Name of the Technology: Rydberg Systems Based broad band E-Field Sensing

Brief Summary: Rydberg atom-based SI- traceable and self-calibrating RF E-field sensor has been developed on optical table and experimental results are reported for Ku band, K band and X-Band bolstering the candidature of Rydberg atoms as broadband potential antenna for microwave E-field sensing. For our system, we have used probe laser beam of 780.24 nm from Toptica DL Pro which is used to excite the Rb atoms from 5S1/2 to 5P3/2 state and corresponding absorption spectra is observed on Photodetector. This probe laser is then locked at this transition by using Saturated Absorption Spectroscopy technique by using Toptica TOPAS software. When this coupling laser frequency matches the exact resonance frequency, a fraction of atoms which were earlier absorbing the probe beam, now excited to the Rydberg state, thereby creating a narrow transmission window inside the probe absorption spectrum. This transparency created by coupling beam is known as Electromagnetically Induced Transparency. The introduction of MW field radiated by horn antenna, further excites the Rb atoms between two neighbouring tunable Rydberg states. The EIT regime is the most sensitive regime for sensing of resonant or near resonant incoming RF/microwave radiations. Any change in the resonant or near resonant microwave field can be observed and measured through optical readout of probe beam using photodetector and recorded on the oscilloscope. The change or ATS splitting seen in EIT signal can be utilized to calculate the amplitude of incident microwave signal.

E-field is given as -

$$E = \frac{\hbar\Omega}{d}$$

where Ω - Rabi frequency of the RF-coupled atomic Rydberg transition

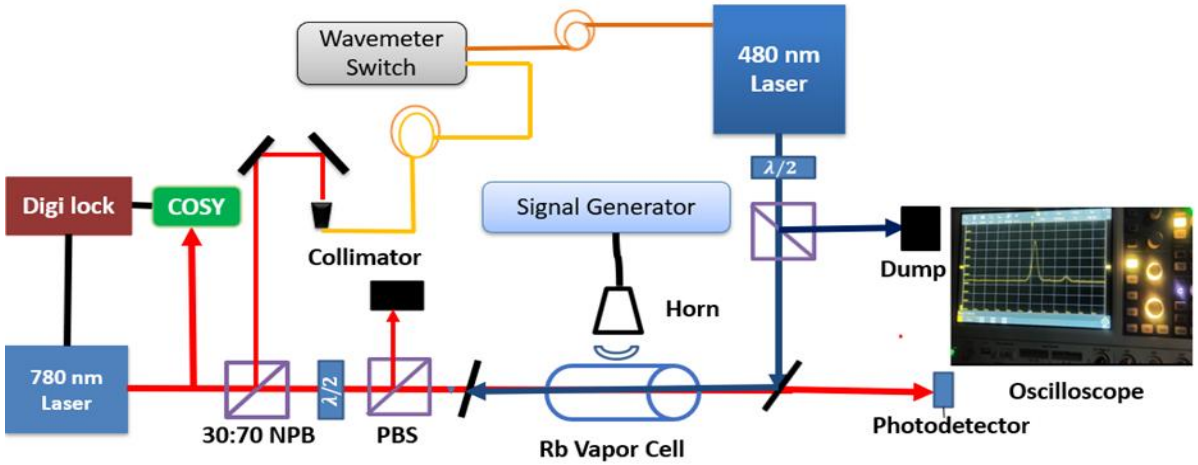

Fig.-1 Schematic diagram of set-up for RF E-Field Sensing

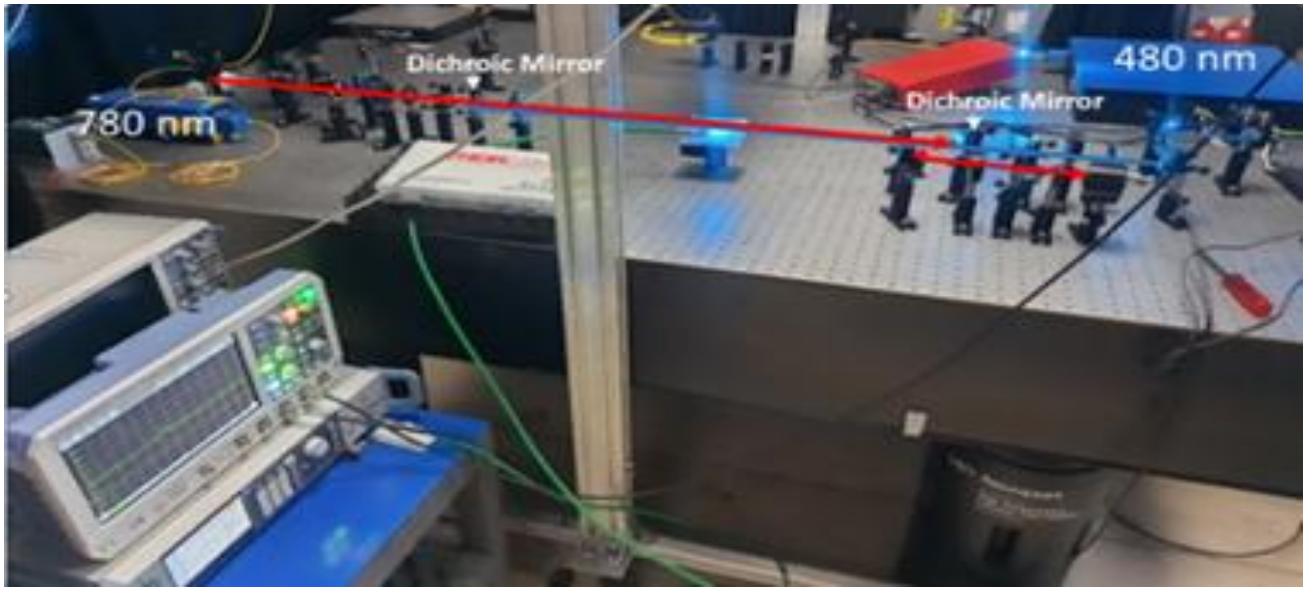

Fig. 2 Experimental set-up for RF E-Field Sensing

Applications:

- ✓ EIT Phenomena based E- Field Sensor for Broadband E-Field Sensing
- ✓ Antenna Performance Measurement
- ✓ Rydberg Atom Based receiver

Novelty Features:

- ✓ Ultra-broadband sensor (from 50 MHz to 40 GHz)
- ✓ EIT Phenomena based sensing (E & H)
- ✓ High sensitivity (can sense weak fields ~ 1 µV/cm/Hz) especially at X Band

Advantages:

- ✓ Absence of metallic dipole which does not perturb the field to be measured.
- ✓ Self-calibrating sensor
- ✓ Frequency Independent Sensor

Technology Readiness Level:

Idea	Concept Definition	Proof of Concept	Prototype	Lab Validation	Technology Development	Technology Demonstration	Technology Integrated	Market Launch

IPR Details: Nil

Broad Area / Category: Electronics & Instrumentation

User Industries: Quantum domain-based Industries