# Abstract


- Presentation content summarizes the basic concepts behind magnetic hysteresis and the magneto-optical Kerr effect. Topics include magnetic domains, hysteresis, the Faraday Effect, and the Kerr effect. The reasons and methodology for using the magneto-optical Kerr effect (MOKE) in measuring magnetic hysteresis at the Stanford Synchrotron Radiation Lightsource are explained. The design and setup up of a device used to measure the MOKE are demonstrated including the MATLAB graphical user interface written to control the device and collect data. Results obtained from the aforementioned device are presented. Hysteresis loops collected from the device are compared to predictions stemming from the Stoner-Wohlfarth model.

# Measuring magnetic hysteresis through the magneto-optical Kerr effect

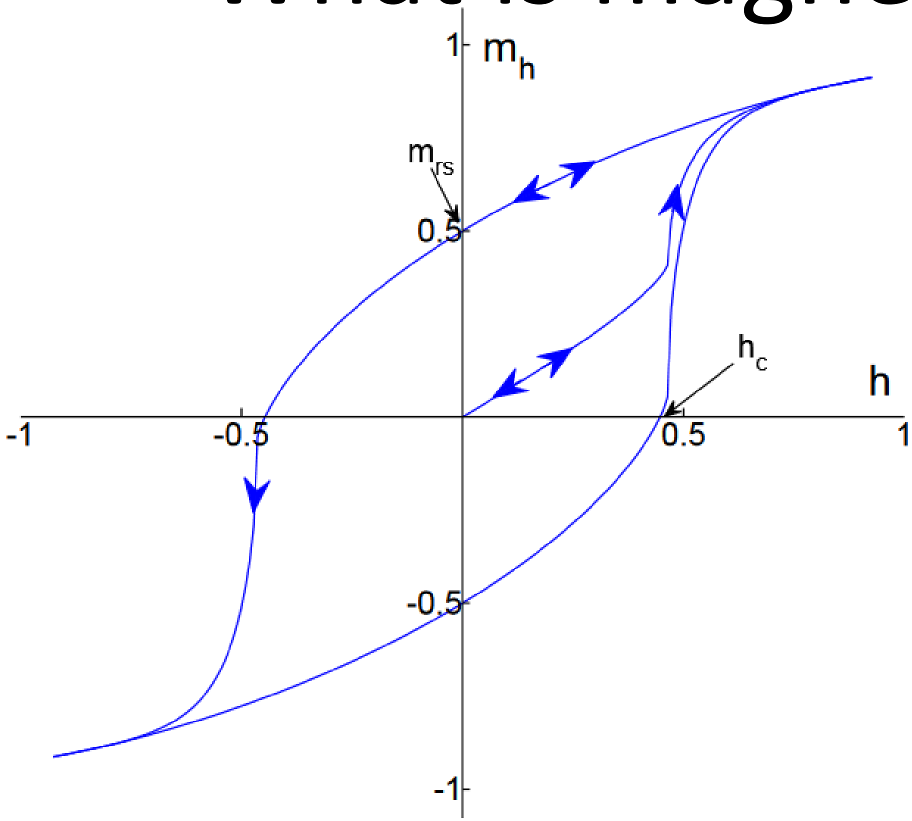

Alex Crawford

under Hendrik Ohldag

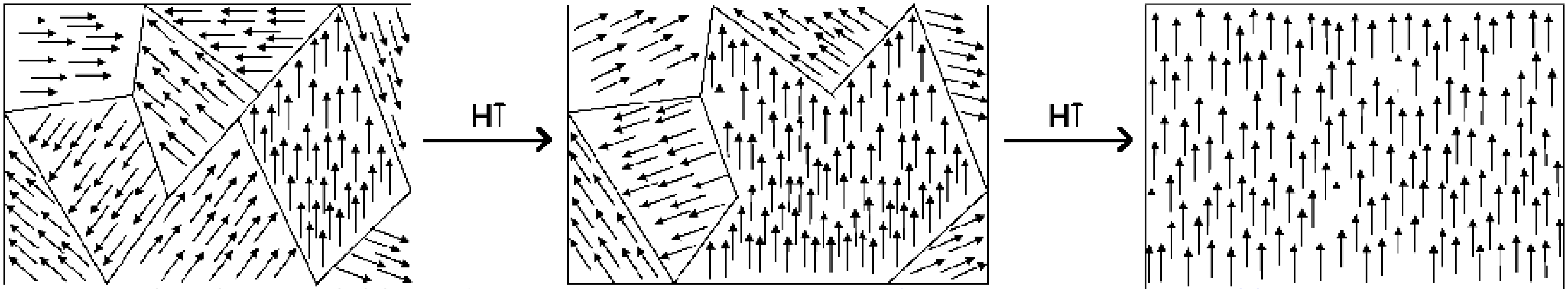

August 16, 2012

SULI

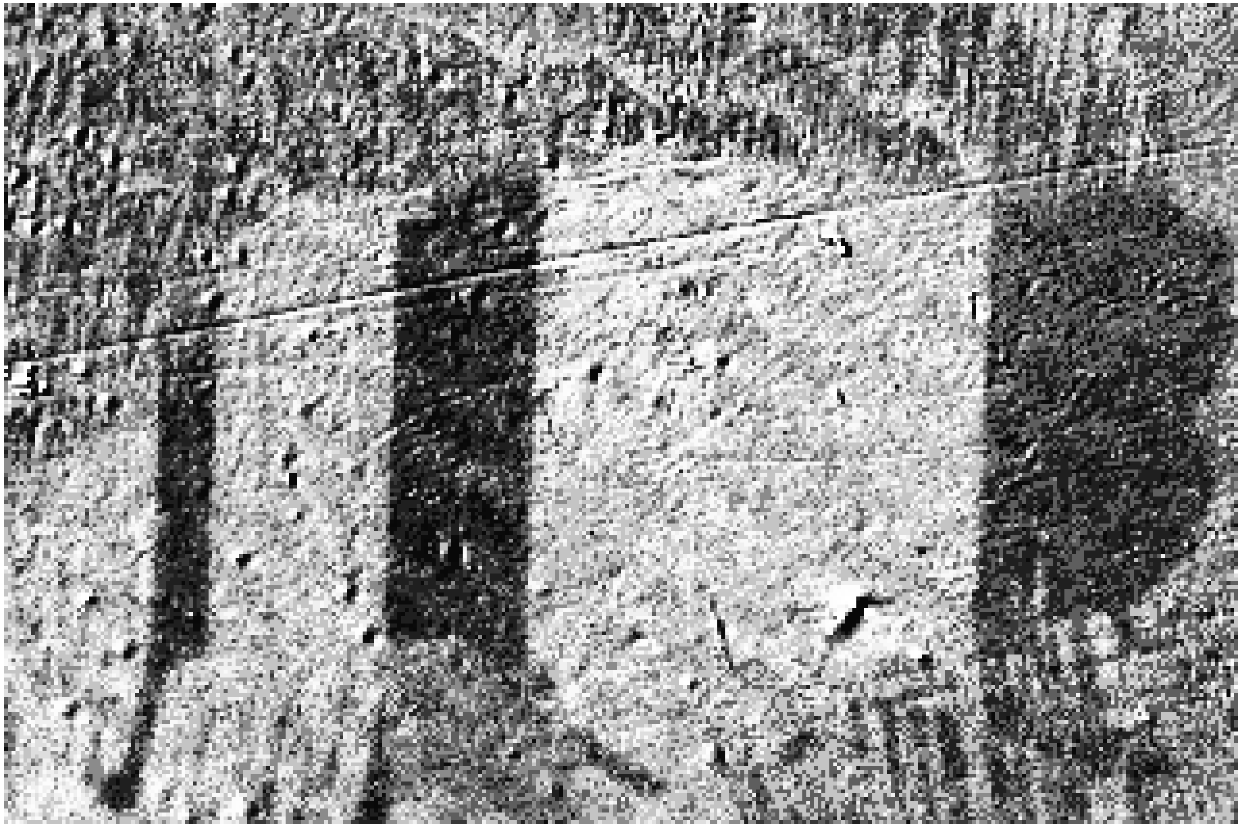
# What is magnetic hysteresis




- Current state is dependent on past history
- Loop behavior
- Magnetic behavior determined by size and shape of hysteresis loop

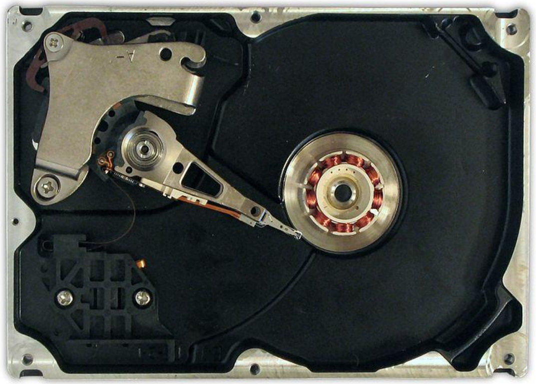


# Switching of Magnetic Domains

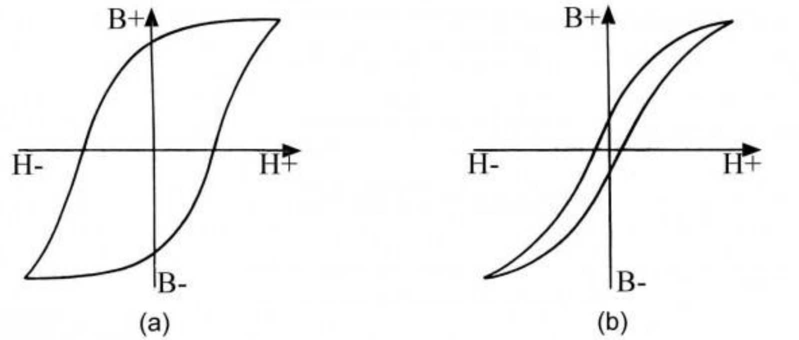


# Why measure hysteresis?

- Magnetic memory
- Permanent magnets
- Determine practical applications

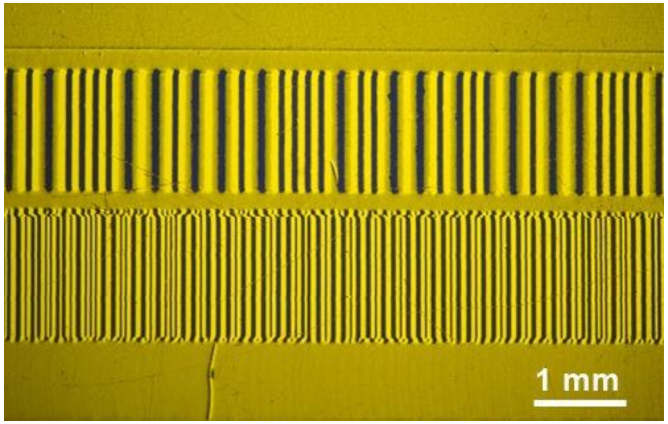






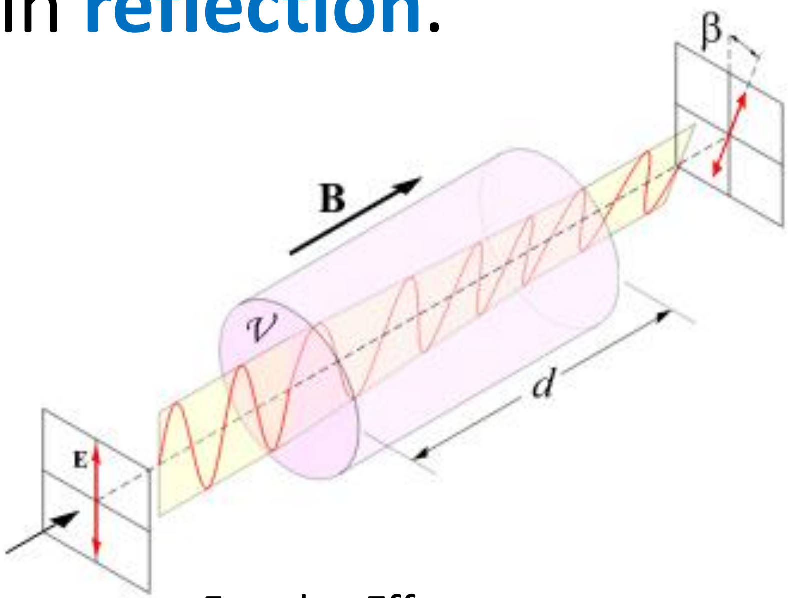

Hard

Soft

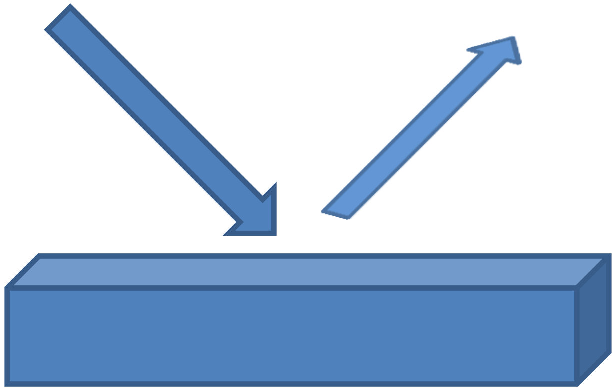


# Faraday and Kerr effects

- The **Faraday** effect is the rotation of polarized light in a magnetic  medium during **transmission**. The **Kerr** effect is analogous but in **reflection**.



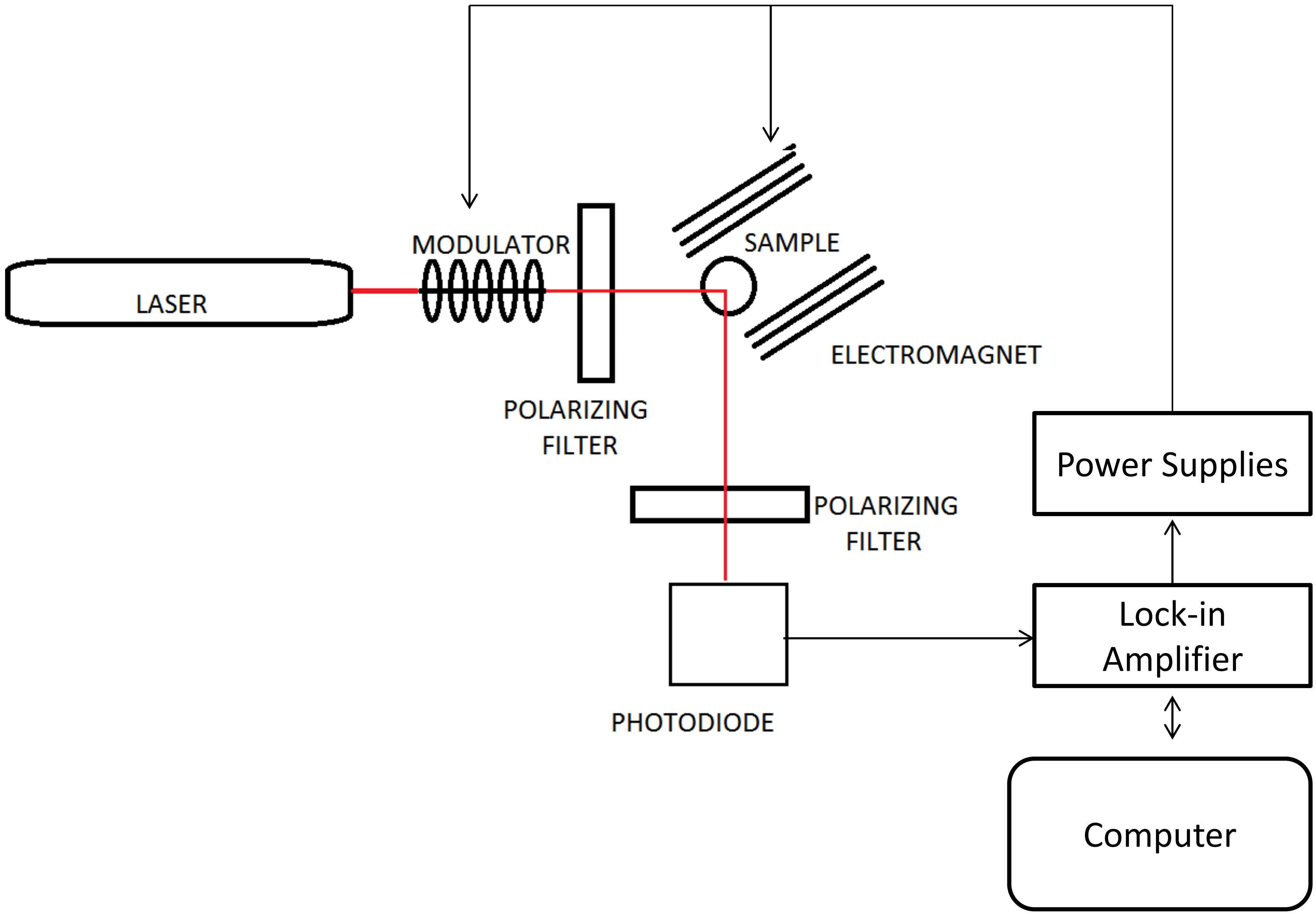

Faraday Effect



Kerr effect

Image by Dr.Bob, available under a GNU Free Documentation Licence

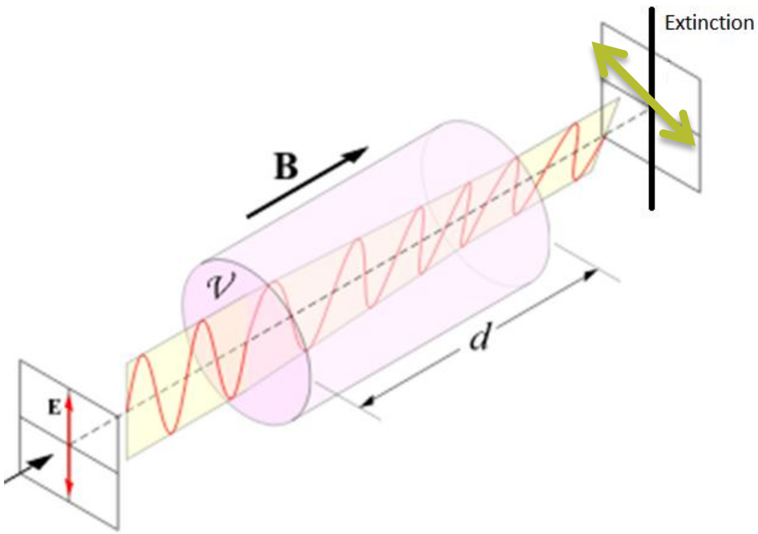
# Measuring hysteresis using the MOKE

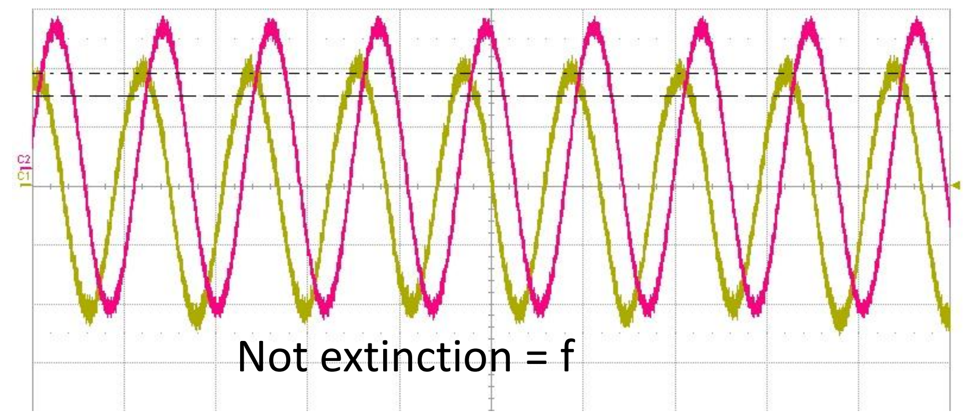


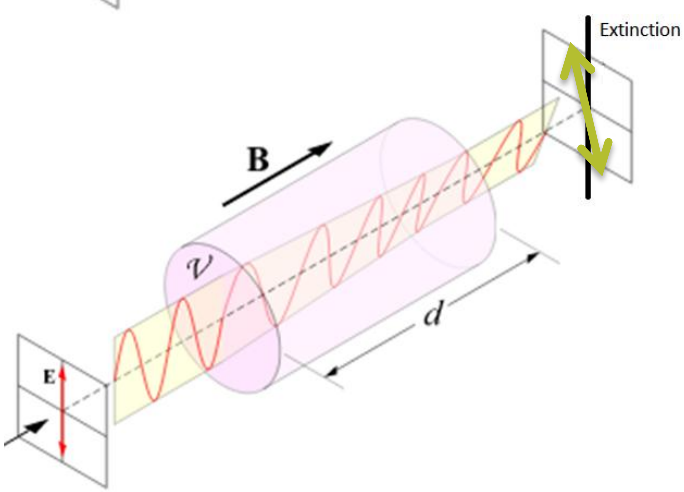
# Modulation

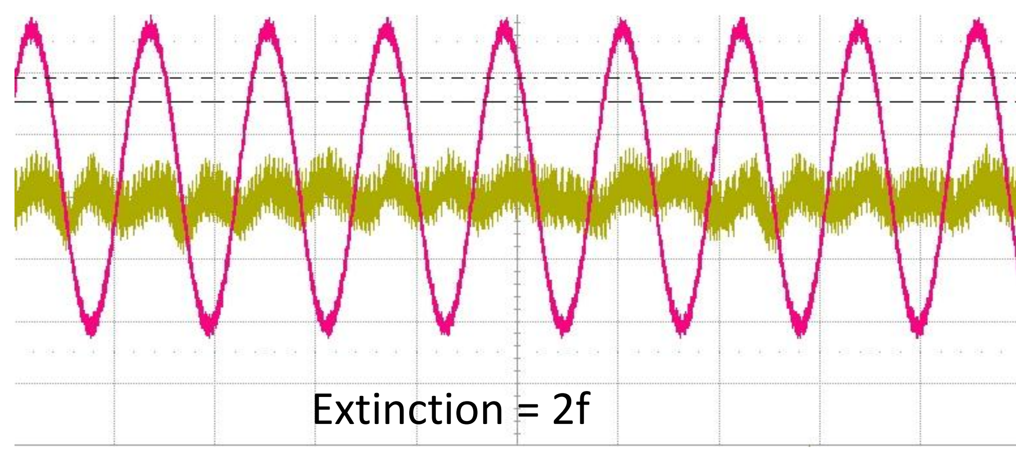
Lock In Signal

Photodiode Signal



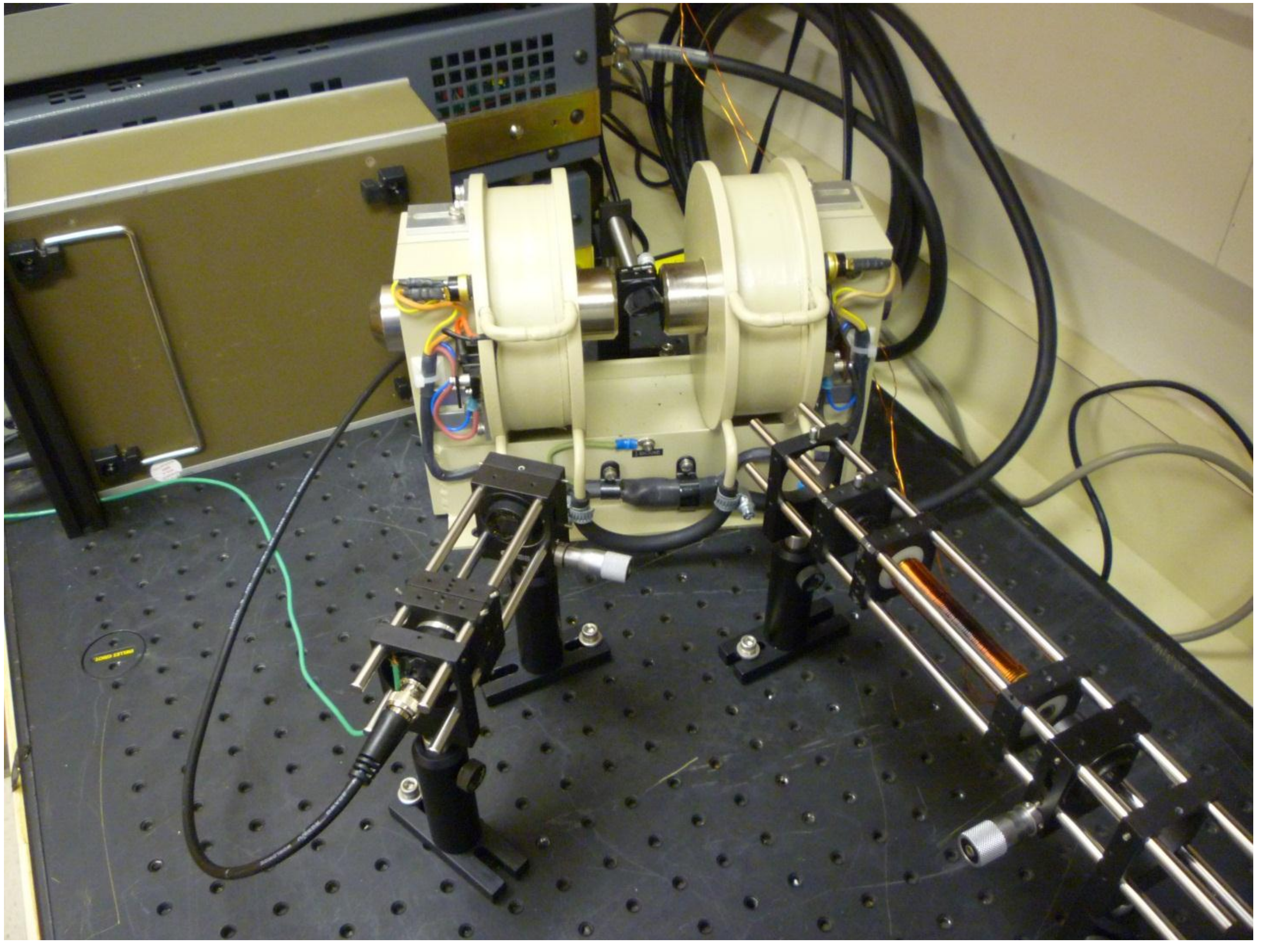



# Setup in Building 137 Rm. 222

# Setup



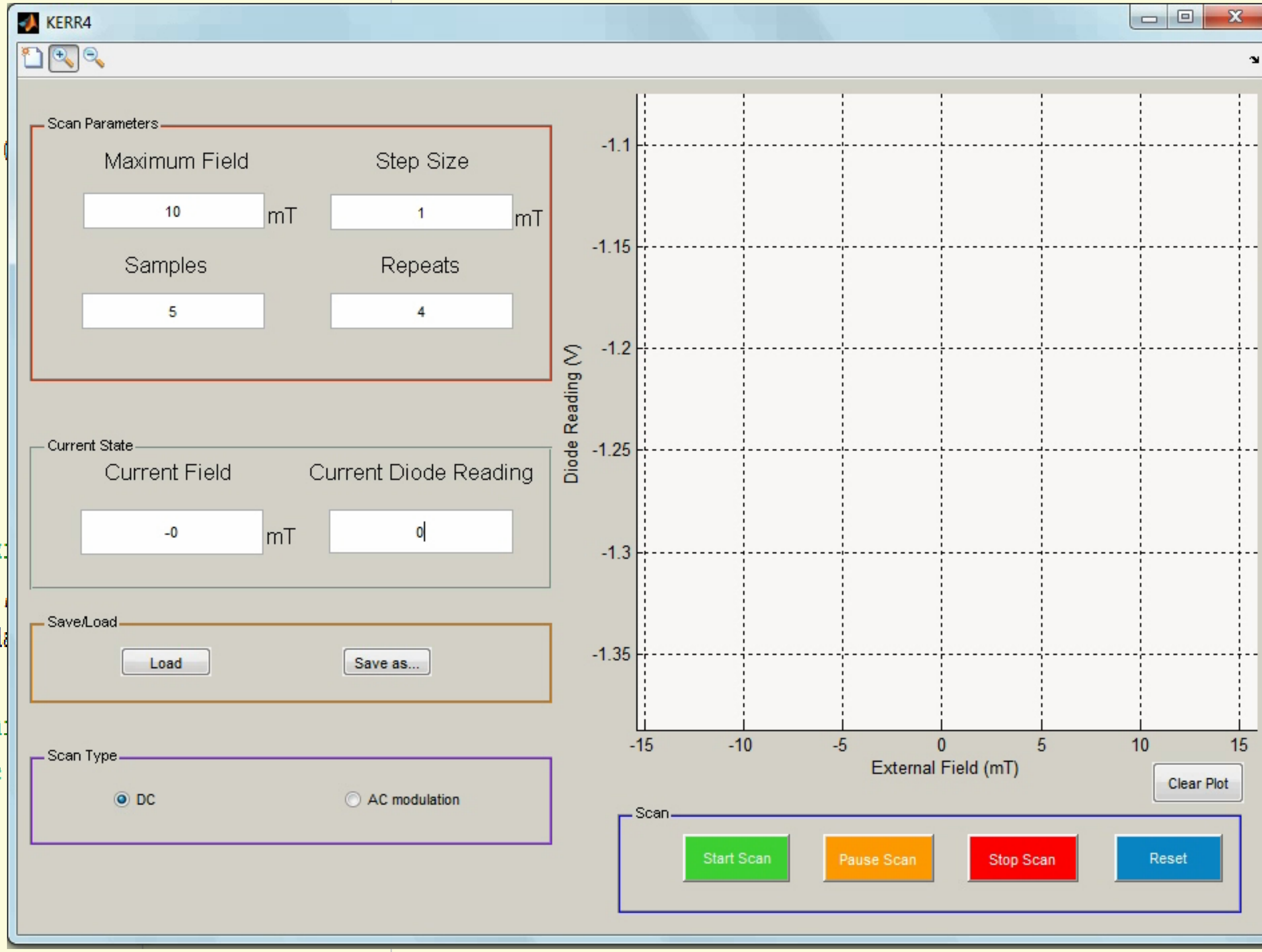
# Measurement in progress

```
%%Set whether field will be increasing or decreasing
    for i = 1:4
        if i == 1
        d = (0:ssizev:maxfv);
            else if i == 2
            d = linspace(maxfv-ssizev,0,(maxfv-ssizev)/ssizev+1);
                else if i == 3
                d = linspace(0-ssizev,-maxfv,
                    else if i == 4
                    d = -maxfv+ssizev:ssizev:(
                        end
                    end
                end
        end

        %%Start Data Output
        for i = d;
        n=n+1;
        dataout(n) = i;             %Max:
        set(handles.currentfield,'string',
        fprintf(inst,sprintf('auxv1,%g',da

        %%Pause for slow down process (th
        %%process so that I can make sure
        %%during initial testing
        pause(.05);

        %%Start the data input
            z=0;
            for i = 1:samples;
                z=z+1;
```



# Results and the Stoner-Wohlfarth Model

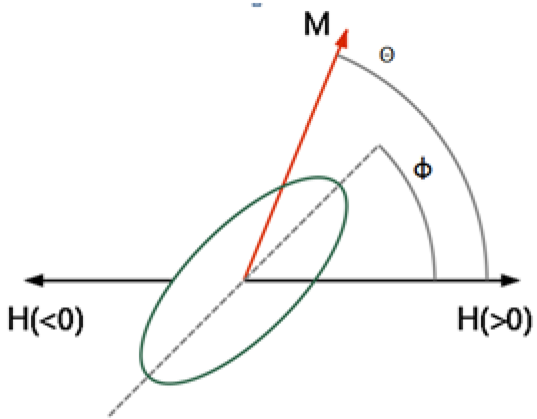



FIG. 3. Relationship between direction of applied field H, magnetization direction M and easy axis (dashed line).

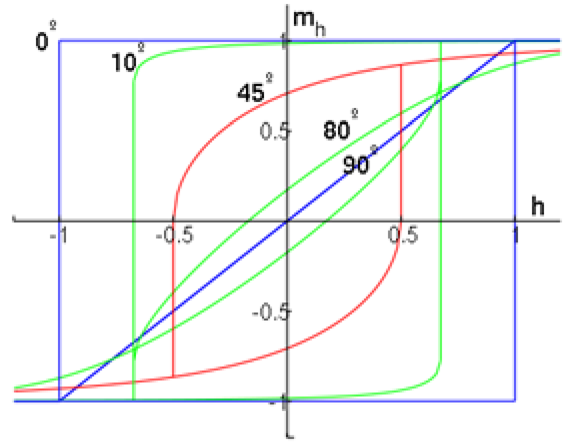



FIG 4. Hysteresis loops predicted by the Stoner-Wohlfarth model for several values of ϕ

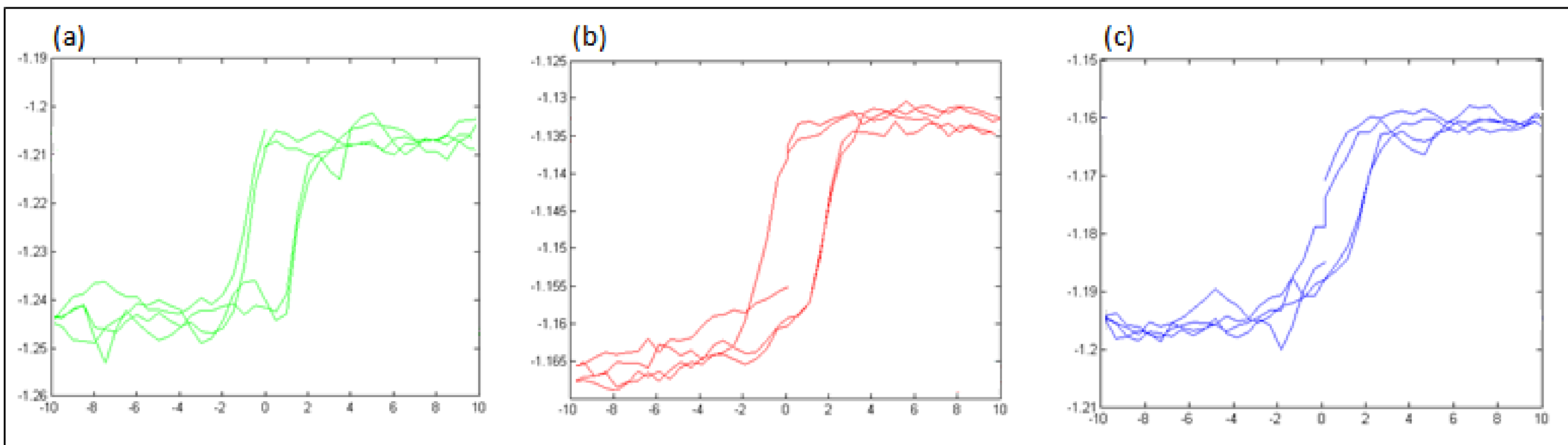



**FIG 5.** Hysteresis loops obtained from MOKE device showing behavior as predicted by Stoner-Wohlfarth model. (a) ϕ=0°, (b)ϕ=45°, and (c)ϕ=90°.

# Why MOKE at the SSRL?

- Simple
- Inexpensive
- Informative
- Non-destructive