Stanford University Physics

GRATTA LABS BASIC SAFETY PROCEDURES


The Gratta labs are located in Varian 022, 024, 034, 125, 127, 153, 161, 163, 163A, 165, 165A and in HEPL South (ESIII). General lab safety rules must be followed to insure 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], Sha 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 (test required every three years)
- Electrical Safety: EHS-2800 (as needed)
- Cryogenic liquids and dry ice safety: EHS-2480 (as needed)
- Radiation Safety Training (EHS-5250-WEB and Hands-On EHS-5251) (for anyone without experience with radioactivity)

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 Alex Fieguth. Alex 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 Sha Zhang (V148). 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. In case you want to know who is in charge for a specific task or safety related question you can also check the list provided on LINK HERE*

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](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 (e.g. 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. Weak elements (e.g. 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, storing a cylinder like in the photo to the left is dangerous and therefore not allowed! 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. Brian Lenardo and the PI, are the only group members who should work on these things. Protocols for this work have been reviewed by health physics and are in the Isotope Logbook. Similar protocols are required for ALL radiochemistry work.

We are also doing some plating work using potassium gold cyanide. Chas Blakemore is the only person authorized to do this (in the fume hood in V022). Chas is also trained to work with hydrofluoric acid (HF) at SNF (using their protocols).

Brian Lenardo and Shuoxing Wu are working with several organic solvents in the fume hood in V125 and in the purification system on the bench in the same lab. In addition they may be occasionally use very reactive Na and K (and NaK alloy) in the glove box in V125. Because of the reactivity of these substances, very specific protocols are used and a Class D fire extinguisher (Metal Fires) is present in that lab. No one is authorized to do this work at this time!

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:** Corrosive chemicals (acids) should be stored in glass containers or, if not available, plastic ones, but never metal. All chemicals have to be stored in secondary containers next to other compatible chemicals of the same storage group. All chemicals have to be labeled with their full chemical name (no abbreviations) and date (this includes water).

**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 Alex. 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 (Alex) 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 and also includes the removal of chemicals from our inventory.

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).

Some of the diode lasers used in V161/163 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. 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:

- 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 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:

<table>
<thead>
<tr>
<th></th>
<th>Wavelength (nm)</th>
<th>Energy (mJ)</th>
<th>Goggles OD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>YAG (Minilite)</td>
<td>1064</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>Doubled YAG (pumps Dye 1)</td>
<td>532</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>Tripled YAG (pumps Dye 2)</td>
<td>355</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Quadrupled YAG (not used)</td>
<td>266</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>Dye 1</td>
<td>553</td>
<td>30</td>
</tr>
<tr>
<td>6</td>
<td>Dye 2</td>
<td>390</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Dye 3</td>
<td>535</td>
<td>30</td>
</tr>
</tbody>
</table>

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 (Aug 2019) the lasers in that lab are not operational. They should NOT be turned on without a new review by the PI.

Special care has to be taken in case of alignment of lasers, as this is not a really standard procedure, where extra risk can occur. The following resource and the summary below give you the guidance in this case. Please familiarize before doing any alignment:


- Exclude unnecessary personnel from the laser area during alignment. Use low-power visible lasers for path simulation of higher power visible or invisible lasers whenever possible.
- Wear laser protective eyewear during alignment. Use special alignment eyewear when circumstances (e.g. wavelength, power, etc.) permit their use.
- When aligning invisible (e.g. UV, IR) beams, use beam display devices such as image converter viewers or phosphor cards to locate beams.
- Perform alignment tasks using high-power lasers at the lowest possible power level.
- Use a shutter or beam block to block high-power beams at their source except when actually needed during the alignment process.
- Use a laser rated beam block to terminate high-power beams downstream of the optics being aligned.
- Use beam blocks and/or laser protective barriers in conditions where alignment beams could stray into areas with uninvolved personnel.
- Place beam blocks behind optics (e.g.: turning mirrors) to terminate beams that might miss mirrors during alignment.
- Locate and block all stray reflections before proceeding to the next optical component or section.
- Be sure all beams and reflections are properly terminated before high-power operation.
- Post appropriate area warning signs during alignment procedures where lasers are normally Class 1 (enclosed).
- Alignments should be done only by those who have received laser safety training.

For questions see the Laser Safety Coordinator, Chas Blakemore.

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 any cryogenic liquid 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 0.16x1000=160m$^3$, far larger than the volume of the elevator cabin.

In principle this principle 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 and 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 small safe in V153 and 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, Brian Lenardo). 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 $1$/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 007, 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.

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

<table>
<thead>
<tr>
<th>ID</th>
<th>Isotope</th>
<th>G3-331</th>
<th>G3-335</th>
<th>76266</th>
<th>68884</th>
<th>J1-185</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Th228</td>
<td>Co60</td>
<td>Fe55</td>
<td>Gd148</td>
<td>Cf252</td>
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</table>

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 V007, next to the machine shop. V007 is, in turn, locked. Brian Lenardo is the specific custodian of this source. Shuoxing and Brian are authorized to use it, and Brian will make sure that is in V007 when not in use. **This is a rather dangerous source, beware.**

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 PI (G. Gratta) before any work is carried out. As already mentioned, at present only Brian and the PI are 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

<table>
<thead>
<tr>
<th>Topic</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>General safety &amp; Chemical safety</td>
<td>Alex Fieguth</td>
</tr>
<tr>
<td>Laser Safety</td>
<td>Chas Blakemore</td>
</tr>
<tr>
<td>Radiation Safety</td>
<td>Brian Lenardo</td>
</tr>
</tbody>
</table>
I have read and understood this March 2021 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 ___________________________ (  )

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
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</table>

I have taken and passed:

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Relevant Lab Safety Coordinator Initials</th>
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</thead>
<tbody>
<tr>
<td>EHS-4200</td>
<td>General Safety, Injury Prevention, and Emergency Preparedness</td>
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<td>Sealed source</td>
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<tr>
<td>Non-sealed source</td>
<td>Non-sealed source training (as needed)</td>
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