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INSIDE

Path to the Energy Frontier?
A Very Large Hadron Collider

Fermilab physicists are contemplating designs for a Very Large Hadron Collider to pursue physics beyond the Standard Model.

By Sharon Butler, Office of Public Affairs

Forty years ago, extrapolating from existing technology, Enrico Fermi thought that by 1994 physicists would need an "accelerator in space"—a fixed-target machine circling the globe—to achieve a beam energy of about 3 TeV in the center of mass. In one sense he was right. Not much before 1994, Fermilab's Tevatron began probing precisely this range of energy, and discovered the top quark.

In another sense, though, Fermi was wrong. Even the newest accelerator that physicists are dreaming up will be big, but not that big. And it won't be flying in space, either; it will be buried 400 feet below the ground.

For lack of a better term, physicists are calling the proposed accelerator the Very Large Hadron Collider. But that name is derivative, suggesting that this state-of-the-art machine would be just a bigger, one-step-better version of the Large Hadron Collider now under construction at CERN, the European laboratory for particle physics. Nothing could be further from the truth.

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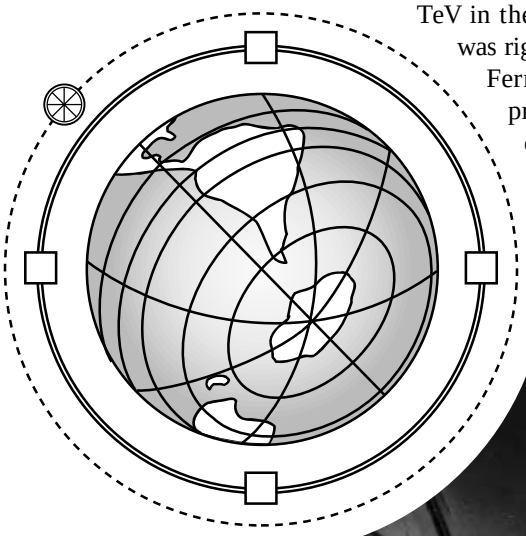

Enrico Fermi's 1954 sketch of his "accelerator in space."

Imre Gonczy applies voltage taps to a high-field quadrupole magnet for the LHC. More advanced magnets of a similar design could be used in a future VLHC.

Photo by Fred Ullrich

Save the Antiprotons!

An Antiproton Recycler will increase the Tevatron's luminosity.

by Andrew Shih, Office of Public Affairs

On the ground floor of Fermilab's Wilson Hall, you'll find bins for recycling paper, cardboard, aluminum cans, and even printer cartridges. But a half-mile to the south, in an underground tunnel, the Beams Division staff are constructing a much larger container for a far more exotic material; they'll be recycling antiprotons.

The Recycler Ring

Following the demise of the Superconducting Supercollider in 1993, high-energy physicists found themselves facing a vacuum in the future of their field. The machine around which many of their plans had circled would never be built.

"It was clear that the U.S. hadron program had to be rejuvenated," recalled physicist Bill Foster. Fermilab physicists began exploring possibilities for upgrading the Fermilab accelerator facility and eventually decided to improve the luminosity, or collision rate, in the Tevatron. The Recycler Ring will make this goal a reality.

A beam of particles in the Tevatron gradually diffuses as it circulates through the accelerator, much as the beam from a flashlight spreads out. Eventually, the beam becomes so diffuse that it must be discarded, or "dumped." In a typical collider run, accelerator operators must dump 80 percent of the particles produced. While this is not a problem with easily produced protons, antiprotons are a different matter; it takes tens of thousands of protons to create a single antiproton. At the end of a cycle, the Recycler will retrieve, decelerate and store these unused antiprotons. Using them in later cycles will increase the number of antiprotons in the beam, doubling the number of particle collisions.

Although others had proposed a Recycler-like machine before, the confluence of two critical ideas made it possible: the integration of antiproton recycling into collider operations, the brainchild of Recycler Project Manager Gerry Jackson; and the use of permanent magnets, which arose during a discussion between Jackson and Foster.

Permanent magnets

The Recycler Ring will use permanent magnets on a scale unprecedented in high-energy physics. While previous rings have used permanent magnets in very small numbers, the Recycler will employ permanent magnets as the primary magnets for the first time.

Electromagnets, the standard in accelerator magnet technology, require a current to generate the magnetic fields that guide particles around a ring. Permanent magnets, like those stuck to your refrigerator, don't require a power source. For particle storage rings like the Recycler, where the magnetic field need not vary, permanent magnets provide a simple solution to magnetic field demands.

Above: Inside the Main Injector tunnel. Recycler magnet models hang from the ceiling above Main Injector electromagnets.

Left: The Recycler will rest in the 2-1/4-mile Main Injector tunnel.

The Recycler project will manufacture its permanent magnets at rates "unheard of for regular copper-iron [electro]magnets," according to Jackson. Assembly consists essentially of stacking magnet bricks together —not a complicated task.

"In addition," he said, "we didn't have to buy power supplies, we didn't have to install cooling water systems, we didn't have to install safety systems, copper busses along the ring, [or] all this other stuff, so it was a huge savings going in this direction."

Foster described it succinctly: "The [magnet] is just sitting fat and happy making its magnetic field."

Of course, even the simplest of plans hits an occasional snag, and permanent magnets were no exception. The magnetic field they generate varies significantly with temperature. Fortunately, someone had already solved this problem. Commonwealth Edison employs the same permanent magnet material in house electricity meters and uses a compensating alloy patented in 1907 that, when stacked side-by-side with the magnets, exactly cancels the effect of temperature on the magnetic field. With that hurdle overcome, magnet design, led by Foster, began in earnest.

Beam position monitoring

While permanent magnet development progressed, other Recycler subsystems moved forward with equal success. Among these is Beam Position Monitoring, which records the exact location of the antiproton beam within the beam pipe, information crucial to the operation of any accelerator or particle storage ring.

"It's always fun to work on a new project, a new kind of machine," said BPM engineer Sharon Lackey. The Recycler "is a little different from any of the systems that we've done before, but not totally different; it's an evolution."

Ed Barsotti Jr., a Fermilab electrical engineer, agrees. Working with technician Rich Meadowcroft and others, he has developed systems to process BPM signals carried from the Recycler Ring to service buildings on the surface. During development, he was pleasantly surprised to discover that the steady beam of the Recycler allowed him to use a computer chip commonly found in cellular phones.

"Although our use for [the chip] is far from its intended use, the fact that it's used in cellular technology means that it's much cheaper. Just by going from the original chip, which we had previously used, to the new one, we saved $40,000," he said.

The unique nature of the Recycler also demanded some creative solutions from the BPM team. Some of their electronics will sit in the Main Injector tunnel during accelerator operations and will have to withstand significant radiation levels. "Radiation-hard" chips typically undergo manufacturer testing that increases their cost by a factor of 20. Fermilab engineers found a simpler solution.

"We found the most radiation-intense place in the Booster and put different chips down there for a year and a half, seeing which chips survived," said Barsotti. This simple approach avoided dramatic cost increases while providing an effective test of the necessary electronics.

Today, Barsotti said, "things are looking pretty good." The BPM team, along with all the other subsystem development teams, looks forward to the day when their systems begin operation.

Funding and the future

Construction and funding of the Recycler Ring falls under the aegis of the Main Injector. At the same time that Jackson and Foster began promoting the Recycler concept, Steve Holmes, Main Injector project manager, realized that the Main Injector would not need the contingency money budgeted by the U.S. Department of Energy.

"There was an opportunity to try to spend that left-over contingency money on the Recycler, which we felt would gain us a factor of two or so in luminosity," Holmes recalled. "It was an enormous bargain."

The Recycler budget currently stands at $12.5 million, making it by far the least expensive accelerator of its size ever constructed. Jackson credits the efforts of many Fermilab physicists and engineers with working to keep the cost down.

"This will be the eighth-largest particle accelerator ever built in the world ... a tremendous bargain. A lot of very good people helped do that," he said.

The Recycler Ring received formal DOE approval in February of this year. Jackson hopes to test a section of the machine in the spring of 1998 and begin circulating antiprotons in summer of that year. In 1999, the Recycler Ring, along with the Main Injector, will begin full operation, making Fermilab home not only to the world's highest-energy particle accelerator, but quite possibly to the world's highest-energy recycling facility, as well. ■

Photos by Reidar Hahn

Engineer Sharon Lackey works on data acquisition electronics for the Recycler Ring.

Physicists Gerry Jackson and Bill Foster inspect a permanent magnet.

Fermilab Considering Means of Reducing Deer Population

After an independent study documented serious environmental damage caused by deer, the U.S. Department of Agriculture is recommending a solution.

White trillium
Deer have devastated populations of this and other wildflowers, shown on the following pages.

by Sharon Butler, Office of Public Affairs

The overpopulation of white-tailed deer at Fermilab is causing an increasing number of vehicle accidents and, according to an independent five-year study, significant damage to the ecosystem.

Because of the ecological damage and the safety hazards, earlier this year the U.S. Department of Energy contracted with the U.S. Department of Agriculture's Wildlife Services to devise a solution.

In an Environmental Assessment required by the National Environmental Policy Act and now under review, USDA has recommended using a combination of methods, including reducing the size of the deer population by lethal means and implementing nonlethal measures, such as altering habitats that attract deer.

While DOE and Fermilab must concur with USDA's proposal before the agency's recommendation can be implemented, Rod Walton, head of Fermilab's Environmental Protection Group, emphasizes that any efforts to manage the deer population will be part of an ongoing program to restore the health of the ecosystem and preserve the Laboratory's site for science and public enjoyment. Through concerted environmental efforts since its inception, Fermilab has restored more than 1,000 acres of tall-grass prairie and maintains today over 200 acres of wetlands and 300 acres of forests.

Deer population

According to Walton, the last aerial survey of the deer population at Fermilab was conducted in 1994 and counted 340 deer. Aerial surveys are the most accurate means available for estimating the size of a wildlife population, but are expensive and require certain weather conditions (e.g., six inches of snow.) Consequently, since 1994, only spotlight surveys have been done—at night, from the back of a pickup truck—which typically underestimate the deer population by at least 50 percent. Using this method in 1997, the Environmental Protection Group counted 332 deer in April and 352 in May. In June and July, when profuse vegetation hides the animals, the staff counted 171 and 182 deer, respectively.

Because of the uncertainties in the survey methods, Walton does not know exactly how many deer are on the site, but estimates of the population size range from about 500 to 1,000.

Even the most conservative estimate of 500 means that Fermilab has 50 deer per square mile. According to a pamphlet issued by the DuPage County Forest Preserve, "the ecological carrying capacity of an ecosystem, or maximum number of deer an area can support and still remain healthy, is estimated to be less than 20 deer per square mile." As deer multiply beyond that number, certain plants dwindle in number or disappear altogether, leading to a loss of biological diversity and a gross alteration in native plant communities. Without plants to

Browsing by deer creates a neatly shaved vegetation line on the edge of the forest.

Photo by Mike Becker

Sparse vegetation in areas browsed by deer (right) contrasts with the taller and more abundant vegetation inside the fence.

Deer damage the bark of trees by rubbing it with their antlers.

Photos by Reidar Hahn

Red trillium

provide habitat and resources, other wildlife are threatened—bird populations, in particular, according to the Forest Preserve literature. Eventually, deer, too, will suffer, as their numbers grow and the competition for limited resources intensifies.

Ecological damage

Damage is already evident in Fermilab's environment.

Walton points to the obvious "browse lines" in the forests, where deer have destroyed the vegetation from the ground all the way up to a height of about five feet. "It looks like someone did a hedge trim," said Walton.

In a 1992–96 study on the impact of white-tailed deer, Victoria Nuzzo, a researcher with Native Landscapes, an environmental consulting firm, documented significant damage in Fermilab's forests and prairies. Nuzzo created what are called deer exclosures, fenced plots of land to keep out deer, alongside open control plots. In contrast with the fenced areas, where vegetation grew significantly taller over two years and plants flowered after three to four years, the vegetation in areas where deer continued to browse remained short and patchy, and the average cover declined.

Perennial herbs suffered most. In plots protected from deer, the coverage of these herbs increased by 200 to 500 percent; in open plots, there was a 50- to 70-percent decline.

In her final report, Nuzzo described the changes due to winter browsing in one of Fermilab's forests over the five-year period: "Woods 23 became increasingly open, as tall shrubs and saplings disappeared and areas lacking woody vegetation increased. The decline in short stems in the fifth year further opened up the understory; by 1996 the woods appeared empty…." Alterations such as these, Nuzzo noted, can lead to a decline in populations of songbirds and insects.

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The Diversity of Aurora

Nearly one-quarter of Fermilab's employees live in this historic river town.

by Donald Sena, Office of Public Affairs

Depending on one's vantage point, the city of Aurora, Illinois, brings different images to mind. Some from outside the state can't help but think of Aurora's infamous cable TV access station and its flagship show starring Wayne and Garth. Closer to Chicagoland, many Fox Valley residents know the city for its new riverboat casino with a Hollywood spin. And at Fermi National Accelerator Laboratory, which skirts the city's northern border, nearly one-fourth of the employees know Aurora as their hometown.

Many of Fermilab's 400 employees who reside in Aurora list a host of reasons for choosing this river town, from the city's rich history to the scenic Fox River to the park system. However, according to residents and community leaders interviewed for this story, the diversity of the population is one of Aurora's greatest attributes and strongest appeals. Aurora is Illinois's third-largest city with about 117,000 residents, and over one-third of the city's population is spread among minority groups.

"We have many cultures that have affected the growth and development of Aurora," said David Stover, Aurora's mayor.

Rene Padilla, an engineer at Fermilab and a 17-year resident of Aurora, said the town offers ethnic groups a chance to celebrate their culture and have a voice in the community. Kenneth Hinterlong, an Aurora alderman, agreed.

"It's really a series of small towns," Hinterlong said, referring to the fact that Aurora has many areas with distinct personalities woven into the community fabric.

Stover added that the city offers numerous opportunities for people of all races and income levels. Specifically, he noted the range of housing available in the city, from inexpensive apartments to starter homes for young families to million-dollar mansions. This allows families to grow in size and income, yet still remain a part of the community. Kathy Johnson's family is proof of the city's lasting appeal. Johnson, Fermilab's receptionist, has lived in the city all of her life and has no plans to leave. The roots are deep, she said; her mother has lived in the same house for 73 years.

History

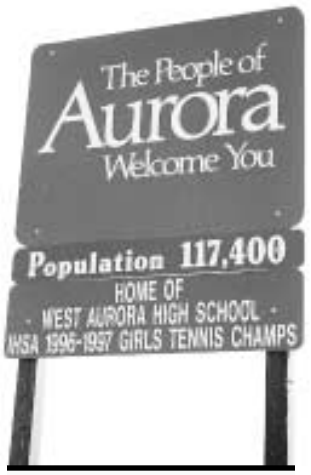
Fermilab's Bill Flaherty said one appeal of the town for him is the rich history, and he hopes to become more involved with the historical society as he nears retirement age. He said that long before Fermilab arrived and the western suburbs exploded in population and development, Aurora was a hub of activity in an otherwise sleepy area.

Michael Saville, one of 10 aldermen, said Aurora "grew up separately from Chicago and we have our own history."

In the 18th century, the Potawatomi Native American tribe thrived in the Fox Valley area. The first white settlers to the area were the two McCarty brothers, who built mills so early residents could construct houses and prepare their food, and the nascent town was known as McCarty's Mills. In the mid 19th century, the population had grown so much, the town applied for a post office. Village residents selected Aurora for a town name, honoring a village in New York. Another pair of brothers slowly developed the west side of the Fox River near the McCarty's home, and in 1857 the two towns united to become the city of Aurora (nicknamed the "City of Lights" because it was the first community nationwide to install electric street lights).

Through the years, Aurora had many industries, from stove works to the second largest corset works in the world. More corset factories arrived in following years, along with other clothing industries, and "Aurora became a major center of women's apparel manufacture," according to the Aurora Historical Society. In the 19th and early 20th centuries, everything from machinery used to dig the Panama Canal to motorcycles and cars to steel lockers and furniture were manufactured in Aurora. However, in the late 1970s and early 1980s, Aurora's economy "bottomed out," according to Saville.

"We suffered the normal blue-collar, manufacturing town syndrome," said Saville, referring to the disappearance of many of the



This is the first in a series of articles on Fermilab's neighboring communities.

Photos by Reidar Hahn

The Hollywood Casino riverboat, which opened last year, is one of the town's largest employers.

COMMUNITY PROFILE

manufacturing industries and jobs that had sustained the city. At about the same time, the Fox Valley Mall opened on Aurora's east side and much of the commercial development followed, draining the downtown of its base.

Economic development

In recent years, Aurora has experienced a bit of an economic revitalization. The city had record commercial investment in 1996 and is on pace for another good year in 1997. According to community leaders, the opening of the Hollywood Casino riverboat has been a major part of the recent upswing. Hollywood Casino's "investment of over $70 million on the boats and connected land facilities was the largest single infusion of capital in Aurora's history," according to the historical society. The casino is now one of the city's largest employers. The median household income is up from $24,279 in 1986 to $48,087 in 1996, and unemployment dropped from over 15 percent in 1982 to 4.6 percent in 1997.

One area of concern for community leaders, however, is the ability to generate interest from investors in downtown Aurora, according to a local newspaper reporter. Growth in that important area has not been as steady as town leaders had hoped.

Issues

Development and increased population can also bring with it growing pains. Aurora has experienced the problems common to many expanding mid-size to large cities in the country. Crime is an increasing concern among residents, and the police force is dealing with growing gang activity.

The crime has worried Glenda Boston, a Fermilab employee and Aurora resident, but she said she hopes the topic doesn't dominate the discussion about her hometown. She admits she can't leave her door unlocked anymore, as her family did when she was a kid, but her neighborhood has a strong sense of community, which brings her neighbors together for Crime Watch as well as an annual summer picnic.

As a source of pride, Boston and community leaders also point to Aurora's school system, which includes 38 elementary schools, eight middle schools and three high schools. Aurora is also the home to Scitech, an interactive science center, and the city has the distinction of being the first large community in the country to connect every school to the World Wide Web.

Fermilab connection

It's fitting that Aurora schools led the way in using the Web, as high-energy physicists pioneered its development.

Fermilab sits just outside Aurora's northern border, where some newer business parks are filling up. Hinterlong said some Aurora residents either don't know what the Lab does or have a misconception about the research. However, several Fermilab employees said many residents know a lot about the Lab's high-energy physics research and its quest to explore the basic constituents of matter and the forces that govern them. Moreover, the employees said Aurora residents are frequent visitors to Fermilab, taking in the science displays in the visitor area or enjoying the open space and recreational activities, such as fishing or biking.

One Aurora resident who knows all about the Laboratory is the mayor.

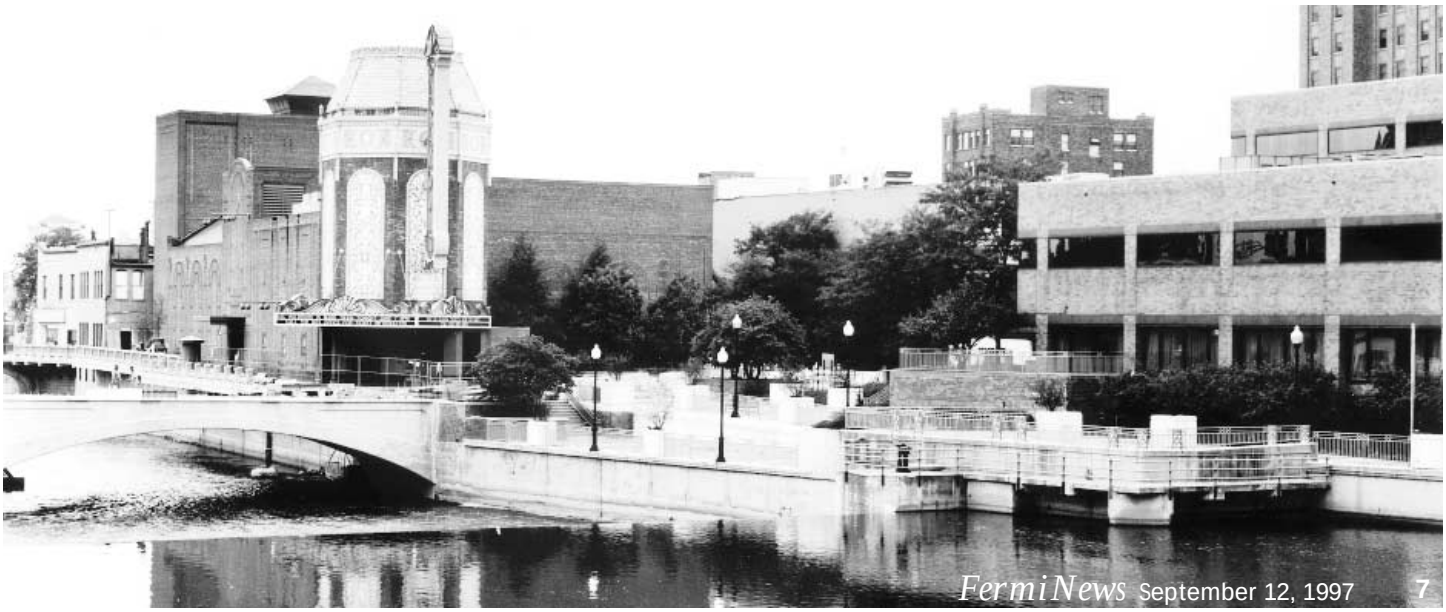
Having Fermilab near Aurora "is really something to be proud of," said Stover. "It provides jobs and career opportunities and it's one of the cornerposts, if you will, of discovery."

He added that he was not surprised so many Aurora residents work at Fermilab, as the city has a diversified work force and people with many talents, which fits with Fermilab's employment opportunities. ■

Glenda Boston, of Fermilab's Key and ID Office, has lived in Aurora all of her life.

Fermilab's Bill Flaherty enjoys Aurora's diversity.

Aurora, with a population over 100,000, is split by the scenic Fox River.



Photos by Reidar Hahn

VLHC

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For scientists here at Fermilab are speculating about accelerators that, by 2015 or even sooner, would begin probing physics beyond the Standard Model. One of the designs for such a "discovery machine" is the VLHC, pitting proton against proton at a center-of-mass energy of 100 TeV, seven times higher than in CERN's LHC. As physicists now conceive the machine, Fermilab's Main Injector would thrust protons into a 3-TeV booster, and from there into a collider so huge it would extend far beyond the Laboratory's boundaries.

To date, the VLHC exists only in intricate calculations, computer simulations and mechanical prototypes. Many questions remain—not only about its name, but about the magnets, the cryogenic hardware, and the vacuum systems, and how these multiple components would mesh. The design will require a "significant amount of engineering study and deep thinking," says Peter Limon, head of the Technical Division.

But momentum seems to be building, and physicists have gotten started none too soon. For according to Michael Albrow, a Fermilab physicist involved in the project, a VLHC could take "up to five years of serious R&D, then perhaps a decade of detailed design and construction."

Some physicists have set themselves an added challenge: they hope to build a machine at one-tenth the current pricetag per TeV, that is, a machine that costs between $20 million and $40 million per TeV of beam energy, instead of $200 million to $400 million.

Technological cleverness

One way to do that is to be "technologically clever," says Limon, although he emphasizes that advances in technology will make the machine "cheaper, but not cheap."

Since the magnets that coax the beam of protons around the circumference of the collider consume 25 to 30 percent of the total cost, says Ernest Malamud, Fermilab physicist and coordinator for a group studying a VLHC, "that's where one really has to focus one's R&D to make an accelerator affordable."

Currently, physicists are considering three magnet designs: a low-field magnet and high- and higher-field magnets.

Magnets—high or low?

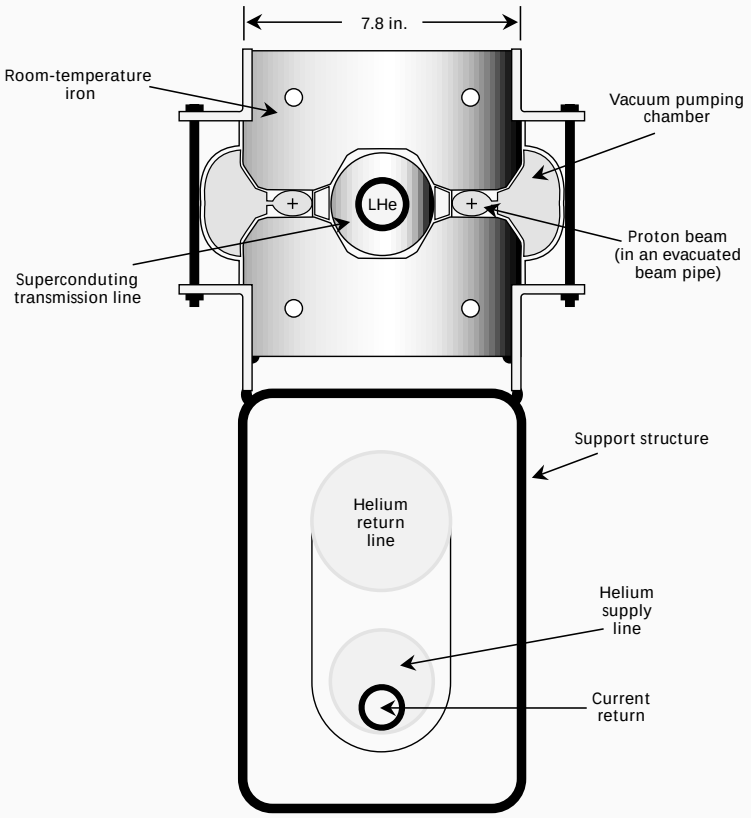
The low-field (two-Tesla), or super-ferric, magnet uses "the magic of iron," says Malamud. The design is "particularly elegant," in Limon's words—and incredibly compact. The brainchild of Fermilab physicist Bill Foster, the device, called the Double-C magnet, carries current in a single transmission line that powers the two gaps in which the proton beams circulate; typically, accelerators have two magnets, one for each beam. It also combines in one unit what most large accelerators allocate to two: the quadrupole, the magnet that focuses the beam, and the dipole, the magnet that steers the beam around the collider.

Another advantage: the Double-C magnet has a low "cold mass." Cold mass is the mass of the material that needs to be cooled to make the material superconducting. If it is low, cooling becomes easier.

Finally, in Foster's design, the conductor sits in the middle with all the other components positioned symmetrically around it. When the conductor is perfectly centered, there are no magnetic forces on the transmission line, so the magnet needs only a flimsy support structure. For cryogenic reasons, the flimsier the better: A smaller support structure means less heat absorbed from outside the magnet, fewer cryogenic parts to keep the magnet cool, and lower operating costs.

But Foster's low-field magnet has problems that need to be resolved. For example, because

Bill Foster's new design for a low-field magnet, called the "Double-C"



of certain design features, some physicists believe the beam could too easily be knocked out of line.

As for the high-field magnets, they have their own advantages and disadvantages, depending on whether the field is 9.5 Tesla or higher still.

The primary advantage of high-field magnets over low is a phenomenon called synchrotron radiation damping. As particles speed around the collider's circumference, they radiate, or lose energy. This creates problems (the energy lost must be replaced, for example), but produces at least one positive and important effect. Energy is lost in all directions, but is replaced only in the direction of motion; consequently, over time, more particles are concentrated in a narrower spot. "You get more luminosity [and hence more particle collisions] for less beam," says Limon. In fact, because of this phenomenon, "you don't have to take care to preserve the brightness [or focus] of the beam, your magnets don't have to be as good." The damping compensates for the imperfections.

The 9.5-Tesla magnet also has a practical advantage. "We know how to build magnets like that," says Limon. The Technical Division is now constructing quadrupoles with peak fields of 9.5 Tesla for CERN's LHC. These magnets won't be as cheap as the low-field magnets, Limon acknowledges, but component, accelerator physics and system design issues are well understood.

No one yet knows how to create a still higher-field (12.5-Tesla) magnet, according to Limon, although the University of Twente, in Holland, and the Lawrence Berkeley Laboratory recently built models using low-temperature niobium-tin superconductors. High-temperature superconductors will be key to creating 12.5-Tesla magnets, but in Limon's view are a "long way away from industrial production."

Underground tunnel

Whichever magnet proves feasible, the collider would have to be larger than any that exist in the world right now—from 62 miles in circumference with the high-field magnets, to a gargantuan 300 miles with the low-field magnets. A collider so large incurs special problems. The sheer scale of the machine, for example, makes construction difficult, says Limon. Also, the tunnel for the collider would have to be built not 20 feet below ground, as the Tevatron is, but 400 feet.

The unusual landscape around Fermilab makes that feasible, says Malamud. First, there is no risk of earthquake; none has occurred in recorded history. Second, the area is flat. And third, this is a glaciated region, whose hard, uniform dolomite rock layer offers predictable tunneling conditions.

Photo by Reidar Hahn

An early prototype of the low-field magnet, with some of the staff involved in its design and installation. From left to right: Butch Bianchi, Cosmore Sylvester, Dean Validis and Peter Mazur. Not shown: Bill Foster and Dean Sorensen.

About that name

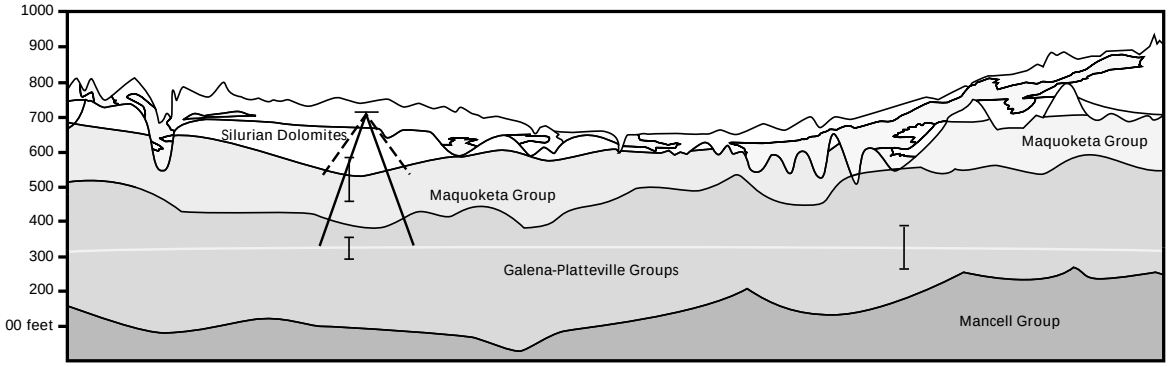
Long before a construction crew breaks ground for a subterranean tunnel, however, the VLHC will need a proper name. Selecting one appears nearly as difficult as correcting a beam's instabilities.

Pinned to Malamud's corkboard is a list of more than 50 names that physicists have suggested so far. The submissions range from the patriotic (Americatron) to the irreverent (sewertron), to the whimsical (Pink Bunny Energizer), the respectful (R.R. Wilson Project) and the presumptuous (Fermilab's Deep Pipe for Science and Humanity).

None of the monikers has stuck just yet. Physicists are still looking for a name that will capture the possibilities lying buried deep in a proposed tunnel in Batavia, deep in inner space. ■

Photo by Fred Ullrich

Steve Gould and Don Nurczyk are keying a high-field quadrupole magnet for the LHC.



The geology of the Fermilab region, with its homogeneous dolomite rock mass, allows low-cost tunneling.

Deer Population

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Wild white indigo

Canada tick-trefoil

Destruction of the prairies was not as evident on a large scale—in part, Nuzzo hypothesized, because deer have so many other sources of food in Fermilab's forests and agricultural fields. However, individual species suffered dramatically. Each year of the study, for example, deer consumed 60 percent of all Canada tick-trefoil.

Safety issues

Meanwhile, Fermilab Security has recorded an increase in vehicle accidents involving deer, from 13 in 1995 to 24 in 1996. These figures underreport the number of accidents, since not everyone calls Security when an incident occurs, according to Walton.

Security has logged eight accidents so far this year, but most incidents occur in the fall, during the rutting season. In one incident last month, a Security staff member swerved to avoid hitting a deer and crashed into a pole, causing $4,600 in damage to the vehicle. The individual lost eight days of work due to whiplash injuries.

USDA's proposal

USDA's proposal contains several alternatives for controlling Fermilab's deer population and preventing accidents and ecological damage. One alternative is to change the crops that are grown in the Lab's agricultural areas that attract deer. Another is to apply chemical repellents to protect ornamental plants.

However, USDA emphasizes that, because the herd of deer at Fermilab is so large, such measures alone cannot resolve the problem. Chemical repellents, for example, which Fermilab currently uses on an experimental basis, can only discourage deer from consuming certain vegetation; the deer can turn to other plants.

Yet reducing the size of the deer population is difficult—and, in terms of public reaction, more sensitive.

One obvious tactic—relocating deer elsewhere in Illinois—is not a viable option. Studies show that relocated deer suffer an 80-percent mortality rate. Moreover, the Illinois Department of Natural Resources requires that deer be relocated only to not-for-profit zoological institutions; deer may not be released into the wild. Currently, however, no zoos in Illinois accept white-tailed deer, according to Marty Jones, head of the Illinois Deer Project.

Recently, an experimental technology called immunocontraception has gained attention as a humane way of stabilizing deer populations. Immunocontraception involves injecting a doe with a hormone created by recombinant DNA methods. The doe then receives a booster shot a few weeks later, and every year thereafter. If the method is successful, the doe's own immune system attacks and destroys the animal's hormones and prevents pregnancy.

"I was very excited about this option a few years ago," said Walton. But immunocontraception proved infeasible at Fermilab. The site is wide open, making it difficult to monitor the deer, both logistically and financially. According to one estimate, a vaccination program can cost more than $500 per doe per year, and the side-effects of the hormone are unknown. Also, Fermilab has no fences or natural barriers to prevent fertile deer from other areas from migrating in. To date, immunocontraception has been successful only with isolated populations, such as the herd at Fire Island National Seashore in New York.

In addition, according to expert Dr. John Turner, at the Medical College of Ohio, immunocontraception is a tool not for reducing deer populations but for controlling populations once desired levels have been reached.

Instead, then, USDA has proposed using sharpshooters, a method employed by Morton Arboretum, DuPage County Forest Preserve District, Argonne National Laboratory and other entities in Illinois.

Dage Blixt, a wildlife biologist with USDA and a certified sharpshooter, said that the process is safe and strictly controlled by the Illinois DNR. According to Blixt, no human injuries have ever occurred in Illinois as a result of sharpshooting. To ensure safety, shooting zones are located in remote areas and must lie within 50 yards of bait laid out for the deer. Security personnel ensure that the areas are clear of people before any shooting begins. In addition, the angle of firing is restricted; no buildings, for example, may lie in the line of fire. With sharpshooting, bullets are aimed so that the animal dies instantly without suffering.

Under guidelines established by the Illinois DNR, all meat is donated to food charities. Consequently, as part of USDA's Environmental Assessment at Fermilab, during the week of September 2 the agency killed five deer for tissue samples to determine the health of the animals and whether the meat would be suitable for consumption.

Whatever one's views about shooting deer, the American Veterinary Medical Association Panel on Euthanasia in 1993 recognized "accurately delivered gunshot" as "an acceptable method of euthanasia."

"The objective," said Walton, "is to bring the ecosystem more closely into balance." While deer are part of the natural environment, he acknowledged, they threaten their own species and other wildlife, as well as the ecosystem, when too many are forced to live in diminishing habitat. ■

Chez Léon

MENU

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

Lunch
Wednesday
September 17

Grilled Steak
Bell Pepper Salad
Peach Cardinale

Dinner
Thursday
September 18

Tomato, Mozzarella
and Basil Salad
Miso-Marinated Cod
with Balsamic Vinegar
Sauteed Spinach
Banana Hazelnut Strudel
with Caramel Rum Sauce

Lunch
Wednesday
September 24

Cayenne Rubbed Catfish Fillets
with Tomatillo Salsa
Creole Pigeon Peas and Rice
Mango Corn Cake

Dinner
Thursday
September 25

Crab and Greens Soup
Sauteed Duck Breasts
with Ginger and
Lime-Roasted Corn and
Spicy Red Pepper
Wild Rice with Scallions
Pear Salad with
Mixed Greens and Walnuts
Plum and Blackberry Turnovers
with Cardamom

MILESTONES

HONORED

URA Scholarships
By Universities Research Association, Inc., with academic scholarships, renewable for four years, the following 1997 high-school graduates, sons and daughters of Fermilab employees:

Matthew Becker, son of Mike Becker, FESS, attends Northwestern University.

Katherine Gaines, daughter of Irwin Gaines, CD, attends the University of California at San Diego.

Jie Gao, daughter of Junye Wang, BD, attends Northwestern University.

Joseph Gelfand, son of Norman Gelfand, PPD, attends Columbia College in New York.

Daniel Geynisman, son of Michael Geynisman, BD, and Olga Geynisman, FESS, attends Northwestern University.

Whitney Jackson, son of Judy Jackson, Directorate, attends the University of Illinois at Urbana-Champaign.

Kira Johnstone, daughter of Carol Johnstone, BD, and John Johnstone, BD, attends the University of Wisconsin at Madison.

Lachlan Kasper, son of Peter Kasper, BD, attends the University of Illinois at Urbana-Champaign.

Stephanie Lackey, daughter of James Lackey, BD, and Sharon Lackey, BD, attends Vanderbilt University.

Gwendolyn Marriner, daughter of John Marriner, CD, attends the University of Illinois at Urbana-Champaign.

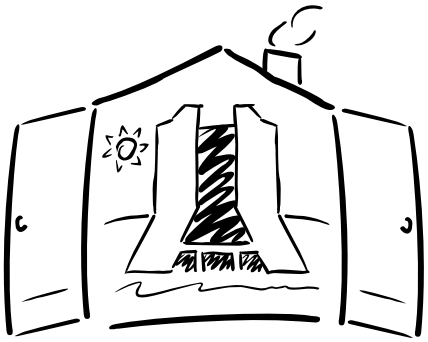
Anna Para, daughter of Adam Para, CD, attends the University of Illinois at Urbana-Champaign.

Anjali Raja, daughter of Rajendran Raja, PPD, attends Northwestern University.

Matthew Smart, son of Wesley Smart, BD, attends the University of Evansville.

Jessica Vonasch, daughter of Larry Vonasch, BSS, is attending the University of Illinois at Urbana-Champaign.

CALENDAR



SEPTEMBER 13

Fermilab is hosting an Open House on Saturday, September 13, the Laboratory's first open house since 1983. The event, which is free to the public, will take place rain or shine from 10:30 a.m. to 4 p.m. Fermilab is expecting 10,000–20,000 people.

SEPTEMBER 16

Blood pressure screening: Atrium, near 1 West & Credit Union, 11:30–1 p.m.

SEPTEMBER 18

Wellness Committee presents: "Benign Prostatic Hypertrophy," Dr. James G. Giblan, M.D., urologist. In 1 West, Noon–1 p.m.

SEPTEMBER 26

International Film Society presents: *To Live (Huozhe)*, Dir: Yi-Mou Zhang, China/Hong Kong (1994). Admission $4, in Ramsey Auditorium at 8 p.m.

THIS FALL

Step aerobic classes on Mondays and Wednesdays and muscle toning classes on Tuesdays and Thursdays from 5:30 to 6:30 p.m. in the Recreation Facility. Two sessions will be held for each, Sept. 8–Oct. 31 ($48) and Nov. 3–Dec. 16 ($36). Registration and payment can be made at the Recreation Office, WH15W; or mail name, class and check payable to Bod Squad to MS 126. Must be a current facility member. For more information, call x2548 or x5427 or e-mail jeanm@fnal.gov.

LETTER TO THE EDITOR

Please add my name to the mailing list for *FermiNews* and related publications. I think that your articles give a different perspective of scientists to the students. There is research and life beyond the dry-looking symbols and numbers in physics.

Thanks,

Prof. C. Rangacharyulu
University of Saskatchewan
Canada

CLASSIFIEDS

FOR SALE

■ '97 Harley Davidson Sportster, 883, many extras, 1K miles. $8,650. Serious buyers only. Call Ed Dijak, x6300 or (630) 665–6674.

■ '95 Saturn SC, automatic, sun roof, spoiler, 2 air bags, am/fm radio w/tape, a/c, 44K miles. Asking $12,000. Call Sandy, x4171.

■ '86 Mazda 323, 2-dr. htchbk, 4 spd, 77K miles. Good condition, battery, exhaust, brakes new, $1000 obo. Contact Oleg, x5801 or kurnaev@fnal.gov

■ '84 Toyota Camry DX, 4 dr, 5 spd, AC, 198K, rusty but good local transportation, $650 obo. Contact Stephen, x4517 or parke@fnal.gov.

■ '88 Nissan Sentra, 2-dr, 4 spd, blue, 105k miles. Good condition, new clutch, muffler. $1550. Contact Vince, x3139, x3600 or vjs@fnal.gov.

■ Maytag electric dryer (4 settings), very good condition, $50. Call Sandy, x4171.

■ Fitness equipment: E-Force Rider, 2 yrs. old, hardly used, like new, $150. Call John, x4020.

■ Hewlett-Packard HP-87 data acquisition computer & disk drive. Lots of extras, serial and parallel interfaces, ROMs, etc. Make offer. Contact Tom, x3441 or tnicol@fnal.gov.

■ Hunter green & dark wood 1-1/2-yr.-old dining room set: farm table, 6 chairs, and hutch. $600. Cherrywood bedroom set: queen sleigh bed, 8-drawer dresser, nightstand, & mirror. $1200. Call Dave Rotolo, (847) 741–2700 x259.

■ Sofa & loveseat, neutral colors w/wood trim, $250. Call (630) 585–8192.

■ PowerMac 6100/60 computer, 8MB RAM, 1.0G HD (w/ ext. HD), 14-in. A/V monitor, CD-ROM, 28.8k modem, extended keyboard, mouse. Loaded w/ MS Office, other business programs, and an enormous amount of expensive games. $1100 or best reasonable offer. Contact Justin x2676, donoho@fnal.gov, or eve. at (630) 682-1721.

■ Tires & wheels, Goodyear Arriva II tires, size 215-70R-14 mounted & balanced on GM 5-bolt wheels. Fits Cutlass, Monte Carlo, etc. Like new $150 for 4. Chevy S-10 Blazer or pick-up truck front fenders. Fits '84 and up, original GM, new in boxes, pair $200. Black velour bucket seats from '90 Z-24 Cavalier, suitable replacements for truck or van bench seat, exc. cond., $150/pair. Kroehler sofa: off-white background w/splashes of mauve, aqua & light blue, high-back cushions, 3 yrs old, very good cond., $125 obo. Formal china: Noritake "Carthage" pattern. Lt. gray/white border w/silver trim, very pale pink & white flowers in half-moon shape on plate, 11 place settings. Value $600, never used, $200 obo. Semi-formal china: Sango "black lilies," square plates w/rounded, upturned corners, black w/calla lilies. Service for 8 w/two, 5-piece serving sets & matching black-handled flatware. $75 obo. Please call (630) 443-9881.

■ Drafting table $50; GE gas stove, Profile series, stainless steel, natural gas & lp gas jets, self-cleaning oven, sealed burners, paid $1350 in Oct 96, $1100, only used for a few hours, possible delivery; Kenwood multi-component stereo system w/cab, system includes linear tracking turn table, amplifier ka-94, synthesizer am/fm tuner kt-54 (memory holds 14 am and 14 fm stations), graphic equalizer ge-34, dual-deck cassette recorder kw-64w, cd player dp-840, 2 4-way 150-watt speakers jl-840. $2000 obo; Skis, Atomic Arc 195 Salomon 547 sport bindings, size 12 us or 13 eu Trappeur 2000 boots, have ski & boot bag, $200 obo; Skis, Head older-style bindings, $25. Contact Terry, x4572 or skweres@fnal.gov.

■ Wooden dining room table, 4 chairs, 2 sideboards, $150 obo. Futon sofa bed, $100 obo. Kitchen table, coffee table, armchair, twin mattress, box spring w/iron frame, ironing board, TV, VCR, assortment of chairs, lamps, shelves, everything must go! Contact Luc, x3489, (630) 406-8453 or luc@fnal.gov.

■ House for sale, Elgin, $104,900, 2 stories, remodeled interior, vinyl siding, 2 BR, 2 bath, large eat-in kitchen, large living room, full basement, 1-car garage, incl. refrig, dishwasher, ov/rg, washer/dryer. Contact Dana x3891, (847) 742-6932 or dgcw@fnal.gov.

FOR RENT

■ 4-bdrm home, 302 Timber Trail, Batavia. Two baths, finished basement and attics. Rental $2400/mo unfurnished, lease option or contract sale. For more information, phone (630) 377-6066.

WANTED

■ Grandma is in need of used baby bed with mattress and car seat. Contact Carol Magnuson, x3451 or (630) 365-6713.

■ Reasonably priced futon (double bed). Contact Cathryn, x8644 or claue@fnal.gov.

LAB NOTE

Fermilab Recreation Facility 1998 Membership Year

1998 memberships are available beginning September 2 in the Recreation Office, WH15W, from 8:30-5:00 Monday-Friday. You may renew your 1997 membership through the mail by sending a completed application form (copy can be found on the Recreation Web page) and a check payable to Fermilab to MS 126. 1998 prices: regular membership - $65; student membership - $35 (visiting graduate students only). New members who purchase their memberships in the beginning of September receive 13 months for the price of 12. 1997 memberships will expire October 1. For more information, contact the Recreation Office, x2548 or x5427.

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Fermi National Accelerator Laboratory

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The deadline for the Friday, September 26, 1997, issue of FermiNews is Tuesday, September 16.

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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