Covert Target Ranging with Chernoff Information Bottleneck

G Ortolano[1], I Ruo Berchera[2], and L Banchi[1]

[1] *Physics, Università degli Studi di Firenze, Florence, Italy*
[2] *Istituto Nazionale di Ricerca Metrologica, Turin, Italy*
Contact Email: giuseppe.ortolano@unifi.it

Target ranging is a fundamental task with many practical applications. We present an analysis of Quantum Target Ranging in the context of multi-hypothesis testing and its applicability to real-world LiDAR systems. We analyze the theoretical bounds and advantages of quantum ranging in the context of phase-insensitive measurements, which is the operational mode of most LiDAR systems. We then find a regime of practical interest by investigating a covert scenario in which the sensing is performed while avoiding detection from an adversary. We do so by introducing a new formalism to quantitatively address sensing tradeoffs. This is based on extending the information bottleneck principle, originally developed for communication and machine learning applications, to decision problems via the Chernoff information. In this context, we show how quantum resources, namely entangled photonic probes paired with photon counting, greatly improve over classical coherent transmitters in target sensing by outperforming the classical performance while also maintaining a given level of covertness.