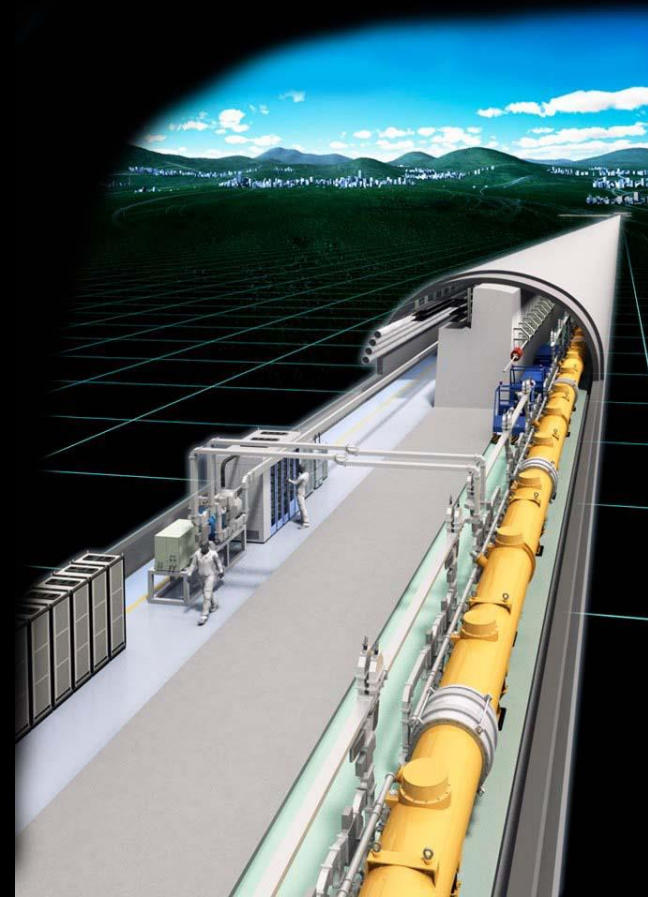


The ILC Project

Hitoshi Yamamoto
Tohoku University

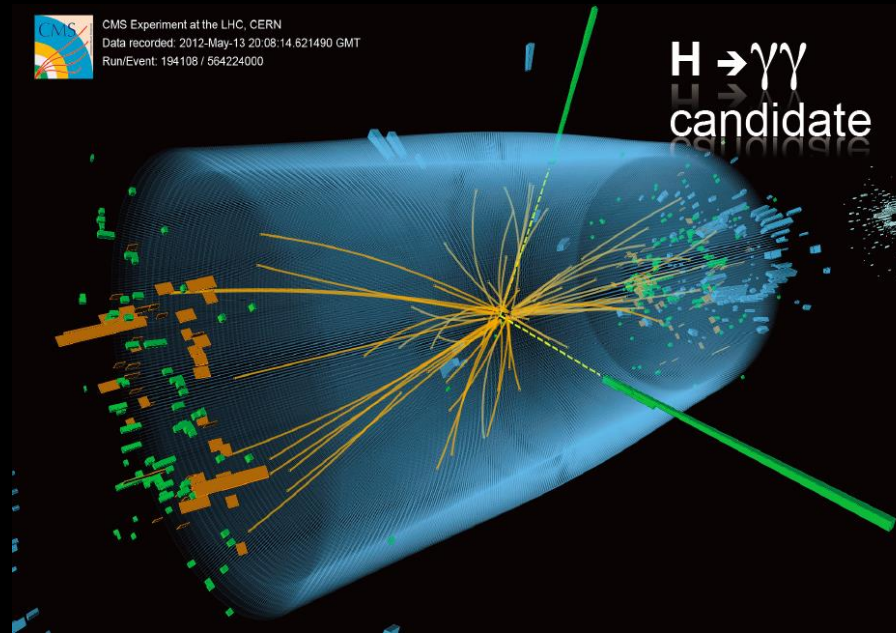
Higgs and Beyond
June 8, 2013, Tohoku University



Four reasons for the recent progress of the ILC situation :

- The discovery of the Higgs-like particle
 - Completion of the ILC TDR
- Expressions of international supports
- Announcement of the Japanese government that it will call for negotiations with other countries

Discovery of Higgs-like particle

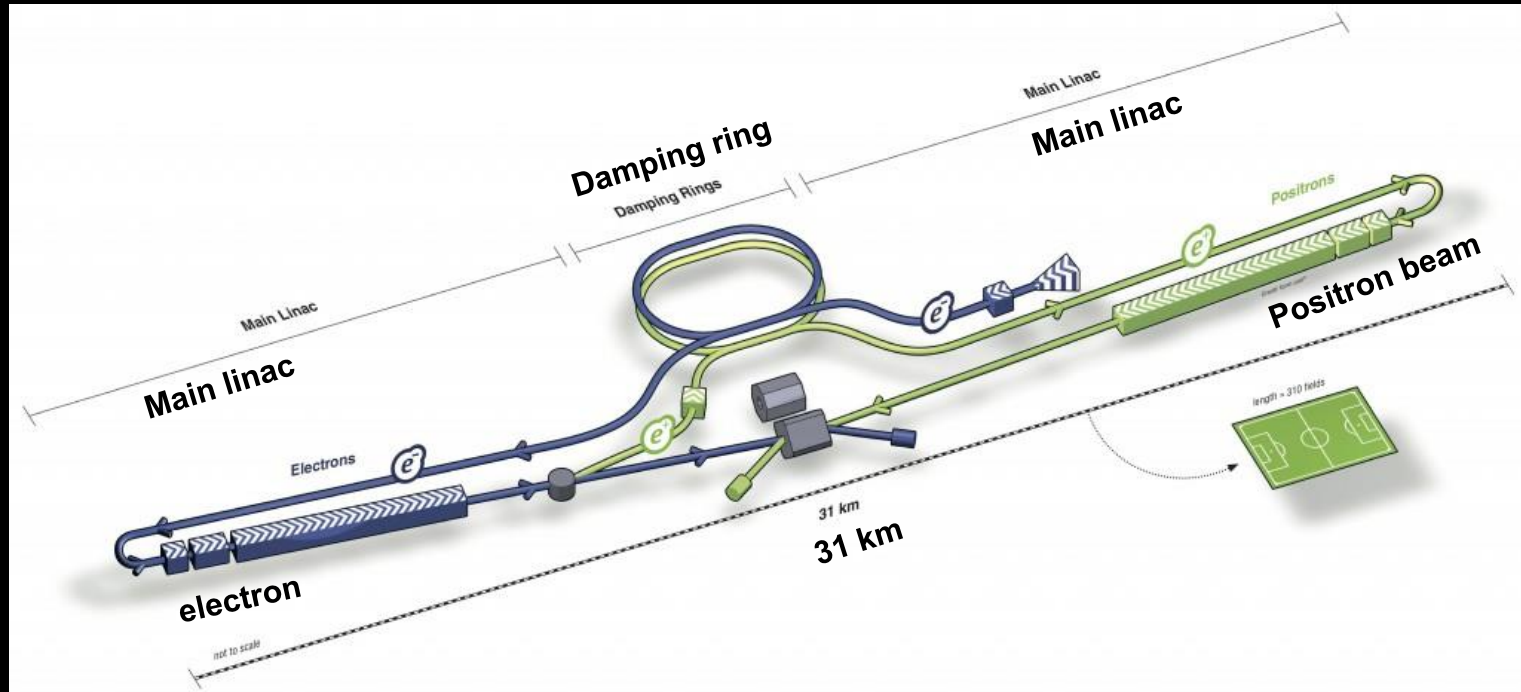


- ▶ The fine-tuning problem of the SM became **real**. (unless ‘multiverse’)
- ▶ The problem of **missing dark matter** in the SM became acute
- ▶ : Compelling reasons for the next step.

A new era of particle physics has begun!

The ILC is designed to lead the new era.

ILC (International Linear Collider)

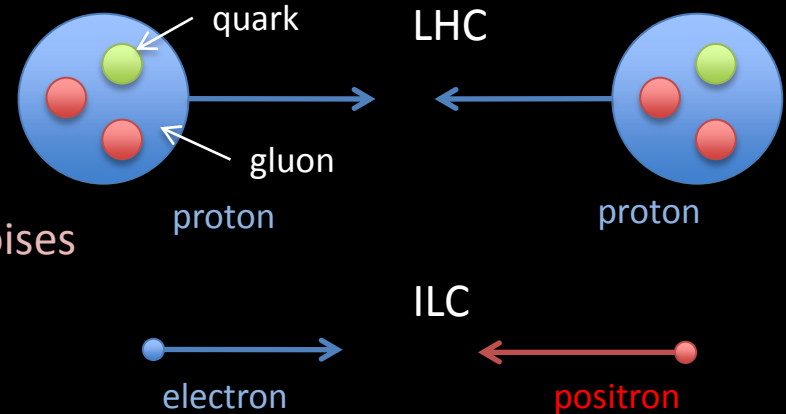


- 500 GeV CM with 31 km → upgrade later to ~ 1TeV CM with 50 km
- Beam size at IP : 6 nm x 500 nm x 300 μm
- Luminosity ~ 2×10^{34} /cm²s

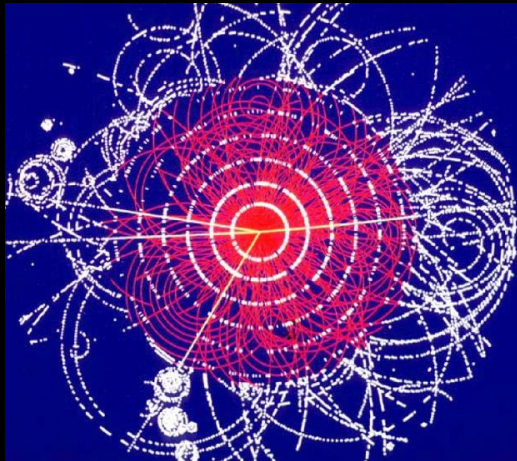
ILC features : cleanliness

■ Collision of two elementary particles

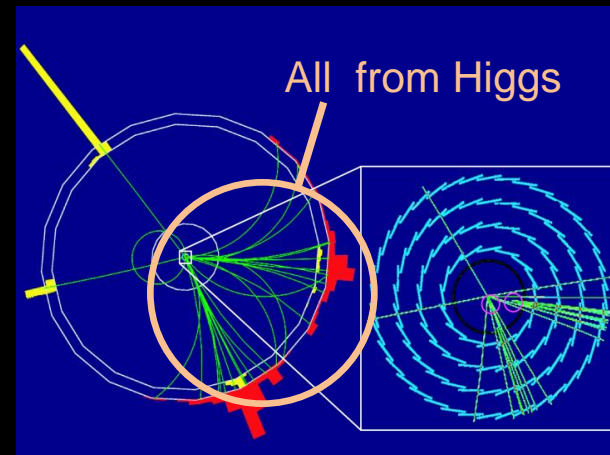
- proton + proton at LHC
 - Proton = 3 quarks + gluons
 - electron + positron at ILC
- Signal is clearly seen without much noises
- Trigger-less data taking
- Theoretically clean
(less theoretical uncertainties)



LHC



LC



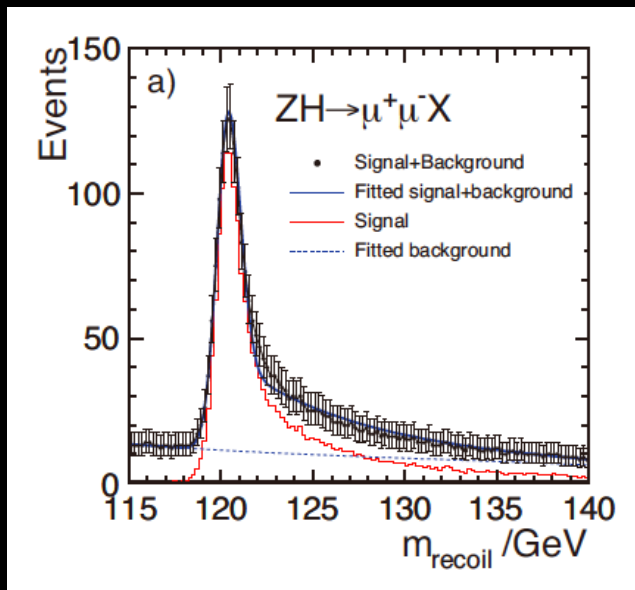
ILC features : control

- Initial state of electron-positron interaction :
 - Energy-momentum 4-vector is specified
 - Electron polarization (90%) is specified
 - Positron polarization (60%) is optional (30% comes for free)

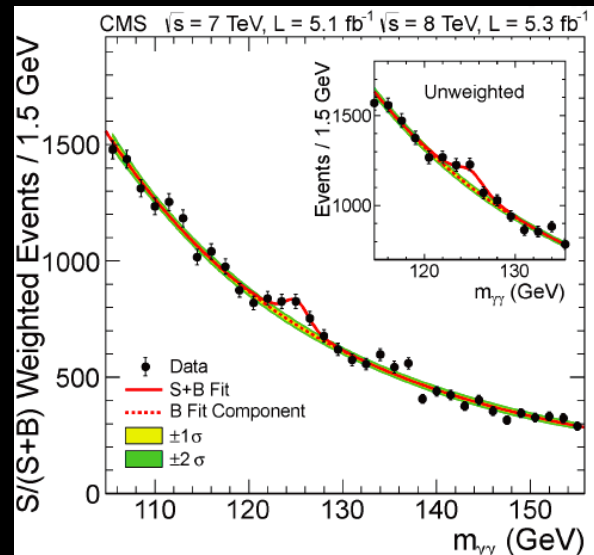
Energy-momentum 4-vector

→ e.g. recoil mass analysis

Higgs to ALL (including invisible final state) is seen



ILC

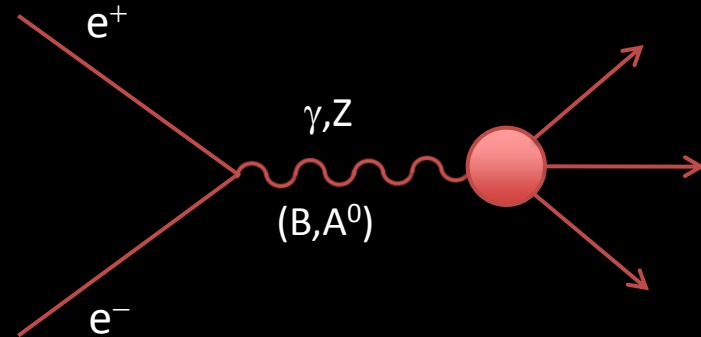


LHC

Electron polarization

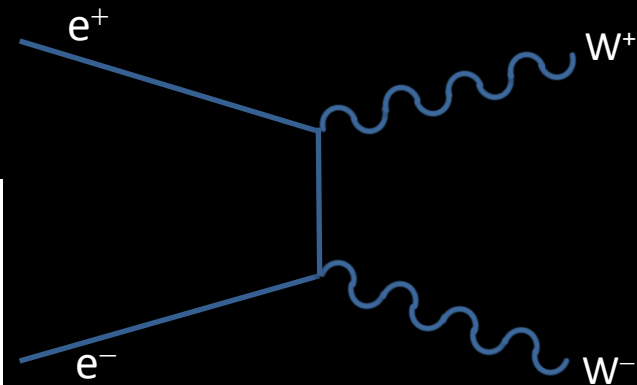
Specify the intermediate state

- Right-handed e^- turns off A^0
 - Information on the character of the final state

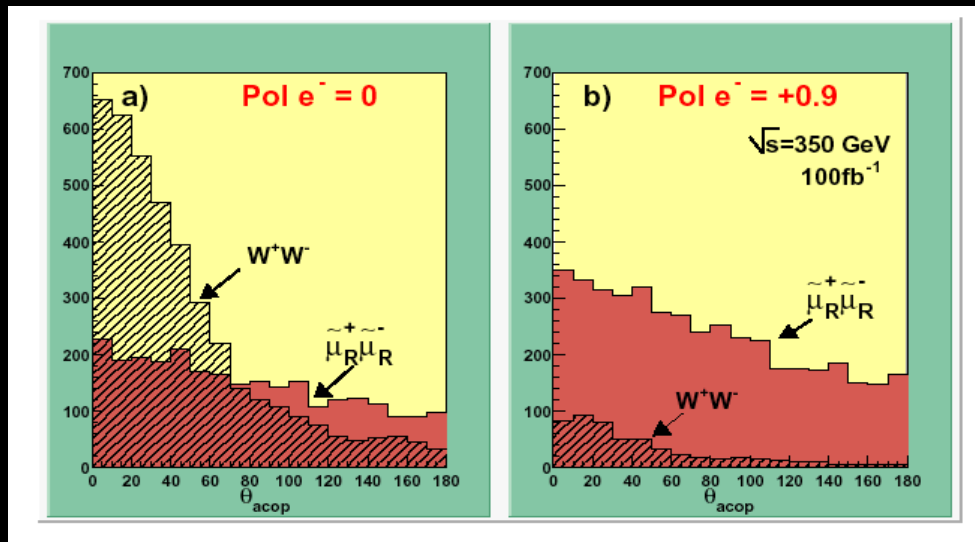


Right-handed e^- turns off W

- Background rejection



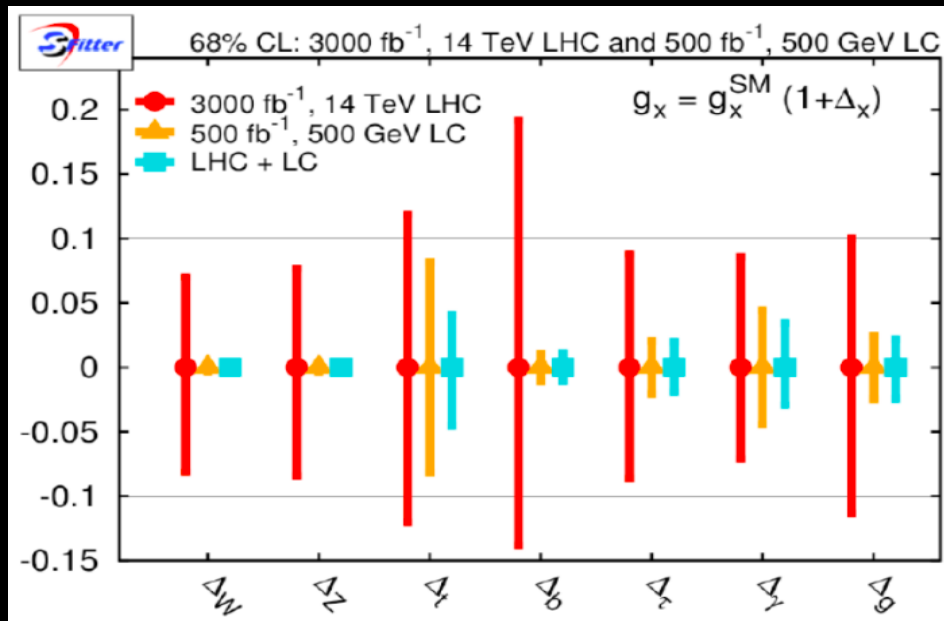
e.g. acoplanar muon pair production
such as smuon pair production



Measurement errors of Higgs couplings

LHC 14 TeV 3000 fb⁻¹ and LC 500 GeV 500 fb⁻¹

D. Zerwas



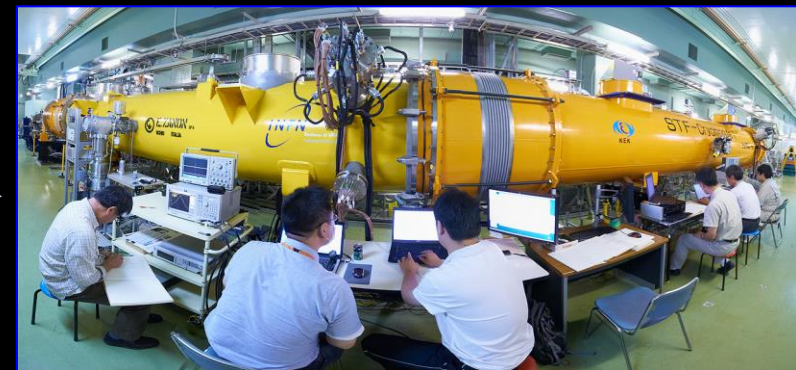
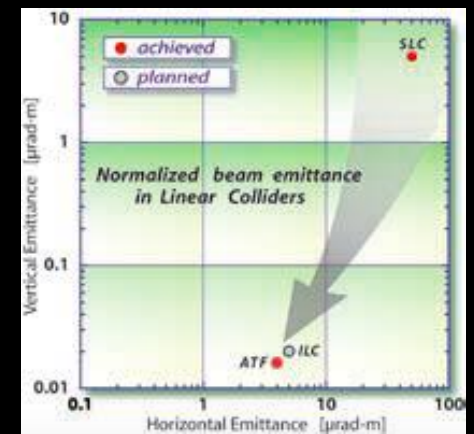
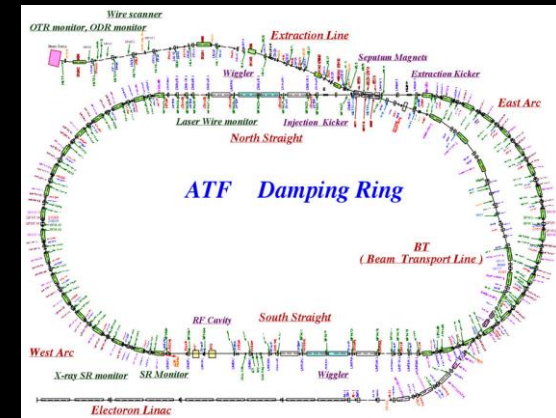
Apart from top and γ , ILC errors are 1/4~1/10 of LHC
(statistical equivalent: 1~2 orders of magnitude more- at about the same cost)

- LHC may improve systematics
- ILC may improve analysis methods

Great prospect for HEP : ILC and LHC running in parallel!

ILC Accelerator

- Ultra-small beam
 - Low emittance : KEK ATF (Accelerator Test Facility)
 - Achieved the ILC goal.
 - Small vertical beam size : KEK ATF2
 - Goal = 37 nm, 70 nm achieved
 - Limit is in measurement. No basic problem seen.
 - Stabilize the beam at nm scale: KEK ATF2
 - Feedback system successful (FONT)
- Main acceleration
 - Accelerating cavity
 - Spec: 31.5 MV/m \pm ($<20\%$)
 - $>80\%$ yield achieved (90% goal)
 - Cryomodule assembly
 - Combine cavities from all over the world
 - KEK S1-global successful
- ILC technology is now ready



ILC Detector

- Concept of SiD, ILD : Particle Flow (PFA)
 - $\times 2$ better jet energy resolution than LHC
 - Quark (b/c) flavor identification by vertexing

→ Requires high granularity (wrt LHC)

Vertexing (e.g. fine-pixel CCD)

- Pixel area 1/1000
- Material 1/30
- Vertex resolution 1/20

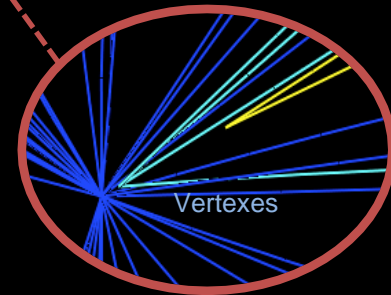
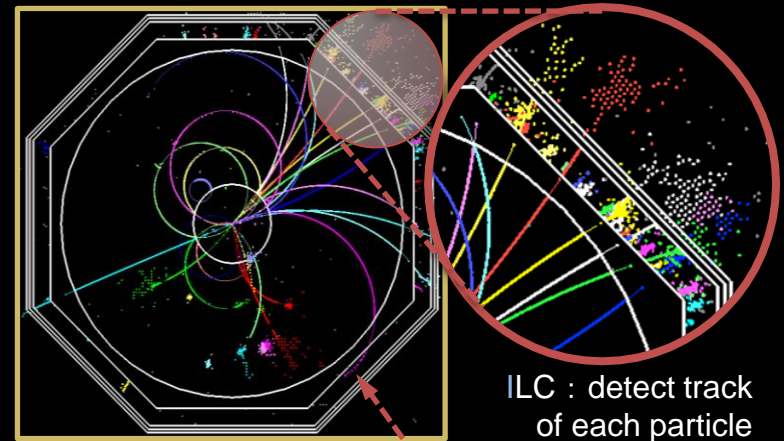
Main tracker (e.g. TPC)

- Material 1/6
- Momentum resolution 1/10

Calorimeter (Si-W and Schint+MPPC-W/Fe)

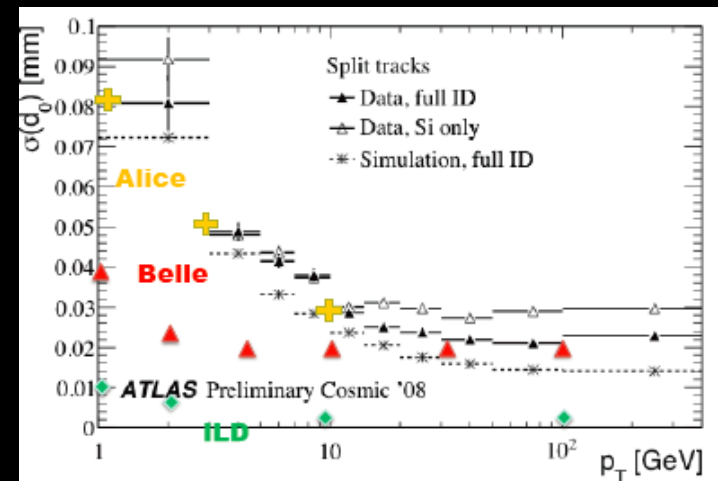
- Cell area 1/200

Detector elements R&Ds:
Principles proven
Now R&D is in systematization



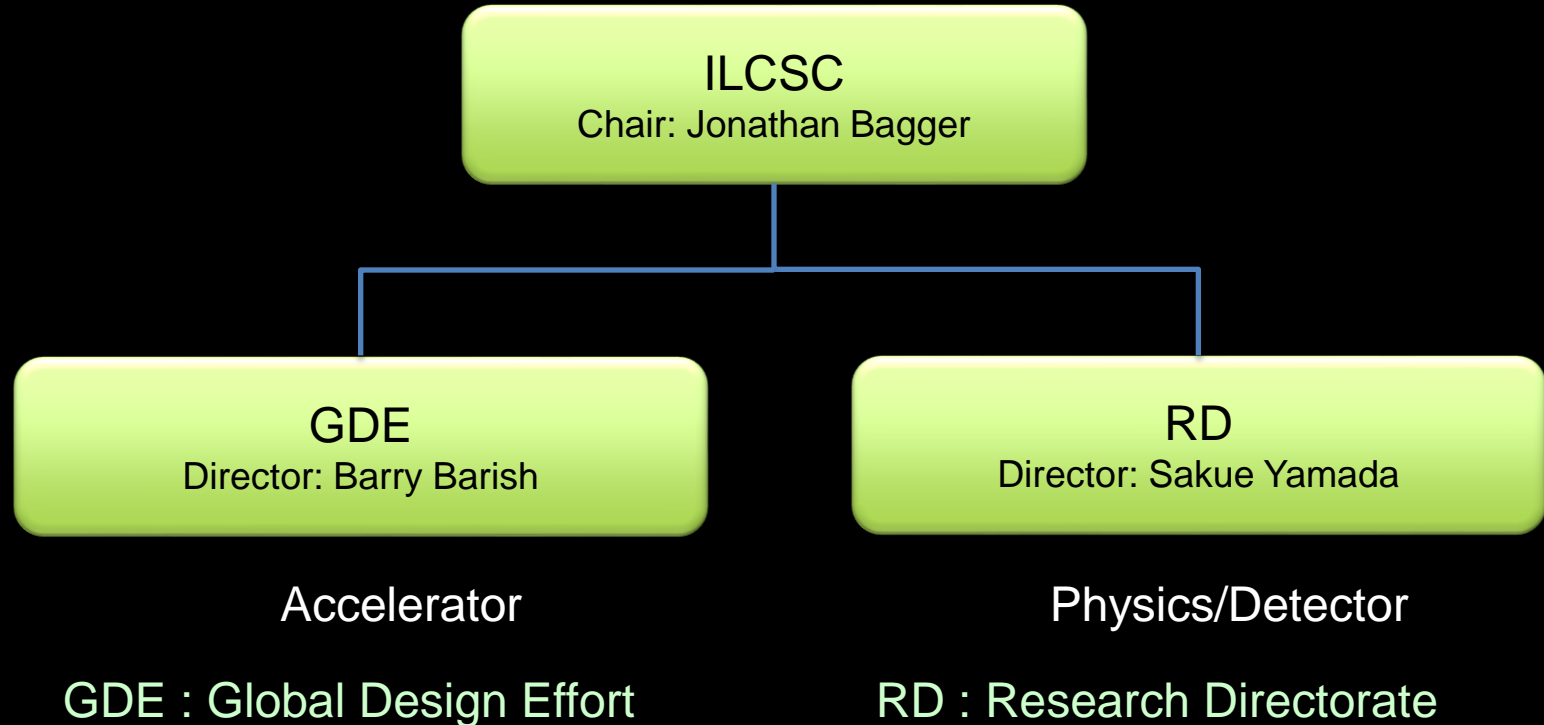
Vertex resolution

1 mm



ILC Organization (old)

- Until June 2013



Mandate : TDR (Technical Design Report)
(DBD for the detectors)

ILC TDR Draft Completion Ceremony

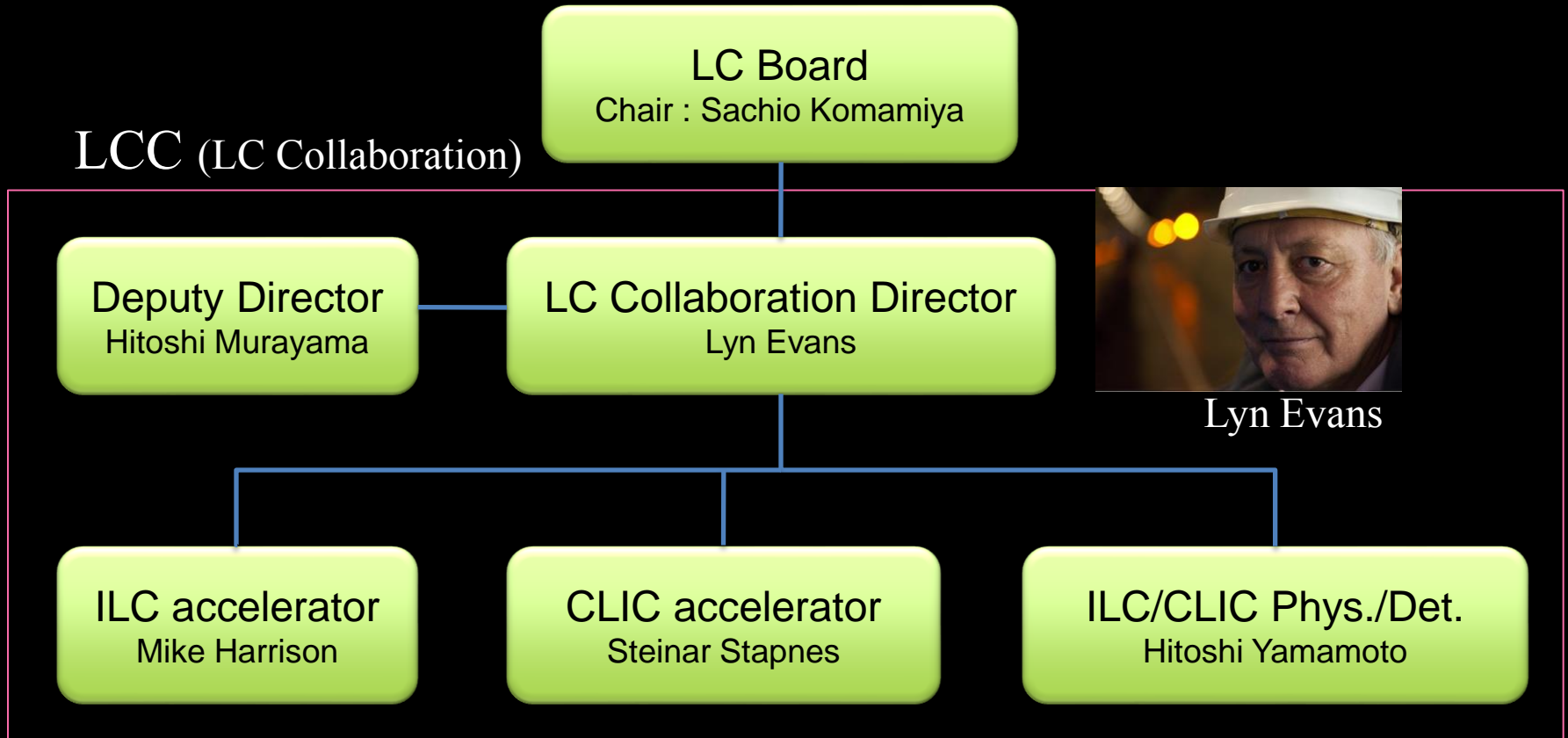


Dec. 15, 2012
Tokyo

The TDR draft was handed from Barry Barish (GDE) and Sakue Yamada (RD) to Jonathan Bagger (ILCSC).

ILC is now technically ready.

New International Organization (ILC+CLIC)



To be officially started on Feb. 21, 2013 in Vancouver.

Primary Goal: 'Realize the ILC'- Lyn Evans

2013 Feb~Jun : transition period

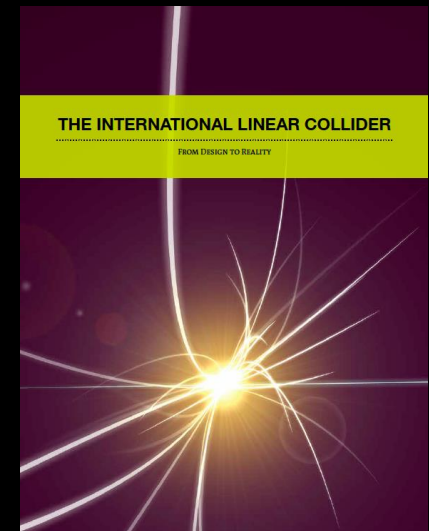
TDR/DBD

- Now 'really' complete.
 - Vol1 Executive Summary
 - Vol2 Physics
 - Vol3 Accelerator Part 1 & 2
 - Vol4 Detectors (DBD)
 - Outreach document
- Sent to the printer
- Not ready for E-distribution yet
 - Ready soon!
- Official devut
 - June 12 'ILC a worldwide event – from design to reality'
The Asian part : at Tokyo U.

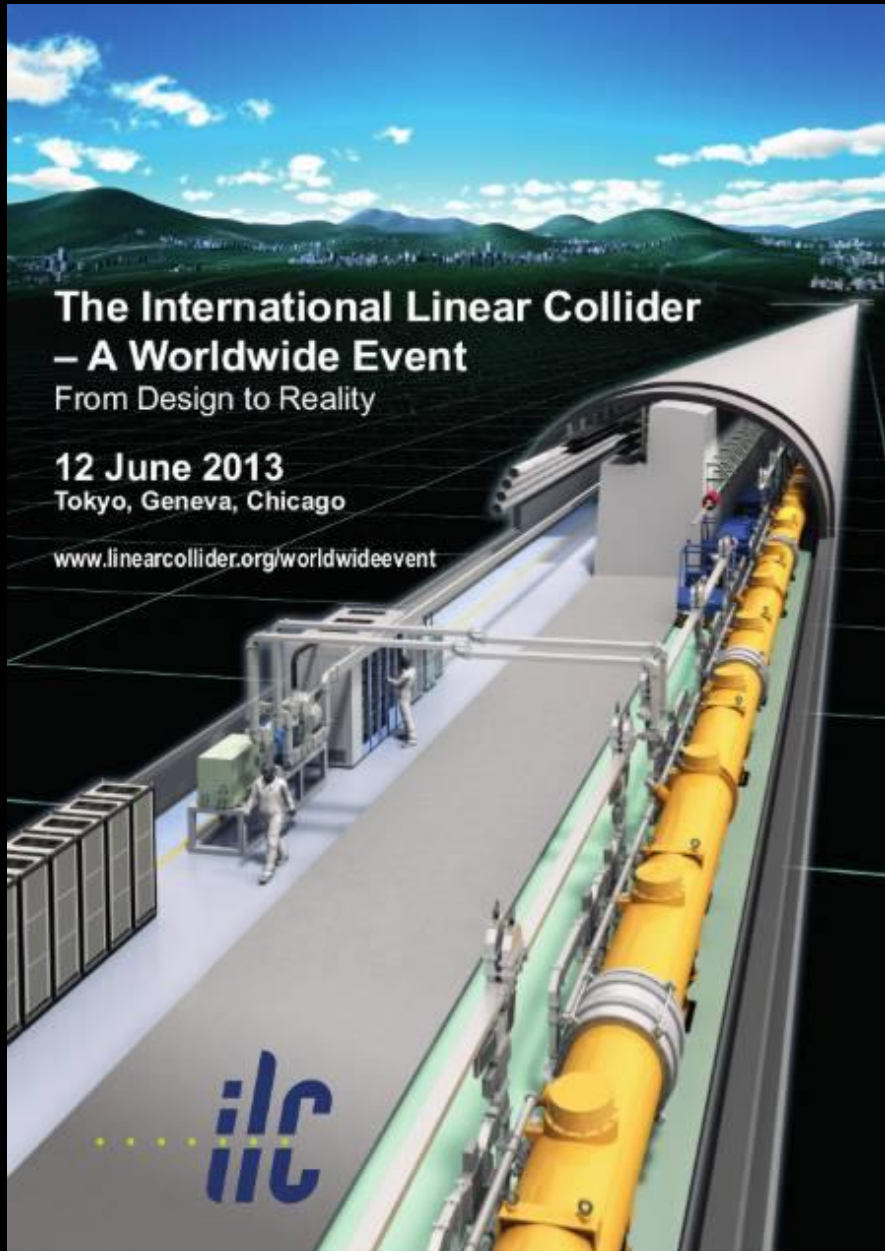
TDR



outreach



'ILC TDR June Event'



On June 12, 2013, Ceremony is relayed from Asia to Europe to Americas.

Asia: Tokyo University

Europe: CERN

Americas: Fermilab

The event will mark

1. Completion of the ILC TDR
2. Full start of the management by the LCC

<http://www.linearcollider.org/events/2013/ilc-tdr-world-wide-event>

Times line

(The possible best scenario)

- End 2013
 - Japanese government announces its intention to host the ILC. It will start negotiation with other government.
- 2013-2015
 - Negotiations among governments
 - Finish R&Ds. Prepare for the international lab.
- 2015-2016
 - Bldding for construction, start construction
- 2026-2027
 - Start operation

Nature Editorial

2012 Dec. 19

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NATURE | EDITORIAL

Head of the line

Japanese scientists deserve support in their bid for the next big collider.

19 December 2012

The International Linear Collider (ILC) is, literally, a pipe dream in the minds of physicists. The proposed 31-kilometre-long superconducting machine is the heir apparent to the Large Hadron Collider (LHC) — the world's most powerful particle accelerator — at CERN, Europe's particle-physics laboratory near Geneva, Switzerland. For now, the ILC remains a paper study, but particle physicists would like to see it built so that they can probe ever more fundamental questions about the nature of matter.

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NATURE Editorial (Dec 20, 2012)

<http://www.nature.com/news/head-of-the-line-1.12064>

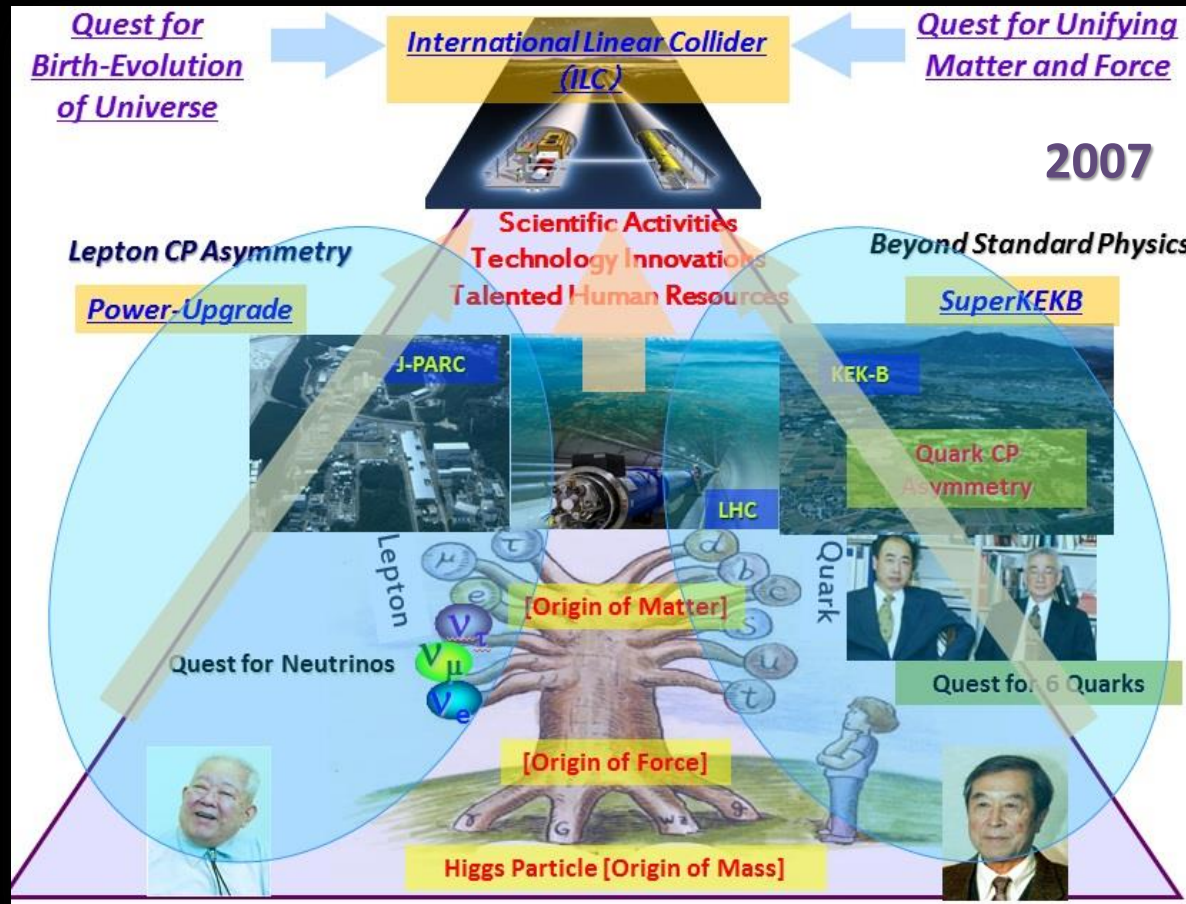
- Statements of support from overseas will not guarantee that the ILC will go ahead. Japan's opaque government will still have to debate the programme's merits internally and come up with a process for committing to its construction. But an early show of support could give the collider the push it needs to get under way. That would be a great victory for Japan, and the world.

European Strategy

- March 22, 2013 -

- There is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and whose energy can be upgraded. The Technical Design Report of the International Linear Collider(ILC) has been completed, with large European participation. The initiative from the Japanese particle physics community to host the ILC in Japan is most welcome, and European groups are eager to participate. Europe looks forward to a proposal from Japan to discuss a possible participation.

KEK Roadmap 2007



- A 5-year plan formed through town hall meetings in 2007
 - ILC at the top of the pyramid
- Recently went through an update
 - just released

KEK roadmap 2013

On the ILC

- KEK will play a central role in creating an international preparatory group and will lead the effort on advanced R&D, the engineering design of the apparatus and facility, and the organizational design toward groundbreaking for the linear collider project to be hosted in Japan, within the framework of a global collaboration.

JAHEP (Japan Association of High Energy Physicists)

- A report on large projects (March 2012)
 - After 2 years of intensive meetings listening to a large amount of talks and opinions
 - ILC and neutrino experiment at highest priority.
 - On ILC:

Should a new particle such as a Higgs boson with a mass below approximately 1~TeV be confirmed at LHC, Japan should take the leadership role in an early realization of an e^+e^- linear collider. In particular, if the particle is light, experiments at low collision energy should be started at the earliest possible time.

(Now, Higgs particle has been found and it is 'light')

JAHEP

- A proposal for staging of ILC (October 2012)
 - Staging
 - A Higgs factory with a CM energy of ~ 250 GeV to start
 - Upgraded in stages to ~ 500 GeV (RDR baseline)
 - Technical expandability to ~ 1 TeV to be secured

This is now an official proposal of the Japanese HEP community.

- Guideline for cost sharing
 - The host country to cover 50% of the expenses (construction) of the overall project of the 500 GeV machine.
 - The actual contribution, however, should be left to negotiations among the governments.

LDP (Liberal Democratic Party) Victory in the lower-house election in Oct, 2012

Our new prime minister
Shinzo Abe



LDP policy document
for the election

The ILC appears twice explicitly
in the policy document:

- Science and technology policies
- Creation of top-class research centers

LDP (Liberal Democratic Party) : New Ruling Party

Election 'promises'

32 Rebuilding true command tower functions that strongly advance science and technology policies

- ...We will actively promote the critical fields of energy creation, energy conservation, energy storage, etc. as knowledge-concentrated national strategies - for example, our country should be able to play a leading role in creation of international centers for scientific innovations such as the ILC (the international linear collider) project which is a grand project in the field of particle physics.

92 Creation of globally top-class centers for research and development

- ...We will significantly strengthen supports for universities and public research facilities that perform studies at levels above the intentional standards, such as significant expansion of WPIs and playing a leading role in creation of international centers for scientific innovations such as the ILC (the international linear collider construction) project which is a grand project in the field of particle physics.

Political Parties

- ‘Federation of diet members for promotion of the ILC’
 - Established in 2008
 - Expanded to a multi-partizan group



- Previous PM Noda made a positive remark on ILC in one of the symposiums co-hosted by the federation.
- Re-invigorated after the Higgs discovery: now ~150 members!
- New chair: Mr. Kawamura (former MEXT minister)

Report by the Association of Corporate Executives (経済同友会)

‘... The Japanese government should announce the intention to site the ILC in Japan, and propose to related countries to begin discussions toward its realization. ‘

‘... On down-selecting the Japanese candidate sites to one, it is important to proceed with a fair selection process in order to build an All-Japan framework. The selection process should be based on the results of the geological and technical studies being conducted by experts, and should be decided fairly.’

Activities of the new Federation (Diet)

- General meetings
 - Feb 1, 2013 : re-establishing the federation
 - Huge attendance:
 - 45 diet members and 25 proxies + researchers/companies
 - Feb 26, 2013 : re-organization
 - March 25, 2013 : invite Lyn Evans (LC collaboration director).
 - Apr : two general meetings held
- Mini-lecture series
 - eg: March 13, by Sakue Yamada etc.
- Visit Washington DC
 - Co-host US-Japan symposium, Apr 30-May 1, 2013
 - goal : enlarge US-Japan collaboration on the ILC

Science-Industry Alliance

- ‘Advanced Accelerator Association for promoting science and technology (AAA)’
 - Established in 2008
 - Headed by a former CEO of Mitsubishi Heavy Industries: Mr. Nishioka
 - Hitachi, Toshiba, Mitsubishi, etc.
 - ~90 industries + ~30 universities

Intensive activities:

- Lecture series, symposiums
- Civil engineering study
- Studies on large projects
- Science-industry cooperation
- ...



US-Japan Symposium on Advanced Science and Technology

Apr 30, 2013, Washington DC

- Speakers from Japan
 - Shimomura: MEXT minister
 - Kawamura: chair of the federation of diet members for ILC, former MEXT minister
 - Masuda: former minister of interior
 - etc.
- Speakers from the US
 - Daniel B. Poneman: deputy secretary of energy
 - L.K. Len: OHEP DOE
 - Tony Favale: president, AES
 - etc.
- In the morning, an agreement was signed between US and Japan on cooperation in science and technology
 - A HEP annex is being written



Lyn Evans visits PM Abe et al.

Apr 25-27, 2013, Tokyo

PM Abe

- Visited

- Prime Minister Shinzo Abe
- Minister of science and technology, Ichita Yamamoto:
- Takeo Kawamura: chair of the federation of diet members for ILC, former MEXT minister

With Koshiba, Murayama, Yamashita

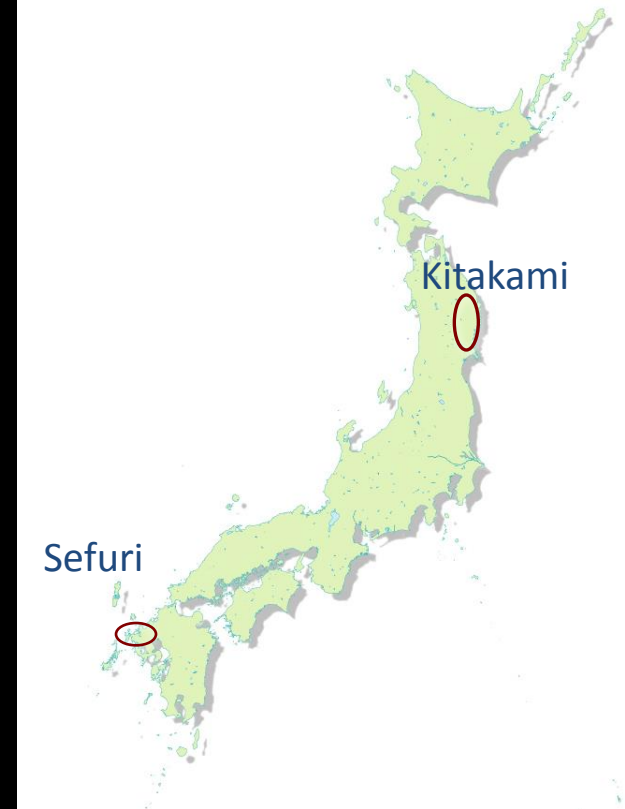
- Hakubun Shimomura: MEXT minister
- Hiroya Masuda: former minister of interior
- Kiyohiko Ito: managing director JACE
- etc. etc.



Two Candidate Sites

- Kyushu
 - Sefuri mountains
- Tohoku
 - Kitakami mountains

Strong and stable granite bedrocks



One of them will be chosen by end of July 2013 based on:

- Geology and technical aspects
- Infrastructure and economic ripple effects

Regional Organizations : Kyushu

- Kyushu

- ‘Association of Advanced Fundamental Science and Future Accelerators’

- Established in 2007

- Local governments, companies and universities

- ‘Kyushu and Saga Universities Promoting ILC’

- Established in 2007

- ‘ILC-Asia-Kyushu Conference Promoting ILC’

- Established in 2013 Feb 14

- ‘City of Karatsu Conference Promoting ILC’

- Established in 2013 Feb 19

- ‘City of Saga Conference Promoting ILC’

- Established in 2013 Feb 26

City of Karatsu



City of Saga



Regional Organizations : Tohoku

- ‘Tohoku Conference for the Promotion of the ILC’
 - Local governments, companies and universities
 - Cities of Oshu, Ichinoseki, Kesennuma joined the Tohoku Conference for the Promotion of the ILC
 - 2013 Mar 6
 - New members joining rapidly now!
- ‘Tohoku University Council for the Promotion of the ILC’
 - Established in 2012
- ‘Federation of Assembly Members Promoting the ILC’
 - Iwate Prefecture : established 2013 Mar 13
 - Miyagi Prefecture : to be established at next assembly

~300 newspaper articles on ILC this year
by major journals in Iwate and Miyagi

Iwate Assembly Members
visiting KEK



Regional Activities (both regions)

- Geological survey
 - Borings, seismic surveys, electrical surveys, etc.
 - Field studies (reconnaissance)
- Study on international academic city and economic ripple effects
 - Residences, medical, educations, etc.
 - Official reports produced
- Outreaching to local public
 - Lectures, symposiums, science cafes etc.
high school lectures (>10k students) and
>50 public lectures, etc. after 2010.
 - Meetings to explain site studies
 - Production of PR DVDs

Science Cafe

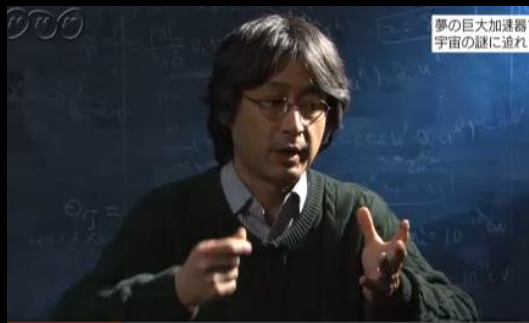


Symposium



National Coverage of the ILC

- Many TV and newspaper coverages
 - ‘Close-up Today’ (クローズアップ現代) Feb 2013
NHK’s flag-ship news program (30 min)
‘Go beyond Higgs – Japan’s Large Accelerator Project’



Anchor: Hiroko Kuniya



Summary

- The ILC is technically ready.
- There are strong supports from the international scientific community. (will they translate to commitments?)
- Japanese government is now willing to negotiate with other governments toward siting the ILC in Japan.
- If the negotiation fails, there will be no ILC in Japan (and probably anywhere).
- In order for the governments of Americas and Europe to commit substantial resources to the ILC, your support is essential.