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Methods to reduce light scattering for spectral analysis of blood components

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Introduction

- Goal of our research is the development of an optical sensor to determine the concentrations of various components in human blood.
- Light scattering of red blood cells (RBC) influences the determination of the concentration of blood components.
- First approach to separate RBC from blood plasma with magnetophoresis.

Theory

- Ferrous iron atom (Fe^{2+}) inside the hemoglobin molecules cause paramagnetic properties of RBC.
- RBC will move along a high gradient field to the highest magnetic flux densities.
- High magnetic flux density is needed because of the small susceptibility of RBC $\chi_{RBC} = 3.9 \cdot 10^{-6}$ [1].
- Magnetic saturated ferromagnetic wire generates high gradient field in microchannel [1].

Results

- Highest flux density inside of the ferromagnetic wire = 1.45 T.
- Experiments with ferromagnetic beads confirm theory.

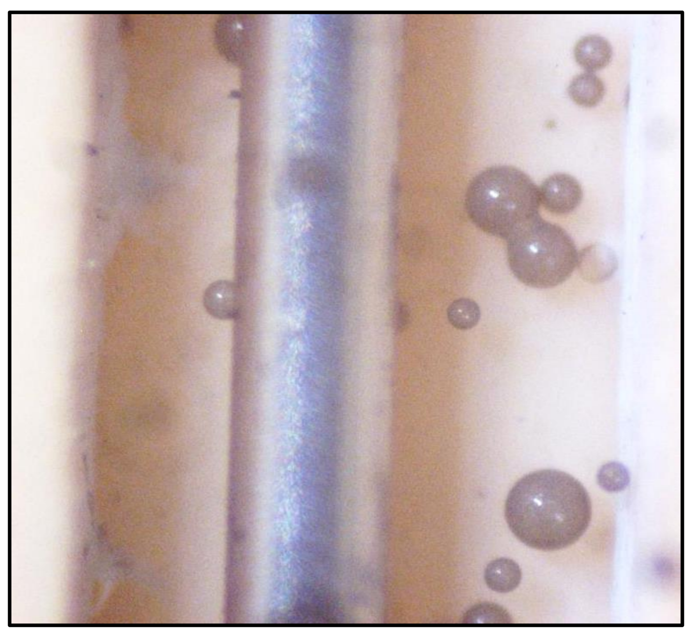

Fig. 5: Ferromagnetic beads in microchannel without applied magnetic field, picture of 1x1 mm

Fig. 6: Ferromagnetic beads in microchannel with applied magnetic field, picture of 1x1 mm

Outlook

- Improved design of microchannel with magnets as close as possible to ferromagnetic wire.
- Tests with real blood samples.

Sources

[1] Ki-Ho Han and A. Bruno Frazier; „Paramagnetic capture mode magnetophoretic micro separation for high efficiency blood cell separations", Lab Chip, 2006, 6, 265-273, DOI: 10.1039/B514539B

Methods

- Simulation of magnetic parts with FEMM 4.2.
- Neodymium-magnets N48 with $B_r = 1.37\ \mathrm{T} - 1.42\ \mathrm{T}$.
- Comparison of theory and simulation results.
- Setup with microchannel of RCP 30 built with rapid prototyping system (*perfactory multi lens mini printer*).
- Experiments with ferromagnetic beads.

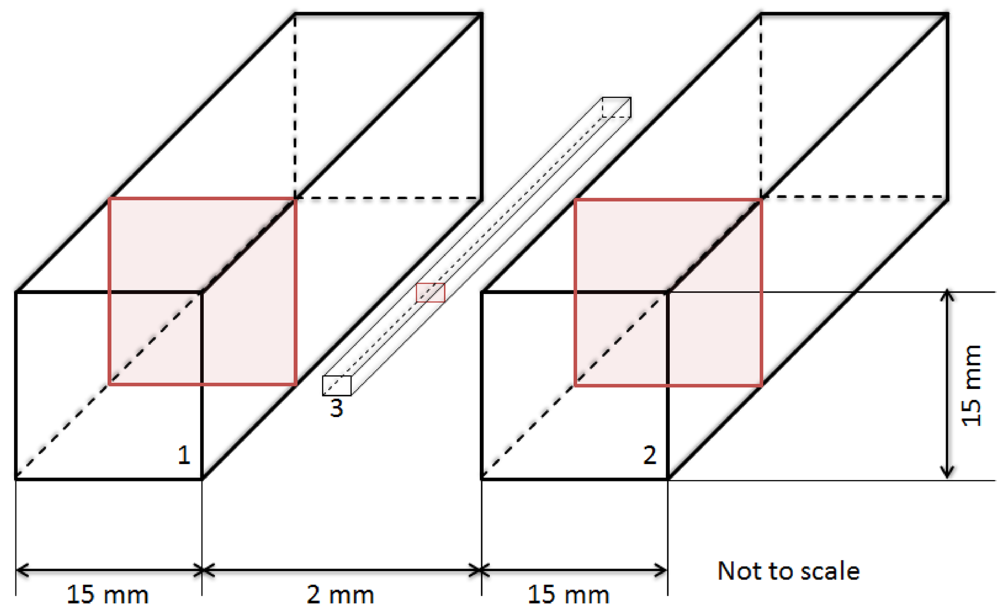

Fig. 1: Principle sketch of magnetic simulation, two neodymium-magnets N48 (1 and 2), 2 mm apart, ferromagnetic wire (3) in between

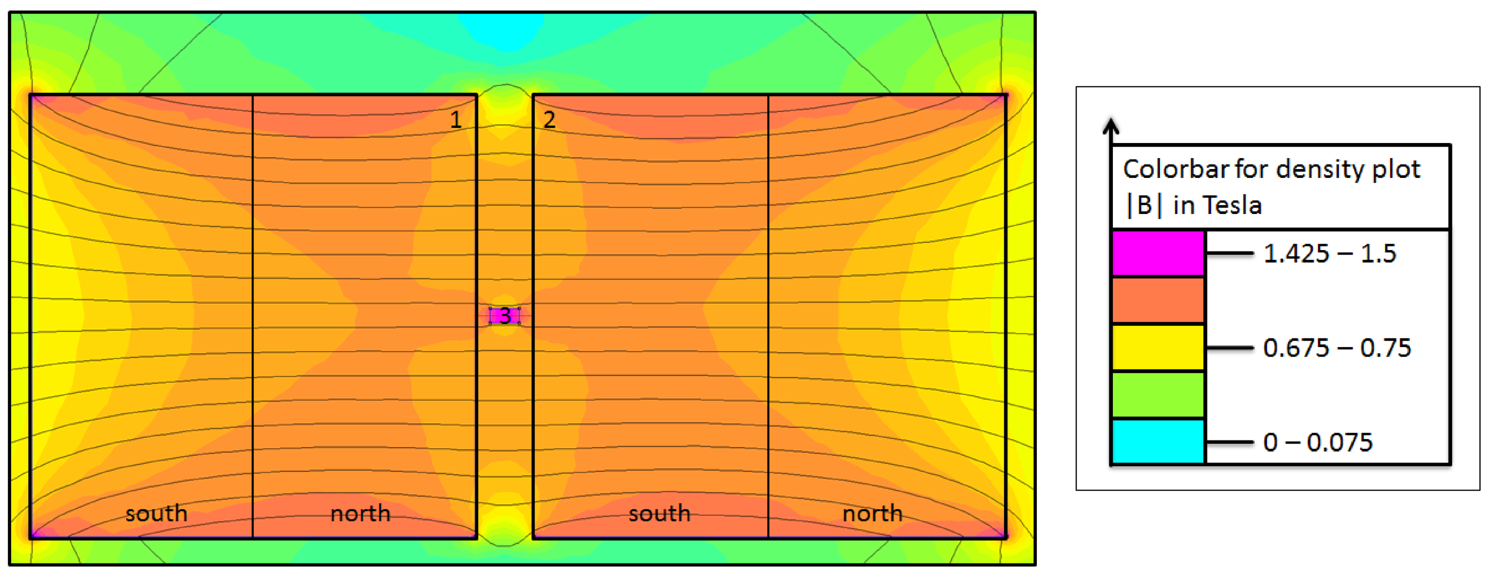

Fig. 2: Magnetic flux density |B| of two neodymium-magnets N48 (1 and 2), 2 mm apart, ferromagnetic wire (3) in between

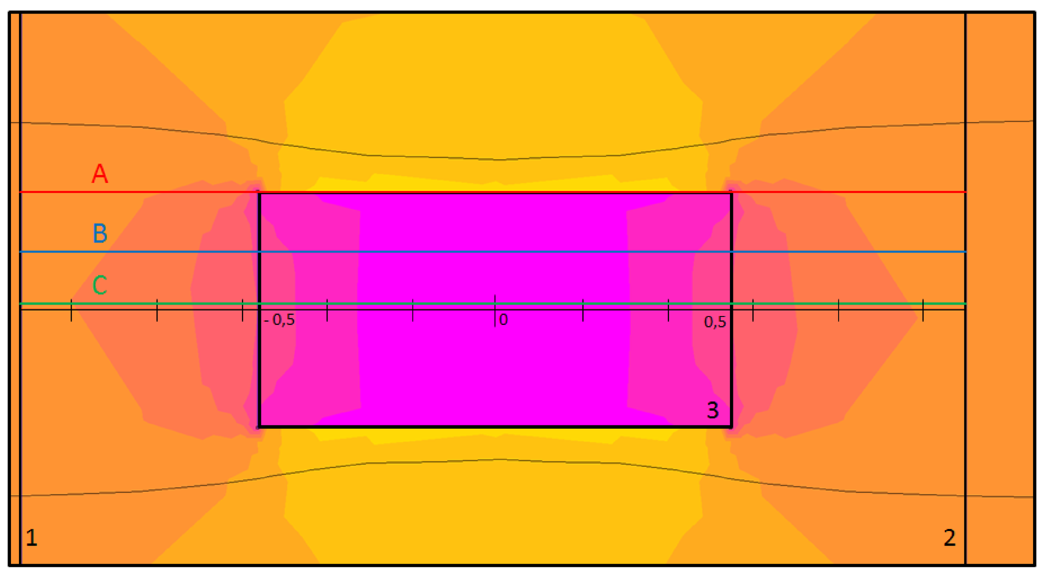

Fig. 3: Magnetic flux density |B| of saturated ferromagnetic wire (3) (0.5x1 mm) in the middle of two neodymium-magnets N48 (1 and 2), magnets 2 mm apart

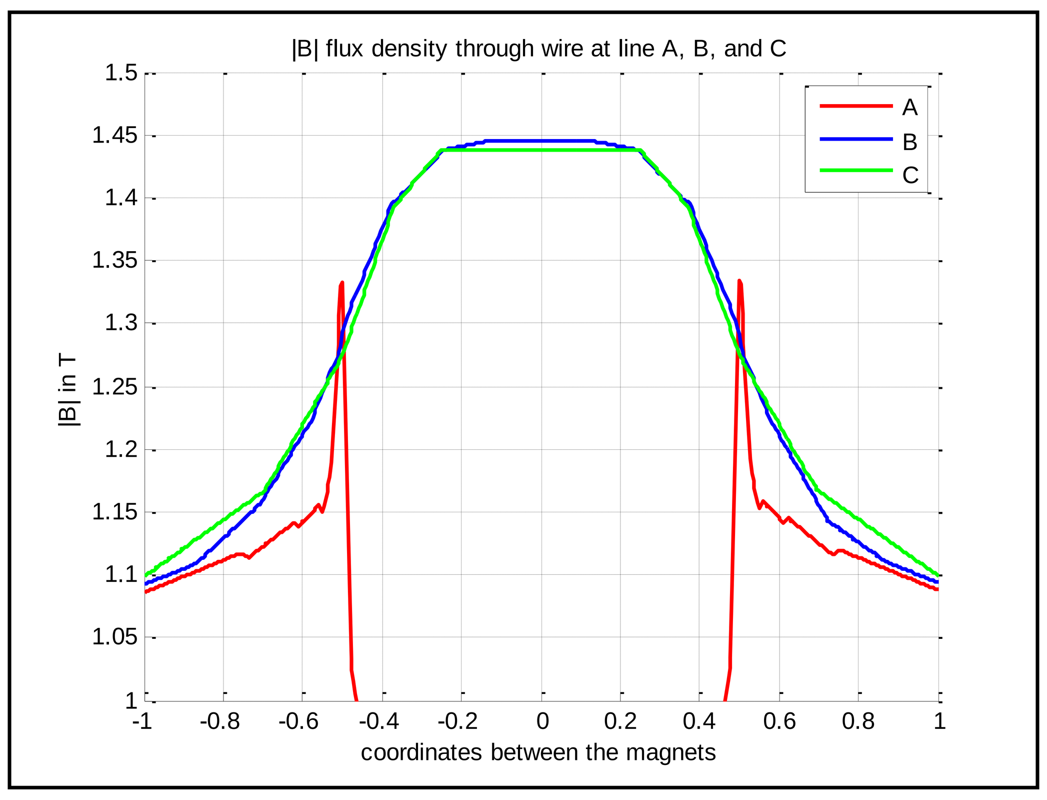

Fig. 4: Magnetic flux density |B| of saturated ferromagnetic wire (0.5x1 mm) at different section between two neodymium-magnets, magnets 2 mm apart

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FKZ: 03FH024PX4
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