Eos Cross-Calibration Radiometers

Stuart F. Biggar
Remote Sensing Group
Optical Sciences Center
University of Arizona

Presented to:

Calibration/Data Product Validation Panel Meeting
April 7-10, 1992
Boulder, Colorado

Eos Radiometers

Philosophy

Spectral Coverage

Specific Design

Philosophy

Portable

Stable

Precise

Accurate

Spectral Coverage

0.4 - 1.0 μm	(Silicon QED)
0.8 - 1.65 μm	(Germanium)
1.5 - 2.5 μm	(cooled Indium Arsenide)
3.5 - 14.5 μm	(cooled Mercury Cadmium Telluride)

Silicon QED

- Design Considerations
- Fabrication
- Data collection/storage
- Concerns

Design considerations

- Spectral
  - 0.4 - ~1.0 µm
  - Silicon detectors
    - (3 Hamamatsu S1337-1010BQN)
  - Interference Filter(s)
- Radiometric
  - No optics (other than filter)
  - Precision apertures (2)
  - QED (5 detector surfaces)
- Thermal
  - Temperature control
    - Detector / Amplifier
    - Apertures
    - Filter
  - Material
    - Invar
    - Stainless steel

Fabrication

- Custom built
- Precision tolerances
  - detector alignment
    - position
    - angle
  - aperture
    - centering
    - diameter
    - circularity
    - separation
- Interchangeable detector blocks

Data collection/storage

- Analog outputs
  - Detector voltage
  - Detector temperature
  - Filter temperature
  - "Instrument" temperature
- Digital outputs
  - Filter id number
- Analog/Digital conversion
  - Commercial data logger
    - 17 bit A/D
    - 0.03% accuracy (dcv / 1 year)
    - Rugged, compact (3 kg)
  - Commercial data acquisition hardware
    - 17 bit A/D
    - 0.01% accuracy (dcv / 1 year)
    - Rugged, transportable
- Storage
  - Data logger (and/or)
  - Small MS-DOS computer (RAM card)

Amplifier

Design

- Transimpedance configuration
- low noise FET type OP AMP
- temperature controlled
  - op amp
  - feedback resistor(s)
- single or 1 per detector

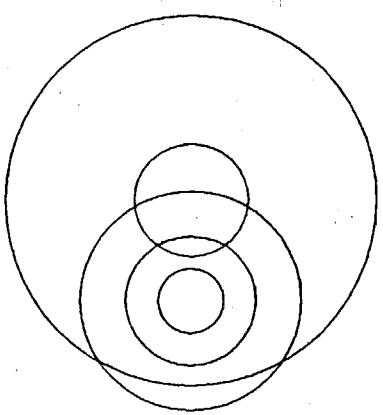
Variable gain

- set by switch
  - or
- digital io from logger

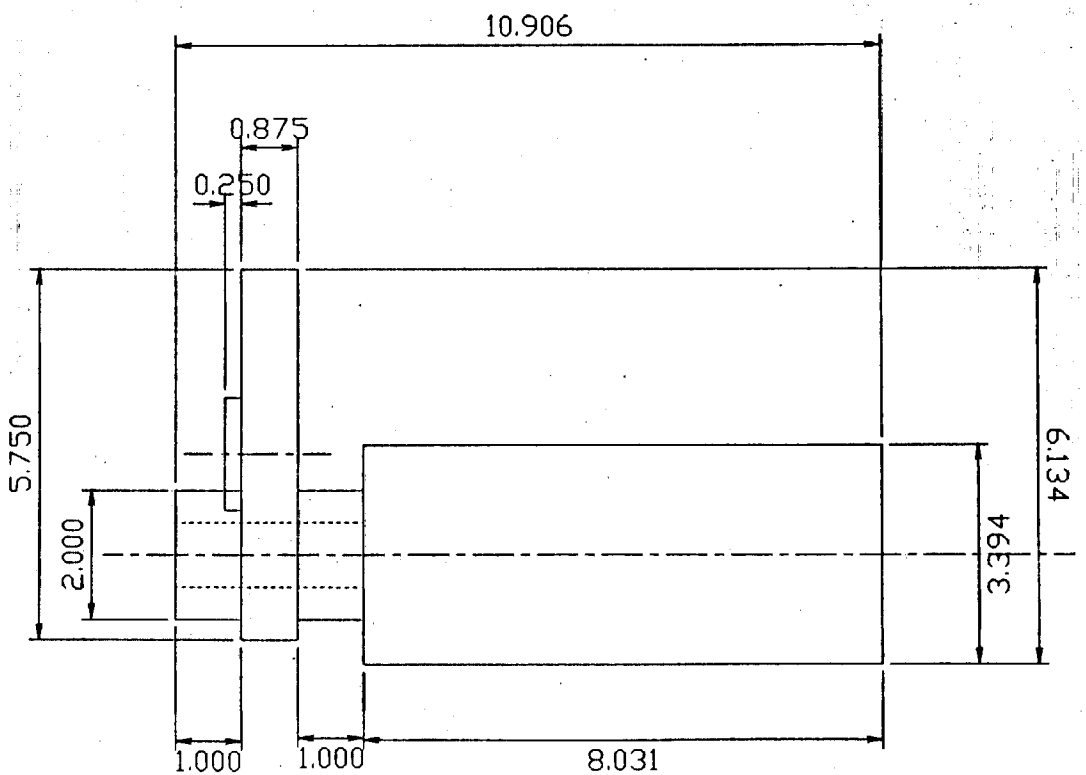
Concerns

- Operating Conditions (vacuum ?)
- Radiance levels
- Scheduling

Dimensions are inches



End on



Side

EOS

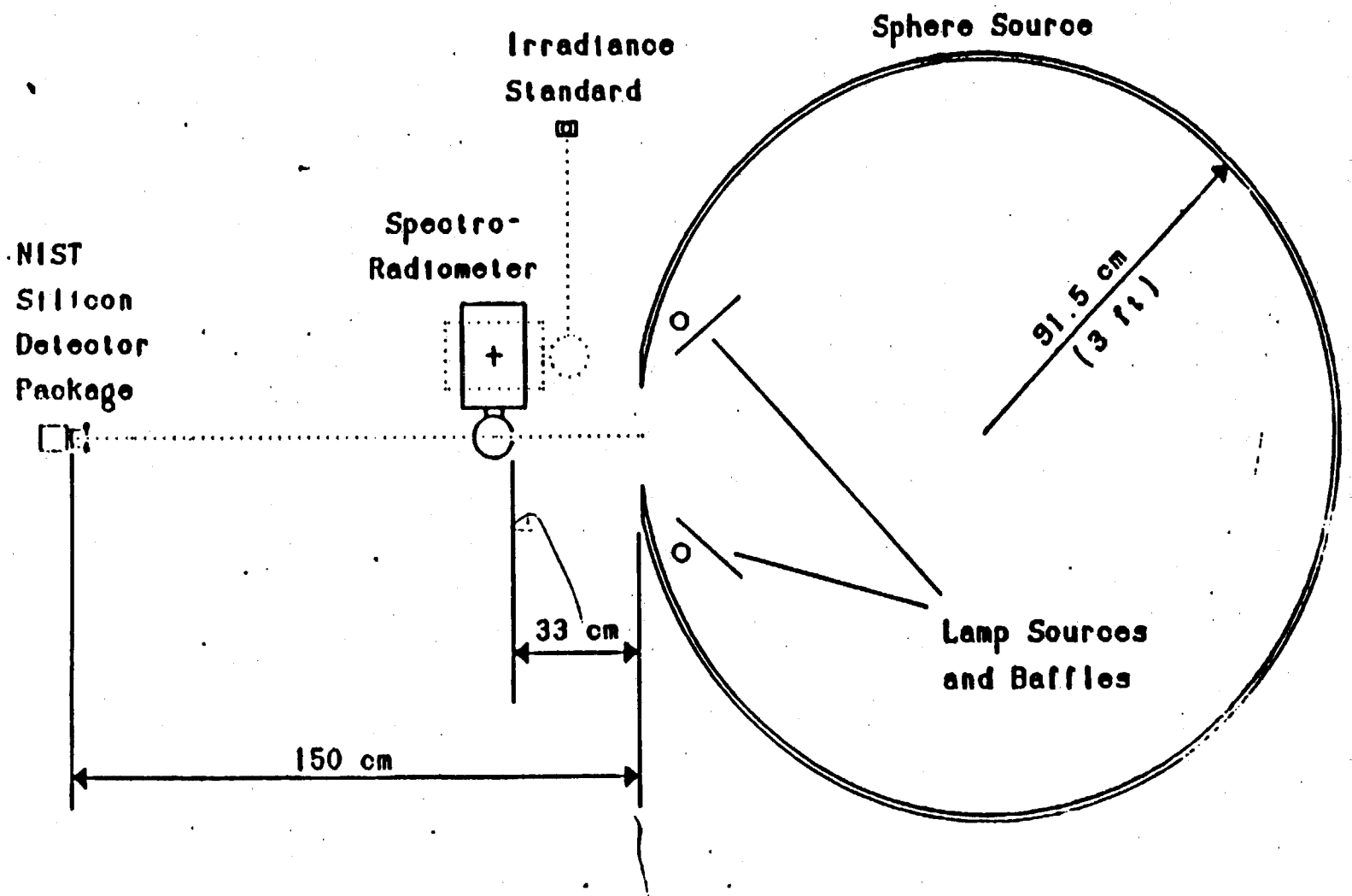
5th Meeting of

Calibration Data Product Validation Reflected Solar Group

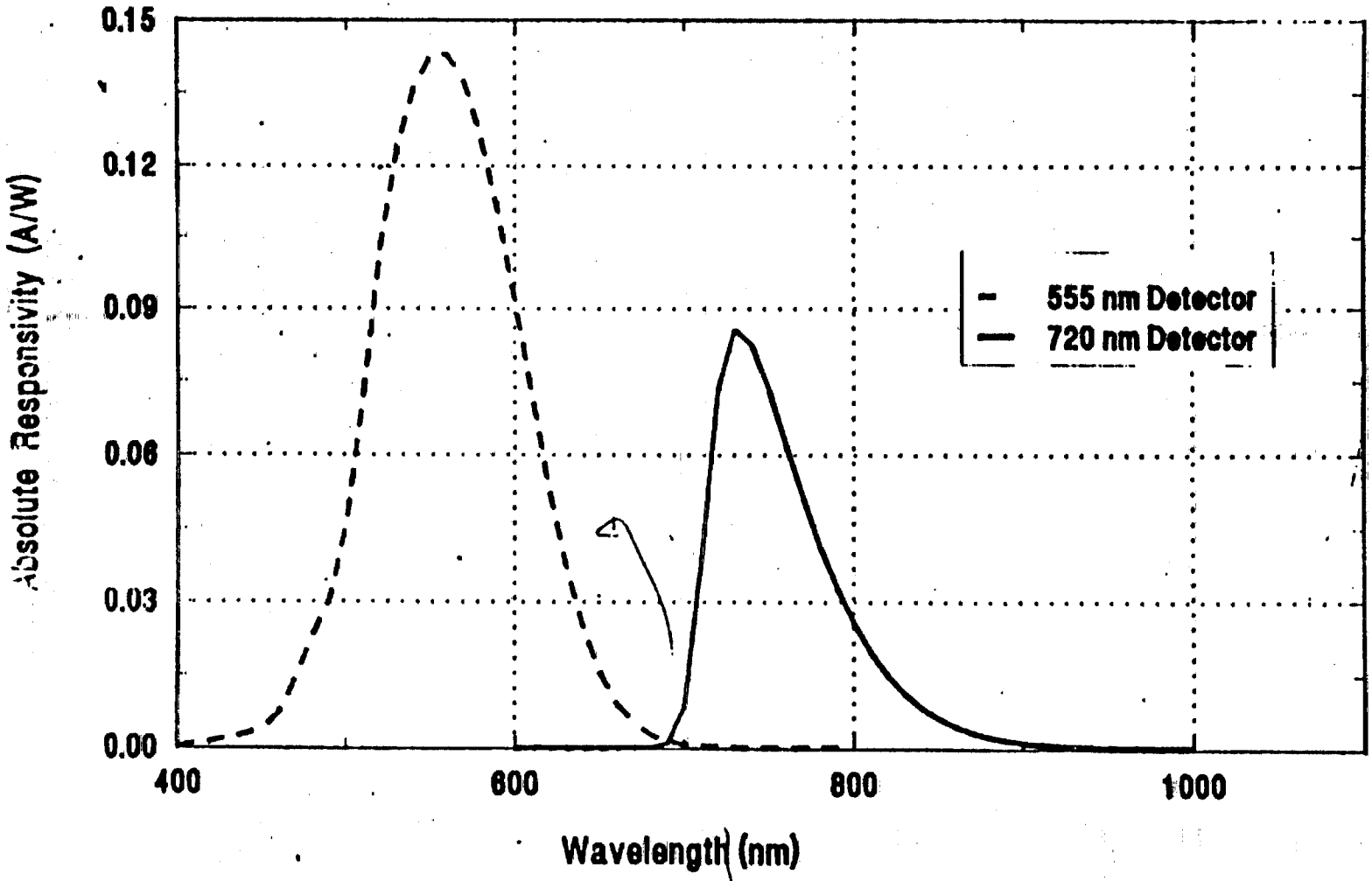
Calibration Source Verification

Dr. Christopher L. Cromer

NASA Goddard Sphere Source Measurement Setup



Spectral Responsivity of Detectors



RESULTS OF NASA SPHERE SOURCE MEASUREMENTS AT NASA

(183 cm diameter sphere with 25.4 cm aperture)

Detector Filter Peak Wavelength (nm)	Source to Detector Distance (cm)	Difference of Predicted Signal from Measured Signal (%)
555	190	-0.2
555	150	-0.1
555	100	-0.1
720	190	-0.4
720	150	-0.2

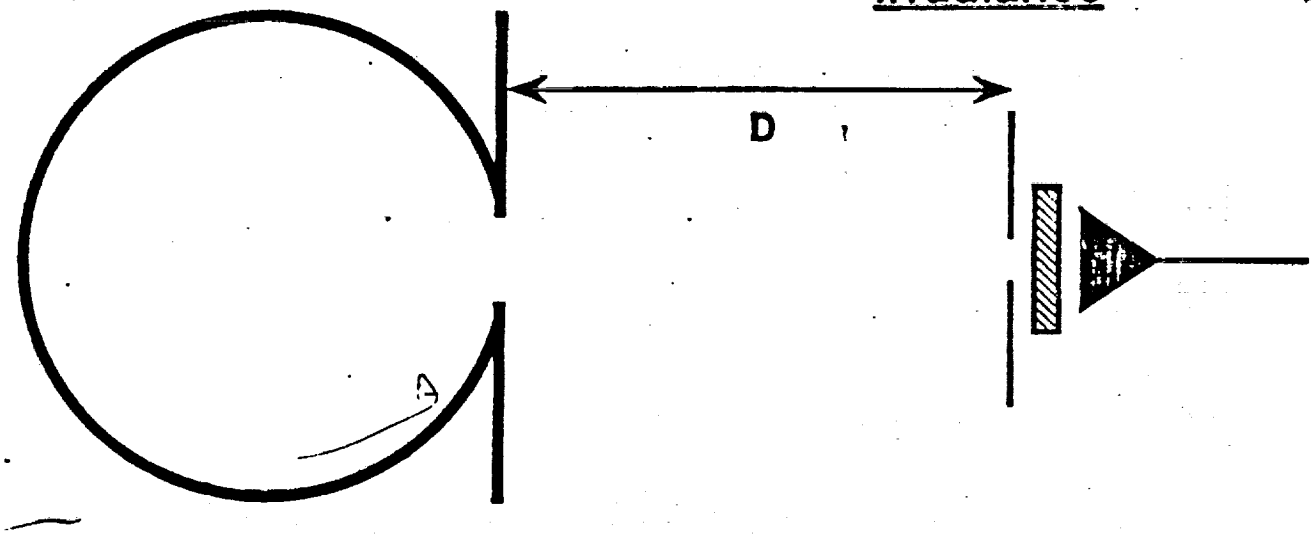
Verification Methods

Sources

Radiometers

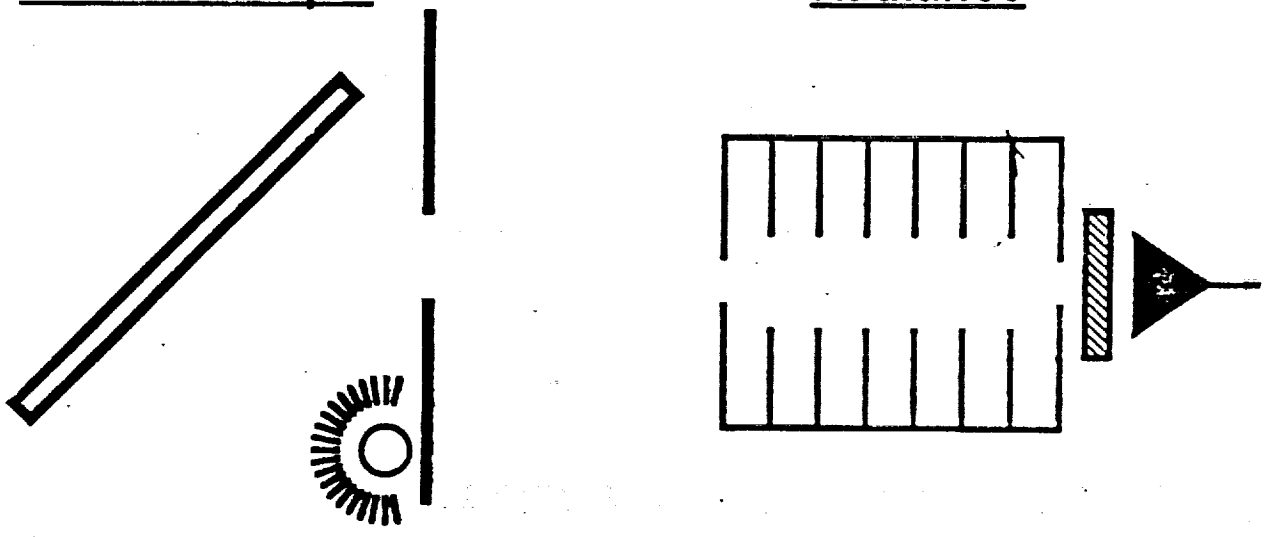
Sphere Source

Irradiance



Diffuser Plaque

Radiance



Options

Entrance Optics

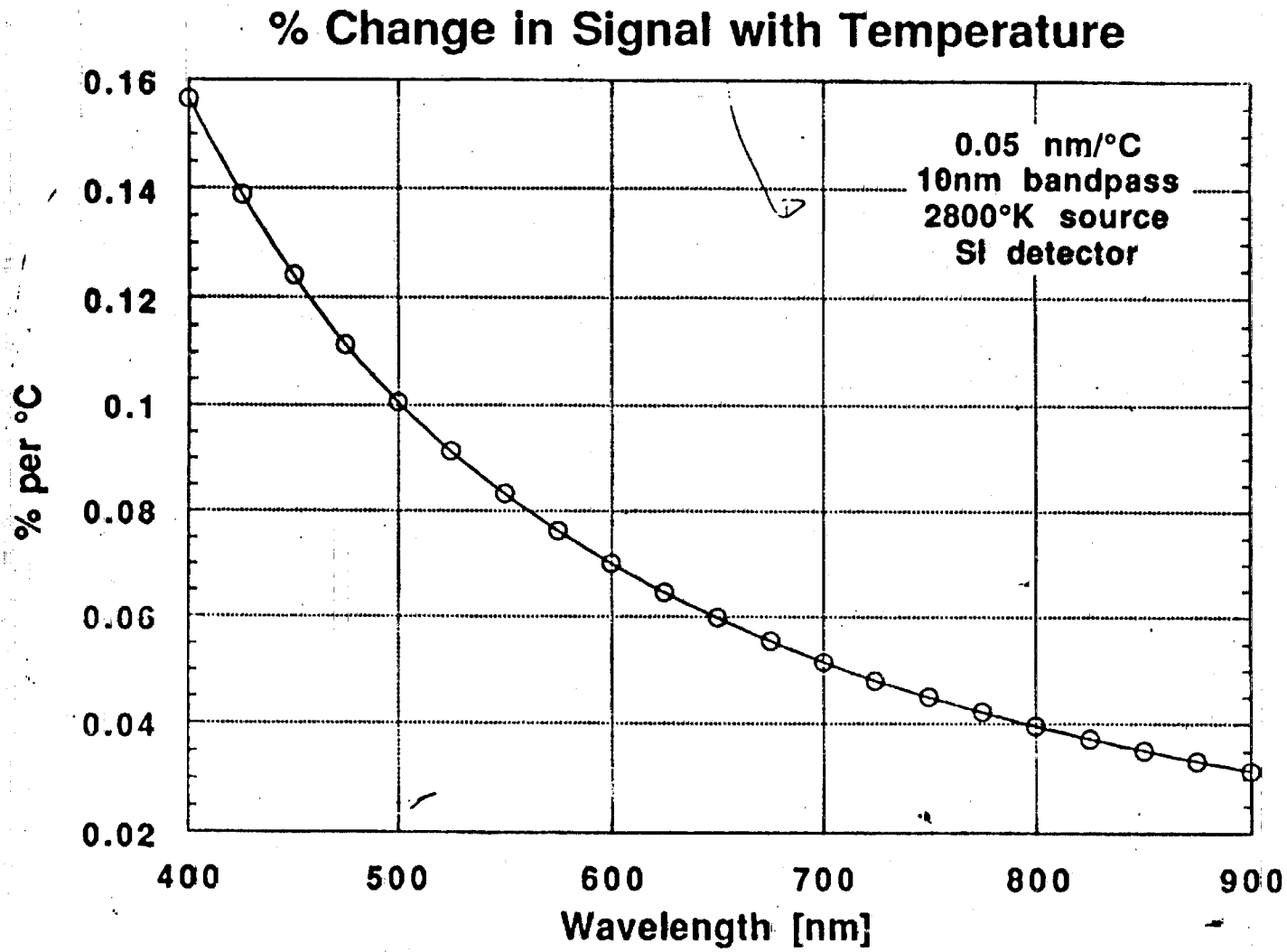
- Aperture
- Telescope
- Baffle Tube

Filters

- Absorbing
- Interference
- Monochromator

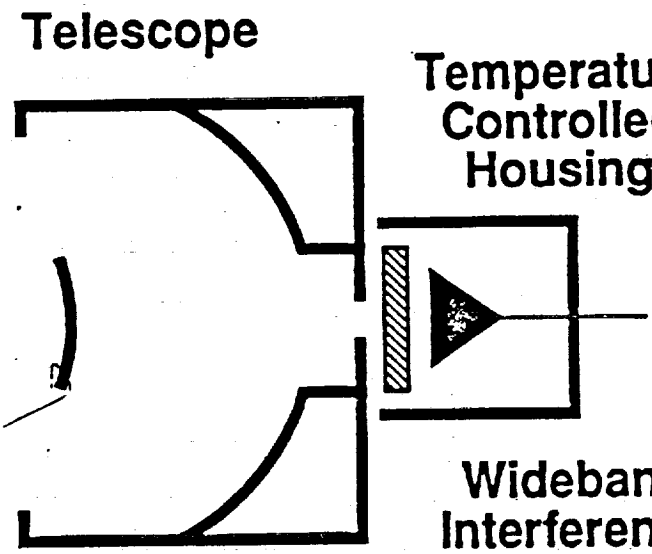
Detectors

• GaP	.2 μm - .5 μm
• GaAsP	.2 μm - .7 μm
• Si	.2 μm - 1.1 μm
• Ge	.9 μm - 1.7 μm
• InGaAs	.9 μm - 1.8 μm
• PbS	1. μm - 3.3 μm
• InAs	1. μm - 3.8 μm
• InSb	1. μm - 5.5 μm

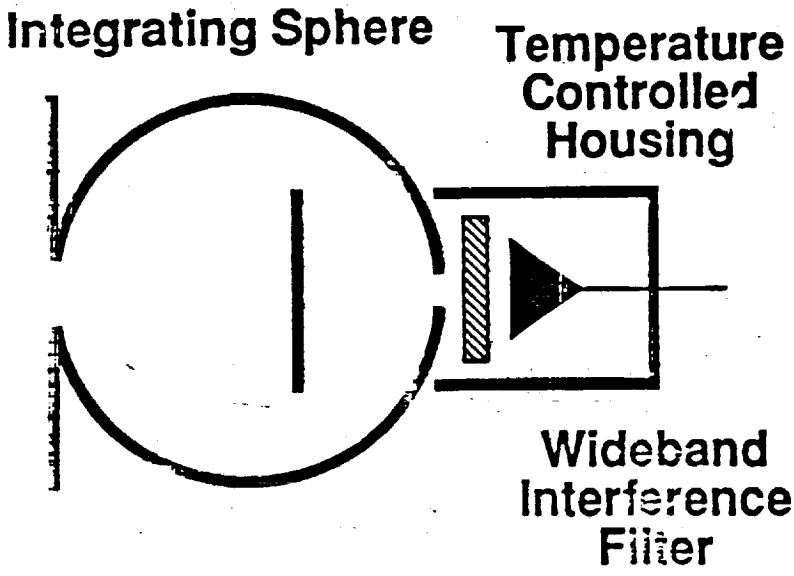

% Change in Signal with Temperature
0.05 nm/°C
10nm bandpass
2800°K source
Si detector
% per °C
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
400
500
600
700
800
900
Wavelength [nm]

Proposed Geometry

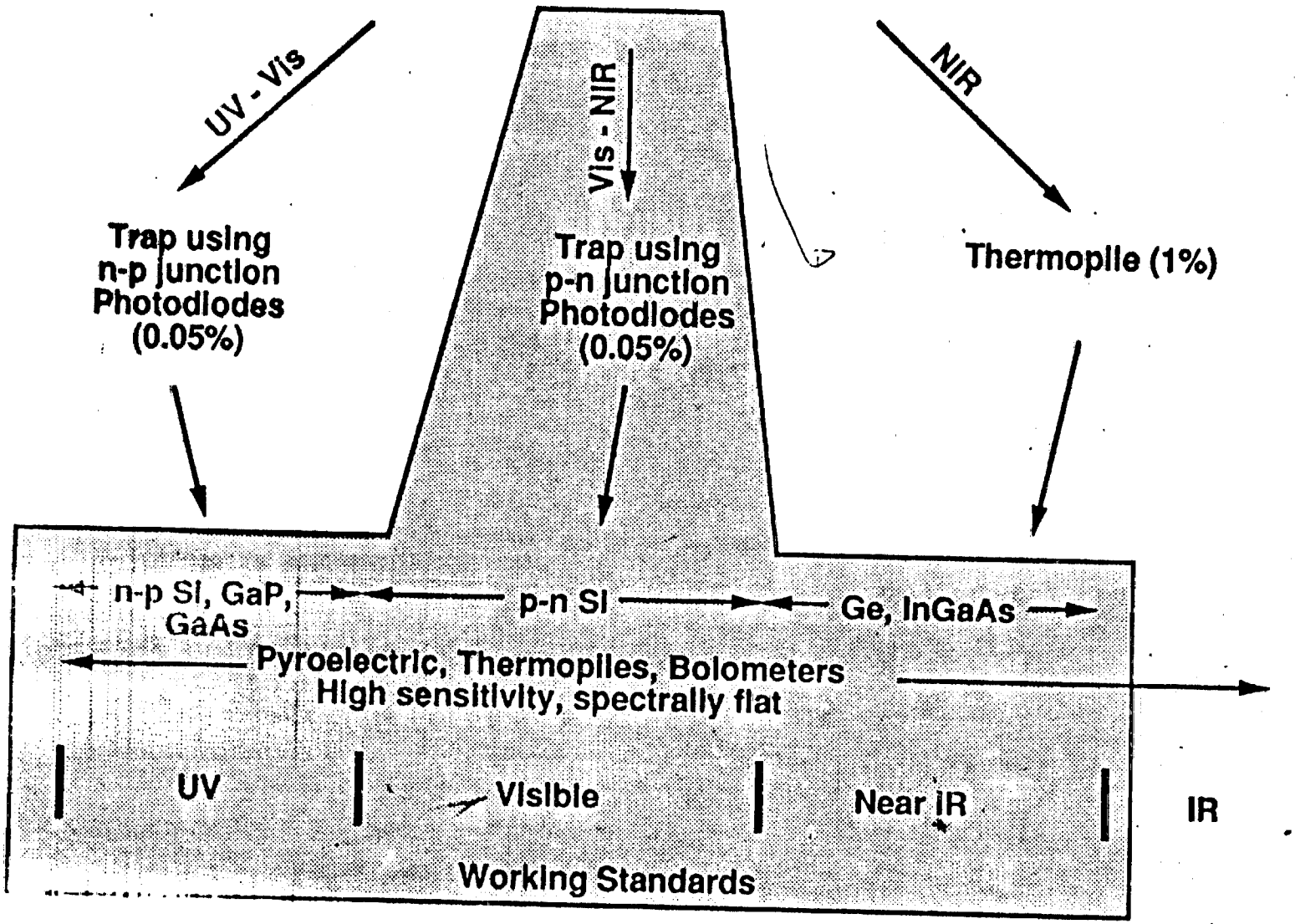
Radiance

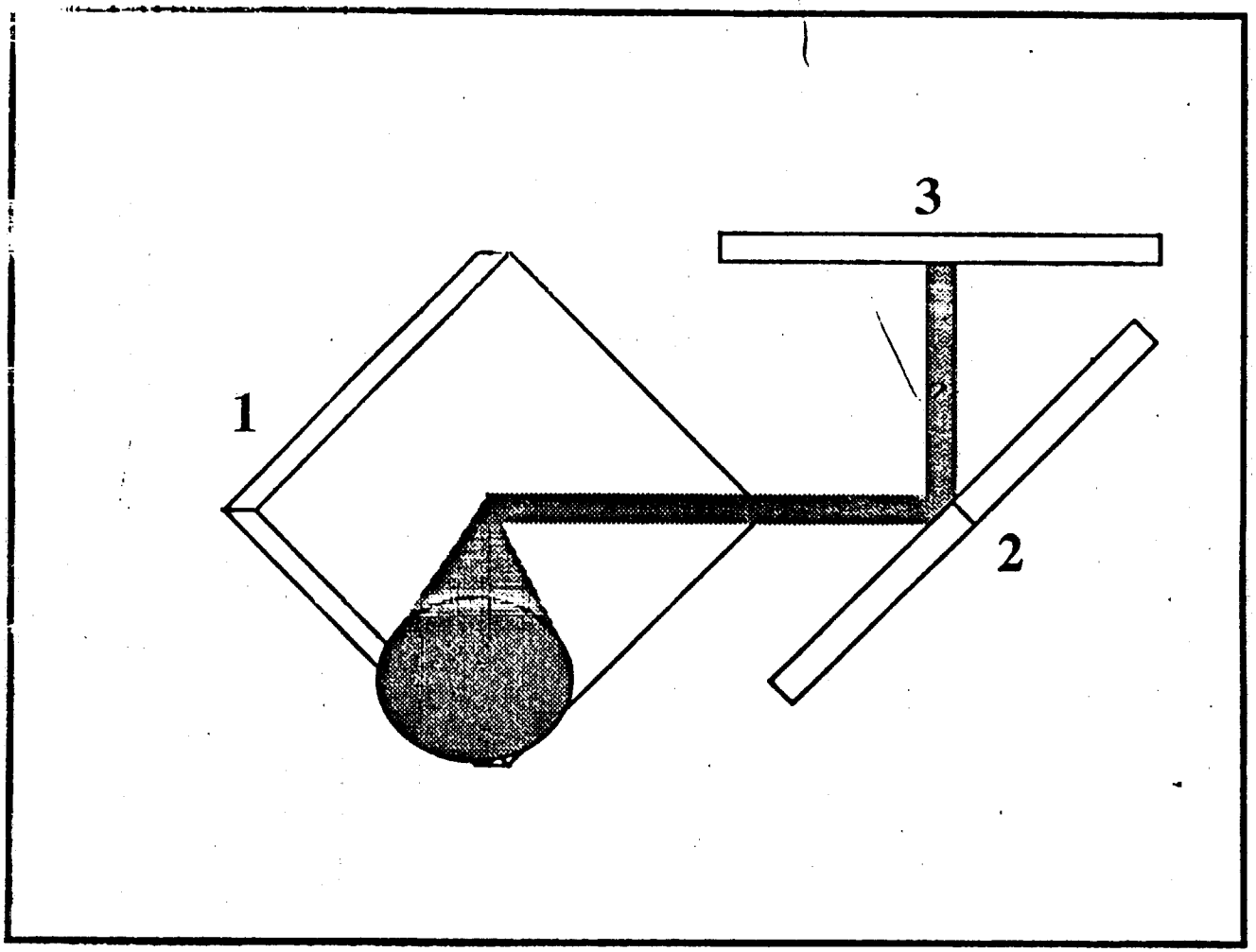


Irradiance



Cryogenic Radiometer (0.01%)





Trap Detector
Arrangement of photodiodes
minimizes light lost to reflections

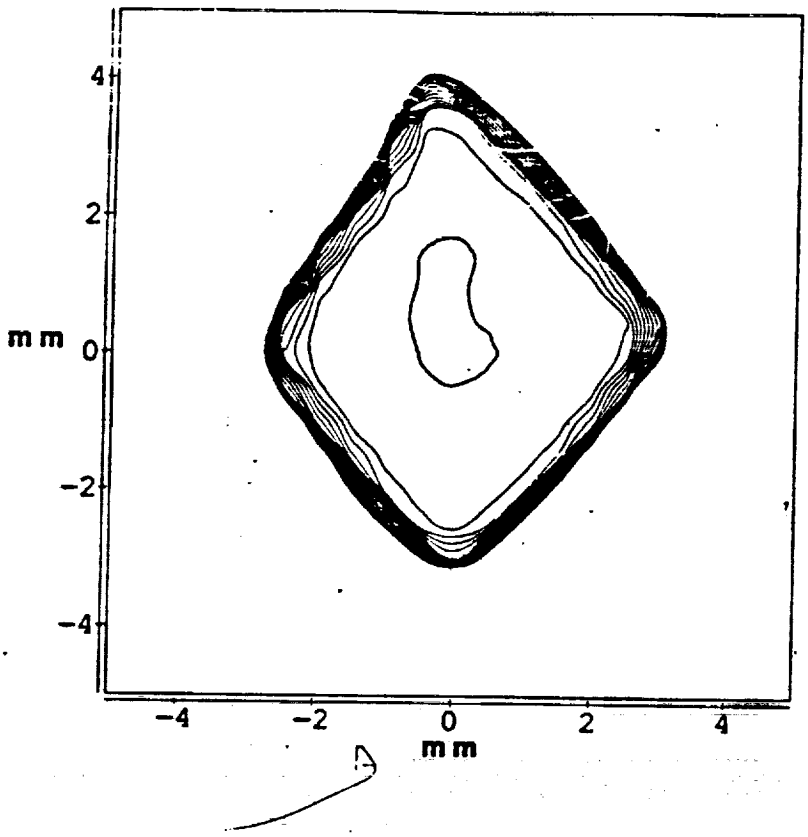


Figure 5a
Response Uniformity of Hamamatsu Trap #3
0.1% contours at 500 nm
1.1 mm resolution

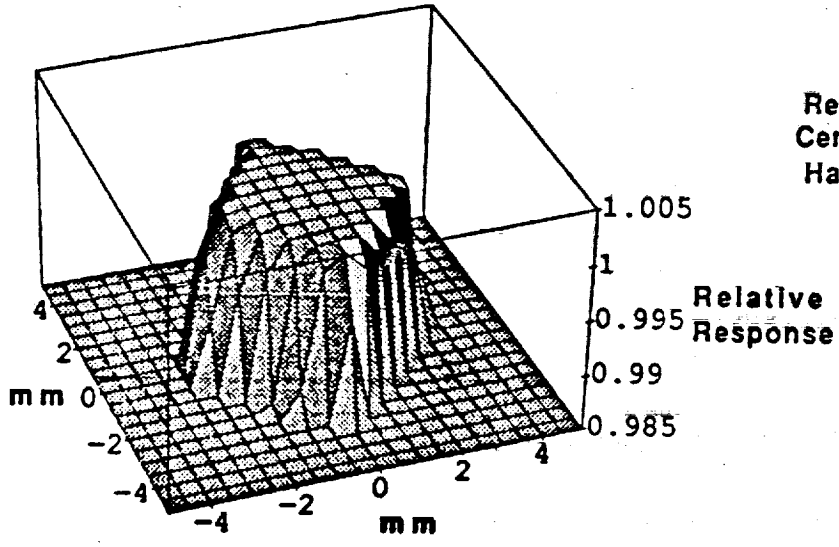
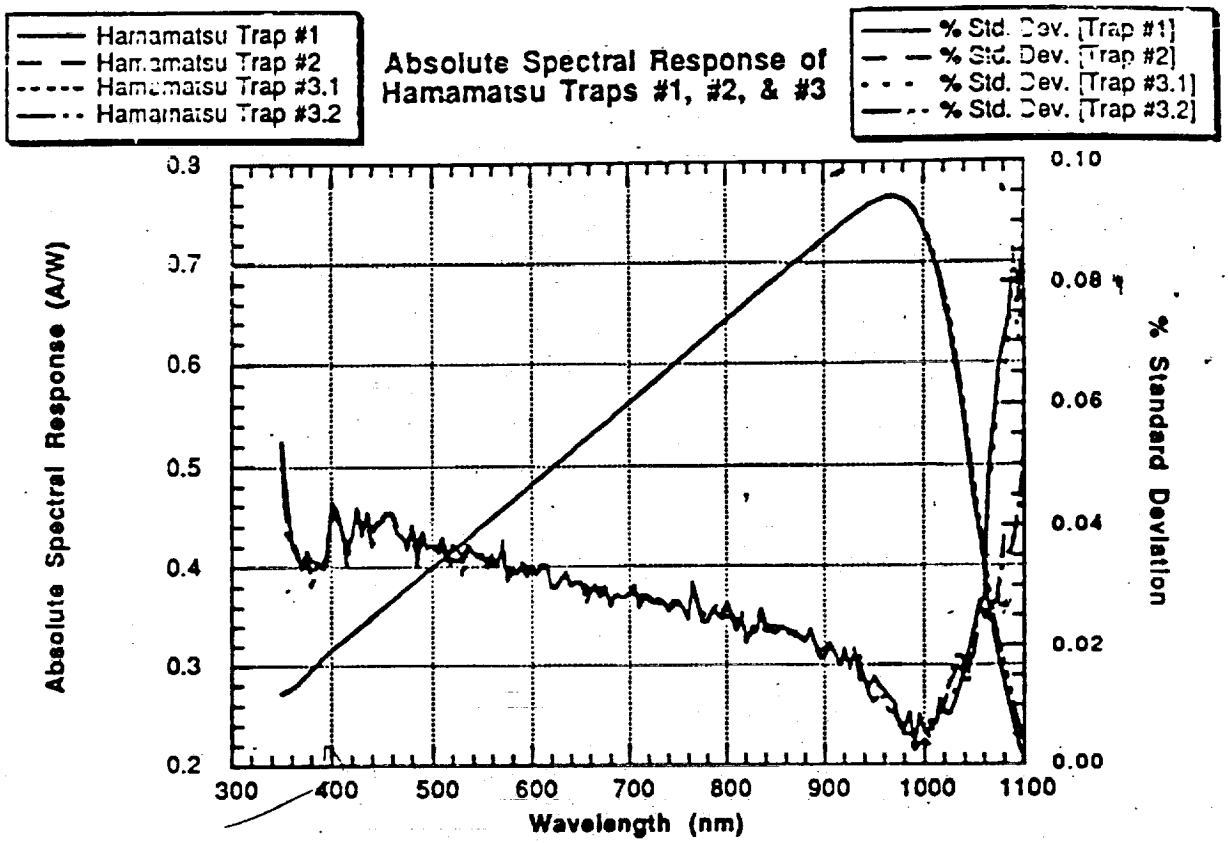
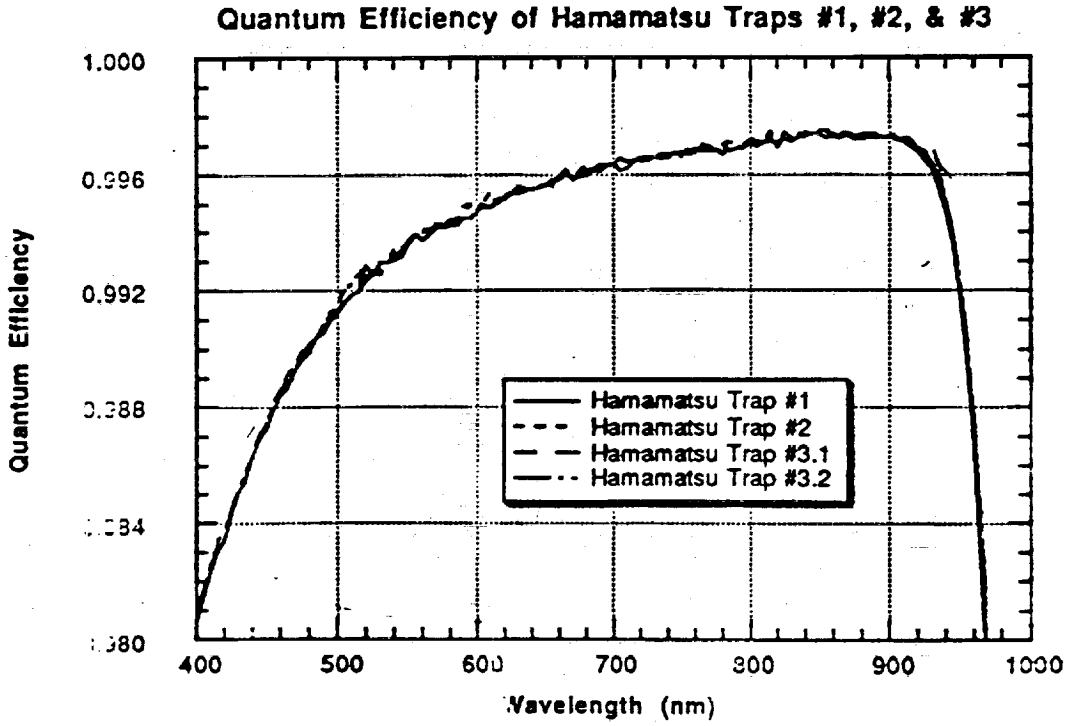


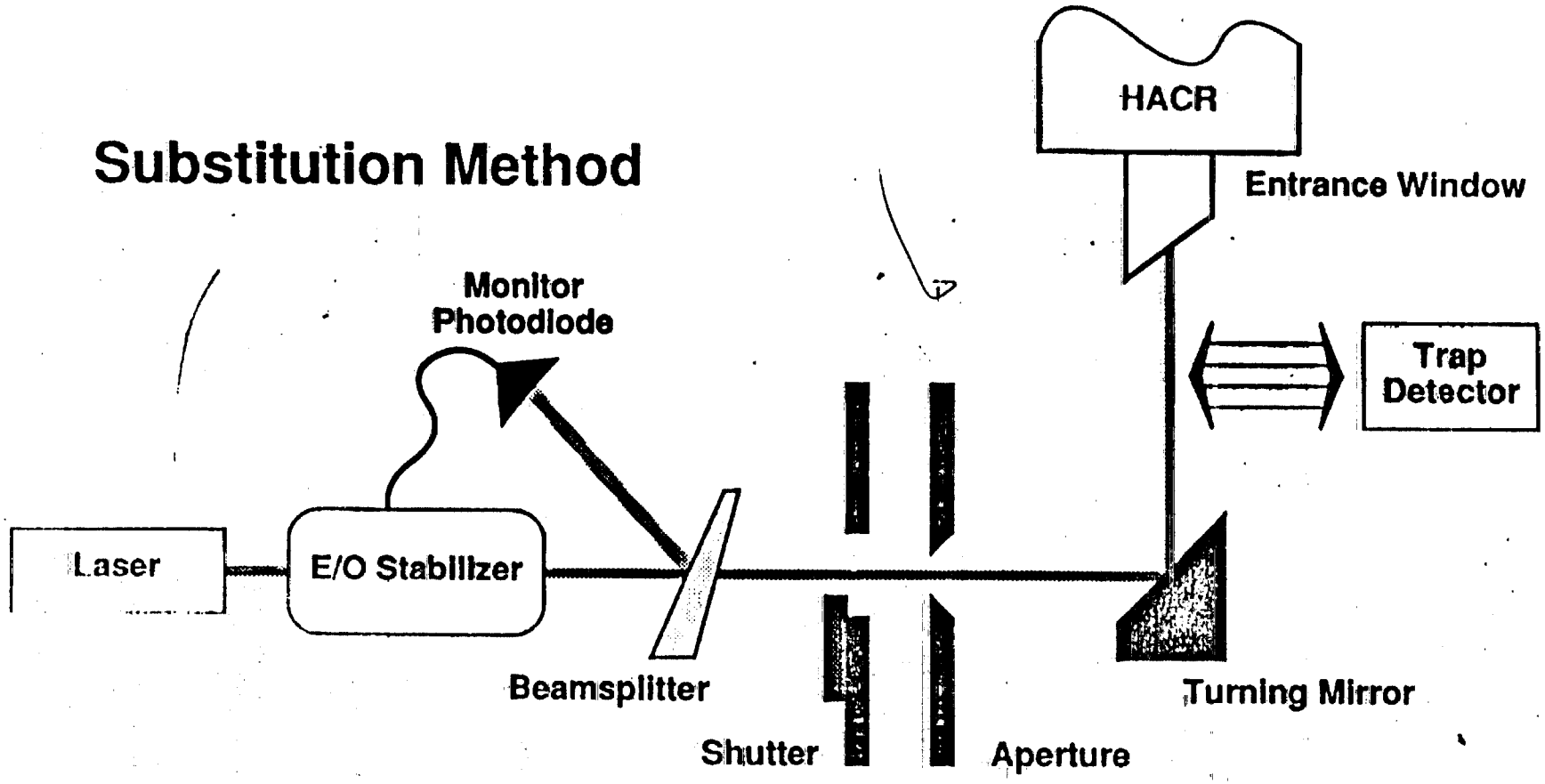
Figure 5b
3D Plot of
Response Relative to
Center of Detector for
Hamamatsu Trap #3

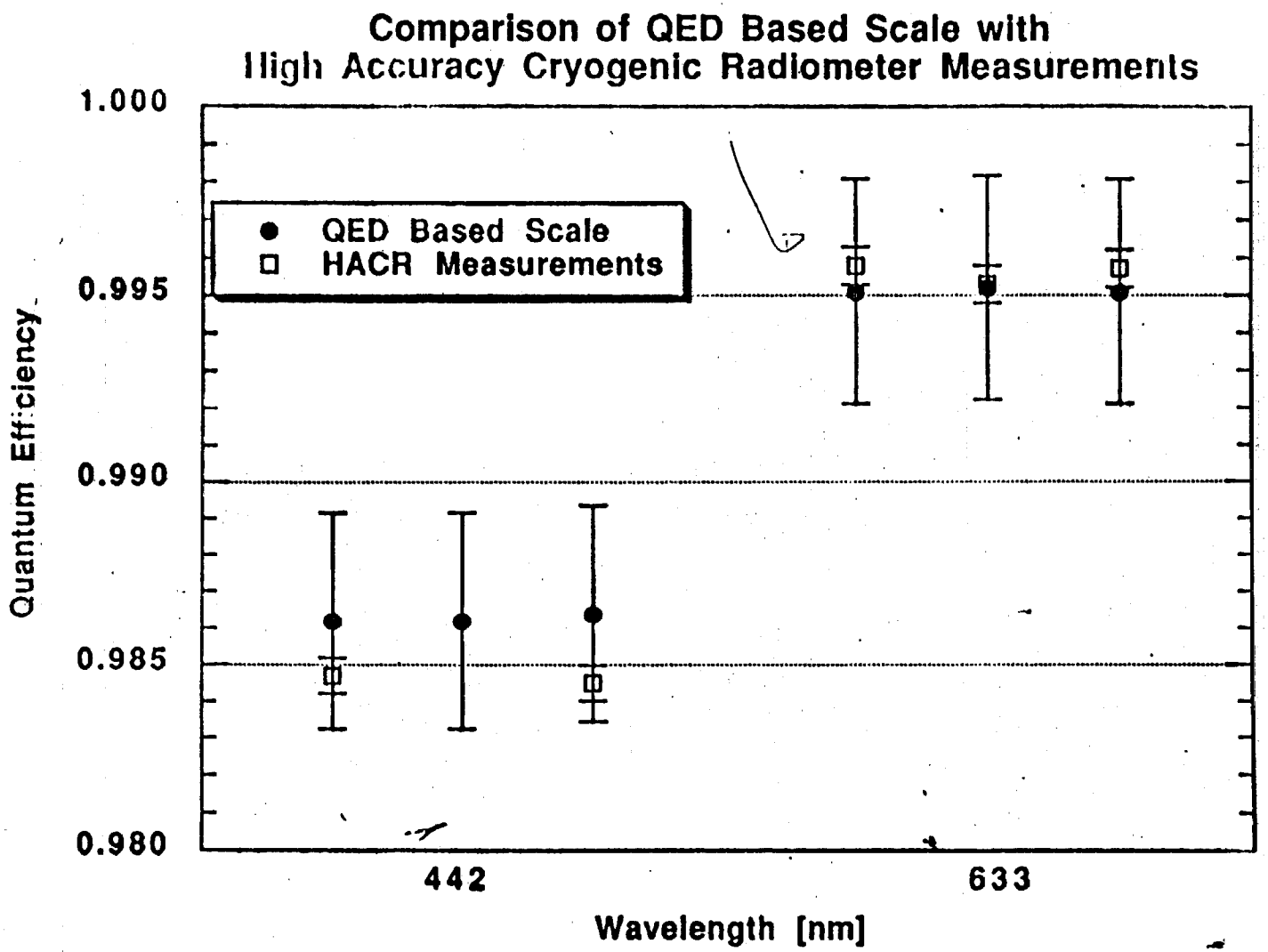


HM Trap summary.abs&%SD.text.11

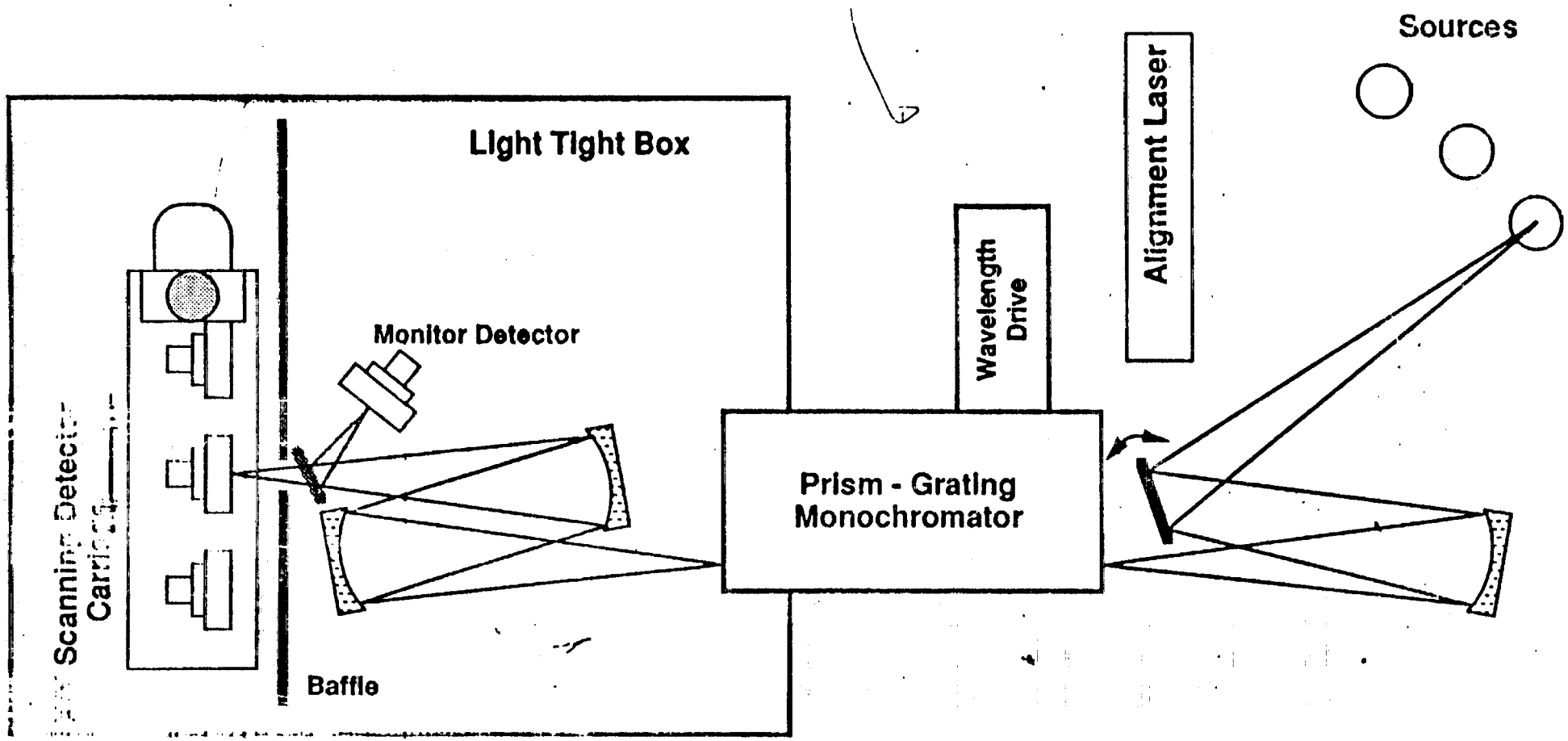


Substitution Method

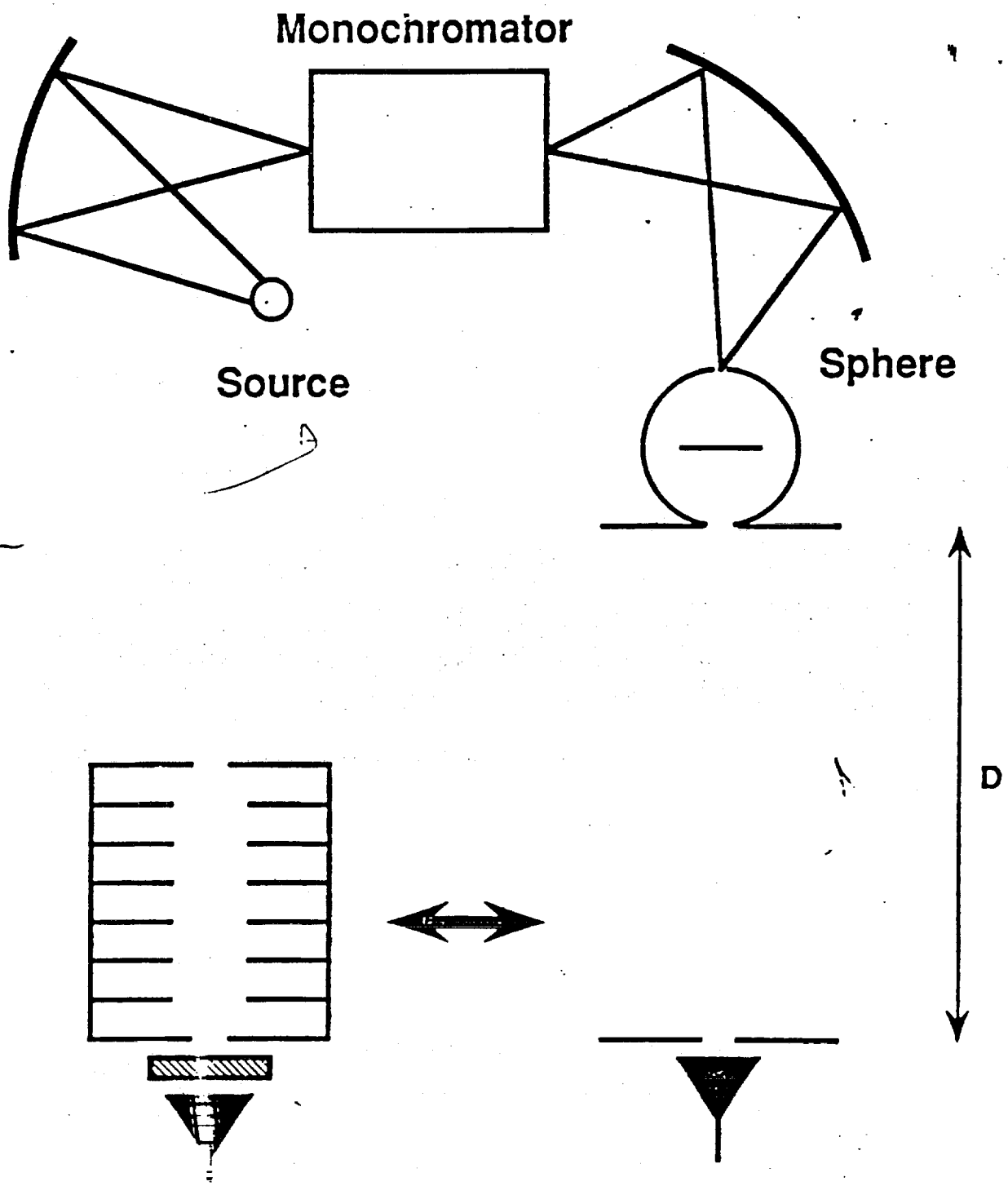



Comparison of QED Based Scale with
High Accuracy Cryogenic Radiometer Measurements
1.000
0.995
0.990
0.985
0.980
Quantum Efficiency
QED Based Scale
HACR Measurements
442
633
Wavelength [nm]

Visible / Near IR Detector Comparator Facility



Irradiance Calibration Method



PAGE LEFT BLANK INTENTIONALLY

PROCEEDINGS REPRINT

SPIE–The International Society for Optical Engineering

Reprinted from

Calibration of Passive Remote Observing Optical and Microwave Instrumentation

OMIT

3-5 April 1991
Orlando, Florida

Volume 1493