Design Considerations of 3D Optical Modulator for TileCal

Kelby Anderson, Mark Oreglia, Fukun Tang
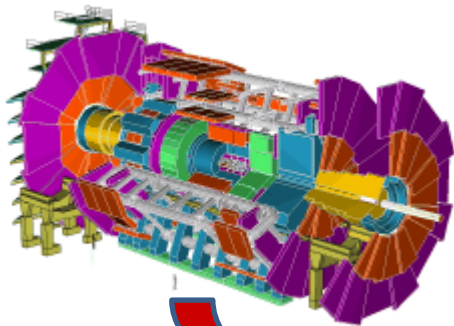University of Chicago

Current and upgrade TileCal data rates per Electronics Drawer:

Current system with analog trigger (< 2.5Gbps/drawer):

- S-link or Glink etc. (< 2.5Gbps/ch)
- VCSEL based

Upgrade system with digital trigger (~240Gbps/drawer, this includes redundancy, headers, FEC etc.)

- GBT   (< 5Gbps/ch)
- SNAP-12:   12-channel (~5Gbps/ch for fiber length <100M)
- Both VCSEL based

Concerns:
- Radiation hardness
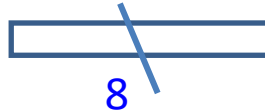- Driven distance

Counting Room

Approaches of 40Gbps Optical Modulator ASICs

The entire optical modulator includes two parts:
- 40Gbps, high swing (modulator $V\pi$ related) mux/driver
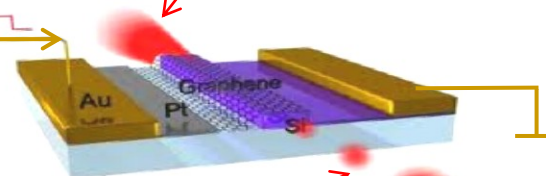- Optical modulator (waveguide)

Obviously, Mux/Driver and optical modulator have very different requirements in the process and materials. Each part requires its designers having very different design knowledge, methodology, techniques and design tools.

Mux/Driver (40Gbps):   90nm CMOS, SiGe BiCMOS, *GaAs* etc. Small real estate.
Design Tools: Cadence tools.
Optical modulator: SOI/SOS, CMOS, GaAs, LiNbO$_3$, InP etc. Huge real estate.
Design Tools: Synopsis tools.
A single process is hardly to fit very well on both mux/driver and optical modulator designs with required performance.

F. Tang

To achieve 40Gbps speed, the Mux/Driver and Optical modulator have to be integrated in a single device.

- Fermilab is a multi project 3-D chip integrator, started in 2006.
   --- experience with few projects.
- Commercial companies for 3-D IC work are also available.
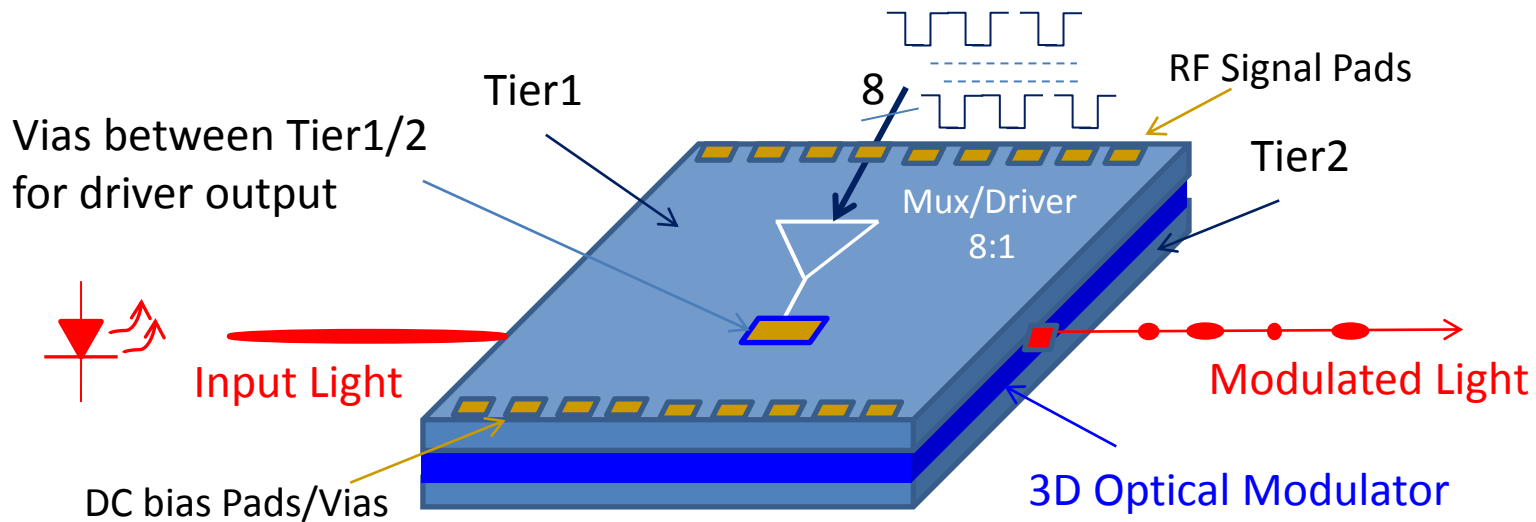
- Tier1: Mux/driver (standard circuit masks, standard cost)
- Tier2: Optical modulator (custom masks, high cost)
- Independent technologies/designs of Mux/Driver and Optical modulator.
- Not many vias between Tier1 and Tier2. (numbers of vias affect 3D yield rate).

THE UNIVERSITY OF
CHICAGO

Test setup for commercial optical modulators

- To test some commercial optical modulators before we move to our own prototype specifications and designs.
- To evaluate the BER and driven distance, power consumption etc.
- To gain knowledge and experience through the tests.

Commercial optical modulator availability for our applications:

- JDSU: 10Gbps +
- Thorlabs: 40Gbps +
- Fujitsu: 40Gbps +
- Others:
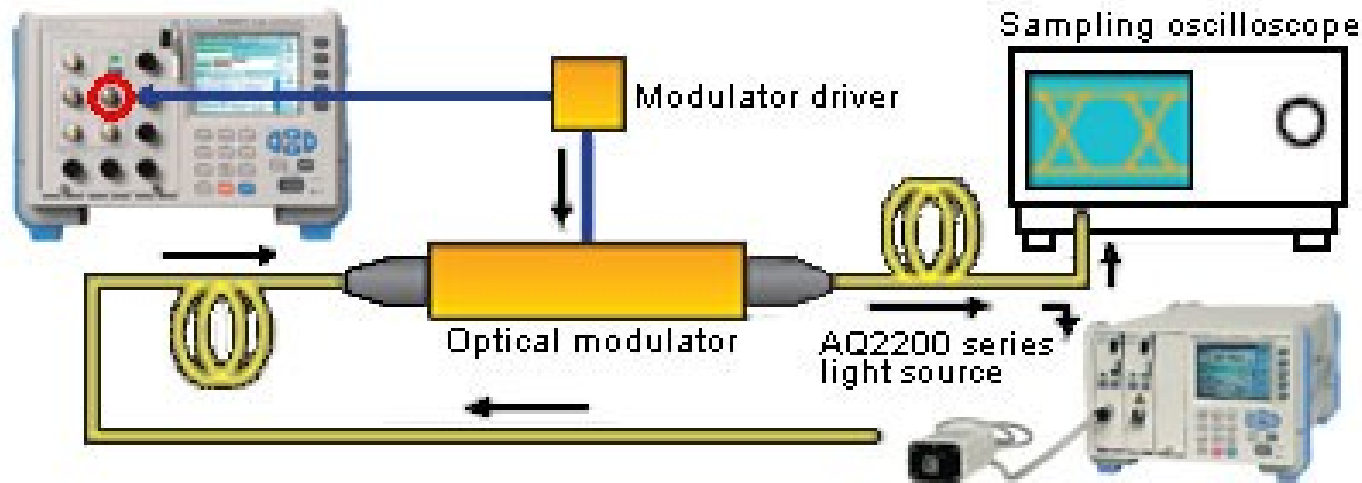
Here is an example of commercial test setup