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# **Raman crosstalk from longer wavelength to shorter wavelength**

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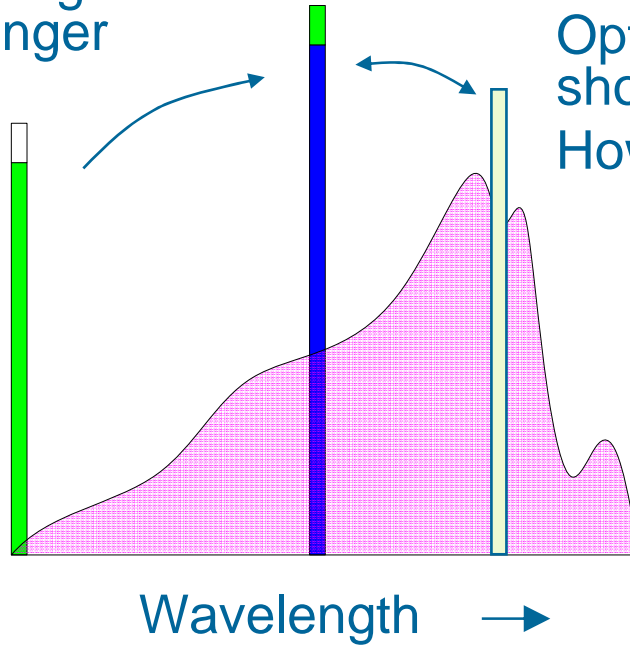
# Scope

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- Raman crosstalk occurs due to fiber nonlinearity. The effect from current PON downstream to Video is well investigated.
- We examined how the higher power signal at longer wavelength influences to shorter wavelength.
- Then we add a calculation under the fiber incident power or wavelength variation.

# Raman crosstalk theory

A part of energy at shorter wavelength transfers to longer wavelength .



Optical power shifts shorter to longer.

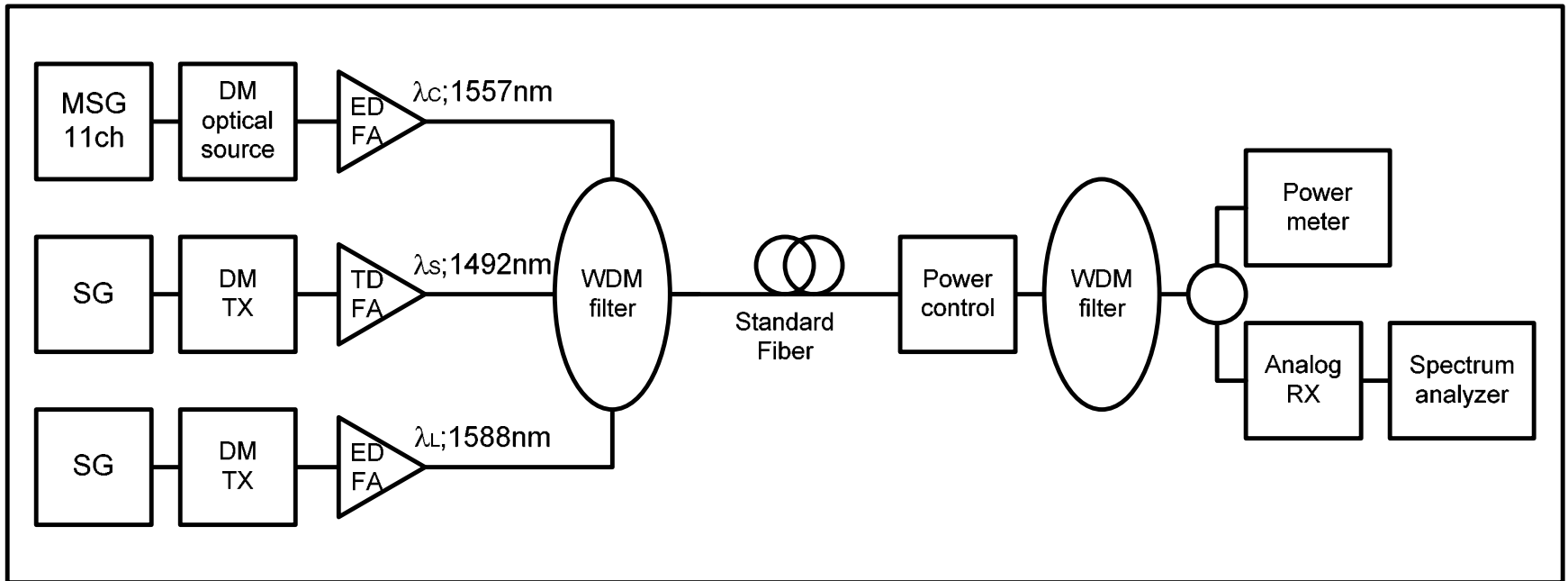
How about RF crosstalk?

$$\begin{cases} \frac{\partial I_1}{\partial z} + \frac{1}{v_1} \frac{\partial I_1}{\partial t} = (gI_2 - \alpha)I_1 \\ \frac{\partial I_2}{\partial z} + \frac{1}{v_2} \frac{\partial I_2}{\partial t} = (-gI_1 - \alpha)I_2 \end{cases}$$

$$g > 0; \lambda_2 < \lambda_1$$

$$g < 0; \lambda_2 > \lambda_1$$

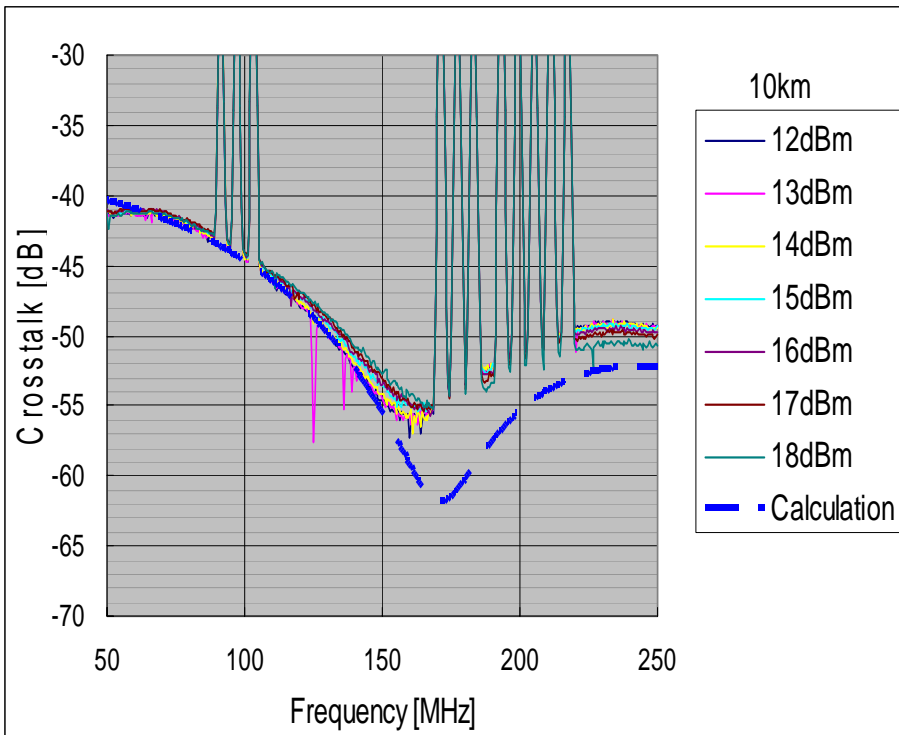
# Examination setup



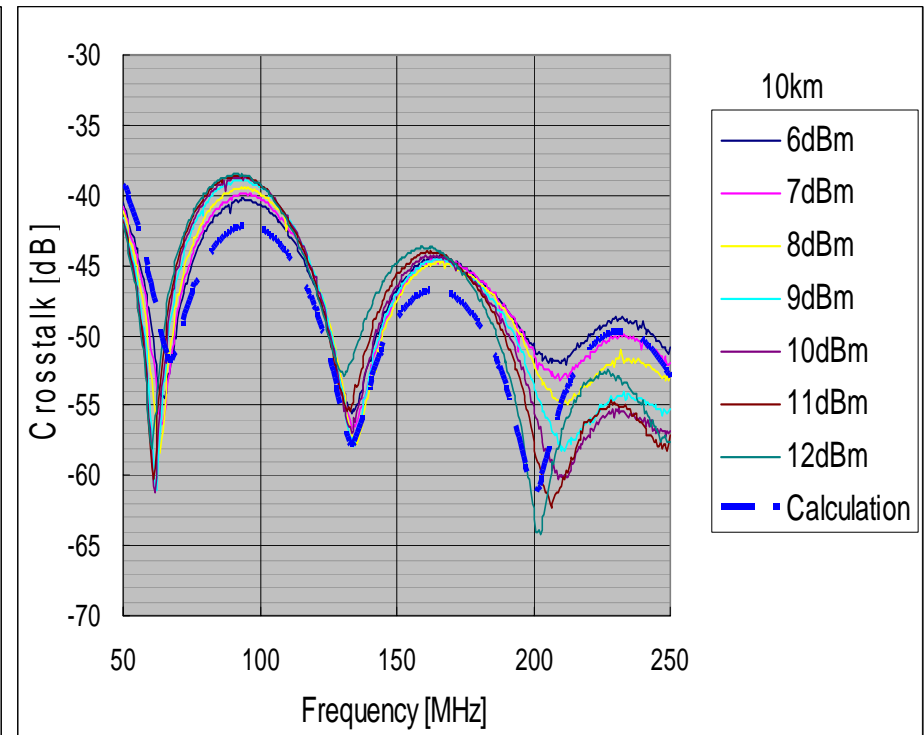
- SG frequency swept for observing frequency characteristics.
- Direct modulation is used to keep from SBS.

# Result1 – effect to shorter wavelength

Raman crosstalk  $\lambda_L$  to  $\lambda_C$



Raman crosstalk  $\lambda_L$  to  $\lambda_S$

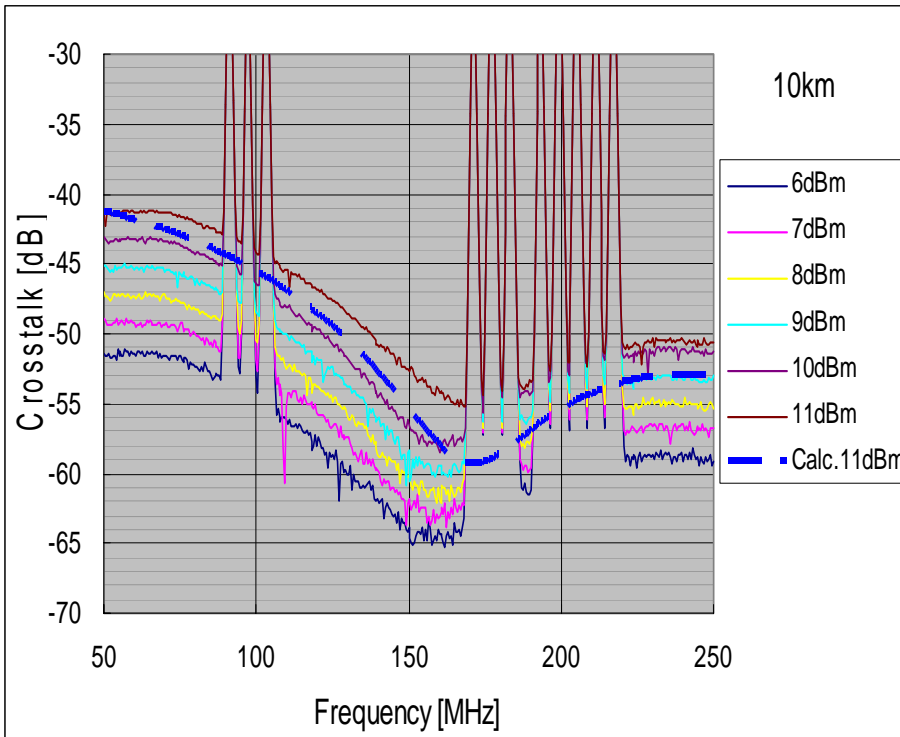


- Power varies at  $\lambda_C$
- Observed at  $\lambda_C$

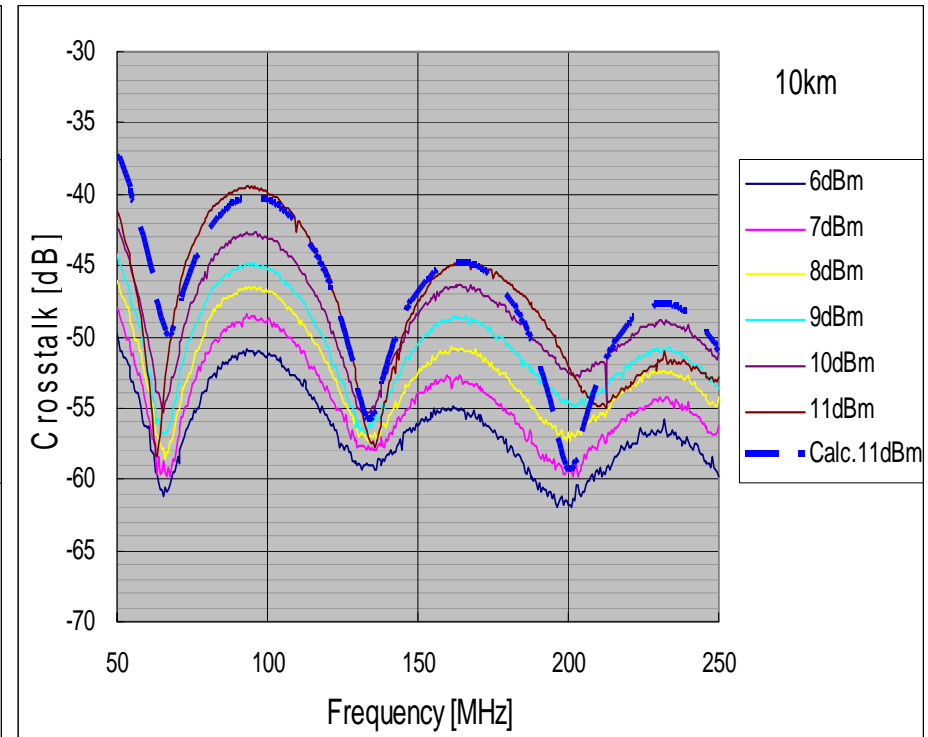
- Power varies at  $\lambda_S$
- Observed at  $\lambda_S$

# Result2 – effect to shorter wavelength

Raman crosstalk  $\lambda_L$  to  $\lambda_C$



Raman crosstalk  $\lambda_L$  to  $\lambda_S$

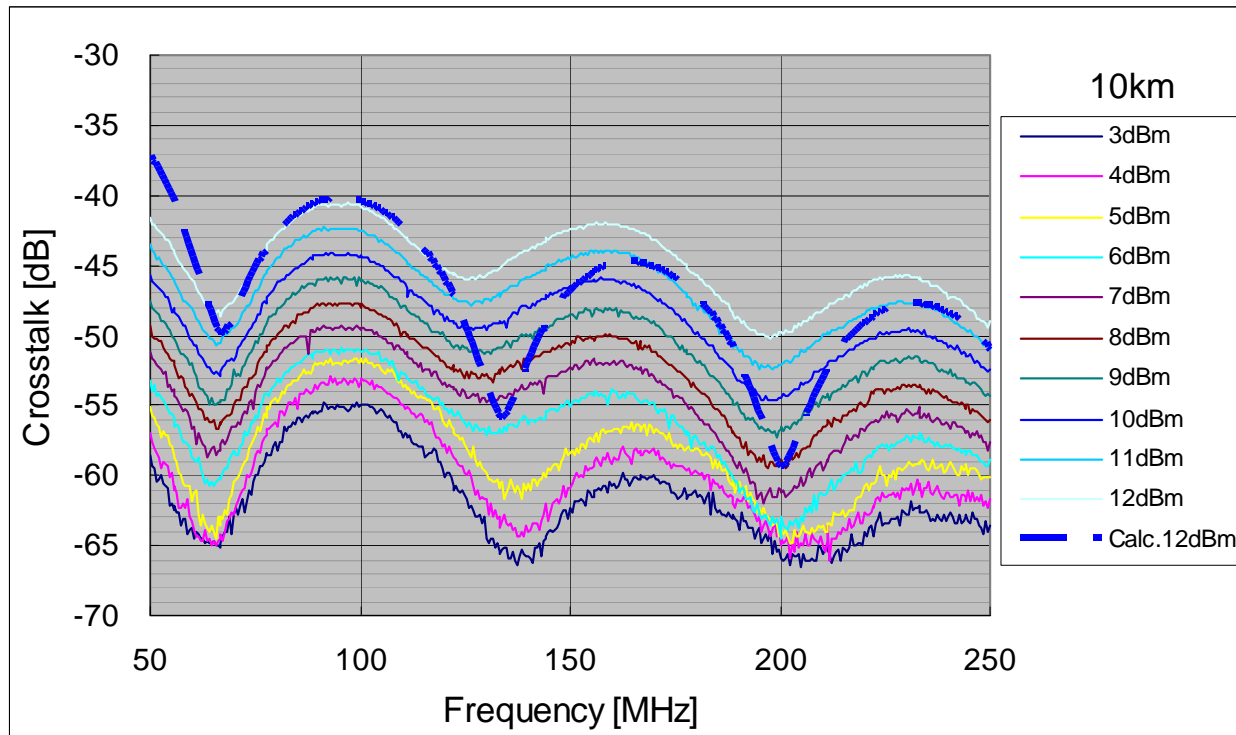


- Power varies at  $\lambda_L$
- Observed at  $\lambda_C$

- Power varies at  $\lambda_L$
- Observed at  $\lambda_S$

# Result3 – effect to longer wavelength

Raman crosstalk  $\lambda_S$  to  $\lambda_L$



- Power varies at  $\lambda_S$
- Observed at  $\lambda_L$

# Consideration

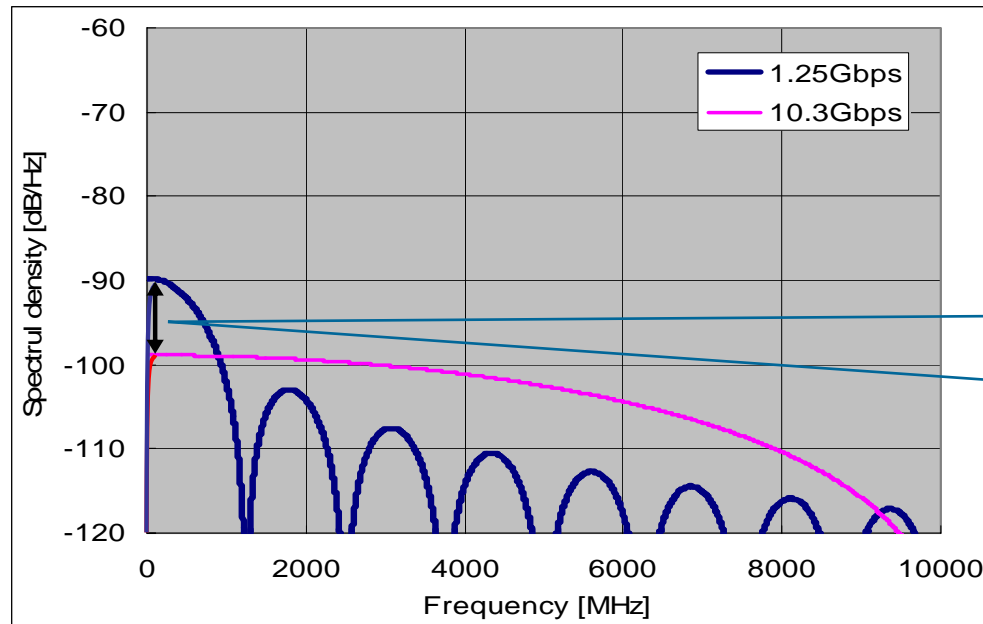
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- From the examination;
  - Shorter wavelength signal is also influenced by Raman crosstalk from longer wavelength signal.
  - When shorter wavelength power varies, Raman crosstalk of shorter wavelength is unchanged.
  - When longer wavelength power varies, Raman crosstalk of shorter wavelength changes as 2dB per 1dB power change.
  - Similar frequency characteristics are observed both from longer wavelength and from shorter wavelength.
  - Calculation gives good approximation at lower frequency.



# Theoretical calculation

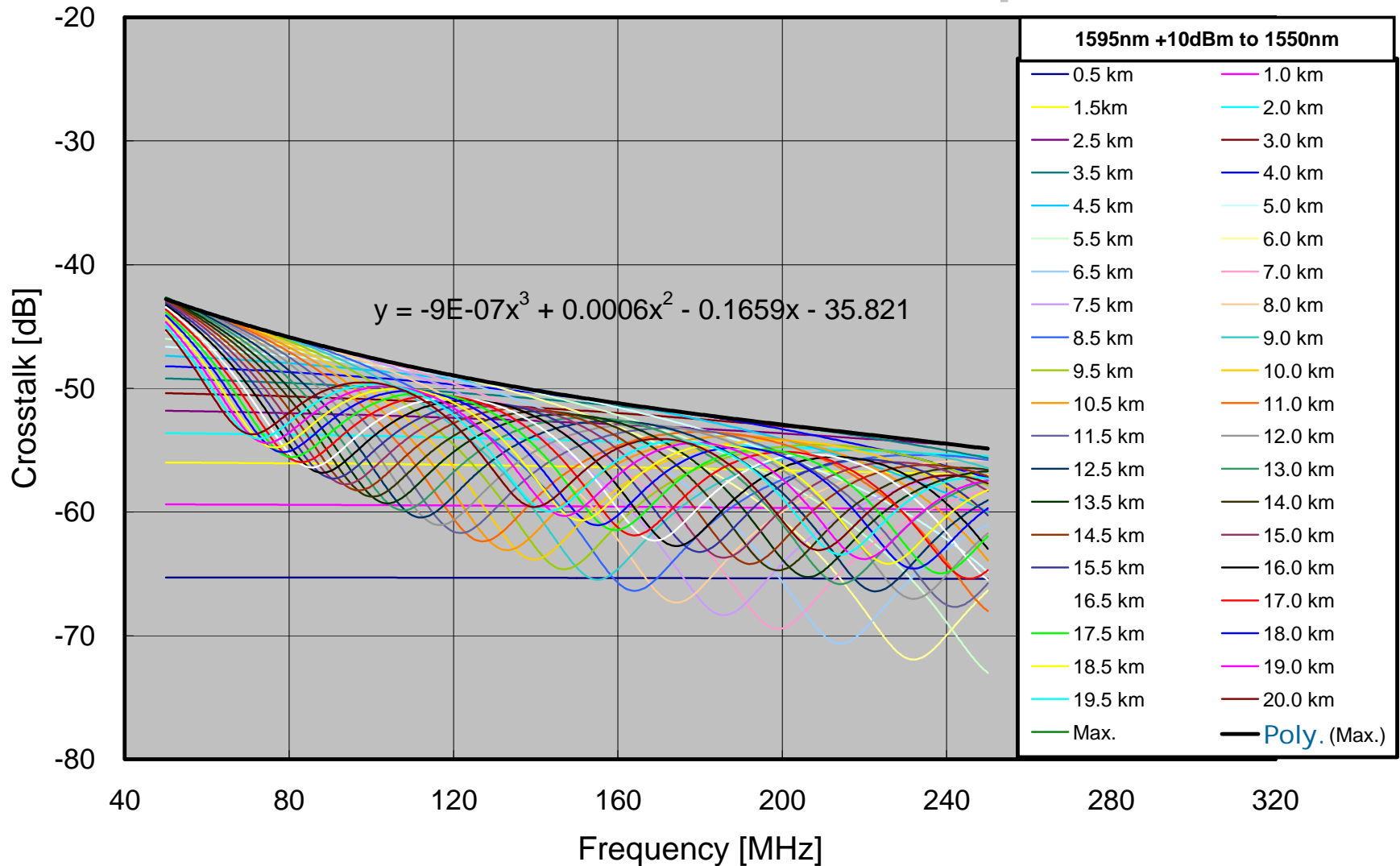
- Calculation assumption
  - C band: 18dBm at 1550nm
  - L band: Fiber incident power varies at 1595nm
  - Paying attention lower frequency (-250MHz)



Signal spectrum  
with E.R. 10dB

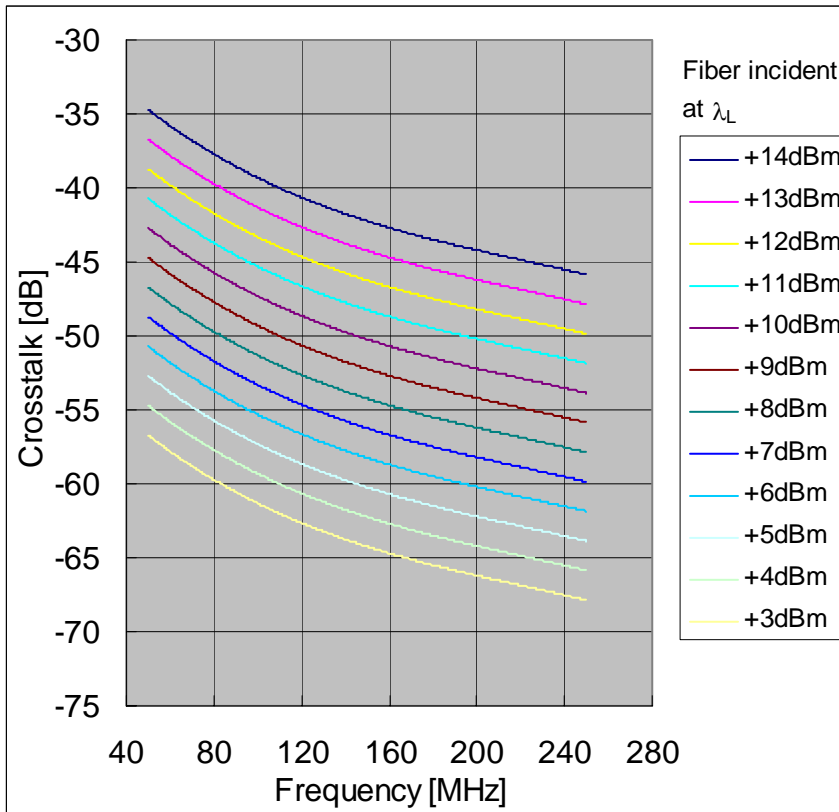
10G signal  
spectral density is  
9dB less than 1G  
at low frequency.

# Calculation example

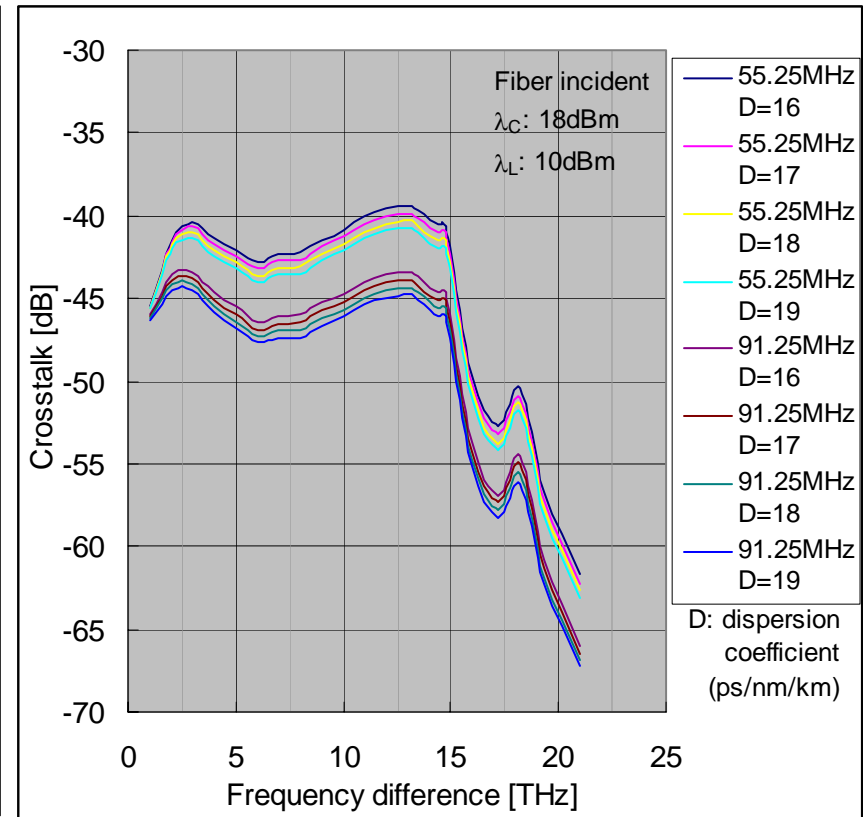


# Power and wavelength calculation

## Fiber incident power



## Wavelength



# Summary

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- There is AC Raman crosstalk from longer wavelength to shorter wavelength as well as shorter to longer.
- From the calculation of Raman crosstalk, wavelength characteristic is slightly better around 30-70nm apart.
- It is necessary to investigate in detail based on video transmission specification.