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Silicon photonic, planar coupled, 4-channel WDM transmitter

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We report on our current developments towards a silicon photonic, 4-channel wavelength division multiplexed transmitter system with planar fiber chip coupling. The optical core components consisting of the photonic chip and the connecting V-groove mounted glass fibers were assembled with sub-micrometer accuracy on a glass plate with low thermal expansion for a stable fiber chip coupling. This setup is ready to attach the DC-biasing and termination board as well as a fan-out board for 4x10 Gb/s drivers or a 4x32 Gb/s driver board. Experimental results of the optical and optoelectrical performance will be presented.

Summary (500 words)

Optical links using silicon photonic transmitters and wavelength division multiplexing (WDM) are the future in particle detector instrumentation, as single channel links with directly modulated laser diodes are not suitable for the projected radiation levels and data amounts anymore. Using silicon photonic modulators, the optical source can be placed in low-radiation areas and radiation hard devices are used inside the detector volume.

We use 3 mm long Mach-Zehnder type modulators for our 4-channel WDM transmitter system. The wavelength demultiplexing and multiplexing is performed by planar concave gratings on-chip, so that just two optical fibers for input and output are required. The coupling is polarization sensitive and to avoid polarization controllers for each wavelength, a polarization maintaining fiber is used to launch light to the chip.

An overview of the setup is shown in figure a). The WDM chip can be seen in the middle on a 770 µm high, thin-glass platform to match its surface height to the fibers. The angle polished optical fibers for a compact and stable coupling [1] are placed in V-groove chips for positioning and mounting and are located diagonally on the upper left and lower right in the picture. After positioning, all components are fixed on a microscope slide using UV-glue. The low shrinkage of the glue while curing introduces just a negligible increase of coupling loss of less than 1 dB. This might even be decreased by a smaller amount and more precise application of the glue.

A side view of the setup is shown in figure b). The fibers protrude 6 mm from the V-grooves to allow for more space for wire bonding the chip to its electronics. In later setups this can be optimized for a smaller size and higher stability.

Current driver electronics are made of commercial driver ICs and are rather bulky. To attach the 4x10 Gb/s version, we developed a fan-out board, shown on the left side of figure c). It converts SMA connectors for each of the four channels on one side to bondpads with a pitch of 140 µm on the other side for wire bonding to the chip. This board can be replaced by another driver board for data rates of up to 4x32 Gb/s, but with decreased voltage swing. As the transmission lines of the modulators needs termination, a second board with termination resistors will be attached on the other side of the chip. This board, shown on the right side of figure c), also includes the DC-biasing circuitry for the modulators, which consists of two bias-Tees per modulator. For illustration a silicon photonic system chip is placed between the two boards and will be replaced by the setup shown in figure a).

At the time of writing this abstract, electrical tests of the individual modulators are being prepared. Full system performance tests will then be performed after bonding the electrical boards to the chip.

[1] M. Schneider et al., "Planar fiber-chip-coupling using angle-polished polarization maintaining fibers", JINST, DOI 10.1088/1748-0221/18/01/C01069

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