HOW DOES THE ILC WORK?

Supersymmetry. Dark matter. Extra dimensions. Scientists have proposed the International Linear Collider (ILC), a next-generation project designed to smash together electrons and their antiparticles at a higher-than-ever energy, to learn more about these and other mysteries of the universe. The ILC Global Design Effort team, which includes more than 60 scientists and engineers from around the world, has agreed on the baseline configuration for the roughly 31-kilometer long, 500 billion-electronvolt (GeV) particle collider.

The Linacs

Scientists will use two main linear accelerators ("linacs"), one for electrons and one for positrons, each 12 kilometers long, to accelerate the bunches of particles toward the collision point. Each linac consists of 8,000 superconducting cavities nestled within a series of cooled vessels to form cryomodules. The modules use liquid helium to cool the cavities to -271°C, only slightly above absolute zero. Scientists will launch traveling electromagnetic waves into the cavities to "push" the particles through, and accelerate them to energies that will total 500 GeV.

Positrons

Positrons, the antimatter partners of electrons, do not exist naturally on earth. To produce them scientists will send the high-energy electron beam through an undulator, a special arrangement of magnets in which electrons are sent on a "roller-coaster" course. This turbulent motion will cause the electrons to emit a stream of photons. Just beyond the undulator the electrons will return to the main accelerator, while the photons will hit a titanium-alloy target and produce pairs of electrons and positrons. The positrons will be collected and launched into their own 250-meter 5-GeV accelerator.

The Detectors

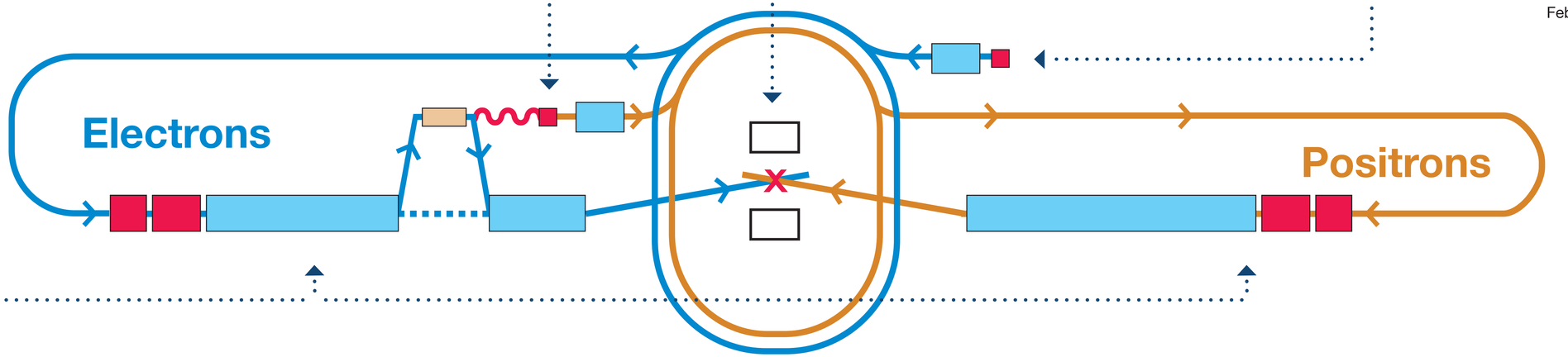
Traveling towards each other at nearly the speed of light, the electron and positron bunches will collide with a total energy of 500 GeV. Scientists will record the spectacular collisions in two giant particle detectors. These work like gigantic cameras, taking snapshots of the particles produced by the electron-positron annihilations. The two detectors will incorporate different but complementary state-of-the-art technologies to capture information about every particle produced in each collision. Having these two detectors will allow vital cross-checking of the potentially-subtle physics discovery signatures.

The Damping Rings

When created, neither the electron nor the positron bunches are compact enough to yield the high density needed to produce collisions inside the detectors. Scientists will solve this problem by using seven-kilometer-circumference damping rings, one for electrons and one for positrons. In each ring, the bunches will travel through a series of wigglers that literally "wiggle" the beam to emit photons. This process makes the bunches more compact. Each bunch will circle the damping ring roughly 10,000 times in only two tenths of a second. Upon exiting the damping rings, the bunches will be a few millimeters long and thinner than a human hair.

Electrons

To produce electrons scientists will fire high-intensity, two-nanosecond light pulses from a laser at a target and knock out billions of electrons per pulse. They will gather the electrons using electric and magnetic fields to create bunches of particles and launch them into a 250-meter linear accelerator that boosts their energy to 5 GeV.



Drawing not to scale
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