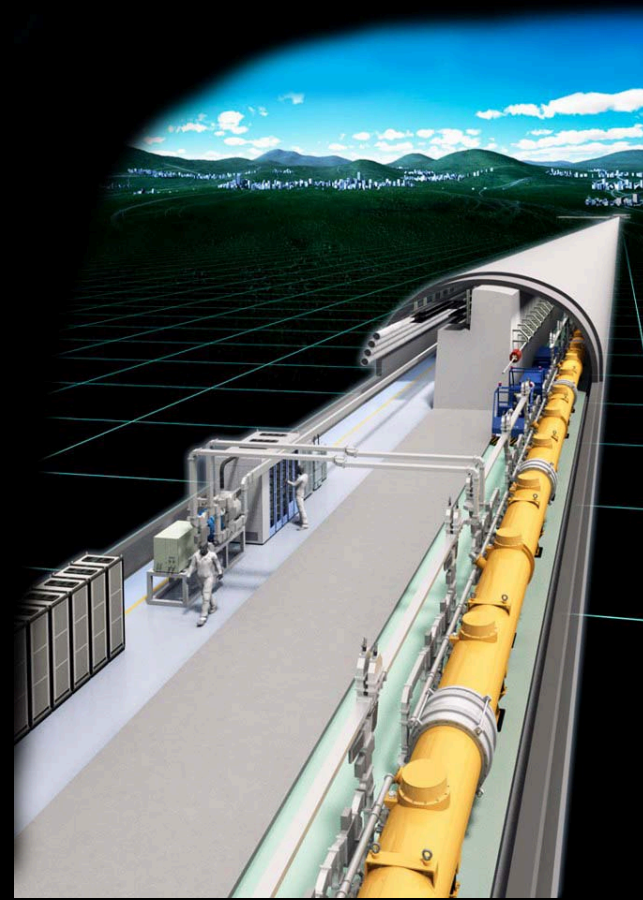


The ILC Project

Hitoshi Yamamoto
Tohoku University

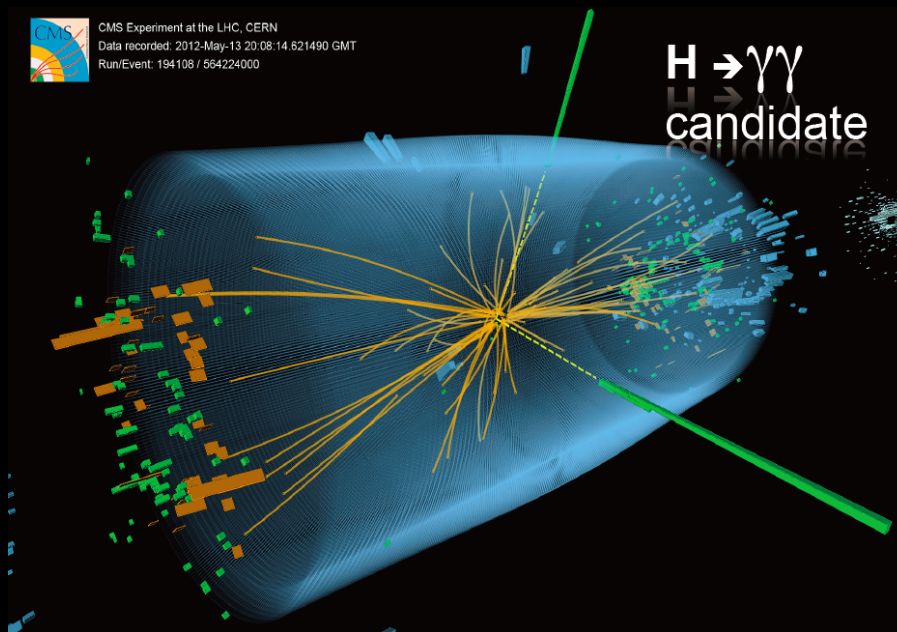
HPNP2013, Toyama
2013 Feb. 15



Four reasons for the recent progress of the ILC situation :

- The discovery of the Higgs-like particle
 - Completion of the ILC TDR (draft)
 - Expressions of international supports
- Announcement of the Japanese government that it will call for negotiations with other countries within first half of 2013

Discovery of Higgs-like particle

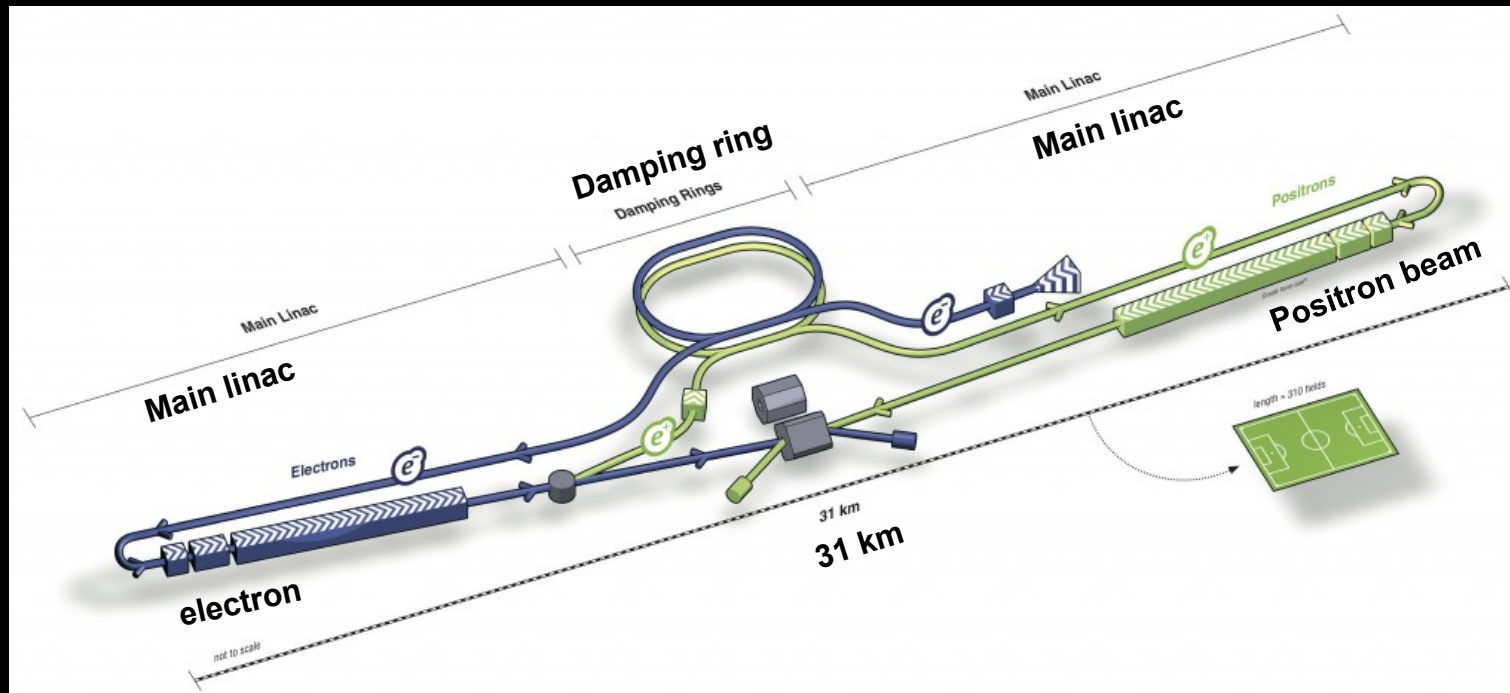


- ▶ The fine-tuning problem of the SM became **real**. (unless ‘multiverse’)
- ▶ We now have to face the **missing dark matter** in the SM.
- ▶ Compelling reasons for the next step.

A new era of particle physics has begun!

The ILC is designed to lead the new era.

ILC (International Linear Collider)

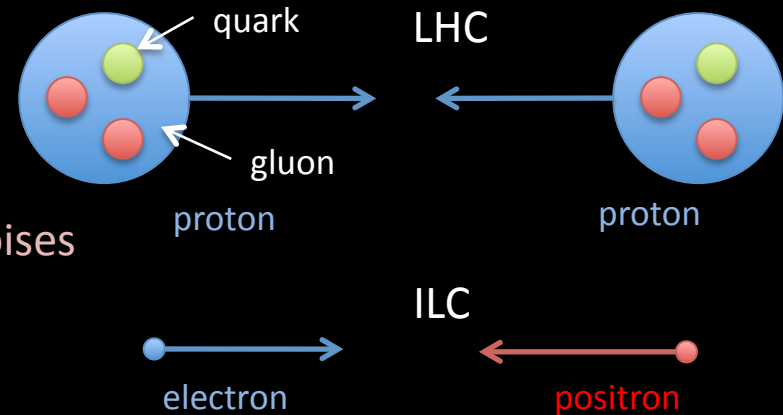


- 500 GeV CM with 31 km → upgrade later to ~ 1TeV CM with 50 km
- Beam size at IP : 6 nm x 500 nm x 300 μm
- Luminosity $\sim 2 \times 10^{34} / \text{cm}^2\text{s}$

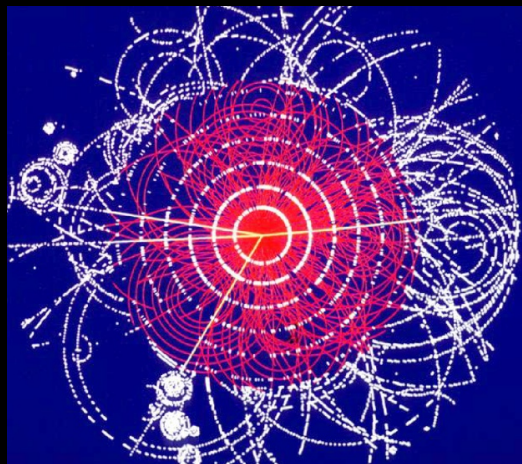
ILC features : cleanliness

■ Collision of two elementary particles

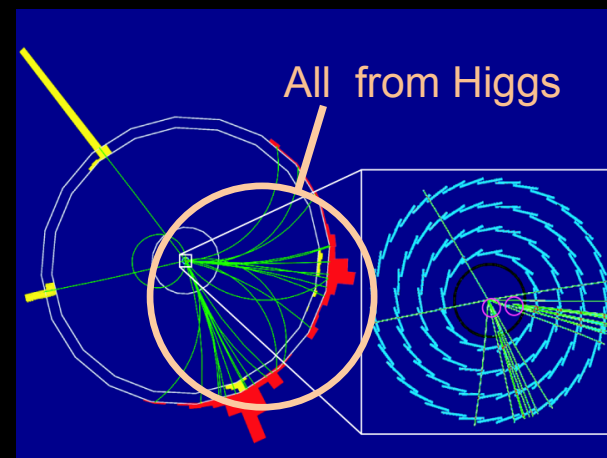
- proton + proton at LHC
 - Proton = 3 quarks + gluons
 - electron + positron at ILC
- Signal is clearly seen without much noises
- Trigger-less data taking
- Theoretically clean
(less theoretical uncertainties)



LHC



LC



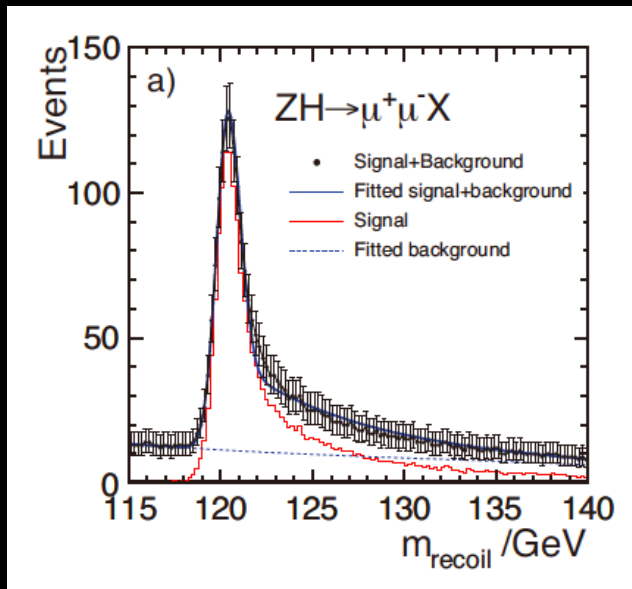
ILC features : control

- 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)

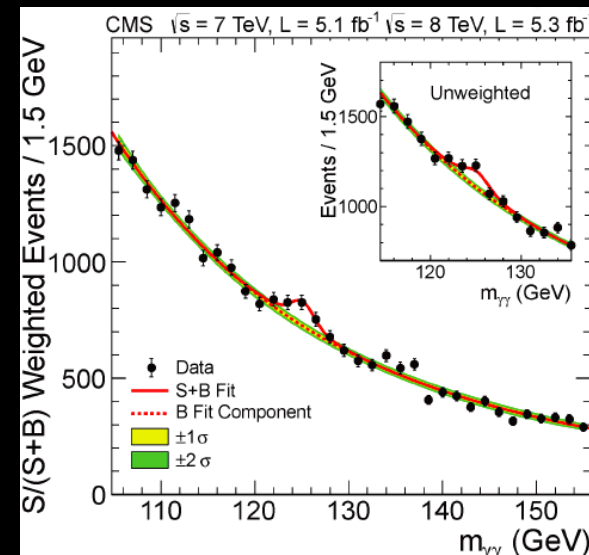
Energy-momentum 4-vector

→ e.g. recoil mass analysis

Higgs to ALL (including invisible final state) is seen



ILC

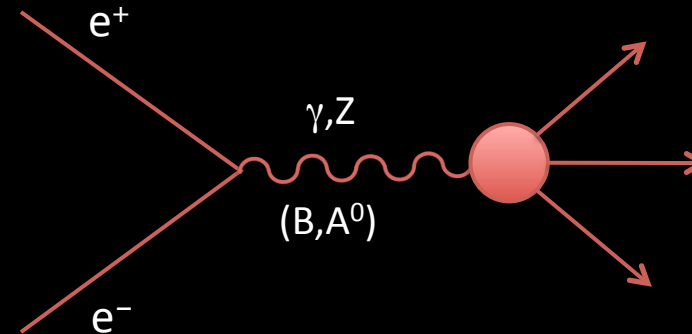


LHC

Electron polarization

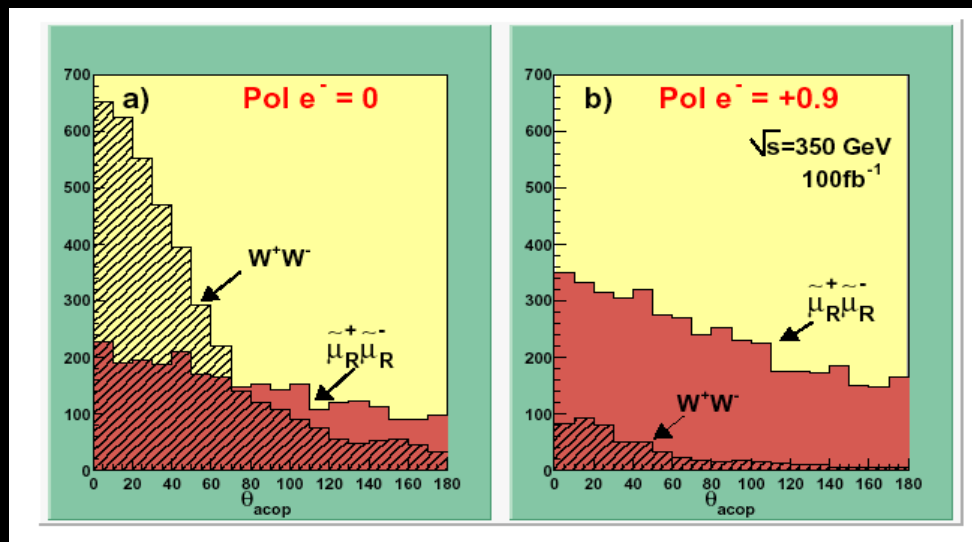
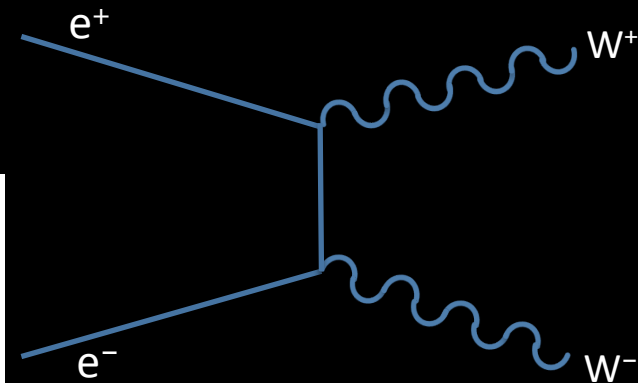
Specify the intermediate state

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



Right-handed e^- turns off W

- Background rejection

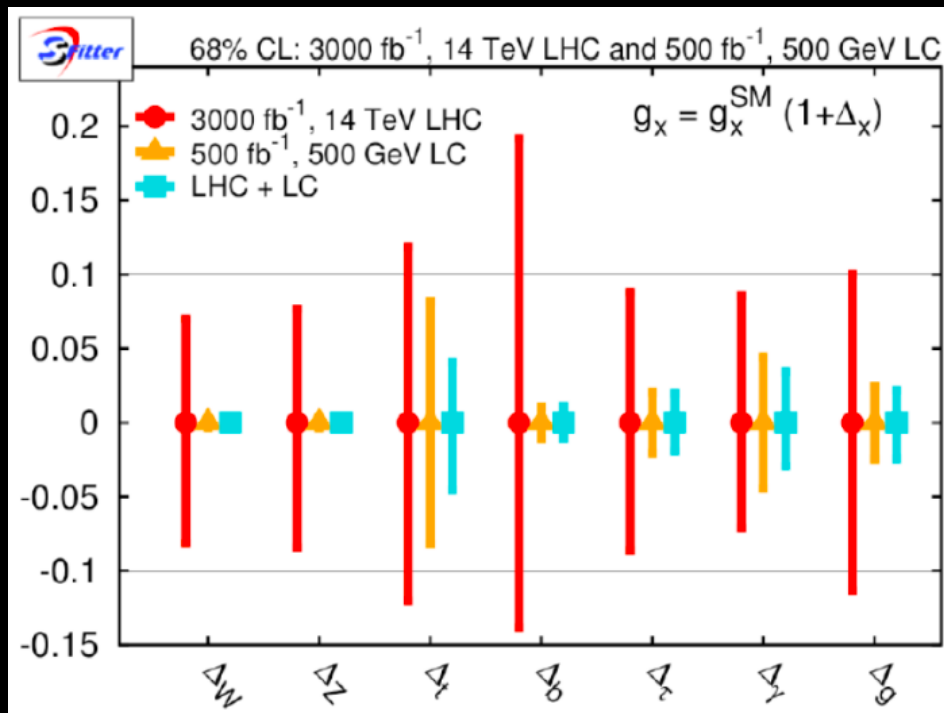


e.g. acoplanar muon pair production
such as smuon pair production

Measurement errors of Higgs couplings

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

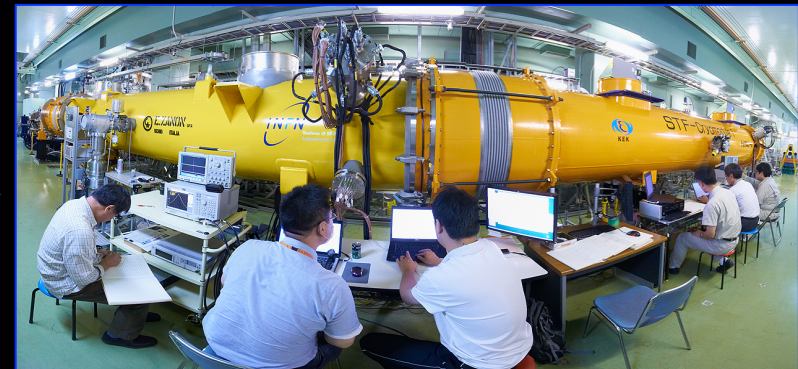
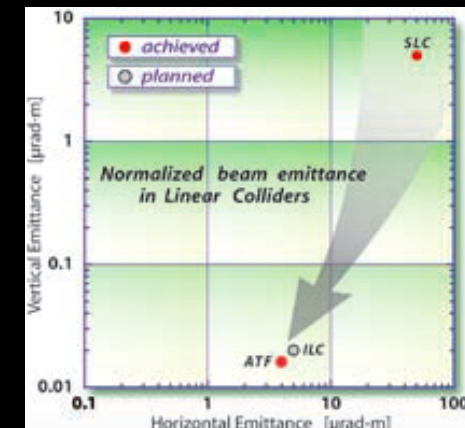
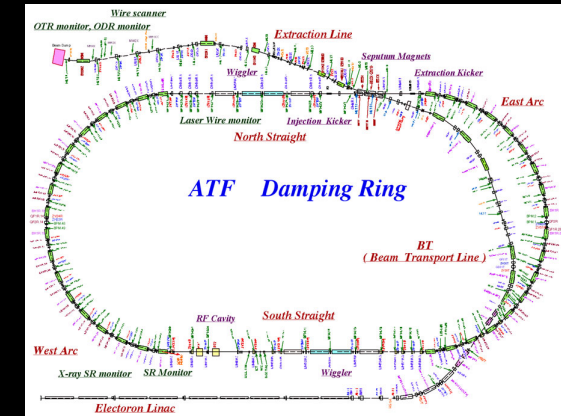
D. Zerwas



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)

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

→ Requires high granularity (wrt LHC)

Vertexing (fine-pixel CCD)

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

Main tracker (TPC)

- Material 1/6
- Momentum resolution 1/10

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

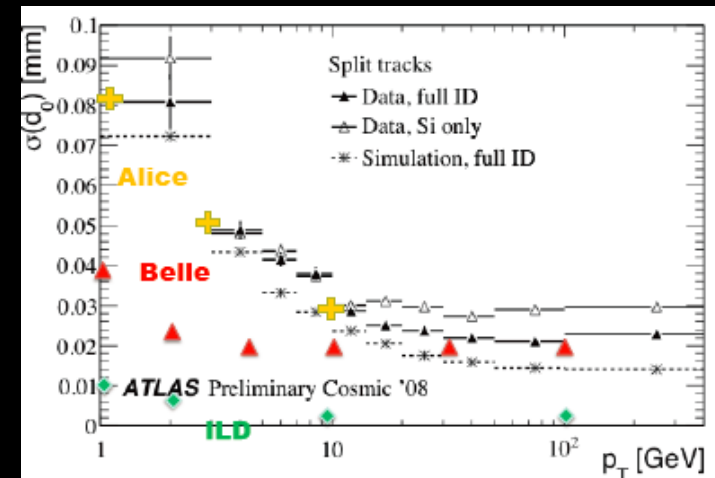
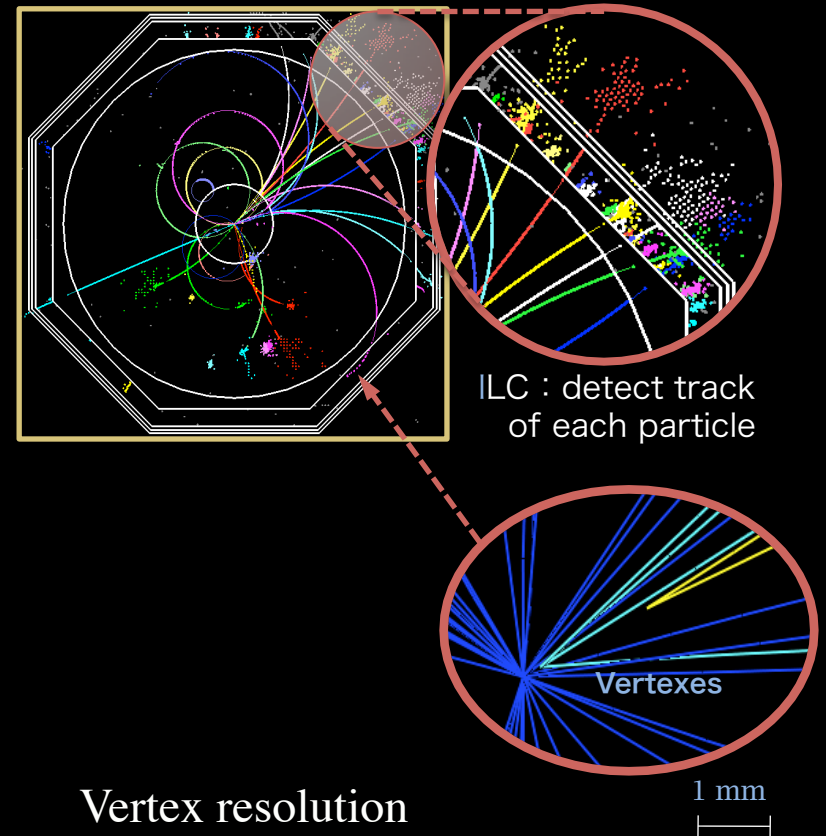
- Cell area 1/200

Detector elements R&Ds:

Principles proven

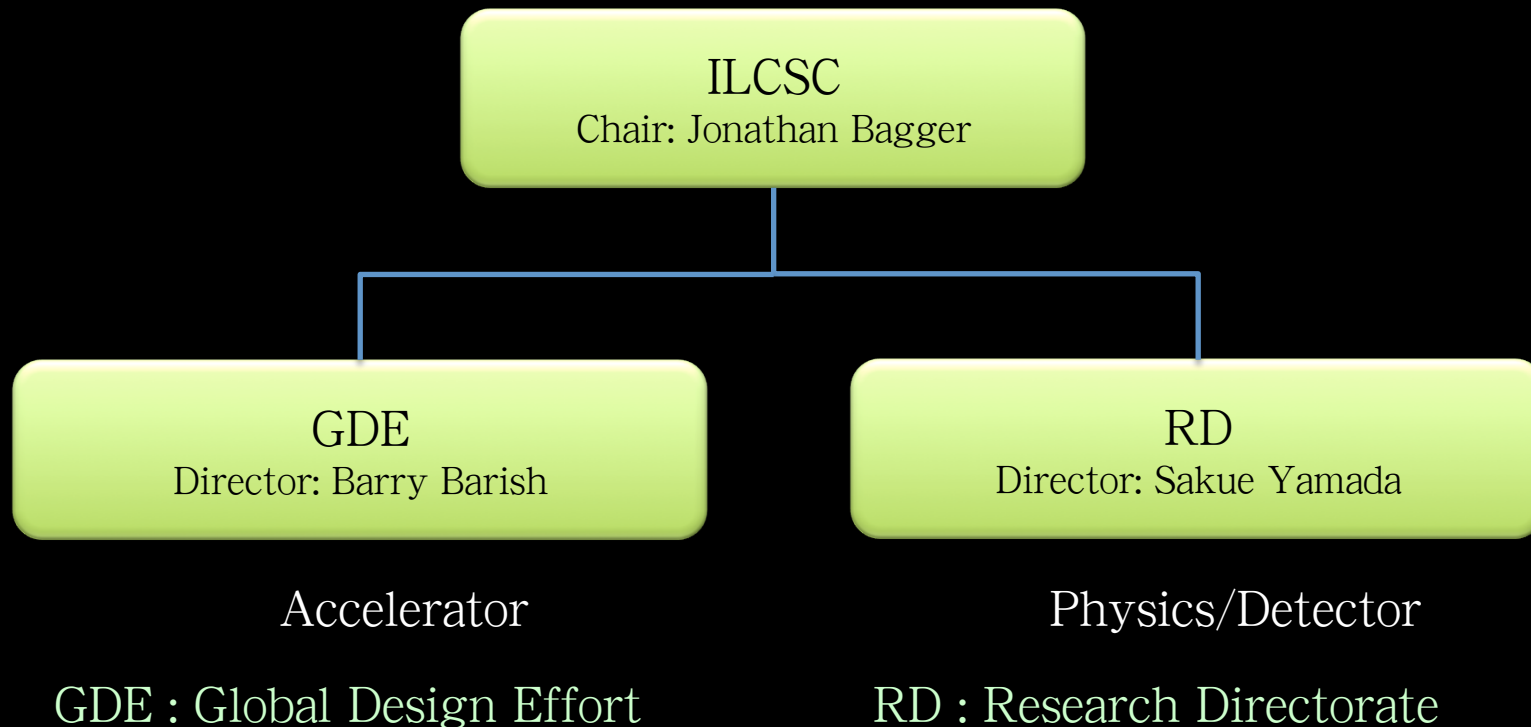
Now R&D is in systematization

Two detector groups: ILD, SiD



ILC Organization (now)

- Until June 2013



Mandate : TDR (Technical Design Report)

ILC TDR Draft Completion Ceremony

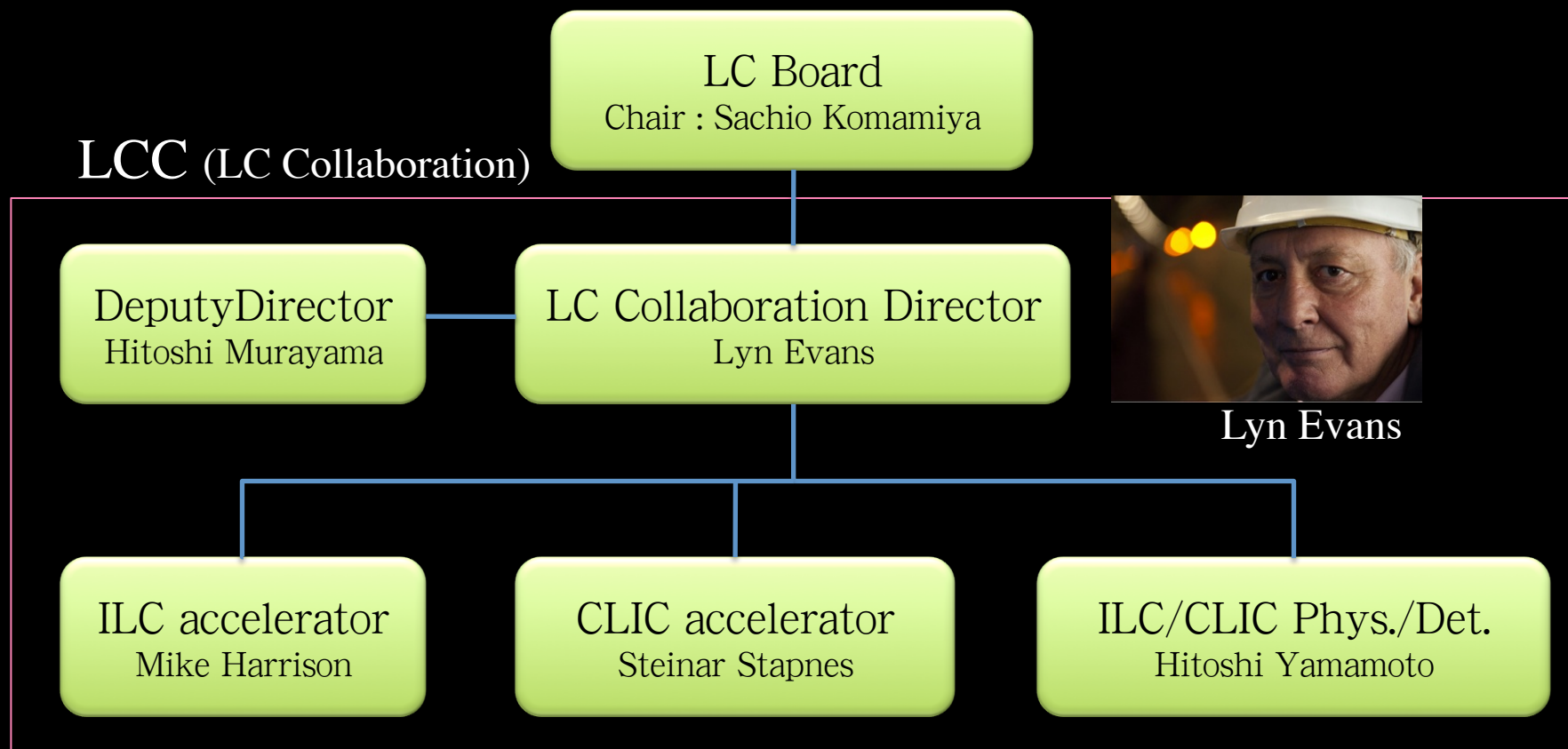


Dec. 15, 2012
Tokyo

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

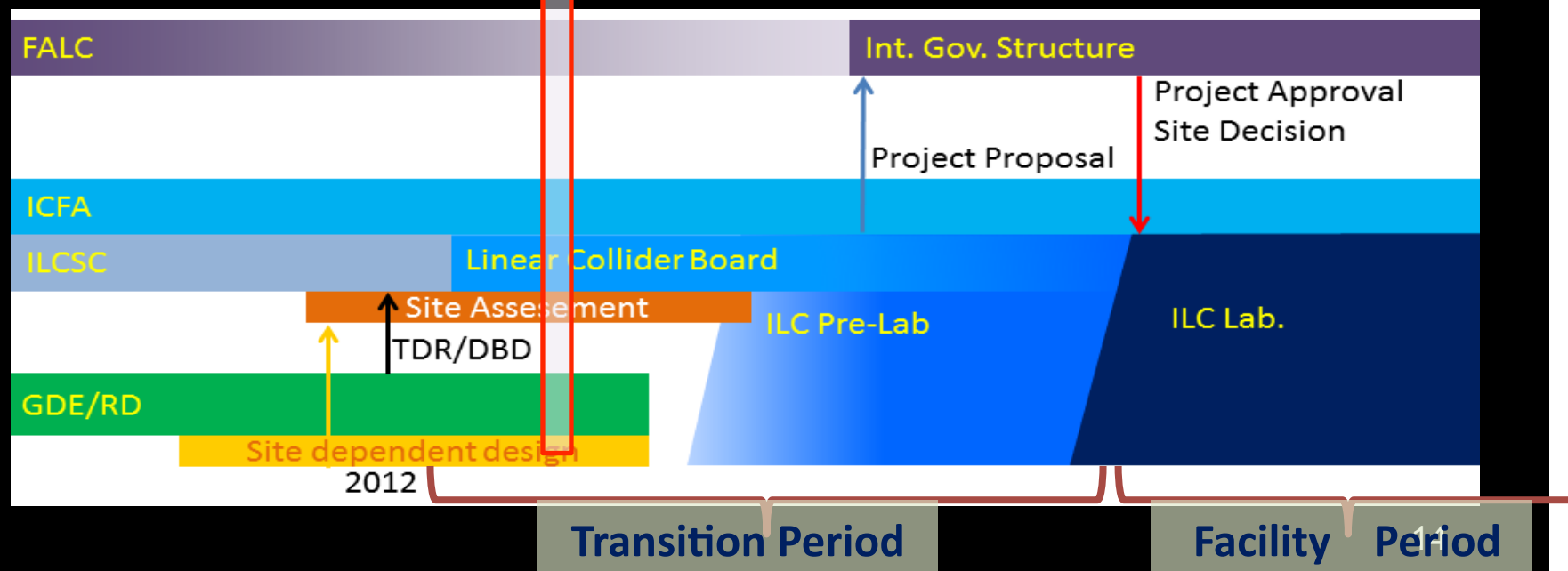
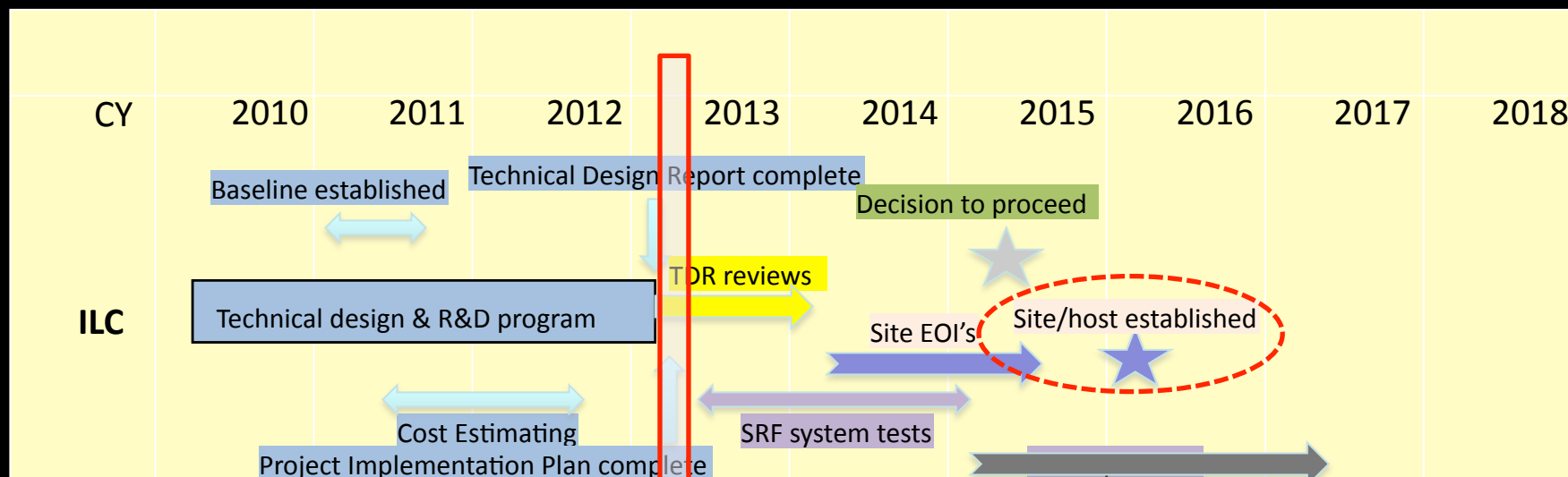


To be officially started on Feb. 21, 2013 in Vancouver.

Goal: 'Realize the ILC' - Lyn Evans

2013 Feb~Jun : transition period

Possible Timeline (by A. Suzuki)




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>

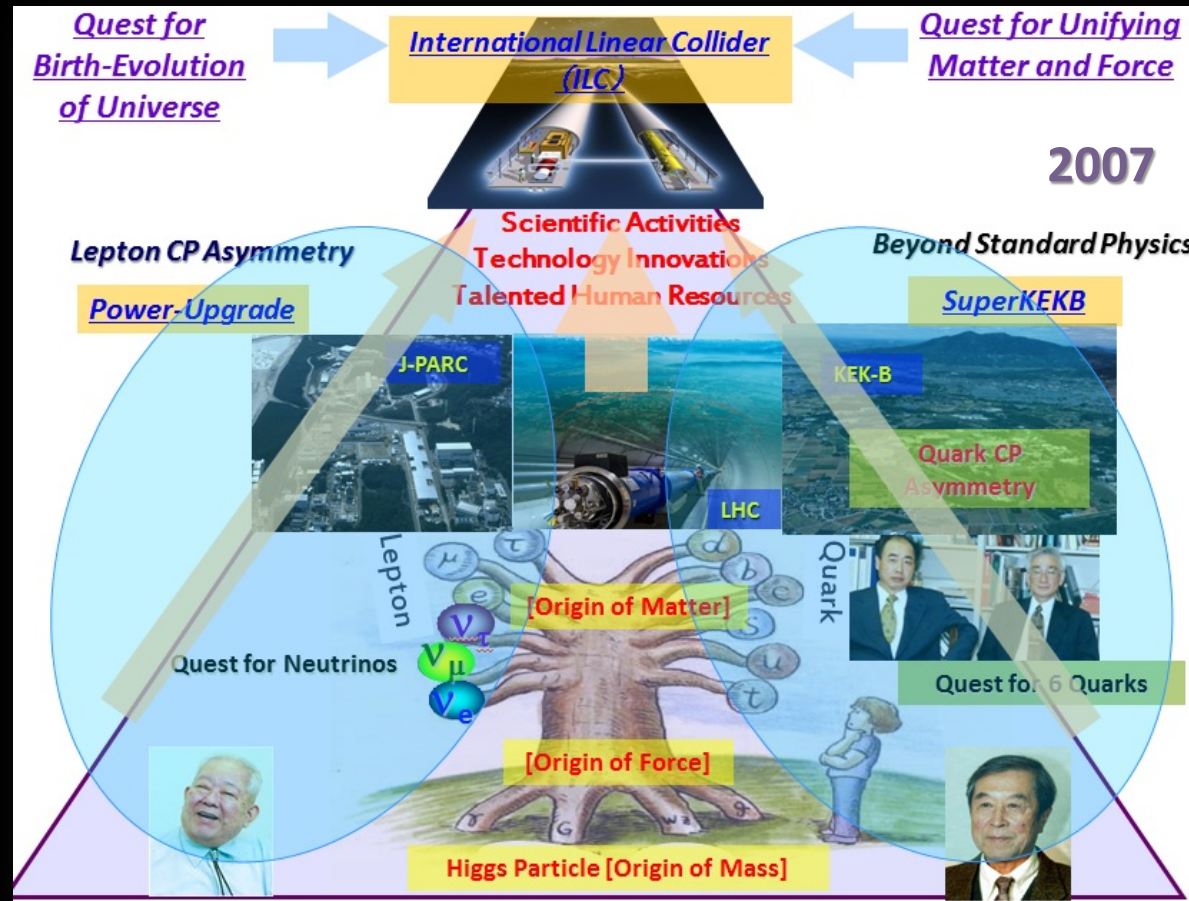
- US and European scientists should throw their support behind the ILC project. For the forward-thinking Europeans, this means a clear commitment to the parts and manpower they might be able to supply. For the Americans, it would probably require a willingness to slow the neutrino programme. That may be hard for them to swallow but, deep down, US physicists know that participation in the ILC is the only real option if the nation is to remain at the vanguard of particle physics.
- 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

- draft is released -

- 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



- A 5-year plan formed through town hall meetings in 2007
 - ILC at the top of the pyramid
- Currently undergoing update
 - just released (English version not yet)

KEK roadmap

- KEKが中心となって、日本がホストするILC計画推進のための国際準備組織を立ち上げ、装置、施設・設備、研究所組織の詳細設計などに取り組み、本ロードマップ期間内(2014年からの5年間)の国際協力の枠組みによる建設着手を目指す。
- KEK takes an initiative to start an international preparatory organization, engage in detailed designs of equipments, facilities, laboratory organization etc., and aims at starting the construction under international framework within the duration of this roadmap (5 years from 2014). (my translation)

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-like 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.**

Press conference by the MEXT minister Shimomura Jan 18, 2013



‘(On ILC) We would like to consider the plan for the near future, while as the government actively negotiating with relevant countries in the first half of this year.’

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.
- General meeting on Feb 1, 2013
 - huge attendance (plan ~30, actual ~80)

Science-Industry Alliance

- ‘Advanced Accelerator Association for promoting science and technology (AAA)’
 - Established in 2008
 - CEO’s and former CEO’s of Hitachi, Toshiba, Mitsubishi, etc.
 - ~90 industries + ~30 universities

Intensive activities:

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



Two Candidate Sites

- Kyushu
 - Sefuri mountains
- Tohoku
 - Kitakami mountains

Strong and stable granite bedrocks



One of them will be chosen by this summer based on:

- Geology
- Economic ripple effects
- Political issues

Summary

- The ILC is technically ready.
- There are strong supports from the European scientific community. (will they translate to commitments?)
- Japanese government is now willing to negotiate with other governments toward siting the ILC in Japan.

Backups

Regional Activities (both regions)

- Geological survey
 - Boring, seismic survey, electrical survey, etc.
 - Field studies (reconnaissance)
 - Literature survey etc.
- Study on international academic city
 - Residential requirements
 - Education of children
 - Medical needs (language...)
 - Job opportunities for spouses
 - Recreation...
- Study on economic ripple effects
 - Learn from past mistakes
 - why there is no high-tech park near J-PARC?
- Education of local public
 - Lectures, symposiums, science cafes etc.

Science Cafe



What is needed?

- 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 US government to commit substantial resources to the ILC in Japan, your support is essential.
- A critical step is the Snowmass Process.
- We will attend the snowmass workshops as much as possible.
 - Coordination with the US HEP people is necessary.

Regional Organizations

- 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
- Tohoku
 - ‘Tohoku Conference for the Promotion of the ILC’
 - Originally established in 2009 (with a difference name)
 - Local governments, companies and universities
 - ‘Tohoku University Council for the Promotion of the ILC’
 - Established in 2012