IEEE SW Test Workshop
Semiconductor Wafer Test Workshop

June 12 to 15, 2011
San Diego, CA

High Density and High Speed Approach for Probe Card PCB

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Overview

- Technical trend for wafer level testing
- Requirement for high density and high speed application on PCB level
- Approach for Higher Density
- Approach for Higher Speed
- Summary

Technical trend for wafer level testing

- **Capability for Higher Density and Higher Speed Device**
- **Lower cost and Shorter testing time (Reduction in number of contact)**

Requirement for PCB level

- High Density and Shorter testing time ;
  - Application of Fine line
  - Additional Signal layers
- High Speed ;
  - Application of Low signal resistance
  - Application of Low Dk, Df material
- Thickness limitation ;
  - PCB thickness must be less than 6.2mm normally

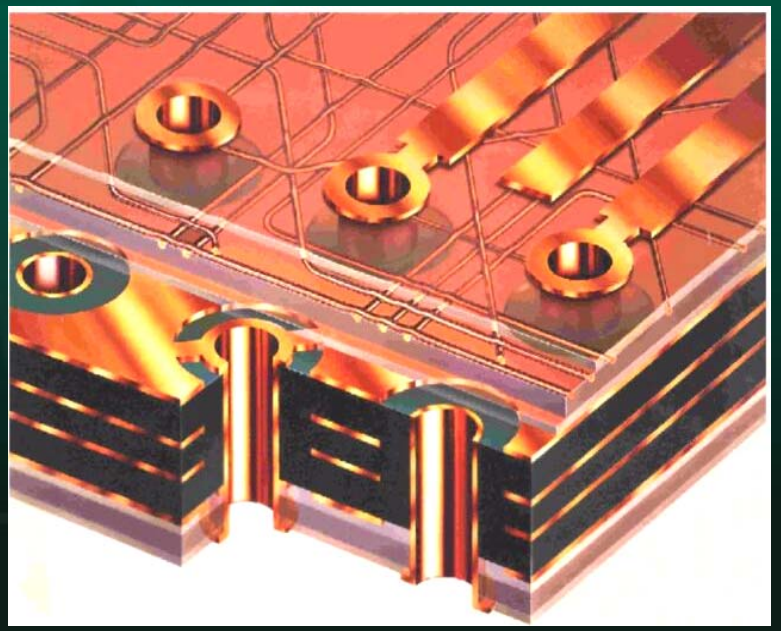
Difficult for MLB (normal print and etch type PCB)

What is a best solution ?????

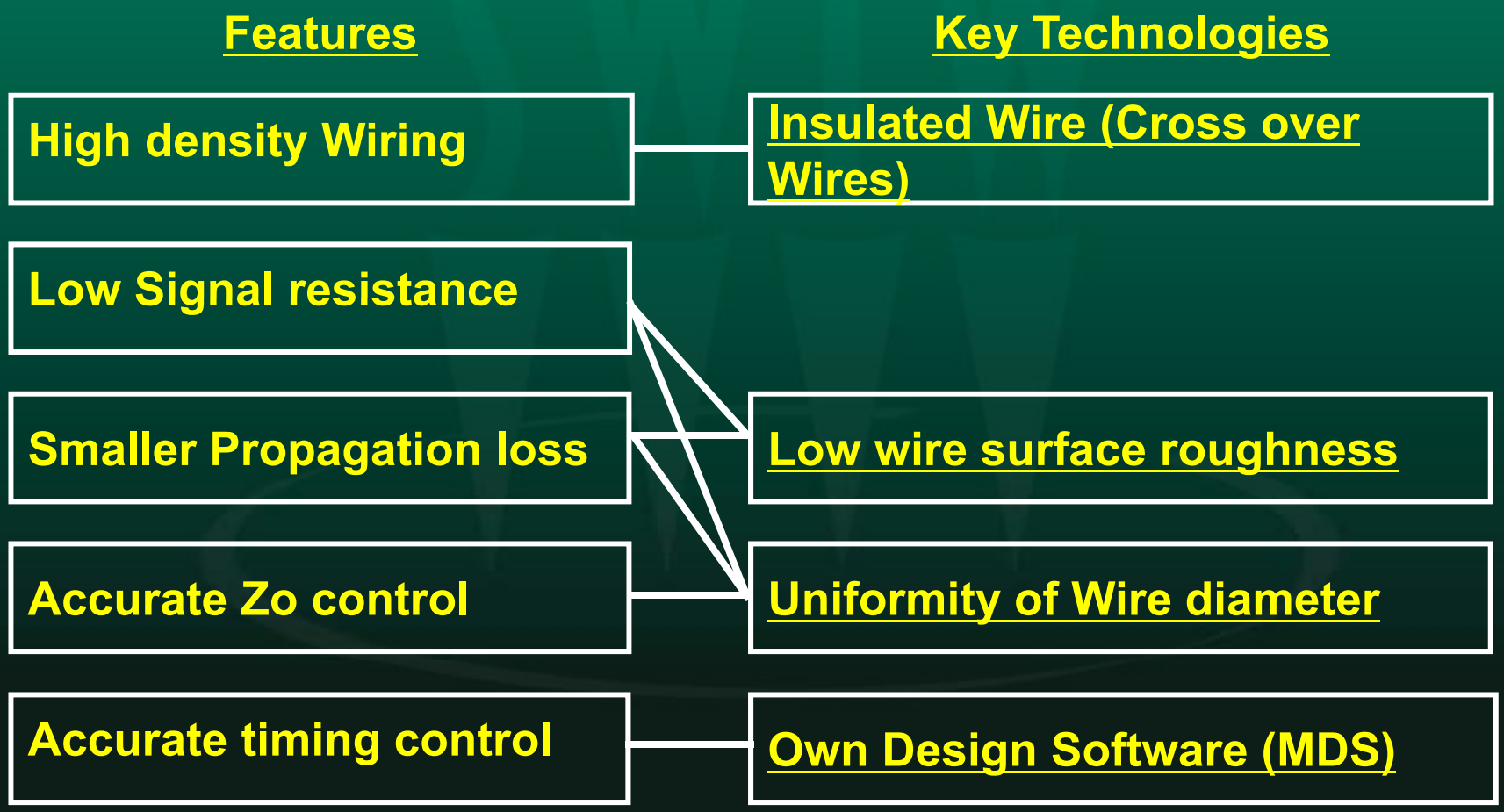
That is a MWB !!

*MWB (Multiwire Board) is a PWB which replaces etched signal traces with insulated copper wires

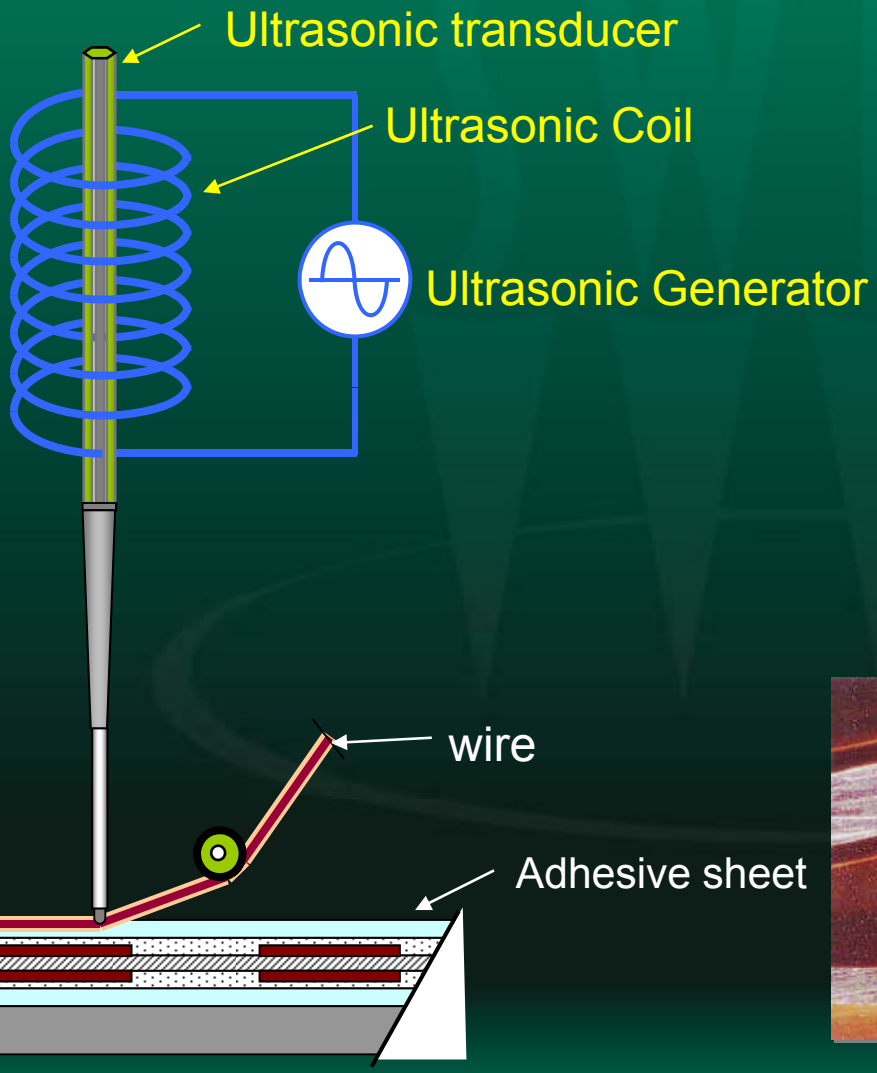
*Use of insulated copper wires greatly improves signal density

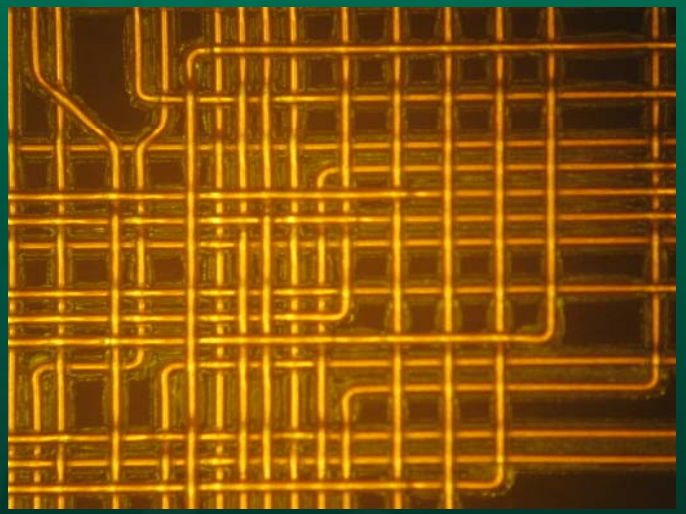


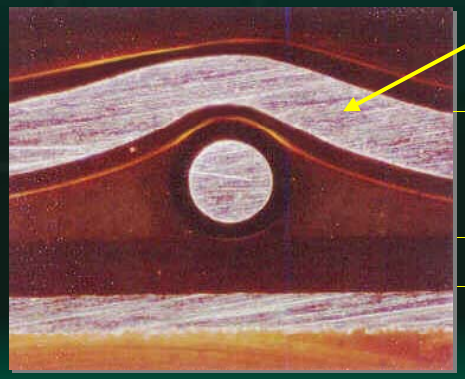
Features of MWB



Mechanism of Wiring

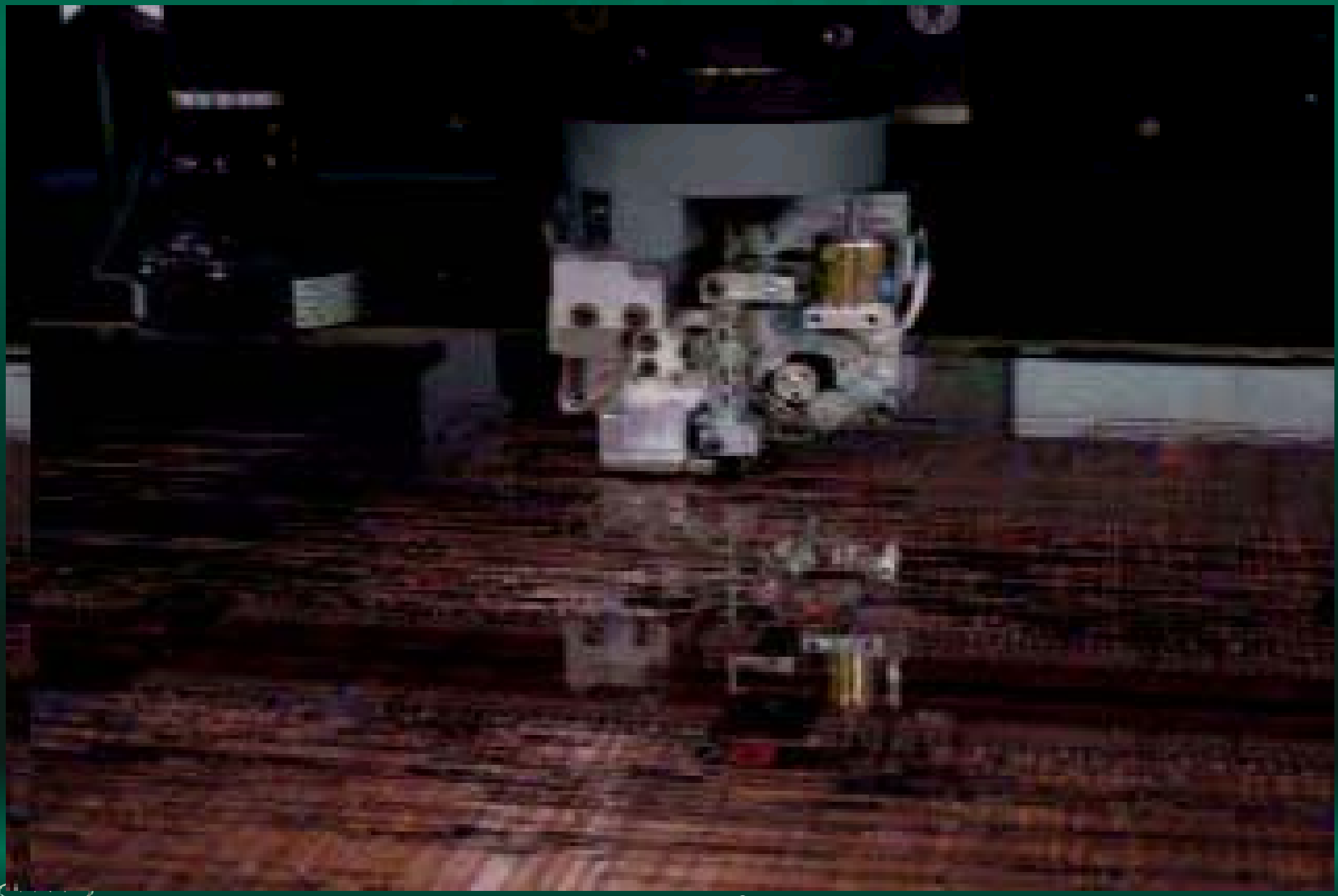




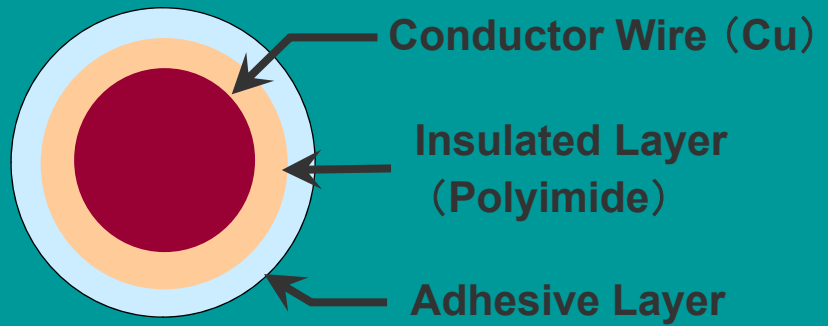


Wiring machine table

Actual Wiring Operation

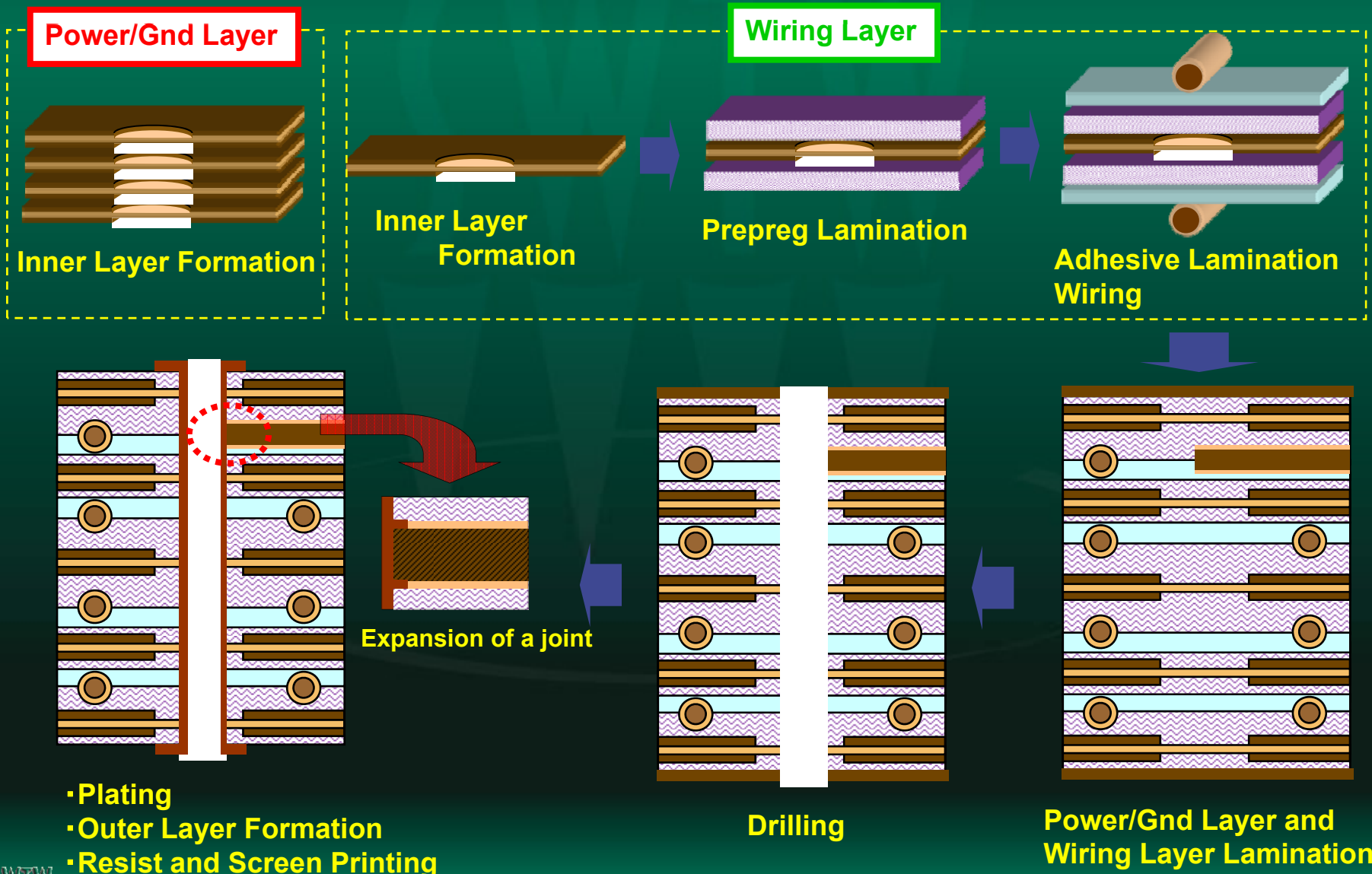


Wire structure and Electrical properties

Structure				
Wire diameter	mm	0.10 (+/-0.003)	0.08 (+/-0.003)	0.065 (+/-0.002)
Insulation thickness	mm	0.015	0.020	0.020
Adhesive thickness	mm	0.014（0.013～0.017）		
Outer diameter	mm	0.158	0.148	0.128
Electrical resistance	ohm/m	2.15	3.5	5.3
Current Capacity	A	0.7	0.5	0.3
Breakdown Voltage （max. available value ）	kV	>3.0 (12)	>3.0 (15)	>3.0 (12.8)

*Using this data as a reference

MWB Process Flow

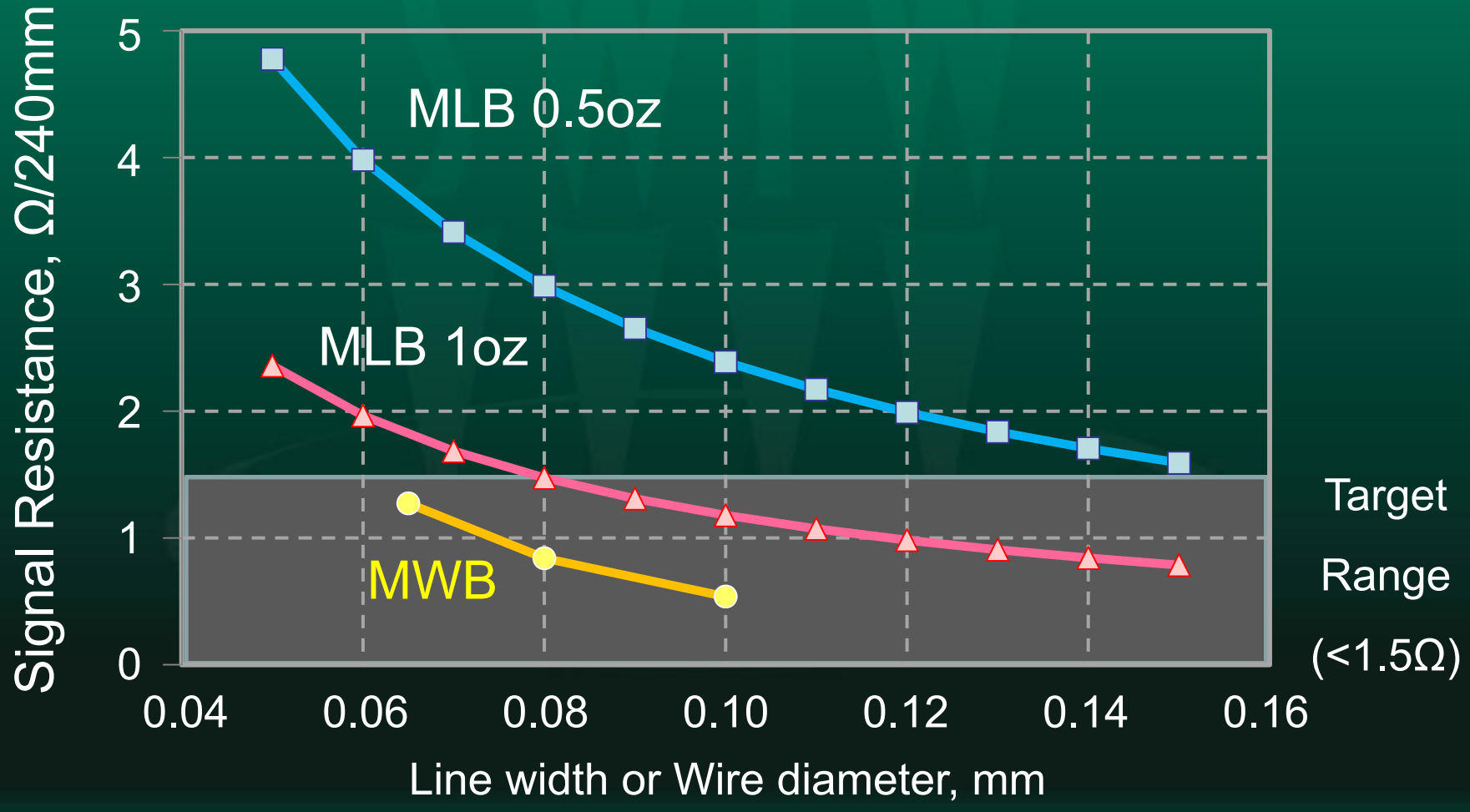


Approach for Higher Density

Key point for Higher Density

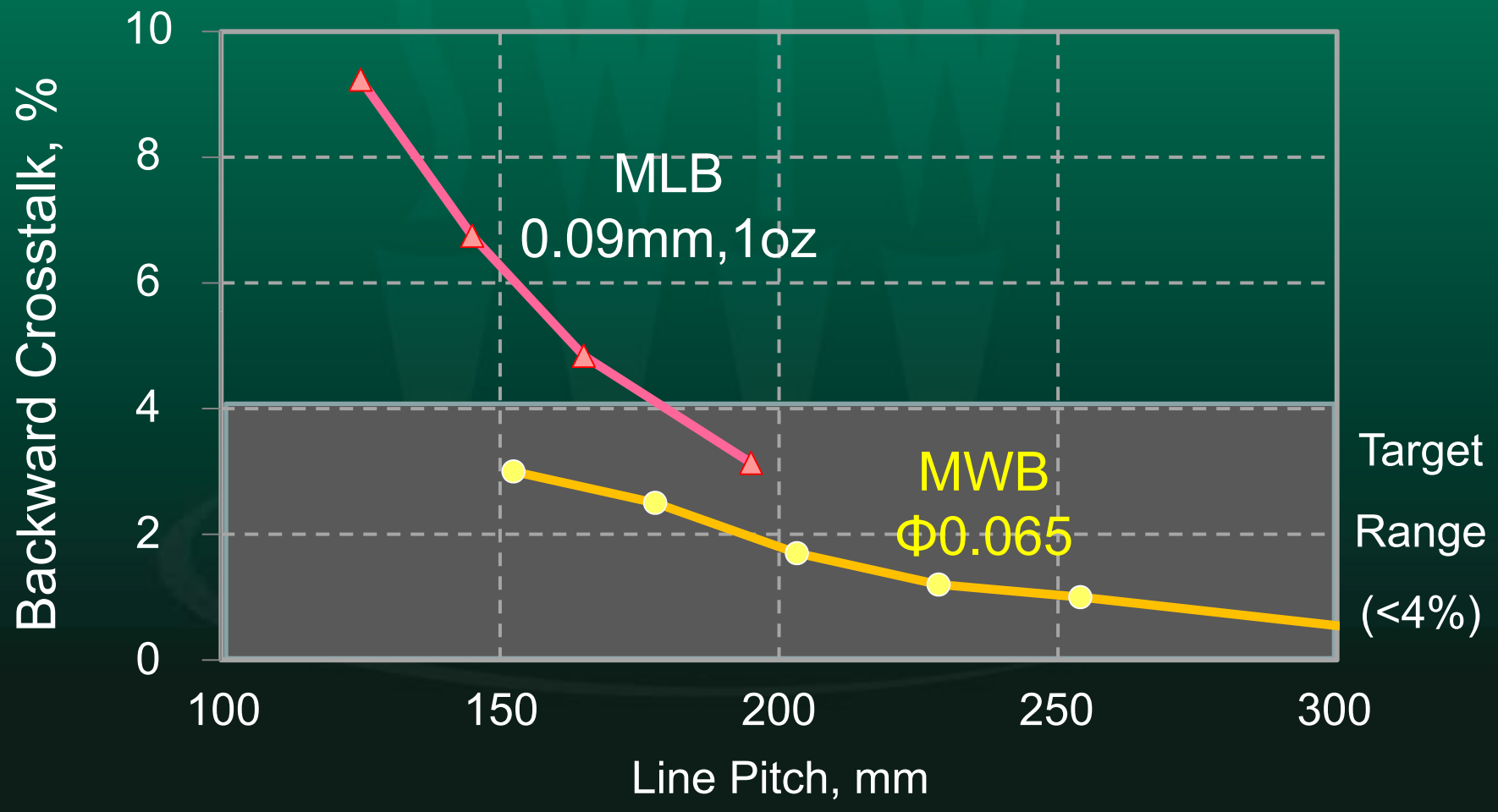
- Signal Resistance for fine line formation
- Cross talk for narrow signal pitch
- Impedance control for additional signal layers (distance between signal and Gnd)

Evaluation of Signal Resistance for MLB and MWB



*Using this data as a reference

Evaluation of Cross-talk (Backward) for MLB and MWB



[Condition] Material: Polyimide, L: 260mm, Z_0:50Ω, Tr:35.5ps

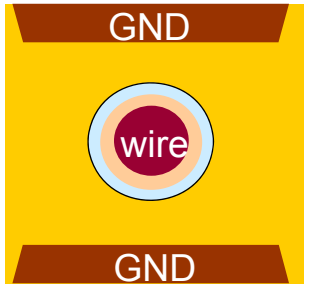
*Using this data as a reference

Evaluation of Impedance for 0.065mm wire

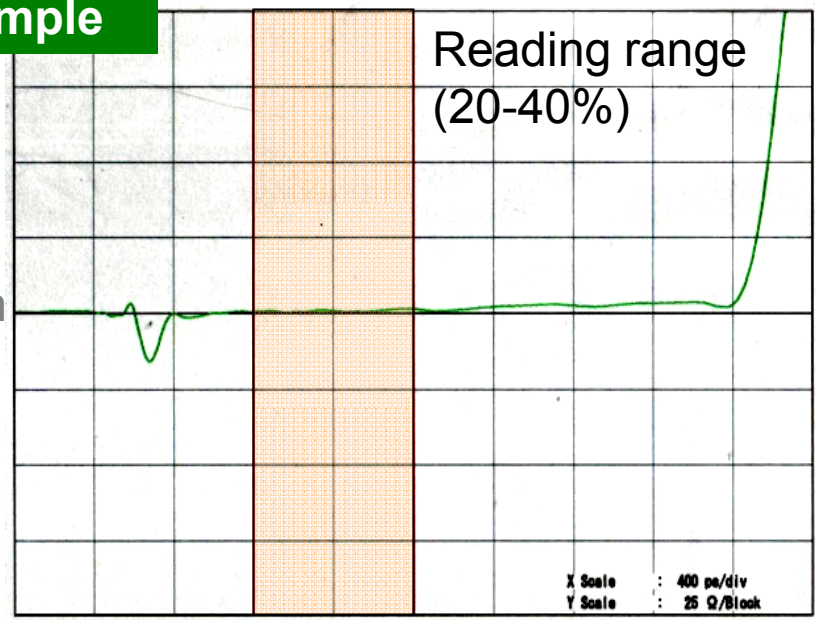
Unit : ohm

Item	Board-1				Board-2				TotalAve
	W1	W2	W3	W5	W1	W2	W3	W5	
Ave	52.30	50.62	52.19	50.66	51.88	50.30	51.83	50.69	51.31

Strip-line



Example

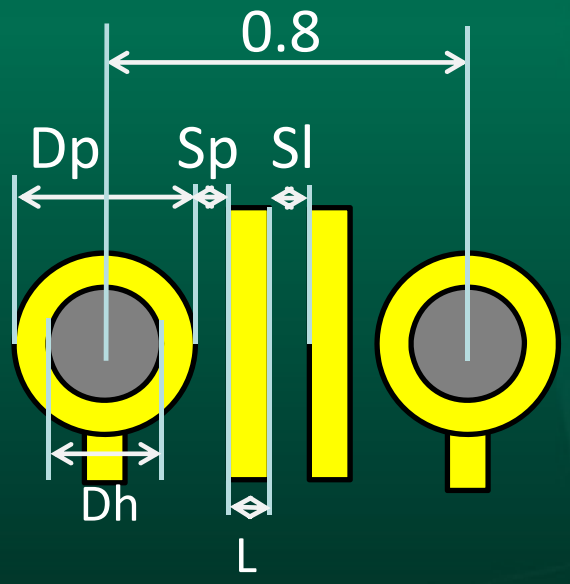


Note :

- Evaluation PWB : MWB (Strip-Line)
- Material : polyimide (I671)
- Temperature & Humidity : 25℃/60% RH
- Method : TDR

*Using this data as a reference

2Lines/0.8mm Design Study for MLB and MWB



Dh : Hole Dia.

Dp : Pad Dia.

L : Line width

Sl : Space (L-L)

Sp : Space (P-L)

Item	Unit	MLB(1)	MLB(2)	MWB
Thickness	mm	6.2		
Drill Dia.	mm	0.25	0.25	**0.25**
Pad Dia.	mm	0.40	0.40	**-**
Line width	mm	0.090	0.080	**0.065**
Space L-L	mm	0.120	0.080	**0.113**
Space P-L	mm	**0.050**	0.080	**-**
Resistance	Ω/m	5.5	**7.0**	**5.3**
Crosstalk	%	<5%	**10% <**	**<4%**
Comment		NG	NG	**OK**

MWB is suitable for both high density wiring and high electric performance

***Using this data as a reference**

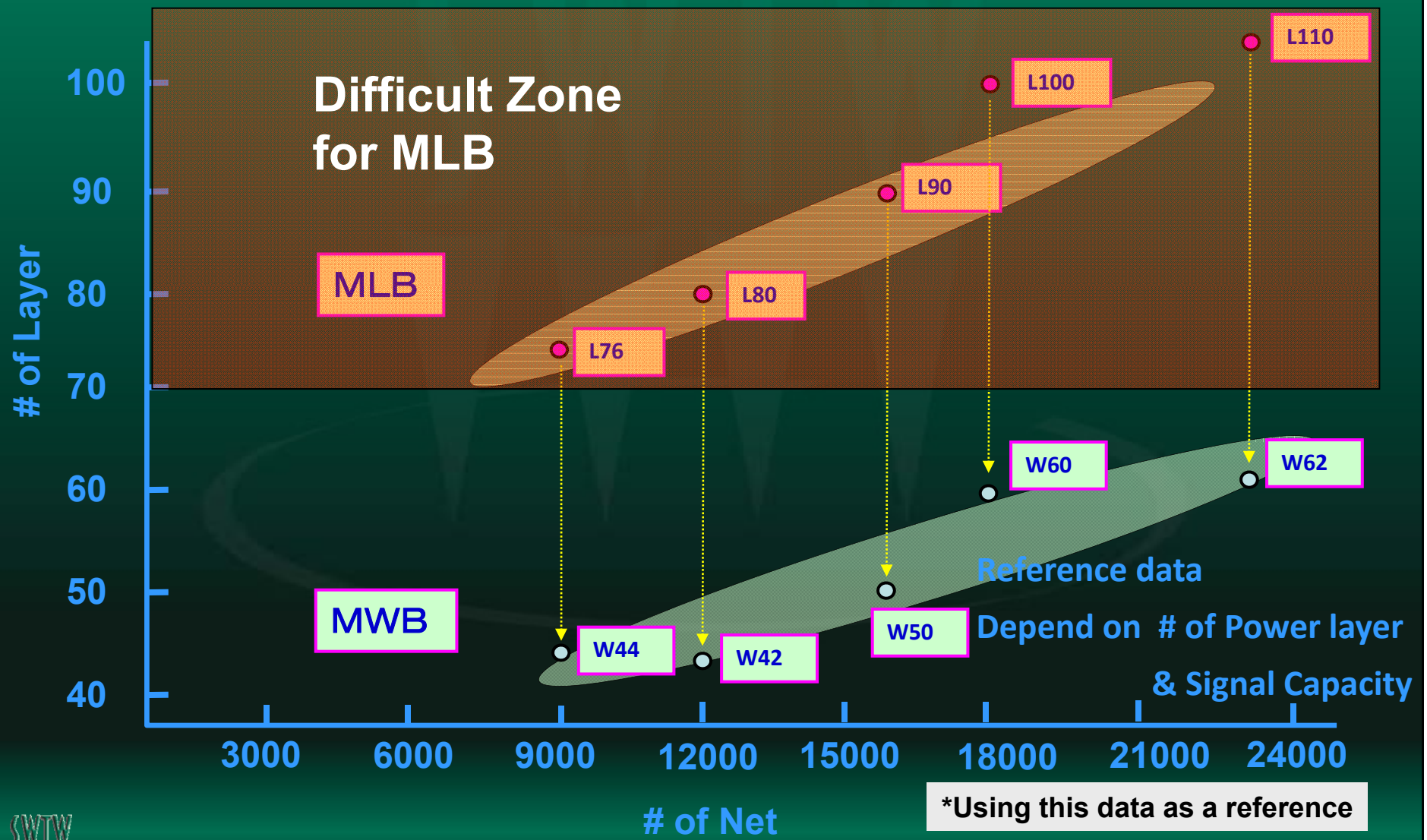
Signal Capability study for MLB and MWB

TH pitch	Item	MLB	MWB
0.8mm	Line/Pitch	1	2
	Signal/Layer	300	1000
	Capable Net Count	9,000 (30 layers)	12,000 (12 layers)
1.0mm	Line/Pitch	2	3
	Signal/Layer	400	1200
	Capable Net Count	12,000 (30 layers)	15,000 (12 layers)

*Using this data as a reference

Signal capability study for MLB and MWB -2

MLB Layer=Wiring layer*2.5+ Power/Gnd Layer



*Using this data as a reference

Conclusion of Higher Density Approach

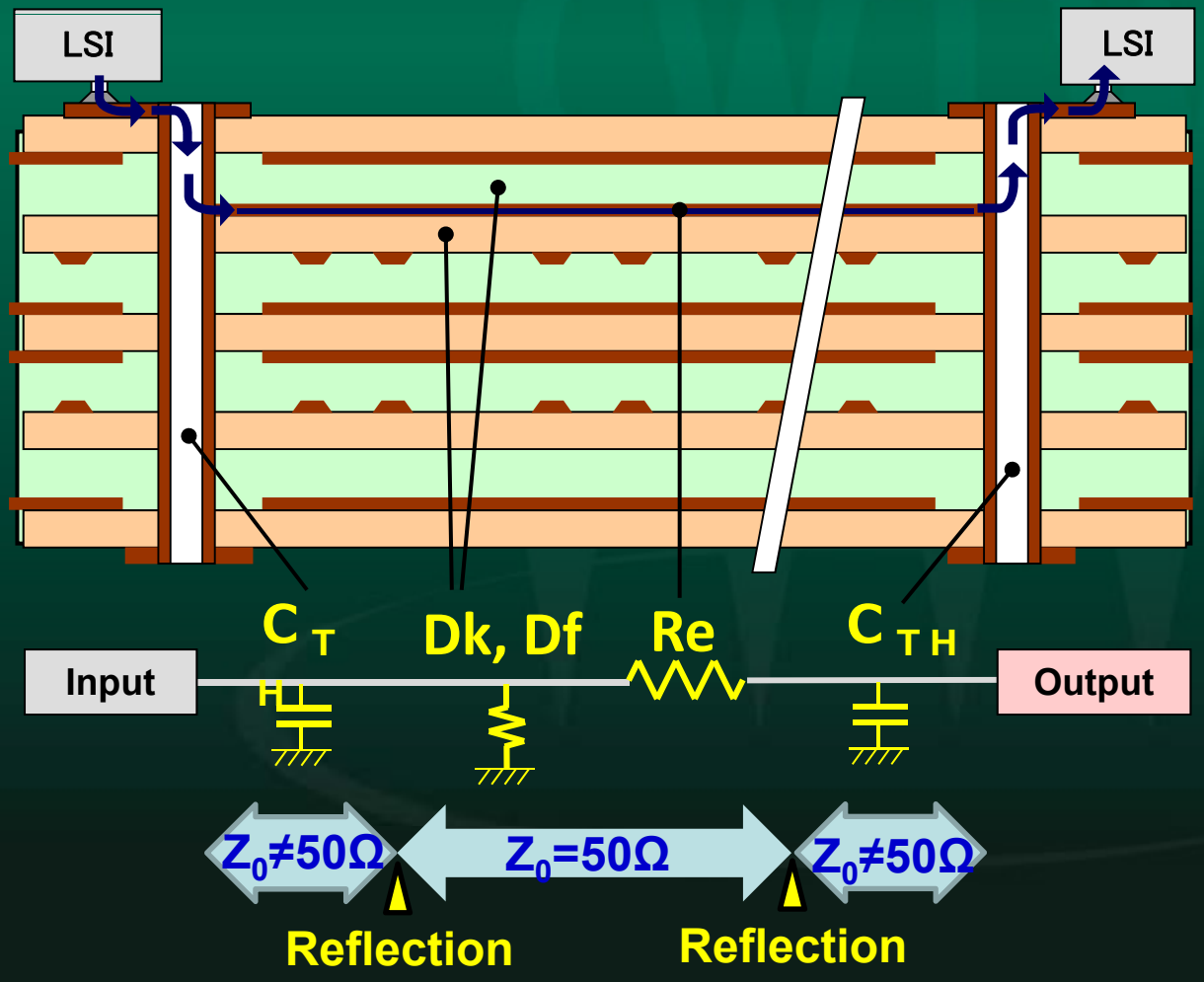
- Signal Density per layer of MWB is 2.5 times higher than MLB by using cross over wires
- MWB is also suitable for high electric performance
- MWB can reduce total # of layers or can use additional power layers by reducing signal layers comparing to MLB
- MWB has a potential capability for 23,000 nets

Approach for Higher Speed

Key point for Higher Speed

- Application of Low Dielectric (Dk, Df) material
- Low Conductor loss
- Elimination of Stub

Signal Integrity



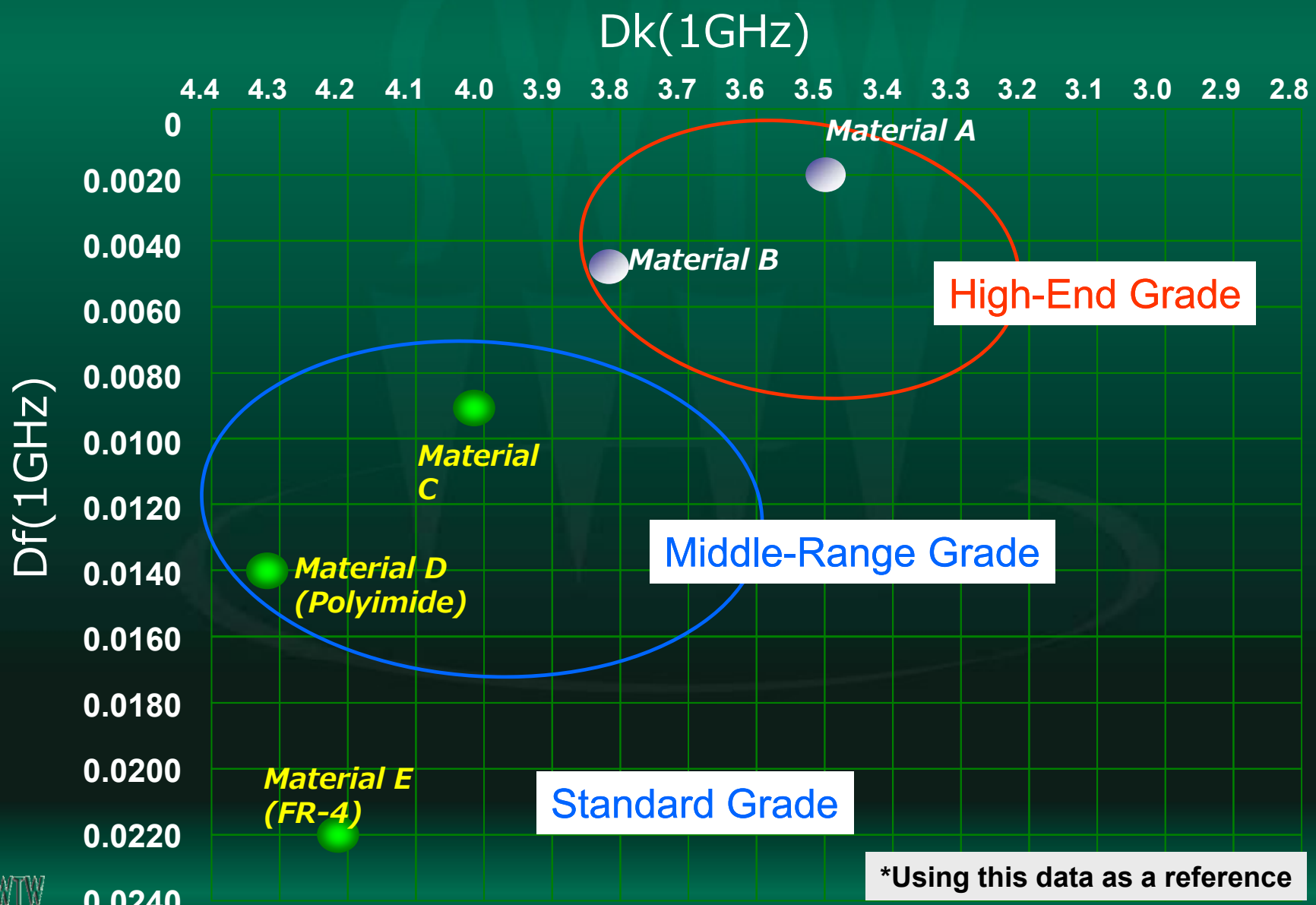
Attenuation

1. Dielectric Loss
   Dk, Df
2. Conductor Loss
   R e
3. TH capacitance,
   Stub C_{TH}

Noise

1. Reflection due to impedance mismatching
2. Crosstalk between signal lines

Dielectric (Dk, Df) property for each Materials



Key point for Low Conductor Loss

- **Low Conductor surface roughness (Minimize Skin Effect)**
- **Constant Conductor width**

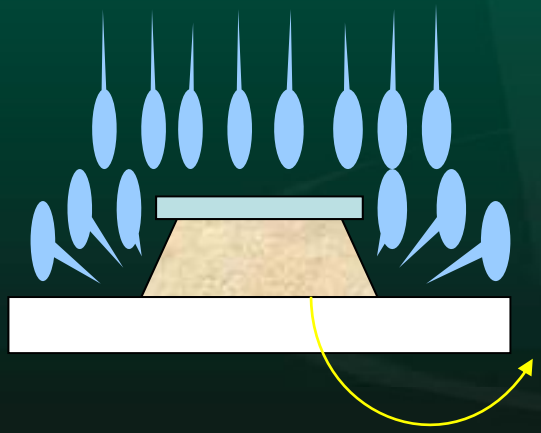
Study of Conductor Width and Conductor Surface Roughness for MLB and MWB

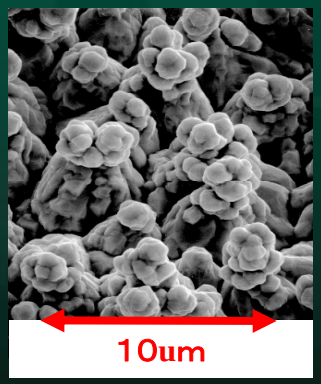
Constant Wire Diameter

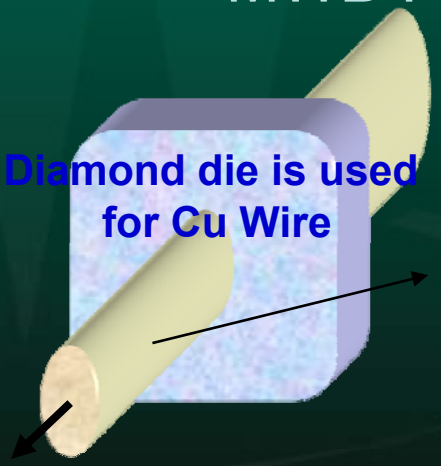
Small Roughness of Wire Surface

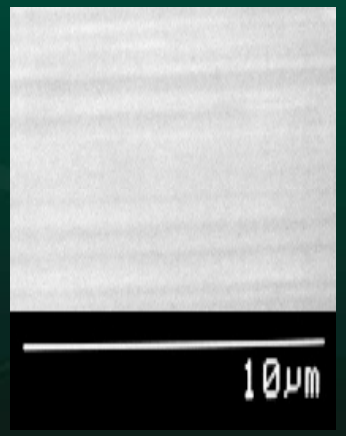
MLB : Etched Cu

MWB : Cu Wire







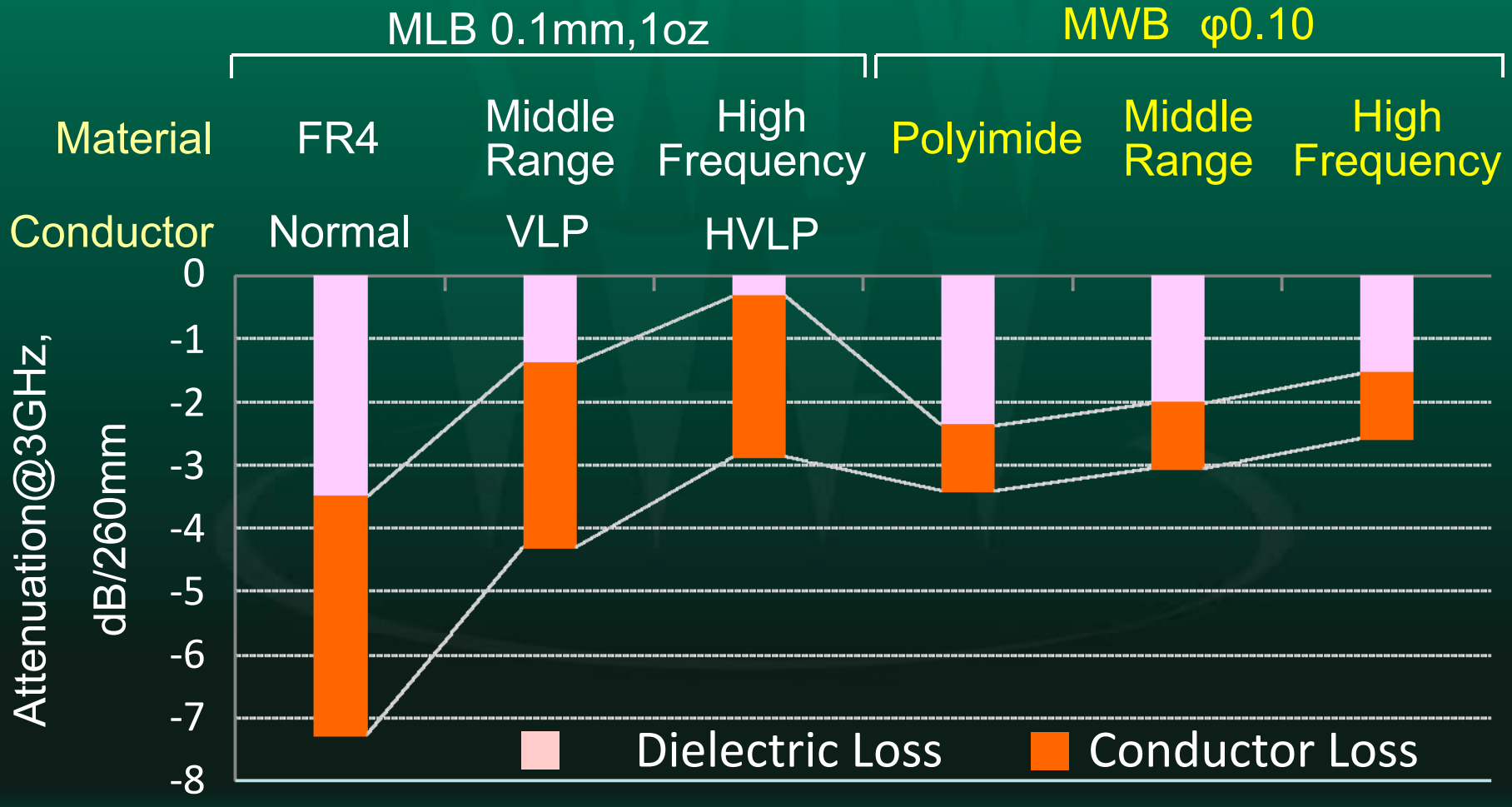


±0.025mm — **Tolerance of Conductor Width** — ±0.003mm

~10um — **Conductor Surface Roughness** — ~0.5um

Signal Attenuation Simulation

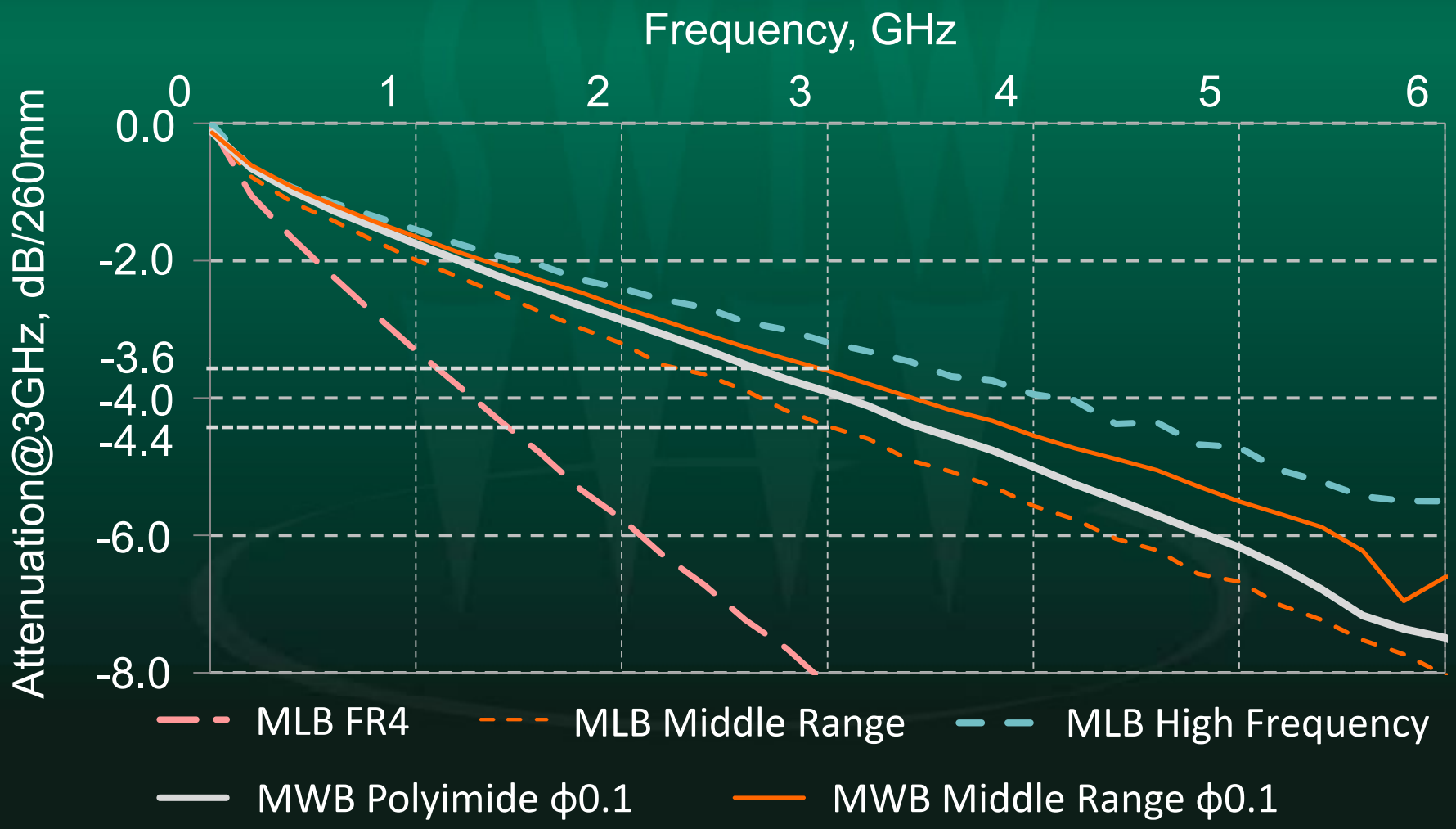
Attenuation = **Dielectric Loss (Dk, Df)** + **Conductor Loss (Re)**



Conductor loss of MWB is much less than MLB's

*Using this data as a reference

Attenuation measurement result

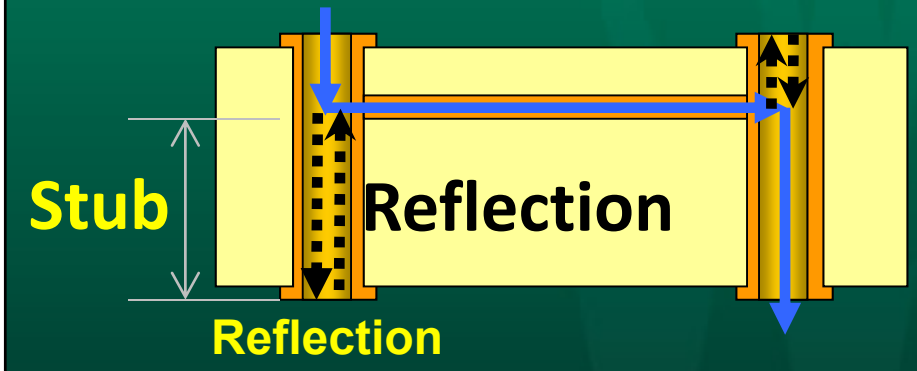


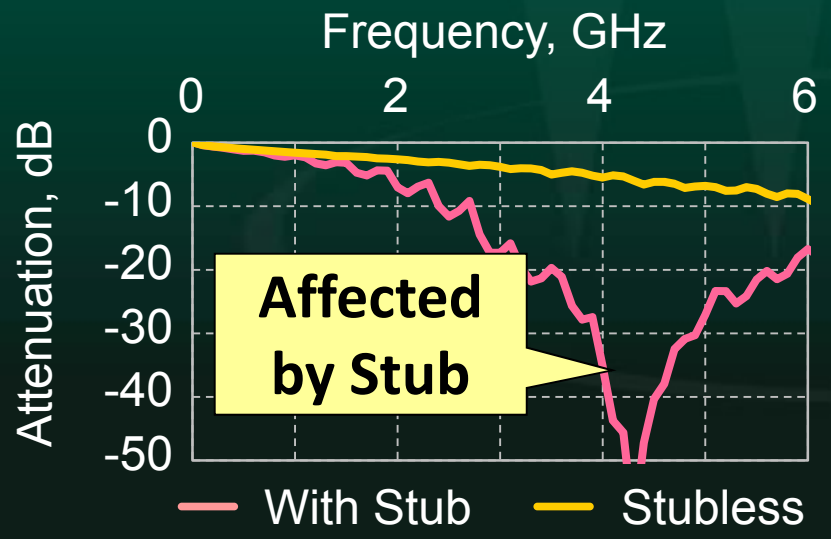
[Condition] MLB Line: 0.1mm/1oz, Z_0:50Ω

***Using this data as a reference**

Elimination of Stub

▪ Affect of Stub

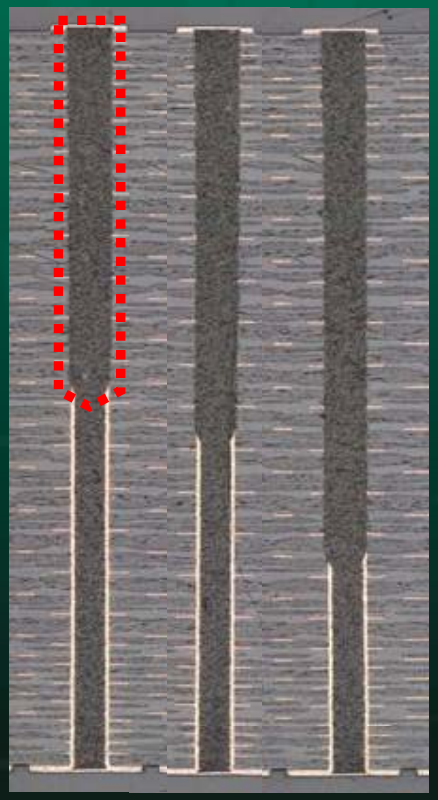




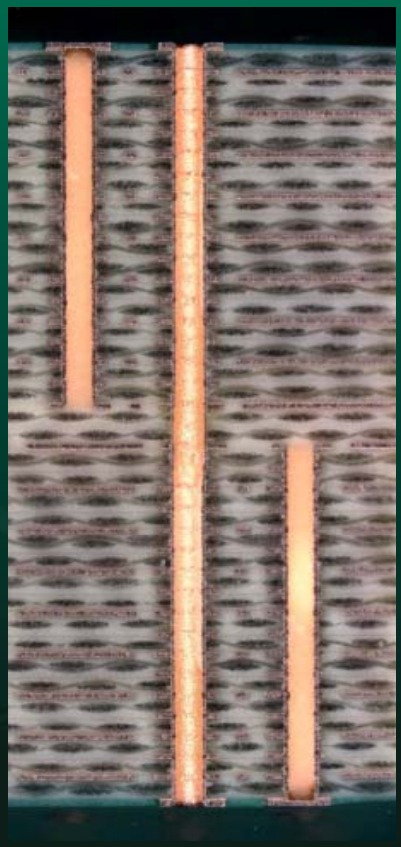
Material : HE-679G, Line Length : 250mm
Board thickness : 6.3mm, Depth of Back Drill : 4.0mm

*Using this data as a reference

▪ Solution for Stub



Back Drill
(Eliminate Stub)



Sequential Structure
(Reduce Via Length)

Conclusion of Higher Speed Approach

- MWB has a Low signal loss（-3.6dB@ 3GHz）) and suitable for higher speed Probe Card due to a good impedance control and low signal surface roughness (low skin effect)
- By using Low loss material and Back Drilling, MWB can be used for more Higher Speed Probe Card

Summary

Application of MWB is good solution for Higher density and Higher speed of Probe Card.

Thank you !!