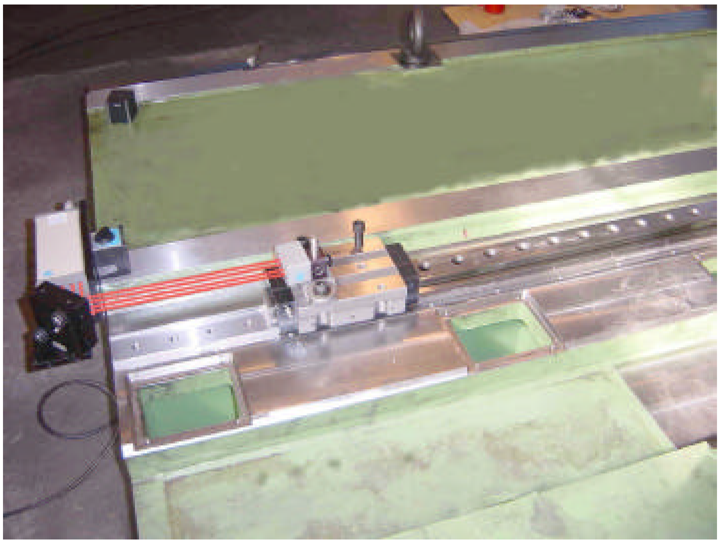
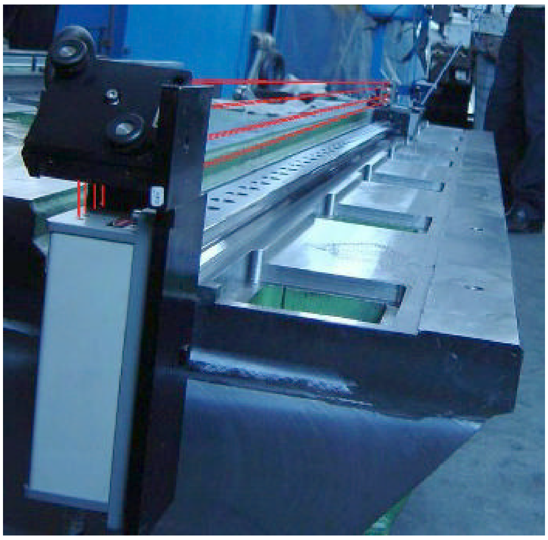
Application Notes AP 1102

Alignment of a Long Guide Way

I. What is the problem

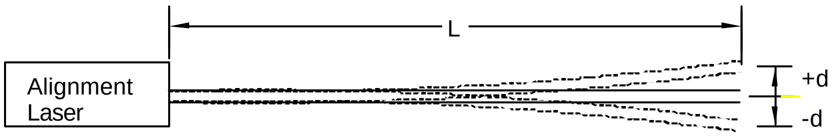
For large machines with long guide ways, it is important to align the guide ways both in the vertical direction and horizontal direction. For vertical direction, electronic levels can be used. For the horizontal direction, alignment lasers with electronic detectors can be used. However, for long guide ways, because of the air circulation (air turbulence) and thermal gradients, the laser beam is not a straight line at long distances.

Horizontal straightness measurement (left) and Vertical straightness measurement (right) on a roller guide mounted on a machine tool basement. Measures performed with Optodyne Dual Beam laser Doppler Displacement Meter.

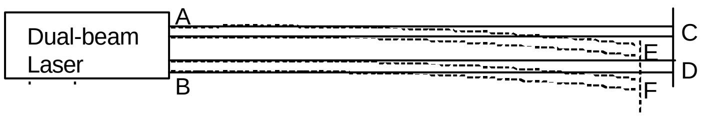
The laser beam wandering and the thermal gradients will cause large errors at a long distance. As shown in Fig.1, this lateral displacement "d" is proportional to the distance "L" and the strength of the air turbulence. For example, at a distance of 30 ft the laser beam may move more than 0.02".

II. How LDDM solves the problem



Laser beam wandering due to air turbulence, d Is proportional to L.

Laser beam is not straight, due to thermal gradient.



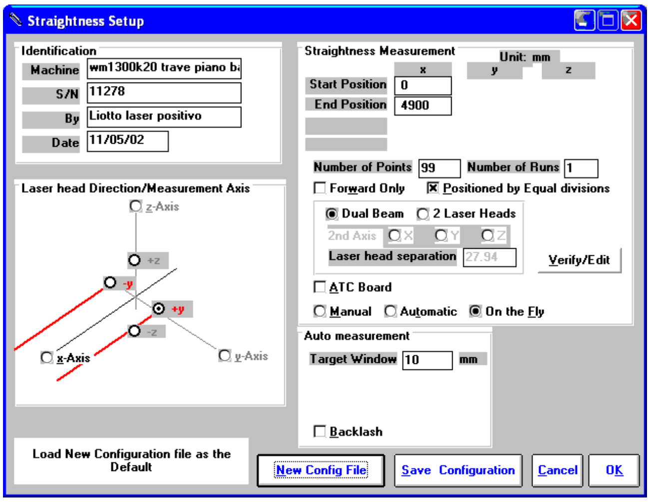
Distances $\overline{AC}$ -$\overline{BD}$ is the same as $\overline{AE}$ -$\overline{BF}$. It is not effected by beam wandering or thermal gradient.

Fig. 1 - A comparison of alignment laser and dual-beam laser for straightness measurement at long range

The straightness measurement using the dual-beam LDDM is based on a different principal and the air circulation does not effect it. The straightness is determined by integrating the angular changes along the travel. The angular change of the dual-retroreflector is equal to the difference of the two linear displacement changes divided by the separation of the retroreflectors. As shown in Fig.1, the displacement "AC" minus the displacement "BD" divided by the separation of the two retroreflectors is the angular change. It is noted that due to the beam wandering, there are also large lateral displacements. However, as shown in Fig.1, the displacement "AE" minus the displacement "BF" is still the same. Hence the air circulation or the beam wandering does not effect the measured angle and the calculated straightness.

III. How it works

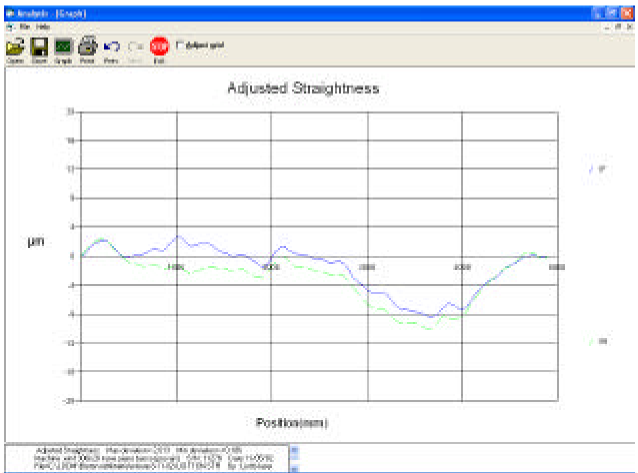
First mount the LDDM dual-beam laser head at one end of the long guide way and mount the dual-retroreflector on a slide. Align the laser beam to be parallel to the guide way and position the dual-retroreflector such that the return laser beams enter the receiving apertures.



MeasurementSet up screen of LDDM software

Start the Windows™ software in the notebook computer and click on the Optodyne icon. A main menu will show on the screen. Click on the "Straightness Display" button, the screen will show the position and the straightness readings. On the lower right-hand side the measured straightness will be plotted.

First enter the increment, offset, target position, and the total travel values. Then move the dual-retroreflector to the starting position and click the "start". More the dual-retroreflector along the guide way, the position will be displayed on the first line and the straightness on the second line. You may more the dual-retroreflector back and forth, and adjust the guide way to reduce the non-straightness. After the guide way is aligned, you may use the straightness software by clicking on the "straightness" button to collect the straightness data for your record.



Accuracy plot of a typical straightness measurement on a 15 ft. (5m) linear guide

IV. Need more information

Call Optodyne at 310-635-7481 or Local representative.