Calculating of the permeability

$$V_{lock-in} = N_{pickup}\frac{\mu\ N\ t}{2\pi}\ln\frac{R_2}{R_1}\frac{dI_{AC}}{dt} = N_{pickup}\frac{\mu\ N\ t}{2\pi}\ln\frac{R_2}{R_1}\omega\frac{V_{AC}}{R1}\cos(\omega t) =$$

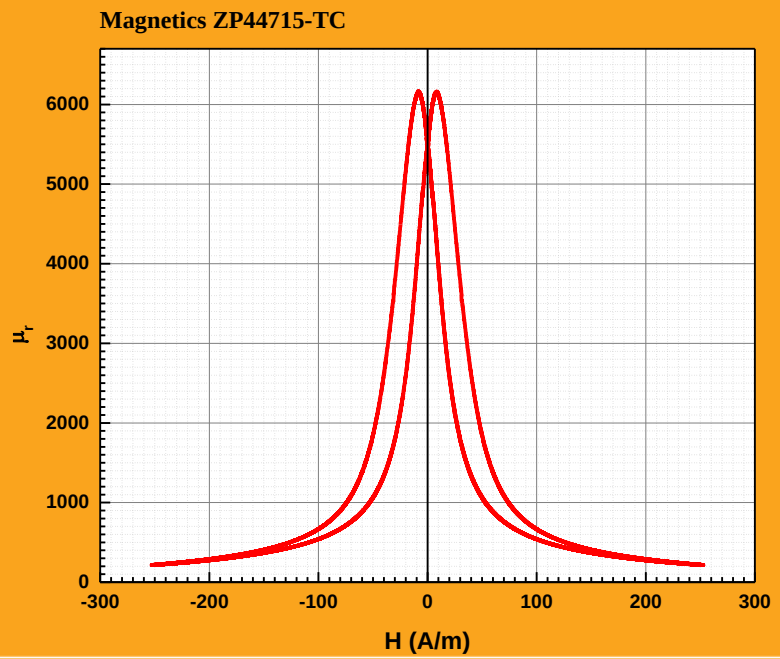
$$= \mu_r L_0 \frac{V_{AC}}{R1}\omega\cos(\omega t); \qquad \text{where } L_0 = N_{pickup}\frac{\mu_0\ N\ t}{2\pi}\ln\frac{R_2}{R_1}$$

Geometry of toroid

Resistor in AC current loop

Magnetics ZP44715-TC

After calculation of H and μ_r



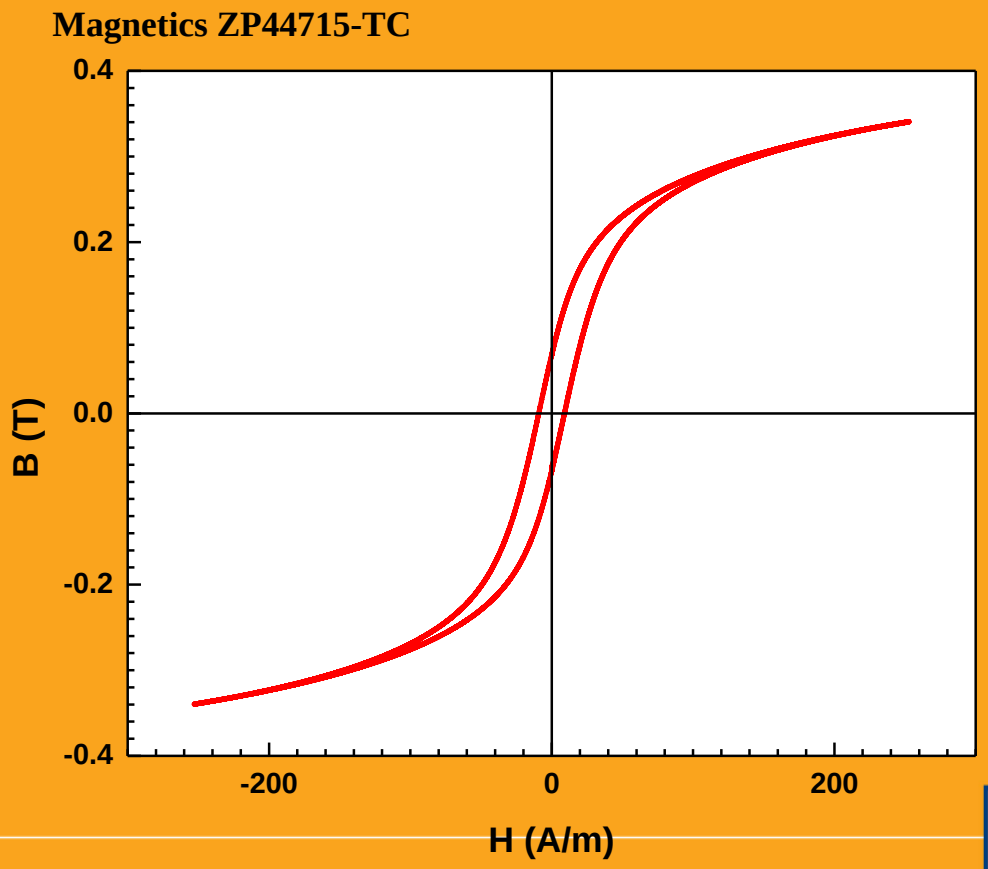
Calculating of the magnetic induction B

$$B = \mu_0 (1+\chi) H = \mu_0 \mu_r H = \mu H$$

$$\mu = \mu_0 \mu_r = \frac{dB}{dH}; \quad B = \mu_0 \int \mu_r (H) dH$$

Magnetics ZP44715-TC

After integrating



Hysteresis Loops. Remagnetization loses

$$W = V \int HdB$$

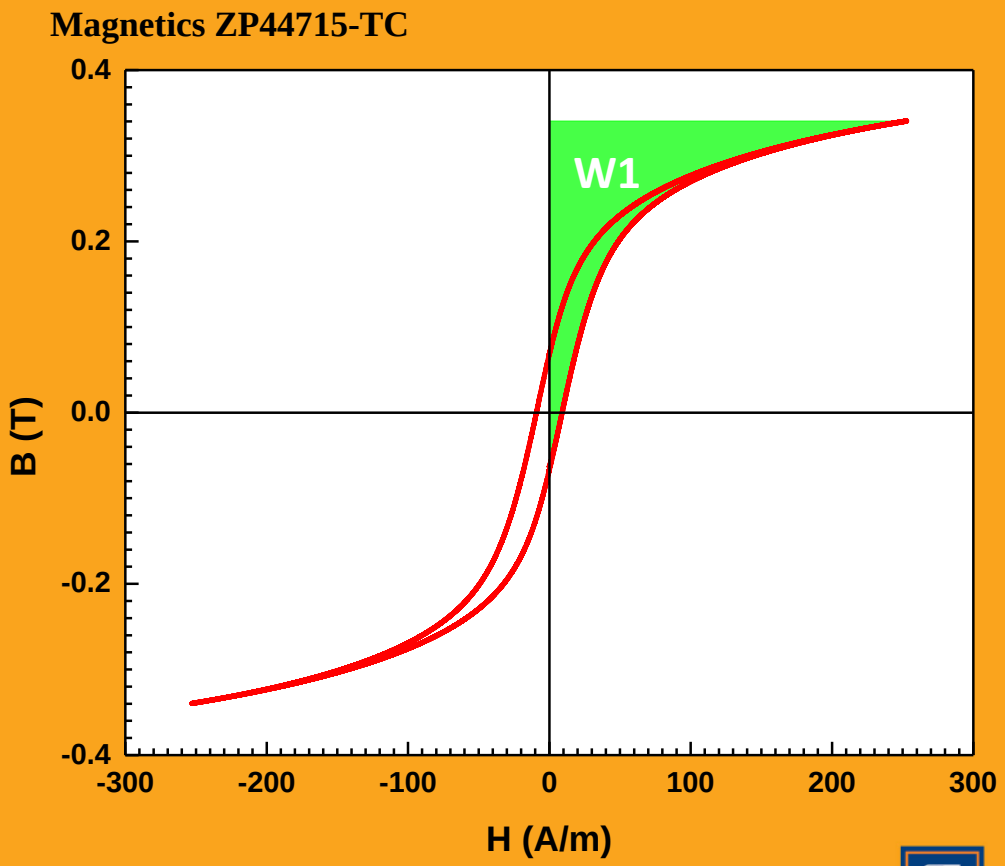
Energy of the magnetic field

$$W_{loop} = V \oint HdB = V*Loop\_area$$

By cycling around the loop

V here is a volume of the magnetic material

Step 1. Calculating the energy **W1** required to go from H=0 to saturation $H=H_{max}$ (for simplicity V=1)



Hysteresis Loops. Remagnetization loses

$$W = V \int HdB$$

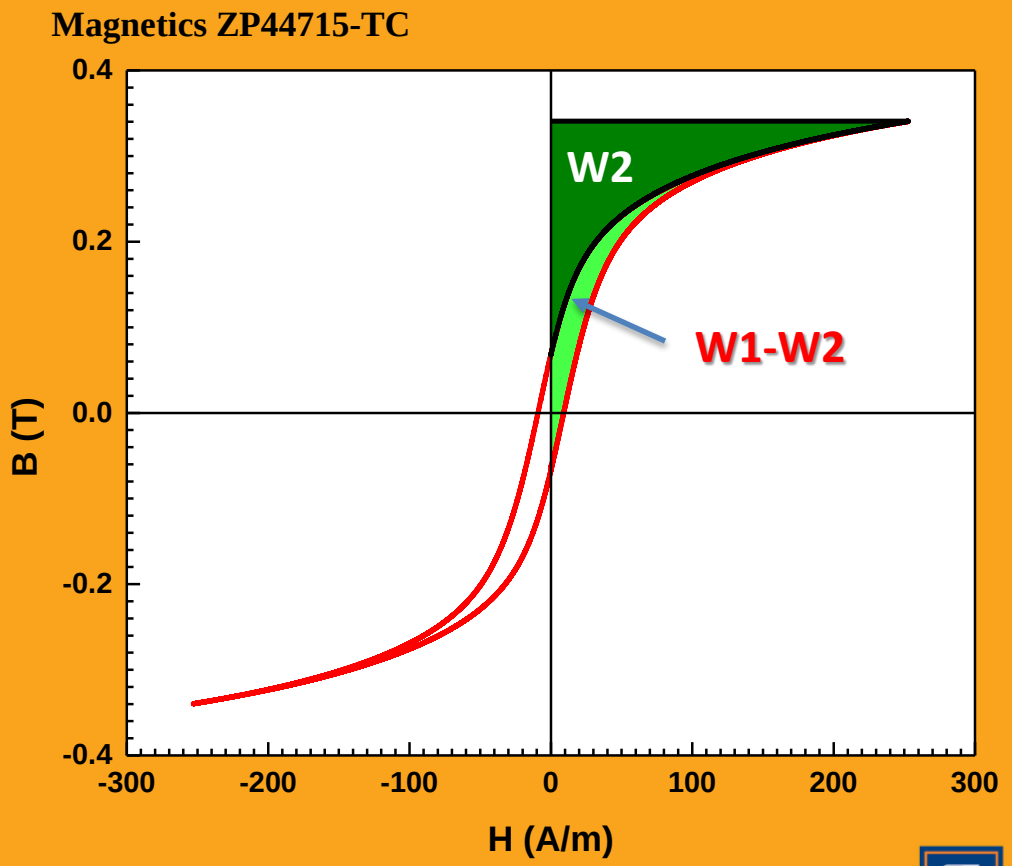
Energy of the magnetic field

$$W_{loop} = V \oint HdB = V^{*}Loop\_area$$

By cycling around the loop

V here is a volume of the magnetic material

Step 2. Calculating the energy **W2** required to go from saturation $H=H_{max}$ to H=0



Hysteresis Loops. Remagnetization loses

$$W = V\int HdB$$

Energy of the magnetic field

$$W_{loop} = V\oint HdB = V*Loop\_area$$

By cycling around the loop

V here is a volume of the magnetic material

Step 3. **W1-W2 gives the energy required for half loop tracing per unit volume of magnetic material. Finally energy losses for one cycle of the B-H hysteresis can be calculated as:**

W=V*2*(W1-W2)

Of course these losses are frequency dependent because $\mu_r(H)$ depends on measuring frequency but this dependence is very weak in frequency range used in our experiment (f<100kHz).