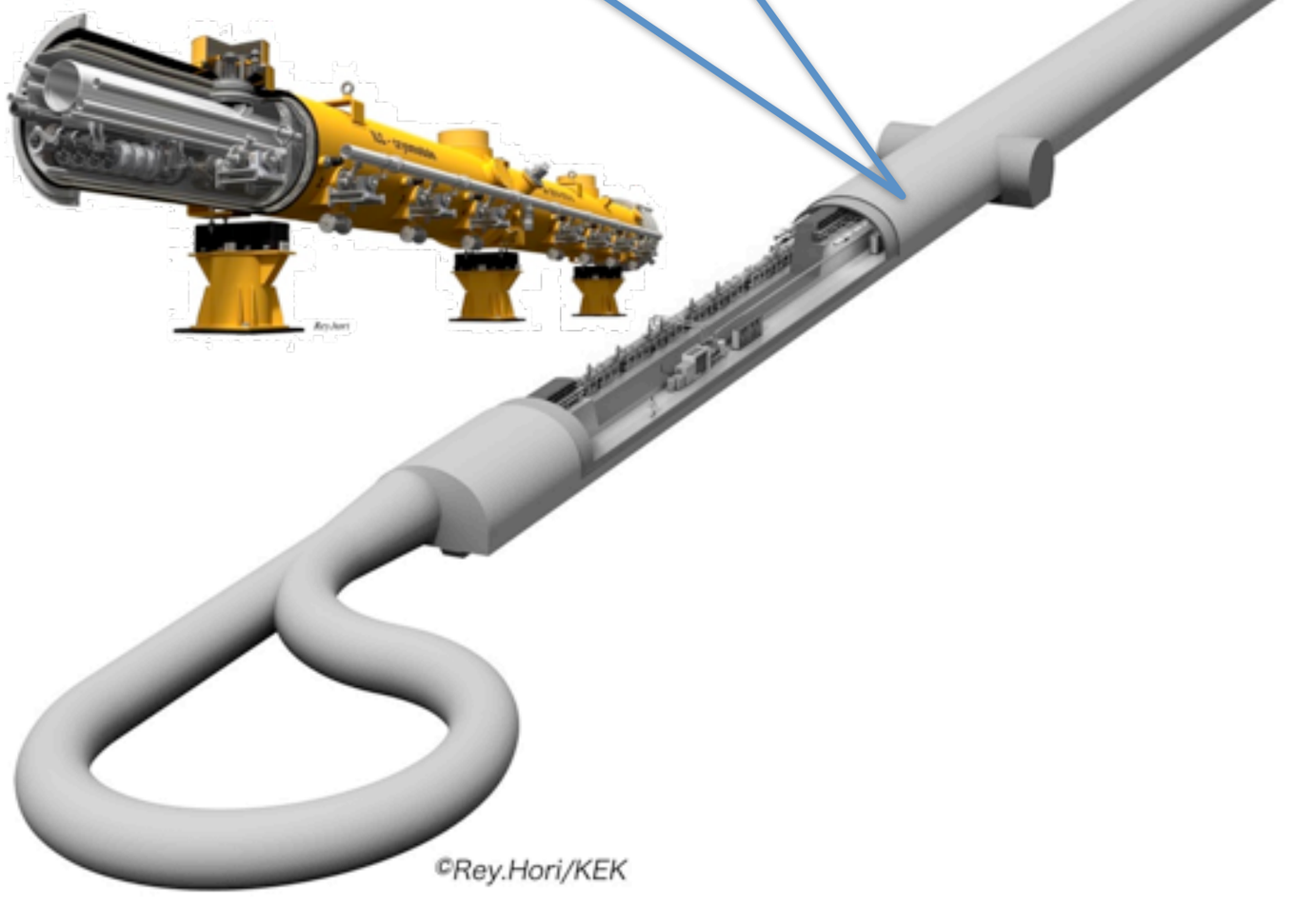
Prospects of ILC in Japan

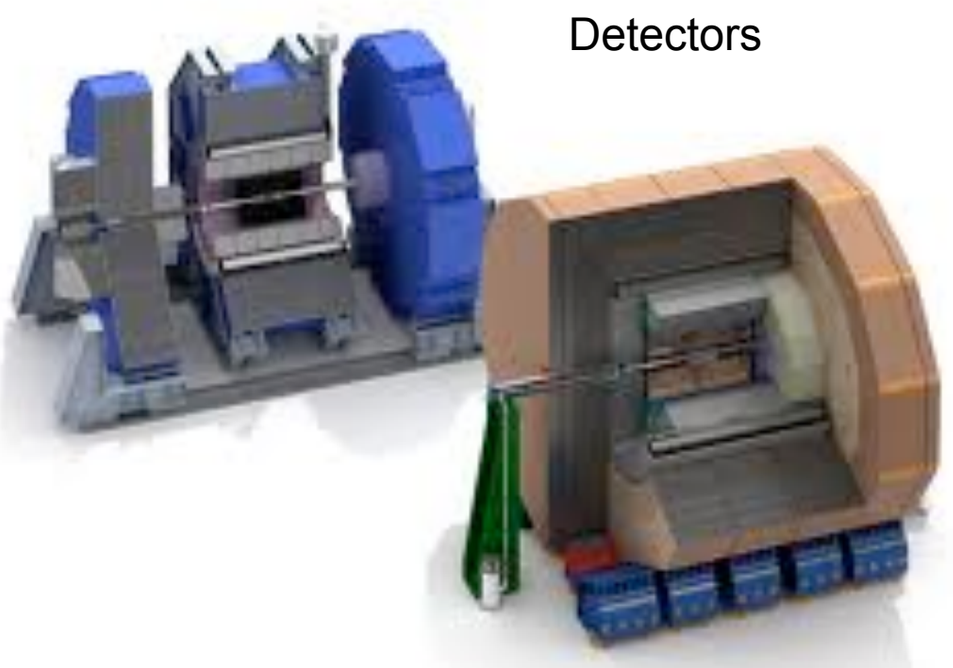
Toshinori Mori
The University of Tokyo

International Linear Collider (ILC)

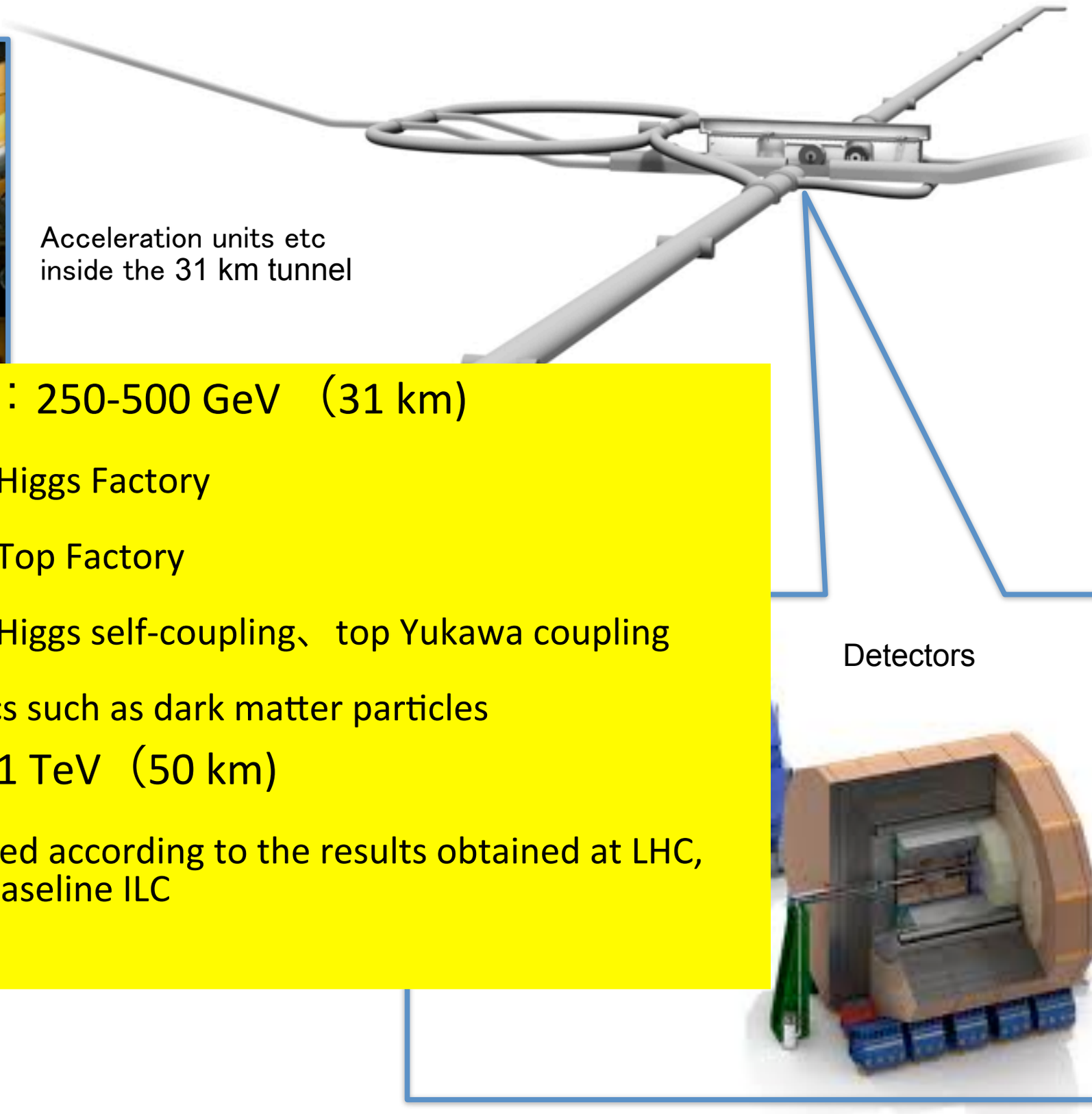
Acceleration units etc
inside the 31 km tunnel



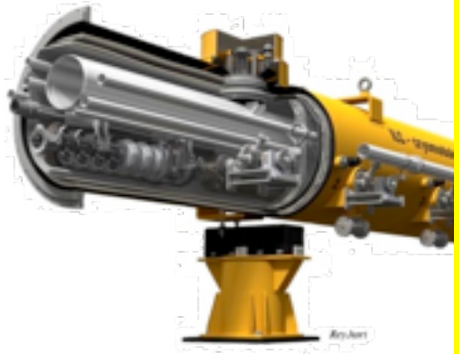
Detectors

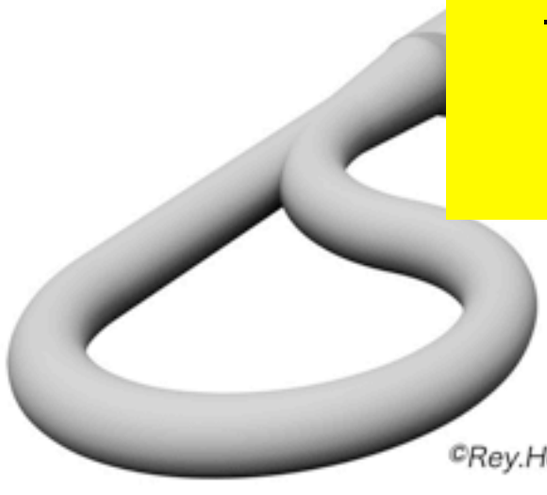


International Linear Collider (ILC)



- Baseline ILC：250-500 GeV （31 km）
  - 250 GeV：Higgs Factory
  - 350 GeV：Top Factory
  - 500 GeV：Higgs self-coupling、 top Yukawa coupling
  - New physics such as dark matter particles
- Extension：1 TeV（50 km）
  - to be decided according to the results obtained at LHC, HL-LHC & baseline ILC





2012：Year of Discoveries

- Feb：Recommendations by JAHEP Subcomm on Future Projects
- Mar：Discovery of 3rd Neutrino Oscillation (θ_{13})
- Mar：Strategies for future projects approved by JAHEP
  ILC Strategy Council started
- Apr~　Discussion started to update KEK Roadmap
- Jul：Discovery of Higgs-like Particle
- Sep：European Strategy discussion started
- Oct：JAHEP proposed to host ILC as Higgs Factory in first stage
- Oct：US Snowmass Process started
- Dec：ILC TDR (draft) completed

2012：Year of Discoveries

- Feb：Recommendations by JAHEP Subcomm on Future Projects
- Mar：Discovery of 3rd Neutrino Oscillation (θ_{13})
- Mar：Strategies for future projects approved by JAHEP
  ILC Strategy Council started
- Apr~ Discussion started to update KEK Roadmap
- Jul：Discovery of Higgs-like Particle
- Sep：European Strategy discussion started
- Oct：JAHEP proposed to host ILC as Higgs Factory in first stage
- Oct：US Snowmass Process started
- Dec：ILC TDR (draft) completed

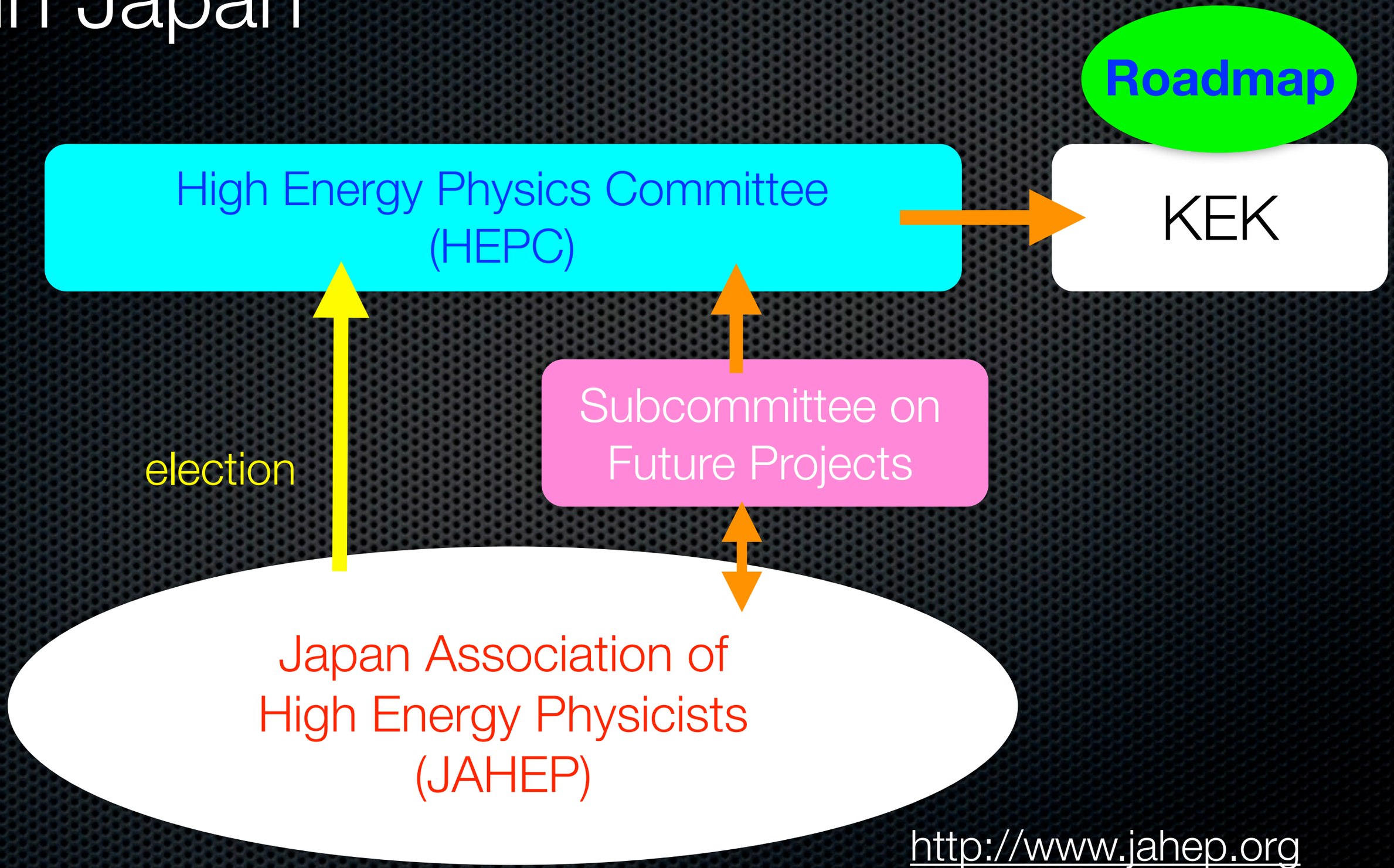
... and Preparations for Future

2012：Year of Discoveries

- Feb：Recommendations by JAHEP Subcomm on Future Projects
- Mar：Discovery of 3rd Neutrino Oscillation (θ_{13})
- Mar：Strategies for future projects approved by JAHEP
  ILC Strategy Council started
- Apr~ Discussion started to update KEK Roadmap
- Jul：Discovery of Higgs-like Particle
- Sep：European Strategy discussion started
- Oct：JAHEP proposed to host ILC as Higgs Factory in first stage
- Oct：US Snowmass Process started
- Dec：ILC TDR (draft) completed

... and
Preparations for Future

High Energy Physics Community in Japan



http://www.jahep.org

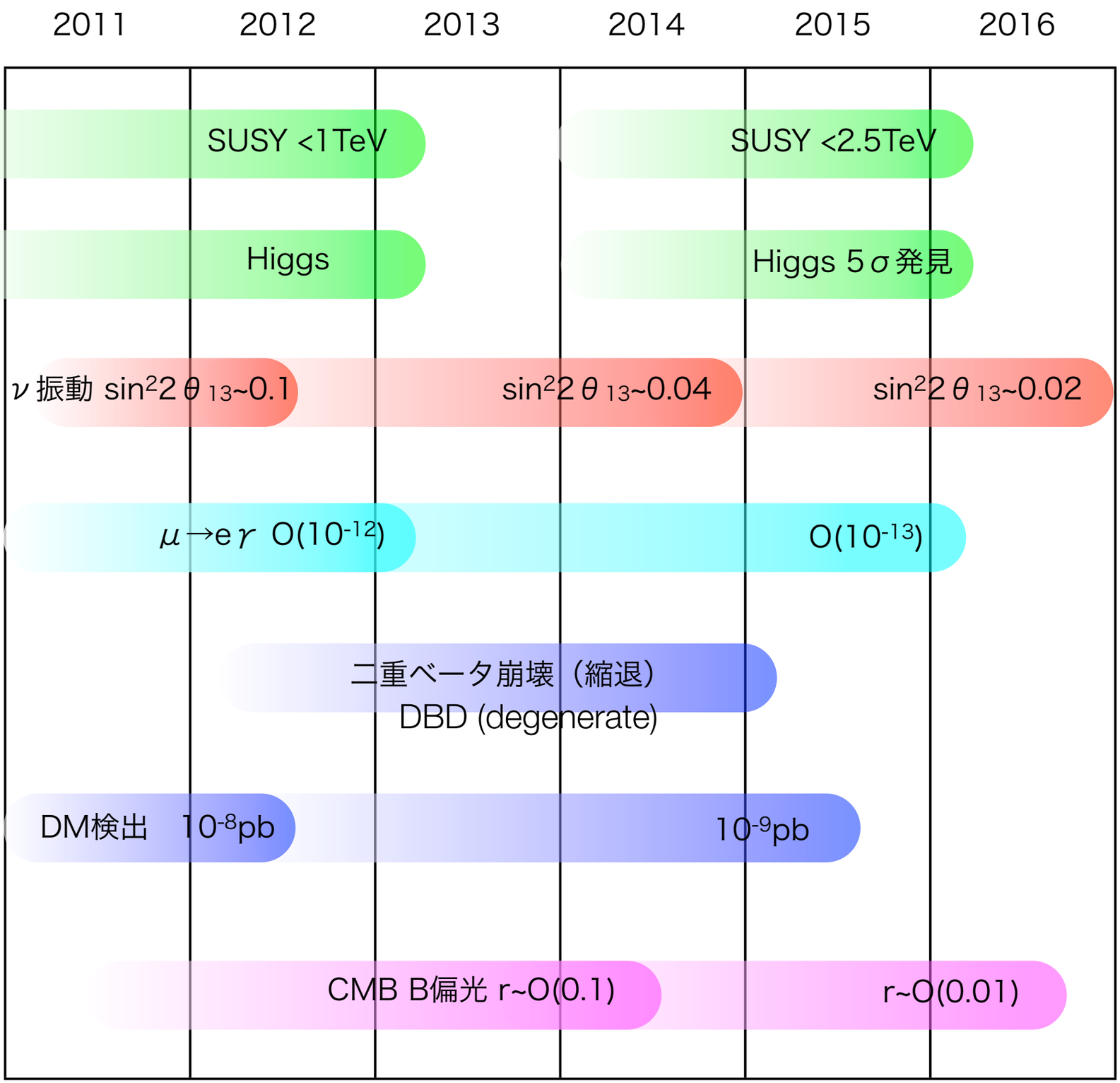
Subcommittee on Future Projects

- Appointed by HEPC after discussion at the general meeting of JAHEP in March, 2009
- Interim Recommendations (April, 2011)
  - Strategies based on scenarios w/ possible discoveries foreseen in the next 5 years
- Several town meetings for community discussions in 2011
  - Interim recommendations generally supported by community
- Final Recommendations (February, 2012)
  - Approved as the community's strategy for the future in March, 2012

http://www.icepp.s.u-tokyo.ac.jp/hecsubc/ (in Japanese)

Prospects for Discoveries as of March 2011

図1　今後数年間に期待される発見（>3σ）

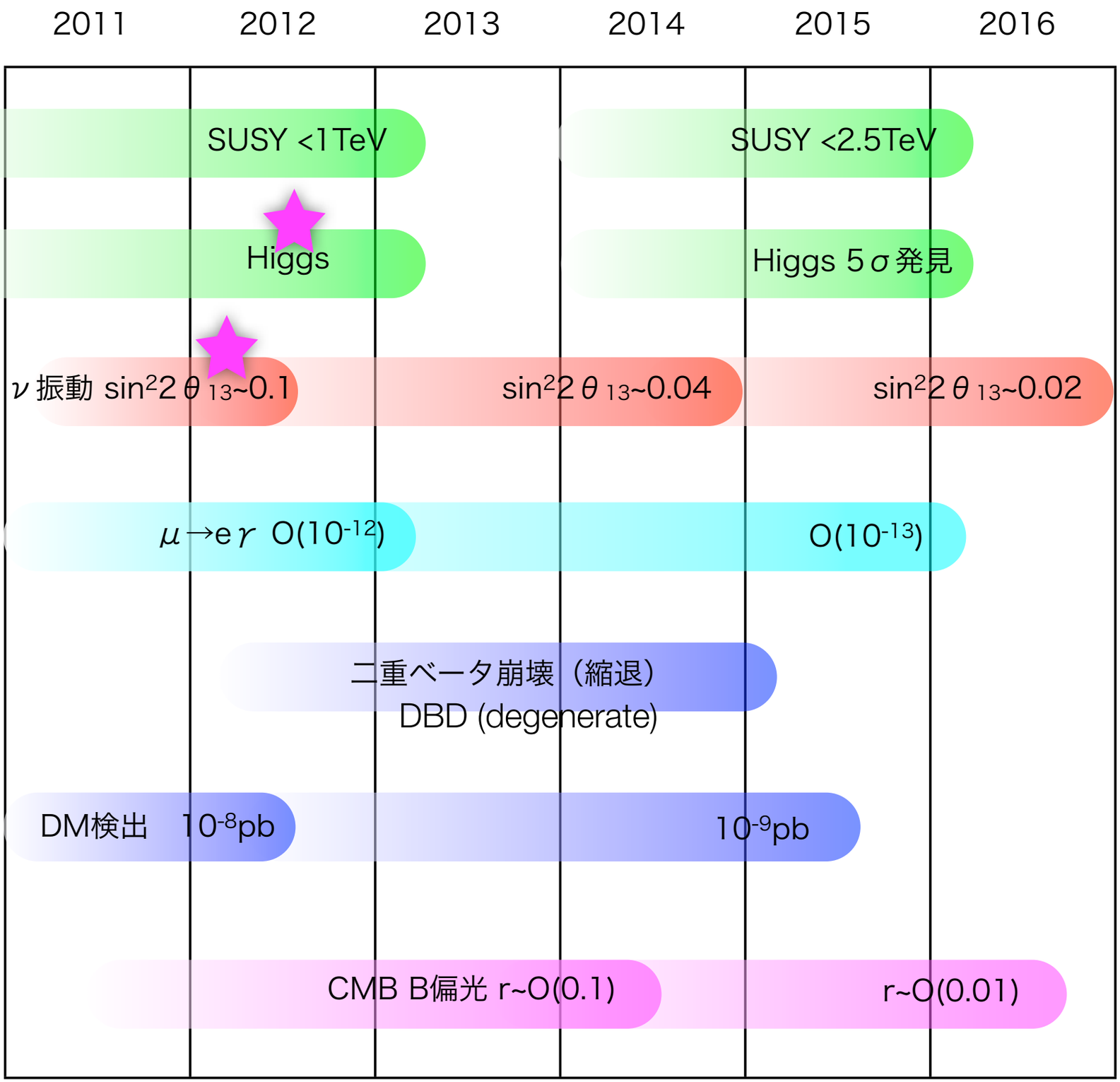


＊本小委員会が関係資料より作成した私的な予測であることに注意。

excerpt from Interim Recommendations by Subcommittee on Future Projects

Prospects for Discoveries as of March 2011

図1　今後数年間に期待される発見（>3σ）



＊本小委員会が関係資料より作成した私的な予測であることに注意。

excerpt from Interim Recommendations by Subcommittee on Future Projects

Recommendations

http://www.jahep.org/office/doc/201202_hecsubc_report.pdf

The committee makes the following recommendations concerning large-scale projects, which comprise the core of future high energy physics research in Japan.

- **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. In parallel, continuous studies on new physics should be pursued for both LHC and the upgraded LHC version. Should the energy scale of new particles/physics be higher, accelerator R&D should be strengthened in order to realize the necessary collision energy.

- **Should the neutrino mixing angle θ_{13} be confirmed as large, Japan should aim to realize a large neutrino detector through international cooperation, accompanied by the necessary reinforcement of accelerator intensity, so allowing studies on CP symmetry through neutrino oscillations.** This new large neutrino detector should have sufficient sensitivity to allow the search for proton decays, which would be direct evidence of Grand Unified Theories.

It is expected that the Committee on Future Projects, which includes the High Energy Physics Committee members as its core, should be able to swiftly and flexibly update the strategies for these key, large scale projects according to newly obtained knowledge from LHC and other sources.

It is important to complete and start the SuperKEKB including the detector, as scheduled. Some of the medium/small scale projects currently under consideration have the implicit potential to develop into important research fields in the future, such as neutrino physics and as such, should be promoted in parallel to pursue new physics in various directions. Flavour physics experiments such as muon experiments at J-PARC, searches for dark matter and neutrinoless double beta decays or observations of CMB B-mode polarization and dark energy are considered as projects that have such potential.

Recommendations

http://www.jahep.org/office/doc/201202_hecsubc_report.pdf

The committee makes the following recommendations concerning large-scale projects, which comprise the core of future high energy physics research in Japan.

- **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. In parallel, continuous studies on new physics should be pursued for both LHC and the upgraded LHC version. Should the energy scale of new particles/physics be higher, accelerator R&D should be strengthened in order to realize the necessary collision energy.

- **Should the neutrino mixing angle θ_{13} be confirmed as large, Japan should aim to realize a large neutrino detector through international cooperation, accompanied by the necessary reinforcement of accelerator intensity, so allowing studies on CP symmetry through neutrino oscillations.** This new large neutrino detector should have sufficient sensitivity to allow the search for proton decays, which would be direct evidence of Grand Unified Theories.

It is expected that the Committee on Future Projects, which includes the High Energy Physics Committee members as its core, should be able to swiftly and flexibly update the strategies for these key, large scale projects according to newly obtained knowledge from LHC and other sources.

It is important to complete and start the SuperKEKB including the detector, as scheduled. Some of the medium/small scale projects currently under consideration have the implicit potential to develop into important research fields in the future, such as neutrino physics and as such, should be promoted in parallel to pursue new physics in various directions. Flavour physics experiments such as muon experiments at J-PARC, searches for dark matter and neutrinoless double beta decays or observations of CMB B-mode polarization and dark energy are considered as projects that have such potential.

Energy Frontier

Large Projects

Neutrino

standing committee

medium/small-scale

Recommendations for Energy Frontier

Feb 2012

- **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. In parallel, continuous studies on new physics should be pursued for both LHC and the upgraded LHC version. Should the energy scale of new particles/physics be higher, accelerator R&D should be strengthened in order to realize the necessary collision energy.

Recommendations for Energy Frontier

Feb 2012

- **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. In parallel, continuous studies on new physics should be pursued for both LHC and the upgraded LHC version. Should the energy scale of new particles/physics be higher, accelerator R&D should be strengthened in order to realize the necessary collision energy.

Discovery of light Higgs-like particle in July 2012

↓

Precision study of the particle at low E (~250GeV) at ILC

Continuous studies on new physics at LHC, HL-LHC

Proposal for Phased Execution of the ILC Project

Oct 2012

In March 2012, the Japan Association of High Energy Physicists (JAHEP) accepted the recommendations of the Subcommittee on Future Projects of High Energy Physics[(1)] and adopted them as JAHEP's basic strategy for future projects. In July 2012, a new particle consistent with a Higgs Boson was discovered at LHC, while in December 2012 the Technical Design Report of the International Linear Collider (ILC) will be completed by a worldwide collaboration. ILC TDR completion

On the basis of these developments and following the subcommittee's recommendation on ILC, JAHEP proposes that ILC be constructed in Japan as a global project with the agreement of and participation by the international community in the following scenario: ILC = Global Project

(1) Physics studies shall start with a precision study of the "Higgs Boson", and then evolve into studies of the top quark, "dark matter" particles, and Higgs self-couplings, by upgrading the accelerator. A more specific scenario is as follows:

(A) A Higgs factory with a center-of-mass energy of approximately 250 GeV shall be constructed as a first phase. Higgs factory as a first phase

(B) The machine shall be upgraded in stages up to a center-of-mass energy of ~500 GeV, which is the baseline energy of the overall project.

(C) Technical extendability to a 1 TeV region shall be secured.

(2) A guideline for contributions to the construction costs is that Japan covers 50% of the expenses (construction) of the overall project of a 500 GeV machine. The actual contributions, however, should be left to negotiations among the governments.

(a translation of the official JAHEP statement, Oct 2012)

New Linear Collider Organization

← ILCSC + GDE/DBD

after TDR completion

ICFA

PAC

Linear Collider Board

S. Komamiya

Directorate

L. Evans

Deputy (Physics)

H. Murayama

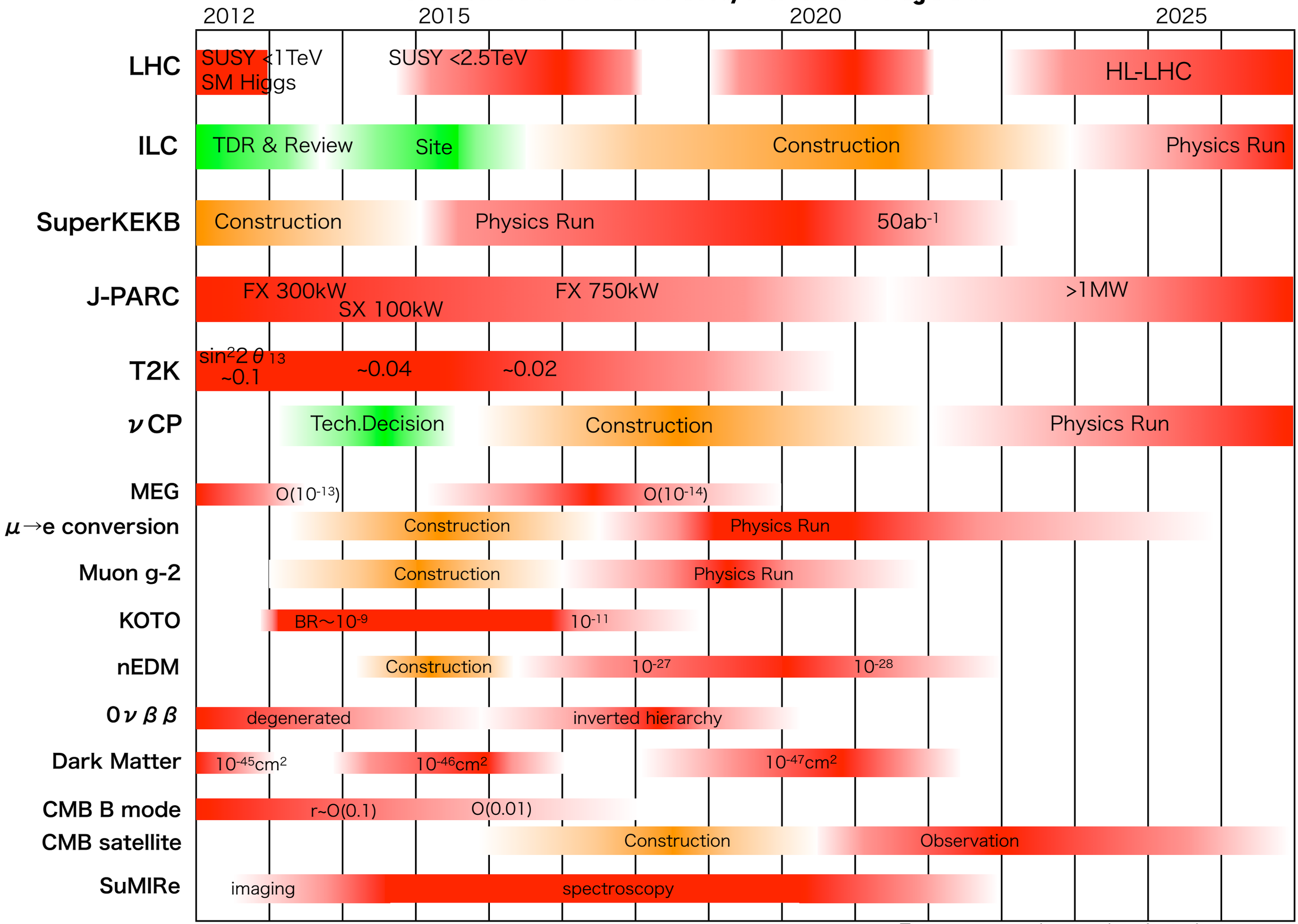
Linear Collider Collaboration

ILC

CLIC

Physics & Detectors

Timelines of Current/Future Projects



Excerpt from subcommittee's final report

Timelines of Current/Future Projects

2012 2015 2020 2025

LHC: SUSY <1TeV, SM Higgs | SUSY <2.5TeV | HL-LHC

ILC: TDR & Review | Site | Construction | Commission

SuperKEKB: Construction | Physics Run | 50ab^{-1}

J-PARC: FX 300kW, SX 100kW | FX 750kW | >1MW

T2K: $\sin^2 2\theta_{13}$ ~0.1 | ~0.04 | ~0.02

νCP: Tech.Decision | Construction | Physics Run

MEG: O(10^{-13}) | O(10^{-14})

$\mu \rightarrow$e conversion: Construction | Physics Run

Muon g-2: Construction | Physics Run

KOTO: BR~10^{-9} | 10^{-11}

nEDM: Construction | 10^{-27} | 10^{-28}

$0\nu\beta\beta$: degenerated | inverted hierarchy

Dark Matter: 10^{-45}cm^2 | 10^{-46}cm^2 | 10^{-47}cm^2

CMB B mode: r~O(0.1) | O(0.01)

CMB satellite: Construction | Observation

SuMIRe: imaging | spectroscopy

Excerpt from subcommittee's final report

Updating KEK Roadmap

- A bottom-up process going on
  - KEK = Inter-University Research Institute Corporation
- Based on inputs from relevant scientific communities:
  - HEP, nuclear physics, synchrotron radiation research, neutron science, muon science
- A new roadmap “KEK Roadmap 2013” is scheduled be published in March 2013

Quest for Birth-Evolution of Universe

International Linear Collider（ILC）

Quest for Unifying Matter and Force

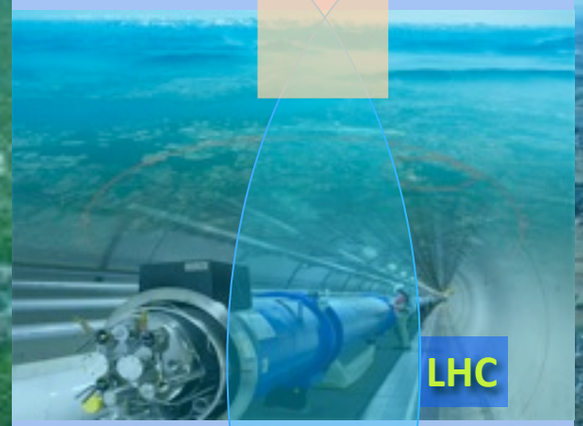
Present “KEK Roadmap”

Lepton CP Asymmetry

Physics Beyond CKM Matrix

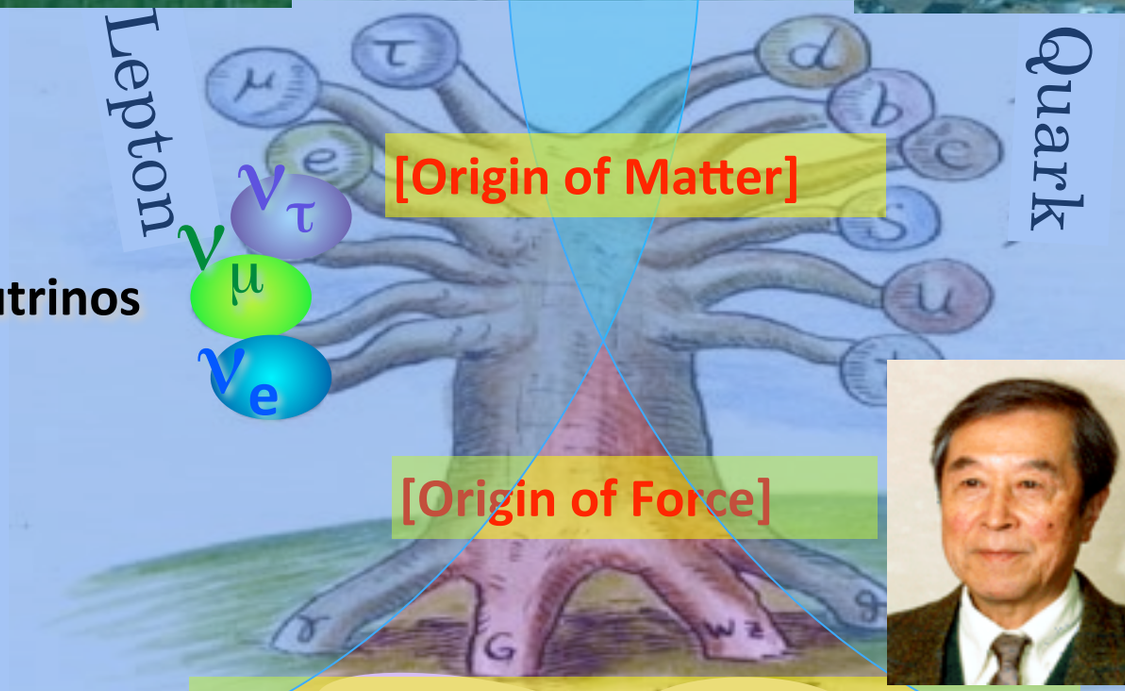
Power-Upgrade

Super-KEKB



Quark CP Asymmetry

Quest for Neutrinos



[Origin of Matter]

[Origin of Force]

Higgs Particle [Origin of Mass]

Quest for 6 Quarks

Quest for Birth-Evolution of Universe

International Linear Collider（ILC）

Quest for Unifying Matter and Force

Present “KEK Roadmap”

Lepton CP Asymmetry

Physics Beyond CKM Matrix

Power-Upgrade

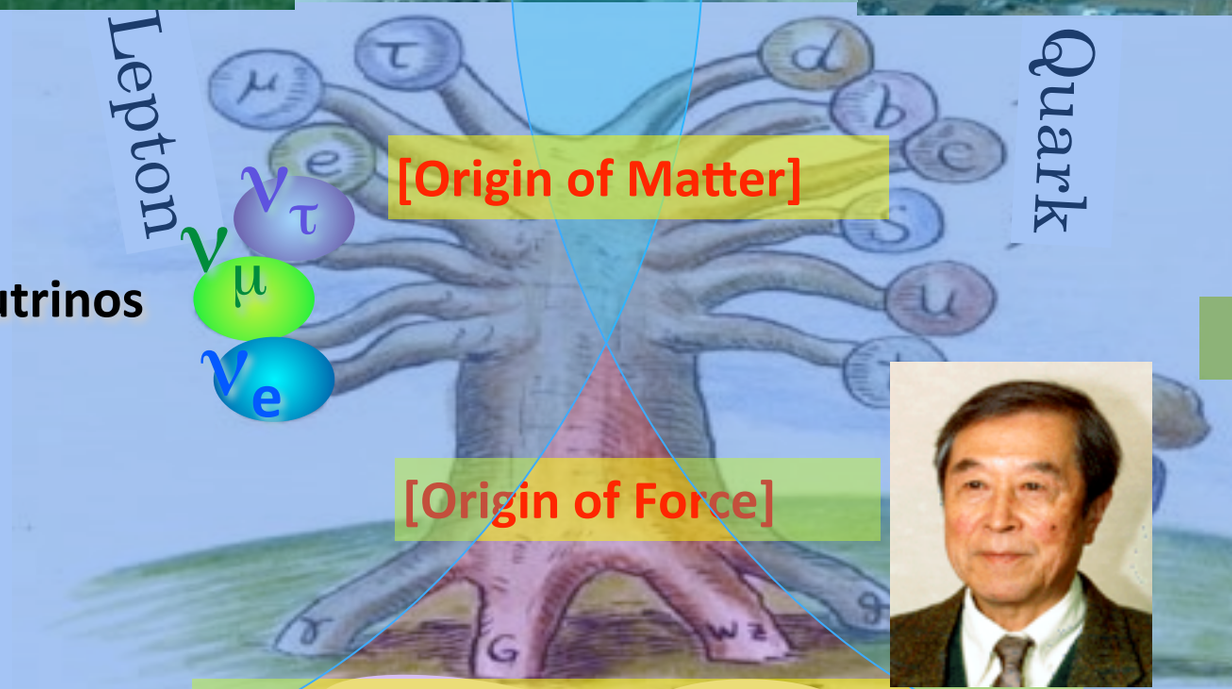
Super-KEKB

Discovery of 3rd ν Oscillation

Discovery of Higgs

Quark CP Asymmetry

Quest for Neutrinos



[Origin of Matter]

Quest for 6 Quarks

[Origin of Force]

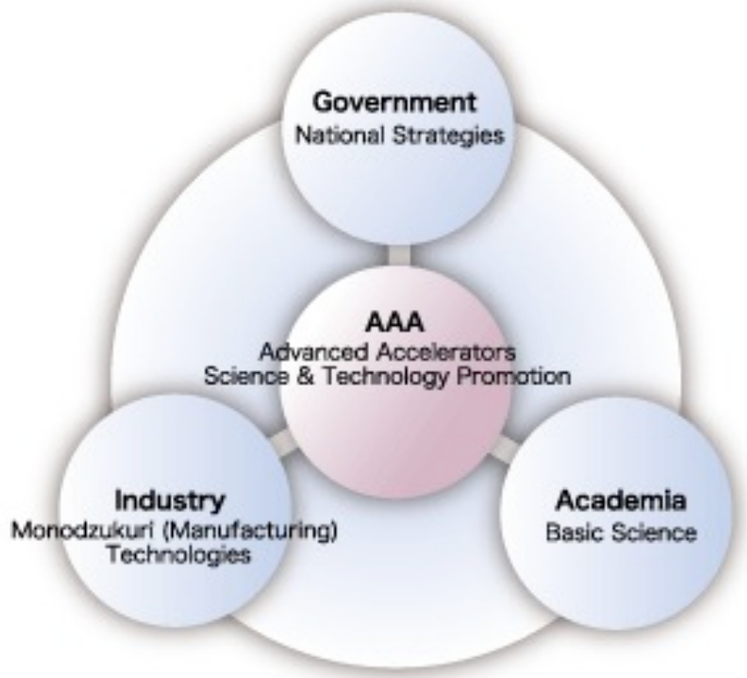
Higgs Particle [Origin of Mass]

Prospects outside the HEP community

- "Master Plan" of large projects by Science Council of Japan
- Politicians/Govn't officials/Industry :
  - Want to have a global center of excellence in science & technology - an idea to build a new S&T city
  - ILC is unique in a sense that it is a truly global scientific project which attracts many brains from all over the world
- Industry: Advanced Accelerator Association
- Politicians: Federation of Diet Members for ILC

Advanced Accelerator Association - Promoting Science & Technology

Established in 2008 to promote accelerator research and ILC. Members include 91 corporations (e.g. Kyocera, Hitachi, Mitsubishi Electric, Mitsubishi Heavy Industries, Toshiba) and 38 universities and institutions.



http://www.aaa-sentan.org/

Takashi Nishioka, Chairman
Former Chairman of the Board, MHI

Kaoru Yosano, Supreme Advisor
Former Minister of Finance, MEXT,
Former Chief Cabinet Secretary

Masatoshi Koshiba, Honorary Chairman
Professor Emer., The University of Tokyo

Atsuto Suzuki, Trustee
Director General, KEK

Federation of Diet Members for ILC

In 2006, members from LDP members established the Federation of Diet members for ILC. In 2008, expanded into "**Joint Federation**" including LDP, DPJ, New Komeito, …
Aims to promote accelerator R&D and Japanese bid for ILC if supported by global society

Core Members of the Federation + AAA Directorates

Annual Symposium jointly hosted by AAA + Federation (Dec 15, 2011)
Prime Minister Yoshihiko Noda was a speaker.

First general meeting after the election in February 1

The campaign pledges of the Liberal Democratic Party

日本を

The campaign pledges of the Liberal Democratic Party

32　科学技術政策の強力な推進力となる真の「司令塔」機能の再構築

資源の少ないわが国にとって、今後の社会・経済をさらに発展させるため、企業の研究開発投資が激減する中、新たな成長に向けて国主導で科学技術イノベーションをリードするのが喫緊の課題です。

しかし、年間約 3.6 兆円にも及ぶ科学技術関係予算については、文部科学省を中心に、経済産業省や厚生労働省等、関係省庁に予算が配分され、各省内で同様な研究が行われている事例も見受けられ、縦割りの弊害が顕著です。また、限られた予算にも関わらず、効果的な配分が行われていないのが現状です。

そこで、産業の生命線である科学技術を国家戦略として推進し、「価値の創造拠点」とするべく、総合科学技術会議の「権限」「体制」「予算システム」を抜本的に強化し、真の「司令塔」機能へと再構築します。

具体的には、各省庁の縦割りを排し、強力な予算配分権限を集中させ、適正な評価を行うことができる人材育成とシステムの構築を行います。例えば、素粒子物理分野の大規模プロジェクトである ILC（国際リニアコライダー※研究所建設）計画等を含む国際科学イノベーション拠点作りに日本が主導的な役割を果たせるなど、再生医療※や創エネ・省エネ・蓄エネ等の重点分野を産学の知を結集した国家戦略として強力に推進

92　世界に冠たる研究開発拠点の形成

イノベーションを生み出していくためには、大学や公的研究機関、産業界等が集い、協働で研究開発に取り組む「場」の構築が必要です。特に、わが国の強みを有する分野において、地域資源等も柔軟に活用しつつ、オープン・イノベーションに対応した「競争」と「協調」による世界最先端の研究開発拠点を形成します。

わが国が世界の頭脳の獲得における中核的な地位を占めていくためには、国内のみならず海外の優れた研究者を惹きつける国際的な研究ネットワークの拠点形成が不可欠であり、「世界トップレベル研究拠点（WPI）」の大幅な拡充や、素粒子分野の大規模プロジェクトである ILC（国際リニアコライダー研究所建設）計画等を含む国際科学イノベーション拠点作りに日本が主導的な役割を果たすなど、世界水準をしのぐ優れた研究活動を行う大学や公的研究機関などに対する支援を抜本的に強化します。

The campaign pledges of the Liberal Democratic Party

日本を

32　科学技術政策の強力な推進力となる真の「司令塔」機能の再構築

資源の少ないわが国にとって、今後の社会・経済をさらに発展させるため、企業の研究開発投資が激減する中、新たな成長に向けて国主導で科学技術イノベーションをリードするのが喫緊の課題です。

しかし、年間約 3.6 兆円にも及ぶ科学技術関係予算については、文部科学省を中心に、経済産業省や厚生労働省等、関係省庁に予算が配分され、各省内で同様な研究が行われている事例[redacted]た、限られた予[redacted]ないのが現状で[redacted]して推進し、「価[redacted]の「権限」「体制[redacted]司令塔」機能へと[redacted]

具体的[redacted]配分権限を集中[redacted]とシステムの構[redacted]規模プロジェクトであるILC（国際リニアコライダー※研究所建設）計画等を含む国際科学イノベーション拠点作りに日本が主導的な役割を果たせるなど、再生医療※や創エネ・省エネ・蓄エネ等の重点分野を産学の知を結集した国家戦略として強力に推進

"... strongly promote important areas of science and technology as a national strategy so that Japan can play a leading role in creating global centers of science and technology including the ILC … through cooperation between industry and science."

92　世界に冠たる研究開発拠点の形成

イノベー[redacted]公的研究機関、産業[redacted]「場」の構築が必要[redacted]において、地域資源等[redacted]ションに対応した「[redacted]究開発拠点を形成し[redacted]

わが国が[redacted]占めていくためには、[redacted]きっける国際的な研[redacted]世界トップレベル研[redacted]分野の大規模プロジェクトである ILC（国際リニアコライダー研究所建設）計画等を含む国際科学イノベーション拠点作りに日本が主導的な役割を果たすなど、世界水準をしのぐ優れた研究活動を行う大学や公的研究機関などに対する支援を抜本的に強化します。

"In order for our country to become a central core in gaining the brains of the world, it is indispensable to create an international research network which can attract top-level researchers, … playing a central role in creating global centers for scientific and technological innovations such as the ILC …"

Japan Policy Council ; Business

Japan Policy Council: experts in policy making, economics, labor, or sociology aiming to create a grand design of Japan for the next decade.
http://www.policycouncil.jp/

Hiroya Masuda, Chairman
Professor at The University of Tokyo, former Minister of MIC, and former Governor of Iwate Prefecture

Recommendations: **"Creation of Global Cities by hosting the ILC" (Jul 2012)**

"Japan should revitalize its provincial cities to revitalize Japan itself…"

"… explore 'Domestic Globalization' taking advantage of the opportunity of Japan's possible bid to host the International Linear Collider…"

Business communities in support of ILC:

Japan Chamber of Commerce and Industry

日本商工会議所
The Japan Chamber of Commerce and Industry

Japan Association of Corporate Executives

KEIZAI DOYUKAI

公益社団法人 経済同友会
Japan Association of Corporate Executives

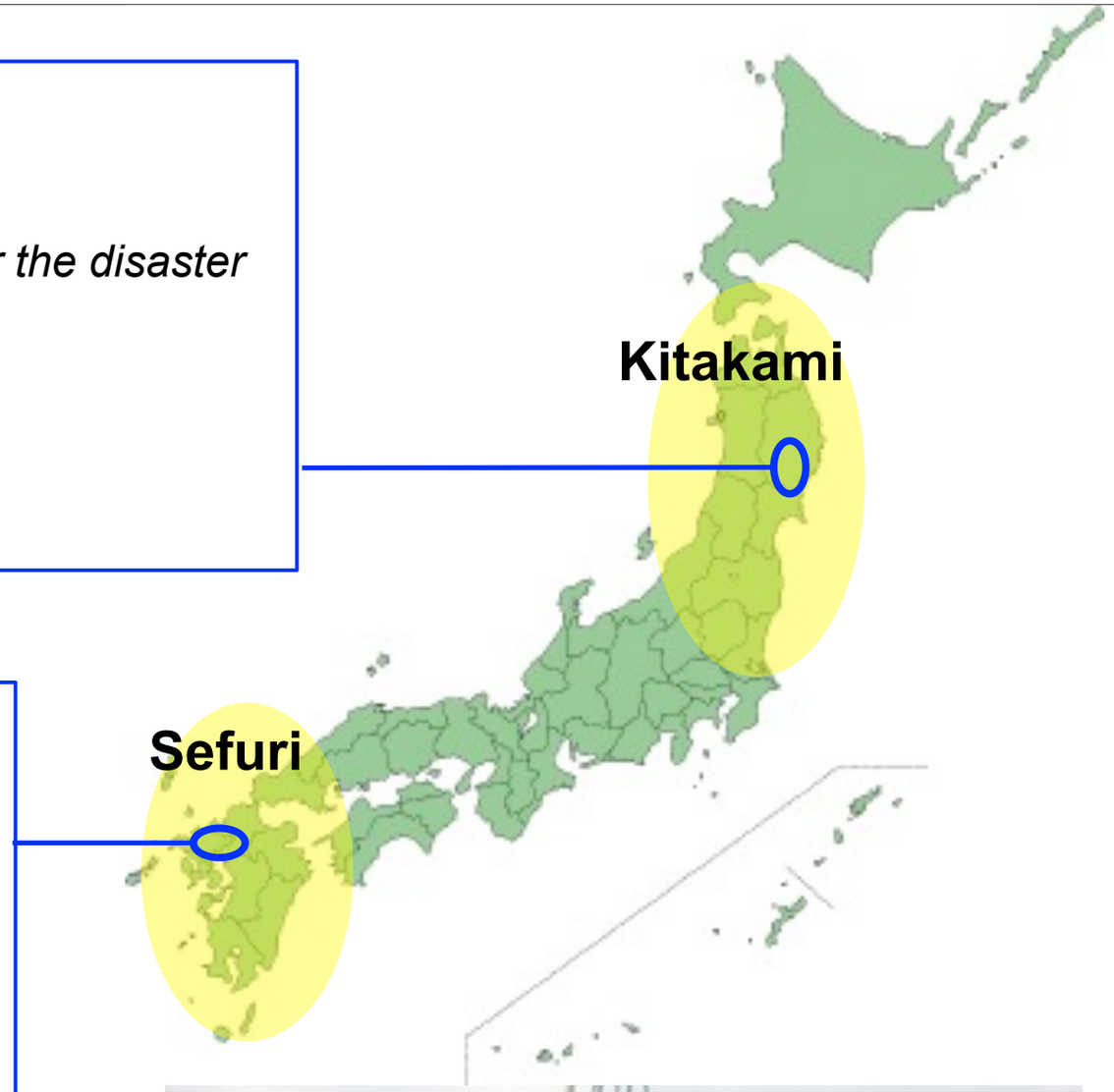
Candidate Sites

Kitakami site in **Tohoku** region

- **Iwate** and **Miyagi** Prefectures + all Tohoku area
  - *Local governments officially proposed ILC as a core project for the disaster recovery effort.*
- **Tohoku University**
- **Tohoku Economic Federation**

Sefuri site in **Kyushu** region

- **Saga** and **Fukuoka** Prefectures
  - Expanded efforts in all Kyushu, and Yamaguchi, Okinawa
- **Kyushu University** and **Saga University**
- **Kyushu Economic Federation**



Japanese government approved supplementary budget for geological survey for ILC (Dec. 2011)

Decision expected this year

Prospects
global HEP community

A consistent strategy of global HEP community must be formed

- European Strategy discussion ongoing
  - Discussion at Krakow Open Symposium
    - Japan's proposal of phased ILC generally warmly welcomed
  - Supporting statements from France and Germany
  - Discussion at CERN SPC
- US "Snowmass 2013" process through next summer

“Proposed Update of European Strategy”

International Linear Collider (ILC)

e) 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*.

Prospects of ILC in Japan

- Various efforts ongoing in Japan to realize ILC as a global project may possibly bore fruits soon
- A strong support from the global HEP community is essential for success
  - European Strategy, Snowmass Process
- Get set for the future !