ENVIRONMENTAL RADIATION SURVEILLANCE AND AREA MONITORING SYSTEM OF ACCELERATORS

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Commencement of Text ABSTRACT

In order to monitor the leaked radiations and the exhaust airborne radioactivity around the Heavy Ion Research Facility in Lanzhou (HIRFL), four stations of environmental radiation surveillance of gamma and neutron have been built. The area monitoring system which is one of HIRFL's safety systems has been also built. In this paper, a brief description of them is presented.

ENVIRONMENTAL RADIATION SURVEILLANCE

We have built four stations of environmental radiation surveillance of gamma and neutron to monitor the leaked radiations and the exhaust airborne radioactivity around HIRFL.[1] The logic diagram of the HIRFL's four stations is shown in Fig.1. Every station consists of a neutron detector, which has been made by using a counter tube composed of BF_3 with moderator of polyethylene containing boron, a gamma detector made by using a cylinder ionization chamber filled with argon, and a simple-plate computer which has been used as a data-collector to read the data from the counter to registers once ten minutes. The data in the registers will be sent to a central microcomputer once a week, in which they will be printed out

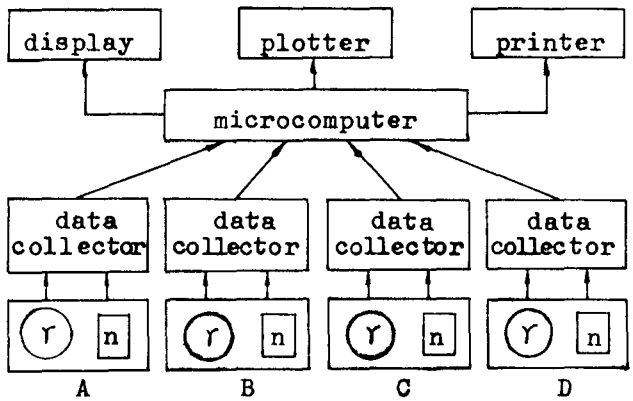

Fig.1 The logic diagram of the HIRFL's four stations

by a printer or drawn a graph by a plotter per mensem. The rooms of the stations have been built with lighter materials which not only can protect the detectors from humidity but also does not reject the data-collecting. The general layout of the HIRFL's four stations is: one of them stands on the centre of the Institute of Modern Physics, Academia Sinica, others stand on the border of the institute area. The communication between central microcomputer and every station is completed by telephone-wire whose resistance usually is less than 10 ohms.

AREA MONITORING SYSTEM OF HIRFL

As the same principle of environmental radiation surveillance, area monitoring system of HIRFL has been built. There are fourteen monitored locations—four in the 170 cm sector focusing cyclotron(SFC) and ten in the separated sector cyclotron (SSC). The area monitoring system, whose block diagram is schematically shown in Fig.2, consists of two sets of the data

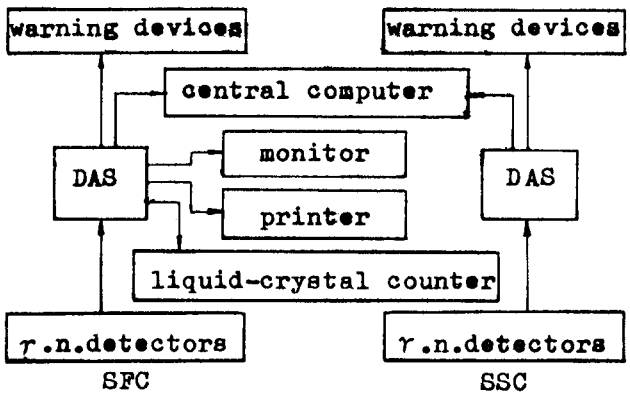

Fig.2 The block diagram of the area monitoring system

acquisition system (DAS) which are automatical patrol devices controlled by two microcomputers separately. One of them is set in the control room of SFC and controls 32 detectors of gamma or neutron, a monitor screen, a printer and a liquid crystal counter. Another is set in the radiation monitoring room of SSC and controls 8 detectors of gamma or neutron.By the way, two sets of DAS can also supply the data to a central computer and give out 30 mA currnet to drive a relay in the controlling box which have been used in the area warning system.

WARNING DEVICES OF HIRFL

In the 14 warning locations which are associated with the monitored locations, every warning unit consists of a green light, a yellow light, a red light and a buzzer. Two sets of the HIRFL's gamma and neutron warning device are equipped in a movable frame at the monitored locations. A controlling box of the devices is set in a radiation monitoring room. In front of the controlling box, there are warning lights related to the warning devices at the monitored locations. After the data coming from gamma or neutron detectors are treated, a relative relay in the controlling box will be switched with power supply according to the result of the treatment, and then an alarm signal will be given. At the same time, a relative warning light in front of the controlling box will flash, too.

The warning device is controlled by two thresholds of P_1 and P_2 ($P_1<P_2$), and the warning thresholds are selected according to the radiation levels in the four radiation fields of HIRFL. When the dose rate at a monitored location is less than P_1, the green light will flash and the man can be freely coming in or going out. When the rate is between P_1 and P_2, the yellow light flashes and the man can be coming in but they must ask help of the radiation protection officers. When the rate is more than P_2, the red light will flash and the buzzer sounds, the man must move away immediately.

THE CIRCUITRY USED IN CONVERTORS

In environmental radiation surveillance and area monitoring system, the weak current signals coming from the gamma or neutron detectors are about between 10^{-9} ampere and 10^{-14} ampere. Only the signals related with the radiation intensity of gamma or neutron are accurately measured and converted, can they be sent to the

DAS or data-collectors. As for neutron detectors, the pulse signals coming from the counter tube composed of BF_3 have been first amplified by a low-noise amplifier whose amplification is about 10^3, and then the signals will be sent to a voltage comparator. If the signal's voltage is higher than a standard-voltage, the comparator will give out a square pulse; otherwise there is not the pulse given out by the comparator. The all square pulse coming from the comparator will be sent to a pulse-width-shaping stage, in which all of them will be changed to the pulses with same width and same amplitude so that they can easily be counted by a counter.

As for the weak current signals of gamma detectors' output, it will be first converted to a series of single pulse by the I/F convertor, then the pulses will be shaped to same width and same amplitude by a shaping circuit, finally they will be sent to the counter. It is obvious that the I/F convertor must be highly accurate, so we adopt the same method with diagnosing profile of the beam lines.[2] A pair of MOS FET whose grid's leakage current is less than 10^{-15} ampere have been first linked as a differential amplifier, and then an integrated operational amplifier package can be obtained by linking the differential amplifier with another IC's operational amplifier. By the way, we have also employed a relay of normally closed contacts linked with FET's grid and source to protect the package from damaging. The reason is that: when the power does not switch on, the FET in the package can not be harmed by the static electric field induction because its grid and source have been linked by the relay's normally closed contacts; when the power is switched on and the I/F have been put on at the same time, the relay's closed contacts will be opened and the FET in the package can not be damaged, too, because there are these or those sorts of electric loops in the convertor which will confine the voltage between the grid and the source in a safe range.

In this way, a good character's operational amplifier package has been made and its input leakage current is also less than 10^{-15} ampere, which is enough to be employed in the I/F convertor.[3] The package is linked as a current-integrator which is first stage of I/V, follow it, there is a voltage comparator which is composed of MOS NOR gate. When the voltage of the integrator arrives at the open gate voltage domain, the comparator will turn over and give out a pulse signal. On the one hand, the pulse can be sent to a counter or the DAS so as to compute the measured current in accordance with the number of the pulses. On the other hand, the signal can be also sent to a pump-discharge circuit to have the charge of the integrator's capacitance pumped off a small part. It is evident that the pump-discharge works by on-off state, and because the time of discharging charges is shorter than 7.5 μs the controlling pulse width which is controlled by another logic circuit must be less than 7.5 μs.

THE PERFORMANCE OF THESE SYSTEM

The system of the environmental radiation surveillance has already been used in HIRFL for two years, and it has not only presented usual environmental background data but also changed data during the operation of the other accelerators.[4] The data which are comparad with elsewhere have presented in the reference material (4). The area monitoring system is also operating.

REFERENCES

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