On the particle speedway

Professor developing stronger magnets for physics research

BY SCOTT JENKINS
The Battalion

At the Fermi National Accelerator Laboratory (Fermilab) in Illinois, physicists send beams of sub-atomic particles whizzing around a huge, four-mile diameter underground loop. And then they crash them into each other, releasing large amounts of energy.

"A major parameter of particle physics is the energy of the collisions," Dr. Peter Limon, head of Fermilab's technology division, said about the shower of elementary particles resulting from these sub-atomic wrecks.

In seeking a complete understanding of the fundamental physical laws governing the universe, physicists use complex instruments at Fermilab and other accelerators to analyze high-energy particle collisions and detect the fundamental particles present.

It was at Fermilab in 1995 that Dr. Peter McIntyre, a Texas A&M professor of physics, and other scientists discovered the top quark, one of the building blocks of matter. A&M physicists Bob Webb, Teruki Kamon and James White were also part of the team.

Now, McIntyre is helping in the search for greater collision energies through his development of stronger magnets essential for bending the paths of the colliding particles in Fermilab's circular loop.

Scientists at Fermilab take advantage of the fact that protons and anti-protons have electric charge to push and pull the charged particles around the four-mile diameter ring of its Tevatron collider.

Since the path of a charged particle bends in a magnetic field, scientists use powerful superconducting magnets to keep the particles traveling in their circular path.

With each lap, the particle beams are given a "kick in the pants", as A&M's McIntyre said, gaining more and more energy.

"The performance of a given particle accelerator at smashing particles together comes from the strength of the magnetic field its magnets can generate," McIntyre said. Higher energy collisions require stronger magnetic fields.

But these very large magnetic fields introduce a significant problem. The field itself exerts an outward force on the magnet's coiled superconducting material.

To help these superconducting coils hold up these huge Lorentz forces, researchers must find ways to make stronger magnetic coils.

"As we have asked how to extend the ability of magnets, the key challenge we face is mechanical stress," McIntyre said.

He and his research group have developed technology they call "stress management" to divert and distribute the Lorentz forces in the superconducting coils.

This will help to increase the level of magnetic field the coils can withstand. McIntyre likened it to the way a tall office building distributes the force of gravity on its occupants by dividing it into floors, so the gravity force is passed through the floors to the walls and down to the ground.

McIntyre is using his stress management design to develop magnets capable of handling fields three times as strong as the ones currently available at Fermilab.

He said his group hopes to test the magnets in the cryogenics facilities at California's Lawrence Berkeley National Laboratory in mid-April. Eventually, they hope to be able to replace the existing magnets at Fermilab.

Fermilab's Limon said that this new magnet technology is being looked at seriously as a way to do cost-effective higher-energy collider research.

"McIntyre's magnet technology is very interesting, and we are watching it closely," he said.

An increase in the energy of the collisions by a factor of three could be important in gaining experimental proof of the existence of particles that have been theorized to exist, but have never been observed, such as the Higgs particle, believed to be responsible for mass.

"That factor of three in energy reach, if we're successful with these magnets, would allow us to get to the region of energy that is predicted to contain these particles," McIntyre said.

COURTESY OF FERMILAB

(Top) Aerial view of Fermilab's four-mile diameter circular collider. Physicists use magnets to accelerate particles, such as protons, to high speeds before smashing them together. The collisions help to explore fundamental nuclear particles.
(Bottom) Fermilab physicists inspect supercondunducting magnets in the collider's main ring.

In addition to furthering understanding in fundamental physics, research in new magnet technology, like McIntyre's, may also have positive effects elsewhere.

Industrial motors, magnetic resonance imaging technology, and nuclear magnetic resonance studies of protein structure might benefit from more powerful superconducting magnets.

DNA cancer chips might provide faster disease diagnosis

(AP) — Scientists say they can more precisely diagnose cancers with a new technology that uses computers to rapidly monitor the activity of thousands of genes in cancer cells.

That kind of detailed information should one day let doctors classify tumors with more precision, helping them tailor treatments to each patient, scientists said.

Currently, doctors diagnose cancer by looking at tissue under the microscope for certain biological changes and by doing other tests. The new technique, however, goes beyond those methods to look at the activity of many tumor genes.

"You could think of it as a new kind of microscope" that looks at gene activity instead of the visible structure of cells and tissues, Dr. Patrick Brown, an associate biochemistry professor at Stanford, said.

In today's issue of the journal Nature, Brown and colleagues from Stanford, the National Cancer Institute and elsewhere describe one of the first large-scale experiments with the technology. They used glass chips the size of a penny to keep track of how active each of 18,000 tumor genes were.

The researchers focused on diffuse large B-cell lymphoma, a type of cancer diagnosed in more than 25,000 Americans each year. They uncovered two distinct forms of that disease, distinguishable by different patterns of gene activation. By checking records of previously treated patients, they found that one form was deadlier than the other.

The findings help explain why two-fifths of patients with diffuse large B-cell lymphoma can be cured with standard chemotherapy while the rest often relapse or die, scientists said.

The new technique works because active genes in a cell give off chemical messages. These messages will bind to specific DNA segments, depending on what gene they came from. The glass chips carried some 18,000 DNA segments, representing each gene the scientists wanted to monitor.

So by tracking which DNA segments attracted the chemical messages, and how many messages bound to each segment, the technology revealed how active each of the studied genes was.

The results need confirmation in larger studies but establish an important principle, Dr. Todd Golub of the Whitehead Institute and Dana-Farber Cancer Institute, said.

"It suggests that we are really at the tip of the iceberg and that our expectation going forward is that there will be similar stories emerging for all common human cancers," Golub said.

In an accompanying Nature commentary, Anton Berns of the Netherlands Cancer Institute agreed patients should someday benefit by genetic analysis. But he cautioned that such analysis may not able to predict how cancers will behave after the initial treatment.

DNA chips also hold promise for cutting the price of treatment. Someday, a DNA chip that costs less than $100 could take the place of a barrage of current tests, said Pat Brown, an associate biochemistry professor at Stanford who also was part of the study.

"The actual technology is cheap, very cheap," he said.