

Novel Sample Stage to Detect Magnetic Signal

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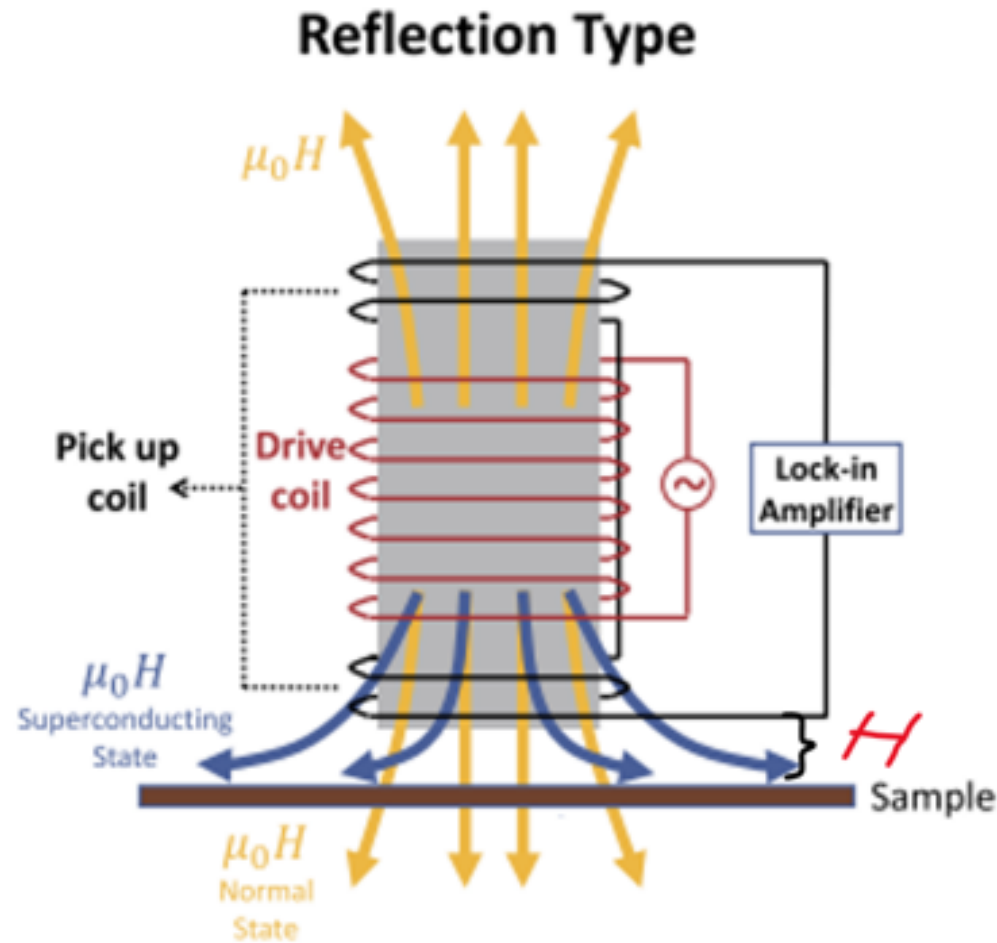
Reporter: Ziyang Li



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1 Theory



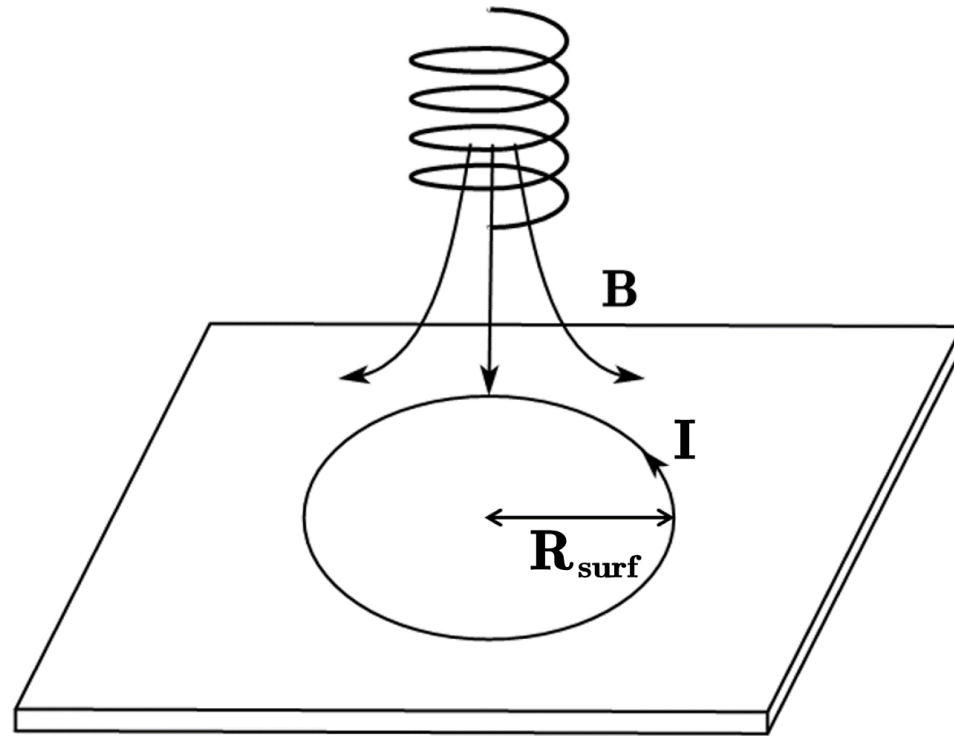
The drive coil could generate alternating current. And the magnetic field will pass the two coils up and down, which are symmetric.

When the magnetic field passes through the superconduct sample. The magnetic field generated by the superconduct material will cause the difference of potential between two coils.

Then we can deduce the property of the superconduct sample.

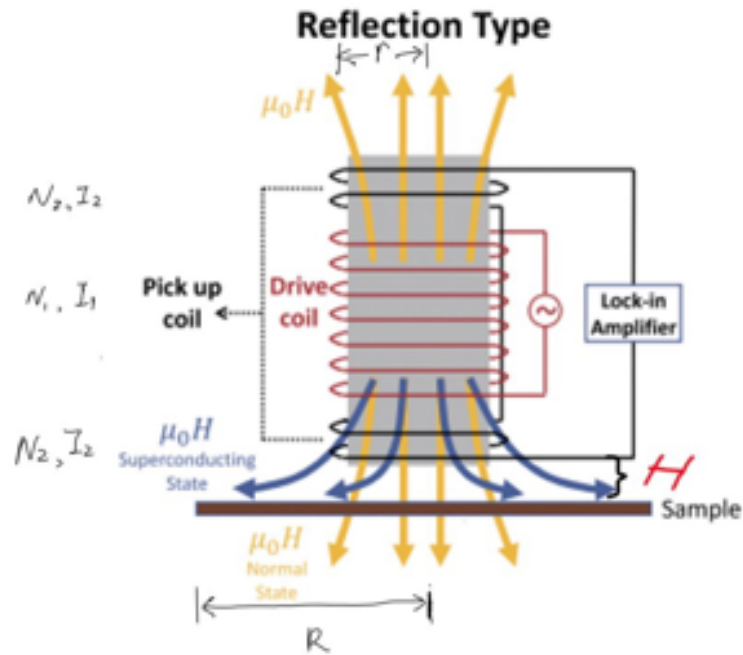
1 Theory

Hypothesis



We assume that the reflected current inside the sample is in the shape of a circle, easy for later calculation.

2 Calculation



1. When d means the distance between coils: $B = \frac{\mu r^2 I}{2} \sum \frac{1}{(r^2 + h_i^2)^{\frac{3}{2}}}$

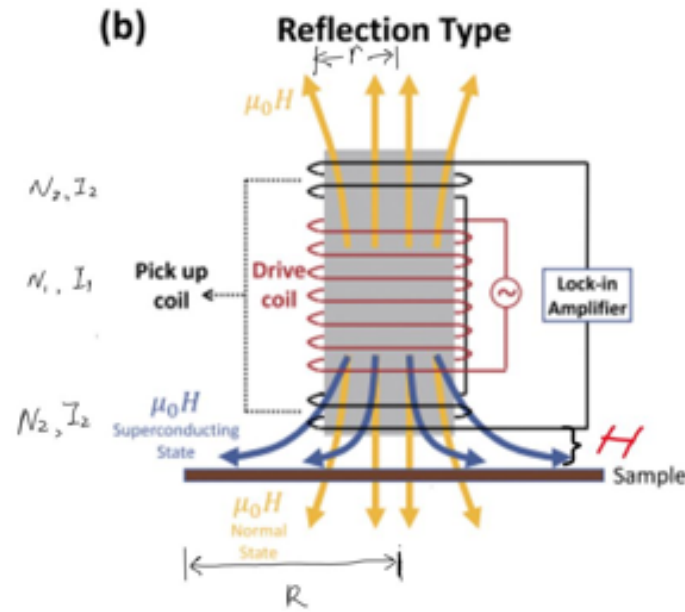
$r \gg d$, we can know $r^2 + h_i^2$ hardly changes. So $B = \frac{\mu r^2 I}{2} \frac{N}{(r^2 + h_i^2)^{\frac{3}{2}}}$

2. if $r \ll R$, we can know the B produced by N_1 coils is $B_s = \frac{\mu I_s}{2r}$

And we know inside the superconduct sample $B = 0$.

So we can get $\frac{\mu I_s}{2r} = \frac{\mu r^2 I}{2} \frac{N}{(r^2 + h_i^2)^{\frac{3}{2}}}$, therefore $I_s = \frac{N_1 I R r^2}{(r^2 + d^2)^{\frac{3}{2}}}$

2 Calculation



$$3. B_{\perp} = \frac{\mu R^2 I_s}{2(R^2 + d_{\perp}^2)}, \quad B_{\downarrow} = \frac{\mu R^2 I_s}{2(R^2 + d_{\downarrow}^2)}$$

$$\text{So } V_{\perp} = -N_{\perp} \frac{d(B_{\perp} S)}{dt}, \quad V_{\downarrow} = -N_{\downarrow} \frac{d(B_{\downarrow} S)}{dt}$$

$$\Delta V = V_{\perp} - V_{\downarrow} = N_2 \pi r^2 \left(\frac{d(B_{\downarrow})}{dt} - \frac{d(B_{\perp})}{dt} \right)$$

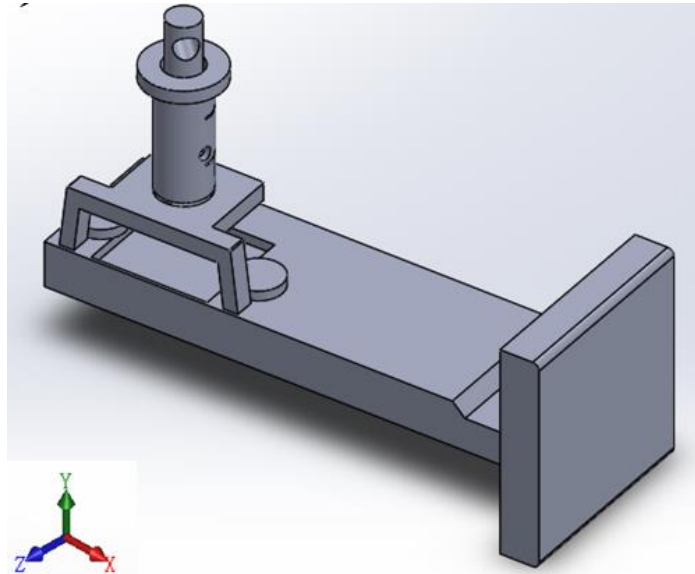
$$= \frac{N_2 N_1 I_0 \pi r^4 \mu R^3 w \cos(wt)}{2(r^2 + d^2)^{\frac{3}{2}}} \left[\frac{1}{(R^2 + d_{\downarrow}^2)} - \frac{1}{(R^2 + d_{\perp}^2)} \right]$$

$$N_1 = 40, N_2 = 30, R = 6\text{mm}, r = 3\text{mm}, I_0 = 100\mu\text{A}$$

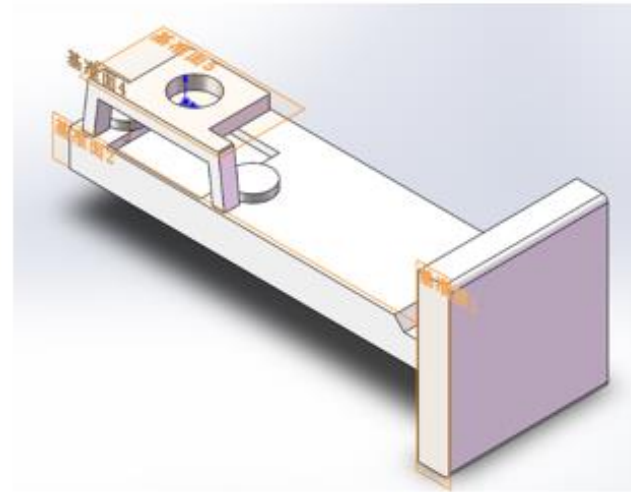
$$\mu = 4\pi \times 10^{-7} \text{N/A}, \quad w = 2\pi f = 2\pi \times 10000\text{Hz}$$

Substitute the value then we can get $|\Delta V|_{rms} = 268\text{nV}$

3 3D Model



3D Model of the novel sample stage

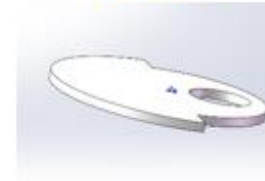


Sample stage

The sample stage which can hold the samples, meanwhile it can support the cylinder.



coils



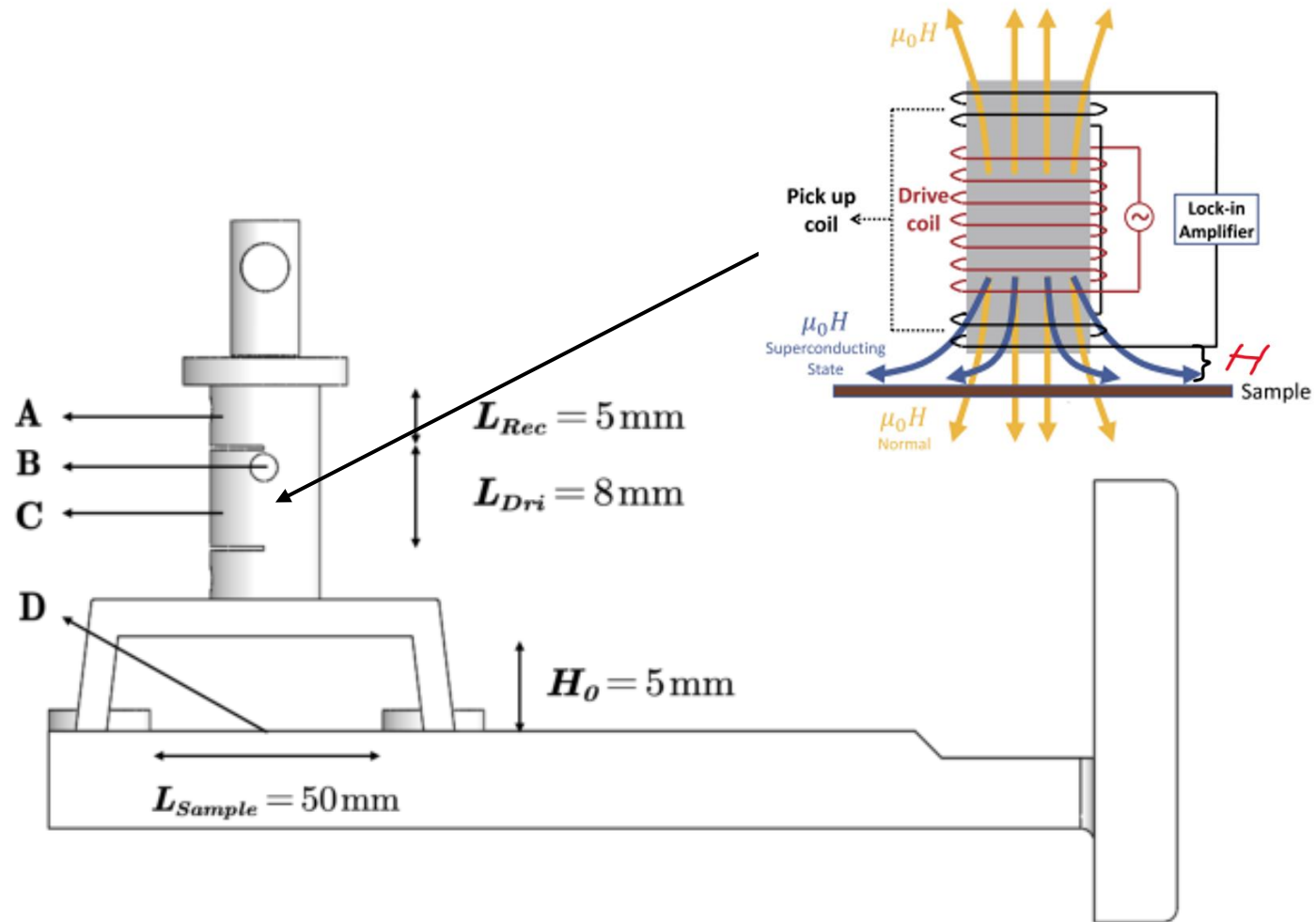
the metal sheet



cylinder

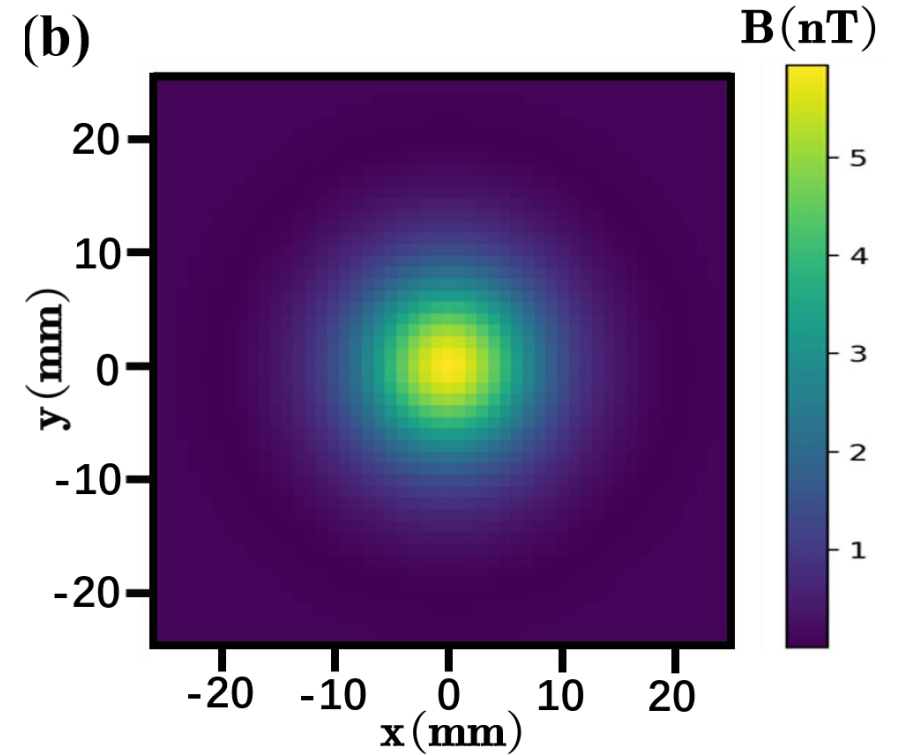
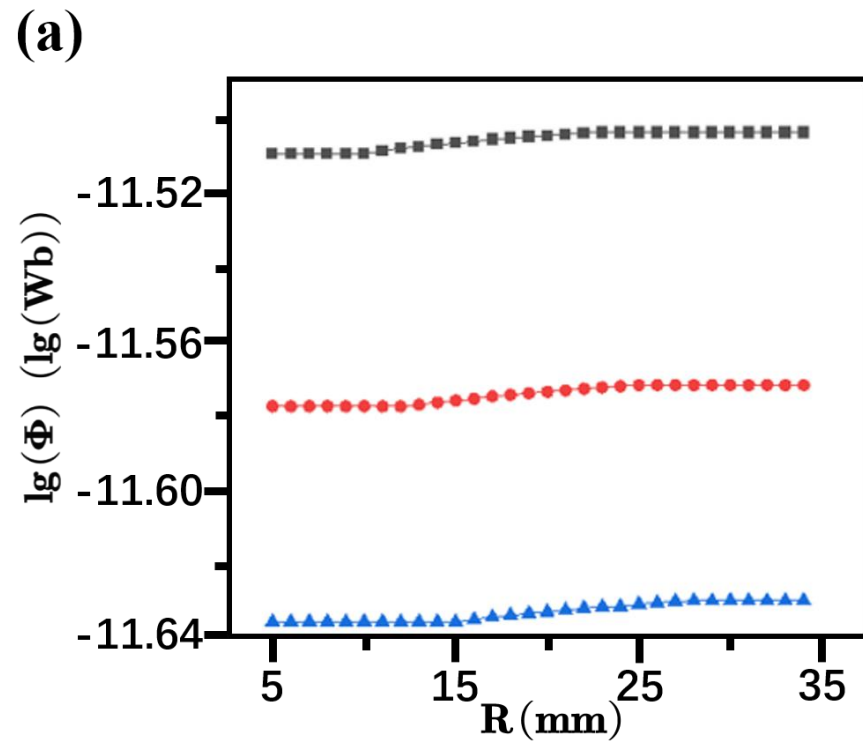
The cylinder can be used to hold coils, the wires can pass the holes, so does the sheet metal.

3 3D Model



A is used to install the pick-up coils and C is used to install the drive coils. D is the stage holding the materials. The distance between the coils and materials could be changed by people.

4 Error Analysis



Discussion of the boundary effect due to the sample materials is not infinite large

Thanks