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# Dynamic BeamPro$_{filer}$ Model 2328

## Applications

### Introduction

The Photon Dynamic BeamPro$_{filer}$ measures spot size and spot position (centroid) at up to eight locations across the print platen of a laser raster scanner. The number of positions is dependent upon the configuration. The Dynamic BeamPro$_{filer}$ is offered with two to eight sensors. Spot-size accuracy is better 2.8% for 30 µm diameter spots (FWHM); smaller spots down to 15 µm can be measured with somewhat lower accuracy. Spot position can be determined to better than 1 µm. For beam position, the software actually computes the centroid, and measures exactly what the photoconductor sees to 1 µm accuracy.

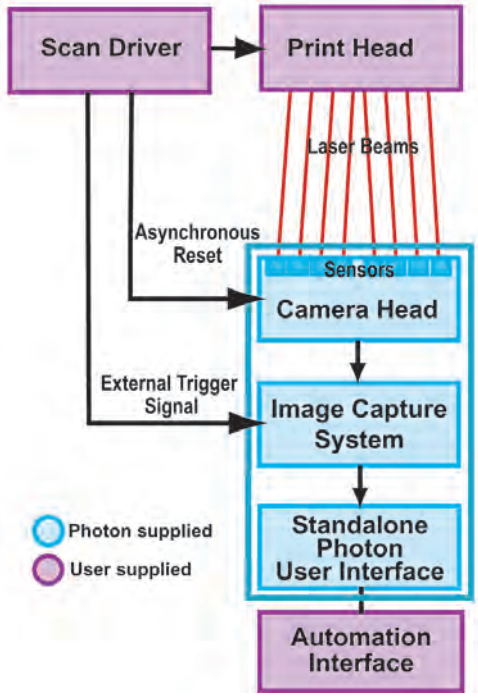


**Figure 1. Typical scanning application of the Dynamic BeamPro$_{filer}$**

### Provided Software

Photon provides software that controls and collects spot size and position information and fully supports ActiveX Automation. ActiveX allows a user to write applications in C/C++, Visual Basic, LabVIEW and other platforms that support it. The standard Dynamic BeamPro$_{filer}$ package can be used to collect spot size and data from any of the [up to] eight sensors sequentially. The user can then write programs to turn the laser in the printer engine on or off at user specific locations.

### User-Provided Software

Because most printer engines have proprietary driver software, and there are particular points at which the test engineer may want to make measurements, each Dynamic BeamPro$_{filer}$ application is unique. For greater flexibility, the instrument allows the user to provide the proper driver software to interface the printer engine to the profiler unit. This will allow the test engineer to create specific test patterns to measure the important features of the raster scan. Using these features it is possible to write routines that will isolate one polygon mirror facet for measurement across the scan plane, or measure each facet successively to one detector location. The test engineer is limited only by his or her imagination. Photon's BeamScan Engineering group can provide assistance with the creation of these routines.

### Applications

The Dynamic BeamPro$_{filer}$ helps manufacturing build print engines faster with greater accuracy,

particularly when using air-bearing polygon mirrors. The traditional way to characterize a laser scanner is to position three to five profilers, such as the Photon BeamScan, across the scan plane. The mirror is manually positioned so the focused print beam enters the profiler's aperture. This is repeated many times on each sensor until the beams are in proper alignment. With air-bearing mirrors it is not possible to stop the polygon and still maintain the pointing integrity of the mirror facets. By using Dynamic BeamPro$_{filer}$, the polygon mirror facets can be measured while they are spinning at operational speed. This both accelerates the process by 5-10X and increases the accuracy and relevance of the measurements.

The Dynamic BeamPro$_{filer}$ provides electronic quality control of a raster scanner prior to its installation into a fully functional printer. Many print engines are tested only after full assembly by printing and then analyzing the print. Photon can show that qualifying the raster scanner in a quick and easy-to-use real-time test will save time in manufacturing printers. Since errors in the printing, seen in traditional testing processes, can come from either the printer electronics or the raster scan engine, isolating the two makes troubleshooting problems much more efficient. The Dynamic BeamPro$_{filer}$ makes it possible to perform electronic verifications of the scan engine prior to installation into a printer.

## Measurements

### Beam Position

For beam position, the software actually computes the centroid, and measures exactly what the photoconductor sees to 1 μm accuracy. This is the first moment of the energy distribution and provides a more precise location of a beam because it uses data from each pixel rather than just a center pixel location. If it depended on a single peak pixel, accuracy would be ±1 pixel or ±4-5 μm. Instead, the Dynamic BeamPro$_{filer}$ measures a composite spot size in the scan plane that includes the effects of the optic system and the rise and fall of laser modulation.

### Scan lens element adjustments

Typically, the multiple-element (F- theta) scan lens requires micro-positioning adjustment of one or more element. Both the spot size and position information are used to provide feedback for this adjustment. The Dynamic BeamPro$_{filer}$ allows the polygon mirror to spin during the measurement making for more accurate dynamic results.

### Facet-to-facet tilt

Each polygon mirror facet has a normal, which should lie in the scan plane. In fact, it is very difficult to fabricate such a device, and as a result each mirror facet raster is printed slightly deflected from the next. The result is a minimally blurred print pattern. To measure the extent of this effect, assume the raster is horizontal. The vertical spot position will be measured as $X_n$ for each facet. The total range of $X_n$ over all facets represents the facet tilt error at the print plane. The Dynamic BeamPro$_{filer}$ measures this value to the sensor uncertainty of 1 μm. For example, for a spot with 30 μm diameter the position or centroid detection error is 1 μm; thus the sensor can detect 1/30th (3%) of the spot diameter. Typical printers tests allow 5% of the spot diameter or less.

### Scan Line Bow

Scan line bow is the shape of a raster across the scan plane, and can also be caused by the facet tilt. Ideally the scan line should be straight, but it is often bowed up or down in the middle of the scan. Scan line bow is measured by first measuring the vertical position (centroid) of a single facet raster for up to eight sensors. We call this a reference raster. The next facet will be slightly bowed if the scan mirror facet is tilted out of the scan plane. Fabrication tolerances of the polygon usually allow some bow to occur. The change across all [up to] eight sensors is used to plot a bow for this facet. Again the centroid uncertainty of 1 μm sets the limit of this measurement.

### Distortion

The F-theta scan lens is designed to correct these errors. With the ability to measure a spot position

to less than 1 µm, it is possible to verify unit-to-unit distortion. To measure this parameter: First, the ideal horizontal print spot location for each sensor is determined. Next, the print engine prints a spot at the "ideal" location. Deviation between the two is a measure of the optical distortion.

### Scan Start Jitter

Non-uniformities in facet-to-facet reflectivity and electronics control can produce variable start-of-scans. This can result in blurred print or wavy vertical print lines. The Dynamic BeamPro$_{filer}$ can easily measure the extent of this by running statistics on horizontal spot centroid for a particular sensor. Again the precision of the jitter measurement is limited to 1 µm centroid uncertainty.

## Summary

Photon's Dynamic BeamPro$_{filer}$ is a practical solution that will enhance quality, cut production costs and improve future designs by providing additional knowledge about the printer scan engine. The Dynamic BeamPro$_{filer}$ brings an important diagnostic tool to the laboratory or the factory floor. Each printer engine has proprietary operating parameters. In order to get more than just spot size and position information, the laser scanner engineer must work with manufacturing, QC, and software engineering to generate printer driver routines to interface with the Dynamic BeamPro$_{filer}$. Photon's BeamScan Engineering consulting group can assist you to develop your application. We can also provide total customized application development. Speak to our sales staff about how we can help you be successful with your manufacturing, research, or engineering projects.