# Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

**Submission Title:** Antenna characteristics for design and evaluation of 300 GHz wireless communication systems

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**Abstract:** Antenna characteristics at 300 GHz are presented. Three kinds of high gain antennas (rectangular horn, cassegrain and off-set parabolic type) are designed, and measurement results using fabricated antennas is shown. This feasibility study of 300 GHz band high gain antennas is contribute to the link design and interference evaluation of 300 GHz wireless communication systems.

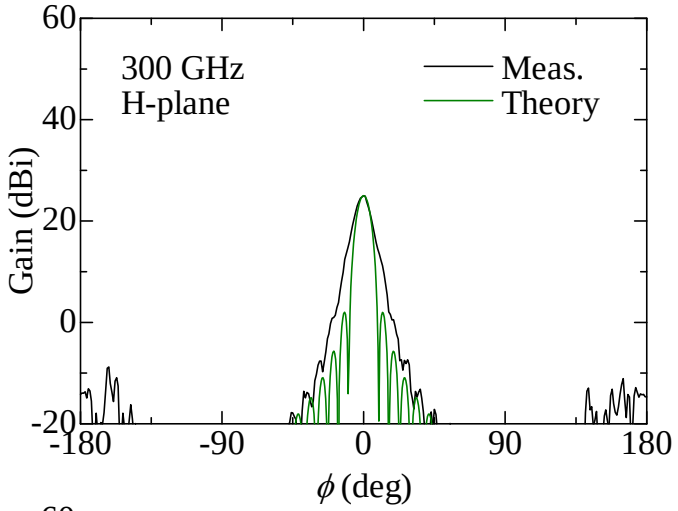
**Purpose:** []

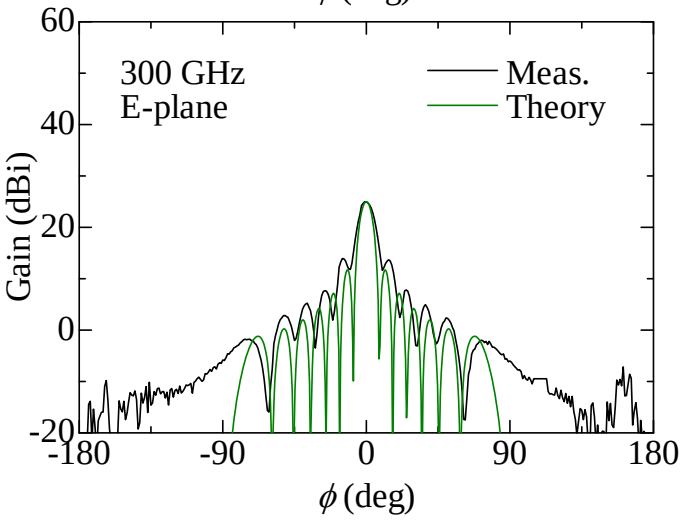
# Introduction

- Antenna characteristics at 300 GHz are presented in this contribution.
- Three kinds of high gain antennas (rectangular horn, cassegrain and off-set parabolic type) are designed, and measurement results using fabricated antennas are shown.

# Rectangular horn antenna

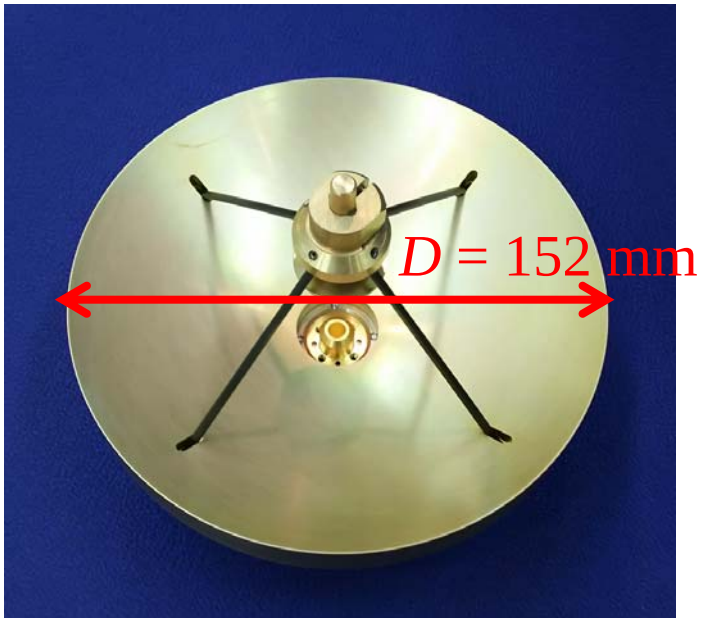
- Aperture: 9×7 mm
- Max. gain: 25 dBi



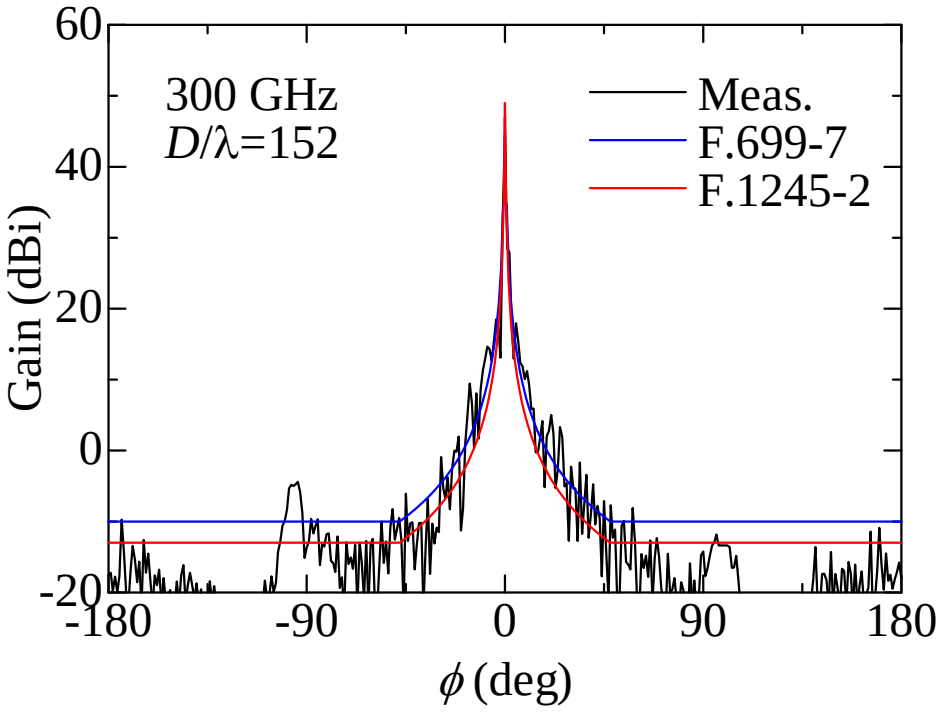



# Cassegrain antenna

- Antenna directivity is compared with antenna models of ITU-R Recommendation F.699-7 and F.1245-2
- These Recommendation is limited below 70 GHz, however, these antenna models have an applicability for 300 GHz communication systems

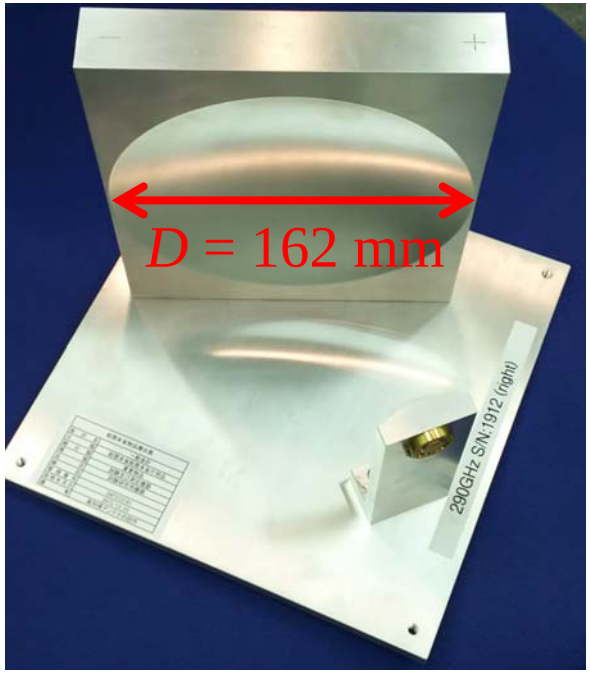



Max. gain: 47 dBi

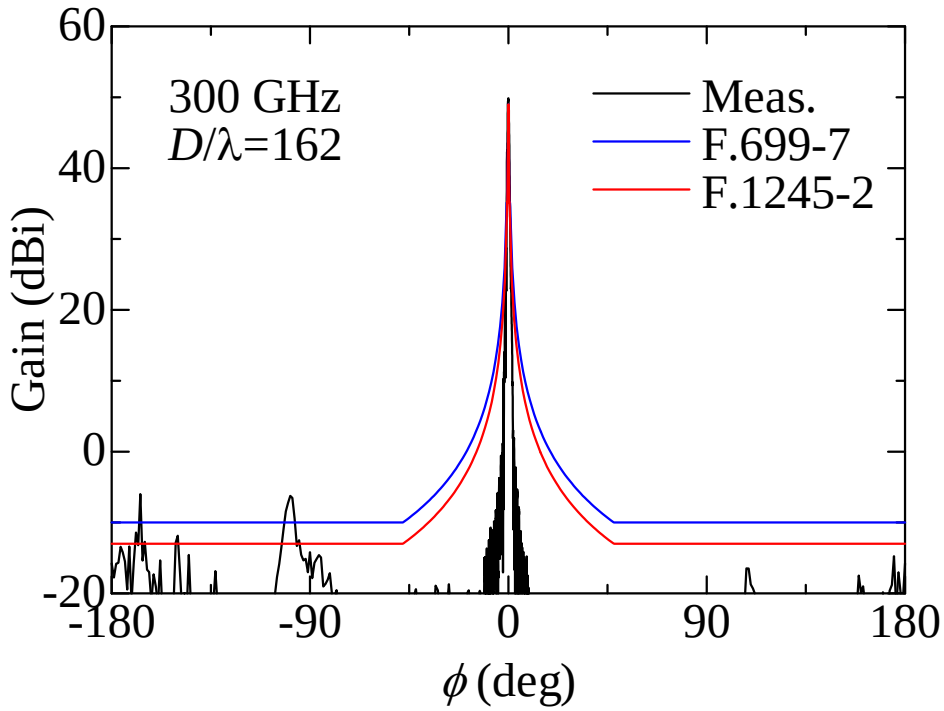


# Off-set parabolic antenna

- As other type high gain antenna, off-set parabolic antenna directivity is shown
- The side lobe level is lower than ITU-R Recommendations within antenna front side from -90° to 90°




Max. gain: 49 dBi



# Conclusion

- This feasibility study of high gain antennas contributes to a link budget design and interference evaluation of 300 GHz wireless communication systems.

# Annex 1 ITU-R F.699-7

- Reference radiation patterns for fixed wireless system antennas for use in coordination studies and interference assessment in the frequency range from 100 MHz to about 70 GHz
- ITU-R F.699 gives the peak envelope of side-lobe patterns

This model is used when D/λ>100.
D: antenna diameter
λ: wave length

$$G(\varphi) = G_{max} - 2.5\times10^{-3}\left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{for} \quad 0^\circ < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \quad \text{for} \quad \varphi_m \le \varphi < \varphi_r$$

$$G(\varphi) = 32 - 25\log\varphi \quad \text{for} \quad \varphi_r \le \varphi < 48^\circ$$

$$G(\varphi) = -10 \quad \text{for} \quad 48^\circ \le \varphi \le 180^\circ$$

where:

$G(\varphi)$: gain relative to an isotropic antenna

$\varphi$: off-axis angle (degrees)

$D$: antenna diameter

$\lambda$: wavelength

} expressed in the same units

$G_1$: gain of the first side-lobe $= 2 + 15\log\frac{D}{\lambda}$

$$\varphi_m = \frac{20\lambda}{D}\sqrt{G_{max} - G_1} \quad \text{degrees}$$

$$\varphi_r = 15.85\left(\frac{D}{\lambda}\right)^{-0.6} \quad \text{degrees}$$

$G_{max}$ is the main lobe antenna gain (dBi)

# Annex 2 ITU-R F.1245-2

- Mathematical model of average and related radiation patterns for line-of-sight point-to-point fixed wireless system antennas for use in certain coodination studies and interference assessment in the frequency range from 1 GHz to about 70 GHz
- ITU-R F.1245-2 gives the average of side-lobe patterns

This model is used when D/λ>100.
D: antenna diameter
λ: wave length

$$G(\varphi) = G_{max} - 2.5 \times 10^{-3} \left(\frac{D}{\lambda}\varphi\right)^2 \quad \text{for} \quad 0° < \varphi < \varphi_m$$

$$G(\varphi) = G_1 \quad \text{for} \quad \varphi_m \le \varphi < \max(\varphi_m, \varphi_r)$$

$$G(\varphi) = 29 - 25 \log \varphi \quad \text{for} \quad \max(\varphi_m, \varphi_r) \le \varphi < 48°$$

$$G(\varphi) = -13 \quad \text{for} \quad 48° \le \varphi \le 180°$$

where:

$G_{max}$: maximum antenna gain (dBi) (see Note 2);

$G(\varphi)$: gain (dBi) relative to an isotropic antenna;

$\varphi$: off-axis angle (degrees);

$D$: antenna diameter
$\lambda$: wavelength
} expressed in the same unit;

$G_1$: gain of the first side lobe;

$= 2 + 15 \log (D/\lambda)$

$$\varphi_m = \frac{20\lambda}{D}\sqrt{G_{max} - G_1} \quad \text{degrees}$$

$$\varphi_r = 12.02\,(D/\lambda)^{-0.6} \quad \text{degrees}$$

$G_{max}$ is the main lobe antenna gain (dBi)