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# Verification of Calculation Method of RF Exposure to Small Animals in Reverberation Chamber by FDTD Method

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Long-term carcinogenicity studies of radiofrequency exposure in the National Toxicology Program (NTP) showed male rats exposed to high levels of radio frequency radiation (RFR), like that used in 2G and 3G cell phones, developed cancerous heart tumors. To validate this result, a verification test using the same reverberation chamber type exposure setup is being conducted in Japan and Korea. To quantify the whole body average specific absorption rate (WBA-SAR) of rats in the reverberation chamber, a hybrid method combing electric field strength measurement and finite difference time domain (FDTD) calculation was used. The reverberation chamber generates a statistically uniform electric field distribution by the rotation of stirrers installed inside the metal box. The electric field at a certain point in an ideal reverberation chamber is considered as plane-waves with the same amplitude and random phases come from all directions, and the calculation of WBA-SAR is based on this. Here, we will verify the validity of the SAR calculation method by comparing the WBA-SAR calculated by the following two methods:(1) calculate WBA-SAR of rat by averaging the results obtained by incident of plane waves one by one from all directions at equal angle intervals and (2) to calculate WBA-SAR of rat by incident of multiple plane-waves at the same time with random phases.The verification was performed using a 686 g rat numerical model consisting of 51 types of biological tissues made by the IT'IS Foundation.
First, for Method (1), TE (Transverse Electric) wave and TM (Transverse Magnetic) wave with $|E| = 1$ V / m at 900 MHz were individually irradiated from 26 directions one by one. Based on the 52 calculated WBA-SARs, Fig. 1 shows the convergence of the WBA-SAR as number of incident directions increases. Based on Fig. 1, it is considered that the WBA-SAR of rat can be calculated by 52 plane waves incident with convergence of ± 1% or less. Second, for Method (2), multiple plane waves with $|E| = 1$ V / m and random phases uniformly distributed at $(0, 2\pi)$ at 900 MHz are incident at the same time, and the calculated WBA-SAR is compared with the result of method (1). A total of up to 300 types of phase combinations were considered for incident at the same time, which is actually achieved by to stirrers to stir the electric field. Fig. 2 shows the difference from Method (1) as number of phase combinations increases. The difference was less than 5% as the number of phase combinations increases to 300, which suggests that the hybrid method (Method 1) used in our NTP verification experiment provides a reliable WBA-SAR as long as the two stirrers sufficiently stir the electric field in the reverberation chamber.

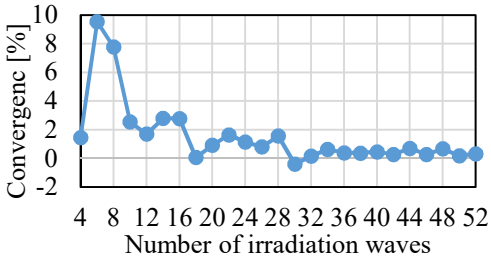


**Figure 1.** Rate of change of WBA-SA as the number of incident directions increases

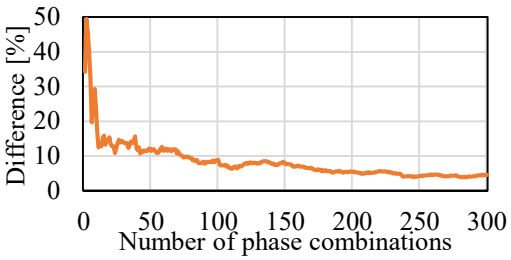


**Figure 2.** Error in the result compared with method (1) as number of phase combinations increases

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