Electromagnetic Wave Propagation Inside the Great Pyramid, Egypt

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The great pyramid in Giza, Egypt, known also as "Khufu's pyramid" is the largest pyramid in the world. The pyramid is made of limestone rock blocks, typically 1.5m x 1.5m x 1.5 cube. However, the surface of each rock is quite rough and electromagnetic wave, typically ground penetrating radar (GPR) is strongly scattered at the gap and investigation inside structure is not easy. We are planning to investigate the inner structure of the great pyramid, and we have conducted electromagnetic wave propagation experiments.

During 2019 and 2022, we have used frequencies below 100MHz and EM wave transmission between the horizontal collider of the Queen's chamber and the great gallery could be observed. The maximum distance in these experiments was about 20m. Our final plan of this experiment is achieving EM transmission more than 50m. Therefore, we investigated another approach to achieve this task. We used dipole antennas having more than 4m for frequencies below 100MHz. The narrowest part of the tunnel inside the pyramid is less than 1m x 1m, and we cannot use large size antenna. We configurated dipole antennas by using cupper wire. Although we could observe the transmitted signal, but we could not have enough S/N ratio. We thought improving antenna gain and improvement of antenna impedance matching would be one solution of higher S/N ratio. In January 2024, we conducted EM transmission experiment using Yagi-Uda array antenna, which works at VHF frequency band. The antenna which we used works are tuned at 2 frequencies, namely around 100MHz and 400MHz, and the size of the array antenna is about 1m, and it fits to the size of the tunnel. Figure 1 shows the antenna set in the corridor.

Figure 1. Yagi-Uda antetna in a horizontal corridor in the gfrat pyramid.

Our system uses an optical link for synchronization, and it makes possible to receive weak signal. We found the new system, which works at 50MHz-500MHz achieves higher S/N ratio compared to the previous system using frequencies below 100MHz.

1. M. Sato, and Anwer S. Abd El-Hameed," Electromagnetic Wave Propagation Inside the Great Pyramid in Egypt," URSI JRSM 2022, Tokyo, Japan, August 2022.

2. M. Sato, A, El-Hameed, "Consideration of Electromagnetic Wave Propagation Inside the Great Pyramid in Egypt," URSI GASS2023, Sapporo , August 2023.