Fast Proton Radiography on the PSI Gantry FROG

P. Pemler, M. Moosburger, E. Pedroni[a], U. Schneider[b], and J. de Boer

[a] Paul Scherrer Institut, Villigen, Switzerland [b] Stadtspital Triemli, Zürich, Switzerland

1. Introduction

The design of the proton radiography system FROG has been completed. The basic concepts of the system described in the last years annual report remain unchanged. Test results have lead us to a new type of photomultiplier (PM) for fiber readout and to a modification of the readout method of the range telescope counters (figure 1).

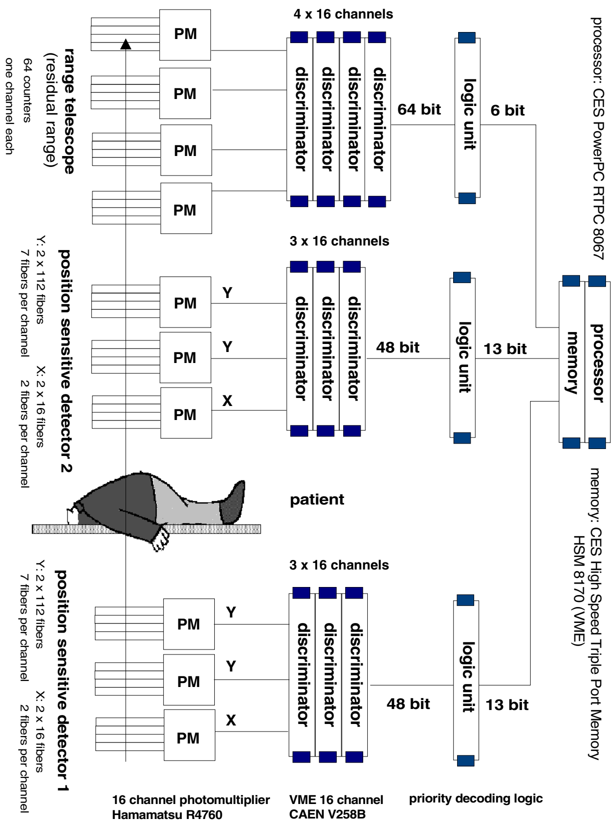

Fig. 1: Schematic view of the system

The fibers of the hodoscopes are arranged on the photocathodes in such a way (see figure 1) that the (x,y)-coordinates can be reconstructed by a priority decoding logic. With this system the number of channels is reduced from 576 to 160. The output of the logic units which combine the 160 input signals coming from 10 VME discriminators to a 32 bit event is fed into a high speed 32 bit ECL in/VME out memory [1]. This memory is read out by a VME workstation which allows connections to SCSI, Ethernet, ATM or FDDI for storing or distributing the preprocessed data [2].

2. The range telescope

The light yield of the range telescope was measured for different ways of attaching wavelength shifting fibers to the scintillator plate: one fiber at a short side (S1), one fiber at a long side (L1), two fibers at both short sides (S2) and two fibers at both long sides (L2). We used Bicron BCF 91A fibers with 2 mm x 2 mm and with 1.5 mm x 1.5 mm cross section. Surfaces of plate and fiber(s) opposite to output surfaces were covered with silver colour as reflector. The light yield for different dE/dx values was measured by reducing the energy and therefore the residual range of the protons in steps equal to 0.47 cm proton range in water using the range shifter installed on the gantry. With this method the Bragg-peak was moved into a given plate. This corresponds to an increase in dE/dx of about a factor of 3. The results are depicted in figure. 2.

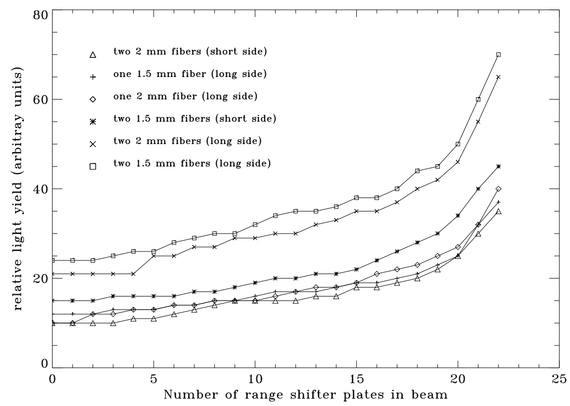

Fig. 2: Light yield for different methods used for the readout of a range telescope scintillator plate

With method S1 (originaly proposed) the light yield was so poor that we could not resolve signal from noise properly. No significat difference in the light yield was measured for 2 mm and 1.5 mm square fibers. This result was expected due to a saturation effect in the wavelength-shifting fiber [3]. Using method L2 instead of L1 increases the light yield by a factor of 2. It is therefore preferable to use a second fiber instead of a reflector. The light yield for L2 is higher than for S2 by a factor of between of 1.5 and 2. The reason lies in a disturbed total internal reflection due to surface imperfections.

References

[1] C.E.S HSM 8170 data sheet
[2] C.E.S RTPC 8067 data sheet
[3] Frans Kniest, Bicron, private communication