§2. Analysis of Burst Radiation from CHS Using Monitoring Data

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At NIFS, radiation monitoring system Radiation Monitoring System Applicable to Fusion Experiments (RMSAFE) was developed and installed. This system has a function for detecting burst radiation.

The Compact Helical System (CHS) is a stellarator-type device for high-temperature plasma experiments, whose major and minor radii of the torus are 1 and 0.2 m, respectively. Because the CHS does not make use of a superconducting coil, the magnetic field rises and falls during each plasma experiment. The electrons in the plasma vacuum vessel are accelerated by this varying magnetic field. When the hydrogen gas in the vacuum vessel is of low density, the accelerated electrons become run-away electrons free from collision, which then do finally hit somewhere in the vacuum vessel, producing bremsstrahlung X-rays. The typical pattern of the magnetic field during a plasma shot is an increase for 0.8 s, followed by a steady level for 0.6-1.2 s, and finally a decrease for 0.8 s.

The burst X-rays were detected at eight monitoring points in the site. Each outdoor post was installed with a high-pressurized argon gas ionization chamber with a sensitivity level of 0.003nSv/count. The stations observed burst X-ray were CHS torus hall, control room, WN, WB, IA, IC, WF and WC. 63 events of burst X-ray were observed in the fiscal year 2001. The maximum dose per one burst event at the site boundary was 18 nSv. The distribution of the dose differs with experimental shots, and there were some events which cannot be explained only by the relation with the distance from the radiation source. This suggests that X-ray outbreak direction and energy vary with each experimental trial.

Doses greater than 0.001 mSv were observed in the CHS torus hall in 23 events. The 22 events detected at more than four stations were selected from these events, and were classified as 5 groups by the space distribution pattern of the observed dose. Selected a representative event from each group, the relationship between the detected dose and the distance from CHS is shown in Fig. 1.

A simulation calculation was done with EGS4 in order to grasp a direction characteristic of X-ray. A point source of photon 1 MeV instead of the CHS was placed as a radiation source in the simulation. And the dose at each monitoring station was calculated. The geometry of rectangular solid was applied for the simulation, in which x direction 29 cells, y direction 27 cells, z direction 19 cells. The basic structure of the R&D building which the CHS is installed in, the peripheral buildings and undulation of land are taken into account. The observed burst dose was divided by the dose provided by the simulation in order to cancel the effect of distance, shielding and sky shine. As a result, the direction of X-ray was understood. The results that analyzed events shown in Fig. 1 is shown in Fig. 2. The data were normalized as mean 0, standard deviation 1. According to the result, it was understood that the almost all X-ray generate to the direction from the north to the east. When the energy of photon was changed to other case such as 3 MeV, 6 MeV, 9 MeV in the simulation, the result of the direction distribution was not varied much from the case of 1 MeV.

As a result, it was understood that most X-ray events occurred in the direction of north to east. Therefore, the understanding on the radiation event was proved by analyzing the monitoring data.

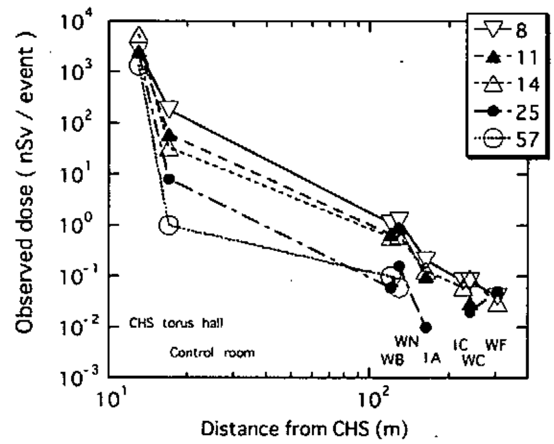

Fig. 1 Relationship between observed dose and distance from CHS.
The numbers in this figure correspond to the burst event number in the fiscal year 2001.

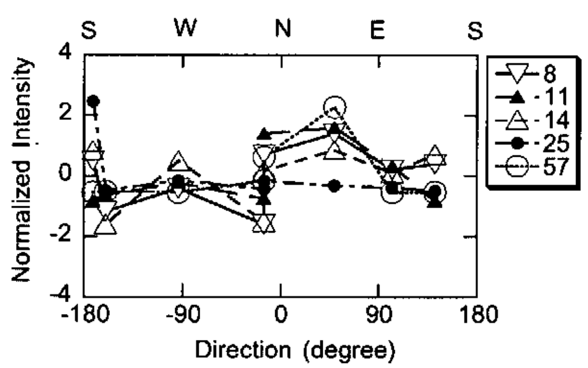

Fig. 2 Evaluated direction of some burst events.