Japanese Roadmap for the Future of HEP

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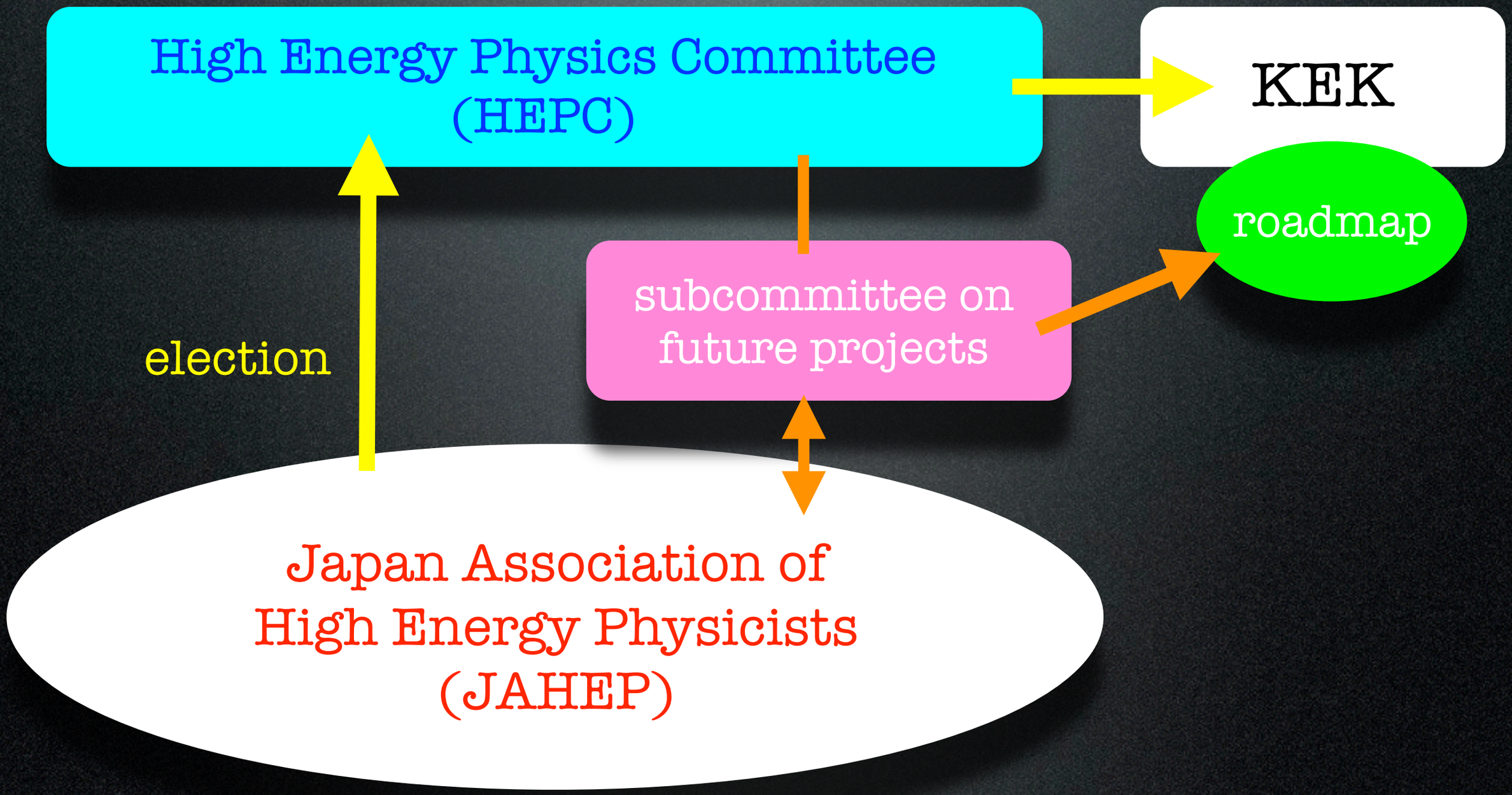
High Energy Physics Community in Japan



Subcommittee on Future Projects

- Appointed by HEPC after discussion at the general meeting of JAHEP in spring, 2009
- Charge:
  - Report on Japan's future projects in the time scale of more than 10 years into future
  - Based on physics importance; also consider global trends/prospects
  - Include non-accelerator experiments

http://www.icepp.s.u-tokyo.ac.jp/hecsubc/

(in Japanese)

Committee members

- S. Asai/Tokyo, T. Iijima/Nagoya, K. Ishii/KEK,
  K. Inoue/Tohoku, Y. Ushiroda/KEK,
  Y. Ohnishi/KEK, J. Hisano/Nagoya,
  M. Kuriki/Hiroshima, T. Kobayashi/KEK,
  Y. Kubota/KEK, T. Nakaya/Kyoto, M. Nojiri/KEK,
  T. Nomura(secretary)/KEK, M. Hazumi/KEK,
  K. Hanagaki(secretary)/Osaka,
  H. Murayama/Tokyo-Berkeley,
  T. Mori(chair)/Tokyo, T. Moroi/Tokyo,
  S. Yamashita/Tokyo

(in “aiueo” order)

Interim Recommendations (April 2011)

- after spending 1.5 years in reviewing the present/ future projects
- starting point for community discussion
  - Potential discoveries foreseen in the next ~5 years
  - Scenario strategies for future projects
  - Proposal to form a standing committee on future strategy for flexible & timely updates (instead of periodic updates) of strategies

The recommendations were ready in March
but was delayed by the earthquake

Road to Final Report

- 2011 4/19 Interim Recommendations
- 2011 6/25 general kick-off town meeting @Tokyo
- 2011 7/29 underground/astrophysics town meeting @Kashiwa
- 2011 8/09 J-PARC town meeting @Tokai
- 2011 9/10 collider town meeting @Nagoya
- 2011 9/17 general town meeting (JPS symposium) @Hirosaki
- 2012 2/11 Final Report submitted to HEPC
- 2012 3/05 Final Report released to public
- 2012 3/25 Discussion at general meeting of JAHEP @Osaka
- 2012 3/26 Approved by HEPC

Interim recommendations essentially supported by community

Final Report

Recommendations

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

Large Projects

- **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.

standing committee

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.

medium/small-scale projects

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 E-mode polarization and dark energy are considered as projects that have such potential.

Large Projects (1)

- **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.

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Discovery of light Higgs-like boson in July

ILC Strategy Council formed in May

Large Projects (2)

- **Should the neutrino mixing angle θ_{13} be confirmed as large, Japan should aim to realize a large-scale 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-scale neutrino detector should have sufficient sensitivity to allow the search for proton decays, which would be direct evidence of Grand Unified Theories.

↓

Large mixing angle θ_{13} confirmed!

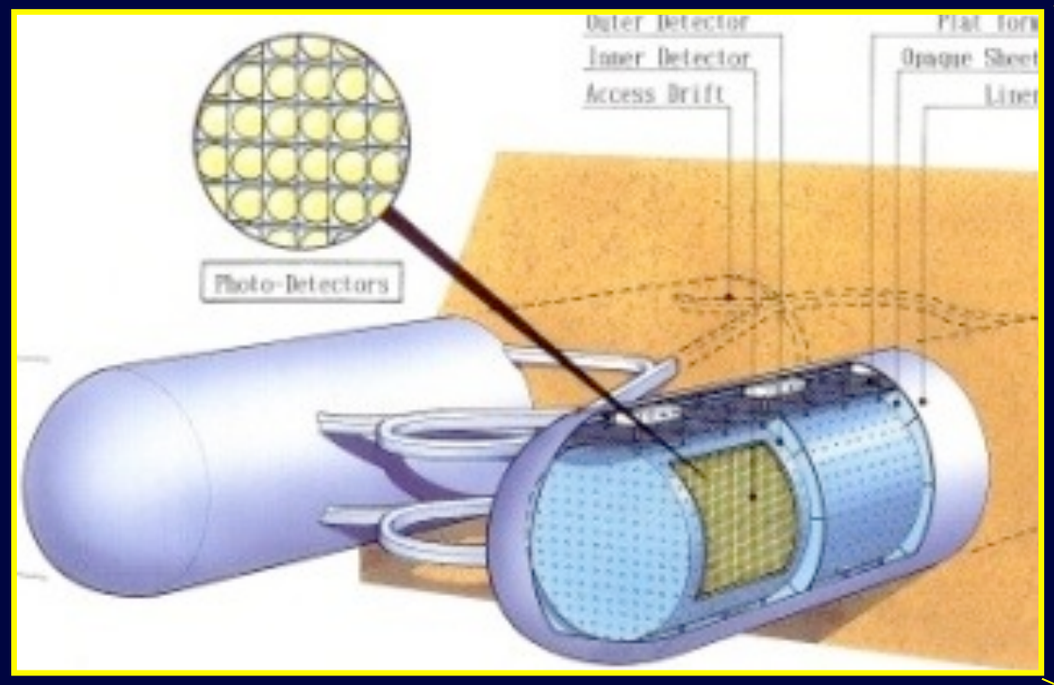
discussion by new Committee on Future Project in June

Large-Scale Neutrino Detector

- studies on CP symmetry through neutrino oscillations by long baseline neutrino experiment
- water cherenkov vs. liquid argon TPC
- international cooperation - global planning
- reinforcement/upgrade of accelerator:
  >1 MW design still under discussion in Japan
- sufficient sensitivity for proton decays

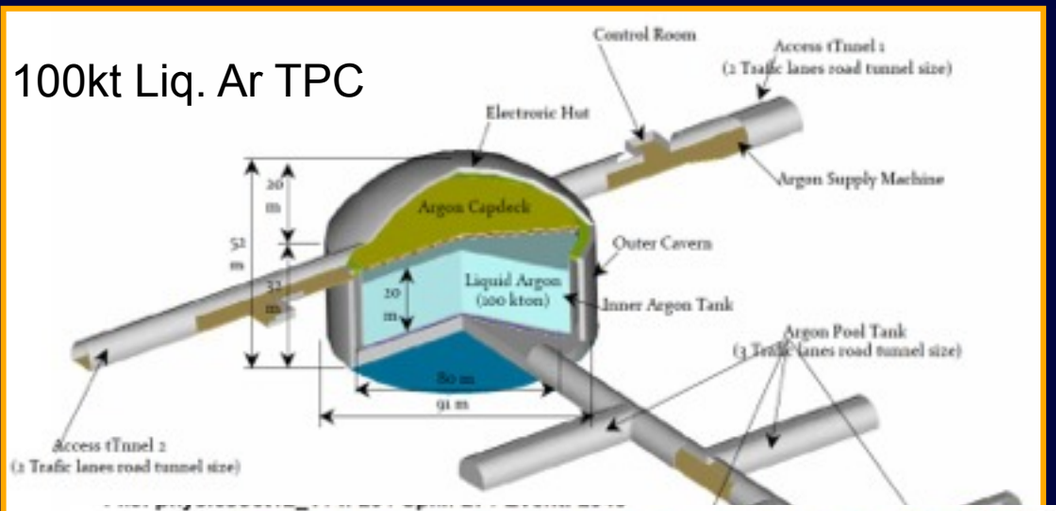
Next ν program at J-PARC

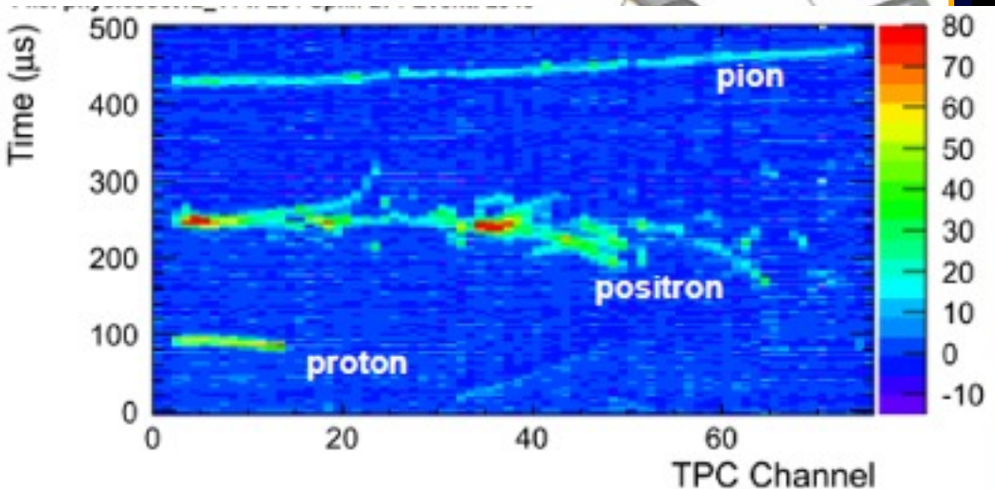
Kamioka L=295km OA=2.5deg

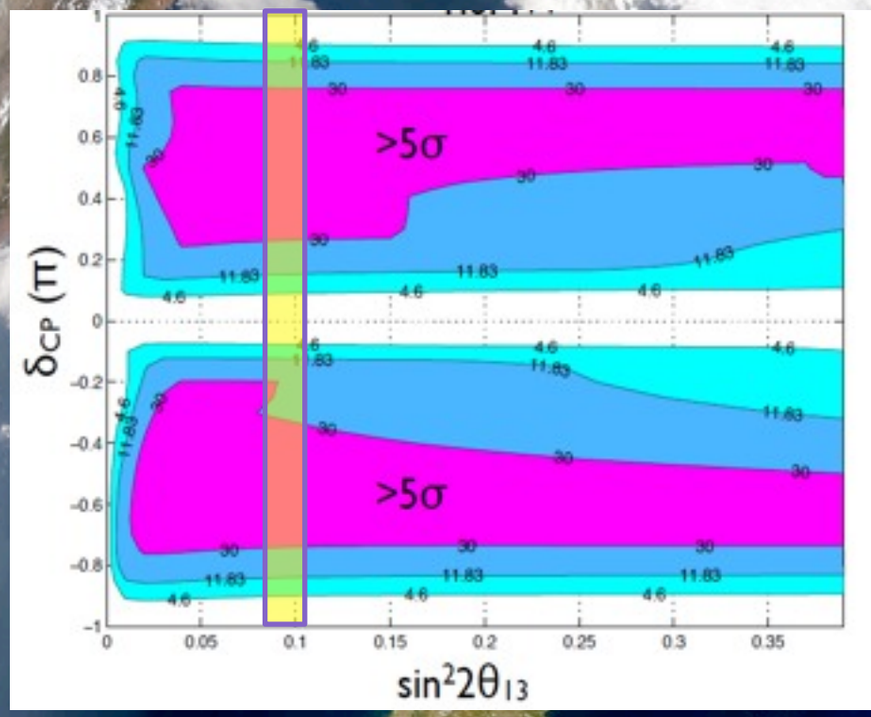


Okinoshima L=658km OA=0.78deg

100kt Liq. Ar TPC







J-PARC
→1.7MW

Hope to start construction ~2018

a standing committee

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.

Committee on Future Projects started

Two meetings held in June & October to discuss neutrino & ILC

other (medium/small) projects

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.

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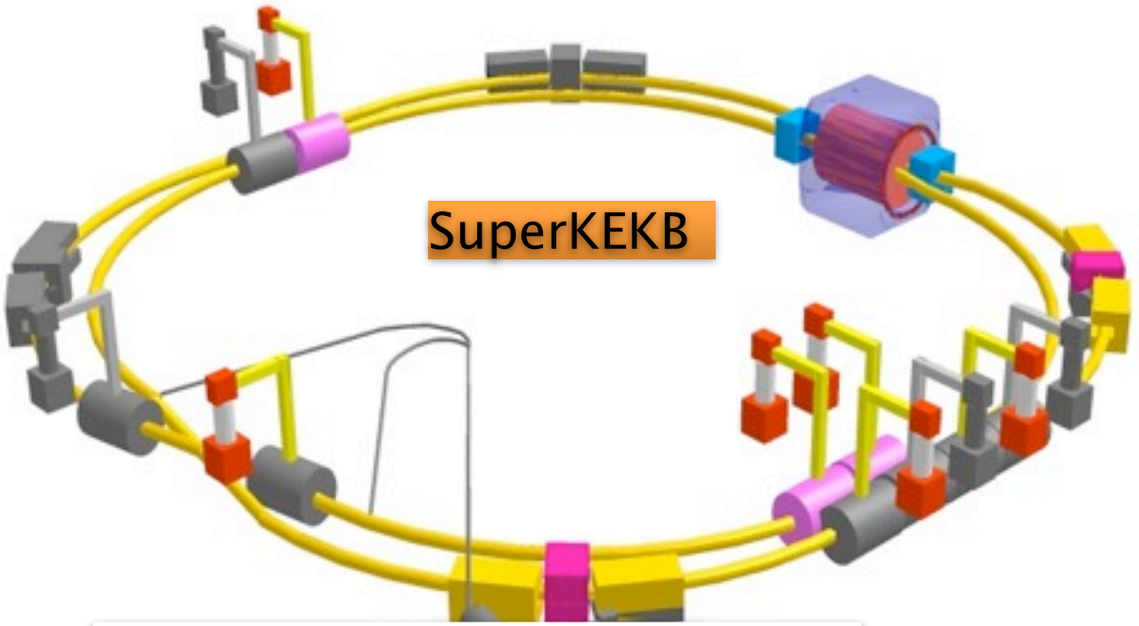
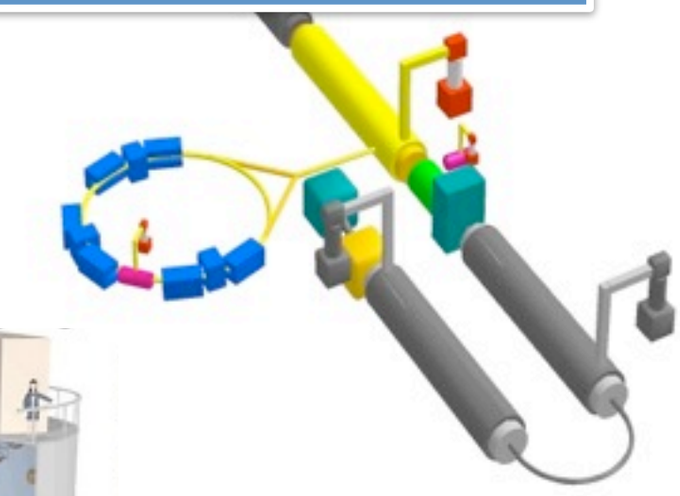
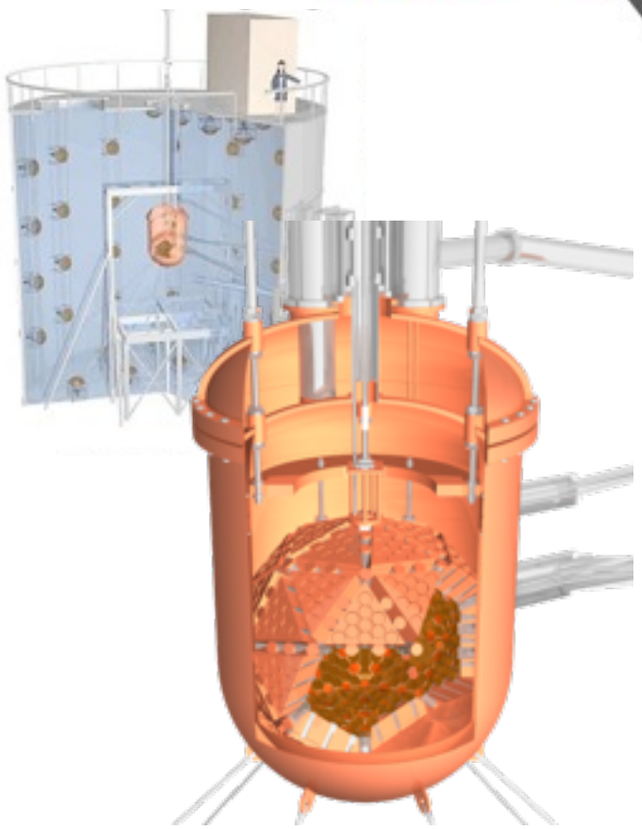
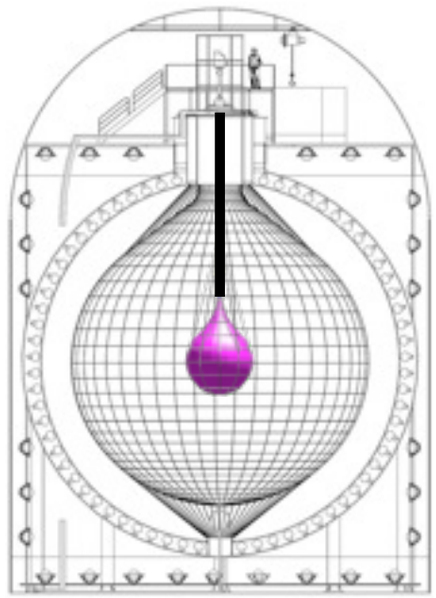
KEK budget request for COMET beam line
(mu-e conversion experiment at J-PARC)

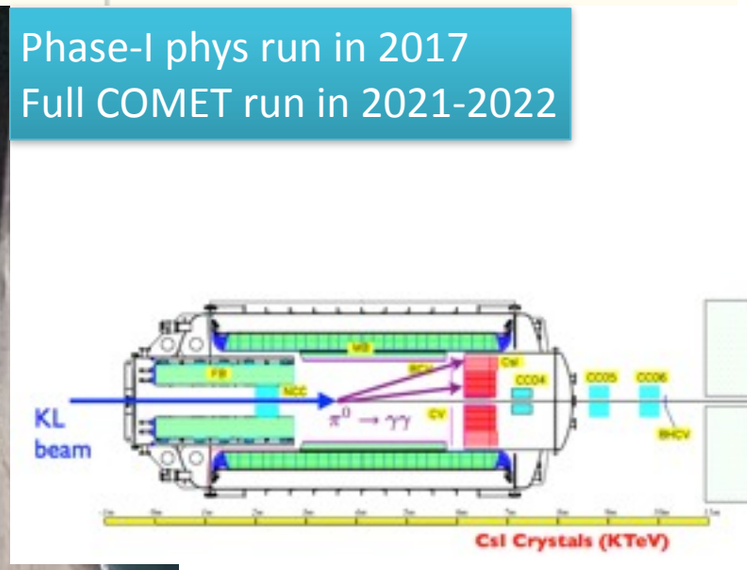


Beam commissioning scheduled in 2015

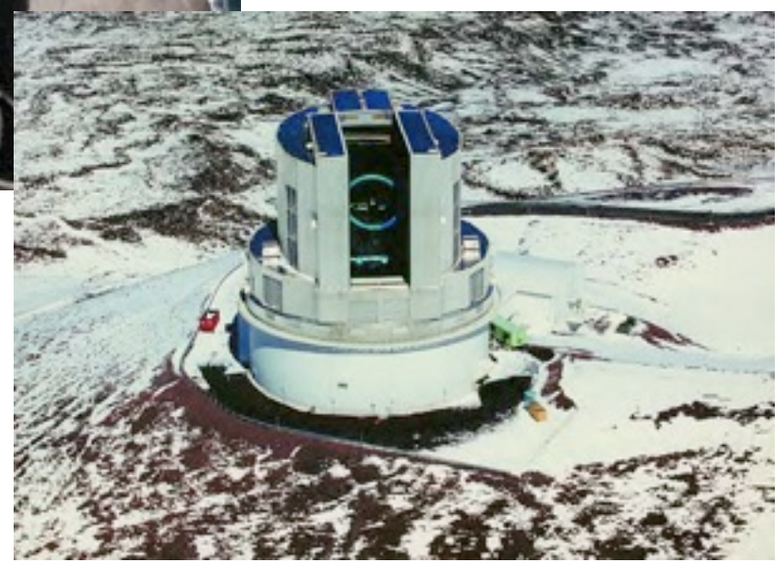








Phase-I phys run in 2017
Full COMET run in 2021-2022



Timelines of Current/Future Projects

2012 2015 2020 2025

LHC
SUSY <1TeV
SM Higgs
SUSY <2.5TeV
HL-LHC

ILC
TDR & Review
Site
Construction
Physics Run

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

full report
~ 28 pages

English translation of the full report is available:
http://www.jahep.org/office/doc/201202_hecsubc_report.pdf

After the Recommendations

- "Committee on Future Projects" set up
  - Two meetings held on neutrino & ILC
- "ILC Strategy Council" formed under HEPC
  - Community-wide consistent efforts to promote ILC
  - Proposal for "Phased Execution of ILC"
    - approved by JAHEP
- A process to update KEK roadmap underway

Proposal for Phased Execution of the ILC Project

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 March 2012. Later 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 the worldwide collaboration.

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

(1) Physics studies shall start with precision study of "Higgs Boson" and will evolve into studies on 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.

(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.

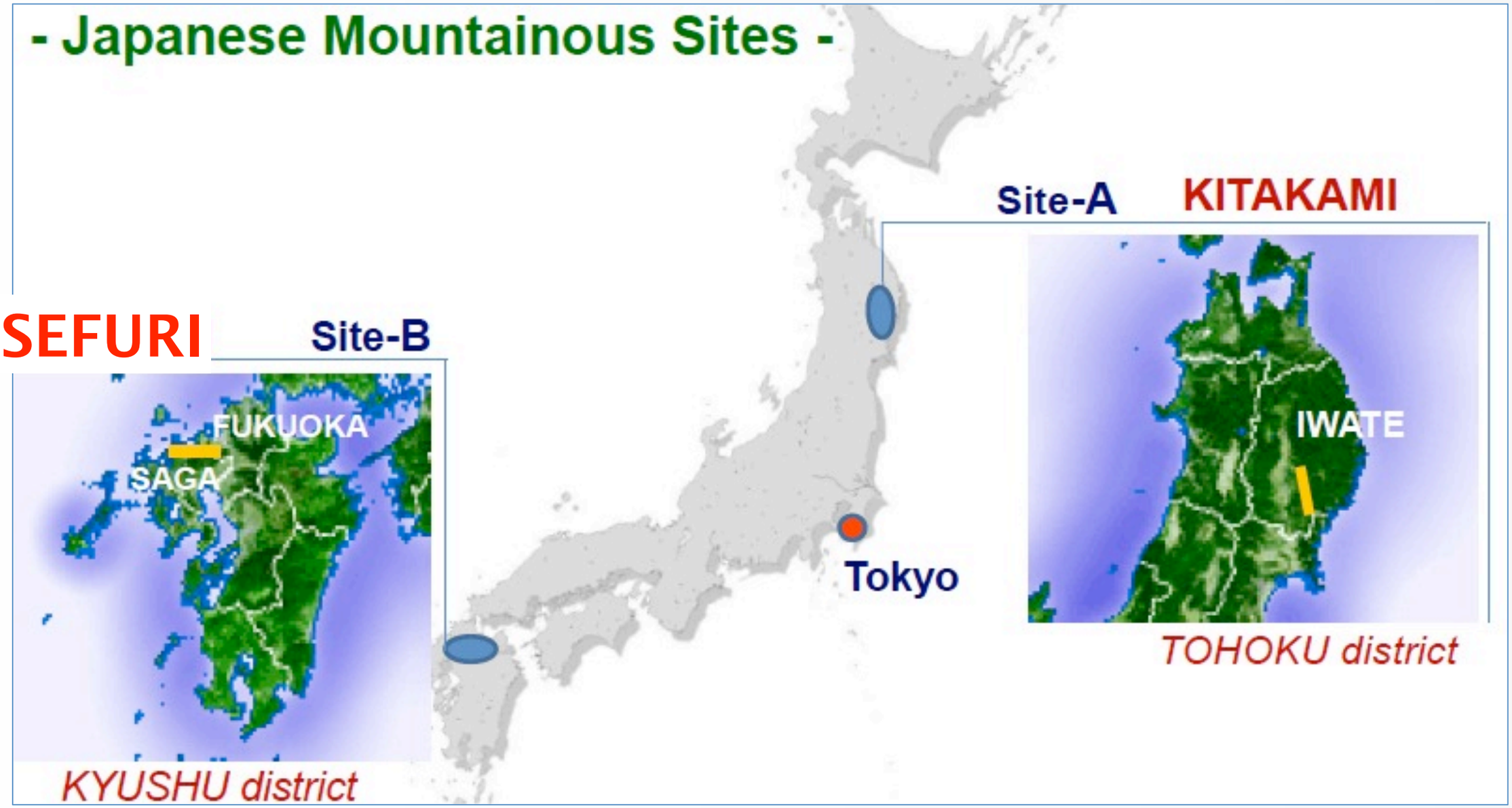
ILC = Global Project

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

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

Two Candidate Sites in Japanese mountainous locations

decision expected ~within next year



Japanese government's third supplementary budget: 5 oku-yen to ILC

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
- Interim report is available at

  http://kds.kek.jp/conferenceDisplay.py?confId=10697
- 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)

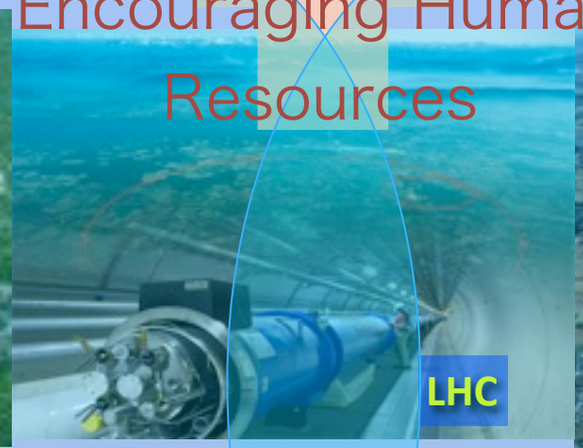
Scientific Activities
Technology Innovation
Encouraging Human Resources

Lepton CP Asymmetry

Beyond Standard Physics

Power-Upgrade

Super-KEKB



Quark CP Asymmetry

Quest for 6 Quarks

Lepton

Quark

[Origin of Matter]

Quest for Neutrinos

[Origin of Force]

Higgs Particle [Origin of Mass]

Prospects - Global Strategy

- A consistent strategy of global HEP community must be formed
    - the subcommittee's Report submitted to European Strategy
        - Discussion at Krakow Open Symposium
            - Japan's proposal of phased ILC generally warmly welcomed
        - "Snowmass 2013" (CSS2013) next year