ModeScan 1780 Calculator

In order to get proper results from the ModeScan 1780, it is necessary to understand which lens to use and where to locate it for particular parameters of the laser under test. The ModeScan 1780 calculator is an Excel spreadsheet to help in configuring the ModeScan 1780 for M^2 measurements. The calculator includes a worksheet that computes laser propagation parameters in the laser space and the test space based on the nominal laser beam specifications, including wavelength, beam exit diameter, and beam divergence, and the test lens focal length and position. The calculator optimizes the configuration to achieve the appropriate beam waist diameter and Rayleigh Range in the test space; the target values for these being >65um <~200um for the waist and 12.7mm for the Rayleigh Range[1]. In order to get accurate measurements of parameters laser waist location and laser Rayleigh, it is important to correct the lens focal length for the wavelength of the laser. The calculator also includes a focal length conversion worksheet based on the Sellmeier equations and coefficients for BK-7(visible and IR) and Fused Silica (UV) lens material. There are also system diagrams to show the various reference positions and distances referred to in the calculator worksheet.

The Calculator has worksheets named “Lens Placement”, “System Diagrams”, “Lens Conversion”, “Equations-Calculations”, and “Lens Selection.” The Lens Placement and Lens Conversion sheets are the ones that you enter values into; the other three are for reference or are used in the internal calculations of the other sheets.

The lens position for the measurement can be either in the cassette inside the ModeScan 1780 box or mounted externally in the beam path. This will depend on the laser parameters, and the purpose of the calculator is to help you determine this. In order to start you should have an approximate idea of the important laser parameters: wavelength, exit diameter, divergence and rough M^2 value. If you do not know these, you should use your best guess.

1. Start by filling in the wavelength, exit diameter, divergence and M^2 in the blue boxes in column E. If you know the waist diameter, rather than the exit diameter, select a value larger than this waist diameter and adjust the exit diameter and/or divergence until the waist diameter is approximately correct. Remember at this point you only need to be close.
2. Select a lens focal length. Start with 200mm. At this point the calculator will provide a “laser-lens distance” in the blue box at the bottom of column E. If this distance is a negative number, it will also suggest increasing the focal length of the lens. Continue to select the next longer lens available until a reasonable number for laser-lens distance is displayed.
3. Enter the laser-lens distance into E18. Check the “Test Space Beam Waist” and” Test Space Rayleigh Range” values. They should be within the limits above. If they are you should see messages displayed in blue that say “Lens Focal Length OK for D_{min}” and “Laser-Lens Distance OK”

[1] This optimal Rayleigh range in the test space yields beam diameters at the endpoints that are approximately 3X the diameter at the waist. Under this condition and when the caustic is centered approximately about the beam waist, 4 of the outer spots are beyond 2 Rayleigh lengths in the “far” field. This measurement configuration gives good results for the hyperbolic fit that is made to the measured beam spots.

4. At this point you are ready to go. You should enter the values in the green boxes into the ModeScan 1780 software. If you have not yet used the corrected lens focal length, go to the Lens Conversion worksheet and enter the nominal focal length and the wavelength into the appropriate boxes and read the corrected wavelength for the lens material being used (BK-7 or fused silica). Enter this corrected value into the MS1780 software.
5. Physically mount the laser and MS1780 so that the beam travels the "ModeScan-Laser Distance" Z_{LM}. Place the proper lens at the "ModeScan-Lens position." It is usually best to have the beam path include some steering mirrors to facilitate the alignment of the beam to the ModeScan.

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