**EMPIR Call 2014 – Industry and Research Potential**

Selected Research Topic number: **SRT-i22**
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# Title: Metrology for the photonics industry - optical fibres, waveguides and applications


## Abstract

Modern photonics systems utilise novel components, which cannot be reliably measured using classical techniques for both their dimensional and optical properties. Dedicated measuring instruments are commercially available for some of the required quantities, but they are often uncalibrated and have insufficient accuracy. New measurement technologies for the European photonics industry are needed to strengthen its competitiveness by the development of on- and off-line characterisation techniques for the latest generation fibre optics, photonic components and photonic devices, and to develop necessary calibration techniques and reference materials allowing calibration of commercially available measuring instruments.



## Keywords

Photonics components, photonics systems, non-standard optical fibres, new multimode fibres, measuring instruments for photonics, THz metrology, optical metrology


## Background to the Metrological Challenges

New optical fibres and photonics components have been recognised as a key enabling technology and numerous ambitious projects have been initiated in Europe [1], and worldwide, to promote the development and deployment of these new technologies. The growing demand for cost effective “Fibre-To-The-Home” (FTTH) technologies, and the increasing implementation of optical fibres and photonic systems in the automotive and in the avionic industry, has led to a major development in the domain of new fibres and photonics components.

Fibre laser sales are expected to grow on average by 21.9 % per year until 2018 [2,3]; and continuous and pulsed high power fibre lasers and power delivery systems based on special fibres are key components for medical, biophotonics, industrial (micro-fabrication, automotive and defence) and environment applications. In addition, frequency stabilised fibre lasers can be used in interferometers, telecommunication and sensor applications.

The development and fabrication of special optical fibres and components is growing rapidly and suffers from a lack of dedicated calibration techniques allowing proper fabrication and application of these new devices. The fabrication of novel fibres is also extremely challenging, underlining the urgent need for new measurement technologies.

Existing calibration techniques are mostly adapted to standard telecommunication fibres and components, so consequently they are limited to a restricted set of wavelengths and properties, and are not adapted to the characterisation and calibration of new optical fibre type and component properties. This situation is detrimental to an efficient development of emerging new technologies.

High-bitrate multimode optical fibre telecommunication systems require accurate control and measurement of the modal distribution in order to obtain the requested bandwidth. However, methods for achieving fully traceable measurements need to be further improved. Traceable and harmonised calibration techniques are under development, but need further optimisation. Photonics crystal fibres possess very special properties (guiding, polarisation, spectral, nonlinear), but traceable calibration techniques do not exist. The new generation of optical fibres with special polarisation properties for sensor applications also set new challenges to metrology, which are still not fully addressed.


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## Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the proposal.

The JRP shall focus on the development of new tools for fibre optics manufacture, for the characterisation of optical fibres and waveguides and for the characterisation of photonic components employed in optical and in THz transmission links.

The specific objectives are

1. To develop traceable online and offline metrology techniques for dimensional and optical characterisation (e.g. concentricity of different layers of the fibre, the layer thicknesses, the filling fraction and uniformity of air pores, index of refraction, mode field diameter, modal distribution, polarisation properties, nonlinear properties and spectral attenuation) of non-standard optical fibres, micro structured fibres and photonic components.
2. To develop the necessary metrology, including calibration techniques and artefacts, for traceable measuring instruments used in photonics and fibre optics domain. The metrology developed should address technologies such as optical time domain reflectometry at high spatial resolution and multimode systems.
3. To develop measurement standards and standard measurement procedures for key parameters of THz transmission links, including, for example, phase references derived from THz frequency combs and the traceable measurement of dynamic range, insertion loss, gain, noise figure, bit error ratio (BER) for various modulation formats, free spectral range, Q factor and bandwidth.
4. To develop functional metrology for optical printed circuit boards used as interconnects within high speed data storage systems including, for example, a characterised measurement system incorporating a variable launch condition to monitor board performance under a range of controlled environmental conditions.
5. To engage with the European photonics industry and photonics equipment manufacturers to facilitate the take up of the technology and measurement techniques developed by the project, to support the development and manufacture of new, innovative photonics related products, thereby enhancing the competitiveness of EU industry.

Proposers shall give priority to work that meets documented industrial needs and include measures to support transfer into industry by cooperation and by standardisation. An active involvement of industrial stakeholders is expected in order to align the project with their needs – both through project steering boards and participation in the research activities.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this and EMRP JRP IND51 (MORSE) ‘Metrology for optical and RF communication systems’.

EURAMET expects the average EU Contribution for the selected JRPs to be 1.5 M€, and has defined an upper limit of 1.8 M€ for any project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 30 % of the total EU Contribution to the project. Any deviation from this must be justified.

Any industrial partners that will receive significant benefit from the results of the proposed project are expected to be unfunded partners.

## Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Drive innovation in industrial production and facilitate new or significantly improved products through exploiting top-level metrological technology,

- Improve the competitiveness of EU industry,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to the photonics industry sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased
- organisations other than NMIs and DIs to be involved in the work

## Time-scale

The project should be of up to 3 years duration.

## Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1] “Seventh Framework Programme (FP7) of the European Commission”, http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&QZ_WEBSRCH=fibre+optics&USR_SORT=

[2] “2012 Annual Economic Review and Forecast”, http://www.industrial-lasers.com/articles/print/volume-28/issue-1/features/2012-annual-economic-review-and-forecast.html

[3] “Global Fiber Laser Market 2014-2018”, http://new.pitchengine.com/pitches/7534362d-0ea4-4741-97d1-97b397b80f66