CBS NEWS

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A Trip Inside The "Big Bang Machine"

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(CBS) As a rule, physics rarely makes news, but it did this past week after equipment malfunctions delayed for several months the start up of one of the biggest science experiments in history. We are talking about the Large Hadron Collider, a massive, multibillion dollar project designed to unlock the secrets of the universe.

For several years now, thousands of the world's most accomplished scientists have been gathering in Europe, not to explore the heavens but the frontiers of inner space. They are hoping to discover subatomic particles so tiny that they have never been detected. They think these particles will help explain why the universe has organized itself into so many different things - planets and stars, tables and chairs, flesh and blood.

To do it, they have constructed one of largest, most sophisticated machines ever built to replicate what the universe was like a few nanoseconds after it was created. And as **Steve Kroft** reports, it is all going to happen 300 feet underground on the border between Switzerland and France.

Under the meadows and mountains outside Geneva, Switzerland, 9,000 physicists from all over the world have been taking part in one of the biggest, most ambitious scientific collaborations in history. It's being conducted in a vast subterranean laboratory carved out of earth and bedrock under two different countries. And it has pushed the limits of technology beyond state of the art, towards the boundaries of science fiction.

It's called the "Large Hadron Collider," a massive scientific instrument that took 20 years to create and cost $8 billion.

Scientist Austin Ball, who helped build it, gave ***60 Minutes*** a tour of the experiment before they sealed it up and began a series of run-throughs. It was during one of those tests that some equipment malfunctioned, setting back the project several months. When it resumes, they hope to begin cracking open the tiniest bits of the atom, by racing them through a 17-mile tunnel and crashing them into each other at nearly the speed of light.

"Forty million times a second, bunches of protons collide in the center of this barrel section," Ball explains, standing in front of a pipe that the particles will come through. "And they reproduce conditions that hadn't existed since a tiny fraction of a second after the Big Bang."

By traveling back in time and recreating the earliest seconds of the cosmos, scientists are hoping to discover the smallest building blocks of nature, and the forces that brought them together to form so many different things. And they're planning to do it with a machine that's simply expanding on one of man's very first ideas.

"I have to say, it is pretty stupid to take two things and throw them at each other as fast as you can and see what comes out," says scientist Bob Stanek, who has been working on the collider for 14 years.

He agrees it's a primitive concept. "But we're humans, and that's all we know."

For the past seven years, Stanek has been a transatlantic commuter of sorts, spending three weeks in Switzerland for every one week back home in Chicago, where, as his hard-hat suggests, he's a die-hard Bears fan.

Asked why scientists are interested in recreating what the universe was like a nanosecond after the Big Bang, Stanek tells Kroft, "It's in humans' interest to know everything, right? And why wouldn't you want to know that?"

"Well, you'd want to know it but, you know, spending eight billion dollars to find out, it must be important," Kroft remarks.

"So, let me ask you this question: because we've studied the interactions of photons and electrons and elementary particles, we can understand how to take the light that bounces off of me and you into that camera and take that signal and put it into mom and pop's living room. Now, imagine, in 10 years, 20 years, will we be able to take, instead of our photons, me and you and put them in mom and pop's living room? So, you tell me, is that worth it?" Stanek asks.

"Transport people?" Kroft asks.

"You tell me. Is that worth it? Is that worth eight billion dollars?" Stanek asks.

Asked if he thinks that could happen, Stanek replies, "I don't know enough right now. But I can't say it can't happen."

The collider itself is a marvel of precision engineering. Two beams of invisible hydrogen protons will be driven around the tunnel in opposite directions inside ultra-high vacuum tubes propelled and guided by super conducting magnets, chilled with liquid helium to a temperature of minus 271 degrees Celsius, colder than deep space. As the two beams approach speeds of 186,000 miles per second, they will smash into each other at four different parts of the collider.

At the heart of the machine are four massive detectors where the actual collision of the subatomic particles takes place. One of them is seven stories tall - nearly 8,000 tons of lead, steel, wires, plastic and magnets that capture and record everything that's going on inside.

"So you can race these little...protons around this 17-mile track at the speed of light, smash 'em in together in a beam that's the width of a hair. And you can measure what happens in a billionth of a second?" Kroft asks Stanek.

"Billionth of a second, actually 25 nanoseconds. So set the scale," Stanek says. "Here to there is 25 feet. Turn my flashlight on, by the time that beam reaches that wall, is the time that we have to have recorded all this information."

A 60 megapixel camera inside the detector captures what's going on at 40 million frames a second. And the digital data detected by layers of sensors can be converted into pictures the human eye can understand. The information goes to super-fast computers, then out to laboratories and universities all over the world for analysis. There are so many sensors monitoring so many collisions that in just one year, the collider is expected to generate ten times more data than all of the information now on the Internet. To make sure the results are valid, the two main detectors are entirely different.

Stanek says the detectors were created by different teams of scientists, with "different criteria, different motivation and so on."

Asked if there's much competition between the two teams, Stanek tells Kroft, "Friendly competition. But, you know, when we hear those guys are behind, we all laugh a bit, and I'm sure they do the same thing. But, you know, at the end, they both have to work."

This is all being conducted under the auspices of the European Organization for Nuclear Research, otherwise known as CERN. But more than 80 countries are contributing money, technology or scientists to the project. There have been Israelis and Palestinians, Indians and Pakistanis, Iranians and Americans working on the collider, and everyone will share in the scientific results.

Asked if he's concerned the collider won't work when it's turned on, James Gillies, CERN's chief spokesman, tells Kroft, "I think we can be pretty confident that it's gonna work. Because everything you can possibly test along the way has been tested."

Gillies told ***60 Minutes*** the kind of equipment malfunctions and delays the project is experiencing now are not uncommon and to be expected. "It's a very complex machine. Nothing like it's been done before. It's its own prototype in some sense," Gillies says.

"All of this is being done to satisfy scientific curiosity?" Kroft asks

"I would say it's all being done to satisfy human curiosity," Gillies replies.

"But are there practical things that are likely to come out of it?" Kroft asks.

"I'm pretty sure there will be in the long-term. I mean, the history of science shows us that the big advances in human technology come about through curiosity-driven research," Gillies says.

"Can you give me an example of something that was created here for research purposes and changed the world?" Kroft asks.

"Yeah. Well, the best-known one is the world wide web."

The system you use everyday to click on links and move from one Internet site to another was invented at CERN to help scientists do research. Because CERN has been required to share its scientific discoveries, the Web was given to the world for free. It has helped transform society, and private industry has made billions off of it. And scientists at CERN anticipate similar results from the collider. When they began planning it, the technology to build it didn't exist. It had to be developed by companies and laboratories in Europe, Asia, and the United States.

"We, in doing these experiments, do push the technologies to the limit. And so, you know, industry eats this stuff up. They say, 'Oh, yeah, here's something. Okay, so we can make this faster. We know how to do this. Okay, so now we can market it.' And that's what's happened," Stanek says.

One of the things scientists are hoping to find with the help of the collider is called the "Higgs" particle. It is named after Peter Higgs, a professor in Scotland. Four decades ago, he theorized that there must be something in the universe that we can't see that gives things weight or substance. Earlier this year, he got a look at the first machine powerful enough to test whether he was right.

The Higgs particle is sometimes called the "God particle." Asked why that is, Gillies tells Kroft, "It's called that

because it plays a very, very important role. In giving mass to the other particles, it allows solid structures, solid things, you, me, tables, chairs to exist. Without it, we couldn't."

"If this particle exists, we should be able to definitively see it. And if it doesn't exist, then this model that we keep confirming over the last 30 years has a big hole in it," says scientist Steve Nahn.

"But there's gonna be an explanation one way or the other?" Kroft asks.

"Yes," Nahn says. "When you disprove a theory…usually, more theories come to take it's place."

For Nahn and two other young American scientists, the opportunity to work on the collider at CERN is the chance of a lifetime. Nahn is from MIT, Monica Dunford is from the University of Chicago, and Steve Goldfarb is from the University of Michigan.

"There's a lot…of Americans here. In a recent report, they said that 52 percent of all particle physicists, all U.S. particle physicists are here right now working on things. There's a lot," Nahn tells Kroft.

The scientists admit they are feeling pressure.

Asked how hard she's been working, Dunford tells Kroft, "Well, I haven't been to the grocery store in five weeks. So I think have a jar of mustard and, like, a stick of butter in my refrigerator right now. "

When asked if she feels part of something historic, Dunford responds, "Absolutely."

"It's like opening a whole new window that you never saw before and you open the window and you get to a whole new vista of things that might happen that you didn't have access to before. So from a scientist's point of view it's the biggest thing to happen in particle physics in say 20 or 30 years," Nahn says.

Asked what the average person is going to get out of this, Goldfarb tells Kroft, "The best thing is, we don't know."

Some scientists believe the experiment could lead to the discovery of other dimensions beyond length and width and depth. They've long suspected they exist, but lack the knowledge to detect them. They also hope to learn about black holes, the dark voids in the universe that swallow up stars. A group of fringe scientists believe the collider might even create a black hole that could swallow up the Earth, and they've filed suit to stop the project from going forward. James Gillies doesn't seem to be too concerned.

Asked how he knows that the collider won't create a black hole, Gillies tells Kroft, "We don't know that it won't do that. But we know that … if it's producing these little black holes, then they are decaying, and they're not doing anything dangerous to us."

"Not going to swallow the earth?" Kroft asks Gillies.

"No," he says.

"You're sure of that?" Kroft asks.

"Absolutely," Gillies says.

Scientists at CERN say we only understand about four percent of the known universe, and it took a century to turn the discovery of electrons into an iPod. There's not likely to be a eureka moment here. It may take years of analyzing data to produce the first results. But Bob Stanek believes the collider will go down in history, and not for swallowing the earth.

"I think the fact that we're given the opportunity to do these experiments enhances everybody's life. I mean, people get smarter because of it. We learn," he tells Kroft.

Stanek says he expects big things from this project. "You know, just think about it: One hundred years ago we knew nothing. And 100 years ago is not that long ago. Can you imagine what we'll know 10 years, even the next 100 years?"

Produced by Andy Court and Keith Sharman