[Intra-cluster response model and parameter for channel modeling at 60GHz (Part 2)]

Date: 2009-11-19

Authors:

Name	Affiliations	Address	Phone	email
Hirokazu Sawada	Tohoku University	2-1-1 Katahira, Aoba-ku, Sendai 980-8577, JAPAN	+81-22-217-6112	sawahiro@riec.tohoku.ac.jp
Shuzo Kato	NICT/ Tohoku University	3-4, Hikarino-Oka, Yokosuka, Kanagawa 239-0847 Japan		shu.kato@nict.go.jp
Katsuyoshi Sato	NICT	3-4, Hikarino-Oka, Yokosuka, Kanagawa 239-0847 Japan		satox@nict.go.jp

Abstract

- This document updates proposed intra-cluster channel models for TGad channel modeling
- On top of channel modeling presented in the last meeting in Hawaii which focused on Living room, Vertical polarization, LOS environments with variable HPBW antenna, this paper shows the rest for TGad channel modeling - intra-cluster channel modeling :

  1. Environments: extended to conference room,

  2. Polarization: extended to circular and horizontal from vertical polarization,

  3. Antenna HPBW: extended to 5, 15, 30, 60, 90 degrees,

  4. LOS: extended to NLOS in Living room.

- By integrating the extracted intra-cluster parameters from the measured data shown in this paper and the inter-cluster channel modeling given by ref (Doc.09/334r4), the channel models for “conference room and living room environments” will be completed.

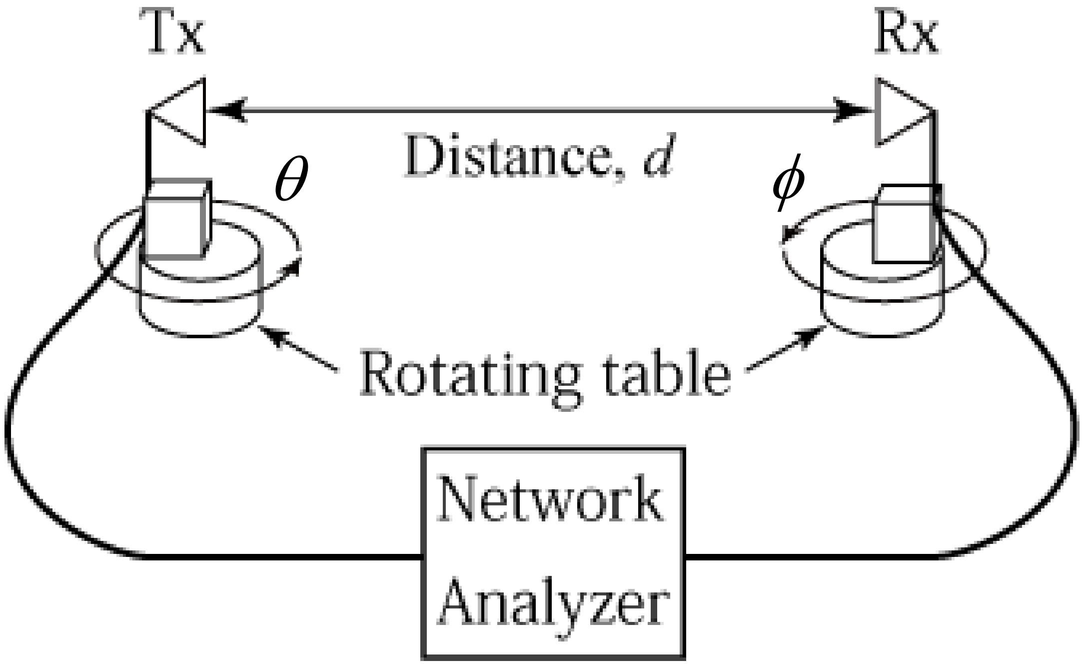
Progress of intra-cluster channel modeling

Environments	LOS/NLOS	Polarization	Antenna HPBW [deg]				
Conference	LOS	V	5	15	30	60	90
		H	5	15	30	60	90
		C	5	15	30	60	90
	NLOS	V	5	15	30	60	90
		H	5	15	30	60	90
		C	5	15	30	60	90
Living	LOS	V	5	15	30	60	90
		H	5	15	30	60	90
		C	5	15	30	60	90
	NLOS	V:	5	15	30	60	90
		H	5	15	30	60	90
		C	5	15	30	60	90
Cubicle	LOS	V	5	15	30	60	90
		H	5	15	30	60	90
		C	5	15	30	60	90
	NLOS	V	5	15	30	60	90
		H	5	15	30	60	90
		C	5	15	30	60	90

Working status

Previous work Doc 09/721r1 Doc 09/874r1 Doc 09/936r1
This contribution

Measurement system



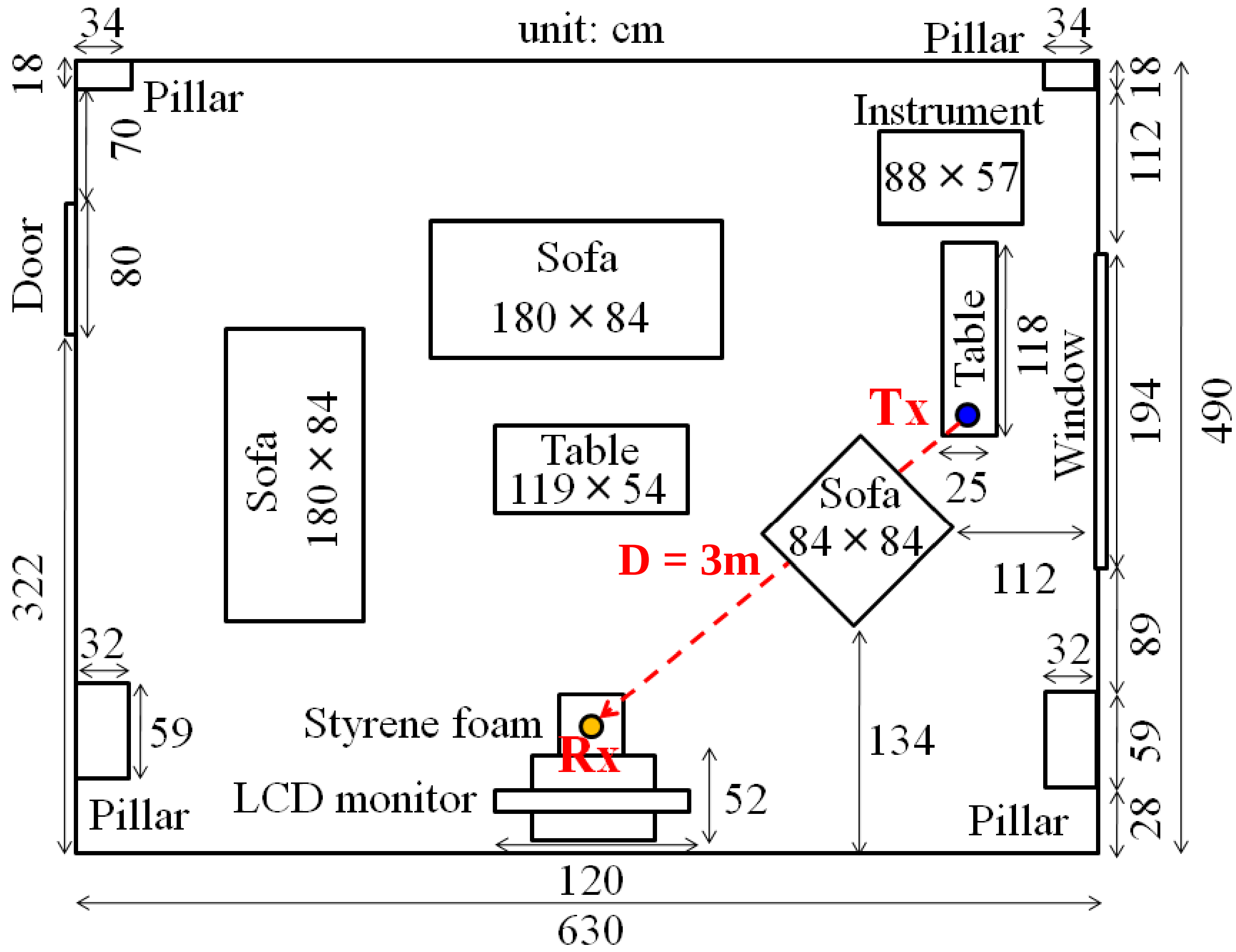
- Instrument: Vector network analyzer
- Antenna: Conical horn antenna

Measurement set up in living room

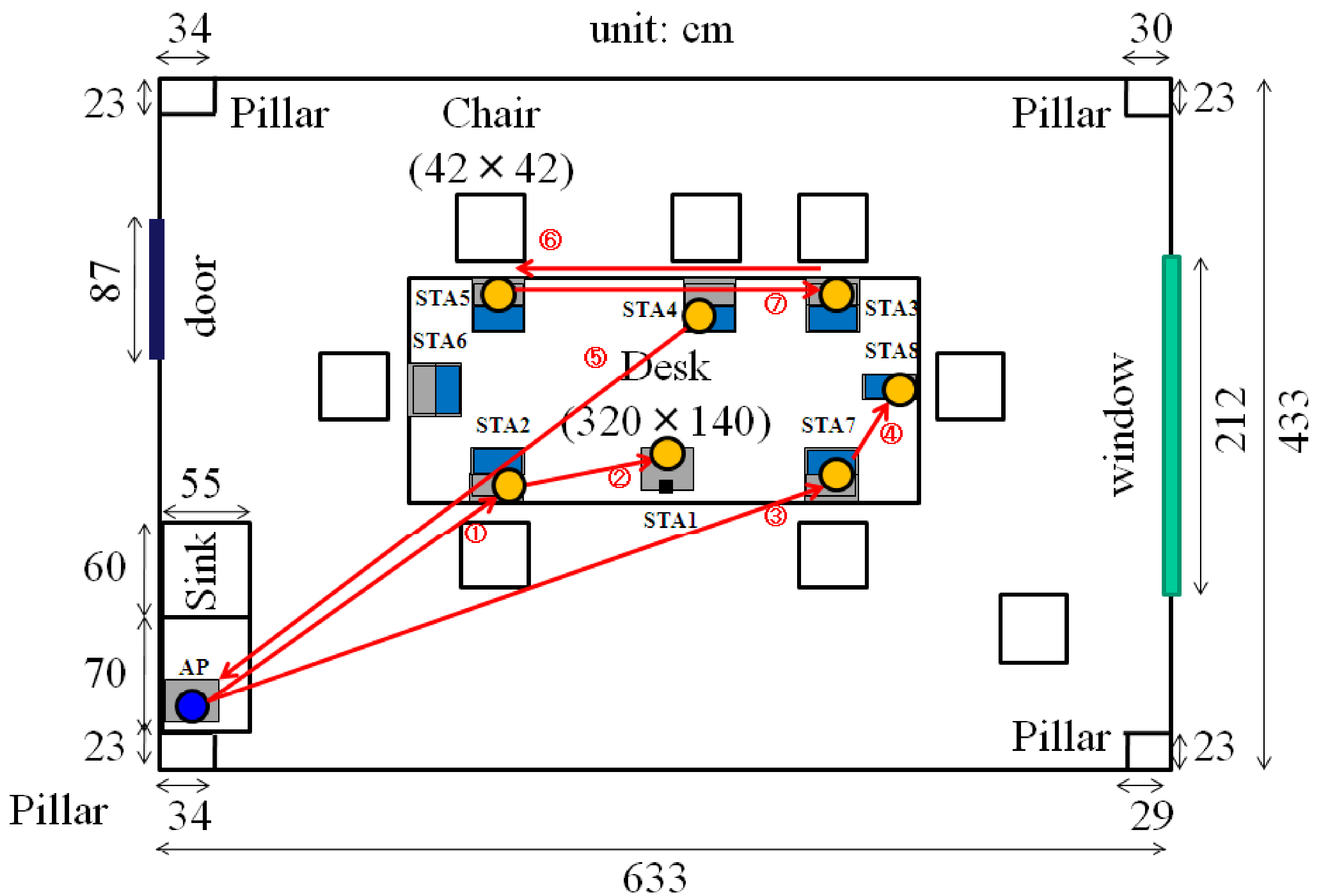
Parameter	Value
Center frequency	62.5 GHz
Band width	3 GHz
Number of frequency points	801
Frequency step	3.75 MHz
HPBW of antenna (Gain)	5, 15, 30, 60, 90 degree
Polarization	Vertical, Horizontal, Circular
Calibration	Direct port connection without antennas

Living room environment ‘defined by TGad’

Antenna height:
1.5m (LoS scenario)
1.0 m (NLoS scenario)



Conference room environment “defined by TGad”

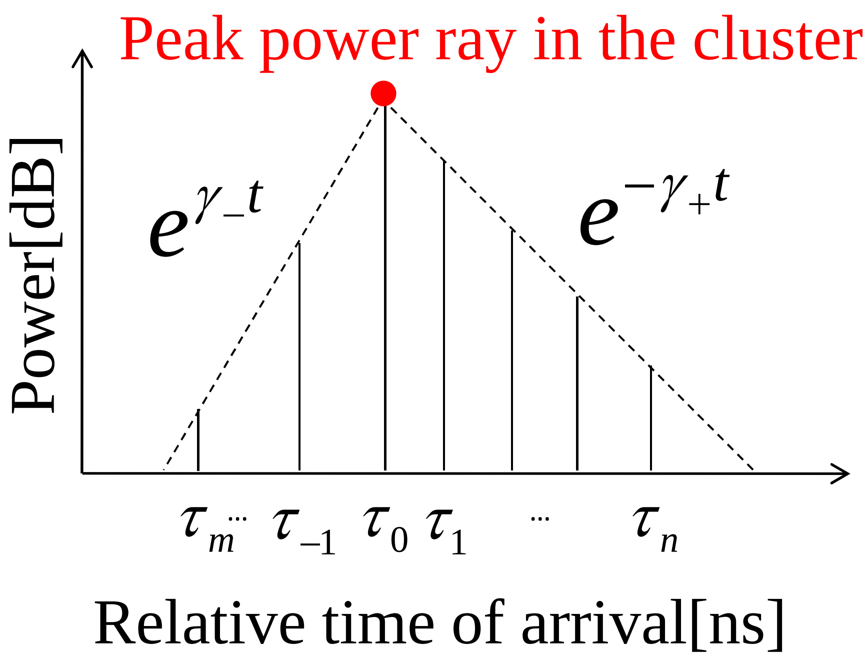


Proposed intra-cluster channel model

- **Two-side exponential decay model**

-Ray decay parameter, γ_- and γ_+

-Ray arrival rate, λ_- and λ_+ are assumed as Poisson process



$$h(t) = \sum_m^n \beta_i(\tau_i)$$

$$\left|\beta_i^2(\tau_i)\right| = \begin{cases} e^{\gamma_- t} & t < 0 \\ e^{-\gamma_+ t} & t \geq 0 \end{cases}$$

$$P(\tau_{k-1}|\tau_k) = \lambda_- e^{-\lambda_-(\tau_k - \tau_{k-1})}, k < 0$$

$$P(\tau_k|\tau_{k-1}) = \lambda_+ e^{-\lambda_+(\tau_k - \tau_{k-1})}, k > 0$$

where k denotes the number of rays

Intra cluster parameters for living room (LoS)

Environment	Pol.	HPBW	γ_- [ns]	γ_+ [ns]	$1/\lambda_-$ [ns]	$1/\lambda_+$ [ns]
LoS Living Room	V	5	N/A	N/A	N/A	N/A
		15	4.76	N/A	0.902	N/A
		30	0.652	1.29	1.79	1.11
		60	0.469	0.510	0.466	0.616
		90	0.795	0.672	1.26	0.690
	H	5	8.63	N/A	0.240	N/A
		15	2.52	9.89	1.63	0.228
		30	0.645	1.03	3.63	0.699
		60	0.543	0.773	0.720	0.842
		90	0.474	0.537	0.790	0.494
	C	5	4.72	6.07	0.557	2.31
		15	4.38	0.993	0.541	1.44
		30	0.623	0.854	4.88	0.968
		60	0.427	0.491	0.691	0.733
		90	0.485	0.546	0.573	0.541

- γ_-, γ_+ are inversely proportional to HPBW ※N/A:Non-cluster

Intra cluster parameters for living room (NLoS)

Environment	Pol.	HPBW	γ_- [ns]	γ_+ [ns]	$1/\lambda_-$ [ns]	$1/\lambda_+$ [ns]
NLoS Living Room	V	5	4.84	7.69	0.541	1.21
		15	2.48	1.11	0.633	1.57
		30	0.981	2.64	1.46	0.949
		60	1.45	0.626	0.834	0.573
		90	1.47	0.623	0.730	0.542
	H	5	7.94	3.57	3.41	0.541
		15	3.30	1.06	0.633	1.26
		30	2.66	2.14	0.424	0.984
		60	0.855	0.596	0.580	0.738
		90	0.722	0.732	0.828	0.851
	C	5	7.18	4.13	0.361	0.832
		15	2.78	2.55	0.633	0.627
		30	0.891	1.78	0.722	1.28
		60	0.884	0.625	1.21	0.655
		90	0.867	0.670	1.43	0.706

Intra cluster parameters for conference room (LoS)

Environment	Pol.	HPBW	γ_- [ns]	γ_+ [ns]	$1/\lambda_-$ [ns]	$1/\lambda_+$ [ns]
LoS Conference	V	5	N/A	N/A	N/A	N/A
		15	2.39	N/A	0.615	N/A
		30	0.613	4.11	1.65	1.35
		60	N/A	N/A	N/A	N/A
		90	N/A	N/A	N/A	N/A
	H	5	N/A	9.91	N/A	2.99
		15	1.68	N/A	2.99	N/A
		30	0.510	0.779	2.70	1.92
		60	N/A	N/A	N/A	N/A
		90	N/A	N/A	N/A	N/A
	C	5	N/A	2.75	N/A	0.739
		15	0.682	0.632	1.28	0.924
		30	0.569	0.831	2.02	1.73
		60	N/A	N/A	N/A	N/A
		90	N/A	N/A	N/A	N/A

※N/A: Reflection waves are as low as noise level

Intra cluster parameter for conference room (NLoS)

Environment	Pol.	HPBW	γ_- [ns]	γ_+ [ns]	$1/\lambda_-$ [ns]	$1/\lambda_+$ [ns]
NLoS Conference	V	5	13.1	0.891	0.341	1.75
		15	2.39	1.31	0.615	0.841
		30	0.795	0.693	1.25	0.271
		60	N/A	N/A	N/A	N/A
		90	N/A	N/A	N/A	N/A
	H	5	N/A	0.788	N/A	0.642
		15	1.68	0.896	2.99	1.68
		30	0.798	0.853	2.44	1.82
		60	N/A	N/A	N/A	N/A
		90	N/A	N/A	N/A	N/A
	C	5	N/A	1.00	N/A	1.23
		15	0.686	0.640	1.18	1.26
		30	0.967	0.567	0.861	1.77
		60	N/A	N/A	N/A	N/A
		90	N/A	N/A	N/A	N/A

※N/A: Reflection waves are as low as noise level

Summary

- Proposed channel model was updated with variable HPBW antenna in living and conference room environments for TGad channel modeling
- By integrating the intra-cluster(Doc.09/334r4) and presented intra-cluster models, the channel models for “conference room and living room environments” will be completed

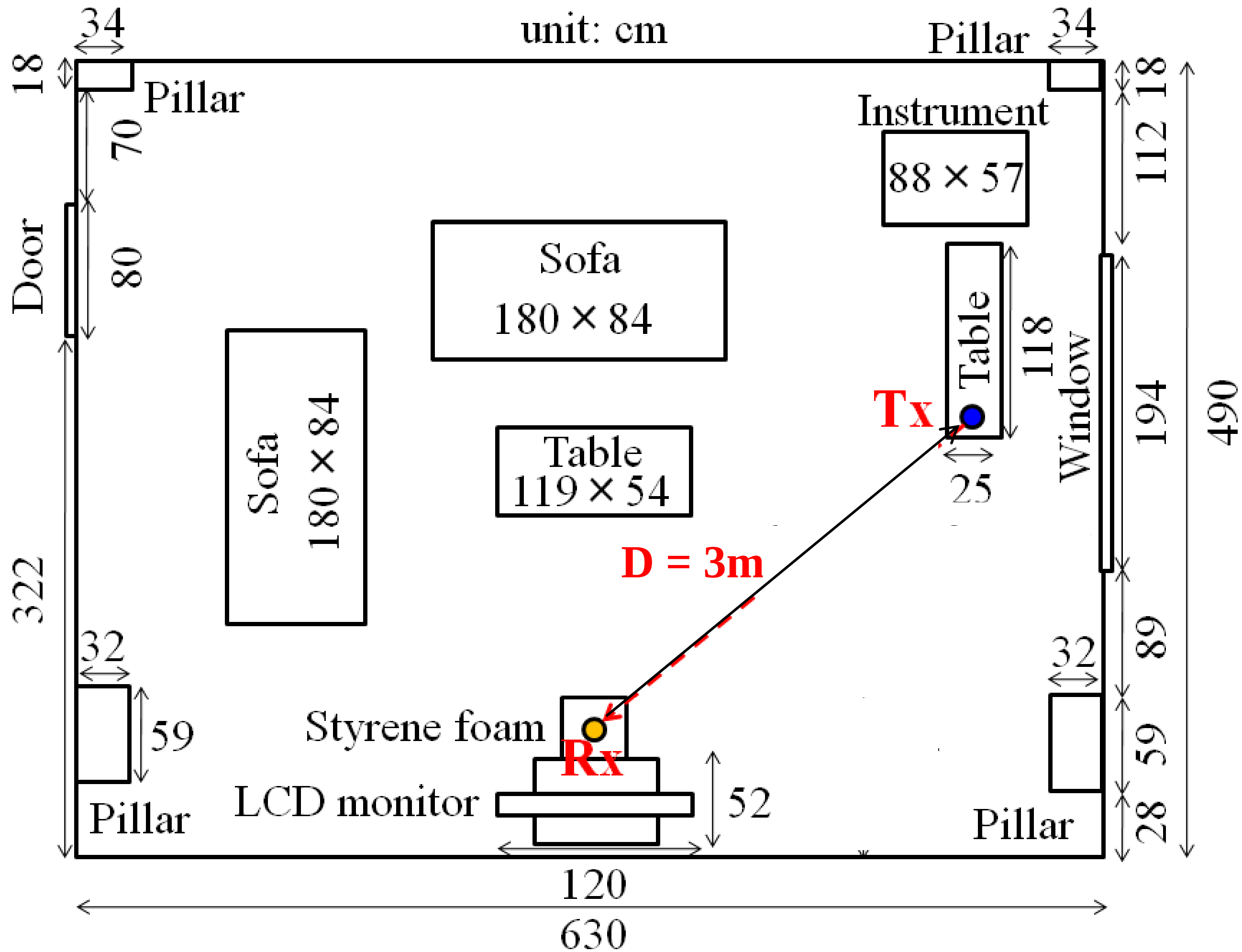
Investigation for human mobility (blockage) and reflection

Two preliminary measurement results are introduced for human mobility

- Fading by human mobility (blockage)
- Reflection by human body

Human mobility fading measurement in living room

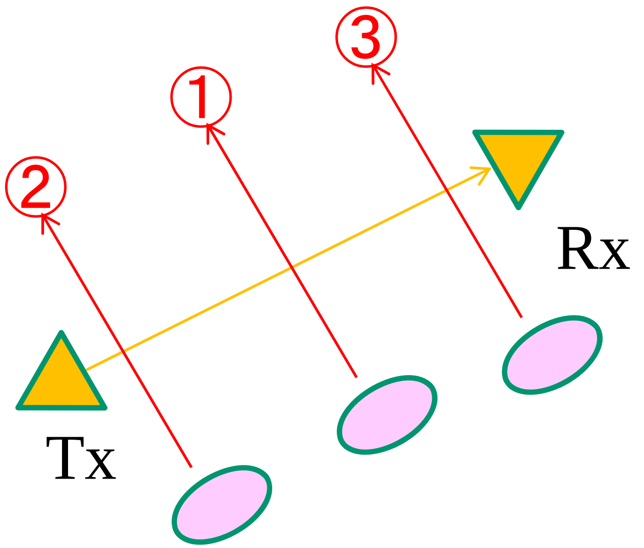
Antenna height: 1.0 m

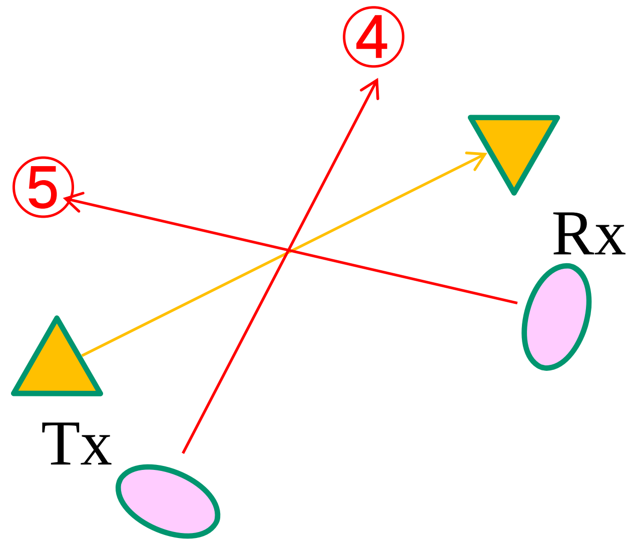


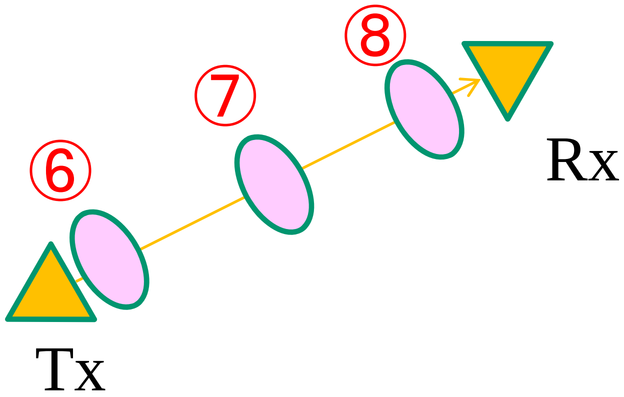
Measurement set up in living room

Parameter	Value
Frequency (CW)	62.5 GHz
HPBW of antenna (Gain)	30 degree
Polarization	Vertical
Calibration	Direct port connection without antennas

Patterns of human moving/still positions

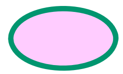




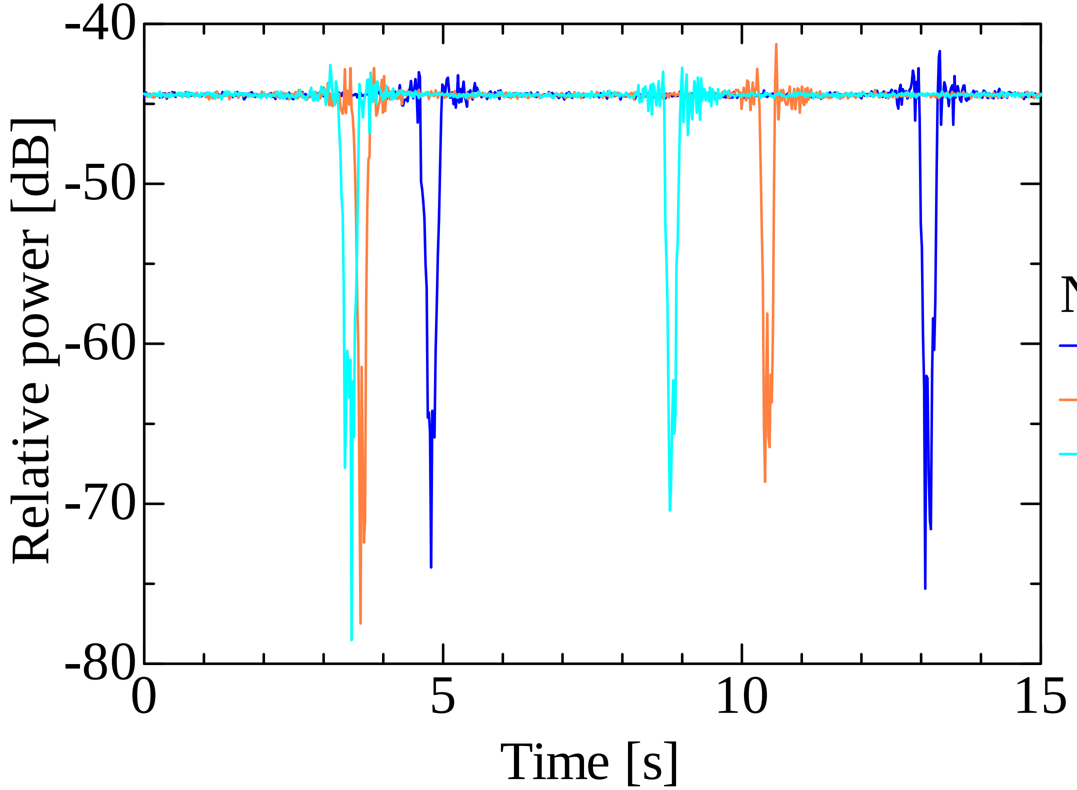


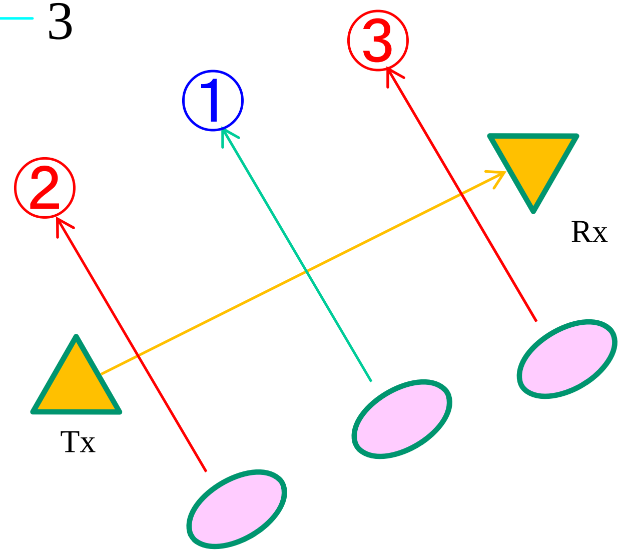
Route :①～⑤

Human Speed: Walking

 : Human body

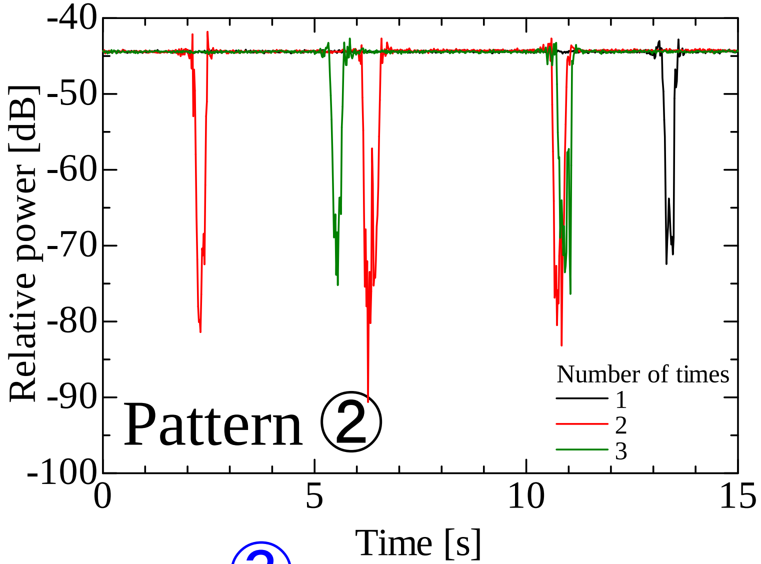
Measurement result (Pattern1)

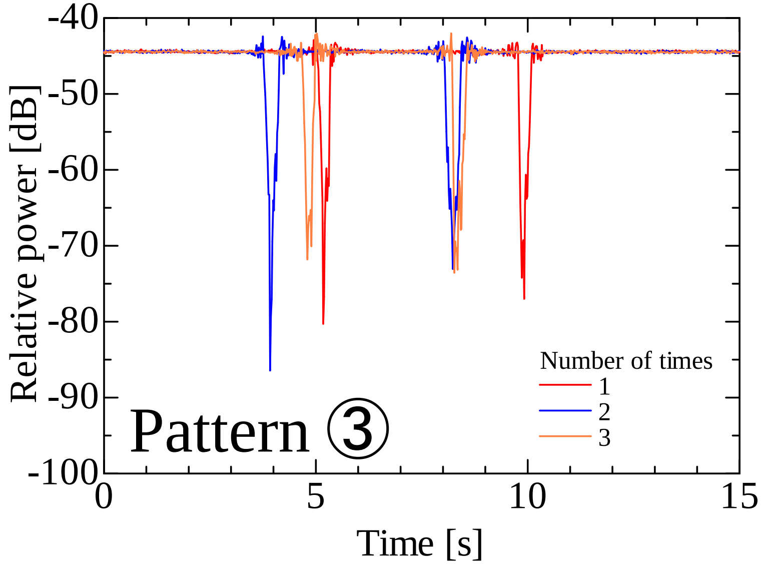


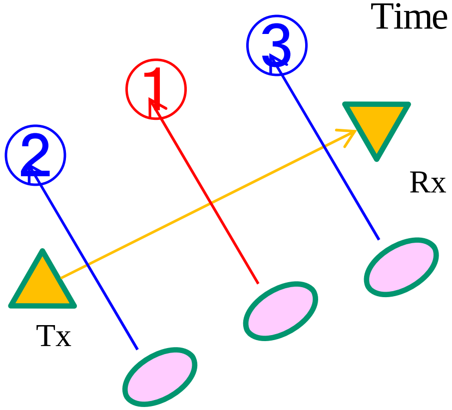


- Fading duration < 0.3s
- Max. attenuation: 30dB

Measurement result (Pattern 2 and 3)



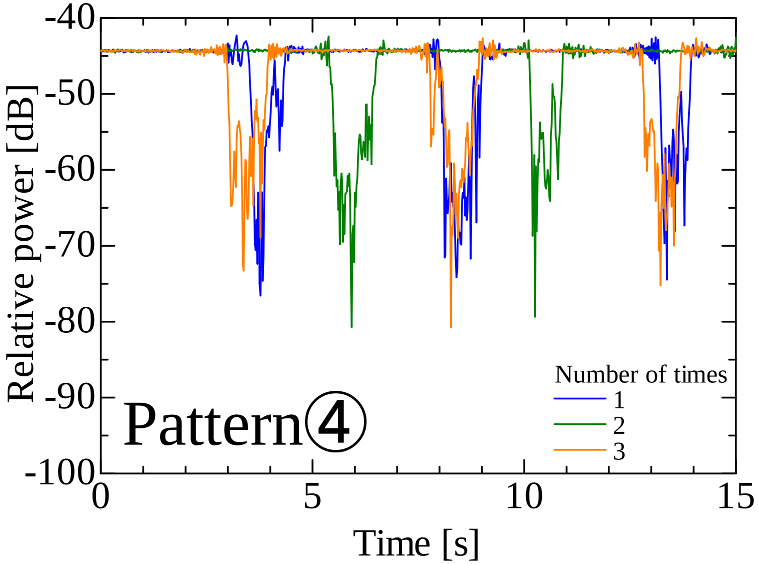


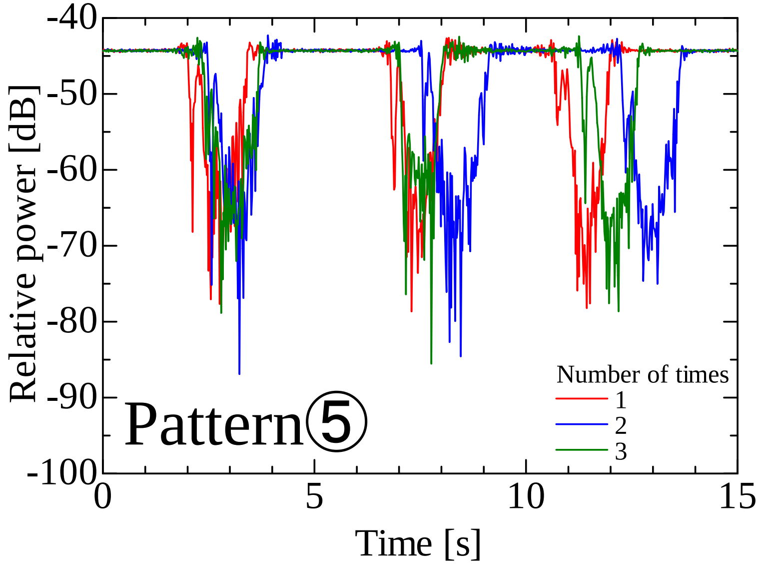


- Fading duration:0.3s
- Max. attenuation: 35dB
  5 dB larger than pattern 1

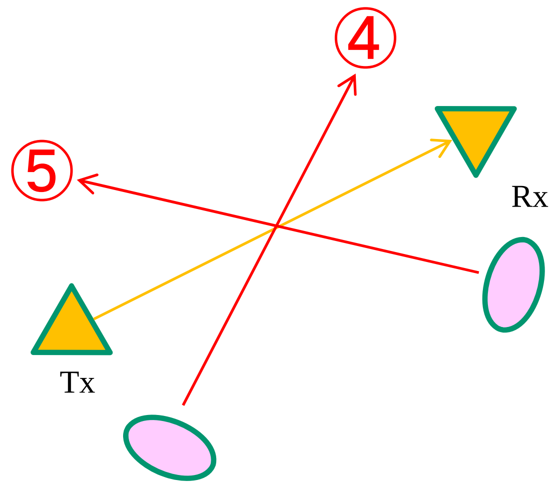
- Fading duration and depth depends on a blocking position between Tx and Rx

Measurement result (Pattern 4 and 5)

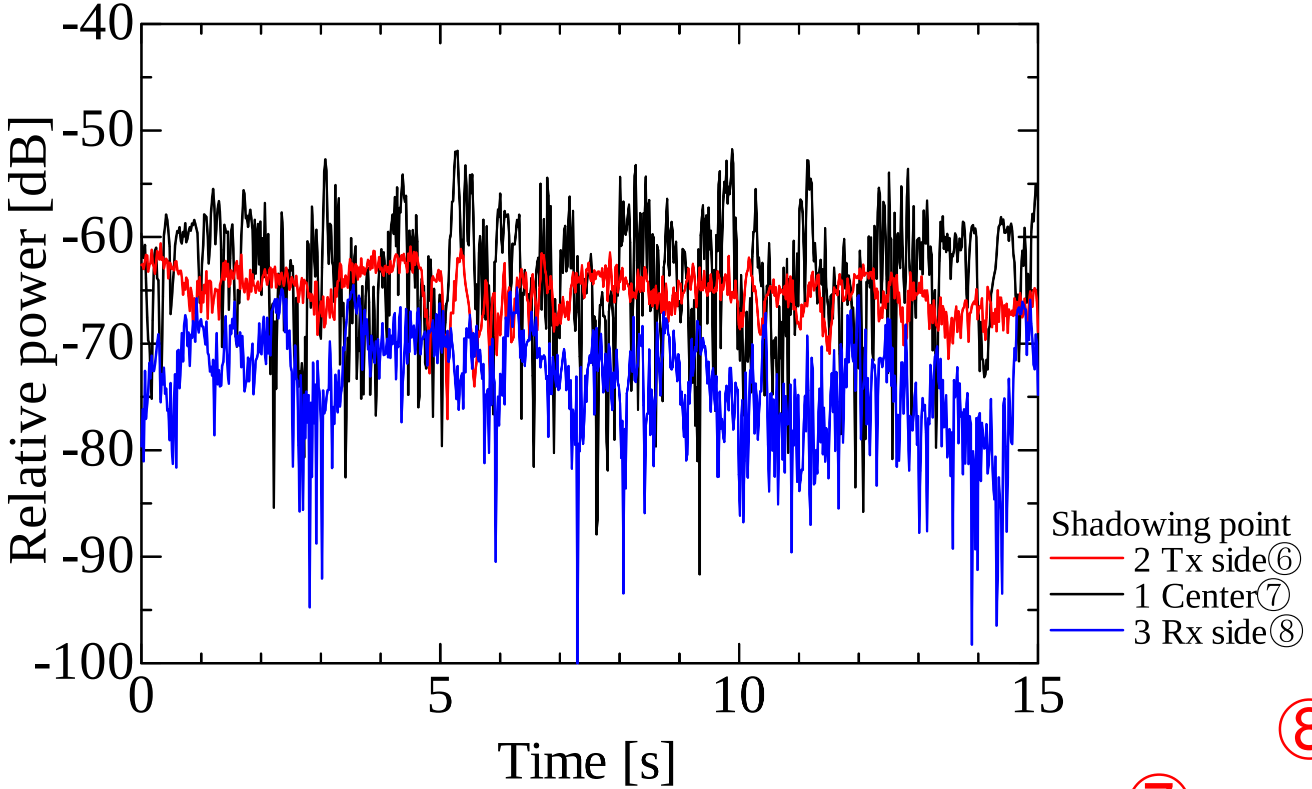




- Fading duration: 1.3～1.7s
- Max. attenuation: 35dB

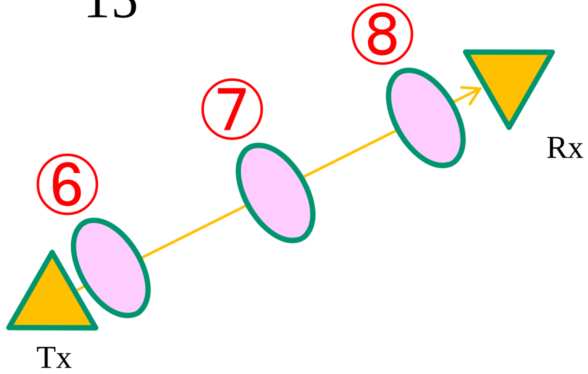


Measurement result (Pateren 6, 7 and 8)



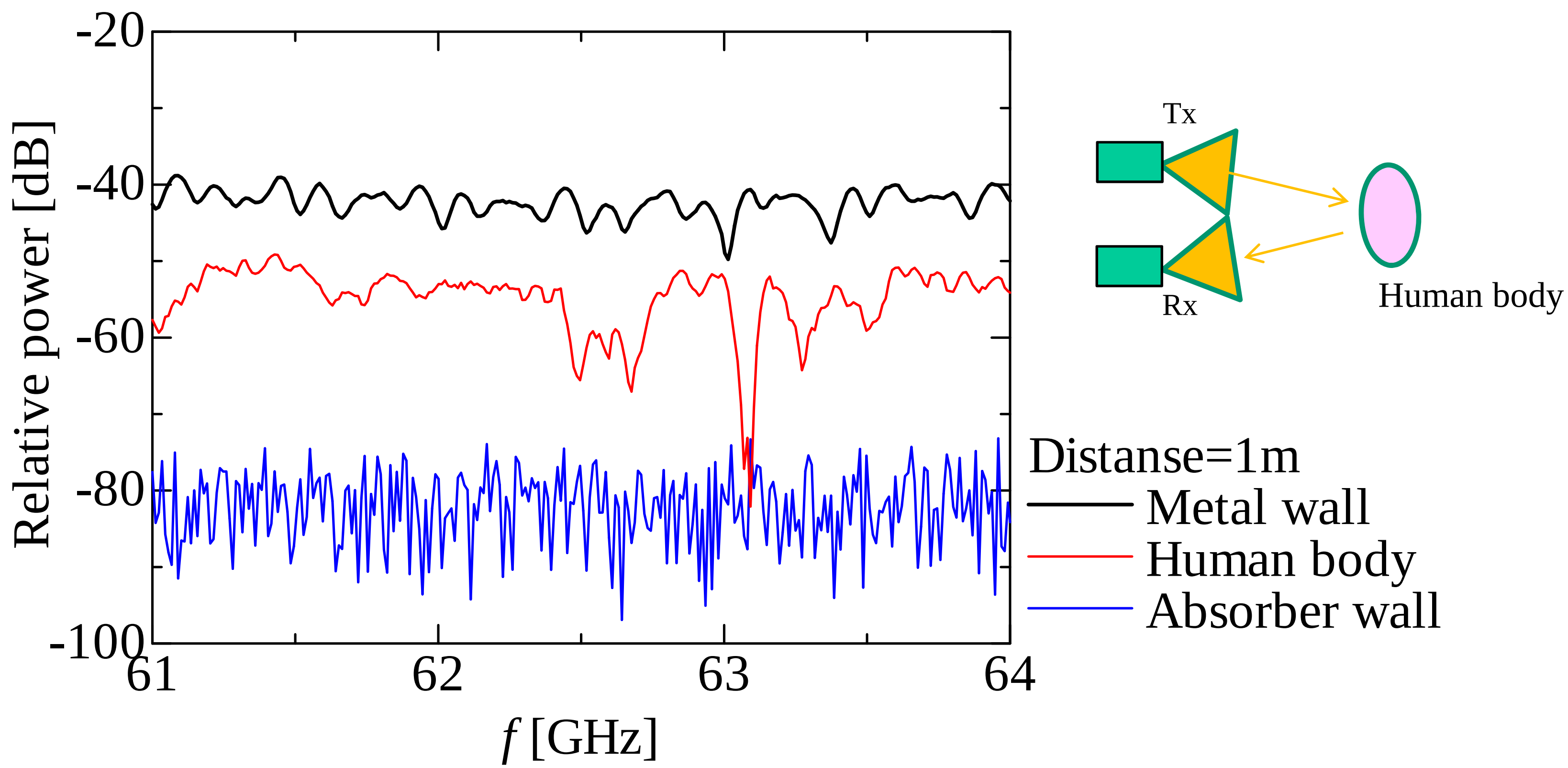
- Attenuation depends on position
- Attenuation difference is 9.7dB

Position	Rx side	Tx side	Center
Average attenuation	73.5 dB	65.2 dB	63.8 dB



Reflection measurement of human body

Reflection power in frequency domain



- Human body make reflection wave, not only absorption effect
- Reflection level became 10dB smaller than metal wall

Summary of human mobility fading and human reflection measurements

- Duration, decay and rising time modeling will be required for MAC design for beam switching timing

- Reflection waves from human body may have an impact on propagation characteristics, however, how to model is a future work