2025 Workshop

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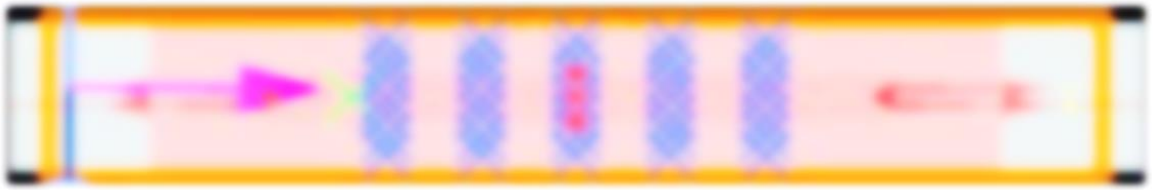
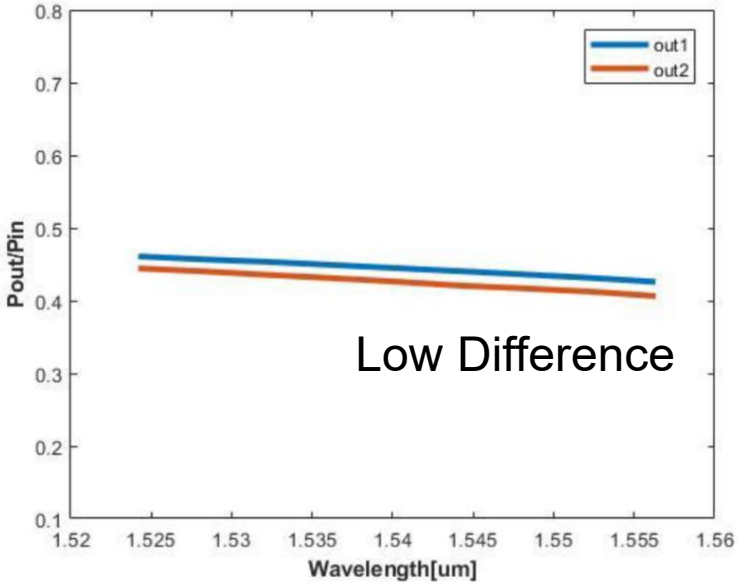
2018 (전기전자종합설계)

- 2 x 2 Multimode Interferometer (MMI)

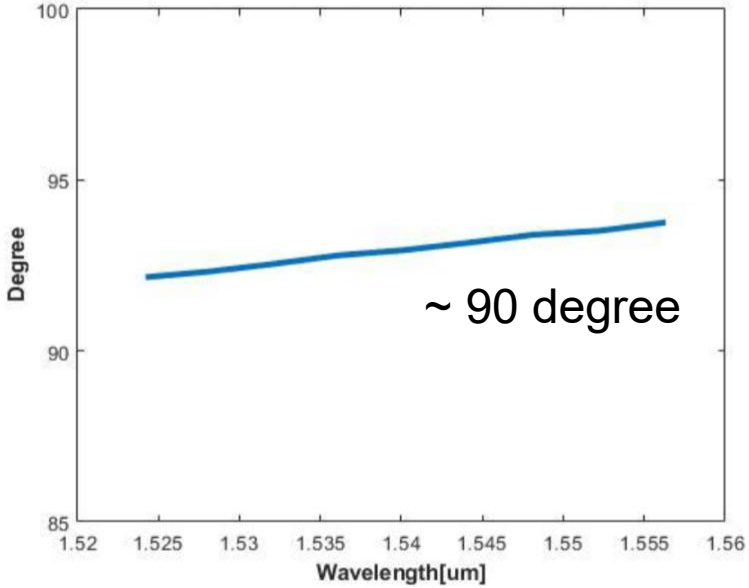
Lumerical - VarFDTD



Power of Output 1 and Output 2

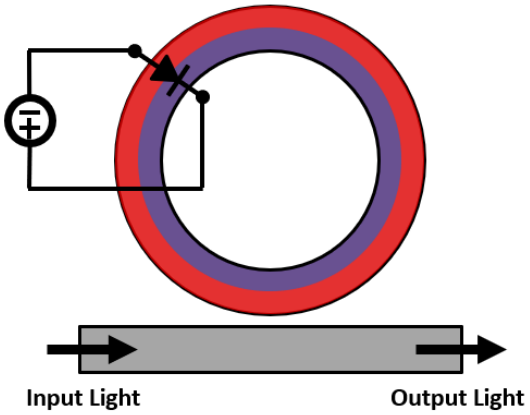


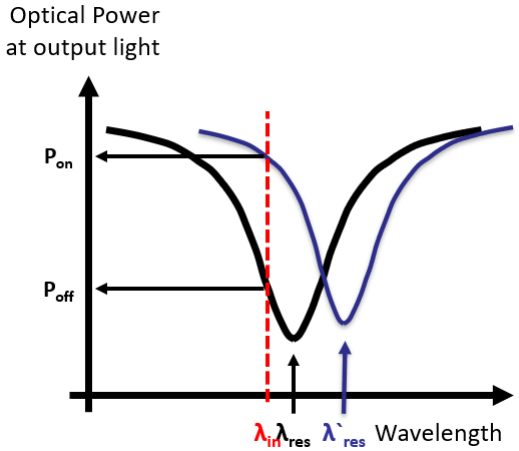
Phase Difference Between Output 1 and Output 2



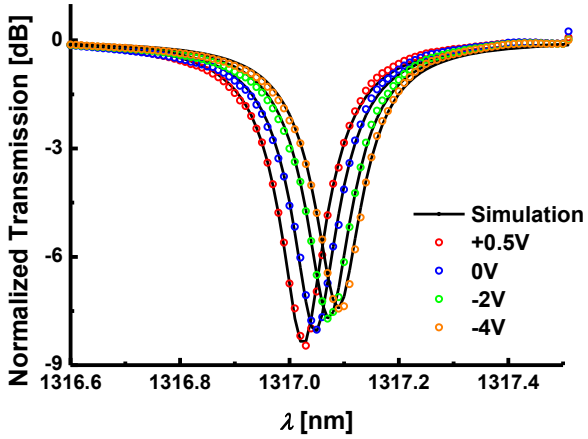
2018 (인턴)

- Si Ring Modulators (RM)





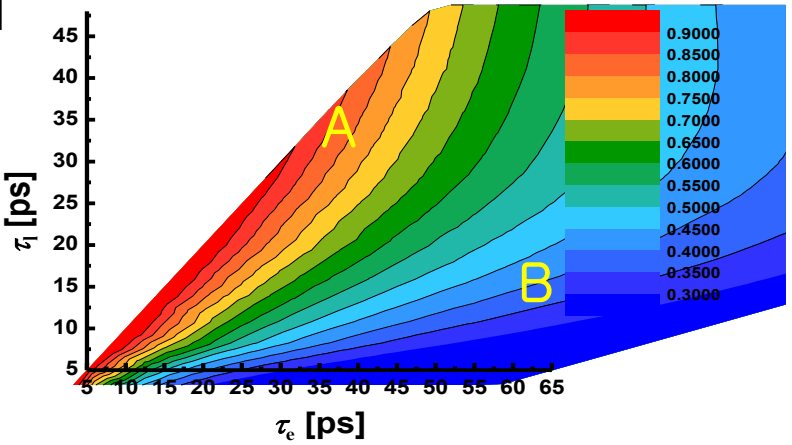
Measured Transmission Curve



n_{eff}, τ_l, τ_e extracted

Small-signal model of RM

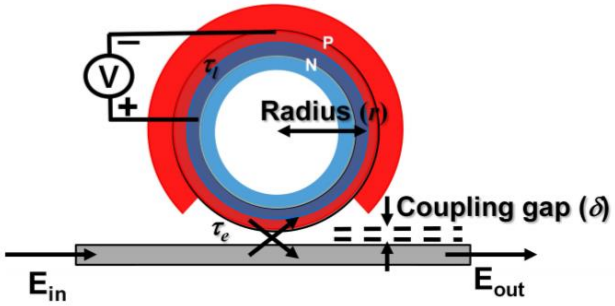
Figure of Merit



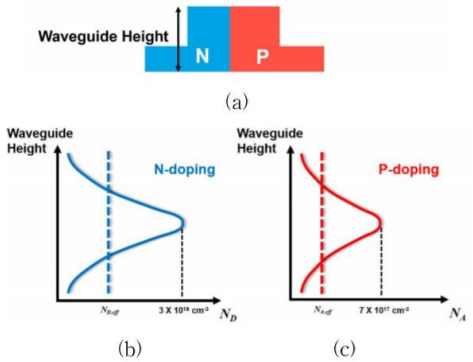
Bandwidth X Optical Modulation Amplitude

2019 ~ 2020

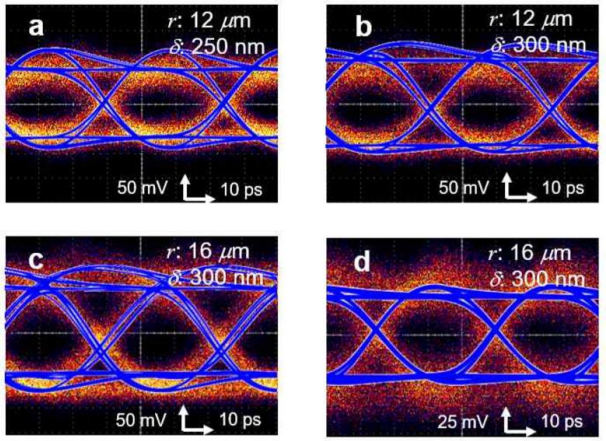
- Si RM Device Structure Optimization



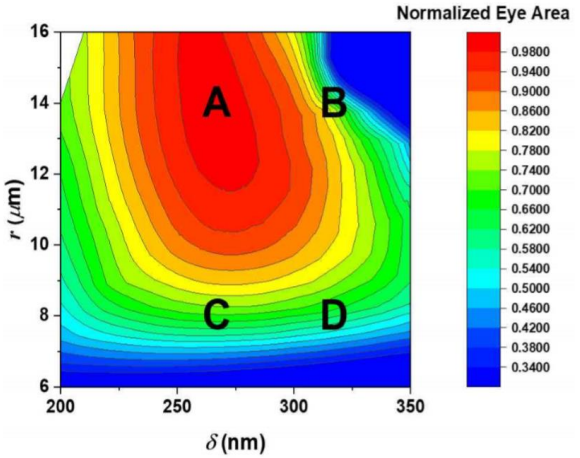
Effective Constant Doping Concentration

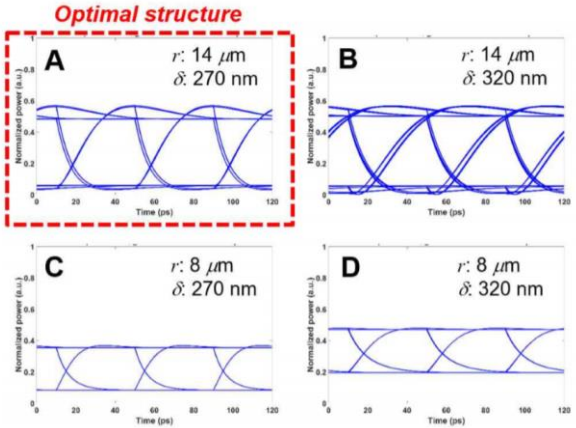


Eye Diagram for Verification of Simulation



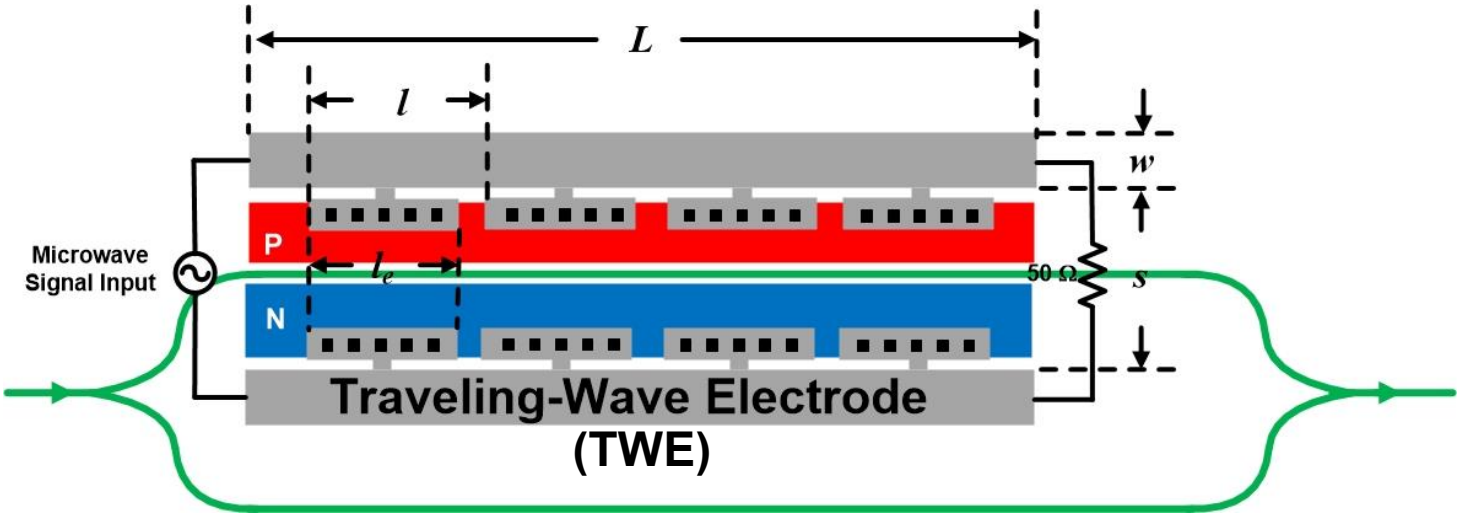
Optimization Results



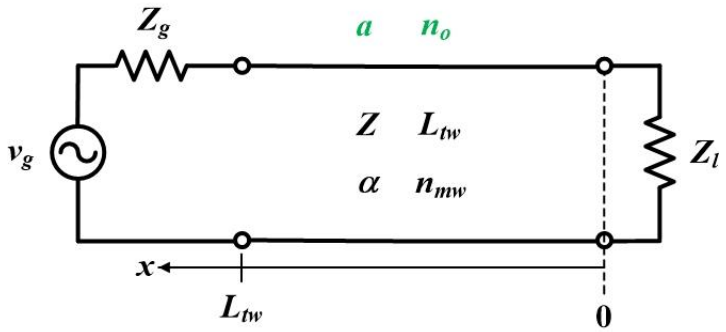


2021 ~ 2022

- Si Mach-Zehnder Modulators (MZM)



Simplified Equivalent Circuit of TWE



Sinusoidal Voltage experienced by optical signal at position x with frequency ω

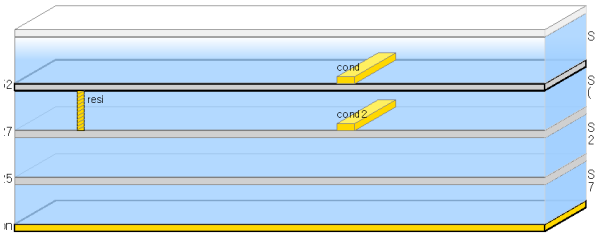
$$v(x,\omega)=\frac{v_g}{2}(1+\Gamma_g(\omega))e^{j\beta_s(\omega)L_w}\cdot\frac{e^{(j\beta_s(\omega)-j\beta_a(\omega))L_w}+\Gamma_l(\omega)\cdot e^{-(j\beta_s(\omega)-j\beta_a(\omega))L_w}}{e^{j\beta_s(\omega)L_w}+\Gamma_g(\omega)\cdot\Gamma_l(\omega)\cdot e^{-j\beta_s(\omega)L_w}}$$

S. H. Lin *et al.*, Applied Optics, 1987

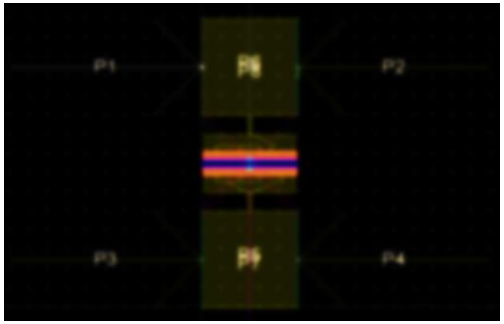
2021 ~ 2022

- MZM Simulation Setup → ADS Momentum, Schematic and Matlab

1. Substrate setup

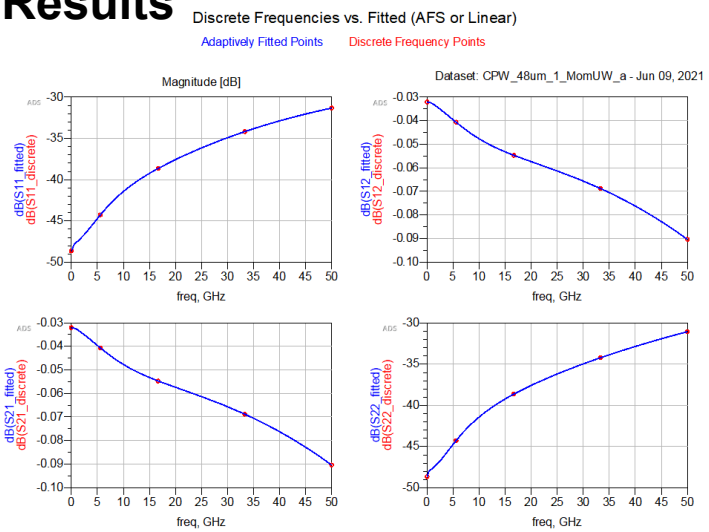


2. Layout



- ❖TWE Layout → Multiple layers
- ❖Applying Customized RC component

3. Results



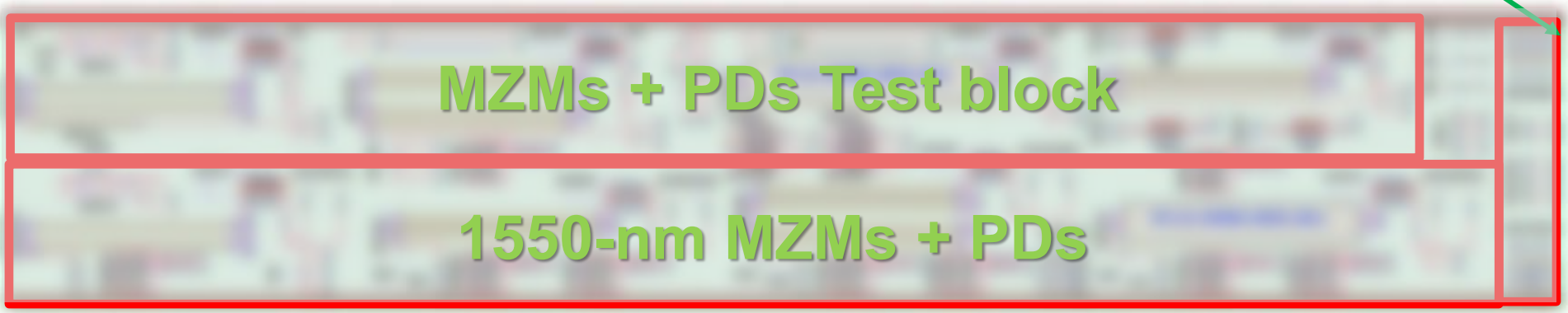
- ❖ S-parameter, etc.

4. Matlab

- ❖ EO S21
- ❖ Large-Signal Simulation

2022

- First Si MZM Fabrication in 2022 w/ AMF



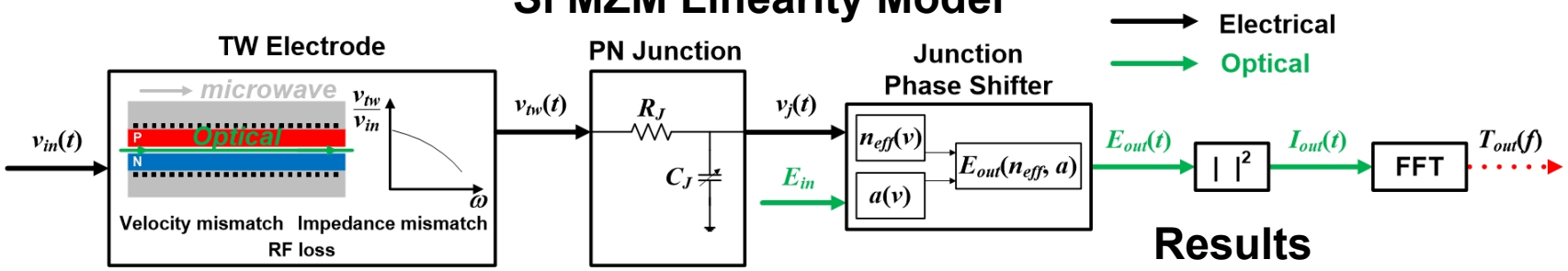
Single Push-Pull MZM

Coplanar Waveguide MZM

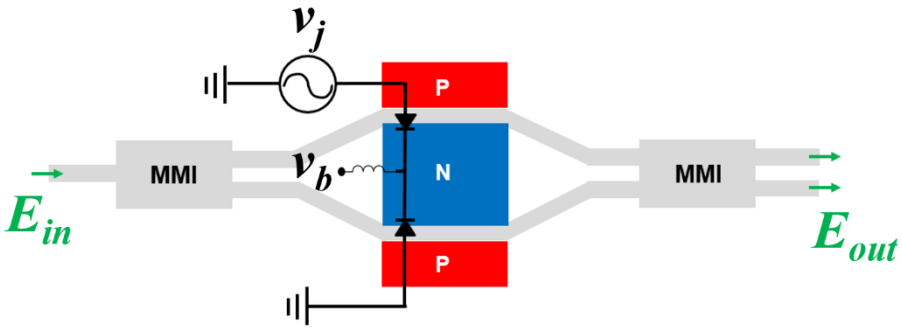
2023 ~ 2024

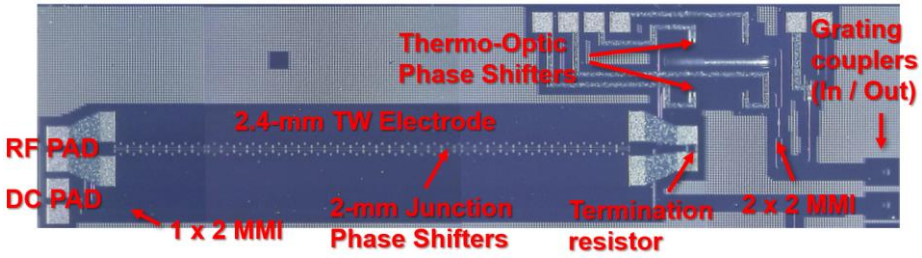
- Si MZM linearity characterization

Si MZM Linearity Model

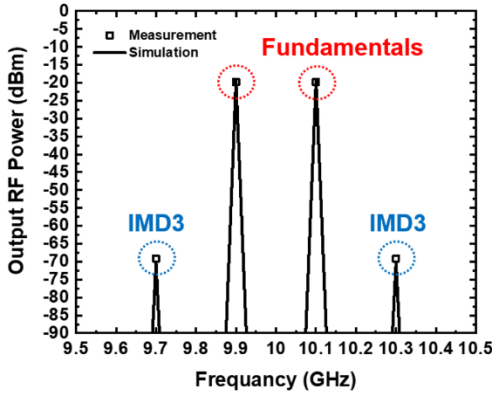


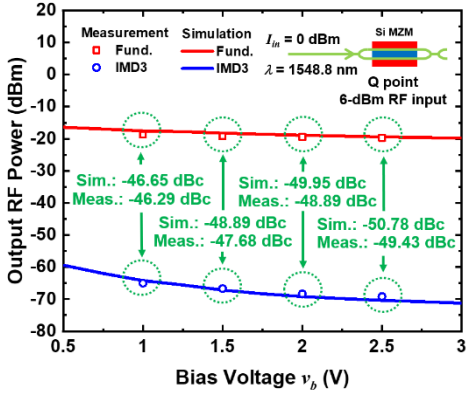
A Sample Si MZM

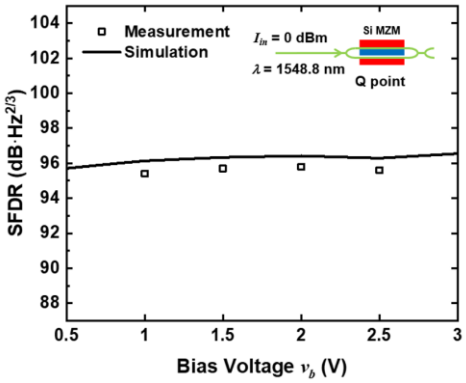


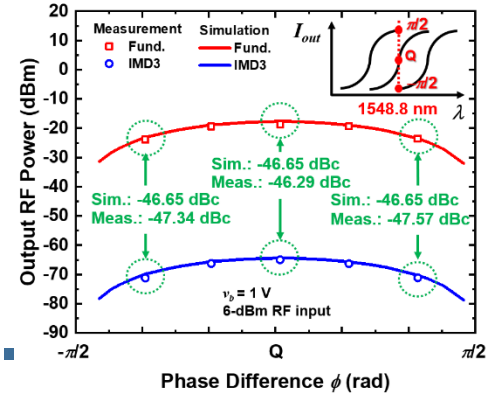


Results





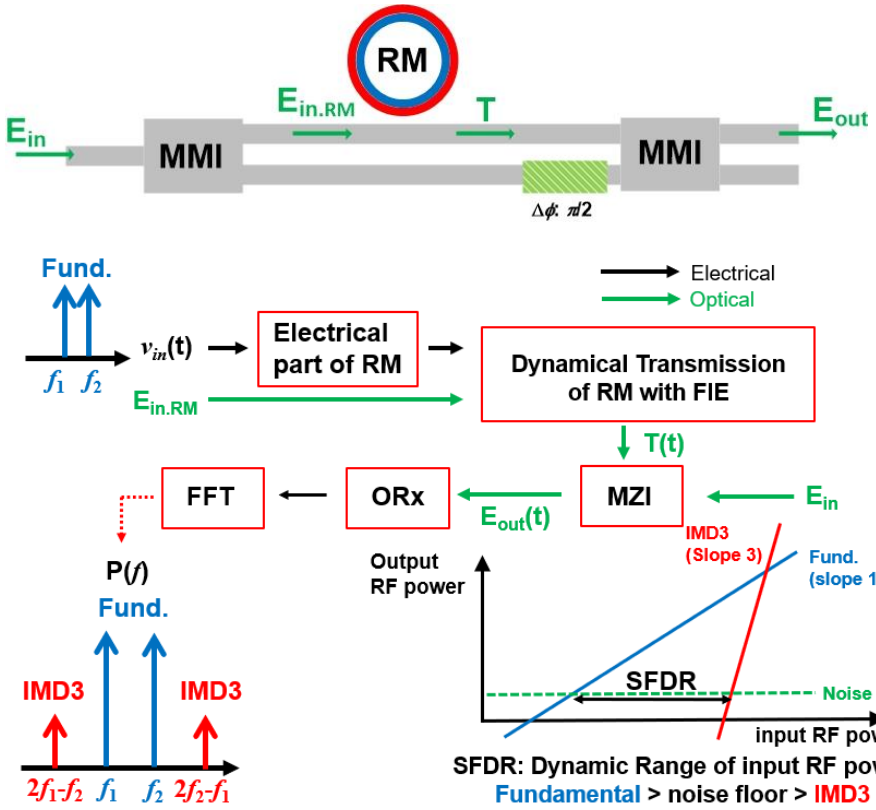




Seong et al., IEEE JLT, 2023

2025

- Linearity of Ring-assisted Mach-Zehnder Modulators (RAMZM)
  - Simulation Method and Results



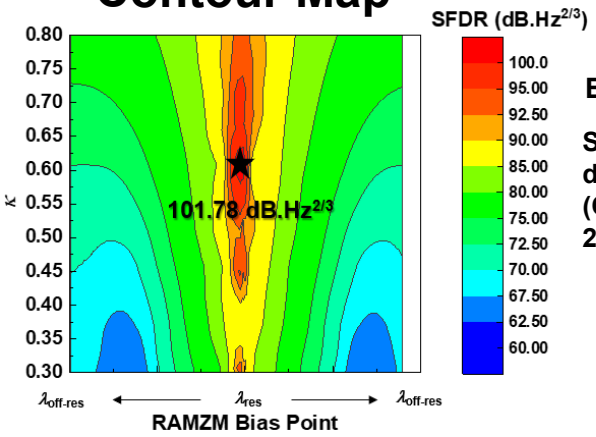
❖ Dynamic Transmission of RM

- **Fredholm Integral Equation of second kind (FIE)**: A model which hereditary and fading memory effect of RM cavity are included in

❖ SFDR Results

- 32-um radius
- 19.9-GHz and 20.1-GHz RF input, DC 1V

Contour Map



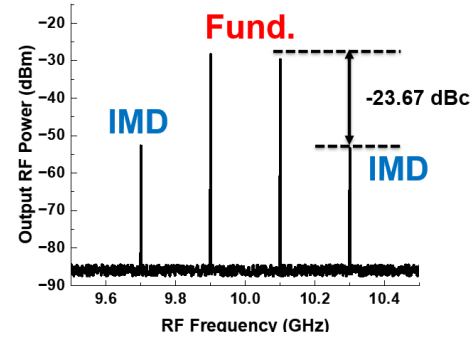
Better than Si RM

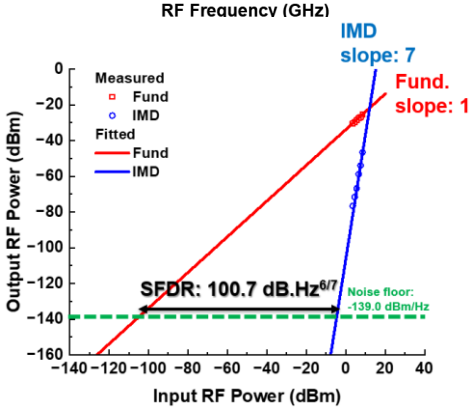
Si RM SFDR Record: 94.7 dB.Hz$^{2/3}$ at 10 GHz (Q. Zhang et al., IEEE PJ, 2020)

2025

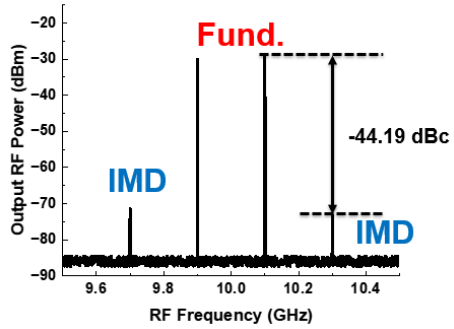
- Linearity of Ring-assisted Mach-Zehnder Modulators (RAMZM)
  - Measurement Results

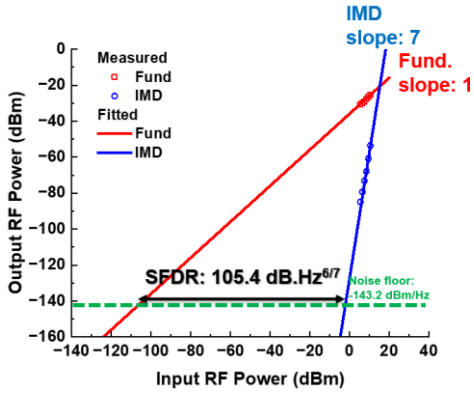
Single-Ended Modulation





Differential Modulation





- At resonance wavelength of RMs
- IMD/Fund.:Single-ended > Differential
- Cancellation of even-order distortions

M. J. Shawon *et al.*, JLT, 2023

- The slope of the IMD component: 7
- 7^{th}-order distortions is dominant!!
- 105.4-dB.$Hz^{6/7}$ SFDR