3. The personnel safety system of BACH beamline

Exit: 8.2
Type: undulator
Beamline: BACH
Hutch: FE

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3.1. Introduction

BACH (Beamline for Advanced DiCHroism) beamline utilizes the synchrotron radiation produced by the electron beam passing through the undulator installed in the straight section n.8 of the ring.
The front-end consists of two different exits: BACH is on the right (see Fig.27).

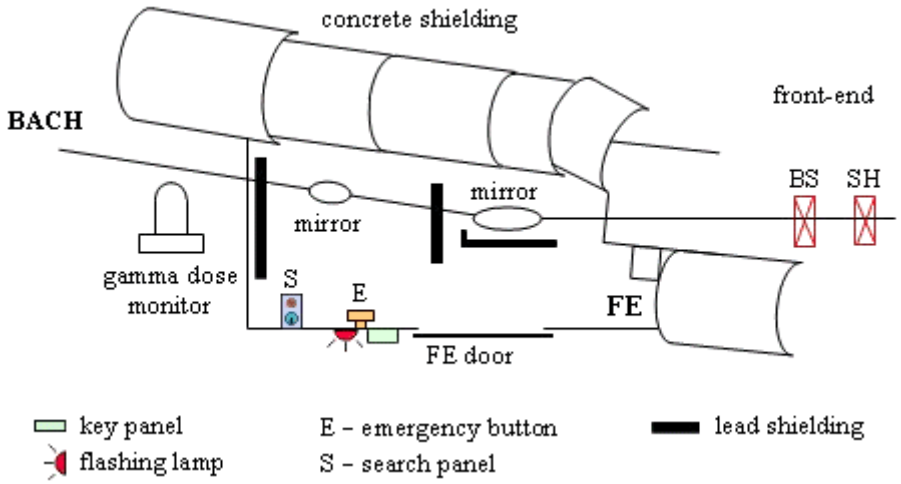

Figure 27. Scheme of the beamline.

The first part of the beamline is enclosed inside shielding walls and is called "Front-End hutch" (or "hutch FE").

The FE hutch includes two mirrors: the first deflects the white beam horizontally of about 3.5 degrees from the original direction, the second vertically of about 2 degrees.
The beamline has been designed to perform light polarisation dependent X-ray spectroscopy; the synchrotron radiation, produced inside the undulator, is polarised circularly or linearly with a range of energy varying between about 30 and 1800 eV.
The penetrating gas bremsstrahlung gamma rays, produced inside the ring by the interaction of the electron beam with the residual gas of the vacuum chamber, is stopped by the lead shieldings placed downstream the first mirror and close to the inner part of the front-end hutch wall. They are 15 cm thick and their size covers a solid angle of ±15° with respect to the gas bremsstrahlung interaction point with the mirrors. A further lead shielding 5 cm thick is placed laterally near the first mirror.
The vacuum chamber itself constitutes the shielding against synchrotron radiation.

3.2. Logic of the safety system

The access control system is based on wired circuits programmed with a redundant logic and "fail-safe" philosophy (the Programmable Logic Controller or PLC).
The safety elements on which the access control system PLC is based are:

- the BeamStopper (BS) for the gas bremsstrahlung, the SHutter (SH) for the synchrotron radiation placed in the beamline front-end, inside the shielding wall
- the gamma dose monitor located outside the hutch and aligned with the straight section of the ring.

3.2.1. Conditions for entrance.

Access inside the hutch is allowed if the following conditions are together fulfilled:

- the injection of the electron beam inside the ring is not in progress
- BS and SH are closed
- the gamma monitor indicates no failure, no pre-alarm and no alarm status
- the PLC of the beamline is on.

3.2.2. Key panel.

A panel with 2 locks and 4 lamps is located outside the hutch, close to the door.
If the safety conditions for entrance are fulfilled, the "B" key, taken by the beamline responsible ("R") or by the authorized personnel, inserted into the first keyhole and turned, unlocks the "C" key which can be extracted and used to open the door.
The lamps show the "injection in progress", the open/closed status of BS and indicate if BS is enabled to be opened.
The list of these lamps and their meanings are reported below:

- red lamp switched on: BS is open
- green lamp switched on: BS is closed
- white lamp switched on: BS and SH can be opened
- lower red lamp switched on: "injection in progress".

A flashing red lamp on the hutch wall indicates the opening of both BS and SH.

3.2.3. Entrance operations.

Entrance operations are reported below:

- R closes BS and SH
- R inserts the B key in the keyhole and turns it *(BS and SH are locked)*
- R takes the C key out *(this action locks the B key)*
- R opens the door using the C key.

3.2.4. Exit operations ("search" procedure).

At the end of operations an inspection ("search") must be executed to verify that nobody is still inside the hutch before opening BS and SH. A search panel with a lock fitting the C key and a button is placed inside the hutch.
The search is performed as follows:

- R asks everybody to leave the hutch, enters and closes the door bringing the C key with him
- R verifies that nobody is still inside the hutch
- R inserts the C key in the search lock and pushes the search button turning the C key at the same time
- R leaves the hutch, bringing the C key with him, and closes the door
- R inserts the C key in the key panel outside the door within 30 seconds, turns it and extracts the B key within 10 seconds.

The first timer starts when the search button is pushed and is reset when the C key is turned in the panel outside the hutch. Further 10 seconds are allowed to extract the B key (the action is completed when the sensor is in the vertical position).
If the search is not correctly carried out, the safety system generates an anomaly status.

3.2.5. Conditions for opening BS and SH.

BS and SH can be opened if the following conditions are together fulfilled:

- the FE hutch door is closed and the search has been successfully carried out
- the injection of the electron beam inside the ring is not in progress
- the gamma monitor indicates no failure, no pre-alarm and no alarm status
- the PLC of the beamline is on.

If, in an anomaly status, BS does not close within 10 seconds from a PLC request, a beam dump is forced inside the ring.
The BS and SH aperture may be inhibited also by other independent equipment.

3.2.6. Beam injection interlock.

The beam injection in the ring is locked (or is interrupted) if:

- the door of the hutch is open (or is forced open)
- the hutch has not been searched
- BS is open
- the gamma monitor is off, indicates a failure or an alarm status
- the PLC of the beamline is off.

3.2.7. Anomaly status.

An anomaly status is generated if:

- the hutch emergency button is pushed
- the hutch door is forced open
- the search is not correctly carried out.

An anomaly status causes:

- the acoustic alarm switching on
- the injection inhibition or the injection interruption if the operation is running
- BS and SH closure (if open) and lock.

An anomaly status is reset carrying out a search. Before beginning the procedure, the anomaly causes must be reset.

3.2.8. PLC switching off.

The PLC switching off causes:

- the injection inhibition or the injection interruption if the operation is running
- the impossibility to enter the hutch
- the beam dump in the ring
- BS and SH closure (if open) and lock.

When the PLC is re-switched on an anomaly status is generated. The anomaly is reset carrying out a search.

3.2.9. Signals from the gamma monitor.

The gamma dose monitor provides 3 logic signals whose meanings are:

- no failure status
- the pre-alarm status
- the alarm status.

The PLC of the beamline acquires these signals and generates different actions according to the logic reported below.

“No failure” status OFF (= malfunction ON) causes:

- the impossibility to enter the hutch
- BS and SH closure (if open) and lock
- no injection allowed or injection interruption if the operation is running.

“Pre-alarm” status ON (= pre-alarm threshold exceeded) causes:

- the impossibility to enter the hutch
- BS and SH closure (if open) and lock.

“Alarm” status ON (= alarm threshold exceeded) causes:

- the impossibility to enter the hutch
- BS and SH closure (if open) and lock
- no injection allowed or injection interruption if the operation is running.

3.3. Radiation emergency inside a hutch

A '*possible* radiation accident' may occur if one or more persons remains inside a beamline hutch *when the access is forbidden by the safety system*.
In case that, after the search execution inside a hutch

- a person is suspected to be, or really has remained, inside the hutch
- an emergency button is pressed inside the hutch
- a hutch door is forced open

you must:

1. immediately close the beamstopper (shopper)
2. enter inside the hutch following the regular access procedure
3. inspect the hutch
4. if necessary, give assistance.

If the event takes place *before* the opening of the beamstopper (shopper), the assistance regards only ordinary safety.
If the alarm takes place *after* the opening of the beamstopper (shopper), an ionising radiation accident may have occurred.

IN THIS CASE YOU MUST IMMEDIATELY INFORM THE RING CONTROL ROOM OPERATOR OF WHAT HAS HAPPENED SO THAT HE CAN ACTIVATE THE PROVIDED PROCEDURES.