Field Test Results of Space-Time Equalizers and Delayed Diversity Transmission in Central Tokyo Area

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- Background
- Space-Time (ST) equalizers
  and delayed diversity transmission (DDT)
- Field test system
- Test locations and propagation environments
- Bit error rate performances
  - ST equalizers
  - ST equalizer + DDT

Background (1/2)

- Proposed ST equalizer at base:

  for combating inter-symbol interference (ISI) in high data-rate TDMA systems,

  - array suppresses excessive long-delayed paths,
  - MLSE obtains path diversity from short-delayed paths,

  for wide delay spread in macro-cell.

- Use of delay diversity transmission (DDT) at mobile:

  for increasing delay spread for path diversity in MLSE,

  for flat fading / small delay spread in micro-cell.

Background (2/2)

- Previous field test:

  for wide delay spread in suburban macro-cell environment (*VTC2001-Fall*),

  - ST equalizer provided ST diversity gain,
  - DDT was not useful.

- This work:

  for urban micro- and macro-cell environments in central Tokyo,

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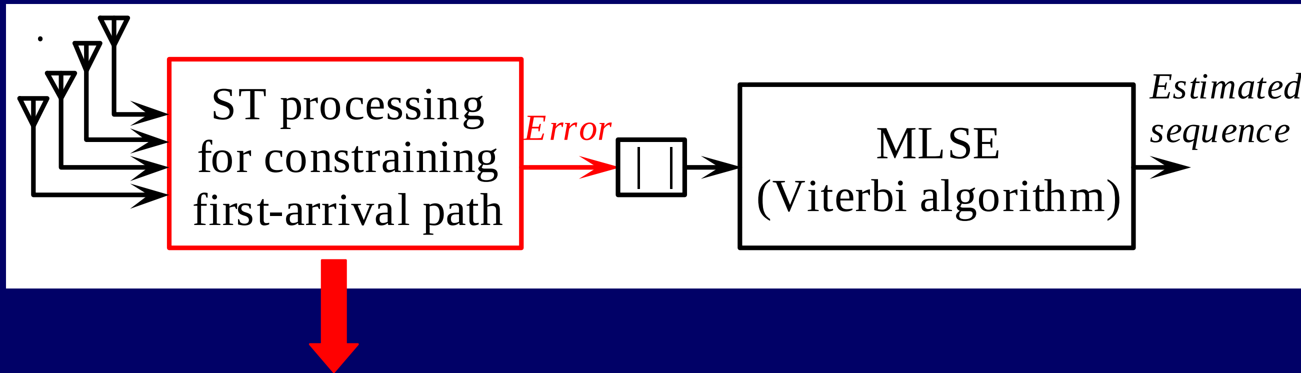
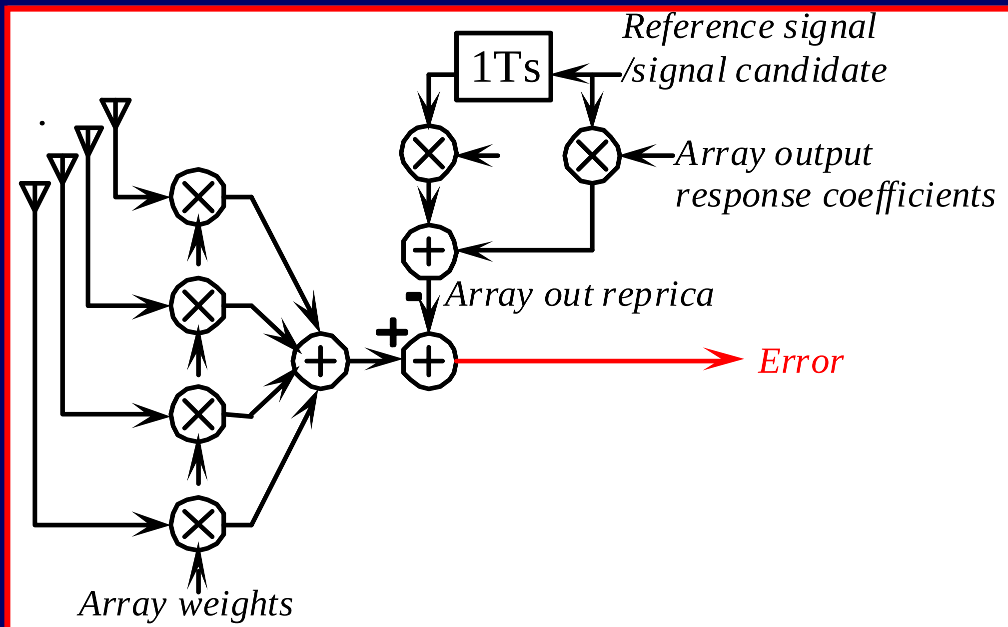
Tested ST Equalizers (1/2)

- ST equalizer I (conventional)

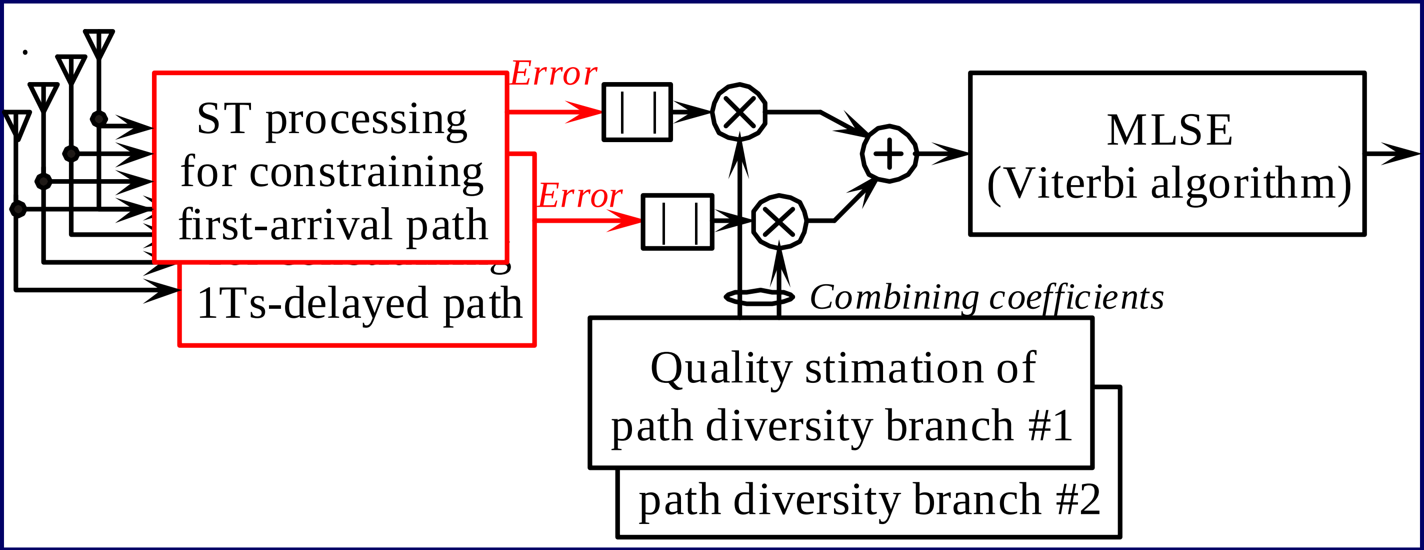




ST processing

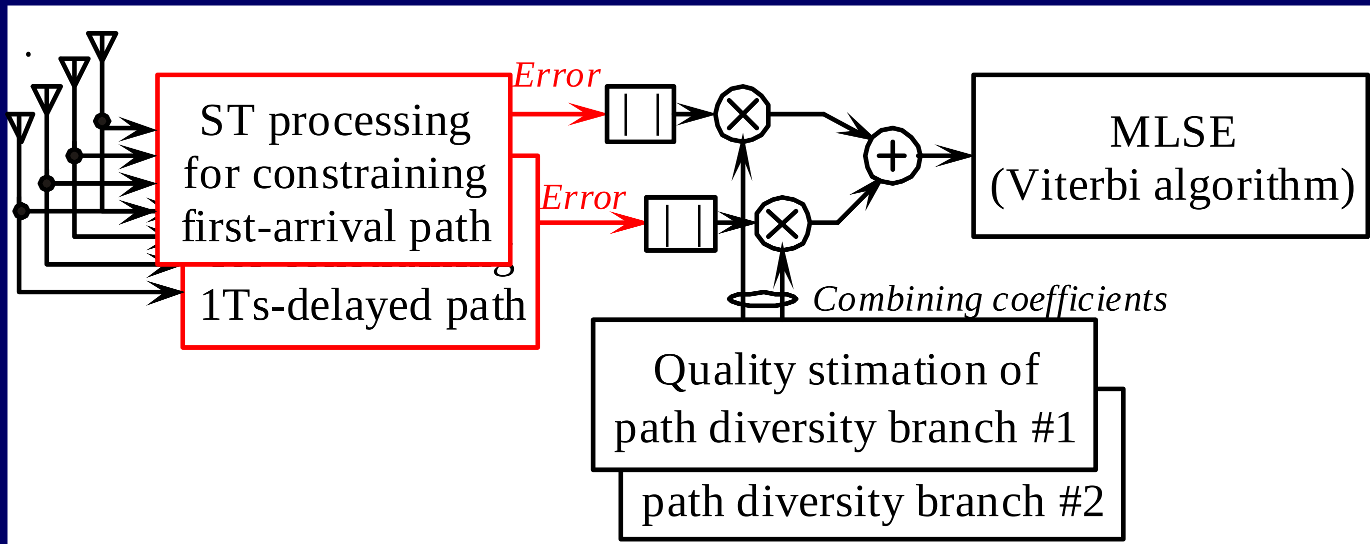
Tested ST Equalizers (2/2)

- ST equalizer II (proposed)

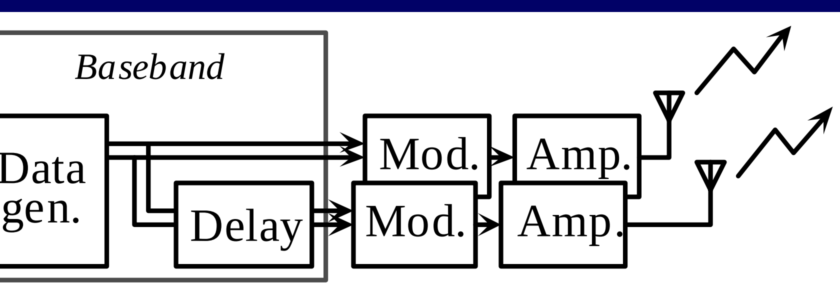


DDT at Mobile for ST Equalizer at base

- For flat fading and small delay spread condition.
- Increased delay spread provide path diversity in MLSE.
- Array processors suppress excessive long delayed paths.



ST equalizer at base



DDT at mobile

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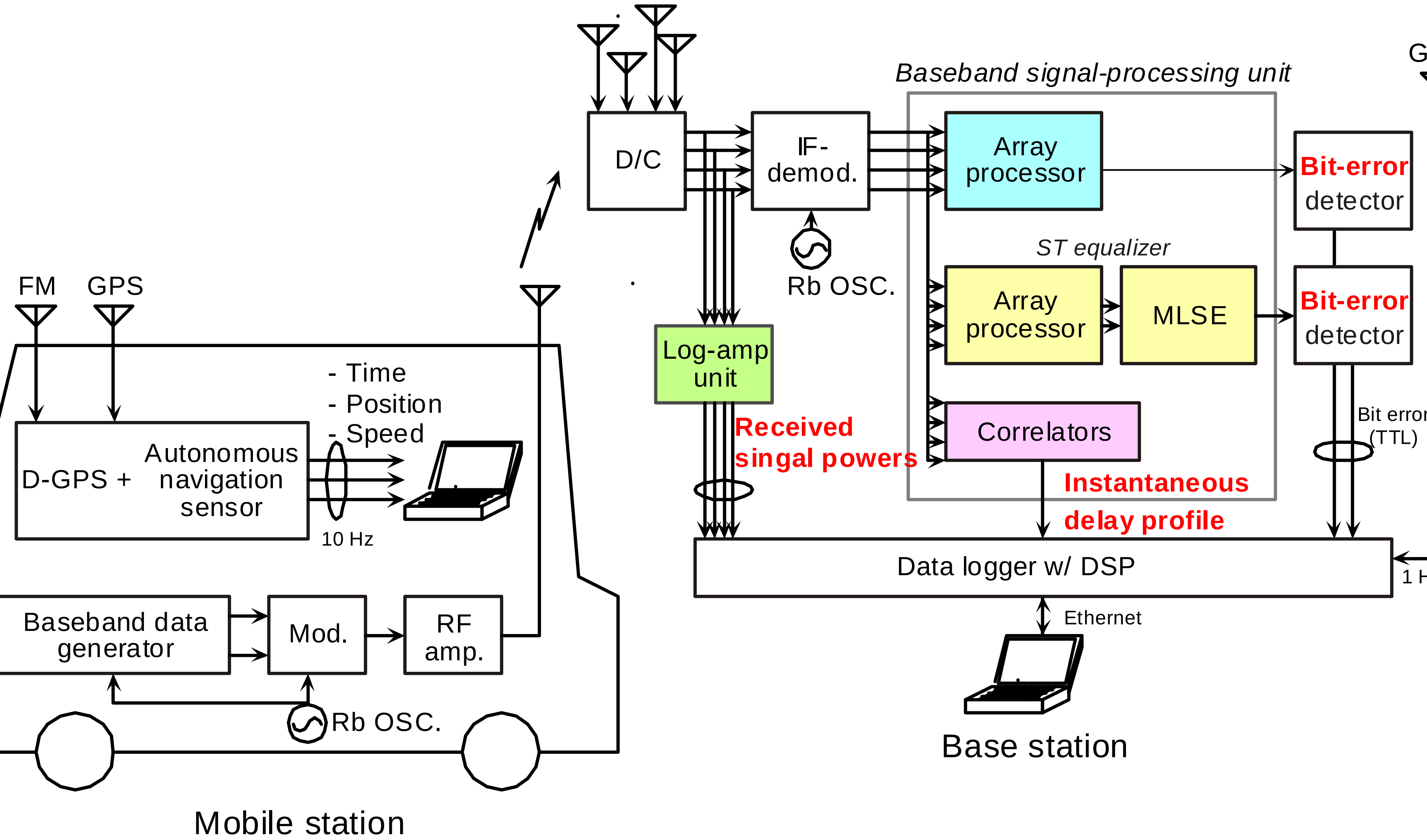
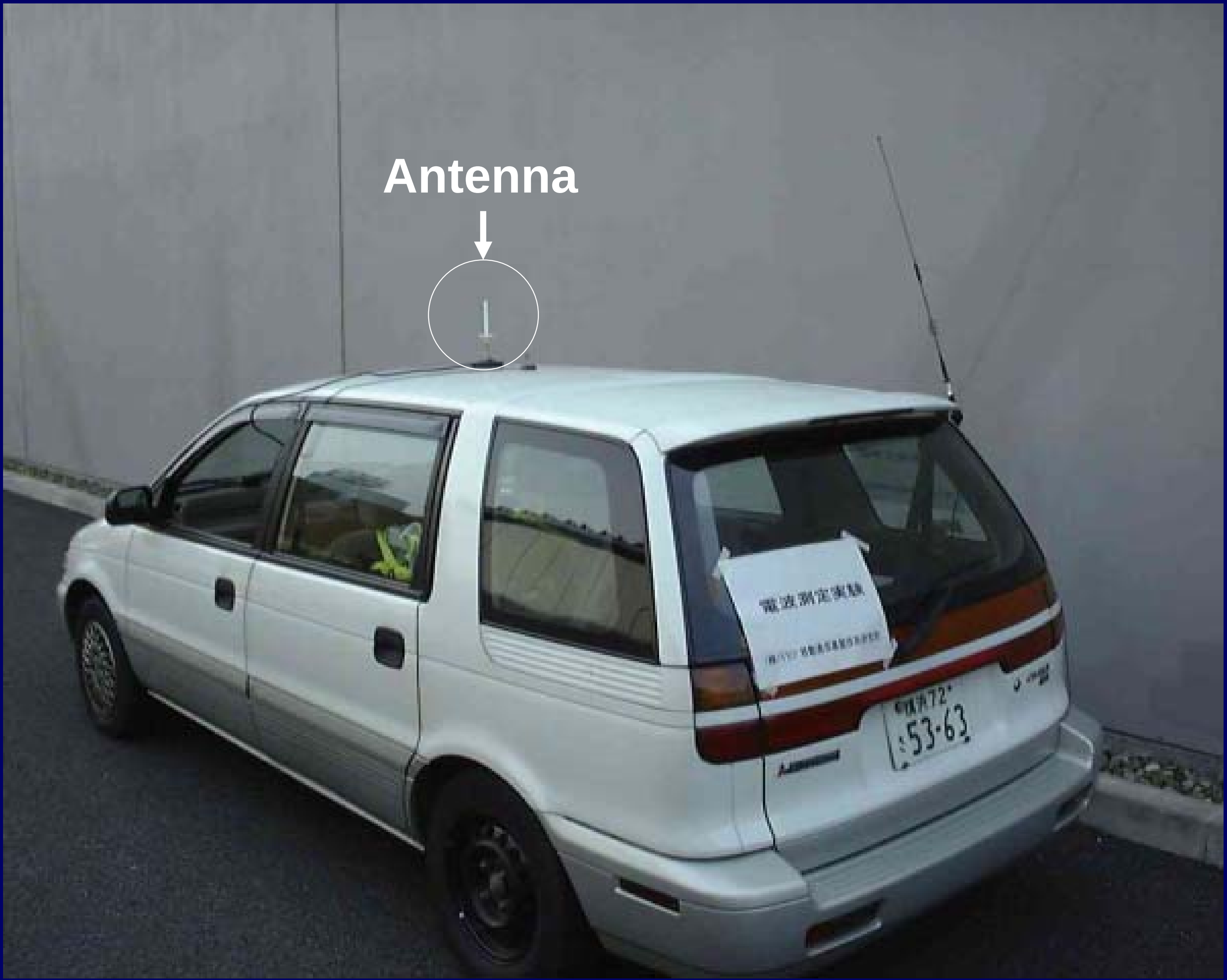
Field Test Specifications

Radio frequency	3.35 GHz
Modulation	QPSK
Transmission rate	4.096 Mb/s
TDM frame format	Training/data : 48/ 208 symbols (32 symbols for correlation)
Tx antenna	- Colinear dipole (5.5 dBi) - 5/15λ antenna-spacing for two-branch DDT
Rx array antenna	Four-dipole circular array (8λ spacing)
MMSE for array	Sample matrix inversion (SMI) algorithm
MLSE	Viterbi algorithm, - Four states (1Ts-spaced two taps) - 10 symbols path memory

Field Test System



Tx Antenna at Mobile



Two Antennas for DDT at Mobile

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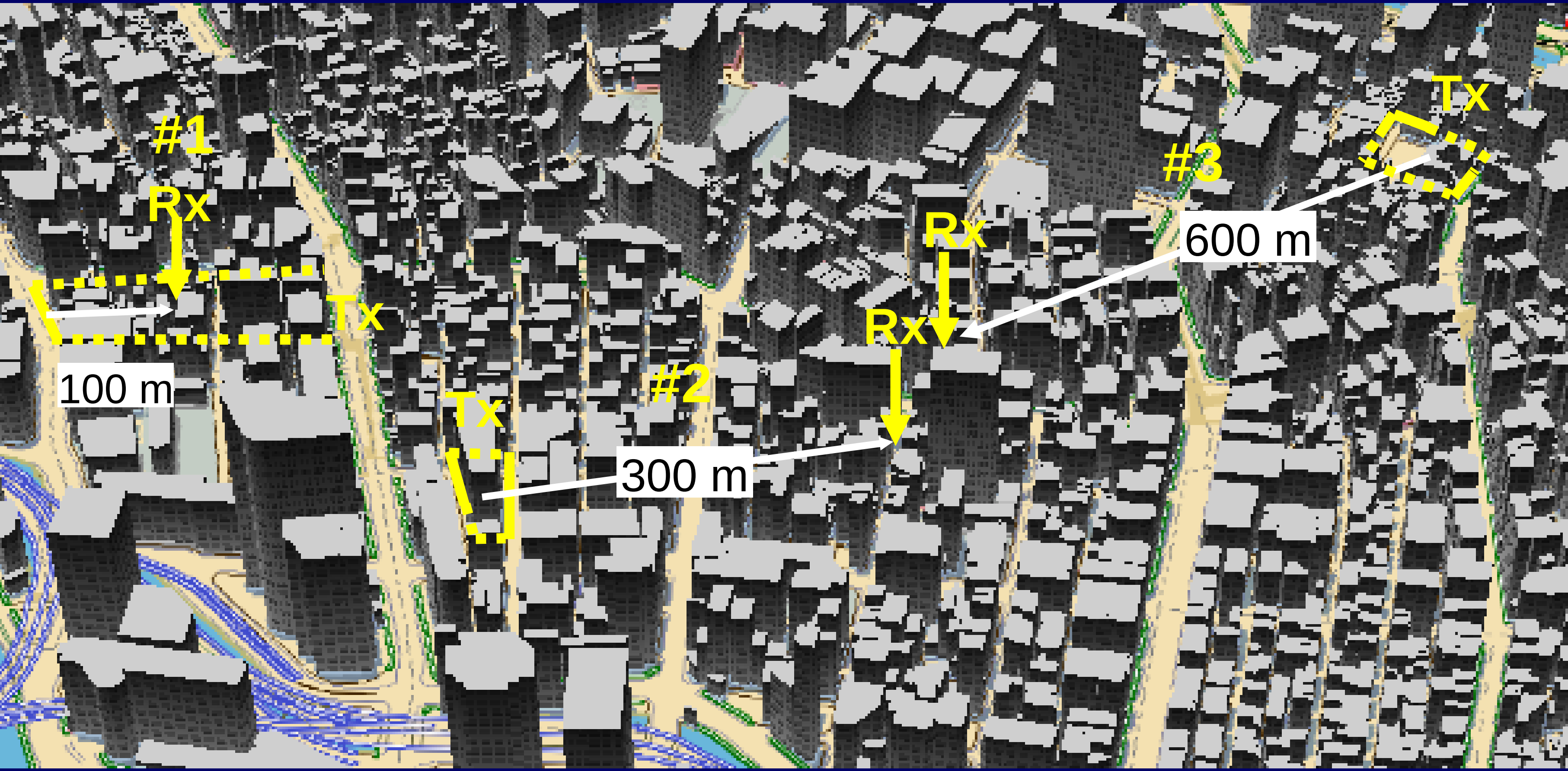
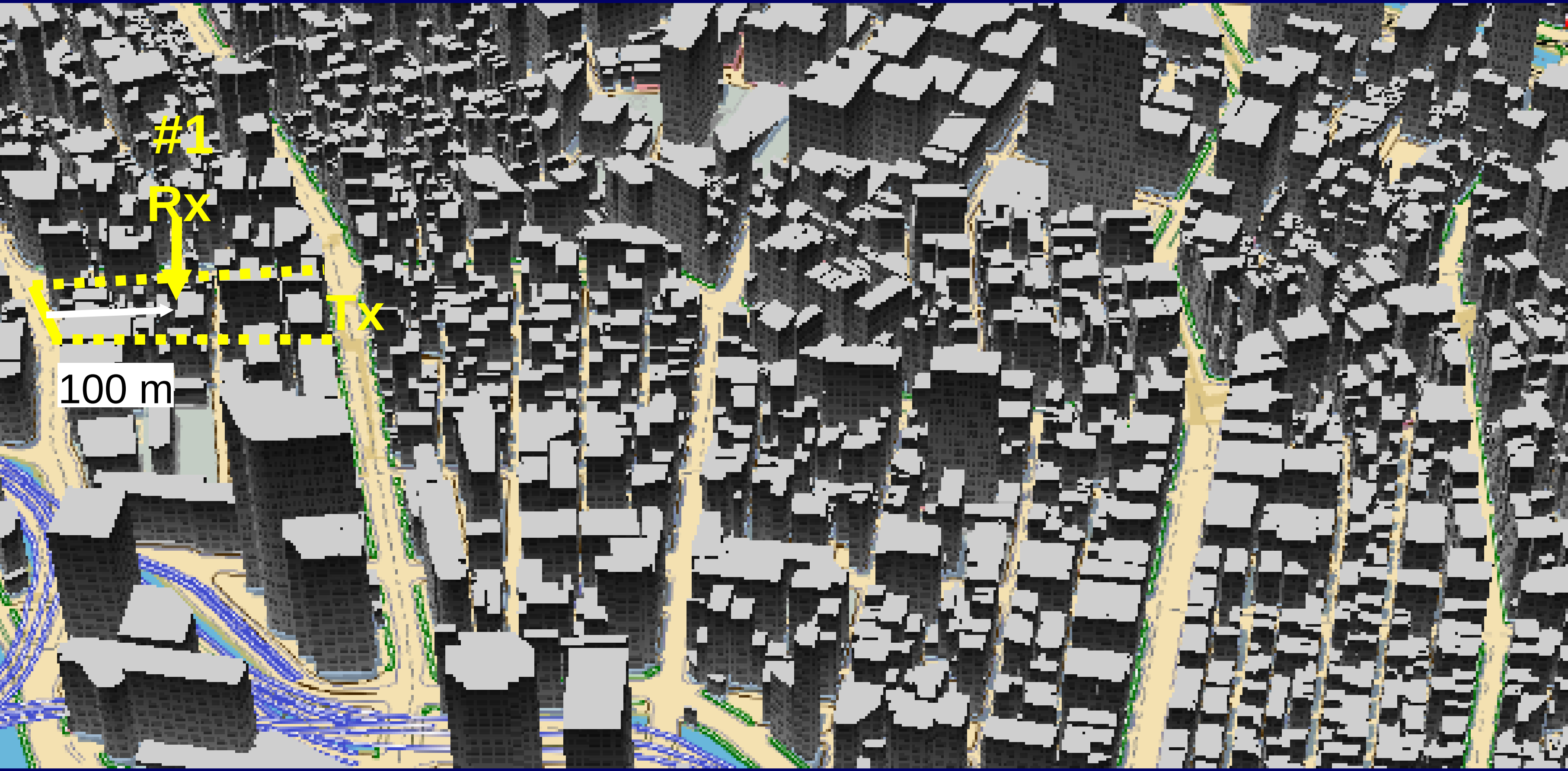
Test Location #1, #2, and #3



Jinbo-chou Kanda Chiyoda-ku, Tokyo

Test Location #1, #2, and #3



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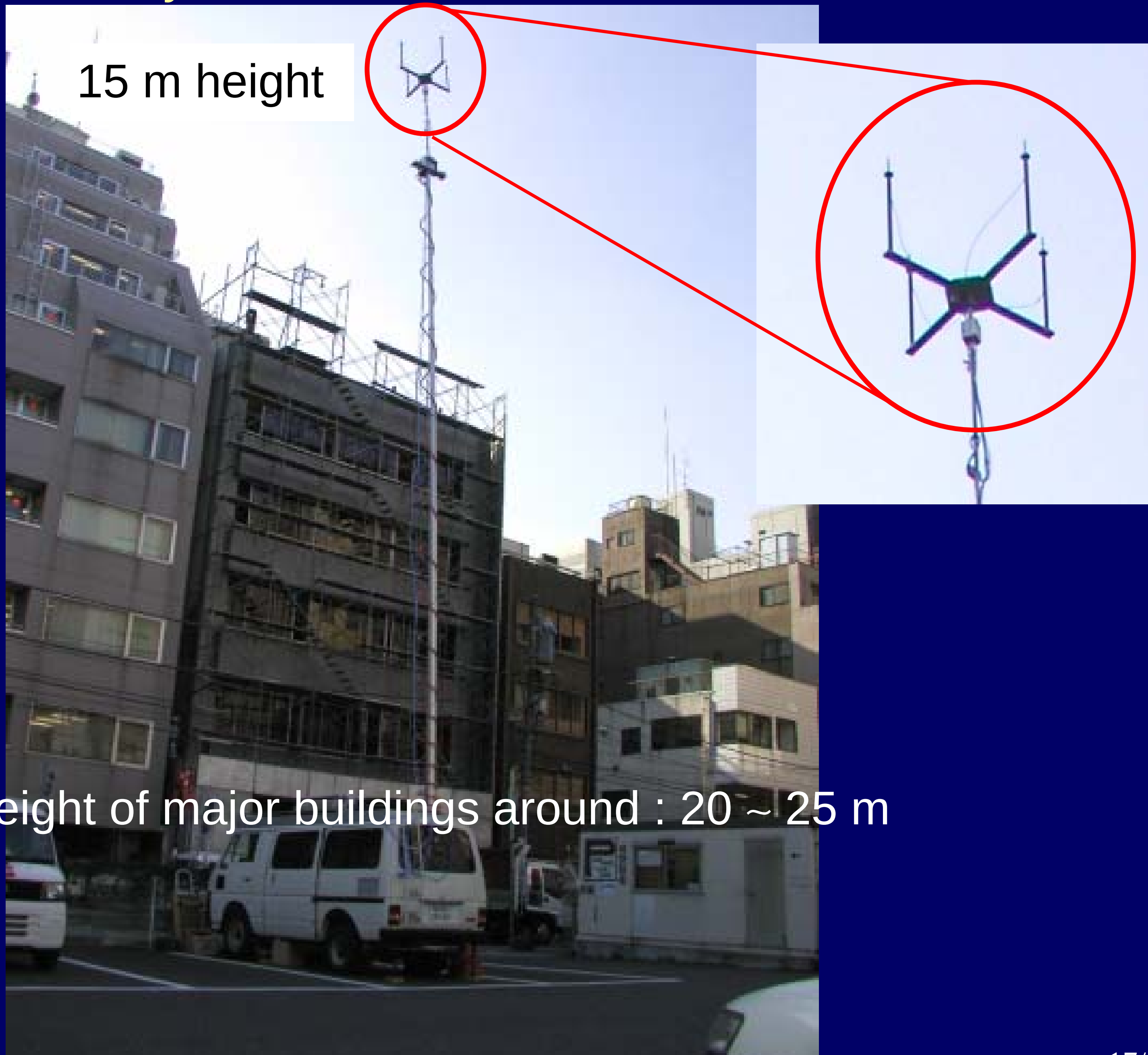
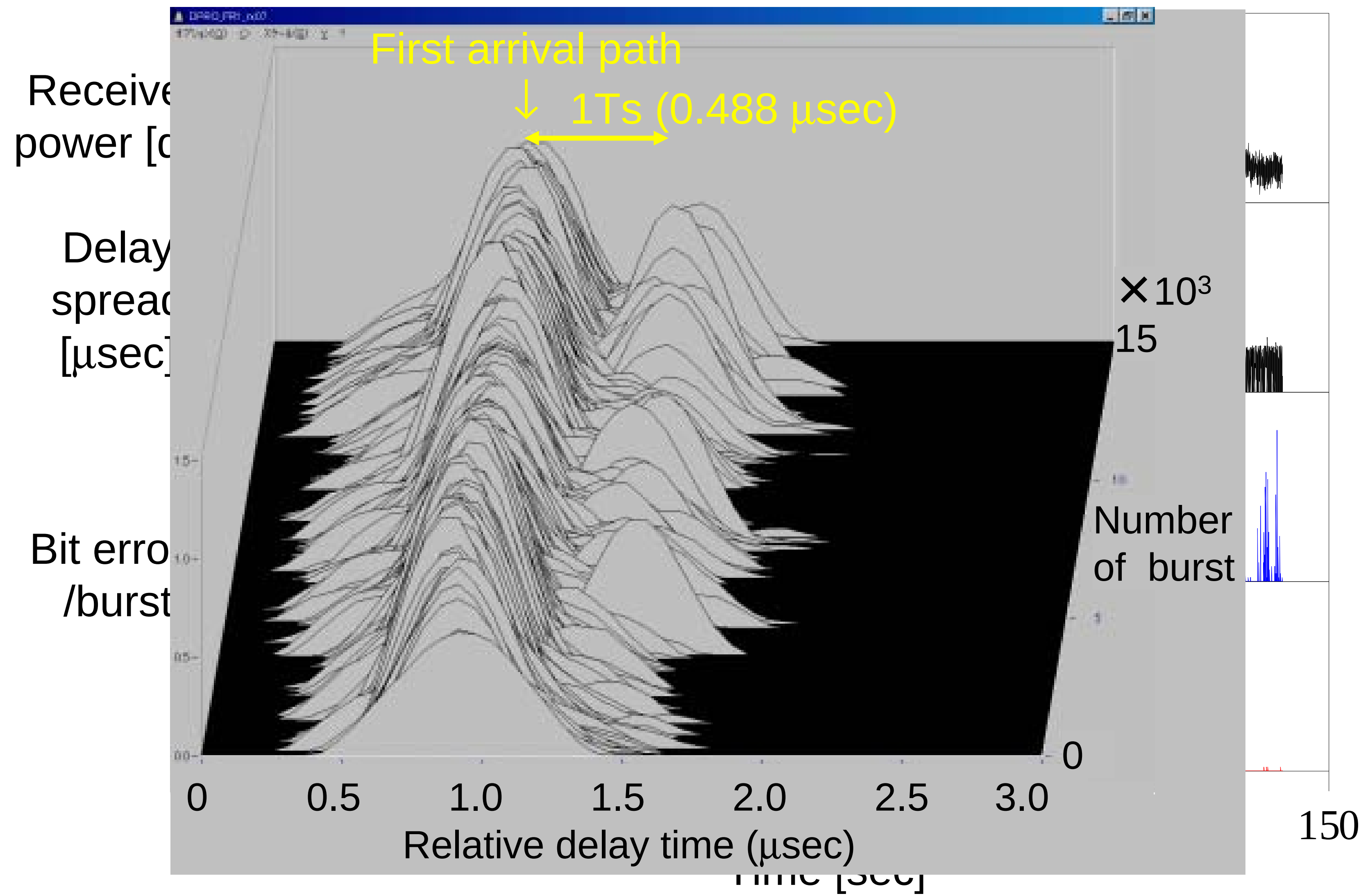
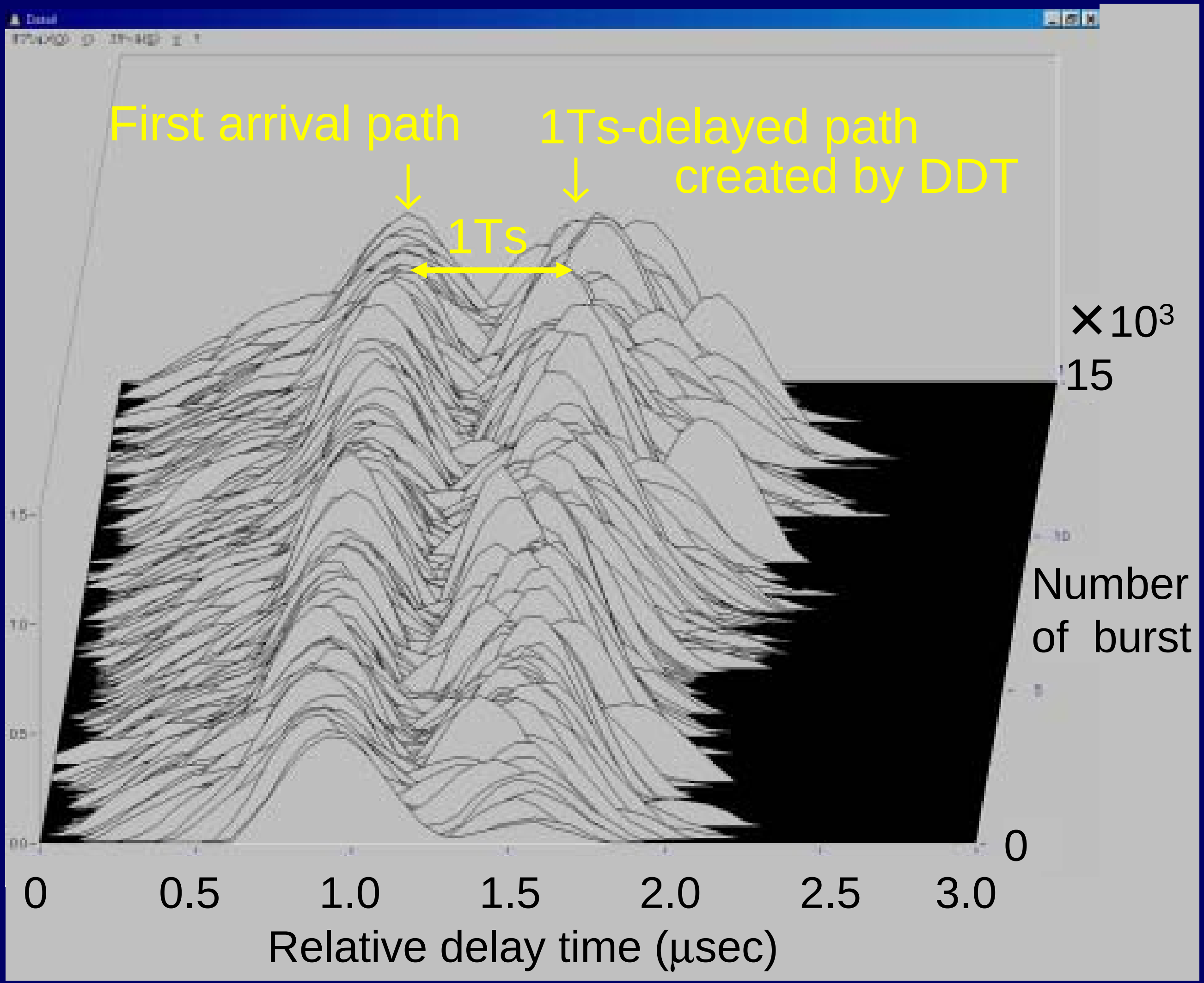
Rx Array Antenna at Test Location #1



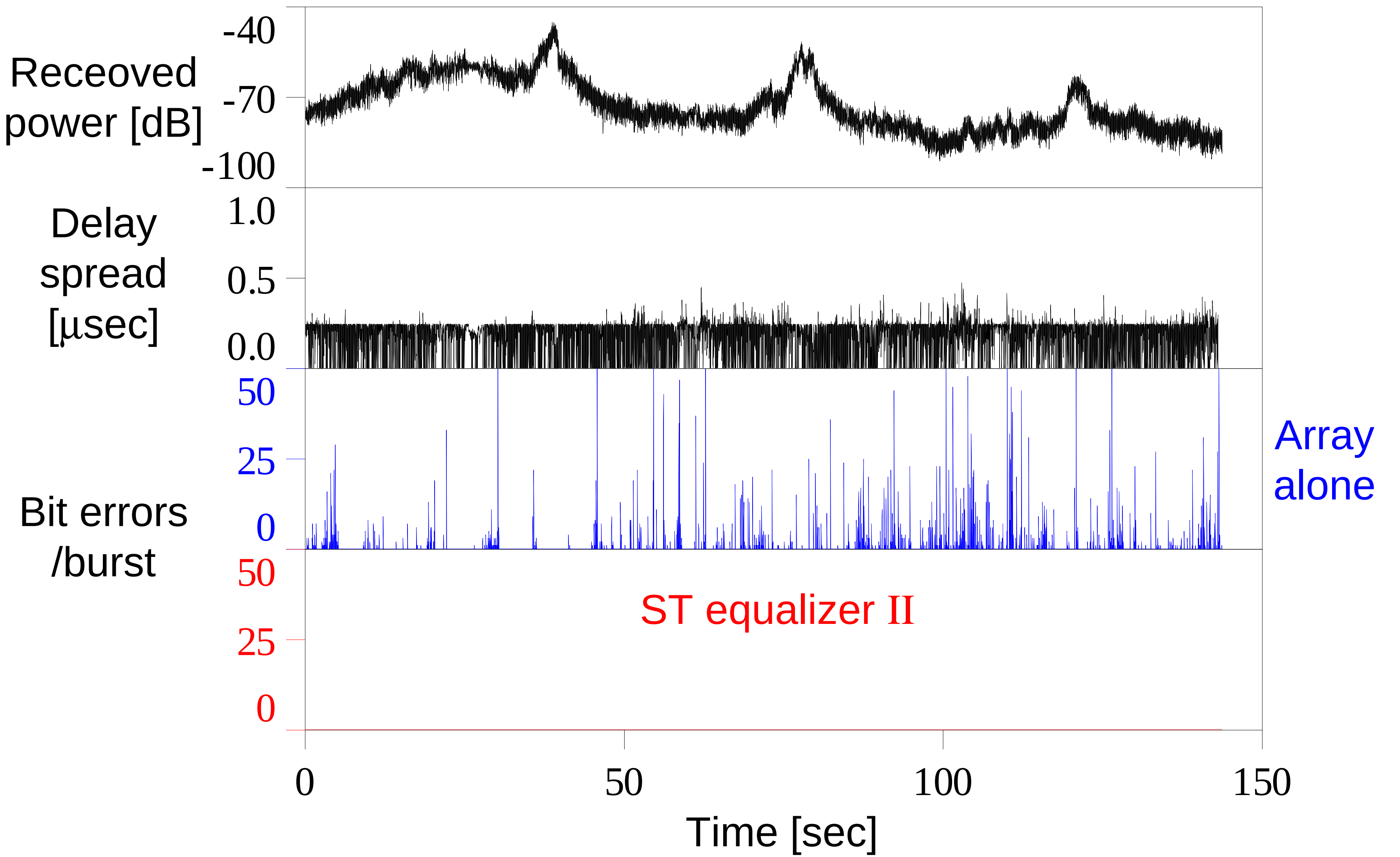
Delay Characteristic and Bit Error Performances in Test Location #1



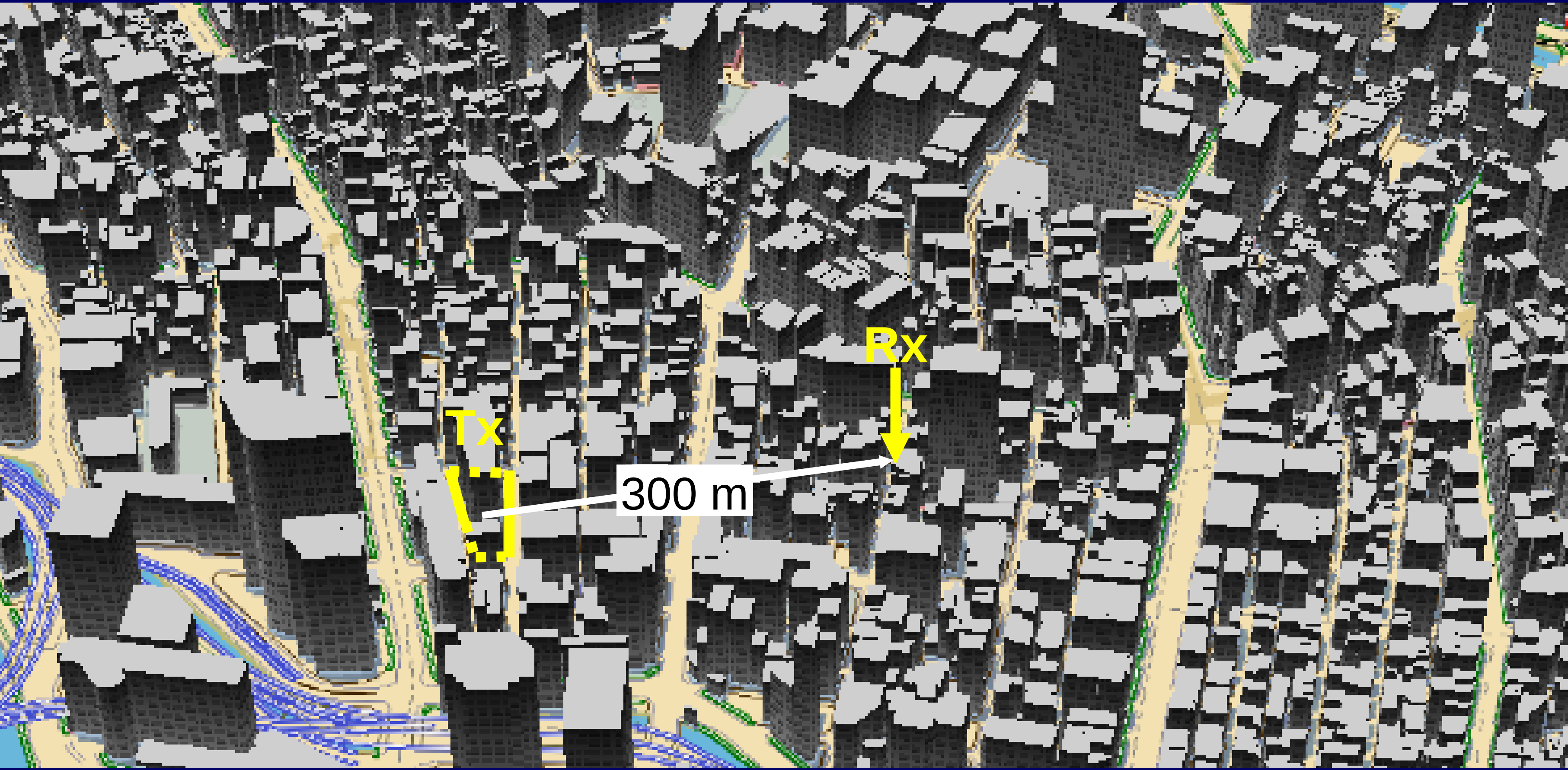
Delay Profile in Test Location #1 with 1Ts-DDT



Delay Characteristic and Bit Error Performances with DDT in Test Location #1



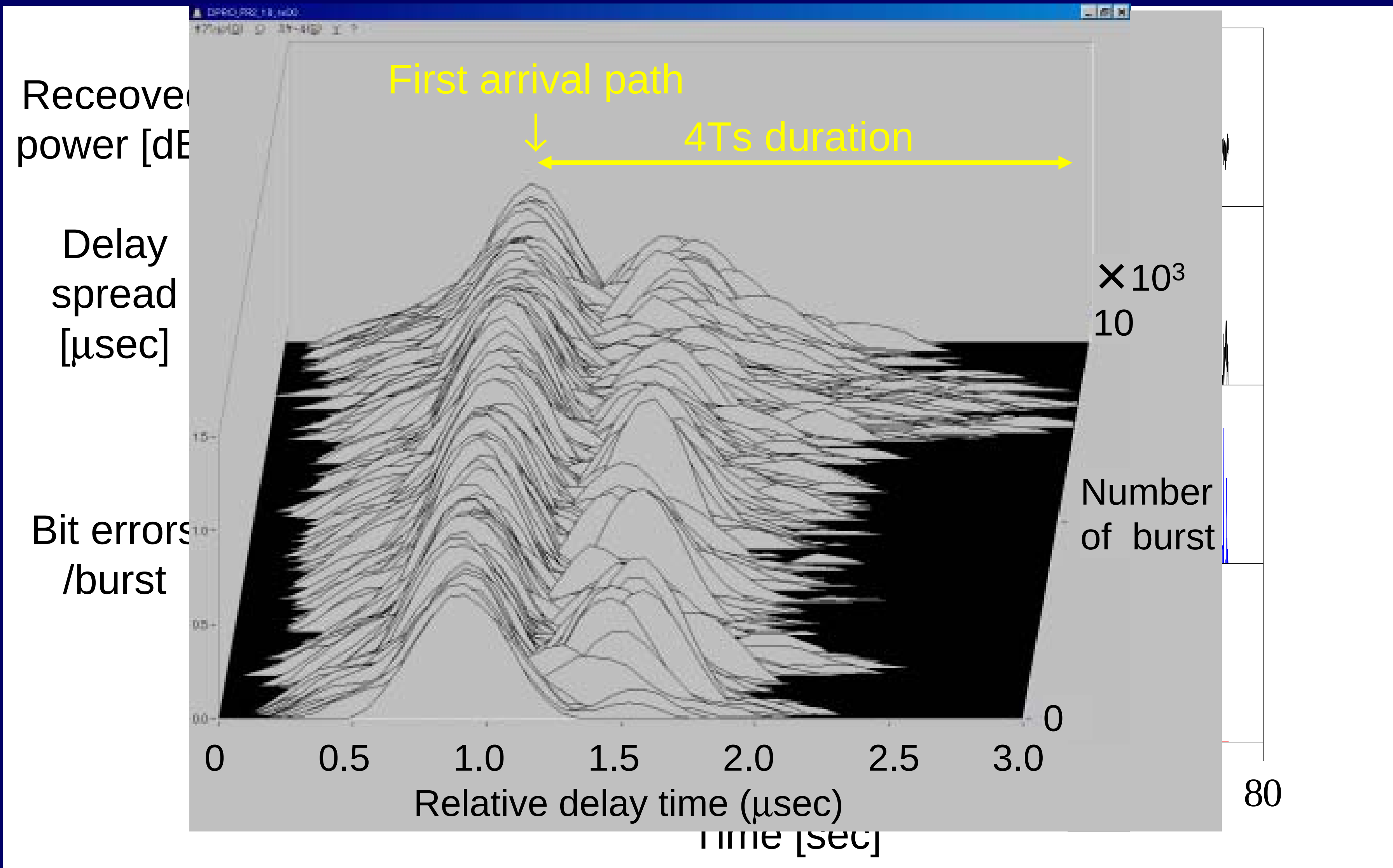
Test Location #2



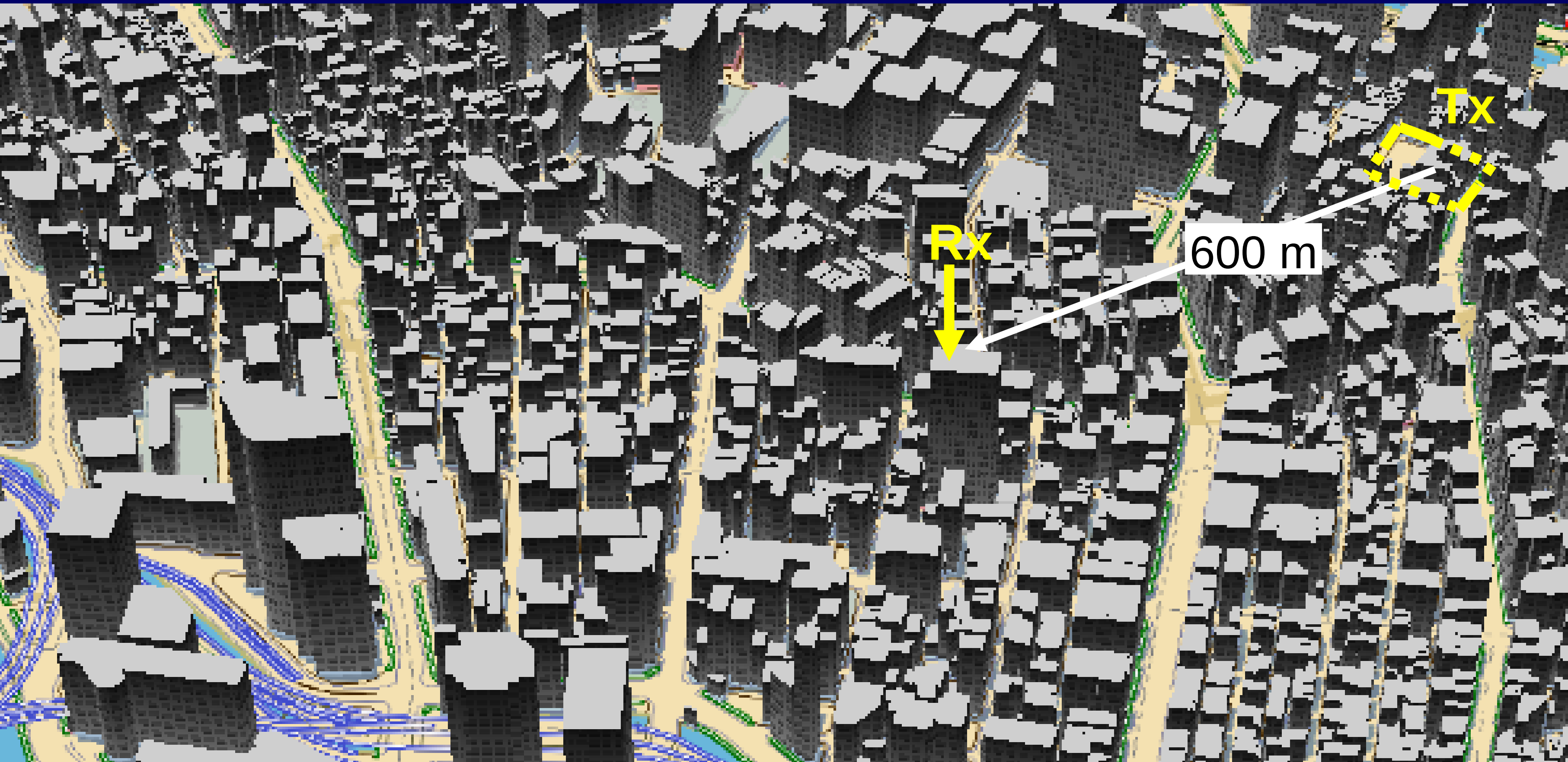
Rx Array Antenna at Test Location #2

Height of major buildings around : 30 ~ 35 m

Delay Characteristic and Bit Error Performances in Test Location #2

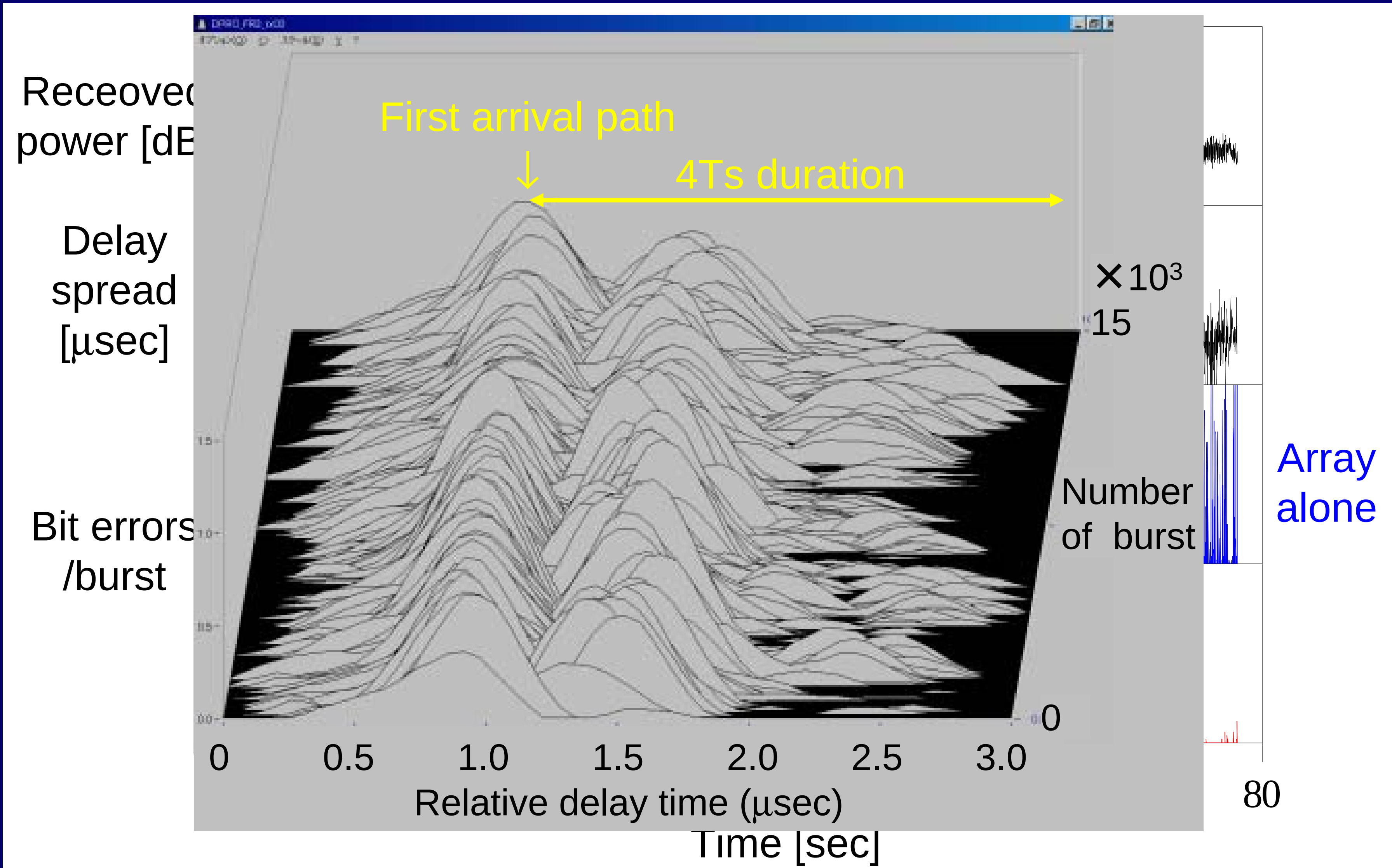


Test Location #3



Rx Array Antenna at Test Location #3

Delay Characteristic and Bit Error Performances in Test Location #3



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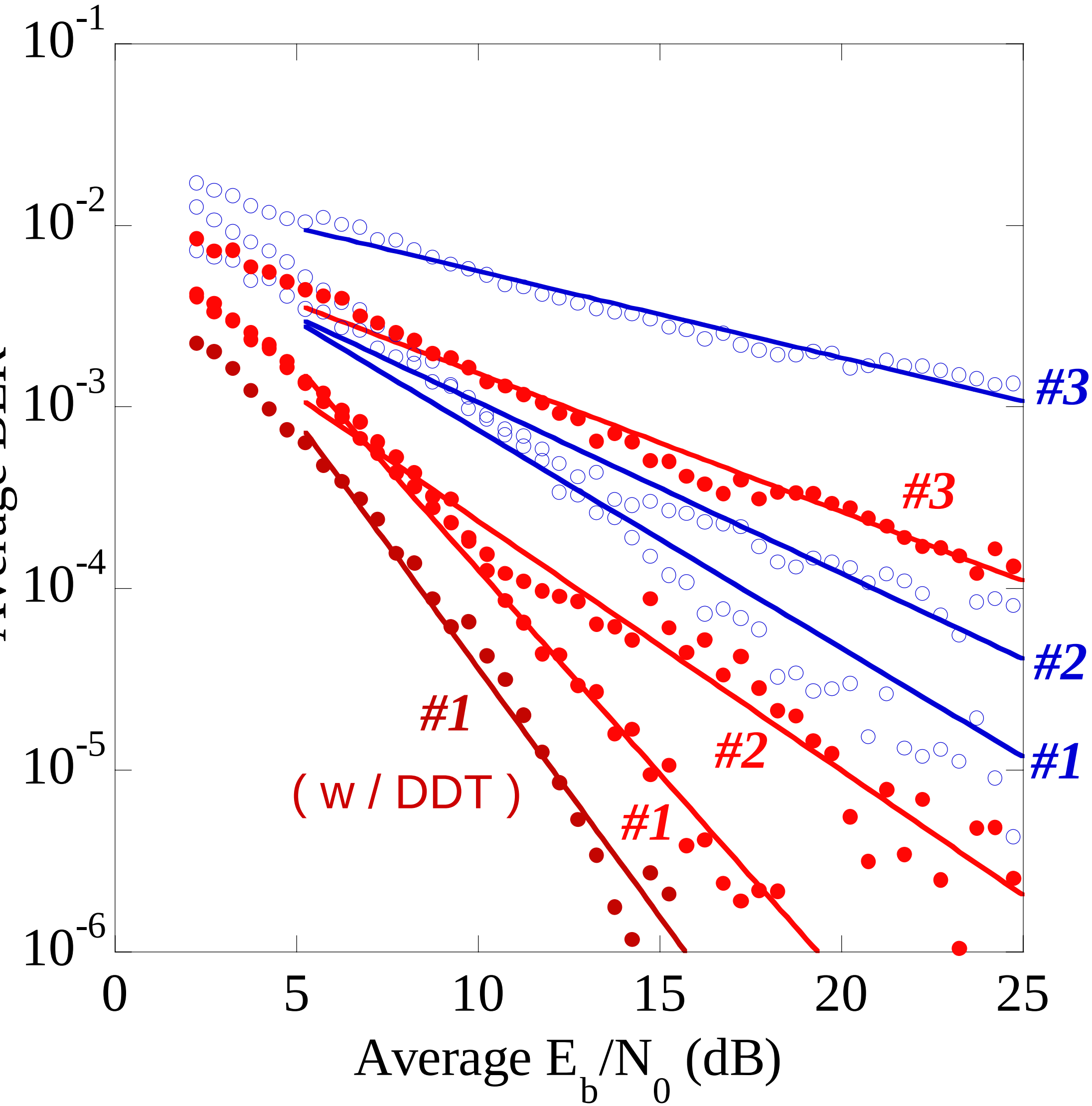
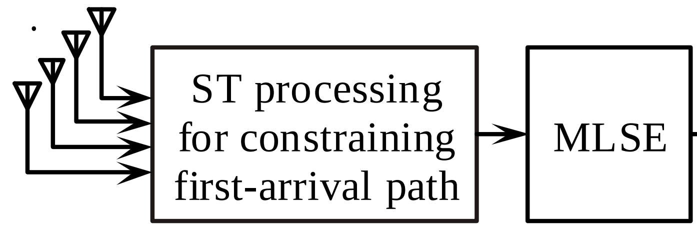
BER Performances of ST Equalizer I and II in Test Location #1, #2, and #3



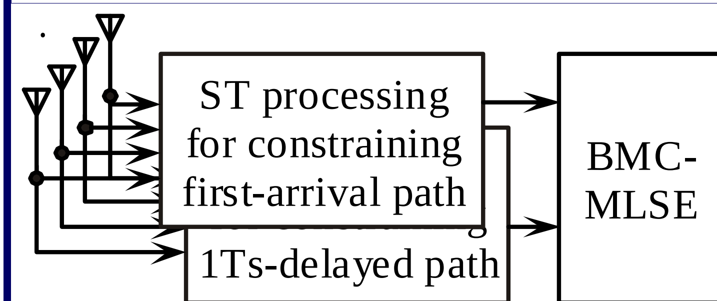
Measured bit errors for more than several hundreds thousands of burst are gathered and averaged in each 0.5 E_b/N_o step.

ST equalizer I

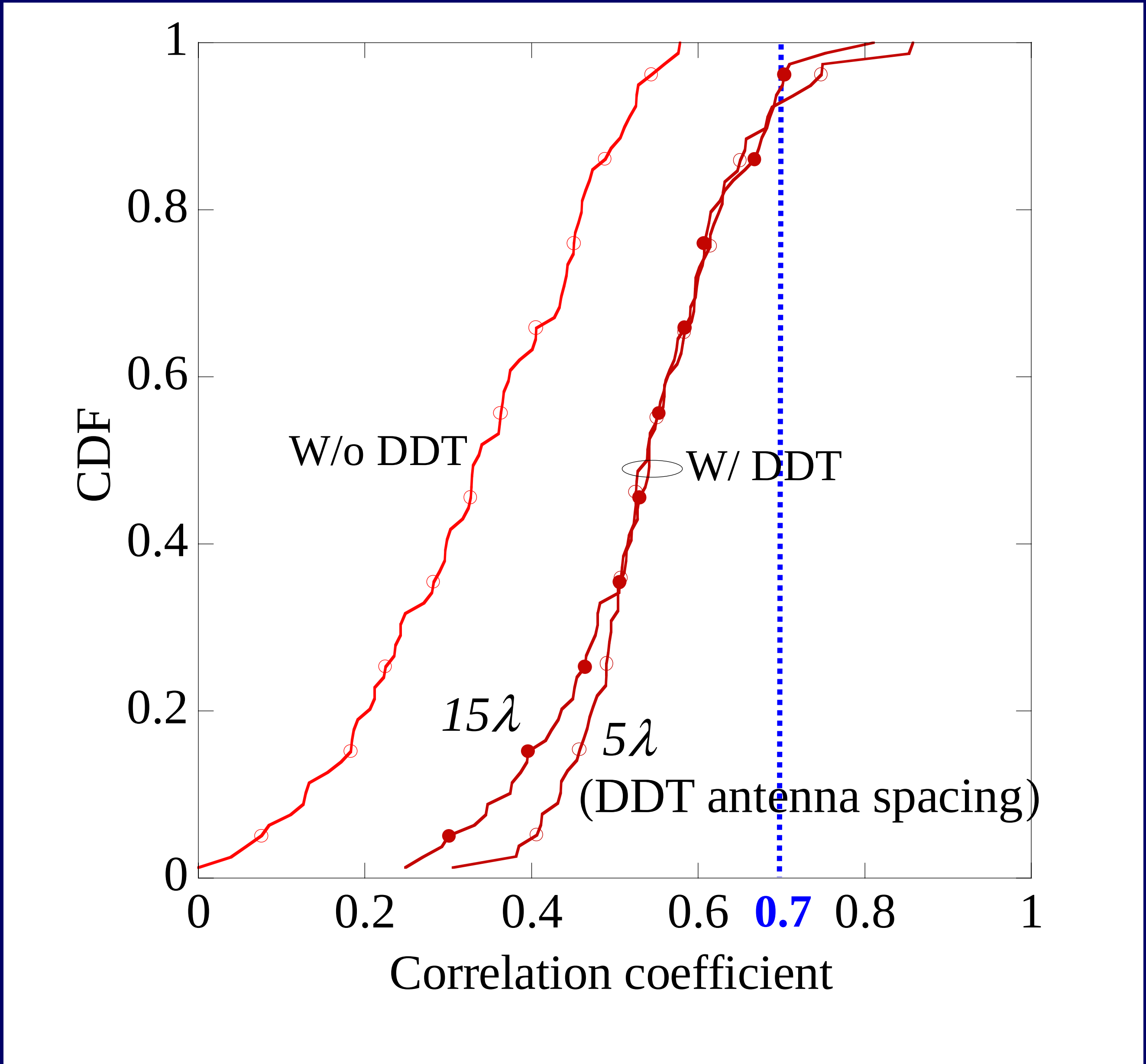


vs.

ST equalizer II (proposed)



Envelope Correlation between First-arrival and 1Ts-delayed Paths Created by DDT in Test Location #1



Conclusions

√ Proposed ST equalizer :

(space and path diversity effect was observed,)

effective in urban micro- and macro-cells environments.

√ Proposed use of DDT for ST equalizer :

(path diversity effect was observed,)

effective in flat fading and small delay spread in urban micro-cell environment.