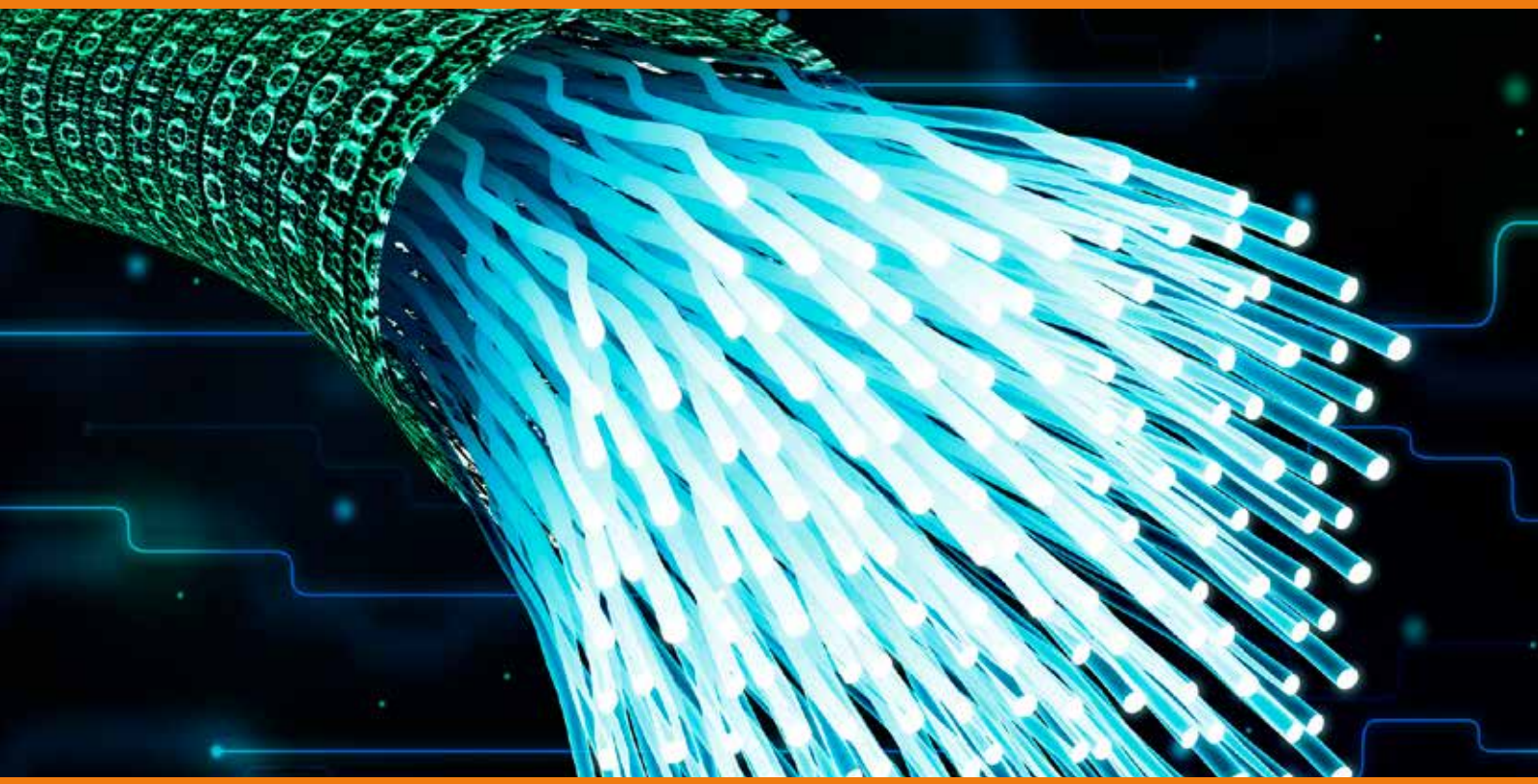
European Metrology Programme for Innovation and Research

Delivering Impact



New instrument for photonics industry

Fibre optic cables carrying data rich signals encoded by light are used in a range of areas such as the internet, industry, health and space applications. During transmission signal strength can be lost or degraded with serious consequences. As the bandwidth is pushed ever higher to meet demand new instrumentation is required to detect and help minimise such losses but it must be both accurate and traceable to the SI.

Europe's National Measurement Institutes working together

The European Metrology Programme for Innovation and Research (EMPIR) has been developed as part of Horizon 2020, the EU Framework Programme for Research and Innovation. EMPIR funding is drawn from 28 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets the future.

Challenge

Telecommunication systems mostly rely on 'singlemode' optical fibres that allow only one path or 'mode' for light to travel as it propagates through the fibre. However, in many important industrial applications, such as in avionics or the automotive industry, 'multimode' fibres are required.

In multimode fibres light can follow many different paths with some signals propagating directly through the optical core, some near the outer edges, and some may 'zigzag' and bounce of the cable's cladding. The types of modes entering such fibres, and how they behave, can affect the level of performance and without knowing this it is not possible to accurately measure critical parameters such as the bandwidth or the amount of signal lost.

To overcome this issue a method to characterize the modal distribution, termed 'Encircled Flux' (EF) has been previously introduced which allows losses to be measured more accurately and this is now specified by international standards. EF measurement instruments give consistent, traceable results but are not applicable to plastic fibres types or certain large core fibres. Encircled Angular Flux (EAF) instruments can address these limitations and although commercial measuring instruments exist, they lack traceability to the SI.

Solution

In the EMPIR project *Metrology for the photonics industry - optical fibres, waveguides and applications*, two instruments for EAF measurement were independently developed by the National Metrology Institute of Switzerland, METAS, and project partner Arden Photonics. The METAS system comprised a reference light source, a moveable stage to position an optical fibre and a high-definition camera to collect the data on light exiting a fibre. Calibrations were performed using SI traceable instrumentation including a highly uniform light source, reference detectors and a high-resolution optical reflectometer. The Arden system used a larger camera and different processing algorithms to transpose specifications into a more industrial-grade product and was calibrated using the same techniques. Factors that can affect measurements were evaluated such as camera uniformity, fibre to camera distance and repeatability of results. An inter-comparison exercise using different fibre types showed excellent agreement and allowed both systems to establish traceability to the SI.

Impact

Arden Photonics, the developer of the commercial EAF instrument, specialise in innovative products for test and measurement of multimode optical fibres. Arden's clients include the manufacturers of photonic components and users in industries such as telecommunications, aerospace and medicine. The new EAF measurement instrument, with an accuracy and traceability backed by a National Measurement Institute, will allow Arden to characterise the launch conditions, the different light modes entering a cable, and signal losses for a range of new fibre types. This will allow the company to expand their range of launch control products and greatly improve their customers' ability to repeatably measure insertion loss in fibre types which were not previously possible before. The company considers that this advancement will further enhance their standing in the field of multimode launch distribution measurement.

For the first time EAF measurements, characterising the angular distribution of the light, alongside EF can be made with full traceability to the SI. This will enable better and comparable measurement of quantities like losses and bandwidth in multimode fibre systems, allow an increase in efficiency in optical networks and the further improvement of relevant normative standards in this field.

New instrument for photonics industry

The EMPIR project *Metrology for the photonics industry - optical fibres, waveguides and applications* developed a novel primary standard radiometer, for optical fibre power measurement, with a one-step traceability to the SI. New standards, instruments and measurement and calibration procedures were produced suitable for several photonic applications markets, including THz transmission systems, silicon photonics and optical printed circuit boards. Novel calibration techniques and artefacts were developed for fibre-optic reflectometers allowing calibration in a simple and accurate way as well as two instruments for measuring Encircled Angular Flux. A freely available good practice guide on measurement procedures for high power fibre optics was also published by the project. These results will help underpin the development and competitiveness of the European photonics industry, enabling innovation and providing faster, cheaper data connectivity.

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