# Development of Magnet System for in vivo EPR Tooth Dosimetry

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Ionizing radiation generates stable radicals in tooth enamel, which enables dose estimation by EPR. In vivo EPR tooth dosimetry facilitates rapid and non-invasive estimation of radiation dose from human body. Digitalized EPR spectrometer have been developed in Seoul National University for in vivo tooth dosimetry purpose. Magnet system of EPR spectrometer have a role to generate magnetic field for energy splitting of unpaired electrons in radical subject. In this study, development of the magnet system for SNU EPR spectrometer is described. Magnet system for EPR is composed of three components; permanent magnets as main magnet, magnetic field sweep coil, and magnetic field modulation coil. In our design, 32 number of NdFeB cylindrical permanent magnets are aligned to generate the main magnetic field. Magnetic field sweep coil and magnetic field modulation coil are electromagnet operating with direct current (DC) and alternating current (AC), respectively. Sweep coil is a DC Helmholtz coil with 100 turns. Sweep coil scans range of magnetic field by changing the field continuously. Magnetic field modulation coil is an AC Helmholtz coil with 80 turns for each side. Modulation coil generates AC magnetic field to transmit EPR signal of subject by varying 1.15 GHz carrier radiofrequency. Main subject of this in vivo system is upper incisor in oral cavity. For this purpose, the system should have gap wide enough to contain a human head between both sides (Fig. 1). COMSOL Multiphysics v5.5 was used to simulate the design of magnet system. Magnetic flux density and its homogeneity was estimated. Stationary study was applied for permanent magnets and sweep coil simulation. Frequency domain study was used for modulation coil simulation for its AC operation. Commissioning test was performed for developed magnet system. Main magnetic field by permanent magnets was 44.47 mT with homogeneity 2923 ppm in center ±1 cm region. This requires RF frequency to be 1.23 GHz. Sweep coil generated 0.35 mT/Ampere, which was enough to sweep 3 mT scan region with reasonable current. Modulation coil could generate over 0.4 mT peak-to-peak magnetic field with 21.5 kHz AC frequency, although the temperature rose up to ~60˚C which was a bit high.

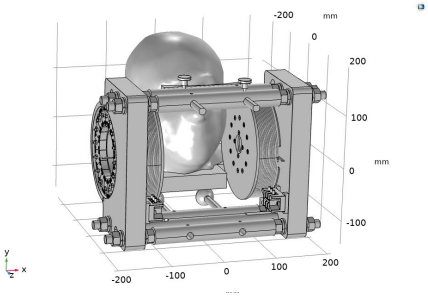


Fig.1. CAD model in COMSOL Multiphysics

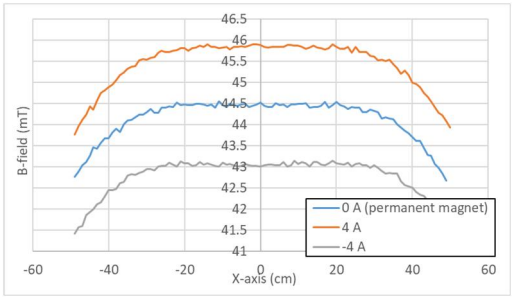


Fig.2. Magnet flux density Measurement for permanent magnet and sweep coil

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