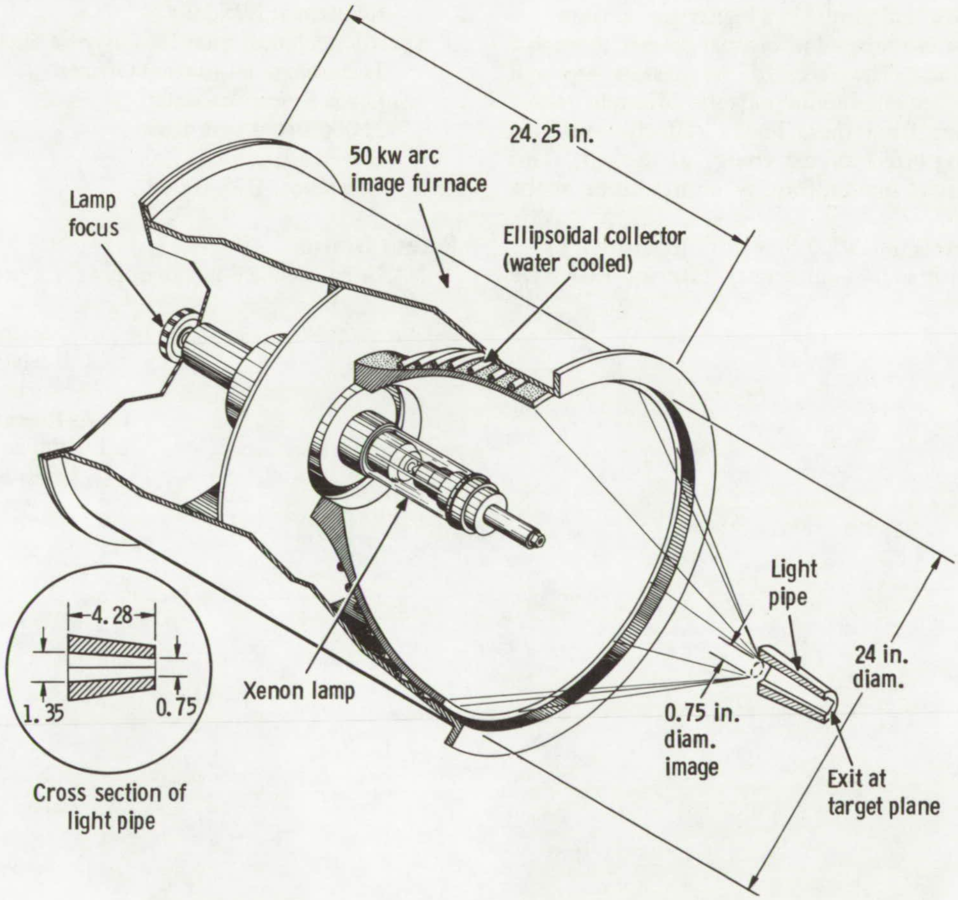
NASA TECH BRIEF
Lewis Research Center

Uniform High Irradiance Source



Cross section of light pipe

The Problem:

To provide uniform irradiance levels up to 2.5 x 10^7 watts/m^2 (15 BTU/in^2-sec) on a 1.91 cm (0.75 in) diameter target with a non-uniformity ratio of less than 1.10. The non-uniformity ratio is defined as the ratio of maximum to minimum irradiance level within the target diameter. At the time of this development, compact short arc lamps in the 20-30 Kw range were all that was available for design of an arc image furnace. Designs utilizing lens imagery suffer reduced efficiency due to the number of reflective and refractive elements required.

The Solution:

A new 50 Kw xenon short arc lamp mounted within an elliptical collector provides irradiance levels up to 4.4 x 10^7 watts/m^2 (26.6 BTU/in^2-sec) with a non-uniformity ratio of 3.30. An energy mixer or light pipe between the lamp source and the target (see figure) improves the non-uniformity to the required ratio.

(continued overleaf)

How It's Done:

The uniform high level irradiance has been achieved by utilizing an arc image furnace and straight taper light pipe. The arc image furnace is composed of a 50 Kw jet-pinched xenon short arc lamp mounted within an elliptical collector. The lamp is unique in three ways. First, it does not require a high voltage discharge across the lamp and current surge to start the lamp. Instead the cathode extends to almost touching the anode, and through a ballast resistor in series, strikes an arc and retracts maintaining a small arc. After retracting, the ballast resistor is dropped out of the circuit and the lamp operates directly from the power supply. Second, the anode surface is concave to allow for increased water cooling surface area on the backside and arc stability. The third unique feature is the constraint of the plasma at the cathode by the higher pressure discharge of xenon gas around the cathode towards the anode. This restricts the shape of the plume and results in a higher arc radiance.

The light pipe is a tapered hexagonal passage through a water cooled block. The faces of the passage are high quality first surface aluminum mirrors. Multiple reflections of the rays from these highly reflective surfaces produce a mixing effect of the energy at the exit. This results in a minimal non-uniformity of irradiance at the target plane.

Irradiance levels up to 2.8×10^7 watts/m^2 (17.3 BTU/in^2-sec) with a non-uniformity ratio of 1.07 have been measured.

Notes:

1. The facility can be used in the study of the structural integrity of materials subjected to extreme heating rates in the development of turbine blades, rocket nozzles, and reactors.
2. Further information is available in the following reports:

   NASA SP-298 (N72-22250), Development of a High Irradiance Source

   NASA CR-134523 (N74-16613), Fundamental Study of Transpiration Cooling

   Copies may be obtained at cost from:

   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B75-10008
3. Specific technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B75-10008

Patent Status:

NASA has decided not to apply for a patent.

Source: A.R. Lunde
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under contract to
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A. Fortini and D.R. Buchele
Lewis Research Center
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