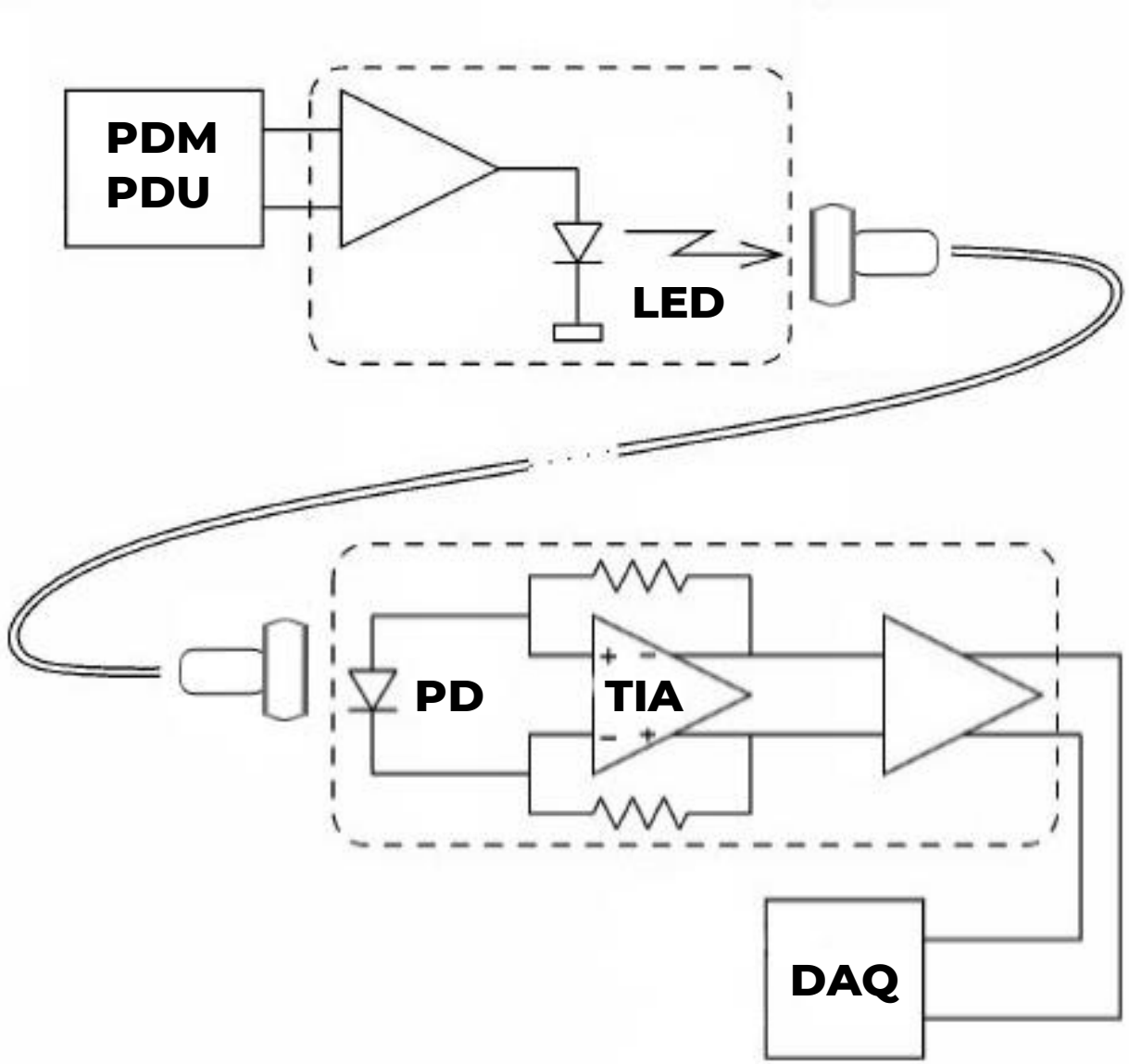
DarkSide and **Dune** opto-link specs



DS specs

- Single PE SNR > 10
- Dynamic Range 200PE (0-2V)
- Rise-Time (10-90)% < 8 ns
- BW > 50 MHz
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Dune specs

- Single PE SNR > 4
- Dynamic Range 2000PE
- Rise-Time (10-90)% < 100 ns
- 5 MHz < BW > 35 MHz
- Power consumption: <100mW

The concepts of **SNR** and **dynamic range** are closely related. Dynamic range measures the ratio between the strongest un-distorted signal on a channel and the minimum discernible signal. **SNR** measures the ratio between an arbitrary signal level (not necessarily the most powerful signal possible) and noise.

$$DR = \frac{A_{MAX}}{A_{sPE}}$$

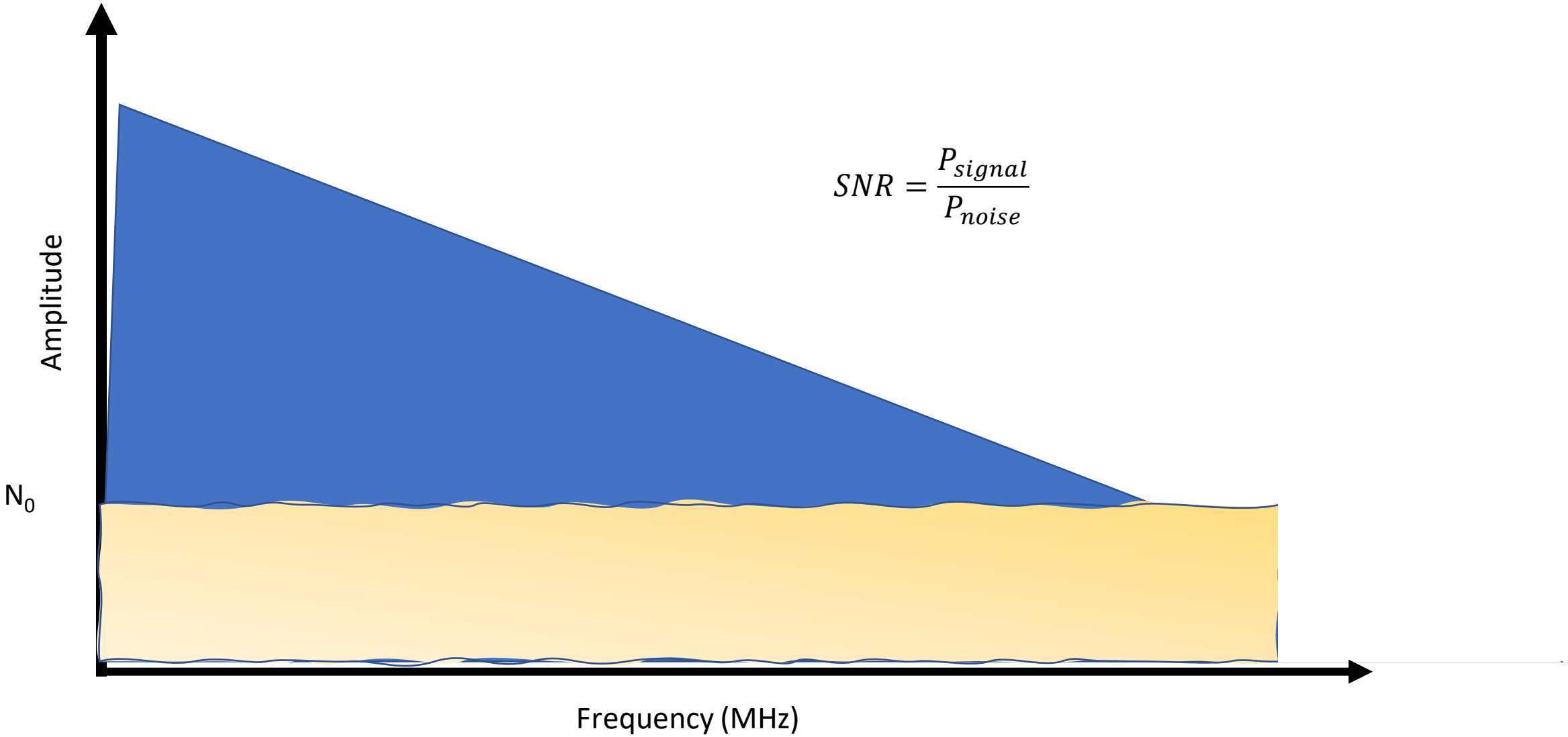
$$SNR = \frac{P_{signal}}{P_{noise}} = \left(\frac{A_{sPE}}{A_{noise}}\right)^2$$

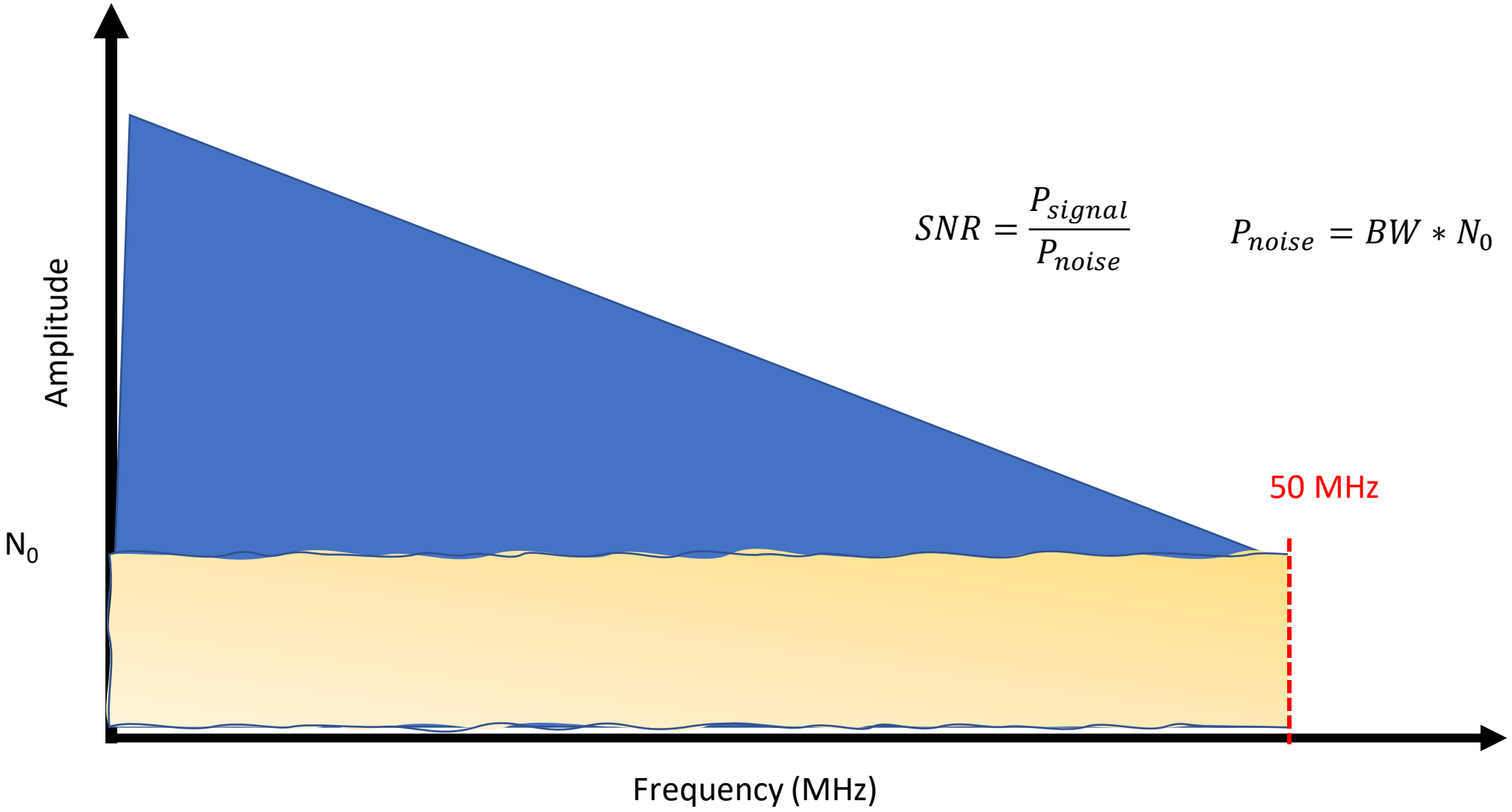
In order to increase the Dynamic Range, we should decrease the amplitude of the single PE (**A_{sPE}**).

But, by decreasing the **A_{sPE}** the **SNR** is affected as well.

If we want to decrease **A_{sPE}** we must reduce the noise amplitude (**A_{noise}**) as well.

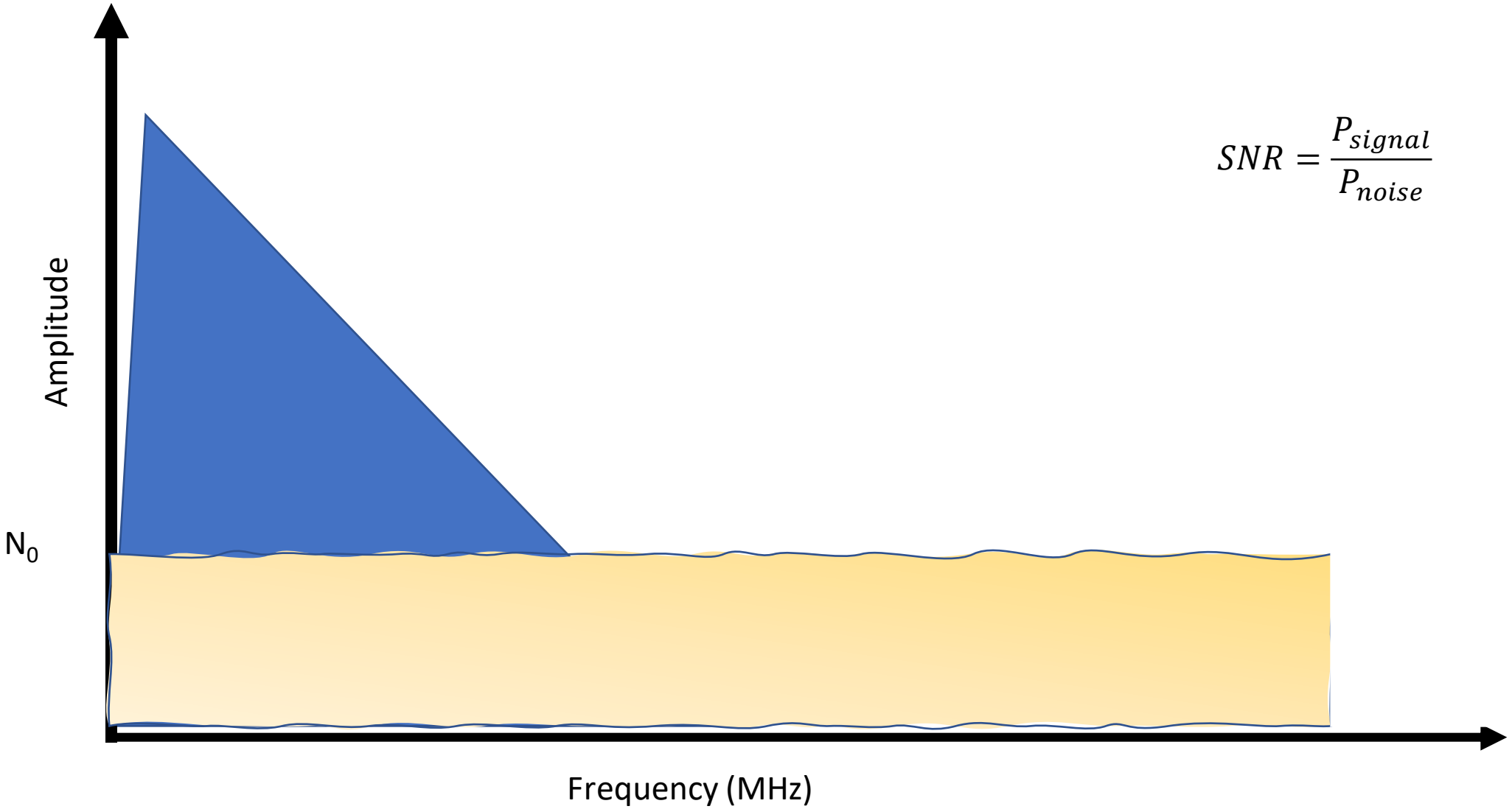
$$SNR = \frac{P_{signal}}{P_{noise}}$$



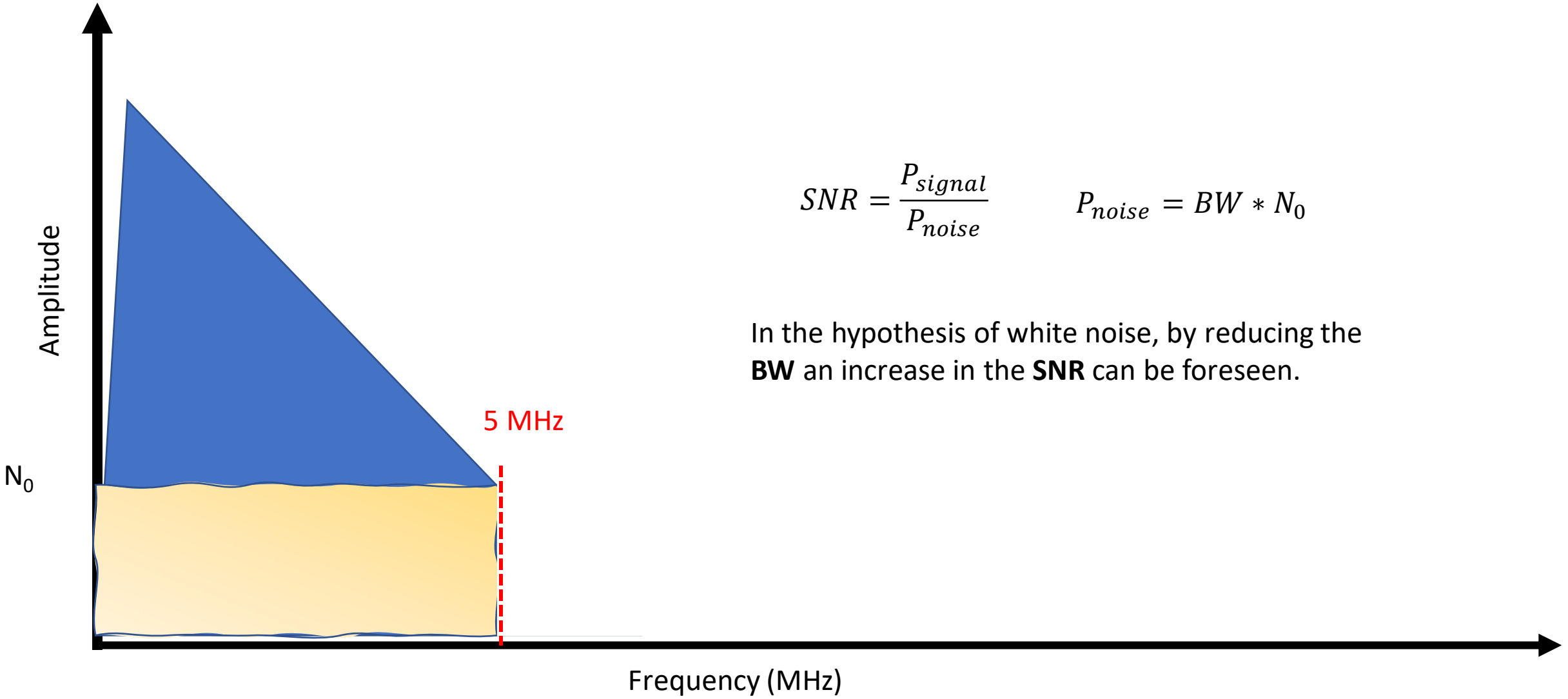


$$SNR = \frac{P_{signal}}{P_{noise}}$$

$$P_{noise} = BW * N_0$$

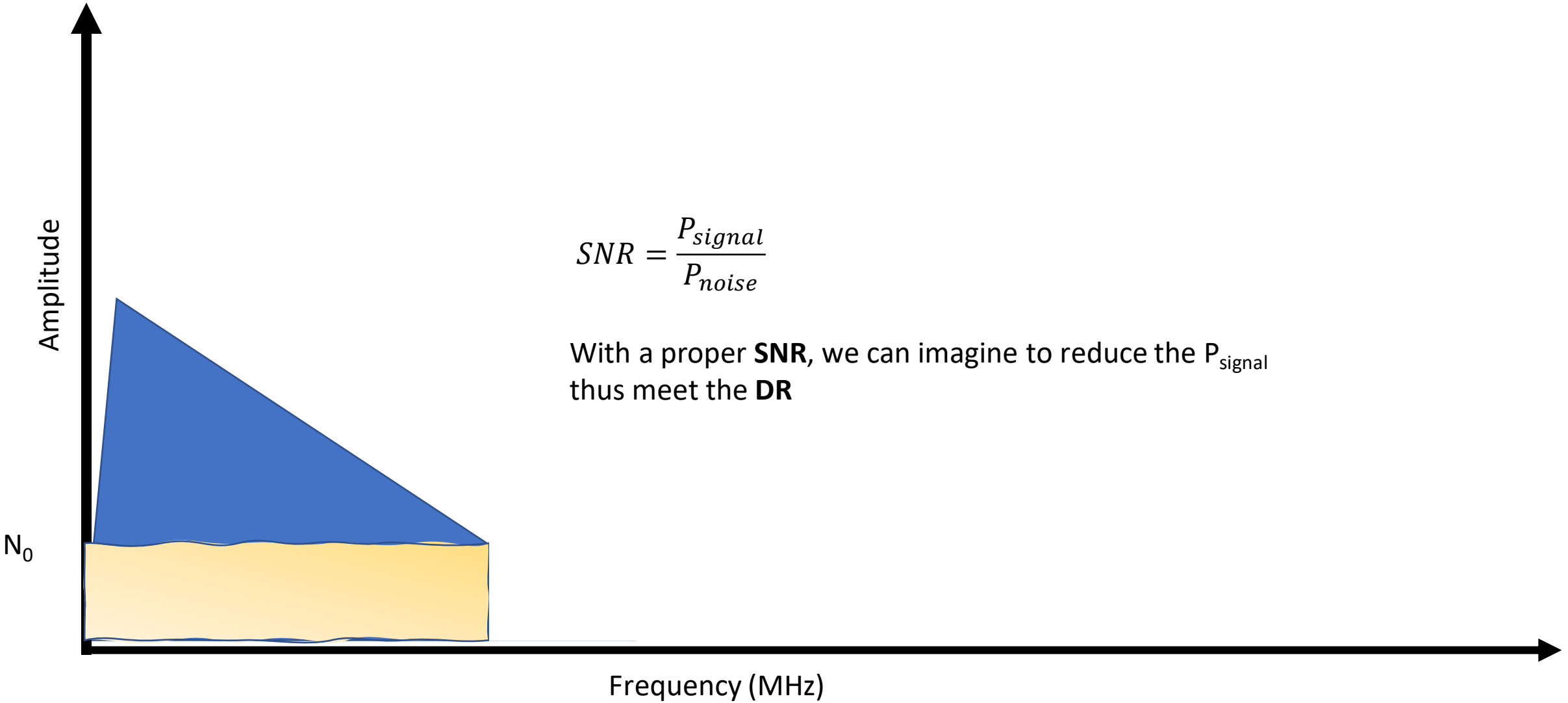


$$SNR = \frac{P_{signal}}{P_{noise}}$$



$$SNR = \frac{P_{signal}}{P_{noise}} \qquad P_{noise} = BW * N_0$$

In the hypothesis of white noise, by reducing the **BW** an increase in the **SNR** can be foreseen.



$$SNR = \frac{P_{signal}}{P_{noise}}$$

With a proper **SNR**, we can imagine to reduce the P_{signal} thus meet the **DR**

How to reduce the noise?

Two main components are responsible for the characteristics noise of the opto-link:

- **Dark current of the Photodiode**
- **Receiver circuit**

How to reduce the BW?

Three main components are responsible for the timing characteristics of the opto-link:

- **LED** *One of the most critical component. A component working in cryogenic environment must be chosen*
- **Photodiode** *This element is less critical, by increasing its active area, its capacitance increases as well integrating the signal (limiting the BW)*
- **Receiver circuit** *In my opinion this is the easiest component to tune the BW limit.*