ENVIRONMENTAL STRAY RADIATION MONITORING AT THE NSRL

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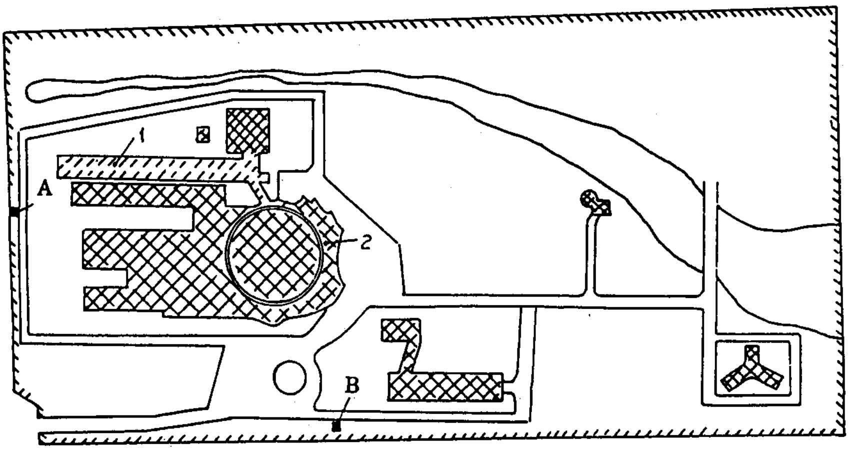
THE NSRL AND ITS ENVIRONMENTAL RADIATION FIELD

The first dedicated synchrotron radiation light source in China is fixed in the National Synchrotron Radiation Laboratory (NSRL). A 200 MeV electron linac and an 800 MeV storage ring are its main equipment. The linac works as the injector and the ring provides VUV synchrotron light for various kinds of optical experiments. Fig.1 is the sketch map of the NSRL.



1. Tunnel 2. SR Hall A. E.M. Station A B. E.M. Station B

Fig.1

The environmental radiation field around it is distinctive and its variation is related closely with the operation states of the synchrotron radiation machine. Its displays are as follows:

1. It is a mixed field. Not only bremsstrahlung but also neutron exists in it. Both of them have wide spectrum. These two components distribute quite differently. The former is directive while the latter is isotropic.
2. It is a prompt field with small duty factor(1×10^{-7}). The high instantaneous value and low average of the radiation dose are the most distinctive differences compared with the steady field.
3. Since the linac is in an underground tunnel covered with three-meter thick soil, no observable radiation dose caused by it can be recorded during the environmental monitoring. The additional environmental stray dose mainly comes from the injection of the storage ring. It skips every time the electrons from linac are injected into the ring. As mentioned above, although the peaks can be observed clearly on the curve recorded, the accumulated dose is limited.

It is necessary to monitor, record and analyze such a characteristic radiation field. To avoid the shortcomings of the discontinuous monitoring and TLD method, an intelligent environmental monitoring system has been set up for this radiation field.

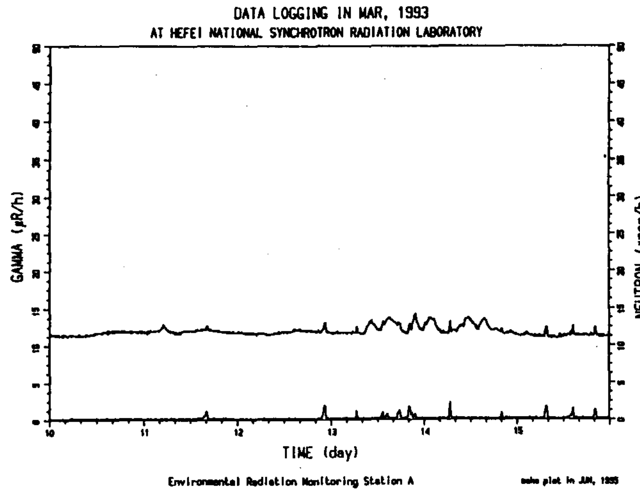
ENVIRONMENTAL RADIATION MONITORING

The intelligent environmental radiation monitoring system includes environmental monitoring stations, control computer and several peripheral devices. In Fig. 1, the points marked A and B are the locations of two environmental monitoring stations. Station A is at the west border of the NSRL area where is close to the linac. Station B is near the south border where is about 104 meters far from the injection point and exactly towards the injection direction. There are detectors and data acquisition device in every station. The gamma detector is a 8.5 liter volume pressurized ionization chamber filled with argon. Its sensitivity is $1.03\times10^{-4}A/(C\cdot kg^{-1}\cdot h^{-1})$. The neutron detector is a BF_3 tube in polythene moderator. Its sensitivity is $(17.0\pm0.3cps)/(n\cdot cm^{-2}\cdot s^{-1})$. The data acquisition device is a microprocessing unit with M146805E CPU. It can work well with rechargeable batteries when power supply fails. The environmental radiation data can be stored in its RAM and transferred to the control computer's disk once a week. In past years, the plenty of data provided scientific basis for us to analyze the field's characteristics and make tables or charts. The software for special research purpose is programmed during the work, such as the program for calculating additional dose or injection time.

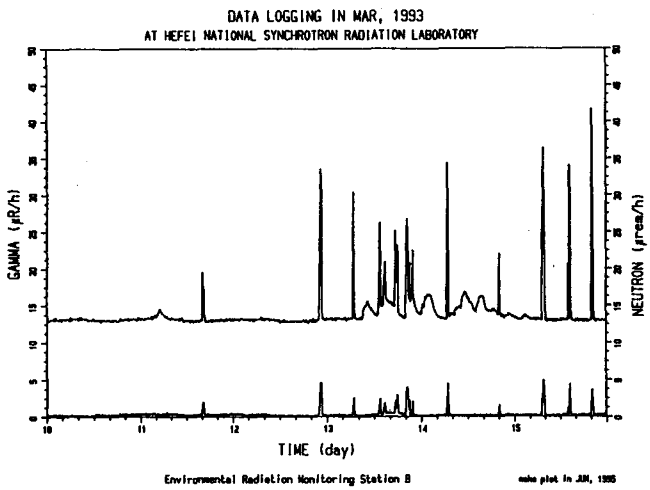
THE ANALYSIS FOR THE NSRL ENVIRONMENTAL STRAY RADIATION FIELD

By the environmental radiation monitoring system, we have gotten a series of monitoring results that reflect the field's characteristic and stray radiation level correctly. At the same time, some interesting things attract us very much and make us to think deeper about certain phenomenon. For instance, we have new idea about the relationship between rain and gamma natural background. Fig.2 includes two charts plotted by the system. They are gamma and neutron environmental radiation dose rate curves in the same six days. Here is the explanation:

1. The chart marked (a) is from monitoring station A and (b) is from station B. In every chart, the upper curve represents gamma dose rate and the lower one represents neutron. Their relative values are shown in the left and right of the chart respectively. The X axis is the date.
2. The increase of gamma dose rate is caused by the bremsstrahlung. Compare chart (a) with chart (b), we can see clearly that the gamma radiation level recorded by station B is much higher than that by station A during the injection period of the ring. This is because of the different location of these two stations. A is at the side of the injection direction while B is toward it. Strong directive is shown here. In the meantime, the neutron dose rate is isotropic. The difference is only because of the different distance between the stations and injection point.
3. On the gamma curve, all the peaks that no responses on the neutron curve are caused by the rain. It seems that the heavier the rain is, the higher the peak rises. The radiation level falls to background as soon as the rain stops. We do not think this phenomenon accords perfectly with the traditional theory about the background increase caused by the rain. So a further research is going on.
4. Neutron radiation level is not affected by rain. Its total dose equivalent is much less than that produced by gamma. It increases only during the injection period. So we can take it as a symbol to recognize if the gamma increase is caused by the rain.
5. From the charts we can see the additional dose is limited. Sometimes the gamma increase caused by rain is higher than that by machine operation. The natural background dose is about 1000 μSv per year, the recorded increase dose caused by the machine operation is usually much lower than 50 μSv even if at the station B.



(a)



(b)

Fig.2

CONCLUSION

We began to cumulate natural background data in 1987. Since then, the environmental radiation monitoring system has worked well for eight years. It helps us and other researchers a lot in many aspects. It is not only a guarantee for the radiation safety, but also a useful tool in the scientific research. The data acquisition device and processing software are improving so that we can study the field in a better way.