

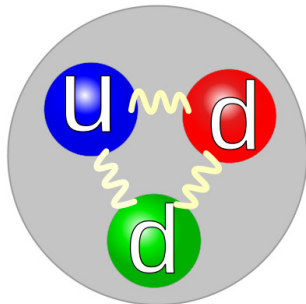
# Effects of a superconducting lead endcap on the magnetic field profile for the nEDM search

Aritra Biswas  
Filippone Group, Kellogg Radiation Laboratory

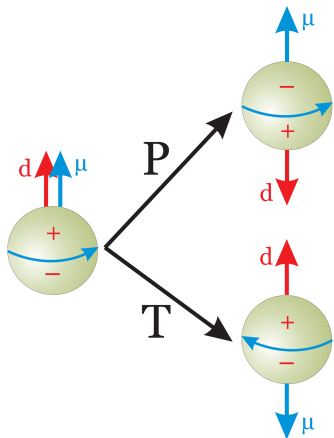
August 27, 2014

# nEDM = neutron electric dipole moment

- ▶ up quark:  $\frac{2}{3}e$
- ▶ each down quark:  $-\frac{1}{3}e$
- ▶ electric dipole moment:  
vector measuring separation  
between + and - charges  
and their orientation

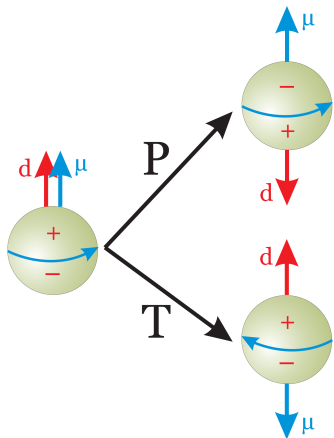


# why does the nEDM matter?



►  $C : q \mapsto -q$

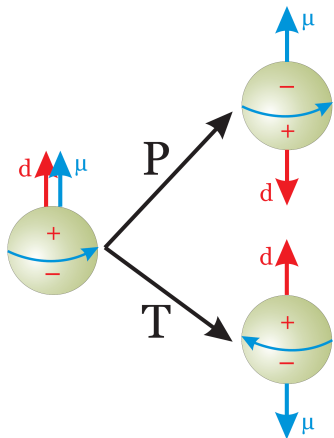
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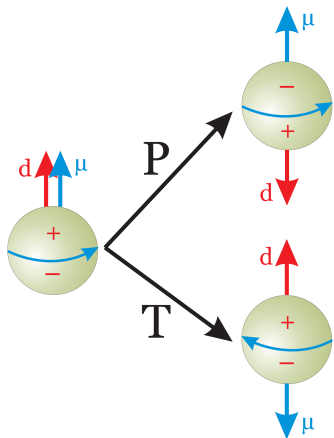
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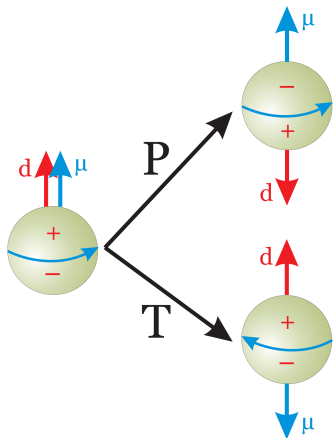
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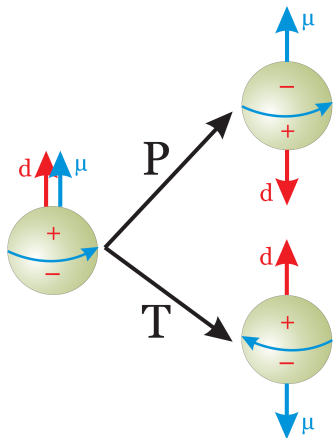
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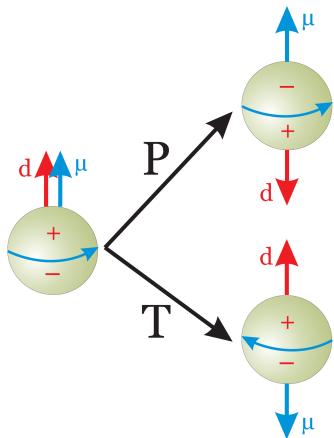
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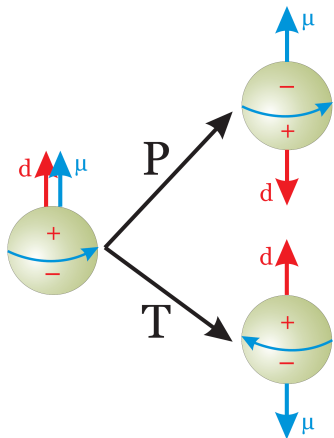


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- ▶ reformulations of Standard Model
- ▶ matter-antimatter asymmetry

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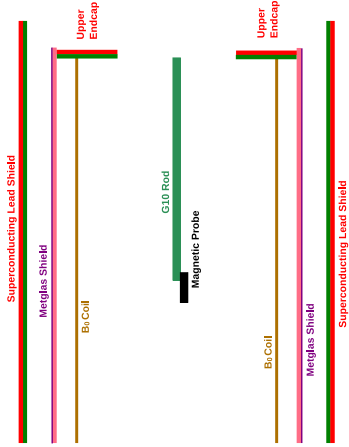
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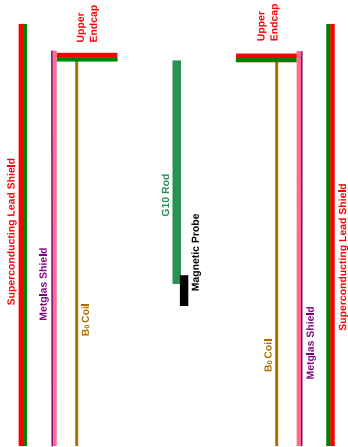
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- ▶ geometric phase  $\Rightarrow$  false measurement!

# creating an uniform magnetic field

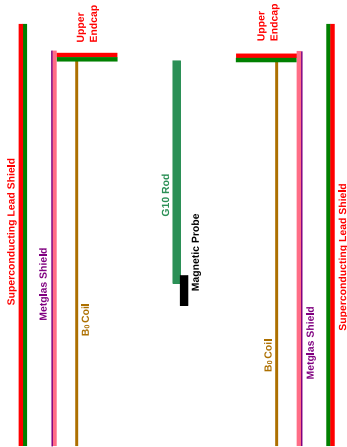


# creating an uniform magnetic field



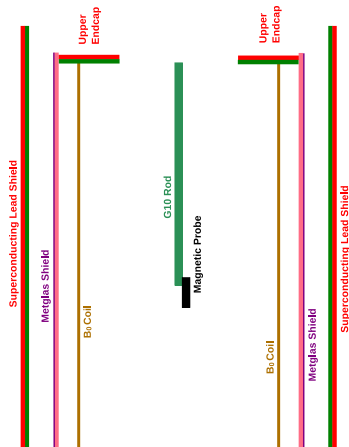
- $B_0$  coil:  $\cos \theta$  coil geometry, emulates sheet current

# creating an uniform magnetic field



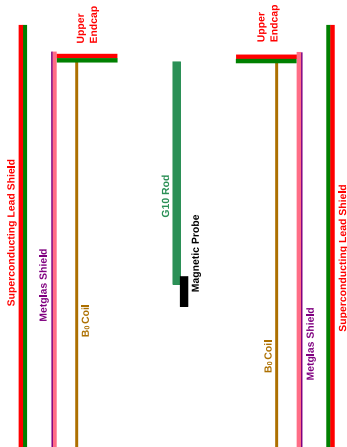
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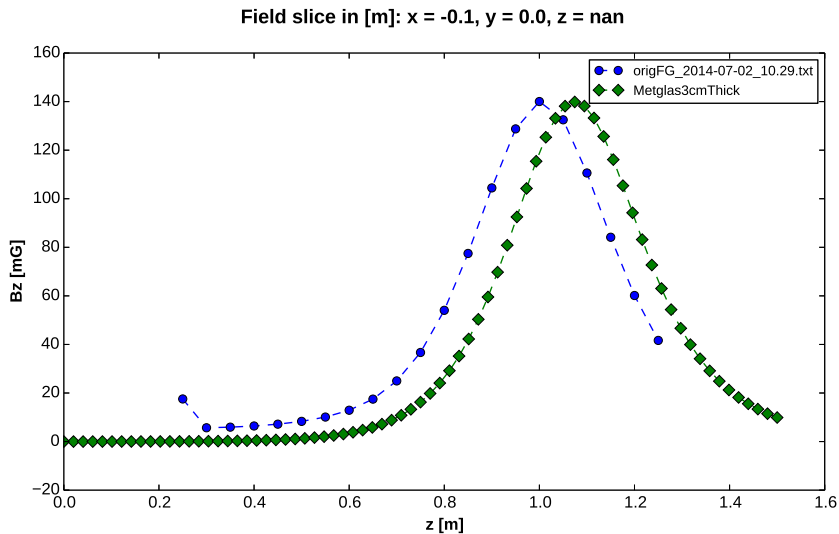
# creating an uniform magnetic field



- ▶  $B_0$  coil:  $\cos \theta$  coil geometry, emulates sheet current
- ▶ ferromagnetic Metglas shield
- ▶ superconducting axial shield
- ▶ superconducting upper endcap

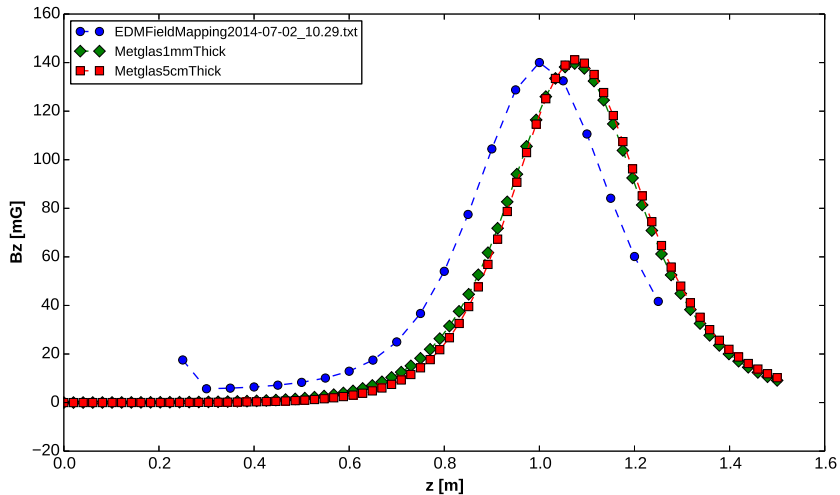


# original comparison, warm



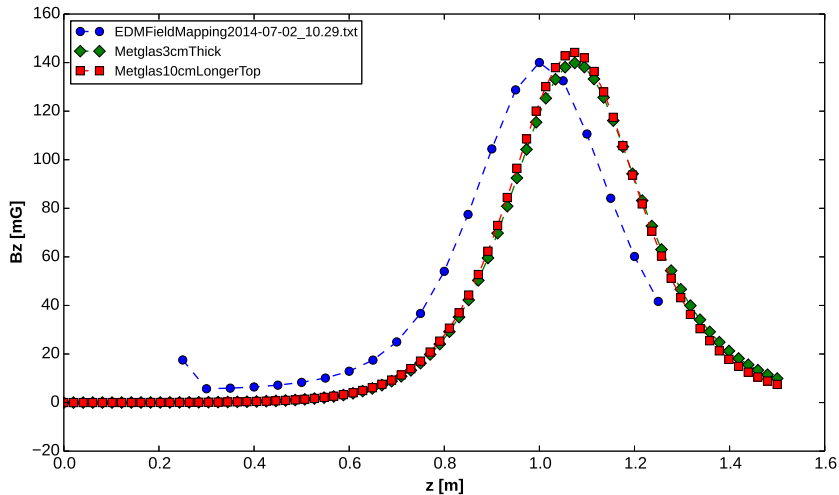
# Metglas thickness

Field slice in [m]:  $x = -0.1$ ,  $y = 0.0$ ,  $z = \text{nan}$

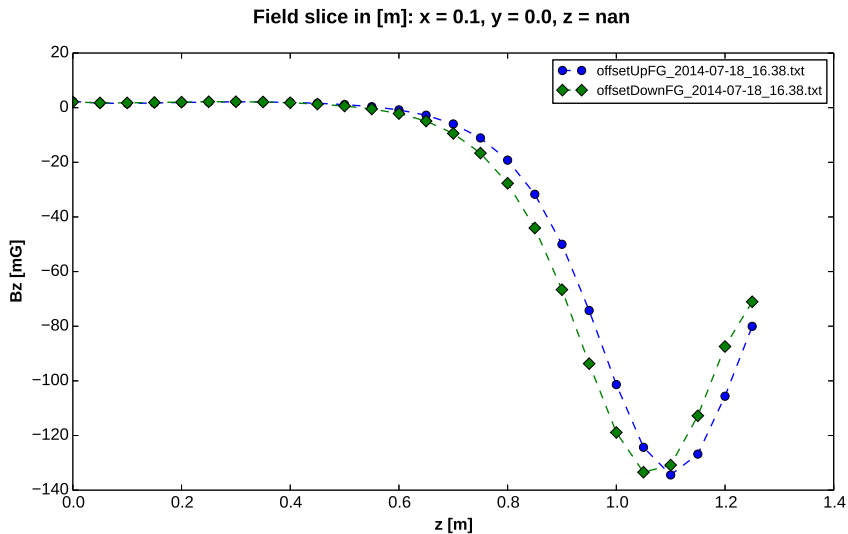


# Metglas 10 cm longer on top

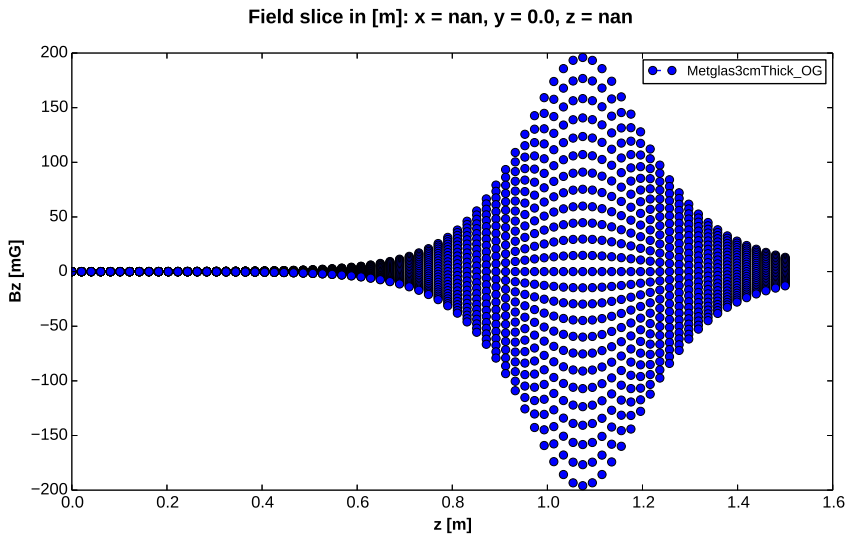
Field slice in [m]:  $x = -0.1$ ,  $y = 0.0$ ,  $z = \text{nan}$



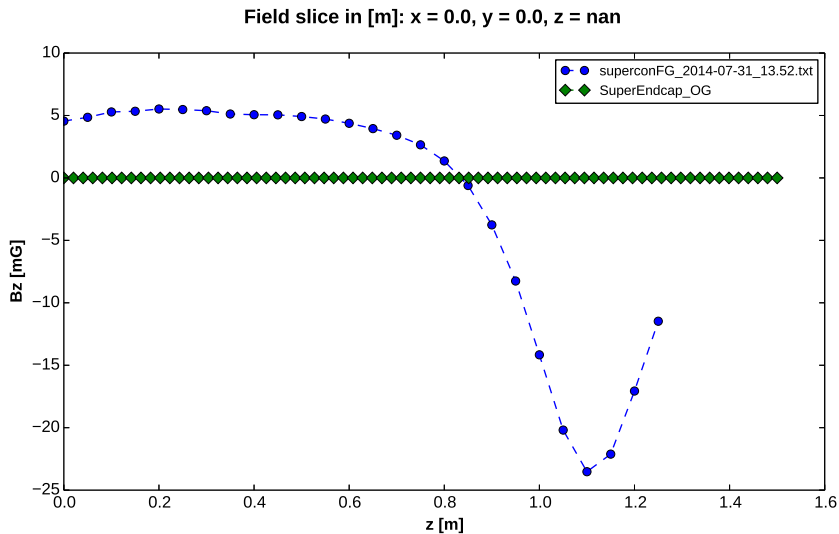
## correction 1: probe measurement time



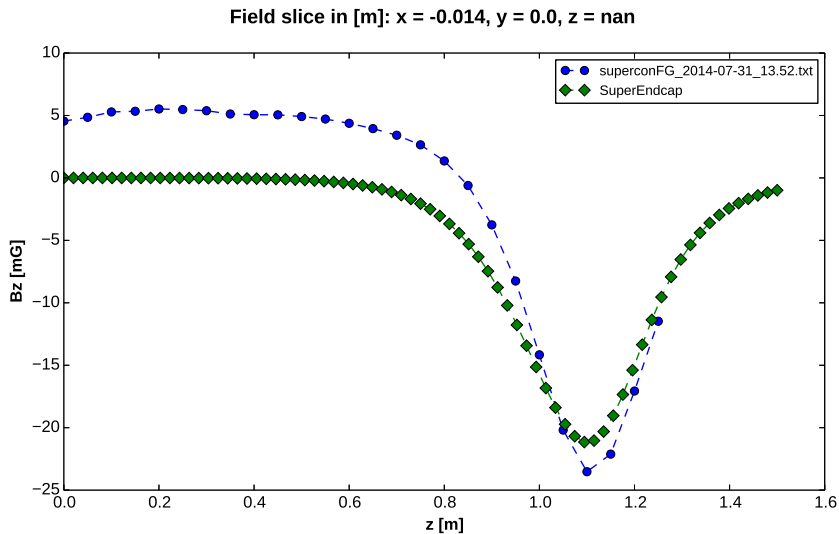
## correction 2: x centering



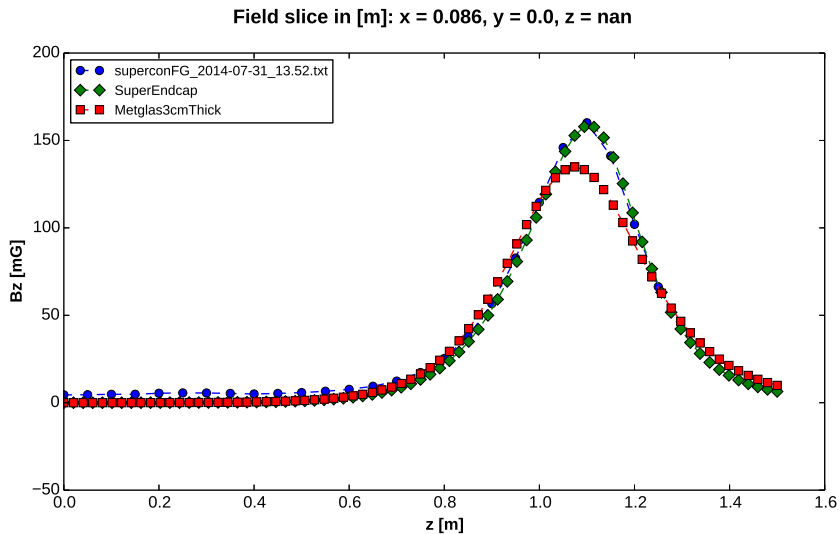
## correction 2: x centering, superconducting



## correction 2: x centering, superconducting, 1.4 cm offset

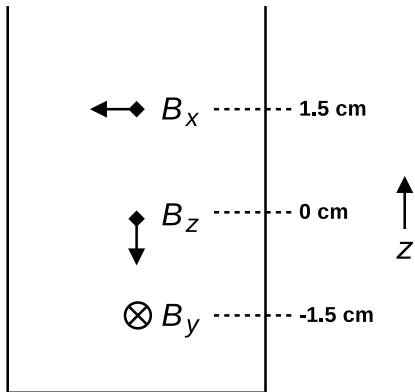


# comparison, superconducting



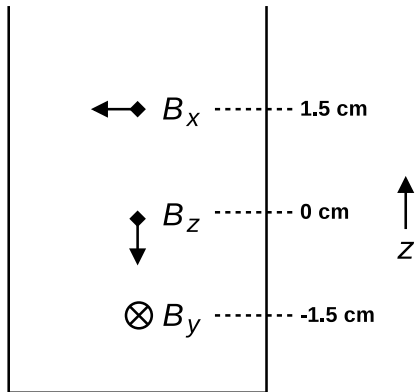


## correction 3: probe axis offset



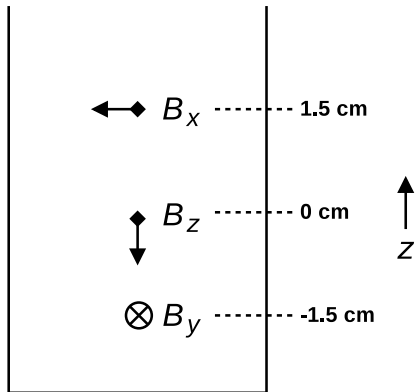
- ▶ 3 separate 1-axis probes

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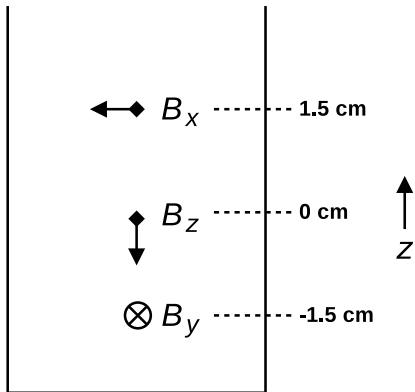
- ▶ 3 separate 1-axis probes
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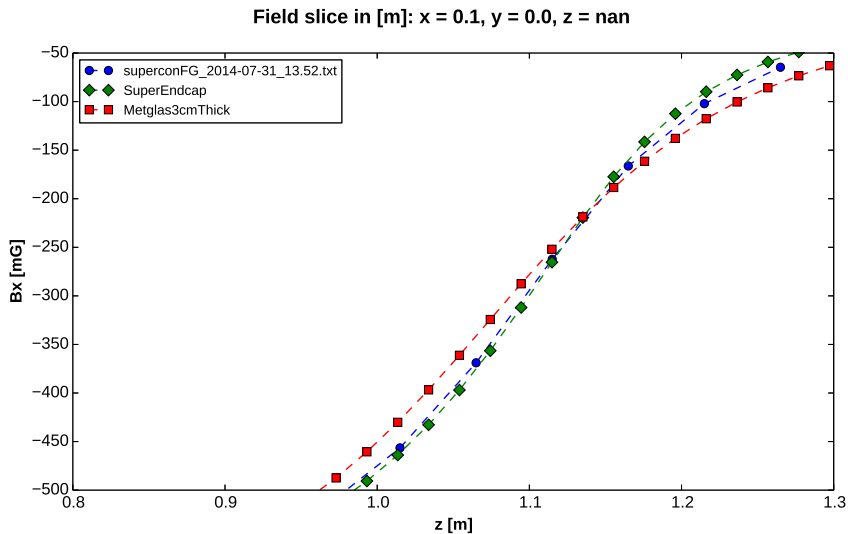
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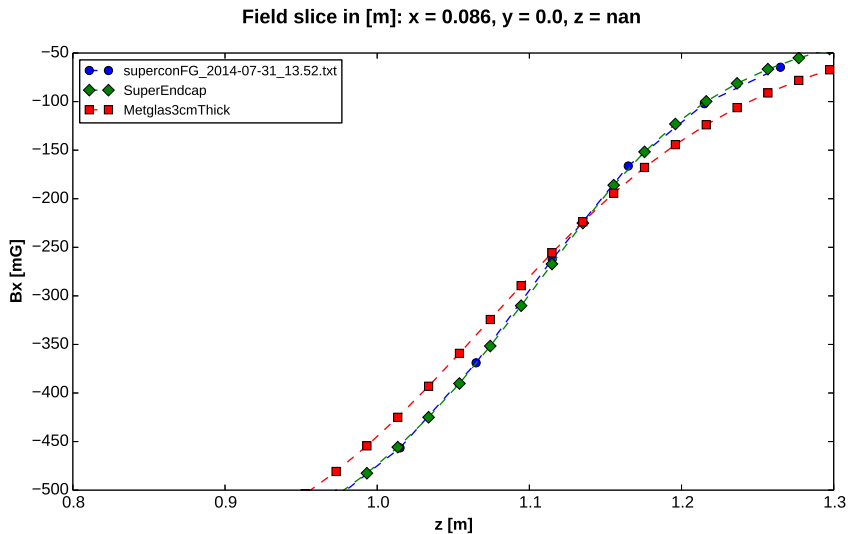


- ▶ 3 separate 1-axis probes
- ▶ incomplete vector map
- ▶ need to store z-axis offset vector along with z array
- ▶ `OffsetAxis` class to return proper spatial axis array based on desired vector component

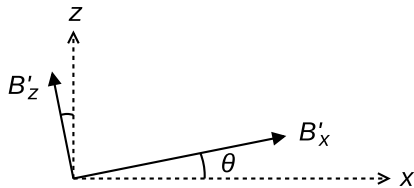
# comparison, superconducting, no offsets



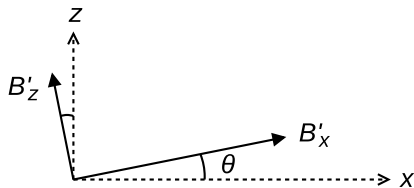
# comparison, superconducting, x-centering and axis offset



## correction 4: probe tilt



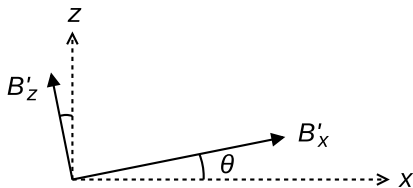
## correction 4: probe tilt



$$B_x = B'_x \cos \theta - B'_z \sin \theta, \quad B_z = B'_z \cos \theta + B'_x \sin \theta \quad (3)$$



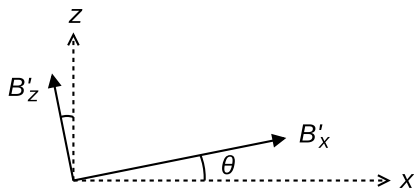
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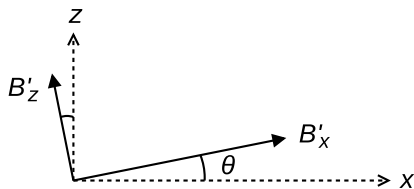


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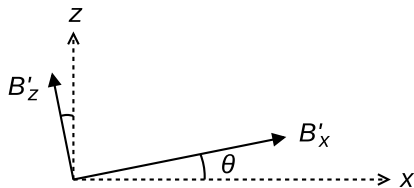
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$$\theta = -\frac{B'_z}{B'_x}$$

# comparison, superconducting

Field slice in [m]:  $x = 0.086$ ,  $y = 0.0$ ,  $z = \text{nan}$

