

An experimental common detector, coaxial Cassegrain laser telescope and its calibration

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Abstract

The Metsahovi SLR (7806) has used a common detector, a Hamamatsu R 4998 photomultiplier, for the start and stop laser pulses, and an axially shifted laser beam in a 1-m Cassegrain-Mangin laser telescope since 1998. The transmitted and received beams share statically the main optics, thus some loss of receiving efficiency is met. Also the alignment of the optical axes has not been optimal. Because the secondary mirror has polished optical surfaces on the both sides, it was possible to place the transmitted laser beam at the obscured center area. Thus the laser beam is coaxial and it can be collimated by a 62-mm diameter plano-convex lens matched to the equiconcave diverging lens formed by the secondary mirror.

The return signal from the calibration target, a prism at a distance of 320.690 m, goes through the lens system and the laser pickup mirror to the receiving channel. In satellite ranging the return signal passes around the pickup mirror. The start pulse is sampled from the laser oscillator. The calibration constant derived from prism measurements needs a correction due to the different return path in satellite ranging, but it can be calculated precisely from the telescope geometry. The calibration measurements have shown rms precisions of 50-75 ps, and the comparison with calibrations from the off-axis configuration agreed within 50 ps. Short-range calibrations are generally preferred. Measurements to a close target prism at a distance of 11.219 m were done, although the measured time interval, 112.2 ns, is near the minimum time interval specified for the MOTIC A012.2 counter (100 ns). The jitter was increased, but the calibration constant matched well the value from the long distance target.

The new concept is not yet ready for use, because some satellite ranging trials have proved inadequacies in the available boresight methods and in the confinement of the laser beam only to the exit lens area. Even a minor leak to the main 1-m mirror forms a competing beam, which can confuse the identification of the calibrated beam. However, these problems should not be insurmountable.