**Safety in the NMR lab**

This note must be read and understood by all NMR users.

POLY’s NMR instrument uses large superconducting magnets that are housed in a cryostat containing liquid helium and liquid nitrogen.

**Magnetic Field Hazards**
Magnets will exert large attractive forces on equipment or other magnetic objects when brought close. The force may become large enough to move the equipment uncontrollably towards the NMR magnet. Small pieces of metallic subjects (wrenches, screwdrivers...) may become projectiles. Large equipment (gas cylinders) can cause bodies or limbs to become trapped between the equipment and the magnet. Keep in mind the following:

The closer to the magnet, the larger the force.
The larger the mass, the larger the force.

**Rules:**
- Do NOT bring any metallic object within 5 feet of any magnet. Assume all metallic objects are ferromagnetic and will be attracted to the magnets, unless verified by NMR staff.
- Do NOT bring compressed gas cylinders into the NMR laboratories without NMR personnel supervision.
- NEVER put any object into the magnet, except the NMR tube and holder. Never put a magnetic stir bar inside a NMR tube into the magnet!

**Medical Implants**
The operation of electronic, electrical or mechanical medical implants, such as cardiac pacemakers, biostimulators, and neurostimulators may be affected or even stopped in the presence of either static or changing magnetic fields. Medical implants such as aneurysm clips, surgical clips or protheses may contain ferromagnetic materials and therefore would be subjected to strong attractive forces near the magnet. This could result in injury or death. Additionally, in the vicinity of rapidly changing fields (pulsed gradient fields), eddy currents may be induced in the implant resulting in heat generation.

**Rules:**
- Persons with these types of implants MUST remain outside the NMR laboratories until more extensive safety training is provided.

**Cryogen Hazards**
Cryogens such as liquid nitrogen (LN2) and liquid helium that are present in the magnet cryostat and portable dewars may pose several dangers, including asphyxiation, frostbite and chemical explosions. A) When a magnet quenches, or suddenly becomes non-superconducting, large amounts of liquid cryogens are quickly vaporized. Due to their large expansion ratios (nitrogen 695:1, helium 760:1), these gases can quickly displace all the oxygen in the NMR room and cause asphyxiation. Effects from oxygen deficiency become noticeable at levels below ~18% and sudden death may occur at ~6% oxygen content by volume. B) Direct contact with cryogenic substances in liquid or vapor form can produce “cold burns” on the skin similar to conventional burns. The temperature of liquid helium is ~269 C and of liquid nitrogen is ~196 C. C) Cryogenic fluids with a boiling point below that of liquid oxygen are able to condense oxygen from the atmosphere. Repeated replenishment of the system can thereby cause oxygen to accumulate.
Violent reactions, e.g. rapid combustion or explosion, may occur if the materials, which make contact with the oxygen, are combustible.

**Rules:**
- If you observe a sudden exhaust of gas from a magnet (and NMR staff are not performing a cryogen fill) or if the oxygen sensor alarm sounds, EXIT the NMR laboratory IMMEDIATELY.
- NMR staff periodically must replenish the magnet’s cryogens. During a fill, keep away from the gaseous exhaust from the magnet as frostbite burns may result.
- When handling cryogens, wear gloves, googles, and closed toe shoes.
- When doing low-temperature NMR work and using the LN2 dewar, beware of liquid splashing and rapid flash off of LN2 when immersing the variable-temperature NMR apparatus into the dewar. This operation must be carried out very slowly.
- Always replace the loose-fitting cap onto the LN2 dewar to avoid the condensation of oxygen in the dewar.

**NMR Tube Safety**
NMR tubes have thin walls and are easily broken. Once broken, they are extremely sharp. When inserting NMR tube into spinner, grasp the tube close to the spinner. This will avoid applying a torque that can easily break a tube and, often, drive it into a finger.

**Chemical Safety - Hazardous and dangerous materials**
All users who conduct experiments with hazardous materials, including toxic and radioactive materials, including pressurized, explosive, or otherwise unusually hazardous materials must consult with relevant PIs and NMR supervisor.

**Rules:**
- When using NMR tubes filled with highly toxic and dangerous materials, please transport NMR tubes in appropriate safety containers, not simply in a flask or other open container, or carried by hand.
- NMR tubes are often broken in and around the NMRs. Please clean up non-hazardous spills and broken glass.