Portable Permanent Magnet Designs for In Vivo L-Band EPR Tooth Dosimetry

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In case of an event in which a human population has been exposed to radiation, for reasons of triage there is a need for a portable and rapidly deployable dosimeter. This need can be satisfied by the use of L-band EPR which offers a unique potential for in vivo and nondestructive dosimetry of teeth. Portability demands that the components comprising such a system, one of which is the magnet necessary for enabling the EPR process, should be compact, light weight and require minimal services. Permanent magnets are likely to offer the best chance of fulfilling this requirement. Permanent magnets suitable for dosimetry were designed using both open `flat' and dipole geometries and will be described.

We will describe the stages in the development of a prototype ‘flat’ permanent magnet suitable for a tooth dosimetry application. In this design the EPR detection volume is projected clear of the surface of the magnet so that no part of the magnet structure enters the mouth cavity; the magnetic field is directed perpendicular to the surface of the magnet. The first stage is the magnet design in which an analytical approach was used to get an initial design. A numerical technique called the boundary element method was then used to finalize this design. The second stage is the mechanical design in which fixtures in the form of a body plate and cover plates were used for embedding the permanent magnet material. The third stage comprises the assembly procedure and the final stage involves the testing. For the testing stage a magnetic field mapping system was developed to measure the magnetic field around the EPR detection volume and to analyse the inhomogeneity of the field.

Recently a strong preference for using the flat surface of the incisors has been expressed. In this configuration it is preferred that the B0 field be parallel to the surface of the tooth with the B1 field perpendicular to the flat surface of incisor. In order to make the B0 and B1 fields perpendicular to each other, a flat permanent magnet with a central magnetic field “transverse” to its flat surface is required. Alternatively, a dipole magnet placed across the chin can provide a B0 field perpendicular to the B1 field. This geometry is more typical of a conventional dipole magnet and is similar to the clinical magnet that is used at Dartmouth Medical School. However, it must be much smaller in size so as to be practical for the field deployable application. The design of such small dipole permanent magnet will be described.

Finally, a brief description is given of the design of sweep and modulation coils which must accompany the magnet that generates the background magnetic field.