Timing system for the Lunar Laser Ranging station at HartRAO, South Africa: preliminary results

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Introduction & Instrumentation

HartRAO is currently developing a Lunar Laser Ranging station based on a 1 metre Cassegrain telescope donated by the Observatoire de la Côte d’Azur (OCA), France¹. We report on current developments on the LLR timing system, which is based on a Microsemi 4380A rubidium clock.

Environmental conditions of the LLR timing system such as variation in temperature can affect clock frequency stability. The 4380A LLR timing system (Fig. 1) requires a thermally stable environment to minimize thermally induced errors.

Methods and Results

The short term frequency stability of the 4380A rubidium clock was measured by comparison – we used a frequency comparator (VCH-314) at 5 MHz, comparing our system’s output with the EFO528 maser output as a reference². Our timing system’s stability has been measured against the maser and maintains less than a picosecond Allan deviation over a period of 10³ s (Fig. 3).

The LLR control room temperature is maintained by three air conditioning systems. The measured temperature variations are in the range of ~3°C per day (Fig. 4). Since our timing system has a thermally-dependent frequency error of 3×10⁻¹⁰ between 0°C and 50°C, the control room temperature is maintained at a sufficient level to ensure optimal operation of our timing system.

Sub-centimetre ranging accuracy requires a timing system with picosecond accuracy. Table 1 provides specifications for our timing system, the 4380A timing system seems to meet our requirement of sub-centimetre ranging accuracy. This requirement only takes into account the capabilities of the timing system without other external factors, which include error contributions by the atmosphere, system calibration errors, etc., some of these are discussed in Munghemezulu et al.²

Conclusion

Initial results indicate that the 4380A timing system can achieve sub-picosecond Allan deviation in a 10³ s period, and that the LLR control room exhibit temperature variations of ~3°C per day. Since the frequency stability of the 4380A is 3×10⁻¹⁰ between 0°C and 50°C, the current LLR thermal control system seems to be adequate to minimize thermally induced frequency errors during ranging. Our LLR normal data point accuracy, due to the timing reference system, is therefore anticipated to be a centimetre or less.

References


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