

Abstract Submitted  
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**All-optical atomic RF phase detection and measurement**<sup>1</sup> GEORG RAITHEL, RACHEL E. SAPIRO, LUIS F. GONCALVES, RYAN CARDMAN, DAVID A. ANDERSON, Rydberg Technologies, Inc. — Advances in Rydberg atom-based RF field sensing, receiving, measurement, and imaging has mostly been rooted in measuring the electric field amplitude,  $E$ , of the RF wave. With established phase-sensitive technologies, such as synthetic aperture radar (SAR) as well as emerging trends in phased-array antennas in 5G, a method is desired that allows robust, optical retrieval of the RF phase using a phase-enabled atom-based field sensor. We present the development of an RF detection and measurement method for the phase of the RF electromagnetic radiation field employing a phase reference. In contrast to other work, we implement the method in an all-optical atomic vapor-cell detector that does not require an antenna or external RF reference wave applied to the atoms [1]. We describe the phase-sensitive RF field detection concept and first demonstrations, including measurements of amplitude and phase of a 5 GHz RF test field. Applications of this sensor technology will be discussed, including phase-modulated signal communication systems, radar, and field amplitude and phase imaging for near-field/far-field antenna characterizations. [1] Anderson, D. A. et al., Atom-Based Electromagnetic Field Sensing Element and Measurement System, Patent WO 2019/126038 A1 (2019).

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