

IEC-ITU-T Workshop on standardization roadmap for cabled multi-core fibre and optical network sensing technologies

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Multicore Fiber Production Measurements: Some Practical Considerations

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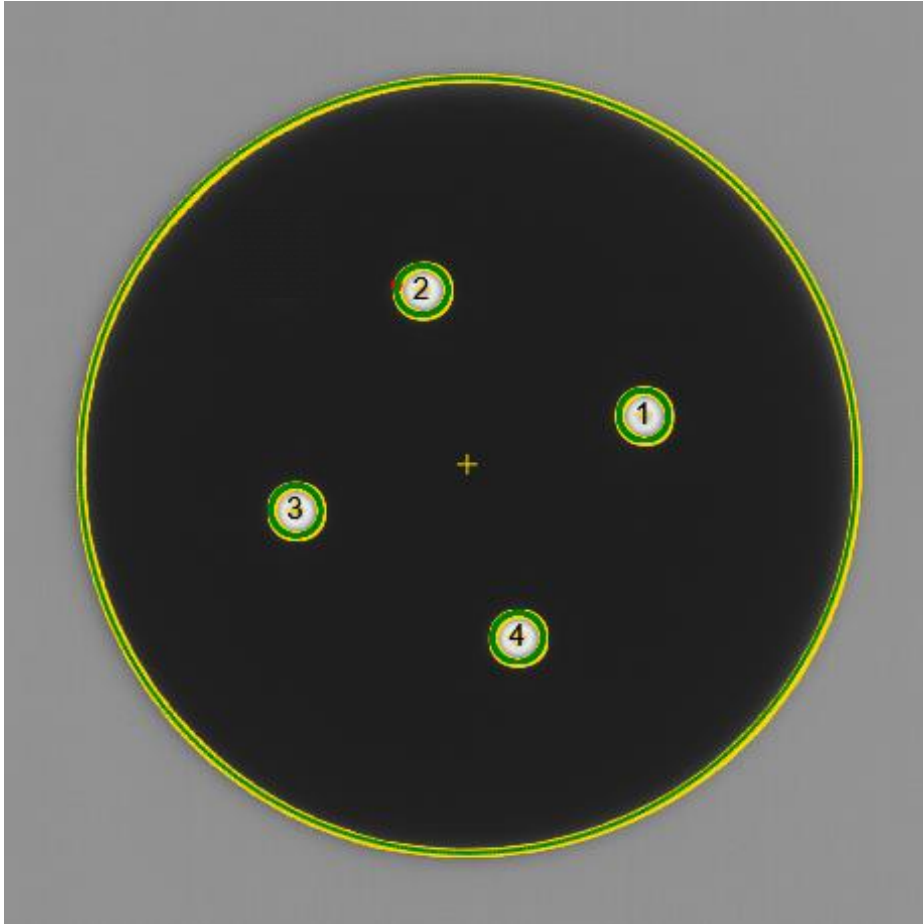
IEC context

- October 2024: Correspondence between ITU and IEC. IEC initiated a new work item to begin development of definitions and test procedures for fibre and cable attributes that need to be revised or created to enable future WC-MCF measurement standards.
- A new Technical Report with the specificities brought by Multi-Core Fibres being edited.
- Chosen Path: minor modifications of existing documents to accommodate the needs of MCF characterization, most of the information specific to MCF in the Technical Report.

Fiber Geometry

- IEC 60793-1-20 (Optical fibres - Part 1-20: Measurement methods and test procedures - Fibre geometry) offers almost all the tools for the characterization of a multiple cores.
- The document is presently under revision (every 5-10 years decisions are made to revise or not the document). It is presently under edition to introduce the few elements that we need to be ready for more than 2 bodies:
 - Report the coordinates of the centers of each body
 - Choose a referential (Cladding) for coordinates
 - Full report on the elliptical fit parameters.

Fiber Geometry



#	R (μm)	Theta (deg.)	Diameter (μm)	Non-circularity (%)
1	29.602	15.912	8.090	2.213
2	29.376	104.742	8.151	4.656
3	28.932	194.647	8.112	1.410
4	29.039	286.051	8.105	3.108

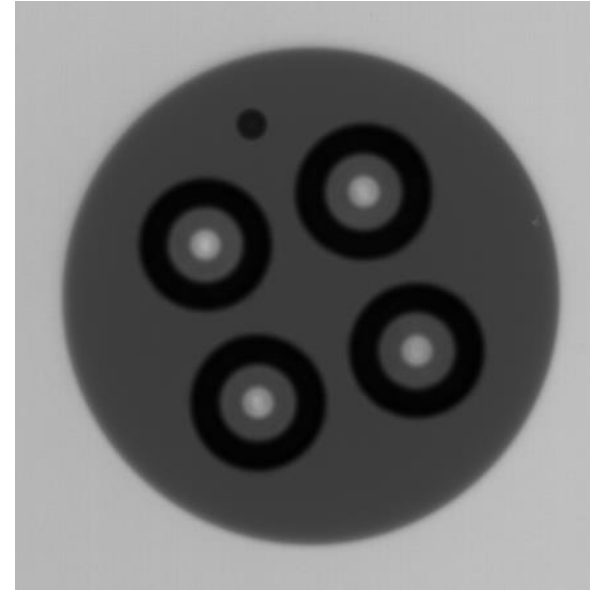
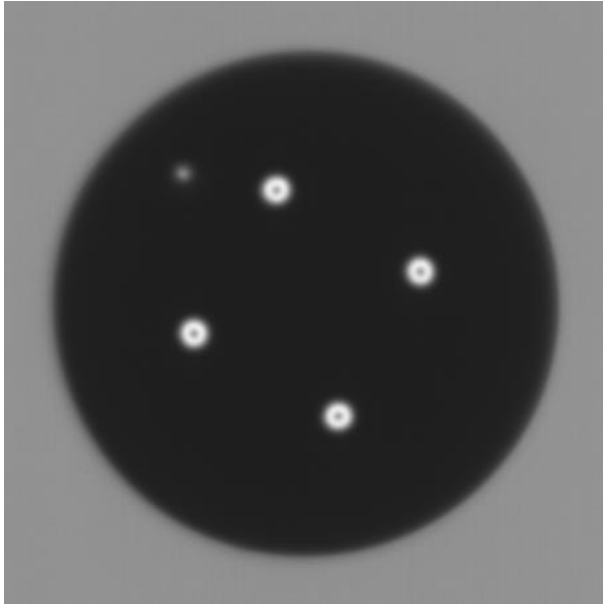
(All data from commercially available fiber)

Fiber Geometry

- New challenges:
 - Definition of the ideal core locations $\Leftrightarrow$ need to know the design
 - Define the guiding principle to calculate the error on the core locations.
 - From there, it is “only” a matter of calculating the error based of the core locations.
- Marker and core labeling :
 - Need for a convention to label the cores.
 - Is the marker used to calculate the core location error or is it only used to identify cores and polarity?
 - Challenge in detecting the marker depending on the design.

Fiber Geometry

There are many different designs where a marker (or a different feature) allows the differentiation of one core, and (possibly) the labelling of the cores.



For measurement purposes an up-doped marker (acting as a waveguide) is highly efficient for core identification as it blends into the measurement flow. (Left image)

A different type of marker requires an additional step (backlit illuminated geometry). This requires stripping the coating of the fiber and cleaving the fiber to have a short sample. (Right image)

Launch and/or Detection restriction

- Restrict the launch to one core at a time, and receive all

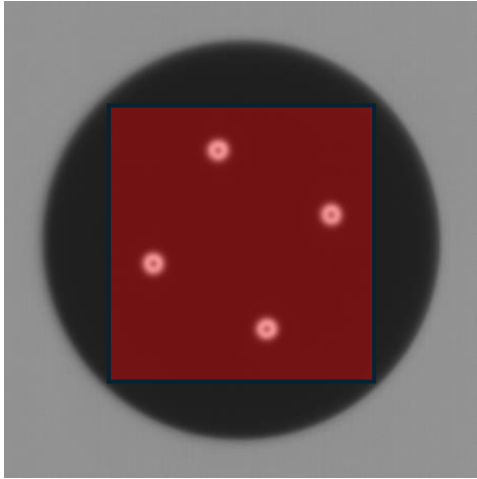
Or

- Launch all cores and restrict the detection to one core at a time,

Or

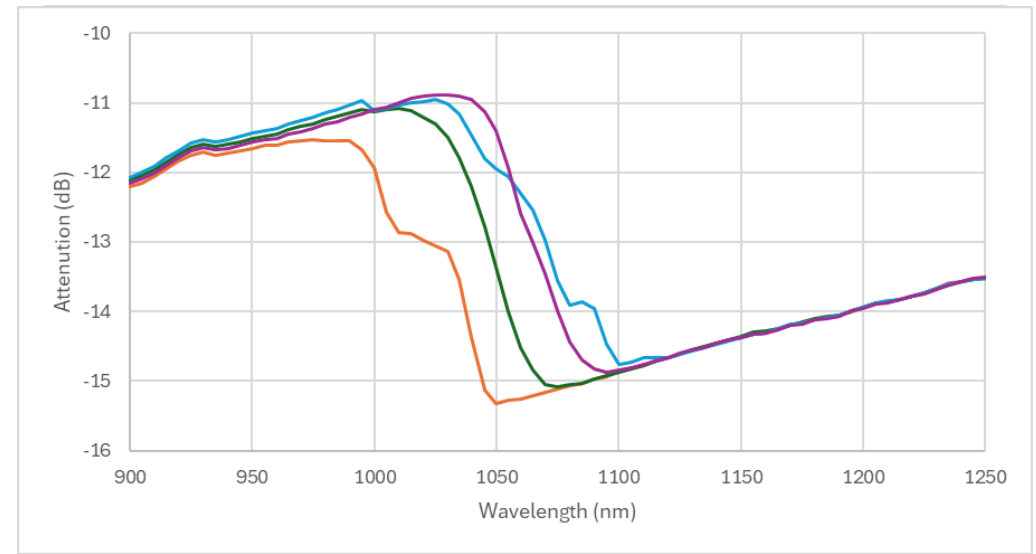
- Restrict both launch and receive to one (matching) pair of cores

Example of launch restriction applied to cutoff wavelength measurements (1/2).

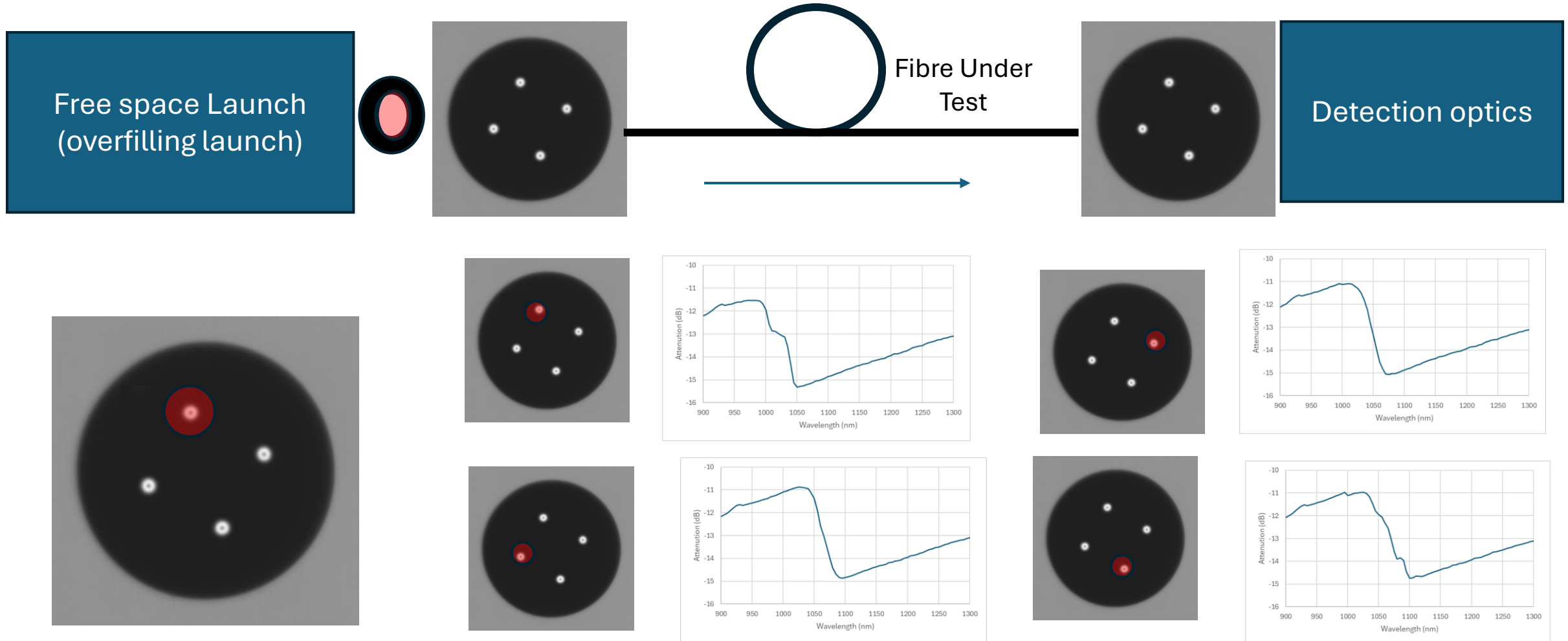


With no restriction on the launch, the received signal is the sum of the 4 cores.

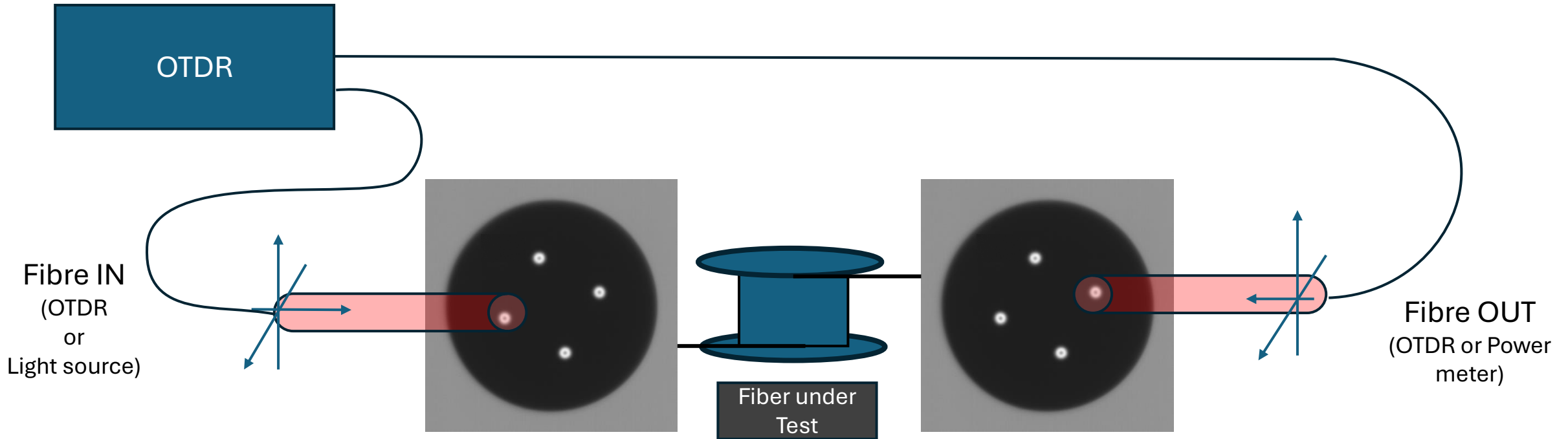
Inability to characterize each core individually: the received signal is the sum of signal from all the cores.



Example of launch restriction applied to cutoff wavelength measurements (2/2).



Restriction of both the launch and the detection via a fiber: suitable for OTDR, CD, PMD, Crosstalk?



Micro-positioners used to couple a fiber to the same core, on both ends of the fiber, to allow the characterization at that particular core.

Limitation for cutoff wavelength and cutback attenuation as launch is restricted by fiber.

Cross talk

- Co-propagation cross talk from power measurement.
- Evaluation with OTDR based method.

In summary

- A need for a template, or a definition of the design, in order to adequately report the results
- The definition for the core location error needs guide principles.
- The marker types directly impact the measurement flow.
- Choice of launch and/or detection restriction(s) guided by the measurement type.

Thank you