

## Large Beam Profiling System - Transmissive Screen



Figure 1: WinCamD-LCM with lens reimaging a transmissive diffusing screen.

### Introduction

This application note describes the use of a static transmissive diffusing screen to image structured illumination. A camera with an imaging lens is placed on one side of a transmissive screen, while a source illuminates the other side of the screen. This system is ideal for incoherent illumination. With coherent illumination significant speckle (amplitude modulation) may be observed, especially if the adjustable aperture is set to be smallest as shown in Appendix B. If speckle is an issue, you may contact DataRay about systems with rotating screens that average out the speckle.

### Pixel Multiplication Factor (PMF)

The camera uses a lens to reimage the intensity pattern of the laser that is transmitted through the diffuser. An accurate pixel multiplication factor is required to define the size of the area on the surface that corresponds to the area of a single pixel on the camera sensor. This pixel multiplication factor is calculated by imaging an object of known dimension, and looking at how many sensor pixels are equivalent to the known dimension. A detailed method to measure and calculate the pixel multiplication factor is provided in Appendix A. As delivered, the camera has already been calibrated with the correct PMF value for the setup specified in this application note and the assembly guide.

### Setup and Use

An initial calibration has already been performed and the PMF values have been saved to the camera. As long as the laser source is incident normal to the back of the diffuser plate and the distance from the front of the plate to the front of the

lens is in accordance with the assembly instructions, calibration will not have to be repeated unless this object distance is changed.

### Assembly

1. Attach the left and right slotted brackets to the included optical breadboard 9 inches apart such that the glass diffusing plate can be mounted in the slots between the brackets. The glass plate should sit on the rubber feet attached to the breadboard.
2. Carefully screw the included C-mount lens to the WinCamD-LCM camera. Be sure to not remove the included spacer(s) which are already attached to the back of the lens.
3. Position the camera system in accordance with Figure 2 and the included assembly instructions. The camera system should be pointing toward the center of the diffusing plate, normal to the surface.

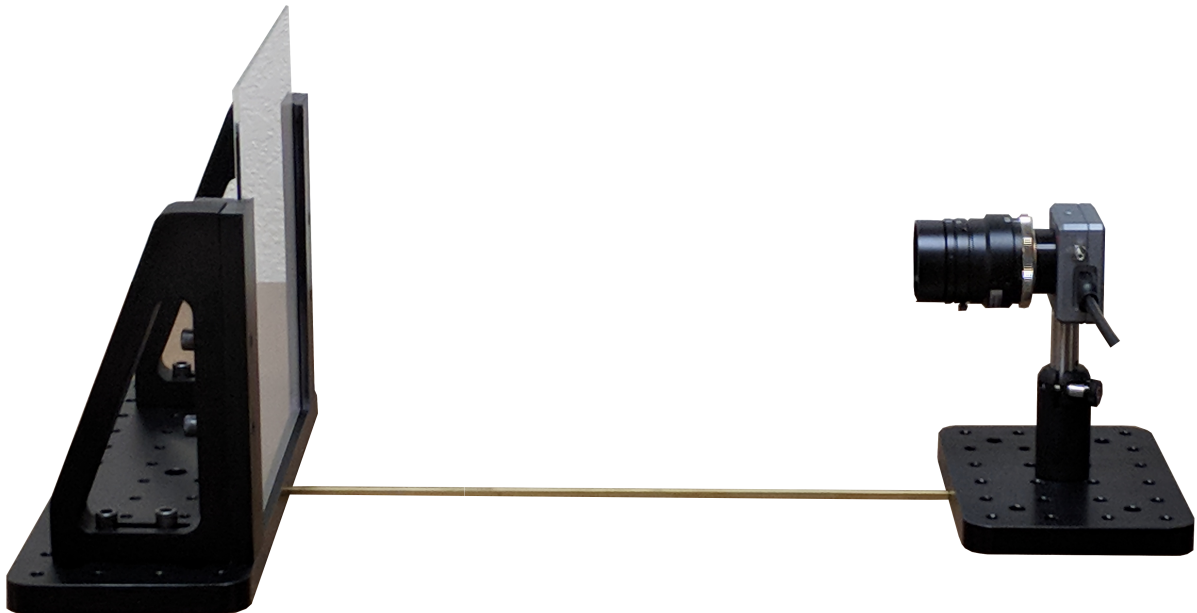


Figure 2: The camera is pre-calibrated for the setup shown above. If a different object distance is used, the PMF must be recalibrated (See Appendix A)

### Software

1. Install the current version of the DataRay software found on the [Downloads](#) page of the DataRay website. The product name is WinCamD-LCM.
2. Connect the camera to the computer using the USB cable.
3. Start the DataRay software and open the **Capture Setup** dialog. The PMF values will be automatically input based on the calibration saved to the camera, check to make sure they are not at a value of 1. Select **Flip vertical, Full resolution**, and start with a **Capture Block** of 2048x2048. Close the dialog and in the **Setup** pull-down menu, in **Numeric Display Modes** select **XXX.YY mm** and click OK.

- The full WinCamD Manual is accessed from the Support pull-down menu.
4. If necessary or desired, perform the PMF calibration described in Appendix A.

### Measurements

1. Use the focus ring on the lens to adjust its focus and make sure the surface is in focus. A sheet of paper with some text or patterns, such as the included 1 cm pitch grid, will help you find the best focus. Use the mouse wheel can zoom in on the 2D image to assist with focusing. You can then lock the focus ring in place. There is also a ring on the lens to adjust the aperture size if desired. The largest aperture provides the shallowest depth of field which is preferred when finding the best focus.
2. Now that the system is set up, measurements can be taken using the same methods as with direct illumination of the sensor. The magnification will be corrected for in the measurements according to the X and Y pixel multiplication factors (X and Y PMF should be equal unless the beam is incident from an angle).

**Important:** Measurements must be taken in a room where the amount of ambient light is insignificant compared to the intensity of the laser beam. It is important that the corners of the capture block are dark, otherwise the baseline calculation will be inaccurate. The capture block size can be set in the **Capture Setup** dialog box and positioned over the 200 x 200 mm viewing screen.

- The auto-exposure range of the camera will handle a range of illumination levels on the screen. As necessary also adjust the imaging lens iris to widen the range of illuminations accommodated.
- Always save \*.wcf files per the instructions in the User Manual.
- Questions? Contact support@dataray.com +1-530-395-2500

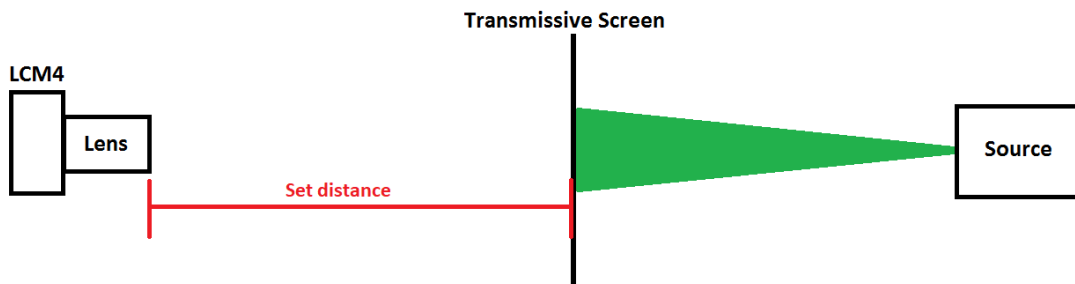


Figure 3: System Schematic

### Appendix A: Calibration

The system has been calibrated for the supplied 200 x 200 mm screen at the object distance specified in the included assembly instructions. If the object distance is changed, the lens focus must be reset and the PMF must be recalculated in accordance with the procedure described below.

1. After connecting the camera to the computer using the USB cable, start the DataRay software and open the **Capture Setup** dialog. Select **Flip vertical** and **Full resolution**. Set the PMF to 1 to prepare for a new calibration. Press OK.
2. In the **Setup** pull-down menu, in **Numeric Display Modes** select **XXX.YY mm** and click OK.

- Slide the included 1 cm grid target in front of the diffusing plate (object plane), or place your own target of known dimensions at the object plane. Adjust the lens focus so that the markings on the paper are in focus, you may Right-click on the 2D image and choose a Zoom factor to help achieve an optimal focus on the object plane (rotating the mouse wheel also zooms). You may choose to set a capture block (in the capture setup dialog) to include only the target.
- Press **Xu** in the toolbar and move the crosshairs to an appropriate position so that the grid markings can be viewed in the horizontal or vertical profile as shown in Figure 4. Center and expand the ripples and measure the pitch P in microns across 10 of the peaks or valleys (100000 microns). Your measurement will be some fraction of 100000 depending on the lens magnification at your object distance. If you did not set the PMF to 1 for calibration and the PMF is already calibrated, this measurement should be close to 100000 microns.
  - Left-click, hold and drag the mouse in the X or Y profile to measure distance
  - New versions of software (8.0C21 or later) also support measuring distance directly on the 2D profile by holding Ctrl and Left-clicking on the 2D profile image.
- Calculate the PMF as  $100000/P$  and enter this in the **Capture Setup** dialog. The Y=X box should be checked unless the incident beam will not be normal to the diffusing plate surface.

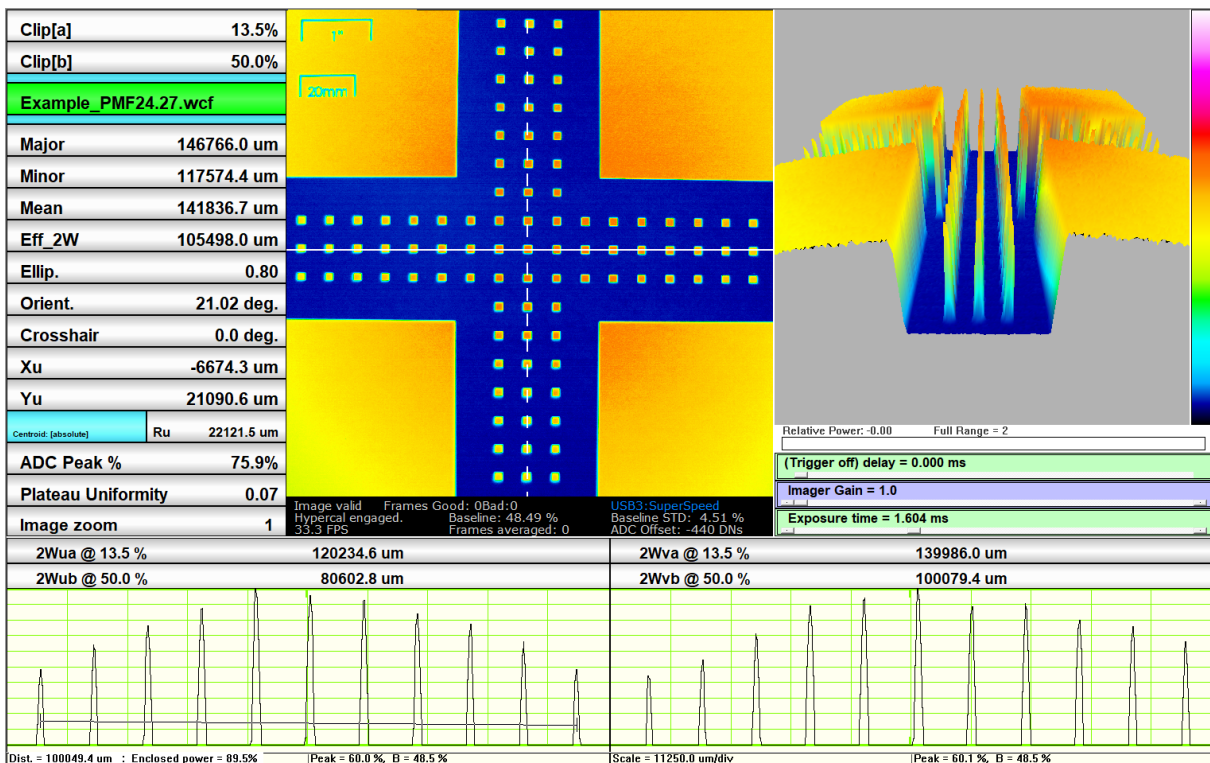
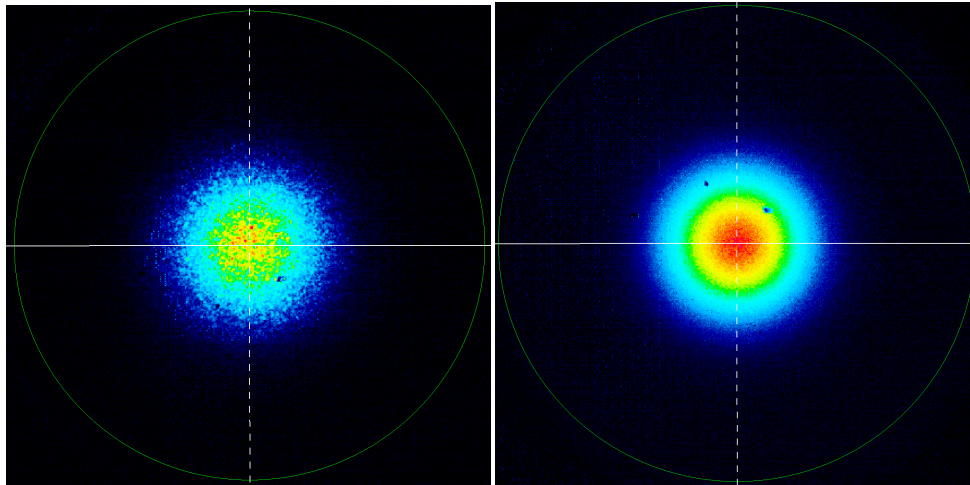


Figure 4: Shown here in the bottom-left X profile is a measurement across 10 centimeters *after the correct PMF has been set*.

### Appendix B: Coherent Source Speckle Reduction

For coherent sources, the diffuse transmission results in a speckle effect due to construction/destructive interference. This can be minimized by opening the adjustable aperture to its largest setting.



(a) The lens aperture is adjusted to F/16 which results in more speckle for coherent sources.

(b) The lens aperture is adjusted to F/1.4 which results in less speckle for coherent sources.