JEITA EDA -WG Activity

Study of Interconnect Model

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JEITA EDA-WG
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Contents

0.1. Measurement equipment and simulation tools

0.1.1 Equipment of Measurement

Time Domain Reflectmetory (TDR)
86100C +54754A(TDR module)

Vector Network Analyzer (VNA)
N5230A PNA-L

Signal Generator (SG) with Real Time Oscilloscope (OSC)
81134A ,DSO81204B

0.1.2 Simulation tools and Venders

4 Company's Tool

1.1. Detail of Measurement

1.1.1 Measurement of Eye-diagram

Signal generator (SG) and real time oscilloscope (OSC) were used to compare measurement with simulation of Eye-Diagram.

SG was used to inject differential signal which were pseudo random bit sequence. (PRBS) PRBS pattern were 255bits.

OSC was used to record transient waveform.

DUT of three types were provided, which simulate PCBs of digital consumer electronics. One of them contains only filter and connector, the others contain filter, connector and also through hole via and slit.

Signal Generator
PRBS 2e8-1
Tr,Tf=96ps
Differential Signal
0.45-0.8v

Device Under Test (DUT)

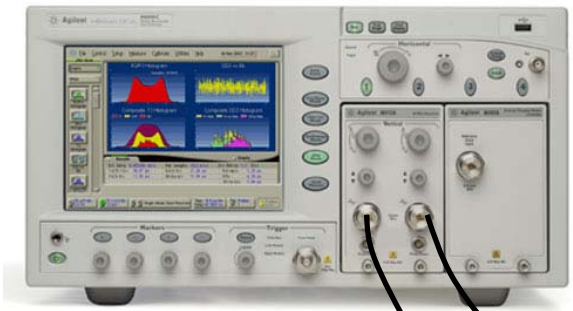
Oscillscope
BW 12GHz
40G sampling/s

1.1. Detail of Measurement

1.1.2 Measurement of TDR

To verify characteristic Impedance of PCB, TDR was used.
The TDR injected differential step pulse and measured reflection waveform, then characteristic Impedance was calculated by the reflection waveform.

One side of DUT were left open in order to measure DUT of electric length which is propagation time to the end ports.



TDR OSC
TDR module
BW 18GHz
Tr 35psec

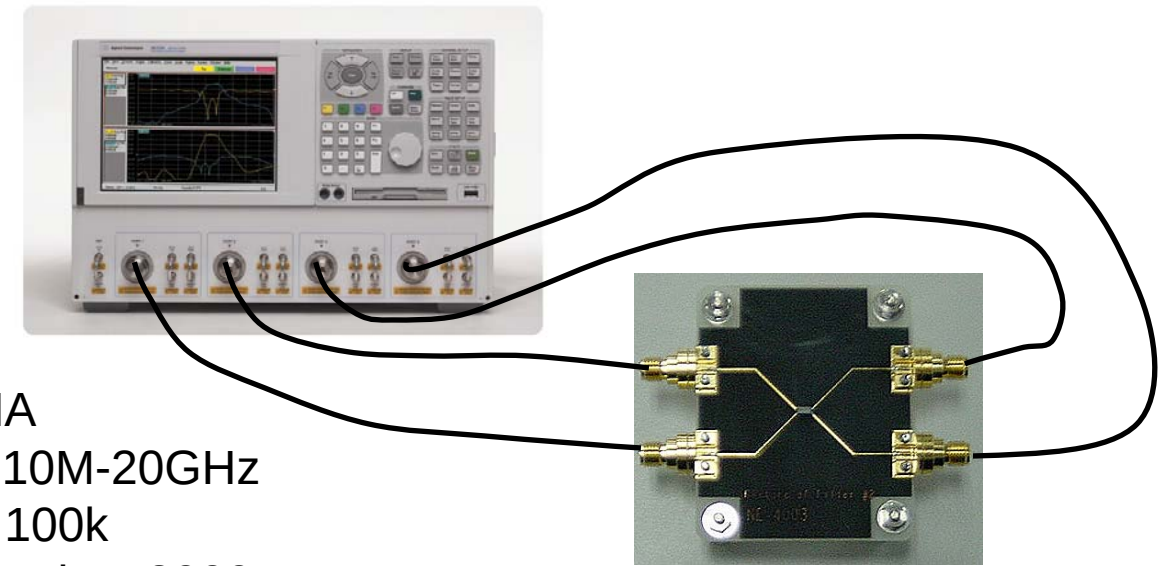
DUT

Open End
Not Terminated

1.1. Detail of Measurement

1.1.3 Measurement of S-parameters

To verify simulation models ,VNA were used to measure S-parameters. The VNA has 4 ports, therefore it measures mixed mode S-parameters which are important parameter to investigate differential transmission line.



DUT

4 ports VNA
BW 10M-20GHz
IFBW 100k
Measured points 2000
Averaging 10 times

1.2. Detail of simulation
EDA models

- EDA models were provided by component manufacturer.
  E.g. Murata,TDK,JAE

- PCB models were extracted from CAD data by simulation tools
  PCB manufacturer does not provide EDA model.
  They provide only layer structure, wire width, space between wires and dielectric constant.

- EDA models were S-parameters or Equivalent Circuits.

1.2. Detail of simulation
Simulation Items

- Eye-Diagram

  Only EDA model provided by the manufacturer.

  To verify Whether the measurement agrees with the simulation

  Measured S-parameters

  To verify whether each simulator accept S-parameters.

- TDR Waveform

  Only wire of PCB

  To verify whether EDA model of PCB which is extracted by each simulator is correct.

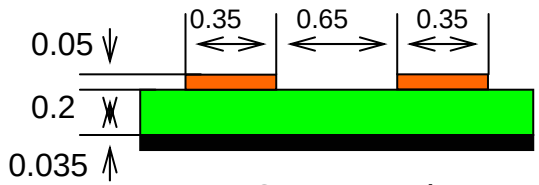
- S-parameters

  Each EDA models

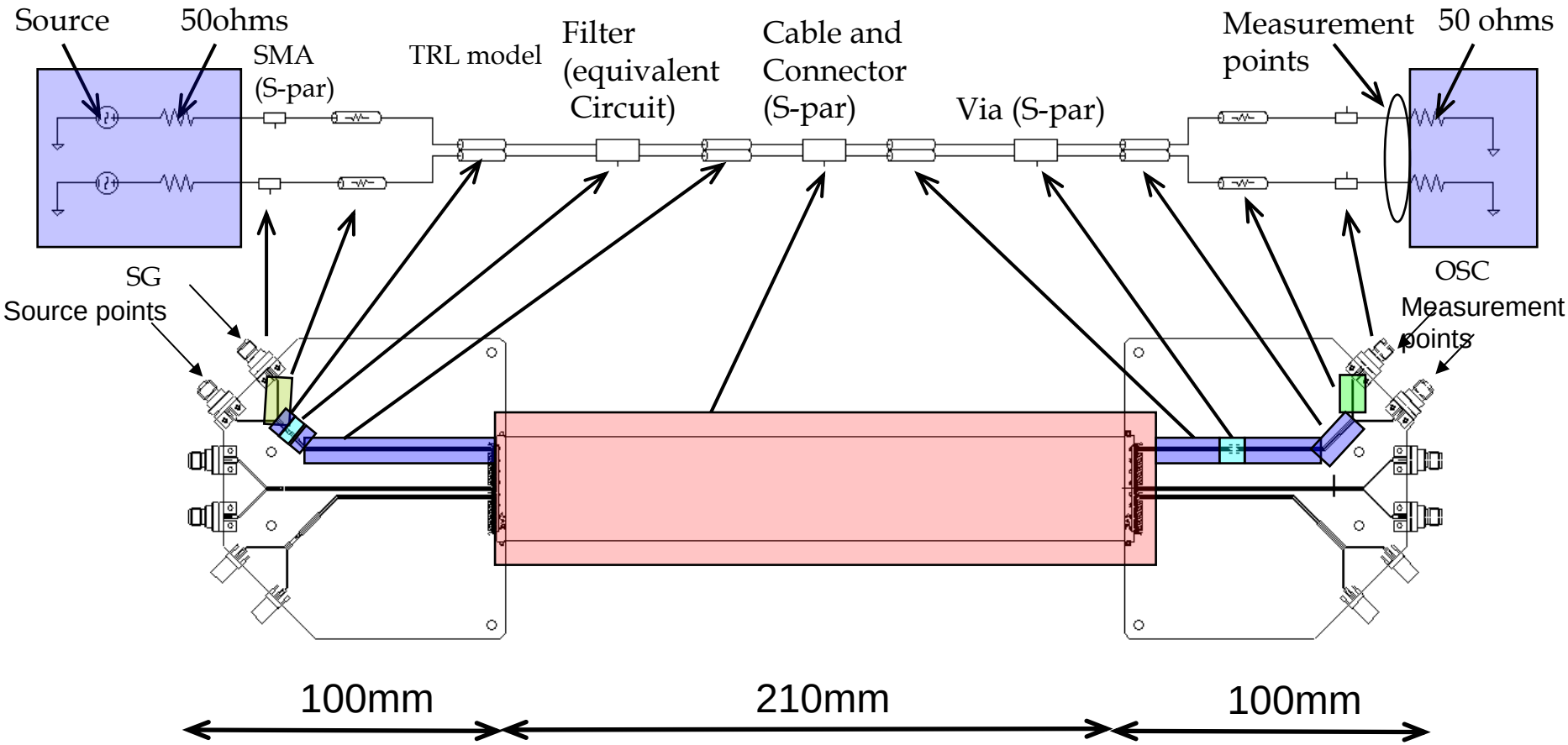
  To verify accuracy of each EDA models

1.2. Detail of simulation

#68 DUT and Simulation model

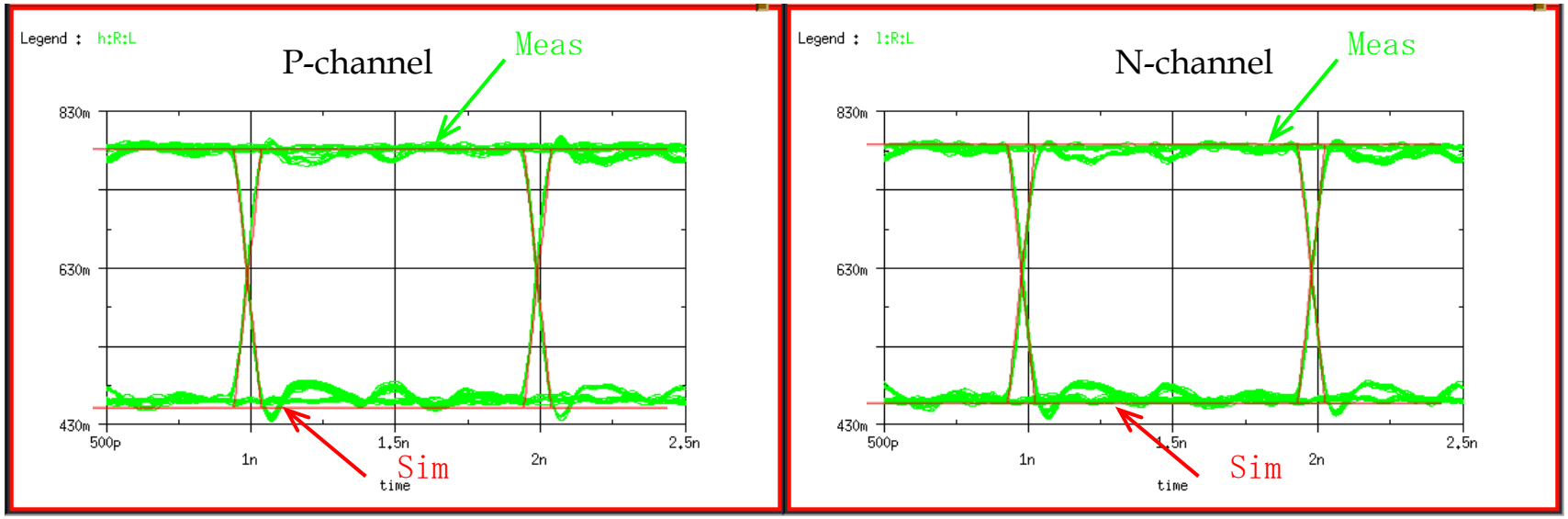


Cross section

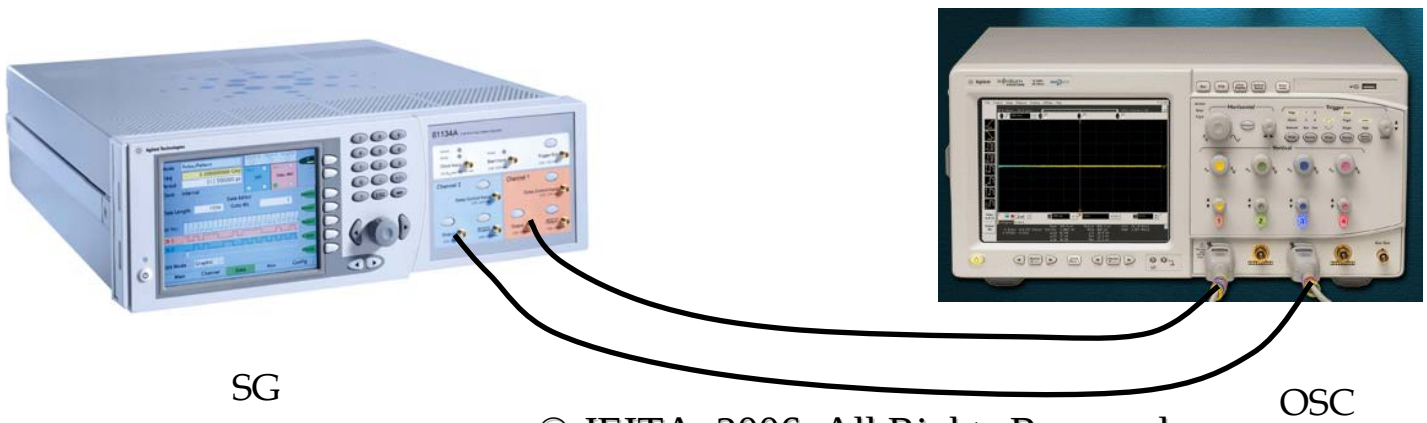


2.1 Comparison between Measurement and Simulation

Eye diagram of Input conditions

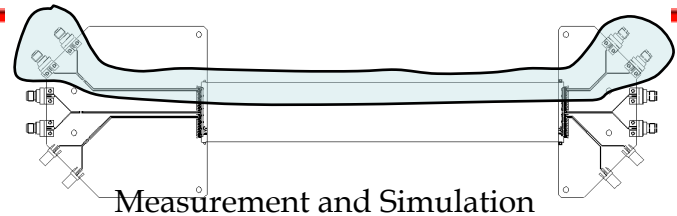


To make source signal of simulation, OSC was directly connected with SG using short cable. Cable length was about 20cm.



2.2 Comparison between Measurement and Simulation

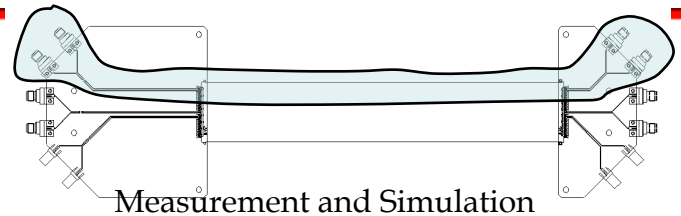
#53 Eye Diagram of Measurement and Simulation



Measurement and Simulation

2.3 Comparison between Measurement and Simulation

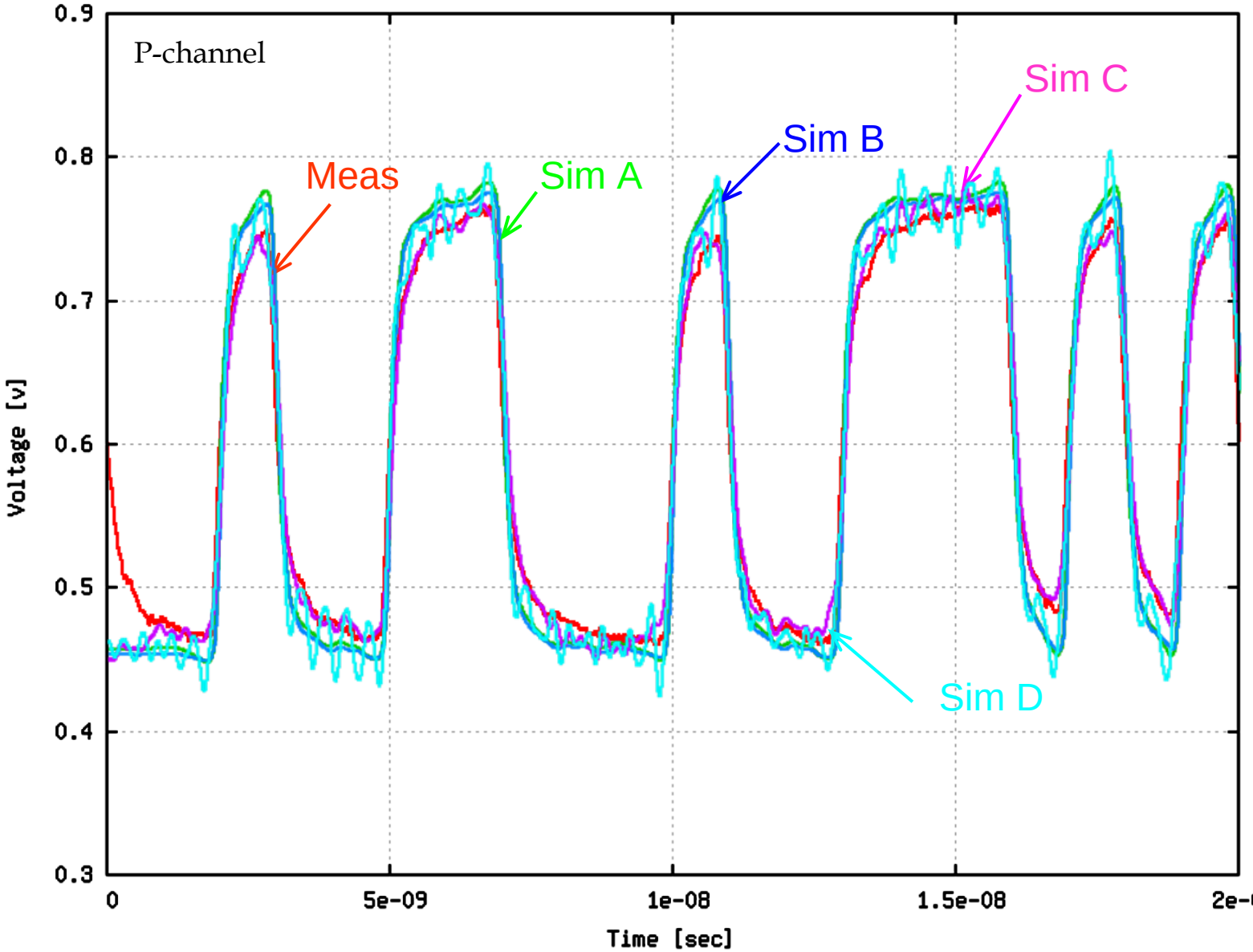
#53 Eye Diagram of Measurement and Simulation



Measurement and Simulation

2.4 Comparison between Measurement and Simulation

#53 Discrete Waveform of Measurement and Simulation

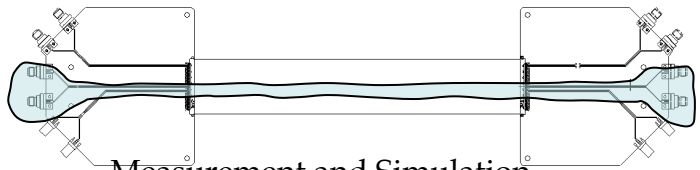


2.5 Comparison between Measurement and Simulation

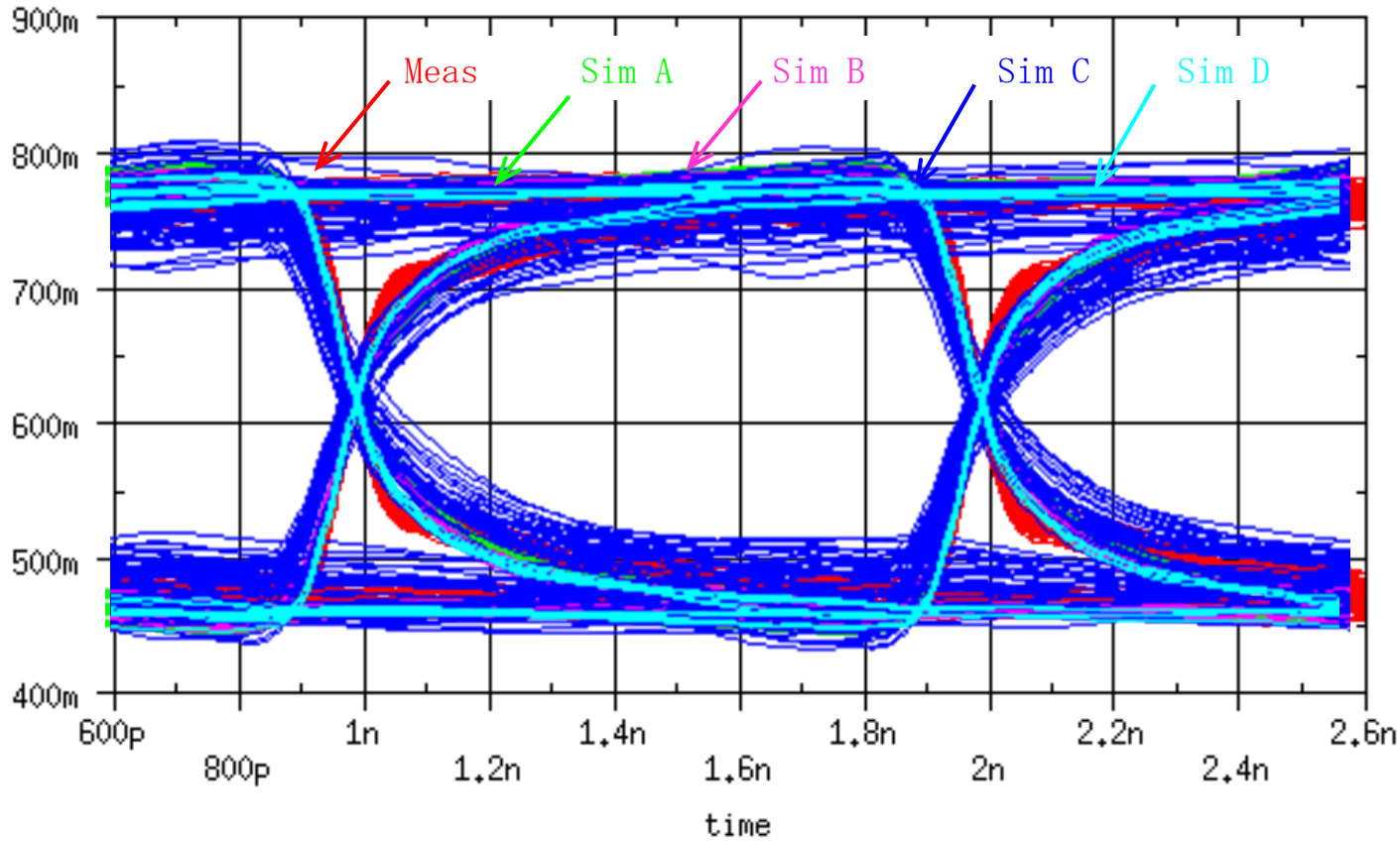
#67 Eye Diagram of Measurement and Simulation

Legend : 67h:R:L

P-channel

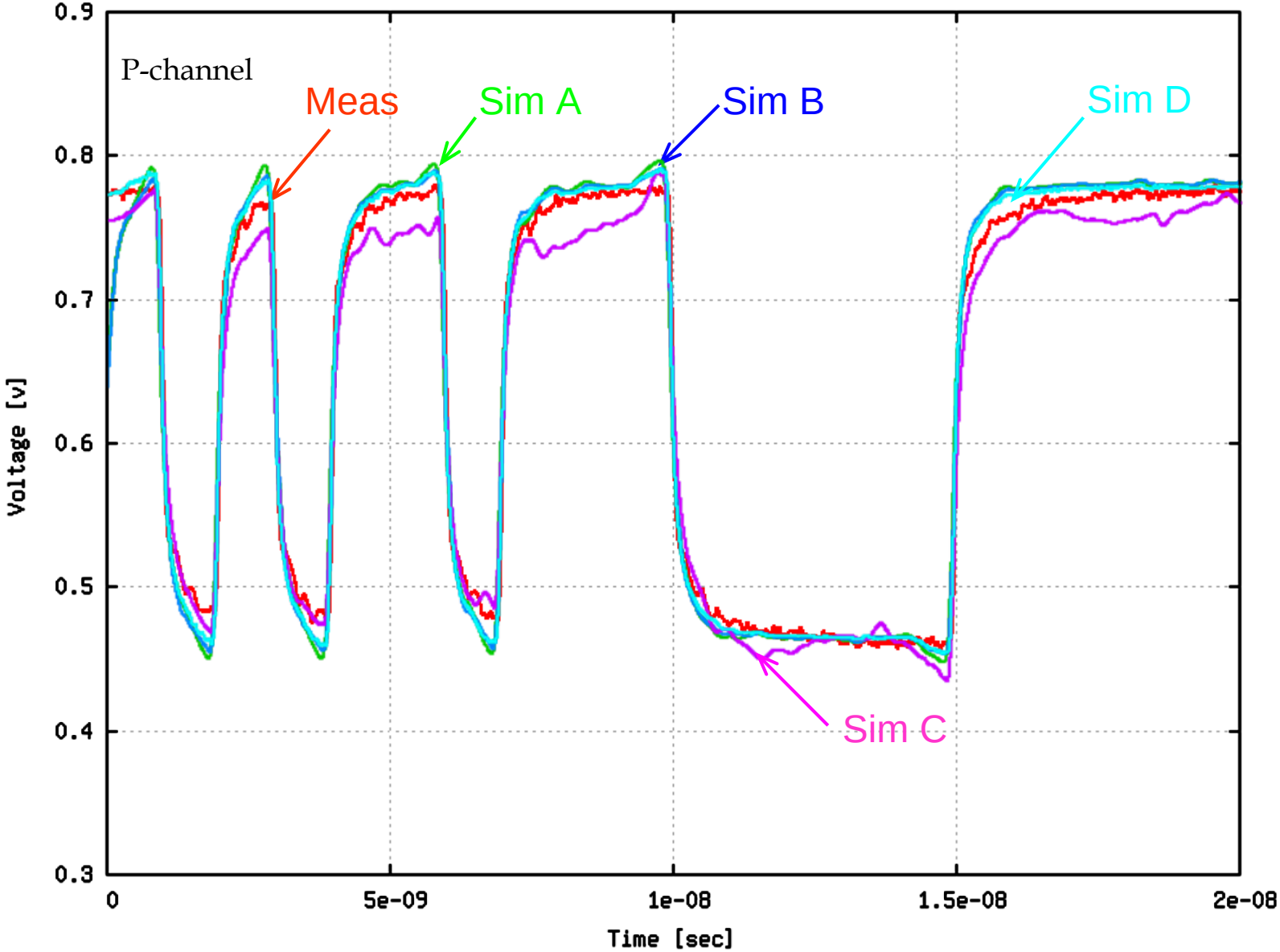


Measurement and Simulation



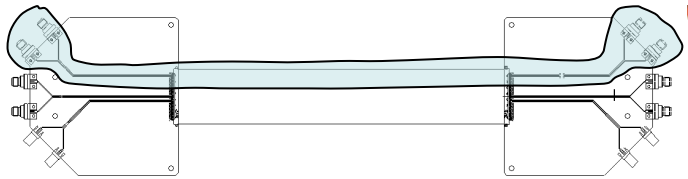
2.6 Comparison between Measurement and Simulation

#67 Discrete Waveform of Measurement and Simulation



2.7 Comparison between Measurement and Simulation

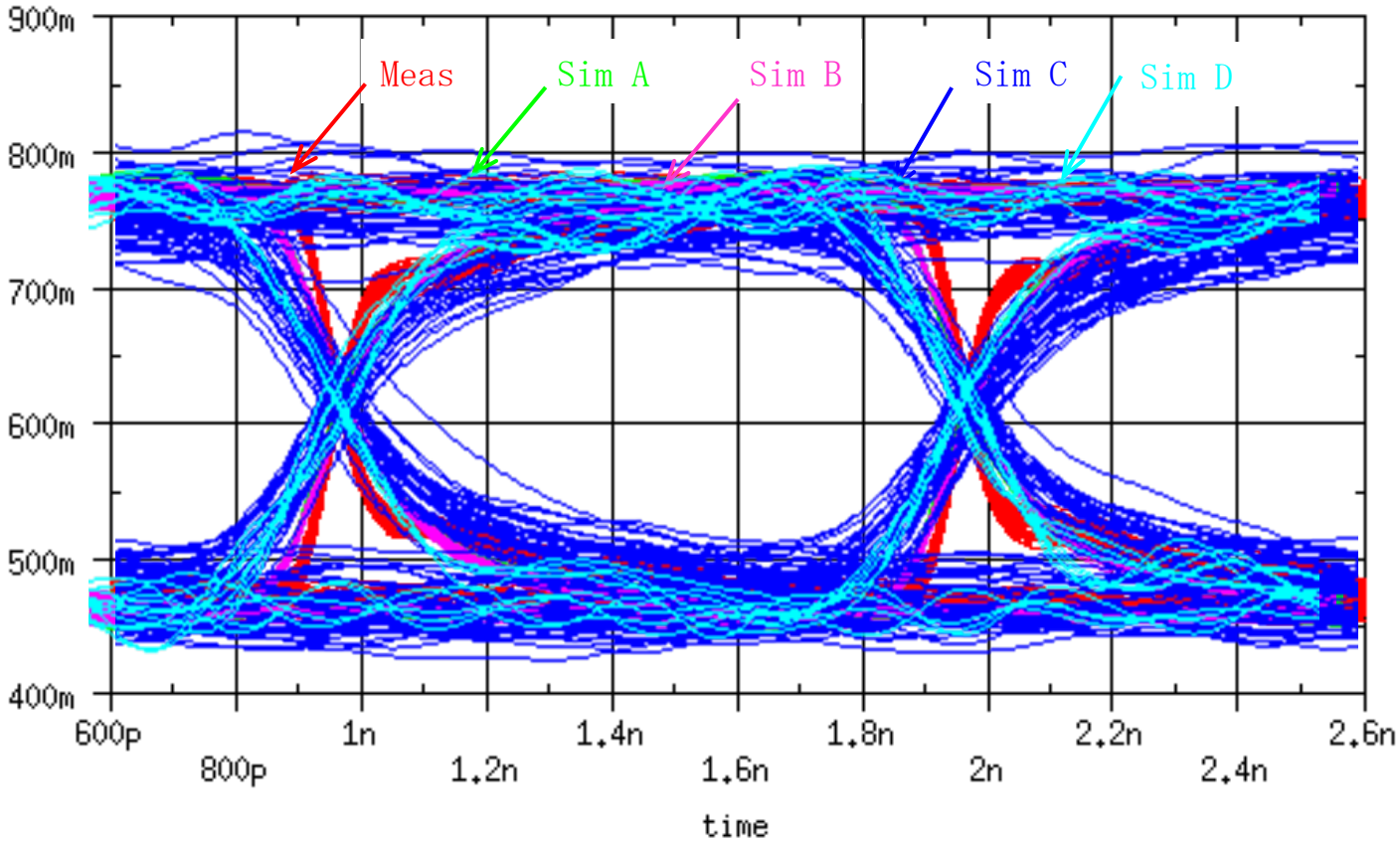
#68 Eye Diagram of Measurement and Simulation



Measurement and Simulation

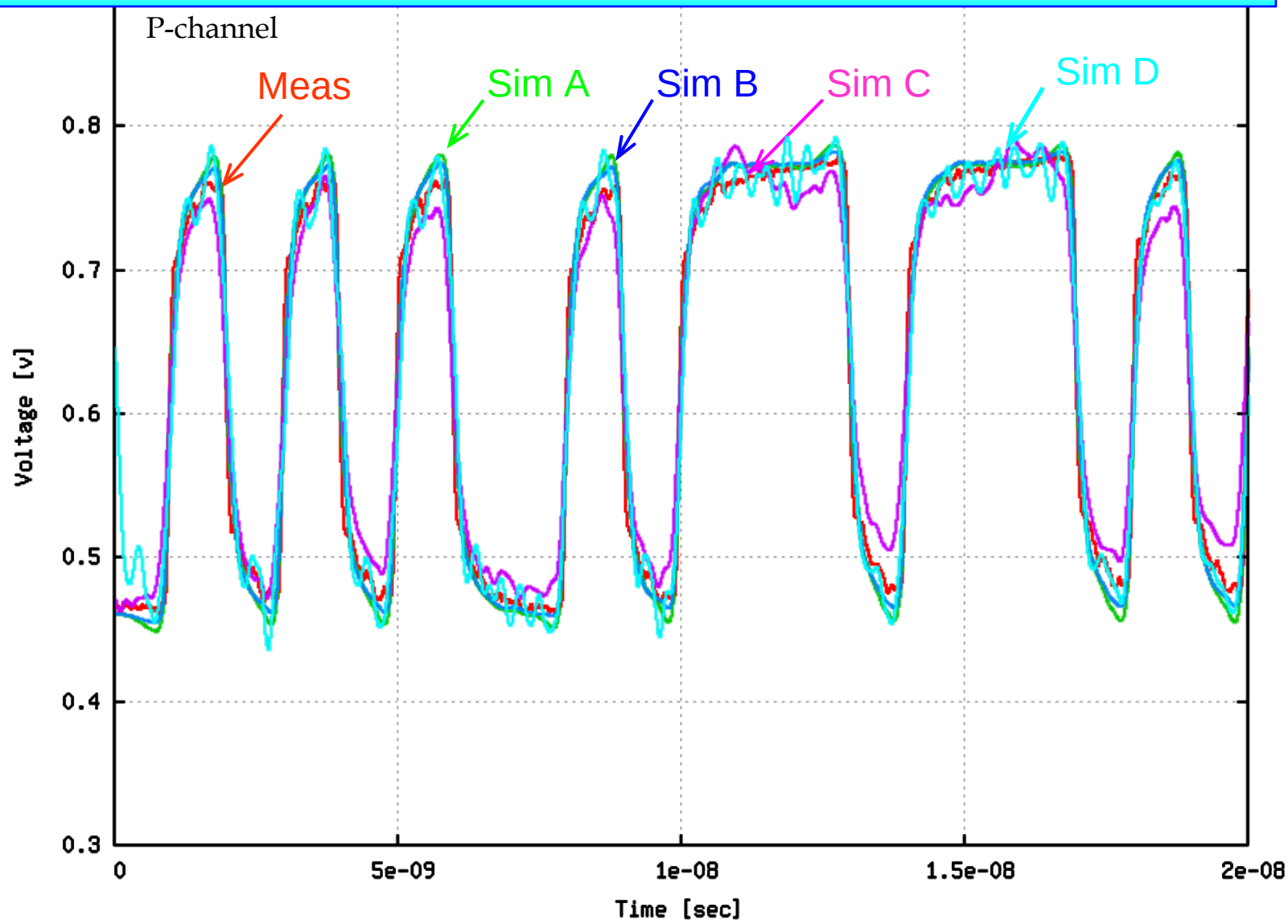
Legend : 68h:R:L

P-channel



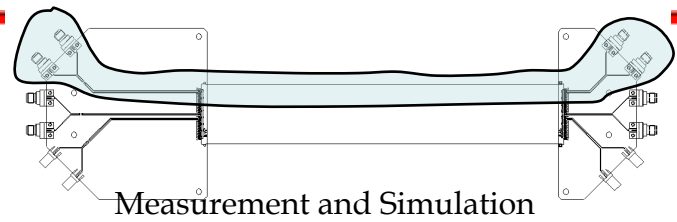
2.8 Comparison between Measurement and Simulation

#68 Discrete Waveform of Measurement and Simulation



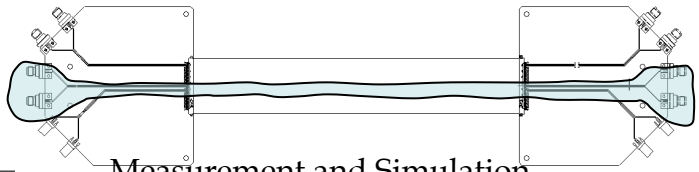
3.1 Simulation for Measured EDA models

#53 Eye Diagram of Measurement and Simulation using measured S-parameters

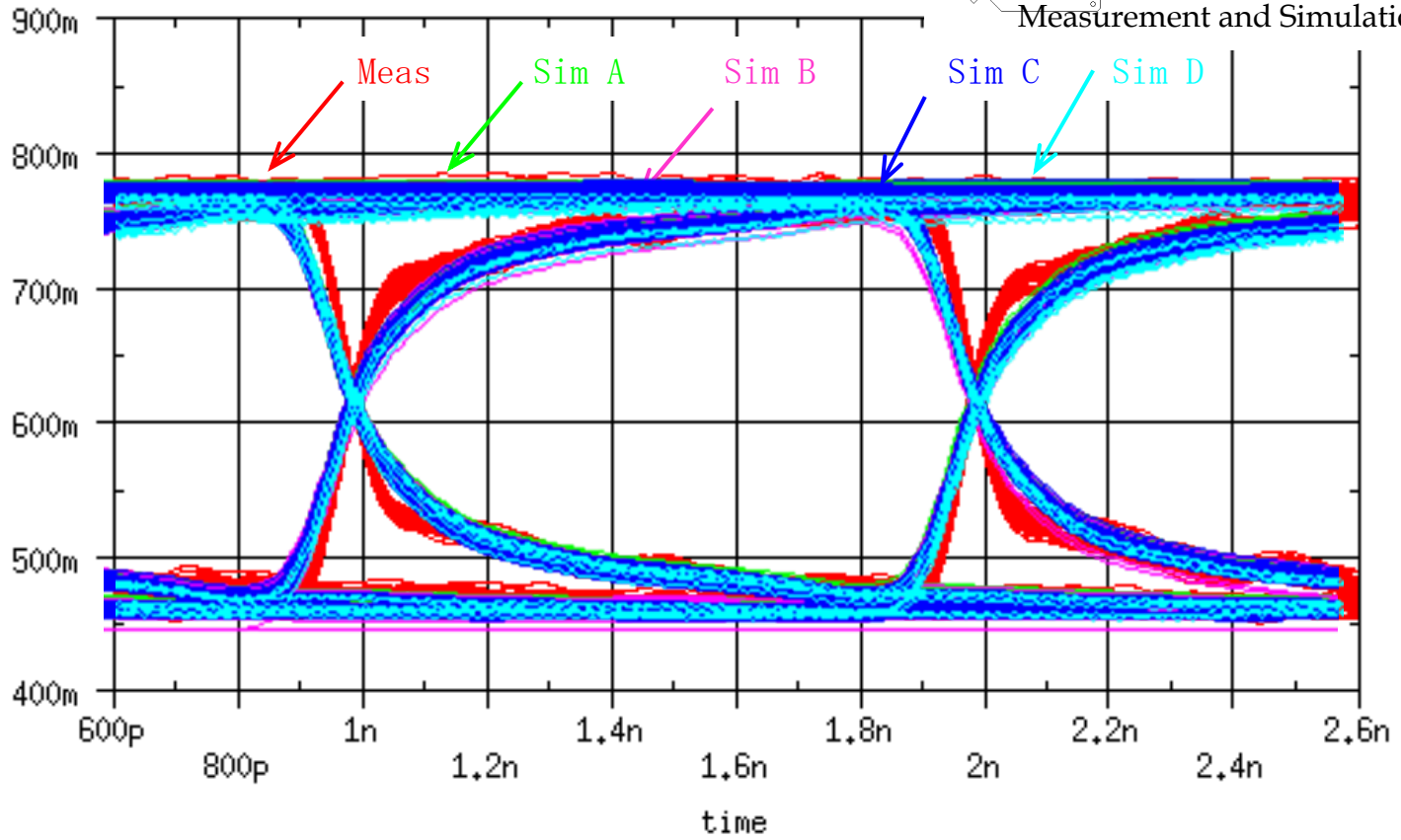


3.2 Simulations for Measured EDA models

#67 Eye Diagram of Measurement and Simulation using measured S-parameters

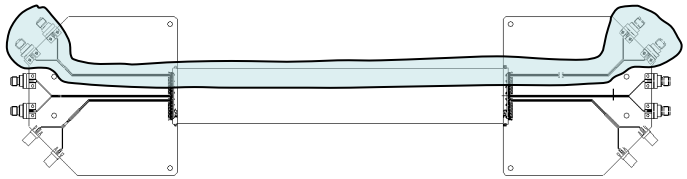


Measurement and Simulation



3.3 Simulations for Measured EDA models

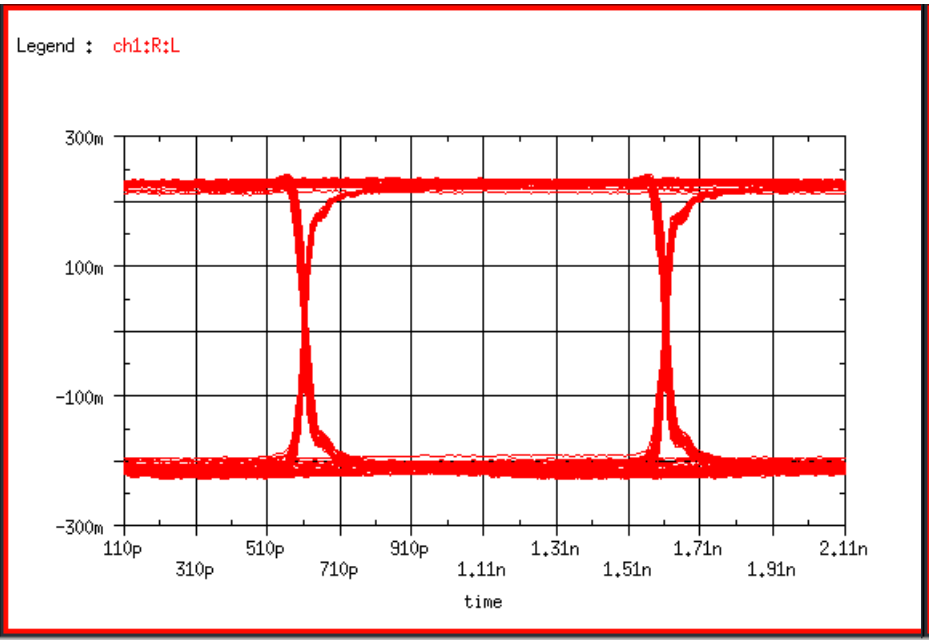
#68 Eye Diagram of Measurement and Simulation using measured S-parameters

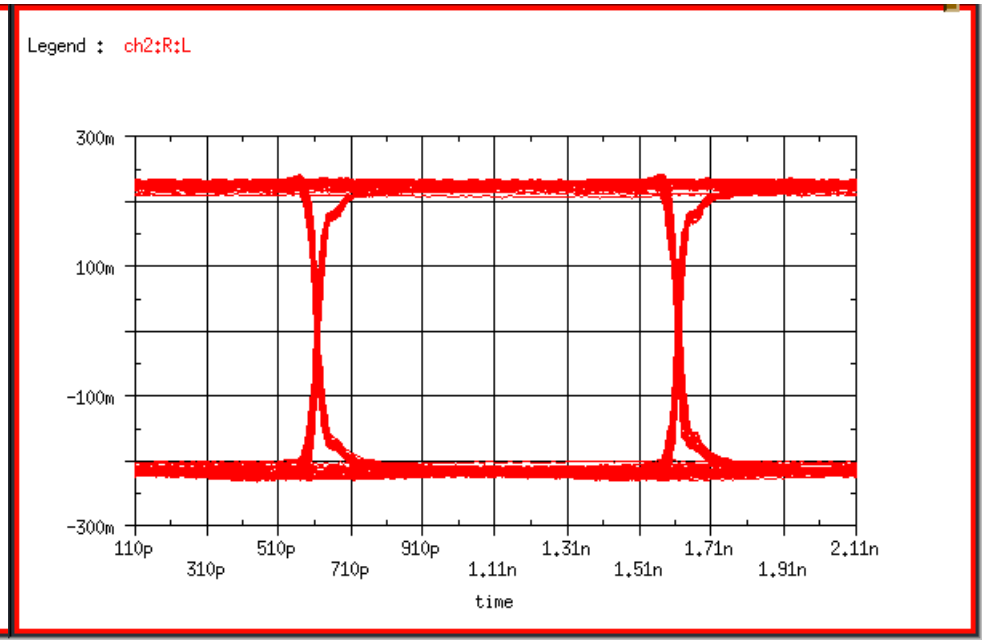


Measurement and Simulation

3.4 Comparison between Measurement and Simulation

SG+Cable(1m+0.3m)+Sampling OSC



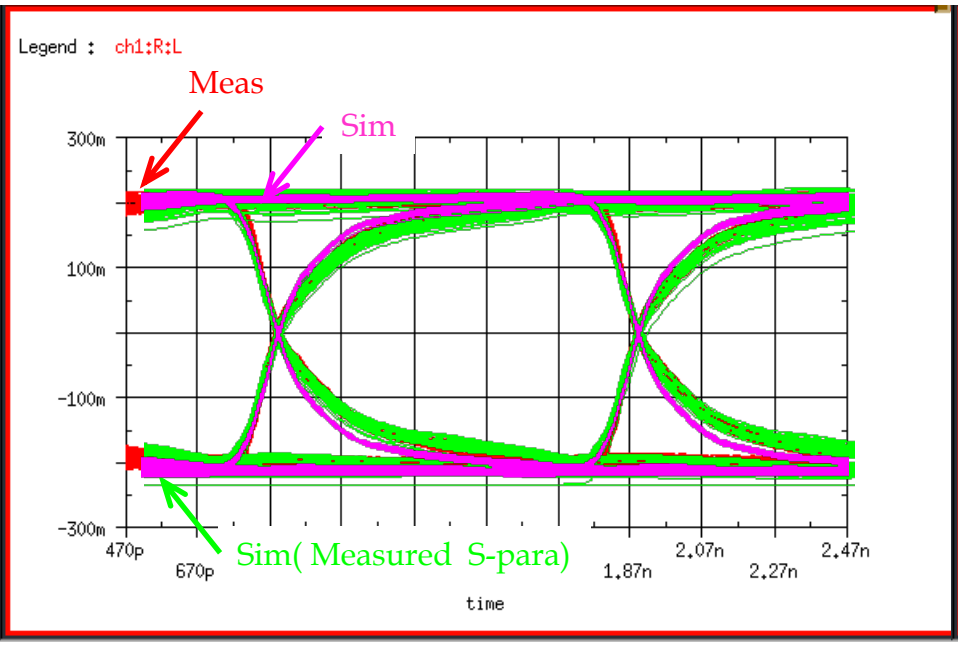


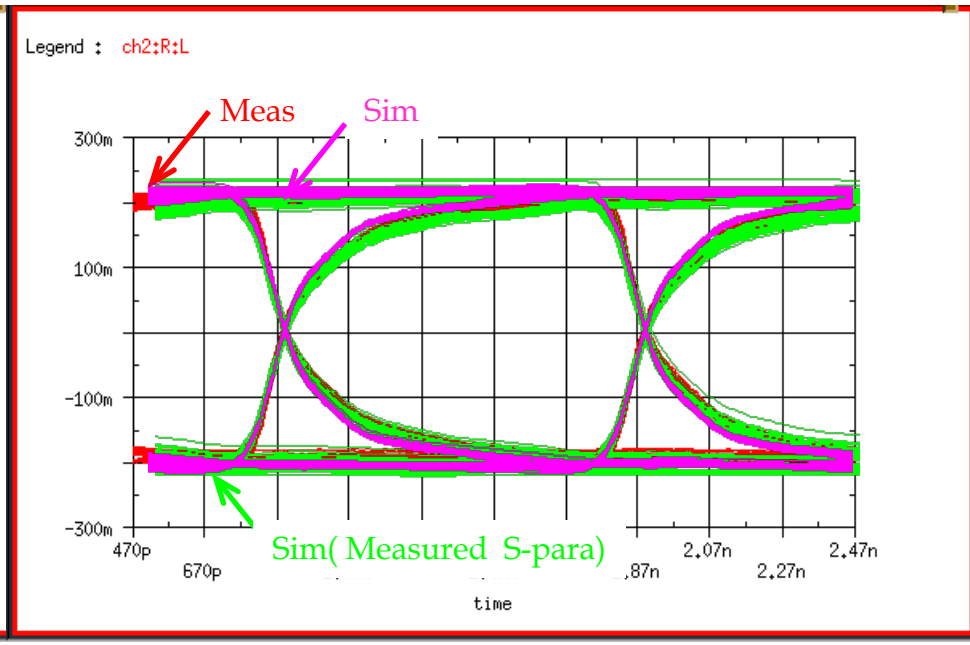
SG
Up to 13.5Gbps
Rise time 18ps

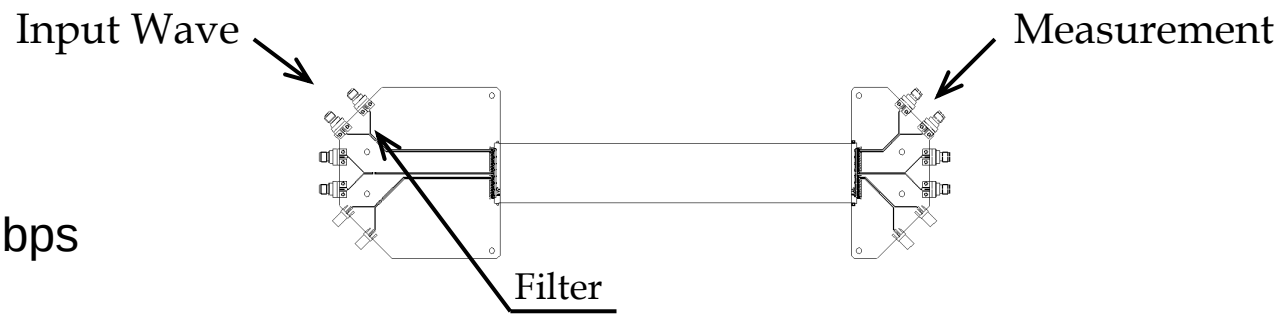
Sampling OSC
Band width 50GHz

3.5 Comparison between Measurement and Simulation

Filter+Cable,Connector+traces without Via and slit



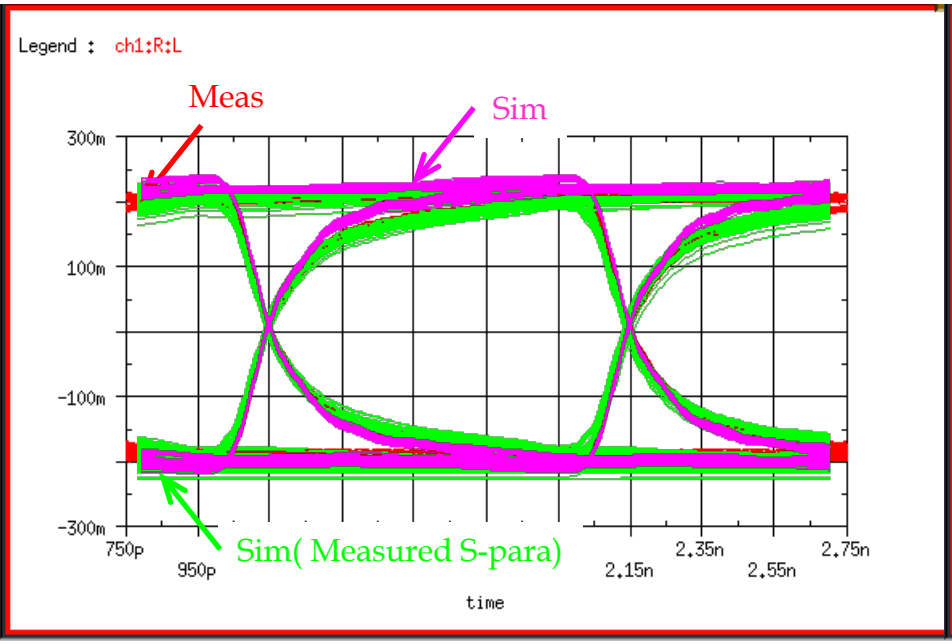


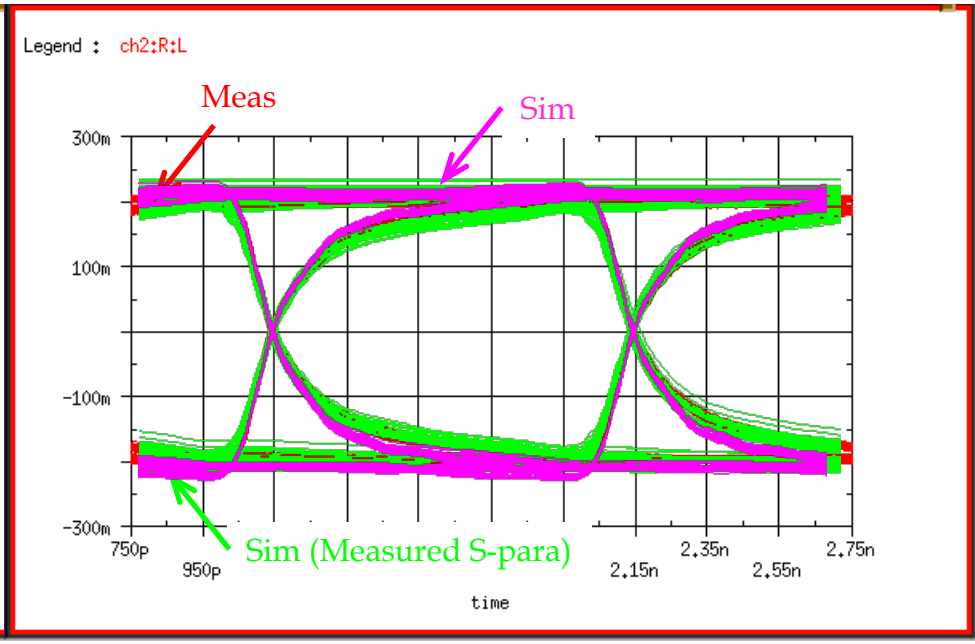


Bit rare:1Gbps

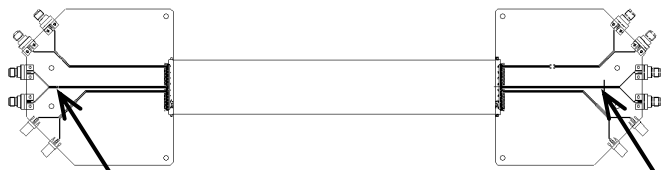
3.6 Comparison between Measurement and Simulation

Filter+Cable,Connector+slit





Input Wave →



← Measurement

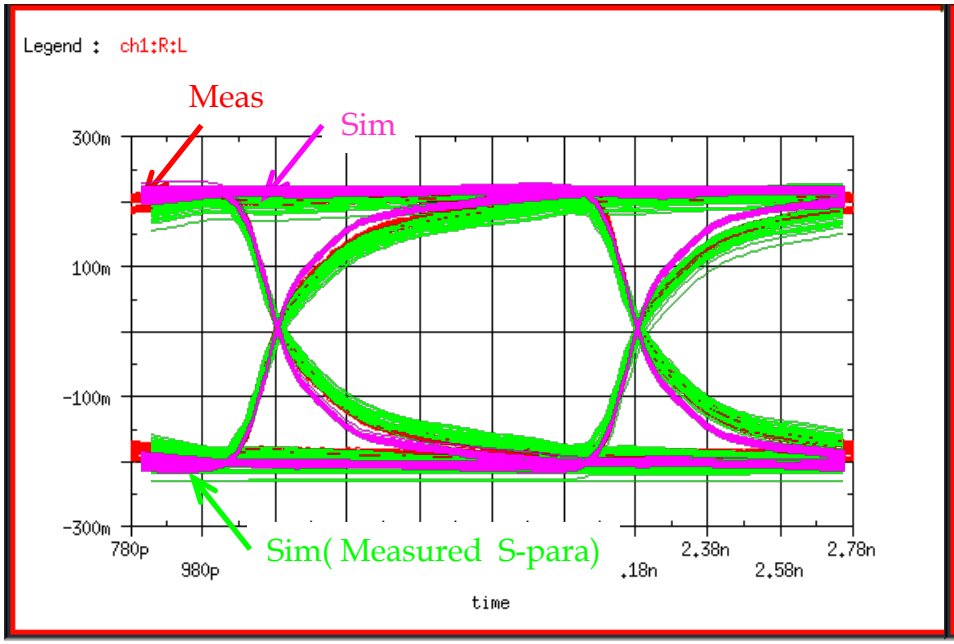
filter

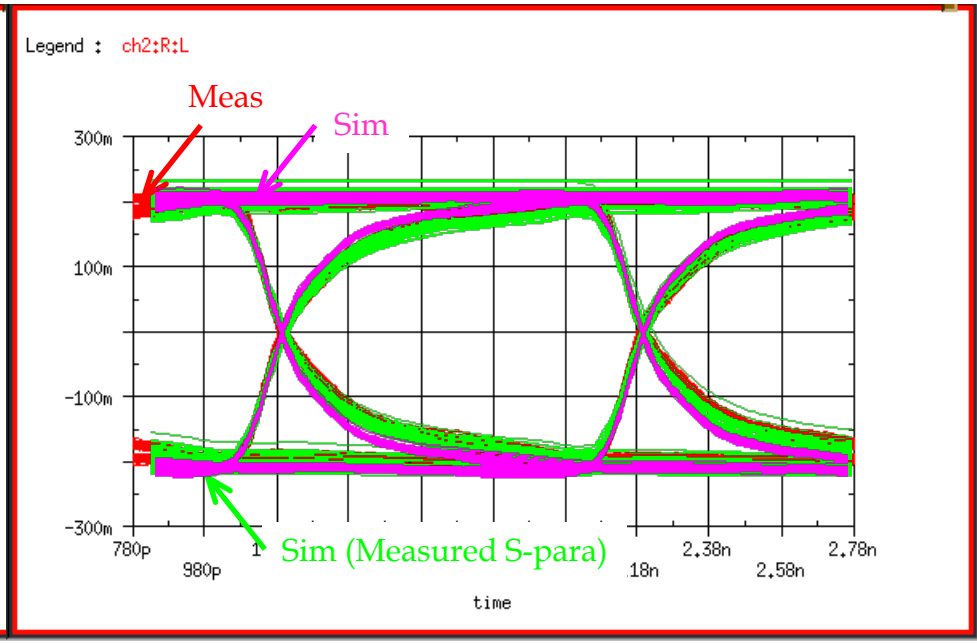
Slit

Bit rare:1Gbps

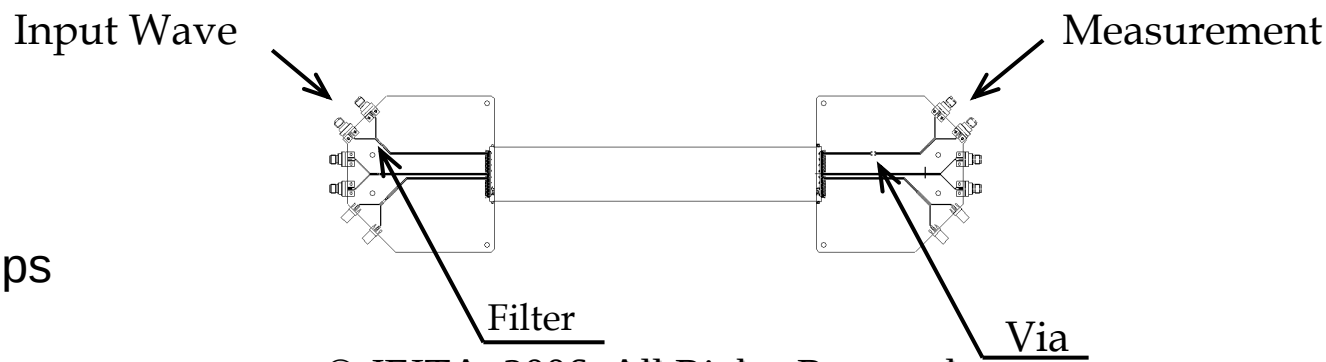
3.7 Comparison between Measurement and Simulation

Filter+Cable,Connector+Via



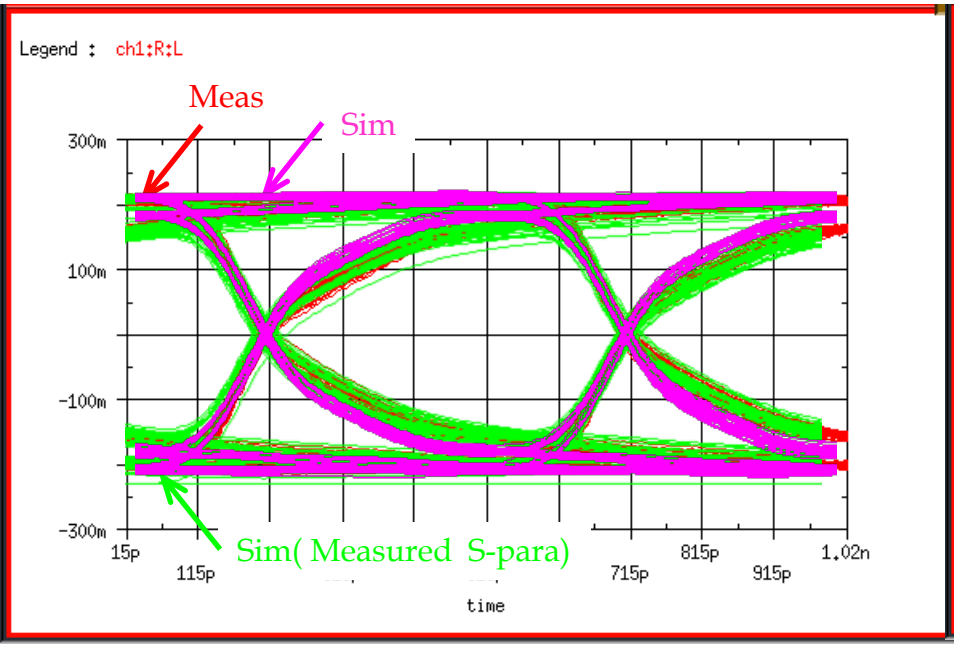


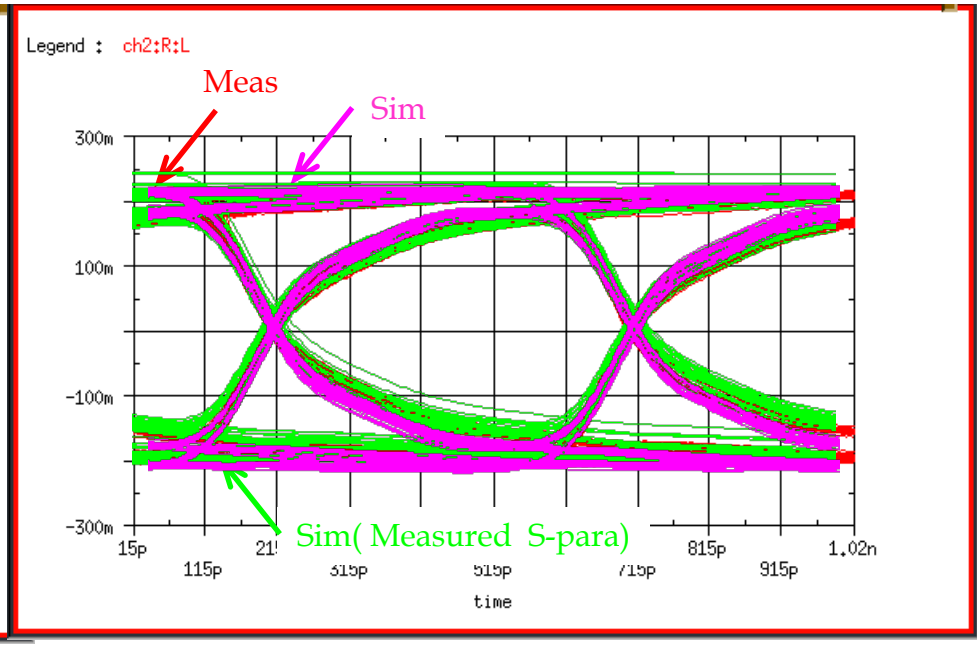
Bit rare:1Gbps



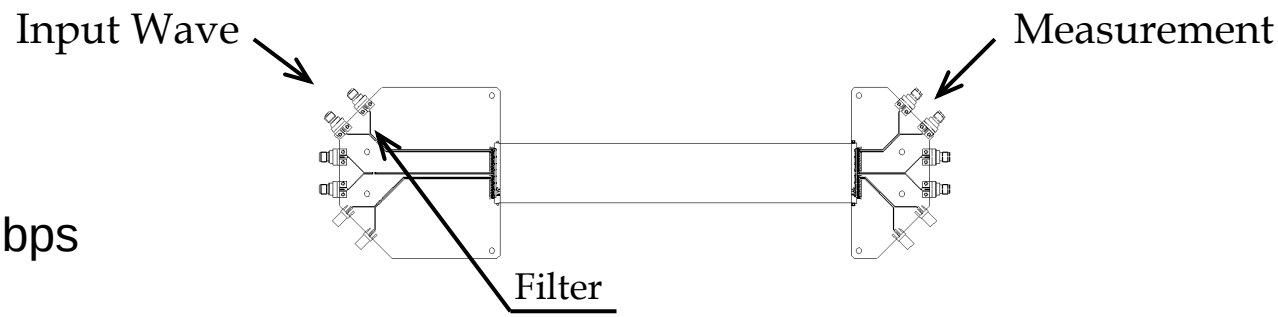
3.8 Comparison between Measurement and Simulation

Filter+Cable,Connector+traces without Via and slit



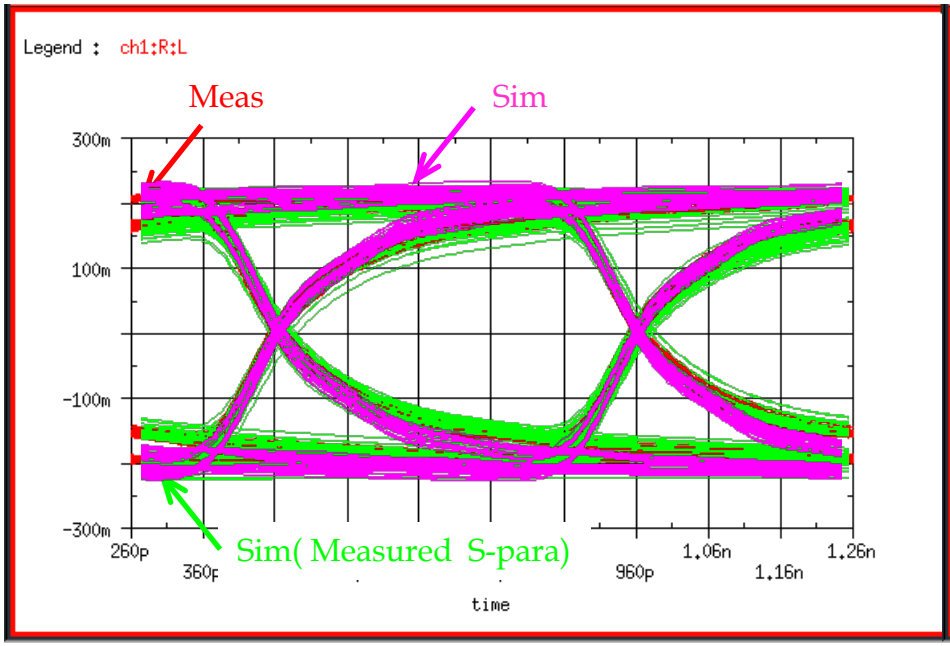


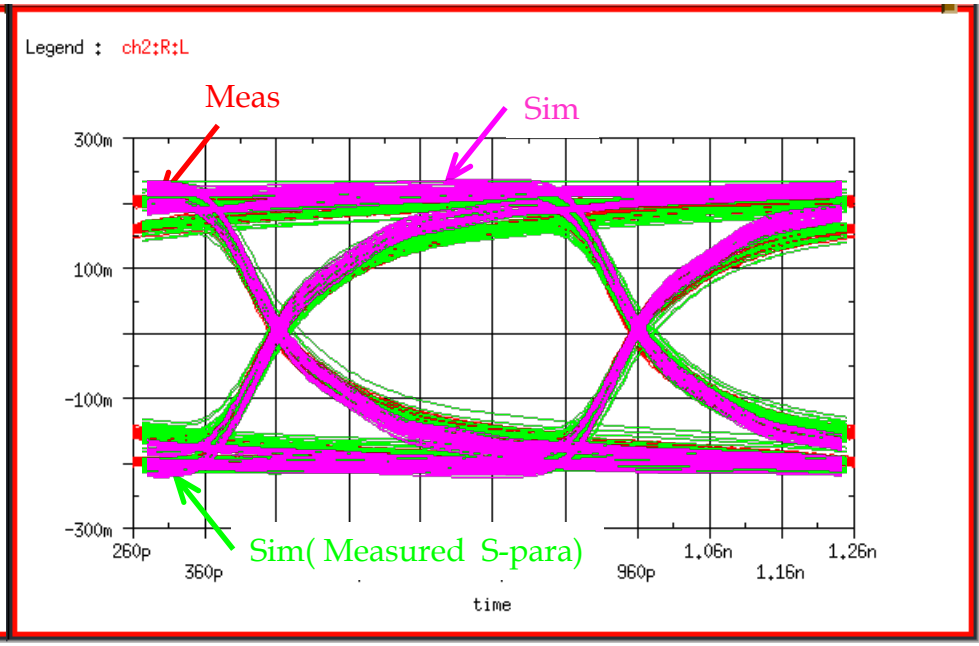
Bit rare:2Gbps



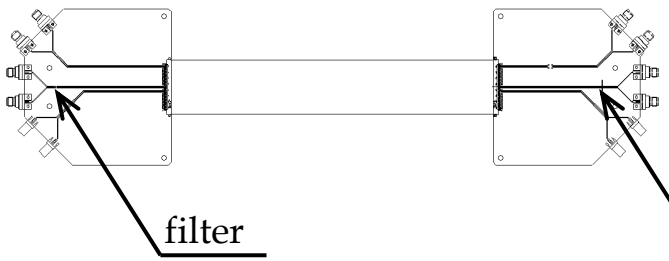
3.9 Comparison between Measurement and Simulation

Filter+Cable,Connector+slit





Input Wave →



← Measurement

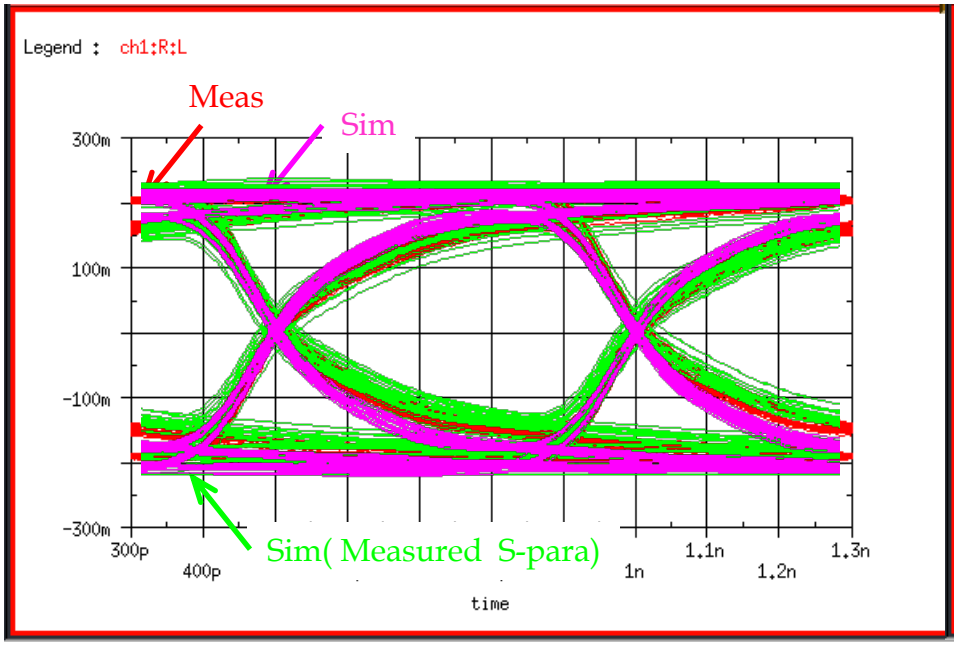
filter

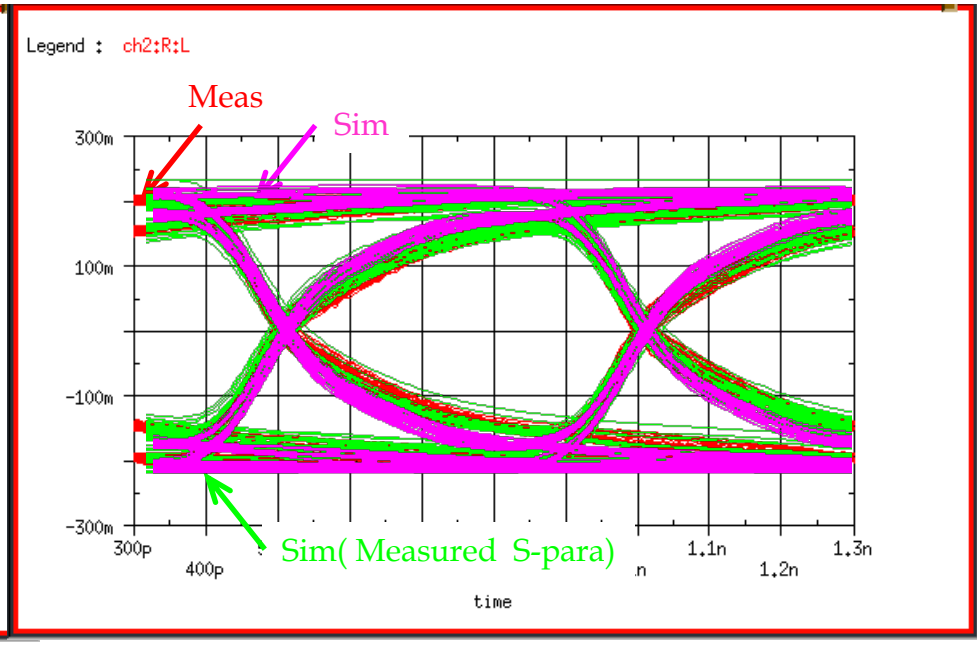
Slit

Bit rare:2Gbps

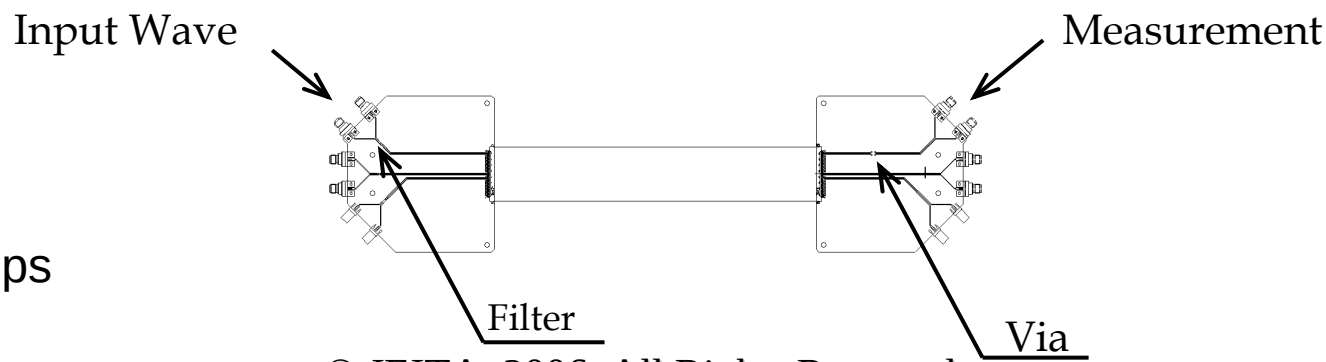
3.10 Comparison between Measurement and Simulation

Filter+Cable,Connector+Via



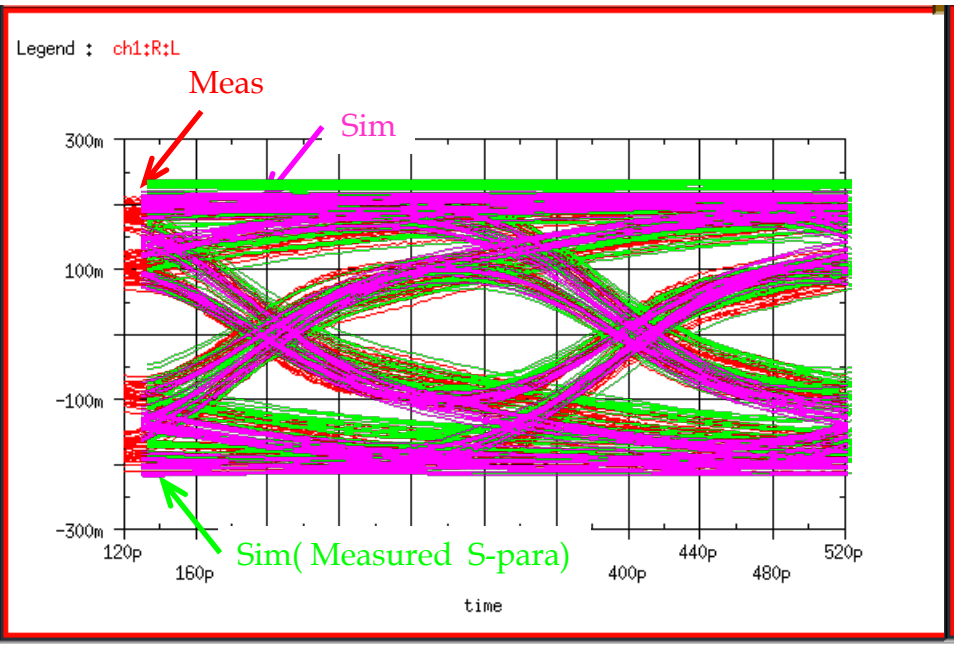


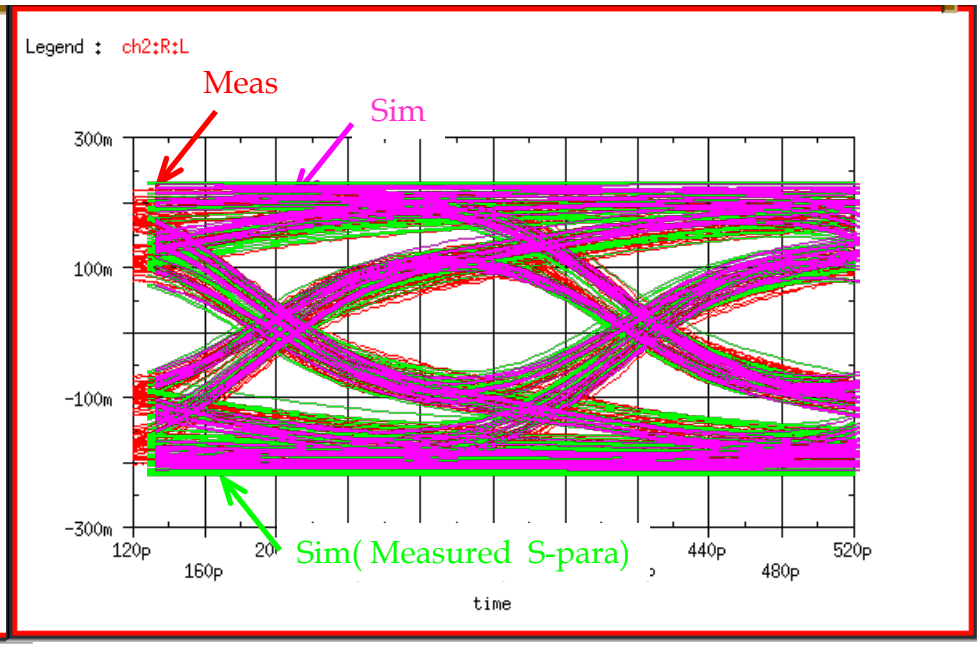
Bit rare:2Gbps



3.11 Comparison between Measurement and Simulation

Filter+Cable,Connector+traces without Via and slit





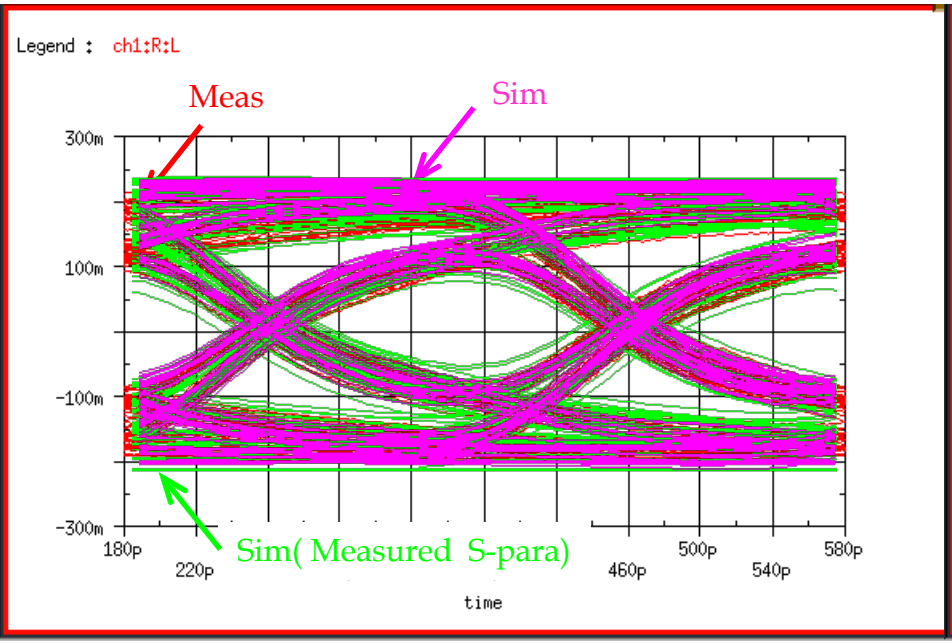
Input Wave

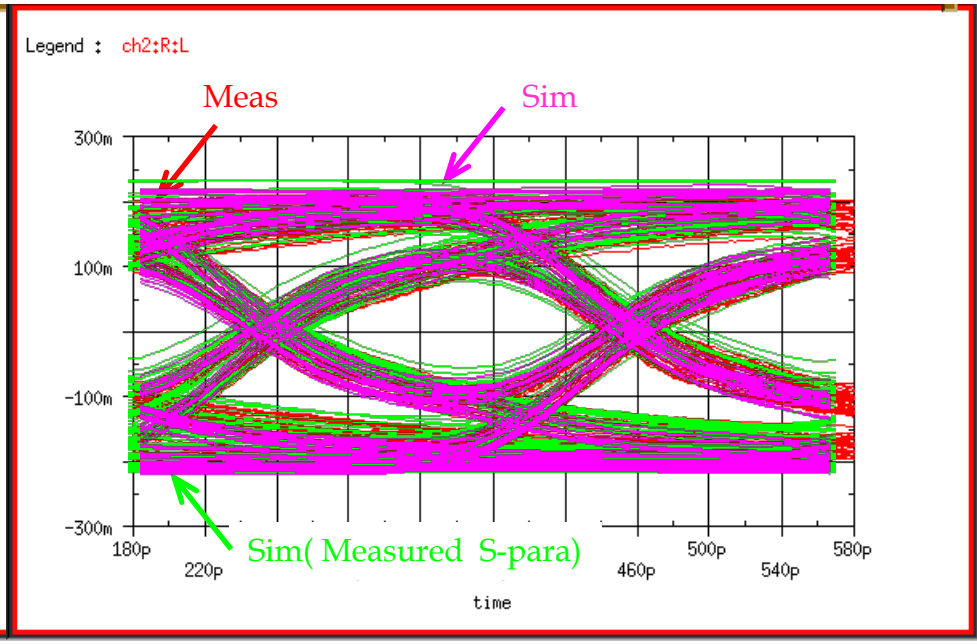
Measurement

Bit rare:5Gbps

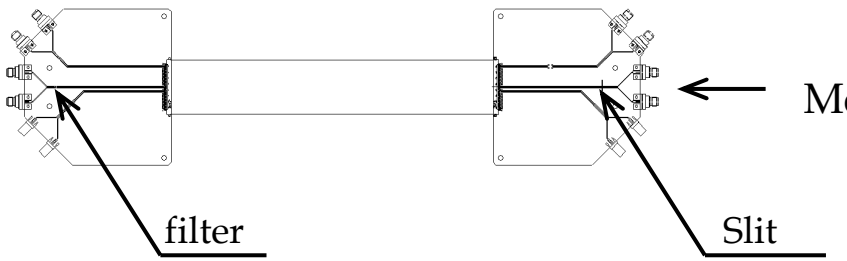
3.12 Comparison between Measurement and Simulation

Filter+Cable,Connector+slit





Input Wave →



← Measurement

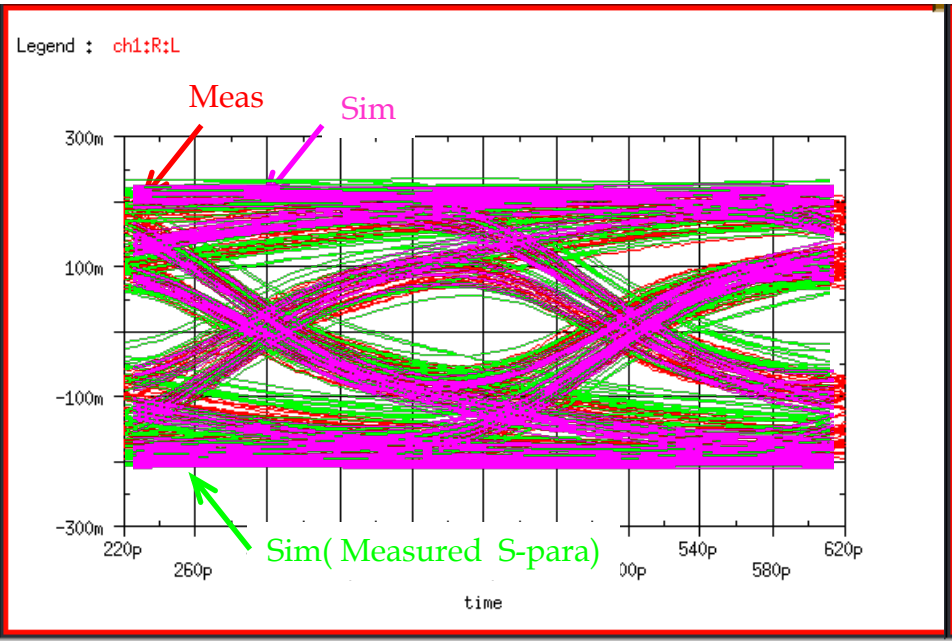
filter

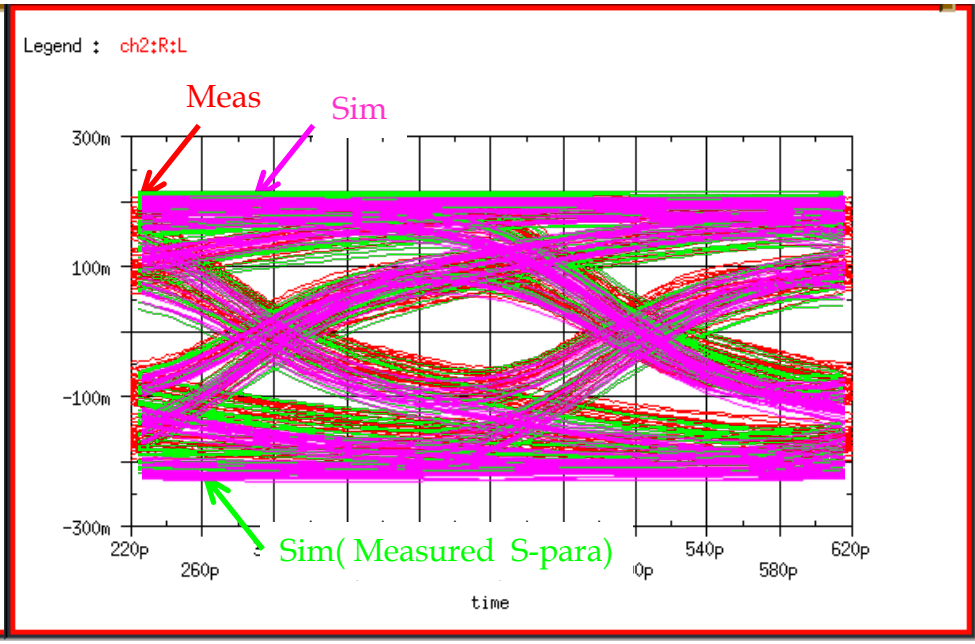
Slit

Bit rare:5Gbps

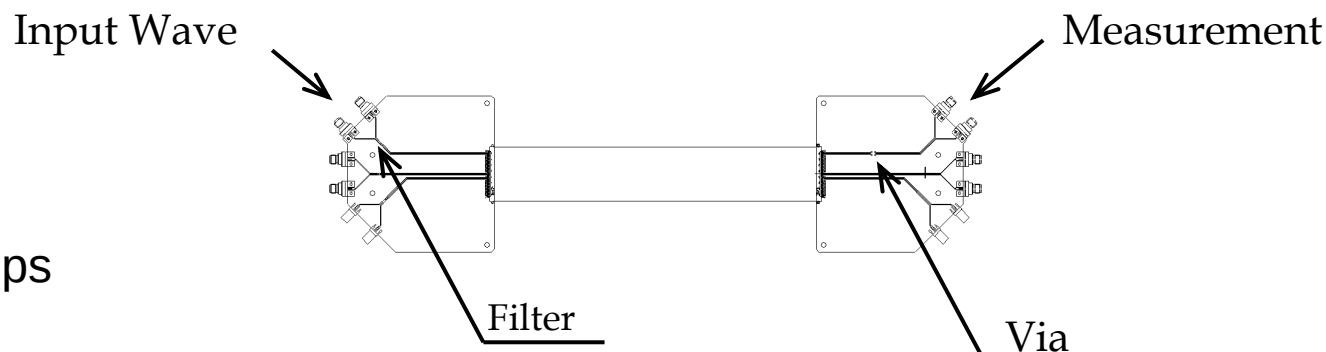
3.13 Comparison between Measurement and Simulation

Filter+Cable,Connector+Via



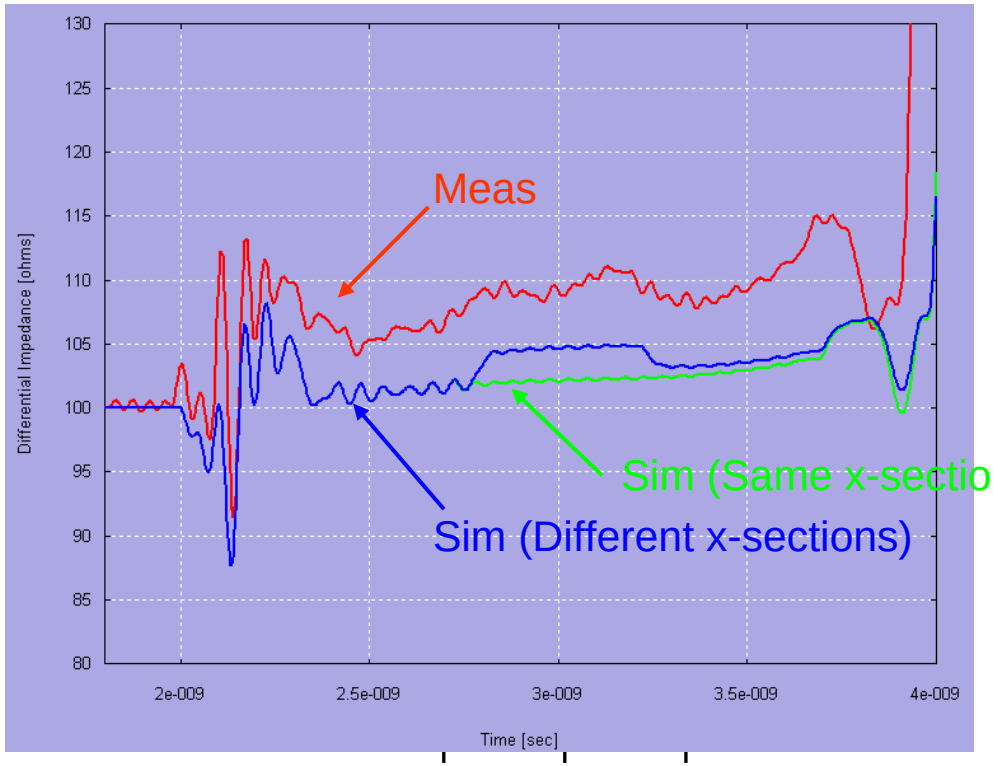


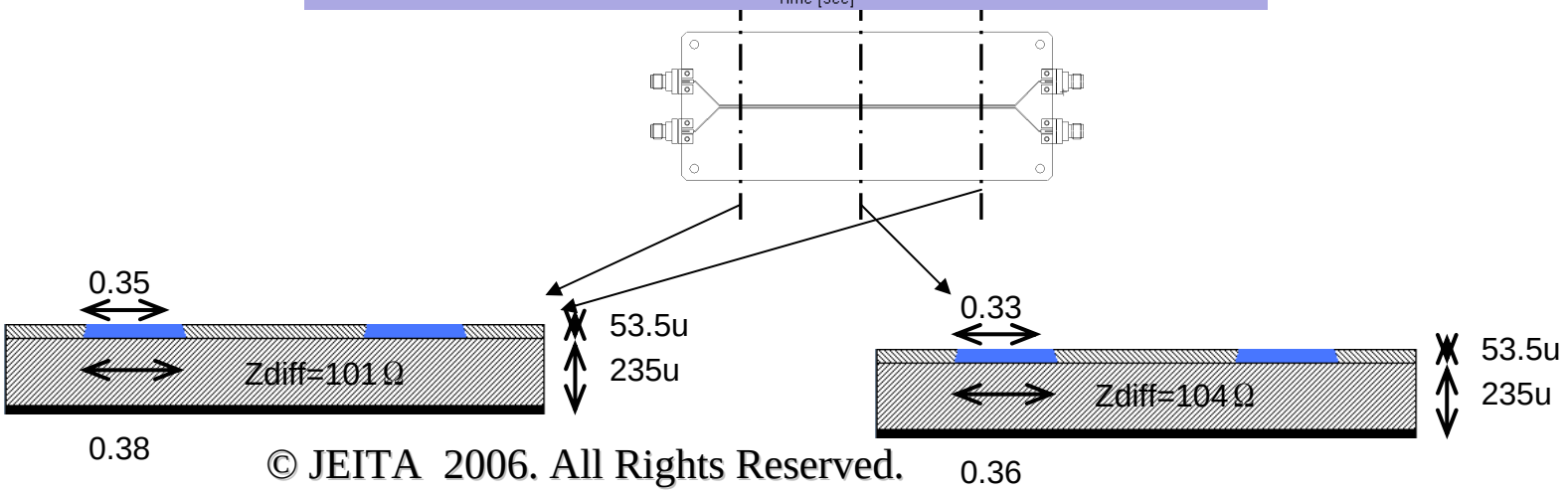
Bit rare:5Gbps



4. Accuracy of EDA models

4.1 Measured and Simulated TDR waveform

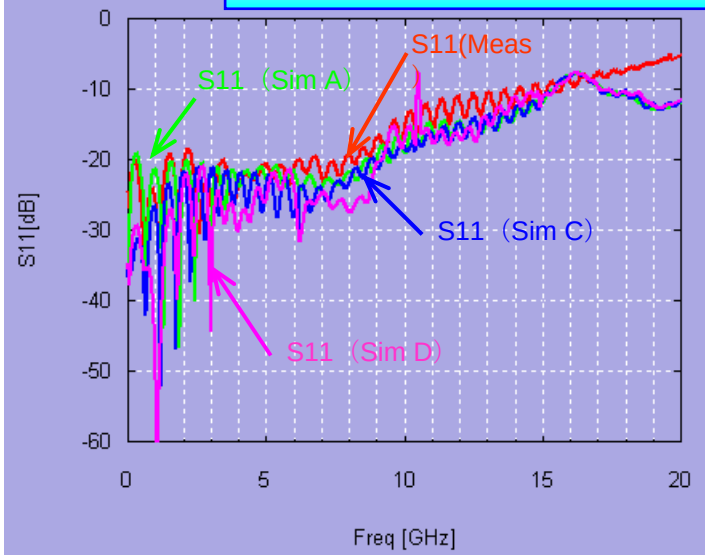


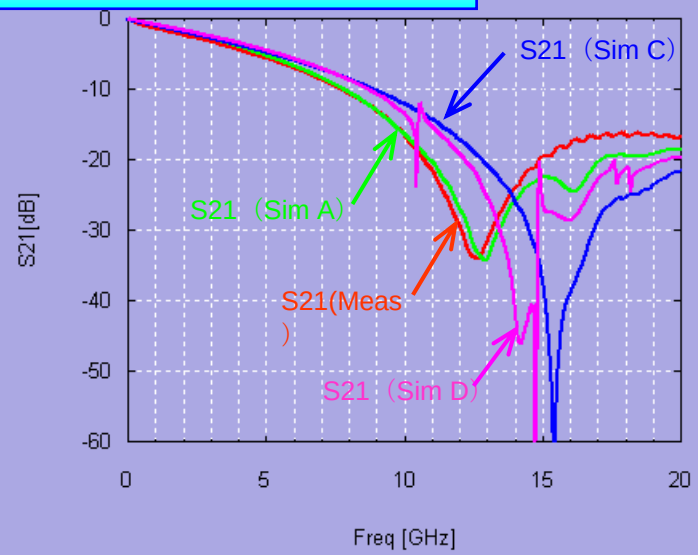


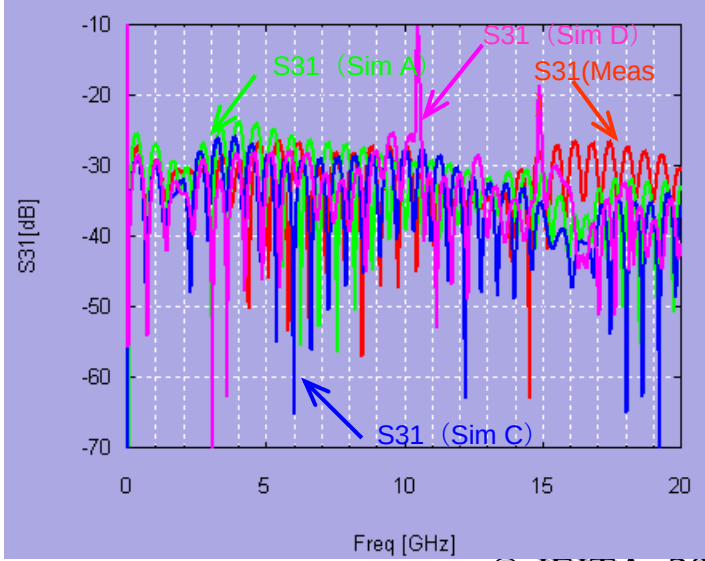
4. Accuracy of EDA models

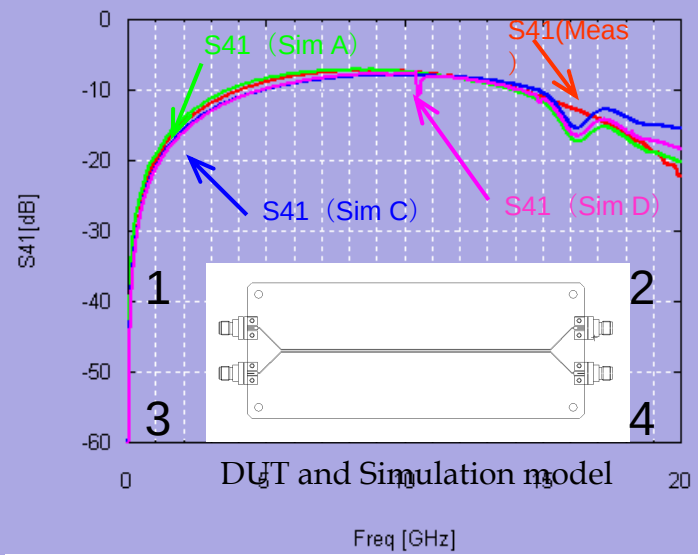
4.2.1 Measured and Simulated S-parameters

Differential MSL with Solid GND Plane







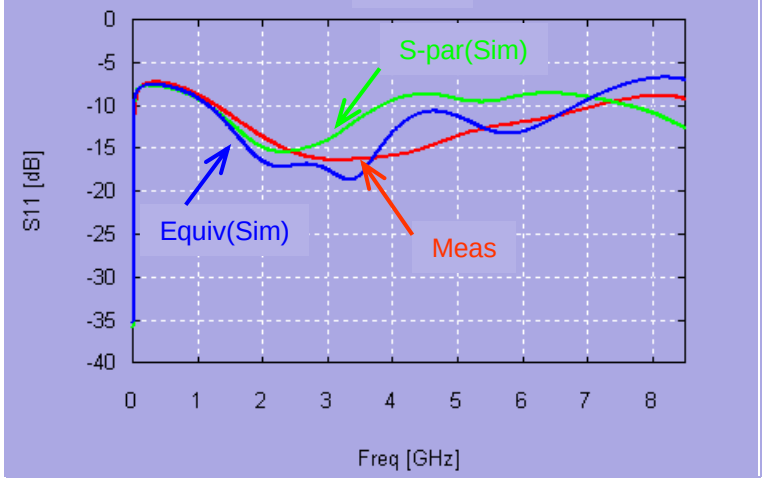


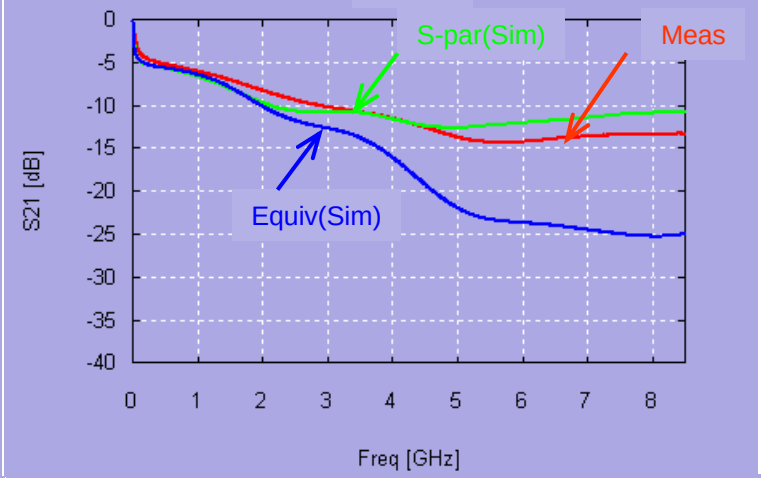
DUT and Simulation model

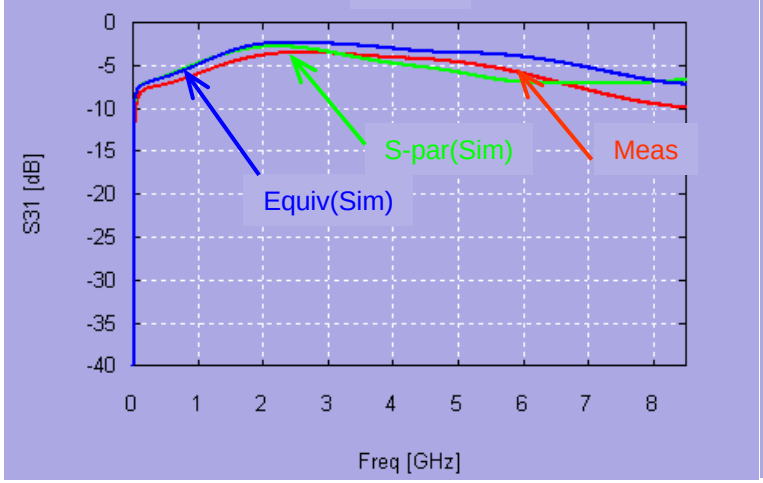
4. Accuracy of EDA models

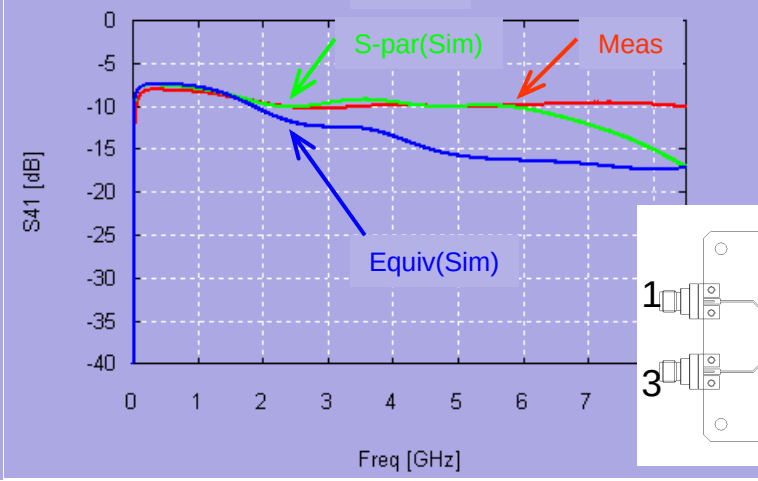
4.2.2 Measured and Simulated S-parameters

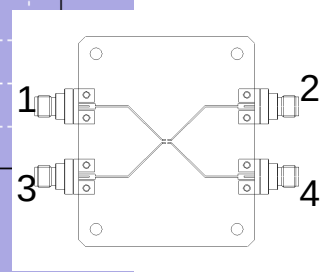
Filter A







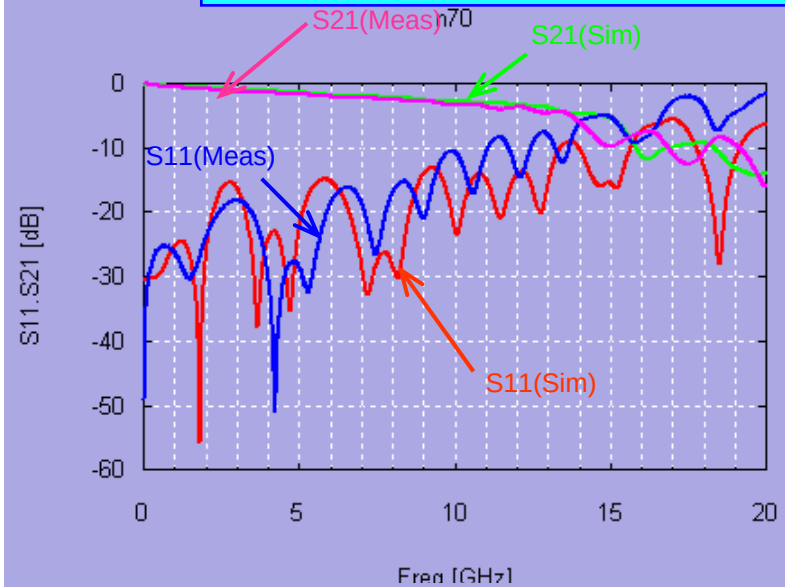


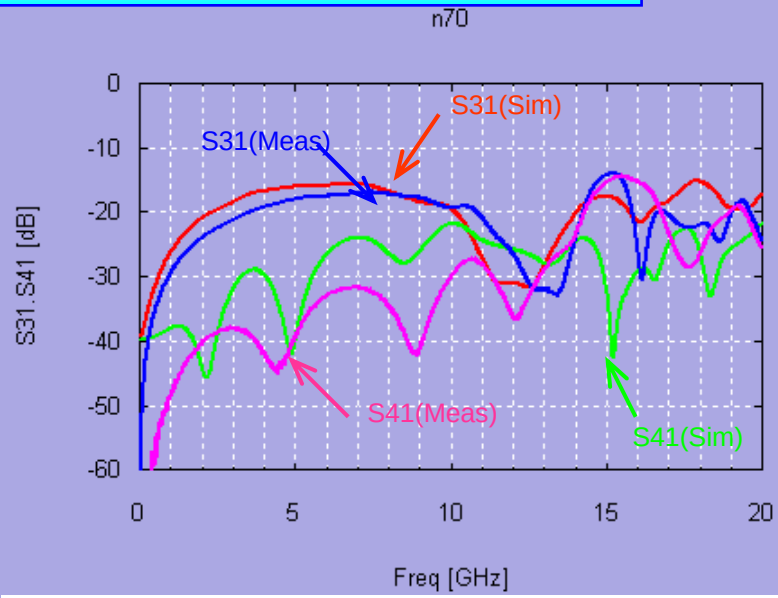


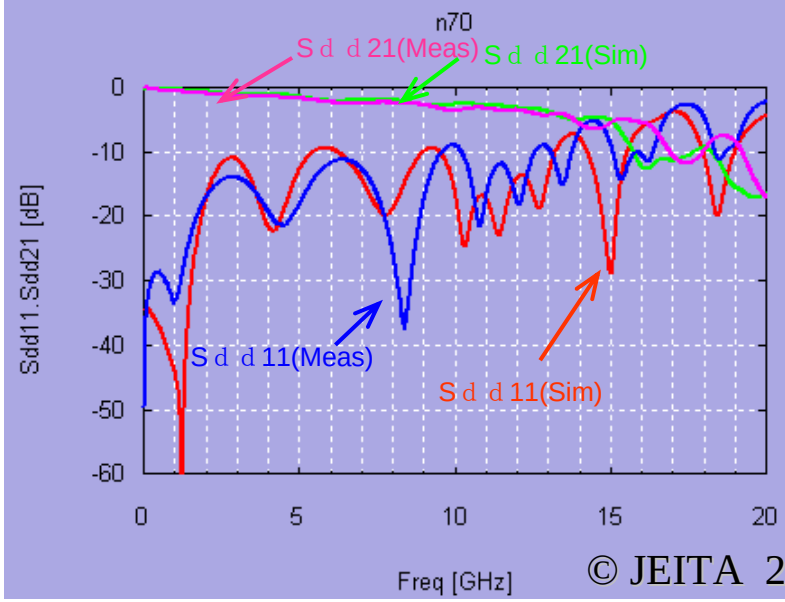
4. Accuracy of EDA models

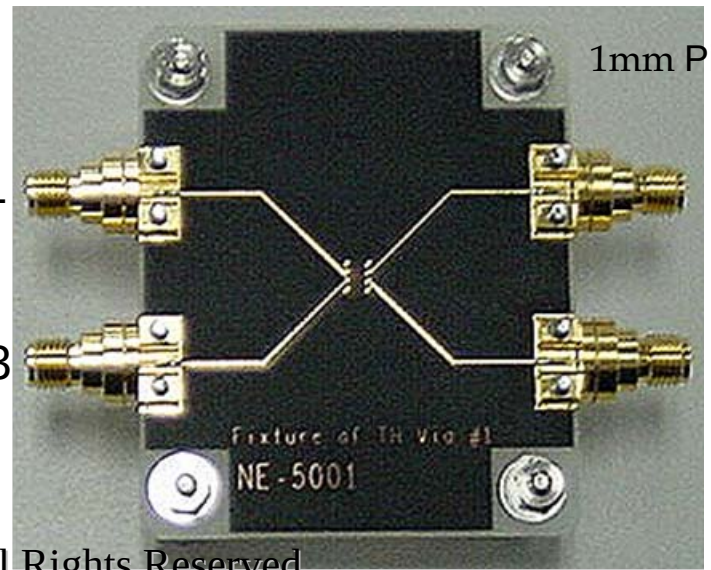
4.2.3 Measured and Simulated Mixed mode S-parameters

Via 1mm pitch



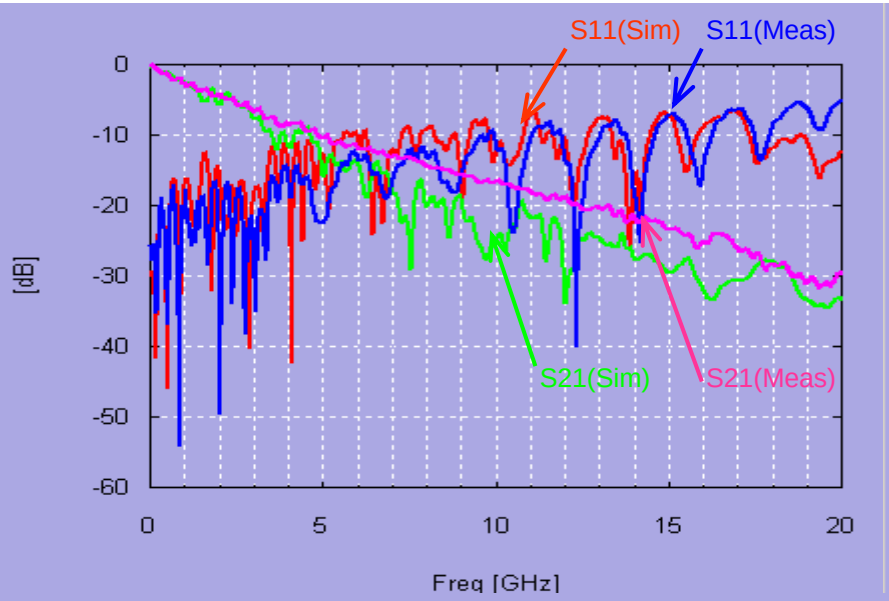


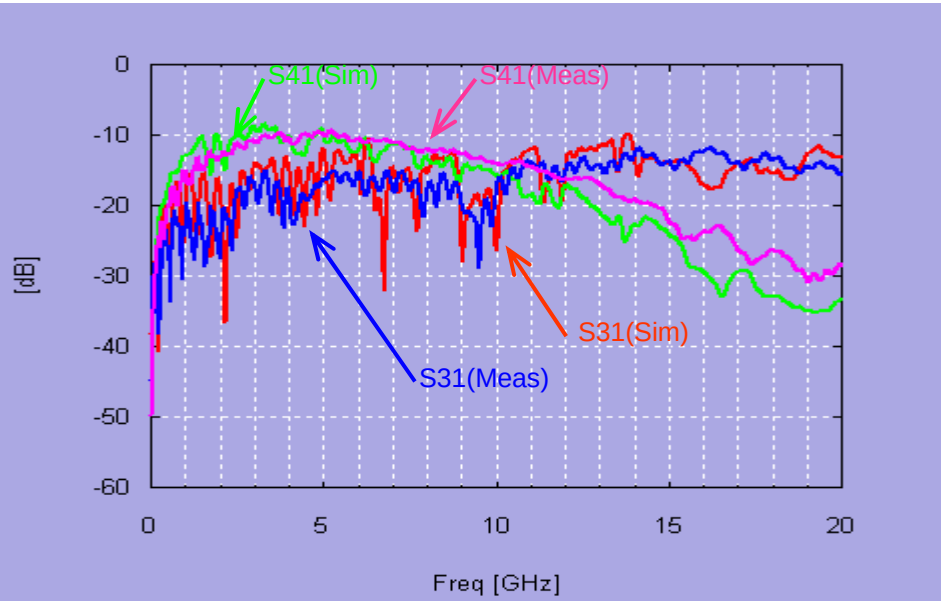


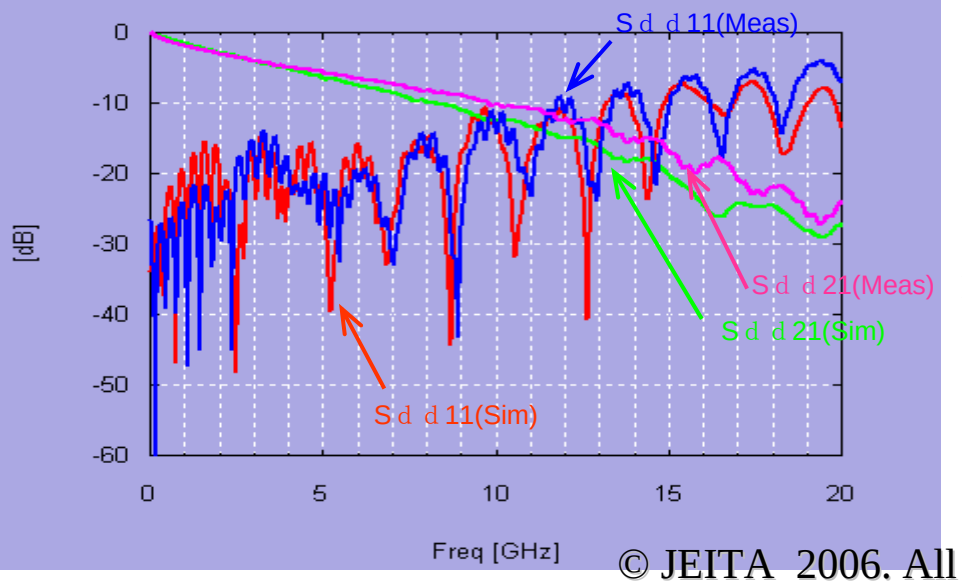


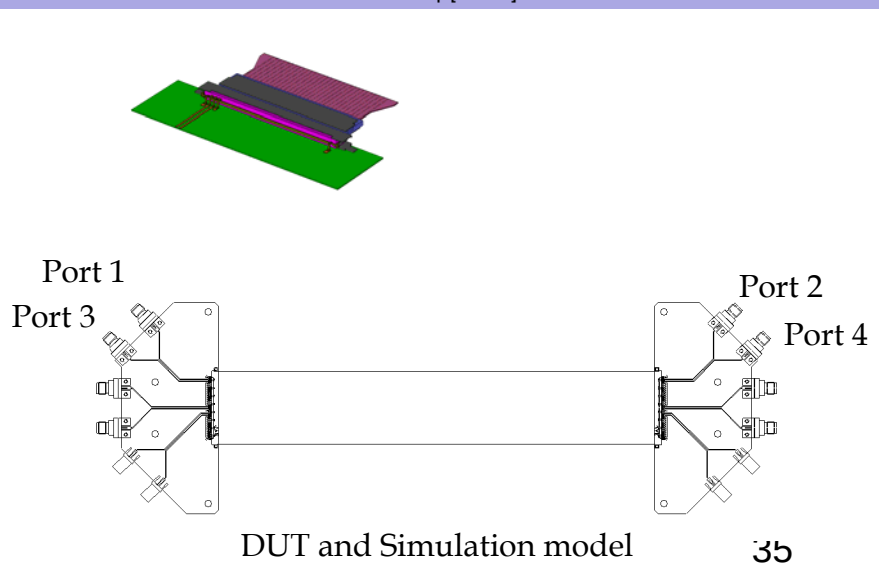
4. Accuracy of EDA models

4.2.4 Edge of Connector Cable









DUT and Simulation model

5. Conclusion

1. Measurement and simulation of Interconnect model were done.

2. Simulation used by EDA models whom component manufacturer provides and measurement are nearly agreed.

3.Each simulator accepts S-parameters and directly simulate them.

4.It is necessary to note that a design value and an actual value might be different when EDA model of PCB is made.

Gratitude to cooperation in measurement and simulation

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Mr. Hirotsugu Ueno	Cadence Design Systems
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Mr. Nobuhiko Kawai	Murata Manufacturing
Mr. Jun-ichi Wakasa	TDK
Mr. Yasumasa Kondo	Toshiba
Mr. Testuo Iwaki	Sharpe