

# T<sub>C</sub>SUH Special Seminar

Texas Center for Superconductivity at the University of Houston



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### “Single-Photon Optical Detectors Based on Superconducting Nanostructures”

**April 7, 2006**

Room 102, Houston Science Center

12:00 noon – 1:00 p.m.

#### Abstract

We review the current state-of-the-art in the development of superconducting single-photon detectors and demonstrate their advantages over conventional semiconductor avalanche photodiodes in terms of very efficient and ultrafast counting capabilities of both visible-light and infrared photons. Superconducting single-photon detectors (SSPDs) are quantum photon counters and their detection mechanism is based on photon-induced hotspot formation and, subsequently, generation of a voltage transient across a nanostructured NbN meander (4-nm-thick and ~100-nm-wide stripe). They operate at 4.2-2 K temperature range. Our best,  $10 \times 10\text{-}\mu\text{m}^2$ -area devices exhibit quantum efficiency of up to ~30% in the visible to 1550 nm wavelength range, dark counts <0.01 per second, and the noise-equivalent power (NEP) of  $5 \times 10^{-21}$  W/Hz.<sup>1/2</sup> The  $4 \times 4\text{-}\mu\text{m}^2$ -area detectors are characterized by >2-GHz photon counting rate and timing jitter of <18 ps. The SSPD structures can be directly coupled to a single-mode optical fiber, packaged in a standard transport helium dewar, and regarded as a room-temperature-like apparatus. The SSPDs have already been successfully applied in commercial testers for debugging of VLSI CMOS circuits and are currently being implemented for free-space satellite optical communication links and in fiber-based quantum key distribution (quantum cryptography) systems.

#### Brief Bio

Roman Sobolewski received the Ph. D. and Sc. D. (Habilitation) degrees in Physics from the Polish Academy of Sciences, Warsaw, Poland, in 1983 and 1992, respectively. Currently, he is a Professor with the Department of Electrical and Computer Engineering and the Materials Science Program at the University of Rochester, Rochester, New York, with a secondary appointment as a Senior Scientist at the University of Rochester Laboratory for Laser Energetics, where he is the Head of the Ultrafast Quantum Phenomena Laboratory. His interests are concentrated on the ultrafast phenomena in condensed matter, novel electronic and optoelectronic materials and devices, and on quantum communications and computation. He is the author or co-author of over 300 publications in peer-reviewed journals and over 100 invited presentations, seminars, and colloquia worldwide. Dr. Sobolewski is a scientific reviewer for several U. S. government agencies and many professional journals, and is a Consultant-Lecturer for the United Nations Industrial Development Organization. In 2004, he was the organizer and Co-Director of the NATO Advanced Research Workshop on Advanced Materials.

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