Cross Talk in Peta-Byte Interconnect

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Silicon Photonics Complexity

How much complexity does HPC require?
An Accelerator for AI

NVIDIA TESLA V100
CT BW 120 Tbps
Bus 2.4 Tbps
Wavelength and Information?

C+L is roughly 12 THz
(1nm = 125 GHz @ 1550nm)
20% use of C+L is 2.5 Tbps
2.5 Tbps = 50 x 50 Gbps
How Big is a Peta Byte per second?

1.25 PBps is 4000 2.5 Tbps
4000 x 50 50 Gbps Channels
Memory Peta Byte Interconnect

64 x 64 Crossbar requires 4032 2.5 Tbps channels
Memory Peta Byte Interconnect II

2.5 Tbps requires 50 modulators and 50 detectors at each chip.
How Big is a 50 Modulator Array?

4000 wg’s -> 3.6 mm
Array limited by crosstalk
Modulator Crosstalk Studies

Experimental Study of Electro-Optic Crosstalk in Parallel Silicon Photonic Mach-Zehnder Modulators

12 Lingjun Jiang, 1 Xi Chen, 1 Kwangwoong Kim, 1 Guilhem de Valicourt, 2 Zhaoran Rena Huang and 1* Po Dong
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Experimental and Numerical Study of Electrical Crosstalk in Photonic-Integrated Circuits

Weiming Yao, Giovanni Gilardi, Nicola Calabretta, Member, IEEE, Meint K. Smit, and Michael J. Wale, Member, IEEE, Member, OSA
Results from Jiang et al. 2017

S to S crosstalk is disastrous
Our Model

S to S crosstalk is disastrous
Our Calculations (Linear Scale)

Shows circa 0.1
CPW from Yao et al. 2015

Is CPW Advantageous?

TABLE I

<table>
<thead>
<tr>
<th>Geometrical Parameters of Test Structures</th>
<th>RF interconnects</th>
<th>Phase-shifters</th>
</tr>
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<tbody>
<tr>
<td>Separation distance D (µm)</td>
<td>25, 50, 100, 200</td>
<td>30, 80, 180, 280</td>
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<tr>
<td>Coupling length L (µm)</td>
<td>1000, 2000</td>
<td>1250</td>
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<tr>
<td>Electrode width W (µm)</td>
<td>10, 20</td>
<td>20</td>
</tr>
<tr>
<td>Ground width G2-G4 (µm)</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Ground width G1 (µm)</td>
<td>75</td>
<td>25 (D=30, D=80 µm)</td>
</tr>
<tr>
<td>Ground width G1’ (µm)</td>
<td>35 (D=180, D=280 µm)</td>
<td></td>
</tr>
<tr>
<td>Ground length G1,G2 (µm)</td>
<td>1800</td>
<td>1500</td>
</tr>
<tr>
<td>Ground length G3,G4 (µm)</td>
<td>800, 825, 875, 975</td>
<td>260, 310, 410, 510</td>
</tr>
<tr>
<td>(in order of incr. D)</td>
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</table>
Results from Yao et al. 2015

5 GHz is still problematic
Our CPW Jiang-Like Model

50 Ohm CPW
Our Calculations (Linear Scale)

Shows circa 0.001
Varying Separation

Grounds assumed 75 micron
Summary

- Crosstalk can be severe
- CPW is a compact solution
- 50 Ohm CPW with 75 individual ground planes may be overkill
Questions?