

SPECIAL EDITION

TeV I, Accelerator, and CDF Put it All Together

Fermilab raced protons and antiprotons against the clock, and the clock lost. With the final deadline before the year-long accelerator shutdown just hours away, the people of the Antiproton Source, the Accelerator Division, and the Collider Detector at Fermilab (CDF) achieved the first proton-antiproton collision at 1.6 TeV, the highest energy yet achieved in a laboratory. Secretary of Energy John S. Herrington lauded the accomplishment by stating, "We are very pleased. This represents a major step forward which restores U.S. leadership in facilities for high-energy physics research.

Upcoming issues of FermiNews will deal with the technical enormity of the accomplishment and give proper recognition to all of the people involved. And, as we pause to appreciate these achievements in retrospect, everyone at Fermilab can anticipate the adventures to come. As our director, Leon Lederman, put it, "We are privileged to look where no one has ever looked before. The new domain of energies our Collider will explore will yield very valuable data, and may well have great surprises in store."

"The People Were Superb"

"I'm excited, exhilarated, and worn out." So said John Peoples, Project Manager for the Antiproton Source, as he reflected on the triumph his group experienced in the early hours of Sunday, the 13th.

"Everyone came through; it was an incredibly fast turn-on. What's really surprising about it is that we didn't finish the Accumulator Ring until early August. To make matters worse, we still hadn't understood that we had problems with collapsed bellows. In early August the Debuncher was commissioned. We were able to inject protons into it and store them for an hour or more. All of the systems, including the cooling systems, were working. At that time the Accumulator was working very poorly. We could inject protons and store them, but we couldn't accelerate them across the aperture.

"We knew there were some improvements that we had to make, but it wasn't until the 21st of August that we had removed the last collapsed bellows and were able to decelerate beam in the Accumulator from the outside of the aperture, where antiprotons are injected, to the inside, where antiprotons are cooled and stored.

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"It's Great!": Tollestrup

"It was a great shakedown cruise, and we're all really looking forward to the future." Roy Schwitters, co-manager of CDF might well have spoken for all of the people of Fermilab when he made that statement. Alvin Tollestrup, the other co-manager of CDF was more succinct, if no less enthusiastic: "It's great!"

Years of planning and intense labor came to a head at 2:52 a.m., Sunday, October 13, when monitor screens in the CDF control room flared with the bright bands of color which indicated proton-antiproton collisions at 1.6 TeV inside the CDF central detector, a new world's record for laboratory-produced energy.

"By 2:30 Sunday morning, things were becoming very intense," Schwitters later recalled. "We'd had minor problems all along, and it was clear we were reaching the end of the road: the deadline for the shutdown was approaching. The bulldozers were waiting to begin work on B0 and D0. It had been a long, hard grind for everyone, and what we were feeling by then might best be described as grim determination."

Meanwhile, in AP10, the Antiproton Source Control Room, "Everybody was calm,"

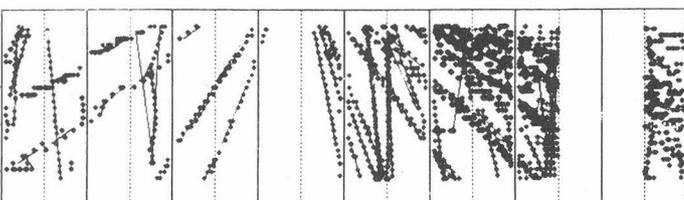
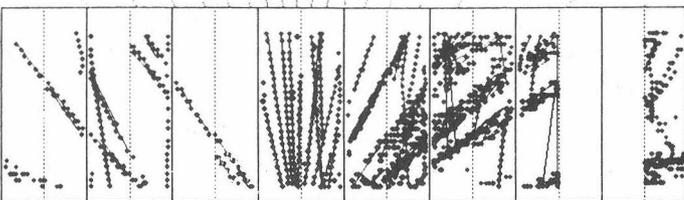
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After August 21, the pace was very fast. By September 5, all of the Accumulator systems were working with protons. On September 7 we had our first tiny stack of 100 million antiprotons. It took most of the day to collect them. The number was too small to inject into the Main Ring, but it was a start. Two weeks later we were doing ten times better. By September 30, the day the Accelerator was scheduled to turn off for D0 construction, we were barely accumulating enough antiprotons to make further efforts worthwhile. In the meantime, the Accelerator Division had made a lot of progress in bunch coalescing, cogging, and squeezing. So we decided to keep trying. By October 5 we were accumulating antiprotons in a reliable manner. That night or morning, antiprotons were extracted from the Accumulator and seen to circulate in the Main Ring. After that, it all happened very fast.

"All the people who worked on the Antiproton Source were superb. It was the best group of people I've ever worked with in my life. It's just been an incredible delight; they really are great. The technicians, engineers, and physicists, everyone did a superb job.

"We still have a lot to do before one can do physics with colliding beams in the Tevatron. By July of 1986 we hope to have the Source to the point where it's close to design specification. We think we know what to do. We're just going to keep working away at it. If we succeed, CDF will have a lot of very interesting events."



Event #15, "the real moment." The original hardcopy is in vivid color.

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said Bob "Obie" Oberholtzer of the TeV I Installation Group. "We were pretty well set up by Saturday night. Basically, all we had to do was initiate our extraction and then it was up to the Accelerator people."

"After the first time," Jim McLaughlin of the TeV I Acceleration Group recalled, "everything worked basically correctly from then on, so that every step of what we had to do was working. We weren't stacking at the rate we were supposed to, and we weren't getting the density of beam we were supposed to, but it was a matter of degree rather than a distinct qualitative difference. Every step worked, and, of course, the Main Ring and Tevatron people [in the Main Control Room (MCR)] hadn't had very much chance to practice with p-bars, we only made ten shots [of p-bars] that night, and that's about all the practice they had had. It was an amazing job on their part."

After hours of anticipation, event #11 almost snuck by. In contrast to the outburst of jubilation which occurred in the MCR when the Tevatron achieved 512 GeV on July 3, 1983, the scene in the CDF control room when event #11 appeared on the screens was remarkably low-key. "The first event [event #11] was slightly off-center in the detector, and someone remarked that it was 'our first beam-gas collision from antiprotons,'" Schwitters said. "But Bob Kephart and I looked at the hardcopy and thought it might not be beam gas, because the tracks were too straight."

Attention shifted from monitor screens to a table in the center of the room, as the CDF group gathered around, some kneeling on the table, watching as Kephart carefully analyzed the hardcopy of event #11.

"Event #11 won me a dollar," said Tollestrup. "I'd bet Larry Nodulman [a member of the Argonne contingent in the CDF collaboration, who ran construction of the electronic calorimetry on the central calorimeter] that we would get collisions before we stopped running. Finally, he came in and said he'd give me a dollar, and I said, fine. So, I've got a dollar bill with his signature on it."

When the first collision was verified, Schwitters phoned the MCR. "It's a

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Congratulations from Around the World

WE ARE VERY PLEASED TO HEAR OF THE MAGNIFICENT SUCCESS OF THE FIRST PROTON-ANTIPROTON COLLISION AT THE TEVATRON AND WISH TO CONVEY TO YOU AND YOUR STAFF OUR HEARTIEST CONGRATULATIONS. IT IS NICE TO BE IN SUCH AN EXCELLENT COMPANY ALSO ON BEHALF OF THE CERN STAFF

HERWIG SCHOPPER CERNLAB

MY WARMEST CONGRATULATIONS FOR THE ACHIEVEMENT OF THE FERMILAB COLLIDER. YOU ARE NOW FIRST IN THE ENERGY SCALE. IT WAS NOT SUCH A BAD IDEA AFTER ALL :

BEST REGARDS

GENEVA

CARLO RUBBIA CERNLAB

CONGRATULATIONS ON A GREAT LEAP FORWARD,
PIEP

STANFORD

DIRECTOR FERMI LAB

PLEASE EXTEND MY HEARTIEST CONGRATULATIONS TO ALL FOR WONDERFUL ACHIEVEMENT OF COLLIDING BEAMS IN TEVATRON. A BEAUTIFUL PERFORMANCE.
B.D.MCDANIEL
CORNELL UNIV

ITHACA

MY COLLEAGUES AND I WOULD LIKE TO CONGRATULATE YOU AND ALL THE SCIENTISTS INVOLVED ON REMARKABLE ACHIEVEMENT - OBSERVATION BY THE CDF DETECTOR OF FIRST PROTON-ANTIPROTON COLLISIONS IN TEVATRON. WE WISH YOU SUCCESS IN FUTURE TEVATRON EXPERIMENTS.

BEST REGARDS I.V.CHUVILO
DIRECTOR ITEP, MOSCOW, USSR

MOSCOW

CONGRATULATIONS ON THE FIRST OBSERVATION OF PROTON-ANTIPROTON COLLISION EVENTS AT THE TEVATRON COLLIDER. WE ARE PARTICULARLY GLAD TO HEAR FROM OUR COLLEAGUES ABOUT A GREAT SUCCESS OF THE CDF COLLABORATIONS UNDER THE US-JAPAN COOPERATIVE PROGRAM. WE DO HOPE FURTHER PROGRESS OF THIS WORLD-HIGHEST ENERGY COLLIDER AND SUCCESS IN ITS NEW PHYSICS FIELD. PLEASE SEND MY BEST REGARDS TO ALL OUR GOOD FRIENDS AT THE FERMILAB, IN PARTICULAR, WHO ARE WORKING AT THE CDF COLLABORATIONS.

TETSUJI NISHIKAWA, KEK

TOKYO

DEAR LEON
CONGRATULATIONS ON YOUR MAGNIFICENT ACHIEVEMENTS
WE ALL ARE IN EXPECTATION OF BIG DISCOVERIES COMING FROM COLLIDER HOWEVER WE HAVE SOME HOPE THAT THESE DISCOVERIES WILL NOT DESTROY COMPLETELY THE FIXED TARGET PROGRAMME
YOURS SINCOFELY VORDROYOV

LENINGRAD

ON BEHALF OF THE INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS I WOULD LIKE TO SEND MY WARMEST CONGRATULATIONS ON THIS HISTORIC EVENT OF HIGHEST POSSIBLE ACHIEVEMENT.
(ABDUS SBALAM DIRECTOR ICTP)

TRIESTE

GLAD TO HEAR OF FIRST PROTON-ANTIPROTON COLLISIONS OBSERVED BY CDF DETECTOR IN FERMILAB'S TEVATRON. HEARTY CONGRATULATIONS ON YOUR ACHIEVEMENT.
ZHANG HOUYING, DEPUTY DIRECTOR IHEPKKXX

BEIJING

CONGRATULATIONS ON THE FIRST F-BAR COLLISIONS.

FANTASTIC

JACK STEINBERGER CERNLAB / EP

CERN

WARMEST CONGRATULATIONS TO YOU ALL FOR MAGNIFICENT RESULT WITH FERMILAB PROTON-ANTIPROTON COLLIDER.

BEST REGARDS

LUIGI DILELLA CERNLAB / EP

DEAR LEON,
CONGRATULATION FOR THE DRAMATIC SUCCESS OF THE TEV-ONE PROJECT. I BELIEVE THIS IS A LAUNCH TOWARD NEW PARTICLE PHYSICS BEYOND THE STANDARD MODEL. I CANNOT MANAGE TO ATTEND THE DEDICATION, BUT I WISH TO CELEBRATE IT FROM THE OTHER HEMISPHERE. SINCERELY,

KUNITAKA KONDO
INSTITUTE OF PHYSICS
UNIVERSITY OF TSUKUBA

TSUKUBA

Congratulations to everyone at Fermilab on the first proton-antiproton collisions in the world at 1.6 TeV. An unparalleled achievement by your dedicated scientists, engineers, operators and support staff. May the physics, when it comes, be bountiful and full of discovery.

TIGNER

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collision event...it's got the right property...it's not just a run-of-the-mill event, it's got everything going for it...it really works, it's the first one. So, tell everyone there's going to be champagne at BO, you can put that on the monitor."

John Cooper, a member of the CDF collaboration, was over in the MCR when the call came in. "It was all sort of depressing, it seemed like nothing was working right, it seemed like we'd taken a thousand shots and nothing worked.

"Finally, I was over there [in the MCR] trying to communicate back to the CDF guys, telling them when the next shot was going to happen so they could really try to look for it. I was talking to Roy Schwitters on the phone one time, and he said, 'You know, John, we might have a believable event over here,' and I accused him of being overly optimistic, so he described the event to me.

"Leon happened to be sitting in the MCR at the desk, and I said, 'Well, Leon's here, do you want to tell him about it?' and Roy said, sure, why not. So, Leon got on the phone, and Roy described the event to him, and Leon said, 'That's very nice,' very low key; I was amazed at how low key he was."

"Actually," Schwitters said, "when event #11 occurred, we were anticipating a dump of that fill [accumulation of anti-protons] because the intensity was rather low, and we were looking for a new fill with higher intensity.

"We did get another fill later, and that's when we had our real moment, because a second event came up [event #15] at about 4 a.m.; it was squarely in the center of the detector, and it confirmed our first event."

"After event #11," Tollestrup remembered, "the excitement grew as some of the subsequent events began appearing on the screen. Number 15 was spectacular. It was centered in the detector, it was absolutely clear, you didn't have to apologize at all for that one."

John Cooper was still in the MCR. "Some of our guys brought over some copies of the event, and people were standing around staring at the copies, as if they'd

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DVM? DVM? What DVM?

Serious business, this particle physics. A lot of long hours for a lot of people. Sometimes, it helps to lighten the mood.

"By Saturday night," recounted Jim McLaughlin, "things at AP10 were getting to seem a little bit routine, and we tried various strategies to liven things up."

"We had no trouble whatsoever shooting antiprotons into the Tevatron," said Obie. "Ours came into the Tevatron at the same point every time. We had circulating beam at 800 GeV by that time.

"After we started sending beam, we'd call the Main Control Room [MCR] and ask how it was going, and they wouldn't tell us anything, they said they'd get back to us, and they never did.

"So, we unplugged our DVM, the monitor readback on how many microamps we had in the Ring, and we also unplugged the picture of the antiproton stack, so that everything went dead, and we sat there waiting to see how long it would take the phone to ring."

McLaughlin: "We didn't hear from the MCR for about three minutes, but I understand that the call from CDF to the MCR was virtually instantaneous. John Elias [at CDF] said that they'd been plotting it [beam intensity], and the instant the beam apparently went away, they called the MCR to find out what was up."

John Cooper: "When TeV I unplugged the DVM, somebody from CDF had just called up the Main Control Room to ask how many shots were left, and they turned around to see how many shots were left up there on the screen, and there was nothing there. So I suggested they call p-bar and ask them what was going on. Turned out they were just playing a little trick..."

Obie: "About three minutes later we got a phone call, and it was the Main Control Room: 'That stack's gone, what's the matter?' And I said, 'Oh, yeah, I guess it is. We'll call you back when we figure out what's wrong.' After a few minutes we called them back, and we plugged everything back in.

"I went over to CDF at about 5:30 a.m. to get some champagne, and I walked in there and I said, 'Sorry we pulled that bad trick on you, but we were feeling

neglected,' and they said, 'Yeah, it was horrible, because a total gloom came over the whole place. And then when it came back on the screen again, there was applause.'"

McLaughlin: "It certainly livened things up for us." 

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expected it to happen. It took awhile for the celebration to get going. By then, everyone had been there for 24 hours, and it was, 'Do we believe this or not?'"

Soon people from TeV I and the Main Control Room had begun arriving at BO. "It was really fun having all the TeV I and Accelerator people come over to celebrate with us," said Schwitters. "Every time someone came in, like Leon, who'd been shuttling back and forth from TeV I to CDF to the Main Control Room, and Helen Edwards, who'd been in the RF building the whole time, the room erupted in cheers."

"Almost everyone was over at CDF," said McLaughlin, "and Alvin said 'Where's Helen, let's get Helen over here.' She was at FO, so Leon called her and they talked on the phone and decided that that was enough, there'd been some events, and that was really the purpose of the run, to demonstrate that all parts of the system worked."

"The crux," said Tollestrup, "the real *tour de force*, was at the accelerator, in getting the limited number of p-bars we had through the Main Ring, into the Tevatron, accelerated, squeezed with the low-beta; everything there had to work with a lower intensity level than had been planned on. You really have to appreciate the inventiveness on the part of Helen Edwards and the rest of the Accelerator people."

"It was not an easy run," said Schwitters. "Everyone in CDF, TeV I, and Accelerator was working against the clock. But everybody felt confident all month, and it is clearly a tremendous achievement for everyone at Fermilab.

"This is really just the beginning for the physicists. Perhaps that's what mellowed the moment. We now have to finish our detector; we've got a lot of assembly work to do, and we're looking ahead eagerly to '87 when we can start doing physics at 1.6 TeV." 