



Operational Instruction

Safety Instructions IUVS Offline Temporary Operating Mode

Membership process: PRSI – Proceed safely

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0.1 Document issuance

This document has followed the following formalization process:

RevNR	Review Notes	Editing:	Date appr.ne	editor
		Validation:	date appr.ne	Process Owner/Stakeholder
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Editing

Validation

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Approval



1 Purpose

The document contains information on the main scientific and technical activities carried out at the "Inelastic UltraViolet Scattering Offline" facility (abbreviated name "IUVS Offline") at Elettra – Sincrotrone Trieste S.C.p.A. ("Elettra Sincrotrone Trieste" or "Company") and a series of *Operating Instructions* needed to perform these activities safely.

This document can be downloaded directly from the offline facility website:

<https://www.elettra.eu/it/lightsources/elettra/elettra-beamlines/iuvs/safety.html>

For anything not expressly considered in this document, reference is made to the laws and regulations in force, and in particular to [LEGISLATIVE DECREE no. 81 of 9 April 2008](#).

2 Person in charge of safety

The responsibility for the safety of workers working at the "IUVS offline" facility lies with the following subjects:

- The *Security Officers* of the offline facility. They are the facility coordinator, i.e. the person responsible for the activity, the researchers and staff of the facility, as well as, in some cases, postdocs and other personnel identified on the basis of specific agreements. In addition, the coordinator and members of the laser support team. The supervisors supervise the various activities carried out in the laboratory, ensuring the implementation of the employer's directives and giving instructions for their correct execution. The list of the Company's security officers can be downloaded from the following link:

https://vuo.elettra.trieste.it/pls/vuo/amm_people.safety_org_chart.printout

- The *Safety Managers*, in the persons of the *Group Coordinators* of the beamlines, the offline user-facilities and of the SPEED and IDEAS laboratories, organise the work activities of each Group and supervise its 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 the facility security officers*

The person in charge of the security of the offline facility must ensure that workers (including users, collaborators, students, trainees, etc.) use the prescribed protective equipment and follow all the safety regulations.

In the absence of the person in charge, this responsibility is fulfilled by the latter through the prior information and training of workers and the provision of safety procedures and instructions.

3 Categories of workers of the offline IUVS facility

Subject to appropriate training, the following categories of workers are allowed to work at the IUVS facility offline:

- Research staff, i.e. the offline facility manager, researchers, and *postdocs*;
- Technical staff of the offline facility and of the laser group;
 - ❖ The names and contact information of the designated research and technical personnel of the Company can be found on the following web page:
<https://www.elettra.eu/lightsources/elettra/elettra-beamlines/iuvs/contacts-test-unpublished.html>
- External research personnel, and in particular users, collaborators, scholarship holders from other institutions, doctoral students, degree students and trainees, industrial users;
- Maintenance personnel: electrical-electronic technical staff, IT-designer staff, mechanical-fluidistic technical staff; technical staff of the Mechanics, Vacuum and Optics group.
- Handling operators.

Every worker is responsible for taking care of his or her own health and safety and that of other persons present in the workplace who are affected by his or her actions or omissions, in accordance with his or her training, instructions and means provided by the employer.

3.1 General safety prescriptions and training

Each job category is required to complete the prescribed training courses for the specific activities of the job assignment, made available through the Virtual Unified Office (VUO) system. All are encouraged to consult **Elettra's Risk Assessment Document** (document code: **PVAR-MAN-01**). In addition, electrical maintenance workers should take notice of the recommendations in the **PVAR-SCH-07** document, electrical-electronic technicians of those in the **PVAR-SCH-16** document, mechanic-fluidistic technicians of those in the **PVAR-SCH-09** e the **PVAR-SCH-19** documents. Administrative-informatics-project staff should take notice of the information provided in the **PVAR-SCH-03** document.

Important note: *it is beyond the scope of this document to report in detail on the safety requirements of electrical maintenance workers called upon to carry out routine and extraordinary maintenance operations on distribution electrical panels, or repair interventions on electrical sockets or similar devices, as there are risk assessment documents and specific safety instructions related to their activities. It is strictly prohibited for scientific and technical personnel, as well as external researchers, to engage in any work activities involving electrical installations.*

4 The IUVS Offline facility

The IUVS Offline facility, hereinafter also referred to as the IUVS Offline laboratory, is located inside the "ES4" building and occupies the two adjacent rooms PT09 and PT10 (see **Fig. 4.1**). Room PT09

is mainly used as a **control room (SC)**. In this space there are two work tables dedicated to the preparation and assembly of samples, as well as a workstation where it is possible to carry out data acquisition and data analysis processes during the experiments. Finally, a service cabinet/technical compartment is placed against the wall separating the ESPT09 and ESPT10 rooms (Fig. 4.1). Figure 4.1 also shows the cabinets/shelving, delimited by gray rectangles. The removal of the materials contained therein is allowed after consultation with the line staff.

Access to the **SC** is granted by key to Elettra staff of the IUVS offline laboratory and the Laser Group as well as to users and collaborators while experiments are performed, subject to the authorization of the line staff. In **SC**, users will be able to follow the experiments running on the S1 and S2 experimental stations, by using the "S&I Vista control" software. For its use, refer to the "Vista control manual".

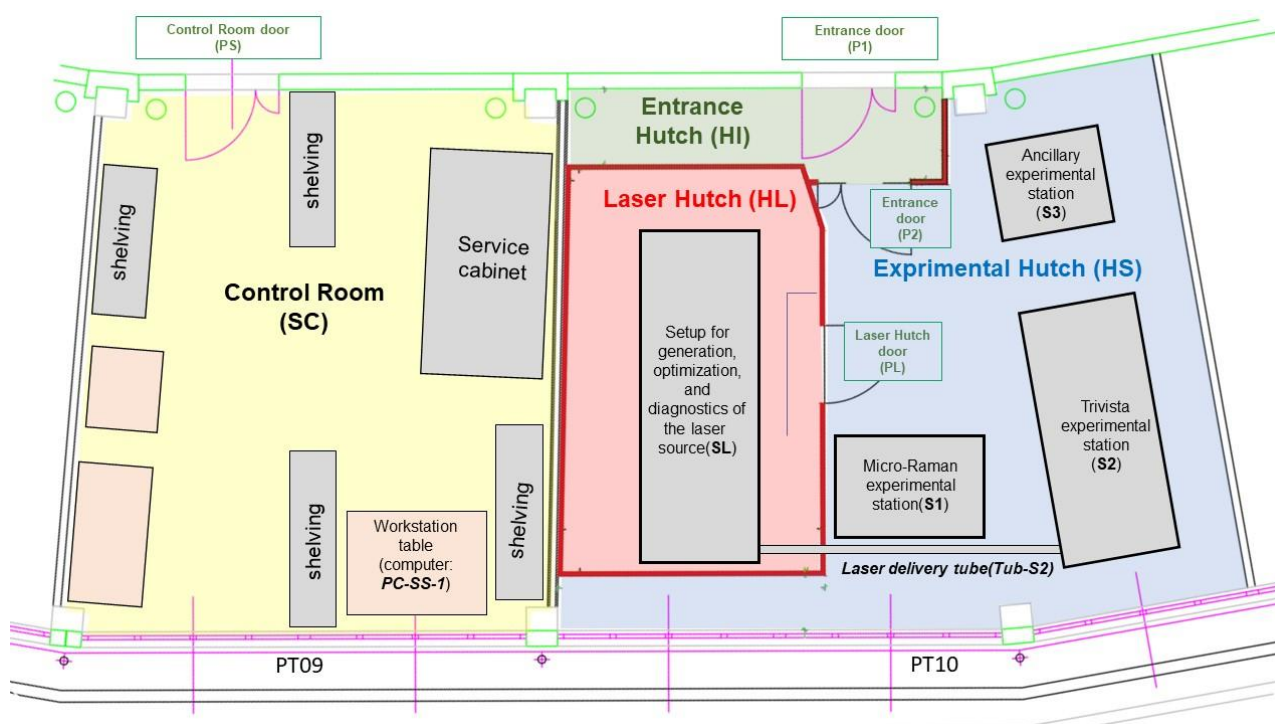


Figure 4.1: Complete layout of the IUVS Offline laboratory located in the ES4PT09 and ESPT10 rooms

Room PT10 is divided into three areas:

- Entrance Hutch (**HI**)
- Experimental Hutch (**HS**)
- Laser Hutch (**HL**)

The function of each of the rooms, the descriptions of the experimental stations housed in them (S1-S3) and the laser sources that can power them will be provided in the following paragraphs.

Access to the rooms of room PT10 depends on the operating status of the facility.

The current operating status of the offline IUVS facility is a temporary state (in force until



the Personal Safety System, currently being installed, is tested).

More details on the transient operating status can be found in Annex 1.

HI is a transit room to access the experimental setups housed in HS, equipped with a double entrance door (P1 and P2), as shown in Figure 1. In this temporary phase, door P1, which leads to the experimental corridor of the Elettra experimental room, has no handle and access occurs only by means of key. An emergency key is placed on the outer jamb of the door, as shown in Figure 4.2, and the red light indicating "laser danger" is always on.

For the current state of transitional operation, the workers authorized to access HI&HS and HI&HS&HL are listed as second and first level operators respectively in Annex 2.

4.1 Scientific activity of the line, sources and experimental stations

The IUVS Offline facility is dedicated to experiments of inelastic light scattering in the near-deep UV range, with three experimental stations mainly dedicated to the collection of UV Raman Resonant spectra, both in macro and micro modes, with variable excitation in the range of near and deep UV (from about 190 to 450 nm) provided by two complementary tunable lasers in the deep ultraviolet region called Laser 1 and Laser 2, as well as three laser sources with fixed energy emission at 213, 224 and 266 nm.

The lasers mentioned above are class IIIB or IV.

4.1.1 Tunable Laser 1 and Laser 2 Sources

The two tunable laser sources with deep UV emission are both placed in HL, access to which is allowed only to first-level operators as per Annex 2. The two laser sources are positioned on a single optical table inside the hutch and have the following characteristics:

- **Laser 1:** ASCEND 40 pump laser (Spectra Physics) diodes and duplicate to obtain output wavelength in the green at 527 nm + Ti:Sapphire CREDO-TISA laser + Harmonic generation modules for pulse generation in the range 230 - 317 nm with THG and 206 - 237 nm with FHG + WS-CREDO unit (Sirah Lasertechnik) which allows to separate harmonics from fundamental, includes 4 Pellin-Broca prisms + Mixing Unit (Sirah Lasertechnik) between fundamental and third harmonic for wavelength generation in the DUV, range 193-206 nm, minimum powers generated in the ranges of interest: 194-205 nm: $P_{av} \geq 0.5$ mW @ 194 nm, $P_{av} \geq 3$ mW @ 205 nm, 206 - 216 nm: $P_{av} \geq 8$ mW, 217 - 230 nm: $P_{av} \geq 25$ mW, 230 - 315 nm: $P_{av} \geq 40$ mW,
- **Laser 2:** Millennia eV 15 pump laser (Spectra Physics): Solid-state CW emission laser pumped by diodes and duplicated to obtain emission wavelength in the green at 532 nm + Ti:Sapphire Tsunami 3950C-15HP laser (Spectra Physics) + UHG harmonic generation unit (Spectra Physics) to obtain emission in the range of interest 210 - 300 nm

The beam emitted by the two lasers is brought up to the chambers of the experimental stations S1 and S2, by means of a shielded transport system, that from HL reaches the optical tables of the shielded cabinet covering the experimental stations S1 and S2 (see Fig. 4.1).

The experimental station S1 can also operate with laser sources other than laser 1 and laser 2, located on the HS optical table, as better specified in paragraph 4.1.2.

All the instrumentation housed on the optical tables of the experimental stations is enclosed inside appropriate cabinets used for shielding laser radiation.



Experimental Station S3 includes a portable UV Raman instrument equipped with a proper internal 248 nm laser source and with an independent sample housing shielding system. More details are provided in paragraph 4.1.4.

In **HS** of IUVS offline are performed the experiments of external users approved by both the Proposal Review Panel of Elettra Sincrotrone Trieste and that of CERIC-ERIC, together with other internal and collaborative research activities.

4.1.2 Non-tunable laser sources

The non-tunable lasers of the offline IUVS facility of the experimental station S1 are listed below:

- Laser with emission at 266 nm (Diode Pumped Passively Q-Switched Solid State 266 nm, laser classification 4 / IV) (CE), hereinafter referred to as Laser-266.
- Laser with emission at 213 nm (Diode Pumped Passively Q-Switched Solid State Laser 213 nm, laser classification 4 / IV) (CE), hereinafter referred to as Laser-213.
- Laser with emission at 224 nm (HeAg lasers @ 224.3nm Class IIIb laser product) (CE), hereinafter referred to as Laser-224.

The non-tunable laser of the offline IUVS facility placed in the S3 experimental station is the one listed below:

- Photon system NeCu laser 248.6 nm, class 3B, working at 8 uJ @ 40 Hz

4.1.3 Experimental Station 1

Experimental Station 1 is dedicated to UV Raman Resonant spectroscopy and microscopy experiments, both with UV-tunable light provided by Lasers 1 and Laser 2 and with fixed emission laser sources working at 213, 224 and 266 nm. It can operate in a mutually exclusive manner with the radiation supplied by Laser 1/Laser 2 or with the radiation coming from one of the three fixed-emission lasers, installed on the same optical table of the experimental station. In detail, experimental station 1 consists of an optical table measuring 130 x 190 cm, on which the following instruments are installed:

- Microscope with optics optimized for the spectral region of the DUV (200-270 nm) equipped with motorized XYZ stage (controlled via a proper management software) for focusing the beam on the sample, LEDs for illumination and CCD camera for visualization (CE);
- Czerny-Turner spectrometer (Acton SP2750, 0.750 Meter Focal Length, Triple Grating Imaging Monochromator/Spectrograph, Princeton Instruments) equipped with a CCD camera detector optimized for the DUV region (200-300 nm) equipped with a thermoelectric cooling system (CE);
- Laser with emission at 266 nm (Diode Pumped Passively Q-Switched Solid State 266 nm, laser classification 4 / IV) (CE);
- Laser with emission at 213 nm (Diode Pumped Passively Q-Switched Solid State Laser 213 nm, laser classification 4 / IV) (CE);
- Laser with 224 nm emission (HeAg lasers @ 224.3nm Class IIIb laser product) (CE);
- Optics to focus the beam ant to the coupling microscopy-spectrometer and laser-microscope, with appropriate switching systems from one source to another.

The entire experimental station 1 is enclosed inside a box for shielding the radiation of direct sources and reflections (**Cover1**) equipped with some removable, non-interlocked panels, positioned near the focusing and alignment optics, as well as a non-interlocked opening in

correspondence with the sample chamber for the insertion of the sample itself. The optical alignment of the instrumentation, the housing of the sample and the focusing of the laser beam on the sample are carried out exclusively by category 1 and 2 operators, as per Annex 2.

4.1.4 Experimental Station 2

Experimental Station S2 is dedicated to UV Raman Resonant experiments in macro configuration with UV tunable light provided by the Lasers 1 and Laser 2 mentioned above. In detail, the S2 experimental station consists of a 150 x 300 cm optical table on which the following are installed:

- Czerny-Turner Triple-state Spectrometer (Acton SP2750, 0.750 Meter Focal Length, Triple Grating Imaging Monochromator/Spectrograph, Princeton Instruments) equipped with a CCD camera detector optimized for detection in the DUV region (200-300 nm) with thermoelectric cooling system (**CE**);
- Focusing optics and source-sample-spectrometer coupling

The entire S2 experimental station is enclosed inside a box for shielding the radiation of direct sources and reflections (**Cover2**), equipped with some removable, non-interlocked panels, positioned near the focusing and coupling optics, as well as a non-interlocked opening in correspondence with the sample chamber for the insertion of the sample itself. The optical alignment of the instrumentation, the housing of the sample and the focusing of the laser beam on the sample are carried out exclusively by category 1 and 2 operators, as per Annex 2.

4.1.5 Experimental Station 3

The S3 experimental station is dedicated to macro- and micro-UV Raman resonant experiments with a fixed emission source of 248 nm. It consists of a fully integrated and compact system (source-sample holder-analyzer-detector) for resonant Raman UV spectroscopy with both macro and micro DUV Raman/PL 200 Photon Systems (**CE**) sampling system. The system is equipped with a chamber for the positioning of the sample with an opening equipped with interlocking and remotely guided movement/focusing. It is positioned on an optical table measuring 140 x 160 cm.

4.2 User and instruction manuals

The manuals of the available instrumentation, as well as all the measurement accessories (quartz cells for containing the samples, accessories for mounting the samples, etc.) are kept at the IUVS Offline control room in the shelves contained in the ES4PT09 room.

4.3 How to access the facility

External research personnel, as defined in 4, who intend to carry out experiments at the IUVS 2.0 beamline must fill out an appropriate request for access to the Elettra-ST site on the VUO portal and pass the required safety tests. Access to the line takes place according to very specific procedures, which depend on the category and professional status of the applicant. See Figure 4.3:

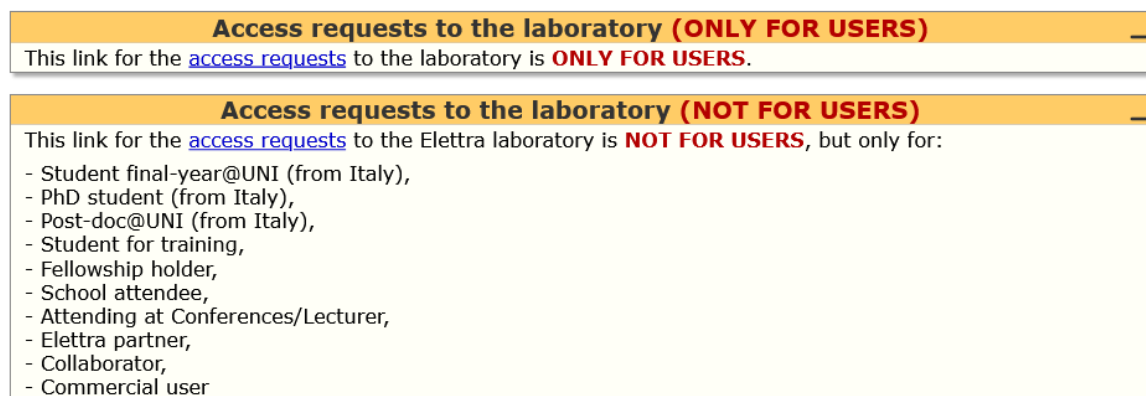


Figure 4.3: Types of access requests and categories of applicants

The main types of access requests are described below:

- **Users (proposal approved by Peer Review Panel, PRP):** submission on the VUO portal of a request for access to the "IUVS Offline" facility of Elettra Sincrotrone Trieste and CERIC-ERIC following the approval of a scientific proposal for beamtime by the PRP of Elettra /CERIC-ERIC. This request is taken over and approved by the Users Office of Elettra /CERIC-ERIC.
- **Users (in-house proposals):** submission on the VUO portal of a request for access to the IUVS 2.0 or IUVS-Offline beamline of Elettra Sincrotrone Trieste as a participant in an internal research proposal, i.e. an "in-house" proposal. This request is taken over and approved by the Users Office of Elettra Sincrotrone Trieste.
- **Industrial Users:** submission on the VUO portal of a request for access to the IUVS 2.0 Beamline as a participant in an industrial research proposal by the ILO (Industrial Liaison Office) of the Company. The request for access is handled by the ILO.
- **Collaborators and partners:** submission on the VUO portal of a request for access to Elettra's IUVS 2.0 beamline as a collaborator or partner. This request is approved by an internal "tutor", i.e. by a member of the line staff and then by the Users Office of Elettra Sincrotrone Trieste.
- **Students and trainees, external scholarship holders, doctoral students:** submission on the VUO portal of a request for access to the IUVS Offline light line of Elettra Sincrotrone Trieste as a student, trainee, external fellow, or PhD student. An agreement (Memorandum of Understanding/Convention) must be in place between Elettra Sincrotrone Trieste and the institution to which the student/scholarship holder is affiliated. The request for access is approved by the Human Resources Department and by an internal "tutor", in this case a member of the offline facility staff.
- **Outside firms:** sending a request to the Prevention and Protection Service (SPP) Activity, for example by e-mail, to carry out installations or provide services following a procurement request and the corresponding order. The contractor is required to provide and update the list of personnel who will go to the Company's website. Entry will be authorized by the Prevention and Protection Service (SPP) Activity, upon sending the names of the personnel involved and the license plate of the vehicle with which access to the site will take place. According to the current occupational safety regulations (Legislative Decree 81/08 and subsequent amendments), 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>



With regard to the Protection and Safety Regulations that govern the activities in the Elettra Experimental Room, **it should be noted that it is accessible to users who have requested access to the "IUVS offline" facility for the sole purpose of reaching the facility along the external corridor.**

5 Safety Operating Instructions

This section lists the safety operating instructions related to the main scientific and technical activities performed at the "IUVS Offline" beamline and the related experimental stations. These instructions are based on the following documents available in the company documents:

- **Risk Assessment Document of the IUVS Offline facility.**
- **Worker risk assessment sheet at the " IUVS Offline " facility.**

All members of the facility staff are responsible for ensuring that the activities indicated here are carried out in accordance with the regulations in force and according to the directives given by the Activity Manager, i.e. the Facility Manager, and the Group Coordinator. Of particular relevance are the provisions concerning the control of access to premises subject to radiation protection measures and the use of the prescribed Personal Protective Equipment (PPE).

NOTE: Experimental activity in the laboratory can be performed only after passing the approval process performed by a pool of experts in the various subjects (chemistry, biology, radiation protection, artificial optical radiation) together with the Prevention and Protection Service Manager (RSPP). The pool of experts, taking into account the information contained in the safety forms provided by the users, defines the feasibility of the specific experimental activity by identifying any operational prescriptions and personal protective equipment (PPE) needed to carry out the activity. The facility scientists collaborate with the Prevention and Protection Service (PPS) by providing the necessary information for the risk assessment of each experiment and for the definition of specific instructions for it, if necessary.

Risk assessment of the experiment is a necessary condition for its execution, and the indicated safety requirements must be scrupulously followed.

5.1 *Special health conditions of the worker*

The performance of certain work activities described below may be incompatible with special physical or medical conditions. Workers are urged to promptly notify the facility coordinator or the safety supervisor of any resulting limitations.

In the special case of pregnancy conditions, it is recommended that only those activities that can be assimilated to office work (described in Section 5.4), i.e., video terminal activities and in particular data acquisition or data analysis operations, should be performed. Particular attention should be paid to the observance of breaks.

Pregnant or post-partum workers must absolutely refrain from activities that expose them to electrical, chemical or radiological hazards or involve the risk of injury, or the performance of 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 General rules of conduct

Laboratories can be a place particularly dangerous for the physical safety of personnel working in them, whose behavior should be marked by the utmost care in the use of machinery and equipment, always in compliance with current regulations and safety procedures.

The main general practical safety rules at the laboratory are listed below:

1. Keep the laboratory clean and tidy.
2. Do not introduce substances and objects unrelated to work activities.
3. Smoking, storage and consumption of food and beverages are prohibited in the laboratory.
4. Observe elementary hygiene rules; it is mandatory to wash hands once handling biological and/or chemical agents, after removing gloves and in any case before leaving the laboratory.
5. Do not bring objects to your mouth.
6. Wear personal protective equipment (PPE) when prescribed.
7. Use only equipment that complies with standards and in accordance with the respective instruction manuals.
8. Do not tamper with or remove equipment safety devices.
9. The use of chemicals in the laboratory is only permitted for commonly used solvents for cleaning substrates: ethanol and acetone in modest amounts (a few mL). Any other operations must be carried out in the supporting chemical laboratory by properly informed and trained staff authorized personnel.
10. Properly label all containers/sample holders so that their contents can be recognized even after some time.
11. Always use the biological fume hood when handling biological samples, where permitted, and preparing biological samples for measurement.
12. Store only minimal amounts of flammable substances or solvents (ethanol and acetone in labeled sprays) in the laboratory.
13. Safely store hazardous chemical agents in the dedicated cabinet (See Figure 5.2).
14. Properly collect, separate and dispose of chemical and biological wastes, solid and liquid, produced in the laboratories; it is prohibited to discharge them into the sewer and dumpsters.
15. Before leaving the laboratory, make sure that your workplace is clean and tidy and that all equipment, except necessary equipment, is turned off.
16. All workers who use the offline IUVS facility for various reasons, as well as visitors, must pay special attention to movements the experimental hutch: small spaces and the presence of equipment increase the risk of tripping and falling.



5.3 Video terminal activities (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 drawing;
- ✓ Document preparation, e.g. scientific articles, email correspondence, etc.

Associated risks:

- demand for special visual attention in carrying out the operation;

The following requirements should be followed:

- no PPE is provided; current regulations require a break of 15 minutes for every 120 minutes of continuous activity;
- Appropriate training must be provided;
- Repetitive movements, fixed postures, uncomfortable positions. Skeletal-muscular damage is possible. It is required to:
 - Maintain an ergonomically correct posture;
- shocks blows, impacts. Possible impact against work tables and instrumentation due to small spaces in experimental hutch, especially for experimental stations named 1 and 2. It is required to:
 - take special care when moving;
 - Do not clutter VDT work spaces with devices that are not necessary for the performance of the task.

Categories of workers:

Video display screen activity may be conducted by the following categories of workers:

- ✓ Research staff of the facility;
- ✓ external research staff;
- ✓ Technical staff of the facility.

Please note:

- ✓ External research personnel may conduct data acquisition activities only after appropriate training by facility staff. Injury to persons and damage to instrumentation with consequent negative impact on the outcome of the ongoing experiment are possible. The Company reserves the right to claim compensation for damages incurred in case of negligent or irresponsible conduct.
- ✓ The activity of data acquisition should not be confused with that of manual operation of the experimental apparatus, which requires more training and experience and may pose risks to the operator.

5.4 Installation and use of low-voltage instrumentation

Task description: work activities involving the installation and use of scientific instrumentation operating at low voltage (< 50 V). In some cases, high currents of up to 10 A may be present. Here are some examples:

- ✓ accessories for measurements, such as LINKAM cell, "Instec HCP621G" temperature controller



- ✓ Thermo-resistances used to control the temperature of the sample.
- ✓ External safety light power supply

Associated risks:

- burns. Possible explosion due to the electric arc generated as a result of the accidental interruption of the continuity of the electrical circuit.

The following requirements must be followed:

- consult the manuals and follow the installation instructions carefully;
- check the integrity of the controller-instrument wiring before installation;
- connect and disconnect the instrument only when the power supply is switched off, being sure that no current passes through the cable that connects the controller to the instrument;
- Pay special attention to the connections between laboratory cables with banana plugs.

Categories of workers:

The installation and use of low-voltage equipment can be carried out by the following categories of workers:

- ✓ facility research staff;
- ✓ external research staff (*);
- ✓ technical facility staff.

* Please note:

- ✓ **External research personnel can independently work with only the accessories for the measurements, unless they have received adequate training and authorization from the facility staff for the other operations considered.**

5.5 Small repairs of electronic instrumentation

Task Description: activities involving replacement of damaged electronic components, such as fuses or capacitors, or replacement of entire electronic boards.

Associated risks:

- electrocution

The following requirements should be followed:

- Before carrying out the repair, consult the manuals and strictly follow the instructions therein. Contact the manufacturer if in doubt;
- Always remove the power supply before operating on the instrument;
- Always pay attention to the residual charge of the capacitors, since it persists even after the instrument is turned off. Wait sufficient time for the capacitors to discharge completely;
- In case of using the tinsmith, choose a suitable workstation. There is a fire hazard from using the tinsmith. Remove flammable objects from the work table. Turn off the tinner immediately after completing the repair;
- After completing the repair, inform the facility manager(s) and agree with him/her on the tests to be performed.

Categories of workers:

Electronic instrumentation repair activities can be performed by the following categories of workers/laborers:



- ✓ Research staff of the staff;
- ✓ Technical staff of the beamline;
- ✓ Maintainers (electrical, electronic, IT and vacuum technicians).

Please note:

- The research personnel (i.e. Users, collaborators, fellows, doctoral or graduate students, and trainees) ARE NOT AUTHORIZED to carry out this type of activity.

5.6 Routine and extraordinary electrical maintenance interventions

Task description: routine maintenance operations of electric appliances, such as:

- ✓ electrical repairs in racks or on the electrical distribution boards;
- ✓ installation/repair of electrical sockets or socket panels;
- ✓ maintenance of electrical panels; testing of proper functioning of circuit breakers.

Associated risk:

- electrocution

The following requirements should be followed:

- strictly comply with electrical safety regulations;
- take note of the recommendations given in document PVAR-SCH-07.

Categories of workers:

Maintenance activities may only be performed by the following labor categories

- ✓ maintenance workers (electrical-electronic technicians in the Infrastructure Group).

Please note: all other work categories ARE NOT AUTHORIZED to perform this type of activity

5.7 Installing/removing heavy or bulky instrumentation

Task description: work activities that must be performed with the support of the handling personnel. Typically, these are the transport, installation or removal of encumbered or heavy parts of the instrumentation, for example:

- Scientific instruments of relevant weight and size;
- Vacuum pumps of significant weight and size;
- Others.

Associated risks:

- Manual handling of loads, shocks, blows, impacts;
- crushing/pulling

The following requirements must be followed

- Agree with the Activity Responsible on a plan for safe assembly/disassembly;
- Request the intervention of handling personnel;



- Always make use of the overhead crane for lifting vacuum chambers and heavy objects. Where it is not possible to intervene with the overhead crane, use a "goat" type lift;
- work in pairs to reduce the load and corresponding strain;
- Always wear the prescribed PPE:
 - mechanical machining gloves;
 - safety shoes;
 - Protective helmet (only in case of overhead crane use).

Categories of workers:

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

- ✓ Technical staff of the offline facility;
- ✓ Handling operators.

Please note:

- **Research staff of the facility does not normally carry out these activities. If their cooperation is needed, follow the indicated requirements.**
- **External research personnel ARE NOT AUTHORIZED to carry out this type of activity.**

5.8 Installation/removal of instrumentation/components weighing up to 20Kg and small/medium size

Task Description: work activities of installing or removing parts of the instrumentation of the facility or corresponding experimental stations, without use of the overhead crane and without support from handling personnel. Typically, this involves performing the following tasks:

- installation or removal of scientific instruments/measuring accessories (weighing up to 20 kg), ionic or turbo-molecular pumps, diaphragm or membrane pumps. Measuring accessories include the following units: IRRAS, focusing optics for sample compartment, bolometer, etc...;
- Installation or removal of small to medium-sized vacuum instrumentation (weighing up to 20 kg);
- Assembly or disassembly of various instrumentation (weighing up to 20 kg);
- Removal/installation of the FPA detector of the experimental stations Micro-1 and Micro-2;
- Others

Associated risk:

- Manual handling of loads.

The following requirements must be followed:

- work in pairs to reduce the load and corresponding strain;
- shocks, blows, impacts.

It is recommended to:

- Wear the following PPE:
 - mechanical machining gloves.

Categories of workers:



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

- ✓ Research staff of the facility;
- ✓ External research staff (*);
- ✓ Technical staff of the offline facility;
- ✓ Handling operators.

*** Please note:**

- **External research staff may independently work only with measurement accessories, unless they have received appropriate training and clearance from facility staff for the other considered tasks.**

5.9 Small fluid-mechanical maintenance interventions

Description of task: minor fluid-mechanical maintenance, such as:

- water leak repairs;
- installation or replacement of faucets, rigid pipes, hoses, and flow switches;

Associated risk:

- shocks, hits, impacts.
 - take notice of the recommendations in the **PVAR-SCH-09** and **PVAR-SCH-19** documents

- electrocution;

take notice of the recommendations in the **PVAR-SCH-07** document and in **Section 6.3**.

Categories of workers:

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

- ✓ maintenance workers (fluid-mechanical technicians of the Infrastructure Group).

Please note: all other work categories ARE NOT AUTHORIZED to perform this type of activity.

5.10 Elevation work

Task description: operations performed in elevation on approved stairs or ladders, such as:

- Laying or removing cables on canal;
- Others.

Associated risk:

- Slipping or falling from elevated positions.

The following requirements should be followed:

- if possible, use a harness (consult SPP) and secure to solid supports;
- Work in pairs; one of the two must hold the ladder firmly.

Categories of workers:

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

- ✓ Research staff of the facility;



- ✓ Technical staff of the facility;
- ✓ maintenance workers (fluid-mechanical technicians of the Infrastructure Group).

Please note:

- **External research personnel ARE NOT AUTHORIZED to carry out this type of activity.**

5.11 Use of cryogenic liquids

Task description: Scientific experiments at experimental stations 1, 2 and 3 may involve the use of cryogenic liquids for the cooling of the sample (liquid nitrogen for the cooling of the controller at "Instec HCP621G" temperature). Liquid nitrogen is taken from the nitrogen tower at the sampling point (see procedures "**Safety procedure to be adopted for handling liquid nitrogen PRSI-PRO-01**" and "**Safety procedure for filling the Dewars at the liquid nitrogen tank PRSI-PRO-03**") by means of a 200L pressurized dewar. The latter will be used to fill a small nitrogen dewar (3L) which will be connected directly to the "Instec HCP621G" sample thermalization system. The transfer operation must be carried out outside the ESPT09 room and exclusively by the staff of the IUVS offline laboratory.

Activities with cryogenic liquids have risks associated with the various stages of their use. Below, the various stages of use, associated risks and requirements are listed:

1. CRYOGENIC LIQUID WITHDRAWAL: DEWAR FILLING AT LIQUID NITROGEN DISTRIBUTION TOWER

Associated risks:

- exposure to cold due to accidental contact with liquid or gaseous nitrogen at low temperature. Frostbite injuries or burns are possible.

The following requirements must be followed:

- wear the following PPE: cryogenic gloves, protective goggles;
- it is advisable to have followed the "cryogenic liquids" course;
- training and information: consult the Safety Procedure **PRSI-PRO-03**.

2. CRYOGENIC LIQUID SAMPLING: DEWAR TRANSPORT OF LIQUID NITROGEN TO THE IUVS OFFLINE LABORATORY

Associated risks:

- bumps, blows, impacts; crushing due to the possible overturning of the Dewar at the access ramp to the experimental room of the Elettra experimental room.

The following requirements must be followed:

- training and information: consult the Safety Procedure **PRSI-PRO-03**.

3. USE OF CRYOGENIC LIQUIDS FOR EXPERIMENTS: FILLING OF THE INSTRUMENT-SPECIFIC SMALL DEWAR (3L), DEWAR CONNECTION TO THE THERMALIZATION SYSTEM BY MEANS OF TRANSFER LINE, PRESSURIZATION OF THE NITROGEN DEWAR FOR THE FLATTENING OF LIQUID NITROGEN TO THE BEAMLINE

Associated risks:



- Bumps, blows, impacts.
The following requirements must be followed:
 - work in pairs during the assembly/disassembly operations of the liquid nitrogen transfer line;
- Material projection during pressurization (danger of expulsion of the suction pipe of the transfer line, danger of expulsion of the tapping valve)
The following requirements must be followed:
 - Check that the transfer tube is firmly screwed to the dewar before pressurization/check that the tap is firmly screwed to the dewar before pressurization;
 - Weld the transfer tube/tapping tap to the neck of the dewar with the appropriate bayonet locks;It is recommended to:
 - Perform all operations while keeping sensitive parts of the body (such as the face) away from the possible ejection trajectory.
 - exposure to cold during disassembly operations due to contact with the suction tube.The following requirements must be followed:
 - use cryogenic gloves;
 - use protective goggles;

Categories of workers:

- The work activities described in this section can be carried out by the following categories of workers:
- ✓ line research staff – activities 1 - 3;
 - ✓ line technical staff - Activities 1- 3;
 - ✓ External Research Personnel: Can only collaborate on activities 1-3 if guided by the researchers and technicians of the beamline.

5.12 Maintenance / service / extraordinary alignment of Laser 1, Laser 2, and non-tunable sources

Task description: extraordinary *maintenance / service / alignment* operations on the tunable and non-tunable laser sources of IUVS Offline. Some example cases are given below:

- ✓ Ordinary or extraordinary alignment of Laser 1, Laser 2 and non-tunable sources.
- ✓ Change the output wavelength of Laser 1 and Laser 2 laser sources, with or without modifications of the harmonic generation modules.
- ✓ Laser repair.
- ✓ Re-alignment of lasers.
- ✓ Transport of laser beams to the experimental stations in HS.
- ✓ Cleaning or replacement of worn optical or optomechanical components.

Associated risks:

- Exposure to non-ionizing radiation from lasers. Direct, reflected or scattered light from lasers can accidentally hit the eye, causing irreversible damage to the front parts of the eye (cornea, lens) in the case of UV radiation, or to the back of the eye (retina) in the case of visible or infrared radiation. UV radiation can also cause damage to the skin.
The following requirements must be followed:

The guidelines for laser operators (PRSI-LNG-02) must be strictly adhered to;

- the use of laser safety goggles appropriate to the wavelength of the radiation being used is mandatory for all those present in HS and HL. These PPE are located in the drawer unit located at the HS access compass or in the drawer unit located near the HL access door;
- for those working on the optical table, it is recommended to assume a high position with respect to the height of the laser beam;
- for those who work on the optical table, it is recommended to remove potential reflective surfaces such as watches, rings, bracelets, pendants from hands, arms and forearms;
- if necessary, arrange screens and veils to mitigate the risk of the beam escaping to the outside of the sources;
- Once the operation is ended, the integrity of the interlocking devices of the laser sources must be checked, before to restore the safety conditions.

Categories of workers:

The activity can be conducted by the following job categories:

- staff of Elettra Sincrotrone Trieste as a category 1 laser operator, as per Annex 2.
- personnel of external companies (in particular technicians and engineers of the manufacturers of the springs). In this case, the drafting of the "DUVRI" is required.

Please note:

- *Users, collaborators, scholarship holders, students and trainees **are NOT AUTHORIZED to carry out this type of activity.***

NOTE: The operations listed above must be carried out only by personnel who have undergone specific frontal training in terms of laser safety (by the TSL or other figures recognized by the company) and must be carried out in compliance with Annex 1 to this risk assessment document, drawn up by the Laser Safety Technician (TSL).

5.13 Optical alignment operations of the collection system of the S1 and S2 experimental stations

Task description: Optimization of the operations on the Acton SP2750 (positioned on S1) and on the Trivista (positioned on S2) spectrometers, carried out through the adjustment of the various microscope-spectrometer coupling optics (S1, see section 4.1.3) and of the source-sample-spectrometer coupling focusing optics (S2, see section 4.1.4). These operations include, in order to be carried out, the partial removal of some protective panels of **Cover1** and **Cover2**.

Associated risks: The associated risks are the same as those highlighted in paragraph 5.11, as the partial removal of the panels of Cover1 and Cover2 means that the operator is exposed to class 4 laser radiation, **even if of attenuated power.**

The following requirements must be followed:

- The guidelines for laser operators (PRSI-LNG-02) must be strictly adhered to;



- the use of laser safety goggles appropriate to the wavelength of the radiation being used is mandatory for all those present in HS and HL. These PPE are located in the drawer unit located at the HS access compass or in the drawer unit located near the HL access door;
- for those working on the optical table, it is recommended to assume a high position with respect to the height of the laser beam;
- for those who work on the optical table, it is recommended to remove potential reflective surfaces from hands, arms and forearms such as, for example, watches, rings, bracelets, pendants;
- the alignment operations must be carried out by removing only the access panels close to the optics that need to be adjusted;
- At the end of the optimization intervention, it is mandatory to restore all the previously removed protective panels to the established position.

Categories of workers:

The activity can be conducted by the following job categories:

- staff of Elettra Sincrotrone Trieste as category 1 and 2 laser operator, as per Annex 2.
- personnel of external companies (in particular technicians and engineers of the manufacturers of the springs). In this case, the drafting of the "DUVRI" is required.

Please note:

- *Users, collaborators, scholarship holders, students and trainees **are NOT AUTHORIZED to perform this type of activity.***

NOTE: The operations listed above must be carried out only by personnel who have undergone specific frontal training in terms of laser safety (by the TSL or other figures recognized by the company) and must be carried out in compliance with Annex 1 to this risk assessment document, drawn up by the Laser Safety Technician (TSL).

5.14 Measurement operations with instrumentation of the S1 and S2 experimental stations

Task description: sample change and sample measurement operations using the instrumentation of the experimental stations S1, and S2 of IUVS Offline.

Associated risks:

The type of risk associated with it depends on the state of operation of the laboratory.

For the transitional state as per Annex 1, the associated risk is comparable to that in item 5.13. The same prescriptions and indications therefore apply.

5.15 Measurement operations with instrumentation of the S3 experimental station

Task description: sample change and sample measurement operations using the instrumentation of the S3 experimental station with its integrated Photon system NeCu laser 248.6nm laser source.



Associated risks:

For data acquisition, only the low-power component can be visually intercepted by the operator: all observation inputs and observation screens included as parts of the laser, as well as the connected optics (lenses, microscopes, etc.) used as an observation point, incorporate connections, filters, attenuators or other devices designed to keep the radiation at safe levels during all standard use situations.

The following is recommended for the protection of the operator: 1. the laser must never be directed towards a person's eyes; 2. Pay attention to the presence of any reflective surfaces (remove or cover if possible) 3. a danger sign with the words "Warning - Do not stand near the laser beam" must be placed in a prominent place on the instrument near the possible exposure areas;

Categories of workers:

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

- ✓ Level 1 and 2 Operators, as per Annexes 1 and 2;
- ✓ external research personnel (facility users)*;
- ✓ technical staff of the offline facility.

NB: Only if an Operator has verified the shutdown condition for all laser sources (tunable and at fixed wavelengths of S1 and S2), users can access HS to carry out experiments with the compact Raman spectrometer S3, as per Annex 1.



5.16 Routine tasks in the laboratory

Task description: experiment preparation and data analysis operations to be carried out in SC.

Associated risks:

- Shocks, blows and impacts due to the presence of protruding objects and furniture
The following requirements must be followed:
 - Keep the access routes to the instrumentation free;
- Slips, level falls due to slippery floors
It is recommended to:
 - Keep the access routes to the instrumentation free;
 - Verify their integrity;

Categories of workers:

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

- ✓ line research staff;
- ✓ line technical staff;
- ✓ external research personnel.



5.17 Sample preparation: use of sharps and needles

Task Description: Sample and substrate cutting operations employing scalpels, razor blades, or sharp tools; use of sewing needles and syringe needles for sample transfer

Associated risks:

- Punctures, cuts, abrasions and shearing
The following requirements should be followed:
 - Use cut-resistant gloves when using scalpels;It is recommended to:
 - Take utmost care when performing operations.

Categories of workers:

The work activities described in this section can be conducted by the following categories of workers/employees:

- ✓ Research staff of the offline facility;
- ✓ External research staff;
- ✓ Technical staff of the offline facility.

5.18 Sample preparation: solvent cleaning of quartz cells

Task description: Solvent (ethanol, acetone) cleaning of quartz cells for sample containment using less than 1 ml of solvent.

Associated risks:

- Splashing, liquid jets
The following requirements must be followed:
 - Consult the chemical risk sheet of the solvent;
 - Carry out operations under a fume hood;
 - Wear the gown and the following PPE:
 - Latex/nitrile gloves
 - Goggles

Categories of workers:

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

- ✓ line research staff;
- ✓ line technical staff;
- ✓ external research personnel.

5.19 Sample Preparation: Handling BSL-2 Biological Samples

Task Description: Direct handling of biological specimens that fall under biological safety class 2 can only be performed at the structural biology laboratory. Associated risks and related persecutions are detailed in the Laboratory DVR.

Categories of workers:

The work activities described in this section can only be conducted by workers who have obtained specific biohazard training.

5.20 Sample preparation: handling of chemicals



Task description: direct handling of chemicals can only be done at the user support laboratory. Associated risks and related persecutions detailed in the Laboratory DVR.

Categories of workers:

The work activities described in this section may be conducted only by workers who have obtained specific chemical hazard training.

5.21 Sample preparation: use of instruments at high temperature ($T > 40^{\circ}\text{C}$)

Task description: Using the heating plate or the thermalized sample holder system.

Associated risks:

- Contact burns/excessive proximity to the heat source.

It is recommended to:

- maintain an appropriate distance from the heat source.

Categories of workers:

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

- ✓ line research staff;
- ✓ line technical staff;
- ✓ external research personnel.

5.22 Non-routine sample preparation activities: other case studies

Description of the task: handling of samples other than those listed in points 5.17 - 5.22.

Associated risks:

The assessment of the associated risks is evaluated for the specific experiment. Specific prescriptions will be drawn up, also including the categories of workers who will be able to carry out the specific activities. Specific training will be prescribed in case of need.

6 Electrical Safety Standards

Electrical and electronic equipment in operation at the experimental stations of the beamline expose operators to electrical risk. This risk is 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 regulations.
- Ensure that the electrical system or equipment has the necessary approvals and certifications, if necessary contacting the relevant business operating units.
- Be sure of the location of the electrical panel supplying power to the area in which you are working so that you can promptly de-energize the system if necessary.
- Use electrical systems in accordance with their intended use and respective operating manuals.
- Ensure that the power cords of electrical appliances are adequately protected from



mechanical (passing people, sharp objects, etc.), thermal (heat sources) or chemical (corrosive substances) actions.

- Make sure the power has been turned off before performing any simple operation on the facilities (including changing a bulb) or equipment.
- Always make sure the electrical system is disconnected (after operating the appropriate switch) before unplugging.
- Disconnect the equipment from the power source before starting periodic cleaning.
- Plug the equipment into the nearest outlet, avoiding the use of extension cords as much as possible.
- Do not overload outlets with too many electrical consumers, always checking that the total current load intensity does not exceed the limits of the outlet itself.
- The multiple adapters allowed by the standards are those with only two side sockets. The other type, with a third socket parallel to the plugs, is considered dangerous because it allows multiple sockets to be chained together.
- German-type (Schuko) plugs can be inserted into Italian-type sockets only by means of an adapter that transfers the ground connection made via the side plates to a central plug. It is absolutely forbidden to forcibly insert Schuko plugs into Italian sockets.
- Avoid subjecting all parts of electrical systems to mechanical or impact actions (passing trolleys, etc.).
- When using roller extensions, they must be fully unwound to avoid overheating. In fact, the capacity of the coiled cable is reduced. The capacity of the cable, which must be indicated, must always be respected.
- Do not pull the power cord to disconnect an electrical appliance from the outlet, but use the plug.
- Do not tamper with electrical equipment (qualified personnel must be requested for any need in accordance with company procedures).

6.2 Prohibitions

- Prohibition of tampering with electrical appliances.
- Prohibition to install or use private electrical equipment or materials.
- Prohibition to intervene in case of failure on switchboards or electrical panels.
- Prohibition of covering or concealing the controls and electrical panels with cabinets or other furnishings (allow inspection and timely intervention in case of anomalies).
- Prohibition of removing the protective channels of electric cables.
- Prohibition of overloading outlets with too many electrical consumers, using adapters or multiple outlets.
- Prohibition of depositing flammable substances in the vicinity of equipment.
- Prohibition of depositing containers filled with liquids on the devices.
- Prohibition of exposing equipment to excessive radiation or heat sources.
- Prohibition of preventing proper ventilation of equipment by covering ventilation openings.
- Prohibition of touching facilities and/or equipment if you have wet hands or shoes.

- Prohibition on the use of water for extinguishing fires of electrical origin.
- Prohibition on the use of water for extinguishing fires of electrical origin.

7 Emergency management

Various and of different severity are the emergencies that can happen at the facility. They must be handled according to the Company's Emergency Plan (see procedure GEEM-PRO-02-rev03IT).

