



Young Fermilab researcher Natalia Kuznetsova seeks a view from the top

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# Research Highlights . . .

## Experiment sees quark effects for first time

Researchers at DOE's **Thomas Jefferson National Accelerator Facility** have seen evidence for the onset of quark effects in a nuclear reaction for the first time in an experiment. When a particle strikes a nucleus at low energies, one can describe the resulting behavior of the nucleus in terms of neutrons and protons and the mesons that hold them together. However, at high energies this behavior cannot be described using neutrons and protons, only quarks and gluons. This experiment showed individual quarks absorbing the momentum of the collision of the electron rather than the protons and neutrons.

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## PPPL's SCiDAC focus is fusion

Researchers at DOE's **Princeton Plasma Physics Laboratory** will participate in four fusion-related Scientific Discovery through Advanced Computing (SciDAC) projects focused on the development and improvement of physics models and computer resources needed for integrated simulations of plasma confinement systems and data analysis. Plasmas are the hot, ionized gases that fuel the fusion process. Three of the projects focus on fundamental phenomena including electromagnetic-wave-plasma interactions, plasma turbulence, and macroscopic stability of magnetically confined plasmas. The fourth project aims to develop a software "collaboratory" allowing workstation and supercomputer resources to be shared among fusion experiments for high-speed data analysis.

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## Sandia foam used in anthrax decontamination

Federal authorities used **decontamination foam** developed at DOE's **Sandia National Laboratories** to help rid Capitol Hill buildings of anthrax that showed up following the September terror attacks on the United States. The foam was used in the Hart Senate Office Complex and the Dirksen and Ford Congressional Office Buildings. Sandia last year licensed rights to commercialize the formulation to Modec (of Denver) and EnviroFoam Technologies (of Huntsville, Ala.). The formulation, which includes ordinary household substances such as those found in hair conditioner and toothpaste, neutralizes both chemical and biological agents in minutes. It can be applied to a contaminated surface as a liquid spray, mist, fog, or foam.

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## Flow in the fast lane

At the nanoscale level of molecules, moving through a fluid is like navigating your car through heavy traffic—great if you could use the fast lane. Liquids have a nanoscale "fast lane," as experiments by DOE's **Pacific Northwest National Laboratory** scientists have shown. This could be crucial to engineering future nanoscale devices, such as lab-on-a-chip, or better lubricants. Using a "soft landing ion system," PNNL scientists recently measured motion at the molecular level in organic solvent films and found that the solvent's outer surfaces were considerably less viscous than the interior. PNNL scientists are using this information to predict how ions transport across the interface of water and oil.

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## Spinach for the eyes

**E**at your spinach. It's good for you, Mom always said. She was right. The famous vegetable may someday even have a role in restoring vision to people who are legally blind.

Researchers at the DOE's [Oak Ridge National Laboratory](#) and the University of Southern California hope to learn whether a protein from spinach could replace a non-functioning light receptor in the eye. People who suffer from age-related macular degeneration or retinitis pigmentosa, diseases that are leading



causes of blindness worldwide, may find hope in this research.

"Although the neural wiring from the eye to brain is intact in people with these diseases, their eyes lack photoreceptor activity," said ORNL's Eli Greenbaum.

[Greenbaum and colleagues](#) propose replacing these non-functioning photoreceptors with a spinach protein that gives off a small electrical voltage after capturing the energy of incoming photons. The main function of Photosystem I, a photosynthetic reaction center protein, is to perform photosynthesis in leaves using the energy of the sun to make plant tissue.

Greenbaum's collaborator is Mark Humayun, a professor in the University of Southern California's [Doheny Eye Institute](#). Humayun and his research team showed that if retinal tissue is stimulated electrically using pinhead-sized electrodes implanted in the eyes of legally blind patients, many can see image patterns that mimic the effects of stimulation by light.

Greenbaum believes that it might be possible to use Photosystem I protein to restore photoreceptor activity. Experiments by Greenbaum's team showed that Photosystem I protein can capture photon energy and generate electric voltages of up to 1 volt.

"What we need to find out is whether these voltages can trigger neural events and allow the brain to interpret the images," Greenbaum said.

In the United States, degeneration of the retina has left 20,000 people blind and 500,000 people visually impaired. Retinitis pigmentosa is an inherited condition of the retina in which specific photoreceptor cells, called rods, degenerate. The loss of function of these rod cells diminishes a person's ability to see in dim light and gradually can reduce peripheral vision.

Age-related macular degeneration is a disease that affects the center of vision. It rarely leads to blindness but people with the disease have difficulty reading, driving and performing other activities that require fine, sharp straight-ahead vision. The disease affects the macula, the center of the retina.

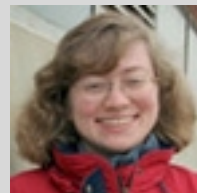
"We have assembled an outstanding interdisciplinary team of scientists, vitreo-retinal surgeons, ophthalmologists and biomedical engineers to attack this important problem," Greenbaum said.

Greenbaum has long envisioned that his group's research in photosynthesis could have an impact on people in terms of energy production and biomolecular electronics. Now, he's especially excited that it could also restore vision to some blind people.

*Submitted by DOE's [Oak Ridge National Laboratory](#)*

## YOUNG FERMILAB RESEARCHER SEEKS A VIEW FROM THE TOP

Natalia Kuznetsova likens the particle physics search for higher and higher energies to scaling the highest peak in a mountain range.



*Natalia  
Kuznetsova*

"Only when you get to the top do you see the full picture," she says, "and the view takes your breath away. I have a thrilling feeling that we are getting closer than ever to seeing the pieces of the puzzle called Nature fit together. This is happening at [Fermilab](#). I wouldn't miss it for the world."

Kuznetsova came from Stanford Linear Accelerator Center to pursue postdoctoral studies at Fermilab on a three-year [Lederman Fellowship](#), "awarded on a competitive basis from among the applicants for first postdoctoral appointments in experimental physics at Fermilab." She spent her first month driving around the site, meeting people and deciding whether she felt she could make a contribution. She had 30 days to make her choice, eventually joining the [CDF collider](#) detector collaboration to work on the highly complex trigger electronics.

"The trigger decides whether or not a given proton-antiproton collision is particularly interesting from a physics point of view," she says. "In Collider Run II of the Tevatron, there will be millions of collisions happening each second, and it will be impossible to record every single one of them. Not only would it require some incredibly fast technology for getting the data out, but the data would fill hundreds of thousands of terabytes (trillions of bytes) of disk space in just one year."

Lederman Fellows must participate in education and outreach efforts as part of their responsibilities, and Kuznetsova has begun with Fermilab's Saturday morning physics program for high school students.

"It was very gratifying to see that the students, especially young women, appeared genuinely interested," she says. "I hope to work on developing a program here at Fermilab would be designed specifically for young girls, to help them see how exciting science can be."

*Submitted by DOE's [Fermilab](#)*