Bubble chamber technology, at its prime in the 1960s and 1970s, is back in business; bouncy bison babies are a sign of spring; reports on neutrino experimental results earn top citations in the last 10 years; synchrotrons breathe in the sun; letters.

Photo: Jim Shultz, Fermilab

Roger Hildebrand in 1955, holding a bubble chamber. *Source:* University of Chicago Magazine, *April 1955*

Bubble chambers are back

Bubble chambers, once at the forefront of particle detection and then relegated to the history books, are coming back. On March 28, 2005, researchers at Fermilab and the University of Chicago lowered the first of a new generation of bubble chambers into the MINOS gallery at Fermilab in an effort to detect elusive dark matter. Juan Collar and Andrew Sonnenschein of the University of Chicago, in association with Fermilab's Mike Crisler, designed the compressed, CF_3I-filled chamber, which is about the size of a bowling ball (photo above). Giving encouragement along the way was Roger Hildebrand, a pioneer of bubble chamber technology in the early 1950s (left).

The first bubble chamber, filled with highly volatile ether, was made by Don Glazer of the University of Michigan. "How he didn't blow himself up I'll never know," said Hildebrand, who took the first photograph of a nuclear reaction via his pencil-case-sized bubble chamber. Hildebrand's team at the University of Chicago built ever-larger chambers as particle detectors, until the use of spark chambers and other devices became widespread in later decades.

Now 83 years old and with four grown children, eight grandchildren, and two great-grandchildren, Hildebrand is investigating far-infrared astronomy and has no plans on slowing down. Is he trying to outdo his father, a renowned chemist who worked though his 90s? "I haven't set that as a goal," he chuckled. "I'm just curious about how nature works, and I'm trying to do the best job I can."

Eric Bland

Frolicking bison

As spring arrived, so did the kids. Their knees wobbly and eyes wide open, they stayed close to their moms. Dad, weighing more than 2500 pounds, made sure that no harm came the babies' way.

Fermilab's herd of bison welcomed its first new family member before crocuses broke the ground and daffodils opened their flowers. By the end of April, about 25 calves were born. Within a couple of days of birth, the little beasts were brave enough to run around, while the adults slowly wandered across the pasture. Looking at the massive grownups, who would have guessed that the little ones could be so bouncy?

Fermilab has been home to bison for more than 30 years. Founding director Robert Wilson introduced the first seven animals from Wyoming and Colorado, bringing a symbol of 19th-century Illinois back to the grounds. Today, the buffalo, as they are commonly called, are as much a part of Fermilab as Wilson Hall and the tall-grass prairie.

Every year, thousands of visitors come to see the animals. But the fling with youth only lasts through the summer. By fall, the calves' hair will have turned dark brown, marking the transition into adulthood, and their frolicking will have stopped. For many of them it will also be the time to say good-bye: farmers from across the Midwest will be bidding for the animals at a silent auction.

In 1889, only 600 bison remained in North America. Today, more than 200,000 roam the continent.

Kurt Riesselmann

The decade of the neutrino

Speaking experimentally, the past decade has been the "Decade of the Neutrino." It produced neutrino experiments across three continents, going from the lab, to the nuclear reactor, to the atmosphere, to the sun, and back to the nuclear reactor. Along the way the experimental results modified the Standard Model of particle interactions, opened a window to "new physics," and broke (and then fixed) the Standard Solar Model. Perhaps no other particle has led us on such a rich and varied journey.

SPIRES, the high-energy physics literature database, identifies 13 scientific papers with over 500 citations in the high-energy physics experiment e-print archive, *hep-ex.* Nine* of the 13 papers have been about neutrino experiments. (The

Photos: Reidar Hahn, Fermilab

others include three papers on the discovery of the top quark at Fermilab, and one on the measurement of the muon anomalous magnetic moment at Brookhaven National Laboratory.) Neutrino papers also account for all five* of the top-cited nuclear physics experiment (*nucl-ex*) publications.

Of all neutrino experiment publications (*hep-ex* and *nucl-ex*), the top-cited paper belongs to the Super-Kamiokande collaboration, based in Japan. Cited more than 2300 times, the paper presents evidence for the oscillation of atmospheric muon neutrinos. Second place goes to the Sudbury Neutrino Observatory (SNO) in Canada. It rescued the Standard Solar Model by finding evidence for muon and tau solar neutrinos, which were essentially undetectable by Super-Kamiokande. Third place belongs to the CHOOZ collaboration, based in France, for its report on seeing no mixing for electron antineutrinos in a reactor-based experiment. Other top-cited experiments include KamLAND (Japan) and LSND (Los Alamos).

Heath O'Connell, Fermilab

* *Full details of the papers are online.*

Breathing accelerator

As the sun rises each day, warming the grounds and buildings of the Stanford Linear Accelerator Center, the entire SPEAR3 synchrotron facility (photo) expands in response. The change is minuscule, on the scale of a few microns—far too slight to observe with the naked eye. But this expansion doesn't escape the watchful gaze of the SPEAR3 feedback regulation system. In fact, the system responds by "breathing" in time with daily fluctuations in temperature.

As the infield area and the shielding tunnel of SPEAR3 heat up and expand radially, the lattice of magnets that keeps the beam focused expands with it. Hence the beam becomes slightly displaced in relation to the magnets.

In order to keep the beam centered, the beam must be expanded in circumference. To achieve this, an array of beam position monitors (BPMs) precisely measures the displacement of the beam and relays the information to a feedback system.

"The BPMs signal that the beam is not where it's supposed to be," explains Jeff Corbett. "The beam circumference is set by radiofrequency, so the feedback system adjusts the radiofrequency to keep the beam centered in the BPMs."

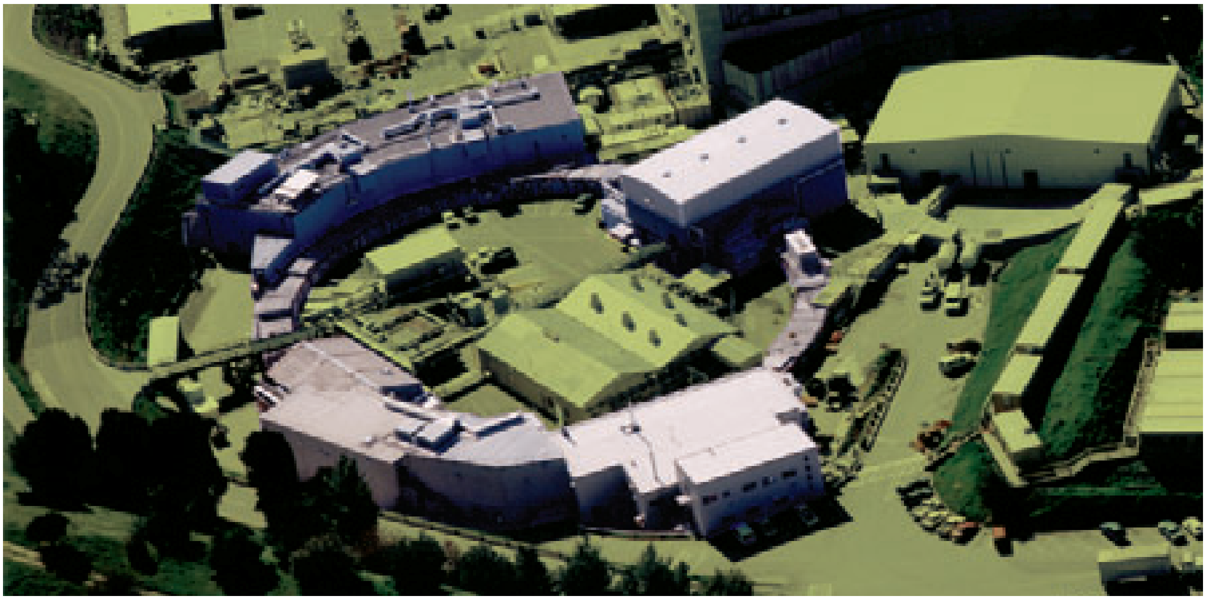
The feedback signal from the BPMs cycles every six seconds. While the sun is rising and SPEAR3 is expanding, the radiofrequency drops by about half a hertz. Then, as temperatures begin to cool off in the early afternoon, the radiofrequency rises again as the building contracts.

Recent plots of the daily frequency shift confirm the pattern. Corbett expects to see a similar effect in response to the change in seasons over an annual time scale.

"The effect is roughly proportional to the circumference of the machine," Corbett says. With a bigger machine, a bigger shift in frequency is generally observed. According to Corbett, the LEP ring at CERN, Geneva, and the Advanced Photon Source, Illinois, have even been observed to breathe in circumference due to gravitational effects of the moon.

Matthew Early Wright

Photo: SLAC



Letters

Don't forget the universities

Great article on the LHC and the US involvement (April 2005)—very complete and well presented. As usual, a nice job with the *symmetry* issue.

I'd like to comment on the sentence, "The United States contributes high-tech accelerator and detector components, developed and built by US national laboratories with some help from industry." While very true, we don't acknowledge here—as part of these projects—the incredibly important US university contribution! I have found myself guilty at times (inexcusably) of having "DOE National Lab" blinders on when talking about this project, but the efforts of approximately seventy US universities across the country on ATLAS and CMS, in collaboration with the four DOE national labs involved, needs to be clear. Aside from being most of the end "users" (doers, really) of the experiments, the universities are much more (as we and they know). Pick your state or region and you'll find a university that has contributed directly through their physics, engineering and technical staffs to the CMS or ATLAS detector design, development, fabrication, and testing at their institutions, and now in the detector installation and pre-operations work at CERN.

As part of the Federal oversight of the US LHC Project, I have been both privileged and impressed in my visits to a number of these universities during the construction work to see first-hand the facilities, capabilities and results from this effort. Scientists and students at every possible career stage (from high school/undergrad to senior scientist) have made the overall collaborations and detector construction possible. There are unique and important stories associated with many of these institutions, for example, from the work of students at Hampton University (a historically black college) building ATLAS transition radiation tracker modules, to the conversion of a pasta noodle shop near Notre Dame University into a lab for processing fiber optic cables and waveguides for CMS hadron calorimeter read-out.

Pepin T. Carolan, DOE/NSF US LHC Project Office, Batavia, IL

North vs. South

Editor's note: Our error regarding the location of the Homestake mine elicited the following response.

In your March 2005 article about deep underground labs you write "…negotiations over the transfer of [Homestake] mine ownership to the state of North Dakota foundered…" I write to point out the obvious reason why this occurred. Your map correctly shows the location of the Homestake mine in South Dakota. My experience as a North Dakota native suggests that North and South Dakota exist in different parallel universes between which exchange of matter, energy, or information is extremely rare.

Don Langenberg, College Park, MD

Smoking mouse chased by Schrödinger's cat?

After reading "The Smoking Mouse" in the March issue of *symmetry,* I believe I may be able to offer a viable theory to explain how the creature obtained entry into a seemingly impregnable H-spool magnet. While scampering through Fermilab, the mouse performed an observation that collapsed the wave-function of Schrödinger's cat, determining with 100 percent certainty that the cat was alive (since it had given up playing with a bit of string theory and was preparing to pounce). In the ensuing chase the mouse calculated that the probability of escape was so slim that, in desperation, it resorted to quantum tunneling, thus penetrating the steel box and ending up safely inside. Later, mistaking the technician for the cat, it tunneled out, and so was never directly observed. Admittedly, the matter of the chewed bird head isn't explained by this theory, but until a larger set of mouse evidence is gathered I think it can safely be dismissed as an observational artifact or anomaly.

Chris Paul, Sackville, New Brunswick, Canada

Editor's note: Despite the suspicions of many readers, The Smoking Mouse *was not an April Fool joke. The story has spread through the world thanks to additional distribution by newswire services.*

Letters can be submitted via letters@symmetrymagazine.org