NATIONAL RADIO ASTRONOMY OBSERVATORY

25-METER MM WAVE TELESCOPE MEMO #70

First Tests of the Stepping Method for Surface Measuring

1. Introduction

The principle of the method was outlined in Memo #68 -- it is the measurement of the inclination of a series of steps of a straight line over the surface.

Since we have at Green Bank a 12.5 meter long test track for the cart tests, it has been possible to make a first trial on this track of the stepping method. This memo describes the results of the trial.

2. The Test Track

The track will be described in more detail in the report of the cart tests. It is made of 1.9 cm thick aluminum plate, the top surface of which is machined. The plate is 25 cm wide and is supported along its length about 90 cm above a strong concrete floor. The track begins and ends on 90 cm long granite surface plates. The whole track is in a basement where the temperature is quite stable. The elevation of the track varies about 3 mms over its length and measures of its elevation can thus be used to test a measurement system.

3. Elevation Measurements

(a) By optical levelling

The elevation profile along the track has been measured in two different ways. An optical level of high quality (a Wild N III Precision

Level) was mounted on a very solid stand at a point near the mid-point of the track and was used in the first (called the optical) method. The level was sighted on the same mark on a small vertical scale which was moved in 20 cm steps along the track.

At the ends of the track the optical path was about 7 meters. Tests suggest that, with care, the error of a level reading at this range was about 25 microns. Near the track mid-point the path was only about 2 meters and here the level accuracy in microns is considerably better.

(b) The stepping method

An electronic level was used in this method. The type immediately available at NRAO was the TALYVEL, whose main characteristics are listed below.

Made by:	Rank Taylor-Hobson, England
Ranges of tilt:	$\pm$ 8 mins, $\pm$ 100 secs, $\pm$ 25 secs.
Angular accuracy:	$\pm$ 2% of reading change; $\pm$ 1% of full-scale
Response time:	About 1 second
Indicator:	Inclination read on a center-zero galvanometer

In using this instrument, the $\pm$ 8 minute and the $\pm$ 100 second ranges were used. The instrument was adjusted so that both read reasonably correctly. The ranges of angle to be measured were from -6 to +3 arc minutes, so that the accuracy of level reading would be about 5 or 10 arc seconds.

A simple stand with its lines of transverse contact with the track about 20 cms apart was used to step the level along 12.3 meters of track. 64 steps were made in about 90 minutes. The stability of the level was good -- the first few readings were repeated at the end of the run and agreement

within $\pm$ 5 arc seconds resulted. The zero of the level was not carefully found, and a value of +4 arc seconds was chosen as giving the best fit for the results.

(4) The Results

The figure shows the results. The lower two curves show the track elevation derived from the optical level and from the stepping run. The agreement is clearly good.

The upper plot shows the point-by-point difference between the two measurements. The maximum divergence is $\pm$ 0.08 mms, the mean difference is +0.016 mms and the RMS of the difference is 0.043 mms.

If we assume that the optical level measures have an RMS of 25 microns, then the stepping method has an RMS of 35 microns ($43^2 = 25^2 + 35^2$). If our error in measuring tilt was $\pm$ 5 arc seconds, then the end-point error in elevation would be

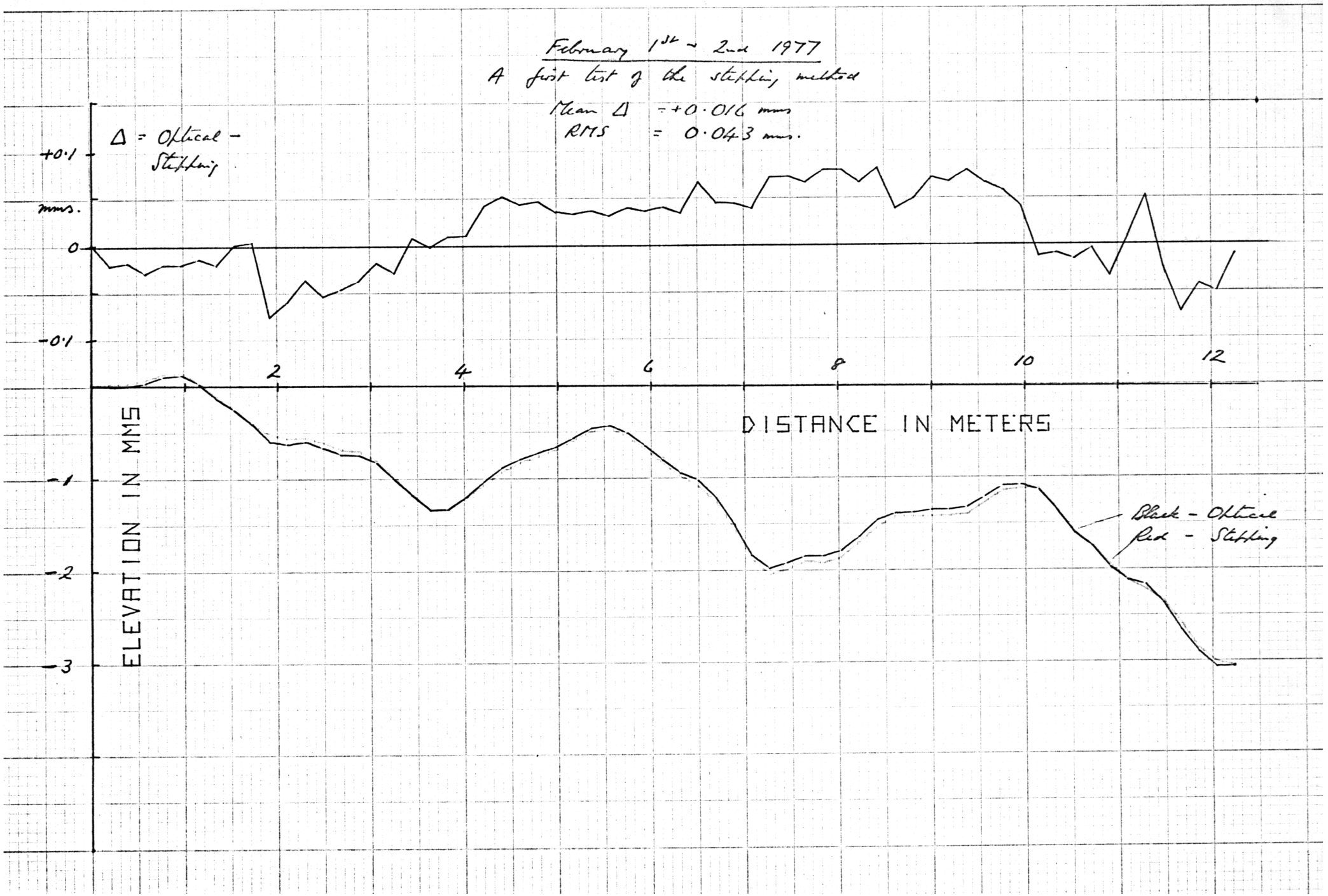
$$\text{End Error} = \pm 5 \times 4.85 \times 10^{-6} \times 191.5 \times \sqrt{64} \text{ mms}$$

$$= \pm 37 \text{ microns}.$$

5. The Next Steps

We propose to buy a Schaevitz inclinometer and test the method on the 140-foot test panels and also measure the telescope.

J. W. Findlay
Feb. 3, 1977


February 1st - 2nd 1977
A first test of the stitching method
Mean Δ = +0·016 mms
RMS = 0·043 mms.
Δ = Optical - Stitching
+0·1
mms.
0
-0·1
2
4
6
8
10
12
DISTANCE IN METERS
ELEVATION IN MMS
-1
-2
-3
Black - Optical
Red - Stitching