Краткие сообщения ОИЯИ №5[51]-91 *JINR Rapid Communications No. 5[51]-91*
УДК 539.1.074

RADIATION HARDNESS TESTS OF A SCINTILLATING FIBER CALORIMETER MODULE

S.V.Afanasiev, Yu.S.Anisimov, V.I.Kolesnikov, V.E.Kovtun[1], A.I.Malakhov, A.A.Nemashkalo[2], A.Para[3], V.F.Popov[2], Yu.N.Ranjuk[2], S.G.Reznikov, E.N.Tsyganov, P.I.Zarubin, A.E.Zatserklyanyi[2]

Scintillating fiber based electromagnetic calorimeter module has been tested on radiation hardness. Energy resolution worsened to 18.2% immediately after irradiation to a dose of 1.25 Mrad comparing with its initial value of 5.4% while light output decreased by a factor of 2.75. Further degradation of the performance as well as partial recovering after rest was observed up to the dose of 7.5 Mrad.

The investigation has been performed at the Laboratory of High Energies, JINR.

Радиационная стойкость калориметрического модуля со сцинтилляционными нитями

С.В.Афанасьев и др.

Исследована радиационная стойкость электромагнитного калориметрического модуля на основе сцинтилляционных нитей. Сразу после облучения дозой 1,25 Мрад энергетическое разрешение ухудшилось до 18,2% по сравнению с начальной величиной 5,4%, тогда как световыход упал в 2,75 раза. Дальнейшая деградация характеристик модуля, равно как и частичное восстановление после отдыха, наблюдались вплоть до поглощенной дозы 7,5 Мрад.

Работа выполнена в Лаборатории высоких энергий ОИЯИ.

Scintillator based calorimeters have been proposed for use in detectors for the SSC. A major question in concern is the survivability of such calorimeters at the expected lifetime doses. The most intensive radiation damages are caused by electrons in the maximum of electromagnetic shower, so electron accelerators with energies of a few GeV are seemed to be very suitable facilities for such studies.

---

[1] Kharkov University, Kharkov

[2] Kharkov Institute for Physics and Technology, Kharkov

[3] Fermi National Accelerator Laboratory, Batavia

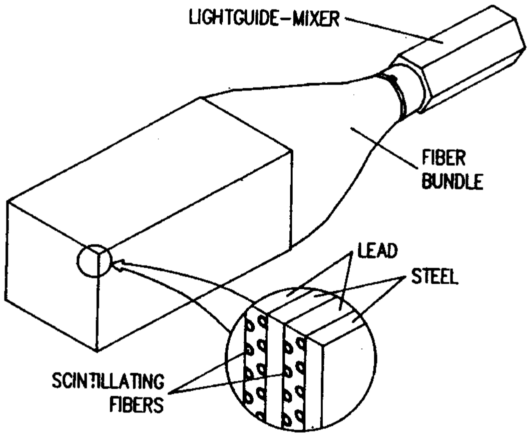

Fig. 1. General layout of the scintillating fiber based calorimeter module

In order to get more information about radiation-induced deterioration in overall response of scintillator based calorimeters, an electromagnetic scintillating fiber calorimeter prototype module, proposed for the SDC/1/, has been tested on radiation hardness. Overall dimensions of the module are 120x115x250 mm^3 (fig.1). It was constructed of laminated lead and steel plates 2.5 and 1.9 mm thick, respectively, with 1.0 mm fibers on a 2.5 mm spacing lying in grooves rolled in both faces of each lead sheet. The fibers, produced by Kuraray Co., were made of polystyrene core doped with Y7 (green) wavelength-shifter and clad with PMMA. Bicron 600 optical epoxy was used to fix fibers in grooves and to assemble a stack of steel and lead plates. A hexagonal plexiglass lightguide was inserted between photomultiplier tube and fiber bundle to distribute light uniformly over the photocathode surface. Soviet-produced photomultiplier FEU-110 with standard base divider was used for the tests.

The module was irradiated in a number of steps with 1.2 GeV electron beam at Kharkov linac. Irradiating dose was distributed uniformly over the module front surface by scanning with beam spot of 2 cm in diameter. The dose uniformity was monitored by a degree of darkening of a thin glass plate placed in front of the module during every irradiation step. The absolute absorbed dose was determined by measuring of the beam current by means of a secondary emission monitor with accuracy better than 1%.

Energy resolution and light output were measured with 1.0 GeV scattered electrons before and after every irradiation step. These measurements were carried out using hardware of magnetic spectrometer

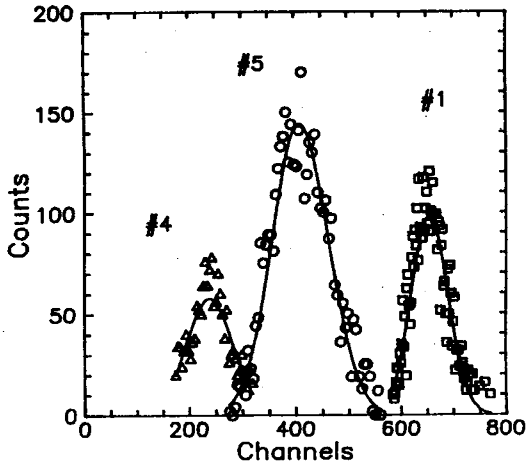

Fig. 2. Pulse height spectra of 1.0 GeV electron

SP-02/2/. Spectra were obtained by a multichannel analyzer with linear gate triggered by four-fold coincidence of signals from three monitoring scintillation counters and a signal from the module itself. Measurement #1 was carried out with nonirradiated module. Other measurements were held under the following conditions:

#2 - immediately after irradiation to a dose of 0.1 Mrad;
#3 - after irradiation to a dose of 0.4 Mrad and 3 day rest;
#4 - immediately after irradiation to a dose of 1.25 Mrad;
#5 - after irradiation to a dose of 1.25 Mrad and 9 day rest.

Some of these spectra are shown in fig.2. All spectra were fitted with Gaussian and exponent for peak and background, respectively. The best fit parameters, in terms of energy resolution and relative light output, are plotted versus integrated dose in fig.3. Recovering processes during the rest time can be clearly seen here. Energy resolution worsened to 18.2% immediately after the dose of 1.25 Mrad comparing with its initial value of 5.4% while light output decreased by a factor of 2.75.

Irradiation was continued up to the dose of 7.5 Mrad. Further degradation of the performance as well as partial recovering after rest was observed, although

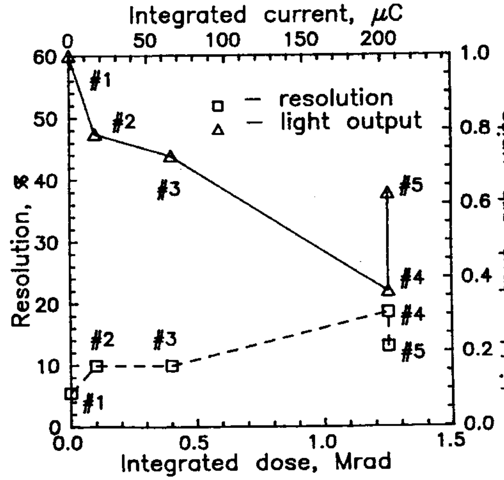

Fig. 3. Changes in energy resolution and relative light output with absorbed dose. Conditions of the measurements are as follows: #1 - nonirradiated module; #2 - immediately after irradiation to a dose of 0.1 Mrad; #3 - after irradiation to a dose of 0.4 Mrad and 3 day rest; #4 - immediately after irradiation to a dose of 1.25 Mrad; #5 - after irradiation to a dose of 1.25 Mrad and 9 day rest

quantitative data have not been extracted from those spectra due to low signal to background ratio. Detailed studies of the radiation damaged fibers will be carried out.

References

1. Solenoidal Detector Collaboration Expression of Interest SDC-90-00085, 24 May 1990.
2. Savitsky G.A. et al. - Preprint KhPhTI 89-34, Kharkov, 1989.

Received on November 21, 1991.