

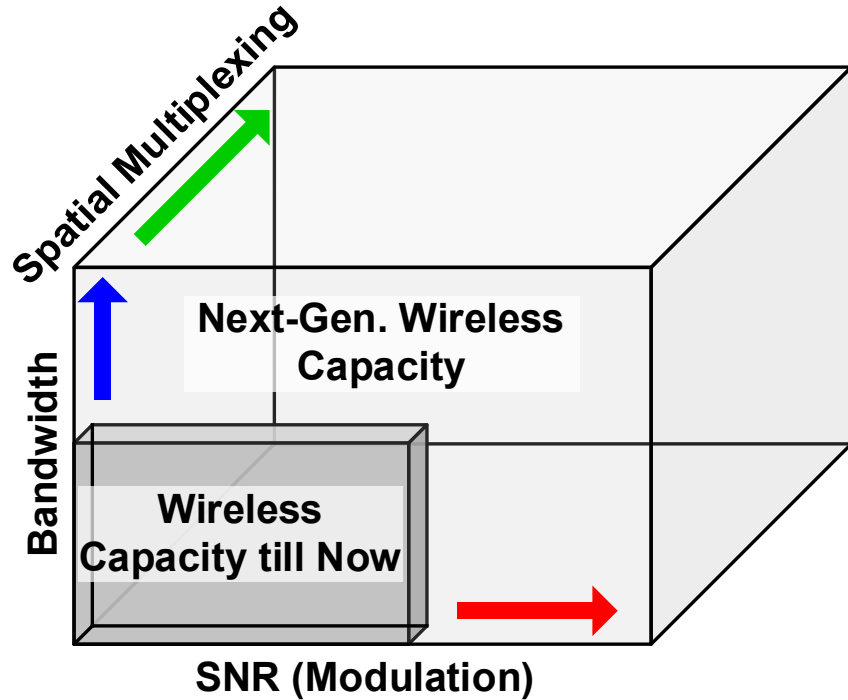
A 4-Stream 8-Element Time-Division MIMO Phased-Array Receiver for 5G NR and Beyond achieving 9.6Gbps Data Rate

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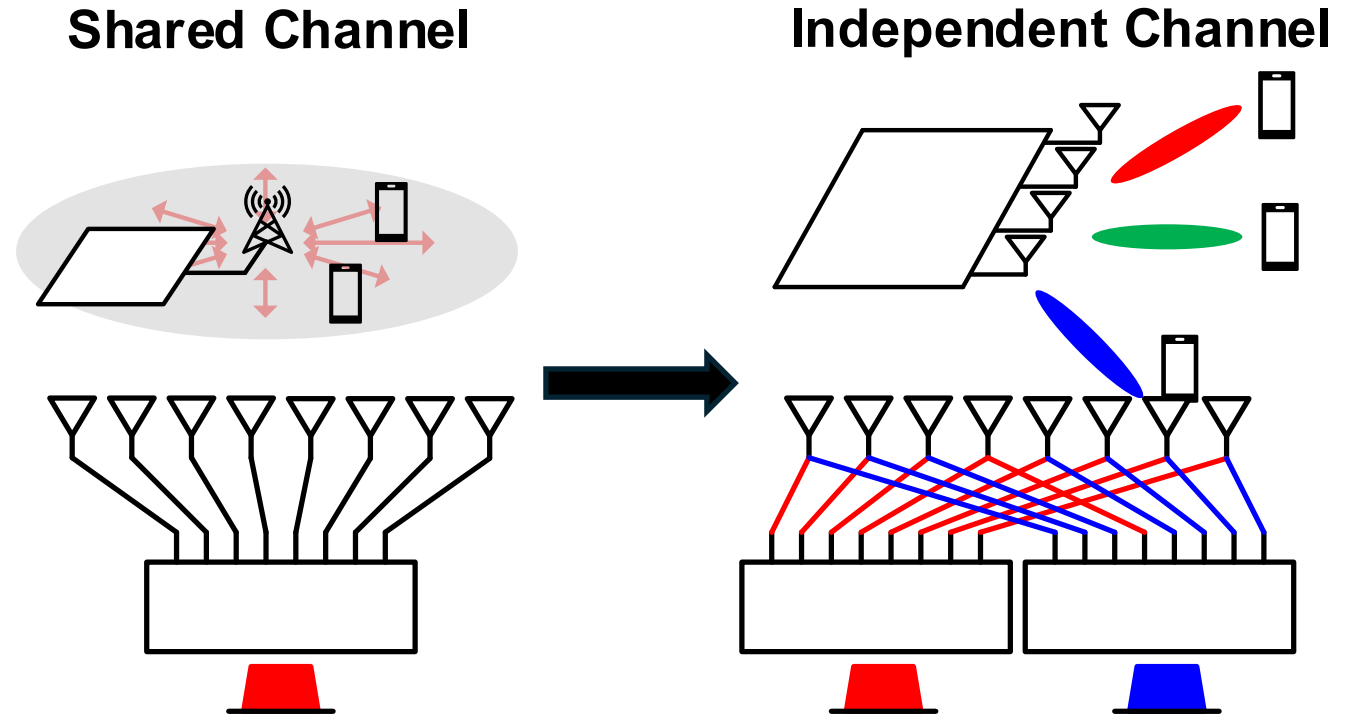
Background

Next-Gen. Demands



- ❑ Spatial multiplexing greatly improved wireless capacity
- ❑ Flexible wireless resource allocation

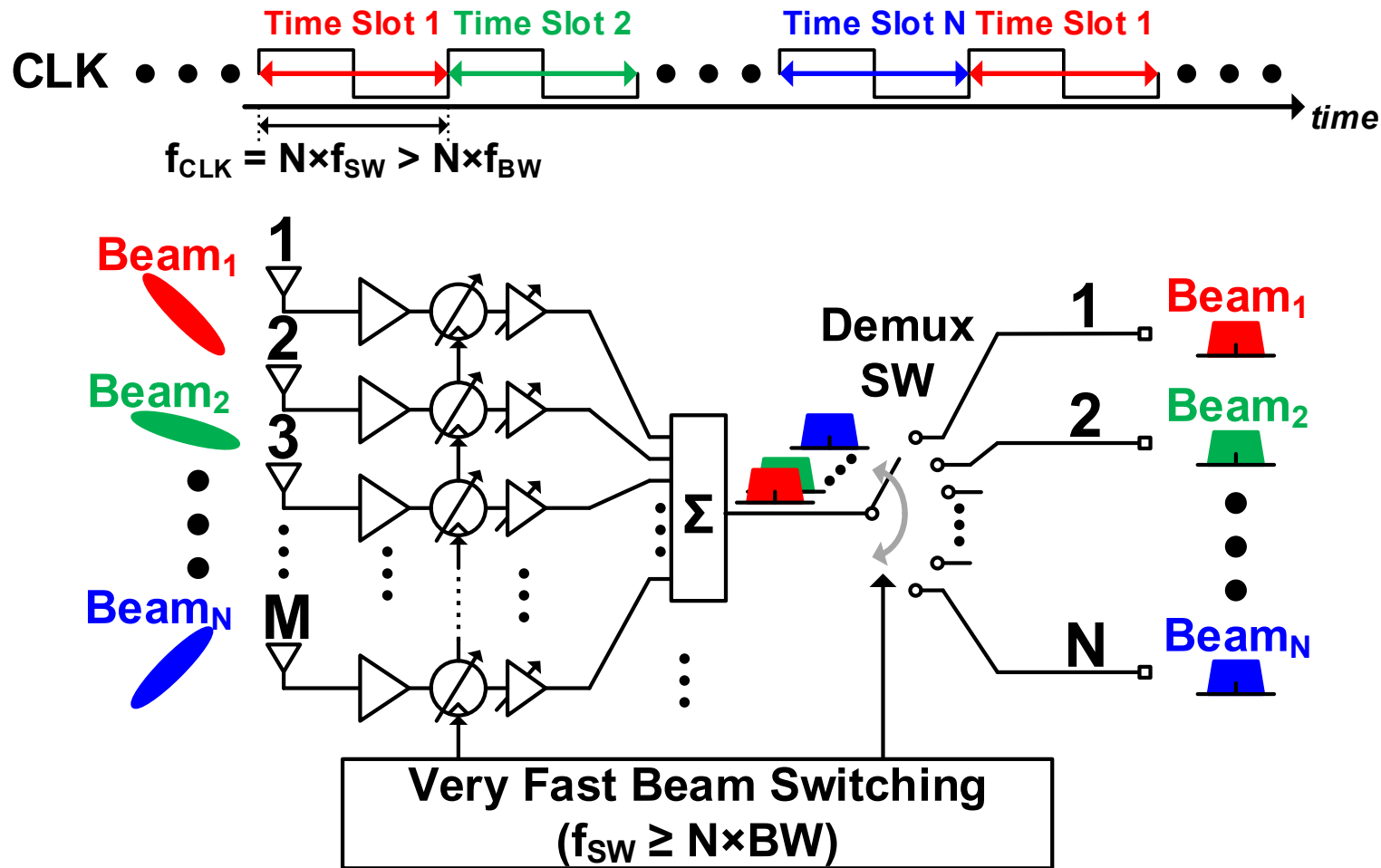
MIMO through Spatial Multiplexing



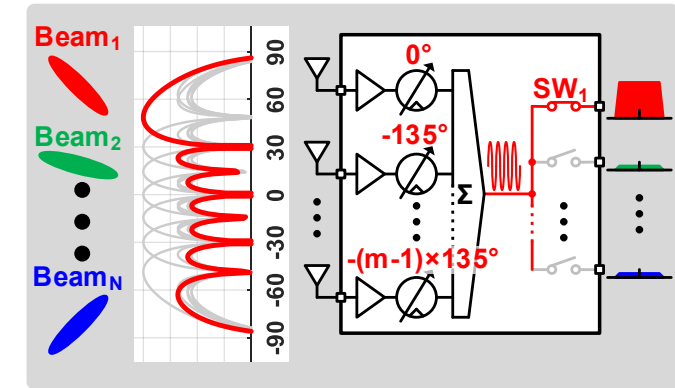
😊 **Compact
Package Size**

😞 **Bulky Chip Area**
😞 **Scalability**
😞 **Multi-IC Array**

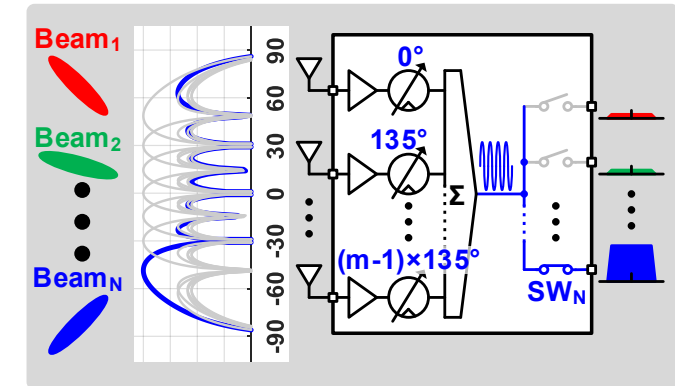
Proposed TD-MIMO Phased-Array Receiver



TD-MIMO RX in Time Slot 1



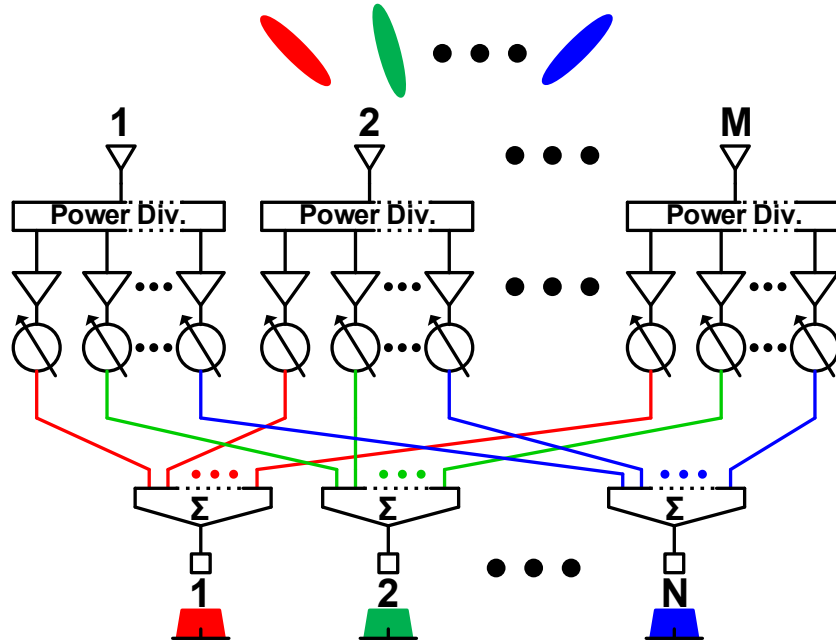
TD-MIMO RX in Time Slot N



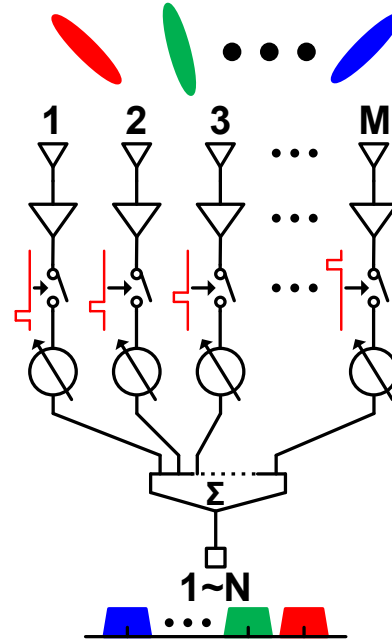
☺ Time-division analog beam switching shares RF blocks

MIMO Architecture Comparison

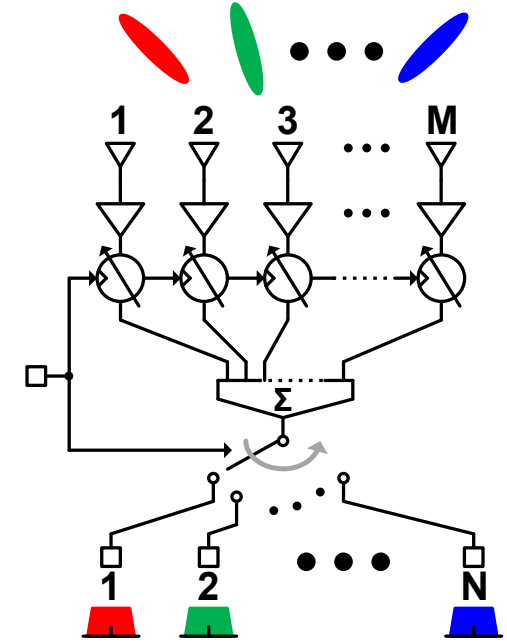
Fully-Connected MIMO



Time-Modulated Array

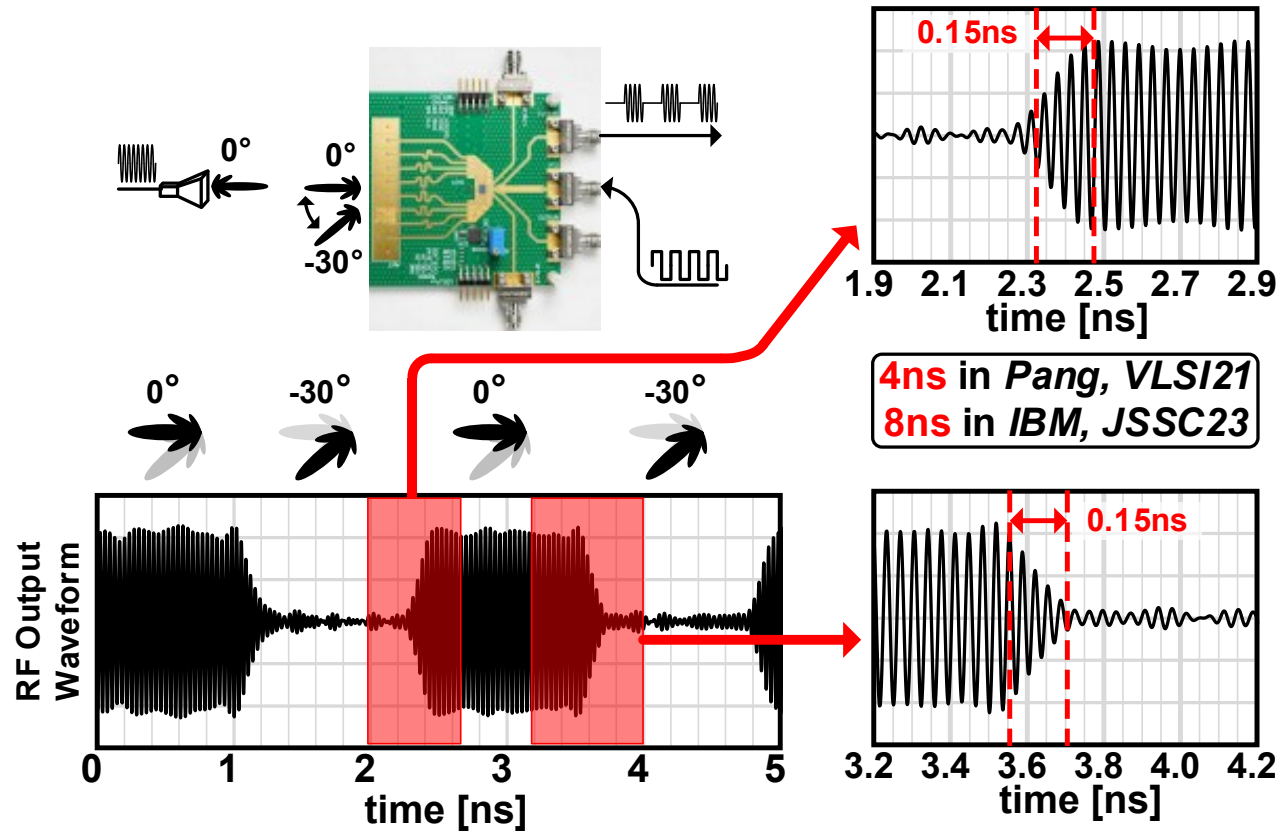


Proposed TD-MIMO

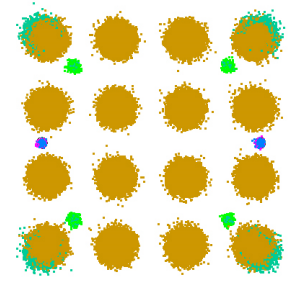
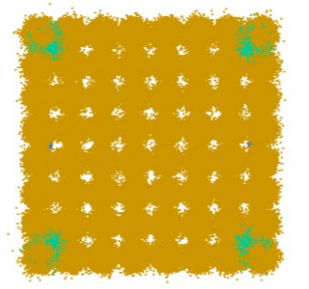


	#Antennas	#Streams	#RF Paths	Spatial Resolution	SNR	Scalability to More Streams
FC-MIMO	M	N	$M \times N$	1	1	-
TMA	M	N	M	N/A**	1/M	+
TD-MIMO	M	N	M	1	1/N	++

Measurement Results



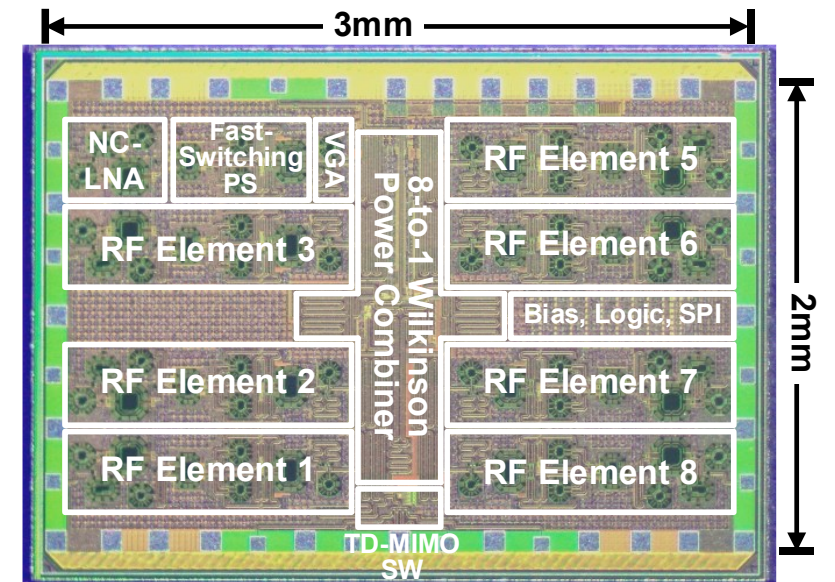
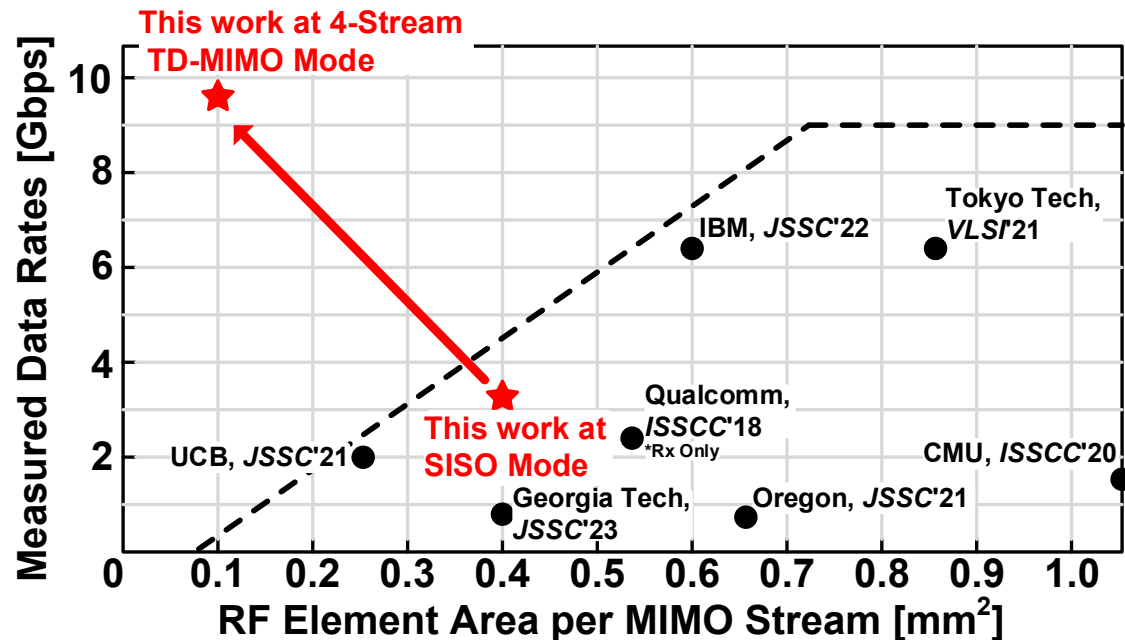
□ Fastest reported beam switching speed (0.15ns)

Mode	4×4 MIMO OTA	
Beam 1-4 Freq.	28GHz	28GHz
Beam 1-4 Modulation*	16QAM (MCS10) OFDMA Mode	64QAM (MCS17) OFDMA Mode
Beam 1-4 BW _c	400MHz	400MHz
CLK Freq.	1.6GHz	1.6GHz
Constellation**		
EVM (RMS)**	-23.32dB (6.8%)	-23.5dB (6.7%)

□ 4-stream MIMO reception in OTA measurement

Performance Comparison

	This Work	Pang, VLSI'21	Lu, RFIC'24	Garg, JSSC'21
MIMO Architecture	TD-MIMO	FC-MIMO	FC-MIMO	FC-MIMO
#MIMO Streams	n=1-4	n=2	n=2	n=2
PDC/#Path/#Stream	8mW	39mW (RX)	35mW	28mW
Area/#Path/#Stream	0.1mm ²	0.85mm ²	0.67mm ²	0.66mm ² *
Beam Switching Time	0.15ns	4ns	N/A	N/A
Measured Data Rates	9.6Gbps	6.4Gbps	N/A	0.8Gbps



Thank You