signal to background

Delicate detector surgery; walking in the dark; dark matter song; flying across Antarctica to catch particles; big bang re-enactment; letters.

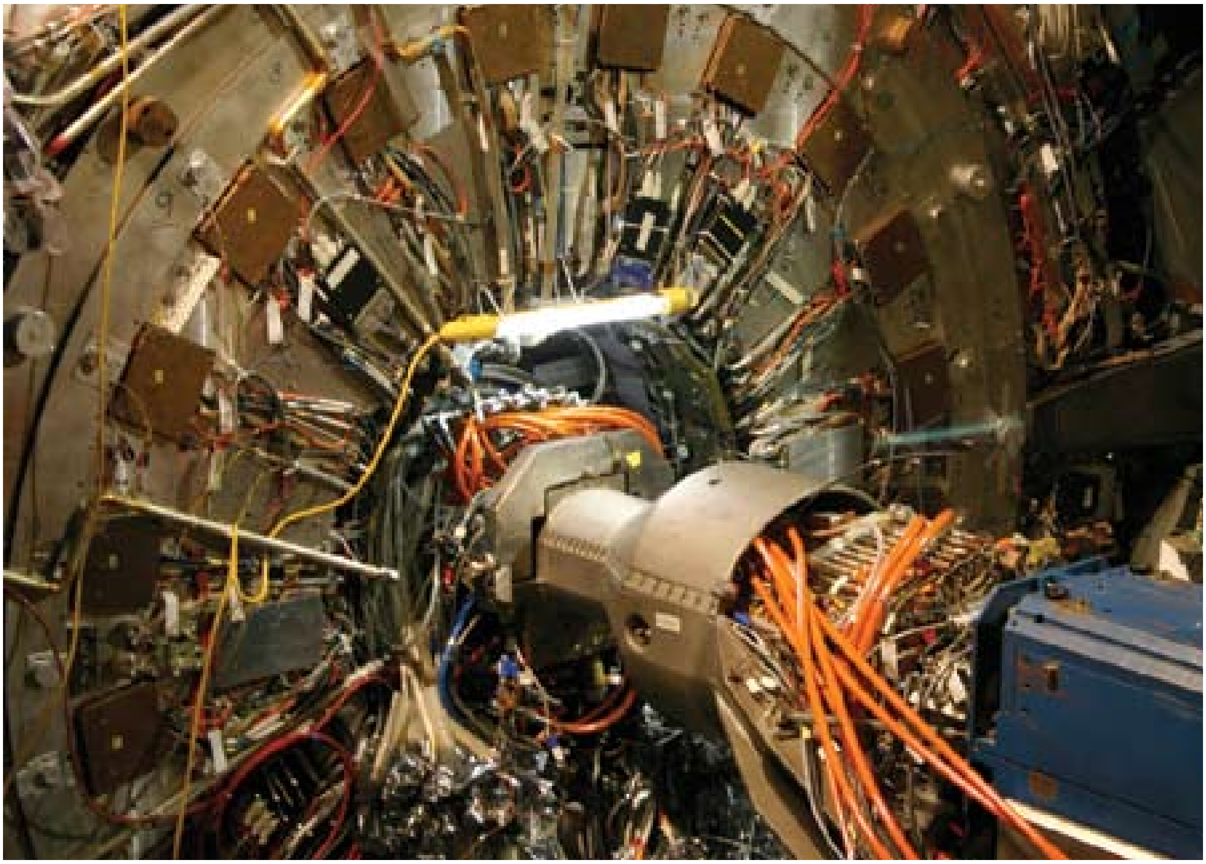


Photo: David Harris

Engineering big upgrades

How do you renovate a delicate, irreplaceable detector? Very carefully.

During the last four months of 2006, the BaBar collaboration at SLAC successfully replaced a prematurely aging muon identification system. Creative and solid engineering played a big role in upgrading a detector that wasn't meant to be taken apart.

Jim Krebs, BaBar's chief engineer for mechanical operations, spent five years on the project. "We had to figure out how to take everything apart."

In August, crews opened the doors that protect the three-story-tall detector, exposing five layers of detection instrumentation and a nervous system of wires and cables. Graduate students disconnected and then lovingly tied, bundled, and organized the thousands of cables that blocked the way to the muon identification system.

To access the outermost layer of the detector where the muon system resides, the mechanical operations crew used thousands of crane lifts to remove several layers and many tons of steel, including critical pieces where the support arms for the calorimeter detector attach. Protecting the calorimeter was one of the toughest engineering challenges, and required suspending 44,000 pounds, about half its weight. The support scheme performed flawlessly.

Early engineering efforts went into building a special lift to tackle the difficult job of pulling out the old muon detectors and feeding the new ones into narrow slots angled at 60 degrees. The lift fit alongside the front end of the detector with only inches to spare, sandwiched between the beam pipe that pierces the center of the detector and the opened door. The new muon detectors come on one-inch-thick, 12-feet-long flexible sheets. Standing on the lift's platform, crews used the built-in angled tray to help hold the long, delicate sheets in position for insertion.

When everything was put back together and the detector doors closed again, many people let out sighs of relief. Opening the detector required taking a calculated risk because not all of the earthquake protection could stay in place. Now, the refurbished detector is taking data again.

Heather Rock Woods

Walking in the dark?

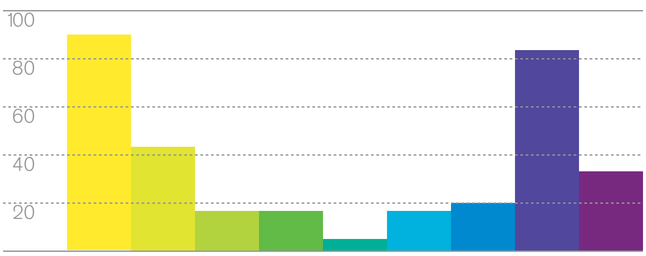
I have been attending hundreds of talks by particle physicists who look for a very specific experimental signature that is predicted by a very specific theory extending the Standard Model. However, I was curious how much faith my colleagues have that what they're looking for can be real. So I asked them in an informal poll.

The chances of certain discoveries looked very low to me, and it seems that the voters agree. The Standard Model Higgs received 90 votes and for many voters was a second tick-mark. (Voters could check multiple answers.) Other potential discoveries received far fewer votes. Supersymmetry, a great "favorite" for some physicists, got only 46 votes. The moral of this, for me, is that unlike the early 90s, when we knew what we were looking for—the top quark that had to be there—now we are walking in the dark.

Something must exist to play the role of the Higgs, but we can only try to guess right now. None of our guesses can be taken very seriously. What will guide our theories will be experimental data. At this point, it makes all the sense to search for the "unknown" in our data. The good thing is that whatever is to be found next, it will be very exciting; even more so than the top quark was.

Georgios Choudalakis, MIT/Fermilab

What kind of physics do you expect to be discovered at LHC?



		Answers	Votes
1		Standard Model Higgs	90
2		SUSY	46
3		Extra dimensions	18
4		Compositeness (excited quarks, leptons, gauge bosons)	18
5		Leptoquarks	5
6		New strong dynamics (technicolor)	18
7		Other, that is not included in this list but has been proposed.	20
8		Other, that would surprise everyone.	82
9		I expect no new physics	34

Answers were taken through the fnalgrads@fnal.gov mailing list, which reaches graduate students, postdocs, and professors. Each person was able to vote for more than one choice. Voter's IP addresses were recorded to prevent them from voting for the same item twice.

Dark Matter Rap

I first heard of dark matter at a Moriond Conference in 1987. A guy named David Spergel had the idea that if dark matter was weakly interacting massive particles (WIMPs) they would be captured gravitationally by the sun and cool it enough to explain why Ray Davis only observed 1/3 of the expected number of neutrinos. I think he named them "Cosmions", but WIMP sounded much better.

My PhD thesis was a big germanium detector designed to look for a type of nuclear reaction called double-beta decay but it turned out we could also look for WIMPs. I spent about a month driving to and from the Gotthard Tunnel in Switzerland where we could reduce the background noise enough to detect dark matter if it was made of heavy neutrinos. Daniel Reusser continued after I left and in 1989 published a paper that showed that dark matter could not be made of neutrinos unless they had a mass of more than about 1 TeV, far higher than what is now known to be the case.

For a long time, I thought dark matter was just something that was cooked up to explain the solar neutrino problem and galactic rotation curves. It was not until I heard David Weinberg's *Dark Matter Rap* that I understood what a long and important history dark matter has had in astronomy. I actually learned much of what I know by reading the papers mentioned in Weinberg's song. I also learned about astronomers who care more about "How much? Do we need it? Where is it?" than what dark matter actually is.

Peter Fisher, MIT

Read the text of the Dark Matter Rap *and listen to an mp3 recording on the* symmetry *website.*

Photo: ANITA collaboration

ANITA takes flight

A one-time visitor to SLAC, the Antarctic Impulsive Transient Antenna (ANITA), recently took to the frigid skies over Antarctica on a mission looking for evidence of cosmic-ray neutrinos.

On December 14, 2006, scientists tethered the 20-foot-tall probe to a high-altitude helium balloon and released it into the atmosphere. ANITA circled the south polar continent three and a half times at an altitude of more than 100,000 feet—three times as high as a passenger jet. The probe's array of antennae was tuned to scan for the radio signals that are produced when cosmic-ray neutrinos strike the Antarctic ice below. ANITA landed nearly 1100 miles from the original launch site on January 19, 2007, after 35 days aloft—the second longest duration for a scientific balloon flight in history.

Before traveling to Antarctica, ANITA first got its bearings during calibration tests at SLAC. In early June 2006, a team of collaborators tuned the antennas with a series of experiments conducted in End Station A using a 10-ton block of ice to simulate the Antarctic environment. Researchers then blasted the ice with pulses of electrons, producing a cascade of radiation called Čerenkov radiation, which included both radio waves and visible light.

Brad Plummer

Berkeley Band re-enacts the big bang

The world, by some accounts, was created in seven days. Not to try and top that, but a university band managed to re-enact the big bang in a period of less than an hour.

The band was recruited by University of California, Berkeley, astrophysicist George Smoot for a "creation" role in the Nobel Prize ceremony in Stockholm, Sweden, at which he was presented the Nobel Prize in Physics for findings confirming the big bang theory. Back in November, Smoot asked the Berkeley band for help in filming a video to be shown during the Nobel festivities on Sunday, December 10, 2006.

"Professor Smoot came up to the band and asked if later that week, when we practiced at Memorial Stadium, we could do a formation like the universe forming. He wanted the band to form up a blob and re-enact the big bang. That's what he asked," marveled Hanadi Shatara, the band's public relations director.

Not long after, Smoot addressed the members of the band, assembled in a modified blob midfield at Memorial Stadium. "It's a little more complicated than 'Go Bears,' but it's just as important!" said Smoot, grinning ear to ear.

Smoot mounted the tall ladder ordinarily used by band director Robert Calonico and delivered a short course in how the universe was created. "Now, I gotta tell you what the big bang is, so you guys can do this before the sun goes down… We're going to simulate a really smooth, hot, dense, early universe and spread out, and we're going to form structure—galaxies, stars, planets, and everything else," he explained. "Let's go for it. Go Bears! Go band!"

A marching band simulate the big bang? Mellophonist Jason Lo spoke for the band: "We can do this!"

Smoot continued with the cosmological choreography. "There's a brass section out there called tubas. They make a real spectacular spiral galaxy, a really big one like our own galaxy, or like Andromeda. You guys get to be near the middle, but you get to orient, and get to rotate with a twist up. You're like the centerpiece of all this. Go tubas!"

A member of the Swedish television crew filming this event said he had one question before the band began its rendition of the big bang. "What starts the big bang?" he asked.

Simple, said Smoot. "Drums!"

Jeffery Kahn, University of California, Berkeley

A video of the performance can be seen online at http://tinyurl.com/yhe23j

Illustration: Sandbox Studio

Letters

Dorm life

I found it fitting that the picture from Fermilab in the article about dorm life (Oct/Nov 2006) came from an ultimate frisbee game. In the summer of 2000, I came to the Fermilab dorms as an undergraduate from Bucknell University to work on MiniBooNE and I ended up working on my ultimate frisbee game every single afternoon. We had a huge group of players all thanks to the organizing and advertising done by Melanie Novak, also from Bucknell. We had tons of fun and even challenged Argonne National Laboratory to a friendly inter-laboratory tournament. I am very glad to see that the ultimate games have continued at Fermilab.

Jeremy Urban, Cornell University

I am writing concerning your article in the October/November issue about dormitories and guest houses at labs everywhere. I realized that I have stayed in such accommodations at 11 different institutes: IHEP Protvino, Moscow Radiotechnical Institute, Manhe Siegbahn Laboratory (Stockholm), DESY, CERN, Brookhaven, Jefferson Lab, Fermilab, ANL, TRUIMF, and KEK. I wonder how my list compares with those of other frequent travelers?

Peter Lucas, Fermilab

Make some noise for whispers

I love the "Whispers of dark matter" article (*symmetry*, Dec 2006). The metaphor of listening for vibrations is wonderful, and the illustrations guide you through our magical world of dark matter with their lucidity.

Ben Kilminster, Ohio State University

A present for the future

During the majority of my 57 years of existence, I've waited with the anticipation of a child on Christmas Eve for the truly exciting discoveries that have been and continue to be made. Whether from deep space, quantum mechanics, or particle physics, they remain important towards expanding our understanding of not only who we are, but what we are.

Twenty years ago, at the age of 6, my daughter was shown a cyclotron housed in the University of Rochester, NY, where we lived. She was taught how to pronounce the word, given a basic explanation of what it did and has never forgotten the moment. I am up to date with the news that Fermilab releases on its Web site and find it absolutely incredible!

In view of what's being discovered, I believe it is vital that scientists be sufficiently funded in order to continue exploring these fundamental building blocks.

I wish I were young enough to see the outcome of these fantastic experiments and I hope the government and private sector keep up the funding so perhaps my daughter may. Thanks for the great write-ups.

Michael Giambra, Reno, NV

Corrections

Our article on lightning at Fermilab (*symmetry*, Oct/Nov 2006 issue, p. 4) incorrectly gave an energy value. Cloud-to-ground lightning bolts typically cross a voltage of 100 million volts.

The insulating vacuum of the ILC test cryogenic vessel (*symmetry*, Oct/Nov 2006 issue, p. 26) typically has a pressure of only 10^{-5} to 10^{-7} torr to avoid heat leaks.

Letters can be submitted via letters@symmetrymagazine.org