# CPS Plasma Page

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## Betti Details Challenges and Benefits of a Star on Earth

On May 12, 2008, the Coalition for Plasma Science (CPS) presented the 12th in a series of biannual educational talks to members of Congress and their staffs. CPS Chair Lee Berry introduced Prof. Riccardo Betti of the University of Rochester's Laboratory for Laser Energetics (LLE), and his talk entitled "A Star on Earth." It addressed the quest for fusion energy, focusing on progress in inertial confinement fusion (ICF).

Using simple and interesting analogies, Betti introduced the physics of fusion, explaining that one ounce of Deuterium-Tritium (DT) fuel could yield 10 billion BTUs, enough energy to drive your car 6,250,000 miles, or to keep your furnace running for 80 years. Betti went on to explain the conditions necessary for fusion to take place and the challenges for reaching the goal of thermonuclear ignition.

While magnetic fusion seeks to confine hot plasma with magnets, ICF focuses on compressing a pellet of frozen hydrogen (DT) to 150 billion pounds per square inch (psi). Betti illustrated this amount of pressure with an image of 10 fully loaded Nimitz class aircraft carriers balanced on a man's thumb, noting that thermonuclear ignition would take 10 times this much pressure. While it does not take much energy to compress a 1 mm pellet of hydrogen fuel to 150 billion psi (only about 150 calories), it takes an enormous amount of power to supply 150 calories in 1 billionth of a second: 500 trillion watts.

Betti suggested that lasers are the answer, because they can focus light and energy into very small volumes. Referencing a number of facilities working on ICF, Betti focussed primarily on the Omega lasers at his own laboratory, and the National Ignition Facility (NIF) being built at Lawrence Livermore National Laboratory (LLNL). The powerful lasers at LLNL will be able to deliver 150 TW over 3 billionths of a second to a pellet of DT.

Betti spent the rest of the talk discussing how lasers can be used to achieve thermonuclear ignition, drawing distinctions between the "direct-drive" method, used at LLE, and the indirect-drive approach used at LLNL. Betti concluded showing the line of progress inertial confinement fusion has made, and projecting that experiments at NIF will bring the prospect of a fusion future even closer.

*Prof. Riccardo Betti responds to questions from Congressional staff and other attendees at the conclusion of his talk, "A Star on Earth."*

## OSRAM Sylvania Works with CPS on Education Tool

For the past two years CPS has been giving teachers half-coated fluorescent lamps at educational outreach events. Produced specifically for CPS by OSRAM Sylvania, these tubes show students what goes on behind the phosphor coating of a typical fluorescent lamp, revealing the purplish plasma inside the bright lamp. Teachers have been able to use these lamps to introduce their students to plasmas and their many applications.

These special lamps are not a part of OSRAM Sylvania's standard production. The CPS Vice-Chair approached a personal contact in Sylvania's Specialty Lamp R&D Group to see if they would consider working with CPS to create a lamp that could be used for educational purposes. The company was happy to oblige, and has managed to squeeze the Coalition's requested lamps into their regular production schedule. The process, however, does require additional time and labor away from the regular production line.

To create a regular fluorescent lamp, clear glass tubes in a production line are first washed to remove any particulate matter from inside. Then a grid of nozzles enters a corresponding grid of vertical tubes from above, and simultaneously dispenses a liquid phosphor suspension to coat the interior surfaces. The excess liquid pours out through the bottom of the tube; it is collected and recycled back to the coating nozzles in a continuous process. The plant can manufacture many lamp sizes, from 15 inches to 96 inches in length, but can run only one size at a time.

To create the special half-coated lamps for CPS, the plant must first wait until they are ready to produce 20-watt T12 lamps (1.5 inches in diameter). After the tubes are washed, production staff moves the CPS lamps from the production line into the lab. There, instead of flushing the tube from above with the phosphor suspension, they dip half the tube into a cylinder of the liquid, so that the suspension enters from below. The exterior is then wiped clean. Because the CPS order requires each tube to be coated separately, 60 tubes take half a day, whereas in a regular production line 60 tubes can be coated simultaneously in less than one minute. After the time-consuming hand-coating, the CPS tubes are placed back in the regular production line, where they are finished like any other fluorescent lamp, except for the label.

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*Continued from page 1*

The half-coated product receives a special ink label, which distinguishes it from Sylvania's regular commercial lamps. It then goes through a "light up" inspection that all lamps must pass. However, because these lamps are only half-coated, certain detectors need to be blocked, and the settings for the automatic inspection need to be altered.

CPS is grateful for the time and effort OSRAM Sylvania has been willing to put into making this special lamp that has helped hundreds of teachers discuss plasma with their students. The lamps clearly peak the interest of many students and teachers, helping to clarify key concepts about plasmas.

## Simple Plasma Discharge Device Impresses CPS at INTEL ISEF

Atlanta, GA - She came all the way from Chiba, Japan, to the 2008 INTEL International Science and Engineering Fair (ISEF) in Atlanta, Georgia, to showcase her project: "The Creation of a Simple Discharge Device Using an Aspirator." And she walked away with the CPS Award for Excellence in Plasma Physics, a $1500 prize.

Motivated by a concern that "standard discharge devices and spectroscopes are too expensive for high school laboratories, " high school student Misaki Makino designed and created a simple discharge device, using an aspirator, and also a spectroscope, using a DVD plate.

CPS Chair Lee Berry (Oak Ridge National Laboratory) and Steve Allen (Lawrence Livermore National Laboratory) judged the 9 plasma-oriented entries. Always most impressed by students who figure out how to engineer a solution to a problem, the CPS judges found Makino's creation inspiring. Steve Allen explained:

"This researcher and her project epitomize what science discovery is all about. She set out to study the spectra of plasmas - without going out and buying a lot of equipment. We were astonished at the spectral resolution she achieved with a slit, DVD, and a digital camera. She found free software to convert the JPEG picture into the familiar spectral plot of intensity versus wavelength. To create a plasma source, she used a simple venturi pump to evacuate a glass tube - and measured the pressure drop with a column of mercury and a meter stick! She introduced several gases and used the familiar H-alpha line as a wavelength calibration."

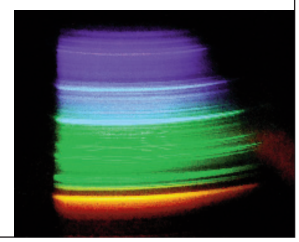
Lee Berry agreed, saying, "Makino's project may just have provided the ideas needed to make demonstrations in the classroom realistic and affordable." The Coalition may explore developing Makino's ideas into a classroom educational package.

A senior at Shibuya Kyoiku Gajkuen Makuhari High School in Chiba, Japan, Makino will attend Tsukuba University, which is known for its Gamma-10 mirror machine fusion experiment.

Although the award went to Makino, the judges were buoyed by the number of good plasma physics projects this year. Although they did not receive the CPS award, most of these projects received other recognition on awards night, as detailed below:

*CPS prize winner, Misaki Makino. Photo/Lee Berry*

*The judges took the image below through Makino's hand-held spectrometer directed at a ceiling light in the exhibition hall.*



**Great Balls of Fire II**: Caroline Julia von Wurden (a CPS finalist in 2007), Los Alamos High School, Los Alamos, NM
Physics and Astronomy Best of Category Award ($5000); First Award ($3000)

**What's Today's Forecast? High Energy Protons. An Investigation to Find the Predictability for High Energy Protons Emitted by X-Ray Solar Flares, and to Predict the Resulting Proton Density:** Sophia Maria Mitchell, duPont Manual Magnet High School, Louisville, KY
Physics and Astronomy Fourth Award ($500)

**A Statistical Analysis of Magnetic Field Measurements in the Solar Wind: Investigating the Structure of the Interplanetary Magnetic Field:** Maximilian Rial Hammer and Max Jacob Maron, Ossining High School, Ossining, NY

**The Effects of Geomagnetic Storms on GPS Receivers**: Ian Chan, Williams H.S, Plano, TX
U.S. Air Force First Award ($3000); U.S. Coast Guard First Award ($5000)

**Intensity and Temperature Variance in Sonoluminescence**: Lyric Elizabeth Gillett, Cornerstone High Homeschool, Houston, TX
Physics and Astronomy Fourth Award ($500); Acoustical Society of America First Award ($1000); American Association of Physics Teachers and the American Physical Society Second Award ($800); Patent and Trademark Office Society Third Award ($150)

**The Marvelous Magnetosphere III**: Gavin Gregory Reen, La Plata High School, La Plata, MD
Earth and Planetary Sciences Fourth Award ($500); Patent and Trademark Office Society Second Award ($200)

**Astrophysics Conditions of Carina Nebula**: Charles Anthony Lozada, Ramon Power Y Giralt High School, Las Piedras, Puerto Rico

**Plasma Pencil: Plasma Jet Generator on the Basis of "Plasma Point" Discharge**: Tatiana Olegovna Pika, Lyceum #1, Petrozavodsk, Russia