

The Village Trier



fermi national accelerator laboratory

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NEGATIVE ATOMS PRODUCE POSITIVE RESULTS

Two years of hard work by the Linac and Booster groups began to pay off a few weeks ago when the H-minus project produced a new Booster intensity record.

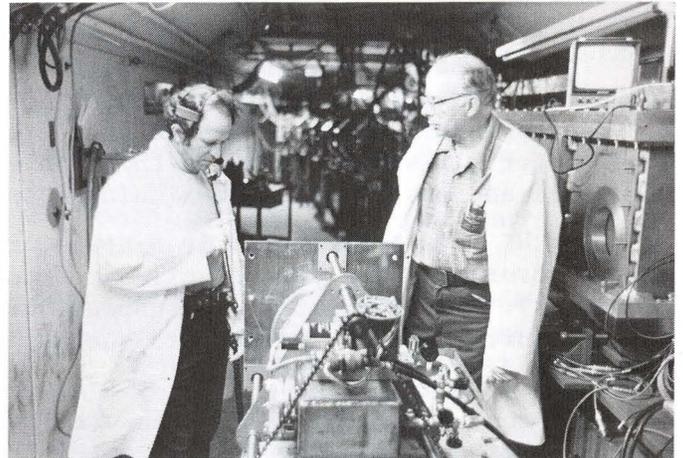
"H-minus," written as "H-" for short, means hydrogen atoms with an extra electron, so they are negative ions. The innovative new project of using them to inject into the Booster is part of the continuing effort to raise accelerator intensity to provide more beam for high-energy physics experiments.

On March 4, the Booster group took advantage of additional study time coming because of the partial shutdown imposed by the coal strike. They recorded a new intensity record: 3.46×10^{13} protons accelerated in the Booster per Main-Ring cycle. The new mark eclipsed the old record of 3.06×10^{13} made with conventional proton (H^+) injection. The achievement came only eight days after starting trials of H-minus injection.

"The rapid initial success," said Chuck Ankenbrandt, Booster group leader, "testifies to the essential simplicity of the injection method. But it took two years of careful preparation by the Linac and Booster groups to lay the groundwork. Work is continuing in order to refine the technique."

The negative charge of the H^- ion makes it bend the opposite way from a proton in a magnetic field. The H^- atoms coming into the Booster can be injected on a path that overlaps the orbit of circulating protons. Where the two paths meet, the H^- atoms pass through a thin carbon foil that strips off the two electrons, leaving protons which add to those previously injected. Injecting for many turns in the Booster builds up the beam intensity, without the growth in the size of the beam that came with other multiturn methods. It allows smaller Linac currents to be used, avoiding the instability and growth in beam size that occur when the Linac is operated at very high current. This also makes it much less difficult for the Linac to fulfill its

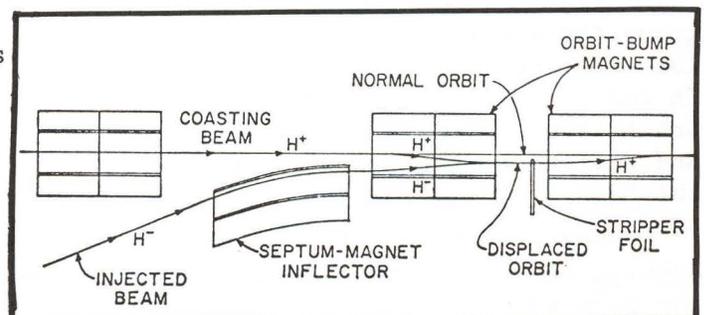
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...C. Hojvat (L) and D. Cosgrove set up H^- equipment in Booster tunnel...



...(L-R) C. Schmidt, W. Smart, C. Curtis, C. Owen, L. Allen watch intently in main control room as H^- commissioning results appear on scopes...



...Diagram of H^- injection into Booster accelerator...

NEGATIVE ATOMS (Continued)

triple role, feeding the Booster, the Cancer Therapy Facility, and the new Electron Cooling Ring all at one time, each with its own beam requirements.

Above all, the intense high-quality beam coming out of the Booster should help to improve capture into Main-Ring orbits and provide more protons for high-energy physics experiments. That has always been the primary goal of the H^- effort.

The scheme was originally proposed by the famous G.I. Budker and his colleague G.I. Dimov at Novosibirsk. Lee Teng, Associate Head for Advanced Projects of the Fermilab Accelerator Division, suggested that the method could be used here and has provided continuing support.

The H^- ions are created in a new source, a highly modified version of a source built at Brookhaven National Laboratory. Chuck Schmidt was responsible for development of the source, one of the keys to successful negative-ion injection.

A second Cockcroft-Walton pre-accelerator was built under the direction of Cy Curtis to use the H^- source. The C-W provides a voltage of 750,000 volts to push the ions through an accelerating column. Home of the new C-W is a recently constructed 26 x 30 x 38-foot enclosure adjacent to the proton-accelerator enclosure.

The accelerating column directs the H^- beam through the wall of the pit. It goes into a 30-foot string of bending and focusing magnets, which guides the beam into the Linac. Wes Smart designed and tested the team transport line.

Mike Shea and Bob Goodwin developed a new micro-processor-based control system linked to the existing Linac control system. Electrical and mechanical engineering efforts were overseen by Tony Donaldson and Glenn Lee. Ray Hren and Jim Wendt played an important support role in the assembly and testing of the new source/preaccelerator system. Curt Owen led the Linac group during this period.

The design goal -- 25 mA of H^- ion beam delivered to the Booster for 20 turns (.000050 seconds) -- was achieved in October and this month a record of 45 mA was attained.

After H^- ions emerge from the Linac, the Booster group takes over. Their first job is to make sure H^- ions move down the 200-MeV line into the Booster tunnel. In the tunnel, the ions are injected into the Booster orbit, two electrons are stripped from the protons, and protons are accelerated to 8 GeV for injection into the Main Ring.

Booster efforts started over a year ago under Rol Johnson and continues under Ankenbrandt. A main task for Booster staffers was to install a new injection

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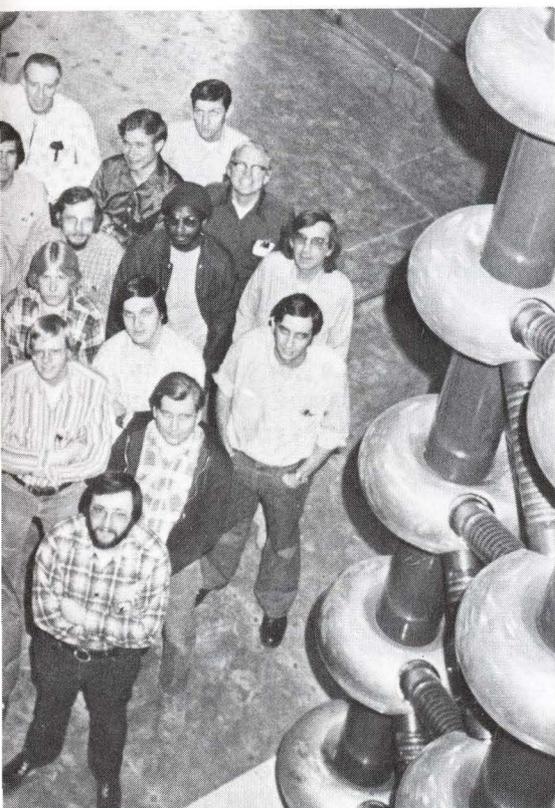
...Booster staffers include (L-R): Mendoza, R. Johnson, B. Brown, row--D. Cosgrove, R. Taacke, J. L. Benson, J. Garvey, H. VanLee, H. Gerzevke, T. Schmitz...



...Linac task force on H^- project: Cilyo, J. Davis, D. Douglas, J. Goodwin, R. Hren, T. Larson, G. B. Ogert, C. Owen, M. Palmer, C. Smart, R. Smith, T. Svejda, J. I.



Front row--G. Taylor, C. Hojvat, J. Douglas, R. Mraz, J. Biggs; Second row--Arrester, R. Webber, C. Ankenbrandt, J. Ranson; Third row--J. Lackey,



. Benson, D. Booth, D. Breyne, F. Mickson, A. Forni, W. Ganger, B. e, S. Lipke, F. Krzich, F. Mehring, Schmidt, K. Schuh, E. Schwass, W. dt, J. Wildenradt...

NEGATIVE ATOMS (Continued)

girder, a 20-foot steel beam supporting an array of components. The girder replaces the older injection girder in one of the Booster's straight sections. It is capable of injecting either protons or H^- ions. Key components include three double magnets used to produce bends in the orbit during injection.

Carlos Hojvat is project leader for Booster H^- modifications and developed the carbon foil stripping method that is vital to the project. The Magnet Facility aided in the construction of magnets; Ken Bourkland developed necessary pulsed power supplies. Dave Cosgrove was responsible for mechanical design, aided by Tom Schmitz and Henry Van Leesten. Doug Maxwell and Jan Wildenradt spearheaded the mechanical assembly and provided expertise with vacuum techniques.

Russ Huson, Accelerator Division head, added, "The negative-ion injection will make possible a substantial increase of intensity from the Main Accelerator. At the same time, Accelerator Division physicists have made an important advance in accelerator technology. Our experimenters will be happy with this new capability because it means better quality beam for their experiments."

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H^- MILESTONES: A CHRONOLOGY

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|----------------------------|---|
| May, 1975 | Initiation of H^- source development program. |
| March 29
1976 | First beam from surface plasma source. |
| May 12
1977 | First beam from source of final design (40mA). |
| July 12
1977 | First beam from Cockcroft Walton in Village. |
| July 22
1977 | H^- testing in Village ends. |
| Oct. 6
12
24
1977 | First beam from H^- preaccelerator.
H^- beam first accelerated through Linac.
H^- beam first transported down 200 MeV line. |
| Nov. 8
1977 | Linac exceeds design intensity (33 mA of H^- beam). |
| Jan. 4
11
1978 | Record H^- current, 42 mA, accelerated through Linac.
First H^- beam to CTF. |
| Feb. 25
1978 | H^- beam first injected into Booster. |
| March 4
1978 | Booster intensity record. |
| March 10
1978 | First high energy physics running with H^- injection. |

TIAA-CREF MEETINGS

As a result of employee interest, two all-Laboratory meetings will be held to review Fermilab's retirement programs. John McCook, Associate Director for Administration, made the announcement. He said the 60-minute programs will be held Tuesday, Mar. 28, in the auditorium. The first session is set for noon; a repeat program will be held at 4 p.m. for the convenience of employees. A TIAA-CREF benefit plan counselor will speak on retirement plan benefits and answer questions. Free literature will be distributed. Attendance is voluntary; employees should notify their supervisors which program they will attend.

MEDIA MENTIONS

Fermilab research programs are profiled in March issues of Science, Smithsonian (Institution) Magazine and National Geographic. Chris Quigg, theoretical physicist, co-authored "The Cluster Concept in Multiple Hadron Production" for Science. His colleague was I.M. Dremin, a theoretical physicist at the P.N. Lebedev Institute, Moscow, U.S.S.R. A historic four-neutrino event photographed at Fermilab was pictured in Smithsonian Magazine. The photo accompanied "Missing Particles Cast Doubt on Our Solar Theories," an article by James S. Trefil, a University of Virginia physicist. Film scanner Karen Carew was shown at work in a full-page color photo illustrating "Wondrous Eyes of Science," a 29-page piece in National Geographic. George T. Mulholland, 15-foot Bubble Chamber group leader, is quoted on Fermilab neutrino experiments.

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SITE-WIDE SPRING CLEAN-UP NEXT WEEK

Monday, Mar. 27, will mark opening day of an annual spring site clean-up by Site Services. Get all winter trash ready for pick-up. For five days, Site Services will supply trucks, bags and manpower. To do the job, your help is required! Area supervisors are: Accelerator and Research -- D. Smith, Ext. 3492; Village and other Sites -- G. Doyle, Ext. 3421; Central Laboratory -- G. Plant, Ext. 3824. For more information, call P. Bishop, Coordinator, Ext. 3101.

GARDEN PLOT REQUESTS DUE APRIL 7

The Fermilab Garden Club announces that request forms for onsite garden plots have been mailed to persons that previously indicated interest. Forms are also available from Helen Ecker, recreation director, CL-1W. The deadline to reserve the same plot tilled last summer is April 7. Effective this year, the Garden Club is assigning plots in both the annual and perennial areas. The club constitution, list of officers and membership rules are available for inspection in the library. More information is available from Alan Schiz, Ext. 4149.

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FORE! GOLF LEAGUES FORMING

Fermilab golf leagues are forming for Tuesday, Thursday and Friday evening play. The Tuesday-Thursday night league will open May 2 and May 4. First tee time will be 5:15 p.m. at Country Lakes Golf Course, Rt. 59, Naperville. Signup will be on a first serve basis from April 3-14. Entry fee is \$10 per person; greens fees are \$4. To register, contact Tim Gierhart, Ext. 4432.

A Friday night league, limited to about 12 golfers, will play at Fox Valley Country Club. Tee time will be 5 p.m. For more information, contact Paul Bishop, Ext. 3101.

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DON'T FORGET . . . NALREC children's Easter egg hunt Saturday (Mar. 25), 1 p.m., east of the Village tennis courts. In case of inclement weather, the hunt will be held in the Village Barn. Egg hunters will need to supply their own baskets.