

# USING MIRRORS FOR DOUBLING AND TRIPLING LABORATORY SPACE

## Compact Testing of EDM Instruments

A new laboratory method for verifying the accuracy of distance measuring solves the problem of having to mount reflectors outside the laboratory. The limited space of the laboratory is duplicated and tripled by using mirrors. The method gives the same results as the standard method.

Verification of EDM equipment involves the determination of instrument errors, then used to monitor instrument performance. Periodic calibration aims to minimise systematic error and determine the highest achievable precision. EDM instruments should be calibrated annually; frequency checks should be made semi-annually. There are two methods for calibrating EDM: the field method and the laboratory method. In 2002 Dzierzega and Scherrer in this journal summarised the problems of field calibration and suggested a compact method for testing total stations based on measuring a series of distances ranging from 5 to 100 metres. They commented that it would be necessary to mount some of the reflectors outside the laboratory, resulting in drawbacks including indivisibility obstructions and atmospheric change along the measured distance.

### Mirror, Mirror

Since EDM measures the travelling distance of a modulated wave between EDM and reflector, it is not necessary that the baseline be straight. Using a mirror, a zigzag path can be created which doubles the distance available in the laboratory. By using two mirrors the distance can even be tripled. This method thus avoids the necessity of mounting the reflector outside the laboratory. We designed two mirror frames to fit over Sokkia digital theodolites, offering optical plummet, levelling and horizontal movement of the mirror surface. The frame secures coincidence of the reflective surface of the attached mirror with the vertical axis of the theodolite.

### Baseline Test

To test the efficiency of the mirror method a baseline was designed so that the intermediate points were placed at even multiples of the unit length of the EDM instrument to avoid the effects of cyclic error in the calibration process. The unit length of Sokkia [total station](#) SET 600 is 5.0 metres. The baseline consists of three parts: the first (point 1 to 4) was used for standard calibration without mirrors; the first and the second parts (point 1 to 6) were used to calibrate the EDM using one mirror over a distance of 70m. The three parts (from point 1 to 7) were used for calibration over a distance of 105m using two mirrors.

### Measuring Procedure

Before starting the actual measurements, reflector constant, temperature and air pressure were keyed into the instrument. The total station and the weather station were kept on for the entire duration of measurements and any changes in temperature or air pressure were also keyed in. The reflector and the mirrors are positioned at the same height as the total station. For standard calibration the distances 1-2, 1-3, 1-4, 2-3, 2-4 and 3-4 were measured. For calibration using one mirror, the mirror was put on point 4, the reflector on point 6 and the distances 1-6, 2-6, 3-6 and 5-6 were measured. Next the distances 5-1, 3-1 and 2-1 were measured. For calibration using two mirrors the first mirror was put on point 4, the second on point 6, the reflector was put on point 7 and the distances 1-7, 2-7, 3-7 and 5-7 measured. Next, the distances 5-1, 3-1 and 2-1 were measured. Each distance was measured ten times and the average was computed.

### Results

Using least squares, the most probable value of the zero constant for each group of measurements was obtained. The figures in Table 1 demonstrate the efficiency of the method. The accuracy and precision of our method can be improved by first using surface mirrors to avoid possible refraction when using back surface mirrors, as we did in our experiments.

### Acknowledgement

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### Further Reading

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