University of Cambridge Multimode-Fiber Model Results ***Release 3.1***

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Refractive-index profiles have been generated which have been approximately scaled to a differential modal delay (DMD) criterion of 2 ns/km. These refractive-index profiles are created by scaling of the perturbations in the current "108-fiber model" of FDDI-grade MMF, which is described in detail in a document of 12 October 2004 [1]. The usual means of achieving the scaling to a worst-case DMD of 2 ns/km is to adjust the calculated modal delays for each of the 108 fibers in accordance with a DMD scale factor. An alternative is to use the DMD scale factor to adjust the perturbations in the original refractive-index profile such that the scaled refractive-index profile has the desired worst-case DMD. For this approach, no further DMD scaling is required. The DMD scale factors for the 108 fibers are provided in CamMMF3p1DMDscaleFactors.txt.

The talk *"More information on statistical modeling of MMF optical fiber links"* presented at the Long Beach interim meeting in May 2004 describes, on slides 13 to 17, the method used to achieve the scaling of the perturbations [2]. Some refinements have been made to this procedure. In particular, the FWHM of the central dip perturbation is scaled in response to the DMD scale factor, rather than the amplitude. Furthermore, the edge perturbation (the exponential decay to the cladding index) is scaled in terms of the *radius of onset* of the perturbation, rather than the amplitude. The kink perturbation is scaled in terms of amplitude, in the same manner as for the central peak perturbation. **The scaling process is approximate**. Information on the success of the scaling process is provided in figure 1. The scaling of some of the fibers (numbers 34, 40, 46, 78, 102 and 108) has been manually adjusted to achieve better agreement with the target DMD.

As before, please note that this release relates to the following case:

Source wavelength	1300 nm	**OFL bandwidth-distance specification**	500 MHz km
MMF core diameter	62.5 µm	**Worst-case DMD target**	2 ns/km

The scaled refractive-index profiles are supplied in 108 text files which accompany this document. Each file contains one column, which lists the 1500 refractive-index values. The refractive-index profile is provided for one half of the fiber, from the axis of the fiber (radius $r = 0$ µm), at the top of the column, to $r = 1499\Delta r$, at the bottom of the column. The radial spacing between the points is $\Delta r = 0.0328333$ µm.

Important Note

This document relates to the "108-fiber model" as it stands on 21 October 2004. Please ensure that you are using the latest version of these scaled refractive-index profiles.

[1] J. D. Ingham, R. V. Penty and I. H. White, *"Statistical modeling of multimode-fiber links: a supplement to the information provided in the release note of 12 October 2004 in relation to Release 1.2 from the University of Cambridge,"* 12 October 2004.

[2] http://grouper.ieee.org/groups/802/3/aq/public/may04/cam_1_0504.pdf

Example of filename format

Fiber number (001 to 108)

CamMMF3p1f108r.txt

Release (present release is 3.1)

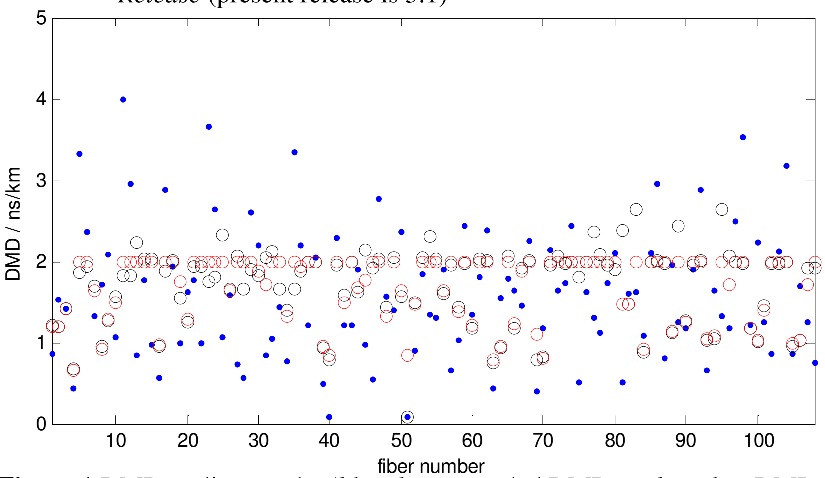

Figure 1 DMD scaling results (*blue dots:* unscaled DMD; *red circles:* DMD after usual scaling process; *black circles:* DMD of the scaled refractive-index profile)

In Figure 1, the performance of the refractive-index profile scaling process is compared relative to the usual scaling of modal delays. ***The aim is to achieve collocated red and black circles.*** For some cases, the process is such that the circles are exactly collocated, in which case only the red circle can be seen. For other cases, a discrepancy exists. For example, for fiber 51, the DMD of the scaled refractive-index profile is equal to that of the unscaled profile. The reason for this is that fiber 51 is the unperturbed profile and it is therefore impossible to scale the (nonexistent) perturbations. The recommendation is to ignore fiber 51.

Throughout this work, all definitions, e.g. of DMD, are *exactly* as in [1], as are settings such as the ignored mode groups.

The fiber numbering and corresponding perturbation settings are *exactly* as in the table in Appendix *A* of [1].