## §10. Theoretical Analysis of Remote Steering Antenna and Comparison with Experiments

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A study for a remote steering antenna on ITER using rectangular corrugated square waveguide is being performed. Fig.1 shows the schematic drawing of the remote steering antenna. When the total waveguide length is around $4a^2/\lambda$, output beam with almost the same field pattern radiates for asymmetric direction. We

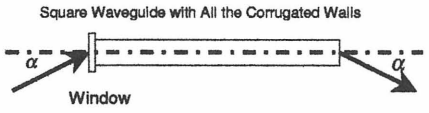


Fig. 1: The remote steering antenna

calculate the near and far field patterns by the 900 hybrid modes with sampling points of 128 × 128 and 512 × 512 by using experimental parameters of waveguide size (60.08 × 60.08 mm), frequencies and waist size (22 mm) of gaussian beam.

Analysis is carried out by mode matching, sum of the propagating hybrid modes and Fourier transform with phase factor. The analysis of (1) polarization parallel and perpendicular to scanning plane, (2) polarization at 45 deg to scanning plane and (3) polarization parallel and perpendicular to scanning plane where waveguide is rotated 45 deg is carried out. The results agree well with the experimental results from IPF[1]. Fig. 2 shows the experimental results of normalized radiation power as a function of beam injection angle for parallel and perpendicular scanning. Here, a receiving direction with the same or opposite angle as injection (asymmetric or symmetric direction) is selected. Using experimental parameters, transmission efficiency with the same waist size as injected beam for asymmetric and symmetric directions is calculated as shown in Fig.3.

For a beam injection larger than around 10 deg in this antenna, phase slippage between excited higher modes at the waveguide output is produced and then unwanted peaks in opposite direction are observed. These observations also agree well with calculations.

We found an improvement of performance on the injection angle more than 10 deg by adjusting the total waveguide length. The improvement enables us directional control of symmetric or asymmetric radiation with high efficiency even when gaussian beam with only positive direction is injected. With increasing the injection angle, the higher modes with large mode number are excited. There is a tendency that higher modes with very large mode number ($a \simeq m\lambda$) can not satisfy approximately the boundary condition at walls for 4-wall corrugated waveguide [2], where $m$ is the mode number. The corresponding mode number can be found experimentally by comparing with results from two-wall corrugated square waveguide in which boundary condition at all the walls is satisfied.

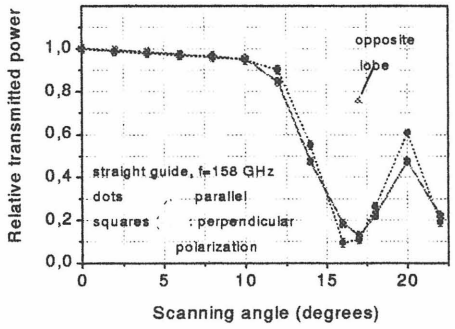


Fig. 2: The experimental results of radiation power

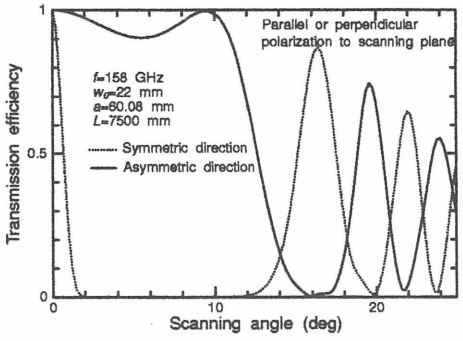


Fig. 3: The calculation of radiation power

### Reference

1)K. Ohkubo et al.:Joint Meeting of US Japan RF Heating Technology Workshop and EU Japan RF Antenna and the Related Technology Workshop Inuyama, Gifu, Japan, Feb 28-March 2, 2002

2)K. Ohkubo: Int.J. Infrared & Millimeter Waves **22**, (2001) 1709.