FermiNews

Fermi National Accelerator Laboratory

/olume 19 | Friday, July 19, 1996 | Number 14

;aston Gutierrez, leputy head of he Research)ivision)perations)epartment, nspects a 'acuum SWIC—ι segmented vire ion hamber—ıne of many ısed throughout he beamlines to ȷet profiles of he beams.

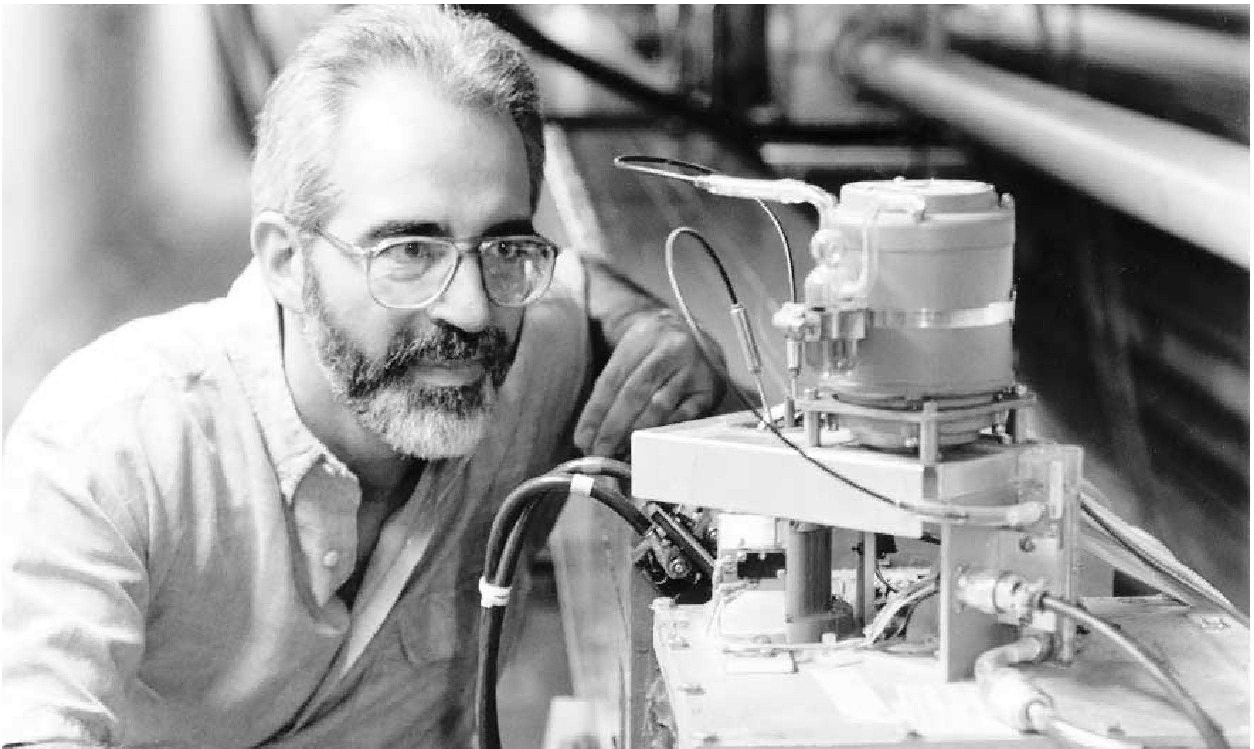


Photo by Reidar Hahn

Bringing the Beam

As the fixed-target run revs up, the Accelerator and Research Divisions begin the complex process of consistently delivering beam to the experiments.

by Eric Berger, Office of Public Affairs

Fixed-target experimenters not only expect Fermilab's Accelerator and Research Divisions to turn water into wine—they need 10 different vintages.

Providing beam to fixed-target experiments presents the challenge of converting high-intensity protons into 10 separate beams of varying intensities and particles, from kaons to neutrinos. The Accelerator Division generates and splits the beam, and then hands the protons off to the Research Division, which converts them into beams of different particles.

The process begins with a breath of hydrogen gas. Eventually the hydrogen atoms lose their outer electrons and become a stream of protons—the formation of the beam.

Physicists measure two characteristics of the beam: its energy (eV) and its intensity. Intensity tells how many particles are packed together. Craig Moore, Accelerator Division fixed-target coordinator, said the Accelerator Division hopes to deliver an 800 GeV beam with a consistent intensity of about 25 trillion protons per pulse to the experimenters.

Beam travels around the Tevatron in bunches of protons, each a few feet long. A spacing of about 20 feet separates each of the roughly 1,000 bunches.

continued on page 8

NSIDE

The Interplay of Theory and Experiment

by Leila Belkora, Office of Public Affairs

"Theory" is one of those confusing words—like "force" or "momentum"—that has a much more precise meaning in physics than in everyday English. In common parlance, a theory may be little more than a hunch. Sometimes, a nonscientist understands "theory" to mean what a researcher should have found, but didn't. No wonder, then, that physicists who describe themselves as theorists get quizzical looks. "I encounter people with only a vague idea of what I do," says Fermilab theorist Gerhard Buchalla. "They think 'experiment' is when you do an experiment, and 'theory' is when you analyze the data."

In fact, few theorists get a peek at an experimenter's raw data. Theorists deal in the mathematical and conceptual foundations of physics. They consider particles and forces in the abstract, rather than seeking their electronic signatures in particle detectors. Yet, ultimately, their goal is to predict and quantify what is real. Theorist Grigorii Pivovarov, visiting Fermilab from the Institute for Nuclear Research in Moscow, summarizes his profession's ideal as follows: "To be a theorist is to try to imagine possibilities that are not frequent in ordinary life, so one could suggest ideas to experimentalists.... One of the most striking examples is the discovery of antiparticles, which was pure theory, without experimental anticipation."

Antiparticles have the same mass as their regular counterparts, but opposite charge; they constitute only a tiny fraction of the matter in the universe, and usually vanish in collisions with particles almost as soon as they appear.

The story of Nobel laureate Paul Dirac's discovery of antimatter, as told by Fermilab Director John Peoples, beautifully illustrates the interplay of theory and experiment. "When Dirac wrote out his formula [in 1928], it was clear that there were mathematical solutions to the equation that represented particles, like electrons, that went backward in time, or were

Photo by Reidar Hahn

Fermilab Director John Peoples leans on a magnet in the Antiproton Source, where antiprotons collect before colliding with protons in Fermilab's Tevatron. Antiparticles, though every bit as real as particles, were predicted by theory before experimentalists found them.

Theorists describe their contribution as building a framework for understanding laboratory results, like scaffolding around the emerging edifice of empirical knowledge.

antiparticles," says Peoples. "At the time, people didn't like [the idea of] a positively charged electron. Dirac tried to make the predicted particle a proton, but that effort failed, and there was a lot of confusion."

In the meantime, says Peoples, Caltech physicist Carl Anderson conducted a series of experiments on cosmic rays, including flying cloud chambers in B-29 airplanes to record the tracks of these energetic particles at high altitude. "It was clear from these experiments that there had to be a positively and negatively charged electron," says Peoples. "Once people gained confidence that the solution to the mystery was the existence of the electron and its antiparticle, they said, 'What about the proton? Should there be an antiproton?' Then the Bevatron accelerator was built [in Berkeley], with enough energy to create proton-antiproton pairs of particles."

Thus, while discoveries may come from either quarter, history suggests that there would be no meaningful theory in the absence of experiment, and no sense in experiment without theory. Theorists describe their contribution as building a framework for understanding laboratory results, like scaffolding around the emerging edifice of empirical knowledge. For Fermilab theorist Chris Quigg, "The essence of making progress is making links between different results.... Where something doesn't make sense, the result might not be right, or the framework might not work."

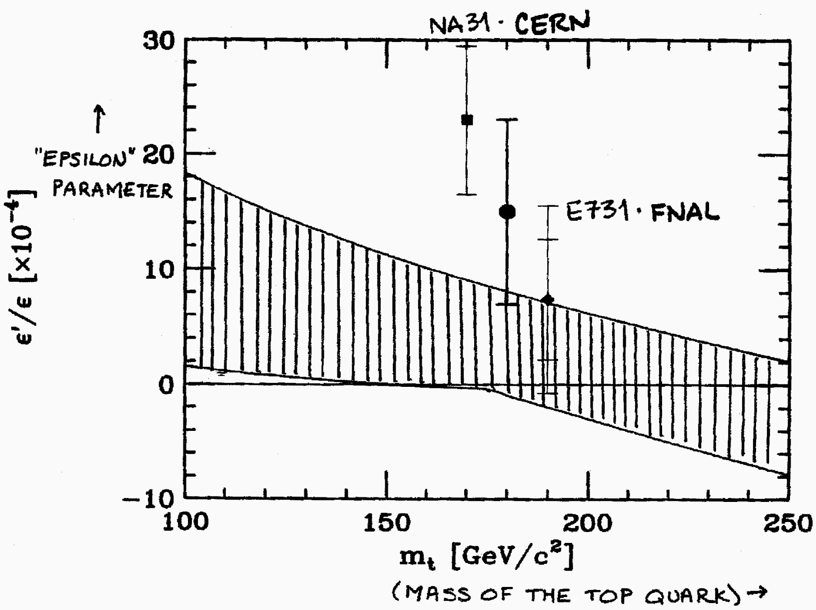
Despite the partnership of theorists and experimentalists in building a tower of knowledge, each according to his strength in mathematics or hands-on construction, they occasionally take potshots at each other. "The difference between theorists and experimentalists?" chortles one physicist, seizing the opportunity to set the record straight, "That's easy: one of them is the good guys. And the other is scum."

Part of the rivalry comes from the uncertainty about who will steal the limelight with the next major step forward. Theorists believe they have in hand a robust theory of the fundamental building blocks of nature—quarks and leptons—and their interactions. This 'Standard Model' includes the effects of electromagnetism, relativity and quantum mechanics, and accounts for the behavior of matter on a wide range of scales, from galaxies down to the gluons that bind quarks in a proton. But challenges remain at even smaller scales, and the race is on to explore that domain.

Theorist Edward Witten of the Institute for Advanced Studies in Princeton sees developments in the last two decades as a triumph of theory. "Experiment was in the lead from the early discoveries of the particles, almost all of which were surprises, right up to the consolidation of the Standard Model in the late 1970s," acknowledges Witten. Subsequently, he says, theory leaped forward. Theorists predicted the masses and properties of the W and Z particles before experimentalists found them at CERN, the European Center for Particle Physics, and although Fermilab's discovery of the bottom quark was a surprise, its follow-on discovery of the top quark in 1995 was expected. "This theoretical framework of physics [...] has been very successful, perhaps surprisingly so, as experiments have gone to higher energies," concludes Witten.

Fermilab theorist Chris Hill says the uncharted territory in physics today is at the small scale of 10^{-17} cm, in a field known as supersymmetry. "People always think we deal in atoms," says Hill, "but we're dealing with sizes that are as small compared to an atom, as an atom is small compared to a person's head."

continued on page 11



The convergence of theory and experiment, illustrated by a plot of predicted and recorded values for the so-called epsilon parameter. The epsilon parameter, on the vertical axis, is a measure of the degree to which matter dominates antimatter in the universe. The shaded area represents the range of theoretically predicted values, which depends on the mass of the top quark. The three experimental points, shown with error bars, come from Fermilab and CERN measurements of the epsilon parameter.

The Night We Saw the Pings

A Letter from the Field

Debbie Harris (right), a physicist from the University of Rochester and a collaborator on Experiment 815, shares with *FermiNews* a recent letter to her college friend Siobahn, a nursing student at the University of California–Berkeley.

July 8, 1996

Dear Siobahn,

I hope you forgive me for not writing sooner, but things have been really hectic getting everything ready for the run. We finally have the detector in good shape, and we can even watch (triumphantly at times!) the data pour in and see, event by event, what kind of data we're taking.

We've actually been seeing real live neutrino events in our detector for over a month now. They look like nothing else you could imagine. Right in the middle of a quiet detector you see this big blob of signals, and then a line of signals pointing away from the blob. It sort of looks like a sideways yo-yo when you plot a picture of which parts of the detector recorded signals. The blob is from a neutrino coming in and breaking up a proton or neutron. The string coming out the end is the muon, which is proof that the neutrino emitted a W boson and became a muon. It's hard to think that people waited weeks for one or two events like these, and here we see them many times a minute.

But actually, that's not even the big triumph I wanted to tell you about. Once in awhile, the neutrino can also break up a proton or neutron by emitting a Z boson. Then the neutrino leaves the detector just as it entered, leaving no signal in its wake: a yo-yo without a string. The special thing about that particular reaction is that the number of times it happens, compared to the number of times you see the W boson reaction, is related to this fundamental parameter of nature that people all over the world are measuring in different ways. (And testing the whole story of how particles interact!).

Anyway, the tricky thing about this rare Z-boson reaction is that when you try to make a computer description of the conditions for that event, it can look like the signal from the cosmic rays that come through the detector all the time. So, the trick is to distinguish the signals of the actual events from the cosmic ray background. To do that, you have to get all the neutrinos to come into the detector in as short a time as possible, and then just look for events in that small time window. Can you imagine the amount of fiddling around you have to do with this high-energy beam of protons hitting some target to make neutrinos with such strange timing?

Well, about two weeks ago we started getting high-intensity "pings" in the detector, and I was lucky enough to be on shift when all these "yo-yo-without-a-string" events started showing up in the data! Without those pings it would be pretty much impossible to actually see those events over the huge cosmic ray background. Anyway, it was really exciting, because it means that we can go ahead and do the measurements we're all here for in the first place!

Watching one event after another like that made me realize that these detector signals are only the last part of the story. There is so much effort that has to happen before those neutrinos get to the detector. It's pretty impressive when you think of all the accelerator people—many of whom don't even get to see the events coming in—putting so much into making it all work.

Well, I guess that's all the news for now. Let me know when you're going to be in town so I can show you all the excitement live. Writing about it hardly does the experience justice!

Love,

Debbie

Profiles
PARTICLE PHYSICS

Charles Matthews

Machine Shop Superintendent

Employee I.D. #802

"In 25 years I can't remember having a day when I didn't want to be here."

by Eric Berger, Office of Public Affairs

Charles Matthews builds things.

As superintendent of Fermilab's Machine Shop in the Technical Support Section, Matthews directs the welding, machining and development of experimental apparatus for Laboratory projects.

"Sometimes you look at something and wonder what in the heck it's going to be used for," Matthews said. "But when you build this thing and the guy goes off and does his thing and gets his results and he's happy, then we're happy that we had some effort in helping him achieve that goal. It's great to be a builder."

One of the most satisfying aspects of his job comes from working with scientists, Matthews said.

"I've been here 25 years and it's always interesting," he noted. "They're so down to earth, and yet they're thinking so far ahead. It's a joy to get some of these things and build them because it kind of makes you feel that you are adding a little bit to their effort."

At 802, with only three digits, Matthews' employee number reflects the length of his 25-year tenure at the Lab.

"In 25 years I can't remember having a day when I didn't want to be here," he said with a smile. The attraction for Matthews comes from the Laboratory's atmosphere. He gestures to the window and speaks of rabbits playing in the grass and deer walking across the prairie. Scenes like these draw him to this place. And he is welcome.

"Charles not only does a great job of managing the shops, but he understands and cares about how the shops fit into the science that we do at Fermilab," said Peter Limon, head of the Technical Support Section.

His Staff

Keeping a capable work force challenges Matthews. "We spend a lot of money on training and a lot of people are recruited away from us," he said. "We are constantly developing skills over and over again." The machinists and welders in his section are experts, and with the skills they learn at Fermilab they are attractive to other bidders.

Matthews' praise speaks for the skill of the machine shop employees.

"My people are called upon to work in difficult conditions and yet they achieve their ends in record time and unmatched quality," he said. "They are people who are capable of interacting with the scientific community, understanding their needs and helping them bring their projects to bear."

To Matthews, who counts woodworking among his hobbies, providing the means to an end makes his work at Fermilab worthwhile.

"You come in in the morning and take your project, you put effort toward it, you see some results and ultimately you've carved something out of that piece of metal that's useful to somebody," Matthews said. "It's quite fulfilling and rewarding to be able to do that." ■

Charles Matthews and John Nowak, Machine Shop technician, working in the Machine Shop.

I Want My A–TV!

You can't catch the ball scores or lottery numbers here, but if you need to know the status of the Lab's Accelerator, Channel 13—Fermilab's Accelerator Television—is the station to tune in.

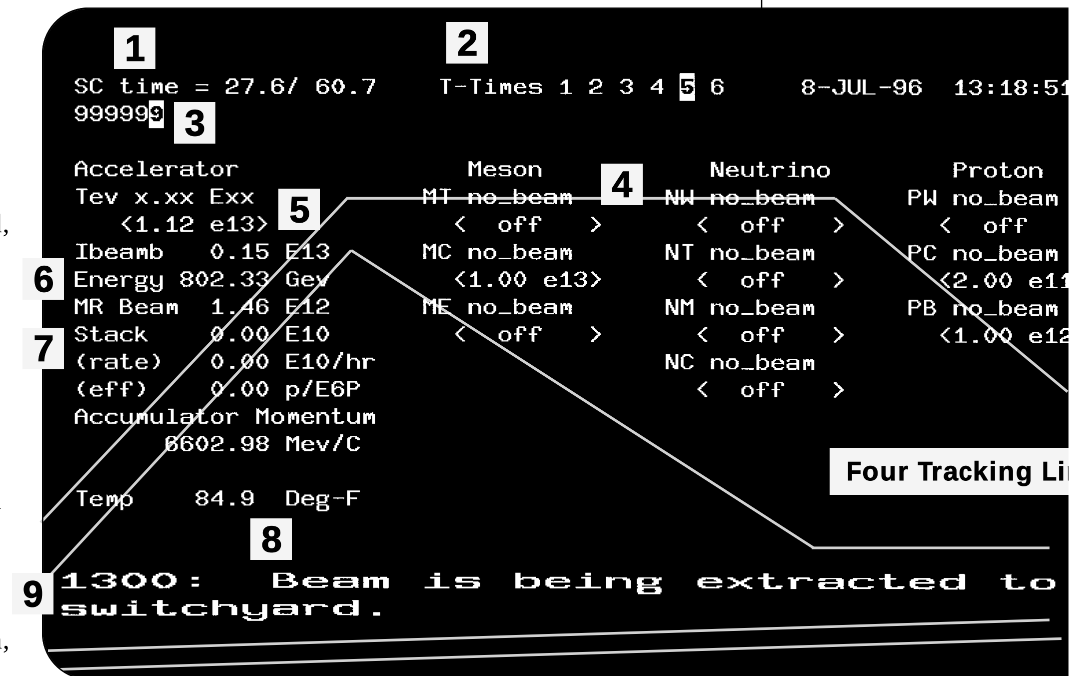
by Donald Sena,
Office of Public Affairs

Channel 13—that popular cable television station seen at a high–energy physics lab near you—is back on the air. Although its audience and content have changed, its mission remains: to keep all Fermilab staff and users informed about the status of the accelerator, with up-to-the-second details on its disparate parameters.

After collider operations halted in February, Channel 13 faded to black for a short time, as Accelerator staff developed the new fixed-target format. For their data-gathering efforts, experimenters at the two collision halls, CDF and DZero, needed specific information, much of it different from what fixed-target researchers require. Consulting the new crop of fixed-target physicists and engineers, operators unveiled the screen in June. At a glance, researchers and operators can now gauge the Tevatron's energy and intensity, check exactly where the protons are at any given moment and see how much beam each experiment is receiving.

"I refer to it quite a bit," said Heather Svedbeck, a Research Division operator. "It tells us the status of the accelerator and how much beam we have in our line. It's quite helpful."

This article explains the new fixed-target screen and all of its intricacies, abbreviations and embedded expertise. So, put down that remote control and become an informed viewer of Accelerator Television.



Four Tracking Li

All numbers on the screen preceded by an "e" are exponents.

The Show

1 *SC time* refers to the supercycle time—the time it takes for the accelerator to run through one cycle of events; in fixed-target operations, it is about 60 seconds (the second number listed.) A supercycle is the amount of time it takes for the Tevatron to "ramp" up and back down. Ramping refers to the energy of the protons, which increases steadily in the accelerator before the particles are extracted and sent to the Switchyard and, eventually, to the fixed-target area.

2 *T–Times* tracks points in fixed-target experimentation during a typical supercycle. By watching this area of the screen, an experimenter can determine exactly what phase the experiments are in. For instance, T–1 means a "reset" is occurring and the Tevatron is getting ready to begin a new supercycle. T–2 signals that some experimental beamline apparatus is getting ready to receive the beam. During T–3, magnets begin to power up, so they are ready for the Tevatron's beam. T–4 is similar to T–3, but comes about three seconds later and is used for magnets that reach full-operation mode quicker.

Dan Johnson, operations head of the Research Division, said timing is critical in T–3 and T–4. The Research Division doesn't want to waste electricity, but needs the magnets to achieve full power and stabilize before beam arrives.

T–5 signals that operators are extracting particles from the Tevatron to the fixed-target beam areas. T–6 notes the end of "flat top," which occurs at the end of the Tevatron ramp. Beam extraction is complete at this point and fixed-target experimental equipment begins to "ramp" down. It takes about one minute to go from T-1 to the next T–1.

At a glance, researchers can gauge the Tevatron's energy and intensity, check exactly where the protons are at any given moment and see how much beam each experiment is receiving.

3 The next two lines (only one of which is seen here) lead a viewer through each individual step the accelerator takes during a supercycle. A cursor moves across the line, jumping down when it gets to letters on the third line, as the accelerator passes from one state to the next. In normal operations, the cursor will move along a line of "1s," which means accelerator operators are sending protons from the Main Ring into the Tevatron. A "9" indicates that antiprotons are being stacked for an experiment in the antiproton source.

Intermittently, the cursor will swipe across an "E," signifying that the beam is in a study cycle and ends in the abort dump. Operators use these opportunities to fine-tune the beam and study the accelerator's performance. Other numbers or letters may occasionally flash on the screen, but they are rarely used, according to Bob Mau, head of operations for the Accelerator Division.

4 This part of Channel 13 specifies the 10 experimental areas that receive beam for this fixed-target run. Beam must reach each experimental hall with precise intensity. The top number refers to the actual intensity of beam that an experiment is receiving; the number in parentheses is the beam intensity that each area is supposed to receive based on program planning.

"This is a way for the experiments to see that they are getting their fair share of the beam," said Mau.

Intensity is measured in protons per pulse of beam, with a pulse equaling about 20 seconds. (For a detailed explanation of protons per pulse and more information on the orchestrated and complicated hand-off of beam from the Accelerator Division to the Research Division, see the story on Page 1).

On Tuesdays at 9:30 a.m., Taiji Yamanouchi and other program planners set the beam allocation limits for the week based on priorities and experimental needs. Mau admits these discussions can become quite lively. The areas labeled on Channel 13 are: Meson (test, center, east); Neutrino (west, test, muon, center); and Proton (west, center, broad band).

5 If one adds up all of the experimental area beam numbers in step 4, actual and allocated, they will equal these figures, which show the accelerator's overall performance.

6 *Ibeamb* refers to the beam intensity (protons per pulse) for the Main Ring. This area of Channel 13 is temporary and will be removed.

Energy is the energy of the protons, generated by the Tevatron's power supply. This number will climb, remain steady for a while and then drop down. It follows the Tevatron's power "ramping" up as it accelerates the particles, flattening out as it reaches peak energy—known as flat-top—then ramping down as the accelerator operators send the particles to the Switchyard.

MR Beam: Accelerator operators only refer to this number during lower intensity cycles of the Main Ring beam.

7 There are two experiments in the antiproton source, and experimenters need antiprotons and a very precise beam of protons for their studies. The *Stack* figure notes the number of pbars (antiprotons) ready for experimentation. The *(rate)* area tells operators and experimenters how quickly antiprotons are being produced, and *(eff)* details the production efficiency for antiprotons. A nominal level for the production efficiency is about 16 antiprotons for every one million protons.

Accumulator momentum details the energy of antiprotons in the accumulator ring. Experiment 835, the charmonium study, needs very precise energies for their experimentation. Researchers can gauge the levels with this area of Channel 13.

Under the momentum number is the "ever-popular outside air temperature."

8 On Channel 13, this space shows computer-generated messages (not seen here) that display the status of the accelerator and beam. This message can be translated into a computer-enhanced voice, allowing staff to keep up with the accelerator's stages and not have to watch the screen constantly.

9 Operators write large, scrolling messages, describing the major events of the day or hour, at the bottom of the screen and precede it with a timestamp.

Photo by Reidar Hahn

Heather Svedbeck, a Research Division operator, consults a Channel 13 monitor in the Experimental Area Operations Center.

More Programming Notes

The fixed–target screen also has two features that were not present on the collider version of Channel 13. The first is an audible "beep" that changes tone as the intensity of the beam changes. The second addition is four very fine tracking lines, called oscilloscope traces, that measure different parameters. These can be seen behind the numbers climbing, jumping, flat-lining and falling as the accelerator cycles through its processes.

- The top line measures the Tevatron's power supply or energy. It follows the Energy parameter noted in step 6.
- The second line is tracing the Tevatron's intensity or protons per 20 second pulse (see step 5). The line jumps up when protons are injected into the Tevatron, then it stays relatively flat as the protons are accelerated. Mau said that line may dip a little as operators lose some of the protons. Finally, the line starts to drop as operators extract the particles, sending them to the Switchyard and into the fixed-target area.
- The last two lines, at the bottom of the screen, monitor the energy and intensity of the Main Ring. ■

Bringing the Beam

continued from page 1

The ABCs of eV

The acceleration process begins with the Cockroft-Walton at an energy of 750,000 eV (electron volts). Next the Linac (linear accelerator) steps the beam's energy up to 400 Mev (million electron volts), the booster pushes the beam to 8 GeV (billion), it reaches 150 GeV in the Main Ring and finally it emerges from the Tevatron at an energy of 800 GeV.

One eV equals the energy of an electron accelerated across an electric field with the potential of one volt. Thus a typical 1.5-volt flashlight expends 1.5 eV for every electron it pushes through the light bulb's filament. A typical photon of light has an energy of 2.5 eV.

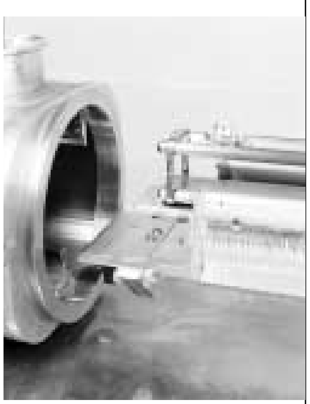


Photo by Reidar Hahn

A partially disassembled electrostatic septum.

Together, the bunches comprise the protons counted in one "pulse." Thus, each bunch contains about 25 billion protons.

Instead of releasing an entire batch of protons from the Tevatron to the fixed-targets at once, a process that would take less than a millisecond, the Accelerator Division "scoops" some of the protons from each bunch as they go around. By leaking the beam this way, Moore and the rest of the accelerator physicists can deliver about 20 seconds of continuous beam (a pulse) every minute.

Experimenters prefer a continuous beam as it allows them to take more accurate data. E815 is an exception, taking a fast extraction of beam.

Splitting the Beam

After they have generated the initial 800 GeV beam, Accelerator Division personnel still must split the beam into several components before handing it off to the Research Division. This splitting occurs in the Switchyard, north of Wilson Hall.

"The beam travels out of the Tevatron and first encounters the electrostatic septa," Moore said. "When the beam goes through the septa, it encounters wires a few thousandths of an inch thick, serving to split the beam."

After encountering a series of septa and magnetic Lambertsons (see diagram at right), 10 different beams of varying intensities are passed off to the Research Division. Even though the splits bear the names meson, neutrino, muon and proton, protons still compose each beam.

Fixed-target experimenters have requested a total of 35 trillion (3.5e13) protons per pulse, but the accelerator cannot deliver that intensity consistently, Moore said.

"We have promised 2.5e13 stably, and our goal is to get up to 3.0e13," he said. "But the most that we've ever done (during the last fixed-target run) per pulse is about 1.8, and typically we had trouble running stably at about 1.6. We're trying to do a great deal more than we've ever been able to do in the past."

Moore said the intensity boost will come from the 1994 Linac upgrade. "But the necessary consequence of that is we will have instability," he said. Instability simply means that the more protons you pack into a bunch, the greater the chance the bunch of protons will wander off course.

"There are two ways to control instability," Moore said. "One is to spread the beam out longitudinally, and the other is to have more dampers in both the Main Ring and the Tevatron."

Spreading the beam longitudinally simply makes the beam longer, slimmer and more manageable. More dampers allow Accelerator Division physicists to stop the growth of the instability.

"Along its circular path through the Main Ring and then the Tevatron, the beam travels through a pair of metal plates, called pickups," Moore said. "If the beam passes closer to one of the plates, it gives a stronger signal."

From measuring the signals of each plate, operators in the Accelerator Division can determine the alignment of the beam and its proximity to the vacuum chamber wall. If the plates detect an unstable wobble, a damper sends a correction in a straight line to a kicker. Since the beam travels around the ring, taking a longer path, the correction beats the beam to the kicker, which can then apply a correction to the beam.

To keep track of the Accelerator Division's progress in generating a 2.5e13-intensity beam, look no further than Channel 13. A related article explaining the Accelerator Division's channel, now showing on a Laboratory TV near you, appears on page 6.

Different Experiments, Different Particles

Once the beam leaves the Switchyard, responsibility for delivering the beam to each experiment falls to the Research Division's Operations Department.

Gaston Gutierrez, deputy head of the Research Division Operations Department, and his group of beamline physicists had the responsibility of designing each beamline, a process that started long ago.

"Essentially the approved experiments put in a request," Gutierrez said. "They say they want a beam of this energy with these particles and all these specifications. If the lab doesn't have a beamline to satisfy their request then a new beamline is designed and built."

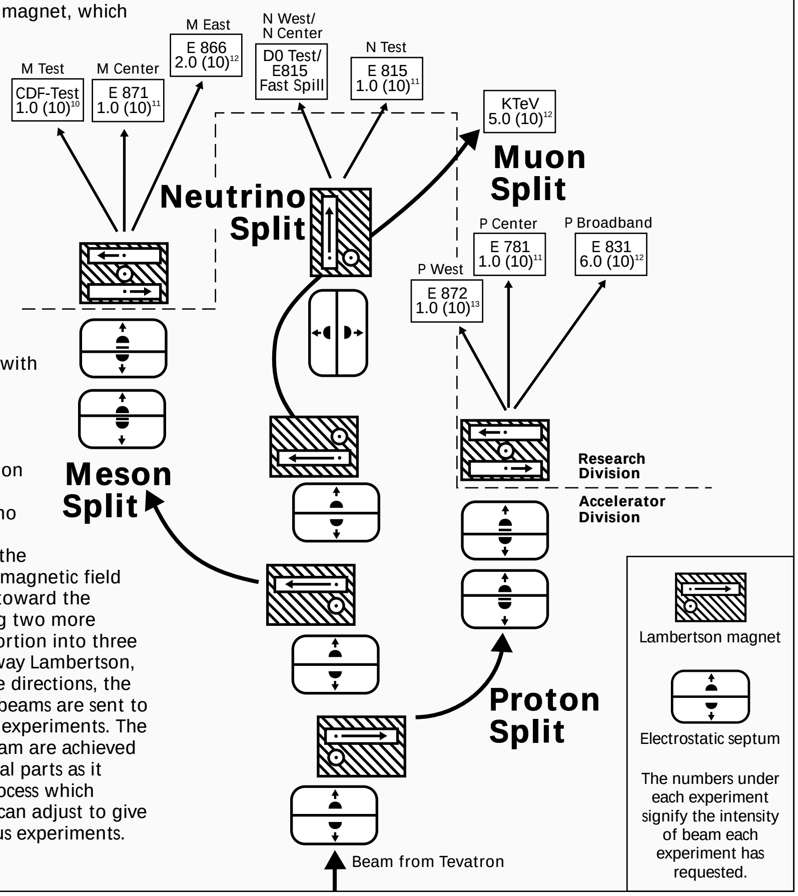
The proton beams that come from the Switchyard are called primary beams. To generate the different types of particles each experiment requires, the primary beam in each beamline strikes one or more targets, creating a series of particle interactions.

In the beamlines designed by Gutierrez's department, high-energy protons generally hit a target, producing myriad secondary particles. By selecting only the desired particles, Research Division physicists can construct beams of particles other than 800 GeV protons.

Physicists usually cannot generate the desired particles in one-step processes. Protons, particles found along with neutrons in the atom's nucleus, give Fermilab physicists good basic particles with which to begin.

The Switchyard

The half-mile long Switchyard splits the single beam of high-energy protons from the Tevatron into 10 proton beams of varying intensity. The single beam first encounters a splitting station. A splitting station houses an electrostatic septum and a Lambertson magnet. An electrostatic septum separates the beam in two. It consists of a ground plane of thin wires between two cathodes, which provide a strong electric field on both sides of the wire plane. The wire plane is oriented along the direction of the beam and uses oppositely directed electric fields to partition the beam. The separated beams flow into a Lambertson magnet, which has two apertures, one of which is in a nearly field-free region and permits one beam to travel in the straight-ahead direction, while the other beam is bent in the desired direction.



To trace the beam that reaches the meson split, begin with the Tevatron beam at the first septum. This septum splits the beam, part of which is bent by the magnetic field, and part of which enters the field-free region of the Lambertson—this part includes the meson and neutrino portion. Another septum splits the beam again, and this time the meson portion encounters the magnetic field of the Lambertson and is sent toward the meson split. After encountering two more septa, which split the meson portion into three disparate beams, and a three-way Lambertson, which sends the beams in three directions, the M West, M Center and M East beams are sent to the primary beamlines of their experiments. The different intensities of each beam are achieved by splitting the beam in unequal parts as it travels through the septa, a process which Accelerator Division operators can adjust to give and take beam from the various experiments.

For example, KTeV experimenters want neutral (charge-free) kaons, particles with about half the mass of protons. The protons strike a target to produce other types of particles, collectively called the secondary beam. Strong magnets sweep away the charged particles produced in the interaction of the protons with the target. Neutral particles, not affected by the magnets, continue straight toward the experiment. Photons, neutral kaons and neutrons mainly compose this “neutral beam.” Since KTeV does not want photons in their beams, these photons are converted, using a thin lead target, into electrons and positrons, which subsequent magnets sweep away.

The Research Division has the responsibility of designing the primary beamlines, the targets and in some cases the secondary beamlines that lead to the experimental halls. Gutierrez said the amount of experimenter participation in the beamline design and construction phase varies from experiment to experiment.

Talking To, Not at Each Other

Fermilab’s experiments live and die by the beam. Unlike collider physics, with only two experimental groups waiting for beam, there are 10 such groups during fixed-target physics.

“Experimenters are eager to get beam a lot of times—obviously,” said Paul Allcorn, Research Division Operations Center group leader. “If there are problems they call here first. We’re the interface between the experiments and the Accelerator. We determine if it’s an accelerator problem or if it’s our problem. If the Accelerator needs to be called, then we would call them.”

Otherwise, Allcorn believes the calls might swamp the Accelerator’s Main Control Room during beam down time. “Plus, a lot of times it might be our problem and not the Accelerator Division and we can best determine that,” he said.

The Operations Center oversees and controls the safe transport of beam to the experi-

continued on page 10

Photo by Reidar Hahn

Craig Moore (right), Accelerator Division fixed-target coordinator, and Rick Janes, technical group leader in the Accelerator Division’s Main Accelerator Department, inspect a SWIC in the Switchyard.

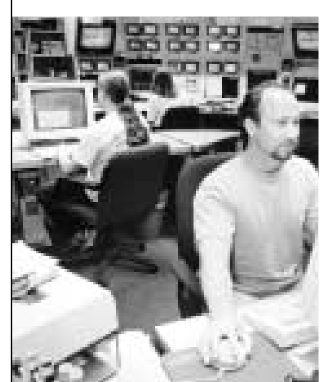


Photo by Reidar Hahn

Dave Jakubek and other operators monitor the fixed-target run in the Research Division Operations Control Room.

continued from page 9

ments during fixed-target running. "We take beam from the Switchyard and then we steer it toward the targets," Allcorn said.

Fixed Target vs. Collider Physics

Some Accelerator Division physicists find the fixed-target run more hectic than collider operations. "From our standpoint, there's a lot more hour-to-hour, day-to-day action in the control room during fixed-target than during collider," said Bob Mau, head of accelerator operations.

Competition for beam provides another difference between fixed-target and collider physics. As Moore said, the Accelerator Division will only be able to deliver 2.5e13-intensity beam consistently, while the experimenters' requests total 3.5e13. The Accelerator and Research Divisions, the beam providers, do not decide who gets the beam.

"During normal running, experiments put their requests in for beam through Program Planning," said Dan Johnson, head of the Research Division Operations Department. "Say all the experiments want a total of more beam than is in the machine, Program Planning will decide who's number one priority, who will get chopped in intensity and how each will run."

The Research Division expects a more fine-tuned fixed-target run than in the past.

"We have some new tools and expect others that will help us," Johnson said. "Thus far data logging has probably been the most beneficial. We have been able to go back and produce data records to see what happened. You don't have to just hope someone wrote it down." ■

The Accelerator Learning Curve

As the Tevatron begins its fixed-target mode of operation, the Accelerator Division is working out kinks and addressing infrastructure failures associated with the start-up.

by Donald Sena, Office of Public Affairs

From June 25 to July 9, Fermilab's accelerator experienced about nine days of downtime, as accelerator experts fixed major and minor problems and addressed various infrastructure failures typical of the inception of a new run of experiments, according to Accelerator Division managers.

"You have to understand, we haven't run fixed-target operations for five years," said Bob Mau, head of accelerator operations. "So, there is the normal turning-on mode of operations, and along with that comes a certain amount of start-up problems."

While many fixed-target scientists are still assembling their experiments' equipment, a few researchers need beam to calibrate instruments, test beamlines or take data. Some of those experimenters who need beam said they're frustrated waiting for the high-energy particles, but acknowledged that it's been awhile since the accelerator ran in fixed-target mode and a learning curve is inevitable.

"It's the struggles of being reborn," said John Cumalat, spokesman for E831.

The Problems

On June 25, after several days of beam, the accelerator lost two Tevatron dipole magnets due to an "arc-over" of power. As the power increases during acceleration, power leads between magnets tend to spread apart. Kevlar string or cable ties hold them together, but if the string or ties fall off, the leads may break apart, resulting in a hole in the vacuum tube. Mau said he thinks that scenario caused the magnets' failure, but he will not be sure until the incident is further studied. He said accelerator experts quickly diagnosed the failure, at accelerator locations C11-4 and C11-5, and fixed it.

"We had to warm [the Tevatron] up, we had to replace the two components, we had to check [the vacuum tube] for leaks, and we had to cool it down. And that typically takes seven days," said Mau.

During the week of repair, the Laboratory performed other infrastructure maintenance, originally scheduled for a later date. The Accelerator Division also completed some civil construction tasks at the Main Injector, including running conduit from the Booster tunnel to the Main Injector tunnel and connecting a water line.

The Tevatron came back up during the July 3 midnight shift, but a ground fault in a voltage tap brought the beam down again during the subsequent evening shift. The voltage tap that failed is not central to the accelerator's performance, but is in place for special tests.
Mau said it took more than 24 hours to diagnose the problem and another six hours to fix it.

From July 5 to July 9, the beam ran reliably, as staff members aligned the Switchyard proton septa and worked to raise the intensity. On July 9, the Accelerator Division brought the beam down again for eight hours, performing two major tasks. The first was the reconnection of an RF building feeder, a major power cable that brings in Commonwealth Edison electricity to the RF building.
At the time of the feeder's failure, the Accelerator Division quickly switched the RF supplies to the Antiproton Source's power feeder, averting any additional downtime.

Workers also installed the Neutron Therapy Facility's bending magnet, allowing the facility to treat patients again. On June 29, the magnet overheated, bringing cancer treatments to a halt.

When asked if he expects any more downtime after the July 9 maintenance period, Mau smiled and said, "Beyond that, my crystal ball is cloudy." ■

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
Dietary Restrictions
Contact Tita, x3524

Wednesday Lunch July 24

Shrimp,
Orange and Olive Salad
with Sherry Vinaigrette
Profiteroles

Thursday Dinner July 25

Sweet Corn Soup
with Shrimp and Chilies
Barbecued Flank Steak with
Grilled Onion Guacamole
Jasmine Rice
Grand Marnier Soufflé

Wednesday Lunch July 31

Ham and Cheese Quiche
Mixed Salad
Chocolate Cake

Thursday Dinner August 1

Summer Vegetable Soup
Beef Tenderloin
Potato Fonteccia
Vegetable of the Season
Lemon Pie

Medical Office to Move

by Eric Berger, Office of Public Affairs

If you catch a bug or need a medical test in the next few days, you may need to look elsewhere for medical treatment because the Fermilab Medical Office closed its doors during the week of July 15.

To open up more space, the Medical Office moved from its first floor location to Wilson Hall's ground floor, near the main west entrance. "It will have a lot better access for ambulance service, more space to give the doctor an office and better record storage facilities," said Charles Marofske, head of Laboratory Services Section.

The new area's design will better accommodate patients, both those waiting and those undergoing treatment.

"There will be more room to move around in the visual and audio test areas," Marofske said. "The facilities in general will be more comfortable and the waiting room will be able to handle more traffic."

The Medical Office's doctor said the move will take about a week. During that time the Medical Office will remain closed except for emergencies. "We won't do routine examinations or blood pressures," Dr. David Morrison said. "But if there are injuries, of course we'll have to see them."

Morrison said the need for space has driven the move. While the new location will not enjoy the prominence that the current location does, he believes it will improve things over the long run.

"It may be a little bit less convenient for people who use the first floor," said Morrison, who has worked as Medical Office doctor since 1989. "But it will be very accessible to the west entrance on the ground floor. The new office will have a little more space and it will be laid out a little bit better."

Long range plans are already in the works to fill the space made available by the Medical Office move.

"The Travel Office and the Users' Office will be moved over there," Marofske said. "Current plans call for expanded meeting room space and some eventual cafeteria expansion." ■

Theory vs. Experiment

continued from page 3

Hill says the particles that the new theory predicts at these small scales (or equivalently, at high energies) are partners to the particles we already know, much as antiparticles are complements of regular particles. "Antiparticles are an inescapable consequence of relativity and quantum mechanics," he says, and "a more elaborate symmetry, yet to be observed" predicts a similar relationship between the matter particles and forces we know now and 'superparticle partners.'

Witten, who dazzled a Fermilab audience recently with a colloquium tying together the Standard Model, supersymmetry, string theory, and something he called "supergravity," issued a challenge to experimentalists to take back the lead by finding evidence for supersymmetry. "The discovery of supersymmetry is not just a yes or no question," he says. "The discovery would lead to a whole host of questions about how supersymmetry is realized, what are the superparticle masses....These questions really don't have preferred answers by theorists, and that is why it would be an experimentalists' game, probably for quite a while, if supersymmetry were discovered." ■

Photo by Reidar Hahn

Everyone's favorite theorist, Albert Einstein. Woodcarving by Fermilab Accelerator Operations head Bob Mau.

CLASSIFIEDS

FOR SALE

■ 1984 Chevy Cavalier CS station wagon, 2.0L, 5 spd.; body, brakes, tires, exhaust system, all in good cond. $800. Call Albert Dyer, x3863.

■ Kitchen set, seats eight, L-shaped-bench style, wood color, round-edge rectangular table with two mauve, vinyl upholstery and chrome leg chairs. New condition! $100, o.b.o. Bob Pucci, x2817. After 5:30 p.m. (815) 886-3308.

■ Queen-size Simmons Beautyrest mattress, box spring and frame. Nine mos. old. Like new. New price $899. $295. Contact Oliver Bardon at x2573 or 527-1725 or bardon@fnald0.fnal.gov

■ 1956 Ford Pickup Truck, "big back window" version. Complete, in running condition. New wheels, trim rings and hub caps. Primed for painting. $6,000. Call (708) 687-6932 after 8 p.m.

■ Electric stove, 24" wide, $75 / firm. DP Prime treadmill, Fit, 0-6 miles m.p.h, $100. Call (815) 286-7327 after 6 p.m.

■ One Bridgestone bike and one Dual Action exercise bike, best offer. Lyon metal desk, $25; old 8-gallon crock, $40. Call John Hoffer, (708) 898-3904.

■ 1988 Honda Civic DX, 4 door, sedan, 5 sp, AC, $3,800, o.b.o. Contact Marianne at x4304, (815) 756-3996, or battista@fanl.gov.

■ Men's 12-speed Schwinn traveler bike, mint green, great shape, complete with travel computer (needs batteries). Call Dave at (847) 519-9222 x259.

■ 1995 Oldsmobile Delta 88, 3.8 liter, V6, full pwr, ABS, keyless entry, traction control, dual airbags, 8K miles, $16,900. Call (708) 892-4849.

WANTED

■ Set of wooden bunk beds; call Albert Dyer, x3863.

FREE

■ Free to a good home: Two indoor house cats, both declawed, one male and one female. You can have one or both. Both are affectionate and good with kids. Accessories included. Contact Dave at vititoe@d0az07.fnal.gov, or (708) 896-6913.

AREA CODE CHANGE

Fermilab's telephone area code will change from 708 to **630** on August 3, 1996.

LAB NOTES

CHILDREN'S SWIMMING LESSONS

Fermilab offers children's swim lessons Monday, Wednesday, Friday. Beginners meet 10:45-11:30 a.m.; Intermediate 10-10:45 a.m. Beginners must be 42" tall or five years old. Session II runs July 15-August 16. Applications are in the Recreation Office, WH15W. First come, first served.

BLOOD DRIVE

The Heartland Blood Center is conducting a blood drive on Wednesday, July 31, from 9 a.m. to 2 p.m. in the WH GF, ES&H Training Room. Prior to this date, a table will be set up in the cafeteria on Wednesday, July 24, for donor scheduling. A donor may also schedule an appointment with the Medical Office, x3232.

CALENDAR

JULY 20 PETE SEEGER - SOLD OUT

An institution in American folk and pop music for more than 50 years, Pete Seeger is still delighting audiences and lending support to environmental and social causes. He modestly takes the stage but when he starts to sing the hall becomes alive with his infectious energy. In his 77th year, the voice is less sure but the spirit is as vital as ever.

The long list of songs known worldwide that he has written or introduced include "Where Have All the Flowers Gone," "Turn, Turn, Turn," "If I Had a Hammer," and "We Shall Overcome." Hundreds of thousands of fledgling banjo players learned to pick from Seeger's book *How to Play the Five String Banjo*. And, despite his best efforts to avoid them, the laurels have been piling up, including a Grammy Lifetime Achievement Award, a National Arts Medal and the Kennedy Center Honor.

JULY 26

The Fermilab International Film Society presents *Matinee*. Gene, a 15-year-old boy, moves to Key West just prior to the Cuban Missile Crisis, the same time that a horror B-film maker comes to town. A movie about movies. Dir.: Joe Dante, USA (1993). Ramsey Auditorium, 8 p.m., tickets available at the door, $4.

MILESTONES

RETIRED

Ronald Grosklaus, on June 28, 1996. He started at Fermilab on July 1, 1971. Grosklaus worked for the Fermilab Fire Department as a Senior Fire Captain.

Delbert Wilslef, on July 8, 1996. He started at Fermilab on January 19, 1972. Wilslef worked for the Accelerator Division in Cryogenics Systems as a Senior Technical Aide.

Sharon Rowland, on July 8, 1996. She started at Fermilab on February 12, 1990. Rowland worked for the Fermilab Fire Department as a Secretary II.

FermiNews
Fermi National Accelerator Laboratory

Published by the
Fermilab
Office of Public Affairs
MS 206
P.O. Box 500
Batavia, IL 60510
708-840-3351
ferminews@fnal.gov

Fermilab is operated by Universities Research Association, Inc. under contract with the U.S. Department of Energy.

The deadline for the Friday, August 2 issue of FermiNews is Tuesday, July 23.

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.

☆ U.S. GOVERNMENT PRINTING OFFICE:
1996--646-065/00046