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## An Integrated Software Based Analytical Model for the Signal Path Efficiency of the HartRAO Lunar Laser Ranger Optical System

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**Abstract content**   
 (Max 300 words)

The Lunar Laser Ranger (LLR) system under development at HartRAO will accurately measure the Earth-Moon distance by the use of laser pulses. We would like to ensure that the transmitted pulses reaches the retro-reflectors located on the Moon and a signal is returned to the Earth-fixed receiving telescope. We start by discussing the hardware components and software used in HartRAO's LLR system to achieve optimal signal path efficiency. This includes thorough descriptions of the laser source, optical components used throughout the coudé path, atmospheric transmission efficiency and retro-reflector's optimal reflectance value. The use of the link budget equation in this work estimates the number of photons that are expected to be received; this result has a direct relationship with total system efficiency. An integrated model for HartRAO's LLR is an essential tool to enable optimal signal path (optical and electrical) efficiency and is useful in estimating the expected number of photon returns for given observational parameters. An improved system will reduce adverse effects (beam divergence) on the transmitted laser beam that result from atmospheric thermal and density fluctuations. Adverse effects cannot be easily minimised, therefore the software based analytical model for HartRAO's LLR will enable evaluation of specific portions of the receive and transmit path, as well as certain atmospheric parameters. This will lead to an understanding of the effects of the numerous variables on the total system efficiency.

**Apply to be considered for a student award (Yes / No)?**

Yes

**Level for award (Hons, MSc, PhD, N/A)?**

PhD

**Main supervisor (name and email) and his / her institution**

Prof Ludwig Combrinck

**Would you like to submit a short paper for the Conference Proceedings (Yes / No)?**

Yes

**Please indicate whether<br>this abstract may be<br>published online<br>(Yes / No)**

No

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