



Elettra  
Sincrotrone  
Trieste

# Radiological risk in Elettra Experimental Hall

*Extracted from:*

**Radiation protection training/information program for beamline users**

**(in compliance with the D.lgs.n.101/2020)**

Radiation Protection

*Katia Casarin, Giovanni Scian, Katia Alikaniotis, Giuliana Tromba*

# Radiation protection training for users: main contents

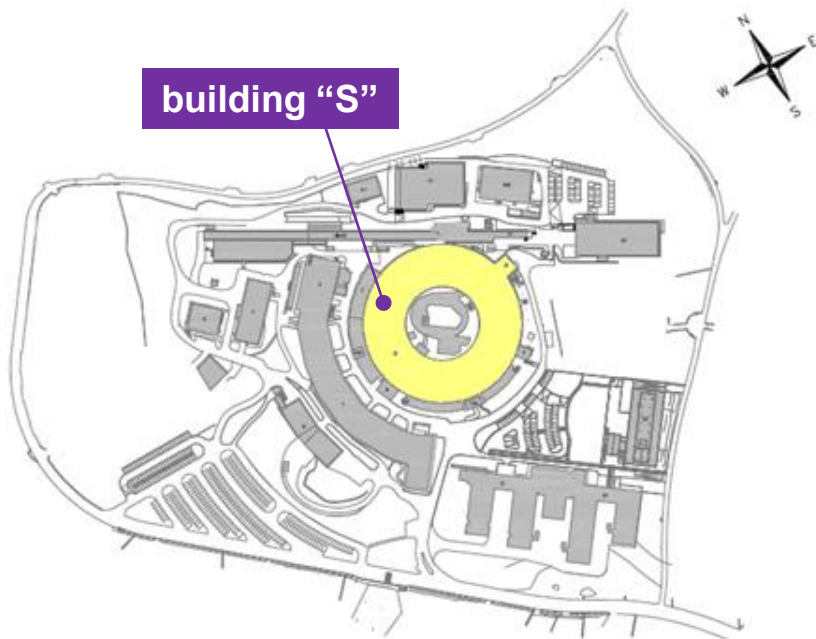


- ▶ Ionizing radiation sources in Elettra Experimental Hall
- ▶ Area classification and radiological risk signs
- ▶ **Access, exit and search procedures for the beamline hutches**
- ▶ What to do in case of radiological accident
- ▶ Radiation monitoring
- ▶ Activities forbidden in the Experimental Hall
- ▶ Workers responsibilities
- ▶ .....

(The training programme consists of 36 slides )

# How to reach Elettra Experimental Hall

Elettra Experimental Hall is located in Building “S”, immediately outside the concrete shielding blocks that enclose the storage ring.



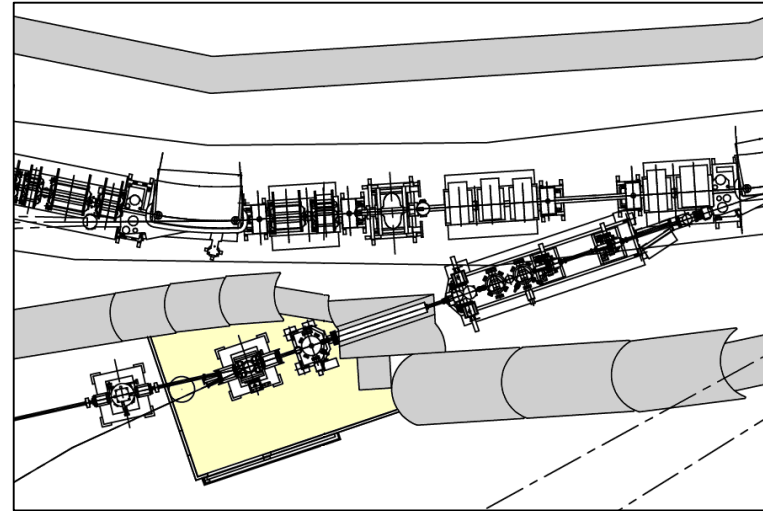


# The beamline hutches: two kinds of beamlines

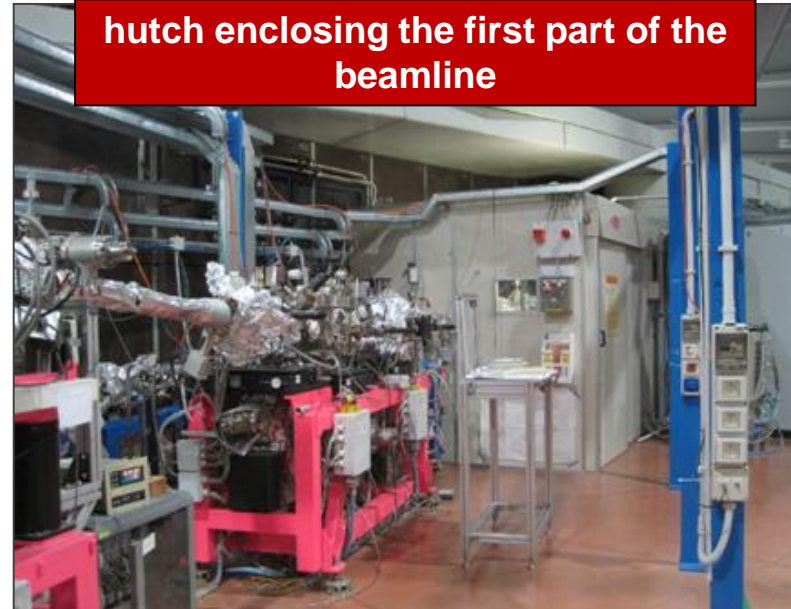
Depending to the its specific characteristics, a beamline may be partially or entirely enclosed inside shielding walls, and may have one or more hutches.



beamlines entirely enclosed inside shielding walls, composed of more hutches



hutch enclosing the first part of the beamline





# Ionising radiation in the Experimental Hall



Ionizing radiation that can reach the Experimental Hall mainly consists of:

- ▶ synchrotron radiation, i.e. photons of relatively “low” energy (up to about 35 keV), produced inside the storage ring and extracted along the beamlines;
- ▶ bremsstrahlung radiation, consisting of high energy photons, produced by the interaction of the primary stored beam with residual gas molecules in the storage ring vacuum chamber. Bremsstrahlung radiation can travel down the beamline, together with the synchrotron radiation, and can therefore reach the Experimental Hall.

# Area classification and radiological risk signs

- ▶ Italian legislation establishes specific limits for the annual dose deliverable to the public: the areas where the risk of exceeding these limits might be exceeded, depending on the risk level, are classified as Controlled Areas or Supervised Areas.
- ▶ Classified areas are fenced and marked with signs: access to these areas is regulated through Radiation Protection and Safety Rules and is forbidden to unauthorized personnel.

risk of exposure to  
ionizing radiation



area classification

# Experimental Hall classification

From the radiation protection point of view, both Elettra and FERMI Experimental Halls are

**FREE RADIATION AREAS**

As a consequence, the Experimental Hall users are not classified as radiation workers.



# Fenced areas in the Experimental Hall

In particular cases, such as during the conditioning of a new vacuum chamber installed in the storage ring, some areas of the Experimental Hall might be affected by higher levels of radiation.

**These areas are fenced and marked with signs: access is regulated through Radiation Protection and Safety Rules and is forbidden to unauthorized personnel.**





# Hutch classification



As far as the beamlines' hutches are concerned, the area inside the hutches is:

- ▶ **FREE RADIATION AREA**, when access is permitted by the Personnel Safety System;
- ▶ **INTERDICTED AREA**, when access is forbidden by the Personnel Safety System.

# The beamline Personnel Safety Systems

Access to the hutches is controlled by a Personnel Safety System that manages:

- end-switches installed on the doors
- emergency and search buttons
- key panels
- movement sensors
- acoustic and light signals
- radiation monitors
- etc.



# The hutch key panel

Each hutch has a key panel, with 4 lights and 2 keyholes:

green light, indicating “stopper closed”

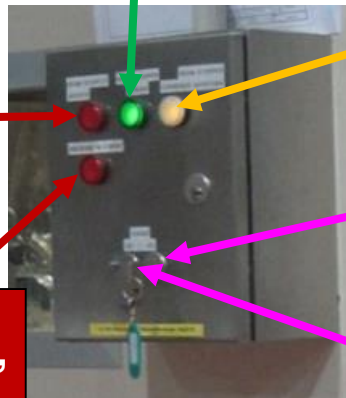
red light, indicating  
“stopper open”

red light, indicating  
“refill injection in progress”

yellow light, indicating  
“stopper aperture enabled”

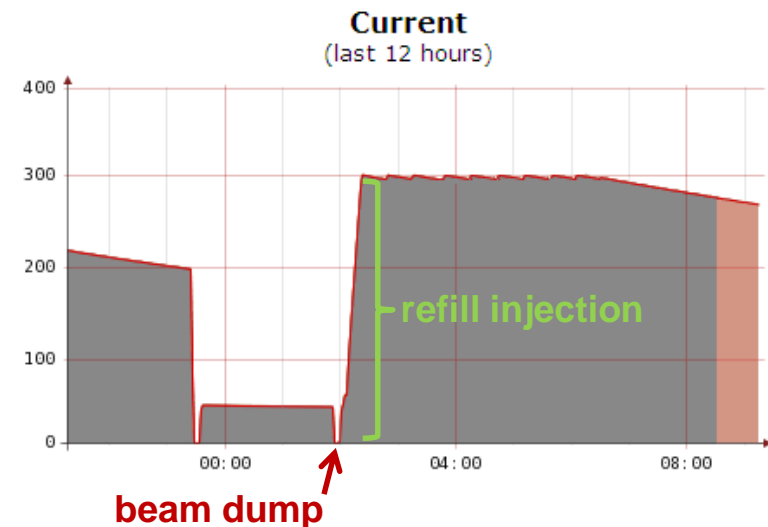
keyhole for the C key

keyhole for the B key



What is the *refill* injection?

The *refill injection* is the injection typically carried out after a *beam dump*, with all the beamlines' stoppers closed.



# Access to the hutches

Access to the hutches is permitted only if all the safety conditions are fulfilled.

To enter, the person authorized to the access has to:

- ▶ insert the B key in the hutch key panel;
- ▶ rotate the B key;
- ▶ extract the C key;
- ▶ open the door with the C key.

**It is important to remember that access to some hutches, for example to all the front-end hutches, disables the refill injection of the electrons inside the storage ring.**

## Aim of the search procedure

After the hutch door has been opened, before opening the beamline stopper, it is necessary to carry out a search.

**The aim of the search is to make sure that nobody is inside the hutch, before restarting the operations with the synchrotron radiation beam.**

The search procedure foresees the use of B and C keys and of the search panel positioned inside the hutch.



To carry out the search, one has to:

- ▶ ask everybody to leave the hutch;
- ▶ take the C key, enter the hutch and close the door;
- ▶ **check that nobody is present inside the hutch;**
- ▶ insert the C key in the keyhole of the search panel and rotate it, pushing the search button at the same time;
- ▶ extract the C key, get out of the hutch and close the door;
- ▶ insert the C key in the external key panel;
- ▶ rotate and extract the B key.

## Blinking light

- ▶ Once the search of the beamline hutches has been completed, the Personnel Safety System enables the transport of radiation inside the hutch.
- ▶ The transport of synchrotron radiation inside a hutch is indicated by a red blinking light on the hutch wall. When the blinking light is on, access to the hutch is forbidden by the Personnel Safety System.



# Users' training organization

- ▶ **Beamline external users** are required to perform an on-line training before their arrival at Elettra, connecting to the “Radiation Protection and Safety training for users” section of the Elettra VUO (<https://vuo.elettra.trieste.it/pls/vuo/guest.startup>).
- Users, who will not follow the on-line training remotely, will be asked to perform it upon their arrival at Elettra.**



Numero domanda	Domanda	Slide n.	Risposta
1	The signal shown in the following picture:	8	marks an area where access is in any case forbidden marks an area which is classified from the radiation protection point of view indicates a risk of exposure to infrared radiation
2	According to radiation protection legislation, "radiation areas" are:	8	areas where access is controlled by a Personnel Safety System areas where access must be authorized by the beamline Responsible areas subject to radiation safety rules
3	From the radiation protection point of view, Elettra Experimental Hall is:	9	a Supervised Area a Controlled Area a Free-Radiation Area, therefore the personnel working there are not classified as radiation workers
4	The beamline stopper is projected to:	12	stop the bremsstrahlung radiation channeling along the beamline stop the synchrotron radiation beam stop the electron beam
5	The hutch walls:	31	must not be drilled because they contain lead and have a shielding function can be climbed over if you are not able to find the key to open the door have not a shielding function
6	Access to the beamline hutches:	15	is permitted when the beamlines are working with the beam is controlled through a Personnel Safety System and is permitted when all the safety conditions are fulfilled is never permitted
7	The aim of the "search" procedure is:	16	to ensure that nobody remains inside the hutch before the opening of the beamline stopper and shutter to verify that nothing has been forgotten inside the hutch before starting to work with the beam just to be enabled to open the stopper from the Personnel Safety System
8	The transport of radiation inside a hutch is signaled by:	19	a red blinking light positioned on the hutch wall a green light positioned on the hutch key-panel a yellow light positioned on the hutch key-panel
9	In case of radiological accident inside a hutch, it is necessary:	21	to interrupt immediately the operations with the beam and inform the Control Room operator to push an emergency button to push a search button
10	The radiation monitors of the Experimental Hall:	25	are turned on only during injection of the electron beam inside the ring according to the measured irradiation levels, may deny access to the beamline, close the stopper and the shutter and stop injection of the beam into the ring can be turned off by the personnel carrying out research activities at the beamlines
11	The fencings utilized to mark the radiation areas:	31	can be crossed if necessary, without authorization can be removed for a short period, without authorization cannot be removed or moved for any reason, without authorization
12	As far as activities in elevated position around the beamlines are concerned:	32	they are in any case forbidden they are always authorized, but for short periods are regulated by Radiation Protection and Safety Rules
13	Before starting the search of a hutch:	17	it is necessary to be authorized by the control room operator it is necessary to ask everyone to leave the hutch it is necessary to press the yellow button located on the key panel of the hutch
14	The ionizing radiation that can be channeled from the accelerator tunnel to Experimental Hall are mostly inside the beamline vacuum chamber:	7	neutrons beta radiation photons

For further information  
visit our website

<https://www.elettra.eu>



**Quicklinks**

- COVID-19 Research at Elettra
- Access and visits
- Working with us
- Industrial Liaison Office
- PhoneBook
- Contacts
- Purchase Office
- Payments
- Radiation Protection**
- Prevention and Safety

**the synchrotron light source**

**Elettra**

Scientists from all over the world can access our beamlines and facilities on the basis of pure scientific proposals that are of high potential impact.

**the free-electron laser**

**FERMI**

The next generation light source is ready to open unprecedented opportunities in science, providing the brightest probe to look at ultrafast processes in the natural world.

**MUR International Projects**

**Quicklinks**

- Applying for beamtime
- Industrial Liaison Office

**User Quicklinks**

Applying for beamtime

Industrial Liaison Office

**EVENTS** **CONFERENCES** **SEMINARS**

passa alla versione italiana

workshop on instrumentation for synchrotron

**Here you can find the contacts of the Radiation Protection Expert and the Radiation Protection Activity.**



Elettra  
Sincrotrone  
Trieste

Thanks for your attention!

[www.elettra.eu](http://www.elettra.eu)

## Emergency procedure (1/2)

The scenario in which one or more persons remain inside a hutch when access is forbidden by the Personnel Safety System, is defined as **possible radiological accident**.

In case that, after the search has been concluded:

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

one shall:

- ▶ immediately close the stopper (shopper) if open;
- ▶ enter the hutch following the regular access procedure;
- ▶ inspect the hutch;
- ▶ if necessary, provide help.

## Emergency procedure (2/2)

If the event takes place before the opening of the stopper (shopper), the help regards only ordinary safety.

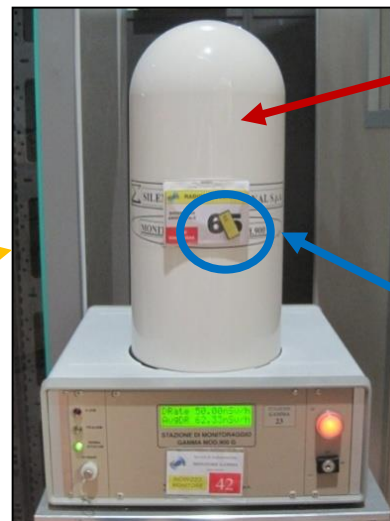
If the event occur after the opening of the stopper (shopper), a *possible* ionizing radiation accident should be considered.

**In this case one must immediately inform the Control Room operator (8922/8923, 8262/8263) of what has happened.**



# Radiation monitoring at the beamlines

Radiation monitoring at the beamlines is carried out both by active monitors (pressurized ionization chambers) and by passive dosimeters (thermoluminescence dosimeters, or TLDs).



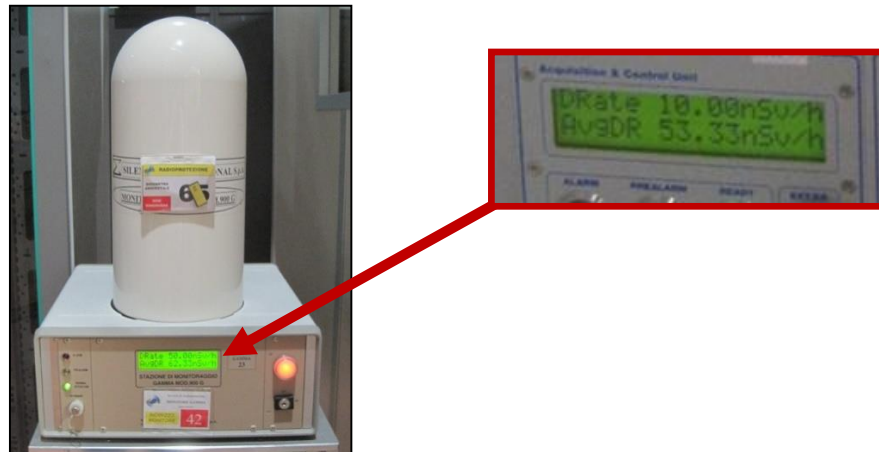
**IONIZATION CHAMBER**

**THERMOLUMINESCENCE  
DOSIMETER**

# The radiation monitor display

The active monitors have a display with two rows:

- ▶ the first one shows the dose intensity (rate), second by second;
- ▶ the second one shows the dose rate averaged over the last 60 measurements and expressed on hourly basis ( $\mu\text{Sv/h}$ ,  $\text{mSv/h}$ , etc.)

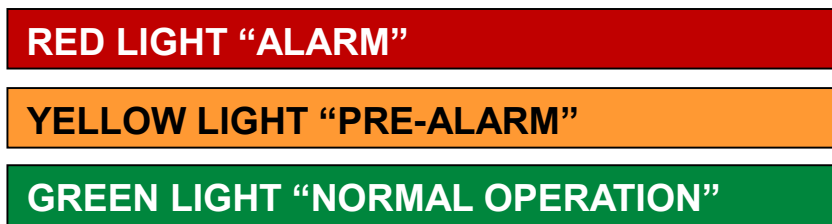


Data shown in the second row are available also remotely in the accelerator Control Room, where they are continuously recorded.

# Normal Operation, Pre-Alarm, Alarm

The monitors provides three output signals, that are acquired by the beamline Personnel Safety System:

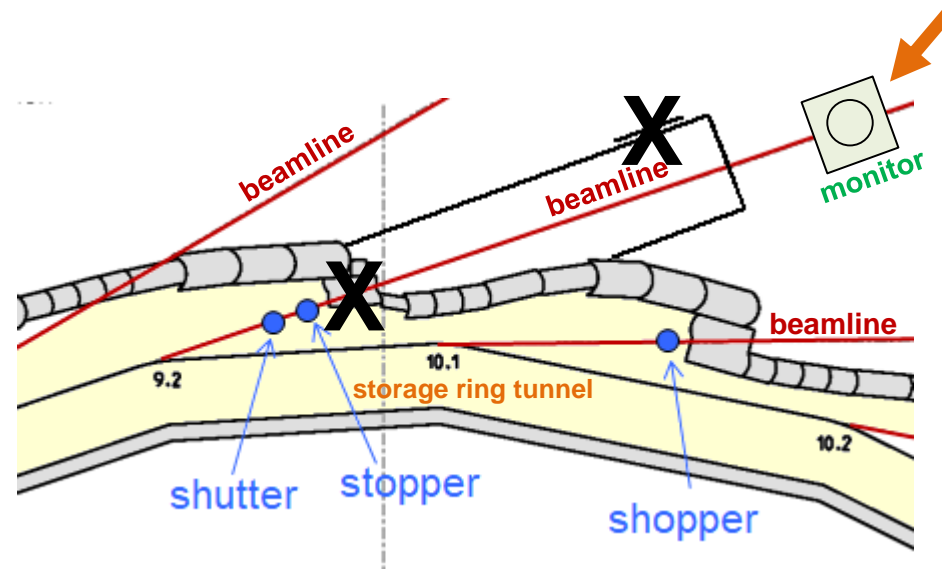
- 1) Normal Operation
- 2) Pre-Alarm
- 3) Alarm





# Interlocks tied to "Failure", "Pre-Alarm", "Alarm"

If a beamline radiation monitors enters a "Failure" or "Pre-Alarm" or "Alarm" state, the beamline Personnel Safety System automatically closes the beamline stoppers and inhibits access to the hutches.



In case of "Failure" or "Alarm", in addition to the interlocks above, also the refill injection is inhibited.

# What to do in case of "Failure", "Pre-Alarm", "Alarm"

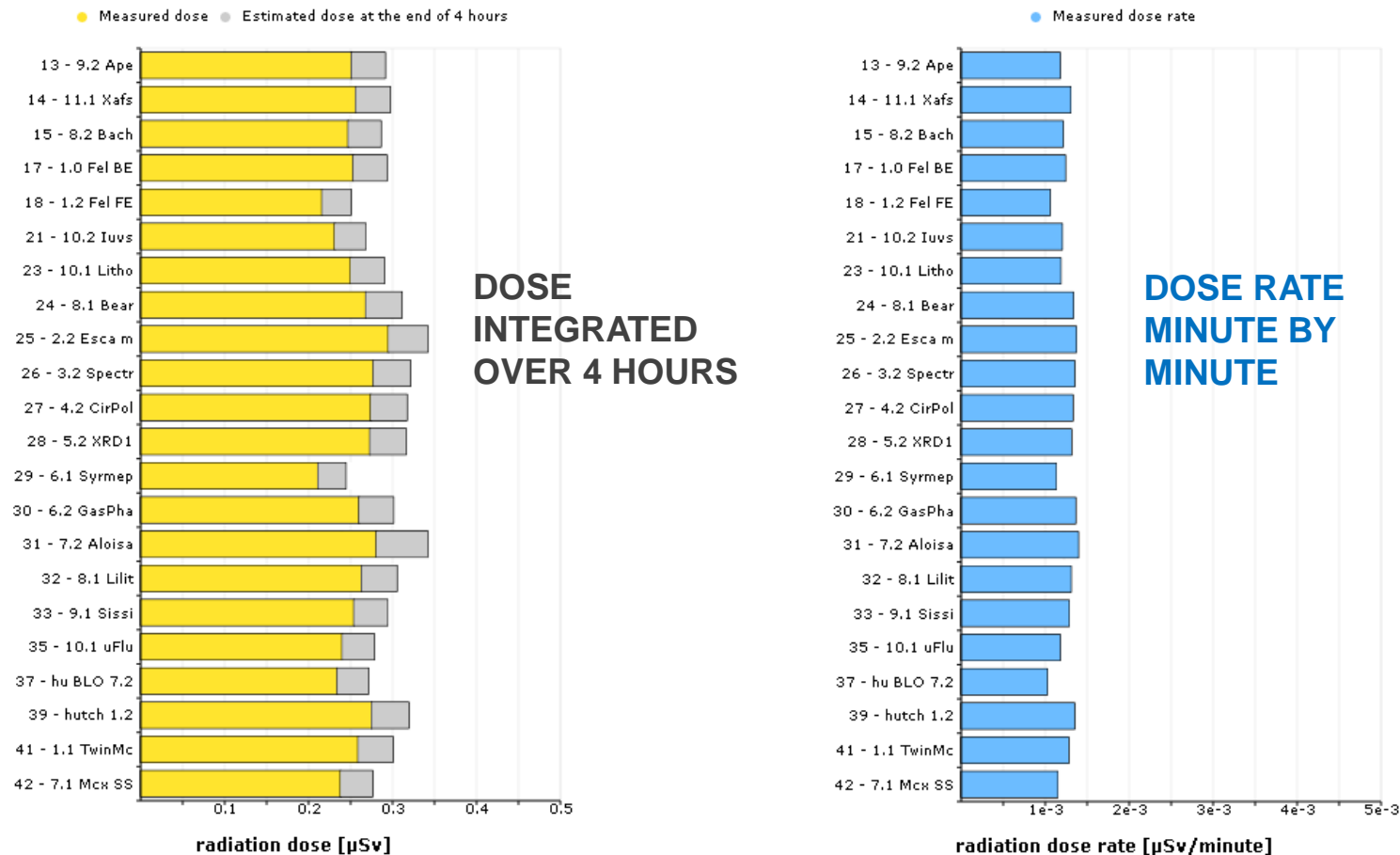
**In all these cases there is no immediate danger of overexposure to ionizing radiation because the interlock is designed in such a way to always guarantee compliance with regulatory limits.**

Nevertheless, it is necessary to notify to the Control Room operator what has happened (8922/8923, 8262/8263); the Control Room operator will contact the Radiation Protection Activity.



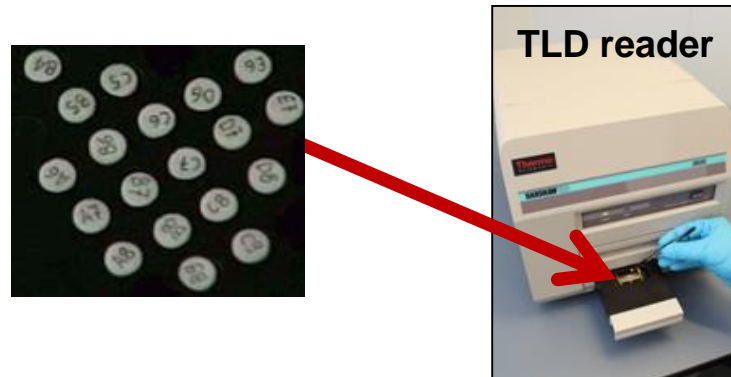
The environmental radiation monitor measurements are available on-line

<http://www.elettra.trieste.it/activities/radiation-protection/silena.html>



# Thermoluminescence dosimeters

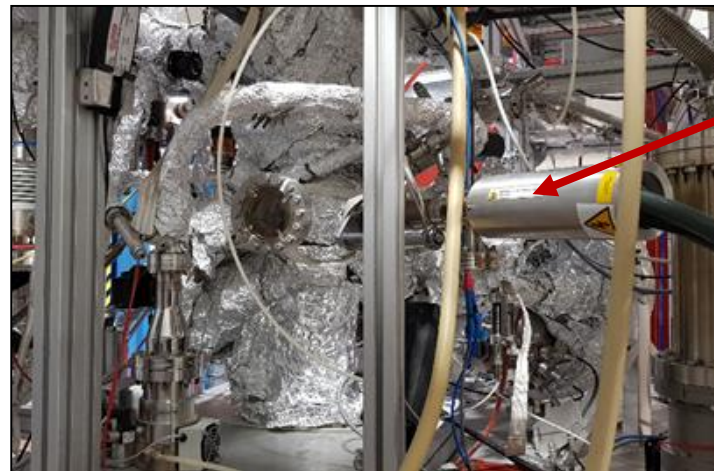
For the environmental radiation monitoring also thermoluminescent dosimeters (TLDs) are utilized. They are replaced and read once a month.



**Thermoluminescence dosimeters are strongly recommended for the evaluation of the dose produced by short pulsed radiation.**

# The X-ray tubes of the Experimental Hall

- ▶ Elettra Experimental Hall hosts also some X-ray tubes.
- ▶ They can be operated only by authorized personnel, who have to attend a specific training.
- ▶ The Radiation Safety Rules regulating the use of X-rays tubes are available next to the equipment and must be consulted before use.




X-ray tube

# Activities forbidden in the Experimental Hall (1/3)

The activities forbidden in the Experimental Hall are listed on posters placed on the hutch doors.





Norme di radioprotezione  
alle linee di luce

**VIETATO L'ACCESSO ALLA HUTCH  
QUANDO IL BEAMSTOPPER  
E' APERTO**

**E' ASSOLUTAMENTE VIETATO:**

- manomettere il sistema di controllo accessi
- praticare fori nelle pareti schermanti delle linee
- spostare i monitori di dose
- spostare o rimuovere le schermature posizionate lungo la linea
- forzare la serratura di una porta o scavalcare le pareti schermanti di una hutch
- salire sulle lastre di copertura dell'anello
- lavorare in sopraelevazione in posizioni tali che permettano la visione all'interno delle pareti schermanti delle linee quando il beamstopper è aperto
- lavorare in sopraelevazione a quote superiori a 3 metri ad una distanza inferiore a 5 metri dalle schermature dell'anello
- introdurre all'interno di Elettra - Sincrotrone Trieste sorgenti radioattive o macchine radiogene senza l'autorizzazione dell'Esperto Qualificato o del Servizio di Radioprotezione.

**PROCEDURA DI ACCESSO ALLA HUTCH**

- Inserire la chiave B nel pannello chiavi
- Ruotare la chiave B (questa operazione è possibile solo se sono verificate le condizioni di sicurezza)
- Estrarre la chiave C
- Aprire la porta usando la chiave C.

**PROCEDURA DI RONDA**

- Munirsi di chiave C
- Entrare nella hutch e chiudere la porta
- ASSICURARSI CHE NON VI SIANO PERSONE ALL'INTERNO DELLA HUTCH**
- Inserire la chiave C nel pannello di ronda e ruotarla premendo contemporaneamente il pulsante di ronda
- Estrarre la chiave C, uscire portando con sé la chiave C e chiudere la porta
- Inserire la chiave C nel pannello chiavi e ruotarla
- Estrarre la chiave B.

**NOTE**

- Le operazioni 4, 5, 6 devono essere compiute in 30 secondi, l'operazione 7 in 10 secondi.
- Se non vengono rispettate queste norme suona la sirena.
- Lo stato di allarme (il suono della sirena) viene annullato da una ronda eseguita correttamente.

**NUMERI TELEFONICI UTILI**

SALA CONTROLLO: 8262 - 8263 - 8922 - 8923	EMERGENZA (VIGILANZA): 8333
RADIOPROTEZIONE: 8012 - 8587 - 8530 - 8017	PRONTO SOCCORSO: 0 118
PREVENZIONE E PROTEZIONE: 8437 - 8297 - 8705	VIGILI DEL FUOCO: 0 115



Radiation protection rules  
at the beamlines

**ACCESS INSIDE THE HUTCH  
IS FORBIDDEN WHEN THE  
BEAMSTOPPER IS OPEN**

**IT IS STRICTLY FORBIDDEN:**

- to modify or to bypass the safety system
- to drill holes in the beamlines' shielding walls
- to move the radiation dose monitors
- to move or to take away the lead shielding placed along the beamline
- to force open a door or to climb over the shielding walls
- to climb on top of the concrete ceiling slabs of the ring
- to work in an elevated position that permits to view the inside of the beamlines' shielding walls when the beamstopper is open
- to work above a height of 3 meters at a distance of less than 5 meters from the ring shielding
- to bring to Elettra - Sincrotrone Trieste radioactive sources or X-ray machines without the authorization of the Qualified Expert or the Radiation Protection Service.

**PROCEDURE TO ENTER THE HUTCH**

- Insert the B key in the key panel
- Turn the B key (this operation is allowed only if the safety conditions are fulfilled)
- Extract the C key
- Open the door using the C key.

**SEARCH OPERATION**

- Take the C key
- Enter the hutch and close the door
- CHECK THAT NOBODY IS INSIDE THE HUTCH**
- Insert the C key into the search keyhole and turn it, pushing the search button at the same time
- Remove the C key, leave the hutch with the C key and close the door
- Insert the C key in the key panel and rotate it
- Take out the B key.

**REMARKS**

- Operations 4, 5, 6 must be concluded within 30 seconds, operation 7 within 10 seconds.
- An acoustic alarm sounds if these operations have not been correctly carried out.
- The alarm status (acoustic signal) is reset after a correct search operation.

**USEFUL TELEPHONE NUMBERS**

CONTROL ROOM: 8262 - 8263 - 8922 - 8923	EMERGENCY (RECEPTION): 8333
RADIATION PROTECTION: 8012 - 8587 - 8530 - 8017	AMBULANCE: 0 118
PREVENTION AND SAFETY: 8437 - 8297 - 8705	FIRE BRIGADE: 0 115

# Activities forbidden in the Experimental Hall (2/3)

## In the Experimental Hall it is forbidden:

- ▶ to force the hutch door lock or to climb over a hutch wall to enter;
- ▶ to modify or bypass the hutches' Personnel Safety System or part of it;
- ▶ to drill holes in the beamlines shielding walls without the authorization of the Radiation Protection Expert or of the Radiation Protection Activity;
- ▶ to move radiation monitors without the authorization of the Radiation Protection Expert or of the Radiation Protection Activity;
- ▶ to move or to remove the lead shielding placed along the beamlines;
- ▶ to move, to remove or to go beyond the fencings delimiting a classified area;

# Activities forbidden in the Experimental Hall (3/3)

- ▶ to climb on top of the concrete ceiling slabs of the ring when the beam is stored in the ring;
- ▶ to work in an elevated position that enables to see the inside of the beamlines' shielding walls where they are working with the synchrotron radiation beam;
- ▶ to work above a height of 3 meters at a distance of less than 5 meters from the ring shielding during the machine physics shifts;
- ▶ to bring radioactive sources or radiation machines inside the Research Centre without the authorization of the Radiation Protection Expert or of the Radiation Protection Activity;
- ▶ to move radioactive sources or radiation machines from one laboratory to another without the authorization of the Radiation Protection Expert or of the Radiation Protection Activity.



# Workers responsibilities (1/3)

Art.118, D.lgs. n.101/2020

1. *Each worker has to take care of her/his own health and safety and of that of the other people present in the workplace, which are affected by her/his actions or omissions, in accordance with her/his training, instructions and means provided by the employer.*



# Workers responsibilities (2/3)

Art.118, D.lgs. n.101/2020

## 2. Workers:

- a) cooperate with the employer, managers and supervisors to comply with the legal obligations foreseen to ensure health and safety in the workplace;
- b) comply with the provisions and follow the instructions given by the employer, managers and supervisors in order to ensure individual and collective protection and safety, according to the duties to which they are assigned;
- c) use, following specific instructions, the safety devices, protective clothing and dosimetric surveillance devices supplied by the employer;

→ violation foresees a fine between 150 and 500 euros



## Workers responsibilities (3/3)

Art.118, D.lgs. n.101/2020

- d) immediately notify the employer, his appointee or any other manager of any fault in safety devices, protective clothing and dosimetric surveillance devices and any risk situation of which they become aware;
- e) not carry out on their own initiative any operations or manoeuvres which are not part of their duties and/or which may jeopardise protection and safety;
- f) undergo medical surveillance as foreseen by the Legislative Decree n.101/2020;
- g) participate in safety training programs arranged by the employer.



# Protection of pregnant and breastfeeding workers



1. Pregnant workers shall not be employed in work carried out in classified areas or, in any case, in work that might expose the unborn child to a dose exceeding 1 millisievert during pregnancy.
2. Pregnant employees shall notify the employer their pregnancy status as soon as they become aware of it.
3. Breastfeeding workers shall not be employed in work involving the risk of radioactive contamination.
4. Working activities involving exposure to ionizing radiation are prohibited to pregnant women and working mothers during gestation and for 7 months after childbirth.