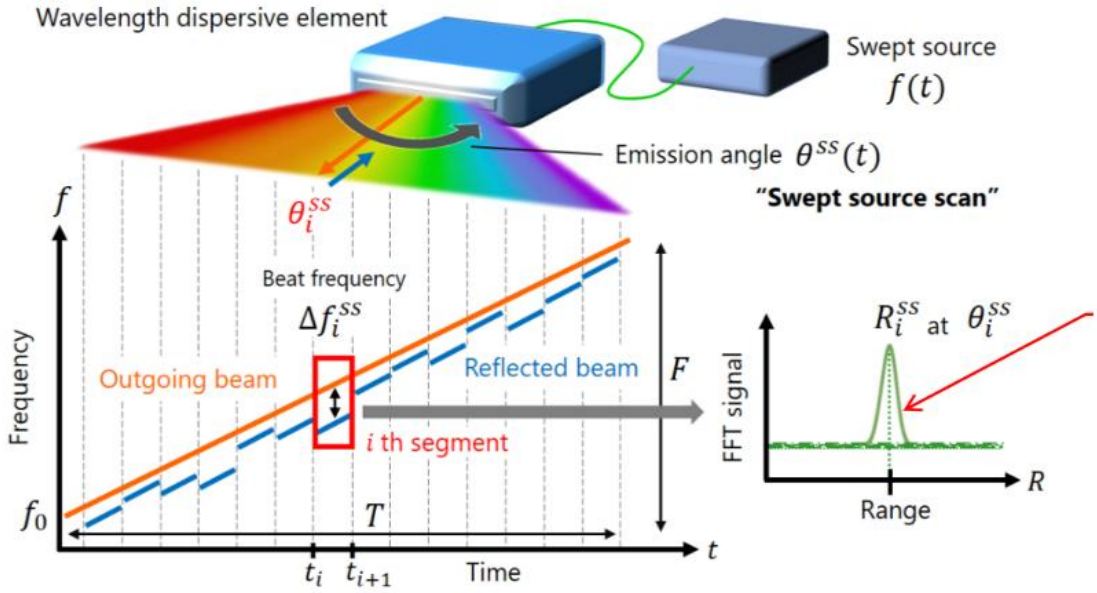
Why do semiconductor lasers need narrow linewidth?

First, with the current explosive growth in demand for network traffic, the transmission rate of optical fiber communication needs to be greatly improved. One way to increase the transmission rate is through higher and more complex modulation formats, and this pair of laser lines The requirements will be higher.

Second, in the fields of spectroscopy, metrology, and biochemical sensing, higher requirements will be placed on the linewidth of lasers. For example, the linewidth of FMCW lidar must be small enough to ensure that the light reflected from 200 meters away can also be coherent with the reference light.



FMCW lidar schematic diagram

So how does the linewidth of the laser come about, and what causes the linewidth to be relatively large? According to the linewidth theory of semiconductor lasers explained by Henry in 1982, the linewidth of the laser can be roughly attributed to the phase jitter of the light field. Part of the phase jitter comes from the phase change caused by spontaneous emission, and the other part comes from changes in light intensity and carrier Phase changes caused by changes in carrier density. Line width formula:

$$\Delta f = \frac{v_g^2 h v g n_{sp} \alpha_m (1+\alpha^2)}{8\pi P_0}$$

In the formula, Vg is the equivalent group velocity, hv is the energy of the laser line, g is the gain of the laser, nsp is the spontaneous emission factor, alpha is the end face loss, Po is the output power of the end face, and alpha is the line width enhancement factor.