KEK-DG Prof. Atsuto Suzuki apologizes
to you for not attending and not giving this talk,
to MEXT for the radiation leakage at J-PARC.

ECFA LC2013

European Linear Collider Workshop

27 – 31 May 2013
DESY, Hamburg

Update on the Japanese (KEK) Strategy

Atsuto Suzuki (KEK)

INTER-UNIVERSITY RESEARCH INSTITUTE CORPORATION
HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION

Outline

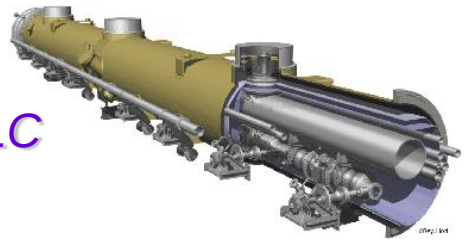
1. Particle Physics Strategy of KEK
2. Intensity Frontier Project : SuperKEKB
3. Intensity Frontier Projects at J-PARC
4. Energy Frontier Projects
5. Summary

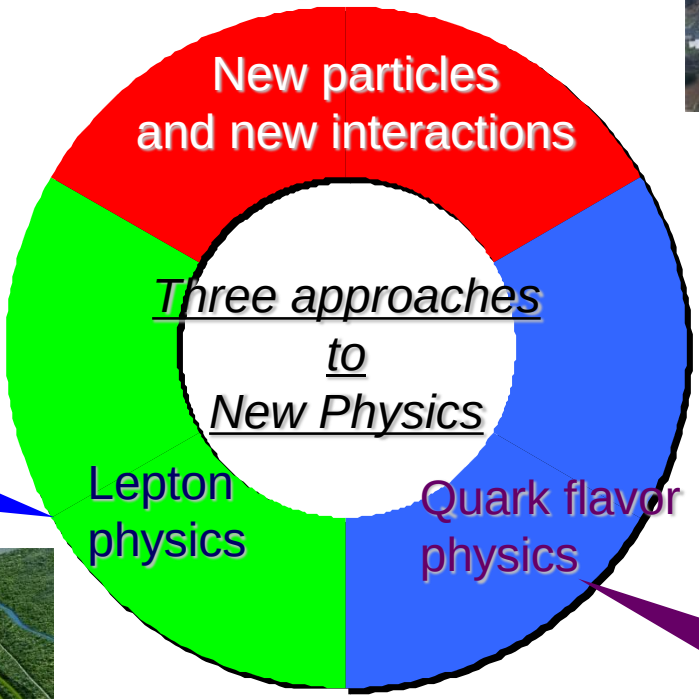
1. Particle Physics Strategy of KEK

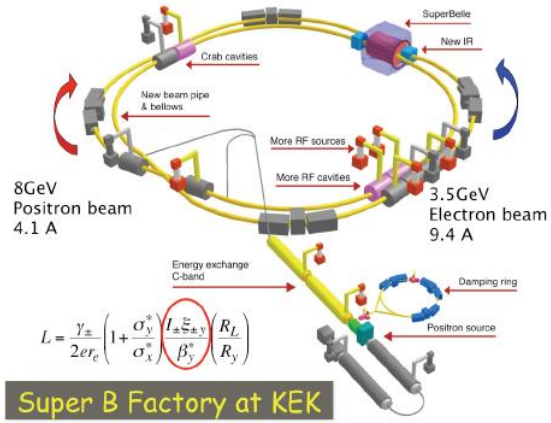
High Energy Physics in the Next Decade (2008)

Energy frontier experiments
LHC, ILC, …

Higgs, SUSY, Dark matter,
New understanding of space-time…







ν exp., μ LFV, τ LFV,
g_μ-2, …

Super-B Factory,
K exp., *etc.*

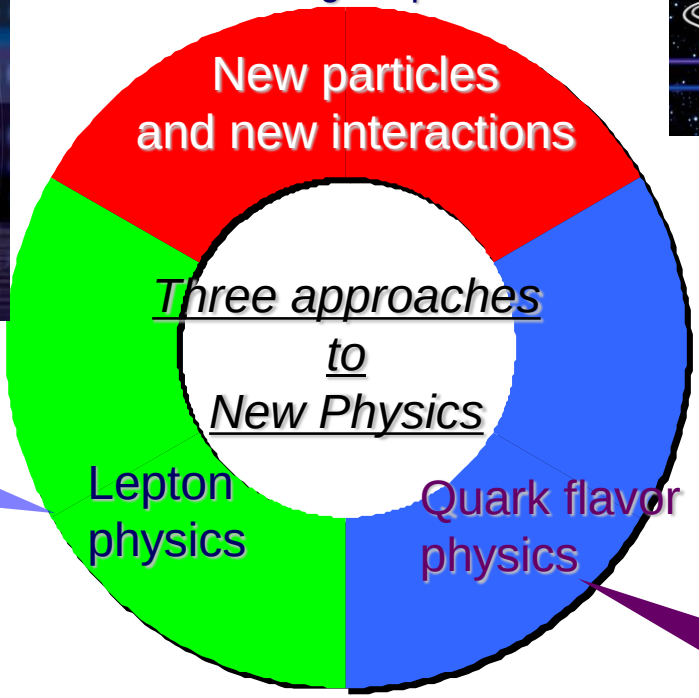
Neutrino mixing/masses,
Lepton number non-
conservation…

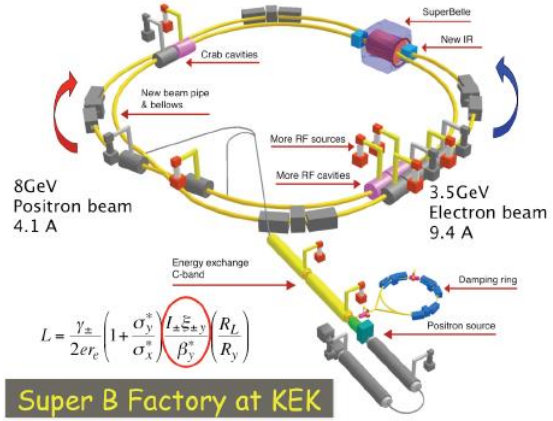
CP asymmetry, Baryogenesis,
Left-right symmetry, New sources
of flavor mixing…

High Energy Physics in the Next Decade (2013)

Energy frontier experiments
LHC, ILC, …

Higgs, SUSY, Dark matter,
New understanding of space-time…





ν exp., μ LFV, τ LFV,
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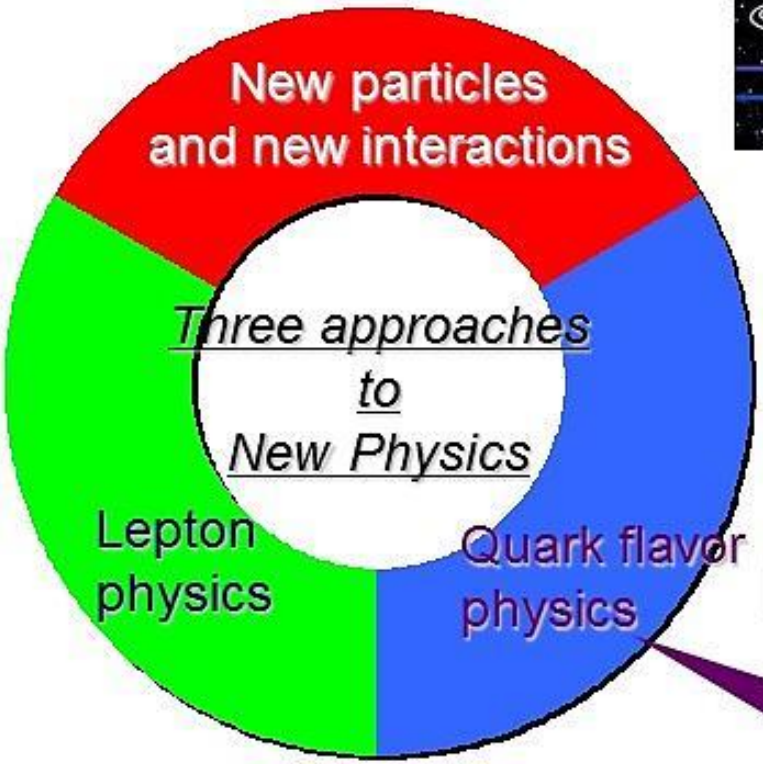
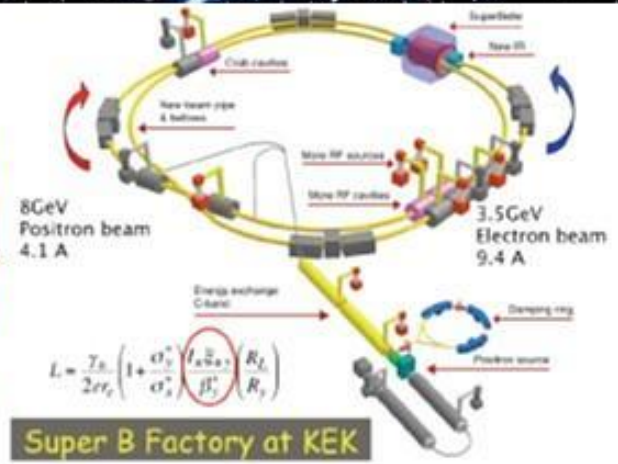
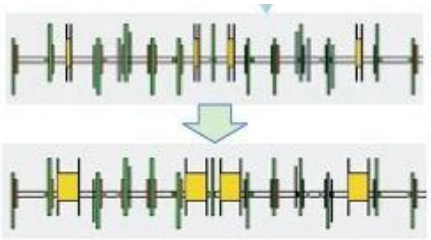
2. Intensity Frontier Project: SuperKEKB





SuperKEKB,

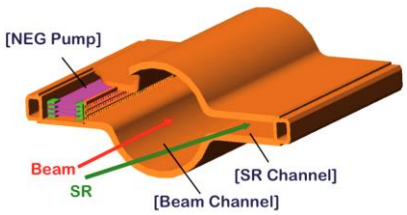
CP asymmetry, Baryogenesis, Left-right symmetry, New sources of flavor mixing…

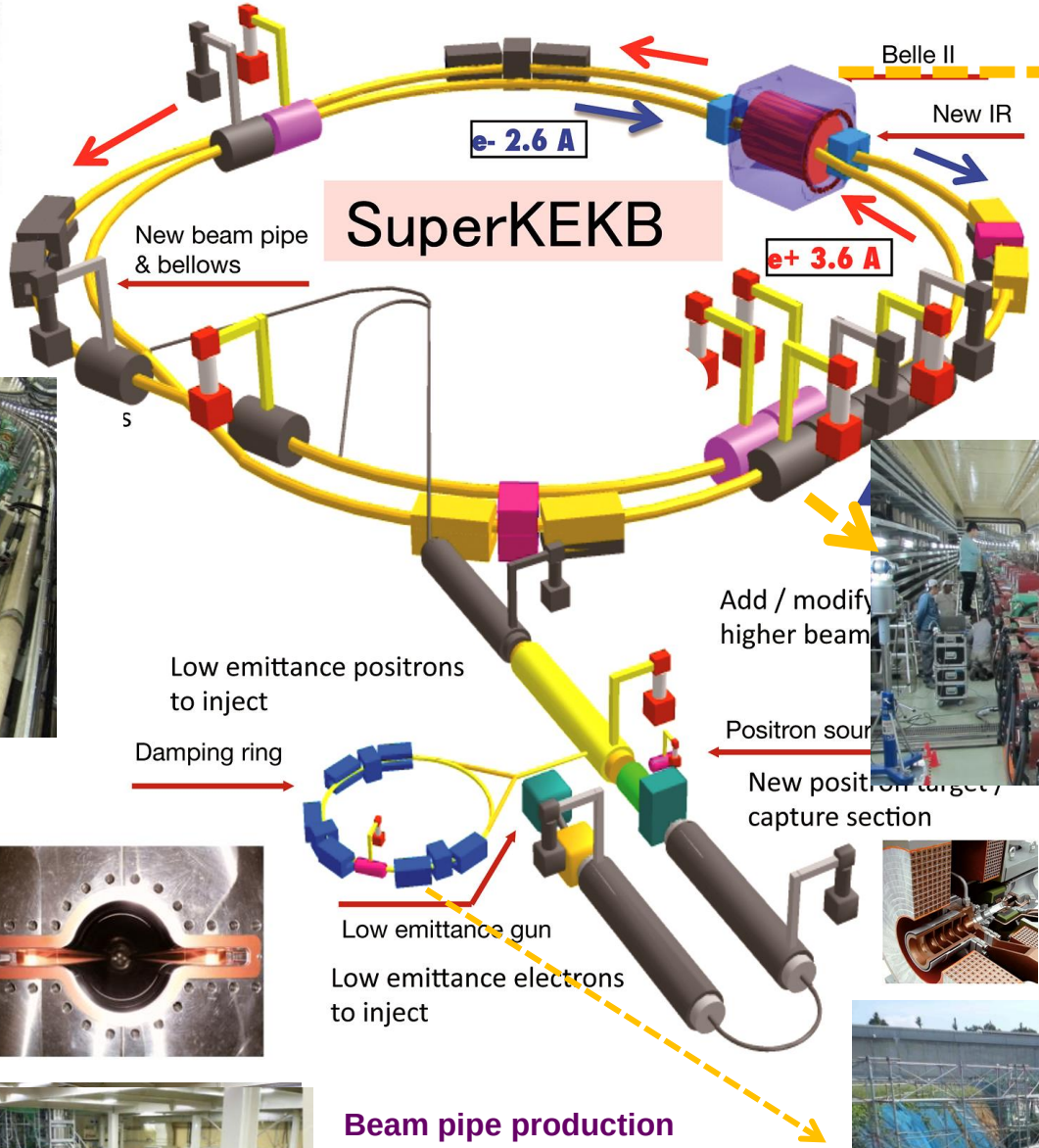


Redesign the lattice to squeeze the emittance (replace short dipoles with longer ones, increase wiggler cycles)

Installation of 100 new LER dipole magnets completed.

TiN coated beam pipe with antechambers





SC final focus: Successfully tested without any quench up to 2157A, well over the design value for nominal operation.

ARES cavities moved from HER to LER, and wiggler magnets for HER installed in D5 Oho straight section.

Beam pipe production at BINP

Beam pipes after baking and TiN coating in a stock area.

Belle II Detector Upgrade

BINP, KEK, Nara
Taiwan, Hanyang, …

CsI(Tl) EM calorimeter:
waveform sampling
electronics, pure CsI
for end-caps

7.4 m

RPC μ & K_L counter:
scintillator + Si-PM
for end-caps

ITEP, Virginia, KEK,
Hawaii, Indiana,
Wayne state, …

MPI, Bonn, Heidelberg, Barcelona,
Karlsruhe, Charles, DESY, Vienna,
KEK, IPMU U-Tokyo, Tohoku, TIFR,
Melbourne, Krakow

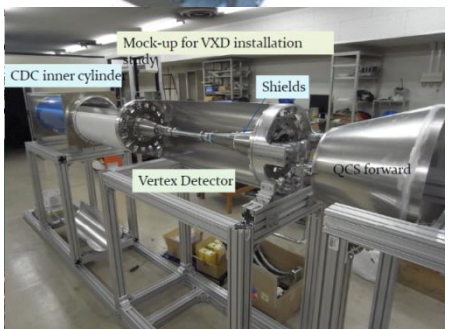
4 layers DS Si Vertex
Detector →
2 layers PXD (DEPFET),
4 layers DSSD

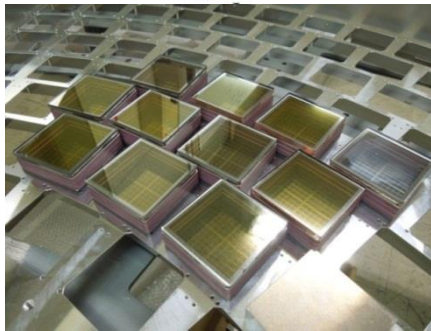
Nagoya, Toho, Chiba, Niigata,
Hawaii, Cincinnati, PNNL,KEK,
Tokyo metro, Ljubljana, …

PID system
Time-of-Propagation counter
(barrel),
prox. focusing Aerogel RICH
(forward)

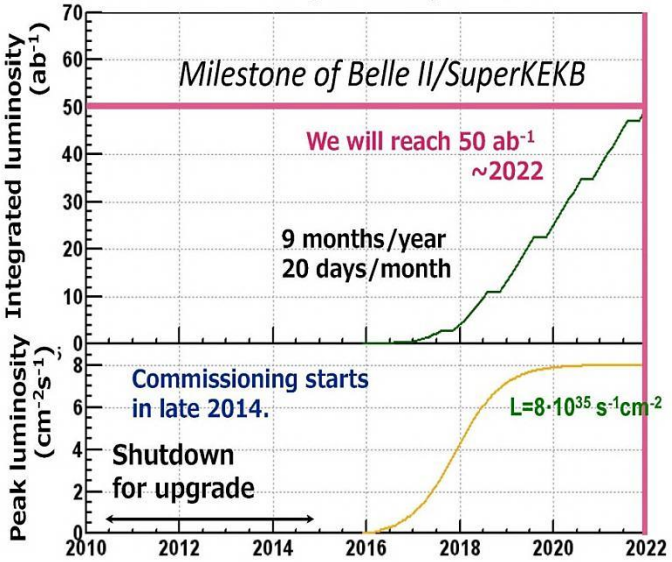
Central Drift Chamber:
smaller cell size,
long lever arm

KEK, Taiwan, RCNP,
Viet Nam, Malaya,
Chiang Mai, …

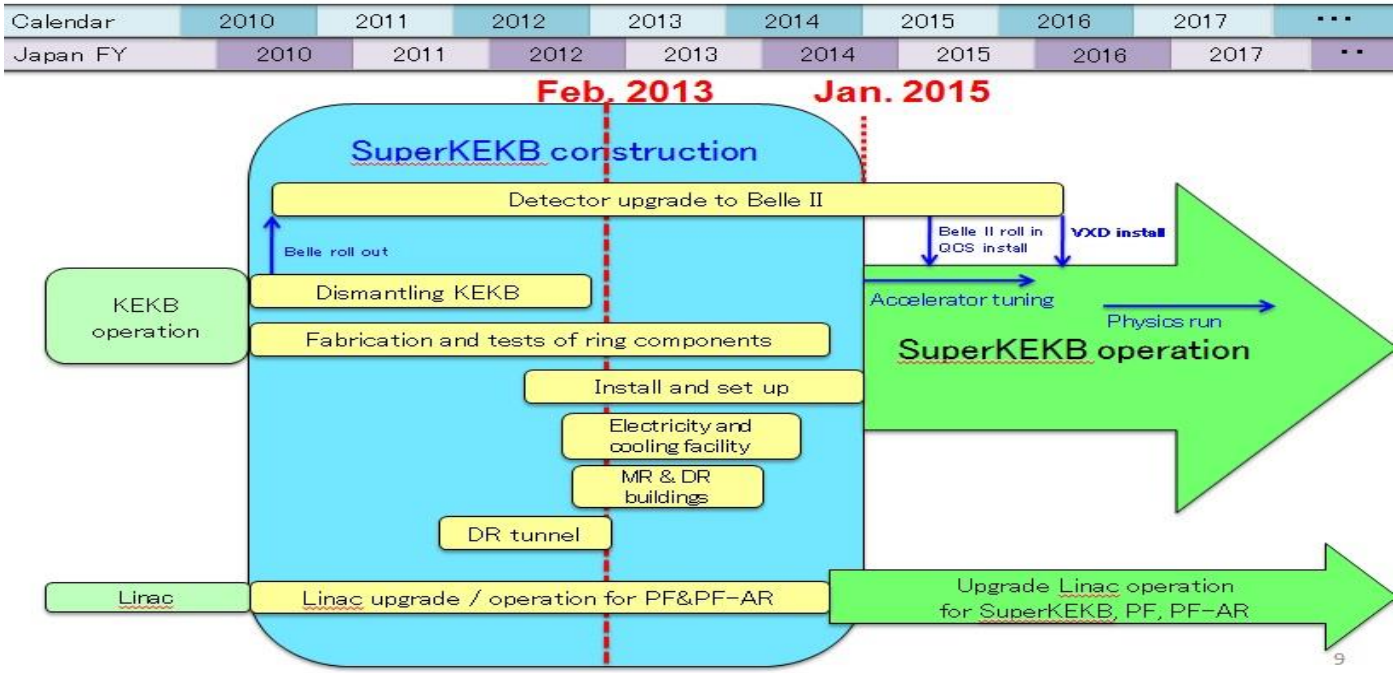




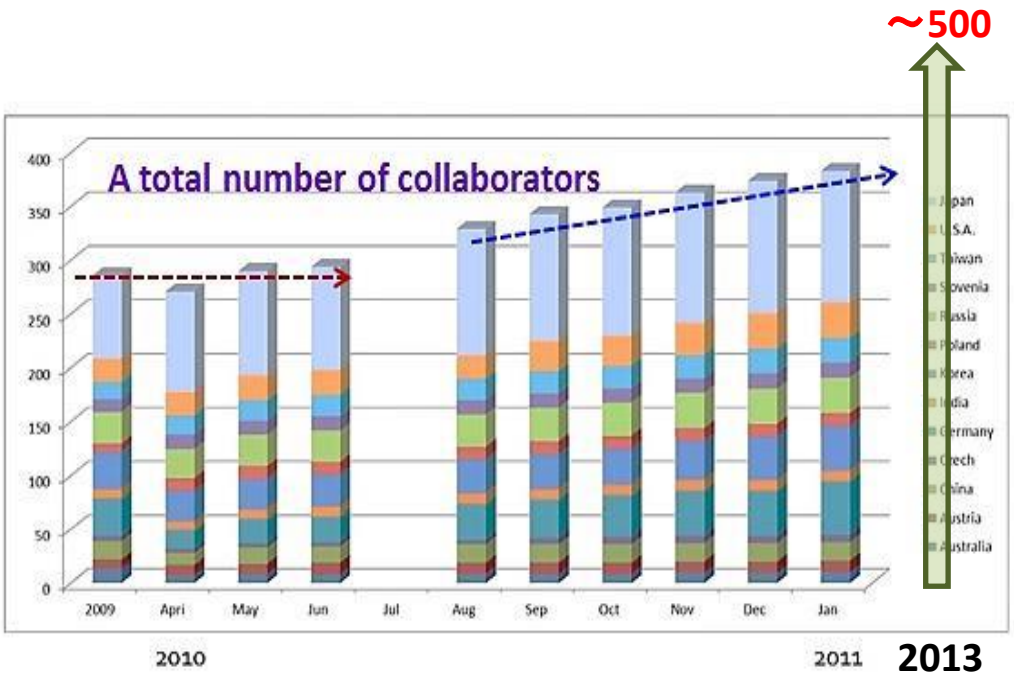
Luminosity Prospects



SuperKEKB Schedule



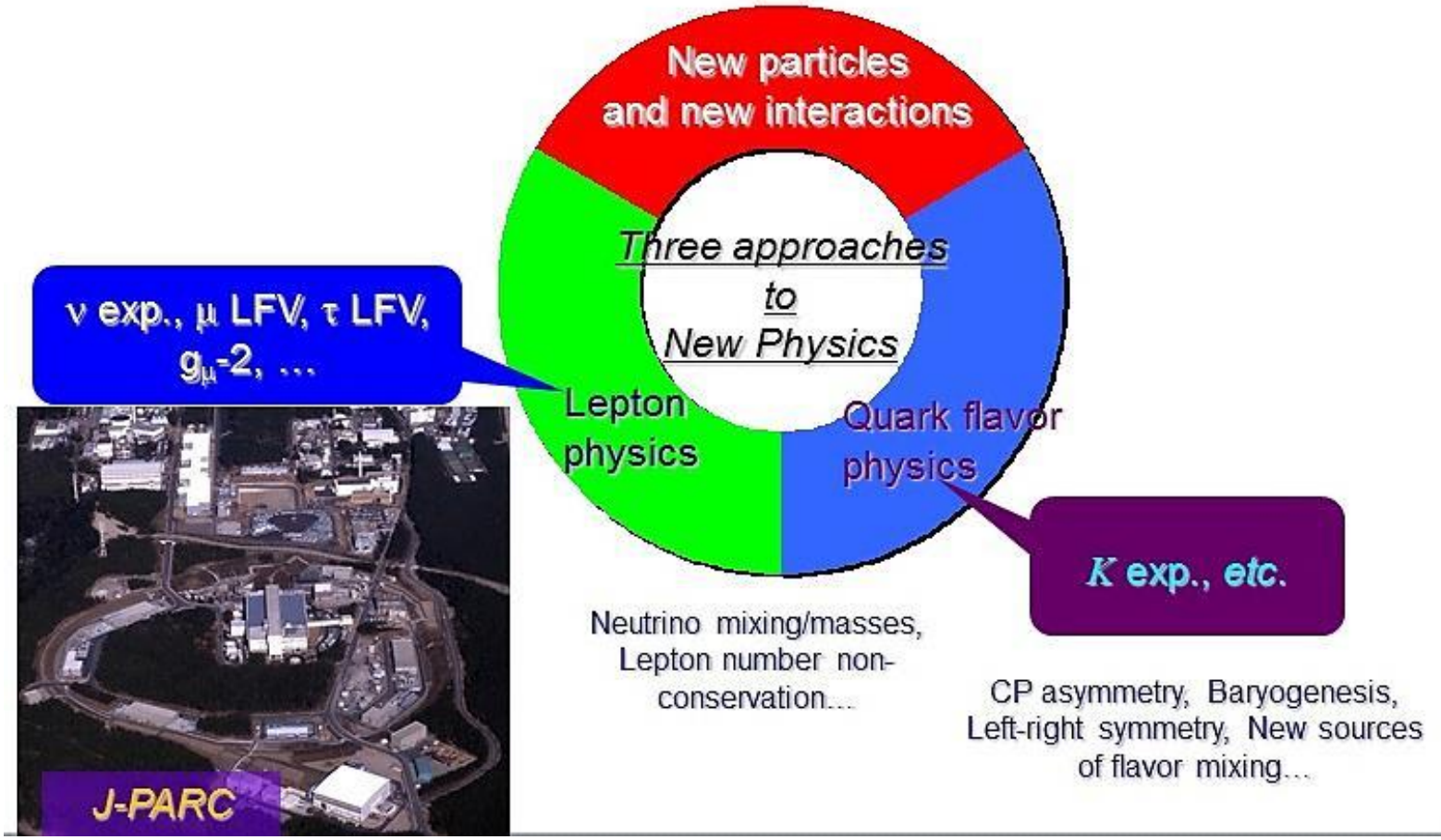
Belle-II Collaboration



- ~500 collaborators from 76 institutions in 21 countries
- Spokesperson:

  Peter Krizan (Ljubljana)
- Series of open collaboration meetings in 2008.03 ~2013.

3. Intensity Frontier Projects at J-PARC



Linac

Neutrin

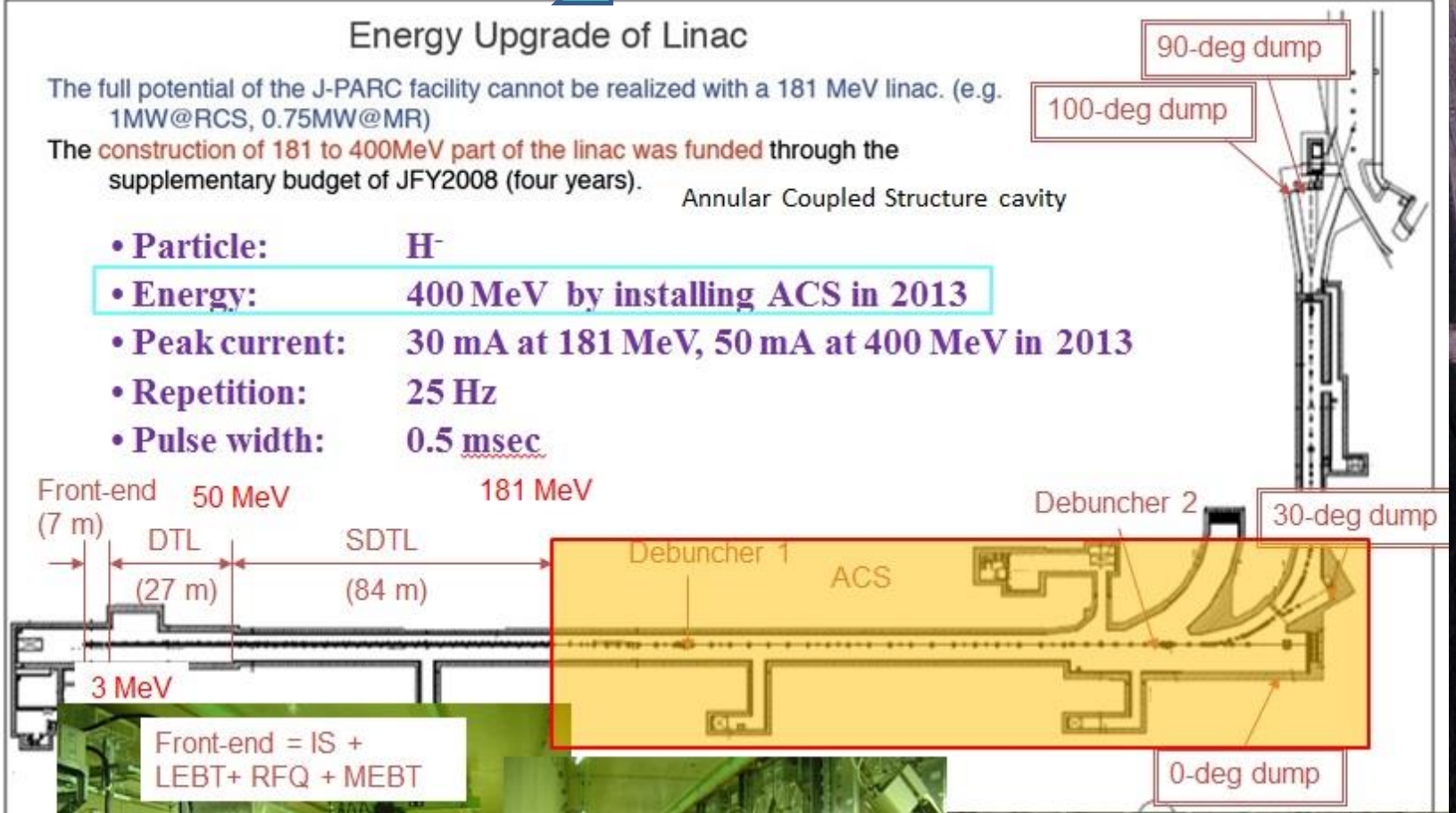
Energy Upgrade of Linac

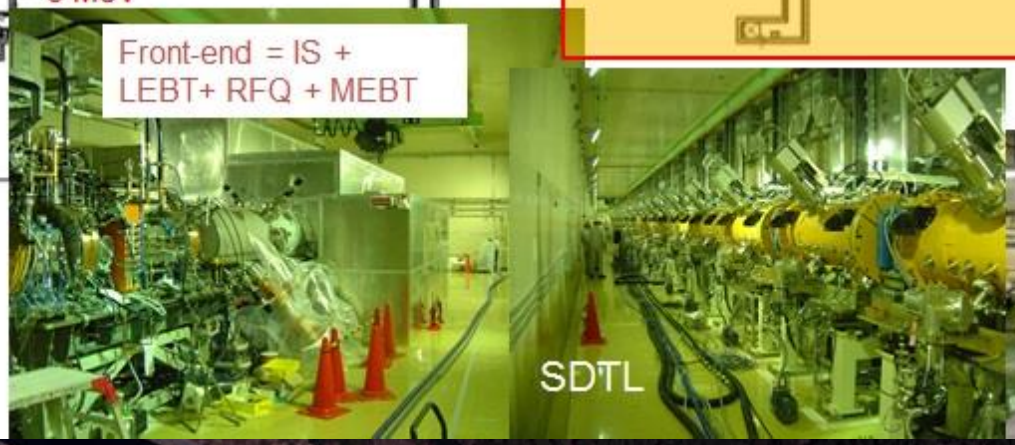
The full potential of the J-PARC facility cannot be realized with a 181 MeV linac. (e.g. 1MW@RCS, 0.75MW@MR)

The construction of 181 to 400MeV part of the linac was funded through the supplementary budget of JFY2008 (four years).

Annular Coupled Structure cavity

- **Particle:** H^-
- **Energy:** 400 MeV by installing ACS in 2013
- **Peak current:** 30 mA at 181 MeV, 50 mA at 400 MeV in 2013
- **Repetition:** 25 Hz
- **Pulse width:** 0.5 msec

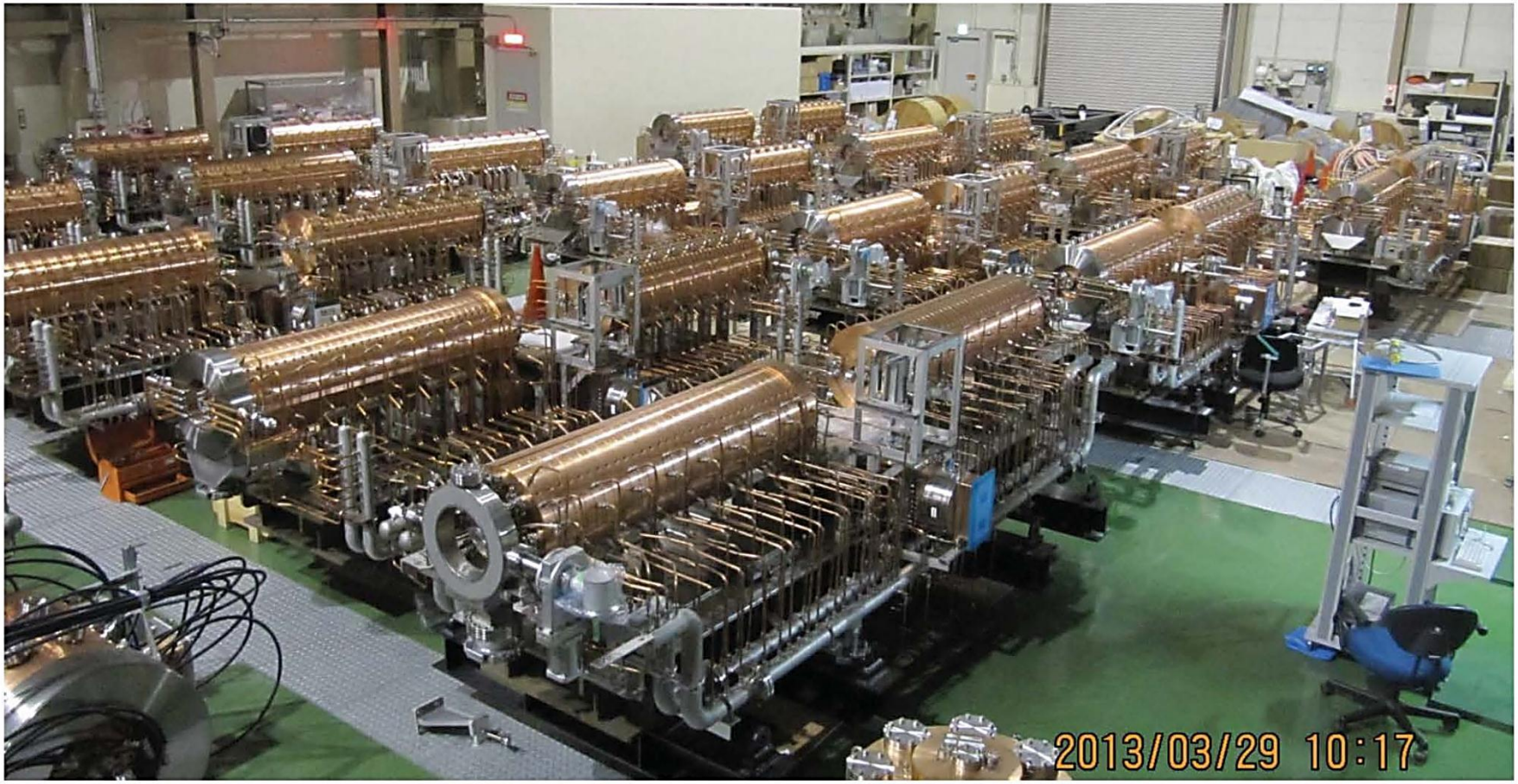


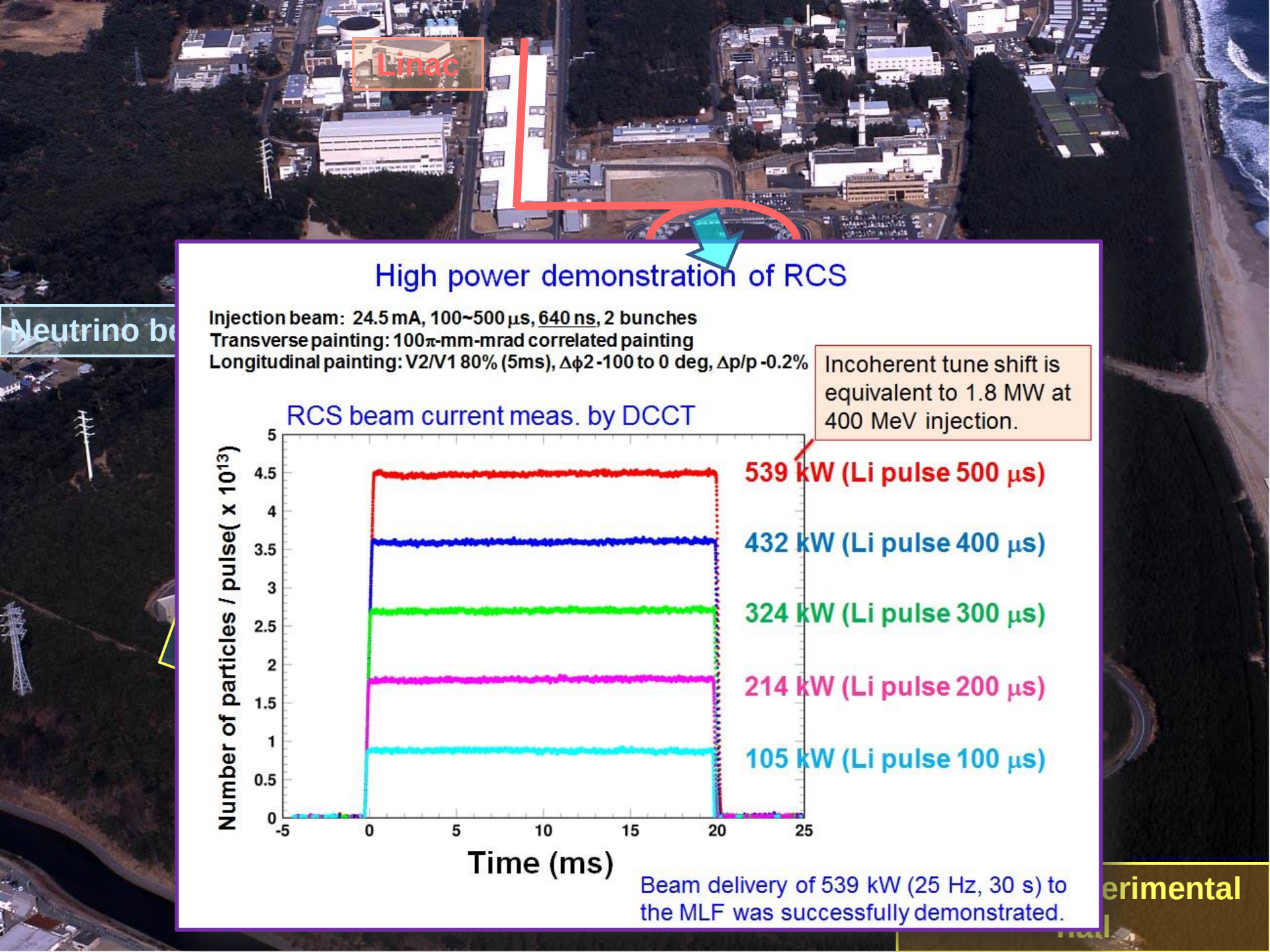


ntal

ACS modules for the energy upgrade of J-PARC Linac

Annular Couple Accelerator





High power demonstration of RCS

Injection beam: 24.5 mA, 100~500 μs, 640 ns, 2 bunches
Transverse painting: 100π-mm-mrad correlated painting
Longitudinal painting: V2/V1 80% (5ms), Δφ2 -100 to 0 deg, Δp/p -0.2%

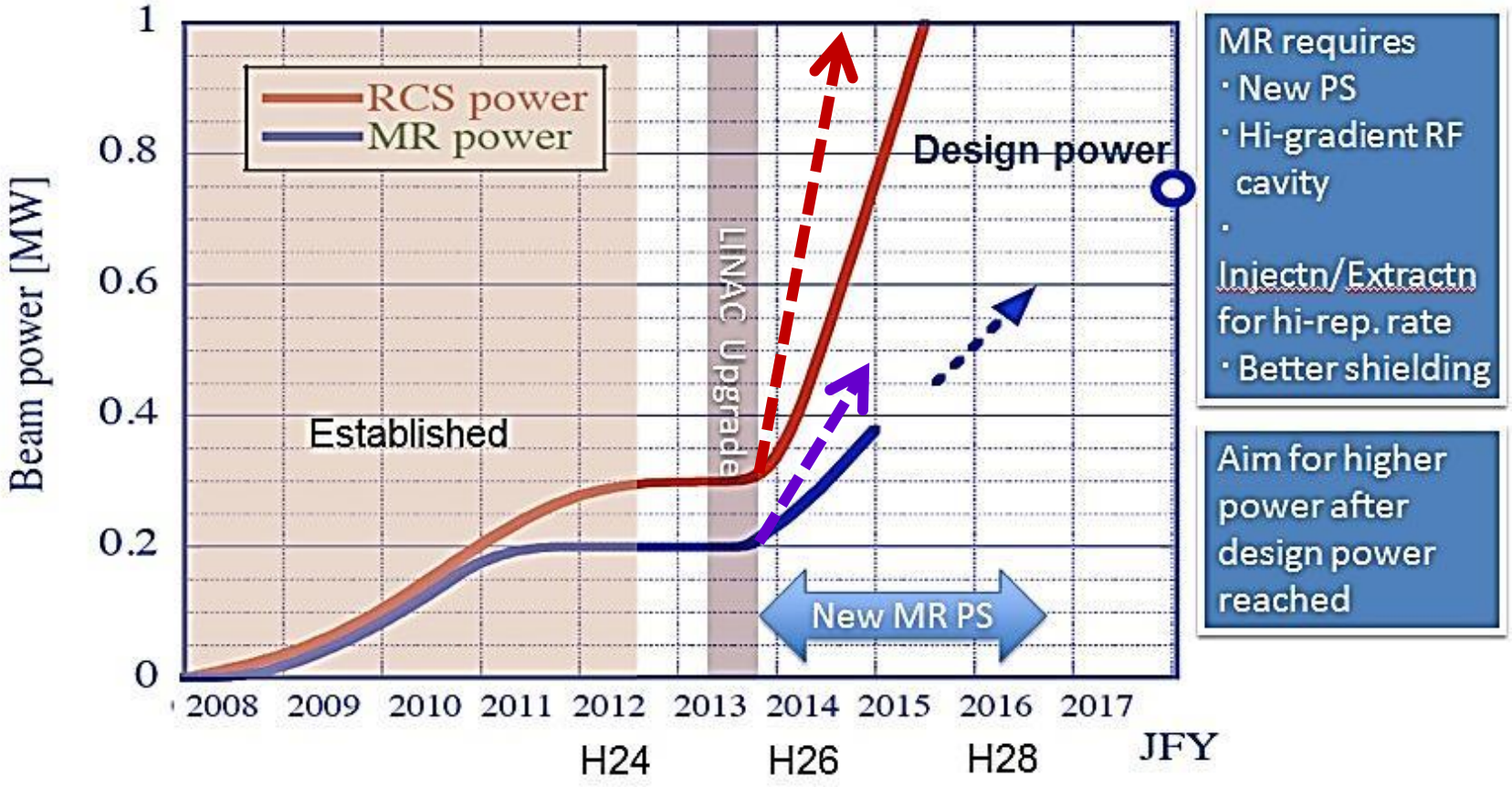
Incoherent tune shift is equivalent to 1.8 MW at 400 MeV injection.

RCS beam current meas. by DCCT

Beam delivery of 539 kW (25 Hz, 30 s) to the MLF was successfully demonstrated.

Beam Power Improvement

RSC reaches 1 MW after LINAC upgrades summer 2013
MR requires new PS (hi-rep.rate) to reach 0.75 MW



MR requires
- New PS
- Hi-gradient RF cavity
- Injectn/Extractn for hi-rep. rate
- Better shielding

Aim for higher power after design power reached

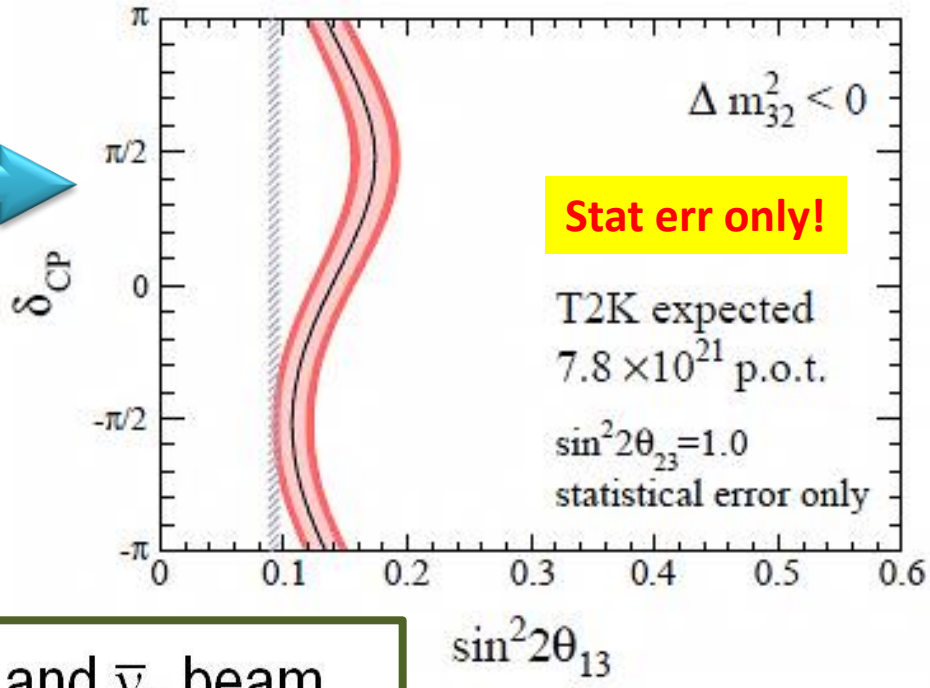
T2K Experiment

5σ significance until this summer

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

Expected beam power

May 2012	2014	2018
190kW	300kW **500kW**	750kW

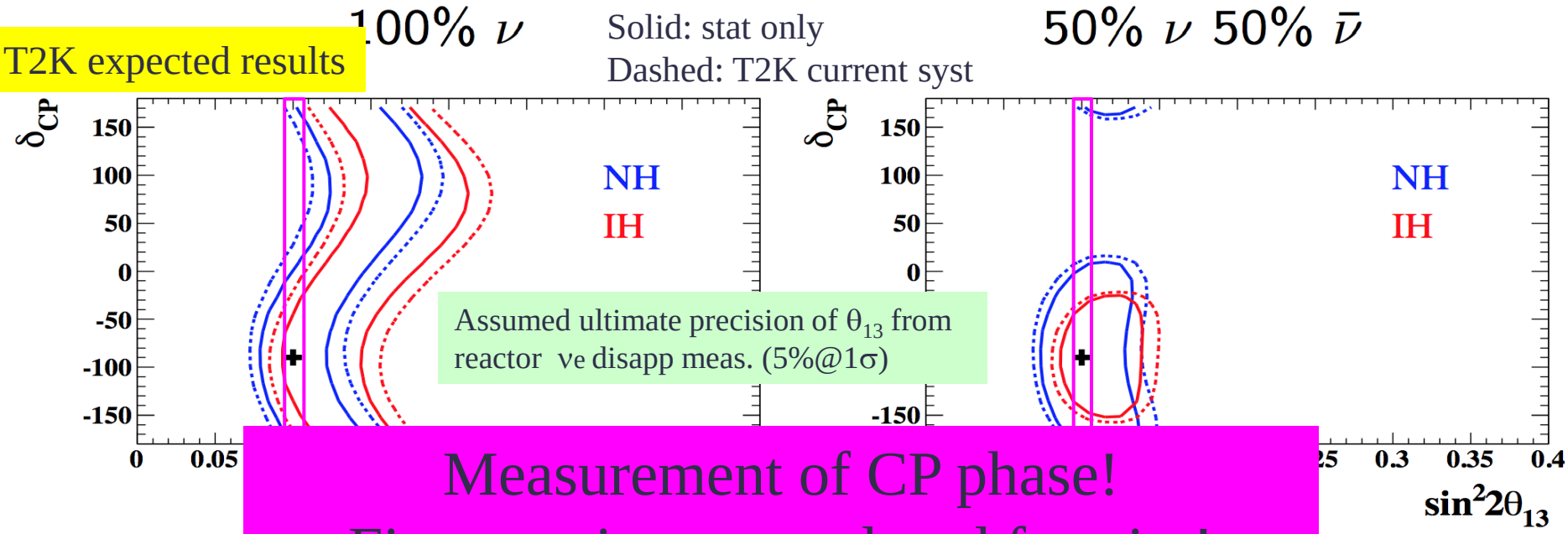


- Measure ν_e app. for both ν_μ and $\bar{\nu}_\mu$ beam
- Take asymmetry

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

Sensitivity to CPV

T2K expected results



Assumed ultimate precision of θ_{13} from reactor ν_e disapp meas. (5%@1σ)

Measurement of CP phase!
First step into unexplored frontier!
NO other experiments in the past had sensitivity to Lepton CPV

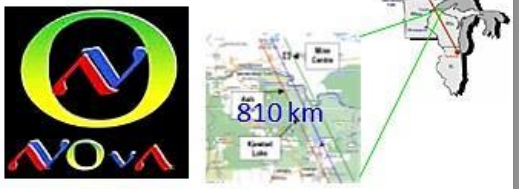
Chance to find something unexpected !!

Japan, Canada, US, France, UK, Switzerland, Poland, Korea, Russia, Spain, Italy, Germany, ……

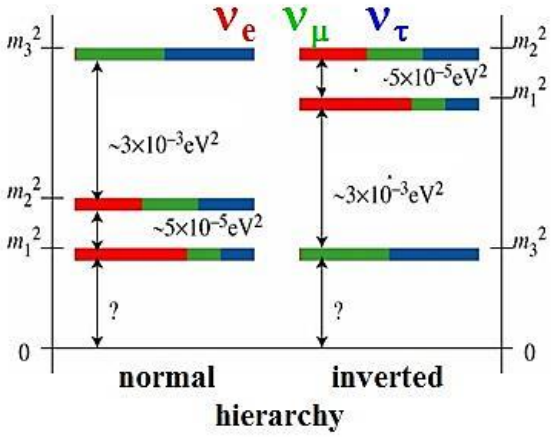
~500 members,
62 Institutes,
12 countries

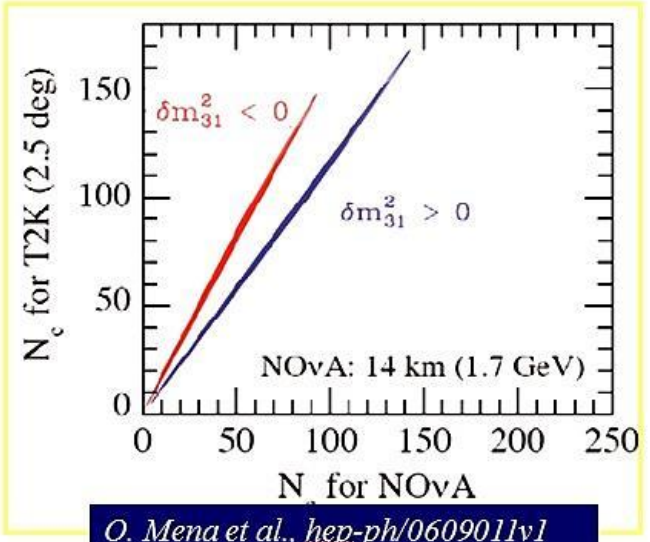
What is the mass hierarchy ?

- Δm^2_{21} : $8.2 \pm 0.6\ (10^{-5}\ eV^2)$
  $m_2 > m_1$



T2K + NOvA

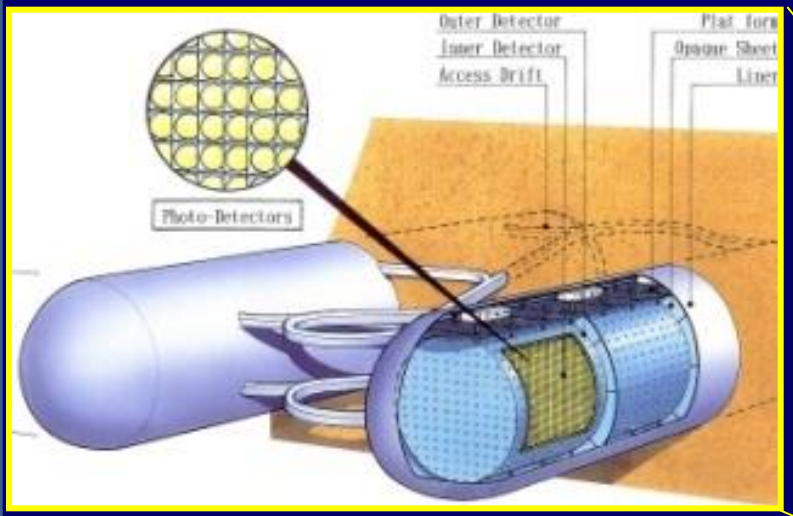




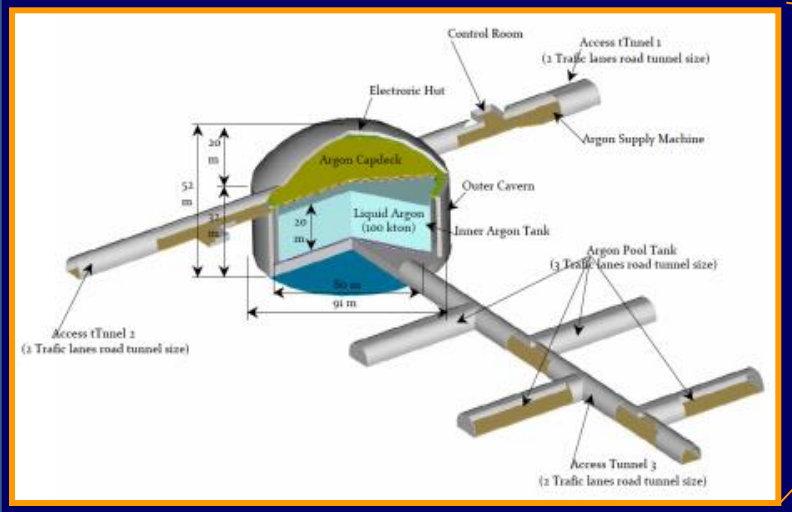
O. Mena et al., hep-ph/0609011v1

Scenarios from J-PARC

Kamioka L=295km OA=2.5deg



Okinoshima L=658km OA=0.78deg
Almost On-Axis



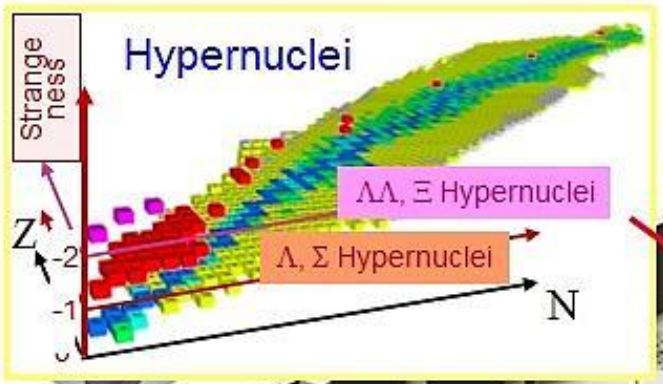
P32 proposal (Lar TPC R&D)
Recommended by J-PARC PAC
(Jan 2010), arXiv:0804.2111

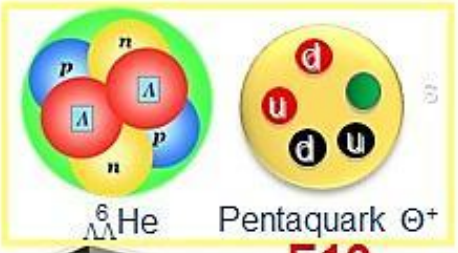
J-PARC

→1.7MW

→??MW

Nuclear & Particle Physics with J-PARC Hadron Beam

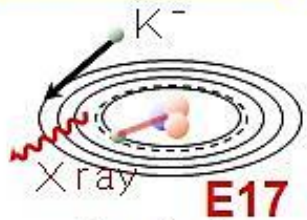




E19

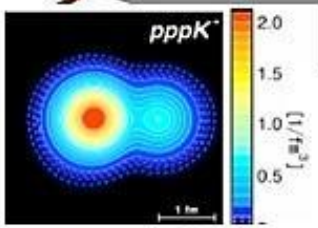
E14

Implantation of Kaon and the nuclear shrinkage

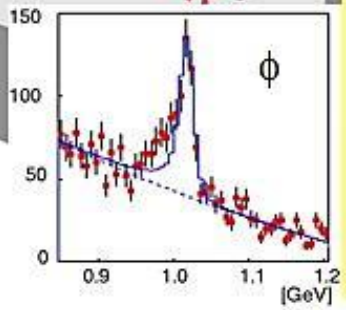


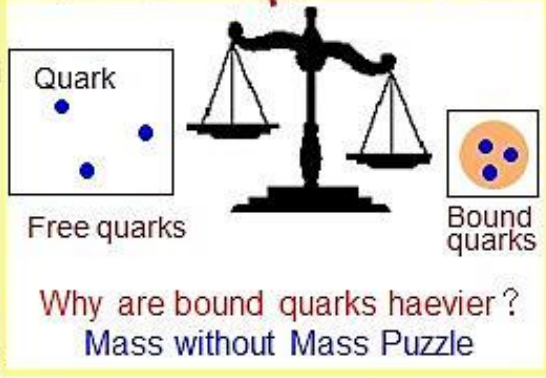
E17

Kaonic atom

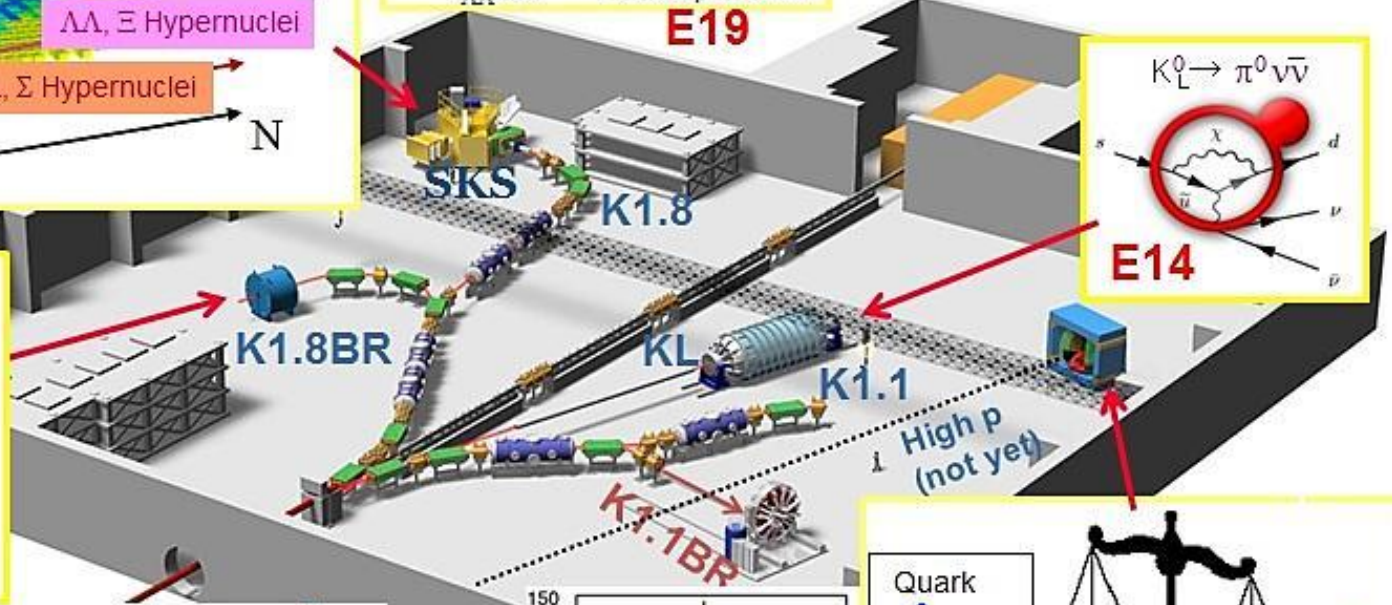


Kaonic nucleus





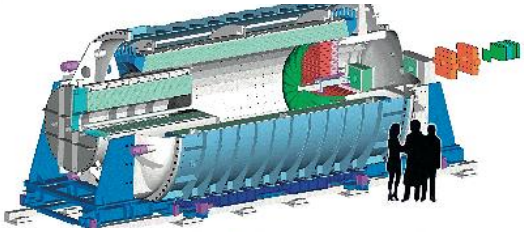
Why are bound quarks haevier ?
Mass without Mass Puzzle

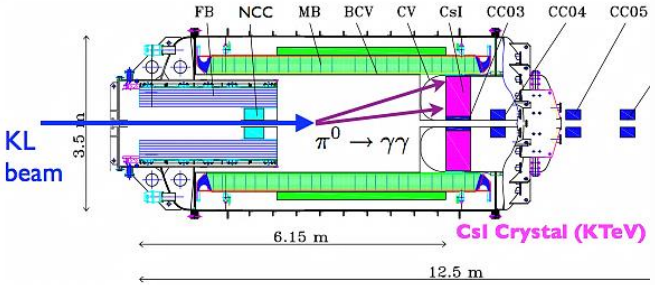


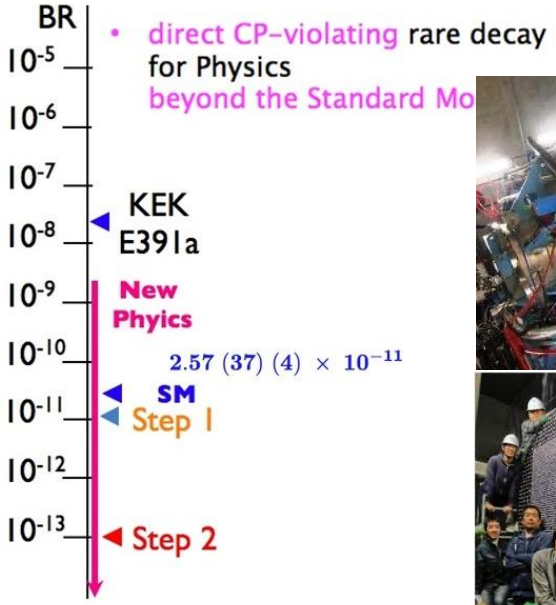
Hadron Facility

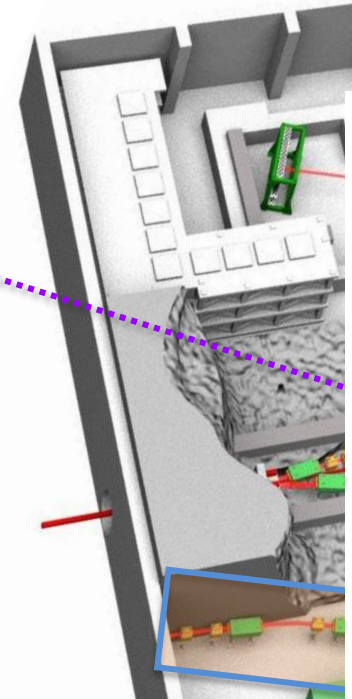
Rare Kaon Decay

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





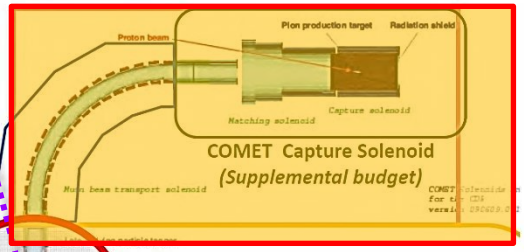




COMET: μ → e Conversion

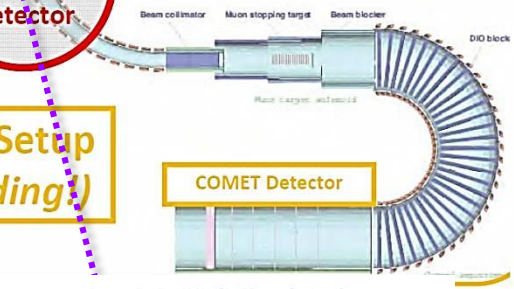
Signal : μ- + (A,Z) → *e*- + (A,Z)

COMET Setup

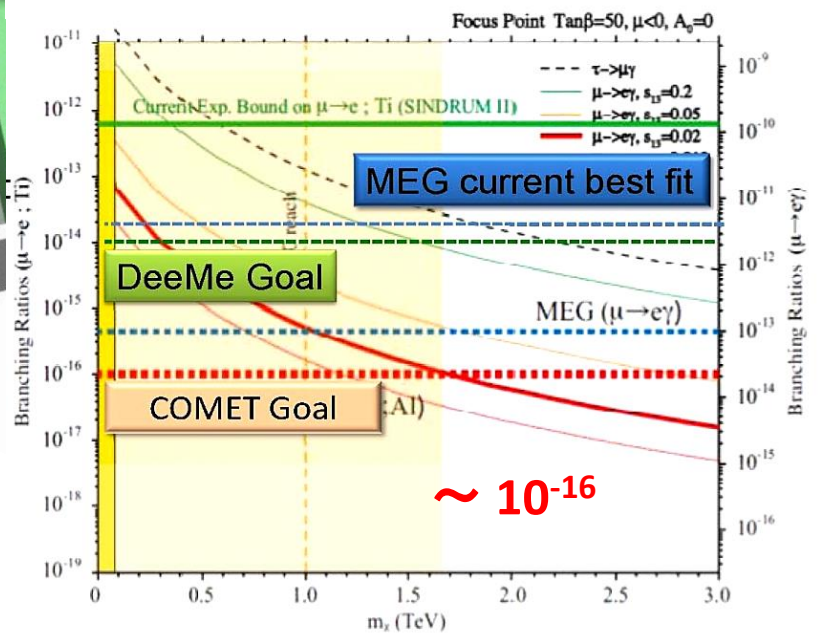


First 90-Degree Bending Solenoid

COMET Phase 1 Detector



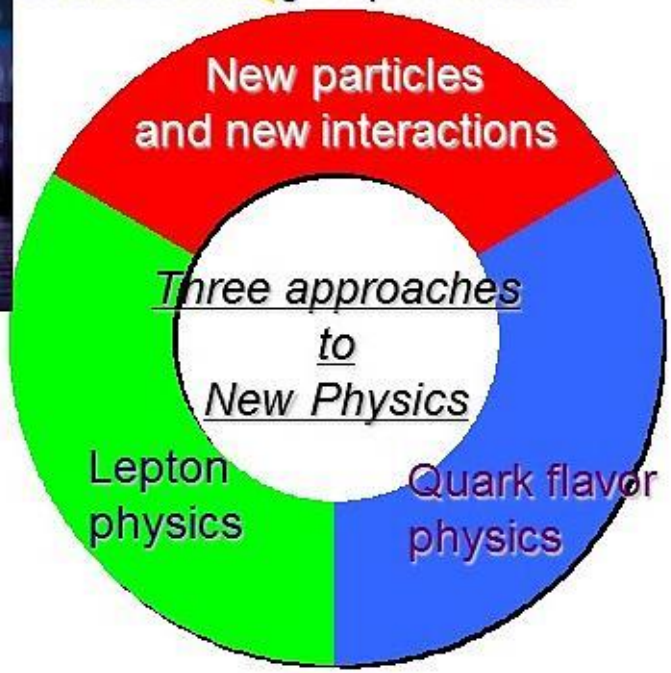
Full COMET Setup (Future Funding!)

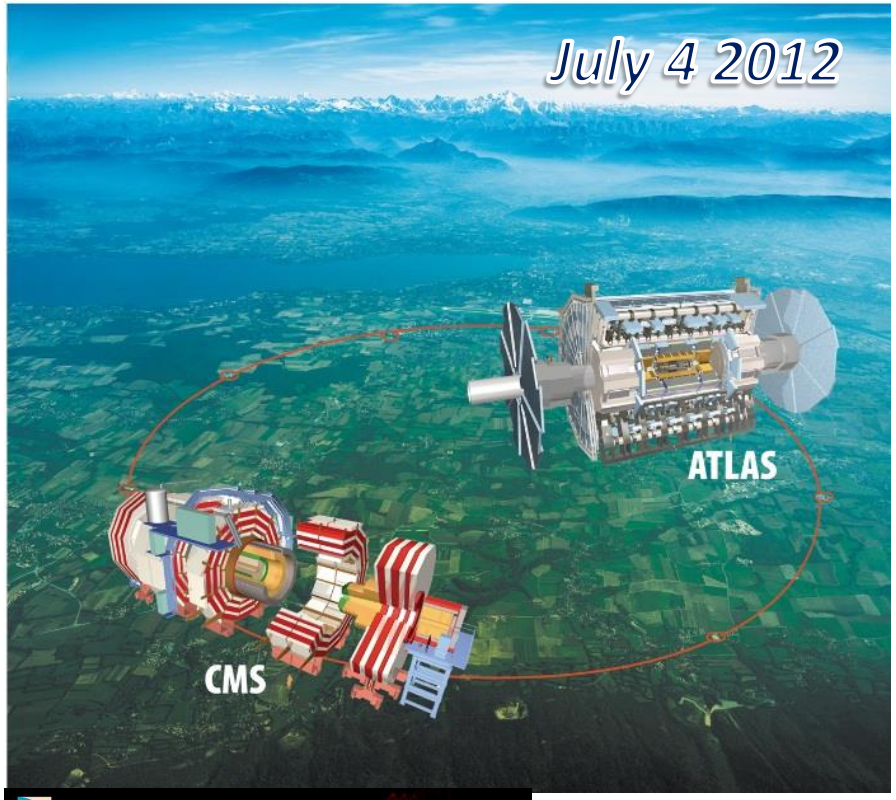


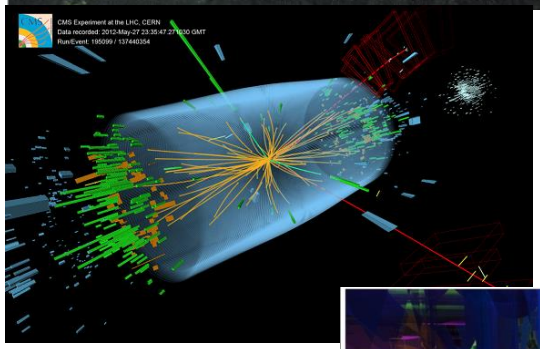
4. Energy Frontier Projects

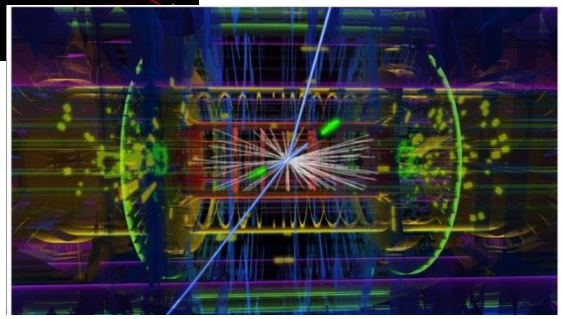
Energy frontier experiments
LHC, ILC, …

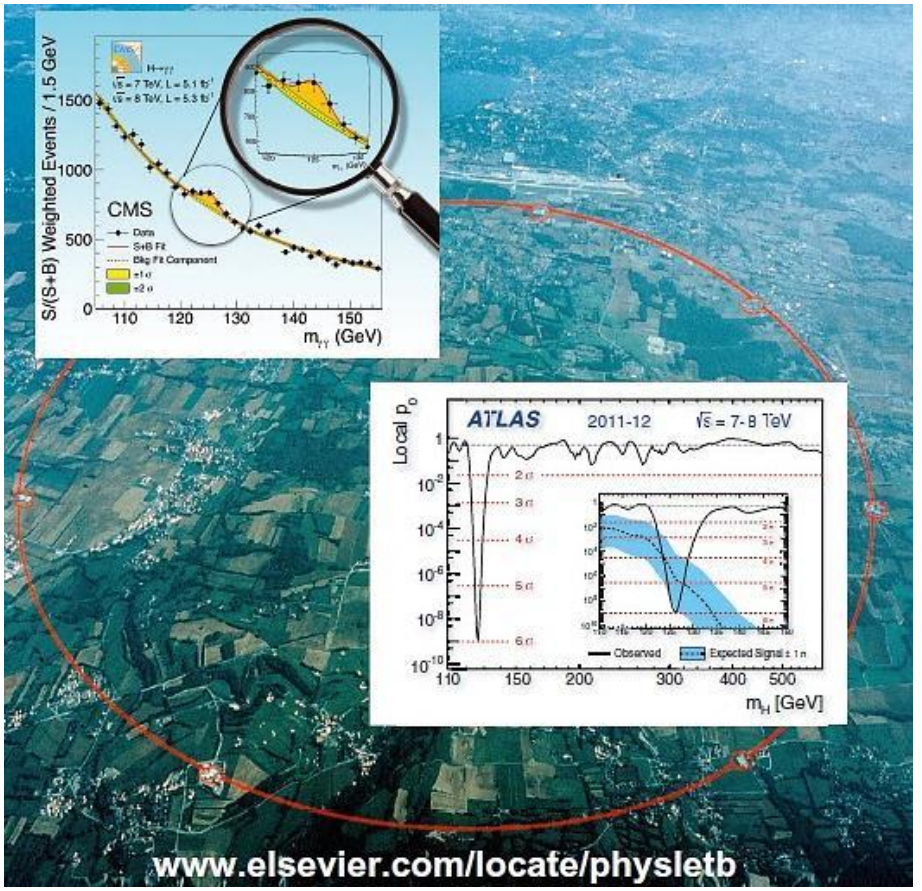
Higgs, SUSY, Dark matter,
ew understanding of space-time…




July 4 2012
ATLAS
CMS

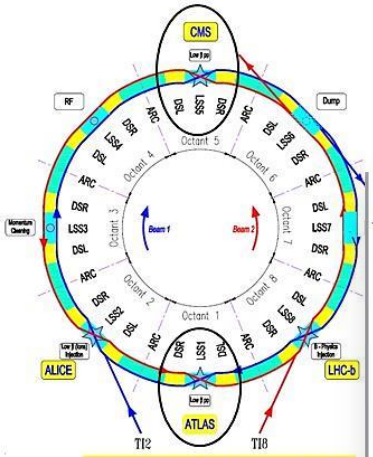

CMS Experiment at the LHC, CERN



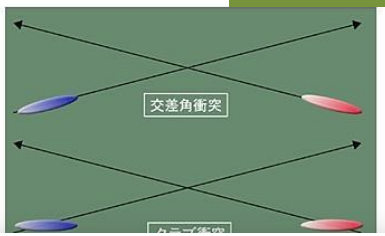

S/(S+B) Weighted Events / 1.5 GeV
CMS
Data
S+B Fit
Bkg Fit Component
$m_{\gamma\gamma}$ (GeV)
Local p_0
ATLAS
2011-12
$\sqrt{s}$ = 7-8 TeV
Observed
Expected Signal ± 1 σ
m_H [GeV]
www.elsevier.com/locate/physletb

LHC Upgrade

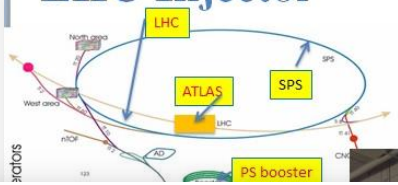
HL-LHC

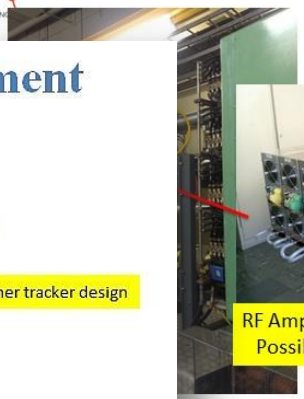


Replace the forcusing magnets around ATLAS and CMS.



LHC Injector

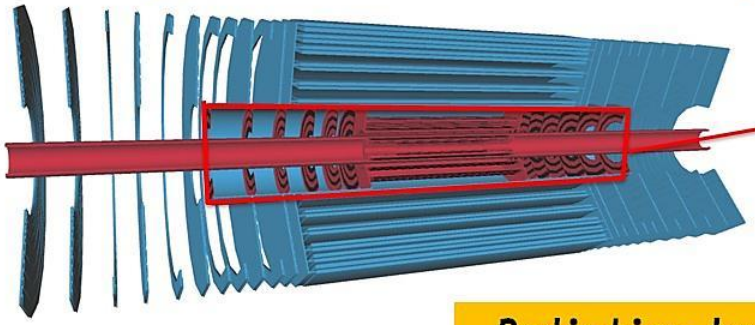




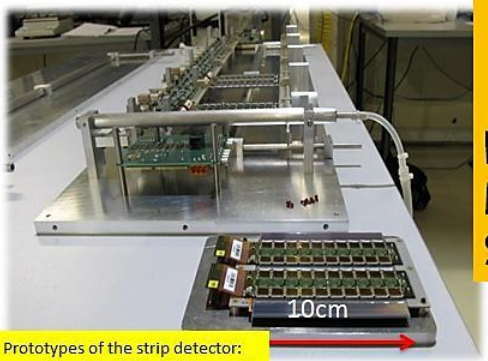
RF Amplifiers:
Possible KEK conributions

25

ATLAS upgrade (1) Inner tracker replacement



A new inner tracker design



Prototypes of the strip detector:
produced by KEK and Geneva U.

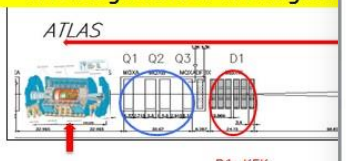
Radiation hard trackers are already in reality!

We need a huge investiment.

Pixel	8.2 m²	600 M ch.
Strip	193 m²	70 M ch.

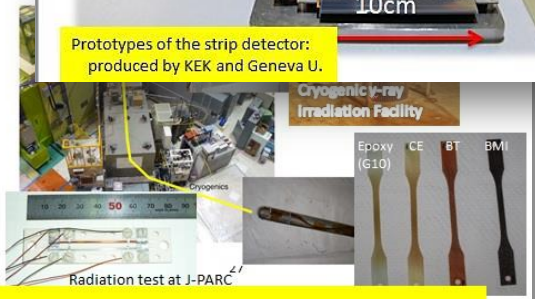
1

International collaboration has st
the design work of the magnet



Q1-3:
US-LARP(Nb3Sn) or
CERN(NbTi)

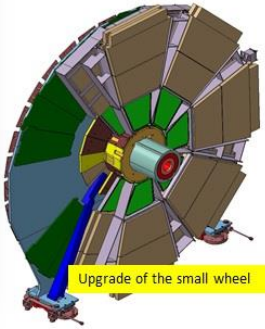
D1: KEK



Radiation test at J-PARC

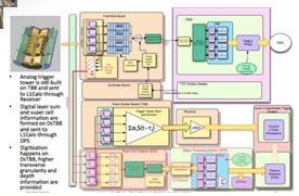
Challenges:
Large aperture (φ130~150mm) 6 Tesla magnet: saturation, flux leakage
High radiation dose: selections of rad-hard materials

pgrade



Upgrade of the small wheel

Track trigger (Waseda University)



CAL trigger upgrade (U. of Tokyo)

ilc newsline

FEATURE

Press Release: International Linear Collider completes draft of its design report

Handover ceremony on 15 December in Tokyo, Japan

20 December 2012

Barry Barish and Sakue Yamada handing over the TDR to ILCSC chair Jon Bagger. Image: Nobuko Kobayashi

パネルディスカッションの様子。左からパネルディスカッションの座長をつとめた村山斉氏、パネリストの鈴木氏、バリッシュ氏、山田氏、バガー氏、増田氏、西岡氏。

The handover was followed by a panel discussion.

8 March 2013

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

White paper

Update of the European Strategy for Particle Physics
by the European Strategy Group for Particle Physics

Endorsed by CERN Council on March 22

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.*

HEPAP Facilities Subpanel:
Report on Energy Frontier Facilities

S. Dawson, BNL
March 11, 2013

S. Dawson

We need an agreement at diplomatic levels

US Participation in Japanese Hosted ILC

- Science drives the need for e^+e^- collider
  - ILC addresses absolutely central physics questions and is complementary to the LHC
  - Japanese hosted ILC could be under construction before 2024
- Parameters of a potential US contribution are not known and depend on international agreements
  - The US has made substantial contributions to detector and accelerator development through the global effort
  - Should an agreement be reached, the US particle physics community would be eager to participate in both the accelerator and detector construction

S. Dawson 22

Federation of Diet Members for promotion of the ILC project

~150 menbers

Lyn Evans in March in Japan

T. Kawamura : former chief Cabinet Secretary and former Minister of MEXT, chairman of the Federation of Diet Members in support of the Linear Collider

I. Yamamoto : Science and Technology Minister

H. Shimomura: MEXT Minister

T. Nishioka: Chairman of Advanced Accelerator Association (AAA) and former President of Mitsubishi Heavy Industries

T. Okamura: Chairman of the Japan Chamber of Commerce and Industry and formally CEO of Toshiba

Prime Minister Abe

Meeting of the U.S. – Japan
Science and Technology
Joint High Level Committee

April 30, 2013

April 30, 2013
n, D.C.

TUESI	
8:30	
	of JHLC Objectives
9:00-9:1	US-Japan Advance
9:10-9:25	Scie • Min Poli min)

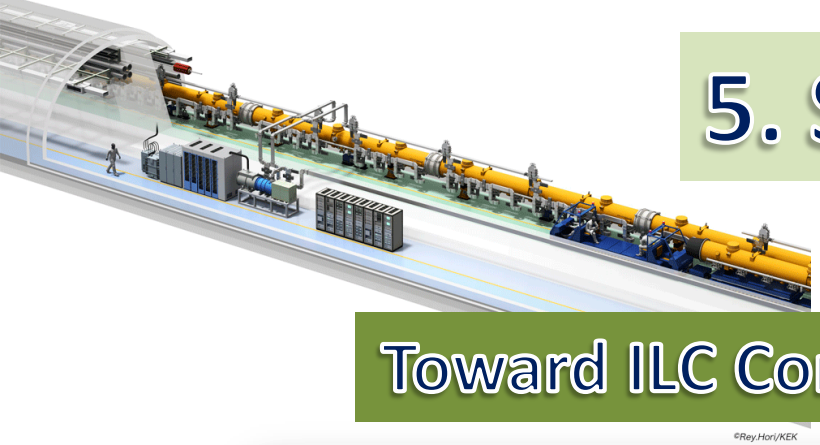
gathers US and Japanese l nd innovation,
lustry. With the International Linear Collider (ILC) as an example, the discussion will cover
the US-Japan co-operation in science and technology, working together for innovation and the realization of
policies for the
resources

meeting on Sci IP
ment officials p n
science and tech
ed by the Linear

Association for
International Linear Collider Americas

Advised by Federation of Japanese Diet members in support of Linear Collider Project.


WILLARD
INTER-CONTINENTAL



5. Summary

Toward ILC Construction : Japan Activities