Construction of SPring-8 Beam line Hutches

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1. Introduction

In the SPring-8 the beam lines which use hard x-rays or white beam has hutches for the radiation shield. Normally two kinds of hutches are constructed in a beam line. One is white beam hutch which consists of optics components mainly and the other monochromatic beam hutch for the users' experiments. We have been constructed 11 beam line hutches for public users and the other several hutches for special users in RIKEN or JAERI in about one year.

2. Main components

In figure 1 we can look a photograph of a typical hutch constructed at the BL09XU. A typical hutch consists of hutch panels, pneumatic and manual doors, labyrinth cable ducts, ducts for air conditioner, lead glass viewing window and utilities. The construction is modular with standard self-supporting panels. We installed cranes with manual hoists which can moves the weight less than 500 kg inside the hutch except 2-ton experimental hall cranes and the doors that operated manually together on hinge in some hutches. The hutch panel has sandwich structure in which the lead is in between steel panels and each panel is 1 m wide x 3.3 m high typically. In a beam line each hutch has two sets of sliding doors with each door having 1 m width. One door is pneumatically operated to enter into the hutch for routine and daily work. The open and close times are typically about 15 and 10 seconds, respectively. The other doors are manually operated when large equipment is installed. The status signals of the doors and the labyrinth cables duct are connected to the beam line interlock system. Just above the door, inside and outside the hutch, human thermic sensors which search the area around the door are set to avoid the accident when the door is closing. Also a touch sensor is set on the door front to protect persons from being shut in the door. Each hutch has a rough air conditioning system which is partially supplied from the experimental hall air conditioners.

Great care was taken for the connections between the ratchet wall and the roof panel, the panel and the panel, the hutch and the hutch, the panel and the floor, the slide door and the panel, and etc. In most cases additional shielding was set to cover the small gap or space between the connections.

In the case of emergency such as electric power-off, one can release the high-pressure air of pneumatic part of the door by a mechanical handle and open the door manually from inside the hutch.

In the SPring-8 we have a special problem that the vertical distance for the photon beam direction from one to next beam lines is narrow. For the construction, we keep the distance 1m at least as much as possible for ease of access.

3. Radiation shield

The structures and the shield thickness of each hutch are based on the instructions from the safety design group[1] and engineering considerations. It is summarized in Table I for each shielding situation (ID beam and bending magnet beam, monochromatic beam and white beam). The values are decided that the radiation dose of outside shielding panel in the experimental hall is less than 7 μSv/hr. In most cases thicker back panels were required compared to the lateral panels due to forward scattering. Local shielding for beam line components was performed to make the hutch lead thickness smaller. We take care the ground shine that is reflected radiation from the floor just below the hutch side panels. The floor was scooped out to the depth from 50 to 100 mm along the hutch side panels except the monochromatic beam hutch and the side panels were installed in the ditch with additional shielding. As for the door section, in all hutches the floor was drilled even if it is a monochromatic beam hutch. The leakage test by using visible light were done and the radiation check using synchrotron radiation should be put into force surely before operation mode.

4 Utilities

In any hutch, cooled water and pressed air are available with quick copular. The water pressure is less than 5 kg/cm^2. The air pressure is regulated to 5 kg/cm^2 for the normal components, but only for the monochromator raw-pressure (=7-8 kg/cm^3) air without regulator is supplied in the white beam hutch. Besides, exhaust ports for draining the exhaust gas and gas ports for introducing nonreactive gas from the gas cylinder (outside) are available in any hutch. 3 types of electric power, 1_-100V, 1_-200V and 3_-200V, are available with plague receptacle (max. 30A). All 200 V receptacles are in a standard box and the 100 V receptacles are placed around the hutch inside/outside. Electric breaker panel (switchboard) for each hutch is placed outside of the hutch. Cable-rack is installed around the hatch inside/top of the hutch. All cables used should be arrayed through the rack.

The earth line was connected to the experimental hall floor earth that has mesh structure made of 6 mm diameter steel at about 10 cm below the experimental floor surface. Note that the mesh earth is laid in the entire experimental floor and is isolated from the others.

5. Structure analyses

The nearest dislocation is Yamazaki-dislocation of which distance from the SPring-8 is about 10 km. From the past data big earthquake is not expected in near future. But finite-element static analyses was performed for safety by MSC/NASTRAN for typical hutches such as the self-standing hutch in BL08W (case A) and the hutch in BL47XU of which roof panels are supported from the ratchet wall side (case B) [2]. We give the power of 0.3*g* horizontally, where *g* is gravity. A typical result is shown in Fig. 2. According to the simulation, size, number and position of the bolts are decided. Chemical anchors were used for the connections between the hutch panels and the floor, and the panels and the ratchet wall. The simulation shows that the eigen values concerning vibration of the hutches are from 2 to 7 Hz for case A and 2 to 10 for case B, respectively.

References

[1]Y. Asano & N. Sasamoto, Proceedings of 9th International Congress on Radiation Protection, Vol. 4 p.4-582 Vienna (1996) .

[2]Yoshizawa LA Co. Ltd., Report of the Structure Analyses for the SPring-8 beam line hutches, 1997 March. (Internal Report in Japanese)

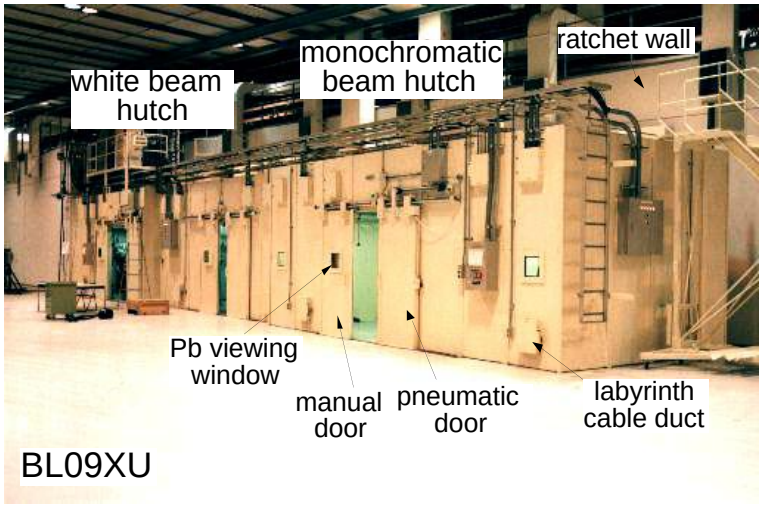

Fig. 1 A photograph of constructed beam line hutch of BL09XU (photo by Y. Furukawa)

Table I Thickness of the hutch lead shield in unit of mm.

source		bending magnet		undulator XU		wiggler (BL08W)	
		only hutch shield	local shield + hutch shield	only hutch shield	local shield + hutch shield	only hutch shield	local shield + hutch shield
white beam hutch	back panel	50	10 + 40	50	30 + 20	85	45 + 40
	side panel	13	3 + 10	20	5 + 15	30	15 + 15
	roof panel	13	3 + 10	20	5 + 15	30	15 + 15
monochromatic beam hutch	back panel	5		8		20	
	side panel	3		3		10	
	roof panel	3		3		10	