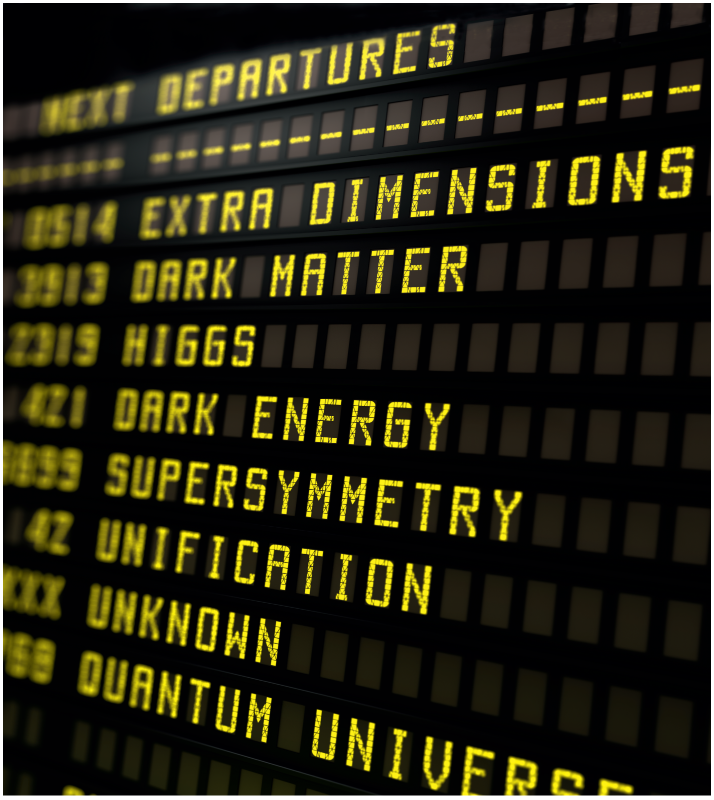


The International Linear Collider

Witness a scientific revolution! The *International Linear Collider* (ILC), a proposed new particle accelerator, promises to radically change our understanding of the universe – revealing the origin of mass, uncurling hidden dimensions of space, and even explaining the mystery of dark matter. Advanced superconducting technology will accelerate and collide particles to incredibly high energies down tunnels that span more than 30 kilometres in length. State-of-the-art detectors will record the collisions at the centre of the machine, opening a new gateway into the Quantum Universe, an unexplored territory where the very small answers questions about the very large. From young graduate students to university professors, more than a thousand scientists worldwide are collaborating today to design and build the particle accelerator of tomorrow.

ILC-HiGrade: Towards the International Linear Collider

ILC-HiGrade or *International Linear Collider and High Gradient Superconducting RF-Cavities* produces a small series of accelerating cavities, superconducting components made of pure niobium for the International Linear Collider. It also plans a possible organisation and governance structure for the ILC as well as measures to prepare for the construction of the machine, including a detailed study on possible sites in Europe.

Participating Institutes:

- DESY (Germany)
- CEA (France)
- CERN (European Organization for Nuclear Research)
- CNRS/IN2P3 (France)
- INFN (Italy)
- Oxford University (United Kingdom)

The ILC – a step-by-step guide

How does the ILC work? Like any complex machine, the 31 kilometre-long accelerator is made up of several systems – each one an essential component for launching particles at close to the speed of light. This step-by-step guide explains how the ILC works.

The linacs

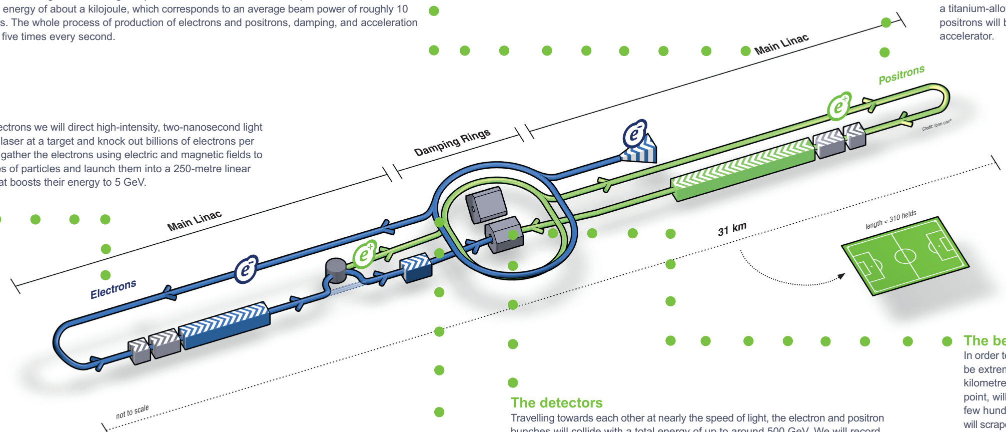
Two main linear accelerators (called linacs), one for electrons and one for positrons, each 12 kilometres long, will accelerate the bunches of particles toward the collision point. Each accelerator consists of hollow structures called superconducting cavities, nestled within a series of cooled vessels known as cryomodules. The modules use liquid helium to cool the cavities to –271 °C, only slightly above absolute zero, to make them superconducting. Electromagnetic waves fill the cavities to 'push' the particles, accelerating them to energies up to 250 GeV. Each electron and positron bunch will then contain an energy of about a kilojoule, which corresponds to an average beam power of roughly 10 mega-watts. The whole process of production of electrons and positrons, damping, and acceleration will repeat five times every second.

Positrons

Positrons, the antimatter partners of electrons, do not exist naturally on Earth. To produce them, we 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 X-ray 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-metre 5-GeV accelerator.

Electrons

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



The damping rings

When created, neither the electron nor the positron bunches are compact enough to yield the high density needed to produce copious collisions inside the detectors. Two 6.7 kilo-metre-circumference damping rings, one for electrons and one for positrons, will solve this problem. In each ring, the bunches will repeatedly traverse a series of wigglers, devices that causes the beam trajectories to 'wiggle' in a way that makes the bunches more compact. Each bunch will spend approximately two tenths of a second in its damping ring, circling roughly 10,000 times before being kicked out. Magnets will keep the particles on track and focused in their circular orbits around the ring. Upon exiting the damping rings, the bunches will be a few millimetres long and thinner than a human hair.

The detectors

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

The beam delivery systems

In order to maximise the luminosity, the bunches of particles must be extremely small. A series of magnets, arranged along two 2-kilometre beam delivery systems on each side of the collision point, will focus the beams to a few nanometres in height and a few hundred nanometres in width. The beam delivery systems will scrape off stray particles in the beams and protect the sensitive magnets and detectors. Magnets will steer the electrons and positrons into head-on collisions.

Find out more: www.linearcollider.org, www.ilc-higrade.eu

SEVENTH FRAMEWORK PROGRAMME