BIOLOGICAL APPLICATIONS AND EFFECTS OF OPTICAL MASERS

Annual Progress Report

December 31, 1963

William T. Ham, Jr.

Supported by

U.S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
Fort Detrick, Frederick, Maryland 21701-5012

Contract No. DA-49-193-MD-2241

Medical College of Virginia
Health Sciences Center, Richmond, Virginia 23219

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* BIOLOGICAL APPLICATIONS AND EFFECTS OF OPTICAL MASERS	5. TYPE OF REPORT & PERIOD COVERED Annual Progress Report 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Dr. William T. Ham, Jr. Dr. Walter G. Geeraets	8. CONTRACT OR GRANT NUMBER(s) DA-49-193-MD-2241
9. PERFORMING ORGANIZATION NAME AND ADDRESS Medical College of Virginia Health Sciences Center, Richmond, Virginia 23219	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62110A.3A162110A824.00.008
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Medical Research and Development Command Fort Detrick, Frederick, MD 21701-5012	12. REPORT DATE December 31, 1963 13. NUMBER OF PAGES c
14. MONITORING AGENCY NAME & ADDRESS*(If different from Controlling Office)*	15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

PROGRESS REPORT

1. Investigators' name and institution:

Dr. William T. Ham, Jr., Department of Biophysics and Biometry
Dr. Walter G. Geeraets, Department of Ophthalmology
Medical College of Virginia

2. Title of Project:

Biological Applications and Effects of Optical Masers

3. Contract Number:

DA-49-193-MD-2241

4. Date of Report:

December 31, 1963

5. Research Progress:

The construction of an optical system to produce images of known size on the retina has been completed. The optical system is mounted as a unit upon a pedestal with provisions for the installation of different types of laser heads employing both ruby and Nd.-glass lasers. Power density control is achieved by means of neutral filters interposed in the beam after divergence through a negative lens. The angle of divergence entering the eye and hence the image size on the rabbit retina is continuously variable from 6° (1 mm. diam.) to less than 1° (0.1 mm. diam.). A specially constructed ophthalmoscope attached to the optical system provides a magnification of 14 and allows the ophthalmologist to remain fixed on the exposure site, thus eliminating the difficulty of having to hunt for very small lesions after radiant exposure. It is expected that this system will make it possible to observe lesions less than 100 μ in diameter.

Several types of laser pumping heads have been designed and tested in an attempt to improve the uniformity of power density in the laser image and to increase the power output. These include elliptical and cylindrical heads as well as laser heads which utilize 8 EG & G lamps. Studies have included characteristics of ruby lasers as to reproducibility, uniformity and total energy output for normal laser operation. Martin-Orlando has designed and delivered a Q-switching system adapted to both a 3" ruby laser and a 3" Nd.-glass laser. The system utilizes an elliptical head and can produce both normal and Q-switched pulses. The Martin-Orlando Q-switching system has been altered recently to include an 8 lamp pumping head which provides greater power density and somewhat better uniformity for both Q-switching and normal laser operation. Power densities on the rabbit retina at the Mw/cm^2 level are readily achievable with this system. The Frankfort Arsenal

XM23 Q-switching ruby laser system has also been made available to this laboratory and has been installed in a special optical system to study threshold and high power density effects on the rabbit retina. Measurements indicate a power output of ≈ 0.07 J/pulse.

Calibration techniques involve the use of a double cone radiometer with 8 Cu - Constantan thermocouple junctions distributed over the outside surface and a photomultiplier receiver which has been carefully checked for spectral response. Both receivers have been calibrated against a standard of total irradiance provided by the National Bureau of Standards. The TRG V-2913B ballistic thermopile and our cone radiometer have been calibrated in a range of energy inputs from 0.01 joules to approximately 5 joules and both exhibit linear output with energy input throughout this range, the slopes being 97.9 and 127 μ volts/joule respectively. Some preliminary experiments have been performed on rabbits to check the performance of the new optical system designed for laser operation.

Lesions of ≈ 140 μ in diameter have been produced on the rabbit retina by a 2" ruby laser emitting a 400 μsec pulse, attenuated by a factor of 10, to produce .0013 J/pulse at the cornea as measured directly with the cone radiometer. Assuming an image diameter defined by the cone (50'), the retinal dose was approximately 0.8 J/cm^2, a figure which agrees well with our previous data on retinal burns. However, the lesions were graded as considerably above minimal as defined in our laboratory. This may be due to the fact that we have not been able to achieve uniform irradiation with a laser beam and also, it is very difficult to define the lesion diameter with accuracy.

In an attempt to obtain some preliminary estimates of laser hazards to the eye, threshold burns were produced in rabbits by means of the electronically pulsed Xenon arc source developed for other purposes. Band pass filters in the blue (432-504 mμ), green (518 - 602 mμ) and red (610 - 700 mμ) were used to test the sensitivity of the rabbit retina to different wavelength regions in the visible spectrum. Very mild or threshold burns were produced on the rabbit retina by 4 ms pulses of ≈ 1.2 J/cm^2 incident on the fundus. No marked dependence on wavelength was demonstrable. These threshold doses agree well with previous data published in this same report. These studies were summarized at the annual meeting of the Southeastern Section of the Association for Research in Ophthalmology, held in Richmond, Virginia, March 22, 1963. A copy of the symposium is included with this report.

The Department of Ophthalmology, in addition to many contributions as listed above has established a tissue culture laboratory in which ocular pigment cells have been grown and are available for "in vitro" studies of laser effects. Time lapse movie techniques using phase contrast have been established for a study of delayed cellular behavior after exposure to various laser radiations.

Dr. Geeraets has visited Dr. Pomerat at the Pasadena Research Foundation to discuss problems associated with the tissue culture of ocular pigment cells. Dr. Ham and Mr. Williams have visited the Martin-Orlando group twice to establish cooperative research efforts involving Q-switching and calibration techniques. Dr. Ham delivered a paper on the ocular hazards of lasers at the Second Boston Laser Conference on 1 August 1963. Dr. Ham also attended a two week course on Optical Physics at the University of California at Los Angeles during the month of July 1963. This will be taught as a seminar course during the coming year. Also, during 1963 Dr. Ham consulted with the Research Analysis Corporation on weapon effects from lasers and contributed to a briefing of members of AFEB at the Edgewood Arsenal on 7 October 1963.

6. Publications (pertinent to this contract)

1. Ham, W. T., Jr., Williams, R. C., Geeraets, W. J., Ruffin, R. S. and Mueller, H. A. Optical Masers (Lasers). Acta Ophthalmologica, Suppl. 76, 59-78 (Copenhagen 1963).

2. Ham, W. T., Jr. Contributions to report by Research Analysis Corporation entitled "A Preliminary Assessment of the Feasibility of Application of a Laser Weapon against Certain Soft Targets", June 1963 (classified).