

Observation of Physical Mechanism of On-Body Channel Fluctuation

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Outline

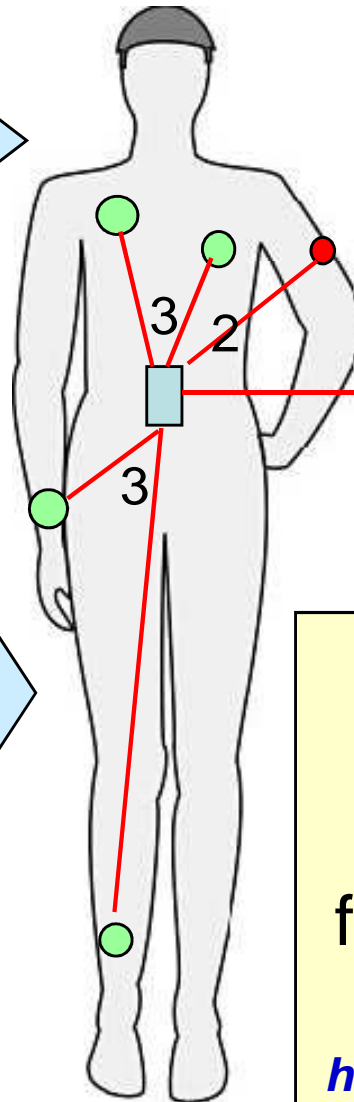
- **Introduction**
- **Observation of on-body Antenna Patterns**
 - Measurement campaigns
 - Results and discussions
- **Observation of Fading Channels with Holder**
 - Measurement campaigns
 - Results and discussions
- **Conclusions**

Introduction

Miniaturization of wireless Communications and Sensor devices.

medical healthcare application
(continuous healthcare monitoring, automatic dosing, etc.)

Non Medical applications
(Entertainment, Sports, military, etc)



- Implant node
- Body surface node

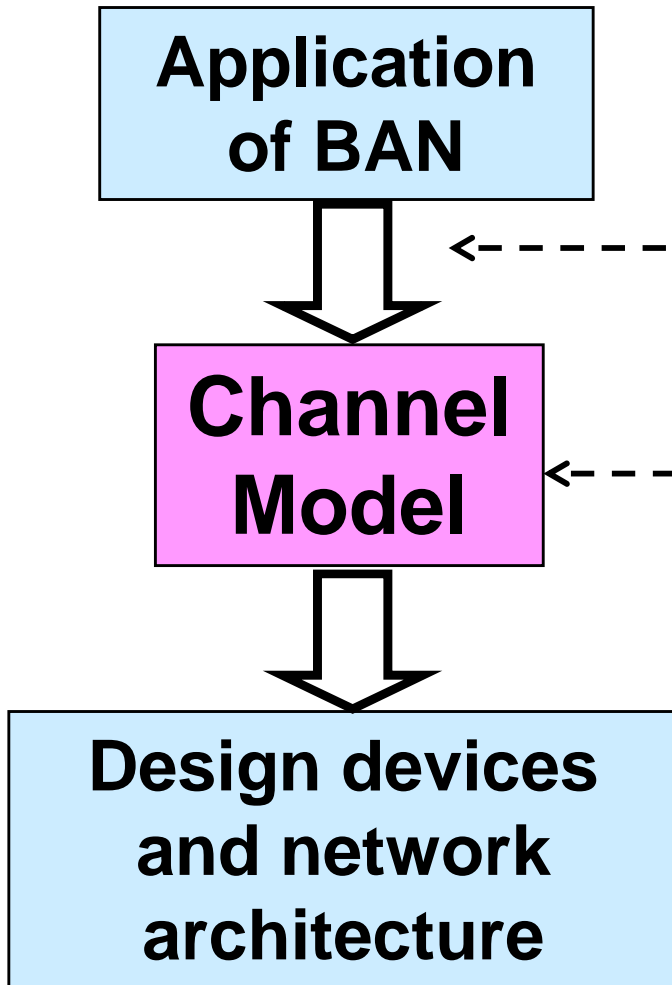
- 1 Off-body
- 2 In-body
- 3 **On-body**

IEEE working group (IEEE 802.15 working group TG6 Body Area Network) was formed in 2007 to develop a BAN standard

<http://www.ieee802.org/15/pub/TG6.html>

Introduction

Standardization steps



Requirements of BAN

- Reliability
- Low emission power
- Low power consumption
- Small formation Size

Channel Model has significant role in the design

Effect of Body Radio wave propagation in BAN

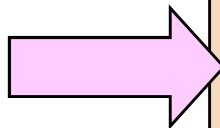
- Reflection, diffraction, creeping wave
- Antenna distortion (pattern, mismatch)
- Fading and shadowing due to body motion

BAN has much different characteristics than the general wireless communication

Introductions

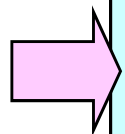
- IEEE 802.15.6 Task Groups has published the standard channel model for body area network (BAN) *
 - Summary of all submitted model but not general channel model
 - In all model, all aspects are assumed as the component of propagation channel include antenna
- This paper presents the **initial step** of the effort to decompose some channel aspects in two observations

– On-body Antenna



Observation of on-body
Antenna Patterns

– Antenna reorientation

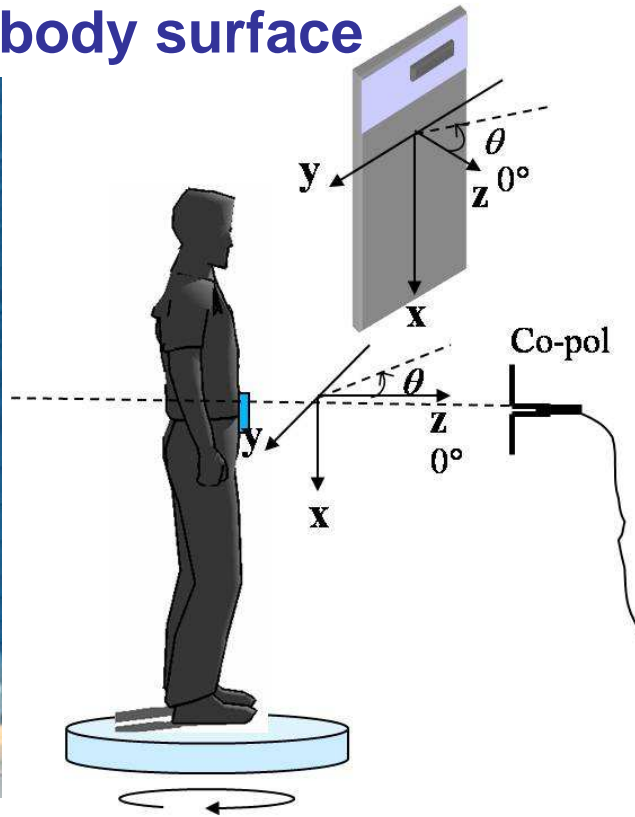


Observation of Fading
Channels with Holder

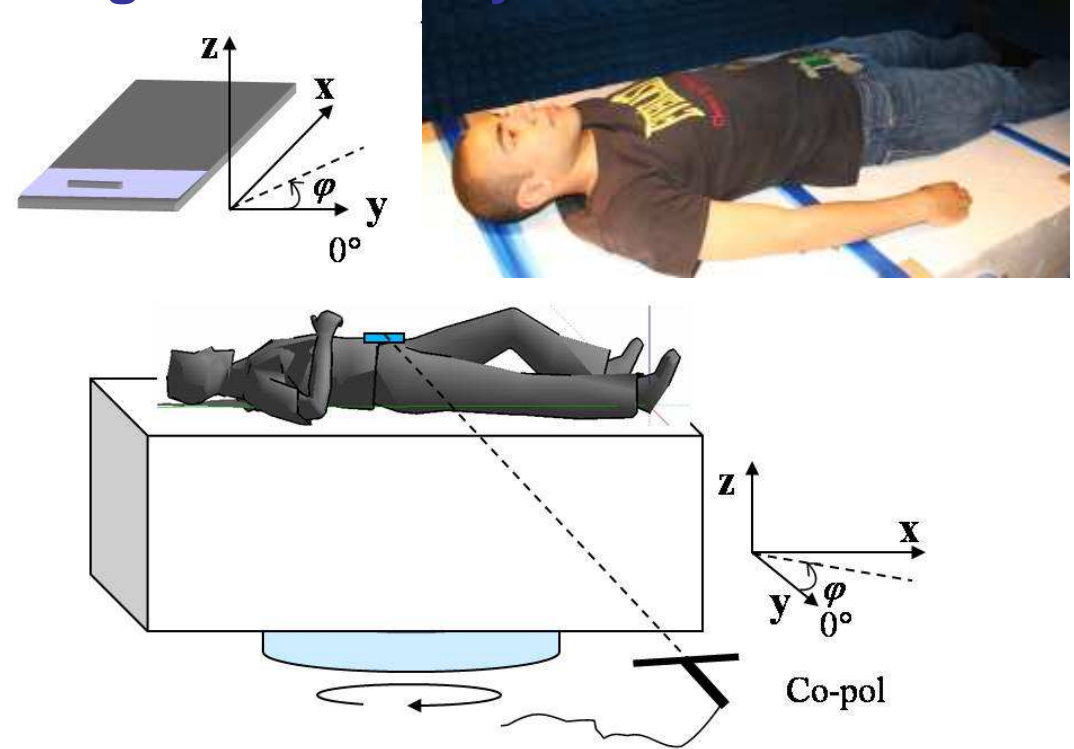
Observation of on-body Antenna Patterns

Measurement campaign

Normal to body surface

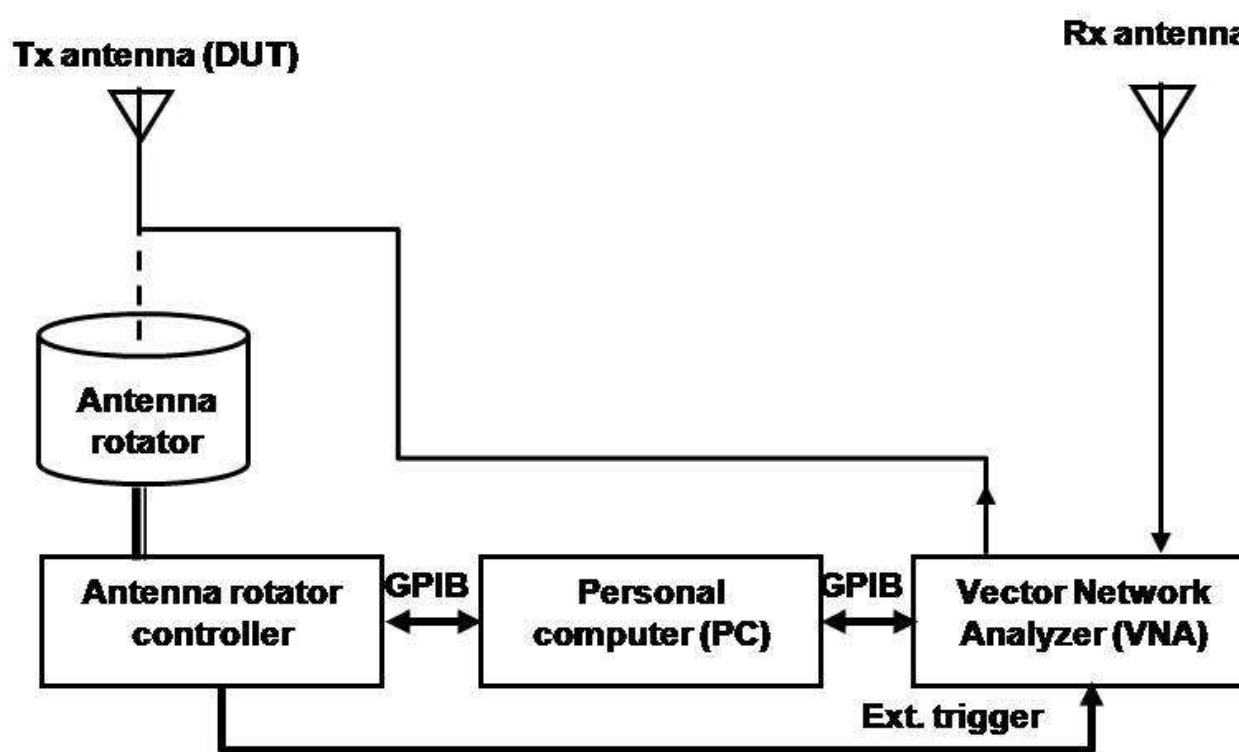


Tangential to body surface



- Observing the far-field on-body antenna pattern for normal and tangential to body surface
- Benefit: give more closer approach to the real application especially in medical health-care application

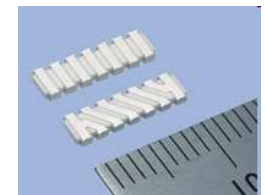
Observation of on-body Antenna Patterns



Measurement campaign (2)

Antenna

- Tx: AMD1103-ST01 surface mountable dielectric chip antennas *

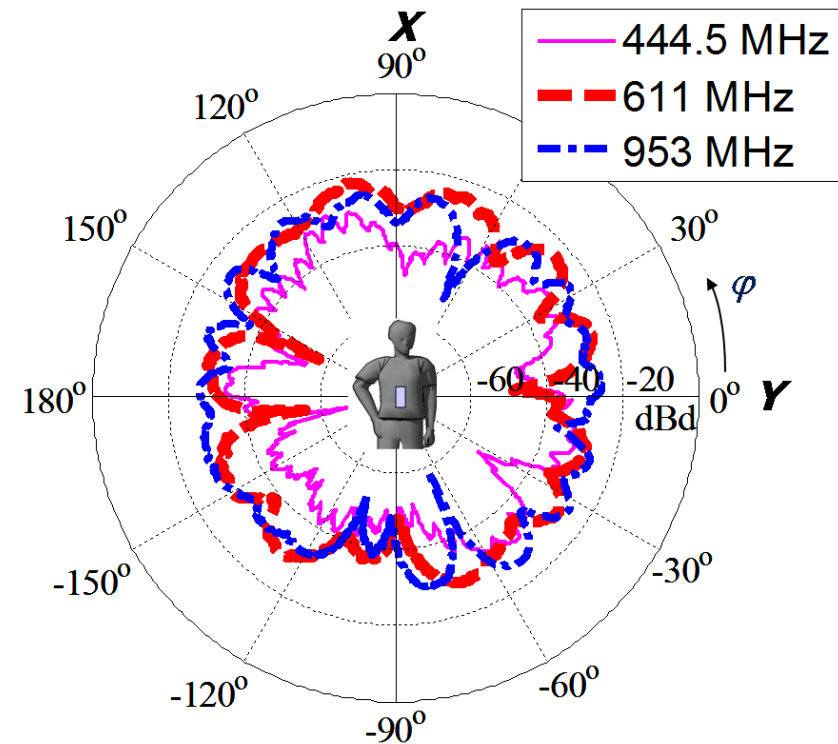
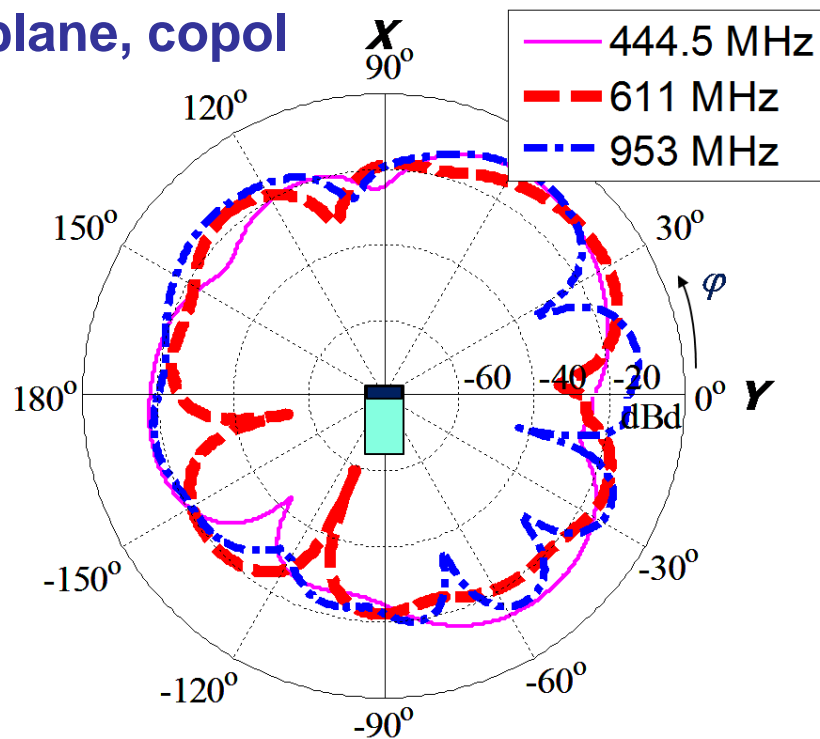


- Rx: dipole antenna
- Location: radio anechoic chamber

Parameter	Value
Frequencies	444.5, 611, 953 MHz
Antenna plane	XY and ZY planes
Polarization	cross-polarization, co-polarization
Body spacing	0 and 15 mm
Subject	2 people
Additional Postures	bending and seated

Observation of on-body Antenna Patterns

XY-plane, copol



Observation results (1)

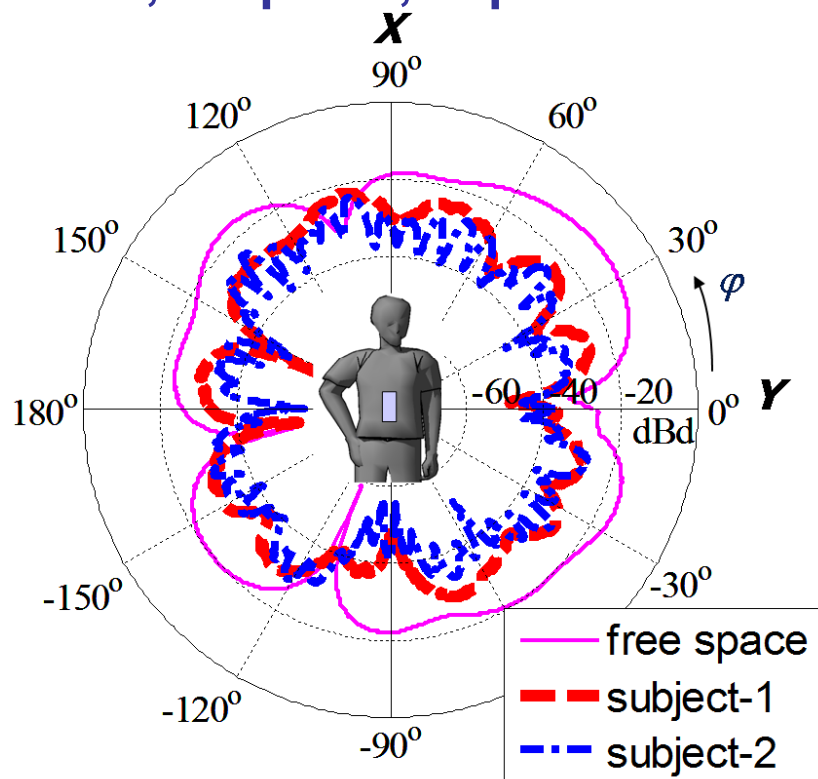
- The theoretical comparison can not be conducted since the antennas are commercial products that structures are not disclosed.
- More simple structure antennas are recommended in further investigations
- On-body antenna patterns have more irregularity than in free space.

Observation of on-body Antenna Patterns

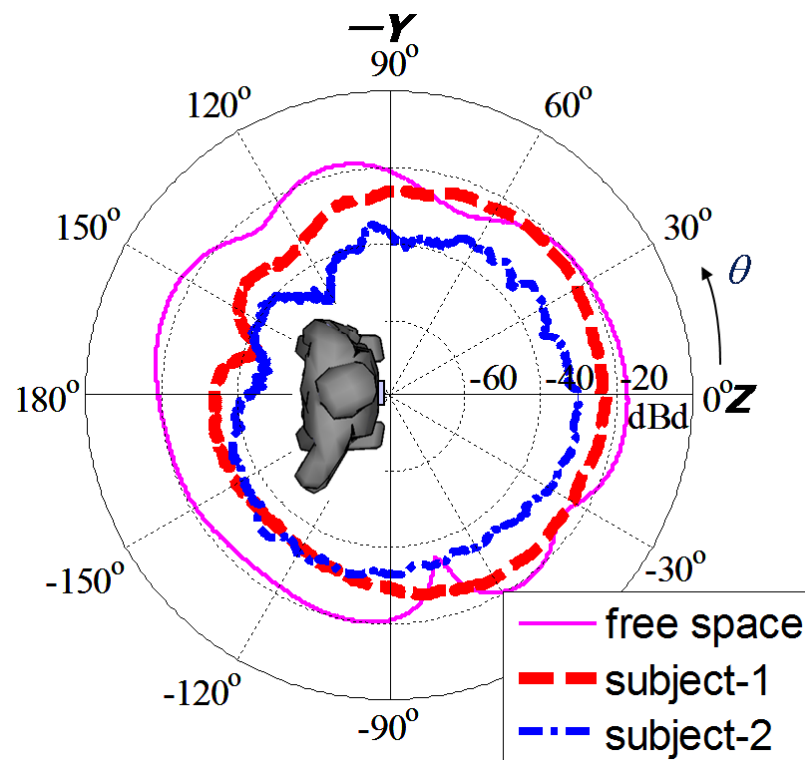
Observation results (2)

- **Subject dependency**

611 MHz, XY-plane, copol



611 MHz, YZ-plane, copol

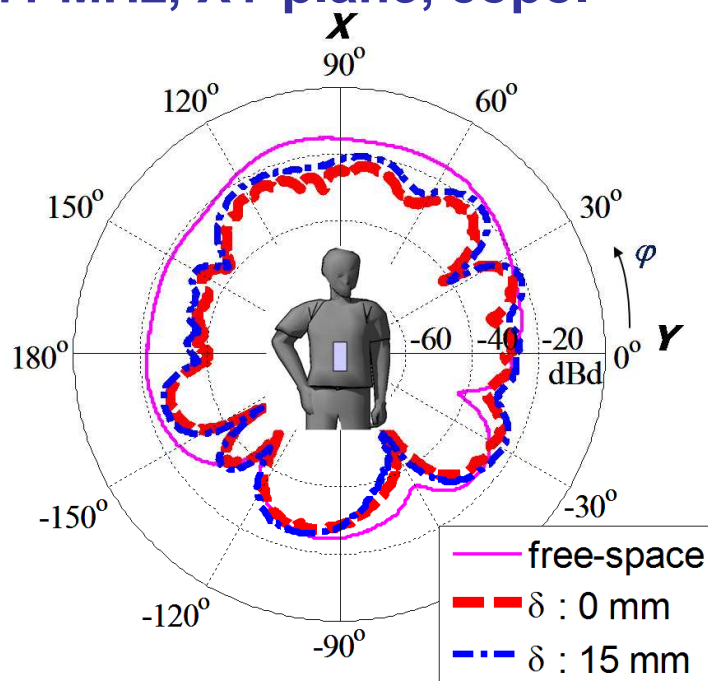


- The patterns for different subject tend to have the same shape
- The patterns on subject 2 are much more ripple due to different behavior of breathing

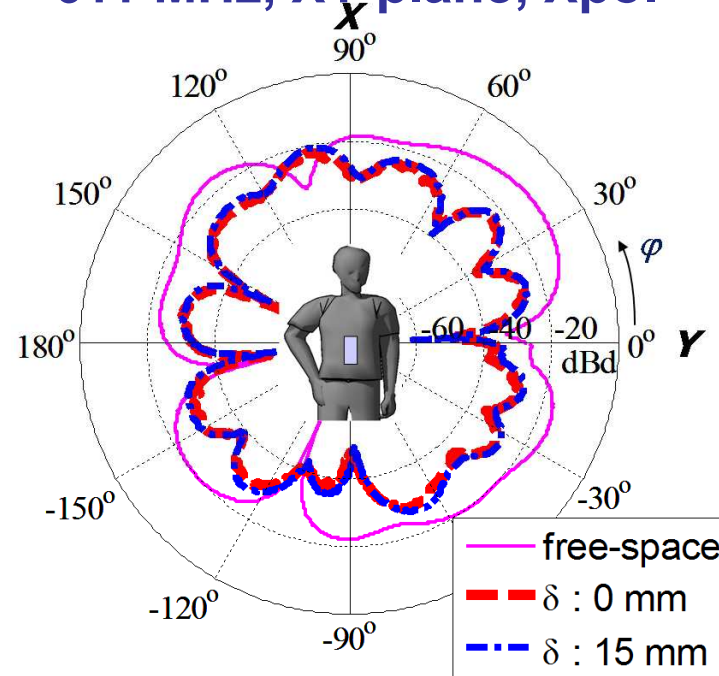
Observation of of-body Antenna Patterns

Observation results (3)

611 MHz, XY-plane, copol



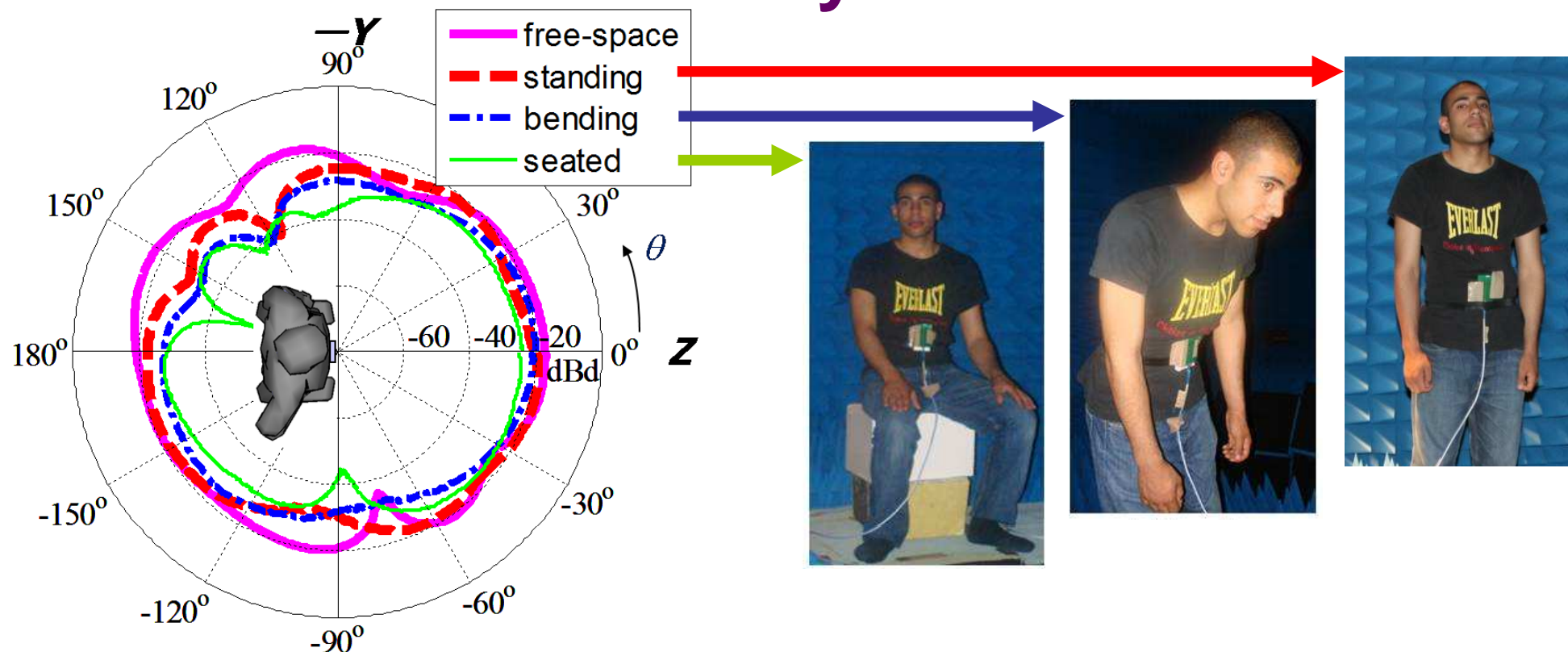
611 MHz, XY-plane, Xpol



Effect of antenna to body spacing

- Smaller antenna-to-body spacing has loss due to the body absorption and reflections

Observation of on-body Antenna Patterns



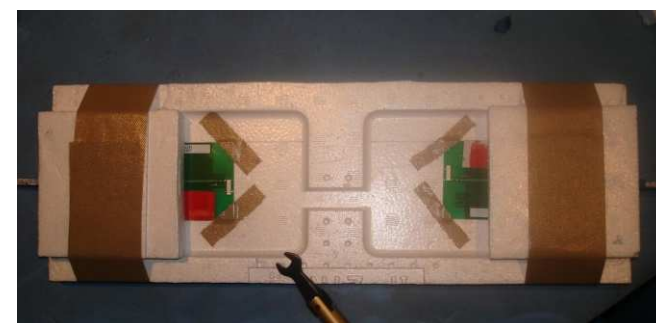
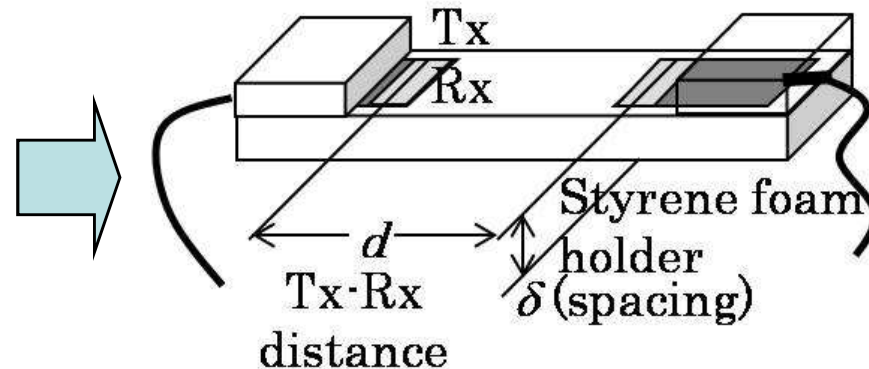
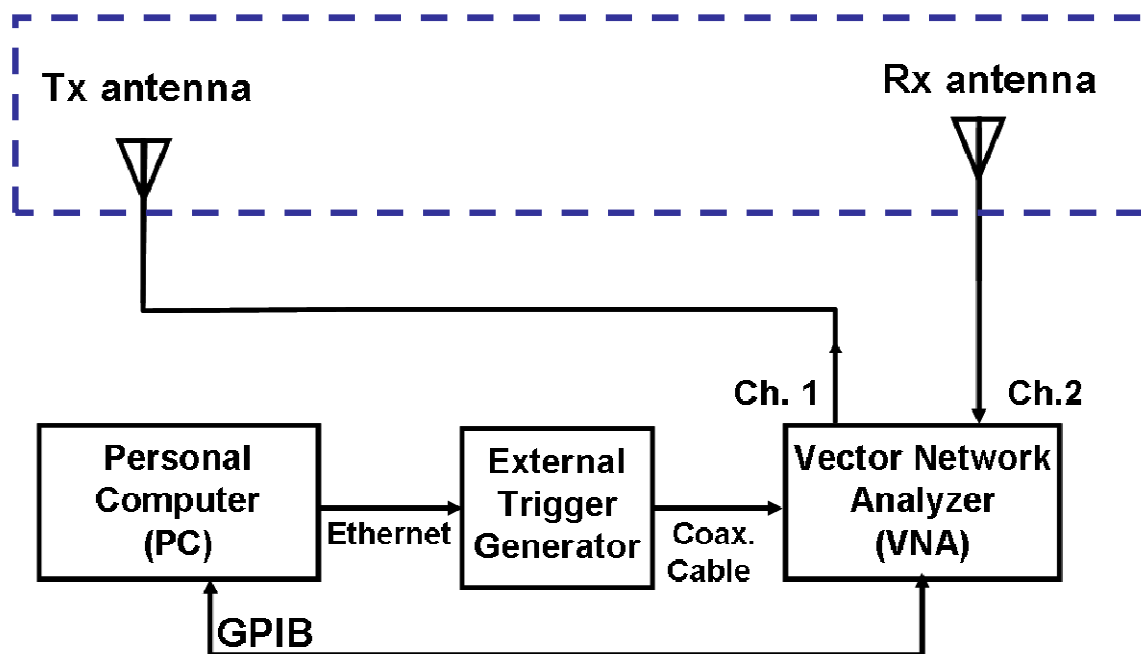
Observation results (4)

Effect of body postures

- The patterns in front of body are not varied so much
- Variations on rear and sides are may be caused by body and hand shadowings

Observation of Fading Channels with Holder

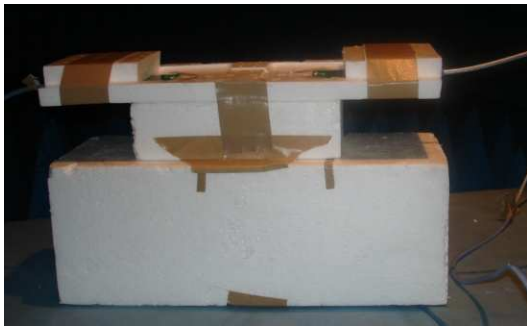
Measurement campaign



- Introduce the use of two-antenna holder to fix the Tx-Rx arrangements.
- Benefits
 - Antenna position is not changed due to the body motion and cable weight
 - The antennas can be kept in the same arrangement even in the case of changing the measurement in free space to multiple objects

Observation of Fading Channels with Holder

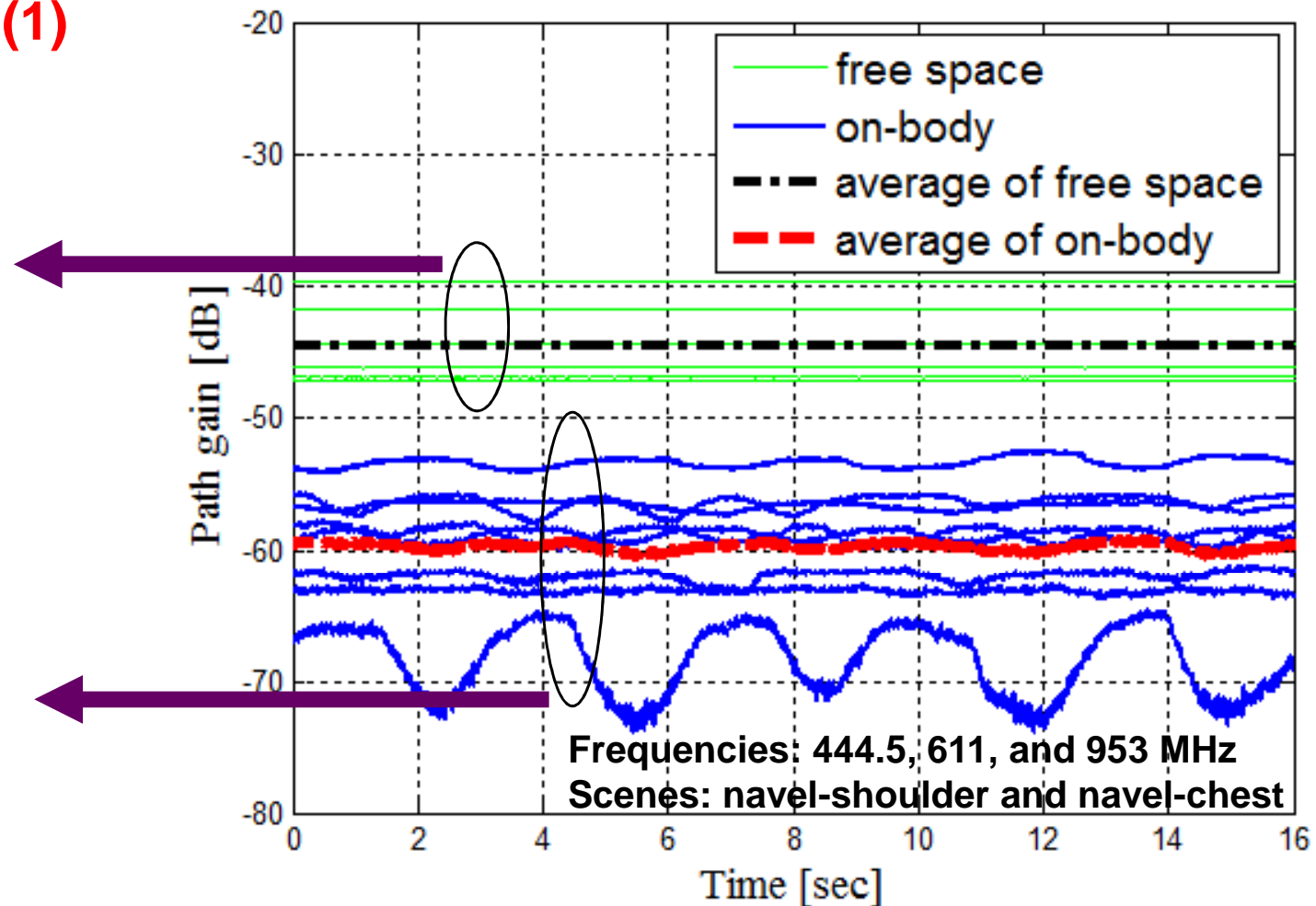
Observation results (1)



In free space

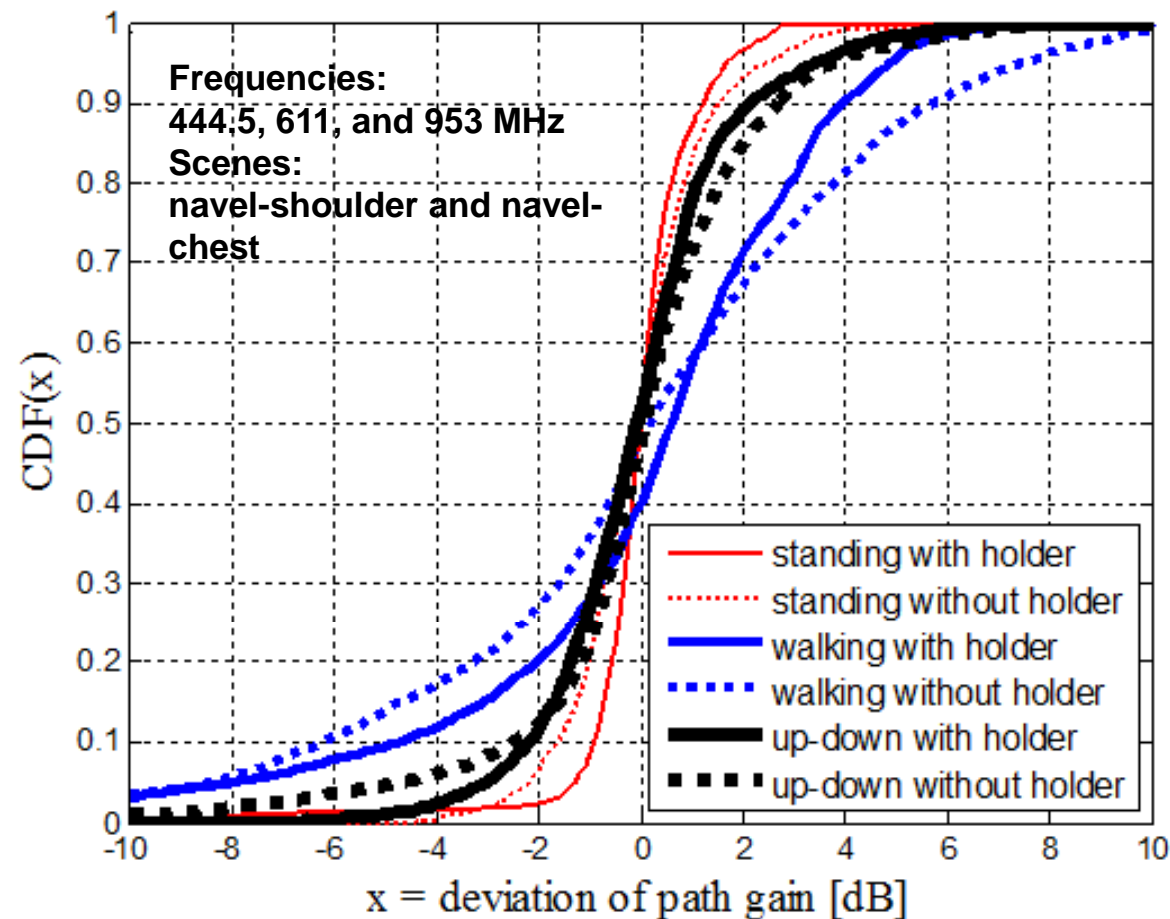


On-body



- Effect of body can be studied in fixed arrangement with two antennas holder
- On-body channels have temporal fluctuation due to minor body movements, such as breathing, heart beat, etc.

Observation of Fading Channels with Holder



Observation results (2)

- Comparison of channel fading with and without holder can be presented
- The use of holder can reduce or remove the fading due to antenna reorientation and cable movement during the motion of body
- The arrangement can be used in future studies to
 - Characterize the effect of antenna re-orientation
 - Formulate more precise distance dependent path-loss

Standard deviation ⇒	with holder (dB)	without holder (dB)
Body postures		
Standing still	1.3049	1.4168
Walking on the spot	3.9779	4.9142
Standing-up sitting down	1.9179	2.7506

Conclusions

- Two physical mechanisms which influence the on-body channel have been observed.
 - **On-body antenna patterns in both tangential and normal to body surface.**

The tangential patterns give closer approach to real situation especially in medical health-care.

- **Fading channel with holder**

The results show that it can remove the effect of antenna re-orientation during the dynamic channel measurement.

This mechanism gives a great advantage for further studies on BAN channel modeling.

Thanks for your attentions

References

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