Using Radiation Pressure to Develop a NEW SI Traceable Power Measurement

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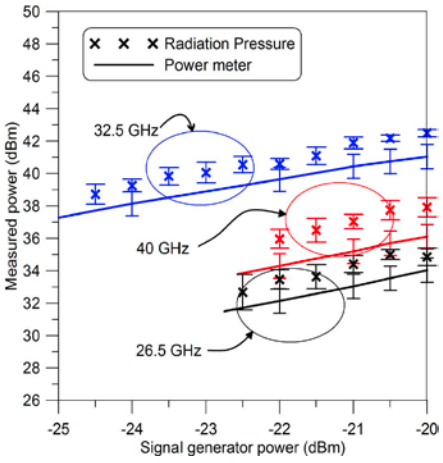
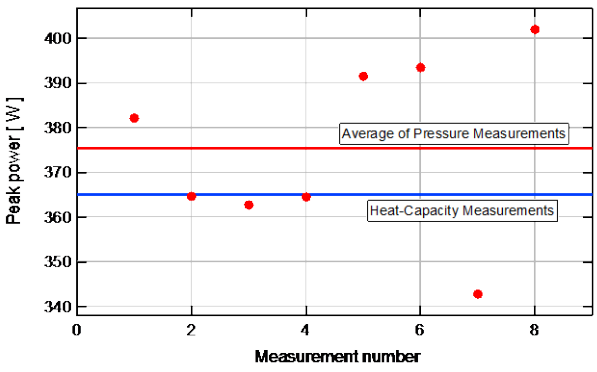
The world of measurement science is changing rapidly due to the International System of Units (SI) redefinition planned for late 2018. As a result of the shift towards fundamental physical constants, the role of primary standards must change. This includes radio-frequency (RF) power (where RF is defined to range from 100s of MHz to THz). In this work, a direct SI-traceable measurement of RF power is accomplished by use of the radiation pressure carried in an EM wave, providing direct traceability to the kilogram and to Planck's constant through the redefined SI.

There are several groups around the world investigating methods to perform more direct SI traceable measurement of RF power. Towards this goal, we demonstrate the ability to measure the radiation pressure/force carried in a field at various frequencies using three different force measurement devices (i.e., mass scales). Here, we will discuss three sets of experiments with three different devices used to perform RF radiation pressure measurements at 2.45 GHz, 15 GHz, 26.5 GHz, 28 GHz, 32.5 GHz, and 40 GHz. With these three devices, we demonstrate power measurements in the range of 2 W -to- 400 W. Fig. 1 shows RF power measurements obtained with the radiation pressure approach compared to those obtained with a conventional power meter. This new technique could potentially enable power measurements and calibrations from mW to MW (and higher) regardless of frequency (from UV to RF) with one traceability chain.



a) 26.5 GHz, 32.5 GHz, 40.0 GHz



b) 2.45 GHz

Fig 1: Measured RF power with comparison to measurements obtained with a conventional power meter.