CRYOGENIC PRIMARY STANDARD FOR OPTICAL FIBER POWER MEASUREMENT

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Summary:

NIST has completed commissioning of a new, state-of-the-art cryogenic primary standard for optical fiber power measurement and calibration. It establishes for the first time, a direct traceability route between the device under test and the primary standard. The expanded measurement uncertainty (k=2) is 0.4 %, which is a 20 % improvement on NIST's previous capability. Measurement repeatability below 50 ppm is routinely achieved.

This presentation marks the culmination of an ambitious program to redefine the traceability route for optical fiber power measurement that serves the broader community with world-wide recognition. The technology behind this development is not only applicable to optical fiber power measurement, but also to radiant power measurement across the broad wavelength spectrum from the ultraviolet to THz region, with unprecedented accuracy [1] – [3]. Our ultimate goal is to develop a family of compact, fast, and easy-to-use calibration systems.

The instrument uses advanced thermal filtering for exceptional stability and noise, and planar micro-machined silicon detectors, with carbon nanotube absorber arrays and superconducting transition edge sensors, for optical fiber power measurement. The detectors are vacuum coupled to laser diode sources using single mode fiber anchored at 5 K. The system operates at a radiant power level of 200 µW, -7 dBm, although this range can vary considerably depending on customer requirements.

We will discuss the application of this technology to the development of this new generation of primary standard, and the implications going forward. Recent work to overcome small deficiencies in the optical / electrical heating inequivalence will be presented. We will also present a detailed measurement uncertainty analysis which is dominated by the spectral linewidth of the source, and the temperature dependence of the beamsplitter ratio; a function of polarization dependent losses.

Finally, we will demonstrate agreement between our previous scale and our new optical fiber power scale.