PART # 8J06011. REV 01

User Notes

# BEAMPEEK™

## BEAM PROFILER AND POWER METER FOR THE ADDITIVE MANUFACTURING (AM) INDUSTRY

## P/N SP90609


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# 1.0 INTRODUCTION

## 1.1 WHAT IS BEAMPEEK?

The Ophir™ BeamPeek™ is designed to analyze laser beams up to 1kW. Its optical design enables measurement of both 532nm and NIR wavelength lasers. It is designed for use inside Additive Manufacturing (AM) chambers and can simultaneously measure power as well as profile the laser beam. Thanks to its innovative design, the BeamPeek can measure continuously for up to two minutes at maximum power; even longer by swapping the replaceable beam dump. BeamPeek is intended to provide a complete solution for beam analysis inside AM machines.

## 1.2 PRINCIPLES OF OPERATION

The beam enters the device through the aperture on the top of the instrument (1). As the beam passes through optical wedges, it is attenuated and profiled by the camera. A beam sampler further splits ~4% of the beam and reflects it to the power meter sensor where the power is measured while the remaining 96% is directed to the beam dump. This design maintains the low operating temperature necessary for accurate power and beam profile measurement. Note that high density beams must be further attenuated before applying them to the camera. To accommodate this, there are two fixed ND filters and three interchangeable ND filters (2) in the camera's path, to allow image intensity control together with camera exposure.

***NOTE*** **IMPORTANT: The BeamPeek is designed to work with one removable ND filter inserted (three total) to maintain the integrity of the optical path between the entrance and the camera**

The tray (4) can hold one of three interchangeable lenses. These are intended to increase spot size in order to lower the power density on the beam dump (5). Refer to section 3.0 Operation for more information.

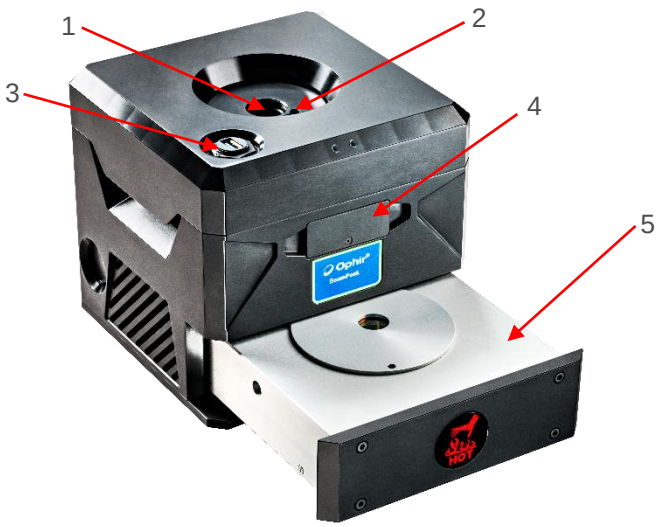



*Figure 1: BeamPeek closeup view*

**NOTE** **Failing to use the proper lens for the beam's wavelength can lead to incorrect power readings or beam dump damage.**

Typical AM machines are equipped with high power lasers which could heat the measurement equipment enough to interfere with the accuracy of measurements. To combat this, BeamPeek includes a beam dump designed to remove the excess heat from the measurement system. See Section 3.0 Operations for full details.

**NOTE** **The beam dump cools passively (it is not a water or fan cooled system). It is removeable so a user can extend the measurement duration by using two beam dumps, interchanging them when one gets too hot (one beam dump can be used continuously for up to 2 minutes and handled without need for thermal protection).**

The device contains two LED's, the green LED indicates when the power is on. The red LED is a warning light that blinks when the device temperature reaches 55°C and remains solid when the temperature reaches 65°C.

**WARNING** **At camera temperatures exceeding 65°C, the measurements lose accuracy and body may become too hot to handle.**

## 2.0 SETUP

The device comes from the factory calibrated and ready to measure.

1. Install the provided software:
   - BeamGage™ Professional
   - StarLab™
   - BeamPeekTools
2. BeamPeek ships with two M6 cylindrical hex locking screws at the bottom of the unit (Figure 2). These secure the beam dump during transportation and must be removed before first use. After screw removal, the beam dump remains secured by the quick-release pins, visible on both sides of the device.

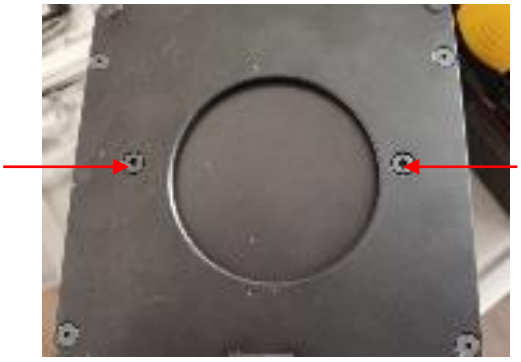


*Figure 2: Hex locking screws on the bottom of the unit*

3. Place the BeamPeek in the correct position relative to beam guide using the supplied target cap (Figure 3).

*Figure 3: Target cap*

| NOTE | **The target cap is mounted on the device to protect from dust and must be returned between uses.** |
|---|---|

4. Connect the USB 3.0 (3) cable provided with the BeamPeek to the PC. The green LED will illuminate when connected.

5. Open BeamGage Professional and load the provided setup for the first use (BeamPeek start config for BeamGage Professional.bgSetup; refer to Figure 5).

| NOTE | **Changes to the setup are automatically saved for next the software is opened.** |
|---|---|

6. Select Juno for the power meter and select the appropriate wavelength at the Configure Power Meter menu (Figure 4).

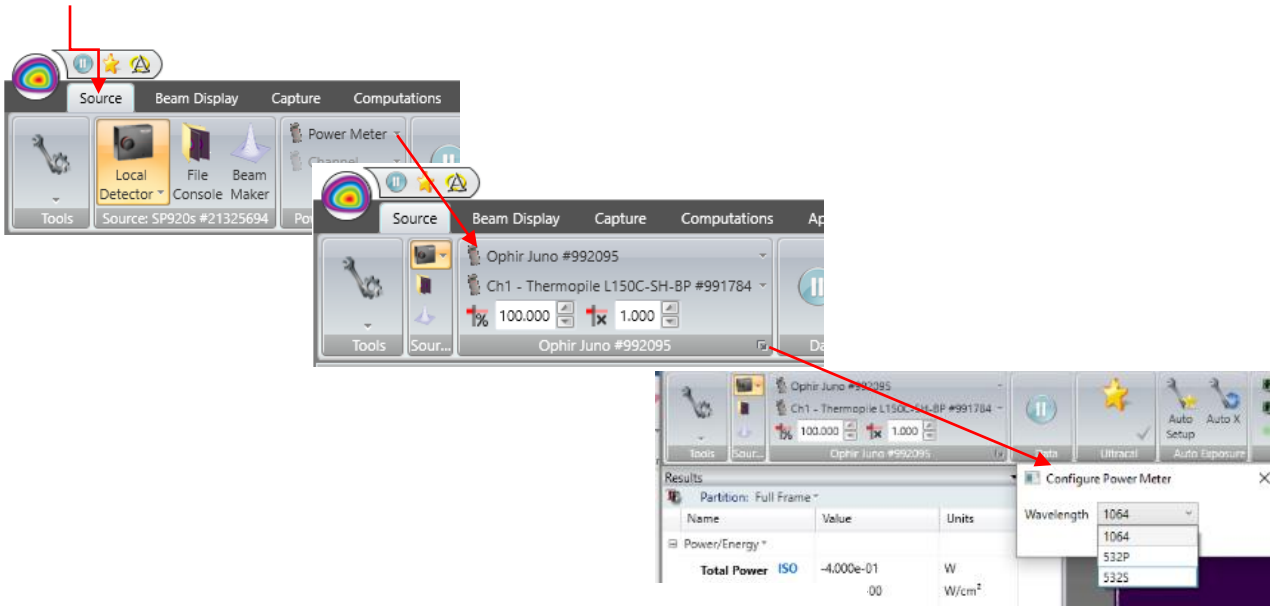



*Figure 4: Setting the power meter measurements*

| NOTE | **There are two options for 532nm beams: 532 for a non-polarized beam, 532P for a P polarized beam in normal position, for a 532nm S polarized beam, rotate BeamPeek by 90 degrees.** |
|---|---|

7. Remove the ND filter and adjust the exposure time to allow the beam guide to be visible in the display window.
8. Adjust the AM machine bed height to the ***Focal Plane*** position printed on the BeamPeek calibration sticker so the focus will be on the camera sensor.
9. Verify that the beam guide is in the center of the sensor. This is defined by the centroid coordinates being within 0.5mm of the optical axis position (X&Y in camera coordinates).
10. Verify that the replaceable lens is the correct one for the laser in use, see Table 2 in section 3, Operation
11. Based on initial laser data and desired measurement sequence, select and install the proper ND filter (see Table 1).
12. Turn on the laser at minimum power and begin to gradually increase it. The power reading should be stable after 3-5 seconds and be within 10% of the expected power. If not, verify that the BeamPeek is set up correctly (steps 6-8 above).
13. Check the focal plane position for different power settings.

14. BeamPeek is now ready to start taking measurements.

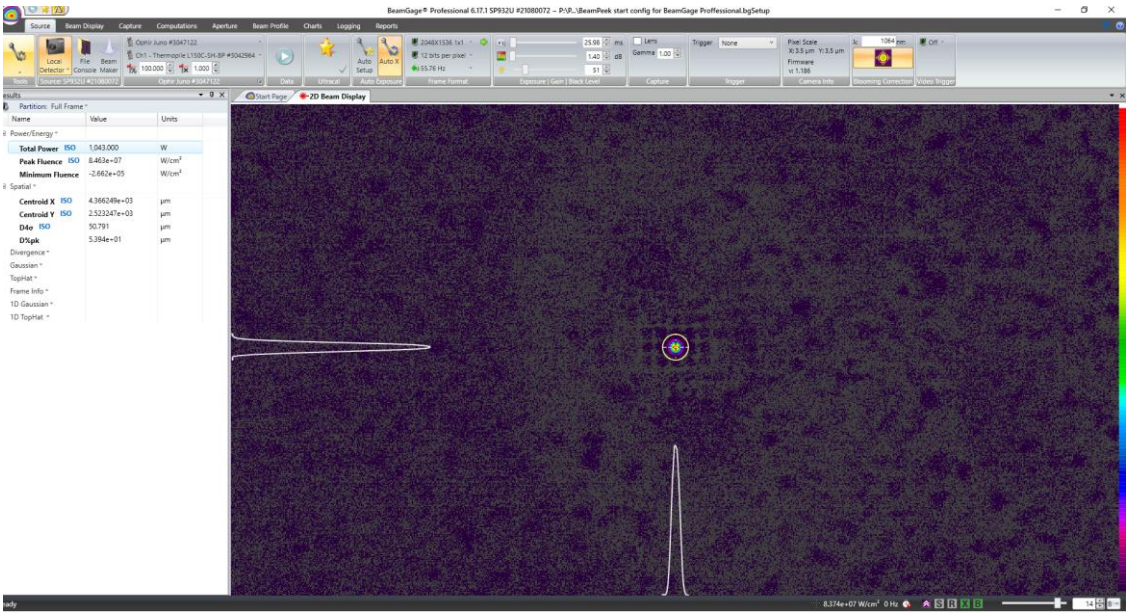


*Figure 5: Typical BeamGage setup*

BeamGage software tools such as Auto Aperture, AutoX, and Blooming correction can be used to get fast, stable, and reproducible results.

The *BeamPeekTools* software (Figure.6) can be used to monitor temperature of the BeamPeek body as well as the camera. The respective temperature readouts turn orange and subsequently red as the temperature increases close or over permissible limits. The body temperature sensor is placed closed to the optical aperture and can indicate mispositioning of the laser beam. With normal use, the temperature increase rate is approximately 10°C per 30s session at high power (>500W). **If mispositioned, the temperature could reach the recommended maximum of 65°C in 10-15 seconds.**

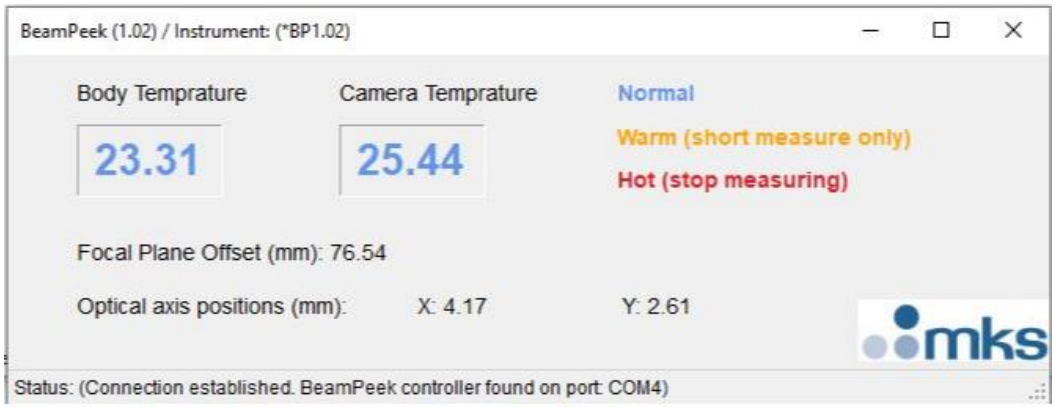



*Figure 6: BeamPeek tools: temperature sensors reading, focal plane and Optical axis position*

## 3.0 OPERATION

BeamPeek is designed to measure beams with diameters from 35um at the focal plane, up to 10mm at entrance aperture (can be evaluated on cover cap) and divergence angles below 0.012mrad. Like with all beam profiling systems, appropriate attenuation and correct alignment is required to ensure measurement accuracy. It is worth repeating that users can modify attenuation by replacing the ND filter. Select an appropriate filter by referencing the information in Table 1. For other power and spot diameter values, evaluate by interpolation using the power to area ($Dia^2$) ratio.

*Table 1*

| Power | Spot size | ND |
|---|---|---|
| W | µm | |
| 1000 | 35 | ND4 |
| 100 | 70 | ND4 |
| 500 | 150 | ND2.5 |
| 20 | 200 | ND2.5 |
| 10 | 200 | ND1 |

***NOTE***

- **Values are for single mode lasers (M2~ 1).**
- **For Beam diameters smaller than 150um, exposure time under 10ms may yield unstable results due to blooming correction.**
- **By default, the ND4 is installed.**

BeamPeek is equipped with three lenses, two F=20mm (one for 532nm, one for 1030 – 1080) and one F=12.7mm (1030nm – 1080nm).

and still be handled without need for protection. For lower powers, this can be spread out over a longer period.

Ensure that you have the correct diffusing lens in place. Use F20 (532nm or 1030-1080nm) lens up to 700W SM mode or 1kW in MM mode and F12.7 for 1030-1080nm, up to 1000W or beam divergence under 0.02rad. Use the information in Table 2 to help select an appropriate lens and the measurement cycles.

*Table 2*

| Lens type | F=20mm | | F= 12.7mm | |
|---|---|---|---|---|
| **Wavelength** | 532; 1030nm – 1080nm | | 1030nm – 1080nm | |
| **Laser type** | Multi-Mode | Single Mode | Multi-Mode | Single Mode |
| **Power levels [W]** | **CW cycle[s]/Pause [s]** | | | |
| **5-500** | w/o limit | w/o limit | w/o limit | w/o limit |
| **500-700 (up to 6 cycles)** | 60s with 5sec break | 30/5 | w/o limit | 45/5 |
| **700-1000 (up to 2 cycles)** | 30/5 | N/A | 45/5 | 30/5 |
| **Beam divergence Half angle** | Min=10mrad | Max=50mrad | Min=5mrad | Max=30mrad |

***NOTE***

- **By default, the F20 for 1030-1080nm is installed.**
- **An incorrect lens will yield incorrect (>10%) power measurements and increased temperature on main body**
- **Body and camera temperature are monitored by two sensors and displayed on software (Figure 6: BeamPeek tools: temperature sensors reading, focal plane and Optical axis position)**
- **F20 lens allows larger X-Y positioning error**

To set up BeamPeek:

1. Turn on the beam guide.
2. Place the BeamPeek so that the beam guide is centered on the cap. For more accurate positioning move the machine bed so that the BeamPeek top is as close as possible to focal plane (approximately 162mm downward).
3. After positioning, return the machine bed to original height and remove the cap and ND2.5 so that the beam guide becomes visible when moved to focal plane offset position (printed on the label on the rear panel).

**NOTE** **Take care to not to turn on main beam as the system is positioned with focal plane aligned to the BeamPeek top. Doing so may damage the beam dump and optical elements since the main beam will be focused on the wrong surfaces.**

4. Move machine bed to the offset position. The beam guide should now be visible in the 2D Beam Display window in BeamGage.
5. Check the beam position relative to optical axis coordinates (X, Y). It should be within 0.5mm when an F20 lens is used and 0.3mm if the F12.7 lens is used to allow high accuracy in power measurements.
6. Start measurements with main beam set at lowest power to confirm that initial setting is correct.
7. Run short measurements at higher power to confirm initial settings, and then proceed to longer and higher power measurements.
8. If needed, slightly move machine bed to find beam waist.
9. For faster cooling, remove the beam dump and place it on a metallic or granite surface.

**NOTE** **Positioning beyond the recommended limits may yield incorrect power measurements and damage the internal parts if main beam power is more than 300W.**

**CAUTION** **Moving AM machine bed down too far beyond focal plane offset position at maximum power may damage the optics. In order to avoid this, M2**

**measurements should be performed with extra care for laser spots with diameter under 100um and or more than 15mm required position.**

**Starting with the bed at upper limit will not cause any damage.**

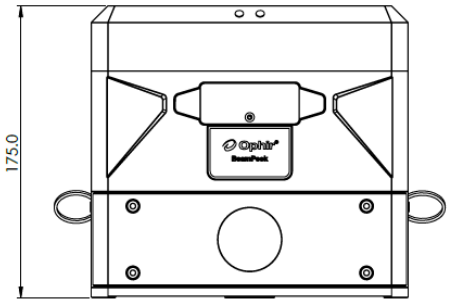
## 4.0 MEASUREMENTS

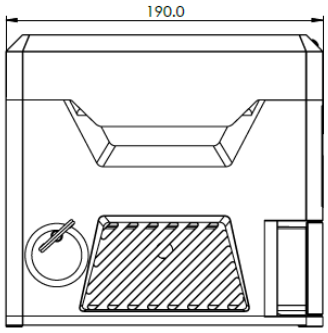
Use BeamGage Professional for both beam size and power measurements (refer to the BeamGage User Guide for installation instructions).
For accurate measurements, follow setup steps outlined in the previous sections in this guide. Take the following comments under consideration during measurement gathering:

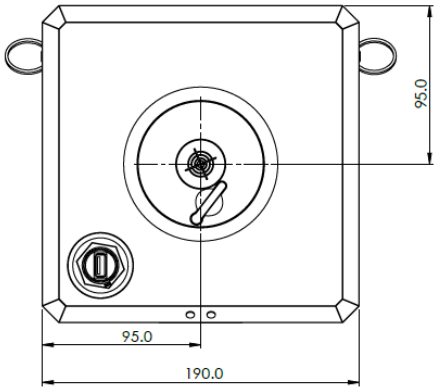
- During measurements, watch power values closely, they should be within 10% of the expected value.
    - If measured power values are different from reference, double-check the following:
        - The beam is correctly positioned relative to optical axis within the recommended limits as described in section 2.0.
        - The correct diffusing lens is used.
        - The correct wavelength is selected in the BeamGage Configure Power Meter menu.
- Do not exceed the recommended exposure of 30s continuous operation and a maximum of 2 minutes cumulated with 5s pause at 1000W or equivalent for power levels of 500W or higher before cooling or replacing the beam dump; beam dump temperature will be close to 80°C after 4 minutes at 1000W or equivalent.
- To avoid long exposure at 1kW power, adjust the height to locate BeamPeek at the lowest possible power level that preserves the focal plane.
- Use the F20 lens whenever possible, the F12.7 requires more accurate positioning.
- Use a thermal camera to determine actual temperatures after intense use or warning.
- We recommend a couple of minutes after powering on the device to warm it up (including the initial settings) before starting to measure power.
- After three seconds the power measurements are at least 95% of the nominal value
- Higher accuracy power measurements can be attained after 15s.
- For accurate focal plane position move around the initial bed position until you get the minimum beam diameter value.

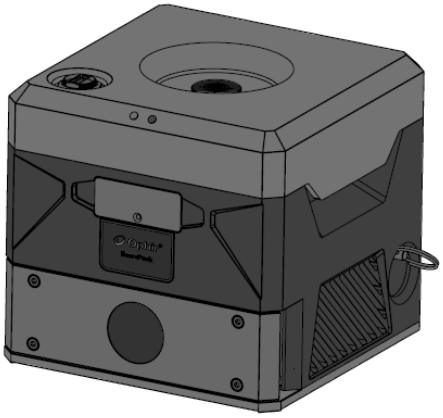
For more information consult the BeamPeek specifications.

## 5.0 DIMENSIONS



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