simple and cyclical AWG

(Arrayed Wave-guide Grating)

its functional characteristics and manufacturing approach

by Ilja Kopacek

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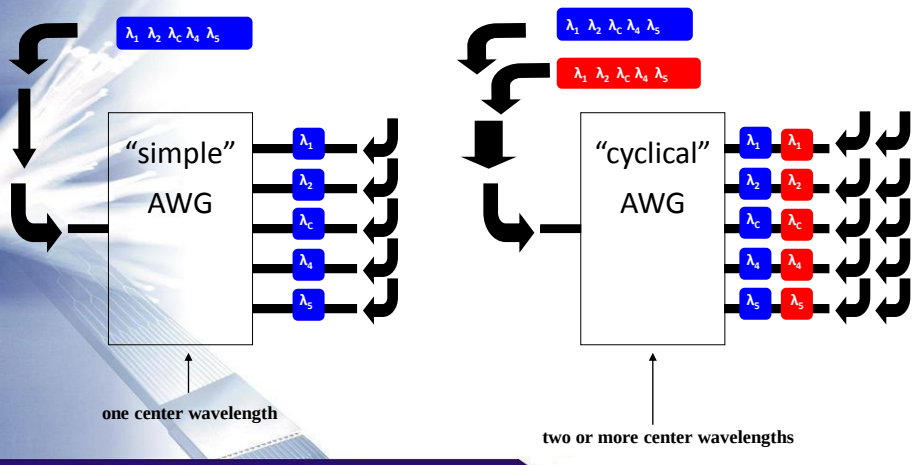
functional characteristics



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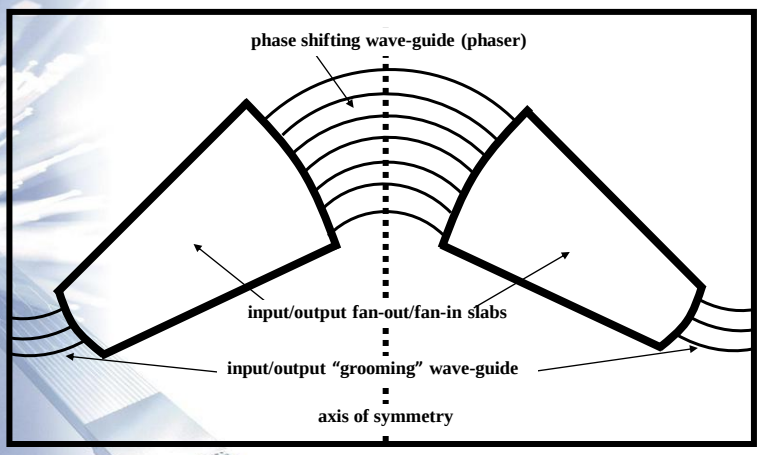
general AWG design



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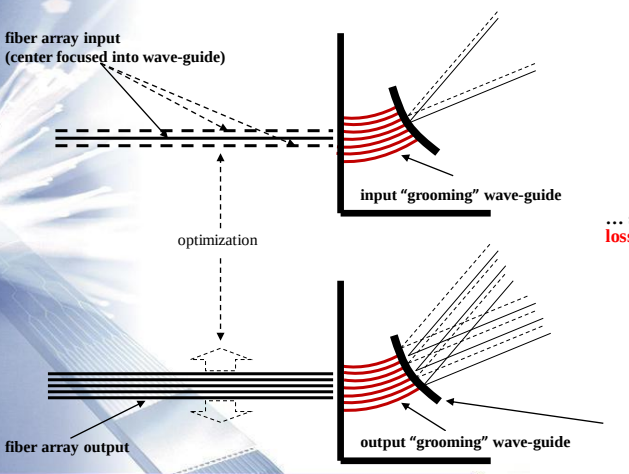
input/output wave-guide

to interface fiber array with divergent/convergent elements…



… so that the optical power losses are minimized

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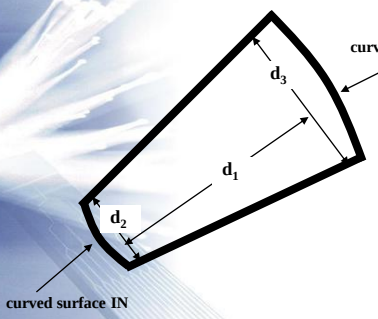
fan-out/fan-in slabs

geometry



our approach

fundamental calculations

and

experimental optimization

length and differences in length of d_1, d_2, d_3 and curvature of "surface IN" and "surface OUT" adjust to the shape of a "phaser"

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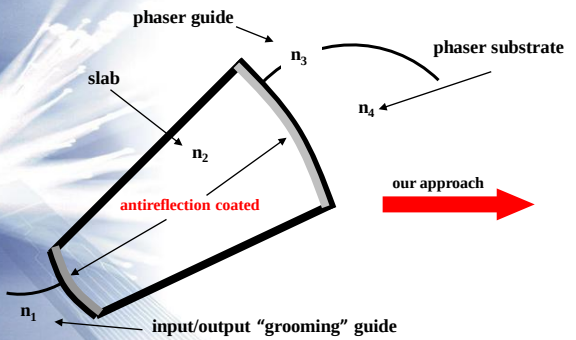
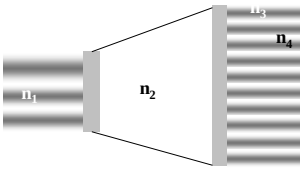
fan-out/fan-in slabs

… and phaser - materials n(χ)



our approach



looking for an optimum ratios among:

$n_1 : n_2 : n_3$

and a contrasting ratio

$n_3 : n_4$

antireflection coatings minimizes losses due to passage of light through arias of different refraction indexes n(χ)

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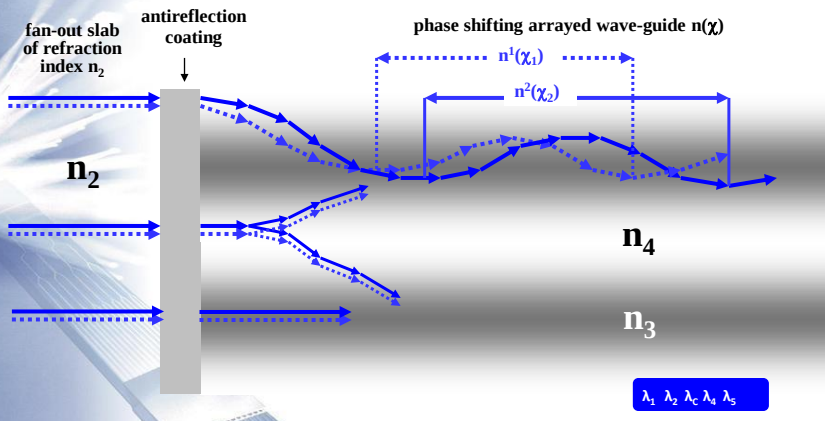
phazer

entrance of light into phazer and index of refraction (zoom in)



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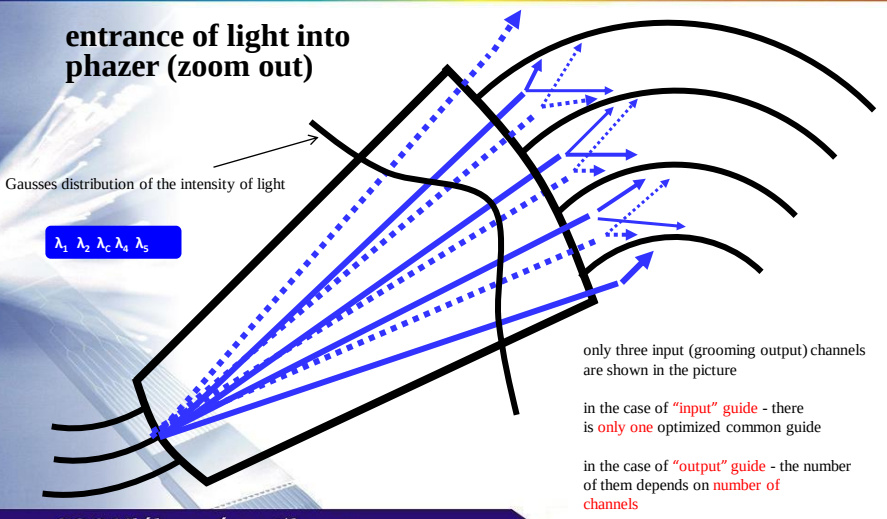
phazer

entrance of light into phazer (zoom out)



only three input (grooming output) channels are shown in the picture

in the case of "input" guide - there is only one optimized common guide

in the case of "output" guide - the number of them depends on number of channels

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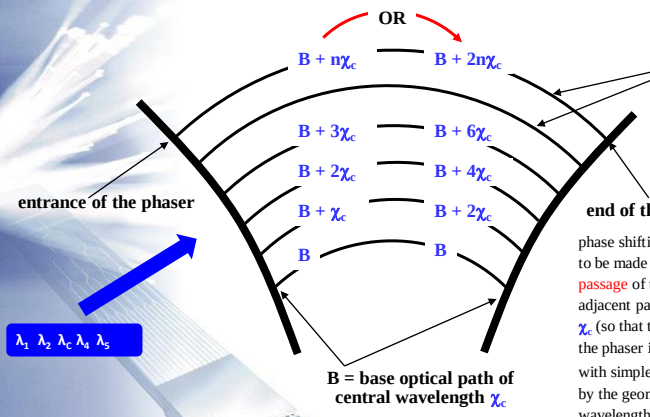
phazer

function and geometry



adjacent paths (**number of paths is in order of 100**)

end of the phaser

phase shifting arrayed wave guide "phaser" has to be made so, that the difference in phase of the passage of the central wavelength χ_c over adjacent paths has to be a whole multiple of that χ_c (so that the electrical field at the entrance of the phaser is the same as at its end)

with simple AWG this difference is given mainly by the geometry of the phaser (for other wavelengths the phase difference is other then the whole multiple of respective wavelengths)

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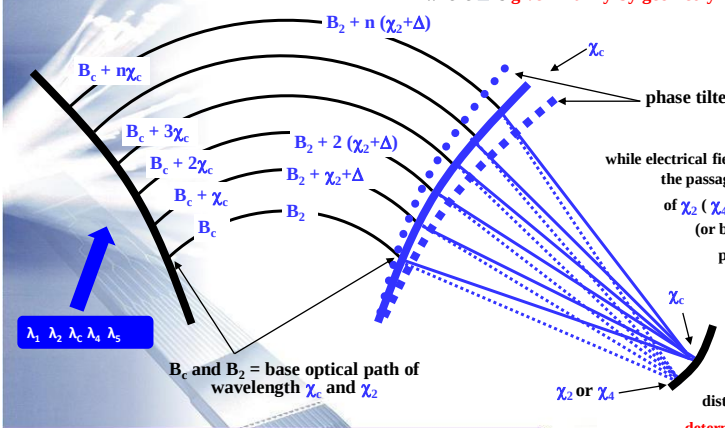
phazer

passage of other than χ_c through the phaser and into the convergent slab

where Δ is given mainly by geometry



phase tilted electrical field of χ_2 or χ_4

while electrical field of χ_c will stay unaffected by the passage through the phaser the fields of χ_2 (χ_4) will be slightly tilted forward (or backward) since the wave-guide path will affect χ_2 (χ_4) slightly more(or less) than χ_c

this tilting of the field will then cause the shift of focal point (basically the distance from focal point of χ_c will determine the selection of χ_2 (or χ_4)

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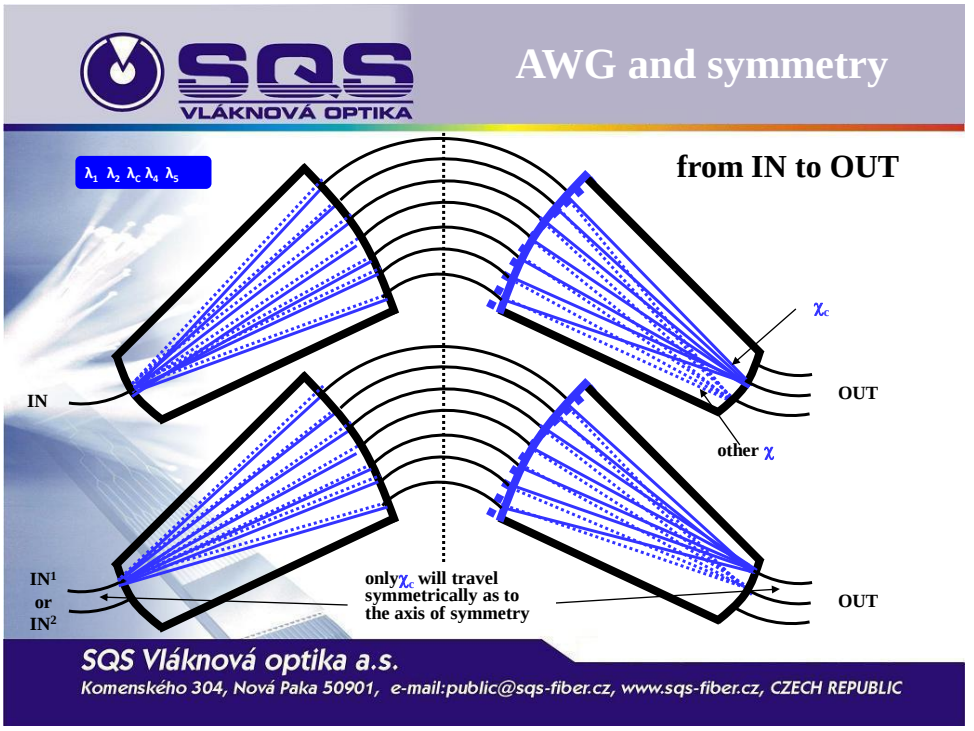
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AWG and symmetry
λ1 λ2 λc λ4 λ5
from IN to OUT
χc
IN
OUT
other χ
IN1
or
IN2
only χc will travel
symmetrically as to
the axis of symmetry
OUT
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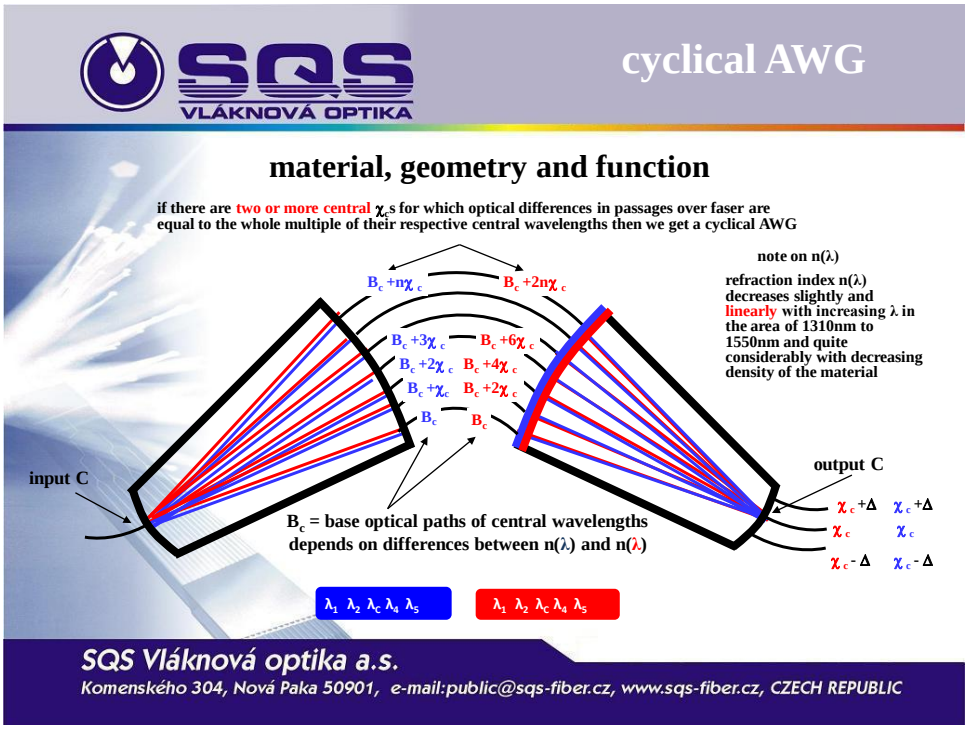
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cyclical AWG
material, geometry and function
if there are two or more central χc s for which optical differences in passages over faser are
equal to the whole multiple of their respective central wavelengths then we get a cyclical AWG
note on n(λ)
refraction index n(λ) decreases slightly and linearly with increasing λ in the area of 1310nm to 1550nm and quite considerably with decreasing density of the material
Bc +nχc
Bc +2nχc
Bc +3χc
Bc +6χc
Bc +2χc
Bc +4χc
Bc +χc
Bc +2χc
Bc
Bc
input C
output C
χc +Δ
χc +Δ
χc
χc
χc - Δ
χc - Δ
Bc = base optical paths of central wavelengths
depends on differences between n(λ) and n(λ)
λ1 λ2 λc λ4 λ5
λ1 λ2 λc λ4 λ5
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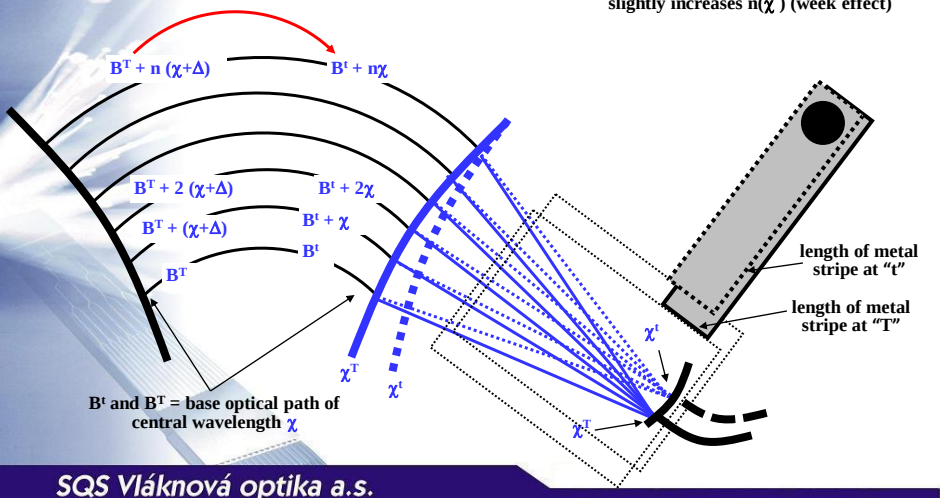
athermal AWG

decreasing temperature from "T" to "t" contracts more longer optical paths of the phaser (strong effect) and slightly increases n(χ) (week effect)



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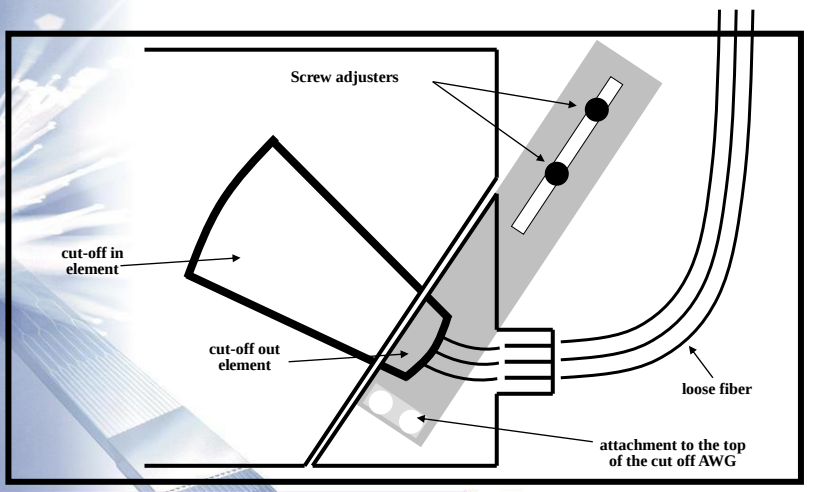
athermal AWG



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athermal AWG

target specifications

(athermal packaging from -5 to 70°C)

parameter	target
band	C or L band
number of channels	32 (**100GHz)**
maximum insertion loss	< 4dB
insertion loss uniforminty	< 1dB
polarization dependent loss	<0.5dB
adjacent isolation	<27dB
non-adjacent isolation	<30dB
total isolation	<25db
return loss	40dB

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