ELECTRO-OPTICS LABORATORY (EO LAB)

Overview

UV/IR Radiometers, Sensors, Sources and Test Equipment

EWA GSI supports an expanding in-house capability involving state-of-the-art ultraviolet (UV) sensor and source technologies. Additionally, our Electro-Optics Laboratory (EOLAB), located in a secured area of the EWA facilities, provides a thorough and complete complement of the necessary calibration instruments and support electronics. The lab is divided into three main areas: 1. Radiometer/Sensor Bay; 2. Source & Spectrometer/ Monochromator Bay; 3. Test Control & Analysis Bay.

Capabilities

◊ **Custom Electro-Optical/Opto-Mechanical Design & Fabrication**

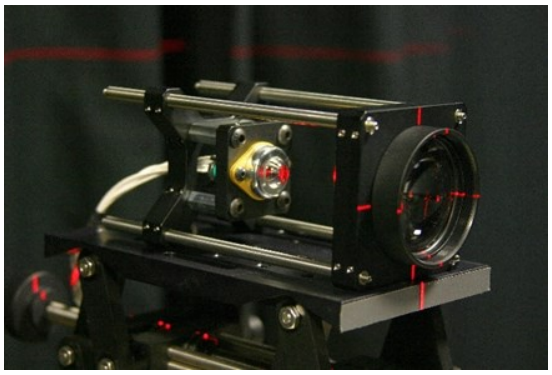
Provide optical and opto-mechanical design and analysis including lens design, custom lenses (UV through LWIR), lens and mirror mounts, non-imaging optics, laboratory prototypes, optical simulations and breadboards, optical and laser system alignment, and specialized test instrumentation. Design tools include MATLAB, OptiCAD, Geomagic (Alibre) CAD, Pro E and AutoCAD.

◊ **Custom Programmable UV & Infrared (IR) Sources Design & Fabrication**

Design, fabricate and characterize a variety of programmable single spectral band and multi-spectral sources. These systems include Deuterium (D2), Quartz Tungsten Halogen (QTH) and LED emitters coupled with custom fiber optic, reflective and/or refractive optical output elements. These systems are ruggedized and designed as field instrumentation.

◊ **Custom UV Witness Sensors & Data Acquisition**

Design, fabricate and test high-resolution, high-speed UV irradiance monitoring (witness) sensors with integrated data acquisition and processing. These sensors are developed independent of, or in conjunction with, the programmable UV/IR sources described above. Standard implementations include digital signal processing and waveform display applications.



◊ **Directed Infrared Countermeasures (DIRCM) Detection and Evaluation System (CD/E)**

Design, fabricate, characterize and operationally test multi-channel DIRCM laser system in an optically shielded environment. These systems characterize the DIRCM laser stimulated responses in four or more IR spectral bands. Each spectral channel is sampled at a 100 kHz rate to ensure non-aliased data acquisition and digital signal processing.

These systems can interface directly with existing Department of Defense (DoD) test range infrastructures, and provide complete hardware-in-the-loop (HITL) functionality for Operational Test and Evaluation (OT&E) of installed sensor hardware.

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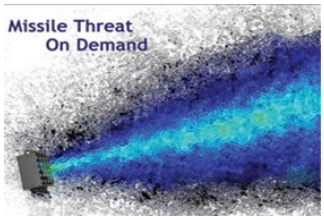
◊ **High Resolution (Sub-nanometer) Source & Sensor Characterization**

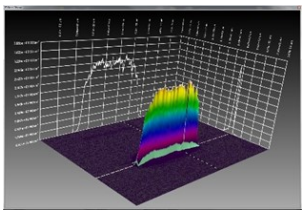
Maintain an engineering research and development (R&D) laboratory providing multi-spectral characterization of both sources and sensors at sub-nanometer resolution. This includes using monochromators and spectrometers, NIST-traceable UV and IR reference sources and blackbodies, laser alignment (when necessary), optical workbenches/breadboards and light-shielded, temperature controlled laboratory conditions.

◊ **Scalable UV Missile Plume Simulators**



Design, fabricate and operationally test UV missile plume simulators. These scalable systems feature adjustable output power levels suitable for small, handheld units used to test missile warning system (MWS) sensors on the flight line, to large, multi-element UV light emitting diode (LED) arrays for testing tactical aircraft at ranges up to 5 kilometers (km). These systems are fully characterized in terms of wavelength, beam width, shape and radiant intensity.

◊ **Laser Beam Characterization**



Characterize and test UV, Visible and IR lasers as required. Standard measurements include laser transverse mode, beam radius/ diameter, spatial intensity distribution or beam profile, divergence, quality factor (M2), laser average power and operational assessment.

◊ **Remote Electro-Optic Telemetry**

Design, fabricate and operationally test radio frequency (RF) networked electro-optic telemetry systems. These systems are tagged using global positioning systems (GPS), and feature a central monitoring station networked to synchronized, environmentally shielded electro-optic sensors located at ranges of up to 5 km. The remote sensors can operate unattended in typical field conditions, and can handle a wide range of temperatures.

They feature update rates in excess of 200 Hz, and offer either linear current and/or pulse width modulated (PWM) output intensity adjustment. The systems offer remote profile access and triggering capability. The missile plume simulators feature removable memory for missile plume libraries, with each library holding up to 100 profiles. Maximum profile durations are in excess of 5 minutes. A set of test profiles is provided, and a standalone MATLAB application for developing additional profiles is also included. These systems are lightweight, tripod mountable and robust, and are designed for routine field use.

◊ **Ultraviolet (UV) Imaging Radiometers (ICCD, IPD, EMCCD)**

Design, fabricate and characterize high speed/high resolution UV imaging radiometers in the spectral region from 250nm-300nm. Integrated sensors include Intensified Charge-Coupled Devices (ICCDs), Imaging Photon Detectors (IPDs) and Electron Multiplying Charge Coupled Devices (EMCCDs). These systems all feature narrow band solar blind filters (SBF) at specified wavelengths. Also included are custom UV optics at multiple focal lengths, neutral density filters (NDF) with a variety of optical densities, custom tripod mounts and imager carriage assemblies, and spotting scopes. These systems optionally feature ruggedized notebook computers.

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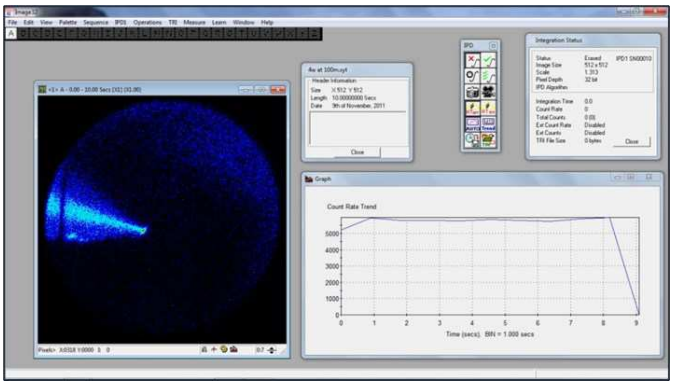
Ultraviolet (UV) Imaging Radiometers

Overview

Design, fabricate and characterize high speed/high resolution UV imaging radiometers in the spectral region from 250nm-300nm. Integrated sensors include Imaging Photon Detectors (IPDs), Intensified Charge-Coupled Devices (ICCDs) and Electron Multiplying Charge Coupled Devices (EMCCDs). These systems all feature narrow band solar blind filters (SBF) at specified wavelengths. Also included are custom UV optics at multiple focal lengths, neutral density filters (NDF) with a variety of optical densities, custom tripod mounts and imager carriage assemblies, and spotting scopes. These systems optionally feature ruggedized notebook computers.



Test Range Image

IPD Imaging Radiometer

- ◊ Initially an in-house R&D effort
- ◊ In use at laboratory and field test assets
- ◊ Second until fielded at the Electronic Combat Ranges, China Lake, California

IPD Specifications

- ◊ Solar blind proximity focused detector
- ◊ 512x512 (user defined) pixel image
- ◊ Timing accuracy is +/- 10ns
- ◊ Frame rate is Selectable (1kHz typical)
- ◊ Image processing software
- ◊ Max photon count rate is 1e6 cps
- ◊ Responsivity is ~2e-17 W/cm^2/cps
- ◊ Image, count rate trend, and video event storage

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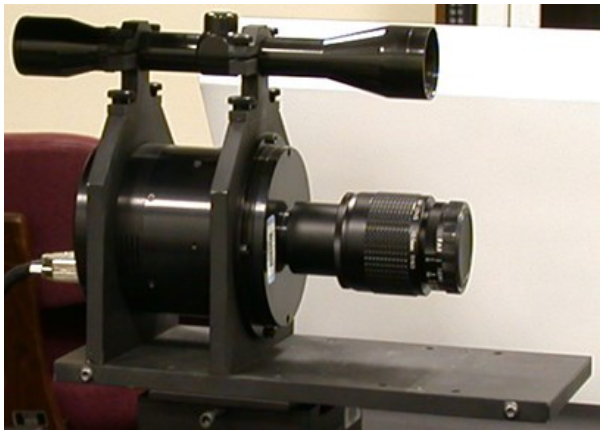
Ultraviolet (UV) Imaging Radiometers

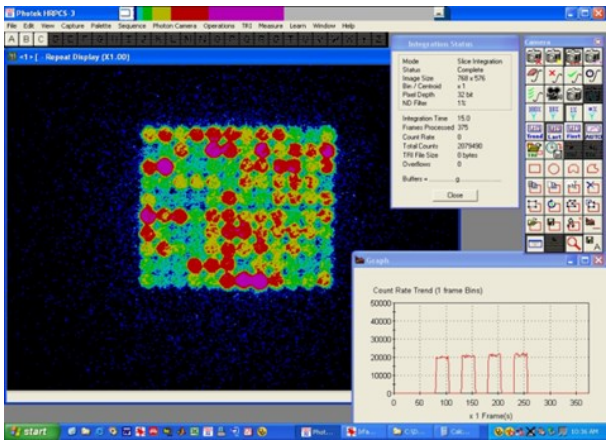
ICCD Imaging Radiometers

- ICCD—Mod 1
- Initially an in-house R&R effort
- In use as a laboratory and field test asset

ICCD Specifications

- Solar blind detector with fused silica taper
- 768x576 pixel image
- Frame rate is 25Hz
- Image processing software
- Max photon count rate is 3e6 cps
- Responsivity is ~3e-17 W/cm²/cps
- Image, count rate trend, and video event storage



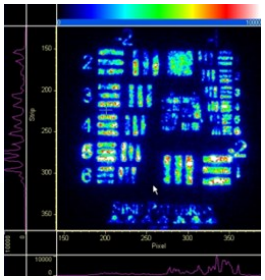


EMCCD Imaging Radiometers

- Developed as a commercial product

EMCCD Specifications

- Back illuminated EMCCD detector
- Solar blind, TE cooled
- 512x512 pixel image
- Multiple digitization modes (100 kHz—10MHz)
- Frame rate is 34–689 Hz
- Image processing software
- EM Gain 1-1000
- Responsivity is ~5e-17 W/cm²/cps
- Image, count rate trend, and video event storage

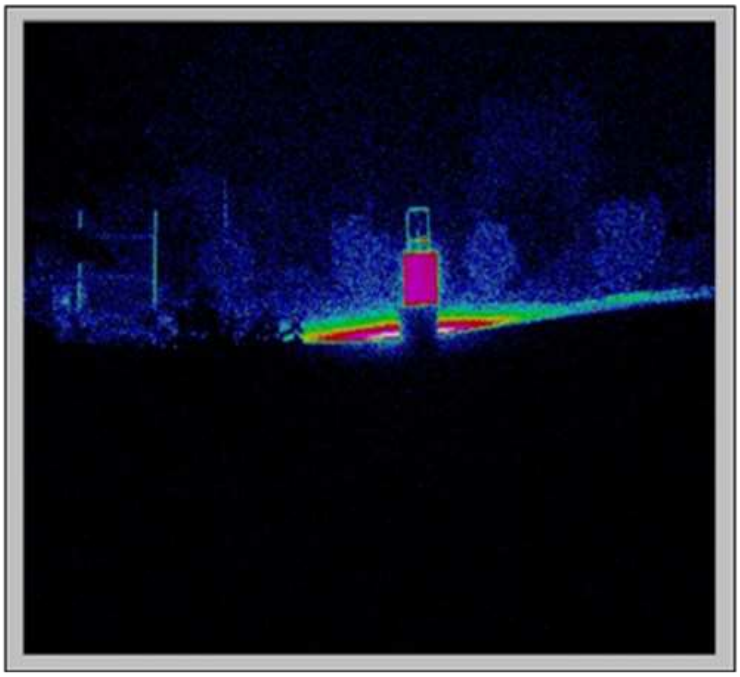


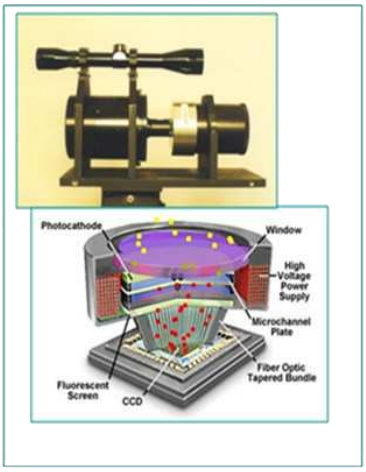
UV Imagers

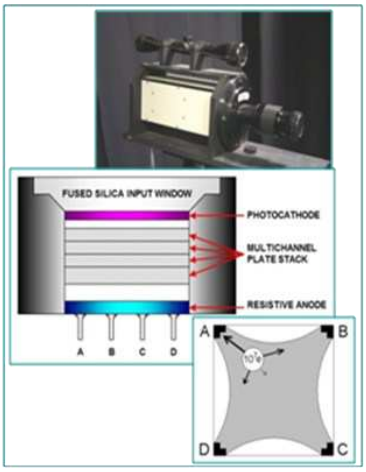
Ultraviolet Imagers—Intensified CCD (ICCD) & Imaging Photon Detector (IPD)

Overview

The ultraviolet (UV) imagers are extremely sensitive, multi-channel plate (MCP) intensified cameras coupled with a set of specialized UV lenses and solar blind optical filters. Each camera and its associated optics are interfaced to a workstation computer running a sophisticated image capture and processing software suite. The integrated systems can be used for a wide variety of imaging applications. The current imagers have been customized to provide reference measurements of UV sources designed to emulate the ultraviolet radiation intensity variations and spectral characteristics generated by missile exhaust plumes.







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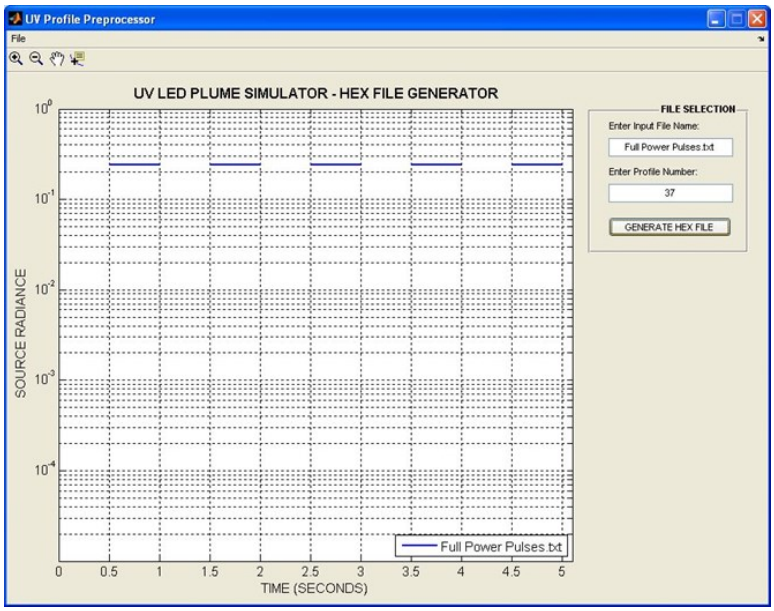
Ultraviolet (UV) Light Emitting Diode (LED) Plume Simulator

System Description

The UV LED Plume Simulator hardware components are shown below. These include the source emitter, source controller, USB flash drive, flash drive cover, controller and AC power cables, and the protective cover.

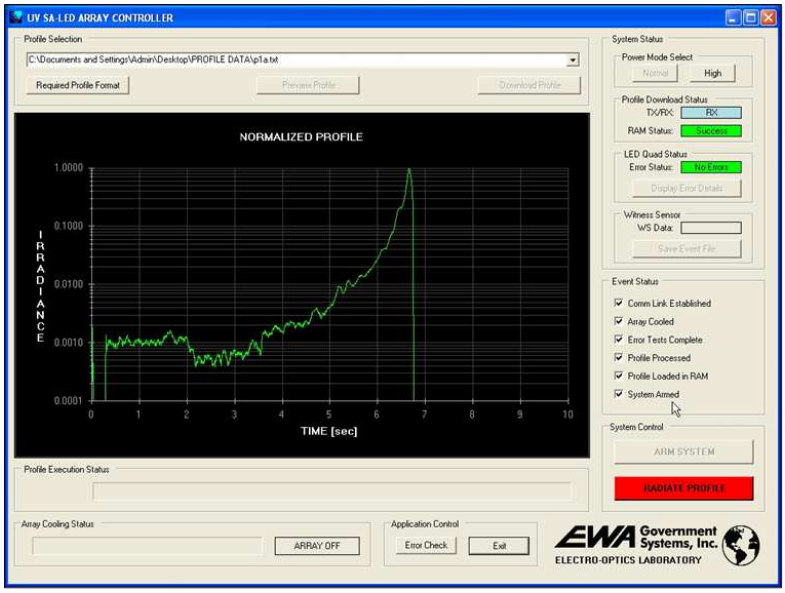


Automated Plume File Generator

The users plume signatures can be entered in ASCII format with time vs. intensity, and the Plume Simulators included software, shown below, will generate the required binary format for the simulator.

Plume Simulator Control Software

The control software allows the user to select the input file to be radiated, verify the status of the Simulator LED Array, and emit the selected profile.



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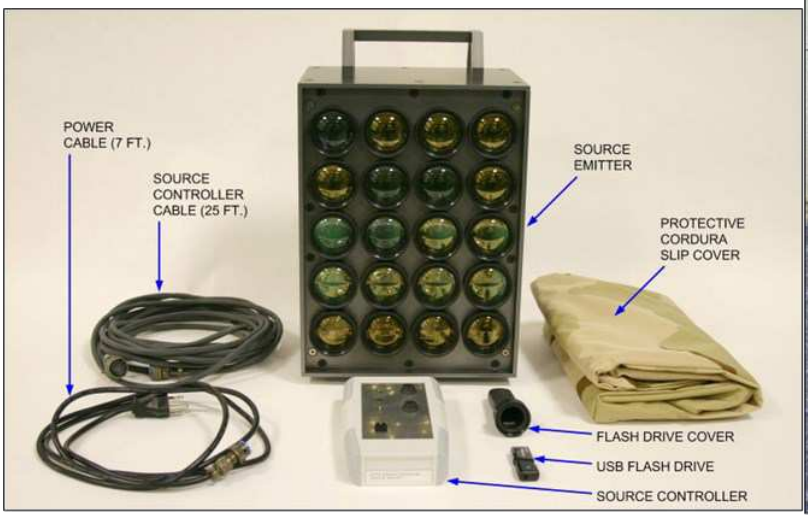
Ultraviolet (UV) Light Emitting Diode (LED) Plume Simulator

Missile Plume Simulator

Portable UVC LED based Plume Simulator providing high fidelity missile plume irradiance on sensor at ranges up to 3 kilometers.



Specification	Value	Remarks
Wavelength	CWL: 275nm, BW: ±5nm	Blue light is visible while profile is radiating
Temporal Resolution	200 Hz (5 msec update rate)	
Beam Shape (FWHM)	Rectangular: Azimuth: 8.7° Elevation: 5.0°	
Radiant Intensity (RI)	RI > 30 W/sr	Based on an inband sensor responsivity of 1.7e-16 $W/cm^2/cps$
Dynamic Range	42.3 dB	
Profiles	Accepts short, medium & long distance profiles, and custom test waveforms Maximum duration of any profile is 327.625 seconds, ~5.5 minutes Up to 100 profiles selectable via attached USB Flash Drive	
User Interface	Pushbutton Hand Controller	
Tripod Interface	Quickset Dovetail Mount	
Software	Windows compatible software for generating profiles and test waveforms	
Weight	24.5 lbs. (11.11 kg)	
Dimensions (H x W x D)	16 in. x 10 in. x 8 in. 40.6 cm x 25.4 cm x 20.3 cm	
Accessories	Profile generation software, camouflage Cordura slip cover, Pelican shipping case, and system manual	

Ultraviolet (UV) Parabolic Simulator (UVPS)

System Description

The UVPS is an advanced stimulator for testing Missile Warning Systems (MWS) operating in the UV-C spectrum. It is ruggedly designed so that it can be tripod-mounted and used in the field, or in the development or production laboratory. The MWS can be mounted on an optical table (if testing in the laboratory), or the installed MWS system can be tested on the flight line. The UVPS produces a strong beam of UV radiation with user programmable temporal dependence, to test the response of the MWS to a multiplicity of threats and approach scenarios, according to need.

As an option, the UVPS can be upgraded to be an integrated warning and countermeasure system tester, by the addition of a dedicated infrared radiometer, which measures the IR countermeasures and/or jam beam function, in case a threat has been detected and declared as such.

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Features and advantages of the UVPS system

- ◊ Compact and light (man-portable)
- ◊ The source is highly stable and durable.
- ◊ Its large diameter beam is strong enough to allow MWS testing in-flight up to a kilometer.
- ◊ It has a high dynamic range and very short maximum to minimum intensity transition time.
- ◊ Required low power enabling it to be used in the field with a battery pack.
- ◊ It has user programmable threat profiles through a user friendly software interface.
- ◊ The UVPS comes calibrated from the factory in radiant intensity units of Watts/steradian.
- ◊ Interfaces a PC with single USB port.

Options

- ◊ It automatically tracks the aircraft through a video tracker and tracking pedestal to make sure the MWS is constantly exposed to the UVTS stimulus, irrespective of the aircraft movement.
- ◊ The UVPS can be equipped with an IR radiometer, capable of assessing integrated missile warning and IR countermeasure systems, by measuring the latencies (the time between detection and declaration) and the IR countermeasures output radiation, intensity, time dependency, etc.
- ◊ A range finder can be included to measure target distance and use this distance to adjust/scale radiation profiles

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Ultraviolet (UV) Parabolic Simulator (UVPS)

Specifications

Specification	*Value*	*Remarks*
Beam Divergence [deg]	30	FWHM
Wavelength range [nm]	270-280	
On-Axis Radiant Intensity [Watt/str]	0.4	
UV rise/fall time [nsec]	<20	
Single engagement dynamic range	>800	
Bandwidth [Hz]	200	
Warm-up time [sec]	<2	
Environmental	Withstands field conditions	
Weight [Kg]	<10	For optical unit
Clear aperture diameter [cm]	40	
Visible output	<10 Watt bulb	
Dimensions [cm]	32 x 43 x 54	L x W x H