# Wavelength Modulation of DFB Diode Lasers

DFB laser diodes are designed for overcoming the drawbacks of Fabry Perot laser diodes. For ensuring a safe single mode operation, a Bragg grating is integrated within the laser chip.

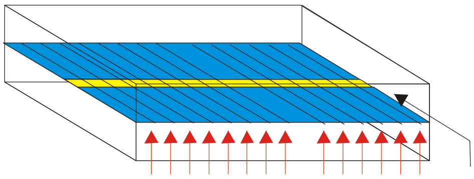


Figure 3: Schematic drawing of a DFB laser diode.

Physical Basis: A DFB laser diode is a laser diode where a Bragg grating is integrated within the laser chip which results in a distributed feedback of the laser light over the entire laser chip. The emission facet is performed with an antireflection coating for suppressing the Fabry Perot modes of the laser chip.

Wavelength Tuning: The emission wavelength of DFB can be tuned by changing the injection current of the laser and/or the temperature of the laser mount. The optical spectrum is well defined by the DFB mode which results in a proper single mode emission and a well defined side mode suppression rate (Fig. 4).

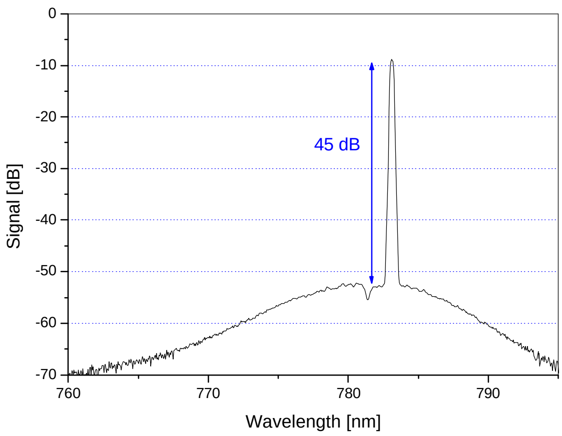


Figure 4: Side mode suppression of a DFB laser diode.



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There are two different methods for tuning the wavelength of DFB laser diode.

1) Temperature Tuning: The thermal tuning method bases on the idea that the optical length of diode lasers varies with the temperature of the laser chip. For applying this method, the temperature of the complete DBR laser chip is changed.

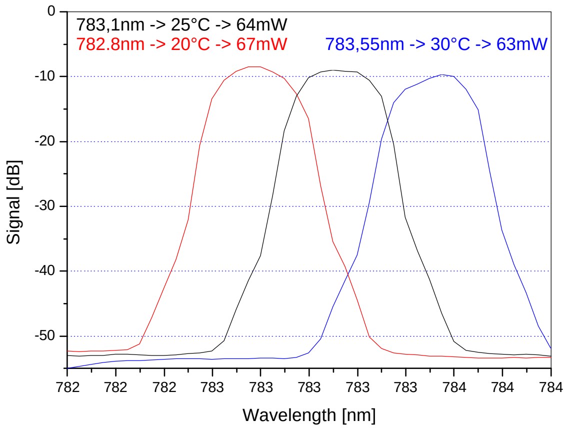


Figure 5: The graphic shows the total tuning range of the 785nm DFB laser with a temperature change from 20°C (red curve) to 30°C (blue curve). The complete temperature tuning range is mode-hop free. The tuning rate is 24GHz/°C (120mA). The tuning speed is limited by the thermal capacity of the laser chip. There is a version of the DFB laser with an integrated Peltier cooler within a TO3 can available.

2) Injection Current Tuning: The direct modulation of the injection current of the DFB laser enables significantly higher modulation frequencies. Since the electrical modulation coefficient is about a factor of 100 below the thermal modulation segment, the total wavelength scan is about a factor 100 below the thermal modulation range. The tuning rate is 1.6 GHz/mA (25 °C). The graph of fig. 6 at the left hand side shows the PI curve of the DFB Laser. The right hand side graph shows the achieved wavelength tuning. There is only one mode-hop of typically 30GHz right above the laser threshold. Beside this mode-hop, the total Injection Current Tuning is mode-hop-free.

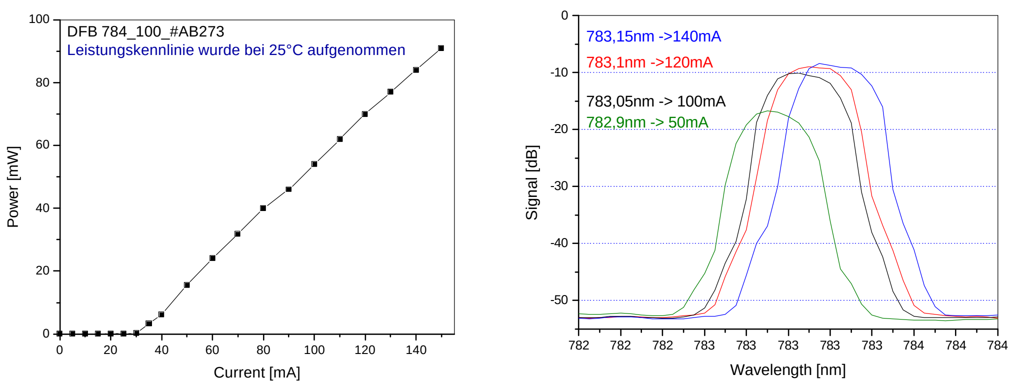


Figure 6:The graph at the left hand side shows the PI curve of the DFB laser. The right hand side graph shows the achieved wavelength tuning. There is only one mode-hop of typically 30GHz right above the laser threshold. Beside this mode-hop, the total injection current tuning is mode-hop-free.



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Modulation Speed of DFB laser diodes: A relative fast modulation of DFB laser diodes can be performed by modulating the injection current. We investigated the modulation of a DFB laser via the modulation input of our Pilot P500 laser driver as well as via the integrated bias tee BT7 of the TEC-030 Cheetah Laser Head. A modulation current of approximately 10 mA pp with a triangular waveform was applied to the DFB diode laser. The modulation response is shown in fig. 7.

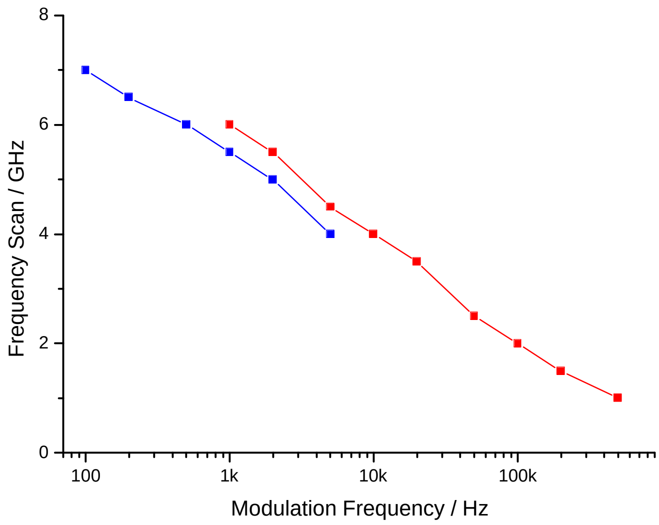


Figure 7: The blue trace shows the modulation response via the P500 modulation input. The red trace shows the modulation response via the BT7 bias tee.

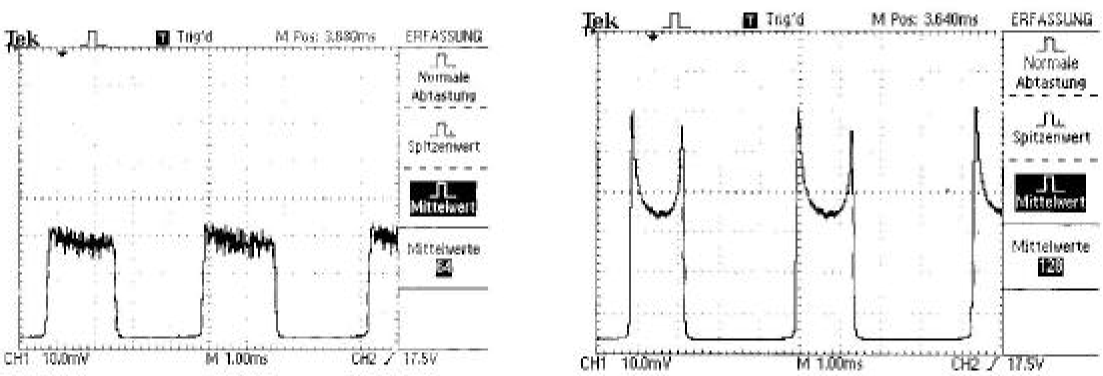


Figure 8. The Fabry Perot spectrum at left hand side shows a modulation response below 10 kHz. The Fabry Perot spectrum at the right hand side shows a modulation response above 100 kHz.

Beyond a frequency of 10 kHz the current modulation of the DFB diode laser changes from triangular to sinusoidal due to the limited modulation response of the DFB laser. This can be identified by a change of the frequency distribution measured via a Fabry Perot interferometer. The Fabry Perot spectra while modulating are shown in fig. 8.

Document: http://data.sacher-laser.com/techdocs/DFBMod.pdf
Note: Specification are subject to change without further notice

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In order to check the linearity of the modulation response at 50 kHz, we measured the frequency scan of the DFB laser as a function of the modulation amplitude. The result is shown in fig. 9.

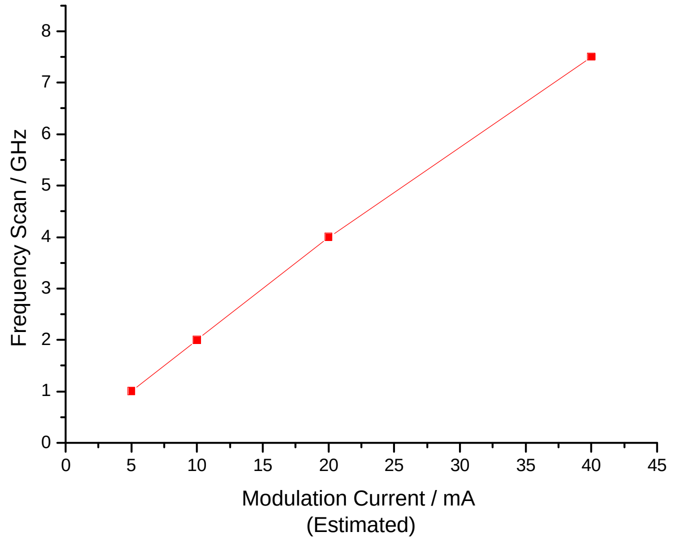


Figure 9. The curve shows an almost linear change of the frequency scan as a function of the modulation amplitude. The tested values range from 5 mA pp to 40 mA pp.

In summary, a DFB laser diode is a well suited instrument for high frequency wavelength scans for moderate frequency scans. Drawbacks of DFB lasers are the relatively high costs and the limited availability of wavelength.




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