Master in Photonics – "PHOTONICS BCN"
Master ERASMUS Mundus "EuroPhotonics"

MASTER THESIS PROPOSAL

Full time from April 2026 (it can start part time from February 2026)
Presentation date to be chosen: end of July or beginning of September 2026

Note: The main Master Thesis supervisor has to be a professor of the Master in Photonics program. One co-supervisor (internal or external) can be defined. Main Supervisor is responsible for the subject of the proposal and has to give continuous support to the student (research development, Report writing and presentation preparation). For external proposals a co-supervisor from the Master program and a collaboration agreement with UPC are needed.
You can find all information about the Master Thesis process in our webpage.

Laboratory:
Institution: Monocrom S.L.
City, Country: Vilanova i la Geltrú, Spain

Title of the master thesis: Beam quality assessment for multi-emitter laser sources

Name and affiliation of the master thesis supervisor: José Antonio Ramos, R&D director @ Monocrom
Name and affiliation of the co-supervisor (if any):
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Keywords: beam quality, laser diode bars, near-field, far-field

1. Summary of the subject (maximum 1 page):

The harmonized standard ISO 11146 defines the procedures and metrics for laser beam quality characterization, focusing exclusively on single-emitter or single-mode laser sources. However, this methodology cannot be directly applied to multi-emitter sources, such as laser diode bars or high-power laser modules composed of arrays. In these sources, the spatial and angular superposition of individual emitters introduces additional complexities, such as non-Gaussian beam profiles, interference patterns, and non-uniform divergence depending on the emitter geometry and alignment.

The main goal of this thesis is to extend and adapt the measurement procedures and quality metrics defined in ISO 11146 to multi-emitter laser sources, establishing a coherent methodology that allows meaningful comparison of beam quality across this class of devices.

The work will be structured into four main phases:

1. Literature review on laser beam characterization and previous research dealing with the extension of beam-quality metrics to complex or composite sources (arrays, bars, or stacked emitters).
2. Analysis of the characterization systems currently available in the company, including experimental setups for near- and far-field measurements and optical modeling tools such as OpticStudio (Zemax).
3. Development of a methodological framework defining adapted or complementary metrics (e.g. effective M^2, angular uniformity, spatial correlation, simulated coupling efficiency).
4. Preliminary experimental validation using one or more real multi-emitter devices, by adapting existing measurement setups and comparing simulation and experimental results.

As an outcome, the project aims to deliver an extended methodological framework for quantifying the beam quality of multi-emitter sources, ensuring compatibility with ISO principles and practical applicability in product development and validation processes within the company.

2. Objectives (maximum 1 page):

General Objective

To develop and validate a beam-quality evaluation methodology applicable to multi-emitter laser sources, based on the extrapolation of the procedures and principles established in ISO 11146.

Specific Objectives

1. Technical and normative review
    - Analyze in depth the contents of ISO 11146 (Parts 1–3).
    - Review scientific and industrial literature on multi-emitter beam characterization and coupling models.
    - Identify the limitations of ISO metrics (M^2, beam diameter, divergence, phase flatness) when applied to non-coherent or structured sources.
2. Diagnosis of existing systems
    - Assess the experimental setups currently available for measuring near- and far-field patterns of individual emitters.
    - Evaluate their possible adaptation for the characterization of laser bars or sub-modules.
    - Review available optical simulation resources (OpticStudio) and build parametric models for both individual emitters and the composite beam.
3. Methodological development
    - Propose extended or alternative beam-quality metrics suitable for multi-emitter sources (e.g. composite M^2, angular uniformity index, partial phase correlation).
    - Design a measurement procedure consistent with ISO 11146 philosophy but adapted to diode-bar geometry.

   - Define a data-processing methodology to derive global metrics from individual measurements.
4. Validation and demonstration
   - Implement experimental tests with a real multi-emitter system, performing near- and far-field measurements.
   - Compare experimental data with optical simulations and evaluate the consistency of the proposed methodology.
   - Assess robustness, traceability, and reproducibility of the extended metrics in an industrial environment.
5. Expected outcomes
   - Technical report describing the proposed extension of ISO 11146 to multi-emitter laser sources.
   - Preliminary experimental validation and recommendations for adoption in laser-development workflows.

Additional information (if needed):
* Required skills: optical design and simulation (familiarity with OpticStudio is a plus), knowledge about lasers, optics laboratory skills.
* Miscellaneous: high degree of autonomy