Spectral and Radiometric Calibration Facility for MidWave and LongWave Infrared Sensors

1. Introduction

This document contains the description, specifications, acceptance tests, and other requirements for a Spectral and Radiometric Calibration Facility for MidWave and LongWave InfraRed (MWIR and LWIR) imagers.

2. Overview

This request for Proposals is for a calibration and characterization facility for infrared imaging systems, to be delivered and set up at the Naval Research Laboratory (NRL) in Washington, DC. The contractor must assemble, test, and deliver a facility that can calibrate and characterize radiometric hyperspectral imaging sensors that operate in the MWIR (3.0 – 5.0 microns wavelength) and LWIR (8.0 – 14.0 microns wavelength) region of the electromagnetic spectrum. The delivered system must be able to perform the radiometric calibration, alignment characterization and spectral response characterization of the sensors to the performance specifications in the Section 4. Section 5 includes a separately-priced option for computer control of the spectral and radiometric sources. A report of the optical and electrical specifications of the facility and a user's manual describing the test setups must be included.

3. Facility Description

The Naval Research Laboratory is in the process of developing broadband, multispectral, and hyperspectral imagers operating in the MidWave InfraRed (MWIR, 3 to 5 microns wavelength) and LongWave InfraRed (LWIR, 8 to 14 microns wavelength) bands. These sensors are intended to image the Earth's surface from airborne platforms, and produce science-quality data. As part of this effort, NRL requires a sensor calibration and characterization facility suitable for developing and calibrating these imagers, including the capabilities for: (a) uniform field calibration, (b) point spread function and focus measurement, and (c) spectral calibration. Examples of similar sensors and their specifications can be found at http://www.higp.hawaii.edu/ahi/ahi.html, and references 2 and 3. The facility must be capable of providing the following infrared sources: (a) a calibrated, broadband, spatially uniform, Lambertian blackbody source, (b) a broadband collimated source, and (c) a continuously-tunable spectral source producing an approximately-collimated beam in selectable wavelength bands within the MWIR and LWIR. The required source capabilities are specified below.

As an example, the required facility could be comprised of a planar blackbody to provide the uniform broadband source, a collimator system with broadband infrared source, and a monochromator system with a broadband infrared source and means to convert the monochromator output to an approximately collimated beam. However, the offerer may propose any facility that meets the minimum requirements. Selection will be based on the system that provides the best value to the Government.

4. Spectral and Radiometric Calibration Facility Specifications

The following items (a), (b), and (c) represent the Government's minimum specifications for the baseline Infrared Spectral and Radiometric Calibration facility. Items (a), (b), and (c) are to be proposed and priced in aggregate, not separately. Although the calibration facility will not operate in vacuum, the Source Spectral Radiance requirements for items (b) and (c) are to be interpreted as the modeled performance in the absence of any atmospheric absorption.

(a) Broadband, Extended Area Infrared Radiation Source

Item (a) is a Broadband, Extended Area Infrared Radiation Source meeting the following specifications.

Source Area: The required size of the radiating surface is a 12 inch diameter circle. The radiation surface can be larger than this if it encompasses a 12 inch diameter circle. The radiating surface need not be round.

Source Spectral Range: Blackbody emitter over the spectral range 3 to 14 microns wavelength.

Source Emission Temperature: The source emission temperature must be selectable, and span the range from less than or equal to 10 degrees C to greater than or equal to 75 degrees C.

Source Effective Emissivity: The emissivity of the radiating surface must be greater than or equal to 0.96 (nominal value).

Source Temperature Accuracy: The temperature of the radiating surface must be known to an accuracy of 0.1 degree C or less.

Source Temperature Uniformity over Surface: The temperature of the required 12 inch diameter radiating surface must be uniform to 0.06 degrees C or less.

Radiance Field of View: The required 12 inch diameter radiant surface must be observable within specifications over a 20 degree full angle field of view.

(b) Collimated Infrared Radiation Source

Item (b) is a Collimated Infrared Radiation Source meeting the following specifications.

Collimated beam diameter (unobstructed): The minimum required diameter of the collimated beam is 8 inches.

Source Spectral Range: The spectral content of the infrared radiation in the beam must approximate blackbody radiation of variable temperature up to 50 degrees C, over the spectral range 3 to 14 microns. The Source must incorporate the ability to use customer-supplied bandpass filters no larger than 2 inches square, to select wavelength bands within this range.

Beam Collimation: The beam collimation must be 1 mrad or less over the 8 inch diameter

Beam Spectral Radiance: For all wavelengths from 3 to 14 microns, the spectral radiance (in W/m^2-sr-micron) of the beam, averaged over a cone with a steradiancy of 1 mrad diameter containing the collimated beam, must be equal to or greater than the spectral radiance emitted by a 50 C blackbody.

(c) Spectral Infrared Beam Source

Item (c) is a Spectral Infrared Beam Source meeting the following specifications.

Beam Source Area: The minimum required diameter of the Spectral Infrared Beam is 4 inches.

Source Spectral Range: The central wavelength of the infrared radiation in the beam must be continuously tunable over the ranges 3 to 5 microns and 8 to 14 microns

Beam Collimation: The Spectral Infrared Beam must be approximately collimated. An example of an approximately collimated as used here would be a beam for which the output of a monochromator is placed at the focus of a collimating optic. A similar definition would apply if a monochromator is not used.

Source Spectral Bandwidth: Variable bandwidths are desirable, but must include as a minimum the bandwidths 0.02 microns Full Width Half Maximum (FWHM) for the 3 to 5 microns range, and 0.05 microns FWHM for the 8 to 14 microns range

Wavelength Accuracy: The center wavelength of the Spectral Infrared Beam must be known to an accuracy 0.002 microns (3 to 5 microns range), and 0.004 microns (8 to 14 microns range), or better.

Source Spectral Radiance: A variable spectral radiance in the Spectral Infrared Beam is desirable. The maximum spectral radiance (in W/m^2-sr-micron) in the Beam must be greater than that of a 50 C blackbody radiator.

5. Optional Requirement

The Government requests that the offerer also propose on the following optional equipment, as a separately-priced option.

(a) Computer Control for Spectral and Radiometric Calibration Facility

Item (d) is a separately-priced option to enhance the usability of the baseline Facility by adding the capability to control the Facility under computer control. Item (d) is comprised of hardware and software to operate items (a), (b), and (c) under computer control. All important functions and settings of the sources should be under the control of a single computer with a unified, user-friendly interface.

6. Deliverables

The required paper deliverable items are: manufacturer-supplied users' manuals for purchased components; a report showing the configuration and operation of the facility; and a report of the optical and electrical specifications of the facility.

References

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2. L. Kirkland, K. Herr, E. Keim, P. Adams, J. Salisbury, J. Hackwell, A. Treiman, "First use of an airborne thermal infrared hyperspectral scanner for compositional mapping," Remote Sens. Environ. **80,** 447-459, 2002.

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