
DTU

# Reinforcement Learning Control of Raman Amplifiers
# 04.12.2025

# Simulation model validation

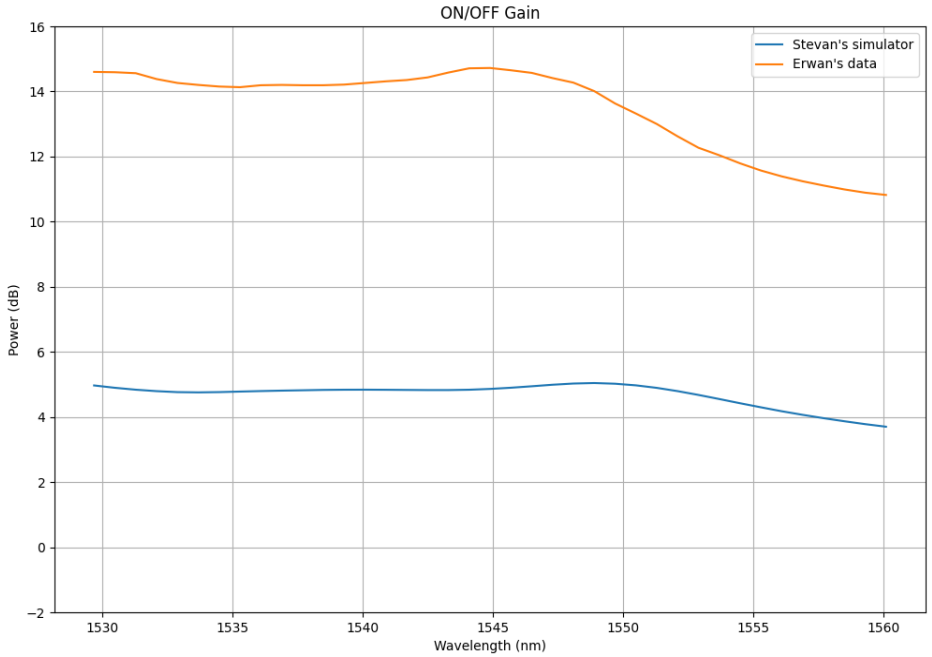
The experiment was performed on Erwan's and Stevan's simulators.

The results are showcasing ON/OFF gain of the Raman system.

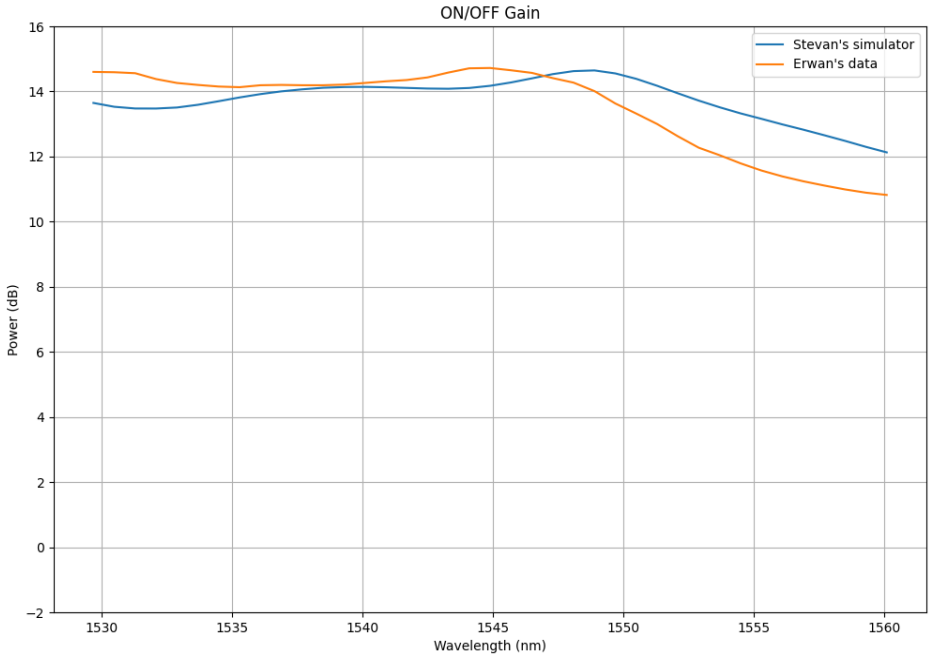
The ON/OFF gain is measured by running the simulation with the pump powers set to their values, then set to 0W, which produces two power spectra. The gain spectrum is calculated by dividing the two power spectra.

- Fiber
  - Type - Standard Single Mode
  - Length - 100 km
  - Attenuation @ signal – 0.2 dB
  - Attenuation @ pump – 0.25 dB
  - Peak Raman efficiency – 0.42
- Raman Amplifier
  - Powers – 200 mW
  - Wavelengths – 1420, 1440, 1455 nm
  - Only forward pumping
- Input spectrum
  - 40 components, 1530 – 1560 nm
  - Component power - 250 uW
  - Total input power – 10 mW

# Simulation model validation




We can observe that Stevan's gain profile is ~10dB lower than Erwan's gain profile, although the shapes look similar.




In order to achieve the same value of Gain, the peak of SSMF's Raman efficiency was scaled 2.7 times larger than in Erwan's experiment.

# Gradient Descent Controller

The gradient descent controller computes the gradient of the loss function using the forward model as an approximation.

The forward model is based on the sampled pairs of Raman input powers and wavelengths, and the corresponding power spectrum at the output.

The dataset for training the forward model will be acquired once the model is validated.

The training of the forward model will be conducted on normalized input and output values.