

REPORT OF CALIBRATION

for

**One Cooled Lead Selenide (PbSe) Detector
OL 730-PbSe-C, S/N: 05100008**

**Calibration Date: August 11, 2005
Certification Date: August 12, 2005
Project No: 909-902**



OPTRONIC LABORATORIES

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for

One Cooled Lead Selenide (PbSe) Detector

Customer: Space Telescope Science Institute
Baltimore, MD 21218

Purchase Order No: 43127

1. Material.

One Optronics Laboratories OL 730-PbSe-C Cooled Lead Selenide Detector (S/N: 05100008), consisting of a 3 mm x 3 mm detector and an OL 730-TE Cooler Controller (S/N:05100045), was calibrated for spectral irradiance response in units of $V_{SQP} \cdot p / (W/cm^2)$ when modulated at a frequency of 167 Hz.

2. Method of Calibration and Standards.

Calibration of the OL 730-PbSe-C Detector for irradiance response (167 Hz) involves the following two step procedure:

- 1) An absolute spectral response calibration is performed at a wavelength of 1300 nm relative to a NIST traceable Standard Germanium Detector 86I00034. For these measurements, an OL 750D Automated Spectroradiometric Measurement System configured for measuring detector spectral response is used in the transfer calibration (see Figure 1).

OPTRONIC LABORATORIES' GENERAL SETUP FOR DETECTOR RESPONSE MEASUREMENTS

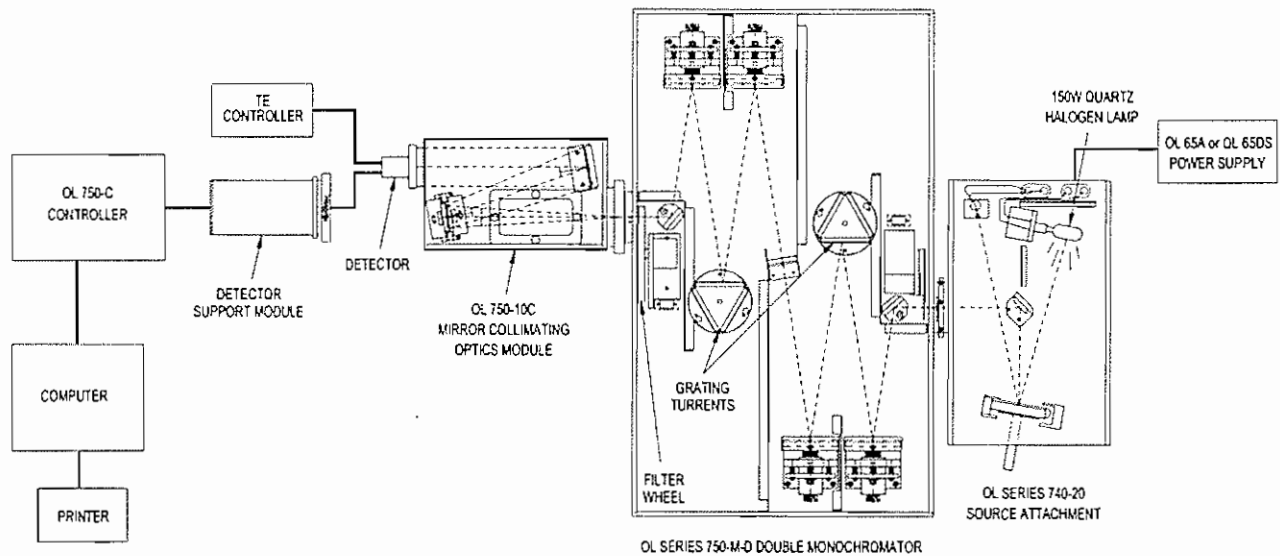


Figure 1

P000485G

The entire sensitive area of the test detector is irradiated with monochromatic irradiance. The half-bandwidth of the monochromator is set to 10 nm. The uncertainty in the calibration of the test detector relative to the NIST detector scale is estimated to be $\pm 1.0\%$. General Information on the calibration procedure along with the NIST traceable standards and estimated uncertainties are described in the attached Information Sheet, "The Optronic Laboratories Calibration of Photodetectors."

The calibration of Standard 86100034 was performed by the National Institute of Standards and Technology (NIST Test No. 844/268141).

The ambient temperature was 23.2 °C and the relative humidity was less than 60%.

- 2) The relative spectral response of the test detector is determined relative to a heavily blackened thermal detector using an OL 750D Automated Spectroradiometric Measurement System configured for operation over the entire 1.0 μm to 5.5 μm wavelength range. The National Physical Laboratory performed the relative spectral response calibration for the thermal detector (Reference: E04070008).

The estimated uncertainty in the transfer calibration from the thermal detector to the OL 730-PbSe-C Lead Selenide Detector varies with wavelength as follows:

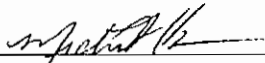
Wavelength (μm)	Uncertainty (%)
1.0 to 2.5	1.0
2.5 to 5.5	2.0

3. Results.

Table 1 provides the OL 730D DSP Lock-in Amplifier configuration for the OL 730-PbSe-C Lead Selenide Detector. The spectral irradiance response values in $V_{SQP} \cdot p / (W/cm^2)$ over the wavelength range of 1.0 μm to 5.5 μm at 0.1 μm are given in Table 2.

Calibration Certified By:

OPTRONIC LABORATORIES, INC.



Michael F. Kelso
Radiometrist

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TABLE 1

OL 730D DSP Lock-In Amplifier Configuration for OL 730-PbSe-C Lead Selenide Detector

AC with optical chopper and standard source (Connect the OL 730-PbSe-C Output BNC to the OL 730D Voltage Input BNC) OL 730D Set-up	
RESPONSE TIME	Set response time for the OL 730-PbSe-C Lead Selenide Detector as follows: For the AC voltage square wave peak to peak mode response times are e^{-3} (5 seconds), e^{-2} (3 seconds), e^{-1} (2 seconds), and e^0 (1 second).
INPUT SOURCE	Set to AC VOLTAGE DC CPLG. This DC couples the signal. The detector provides the AC coupling.
SELECT MEASUREMENT	SQUARE INPUT, PK-PK. This will equate the measurement of the standard germanium detector performed in the DC with the AC measurement units of the test detector.
SELECT REFERENCE	Set to CHOPPER REFERENCE
DYNAMIC RESERVE	0 db should be sufficient for these measurements.
SELECT NOTCH FILTERS	1X OUT 2X OUT. Unless calibration is performed in the presence of room light, no notch filtering should be required. If measurements are performed in the room light select 2X IN. Using this option during the calibration can affect the accuracy of the measurement when the reference frequency is in the proximity to the notch frequency (Q=4). Highest accuracy will be achieved without this filter.
REFERENCE FREQUENCY	167 Hz

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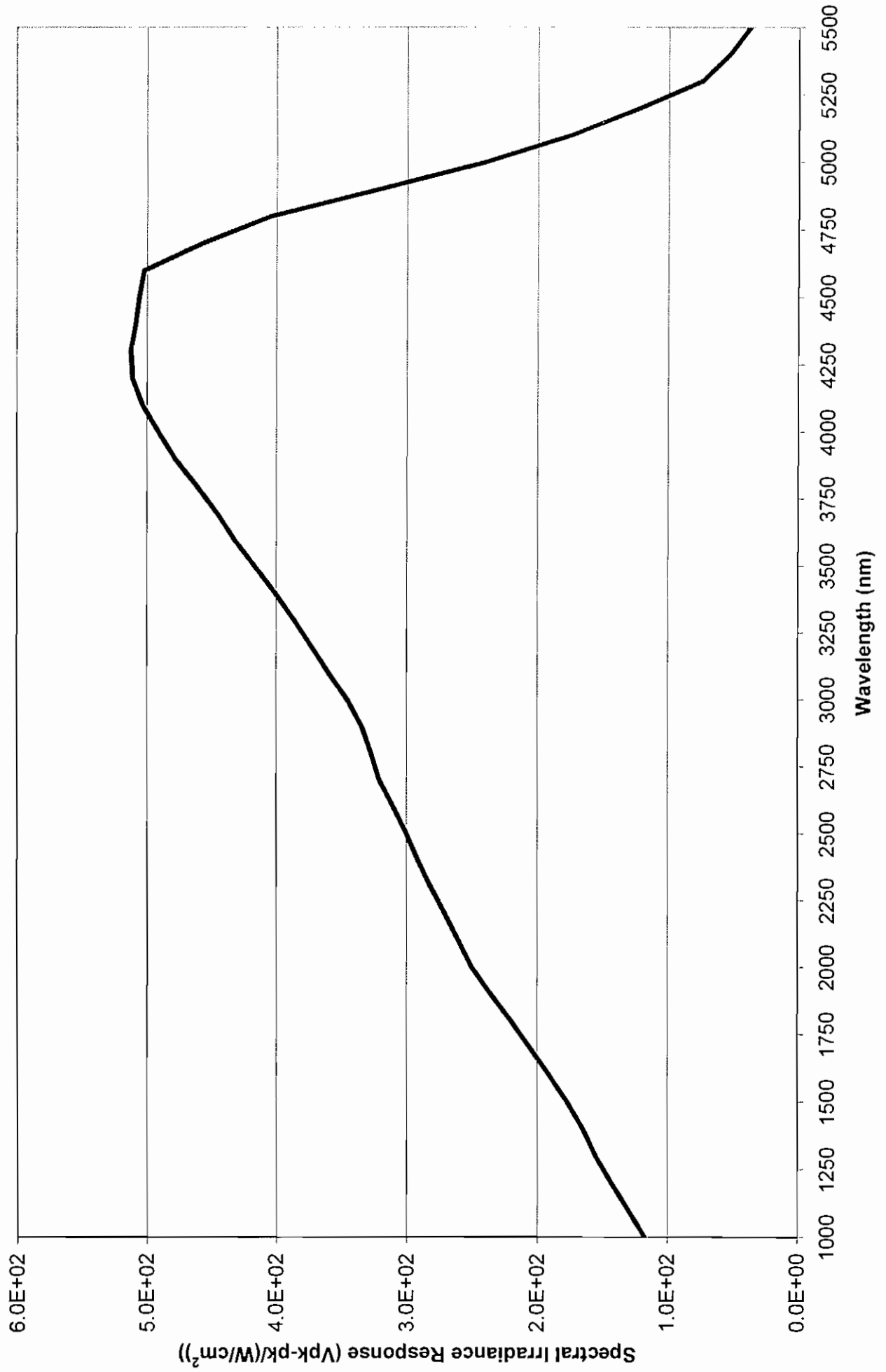
TABLE 2

Spectral Response for OL 730-PbSe-C Lead Selenide Detector, S/N: 05100008

Wavelength [nm]	Response [$V_{SQP \cdot P} / (W/cm^2)$]
1000	1.167E+02
1100	1.294E+02
1200	1.424E+02
1300	1.546E+02
1400	1.643E+02
1500	1.763E+02
1600	1.903E+02
1700	2.047E+02
1800	2.192E+02
1900	2.346E+02
2000	2.492E+02
2100	2.596E+02
2200	2.698E+02
2300	2.805E+02
2400	2.904E+02
2500	2.992E+02
2600	3.093E+02
2700	3.201E+02
2800	3.265E+02
2900	3.336E+02
3000	3.445E+02
3100	3.588E+02
3200	3.723E+02
3300	3.858E+02

Wavelength [nm]	Response [$V_{SQP \cdot P} / (W/cm^2)$]
3400	4.001E+02
3500	4.159E+02
3600	4.319E+02
3700	4.452E+02
3800	4.608E+02
3900	4.774E+02
4000	4.902E+02
4100	5.025E+02
4200	5.104E+02
4300	5.118E+02
4400	5.080E+02
4500	5.052E+02
4600	5.014E+02
4700	4.567E+02
4800	4.040E+02
4900	3.207E+02
5000	2.394E+02
5100	1.736E+02
5200	1.214E+02
5300	7.365E+01
5400	5.219E+01
5500	3.647E+01

Spectral Irradiance Response for OL 730-PbSe-C S/N: 05100008





THE OPTRONIC LABORATORIES CALIBRATION OF PHOTODETECTORS

Introduction

Detector spectral response measurements over the wavelength range of 200 nm to 1800 nm are based directly on standard detectors supplied to Optronic Laboratories by NIST (National Institute of Standards and Technology). All measurements made outside of the 200 nm to 1800 nm region are referenced to a heavily blackened thermal detector, which covers the entire 0.2 μm to 30 μm wavelength range. All primary detectors are calibrated in a uniform, semi-collimated beam which irradiates the central portion of the detector's active area.

Instrumentation

A typical configuration for spectral response measurements consists of the Optronic Laboratories OL 750D Double Monochromator Automated Spectroradiometric Measurement System supplemented with the:

1. OL 740-20D/UV UV-Visible Dual Source Attachment
2. OL 740-20D/IR Visible-IR Dual Source Attachment
3. OL 750-10C Mirror Collimating Optics Module
4. OL 65A Programmable DC Current Sources
5. OL 45D Deuterium Lamp Precision Current Source
6. OL 750-425 Detector Spectral Response Software Package

Appropriate gratings and blocking filters supplement the above equipment.

Measurement Procedure

Optronic Laboratories has set up a series of calibrated UV-enhanced silicon detectors for the 200 nm to 1100 nm wavelength region and TE cooled germanium detectors for use over the range of 800 nm to 1800 nm. These detectors have been compared directly to the NIST calibrated detectors. All IR detector spectral response calibrations (with the exception of the Ge and InGaAs detectors) are based on a standard thermal detector. The relative spectral response of the thermal detector was determined from a knowledge of the spectral reflectance of the blackened receiver and independently verified by comparison to a blackened, conical shaped, thermopile detector. The absolute response of the thermal detector was determined by comparison to

a NIST traceable silicon detector at a wavelength of 1.0 μm . Accordingly, the absolute spectral response of the thermal detector was determined from a knowledge of the relative spectral response over the wavelength range of 1.0 μm to 30 μm and the absolute response at 1.0 μm .

Uncertainty (k = 2)

The estimated uncertainty in the calibration of the NIST supplied standard silicon photodiodes and the transfer uncertainty to the Optronic Laboratories Standard Detector varies as follows:

Wavelength Range (nm)	NIST Uncertainty (%)	Transfer Uncertainty (%)
200	± 3.8	± 1.5
205 to 210	± 1.4 to 2.0	± 1.5
215 to 300	± 0.9 to 1.3	± 1.0 to 1.5
305 to 350	± 1.1 to 1.9	± 0.75
355 to 400	± 0.4 to 1.0	± 0.5
405 to 465	± 0.22 to 0.31	± 0.5
470 to 920	± 0.20	± 0.5
925 to 1070	± 1.6 to 2.9	± 0.5 to 1.0
1075 to 1100	± 3.2 to 4.4	± 1.0 to 1.5

The estimated uncertainty in the NIST calibrated germanium detector varies from $\pm 0.40\%$ to $\pm 3.8\%$, and the transfer uncertainty to the Optronic Laboratories Standard Detectors is $\pm 1.0\%$.

The estimated transfer uncertainty in the relative spectral response of the pyroelectric detectors supplied by Optronic Laboratories varies with wavelength as follows:

Wavelength Range (μm)	Transfer Uncertainty (%)
1.0 to 2.5	1.0
2.5 to 5.0	1.5
5.0 to 15	2.0
15 to 20	2.5
20 to 30	4.0

The estimated transfer uncertainty in the absolute spectral response of the pyroelectric detectors at 1.0 μm is $\pm 1\%$ to 2% .