MPI penalty in short length fibers

Rick Pimpinella
Panduit Labs, Panduit Corp.

Increased-reach Ethernet optical subscriber access
P802.3cs Super-PON

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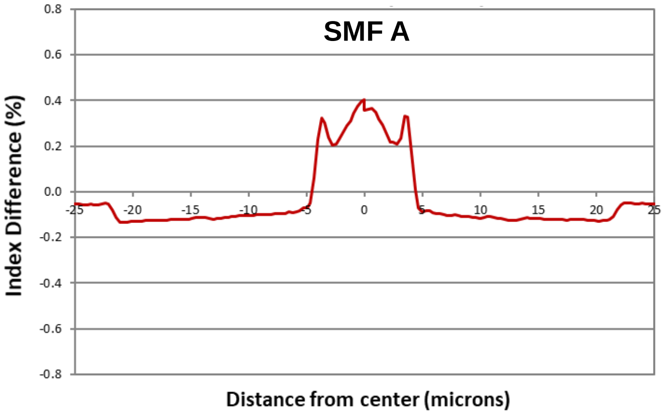
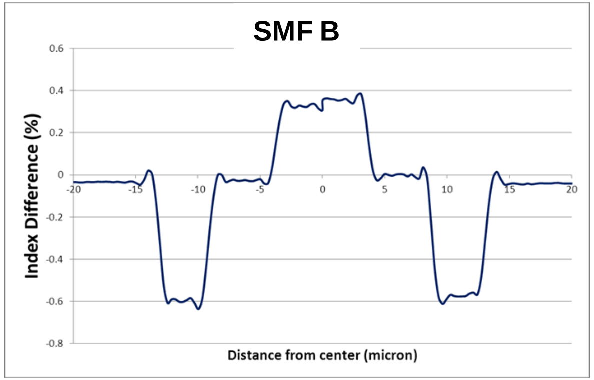
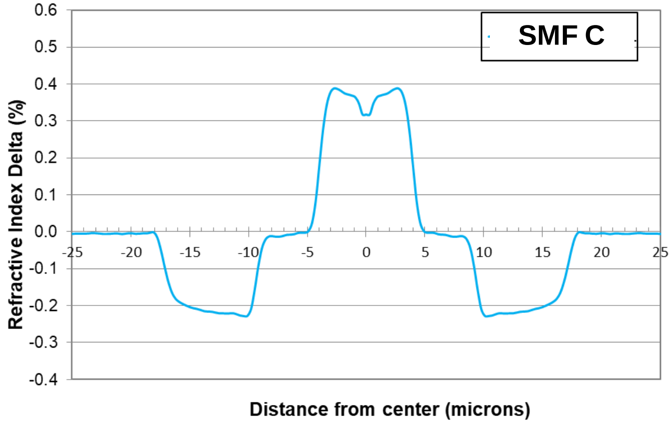
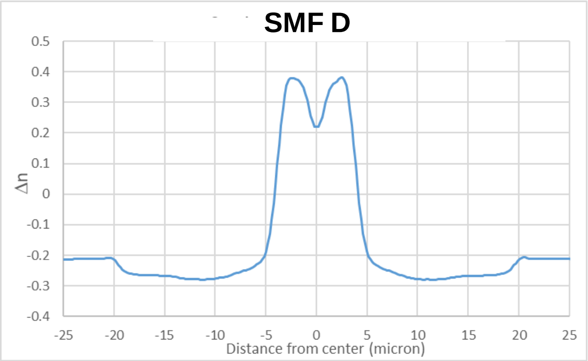
Single-mode fiber index profiles (G.657.A2)

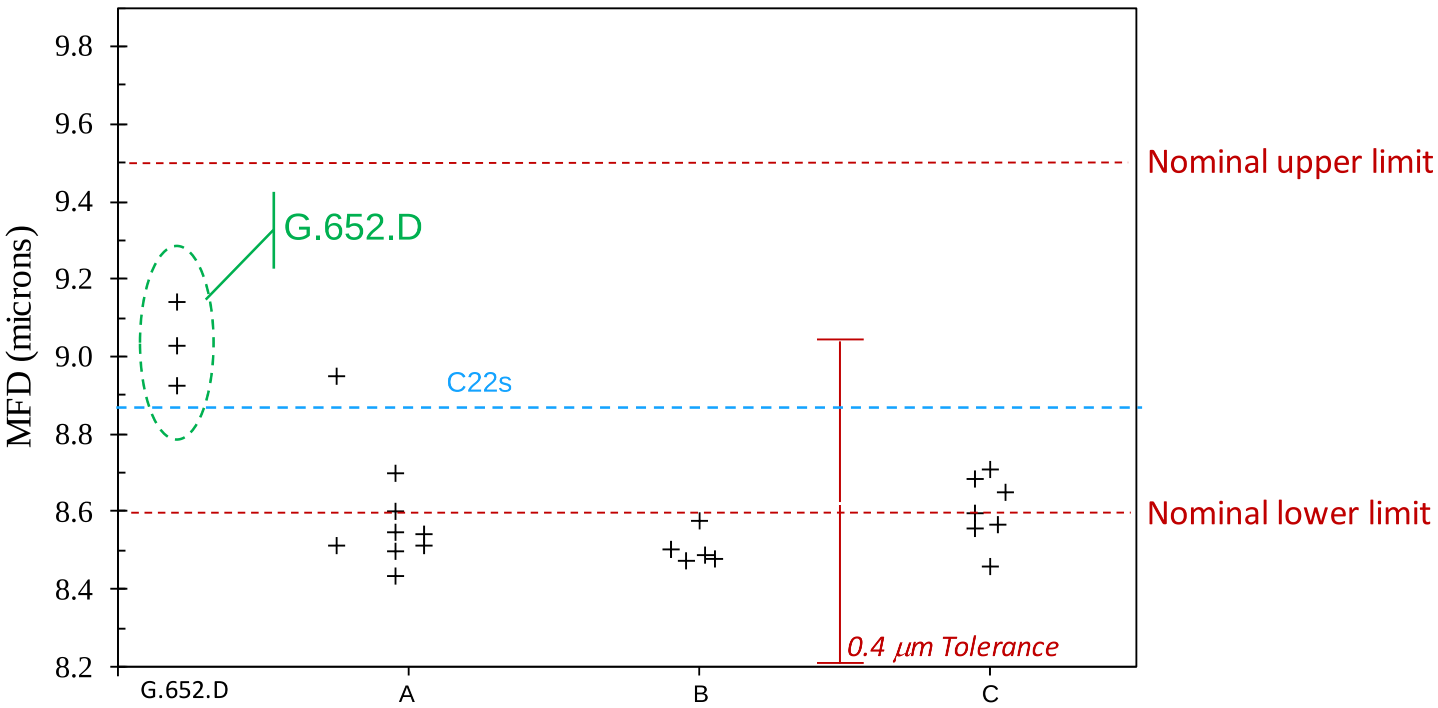








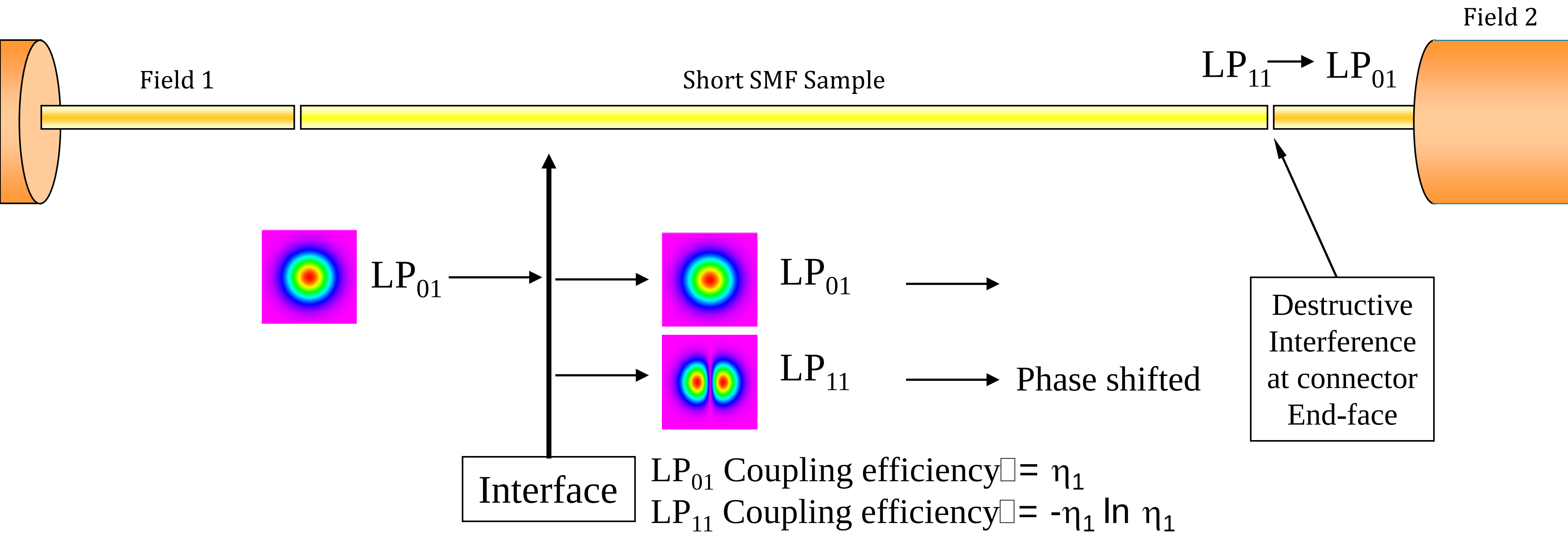
MFD measurement results



- ***Bend-insensitive fibers have smaller MFDs***

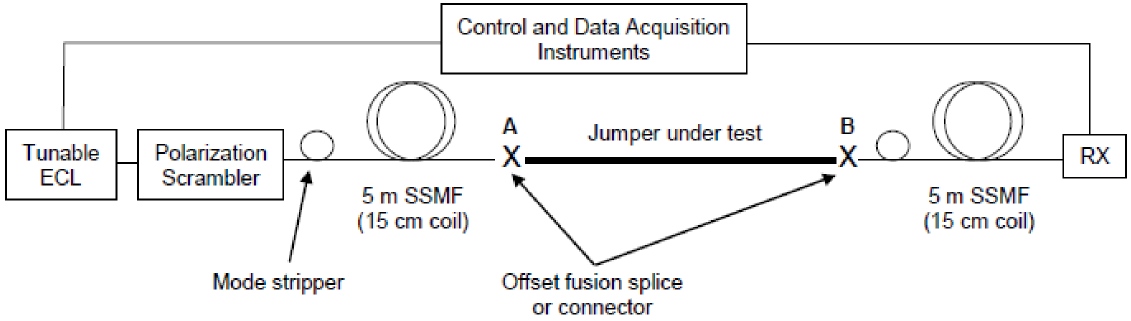
Higher Order Mode Multi-Path Interference

- Excitation of second-order mode at fiber interface
- Patch cord length is less than the coherence length
- Destructive interference can occur



Multipath interference (MPI) Measurements

- Measurements are conducted based on ITU G.650.1, appendix IV (Test methods for measuring coherent MPI in short optical fibre cables (jumpers)



MPI measurement test set-up (ITU G.650.1) (narrowband ECL-PM method)

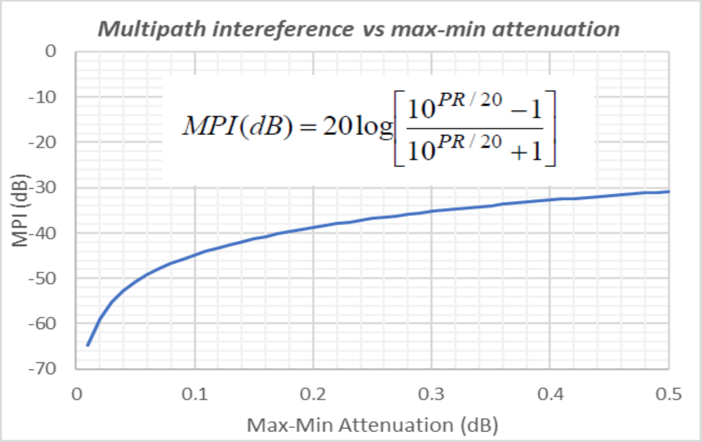
ECL: NetTest Osics
Polarization scrambler (100 random SOPs): Keysight N778 B (based on $LiNbO_3$ with typical PDL of <0.5 dB for O-band and <0.2 dB for C/L bands. Reference measurement without DUT was needed to get rid of the PDL effect.

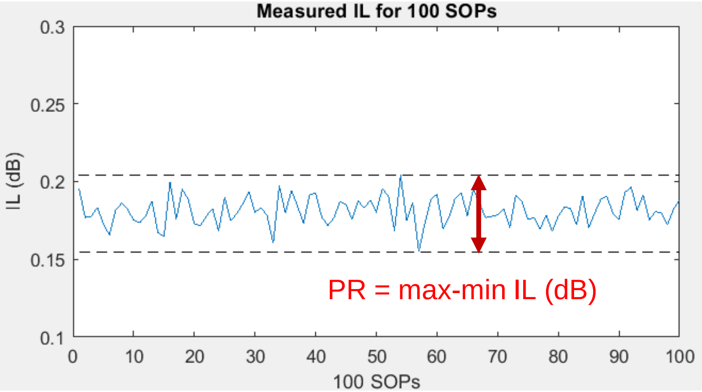
$$MPI(dB) = 20\log\left[\frac{10^{PR/20}-1}{10^{PR/20}+1}\right]$$

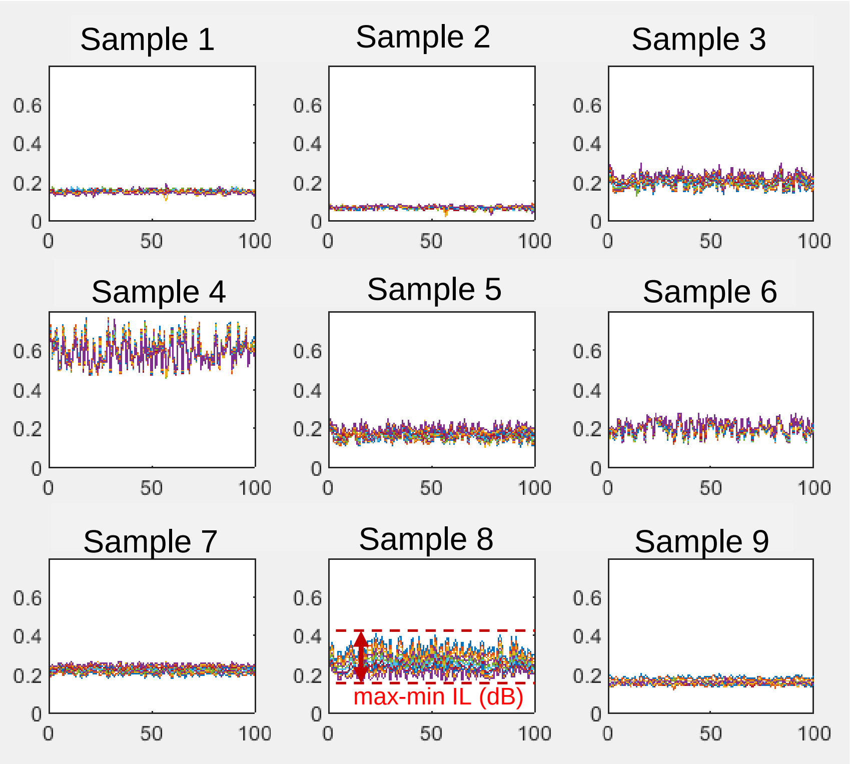
PR is the difference between maximum and minimum detected power in dB, at a particular wavelength (MPI shown here is at a given wavelength). In general, there is wavelength dependence of MPI due to resonance of mode coupling.

Free spectral range (nm) $\Delta\lambda = \lambda^2 /(\Delta n_g L)$

Multipath interference (MPI) Measurements



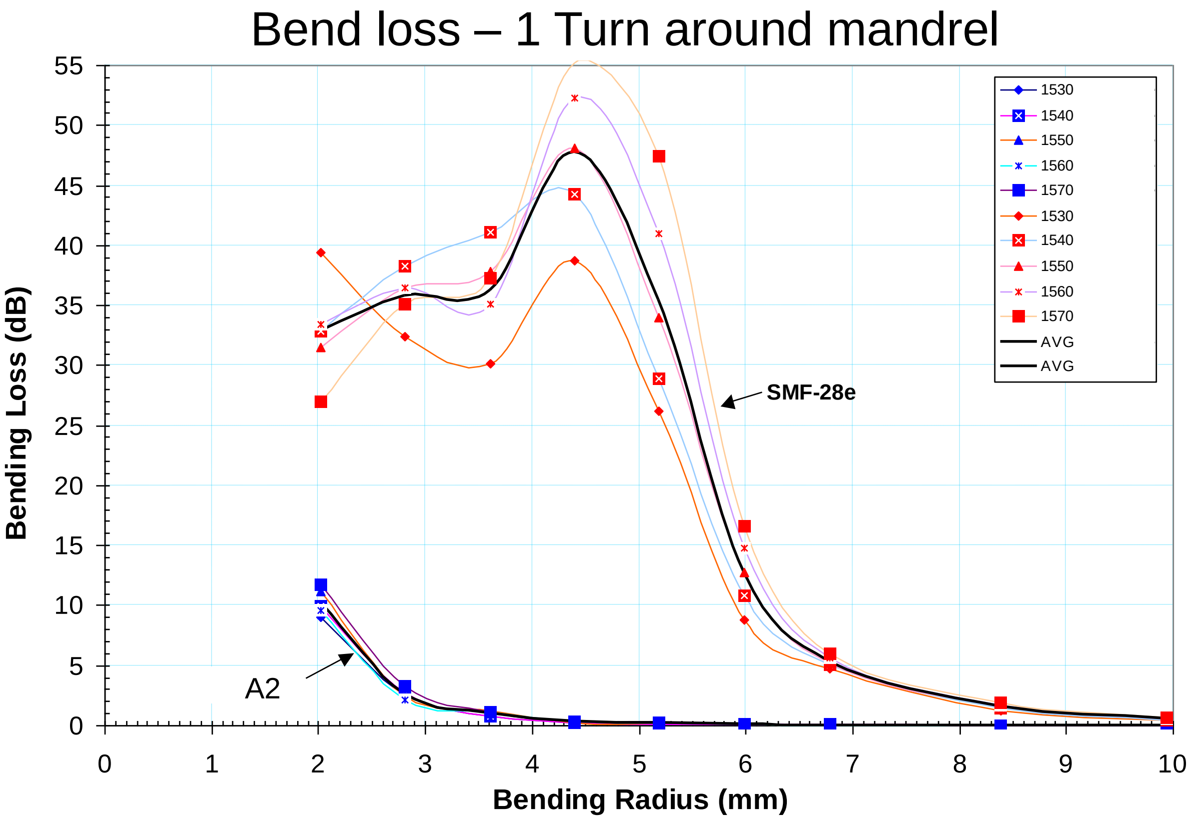




Measured IL vs 100 random SOP states (at a single wavelength)

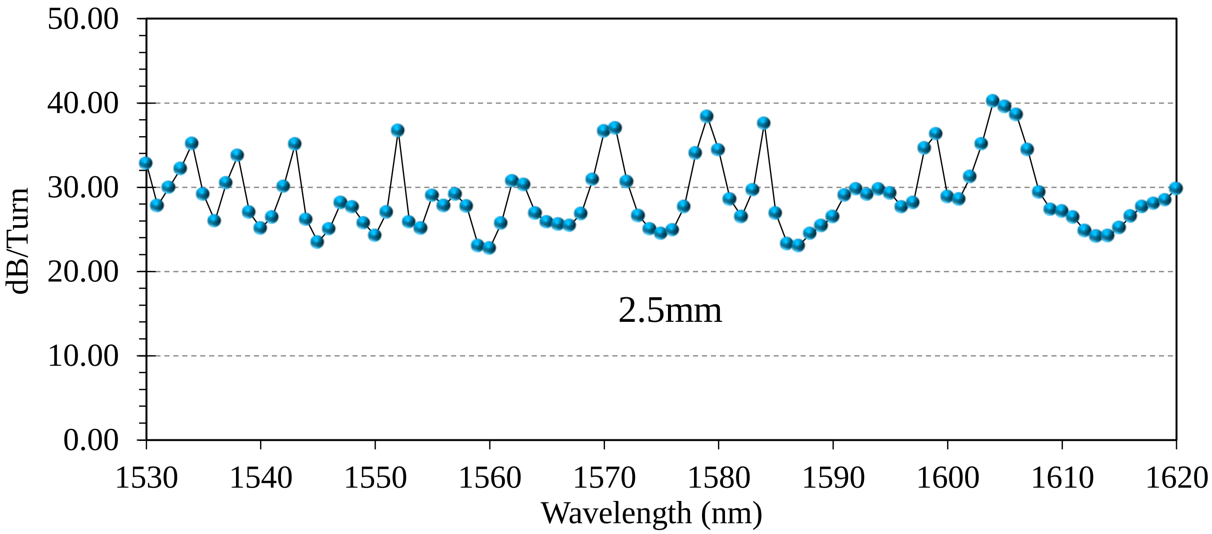
MPI due to tight bends

Cladding mode phase delayed & coupled back into fundamental mode



Wavelength Dependent IL – Sample A16s

Destructive interference is wavelength dependent



Summary

- This was only intended to be a brief introduction of MPI due to the excitation of higher-order modes
- Multi-path Interference can occur when the optical path includes a short fiber segment
- MPI penalty depends on the combination of fiber types
- MPI can be as large as several tenths of a dB in short fiber lengths