Characterization of rubidium vapour lamps for atomic clocks

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Since 1960s, alkali-based RF discharge lamps have been used as a frequency-stable light source while being extremely robust and reliable[1,2,3]. However, it is often reported that rubidium (Rb) lamp-based standards suffer from lamp related frequency ageing phenomena such as light-shift effects[4]. For understanding this behaviour, we are characterizing a commercial Rb based RF discharge lamp over extended periods and will present the data gathered up to now.

Electrical and optical measurements on a rubidium lamp is presented here after a week of monitoring. Output of the lamp was coupled to an optical fibre to observe its emitted light characteristics with an optical spectrum analyser. Subsequently, the lamp was monitored for output optical power, temperature, and electrical power dynamics in a benign environment.

Optical spectra results indicated that the lamp had a substantial buffer gas content (figure 1). The lamp exhibited various buffer gas excitation lines as well as strong Rb excitation lines of 780 nm (D2 line) and 794.8 nm (D1 line). During monitoring, optical intensity jumps were observed which appear to correlate with the lamp temperature and current draw fluctuations while the supplied lamp voltage was kept constant. Depending on the previous studies, temporal changes in the light intensity of the lamps may lead to observable frequency fluctuations in an atomic clock[5].

Further characterization measurements for longer periods are needed to check whether the intensity jumps are consistently correlate to the clock frequency fluctuations and/or temperature and power supply anomalies. Additionally, the relationship between the buffer gas contents and the intensity fluctuations of the lamps must be investigated via residual gas analysis.

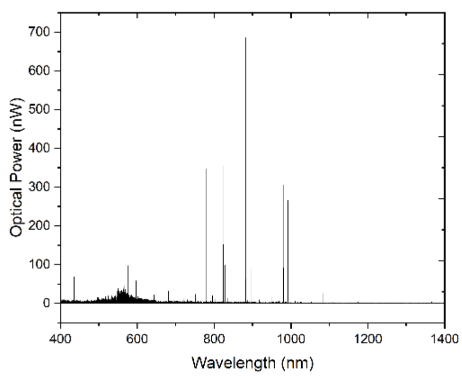

Fig. 1: Optical spectra result of the lamp.

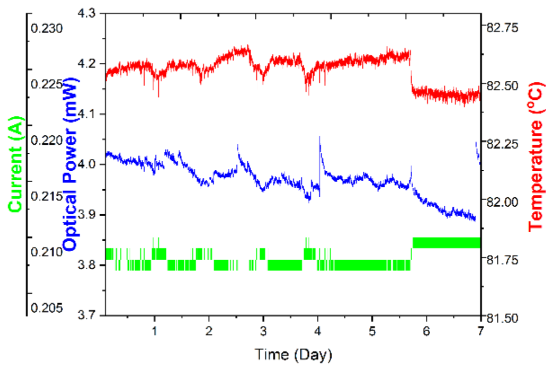

Fig. 2: Optical power, current and temperature measurement results of the lamp.

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