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Self-Calibrated Optical Power Measurements Using the PQED and Integrated Photonic Chips

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The Predictable Quantum Efficient Detector (PQED) is an internationally recognized primary standard for optical power measurements, with its core technology developed entirely in Norway. Led by Justervesenet, the Chip S·CALe project focused on producing practically loss-free photodiodes, along with three independent methods to quantify residual losses—shown to be below 10 ppm. These methods include fitting a simulation model to either charge carrier lifetime or photocurrent measurements, as well as a purely experimental approach known as the dual-mode method, which combines photocurrent and electrical substitution on a single photodiode chip.

We present approaches for achieving self-calibration in optical power measurements, demonstrating record-low uncertainties on the order of 150 ppm. Self-calibrating photodiodes enable integration of primary standards directly into instruments, eliminating the need to return equipment to the laboratory for calibration. This is particularly valuable for measurements in inaccessible or remote environments. A practical example is provided, showing how PQEDs and integrated photonic chips are used to ensure traceability in the calibration of detectors operating in the low-photon regime. This work reflects a broader development trend towards photonic integrated circuits for compact and scalable photonic measurement systems.

Author: HEITMANN SOLHEIM, Johanne (Justervesenet)

Co-authors: BARDALEN, Eivind (Universitetet i Sørøst- Norge); GRAN, Jarle (Justervesenet); SKAAR, Lars Kristian (Justervesenet); TRAN, Trinh (Justervesenet)

Presenter: HEITMANN SOLHEIM, Johanne (Justervesenet)

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