

# SYSTEMS & SOLUTIONS

## IR Measurement Portfolio & Solutions

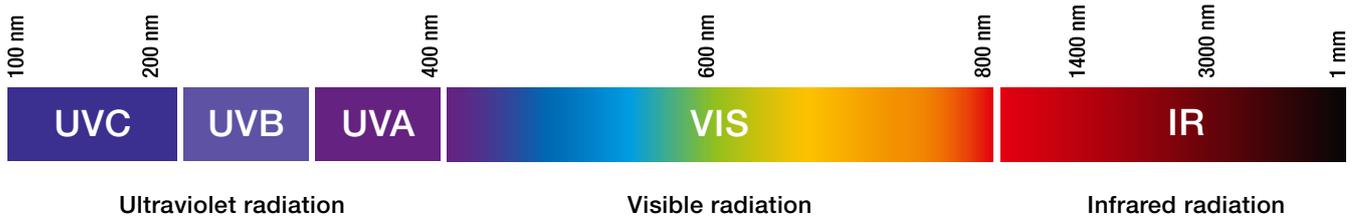


**For Infrared  
Light Sources**

# 01 \ Introduction

Infrared (IR) is defined as electromagnetic radiation (800 nm – 1 mm range) with wavelengths longer than those of visible light. The relevant range for radiation measurement is the near-infrared range (NIR) from 800 – 1400 nm and the short-wavelength IR (SWIR) from 1400 – 3000 nm.

Especially the use of VCSEL (surface emitting lasers) has enabled many new applications for consumer equipment and in the field of 3D sensing.



## IR application examples

- ▲ 3D sensing in consumer electronics:
  - Time-of-Flight (ToF)
  - Facial recognition (structured light)
- ▲ 3D sensing in automotive / industry:
  - LiDAR
  - In-cabin driver monitoring systems
  - Occupancy monitoring systems
- ▲ Optical under-display fingerprint sensor (e.g. 1380 nm)
- ▲ Proximity sensors and 1D Time-of-Flight
- ▲ Eye tracking and gesture recognition (AR / VR)
- ▲ Optical sensing for healthcare wearables
- ▲ Night vision (IR illumination for cameras)
- ▲ Data transmission
- ▲ Sunlight / solar simulators



3D sensing in automotive (LiDAR)



Face ID (structured light), eye tracking & gesture recognition (AR/VR)



Broadband IR sources (sun light / solar generators)

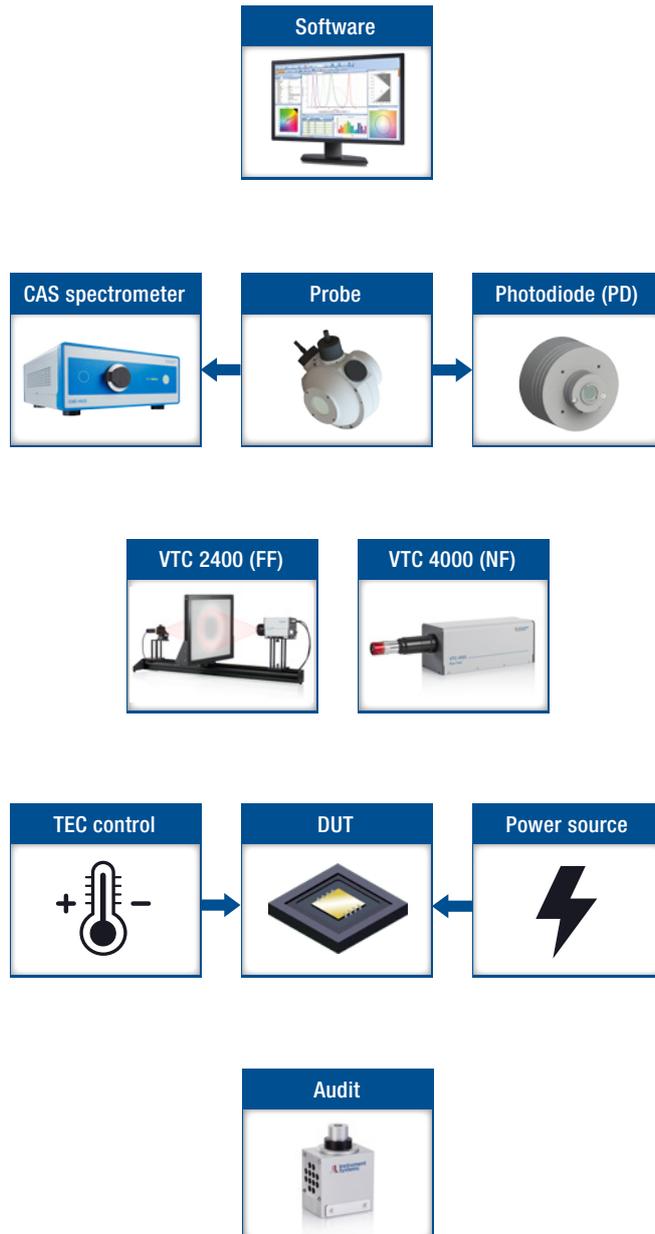


Optical fingerprint detection

# 02 \\ Measurement systems

We offer an extensive portfolio covering IR radiation measurement as well as other aspects related to the control of the device under test (DUT). Our key benefits are highest accuracy combined with a high modularity and therefore high flexibility.

Based on the application requirements we create a system solution by combining hardware and software. The table below shows the key items of a system.



## Software

- ▲ Controls measurement equipment and other system components
- ▲ Provides results and reporting

## Radiometric 1D measurement equipment & calibration

- ▲ Measurement with spectroradiometer and optical probes, i.e. integrating sphere
- ▲ Photodiode for fast power measurement

## 2D measurement equipment & calibration

- ▲ Camera based measurement
- ▲ Near-field and far-field options

## Device under test (DUT) control

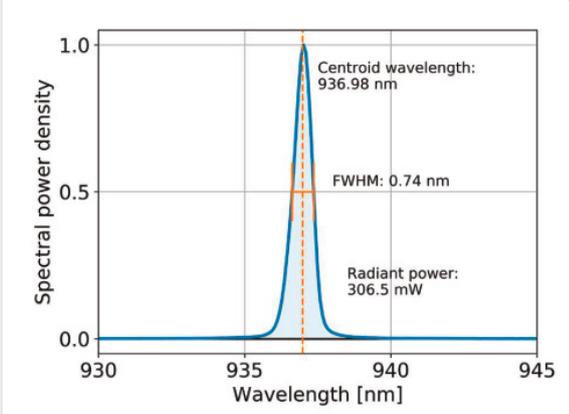
- ▲ TEC Control: temperature control and measurement
- ▲ Power Source: driving and electrical measurements

## Audit concept

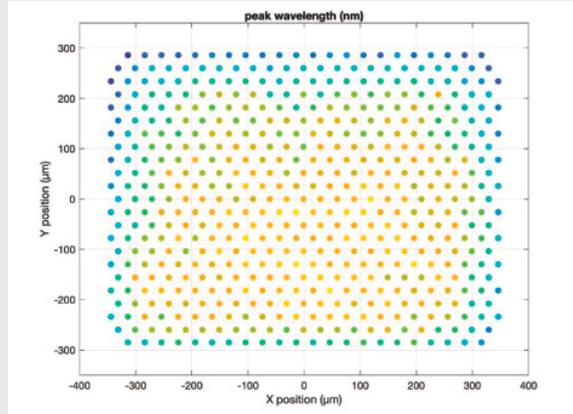
- ▲ Ensures traceability and error budget
- ▲ Worldwide service partners

Our systems are used to test IR sources in lab applications as well as during the production process. There is a wide range of measurements as shown below:

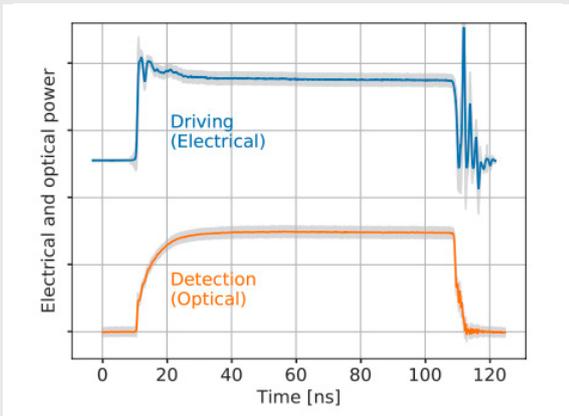
### Spectral and power measurement



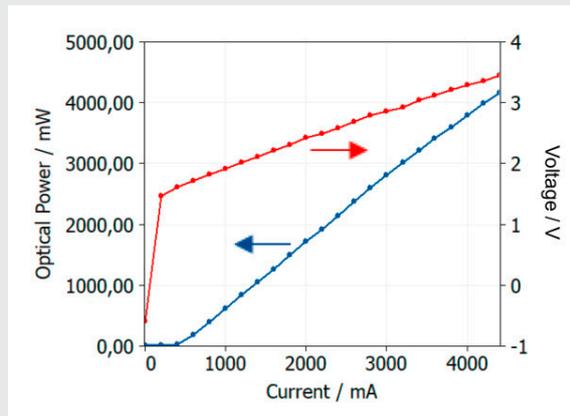
### Single emitter uniformity (2D)



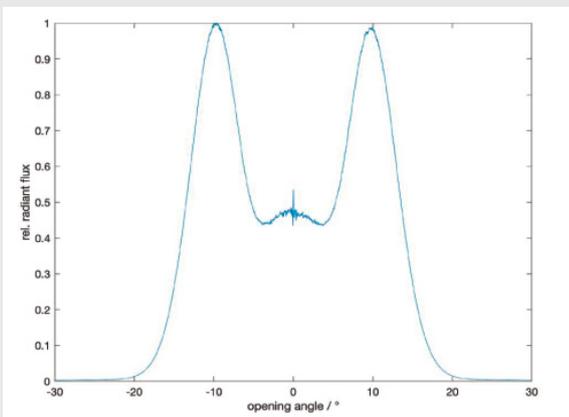
### Time-resolved optical output measurement



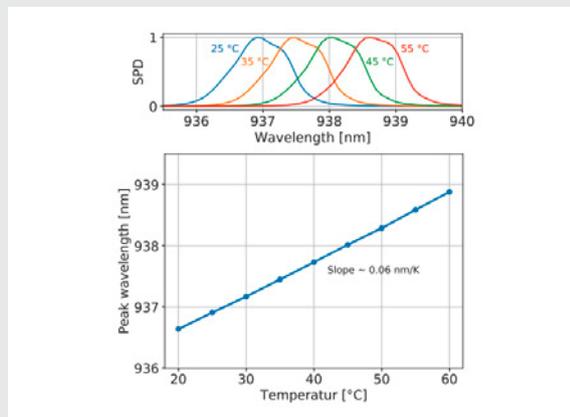
### Optical output as function of current/voltage (LIV curve)



### Angular-resolved measurement



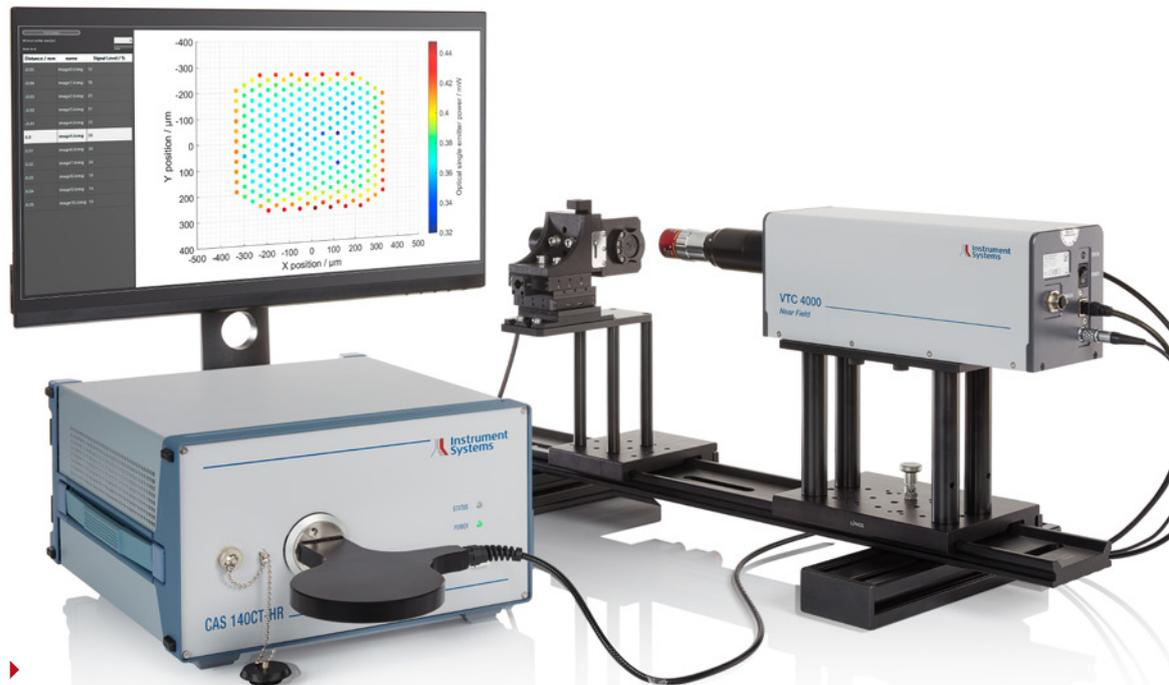
### Temperature dependence of the optical output



The following table provides an overview of four different system solutions: The modular test system, the pulsed VCSEL testing system PVT, and the camera-based systems VTC 2400 and VTC 4000 and the scope of measurement possible with each. A more detailed description of each solution will be given in the next sections.

	Modular test system	PVT	VTC 2400	VTC 4000
DUT (device under test)	VCSEL, LED, other	VCSEL	VCSEL	VCSEL
Spectral-resolved	●	●	-	○
Radiant power	●	●	●	●
Time-resolved: microsecond (μs)	●	-	-	-
Time-resolved: nanosecond (ns)	-	●	-	-
Angular-resolved: 4pi	○	-	-	-
Angular-resolved: < 2pi	●	-	●	-
Single emitter uniformity (2D)	-	-	-	●
LIV curves (optical-electrical)	●	●	-	-
Temperature dependency	●	●	-	-

- Possible
- Optionally available

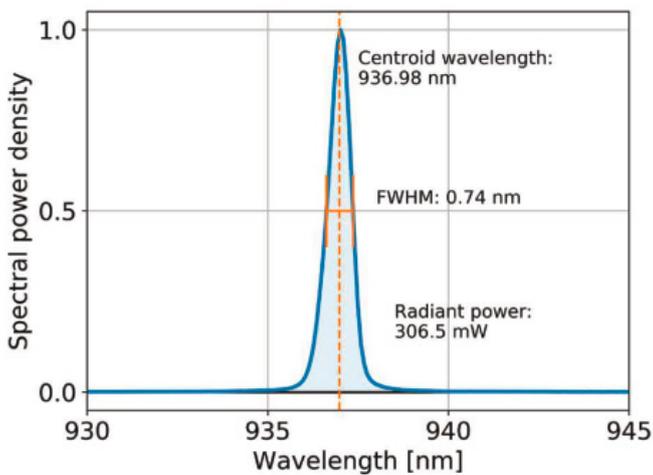
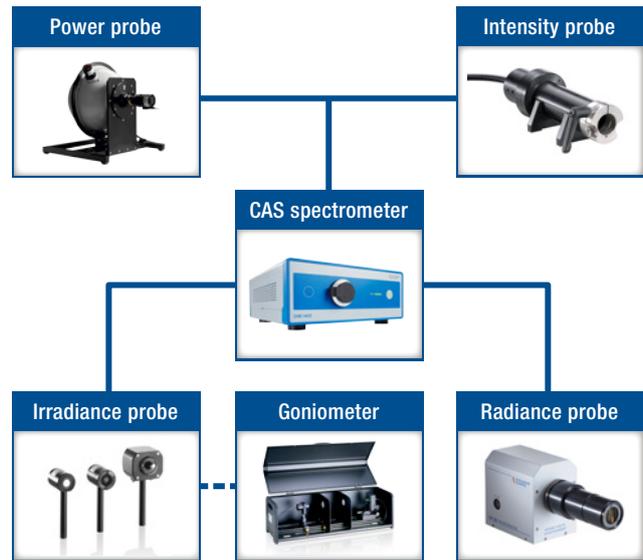


VTC 4000 VCSEL testing camera for comprehensive near-field analysis of complete VCSEL arrays.

## 2.1 Modular test system and PVT

Our modular spectroradiometers can be combined with a wide range of interchangeable measurement probes that are connected by a fiber bundle and serve as “light collector” (see image). Depending on the physical quantity to be measured, e.g. luminous flux, different optical probes must be used. Each measurement probe is calibrated together with the spectroradiometer in our ISO 17025 accredited testing lab. This allows the traceable measurement of the calibrated optical quantity together with the spectral data and a specified error budget.

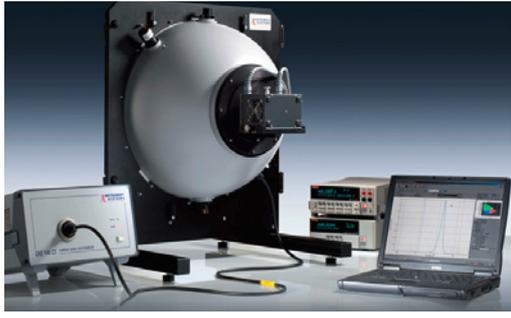
We offer an extensive portfolio of spectroradiometers that cover a broad spectral range. Specifically designed for VCSEL measurements we offer a high-resolution version (HR) that can achieve a spectral resolution down to 0.09 nm to resolve narrow laser spectrum (see image).



Goniometer systems additionally enable angle-resolved determination of the radiation pattern. For production line applications where every ms matters, photodiodes can be incorporated into the system. Attached to the integrating sphere this allows fast power measurement. A traceable calibration ensures correct absolute values.

With the pulsed VCSEL testing system PVT we offer a comprehensive solution specifically for nanosecond pulse driving and measurement as used for LiDAR or Time-of-Flight (ToF) applications.

Within the modular test system and the PVT product family, our equipment and software can be flexibly combined to a system solution that meets the demanding application requirements for diverse IR measurement tasks.

	Modular Test System	Pulsed VCSEL Testing System (PVT)
		
<b>Applications</b>		
	<ul style="list-style-type: none"> <li>▲ For laser sources / VCSEL, LEDs and other emitter</li> <li>▲ Range 200 – 2150 nm</li> <li>▲ Pulse driving and time-resolved measurement &gt; 1 μs possible</li> <li>▲ High flexibility thanks to modularity</li> </ul>	<ul style="list-style-type: none"> <li>▲ For VCSEL used for 3D sensing (LiDAR, ToF)</li> <li>▲ Range 800 – 1000 nm</li> <li>▲ Nanosecond pulse driving and measurement</li> <li>▲ Total system for lab measurement or components for in-line testing</li> </ul>
<b>Software</b>		
For lab (GUI)	SpecWin Pro /Light	PVT lab software
For integration/production	SDK (CAS-DLL)	SDK
<b>Radiometric measurement equipment</b>		
Spectrometer	<ul style="list-style-type: none"> <li>▲ CAS Series spectrometer (range 200 – 2150 nm)</li> <li>▲ Various probes</li> </ul>	<ul style="list-style-type: none"> <li>▲ HR-CAS spectrometer (range 800 – 1000nm) with 100 mm sphere</li> </ul>
Photo Diode	<ul style="list-style-type: none"> <li>▲ For power measurement (range 800 – 1700 nm)</li> <li>▲ For time-resolved measurement (&gt; 1 μs)</li> </ul>	<ul style="list-style-type: none"> <li>▲ For power measurement (range 800 – 1000 nm)</li> <li>▲ For time-resolved measurement (ns – μs)</li> </ul>
Goniometer (angular distribution)	<ul style="list-style-type: none"> <li>▲ LEDGON</li> <li>▲ LGS</li> </ul>	-
<b>DUT Control</b>		
Power source	<ul style="list-style-type: none"> <li>▲ Keithley SourceMeter</li> <li>▲ Vektrex SpikeSafe SMU</li> <li>▲ Constant power or pulse driving (&gt; 1 μs)</li> </ul>	<ul style="list-style-type: none"> <li>▲ DUT board with Short Pulse Unit</li> <li>▲ Pulse driving (ns – μs)</li> </ul>
TEC Control	<ul style="list-style-type: none"> <li>▲ Arroyo TEC driving</li> <li>▲ Temp. range 15 – 150 °C</li> </ul>	<ul style="list-style-type: none"> <li>▲ Temp. range 20 – 70 °C</li> </ul>
<b>Calibration standard</b>		
	<ul style="list-style-type: none"> <li>▲ ACS NIR standard for radiant flux (860 / 950 nm)</li> </ul>	<ul style="list-style-type: none"> <li>▲ ACS NIR standard for radiant flux (860 / 950 nm)</li> </ul>

## 2.2 Camera based systems for VCSEL measurement

VCSEL devices typically consist of several hundreds of single emitters being arranged in an array (also referred to as a “VCSEL array”). Instrument Systems offers cameras for two-dimensional characterization of both single emitters (called “near-field”) as well as the beam resulting from the complete array (called “far-field”).

The VTC 2400 is the perfect solution for analyzing the far-field beam profile of the complete VCSEL array/ensemble. It consists of a light-permeable screen, which is irradiated by the device-under-test, and a camera, which captures the radiant intensity distribution from the other side of the screen. Coming with a PTB-traceable calibration, the VTC 2400 allows absolute measurement of 2D radiant intensity distribution in a defined distance

of the device-under-test. This allows analyzing the beam opening angle, the cross-section profile and the identification of the highest intensity spot for laser safety evaluations.

On the other hand, the VTC 4000 is our VCSEL testing camera for the comprehensive near-field analysis of single emitters on a VCSEL array. The camera comes with absolute power and flat-field calibration traceable to national standards. As a results, the VTC 4000 allows absolute and polarization-resolved 2D characterization of all relevant parameters for every single emitter on the array such as position, radiant power, polarization, numerical aperture, beam waist,  $M^2$  value and peak wavelength.

	VTC 2400 for far field characterization	VTC 4000 for near field characterization
		
<b>Applications</b>		
	<ul style="list-style-type: none"> <li>▲ Angular distribution measurement for complete VCSEL arrays/IR LEDs</li> <li>▲ Range 800 - 1100 nm</li> <li>▲ Uniformity control of the radiation pattern</li> <li>▲ Investigation of the absolute radiant power of the device-under-test for eye safety considerations</li> <li>▲ Suitable for R&amp;D as well as production applications (with light-proof housing)</li> </ul>	<ul style="list-style-type: none"> <li>▲ 2D analysis of single VCSEL emitters on an array with unprecedented measurement accuracy</li> <li>▲ Range 900 – 980 nm</li> <li>▲ Defect emitter analysis on wafer or chip level</li> <li>▲ For VCSEL quality control in production lines and laboratory applications</li> </ul>
<b>Measurement results</b>		
	<ul style="list-style-type: none"> <li>▲ Single-shot absolute radiant flux</li> <li>▲ Angular and spatial distribution of radiant intensity</li> <li>▲ Opening angle as well as cross-section profile of the emitted light</li> <li>▲ Identification of highest intensity spot according to IEC:60825-1 laser safety norm</li> </ul>	<ul style="list-style-type: none"> <li>▲ One-shot single emitter position, absolute radiant power and polarization characteristics (angle and degree)</li> <li>▲ Divergence, numerical aperture, <math>M^2</math> value (with z-stage)</li> <li>▲ Spectral information (e.g. peak wavelength) available as optional extension</li> </ul>
<b>Software</b>		
For lab (GUI)	-	-
For integration/production	LumiSuite SDK	LumiSuite SDK
<b>Radiometric measurement equipment</b>		
Camera	▲ VTC 2400 with light-permeable screen	▲ VTC 4000
Spectrometer	-	▲ HR-CAS spectrometer (range 800 – 1000nm)

### 2.3 Audit system

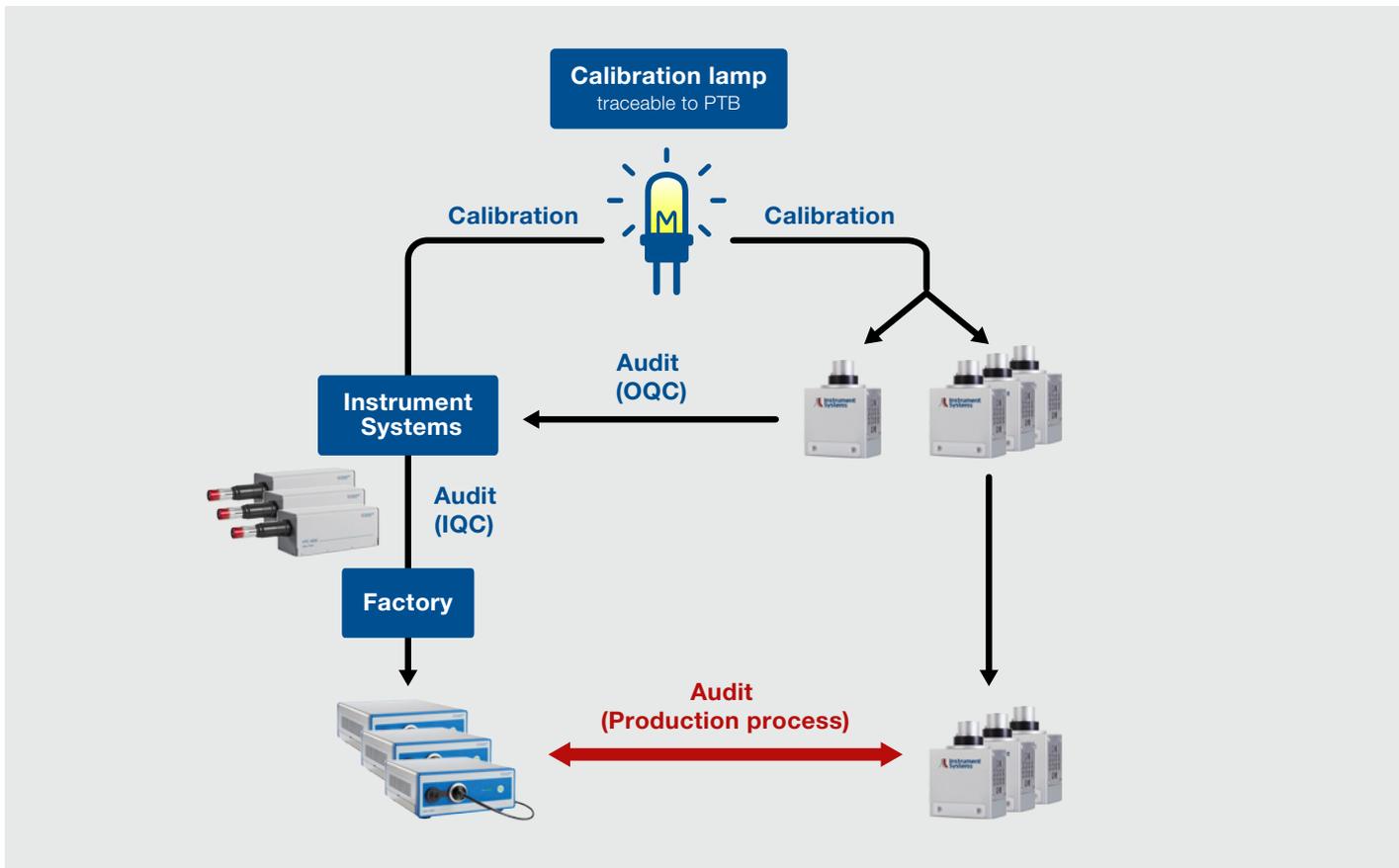
Only regular checks of a measuring system for conformity with its specifications will ensure the proper functioning and quality of the measuring system and the comparability of readings in the long term. For this purpose, the audit portfolio from Instrument Systems offers a large selection of application-specific solutions in factory or lab.

For an audit in the infrared region, Instrument Systems offers calibration standards of ACS 57x series.

These highly stable infrared sources based on LED technology are available in five versions with typical peak wavelengths of 860 nm, 950 nm, 1200 nm, 1300 nm, and 1450 nm. As a service, Instrument Systems provides traceable reference values for radiant flux.



ACS-57x series IR LED calibration standards for radiant flux and ACU Control Unit



Audit process in production

# 03 \\ Portfolio Overview

## Spectrometer



Device	Description
CAS Standard Series (CAS 120/125/140D)	<ul style="list-style-type: none"> <li>Standard UV-VIS-NIR versions</li> <li>For LEDs and broadband emitter</li> <li>Detector: CCD or CMOS</li> <li>Range: 200 – 1100 nm</li> </ul>
CAS HR Series (CAS 120-HR/125-HR/140CT-HR)	<ul style="list-style-type: none"> <li>High resolution NIR versions</li> <li>For Laser / VCSEL</li> <li>Detector: CCD or CMOS</li> <li>Range: 800 – 1000 nm</li> </ul>
CAS IR Series (CAS 140CT IR)	<ul style="list-style-type: none"> <li>IR versions</li> <li>For emitter in range above 1100 nm</li> <li>Detector: InGaAs</li> <li>Range: 780 – 1650 nm / 1500 – 2150 nm</li> </ul>

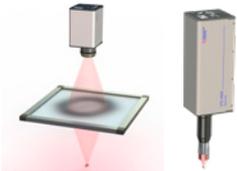


## Radiometer / Photo diode



Device	Description
Standard photo diode	<ul style="list-style-type: none"> <li>For power and microsecond pulse measurement</li> <li>For all kind of applications</li> <li>Keithley multimeter Plugin for SpecWin Pro (DMM 65xx / 75xx)</li> </ul>
Fast photo diode used in PVT	<ul style="list-style-type: none"> <li>For nanosecond pulse measurement</li> <li>For 3D sensing applications (LiDAR, ToF)</li> </ul>

## Camera-based measurement instruments



Device	Description
VTC 2400	<ul style="list-style-type: none"> <li>Camera combined with a screen to measure the angular intensity distribution.</li> <li>Faster alternative to a goniometer measurement, especially for production testing.</li> </ul>
VTC 4000	<ul style="list-style-type: none"> <li>Camera with microscope lens to measure the individual emitter on a VCSEL array directly.</li> <li>Optional with a spectrometer for wavelength measurement.</li> </ul>

## Light measurement accessories (for spectrometer)



Device	Description
Integrating spheres (ISP-xxx)	<ul style="list-style-type: none"> <li>Quantity: Power (W)</li> <li>Measure total light output</li> <li>Size from 75 mm up to 2 m</li> </ul>
Irradiance probes (EOP, ISP 40, LEDGON head)	<ul style="list-style-type: none"> <li>Quantity: Irradiance (W/m<sup>2</sup>)</li> <li>Measure received radiation / illuminated area</li> <li>Used for goniometer measurement</li> </ul>
Intensity probes (LED-4xx, LED 25)	<ul style="list-style-type: none"> <li>Quantity: Radiant intensity (W/sr)</li> <li>Measure at a defined distance and angle</li> <li>I_LED_B geometry</li> </ul>
Telescopic Probes (TOP 150/200)	<ul style="list-style-type: none"> <li>Quantity: Radiance (W/sr/m<sup>2</sup>)</li> <li>Measure spot on the emitter surface</li> <li>Includes view-finder camera</li> </ul>
LEDGON	<ul style="list-style-type: none"> <li>Goniometer for single emitter and small boards</li> <li>DUT up to 160 mm diameter</li> <li>Includes a light cover</li> </ul>
LGS 350	<ul style="list-style-type: none"> <li>Goniometer for medium sized samples</li> <li>DUT up to 740 mm diameter</li> <li>DUT temperature control option</li> </ul>

## Calibration and monitoring equipment



Device	Description
ACU 100	<ul style="list-style-type: none"> <li>▲ Control Unit for ACS-570</li> </ul>
ACS 570-15 ACS 570-17 ACS 570-42 ACS 570-44 ACS 570-46	<ul style="list-style-type: none"> <li>▲ IR-LED standard for radiant flux (860 nm)</li> <li>▲ IR-LED standard for radiant flux (950 nm)</li> <li>▲ IR-LED standard for radiant flux (1200 nm)</li> <li>▲ IR-LED standard for radiant flux (1300 nm)</li> <li>▲ IR-LED standard for radiant flux (1450 nm)</li> </ul>

## DUT Electrical driving and measurement



Device	Description
Keithley SourceMeter (W-11x/12x/13x)	<ul style="list-style-type: none"> <li>▲ 24xx/26xx product range for all kind of DUTs</li> <li>▲ Model 2601B-Pulse supports 10 <math>\mu</math>s pulses</li> <li>▲ Control plugin for SpecWin Pro/Light</li> </ul>
Vektrex SpikeSafe SMU	<ul style="list-style-type: none"> <li>▲ For <b>microsecond</b> pulse driving</li> <li>▲ Control plugin for SpecWin Pro</li> </ul>
Short Pulse Unit used in PVT (SPU 100)	<ul style="list-style-type: none"> <li>▲ For <b>nanosecond</b> pulse driving</li> <li>▲ For 3D sensing applications (LiDAR, ToF)</li> <li>▲ Special control software</li> </ul>

## DUT Temperature control and test sockets



Device	Description
Arroyo TEC-Source 53xx (W-210)	<ul style="list-style-type: none"> <li>▲ TEC Control unit for LED-850/870</li> <li>▲ Control plugin for SpecWin Pro</li> </ul>
Arroyo TEC-Mount (LED-870)	<ul style="list-style-type: none"> <li>▲ TEC Fixture with cooling plate for DUT</li> <li>▲ Test DUT on a board</li> </ul>
Test socket with TEC (LED-850)	<ul style="list-style-type: none"> <li>▲ Mount for packaged LED with TEC control</li> <li>▲ Includes wiring for DUT driving</li> </ul>
Test sockets (LED-5xx and -6xx)	<ul style="list-style-type: none"> <li>▲ Mount for packaged LED (without TEC)</li> <li>▲ Includes wiring for DUT driving</li> </ul>

## Software



Device	Description
SpecWin Pro/Light	<ul style="list-style-type: none"> <li>▲ For spectrometer related measurements</li> <li>▲ Plugins for current sources and TEC control</li> </ul>
LumiSuite GUI	<ul style="list-style-type: none"> <li>▲ For camera-based measurement devices</li> </ul>
SDK / DLL / LabView driver	<ul style="list-style-type: none"> <li>▲ Software integration</li> <li>▲ Automated production testing</li> </ul>

