3LP4-03

Force acting on a magnetic cloak placed in magnetic field

Mykola Solovyov[1], Fedor Gömöry[1], Ján Šouc[1], Edita Mikulášová[1], Marianna Ušáková[2], Elemír Ušák[2]

[1] Institute of Electrical Engineering, Slovak Academy of Sciences, Dubravska cesta 9, Bratislava, Slovakia
[2] Faculty of Electrical Engineering and Information Technology, Slovak University of Technology, Bratislava, Slovakia

Magnetic cloak → advanced magnetic shield that does not affect external magnetic field.

We use coaxial arrangement of superconducting and ferromagnetic cylinders.

Magnetic invisibility → negligible force in non-uniform magnetic field (?)

numerical model in 3D and experimental verification

Superconducting cylinder

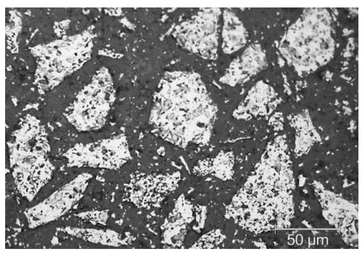
6 layers from 12 mm wide SuperPower SCS12050-AP tape (I_c ~400 A), wound in the same direction with overlapping,

D_{in} = 45.2 mm, thickness = 0.6 mm, length = 145 mm

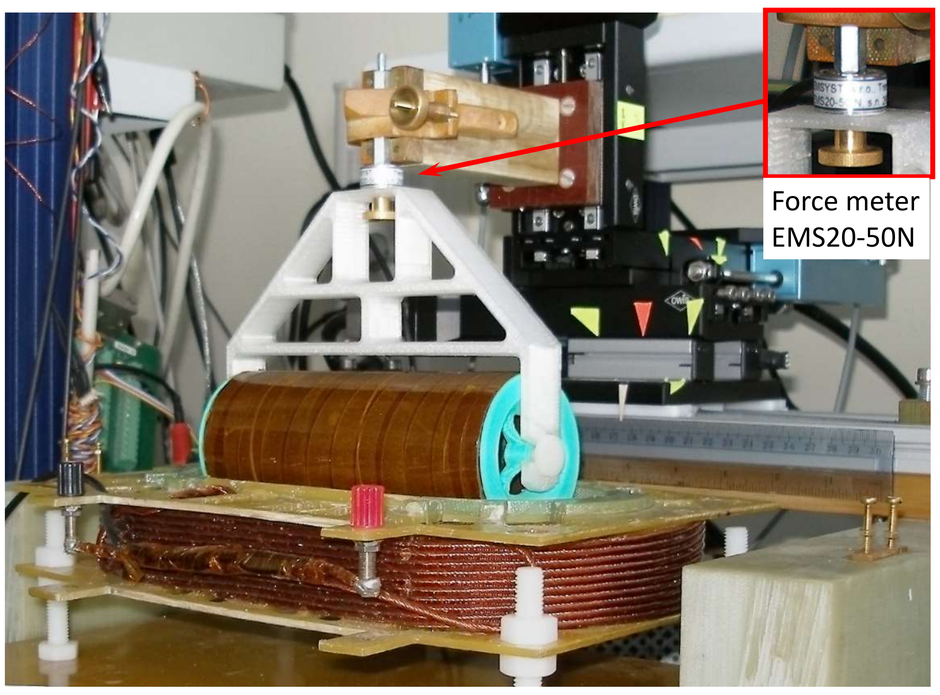
Ferromagnetic cylinder

$Li_{0.575}Zn_{0.4}Ti_{0.55}Fe_{1.475}O_4$ ferrite powder with grain size below 80 µm mixed with the epoxy resin (Epoxy 1200 with the hardener P11)

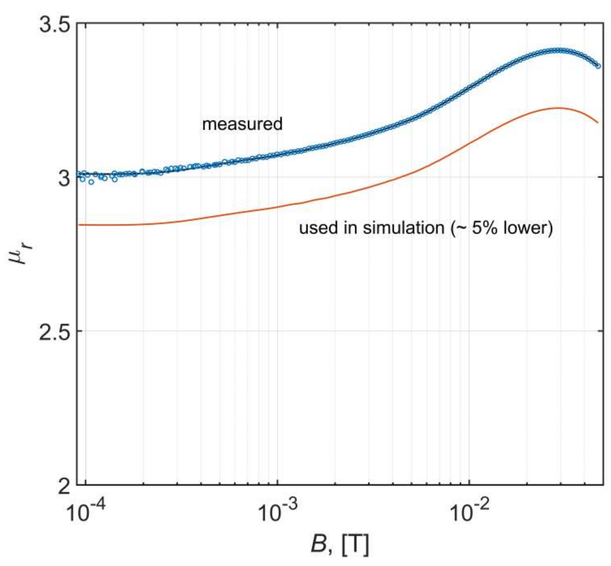
D_{in} = 50 mm, thickness = 12.75 mm, length = 150 mm



Experimental setup

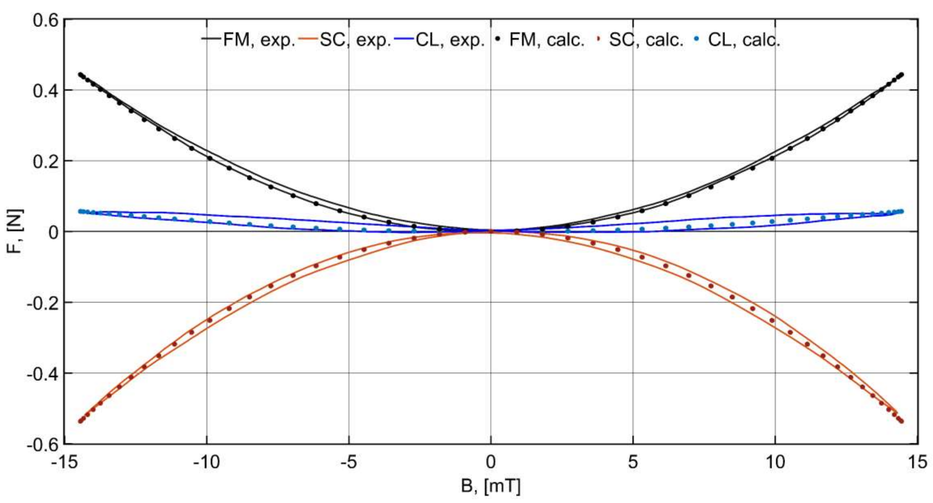


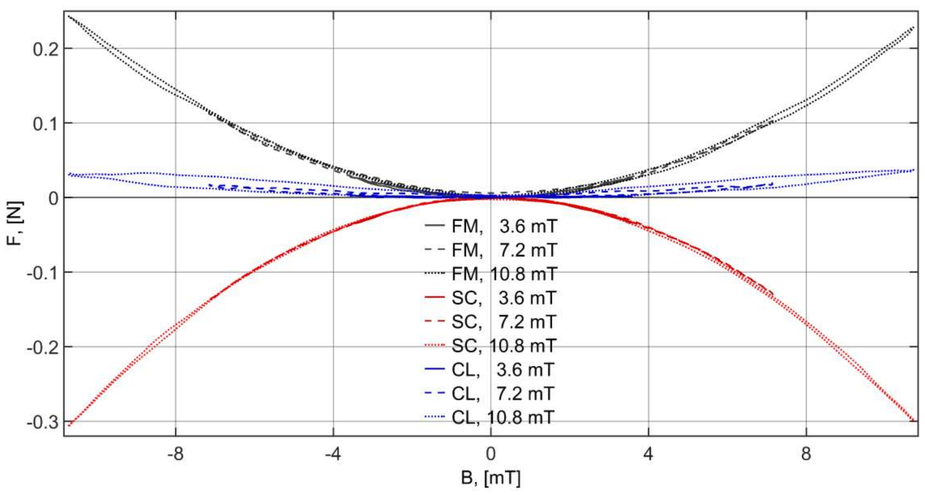
Numerical simulations



Relative magnetic permeability of ferromagnetic material.

Results

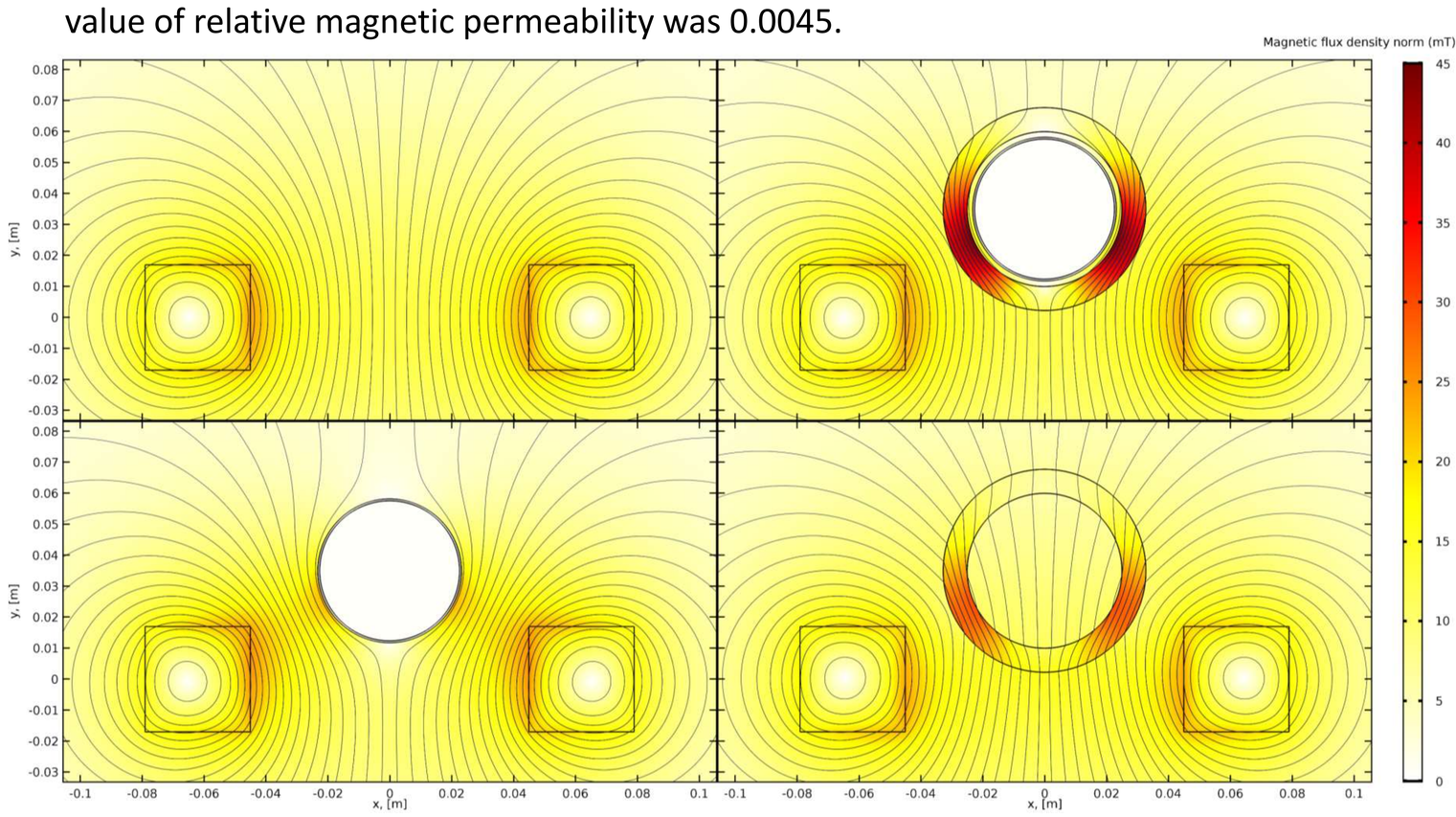




FM – ferromagnetic shell only;
SC – superconducting tube;
CL – magnetic cloak

exp. / calc. – experimental data and numerical simulations, respectively

Superconducting part was simulated as the tube, which value of relative magnetic permeability was 0.0045.



Conclusions

Simplified 3d model shows good prediction of the magnetic cloak behavior in non-uniform magnetic field, generated by the real magnet.

Presented model do not consider hysteresis of both used materials and non-linear properties of superconductor which critical current depends on magnitude and direction of the applied magnetic field.

This work was supported by the grant APVV-0062-11