

Enhancement of Magnetic Field Sensing Resolution by Using High Temperature Superconductor Shields in Multilayer Planar Configuration

Jozef Kvitkovic, Sagarkumar Patel, Min Zhang*, Zhenyu Zhang, Joseph Peetz, Adam Marney, and Sastry Pamidi

Center for Advanced Power Systems, Florida State University, Tallahassee, Florida, USA
*University of Bath, Bath, UK



Motivation

- YBCO tape shields are being considered for shielding strong magnetic fields from high power density rotating machines
- For protection of sensitive equipment from external magnetic noise sources
- Shielding factor (SF) characteristics of HTS depend strongly on geometry, operating frequency and number of layers
- Data on $SF=f(B)$ are needed for designing practical shields
- To prevent penetration of magnetic noise to the sensor vicinity

Goals

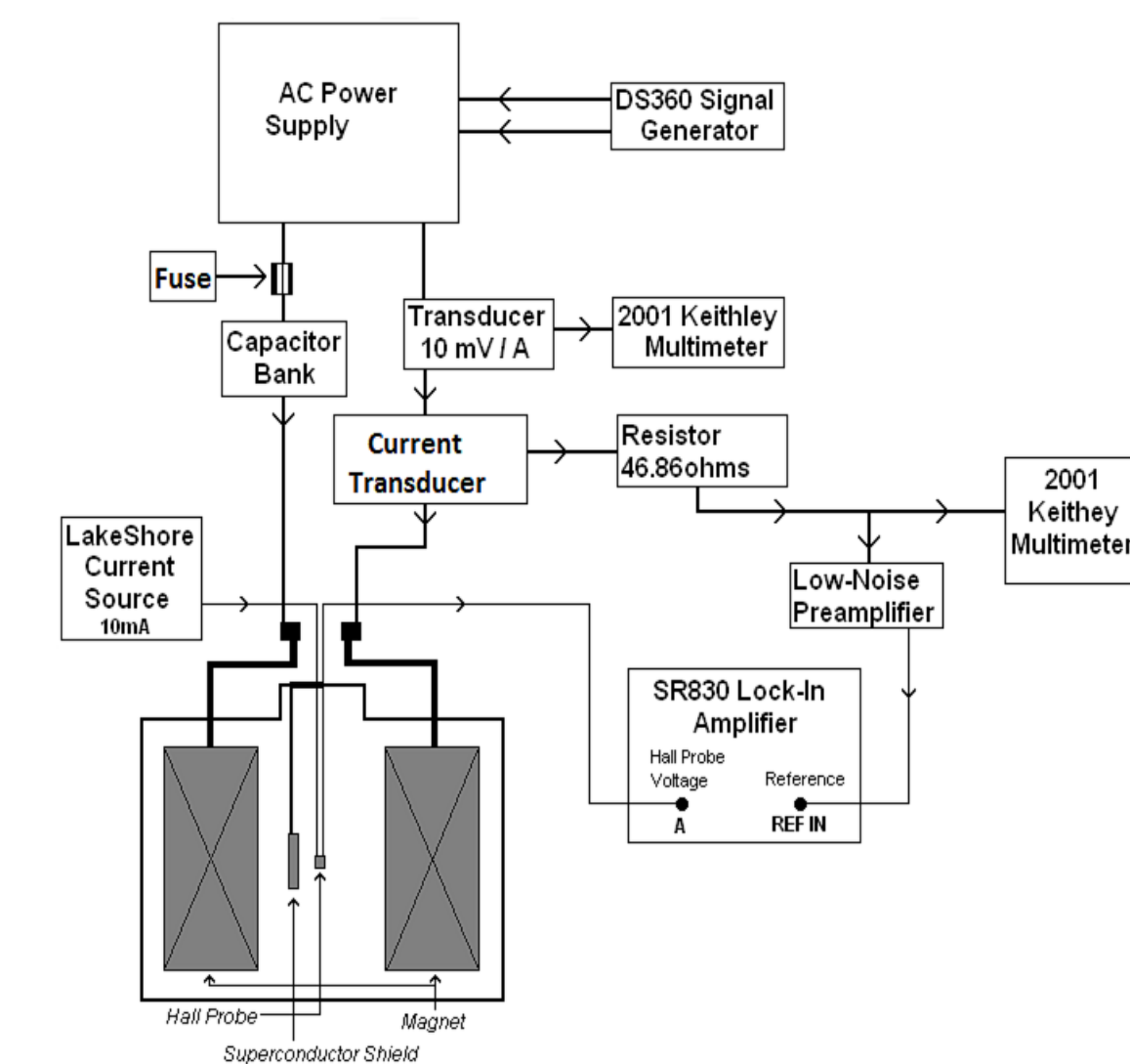
- Set up experimental facility to measure Shielding Factors of YBCO one side planar sheets at 77 K
- Measurement method: Hall probe and Lock-in amplifier
- External magnetic field: zero to 50 mT
- Frequency range: 20 - 400 Hz and DC

Experimental

- Shape of the one side planar shield: 4.5 cm x 10 cm
- YBCO tape used: 45 mm wide, $I_c = 400$ A/cm at 77 K and $B_{ext} = 0$
- Hall probe was placed in the horizontal and vertical center of the shield, all experiments were done at 77 K
- Shielding Factor – SF: $SF = ((B_{ext} - B_{HP}) / B_{ext}) * 100 \%$
- B_{ext} – external magnetic field
- B_{HP} – Hall probe magnetic field

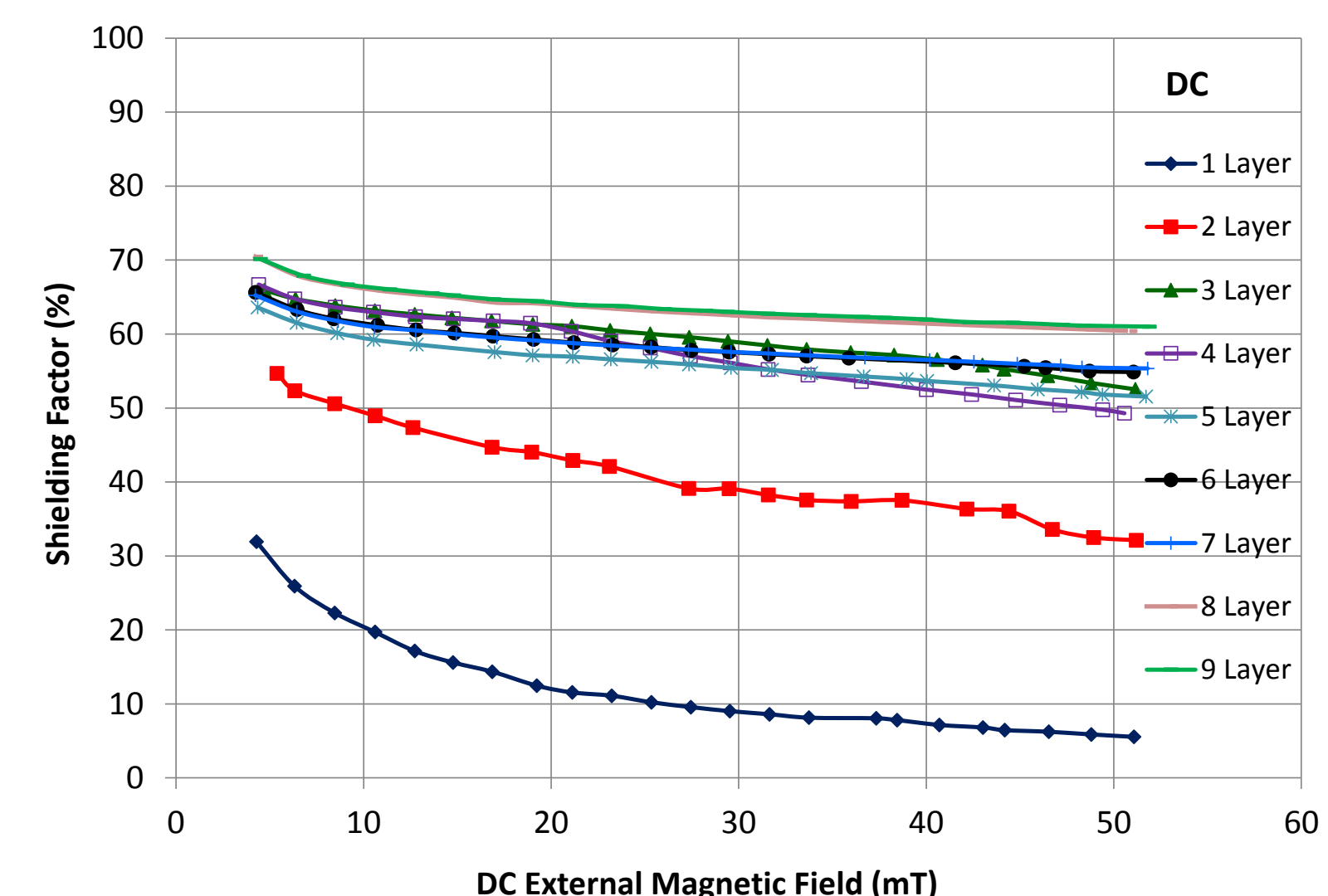
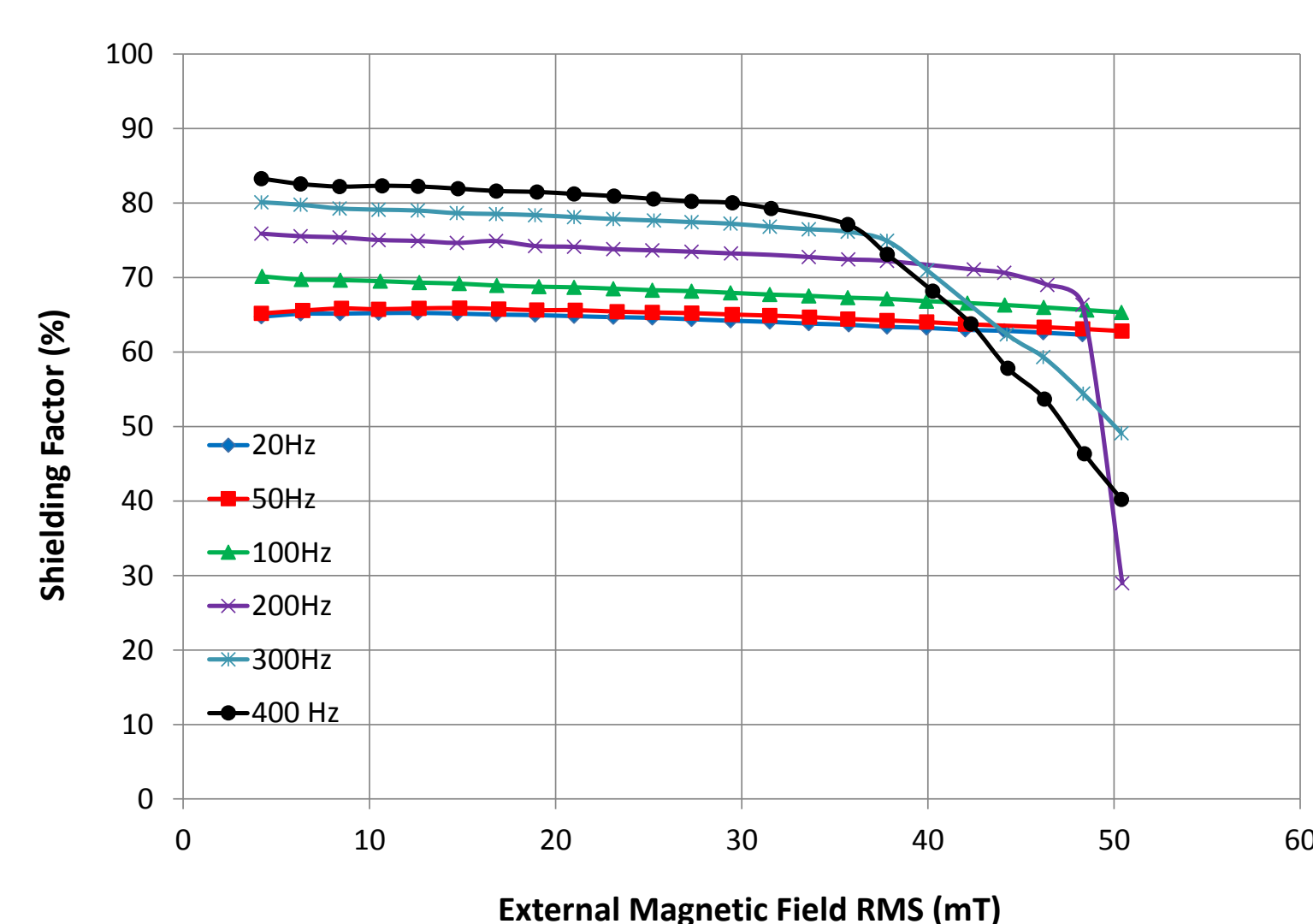
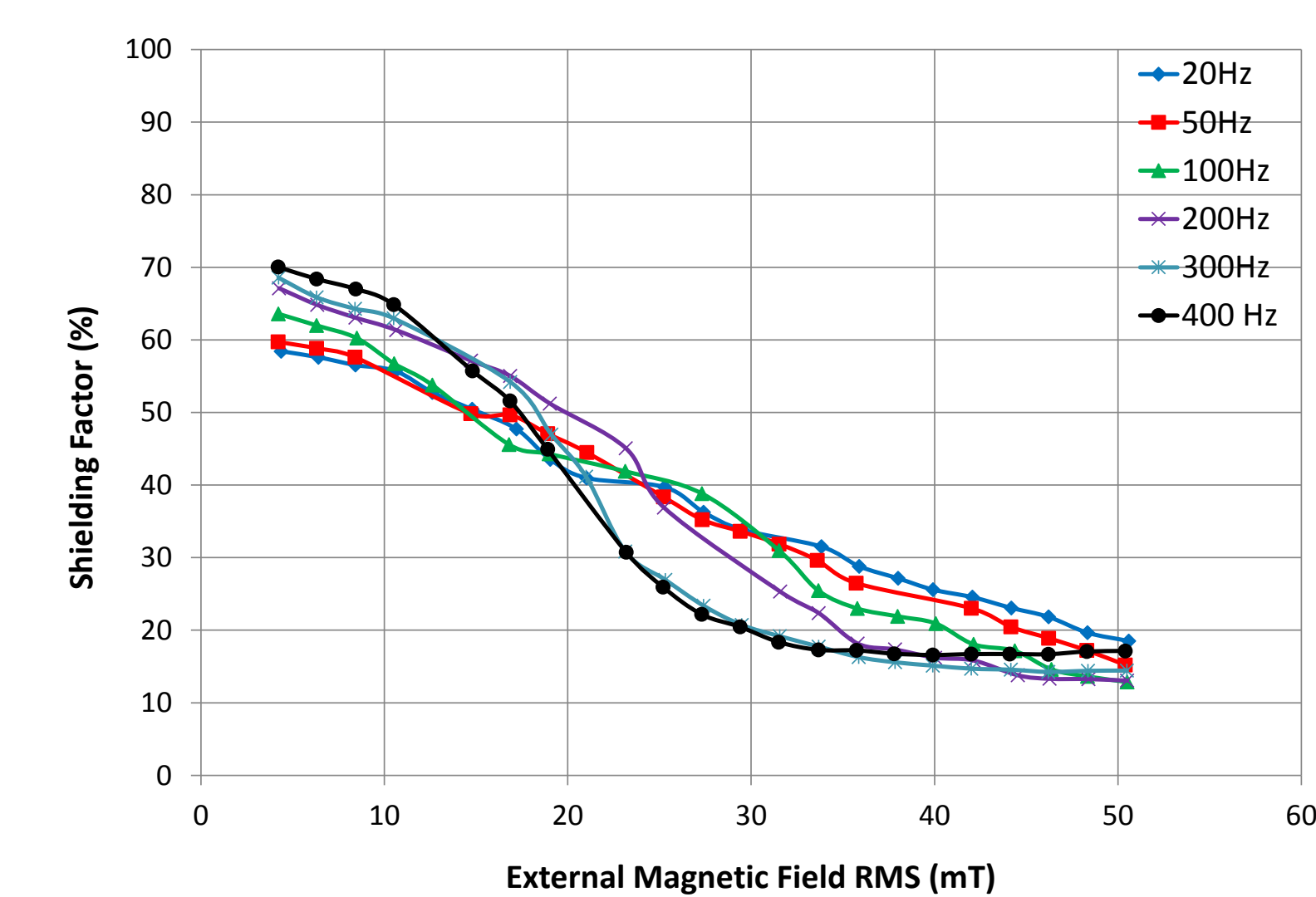
Results

- Measurement setup was successfully tested
- 1 up to 9-layer one side planar shield $SF=f(B)$, $SF=f(f)$, $SF=f(f)$
- AC and DC magnetic fields
- Measurements were compared with 3D Comsol model



A schematic of the experimental set-up for AC shielding measurements with one side planar sheets.

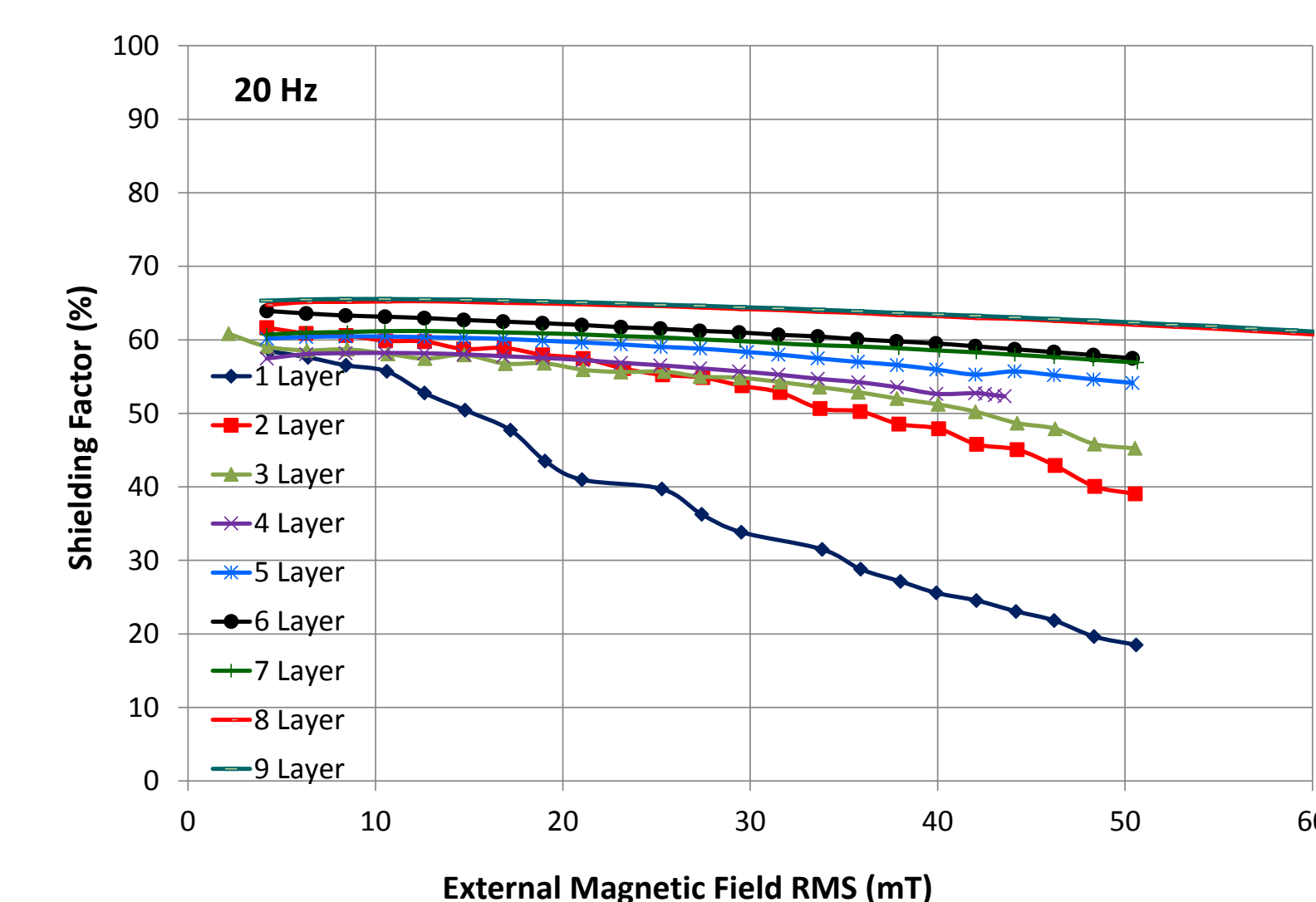
Photographs of the sample and the magnet used for SF measurements.



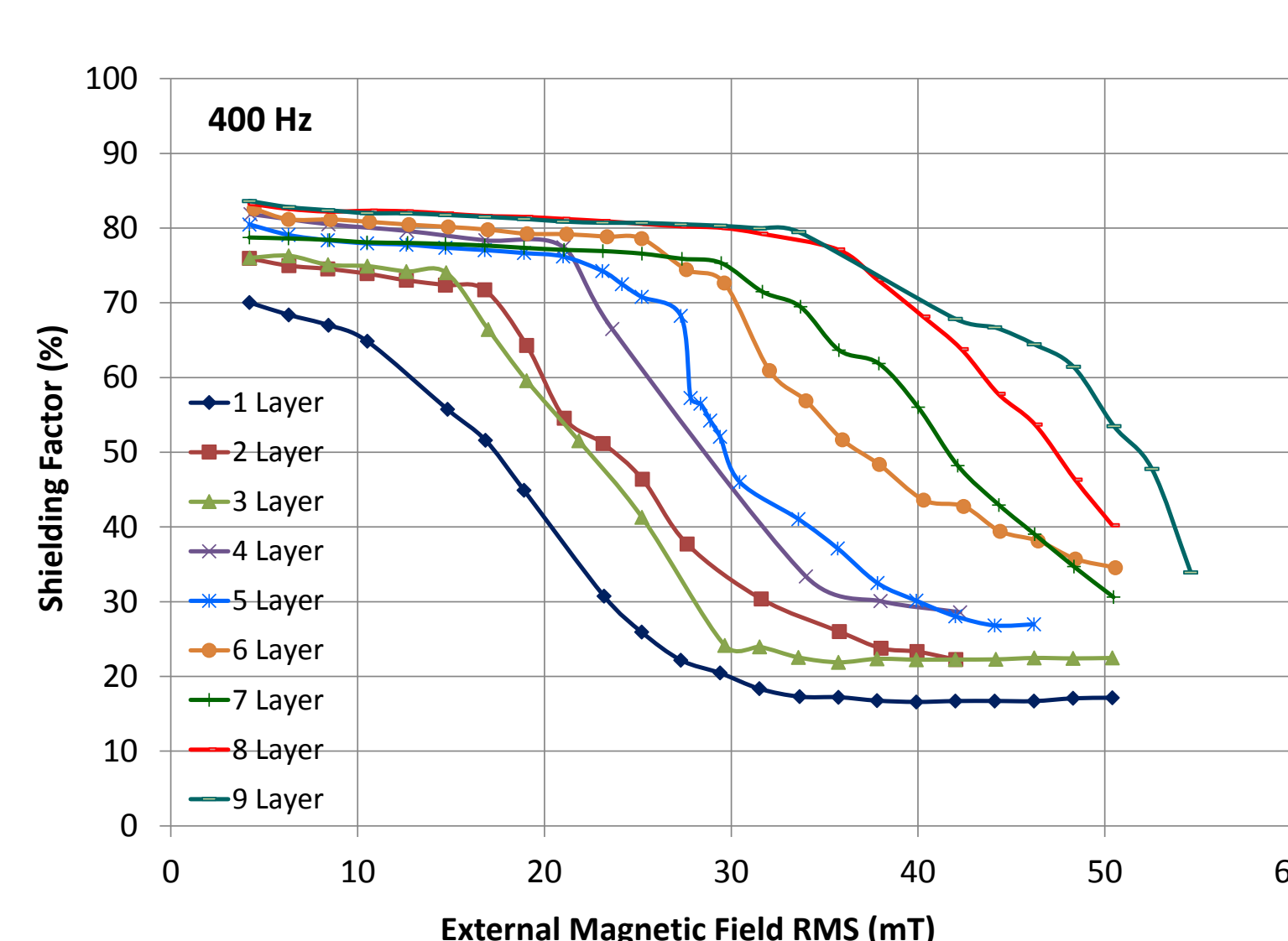
AC shielding factor for a one-layer one side planar shield at 20 - 400 Hz and 77 K.

AC shielding factor of a nine-layer one side planar shield as a function of AC magnetic field at 77 K.

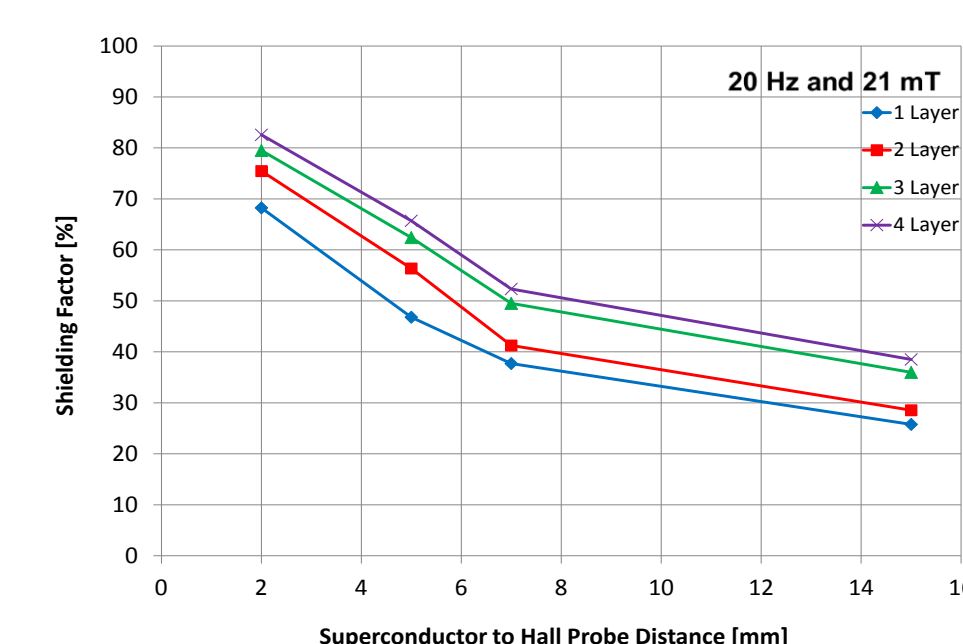
DC shielding factor for 1 up to 9-layer one side planar shield at 77 K.



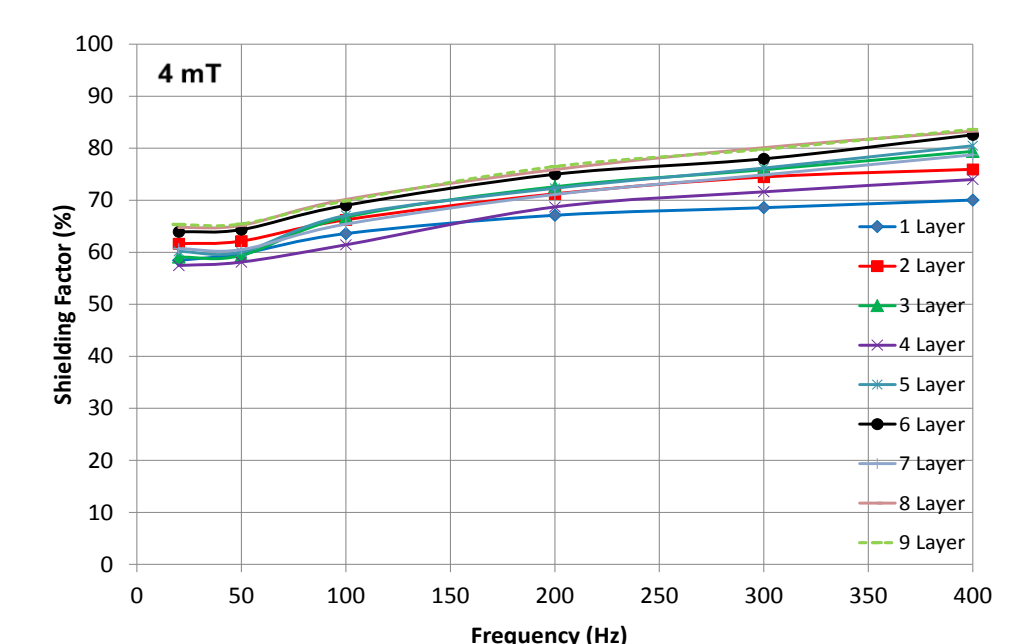
AC shielding factor for 1 up to 9-layer one side planar shield at 20 Hz.



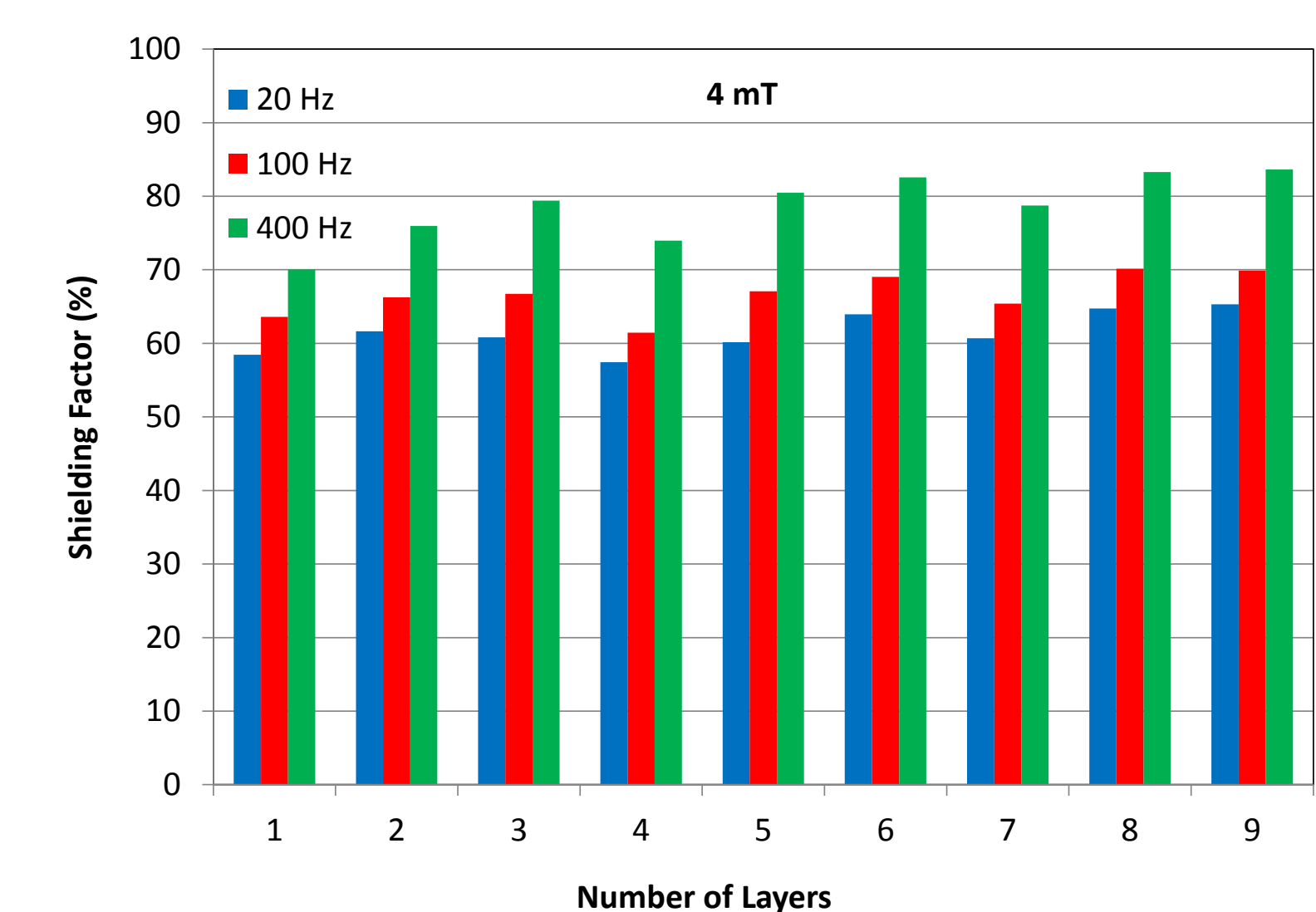
AC shielding factor for 1 up to 9-layer one side planar shield at 400 Hz.



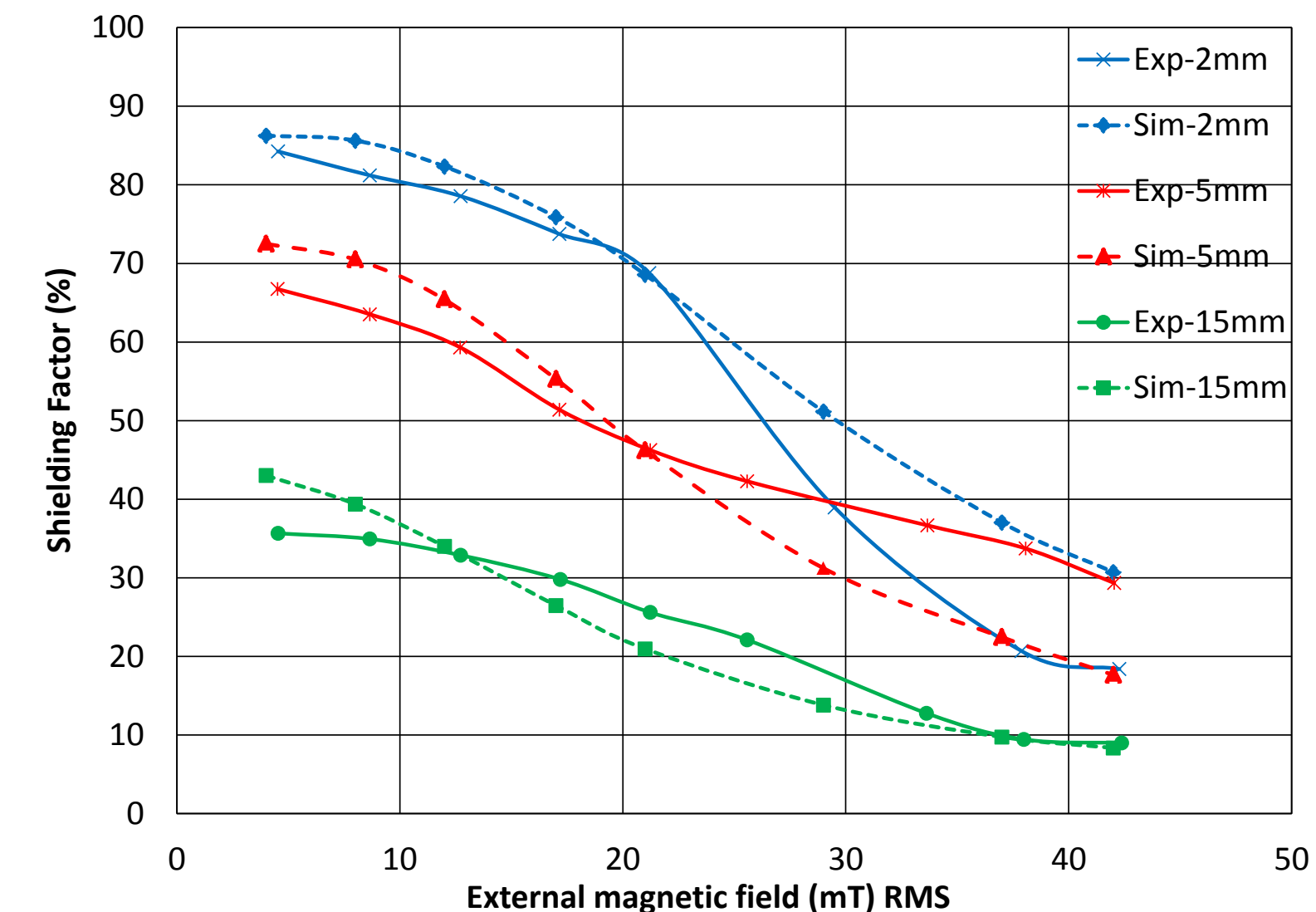
Shielding factor as function of shield to Hall probe distance at 20 Hz and 21 mT for 1 up to 4-layer one side planar shield.



Frequency dependence of AC SF for 1 up to 9-layer one side planar shield at 4 mT.



Shielding factor as a function of number of layers at 4 mT for 20, 100, 400 Hz at 77 K.



Comparison of 3D simulation and experimental results of SF for one-layer one side planar shield at various distances 2, 5, 15 mm from the sensor at 50 Hz.

Summary

- A new measurement set up for Shielding Factor measurements of YBCO one side planar shields has been designed and successfully tested
- Will be useful in the future for obtaining experimental data on various types of high-temperature superconductor tapes
- SF up to 84 % were achieved at 30 mT and 400 Hz, at 77 K
- SF increase with increasing frequency at the low external magnetic field (<10 mT) and decrease with increasing frequency at high (>40 mT) magnetic fields

Acknowledgment

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