



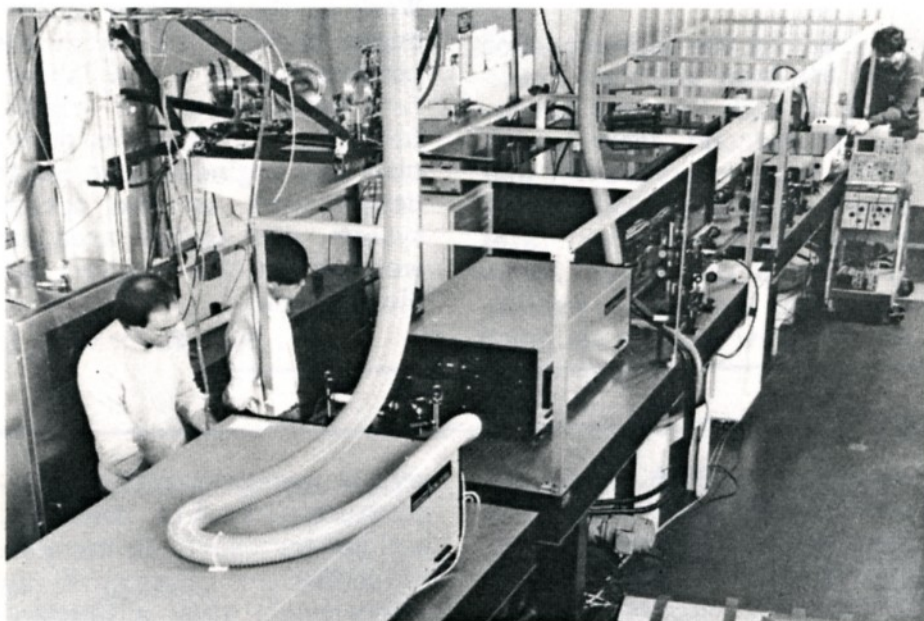
HOTLINE

PRINCETON PLASMA PHYSICS LABORATORY

Vol. 8, No. 8

February 4, 1987

PICOSECOND LASER SUCCESSFULLY FIRED



Bill Tighe, Chang Hee Nam, and John Robinson (left to right) adjust the optics on PPPL's powerful new picosecond laser system.

After 1-1/2 years of preparation, PPPL's X-ray laser group, headed by Szymon Suckewer, has successfully pulsed its new powerful picosecond laser system. Initial tests were conducted at powers up to 25 billion watts. When fully operational this summer, the laser system will be capable of one trillion watts output, making it one of the most powerful picosecond laser systems available anywhere.

The new laser will be used in conjunction with a CO₂ infrared laser to produce X-ray lasing action at wavelengths below ten nanometers, signifi-

cantly shorter than past experiments. Most applications envisioned for X-ray lasers would require wavelengths below one nanometer.

For the past 2-1/2 years, PPPL researchers have routinely produced soft X-ray laser light at a wavelength of 18.2 nanometers, in a narrow beam with a power of about 100 kW. In the PPPL approach, a CO₂ laser pulse is focused onto a solid carbon disc. When the laser strikes the target, a dense carbon plasma column of 1-2 cm in length is produced. The column is held to a 1- to 2-mm diameter by a strong magnet-

ic field which radially confines the plasma but allows free axial expansion. The plasma temperature rapidly increases to a point at which the carbon atoms become completely ionized, or totally stripped of electrons. The plasma is then allowed to cool rapidly by intensive radiation losses, causing ions to recombine with free electrons. Because recombination occurs primarily on the higher energy levels (outer orbits) while lower levels (inner orbits) do not capture electrons, an unstable condition known as "population inversion" occurs. Electrons in the higher energy levels then avalanche to the lower levels to bring about a more stable electron configuration. In the process, each electron loses energy in the form of a photon of X-ray light. The lasing process occurs when the photons produced in this fashion stimulate the emission of additional photons from other ions, starting a chain of such events. The result is an intense, soft X-ray pulse of a single wavelength.

Compared to conventional lasers, vast outlays of power are required to produce X-ray lasing action. The high-power requirements can be met, however, if the laser delivering energy to the plasma in order to create the X-ray la-

(continued)

sing action (the pumping laser) is fired for only a very small fraction of a second. PPPL's existing experiment utilizes a CO₂ laser with a 50-80 nanosecond pulse length. A nanosecond is one billionth of a second. A picosecond is one trillionth of a second, an extremely short interval during which light can travel only one-eightieth of an inch.

In its current configuration, PPPL's new picosecond laser system is comprised of a chain of six individual lasers which interact successively in stages to finally produce a 25-billion-watt picosecond pulse of ultraviolet light with a wavelength of 250 nanometers.

Later this year, the action of a 1.0-1.5 kilojoule CO₂ laser will be combined with that of a one-terawatt picosecond laser system. The CO₂ laser will irradiate a target to create a carbon plasma. A 150-kG magnetic field will confine the plasma column, which will then be irradiated by the picosecond laser pulse.

By creating the carbon plasma with one laser and then irradiating it with the very powerful picosecond laser pulse, PPPL researchers predict that plasma ions can be selectively excited to high-energy states creating a population inversion. This approach is expected to allow access to much

higher energy transitions than previously available and so provide X-ray lasing action in a shorter wavelength (higher energy) spectral region, significantly below ten nanometers. The X-ray laser team will also attempt to increase the population inversion and gain at 18.2 nanometers utilizing the two laser approach.

Work on the two-laser system began during FY85 with the construction of a new laboratory adjacent to the original facility. At that time, physicists and engineers also began design work on the optical system and target area, as well as on the magnet and diagnostics.

by A.R. DeMeo, Jr.

Applications for X-Ray Lasers

Scientists envision a multitude of applications for X-ray lasers in a variety of fields including physics, electronics, biochemistry, and medicine.

Medical applications are perhaps of the broadest interest, especially diagnostics. The finely focused X-ray laser would allow a much higher degree of localization in the use of CAT scanners, thereby lowering patient exposure considerably. The higher resolution afforded by the laser would provide greater detail of the subject.

Closely related are many biological applications including the ability to make three-dimensional pictures, or holograms, of molecular struc-

tures such as DNA. X-ray lasers would allow biological structures to be viewed in detail in their natural environments, since specimens would not require special (usually destructive) preparation as in electron microscopy.

In the field of electronics, X-ray lasers might be used in photolithography to "print" complex integrated circuit patterns onto semiconductors, allowing even greater miniaturization for a myriad of electronic devices ranging from satellite components to television sets.

Finally, but not of least importance, are a host of apparent applications in physics and chemical research. Plasma physicists would use X-ray la-

sers in measurements of temperature, impurity densities, and ion transport. In the area of solid-state physics, X-ray lasers would allow a substantial improvement in the ability to analyze the structure of crystalline solids and surfaces. Advances in the use of spectroscopy for chemical analysis would also be possible utilizing the X-ray lasers inherent brightness and narrow energy linewidth. These features might lead to more precise instrument calibration through the ability to stimulate a few select atomic transitions. Because of the speed with which X-ray lasers operate, chemists could be given the opportunity to analyze short-lived chemical intermediates.

The PPL HOTLINE is issued by the Princeton University Plasma Physics Laboratory, a research facility supported by the United States Department of Energy. Correspondence should be directed to PPPL Information Services, B380, C-Site, James Forrestal Campus, ext. 2754.

Visions of a World Peace

"Giving life to a vision of the world at peace" is why the Living Visions Ensemble will raise its voice in song at the Princeton University Chapel on Friday, February 6 at 8:00 p.m.

The ensemble is a professional choir of thirty-six singers, most of whom are, or have been, students at Westminster Choir College in Princeton. The ensemble performs benefit concerts of "classical" music for organizations that work to eliminate hunger, poverty, illiteracy, and homelessness; the "hidden" obstacles to peace. The ensemble also serves an educational purpose. Each concert includes guest speakers who use their professional expertise to address the issue of severe deprivation and the disruptive influence it has on world peace.

Janet Davis is the conductor of the ensemble and founder of its parent organization, C-Major Visions, Inc. She created the ensemble with two purposes in mind: to perform benefit concerts for those in need and to actualize a vision of using music as a healing and unifying force in the world.

This vision will become a reality in February. The Living Visions Ensemble will perform their first major work, the world premiere of "Unispace" by R. Davidson. "Unispace" was written to commemorate the 1982 international Unispace Conference convened by the United Nations in Vienna, Austria. All of the space-faring nations of the

world gathered at the conference to explore the peaceful uses of outer space.

The beneficiary for this concert is UNICEF, the United Nations Children's Fund. UNICEF has programs in underdeveloped countries to aid children by providing medical care, growth monitoring, oral rehydration to combat malnutrition, and education training.

The Living Visions Ensemble will present concerts in Princeton, NJ on February 6; Washington, D.C. on February 8; Manhattan, N.Y. on February 13; and Philadelphia, PA on February 15.

There is no fee for the concert, although a suggested donation of \$12.00 per person can be paid at the door. Donations in any amount are welcomed.

Art Exhibit

The Squibb Gallery is currently showing "Landscapes: Real and Imagined." The display, which includes work by ten painters and one photographer, will run until March 8th.

Following "Landscapes," the gallery will feature the mixed-media work of several black artists. This exhibition will run from March 22nd to May 7th.

The Squibb Gallery is located in the world headquarters of the Squibb Corporation located on Route 206, three miles south of Princeton. Gallery hours are 9:00 a.m. to 5:00 p.m. Monday through Friday, and from 1:00 to 5:00 p.m. on weekends. Thursday gallery hours are extended to 9:00 p.m.



Bowling Update

The "Low Rollers" bowling team won the first half of the 1986/1987 Princeton University Mixed League.

Facing stiff competition from the second place team, Low Rollers team members Noreen Cruiser, Matt Lawson, John Luckie, Kim Prutky, and Jerry Siminoff won 75 games and lost 44.

The bowling league is composed of eight teams that compete against each other every Wednesday at Colonial Lanes, Route 1, Lawrenceville. The season is divided into two halves, with the winner of each half rolling off against the other for the league championship.

A banquet honoring the champions and the winners in various other categories takes place in the spring. If you are interested in substituting for the league or in joining a team for next season, contact league secretary Sarah Thomas at ext. 3711.

Search Begins for Deputy Director

A search for Deputy Director for Technical Operations began in January. Advertisements were placed in The New York Times, The Wall Street Journal, SCIENCE, and SPECTRUM.

Internal and external nominations from members of the Laboratory staff for the post are now in order. Please send nominations to Mary L. Shoaf, LOB B333C.

FEBRUARY SPEAKERS

Colloquiums

A series of colloquiums are given each year from September to June. They are held on Wednesday at 4:15 p.m. in the MBG Auditorium, unless otherwise noted. The February colloquiums include:

"Transport on TEXT," by Alan Wootton, Fusion Research Center, University of Texas at Austin, 4 February.

"NRL Program in High-Power Gyrotrons," by Wallace Manheimer, National Research Laboratory, Washington, D.C., 11 February.

"Safeguards and Proliferation Aspects of Fusion," by Leslie Fishbone, Brookhaven National Laboratory, Tuesday, 17 February.

"Hot Rock Program," by Hugh Murphy, Los Alamos National Laboratory, 25 February.

SOSSO Seminars

The Secretarial and Office Support Staff Organization hosts a number of seminars during the year for the secretarial and office support staffs.

Due to the snow storm on Thursday, January 22, the SOSSO seminar entitled "Benefits for the Bi-Weekly Staff," is rescheduled for Wednesday, February 4, 11:30-12:30 in the MBG Auditorium.

The February seminar, entitled "Listening with Corporate Ears, Between the Lines, and to Your Inner Self," will

be presented by Ms. Barbara Chilakos, a Human Resource Consultant. It is scheduled for Thursday, February 19, from 11:30 to 12:30 in the MBG Auditorium.

TRANSITIONS

New Hires

The HOTLINE welcomes the following new employees:

Charles Walling, who joined PPPL in December as a Scientific Applications Programmer in the Computer Division.

Sandra Nemeroff, who joined PPPL in January as a Scientific Applications Programmer in the Computer Division.

Dwight Bashore, who joined PPPL in January as an Electrical Engineer in the Computer Division.

Promotions

The HOTLINE offers its congratulations to the following employees, who recently received promotions.

Dawn Horner, who was promoted in December to Staff Assistant IV in the Accounting Department.

Virginia Zelenak, who was promoted in January to Secretary VII in the Computer Division.

Births

The HOTLINE offers its congratulations to the following employees, who recently became proud parents:

John Robinson of the X-Ray

Laser Project and his wife, Trish, whose daughter, Heather, was born on November 18.

Kenneth Andreas of TFTR and his wife, Janet, whose son, Kenneth Ray, was born on December 1.

Ray Pressburger, Jr. of the MG Section and his wife, Lisa, whose daughter, Laura Emily, was born on December 16.

John Bauer, Jr. of Maintenance and his wife Luann of Motor Pool, whose daughter, Shannon April, was born on January 2.

Yvonne Harris of Janitorial Services and her husband, Robert, whose daughter, Alexis Nicole, was born on January 13.

Sheryll Poris of Personnel and her husband, Carl, whose son, Eric Michael, was born on January 19.

NEW LOCATION



The Personnel Division was relocated to the first floor, west wing of the LOB during January. All telephone extensions will remain the same. Check with the PPPL receptionist for individual room locations.

FOR SALE: 1978 Skyhawk; air conditioning, am/fm radio. Good condition. Call Marilyn Hondorp, ext. 2656.



The potential for employees to hurt their backs during the next few months while relocation and moving of offices takes place at the Laboratory is great. In an effort to help prevent these injuries, a Safety Bulletin was issued describing the correct methods to use when lifting heavy loads. These tips are listed below.

- Plan your move. Don't overestimate your physical abilities.

- Grasp the item to be moved firmly with full palm grips, not just your fingertips. If the item is low, squat and use your legs to lift, not your back.
- Carry the load close to your body. When turning, turn with your feet and not by twisting your back.
- Set the load down by bending your knees, not by bending your back. Keep your fingers out from under the load.
- Under no circumstance should a pregnant woman participate in the heavy physical labor of moving.
- Don't be afraid to ask for help. Persons who are not used to physical labor are especially prone to injury

during moves. Furniture moving and heavy lifting should be left to the professionals.

The Occupational Medicine and Safety Office has a one hour back injury prevention program. It is highly recommended for personnel involved in moves. To attend, have your supervisor call Mary Ann McBride at ext. 3468.

IN FUTURE ISSUES

- PPPL leads in percentage increase in contributions for United Way Campaign
- PPPL relocation and consolidation efforts remain on schedule
- TFTR operates with new ion sources
- PU reaffirms EEO policy



Tour Guides



During October, November, and December 1,222 visitors were taken on guided tours of the Laboratory. November led the period with 24 tours and 511 visitors. We'd like to thank the tour leaders who conducted the tours.

OCTOBER

Charles Bushnell
Hsi Feng
Robert Fleming
George Gammel
Charles Gentile
Glenn Grotz
Daniel Huttar
Naren Kokatnur
Frank Lawn
Benoit LeBlanc
George Levitsky
George Martin
Ernst Nieschmidt
Doug Post
Ronald Radeztsky

NOVEMBER

Dale Ashcroft
Norton Bretz
Lloyd Ciebiera
Dave Ciotti
Larry Dudek
Fred Dylla
Hsi Feng
Joseph Fennimore
Robert Fleming
John Frankenberg
George Gammel
Phil Heitzenroeder
Naren Kokatnur
Paul LaMarche
Doug Loesser
Milt Machalek
George Martin

John Murray
Ernst Nieschmidt
John Quanci
Richard Reny
Stan Schweitzer
Robert Smart
Joseph Stencel
John Tobin
Mike Ulrickson
Al von Halle

DECEMBER

William Blanchard
Dave Ciotti
Hsi Feng
Robert Fleming
James French
Charles Gentile

Boris Grek
Donald Harnsberger
John Johnson
James Kamperschroer
Naren Kokatnur
Benoit LeBlanc
George Levitsky
Milt Machalek
George Martin
Ernst Nieschmidt
Gary Oliaro
Dave O'Neill
John Quanci
Allan Ramsey
Teguo Saito
Stan Schweitzer
Steve Scott
S. von Goeller
Irving Zatz

Why are These People Wearing Funny Hats ?



Quality Control Technician Wayne Sloyer (left) and Neutral Beam Ion Source Technician Donald West (right) joined forces to perform a dimensional inspection of the Long Pulse Ion Source (LPIS) flange and cuff assembly. The flatness of the flange surface is critical to LPIS operational reliability when installed on TFTR. It had to be held to a difficult 0.005-inch TIR to avoid cracking a casted epoxy insulator. (TIR stands for total indicated reading, which is the total distance between two parallel planes that contain the entire surface being measured.) The welding and machining operations were planned and executed successfully by PPPL's Vacuum Shop. All dimensional verification work was performed under controlled conditions within the CAS Building Clean Room--hence the unique headgear. Training people to perform precision measurements while simultaneously wearing funny hats is another example of Ken Wright's successful management style.
