

Stanford University Physics

GRATTA LABS BASIC SAFETY PROCEDURES

Hazard and PPE assessment last updated by G.Gratta, December 2025.

The Gratta labs are located in Varian 020, 022, 024, 034, 125, 127, 153, 161, 163, 163A, 165, 165A and in HEPL South (ESIII). General lab safety rules must be followed to ensure safe and productive research. To work in our labs, you need to take the following Stanford-wide Safety trainings (all offered online through axess [STARS], Natalie can get you guest access if needed):

- General Safety, Injury Prevention, and Emergency Preparedness: EHS-4200
- Ergonomics - Computer Workstation: EHS-3400
- Compressed Gas Safety: EHS-2200
- Chemical Safety for Laboratories: EHS-1900
- Laser Safety Training: EHS-4820 (as needed, test required every three years)
- Electrical Safety: EHS-2800 (as needed)
- Cryogenic liquids and dry ice safety: EHS-2480 (as needed)
- Radiation safety: (as needed and at the appropriate level (sealed or non-sealed sources))

You may have already taken some or all of these (please check)

When working in our labs use caution and common sense. Generally, think of the possible hazardous consequences of what you are doing before doing something and plan on how to react to emergencies. If you are not completely confident do ask for help.

Our lab safety coordinator is Soud Al Kharusi. Soud or G. Gratta (V146) are always happy to give you a tour and point out possible hazards. In addition, please read and understand this write-up and return it to Natalie Pogue (V310). In case of doubts or questions contact the PI or the lab safety coordinator above.

Important: if you have not read and signed this document AND you have not taken the Stanford training below here, you will NOT receive a key to the labs. This is non-negotiable.

Activities with special hazards require specific operating procedures that must be reviewed by the PI. For guidance, please refer to the template provided by EH&S at: <http://web.stanford.edu/dept/EHS/cgi-bin/lcst/docs/10-097.docx>

The following specific hazards and safety issues may be encountered:

- 1) **High Voltage:** We have several HV (a few kilovolts), somewhat high-current (20 mA) power supplies in the lab. Always make sure to turn off HV before touching or sticking your hands close to conductors potentially at HV. Do not disconnect/connect connectors with HV applied. Remember that charged capacitors can deliver shocks even when power is off. Always use proper grounding when working with high voltage power supplies. Be particularly careful if you have to work in the dark (for instance while testing photomultipliers).

We also have higher voltage sources (>10 kV) at low (~1mA) current. Special precautions need to be followed with these instruments and only qualified personnel (i.e. explicitly instructed and authorized by the PI) should work with them. In particular remember that above ~5kV you do not need to touch a conductor to be shocked, you can get hurt by just having your hand too close.

Work on open HV chassis (eg fixing a power supply) requires specific authorization from the PI.

- 2) **Implosion:** Our research may involve the use of large photomultiplier tubes. These tubes are made of thin glass and are under high vacuum. Breaking them (greatly upsets the PI and) may cause glass fragments to be projected away. Always use goggles or safety glasses when handling large vacuum tubes.
- 3) **Explosion:** When working near systems with liquid xenon, be aware of the fact that a loss of cryogenics may result in pressure buildup in the system. While we always use burst disks, weak elements (eg quartz windows, feedthroughs and bellows) may rupture. Always wear safety glasses! Only authorized people with specific training should operate liquid xenon systems. *In particular, a simple and effective rule is to never dunk a Xe pressure cylinder in liquid nitrogen for more than half its length!*



You should know that pressurized gas cylinders are powerful devices that need to be treated with great respect. The pressure inside them is often larger than 100 atm. If a valve breaks or, maybe due to the cylinder falling, gets sheared off, the cylinder will literally fly like a rocket, propelled by the gas exhaust. Under these conditions gas cylinders have been seen going through walls! The screw-on cap is there to protect the valve from direct hits and can only serve its purpose if in place. So, you should keep the cap on when the cylinder is not in use and ALWAYS during transportation. Just to be clear, the cylinder in the photo to the left is dangerous and illegal: if a cylinder is on a cart it HAS to have the protective cap.

In addition, standard plumbing CANNOT take the full pressure from a gas cylinder; this is why they have invented regulators. Except for specially designed devices that are specifically approved by the PI, the first thing a gas cylinder is connected to is a proper regulator with 2 manometers (one measuring the input and the other output pressures). If you think you need to plumb things otherwise come explain the PIs why first!

Always wear safety glasses when connecting/disconnecting gas cylinders.

Chemicals: Please take the chemical safety training mentioned above. Minimum personal protective equipment (PPE) for handling chemicals includes safety glasses and the appropriate chemical-resistant gloves. Some radiochemistry with very small amounts of chemicals and very small activities is done in V022. Giorgio is currently the only group members who should work on these things (ex-postdoc Brian Lenardo has also the expertise). Protocols for this work have been reviewed by health physics and are in the Isotope Logbook. Similar protocols are required for ALL radiochemistry work.

Some of us work at SNF/SNSF and have proper training for handling more dangerous chemicals (e.g. HF).

In the past we have handled liquid scintillators that basically consist of aromatics (usually pseudocumene) dissolved in mineral oil. Procedures for these materials will be added if we will need to handle scintillators again.

Many of you only use ethanol (or isopropanol) and/or acetone to sonicate vacuum parts. Only water is supposed to go in the main tub of the sonicator!! The solvent goes in a small beaker which, in turn, is in the water. You may need a basket to keep the beaker from tipping over. Do not use solvents in open beakers of volume larger than 100cc. If you need more than 100cc of solvent you have to use a Tupperware box with a closed lid. Do not run the heater of the sonicator (or any other heater) when using acetone or isopropanol/ethanol because this produces flammable fumes and is not really needed for the cleaning.

Storage: Follow the instructions in the chemical safety training. In practice, corrosive chemicals (acids) in our labs should be stored in glass containers or, if not available, plastic ones, but never metal. All chemicals should be stored in secondary containers next to other compatible chemicals of the same storage group. All chemicals should be labeled with their full chemical name and date (even containers of water should be labeled).

Disposal: Chemicals not to be used anymore should be marked for removal. Chemical waste can be organized into four groups: acidic, basic, organic, and solid. Attach a hazardous waste tag to the container and arrange for pickup (<http://wastepickup.stanford.edu>), or ask Albert. We generally gather the waste in V153. Do not, under any circumstances, pour chemicals down the drain (even just ethanol). This is illegal dumping.

Inventory: All new chemicals must be added to the group's inventory on chemtracker. The chemical safety coordinator (Soud) can update this inventory. If you are frequently obtaining new chemicals, the safety coordinator can get you a personal chemtracker account, so that you can update the inventory yourself. The inventory must also be updated when transferring more hazardous chemicals (such as acids or gas cylinders) to other rooms for extended periods of time.

In general, if you feel that you need to do chemistry in our labs beyond what described above please talk to the PI.

Use appropriate protection i.e., lab coat, gloves, and safety glasses, when handling acids and other chemicals in the fume hood.

Make sure that you know where fire extinguishers, showers, medical kits, and spill kits are located (this is a good practice; it's not just about chemical safety!).

- 4) **Laser Safety:** All people working with (or in a lab with) lasers are required to have laser safety training EHS-4820. Use appropriate PPEs (i.e. laser goggles in this case). The group's laser safety coordinator is Zhengruilong Wang.

Some of the lasers used in our labs may have sufficient power to permanently damage the retina and impair vision. In addition, we will soon have a 10W 1064nm fiber laser in that setup. Pay attention to the "Laser on" sign at the entrance of V163. To avoid unintentional exposure to stray beams, every care must be taken to minimize stray beams.

In addition, we have a class 4 pulsed lasers in V034 (although currently not in use). These lasers are seriously dangerous, as a single shot of it WILL kill your eye. The pulse is (way) too fast for your natural reflex (to close the eye) to protect you. The following additional observations/rules apply to V034 if the pulsed laser is in use:

- All beams should propagate in a plane, close to the surface of the table(s). New beamlines must be inspected and approved by G.Gratta
- Never do anything with your head close to the plane of the beams (even if you wear goggles and/or if the shades are in place)
- If you drop something to the floor do resist the temptation to simply pick it up, as doing so your head will travel through the plane of the beams.
- If you really need to do something that requires your head to transit at table level, close your eyes (in addition to wearing goggles and having the shades in place) to do this. As always, think first.
- In some cases the table may be surrounded by black foamboard shades. These are there to prevent stray light from going around the room. They are NOT beam stops. A direct beam on a panel WILL burn it and produce a fire hazard. For this reason the foamboard panels should be neatly lodged in the channels of the 80/20 verticals so that they can't fall. If you need to remove a panel for alignment or other construction, make sure it is back in place before returning to routine operations.
- Be particularly careful when handling posts or other materials (tools, etc) when the lasers are on, as intercepting a beam may steer it into someone's eye.
- The curved surface of lenses will reflect and fan out some of the beam. While this decreases the energy density, it does also produce a broader region of potential danger. Also be very careful with light concentrated by lenses as it may dangerously shock vacuum windows (most of our windows are not AR coated). Always make sure that the focal point is inside the vacuum chamber.
- Note that the YAG pump beams do hurt if they hit your hand (in fact the direct YAG beam will do real damage). I am also told (have not tried!) that a shot on a fingernail may produce really painful bleeding under the nail, similar to that obtained by pinching your finger in a door.

- The parameters of the pulsed lasers on the large table in room 034 are:

| | | Wavelength (nm) | Energy (mJ) | Goggles OD |
|---|---------------------------|-----------------|-------------|------------|
| 1 | YAG (Minilite) | 1064 | 50 | 6+ |
| 2 | Doubled YAG (pumps Dye 1) | 532 | 200 | 5+ |
| 3 | Tripled YAG (pumps Dye 2) | 355 | 100 | 5+ |
| 4 | Quadrupled YAG (not used) | 266 | 55 | |
| 5 | Dye 1 | 553 | 30 | 5+ |
| 6 | Dye 2 | 390 | 10 | 5+ |
| 7 | Dye 3 | 535 | 30 | 5+ |

Beams in items 2 and 3 are particularly dangerous.

Everybody should adhere strictly to the laser status indicator outside of the lab (an intercom is provided to talk to people in the lab).

At present (Sept 2025) the lasers in that lab are not operational. They should NOT be turned on without a new review by the PI.

For questions see the Laser Safety Coordinator, Zhengruilong Wang.

- 5) **Cryogenic Liquids:** Some experimental setups may involve cryogenic liquids such as liquid nitrogen, xenon and helium. In general, make sure that you do not spill cryogenic liquids on you as this may cause severe frostbite. Use some tool or insulated gloves to touch materials—such as liquid nitrogen transfer tubes—that have been cooled down to very low temperature. Use safety glasses and wear closed-toe, non-woven shoes. Never tilt LN2 dewars beyond the specified angle as this may cause overpressures. Dewars and cryostats have different vent valves that may look unfamiliar. Do not touch if you do not know what you are doing.

It is illegal to travel in an elevator with a LN2 or LHe dewar. This is because the dewar may vent and fill the elevator cabin with its content, displacing the air and suffocating you. This is part of the Stanford safety training and is reported here for reinforcement. As a rule of thumb LN2 has a density ~1000x that of STP gas. So 160 liters of LN2 (the typical volume of the dewars we use) when warming up expand to a volume of $0.16 \times 1000 = 160 \text{m}^3$, far larger than the volume of the elevator cabin.

In principle this applies also to high pressure gas cylinders. However, in this case my intuition is that it is more dangerous to leave the cylinder alone, with the risk that an elevator jolt may make it fall and break, that it is to be suffocated, particularly because dewars physiologically vent while high pressure cylinders don't. So, I personally prefer to ride with a cylinder.

- 6) **Radiation:** Our work involves use of usually weak radioactive sources. They are generally stored in the large safe in V022 and they should always be returned to an approved and locked storage when not in use. In addition to the safe in V022, approved storage is a locked cabinet in our area in HEPL ESIII. To handle sources you **must** have completed the health physics training and have a radiation badge (see our current radiation safety czar, Chiara Brandenstein). Safety procedures for small sealed sources can be summarized by the following three rules:

- Avoid unnecessary exposure (remember A.L.A.R.A.!).

- Remember that the dose goes as $1/\text{distance}^2$, so try not to hold sources in your hand and certainly do not put them in your pocket)
- Do not lose them (they are small!)

In Varian, only 022, 024, 034, 125 and 127 are permanently authorized for the use of sealed sources. The transfer of a source – no matter how small – to any other lab requires the written (email) consent of health physics and of the PI. Sources can be removed from their locked storage for short-term use (eg calibration) in one of the labs above, but they should be returned to the locked storage (in whatever container you found them) as soon as you are done. **While the source is out of the safe you are responsible for the safe handling and the security of the source.** Objects that may have been contaminated by radioactive isotopes are labeled as such (yellow sticker with radiation sign) and stored in the safe in an appropriate box or bag. It is absolutely forbidden to remove, take apart or otherwise manipulate objects with the radiation sign on them unless you have generated the object and you know exactly what you are doing. Do not dispose of non-radioactive waste in the rad waste container (as waste labeled radioactive is expensive to dispose of).

The following sealed sources live in ESIII and should be returned to the locked box there when not in use:

| | | | | | |
|---------|--------|--------|-------|-------|--------|
| ID | G3-331 | G3-335 | 76266 | 68884 | J1-185 |
| Isotope | Th228 | Co60 | Fe55 | Gd148 | Cf252 |

In addition to the small activity sources above, we control (under our license (“CRA”)) a ~3Ci AmBe neutron source, contained in a special, shielded drum. The “storage” of this source consists in chaining it (the drum) to anchors in the wall in room V020. Chiara is the specific custodian of this source, she is authorized to use it, and he will make sure that stays in V020 when not in use. This is a rather dangerous source, beware. We also currently have a few 57Co sources with activity >50mCi. These should generally be in their shielded container, in the safe, or in the Mossbauer spectrometers (also shielded). Again, Chiara is in charge of handling those.

Our CRA also allows us to also handle “unsealed sources” that usually are in the form of “plating solutions” used to transfer a particular isotope onto a surface. The fact that we have this license means we have to be particularly careful and responsible. Special rules apply to the handling of unsealed sources. You will need special training from health physics to handle those. Furthermore, a written protocol of the intended source usage and procedures must be submitted and approved in writing by the P.I. (G. Gratta) before any work is carried out. As already mentioned, at present only the PI is authorized to work with unsealed sources.

The sources safe is for storage of radioactive sources and should not be cluttered with other things. In particular, if small amounts of (radioactive) liquid solutions are stored in there, special care will be taken that the solution is sealed into a DOUBLE airtight container. This means that there will be a sealed vial type of container and it will be further enclosed into a sealable Tupperware-type box. You will need to have all this hardware in hand before being approved to use non-sealed sources.

Summary of safety responsibilities in the group

| Topic | Name |
|---|----------------------------|
| General safety & Chemical safety | Soud Al Kharusi |
| Laser Safety | Zhengruilong Wang |
| Radiation Safety | Chiara Brandenstein |
| | |

I have read and understood this Sept 2025 write-up of Gratta Labs Basic Safety Procedures; I have my own copy.

I have reviewed the lab-specific training classes with my supervisor.

This lab-specific training was carried out (check the right option):

- at the annual group safety meeting ()

- on an ad-hoc basis by _____ ()

Name Signature Date

I have taken and passed:

| Class | Name | Relevant Lab Safety Coordinator Initials |
|-------------------|---|---|
| EHS-4200 | General Safety, Injury Prevention, and Emergency Preparedness | |
| EHS-3400 | Ergonomics - Computer Workstation | |
| EHS-2200 | Compressed Gas Safety | |
| EHS-1900 | Chemical Safety for Laboratories | |
| EHS-4820 | Laser Safety Training (as needed, retest required every three years) | |
| EHS-2800 | Electrical Safety (as needed) | |
| EHS-2480 | Cryogenic liquids and dry ice safety (as needed) | |
| Sealed source | Sealed source training (as needed) | |
| Non-sealed source | Non-sealed source training (as needed) | |