UV Measurement and Process Control Instruments

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Data Collection Instructions, Suggestions, and Techniques

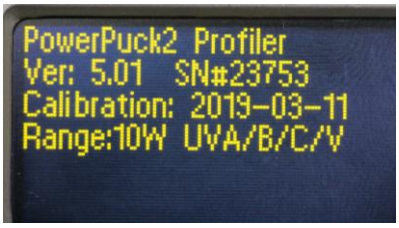
Collecting data in a consistent manner helps generate consistent results. The suggestions & techniques below will help you to improve data collection which can lead to more consistent results with EIT 2.0 Instruments.

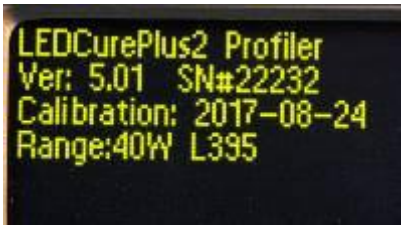
1. *Match the Instrument Optic Response to the Source*

- EIT 2.0 Broadband instruments (PowerMAP II, Power Puck II, UviCure Plus II) were designed and have spectral responses (UVA, UVB, UVC, UVV) optimized for mercury based sources.
  - The EIT MicroCure has a UVA response for broadband sources
  - The EIT SpotCure has a UVA response for broadband sources
- EIT 2.0 LED instruments (LEDCure, LEDMAP) were designed and have spectral responses (L-365, L-385, L-395, L-405) optimized for UV LED sources.
- EIT 2.0 Germicidal instruments (UVKey) were designed and have spectral responses (G-254, G-222) optimized for 254 nm & 222 nm germicidal sources.
- Numbers obtained on an instrument not matched to the source type should not be considered reliable and can vary considerably source-to-source and instrument-to-instrument.

2. *Match the Instrument Dynamic Range to the Source*

- We often use weight measurement as an analogy for instrument dynamic range
  - Weighing a baby on a scale optimized for trucks can lead to inaccurate results
  - Weighing a truck on a scale optimized for a baby can also lead to inaccurate results
- EIT 2.0 instruments have a Suggested Operating Range based on the irradiance/intensity (W/cm^2) of the source, not the number of Joules.
- The Suggested Operating Range is specified at the time of order and is the range which units will best perform
  - Units will “turn on” (Start Threshold) at a much lower value than the Suggested Operating Range
  - Using an instrument outside of the Suggested Operating Ranges can lead to variations in the readings
  - If the unit is used well below the Suggested Operating Range, there can be variations in the Joules, especially on long runs
  - If you try to use an instrument on a source well above the Suggested Operating Range, you may wind up ‘maxing’ out the unit on each run
- Check the Suggested Operating Range of each EIT 2.0 product
  - PowerMAP II, Power Puck II and UviCure Plus II High (H-10 Watt) units have a silver optic window
  - Power Puck II and UviCure Plus II Mid (M-1 Watt) units have a silver optic window
  - PowerMAP II, Power Puck II and UviCure Plus II Low (L-100 milliWatt) units have a milky white optic window
  - LEDCure and LEDMAP units have a silver optic window
- The Dynamic Range and Optic Response are shown on the bottom line of the two examples below
- This screen is displayed when the unit is first turned on





- On units without a display, look for a sticker or contact EIT 2.0 (uv@eit20.com) with the serial number of the unit.

3. ***Instrument Sample Rate***

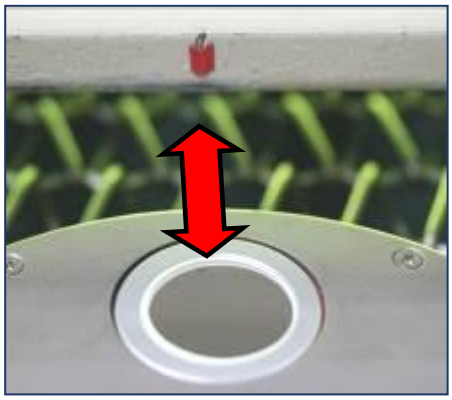
- For most applications, we suggest using an effective sample rate of 128 Hz (Samples per second)
- On the Power Puck II, UviCure Plus II and LEDCure instruments, the instrument sample rate should be set to "Smooth Profiler" (128 Hz). Use "Smooth Off" for fast process speeds greater than 120 feet per minute (40 meters per minute)
- On PowerMAP II and LEDMAP use 128 Hz.
- Increase the rate for faster process speeds
- If comparing multiple EIT radiometers, make sure each radiometer has the sampling set the same
- The MicroCure sample rate is fixed at 2048 Hz.
  - Make sure the MicroCure case halves are not touching metal
- When comparing values within your supply chain, clarify what sample rate was used
- See more details in ***Instrument Sample Rates*** after number 12

4. ***Follow EIT 2.0 LLC Optics Cleaning Guidelines***

- The best images are taken when a camera/phone lens is clean. Think of the optics in your EIT 2.0 instrument as a camera instead of an electro-optical instrument designed to measure UV in a harsh environment
- Follow our suggested cleaning techniques for best performance of our instruments
- The cleaning techniques as well as an instructional video are posted on our website at: https://www.eit20.com/products/instrument-care-service-ordering/instrument-care/

5. ***Use Consistent Data Collection Techniques***

Data Collection on a Conveyor



- For best results, place the instrument in the same location with the optics in the same orientation
- A small index mark on UV System allows the user to align the optics in the same location and orientation each time on the conveyor
- Align the units on the belt so that they measure the system in the same exact spot
- Make sure each radiometer has the same range, optics and is placed in the same position
- Space the radiometers by at least 12 inches (30 cm) if sending one after the other
- Orientate the optics window and radiometer body in the same position each time
- With appropriate UV eye protection, check to make sure the instrument optics are maintained at a consistent height throughout the path of travel in the UV system
- Consider the use of a fixture to stabilize the instrument height if the conveyor belt is 'bouncing' or the space between any rollers is causing an 'up and down surfing' motion. This can lead to inconsistent Watt values.
- On wide arc-based systems, consider taking multiple readings (left-middle-right) across the width of the conveyor

Data Collection in a Chamber

- Place the unit in the exact same position and orientation every time that data is collected
- Alternate radiometers

Profiler Enabled Radiometer

- Use EIT's PowerView III Software to isolate individual lamps for comparison after taking one measurement

6. ***Perform UV System Maintenance***

- On Broadband UV systems or systems with reflectors, clean and replace as needed

- 60-80% of the UV energy arriving at the substrate comes off the reflector(s)
- Reflectors with even a little contamination transmit less energy, especially in the shortwave (UVC) region than clean reflectors

- On LED UV systems, make sure the quartz window on the front of the LED is clean
- Maintain the belt/conveyor tension to prevent slippage
- Inconsistent speeds can lead to variations, especially in the Joule readings
- Verify the correct source type has been installed
- This could include bulb type (mercury, mercury-iron, etc.) and LED (nm) output
- Verify the expected height above the substrate is correct
- If you have a broadband source, purchase UV bulbs based on performance (output, life, spectral content) and not cost
  - Carefully evaluate bulbs from new suppliers before switching
- Follow the maintenance recommendations for these parts of your UV system if present:
  - Cooling supply-air and or water
  - Power Supply
  - Shutters
  - Quartz Plates
  - Specialty (dichroic) Reflectors
  - RF related items: Screens, gaskets and magnetrons

7. ***Evaluate your UV System Stability***

- **Disable the dispensing of any coating, ink or adhesive before taking a reading**
- Allow your system to warm up and stabilize per the recommendations of the manufacturer.
- Avoid Human Error
  - Double check and confirm the applied power and speed controller settings before taking a reading
  - Applied power and speed controller settings are not always linear and can vary widely
- With appropriate UV eye protection, check to make sure the instrument optics are maintained at a consistent height throughout the path of travel in the UV system
  - Consider the use of a fixture to stabilize the instrument height and to prevent ‘up and down surfing’ motion between the rollers. This can lead to inconsistent Watt values.

8. ***Watch the Instrument Temperature***

- Disable any infrared (IR) or thermal processes, sometimes called pre-heat or “flash-off” sections of your line
- If this is not possible, add the instrument after the thermal or IR section
- The internal temperature of instrument is shown on the display each time “RUN” mode is activated
- An alarm will sound when the unit reaches an internal temperature of 65°C or greater
- Repeated, slow long runs on high power UV systems without letting the instrument cool between runs can damage the radiometer and/ or give inconsistent results
- Let the instrument cool between readings
- **Rule of Thumb: If the instrument is too hot to touch, it is too hot to measure**

9. ***Establish a Process to Collect, Record & Maintain Instrument Values***

- Based on your process, decide how and who will collect data. This includes:
  - Line conditions
  - Speed and power levels
  - Frequency of measurement
  - Instrument settings (see section on Instrument Sampling below)
- Decide how to record/store
- Keep **both** the Joule and Watt values

10. Maintain Your Instrument

- EIT 2.0 instruments are used in harsh conditions including intense energy (UV, visible, infrared) and temperature.
- Instruments can become coated, dropped or stuck in a system
- We suggest service on a six month cycle
- The interval you decide to use is based on of use, how the instrument is handled, and cleaned.

Customer damaged instruments

frequency maintained

- Also use the “As Received” data on your EIT 2.0 calibration certificate to determine the best calibration interval for your instruments
- When your instrument needs service, use EIT 2.0 or an EIT 2.0 LLC Authorized Service Center (https://www.eit20.com/products/eit-worldwide-calibration-facilities/)
- EIT 2.0 and our Authorized Service Centers have the training, procedures and software to properly service your instrument
- If repairs or replacement optics are needed, EIT 2.0 and our Authorized Service Centers have genuine replacement components
- EIT 2.0 and our Authorized Service Centers can work with you to determine the best bulb type to use when calibrating your instrument

11. Decide on the best Instrument Sample Rate for your Application

- When comparing values within your supply chain, clarify what sample rate was used
- This is discussed in detail in the next section

Instrument Sample Rates

Collecting accurate, repeatable source values depends on getting an adequate number of samples while the instrument is under the UV source.

- For a broadband source, the area of peak irradiance normally corresponds to the bulb diameter; typically, 0.35-0.75” (9-19 mm). The total time under the broadband source is usually much longer and is based on the width of the source, in some cases up to 6+” (152 mm).
- For an LED source, the area of peak irradiance and time under the LED are normally the same as the width of the LED array. The width of an LED array can vary widely from 0.25-2” (6-50 mm)

The data (especially the irradiance value) collected and displayed EIT instruments can vary based on the:

- Line speed at which the data was collected
- The effective instrument sample rate which impacts how the irradiance values are reported

EIT instruments designed in the early 1990’s were state-of-the-art and featured a ‘blazing’ s Hz (samples per second). We suggested a maximum data collection ‘speed limit’ of 40 f minute to allow the units to collect an adequate number of samples to measure the peak irr density values. Exceeding the suggested ‘speed limit’ when collecting data would lead to var the irradiance values.

As technology improved, the sample rates in our instruments have also dramatically increased. We refer to the effective sample rate as ‘smooth’ or ‘smoothing’

Smooth/Smoothing

EIT 2.0 “puck style” (UviCure Plus II, UviCure Plus II Profiler, Power Puck II, Power Puck II Profiler, LEDCure, LEDCure Profiler) instruments ‘oversample’ at a high sample rate (> 30,000 Hz). The user can adjust the effective sample rate to one of three settings in the set-up menu of the “puck style” instruments.

The effective sample rate is based on the Data (not Optical) Filter Bandwidth. From a technical standpoint we use 7, 35 and 700 Hz data filters in the “puck style” instruments.

The three data filters in the “puck style” units equate to the following sample rates:

- 7 Hz: Effective sample rate of 25 samples/second, referred to as **Smooth On**
- 35 Hz: Effective sample rate of 128 samples/second, referred to as **Smooth Profiler**
- 700 Hz: Effective sample rate of 2048 samples/second, referred to as **Smooth Off**

From a practical standpoint, we refer to this data filtering as an effective sample rate or “Smooth/Smoothing”. The button to the left of the instrument display will allow you to access the Setup Menu to adjust the Smooth or sample rate

SMOOTH: ON

- **SMOOTH ON** displays the Peak Irradiance at an effective sample rate of 25 samples per second (25Hz)
- This rate matches the old legacy two button Power Puck and UviCure Plus instruments
- This rate should only be used when trying to compare the values on old legacy two-button legacy Power Puck and UviCure Plus units. All support on the legacy Power Puck and UviCure Plus units ended December 31, 2019, and we hope you have phased these units out.

SMOOTH: PROFILER

- **SMOOTH PROFILER** displays the Peak Irradiance at an effective sample rate of 128 samples per second (128 Hz)
- For most applications, this is the setting recommended.
- This rate matches the slowest sample rate on the PowerMAP II/LEDMAP systems

SMOOTH: OFF

- **SMOOTH OFF** displays the Peak Irradiance at an effective sample rate of 2048 samples per second (2048 Hz)
- This rate (2048) matches the fastest sample rate on the PowerMAP II/LEDMAP systems and also matches the sample rate on the MicroCure Radiometer.

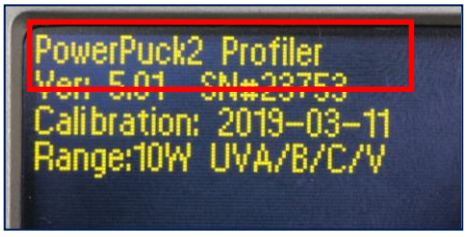
“SMOOTH” PROFILER vs. PROFILER “INSTRUMENTS”

EIT 2.0 uses the term **“PROFILER”** to describe two separate instrument features.
When **PROFILER** is used in the **“SMOOTH”** context, it refers to an effective sample rate of 128 Hz as described above.
When **PROFILER** is used in the **“INSTRUMENTS”** context, it refers to instruments (Power Puck II **Profiler**, UviCure Plus II **Profiler**, LEDCure **Profiler**) that can transfer the irradiance profile (Watts/cm^2 as a function of time) to a computer for further analysis.

Profiler enabled **“INSTRUMENTS”** can be identified in the first line of the start-up screen.

Below: Display referring to SMOOTH PROFILER (Sample Rate)

Below Right: PROFILER Enabled Instrument



Power Supplies: AC vs DC

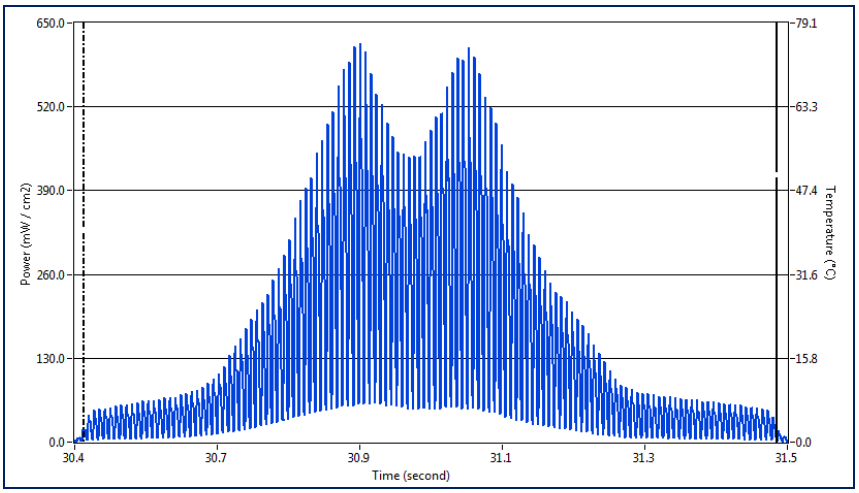
Broadband (mercury) lamps have traditionally been driven with Alternating Current (AC) power supplies running at local frequencies, most often 50 or 60 Hz. More recently, higher frequency (200-400 Hz) AC power supplies have also been used to drive broadband lamps.

LEDs are normally driven with Direct Current (DC) power supplies.

When light sources (visible or UV) are driven at 50/60 Hz, they appear to be ‘on’ and have steady output. If your eye or an instrument had the ability to sample faster, we would see the impact of the ‘alternating’ current on the irradiance or intensity of the source.

When we sample at 2048 Hz with our PowerMAP II, we can see this impact.

The two examples below show UVA data <u>for the same exact lamp and conditions</u> in two different ways. Both are technically correct based on how you elect to measure the irradiance. Note: The X-Axis is time and the Y-Axis UV irradiance

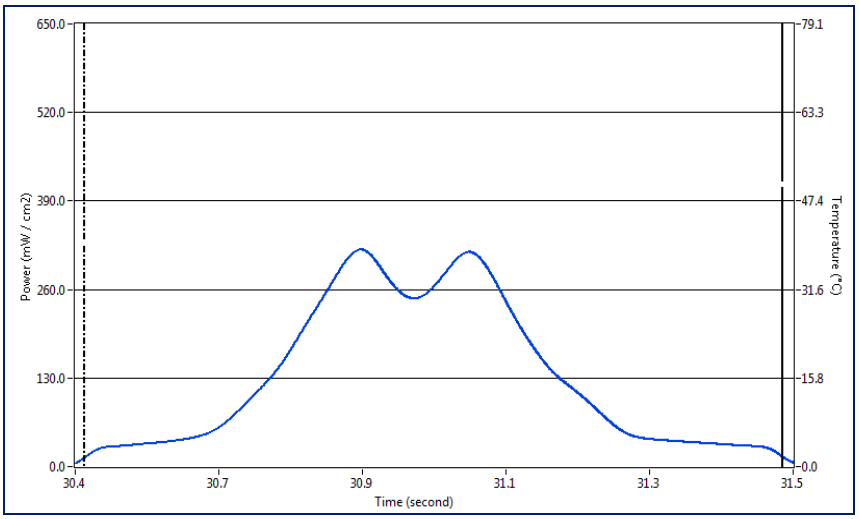


The data in this example was collected at an effective sample rate of 2048 Hz.

The peak UVA irradiance in this example is **618.0 mW/cm^2**, the total UVA energy density is **139.9 mJ/cm^2**

If you zoom in (see next page), you can see the lamp irradiance cycling at the same frequency (usually 50 or 60 Hz) as the alternating current (AC) from the power company.

The irradiance values and profile shown are referred to as the instant peak or “**Smooth Off”** intensity.

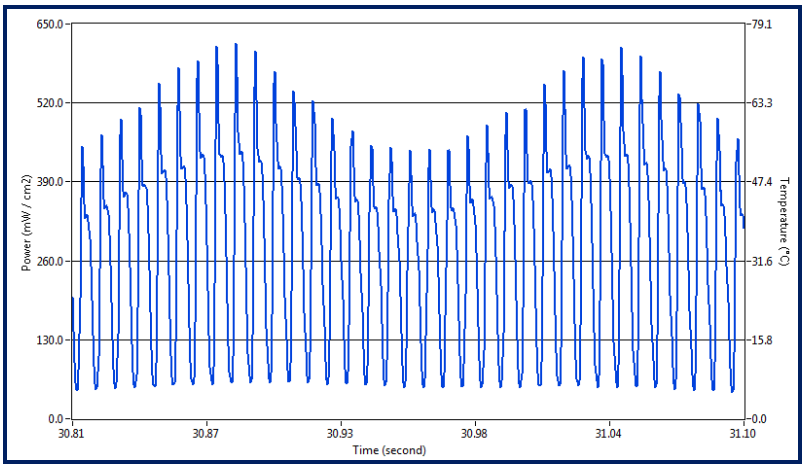


The data in this example was collected at an effective sample rate of 128 Hz.

The peak UVA irradiance in this example is **318.3 mW/cm^2** and the UVA energy density is **139.9 mJ/cm^2**

The irradiance profile show the average RMS lamp power.

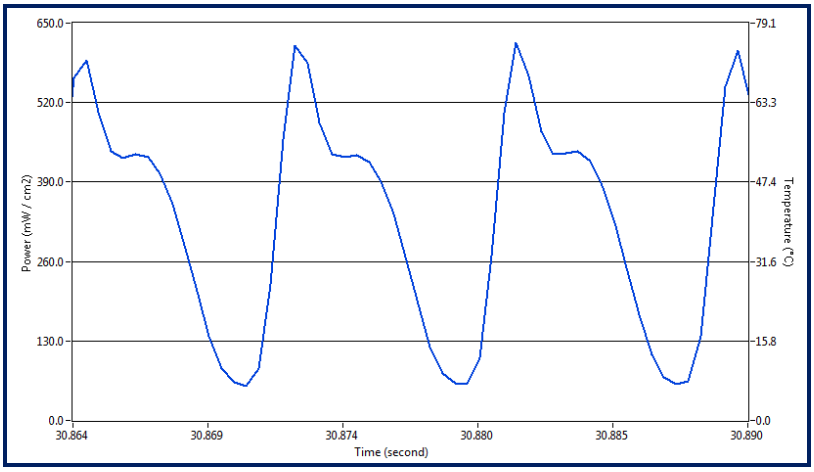
The irradiance values and profile shown are normally referred to as the Average Peak Intensity or **“Smooth Profiler**” intensity.



This example shows a 0.30 second section of the file collected at 2048 Hz.

It is clear from this example that the power supply is cycling.

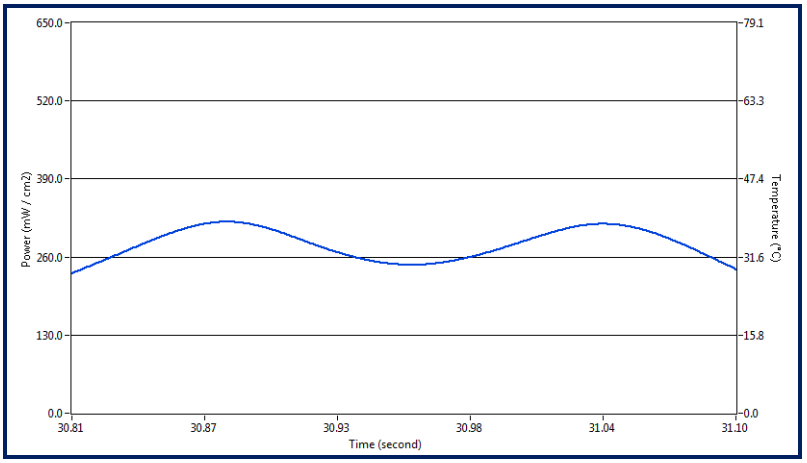
The irradiance values shown are **"Smooth Off"** values at an effective sample rate of 2048 Hz.



This example further zooms in on the example collected at 2048 Hz and shows a 0.03 second section.

The power supply is cycling.

The irradiance values shown are **"Smooth Off"** values at an effective sample rate of 2048 Hz.

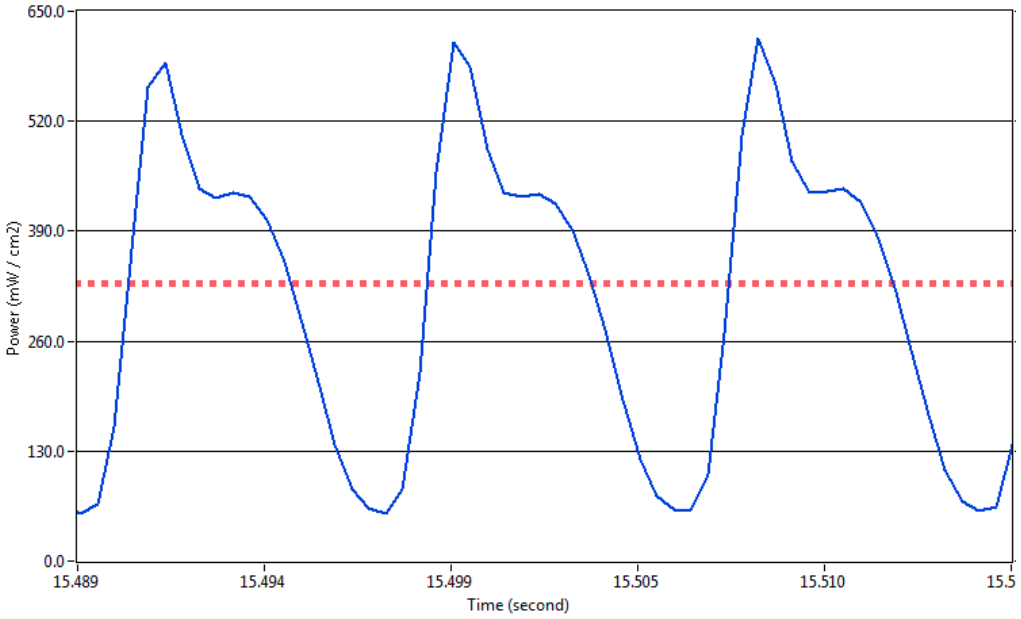


This example shows the same 0.30 second section of the UV lamp in the top example on this page, with an effective sample rate of 128 Hz.

The irradiance value is the RMS or **"Smooth Profiler"** irradiance at an effective sample rate of 128 Hz.

The irradiance profile below shows two other files.

- The time on the X-Axis is approximately 0.026 seconds
- The blue irradiance profile below shows data collected at 2048 Hz (**SMOOTH OFF**)
- The peak irradaince value for this blue file is 618 mW/cm^2, EIT 2.0 LLC UVA
- The red irradiance profile below shows data collected at 128 Hz (**SMOOTH PROFILER**)
- The peak irradiance for this red file was 329 mW/cm^2, EIT 2.0 LLC UVA.
- Both values are technically correct and are based on the how the UV was sampled and is reported.

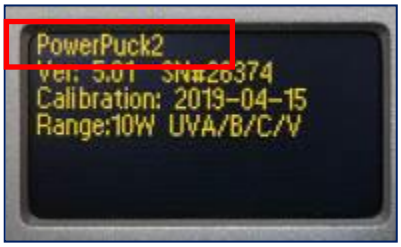


Instrument and Types Software

There are two versions of each “Puck” style instrument: “Standard Version” and “Profiler Version”

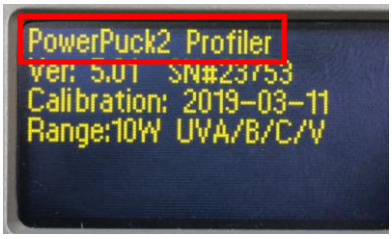
The Standard Version

- The Standard can be identified on the start-up screen as shown to the right
- All information is shown on the display of the instrument
- Standard Puck style instruments with USB ports can be upgraded to a Profiler Versions at EIT 2.0



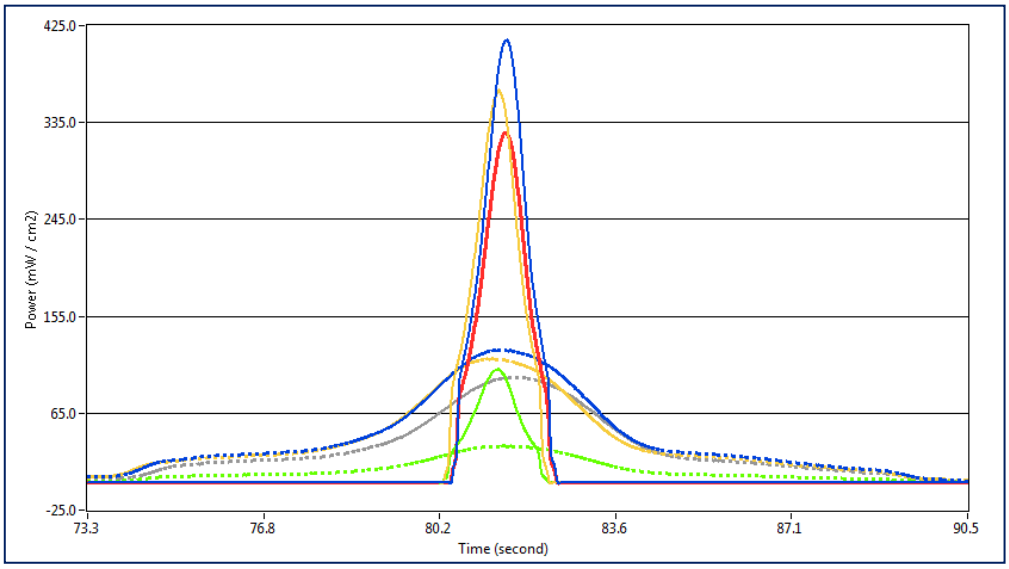
The Profiler Version

- Profiler versions are available for the Power Puck II, UviCure Plus II and LEDCure. Each unit operates the same as the Standard Version of the instrument
- The Profiler option needs to be specified when the instrument is ordered
  The Profiler Version adds the ability to download the irradiance profile (Watts/cm^2 as function of time) to a computer using EIT LLC’s PowerView® III Software (https://www.eit20.com/products/uv-measurement-products-and-software/eit-instrument-markets-software/)



- The Profiling function allows for detailed analysis of the UV sources and application. The Profiler quickly identifies bulb type, focus, changes in speed and power. It also allows the user to break down the contribution from each individual lamp on multi-lamp systems.
- EIT LLC’s UV PowerView® III Software for **Profiler enabled instruments** is available from the EIT 2.0 website and is designed to work on Windows 7-10
- **For best matching between the instrument display values and PowerView III calculated values, the sample rate of the Profiler enables instrument should be set to SMOOTH Profiler**
- More information on Profiler instruments is available from EIT 2.0 or local EIT 2.0 representative/distributor
- Please contact EIT 2.0 to see if your “Standard Version” instrument can be upgraded to a “Profiler Version”

Examples of PowerView III screens are below



Left: PowerView III Graph View with UV irradiance on the Y-Axis and Time on the X-Axis.

Two files are shown with different irradiance levels and data collection speeds

Right: Data Table Summary with Watt and Joules values from two files

Summary By Table

	Sample File	Reference File	Difference	%
UVA- Power (mW/cm2)	411.703	123.707	287.996	232.8
UVB- Power (mW/cm2)	364.889	115.459	249.430	216.0
UVC- Power (mW/cm2)	105.443	34.338	71.105	207.1
UVV- Power (mW/cm2)	325.437	98.340	227.096	230.9
UVA- Energy (mJ/cm2)	444.784	718.538	-273.753	-38.1
UVB- Energy (mJ/cm2)	396.529	670.646	-274.117	-40.9
UVC- Energy (mJ/cm2)	118.129	205.020	-86.891	-42.4
UVV- Energy (mJ/cm2)	358.530	567.458	-208.927	-36.8
Enable cursors	ON			
Time	70.17			
Time - Ref	94.12			
Smoothing	ON			
Sync Plots	ON			
Use Threshold	OFF			

EIT 2.0 LLC UV Measurement Products are designed and built in the USA

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