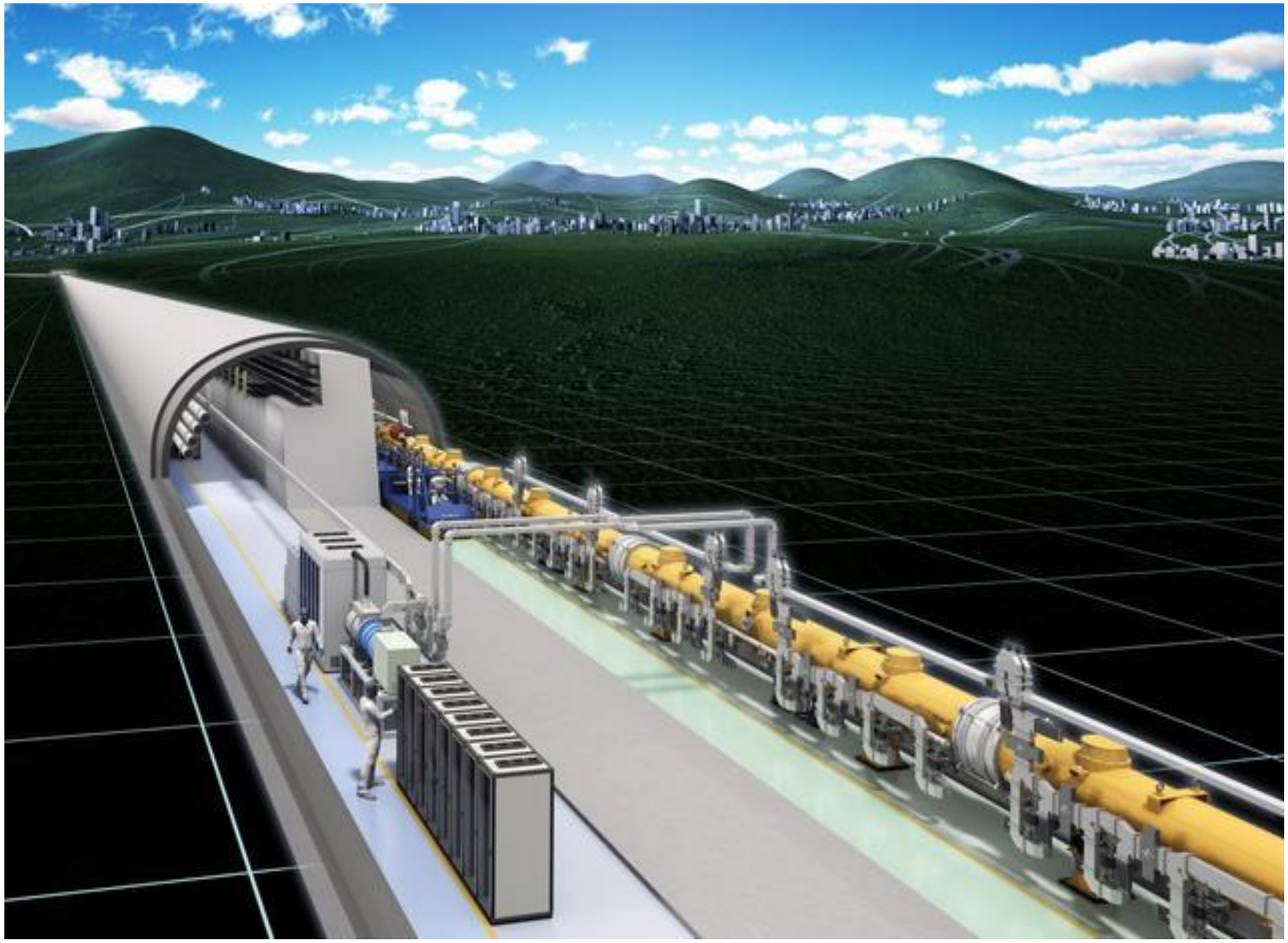
ILC

US-Japan HEP Committee in Honolulu, Hawaii

- 16th April 2019 Sachio Komamiya Waseda University/The University of Tokyo



ICFA and LCB Meeting in Tokyo

From 7 to 8 March 2019, the International Committee for Future Accelerators (ICFA) had its 83rd meeting held at the University of Tokyo. About 40 representatives from around the world gathered to discuss the current status and future prospects of high-energy physics.

KEK
High Energy Accelerator Research Organization

Statement by MEXT at LCB Meeting in March 2019

- Following the opinion of the SCJ, **MEXT has not yet reached declaration for hosting the ILC in Japan at this moment.** The ILC project requires further discussion in formal academic decision-making processes such as the SCJ Master Plan, where it has to be clarified whether the ILC project can gain **understanding and support from the domestic academic community**.

- MEXT will pay close attention to the progress of the discussions at the European Strategy for Particle Physics Update.

- **The ILC project has certain scientific significance in particle physics particularly in the precision measurements of the Higgs boson, and also has possibility in the technological advancement and in its effect on the local community,** although the SCJ pointed out some concerns with the ILC project. Therefore, considering the above points, **MEXT will continue to discuss the ILC project with other governments having an interest in the ILC project.**

Presented by Dr. Keisuke Isogai, Director-General of the Research Promotion Bureau of MEXT (Copy of the talk by KEK-DG Prof. Yamauchi at Lausanne meeting for LC community)

KEK
High Energy Accelerator Research Organization

Message from the Federation of the Diet Members for ILC

- I believe the ILC should be realized through politically-led efforts, cutting across different ministries and agencies. As such, **we're proceeding to realize a budgeting as a national project with a separate budget outside of the regular science and technology budget.**

- **On the international cost sharing, we have to separate the infrastructure part of civil engineering and conventional equipment that is natural to be taken up by the host country and the apparatus part that is natural to be internationally cost-shared among technically competent countries.**

- As the environment has ripened socially, politically, and administratively, **the next mission for politics is to secure the budget for the construction.** In parallel, with the government's administrative process, we will begin in earnest from our role as political and legislative body to obtain the necessary budget for construction.

Presented by Hon. Takeo Kawamura president of the Federation on 6th March
(Copy of the talk by KEK-DG Prof. Yamauchi at Lausanne meeting for LC community)

KEK
High Energy Accelerator Research Organization

Actions to be done by MEXT

Answers given by MEXT at the Diet session on March 13, 2019.

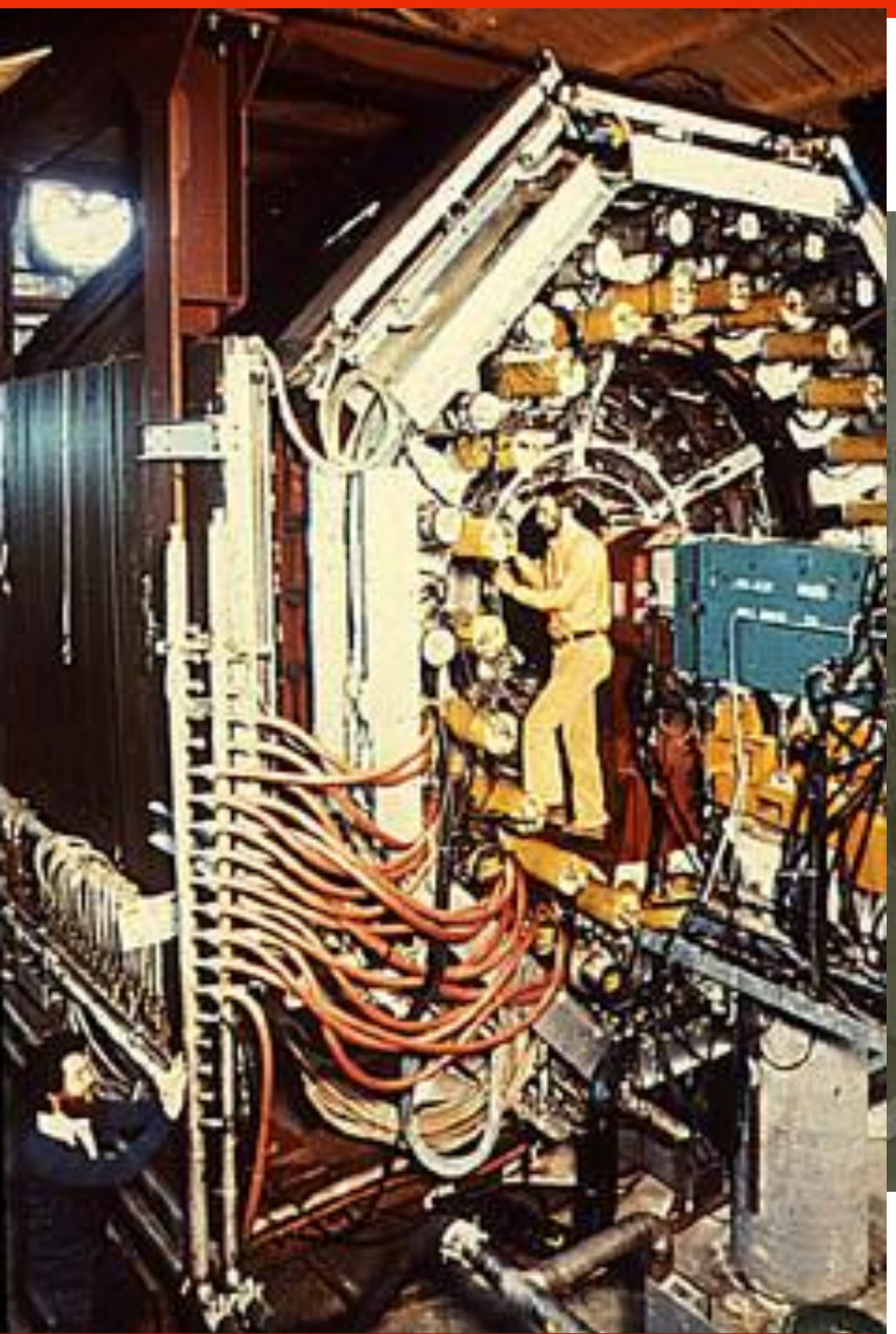
- In the future, while paying close attention to the progress of discussions on the European Elementary Particle Physics Strategy, we would like to **deepen discussions with France and Germany at the governmental level**, by proposing, for instance, to establish a standing discussion group similar to the one with the US. (Dr. Isogai of MEXT)

- So, also for the ILC project, we expect there will be **a working group set up in the High Energy Accelerator Research Organization, so-called KEK, and at its initiative,** discussions within the community of domestic and foreign researchers will proceed regarding international cost sharing, etc. (Dr. Isogai of MEXT)

- As I mentioned earlier, I am also aware that this is a project of great significance both from the academic research point of view and from the perspective of regional revitalization. Therefore, I would like to **continue our investigations, closely collaborating with related communities while keeping an eye on the international situation.** (Minister Shibayama)

(Copy of the talk by KEK-DG Prof. Yamauchi at Lausanne meeting for LC community)

Importance of e^+e^- collision was recognized by the November Revolution in 1974

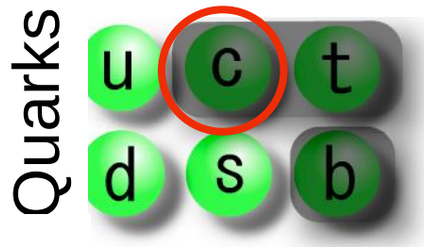


Concept of 4π Detector

Discovery of J/ψ

Burton Richter

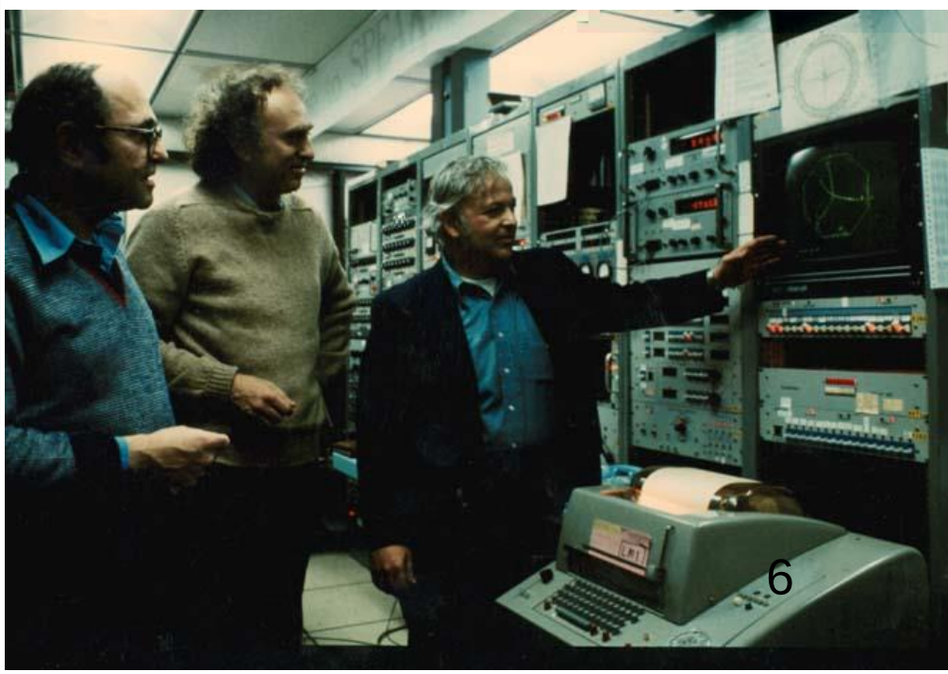
1931-2018



Gauge Bosons

Higgs Boson

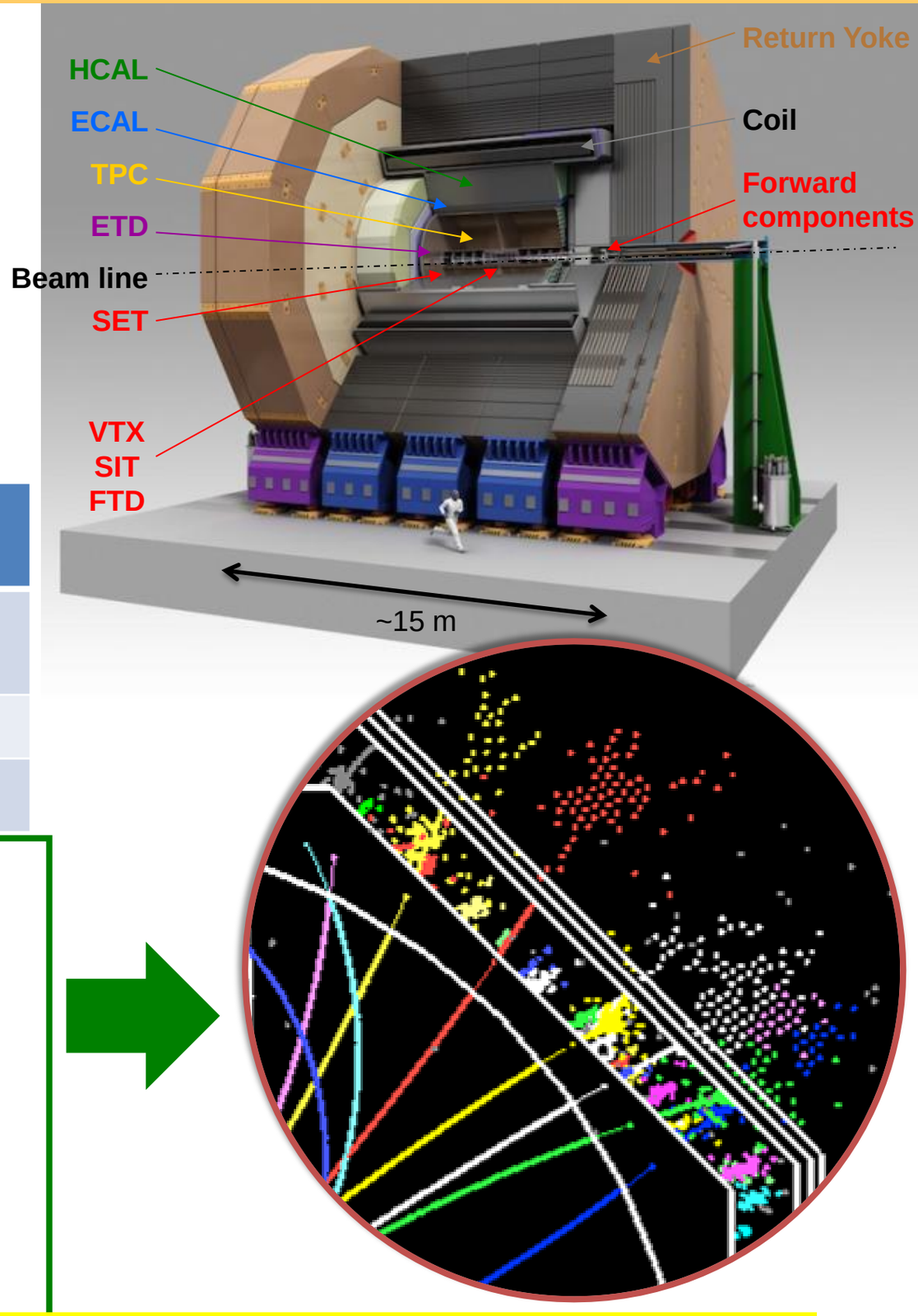
Gerson Goldhaber
Martin Perl
Burton Richter



ILC Detector R&D (SiD,ILD) Hitoshi Yamamoto`s talk

- Vertex Detector: pixel detectors & low material budget
- (Time Projection Chamber: high resolution & low material budget, MPGD readout)
- Calorimeters: high granularity sensors, 5x5mm^2 (ECAL)、3x3cm^2 (HCAL)

Sensor Size	ILC	ATLAS	Ratio
Vertex	5×5 mm^2	400×50 mm^2	x800
Tracker	1×6 mm^2	13 mm^2	x2.2
ECAL	5×5 mm^2 (Si)	39×39 mm^2	x61



Particle Flow Algorithm

Charged particles → Tracker,

Photons → ECAL, Neutral Hadrons → HCAL

Separate calorimeter clusters at particle level

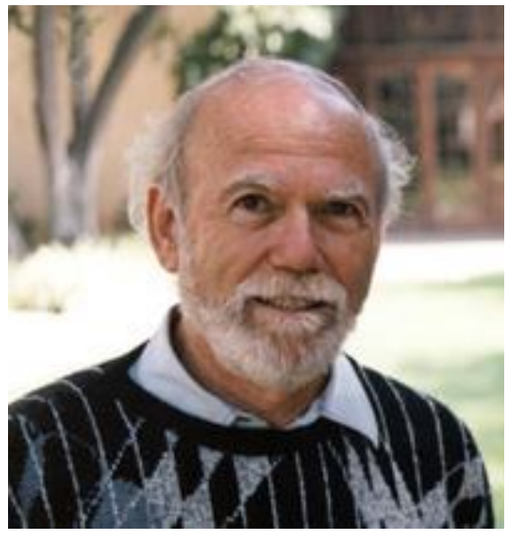
→use *best* energy measurement for *each* particle.

→offers unprecedented **jet energy resolution**

State-of-the-art detectors can be designed for ILC

Brief History of International LC Community

1965 M. Tigner proposed linear collider concept
1980s LC accelerator R&D started at DESY, KEK, SLAC , CERN, …
1990s 5 different designs: TESLA , S-band, C-band, X-band, CLIC
DESY DESY KEK SLAC/KEK CERN
1998 World-wide-studies of physics and detector for LCs was established (as a grass-root organization of Americas, Asia, Europe)
2003 International LC Steering Committee (ILCSC) formed by ICFA
2004 Selected superconducting RF for the ILC main linac by ITRP （Chair Barry Barish)
2005 Global Design Effort (GDE) was formed (Director Barry Barish)
2007 Reference Design Report



2012July Higgs Boson was discovered at LHC

Strong Motivation for ILC

2012 October A Proposal for a Phased Execution of the International Linear Collider Project was worked out (The Japan Association of HEP)

2013 March ICFA creates Linear Collider Board（LCB) (Chair: SK) and Linear Collider Collaboration (LCC) (Director: Lyn Evans)

ILC and CLIC are under the same organization

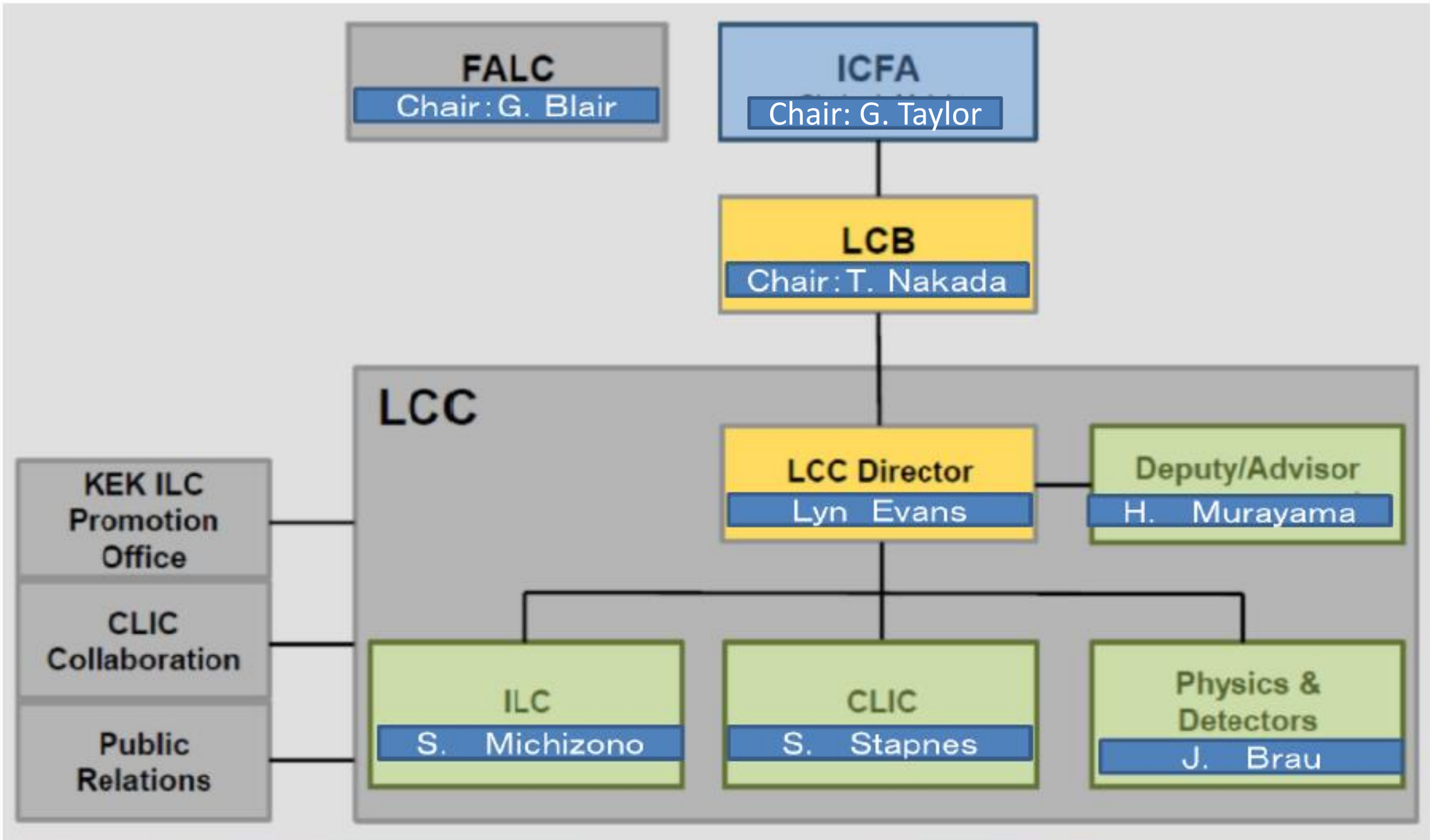
2013 June **Technical Design Report (TDR) of ILC was issued**

2016 December LHC results ⇒ Discussions on 250 GeV ILC as a Higgs Factory was started in the Linear Collider Workshop in Morioka

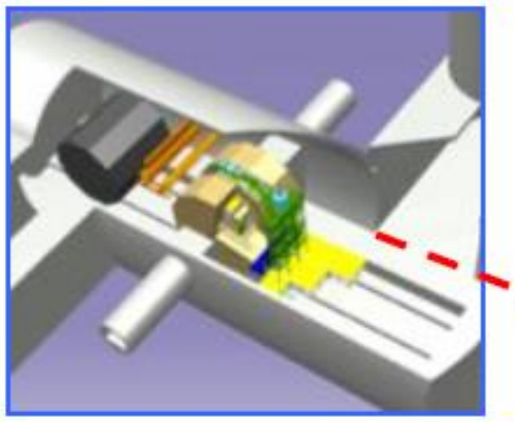
2017 July In Japan Report by the Committee on the Scientific Case of the ILC Operating at 250 GeV as a Higgs Factory (Asai Committee)

2017 November LCB/ICFA strongly supports the JAHEP proposal to construct the ILC at 250 GeV (International consensus)

LCC international structure (2018～)



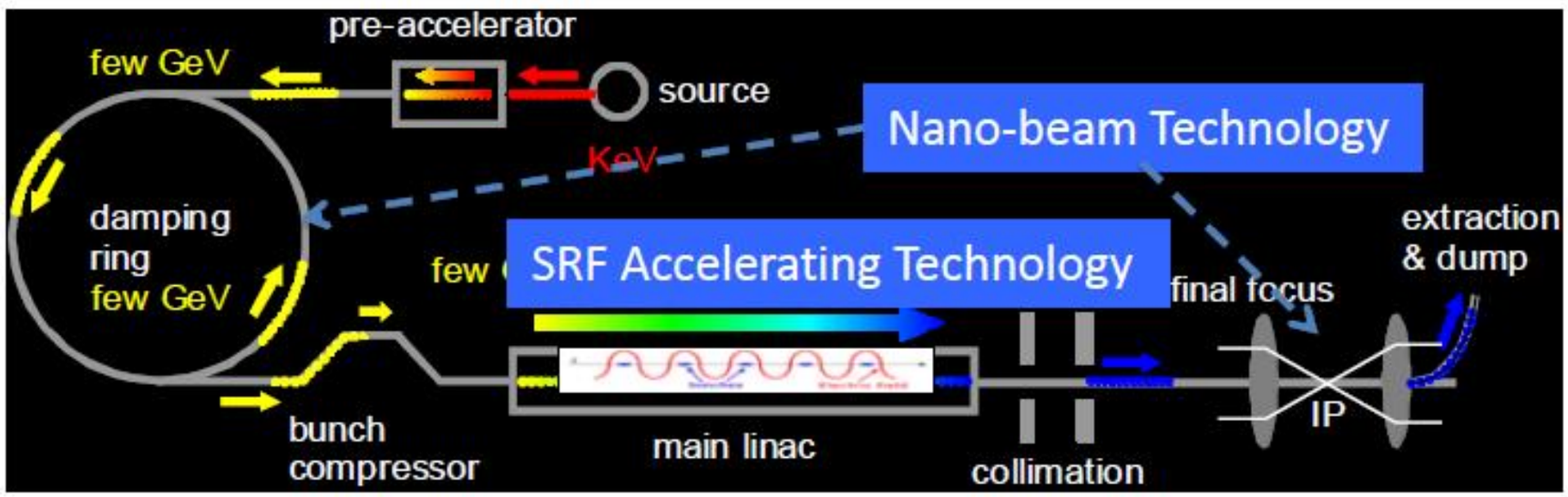
ILC250 Acc. Design Overview



Physics Detectors

Item	Parameters
C.M. Energy	250 GeV
Length	20km
Luminosity	1.35 x10^{34} $cm^{-2}s^{-1}$
Repetition	5 Hz
Beam Pulse Period	0.73 ms
Beam Current	5.8 mA (in pulse)
Beam size (y) at FF	**7.7** nm@250GeV
SRF Cavity G.	**31.5** MV/m (**35** MV/m)
Q_0	Q_0 = 1x10^{10}

Key Technologies

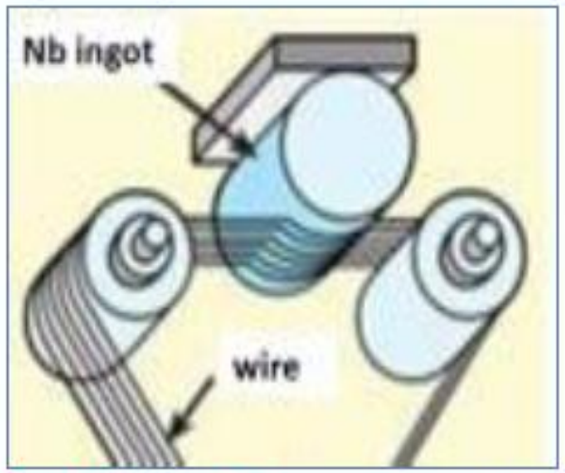


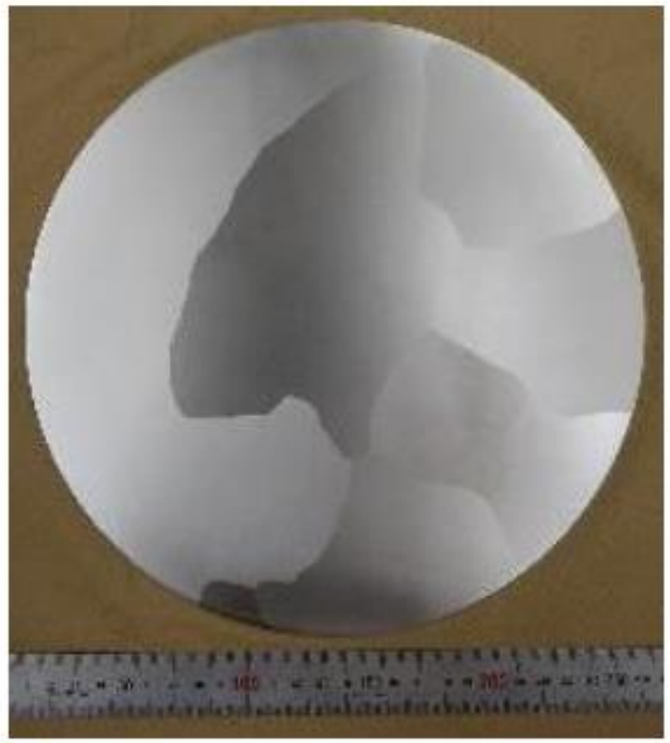
ILC Cost-Reduction R&D in US-Japan Cooperation on SRF Technology

Based on recent advances in technologies;

– Nb material/sheet by direct-slice

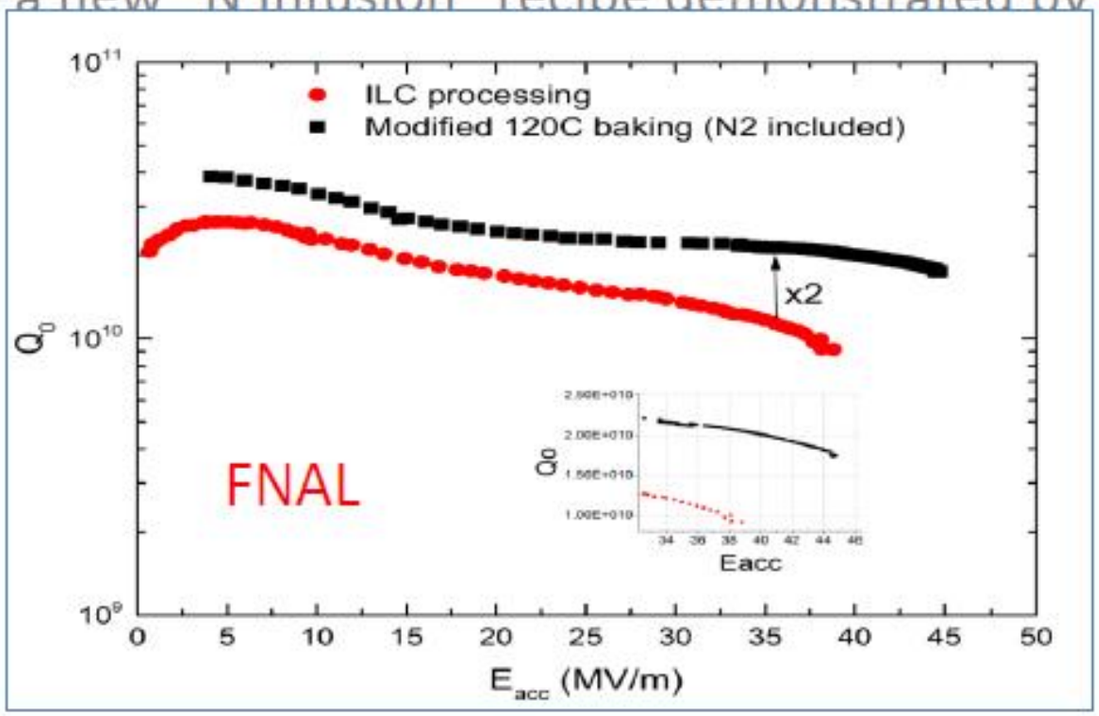
- w/ optimum Nb purity and clean surface



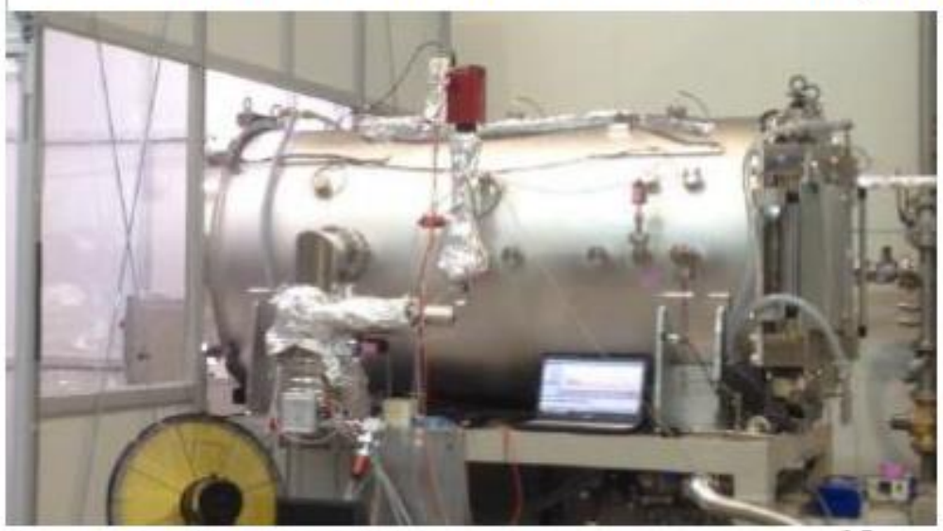


– SRF cavity fabrication for high-Q and high-G

-w/ a new "N Infusion" recipe demonstrated by **Fermilab**

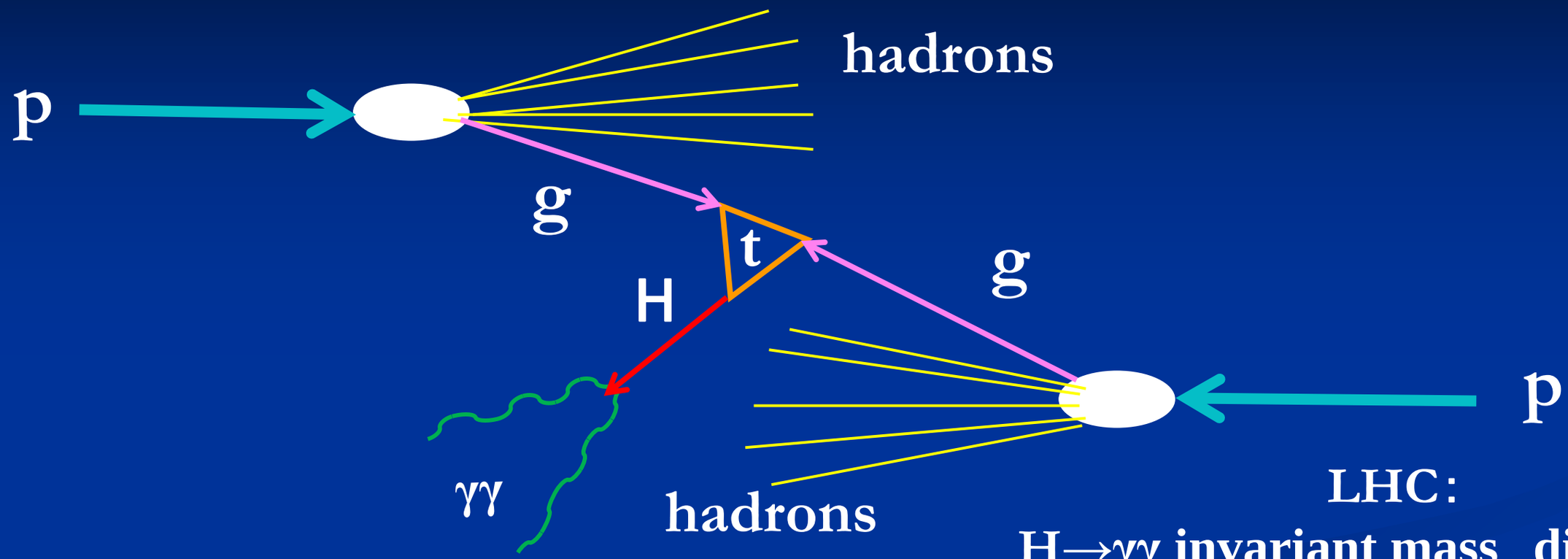


Vacuum furnace for N-infusion (KEK)



Complementarity and Synergy between LHC and ILC

Start with Higgs boson discovery at LHC

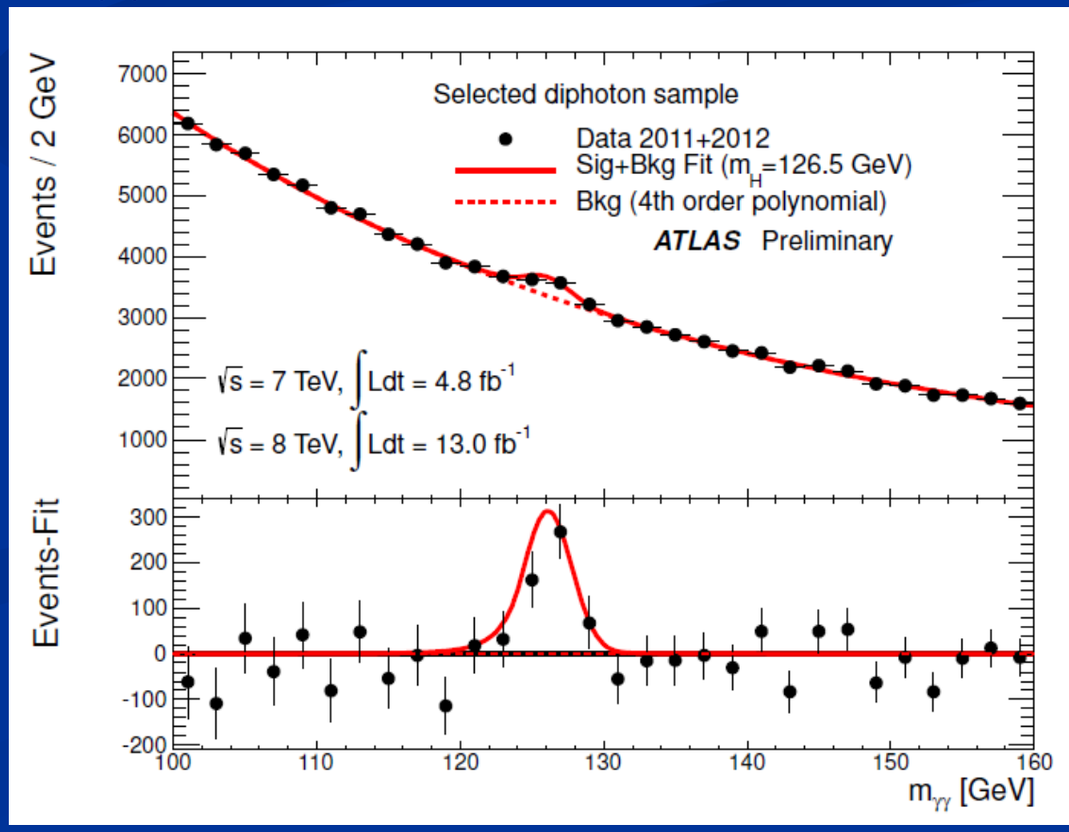


Proton is a composite particle

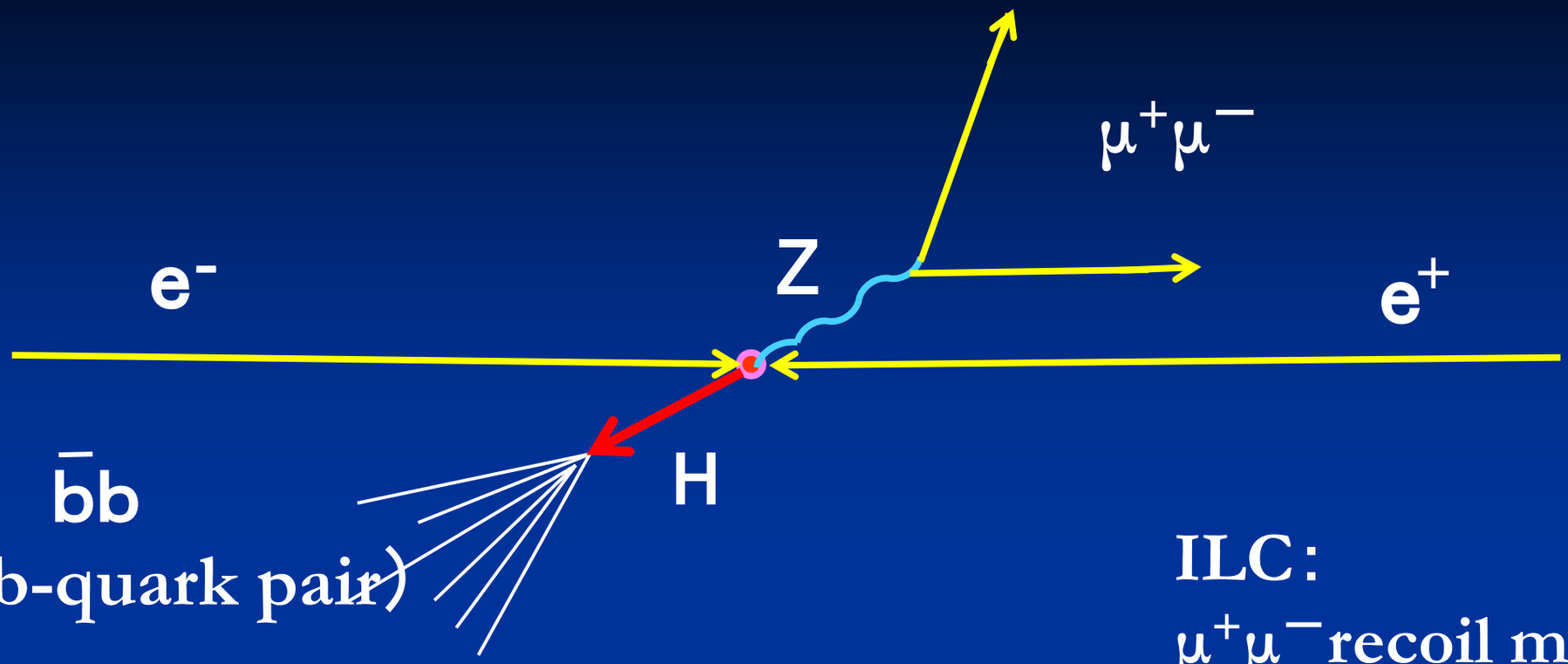
⇒ processes are complicated background level is very high radiation level and event rate are high

⇒ need high-tech detectors and powerful trigger/computing system. BUT very high energy collisions can be achieved by the current accelerator technologies.

LHC:
H→γγ invariant mass distribution

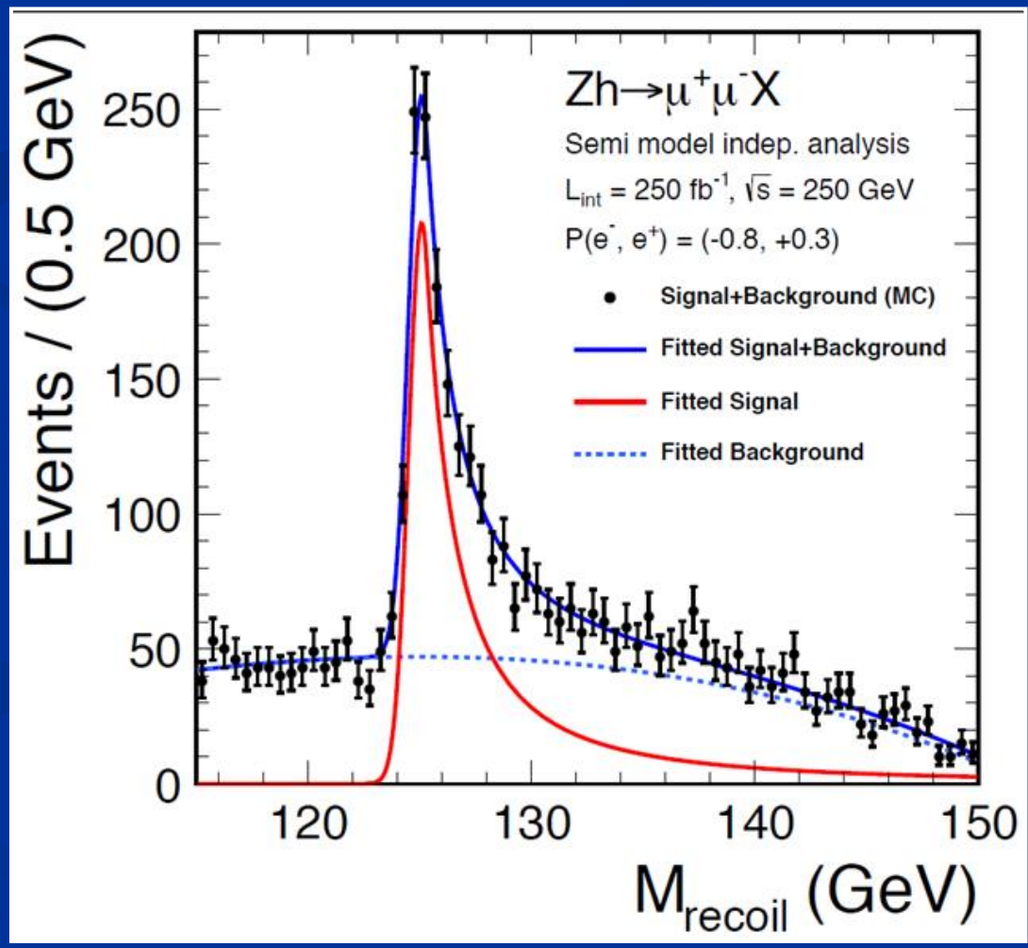


Precise measurement of Higgs Boson at ILC



ILC:
$\mu^+\mu^-$ recoil mass distribution

e^+ and e^- are pont-like elementary particles
⇒ Processes are simple and clean.
Higgs boson is produced with Z boson which we know very well from SLC/LEP studies.
⇒ Precise measurements of all decay modes are possible in the clean experimental environment ⇒ State-of-the-art detector can be build. But severe energy loss is due to synchrotron radiation for high energy ring machines. Linear Collider is inevitable.



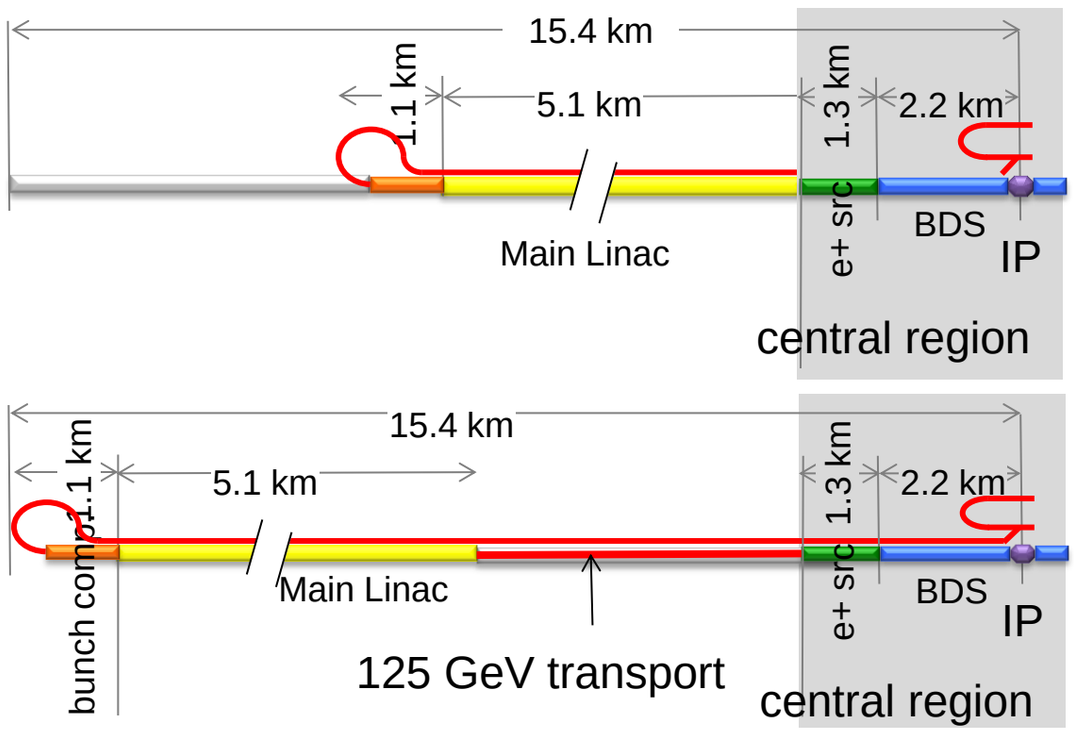
ICFA Statement on ILC Operating as a Higgs Boson Factory

.....

ICFA thus supports the conclusions of the Linear Collider Board (LCB) in their report presented at this meeting and very strongly encourages Japan to realize the ILC in a timely fashion as a Higgs boson factory with a center-of-mass energy of 250 GeV as an international project1 , led by Japanese initiative.

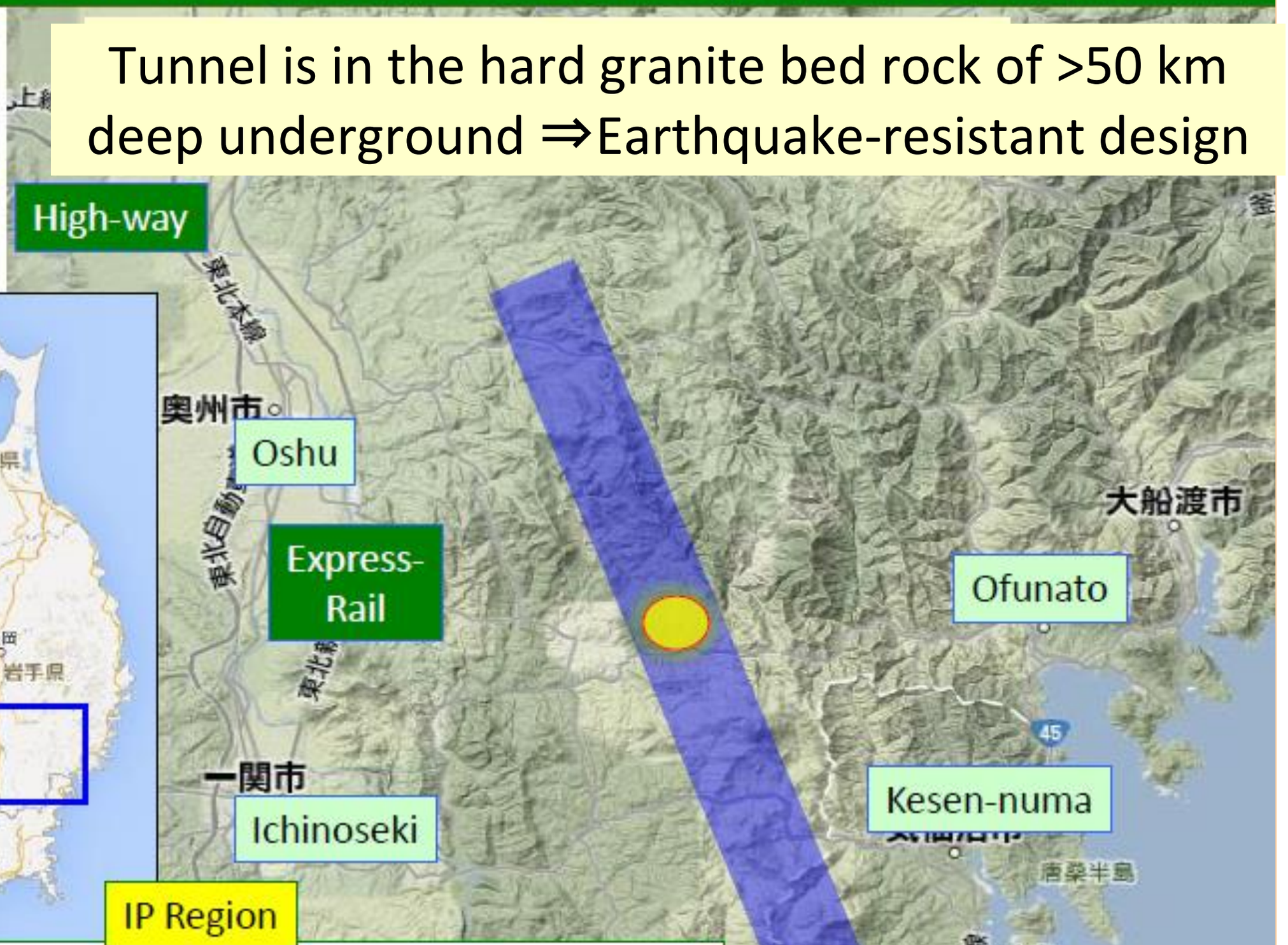
Ottawa November 2017

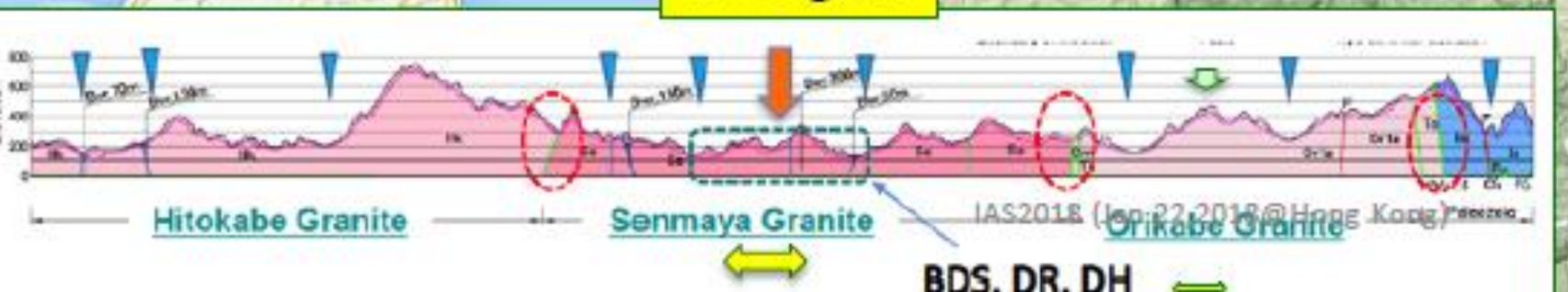
Higgs factory is very important step for the ILC.
In the same time the fascination of the linear collider is a potential of energy extendability by extending the main linac and/or using higher gradient cavities for extension. ILC can be a long term project by extending energy to TeV region.



ILC Site Candidate Location in Japan: Kitakami

Tunnel is in the hard granite bed rock of >50 km deep underground ⇒Earthquake-resistant design





Big Questions in the Particle Physics beyond SM

(1) Mechanism of the **electroweak symmetry breaking** ? ★

Text books say that the Higgs field is condensed in the vacuum, and the elementary particles interact with the field and obtain masses. However, we do not know the mechanism of the Higgs condensation.

SUSY ? Composite Higgs ???

(2) Why we have **so many free parameters in the SM** (quark and lepton masses mixing matrices, three different gauge interactions,…) ?

GUTS ? Neutrino mass (Dirac/Majorana fermion)?

(3) What is the **Dark Matter** ? ★

SUSY ? Axion (CP problem of QCD)?

(4) Why **antimatter disappeared** from the universe? ★

Leptogenesis ? EW baryogenesis ? CP in Higgs sector ?

(5) What is the **Dark Energy** ?

What was the origin of the **Inflation** of the universe ?

We know that the expansion of the universe is accelerating.

(6) How to implement **Gravity into the quantum theory** ?

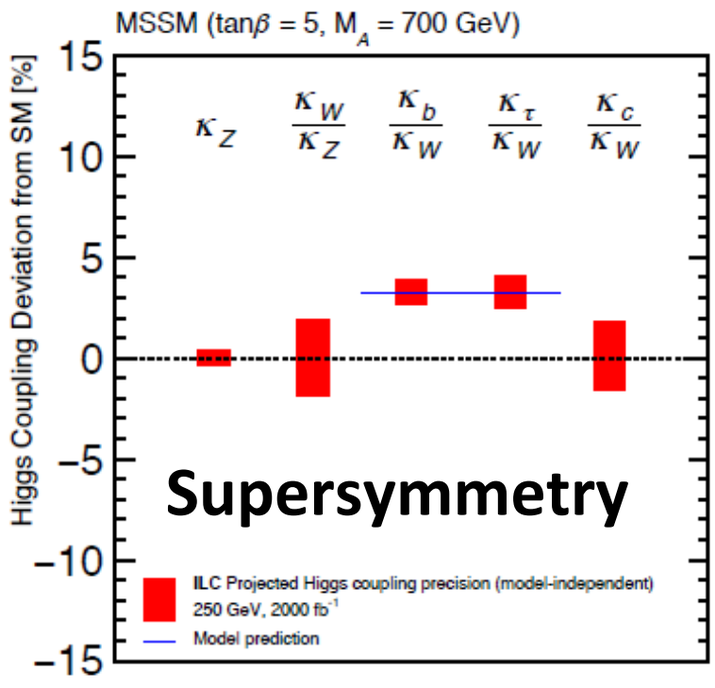
Supergarvity ?? Superstring ??

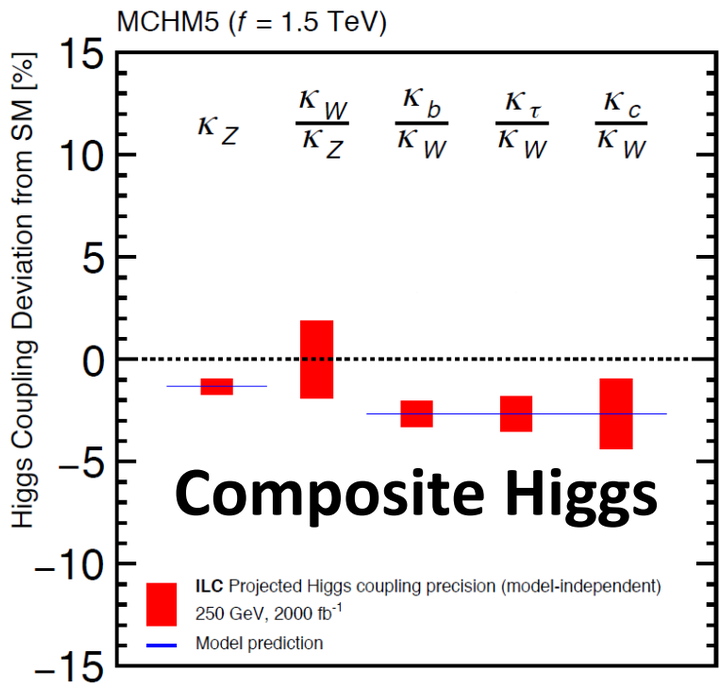
★ One of these can be discovered at ILC ⇒Paradigm shift.

Precise measurement of the Higgs Boson (window to new physics)

Measure Higgs Boson coupling to other elementary particles to search for deviations from the Standard Model predictions. Analyzing the pattern of these deviations, new physics beyond the Standard Model will be identified.

Model independent studies can be done using the Effective Field Theory. This cannot be done at LHC.





CP violation in the Higgs sector, ex. mixing in SUSY particles. … are very interesting. It may related to baryon asymmetry of the Universe.

through H—>τ⁺τ⁻ $L_{Hff} = -\frac{m_f}{v} H \bar{f} (\cos\Phi_{CP} + i\gamma^5 \sin\Phi_{CP}) f$

$\Delta\Phi_{CP} \sim 3.8°$ D.Jeans @ LCWS16

through HZZ/HWW $L_{HVV} = 2C_V M_V^2 (\frac{1}{v} + \frac{a}{\Lambda}) H V_\mu V^\mu + C_V \frac{b}{\Lambda} H V_{\mu\nu} V^{\mu\nu} + C_V \frac{\tilde{b}}{\Lambda} H V_{\mu\nu} \tilde{V}_{\mu\nu}$

(CP-odd)

$\Delta\tilde{b} \sim 0.016$ (for Λ=1TeV) T.Ogawa @ LCWS16

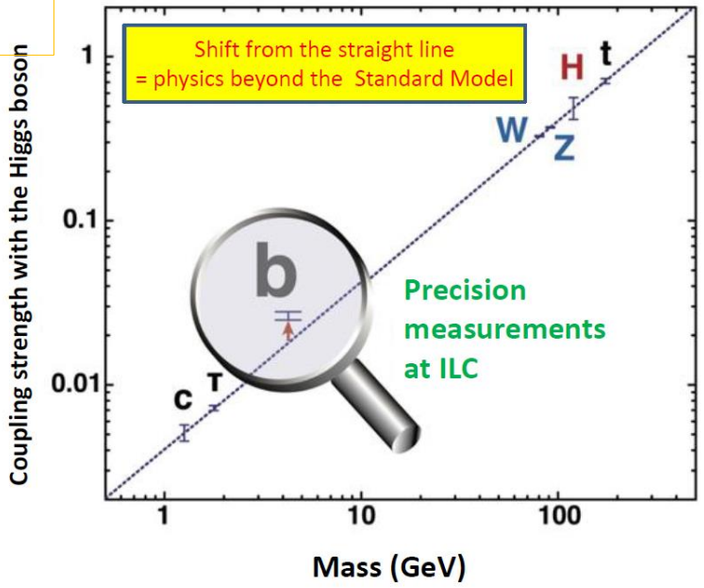
ILC is a general purpose Machine. Variety of physics is very rich.

Higgs precise measurements

- **Definitely possible at ILC**

Higgs boson is so special

Inclusive cross section : $e^+e^- \to H\ (Z \to e^+e^-)$
Inclusive cross section: $e^+e^- \to H\ (Z \to \mu^+\mu^-)$
Inclusive cross section: $e^+e^- \to H\ (Z \to q\ q)$
Z angular distribution : $e^+e^- \to H\ (Z \to e^+e^-)$
Z angular distribution :$e^+e^- \to H\ (Z \to \mu^+\mu^-)$
Z angular distribution : $e^+e^- \to H\ (Z \to q\ q)$
Partial production cross sections
$e^+e^- \to (H \to b\ b)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to c\ c)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to g\ g)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to \tau^+\tau^-)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to \mu^+\mu^-)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to W\ W)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to Z\ Z)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to$ invisible$)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to$ "exotic"$)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to b\ b)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to c\ c)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to g\ g)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to \tau^+\tau^-)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to \mu^+\mu^-)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to W\ W)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to Z\ Z)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to$ invisible$)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to$ "exotic"$)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to b\ b)\ (Z \to q\ q)$
$e^+e^- \to (H \to c\ c)\ (Z \to q\ q)$
$e^+e^- \to (H \to g\ g)\ (Z \to q\ q)$
$e^+e^- \to (H \to \tau^+\tau^-)\ (Z \to q\ q)$
$e^+e^- \to (H \to \mu^+\mu^-)\ (Z \to q\ q)$
$e^+e^- \to (H \to W\ W)\ (Z \to q\ q)$
$e^+e^- \to (H \to Z\ Z)\ (Z \to q\ q)$
$e^+e^- \to (H \to$ invisible$)\ (Z \to q\ q)$
$e^+e^- \to (H \to$ "exotic"$)\ (Z \to q\ q)$
Inclusive cross sec.: $e^+e^- \to \gamma\ H$
Photon angular dist.: $e^+e^- \to \gamma\ H$
CP effects
$e^+e^- \to (H \to \tau^+\tau^-)\ (Z \to q\ q)$
$e^+e^- \to (H \to \tau^+\tau^-)\ (Z \to e^+e^-)$
$e^+e^- \to (H \to \tau^+\tau^-)\ (Z \to \mu^+\mu^-)$
$e^+e^- \to (H \to \tau^+\tau^-)\ (Z \to \nu\ \nu)$
$H \to (W \to q\ q)\ (W \to q\ q)$
$H \to (W \to q\ q)\ (W \to l\ \nu)$
$H \to (Z \to q\ q)\ (Z \to q\ q)$
$H \to (Z \to q\ q)\ (Z \to l\ l)$
$H \to (Z \to l\ l)\ (Z \to l\ l)$



Precise measurement Elctroweak

- Definitely possible at ILC
- 3 orders of magnitude better than LEP
- Closely related to Higgs precise meas.
- Polarization is essential

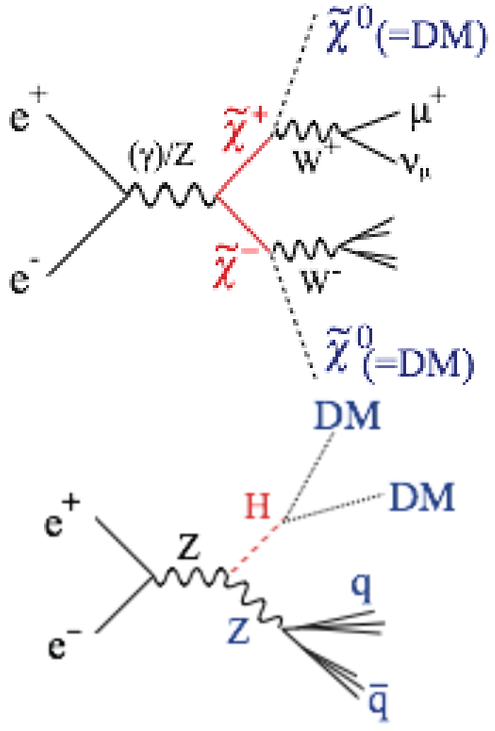
Cross section: $e^+e^- \to (W \to q\ q)\ (W \to q\ q)$
Cross section: $e^+e^- \to (W \to q\ q)\ (W \to l\ \nu)$
Cross section: $e^+e^- \to (W \to l\ \nu)\ (W \to l\ \nu)$
W boson decay branching, mass width
$e^+e^- \to (W \to q\ q)\ (W \to q\ q)$
$e^+e^- \to (W \to q\ q)\ (W \to l\ \nu)$
CP conserving triple gauge coupling
$e^+e^- \to (W \to q\ q)\ (W \to l\ \nu)$
CP violating triple gauge coupling
$e^+e^- \to (W \to q\ q)\ (W \to l\ \nu)$
Cross section : $e^+e^- \to (Z \to q\ q)\ (Z \to q\ q)$
Cross section: $e^+e^- \to (Z \to q\ q)\ (Z \to l\ l)$
Cross section: $e^+e^- \to (Z \to l\ l)\ (Z \to l\ l)$
CP conserving anomalous triple gauge boson coupling:
$e^+e^- \to (Z \to q\ q)\ (Z \to q\ q)$
$e^+e^- \to (Z \to q\ q)\ (Z \to l\ l)$
$e^+e^- \to (Z \to l\ l)\ (Z \to l\ l)$
CP violating anomalous triple gauge boson coupling :
$e^+e^- \to (Z \to q\ q)\ (Z \to q\ q)$
$e^+e^- \to (Z \to q\ q)\ (Z \to l\ l)$
$e^+e^- \to (Z \to l\ l)\ (Z \to l\ l)$
Cross section: $e^+e^- \to \gamma\ Z$
Photon angular distribution: $e^+e^- \to \gamma\ Z$
Cross section: $e^+e^- \to \gamma\ \gamma$
Angular distribution: $e^+e^- \to \gamma\ \gamma$

These are just selected examples of the physics analyses at ILC
⇒ Many PhD Theses

New particle searches

- possibility of direct observation of new particles

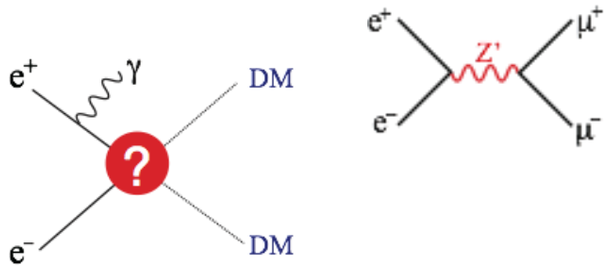
New Higgs boson searches
$e^+e^- \to (Z \to e^+e^-) + X$
$e^+e^- \to (Z \to \mu^+\mu^-) + X$
$e^+e^- \to (Z \to q\ q) + X$
$e^+e^- \to A\ H$
Singly charged Higgs boson searches
$e^+e^- \to H^-\ H^+,\ H \to \tau^+\nu,\ c\ s\ ,\ c\ b$
$e^+e^- \to W^-H^+$
Doubly charged Higgs boson searches
$e^+e^- \to W^+\ W^+ + X$
$e^+e^- \to e^+e^+ + X$ $e^+e^- \to \mu^+\mu^+ + X$
$e^+e^- \to \tau^+\ \tau^+ + X$
Ecited lepton searches
Long lived particle searches
Heavy ion particle searches
New particle searches
$e^+e^- \to e\ e\ + X$ $e^+e^- \to \mu\ \mu + X$
$e^+e^- \to \tau\tau + X$ $e^+e^- \to e\ \mu + X$
$e^+e^- \to e\ \tau + X$ $e^+e^- \to \mu\ \tau + X$
$e^+e^- \to b\ b + X$ $e^+e^- \to c\ c + X$
$e^+e^- \to q\ q + X$ $e^+e^- \to b\ c + X$
$e^+e^- \to b\ q + X$ $e^+e^- \to c\ q + X$
$e^+e^- \to g\ g + X$ $e^+e^- \to e\ q + X$
$e^+e^- \to \mu\ q + X$ $e^+e^- \to \tau\ q + X$
$e^+e^- \to W + X$ $e^+e^- \to Z + X$
$e^+e^- \to \gamma + X$



2- Fermion processes

- Possibility of new force discovery
- **Statistics is 3 times higher than LEP**
- Polarization is very important

Cross sections and angular distributions
$e^+e^- \to e^+e^-$ $e^+e^- \to \mu^+\mu^-$
$e^+e^- \to \tau^+\tau^-$
$e^+e^- \to b\ b$ $e^+e^- \to c\ c$
$e^+e^- \to s\ s$ $e^+e^- \to q\ q$
Interference between SM and new physics
Decay branching fractions of τ
Polarization of τ
Lifetime of τ
Composite particles of quark and lepton
Lepto-quarks
Search for extra-dimensions



QCD, Nuclear, Physics

- **Definitely possible at ILC**
- **Detailed understanding of bkg**
- **Important for new particle searches**

Measurement of α_S (q^2)
$e^+e^- \to b\ b,\ b\ b\ g,\ b\ b\ g\ g$
$e^+e^- \to c\ c,\ c\ c\ g,\ c\ c\ g\ g$
$e^+e^- \to q\ q,\ q\ q\ g,\ q\ q\ g\ g$

Measurement of fragmentation functions
b, c, s, q, gluon
Particle correlations in hadronic system
Production and decay of b,c,s,u,d-baryons、and mesons
Search for exotic hadrons:
tetra-quark、penta-quark、glueball、etc.
Jet production in the two photon processes
Production and decay of b,c,s,u,d-baryons and mesons in two photon preocesses
Lepton production in two photon processes

Federation of Diet members to promote a construction of international laboratory for ILC

31st July 2008 established a suprapartisan ILC supporters

Renewed on 1st Feb 2013
lead by Takeo Kawamura

(July 2008～)

President	Kaoru Yosano
Deputy	Yukio Hatoyama
Secretary-General	Takeo Kawamura
Directors	Yoshihiko Noda
Director	Norihisa Tamura
	Masamitsu Naito

Officers

Supreme advisor	(Kaoru Yosano)
President	Takeo Kawamura
Secretary-general	Tatsu Shionoya

> 130 Diet Members

White House July 2014

Supporter of Industrial Sector : Advanced Accelerator Association of Japan (AAA)

Established in June 2008 ⇒ Reformed as a general incorporated organization in 2014

Industry: ～110 companies (Mitsubishi HI、Toshiba、Hitachi、Mitsubishi Electric、Kyoto Ceramic et al.) Academy: 40 institutes (KEK, Tokyo、Kyoto、Tohoku, Kyushu, RIKEN, JAEA et al.)

AAA homepage http://aaa-sentan.org

Supreme advisor	(Kaoru Yosano)
President Emeritus	Masatoshi Koshiba
President	Takashi Nishioka (Mitsubishi HI)
Trustee	Masanori Yamauchi (KEK)
〃	Akira Maru (Hitachi)、
〃	Yasuyuki Ito (Mitsubishi Electric)
〃	Shigenori Shiga (Toshiba)、
〃	Akira Noda (Kansei University)
〃	Masayuki Inagaki (Kyoto ceramic)
Auditor	Sachio Komamiya (Waseda University)

NEW ! Coordination Council for the Realization of ILC LDP

……

In view of this cross-policy nature, it is necessary to take a budget measure separate from the normal science and technology, academic, or university budgets. We, requesting that ILC be realized as a national project, propose as follows:

1. To position ILC as a cross-policy ”national project", covering not only science, technology and innovation but also many challenges faced by the national government;

2. To secure the financial resources for the realization of ILC (beyond the Olympic Games) outside of the ordinary science and technology, academic or university budgets; and in addition,

3. To make sure that, as for the international agreement of ILC, certain critical decisions, such as the share of overseas investments be roughly half, be satisfied before the international agreement necessary for the start of construction of ILC is reached.

We resolved as above.

September 18, 2018

Liberal Democratic Party, Coordination Council for the Realization of ILC

Realize ILC as National Project with Cross-Cutting Policy

Unified HQ for Implementing Regional Revitalization

Head: Hon. Takeo KAWAMURA

HQ for Promoting National Land Resilience

Head: Hon. Toshihiro NIKAI

Research Council for Strategy on Science, Technology and Innovation

Chair: Hon. Kisaburo TOKAI

HQ for Accelerating Reconstruction from Great East Japan Earthquake

Head: Hon. Fukushiro NUKAGA

Research Council for Strategy on Intellectual Property

Chair: Hon. Akira AMARI

Coordination Council for Realization of ILC
(Representative: Hon. Takeo KAWAMURA)

(Across-party group) Science and Technology Group

Chair: Hon. Hiroyuki HOSODA

Advanced Accelerator Assoc. Promoting Science and Technology

Chair: Mr. Takashi NISHIOKA

ILC 100 People Committee

Knowledgeable Advisors

Hon. Hiroya MASUDA (former Minister for Internal Affairs)
Prof. Satoshi FUJII (Counselor, Cabinet Secretariat)
Prof. Atsushi SUNAMI (Vice President, GRIPS)

Tohoku ILC Promotion Council

Representative: Mr. Hiroaki TAKAHASHI, Prof. Hideo OHNO

ILC Supporters

(Across-party group) Federation of Diet Members in Support of ILC

Chair: Hon. Takeo KAWAMURA
Secretary General: Hon. Ryu SHIONOYA

- Academia
- Politicians
- Government officers
- Industrial leaders
- Local Government/community

⇒ to effectively push the Prime Minister's office and MOF to take positive reactions for the ILC.

Time line for the ILC Project

Years need

2 Preparation period (informal international negotiation)

4 Preparation for the construction (International Negotiation)

9 Construction

6th year - Start Installation

7th year- Start of step-by-step accelerator test

1 Beam Commissioning

>10 Physics Run (250 GeV) Including Luminosity upgrade

TBD Energy upgrade (500 GeV, 1TeV or more)

Superconducting technology for ILC Accelerator

⇒ **Superconducting Magnets、Linear Motor Car (Magnetic levitation train)、… …**

Conclusion

(1) We optimized ILC as a Higgs Boson factory. Elucidation of the identity of the Higgs Boson and the mechanism of Higgs field condensation in the vacuum are the central subject in the particle physics. Dark Matter particle or other new physics can also be discovered.

(2) The international community desperately desires the early construction of ILC.

(3) The accelerator technology of ILC is mature, it is guaranteed by the firm cooperation between DOE-MEXT.

(4) Possibility of energy upgrade is essential for ILC, hence the project can be attracted over a long period.

(5) The global project helps for the world peace.

(6) ILC will give a strong hope to the future and a vital power to the next generation.