"Faster than light-like-events" in cosmic ray vetoing

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Abstract— **The anticosmic veto system developed around the extended range HPGe detector is described. In order to maximize the vetoing effect in the low-energy Ge spectrum region, the Ge fast output was amplified and the subsequent CFD threshold was set above background (~20 keV). The timing curve derived with this setup exhibited unusual features. Two peaks appeared at the distance of the 125 ns. The second peak appeared to be "prompt" on the position where the coincidence events from positron annihilation (22Na) occur. The apparently superluminal nature of the first peak is discussed in terms of saturation of the spectrum in the fast amplifier.**

I. Introduction

In our attempts to explore and optimize the vetoing effect of the anti muon shield for low level for gamma spectrometry, we made the observations which involve at first sight the superluminal velocities.

The detector system is presented on Fig.1. The extended range GMX type gamma spectrometer (HPGe) with nominal efficiency of 32 %, made by ORTEC, was shielded with the cylindrical lead shield with 12 cm wall thickness.

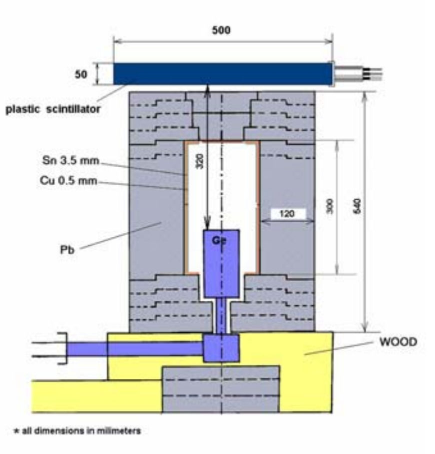

Fig.1

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Above the lead shield, the 0.5 m x 0.5 m x 0.05 m plastic veto detector, produced by SCIONIX, was placed. The coincidence/anticoincidence signal processing NIM electronic is presented on Fig 2.

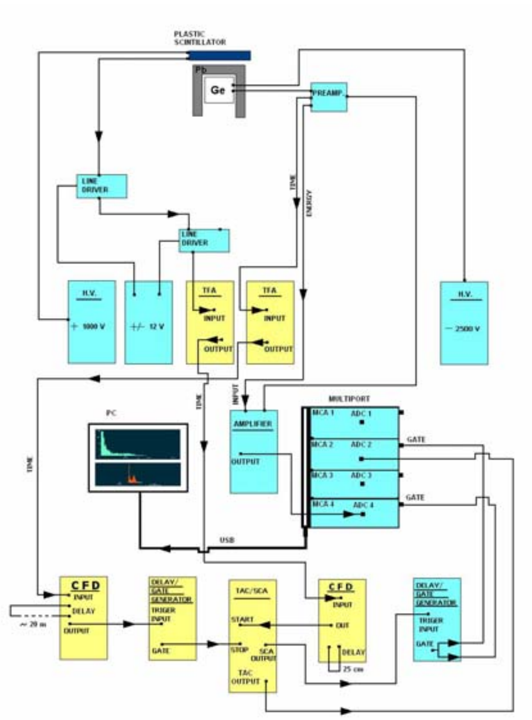

Fig.2

II. Experimental Results and Discussion

In the first runs, the time spectrum from the TAC (Time to Amplitude Converter), had the broad tail on right side (Fig.3), pointing towards slow (probably neutron induced) coincidence events.

In order to explore the slow event contribution, we adjust the TFA (Timing Filter Amplifier) amplification and shaping, and the CFD's delay cables and walk. The TFA settings are presented in Tab.1. The GMX energy threshold on the CFD was set to 30 keV (CFD was operated in constant fraction mode), while on the plastic CFD the threshold was set to 3 MeV (above environmental gamma rays and far below the muon maximum at 10 MeV).

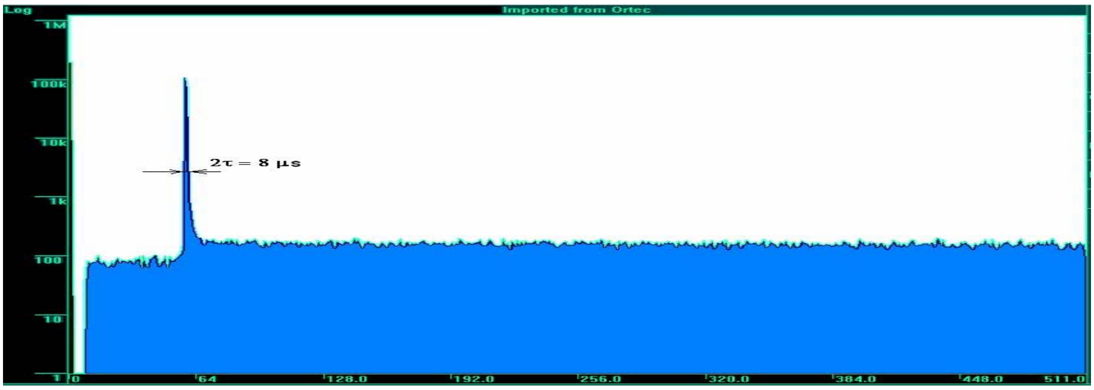

Fig.3

TABLE I
TFA SETTINGS

Parameter	TFA Of HPGe detector	TFA of plastic detector
Coarse gain	100	30
Fine gain	2	1.65
Differentiate	500 ns	10 ns
Integrate	500 ns	OUT

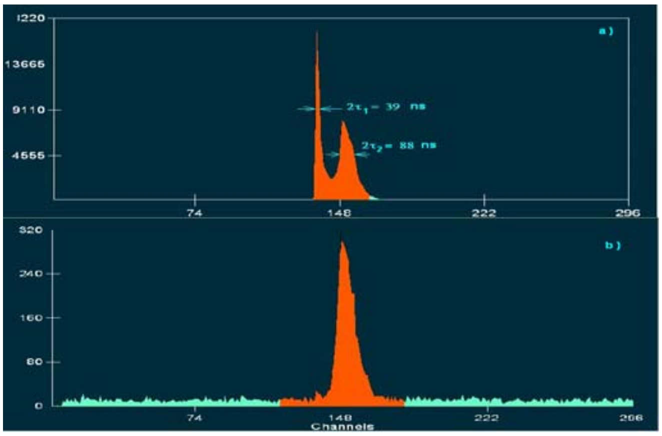

Fig.4

These settings improved significantly the time resolution of the coincidence circuit (Fig 4a.). In the time spectrum, two almost separated peaks appeared at the distance of 125 ns. The biggest surprise occurred during the test of the system timing with the 10 µCi activity ^{22}Na positron source. The maximum of the prompt time spectrum was placed on the same channel as the second maximum of the cosmic coincidence spectrum (Fig. 4b). This result can be naively explained by superluminal speeds. The gammas from ^{22}Na (energies 511 keV and 1275 keV) have the speed of light and cross the 32 cm detector to detector distance in about 1.1 ns (regardless to the source position between the detectors) defining thus the prompt (zero) time between the start and stop pulses. The pulses below this point on the time spectrum can be produced by random coincidences (flat distribution), electronic noise (not detected in our experiment), or by a particle traveling with superluminal speed [1] from the plastic to the Ge detector.
According to the data measured, the speed of this particle is about 115 c (c x 125ns/1.1ns).

In order to explore the interaction of this particle with the Ge detector, we measured the coincidence spectra with the events of first ("superluminal") peak, and second ("prompt") peak (Fig. 5 a,b).

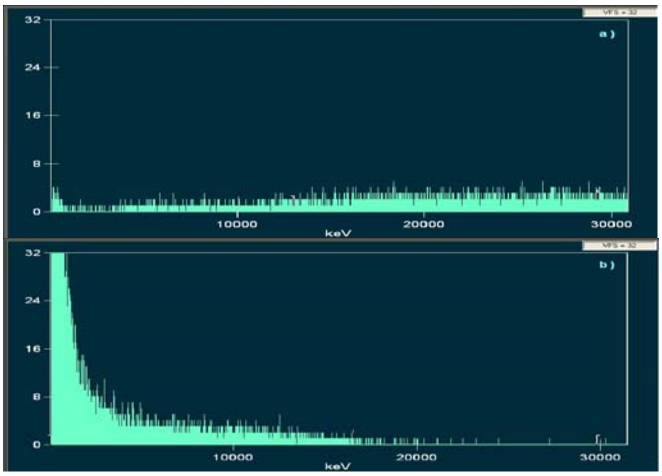

Fig.5a,b

III. Conclusion

Fig.5.a clearly shows that the first time peak triggers high energy GMX events, while the second, the low energy ones. Thus the exotic tachyonic [1] explanation can be replaced by the more realistic electronic saturation effect. High energy GMX pulses (from muons and gammas above 1.5 MeV) saturate in the TFA, yielding much shorter rise time than the non saturated pulses from ^{22}Na. So the saturated events are triggered by the CFD much sooner than the non saturated ones and follow the plastic start signal faster than the "prompt" ones. The first peak in the time spectrum is the signature of such events. Similar double peaked time spectrum is reported also by Povinec [2].

It looks surprising that the CFD sharply grouped the signals with significantly different rise times and in wide energy ranges acts as a pulse shape discriminator.

Further investigations of this effect are under way.

References

[1] Roman Tomaschitz, Tachyonic synchrotron radiation, Physica A 335 (2004), 577-610.

[2] P.P. Povinec, J-F.Commanducci, I. Levy-Palomo, IAEA-MEL's underground counting laboratory (CAVE) for the analysis of radionuclides in the environment at very low-levels, Journal of Radioanalytical and Nuclear Chemistry, 263, No. 2 (2005) 441-445.