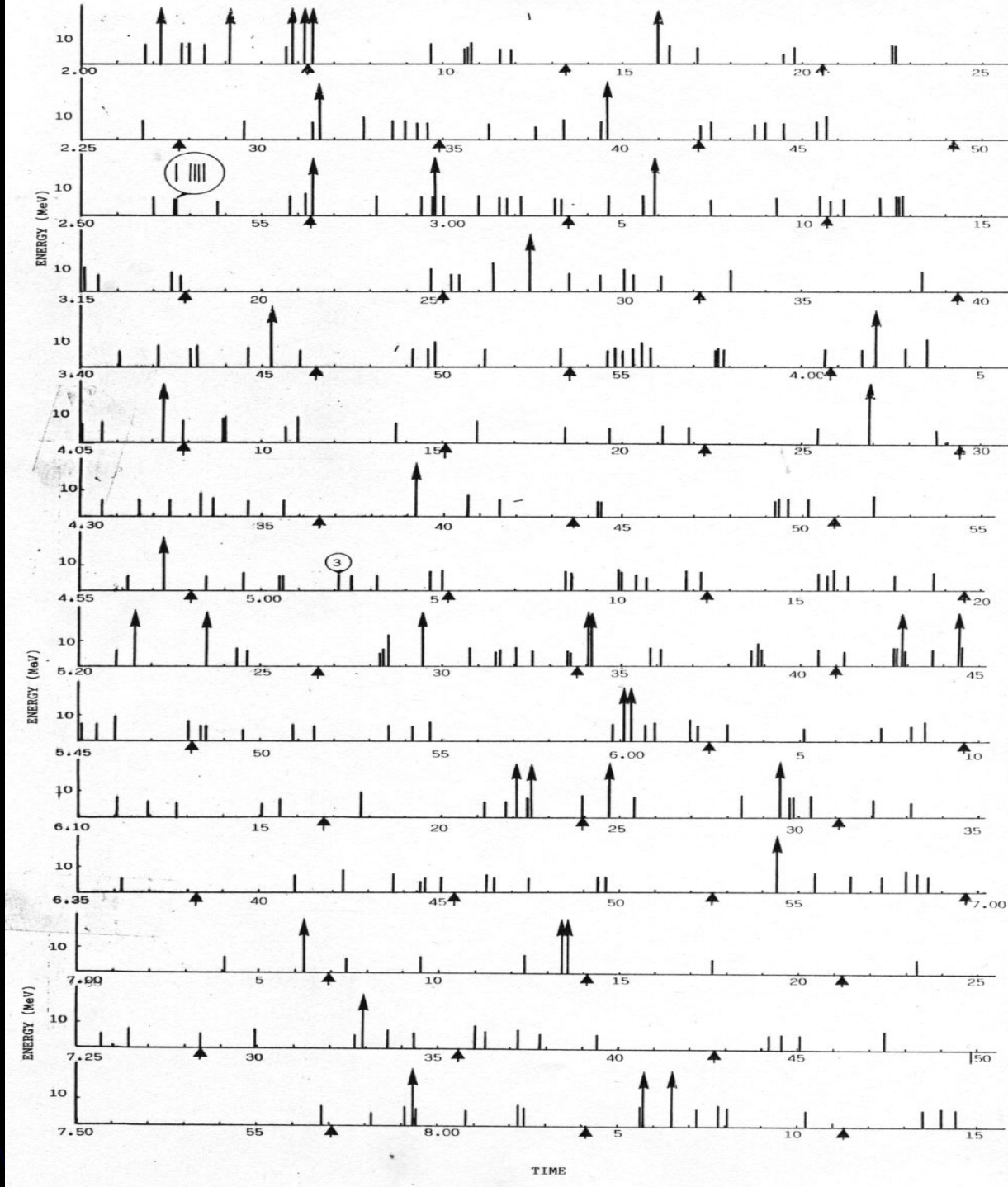
EVENT	TIME	TANK	ADC
980	2:37:43.5	11	35
981	2:38:24.9	13	49
982	2:39:22.7	50	36,14
983	2:39:35.6	3	255
		9	208
		10	255
		16	255
		23	255
984	2:42:03.2	TDC TEST	
985	2:42:11.1	69	37,13,13
986	2:42:27.6	31	42
987	2:43:47.4	35	33
988	2:43:58.5	61	39
989	2:44:29.2	41	45
990	2:45:26.4	42	45,13
991	2:45:38.8	59	50
992	2:49:12.7	TDC TEST	
993	2:52:02.0	16	35
994	2:52:36.8	31	33
995	2:52:40.6	14	37
996	2:52:41.0	25	46,14
997	2:52:42.7	35	32
998	2:52:43.8	33	40
999	2:53:47.3	63	40,24
1000	2:55:51.2	11	49
1001	2:56:12.1	55	44,12
1002	2:56:22.2	TDC TEST	
1003	2:56:24.6	5	255
		11	59,13
		29	113,14
1004	2:58:14.8	31	43,17,15
1005	2:59:28.3	42	44
1006	2:59:46.6	43	39
1007	2:59:50.6	11	255
		35	255
		59	255
1008	3:00:01.5	25	44
1009	3:01:04.7	61	44,17,16
1010	3:01:39.6	1	38
1011	3:01:47.2	3	34

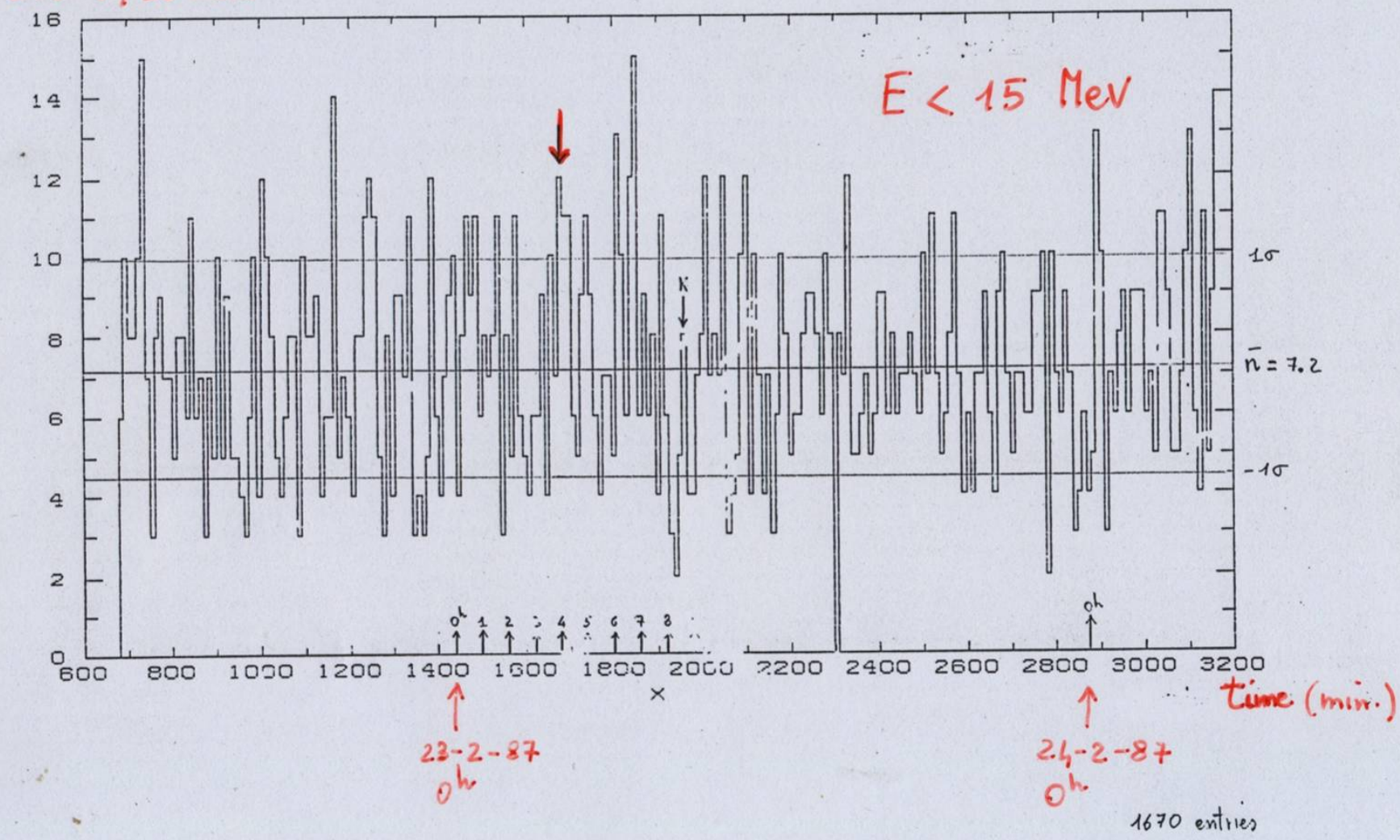
All pulses recorded in LSD from 2:37:43 to 3:01:47 UT on Feb.23
Events No. 983, 1003 and 1007 are cosmic ray muons

EVENT	TIME	TANK	ADC
1270	7:13:35.2	10	255
		11	184
		28	106
		29	255,41
		53	255
1271	7:14:04.1	TDC TEST	
1272	7:17:35.5	4	26,10
1273	7:21:13.6	TDC TEST	
1274	7:23:19.0	14	34
1275	7:25:46.4	1	42
1276	7:26:28.1	12	48
1277	7:28:23.1	TDC TEST	
1278	7:28:25.3	10	36
1279	7:29:57.1	6	45,16
1280	7:32:43.9	41	41
1281	7:32:53.9	25	255
1282	7:33:39.7	20	37
1283	7:34:21.6	17	36
1284	7:35:32.6	TDC TEST	
1285	7:36:00.5	2	34
1286	7:36:18.9	14	38
1287	7:37:12.8	20	42,11
1288	7:37:50.1	31	35,15,14
1289	7:39:25.2	27	35,14
1290	7:42:42.1	TDC TEST	
1291	7:44:09.1	41	40
1292	7:44:33.0	53	42
1293	7:45:08.6	14	33
1294	7:47:24.9	33	40
1295	7:49:51.6	TDC TEST	
1296	7:56:47.4	35	42
1297	7:57:01.1	TDC TEST	
1298	7:58:11.3	41	35
1299	7:59:08.2	54	45,12,15
1300	7:59:17.1	25	255,22
1301	7:59:18.5	17	42

All pulses recorded in LSD near the Kamiokande-IMB.
Events No. 1281 and 1300 are cosmic ray muons

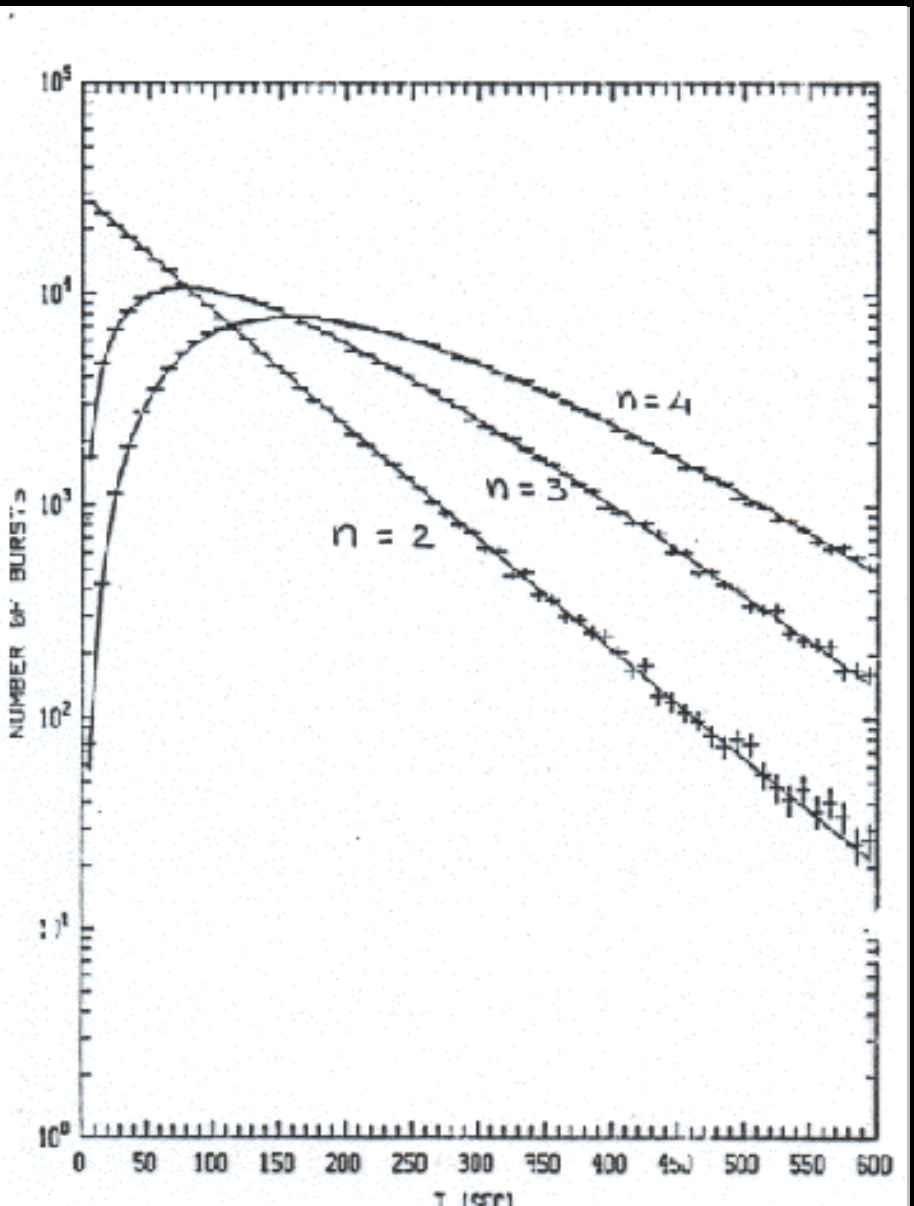
Scater plot of all events detected on Feb/23/1987 since 2:00:00 to 8:15:00 UT.
The Y axis is the energy up to 20 MeV. Large vertical arrows show The arrival time of cosmic muons. The small arrows, below the time axes are the authomatic electronic test.

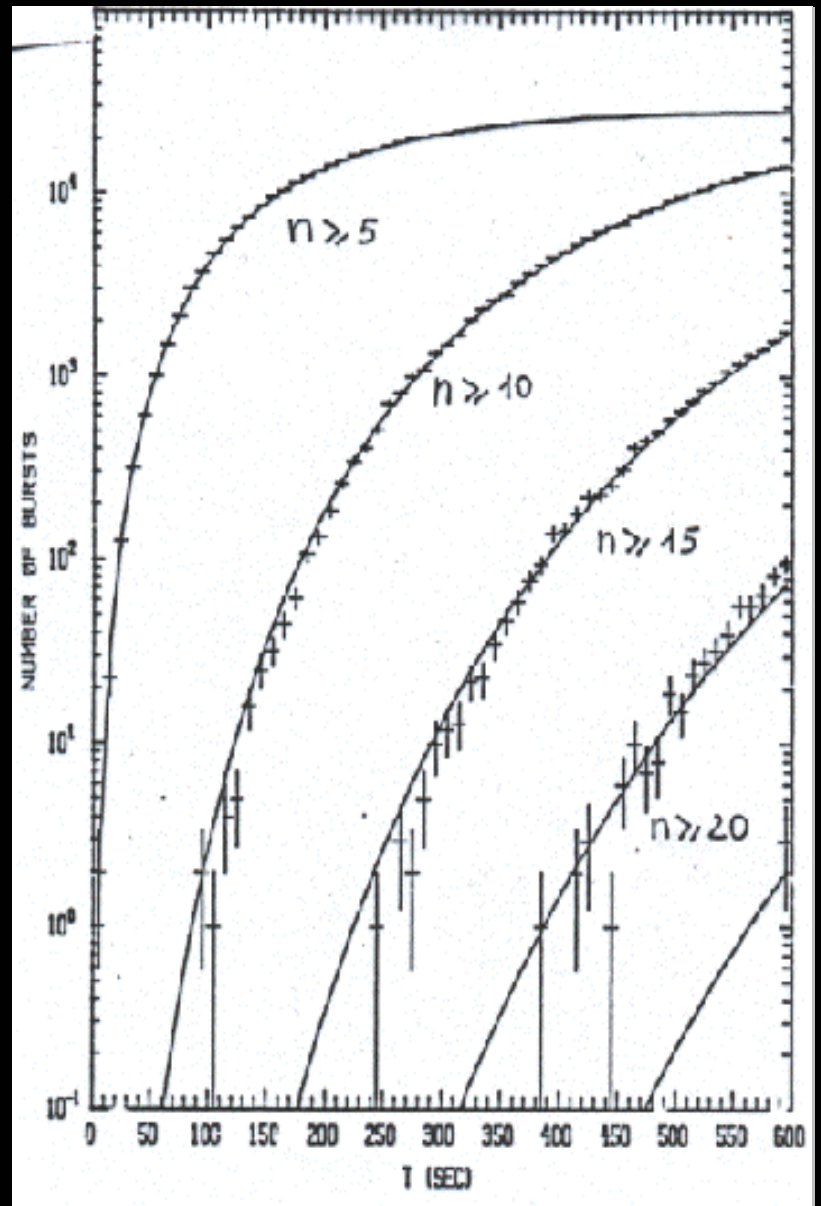



Events / 10 min.
E < 15 MeV
16
14
12
10
8
6
4
2
0
1σ
n̄ = 7.2
-1σ
K
0h 1 2 3 4 5 6 7 8
0h
600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000 3200
time (min.)
23-2-87
0h
24-2-87
0h
1670 entries

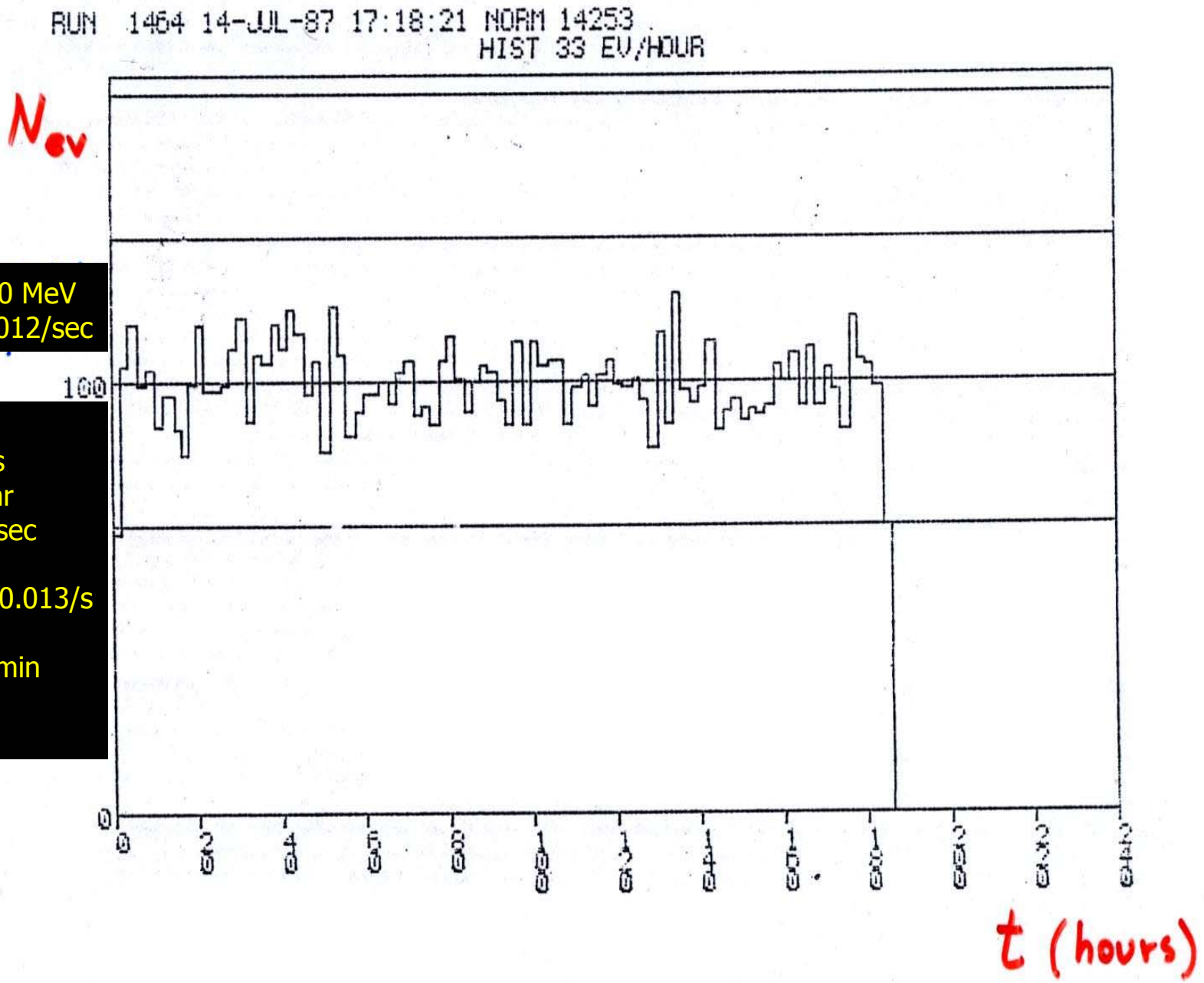
Number of burst as a function of thei duration for mulipliciyof pulses n=2, n=3 and n=4 (fig. a) and for n ≥ 5, n ≥ 10, n ≥ 15 and for n ≥ 20 (fig. b). From 9/28/1986 to 5/23/1987.

T=217.7 days, N = 234.168, <f>= 0.012 ev/sec





On line monitoring



for 7<E<60 MeV
freq. = 0.012/sec

Freq. of μ's
= 3.5/hr
= 10^{-3}/sec

total freq.=0.013/s

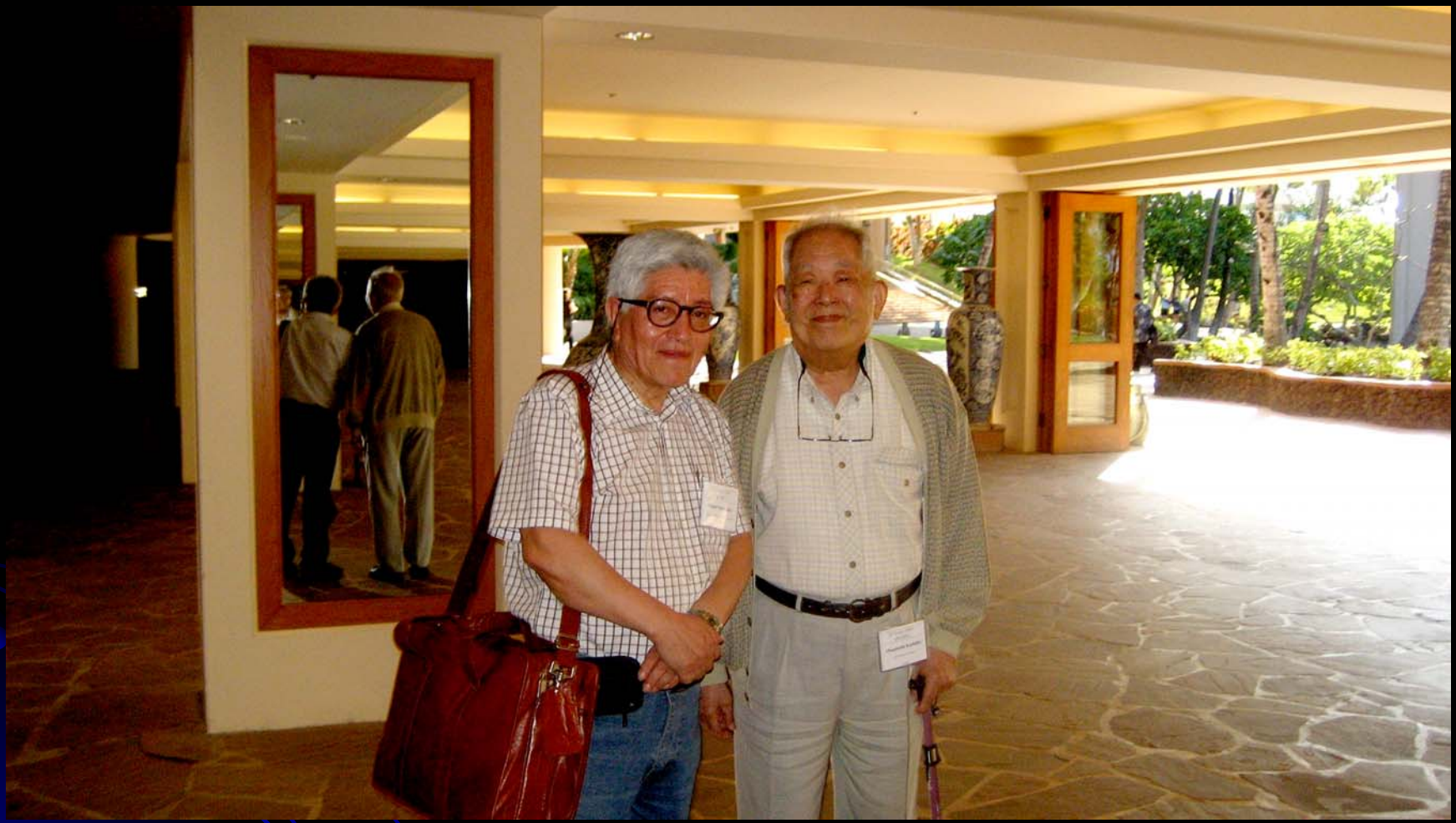
= 0.78/min

Two bangs can produced the two separated neutrino burst?

- De Rujula
- Imshennik and Ryazhskaya

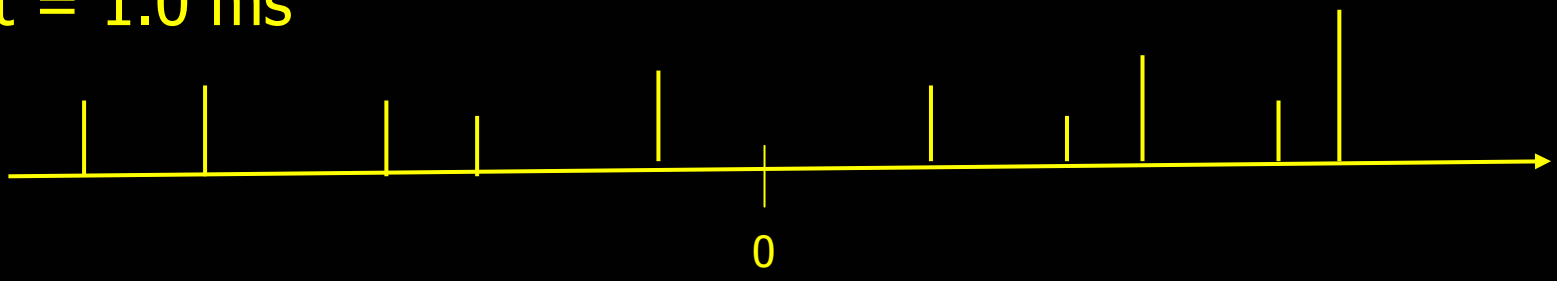
Phase C

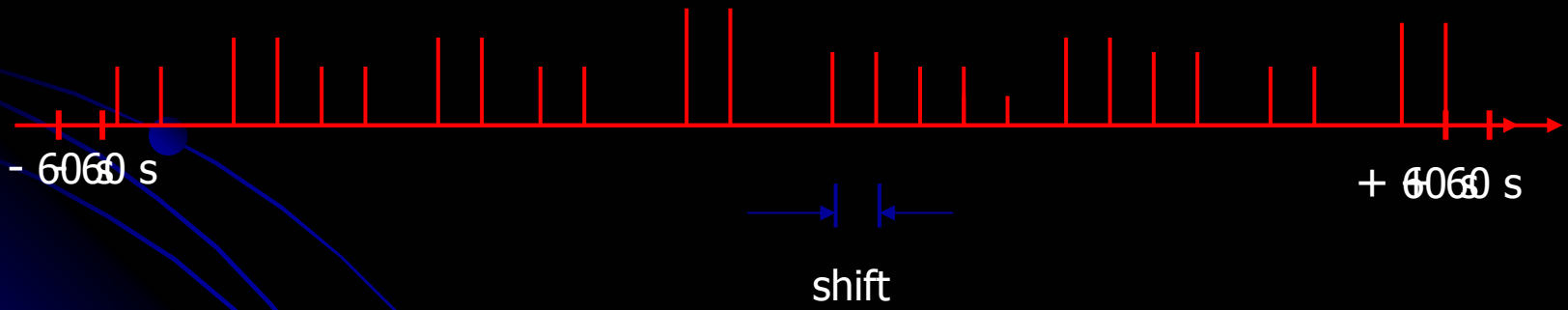
Correllations between LSD - K-II and BST



Kamioka-LSD correlations

LSD Δt = 1.0 ms





Kamioka Δt= 60 sec

$$N_c = 2\frac{N_1 \cdot N_2}{T}\Delta\tau$$

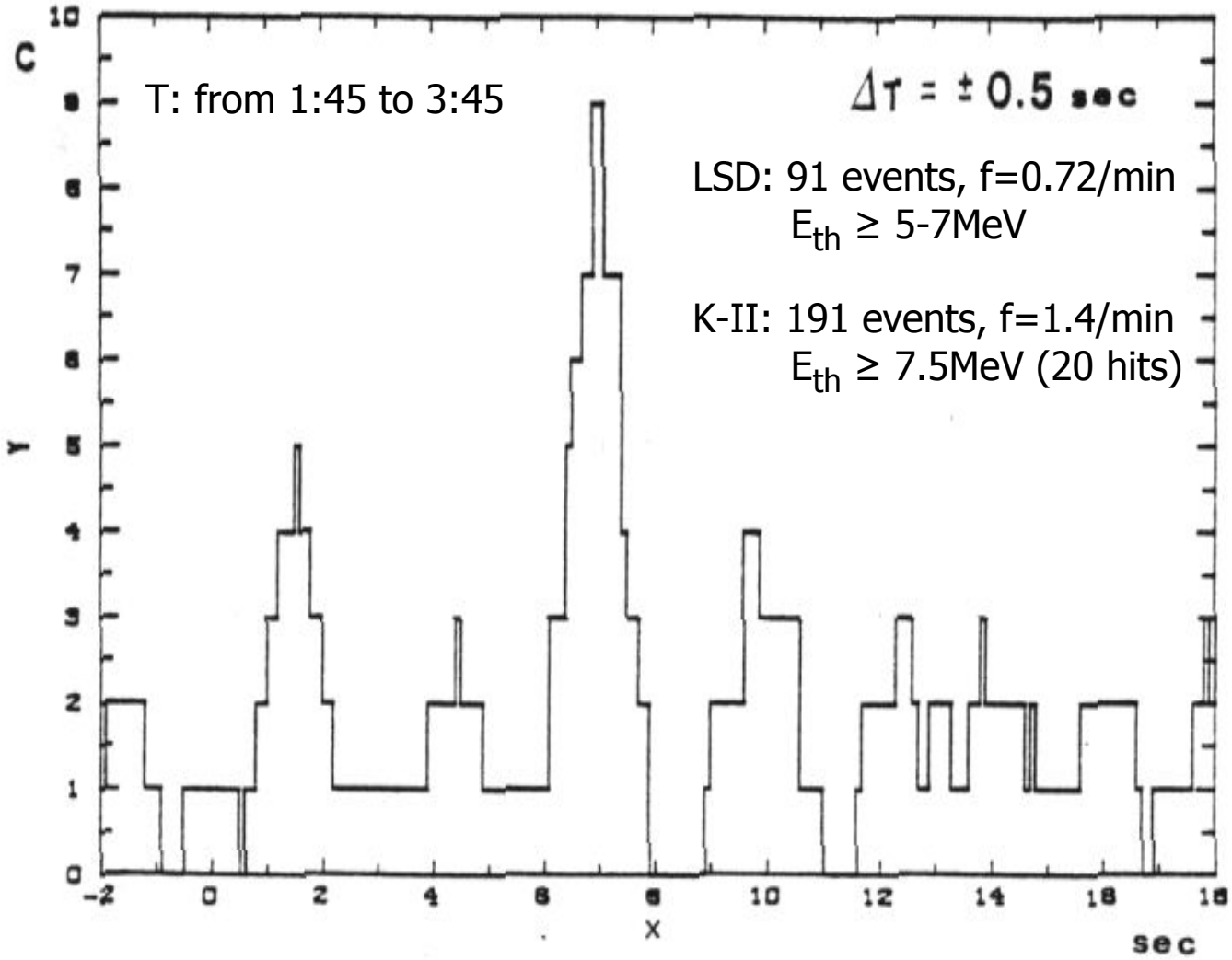
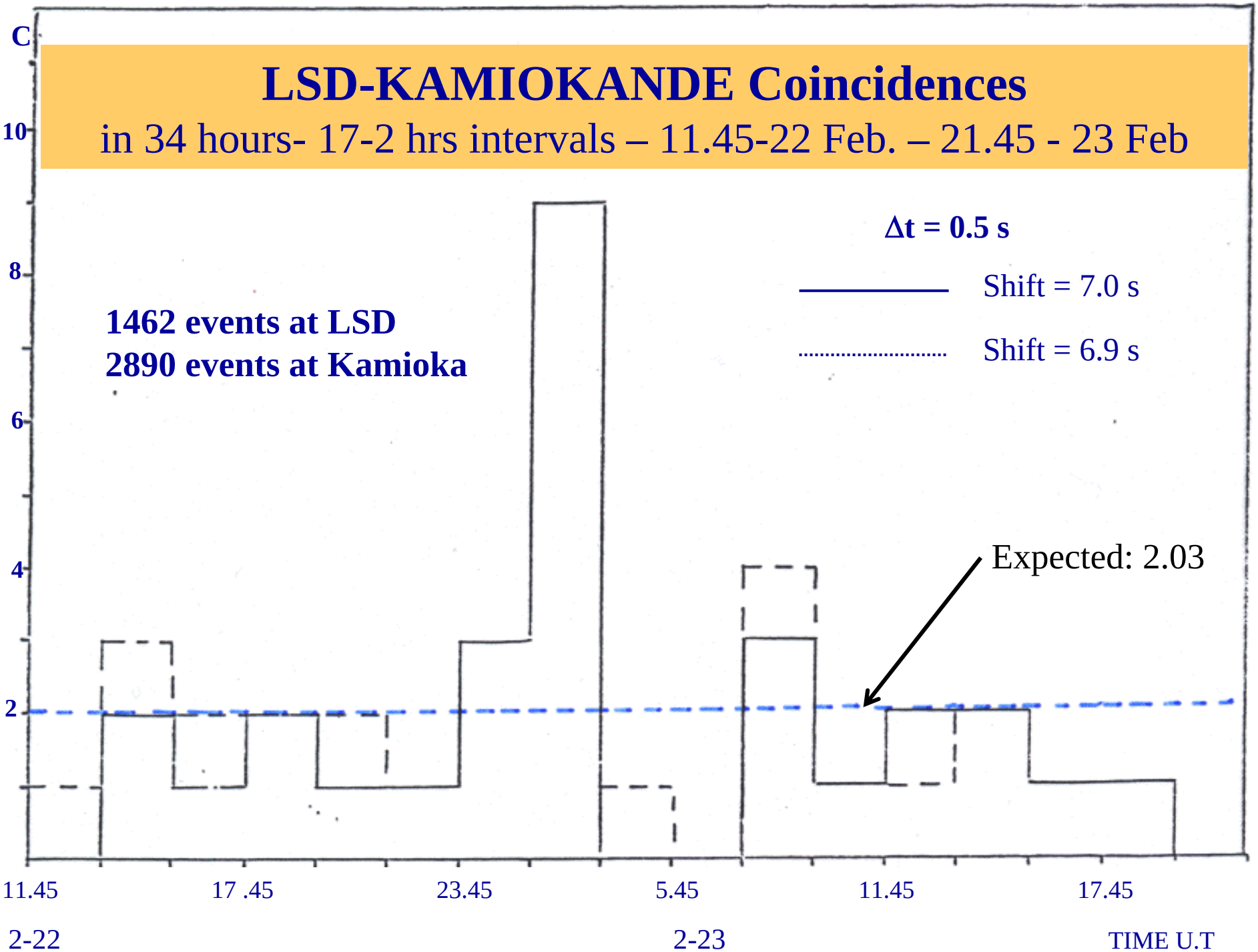


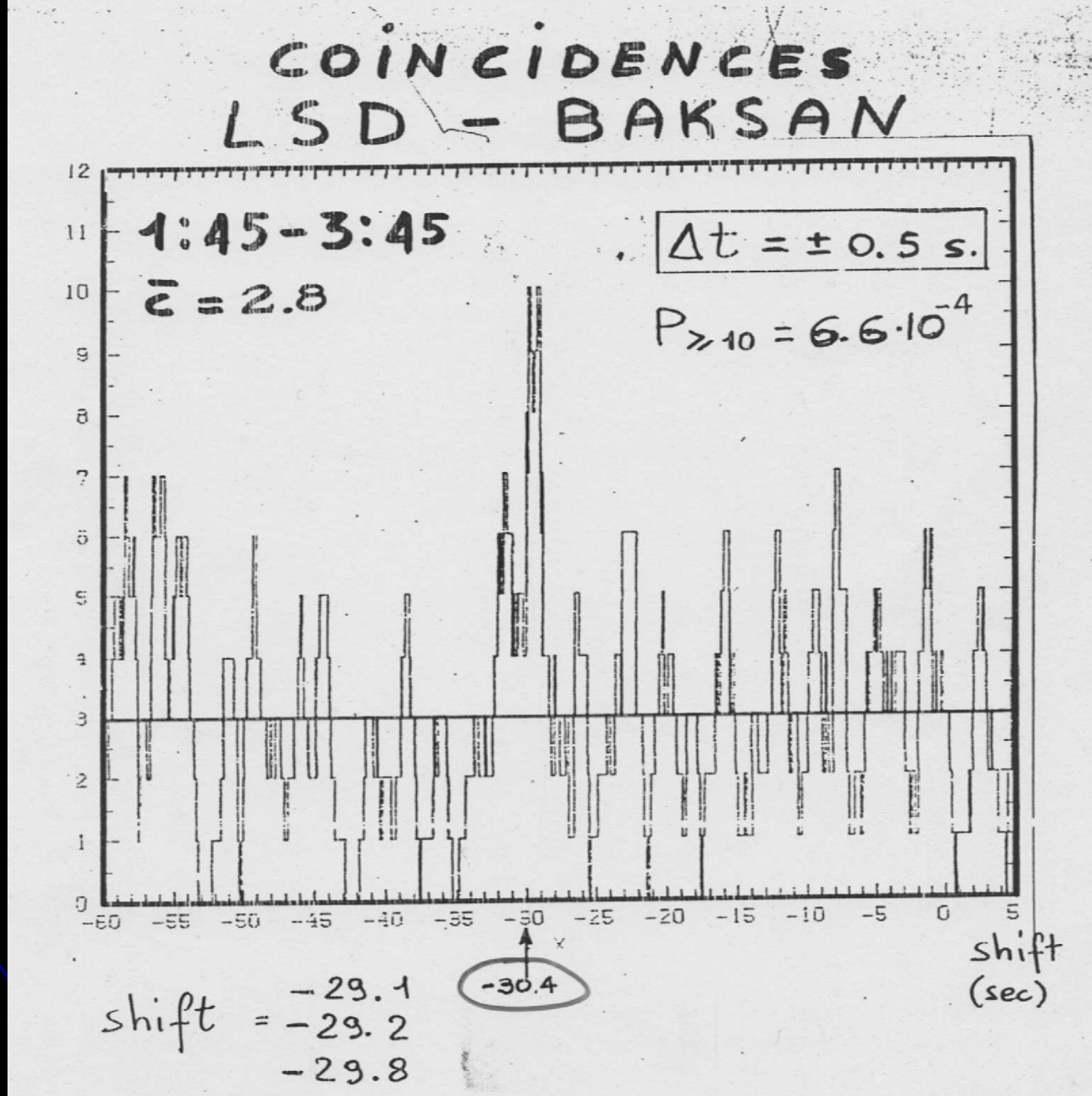
FIGURE 2. Distribution of the number of coincidences between K2 and LSD in the period from 1:45 to 3:45 U.T. on 23 February 1987 as a function of the time shift in the K2 absolute time.

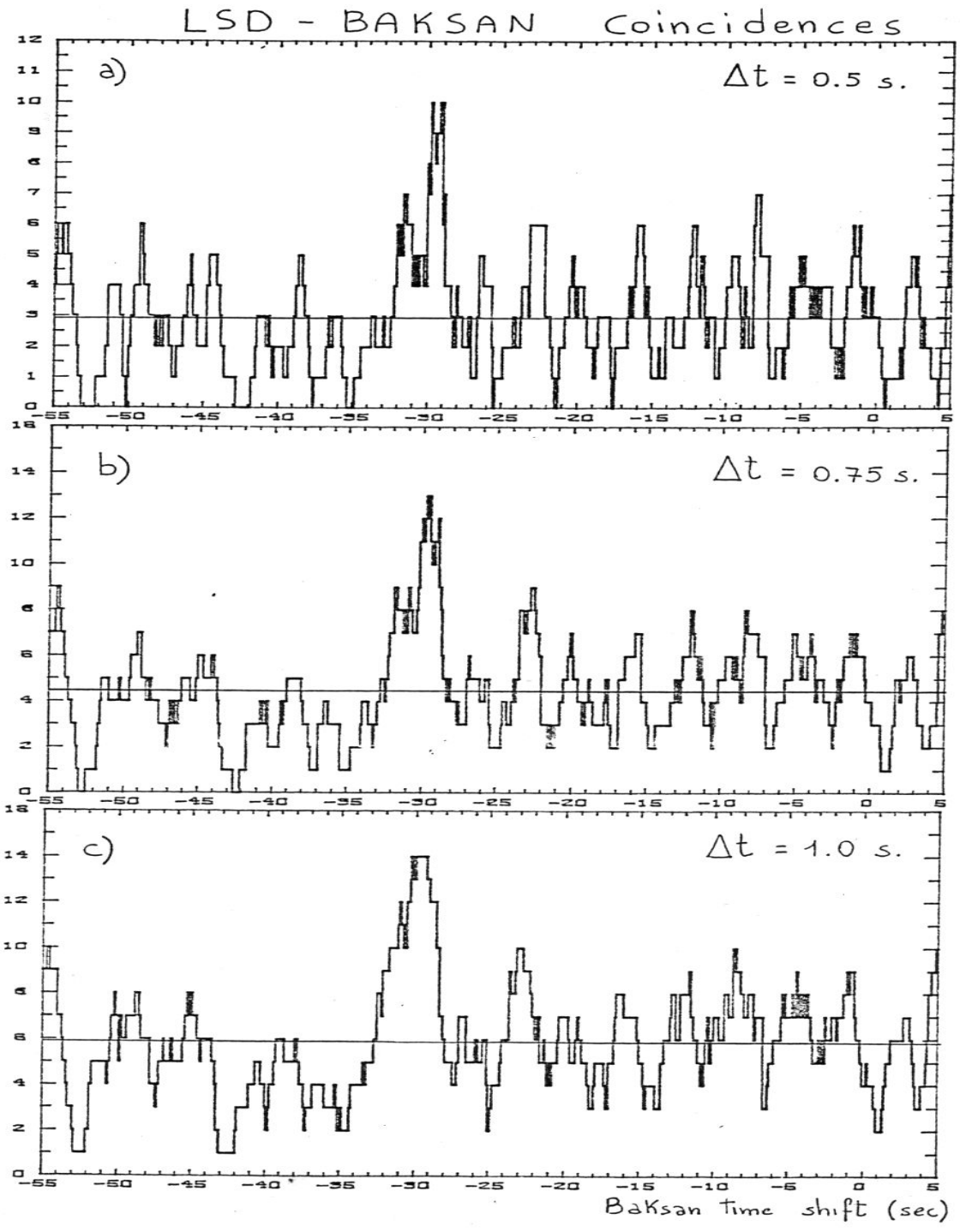
LSD-KAMIOKANDE Coincidences

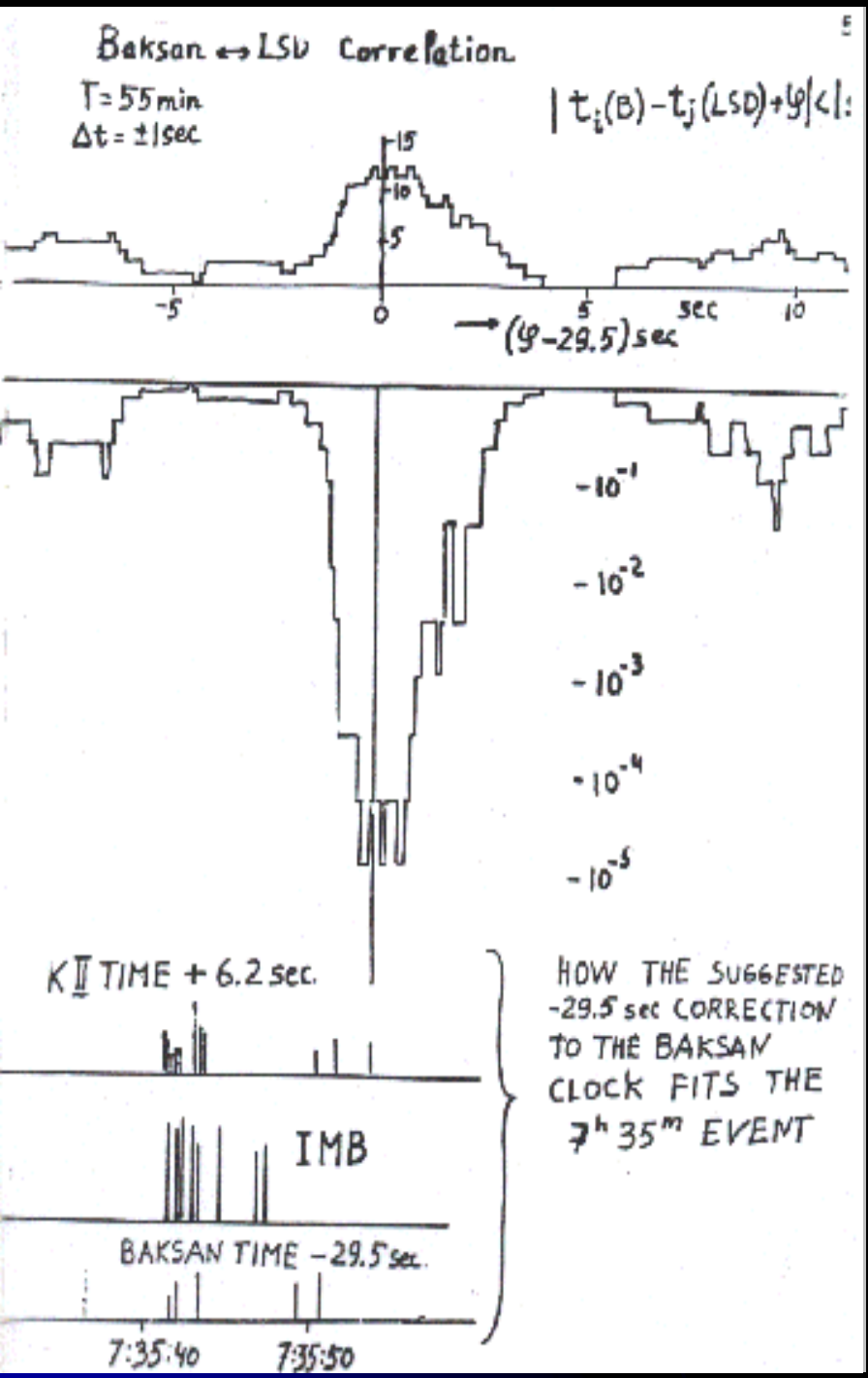
in 34 hours- 17-2 hrs intervals – 11.45-22 Feb. – 21.45 - 23 Feb

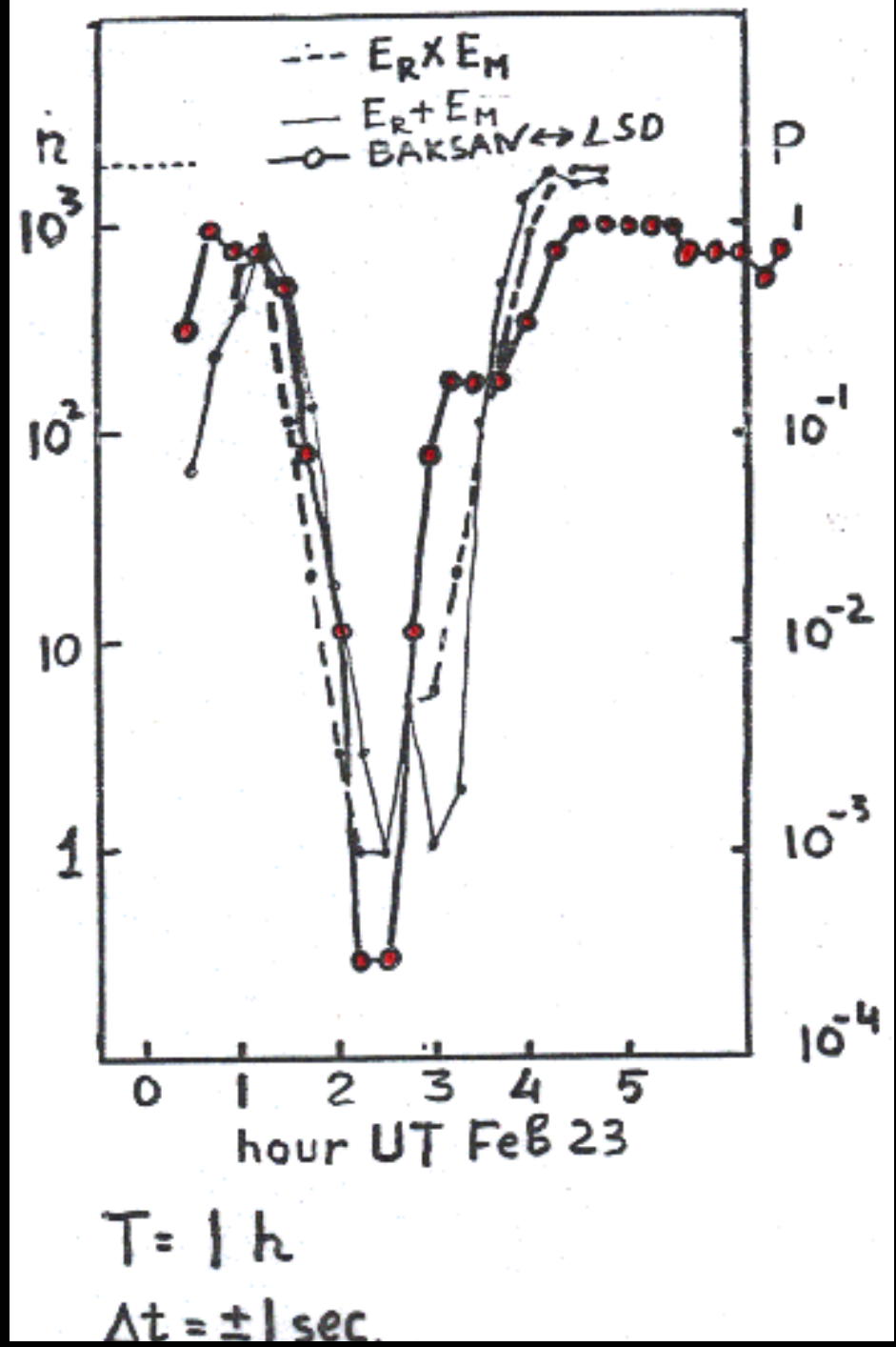


91 Mt. Blanc events
240 Baksan events




LSD - BAKSAN Coincidences
a)
Δt = 0.5 s.
b)
Δt = 0.75 s.
c)
Δt = 1.0 s.
Baksan time shift (sec)


Baksan ↔ LSD Correlation
T = 55 min
Δt = ±1 sec
$|t_i(B) - t_j(LSD) + \psi| < 1$:
15
10
5
-5
0
5
sec
10
$\rightarrow (\psi - 29.5)$ sec
-10^{-1}
-10^{-2}
-10^{-3}
-10^{-4}
-10^{-5}
K II TIME + 6.2 sec.
IMB
BAKSAN TIME −29.5 sec.
7:35:40
7:35:50
HOW THE SUGGESTED -29.5 sec CORRECTION TO THE BAKSAN CLOCK FITS THE $7^h 35^m$ EVENT


$E_R \times E_M$
$E_R + E_M$
BAKSAN ↔ LSD
n
P
10^3
10^2
10
1
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
0
1
2
3
4
5
hour UT Feb 23
T = 1 h
Δt = ±1 sec.

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On the Correlation between Mont Blanc and Baksan Underground Detectors in February 1987

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INTRODUCTION

After hearing the lecture of professor, E. Amaldi, at the Erice School (April 1988) concerning the observation of a correlation between gravitational antennas (G.A.) and Mont Blanc (LSD) signals[1] and then discussing the subject also with O. Saavedra in Torino, I suggested to look for a correlation directly between the LSD and Baksan data, thus of two quite similar underground scintillation detectors.

The idea is very simple: If something really happens that activates the G.A. signal and that, after 1.2 s, gives a signal in a particular scintillator, then there should be a chance to observe a quasi-simultaneous signal in another, possibly very distant scintillator. The big distance between the Baksan and LSD detectors should exclude the common electrical power supply as a possible source of correlation. Another advantage of the suggested search could be a simplicity of statistical analysis when the duration of the signal (in the scintillation counter) is much less than the correlation time interval (1 s).

Of course, the negative result of the proposed analysis would not mean a strict contradiction with reference 1 for at least two reasons:

(1) the probability of recording the signal in LSD is unknown;
(2) although the target mass of the liquid scintillator at Baksan is twice that of LSD, the energy threshold (10 MeV) is nearly two times higher than in LSD.

Both effects could make a cross-correlation of LSD-Baksan unobservable.

Certainly, I also did not expect a positive result because of the fantastic nature of the phenomenon in question. Therefore, most surprising was the news from O. Saavedra, who, after receiving the Baksan data, informed me of a positive effect in the LSD-Baksan correlation. Consequently, I made an independent analysis that unambiguously confirmed Saavedra's message. However, at the same time, we found some peculiar strangeness and possible internal contradictions in this correlation.

In this report, I would like to discuss both positive and "negative" evidence concerning the LSD-Baksan correlation. However, as the saying goes: the good news first, then the bad news.

POSITIVE EVIDENCE NO. 1

Following reference 1, we have to choose several quantities for our correlation analysis:

(1) Δt = the time gate or correlation time,
(2) T = the time period in which coincidences are summarized,
(3) t = the position of the center of the T period on the U.T. scale,
(4) t_0 = a relative shift of the time scales of the two detectors; in our case, a correlation of the Baksan clock.

We first choose $\Delta t = \pm 1$ s. One second is exactly the time gate chosen in reference 1 and the plus-minus sign arrives from the assumed symmetry of the detectors. The choice of Δt by intention is not made as an optimal one (for $\Delta t = \pm 0.2$ s or $\Delta t = \pm 2$ s, the result could be made more impressive).

Next, $T = 1$ hour is in our opinion a good choice, both improving the significance of the result by a factor of four (as compared with $T = 2$ hours) and indicating the maximum of activity better.

The choice of $t = 2{:}15$ U.T. is illustrated in FIGURE 1.

The choice of $t_0 = -29.5$ s for the correction of the Baksan clock is shown in FIGURE 2.

FIGURE 1 shows the significance of the correlation both for the G.A.-LSD pair

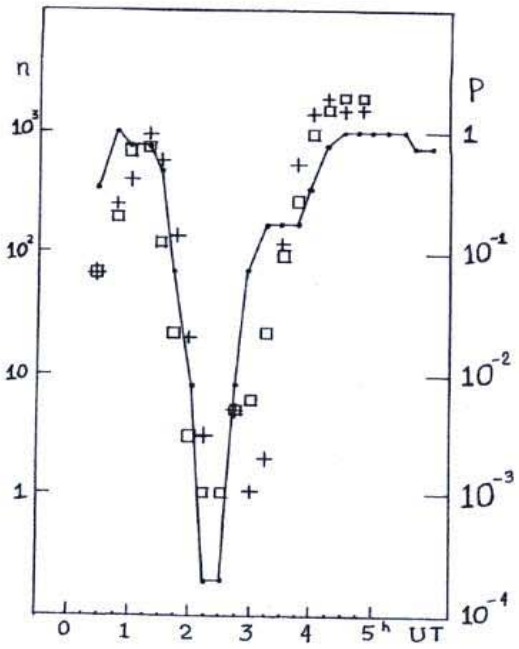


FIGURE 1. The significance of observed correlations for both G.A.-LSD (squares and crosses) and LSD-Baksan (dots and solid line) as a function of the position of the period T on the U.T. scale. Squares: $E_M \times E_R$ algorithm; crosses: $E_M + E_R$ algorithm (see reference 1).

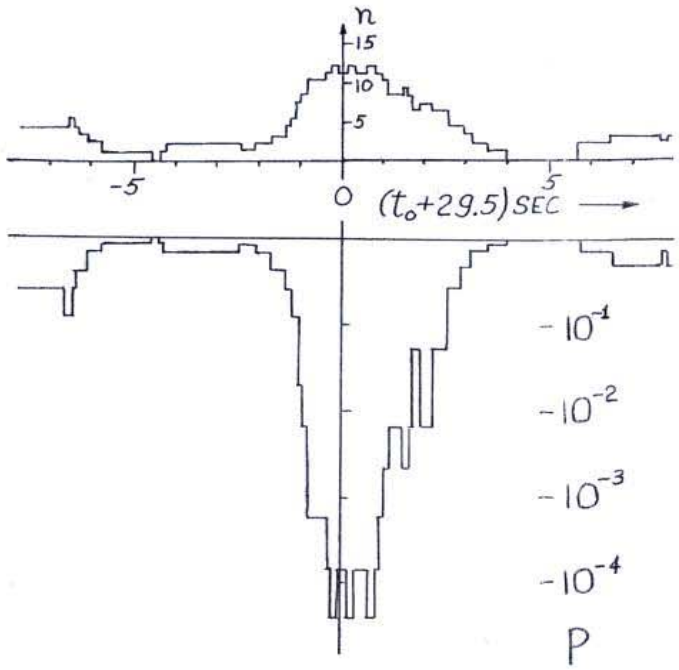


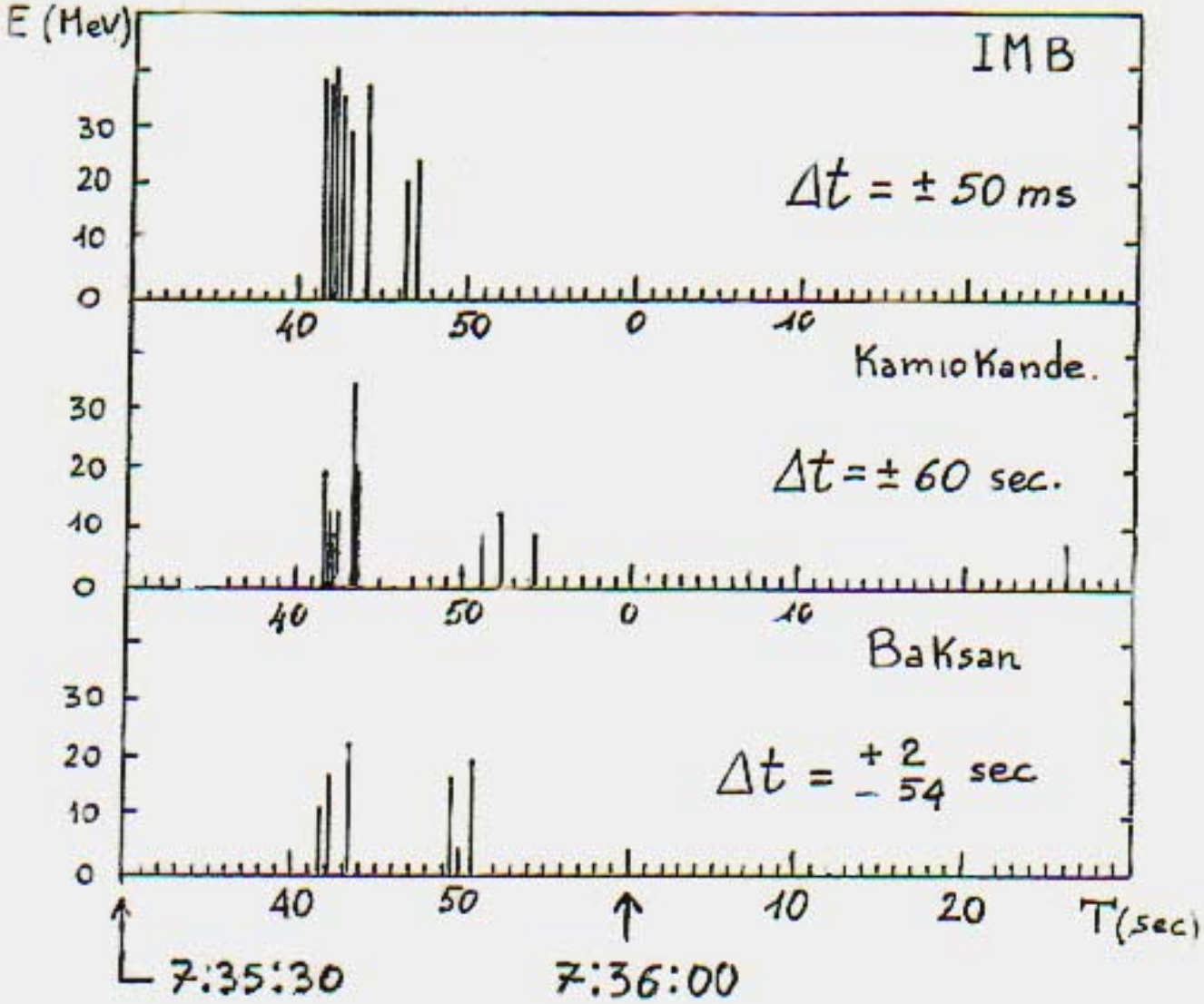
FIGURE 2. The number of LSD-Baksan coincidences as a function of the time shift, t_0 (top histogram). The Poisson probability to have the observed number or more (bottom histogram).

(crosses and squares) and the LSD-Baksan pair (solid line with dots). Note that data for the G.A.-LSD pair are taken from reference 1.

For both data, the time period of $t = 1$ hour is moved by steps of 15 min along the U.T. time scale. On the left vertical scale, the quantity, n, is plotted (see reference 1); $n = 2000$ roughly represents the chance probability to observe the recorded magnitude of the G.A.-LSD correlation. On the right vertical scale, the chance probability to observe the recorded number or a bigger number of LSD-Baksan coincidences, $\Delta t = \pm 1$ s, is plotted. Although this quantity strictly does not obey the Poisson distribution, the latter is quite a good approximation in our particular case. For $t = 2{:}15$, we have: $N(\text{LSD}) = 44$; $M(\text{Baksan}) = 116$; the mean (expected) value of coincidences is $\lambda = 2 \times 44 \times 116/3600 = 2.84$; the observed one is 11. The practical validity of the Poisson distribution of the number of coincidences for these particular figures was checked by 32,400 trials.

Looking at FIGURE 1, we see a striking similarity between the G.A.-LSD data and the LSD-Baksan data. The correlation arrives at the same time and, approximately, with the same strength. The probability of this to happen by chance is $P = 2 \times 10^{-4}$. However, the last figure should be corrected for the arbitrary choice of $t_0(\text{Baksan}) = -29.5$ s.

Feb/23/1987 at 7:35 UT



$T_{IMB} - T_{KAM} = 7.7$ sec

$T_{IMB} - T_{BAK} = -30.4$ sec

LSD			Kamiokande				
Event Number	Time	Energy (MeV)	Event Number	Time	Nhit	cos(teta)	Time dif.(sec) LSD-Kam
957	2:11:37.04	6.4	124037	2:11:29.72	23	-0.647	7.31
970	2:29:30.77	7.5	124948	2:29:23.39	21	-0.807	7.37
971	2:31:23.31	6.8	125041	2:31:16.51	20	-0.805	6.80
979	2:36:17.75	6.5	125275	2:36:10.91	20	0.170	6.84 ← BST
1017	3:05:35.37	7.1	126600	3:05:28.82	34	-0.028	6.55
1026	3:12:39.10	7.2	126905	3:12:32.57	21	-0.842	6.53
1027	3:12:39.46	7.3	.	.	.	.	6.89
1040	3:28:33.18	7.2	127782	3:28:25.99	39	-0.845	7.19
1044	3:31:06.14	5.5	127904	3:30:59.18	21	0.321	6.96

Coincidences between LSD and K2 in the period from 1:45 - 3:45 UT, Feb. 23 1987.
The coincidence window is $\pm$0.5 sec.

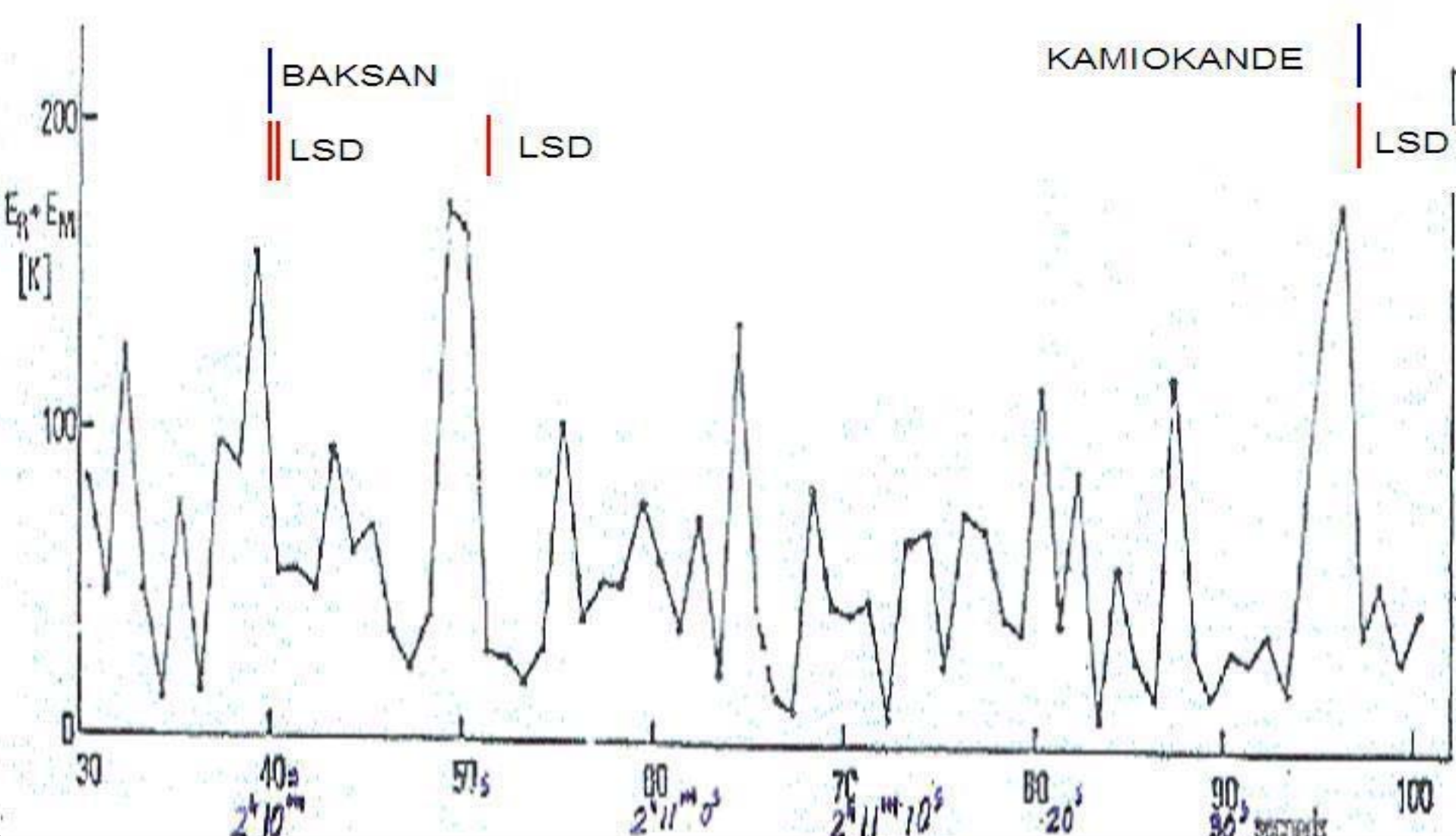
LSD				Baksan		
Index	Event Number	Time	Energy (MeV)	Time	Energy (MeV)	Time dif.(sec) LSD-Baksan
1 2 3 4	931	1:47:48.80	8.4	1:48:18.12	22.9	-29.32
1 3 4	934	1:52:22.45	6.3	1:52:52.63	17.5	-30.18
1 2 3 4	945	2:03: 0.48	7.9	2:03:30.04	8.8	-29.56
1 2 3 4	954	2:10:40.10	6.2	2:11:09.70	35.6	-29.60
1 2 3 4	955	2:10:40.32	6.8	•	•	-29.38
2 3	962	2:17: 5.05	7.2	2:17:33.84	22.9	-28.79
2 3 4	966	2:22:31.19	7.5	2:23: 0.33	12.5	-29.14
1 3 4	968	2:26:42.26	7.4	2:27:12.49	35.9	-30.23
1 2 3 4	977	2:34:35.62	6.9	2:35: 5.00	19.2	-29.38
1 3 4	979	2:36:17.75	6.5	2:36:47.80	29.1	-30.05 ← K-II
1 2 3 4	981	2:38:24.89	7.8	2:38:54.41	24.7	-29.52
1 2 3 4	036	3:25:15.53	7.0	3:25:45.11	23.5	-29.58
2 3 4	1047	3:38:21.10	7.8	3:38:50.08	20.6	-28.98
4	1051	3:43: 3.69	6.9	3:43:34.09	22.1	-30.40

Coincidences between LSD and BST in the period from 1:45 UT to 3:45, Feb. 23 1987.
The meaning of the index is:

Index	Coinc.window (sec)	BST time shift (sec)
1	± 0.5	-29.8
2	± 0.5	-29.1 o -29.2
3	± 0.75	-29.5
4	± 0.75	-29.7

Phase D

Correllations between
BST - IMB
LSD – IMB
and GW antennas


BAKSAN
LSD
LSD
KAMIOKANDE
LSD
200
100
0
$E_R + E_M$
[K]
30
40s
50s
60
70
80
90s
100
seconds

Professor F.Raines
University of California
Department of Physics
Irvine, California 92717
USA

15 March, 1990

Dear prof. Reines,

By this letter I would like to draw your attention to the crazy bysness conserning correlations between underground detectors data 23 Feb. 1987 prior to SN1987A. My personal connection (and attitude) to the subject was formulated in my talk at Texas Symposium at Dalla Dec. 1988 (ref.1)(I enclose the paper). After Dallas during my stay at Irvine R.Svoboda, d.Kielczewska and myself tried to look if there is any correlation between LSD(Mont Blanc) and IMB data similar to LSD x Baksan correlation and found none. As I remember at that stage of analysis we tried to select the small energy IMB events (small number of hits). More complete results are presented in 21 ICRC Proc vol.10,p.40(Ref.2).

Meanwhile people at Baksan lab. E.N.Alexeev and I.M.Kogai have found some correlation between LSD or Baksan neutrino-like low energy events and high energy Baksan events looking like muon induced cascades or horizontal muons-Pisma JETP vol.49,N9,p.480,1989(Ref.3).

The signal was not very strong but it gave them the idea to try also high energy IMB events. A remarcable correlation was observed between LSD and those IMB events wich have been identified as horizontal muons.

To evaluate the significance of this result I suggest the following procedure:

1. First of all avoid the temptation to ajust the parameters involved in analysis as time period T, time gate Δt or time shift specifically to correlaton with IMB. Let us use the same parameters as in (ref.1) which certainly are independent on IMB data.
2. Let us select for the testing IMB those LSD events, which arrived in the period 1:45 ÷ 2:45 in coincidence with GA(gravitational an-

Table 2.

		IMB-tot N=8084	IMB- N=6340	IMB 70° N=317
1.	LSD x (BC+GA) N=13	72/58,8 $5,5\cdot10^{-2}$	61/46,1 $2,1\cdot10^{-2}$	11/2,31 $3,0\cdot10^{-5}$
2.	LSD x BC N=10	58/45,4 $4,1\cdot10^{-2}$	49/35,6 $1,9\cdot10^{-2}$	9/1,72 $1,0\cdot10^{-4}$
3.	LSD x GA N=7	40/31,9 $9\cdot10^{-2}$	35/25,01 $3,5\cdot10^{-2}$	6/1,25 $1,8\cdot10^{-3}$
4.	LSD x BC x $\widetilde{GA}$ N=6	32/26,2 $15\cdot10^{-2}$	26/21,1 $17\cdot10^{-2}$	5/1,06 $4,6\cdot10^{-3}$
5.	LSD x BC x GA N=4	26/18,4 $5,5\cdot10^{-2}$	23/14,4 $2,3\cdot10^{-2}$	4/0,72 $6,4\cdot10^{-3}$
6.	LSD N=43	214/198 $13\cdot10^{-2}$		
7.	BC N=116	545/516 $10,0\cdot10^{-2}$		

I believe that the data in table 2 shows an another independent support of the reality of the fantastic phenomenon in question. It is difficult to evaluate some confidential level, but I suppose that the probability to have such evidence just by chance is less than 1%, If so the statement in ref.2 concerning the absence of significant correlation between IMB and LSD-Baksan probably should be corrected.

I suggest three things:

1. To look into the data more thoroughly.
2. If the evidence will be confirmed - think about the publication of the results in spite of its unbelievable and fantastic meaning.
3. It seems very important to look for the Kamiokande high energy events, specifically horizontal muons. Unlike with IMB there is though a quite small but positive correlation with my algorithm of a neutrino - like Kamiokande signals - 2 when 0,6 expected. No serious disagreement with IMB really. But the muon - like events can be crucial. We do not have them.What do you think about going in touch with Koshiba or Totsuka? In Dallas I made no success asking Al.Mann of more complete Kamiokande data.

I am sending the copy of this letter to R.Svoboda and O.Saavedra and hope you will be able to discuss the subject with D.Kielczevska or others involved whom I do not know .

Hoping to hear your advice concerning the matters discussed.

Yours sincerely

A.E.Chudakov

Conclusions

- LSD detected on real time a burst of 5 signals at 2:52:36 before optical observation.

  Means this signal the first bang of the SN1987a?

  Can two bangs or rotated SN star model explain this effect?

- LSD detected one pulse at the IMB-K-II time

  LSD was the unique that give a prediction about the SSN ν's

- A series of coincidences have been found among LSD-Kamiokande-Baksan underground detectors in a period encompassing 1.5-2.0 hrs the Mt. Blanc burst.

Are the LSD, Kamioka, Baksan pulses real one?

The "phantastic effect", as is called by Chudakov, are something to do with the SN1987a?

If it is so, what they are?