

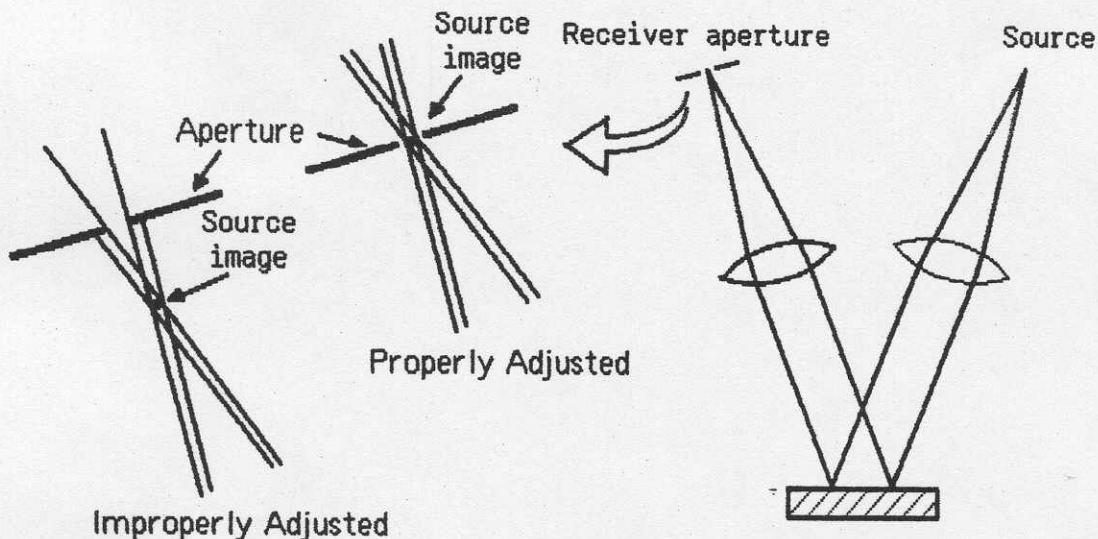
# Devices & Services Co.

D&S TECHNICAL NOTE 88-1

## 7 MRAD APERTURE FOR THE PORTABLE SPECULAR REFLECTOMETER MODEL 15R

The 7 milliradian aperture option, normally installed in place of the 46 mrad. aperture, requires special factory adjustment of the source and receiver lenses so that all of the reflected beam is passed thru the aperture. Since there is no way to locate the lenses with absolute precision, it might be helpful to explain the procedure that is used to adjust the lenses and some of the limitations.

To test for proper positioning of the lenses, we measure a highly specular mirror with all three apertures. The reflectance reading should be the same for all three apertures, assuming that the mirror is perfectly specular and that the optics are clean and free from defects. This is never quite the case, but we can normally get the difference in the readings between the 25 mrad and the 15 mrad aperture to be 0.003 - 0.004 by adjusting the position of the lenses.



Of the remaining difference, we do not know what part is due to the mirror or losses in the reflectometer. We believe that for the standard apertures, most of the difference is due to scattering within the reflectometer. There are two sources of scattering error within the instrument. Scattering of the source in the interior of the instrument results in a small amount of stray light reaching the detector thru the aperture. The larger the aperture, the more stray light is collected. Secondly, dirt or imperfections on the lenses can cause light that would have normally passed thru the aperture to be deflected. The smaller the aperture, the more scattered light will be deflected. Even though the difference is small with the standard aperture sizes of 46, 25 and 15 mrad., the

recommended procedure for making measurements is to calibrate the reflectometer each time the aperture is switched. If the lenses get dirty, the amount of loss in the reflectometer will increase. Recalibration will correct for the loss of reflected light.

For the smaller 7 mrad aperture, the difference in the reflectance reading compared to the larger apertures is greater. It is less certain that the difference is due to losses in the reflectometer rather than the degree of specularity of the mirror used for testing. We assume that most of the difference is still due to scattering within the reflectometer. For all of the model 15R reflectometers that have been modified, the difference in reflectance readings for a highly specular reflector with the 25 mrad and the 7 mrad apertures has been 0.008 or less. In addition to minimizing this difference, we also make sure that with the 7 mrad aperture in place there is a small range of adjustment in both alignment axes, over which the reading does not change. This ensures that the entire image passes cleanly thru the aperture. For the standard mirrors that we supply with the instrument, the difference is much larger than this and a maximum reading is difficult to obtain. These mirrors are obviously not specular enough to be used as standards with the 7 mrad aperture. Also because the positioning of the image within the receiving aperture is so exacting, the standard will not remain in good alignment under repeated use.

For these reasons, we suggest two possible ways of using the instrument with the 7 mrad aperture. One is to calibrate with the larger aperture and then measure the sample with the smaller aperture. This assumes that the reflectometer remains clean and that losses in the reflectometer are negligible. The other method is to use another mirror known to be highly specular, as a standard. This mirror can be calibrated against the standard supplied with the 15R, using the 25 or 15 mrad aperture and is assumed to have the same reflectance at 7 mrad. Using this mirror as a working standard will compensate for any contaminate build-up in the reflectometer. This second method is preferred for that reason.

Obtaining a peak reflectance value with the 7 mrad aperture is more difficult than with either of the larger apertures. It will usually be necessary to locate the image of the source in the 25 mrad aperture and then switch to the 7 mrad aperture for final adjustment of the instrument with the two adjustable supports. With the working standard that you select to use with the instrument, it should be possible to adjust the instrument to produce a peak reading that remains about the same over a small range of adjustment for both axes. This indicates that all of the reflected image passes cleanly through the aperture with a small amount of clearance on all sides. For many mirrors, this will not be the case and the reading will vary with very small adjustments. This is an indication of the specularity of surface. The correct reflectance reading is the peak value that can be obtained by varying the position of the image in the aperture.