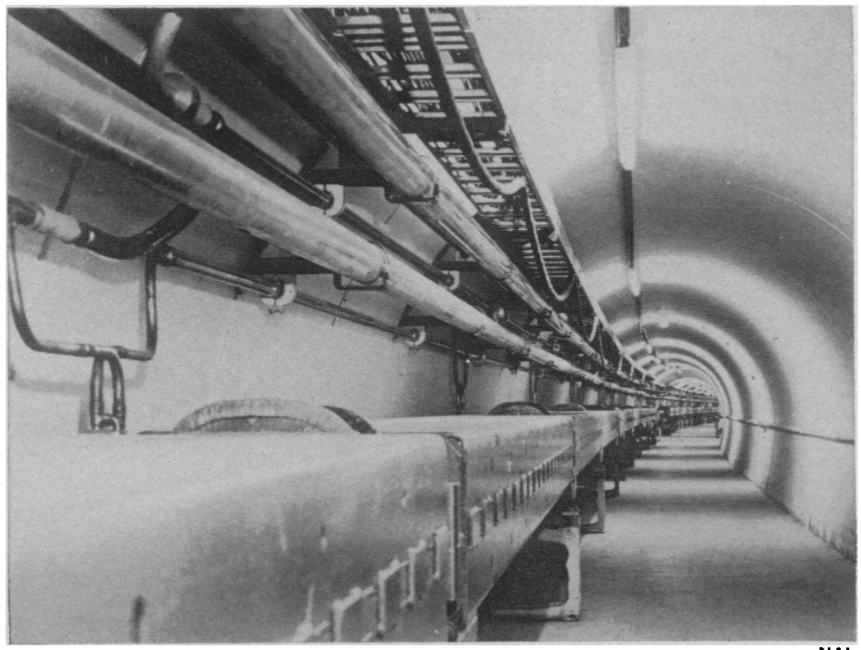
# Double and redouble

## Superconducting tubes at the National Accelerator Laboratory could produce 1,000- or 2,000-GeV protons



NAL

*Energy-doubling tubes would lie on these magnets in NAL's main ring.*

by Dietrick E. Thomsen

The annual electric bill will be in the neighborhood of $3 million. That is the kind of power it will take to run the National Accelerator Laboratory. The laboratory, which will have the world's most energetic proton accelerator, is now nearing completion on a site near Batavia, Ill.

Very little of the energy will actually be delivered to accelerated protons in the laboratory's main accelerating ring. A large part of the power will go to energize the magnets that bend and focus the accelerated beam, and much of this is lost as heat generated by electrical resistance.

**When the management** of the NAL began to look for ways to increase the accelerator's planned maximum energy of 500 billion electron-volts, they turned their attention, therefore, to superconducting magnets. Magnets made with superconductors can produce higher fields at less power cost than conventional ones. This is important because their use would not only reduce the electric bill but also allow a more energetic beam to be circulated in a ring the same size as the NAL's present one. The more energetic the accelerated particles are, the stronger must be the magnetic field to keep them in the same circle. To build a 1,000-GeV accelerator with conventional magnets would mean a ring approximately twice as big as NAL's present 1.24-mile diameter.

On the other hand, to build a 1,000-GeV machine from scratch with superconducting magnets would produce other problems. Superconductors, which certain metals become at temperatures near absolute zero, will pass direct electric currents without resistance. But to alternating and pulsed currents superconductors offer impedance; energy is dissipated when the motion of the conduction electrons in the metal is speeded up or reversed.

Accelerator magnets are pulsed. As the beam of particles accelerates, the magnetic fields must rise to keep the particles in the same circle. For 1,000 GeV in a mile-wide circle this can mean a rise from zero to 50 kilogauss in ten seconds. Some experts in accelerator technology fear that this kind of pulsation may use up so much energy that superconducting magnets will be no advantage over conventional ones.

The energy-doubling device that Dr. Robert R. Wilson, director of the NAL, proposes goes neatly between the horns of this dilemma. It would be a ring with superconducting magnets and would be laid on top of the present main ring. Pre-accelerated particles would be fed to it from the main ring. The magnets would have a power advantage since they would not have to pulse all the way from zero to 50 kilogauss. They could idle at 22 kilogauss, the maximum field in the main ring, and then pulse from there to 50 kilogauss as the doubler raised the energy of the particles.

**There is plenty of room** in the ring tunnel for such a second tube, says Dr. Wilson, even for more than one. He talks of the possibility of someday going to 2,000 GeV with yet another energy doubler piggy-backed on the first.

Dr. Wilson describes the cost of an energy doubler as modest. No actual cost survey has been done yet, but others peg the cost at something in the neighborhood of $10 million, a small fraction of the $250 million capital cost of the present laboratory.

At Congressional hearings last week, Dr. Wilson described the idea to the Joint Committee on Atomic Energy. He is not at present asking for any authorization of money for an energy doubler, but he told them he would like to study the feasibility of one and wants them to think about the idea.

Meanwhile, the laboratory is preparing to begin experimentation with the present main ring this summer. The target date for the first accelerated beam is about July 1. According to Dr. James R. Sanford, head of the experimental facilities section, actual experiments should begin shortly after the first beam is accelerated.

**Initial operation** will certainly be at least at the accelerator's original design energy of 200 GeV. If certain bugs in the power supply can be worked out, it may be as high as 500 GeV—a boost made possible by improved electronics.

The problem, says Donald R. Getz, assistant director of the laboratory, is not the total amount of power that operation at 500 GeV would require, but the possible effects of the power pulses on the electrical network. The power company, Commonwealth Edison, belongs to a grid with ample reserves to supply it now and then, but power pulses of the size drawn by the accelerator can cause surges in the network that would blink lights all over the Middle West.

The company has done a network survey and told the laboratory what rates of pulsation are safe from surges for operation at 200 GeV. Such a survey has not yet been done for 500 GeV. If it should turn out that there are no safe rates at 500 GeV, it may be necessary, says Getz, to use an energy doubler to get 500 GeV. □