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

**Submission Title:** [A small printed dipole UWB antenna for mobile handset applications]
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**Re:** [Technical contribution]

**Abstract:** [This presentation presents a printed dipole UWB antenna for mobile handset applications. The antenna features a small-sized radiator and can be manufactured with printed circuit technology.]

**Purpose:** [To provide technical contribution to the IEEE 802.15.3a.]

# A Small Printed Dipole UWB Antenna for Mobile Handset Applications

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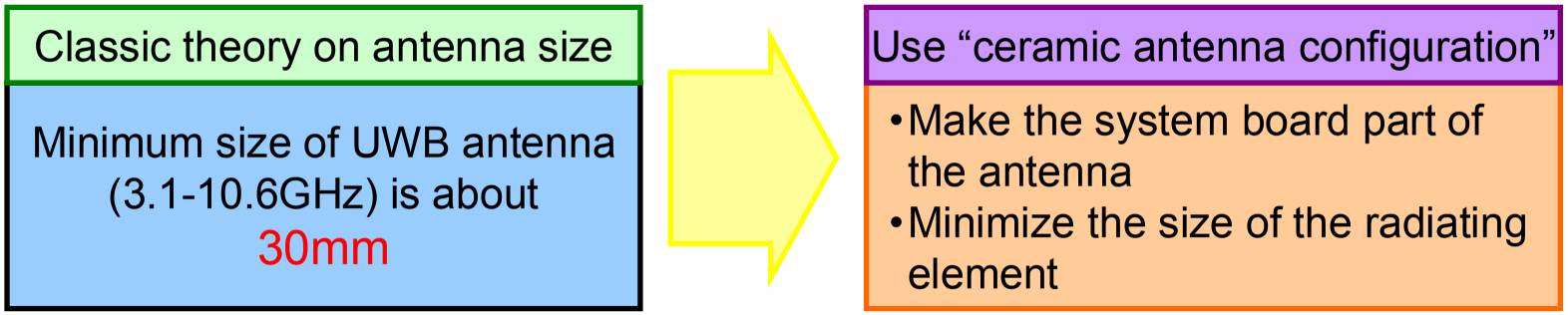
# Outline

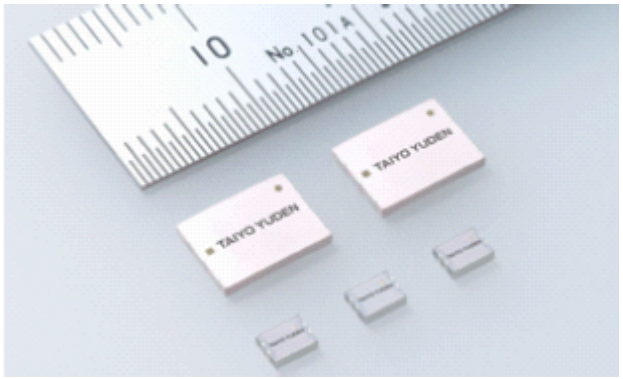
1. Motivation
2. Previous/related work
3. Antenna structure
4. Measurement procedure
5. Measurement results
   - VSWR
   - Gain and group delay
   - Omni-directionality
   - Gain patterns
   - Antennas with different ground plate sizes
6. Conclusions

# Motivation

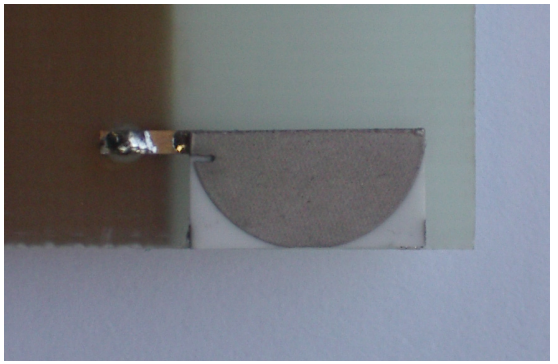
- Requirements on antennas
  - For digital TV, DVD player, digital camcorder, notebook computer
    - Cheap manufacturing cost
    - Possibility of integration with the system board
    - Impedance bandwidth, gain and phase requirements
  - Additional requirements for mobile handsets
    - Small form factor
    - Omni-directional radiation pattern



# Previous/related work

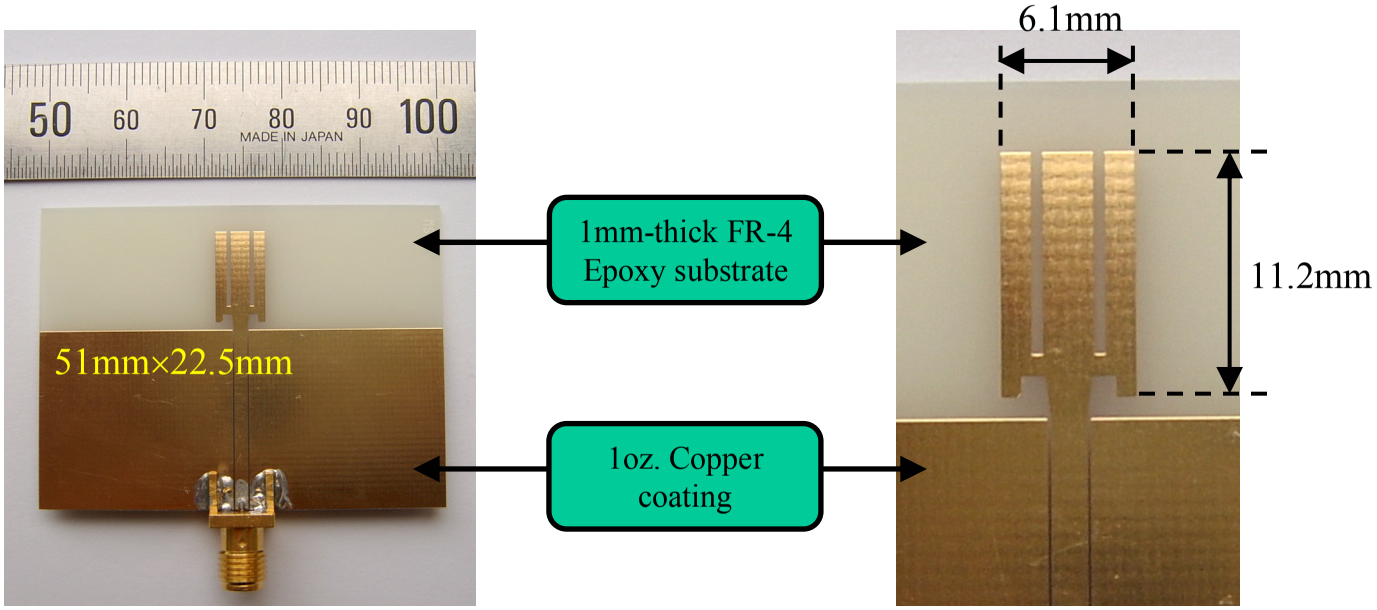



- Taiyo-Yuden/TRDA's ceramic chip UWB antenna
  - Announced in June 2004
  - Ceramic chip size: 8mm×6mm×1mm



- Samsung's ceramic UWB antenna
  - Reported in May 2004 in UWBST 2004
  - Ceramic chip size: 10mm×5mm×1mm
  - Semi-circular conductor patch on a single layer of ceramic

# Antenna structure

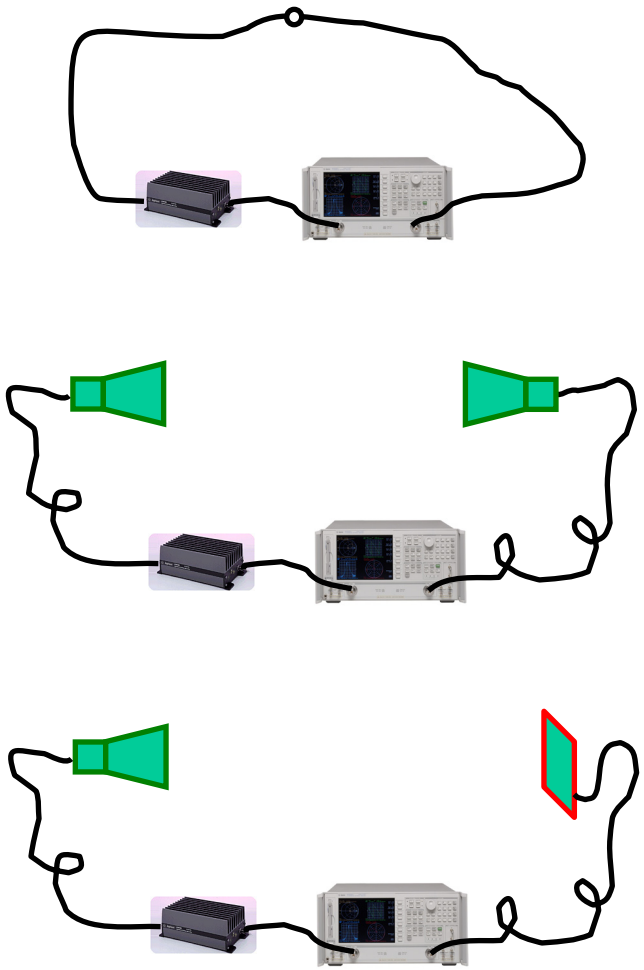



- Planar structure
  - Planar dipole antenna with a Co-Planar Waveguide(CPW) feed
  - Direct feeding arrangement can be used as well.
  - Ground plates of different shapes and sizes can be used.
  - Electric components can be mounted on the central portion of the ground plate.
- The radiating element
  - Size: 6.1mm×11.2mm

Main features

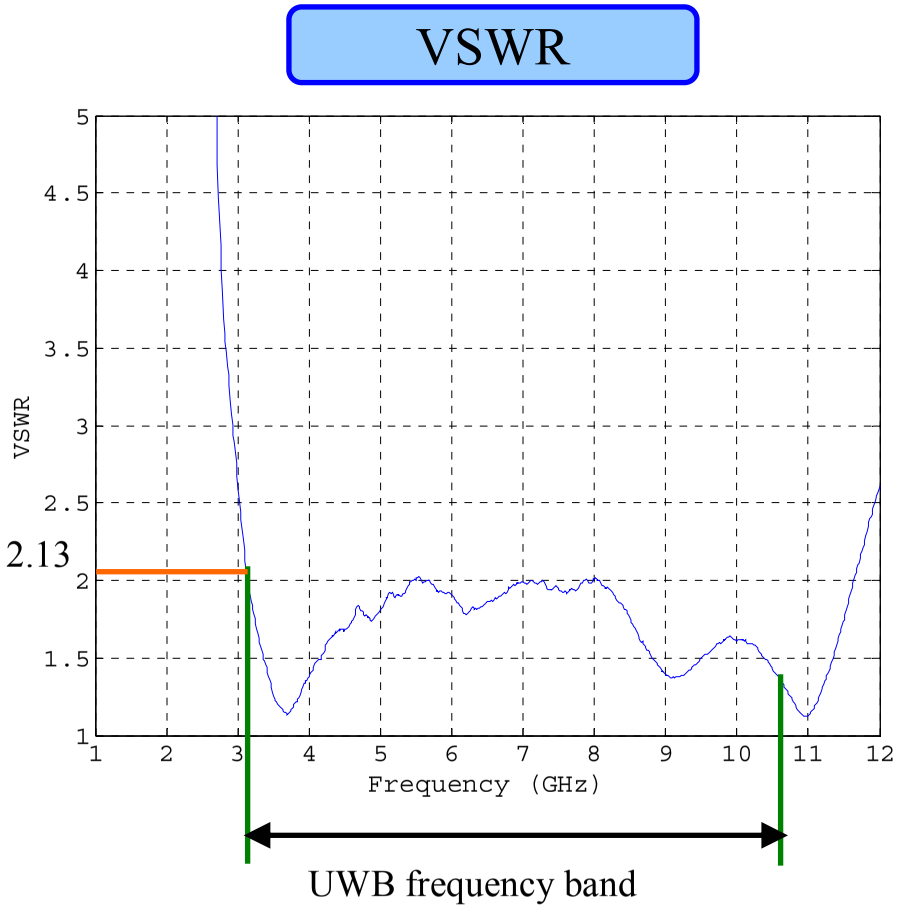
- Completely planar structure
- Can be produced with PCB technology
- Does not use ceramic material → near-zero manufacturing cost

# Measurement procedure



1. Cable through
   - Measure the effect of cable+amplifier
   - Beware of high received power level
2. Horn-Horn
   - Use #1 to remove cable+amp effect
   - “Take the square root” to get the gain and phase response of a single horn
3. Horn-AUT
   - Use #1 to remove cable+amp effect
   - Use #2 to remove horn effect

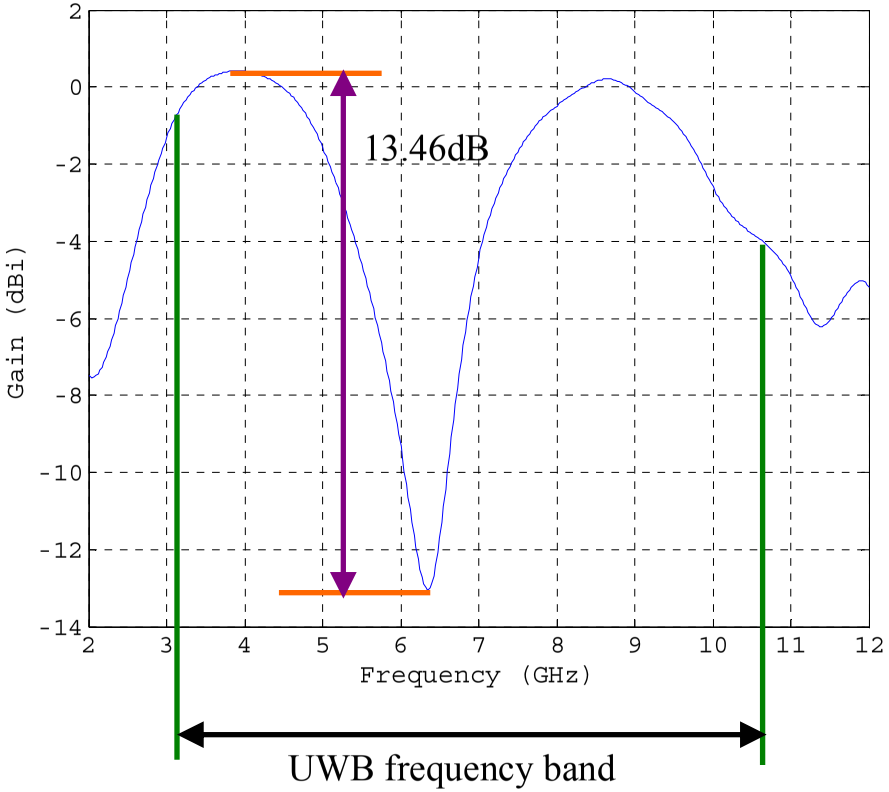
# Measurement(1/9)



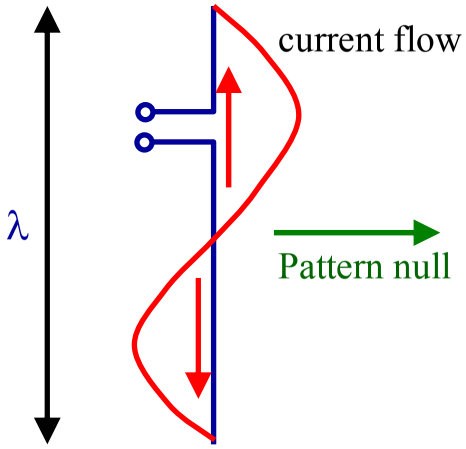

- VSWR<2.13 for 3.1GHz<f<10.6GHz
- VSWR<2 for f>3.14GHz

# Measurement(2/9)

Gain (boresight)

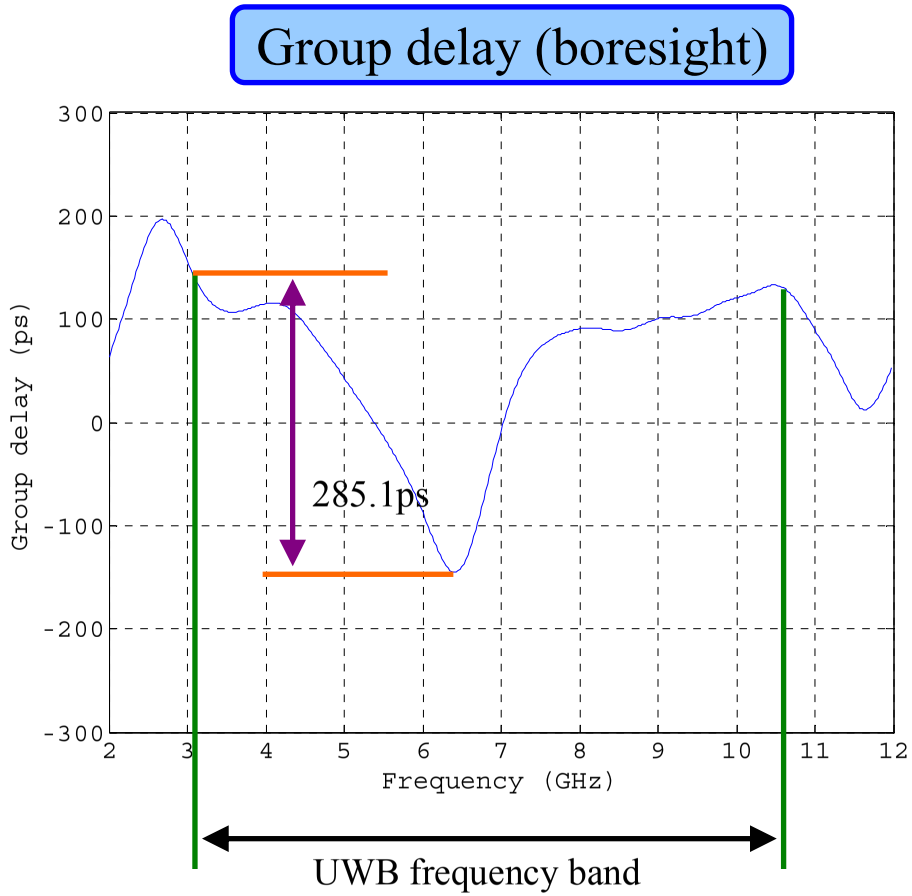



A wire dipole with an off-center feed



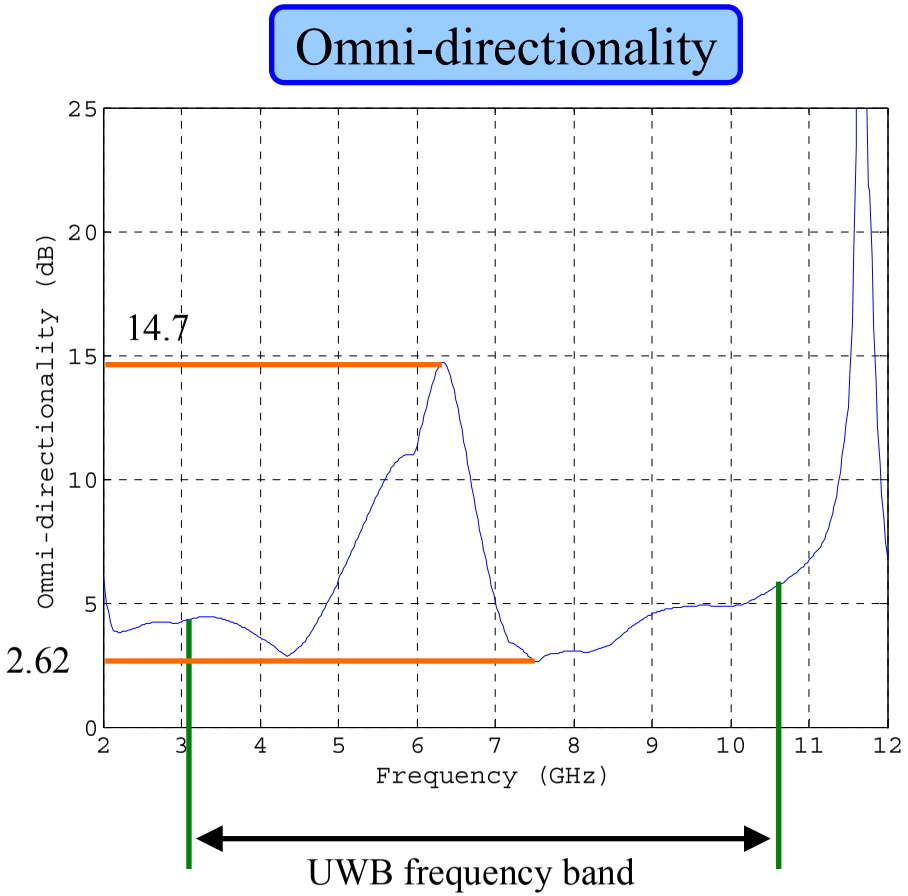

- Max gain=0.41dBi @ f=3.9GHz
- Min gain=-13.05dBi @ f=6.35GHz
- There exists a pattern null @ f=6.35GHz
  - Due to the off-center feed of the dipole antenna

# Measurement(3/9)



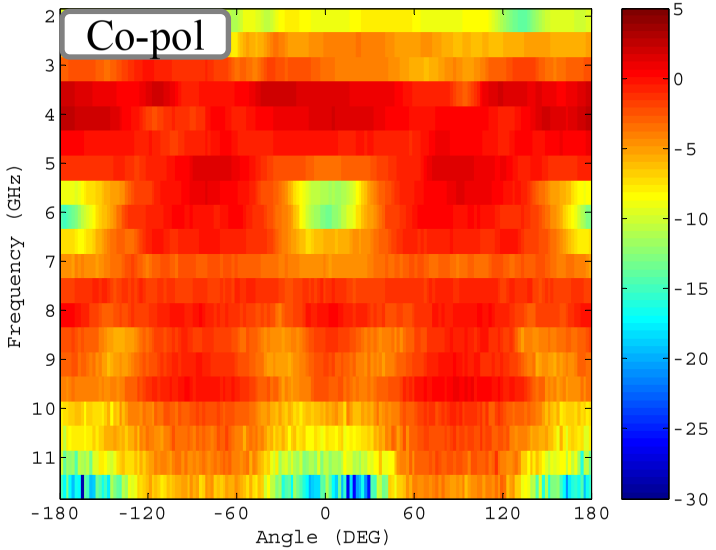

- Maximum group delay variation = 285.1ps
- The space wave propagation factor has been calibrated out.
  - So that the measured value reads close to time zero

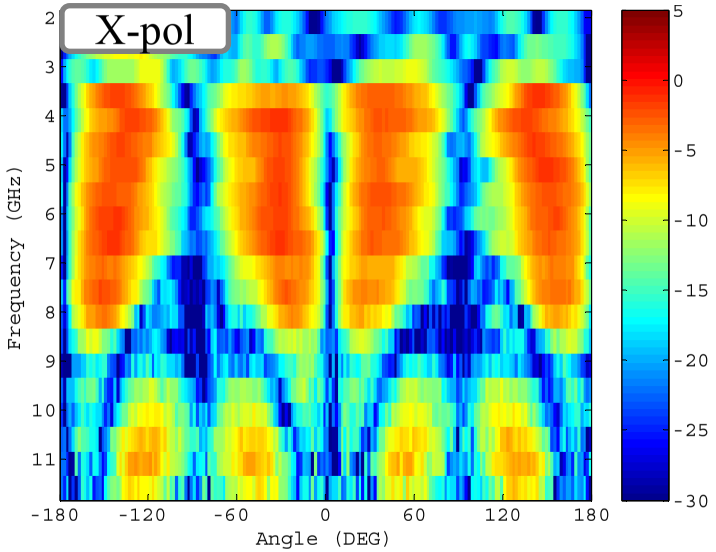
# Measurement(4/9)

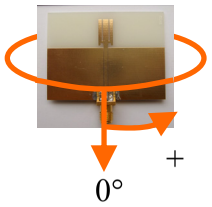



- Omni-directionality=max gain/min gain (on the azimuth plane)
- Max. omni-directionality=14.7dB @ 6.33GHz
- Min. omni-directionality=2.62dB @ 7.53GHz

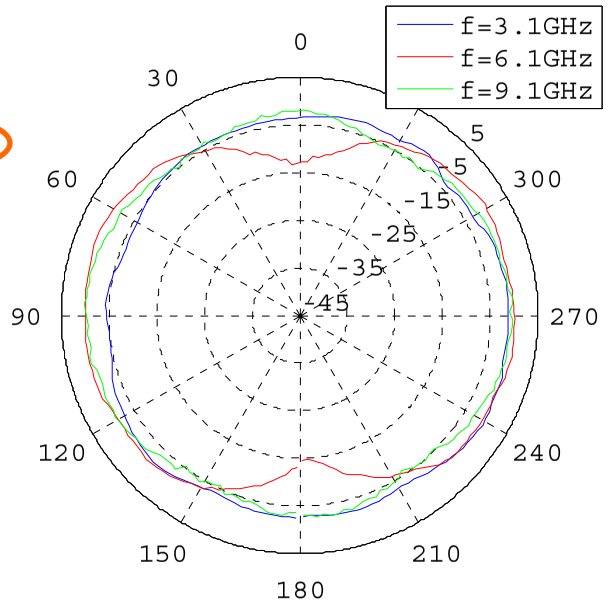
# Measurement(5/9)



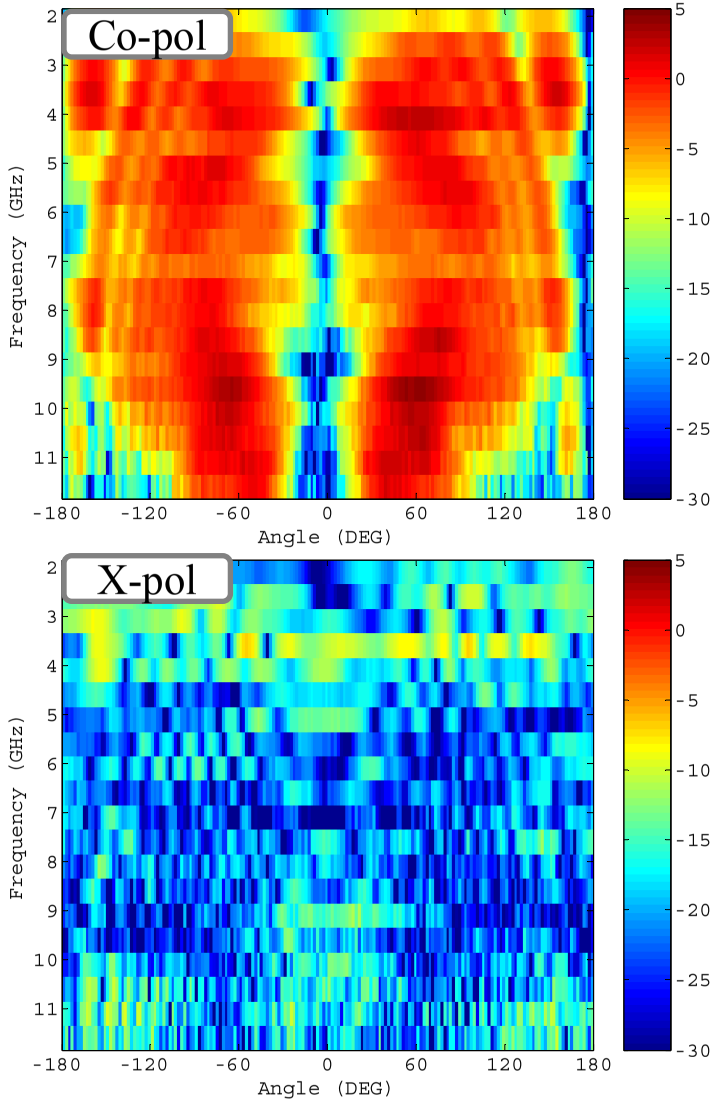



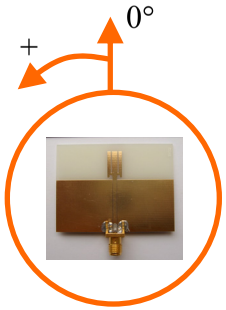

Gain pattern (azimuth)

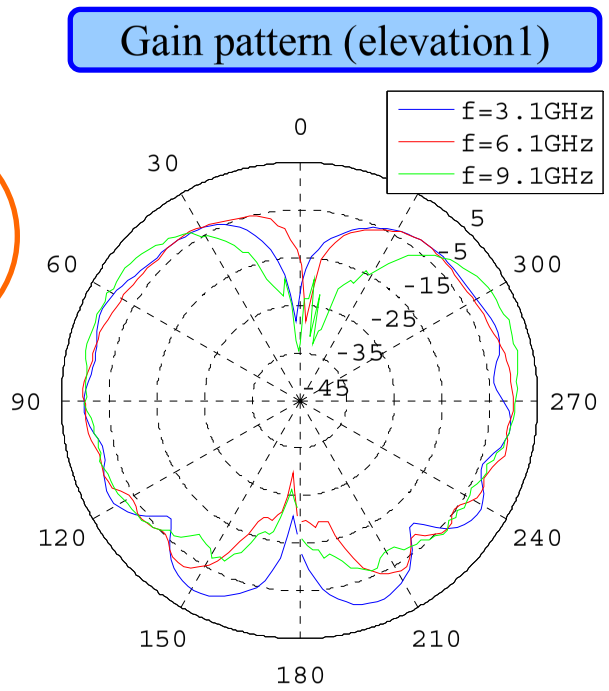



- The main beam changes direction with frequency
  - For f<4.5GHz, it is in the boresight direction
  - For f>4.5GHz, the main beam splits and points in the edge-on direction
- High level of cross-polarization component
  - Very strong at an angle from boresight
  - Caused by large current flowing in the horizontal directions

# Measurement(6/9)

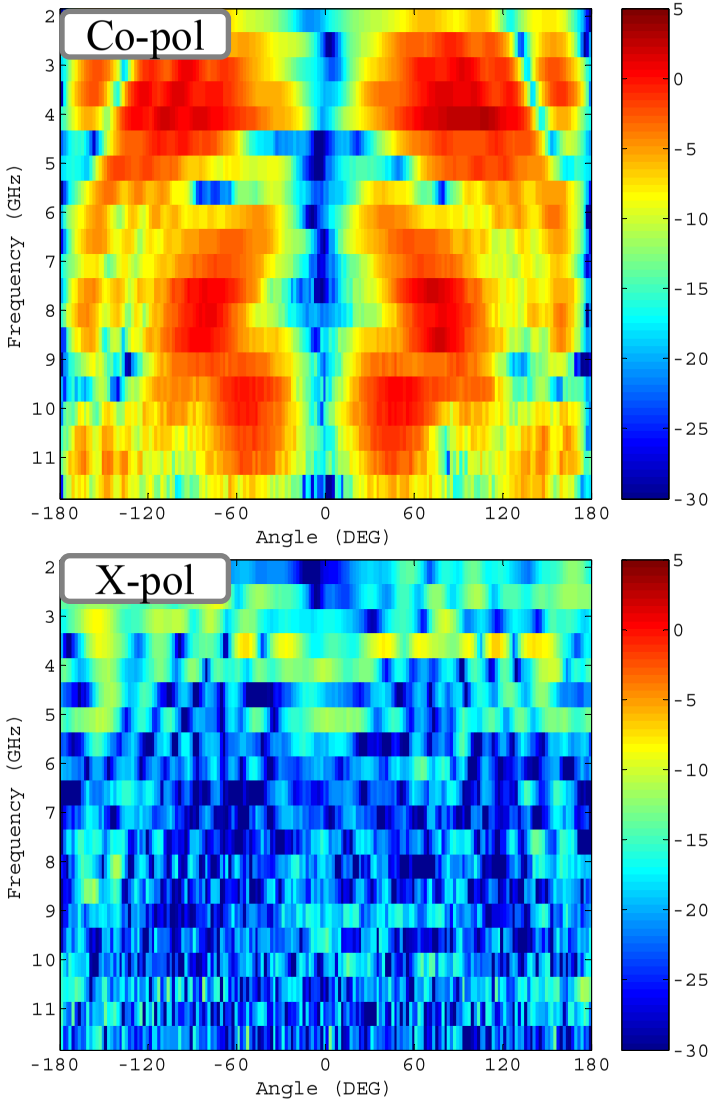


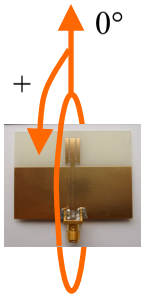



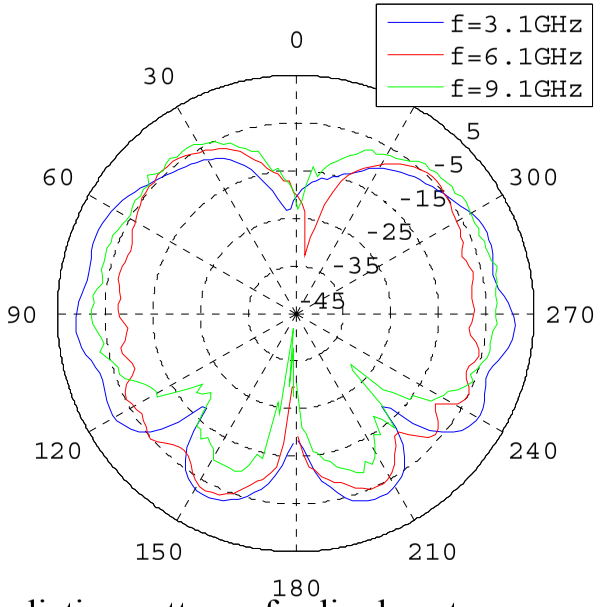

- Typical radiation pattern of a dipole antenna
  - Deep nulls at angle=0°, 180°
  - Strong radiation in the direction of the ground plate in the low-frequency range
- Low cross-polarization level in the plane
  - Currents on the radiating element and the ground plate cannot produce cross-polarization component in the plane of the antenna

# Measurement(7/9)



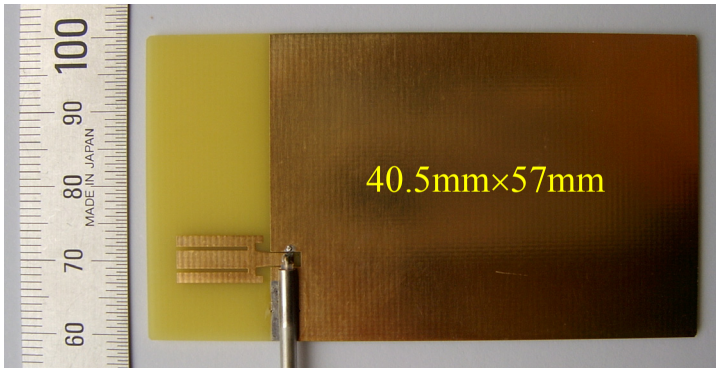

Gain pattern (elevation2)

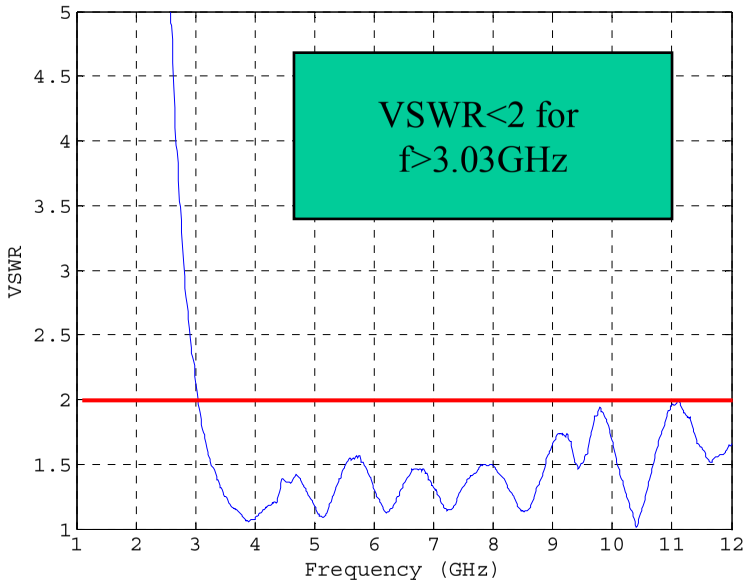



- Radiation pattern of a dipole antenna
  - Nulls at angle=0°, 180°
  - The main beam points above the horizon in the high-frequency range
  - Weaker radiation than in the elevation plane 1
- Low cross-polarization level in the plane
  - It is due to the cancellation effect of horizontally flowing currents.
  - Cross-pol level expected to rise off the observation plane

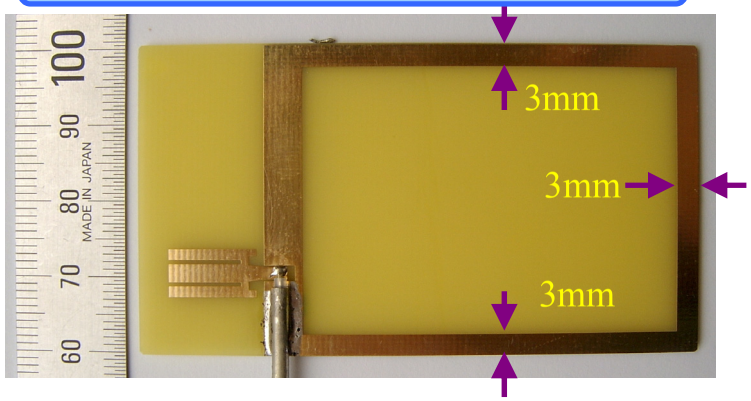
# Measurement(8/9)

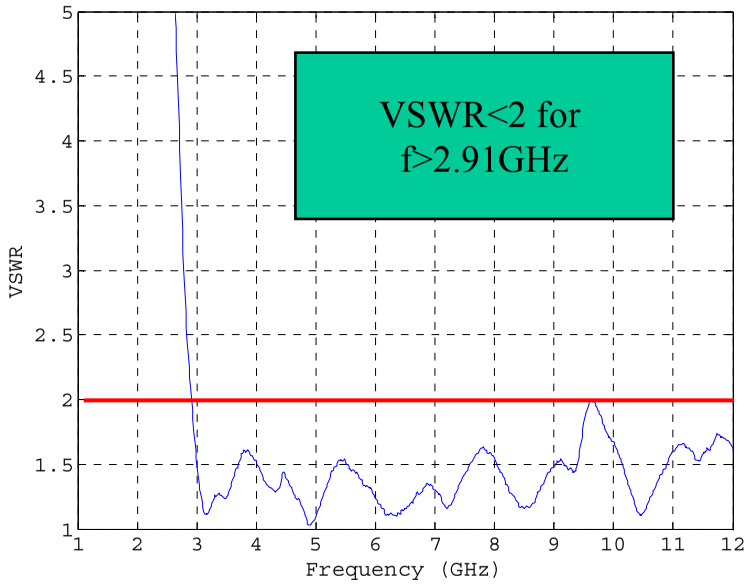
Different ground shape and size



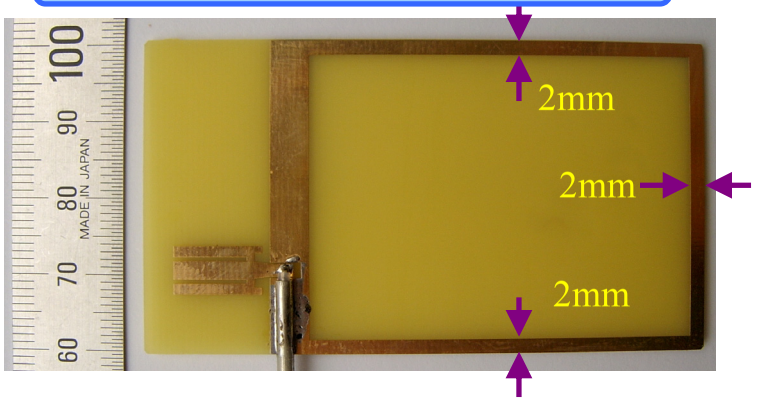

Central portion of ground removed



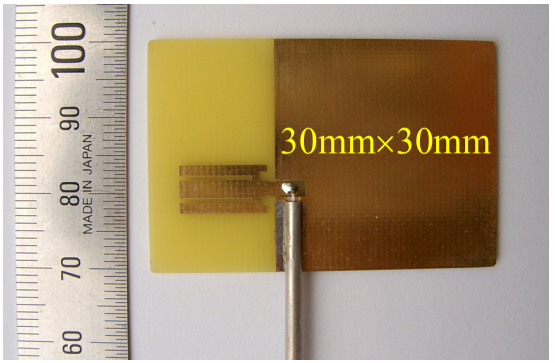



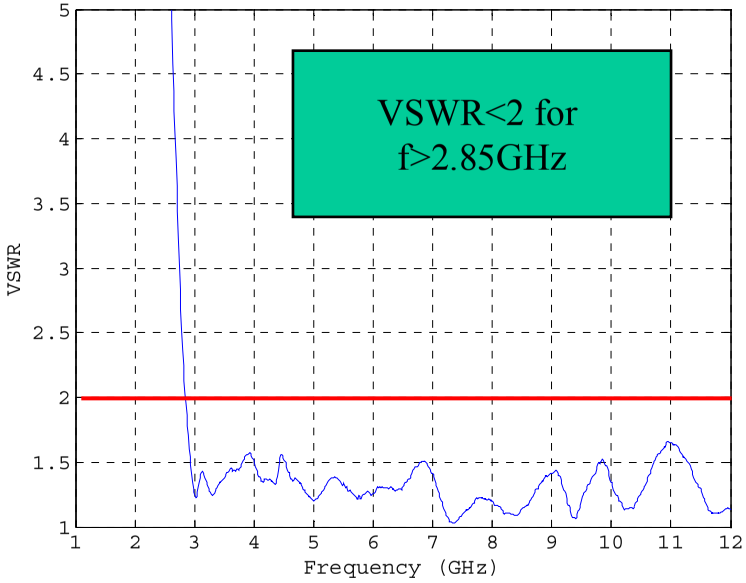
# Measurement(9/9)

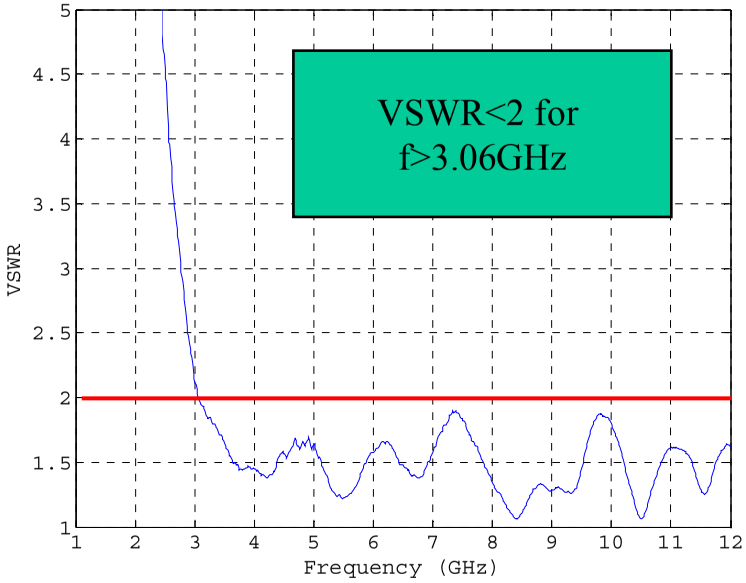
Central portion of ground removed




Smaller ground plate



# Conclusions

1. A printed dipole UWB antenna with a small radiating element has been presented.
   - Designed with focus on completely planar realization with small radiating element size
   - The dipole uses the ground plate of the system board as part of the antenna.
   - Operable over the entire UWB band
   - The off-center feed results in large gain variation(13.46dB) and makes the main beam slightly tilt toward the ground plate.
   - Boresight group delay variation = 285.1ps
   - Omni-directionality w.r.t. frequency = 14.7dB Max.
2. Other features
   - Does not need expensive ceramic process
   - Can be manufactured completely with PCB technology
   - Electronic components can be mounted on the central portion of the ground plate without affecting the antenna performance.
3. Applications
   - Suitable for mobile handset applications