NEWS

Remembering the long day's journey to a historic machine's Christmas Eve first plasma

By John Greenwald
December 21, 2012

(Photo credit: Princeton Plasma Physics Laboratory)

The big moment arrives: The successful first plasma brought cheers to the command center.

'Twas the night before Christmas and all through the cell

Not a creature was stirring. Just the warning bell.

The diagnostics were hung on the tokamak with care

In hopes that first plasma soon would be there.

—From "Santa Claus Comes to Fusion" by Paul Reardon, project manager for the construction of TFTR

Staffers at the U.S. Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) had more than the holidays to celebrate this past Christmas Eve. The date marked the 30th anniversary of a scientific milestone that saw the Laboratory's Tokamak Fusion Test Reactor (TFTR) produce its first plasma—the superhot, electrically charged gas that fuels fusion reactions as a potential source of clean and abundant energy. The dramatic 1982 event climaxed months of furious preparation to meet a year-end deadline and ushered in more than a decade of record-setting experiments on the big PPPL machine.

But that first step was hardly easy.

The historic day began on Dec. 23, 1982, and stretched into the early hours of Christmas Eve as glitches stalled progress. The day-and-night-long effort produced a stopped clock, a critical machine part tied together with rope, and a souvenir T-shirt that had to be replaced as the day wore on. "It was pretty crazy," recalled Rich Hawryluk, who headed a physics operations group during that time and is currently completing a two-year tour as Deputy Director-General of ITER, an international fusion experiment under construction in France. "Most of us had worked pretty much nonstop 16-hour days, seven days a week to get ready for the first plasma," said Hawryluk, "and by the time we finally made it we were all feeling weary and slightly punchy."

The balky 600-ton, 17-foot- high TFTR device behaved like a car that wouldn't start. "We had to go underneath the hood to find out the problem," Hawryluk said. The machine's power system created havoc when a copper component called a bus bar failed its preoperational tests. This was like warning lights coming on in a car, and forced some unanticipated maintenance. After due consideration, technicians replaced the bus bar with cables lashed together with rope—an ad hoc fix that was only possible because of the restrictions on machine capability at the time.

Contact Info

Kitta MacPherson
Email: kittamac@pppl.gov
Phone: 609-243-2755

Download

Select and View High Resolution Images to Download

Learn More

- Engineering
- Fusion energy
- Fusion reactor design
- ITER
- Nuclear energy
- Plasma physics
- Power systems
- Tokamaks

Water leaks and complex interlocks

The faulty bus bar was just one source of electrical woe. Charles Neumeyer, who ran the power supply system, had to contend with frequent leaks in water-cooling lines plus an unreliable interlock system that controlled access to the TFTR test cell so that workers could fix problems. "Trying to get the interlocks armed and ready was very difficult because of the newness and complexity of the system," said Neumeyer, who now heads the Electrical Engineering Design Branch at PPPL and serves as team leader for the Steady State Electrical Network for ITER. "It took half an hour to restore the system to operating condition each time we used it."

Computers were another challenge, since the system that controlled TFTR experiments had not been fully installed. So the Laboratory created a makeshift command center near the TFTR test cell to augment the control room in the basement of the subsequently named "Lyman Spitzer Building" (LSB).

The 100 or so staffers trying to make plasma were unable to attend the annual holiday parties that PPPL departments were holding that day. "We started early in the morning and were pushing hard to make first plasma by noon so we could have lunch and join the parties," recalled physicist Dale Meade, who served as deputy to TFTR Project Head Don Grove. "But we just kept running into problems."

Meade wanted to present Grove with a T-shirt that read, "TFTR First Plasma Dec. 23 1982" once the plasma was made. He asked Sallie Connell, who worked in the budget office, to hunt up such a shirt. Connell, who has since married Meade and uses his last name, returned with the shirt only to find that the date needed changing since there still was no plasma. "I had to hurry back down to Trenton before the shop closed," she recalled. She made it in time and brought back a T-shirt with "Dec. 24" as the date.

Down in the LSB basement control room, Kenneth Young, who headed the TFTR diagnostic unit, found little to occupy him. The bank of computer monitors had few new data to report since there was no plasma to diagnose. "We got rather bored because there was little we could do. The few active diagnostics had all been thoroughly checked out," Young recalled. "I am sure that pizza was ordered in to keep us all going through the evening." Young passed time chatting with Ned Sauthoff, who was deputy division head for the central instrumentation, control and data acquisition system and now directs the ITER Project Office at the DOE's Oak Ridge National Laboratory.

Sauthoff had his own glitches to deal with. "Something was corrupting the computer program's automatic sequencing of programs," he recalled. This forced programmer Walt Stark to restart the sequence after each attempt to make plasma.

A**n unplugged command-post clock**

As time dragged on, PPPL Director Harold Furth decided to halt work at midnight to keep staffers from getting too tired. But Grove and Meade, who were in the makeshift command center with Furth, persuaded him to extend the deadline to 2 a.m.—yet still there was no plasma. So at 1:55 Meade ducked under a bank of control panels and unplugged the clock's cord from the wall. When Furth glanced at the clock an hour later, he seemed surprised that it was still before 2. Pulling out his pocket watch, he saw that the time was actually 3 in the morning and mouthed something inaudible when he realized what had happened.

The delay worked, however, since all TFTR systems were now ready to go. At 3:06 a.m. on Christmas Eve, then-smoker Charles Neumeyer, with a walkie talkie in one hand and a cigarette in the other, announced the countdown "5-4-3-2-1-0," and pushed the button to initiate the first plasma.

The big moment lasted some 50 milliseconds as an electric current pulsed through the hydrogen gas in TFTR, stripping electrons from the hydrogen atoms and turning the gas into plasma. Cheers broke out in both control rooms as bright wavy lines displayed the current and its voltage on computer screens. In the LSB basement, Kenneth Young witnessed the plasma itself as a flash of white light that a camera that looked inside TFTR beamed to a control room screen. "There was a terrific cheer," said Young, "and a feeling of huge relief that we had done it."

Among those celebrating the achievement was Nelson Grace, the DOE's on-site area manager. His presence was vital since he needed to certify that the Laboratory had kept its commitment to DOE to produce a TFTR plasma by the end of that year. "Achieving first plasma allowed the Department of Energy to complete the construction phase of TFTR and move on," recalled Milt Johnson, the Chief of the Engineering and Construction Branch in the DOE's area office at PPPL.

The weary workers could now finally party. Champagne greeted them in the LSB lobby, Don Grove got his T-shirt and Kenneth Young presented Harold Furth with the computer tape of the first plasma data, which now resides in the Computer Division's tape vault at the Laboratory. "We all celebrated in the lobby and then dragged ourselves into our cars and went home in the wee hours of the morning," Rich Hawryluk recalled. There still would be much to do, because "Santa Claus was arriving 24 hours later and many of us had relatives to entertain."

Princeton Plasma Physics Laboratory
P.O. Box 451
Princeton, NJ 08543-0451
GPS: 100 Stellarator Road
Princeton, NJ, 08540
(609) 243-2000
Website suggestions and feedback

Google+ · Pinterest · Instagram · Flickr

Princeton Plasma Physics Laboratory is a U.S. Department of Energy national laboratory managed by Princeton University.

Twitter
Facebook
YouTube
Flickr