Refinements in Sensor Calibration for Positron Accumulation at ATRAP

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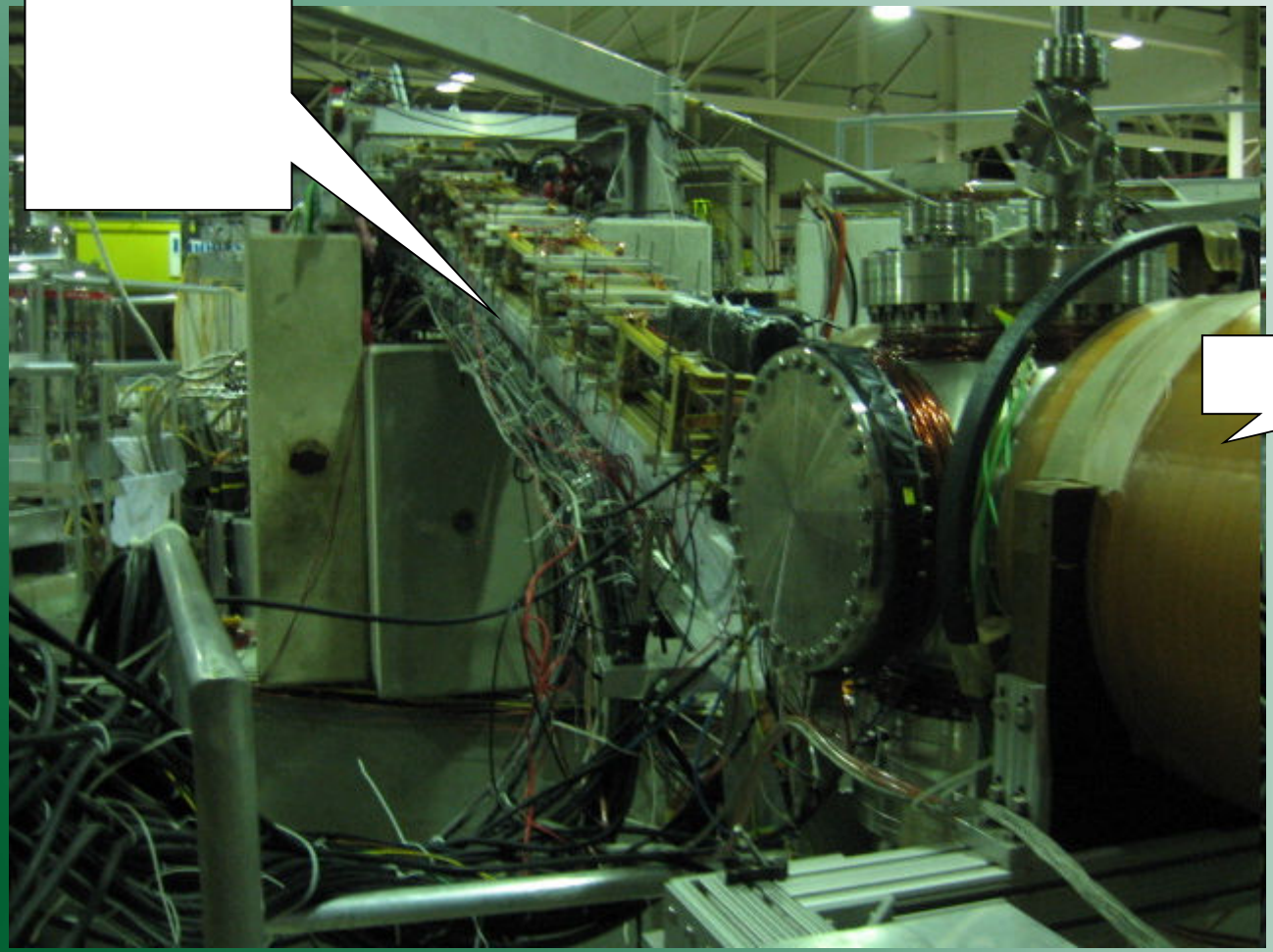
Review

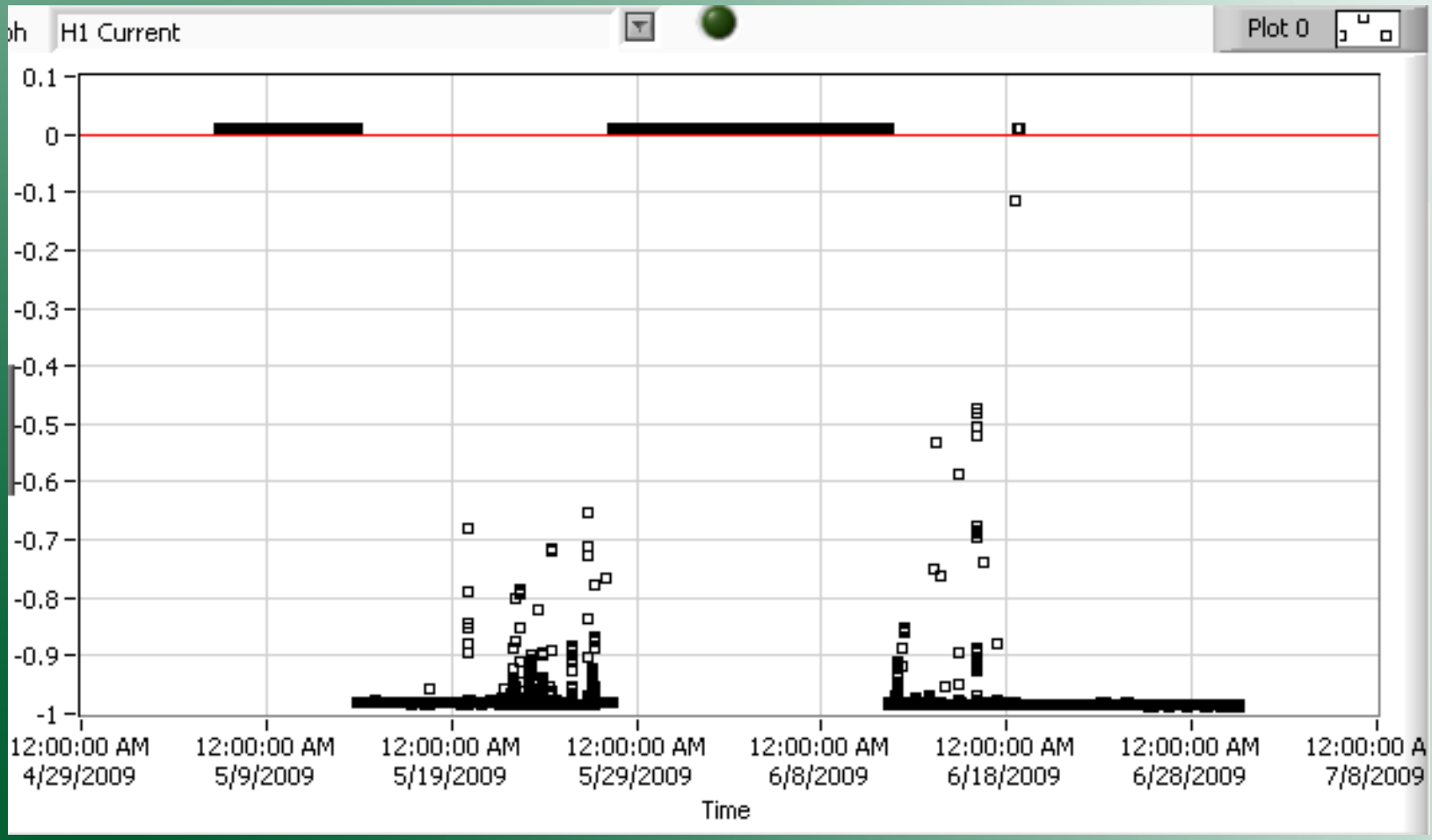
- ATRAP obtains positrons from a Na-22 source (half-life 2.6 y)
- Positrons are then cooled by a Ne moderator and collisions with gas molecules in a Penning trap
- Cooled positrons are transferred through two sections (2m and 3m) of 95 electromagnets until they reach cooled antiprotons
- Sufficiently cooled antiprotons and positrons can combine to form antihydrogen



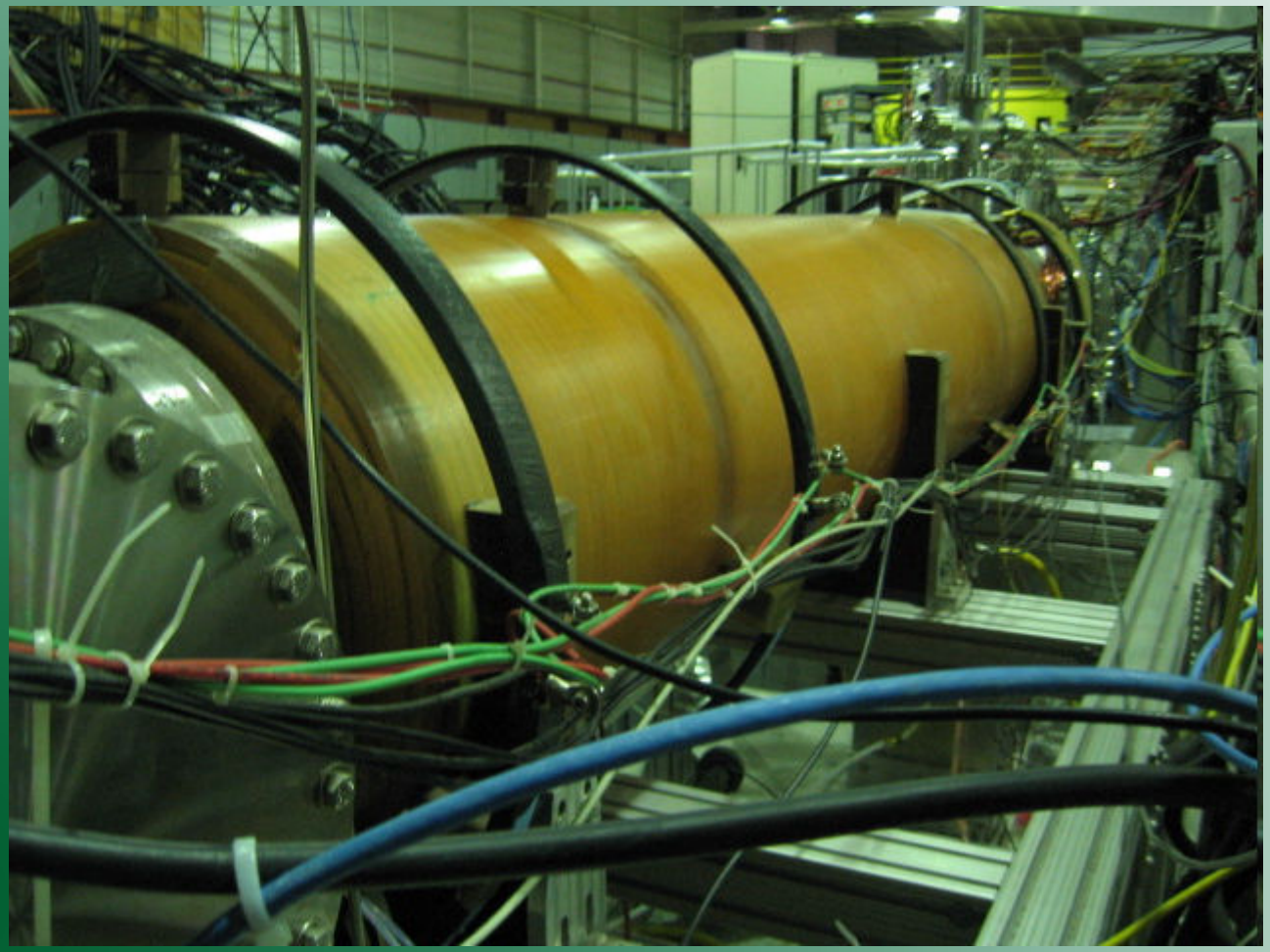
Challenges

- Unexpected behavior visible in logged data from the power supplies that generate the magnetic field in the positron transfer line
- Measurements of magnetic field around Penning trap show unexplained background readings—sensor calibration problems?

Logging of the current applied to one of the 95 magnets



Measure the magnetic field around the accumulator



Solution

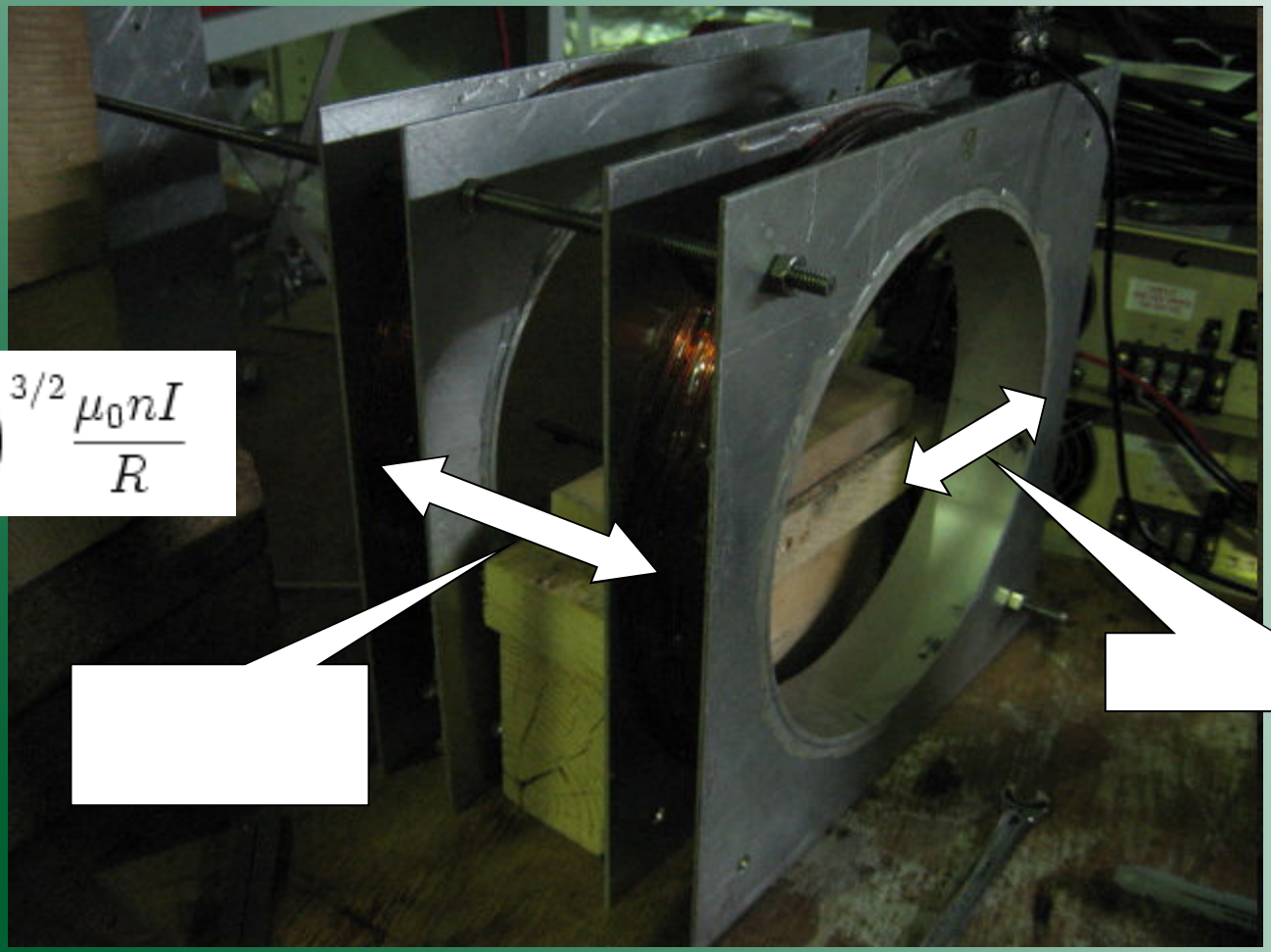
- Voltage readings from magnetic field sensors are converted from volts to gauss using a database of calibration equations specific to each magnetic field sensor
- Recalibration of the magnetic field sensors may be necessary to provide more accurate equations for voltage-gauss conversion

Magnetic Field Sensor Calibration

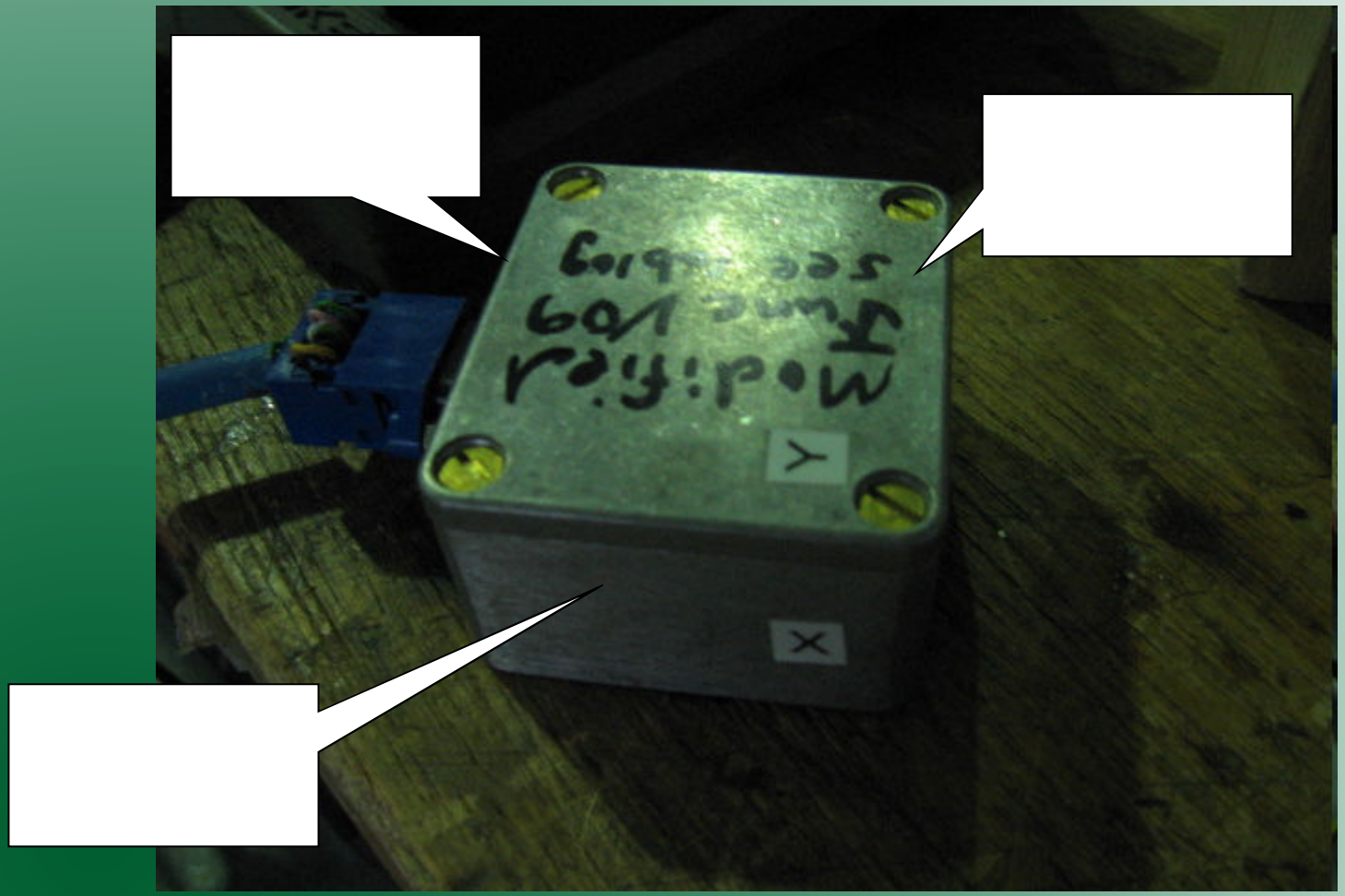
- Set up Helmholtz coils (coil separation=coil radius) to create uniform magnetic field
- Measure field at different current values with a Gaussmeter to obtain equation describing ideal variation of magnetic field with current
- Measure the voltage output of the magnetic field sensor within the Helmholtz coils at various applied currents; use readings to define variation of voltage with current
- Compare equations to obtain relationship between voltage readings of the magnetic field sensor and the Gaussmeter

Helmholtz Coil

$$B = \left(\frac{4}{5}\right)^{3/2} \frac{\mu_0 n I}{R}$$



Magnetic Field Sensor



Background (V)			Background (gauss)		
x	y	z	x	y	z
2.220	2.210	2.215	-9.664	-9.727	-9.377
2.220	2.210	2.215	-9.664	-9.727	-9.377
2.220	2.210	2.215	-9.664	-9.727	-9.377
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Background (V)			Background (gauss)		
x	y	z	x	y	z
2.220	2.210	2.215	-0.416	-1.031	-5.279
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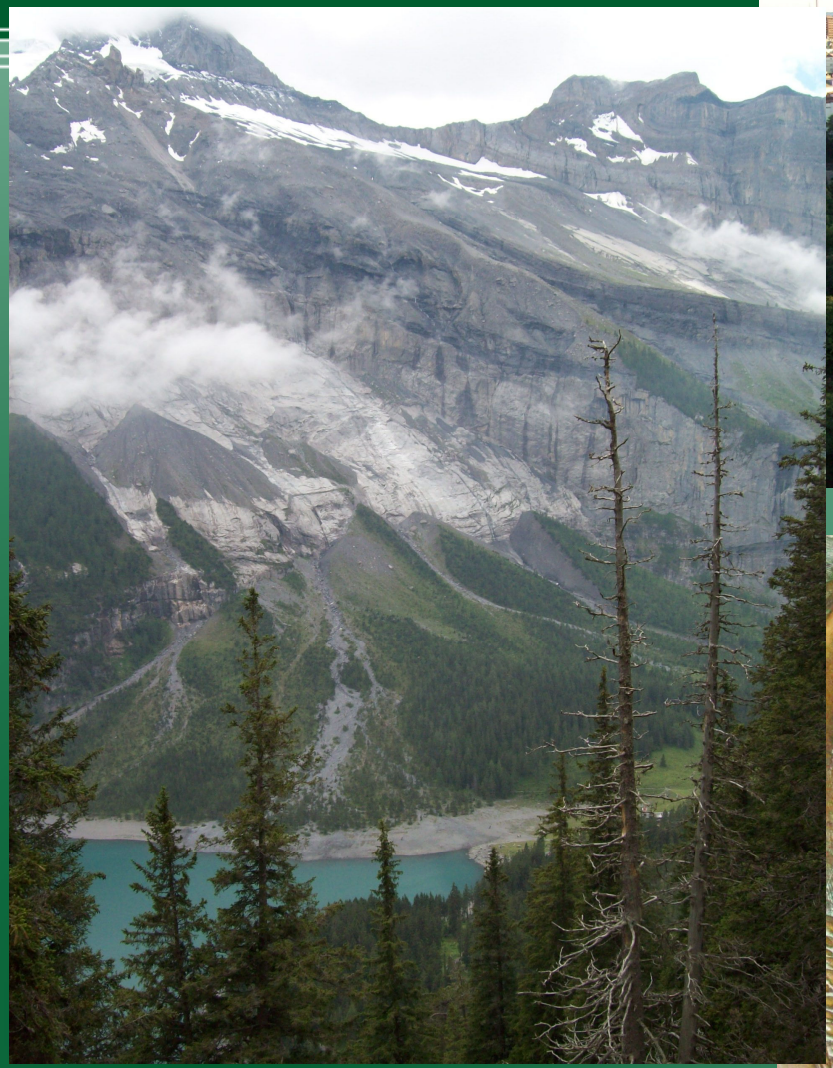
Future Work and Questions

- Should other magnetic field sensors on the electromagnet arm be recalibrated as well?
- Program the power supply that controls the voltages on the Penning trap electrodes to automatically cycle through the trapping potentials for every positron accumulation and positron transfer.