



# TIMEX beamline Safety Instructions

Belonging process: PRSI – Procedere in sicurezza

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# TIMEX beamline Safety Instructions

Procedure

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Approval process

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# 1 Purpose

This document contains information on the main scientific and technical activities carried out at the "TIMEX" beamline at Elettra – Sincrotrone Trieste S.C.p.A. (hereinafter "Elettra Sincrotrone Trieste" or "Company") and a series of *Operating Instructions* necessary to perform these activities safely.

This document can be downloaded directly from the beamline website:

<https://www.elettra.eu/lightsources/fermi/fermi-beamlines/eis-timex/eis-timex.html>

For anything not expressly covered below, reference should be made to the laws and regulations in force, and in particular to [LEGISLATIVE DECREE No. 81 of 9 April 2008](#).

## 2 Safety officers

The following persons are responsible for the safety of workers operating at the beamline:

- *Those responsible for safety* at the beamline. These are the *beamline coordinator*, i.e. the person in charge of the activity, the *beamline scientists* and, in some cases, the *postdocs*. Those responsible supervise the various activities carried out at the beamline, ensuring that the employer's directives are implemented and giving instructions for their correct execution. The list of the Company's safety officers can be downloaded from the following link:

[https://vuo.elettra.trieste.it/pls/vuo/amm\\_people.safety\\_org\\_chart\\_printout](https://vuo.elettra.trieste.it/pls/vuo/amm_people.safety_org_chart_printout)

- *Safety Managers*, in the persons of the *Group Coordinators* of the SPEED and IDEAS beamlines, who organise the work activities of each Group and supervise their correct implementation, with particular attention to prevention and protection measures. Their names can be found on the web page:

<https://www.elettra.eu/it/about/contatti-dei-coordinatori-di-gruppo.html>

### 2.1 Duties of light line safety officers

The light line or laboratory safety officer must ensure that workers (including users, collaborators, students, trainees, etc.) use the prescribed protective equipment and follow all safety regulations.

*In the absence of the person in charge, this responsibility is fulfilled by providing workers with prior information and training and making safety procedures and instructions available.*

## 3 Beamline personnel

The names and contact details of the personnel appointed by the Company can be found on the following web page:

<https://www.elettra.eu/lightsources/fermi/fermi-beamlines/eis-timex/contacts.html>

### 3.1 Job categories

After receiving adequate training, the following categories of workers are authorised to work at the experimental stations and other parts of the beamline:

- beamline research personnel, i.e. the *beamline coordinator* (or *beamline manager*), *beamline scientists on both fixed-term and permanent contracts*;
- photon transport support research staff (PADReS group).
- laser support research staff (Laser group).
- external research staff, and in particular academic or industrial users, collaborators, fellows from other institutions, doctoral students, undergraduate students and interns;
- line technical staff;
- maintenance personnel: electrical-electronic technical staff, IT-design staff, mechanical-fluid technical staff; technical staff from the Mechanics, Vacuum and Optics group.
- Handlers.

Every worker is responsible for taking care of their own health and safety and that of other people in the workplace who may be affected by their actions or omissions, in accordance with their training, the instructions and the means provided by the employer.

### 3.2 General safety requirements and training

Each job category is required to complete the training courses prescribed for the specific activities of the job, made available through the VUO (*Virtual Unified Office*) system.

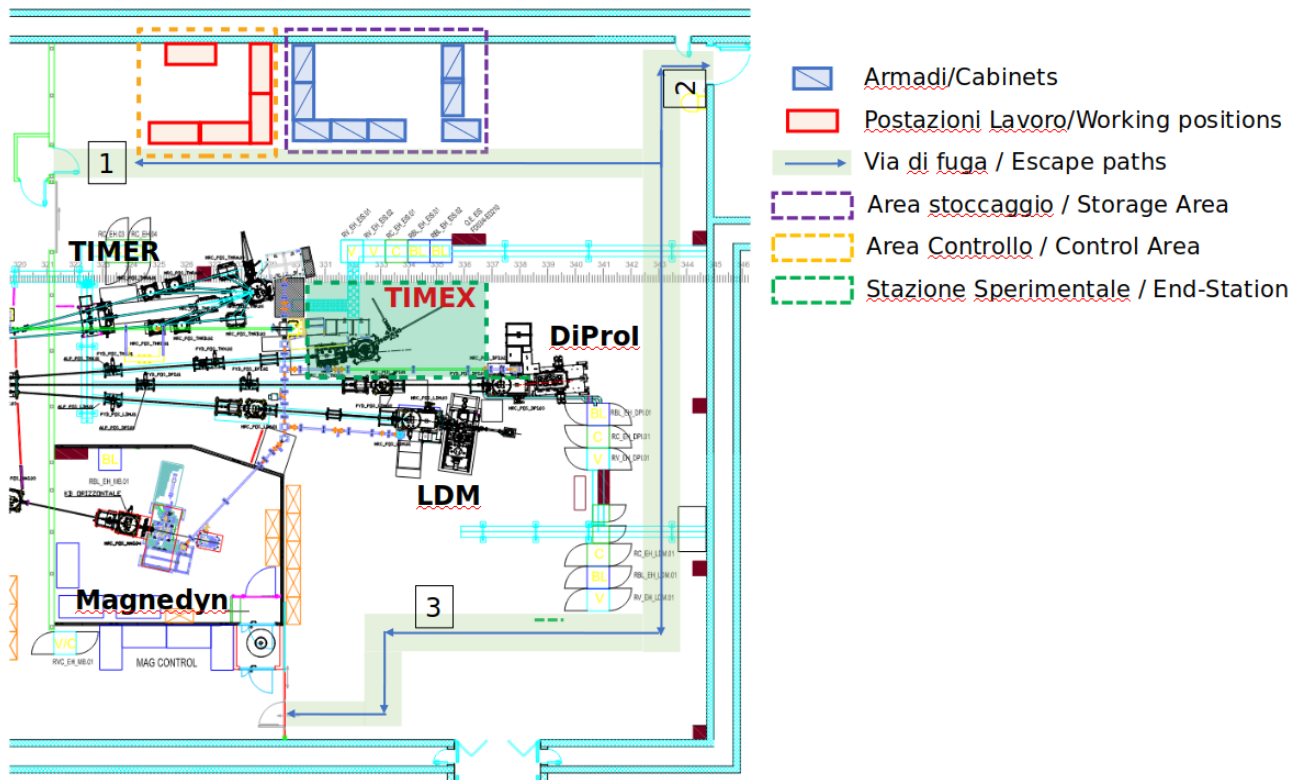
Everyone is invited to consult **Elettra's Risk Assessment Document** (document code: **PVAR-MAN-01**). In addition, electrical maintenance personnel should review the recommendations in document **PVAR-SCH-07**, electrical-electronic technicians should review those in document **PVAR-SCH-16**, and fluid-mechanical maintenance **personnel** should review those in documents **PVAR-SCH-09** and **PVAR-SCH-19**. IT designers must read document **PVAR-SCH-03**, while research and laser support staff must read those in documents **PVAR-SCH-70**.

**Please note:** *it is beyond the scope of this document to detail the safety requirements for electrical maintenance personnel called upon to perform routine and extraordinary maintenance on electrical distribution panels, or repairs on electrical pre-switches or similar devices, as there are already risk assessment documents and specific safety requirements relating to their tasks. It should also be noted that scientific and technical personnel working on the beamline and external researchers are strictly prohibited from carrying out any work on electrical systems.*

## 4 The 'TIMEX' beamline

### 4.1 Description of the work area

The "TIMEX" beamline (see **Figure 1**) is located inside the "EHF" building in a central position on the floor plan of the FERMI experimental room, in the area between the LDM and DiProi lines. Escape routes 1-2-3, within the controlled access laser area, are highlighted in green in **Figure 1**.



**Figure 1:** Plan of the "TIMEX" beamline

With reference to **Figure 1**, the areas marked with **yellow** and **magenta** dotted lines correspond, respectively, to the area reserved for instrument control during the data acquisition phase and the area intended for the storage of beamline instrumentation and/or *online* data analysis by instrument users. The areas marked by **green** dotted lines are reserved for access and placement of equipment that can be used during *beamtimes*, i.e. the periods of activity during which experiments approved by the FERMI *Proposal Review Panel* are carried out.

The 'TIMEX' experimental station has a sufficient number of workstations (yellow area in **Figure 1**) where data acquisition and analysis activities can be carried out during experiments. Each workstation is equipped with a desk and one or more ergonomic chairs.

### 4.2 Scientific activity of the beamline

The TIMEX beamline operates in the spectral range of 25-300 eV and is used by a diverse community of users active in the fields of materials science, functional materials, nanoscience and solid state physics, including high energy density states (matter under extreme conditions, dense plasma) and transient states (ultrafast phenomena). Recently, experiments have also been conducted on gaseous samples.

The TIMEX beamline experimental station houses an experimental chamber dedicated to light/matter interaction experiments exploiting the characteristics of FERMI *free electron laser*

(FEL) radiation. *TIMEX* was established in 2010 as a collaboration between Elettra-Sincrotrone Trieste and the University of Camerino (MC). The beamline has since undergone numerous improvements and upgrades, first and foremost the installation of an EUV spectrometer (called WEST) downstream of the experimental chamber. *TIMEX* allows a wide range of experiments with structural and chemical sensitivity to be performed, in particular:

- Time-resolved spectroscopy techniques using extreme ultraviolet (*EUV*) or *soft* X-rays as a probe, mainly in transmission geometry:
  - *Time-resolved X-ray Absorption Spectroscopy* (tr-XAS)
  - *Time-resolved XUV and optical reflectivity*.
  - *Nonlinear spectroscopy*
  - *Impulsive stimulated Raman scattering* (ISRS)
  - *Self amplified spontaneous emission from dense gases*

### 4.3 Available instrumentation

This section provides a list of the main equipment used (the *CE* symbol indicates the specific marking required for the marketing of products within the European Community).

#### 4.3.1 User manuals and instructions

The manuals for the equipment available at the experimental station are kept in the beamline cabinets located near the perimeter wall of the experimental room, close to the experimental chamber. See the 'magenta' area in Figure 1.

#### 4.3.2 Experimental station instrumentation

Although their configuration may vary depending on the specific requirements of the particular experiment, the main components of the "*TIMEX*" experimental station measurement system are listed below:

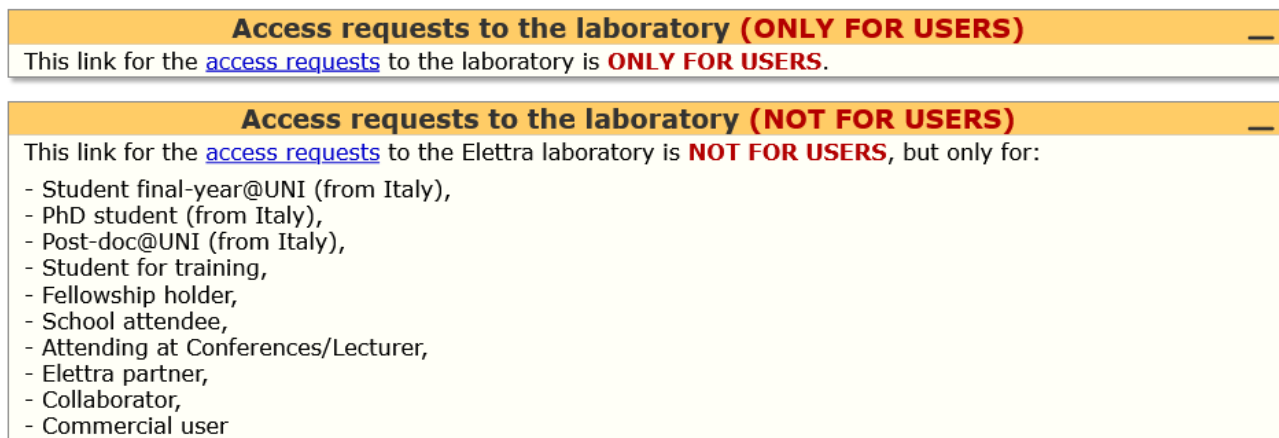
- Standard instrumentation positioned and operating inside the experimental chamber operating under high vacuum conditions (1e-7 mbar)
  - 2x filter wheels equipped with Smaract motors (CE)
  - 1x XRS6 model electromagnetic mechanical vacuum shutter (fast-shutter) manufactured by Uniblitz Inc. (CE)
  - 1x Smaract wheel (CE)
  - 1x laser optics positioning device (lens) equipped with a motorised translator (CE)
  - 1x laser optics alignment device (concave flat mirror) equipped with 2 motorised translators and a kinematic support equipped with 2 piezoelectric actuators (CE)
  - 1x *Micro Channel Plate* (MCP) model.
- Instrumentation inside the WEST spectrometer chamber (1e-6 mbar) located downstream of the main experimental chamber:
- 12x Smaract motor
- Additional instrumentation on board the experimental chamber:
  - Questar QM100 telemicroscope

- 3x Schott fibre optic LED lamps (CE) + power supplies
- 2x ACE model CCD cameras, Basler (CE)
- 1x CCD camera, Axis (CE)
- 2x VCM-D1 electromechanical shutter controllers, Uniblitz (CE)
- 2x stepper motor controllers, model 8SMC3-RS232, manufactured by Standa.
- 1x S-LINK light intensity sensor, Gentec (CE)
- 1x Nanoradian Beam Steering device, manufactured by Elettra
- Mini rack on the edge of the experimental chamber
  - 1x Pfeiffer HiPACE80 pump controller (CE)
  - 1x Adixen MDP5011 pump controller
  - 2x Remote power distribution unit, APC (CE)
  - Analogue-digital acquisition card, model vt17xx., CAEN (CE)
  - 1x 0-300 V power supply, Deltaelectronika (CW)
  - 1x MCS controller for Smaract piezoelectric motors
  - 1x MCS2 controller for Smaract piezoelectric motors
  - 1x trigger and power signal distributor (8 channels) for Basler cameras
  - Patch panel for LAN network distribution
- Sample manipulator:
  - 5x stepper motors (one with electromagnetic lock) (CE)
  - 5x encoders (CE)
- Telemicroscope manipulator:
  - 3x stepper motors (CE)
  - 1x encoder (CE)
- Air pumping system consisting of:
  - 1x Edwards nEXT1230 turbomolecular pumps (CE)
  - 1x Pfeiffer HiPACE80 turbomolecular pumps (CE)
  - 1x Adixen MDP5011 turbo-drag pumps (CE)
  - 1x Edwards XDS35i scroll pumps (CE)
  - 1x Edwards XDS20i scroll pumps (CE)
  - 1x Edwards XDS10i scroll pumps (CE)
- Vacuum measurement system consisting of:
  - 1x Pfeiffer TPR018 (Pirani) sensors (CE)
  - 2x Pfeiffer IKR070 (Penning-Cold cathode) sensors (CE)
  - 1x Edwards WRG-S-14.5 WideRange sensor (CE)
- **G.4.2 Control instrumentation for the experimental station**
  - Rack RBL\_EH\_EIS
    - 2x YAMS basket for stepper motor control (made in Elettra)
  - RC\_EH\_EIS\_01-TMX rack
    - 2x diskLess PCs
    - 2x servers for experimental station control
    - 3x Ethernet switches for data traffic
    - 1x crate with Event Receiver and CAEN vt1720 acquisition card

- Rack RV\_EH\_EIS\_01
  - 1x MOXA N-port 5650-8 (CE)
  - 2x TPG 100 pressure readers, Pfeiffer (CE)
  - 1x SCU-800 turbomolecular pump controller, Edwards (CE)
  - 1x TIC model turbomolecular pump controller, Edwards. (CE)
  - 1x PLC, manufactured by Elettra
  - 4x high voltage power supply, manufactured by Elettra
- **G.4.3 Additional instrumentation**
  - VIS spectrometer
    - CCD (*Charge Coupled Device*) Newton model manufactured by Andor-Oxford Instruments PLC, and related controllers (external). (CE)
  - EUV spectrometer (WEST)
    - CCD (*Charge Coupled Device*) model Ikon-M manufactured by Andor-Oxford Instruments PLC, and related controllers (external). (CE)
    - Chiller

#### 4.4 Access to the beamline

External research personnel who wish to carry out experiments at the "TIMEX" beamline must fill in an appropriate request for access to the Elettra-Sincrotrone Trieste site on the VUO portal and pass the required security tests. Access to the beamline is granted according to specific procedures, which depend on the category and professional status of the applicant, see **Figure 2**:



**Figure 2:** types of access requests and categories of applicants

The main types of access requests are described below:

- **External users (*proposal approved by the panel*):** submission of a request on the VUO portal for access to *the* 'TIMEX' beamline at Elettra- Sincrotrone Trieste following the approval of a scientific proposal for *beamtime* by the FERMI *Proposal Review Panel*.
- **Internal users (*in-house proposals*):** submit a request for access to Elettra's "TIMEX" beamline on the VUO portal as *a participant* in an internal research *proposal*, i.e. an *in-house proposal*. This request is handled and approved by *the Users Office* of Elettra Sincrotrone Trieste.
- **Industrial users:** submit a request for access to the "TIMEX" beamline on the VUO portal as a

participant in an industrial research proposal managed through the Company's ILO (Industrial Liaison Office). The access request is handled by the ILO.

- **Collaborators and partners:** send a request to access the "TIMEX" beamline at Elettra-Sincrotrone Trieste via the VUO portal as a *collaborator* or *partner*. This request is approved by an internal "tutor", i.e. a member of the beamline *staff*, and then by *the Users Office* at Elettra Sincrotrone Trieste.
- **Students and interns, external fellows, PhD students:** send a request to the VUO portal for access to the "TIMEX" beamline at Elettra-Sincrotrone Trieste as a *student*, *intern*, *external fellow*, or *PhD student*. At the time of the request, an agreement (e.g. a *Memorandum of Understanding/Convention*) must be in place between Elettra-Sincrotrone Trieste and the institution to which the student/fellow is affiliated. The access request is approved by the Human Resources Department and by an internal tutor, in this case a member of *the beamline staff*.
- **External companies:** send a request to the Prevention and Protection Service (SPP), for example by e-mail, to carry out installations or provide services at the 'TIMEX' beamline following a supply request and the corresponding order. The contractor is required to provide and update the list of names of personnel who will be visiting the Company's site. Access will be authorised by the SPP, subject to the submission of the names of the personnel involved and the number plate of the vehicle with which access to the site will take place. In accordance with current workplace safety regulations (Legislative Decree 81/2008 and subsequent amendments and additions), any activity entrusted to the contractor must be preceded by a mutual exchange of safety documents, see: <https://www.elettra.eu/activities/spp/information-for-external-firms.html>

## 5 Safety operating instructions

This section lists the safety operating instructions relating to the main scientific and technical activities carried out at the TIMEX beamline and related experimental stations. These instructions are based on the following documents available in the company's documentation.

- **Summary risk assessment document for the *TIMEX* beamline (document code: PVAR-SCH103-rev00IT)**
- **Risk assessment form for workers at the *TIMEX* beamline (document code: PVAR-SCH104-rev00IT)**

All members of the beamline *staff* are responsible for ensuring that the activities indicated here are carried out in accordance with current regulations and in accordance with the directives issued by the Activity Manager, i.e. *the beamline coordinator*, and the *group coordinator*. Of particular importance are the provisions relating to the use of Personal Protective Equipment (PPE) described below.

With regard to the Protection and Safety Regulations governing activities in the FERMI Experimental Hall, please refer to the document 'Radiological Risk in the FERMI Experimental Hall' (document code: **RPFO-SCH-06**), and for regulations on laser sources, the document "Instructions for the use of Seed Laser Users (SLU) in the Experimental Hall" (document code: **PRSI-IOP-07**).

### 5.1 Special health conditions of workers

The performance of certain work activities described below may be incompatible with particular physical or medical conditions. Please promptly notify the beamline coordinator or supervisor of any limitations that may arise.

In the specific case of pregnancy, it is recommended that only office-related activities (described in

point 5.2) be carried out, i.e. activities at a video terminal and, in particular, data acquisition or analysis operations. Particular attention should be paid to taking breaks.

Pregnant or postpartum workers must absolutely refrain from performing activities on the line that expose them to electrical, chemical or radiological risks or that involve the risk of injury or physical exertion. Please refer to the procedure '**Pregnant and postpartum workers. Protection from health risks in the workplace**' (document code: PVAR-IOP-01).

## **5.2 Activities at video terminals (data acquisition and analysis, etc.)**

*Task description:* all work activities that require the use of *personal computers* or *workstations*, and in particular:

- data acquisition;
- data analysis;
- *software* development;
- CAD design;
- document preparation, e.g. scientific articles, *e-mail* correspondence, etc.

*Associated risks:*

- requires particular visual attention when performing the task;
- no PPE is required; current legislation requires a 15-minute break every 120 minutes of continuous activity;
- adequate training must be provided;
- repetitive movements, fixed postures, uncomfortable positions. Damage to the musculoskeletal system is possible. The following is required:
- maintain an ergonomically correct posture;

During night-time and weekend data acquisition activities, conditions may arise that are attributable to the situation of a 'lone worker', with no or limited ability to alert emergency services. In these circumstances, it is recommended that:

- Notify the FERMI Control Room (internal telephone: 8800) at the beginning and end of solo operations.
- Establish contact with the FERMI Control Room via video terminal using the 'Zoom' application, available on the experimental station workstations, using the following link: <https://zoom.us/j/7260842412?pwd=ZGVrL2U4OFVNeGxUbk5zbzVjb3NPQT09>.
- In the case of external research personnel (i.e. external users, collaborators, fellows, interns), it is recommended not to operate in 'isolated worker' conditions.

Work at video terminals may be carried out by the following categories of workers:

- line research staff;
- photon transport support research staff (PADReS group).
- laser support research staff (Laser group).
- external research staff;
- line technical personnel.

Please note:

- *users, collaborators, fellows, students and trainees may only carry out data acquisition activities (i.e. active and independent use of the experimental station's equipment) after adequate training by the line staff. Damage to the equipment is possible and may therefore have a negative impact on the outcome of the experiment in progress. The Company reserves the right to claim compensation for damages suffered in the event of negligent or irresponsible conduct.*
- *Data acquisition should not be confused with manual operation of the experimental apparatus, which requires greater training and experience and may involve risks for the operator. As stated in section (5.2), users, collaborators, fellows, students and trainees may not work independently on the optical tables of the experimental station, nor may they independently remove any covers, window caps or laser protection fabric covers from the experimental station when the SLU laser shutter is open.*

### **5.3 Installation, alignment and removal of laser optical set-ups on the optical table of the experimental station**

*Task description:* work activities involving the installation, alignment and removal of laser optical setups for time-resolved experiments on the optical table of the experimental station, such as:

- Installation of non-linear generation systems for higher harmonics, e.g. second or third harmonics, of the fundamental radiation of the SLU laser.
- Installation of temporary diagnostics of the spectral properties and pulse duration of the optical laser.
- Installation of non-linear parametric amplifiers, aimed at generating wavelengths in the range from mid-infrared to ultraviolet through non-linear optical processes.
- Alignment of optical *set-ups* inside optical tables and/or experimental chambers.

*Associated risks:* Exposure to non-ionising radiation from the FERMI SLU laser. Reflected laser light may accidentally be focused on the retina. The following requirements must be observed:

- The guidelines for laser operators (**PRSI-LNG-02**) and the provisions for putting the FERMI experimental room into 'Laser Maintenance' mode (**PRSI-IOP-06**) must be strictly observed.
- The use of laser safety goggles appropriate for the wavelength of the radiation being used is mandatory for all those present in the experimental room. This PPE is located in the filing cabinet at the entrance to the laser-controlled area in the FERMI experimental room.
- For those working on the optical table, it is recommended to assume an elevated position with respect to the laser beam, using the special platform fixed to the long side of the optical table.
- For those working on the optical table, it is recommended to remove any potentially reflective surfaces from hands, arms and forearms, such as watches, rings, bracelets and pendants.
- If necessary, place screens and veils to mitigate the risk of the beam escaping to the outside.
- Once the operation is complete, check the integrity of the protective casing and restore safety conditions.

The activity can be carried out by the following categories of workers:

- laser support research personnel (Laser group).

- Line research personnel authorised to perform 'Laser Maintenance' – the list of authorised personnel can be found in the following company document (**PRSI-SCH-17**);

Please note:

- *Users, collaborators, fellows, students and interns **ARE NOT AUTHORISED** to carry out this type of activity.*

#### **5.4 Use of laser optical set-ups on the optical table of the experimental station for time-resolved measurements**

*Task description:* work activities involving the use by line research staff, users, collaborators, fellows, students and trainees of a laser optical set-up for time-resolved experiments with equipment confined in a segregated enclosure with class 1 laser emission.

Under these conditions, there are no particular individual laser protections to be adopted; please refer to the general precautions set out in the following guidelines:

- Guidelines for laser users (**PRSI-LNG-03**).
- Instructions for the use of the Seed Laser Users (SLU) in the Experimental Hall (**PRSI-IOP-07**).

In particular, please note:

- Before starting an experimental activity and/or after laser maintenance, the operator or person in charge is required to check the integrity of the non-interlocked optical confinement devices (with particular attention to caps on viewports, movable screens and fabric protections).
- In the event of a brief temporary absence from the experimental station, those leaving the laser confined within hermetically sealed optical tables must ensure that there are no precursors of damage in the experiment (e.g. combustion, spillage of materials or liquids, inadequate cables, uncertain assemblies, etc.) and that the equipment guards are closed, checking for the absence of free beams.
- In the event of unattended operation, to allow experiments to be carried out remotely, or the acquisition of long scans, during which the physical presence of the Operator or Supervisor is not necessary, before leaving the experimental station with an SLU experiment in progress, the Operator or Supervisor must send an email to the lists [fermi-laser-maintenance@elettra.eu](mailto:fermi-laser-maintenance@elettra.eu) and, for information, to [operatori@elettra.eu](mailto:operatori@elettra.eu) reporting the situation. The experimental station concerned must be indicated. An email to the same lists at the end of the unattended operation signals the end of this mode.
- Removing/tampering with the integrity of laser safety guards, in particular for non-interlocked optical confinement devices (with particular attention to caps on viewports, movable screens and fabric guards) is prohibited.
- Visual inspection of the sample holder area by removing the protective caps on the viewports of the experimental station without first closing the laser safety shutter of the beamline is prohibited.

The activity may be carried out by the following categories of workers:

- line research personnel;
- photon transport support research personnel (PADReS group).
- laser support research staff (Laser group).
- external research personnel;

Please note:

- *users, collaborators, fellows, students and trainees may only carry out this type of activity after receiving adequate training and authorisation from the line personnel responsible for safety. The instructions received must be followed scrupulously.*

## 5.5 Installation, use and removal of high-voltage equipment

*Task description:* work activities involving the installation and use of scientific instruments whose internal parts can reach voltages exceeding 500 V up to several thousand volts, for example:

- Penning pressure sensors;
- time-of-flight (TOF) spectrometers;
- Micro Channel Plate (MCP) detectors;

*Associated risks:* electrocution. The following requirements must be followed:

- consult the manuals and follow the installation instructions carefully, paying particular attention to the type of connection;
- check the integrity of the controller-instrument cabling before installation;
- do not exceed the maximum permissible curvature of the power cables;
- connect and disconnect the instrument only when the power supply is switched off;
- follow the instructions for the correct earthing of the instrument and its controller.

The activities described above can be carried out by the following categories of workers:

- line research personnel;
- external research personnel;
- line technical personnel;
- maintenance personnel (electrical, electronic, IT and vacuum technicians).

Please note:

- *users, collaborators, fellows, students and trainees may only carry out this type of activity after receiving adequate training and authorisation from the line personnel responsible for safety. The instructions received must be followed scrupulously.*

## 5.6 Installation, use and removal of low-voltage equipment

*Task description:* installation, use and removal of scientific equipment operating at low voltage (< 50 V). In some cases, high currents (\*) of up to 10 A may be present. Here are some examples:

- capacitive pressure sensors;
- Pirani pressure sensors;
- bipolar power supplies for electromagnets;
- stepper and/or piezoelectric motors;
- inspection cameras;
- CCD and/or CMOS detectors;
- Oscilloscopes, picoammeters, low-voltage waveform generators;

*Associated risks:* burns. Possible explosion due to electric arcing caused by accidental interruption of the electrical circuit. The following instructions must be followed:

- consult the manuals and follow the installation instructions carefully, paying particular attention to the type of connection;
- check the integrity of the controller-instrument wiring before installation;
- connect and disconnect the instrument only when the power supply is off, making sure that no current is passing through the cable connecting the controller to the instrument;
- pay particular attention to connections between laboratory cables with banana

connectors.

The activities described above can be carried out by the following categories of workers:

- line research personnel;
- photon transport support research personnel (PADReS group).
- laser support research personnel (Laser group).
- line technical personnel;
- maintenance personnel (electrical, electronic, IT and vacuum technicians)

Please note:

- *users, collaborators, fellows, students and trainees may only carry out this type of activity after receiving adequate training and authorisation from the line personnel responsible for safety. The instructions received must be followed scrupulously.*

### **5.7 Minor repairs to electronic equipment**

*Task description:* replacement of damaged electronic components, such as fuses or capacitors, or replacement of entire electronic boards:

*Associated risks:* electrocution. The following requirements must be followed:

- before carrying out the repair, consult the manuals and follow the instructions contained therein scrupulously. Contact the manufacturer if in doubt;
- always disconnect the device from the power supply before working on it;
- always pay attention to the residual charge of the capacitors, as it persists even after the instrument has been switched off. Wait long enough for the capacitors to discharge completely;
- if using a soldering iron, choose a suitable workstation. The use of a soldering iron involves a fire hazard. Remove flammable objects from the work table. Switch off the soldering iron immediately after completing the repair;
- After completing the repair, inform the line coordinator and agree on the tests to be performed.

Repairs to electronic equipment may be carried out by the following categories of personnel:

- line research personnel;
- photon transport support research personnel (PADReS group);
- laser support research personnel (Laser group);
- line technical personnel;
- maintenance personnel (electrical, electronic, IT and vacuum technicians).

Please note:

- *Users, collaborators, fellows, students and trainees **are NOT AUTHORISED** to carry out this type of activity.*

### **5.8 Routine or extraordinary maintenance work on the racks and controls of the end station**

*Task description:* repair/replacement of instruments (e.g. controllers and power supplies) installed in the control racks of the beamline or experimental station, or repair/replacement of signal or serial/Ethernet communication cables.

*Associated risks:* electrocution. The following requirements must be observed:

- strictly comply with electrical safety regulations
- take into account the information provided in Sections 5.5, 5.6 and 5.7.
- before installing or repairing any equipment, consult the manuals and strictly follow the instructions contained therein. Contact the manufacturer if in doubt;
- always disconnect the device from the power supply before working on it; if necessary, disconnect the power supply to the rack;
- Always pay attention to the residual charge of the capacitors, as it persists even after the instrument has been switched off. Wait long enough for the capacitors to discharge completely.
- be careful not to damage the cables of other instruments, especially those carrying high voltage (pressure sensors, ion pump power supply); if necessary, switch off these instruments and move or remove their cables;
- After completing the repair, inform the beamline coordinator and agree on the tests to be performed.

Repairs to electronic equipment may be carried out by the following categories of personnel:

- line research personnel;
- photon transport support research personnel (PADReS group);
- laser support research personnel (Laser group);
- line technical personnel;
- maintenance personnel (electrical, electronic, IT and vacuum technicians).

Please note:

- *users, collaborators, scholarship holders, students and interns* **ARE NOT AUTHORISED** to carry out this type of activity.

### **5.9 Routine and extraordinary electrical maintenance work**

*Task description:* routine maintenance operations on the power line, for example:

- electrical repairs in racks or on electrical distribution panels;
- installation/repair of electrical sockets or outlets;
- maintenance of electrical panels, testing of the correct functioning of circuit breakers.

*Associated risk:* electrocution. The following requirements must be followed:

- strictly comply with electrical safety regulations;
- read the recommendations in document **PVAR-SCH-07**.

Maintenance activities may only be carried out by the following categories of workers:

- maintenance technicians (electrical and electronic technicians from the Infrastructure Group);

Please note:

- *all other job categories* **are NOT AUTHORISED** to carry out this type of activity.

### **5.10 Installation/removal of heavy or bulky equipment**

*Description:* these are activities that must be carried out with the support of personnel assigned to handling. Typically, this involves the transport, installation or removal of bulky or heavy parts of the instrumentation of the beamlines or their experimental stations, for example:

- vacuum chambers;
- manipulators;
- scientific instruments of significant weight and size;
- ion or turbo-molecular pumps of significant weight and size;

*Associated risks:* manual handling of loads, collisions, blows, impacts. The following requirements must be followed:

- agree a plan for safe assembly/disassembly with the beamline coordinator;
- request the assistance of personnel assigned to handling;
- always use the overhead crane to lift heavy chambers and objects. If it is not possible to use the overhead crane, use a 'goat' type lift;
- work in pairs to reduce the load and the corresponding effort;
- always wear the prescribed PPE:
- protective gloves, e.g. leather gloves or cut-resistant gloves;
- safety footwear;
- protective helmet (only when using a bridge crane).

The work activities described in this section may be carried out by the following categories of workers:

- line research personnel;
- photon transport support research personnel (PADReS group);
- line technical personnel;
- handlers.

Please note:

- *users, collaborators, fellows, students and trainees* **are NOT AUTHORISED** to carry out this type of activity.

### **5.11 Installation/removal of vacuum equipment and instrumentation**

*Task description:* installation or removal of parts of the instrumentation of the beamlines or corresponding experimental stations, without the use of the bridge crane and without the support of the personnel assigned to handling. By way of example, this involves performing the following tasks:

- installation or removal of scientific instruments (weighing up to 20 kg), ion or turbo-molecular pumps, diaphragm or membrane pumps;
- installation or removal of small or medium-sized vacuum instruments (weighing up to 20 kg);
- assembly or disassembly of various instruments, such as manipulators (weighing up to 20 kg);
- assembly or disassembly of motorised translators and/or CCD and CMOS detectors (weighing up to 20 kg);
- installation or removal of equipment in *racks* (weighing up to 20 kg);

*Associated risk:*

- manual handling of loads. The following requirements must be followed:

- work in pairs to reduce the load and the corresponding effort;
- bumps, blows, impacts. It is recommended to:
  - wear the following PPE: protective gloves, e.g. leather gloves or cut-resistant gloves.
- Slips, falls on level ground, trips. We recommend:
  - keep the floor free of sharp objects, highlight any obstacles.

Precautions:

- During the wiring phase of motorised transmitters and/or detectors, it is recommended to carry out the operation by switching off the power supply and/or instrument controller.

These work activities can be carried out by the following categories of workers:

- line research personnel;
- photon transport support research personnel (PADReS group).
- external research personnel;
- line technical personnel;
- maintenance personnel (electrical, electronic, IT and vacuum technicians)

Please note:

- *users, collaborators, fellows, students and trainees may only carry out this type of activity after receiving adequate training and authorisation from the line personnel responsible for safety. The instructions received must be followed scrupulously.*

### **5.12 Minor maintenance work on vacuum chambers**

*Task description:* routine maintenance of vacuum chambers and/or their vacuum components, for example:

- installation/removal or assembly/disassembly of instrumentation or parts and components of vacuum systems, e.g. *gate valves, leak valves*, linear manipulators (*z-translators*), pressure sensors, vacuum motors;
- opening/closing flanges to allow repairs and routine maintenance operations inside the vacuum systems of the beamline or experimental stations;

*Associated risk:*

- collisions, blows, impacts;
  - no requirements or use of PPE
- Slips, falls on level ground, trips. It is recommended to:
  - keep the floor free of sharp objects, highlight any obstacles.

Maintenance activities may be carried out by the following categories of workers:

- line search personnel;
- external search personnel;
- line technical personnel;

Please note:

- *users, collaborators, scholarship holders, students and trainees may only carry out this type of activity after receiving adequate training and authorisation from the line personnel responsible for safety. The instructions received must be followed scrupulously.*

### 5.13 Minor fluid-mechanical maintenance

*Task description:* plumbing installations or repairs, for example:

- repairs of water leaks;
- Installation or replacement of taps, rigid pipes, flexible pipes and flow switches.

*Associated risk:* bumps, blows, impacts.

- Please refer to the recommendations in documents **PVAR-SCH-09** and **PVAR-SCH-19**.

*Associated risk:* electrical risk, electrocution.

- Please refer to the recommendations in document **PVAR-SCH-07** and **Section 6.3**.

Maintenance activities may be performed by the following categories of workers:

- maintenance technicians (mechanical-fluid technicians from the Infrastructure group)

Please note: *all other job categories are NOT AUTHORISED to carry out this type of activity.*

### 5.14 Work at height on ducts or vacuum chambers

*Task description:* operations performed at height on ladders or scaffolding, such as:

- laying or removing cables on channels;
- maintenance operations on internal or external parts (e.g. manipulators) of the vacuum chambers of the light line.

*Associated risk:* slipping or falling from elevated positions. The following requirements must be followed:

- where possible, always use a harness and secure it to solid supports;
- work in pairs; one of the two must hold the ladder firmly.

Activities related to working at height may be carried out by the following categories of workers:

- technical line personnel.
- maintenance personnel (electrical, electronic and IT technicians)

Please note:

- *line research personnel, users, collaborators, fellows, students and trainees are NOT AUTHORISED to carry out this type of activity. Beamline personnel may assist technical personnel.*

## 5.15 Cleaning of vacuum components and tools

*Task description:* these are operations carried out during routine or extraordinary maintenance of vacuum chambers and/or their parts and components:

- cleaning of small metal parts, such as sample holders, manipulators, and sensors. Cleaning is carried out by immersion in ethyl alcohol or acetone;
- cleaning of tools used for the assembly/disassembly of parts in ultra-high vacuum;
- removal of material by filing or sanding, resulting in the formation of metal dust.

*Associated risks:*

- inhalation of gases or vapours. The following requirements must be observed:
  - avoid prolonged exposure to acetone vapours; if necessary, work under a fume hood;
  - wear latex gloves;
- inhalation of dust or fibres. The following precautions must be taken:
  - work under a fume hood;
  - wear latex gloves and a lab coat;
  - wear an FFP2 or FFP3 mask during all material removal operations.

Activities related to the cleaning of components and parts to be used in ultra-high vacuum can be carried out by the following categories of workers:

- line research personnel;
- photon transport support research personnel (PADReS group).
- external research personnel;
- line technical personnel.

Please note:

- users, collaborators, fellows, students and trainees may *only* carry out this type of activity *after receiving adequate training and authorisation from the line personnel responsible for safety.* The instructions received must be followed scrupulously.

## 5.16 Maintenance of primary pumps

*Task description:* this is a routine maintenance operation, typically carried out once every one or two years, necessary to restore the pumping capacity of *scroll*, diaphragm or membrane pumps. The seals/membranes are replaced and mechanical cleaning is carried out using brushes, vacuum cleaners and damp cloths.

*Associated risks:* inhalation of dust. The following instructions must be followed:

- consult the manual supplied with the pump maintenance kit. Follow the manufacturer's recommended instructions;
- work under a hood or outdoors;
- wear latex gloves;
- wear an FFP2 or FFP3 mask throughout the cleaning operation.

Work relating to the cleaning of primary pumps may be carried out by the following categories of workers:

- line technical personnel;
- vacuum maintenance technicians;

Please note:

- *Line research personnel may assist technical personnel. Users, collaborators, fellows, students and trainees are **NOT AUTHORISED** to carry out this type of activity.*

### 5.17 Preparation of samples with powders

*Task description:* powders or nanoparticles are deposited on metal or semiconductor samples, for example by *spin coating* or pressure bonding.

*Associated risks:* inhalation of powders and/or fibres. The following requirements must be followed:

- consult the User Support Laboratory Safety Procedure (**GSLA-PRO-03**);
- consult the chemical risk sheet for the substance and take the necessary precautions;
- carry out preparations in the Support Laboratory, always working under a fume hood;
- wear the prescribed PPE: chemistry lab coat, latex gloves, protective goggles, FFP2 or FFP3 mask throughout the preparation process.

The preparation of samples with powders can be carried out by the following work categories:

- line research personnel;

Please note:

- *users, collaborators, fellows, students and trainees may only carry out this type of activity after receiving adequate training and authorisation from the line personnel responsible for safety. The instructions received must be followed scrupulously.*

### 5.18 Assembly and insertion of samples into the experimental chamber and in experiments involving the use of FERMI's optical laser (SLU)

*Task description:* mounting samples in the chamber for experiments involving time-resolved measurements and the use of FERMI's optical laser (SLU).

*Associated risks:*

- inhalation of dust and fibres. The following requirements must be followed:
  - consult the chemical risk sheet for the substance(s) that make up the sample and take the necessary precautions;
  - Use latex gloves; if necessary, wear an FFP2 or FFP3 mask;
- Repetitive movements, uncomfortable workstations. Temporary adoption of awkward postures can cause musculoskeletal disorders.
- Exposure to non-ionising radiation from the FERMI SLU laser. Reflected laser light may accidentally be focused on the retina; it is mandatory to wear the following PPE: LASER safety glasses.

The following instructions must be followed:

- Before replacing the sample and removing the opaque screens placed on the windows of the experimental chamber, ensure that the SLU laser transport shutter is in the closed position, inhibiting the transport of the laser to the optical coupling table of the experimental station.

- During the pumping phase of the experimental station, before reactivating the SLU laser transport on the optical table of the experimental station, ensure that the opaque laser protection screens have been repositioned on the windows of the experimental chamber.

Sample assembly can be carried out by the following categories of personnel:

- line research personnel;

Please note:

- *External research personnel, i.e. users, collaborators, fellows, students and trainees, **are NOT AUTHORISED** to carry out this type of activity.*
- *Laser safety glasses are located in the filing cabinet near the entrance to the controlled access area. Copies of the keys to the filing cabinet are kept in the key cabinet of the experimental station in position No. 12.*

### **5.19 Assembly and insertion of samples into the experimental chamber in experiments that do NOT involve the use of the FERMI optical laser (SLU)**

*Task description:* mounting samples in the chamber for experiments that **do not** involve the use of the FERMI optical laser (SLU).

*Associated risks:*

- inhalation of dust and fibres. The following requirements must be followed:
  - consult the chemical risk sheet for the substance(s) that make up the sample and take the necessary precautions;
  - use latex gloves; if necessary, wear an FFP2 or FFP3 mask;
- repetitive movements, uncomfortable workstations. Temporary adoption of awkward postures may cause musculoskeletal disorders. No special requirements are envisaged.

*Precautions:*

- In the event of prolonged absence from the FERMI experimental room, for example during the pumping phase after sample replacement and/or for automatic acquisitions during the night, it is advisable to inform the FERMI Control Room (internal telephone 8800).

Sample assembly can be carried out by the following categories of workers:

- line research personnel;
- external research personnel.

Please note:

- *External research personnel, i.e. users, collaborators, fellows, students and trainees, may assemble and insert samples into the experimental chambers only after receiving adequate training and authorisation from the safety officer. The instructions received must be followed scrupulously. Significant damage to the equipment may occur if the experimental apparatus is unintentionally returned to the air. The Company reserves the right to claim compensation for damages incurred in the event of negligent or irresponsible conduct.*

## 6 Electrical Safety Regulations

The electrical and electronic equipment in operation at the experimental stations of the beamline exposes operators to electrical hazards. This risk can be reduced by complying with current regulations and following the guidelines and prohibitions set out below:

### 6.1 Recommended electrical safety guidelines

- Comply with safety signs and related provisions.
- Ensure that the electrical system or equipment has the necessary approvals and certifications, consulting the competent personnel if necessary.
- Check the location of the electrical panel that supplies the area in which you are working so that you can quickly disconnect the power supply if necessary.
- Use electrical systems in accordance with their intended use and the relevant user manuals.
- Ensure that the power cables of electrical appliances are adequately protected from mechanical damage (people walking over them, sharp objects, etc.), thermal damage (heat sources) or chemical damage (corrosive substances).
- Ensure that the power supply has been disconnected before carrying out any simple operations on the systems (including replacing a light bulb) or on the equipment.
- Always ensure that the electrical system is disconnected (after operating the appropriate switch) before unplugging the plug.
- Disconnect the equipment from the power source before starting periodic cleaning.
- Connect the equipment to the nearest socket, avoiding the use of extension cords as much as possible.
- Do not overload sockets with too many electrical appliances, always checking that the total current load does not exceed the limits of the socket itself.
- The only multiple adapters permitted by regulations are those with only two side sockets. The other type, with a third socket parallel to the pins, is considered dangerous because it allows multiple sockets to be connected in series.
- German-type plugs (Schuko) can only be inserted into Italian-type sockets using an adapter that transfers the earth connection made via the side plates to a central plug. It is strictly forbidden to force Schuko plugs into Italian sockets.
- Avoid subjecting all parts of the electrical system to mechanical action or impact (passing trolleys, etc.).
- When using extension cords, they must be completely unwound to prevent overheating. The capacity of the wound cable is reduced. The capacity of the cable, which must be indicated, must always be respected.
- Do not pull on the power cable to disconnect an electrical appliance from the socket; use the plug instead.
- Do not tamper with electrical equipment (for any requirement, the intervention of qualified personnel must be requested in accordance with company procedures).

### 6.2 Prohibitions

- Tampering with electrical equipment is prohibited.

- Prohibition on installing or using private electrical equipment or materials.
- Prohibition on intervening in the event of a fault on switchboards or electrical panels.
- Prohibition on covering or concealing controls and electrical panels with cabinets or other furnishings (to allow for inspection and timely intervention in the event of anomalies).
- Prohibition on removing electrical cable protection channels.
- Prohibition on overloading power sockets with too many electrical appliances, using adapters or multiple sockets.
- Prohibition on storing flammable substances near appliances.
- Do not place containers filled with liquids on the appliances.
- Do not expose appliances to excessive radiation or heat sources.
- Do not obstruct the proper ventilation of the appliances by covering the ventilation openings.
- Do not touch systems and/or appliances with wet hands or shoes.
- Do not use water to extinguish electrical fires.

### **6.3 What to do in the event of water leaks**

The turbomolecular pumps used at the experimental station require cooling water. This water is demineralised and therefore non-conductive.

Given the presence of high voltage in many pieces of equipment, the risk of electric shock cannot be completely ruled out. For this reason, it is important to avoid putting yourself or others in danger. The following recommendations must be followed:

1. Consult the beamline safety officer, if on site.
2. Do not rush or panic.
3. Avoid walking on wet areas.
4. Avoid touching wet areas with your hands.
5. Prevent flooding by immediately closing the cooling circuit that is leaking.
6. DO NOT dry wet areas with paper or rags unless the power supply to all racks and utilities has been completely shut down. Cordon off the area to prevent unauthorised access.

## 7 Emergency management

Various emergencies of varying severity may occur on the light line. They must be managed in accordance with the company's Emergency Plan (see procedure GEEM-PRO-02-rev03IT).

