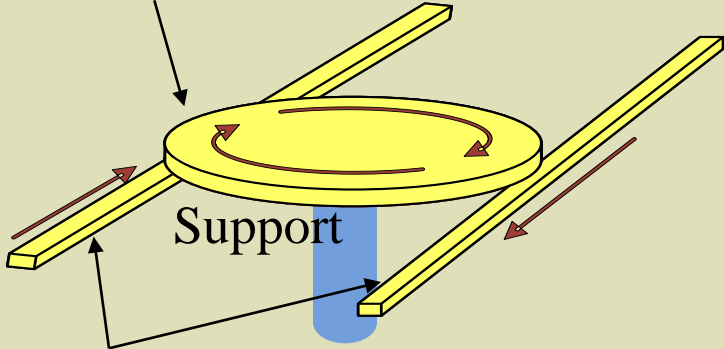


# Complex permittivity measurement for dielectric materials in millimeter wave region 2

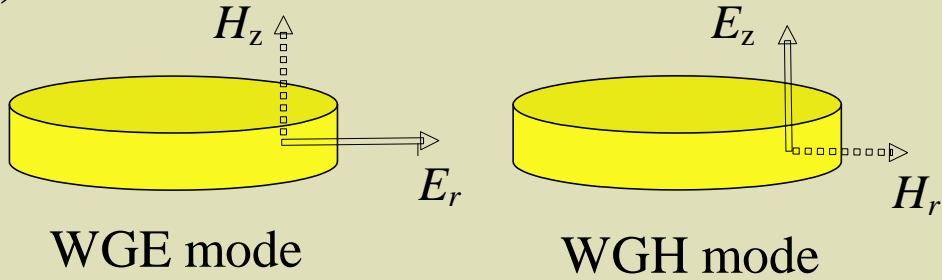
## Whispering-Gallery mode resonator method

Dielectric disk (measured sample)



Dielectric waveguide

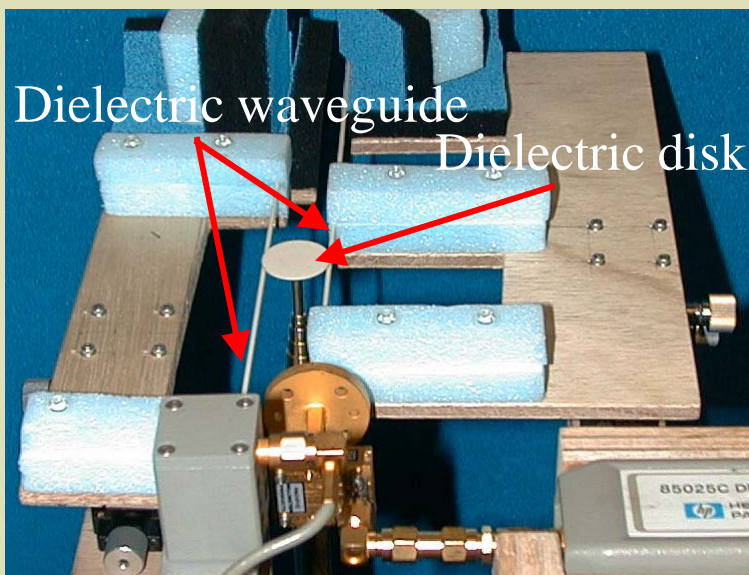
(a) WG mode dielectric disk resonator



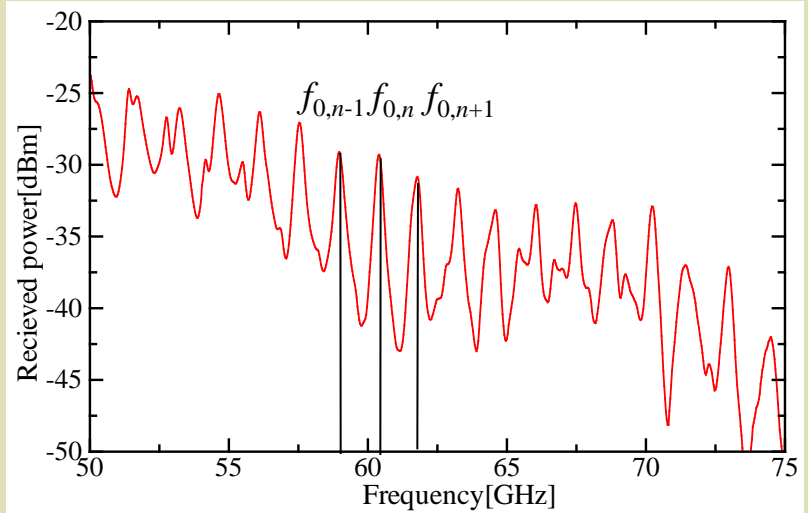
WGE mode

WGH mode

(b) Polarization of axial and radial directions



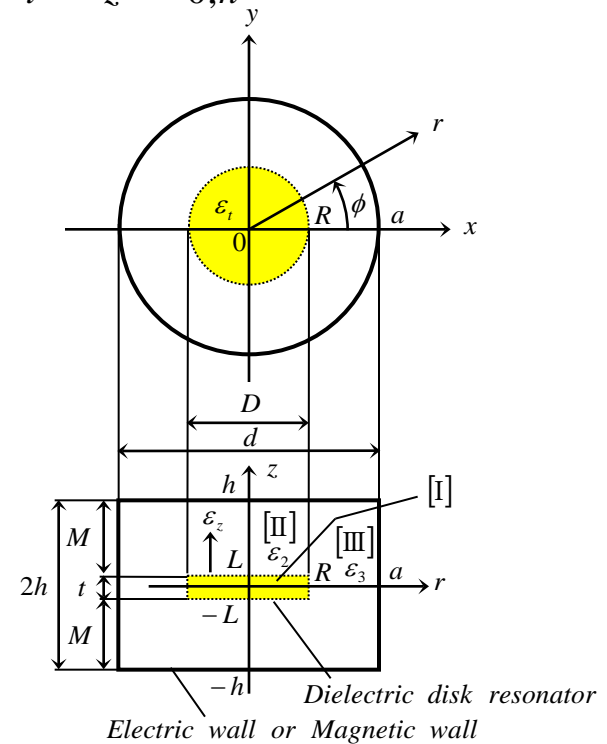
(c) Measurement system



(d) Frequency response

Relative permittivity  $\epsilon_t, \epsilon_z$

$$\det H(\epsilon_t, \epsilon_z; f_{0,n}, n, d, D, 2L, 2h) = 0$$

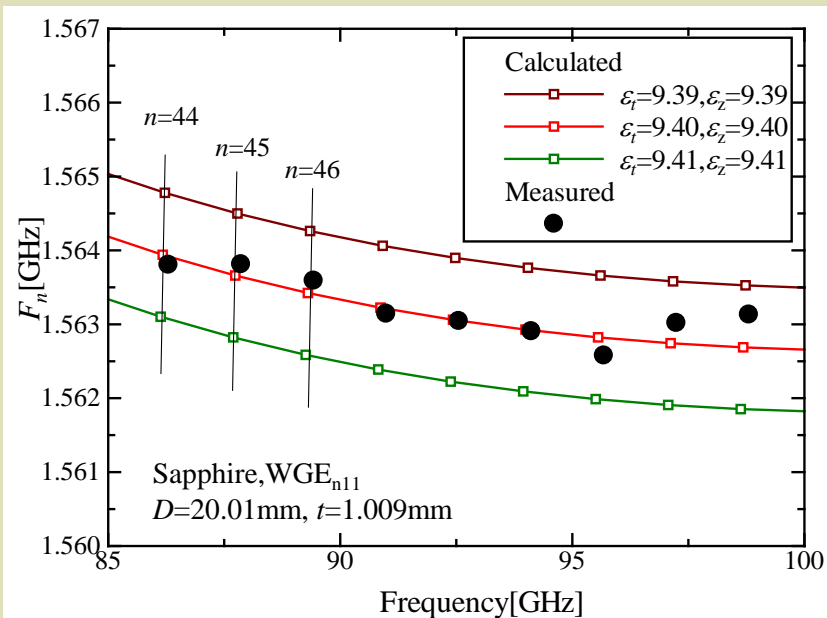


Mode matching analysis of WG mode resonator

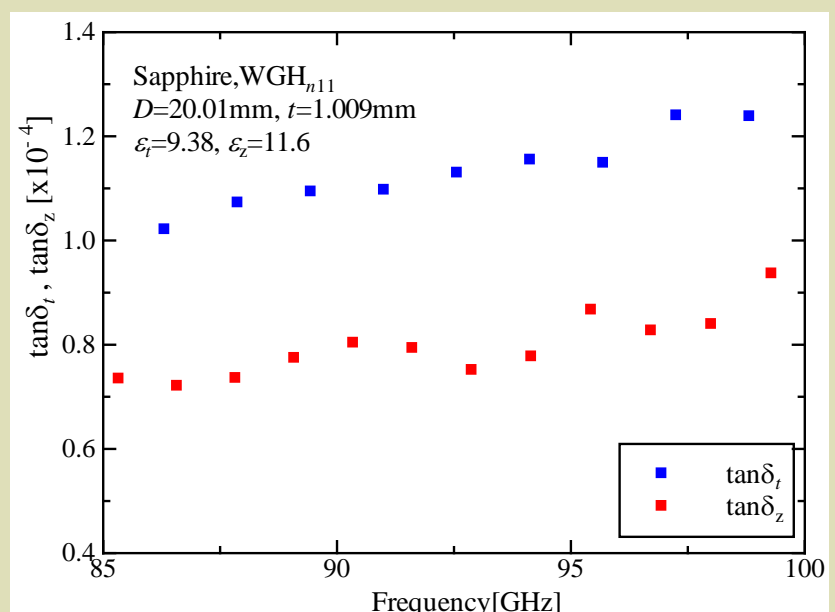
## Measured results

$$F_n = \frac{f_{0,n+1} - f_{0,n-1}}{2}$$

$$\tan \delta = \frac{1}{Q_u} \frac{f_0}{(-\Delta f / \Delta \epsilon_r) \cdot 2\epsilon_r}$$



(a) Relative permittivity  $\epsilon_t, \epsilon_z$



(b) Loss tangent  $\tan \delta$