Contra-directional Couplers for Wavelength Selective Switches

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Reducing Energy Consumption in Data Centers

❖ **Electronic Switches**
  ➢ Transfer information in data centers
  ➢ Energy Inefficient, but cost effective

❖ **Optical Switches**
  ➢ Reroutes light signals between fibers
  ➢ Energy Efficient; no need to convert to electrical signal
What is a Wavelength Selective Switch?

- *A type of optical switch*
- Accepts light input with a multitude of wavelengths
- Filters light output according to wavelength
- Flexible and cost effective in data centers
What is a Contra-directional Coupler?

- *The device acts as a filter*
- **Contra-Directional**: Light travels in opposite directions
- **Coupling**: Light exchanged between waveguides
- **Grating**: reflects light to other waveguide
Finding Wavelength Spectrum for Different Filters

❖ Computer Simulations

➢ Generate the wavelength spectrum for different contra-directional couplers

➢ Use simulations to analyze experimental data

❖ Optical Testing

➢ Measure the spectrum of test structures in the laboratory

➢ Examine how grating length affects spectrum
Lab Set-up for Optical Testing

-Performing parameter sweep, varying wavelength.

- Measuring power response in each port.
Simulations to Analyze Contra-directional Couplers

Reflectance Spectrum

- $k$ = coupling constant
- $L$ = interaction length

Phase matching:

$$\Delta \beta = (n_a + n_b)\left(\frac{2\pi}{\lambda} - \frac{2\pi}{\lambda_0}\right)$$

- Indices of Refraction
- Wavelength varies
Filter Simulation for Transmission and Reflection

Reflectance Spectrum

Transmission Spectrum

\[ \Delta \beta = (n_o + n_b) \left( \frac{2\pi}{\lambda} - \frac{2\pi}{\lambda_0} \right) \]

Indices of Refraction varies

Wavelength varies
Measured Spectrum of Contra-directional Couplers

**Drop Spectrum**

**Through Spectrum**

![Graphs showing measured spectra for different filters and wavelengths.](image-url)
Future Plans

- Test more contra-directional couplers
- Run sophisticated simulations for data analysis
- Determine coupling constant (“k”)
- Design new contra-directional couplers using results
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