

3.9 Additive Manufacturing Systems

Additive manufacturing (AM) has restructured how prototype, developmental and advanced design mechanical components are made. Direct Laser Melting, Selective Laser Sintering or 3D Metal Printing is quickly becoming the standard for designs that could not be fabricated with traditional metal removing techniques. To create consistent, strong structures using laser-based additive manufacturing processes that meet aviation DOD standards or medical device FDA requirements, the metallurgy must be consistent, and a laser beam of known dimension, power density and focal spot location is required. Quality 3D laser printed processes require a laser delivering the correct amount of power, distributed correctly and focused at the correct location. To insure consistent and structurally sound parts these parameters should be directly measured before and after any critical part is made.

As AM systems have gained in popularity for the mass production of metallic parts, the components produced are becoming larger in size while having finer details. This requires increasing AM chambers, having larger powder platforms and longer laser focal lengths. Simultaneously,



they are equipped with more powerful lasers having smaller focal spots.

Ophir instruments designated for AM systems meet the accuracy requirements of modern AM chambers and lasers, allowing accurate measurement of focal spot size and position, laser profile, and power distribution. They measure how those parameters change with time as well, to assist maintenance of quality and repeatability of the manufactured parts.

Model	BeamPeek™	BeamWatch® AM
Wavelengths (nm)	532, 1030-1080	700-1100
Maximum power (Watt)	1000	1000
Minimum Focal Spot (µm)	34.5	35
Cooling	Passive	Fan
Analysis		
M ² (Caustic)	√	√
Rayleigh length	√	√
Focal Spot location	√	√
Beam Profile	√	√
Power	√	√
Software	BeamPeek Software, BeamGage Pro	BeamWatch
Part Number	SP90609	SP90655

3.9.2 BeamWatch® AM

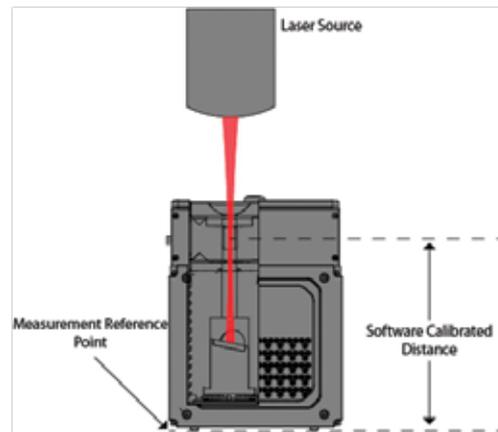
BeamWatch AM provides simultaneous measurements of multiple profiles along the beam caustic in the camera field-of-view (FOV). Real-time measurements are performed at video rates.

They include:

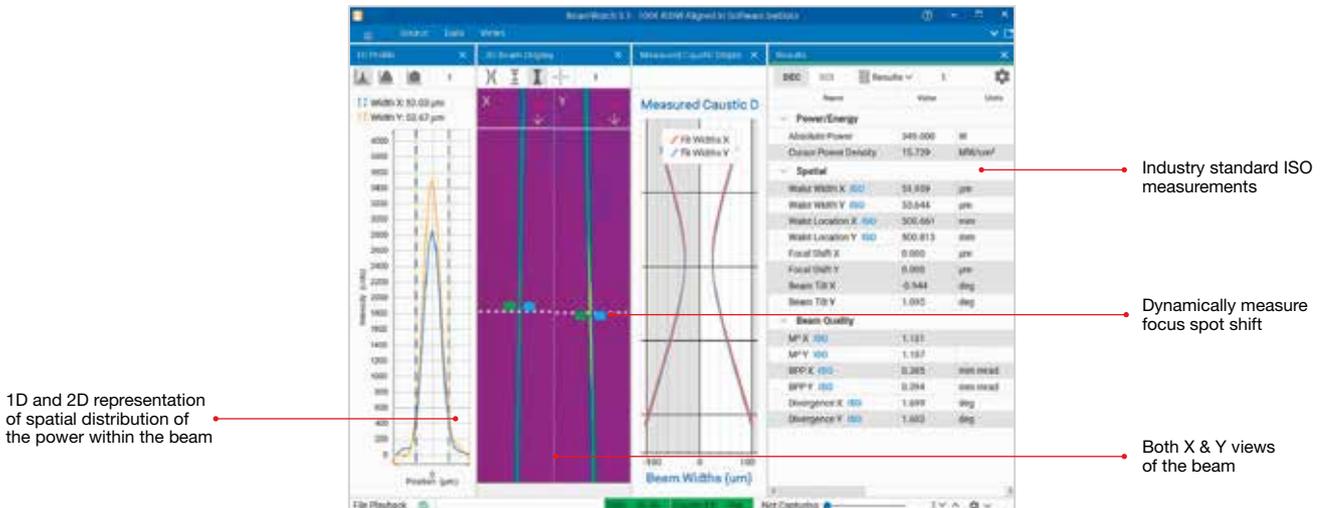
- Waist (focus spot) width and location
- Focal shift
- Centroid
- M^2 or K
- Divergence
- Beam Parameter Product
- Rayleigh length
- Absolute power
- Tilt angle



Real-time performance also allows for measurement of dynamic focal shift during laser startup. BeamWatch AM measurement technique is based on Rayleigh scattering of laser light by oxygen and nitrogen molecules in the air as the beam propagates through the medium. Measurement of this scattered light provides an equivalent slit-scan of the laser beam in the direction of the observed view. The scattered light is measured using a conventional camera and image capture systems. BeamWatch AM includes a camera for spatial measurements and a NIST-traceable power sensor that will provide a complete analysis of the laser power density profile. The camera is simultaneously, and real-time, viewing the beam caustic including the near/ focus/and far field of the beam. This measurement technique includes Propagation and M^2 measurements adhering to the ISO 11146 standards. In addition, and because all measurements are made in real-time, any focal shift occurring during the critical start up seconds is measured and reported. BeamWatch AM has USB connectivity to Windows personal computers for data acquisition, analysis, and display.



Calibrated beam path for precise focus spot location



1D and 2D representation of spatial distribution of the power within the beam

Industry standard ISO measurements

Dynamically measure focus spot shift

Both X & Y views of the beam

Specifications

Model	BW-AM-3
Beam Profiling and power measurement	
Wavelengths ⁽¹⁾	700-1100nm , for wider optical range, see note 1
Minimum Linear Power density ⁽²⁾	1 kW/cm @ 1070nm
Measured Power	20W - 1kW for 2 minutes (120 kJ)
Minimum spot size	35 µm
Field of View (FOV)	9.01mm x 2.99mm
Beam Divergence	15-60 mrad
Maximum Rayleigh Range	3 mm
Maximum beam diameter at entrance	6 mm
Distance from bottom to center of FOV	~140 mm (calibrated)
Accuracy ⁽³⁾	
Waist width (Spot size)	±5%
Waist location	±125µm
Focal shift	±50 µm
Beam parameter product	±2% RMS
Divergence	±2% RMS
M ²	±2% RMS
Power Measurement	NIST traceable calibration, ±3%
Cool-down time	20 minutes with fan cooling if used with maximum energy
General	
Communication to PC	USB 3.0
Power supply	110 - 220 Volts AC 50/60Hz
Particulate purge	Clean dry gas, 3-8 SLPM (35-100 PSI / 250-650 kPa). 1/4" hose included.
Weight	8 kg
Dimensions	177.96mm x 126.44mm x 185.33mm
	7.01in x 4.99in x 7.29in
Operating Temperature	10 to 40°C
Storage Temperature	-20 to 80°C
Operating/Storage Humidity	20% to 80%, relative, non-condensing
Compliance	CE, UKCA, China RoHS
Ordering Information	
Part Number	SP90655

Notes: (1) Covering the 420–1100 nm range (visible and NIR), a custom-made BWAM is also available.
 (2) linear Power Density calculated by Power / beam diameter.
 (3) Specified accuracy for beam tilt < 5°.

Accessory Ordering Information

Item	Description	P/N
Turning Cu mirror & springs	Replacement mirror for BW-AM	SP90611

