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Full-Wave Modeling of Microwave Frequency Single Photon Sources

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Deterministic sources that can efficiently generate single photon states play an important role in many quantum information processing applications. Typically, for these systems to work, the photons emitted from different single photon sources need to be highly indistinguishable. This allows for the photons emitted from different sources to coherently interfere with each other at other components in a system, such as beam splitters. Current approaches to modeling single photon sources often focus on computing optimistic bounds on system performance by only considering a local system formed between a quantum emitter and a single mode of an electromagnetic resonator within a cavity quantum electrodynamics formalism. As a result, these models often cannot fully account for the geometric complexity of practical single photon sources, how a photon's propagation path can impact its indistinguishability, or how manufacturing variability of key system parameters can impact the performance of a source in practice. In this talk, we present preliminary results on how fully classical computational electromagnetics methods can be leveraged to more fully characterize the performance of single photon sources. To make the development more concrete, we specifically focus on modeling a microwave frequency single photon source that uses a transmon as a quantum emitter.

Thomas E. Roth is an Assistant Professor at Purdue University in the School of Electrical and Computer Engineering. Prior to joining Purdue in January 2021, he was a Senior Member of the Technical Staff at Sandia National Laboratories in the Electromagnetics & Sensor Technologies department within the Radar Intelligence, Surveillance, and Reconnaissance business area. He received the M.S. and Ph.D. degrees from the University of Illinois at Urbana-Champaign in electrical engineering and B.S. degrees in electrical and computer engineering from Missouri University of Science and Technology. His current research interests are in multiscale and multiphysics electromagnetic modeling, particularly for quantum electromagnetic devices.

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