ELECTRON SPIN RESONANCE

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BACKGROUND

- The electron has a dipole moment that is related to its angular momentum (spin)
- The g-factor is a constant characteristic of the electron relating these two quantities
- A magnetic field can interact with a dipole moment flipping an electrons orientation
- can only be oriented in two ways due to its quantum nature

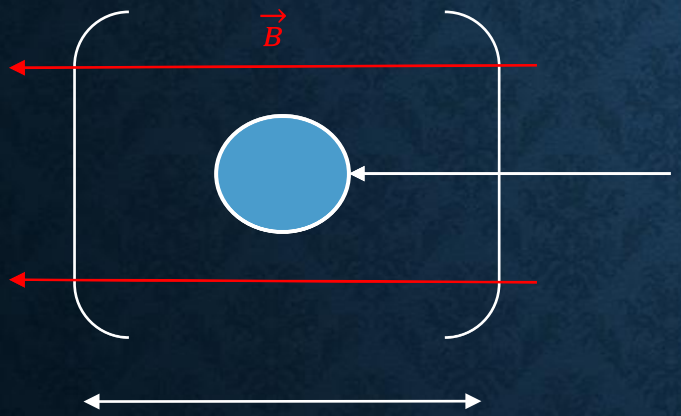
GOAL

Take advantage of the relationship between the magnetic dipole moment and angular momentum (spin) of an electron to find an experimental value of the g-factor

Prediction: g-factor will have a value of 2.0023 (one of the most precise measurements in physics!!!)

EXPERIMENTAL SET UP

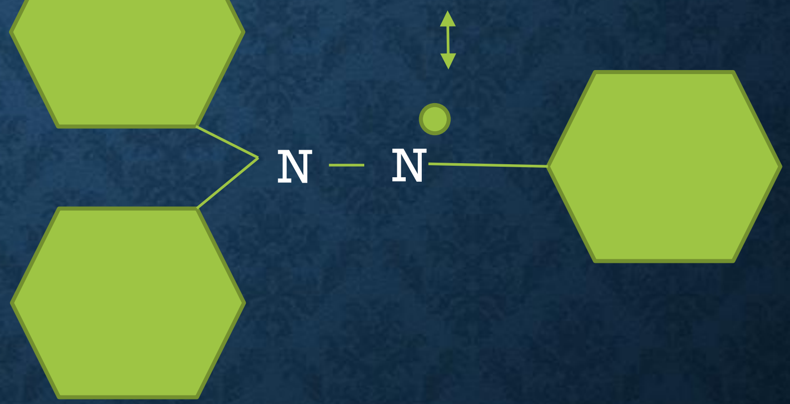
Front view of
Helmholtz Coil



Sample of
DPPH
surrounded
by a coil

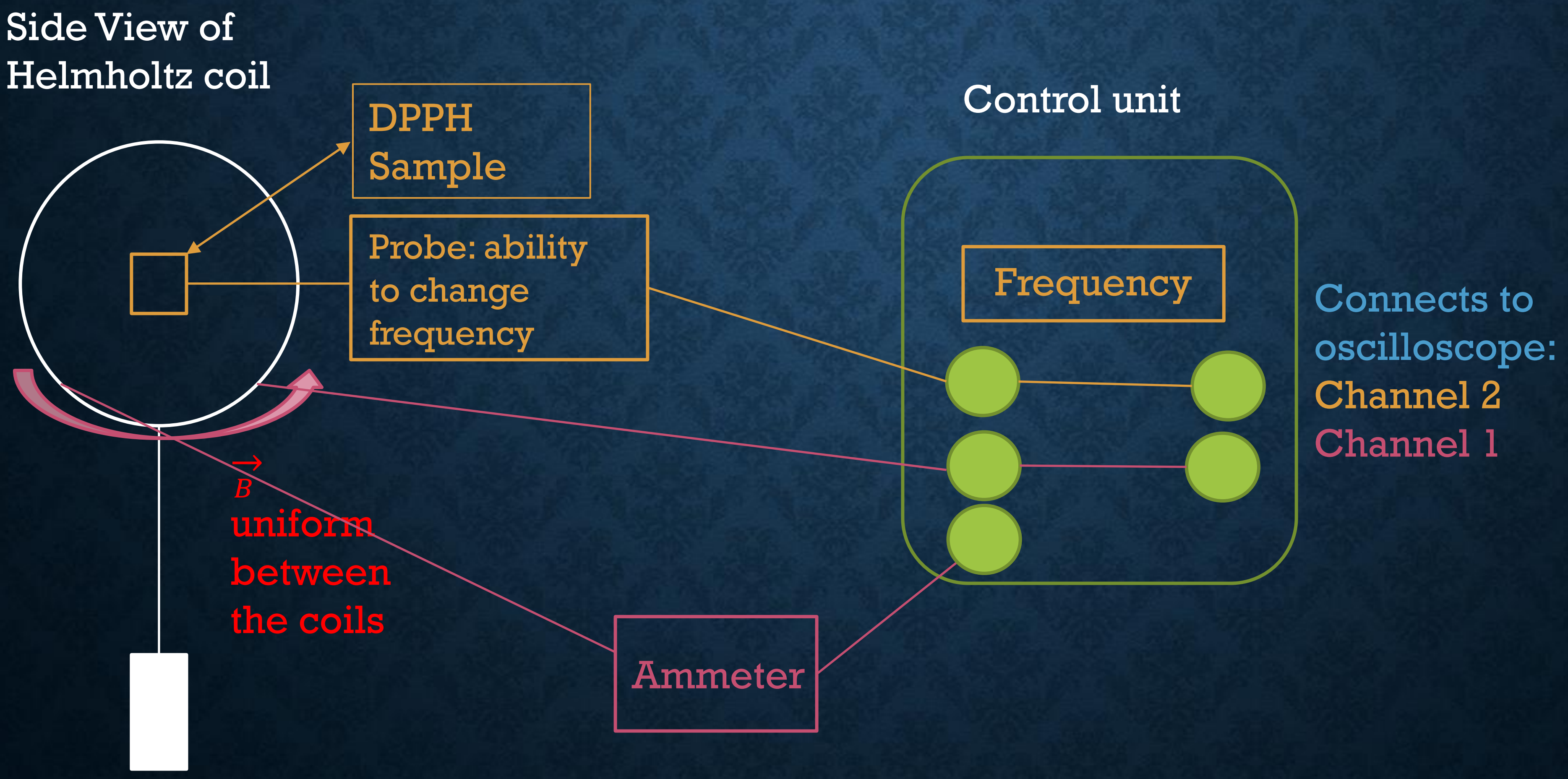
Distance = Radius (.068m)

Free
electron



DPPH Molecular representation

EXPERIMENTAL SET UP



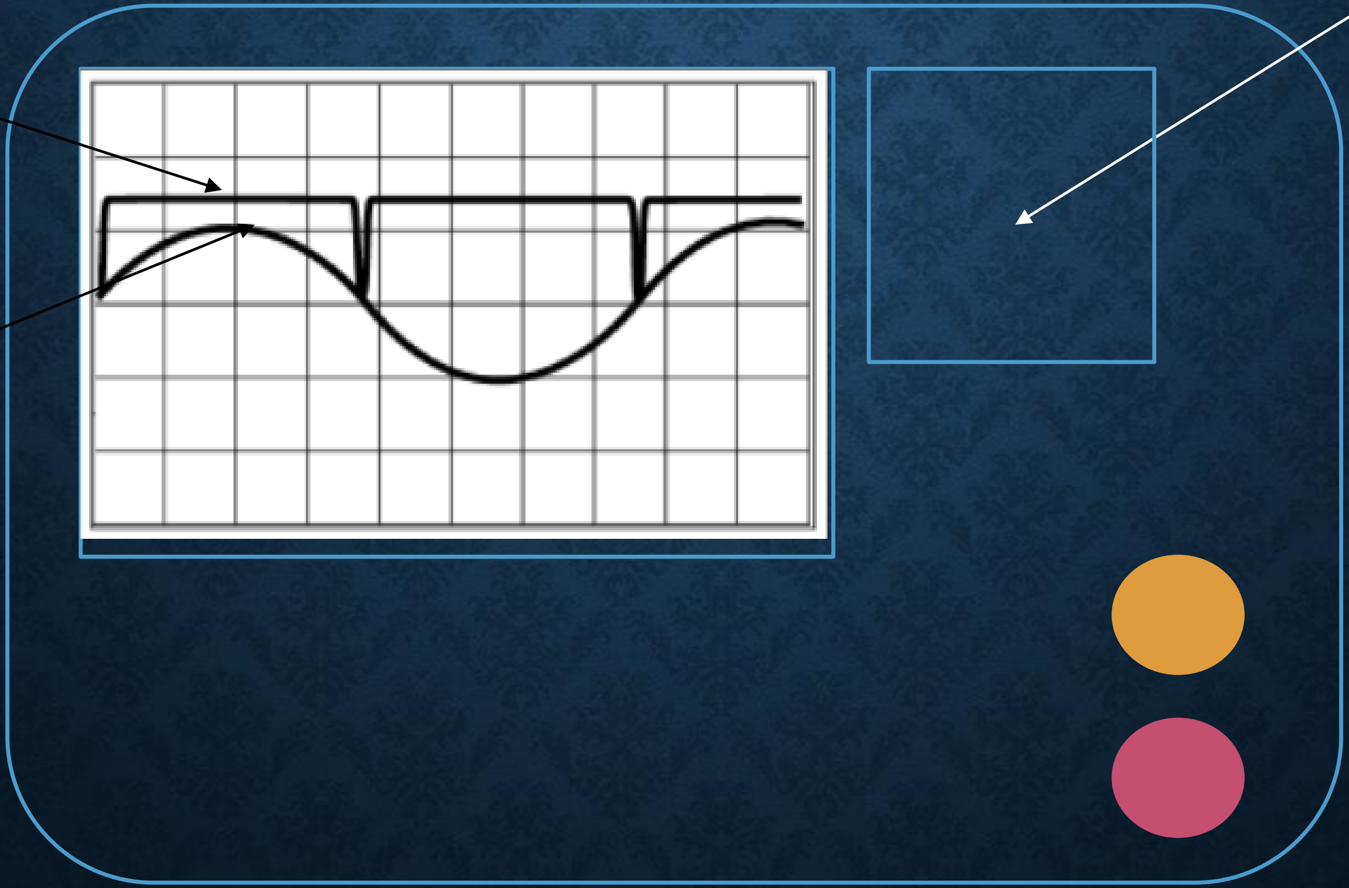
EXPERIMENTAL SET UP

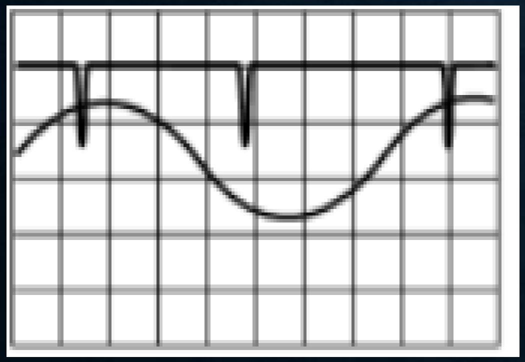
The oscilloscope

Knobs that allow adjustment of sensitivity and sweep rate

represents when the electron takes energy (the dips)

DC and AC current super positioned





Channel 1

Channel 2

CALCULATIONS

- Only 2 orientations means 2 energies
- Difference between energy levels is related to the g-factor

$$h\nu = g_s \mu_b B$$

- Assumes infinitesimally thin Helmholtz coil

Constant	Value
h	6.582 * 10^-16 (eV/G)
μ_b	5.788*10^-9 (eV-sec)
g_s	2.0023

- B (magnetic field) is calculated
- ν(Frequency) is taken off of control unit

FINDING THE MAGNETIC FIELD

$$B = \mu_0 (\frac{4}{5})^{\frac{3}{2}} N (\frac{I}{R})$$

Where:

- $\mu_0 = 1.256(10^{-6})(\frac{Vs}{Am})$
- N = Number to turns in coil per meter = 320 $(\frac{Turns}{meter})$
- I = current running through the coil (changing)
- R = Radius of coil = .068 (m)

Amps (I)	Magnetic field	δMagnetic Field
0.4	0.00169	0.000501
0.45	0.0019	0.000563
0.48	0.00203	0.000601
0.53	0.00224	0.000663

G-FACTOR CALCULATION

$$h\nu = g_s \mu_b B$$

$$g_s = \left(\frac{h\nu}{\mu_b B}\right)$$

Where:

- h= $6.582(10^{-16})(\frac{eV}{G})$
- v= frequency(dampened)
- $\mu_b = 5.788(10^{-9})(eVsec)$

Frequency (MHz)	Amps (I)	Magnetic field	δMagnetic Field	G-Facor	δG-factor	With in 2.002?
45	0.4	0.00169	0.000501	3.02	0.895	No
50	0.45	0.0019	0.000563	2.69	0.796	Yes
55	0.48	0.00203	0.000601	2.8	0.829	Yes
60.2	0.53	0.00224	0.000663	2.28	0.676	Yes

FUTURE WORK

- Use an infinitesimally thin coil
- Use a model that takes into account thickness of coil
- Create a perfect Helmholtz coil
- Center the DPPH perfectly in the coil
- Use other materials that are not DPPH for reproducibility