Measuring Flashed, Pulsed, and Other *Short-Lived Light* Phenomena

Presented by

InternationalLight Technologies

A DIVISION OF LABSPHERE

Recorded Presentation

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Goal

For 90%+ of the flash/pulse measurement use-cases, this training leaves the customer with a prescribed method to make proper and informed measurements with the appropriate ILT system and measurement method

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Agenda

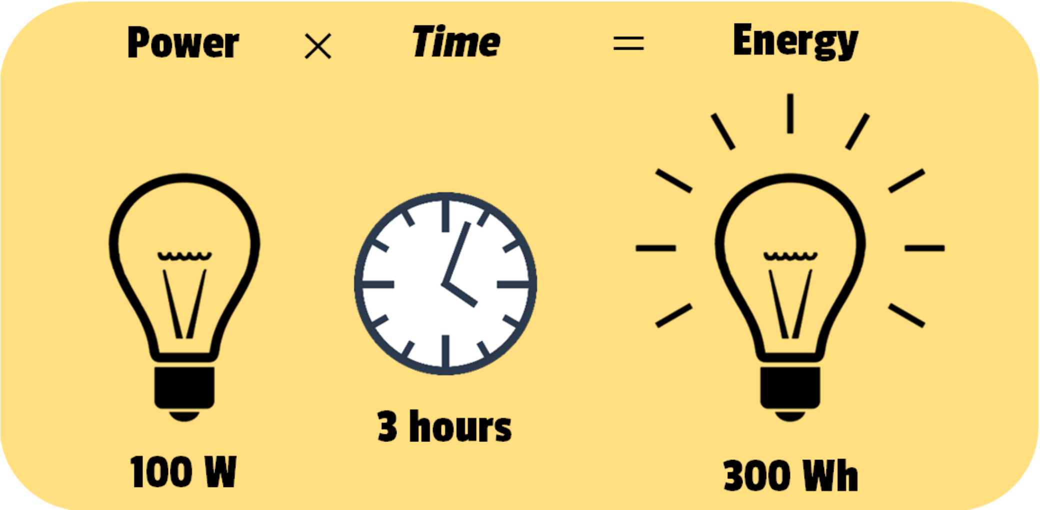
- The Problem Statement
- Energy vs power
- Short-lived light (flash, strobe) sources and applications
- ILT Meters, software, and modes for measuring short-lived light phenomena
- Measurement examples
- Appendix: Measurement Considerations

The Problem Statement

- Measuring light can be tricky. Measuring *short-lived light* can be very difficult, requiring:
  - Coordination of the [abrupt] presence of the light power and the start of the data capture
  - High-speed data sampling to reliably capture the short-lived light occurrence with acceptable time resolution
  - Wide or selectable dynamic range to properly capture momentary peaks in power
  - The ability to comprehend the measurement results, understanding the [potential] difference between physical phenomena and measured results

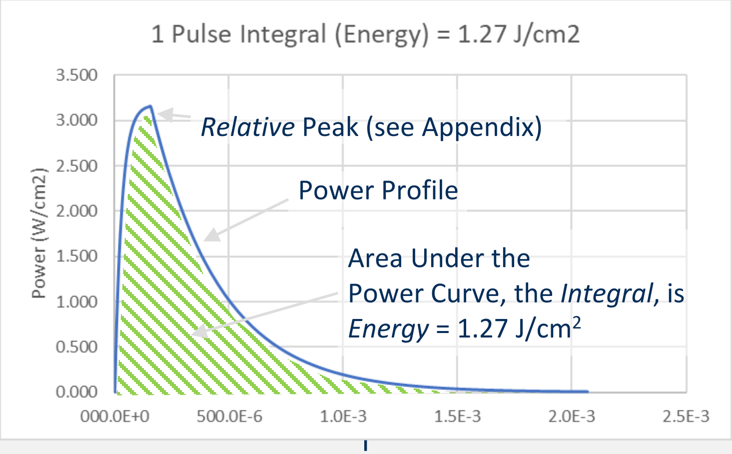
Energy vs Power

- Energy is the integral, over time, of power
- There is electrical power and radiant power
  - Don't confuse these!
- For short-lived light (flashed and pulsed):
  - Energy can be reliably measured
  - Power, in some cases, can *not* be reliably measured (more later)
    - *Due to the difference between the physical world and the light meter's analog front end (AFE)*

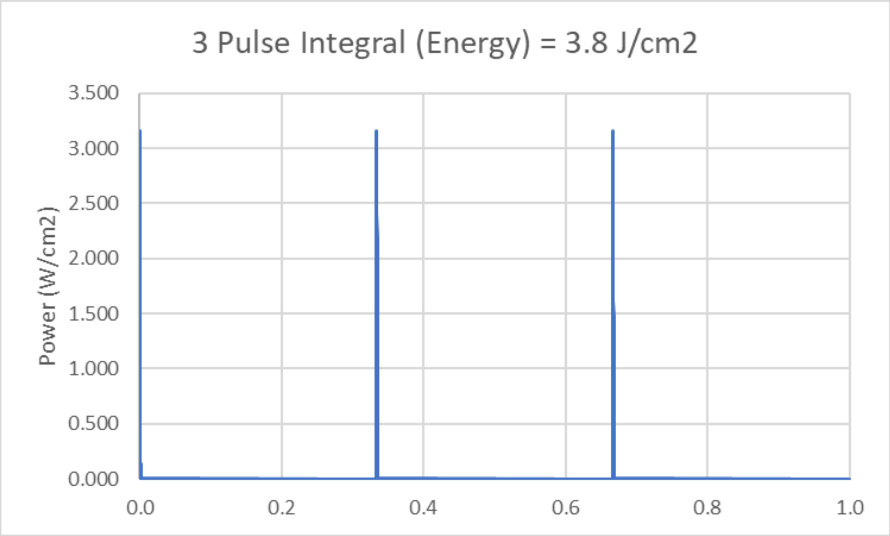


Energy as the Integral of Power

Single Pulse



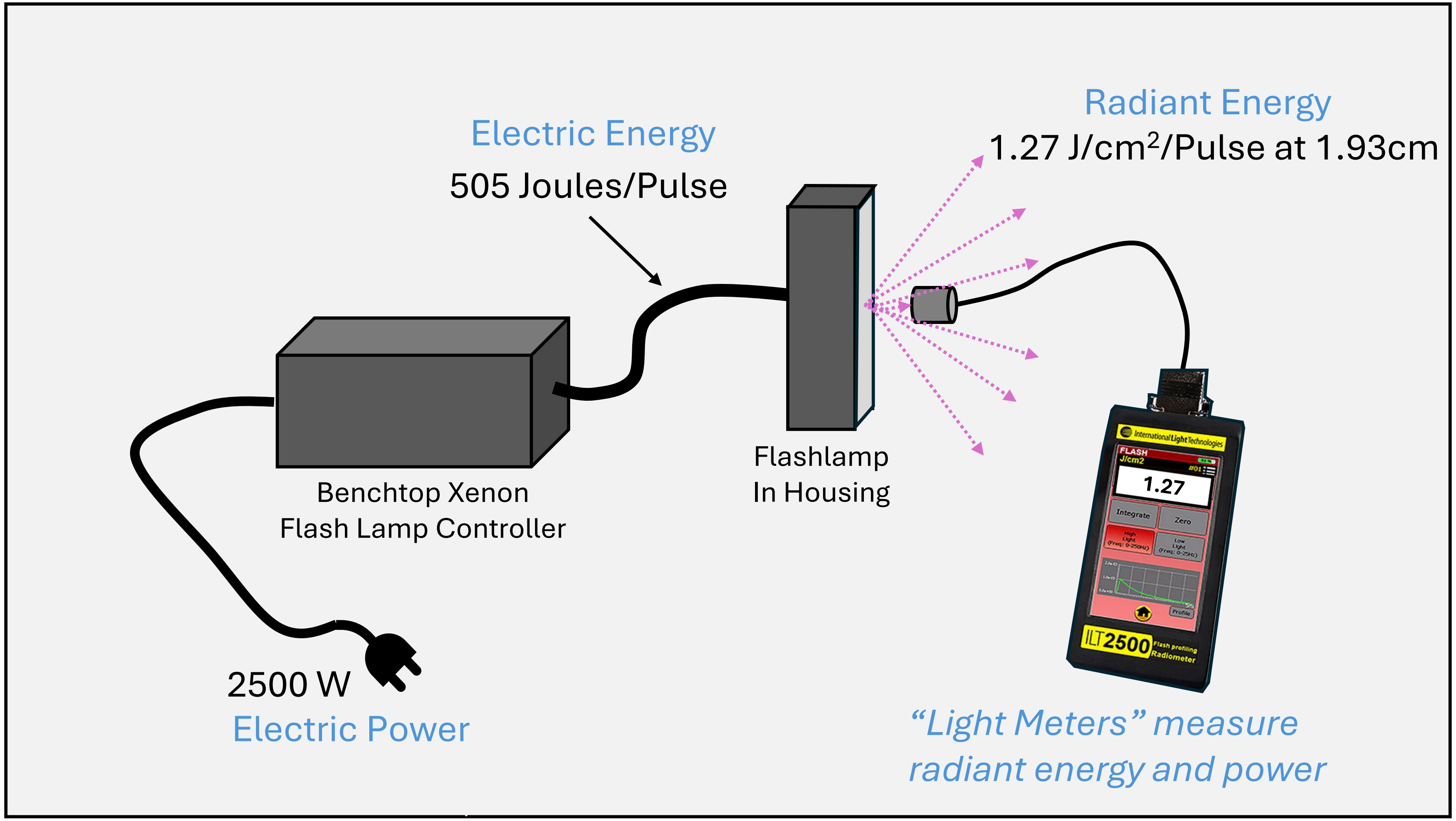
Three Pulses per Second (3 Hz)



Note change in X-axis time scale required to depict all three pulses. The area under each curve, the integral or total energy, is still 1.27 J/cm2

Energy vs Power

Electric power supplies electric energy input to a lamp which, in turn, produces radiant energy



Common Power and Energy Units

Application	Power Units	Energy Units
UV-C Disinfection	W/cm^2	J/cm^2
Camera Flash	Lux ($Lumen/m^2$)	Lux-Seconds
Warning/Indicator Strobes	$Candela/m^2$	$Candela\text{-}Seconds/m^2$
Laser Safety	W/cm^2	J/cm^2

Power and Energy
also known as…

Power

- Irradiance
- Intensity
- Fluence Rate

Energy

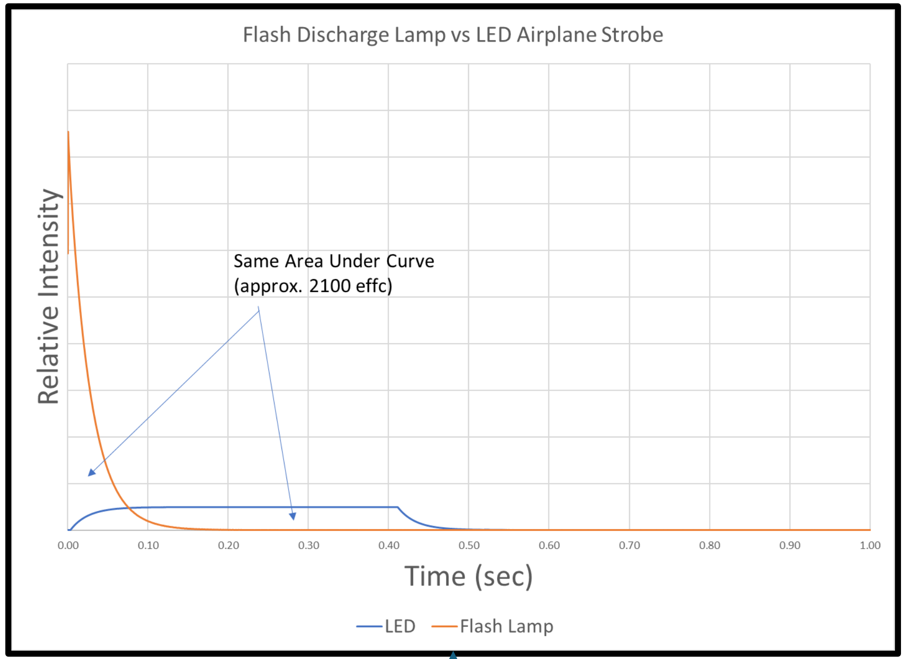
- Exposure
- Dose
- Fluence

Energy: Discharge vs LED Flash

- Discharge flash
  - Abrupt, brief, high-power output
  - Pulse duration is typically 10s of microseconds

- LED "flash"
  - More gradual, longer, lower-power output
  - Pulse duration is typically on the order of 100s of milliseconds

- But the *energy* can be equivalent
  - Energy is the area under the curve



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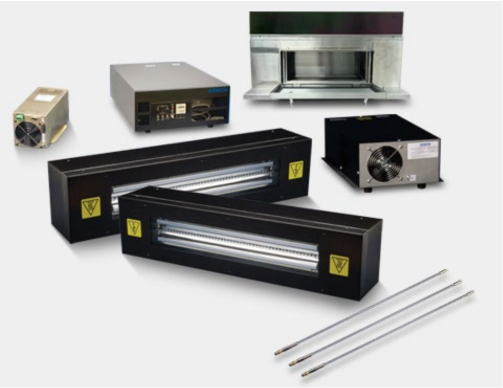
Short-Lived Light Sources



Pulsed Xenon Sources

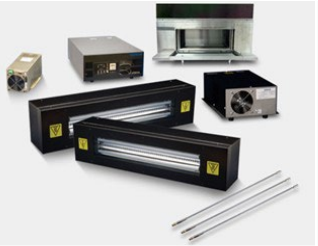
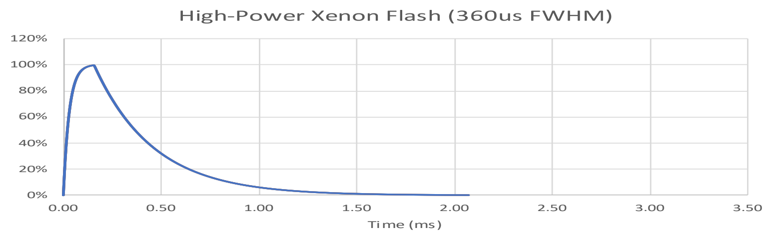
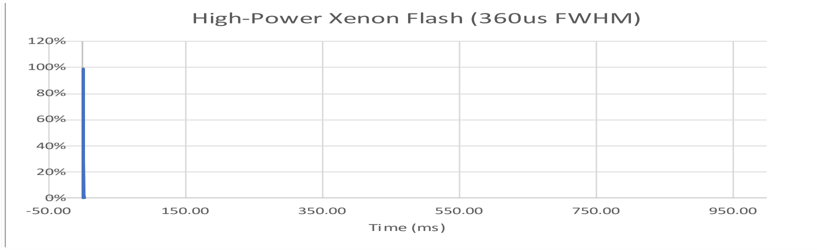
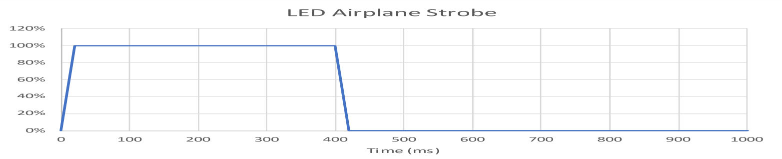
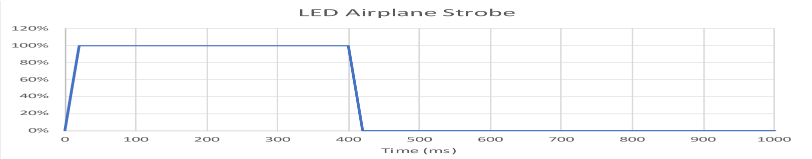
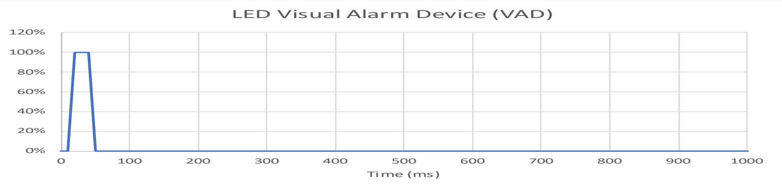
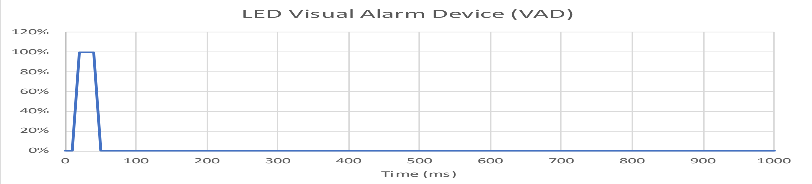
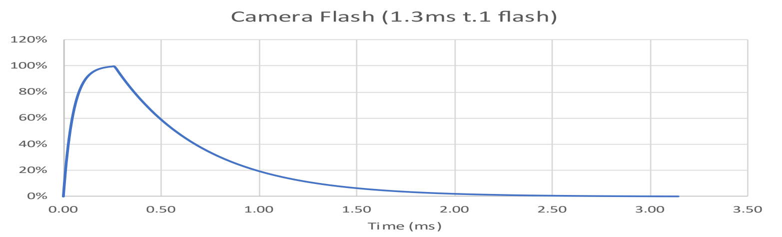
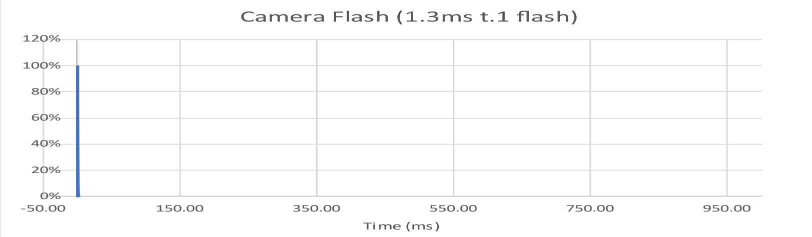
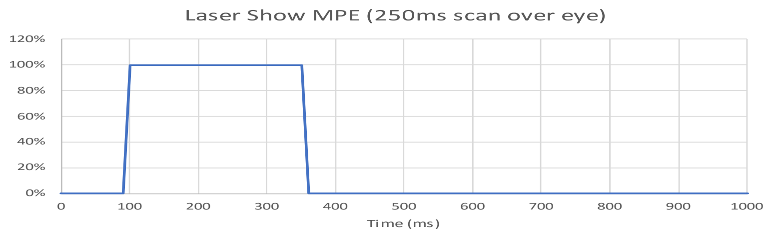
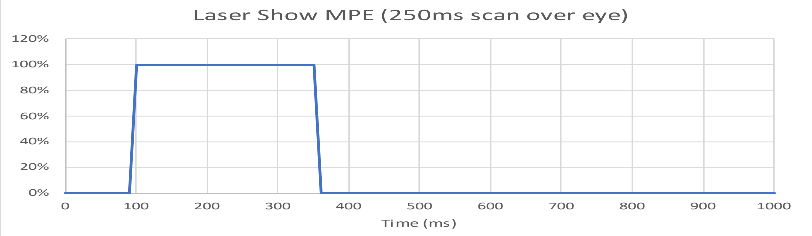
Airplane [Wing] Strobes

Laser Light Show, “Audience Scanning”

Fire Alarm Strobe

Camera Flash

Power-Over-Time, Various Sources

Type	Example	Time Scale Zoomed	Time Scale 1s
Xenon Flash			
LED Aircraft Strobe			
Fire Strobe			
Camera Flash			
Scanning Laser			

ILT Light Meter SLL Measurement

Meter or Application	Measurement Method	Internal API Used	Flash Detection Method	Detects
ILT1000, 2400, 2500, 5000	Start/Stop Integrate	startintegrate	N/A	Integral (Energy)
ILT1000, 2400, 2500, 5000	FW Peak[1]	startpeak	N/A	Peak Power[2]
Windows Flash App (ILT1000, 2400, 2500, 5000)	Flash Capture, Flash Profile	captureflash	Minimum Light Level External Trigger (ILT5000)	Integral (Energy), Profile (Power-over-time)*
Windows Flash App (ILT1000, 2400, 2500, 5000)	Repeating Profile	startpeak	ILT Flash Detect Algorithm	Integral (Energy), Profile (Power-over-time)*
ILT2500	Flash Applet	startintegrate startpeak	ILT Flash Detect Algorithm	Integral (Energy), Profile (Power-over-time)*
ILT2500	Beacon Applet	startpeak	ILT Flash Detect Algorithm	Integral (Energy)

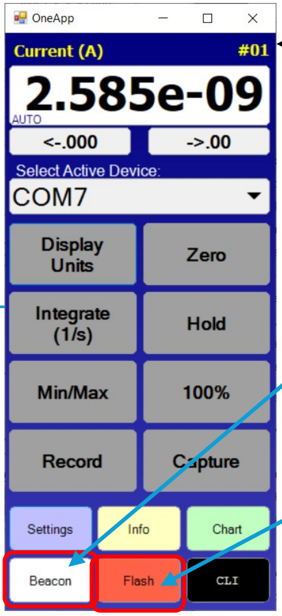
1. FW [Firmware] Peak described later on Slide 25, Note 2.
2. The power levels for high-speed sources (i.e. discharge sources) presents a relative power level (See Appendix)

Measurement Examples

Measurement Setup

- Ensure the flash or strobe power level rises well above ambient power levels:
  - Dark room is recommended for visible light
  - Lighted room is acceptable when the detector is “visible blind” (the detector filters out visible light), for example when measuring UV-C flash
  - Position the detector as close as practical to the source, without saturating the detector
- Ensure the meter is configured for the following:
  - Fixed range (Auto Gain Range = OFF) to ensure the power burst is not missed during a gain range change
  - Integrating Mode = Flash and Min/Max Mode = FW Peak, both to instruct the meter’s CPU to favor measurement over monitoring user UI activity
  - 5V Bias = ON, to ensure fastest possible detector response to the power burst (See Appendix for more information)

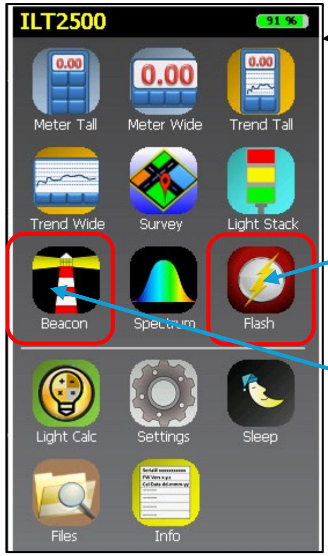
App Reference



"Windows Meter App" (ILT1000,2400, 2500,5000)

"Windows Meter App Beacon Applet"

"Meter Windows App Flash Applet"



ILT2500 Home Screen

"ILT2500 Flash Applet"

"ILT2500 Beacon Applet"

ILT DataLight III Desktop Folder

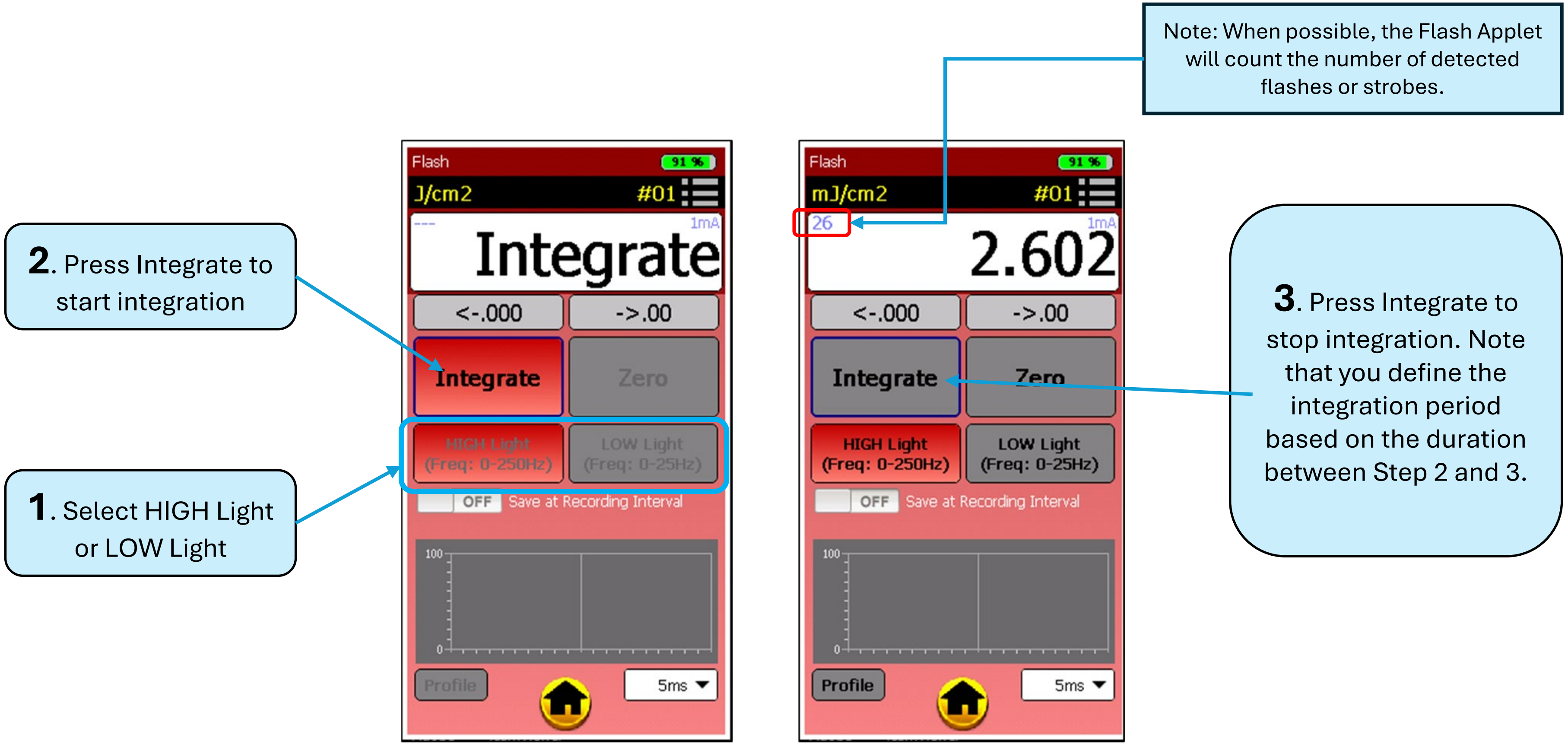
"Windows Flash App" (ILT1000,2400, 2500,5000)

Name	Date modified	Type	Size
CLI	8/18/2022 9:41 AM	Shortcut	3 KB
Datalog	8/18/2022 9:41 AM	Shortcut	3 KB
Flash	8/18/2022 9:41 AM	Shortcut	3 KB
FW Update	8/18/2022 9:41 AM	Shortcut	3 KB
Meter	8/18/2022 9:41 AM	Shortcut	3 KB
NetConfig	8/18/2022 9:41 AM	Shortcut	3 KB

Utilizing the Flash Applet

This applet automatically configures the meter for flash measurement

Simple Flash Integration



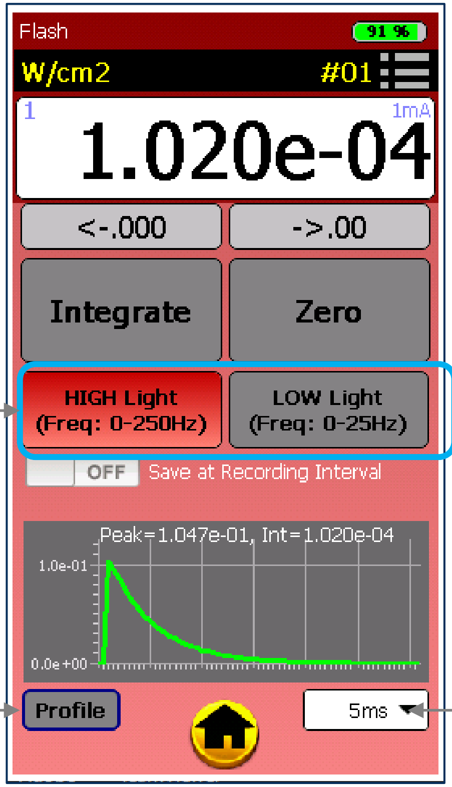
Notables:

1. ILT2500 screens shown. The Windows Meter App Flash Applet has similar screens.
2. Entering the Flash Applet sets the appropriate meter configuration automatically.
3. The HIGH Light is equivalent to the 1mA fixed range, and LOW Light is equivalent to the 3uA fixed range.

Simple Flash Profile

1. Select HIGH Light or LOW Light

2. Select Profile



Optionally
Select a profiling time (X-axis duration)

Notables:

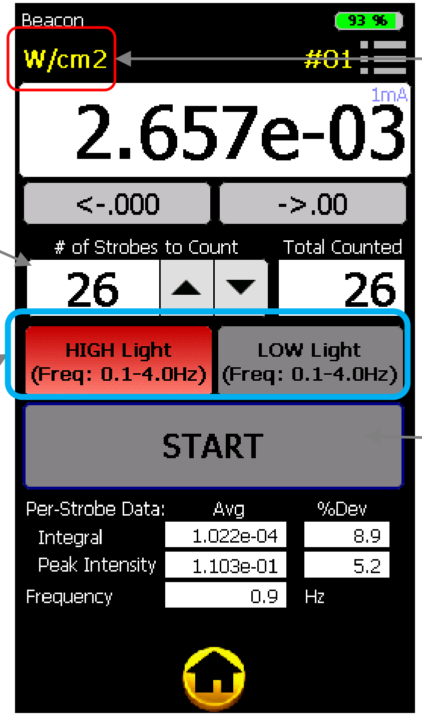
1. Notables on the previous slide apply.
2. It is important to ensure that the ambient conditions allow the flash or strobe to rise considerably above ambient such that the flash detect algorithm can sense the start of the power rise. If the algorithm fails to detect a flash or strobe, because it either rises too slowly or too little above the ambient levels, the applet will report “Timeout looking for peak”. Note that some flashes or strobes can not be detected with this algorithm. In those cases the Windows Flash App is a better solution.

Utilizing the Beacon Applet

This applet automatically configures the meter for strobe measurement

Strobe Measurement

Note: Known bug. This should read energy units, J/cm2 in this case.



1. Select the number of strobes to measure.

2. Select HIGH Light or LOW Light. Note the frequency limitations show for each.

3. Press START to start sensing, counting and analyzing the strobes.

Notables:

1. ILT2500 screens shown. The Windows Meter App's Flash Applet has similar screens.
2. Entering the Beacon Applet sets the appropriate meter configuration automatically.
3. The HIGH Light is equivalent to the 1mA fixed range, and LOW Light is equivalent to the 3uA fixed range.
4. It is important to ensure that the ambient conditions allow the flash or strobe to rise considerably above ambient such that the flash detect algorithm can sense the start of each strobe.

Utilizing the standard meter functions

These methods require YOU to configure the meter for flash measurement

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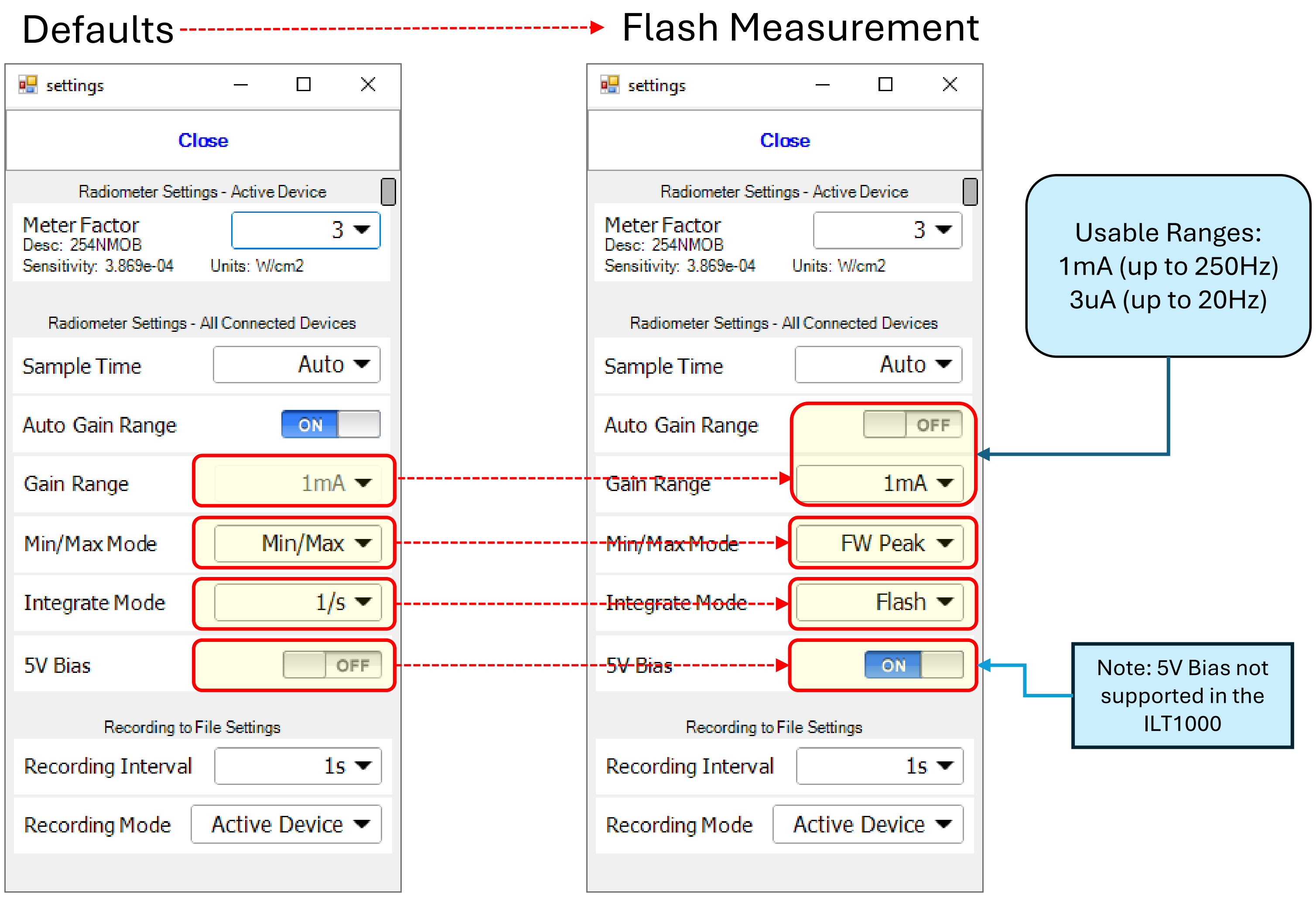
Meter Configuration

Note:
Windows Meter App shown. Press the *Settings* button to see these screens. ILT2400/2500 screens are similar.



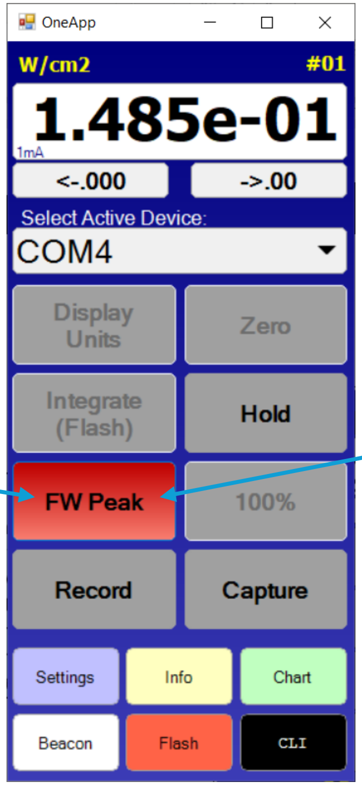
Simple Flash Integration

1. Press Integrate to start integration. Note that the gain settings will match what was configured in the earlier *Meter Configuration* slide.

2. Press Integrate to stop integration. Note that you define the integration period based on the duration between Step 1 and 2.

Simple Peak Detection

1. Press FW Peak to start peak detection. Note that the gain settings will match what was configured in the earlier *Meter Configuration* slide.



2. The peak value will be displayed on the screen. Press FW Peak to return to live sampling mode.

Notables:

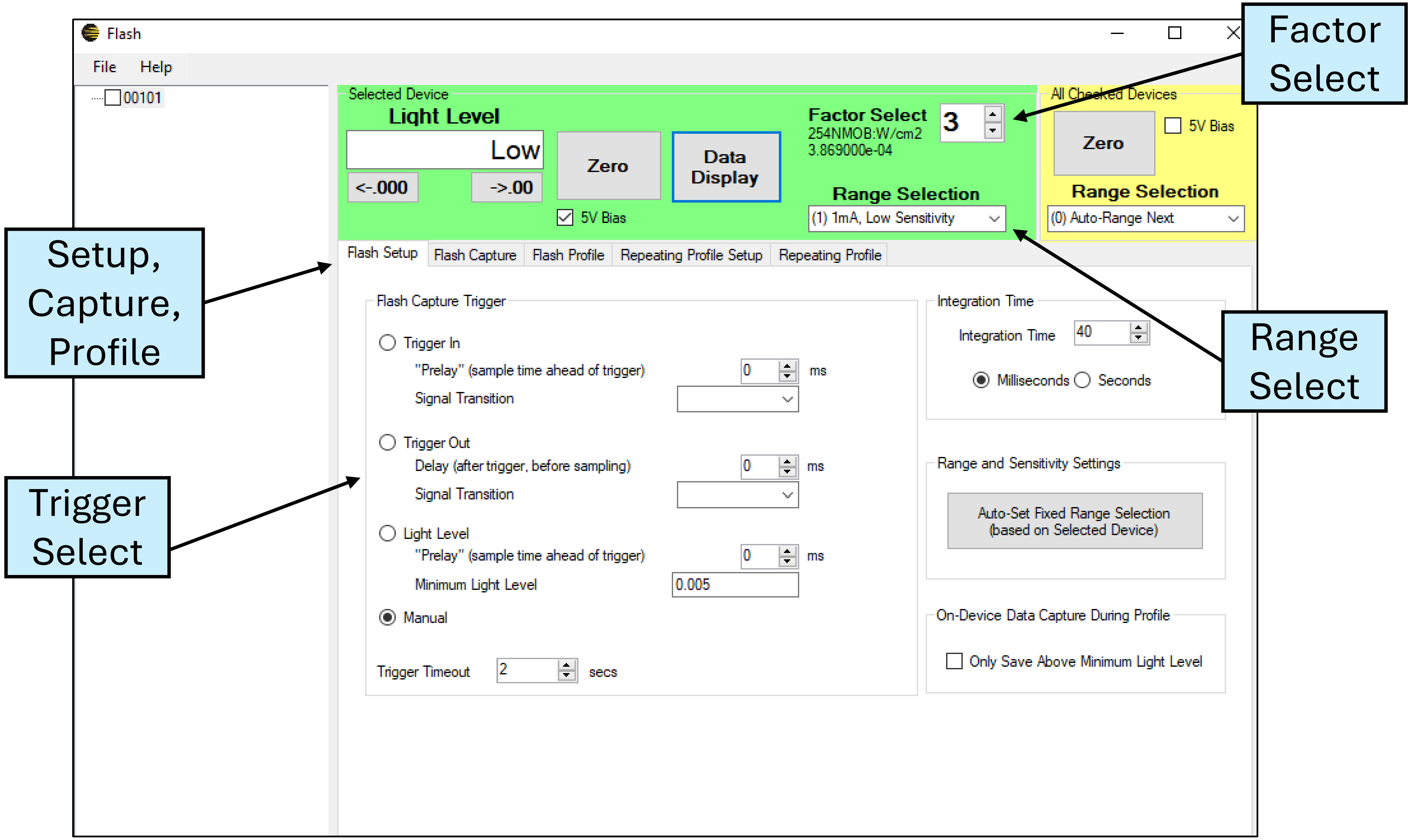
1. The Windows Meter App screen shown. ILT2400/2500 models have a similar screen.
2. FW peak is shorthand for “Firmware Peak” and indicates that the peak is being detected at the speed of firmware (several thousand samples per second) as opposed to the sampling rate (typically a few samples per second).
3. The peak detection is a good exercise prior to using the Windows Flash App, which has the option to use a power level to sense the start of a flash or strobe. This value provided by FW Peak can be used to set that power level.

Utilizing the Windows Flash App

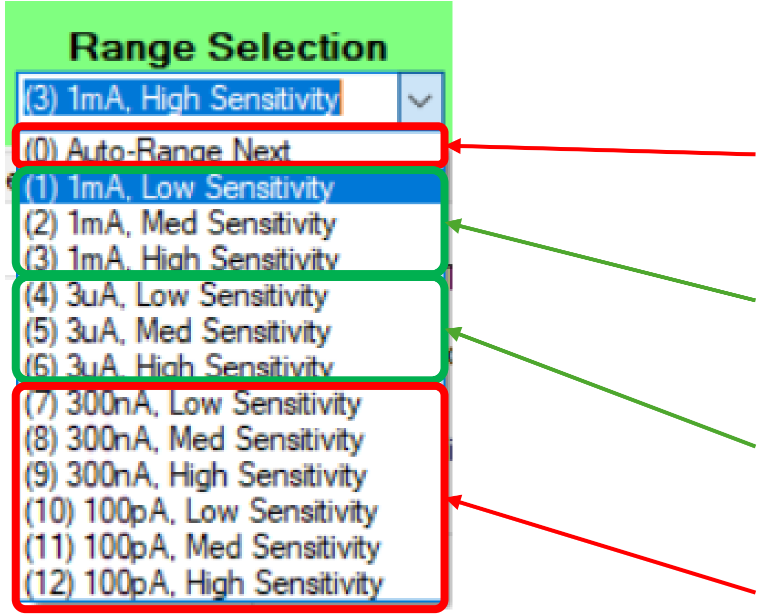
Windows Flash App

- Most feature-rich solution for capturing short-lived light occurrences
- Many “knobs” provide flexibility but also adds complexity
  - Consult the user manual for full details
- Detects the start of a flash or strobe with one of two mechanisms:
  - Detection of a rise above a configured minimum light level
  - Detection of an external trigger (ILT5000 only)
    - Not covered here

Windows Flash App



A Note on Range Selection



Not Recommended, fixed ranges preferred.

Recommended, supporting signals up to 250 Hz

Recommended, supporting signals up to 20 Hz

Not Recommended, with supported bandwidth < 1Hz

* See Technical Note on Page 42

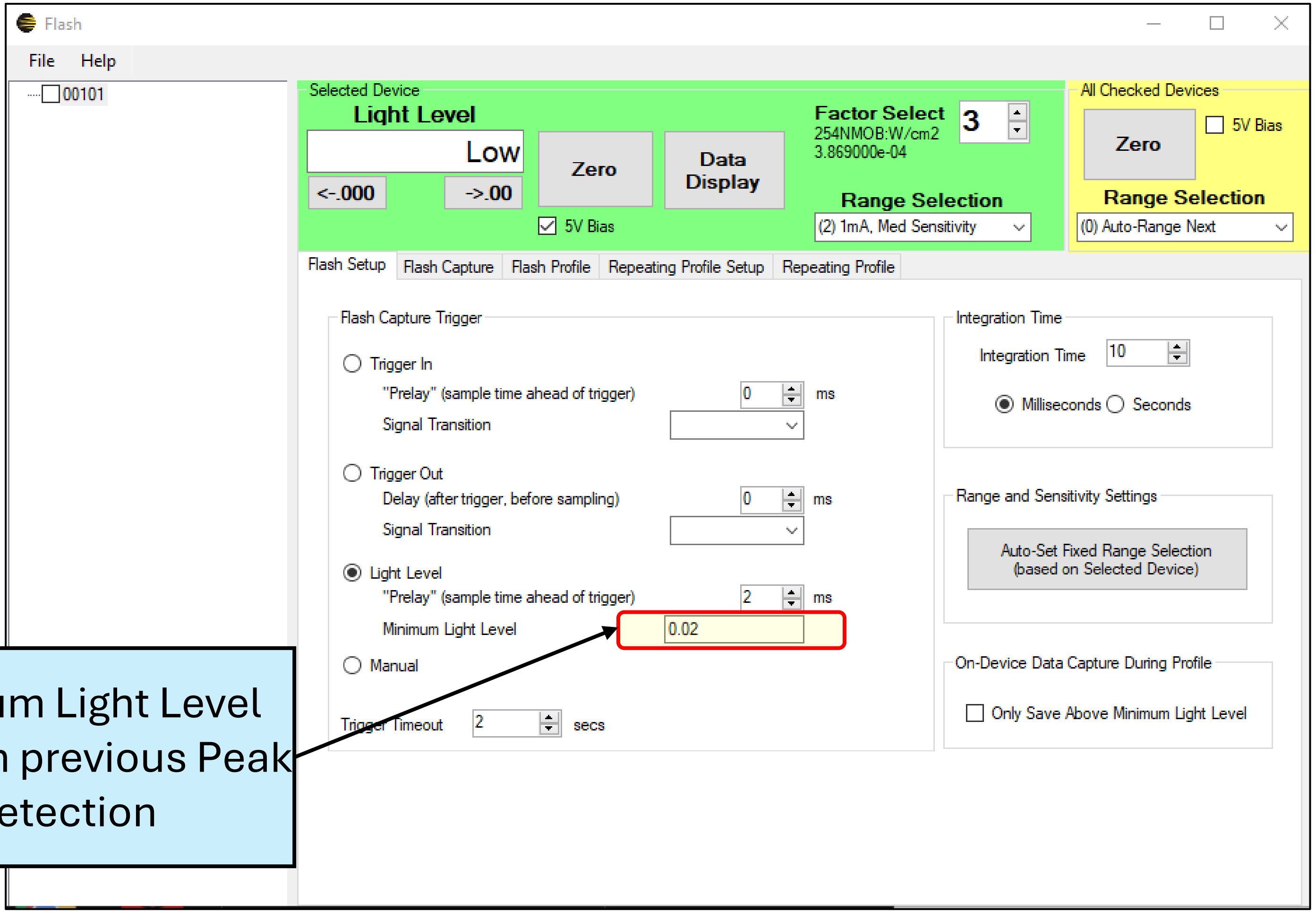
Flash Capture

- Work in an environment where the ambient background power (intensity level) is “dark” relative to the radiant energy being measured

- Learn the [relative] peak power level, either with:
  - Peak Detection mechanisms demonstrated above
  - By using a *Manual* Flash Capture Trigger
    - In cases where a repeating flashed source can reliably detect a flash within the configured *Integration Time*.

- Use a *Light Level* Flash Capture Trigger
  - Set the Minimum Light Level to a fraction (typically 1/4th) of the measured peak power level

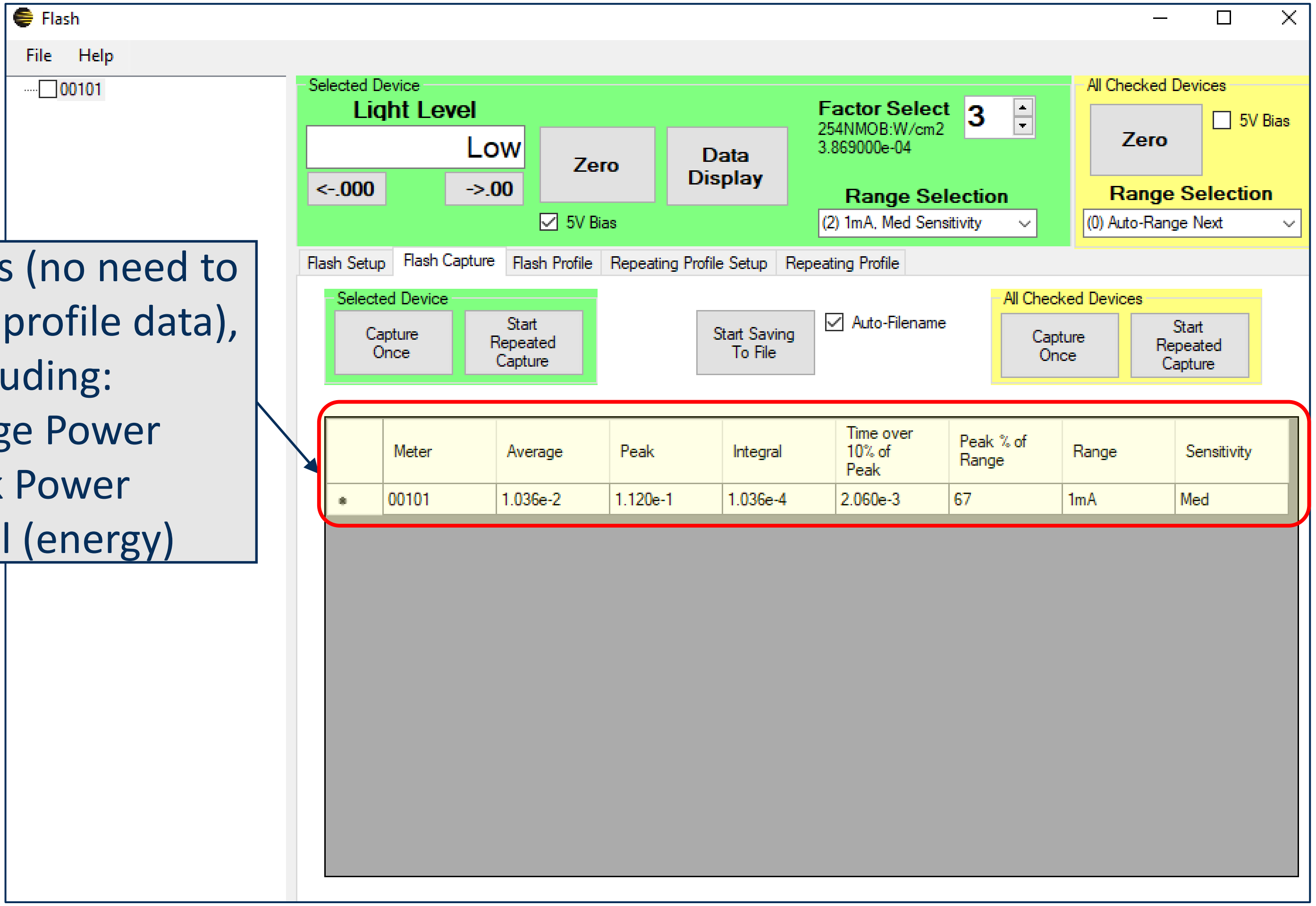
Light Level Trigger



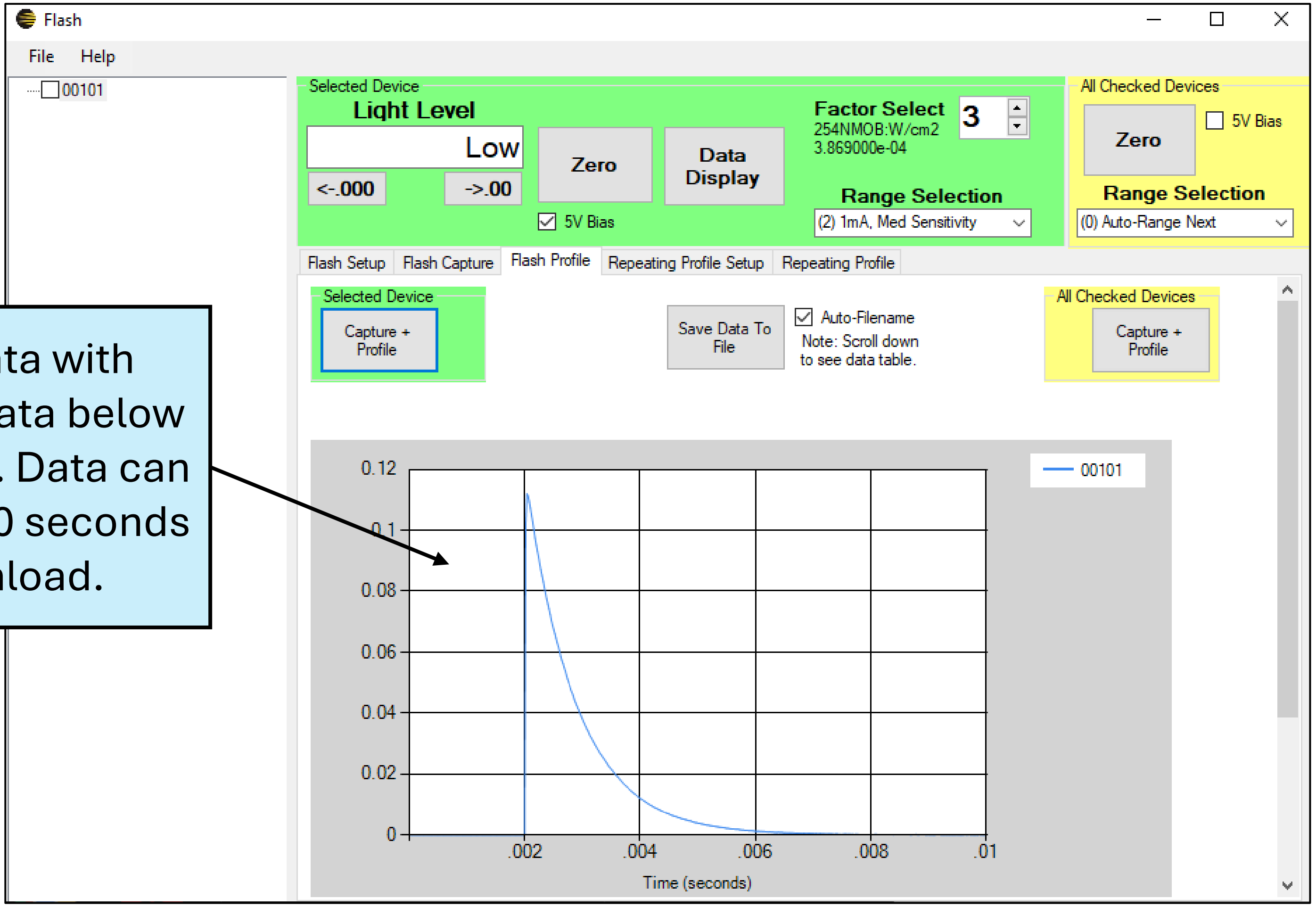
Minimum Light Level based on previous Peak Detection

Capture Once Results

Fast results (no need to download profile data), including:
Average Power
Peak Power
Integral (energy)

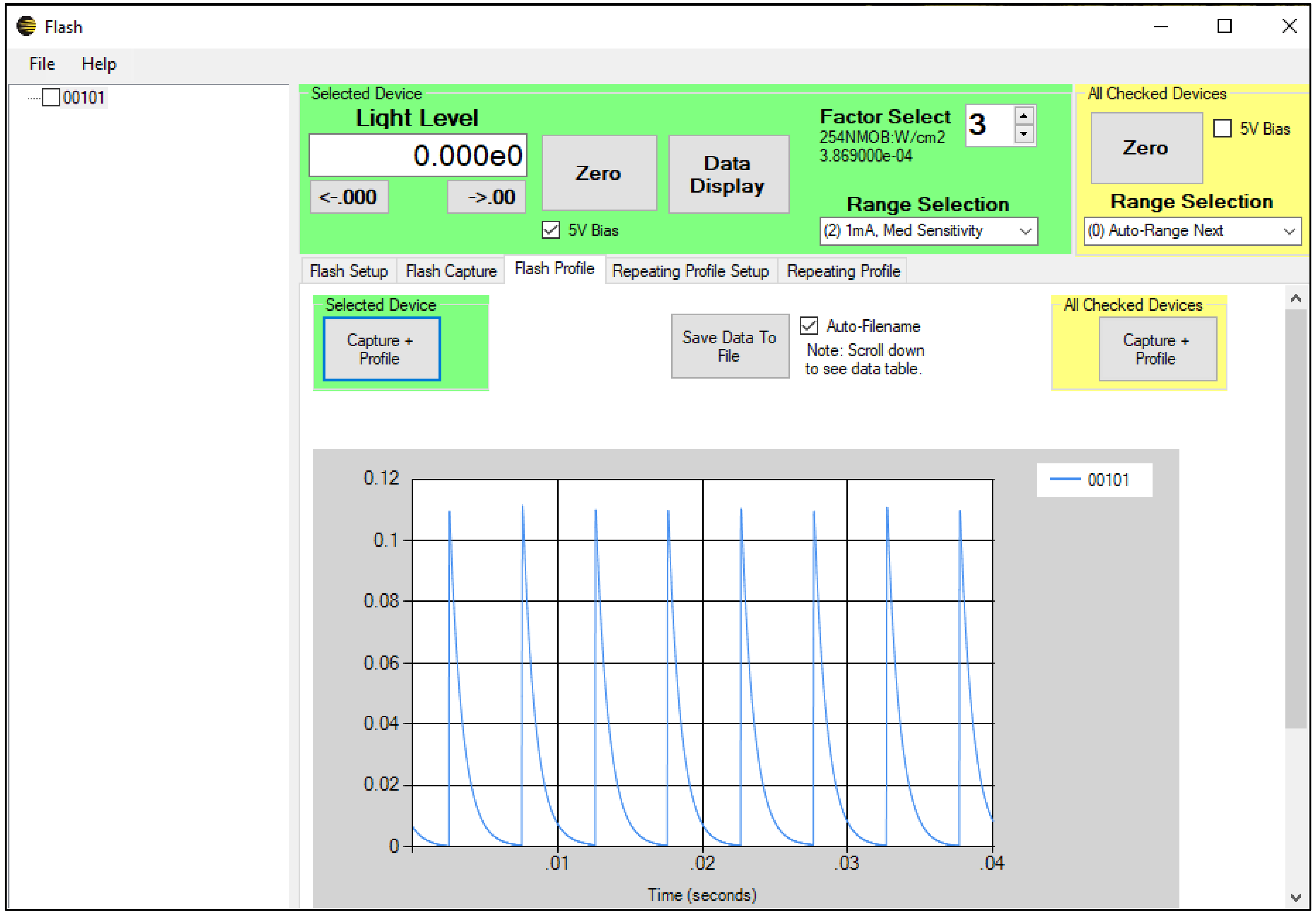


Capture + Profile (Single Pulse)



Profile data with tabulated data below (not shown). Data can take up to 20 seconds to download.

Capture + Profile (Pulse Stream)



Appendix

Measurement Consideration

- Detector Covers
- Detector BIAS
- Relative Peak
- Other References

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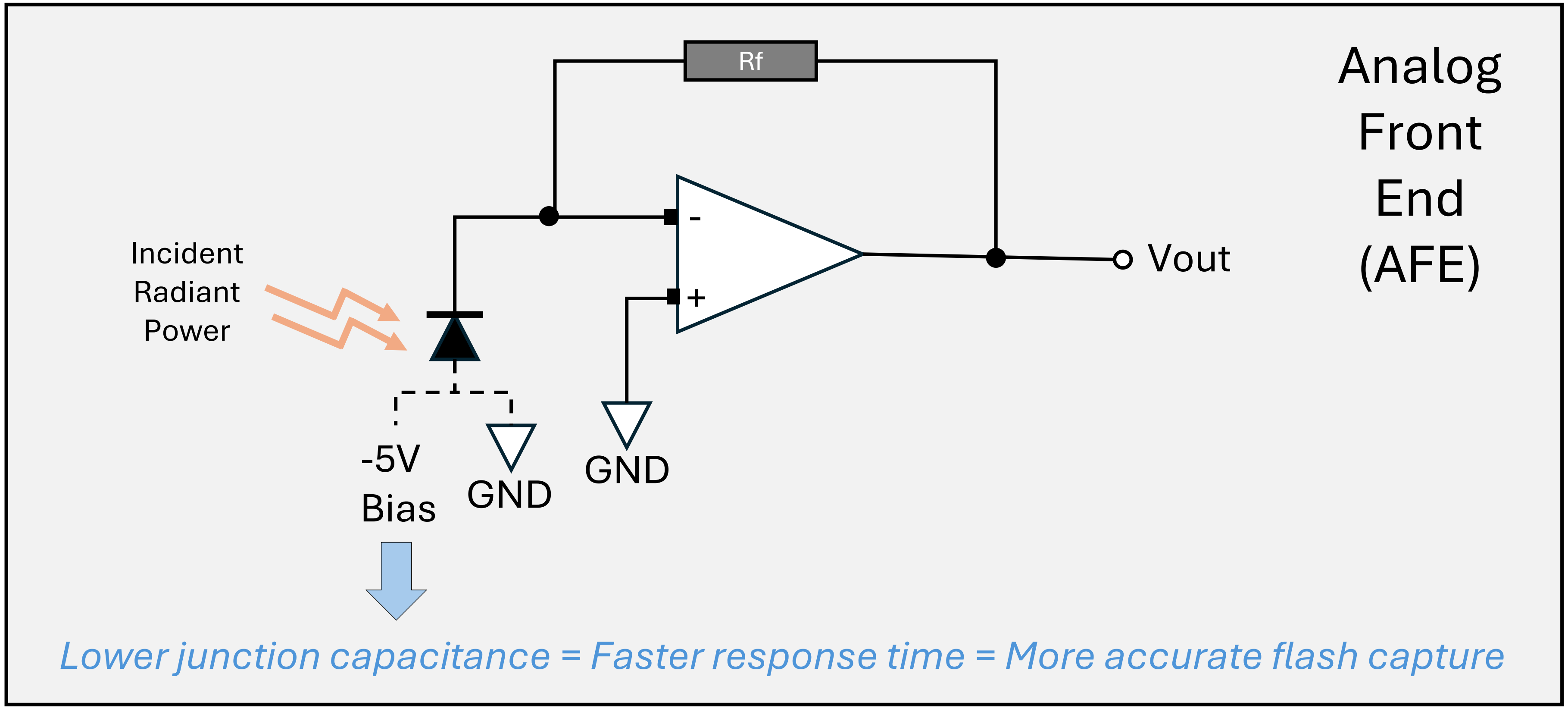
Remove the protective cover!

Protective cover. This must be removed.

Cover removed. Your “intake optic” may be larger, smaller, domed, etc.

"Reverse Bias" for Speed



- "Reverse Biasing" the solid-state detector reduces its junction capacitance, allowing the electric signal at Vout to better mimic the fast-rising light phenomena.
- Setting the 5V Bias "ON" achieves this effect.

Relative Peak

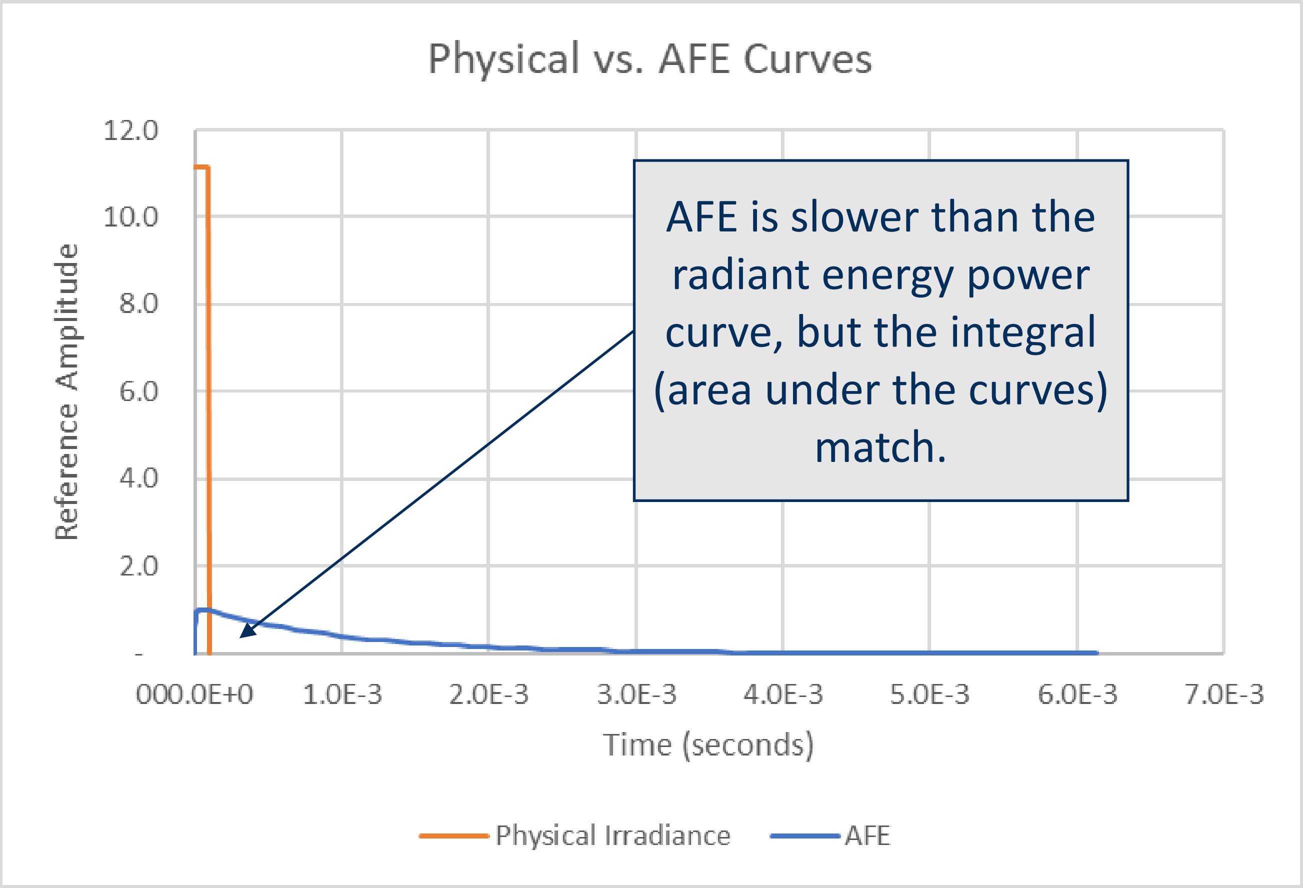
- The Analog Front End (AFE), due its own capacitance and time-constant, can potentially reshape the signal.

- *Potentially* because:
  - Incident radiant power that rises *faster* than the AFE can handle it will result in an electrical signal that is shorter and wider than the physical light signal
  - Incident radiant power that rises *slower* than the AFE is accurately represented

- The energy or integral, the area under the power curve, is accurately represented regardless of this effect

- But, for fast rising signals, the “Peak” power level must be considered relative and not absolute.

Relative Peak

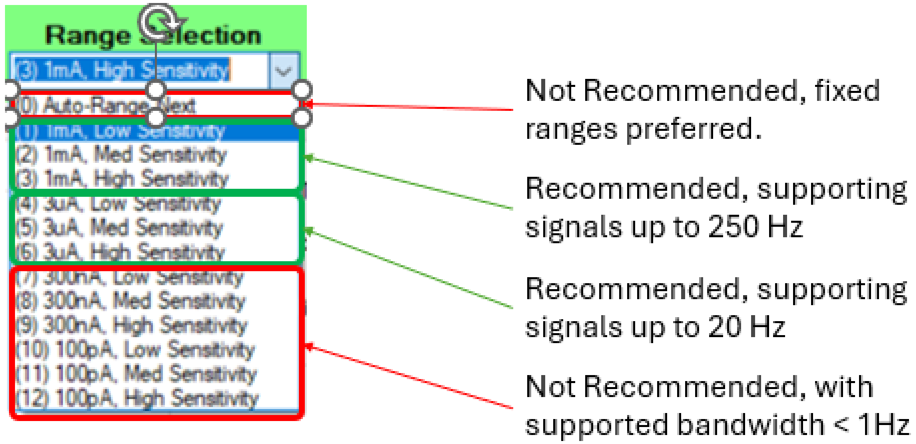


References

- DataLight III Windows Flash App User Manual
- DataLight III Meter User Manual
- ILT2500 User Manual
- Flash Capture App Note

Technical Note

Lux cal factor/ 5 /(distance in meters)^2= Cal factor for **eff cd. For pulsed lights**
Lux cal factor /(distance in meters)^2= Cal factor for **cd (CW light)**
If you have already measure in lux, but need to know the cd or eff. cd you can use the formula below:
converting lux to cd
Lux reading * (distance)^2 = candela
Lux reading * (distance)^2 *5 = eff. candela (the human eye is five times more sensitive to a pulsed light flash.
If you have taken light reading and need to know which current range you are working in, you can easily converting calibrated light level reading to Amps using this formula:
Converting a reading to Amp. (Reading * Calibration factor) = Current in Amps.
This is very useful when verifying proper range selection as discussed on page 29



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