Data Collection Techniques

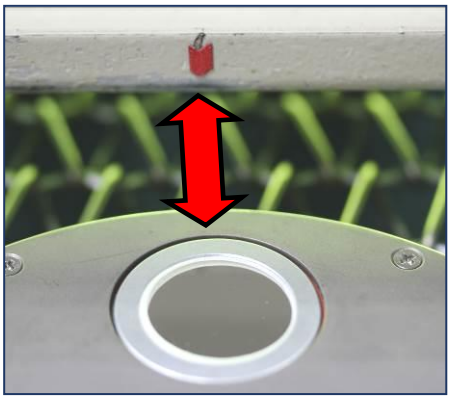
Collect the data in a consistent manner for consistent results. The following techniques will help you to get better data with the Power Puck II or UviCure Plus II.

1. Match the ***Instrument Response*** to the source
    - The Power Puck II and UviCure Plus II bands (UVA, UVB, UVC and UVV) were designed and optimized for mercury based sources
    - Your will get numbers on the instruments when they are used on a LED but chances are the numbers will be under or over reported and vary source-to-source and instrument-to-instrument

2. Match the ***Dynamic Range*** of the instrument to the source
    - The Power Puck II and UviCure Plus II are available in three dynamic ranges
    - The ranges below are based on the irradiance (intensity) of the source, not the number of Joules that will be collected
    - **Suggested Operating Ranges** for Power Puck II and UviCure Plus II instruments
        - **10 Watt Standard (High- H) Range:**
            - UVA, UVB, UVV - 100mW/cm² to 10W/cm²
            - UVC - 10mW/cm² to 1W/cm²
        - **1 Watt Mid (M) Range:**
            - UVA, UVB, UVV -10mW/cm² to 1W/cm²
            - UVC: 1mW/cm² to100mW /cm²
        - **100 milliWatt Low (L) Range:**
            - UVA, UVB, UVV - 1mW/cm² to 100mW/cm²
            - UVC - 1mw/cm² to 100mW/cm²
    - Units will “turn on” (Start Threshold) at a much lower value than the Suggested Operating Range values
    - 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

3. Follow EIT 2.0 LLC ***Optics Cleaning Guidelines***
    - Your Power Puck II or UviCure Plus II is an electro-optical instrument designed to measure UV in an harsh environment
    - Follow the Guidelines in Appendix A of this User’s Guide for proper cleaning techniques
    - The Guidelines as well as an instructional video on proper cleaning techniques are posted on our website at: https://www.eit20.com/products/instrument-care-service-ordering/instrument-care/

4. Use ***Consistent Data Collection Techniques***
    - 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
    - On wide arc based systems, consider taking multiple readings (left-middle-right) across the width of the conveyor



5. Evaluate your ***UV System Stability***
    - 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.

6. Perform ***UV System Maintenance***
    - Keep 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
    - Maintain the belt/conveyor tension to prevent slippage
        - Inconsistent speeds can lead to variations, especially in the Joule readings
    - Verify the correct bulb type has been installed and that it is situated in the reflector as expected
    - 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. Watch the ***Instrument Temperature***

    - 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
    - Avoid pre-heat, "flash-off" and/or IR sections of your line
    - 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 Power Puck II or UviCure Plus II cool between readings
    - Rule of Thumb: If the instrument is too hot to touch, it is too hot to measure

8. 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

9. Maintain Your Instrument
- EIT 2.0 instruments are calibrated on a six month cycle. The Power Puck II and UviCure Plus II can be used in harsh conditions including intense energy (UV, visible, infrared), temperature and coatings
- Instruments can become coated, dropped or stuck in a system
- When your instrument needs service, use EIT 2.0 or an EIT 2.0 LLC Authorized Service Center
    - 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

Customer damaged instruments

10. 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 Rate

Instrument Sample Rate

Instrument Sample Rates

Collecting accurate, repeatable source values depends on getting an adequate number of samples while the instrument is under the UV source. The area of peak irradiance normally corresponds to the bulb diameter; typically 0.35-0.75" (9-19 mm).

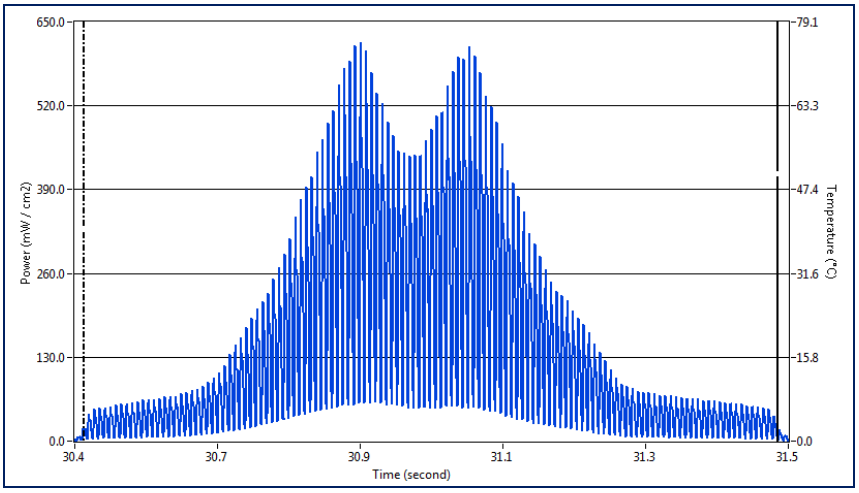
EIT 2.0 LLC instruments designed in the early 1990's were state-of-the-art for the time and featured a 'blazing' sample rate of 25 Hz (samples per second). The two-button Power Puck/UviCure Plus units had a maximum suggested 'speed limit' of 40 feet (12 meters) per minute to allow the units to collect an adequate number of samples to measure the peak irradiance and energy density values. Exceeding the suggested 'speed limit' when collecting data would lead to variations, especially in the irradiance values.

As technology improved, the sample rates in our instruments have also dramatically increased. The PowerMAP when released had a user adjustable sample rate of 128-2048 Hz (samples per second) and the MicroCure a sample rate of 2048 Hz.

The data (especially the irradiance value) collected and displayed EIT 2.0 LLC instruments can vary based on the:

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

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

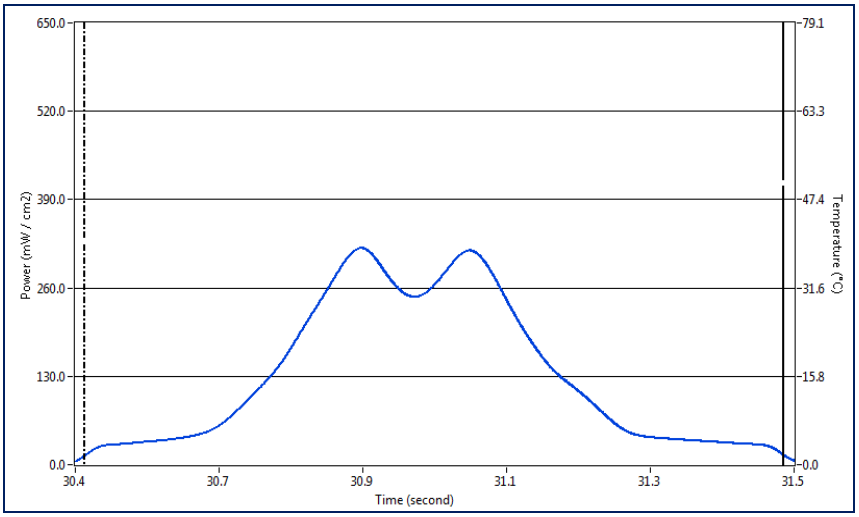


The data in this example was collected at an effective sample rate of 2048 Hz.

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.

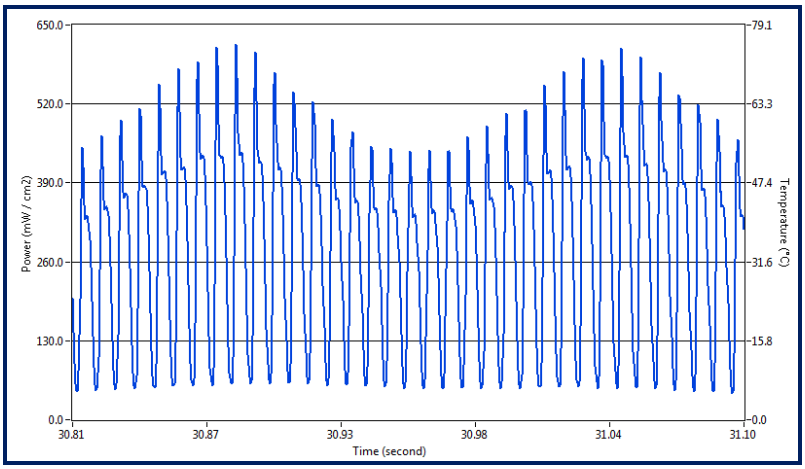


The data in this example was collected at an effective sample rate of 128 Hz.

The peak UVA irradiance in this example is **318.3 mW/cm²** and the UVA energy density is **139.9 mJ/cm²**

The irradiance profiles shows the average RMS lamp power.

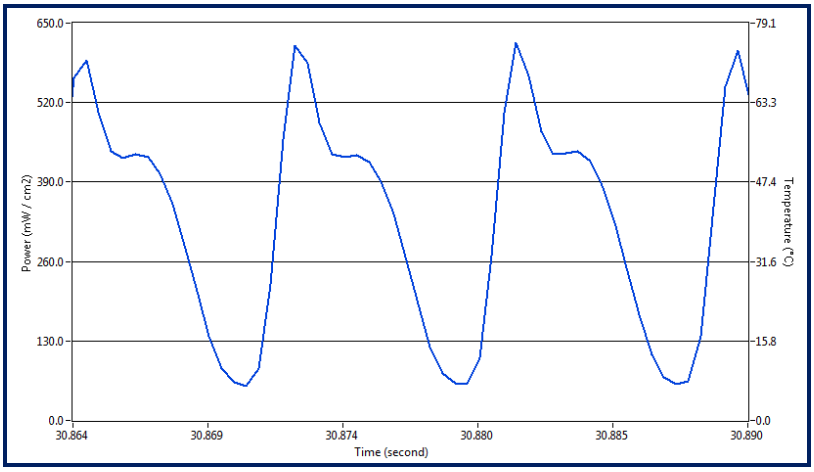
The irradiance values and profile shown are normally referred to as the Average Peak Intensity or **"Smooth Profiler**" intensity.



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.

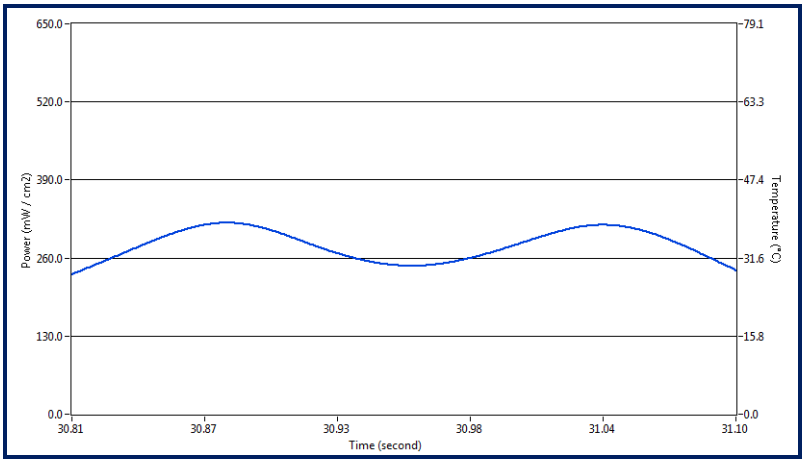
The irradiance values shown are **"Smooth Off"** values at an effective sample rate of 2048 Hz.



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

It is clear that the power supply is cycling.

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

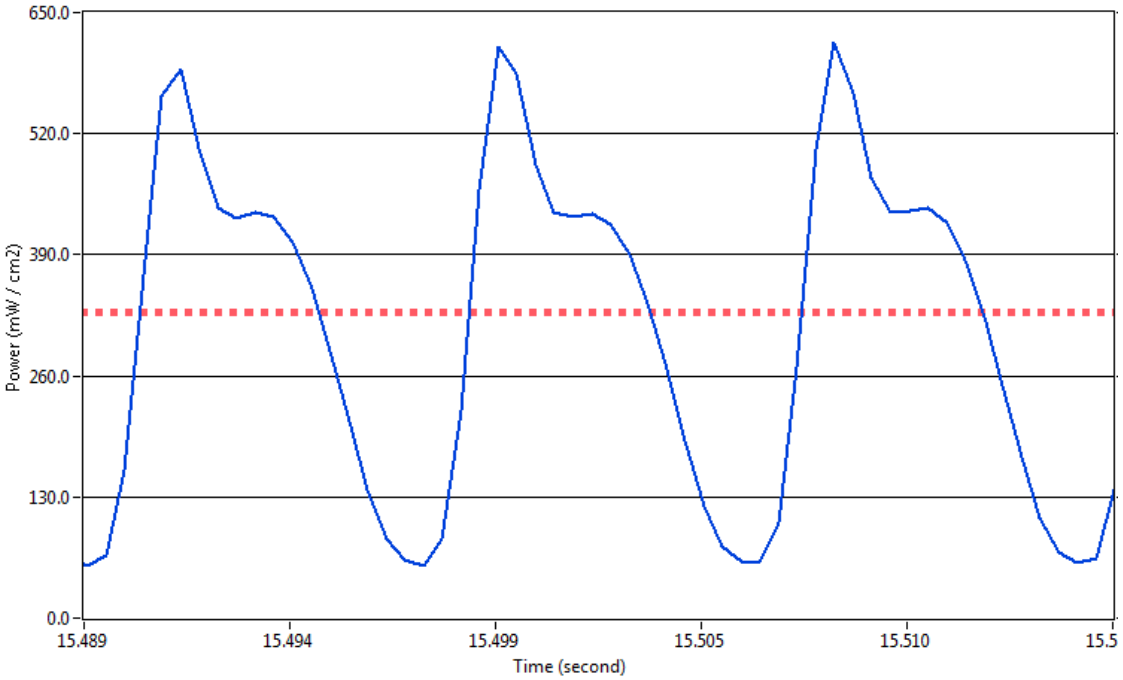


This example shows the same 0.30 second section of the UV lamp in the top example on this page, with an effective sample rate of 128 Hz.

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.



Smooth/Smoothing

The UviCure Plus II and Power Puck II 'oversample' at a very high sample rate. The user is able to adjust the effective sample rate to one of three settings in the set-up menu of the instrument.

The effective sample rate is based on the Data (not Optical) Filter Bandwidth. EIT 2.0 LLC instruments use different bandwidths for the data filters.

From a technical standpoint we use 7, 35 and 700 Hz data filters in the UviCure Plus II and Power Puck II instruments.

The three data filters in the Power Puck II/UviCure Plus II 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 stand point 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 irradiance values on old two-button legacy Power Puck and UviCure Plus units
    - Old Legacy units should not collect data as lines speeds over 40 feet (12 meters) per minute
    - All support on the legacy Power Puck and UviCure Plus units ends December 31, 2019

SMOOTH: PROFILER

- **SMOOTH PROFILER** displays the Peak Irradiance at an effective sample rate of 128 samples per second (128 Hz)
- This rate matches the slowest sample rate on the PowerMAP and PowerMAP II systems

SMOOTH: OFF

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

"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 have the ability to 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.

Please see **Appendix C** for more information on **PROFILER** enabled instruments

Right: Display referring to SMOOTH PROFILER (Sample Rate)

Far Right: PROFILER Enabled Instrument