

W.H. Christiansen
FROM: UNIVERSITY OF WASHINGTON
Aerospace & Astronautics Research Program
120 Aero. & Engn. Bldg. Bldg. F-10
University of Washington
Seattle, Washington 98195
RETURN
POSTAGE
GUARANTEED

DAA/Langley

Scaling Studies of Solar Pumped Lasers

Semi-Annual Progress Report
January 1, 1985 - June 30, 1985

NASA Grant #NAG 1-176

W.H. Christiansen and J. Chang

August 1985

(NASA-CR-176240) SCALING STUDIES OF SOLAR PUMPED LASERS Semiannual Progress Report, 1
Jan. - 30 Jun. 1985 (Washington Univ.) 8 p
HC A02/MF A01 CACL 20E
N86-10540
Unclas
G3/36 15853



SCALING STUDIES OF SOLAR PUMPED LASERS

by

W.H. Christiansen and Jim Chang

Conversion of blackbody radiation into laser light has been demonstrated at the University of Washington. Parametric studies of the variation of laser mixture composition and laser gas temperature have been done for the CO_2 and N_2O gases. Theoretical analysis and modeling of the system have been performed. Reasonable agreement between predictions in the parameter variation and the experimental results have been obtained. This work will be published in the IEE Journal of Quantum Electronics¹ and is the subject of a masters thesis². Almost 200 mW of laser output at 10.6μ was achieved by placing a small sapphire laser tube inside an oven at 1500°K ; the tube was filled with CO_2 laser gas mixture and cooled by longitudinal nitrogen gas flow.

Finite optical depth of the pumping radiation and the axial coolant flow limit the size and power of the axial flow laser. Thus, the geometry of the situation should be changed. One solution is to apply transverse flow configuration and pump the laser gas perpendicular to the flow field. The gas heating distance is reduced and the mode volume can be made larger. Besides, the laser beam quality may also be improved due to lack of axial temperature gradient.

A study of this idea is being carried out using non-steady technique. The cavity design is shown in Figs. 1 and 2, and the experimental set-up in Fig. 3. Two pieces of stainless steel shim ($1.5'' \times 40'' \times 0.002''$) are electrically heated to about 1500°K in 5 ms using a capacitor bank (6.6 mF) discharge. The emissivity of the stainless steel shim is about 0.8 after

oxidation. Laser mixtures between these metal surfaces are pumped by the pulsed radiation field which lasts on the order of 0.1 sec. A solar cell is used to measure the blackbody radiation and a Rogowski coil probe is used to measure the discharge current.

Initially, no infrared transmission material is placed between the metals and laser gas, in order to get the highest pumping power. It was estimated that the thermal diffusion time through the laser medium exceeds 0.1 sec and gas heating is not a problem. However, the fast temperature rise of the shims creates pressure waves inside the cavity. A small electrical discharge CO₂ laser is placed inside the blackbody laser cavity in order to measure the optical property of the cavity. The measured results before and after the blackbody discharge are shown in Figs. 4 and 5. It is obvious that the resonance cavity is influenced strongly by the pressure waves. To prevent the waves from reaching the laser region, a rectangular quartz tubing (18 mm × 10 mm) with about 50% transmittance at 4.3 μ is inserted into the cavity and is sealed from the radiation pumping source. The reason for using a rectangular quartz tubing is that its lasting region is similar to the transverse flow model.

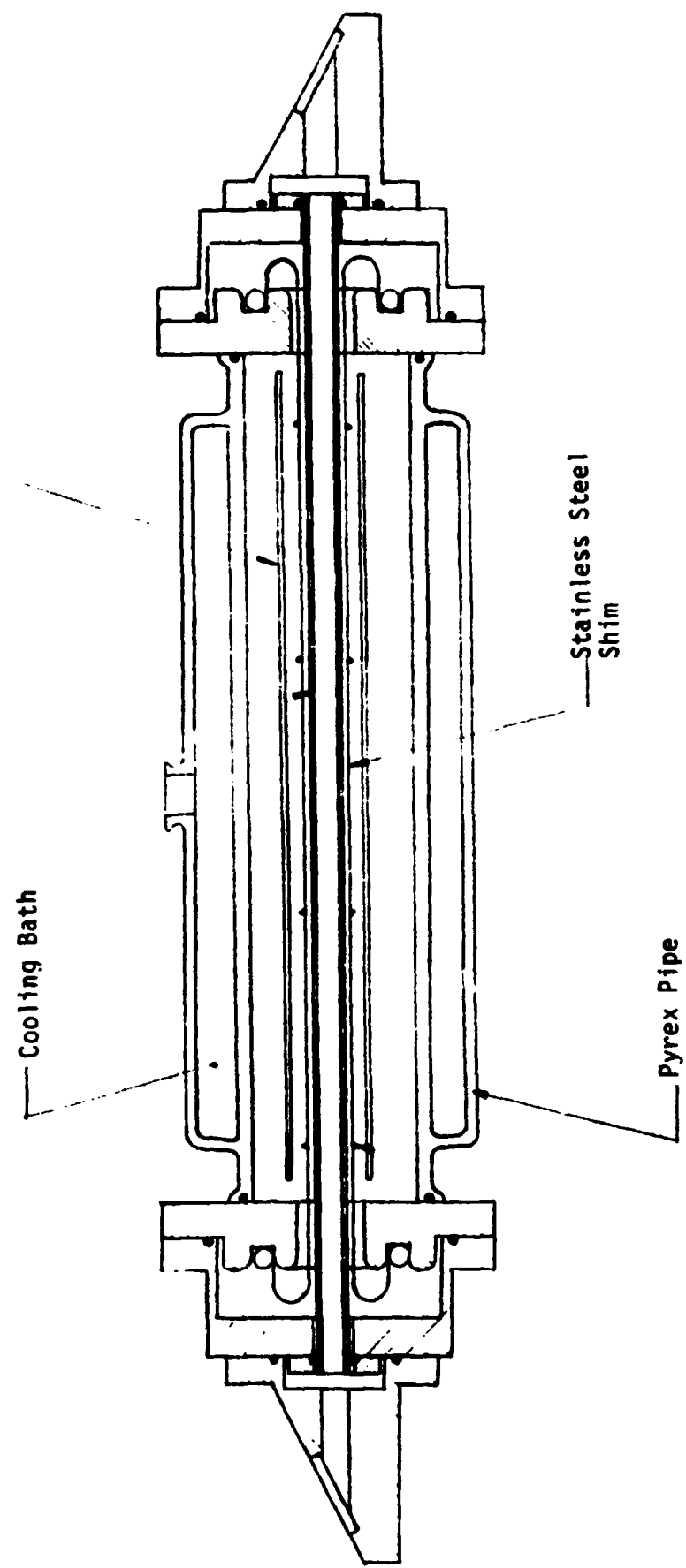
Increasing the laser media absorption spectrum width is always the key factor in increasing the blackbody laser efficiency. One way to approach it is to use a different laser gas; the other way is to increase the laser gas pressure. Our calculation shows that the gas pressure for optimal output intensity can be increased by increasing the blackbody temperature or the laser gain path or decreasing the laser gas temperature. At present, a new cavity design with a rectangular quartz tubing inside, as shown in Fig. 1, is under construction. This preliminary work³ on scaling possibilities will be presented at Lasers '85 Conference in Las Vegas, November 1985.

References

1. J.M. Sirota and W.H. Christiansen, "Lasing in N₂O and CO₂ Isotope Mixtures Pumped by Black Body Radiation" to be published in IEE J. Quantum Electronics.
2. J.M. Sirota, "Studies of CW Lasing Action in N₂O and CO₂ Isotope Mixtures Pumped by Black Body Radiation," M.S. Thesis in Aeronautics and Astronautics, University of Washington (1984).
3. J. Chang and W.H. Christiansen, "Scaling Studies of Solar Pumped Laser," to be presented at Lasers '85, Las Vegas, NV, 1985.

Quartz Tubing
(18mm x 10mm)

Front Surface
Mirror



Glass Rod

Fig. 1.

ORIGINAL PAGE IS
OF POOR QUALITY

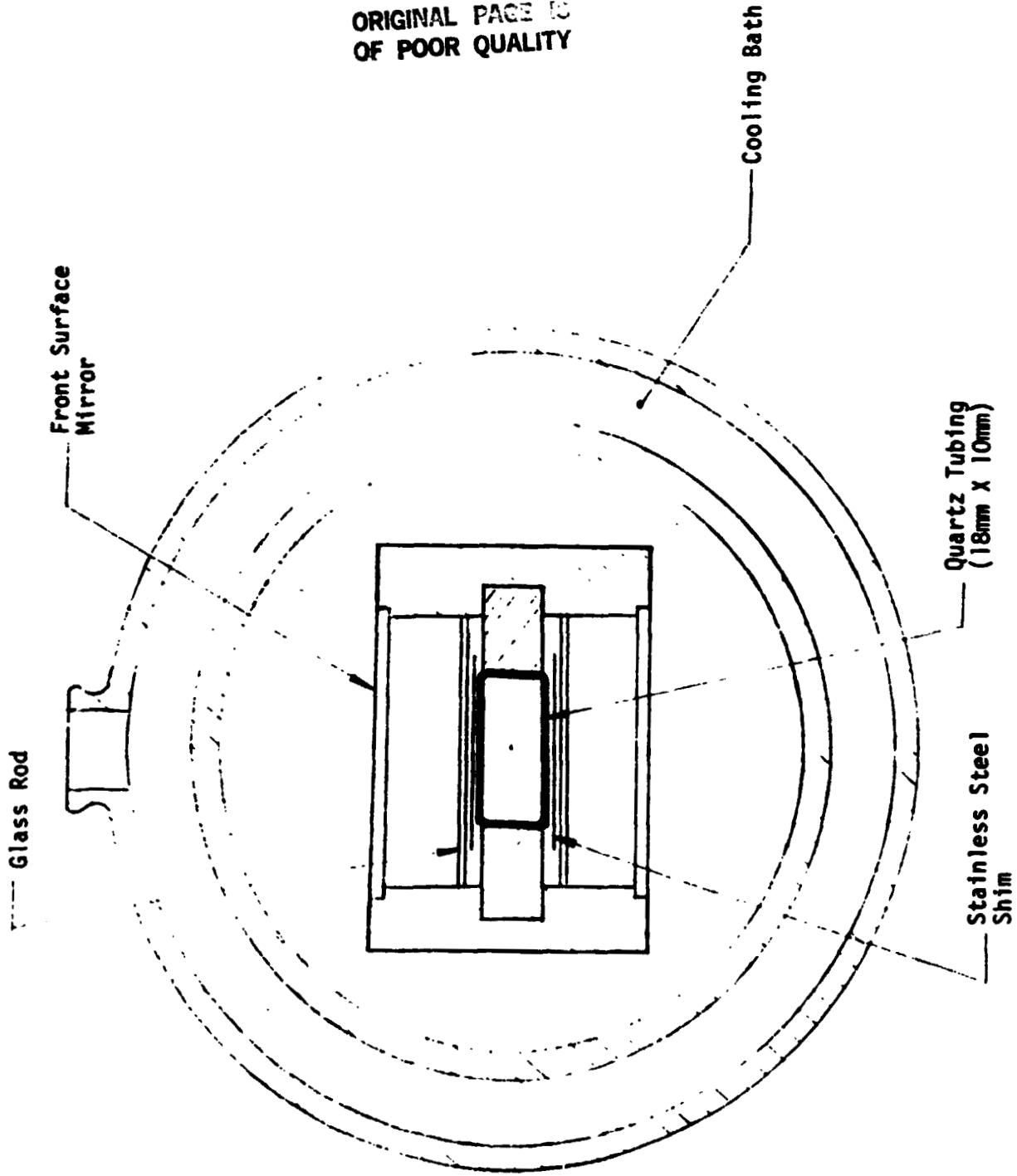


Fig. 2.

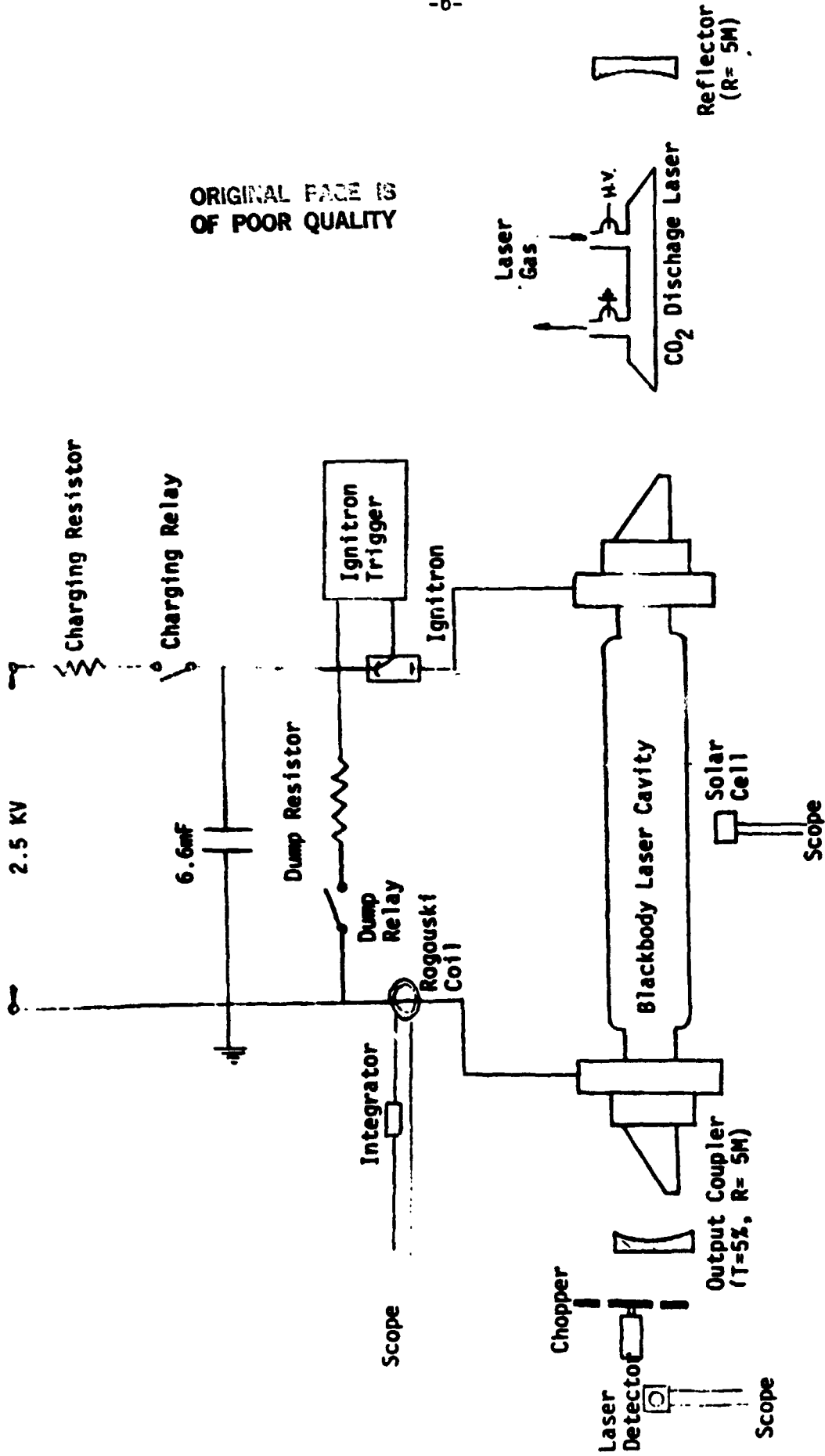
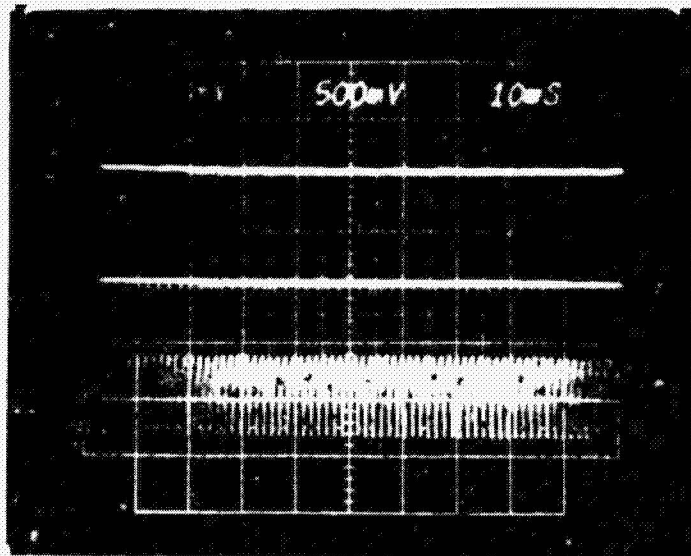
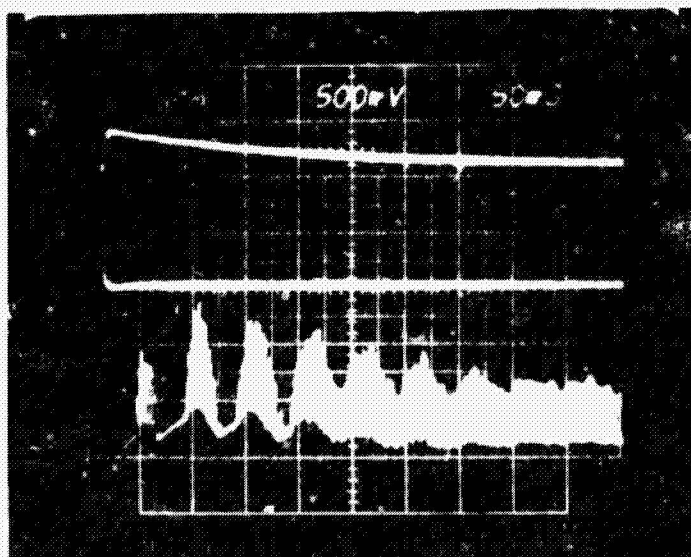


Fig. 3.



— CO₂ Discharge Laser Output

FIG. 4
(Before blackbody discharge)



— Blackbody Radiation Intensity

— Discharge Current(Blackbody)

— CO₂ Discharge Laser Output

FIG. 5
(After blackbody discharge)