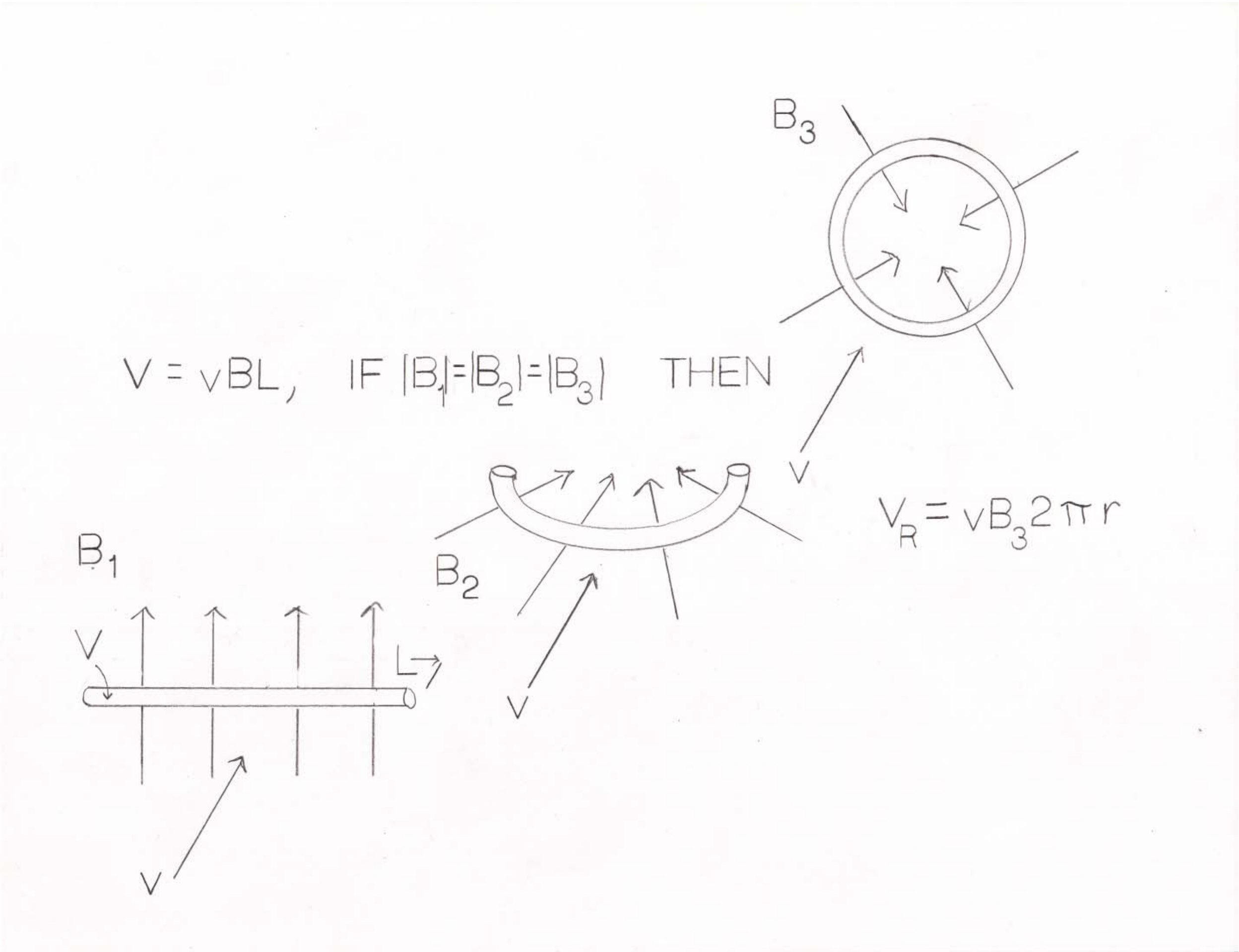
Faradays Law and an Instrumented Magnet Drop Tube:

The lower left frame in the illustration below shows a classic example of Faraday's Law of induction. A conductive bar, length L is travelling with a velocity v through a perpendicular magnetic field B_1 generating a voltage (V) across the length of the bar. The middle frame shows a bent bar in a bent magnetic field, the field lines of B_2 are perpendicular to the bent bar. The ring on the right also has a velocity v and is travelling through a radial magnetic field B_3.



If the magnitude of the three B fields are the same, i.e they have the same flux density per length, all examples would have the same induced voltage across the bar, and around the ring. This logical sequence was intended to emphasize that the currents induced in our polarimetry sensors are induced by the radial magnetic fields of the polarized electron bunch.

If it is also accepted that a ring moving ring through a stationary field, is the same thing as a moving field through a stationary ring, then, the radial component of the magnetic field of a polarized electron bunch could help determine the energy exchange between passing polarized electron bunches and our polarimeters.

The magnetostatic modeling program FEMM can be used to measure the radial component of magnetic field from a magnetic material. When a polarized electron bunch is carefully modeled in FEMM, the models radial magnetic field can be used to calculate the voltage induced in a ring or in a tube and the conductivity of the ring or tube will provide current and power.

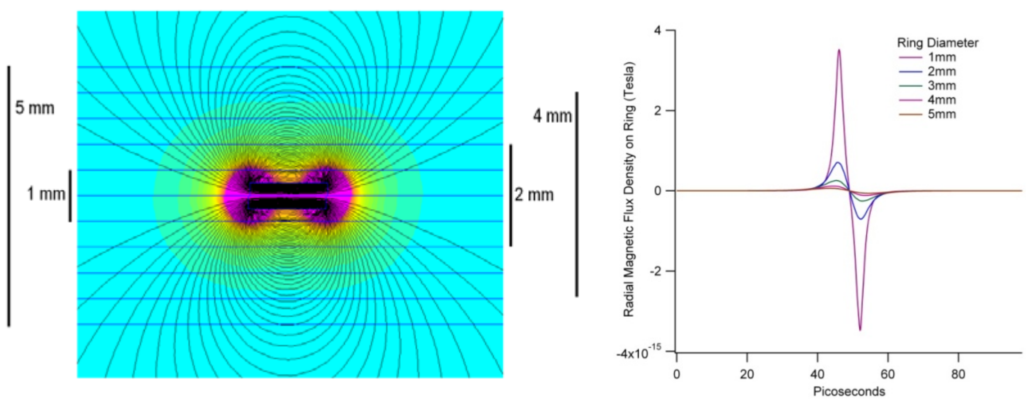


Figure 2a: A magnetostatic model 2b: The radial magnetic field as a function of ring radius using the program FEMM.

To validate this approach, and to validate the process of modeling a custom material, a simple experiment has been assembled, a magnet drop tube shown in figure 3.

When a magnetostatic model of the Hitachi NdFeB magnets is constructed, it will be used to compare the drop tube velocities with different weights driving the magnet. With no weights these magnets drop slowly, taking 13 second to travel the one meter tube. Induced current, voltage, induced B etc. will be compared to gravitational potential energy and velocity, keeping the math on track.

Figure 3: Magnet drop tube with photosensors one meter apart measuring velocity with an oscilloscope. The magnets in the background are fully characterized NdFeB disks.