



# Improvement of the Channel Crosstalk in Narrow Channel Spacing Arrayed Waveguide Gratings Applying Specially Shaped Couplers

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## Motivation

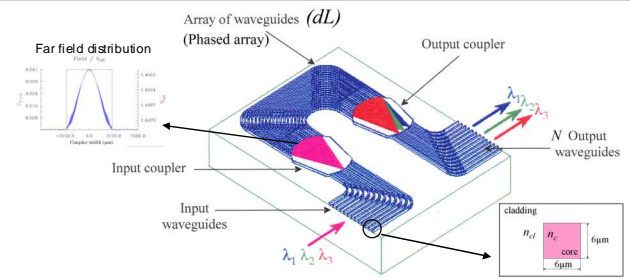
The recent rapid growth in network capacity has meant that even higher capacity transmission is required in Dense Wavelength Division Multiplexing (DWDM) systems. Arrayed waveguide gratings (AWG) have been found well-suited for use in these systems. While the standard channel count (up to 40) and standard channel spacing (100 GHz or 50 GHz) AWGs feature very good transmission characteristics, increasing the channel counts and narrowing the channel spacings leads to a rapid increase in the AWG size and this, in turn; causes the deterioration in optical performance like higher insertion loss and, in particular, higher channel crosstalk.

Channel crosstalk is a result of amplitude errors of the far field distribution at the end of the input coupler and phase errors appearing in the phased array as a result of possible effective index and geometrical irregularities of the arrayed waveguides.

## Design of the narrow channel spacing - 25 GHz AWG

The AWG consists of input/output waveguides, two couplers and an array of waveguides (also called phased array) with the constant path-length difference  $dL$  that causes multiplexing / demultiplexing of optical signals carrying the information ( $\lambda_1 - \lambda_n$ ).

**Design parameters:**  $N = 256$  output channels  
 $\lambda_c = 1550$  nm (AWG central wavelength)  
 $n_{cl} = 1.445$  (refractive index of the cladding)  
 $n_c = 1.456$  (refractive index of the core)  
 $dL = 30.896$  (to minimize the phase errors)



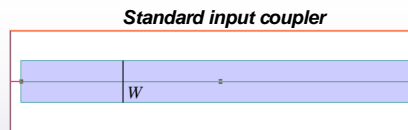
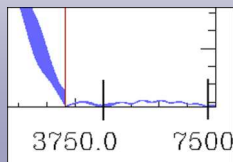
## Solution

Specially-shaped AWG couplers cause an alteration of the far field distribution at the end of the input coupler - the far field distribution becomes smoother (amplitude errors are eliminated).

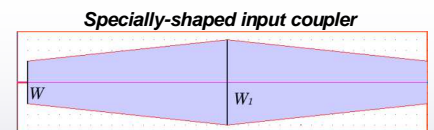
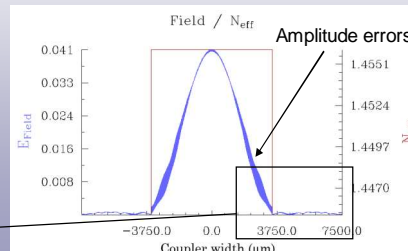
This leads to a strong improvement of the channel crosstalk.

### Design of the specially-shaped couplers

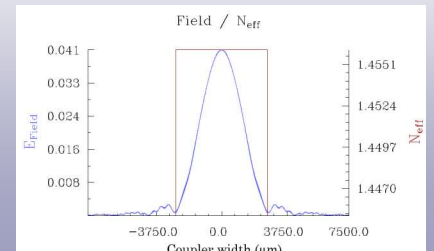
Coupler width  $W_1$  corresponds to any point where the far field distribution at the end of the standard input coupler reaches its zero value outside of the coupler ( $W_1 = 9000 \mu\text{m}$  or  $15000 \mu\text{m}$ ).



Far field distribution at the end of standard input coupler



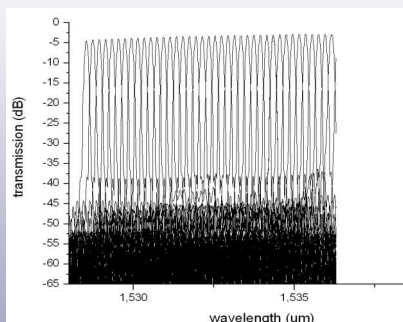
Far field distribution at the end of specially-shaped input coupler



## Simulation Results and Discussion

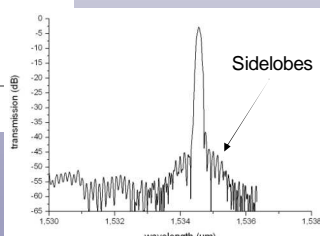
AWGs with narrow channel spacing can be designed with both, the short arrayed waveguides (to minimize the phase errors) as well as the specially-shaped couplers (to eliminate the amplitude errors) leading to a strong reduction of the channel crosstalk without deterioration of other transmission parameters like insertion loss and uniformity.

### Transmission characteristics



#### Standard AWG

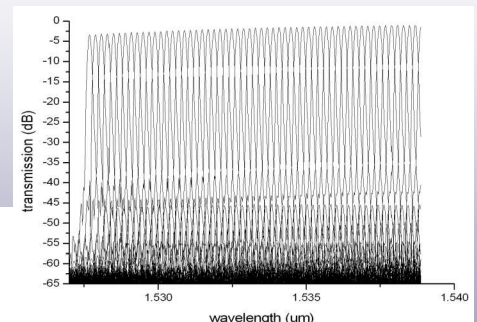
Output optical signal features high sidelobes causing high channel crosstalk.



### Transmission parameters

25 GHz, 256-channel AWG	Standard couplers	Specially-shaped couplers
Insertion loss	3.5 dB	3.3 dB
Uniformity	3.1 dB	3.1 dB
Adjacent crosstalk	24 dB	28 dB
Non-adjacent crosstalk	45 dB	50 dB
Background crosstalk	52 dB	62 dB

### Transmission characteristics



#### Specially-shaped AWG

The sidelobes of the signal are strongly suppressed leading to the significant improvement of the channel crosstalk.