White Paper

>> D-5006

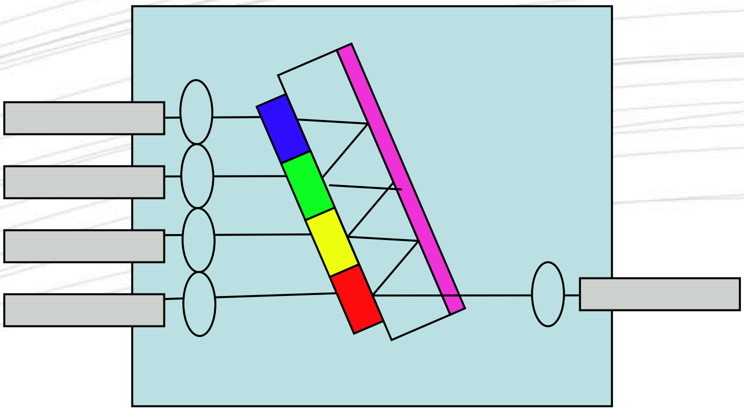
CWDM components for 40 G and 100 G Transceivers

Introduction

In this White paper the principals of Cube's Thin Film Filter design and their performance with regard to construction tolerances and filter performance will be explained. We will look at 3 areas that are key to explaining Cubes core technology. These areas are the construction tolerances of the demux device with regard to loss, the optical pass band performance of the demux with regard to angle and the third is to look at the over all performance of a 25 G link.

Loss performance as a function Angle of Incidence (AOI)

The basic construction of the device uses the principals of thin film filters in a "zig zag or multiple bounce" construction. The basic 4 channel would look like the figure below:



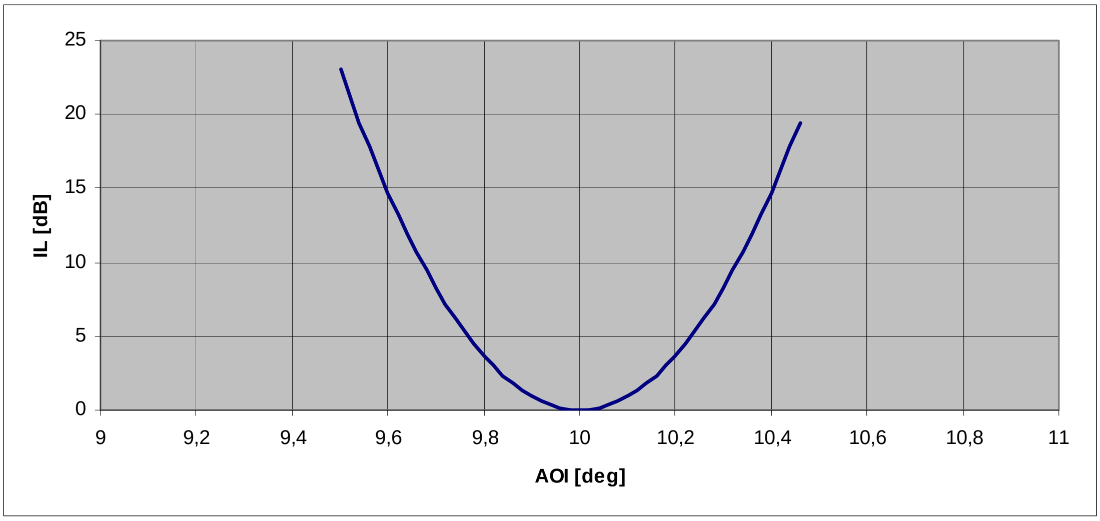
Construction of simple 4-channel demux with input and output fibers.

The 4 channels on the left show the output fibers, where individual wavelengths are selected and passed through the filter. The fiber on the right contains all 4 wavelengths with each of the colored blocks representing a specific thin film filter. The development of the part has some basic constraints that can be described in the following:

1- The key design challenge for thin film filter multiplexing is the routing of the collimated optical beam through the 'zig zag' as shown above.

2- To achieve this high angular alignment accuracy are required (filters are essentially mirrors)

The angular tolerance is the ability to guide the light through this structure with the least amount of loss. The light leaving the structure needs to be confined to a specific area. The enabling technology here is to keep the filters in a well-defined fixed position with regard to angle; this would enable the lowest insertion loss through the device. The variation of angular tolerance with regard to insertion loss can be seen in the figure below. This data is for a standard 4 channel demux with a nominal 10° incident angle.



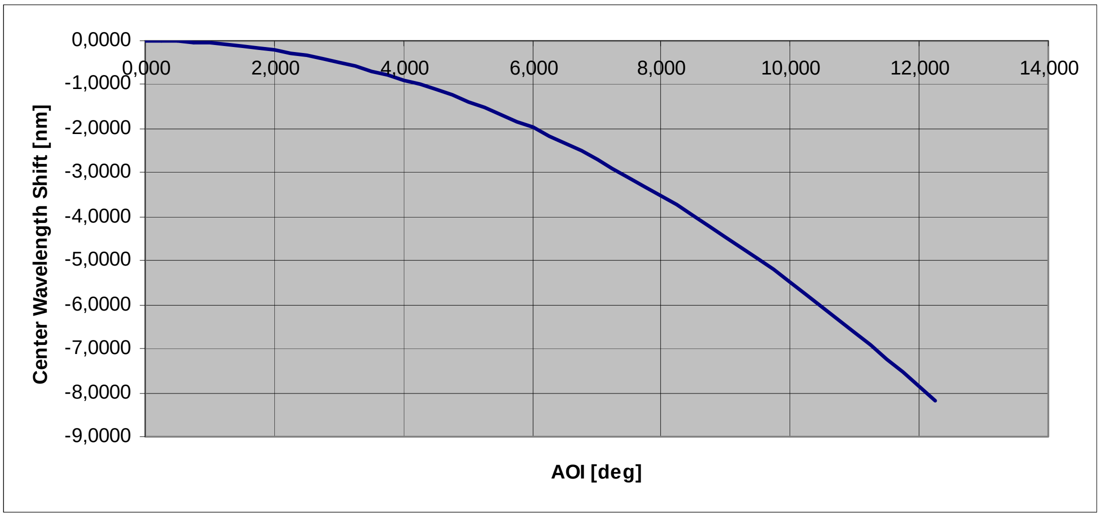
On the vertical axis is the insertion loss in dB, with the angle of incidence (AOI) on the horizontal axis.

Results

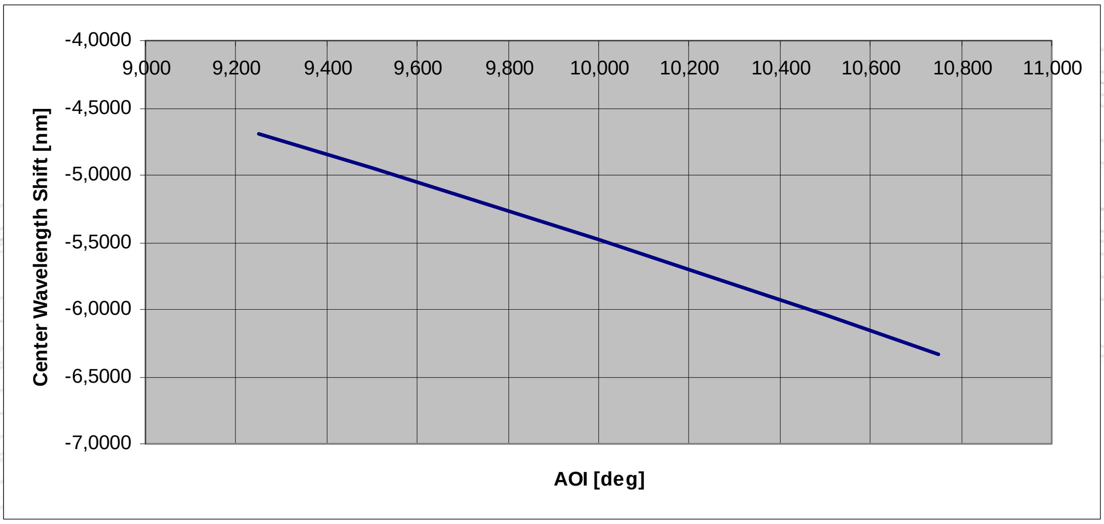
As we approach the 10-degree angle, the insertion loss is at a minimum. The loss increases dramatically as we deviate from the minimum loss point. This variation off the 10-degree correlates with loss found in the y-axis, the ability to confine the angular variation in the x-axis will yield better insertion loss performance. The data assumes that only one filter is mis-aligned. If more filters are mis-aligned the loss penalty gets even higher.

Angular tolerance as a function of filter pass band performance

The filter pass band performance can also change as a function of angular variations associated with the tolerance of the filter placement and temperature effects. The pass band shifts as a function of Angle of Incidence (AOI) can be expressed with the following graph.



On the x-axis is the angular variation expressed in degrees. On the Y-axis is the shift in pass band. If we look at the nominal value of 10 degrees, the value of the center wavelength shift is approximately -5.5 nm. The chart below shows the region around 10 degrees where the slope of the angular variation vs. CWL shift is approximately linear.



Results

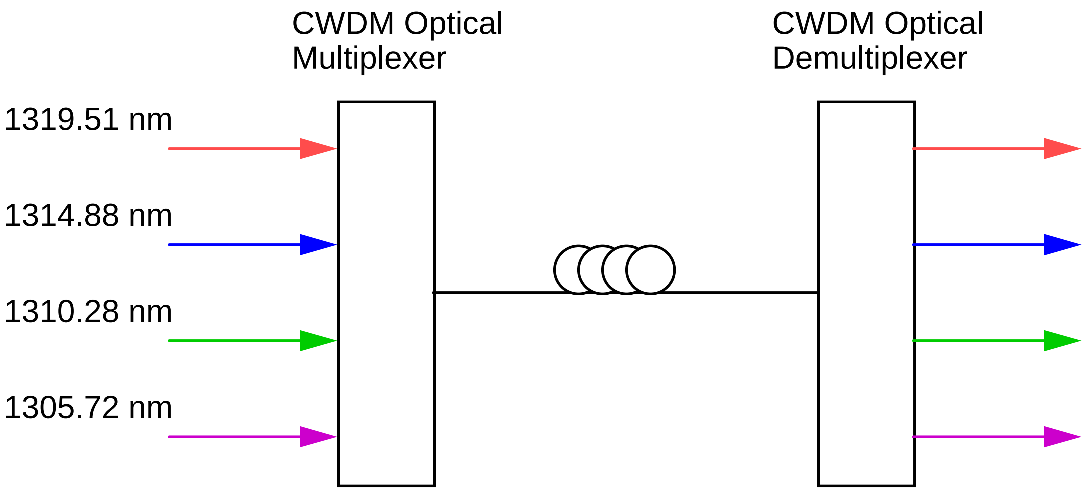
The deviation from the nominal 10-degree angle as a function of wavelength does create some minor shift in the center wavelength, however, if the deviation is kept within a fraction of a degree, less than

0.25, degrees, the effect is relatively small. If we compare this deviation with the insertion loss numbers in the previous section, the same 0.25 degrees of angular tolerance would generate approximately 5 dB of loss.

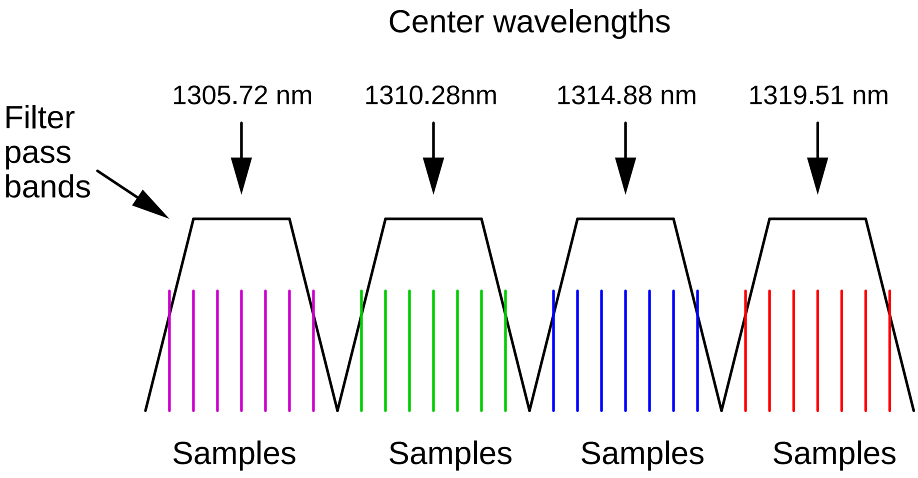
4 x 25 G Link Simulation

The introduction of thin film filter optical multiplexing and demultiplexing in an optical link can produce chirp in the signal. This can be related to group delay dispersion of the filters. The impairment of the link with regard to chromatic effects is the combination of the interaction of pulse spreading and the fiber itself.

To simulate the LAN CWDM link we have set up the basic transport link shown below using the 4 proposed center wavelengths.



The implementation would be to vary the position of each of the wavelengths with in it's own pass band.



The sampling interval is 0.25 nm with the data taken from the extreme edge of the passband (approximately 3dB down) to generate the highest chirp.

The simulation input would use a reference narrow line width laser source (approximately 0.001 nm) and the filter data provided by the filter manufacturer. The output are sets of eye diagrams showing the effect of Group Delay Ripple on the optical signal traveling over 2 and 10 km of SMF 28e fiber.

Results

The data taken across the 1319.51 nm passband, shows no appreciable impairment as seen in the eye diagram from the effect of filter chirp in combination with either the 2 km or the 10 km lengths of SMF28e fiber. The 1319.51 filter was selected because the filter is the farthest away from the zero dispersion null of the SMF 28e fiber and the wavelengths found in this region would experieince the greatest chromatic dispersion.

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