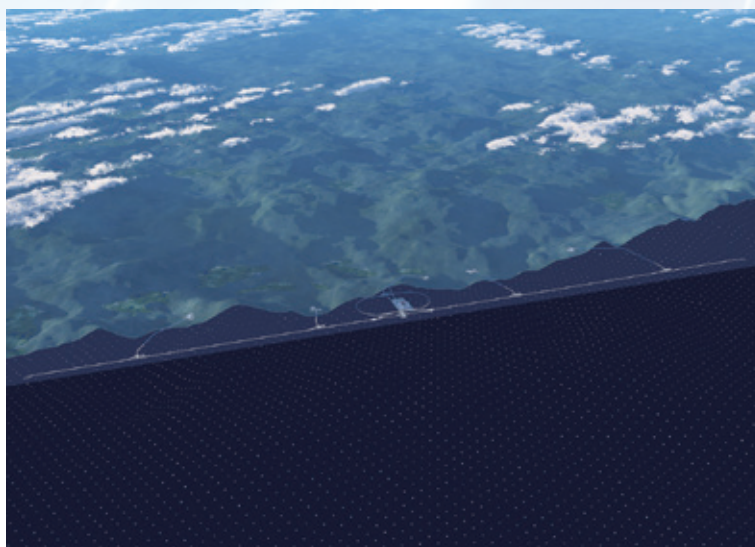


The Value and Future Promised by Developing the ILC in Japan



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What is the ILC?

- The proposed International Linear Collider (ILC) takes electrons and positrons (a particle with an opposite charge to electrons) to accelerate and collide them at nearly the speed of light, in a linear underground tunnel around 20 km long. This reproduces the state of the universe immediately following the Big Bang some 13.8 billion years ago, just one-trillionth of a second after the birth of the universe. The ILC would allow us to precisely measure the reactions of elementary particles such as the Higgs boson, which accounts for the property of mass appearing at this moment in time.



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- The ability to measure these particles will help us unlock a mystery that has long perplexed humanity: how did space and matter first form?
- This is an international project on a massive scale, driven by humanity's inquiring mind, one in which Japan is hoped to undertake as a national project.
- Construction costs would range from 735.5 billion to 803.3 billion yen. Operating expenses would range from 36.6 to 39.2 billion yen/year.
Construction costs and other expenses will be shared by the international community, with Japan contributing around one-half of the cost. The construction period is expected to take around 10 years.
The costs borne by Japan include 400 billion yen over the 10 year period in construction costs, or 40 billion yen per year, and 20 billion yen per year in operating expenses.
- In 2013, the international research community selected the Kitakami highlands, which stretches from Iwate Prefecture to Miyagi Prefecture, as the optimal construction site. Since then, geological surveys and environmental impact surveys have been conducted in the area in the immediate vicinity of the proposed construction site. Additional measures have been implemented to accommodate foreign visitors and residents, and to facilitate the development of industries related to particle accelerators.

Introduction

The international research community hopes to construct the International Linear Collider (ILC) - a next-generation particle accelerator which will unlock the mystery of the birth of the universe - in Japan, and the Kitakami highlands in Tohoku is being considered as the optimal construction candidate site. The development of the ILC will represent the first major international science and technology center in Asia, and will attract people from every country and region around the globe, regardless of race, ethnicity, religion, or language, to seek the answers to the mysteries surrounding the creation of the universe something that mankind has fundamentally sought to uncover since time immemorial.

The ILC is intended as a facility of international cooperation where international researchers, their families, and related industries gather to drive innovation using a broad range of advanced technologies, including superconductivity, nanotechnology, super computers, and digital transformation (DX), contributing to science for peace and development for the future.

The ILC will also serve as a model for a new form of globally-linked regional development that incorporates the concept of an “eco-friendly ILC” ahead of the SDGs. This includes energy reuse, the use of waste heat, and the construction of wooden research facilities.

The ILC will give this site - still recovering from the impact of the Great East Japan Earthquake and Tsunami and facing the challenges of a declining population - hopes and dreams for the future, and will help pave the way for the realization of a new Tohoku, one that has achieved a true creative recovery.

In this way, the value and future promised by developing the ILC in Japan extends beyond scientific development, and manifests in numerous ways.

This guideline was prepared to compile the potential value and future promised by developing the ILC in Japan in the four areas outlined in the diagram below.

The Value and Future Promised by Developing The ILC in Japan

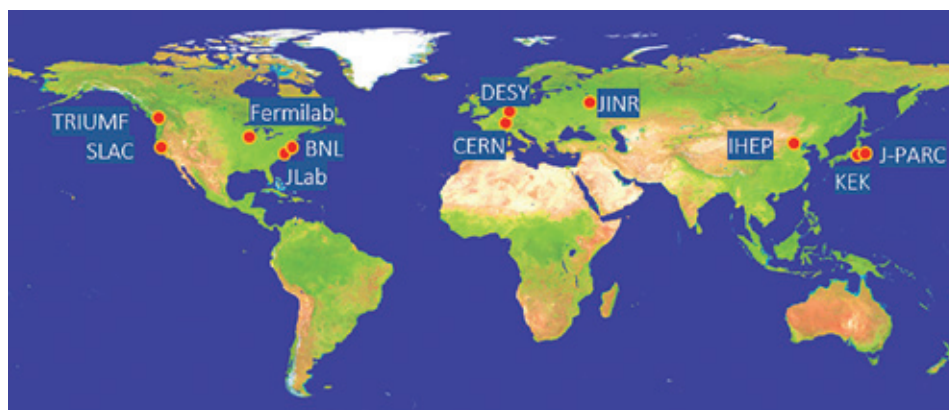


1 International Trust and Scientific Technology Diplomacy as The Host Country of The ILC

A country that contributes to, and leads the world

Eleven Japanese scientists have won a Nobel prize for physics in the field of particle physics. Japan is also a world-leader in ultra-fine processing technology, boasting sites such as the SuperKEKB particle accelerator (Tsukuba City), which holds the world record for elementary particle collision performance, and testing facilities that pave the way to new discoveries in physics, including superconductive accelerators. These achievements have prompted the international research community to look to Japan as the construction site of the ILC, and the U.S. government in particular has expressed widespread support across the Department of Energy, Department of State, and other government departments.

As the host country of the ILC, Japan has a golden opportunity to establish itself as a scientific and technological nation while leading the international community in science.



Major research centers with high-energy accelerators across the globe

Japan's science and technology capabilities are held in high regard internationally, and the development of the ILC as an international cooperation facility will be a great boon to the international community through new science and technology creation from Japan to the world.

Furthermore, developing the ILC in Japan is also set to greatly bolster Japan's core technological capabilities. In addition, research activities between countries and regions with shared values for freedom and democracy will both help preserve the international order, and serve as a catalyst prompting a shift away from a "drain" to a "gain" in technology and human resources.



Japan as a respected world leader!

From a country that seeks support elsewhere, to a country sought after!

Science for Peace

The European Organization for Nuclear Research (CERN) was established in Switzerland in 1954, nine years following the Second World War, in an attempt to bring a Europe that had been reduced to rubble through war together and forge a peaceful alliance through scientific pursuit. With a staff roll of over 3,000, every year CERN invites over 10,000 researchers from over 100 countries and regions from around the world.

In 2012, it was granted the status of United Nations Observer as a model for international cooperation.



European Organization for Nuclear Research (CERN)

In addition to environmental issues and resource-based energy concerns, the world is currently facing a crisis of fragmentation including the COVID-19 pandemic and the escalation of conflicts across the globe.

As the first major international science and technology center in Asia capable of hosting thousands of researchers from across the globe, the ILC will seek to serve the same role as CERN in which researchers from around the world work to address common issues facing humanity, contribute to the international community through science, and act as a place for peace-building.

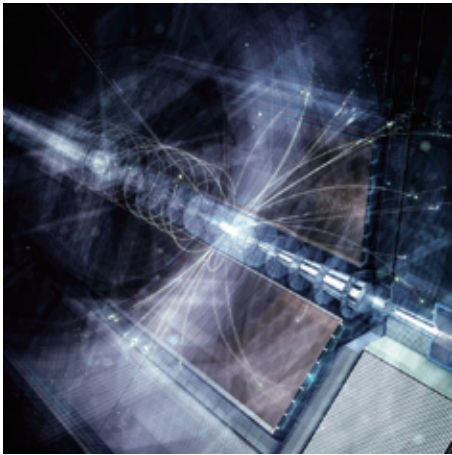
The ILC's activities will help firmly entrench Japan's image as a leader in science and technology in the eyes of the world, and will serve as a tremendous pillar in science and technology diplomacy through the soft power this grants.



Significant contribution to world peace through ILC in Japan

2 International Scientific Development and Human Resource Development

Discovering new paths leading to the truth of the universe



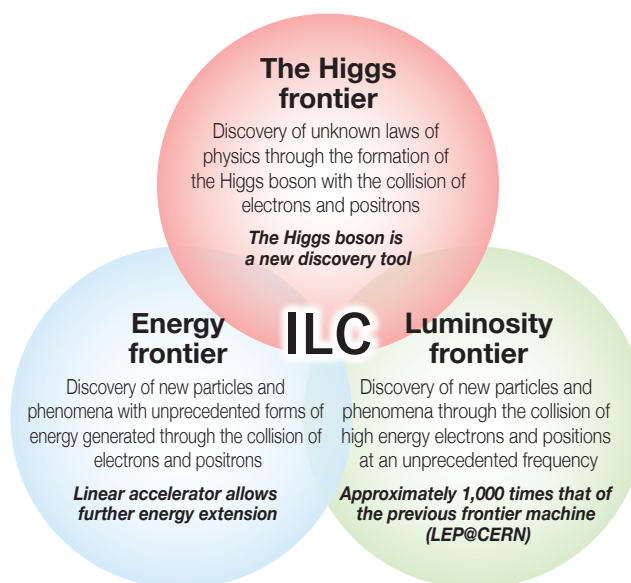
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ILC/Image of collision point

The ILC would be a large-scale testing facility that seeks to solve the mysteries of the universe by reproducing the Big Bang state, generating and precisely measuring a vast quantity of Higgs boson particles, which couples to an elementary particle's mass.

Particle physics, which aims to uncover the source of physical substances and the origins of the universe, finds itself at a major crossroads.

Experiments performed at the ILC will help greatly advance scientific development, helping us discover new reasoning addressing unsolved mysteries surrounding particle physics, included questions such as “Are the basic forces of nature, namely strong force, weak force, electromagnetic force, and gravity, bound together in a uniform manner?”, “How are the various properties of quarks and leptons determined?”, and “What is the true nature of dark matter and dark energy?”.



What is luminosity?

A measure of volume representing the intensity and spread of beams that affect collision frequency

To increase luminosity, larger numbers of particles are concentrated on finer beams

The ILC is a next-generation electron/positron frontier machine



Creating a new form of science for the world first in Japan,
and contributing to global scientific development

Human resource development, and going from a brain drain to a brain gain

While we have continued to see outstanding Japanese researchers leave to pursue research opportunities overseas, the ILC represents the first research facility of its kind that has the potential to attract the latest in science and technology from around the world. The site will continue to draw in leading researchers, engineers, young researchers, graduate students and more from across the globe to conduct joint research and work well into the future.

Additionally, various related industries will gather in the surrounding area, enhancing research and development capabilities and facilitating the development of highly skilled industry personnel through exchanges with some of the world's leading research facilities.

In this way, specialists brought in from overseas and people with experience in advanced basic science projects will undoubtedly go on to serve in a broad range of science and technology fields, industries, and international institutions.



European Organization for Nuclear Research (CERN)

The ILC will be one of the world's foremost research facilities. Having such a facility nearby will make the challenges undertaken by researchers at the site readily visible, and regular exchanges will serve as a motivator to children, giving them dreams and hopes for the future. This will greatly contribute to the development of the next generation of scientists, and globally-minded human resources capable of working in a broad range of fields.



The ILC shall serve as a source of motivation, and dreams and hopes for children

3 Innovation Creation and Industry Development

Create innovation by gathering the world's most advanced knowledge and technology in the one place

A “core technology”, such as the World Wide Web (WWW), resulting in an upheaval in how we live, was created as a new technology from an international elementary particle research laboratory.

The first accelerators were seen with the discovery of X-rays (roentgen rays) emitted from vacuum tubes in 1895, and the 20th century has led to the development and advancement of cyclotrons, synchrotrons, colliding beam accelerators, superconductive magnets, and superconductive accelerator technology. In addition, cutting-edge component technologies and high-power, high-frequency technologies have been co-opted for use in a large number of commercial products. Further, the use of electron beams, radiated light and neutrons emitted from accelerators has led to the development of revolutionary new products and technologies. The X-rays and particle rays emitted from linear accelerators, cyclotrons, and synchrotrons are an indispensable part of cancer therapy and diagnosis.



High precision MRI image-guided cancer radiotherapy device at Tohoku University Hospital

We are tantalizingly close to using superconductive accelerators - the core technology in the ILC - in the production of RI elements for medical use. Research into compact accelerators for semiconductor lithography and infrastructure diagnosis and modification is also ongoing. Accelerator technology, measuring technology, and information technology used for big data analysis are being used in medical, industrial, information technology, and a broad range of other fields.

In addition, attracting cutting-edge technology and leading researchers and engineers, along with establishing a collection of related industries will serve to create new value, drive broad-reaching reforms, and usher in a wave of innovation from Japan rippling out to the world.



**Japan as a leader in science and technology, ushering
in a wave of innovation that ripples out to the world**

Broad-reaching industrial agglomeration and development

The ILC's construction and operation period will drive new demand from increased construction orders and consumer activity of researchers, etc., and increased external procurement from research facilities and elsewhere, delivering a significant ripple effect for a great many industries. Further, the collection of a diverse array of industries growing as a byproduct from the field of accelerator science and technology will, in turn, act as a source of growth for local companies, and facilitate the development of the healthcare, electrical and electronic, and information and communications sectors.

There are six industrial product categories using accelerator beams - semiconductors, automobiles, industrial equipment, civil aircraft, household appliances, and healthcare equipment, with an annual total global market size of around 56 trillion yen.* Its size is expanding significantly. (*Figures released by the U.S. Department of Energy in 2010)


Tohoku is already home to a number of cutting-edge ILC technology research initiatives. These include joint research activities involving research institutions, universities, public organizations and local companies into high performance superconducting acceleration cavity manufacturing technologies using niobium-tin alloys, frame manufacturing and precision positioning control technologies using foundry techniques, and electron beam drive position source manufacturing, to waste heat management and wood use in the ILC.

Moreover, local companies and municipalities are working in line with initiatives implemented to achieve carbon neutrality by 2050 in an aim to achieve what is referred to as an “eco-friendly ILC”. To this end, local companies and municipalities are conducting research into the construction of super energy-efficient facilities through the use of local sources of wood, the development and supply of renewable energy, the strategic absorption of greenhouse gases, as well as various other ILC-related measures.



Sumita Town Hall, Iwate Prefecture, built with locally produced timber

Bringing companies in the healthcare, life sciences, environment and energy, and other leading materials sectors based on core ILC technologies together, coupled with the growth of local companies, is expected to lead to dramatic industrial development as a cluster region servicing advanced science and technology industries. There are great expectations for the ILC to serve as a catalyst for attracting globally-minded industry to the area, and over 200 local companies actively participate in a research society for industries connected in some way to accelerators.

 **Achieving dramatic industrial development through the clustering
of advanced science and technology industries**

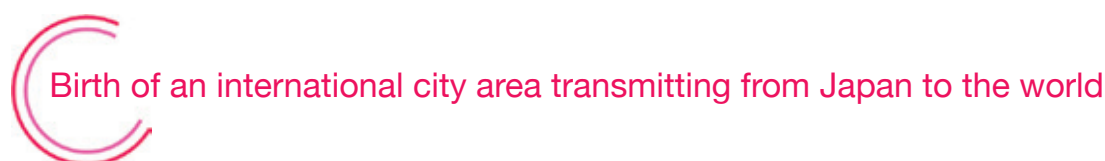
4 New Regional Development and Recovery from The Earthquake

The birth of an international city and region

The ILC is poised to bring knowledge and technology from around the world together. The ILC will invite researchers and their families from around the world to participate in projects with a large number of private companies. The number of personnel involved with the ILC is expected to be more than 10,000, establishing the area as a base for international science and technology research.

This “satoyama” (hilly heartland) region co-exists alongside nature, and will be home to people from all over the world, giving way to vibrant exchanges with local residents and children. The gathering of the world’s brightest minds and most advanced technologies will inspire youth to dream, give them courage and pride, and serve as a motivating tool driving creative research, the development of a diverse range of new technologies, and innovation creation.

This coalescence of people from around the world will lead to a creative international community and promote the region as a flourishing multicultural area. In addition, proactively spreading the word about not only science and technology, but local traditions and culture as well, will help establish a Tohoku zone that attracts people from all over the world.



Extract from “Earth Village Vision” (general edition) from the National Land Planning Association
https://www.kok.or.jp/project/global_village_vision.html

Globally-linked regional development

The attraction of a great many researchers, engineers, and their families from around the world is expected to lead to relocation and long-term stays, increasing the population and creating a wealth of employment opportunities by rejuvenating industry through increased construction and services. Consumption from researchers from around the world using the facility will have a significant inbound effect on the local economy. The ILC area, fully equipped with the latest in information communications technology, such as 5G and optical fiber, will act as the manifestation of the “national digital garden city concept”, and will serve as a model of a DX society that is continually evolving.

This “eco-friendly ILC” will incorporate environmentally friendly concepts in its design ahead of SDGs, including energy reuse, the use of waste heat to revitalize the agriculture, forestry, and fishery industry, and the wooden construction of research facilities, and will strive to introduce a new form of the globally-linked regional economic cyclical model.



Globally-linked regional development led by the ILC

True recovery from the Great East Japan Earthquake

Eleven years have passed since the unprecedented damage caused by the Great East Japan Earthquake and Tsunami. While progress has been made in redeveloping roads, ports, commercial areas, housing, and other infrastructure, a lot still needs to be done in revitalizing the local economy due to the decline in the local population, the slump felt by the fishing industry, and other adverse impacts. A mindset full of dreams and hopes for the future is what is needed to work towards a full regional recovery.

Tohoku is experiencing the fastest population decline in the country. While there is great potential in the agriculture, forestry, and fishing industries and the manufacturing industry, the area is fraught with issues preventing this potential from being fully realized.

By seeking to uncover the very mysteries of space, the ILC will serve as a source of motivation, and dreams and hopes for children. The ILC will open up a line of communication to the world, not just for research results, but to also to communicate on the state of recovery efforts, and to promote tourism resources, culture, dining, and many other aspects of Tohoku. This active communication will serve as a source of pride for locals in disaster-affected areas, and greatly contribute to the true revitalization of a new Tohoku.

Supplementary resolution to the Bill for the Establishment of Reconstruction Agency (extract)

With Tohoku a world-class candidate site for the International Linear Collider Project, its promotion, together with the Fukushima Innovation Coast Framework, will help usher in a “new Tohoku” driven by the creation of scientific innovation in Tohoku. This matter requires further review with related bodies with a view to promoting Japan as the site for this project. (House of Councilors)



ILC as a symbol of recovery from the earthquake



“The Miracle Pine Tree” in Rikuzentakata City, Iwate Prefecture