SURF MRI/NMR Initial Outline

Goals

1. Help develop solution to time-varying local magnetic field that disrupts MRI experiment.
2. Investigate possible extensions to NMR experiment.

Specific Safety Issues

- MRI coil is heavy; NMR magnetic field is strong.

MRI

1. Become familiar with existing Magritek Terranova MRI experiment:
    - Observe MRI free induction signal, observe varying frequency
2. Calculate how big a set of Helmholtz coils are needed to create a uniform (0.1% to 0.01%) magnetic field over the sample volume of the MRI detector.
    - Code **B**(x,y) solutions from "*On the magnetic field near the center of Helmholtz coils*", M.S. Crosser et al., Review Of Scientific Instruments **81**, 084701 (2010).
    - Confirm results by independently calculating in Python and one other form (e.g. MatLab, Excel, C++, Fortran, …).
3. Test Rock Magnetism Coils
    - Figure out how to turn them on without burning anything out.
    - Measure physical/electric parameters of coils.
    - Measure field vs current at different locations and compare with calculations.
    - place MRI coils inside coils, set 0.5 gauss field, observe if free induction signal is present.
4. If less than perfect success with previous step, repeat with Muon Coils.
5. Depending on success with above results, if/when fluxgate magnetometer (http://www.stefan-mayer.com/Lcsing.htm), try active compensation.
    - First need measurements of Terranova interior compensation coil.
6. Study RF and magnetic shielding with various metals.

NMR

1. Become familiar with existing NMR experiment:
    - Observe MRI free induction signal, spin echo in $FeCl_3$ solution
    - Observe signals in distilled water as reference
    - Measure approximate magnetic moment of F^{+++} ion.
2. How accurately can resonance frequency be measured? What is linewidth? Is there any hope of observing chemical shifts of a few ppm? (Very unlikely, but worth confirming.)
3. Convert Equation 14 in manual from cgs to SI. (This is not trivial, which is why no one has gotten around to it before.)
4. Look at NMR signal in other hydrogen rich materials, e.g. pure alcohol, various oils, paraffin, plastic, fat, …
5. Can magnet moment of other ions be measured, e.g. other Fe, Co, Ni ions?
6. Can F19 NMR be seen, e.g. in Teflon or other safe fluorine rich samples?