Room temperature Cs-based RF field camera: concept and design

Alexandra Artusio-Glimpse[1], Matthew T. Simons[1], Vladimir Aksyuk[2], Daniel Lopez[2], and Christopher L. Holloway[1]

[1]NIST, 325 Broadway, Boulder, CO 80305, US; [2]NIST, 100 Bureau Dr, Gaithersburg, MD 20899, US

Now that room-temperature Rydberg atom probes of radio frequency (RF) electric field magnitude and phase have been demonstrated with great success [1-4], we endeavor to develop an RF field camera using these same principles. Rydberg atom RF probes are unique for their lack of conductive components. Because these probes consist of only dielectric materials, scattering of RF fields by the probe is minimized, which can reduce uncertainties in channel sounding measurements and in RF field probe calibrations. With an array of probes, we can do away with probe scanning systems, further minimizing measurement uncertainties and ambiguities that arise from scattering off the scanning equipment. We present our concept for a 10×10 pixel camera for detecting 60 GHz RF fields. The camera consists of a single large vapor cell (Fig. 1a) and a photonic integrated circuit (PIC) used to direct the array of lasers (Fig. 1b). Collecting optics and a single photodetector are positioned in free-space, external to the camera in this first concept. Our design allows for multiple passes of the counter-propagating probe (852 nm) and coupling (511 nm) lasers within each 2×0.5 mm by 2 mm deep voxel to maximize the interaction length of the atoms and lasers while maintaining good spatial resolution. This presentation will outline our camera concept with important fabrication considerations and will report on fabrication tests of the vapor cell and PIC components completed to date.

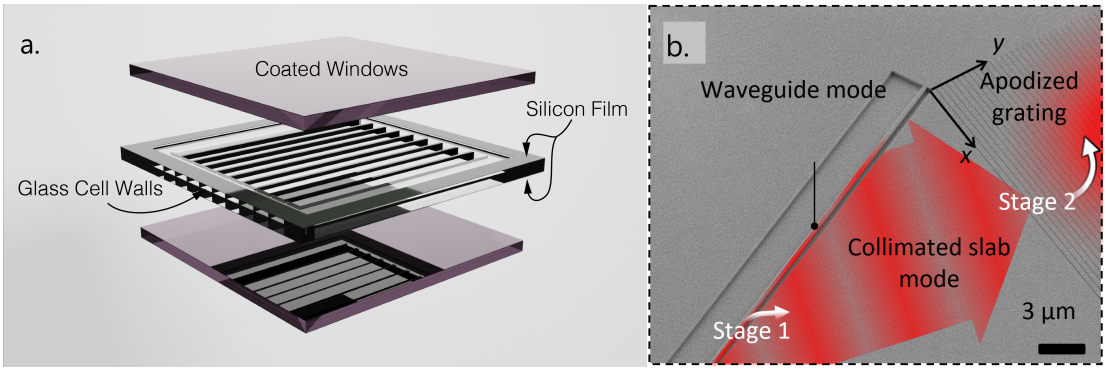

Figure 1. (a) Exploded view of anodically bonded, fused silica vapor cell including trenches defining camera rows (isolating atoms along each row) and coated widows. (b) Microscope image of fused silica PIC used to direct the probe laser up and into the vapor cell.

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[3] C. Holloway et al., "Atom-Based RF Electric Field Metrology: From Self-Calibrated Measurements to Sub-Wavelength and Near-Field Imaging," IEEE Trans. on EMC, 2016.
[4] M. Simons et al., "A Rydberg Atom-Based Mixer: Measuring the Phase of a Radio Frequency Wave," Applied Physics Letters, vol. 114, 114101, 2019.