# Design and test of a special magnet for the Mu2e experiment

Midterm presentation 29 August 2022

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AC Dipole

AC Dipole

Ferrite plates

Beam direction

Fermilab
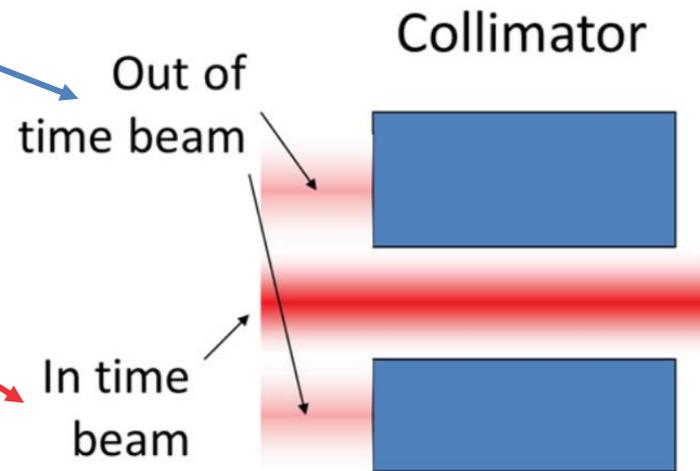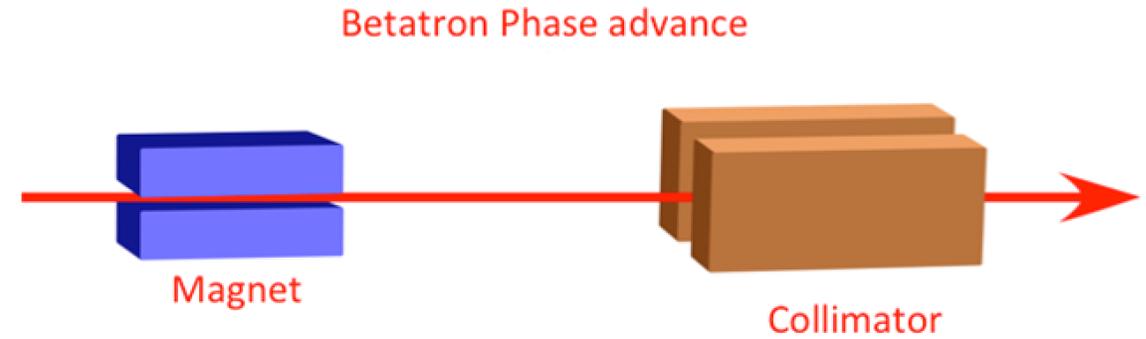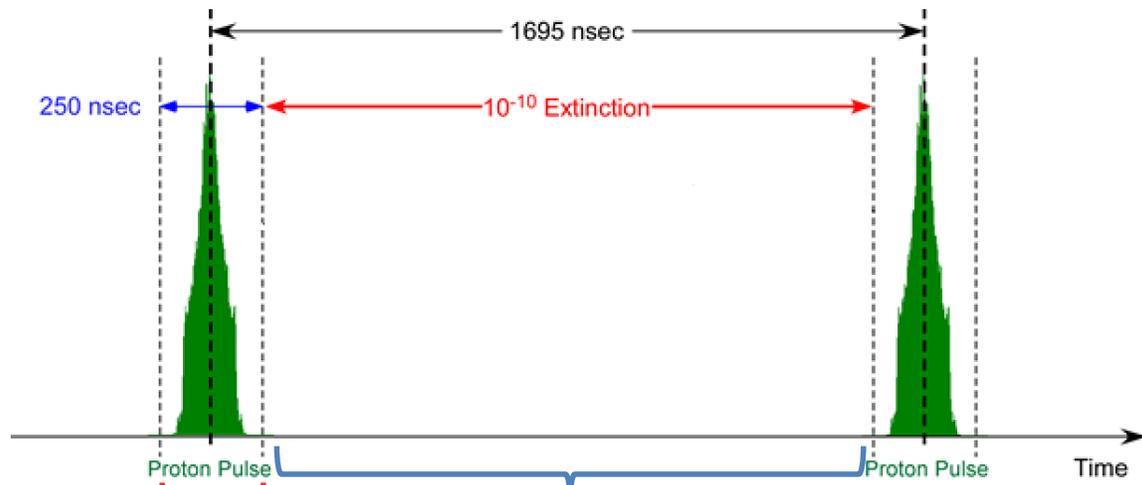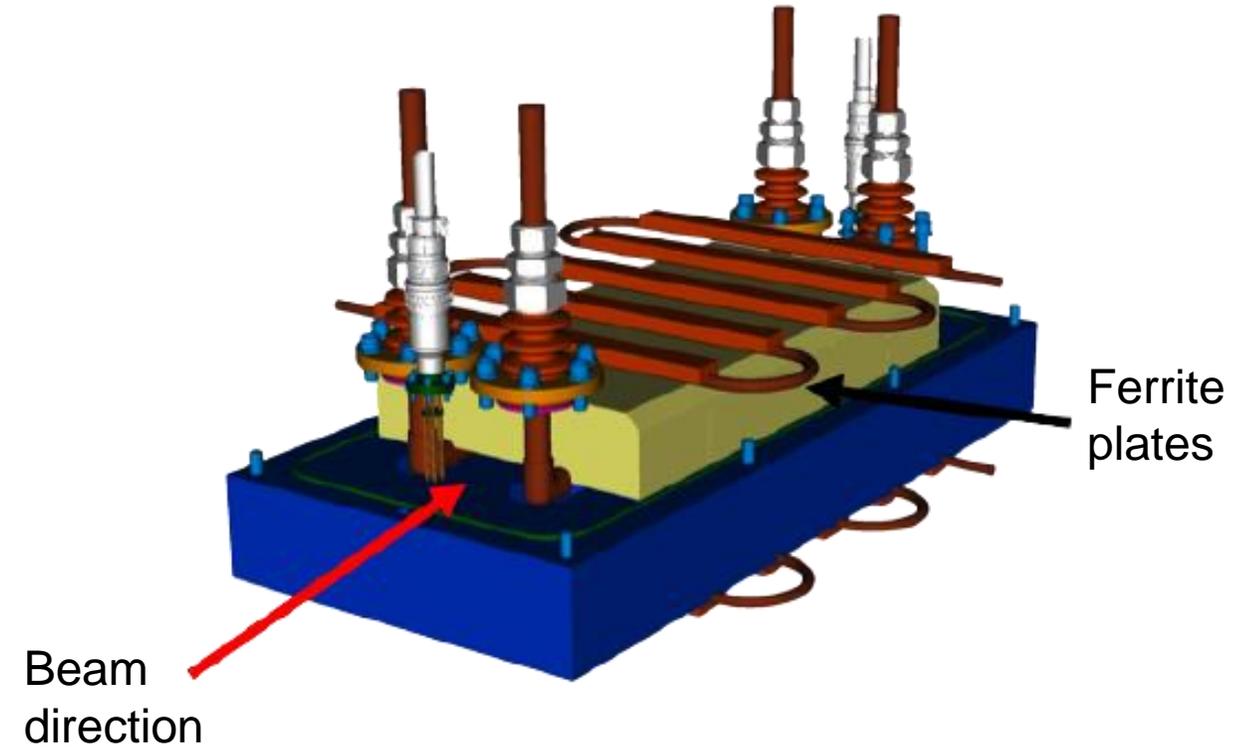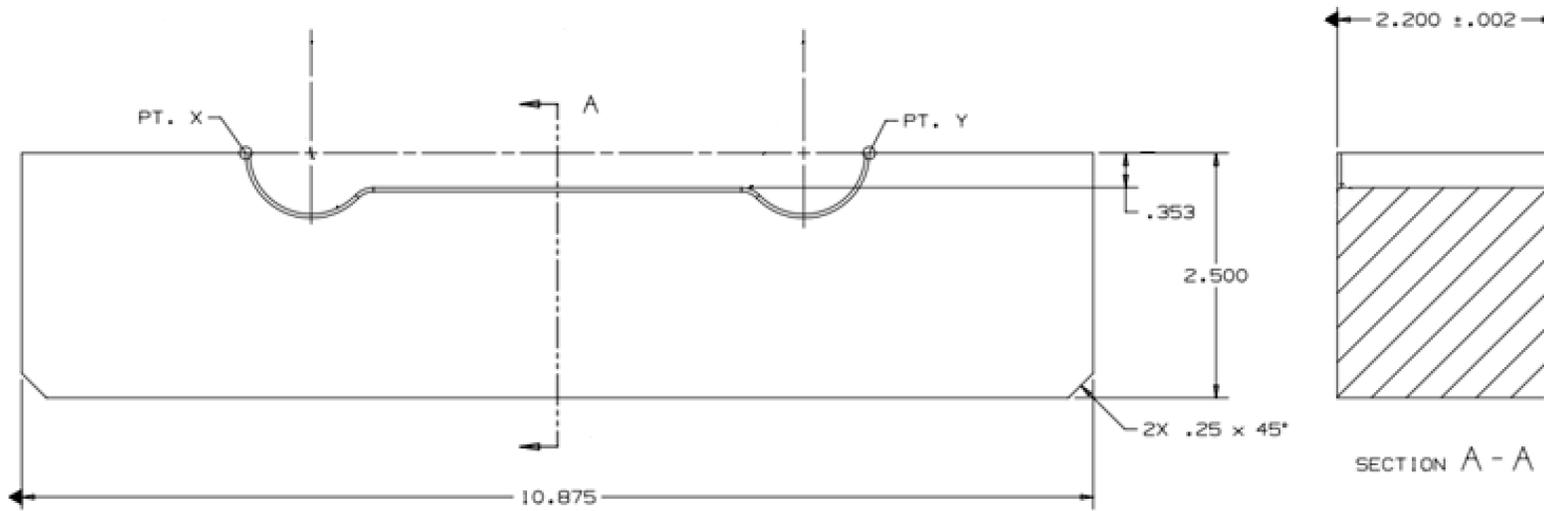
Ferrites

- High magnetic permeability ($\mu_r = 620$)

- Low Electrical Conductivity

⬇
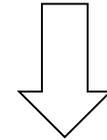
Low eddy current losses

# Ferrites
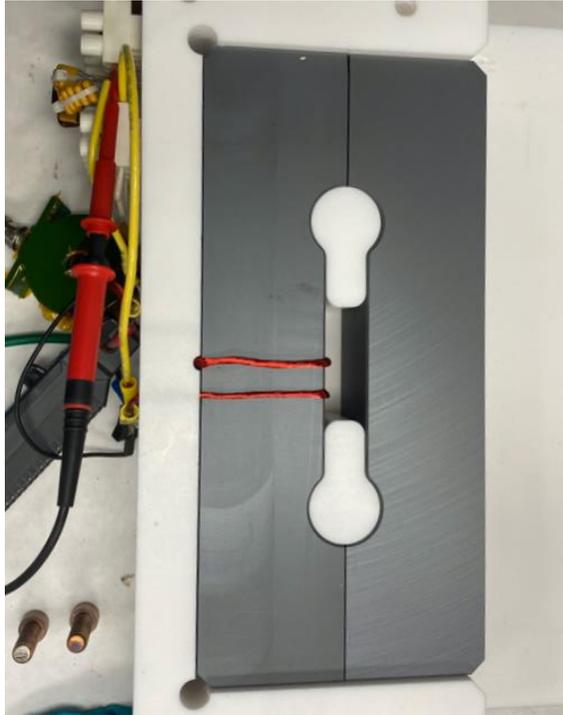
Toroid Mode

300kHz

4.4MHz

Dipole Mode

300kHz

4.4MHz

Toroide Mode setup
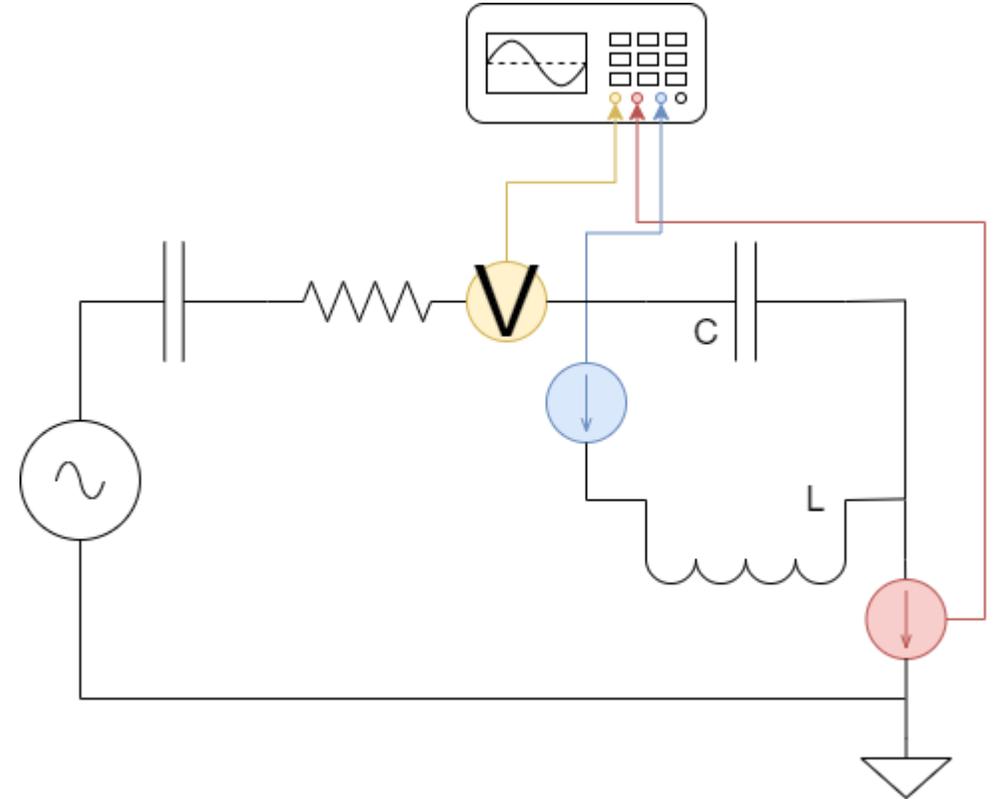
$$L = \frac{\mu N A_c}{l_m} \cong 15\mu H \qquad C = \frac{1}{L\sqrt{2\pi f}}$$

Dipole Mode setup
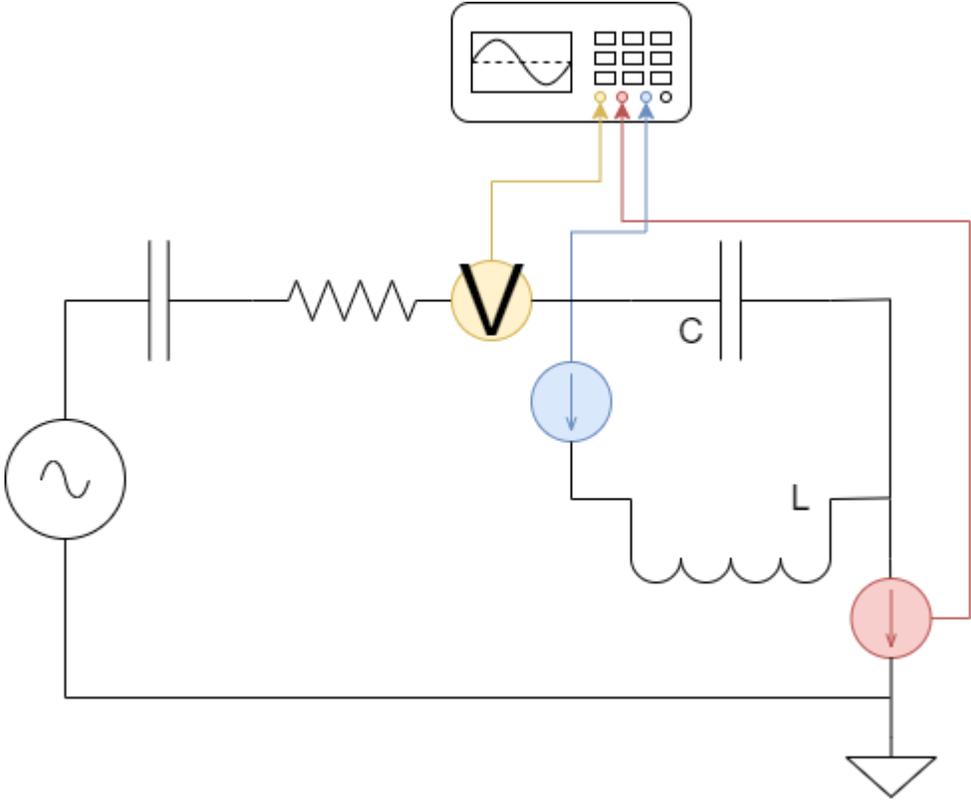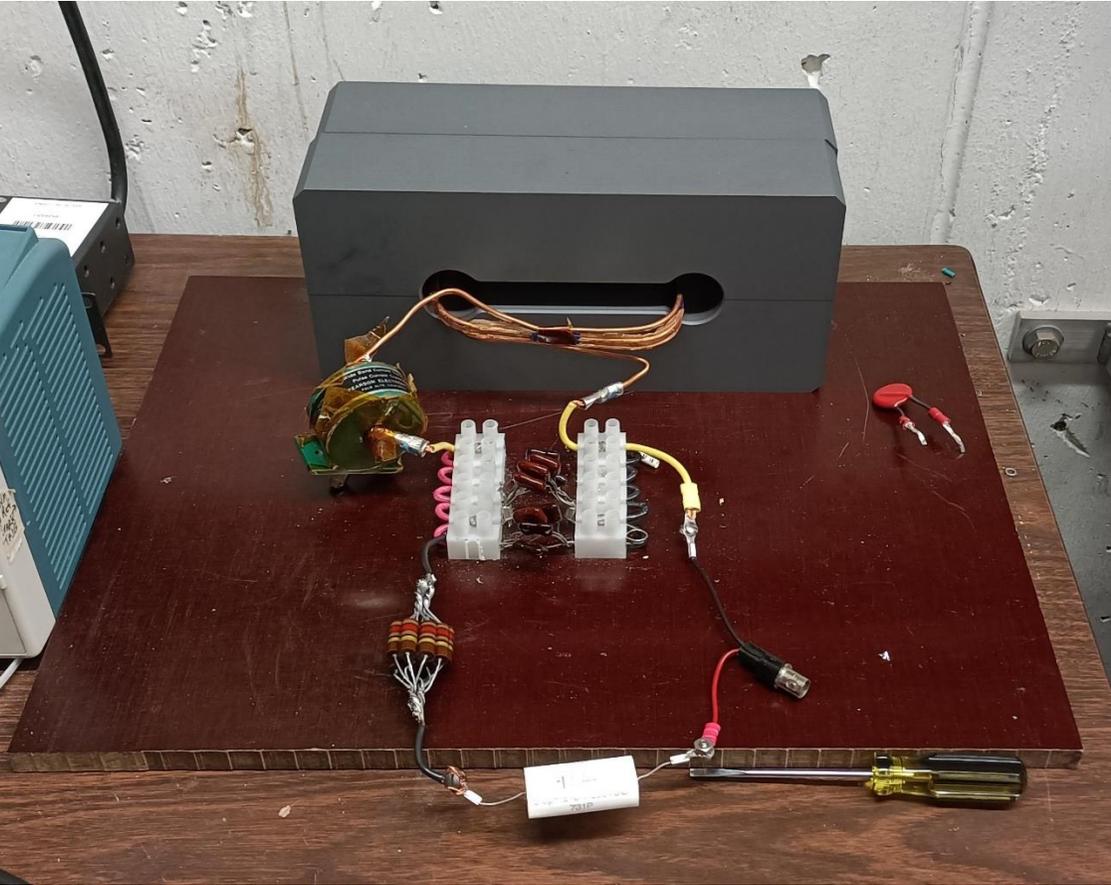
Analysis

Faraday-Neumann-Lenz Law:

$$\varepsilon(t) = -N\frac{d\Phi(B)}{dt} = -NA_c\frac{dB(t)}{dt}$$

$$\int_{B(0)}^{B(\frac{T}{2})} dB(t) = \int_0^{\frac{T}{2}} \frac{\varepsilon(t)}{NA_c}\, dt = \frac{V_p}{NA_c}\int_0^{\frac{T}{2}} \sin(\omega t)\, dt$$
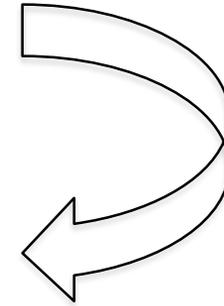
$$\Delta B = \frac{V_p T}{NA_c\pi} \qquad P = \frac{1}{M}\sum_i I_i V_i$$

Analysis

Faraday-Neumann-Lenz Law:

$$\varepsilon(t) = -N\frac{d\Phi(B)}{dt} = -NA_c\frac{dB(t)}{dt}$$

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$$\Delta B = \frac{V_p T}{NA_c \pi} \qquad P = \frac{1}{M}\sum_i I_i V_i$$

N = number of turns in the coil
A$_c$ = area of the coil
B = magnetic field (Gauss units)

$\varepsilon(t)$

V$_p$
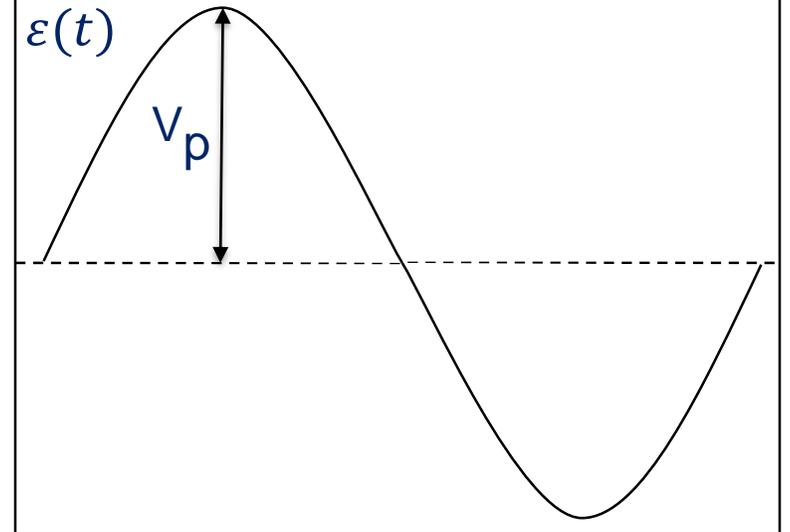
Results Toroide Mode

300 kHz Toroid Mode Loss/Volume
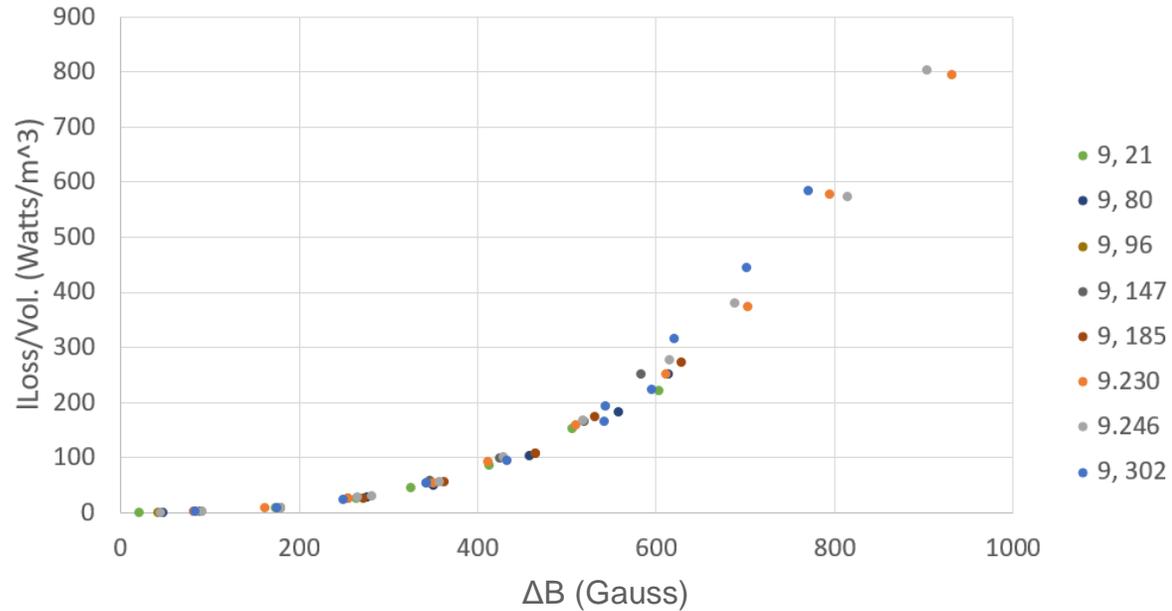
4.4 MHz Toroid Mode Loss/Volume
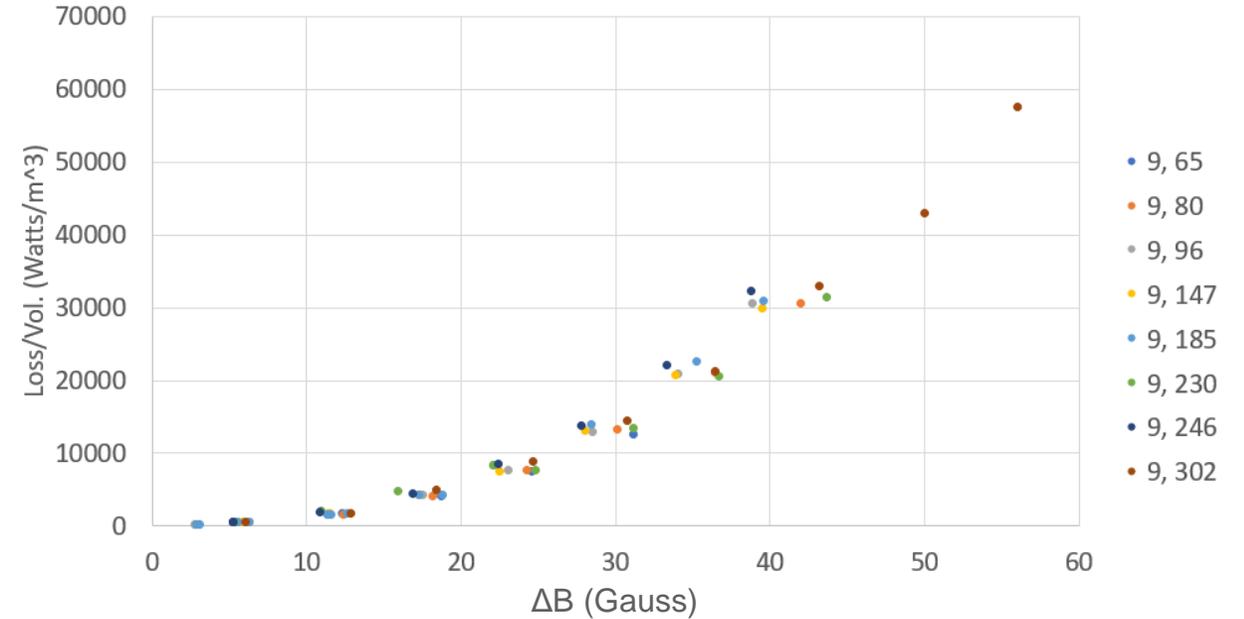
Results Dipole Mode

300 kHz Dipole Mode Loss/Volume

Legend:
- 39,21,19,13
- 6,5,2,1
- 96,105,147,185
- 246, 247, 230, 228
- 301, 259, 306, 317

4.4 MHz Dipole Mode Loss/Volume

Legend:
- 39,21,19,13
- 6,5,2,1
- 96, 147, 105, 185
- 230, 246, 247, 228
- 302, 317, 259, 306

Fermilab
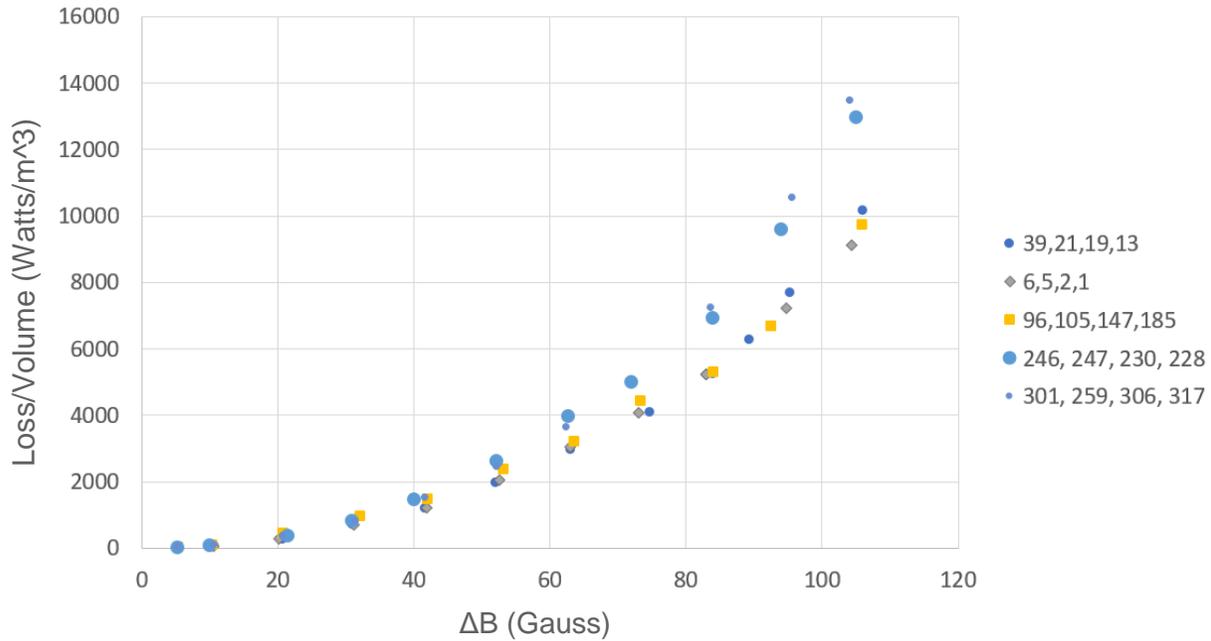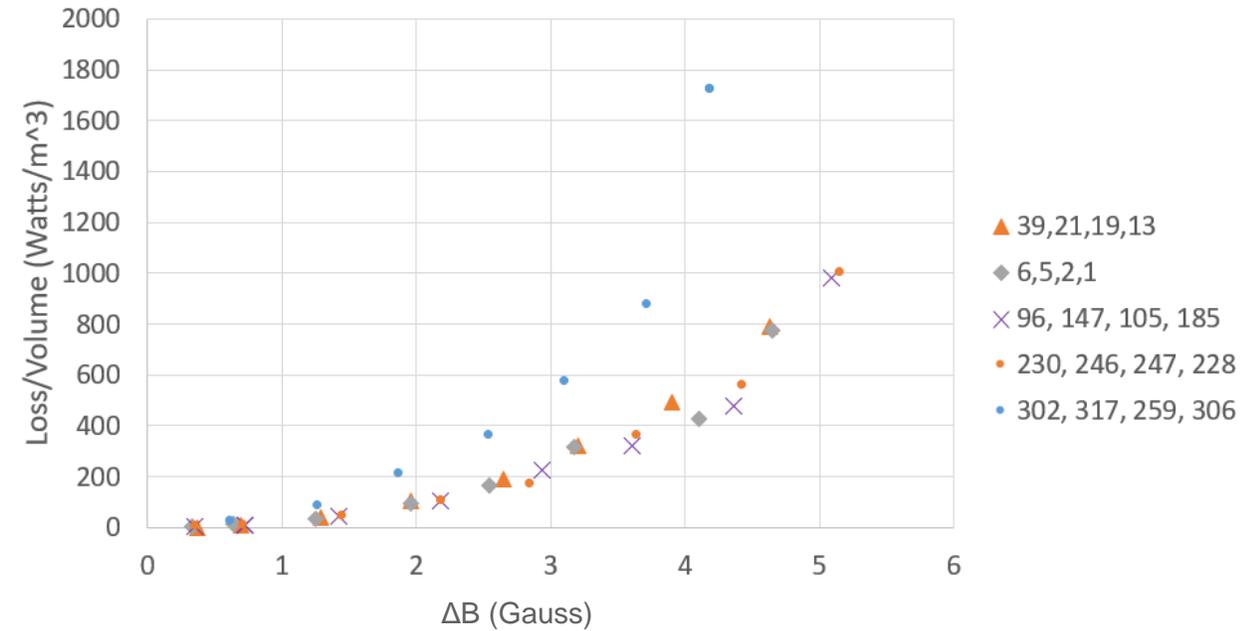
New results Dipole Mode at 4.4 MHz

4.4 MHz Dipole Mode Loss/Volume
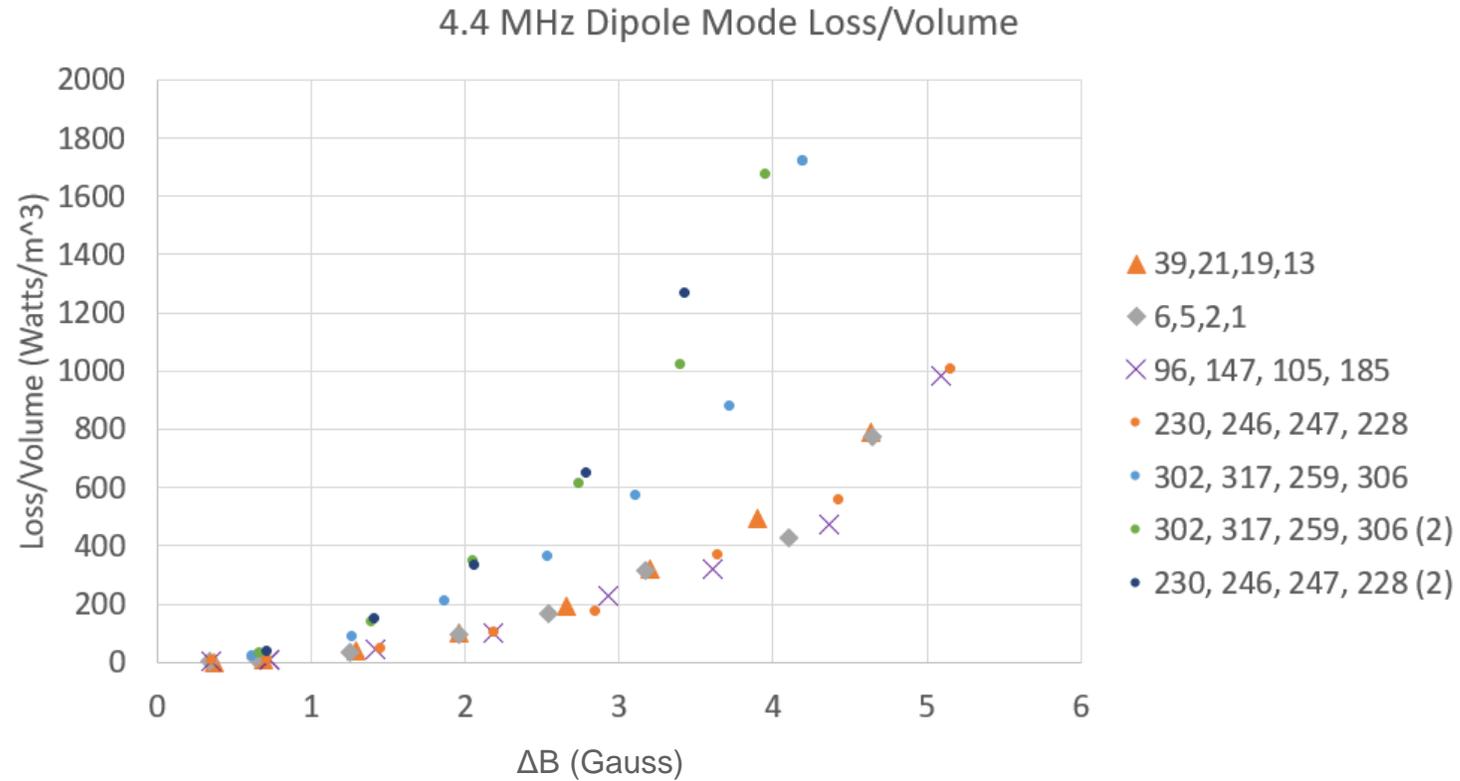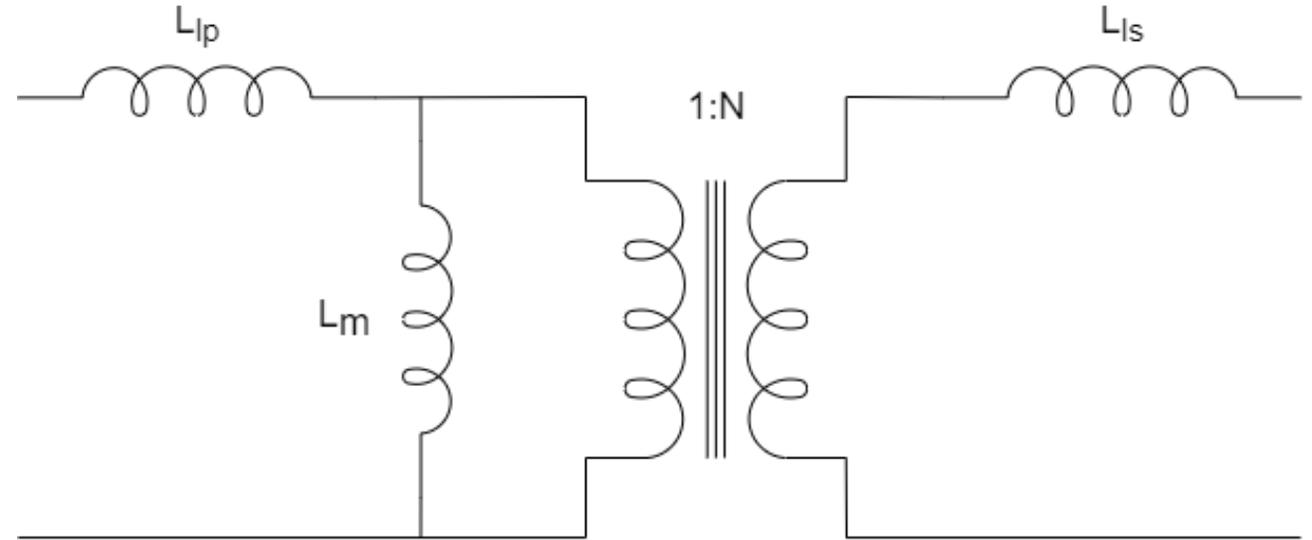
Future work

Future work

Transmission Line Transformer:
- High bandwidth
- Less losses

🪦 Fermilab

Thanks for the attention