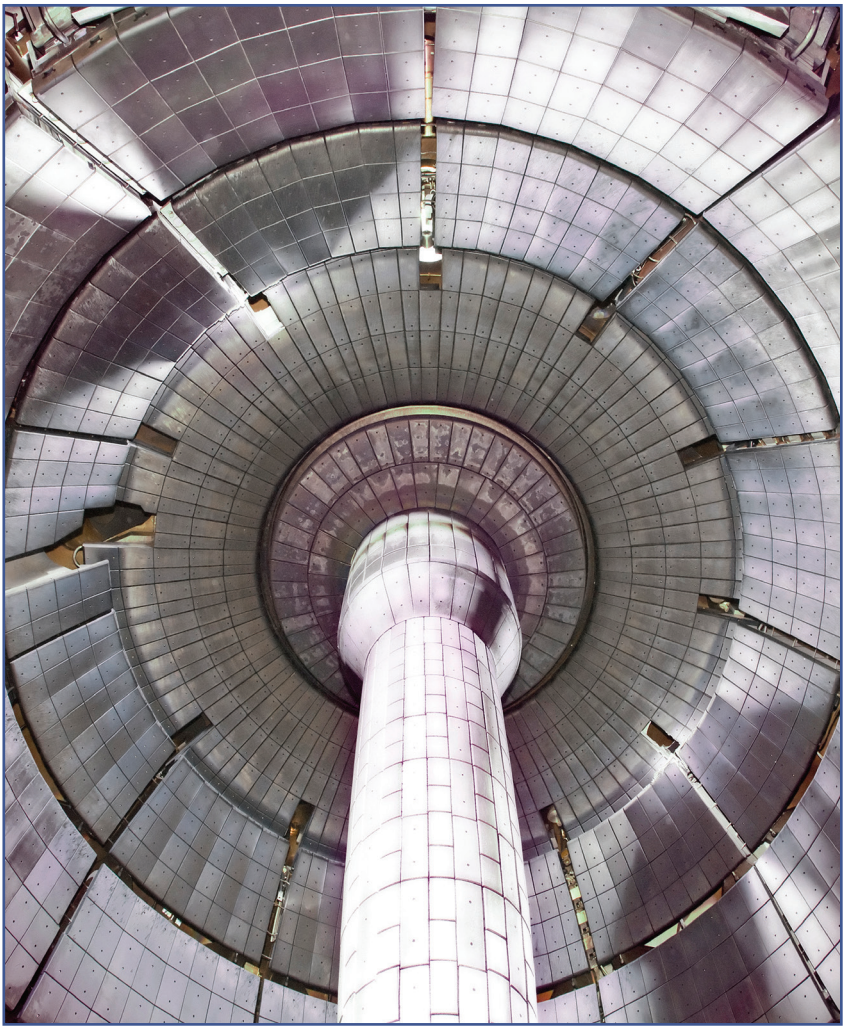
A Guide to the U.S. Department of Energy's Princeton Plasma Physics Laboratory

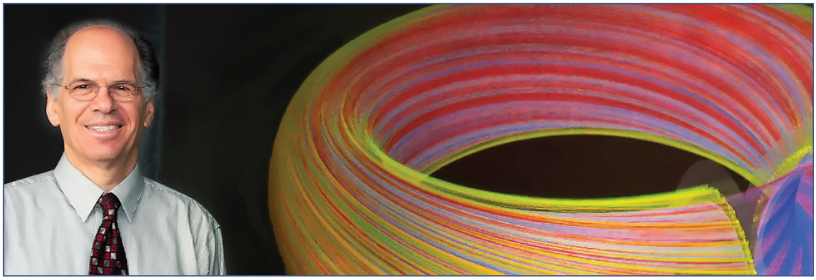


Interior of PPPL's National Spherical Torus Experiment

Open House — June 1, 2013

PPPL PRINCETON PLASMA PHYSICS LABORATORY

Hot Plasma, Cool Science



Stewart Prager, Director — Princeton Plasma Physics Laboratory

Welcome to the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL), a collaborative national center for research in fusion energy and plasma science, with its many applications. We are delighted to open our doors to our friends and neighbors to see the cutting-edge research taking place at our Laboratory.

PPPL is a world leader in developing the knowledge, understanding and key innovations needed to make fusion energy a plentiful, safe and environmentally healthy energy source for future generations. Much of our research is focused on plasma, a hot gas of charged particles and the fuel for fusion energy.

PPPL is home to the National Spherical Torus Experiment (NSTX), which is undergoing a $94 million upgrade that will make it the most powerful experimental fusion facility of its type when it is completed in 2014.

At PPPL, we collaborate with researchers around the globe on fusion research. The Laboratory plays a key role in ITER, the huge international facility being built in Cadarache France.

In addition to studying plasmas for fusion energy, our research has focused on a wide range of plasma physics and its applications – from understanding plasmas in the cosmos to using plasmas to develop newnano materials.

Thanks for visiting PPPL, the home of hot plasmas and cool science!

Stewart C. Prager

PRINCETON PLASMA PHYSICS LABORATORY

GENERAL INFORMATION

Welcome to the PPPL Open House 2013, where you can tour one of the nation's largest operating fusion machines, check out energy and plasma-related exhibits, and join the kids in hands-on science demonstrations and safety activities. See pages 5 and 6 for a map of the site and the areas open to the public. Page 3 includes the events scheduled in the Auditorium and Cafeteria. A listing of the tour stops, with a brief description of each starts on page 4 and continues on pages 7 - 11. Below is general information for your visit.

Self-guided Tours

All tours are self-guided. There are two routes: **THE PLASMA SKY-WAY** and **THE FUSION FREEWAY**. Follow the signs and the map in this guide. Researchers will be on hand at the experimental sites to answer your questions. **Please stay in the designated tour areas.** Tours require a moderate amount of walking and stair climbing.

Information Desk

An Information Desk is in the Lobby. PPPL volunteers will be at the desk, as well as throughout the Laboratory to help you — just look for individuals wearing black T-shirts with the PPPL Open House logo. Signs are posted in the public areas to help you find all facilities, tour stops, and activities areas. "Ask a Scientist" and "Ask an Engineer" booths will be outside in the parking lot.

If you require assistance, please go to the Information Desk.

Free Refreshments

Refreshments will be served outside the main office building beginning at 9 a.m. with donuts and coffee. Snacks — yogurt, chips, fruit, ices and beverages — will be available all day *(until supplies run out)* at the same location. **At PPPL we recycle!** Please put all trash and recyclables in the appropriate receptacles.

Shuttle Buses

Shuttle buses will loop the site continuously. Hop on and off outside the Main Lobby, the Fire Safety Demonstration area, the Water Jet Cutter area, and the Parking Lot *(see map)*.

Emergencies and Safety

In case of an emergency, **dial 3333** *(609-243-3333 from your cell phone)* or ask any PPPL volunteer for assistance.

Please obey all safety signs.

Some Do's and Dont's

DO NOT remove any items or touch any buttons or switches as you tour PPPL. The Laboratory is a U.S. Department of Energy facility and removal of Government property is a federal crime.

DO take an information bag when you exit the Open House.

DO stop by the **Plasma Hutch** if you would like to purchase PPPL souvenirs such as T-shirts, stuffed animals, and other items with the PPPL logo. The Plasma Hutch is off the Lobby.

Accessibility

If you need special assistance, please stop by the Information Desk in the Lobby.

AUDITORIUM

PPPL Director Stewart Prager
"The Path to Fusion Energy"
Show Times: 9:30 a.m and 1:00 p.m.

John Krasting, Geophysical Fluid Dynamics Laboratory
"Making Sense of Climate Science: The Earth is warming, but why?"
Show Time: 10:30 a.m

Charlie Gentile, PPPL
"Plasma Technology at PPPL"
Show Times: 12:00 p.m and 2:30 p.m.

CAFETERIA

Laser Arm Show
Show Times: 9:30 a.m., 11:30 a.m. and 2:00 p.m.

Mark Cropper, PPPL
Cryogenics
Show Times: 10:15 a.m. and 1:00 p.m.

OTHER ACTIVITIES

U.S. Department of Energy
The Office of Science has ten national science laboratories. PPPL is one of the ten. This display in the lobby will highlight the research conducted by the DOE National Science Labs.

Scavenger Hunt Start & Finish (Lobby)
The hunt is on! Explore PPPL and get your official Scavenger Hunt card stamped at the Lab exhibits listed. Return your completed card to the Information Booth in the Lobby to collect a special PPPL prize.

Kids Color Creation Lab: Coloring & Ooblek! (Courtyard)
Hey Kids! Come and get your free "Color Me Physics" coloring book and crayons. Learn about famous scientists throughout history!

Experiment by walking across a pond of Oobleck – what happens when you walk fast? Slow?

Machine Shop and Water Jet Cutter
See the equipment PPPL uses to fabricate the hardware used on our experimental machines, including a very large machine that was once used by NASA.

TOUR ROUTES

Plasma Skyway ← PLASMA SKYWAY and FUSION FREEWAY → **Fusion Freeway**

Plasma Skyway

Art of Science (1st Floor outside Lobby)
See beautiful images by PPPL staff featured in previous Princeton University Art of Science created in the course of scientific research.

MG Art (Hallway, 2nd Floor)
Artist Josephine Halvorson and her Princeton University art class have spent several weeks and countless hours painting stunningly beautiful works based on not so-beautiful objects – metal beams and grates and even an old telephone booth from the basement in the old motor generator (MG) site at PPPL.

Controlling a Plasma With Magnetic Fields (2nd Floor)
Want to know what it's like to control a plasma in a fusion experiment? This computer game, based upon the experiment Alcator C-Mod located at MIT, allows up to 8 individuals to control magnets holding a plasma in a magnetic bottle. How long can you hold the plasma? See if you can get the highest score!

Physics Demos
Princeton University will have several physics demonstrations including a superconducting rail and the laboratory will have the Lego Mindstorm for experimentation.

Surface Science & Technology Laboratory (2nd Floor, Room T260)
This laboratory explores how the science of surfaces can be used to solve one of the biggest obstacles facing fusion: how to keep the fusion reaction burning for long periods. This research is a collaboration with Princeton University.

Magnetic Reconnection Experiment (MRX) (2nd Floor, Room 215)
A research experiment studying basic plasma physics. Experiments study the physics of magnetic reconnection, one of the most fundamental processes of plasma physics, which relates to the physics of the sun and the Earth's magnetic field.

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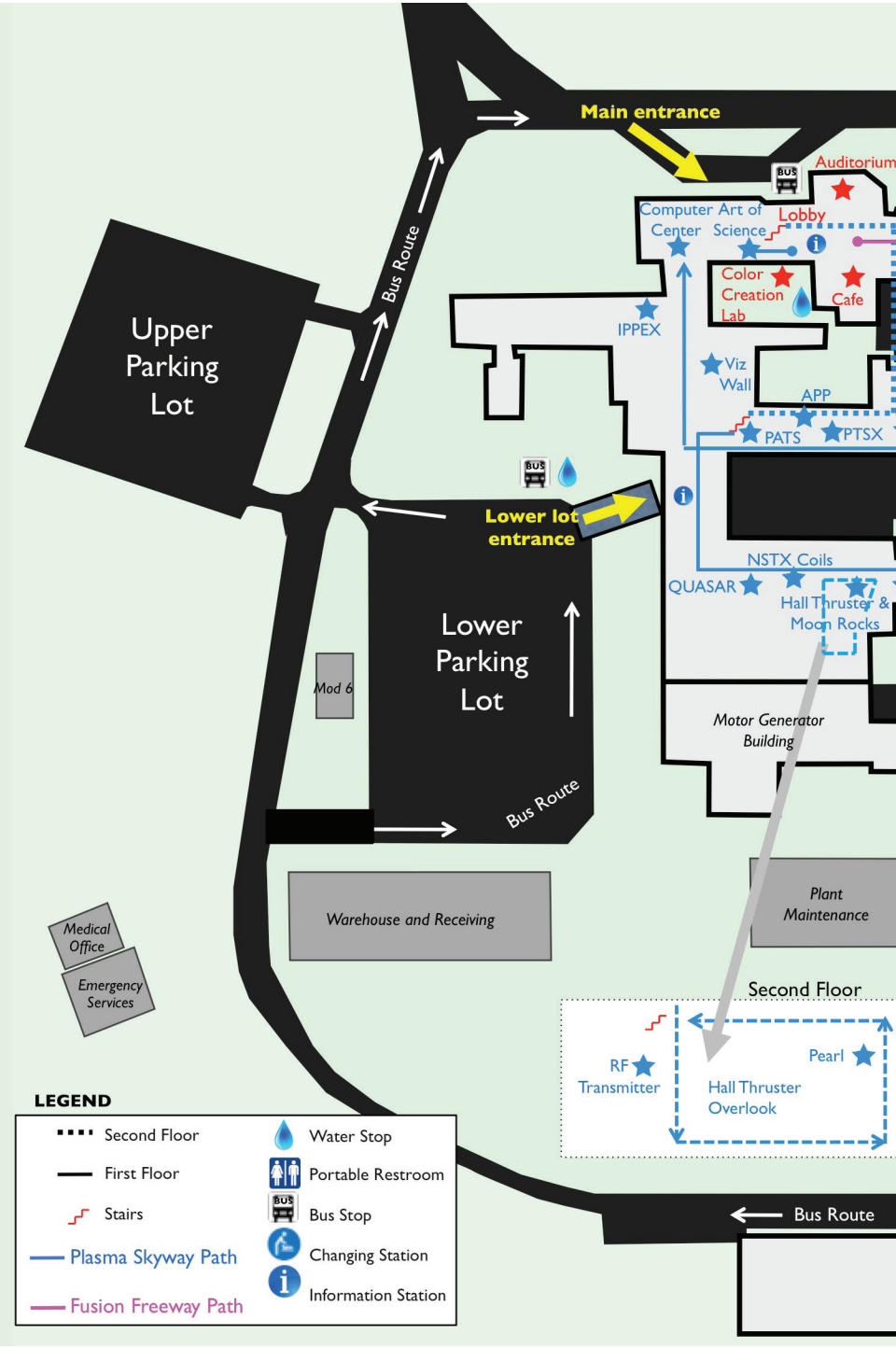
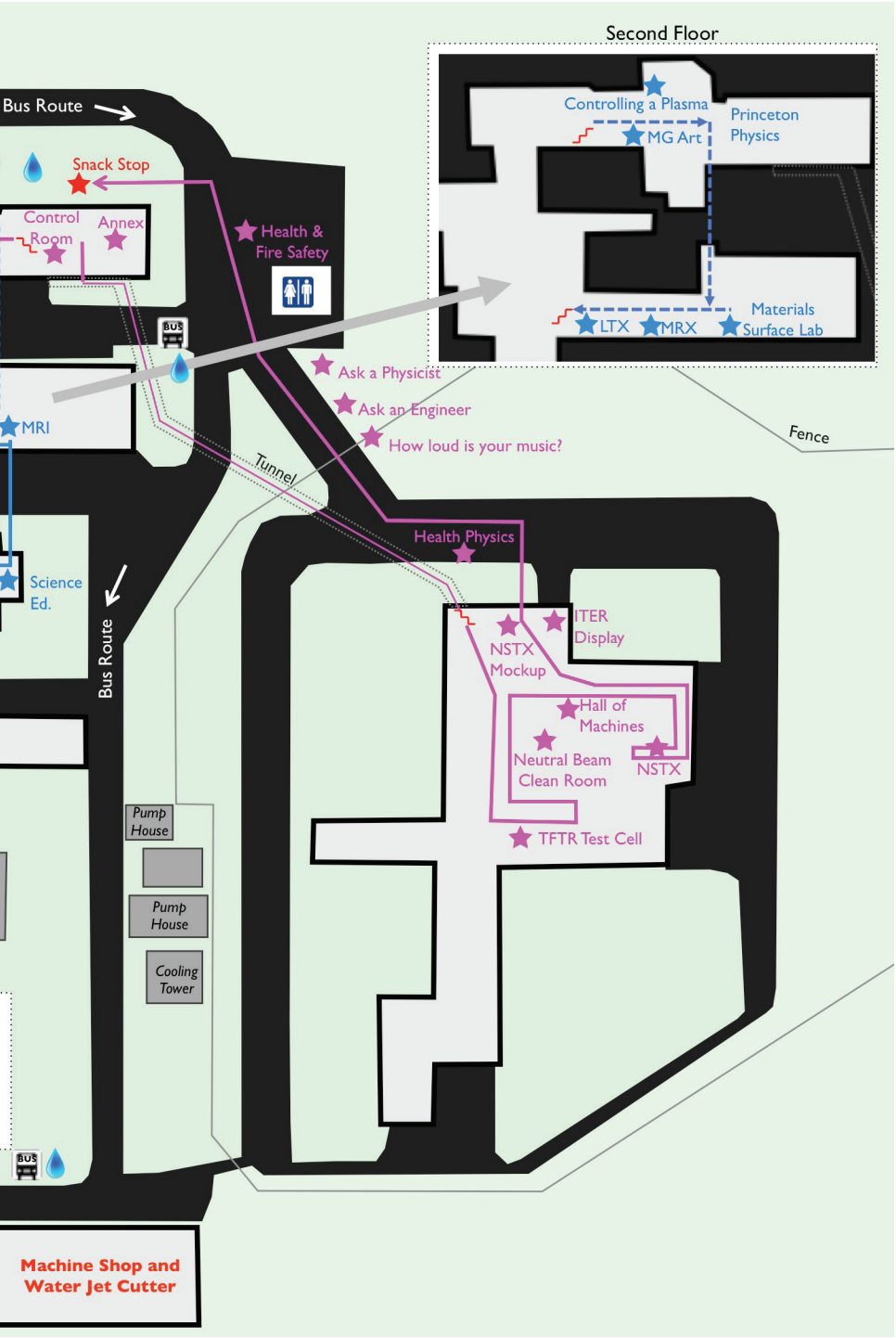

Main entrance
Auditorium
Lobby
Computer Art of Science
Center
Color Creation Lab
Cafe
IPPEX
Viz Wall
APP
PATS
PTSX
Upper Parking Lot
Bus Route
Lower lot entrance
NSTX Coils
QUASAR
Hall Thruster & Moon Rocks
Lower Parking Lot
Mod 6
Motor Generator Building
Bus Route
Warehouse and Receiving
Plant Maintenance
Medical Office
Emergency Services
Second Floor
RF Transmitter
Hall Thruster Overlook
Pearl
LEGEND
Second Floor
First Floor
Stairs
Plasma Skyway Path
Fusion Freeway Path
Water Stop
Portable Restroom
Bus Stop
Changing Station
Information Station
Bus Route


Second Floor
Controlling a Plasma
Princeton Physics
MG Art
LTX
MRX
Materials Surface Lab
Bus Route
Snack Stop
Control Room
Annex
Health & Fire Safety
Ask a Physicist
Ask an Engineer
How loud is your music?
Fence
MRI
Tunnel
Health Physics
Science Ed.
Bus Route
ITER Display
NSTX Mockup
Hall of Machines
Neutral Beam Clean Room
NSTX
TFTR Test Cell
Pump House
Pump House
Cooling Tower
Machine Shop and Water Jet Cutter

Lithium Tokamak Experiment (LTX) (2nd Floor Room L208)

Scientists In the Lithium Tokamak Experiment are studying the use of liquid lithium metal as an inner wall for fusion devices and how such a wall affects plasma. Lithium walls may dramatically improve plasma performance, yielding hotter and cleaner plasmas.

NSTX Coil Shop

This facility is currently constructing the new center stack for the NSTX facility upgrade. This new coil will allow the experiment to double the magnetic field. Many steps are required to build an electromagnet. You'll be able to see work in progress including a complete quadrant of the coil.

QUASAR

PPPL and its industrial suppliers fabricated complex magnetic coils and the vacuum vessel for the National Compact Stellarator Experiment (now called QUASAR). A stellarator confines the plasma with three-dimensional magnetic fields, which may be highly desirable for a future power plant. PPPL is maintaining the components seen here, as well as the knowledge base as an asset for the U.S., should the Department of Energy decide to complete the project.

Radio Frequency Heating Systems

PPPL has some of the largest radio transmitters in the world. They are used to heat plasmas. You'll be able to see some of this hardware.

PEARL

PPPL's Environmental, Analytical and Radiological Laboratory monitors effluents within the environment (self guided – see HP personnel on other tour route for any questions).

Hall Thruster

Hall thrusters are plasma-based propulsion systems for space vehicles such as satellites that greatly reduce the amount of fuel used by space vehicles.

Moon Rocks and Meteorite Samples

Between 1969 and 1972, six Apollo missions brought back more than 2,200 separate samples of lunar rocks, core samples, pebbles, sand and dust from six exploration sites of the lunar surface. The lunar sample disk consists of three soils and three rocks encapsulated in a Lucite disk. The meteorite sample disk contains six meteorites which are embedded in a plastic disk. These samples will be presented by Patricia Hillyer, a former DOE ACTS teacher and current teacher-researcher at PPPL. She serves as one of approximately 1,000 teachers certified by NASA to present the lunar and meteorite samples.

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Science Education for the Whole Family
Participate in hands-on plasma activities for all ages. Have fun playing with plasmas, magnets, and other toys that demonstrate the scientific principles of magnetic fusion.

Magnetorotational Instability Experiment (1st Floor Room L114)
Scientists are studying how magnetorotational instability — a disruptive plasma process — affects accretion the process by which matter becomes a planet.

Atmospheric Pressure Plasmas (1st Floor Room L127)
This experiment is devoted to the study and applications of dielectric barrier discharges, surface discharges, and sparks. The plasma sources provide an inexpensive and energy efficient way of changing the surface properties of various materials. Visitors will observe small but bright dielectric barrier discharges and compare the discharge in air and other gases. This experiment is conducted by one of our collaborating teachers and her students.

PTSX Paul Trap Simulator Experiment (1st Floor Room L113)
This experiment determines the properties of intense charge particle beams as they travel through transport systems using quadruple magnets to confine the beam along a path.

The Princeton Advanced Test Stand (PATS) (1st Floor Room 110)
This device is capable of generating 100kV ion beams for the purpose of studying beam focusing and neutralization for Heavy Ion Fusion.

Visualization Wall (1st Floor Room A104)
The display wall in the Visualization Lab is a large format, rear projection system. See images of fusion experiments and computer simulations, and examples of scientific computing on the Wall.

Interactive Plasma Physics Education Experience (IPPEX) (1st Floor Room A118)
Operate your own tokamak – see if you can make fusion energy!

Fusion Freeway

Stellarator Model (Lobby near Plasma Hutch)
The stellarator was the earliest magnetic fusion concept investigated at Princeton in the 1950s and 1960s. A version of this model was displayed in 1958 at the United Nation's Second International Conference on Peaceful Uses of Atomic Energy in Geneva, Switzerland.

NSTX Control Room (Basement Room B006)
NSTX experiments are conducted from the NSTX Control Room. Plasma shots and preliminary data can be viewed in real-time on the monitors and the display wall.

NSTX Expo Room (Basement Room B021)
See scientific displays on:
Coalition for Plasma Science
PPPL Communiversity Poster
Eight Reasons for Fusion
How To Do Business at PPPL
Plasma Research Applications
Princeton Satellite Systems – plasma rocket – solar system
PPPL Engineering – analysis and computer displays
Collaborator Fusion Research Posters

Tunnel
Use this 580-foot tunnel as the route to get from the NSTX Control Room to the TFTR and NSTX Test Cells.

TFTR Test Cell
The Tokamak Fusion Test Reactor (TFTR) operated at PPPL from 1982 to 1997. TFTR set a number of world records, including a plasma temperature of 510 million degrees centigrade -- the highest ever produced in a laboratory. In addition to meeting its physics objectives, TFTR achieved all of its hardware design goals, thus making substantial contributions in many areas of fusion technology development. In 1993, TFTR became the world's first magnetic fusion device to perform extensive experiments with plasmas composed of 50/50 deuterium/tritium -- the fuel mix required for practical fusion power production. Consequently, in 1994, TFTR produced a world-record 10.7 million watts of controlled fusion power, enough to meet the needs of more than 3,000 homes.

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ITER Port Plugs

When ITER, the huge international experimental fusion reactor in Cadarache, France, begins operation in the 2020s, it will have over 40 diagnostic tools, which will provide essential data to researchers seeking to understand plasma behavior and optimize fusion performance. Some 25 Port Plugs, large 11-foot-long by 6-foot-wide, 50-ton boxes made of special stainless steel, will protect the delicate diagnostic hardware and other machine parts from neutron flux and intense heat. PPPL has proposed assembling and testing some of the ports in this facility.

Neutral Beam Clean Room

The Neutral Beam Source Shop consists of a Decon Room for cleaning parts, a Clean Room for reassembling and testing sources, and a Test Area on the mezzanine above for high voltage testing and storage. The Neutral Beam Ion Sources are the engines that produce the particle beams for the Neutral Beam Injector on NSTX. The Clean Room area has alignment equipment, vacuum leak detector equipment, and cranes and fixtures for moving heavy assemblies. Although the parts are different, source refurbishment is similar to rebuilding automobile engines.

NSTX Mock Up

This life-sized model shows the physical changes being made to the vacuum vessel by adding a port for the new neutral beam heating unit. The photo behind the exhibit shows the interior of the vacuum vessel, including the antenna for radio frequency heating.

ITER Exhibit

The U.S. ITER Project exhibit illustrates how ITER — a huge international fusion facility that aims to demonstrate the scientific and technical feasibility of fusion power — is being designed and will operate when completed in Cadarche, France. ITER has seven project partners, including China, the EU, India, Japan, Russia, South Korea, and the U.S.

Hall of Machines

The Hall of Machines will show huge drawings of the 20-foot tall ITER experiment and other fusion machines to demonstrate the scale of the largest fusion experiment ever created.

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National Spherical Torus Experiment (NSTX)

NSTX is one of the major fusion experiments in the nation. Supported by the U.S. Fusion Energy Sciences Program, this collaborative fusion facility began operating in 1999. NSTX tests the physics principles of spherically shaped plasmas, which could lead to the development of smaller, more economical fusion reactors.

Please note that due to construction activities, we have only one access point for people to enter and leave the facility. We expect that there will be wait times to see this experiment, so please be considerate of others and limit your time at NSTX.

Health Physics Demonstrations

See how you can measure radiation in the human body and use a Geiger counter to measure radiation.

"Ask a Physicist" Booth

Scientists will be on hand to answer your questions about the experiments at PPPL.

"Ask an Engineer" Booth

Engineers will be on hand (every hour on the hour) to answer your questions about the experiments at PPPL.

How Loud is Your Music?

The Laboratory's industrial hygienists will be on hand with instruments to measure how loud your iPod, phone or other mobile device is. They'll be able to compare it to other common noise sources and tell you whether you are listening to your favorite tunes at a safe volume.

Health and Fire Safety Demos (Parking Lot)

Fire Engine — Sit behind the wheel and try on fire protection gear.
Fire Extinguisher Safety and Training

Community Exhibits (Parking Lot)

University Medical Center at Princeton

PPPL Occupational Medicine Office

Mercer County Sheriff's Office, Patrol/K-9 Unit

Middlesex County Fire Safety Trailer

Trenton EMS Mass Casualty Rescue Unit

We hope you enjoyed your visit to the Princeton Plasma Physics Laboratory

Please take a few minutes to complete our Questionnaire

The Princeton Plasma Physics Laboratory is funded by the U.S. Department of Energy and managed by Princeton University.
For additional information please go to
www.pppl.gov

U.S. DEPARTMENT OF ENERGY

PPPL PRINCETON PLASMA PHYSICS LABORATORY