RADIATION HARDNESS TEST OF BARIUM FLUORIDE SCINTILLATOR

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The main advantage of barium fluoride as compared with the other commonly used crystal scintillators is sufficiently high radiation hardness up to 10 *Mrad* defined as a rule with a little size crystals and ^{60}Co-source. The study of the radiation damages induced by γ-rays shows that the transmission curve saturation at $\approx$100 *krad* takes place [1]. The goal of the present work is to investigate the effect mentioned above v.s. dose rate and to measure the fast component light output of BaF_2 crystal irradiated by the high energy protons.

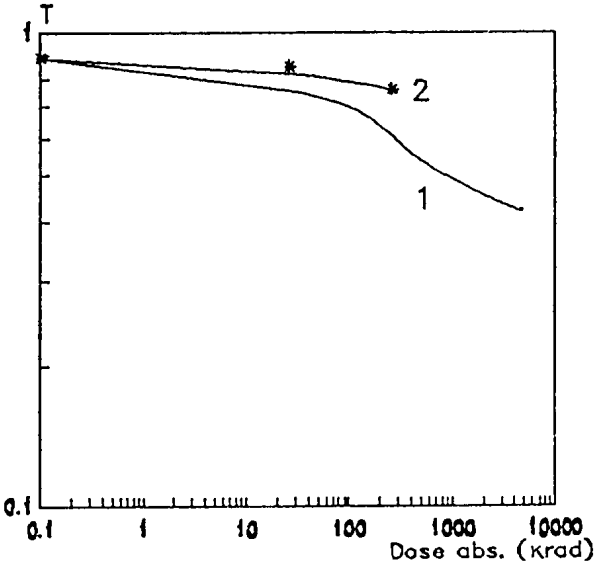

Fig.1. BaF_2 light transmission on 220 *nm* v.s. dose per 1 rad.length. *1* — [2]; *2* — present paper

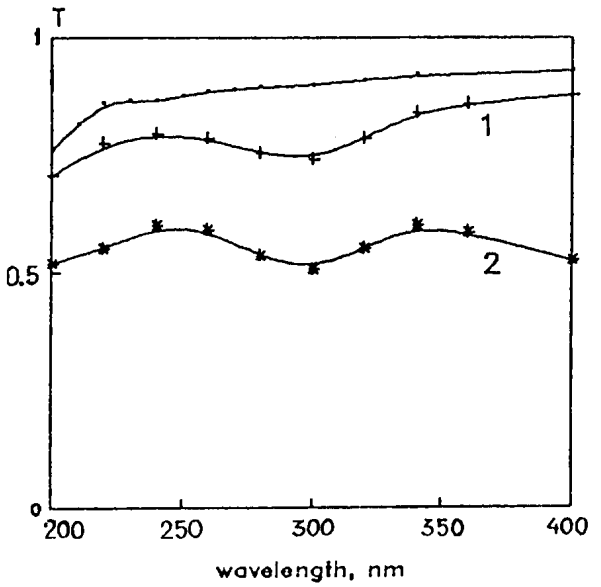

Fig.2. Transmission spectra before and after proton irradiation (L = 6.2 *cm*, 130 *rad/s*): *1* — 26 *krad*; *2* — 260 *krad*

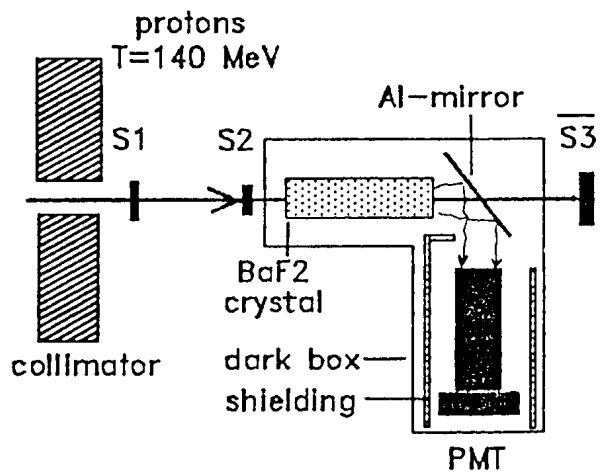

Fig.3. Experimental set-up. The trigger scint. counters signal is S1×S2×$\overline{S3}$

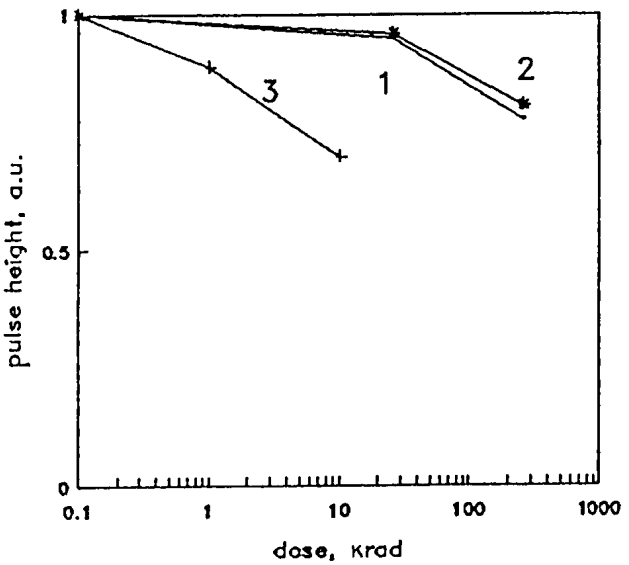

Fig.4. Fast component peak position v.s. dose. *1* — experiment, *2* — calculation, present paper, *3* — data of [3]

In previous run BaF_2 crystals (2.5×2.5×5.2 cm^3) were irradiated by 1 *GeV* protons with the dose rate 2300 *rad/s* along the main axis [2]. The results of that run are shown in fig.1 (curve 1). The data of the present run are shown in fig.1 (curve 2) and in fig.2. In contrast to the first run the present dose rate is 130 *rad/s*. As it is seen from fig.1, the radiation induced light absorption in BaF_2 crystal because of the radiation damage is strongly dose rate dependent. In future proton collider experiments one can expect the dose rate of order 1 rad/s. Therefore radiation damages may still be less appreciable.

C.Woody et al. [3] observed the BaF_2 fast component light output to be decreased when crystals were irradiated by ^{60}Co γ-quanta at the doses 1—10 *krad*. We checked this effect for the BaF_2 crystals irradiated by 1 *Gev* protons and made use for the test by 140 *MeV* proton beam. The layout of the experiment is shown in fig.3. The BaF_2 crystal was coupled to the quartz window PMT with air gap. The PMT amplitude distributions induced by stopped protons were measured before and after the irradiation. The signals from PMT were gated by 35 *ns* trigger pulses. The luminescent light from irradiated BaF_2 sample was reflected on PMT through Al maylar mirror to decrease the background due to soft γ-rays and permanent light from the residual radioactivity. Fig.4 shows the results of this experiment with data of [3]. In our case the influence of the radiation induced effects on the BaF_2 scintillator fast component light output is significantly less. The change of this light component practically coincides with the one calculated on the base of the BaF_2 crystal irradiated transparency deterioration curve.

Finally one has to mark, that the recovery rate and the recovered optical transparency after the thermal "annealing" at home temperature are significantly different for γ-rays and protons.

References

1. Yanovsky V., Reiterov V., Rodnyi P. //Nucl.Phys.B. 23A. 1991. P.347.

2. Chizov V., Seliverstov D., Skorikov V., Yanovsky V., Zakharov N. Proceedings of Int.Symposium LUMDETR-91. Riga. 1991. P.126.

3. Woody C., Kierstead J., Levy P., Stoll S. BNL Internal Rep. Aug. 1991.