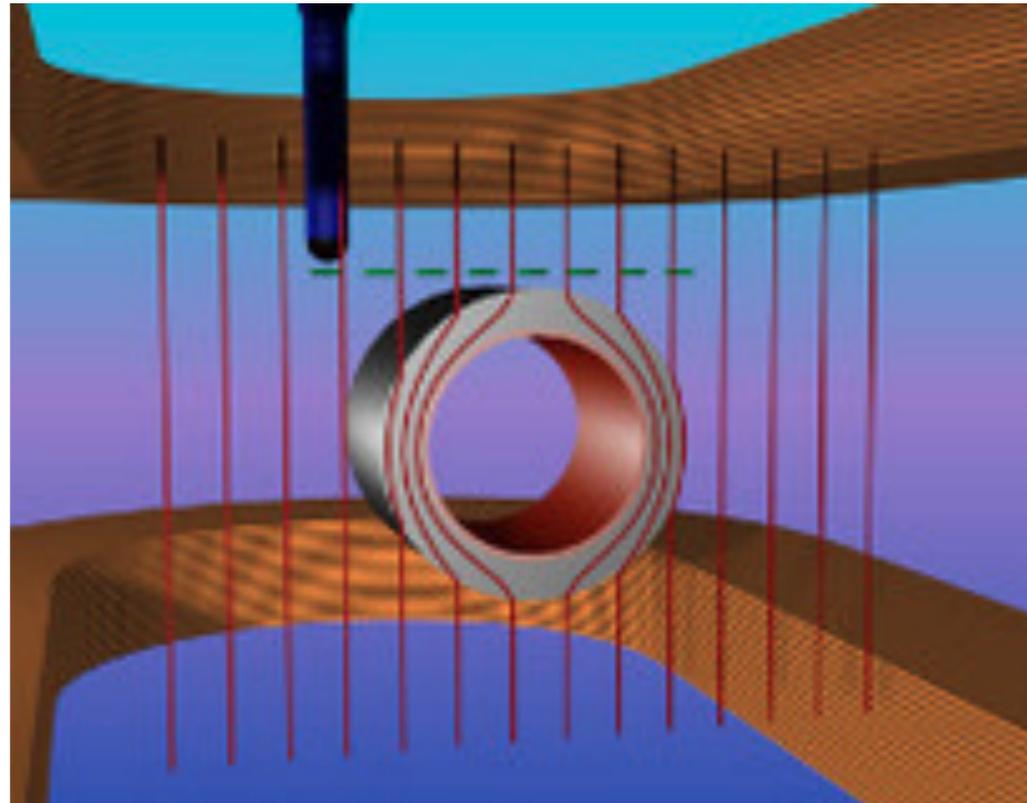


Stony Brook University



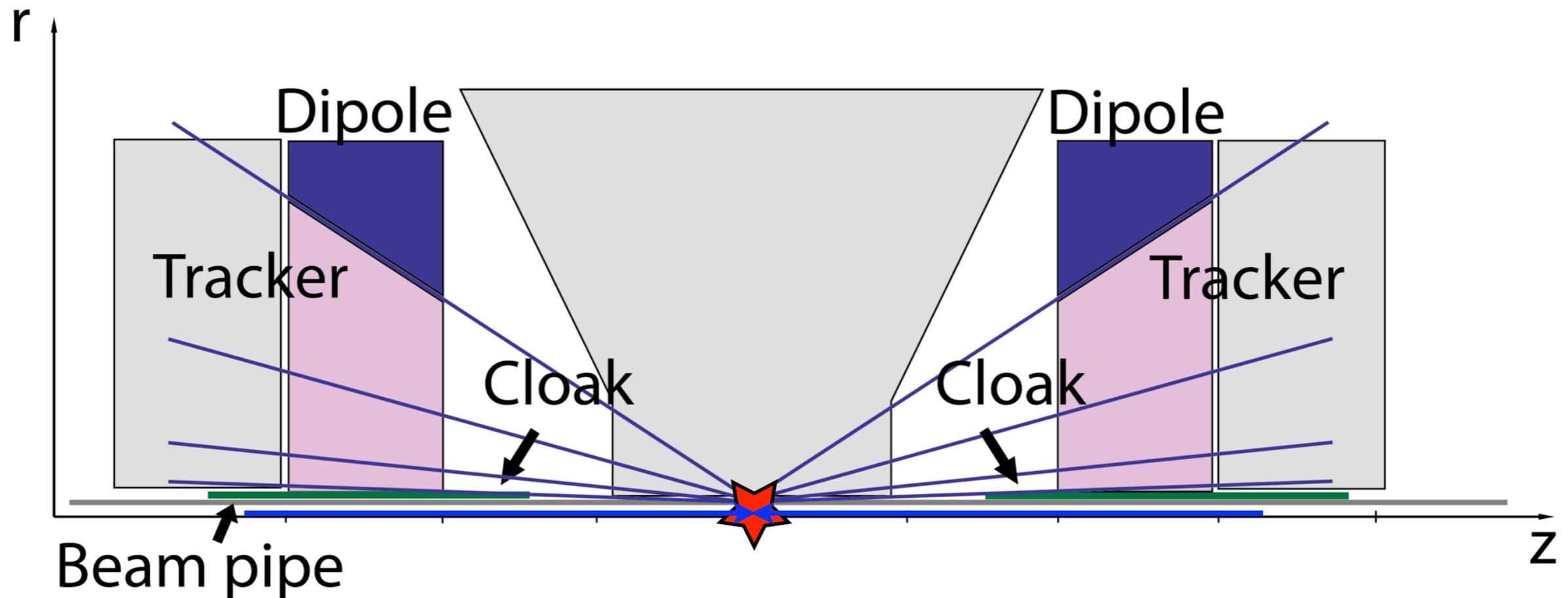
Magnetic Field Cloaking Device

RD2013-2 Progress Report

Abhay Deshpande, Nils Feege

EIC Advisory Committee Meeting; BNL, January 14, 2014

Goal: Measure particle momenta with dipole + tracker close to beam pipe



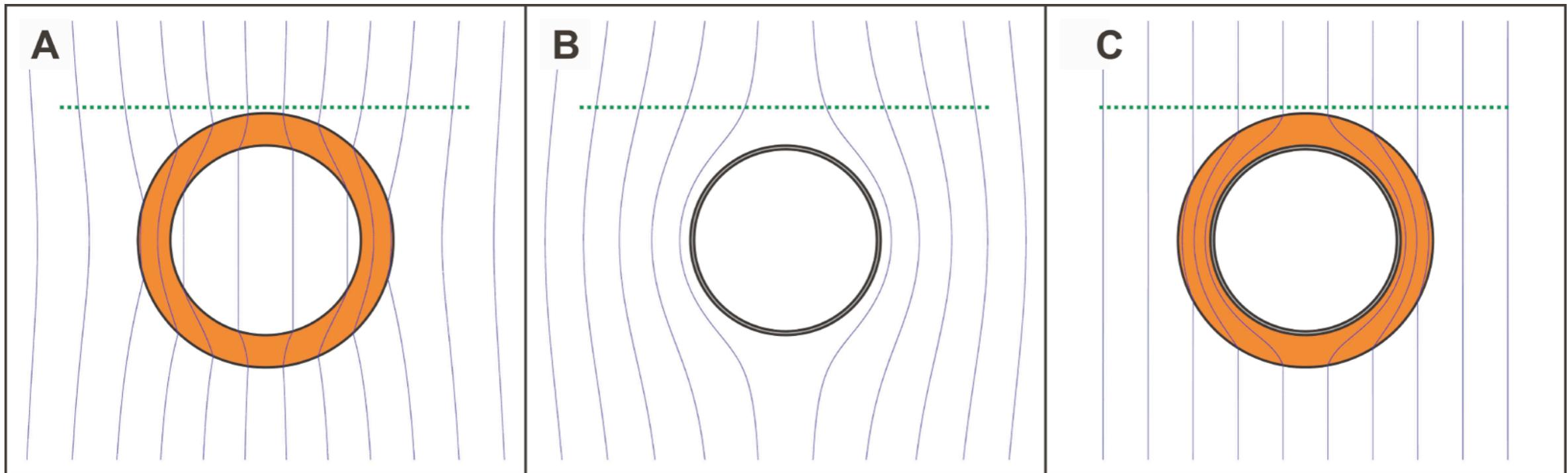
- Magnetic Cloak:**
- Shield fields up to 0.5 T
 - No outside field disturbances
 - Thin, > 1 m long

A simple cylindrical magnetic cloak

ferromagnetic

superconducting

combined



magnetic permeability (ferromagnetic): $\mu_2 = \frac{R_2^2 + R_1^2}{R_2^2 - R_1^2}$

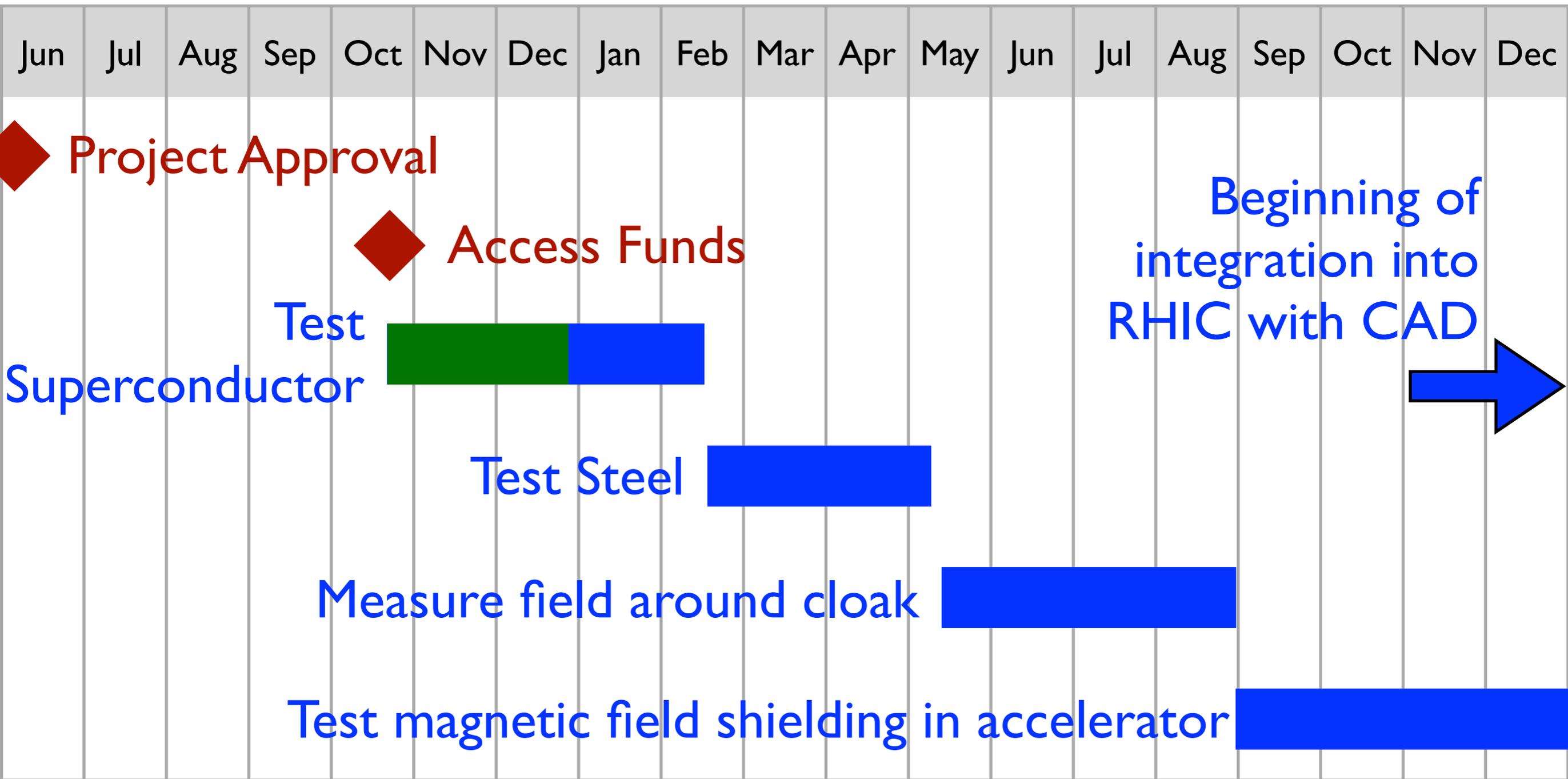
Fedor Gömöry et al.

DOI: 10.1126/science.1218316

Project Timeline

2013

2014



Thanks to all our collaborators!

RIKEN

Y. Goto, I. Nakagawa

RIKEN BNL Research Center

K. Boyle, J. Seele

Seoul National University

I. Yoon

BNL Advisors

R. Gupta, B. Parker, V. Ptitsyn

Stony Brook University (SUNY)

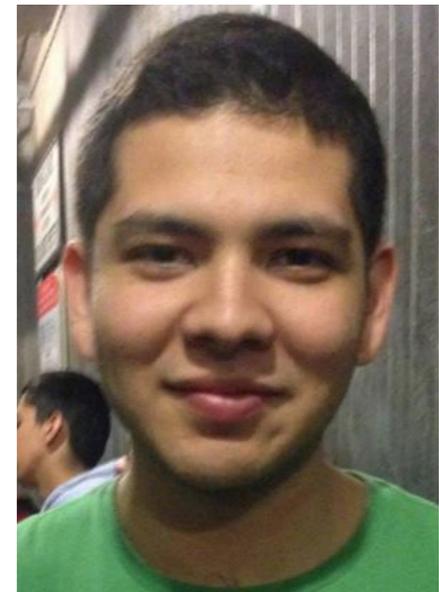
R. Cervantes, J. Chang, B. Coe,

K. Dehmelt, A. Deshpande,

N. Feege, T. K. Hemmick,

P. Karpov, Y. Ko, R. Lefferts,

A. Lipski, A. Quadri



MSI Student



*Undergraduate
Students*

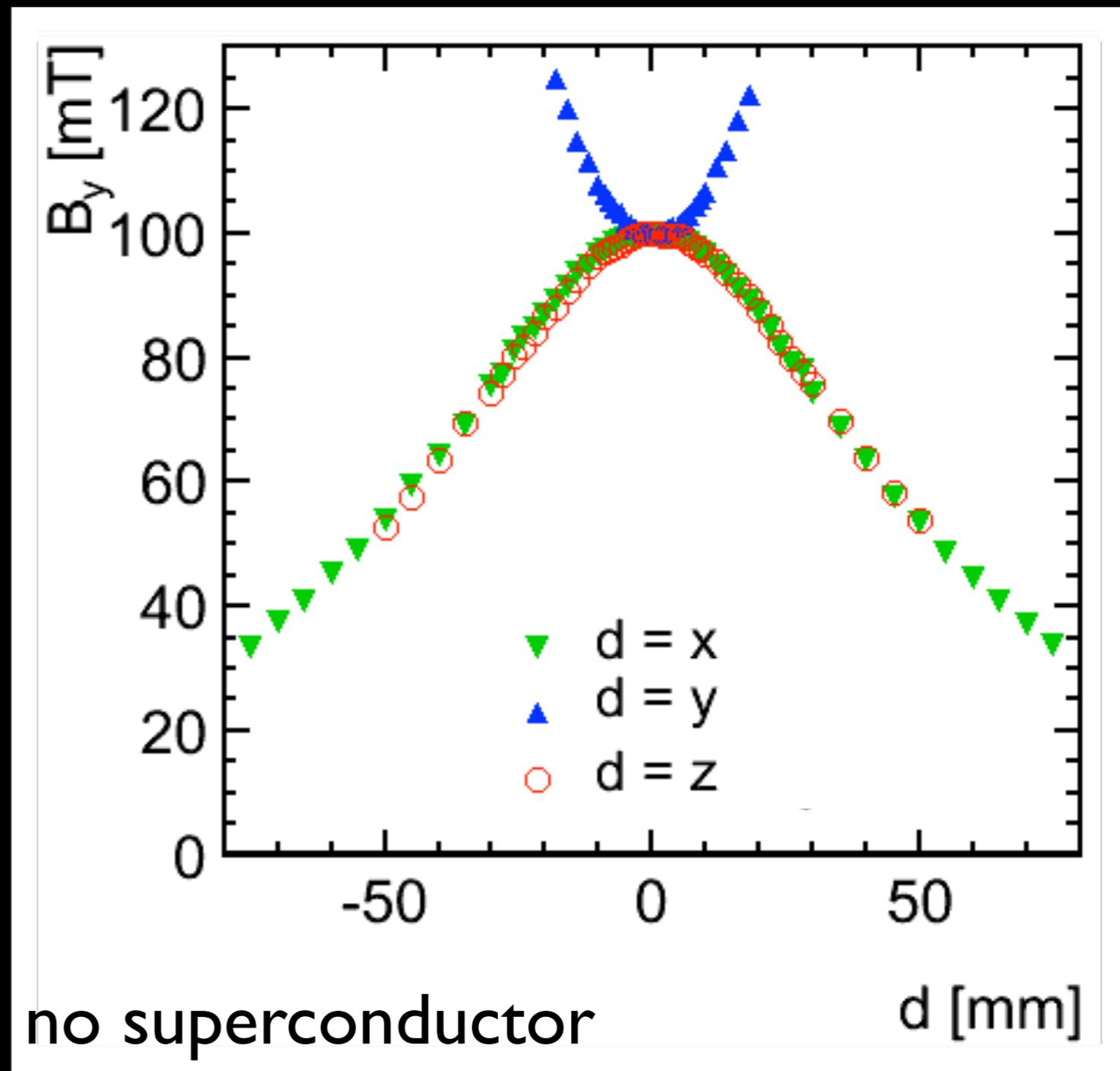
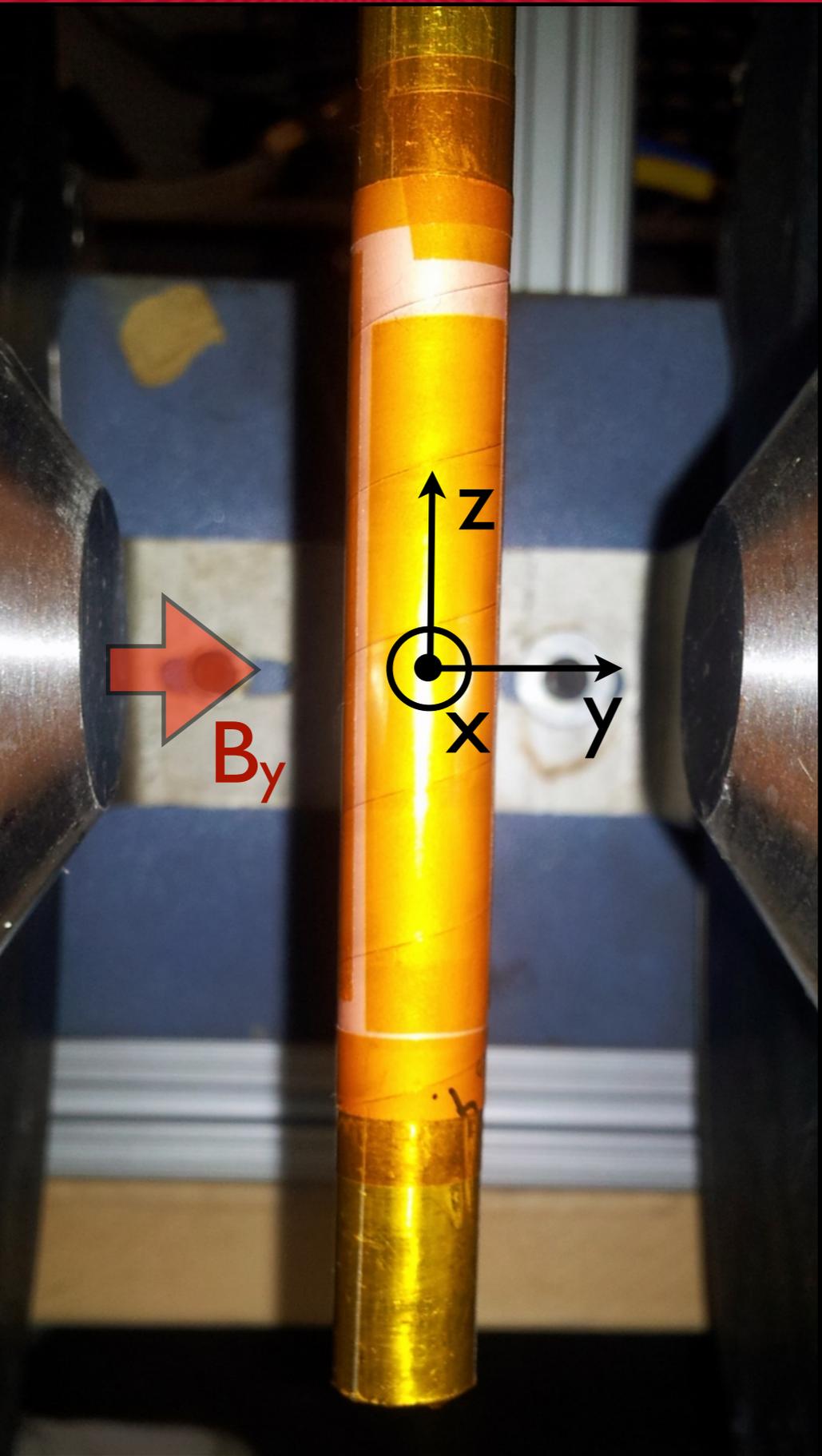
Test Superconductor

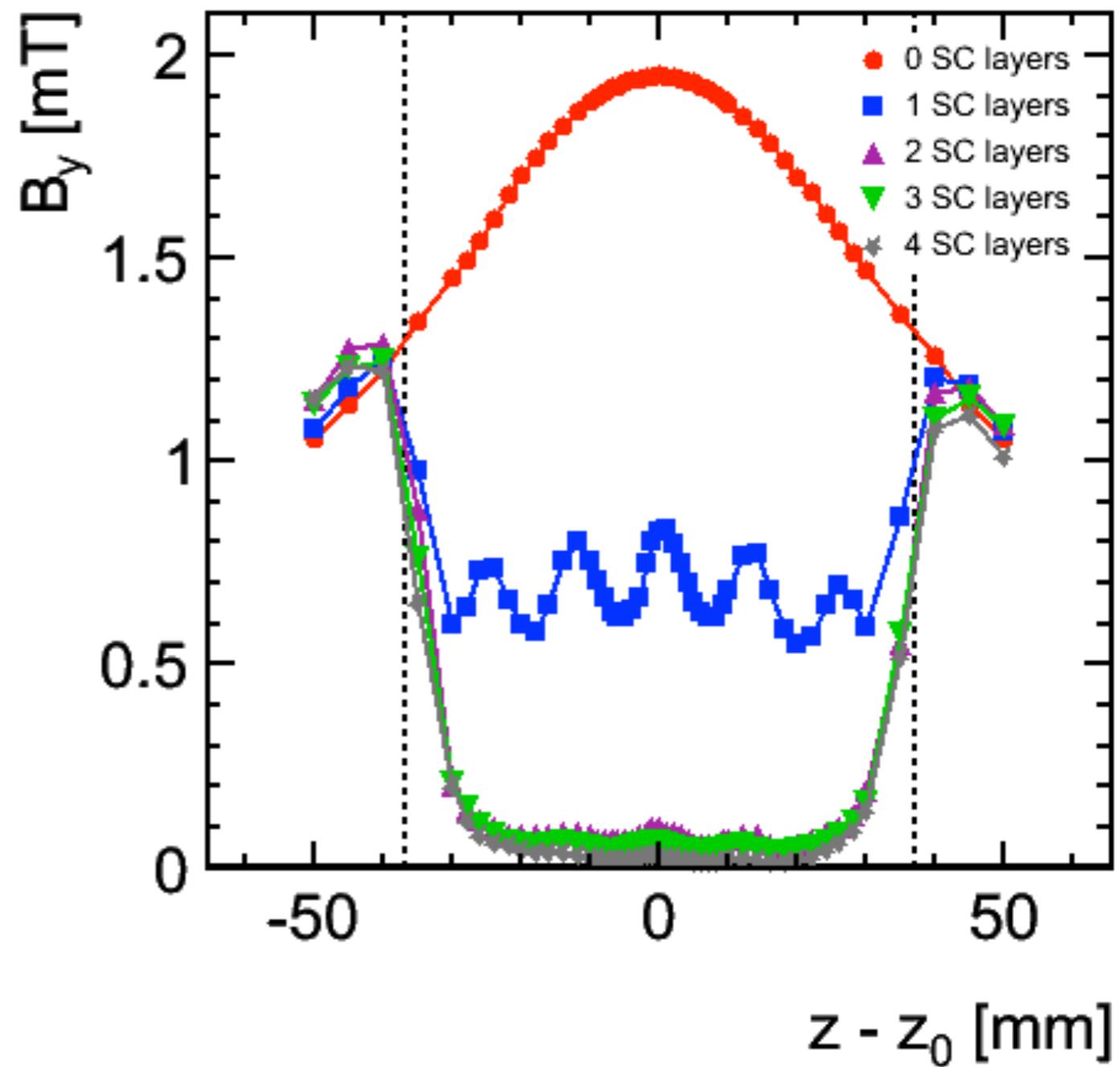
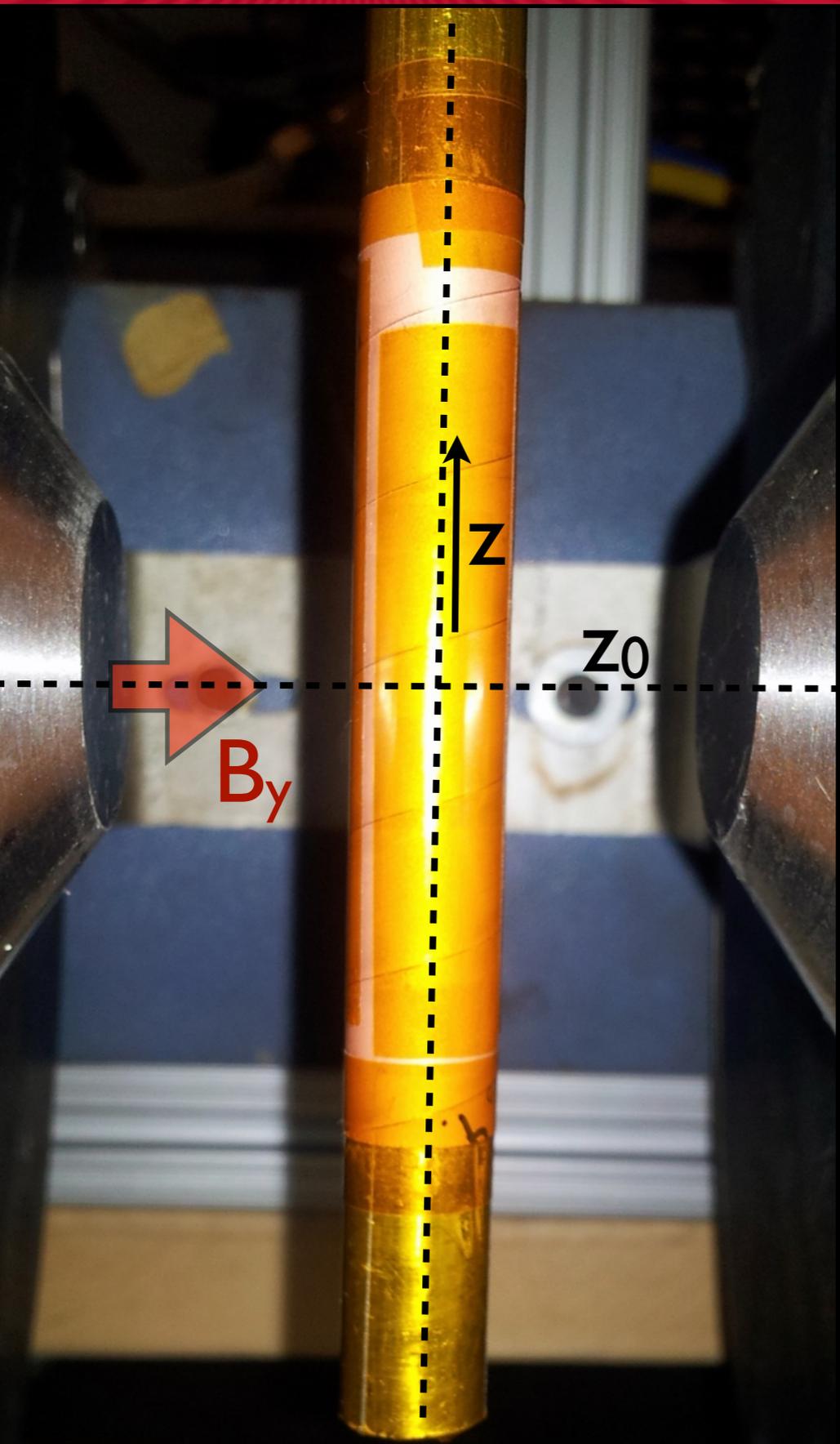


SC Tape (SuperPower):
12 mm wide, $I_c > 298$ A





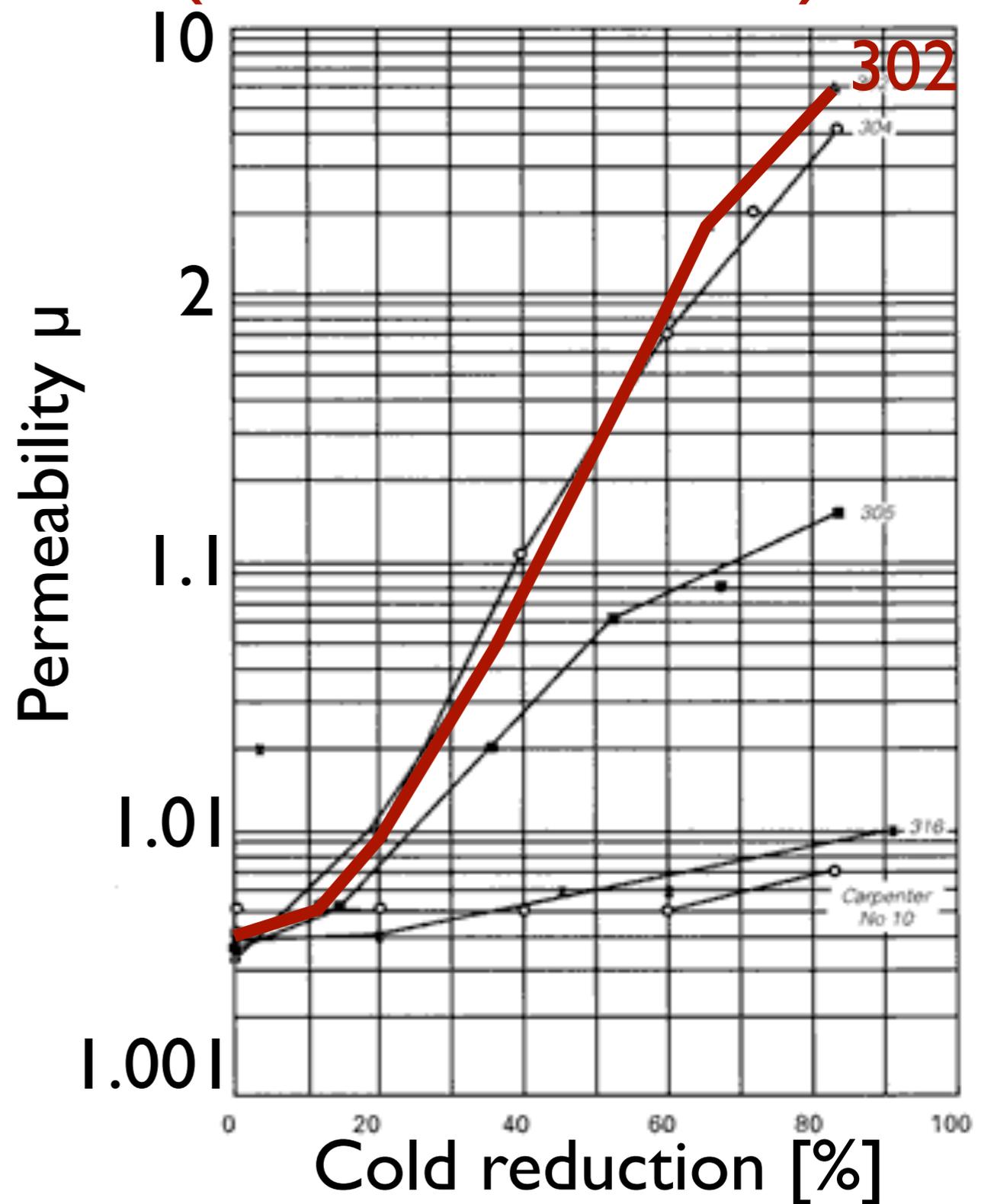




First success!

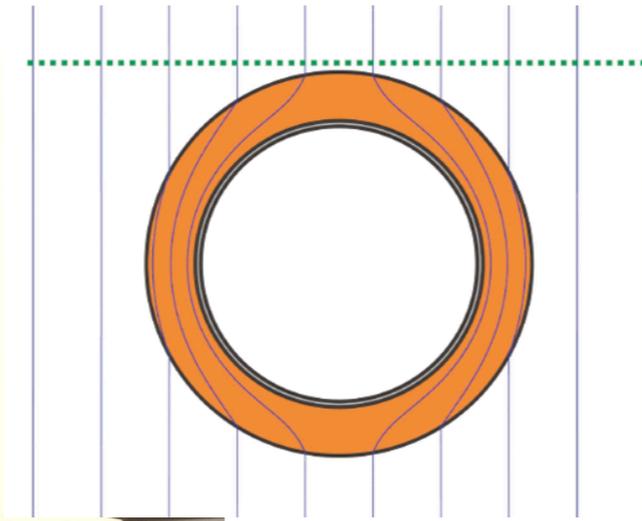
Next step: Higher fields

Soon: Test Steel Foil (Fe18Cr9Ni)

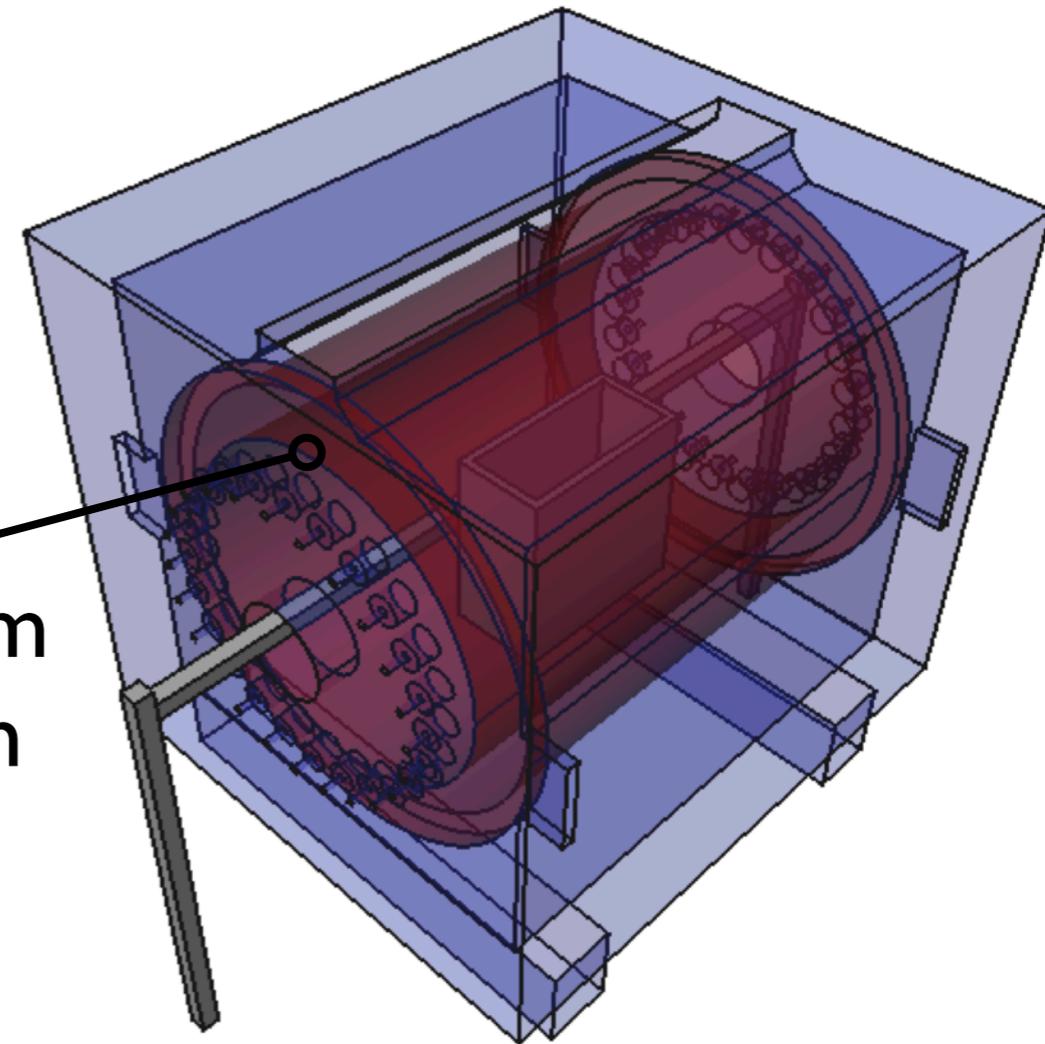


Material	302 Stainless Steel
Thickness	0.127 mm
Width	152.4 mm
Length	1270 mm
μ	?

Soon: Measure field disturbance around cloak

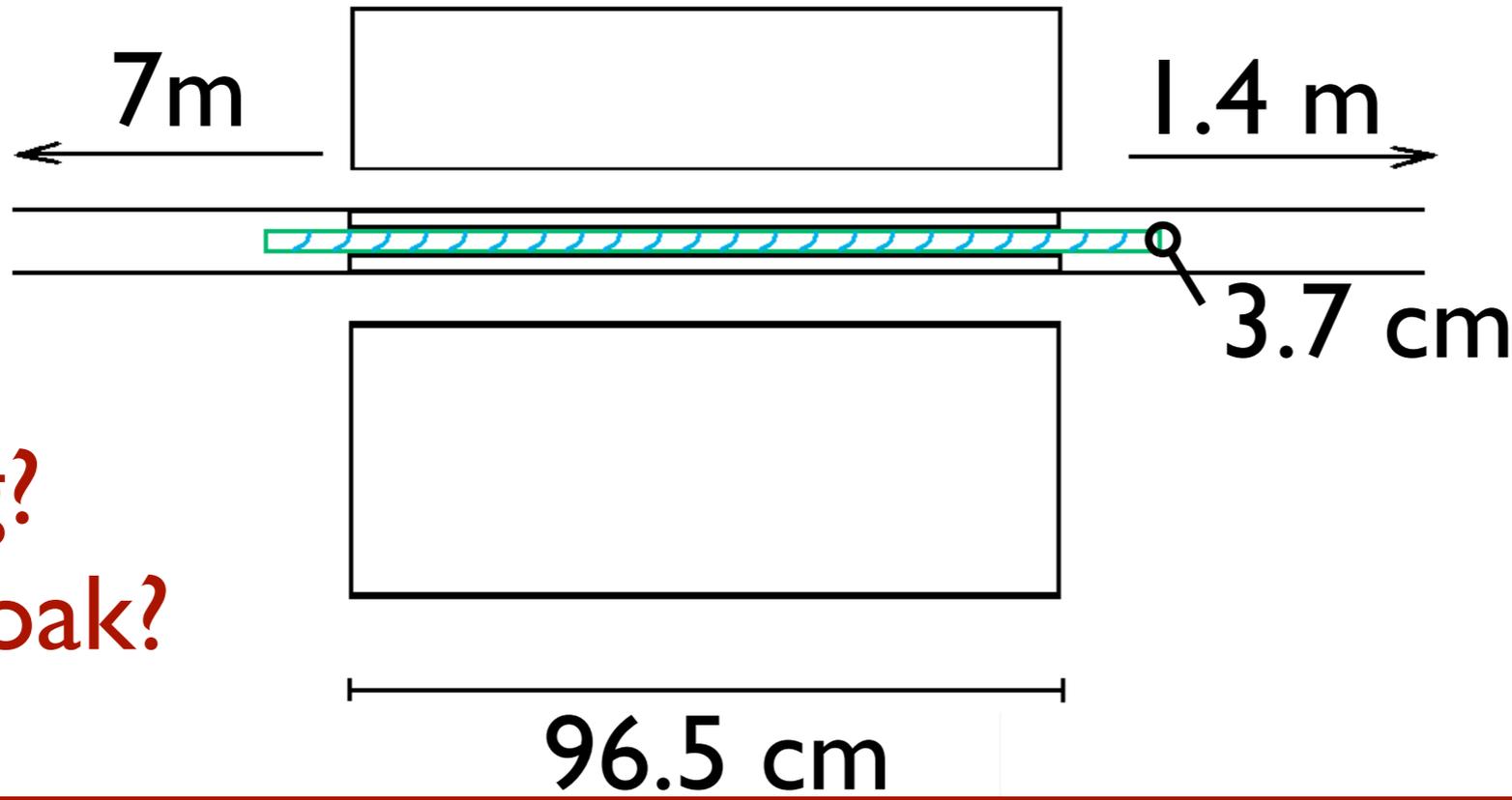
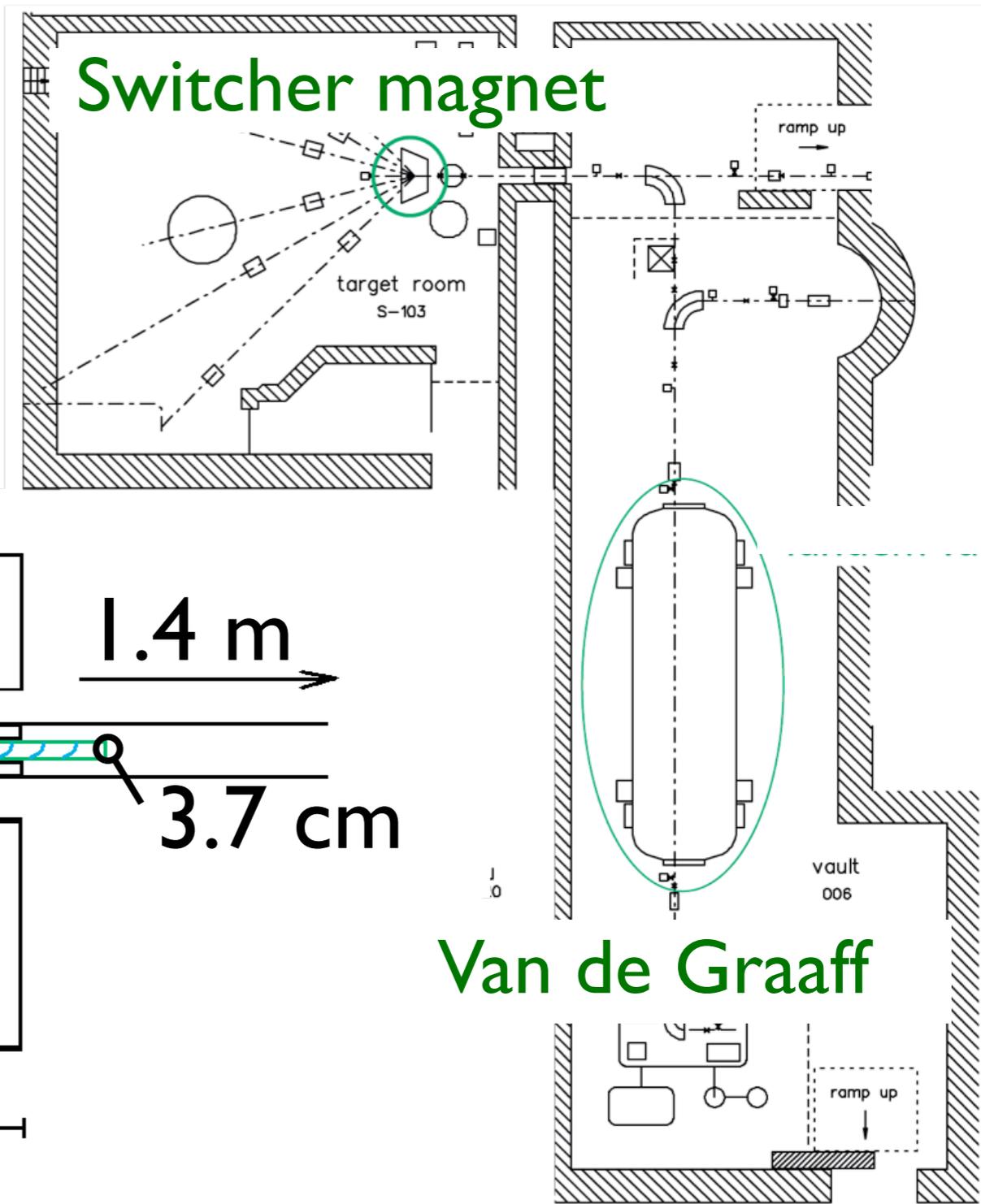
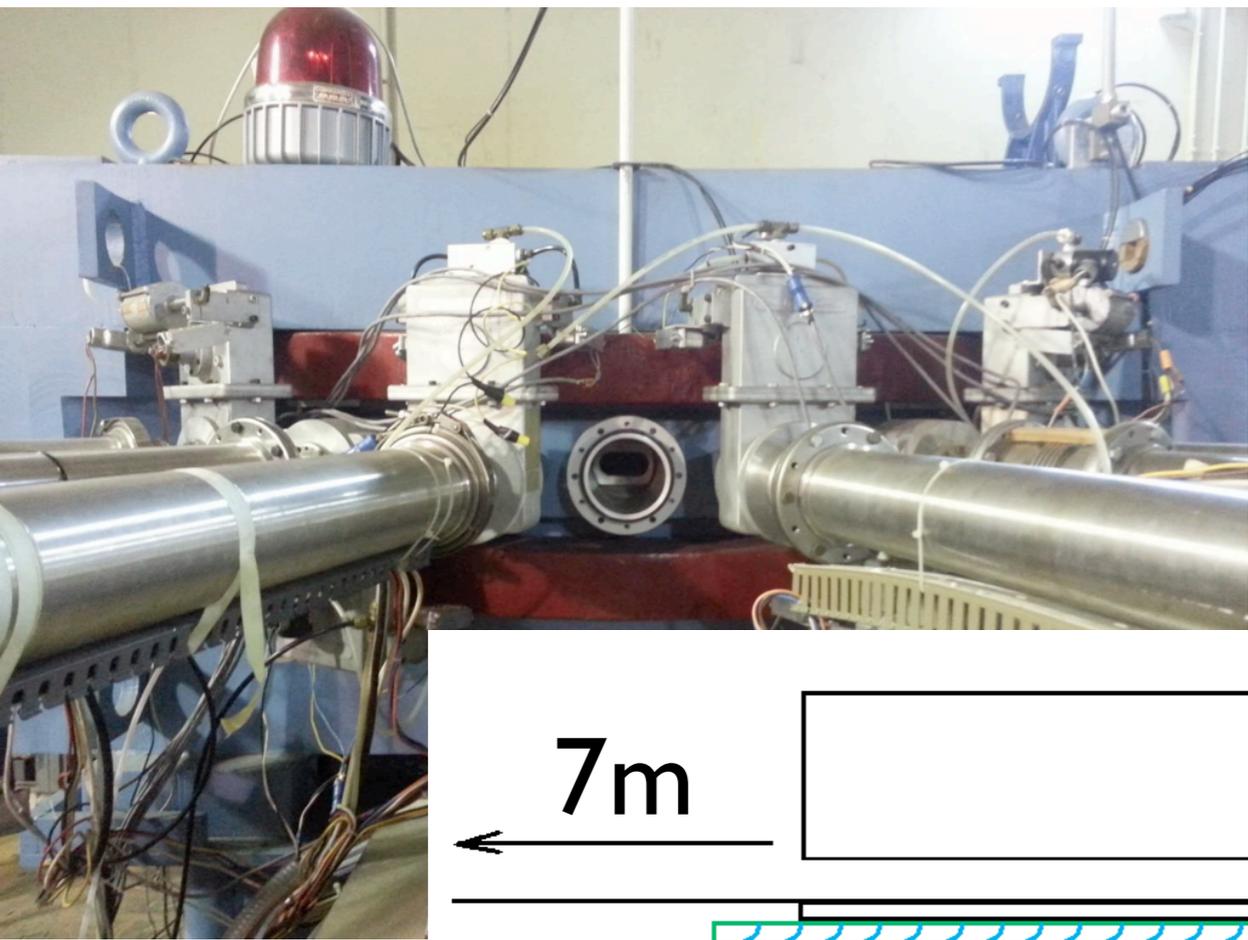


L 1092 mm
Ø 718 mm



Magnet commissioning?

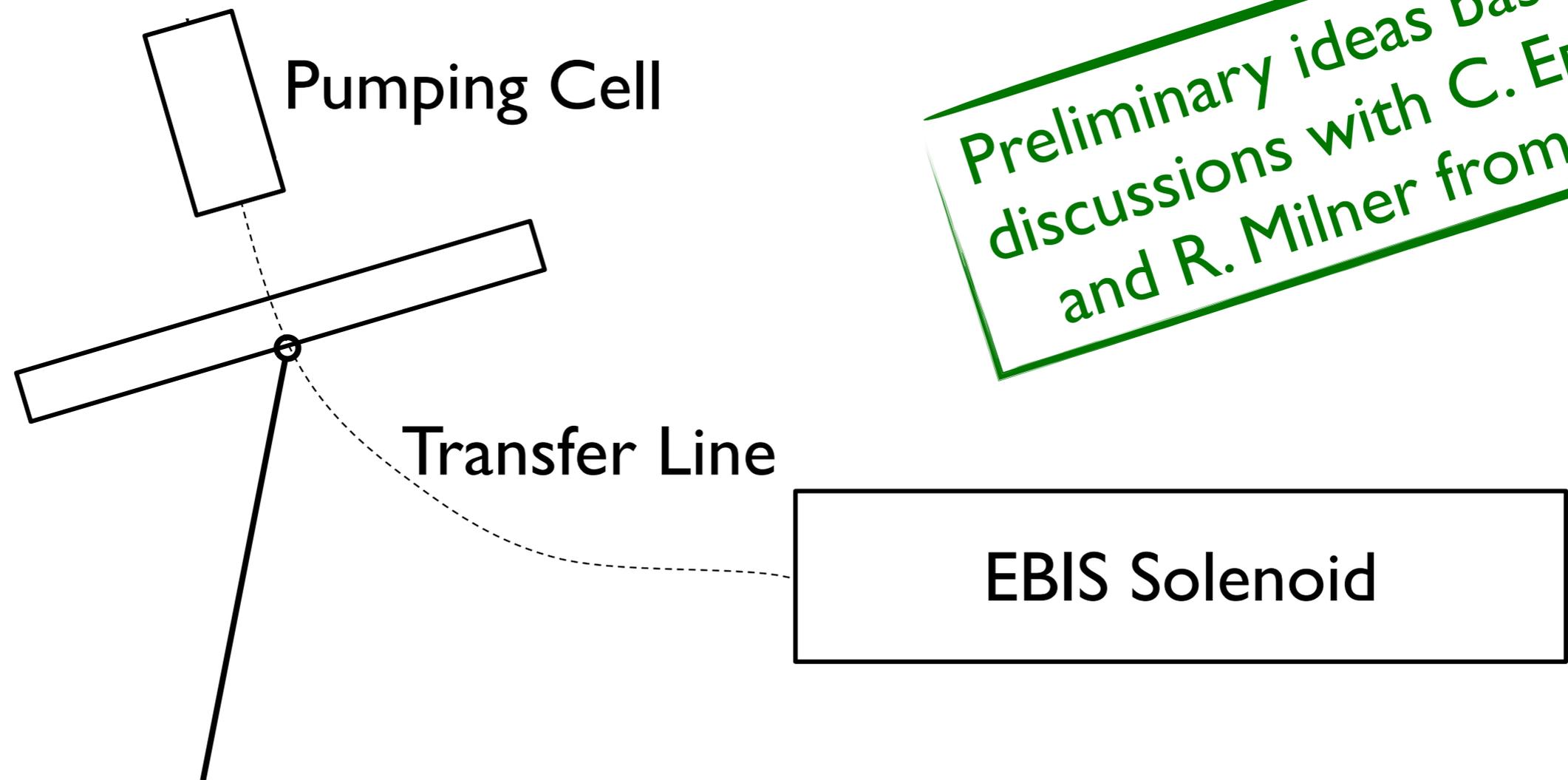
Soon: Test magnetic field shielding in Van de Graaff Accelerator



Cooling?
Long cloak?

Van de Graaff

Potential Cloak Use In Polarized ^3He Ion Source at BNL



Preliminary ideas based on discussions with C. Epstein and R. Milner from MIT

Depolarization due to transverse magnetic field gradients
→ Need correction coil OR magnetic cloak

Committee Questions (June 2013)

Has COMSOL already been used reliably for similar problems?

→ Yes, e.g. crosscheck with CERN's ROXIE code.

I. Rodriguez et al, Benchmark of COMSOL vs. ROXIE Codes for the Calculation of a Particle Accelerator Quadrupole.
Proceedings of the 2011 COMSOL Conference in Stuttgart, 2011



Are questions related to how to operate COMSOL correctly? Talk to an expert who has a real experience with this code for similar magnet applications.

→ COMSOL expertise among collaborators, discussion with COMSOL representative.



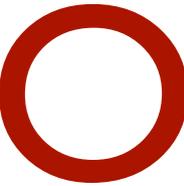
Does the dependence of the permeability on magnetic field impact the simulation? Verify by measurements if needed.

→ COMSOL simulation with generic steel magnetization curve shows no impact of curve on cloak behavior.

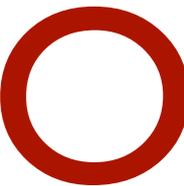


Committee Questions (June 2013)

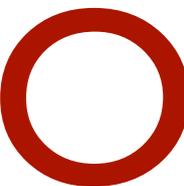
Provide some quantitative study of the physics benefit for a conceptual forward dipole spectrometer.



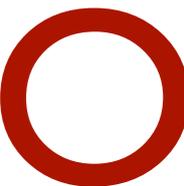
Work closely with an accelerator expert to check what is the effect of the end-field on the accelerator performance.



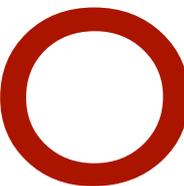
What is the effect of a possible cryostat and its flanges on the detector acceptance and performance at small angles?



Investigate thermal effects due to accidental beam dumps to see if one could damage the structure.



Check the radiation hardness of the ferromagnetic and superconducting material.



Additional Budget Request

Item	Cost Estimate [\$]
Post-doc salary (3 months) + fringe benefits	12,500 + 5,125
Graduate student salary (1 year) + fringe benefits	24,000 + 3,675
Total	49,988
Overhead (indirect)	15,545
Total Additional Budget Request	65,533

Summary

Test setup for superconductor cylinders built and working well.

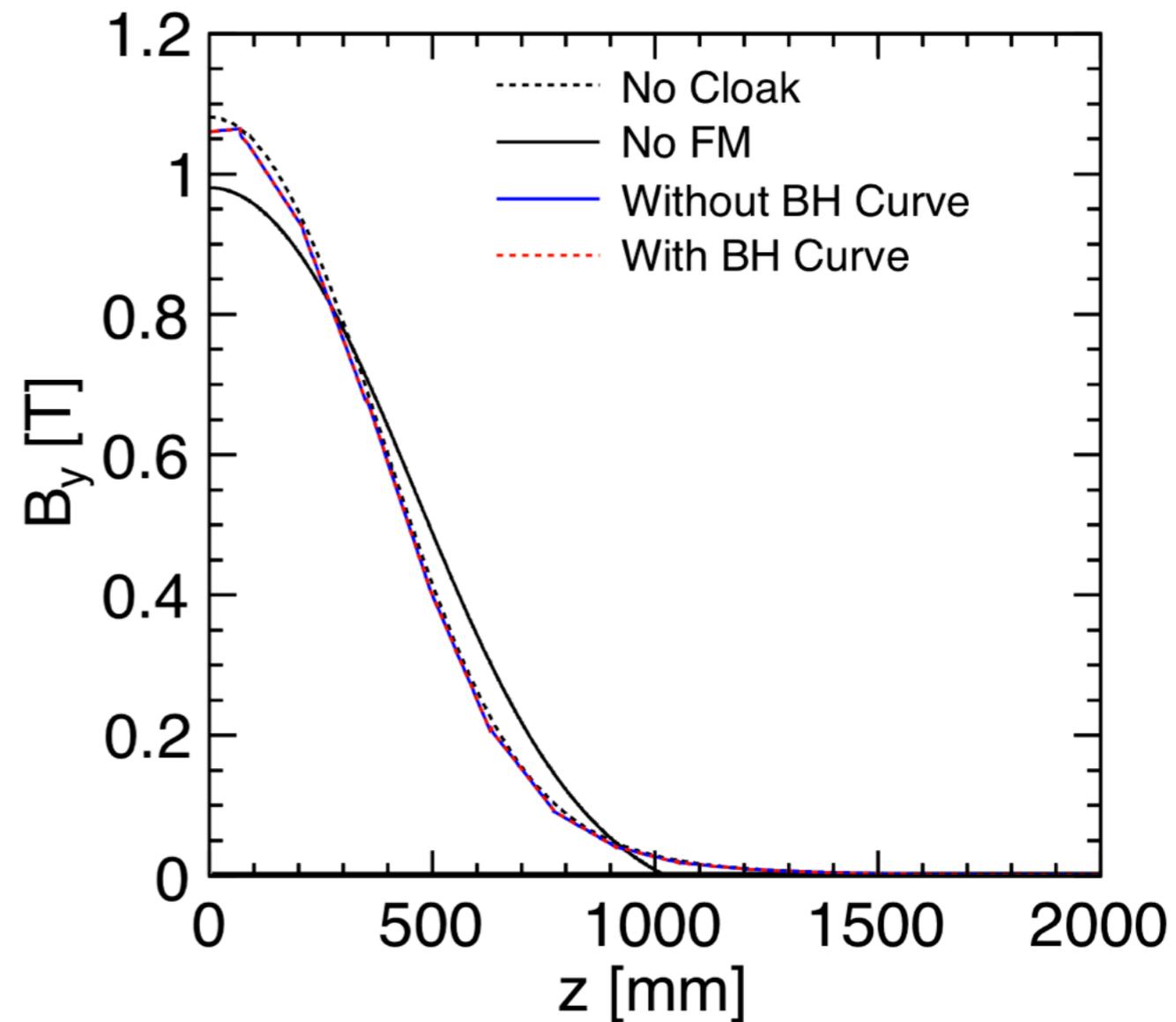
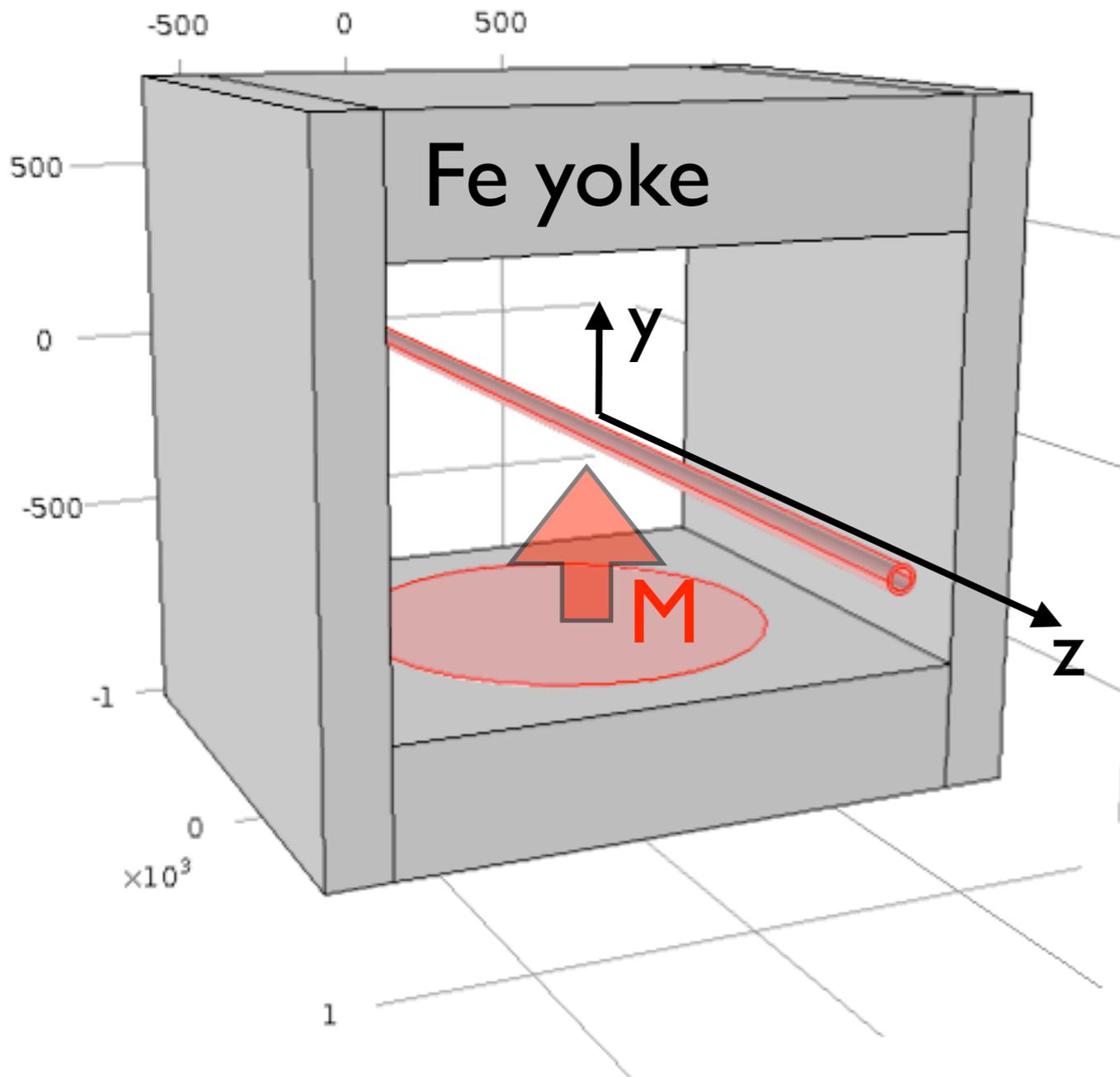
Successfully shielded low (2 mT) magnetic field with cylinder made from superconductor tape.

Excellent opportunity for students to collect laboratory experience.

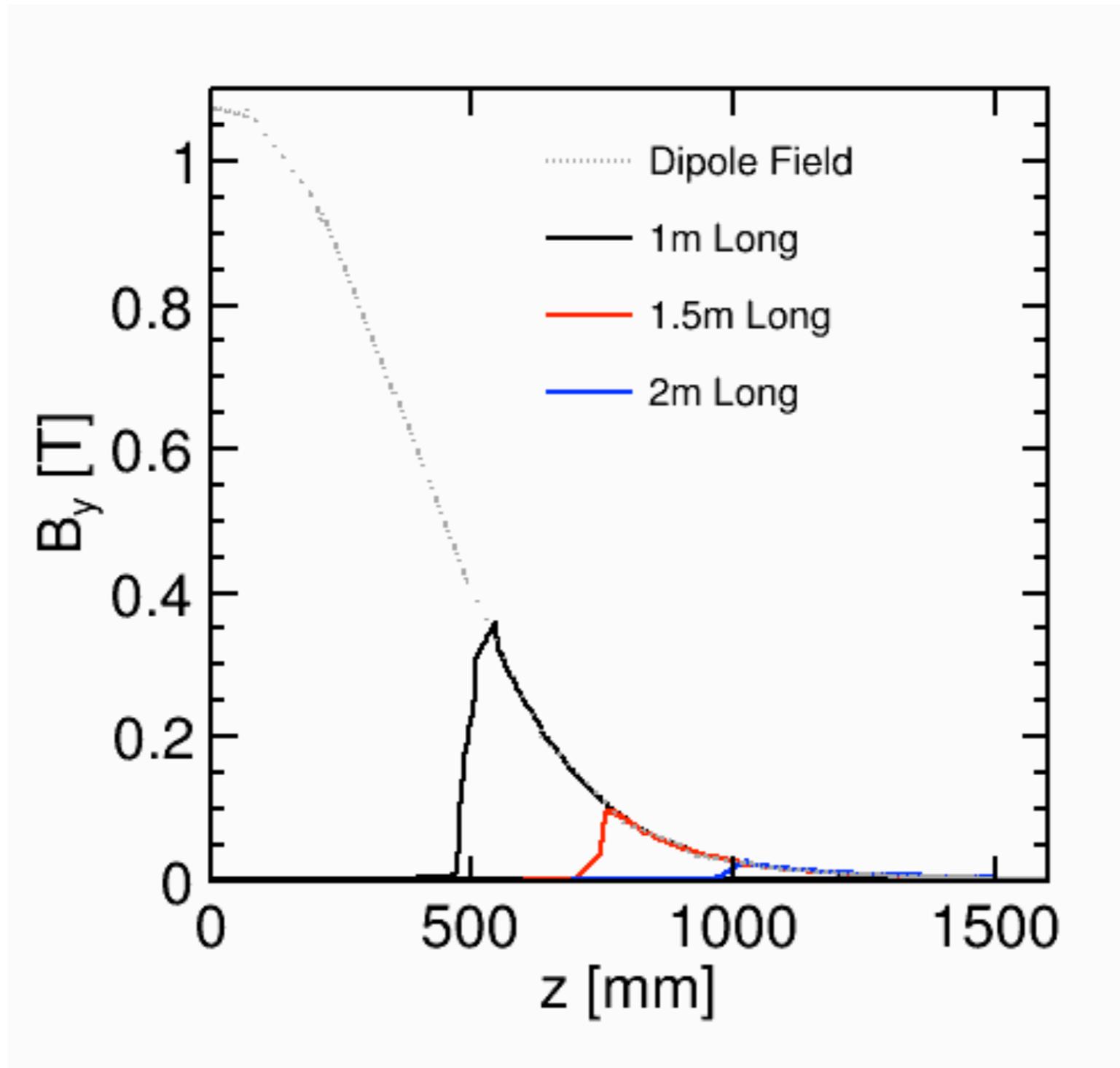
Project continues.

ADDITIONAL SLIDES

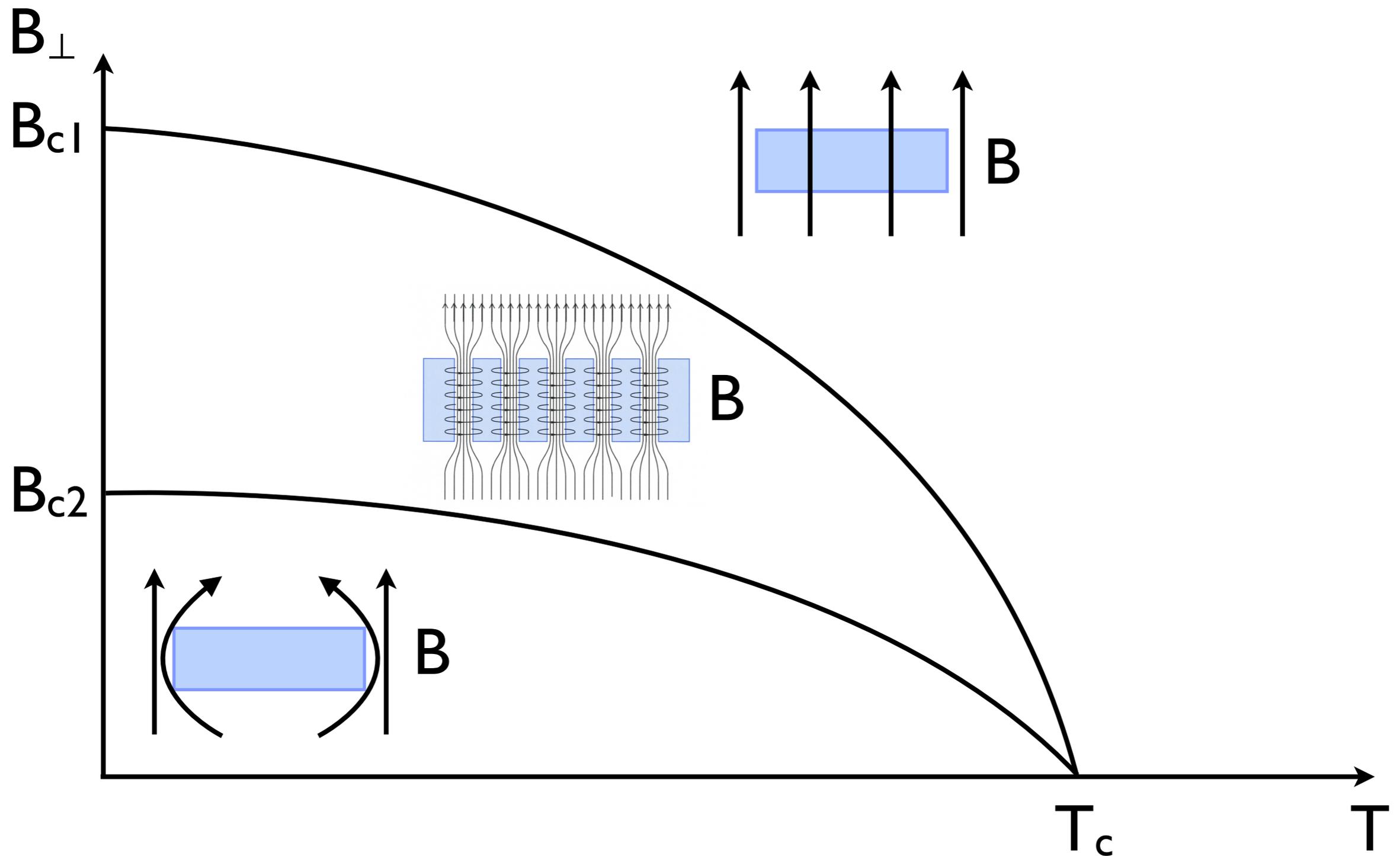
COMSOL: Cloak behavior is not affected by magnetization curve

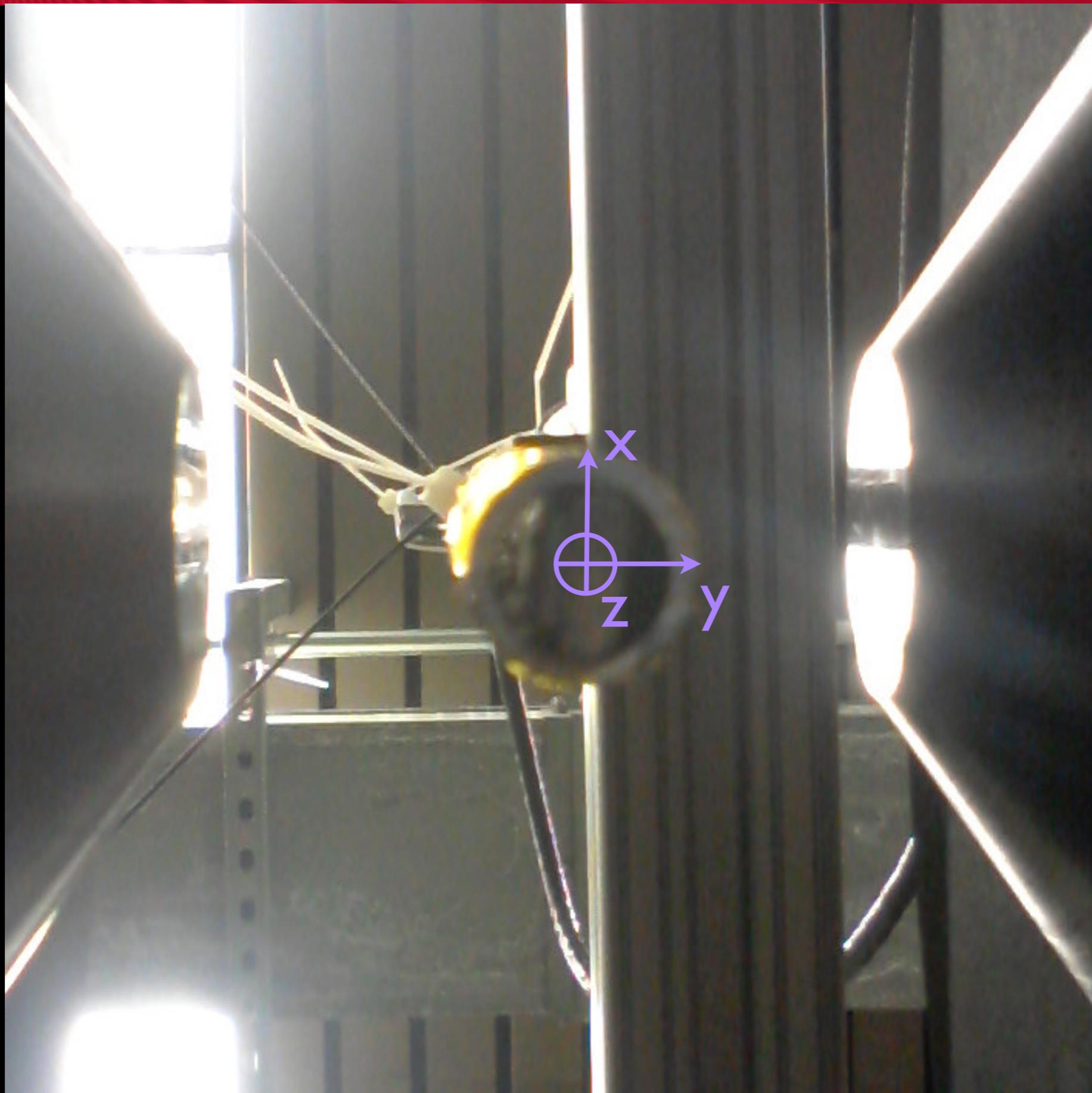


COMSOL: Cloak Length Scaling



Type II superconductors





Van de Graaff Beam Pipe Dimension

