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LNF-85/7(R)
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PRELIMINARY MEASUREMENTS OF THE GAMMA RAY AND NEUTRON BACKGROUND IN THE GRAN SASSO TUNNEL

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We have measured gamma ray and neutron activity at the entrance, in Bypass 12 (about 5650 m from the entrance) and in Laboratory B (about 6170 m from the entrance) of the Gran Sasso Tunnel (Fig. 1).

Gamma activity has been measured with a 90 cm^3 true coaxial GeLi detector connected to a 2048 channel analyser. The spectra were recorded on magnetic tape and analysed in Milano with the program Marmot to search for the lines produced by local radioactivity. Spectra obtained in the three locations are shown in Figs. 2, 3 and 4, while the corresponding activities are compared with those measured in Milano in Table I. It can be seen that the activity immediately outside the Tunnel is considerably low: less than in Milano by factors of about 2.4, 7.4, 2.4 and 14 for the series of ^{238}U and ^{232}Th and for ^{137}Cs and ^{40}K, thus confirming the very low activity contamination of the rock[1,2]. The intensity of the most important lines in Bypass 12 is comparable to that at the entrance of the Tunnel, with some decrease in the counting rate at 511 keV due to the suppression of cosmic rays. In the main Laboratory B the general activity is considerably larger (by a factor of 1.7 ± 0.3 in average). We attribute this effect to the much thicker lining of the walls which, even

though of a good quality[1,2], does not present such a low intrinsic radioactivity as the rock. It is interesting to note, both in Bypass 12 and in Laboratory B, the impressive lack of counts above the 2014.6 keV line of ^{208}Tl, due to the strong suppression of the contribution of cosmic rays.

Neutron background has been measured in the same locations using a cylindrical 600 mm long and 50 mm diameter BF_3 detector operated at atmospheric pressure, whose pulses have been analysed with the same procedure as for GeLi. Measurements have been carried out both with the bare detector and surrounding it with a 15 cm layer of paraffin, to detect thermal and fast neutrons, respectively. Measurements at the entrance of the Tunnel show (Fig. 5) the peaks of the excited state of ^{7}Li with intensities at the main peak of 529 ± 28 and 422 ± 50 counts per hour, respectively, while the same rates in Milano, when no accelerator was in operation, were of 314 ± 8 and 227 ± 7 counts per hour.

Both in the Bypass and in Laboratory B no peak appears for fast and thermal neutrons. A maximum likelihood procedure gives 90% upper limits of 5 and 4 counts per hour, respectively. Taking into account the efficiency of the detector, this corresponds to upper flux limits (for both the thermal and fast neutron components) of less than about $3\times10^{-5}ncm^{-2}s^{-1}$ or less than about $4\times10^{-6}ncm^{-2}s^{-1}sr^{-1}$, if one assumes that the incident neutrons are distributed over 2π steradians.

We conclude that the Gran Sasso Laboratory is excellent as far as gamma and probably neutron activity are concerned. However, more thorough measurements of the neutron component and of other possible components are needed for precisely assessing the radiation background.

It is pleasure to acknowledge the courtesy and understanding of COGEFAR and ANAS, and the skillfull help of R. Cavallini, F. Chignoli and M. Lindozzi, during these measurements.

REFERENCES

(1) G.Campos Venuti et al., Studio della radioattività naturale in rocce e cementi, ai fini della costruzione del Laboratorio del Gran Sasso dell'INFN, Frascati Report LNF-82/78 (1982).
(2) Milano Group, Comparison of the background between the Mont Blanc and Gran Sasso Laboratories, Preprint (1984).

TABLE I - Gamma ray activities (in counts per hour)

Energy (keV)	Source	Milano	Outside the tunnel	Bypass 12	Laboratory B
238.6	^{212}Pb	2013±67	277±55	390±74	588±102
295.2	^{214}Pb	562±45	291±73	376±40	512±88
352	^{214}Pb	1074±33	299±48	490±44	846±80
511	---	517±33	212±36	150±40	118±47
583.1	^{208}Tl	812±32	105±27	150±22	222±44
609.3	^{214}Bi	1000±33	313±30	450±38	897±56
661.65	^{137}Cs	330±22	139±23	46±27	92±32
911.2	^{228}Ac	582±25	103±28	43±26	96±34
1120.3	^{214}Bi	260±21	131±24	124±25	202±32
1238.1	^{214}Bi	154±21	99±22	73±22	32±29
1460.8	^{40}K	3160±44	224±21	340±29	442±34
1766.5	^{214}Bi	244±54	64±10	100±16	148±20
2614.6	^{208}Tl	584±50	65±10	52±12	108±12

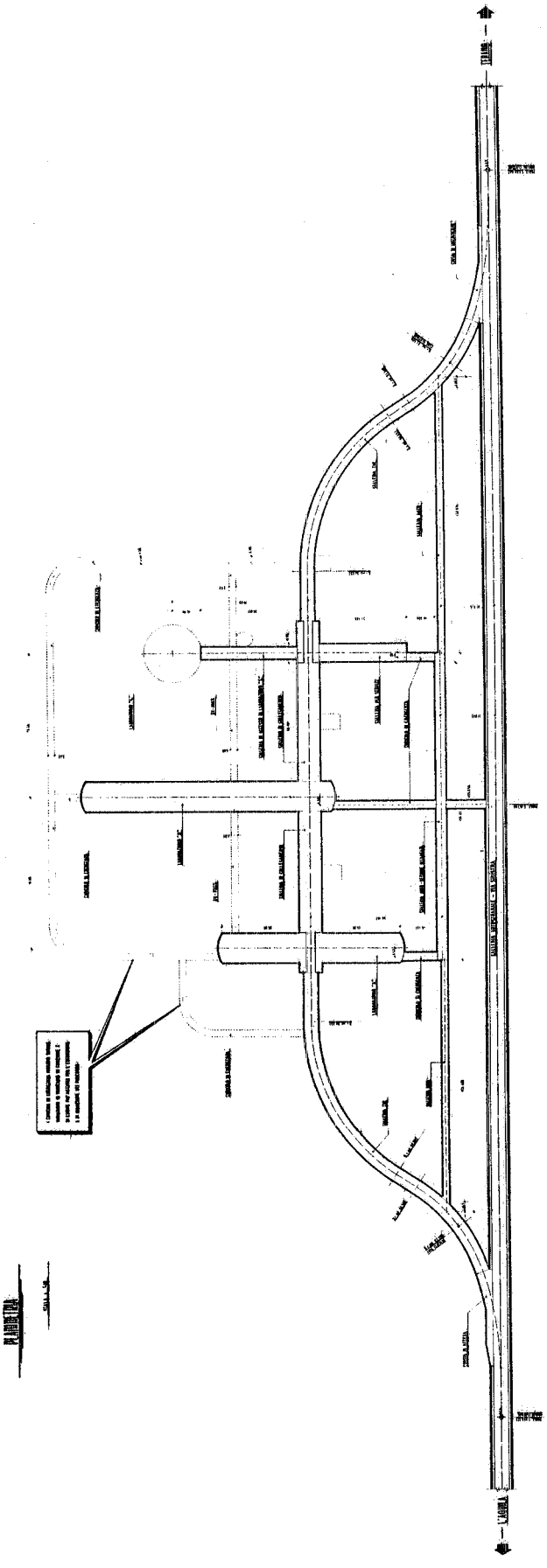

FIG. 1 - The Gran Sasso Laboratories.

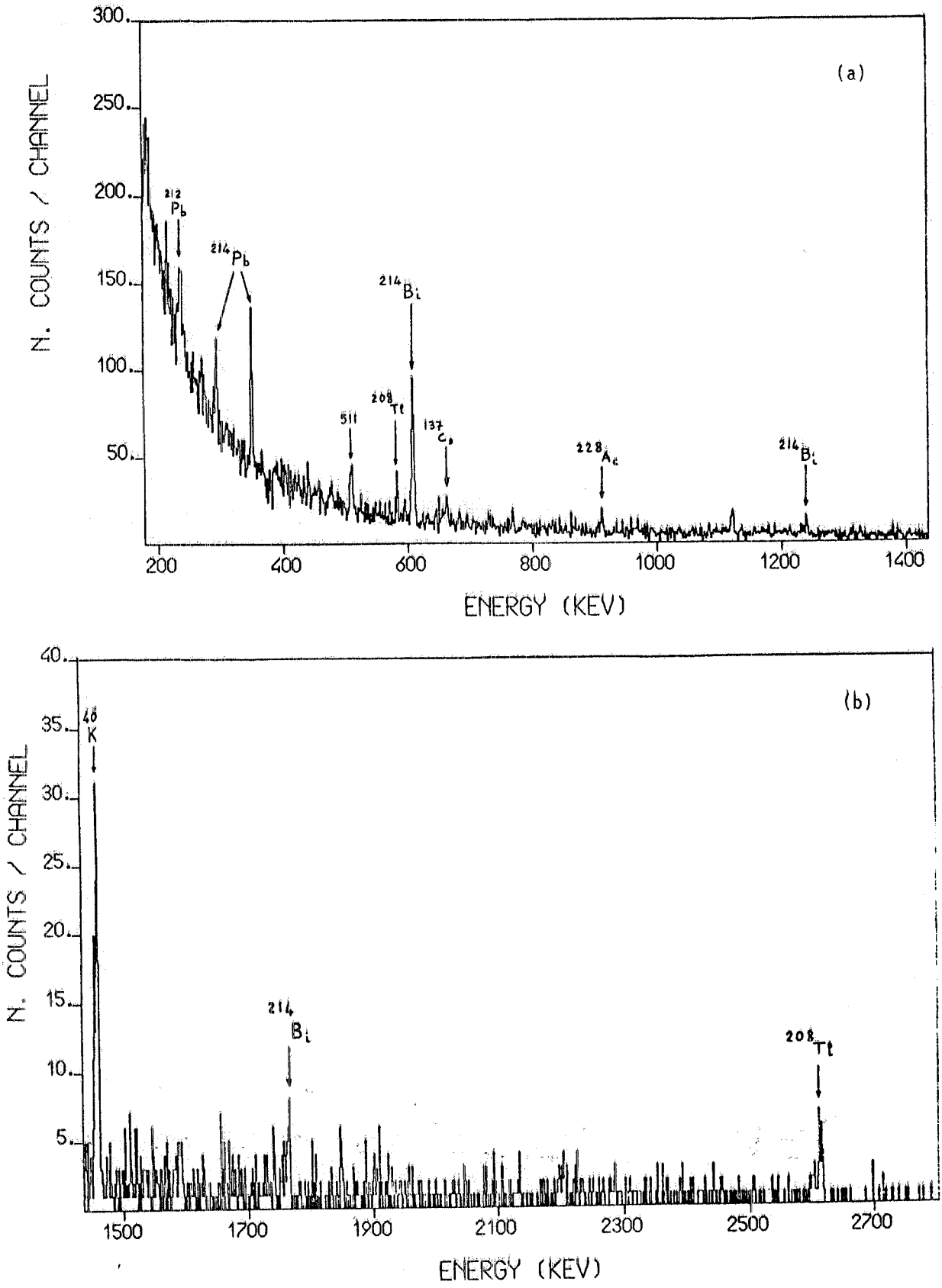

FIG. 2 - Gamma spectrum outside the tunnel.

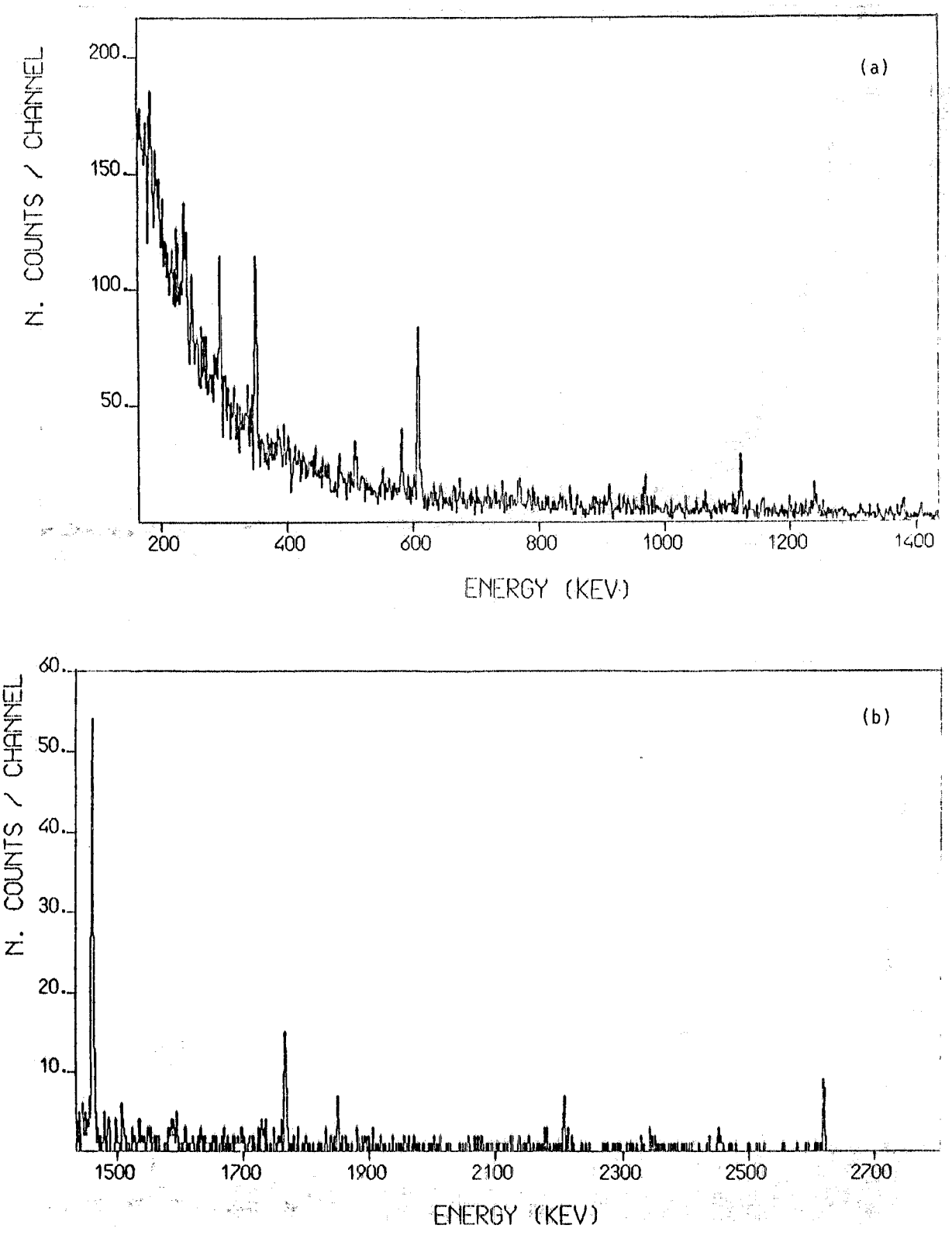

FIG. 3 - Gamma spectrum in Baypass 12.

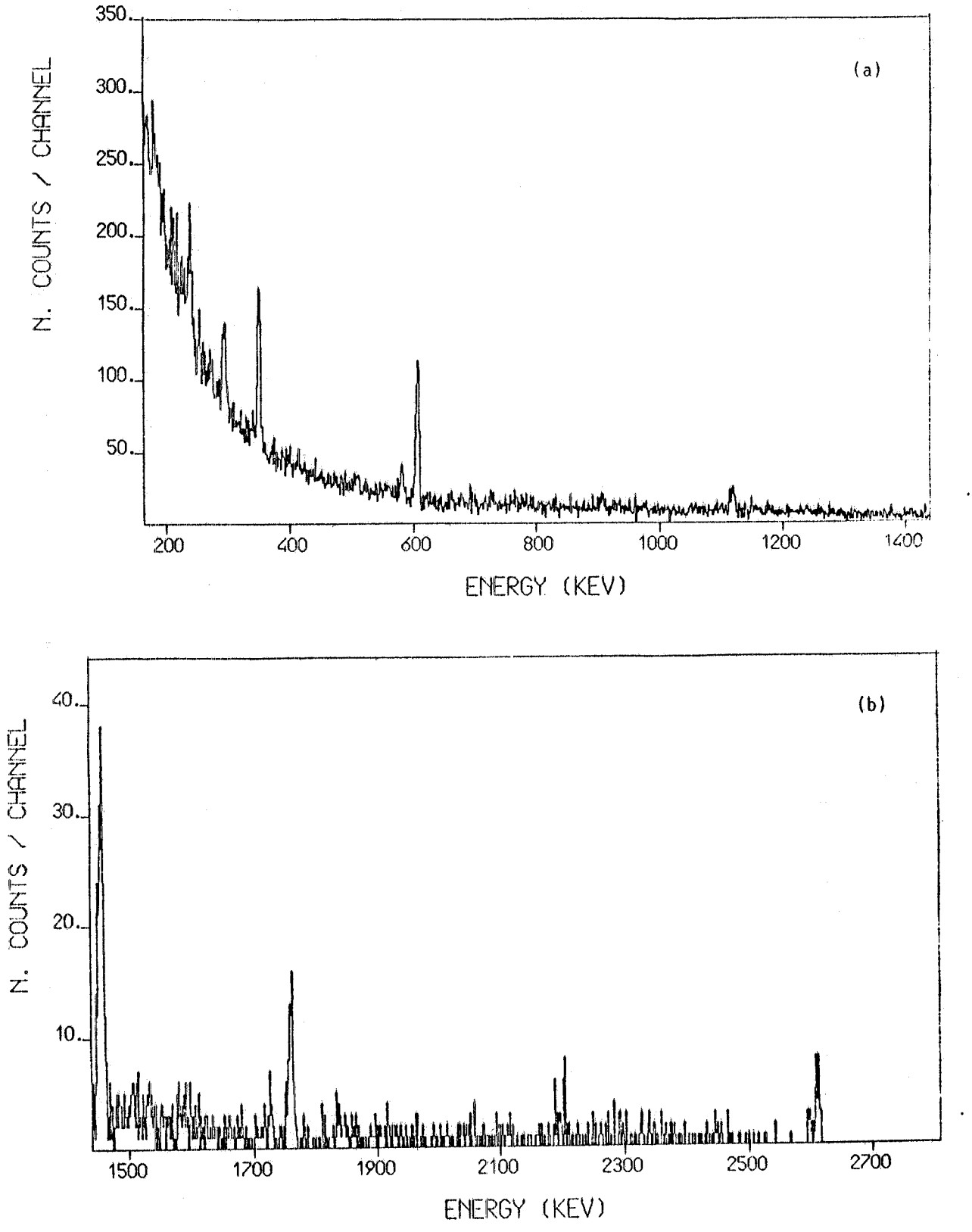

FIG. 4 - Gamma spectrum in Laboratory B.

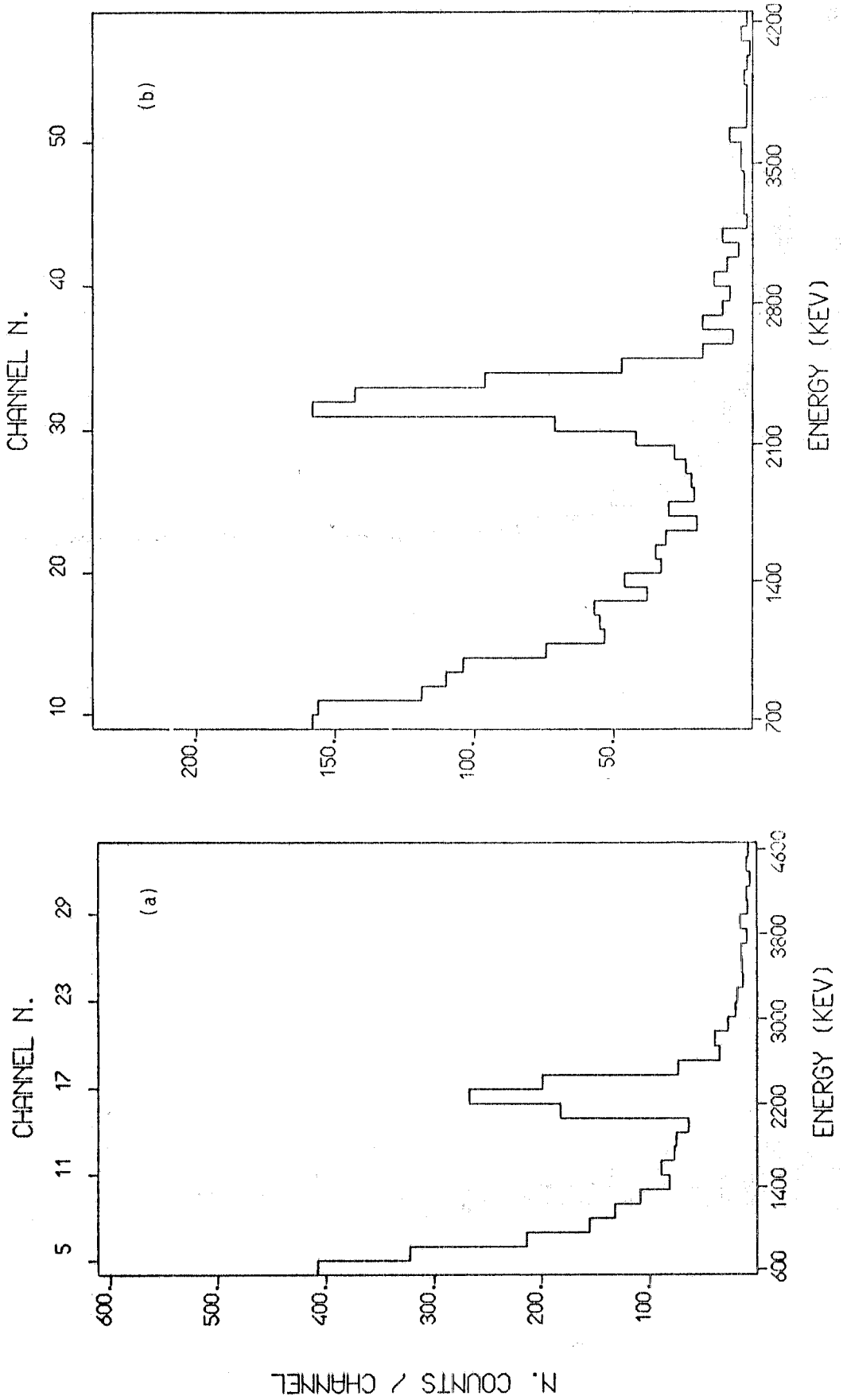

FIG. 5 - BF_3 neutron spectrum outside the tunnel: (a) bare detector; (b) with paraffin.

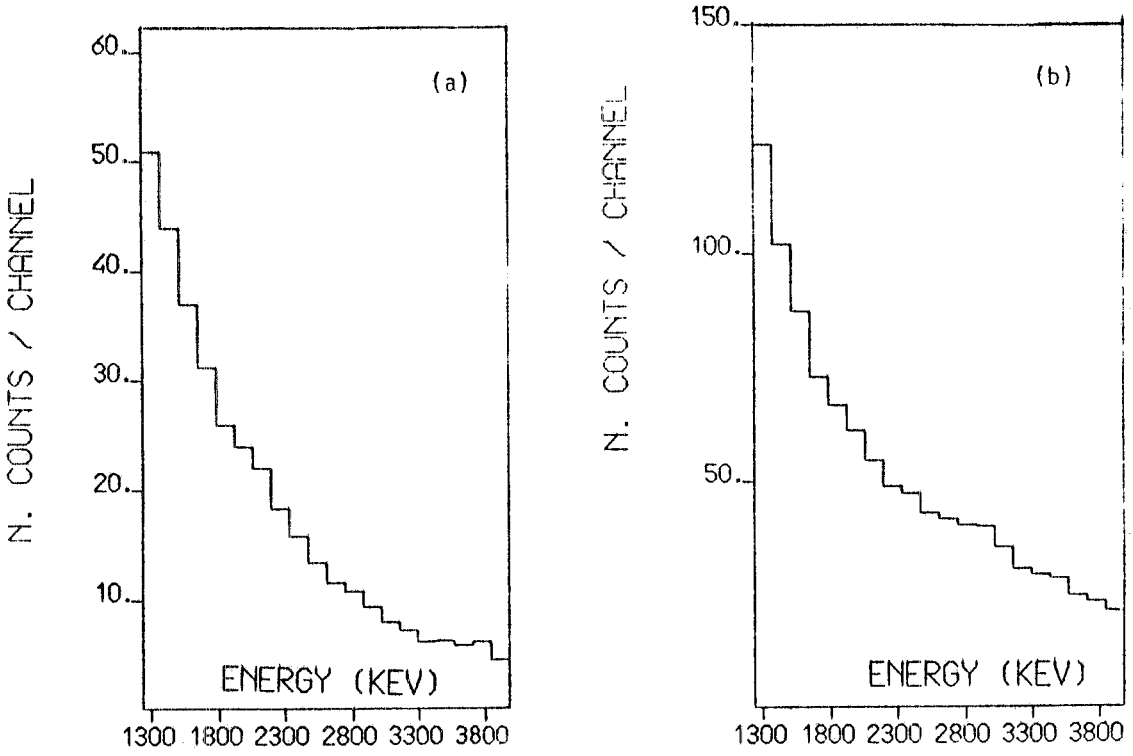

FIG. 6 - BF_3 neutron spectrum in Baypass 12: (a) bare detector; (b) with paraffin.

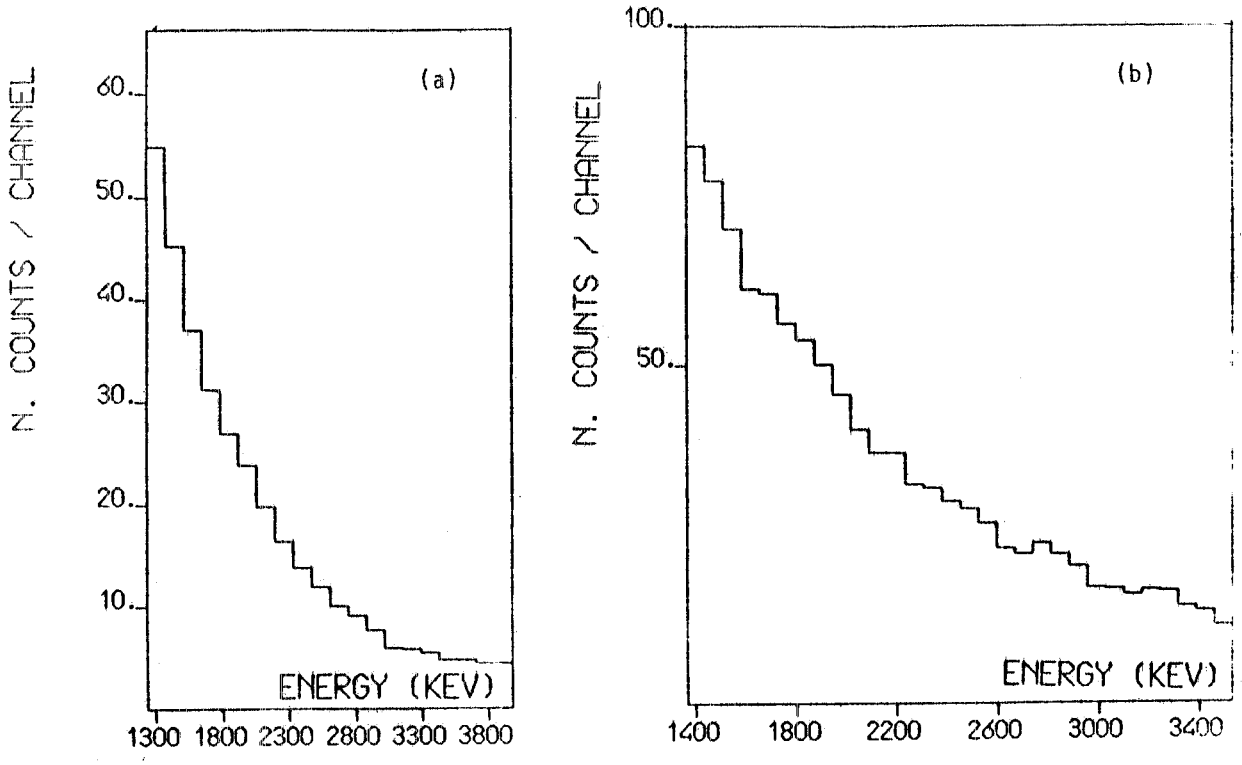

FIG. 7 - BF_3 neutron spectrum in Laboratory B: (a) bare detector; (b) with paraffin.