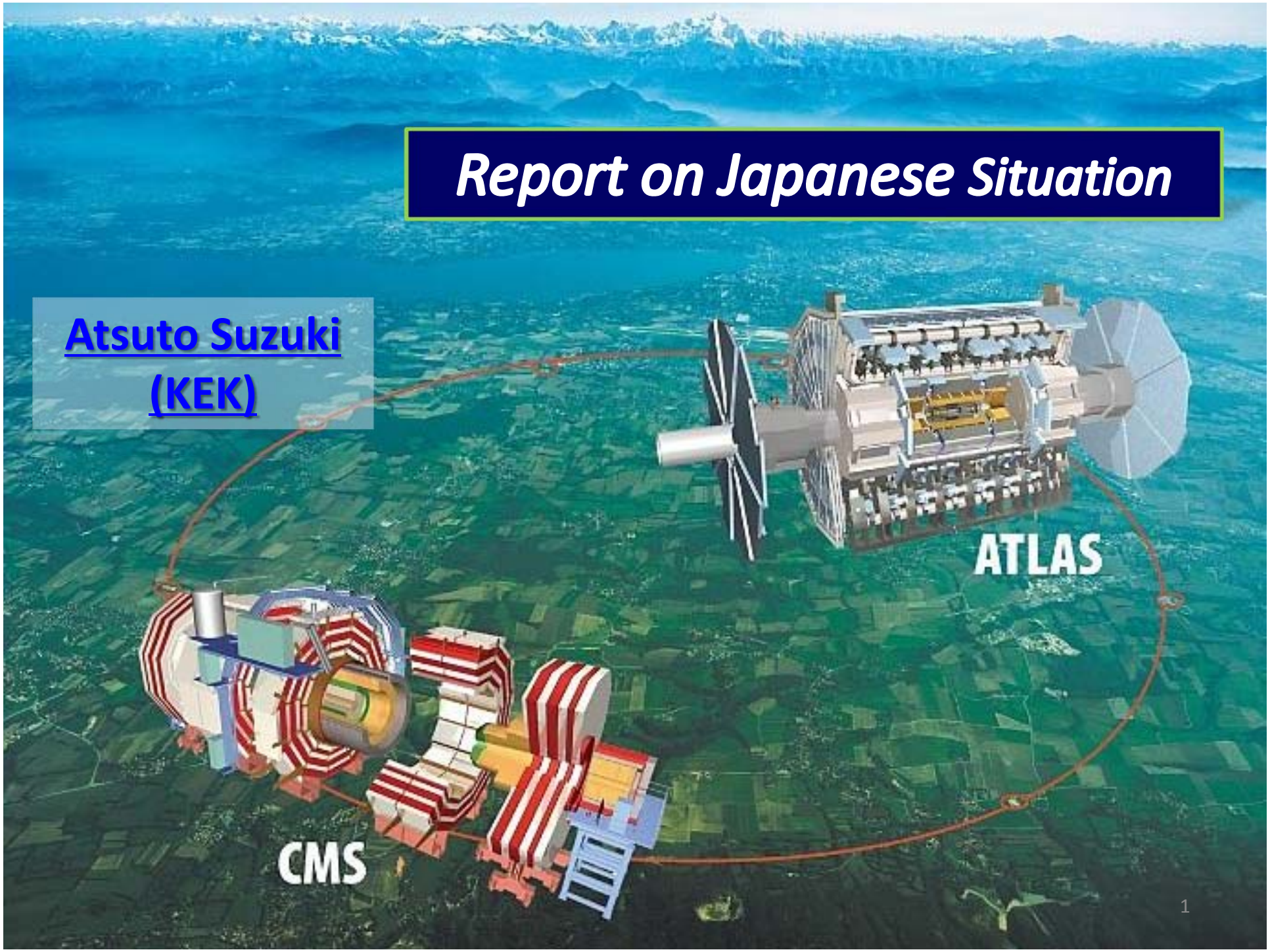
Report on Japanese Situation

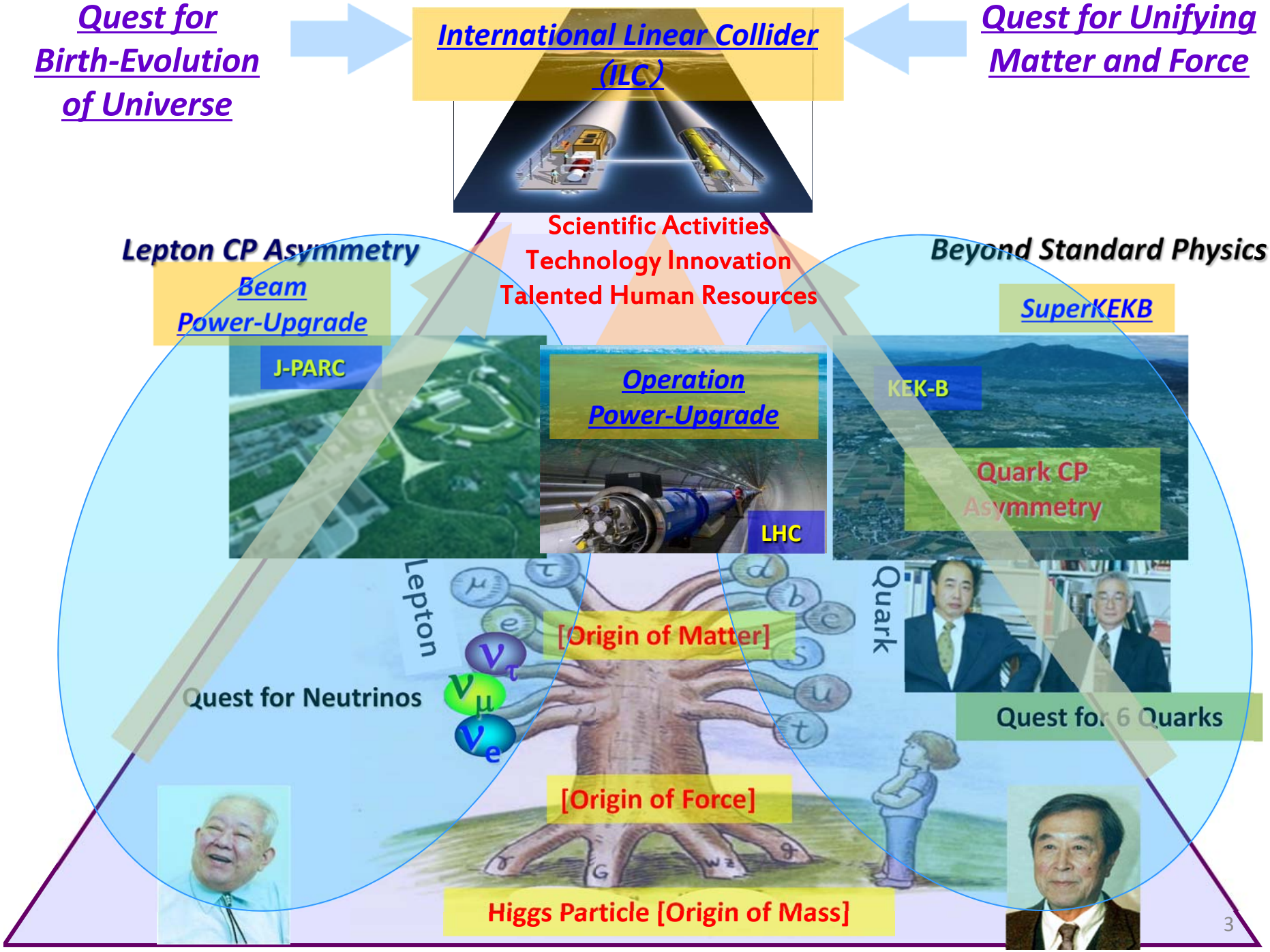
Atsuto Suzuki
(KEK)



Japanese Roadmap for High Energy Physics

2008 - 2012
Roadmap
:
FY 2007

Beyond 2012
Roadmap
:
up to the end of
FY 2012


Quest for Birth-Evolution of Universe
International Linear Collider (ILC)
Quest for Unifying Matter and Force
Scientific Activities
Technology Innovation
Talented Human Resources
Lepton CP Asymmetry
Beam Power-Upgrade
J-PARC
Operation Power-Upgrade
LHC
Beyond Standard Physics
SuperKEKB
KEK-B
Quark CP Asymmetry
Lepton
Quark
[Origin of Matter]
Quest for Neutrinos
Quest for 6 Quarks
[Origin of Force]
Higgs Particle [Origin of Mass]

Contents of the Report

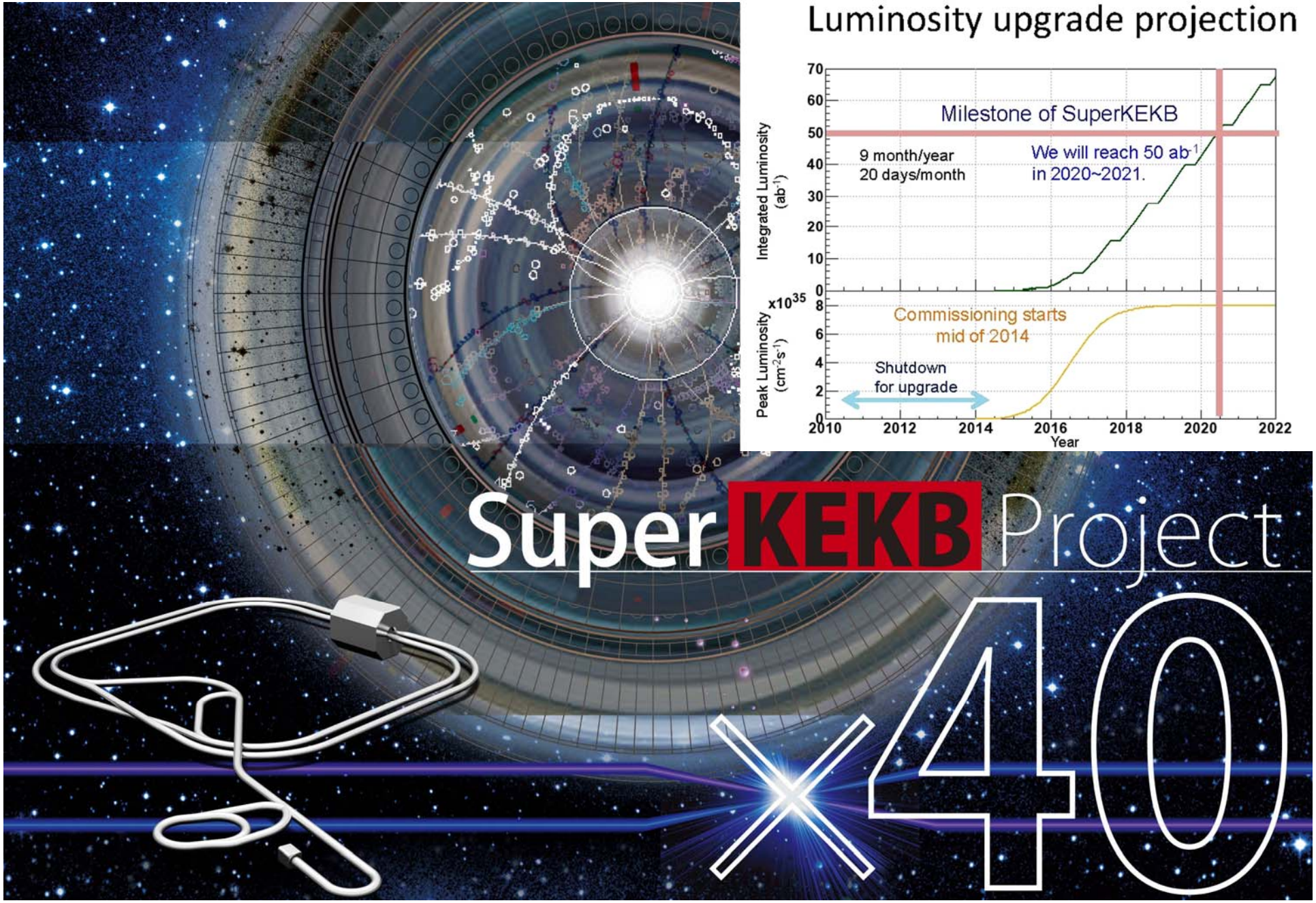
- Status and Prospects
- Energy Frontier
  - ILC, LHC upgrades, other projects
- Neutrino Oscillations
  - Long Baseline Neutrino Experiment (water Cherenkov, liquid argon)
- Flavor Physics
  - Super KEKB, muon, Kaon, neutron
- Non-Accelerator
  - DM, double β decay, CMB B mode, DE ω

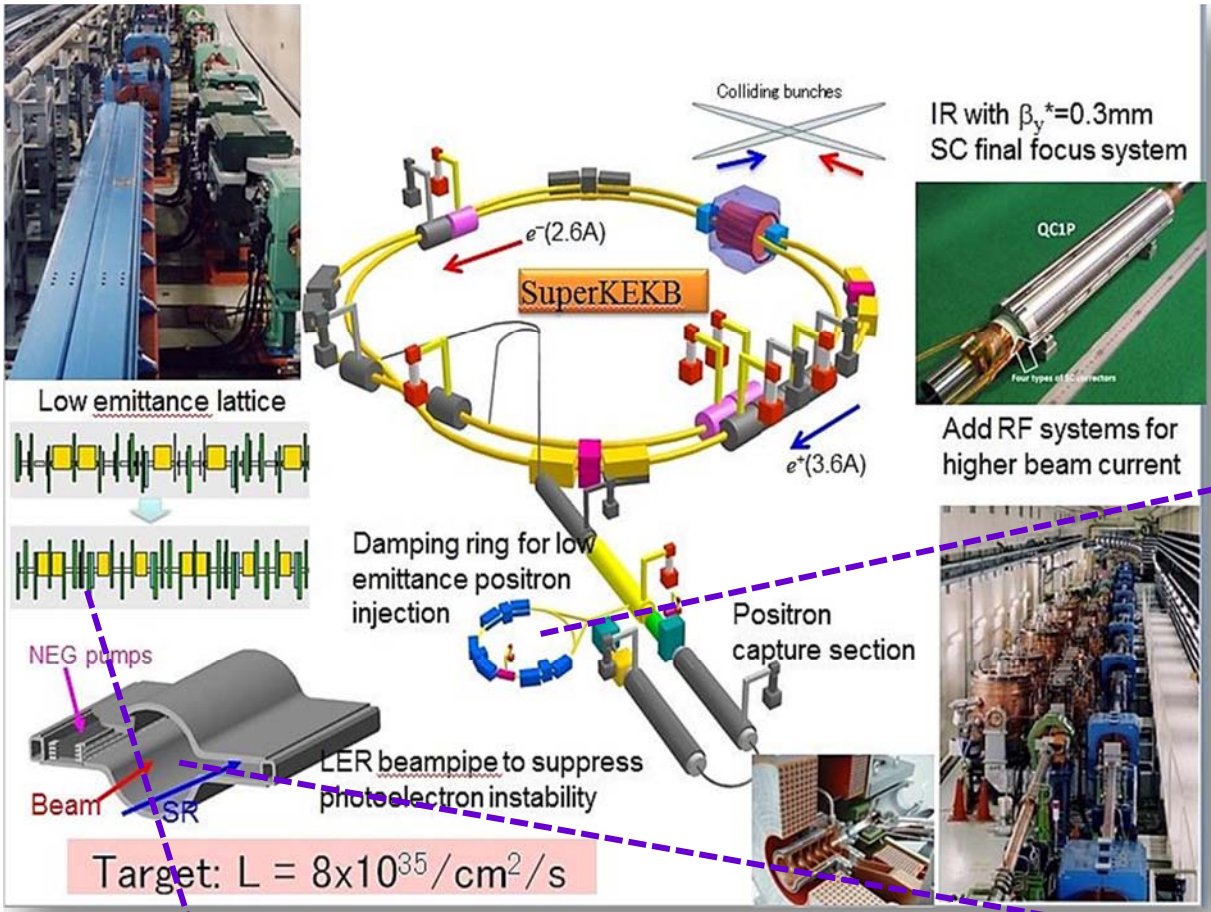
Large Projects (1)

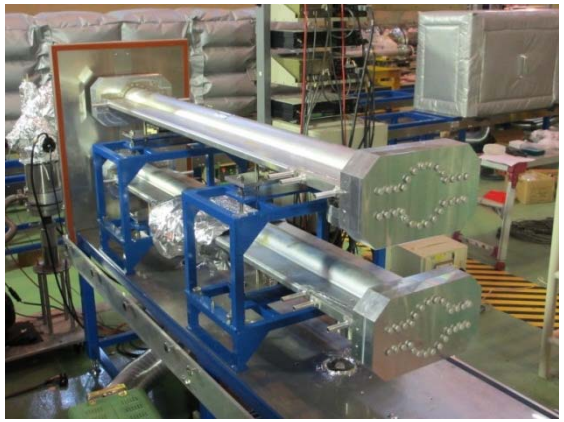
- If a new particle such as a Higgs boson with a mass below around 1TeV is confirmed at LHC, Japan should take the leadership in early realization of e^+e^- linear collider. In particular if the particle is light, experiments at low collision energy should be started at the earliest possible time. In parallel continuous studies on new physics should be pursued at LHC and upgraded LHC. If the energy scale of new particles/physics is higher, accelerator R&D to realize the necessary collision energy should be reinforced.

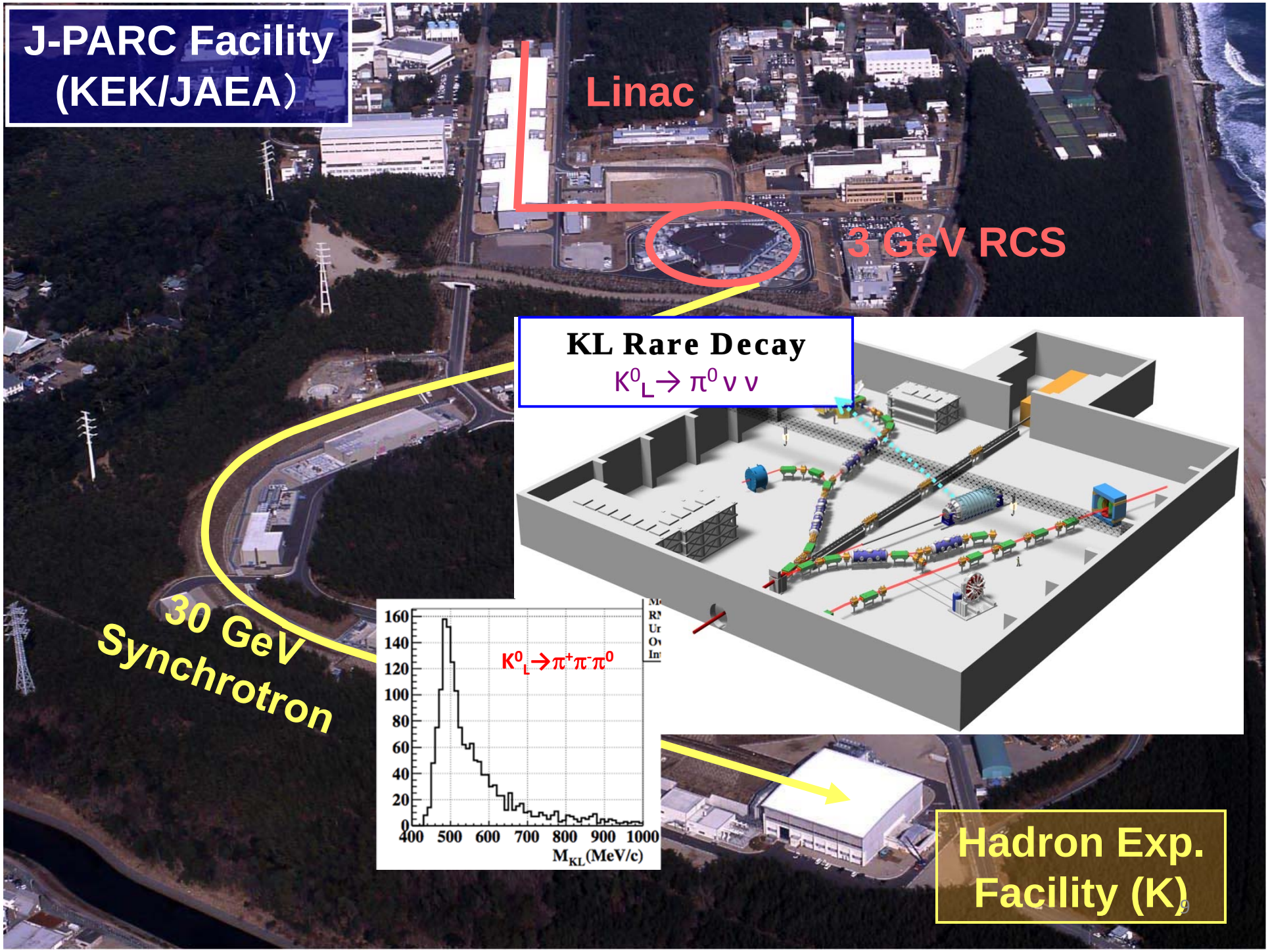
1. Quark Flavor Project

KEKB upgrade to SuperKEKB



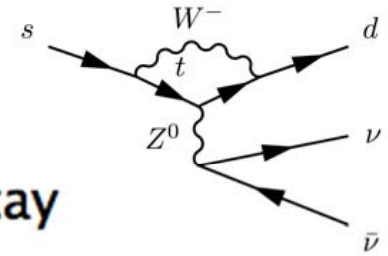

Colliding bunches
IR with β_y*=0.3mm
SC final focus system
QC1P
Four types of SC correctors
e^-(2.6A)
SuperKEKB
e^+(3.6A)
Low emittance lattice
Add RF systems for higher beam current
Damping ring for low emittance positron injection
Positron capture section
NEG pumps
Beam
SR
LER beampipe to suppress photoelectron instability
Target: L = 8x10^{35}/cm^2/s

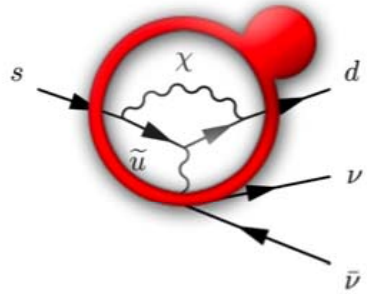



J-PARC Facility
(KEK/JAEA)
Linac
3 GeV RCS
KL Rare Decay
$K^0_L \rightarrow \pi^0 \nu \nu$
30 GeV
Synchrotron
$K^0_L \rightarrow \pi^+\pi^-\pi^0$
160
140
120
100
80
60
40
20
0
400 500 600 700 800 900 1000
M_{KL}(MeV/c)
Hadron Exp.
Facility (K)

Rare Kaon Decay

$$K_L^0 \to \pi^0 \nu \bar{\nu}$$





BR

10^{-5}

10^{-6}

10^{-7}

10^{-8} KEK E391a

10^{-9} New Phyics

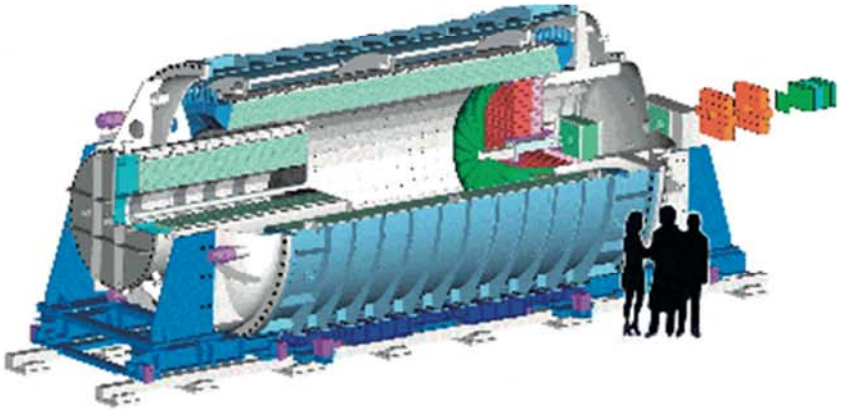
10^{-10}

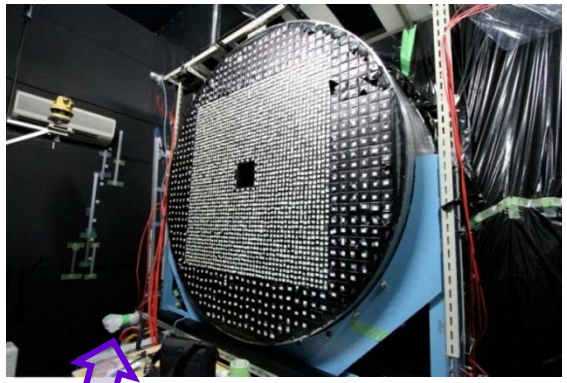
10^{-11} SM, Step 1

10^{-12}

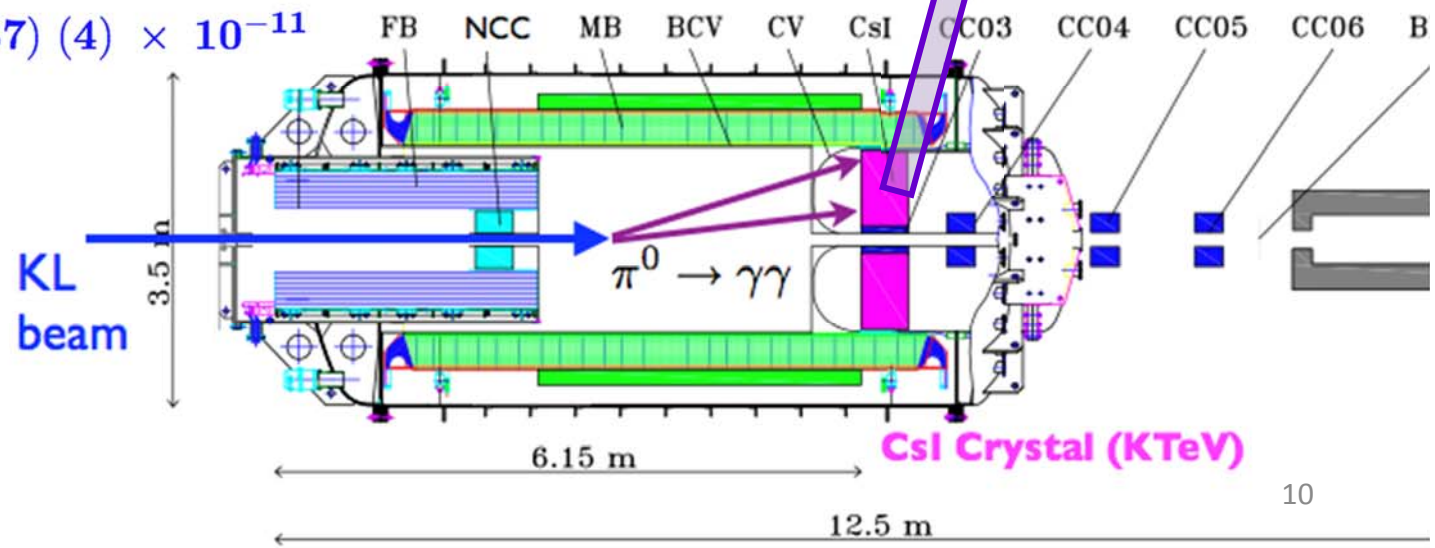
10^{-13} Step 2

- direct CP-violating rare decay for Physics beyond the Standard Model

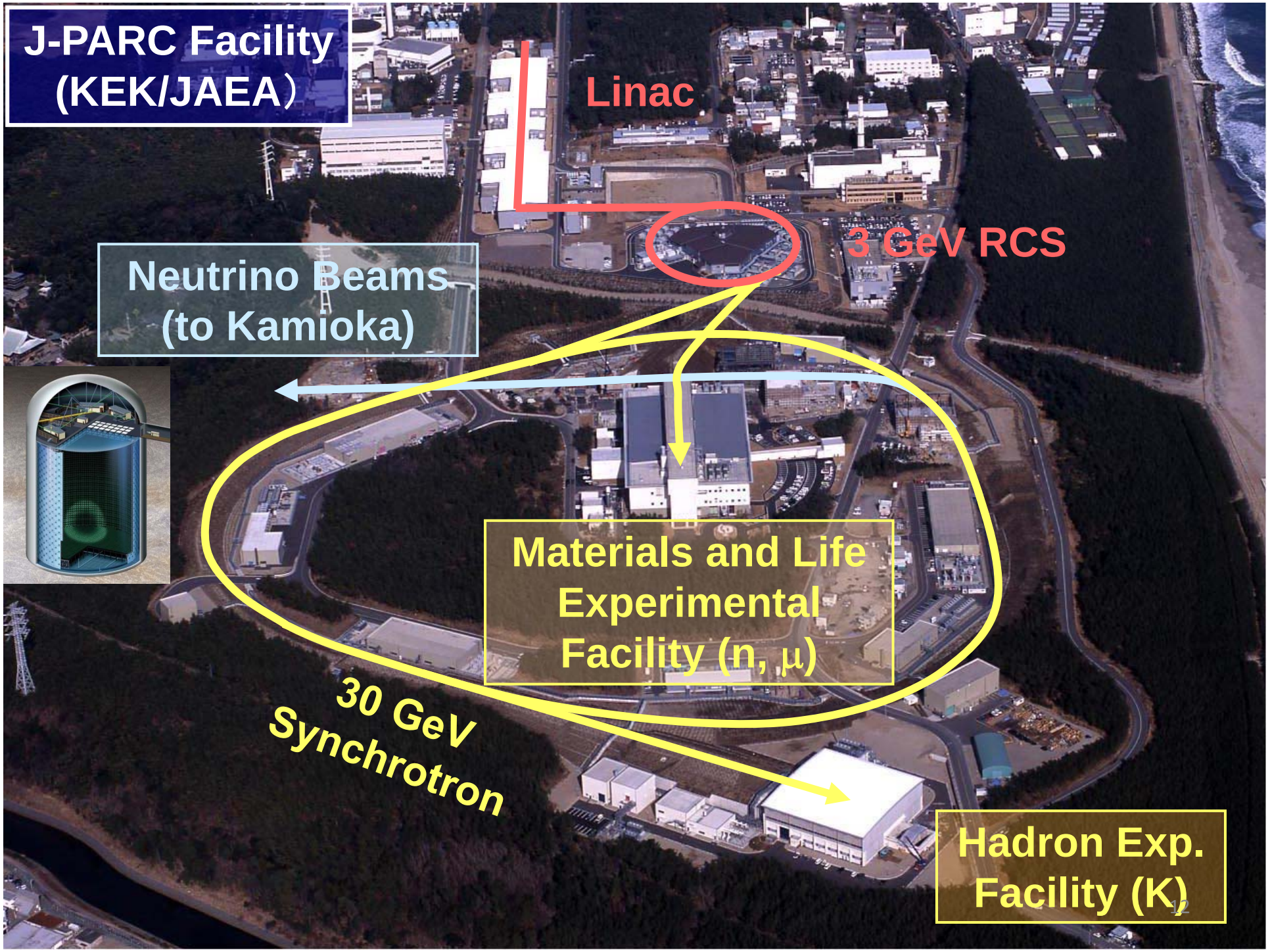




$2.57\ (37)\ (4)\ \times\ 10^{-11}$



2. Lepton Flavor Project

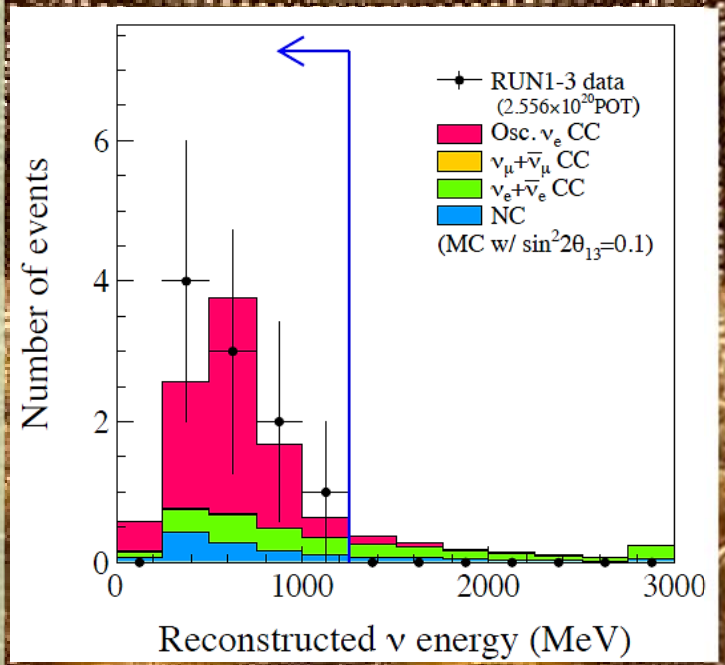

J-PARC Facility
(KEK/JAEA)
Linac
3 GeV RCS
Neutrino Beams
(to Kamioka)
Materials and Life
Experimental
Facility (n, μ)
30 GeV
Synchrotron
Hadron Exp.
Facility (K)

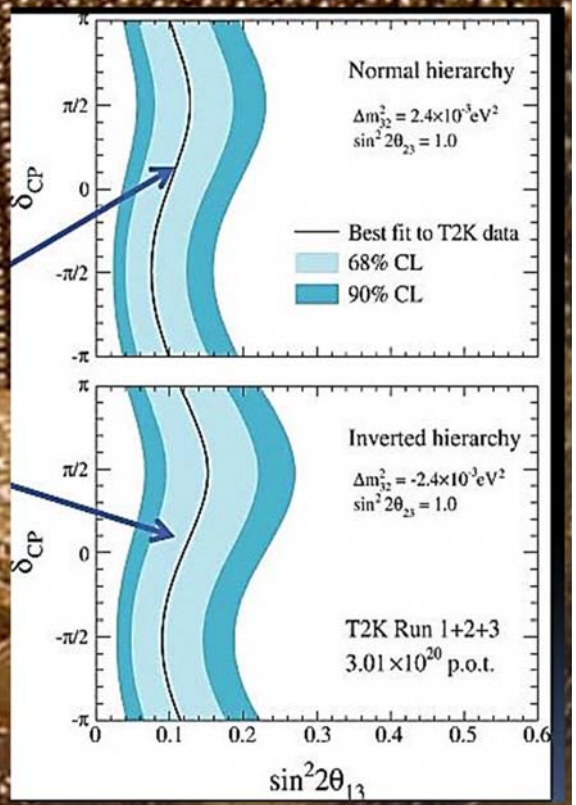
T2K Experiment

Long-Baseline Neutrino Experiment

$\nu_\mu \rightarrow \nu_e$ Result from T2K

- **10 electron neutrino candidates are detected**
- Expected **BG** (θ_{13}=0) is estimated to be **2.73±0.37 evts**
- Probability to observe >=10 evts w/ θ_{13}=0 is **0.08% (3.2σ)**
  - C.f. 0.7% (2.5σ) in 2011



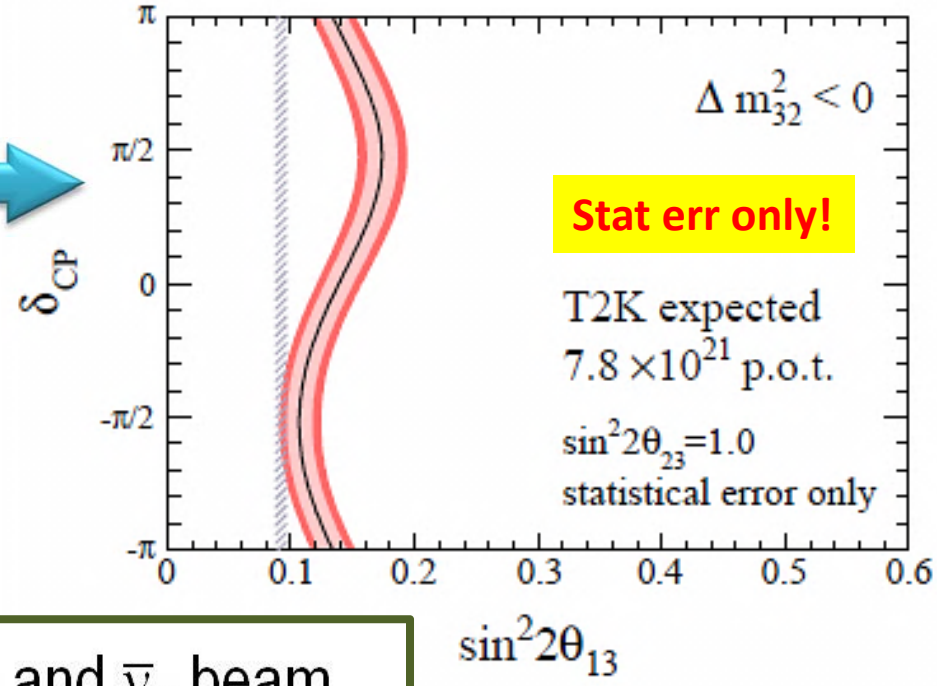


Improvement of both reactor and accelerator experiments will provide first handle on the CP violating complex phase δ_{CP}.

Expectation with ~50 times more data (750kWx 5×10^7s)

Expected beam power

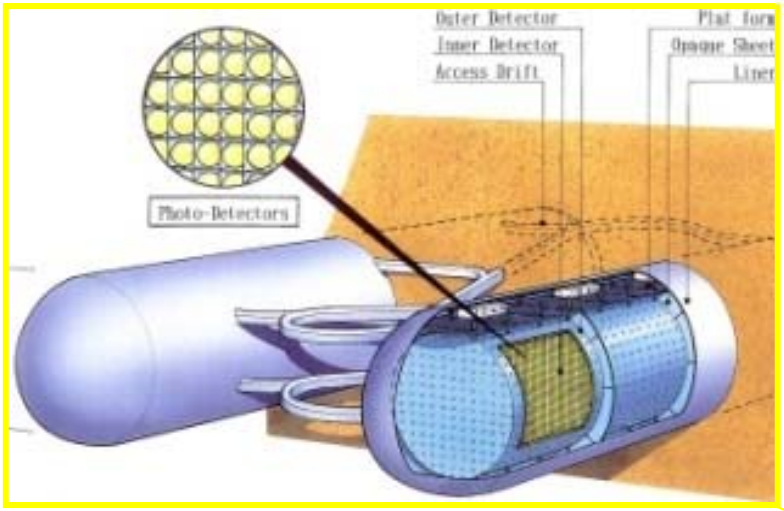
May 2012	2014	2018
190kW	300kW	750kW

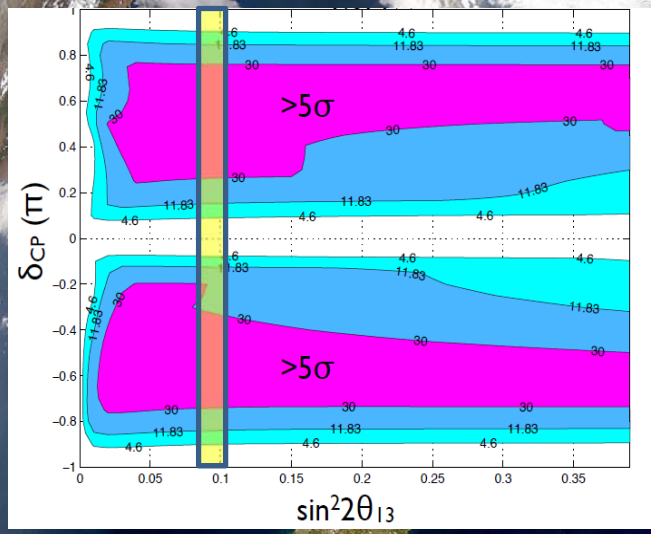


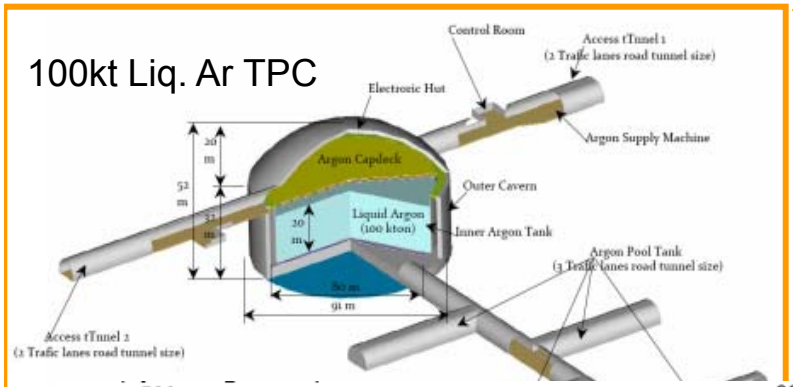
- Measure ν_e app. for both ν_μ and $\bar{\nu}_\mu$ beam
- Take asymmetry

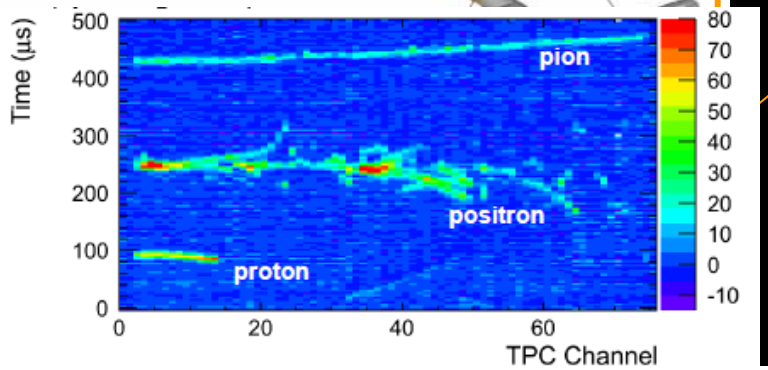
$$A_{CP} \equiv \frac{P(\nu_\mu \to \nu_e) - P(\bar{\nu}_\mu \to \bar{\nu}_e)}{P(\nu_\mu \to \nu_e) + P(\bar{\nu}_\mu \to \bar{\nu}_e)} \approx \frac{\Delta m^2_{12} L}{E} \cdot \frac{\sin 2\theta_{12}}{\sin \theta_{13}} \cdot \sin \delta$$

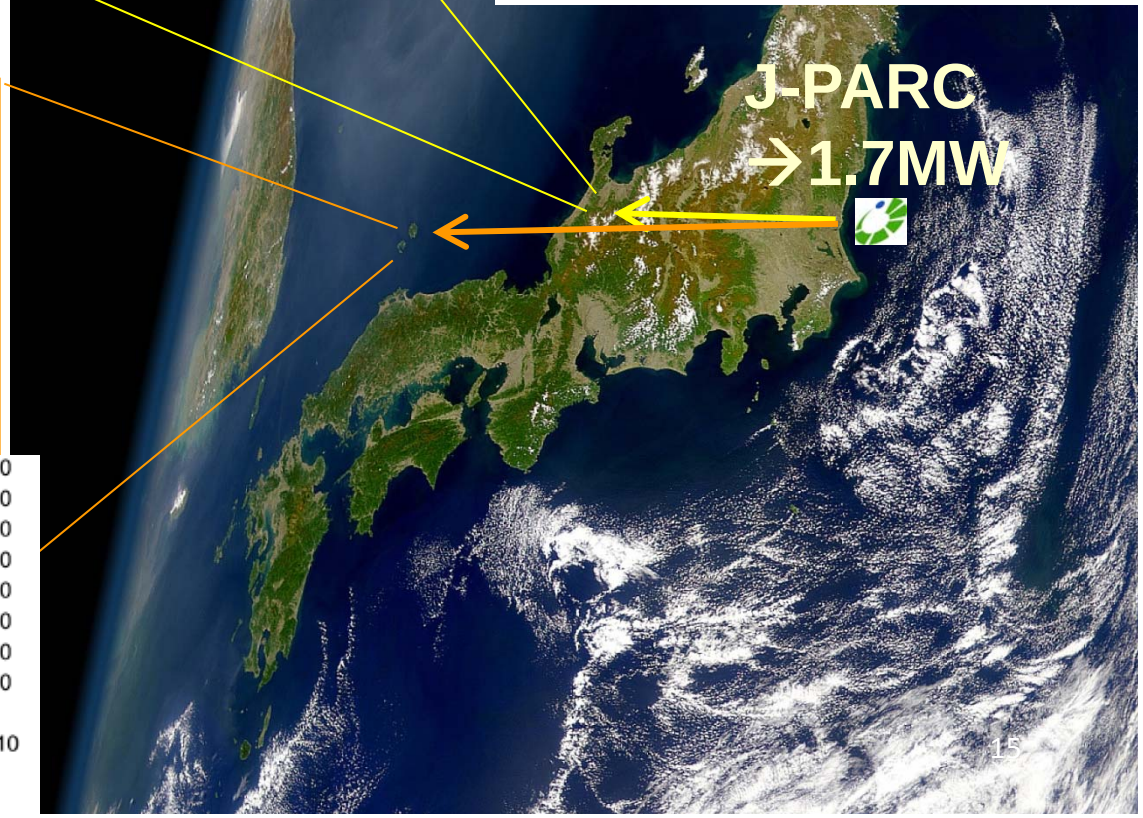
Next ν program at J-PARC





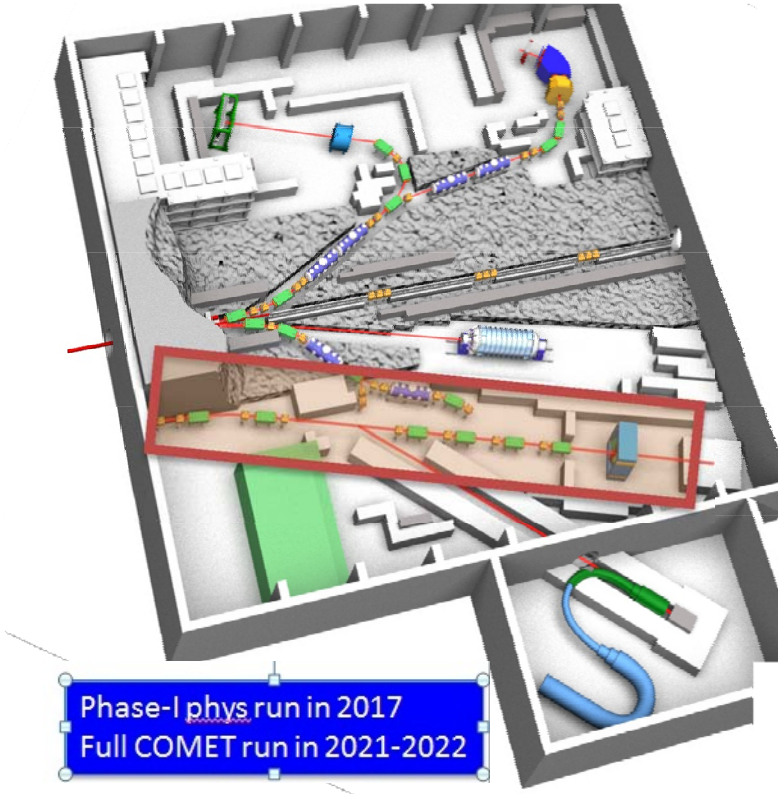




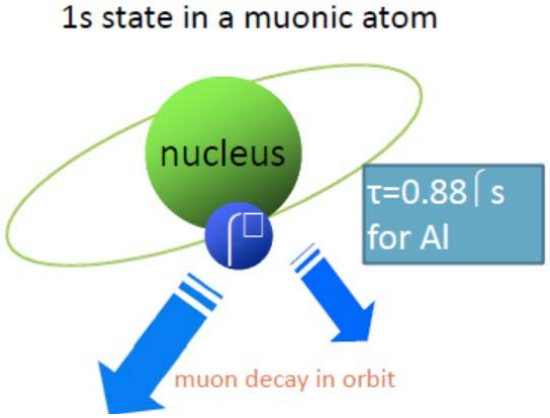


μ → e Conversion

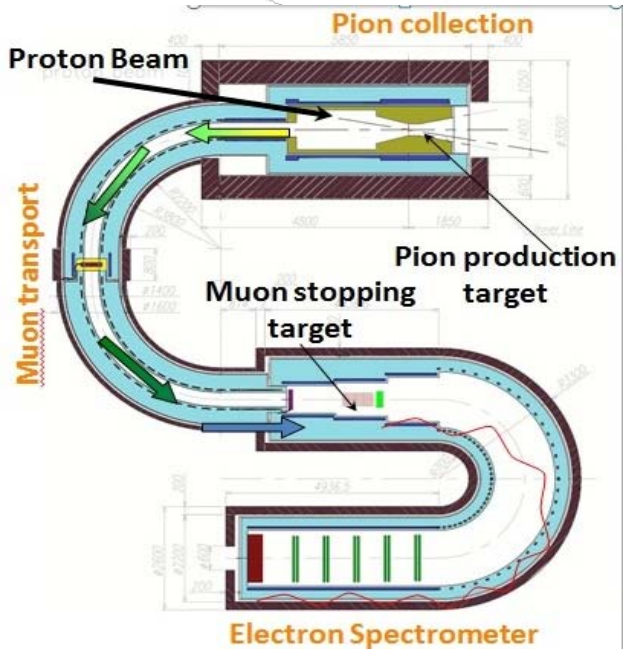
Signal : μ- + (A,Z) → *e*- + (A,Z)

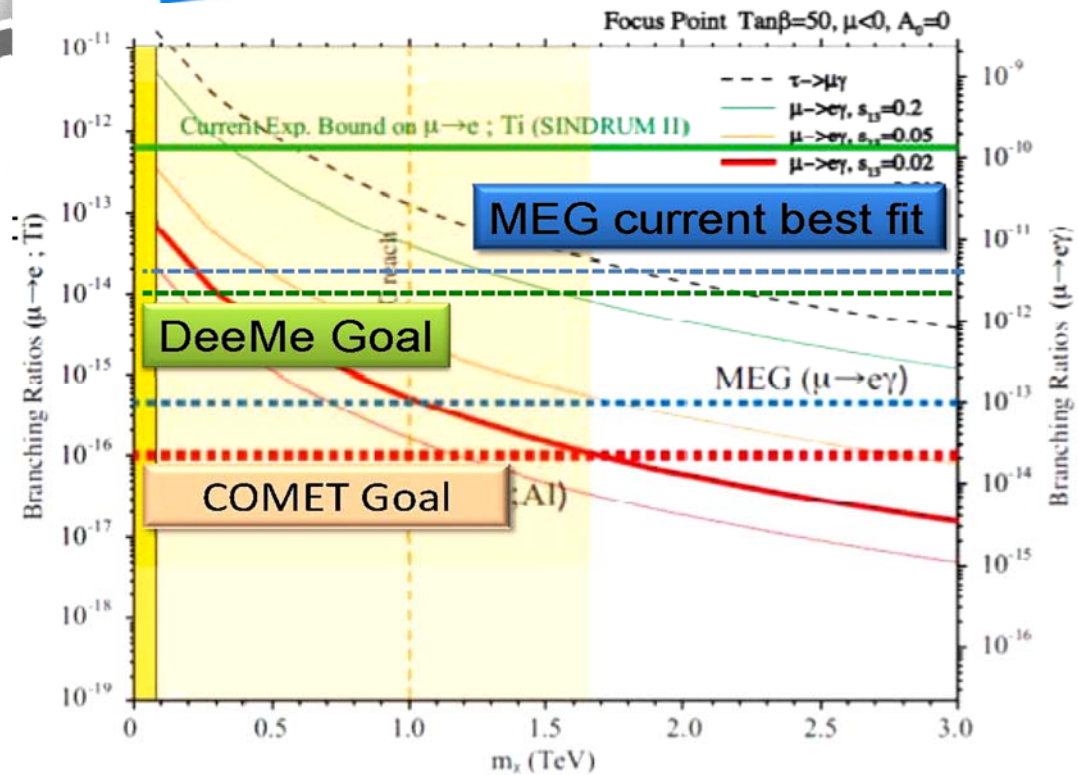


Phase-I phys run in 2017
Full COMET run in 2021-2022



- Search for cLFV mu-e conv.
  - 10^{-16} sensitivity (Target S.E.S. 2.6×10^{-17})
  - Improve **O(10^4)** than present upper bound such as SINDRUM-II BR[$\mu^- + Au \rightarrow e^- + Au$] < 7×10^{-13}



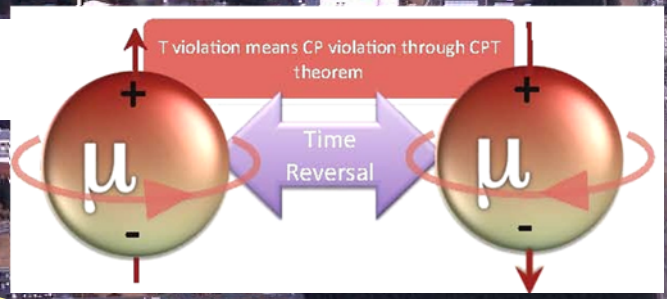


Muon g-2@J-PARC

g−2

Improve Precision by 5 (0.1 ppm)

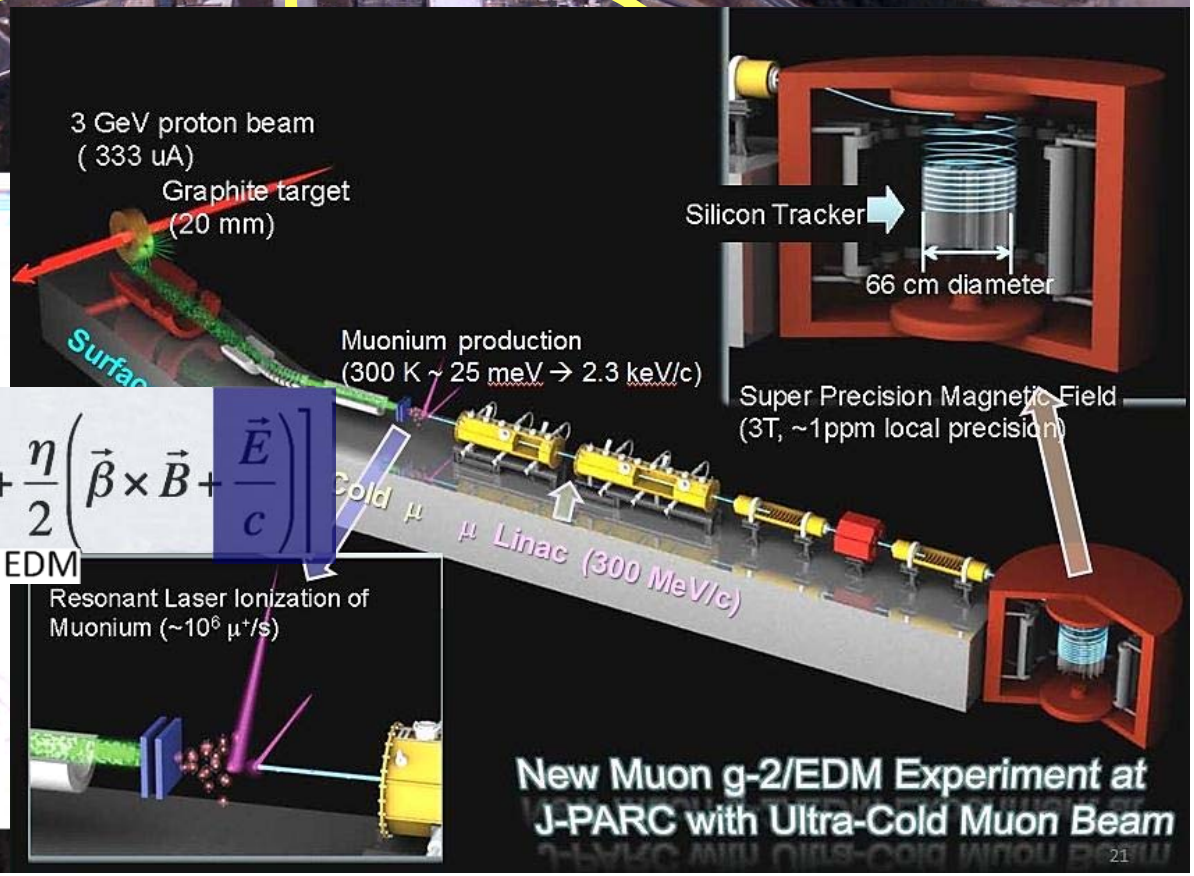
EDM



Improve Precision by 100

$$\vec{\omega} = -\frac{e}{m}\left[a_\mu \vec{B} - \left(a_\mu - \frac{1}{\gamma^2 - 1}\right)\frac{\vec{\beta}\times\vec{E}}{c} + \frac{\eta}{2}\left(\vec{\beta}\times\vec{B} + \frac{\vec{E}}{c}\right)\right]$$

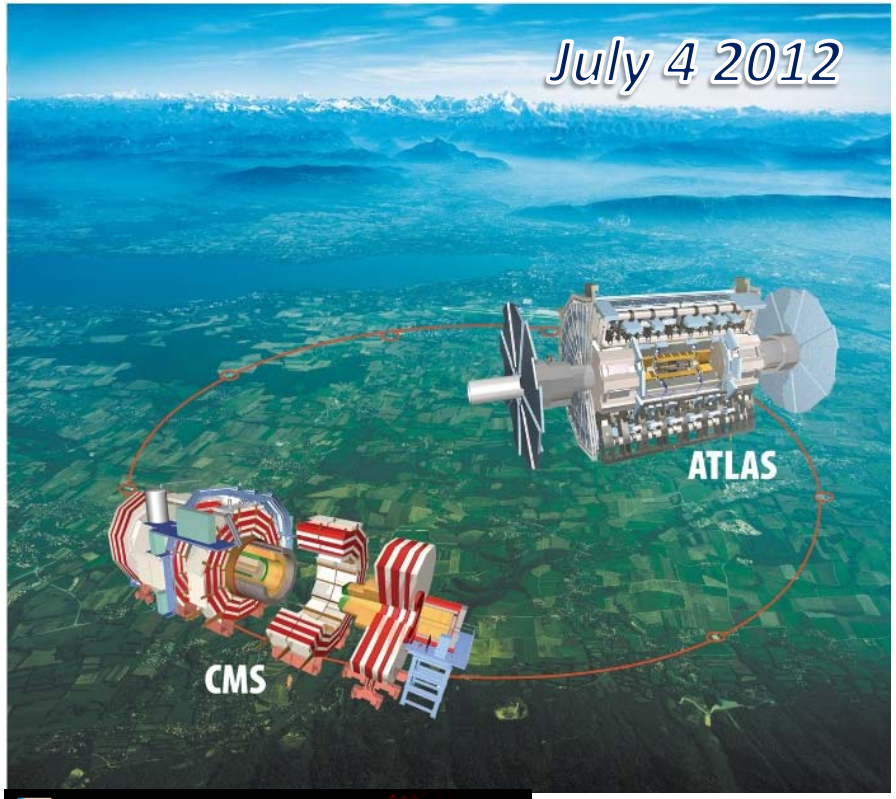
g−2 EDM

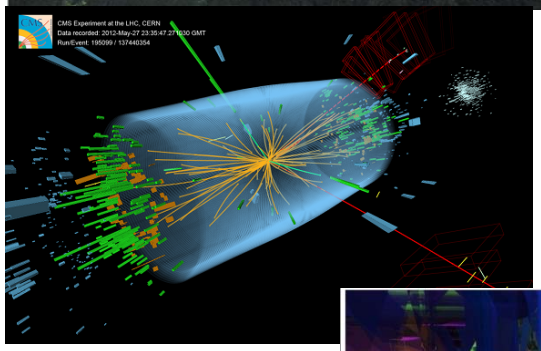


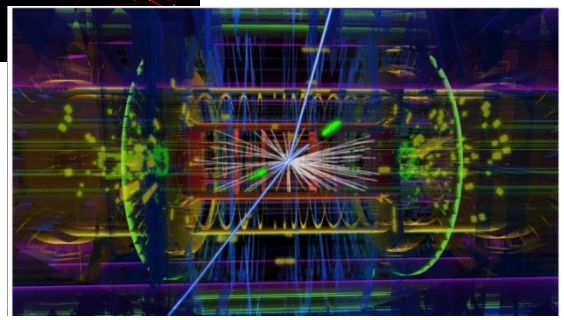
Bird's

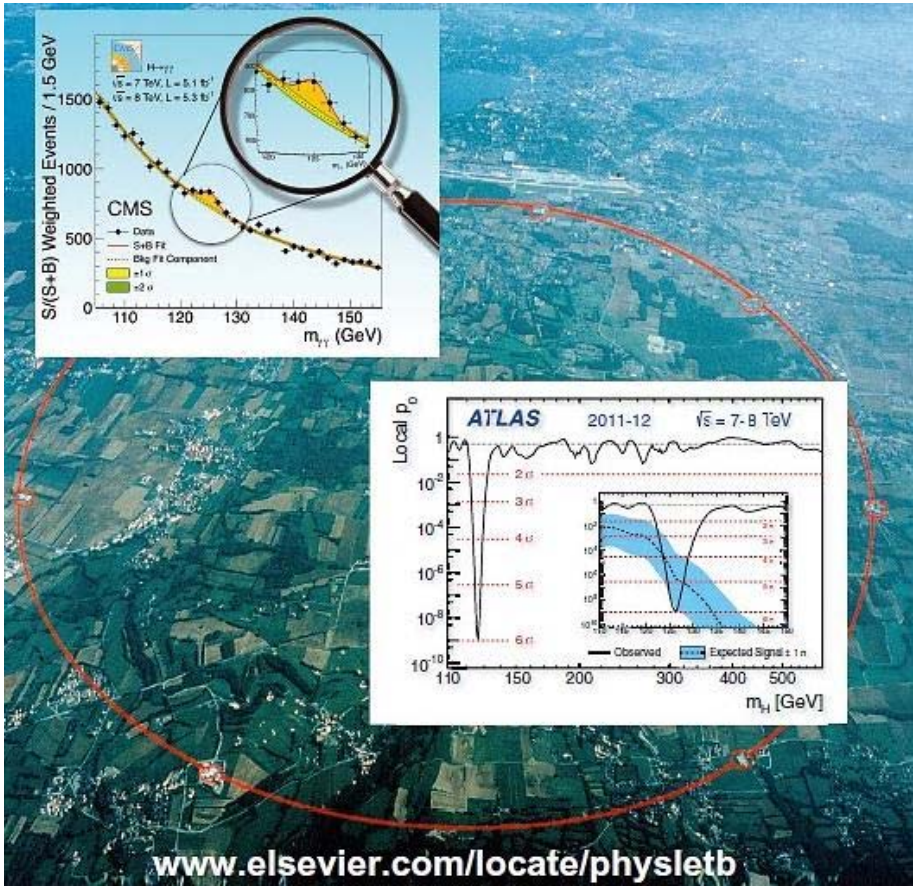
New Muon g-2/EDM Experiment at J-PARC with Ultra-Cold Muon Beam

3. Energy Frontier Project


July 4 2012
ATLAS
CMS






S/(S+B) Weighted Events / 1.5 GeV
CMS
Data
S+B Fit
Bkg Fit Component
$m_{\gamma\gamma}$ (GeV)
ATLAS
2011-12
$\sqrt{s}$ = 7-8 TeV
Local p_0
Observed
Expected Signal ± 1 σ
m_H [GeV]
www.elsevier.com/locate/physletb

Institute of Electrical and Electronics Engineers

2012 IEEE NSS/MIC/RTSD Anaheim, California

27 October - 3 November 2012

Special Linear Collider Event

29-30 October 2012

As part of the NSS Symposium, a special Linear Collider (LC) event is organized, which will include presentations on:

- **International Linear Collider (ILC) and the Compact Linear Collider (CLIC) accelerator**
- **Detector concepts**
- **Impact of LC technologies for industrial applications**
- **Forum discussion about LC perspectives**

James Brau, University of Oregon, USA
Juan Fuster, IFIC Valencia, Spain
Michael Harrison, BNL, USA
Steinar Stapnes, CERN, Switzerland
Hitoshi Yamamoto, Tohoku University, Japan
Maxim Titov, IRFU/CEA Saclay, France (ex officio)
Ingrid-Maria Gregor, DESY Hamburg, Germany (ex officio)

More information: www.nss-mic.org/2012
Contact: nss2012@desy.de

clic ilc IEEE NUCLEAR & PLASMA SCIENCES SOCIETY

Forum Discussion About Linear Collider Perspectives

Tuesday, Oct. 30 (17:30 -18:30)

- **LC Project Implementation Plan**
- **LC Technology Roadmap**
- **LC Added Value to Society**

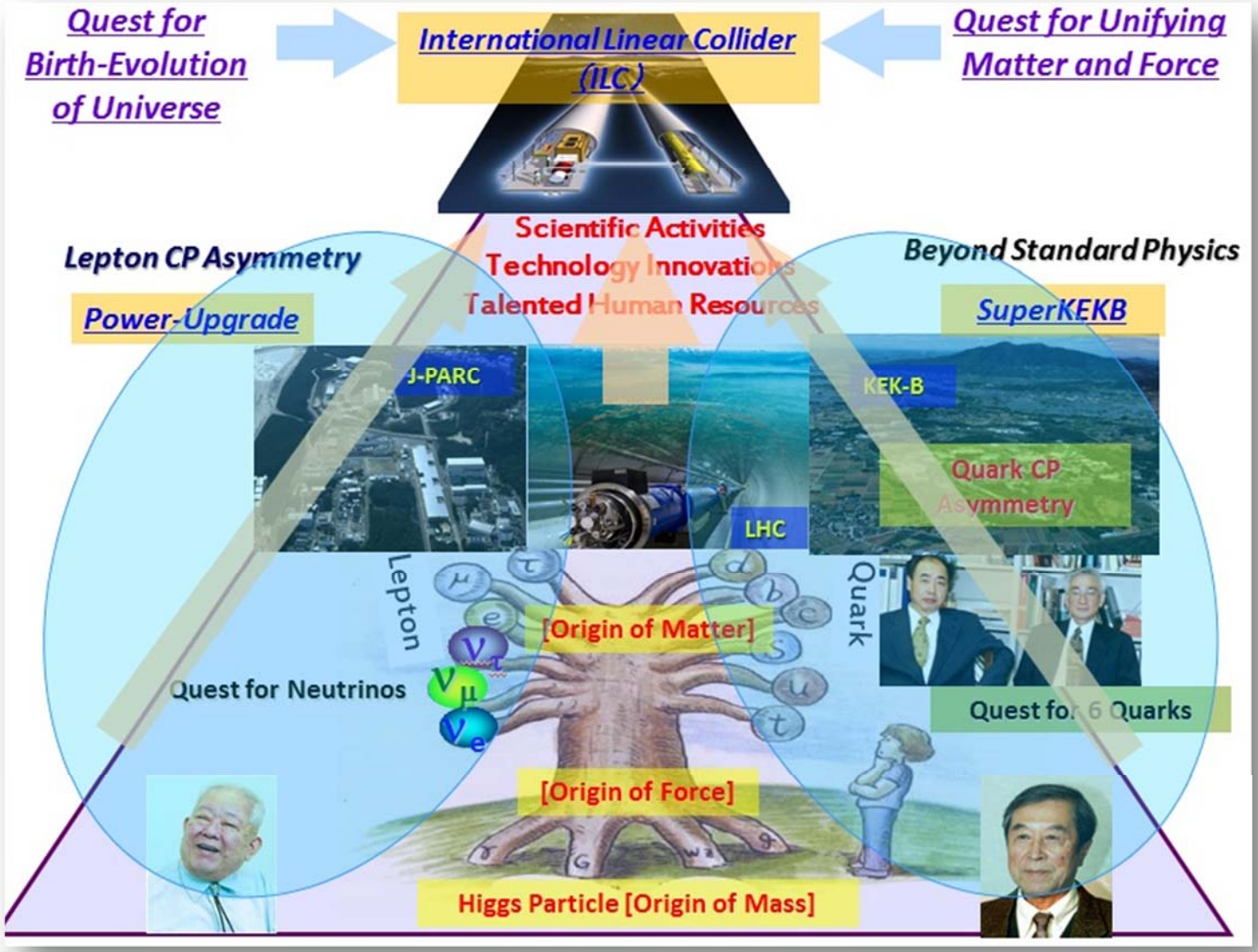
With participation of:

Rolf-Dieter Heuer (CERN)
Atsuto Suzuki (KEK)
Joachim Mnich (DESY)
Stuart Henderson (FNAL)
Hitoshi Murayama (LBNL/IPMU)
Akira Yamamoto (KEK)
Steinar Stapnes (CERN)

ILC Proposal from Japan

1. Why ILC in Japan ? : 1

In 2008



A bid-to host activity in Japan

Promoter's Meeting on
Industry – KEK Collaboration Council

2008. 02.21

Industry – KEK Collaboration Council
(June 11, 2008)
Advanced Accelerator Association Promoting Science & Technology

- **Honorary Chairman :** Masatoshi Koshiba — Director General at Heisei Foundation for Basic Science
  - **Advisory Meeting**
  - **Chairman:** Takashi Nishioka
    - **General Meeting**
      - **Secretariat**
      - **Technology Study Group**
      - **Outreach Group**
      - **Intellectual Property Study Group**
      - **Large Project Study Group**
    - **Board of Directors**
  - **Supreme Advisor :** Kaoru Yosano

Federation of Diet Members for promotion of the ILC project

Expand to Suprapartisan Federation

Kickoff Meeting : July 31st, 2008

Vice Chair Hatoyama | Chair Yosana | Secretary Kawamura

~50 members took part in this meeting.

Advanced Accelerator Association
Promoting Science & Technology

15/Dec./2011

Symposium

Prime Minister Noda

positive reference to the ILC

Why ILC in Japan ? : 2

July 12, 2012

Japan Policy Council Second Recommendations: Regional Development through Creation of Global Country inside Japan

Realizing a global city that can attract human and financial resources from around the world: Regional development triggered by the International Linear Collider (ILC)

<u>Realizing an international organization for the International Linear Collider (ILC), to push towards reforming regional cities as a role model for the creation of a global country.</u>

要約版

日本創成会議　第２回提言「グローバル都市創成」
～ＩＬＣ（国際リニアコライダー）を契機とする地域開国～

日本の立て直しには、地方都市の立て直しが必須。「内なるグローバル化」を進め、世界の成長を取り込み、空洞化・過疎化から脱却する。

提言１

地方都市をグローバル都市に変革し、東京以外にも世界から人材・資本を集められる都市をつくり、地域主導で成長する国づくりを目指すべきである。

①日本を国際機関や国際的な研究所、大学、企業が集積する「知の拠点」にする。

②都市全体の景観のハーモナイゼーションを高める。中心に共有空間を創出することにより住民コミュニケーションを活性化し、コミュニティーの機能を向上する。

③国によってライフ・スタイルが異なることを念頭にレジャーのメニューを多様化し、余暇活動の質を高める。

④外国人が家族で安心して暮らせるよう欧米では一般的な家庭医制度を導入し、地域医療の再生を行う。

⑤日本の教育の優れた点や独自性は活かしながら外国人子女の転入出に配慮し、外国とのシームレスな教育環境を整備する。

⑥外国との交通アクセス網を整備する。

提言２

国際プロジェクトＩＬＣ（国際リニアコライダー）の国際機関としての誘致実現を通し、グローバル都市創成のモデルを構築すべきである。

①内閣府にプロジェクトを設置し関係省庁の連携をはかる。国内候補地、大学・研究機関、産業界とともにオール・ジャパンによる推進体制をつくる。

②各国がコミットする国際機関としてＩＬＣを実現する。「国際機関ＩＬＣ準備委員会（仮称）」設置を提唱し、これを主導する。

③「アジア候補地」として各国の参加も視野に国内候補地決定のプロセスを決める。

④ＩＬＣ建設（約１０年間）と平行し、医療、教育など生活環境の整備を行う。

⑤ＩＬＣキャンパス内を特区とし、外国の医師免許等の所持者の就労を可能にし、研究者の配偶者の職をつくる。

⑥安全に関する情報公開のしくみを検討し、施設や制度の設計に盛り込む。

⑦ＩＬＣを核とする産業集積基盤を形成し、日本の経済成長に結びつける。

Rolf Heuer, global ILC cities and the role of Japan

Share |

Rika Takahashi | 1 November 2012

Rolf Heuer giving a talk at the ILC symposium held at University of Tokyo

On 24 October, a symposium to boost activities to invite the ILC to Japan was held at the University of Tokyo, Tokyo, Japan. This event was entitled "Forum on Advanced Accelerator Science & Industry – Creation of Global Project Cities." Because this event's date coincided with the height of the big ILC conference, LCWS12, held at University of Texas, Arlington, US, many Japanese scientists were unable to attend. Nonetheless, it attracted an audience of about 300 people – clearly not too many experts in th as they were all in Arlington. The talk that received greatest attention the one delivered by Rolf Heuer, Director-General of CERN.

The forum was jointly hosted by the Japan Policy Council (JPC) and t Advanced Accelerator Association promoting science and Technolog (AAA). JPC was founded by business and labour leaders and scholar aims to create a grand design for Japan and to develop a strategy towards its realisation.

Next Prime Minister ??

Toward ILC Construction : International Activities

2012 | 2013 | 2014 | 2015~6

GDE RD

Linear Collider Directorate (LCD)
- Accelerator/Detector R&D
- Cite Recommendation
- Detailed Design for Construction
- Project Proposal

ILCSC

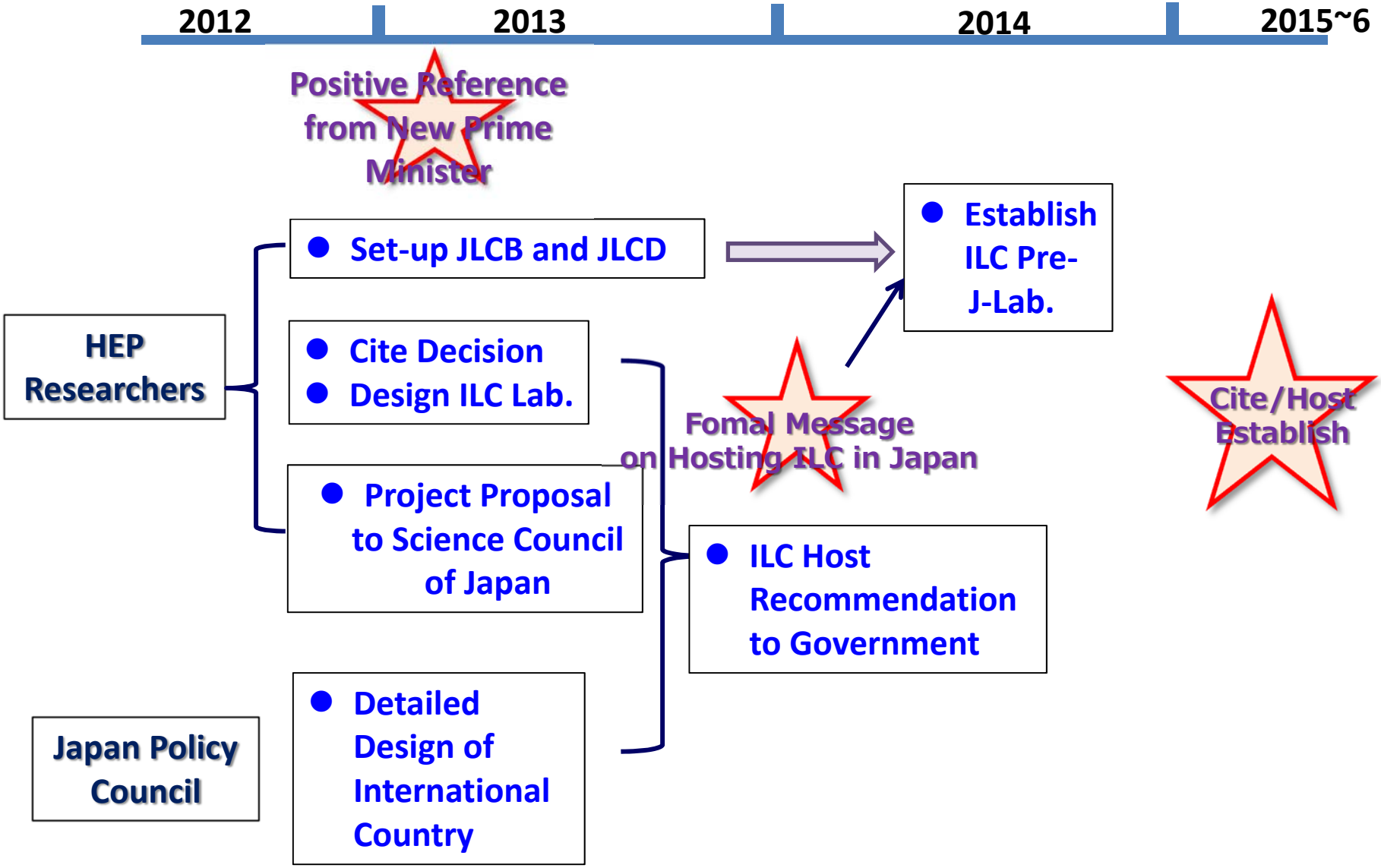
Linear Collider Board (LCB)
- Detailed Design for ILC Lab.
- Chart-out of Approval Process
  for instance, ICFA→IUPAP→ OECD
  → Governmental Board

ICFA

- Project Proposal to
  ICFA → IUPAP → OECD
  → Governmental Board

Cite/Host Establish

Toward ILC Construction : Japan Activities



Budget support from the government

In principal (researcher's proposal)

- 50% of the total ← host country
- the other ← non-host countries

Extra support

- Given the special aims in Japan (Creation of Global Country inside Japan), the extra support from the government is feasible.
- Multi-body promotion :

  MEXT (Ministry of Education, Culture, Sports, Science & Technology)

  + METI (Ministry of Economy, Trade and Industry)

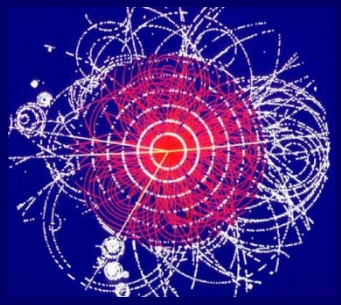
  + MLIT (Ministry of Land, Infrastructure, Transport and Tourism)

  + ……..

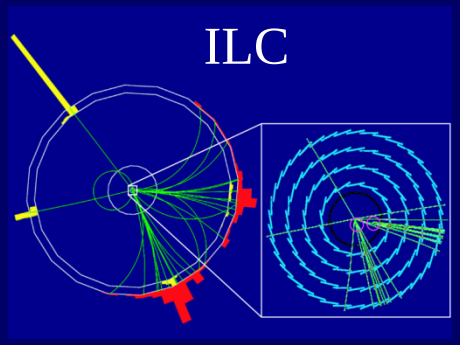
ILC Physics

- LHC discovery of Higgs-like particle :
  - Beginning of new era of particle physics
    - Is it the Standard Model Higgs?
    - Where is the dark matter?
    - Is there really new physics at Terascale?
- ILC Higgs
  - Generate ~10K Higgs (can be tagged!)
    - 5 σ sensitivity in ~ 1 day (LHC : ~1 year)
  - Higgs Brs to a few % (LHC : a few 10s %)
    - e.g. H → cc (LHC : cannot)
  - Γ_{tot} to 5% (challenging at LHC)
  - CP to 3~4% (mix coeff)
- ILC top
  - m_t(msbar) to 100 MeV (LHC: ~ 1 GeV)
  - Anomalous ttZ, tbW, ttg coupl (LHC: hint of ttg only)
- ILC new physics
  - Composite Higgs scale to 45 TeV (LHC: ~7 TeV)
  - Anomalous WWV coupl (x10 better than LHC)

LHC



ILC

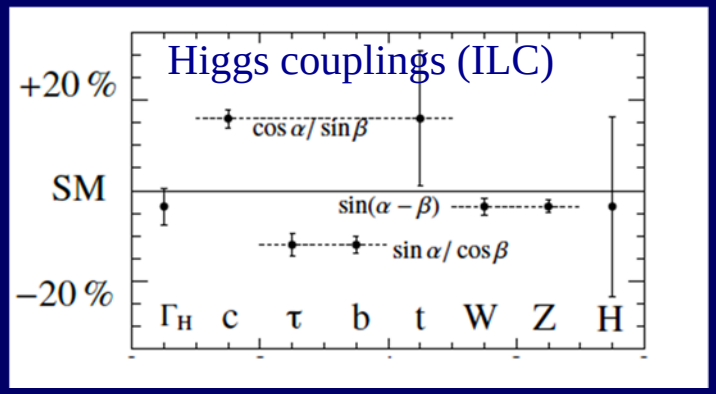


ILC: Simple and clean initial&final states

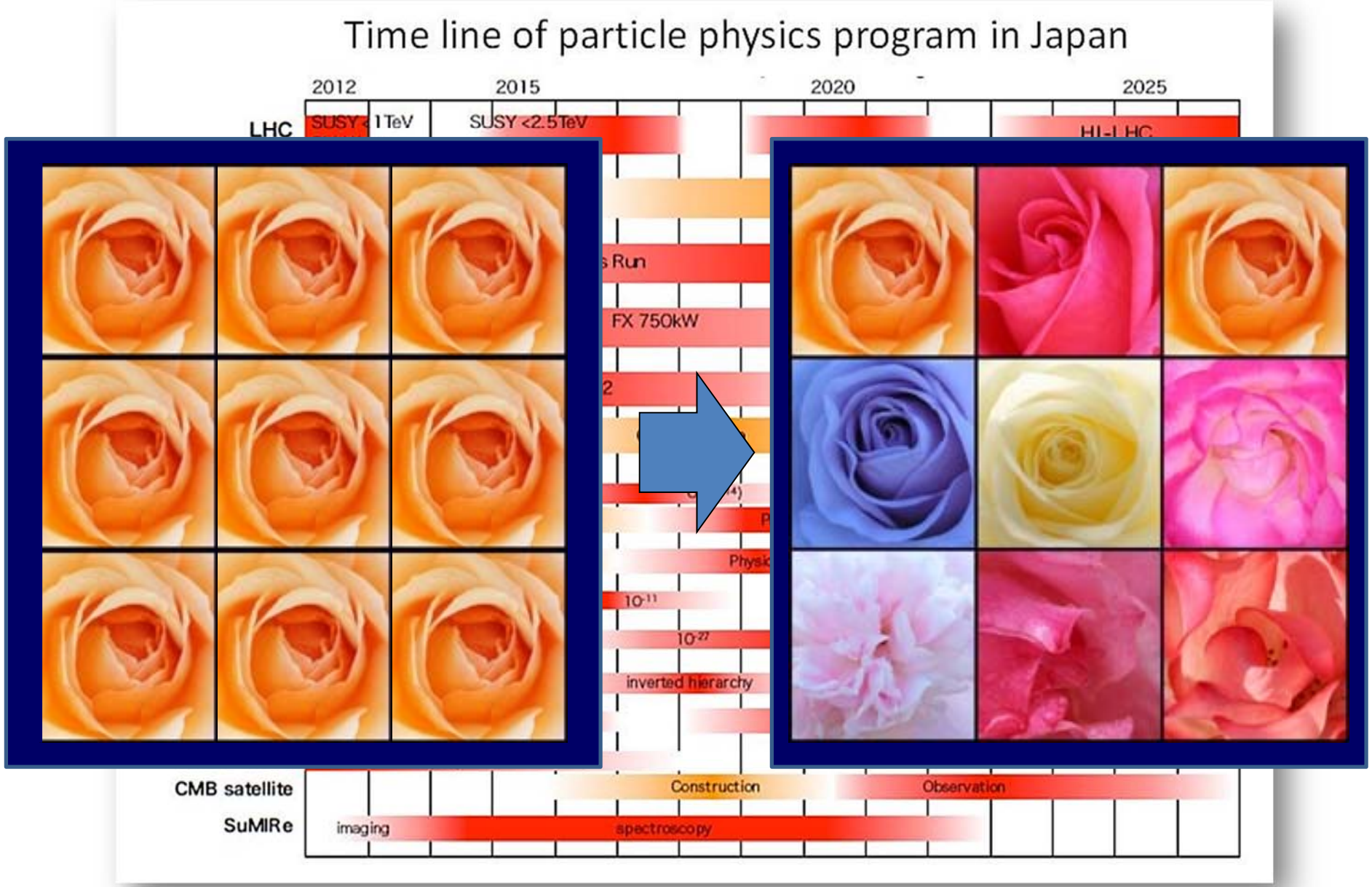
Specify Initial-state 4-momentum

& beam polarization : control intermediate state

(e.g. e_R turns of $W^{\pm}$&A^0)



4. Summary


Time line of particle physics program in Japan
2012
2015
2020
2025
LHC
SUSY <1TeV
SUSY <2.5TeV
HL-LHC
Run
FX 750kW
inverted hierarchy
CMB satellite
Construction
Observation
SuMIRe
imaging
spectroscopy