Standard operating procedures (Xu Laboratory):

**Safety training:** You must complete your required trainings and keep them updated before working in the lab.

Online training: <http://ehs.unl.edu/training/online> course:

1. Core – Injury and Illness Prevention Plan (IIPP)
2. Core – Emergency Preparedness Training
3. Chemical Safety Training (all four parts).
4. Lockout/Tagout for Machines & Equipment.
5. Laser Safety General Awareness training

Virtual Manual on-line safety manual:

<https://scsapps.unl.edu/virtualmanual/AccessYourProfile.aspx> use xiaoshan.xu@unl.edu to access our group’s profile.

**Work Environment:** If at all possible, don’t work in the laboratory alone. If you do work in the laboratory alone, prop the laboratory door open or at least make sure that the door is unlocked. This may break Fire-Marshall rules, but do so anyway. The biggest risk you face are electrical shocks and a vacuum implosion. If injured, I want you to be able to call out for help and have people rush in to help you. A locked door only hinders getting you aid. Don’t work in an empty building please. Do not wear rings in the lab. Do not wear flammable clothes.

No undergraduate should work alone in the laboratory without at least a graduate student around.

Do not eat or drink in the lab.

**Chemicals:** All bottles must be labeled, even water. No uncapped bottles, even empty bottles. No empty bottles outside the chemical storage cabinet. Return used chemicals to EHS [using the hazardous material collection tag, or contact Biohazard Waste Pickups - Tony Lloyd Tony Lloyd, (402) 472-4942, alloyd4@unl.edu ], don’t let used chemical accumulate. Don’t stockpile used chemicals and if you see used chemicals accumulate, don’t keep silent. Store oils in the separate cabinet. Don’t prop open or leave open the chemical cabinets. Use the hood if at all possible when clean parts, or using chemicals to prepare or make samples. Don’t put your head in the hood when using it and try and have the sash (glass doors) to the hood closed as far as is possible.

Store the lecture bottles and gas cylinder regulators in the cabinet under the hood when not in use – do not leave in the general laboratory spaces. Store the big gas cylinders against the wall in the appropriate places. Make sure all gas cylinders in use are upright and strapped to the wall or equipment.

Organic and inorganic acids are incompatible due to possible heat and innocuous gas release when subjected to each other. Because of this possibility they must be separated in the storage space or within secondary containment to control a spill scenario*.*

In case of chemical spill, use the spill Kit. The Spill Kit consisted of a properly labeled box containing: absorbent pads, one plastic bag, gloves, and eye wear.

**Toxic gases**: The KrF gas is toxic, which is why the cylinders is stored in the gas cabinet. Keep the gas cabinet shut except for a temporary access to the valves of the bottles when you are refilling the excimer laser. Make sure the main valves of the gas cylinders are closed when the refill is done.

**Lasers:** The excimer/YAG laser is a class 4 laser which is dangerous. When you operate it, keep the beam path enclosed. But when you temporarily open the enclosing (e.g. for alignment), safety goggle is required; at the same time, shut the laser curtain. The open-beam He-Ne laser is Class 3B. In general, don’t shine a laser near or at anybody’s eyes. Have beam stops in place and don’t take risks. Do not work with your eyes at the level of the laser, and close your eyes if you must cross that level, for example to pick something up from the floor.

**Electrical:** There are high voltage at on the RHEED power supply and RHEED gun.

When on, avoid the contact points. When off, short the contact points to make sure there is NO capacitively held charge. The Ion pump power supplies are similarly dangerous as are the power supplies for the e beam heating.

*Daisy chaining power strips and extension cords is prohibited*. This practice creates the potential to overload and damage wiring or circuits. *Power strips are to be plugged directly into a permanently installed electrical outlet.*

**Sharps:** Dispose of unnecessary razor blades in a "Sharps" labeled plastic container or sheath the blades.  If the original sheath is not available, consider embedding the blades in Styrofoam blocks when not in use.

**Lockup:** We don’t want stuff stolen. Make sure the laboratory doors are locked. Even if a group member is around, still check all the doors to places used by the group not occupied. Don’t assume the last person will check but if you are the last person, please check every door!

**Eyewash**: Eyewash stations should be tested on a weekly basis to ensure proper operation. Documentation is required, a log next to the station is recommended.

**Injuries:** To be avoided and may they never happen, but if you get injured, not matter how small, get help. Report injuries if you can immediately (Xu, EHS, Dan Claes), but above all get help. If at all possible get someone to take you to the hospital – if you can’t get help call 911 and get the University Police to take you to a hospital. Don’t worry about the paperwork: your doctor bills will be paid so get treatment first, the paperwork can be sorted out later.

**Sample handling:**

* Name every sample (even failed ones) and save it in a small sample box.
* Store samples not useful in recent future in the large sample storage box (up on the shelf).
* Record every transaction of sample, including sending samples to collaborators, getting samples from collaborators. Write down sample info, time, from whom, purpose of the transaction.
* Record when you take substrate from the storage. Keep in mind it takes months to order some substrates.

**Instrument management**:

* We need to know the history of every instrument so that if something goes wrong, we have a better idea on how to fix it.
* Write done what you did briefly on OneNote every time you use the instrument, including your name, sample info, and a couple of phrases on why you run the instrument, e.g. “XXX’s training on R-T measurement using sample XXX”.
* If you are helping people from other group on the measurement using our instrument, you still need to write down what has been done on the instrument.
* Do this as soon as possible, ideally before you start using the instrument.

**Data management**:

* Metadata (experimental conditions) are important. Your data will essentially be meaningless without experimental conditions. Write that down as soon as possible on OneNote before you forget.
* When you are running a long, automated measurement, note that in OneNote so that other people know who is using the instrument and what sample is in the instrument.
* Log your experiment, even if it is just a quick test for other experiments. Again, it doesn’t have to be a long description, snapshots and pictures of experiments will be mostly good enough.
* Copy all the raw data from user facility (NCMN, National Labs) to the lab computer.

**Tools handling**:

* Put away tools that are not being used. Tools left on the table have unknown history and cannot be assumed clean.
* If you are unsure whether some tools are clean, clean it first or buy new clean tools instead of taking the risk.
* Use only plastic tweezers to handle magnetic materials.
* Keep personal clean tools (e.g. tweezers) in personal container.

**Chemical handling**:

* Record every sample transaction, including when and how it is acquired.

**Chill water**:

* Turn off the chill water when you don’t need it. This is to save energy of the building and the water filters in our labs.
* Turn on the chill water slowly because a burst of water flow will trigger the “shut off” function of the faucet, which causes zero flow of the chill water.

Other Safety:

If you leave town, make sure there is a schedule of people to look at your equipment every day.

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Department of Physics and Astronomy Peer Inspection Guidelines

**General Condition of Lab or Facility**

 Yes No

[ ]  ☐ Are doors kept closed while potentially hazardous operations are in progress?

☐ ☐ Is the space free of obstructions, trip hazards, or “clothesline” hazards?

☐ ☐ Are aisles and exits easily accessible?

☐ ☐ Are furnishings/equipment stored/used in a safe manner (e.g., falling or crushing

 hazards)?

☐ ☐ Are there concerns with overall cleanliness or organization?

☐ ☐ Is the lighting adequate (and in good condition)?

**General Electrical Safety:**

 Yes No

☐ ☐ Are power strips, extension cords, or multi-plug adapters plugged directly into a

 permanently installed electrical outlets?

☐ ☐ Are extension or flexible cords limited to temporary use only?

☐ ☐ Are electrical cords protected from damage and/or in good repair?

☐ ☐ Are Ground Fault Circuit Interrupters (GFCI) installed on outlets/circuits in damp/wet

 locations or outlets in damp/wet locations (alternative is water-tight housing)?

**General Electrical Safety: (cont’d)**

Yes No

☐ ☐ Do electrical appliances appear to be UL (Underwriters Laboratory, most purchased

 equipment) or Facilities Management approved?

☐ ☐ If equipment appears to have been custom installed, are electrical components/ outlets

 enclosed to protect against shock or electrocution (vs. open wiring)?

☐ ☐ Is there adequate clearance in front of electrical panels/breaker boxes (three feet from

 the panel or boxes)?

☐ ☐ Are electrical controls, including emergency shut-offs, accessible?

☐ ☐ Are high-voltage hazards identified?

**Compressed Gas Cylinders:**

Yes No

☐ ☐ Are toxic or pyrophoric gases used/stored outside of a fume hood/gas cabinet?

☐ ☐ Are compressed gas cylinders properly restrained (mount, chain, or strap) and

 labeled?

☐ ☐ Is there evidence of safe transport practices?

☐ ☐ Are fittings and equipment associated with compressed gases appropriate and in good

 conditions?

☐ ☐ If toxic gases are in use, are they vented through a scrubber?

**Ventilated Cabinets (Fume Hoods, including laminar flow hoods)**

 Yes No

☐ ☐ Are cabinet certifications current and legible?

☐ ☐ Is the cabinet being used in a manner consistent with design?

 (concerns: Radioactive materials; perchloric acid; laminar flow hoods used with high

 volumes of volatile chemicals, etc.).

☐ ☐ Are hood sashes closed when the hood is not in use?

☐ ☐ Is the cabinet being used in a manner that might compromise its efficacy?

 (blocked/crowded/used for chemical storage).

☐ ☐ If chemicals are stored in or under the hood, are the stored appropriately?

**Door Placarding**

 Yes No

☐ ☐ Are appropriate and accurate door placards (including hazard assessments) present?

☐ ☐ Are emergency contact numbers available and current?

**Chemical Safety**

 Yes No

☐ ☐ Is an accurate chemical inventory available (on paper or via computer)? Did the Department do an inventory or regular evaluation of the stored chemicals?

☐ ☐ Are those in the lab or facility aware of procedures for accessing MSDS information?

☐ ☐ Are chemical storage containers adequately labeled?

☐ ☐ Are chemicals stored in a safe manner (segregation of classes by reactivity)?

☐ ☐ Are chemical containers closed (sealed or capped)?

☐ ☐ If chemicals are stored in a common and/or remote area, does the cabinet labeling

 provide adequate information (contents, who is the owner, emergency contact

 information)?

☐ ☐ In areas where chemicals are used, are adequate and appropriate chemical spill

 supplies readily available?

**Management of Used/Spent Chemicals (for disposal or recycling)**

 Yes No

☐ ☐ Are collection containers safe (appropriate) and capped/closed?

☐ ☐ Are collection containers appropriately labeled (full names of all possible contents,

 indication of whether used/spent, and indication of composition)?

☐ ☐ Is there any evidence of improper disposal practices (e.g., chemicals in drain or trash;

 chemicals being allowed to evaporate in fume hoods or escape to sewer)?

☐ ☐ Is there evidence of unnecessary accumulation of spent/used materials?

☐ ☐ Are radioactive materials stored in a container identified with the name of the isotope,

 the radiation trefoil symbol, and the words "Radioactive Material"?

**Personal Protective / Safety Equipment**

 Yes No

☐ ☐ Are researchers/students wearing appropriate clothing/footwear?

☐ ☐ Are researchers/students/staff using gloves that are appropriate for the exposure?

☐ ☐ Are emergency showers and eyewashes available and accessible in areas where toxic

 and/or corrosive materials are used? Any evidence and records of testing/cleaning?

☐ ☐ Are appropriate (by class) fire extinguishers available/charged/up-to-date in areas

 where flammable materials are used?

**Engineering Controls**

 Yes No

☐ ☐ Is broken glass placed in a heavy-walled and lined cardboard box?

☐ ☐ Are water hoses and fitting secured (hoses in good shape; wire or hose clamps across

 junctions; use of locking connectors)? If there is evidence of 24/7 water usage, does

 this appear necessary?

☐ ☐ Is there any equipment that requires investigators to be clear of a particular area during
 operation? If so, are interlocks or lock-out/tag-out in place?

**Administrative Controls**

 Yes No

☐ ☐ Is there evidence of supervision of inexperienced researchers/students?

☐ ☐ Is there any sign that inexperienced students are working alone?

☐ ☐ Does the lab have special hazards not covered above (cryogens, high

 pressure, high magnetic fields, powerful UV or laser sources)? If so, is there evidence

 of training, signage, or SOPs to warn/protect against these hazards?