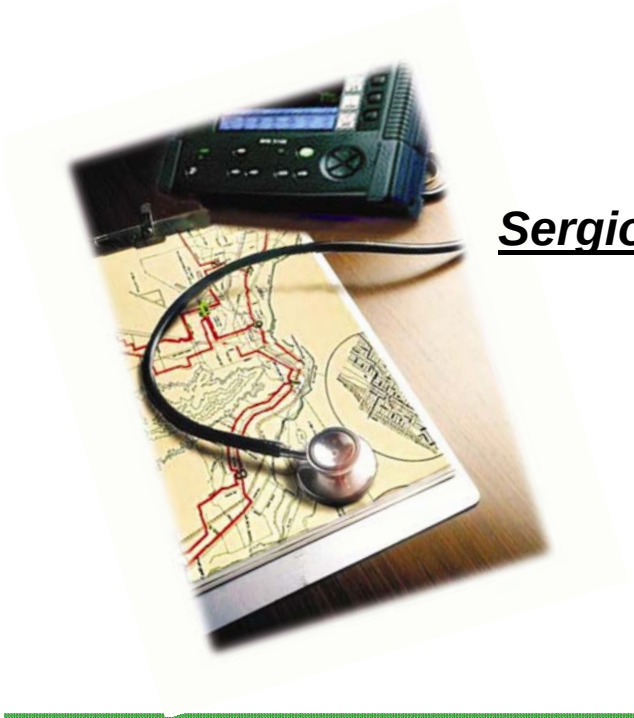
OFCNFOEC 2007

# Nation-wide PMD audit of installed fiber networks




***Elso Rigon,*** *MSc*

***Sergio Barcelos, Rogerio Oliveira, Willian Muramoto***

***sbarcelos@fiberwork.net***

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# PMD Audit of Installed Fiber Networks

- **FiberWork has conducted PMD characterization in several thousands of installed fibers ( Link PMD ! )**
- **Part of this data compiled into a PMD audit:**
  - **Most installations from 1997 to 2002 (*i.e., boom-time installations*)**
  - **In Brazil**
  - **First audit presented at OFCNFOEC'05**
- **Different plant types, cable manufacturers and fiber types**
- **Different regions and climates**
- **Incumbents, utilities, CAP's/new telecom operators**
- **Fiber span lengths: 60 to 140km**

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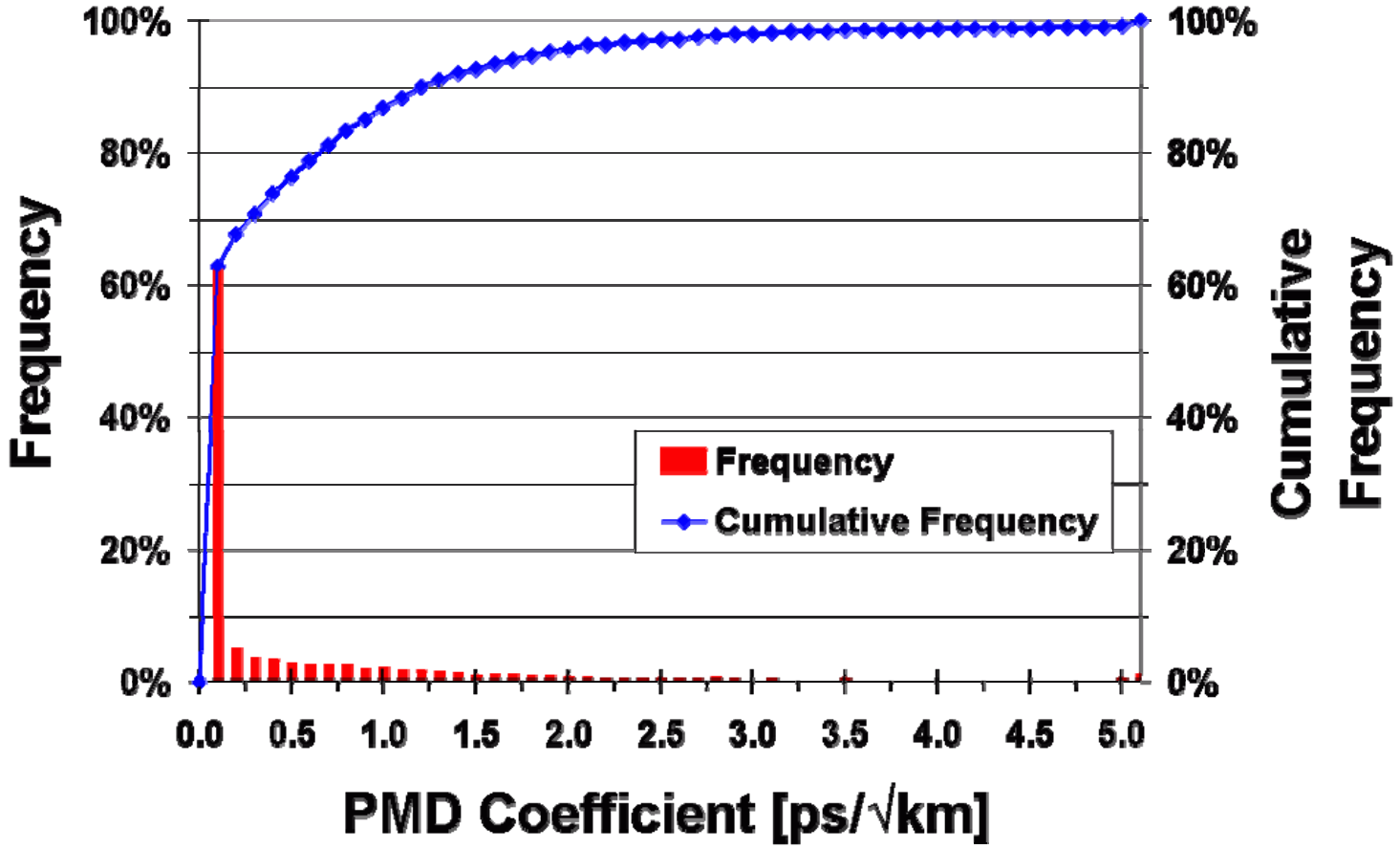
# PMD measurements of 2,614 fibers




| *PMD Coefficient* | *Cumulative Frequency* |
|---|---|
| > 0.2 ps/√km | 32% |
| > 0.5 ps/√km | 24% |

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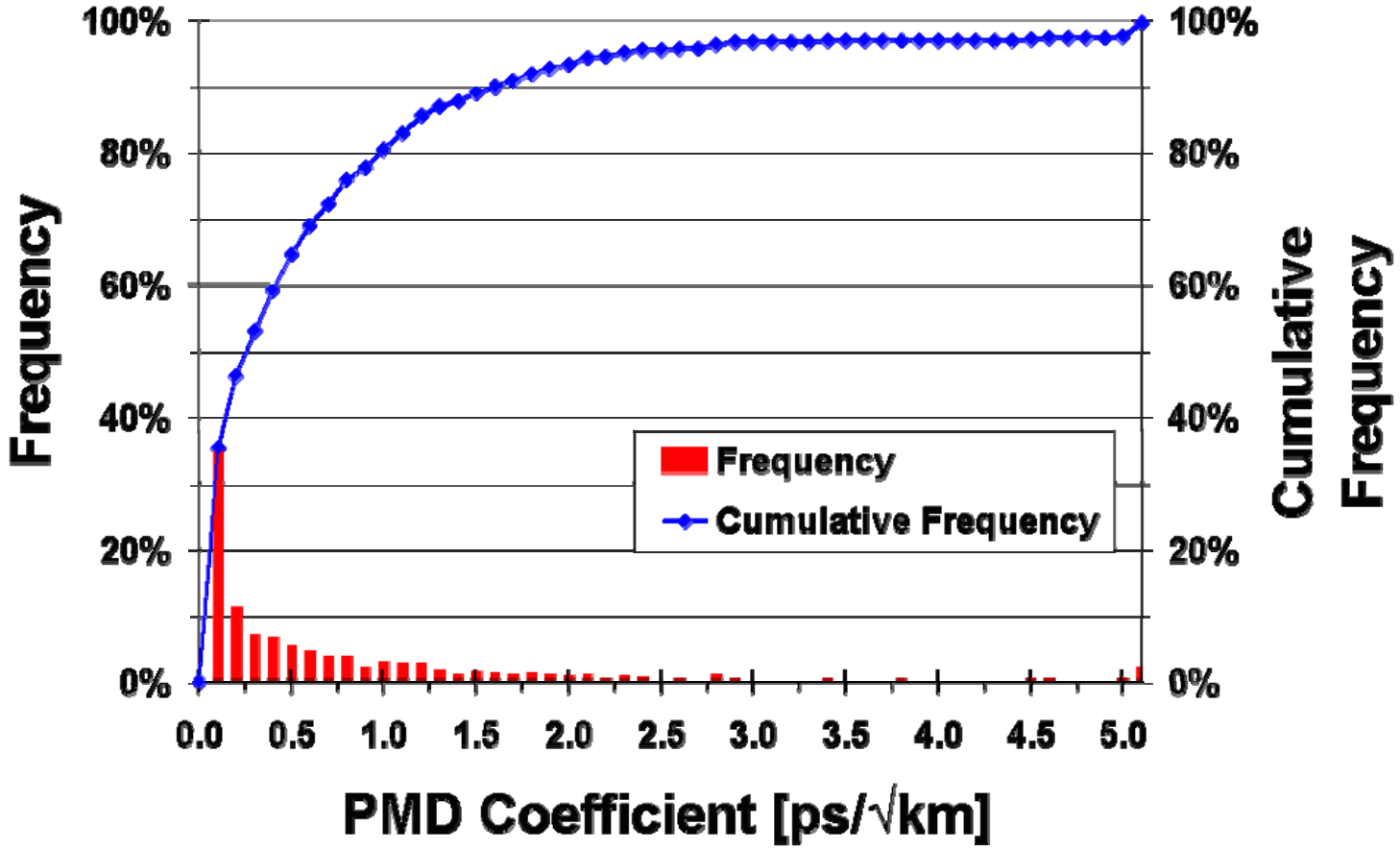
# Per-Route Balanced Analysis (Data Equalization)




| PMD Coefficient | Cumulative Frequency |
|---|---|
| > 0.2 ps/√km | 54% |
| > 0.5 ps/√km | 36% |

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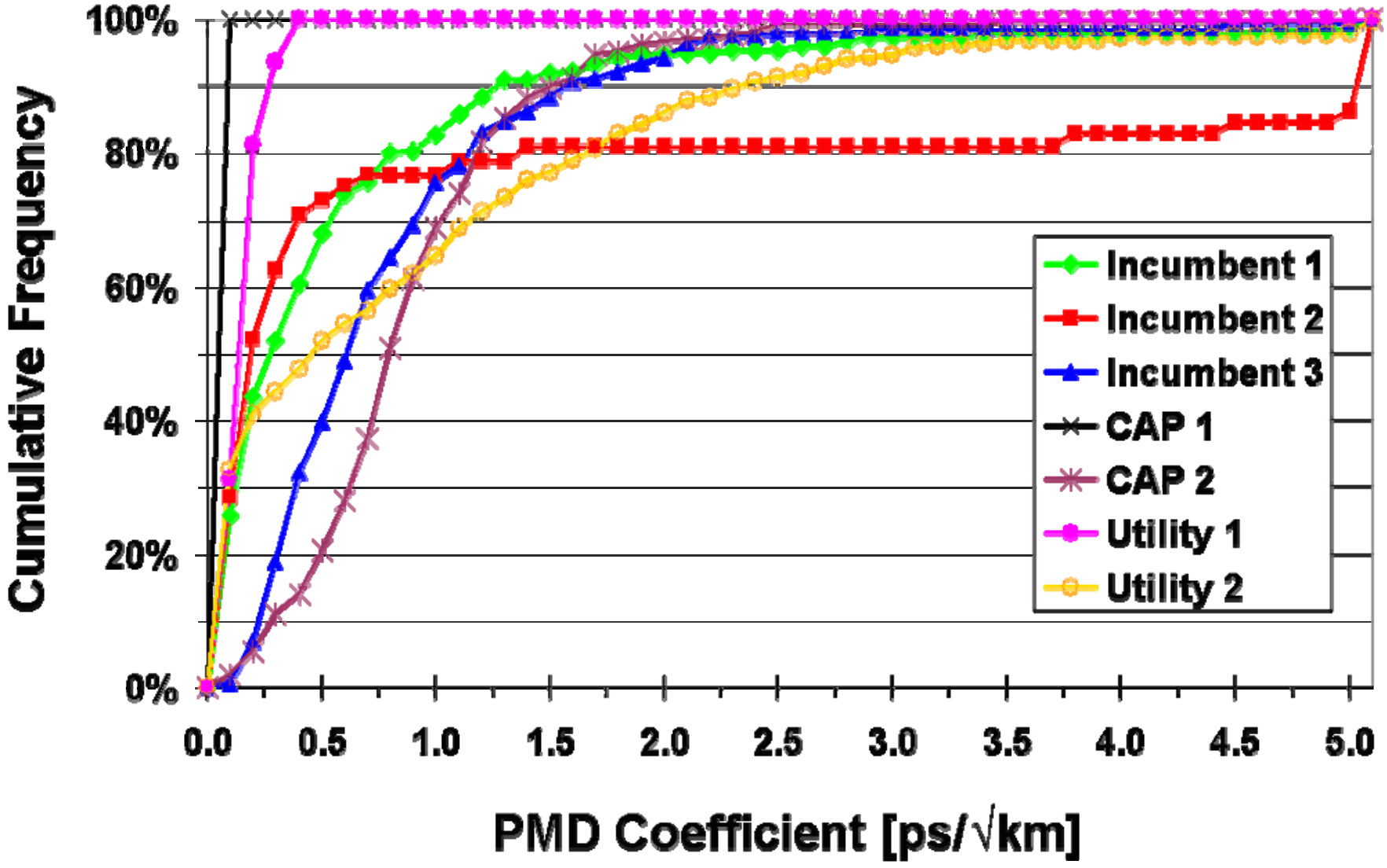
# Results Grouped by Carrier Type

*Per-route balanced analysis*

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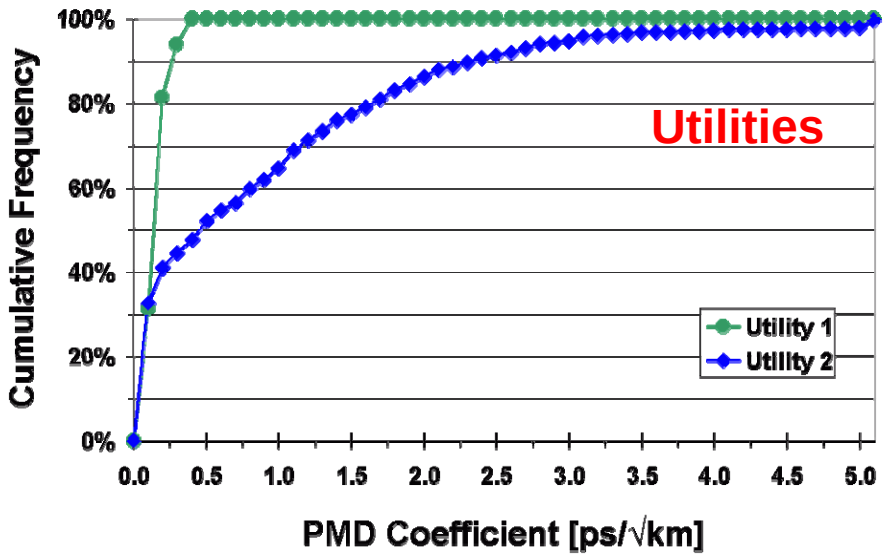
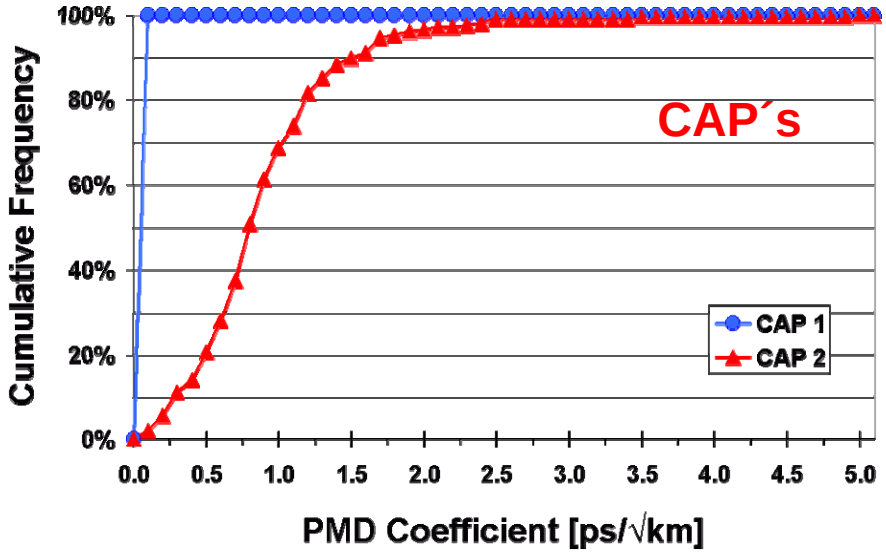
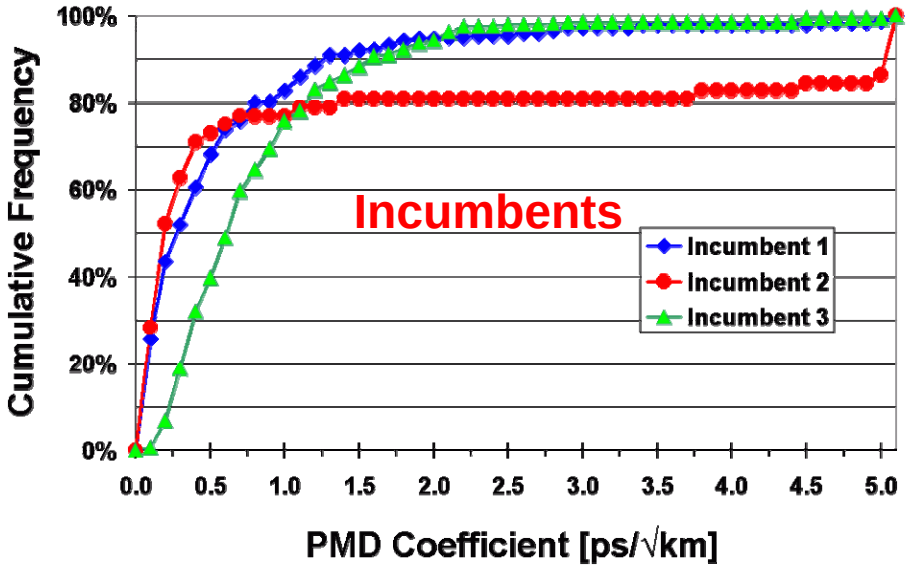
# Incumbents, CAP´s & Utilities



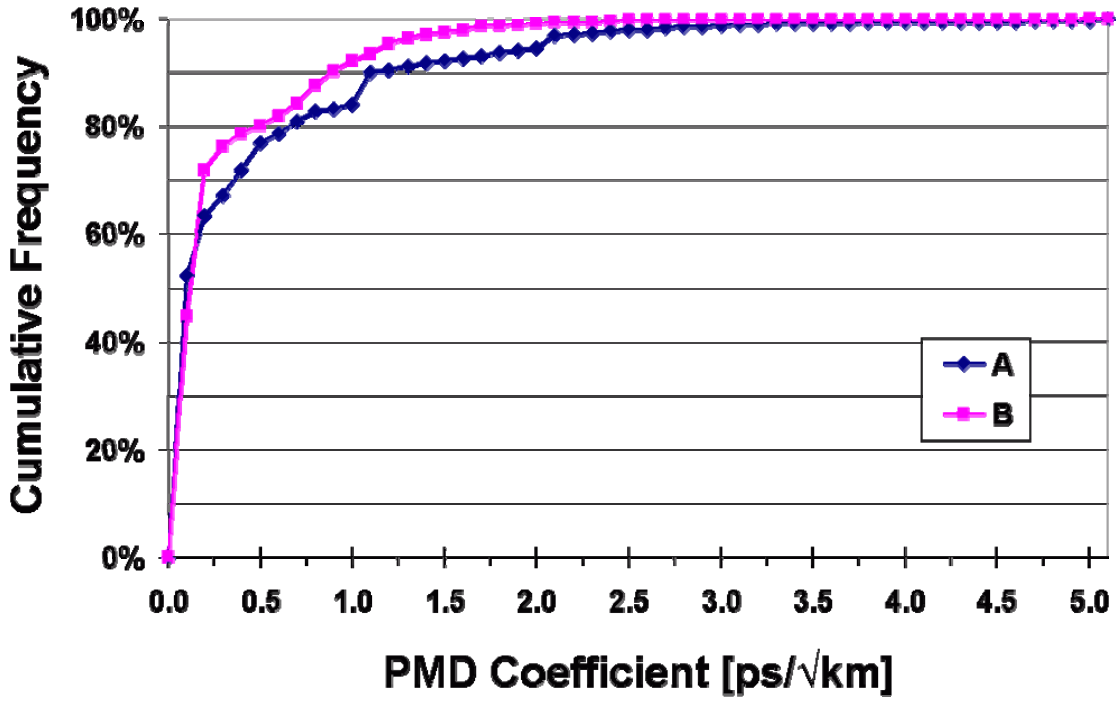




| *Incumbents* | |
|---|---|
| ***PMD Coefficient*** | ***Cumulative Frequency*** |
| **> 0.5 ps/√km** | **27% - 60%** |

# Results Grouped by Plant Type

- Buried and OPGW data sub-universes
- Manufacturers and fiber type data were *equalized* in each sub-universe
- 2,119 fibers, boom time installations




| PMD Coefficient | Plant Type A | Plant Type B |
|---|---|---|
| > 0.2 ps/√km | 37% | 28% |
| > 0.5 ps/√km | 23% | 20% |

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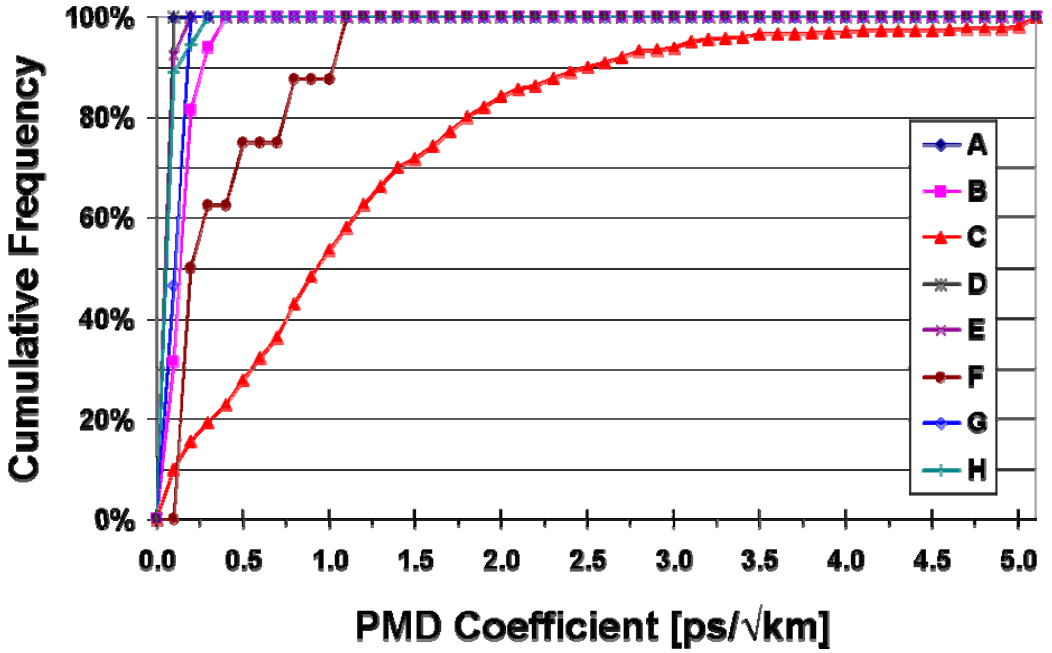
# Results Grouped by Cable Manufacturer

- 8 different manufacturers (A through H)
- 2,119 fibers, boom time installations
- *Per-route balanced analysis*




| PMD Coefficient | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| > 0.2 ps/√km | 0% | 19% | 84% | 0% | 0% | 50% | 0% | 6% |
| > 0.5 ps/√km | 0% | 0% | 72% | 0% | 0% | 25% | 0% | 0% |

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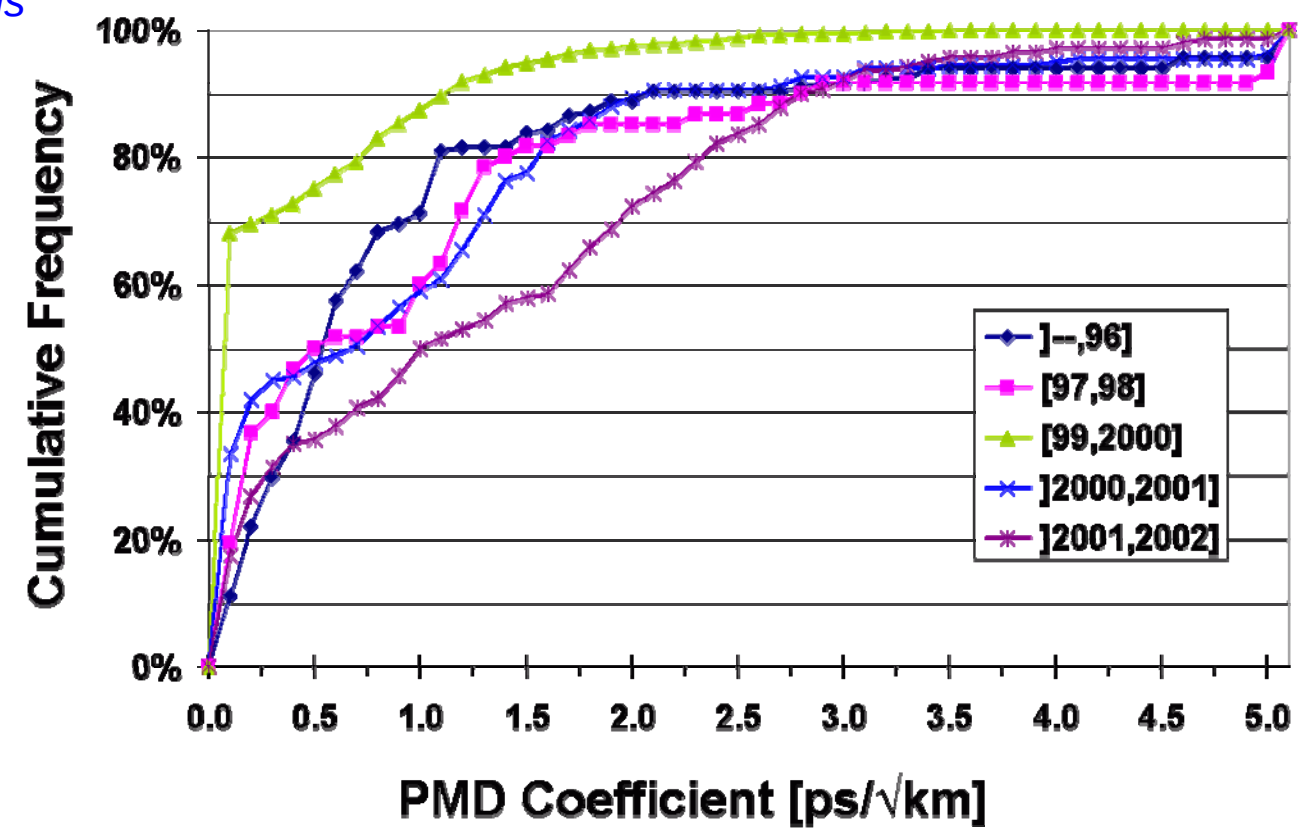
# Results Grouped by Installation Age

*Per-route balanced analysis*




| *PMD Coefficient* | *]--,96]* | *[97,98]* | *[99,00]* | *]00,01]* | *]01,02]* |
|---|---|---|---|---|---|
| **> 0.2 ps/√km** | **78%** | **63%** | **31%** | **58%** | **73%** |
| **> 0.5 ps/√km** | **54%** | **50%** | **25%** | **52%** | **64%** |

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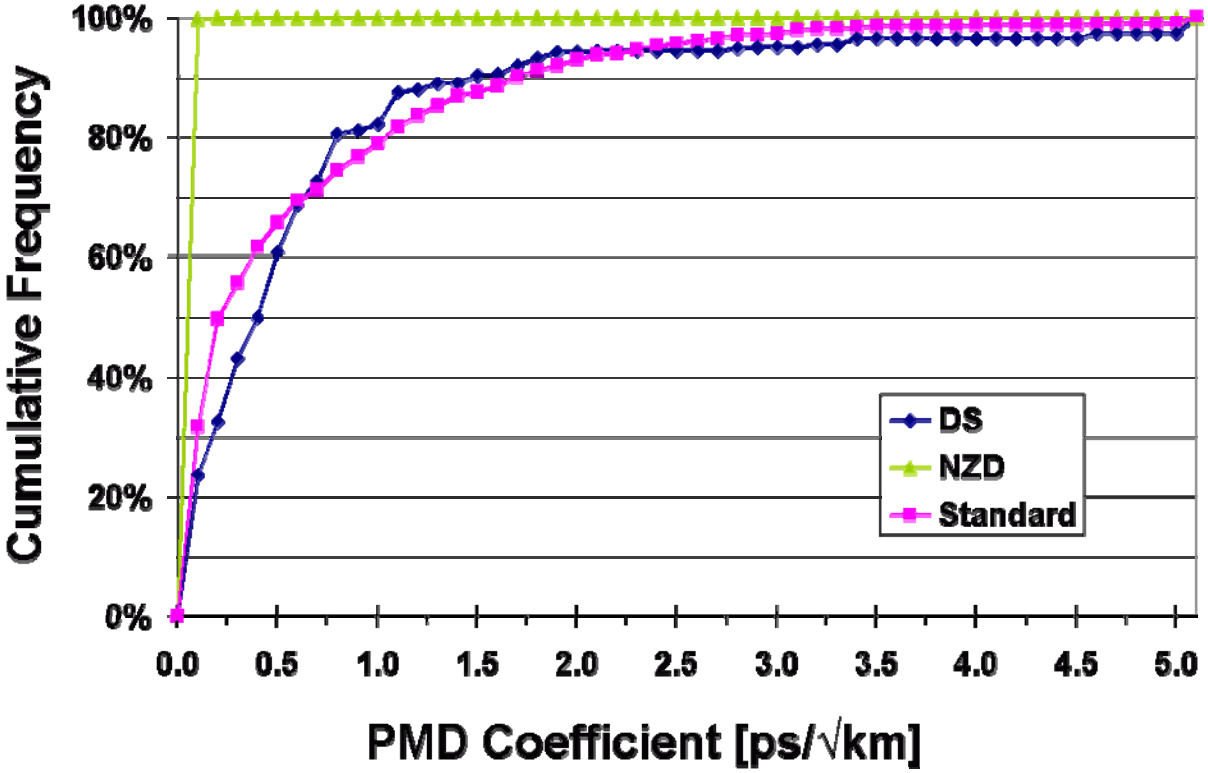
# Results Grouped by Fiber Type

- Standard, DS and NZD fiber sub-universes, *per-route balanced*
- 2,119 fibers, boom time installations




| *PMD Coefficient* | *DS* | *Standard* | *NZD* |
|---|---|---|---|
| **> 0.2 ps/√km** | **68%** | **50%** | **0%** |
| **> 0.5 ps/√km** | **39%** | **34%** | **0%** |

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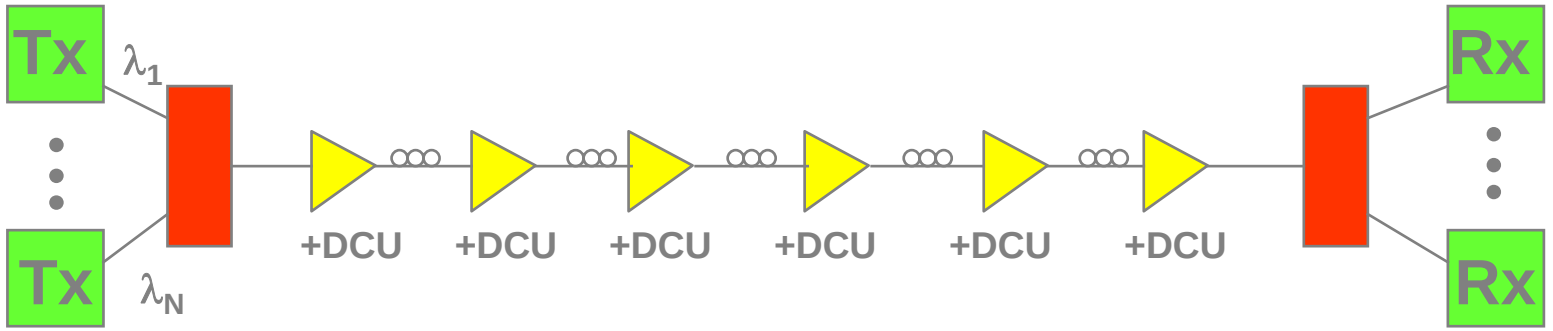
# Optically Amplified Fiber Routes



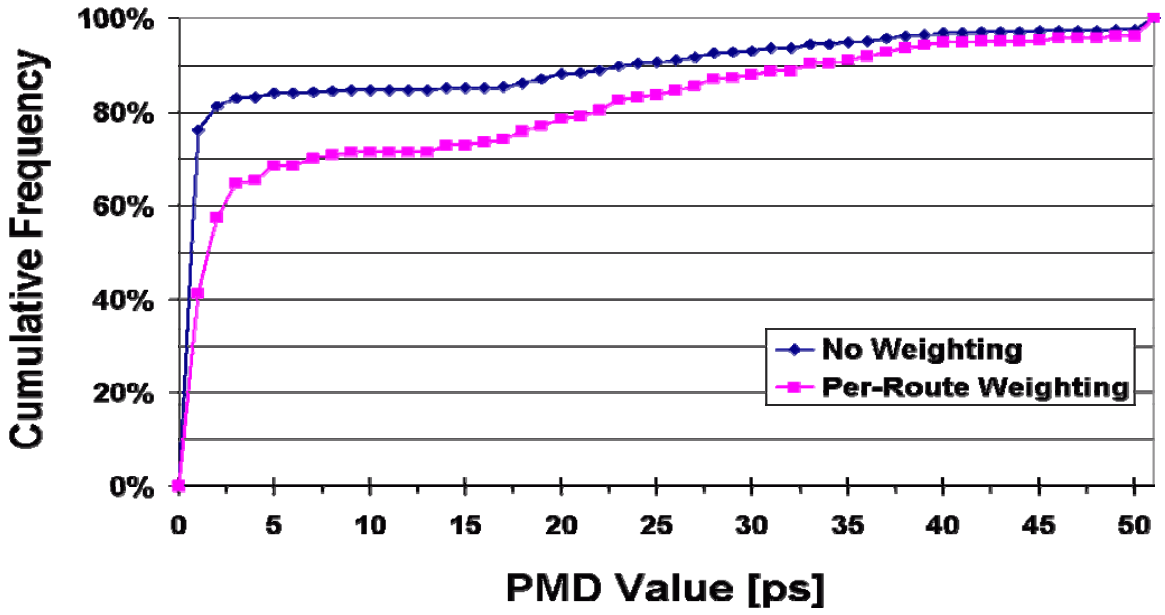

**Concatenation of fiber spans and network elements**

**⇒ Concatenated PMD**

# PMD Results for Concatenated Fiber Spans

⇒ *Optical network elements not considered !*

⇒ 2,119 fibers, boom time installations




| *PMD Value* | *No Weighting* | *Per-Route Weighting* |
|---|---|---|
| **> 2.5 ps** | **18%** | **39%** |
| **> 10 ps** | **15%** | **29%** |
| **> 40 ps** | **3%** | **5%** |

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# Conclusions

- **Installed fibers with PMD coefficient > 0.5 ps/√km:**
  - **Non-weighted data: 24%**
  - **Weighted data: 36%**

  **⇒ Not adequate for 10 Gb/s**

- **Installed fibers with PMD coefficient > 0.2 ps/√km:**

  **Non-weighted data: 32%**

  **Weighted data: 54%**

- **Concatenated spans with PMD value > 2.5 ps:**
  - **Non-weighted data: 18%**
  - **Weighted data: 39%**

  **⇒ Not adequate for 40 Gb/s**

- **Utilities and CAP´s**

  **⇒ PMD levels varies significantly among carriers**

- **Incumbents**

  **⇒ High PMD fibers (*i.e.*, PMD > 0.5 ps/√km): ranges from 27% to 60%**

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# Conclusions

- **Buried and OPGW plants ⇒ High PMD fibers varies by only 3%**

- **Frequency of high PMD cabled fibers varies enormously between cable manufacturers (0% to 72%)**

- **PMD is a worrisome problem in old fibers as well as in boom-era fibers**

- **Average DS fibers *worse than average* Standard fibers**
- **NZD fibers ⇒ Very good results !**

- **0.3 ps/√km link PMD coefficient is feasible for most manufacturers**

**PMD Audit by FiberWork:**

- **Sample of PMD status of Brazilian installed fiber plant**
- **Do not correspond to market shares**
- **Reasonable sample of the *world PMD status* (*a considerable amount of fibers have been imported into Brazil* !)**

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