

CLASSIFIEDS

FOR SALE

- '91 Subaru silver Justy, excellent condition, 28K miles, 5-speed, A/C, \$3,600 obo. Erik Gottschalk, x6416, erik@fnal.gov.
- '90 Mazda Protege, 1.8L, 5 speed manual, 150K miles. One owner, one service station, well maintained. Good tires, new clutch, no rust. \$1,250. Roy, x4108 (30) 858-9443, royr@fnal.gov.
- '90 Plymouth Voyager minivan, V6, AC, AM/FM cassette, cruise, tilt, 1 owner, well maintained, garage kept, exceptional condition, 70K miles, tan, all records, \$4,500 obo; hathaway@fnal.gov, x3649 or (630) 879-2387.
- '84 Corvette, black, glass top, 60K miles, new paint & tires. Very good running order. Best offer, (630) 852-2475.
- Nordic Track 'Walk-Fit' non-motorized treadmill. Barely used, \$100. Call Howie, x4425.
- Queen size sleeper sofa with Serta spring bed. Excellent condition. Rarely used, \$350. Call (630) 717-5181.
- Golf clubs, Callaway War Bird 1, 3, & 5, Memphis 10 steel shafts, \$240. Callaway X12 Lob Wedge Memphis 10 steel shaft, \$60. Call Ron, x3850 or (630) 906-0237.
- Aquarium, 15 gal, clean, like new (1 yr old) \$50. Includes everything, ready to set up and use. Call Karen (630) 897-8125.

■ Creme colored Schweiger sofa & oversized ottoman. Less than 1 year old, \$400. Mixed floral pattern (mostly burgundy) Rowe sleeper-sofa w/innerspring mattress, 3 years old, \$350. Nordic track ski machine, \$250. White '87 Ford Mustang, 110K miles, runs good, \$1,400. John x2237 or scifers@fnal.gov.

RENT

■ 2-flat house in Holy Angels area, Aurora. Both units have 2 bedrooms, ready for cable, 4 phone lines, and individual laundries. Tenants pay own gas & electric and control their own climates. Non-smokers. Share 1/4 acre, garage & basement. Security deposit & pet deposit required. 1st floor \$875/mo; 2nd floor \$775/mo.

WANTED

■ Day Care for 18 month old boy, mornings two or three times a week. Russian or English native language. Adults only. Please contact Julia Yarba, (630) 859-3463, or x8366, or e-mail yarba_j@fnal.gov.

CORRECTIONS

■ In a photo with the article "Answering the Call of the Sky" (Vol. 21, No. 13, July 3, 1998), the person rolling the cart under the telescope is Steve Bastian of PPD-Technical Centers, not Carl Lindenmeyer.

■ **Dick who?** Many readers wrote to fill in the inadvertent blank in a letter to the editor in the July 3, 1998 *FermiNews* from physicist Tim Toohig. The sentence should read: "[Wilson] also had to choose his engineers, like Hank Hinterberger, Dick CASSEL, Wayne Nestander."

CALENDAR

JULY 10

Potluck Supper at Kuhn (Village) Barn. This time please bring meat to barbecue as well as a salad, dessert or side dish to share. For kids, we have hamburgers & hot dogs, for everyone soft drinks, for adults wine & beer. We will start at 6:00 p.m., the grill will be hot at 6:30 PM. Babysitting is not provided for the summer potlucks. Call Martina Erdmann (630) 983-7021 or Sherry Nicklaus (630) 761-3139.

JULY 24

Golf Outing at Wedgewood Golf Course in Plainfield. Tee times start at noon. Lab employees are required to have approved vacation. Format will be Best Ball. Cost is \$40. It includes golf, cart rental (mandatory) and contests. To register or for more information, please call Gary Golinski x4055 or Michelle Gleason x8062. This event is sponsored by the Fermilab Golf League.

Fermilab International Film Society presents: *Brassed Off* Dir: Mark Herman, (UK). Film begins at 8 p.m., Ramsey Auditorium, Wilson Hall. Admission \$4. (630) 840-8000.

JULY 25

Fermilab Art Series presents: *Muzikas with Marta Sebastyen*, \$16. Performance begins at 8 p.m., Ramsey Auditorium, Wilson Hall. For reservations or more information, call (630) 840-ARTS.

ONGOING

NALWO coffee mornings, Thursdays, 10 a.m. in the Users' Center. Call Selitha Raja, (630) 305-7769. In the Village Barn, international folk dancing, Thursdays, 7:30-10 p.m. Call Mady, (630) 584-0825; Scottish country dancing Tuesdays, 7-9:30 p.m. Call Doug, x8194.

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

MILESTONES

BORN

■ [REDACTED] Martha (FESS/Admin) & Cleofas Garcia, [REDACTED]

HONORED

■ Don Petravick, of the Computing Division, on June 29, 1998, with a Fermilab Employee Recognition Award. Petravick led the group creating the data "pipeline" systems for the Sloan Digital Sky Survey.



RETIRING

■ Joseph Davids, I.D. #1812 on August 28, from PPD/Engineering & Tech Teams. His last work day was June 30.
■ Alan Guthke, I.D. #405 on September 30, from PPD/Engineering & Tech Teams. His last work day will be July 31.



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Please send your article submissions, classified advertisements and ideas to the Public Affairs Office, MS 206 or e-mail ferminews@fnal.gov.

FermiNews welcomes letters from readers. Please include your name and daytime phone number.

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Number 14

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All Roads Lead to FZero

There are no historic cathedrals, fountains, statues or paintings in evidence, but FZero is the Rome of Collider Run II at the Tevatron: all proton roads lead to it. Story on page 2.

FZero

The FZero project is paving a new proton-antiproton route between the Tevatron and the Main Injector. Temporary walls installed between the tunnels are coming down.

Photo by Reider Hahn



All Roads Lead to FZero

Switching area is on the Critical Path for success of the Tevatron in Run II.

by Mike Perricone, Office of Public Affairs

When Fermilab's Tevatron begins its next campaign in the realm of the subatomic, legions of particles, moving just below the speed of light, will engage in complex maneuvers through FZero on their way to the Tevatron and the collider detectors. FZero, named for its geographic location in the Tevatron tunnel, is the junction for protons moving along the acceleration process or heading off for the collisions that will produce antiprotons, as Fermilab takes the exploration of matter into the 21st century.

FZero used to be a "straightaway" where radiofrequency (RF) cavities accelerated the particle beam on its transit around the Tevatron and the Main Ring, which formerly sat atop the Tevatron but has been deposed by the Main Injector. There was no crossover point, because there was no Main Injector.

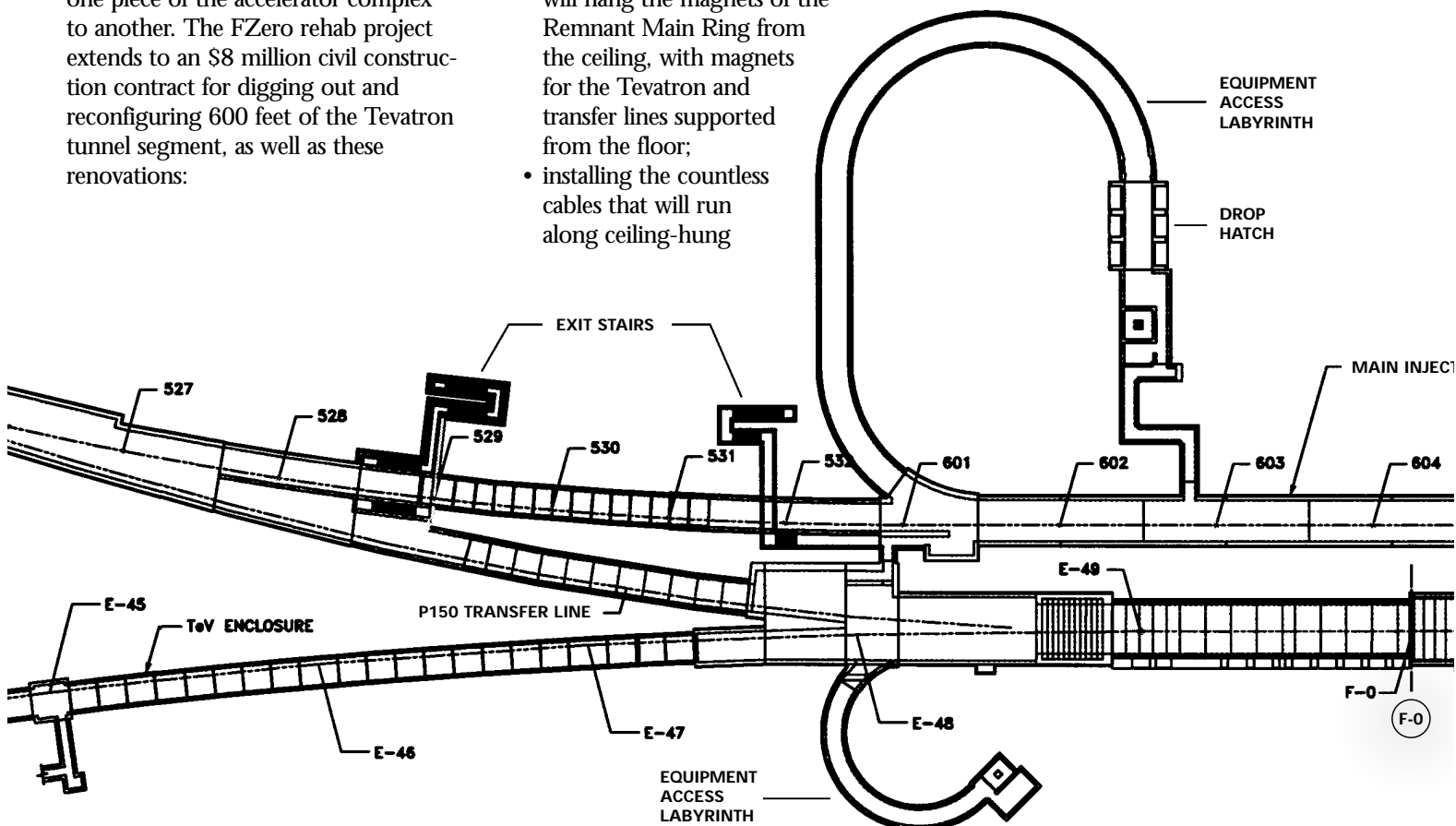
Run II makes FZero the busy main switchyard for protons zipping from one piece of the accelerator complex to another. The FZero rehab project extends to an \$8 million civil construction contract for digging out and reconfiguring 600 feet of the Tevatron tunnel segment, as well as these renovations:

- temporarily walling off the construction site from the remainder of the Tevatron and Main Injector tunnels, to prevent flooding;
- adding the transfer lines, which carry protons and antiprotons from one ring to another;
- demolishing part of the Tevatron RF service building, relocating former Main Ring RF instruments into the new Main Injector service building, and moving Tevatron RF instruments into the remaining part of the building;
- installing 4,000 tons of steel shielding;
- adding earthen berms to complete the shielding;
- re-installing the Tevatron's eight RF cavities;
- installing the magnets for the Tevatron, Main Injector and Main Ring Remnant (which come in a variety of lengths up to 20 feet) with as little as 3/4 inch of clearance between them;
- engineering a system of carriers that will hang the magnets of the Remnant Main Ring from the ceiling, with magnets for the Tevatron and transfer lines supported from the floor;
- installing the countless cables that will run along ceiling-hung

trays, carrying power and information to and from the site, and making sure there's no interference with the magnet hangers;

- aligning the Lambertson magnets, which provide the crucial beam switching between the 150 GeV transfer lines, the Main Ring Remnant and the Tevatron, to about 5/1000 of an inch;
- ...in a tunnel whose precise geometry won't be known until it's surveyed after the construction is completed, a tunnel that is likely to settle as much as an inch once the earth is backfilled above it, and that might not settle identically in all areas.

"It's a lot more complicated than we envisioned two years ago," said Larry Sauer of Mechanical Support, who is responsible for installing and aligning all the tunnel components. "We're putting more stuff back in than we took out."



In Run II, protons will come from the Main Injector and enter the Tevatron through the transfer line at the south of FZero; antiprotons will enter through the transfer line at the north. But first the antiprotons have to be manufactured. That means protons will come from the Main Injector and transfer to the Main Ring Remnant, exit at F 17 and head to the Antiproton Source; their numbers stack up in the Accumulator before they return to the Tevatron via the Main Ring Remnant and FZero.

CRITICAL PATH

“We can’t get beam into the Tevatron without FZero,” Sauer explained. “So it’s all got to work.”

The heart of the Tevatron, and thus the heart of Run II, resides in the eight RF cavities that were removed from the accelerator and have been sitting in a dusty service building that is itself awaiting renovation. The RF cavities accelerate particles by generating a 180,000-volt electric field across a gap of two inches, changing polarity at a rate of 53 MHz—53 million cycles per second.

“The cavities are resonators, like big organ pipes, except they resonate at 53 MHz,” said Dave Wildman, head of RF and Instrumentation. “They store energy from a power amplifier upstairs, which is like a big TV transmitter. There’s a gap at each end of the cavity. The beam gets accelerated when it goes through the first gap. Then it goes through a drift

continued on page 4



Photo by Reidar Hahn

The reconfigured FZero tunnel segment uses about 4,000 tons of steel for radiation shielding. “If we put all 4,000 tons together, the steel would form a cube 25 feet on a side,” said Dixon Bogert.

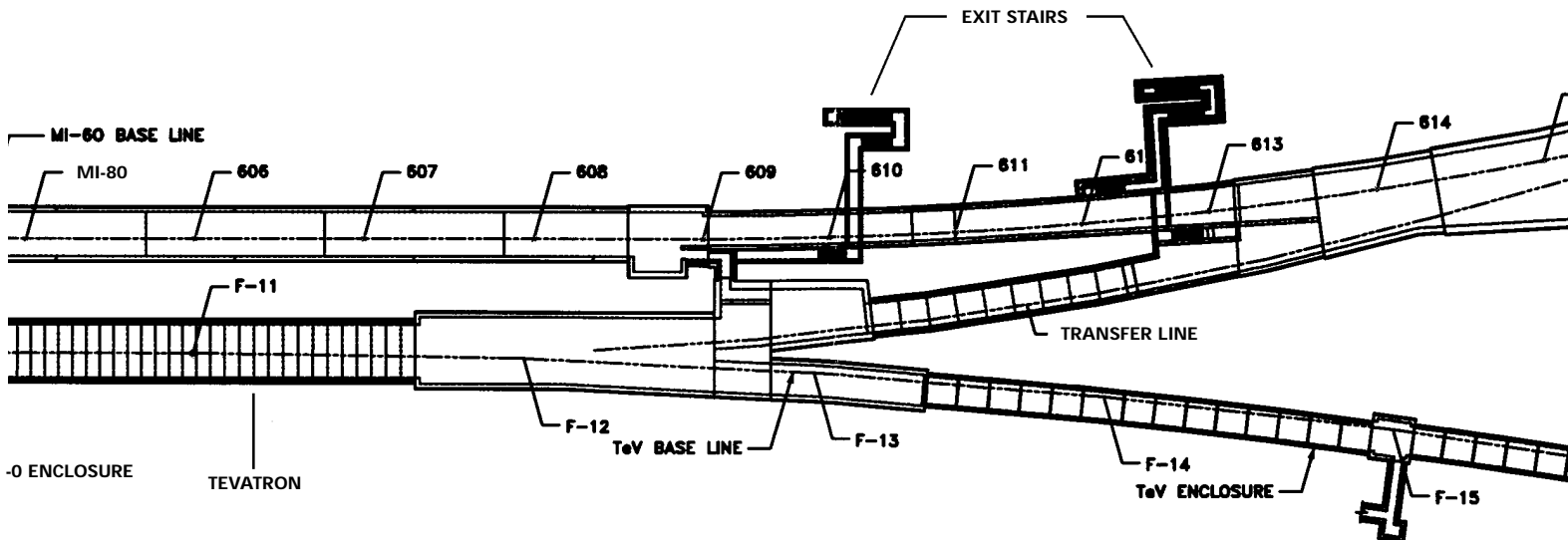




Photo by Reidar Hahn

Inside the accelerator enclosure, the Tevatron will be re-installed in the higher section on the left, while the Main Injector will reside in the lower section on the right. The temporary wall in the background is being removed.

FZero

continued from page 3

CRITICAL PATH

tube, about nine feet long. While it's in that tube, it doesn't see any field at all. Meanwhile, the field in the cavity has reversed, so as it goes out the other side it gets another kick. The two kicks are timed exactly to the resonant frequency of the cavity."

The Tevatron RF system, which cost about \$10 million in 1980, had to be removed from the FZero tunnel segment because it obstructed the construction.

"It took 40 people—the entire department—three weeks to tear (the RF system) apart," Wildman said. "It will probably take us at least three months to put it back together again, and it's going to take 40 people to get it done on time."

The tunnel work is proceeding from north to south under the watchful eye of Dixon Bogert, deputy head of the Beams Division, who was recently cited with

Project Support's Tom Pawlak for an Employee Recognition Award (see accompanying story). When the tunnel is completed to the point of full access, or beneficial occupancy, Lab personnel will install equipment, working side-by-side with construction crews.

The Main Injector can begin commissioning before the FZero project is completed, though it can't be run with beam until the construction area is secured. And because of the radiation hazard, other installation projects can't take place in the Tevatron tunnel while beam is running through the Main Injector, meaning shifts will have to be staggered.

"The only thing making it possible is that we can schedule many different activities simultaneously in different areas," said Phil Martin of the Main Injector Department, who has overall responsibility for the FZero project. "It's going to be tight, especially if we want to stop construction to do commissioning."

The other Rome wasn't built in a day, either. ■

Bogert, Pawlak Cited For Main Injector Construction

Bringing the FZero construction to a finish will mean closing a critical loop for the Main Injector, Fermilab's largest civil construction project since the Lab itself was built.

The Main Injector tunnel was completed in June 1996, the major component of the \$102-million construction project whose earliest design concepts date back more than 10 years. In its earliest stages, the Main Injector tunnel competed for funds with the Superconducting Super Collider. But ground was broken for the tunnel in March 1993, and the Main Injector took on added significance when Congress cut off SSC funding later that year.

"That changed the equation," said Beams Division head Steve Holmes, an original member of the Main Injector design team. "The project had good support, and we've been building since then."

Even with good support, Holmes described funds as "dribbling in slowly;" construction estimated at three years will take around six years to complete. Managing the civil construction was almost a "piecemeal" project for Dixon Bogert and Tom Pawlak, who were recently cited with Employee Recognition Awards for their work over the life of the Main Injector.

"If you have a lot of money up front, you can award big jobs to a single general contractor," Holmes said. "But they were doing phased funding, options, splitting big jobs into smaller jobs, to make do with the money we had available. That made their life much more difficult, but they did a great job."

Holmes expects the Main Injector to be ready for beam at the end of August, with commissioning beginning in mid-September. ■

"To Get Science Done"

DESY's Matthias Kasemann will head Fermilab's Computing Division.

by Judy Jackson, Office of Public Affairs

When the new head of Fermilab's Computing Division takes up his job on October 1, his first priority, he says is "to get experiments working."

But, says Matthias Kasemann, "this includes the role of Computing in giving service to all the areas of the lab. Computing is critical for data-taking and data analysis, for sure. But services for administration and engineering and all the other parts of the laboratory also belong to the effort, because they are all part of the work that contributes in the end to get science done."

In meeting the challenges coming up in Run II, with its huge amount of data, Kasemann said, it's important not to neglect the other computing needs of the laboratory, which he views as "at least as important" in achieving Fermilab's science goals.

Kasemann, 41, a high-energy physicist born in Dortmund, Germany, is currently a collaborator on the ZEUS experiment at Hamburg's DESY laboratory, where he has managed offline computing. He's working to complete a ZEUS detector upgrade, a project that will keep him in Europe until October.

Kasemann will replace Fermilab physicist Joel Butler as division head. Butler, who led the division for four years, began a new assignment on July 1 as leader of the Particle Physics Division's BTeV R&D Group, whose mission is to determine the scientific merit and technical feasibility of a proposed B physics experiment at the new CZero collision hall.

Fermilab physicist Steve Wolbers will serve as acting head of the Computing Division until Kasemann formally joins the laboratory in the fall.

"I've asked Steve to run the division until I can come to Fermilab, with frequent discussions with me," Kasemann said. "He is doing a great job, and I very much enjoy working with him."

Before joining DESY in the early 1990s, Kasemann spent several years at CERN, where he did his thesis research and joined the ALEPH collaboration at CERN's LEP collider. One of the great strengths of computing at Fermilab, as Kasemann sees it, is the number of scientists working in the Computing Division, and the resulting close ties to experiments.

"Compared to CERN and DESY," he said, "there is much more interaction between the Computing Division and the experiments. I think this is a good thing, because it helps to get efficient solutions to the challenges that the experiments face."

Fermilab officials were pleased to have recruited Kasemann, whose appointment resulted from the work of a search committee led by Fermilab theorist Estia Eichten.

"Matthias is very knowledgeable technically," said Associate Director Tom Nash, "and he is a careful, thoughtful decision-maker. He takes the time to find the best solution to both technical and human problems—and it's not always the most obvious solution, at first glance."

As a high-energy physicist, will Kasemann join a Fermilab experiment himself? Not right away, he says.

"For the first year or so, I have enough to do to try to step into Joel's footsteps. He was a good leader and he has an expert knowledge of the Laboratory, which I have to learn. So for the first year at least I will concentrate completely on the job of being Computing Division head. Afterwards, I am looking forward to participating in experiments. Because, in the end, I am a scientist and I want to work as a scientist."

Any thoughts about where he might find an experimental home?

"No," said Kasemann. "But I've already had some suggestions." ■



Photo by Reider Hahn

Matthias Kasemann, new Computing Division head will arrive at Fermilab October 1, 1998.

The Man Who Loved Ideas

The Meaning of It All: Thoughts of a Citizen Scientist.

By Richard P. Feynman. 133 pp.
Reading, Mass.: Helix Books /
Addison-Wesley. \$22.

by Chris Quigg, Theoretical Physics Group

Richard Feynman was my teacher long before we met. Ten years after his death, he remains an inspiration and example to me and to many physicists, an icon of a public scientist to a growing legion of admirers in the world at large.

Feynman was a remarkable presence. He was Feynman, the peerless scientist: the Nobel laureate who had constructed the theory of photons and electrons, invented the little diagrams that supplanted equations as the way physicists think about fundamental processes, and spoken delphically of antiparticles as particles moving backward through time. He was Feynman the captivating lecturer: the performance artist, really, who took seriously both his subject and his audience, punctuating his performances with wisecracks and homilies alike. And he was Feynman, the character: the bongo-playing safecracker who defended the First-Amendment rights of topless dancers.

When I met Feynman—having heard him lecture on film and in person, having studied the classic papers and worked through his two little books on *Quantum Electrodynamics* and *The Theory of Fundamental Processes*—I saw yet another face. One evening at a conference at Cornell in 1971, he took me off to a quiet corner and acted as if he expected to learn something from me. For more than an hour, he kept asking, “What do you know?” and “How do you know that?” and “How do you think about that?” and “What do you think *that* means?” I began to feel that he had catheterized my skull to siphon out every thought. This was Feynman the comrade, who wanted to learn to think the way Nature does; the man who loved ideas—and not just his own.

The Meaning of It All is drawn from three lectures Feynman gave in April 1963 at the University of Washington on the theme, “A Scientist Looks at Society.” The world was

Courtesy of the Archives, California Institute of Technology



Richard Feynman reveling in the company of one of the “new generations” at Caltech’s Freshman Camp in 1978.

still exhaling after the Cuban missile crisis. Two weeks earlier, Pope John XXIII had issued *Pacem in Terris*. The tyrant Trofim Denisovich Lysenko still directed the notorious Institute of Genetics in the Soviet Union. Feynman himself was just completing the two-year introductory course now known as the *Feynman Lectures in Physics*. He would soon give the famous Messenger Lectures at Cornell (which physics students still watch in grainy black-and-white film), and would receive the Nobel Prize in 1965 with Julian Schwinger and Shin’ichirō Tomonaga.

In the first lecture, “The Uncertainty of Science,” Feynman is the jubilant tour-guide to scientific insights and fervent apostle of “science as a method for finding things out.” Of knowledge gained through science, he writes: “This is the gold. This is the excitement, the pay you get for all the disciplined thinking



Photo by Reider Hahn

Chris Quigg, of Fermilab’s Theoretical Physics Group, regards Richard Feynman as an inspiration and an example.

and hard work. The work is not done for the sake of an application. It is done for the excitement of what is found out. ... [W]ithout understanding that, you miss the whole point. ... You do not live in your time unless you understand that this is a tremendous adventure and a wild and exciting thing.”

Science lives by its disdain for authority and its reliance on experimentation. The seventeenth-century gentlemen who founded the Royal Society of London took as their motto *Nullius in verba*—“Don’t take anyone’s word for it!” For Feynman, science “is based on the principle that observation is the judge of whether something is so or not.”

“Why repeat all this?” he asks rhetorically. “Because there are new generations born every day. Because there are great ideas developed in the history of man, and these ideas do not last unless they are passed purposely and clearly from generation to generation.” But Feynman does not merely “repeat all this.” He shows that the strength of science lies in its provisional nature, its open-mindedness, its capacity for doubt and uncertainty. Perhaps, he suggests, science’s experience with doubt and uncertainty is its great lesson for humanity.

In “The Uncertainty of Values,” Feynman argues that by admitting ignorance and uncertainty we may find hope for human institutions. He steps outside the safe terrain of scientific discourse because he acknowledges the limitations of science, and because “[w]estern civilization, it seems to me, stands by two great heritages. One is the scientific spirit of adventure—the adventure into the unknown, an unknown that must be recognized as unknown in order to be explored ... To summarize it: humility of the intellect. The other great heritage is Christian ethics—the basis of action on love, the brotherhood of all men, the value of the individual, the humility of the spirit.”

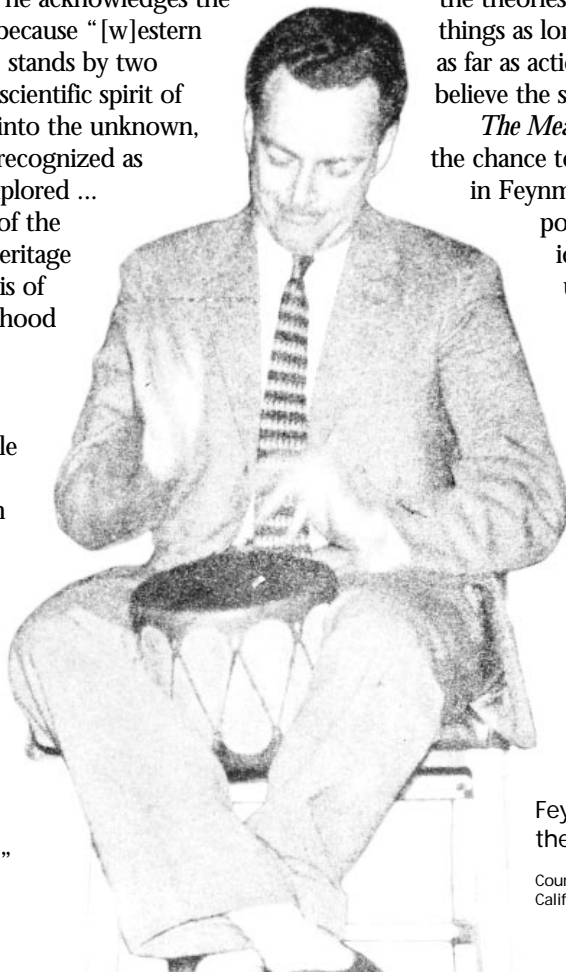
The ideological struggle of the 1960s between east and west was not “between socialism and capitalism, but rather between suppression of ideas and free ideas.” He believes that the “writers of the Constitution knew the value of doubt. ... The United States government, in that respect, is new, it’s modern, and it is scientific.”

Whether you find Feynman’s political science insightful or naïve, the link between science and freedom has not lost its importance. Czech President Vaclav Havel, who saw through every Stalinist lie except the specious claim that the Soviet system was “scientific,” now delivers postmodern indictments of the scientific worldview he links with totalitarian régimes. But Feynman counters: “Where did we ever get the idea that the Russians were, in some sense, scientific? ... [I]t is not scientific ... to be blind in order to maintain ignorance.”

The final lecture in this collection, “This Unscientific Age,” is a grab-bag of opinions and ideas, as long in print as the first two lectures combined. Here we find an early indication of his impatience with NASA: “It’s not necessary that we have so many failures, as far as I can tell. There’s something the matter in the organization, in the administration, in the engineering, or in the making of these instruments.”

Most provocative is Feynman’s view of religion as an impetus toward ethical behavior. In scientific matters, we require not only the correct conclusion, but also a correct chain of reasoning. What matters to Feynman in human affairs is not the motivation, but the behavior. He receives John XXIII’s encyclical with optimism “as the beginning, possibly, of a new future where we forget, perhaps, about the theories of why we believe things as long as we ultimately, as far as action is concerned, believe the same thing.”

The Meaning of It All is the chance to spend a few hours in Feynman’s company, to ponder and debate his ideas. It is also an unspoken challenge to physicists to think about the cultural and spiritual value of science and, following Richard Feynman’s example, dare to think aloud and in public. ■



Feynman,
the bongo aficionado.

Courtesy of the Archives,
California Institute of Technology

“ [Knowledge]
is the gold.
This is the
excitement, the
pay you get for
all the disciplined
thinking and
hard work.
The work is not
done for the sake
of an application.
It is done for
the excitement
of what is
found out.”

~ Richard Feynman

Tom Fields

NuMI Project Manager

Tom Fields, beside stakes marking the future site of the NuMI beamline

by Sharon Butler, Office of Public Affairs

Neutrinos may oscillate from one flavor to another and back again, but the four-decade career of Tom Fields has been as steady and solid as steel. Even as a teenager, he had already decided that, if there was such a thing as a physicist, that's what he wanted to be.

Fermilab has just coaxed Fields out of half-time retirement/half-time proton decay sleuthing at Argonne National Laboratory to serve as project manager for the NuMI experiment, designed to determine whether neutrinos have mass. Fields's declaration at his 65th birthday party in 1995 that he was "out of the administrative business for good" was apparently premature. Immersed now in technical design reports, budgets, reviews and WBSs, he has barely had time to settle into his sparsely appointed office space—which, appropriately, overlooks the site for the NuMI beamline.

It is the no-frills office space of a clear-thinking, nuts-and-bolts man who knows few distractions. So intense is Fields about physics that when he was on sabbatical at CERN, the European Laboratory for Particle Physics, in 1977, he sent back long and frequent letters detailing interesting measurements that could be taken with the new spectrometer at Argonne's ZGS accelerator—measurements that would have taken a good 10 years to complete. Cancellation of the Superconducting Supercollider was almost a personal affront.

Fields is skeptical of the oft-quoted idea that "all I really need to know about physics I had to dig up myself," insisting that the "help, advice and forbearance" of kindred collaborating souls got him through each new physics adventure. After earning his doctorate at Carnegie-Mellon University in 1955, his advisor suggested he study the new bubble chambers—and build one if it seemed to be a promising tool. Having spent his graduate days engaged in accelerators and counters, pions, muons and protons, he had barely heard of bubble chambers. But he built one anyway, with, of course, the help of others.

"Scrambling very hard on the steep part of the learning curve," as Fields puts it, didn't end there. With colleagues, he later built a 10-inch superconducting magnet, the first of its kind for use in bubble chambers. The magnet is now in the Smithsonian Institution's collection of particle-physics artifacts. Taking on administrative responsibilities as director of Argonne's High-Energy Physics Division in the 1960s was yet another novel experience.

Neutrinos are nothing new, though. Thirty years ago, Fields and colleagues published a limit on the neutrino mass from their bubble-chamber experiments.

Friends at Argonne believe Fields was eager to get back into the thick of things. And that's exactly where he is.

The NuMI project is well under way. Fields's predecessor, Gina Rameika, nursed the collaboration through difficult early years, says MINOS spokesperson Stanley Wojcicki, when the project was starved of funding because of Fermilab's other priorities. Wojcicki said Rameika will continue to be a crucial member of the NuMI collaboration. She is also doing important new work analyzing data from the DONUT experiment, looking for the tau neutrino, the only fundamental particle of the Standard Model not yet observed.

As Fields describes it, his task is to "get the NuMI project well enough defined so that we can move to the construction phase." A mile-long beamline needs to be built underground, and two huge multi-ton detectors.

Adding impetus to the NuMI project are the recent results from the Super-Kamiokande experiment suggesting that neutrinos have mass. Many physicists are now saying that the next new thrust in particle physics will be a deeper study of the lepton sector.

Fields reacts with a grin that spreads from ear to ear like a sinusoidal wave: "That's what we [in the MINOS experiment] have been saying all along." ■



Photo by Reidar Hahn

Do Not Sit on Your Hard Hat

The evolution, care, and application of modern safety head gear

by John Scifers, Office of Public Affairs

It goes by names like “brain bucket,” “cranial” and “protective head gear,” but the plastic helmet worn by industrial workers is most commonly called a “hard hat.” The path toward appreciating the hard hat and what it does has as many turns as the device has names.

Each year, manufacturers sell six million hard hats to customers who may give little thought to how the device, often the sole guard against serious personal injury, came into being. Its story began over 80 years ago, in the gold and copper mines of California, Nevada and Arizona. With little more head protection than soft, leather-brimmed derby hats, miners often suffered injuries from falling debris.

In 1915, Edward Bullard, whose father’s company sold carbide lamps and mining equipment, began designing a protective hat based on the “doughboy” helmet he’d worn in World War I. The device, made from layered canvas, glue and black paint, was known as a “hard-boiled hat” because of the steam used in its manufacture. The addition of a suspension device, and a patent in 1919, brought this forerunner of the modern hard hat into the world of industry.

Fourteen years later, the construction of the Golden Gate Bridge in San Francisco brought about America’s first designated “hard hat area.” Falling rivets threatened to injure construction workers, so Bullard reworked his mining head gear into a hard hat for the project.

The need for light, durable materials led to the aluminum hard hat in 1938. But because the metal hat exposed its wearer to electrical hazards, designs in the next decade incorporated nonconductive fiberglass materials. Cheaper thermoplastics entered the industry in the 1950s. Today’s hard hats use polyethylene plastic, valued for being lightweight, durable, malleable and electrically nonconductive.

Material choice reflects only one aspect of a hard hat’s design. Today’s hard hats provide more comfort and convenience than previous models. Accessories like face shields, hearing protectors and lamps can now be attached. Adjustable suspension devices inside the hats provide a snugger fit for comfort and safety.

Keeping a hard hat safe requires regular inspection and cleaning, which extend a hat’s service life. Cracked, gouged or dented shells

must be replaced, as should frayed or excessively worn suspension devices. The wearer should inspect the hat after any impact, replacing it after a heavy blow. The hat should not be thrown, dropped, or used for cooking lunch. And, Bullard advises, “Do not sit on a hard hat.”

Surprisingly, how to wear a hard hat is less clear. Some construction workers wear their hard hats with the brim to the rear. But most Fermilab safety professionals favor a brims-forward approach. Current Fermilab guidance calls for wearing hard hats brims-forward, but Laboratory safety staff will be reviewing this advice in the light of a new design and testing standard approved by the American National Standards Institute in 1997 and adopted by the Occupational Safety and Health Administration, said Environmental Safety and Health Section Head Bill Griffing.

From obscure beginnings, the hard hat has become an icon for worker safety around the world. In archaeological digs unearthing the oldest civilizations and in tunnel building for particle physics’s newest accelerator, hard hats crown the heads of the people who get the job done. ■



Photo by Reidar Hahn

The creation of industrial hard hats helped to protect construction crews, like these ironworkers, while working at the site of the Golden Gate Bridge, the first designated “hard hat area.”



Photo credit: Golden Gate Bridge, Highway and Transportation District.

At the Cold, Cold Heart of the Tevatron

Liquid helium, superconductivity and getting to 2 TeV.

By John Scifers, Office of Public Affairs

At 31 degrees Fahrenheit, North Atlantic waters can freeze a steel hull into brittle vulnerability, as the story of the Titanic revealed. At 40 degrees below zero, conventional thermometers become useless; the mercury freezes solid. At even colder temperatures, a child's rubber ball shatters like glass. And at 452 degrees below zero, close to the coldest temperature possible, an even stranger phenomenon emerges: "superconductivity."

This change in electrical property, which occurs in certain materials at extremely low temperatures, throws the floodgates open and allows electrons to flow unimpeded by resistance. It is achieved through the cooling effects of liquid helium. This element, the only substance that won't freeze solid at temperatures approaching absolute zero, cools electrical conductors to 4.5 degrees Kelvin, about -452 F, where a niobium-titanium wire's electrical resistance falls to zero and current flows freely.

Most house or car wiring carries about 15 amperes of current.

Superconductors can handle more than 250 times that amount, without heating up. Zero resistance also allows a relatively small voltage to generate massive current flow. In this way, the Tevatron's superconducting magnets operate at high energies with a lower electrical cost than conventional electromagnets. But cooling those magnets to cryogenic temperatures isn't cheap.

Fermilab spends about \$1 million each year on helium. When the Laboratory pioneered the large scale use of superconductors, helium conservation wasn't a design priority. So "quenches"—in which magnets lose their superconducting property and helium pressure shoots to a peak in under 250 milliseconds—add to losses from countless leaks, stealing a full inventory of helium each month, about \$80,000 worth. According to Jay Theilacker, head of the Cryogenics Department for the Beams Division, bubble leak checking and portable helium detectors don't help much: "[We can] find hundreds of leaks and we'll fix them and it won't put a dent in our helium loss."

The cost of cooling helium to extreme temperatures also adds up. Monthly electrical costs for the cryogenics system exceed \$350,000. This is due to "Carnot work," the theoretical minimum compressor power needed to cool a gas, 67 watts of compressor power for every cold watt of refrigeration. Ideally. In real life, though, the power required is much higher. Fermilab's compressors consume about 400 watts for every watt of 4.5 K refrigeration.

Those costs will rise in Run II, where additions and improvements to cold compressors and heat exchangers will allow temperatures as low as 3.5 K, roughly a degree colder than in previous runs. According to Theilacker, every degree closer to absolute zero at these temperatures translates to a 12-percent increase in the superconductor's current-carrying capability. This will aid the Tevatron in reaching a center-of-mass energy of 2 TeV in Run II. Because of Carnot work, the electrical cost of achieving this extra degree of refrigeration will be almost an additional \$50,000 each month.

Theilacker refers to the Tevatron's cooling system as "hybrid." Its central helium liquefier feeds up to 5,000 liters of liquid helium per hour to 24 satellite refrigerators distributed around the accelerator ring. Over 50 people operate and maintain the system, which is one of the world's largest.

Keeping the Tevatron's magnets cool enough to achieve superconductivity requires a staggering number of resources. And Run II will call for record levels.

Eighty-six years ago, cold liquid shattered a great endeavor when it helped break, and then sink, the massive Titanic. But today, the coldest liquid on earth makes it possible for the smallest particles to fly at close to the speed of light. ■



Photo by Jenny Mullins

To prevent the ultimate cold shower, Engineer Jay Theilacker checks the tag on a helium dewar, a storage tank used to minimize helium loss from the Tevatron.

"A Little to the West..."

The DZero solenoid magnet, encased in the Central Preshower Detector, moves slowly towards its place in the heart of the DZero Collider Detector. Senior technician Del Miller (bottom of photo) directs the crane operator in the delicate operation, with ample sidewalk superintendence by, among others, Deputy Department Head Gene Fisk (far right). The new magnet is a critical part of the detector upgrade that will prepare DZero for the high-luminosity collider physics of Run II at the Tevatron. ■



Photo by Reidar Hahn

Chez Léon

M E N U

Lunch served from
11:30 a.m. to 1 p.m.
\$8/person

Dinner served at 7 p.m.
\$20/person

For reservations, call x4512
Cakes for Special Occasions
Dietary Restrictions
Contact Tita, x3524
[http://www.fnal.gov/faw/
events/menus.html](http://www.fnal.gov/faw/events/menus.html)

Lunch Wednesday July 22

Thai Chicken Pasta
Cream Puffs with Pineapple
and Caramel Rum Sauce

Dinner Thursday July 23

Séviche
Grilled Duck Breast
with Orange Bourbon Sauce
Wild Rice with
Green Onions and Pecans
Vegetable of the Season
Crêpes with Strawberries
and Grand Marnier

Lunch Wednesday July 29

Beef and Vegetable Salad
with Ginger Dressing
Mango Banana Cake

Dinner Thursday July 30

Grilled Vegetable Salad
with Goat Cheese and Pine Nuts
Tuna with Sweet and Spicy Sauce
and Mango Pineapple Salsa
Lemon Pepper Pasta
Hazelnut Meringue
with Espresso Ice Cream
