Raman Crosstalk and Coexistence

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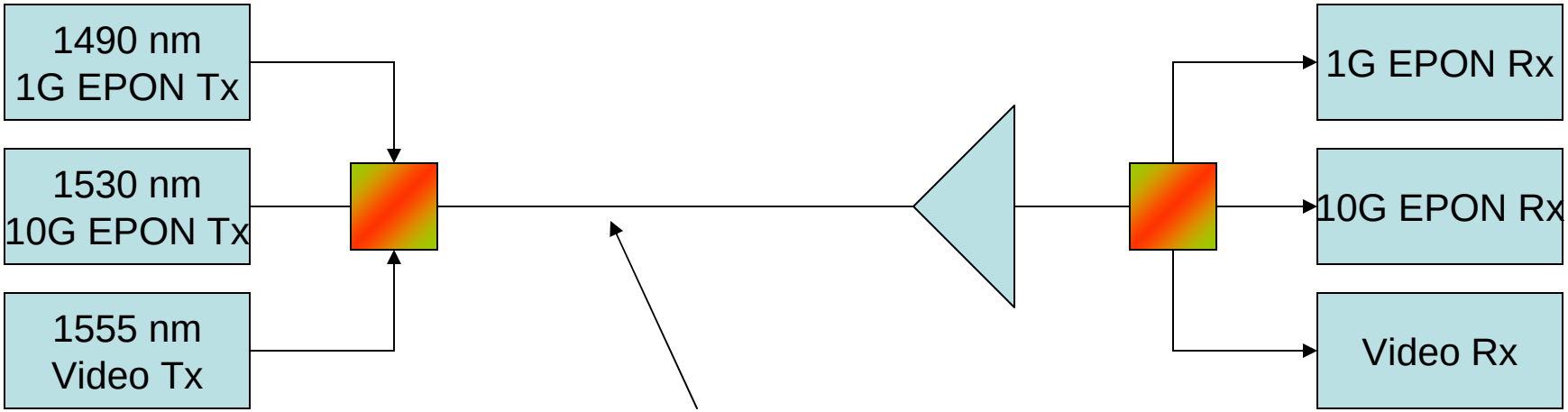
Basic set-up



Both 1490 nm and 1530 nm waves transfer modulated power to 1555 nm video wave in the transmission fiber

Raman Issues

- Raman causes signal degradations via
  - "Pump depletion": Conversion of energy
    - Mainly an impairment to the 1490 nm wave
    - Small; can be overcome with increased Tx power

$$Loss = 10\log_{10}\left[1-\left(\frac{\rho_{SRS}g_{12}}{A_{eff}}\right)\frac{1-e^{-\alpha L}}{\alpha}P_{\text{int}}\right]$$

  - Modulation crosstalk: Transfer of RF signals
    - Mainly an impairment to the 1555 nm video
    - Digital signals are relatively immune

$$CCR = \left(\frac{A_{eff}\,m_{CATV}}{\rho_{SRS}\,g_{12}P_{\text{int}}m_{\text{int}}}\right)^2 \frac{\alpha^2+(2\pi f d_{12})^2}{1+e^{-2\alpha L}-2e^{-\alpha L}\cos(2\pi f d_{12}L)}$$, where $m_{\text{int}} = \sqrt{\frac{4B}{R}}\frac{\sin(\pi f / R)}{\pi f / R}$

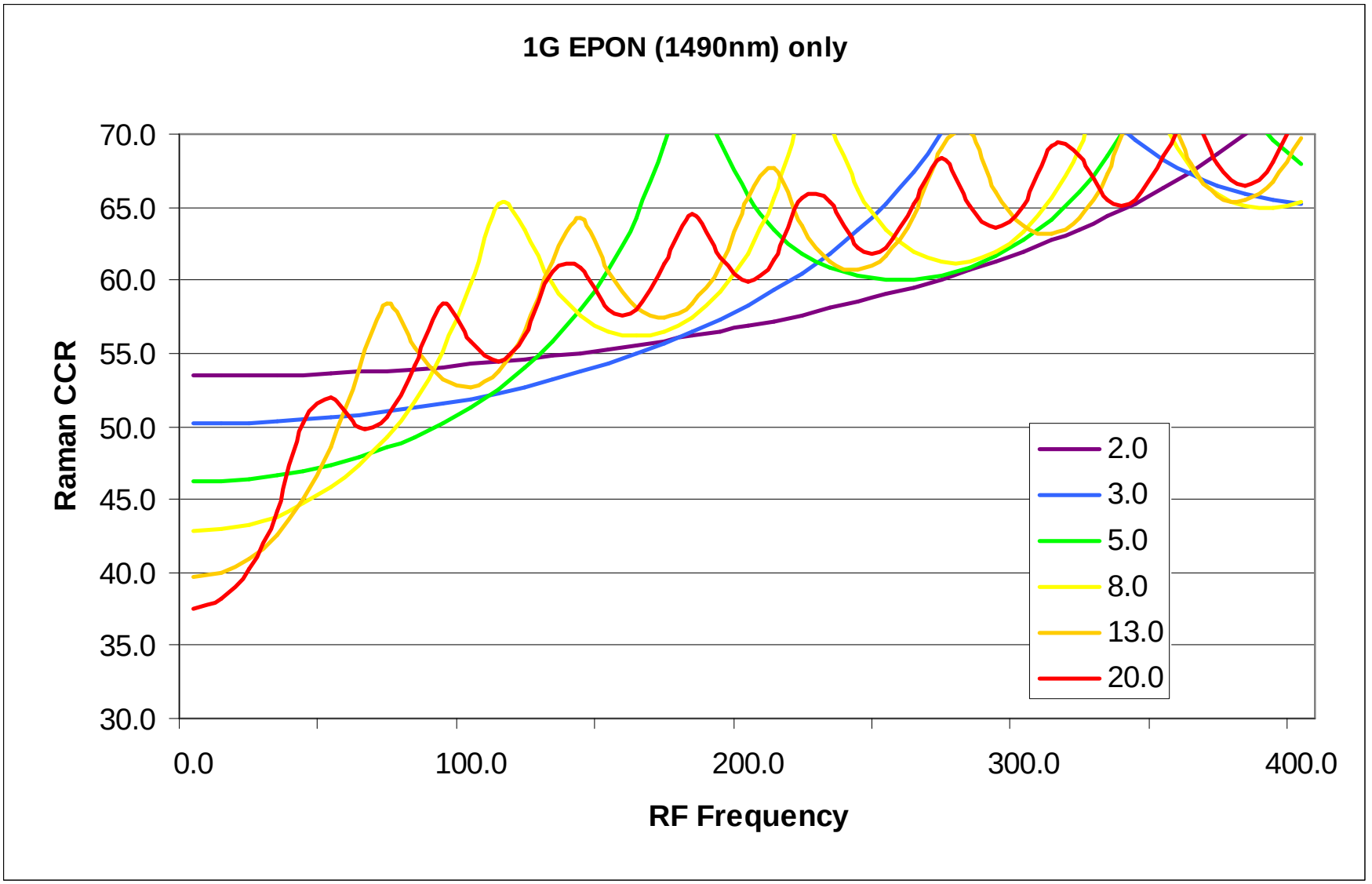
Dependence on wavelength

- D12 varies linearly with wavelength separation
  - 60 nm separation has a D12=1.03 ns/km
- G12 varies roughly linearly with wavelength separation, up to ~140 nm separation
  - 60 nm separation has an A12=0.5 1/W/km
- Raman crosstalk can be calculated in different cases
  - 1490 nm 1G EPON
  - 1530 nm 10G EPON
  - Both at the same time

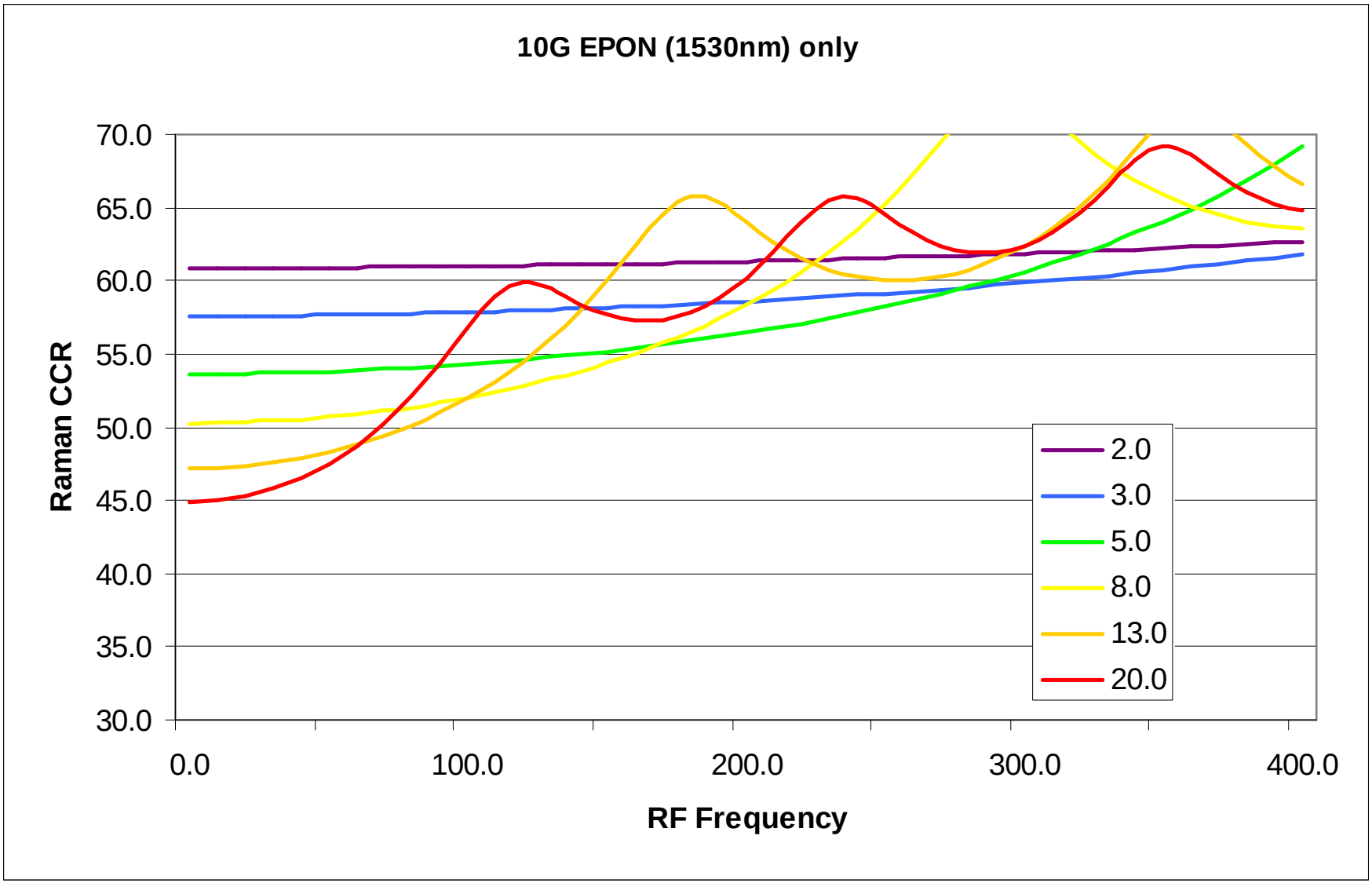
Parameters used

Parameter	Value	Unit	S.I. Unit	Value	Unit
Transmitter RIN	-165.0	dB/Hz	3.16E-17	-165.0	dB/Hz
Video Source Quality	60.0	dBc	1.00E+06	60.0	dBc
Number of Analog Channels	45		45.0	45.0	
Number of Digital channels	63		63.0	63.0	
Bandwidth of carrier	4.0	MHz	4.00E+06	4.0	MHz
Receiver Thermal Noise	7.3	pA/rt(Hz)	7.30E-12	7.3	pA/rt(Hz)
Receiver Impedance	300.0	Ohms	300.0	300.0	Ohms
Receiver Responsivity	0.92	A/W	0.92	0.92	A/W
Analog Modulation index	4.3%		0.043	4.3%	
Digital Modulation index	2.2%		0.022	2.2%	
Video wavelength	1555	nm	1.555E-06	1555.0	nm
Data wavelength	1490	nm	1.490E-06	1530.0	nm
Optical Power	-7	dBm	0.000200	-7.0	dBm
Fiber loss	0.25	dB/km	0.25	0.25	dB/km
D12	1.116	ns/km	1.12E-09	0.429	ns/km
Fiber Length	20	km	20.00	20.0	km
Frequency	55.25	MHz	5.53E+07	55.25	MHz
Raman Coef (gr/Aeff)	0.54167	1/W/km	5.417E-01	0.2	1/W/km
Polarization Factor	0.5		0.5	0.5	
Data Rate	1250	MHz	1.25E+09	10312.5	MHz
Data Power	2	dBm	0.001584893	7.0	dBm

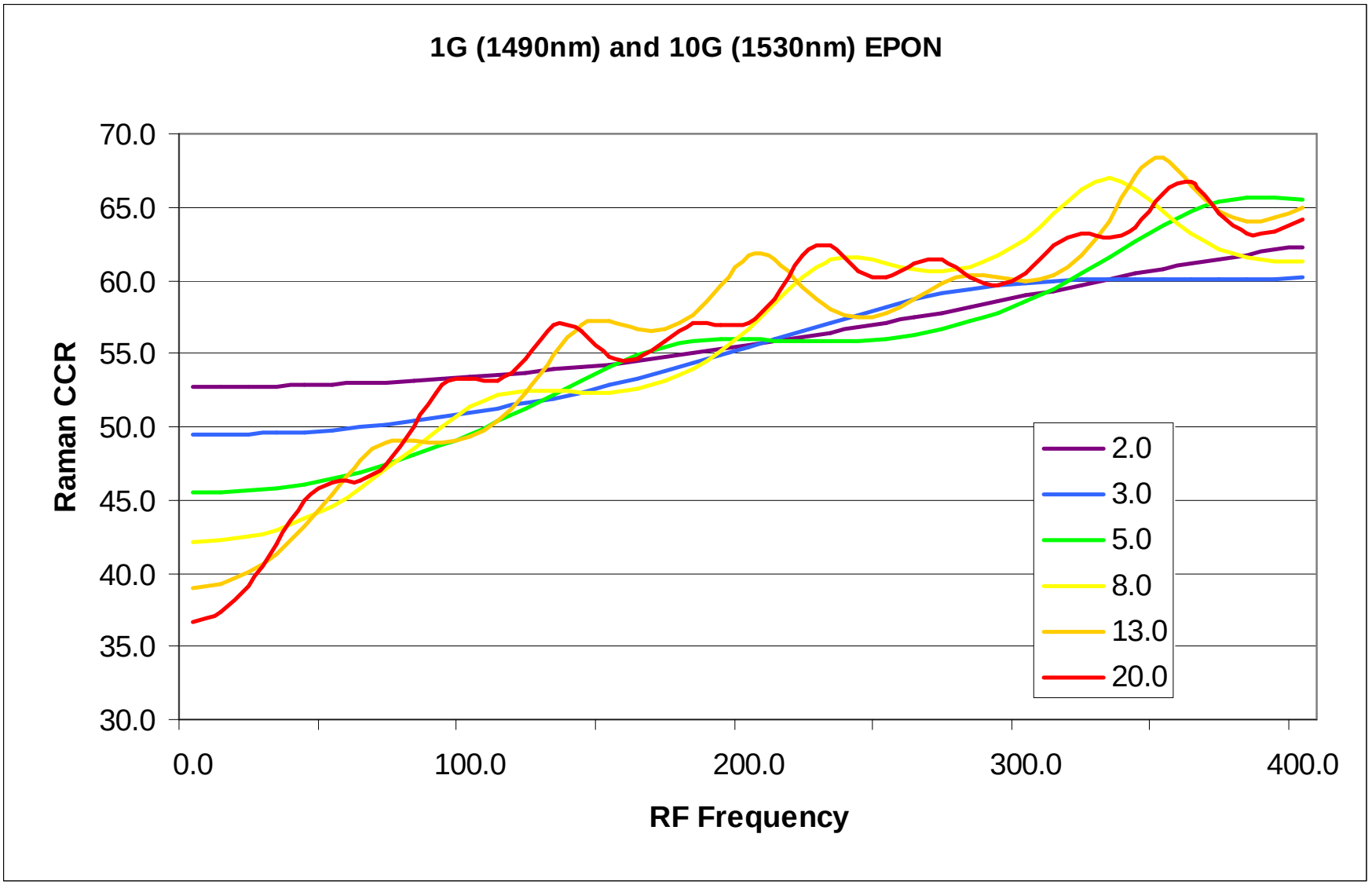
Video with 1G EPON



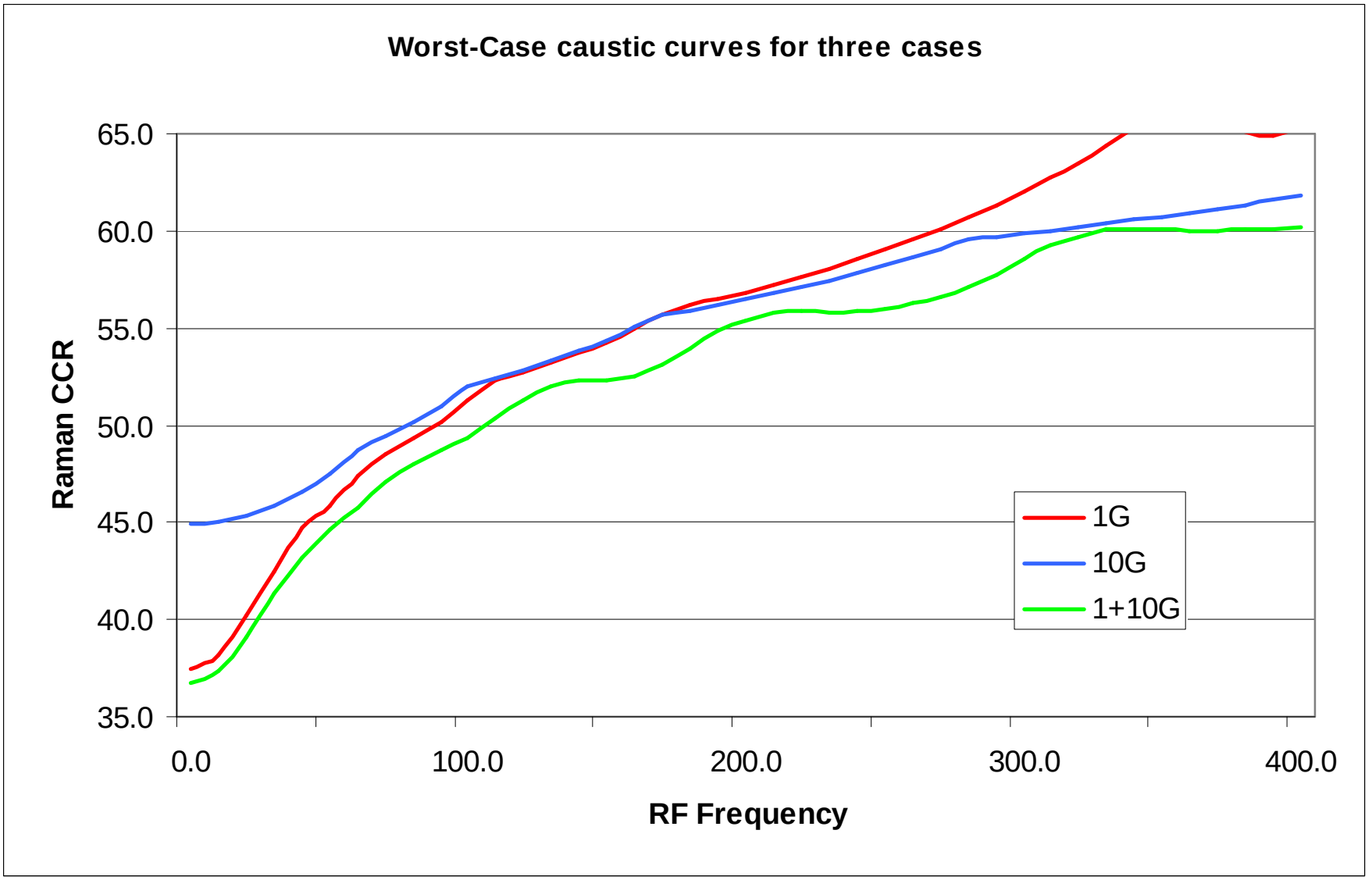
Video with 10G EPON



Video with both 1 and 10G



Worst Case Curves



Conclusions

- 10G and 1G signals have similar magnitude of Raman effect
  - Higher speed reduces strength (spectrum wider)
  - High power (needed at speed) increases strength
- Wavelength spacing has an impact
  - 1490nm has faster dephasing, more Raman strength than 1530nm
- The 1490/1530/1555nm wavelength plan seems acceptable on this basis
  - Raman marginally worsened, but likely manageable