

Projeto de Circuitos Fotônicos Integrados

Circuitos fotônicos básicos

Atividade 1 – Interferômetro de Mach-Zehnder

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Hardware Inteligente para a Indústria

CURSOS, CAPACITAÇÃO E TREINAMENTOS



Sumário



- Introdução;
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- Transmissão do MZI (ideal, pkg e simulado);
- Variação do comprimento do braço inferior;
- Comparação de performance.



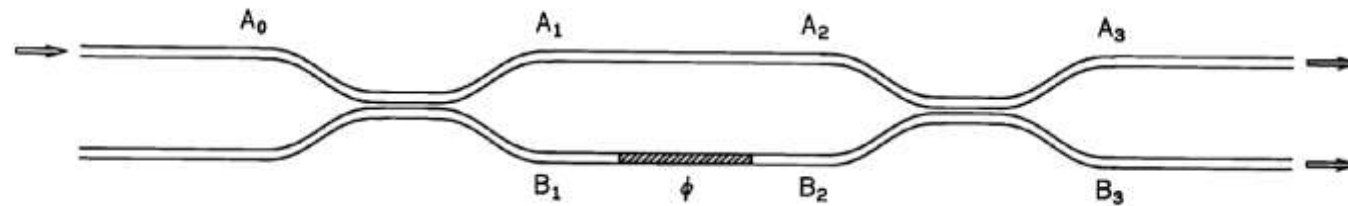
Introdução



Utilizado para medição de diferença de fase relativa entre dois percursos ópticos.

Aplicações:

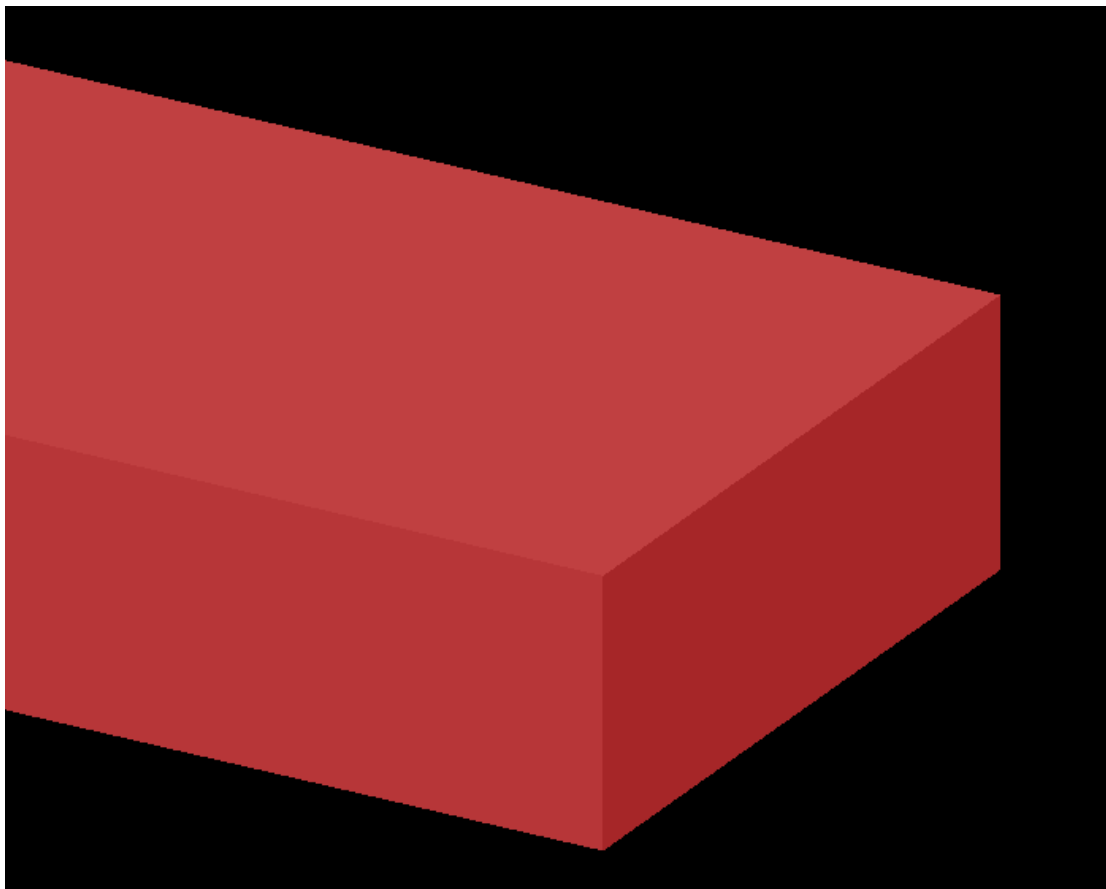
- Chaveamento;
- Modulação;
- Sensoriamento;
- Filtragem.



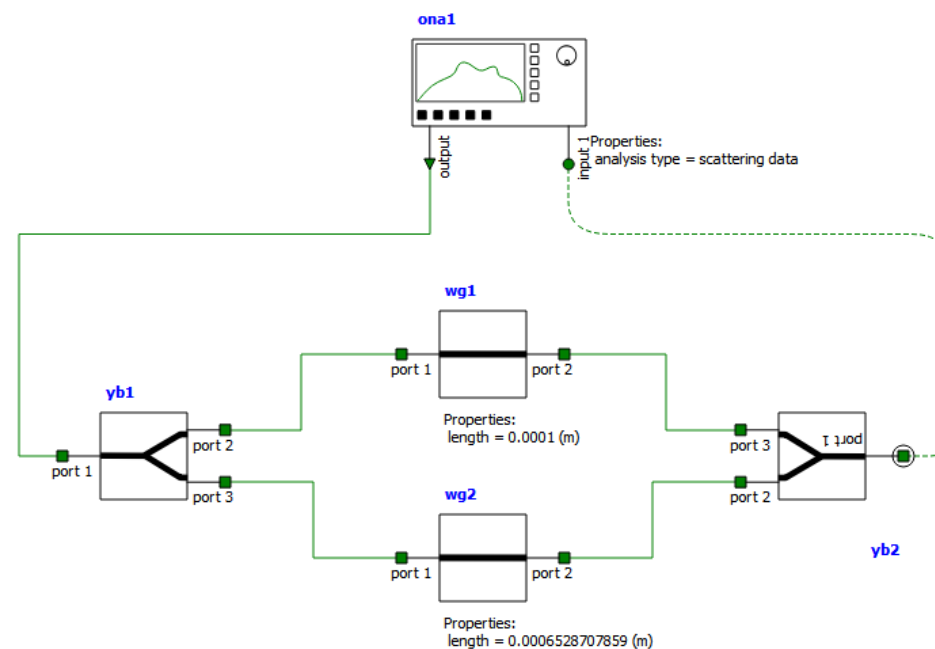
Tecnologia, geometria e topologia



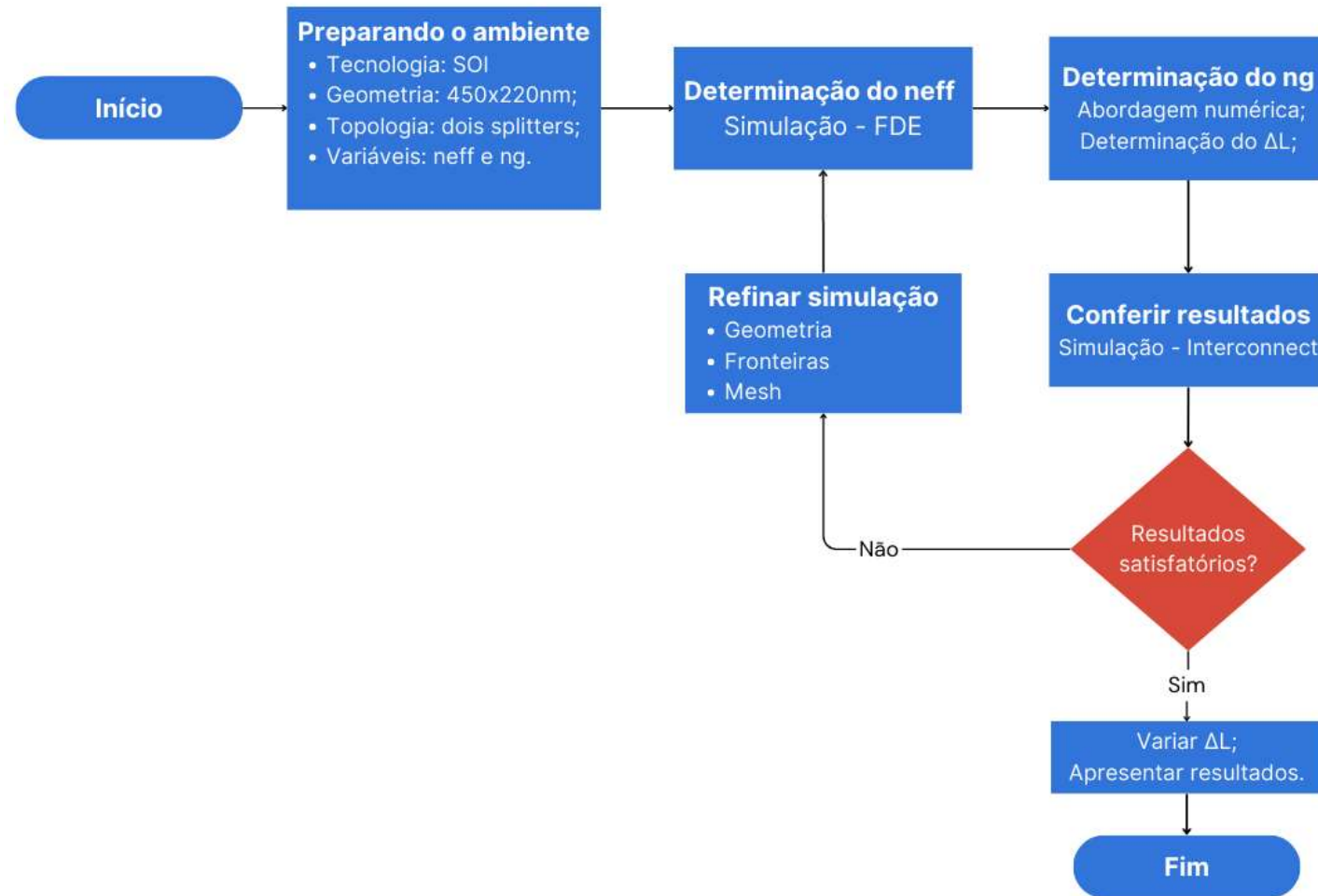
SOI - 450 x 220 nm



Topologia: dois splitters

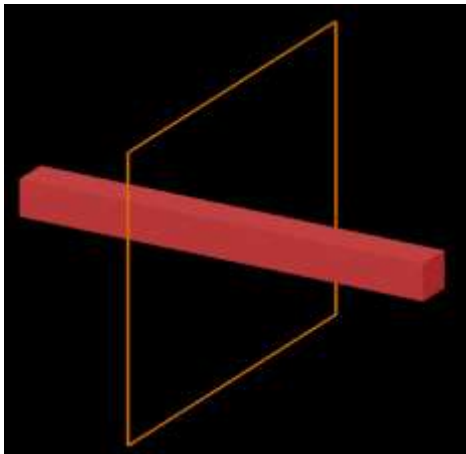


Fluxograma de determinação dos parâmetros iniciais



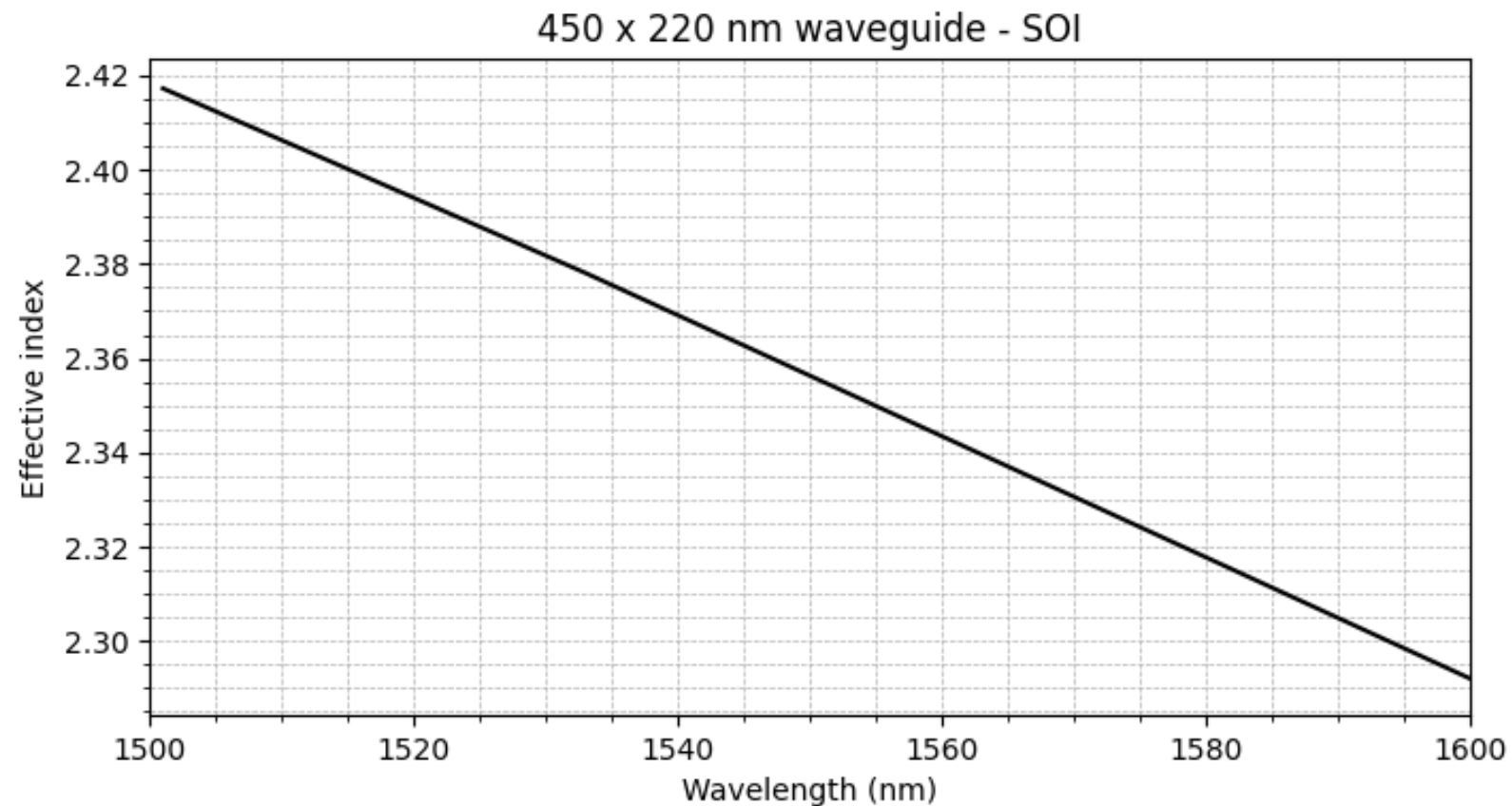
Extração do índice efetivo - FDE

Solver: 2D x normal



Condições de fronteira

| | |
|----------|-------|
| x min bc | Metal |
| x max bc | Metal |
| y min bc | Metal |
| y max bc | Metal |
| z min bc | Metal |
| z max bc | Metal |



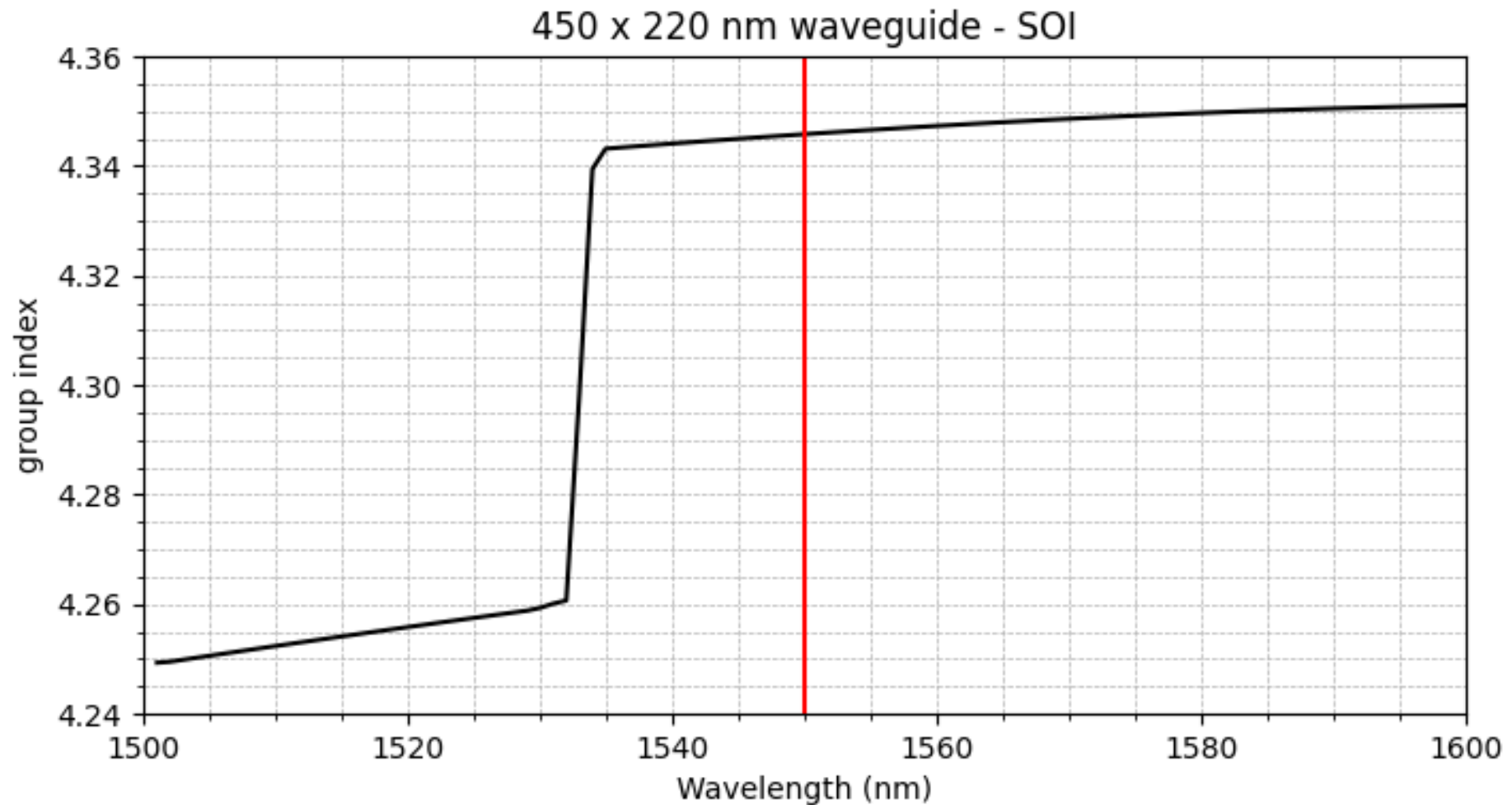
Determinação numérica do índice de grupo

$$n_g(\lambda) = n_{\text{eff}}(\lambda) - \lambda \frac{dn_{\text{eff}}}{d\lambda}$$

```
def derivative(data):
    derive = np.zeros(len(data[:, 1]))
    derive[1:-1] = (data[2:, 1] - data[:-2, 1]) / (data[2:, 0] - data[:-2, 0]) # central
    derive[0] = (data[1, 1] - data[0, 1]) / (data[1, 0] - data[0, 0]) # forward
    derive[-1] = (data[-1, 1] - data[-2, 1]) / (data[-1, 0] - data[-2, 0]) # backward
    return np.transpose([data[:, 0], derive])

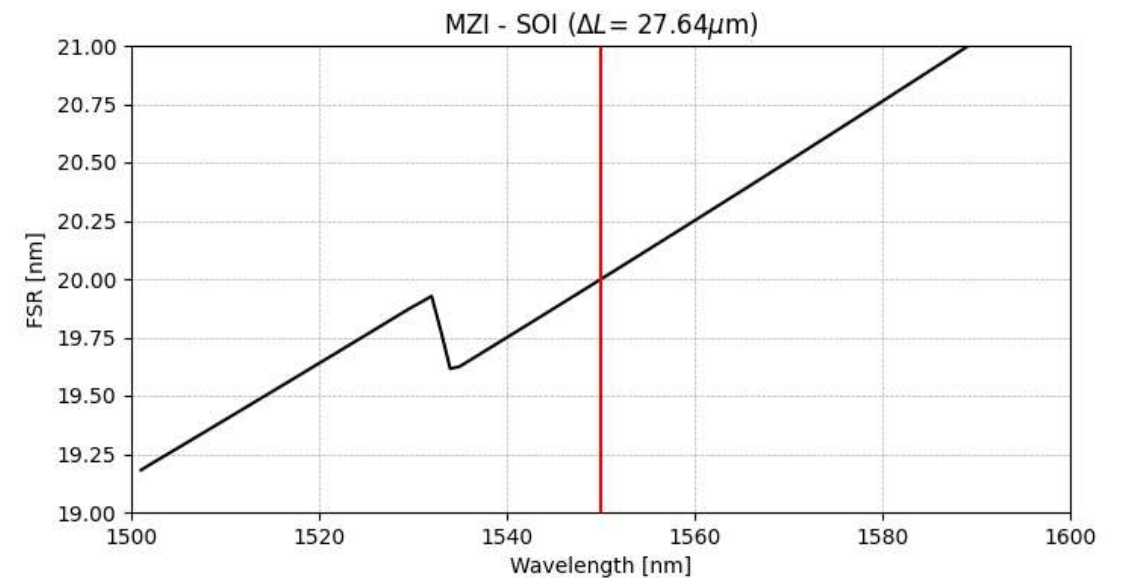
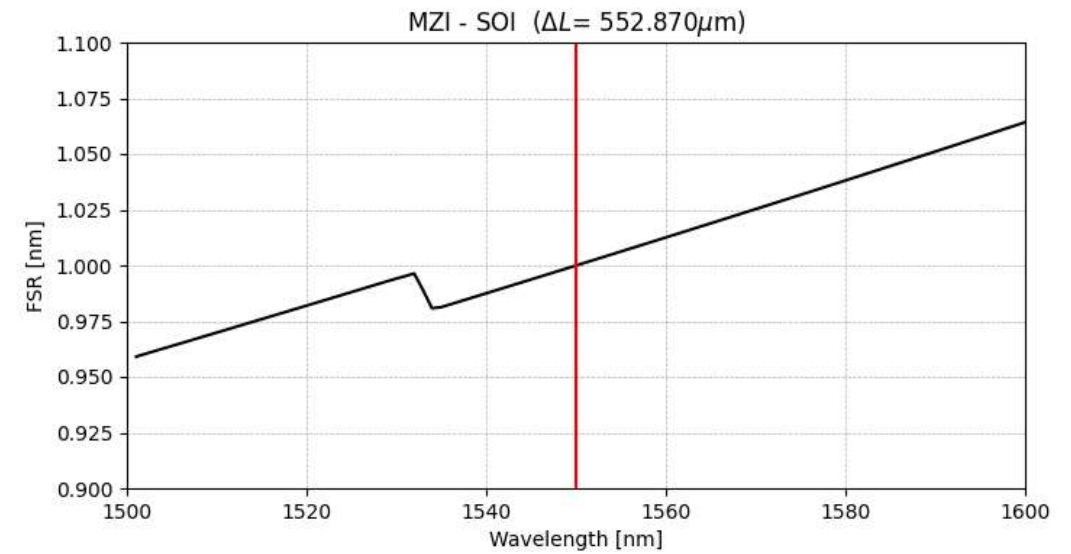
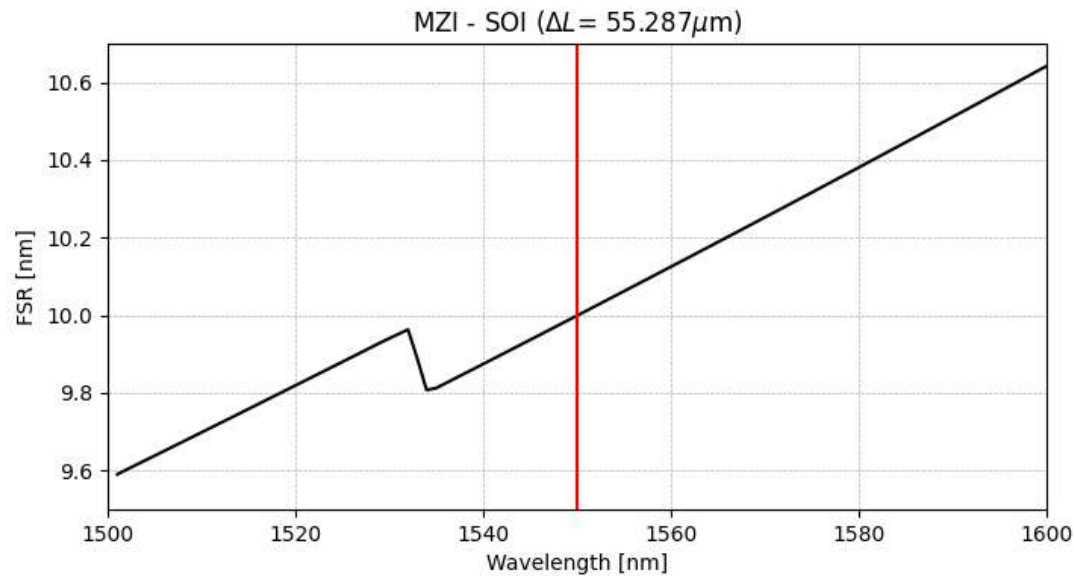
#####
neff_lambda = np.column_stack((wavelength_sweep, neff_sweep))
derivative_neff = derivative.derivative(neff_lambda)
ng = neff_sweep.flatten() - (derivative_neff[:, 1] * wavelength_sweep.flatten())
```

Gráfico obtido – índice de grupo

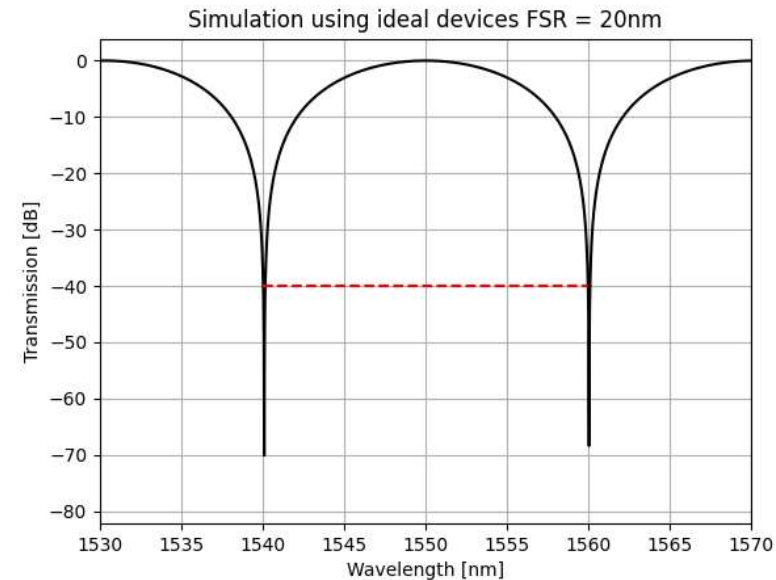
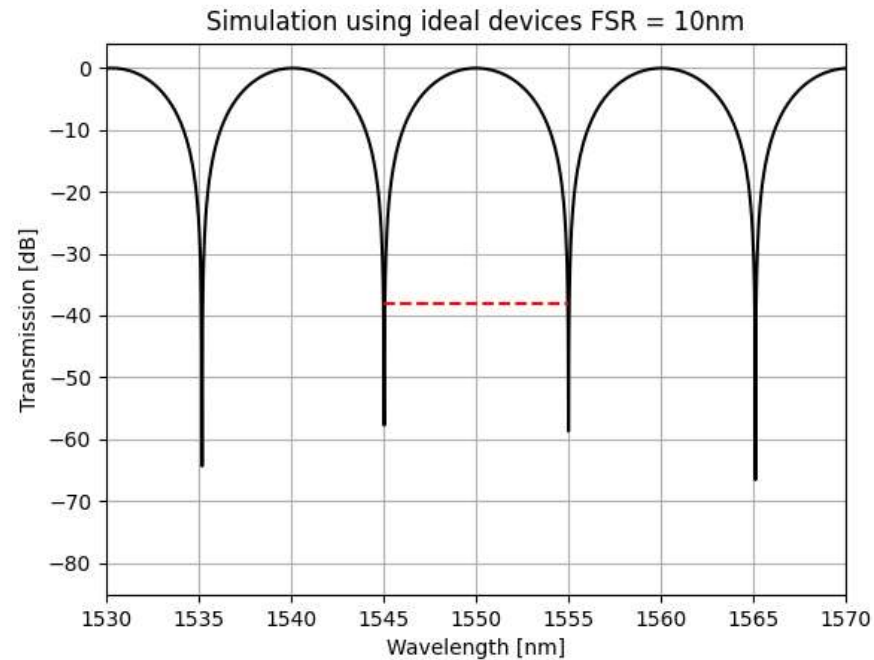
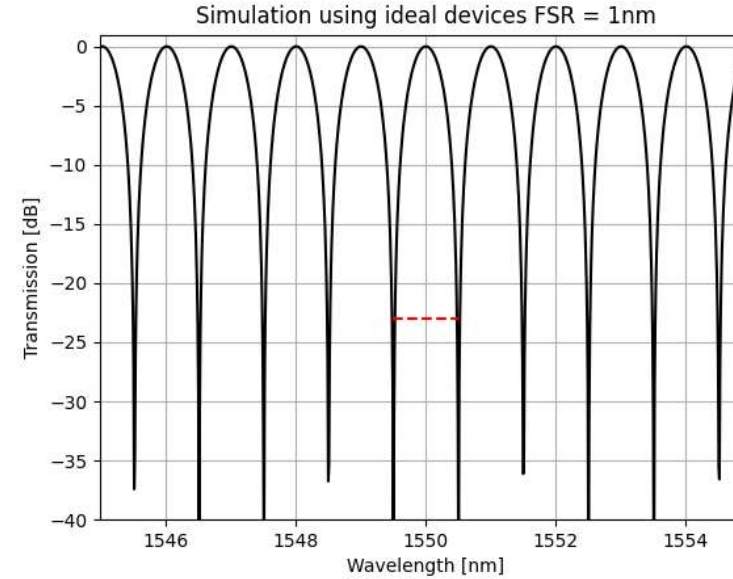
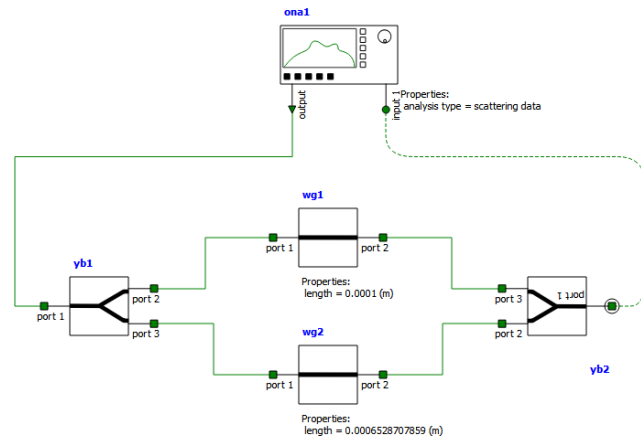


FSR em função do comprimento de onda com ΔL fixo

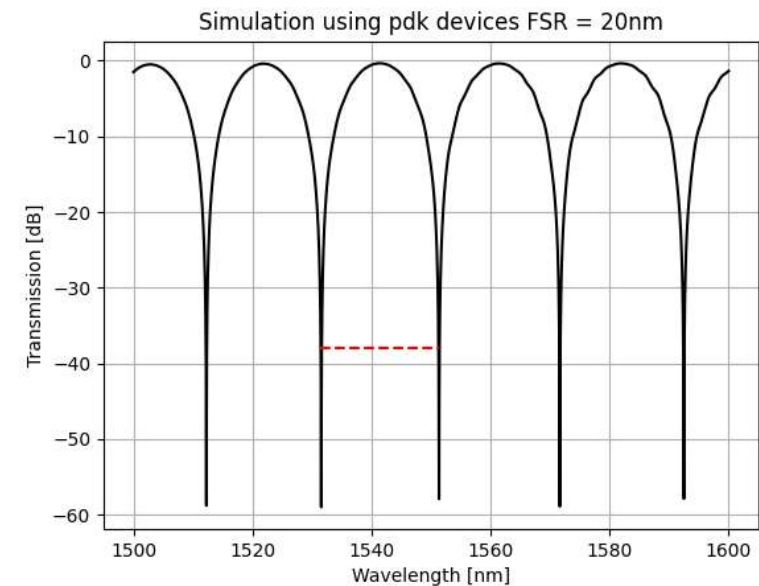
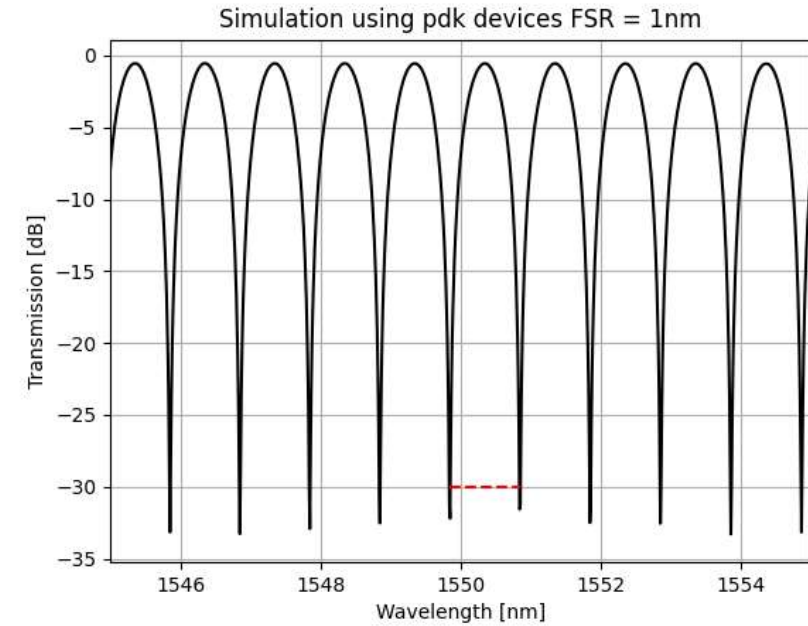
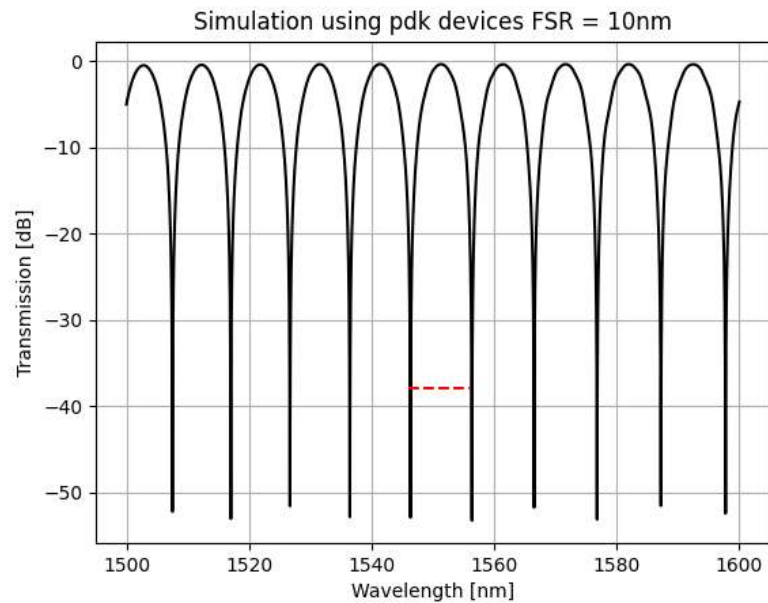
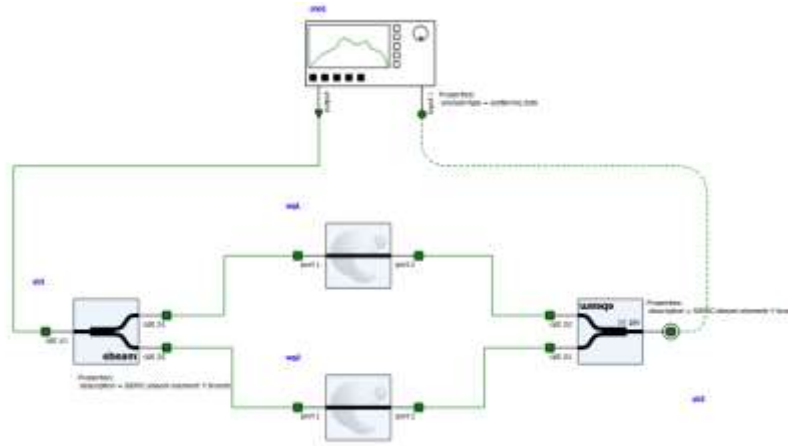
$$FSR [m] = \frac{\lambda^2}{n_g \Delta L}$$



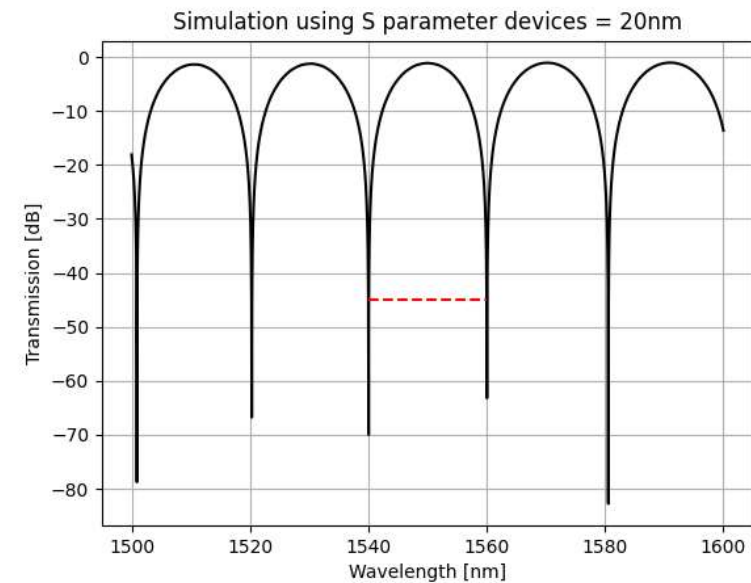
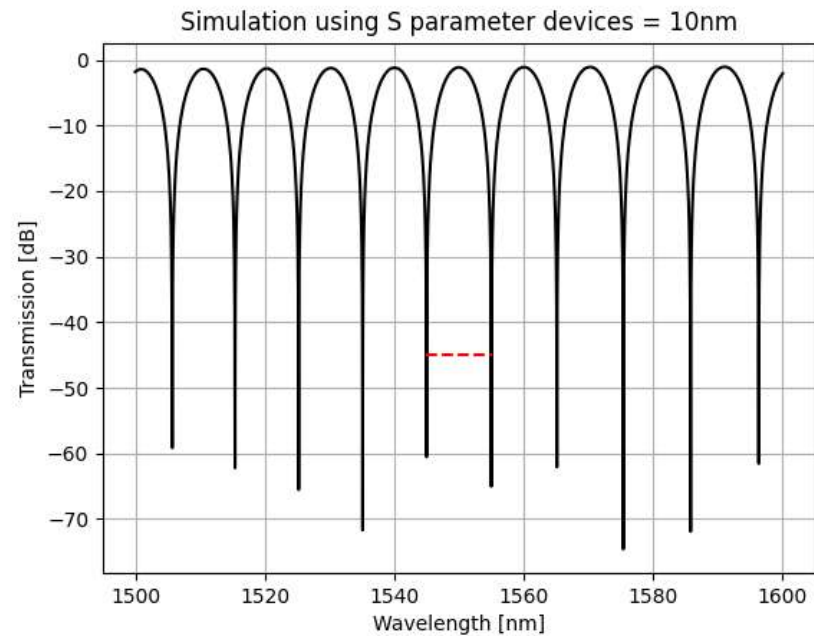
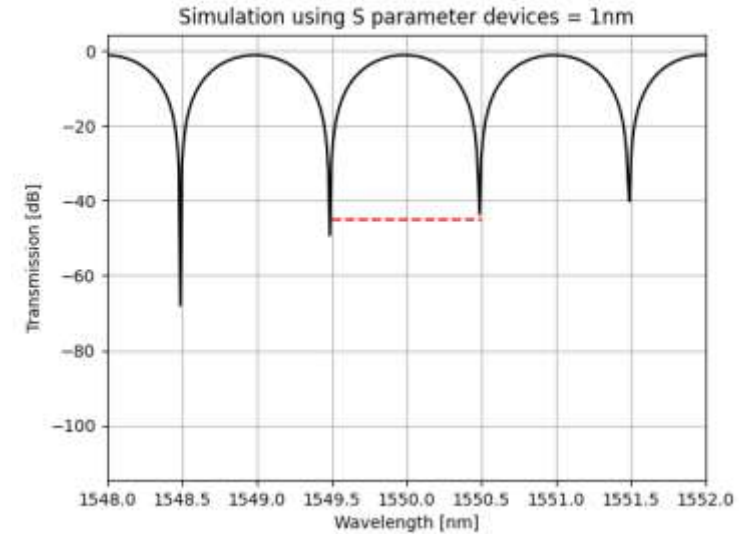
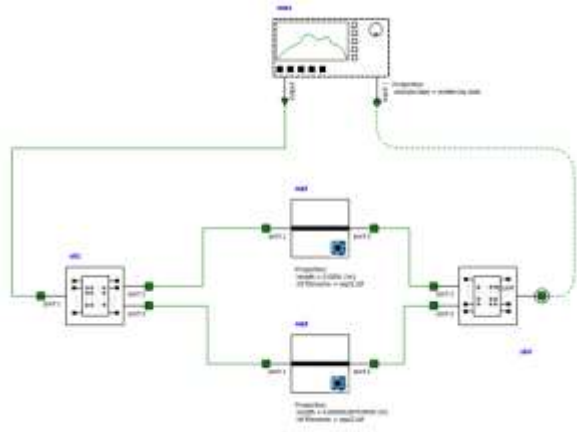
Transmissão do MZI – Caso ideal



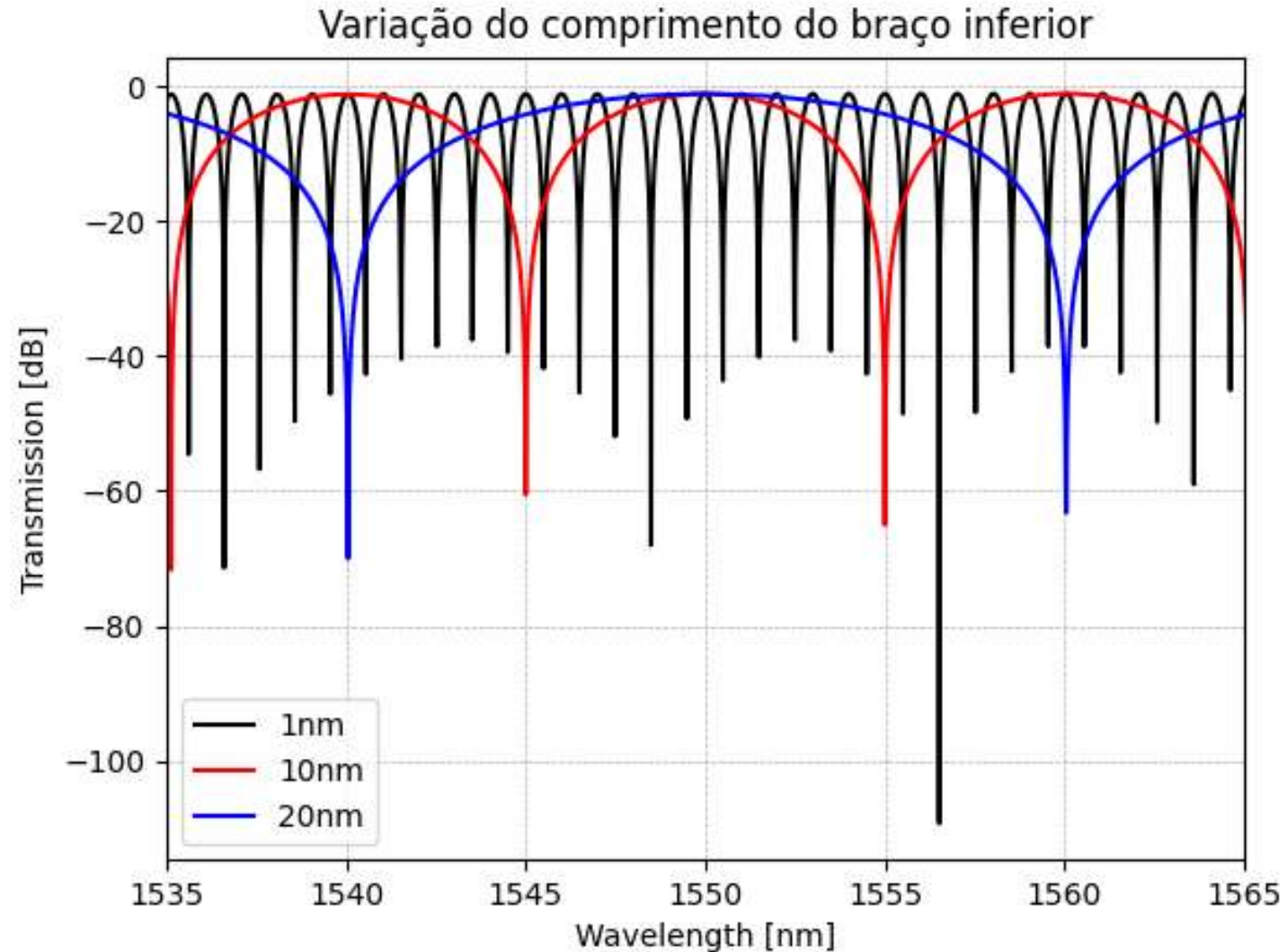
Transmissão do MZI – PDK SiEPIC



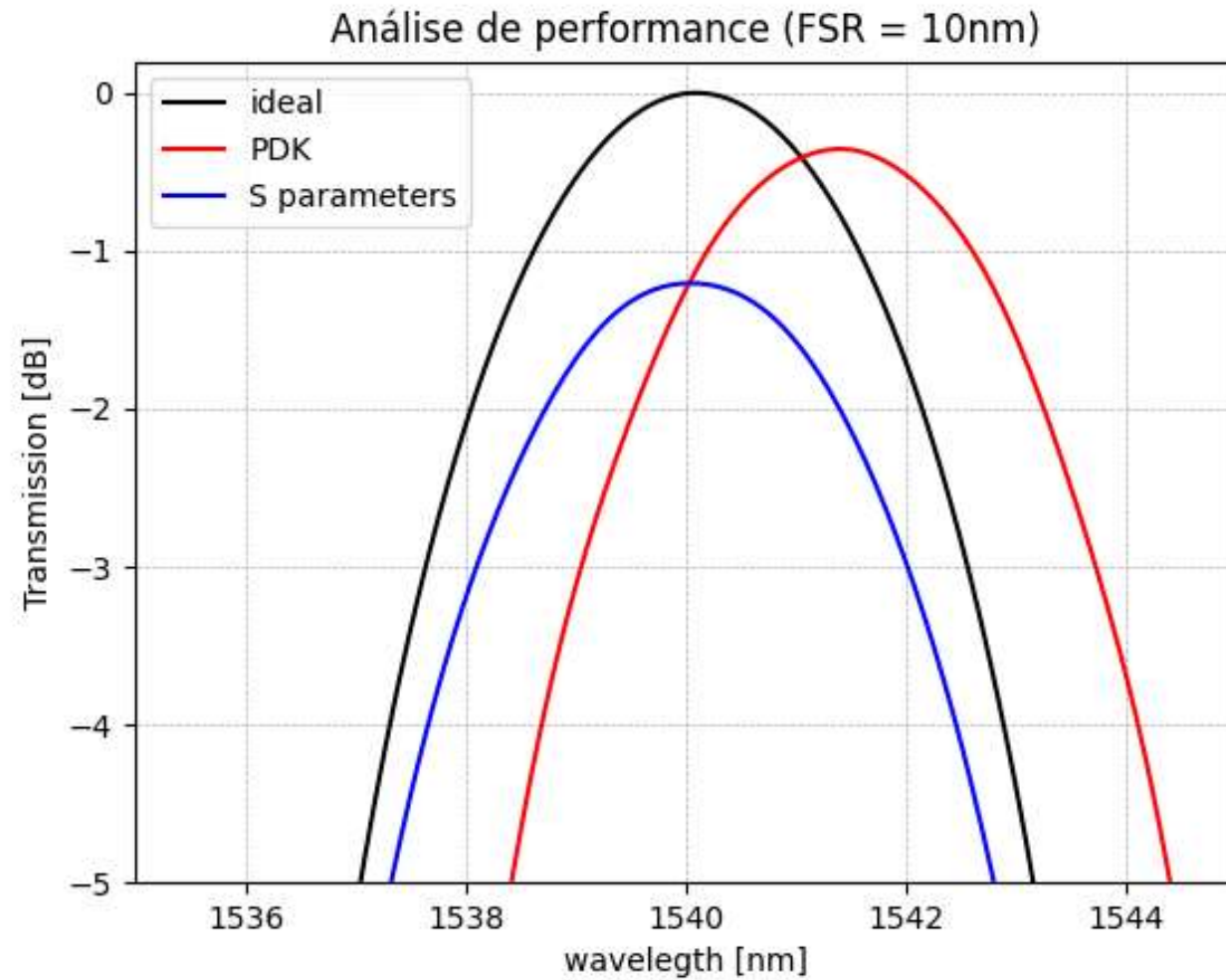
Transmissão do MZI – Parâmetros S



Variação do braço inferior – MZI caso ideal



Comparação: Ideal, PDK SiEPIC e Parâmetros S



Referências



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