FERMI NEWS

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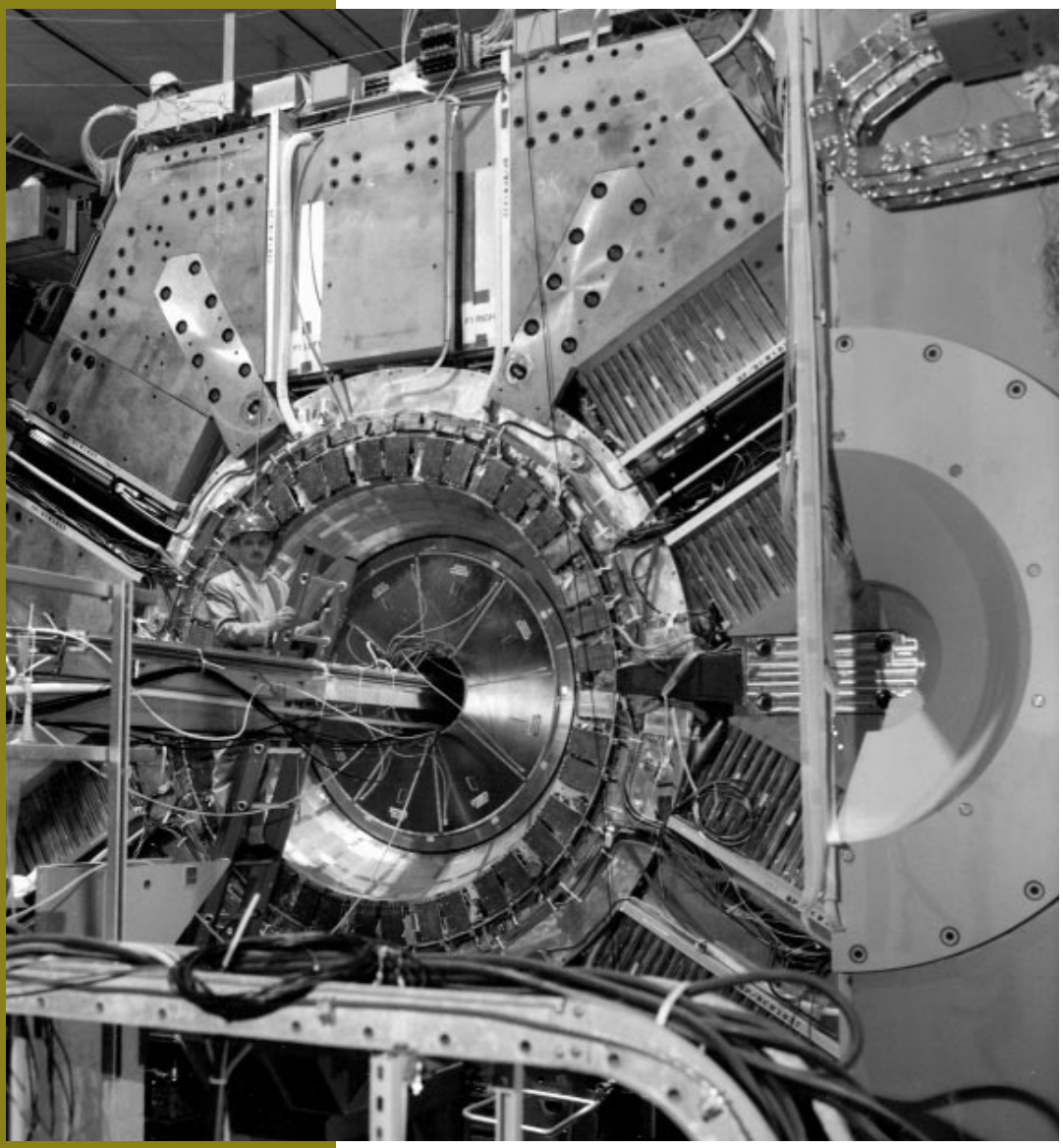

Photo courtesy SLAC

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INSIDE:

BABAR AND BELLE HIT THE BIG-TIME

by Kurt Riesselmann

BaBar and Belle took center stage recently in the long-running drama, "The Search for CP Violation." They showed why they are hot box-office draws in exploring the differences in behavior between matter and antimatter, as they reported their first results on July 31 at the International Conference on High Energy Physics in Osaka, Japan.

Both BaBar, using electron-positron collisions at Stanford Linear Accelerator Center's Pep II collider, and Belle, also using electron-positron collisions at Japan's KEK laboratory, announced that their early data indicate signs of CP violation in B mesons, particles containing a bottom quark or anti-bottom quark. Their findings add luster to B physics as the next big show in CP violation, after 35 years in which the only show in town has been the kaon, a particle containing a strange or anti-strange quark. The BaBar and Belle findings show large statistical errors, but the experimenters know they'll have lots of chances to polish the script.

"We are encouraged that we will have some very good physics results by the end of our current run in October," said SLAC Director Jonathan Dorfan. Hiroaki Aihara, spokesman of the Belle collaboration, added that the Japanese collaboration would resume data taking in October and continue until the summer of 2001.

"It's most gratifying to see how well the PEP II collider and the BaBar detector are working," added Dorfan, former project leader of the PEP II construction at SLAC. "Having been involved in the design, construction and commissioning, I can't tell you how pleased I am that the whole process has gone so smoothly. It's a real credit to two exceptional teams: The SLAC, LBNL and LLNL builders, commissioners and operators working on PEP II, and the nine-nation BaBar collaboration."

CP violation was postulated in the 1960s by the late Russian physicist Andrei Sakharov, seeking to explain why more matter than antimatter existed in the universe after the Big Bang. In 1964, recreating some of the particles that were abundant at the beginning of the universe, high-energy physicists James Cronin and Val Fitch observed CP violation in processes involving kaons, which brought them the Nobel Prize in 1980. Now physicists are on the verge of proving that B mesons, which are 10 times heavier than kaons, also exhibit CP violation.

Early in 1999, the CDF collaboration at Fermilab made a splash with a significant observation in B mesons. The Fermilab production will continue when Collider Run II of the Tevatron begins in March 2001, with major upgrades in both the CDF and DZero detectors.

They'll all be in pursuit of a measure for CP violation called sin2ß (pronounced *"sign two bayta"*), the trigonometric function of a mixing angle whose value can range from –1 to 1. Experimental results obtained during the last three decades, together with theoretical calculations, suggest

Photo courtesy SLAC

Jonathan Dorfan, Director of SLAC, and Pier Oddone, Deputy Director of LBNL (front), inspect SLAC's PEP II collider, the accelerator that provides electrons and positrons for BaBar. As project leader, Dorfan brought in the PEP II collider on time and within budget. Oddone had the idea of building a collider with different energies for electrons and positrons to improve BaBar's B meson identification.

Cover: David Hitlin, spokesman of the BaBar collaboration, climbs toward the top of BaBar's calorimeter. The concentric layers are used to track particles and determine their energy.

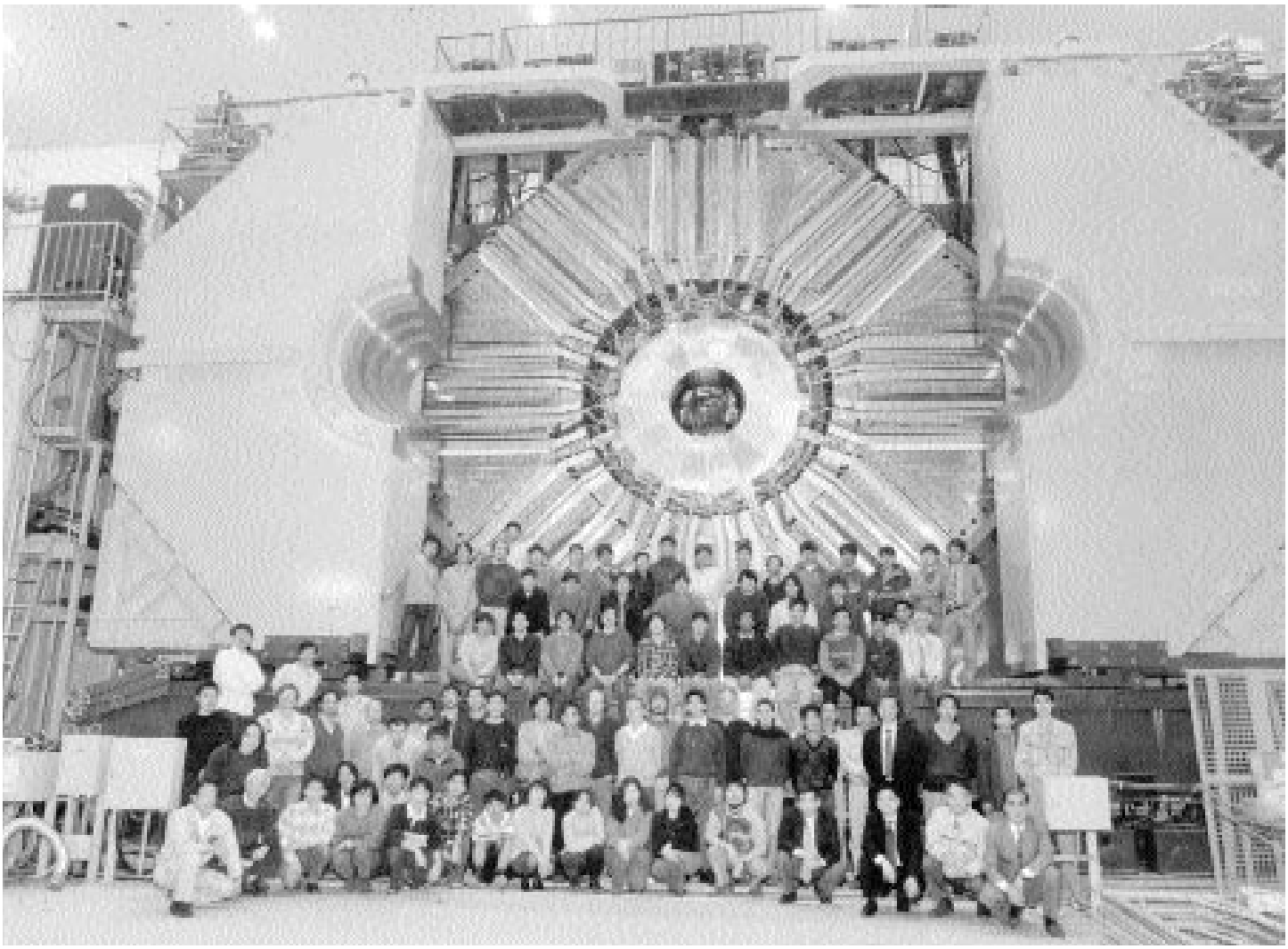


Photo coutesy Belle

The Belle collaboration

a Standard Model value of about 0.7. A direct measurement of sin2ß had not been possible until recently. KEK physicists reported a result of 0.45, while experimenters at SLAC measured 0.12. However, both numbers have an uncertainty of about plus or minus 0.4, making conclusions premature. CDF, using proton-antiproton collisions, found a value of 0.79 for sin2ß, with an uncertainty similar to the two recent measurements at SLAC and KEK.

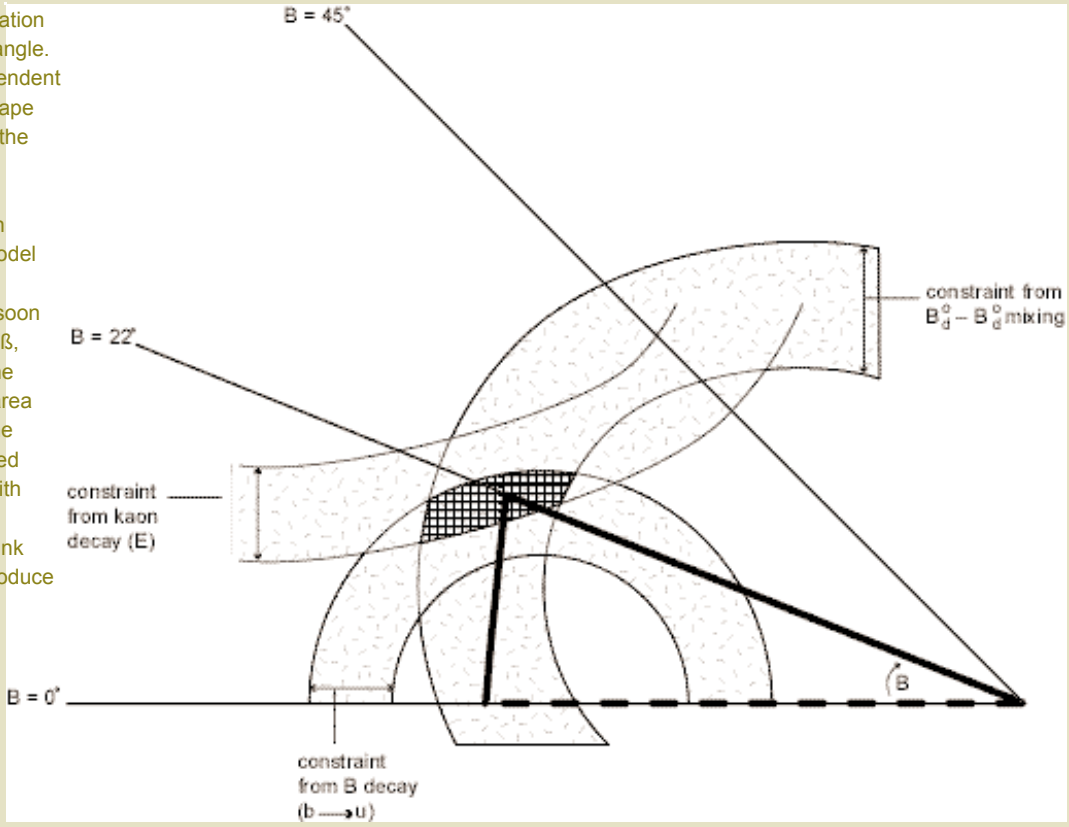
“The large and small numbers are not in serious disagreement,” said David Hitlin, spokesman of the BaBar experiment.

Eric Prebys, a physicist at Princeton University who is working on the Belle experiment, agreed. “Everything at the moment is consistent with each other,” he said.

Extending the CDF effort, collaborator Christoph Paus of the Massachusetts Institute of Technology is working with scientists from nine other institutions, building a system to measure the time of flight of particles produced in the CDF detector. The device will improve the B physics analyses at CDF, in general; and in particular, the measurement of the mass difference of two different states of B mesons that colliders at KEK and SLAC cannot produce. This mass difference also plays an important role in CP violation studies.

Unitarity Triangle

In the Standard Model, CP violation is described by the unitarity triangle. Physicists identified four independent quantities that constrain the shape of the triangle, one of which is the angle ß. Presently, values of ß somewhere between 0 and 45 degrees seem possible, though consistency of the Standard Model suggests a value of around 22 degrees. BaBar and Belle will soon obtain more stringent limits on ß, either confirming or rejecting the Standard Model. The shaded area indicates the region in which the triangle's peak should be located to be in excellent agreement with the Standard Model. Future experiments will be able to shrink the width of the bands and introduce additional constraints.



"In Run I, which ended in 1996, the CDF detector triggered on B mesons using lepton production as a signal," Paus explained. "Starting next year, we will be able to trigger on events containing B mesons which decay into hadronic particles."

Leptons, such as electrons and neutrinos, don't allow for a precise determination of the energy of the B mesons, since CDF and DZero cannot detect neutrinos. Looking for hadrons, which are particles containing quarks, is technically challenging, but leads to better results.

Both CDF and DZero will be able to explore an area of CP violation that cannot be probed by BaBar and Belle: B_s mesons. These particles contain both bottom and strange quarks, and their production requires more energy than is the case for the usual B mesons. With both CDF and DZero upgrades focusing on B_s identification, Fermilab's experimental program will complement the B meson data obtained by BaBar and Belle.

A third method of testing CP violation is pursued by Hera-B, a new detector at DESY, the German high-energy laboratory. It will identify Bs mesons created by smashing protons into a stationary target.

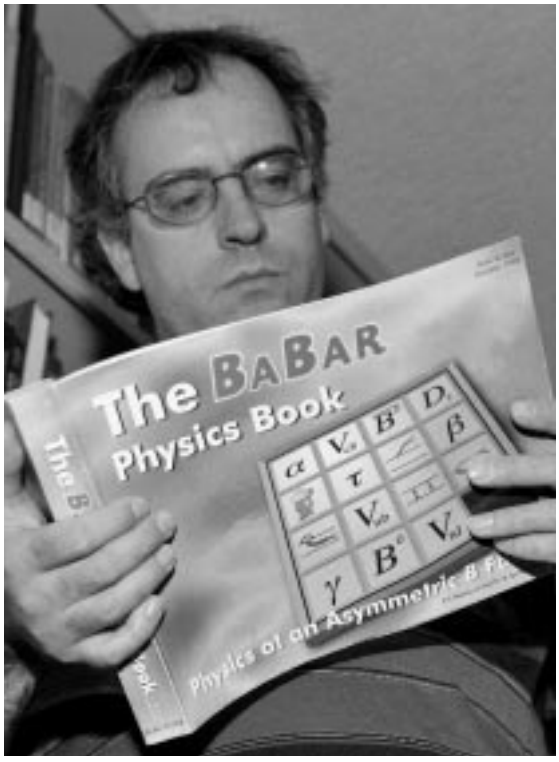
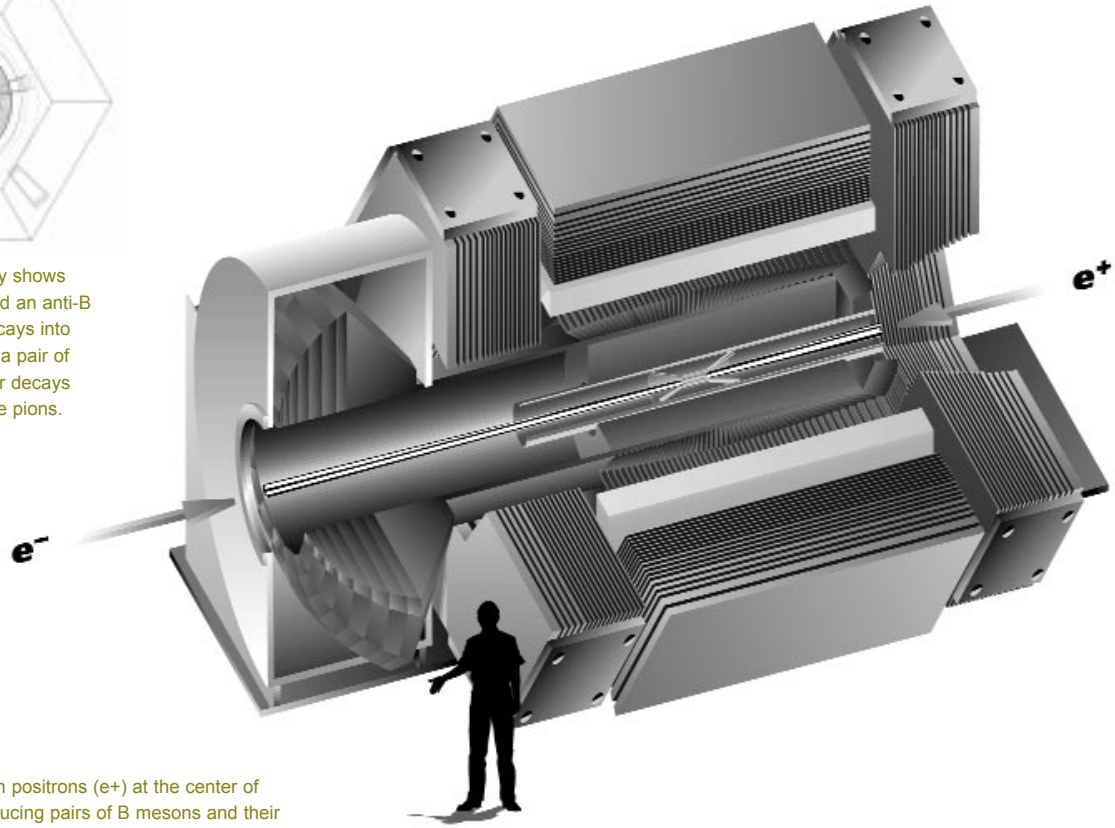


Photo by Jenny Mullins

Ulrich Nierste (shown) and Zoltan Ligeti are theorists at Fermilab who have made important calculations of CP violating processes in the Standard Model. Together with many colleagues from around the world, they are co-authors of *"The BaBar Physics Book."*

This BaBar event display shows the production of a B and an anti-B meson. One of them decays into a pair of muons (μ) and a pair of pions (π), while the other decays into a kaon (K) and three pions.



Electrons (e-) collide with positrons (e+) at the center of the BaBar detector, producing pairs of B mesons and their antiparticles. Since the positrons enter the collision with energy higher than their electron counterparts, the B and anti-B decay dominantly in the direction of the positrons. The detector design accommodates this asymmetry.

"Our theoretical understanding of CP violation is summarized by the so-called unitarity triangle," explained Ulrich Nierste, a postdoc of Fermilab's theory group. "Presently, there are four quantities that place constraints on the shape of the triangle, none of them very stringent. All B experiments aim at tightening the limits."

Knowing two of the four quantities with great precision would be sufficient to uniquely fix the triangle. All additional information on the unitarity triangle then tests the correctness of the Standard Model.

"Over the next few years we will see whether all constraints will merge and meet at the peak of the triangle," Nierste said. "If the results don't intersect, as could be the case for a small value of sin2ß, experimenters will establish evidence for physics beyond the Standard Model. In that case, the Standard Model could even fail to correctly describe CP violation in the kaon system."

If all quantities match up, the Standard Model would come out as the correct theoretical description. It would explain the breaking of matter-antimatter symmetry in both the kaon (strange quark) and B meson (bottom quark) sector. However, theorists have already realized that the overall magnitude of CP violation in the Standard Model is too small to explain the imbalance between matter and antimatter that must have occurred in the early universe. Clearly, the current description of nature's fundamental interactions is far from complete.

"It's not just the discovery of a new particle that is important for particle physics and cosmology," said Hirotaka Sugawara, director general at KEK. In addition, the "[breaking of] symmetry is something we have to understand."

With precision results just around the corner, BaBar and Belle may set the stage and provide the first look at physics beyond the Standard Model. B physics will hold the spotlight for years to come. □

Revival

by Judy Jackson

Tuesday, April 4, 2000 was a proud day for the Technical Division. That was the day they received a plaque from the Fermilab director recognizing them as the laboratory division with the "most improved safety record for 1999." On that day, employees of the Technical Division had worked for 628 straight days without an injury serious enough for anyone to require time off from work.

Pride goeth before a smashed finger.

Photos by Jenny Mullins

In happier times,Technical Division Head Peter Limon (left) accepts a plaque from Fermilab Director Michael Witherell citing the most improved safety record for 1999.

On Thursday, April 6, just two days after receiving the safety award, a Technical Division employee hurt his finger while using a machine. The injury was serious enough to require stitches, and the employee went home.

After more than a million working hours without a serious injury, the Technical Division's "Days Without a Lost-Time Injury" board went to zero. Moreover, since April, the division has been plagued by a series of accidents and near misses that have kept the number of injury-free days frustratingly low.

What happened? And, more important, what is the Technical Division doing to get back on track?

"Just as in religion," said Bill Griffing, head of Fermilab's Environment, Safety and Health Section, "backsliding is very common in safety. When an injury destroys a long safety record in an organization, it's very normal for more injuries to follow. People might let up a little in their extreme attention to safety, because they are not so worried about being the one to end the great safety record. Sometimes people with chronic injuries who have suffered in silence may come forward after the safety record is gone."

When that happens, Griffing said, "it means you've got to re-immerse yourself. When you start to slide into those old bad habits, you need the equivalent of a religious revival. It's time to get fired up again and think hard about safety. What has happened in the Technical Division is very common in organizations, and we can all learn from their response."

Their response has meant taking a hard new look at policies and procedures throughout the division.

"In the Technical Division, we are disappointed but not discouraged in our determination to be completely injury free," said Division Head Peter Limon. "We might be tempted to think that our recent string of accidents was just a streak of bad luck, or that our previous excellent safety record was just good luck. But if we look at each of the accidents, and also at some recent close calls, we see that every one of them could have and should have been prevented. In each case, there were specific, identifiable causes that shouldn't have happened."

As a result, Limon said, the division has made changes in policy and in training.

Fermilab's Technical Division struggles to regain an injury-free workplace.

For example, a near miss occurred when a portable lifting device proved inadequate for the weight to be lifted. This prompted a review of the policy for using such devices.

"It was generally a good policy for most lifting situations," said Associate Division Head Romesh Sood, "but after the close call, we found that it didn't cover *portable* lifting devices. Now, it does."

Although no one wants accidents, Sood said, each one brings a new perspective.

"Each accident does represent an opportunity to re-examine our policies, our training and our workplace and to make them safer," he said.

The division's senior safety officer, Rich Ruthe, has had many opportunities in recent months for the safety equivalent of soul searching.

"The series of accidents that we've had since April have forced us to re-think what we're doing," Ruthe said. "Maybe we got a little smug. That's an invitation for accidents to happen. The good news is that all of these accidents were preventable. That's encouraging, because it means we can do something. It is definitely possible to achieve our goal of zero injuries. The same integrated safety principles that let us achieve 629 days without a serious injury still apply. We just have to redouble our efforts to practice them every day."

Meanwhile, Sood said, a series of safety "revival meetings" with the division head has brought together more than 90 percent of the division's employees for a message of rededication to safety in the workplace. At each meeting, Limon reminded employees that each of them has not only the power but also the responsibility to stop the work at any time if they think it is unsafe.

"Instead of dwelling on our disappointment that our string of work days without serious accidents is ended," Limon wrote in a recent letter to Technical Division employees, "we should take this opportunity to remind ourselves that we need to think about safety in everything we do. Before any operation, no matter how trivial it seems, take a moment and look around, think about what you are about to do, make a mental risk-assessment. Stop and think. If anything seems amiss or unusual, think again. Don't hesitate to ask for help. Now is the time to redouble our dedication to safety at the workplace and to begin a new record-breaking string of safe work days. Our intention is never to have another accident."

Amen.

Méthode Champenoise:

Pbars
EARN A BUBBLY SALUTE

by Mike Perricone

Carbonic acid (H_2CO_3), formed by combining carbon dioxide and water, is a mundane substance with a magical effect: during the final stages of fermentation inside a corked bottle, it turns wine into champagne, the sparkling stuff of celebrations.

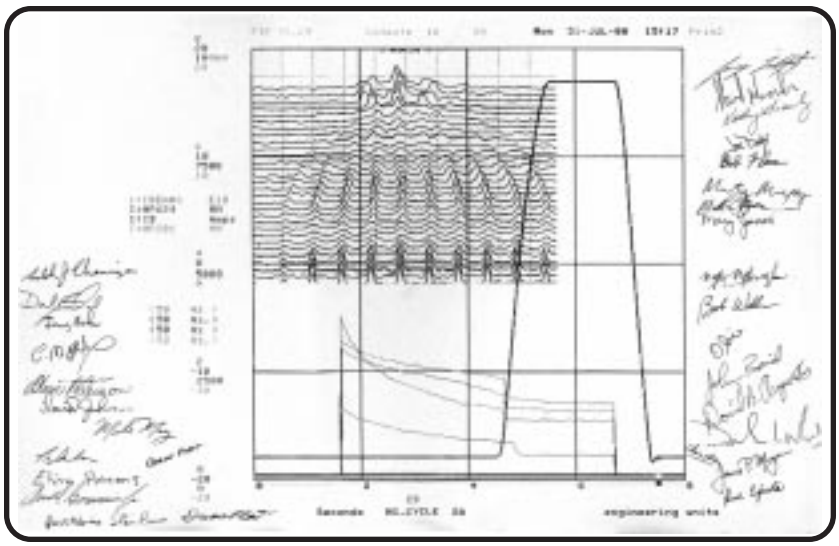
Fermilab's Antiproton Source Department broke out the bubbly on August 1 after effecting a little magic of its own: bringing antiprotons ("pbars") into the new Main Injector for the first time, accelerating them to machine's limit of 150 GeV, and coalescing several particle bunches into unit form fit for forwarding on to the Tevatron, all critical stages in preparing for Collider Run II in March 2001.

"There's a lot of work yet to do, but we're well on our way to having the antiproton segment of Collider Run II ready to go," said Elvin Harms, deputy head the Antiproton Source. "There's another big step yet in getting them [antiprotons] injected into the Tevatron, but we proved we can do it in the Main Injector."

The Tevatron, meanwhile, is prospering in its own preparations, reaching a record energy of 980 GeV for protons just days after the Antiproton Source success.

But as anyone in the Antiproton Source will readily attest, protons are plentiful. Producing increased numbers of collisions in Run II pivots on providing an equivalent plenitude of antiprotons at equally high energies. Since it takes about a million proton hits on a fixed target to produce just 18-20 antiprotons, sending a million or more pbars around the two-mile Main Injector for the first time means coming by the champagne the old-fashioned way—earning it.

Coalescing the antiprotons into a Tevatron-ready beam was an absolute must in achieving the champagne milestone. Coalescing sounds simple enough: take several pulses (usually 11) of antiprotons at fairly uniform energy, spread out over time, and mold them into a single pulse, where the energy of the particles is spread out but the delivery is, in effect, all at once. It comes down to swapping energy for time—and it has demanded plenty of both.



The chart (signed by participants in the milestone) shows the antiproton beam in the Main Injector starting with a "bunch of bunches" at the bottom of the chart and coalescing into fewer and fewer bunches, moving toward the top of the chart. The peak at the top represents successful coalescing—and reason to break open the bubbly.

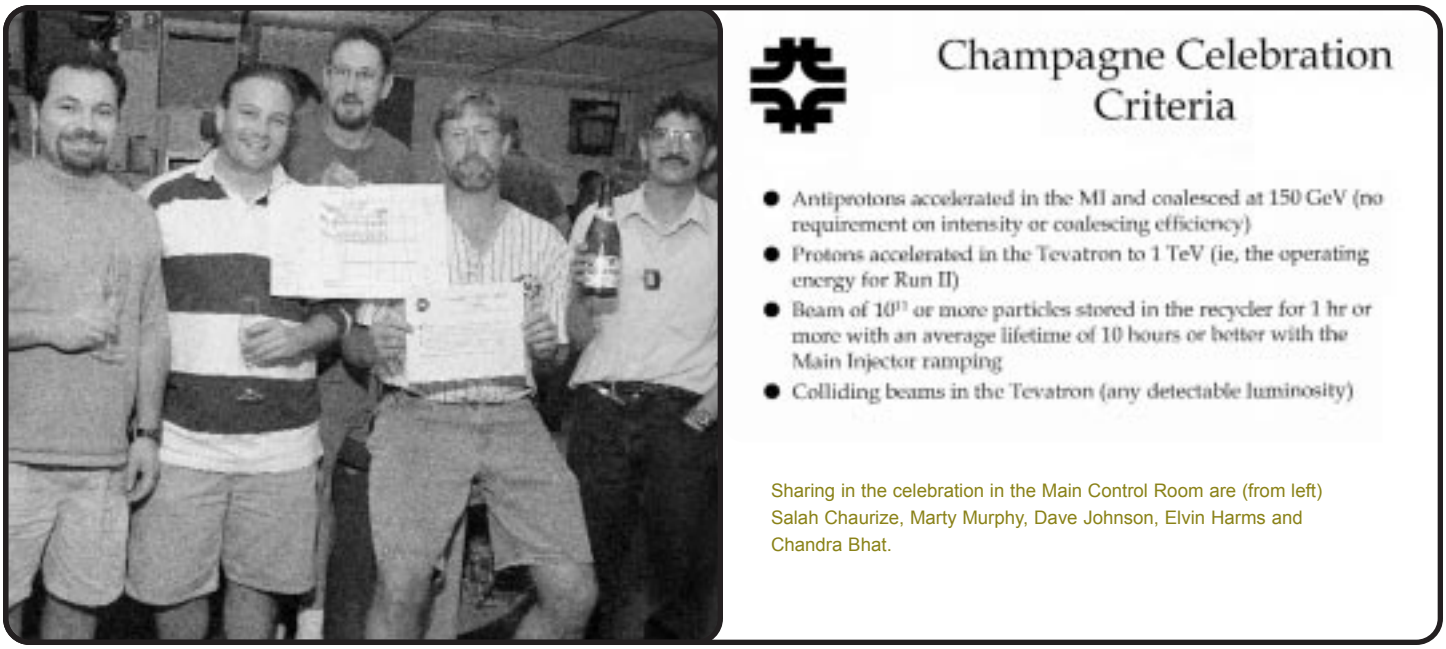


Photo by Reidar Hahn

Sharing in the celebration in the Main Control Room are (from left) Salah Chaurize, Marty Murphy, Dave Johnson, Elvin Harms and Chandra Bhat.

"We've been working seriously on this since January, and in some sense the entire Beams Division has played a role," Harms said. "We've been coordinating efforts between the Antiproton Source, Controls, Main Injector and RF [Radiofrequency] and Instrumentation Departments. We meet every morning at 9:30, and talk about the focus of the day's studies. We've been typically spending three days a week just making pbars and sending them on."

Even the transfer from the Accumulator in the Antiproton Source is a serious undertaking: the beam travels about a half-mile of transfer beam before reaching the Main Injector. Protons (remember, they're far more plentiful than pbars) are used to make sure the transfer line is "tuned" to promote the highest efficiency and thus, the lowest beam loss. Protons (positive charge) are sent backward through the line, injected where antiprotons (negative charge) would emerge, and emerging where antiprotons would be injected.

"If we have good results with protons," Harms explained, "then we have a high level of confidence that the efficiency will be just as good when we send antiprotons through."

Efficiency is essential because the antiprotons undergo preparations for the Main Injector similar to preparations for the Tevatron. The energy distribution in the antiproton beam is Gaussian (classic "hump," or bell curve), but the Main Injector requires more uniformity in the nine pulses inserted with each transfer. The previous procedure involved using RF to pull beam out of the top of the hump; now, that hump will be (metaphorically) shaken back and forth for about five minutes to produce a rectangular shape. Then RF will be used like a cleaver for what's called "unstacking," slicing off nine uniform segments to send on to the Main Injector.

Four "clumps" of nine slices each are sent into the Main Injector, where the RF shaking and cleavering are repeated to produce the all-important coalescing, forming four "superclumps." Filling the Tevatron requires coalescing nine superclumps.

Even as it's being developed and perfected, the new coalescing process is being automated. A new "sequencer" is being programmed for computer control of the RF frequencies and the durations of shaking the beam into its rectangular shape and paring off the slices.

"In the big picture, we hope it will mean faster transfers with greater efficiency, achieving maximum luminosity and making the collider operation more routine," Harms said. "The sequencer will take the old 15-page, densely-printed checklist we had in the early days, and make sure every step is followed. It reduces the chances for human error. We're not quite at the stage of just pushing a button and making it happen, but we're close."

Even then, there will still be room for magic, especially the carbonic acid kind. □


FNAL BD-Operations Old Milwaukee Celebration Criteria

- It's Wednesday morning!
- Remembering to shower before work.
- A successful test of the 113 Emergency Paging System.
- Start shift twice without calling Wally for corrections.
- Manage to open Lumberman bottle with out a blood-born pathogen alert.
- At $6.99 per case, "Why not?"
- Not banging one's head during an access in SY.
- 1.2 % cost of living adjustments every other October.
- Accurate calculation of shift numbers!

Other celebrations require less stringent criteria.

The software formerly known as Sherlock ...

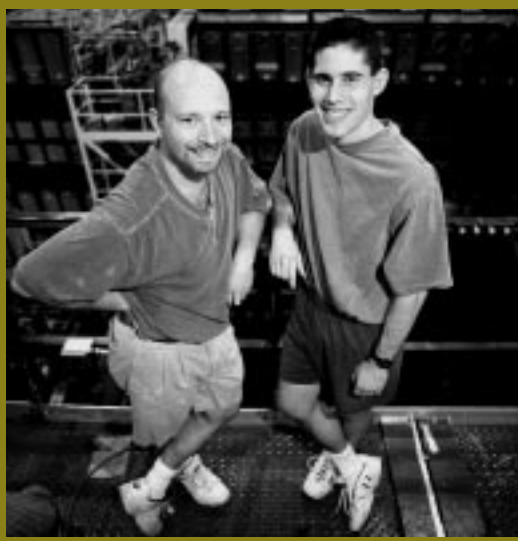


Photo by Jim Schultz

Bruce Knuteson (left) and Dave Toback are the people behind Sleuth.

by Kurt Riesselmann

Whether it's your newborn, your latest cooking creation or a physics software package: Finding a great name is always a difficult task. You search for something terrific. Perhaps you want to create a wonderful association. Or you may have to focus on avoiding trouble: With family, friends– or the law.

Bruce Knuteson, a UC Berkeley graduate student and member of the DZero collaboration at Fermilab, thought he had found the perfect name for his particle-physics software, an analysis package for quickly searching large amounts of experimental data for new particle signatures. Since the identification of new and unpredictable particles requires detective-like strategies, Knuteson chose a name connected to more than a century of detective work: Sherlock.

The name turned out to be too good. Sherlock is already the name of a commercial software package that finds electronic files rather than particles. Knuteson and Dave Toback, postdoc at the University of Maryland and co-author of the program, were prohibited from using the name Sherlock in the future.

To remedy the situation, Knuteson and Toback initiated a naming contest within the DZero collaboration. Fellow scientists, who clearly appreciated the detective aspect of the name-stripped software, made appropriate suggestions. Based on those results, the program formerly known as Sherlock…

... is now called Sleuth.

What is Sleuth all about?

Knuteson's and Toback's software creation is designed to sleuth for new particles in collider data using a model-independent approach—making as few assumptions as possible, and embracing as many possibilities as nature may offer.

"Even if you are looking for nuggets, you need to make sure that you don't miss the diamonds in your gold pan," says Toback.

Sleuth is designed to catch it all.

"Most search strategies test whether experimental data fit a particular model," explains Knuteson. "This approach is reasonable if the number of competing models is small—contrary to our situation. Given the plethora of new possibilities, we decided to assume as little as possible about what we might discover. We want to let the data speak to us, rather than asking it narrowly-focused questions."

Run II data collection will start in March 2001, and the CDF and DZero detectors will record almost a million proton-antiproton scattering events per day. Physicists expect to identify about one hundred classes of events, with all events in a particular event class identified by a unique number of leptons, electroweak bosons, neutrinos and jets. For each event class, the software package Sleuth assigns two to four variables, which can be calculated from the transverse momenta and missing energy associated with the particles and jets observed in each event.

"IT IS A CAPITAL MISTAKE TO THEORIZE BEFORE ONE HAS DATA. INSENSIBLY ONE BEGINS TO TWIST facts to suit theories, INSTEAD OF theories to suit facts..."

—Sherlock Holmes (from "A Study in Scarlet," by Sir Arthur Conan Doyle)

Sleuth looks at one event class at a time. It uses various other software packages to calculate the Standard Model background in a given class. Then the search for new particles begins.

"New interactions may create what we call signal events, which, we hope, look different from the background," says Toback. "Sleuth contains an algorithm to help distinguish these possible signal events from the background events in a very efficient and model-independent way."

The importance of pobfutoatonoes

To identify signal events in a specific event class, Sleuth transforms the background distribution to every statistician's field of dreams: the unit box.

Instead of several variables ranging from zero to infinity, Sleuth introduces a new set of special variables limited to values between 0 and 1. In addition, Sleuth's transformation spreads the background uniformly across the unit box, making it a flat distribution. A set of signal events would ideally stand out like Mount Everest in the Midwest. Physicists, however, are prepared to look for the appearance of a molehill.

When Sleuth analyzes the data of an event class as recorded by the particle detectors, it looks for deviations from the flat background. Data taking, of course, is a statistical process and is subject to fluctuations. To test whether a seeming excess of events in one region of data space could be a hint for new physics, Sleuth calculates a quantity that Knuteson refers to as a "pobfutoatonoe:" probability of background fluctuating up to or above the observed number of events. Each pobfutoatonoe value indicates how likely it is that the mismatch between the data recorded and the Standard Model prediction is just a statistical fluke.

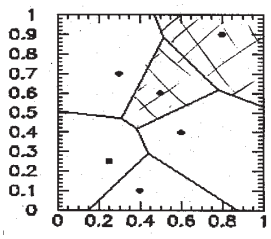
To calculate a pobfutoatonoe (pronounced pub-phooto-what-to-know), Sleuth needs to divide the unit box of a certain event class into many small subspaces. Knuteson looked a long time before discovering the concept of Voronoi regions, which yields an algorithm that can accomplish this task in a sensible, reproducible and quick way (see figure).

"This is sort of cute," Knuteson smiles. "I was fortunate to stumble across Ken Clarkson's Internet pages at Bell Laboratories in Murray Hill, New Jersey. Clarkson worked in the area of computational geometry and had developed a software package to calculate Voronoi regions in many dimensions. It turned out to be the perfect solution to my problem." Clarkson's software only needs a few minutes of drawing all Voronoi regions for 1000 data entries in a two-dimensional unit box.

Once the unit box is divided into Voronoi regions, Sleuth assembles subspaces composed of many adjacent regions and calculates pobfutoatonoes for each subspace. Comparing many different subspaces, Sleuth provides a measure of judging how significant a set of seemingly unusual events is, without the bias of model-dependent search strategies. The subspaces with the smallest values are the most likely candidates for physics signatures beyond the Standard Model.

"Sleuth cannot identify any particular event to be the signal for a new particle," Toback cautions. "However, it would be able to single out 10 events and indicate that 8 of these events are not in accord with the Standard Model."

No matter what kinds of new particles Knuteson and Toback may discover, they'd better talk to a lawyer before naming them. □



Voronoi diagrams divide a volume with N data entries into N unique regions. Each region is defined as the set of all points that are closer to a particular data entry than to any other data entry.

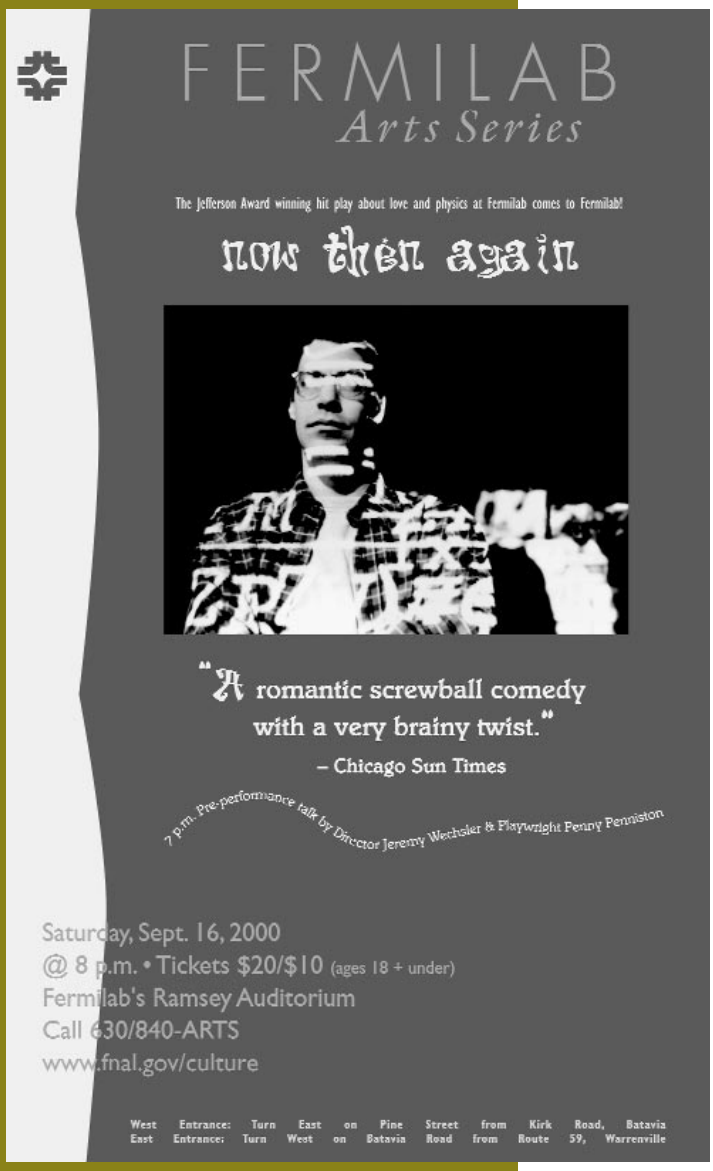
Time Bending Love Story

by Mike Perricone

Physicists.

They walk, they talk, they chew gum—and all at once, with or without style points.

They fall in love, they agonize over commitment, they think about quantum mechanics—again, all at once; and as a bonus, with the identical potential for emotional dysfunction afflicting most non-physicists.



"They [physicists] are not that different from other people," asserts playwright Penny Penniston. "They are regular people who happen to be very bright. The difference lies in their being obsessed with science the way the rest of us are obsessed with other things that are important to our lives. I wanted to show how that passion for their work affects them in life, and love."

All the evidence indicates she has done just that, in award-winning style.

"now then again," a play about Fermilab physicists in love penned by Penniston and directed by her husband, Jeremy Wechsler, won the Joseph Jefferson Award as the outstanding new work in Chicago theater for the 1999-2000 season. It added a second Jeff Award for Michael Rourke's lighting design, also earning a Jeff nomination for Joseph Fosco's original music.

The production opened in a 50-seat venue at the Bailiwick Repertory, but the response of theatergoers soon prompted a quantum leap to the 500-seat Ivanhoe Theater in the city's humming north side theater district. Chicago critics were duly impressed: "One of the biggest critical and popular hits of Chicago's theatrical year" *(Tribune)*; "A deft little romantic screwball comedy with a very brainy twist" *(Sun-Times)*.

Yet despite the accolades, Penniston and Wechsler are as nervous these days as physicists facing a peer review. Why? Because, in a sense, that's just what's happening to them.

On Saturday night, September 16, they're bringing "now then again" to 800-seat Ramsey Auditorium at 8 p.m., kicking off Fermilab's 2000-2001 arts series. In visiting the real-life setting of their time bending stage romance between outgoing graduate student Ginny (who also happens to be newly married) and introverted physicist Henry (who has social "stage fright"), Penniston and Wechsler are inviting the scrutiny of the very people they seek to portray: particle physicists to whom quantum mechanics is the sacred and profane stuff of their everyday lives.

"Trepidation? Absolutely," Penniston admits. "This is going to be a very tough audience, just as the toughest audience for 'ER' would be people who actually work in an emergency room."

Comes Home to Fermilab

While Penniston's goal was to stay as close as possible to the science involved, she characterizes the play as a simple love story against a backdrop of physics. She groans at memories of movie characters spouting nonsense science ("insulting" is her term for a description of cold fusion in "The Saint" a few years back), and admits to some "conceits" in the play. For example, as a student, Ginny would have to be "exceptionally brilliant" to participate at the level of research portrayed.

Wechsler has his own defense ready.

"If anyone has any issues with the play," he declares, "they can blame Morris Binkley."

Binkley, a lanky, mild-mannered physicist at CDF and an inveterate theatergoer in Chicago and beyond (he and his wife attended "Copenhagen" in London), answered a general e-mail call for help issued by Fermilab's head of Public Affairs, Judy Jackson, who was in turn responding to a plea from Penniston, who felt caught with an unvetted script when Bailiwick announced plans to go ahead with production of the play hinging on the transactional interpretation of quantum mechanics—in a hurry.

"The transactional interpretation of quantum mechanics is a subject which most physicists are interested in, but it's not really crucial in our day-to-day physics," Binkley explains. "Two particles interact and there is the possibility of going backwards in time. It doesn't violate causality, but it does say there's some fuzziness at the quantum level. It's something that troubled Einstein back in the 1920s and '30s, leading to his famous quote about God not playing dice."

The collaboration involved an intense three-way storm of e-mail messages between Penniston, Binkley, and physicist John Cramer of the University of Washington. Penniston says once she saw the other two debating physics by e-mail, she figured she was in good shape. Cramer's introduction to John Gribbin's *"Schroedinger's Kittens and the Search for Reality"* sparked Penniston's creativity, with its concept of quantum waves traveling forward and backward in time.

Photo by Tom Gustafson

Henry, the physicist (Joseph Wycoff), hides from Felix, the janitor (Richard Cotovsky), who is attempting to act as a catalyst for a romance between Henry and Ginny, the graduate student (Katie McLean, not pictured), in "now then again." The award-winning play, set at Fermilab, will be presented in Ramsey Auditorium on Saturday, September 16.

"I envisioned a story that moves forward and backward in time, seeing moments in our lives as an interaction between future and past, not just as a series of things that lead us forward," Penniston recalls. "But what was the beginning moment, and what's the moment at the end that causes things to move backward? In the play, that moment is [Ginny's and Henry's] first kiss. In a story of how people meet, there can be a little insignificant thing, an event that doesn't get a second thought, but in hindsight becomes very important because of how the story ends."

Binkley added invaluable savvy to make the physics (and Fermilab) background credible. Penniston wanted to make a point that, viewed from the reference frame of a relativistically-accelerated particle, a stroll to the door might appear to take 10 years; Binkley did the math, found it would take only four days, then (at Penniston's urging) came up with a faster particle that would make the journey appear to take two years.

now then again

COMES HOME TO FERMILAB

And the verdict is...

"A very provocative and surprising play about time, science fantasy, the portrayal of characters, and the eternals of love, chance, and humor. These concepts are interwoven with the kind of imagination and artfulness that is characteristic of research at Fermilab.

—Leon Lederman, Nobel Laureate, Fermilab Director Emeritus, author of "The God Particle"

"An intricately woven tale, with hauntingly familiar personalities, situations and hot topics. It's a cleverly crafted history with dual outcomes—built upon the notions and uncertainties of quantum mechanics and broken symmetry. This leads me to consider the 'Grande Dual Histoire du Monde' in which our heroes DON'T, THEN DO discover the WIMP. Intriguing!"

—Michael Tartaglia, Technical Division-Development and Test

"What's nice is that in this world, hindsight is 20-20, as what is discovered in the future can then be applied to the past. A very enjoyable intertangling of events!"

—Robin Erbacher, CDF

"The usual complications of a relationship between scientists (in this case HEP physicists) are further exacerbated by introducing the concept of forward and backward propagating probability waves at the macroscopic level. It can be a wild ride when future events are able to influence the past. I was almost convinced that I recognized several of my colleagues up on that stage."

—Fritz Bartlett, DZero

"A pleasant love story set at Fermilab (credible) in which, through the mysteries of quantum mechanics, the direction of time can change (credible) and in which one of Fermilab's favorite physicists is referred to by a grad student as 'Dr.Binkley' (not credible)."

—Peter Mazur, Technical Division-Development and Test

"An intriguing parallel of physics and humanity. You don't really know what's going on until near the end of the play and then there's a wonderful sense of, 'Ah, now I get it!' It doesn't require a physics background, but if you have some sense of the science you will get a few extra chuckles."

—Bruce Worthel, Beams Division-Accelerator Operations

"Even though it takes place at Fermilab, the play is a love story between two scientists that will appeal to a broad audience. This may have a strong tie to quantum mechanics, but a Ph.D. in high energy physics is not required to enjoy this play. It is witty, and funny in parts, and a very entertaining evening."

—Ralph Pasquinelli, Beams Division-RF & Instrumentation

Photo by Jenny Mullins

Morris Binkley

Penniston credits Binkley with "always wanting us to be more precise;" in turn, Binkley appreciated the author's self-taught but firm grasp of physics. Penniston uses the number "137" in her e-mail address, adapting the fine-structure constant as irreverently described in Leon Lederman's *"The God Particle."*

"The play is a light romantic comedy, but it has some interesting physics imbedded in it and the audience can get a little of the flavor of quantum mechanics," Binkley says. "Penny does not have an academic science background, but she clearly has read a lot and she knows her way around the subject and the lab. I'm happy for her because she worked very hard on this play."

Penniston and Wechsler will give a talk before the performance at Ramsey Auditorium, with an opportunity after the play for the audience to speak with physicists and with the performers. Special food and refreshments will be available, and prizes will include a season subscription as opening night is given the "red carpet" treatment with decorations, banners and—yes, an actual red carpet.

For Penniston, bringing the play to Fermilab brings added meaning to the play.

"In the areas of physics that people at Fermilab are studying, the universe is so complicated that it gives up only little tiny glimpses," she says. "That tiny little piece of the picture is very similar to life. Being human in the universe, the image is so complicated that we can't begin to understand it. We get little glimpses of a larger purpose, of a puzzle we fit together to learn our place in the universe. There is that kind of similarity in the complexity of the quest." □

CALENDAR

Web site for Fermilab events: http://www.fnal.gov/faw/events.html

International Film Society Presents:
The Red Violin, Dir: Francois Girard, Canad/Italy (1998), 131 min. September 8 pm, Ramsey Auditorium, Wilson Hall, tickets $4. We follow the violin through its travels around the world. The music it produces is so beautiful that it brings a tear to the eye.

Fermilab Arts Series

NOW THEN AGAIN
Saturday, September 16, 8:00 pm. Tichets are $20. This romantic comedy, set at Fermilab, has been delighting sold-out Chicago audiences since its debut last spring at Bailiwick Repertory Theatre. A love story about two scientists who fall in love at Fermilab provides proof that relationships are usually complex and quantum mechanics can be simple.

ONGOING

■ NALWO is pleased to announce that the free morning English classes in the Users' Center for FNAL guests, visitors, and their spouses have been expanded. The schedule is: Monday and Thursday, 9:30 am - 11 am beginner (Music Room) and intermediates (Library), Monday and Thursday, 11 am - 12:30 pm advanced, emphasizing pronunciation and American idioms (Music Room).

■ NALWO coffee for newcomers & visitors, Thursday, August 31 at Housing Office (Aspen East) 10:30 am 12 pm.

■ In the auditorium, International folk dancing, Thursdays, 7:30-10 p.m., call Mady, 630-584-0825.

LAB NOTES

PARLA ITALIANO?
The Italian consulate in Chicago is seeking information on how many people might be interested in Italian language courses at Fermilab. Depending on the level of interest, the consulate could provide native Italian instructors for beginning, intermediate and advanced adult students, as well as for children. Adult classes would meet weekly for two hours for 10 weeks, either on Saturday mornings or weekday evenings, and would cost $170, plus the cost of books. Children's courses, 1.5 hours per week for 10 weeks and also meeting on Saturdays or weekday evenings, would cost $100 plus the cost of materials. If you'd be interested, please call the Office of Public Affairs at ext. 3351.

PRAIRIE HARVEST
Fermilab again invites volunteers to help harvest prairie flower seeds on Saturday, September 23, and Saturday, October 28, 2000. Volunteers should wear field clothes and gloves, and bring pruning shears and paper grocery bags. Refreshments will be provided. Any large groups planning to attend should contact Roads and Grounds at 630-840-3303.

MILESTONES

THANKS

■ My sincere appreciation to everyone for the overwhelming celebration on July 22 in my honor on the occassion of my retirement. Thanks to one and all for 31 memorable years of Fermilab. I wish you all continued success and much happiness.

Don Carpenter.

BORN

■ [redacted].

RETIRING

■ Ronald Stazak, ID 4598 FES-Services, September 19, his last day of work was August 9.

■ David Wilson, ID 400 TD-Machine Shop October 21, his last day of work will be September 8.

■ Herb I. Vore, resident iguana of the ES&H Section, after three years of service, to private life in Batavia. A day-long open house on August 25, at WH7E, will honor Vore's final day on the job.

LUNCH SERVED FROM
11:30 A.M. TO 1 P.M.
$8/PERSON

DINNER SERVED AT 7 P.M.
$20/PERSON

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LUNCH
WEDNESDAY, AUGUST 30

Grilled Shrimp, Corn, Black Bean and Tostada Salad

Cornmeal Cake with Apples and Pears

DINNER
THURSDAY, AUGUST 31

Crab and Corn Chowder
Five Vegetable Stir Fry
Pork Tenderloin with Mango Chutney
Jasmine Rice
Lemon Tart with Blueberry Sauce

FERMINEWS

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A U.S. DEPARTMENT OF ENERGY LABORATORY

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The deadline for the Friday, September 15, 2000, issue is Tuesday, September 5, 2000. Please send classified advertisements and story ideas by mail to the Public Affairs Office MS 206, Fermilab, P.O. Box 500, Batavia, IL 60510, or by e-mail to ferminews@fnal.gov. Letters from readers are welcome. Please include your name and daytime phone number.

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CLASSIFIEDS

FOR SALE

- ’99 Subaru Legacy L 30th anniversary Wagon, 17k miles, all-wheel drive, automatic, power locks/mirrors/roof/antenna/steering, roof rack, fog lights, CD player with 6-way speakers, air conditioning, double airbag, ABS. Call Tommaso at x4374 or 717-0711.
- ’98 Black Pontiac Sunfire 2 dr; 40K miles; a/c; keyless remote entry; power windows, locks, & mirrors; cruise control; rear window defogger; AM/FM CD radio w/eqalizer. Asking $10,250. Please call Mary Kohler at X3723 or 815-498-3765 or e-mail Kohler@fnal.gov.
- ’94 Pontiac Sunbird, black w/gray interior, CD player, keyless entry, remote start, spoiler, AC, one owner/female driven. No smokeing or eating in the car, 72K excellent condition - inside and out. $5,100 obo, x8027 or 630-236-6070.
- ’94 Olds Cutlass Supreme S, 6-cyl, auto 4-speed w/ OD, black w/ tan cloth, 4-door, loaded trailer hitch, 160k miles, $5,385 o.b.o. Jamie x4996.
- ’92 GEO Storm Coupe, automatic transmission, AC, AM/FM Stereo, power steering/brakes, airbag, very low mileage: 51k miles, green, garaged in winter, available mid/end September, $3800, call Uli x3667, nierste@fnal.gov.
- ’92 Toyota Corolla DX wagon. Very good condition, well maintained, one owner. $3,000. Jim Strait, x2826, strait@fnal.gov, home phone 708-524-2630.
- ’90 Chevy Lumina, 4 dr, 3.1L, air, automatic, power steering, AM/FM/Tape radio, 78K miles, very good condition and very reliable. Ask $3,200 o.b.o. newtonol@fnal.gov, x2362 or x4321.
- ’90 Honda Civic LX, 4 door, 135K miles, manual 5 speed, power windows/locks/mirrors, $1,800. Call 840-2248 or mieland@fnal.gov
- ’90 Pontiac Bonneville LE, 101k miles, in good condition, ps, pb, pw, pl, ps, ac, sunroof. Asking $3,950 Call x8630 - Randy or rlwyatt@fnal.gov or 630-964-2311
- ’88 VW Fox 4dr.,air, dark blue,stick-shift, very reliable,$1,800, X8618 albrow@fnal.gov.
- ’88 Isuzu Trooper II LS for sale. 4x4, 4dr., manual, lots of new stuff, runs great! 125k miles, 1 owner. Call x2669 or 630-208-9882 for more info.
- ’88 Lincoln Towncar. Burgandy, recently passed emmisions test, good condition, all power. 145k highway miles. Gets 21 m.p.g. seats 6. Asking $1,900. o.b.o. ext 3403, 312-310-7512 or 630-584-1263.
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- ’77 Honda Goldwing 1000, excellent condition with Vetter fairing and packs, 66k miles. Lots of extras. Asking $1,200 or best offer. Contact Gary at 896-6196 evenings.
- Car top carrier, Sears “X Cargo”, $15 Call Ed Dijak x6300, dijak@fnal.gov.
- Set of four 15” aluminum alloy American Racing truck rims. Very good condition - used for one year and now in storage. $350 o.b.o. Contact Josh at 815-286-7244 or x8494 (juneau@fnal.gov).
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- Bed sofa, queen size with futon (black/red), black metal frame, can be disassembled, 1-1/2 yrs. old, ideal for guests, $90, call Uli (x3667, nierste@fnal.gov).
- Scott’s Classic 20” reel lawn mower, 1 year old, $25.00 Women’s golf clubs with cart, $50. Kenmore electric dryer, 6.5 years old, works fine, $25.00. Oak bedroom set with small 3-drawer bedside dresser & larger 9 drawer unit with mirrors, $400, x5165 or aicher@fnal.gov.
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- Model TRAINS, mostly “HO” and “N” scale, cars, track, transformers. Some “O” scale track, and other accessories. Call Ed Dijak x6300 or dijak@fnal.gov.
- Kohler Bathroom Sink (Almond) $25. deconn@fnal.gov, Dean or Cyndi at (630)879-2630.

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- Room independent floor living, shareable one car garage, use of kitchen and laundry calm residential Naperville 395./month - available 8/1/00 call 840-2574.

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BIBLE STUDY

The 12 o’clock (noon) Bible Study meets in the Huddle every Wednesday. Everyone is welcome. If interested contact Jeff Ruffin x4432, or ruffin@fnal.gov.

http://www.fnal.gov/directorate/public_affairs/ferminews/

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