A MICROPROCESSOR BASED AREA MONITOR SYSTEM FOR NEUTRON AND GAMMA RADIATION

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At the MPI-Heidelberg two Tandem van de Graaff (6 and 12 MV)and one postaccelerator are in operation. The 10 MV postaccelerator which consists of independently phased spiral resonators is coupled to the 12 MV Tandem. Depending on the specific ions accelerated, their energy and current, the dose rates range from nondetectable values up to some 10 rem/h. High-energy neutrons contribute 80 to 90% of the stray radiation total rem dose and gamma rays make up the balance. The extreme dose rate situations request flexible radiation protection regulations. They have to ensure that the absorbed dose of the personnel is kept as low as achievable without restricting the experimental operations more than necessary and that at beamtimes with high dose rates accidental exposures are strictly avoided. Since the radiation regulations are basedon dose rate measurements of the area monitor system it has to operate in a wide dynamic range at a high reliability level.

The old system was no longer able to fulfil this requirement. There have been too many failures of the electronics. The choice for its replacement is a system consisting of individually microprocessor controlled area monitors which are connected to a microcomputer. A system without the monitor processors which would have been possible, too, was not chosen because of insufficient reliability. Failures of the central microcomputer would have blocked the whole monitor system. A conventional hardware solution would have been less secure and at least two times more expensive.

In Fig. 1 a block diagram of the complete new system is shown. The area monitors as well as the microcomputer have been developed on the basis of the 16 bit TMS 9900 microprocessor. The pulses of the neutron rem counter and of the gamma counter are each fed into 8 bit binary counters of the area monitor microprocessor system. Fig. 2 shows how the pulses are processed by the developed software. All operations are executed in the work space register of the TMS 9900. The overflow rate of the counters is stored in incremental registers. After 1 second the contents of the counters are read into one register and then added to the product of the overflow rate by 8 bit in another register. Now, the γ-count rate is normalized to give the same relative dose equivalent unit as the neutron count rate and finally converted into mrem/h. The γ- and neutron dose rates and their sum are stored in the memory. A comparison of the sum with two thresholds identifies three different dose levels. For failure surveillance the results of the γ- and the neutron measurement are integrated for a long enough time to judge from background statistics if there are too few counts. A subprogram converts the data from the hexadecimal into the decimal notation.

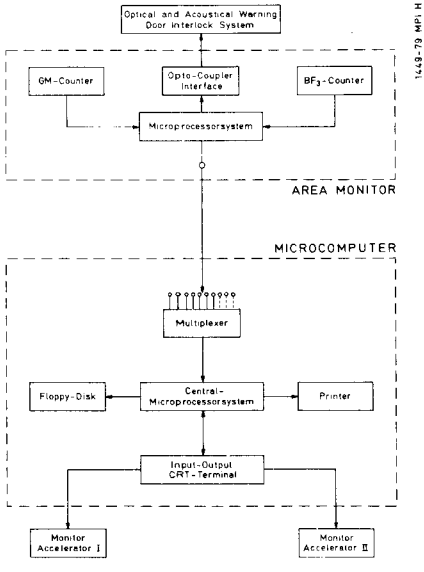

Fig. 1: Block diagram of the area monitor system.

Dose rate and failure indications are transmitted to different warning installations and to the door interlock system as shown in Fig. 1. All in- and output signals of the microprocessors are transmitted through opto-couplers. Each channel can process count rates up to 65000 per sec, which corresponds to about 30 rem/h for γ-rays and neutrons, respectively . The whole area monitor as encircled in Fig. 1 is housed in a box with a transparent front cover.

The dose equivalents of the individual area monitors are read by the central microcomputer via a multiplexer. Here, the data are processed for printing, display on TV monitors and recording on floppy disk. The printed data give information on the near past, whereas long time records are taken from the floppy disks. The TV monitors, with a turnover time of 10 sec, display the actual dose rate situation at the radiation protection office and the control rooms of the Tandems. Here the high dose level is also indicated on inspection panels of the door interlock systems. Fig. 3 shows the inspection panel of the 12 MV Tandem and the postaccelerator. 12 monitors survey this area. If a high dose threshold is surpassed, the red LED within the radiation sign lights up.The doors adjacent to that area can be locked either by switches on the console or automatically. Their state (open, locked and closed, locked but open) are also signaled by different LED. In the automatic mode the beam is interrupted if a door that should be

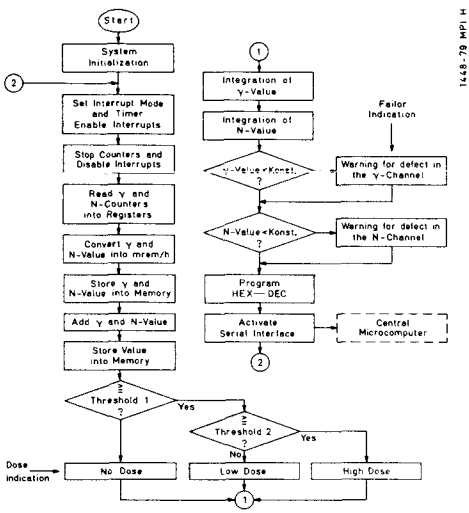

Fig. 2: Flow chart of the area monitor microprocessor program.

closed stays open for more than 2 minutes. In the experimental area, the low and high radiation levels are indicated by acoustic and light signals inside the individual target places and by a kind of traffic lights at the entrance doors to these places. Green light "no dose", yellow light "low dose", red light "high dose".

The microprocessor-based area monitor system provides high flexibility, which is desirable in view of the rather frequent changes in accelerator experiments.

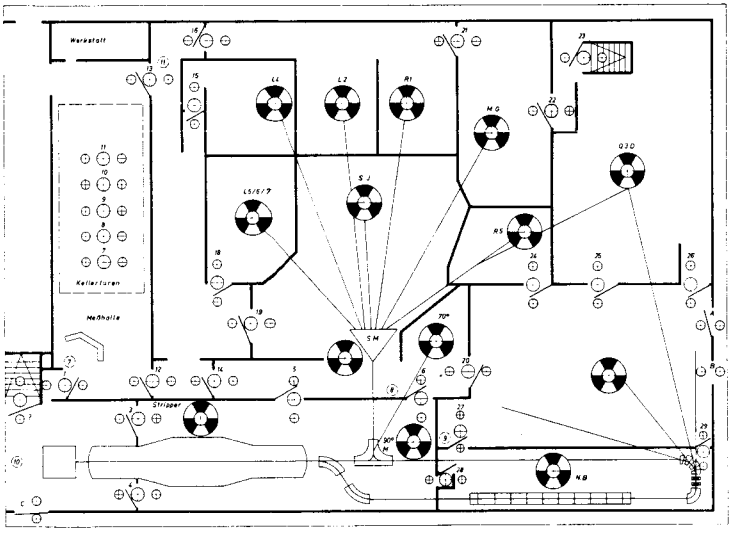

Fig. 3: Inspection panel of the MP Tandem.

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