

Multimode Chromatic Dispersion

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Summary: OM3, OM4, OM5 CD are equivalent

This presentation summarizes a 2015 round robin held in TIA during the development of the OM5 fiber standard to obtain more accurate bounds on multimode chromatic dispersion.

The results allow for tighter bounds on CD for OM3-OM4 fiber which was analyzed in the round-robin. The results were incorporated into the standards specifications for OM5 fiber but also apply to the OM3 and OM4 fiber measured.

Outline of Round Robin

Casey Shaar (Photon Kinetics) coordinated the round robin: preparing samples, preserving anonymity, compiling/analyzing the results.

Two 1000m BIMMF “sisters” were provided by the following companies:

- (1) Corning
 - (2) Prysmian
 - (3) J-Fiber
 - (4) OFS
 - (5) YOFC
 - (6) In addition, OFS provided two non-BIMMF OM3/OM4 samples.
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- (a) First set of six samples measured at Corning, OFS, Panduit
 - (b) 2nd set of six samples measured at Prysmian, J-fiber, YOFC

Each sample is measured 3 times at each lab.

How MM Chromatic Dispersion is measured/used

IEC 60793-1-42 Annex B specifies how to measure MM chromatic dispersion.

The delay $\text{Tau}(\lambda)$ is measured at 3 or more wavelengths.

The delay is fit to the formula

$\text{Tau}(\lambda) = A + B\lambda^2 + C\lambda^{-2}$, and so dispersion $D(\lambda) = d\text{Tau}/d\lambda = 2B\lambda - 2C\lambda^{-3}$

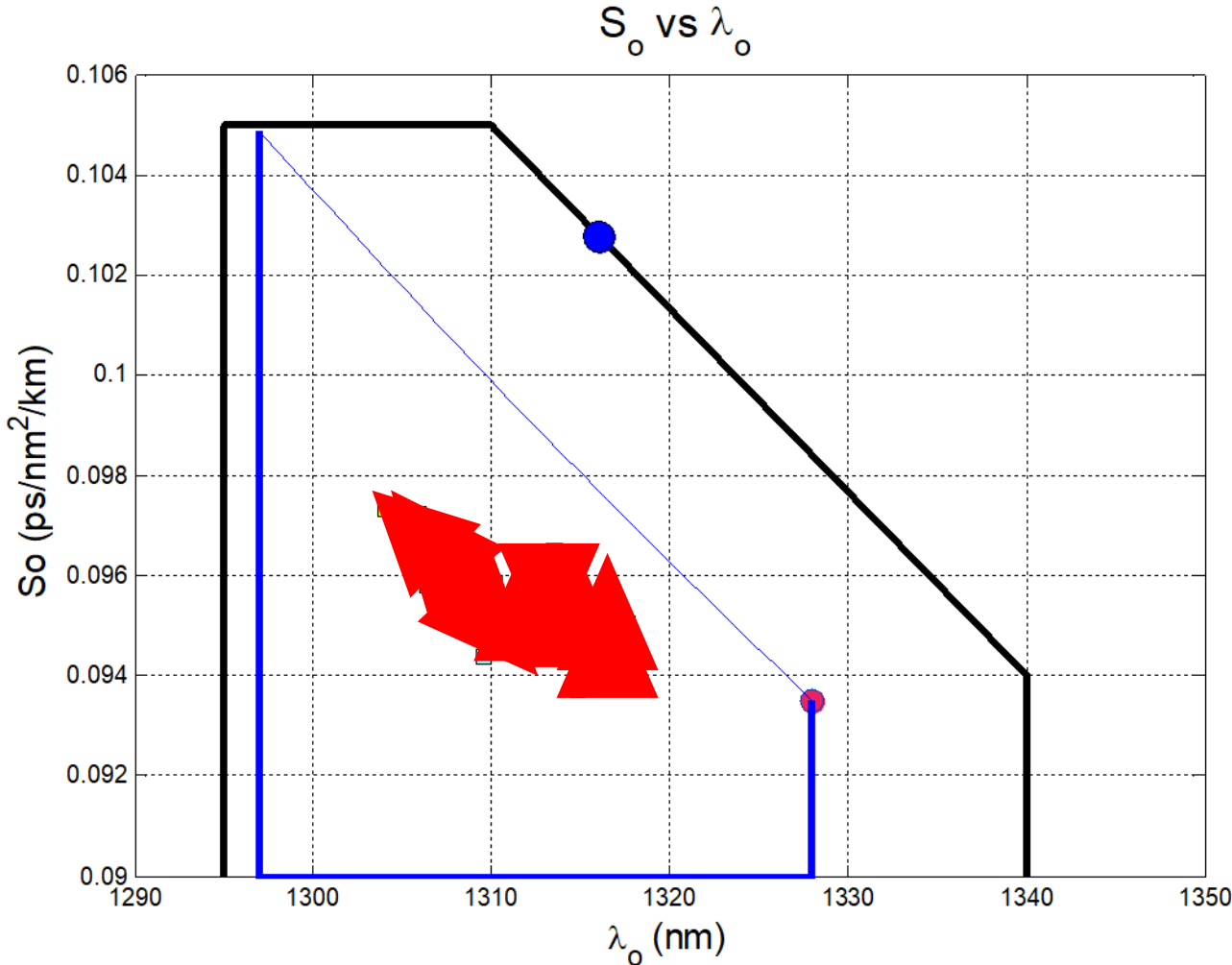
The dispersion zero λ_0 is determined from $\text{Tau}(\lambda)$ as well as the slope S_o at λ_0
In the IEEE link model spreadsheet λ_0 is written U_o and both notations show up here.

The dispersion $D(\lambda)$ is then given by

$$D(\lambda) = \frac{S_o}{4} \lambda \left(1 - \left(\frac{U_o}{\lambda} \right)^4 \right)$$

$$S_o(U_o) = 4 \frac{(-103.000)}{840 \left(1 - \left(\frac{U_o}{840} \right)^4 \right)}$$

Final 2015 Round Robin Results of OM3 & OM4 fiber



Black region – OM3,OM4 spec region.

Blue circle –OM3/OM4 spec

Blue region – OM5 spec region

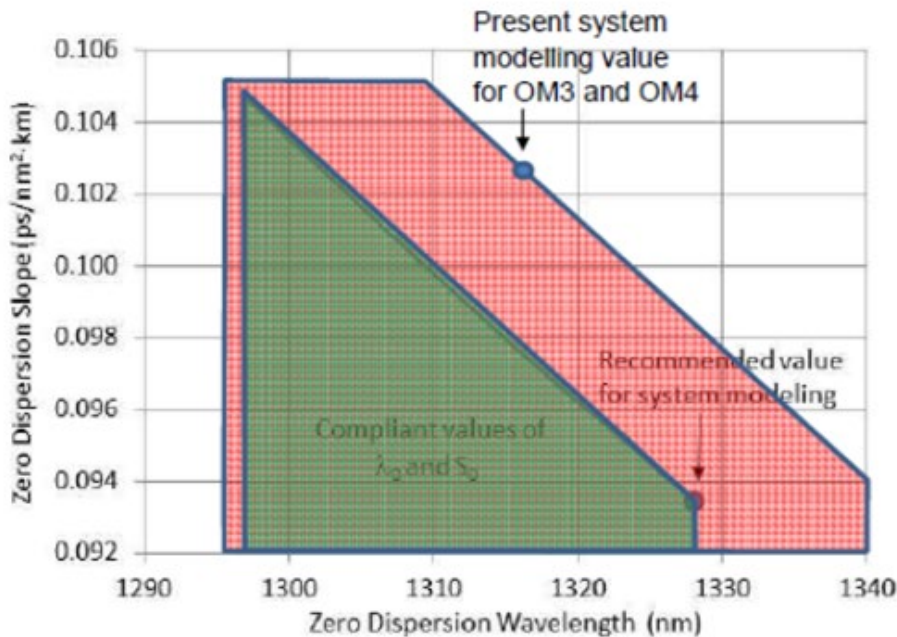
Magenta dot – OM5 spec

RED region – all OM3 and OM4 fiber data (6 manufacturers* x 6 labs)

$$S_o(U_o) = 4 \frac{(-103.000)}{840 \left(1 - \left(\frac{U_o}{840} \right)^4 \right)}$$

Recommendation for WB MMF applies to OM3, OM4.

Improved Chromatic Dispersion Spec



Chromatic dispersion specification for wide band fiber tightened from the red region (OM3 & OM4) to the green region.

Increases chromatic bandwidth by 5%, reducing ISI, MPN and Pcross penalties.

The following values recommended for system modeling:

$$\lambda_0 = 1328 \text{ nm}$$

$$S_0 = 0.093477 \text{ ps/nm}^2 \cdot \text{km}$$

Specification limits:

$$\text{ZDW } (\lambda_0): 1297 \leq \lambda_0 \leq 1328 \text{ nm}$$

$$\text{ZDS } (S_0): S_0 \leq 4(-103)/(840(1-(\lambda_0/840)^4)) \text{ ps/nm}^2 \cdot \text{km}$$

STATUS IN IEC

A request to change OM3/OM4 spec to agree with the 2015 OM3/OM4 roundrobin has been submitted.

802.3db will be updated on the progress and estimated timing as the work progresses.

Discussion and Recommendation

In the course of the round robin, discrepancies in results between labs were reviewed and measurement errors corrected at more than one lab. After reconciliation, there was tight agreement between measurements of the same fiber at different labs.

All of the OM3 and OM4 data fell well inside the previous spec developed from an earlier round robin with larger scatter. The explanation is increased attention to detail and collaboration in correcting measurement issues, rather than a change in the fiber itself.

The best estimate for chromatic dispersion for standard 50um OM2/OM3/OM4/OM5 fiber is the current OM5 specification. This is one parameter in the link models which is well characterized.

Use $S_o=0.093477$ $U_0 = 1328$ (OM5 spec) based on 2015 OM3/OM4 roundrobin

Chromatic Dispersion Values and Tables & RECOMMENDATION

1GbE Table 38-12 OM1, OM2

Use $S_o=0.11$ $U_o = 1320$ OM1, OM2 [before OM terminology]

10GbE Table 52-25 OM1, OM2, OM3, OM4

Use $S_o=0.11$, $U_o = 1320$ OM1, OM2, OM3 or OM4 spec(footnote g)

Use $S_o=0.10275$ $U_o = 1316$ OM4 based on OM3 older roundrobin

40/100 GbE Table 86-14 OM3, OM4

Use $S_o=0.10275$ $U_o = 1316$ OM3, OM4

RECOMMEND 2015 values for OM3, OM4, OM5

50/100/200 GbE Table 138-15 OM3, OM4, OM5

Use $S_o=0.10275$ $U_o = 1316$ OM3, OM4

Use $S_o=0.093477$ $U_o = 1328$ OM5 based on 2015 OM3/OM4 roundrobin

At 850nm

$S_o=0.11$ $U_o = 1320$ gives CD = -112.57 8.6% higher than old OM3/OM4

$S_o=0.10275$ $U_o = 1316$ gives CD = -103.62 old OM3/OM4

$S_o = 0.093477$ $U_o= 1328$ gives CD = -98.49 5% lower than old OM3/OM4

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