HOTLINE
PRINCETON PLASMA PHYSICS LABORATORY

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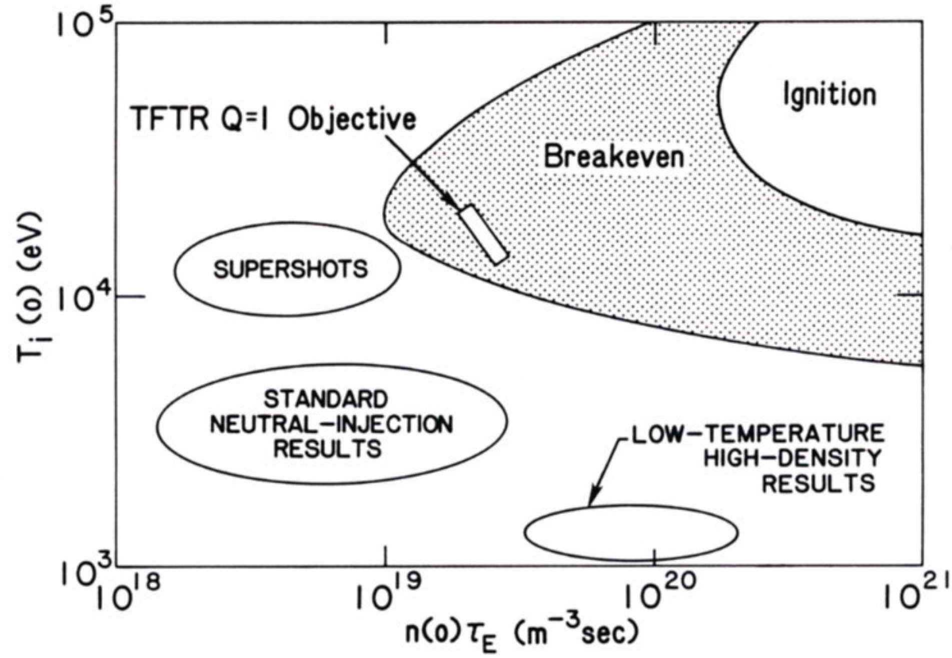
TFTR RESUMES EXPERIMENTS WITH LONG-PULSE ION SOURCES



TFTR progress is shown in the diagram above, where ion temperature is plotted against the product of density and confinement time (nτ). The present experimental run is aimed at extending the supershots toward TFTR's Q = 1 objective.

TFTR operations resumed in January after a two-month shutdown to install 11 new ion sources on the neutral-beam heating system. The new long-pulse ion sources operate with 2.0-sec pulses, up from 0.5-sec for the old sources, and with a full-power capability of about 3 MW per source. This should allow the final 12 sources that will be available in the fall of 1987 to comfortably reach the design value of 27 MW. One of the sources has been operated to essentially full parameters on the TFTR test stand.

The major objectives of this run, which will continue until early June, are to extend the supershot regime to better confinement using the long-pulse ions sources, and to use the deuterium pellet injector to enhance confinement in either ohmic-heated or beam-heated plasmas.

Last summer's record temperature results of 20 keV (220

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What is a Supershot?

The summer of 1986 was notable not only for the Statue of Liberty Centennial celebration and the Mets' World Series victory but also for the attainment of new, record-high temperatures on TFTR and the coining of a name to explain them. "We first started talking about supershots in June of '86," said Rich Hawryluk. "We saw a few pulses that were so clearly distinctive and so far superior to those we had seen previously, that in the control room we gave them the nickname 'supershots'," Hawryluk said. The name continued to be used, and was picked up by many of the science writers and reporters describing the results. "The name irritates some of our colleagues at the other labs," said Hawryluk, "but by now it has taken on a life of its own."

Supershots are low-current, high-density plasma discharges combined with intensive neutral-beam heating (17 MW last summer) that are fired in a machine where the walls have been scrupulously conditioned via high-power discharges to remove adsorbed deuterium. These conditions provide a plasma that is much denser at its center than at its edge. When intensively heated, the plasma enters an "enhanced confinement regime," where the plasma temperatures attained are much higher than previously predicted.

million °C) were done at low plasma currents (1 MA) and rather low plasma densities about 7×10^{13} cm^{-3}). TFTR physicists hope to use the new long-pulse ion sources to run supershots while increasing the plasma current during the 2.0-sec neutral-beam pulse. Furthermore, these new sources are expected to heat higher density plasmas because they operate at higher voltages and have a larger fraction of their power at full voltage.

Last summer, physicists found that supershots work best when the neutral-beam power injected in the same direction as the ion movements (co-injection) and the power injected opposite to the direction of the ion movement (counter-injection) are roughly equal. TFTR presently has three co-injection beamlines and one counter-injection beamline. "We are planning to move one co-beam to a counter position this summer," said TFTR Project Head Dale Meade. "This costs about $3 million to do. Before moving the beamline, TFTR needs to study plasmas at near-balanced conditions using the long-pulse ion sources. Fortunately, the recent incident that disabled beamline #5 (a co-beamline with two sources) should not significantly impact our ability to do the critical heating experiments," he said.

With the new ion sources, a total of about 24 MW of power from the four neutral beams was originally expected. About 15 to 20 MW are now anticipated from the three operable beamlines. "The damaged valve will cause us some operational headaches, but we should be able to achieve the major objectives of the run," Meade said.

Extending the Supershots

A key measure of TFTR performance is referred to as Q. It represents the ratio of fusion energy output to plasma heating power input. Last summer's supershots yielded plasma conditions that would have provided a deuterium-tritium (D-T) equivalent Q value of 0.2 at plasma currents of 1 MA in a deuterium plasma. Because of the limitations of the old neutral-beam ion sources, the pulses were short (0.5 sec) and the average energy of the full-energy beam ions was only 95 keV out of the nominal 120 keV. The new neutral-beam ion sources are designed to overcome these difficulties. A D-T equivalent value of Q between 0.3 and 0.4 could be achieved.

However, to get to Q = 1, TFTR performance must be improved by a factor of three. "What we need to do is to run supershots at a higher plasma current. About 2.5 MA should give us the results we want," said Dale Meade. "It will take some time to learn to run the supershots at that level. For example, should we start at a relative low plasma current and ramp it up during the neutral-beam pulse? Or perhaps the new, better beams will allow a higher current without any additional tricks. All of this will take some time to work out, and this is what we hope to do between now and June."

Pellet-Injection Experiments

Pellet injection is another area that will receive a lot of attention in the upcoming runs. Experiments with pellet injection in 1986 led to an increase in $n\tau$ in ohmically heated plasmas from the previous record of 0.7×10^{14} cm^{-3} sec set by Alcator-C at MIT in 1983 to a world record 1.5×10^{14} cm^{-3} sec. However, when combining pellet injection with neutral-beam injection, physicists found that either the pellets or the beams did not penetrate well to the plasma's center. Meade hopes that during this run, some insight can be gained into why this is so. "More than that, we would like to find a way to have these two techniques work effectively in concert," he said. "In any event, the ICRF (ion cyclotron radiofrequency) heating from PLT that we will add should provide a way around the problem and demonstrate significant heating of a high-density pellet-injected plasma."

Although D-T operation is three years away, significant effort is underway to prepare for this phase of operations. The tritium storage and delivery system is now being tested using deuterium. By the summer of 1988, testing will be underway using 100 Curies (Ci) of tritium. This will be boosted to 1,000 Ci by the summer of 1989, in preparation for the full 50,000-Ci (5 grams) tritium operation in 1990.

During the next six months, PPPL will be doing a preliminary design for the igloo shield that will be installed around the TFTR to absorb the additional high-energy neutrons expected during D-T operation.

Research into techniques for providing tritium fuel in the

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plasma's center is also underway. Oak Ridge National Laboratory has been funded to design and build a tritium pellet injector that will be tested at the Los Alamos National Laboratory. A tritium pellet injector would be used to produce a well-confined plasma with tritium fueling at its center. Similarly, PPPL is also studying the technical feasibility of using tritium neutral beams to fuel the plasma center with tritium.

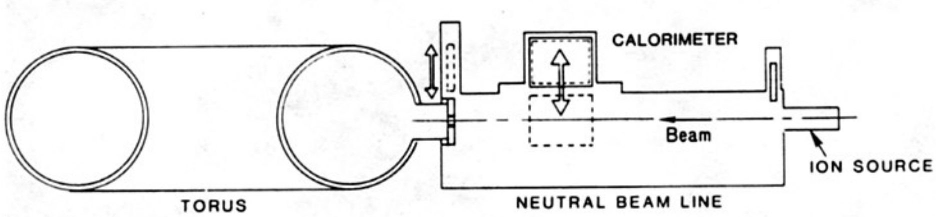
Under the present Laboratory budget, "All of these activities are possible, but just barely," said Meade. "It will require considerable ingenuity and effort on the part of the staff to accomplish all of these goals. We will soon have an indication of what is proposed for PPPL for FY88. That will help us make more detailed plans for next year. Beyond that, all of these plans are subject to fiscal constraints."

In early June, TFTR will enter a scheduled shutdown period to add 4 MW of ICRF heating from PLT. This will be followed by an increase to 7.5 MW in the fall of 1988. During the spring opening, the damaged neutral beamline valve will be replaced, and one beamline will be reoriented to inject counter to the direction of the ion movements. Additional plasma diagnostics will be added to increase physicists' understanding of the plasma, and existing diagnostics will be provided with greater neutron shielding to improve their performance.

This will pave the way for the Q = 1 demonstration in an all-deuterium plasma early in 1988, to be followed by the deuterium-tritium Q = 1 experiments in 1990. TFTR will then be "mothballed," according to Meade, while staff and facilities are concentrated on CIT.

by Diane Carroll

TFTR Neutral Beamline Mishap Damages Valve



A month after beginning the current experimental run, the failure of an interlock system on one of the TFTR neutral-beam injectors resulted in damage to that beamline's isolation valve gate. The mishap was discovered on Friday, February 20 during conditioning of the beamline.

The isolation valve separates the TFTR vacuum vessel from the neutral beamline. The gate is normally open when the beam is fired, allowing the beam to penetrate into the plasma. During conditioning and testing, the valve is normally closed, and the beam is fired into a calorimeter to measure the beam's thermal profile and to protect the valve cover.

On February 20, no readings were received from the calorimeter, so engineers and technicians used video cameras to inspect the beamline. They found the calorimeter out of the beam path, which allowed the beams to reach the isolation valve gate, burning a hole into it.

The damage to the beamline is not expected to significantly affect TFTR experiments planned for this spring (see accompanying article). Initial estimates put repair costs at between $50,000 and $100,000. A team of Engineering Department personnel is investigating the causes of the mishap and will recommend remedial action. In addition, TFTR will be reviewing the entire interlock system as it prepares for future operation.

ORC Status Report

Over 200 Laboratory employees completed the PPPL Social Program's Questionnaire mailed to all staff members in February. The questionnaire was developed by the PPPL Social Committee.

The Committee, which was formed in December as an action item to the ORC Survey, was asked to review the Laboratory's Morale Fund to determine if it is being optimally used to meet the needs of the employees.

The Committee has reviewed the questionnaires and will present their recommendations to management in the very near future.

Equal Opportunity Policy Reaffirmed

The Plasma Physics Laboratory, consistent with the policies of Princeton University, subscribes to a policy of equal opportunity in all aspects of employment. The Laboratory is committed to principles of fairness and respect for all and seeks to reach out as widely as possible in order to attract the ablest individuals to its staff. For these reasons, employment decisions are made on the basis of an individual's qualifications to contribute to attaining the Laboratory's programmatic objectives. In applying this policy, the Laboratory is committed to the principle of nondiscrimination on the basis of personal beliefs or characteristics such as political views, religion, national or ethnic origin, race, color, sex, sexual orientation, age, marital status, veteran status, or disability unrelated to job or program requirements.

In addition to the general policy just defined, the Laboratory has specific legal obligations as a federal contractor. These obligations include the development and implementation of a plan to undertake appropriate forms of affirmative action to employ women, members of minority groups, handicapped individuals, and veterans. An Affirmative Action Plan written in compliance with Executive Order #11246 has been filed with, and approved by, the U.S. Department of Labor's Office of Federal Contract Compliance Programs. This plan is available for review at the University upon request.

The Provost is the University Officer with responsibility for overseeing the implementation of this Equal Opportunity Policy and the Affirmative Action Plan. The Manager for Employment, Personnel Division, is the responsible Equal Opportunity Officer for the Laboratory.

Service Awards

Representing 1,250 years of service to the Laboratory, employees with five, ten, fifteen, and twenty year anniversaries were honored recently at the seventh annual service awards program. Each employee will receive a momento of their choice and an individual photograph taken during the presentation ceremonies. The above photo is of Technical Operations technical staff who were honored for ten years of service.

News Bits

Trentonian Photo By BILL RYAN

Harold Murphy (left), an electronics technician in the TFTR Fusion Products Division, and attorney Thomas Sumners, Jr. were quest speakers recently at Trenton Junior High School No. 5. Mr. Murphy was invited to talk with the students about his work at PPPL as part of a month-long program celebrating Black History Month.

R. Richey Pfeifer was appointed Head of the Plant Engineering Branch in the Plant Maintenance and Engineering Division. Pfeifer joined PPPL in 1984 as a Project Engineering Manager. He replaces Frank Fumia who recently retired.

TRANSITIONS

New Hires

The HOTLINE welcomes the following new employees:

Hans-Stephen Bosch, a Staff Research Physicist in the Research Department.

Steven Cowley, a Staff Research Physicist in the Research Department.

Joseph Greco, a Health Physicist in the Project and Operational Safety Office.

Gary Hill, a Material Handler in the Materiel Control Group.

David Hwang, a Health Physics Technician in the Project and Operational Safety Office.

Karen Ossmann, a Computer Operator in the Computer Division.

Michaela Mole, a Technical Writer in the Computer Division.

Marriages

The HOTLINE offers its congratulations to **Ed Murfit** of Public Safety, Forrestal Campus, and his new wife Viviann who were married February 14.

Births

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

Tom Holoman of Diagnostic Neutral Beams and his wife, Beverly, whose daughter, Lisa, was born March 7.

Jill Barszcz of the Computer Division and her husband, Mike, whose daughter, Jessica Lynn, was born March 16.

Retirees

The HOTLINE wishes the best to the following recent PPPL retirees:

Fred Kloiber after twelve years of service. Fred was a Project Engineer in the Rectifier Section of the Engineering Department

Kenneth LeBon after ten years of service. Ken was a draftsman in the Mechanical Drafting Section of the Engineering Department.

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Robert Sathre after eleven years of service. Robert was a Technical Associate in the Vacuum Branch of the Engineering Department.

Joseph Sherlock after thirty-one years of service. Joseph was a Technical Associate in the Mechanical Engineering Section of the Engineering Department.

NEW LOCATION

The QA Division has moved to the new trailers located above to the right of the safety building. Telephone extensions will remain the same.

Correction

The recent HOTLINE article on consolidation efforts at PPPL contained an error. In Table 2 under New Building, the milestone date for "Establish Space Requirements" is November 1986 not November 1987.

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.

Disposal Procedures for Hazardous Material

Employees are responsible for seeing that hazardous materials (HazMat) are disposed of correctly. HazMat should never be dumped down sinks, tossed in trash cans or dumpsters, or left lying around. Below are the correct procedures to be followed when disposing of HazMat:

- Departments using HazMat must have Material Safety Data Sheets (MSDS) on hand for all HazMat used in a PPPL work area.

- All HazMat requesters will complete a three-part Hazardous Waste ID Card, available at the C-Site stockroom. After filling in all the necessary information on the Hazardous Waste ID Card, the top copy should be sent to Materiel Control with all applicable MSDS sheets. The second copy should be sent to Occupational Medicine and Safety (OM&S). The third copy (card) should be attached to the material to be disposed of.

- Upon receipt of any Hazardous Waste ID Cards with MSDS information, Materiel Control will pick up the material as promptly as possible -- usually within ten working days. The OM&S Office (ext. 3372) should be advised of any materials requiring immediate action due to imminent danger. Arrangements will be made for prompt removal of the material.

- If the requester does not have the MSDS sheets, or does not know the identity of the material, the requester should contact the OM&S Office. The needed information will be obtained -- either by checking OM&S files, by contacting the manufacturer, or by arranging for an analysis. Once this information is available, Materiel Control will promptly pick up the material.

HazMat Section employee packs hazardous waste for disposal.

- If requesters find it necessary to remove the material from a work site prior to scheduled pickup by Materiel Control or prior to the availability of MSDS data, they will be allowed to move the material themselves to a "quarantine" area set up by Materiel Control. Each requester must make prior arrangements with the Hazardous Materials Section of Materiel Control (Scott Larson, ext. 3387) for receipt and storage of the material.

- In all cases, the requester is responsible for having the material in a container

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suitable for transportation to Materiel Control and to ensure that items in the work area are stored properly prior to removal for disposal.

In order to assure expeditious handling and follow-up of disposal actions, Materiel Control will present a status report of pending actions at the Laboratory's monthly safety meetings.

Any questions or problems relating to the disposal of HazMat should be referred to Scott Larson in the Hazardous Materials Section of Materiel Control, ext. 3387.

Falls

The ways to prevent accidents due to falling are well known to most everyone. The reasons for falls are perhaps less obvious. Below is a short summary of these reasons. Take the time to read them.

Falls happen because of unsafe conditions: breaks in flooring, slippery spots, makeshift platforms, unlighted walkways and stairwells, tools and equipment scattered in aisles, cords and piping stretched across pathways.

Falls happen because of unsafe acts: running in aisles, hurrying on stairs, failing to use handrails, climbing on improvised supports, overreaching in high places, tilting far back in chairs, leaving obstacles in the way of walkers.

Falls happen because of combinations of unsafe conditions and acts: Racing down stairs made slippery by spills, climbing on boxes or crates in darkened areas, leaning misfit ladders against shaky supports.

Serious injuries can result from accidents due to falls. Being aware of the situations that cause falls could save you or your friends much pain and suffering.

Meeting Calendar

April 1987

06-08 **Annual Controlled Fusion Theory Conference** (Sherwood Meeting), San Diego, California. Contact: Don Dobrott, SAIC, P.O. Box 2351, La Jolla, CA 92038.

08-09 **Fusion Power Associates' Annual Meeting and Symposium on Applications of Laser, Particle Beam, and RF Power Technologies,** Pleasanton, California. Contact: Ruth Watkins, FPA, 2 Professional Dr., Ste. 248, Gaithersburg, MD 20780. 301-258-0545.

14-16 **14th Annual Energy Technology Conference and Exposition,** Washington, D.C. Contact: Karen Noyes, Government Institutes, Inc., 966 Hungerford Dr., No. 24, Rockville, MD 20850. 301-251-9250.

26-30 **Symposium on Fabrication and Properties of Lithium Ceramics** (To be held during the 89th Annual Meeting of the American Ceramic Society), Pittsburgh, Pennsylvania. Major emphasis will be on issues involved in the application of lithium ceramics to fusion reactor blankets. Contact: Glenn Hollenberg, Westinghouse Corp., Hanford, WA. 509-376-5515.

27 Apr-01 May **OSA/IEEE Conference on Lasers and Electro-Optics** (CLEO '87), Baltimore, Maryland. Contact: Optical Society of America, 1816 Jefferson Pl., N.W., Washington, DC 20036. 202-223-8130.

More comprehensive meeting listings may be found in Nuclear Fusion, Physics Today, IEEE Spectrum, and Communications of the ACM.

Safety Training Courses

The Occupational Medicine and Safety Office has scheduled the following safety training courses for April:

Course	Date/Time/Location
Lockout/Tagout Procedures	16 April, 1:30-3:00, Safety Training Trailer
Forklift Training	21 April, 8:30-12:00, Safety Training Trailer
Confined Space Entry	23 April, 8:30-11:00, Theory Conference Room
Proper Use of Fire Extinguishers	28 April, 9:00-10:00, Safety Training Trailer
Radiation Safety Training	29-30 April and 1 May, 8:30-12:00 each day Theory Conference Room

Employees must obtain permission from their immediate supervisor to attend these classes. Supervisors should call Mary Ann McBride at ext. 3468 to enroll their employees.

Basic Safety Orientation for new employees is offered every Monday beginning at 8:30 a.m. in the Safety Training Trailer.

Holiday Schedule

The official 1987-1988 Princeton University Holiday Schedule is given below:

Independence Day	03 July	Friday
Labor Day	07 September	Monday
Thanksgiving	26 November 27 November	Thursday Friday
Christmas	24 December 25 December	Thursday Friday
New Year's	31 December 01 January	Thursday Friday
Memorial	30 May	Monday
Optional Holidays		Two Additional

The optional holidays may be used at the staff member's discretion and with the approval of the supervisor for religious holidays or any other personal reason.

Alternate holiday arrangements may be made by Departments and Offices such as the Library and Food Services where work schedules or union contracts dictate other holiday schedules.