

Collision at near light-speed, science sees new world at end of the tunnel

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AFTER 16 years and \$10 billion — and a long morning of electrical groaning and sweating — there was joy in the meadows and tunnels of the Swiss-French countryside Tuesday: the world's biggest physics machine, the Large Hadron Collider, finally began to collide subatomic particles.

Following two false starts due to electrical failures, protons whipped to more than 99 per cent of the speed of light and to energy levels of 3.5 trillion electron volts apiece around a 17-mile underground magnetic racetrack outside of Geneva a little after 1 pm. They crashed together inside apartment-building sized detectors designed to capture every evanescent flash and fragment from microscopic fireballs thought to hold insights into the beginning of the world.

The soundless blooming of proton explosions was accompanied by the hoots and applause of scientists crowded into control rooms at CERN, the European Organization for Nu-

Recreating the Big Bang

LARGE HADRON COLLIDER aims to simulate conditions milliseconds after the Big Bang which created the universe

ENERGY PARTICLES from accelerator pumped into 27-km beam pipe of LHC, steered counter-clockwise for 3 km

COLLISIONS MONITORED on computers at CERN, laboratories around the world for a particle that made life possible

ELUSIVE PARTICLE named Higgs Boson after Scottish physicist Peter Higgs who first postulated it must exist

CONSIDERED the mysterious factor that holds matter together

INDIAN PHYSICISTS HAIL SUCCESS

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clear Research, which built the collider.

The relief spread to bleary gatherings of particle physicists all around the

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Celebrating the collision at the CERN lab in Geneva

From the **FRONT PAGE**

Collision at near light-speed

world, who have collectively staked the future of their profession on the idea that the collider will eventually reveal new secrets of the universe, like the identity of the dark matter that shapes the visible cosmos and the strange particle known as "Higgs," which is thought to imbue other particles with mass. Until now, these have been tantalizingly out of reach.

"We're expecting some answers," said David Politzer, a Nobel laureate at the California Institute of Technology. Rolf Heuer, director general of CERN, speaking from Japan, said the new collider "opens a new window of discovery and it brings, with patience, new knowledge of the universe and the microcosm. It shows what one can do in bringing forward knowledge." He added: "It will also bring out an army of

children and young people who will get into the private sector and academia."

"We are all proud and so happy," Fabiola Gianotti, a spokesman for CERN, said of one of the giant particle detectors at the collider, known as Atlas. Guido Tonelli, leader of a rival detector called CMS said, "We are really starting physics."

The success in colliding protons marks a remarkable comeback for CERN, but the lab is still only halfway back to where it wanted to be: Only a year and a half ago, the first attempt to start the collider ended with an explosion that left part of its tunnel enveloped in frigid helium gas and soot when an electrical connection between two of the powerful magnets that steer the protons vaporized.

A subsequent investigation

revealed that the collider is riddled with thousands of such joints, the result of what Lucio Rossi, head of magnets at CERN, said stemmed from a "lack of adequate risk analysis" in a recent report in the online journal *Superconductor Science and Technology*.

As a result, the collider, which was designed to accelerate protons to 7 trillion electron volts and then smash them together to reveal particles and forces that reigned during the first trillionth of a second of time as we know it, can only be safely run for now at half power.

CERN physicists say that operating the collider for a year and a half at this energy level should allow them to gather enough data to start catching up with its American rival, the trillion-volt Tevatron at the Fermi National Accelerator

Laboratory in Illinois, which is smaller but has been running for years and thus has a head start in data. After that, the CERN machine will shut down for a year so that the connections can be rebuilt.

Particle colliders get their oomph from Einstein's equation of mass and energy. The more energy — denoted in the physicists' currency of choice, electron volts — that these machines can pack into their little fireballs, the further back in time they can go, closer and closer to the Big Bang, and the smaller and smaller things they can see.

The collider first ramped its beams to 3.5 trillion electron volts two weeks ago, but the engineers took pains to prevent them from colliding so as not to steal the thunder from what was billed as "First Physics Day" on Tuesday.

Because of the defective joints and some mysteriously underperforming magnets, it will still be three years at least before CERN's collider runs at or near full strength. According to theoretical models, that would stretch out the time it should take to achieve the collider's main goals, including producing the Higgs boson.

Engineers also want to identify the dark matter that astronomers say makes up 25 percent of the cosmos, and test more exotic ideas like extra dimensions. Until then, the American accelerator Tevatron will chase CERN for big goals like the Higgs boson, physicists say. The CERN experimenters will spend the next 4 to 6 months learning how their detectors work and rediscovering known physics. Then, anything is possible.