RF heating of aligned membrane samples is significant problem for static protein structure experiments. Sample heating occurs due to both inductive and dielectric loss in the conductive biological material exposed to a strong, high RF (400-900 MHz) electromagnetic field. Although the inductive loss can not avoided as it results from the alternating \( B_1 \) field needed for NMR, the dielectric loss can be reduced, in principle, by placing an electrical screen or Faraday Shield (FS) between the coil and the sample [1]. However, the FS has not been widely used for NMR because it is thought to reduce the coil’s electrical performance. We have recently shown that by using a partial FS that it is possible to reduce sample heating and even improve electrical performance for oriented membrane samples [2].

Numerical simulations carried out with Ansoft HFSS, based on the finite-element method, were used to predict the effect of the shields [3]. Figure 1 shows a conducting sample (purple) with metal plates (green) above and below the sample to form a FS. Because there are no plates on the side of the sample, we call it a partial FS. An RF solenoid surrounds the sample, which is taken to have a dielectric constant of 3.3 and conductivity of 0.5 S/m. Figure 2a shows the very significant reduction of electric field along the axis of the coil due to the partial FS for 600 MHz. As RF heating is directly proportional to the square of the electric field intensity, this result predicts a significant reduction of undesired sample heating. Furthermore, Figure 2b indicates that the use of the FS slightly improves the \( B_1 \) field intensity as well as the overall homogeneity. These improvements in the \( B_1 \) field can be attributed to the induced current distribution on the plates of the FS.

NMR experiments were conducted at 400 and 600 MHz to determine the effect of the partial FS, and the results are summarized in Table 1. Measurements of the amplitude (\( B_1 \)) and homogeneity (\( A_{810}/A_{900} \)) of the RF magnetic field were made using a sample of 100% neutral paraffinic oil. Measurements of heating (\( \Delta T_{\text{surface}} \)) used an actual membrane sample. Because different coils and samples were used at the two frequencies, it is not possible to compare the 400 and 600 results directly. However, at both frequencies the presence of the partial FS reduced sample heating while improving at least slightly the NMR performance of the probe.

\[
\begin{array}{ccc}
400 \text{ MHz} & 600 \text{ MHz} \\

\hline \\
B_1 & +2.5\pm1\% & +6\pm1\% \\
A_{810}/A_{900} & +29\pm5\% & +6\pm2\% \\
\Delta T_{\text{surface}} & -75\pm25\% & -35\pm15\% \\
\hline
\end{array}
\]

Table 1. Changes in quantities of interest upon insertion of partial FS.

**References**