OPEN ACCESS
IOP Publishing

Metrologia

Metrologia **56** (2019) 015016 (7pp)

https://doi.org/10.1088/1681-7575/aaf6c8

Feasibility study towards comparison of the $g^{(2)}(0)$ measurement in the visible range

E Moreva[1], P Traina[1], R A Kirkwood[2], M López[3], G Brida[1], M Gramegna[1], I Ruo-Berchera[1], J Forneris[4,5], S Ditalia Tchernij[6,4], P Olivero[6,4,1], C J Chunnilall[2], S Kück[3], M Genovese[1] and I P Degiovanni[1]

[1] Istituto Nazionale di Ricerca Metrologica (INRIM), Strada delle cacce 91, 10135 Torino, Italy
[2] National Physical Laboratory (NPL), Hampton road, Teddington, TW11 0LW, United Kingdom
[3] Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, Germany
[4] Istituto Nazionale di Fisica Nucleare (INFN) Sez. Torino, Via P.Giuria 1, 10125 Torino, Italy
[5] Ruđer Bošković Institute, Bijenicka 54, PO Box 180, 10002, Zagreb, Croatia
[6] Physics Department and NIS Inter-Departmental Centre, University of Torino, Via P.Giuria, 1, 10125 Torino, Italy

E-mail: p.traina@inrim.it

Received 30 July 2018, revised 12 November 2018
Accepted for publication 6 December 2018
Published 4 January 2019

Abstract

This work reports on the pilot study, performed by INRIM, NPL and PTB, on the measurement of the $g^{(2)}(0)$ parameter in the visible spectral range of a test single-photon source based on a colour centre in diamond. The development of single-photon sources is of high interest to the metrology community as well as the burgeoning quantum technologies industry. Measurement of the $g^{(2)}(0)$ parameter plays a vital role in characterising and understanding single-photon emission. This comparison has been conducted by each partner individually using their own equipment at INRIM laboratories, which were responsible for the operation of the source.

Keywords: colour centers, single-photon source, metrology for quantum technologies

(Some figures may appear in colour only in the online journal)

1. Introduction

Single-photon sources (SPSs) [1–3], i.e. sources that are able to produce single photons on demand, can prove to be key elements for the development of quantum optical technologies. They will also be essential for providing metrological support for the development and commercialisation of these technologies, as well as for radiometry and photometry at the single-photon level. SPSs based on different physical systems (parametric down-conversion [4–11], quantum dots [12, 13], trapped ions [14], molecules [15] and colour centres in diamond [16–25]) and single-photon sensitive detectors [26, 27] and cameras [28] are widely available today as well as more complex equipment such as quantum key distribution systems [29, 30]. Despite several recent dedicated studies [31, 32], a standardized methodology for the characterization of SPSs has not emerged.

The typical parameter employed to test the properties of a SPS is the second order correlation function (or Glauber function) defined as

$$g^{(2)}(\tau=0)=\left.\frac{\langle I(t)I(t+\tau)\rangle}{\langle I(t)\rangle\langle I(t+\tau)\rangle}\right|_{\tau=0}, \qquad (1)$$

where $I(t)$ is the intensity of the optical field. In the regime of low photon flux, this parameter has been shown to be substantially equivalent to the parameter α introduced by Grangier *et al* [33], which is experimentally measured as the ratio between the coincidence probability at the output of a Hanbury Brown and Twiss (HBT) interferometer [34], typically implemented by a 50:50 beam-splitter connected to two non photon-number-resolving detectors, and the product of the click probabilities at the two detectors, i.e.: