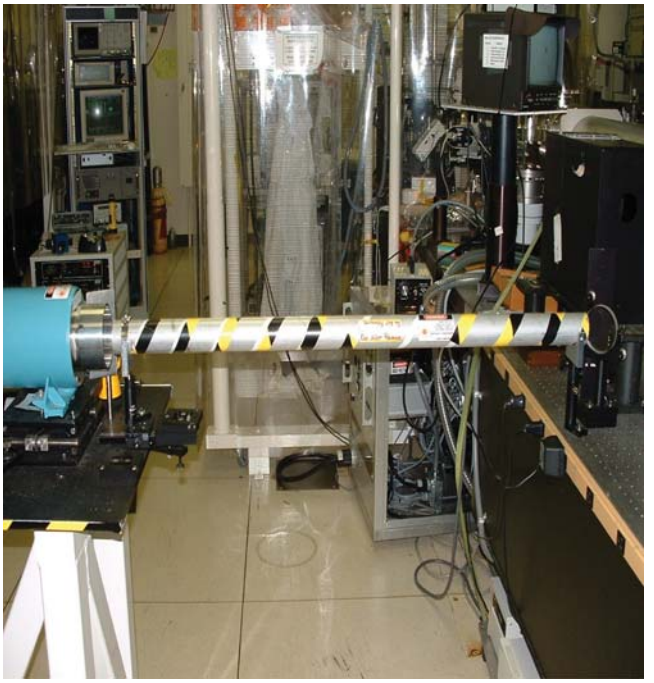

Figure 50 Fixed beam tube across walkway.

3 Environmental Factors

3.1 Utilities

These items are critical to the performance on your laser system and cannot be overlooked or taken for granted.

- Utilities shut-off controls should be located outside the lab and be labeled.

Figure 51 Device to hold long beam tubes leaving the table: (a) holder at the enclosure exit, and (b) holder for long tubes.

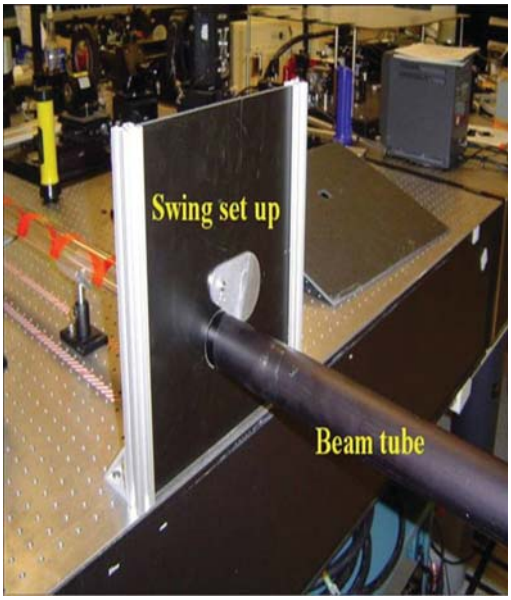

Figure 52 If the beam tube falls or is not put into place, the shutter swings down.

3.2 Temperature control/chillers

- If needed, plan for cooling chilled water loops and take into consideration how available they are.
  - Loops help to avoid excessive wastewater.
  - Many chillers can generate heat; it is critical that one think about where the pumps will be located. In a dedicated room or outside of the laser use area is the best option. A wide variety of chiller options are on the market. Select well.

Note: A wise move is to obtain the water temp history for the building in order to see temp variation range over the length of a year.

3.3 Ventilation

There are three components to consider regarding ventilation in a laser lab.

First is airflow in the room.

- Not only can excessive air currents be trouble for your experimental setup, but it can be a source of particulates from the air handling system. One needs to make sure you notice the position of air vents as they relate to the position of your experimental setup.

- A unique solution for air flow is the use of an "Air Sock" which is a system that provides air flow and stops particulates.

The second is that appropriate ventilation to remove laser generated airborne contaminates (LGAC) must be provided. If you are not familiar with LGAC, it includes carcinogenic and mutagenic chemicals produced by laser beam interaction with target materials. If you see smoke or notice an odor, ventilation is a must. For some systems or experiments, ozone production may occur, which will also need to be addressed.

The third is the need for local ventilation due to hazards in the room, both brought in and generated. The following are the standard building and institutional codes that relate to ventilation:

- Provisions should be made for local exhaust of instruments, gas cabinets, vented storage cabinets, or other operations requiring local ventilation.
- Laboratories must be designed to pull air into a laboratory from the corridor (negative pressure in relation to rest of the building).
- Placement of "supply air" and "exhaust air" vents must be located to avoid short-circuited air movement patterns. Further, in laboratories requiring tremendous volumes of supply air, such as laboratories with multiple fume hoods, low velocity air diffusers will be required to avoid turbulence and noise.
- Fume hoods.
  - Bypass style fume hoods should be used.
    - Auxiliary hoods should not be used.
  - Each hood must contain a monitoring device.
    - Ex: Magnehelic gauge.
    - Device should display either air velocity or static pressure.
      - Not just an audible alarm.
  - Canopy hoods are not acceptable for contaminant exhaust.
  - Should have recessed work surfaces to control spills.
  - Location of fume hoods, supply air vents, operable windows, laboratory furniture, and pedestrian traffic should encourage horizontal, laminar flow of air into the face of the hood, perpendicular to the hood opening.
    - Hoods should be placed away from doors and not where they can face each other across a narrow aisle.
    - Located to minimize cross-drafts and turbulence.
  - Unless otherwise specified, air pressure in lab should be negative with respect to outer hallways and nonlab areas.
  - Hoods may have a face velocity of 100 to 125 linear feet per minute with the sash fully open or at its standard configuration (at the stopper height).
  - Noise from fume hood should not exceed 65 dBa at the face of the hood.
  - Use hard ducting for the positive side of exhaust ducting for all internal fans to prevent contaminant leakage into work areas.
  - Exhaust ducts must not contain fire dampers.

- Single vertical sliding sashes are preferred over horizontal or split sashes.
- No chemicals or equipment within 6 in. of sashes during experiments.
- Debris screens should be placed in the ductwork leading from the hood.
- For perchloric acid storage, stainless steel construction, a wash-down system and a dedicated isolated fan are required.
- Radioisotopes or biological materials may require hoods with filters.
  - Hoods with filters should be designed and located such that filter may be accessed and changed easily.

- For excimer lasers:
  - Ventilation system capable of maintaining an average face velocity of 200 fpm at the cabinet's window opening when the window is fully opened.
  - Alarming airflow meter should be used to monitor and indicate low-flow conditions.

3.4 Vacuum pumps

Many laser related experiments require the use of a variety of vacuum pumps. These pumps can be sources of noise, heat, and contamination. One needs to consider their location which might lead to the pumps going into an auxiliary room.

Central vacuum systems should not be used:

- these are vulnerable to contamination.

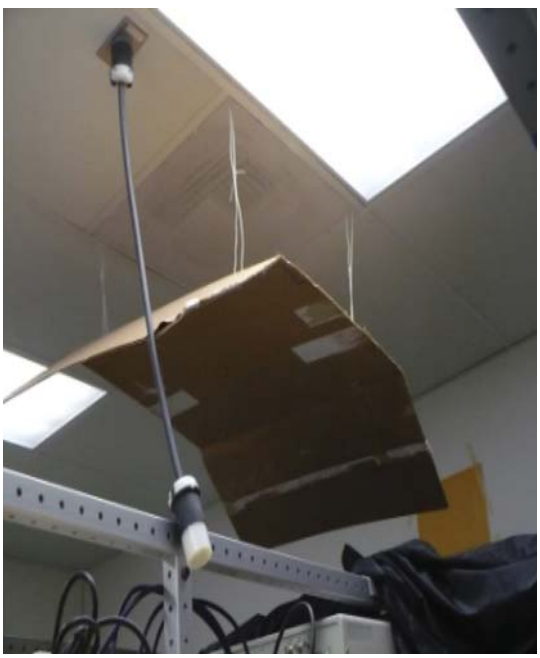

Figure 53 Homemade airflow shield.

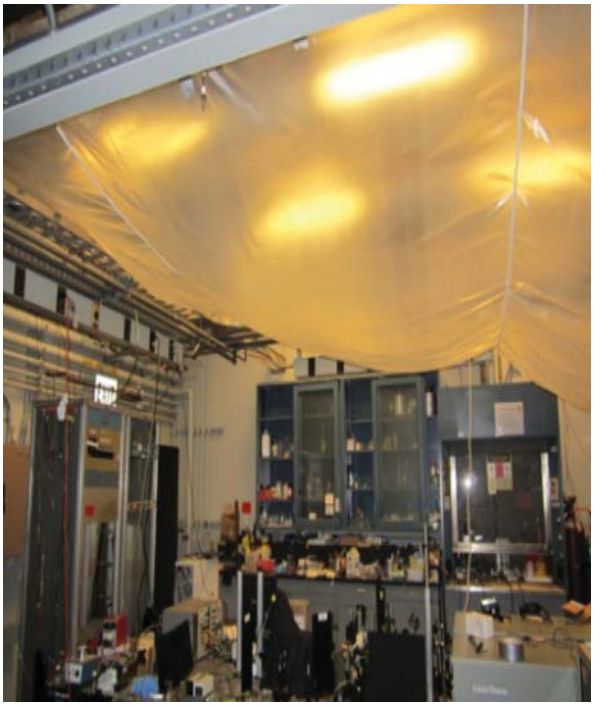

Figure 54 Plastic hanging from ceiling to trap particulates from air handling system.

Figure 55 Box being used to avert downward air currents.

Figure 56 Example of an "Air Sock" ventilation approach.

- All vacuum lines should have cold traps or filters to prevent contamination.
- Auxiliary valves for gas/vacuum lines should be located outside the lab.

3.5 Lighting

You need to consider room lighting requirements and experimental lighting requirements. If work is light sensitive, task lighting may be needed just for vision in the lab during experimental runs.

- Windowless labs need to have emergency lighting.

3.6 Fire safety and controls

Fire safety cannot be overlooked in your design process. Consider the following:

- coaxial cables near the beam path can melt and give off noxious fumes.
- dangling wires can be a combustion source. They can also block your beam path. If you have wires hanging from shelves above the optical table, make sure they are clear of the beam.
- floor to ceiling curtains can block fire sprinkler patterns.

For fire safety, check for placement of:

- smoke detectors.
- sprinkler heads.
  - Additional ones may be necessary if there is gas use.

- Fire extinguishers:
  - should be conspicuously labeled, particularly if recessed.
  - appropriate for chemicals/equipment in use should be placed near the entrance of each lab, mechanical, electrical room.
  - carbon dioxide fire extinguishers rather than dry chemical extinguishers should be used.
- Fire alarm annunciators.
- Some chemical operations may benefit from hood fire suppression systems.
  - Ex: Distillation hoods.
- Flammable/combustible construction materials shall be avoided in spaces with a class 4 laser.

3.7 Electrical power

- Determine how much power you will need for experimental equipment.
  - Where the outlets for such power will go.
  - Number and location of standard 110 V outlets for scopes, etc.
- Wires/equipment present electrical hazards.
  - If wires are disconnected or damaged, electrical pulsars for Pockels cells can be a hazard.

Figure 57 Excimer gas cabinet.

Figure 58 Gas cylinder holder.

- Labs should have an abundant amount of electrical supply outlets to eliminate the need for extension cords and multiplug adapters.
  - Outlets can accommodate electrical current requirements with an additional 20% to 40% capacity.
- Electrical systems shall be marked to show voltage, frequency, and power output.
  - All high voltage sources need to be marked properly and secured to prevent accidental access.
- Electrical receptacles:
  - provide ground fault indicator (GFI) protection to electrical receptacles above counter tops and within 6 in. of sinks, safety showers, and other sources of water.
  - For those receptacles that are not readily accessible or those for appliances occupying dedicated space, which are cord-and-plug connected, they are exempt from the above requirement.
- Electrical outlets need to be positioned such that leakage of water coolant will not lead to risk of electrocution.
  - Away from cooling water pumps, lines, filters, etc.

- Grounding:
  - ground fault circuit interrupters should be installed near sinks, wet areas, near water-cooling systems.
  - Consider using chilled water loops.
  - appropriate grounding connections for laser power supplies/electrical components.
  - ground all optical tables, all tables with energized equipment, racks that contain energized equipment.
  - mark all grounding connections.
- Circuit breakers—located outside the lab, not in rated corridors.
- Protection against electric shock:
  - barrier system for energized conductors.
  - unplug before working with equipment.
- Working with or near live circuits should be avoided.

3.8 Eyewash/shower station

Must be installed in labs with fume hoods. Also consider that laboratories using hazardous materials must have an eyewash and safety shower within 55 feet or 10 s travel time from the chemical use areas.

- Items that cannot be close to them:
  - no obstructions, protrusions, or sharp objects shall be located within 16 in. of the center of the spray pattern of the emergency shower facility (i.e., a 32-in. clearance zone shall be provided).

Figure 59 Clear space around electrical panel marked off and clear.