

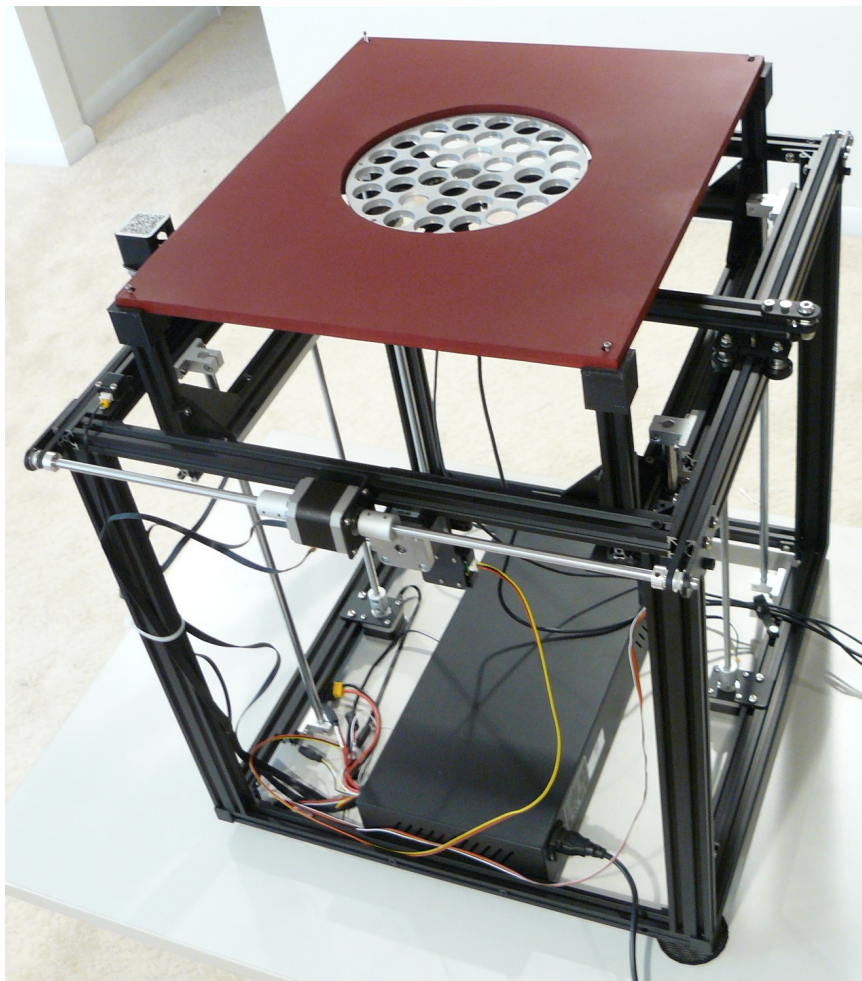
Boulder Optical Design

BoulderOpticalDesign.com

The new automated inspection for surface quality measurement of optical elements

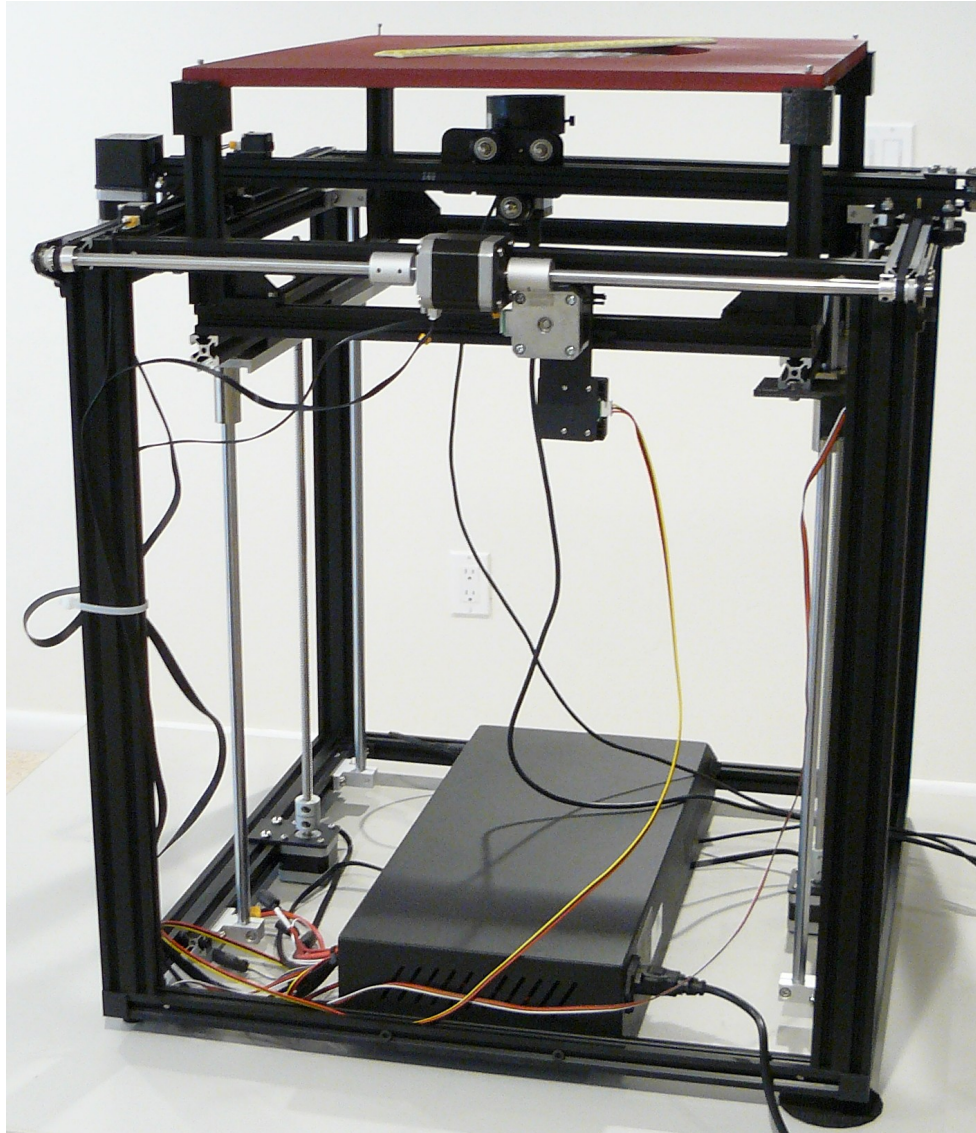
Introduction- The automated system scans optical surfaces for defects. The new system is much larger and is an improvement in many ways. The user drops in the parts, and runs the application. Defects are classified and counted.

The system is designed so that the same tooling that holds parts during thin film deposition can be dropped directly into the system, which usually avoids double handling and extra tooling costs. Whole planets of parts up to 13 inches in diameter can be dropped right in.



The photo shows the system from the back, with an 8.5 inch diameter planet dropped in and ready for measurement. The brick-colored mounting plate is normally made by the customer, for a particular type of parts tray or deposition planet.

Next is a view of the system that shows the microscope camera on the stage gantry. To show the scale, a 12 inch ruler is placed over the drop-in planet tooling that holds the parts.



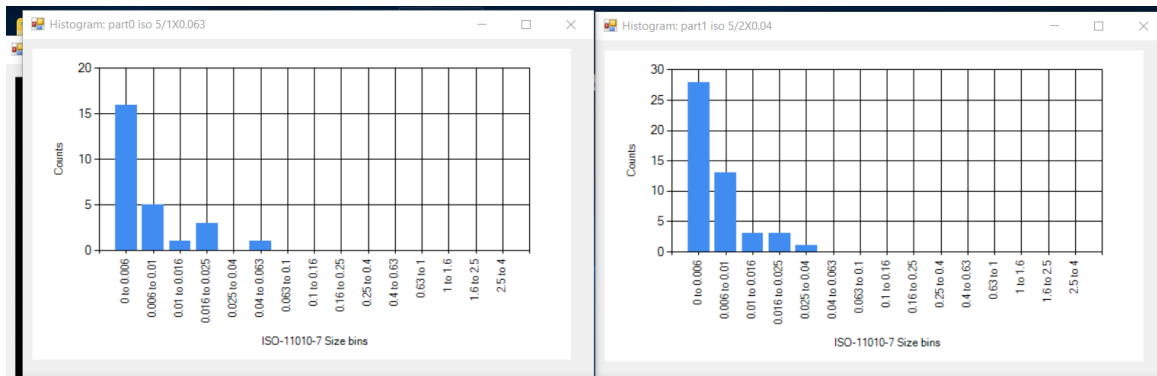
After the measurement, the user can review defects from a drop-down list (ordered largest first), and can also move the stage to the defect position for “live” inspection with video. The user can also move the stage manually. For documentation, a small image is saved for each defect, and the run can be re-loaded and reviewed later. The complete images can also be optionally saved. The system works for flat and spherical surfaces.

Features and specifications-

- The system works to the ISO 10110-7 5/NxA surface specs.
- Dark field illumination with a ring LED illuminator.
- System measures the bottom surface, which helps to reduce particle contamination.
- The system actually snaps a series of images at different exposures for each position, thus greatly improving the dynamic range of pixel intensities.
- Aspect ratios of defects are also calculated for identifying scratches.
- Parts, trays, and analysis parameters are specified by text-based xml files.
- Regions of interest can be specified, both simple and complex.
- A separate application is included for bringing results into a spread sheet, passing or failing parts, and printing certificates. This makes the results highly customizable.
- Normal range of motion 330 mm x 330 mm. (E.g. planets up to 13 inch diameter).
- Positional accuracy: 0.1 mm. (repeatability somewhat better.)
- Minimum defect size about 0.003 (square root of area in mm), lowest ISO size grade 0.006.
- Speed: Full coverage of 2 inch part, 90% CA, currently takes about 8 minutes.
- Weight capacity for substrate, up to about 15 pounds.
- Normal system measures flat parts or spherical parts. We could set up other surface shapes if you have a need.
- System recognizes and ignores back-side defects, if substrate is thicker than 1 mm.
- Measurements to within about 0.5 mm of edges.
- System can subtract off background images that are taken with tooling holding no parts.
- Help files describe the system, basic operation, and details for setting up measurements.

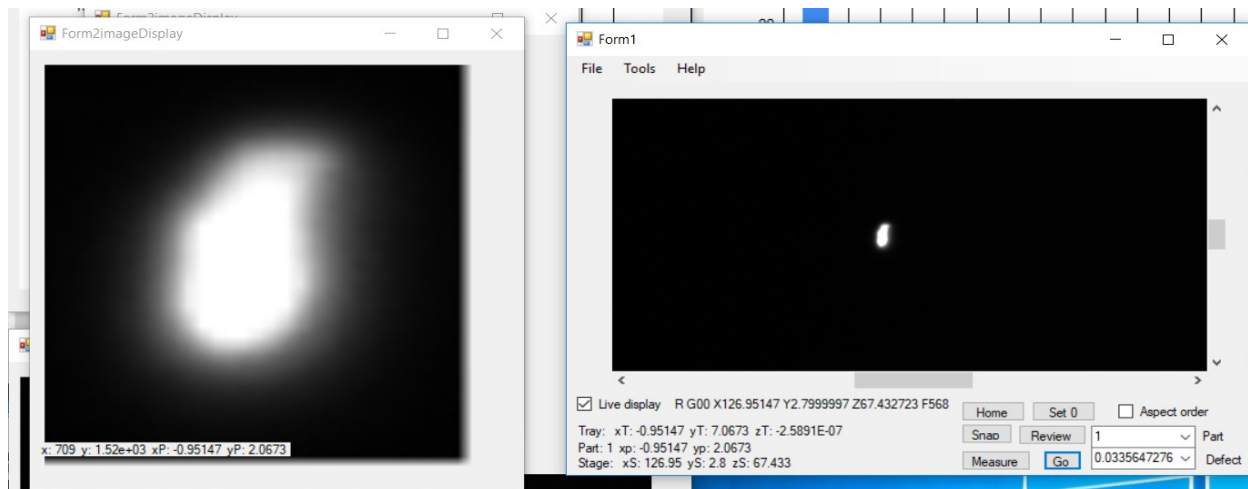
Software and discussion

For each part on the tray, the system produces a histogram of the ISO 10110-7 size bins, as shown below.



The system also produces a drop-down list of the defects, ordered by size. The user can select a defect and click to move the stage, to put that defect in the center of on live microscope video.

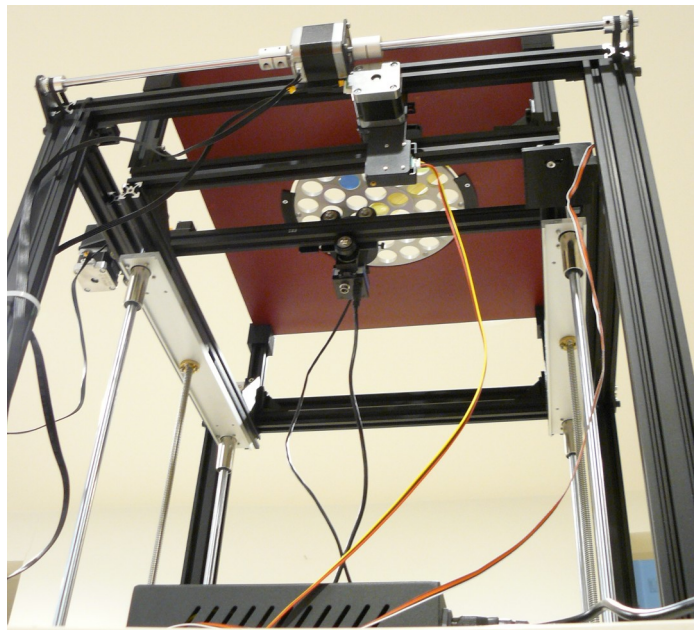
Below we show a screenshot of the live video (right) and also the review window of the archived image (left). Here we have just selected the defect from the drop-down list.



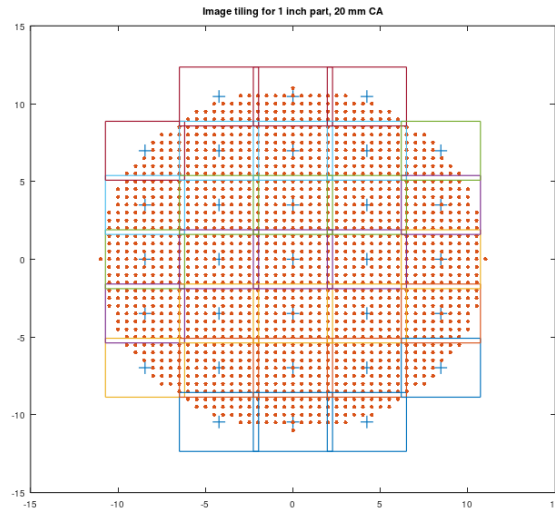
In this case, the defect in the live video (right) and also shown in the review window (left), is ISO 10110-7 size grade 0.034 (Square root of area, in mm).

The microscope camera is low-distortion, for accurate mapping of defects. The stage is based on a large-volume 3d printer. These 3d printers have become consumer items, so we can offer the system at a cost that is surprisingly low.

Here is another view, now looking up from the bottom, which is how the camera “looks” at the parts. This geometry is good because it helps to prevent dust from falling onto the surface that is under test.



Covering one of the parts requires many images from the microscope camera, and the system steps through and snaps the set of images for each part in the tray. Here is an example covering for 1 inch parts. If full coverage is required, there is some overlap between the images, as shown. Complex regions of interest (ROI) can be defined.



Example image covering of a 1 inch diameter part

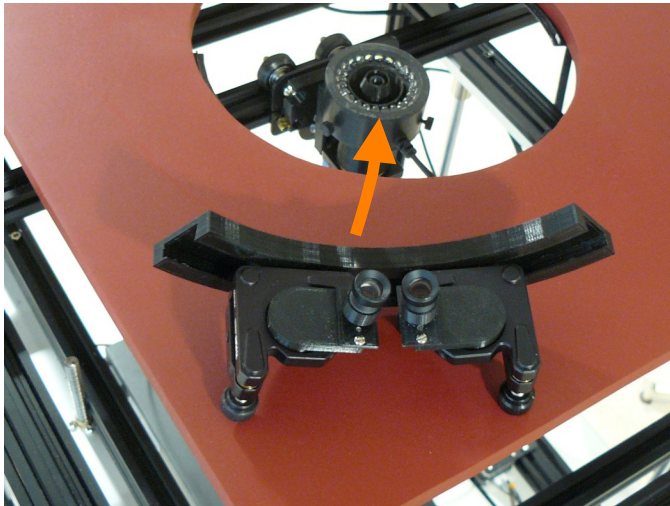
The software also includes a separate utility for presentation of results. This utility has two parts: (1) A very simple example c# application reads in the results from the main program and sets up a summary spread sheet; and (2) An example certification spread sheet automatically reads that in, passes or fails parts based on the results, and sets up a printable inspection certification. The user has full source code for these example utilities, and the intention is to help users set up their own systems for interpreting the results and printing (or saving as pdf) certificates for their customers. Below is a screen shot of a very simple certificate.



The user has full control of the certificate spread sheet, and so can make certificates that are as fancy and beautiful as needed, and can optionally display vast amounts of detail. This spreadsheet format also provides convenient integration with data logging systems within your company.

Optional fixture for spectral step-and-measure

This option includes a reflection measurement fixture, that replaces the camera assembly, thus converting the system into a spectral step-and-measure system. Below we show the reflection measurement fixture, placed on top, with part mounting removed so that the normal camera assembly can also be seen. The fixture replaces the camera assembly on the gantry carriage, as indicated by the arrow. The image on the right shows the spectral step-and-measure fixture in place.



The fixture allows reflection measurements up to 45 degrees angle of incidence. Much more detail can be found in our literature for the step-and-measure system. The software for that system works as described there. Switching from normal inspection to spectral step-and-measure is quick and easy.

Invitation for further discussion

Simply put, the system is amazing. I would love to show it off and discuss the science. Please feel free to call..

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