DOSE AND DOSE RATE MEASUREMENTS AROUND THE SIS

J. G. Festag

Gesellschaft fuer Schwerionenforschung mbH, Darmstadt,
Federal Republic of Germany

ABSTRACT

Dose equivalent measurements with a TEPC and a modified rem counter around a heavy ion accelerator are reported. These measurements give some informations about the composition of the radiation field.

INTRODUCTION

A heavy ion synchrotron (SIS) is operated by the GSI at Darmstadt, Germany. The highest attainable specific energy of 2 GeV/n for carbon descends to about 1 GeV/n for uranium. Till now ions from neon to bismuth have been accelerated with up to 10^9 particles per spill. The length of the interval between two successive spills depends on the extraction mode, but this time is usually longer than 1 second at the moment.

EXPERIMENTAL MEASUREMENTS

Dose and dose rate measurements were made by a TEPC, type HANDI (1), and a high pressure ionization chamber (7 bar, Ne/Ar mixture), type FAG FHT 191 N, in regions with thin and thick shielding. The dose equivalent is calculated from the energy dose by using the ICRP 21.

Behind thick shielding (more than 400 g/cm^2 concrete) the TEPC gives a quality factor near to 4 (3,94). Such a value is known from other high energy accelerators (2). Distributions of the lineal energy are shown in figure 1a. The contribution of the neutrons to the dose equivalent appears in the higher lineal energies.

Measurements with ^{6}LiF–TLD's in a 12 inch polyethylene moderator give also a quality factor of 4. Here the calibration was made with neutrons coming out of an Am–Be–source.

In regions with a thin or almost no shielding the quality factor varies depending on the degradation of the primary beam. The figures 1b and 1c show two examples. ^{197}Au ions of 814 MeV/n are stopped in carbon surrounded by concrete (less than 300 g/cm^2); the secondary high energy particles deposit only a little energy in the detector (figure 1b); the Q - value is 2.1 . Figure 1c shows the frequency distribution of the lineal energy registered by the TEPC during stopping and focussing of an ^{197}Au ion beam with a specific energy of 1 Gev/n. This distribution is very similar to that measured behind thick shielding (figure 1a) and indeed here the quality factor is also near to 4 (3.99).

For comparison a frequency distribution of the lineal energy of a background measurement with Q = 2.2 is shown in figure 1d.

The energy doses (Gy) registered by the TEPC and by the ionization chamber are very similar.

The measurements were made for times of several hours during the normal course of nuclear physics experiments, therefore relations between the dose rate and the ion current of the beam cannot be given because the intensity of the beam was not held constant.

Activation techniques for the evaluation of the neutron energy spectrum could not be applied on behalf of too low intensities.

Birattari et al. (3) have described an extended range neutron rem counter, which shall be able to measure neutrons with energies up to about 400 MeV with an adequate sensitivity.

An unmodified rem counter and a rem counter surrounded by a layer of 2 cm lead were used to look for neutrons with energies above 20 MeV. The measurements were taken behind thick shielding. The results are given in the following table.

accelerated ions	ion energy MeV/n	measured dose equivalent by the unmodified rem counter μSv	(dose equivalent measured by the rem counter with lead) divided by (dose equivalent of the unmodified rem counter)
^{20}Ne	310 - 400	6.7	1.71 ± 0.03
^{20}Ne	400	0.3	1.84 ± 0.61
^{209}Bi	800	1.1	1.65 ± 0.08

The given uncertainties of the result take only into account the standard deviation of the registered counts.

CONCLUSIONS

The results are preliminary, but at this stage they point out that a not negligible share of the dose equivalent is caused by neutrons with energies of more than 10 Mev.

REFERENCES

1. Dietze,G. et al., 1988, Investigastion of radiation protection instruments based on tissue - equivalent proportional counters. Results of a EURADOS intercomparison, EUR 11867 EN.
2. Hoefert, M. et al., 1980. Nucl. Instr. and Meth. 176, pp. 443-448.
3. Birattari, C. et al., 1990. Nucl. Instr. and Meth. A297, pp. 250-257.

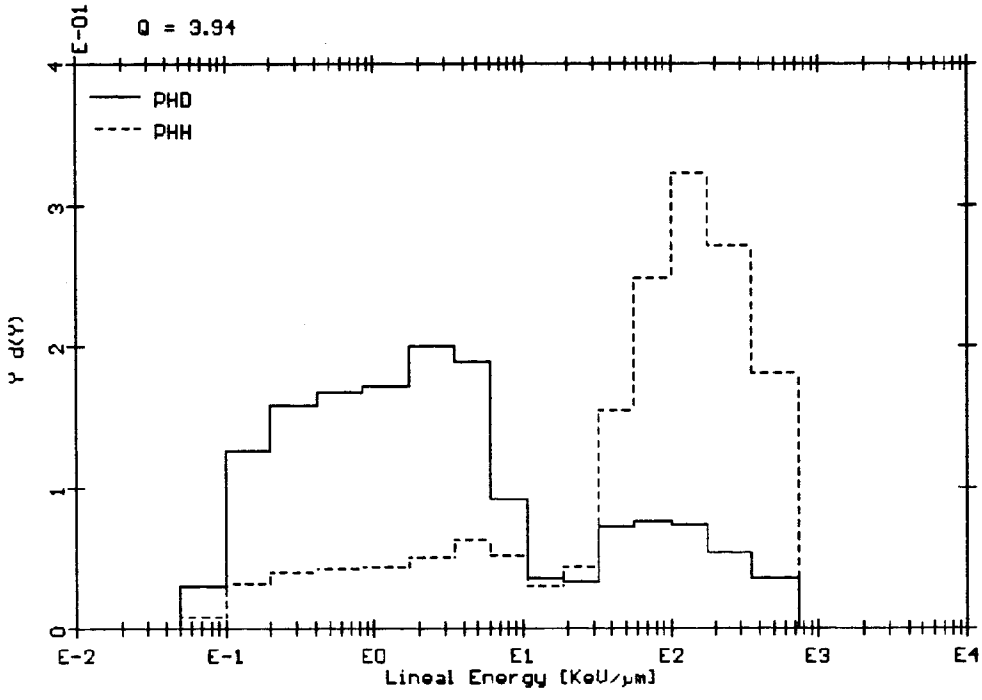

figure 1a

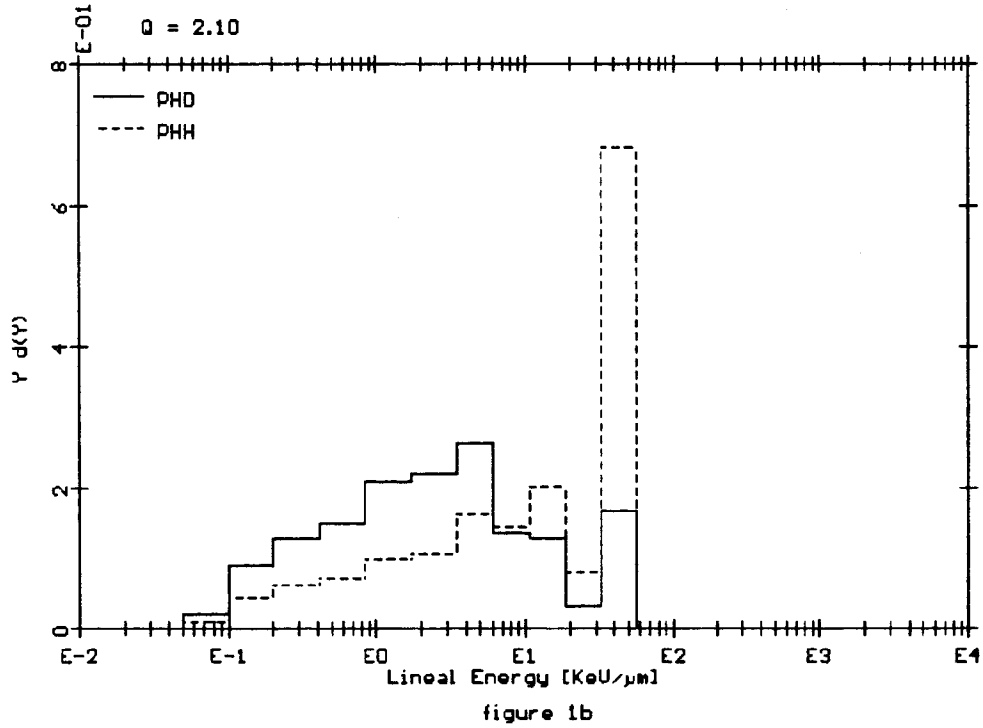

figure 1b

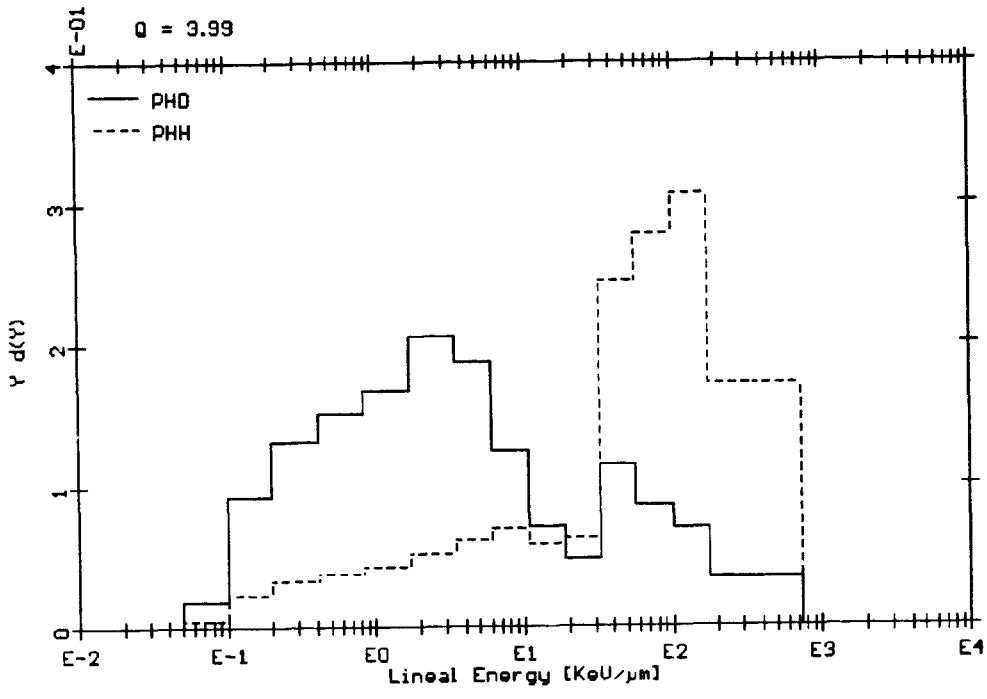

figure 1c

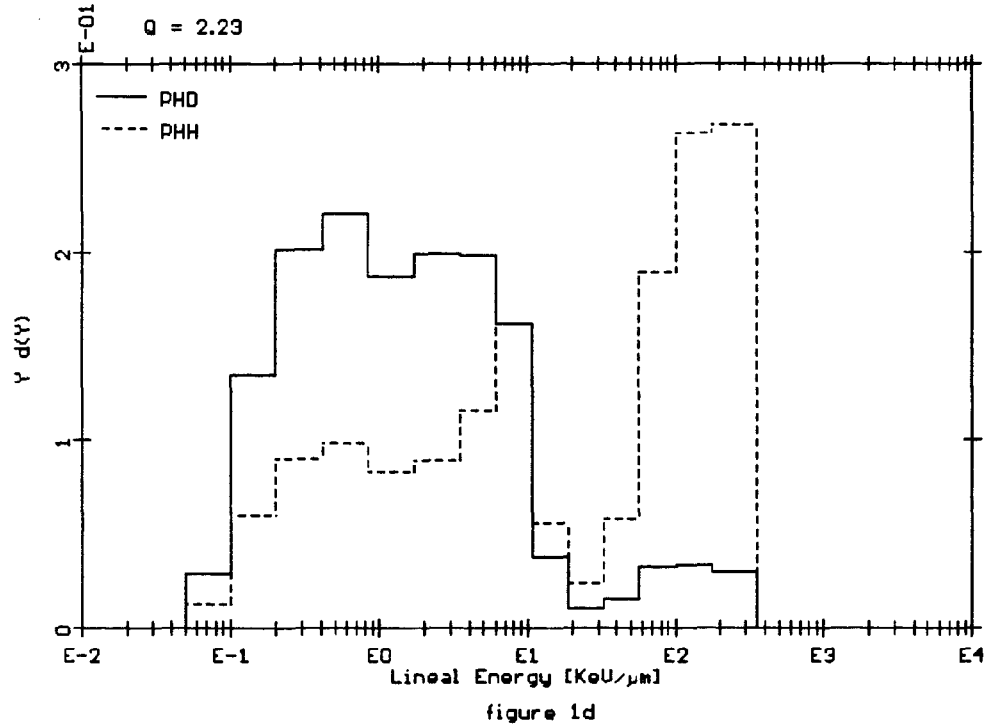

figure 1d