THE JPL FLUX MAPPER*

W. A. Owen
Jet Propulsion Laboratory
Pasadena, California

ABSTRACT

The JPL Flux Mapper is a device that can map the intensity distribution in three dimensions of concentrated solar energy at the focus of a concentrator. Intensities to 10,000 solar constants can be measured. Constructed to assist in concentrator and receiver development, it consists of a radiometer which is moved through the concentrated sunlight in a series of planes perpendicular to the optical axis by means of a mechanical rastering device. Various radiometer probes can be utilized depending on the time and accuracy requirements of the program. Energy levels are recorded as a function of location. Reduction of this data can be in various formats, e.g., contour maps, digital arrays, isometric visualizations and other displays as the user requires.

THE FLUX MAPPER

Purpose

While optical theory is quite exact, real optical systems have many non-idealities that make their precise performance difficult to predict. This proves to be particularly evident where very large solar energy collection systems are designed to be produced at low cost. To help overcome this difficulty, JPL has designed and built a Flux Mapper to gather empirical data about the concentrated energy at the focal zone of a solar concentrator. This data is essential to understanding optimum solar receiver design, helps characterize solar concentrators, provides a means for comparing analysis with actual hardware, and provides a tool for comparing various systems in the field.

System

The principal components of the Flux Mapper system (Figure 1) are a radiometer probe, a mechanical locating device, a data and control processor, and a data acquisition system.

Probes

Two radiometer probes are currently in use at JPL. The high speed probe (Figure 2) consists of a highly reflective, water cooled body and heat shield. A 0.006 inch diameter aperture limits the amount of energy falling on the PIN diode detector whose voltage output provides a signal proportional to the incoming energy. This system has an extremely short time constant

---

*The research described in this paper was carried out at the Jet Propulsion Laboratory, California Institute of Technology, and was sponsored by the U.S. Department of Energy through an agreement with NASA.

(nanoseconds) and when carefully calibrated can provide data with about ± 10% accuracy. The second probe (Figure 3) is a Kendall absolute cavity radiometer. This probe is a ruggedized version of the absolute standard laboratory instrument. Where the longer time constant of 4 to 6 seconds can be tolerated, this instrument can provide accuracies of less than ± 2%.

Mechanism

The traversing mechanism (Figure 4) consists of a mounting frame from which the probe mounting carriage travels in an x-y plane. This carriage contains a stepping motor which allows the probe to be indexed in the z direction. Normal scanning sequence is horizontally (x) from the lower left corner, stepping upward (y) at the end of each line until an entire x-y plane is measured. The probe then moves to a new plane (z) and the x-y process is repeated. Scanning rates are variable but a typical 1250 data point plane takes about 90 seconds to scan.

Data Acquisition

Data is acquired simultaneously in both a hard copy "quick look" mode and on magnetic tape. For "quick look" needs, an x-y-y plotter is utilized giving an intensity trace as a function of position with system parameters displayed or printed from the CRT. This same data can also be stored on magnetic tape for later computer reduction.

Data Reduction

Data display can be either full digital, semi-reduced digital (Figure 5) for rapid utilization or in a variety of graphical displays such as contour plots of each plane (Figure 6) or isometric displays for visual examination (Figure 7).

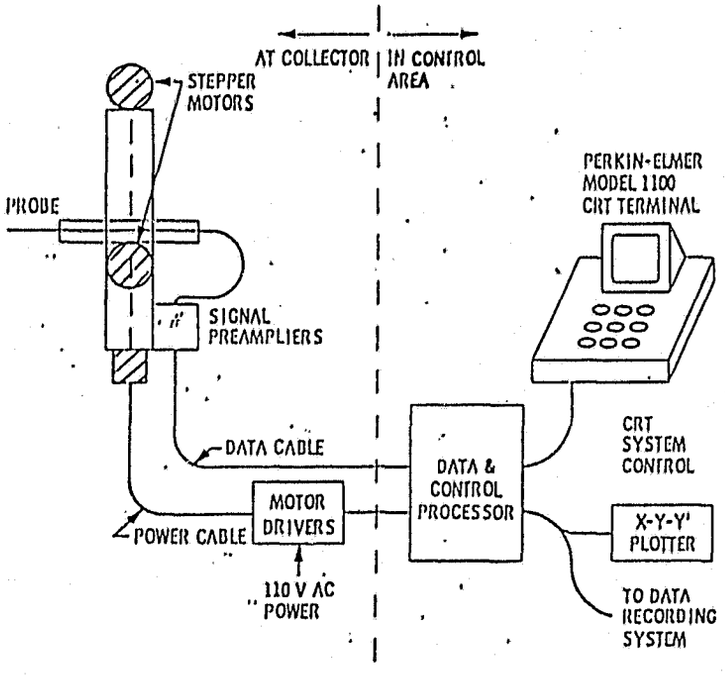

FIGURE 1. FLUX MAPPER LAYOUT

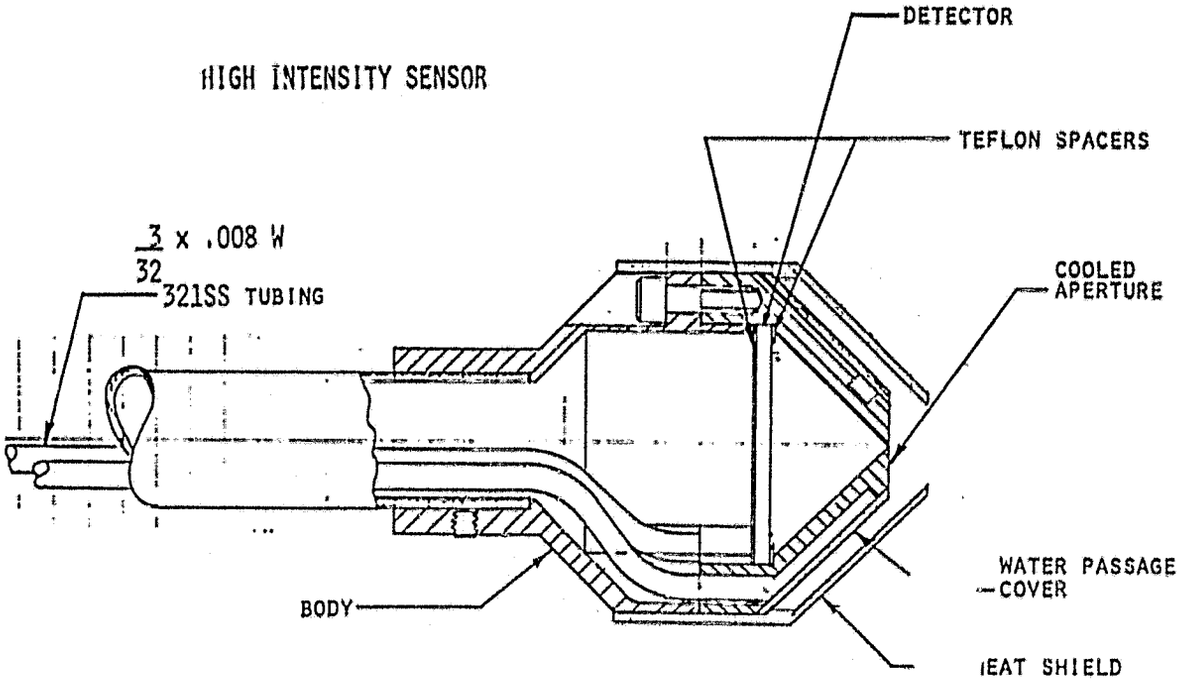

FIGURE 2. HIGH INTENSITY PIN SENSOR

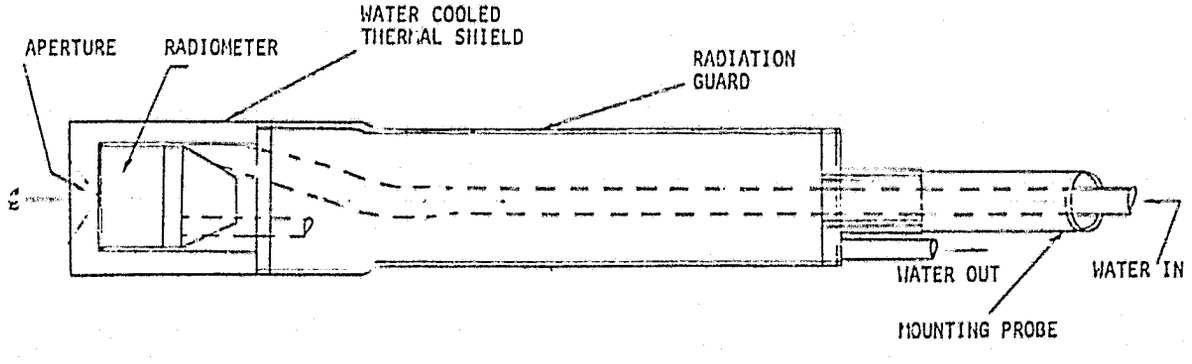

FIGURE 3. ABSOLUTE CAVITY RADIOMETER

FIGURE 4. FLUX MAPPER MECHANISM

	1	2	3	4	5	6	7
1	1	3	10	16	15	9	1
2	5	13	19	60	63	39	17
3	9	29	73	169	180	85	36
4	7	37	139	320	275	102	29
5	3	28	106	218	174	93	36
6	2	12	38	57	58	45	15
7	0	0	2	4	6	6	1

$\frac{\text{Watts}}{\text{in}^2}$

2"

2"

TOTAL = 10,660 Watts

FIGURE 5. MATRIX DATA DISPLAY

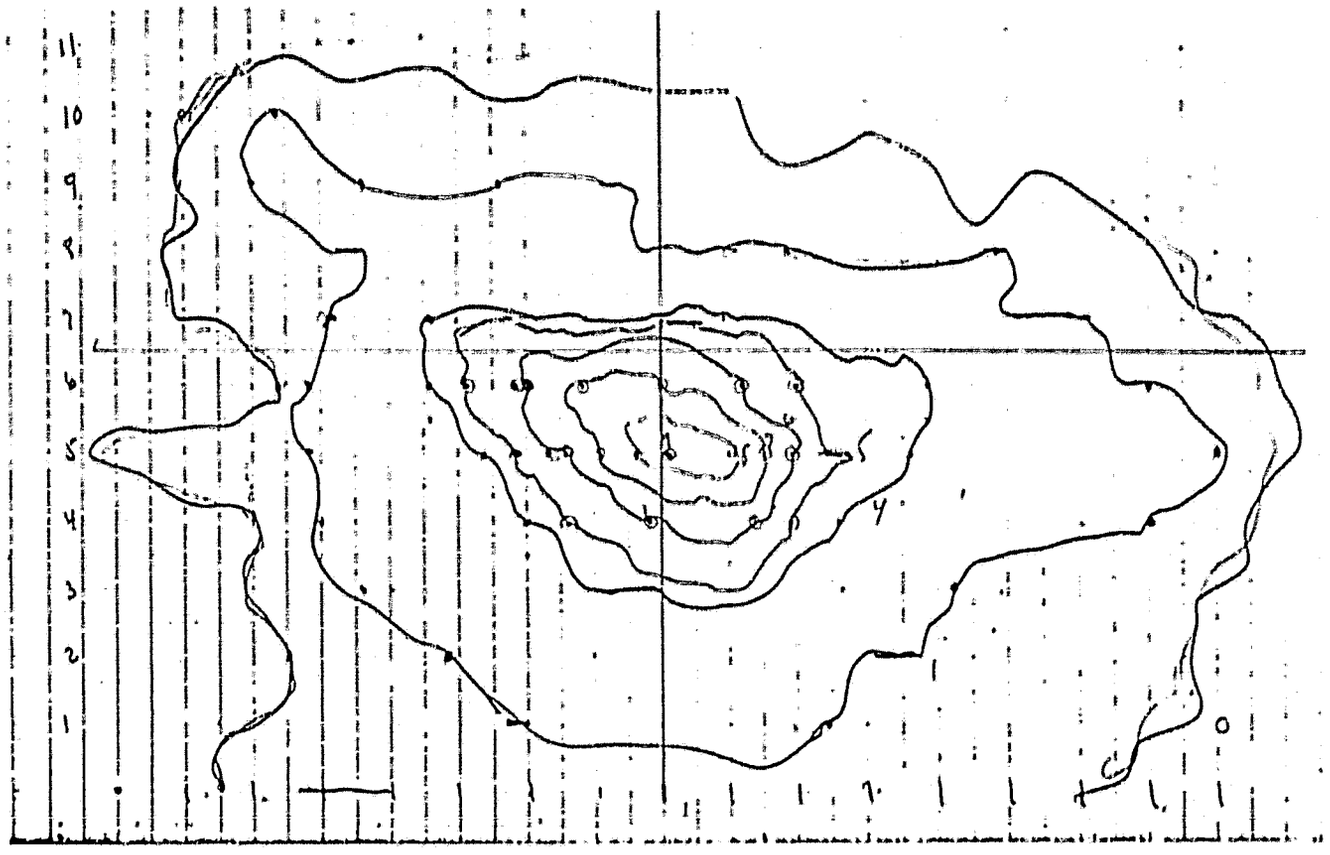

FIGURE 6. CONTOUR PLOT DISPLAY

ORIGINAL PAGE IS
OF POOR QUALITY

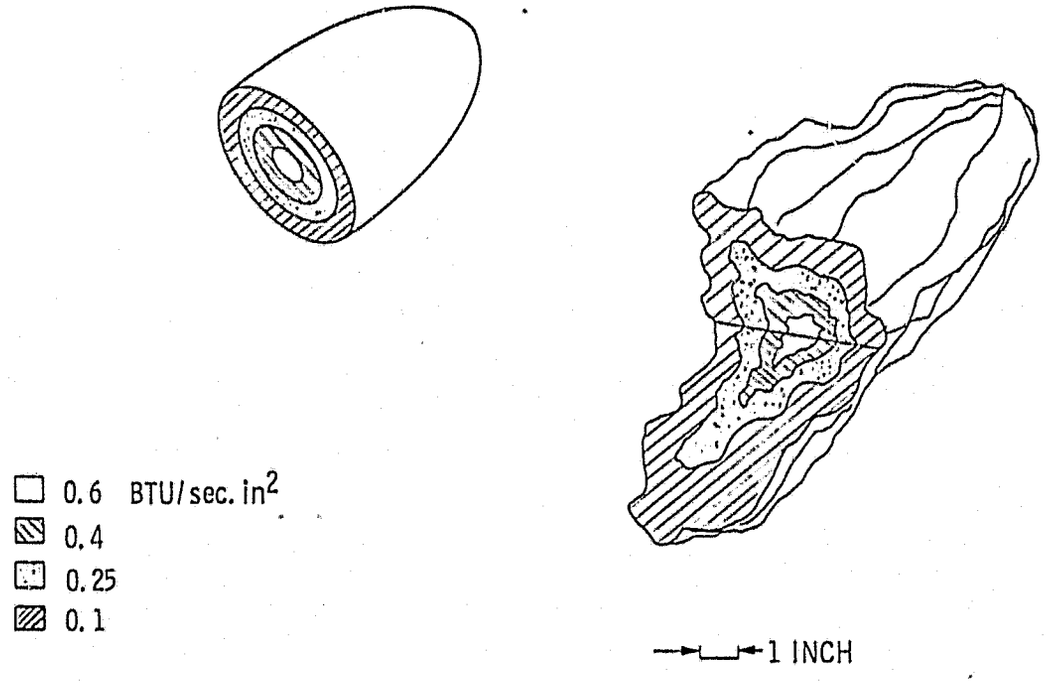

FIGURE 7. ISOMETRIC DATA DISPLAY