signal to background

151-year-old recording sings for the first time; labs in *Jeopardy!*; fueling up on grass; cosmic rays point to better solar panels; electronic circuits with altitude; letters

Photo-illustration: Sandbox Studio

Physicist revives oldest recording of the human voice

In 1860, Parisian inventor Édouard-Léon Scott de Martinville set out to capture the beauty of a French folk song, "Au Clair de la Lune," using pig hair and soot.

He had a singer croon into a speaking horn, sending sound waves into a diaphragm. This vibrated a stylus—a hair plucked from a pig's ear—that scratched wavy lines into soot-covered paper.

Scott never intended to play back his recording. His apparatus, called a phonoautograph, was meant to preserve only a paper record of sound vibrations; Thomas Edison would not invent the phonograph until 17 years later.

So it was all the more remarkable when particle physicist Carl Haber of Lawrence Berkeley National Laboratory pulled the sound from Scott's soot-covered paper and brought the snippet of song back to life in March 2008. It was the earliest recording of the human voice ever successfully played back.

"It has been a really great way to use physics and technology to impact other areas of society," Haber says of his technique, which sprang from computer algorithms and imaging methods used to design particle detectors for CERN, the European particle physics center.

Giving voice to Scott's recordings is the latest of Haber's contributions to the preservation of historic sound. Currently, he's digitizing and recording turn-of-the-century stories and songs in Native American dialects, some now extinct, that had been captured on 3000 cylinders stored at the University of California, Berkeley.

The challenge is to restore those sounds without damaging their delicate cylinders of wax, foil, shellac, lacquer, or plastic. To do that, Haber takes a 3-D, high-resolution photo of the cylinder's grooves, which reflect various wavelengths, or colors, of light. Each color comes into focus at a different depth, allowing Haber to plot the topography of the area inside the grooves within a fraction of a hair's width.

A computer translates the images into sound pitches and durations. It also filters out damage to reduce static, remove skips, and fill in portions that are chipped, moldy, or worn, creating the equivalent of a retouched photograph.

Haber says that when the US Library of Congress finishes constructing a new center to store the world's sound recordings, he will move his imaging machine there.

You can hear Scott's recording, and others restored by Huber and his colleagues, at firstsounds.org.

Tona Kunz

I'll take particle accelerators for $200, Alex

Knowing accelerator trivia may someday earn you cash and a shot at fame.

During the past few months, the TV quiz show *Jeopardy!* visited Brookhaven National Laboratory in Long Island, NY, and SLAC National Accelerator Laboratory in California to shoot footage for rounds of questions on particle accelerators.

In a twist on traditional quiz shows, Jeopardy! host Alex Trebek gives contestants answers for which they must provide the questions. For example, under the category "Accelerators: Science at Nearly the Speed of Light from the Stanford Linear Accelerator Center," one clue stated: "In the two-mile-long linear accelerator, an electromagnetic wave pushes these particles along, kind of like surfers." The correct question: "What are electrons?"

The show's roving "Clue Crew" filmed video clues eight to 12 seconds long at various locations in the labs.

At Brookhaven, this involved standing in the accelerator tunnel for the Relativistic Heavy Ion Collider, or RHIC, to illustrate how magnets help push particles to nearly the speed of light. The segment has not been scheduled to air yet, but a local TV news report on the filming can be seen at http://tinyurl.com/55zvb9.

At SLAC, the camera crew filmed in the main control room as staffers worked in the background, seemingly undisturbed. But filming in the lab's klystron gallery was not so easy; the buzz from the microwave-generating klystrons that provide power to the accelerator's beam line nearly drowned out the speaker's voice. The episode aired in September; you can find clips at http://tinyurl.com/58r4q9.

What is the sound of discovery, Alex?

Calla Cofield

Photo: Fermilab

Fermilab grasses may thwart damaging greenhouse gases

Michael Miller watches grass grow for a living—super grass, of sorts, grass that could fuel a car and reduce carbon dioxide emissions at the same time.

He and other researchers from Argonne National Laboratory and the University of Chicago have turned 13 acres at Fermilab into an outdoor laboratory. Their goal is to find the best ways to use native prairie grasses to attack the global warming and fuel crises.

"I believe nature has given us a lot of variety to work with," says Miller, a senior Argonne scientist. "It is just identifying those traits that fit best with what man needs."

Miller and his colleagues are studying seven combinations of prairie grasses, including plots of switchgrass and big bluestem planted in June as well as native grasses that thrive on Fermilab's restored prairie.

He's trying to determine which factors produce the most durable, bountiful grasses for use as fuel. He'll also determine their carbon footprints, balancing the amount of carbon needed to grow the plants and turn them into fuel against the amount of carbon they sequester, or store, in the soil as their roots die and decompose.

By the end of 2009, Miller and his team hope to have a clearer picture of which combinations of grasses would create the most efficient, environmentally friendly feedstock for fuels.

Switchgrass already has known advantages over corn as a feedstock for biofuels. It grows four to eight feet tall in dense patches across the Midwest, flourishing in areas not normally tilled for crops. The grass needs replanting only once every decade, can grow with little or no fertilizer, tolerates drought, and sequesters the same amount of CO_2 that would be released by burning it for fuel. That makes the production of fuel from switchgrass carbon neutral or even carbon negative.

Even if native grasses are not harvested for fuel, they still provide a benefit by trapping greenhouse gases. Miller says 900 acres of Fermilab prairie store as much carbon dioxide in soil as 250 compact cars emit in a year.

"What we are trying to do is take advantage of our prairie system," Miller adds. "Fermilab's long history of maintaining and restoring the prairie gives us a lot of knowledge about the grasses."

Tona Kunz

Pierre Auger tests solar technology

As the Pierre Auger Observatory in Argentina collects cosmic rays for science, its thousands of solar panels are collecting data that could make solar power cheaper, more efficient, and more reliable.

Pierre Auger is "a fantastic experimental test," which is the best in the world right now for solar panels and their batteries, says Angeles Lopez Aguera, dean of physics faculty at Santiago de Compostela University in Spain. "Industry never, never will be able to have this large an amount of experimental data."

Spain is a global leader in the production and design of solar panels and home to the 11 biggest photovoltaic power plants in the world (see image below). Much bigger plants are on the drawing board worldwide, including a 550 MW installation proposed in California that would generate enough electricity for roughly 550,000 homes.

Battery outages in these large solar parks can take two weeks to reach and repair. Reliability is also an issue for solar panels in remote areas, from isolated villages in developing countries to the Colorado site where a second Pierre Auger Observatory is planned.

So Santiago University is working with two Spanish corporations—including ISOFOTON, the second-largest producer of solar panels in Europe—to monitor the performance of the 3320 solar panels that power Pierre Auger's detectors, which are scattered across 1200 square miles of semi-arid pampas. Spain provided most of the solar panels and Brazil most of the batteries as their contributions to the international observatory.

The companies hope the 70 million bits of data the panels provide each year will help them produce solar panels and batteries that last longer, withstand long periods of extreme temperatures, better respond to peak power needs, and optimize the amount of sunlight converted to electricity.

Researchers recently created a prototype "intelligent" regulator for the solar panels that will be tested in Spain and at the Colorado observatory. The regulator will sound an alarm when a battery is about to go out so it can be replaced, avoiding power outages and optimizing the life spans of batteries.

"This is important for Pierre Auger, that is clear," Aguera says, "but it is also important for the big solar parks."

Tona Kunz

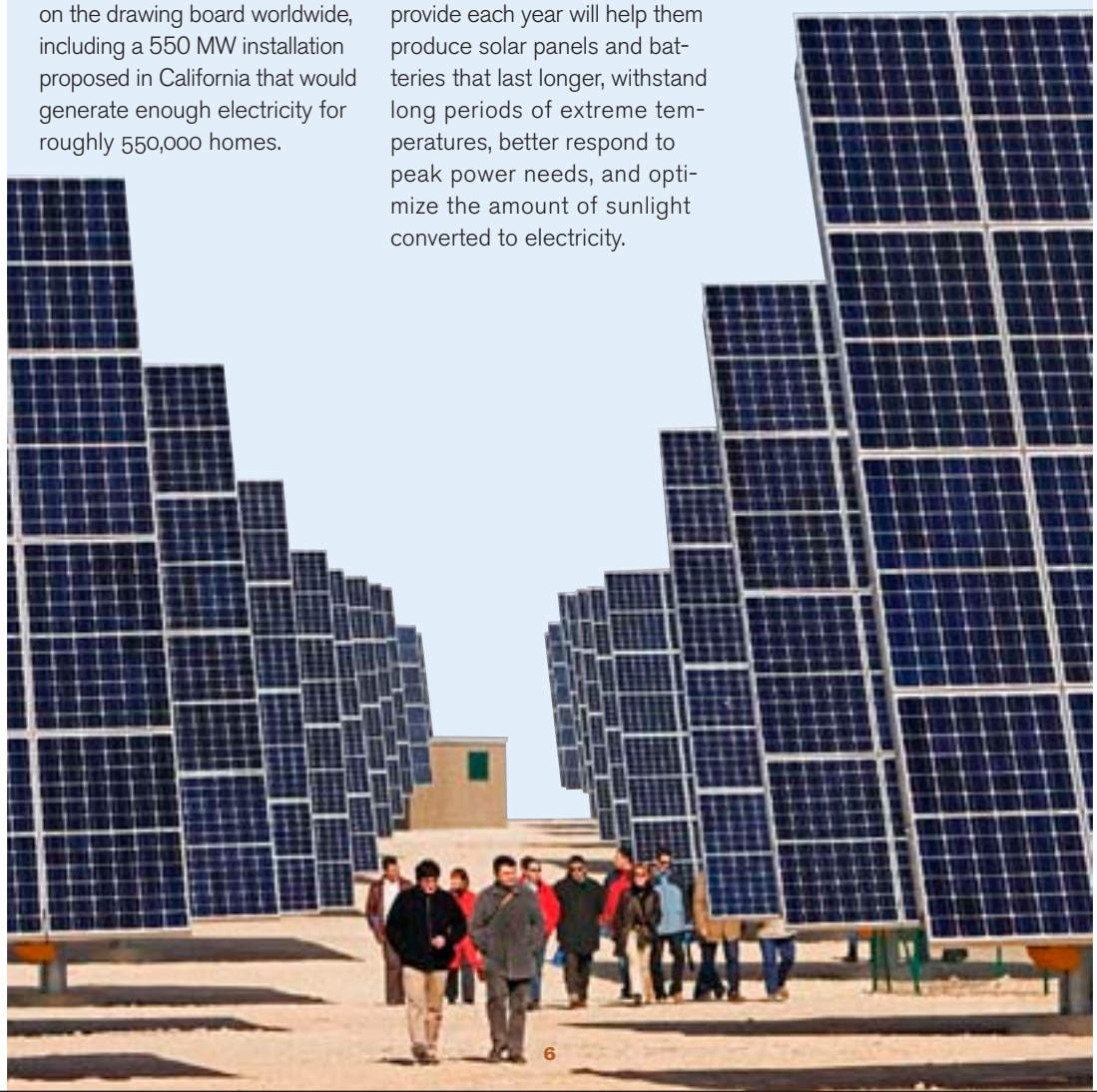


Photo courtesy of Acciona Energia

Labs and industry perfect 3-D chip

High-tech businesses must constantly innovate or become obsolete. But when it comes to investing in new machinery and adopting new techniques, industry can be timid, says Bob Patti, chief technical officer of Tezzaron Semiconductor.

That's where research laboratories come in. Freed from market constraints, they can afford to break new ground and demonstrate that an innovative technology works. Companies can then adapt the technology, with minimal risk, for products with mass appeal.

In this case, Fermilab has recruited more than a dozen other research labs to work with Tezzaron to develop three-dimensional computer chips.

Fermilab has been working on 3-D chips since 2006 as a way to make detectors that track particles coming out of high-energy collisions more precise and compact. Now it hopes to use industry's economy of scale to accelerate the production of the new chips.

Tezzaron benefits by sharing the cost of developing new prototypes and by demonstrating to potential customers that the 3-D chip is cost-effective.

Once companies see others out there using a new technology, "they feel more comfortable placing bets on it," Patti says.

For almost a decade, Tezzaron has been developing 3-D chip technology to give devices such as cameras and cell phones more memory and to improve the speed and energy efficiency of information processors.

Traditional integrated circuits are flat and connect at the edges like tiles. "They were like one-story buildings built on different lots," Patti says.

In the late 90s, companies began stacking the flat chips and connecting them at the edges like buildings with multiple stories—but with no way for electrical currents to move up and down, aside from outdoor fire escapes.

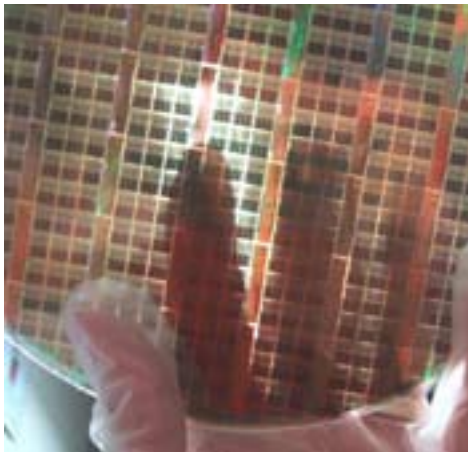


Photo courtesy of IBM

In today's 3-D circuits, wires run directly from one layer to the next, a shorter distance that uses 40 percent less energy.

"We're installing elevators," says Gretchen Patti, a member of Tezzaron's technical staff.

Working with research laboratories pushes the company to improve its product, she says.

"If you're working with a client who is not afraid to push the envelope," she says, "you're more likely to come up with something better than expected."

Kathryn Grim

letters

Unfair dice

I enjoy the magazine very much, but must register my complaint about the illegal dice depicted on the rear cover of the March/April 2008 issue. The opposite faces on each legal die must add up to seven, obviously not possible with those on the cover unless they have really been "doctored." Anyway, don't shoot craps with this guy!

Nils I. Larson

After sifting through the 14 dice on the back cover of the March/April 2008 issue, I discovered and confirmed that ten of them are very rare indeed. Or at least they are rare in any legitimate gaming house. As shown, these ten dice could dramatically change the outcome of the game, but would definitely affect the user's ability to roll again, if caught using them.

Guy R. Martino

Antimatter novels

I'm surprised that William Higgins' brief article about antimatter in science fiction (September 2008) ended so abruptly, especially without any reference to Jack Williamson's *Seetee Ship* and *Seetee Shock*. I've enjoyed those two so often that the pages are falling out, needing glue for rebinding.

What's great about your article is it reminded me about my favorite sci-fi topic, which I've overlooked for some time. I've been busy re-reading my A.E. van Vogt collection.

Now I need to check eBay for other antimatter novels, as well as the missing van Vogt books I'd planned to repurchase!

Walter P. Kraslawsky

Highlights from our blog

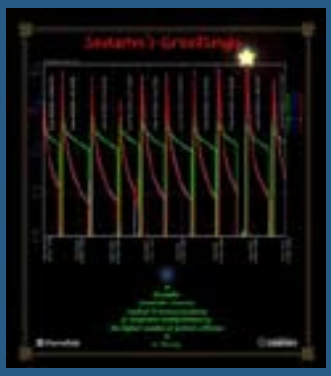
Project X collaboration forms, project moves forward

December 18, 2008

Project X, a Fermilab-hosted international accelerator facility, could break ground as soon as 2013. Accelerator experts from around the world gathered at Fermilab last month to work toward establishing a formal collaboration and further plans for Fermilab's proposed proton accelerator.

Physics lab holiday cards

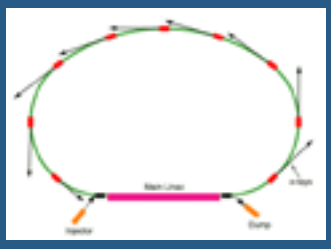
December 18, 2008



A tradition in many organizations is to send out a holiday card. With the near ubiquity of the Web among lab audiences, many of these cards are solely electronic, leaving the wood that would have gone into cards for Christmas trees or other uses! Here is a selection from a few science organizations, showing the usual geeky tendency to incorporate some kind of scientific imagery as a visual metaphor.

Energy recovery linac demonstration successful

December 16, 2008



An ERL is a combination of a linear accelerator and storage ring with a few twists thrown in to make the machine incredibly efficient. They allow particle acceleration at much lower power use for the facility, or much higher-energy acceleration for the same power use. Now one has been shown to work at Accelerators and Lasers In Combined Experiments, or ALICE, at the Daresbury lab in Cheshire, England.

In person at Nobel week in Stockholm

December 12, 2008

A guest essay from David Hitlin, Caltech physics professor and founding spokesperson for the BaBar collaboration at SLAC National Accelerator Laboratory, recounts the celebrations and festivities of the Nobel week in Stockholm, where he attended the ceremonies as a guest of Makoto Kobayashi.

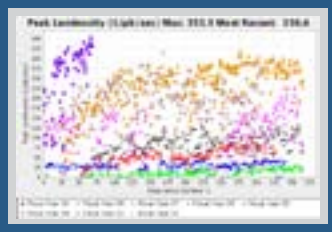
Do neutrinos and antineutrinos behave differently?

December 12, 2008

Stretch out your hand, and a trillion neutrinos cross it within three seconds. Yet little is known about these invisible particles. Scientists do know that neutrinos have mass and that they can morph from one type into another—a process called neutrino oscillation. The MiniBooNE collaboration at Fermilab has a preliminary result that sheds more light on neutrino oscillation. This is the collaboration's first result with antineutrinos, the antiparticles of neutrinos.

Another record! Tevatron accelerator surpasses expectations repeatedly

December 11, 2008



In the past five years, Tevatron's, luminosity—the number of collisions per second—has increased six fold. In the last six weeks alone, overall luminosity has improved 10 percent, generating more than a dozen luminosity records, sometimes multiple records in one week. Just since October, the Tevatron has had nine of the top 10 stores in its history.

Lights, camera, render

December 9, 2008

A red plume of hydrogen gas streams in three dimensions across a movie screen that almost spans the width of a dark conference room. Within the plume a brilliant white spot forms. The spot expands and quickly explodes into an orange and red cloud. Soon this cloud dissipates and a new bright dot grows elsewhere on the screen. In less than a minute, the movie has told the story of a young galaxy forming.

Flat Children visit labs by mail

December 8, 2008

Hand-drawn by 8-year-old Johnny, Flat Johnny took a tour of the Large Hadron Collider with researcher Sarah Demers. Flat Maya did the same with SLAC's Travis Brooks.

Free multimedia education material on particle physics, accelerators

December 4, 2008

If you want to explain particle physics, accelerators or colliders to friends, family, students, or others you encounter, you won't want to miss this Web site. The University of California, Santa Barbara has announced the winners of a contest to make particle physics accessible in high school classrooms. You can see them at www.kitp.ucsb.edu/

Should you care about particle physics or the Higgs boson?

December 2, 2008

In an era of tight budgets, why care about basic research—science done for knowledge's sake? The documentary *The Atom Smashers* put the question on the screen and drew some compelling answers.

The Panofsky turkey constant

November 26, 2008

Just in time for the Thanksgiving holiday, Nicholas Panofsky shares a flavorful tidbit of Panofsky family lore with the precise equation for determining the cooking time for a turkey.

Gorgeous physics photos from the *LIFE* archives

November 19, 2008

The archive released by Google yesterday contains a number of gems, from Einstein's messy desk to a 1939 cartoon from a Berkeley cyclotron bulletin board, portraits of famous physicists, and a chain of nails.

Particle physics gives boost to areas of Latin American

November 18, 2008

In the quest to improve the quality of life in developing countries, people focus on key barometers of affluence, such as literacy rates and affordable food supplies. Few think of high-energy physics as a grassroots growth engine. But it can be. A good example is the Pierre Auger Observatory in Malargüe, Argentina, a rural area of isolated ranches nestled at the base of the Andes.

You can find the full text of these and others at www.symmetrymagazine.org