Targeted Drug Delivery via Focused Magnet

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A specially focused magnet, designed for use in a magnetic targeted drug delivery system, was constructed. From the theoretical calculation of the adhesion condition for a magnetic fluid drop in magnetic field we have found, that the constructed focused magnet generates a sufficient magnetic force for the capture of a magnetic drop on the vessel wall and can be used 2.5 - 3 cm deeper in organism comparing with a prism permanent magnet. This enables to the non-invasivity of the magnetic drug targeting procedure.

The success or failure of the chemotherapy depends not only on the drug itself but also on how it is delivered to its target. One of the major problems in pharmacotherapy is the delivery of drugs to a specific location and maintenance of this location for the desired interval time. Because of the relatively non-specific action of the chemotherapeutic agents, there is almost always some toxicity induced to the normal tissues. Therefore, it is of great importance to be able to selectively target the magnetically labelled drug to the tumor target as precisely as possible, to reduce the resulting systemic toxic side effects from generalized systemic distribution and to be able to use a much smaller dose, which would further lead to a reduction of toxicity. The method of magnetic drug targeting depends on physical properties, concentration and the amount of applied nanoparticles, on the type of binding of the drugs, on the physiological parameters of the patient and, of course, on the magnetic force, which is defined by its field and field gradient [1, 2, 3, 4, 5]. The measured magnetic field by Hall probe was used for the construction of the map of magnetic field of focused magnet. The examples of all components of magnetic field i.e. B_x(x,y,z), B_y(x,y,z), B_z(x,y,z) are illustrated in Figure 1, 2, 3 (for y=0.0).

To fit the magnetic field values B_x(x,y,z), B_y(x,y,z), B_z(x,y,z) a three variable polynomial fitting function of the tenth degree was used. For each B_x(x,y,z), B_y(x,y,z), B_z(x,y,z) coefficients were calculated on the Grid, starting with a third degree fitting polynomial and ending with a maximum tenth degree fitting polynomial. The third degree case

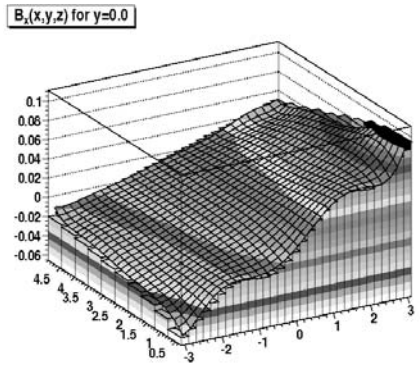

Figure 1: The x component of magnetic field as a function of x, z for y=0.0

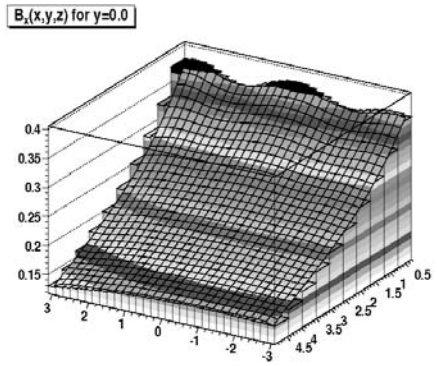

Figure 2: The y component of magnetic field as a function of x, z for y=0.0

needed 6.8 s CPU time, while the highest tenth degree case needed 25 hours CPU time.

Using our specially focused magnet, a higher magnetic field as well as its gradient can be turned to a deeper position, resulting in reduced invasivity of the magnetic drug targeting procedure.

In summary, a focused magnet consisting of 36 prisms with pyramidal shape was manufactured, generating higher magnetic field and higher magnetic field gradient as compared with classical prism. The magnetic field of the focused magnet was mapped and its profile was used in numerical calculations, which yielded the upper bound of

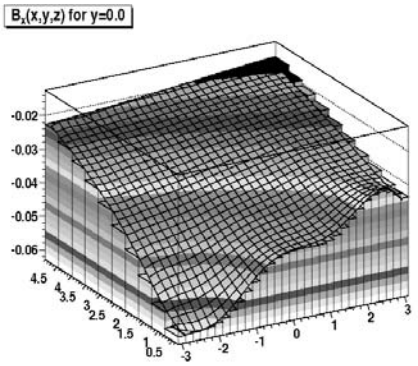

Figure 3: The z component of magnetic field as a function of x, z for y=0.0

the mean blood flow velocity, at which the applied magnetic field is able to capture a magnetic drug drop on the blood vessel wall. The obtained results proved the ability of the magnet to generate a sufficient magnetic force in deeper position (2.5 – 3 cm), what could contribute to the non-invasivity of the magnetic drug targeting procedure.

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