

# A High-Accuracy UV-LED Characterization System

Jeff Hulett, Vektrex, November 12, 2024  
[jhulett@vektrex.com](mailto:jhulett@vektrex.com)

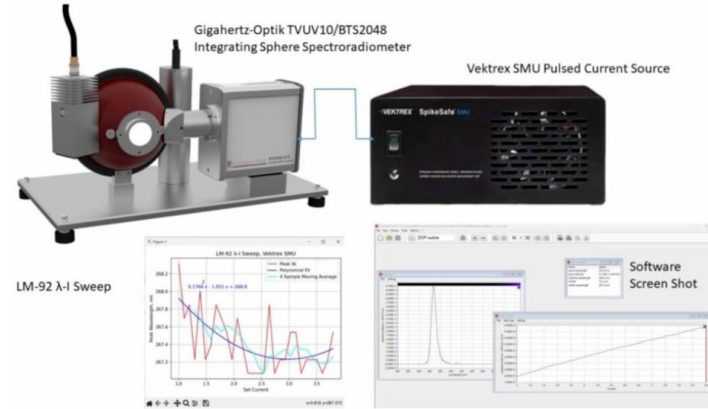
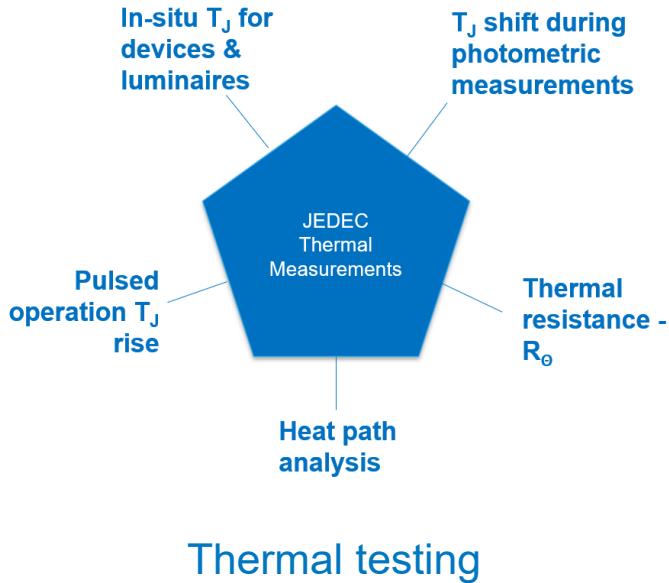
# Abstract

This paper presents a UV-LED characterization system that automates both electrical and optical measurements. The system is highly flexible, supporting long-pulse measurement methods (e.g., 20 ms pulses) and newer short-pulse techniques, which are typically 100 times more accurate. Measurement flexibility is a critical issue as the LED industry transitions from traditional long-pulse measurements, which involve significant device heating, to short-pulse measurements that minimize heating

The presented UV-LED characterization system supports both legacy and modern measurement techniques. It features a novel compact spectroradiometer with a back-thinned, TEC-cooled detector and an integrated photodiode. A low-jitter pulsed Source/Measure Unit (SMU) drives the LED. The system software implements several widely-use measurement methods, including the powerful Differential Continuous Pulse (DCP) measurement method described in ANSI/IES LM-92 and LM-85.

This presentation outlines the system architecture, highlights its key features, and presents actual commercial LED test results.

# Vektrex supports optoelectronics in these areas



Characterization,  
binning, calibration



Reliability/Burn-in

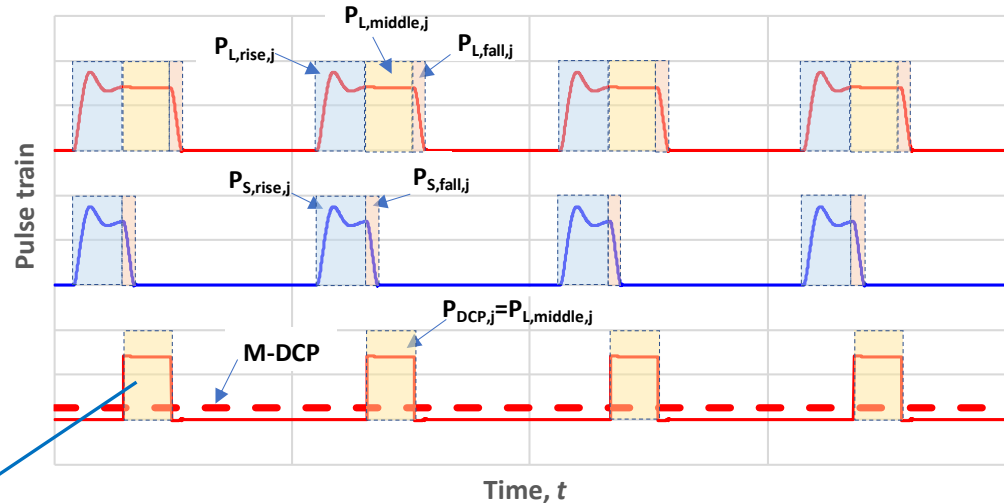
# Background

- This research is a continuation of the research that was presented last year.
- Last year we showed preliminary results using python and some results with a photodiode
- Now spectrometer is fully integrated with the current source and there are python and commercial implementations of the DCP method

# Review: LM-92's Differential Continuous Pulse (DCP) method reduces CP error sources by about two orders of magnitude

DCP takes the difference of two CP measurements – one with long pulses (e.g. 20 $\mu$ s) and one with short pulses (e.g. 10 $\mu$ s)

Light remaining after subtraction is from middle, flat portion of long pulse, amplitude, timing, and dark current errors subtract out



# The LM-92 Standard Requires 3 Test Methods

For Test Currents:	Method
Above 10% of nominal	DCP (10/20 us) 1% Duty
Between 1% and 10% of nominal	DCP (25/50 us) 1% Duty
Below 1% of nominal	Single Pulse


M-DCP can be used instead of DCP And DC can be used instead of Single Pulse

# Commercial UV-LED measurement

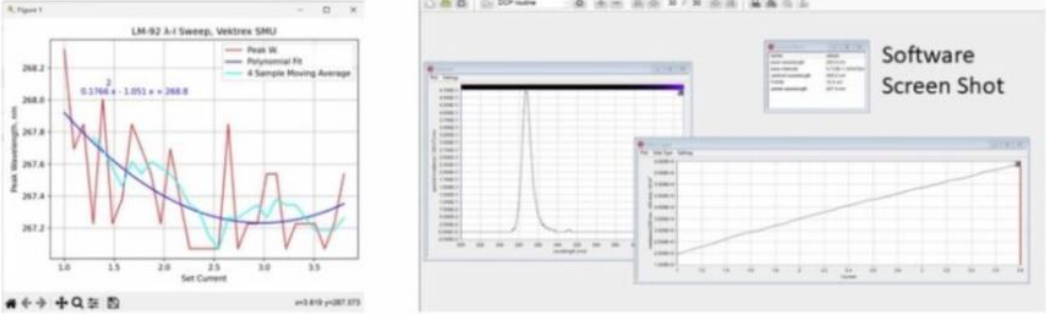
Gigahertz-Optik TVUV10/BTS2048  
Integrating Sphere Spectroradiometer

Vektrex SMU Pulsed Current Source

LM-92  $\lambda$ -I Sweep



Software Screen Shot

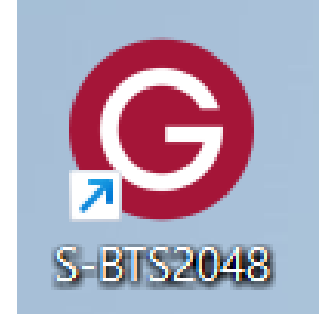


# Key system features

- Spectrometer
  - back-thinned, TEC controlled detector
  - minimal optical fiber
  - 200 nm – 400 nm
- SMU
  - Low jitter precision pulsing
  - True-differential digitizer
  - Support for JEDEC thermal measurements

# Two primary software packages

- Gigahertz-Optik S-BTS2048
  - Interactive windows application
  - Individual measurements, scripts & logging
  - Built-in support for DCP
  - 3-5 measurements/second
  
- Vektrex Python LM-92 LIV
  - Python program with source
  - Individual measurements, sweeps
  - 3-5 measurements/second
  - Graphic output
  - File output

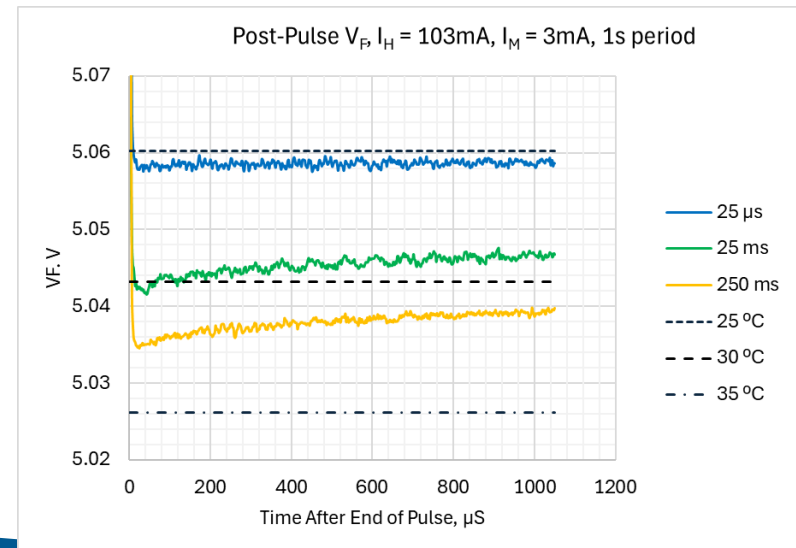


# In addition, for thermal corrections:

- Vektrex Control Panel
  - Interactive windows application
  - Controls source and measure functions
  - Supports VF digitization and projections needed for LM-92 and LM-85 measurement methods
- Arroyo temperature platform



Example temperature correction data: Post-pulse VF capture, using SMU's digitizer and bias current source functions



# Both packages support DCP and legacy measurements

<b>Measurement Method</b>	<b>S-BTS2048</b>	<b>Python LIV</b>
Direct Current - DC	Yes	Yes
Single Pulse - SP	Yes	Yes
Continuous Pulse - FP	Yes	Yes
Flash Pulse - FP	Yes	Yes
Differential Continuous Pulse - DCP	Yes	Yes
Mean Differential Continuous Pulse - M-DCP	Yes	Yes

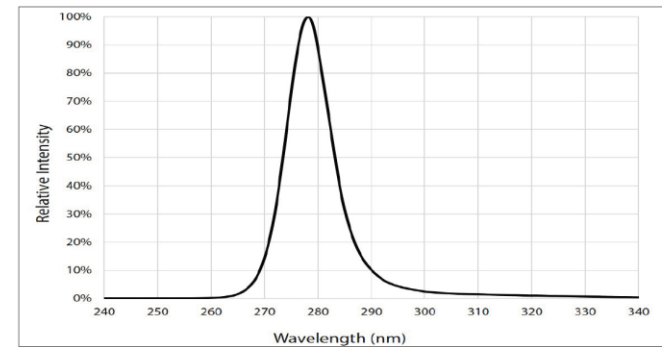
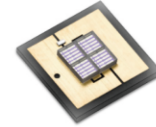
# DUT 1: Luminus UV-C LED

- High power UV-C LED
- 6-8V, 2A part
- 270-280 nm
- Mounted on star boards

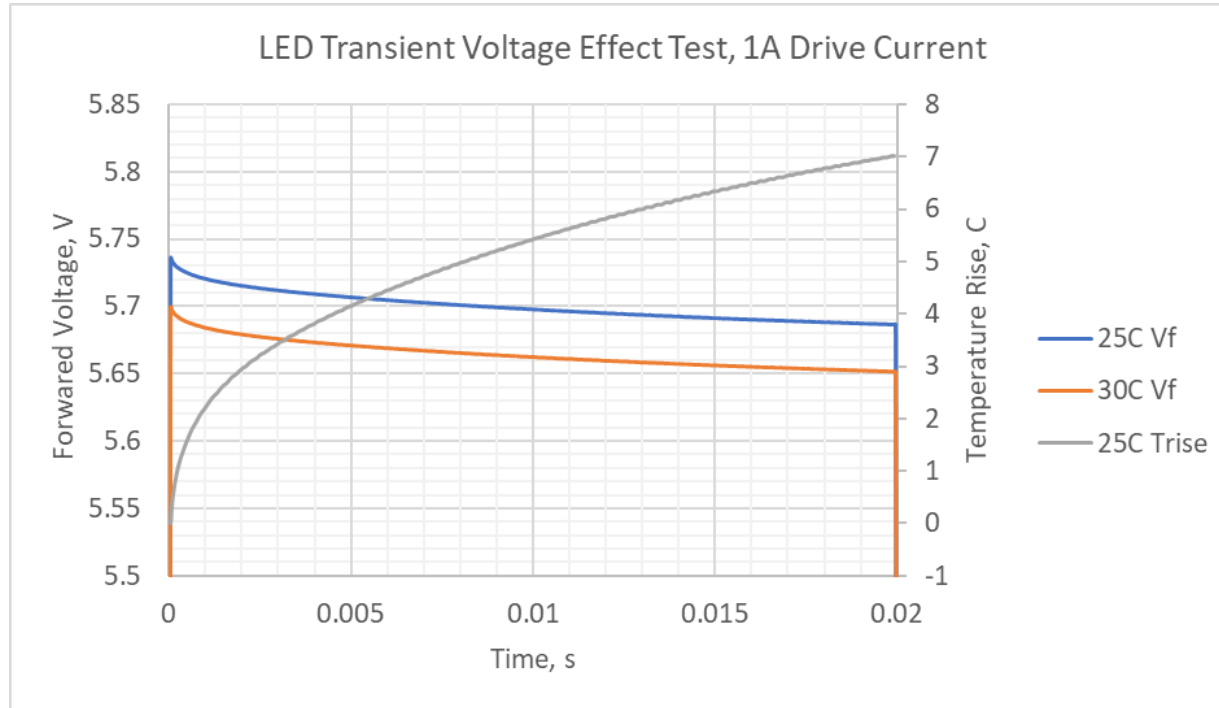


XFM-5050-UV  
Product Datasheet

**XFM-5050-UV**  
**4-chip Surface Mount**  
**UVC LED**



# DUT 1 Showed No Transient Voltage Effect

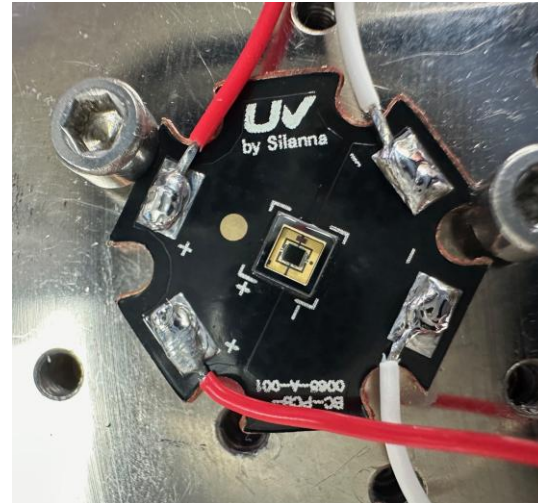
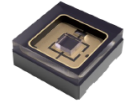


# DUT 2 for Experiment: Silanna UV-C LED

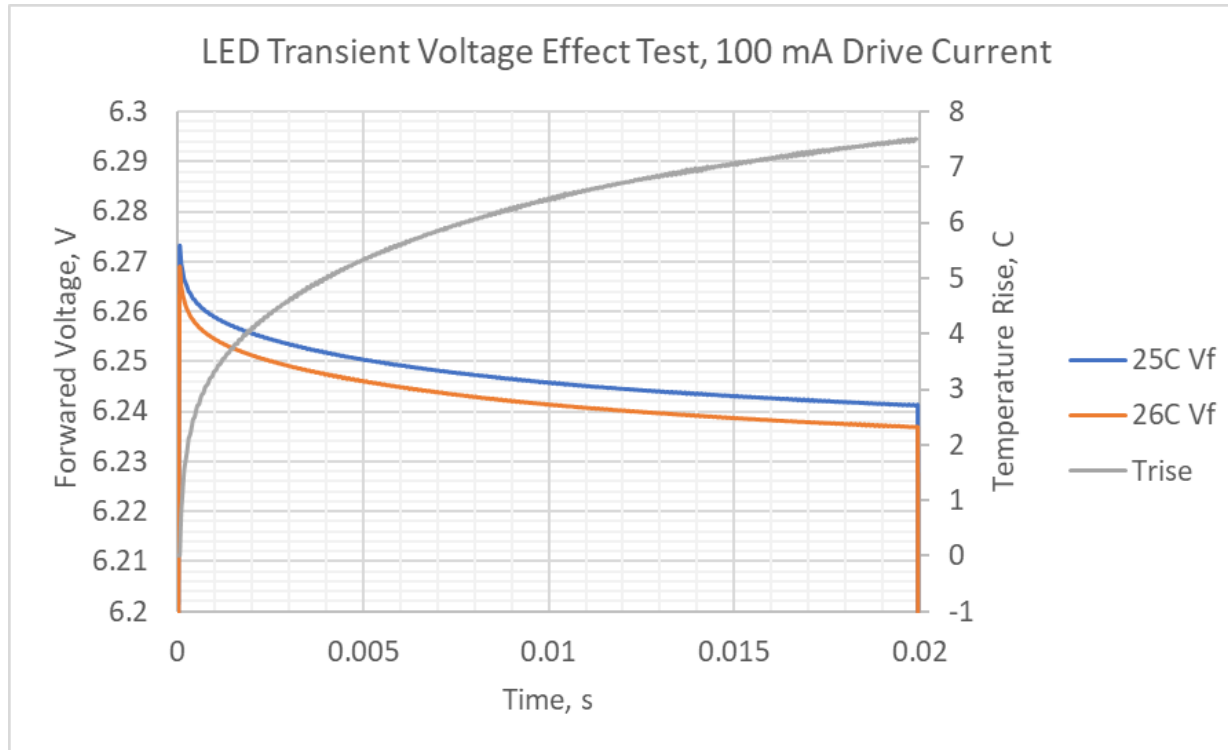
- Far UV-C LED
- 6.2V, 100 mA part
- 239 nm
- Mounted on star boards



**SF1 Series**  
Far UV-C Light Emitting Diode  
Product Datasheet

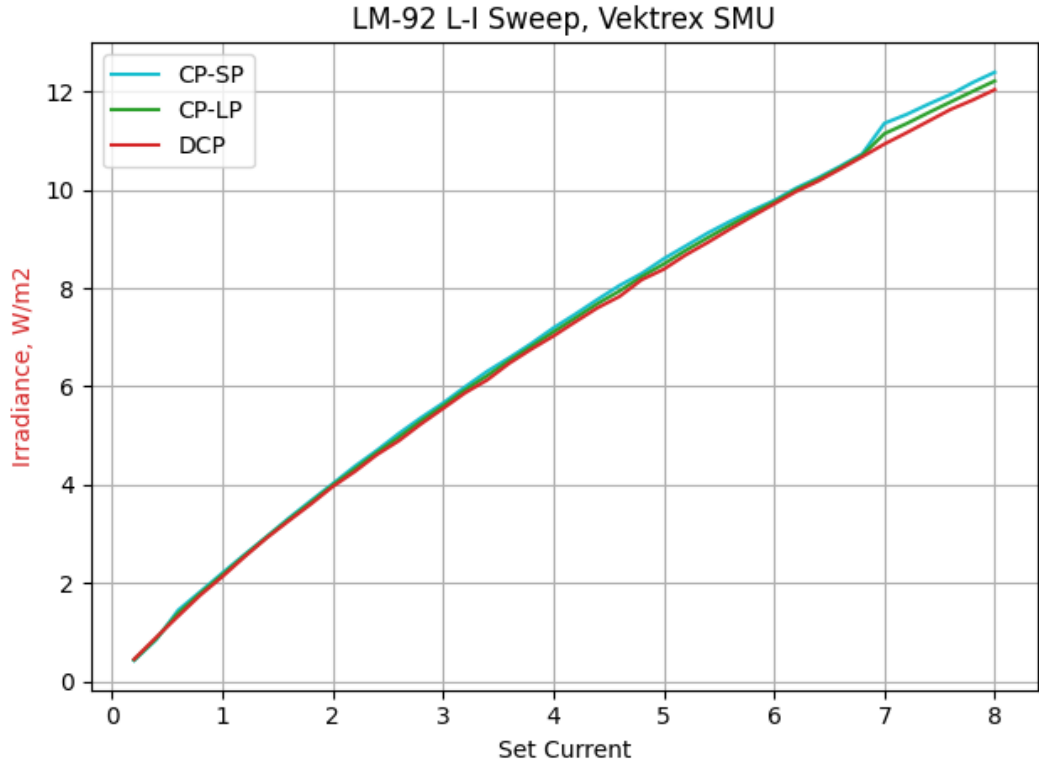


# DUT 2 Also Showed No Transient Voltage Effect

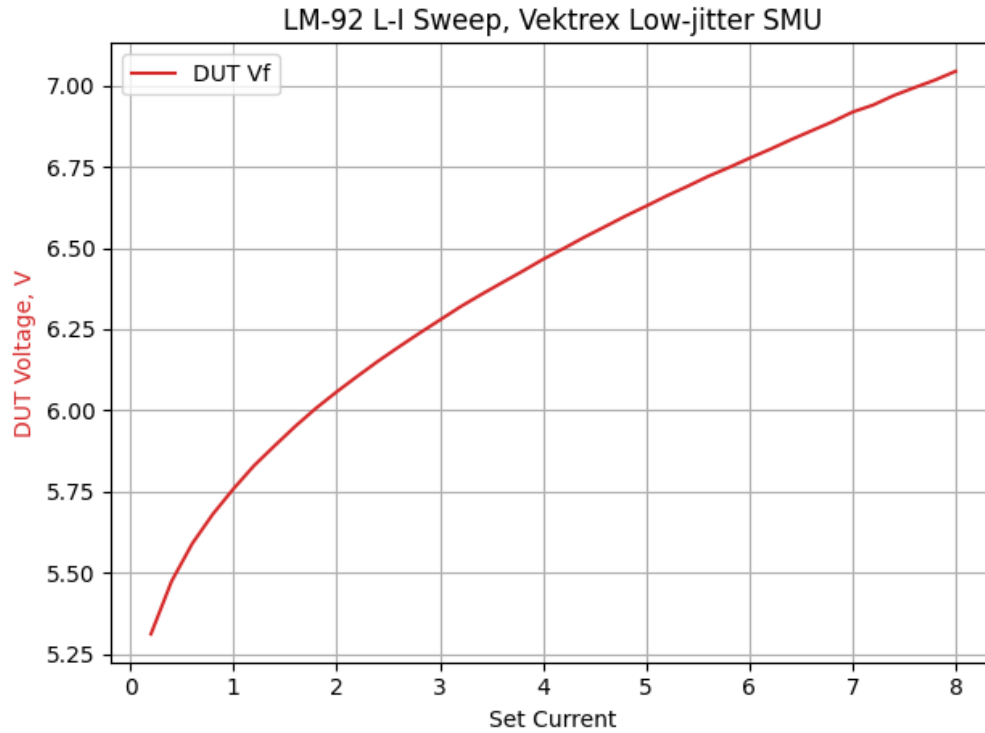


# Luminus Results – DUT 1

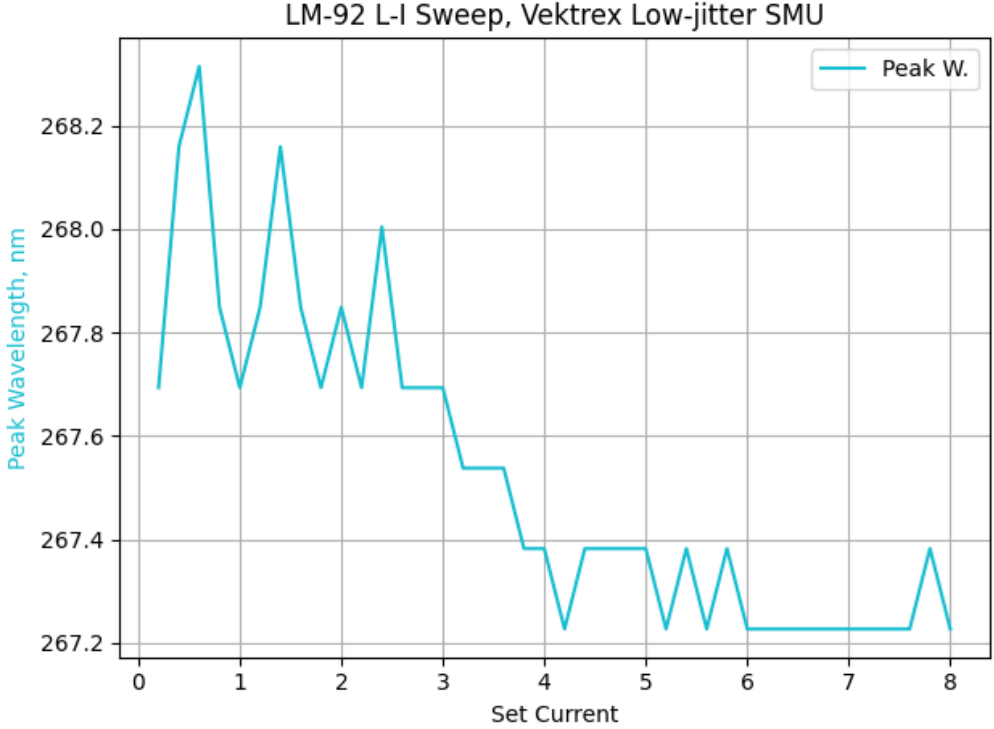
# Test 1: DUT 1 Device LM-92 Irradiance



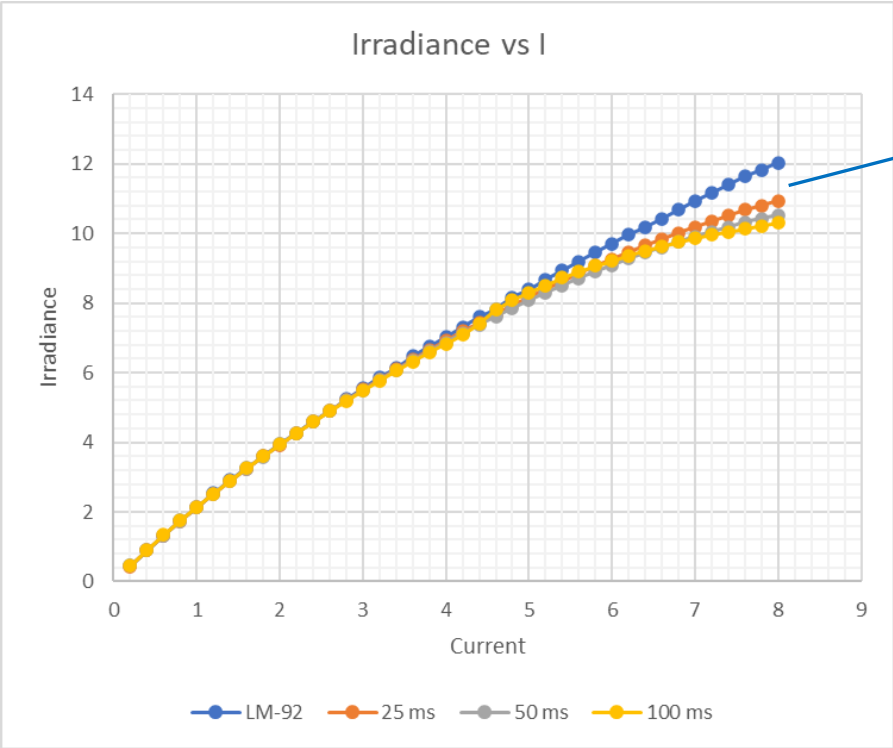
# DUT 1: UV Device LM-92 $V_F$



# DUT1 : UV Device LM-92 Peak Wavelength



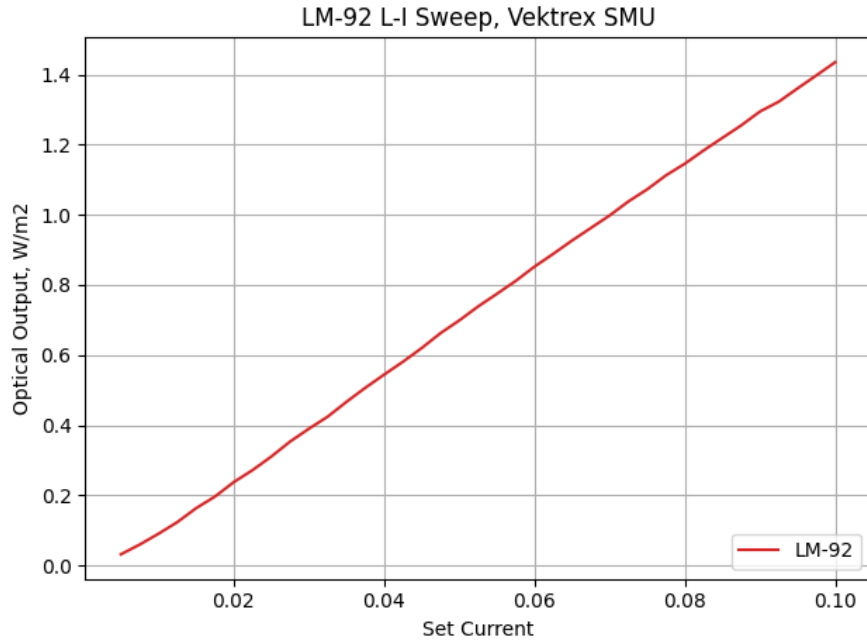
# DUT 1 LM-92 and Single Pulse Compared, Irradiance



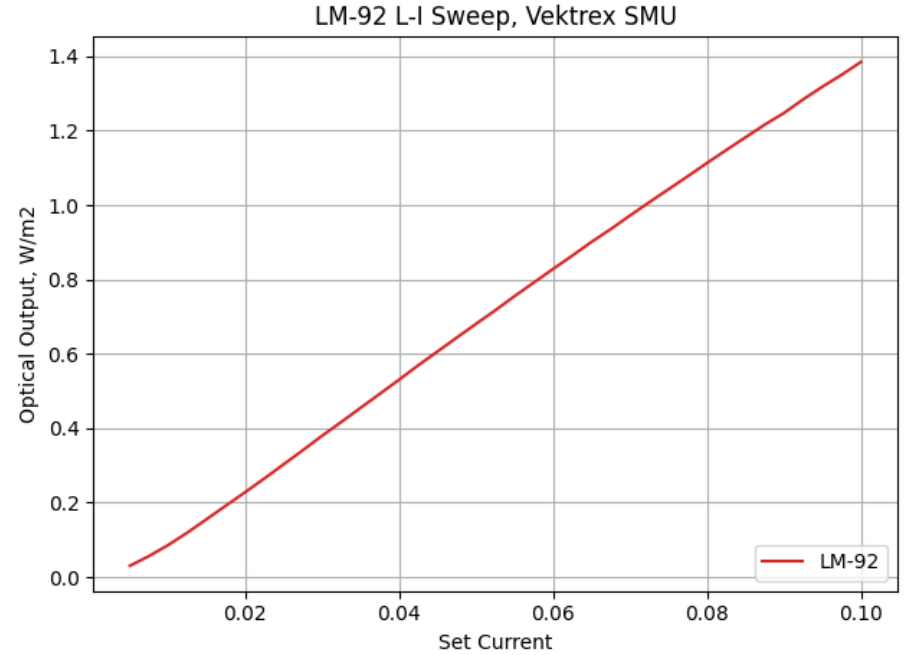
6.7% Error at 8A

# DUT 2: Silanna Results

# Irradiance

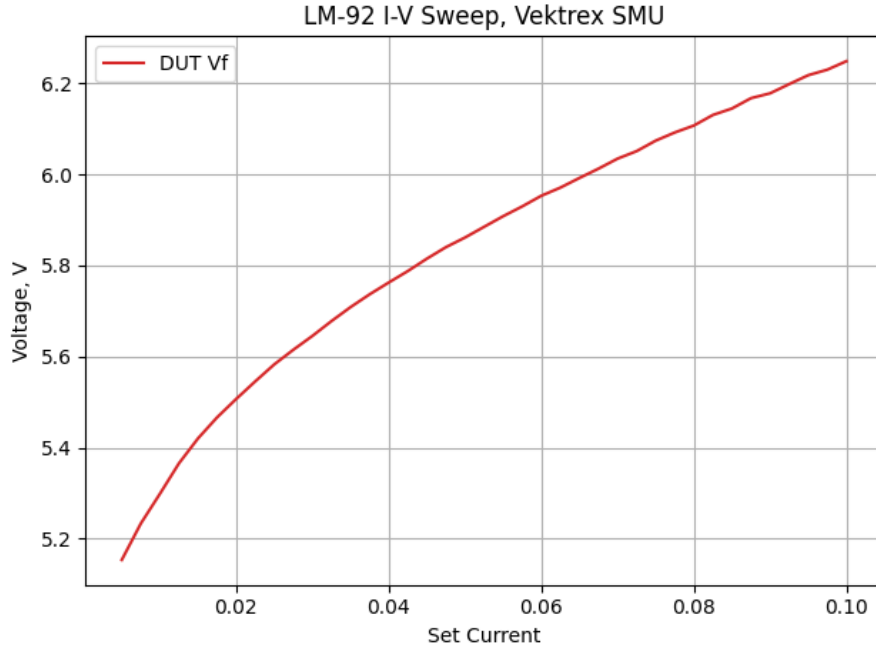


LM-92 DCP

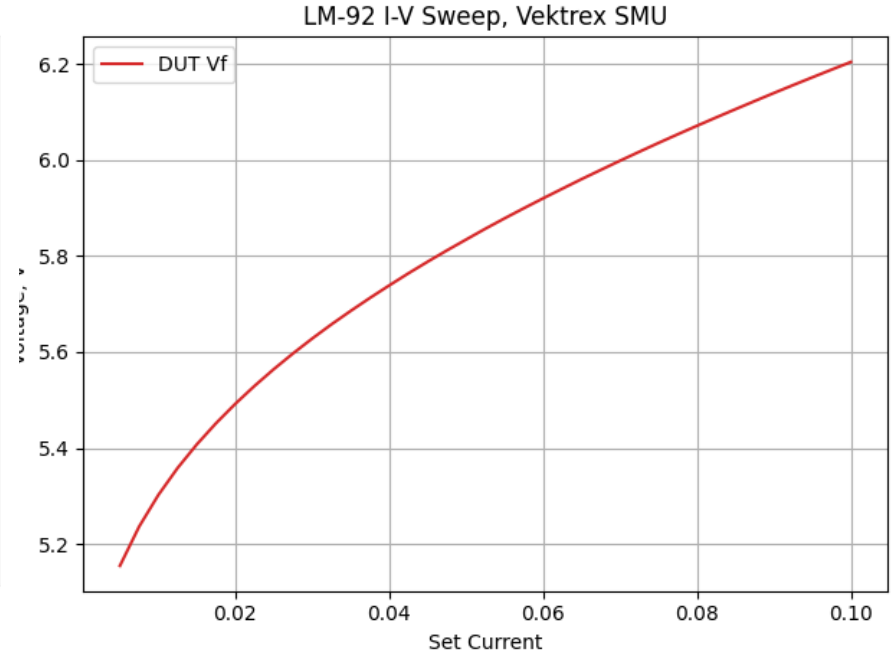


250 ms SP

# Forward Voltage



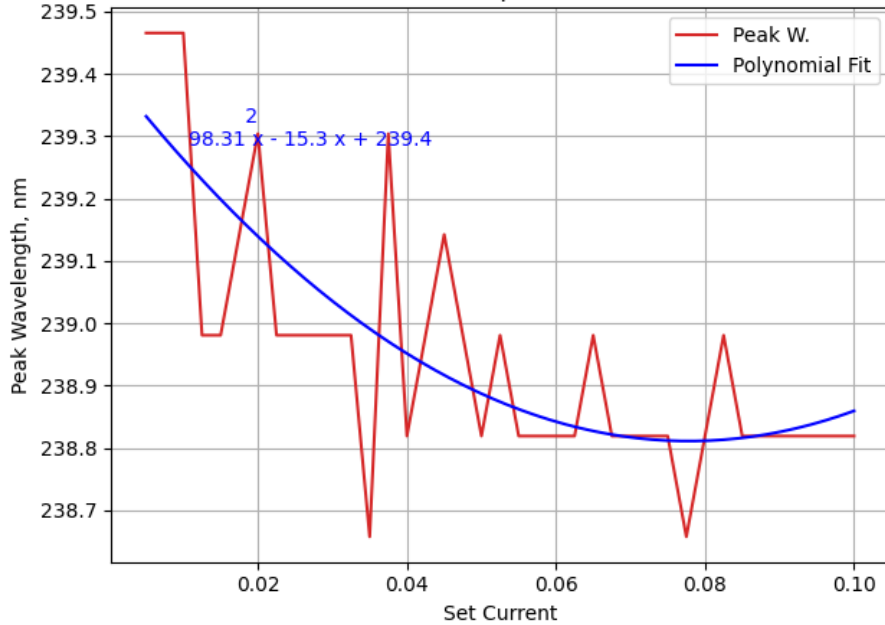
LM-92 DCP



250 ms SP

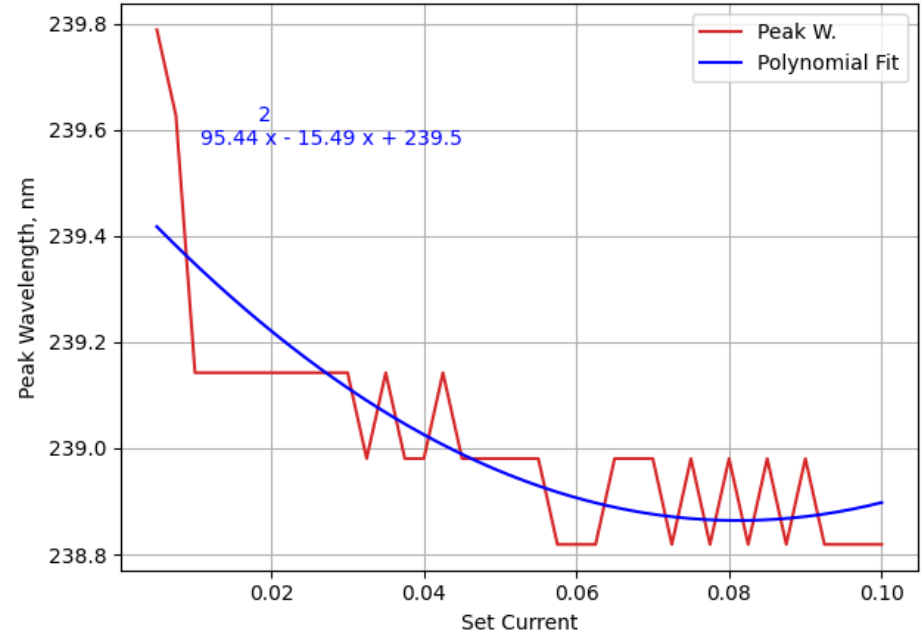
# Peak Wavelength

LM-92 λ-I Sweep, Vektrex SMU



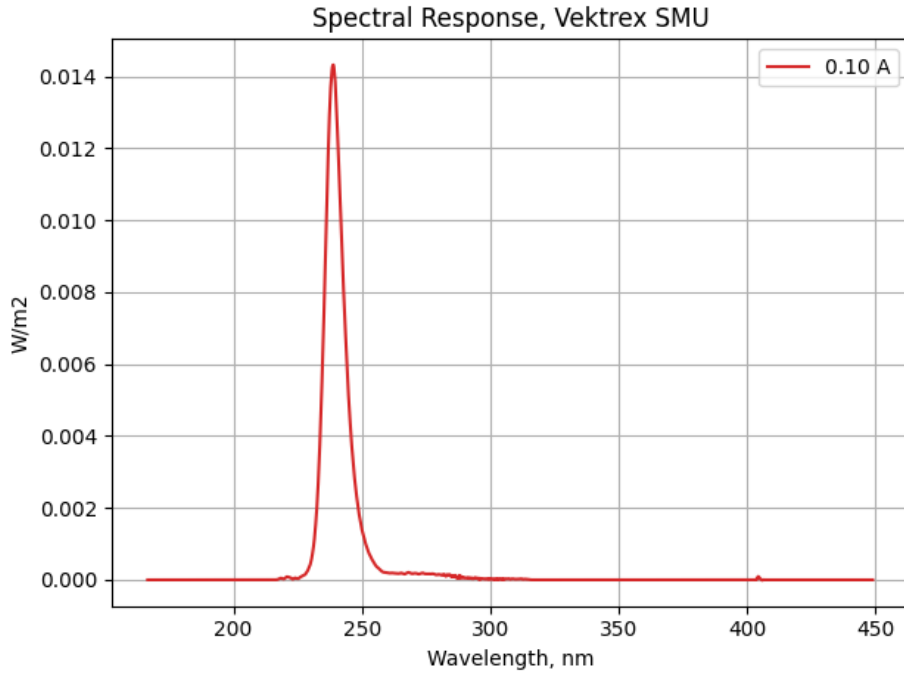
LM-92 DCP

LM-92 λ-I Sweep, Vektrex SMU

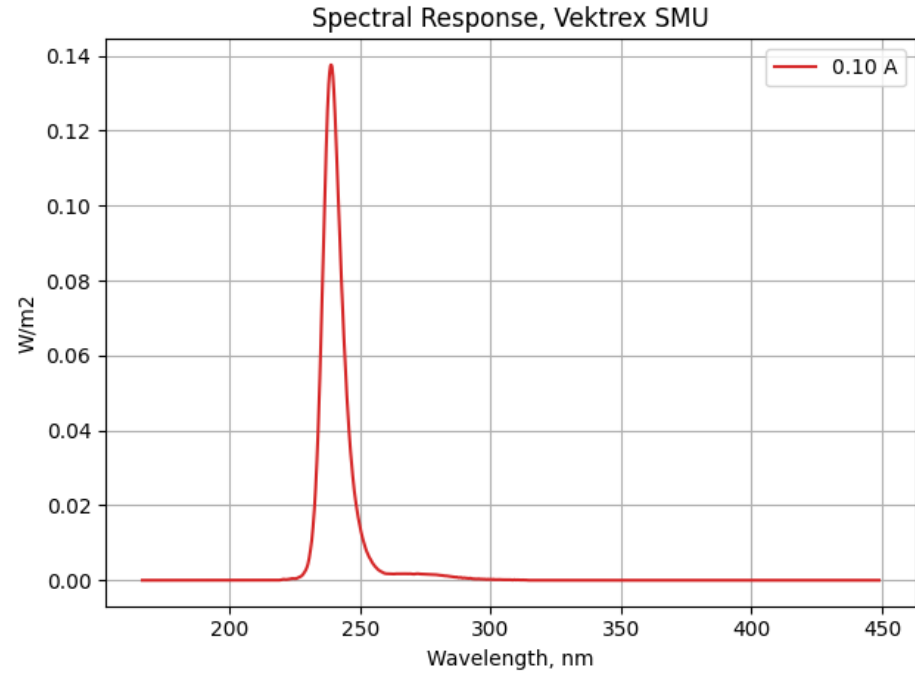


250 ms SP

# Spectrum



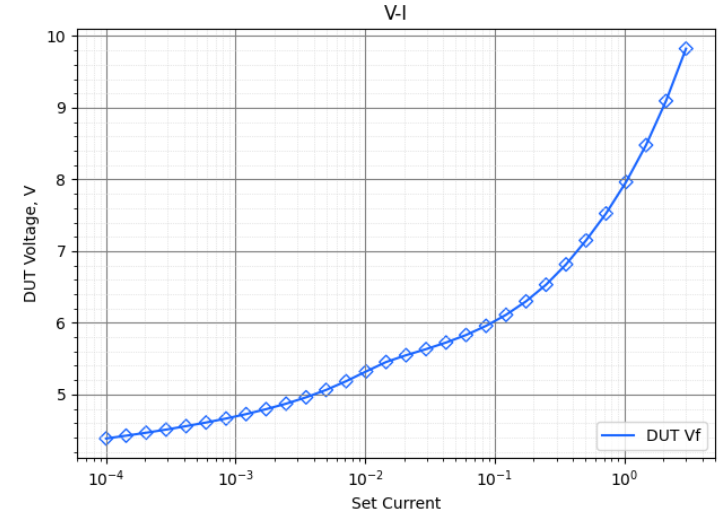
LM-92 DCP



250 ms SP

# Conclusions

- LM-92's three-method approach really simplifies LIV measurements, especially over large current ranges
- DCP is complex but when it is implemented in a software it is easy-to-use.
- This system supports legacy measurements, including now-required thermal corrections
- Thermal corrections are unnecessary with DCP



5-Decade I-V sweep

Thank you