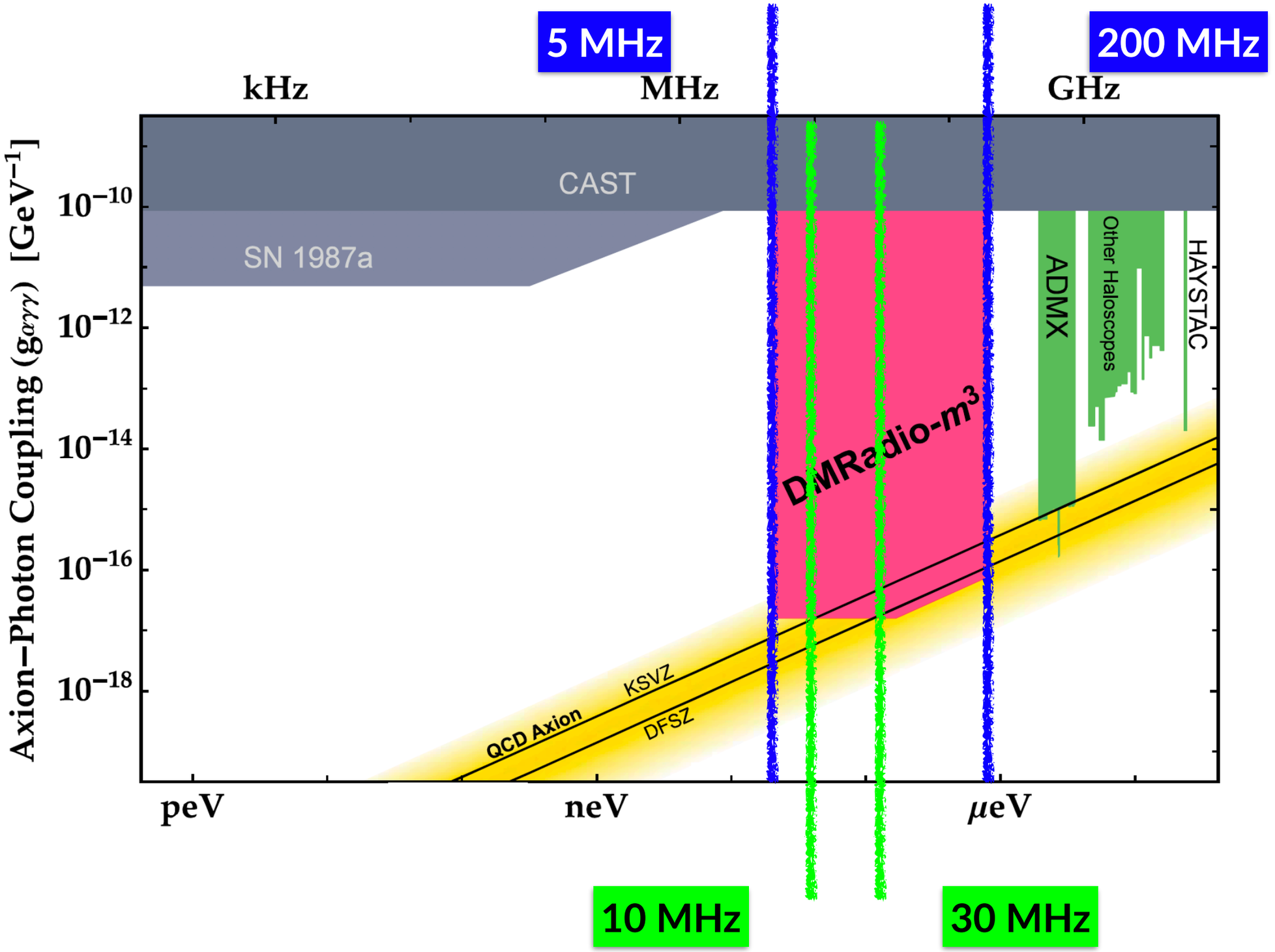
DM Radio M^3 Overview

DM Radio Collaboration Meeting

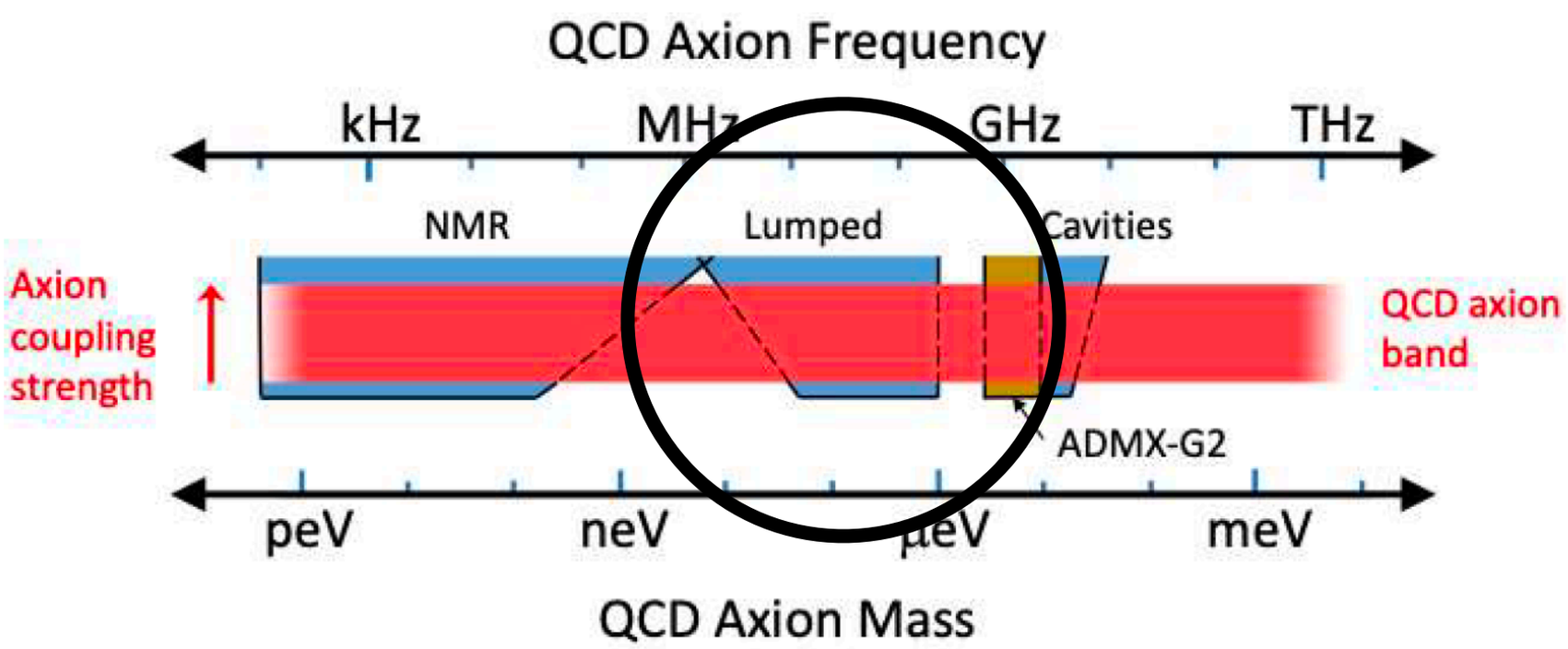
J. Singh — Stanford University

13 August 2020

Science Goals



- DM Radio M^3 targets higher frequencies than 50L — lumped element still optimal but beginning to break down.



Experimental Context

- Low frequency & high frequency cases:

1. At low frequency we use the figure of merit to estimate sensitivity.

2. At high frequency investigate mode structure to set cutoff.

Goal: Optimise Figure of Merit

Geometrical Pickup Factor | Magnetic Field | Pickup Volume | Quality Factor

$$\mathrm{FOM} \propto \frac{c_{\mathrm{PU}} B_0 V^{5/6} Q^{1/4}}{\eta^{1/4} T^{1/4}}$$

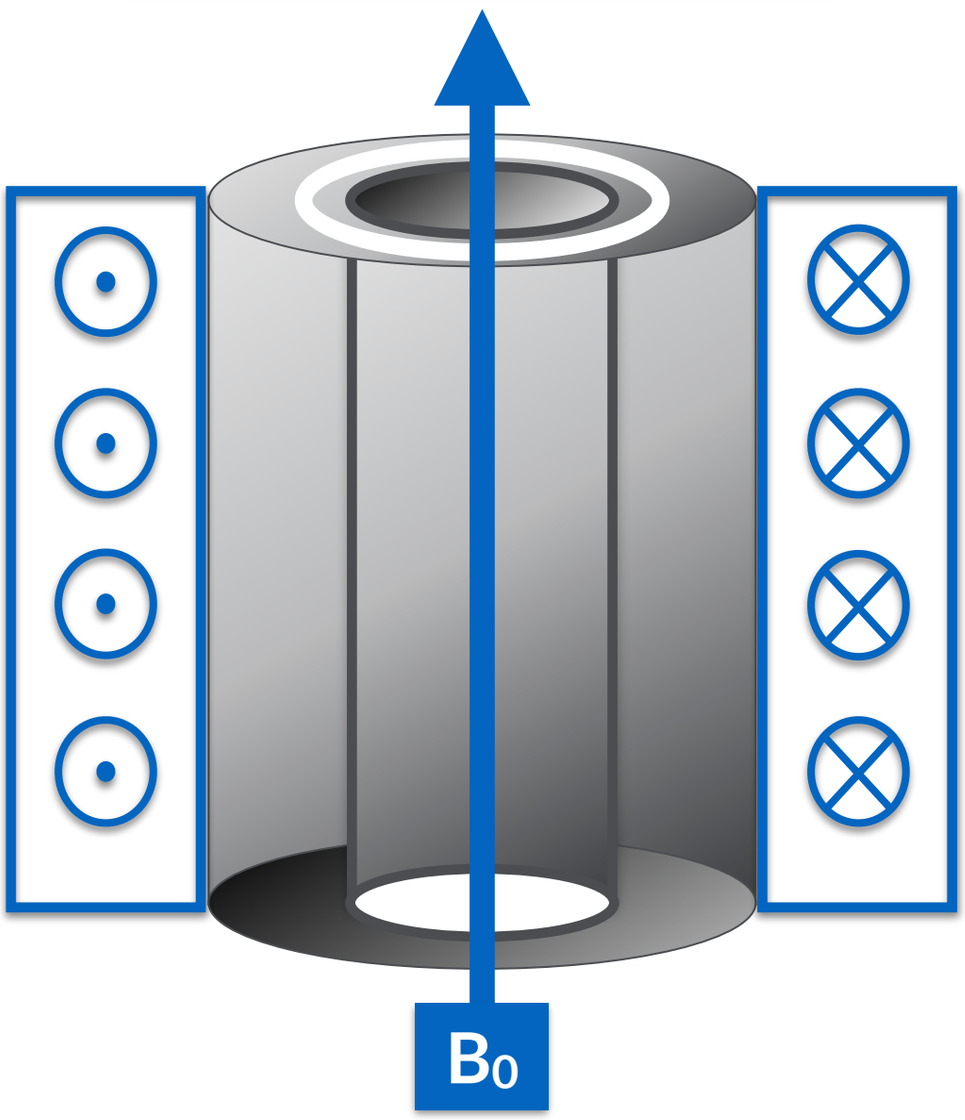
Amplifier Noise | Temperature

Goal: Optimise Figure of Merit

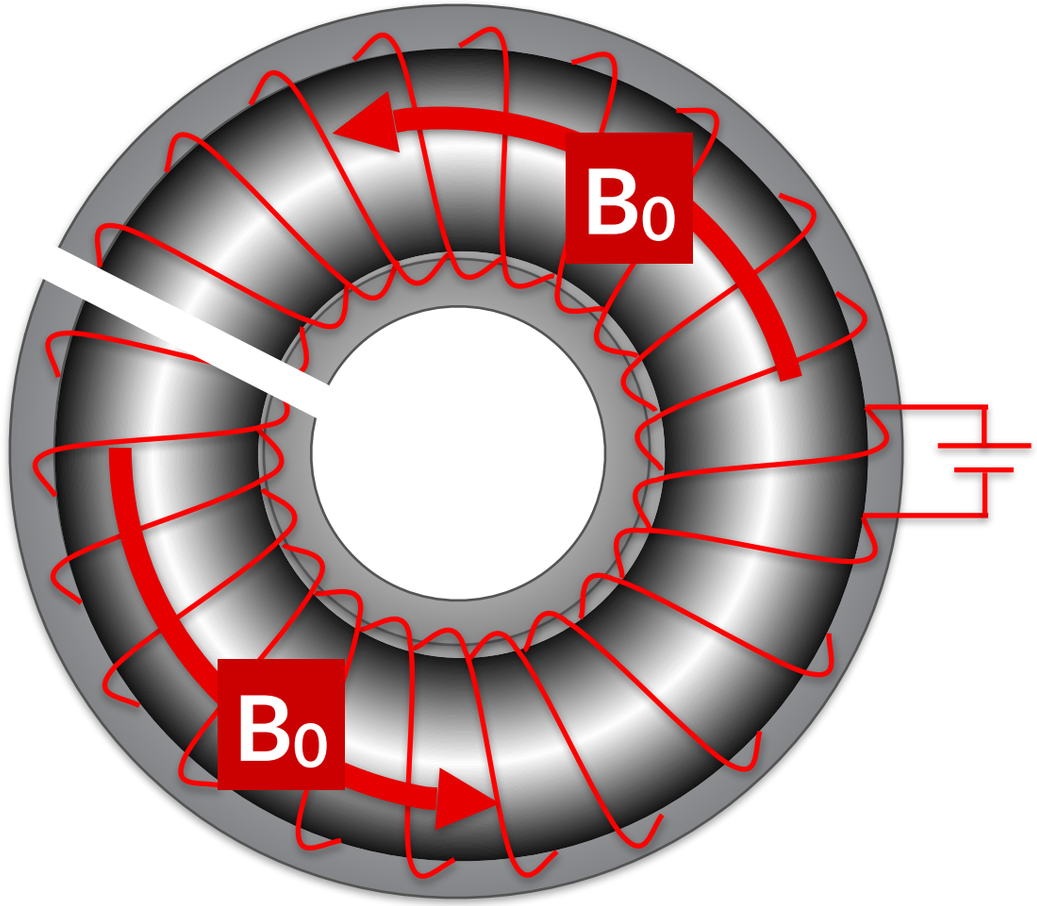
$$FOM \propto \frac{c_{pu} B_0 V^{5/6} Q^{1/4}}{\eta^{1/4} T^{1/4}} \propto \frac{U_{coupled}^{1/2} Q^{1/4}}{\eta^{1/4} T^{1/4}}$$

Key Question: Toroidal vs Solenoidal Magnet

Solenoid Magnet

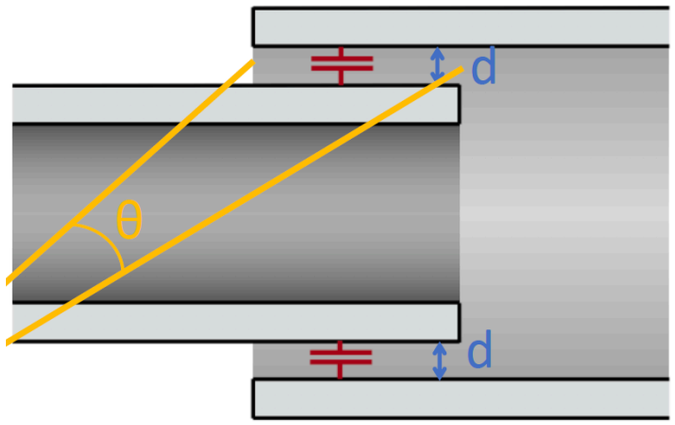


Toroid Magnet (50L)

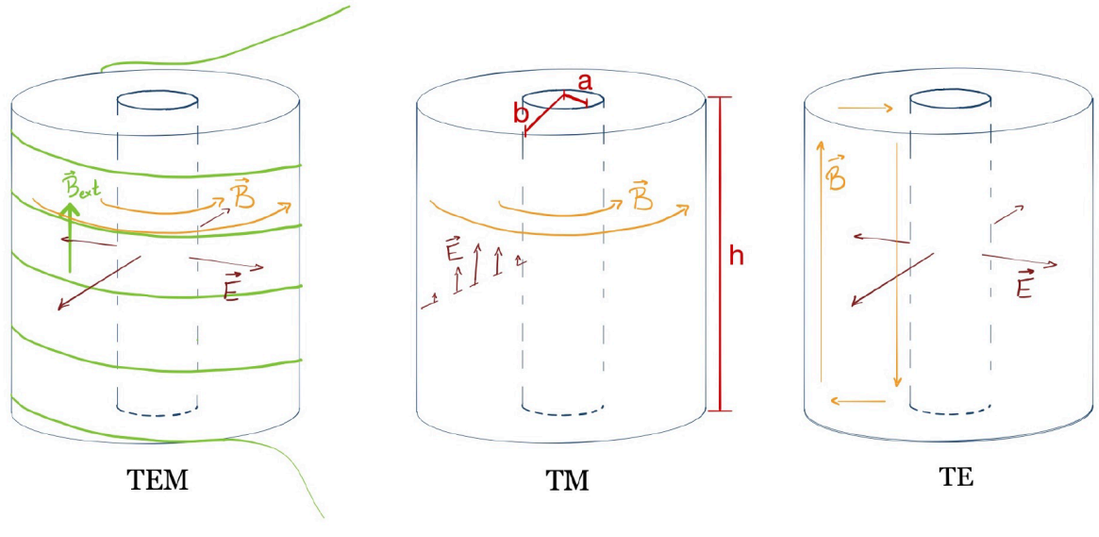


Agenda I: Problems with Toroid, High Frequency Analysis

- Challenges with toroidal magnet in M^3 regime.



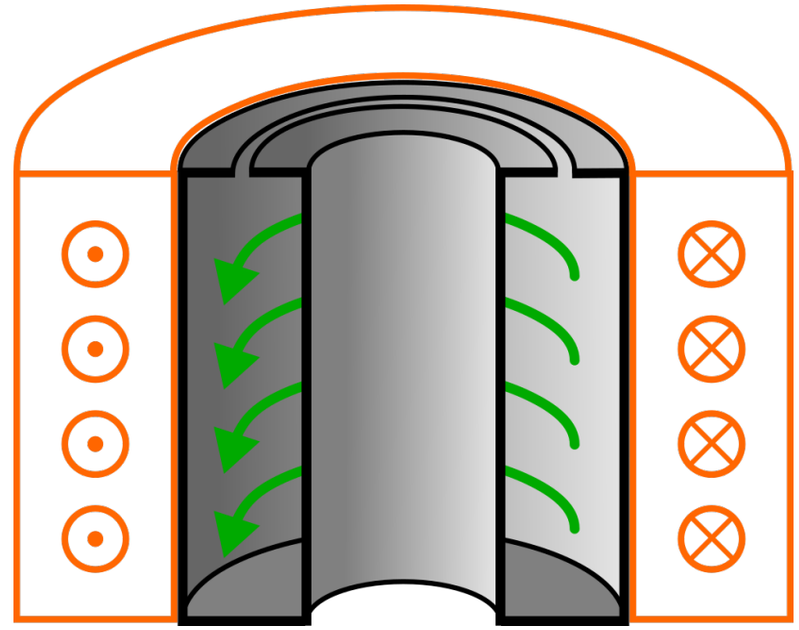
- Investigation of mode structure in coaxial pickup — impact on high freq. science goals.



Agenda II: Solenoidal Magnet in Quasistatic Limit

- Behaviour of uncoupled coaxial pickup in quasistatic limit.

- Initial sensitivity estimate based on FOM.



Agenda III: Sensitivity Estimate with Resonator Coupling

- Repeat Cady's analysis with a coaxial pickup coupled to a resonator.

- Initial sensitivity estimate based on FOM.