JAHEP
- Japan Association of High Energy Physicists -
日本語

ilc international development team

Status and plans for the realisation of the International Linear Collider (ILC) and other **large-scale** projects in Japan

(？)

Nice Venue, I enjoy stay.

Shoji ASAI (KEK)

24 June 2025

Many Thanks to T.Nakaya, U.Ushiroda, Y.Matsuoka, K.Shibata, T.Kobayashi,T.Nakadaira, H.Nanjyo, S.Mihara, T.Nakada, A.Yamamoto, S.Michizono, M.Ishino and H.Sakai

Insight through Accelerators. KEK

National Input By Chair: Tsuyoshi Nakaya

Japan's Updated Strategy for High Energy Physics for the ESPP Update 2026

Japan Association of High Energy Physics (JAHEP)
(Contact: Tsuyoshi Nakaya [t.nakaya@scphys.kyoto-u.ac.jp])

March, 2025

Abstract

The Japanese High Energy physics community, JAHEP (Japan Association of High Energy Physicists) provides Japan's Updated Strategy for High Energy Physics for the ESPP Update 2026. High energy physics research in Japan encompasses a variety of groundbreaking experiments conducted at major facilities. These include the SuperKEKB accelerator and the Belle II experiment, which focus on search for new physics in heavy flavor decays; the high power proton accelerator complex J-PARC, where experiments are conducted using the high intensity neutrino, kaon, muon and neutrons beams; and collaborative efforts in CERN's Large Hadron Collider (LHC and HL-LHC) experiments. For neutrino research, the construction of the Hyper-Kamiokande experiment started and is currently underway. We emphasize the importance of maintaining timely progress in these ongoing experiments and construction of experimental facilities. We acknowledge significant contributions by European collaborators to the Japan-based experiments, and wish to see more participation. We also acknowledge essential support of CERN to the experiments as a key hub for the European activities.

Looking into the future, the early realization of a Higgs factory through international collaboration is crucial for our field. We take into account the evolving situation of Higgs factory proposals: CEPC, FCC-ee, ILC, and LC@CERN. To ensure the realization of a Higgs factory, we pursue the following key directions:

- We prioritize efforts to realize the ILC as Global Project, taking a leading role in advancing ongoing initiatives. We will engage with international partners to discuss governance, responsibilities, and site selection. We intend to develop and expand our scientific and promotional activities to host the ILC as Global Project in Japan .
- We also extend our activities in other Higgs factory proposals as a collective approach to maximize the chances of timely realizing a Higgs factory.

In addition, the ILC Technology Network (ITN), international R&D framework for the ILC accelerator initiated by KEK and ILC International Development Team (IDT), has started. The collaboration with CERN is essential for ITN. The detector R&D with test beams are essential for future experiments, and we would promote international collaborations in detector developments, such as ECFA-Detector R&D. Beyond a Higgs Factory, developing high-field magnets using state-of-the-art superconductors is critical to realize a future hadron collider.

By advancing current and future projects, we aim to continue contributing to fundamental discoveries and to foster international collaboration. We will actively participate in international discussions on shaping the global strategy for high-energy physics.

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- Importance of maintaining timely progress in the ongoing experiments and construction of experimental facilities.

SuperKEKB/Belle II, J-PARC, HL-LHC/ATLAS,
T2K Super-Kamiokande / Hyper-Kamiokande

- Early realization of a Higgs factory through international collaboration is crucial

We prioritize efforts to realize the ILC as Global Project: activities to host the ILC as Global Project in Japan
We also extend our activities in other Higgs factory proposals to maximize the chances of timely realizing a Higgs factory.

Insight through Accelerators.
KEK

Current / Future Plan

arXiv:2203.13979 input for Snowmass

Japan's Strategy for Future Projects
in High Energy Physics

Today

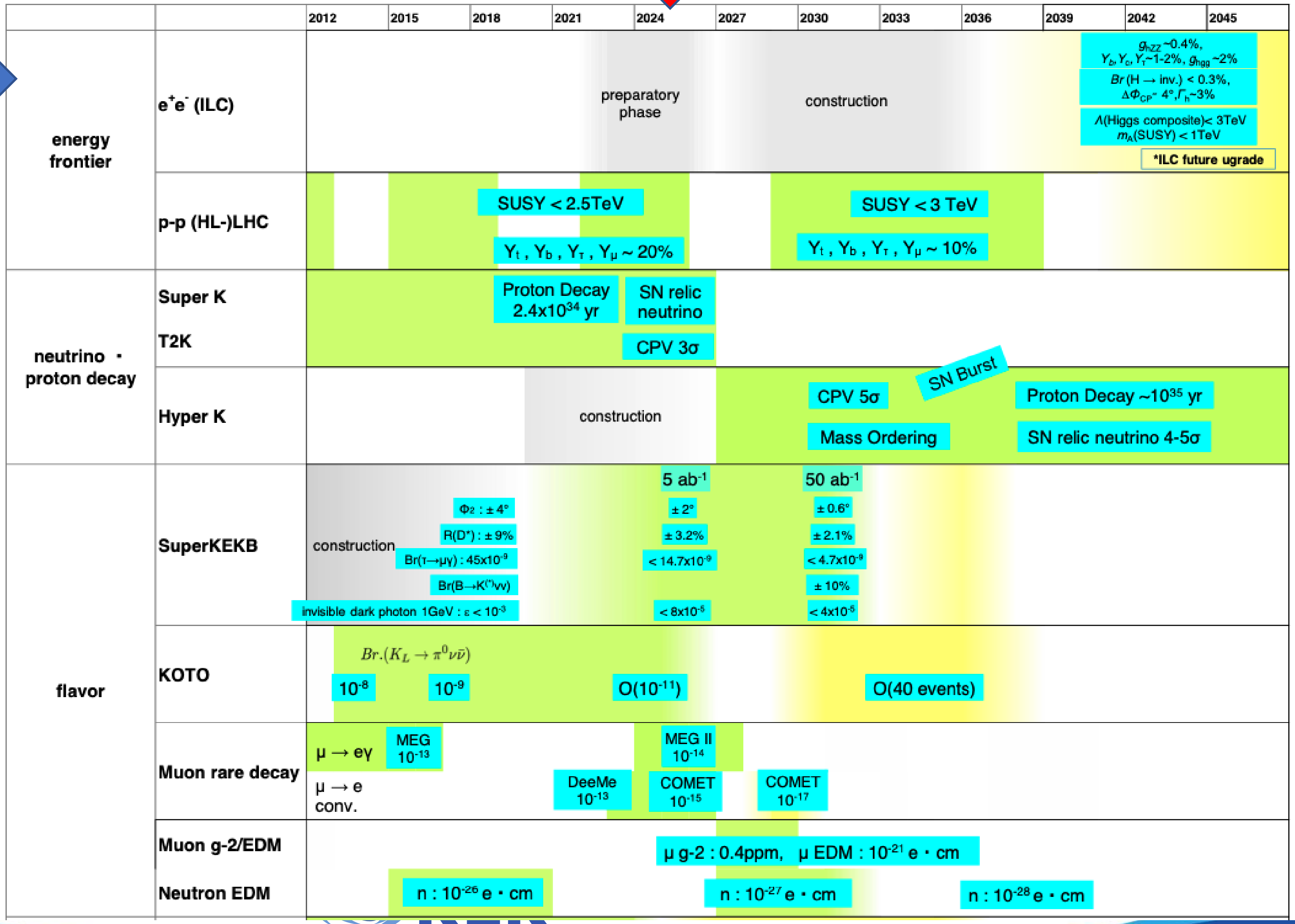
horizontal axis is year;
a few years delay.

ILC is the
future project
after SuperKEKB
and T2K HK (CPV).

Human Resource
is critical;

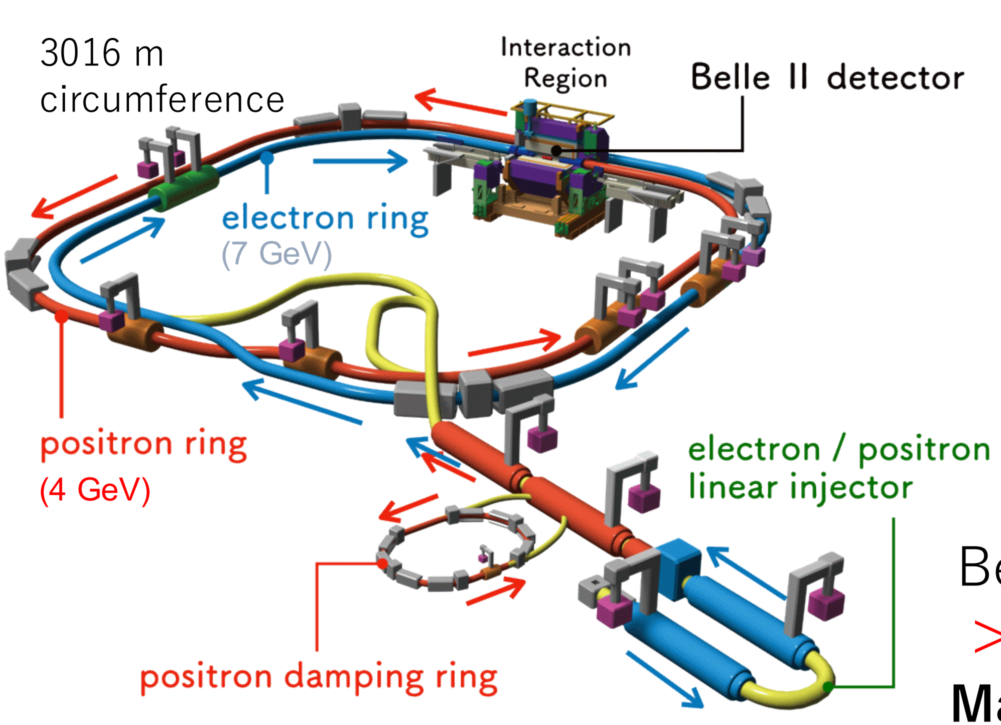
- LHC/HL-LHC
- SuperKEK B
- J-PARC+T2K
- HyperKamiokande

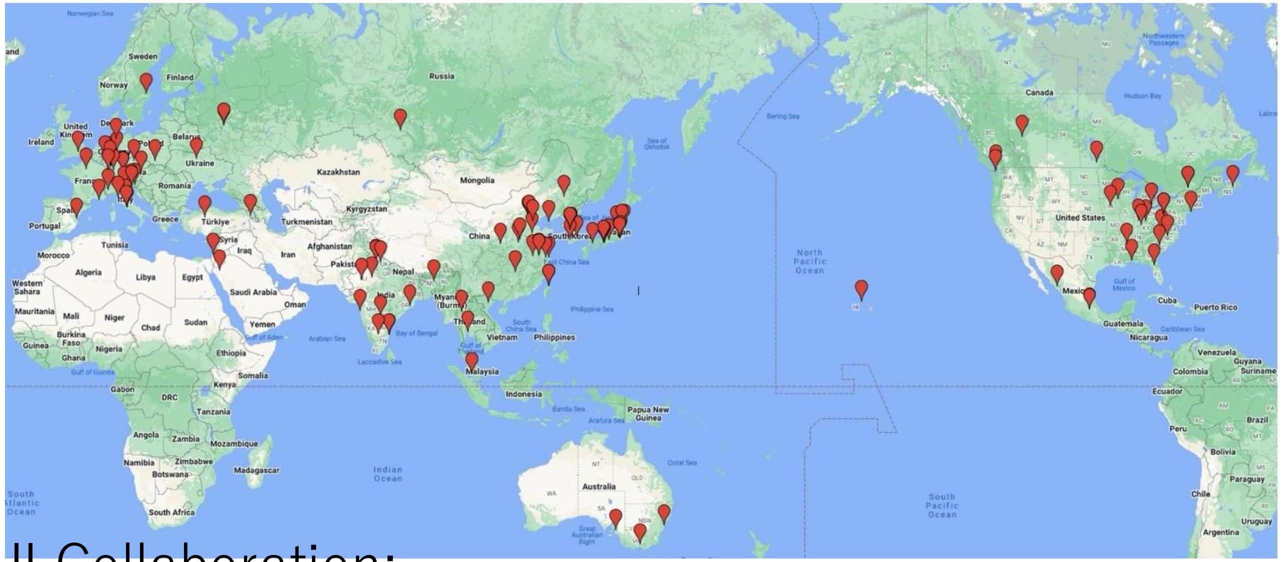
We try to shift
HR in Japan
gradually to Future



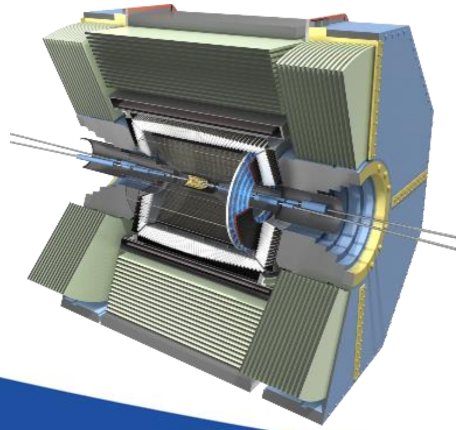
1. SuperKEKB / Belle II

The world-highest Luminosity was recorded
5.1×10^{34} cm^{-2} s^{-1} (Dec. 2024)



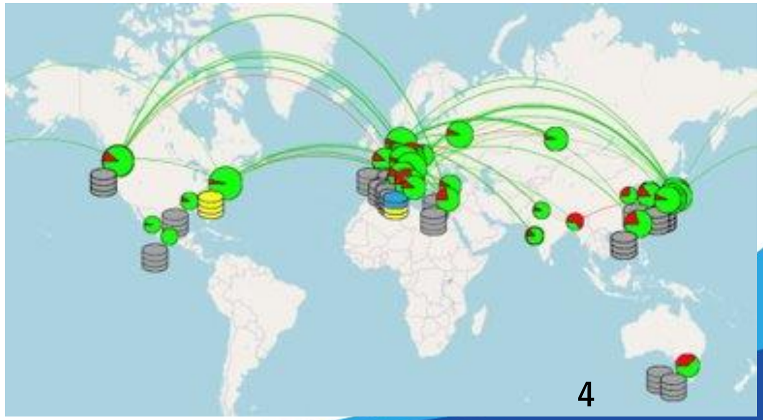


Belle II Collaboration:
>1200 members from 28 countries/regions
Many European countries join! Thanks!! Keep tight collaboration



Belle II Detector
- High-Precision Tracking (CDC)
- Vertex SD (2PXD+4 double-sided strip)
- Particle ID (TOP+A-RICH)
- Good detection of Neutrals (γ, K_L, n),
- Good Hermeticity for missing particles (ν)

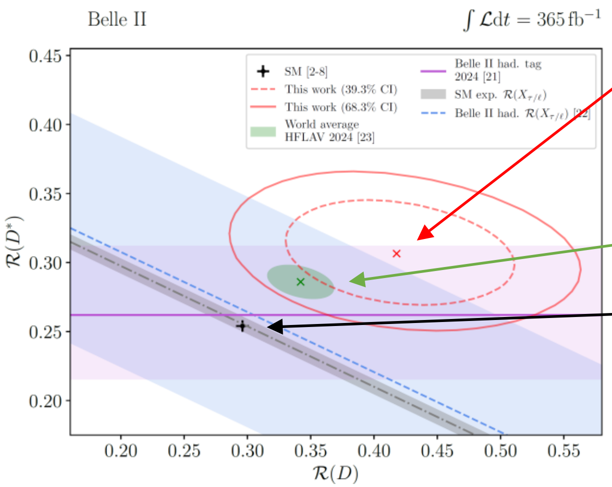
GRID computing



Recent physics results

We have advantage in Missing/Neutral/tau

Test of Lepton Flavor Universality in B→D(*)τν.



First analysis of $R(D^{(*)+})$ with semileptonic tagging **1.7σ** away from the **SM prediction**

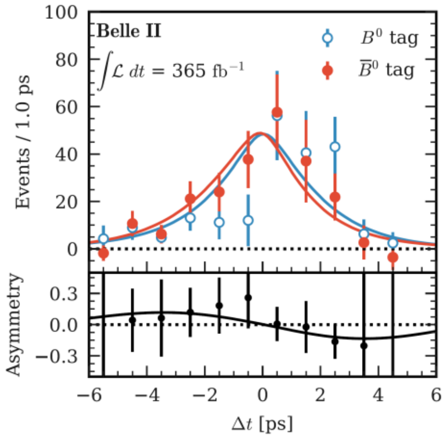
W.A. before including this measurement
3.3σ away from **SM prediction**

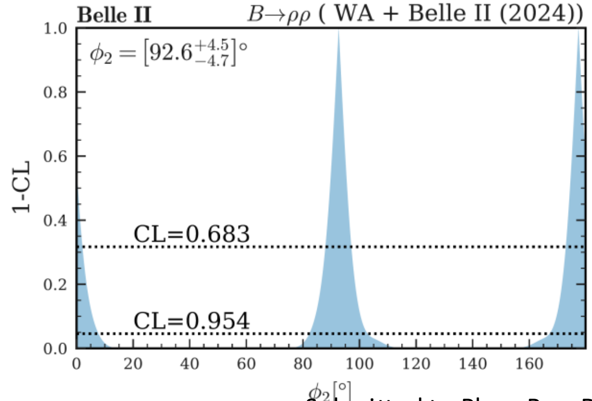
Hint of New Physics?

Submitted to Phys. Rev. D

Test of Unitarity Triangle of Cabbibo-Kobayashi-Maskawa matrix
: probe for high scale new physics, >10^3TeV with EFT

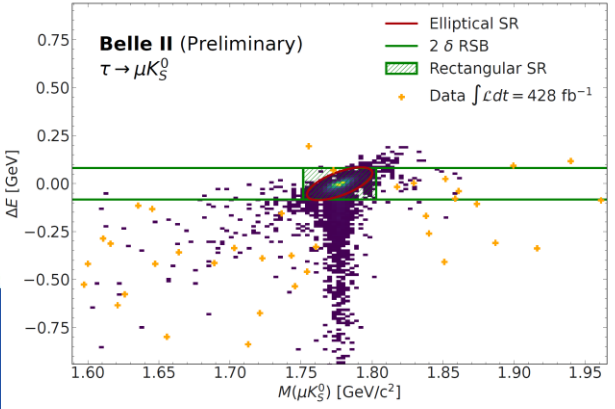
Time dependent CP Violation in B→$\rho^+\rho^-$ improves the angle of Unitarity Triangle **ϕ_2**





Submitted to Phys. Rev. D

Belle II is the place where world leading searches for **Lepton Flavor Violating τ decay** can be performed.

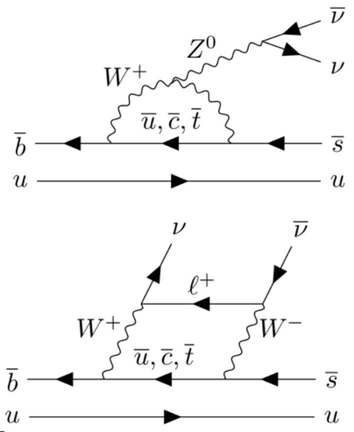


$B(\tau \to \mu Ks) < 2.8 \times 10^{-8}$
($980\mathrm{fb}^{-1} + 428\mathrm{fb}^{-1}$)

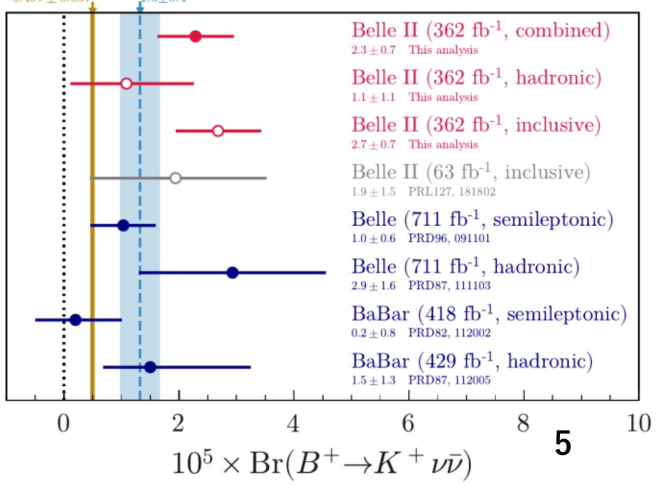
World's best upper limit.
Combination of Belle and Belle II gives better sensitivity

Submitted to JHEP

B→ Kνν



Phys. Rev. D 109, 112006 (2024)



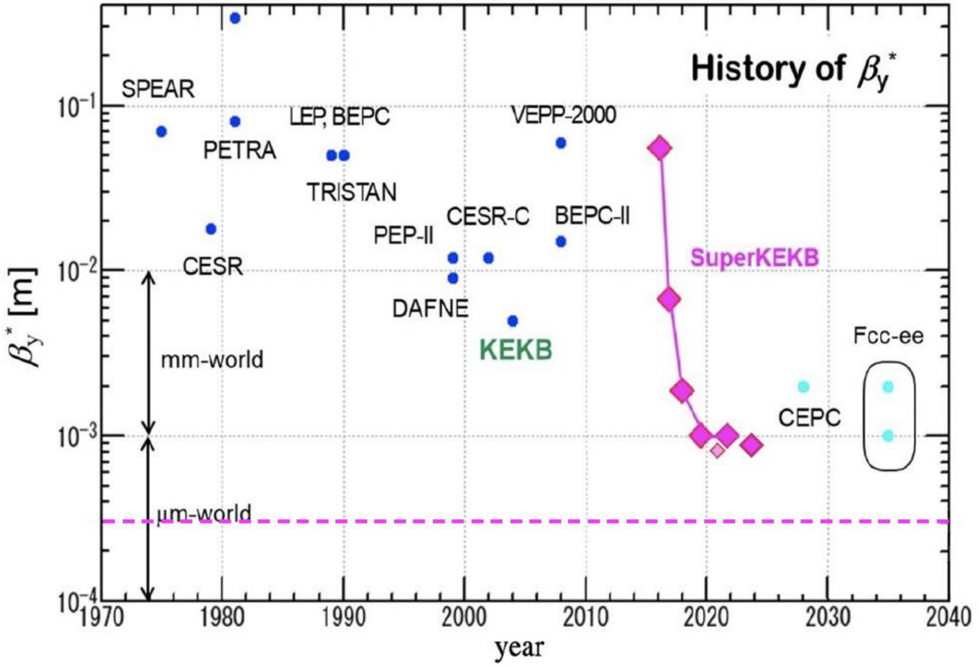
Insight through Accelerators

Current Status of SuperKEKB

SuperKEKB is Luminosity frontier:

- Nano-beam technology
- Powerful injector Linac

Nano-beam is standard for next e^+e^- colliders



β is squeezed less than 1mm smaller than future collider design

We try to understand various problems in 2024 run

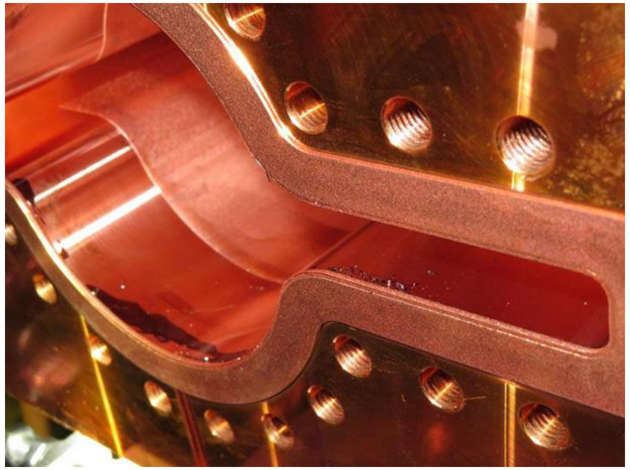
(1) Sudden Beam Loss (**SBL**)

(2) low Injection efficiency due to **beam-beam int.**

(3) Beam can not squeeze due to **beam-beam int.**

- "Vac seal" is one cru of SBL:

Now we are cleaning the pipe. Strong SR and heat cycle cause various problems:



We fix step by step.

We can obtain many **information about materials/beam monitor..** for future high current colliders.

Beam-beam interaction is new topics of frontier

The international collaboration with CERN, DESY(injection), IHEP has started to study the beam-beam interaction.

(Thanks! Fabiola, Beate, Yifang)

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Plan of SuperKEKB

New Trials
・Beam current
・Squeeze
Nano-beam

Three steps are considered.

1st step 2025 Plan: Increase beam current
2nd step 2026 & later squeezing upto 0.6mm
$L > 2.4 \times 10^{35}$ cm^{-2} s^{-1}

LS2 is planed (~ 2032) for the 3rd step
1) detector update CDC, VX, TOP..
2) **final focus QCS magnet**

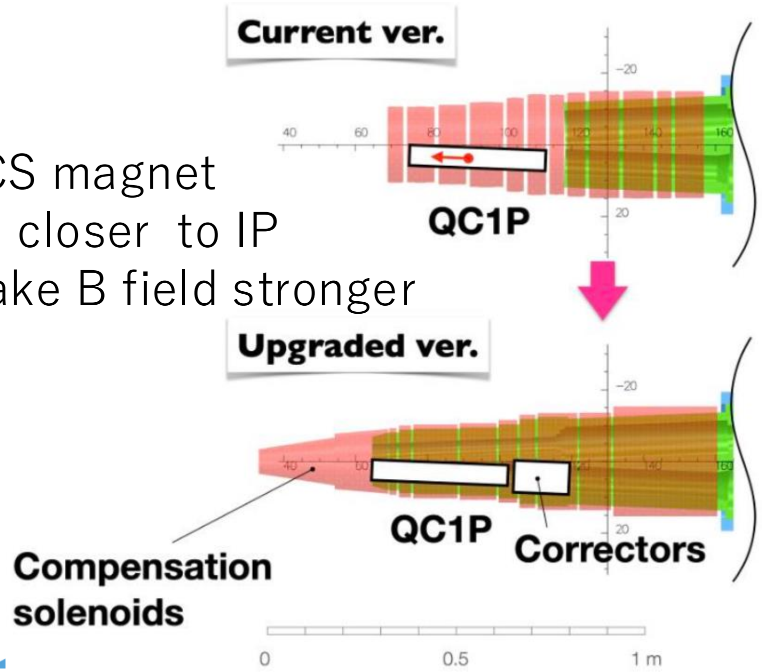
First step	Second step		Third step
1.0×10^{35}	2.4×10^{35}	2032~ LS2 Hardware upgrade	6.0×10^{35}
2025 Run			

Cont. SBL
Update Beam injection
squeezing Beam

QCS magnet update Nb3Sn (with FNAL)
Other optics
Detector Upgrade

2025 target These are not yet approval by MEXT
$L > 10^{35}$ cm^{-2} s^{-1}
Integrated Lumi > 1 ab^{-1}

QCS magnet
is closer to IP
Make B field stronger



Thin strong magnet
is necessary (Nb_3Sn)

collaborate
with FNAL

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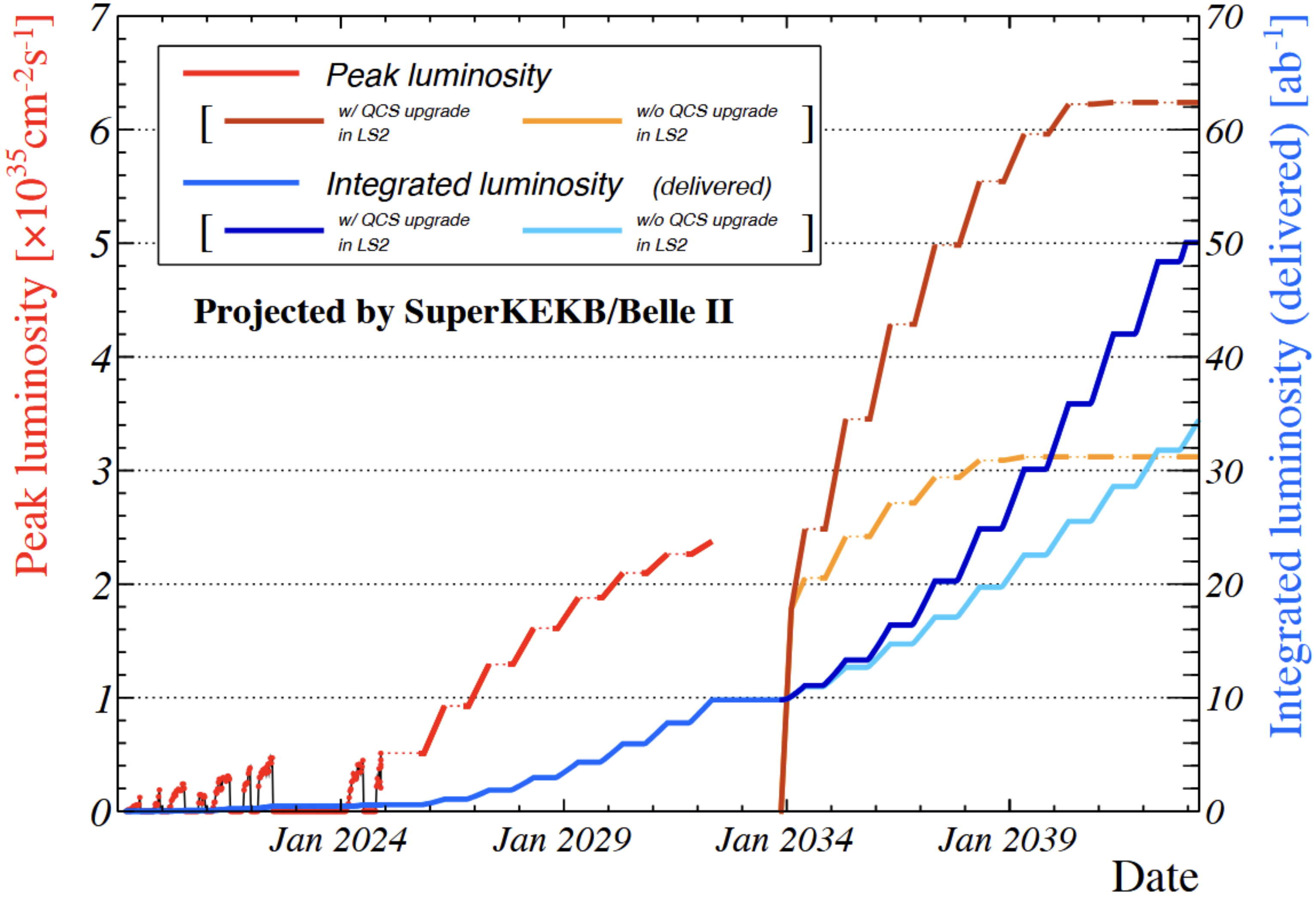
Roadmap

2 cases shown
with / without QCS Upgrade



Interesting Topics we can cover

1) B → Kνν **excess?**
   (C_9^U in B->Kll angular distribution anom. in LHCb)
2) R(D) – R(D*) **final examine hint of new physics** (H^{+-}? LQ?)
3) New CP violation in quark sector?
4) Search for LFV using tau
5) Dark Photon/ Dark Matter
6) Check Vacuum Polarization for **lattice studies** (muon g-2)
7) New hadronic state of quark / gluon

2. J-PARC

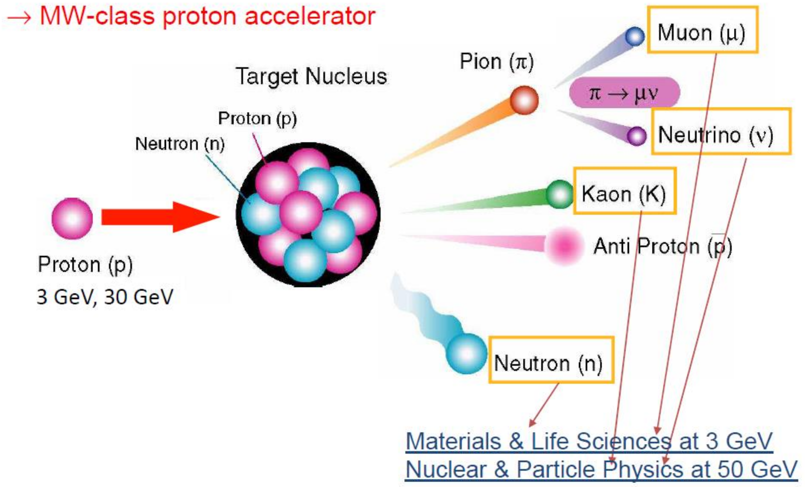
There are two Rings

RCS 3GeV

MR 30GeV

There are three facilities: **MLF, T2K, HD**

MLF: Material / Life Science Facility (muon/neutron) muon acc.



Various particle beams are used:

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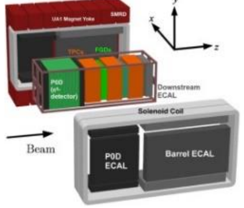
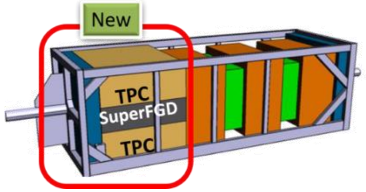
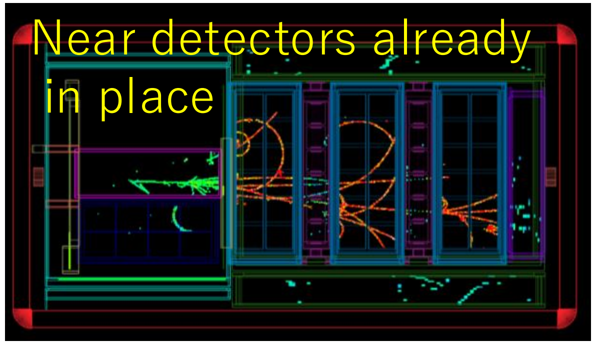
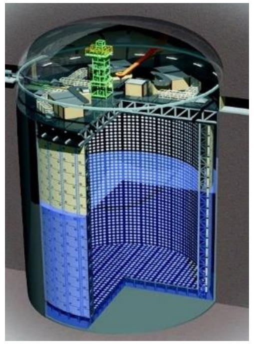
J-PARC/T2K program

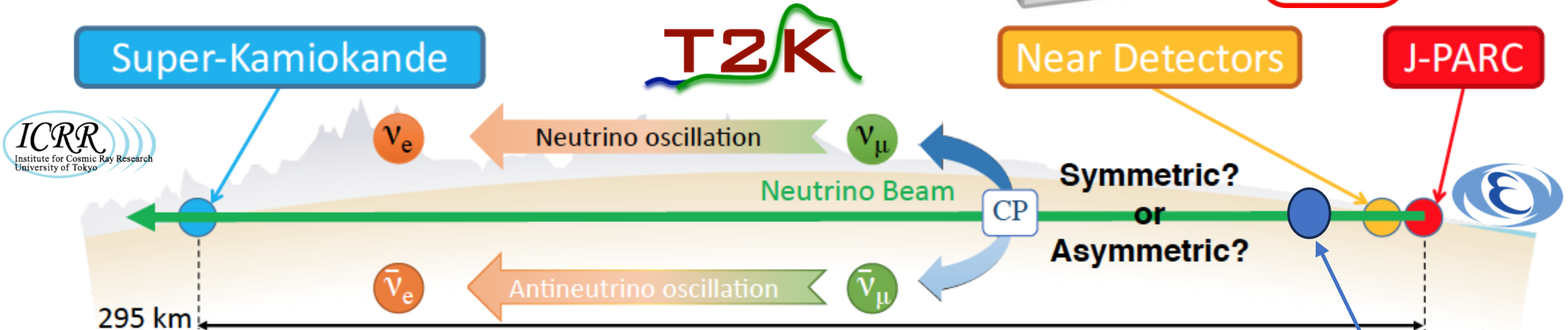


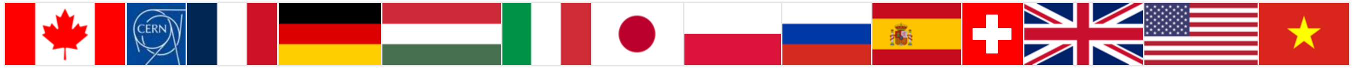


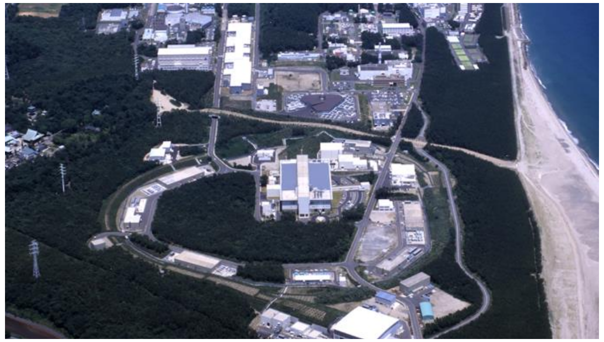




HK

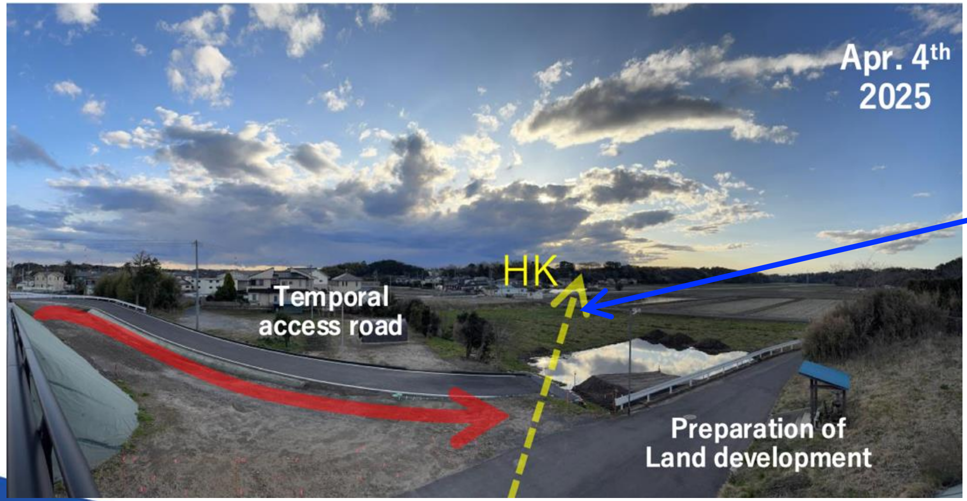




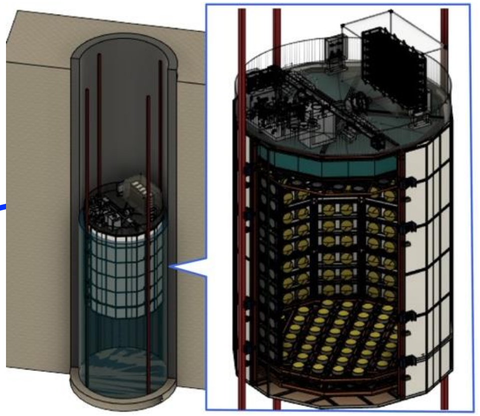


~560 members, 74 Institutes, 15 countries (incl. CERN)

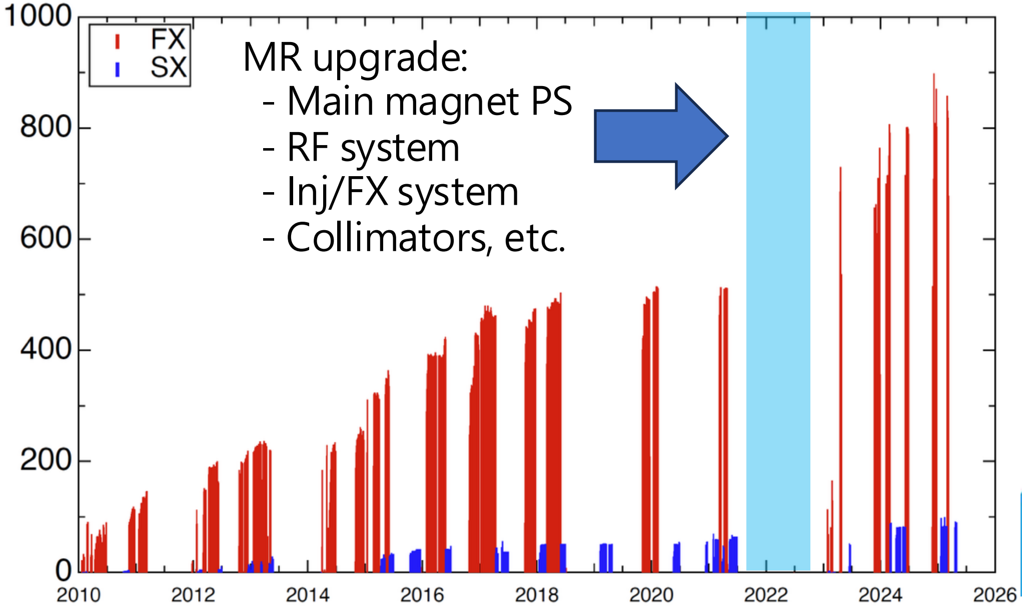
Many thanks !! Still OPEN!!



IWCD



under construction (ready in 2028)



High power neutrino beam; ~900 kW (achieved)

→ upgrade up to 1.3MW

Beam-line upgrade is also on going

Horn Power Supply for MR upgrade (~1Hz operation)

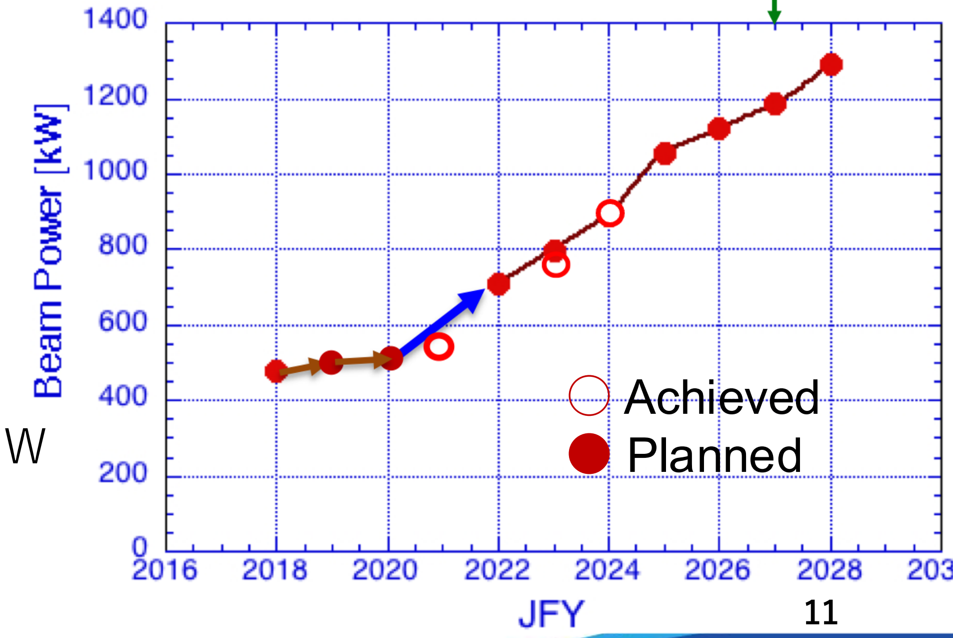
Installation for
Horn-1 improved for
1.3MW beam power

Horn needs huge current
(320kA)

J-PARC MR RF upgrade

Power Upgrade
is on schedule

Start of Hyper-Kamiokande



We aim to produce 1.3MW beam @ 2028

Hyper-Kamiokande (HK) project

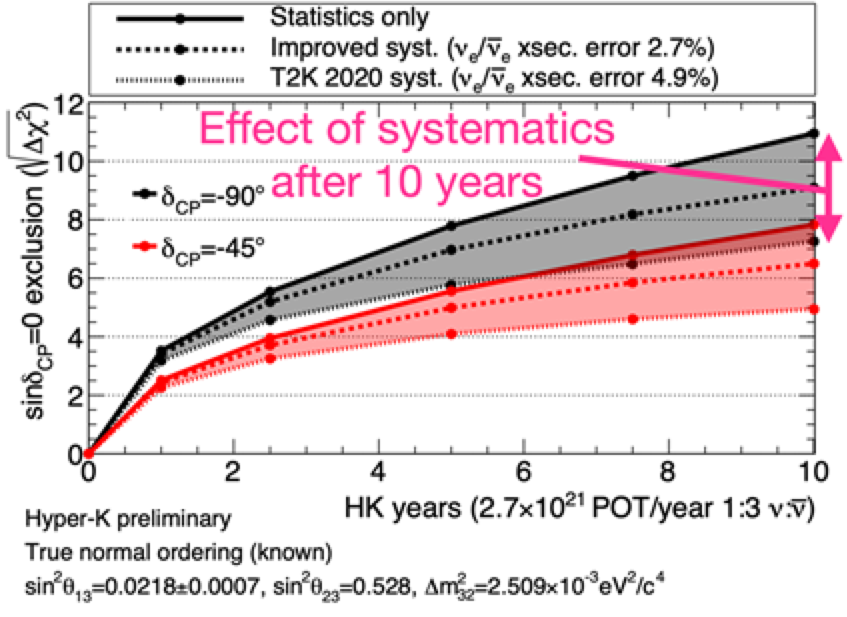
- **Funding approved and construction started in 2020 (U-Tokyo and KEK)**
- **Construction of HK**

  Excavation of main detector cavern finish now.
  mass-production of PMTs/electronics are on-going.

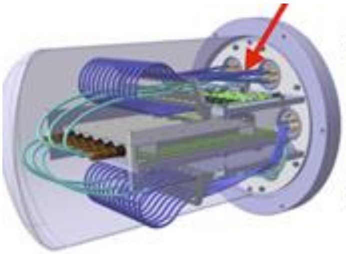
- **Budget/schedule are under control.**
- Aiming to start operation in early 2028

  (I hope discovering CP violation around)

Cavern is ready Now
We have "ceremony" in this Saturday.



Using Near +IWCD, we can reduce ~3%



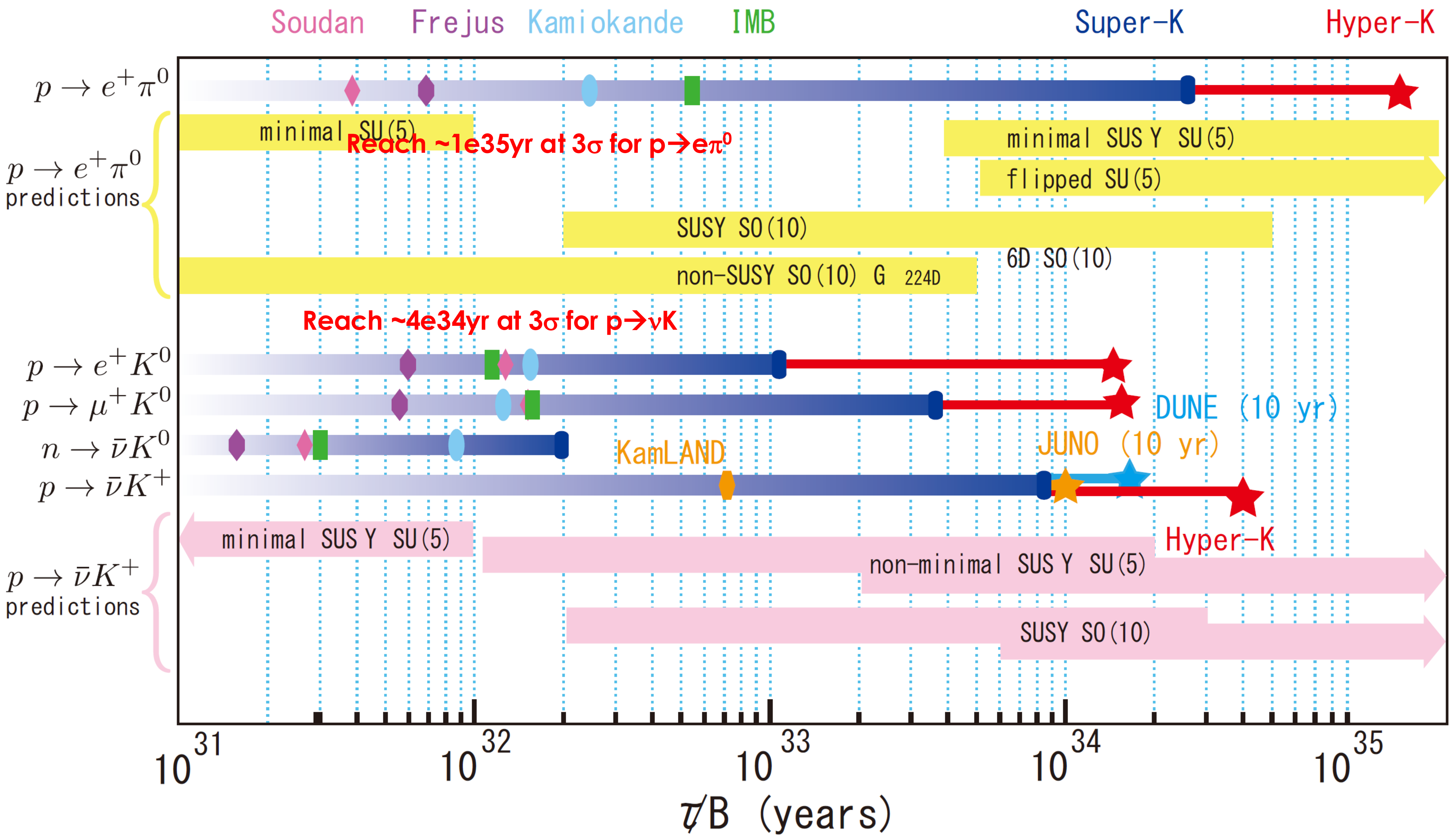
Sara-san will give more detail

~660 members from 22 countries,
~100 institutions and growing

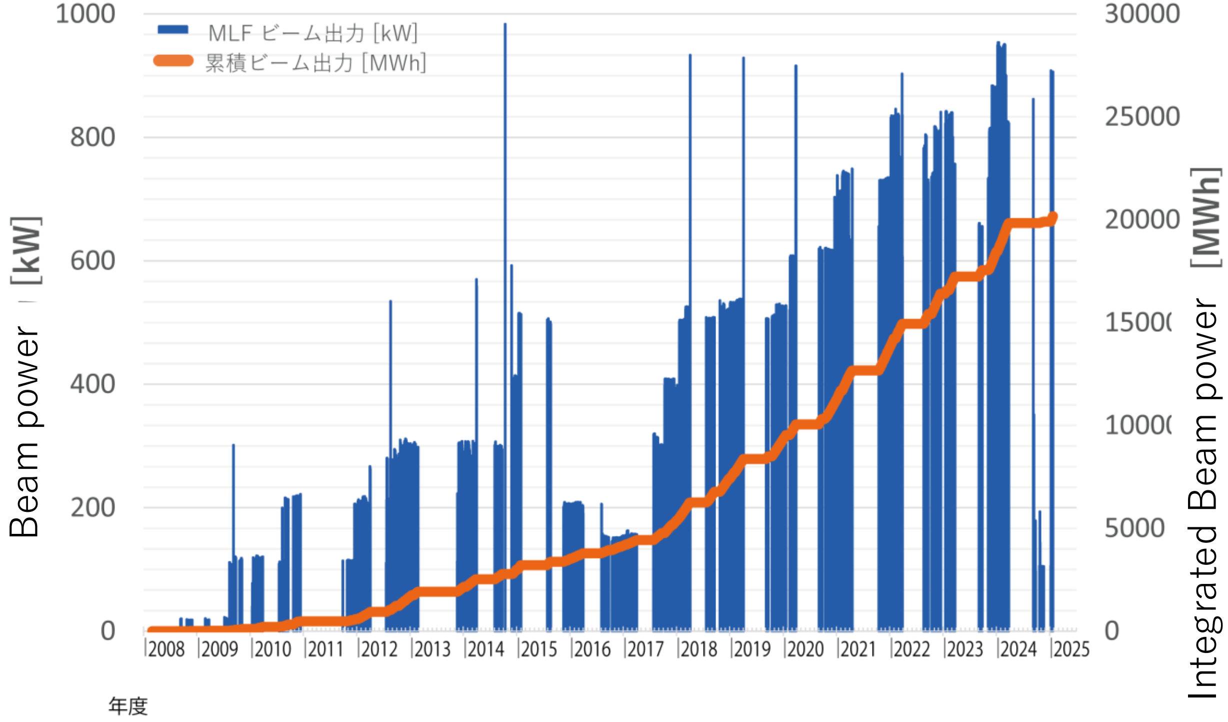
Insight through Accelerators. KEK

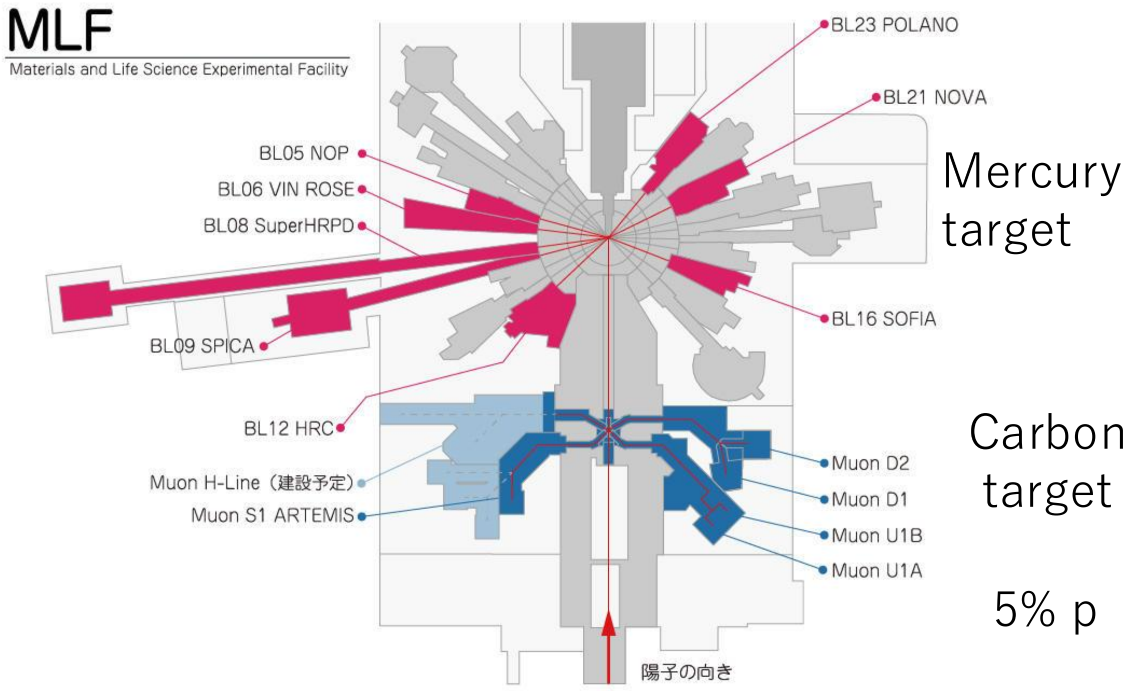
Proton decay

After CPV is discovered, we can enjoy SUSY hunting



Beam power history of MLF



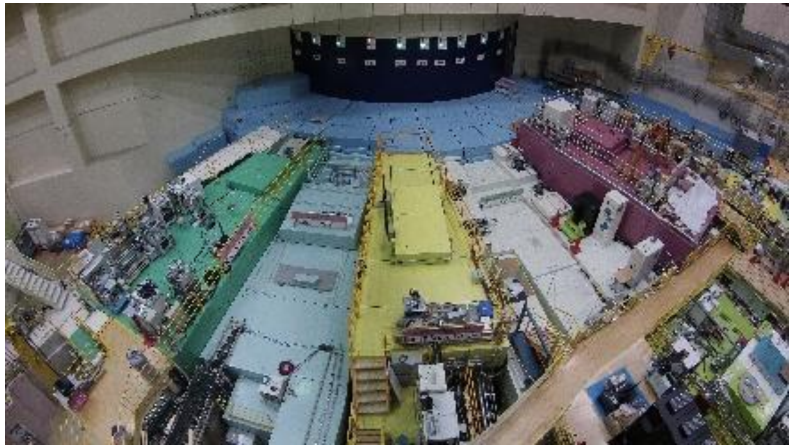


Power increases step by step.
Beam power is **~1MW** for user usage (2024)

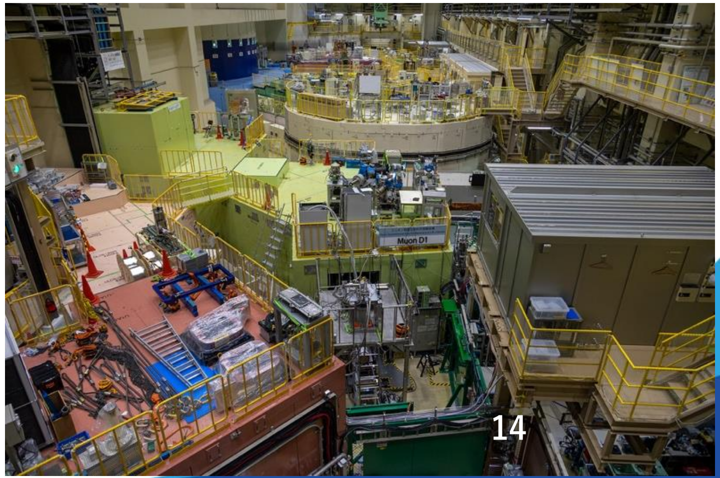
Not only M/L science, but also PP with neutron/muon is on going

We have many users
We start discussion about 2nd Target

Neutron



Muon



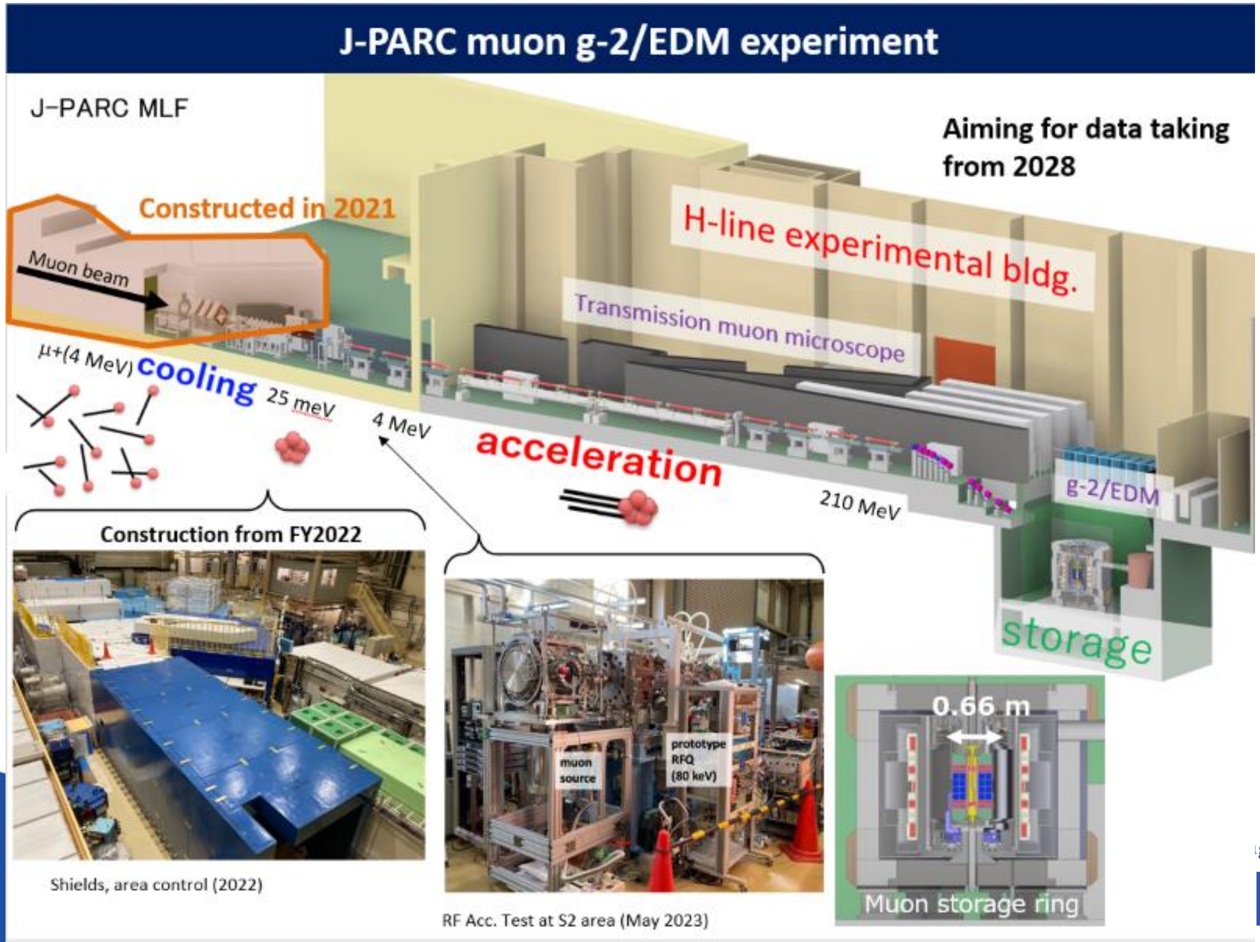
Muon Facility @ MLF： Cold+Acceleration

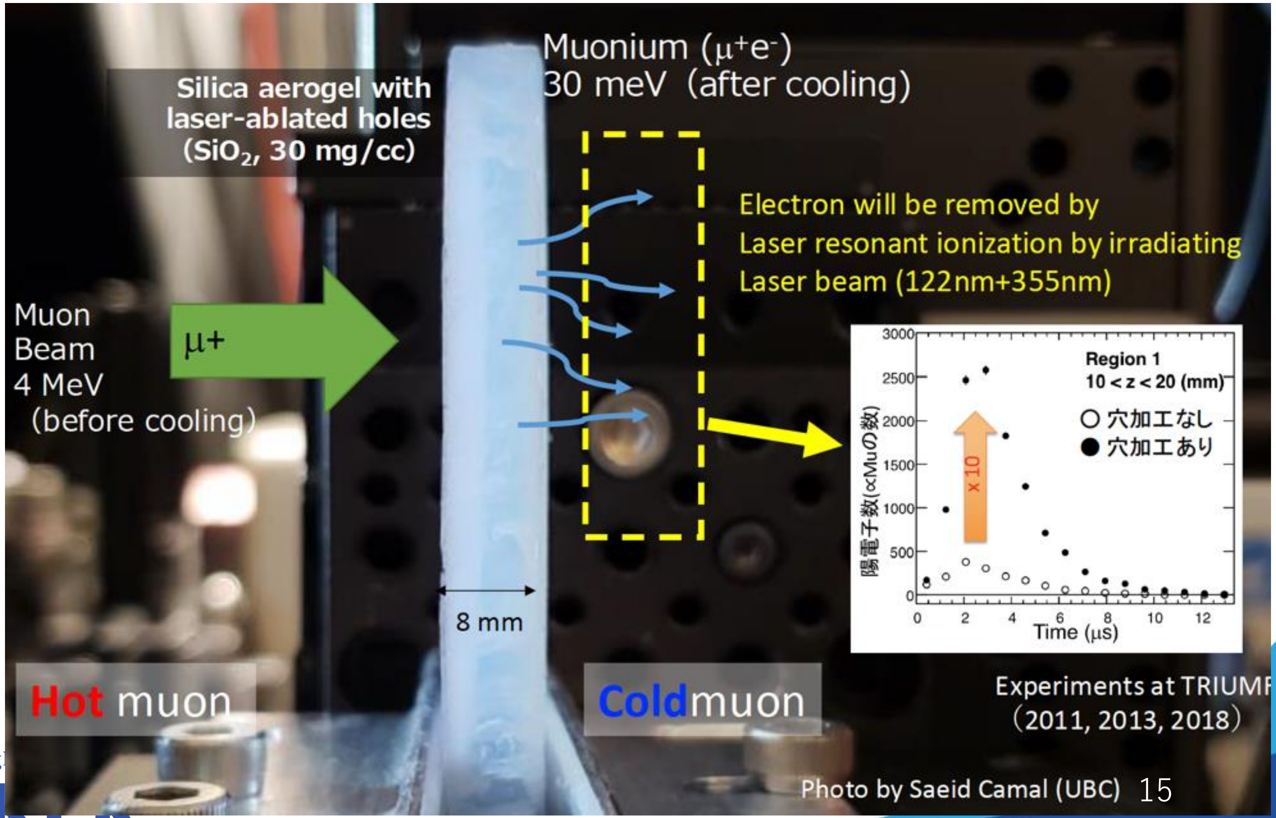
World's first cooling and acceleration of muon

1) Cold muonium are produced efficiently using special silica aerogel (laser ablated) factor 10 efficiently
2) First demonstration of positive muon acceleration to 100 keV

3) Next step : Muon beam acceleration upto a few MeV
muon is used for microscope & scan with artificial muon:
also basic science (Muonic Atom) funded

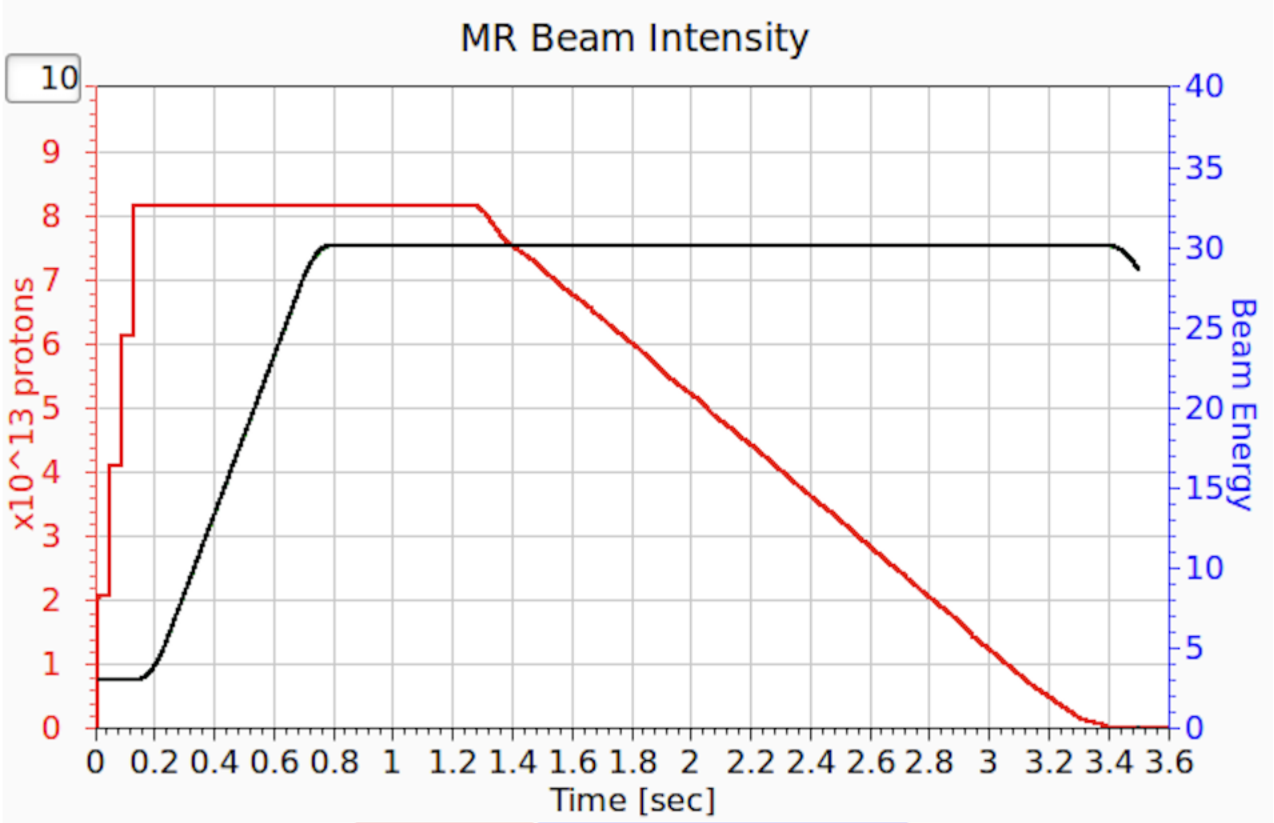
4) 3rd Step: Experimental Hall/ beam-line will be extended + muon accelerated upto 200 MeV.
(R&D muon collider, microscope and measure muon g-2 / EDM)

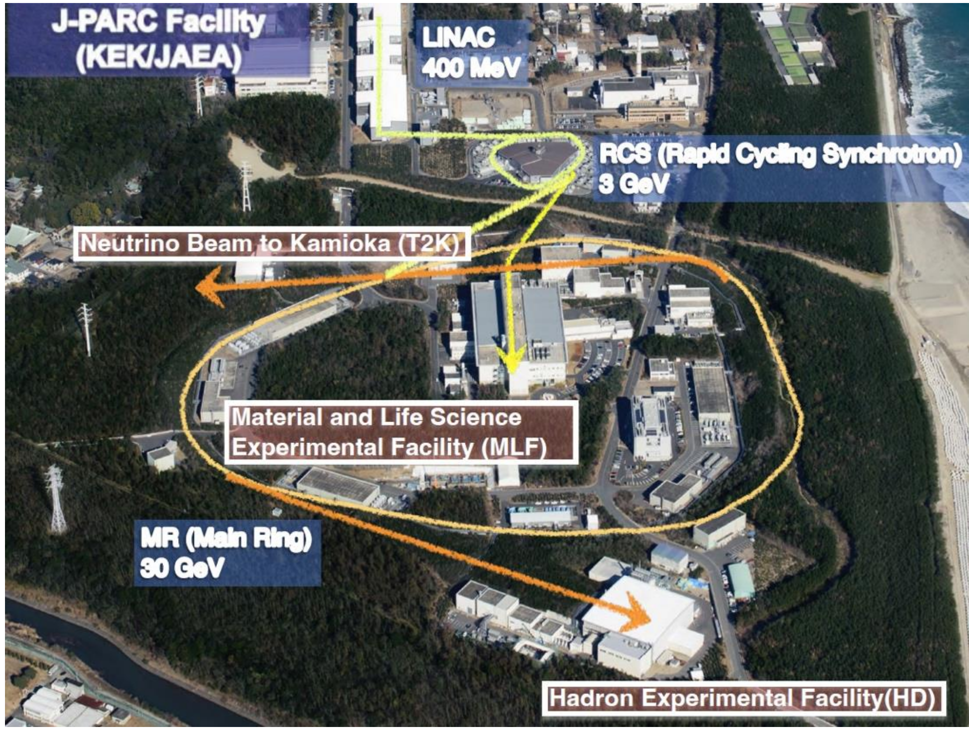




J－PARC Hadron　Hall

Slow Extraction (~ 2sec) for hadron Hall





These protons are injected to Hadron Experimental Hall

Beam power for slow Extraction : **92.2 kW achieved**

Extracted protons per pulse : 8.12 x 10^{13}

This is the world-record

Insight through Accelerators.
KEK

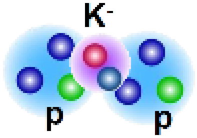
Hadron Experimental Facility

Strange Hadron

You can use
Strange Hadron
muon, proton

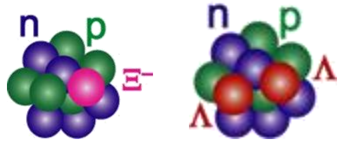
K1.8BR
（~1.0 GeV/c K^-）

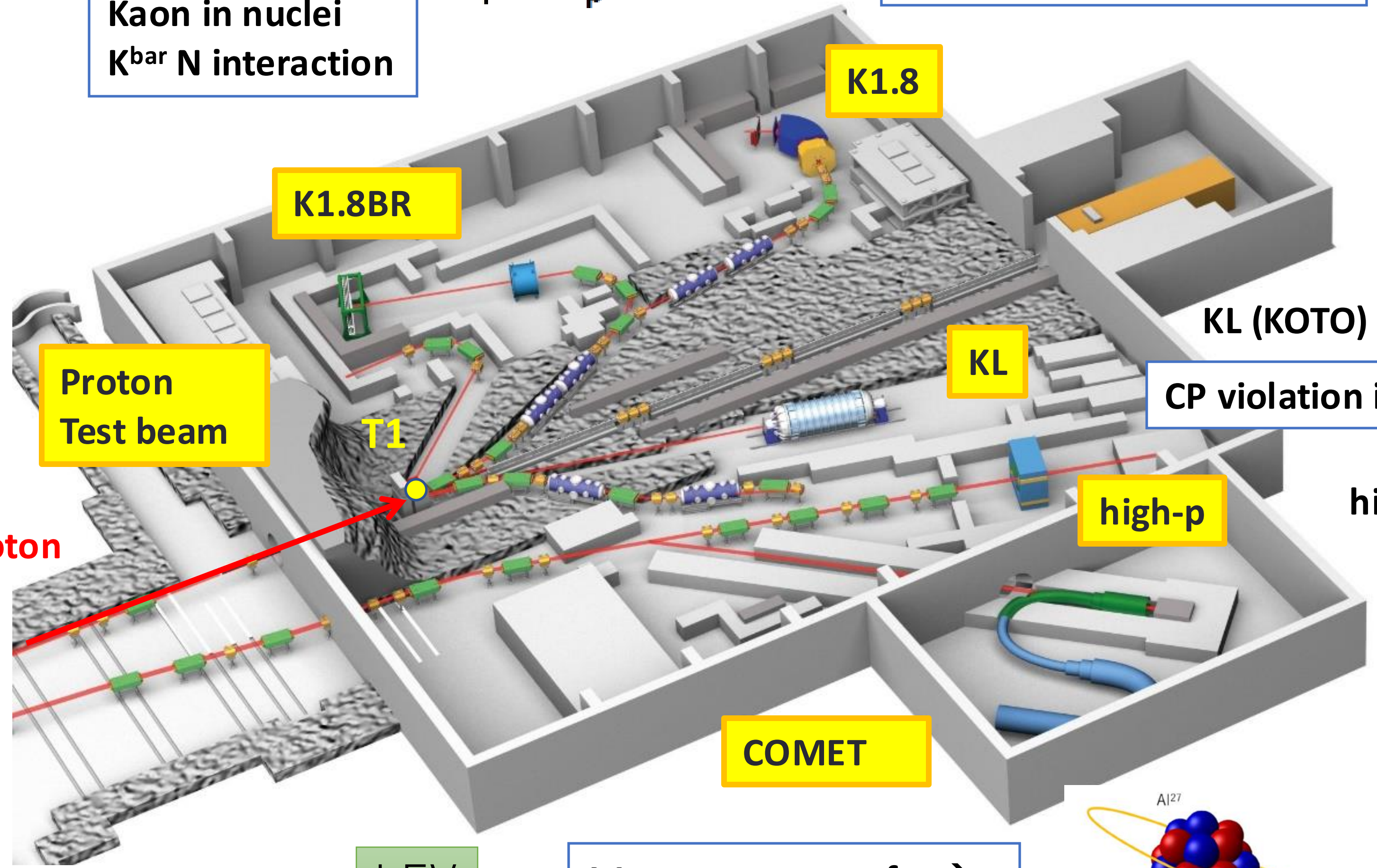
Kaon in nuclei
K^{bar} N interaction

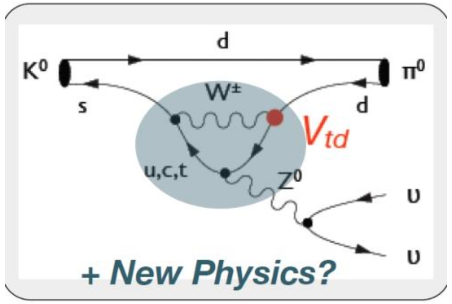


K1.8（~1.8 GeV/c K^-）

S=-1, -2 hypernuclei
Baryon-Baryon interaction







KL (KOTO)

CP violation in K^0_L decay

CP in Strange Quark

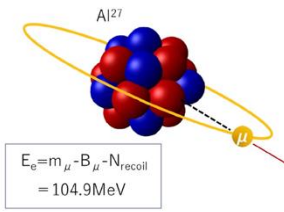
high-p （30GeV primary proton beam）

Hadron property in nuclear medium
Origin of hadron mass

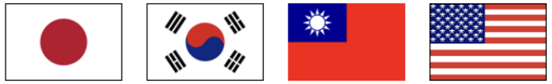
QCD
mass

LFV

Measurement of μ→e conversion (2023~)



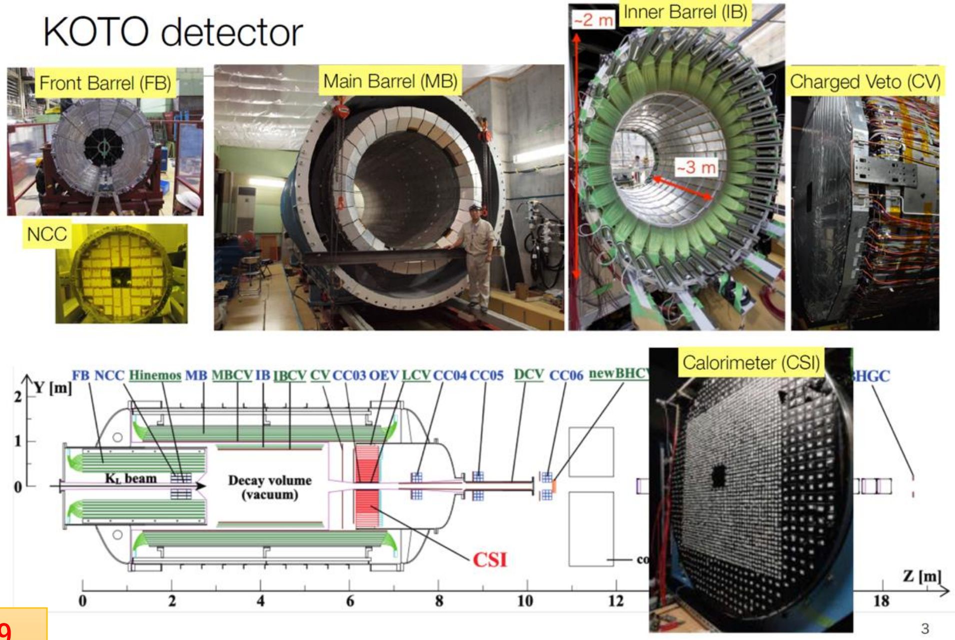
KOTO



~30 members, 11 institutions, 4 countries

Welcome contribution to the current KOTO

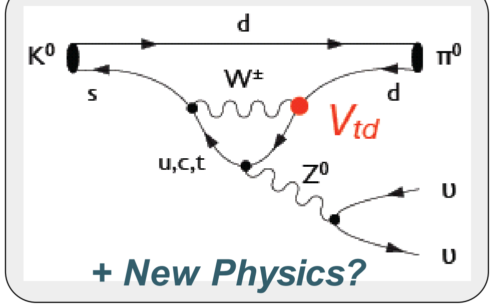
Many European countries contribute to make proposal of Koto-II.



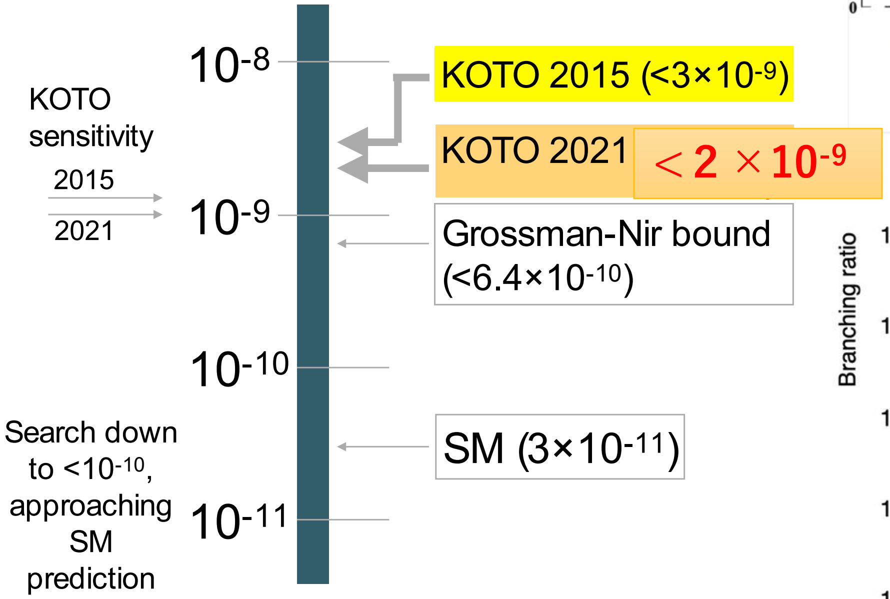
- Feature of $K_L \to \pi^0 \nu\nu$ decay
  - CP violating process
  - Suppressed in Standard Model; BR(SM)=3×10^{-11}
  - ~2% theoretical uncertainty

Good probe to search for New Physics beyond SM

Standard Model

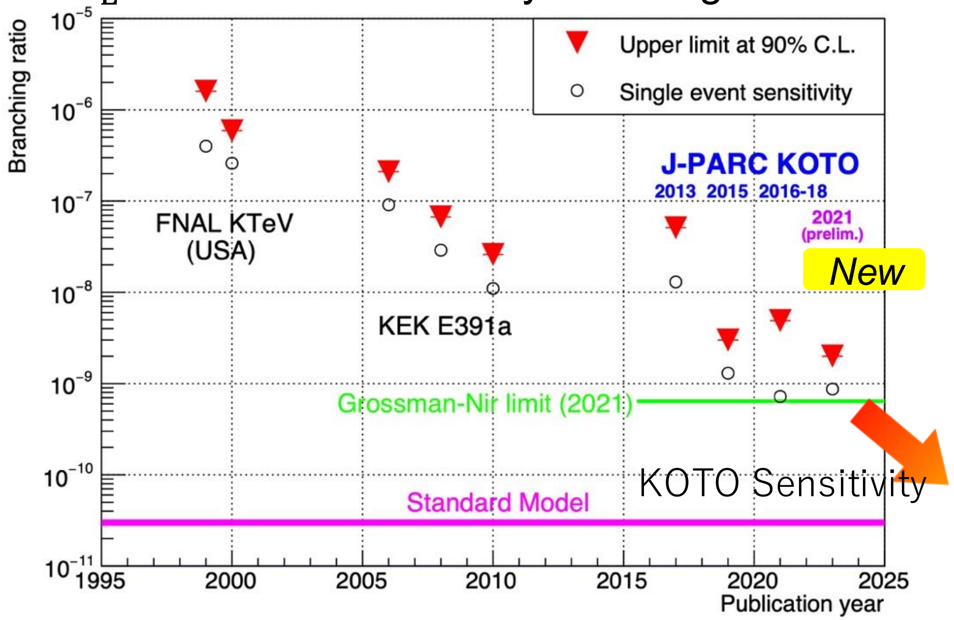


Branching ratio (BR)



Grossman-Nir bound:
indirect limit from relation to BR($K^+ \to \pi^+ \nu\nu$);
Calc'd from NA62 results (2021) with 1σ region

$K_L \to \pi^0 \nu\bar{\nu}$ search history including KOTO



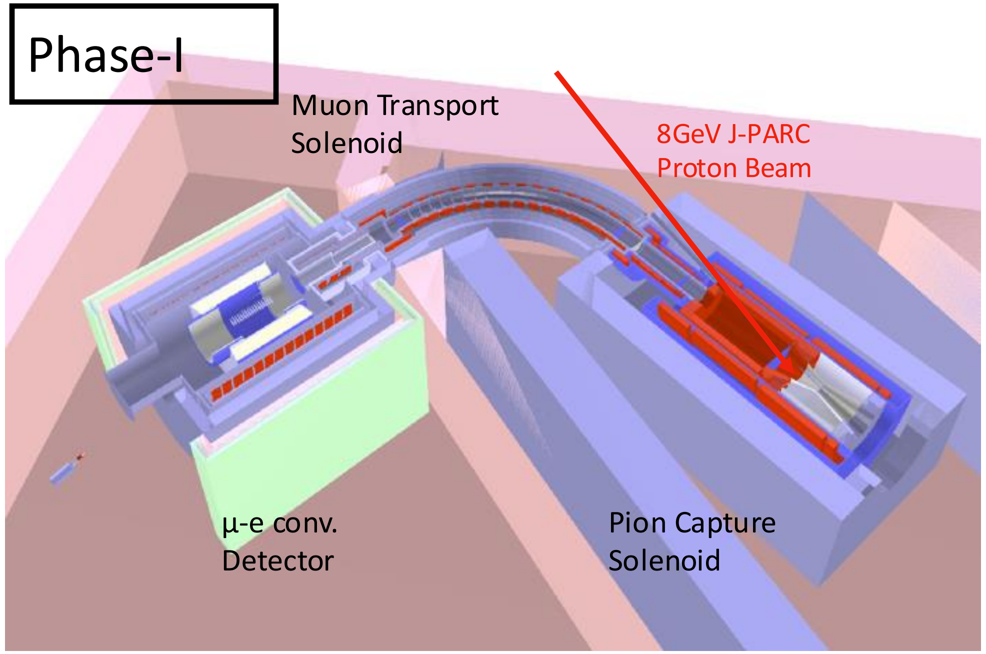
Insight through Accelerators.
KEK

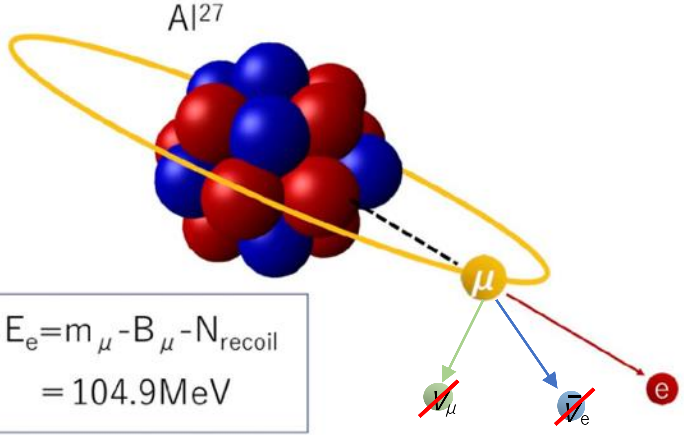
COMET experiment at J-PARC

search for mu-e conversion down to the level of 10^{-16}

- Search for muon “decay” to one electron without emitting neutrinos
  - Aiming at 100 times better sensitivity ($<10^{-14}$) than past experiments (U.L. 7×10^{-13} @ 90% C.L.)
  - Eventually in future 2nd phase, 10,000 times better sensitivity ($< 10^{-16}$) is envisioned

- International collaboration composed of 43 institutes from 19 countries





$$E_e = m_\mu - B_\mu - N_{recoil} = 104.9\,\text{MeV}$$

We have already done eng. run

	2022	2023	2024	2025	2026	2027	2028
Eng. run		★					
Facility	Magnet construction (2022–2024)		Installation & test (2024–2026)			Beam PW upgrade (2027–2028)	
Detectors	Construction / Stand-alone test (2022–2025)		Installation (2024–2026)		CR test (2026–2027)		
Phys. run					★	Phase-I Physics (2027–2028)	

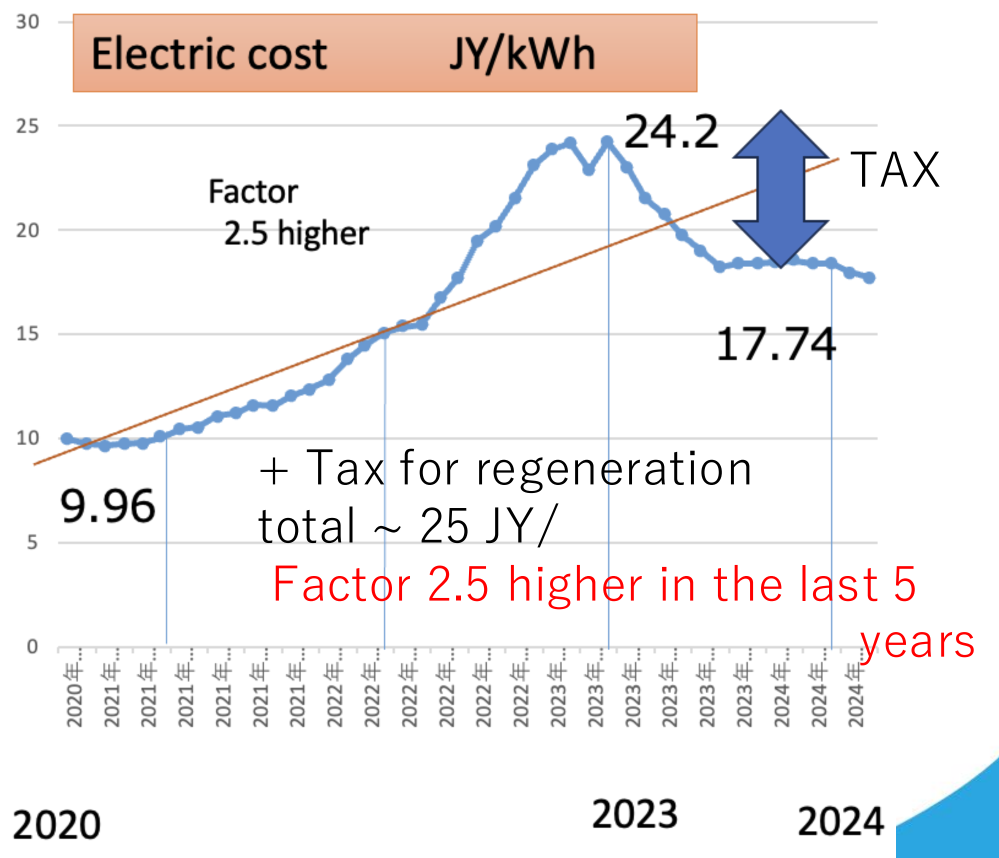
We start discussion of tight collaboration for future (Flavor Physics and Hadron)

1) FNAL, PSI, TRIUMF, KEK have muon facilities.
   there are some overlap in Physics program.

2) CERN will shut down Kaon Facility.

Human resource and budget are very limited in many Labs.
Global assignment/discussion will help us.

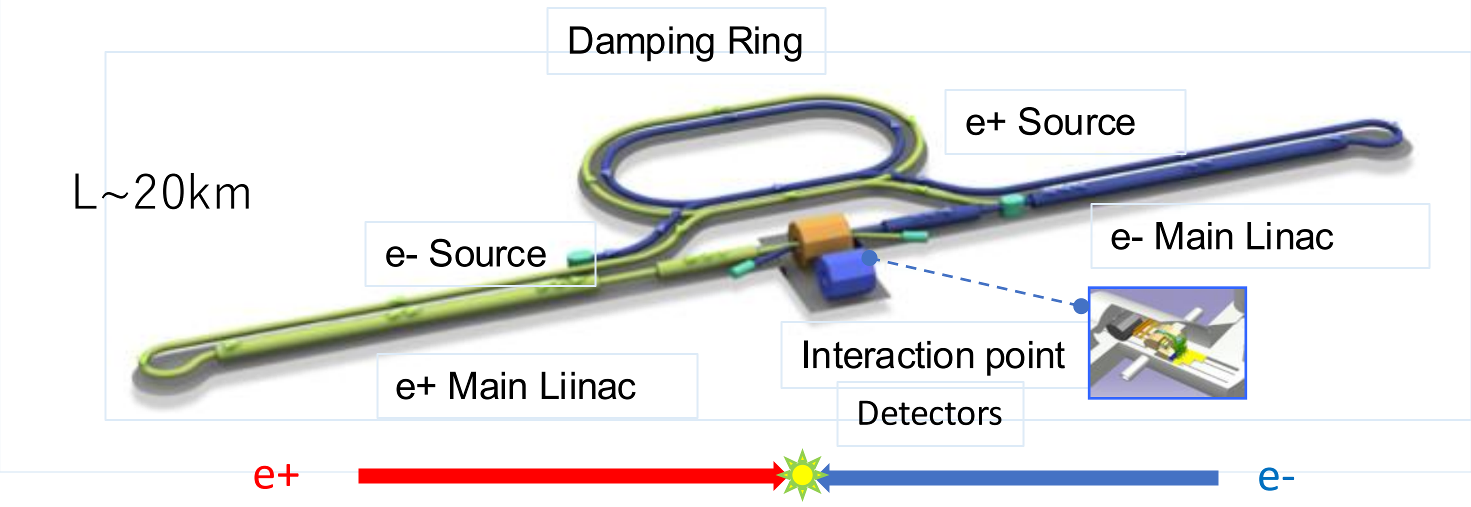
Initial contacts made with FNAL and TRIUMF, and will continue and extended to "other laboratories"

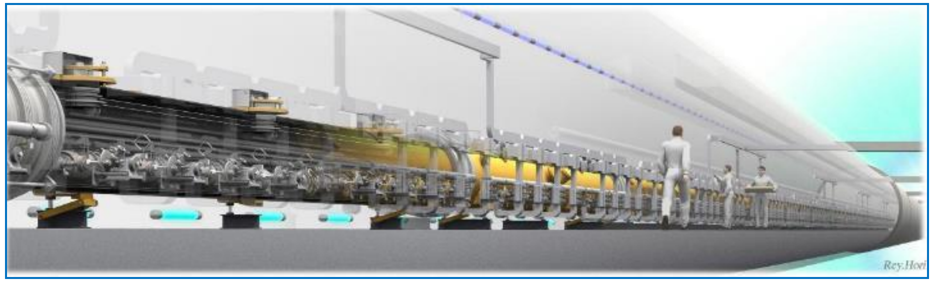


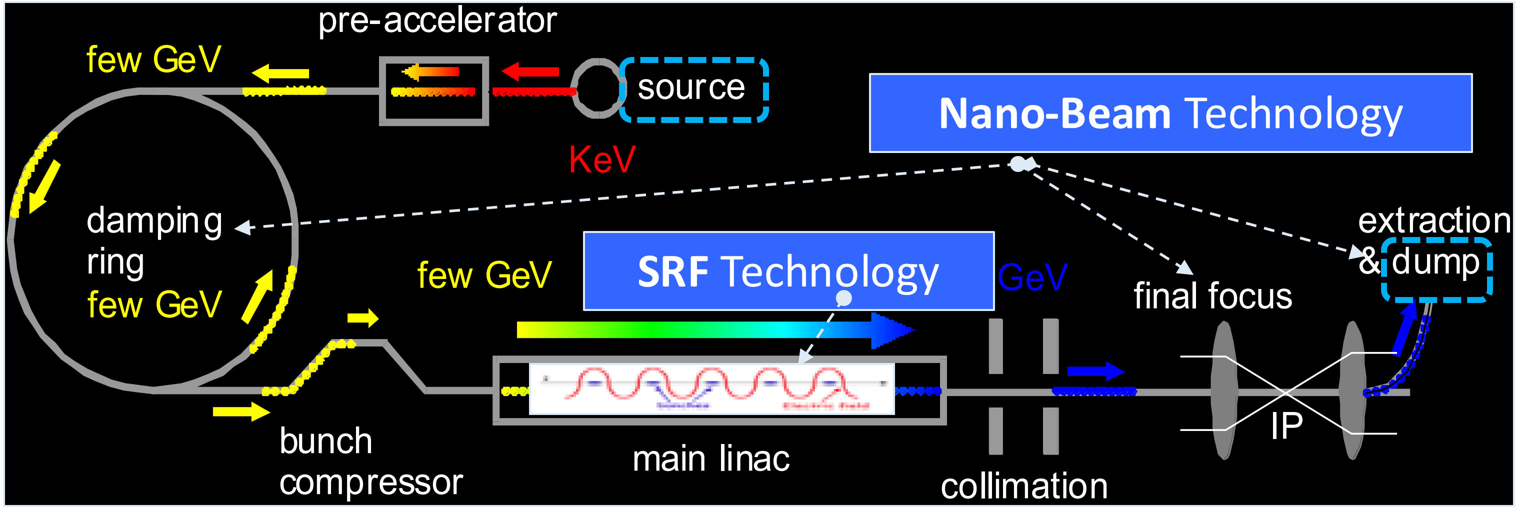
Insight through Accelerators. KEK

3. Future Project: ILC Higgs Factory

IDT + KEK + ILC-Japan(JAHEP) collaborate from 2021







Parameters	Value
Beam Energy	125 + 125 GeV
Luminosity	1.35 x 10^{34} cm^2/s [2.7 x 10^{34} cm^2/s]
Beam rep. rate	5 Hz
Pulse duration	0.73 ms [0.961 ms]
# bunch / pulse	1312 [2625]
Beam Current	5.8 mA [8.8 mA]
Beam size (y) at FF	**7.7 nm**
SRF Field gradient	**< 31.5 > MV/m (+/-20%)** Q_0 = $1x10^{10}$
#SRF 9-cell cavities (CM)	~ 8,000 (~ 900)
AC-plug Power	111 MW [138 MW]

* Black is basic & green is written in snowmass

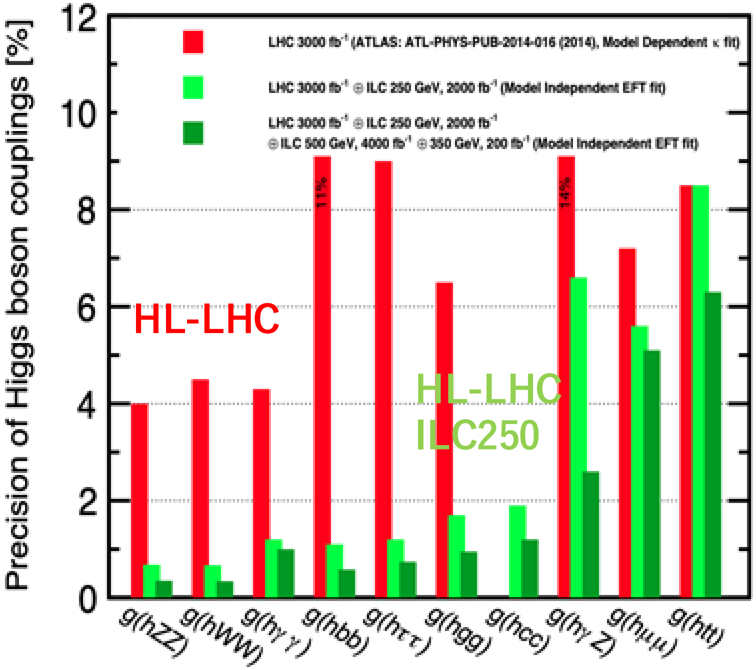
(ILC key technologies)

1. SRF cavities of 9000 numbers
2. Nanobeam production and stability。
3. Huge electron and positron production

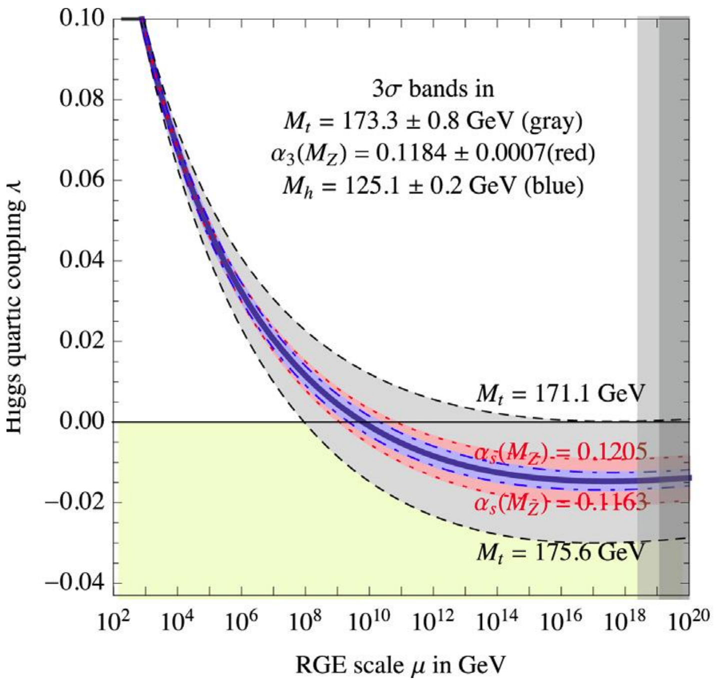
Advantage of ILC/LC

Self coupling/top mass are urgent topics

Ecm=250GeV



Ecm=350GeV
Ecm=700GeV



1. Sustainability

Length becomes 20km
Shorter than LHC
Moderate initial Cost
Small Carbon emission

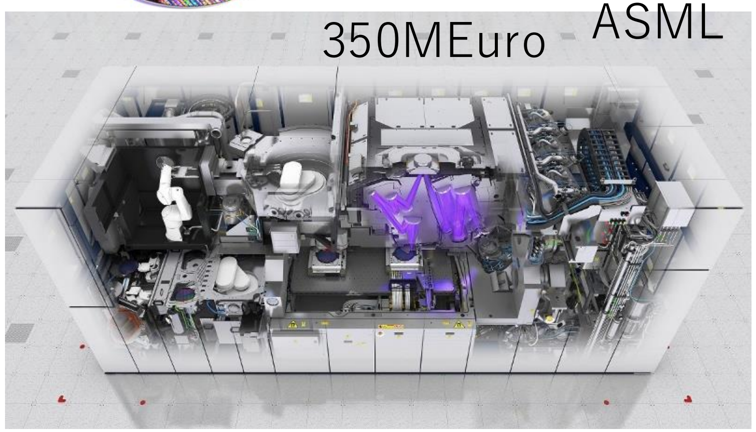
2. E_{CM} extendable: LC vision includes all technologies: SC, HELEN, CCC, CLIC, Plasma

Jenny/Steinar have already shown the detail about LC vision.
We do not know New physics scale (TeV, 10TeV, 100TeV?),

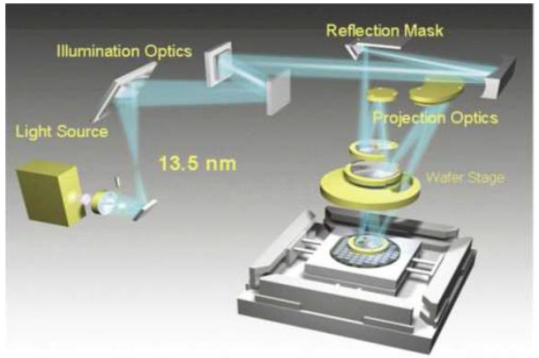
3. **Energy Recovery Technology** could lead to significantly reduced power consumption and much higher luminosity ($e^+ e^-$ reuse). Principle of energy recovery has been demonstrated by cERL:

Advantages
- Smaller footprint
- "Moderate" initial investment
- Upgrade path to higher energy.
- Higher Luminosity with advanced acceleration technologies.

ERL technology applied to "Semiconductor EUV-FEL for lithography"



Present EUV-lithography uses LPP source



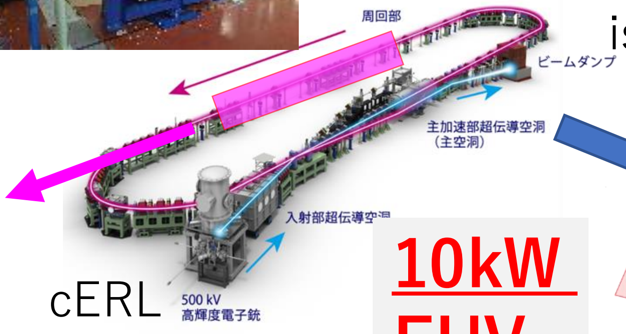
LPP(**Laser Produced Plasma**)
Wavelength: 13.5nm(EUV)
→ A few100W level (error, debris)
>1kW : need breakthrough
Efficiency too low 0.02%

- Development of a high-intensity EUV light source for EUV lithography
- **10 kW** level EUV light source based on ERL-FEL technology.

ERL : Energy recovery linac
reduce power consumption and radiation

FEL: Free Electron Laser
EUV light with some specific wave Length / polarization

Achieve IR-FEL generation using cERL in 2021

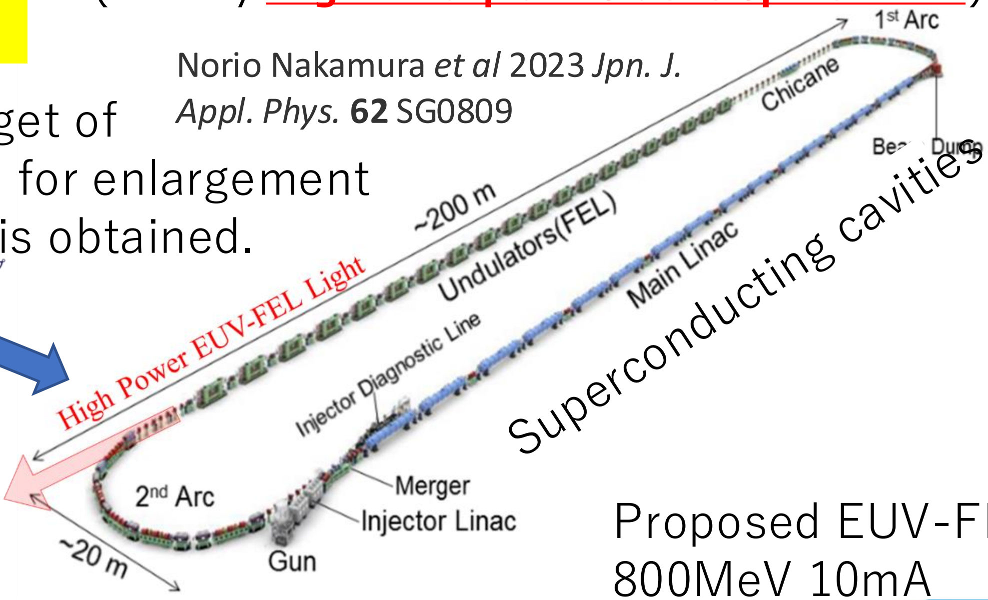


Budget of R&D for enlargement is obtained.

10kW EUV

Most promising next generation EUV light source (recently **xlight Inc. plan to develop EUV-FEL**)

Norio Nakamura *et al* 2023 *Jpn. J. Appl. Phys.* **62** SG0809



Proposed EUV-FEL 800MeV 10mA

We can polish up ERL technology -> Start R&D ERL for ILC

IDT performs

arXiv:2506.00353

ILC250 Cost Update

from Backup document for "Status of ILC [arXiv:2505.11292]"

Cost Estimate/Updates (Year)	ILC500 (2012)		ILC250 (2017)		ILC250 (2024)	
Accelerator Construction (in 9 years)	[B_ILCU]	[B JPY]	[B ILCU]	[B JPY]	[B ILCU]	[B JPY]
Value: Acc. + Conv. Facility (CF : global)	6.52		4.24		6.78	
Civil Engineering (CE : JP specific)		160		129		196
Breakdown:	4.32		2.34		3.69	
Acc-SRF related	1.39		1.20		1.71	
Conv. Acc. Tech. (mag., vac, and others)	0.91		0.71		1.38	
CF (utility service): Electric., cooling, ventil.						
Labor (HR): Laboratory staff	10.12 [k FTE-yrs]		7.47		7.47	
Installation worker	3.35 [k FTE-yrs]		2.65		2.65	
Acc. Operation (/year)						
Value (Electricity, Cooling, etc.)	0.39 [BILCU/yr]		0.32		0.41	
Labor (HR):	850 [FTE]		638		638	
Uncertainty (cost premium) [3,4]	25%		25		29	
Contingency (common fund reserve) [21]	10%		10		10	

KEK

R&D for Key technologies are on-going

Work packages at ILC Technology Network (ITN)

ITN is the global collaboration program.
https://linearcollider.org/documents/idt-docs/idt-eb-docs/
https://linearcollider.org/wp-content/uploads/2023/09/IDT-EB-2023-002.pdf

MEXT Development of key element technologies to improve the performance of future accelerators Program

advanced Accelerator element Technology Development (MEXT-ATD)

Budget 0.7BJYEN/year from MEXT + KEK internal

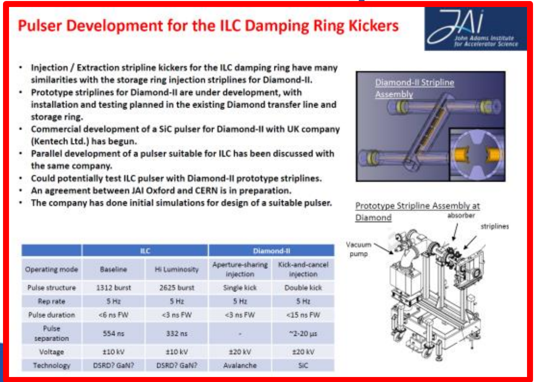
- Creating particles — ***Sources***
  - polarized elections / positrons
- High quality beams — ***Damping ring***
  - Low emittance beams
    - Small beam size (small beam spread)
    - Parallel beam (small momentum spread)
- Acceleration — ***Main linac***
  - superconducting radio frequency (SRF)
- Getting them collided — ***Final focus***
  - nano-meter beams
- Go to ***Beam dumps***

SRF

e-, e+ Sources

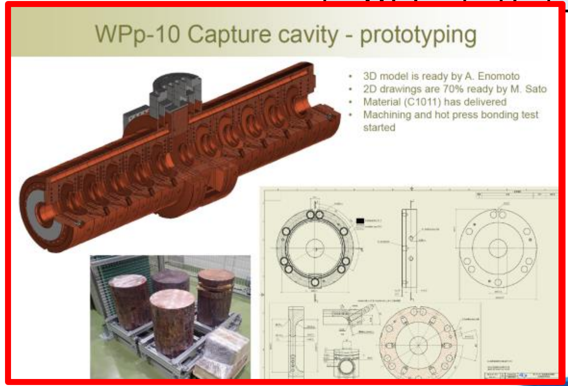
Nano-Beam

WPP	1	Cavity production
WPP	2	CM design
WPP	3	Crab cavity
WPP	4	E- source
WPP	6	Undulator target
WPP	7	Undulator focusing
WPP	8	E-driven target
WPP	9	E-driven focusing
WPP	10	E-driven capture
WPP	11	Target replacement
WPP	12	DR System design
WPP	14	DR Injection/extraction
WPP	15	Final focus
WPP	16	Final doublet
WPP	17	Main dump



	ILC		Diamond-II	
Operating mode	Baseline	Hi Luminosity	Aperture-sharing injection	Kick-and-cancel injection
Pulse structure	1312 burst	2625 burst	Single kick	Double kick
Rep rate	5 Hz	5 Hz	5 Hz	5 Hz
Pulse duration	<6 ns FW	<3 ns FW	<3 ns FW	<15 ns FW
Pulse separation	554 ns	332 ns	-	~2-20 μs
Voltage	±10 kV	±10 kV	±20 kV	±20 kV
Technology	DSRD? GaN?	DSRD? GaN?	Avalanche	SiC

Insight through Accelerators.
KEK



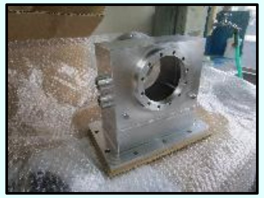
Interesting trials in many European counties

Example: WPP-1/2 cavity fabrication & cryomodule

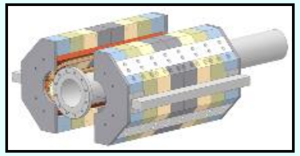
Production ~2025

L-band SC 9-cell cavity

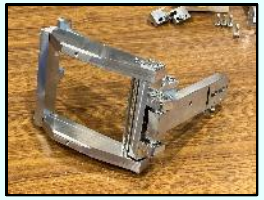
Power coupler



SCQ magnet



Frequency tuner

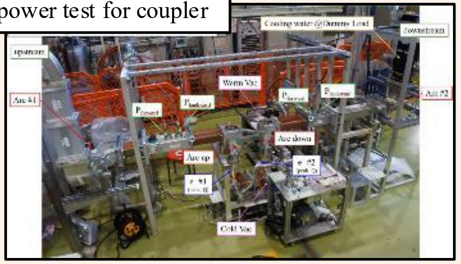


Magnetic shield

Component Test 2025/26

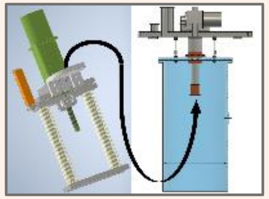
Vertical test for cavity

High power test for coupler



Conduction cooling system for SCQ

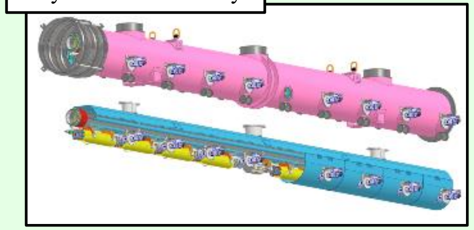
Cold test for motor



Installation ~2026

Demagnetization of cryo-vessel

Cryomodule assembly

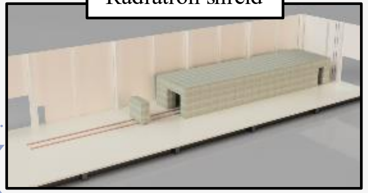


Preparation

Cryogenic

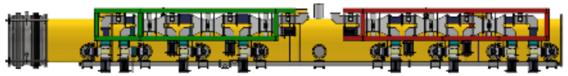
CM assembly hall

Radiation shield



CM Test ~2027

Waveguide assembly



Installation into bunker

Cold test at bunker

ILC Technology Network starts:

This shows Labs/Univ.s join to IDT WG2 :

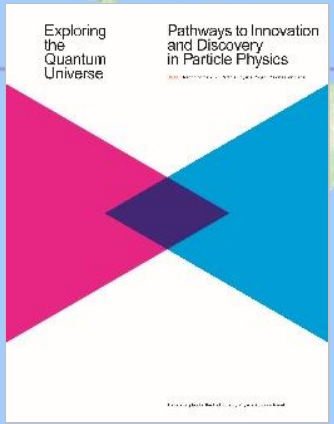
My opinion : Future collider is not affordable in one Lab.
Too big budget is necessary
Missing Diversity in Science
Risk: Large HR is used in Long Priode.

Future collider will require global collaboration among national and regional labs to bring in global resources, including human resources.

The ITN could serve as a miniature model case

CERN, German, UK, France, Italy, Spain

KEK, Korea Australia



P5 recommendation:
MEXT-DOE discussion:
US Labs. join using Japan-US funding.

Insight through Accelerators. KEK

Timeline / Promotion Step-by-Step

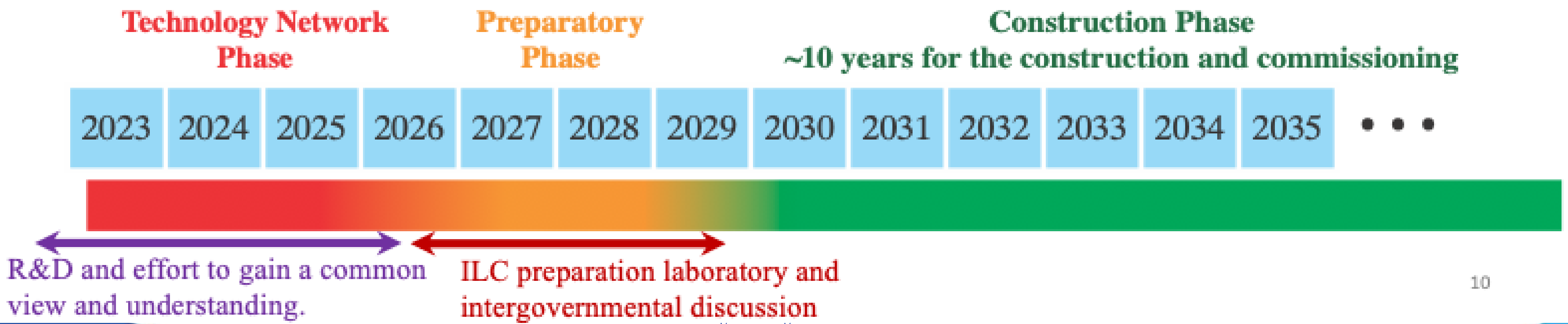
The following issues to be considered for the overall timescale of the ILC

- ITN work packages are two to four years.
- Given ITN, the preparatory phase could be less than what was considered for the Pre-lab proposal, i.e. four years, for the accelerator and site related work.
- MEXT funding programme for the accelerator R&D is planned for five years.
- For entering the preparatory phase, concerned government authorities, not only Japanese but also the European and the US, must become ready to discuss the ILC specific matter.
- P5 discussion in the US and FCC feasibility studies at CERN will have an impact.

Cultivate of relation for global discussion

ILC project timeline

-success oriented and asuming no major incident-



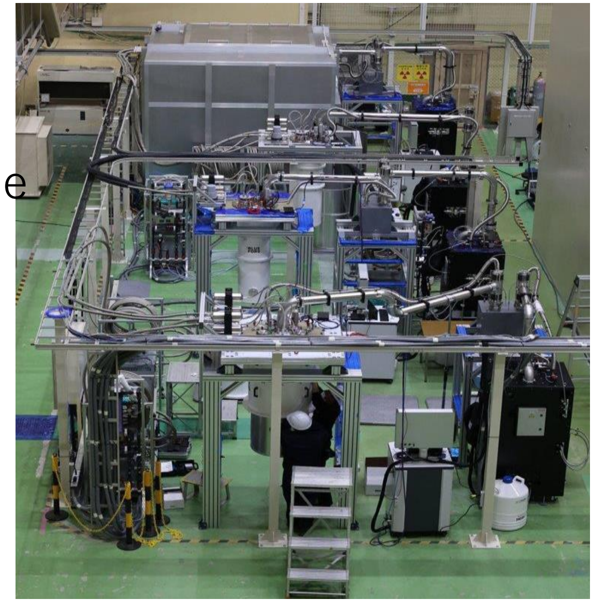
KEK

Eric/Fabiola mentioned Axion/PBC yesterday

4. Quantum technology

All KEK has Synergy based on "Quantum"

Big Cryo-Labo
4 cryomodule
XLD400 in one place



Private Companies + Labs

TOYOTA

NIMS

AIST
NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

Application
Sensor
Q-Connection

Quantum Material using multibeam

academic-industrial Collab. office

QUP

Q-Sensor
Basic Science

Mat.Lab

IMSS

PF

KEK

Accl. /Workshop Labs

PP Lab

IPNS

International Collaboration

CERN

Fermilab

ASPIRE

UTokyo

Study Q Material
(Various Quantum beams prove spin/state of atom, electron, nuclear)

CryoCMOS
Cryo technology
SC Cavity Q>10^{11}

Sensor for Basic Science
Gravity
Q-Connection
Dark Matter detection

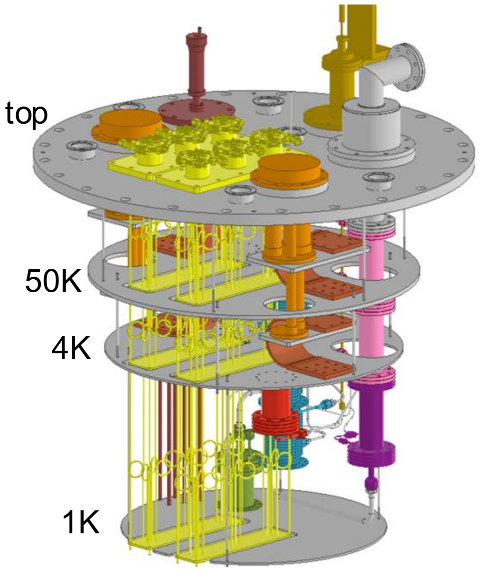
Insight through Accelerators. KEK

Let's have tight collaboration in this field

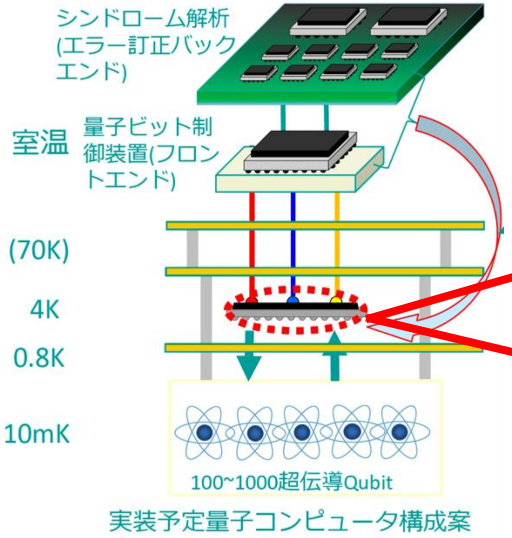
Cryo technology　　CryoCMOS

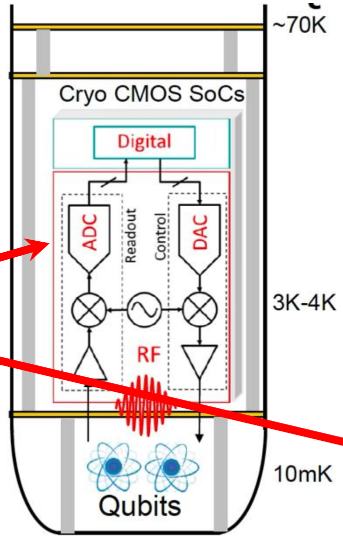
- The integration of the cryogenic, mechanical, and electronics groups within ITDC is starting to generate synergy.

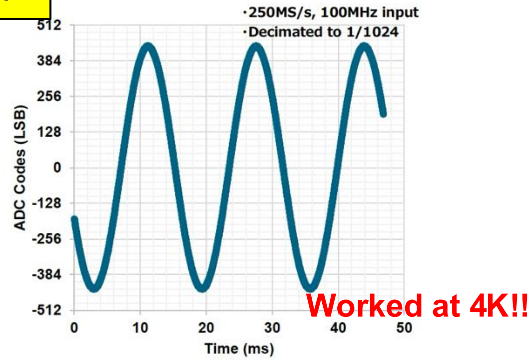
Construction of sub-K cryogenic system



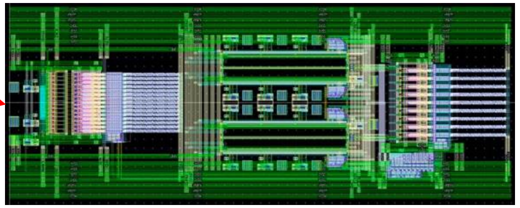
Cryo CMOS for Qubits control







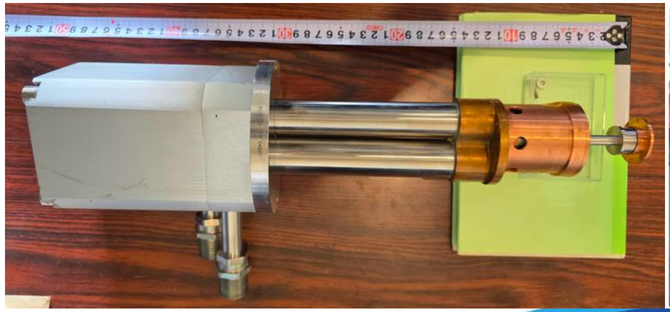
Sine wave input test of ADC @4.2K

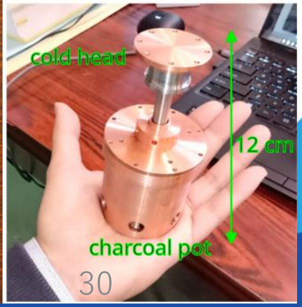


10bits Cryo ADC (22nm CMOS)

- Strengthen cryogenic technology development in alignment with KEK's International Excellence of Quantum Frontier.
  - ➢ Cryogenic systems for quantum computers and quantum sensing (including application in searches for new particles)
- Foster industry-academia collaboration through KEK's cryogenic technology
  - ➢ Compact cryocooler for in-vehicle quantum sensors (under exploration)

Compact sorption Cryocooler





Summary

- We have **Diversity** in Science Program / Application:
- SuperKEKB/Belle II **recorded the highest Luminosity**.

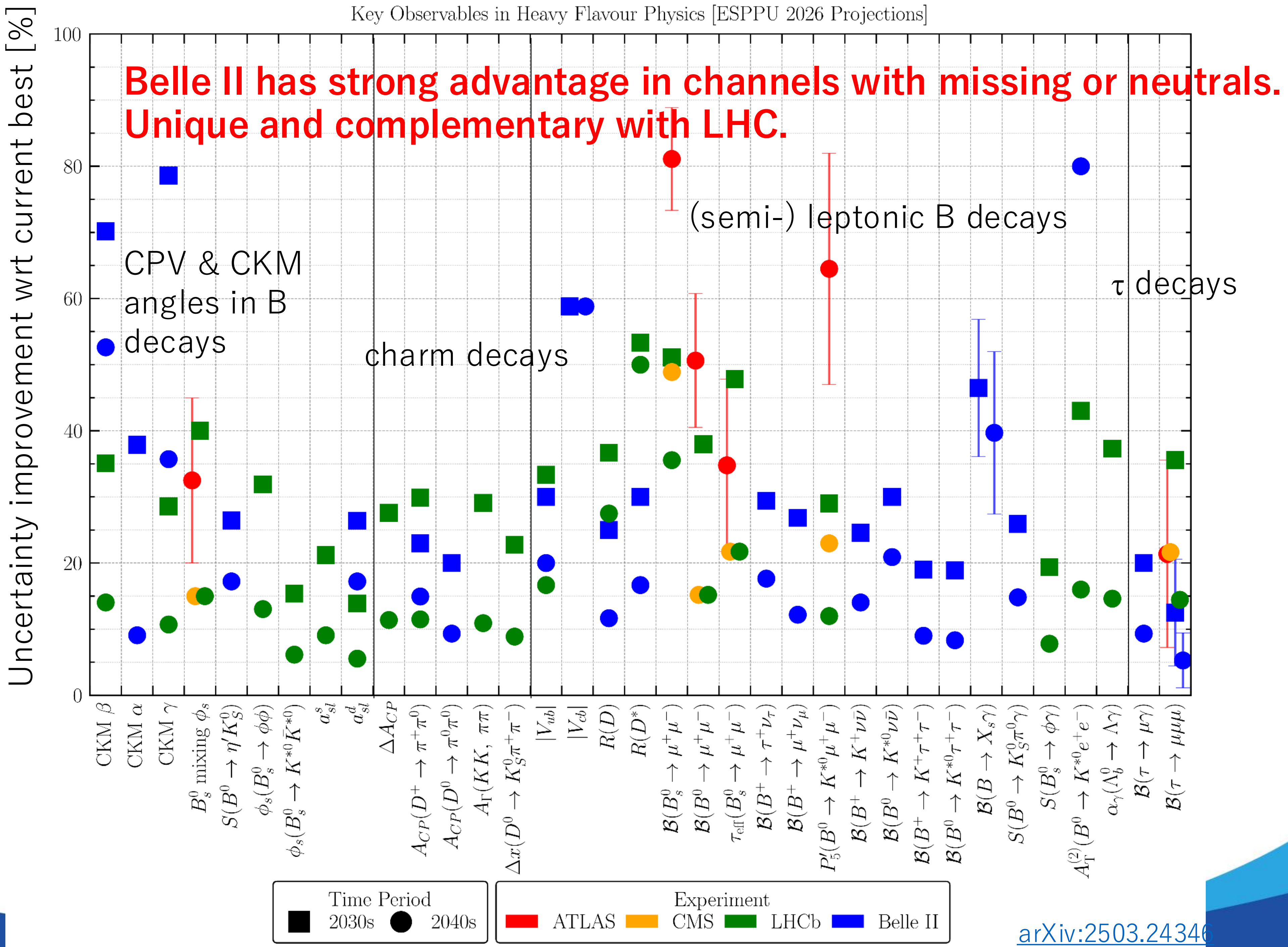
  Moves to the next stage: We can access the interesting physics results
- J-PARC for neutrino achieves 900kW. Construction of Hyper-K & power UG are on going; **we aim to start at 2028 (budget / schedule**
- MLF 1MW achieved: MR SX 92kW achieved

  Global discussion for muon, K, .. are important.
- KEK/IDT/ILC-JAPAN collaborate tightly to make leading efforts to realize the ILC as global project.
- ILC TN is on-going / OPEN discussion for global collaboration
- Quantum is also important field.

おまけ

Insight through Accelerators.
KEK

Marie-Helene san will give detail in tomorrow

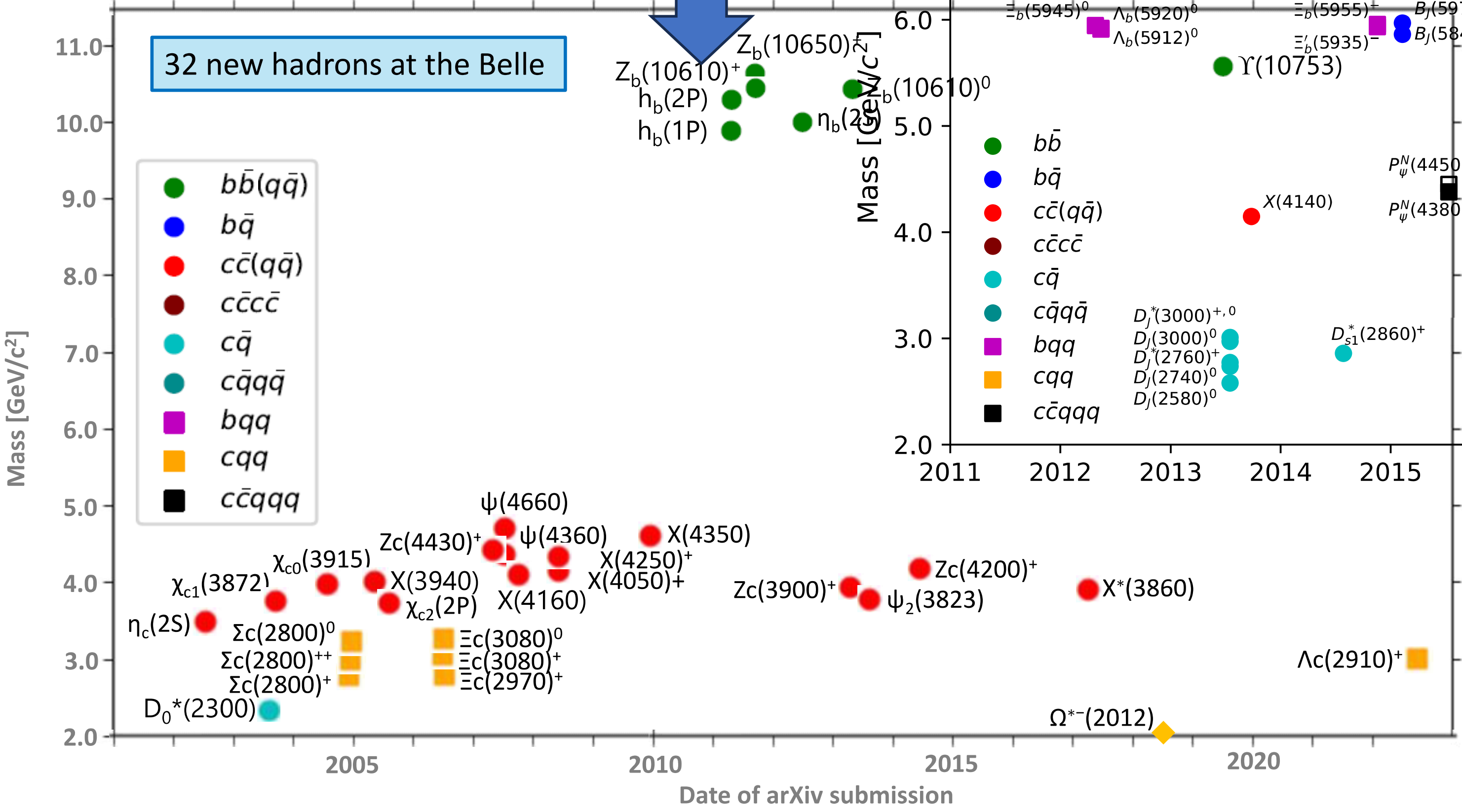


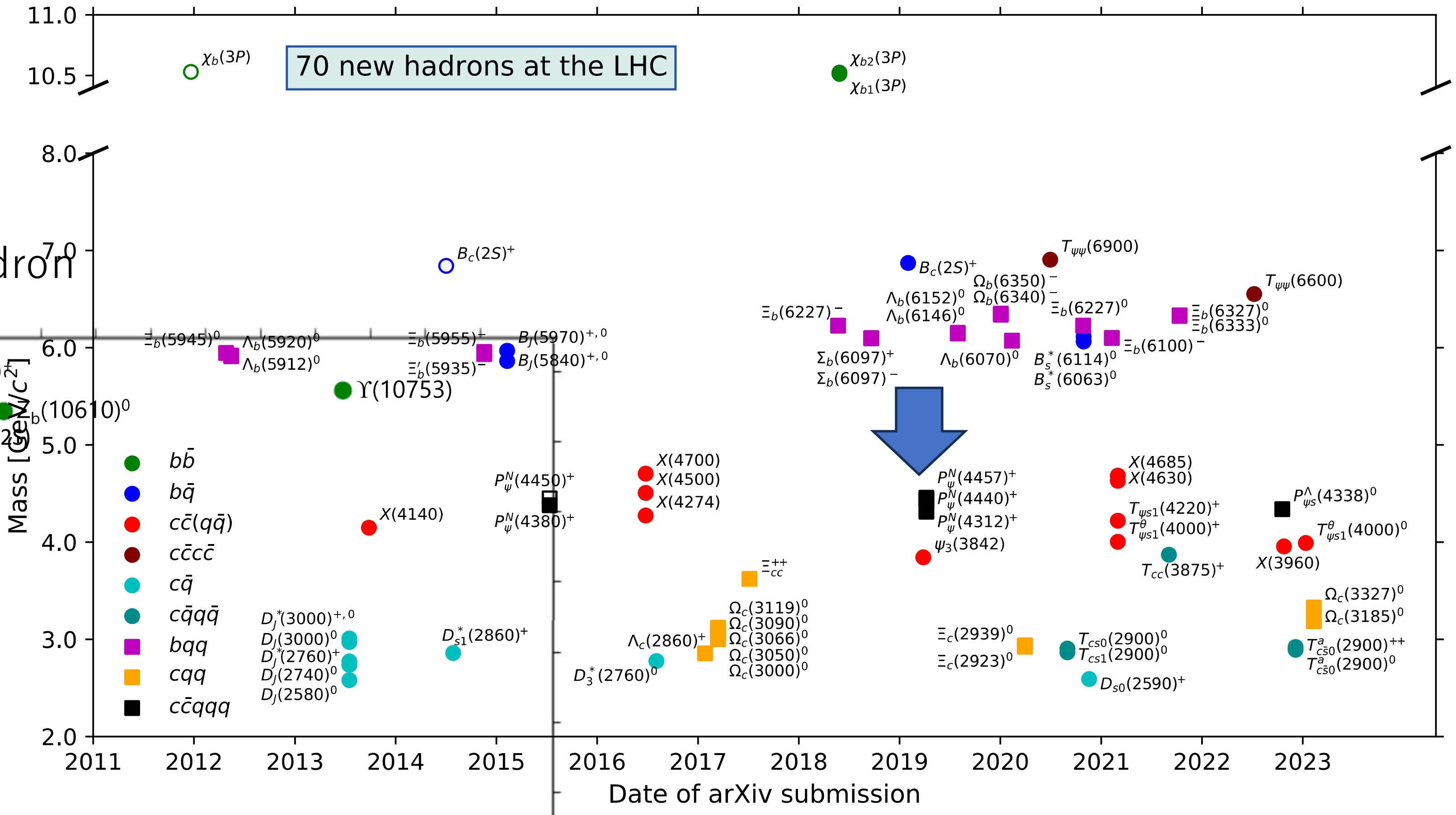
	2030s	2040s
ATLAS		3000 fb^{-1}
CMS		3000 fb^{-1}
LHCb	50 fb^{-1}	300 fb^{-1}
Belle II	10 ab^{-1}	50 ab^{-1}

arXiv:2503.24346

History of discovery of New Hadron states.

Tetraquark, pentaquark exotic Hadron





KEKB opened this window about 20 years ago.

For **Lattice QCD study**:
State just under threshold of bound-state is interesting .
Enerrgy-momentum resolution is crucial

Color confinement

Insight through Accelerators.
KEK

Latest status of CPV search in T2K

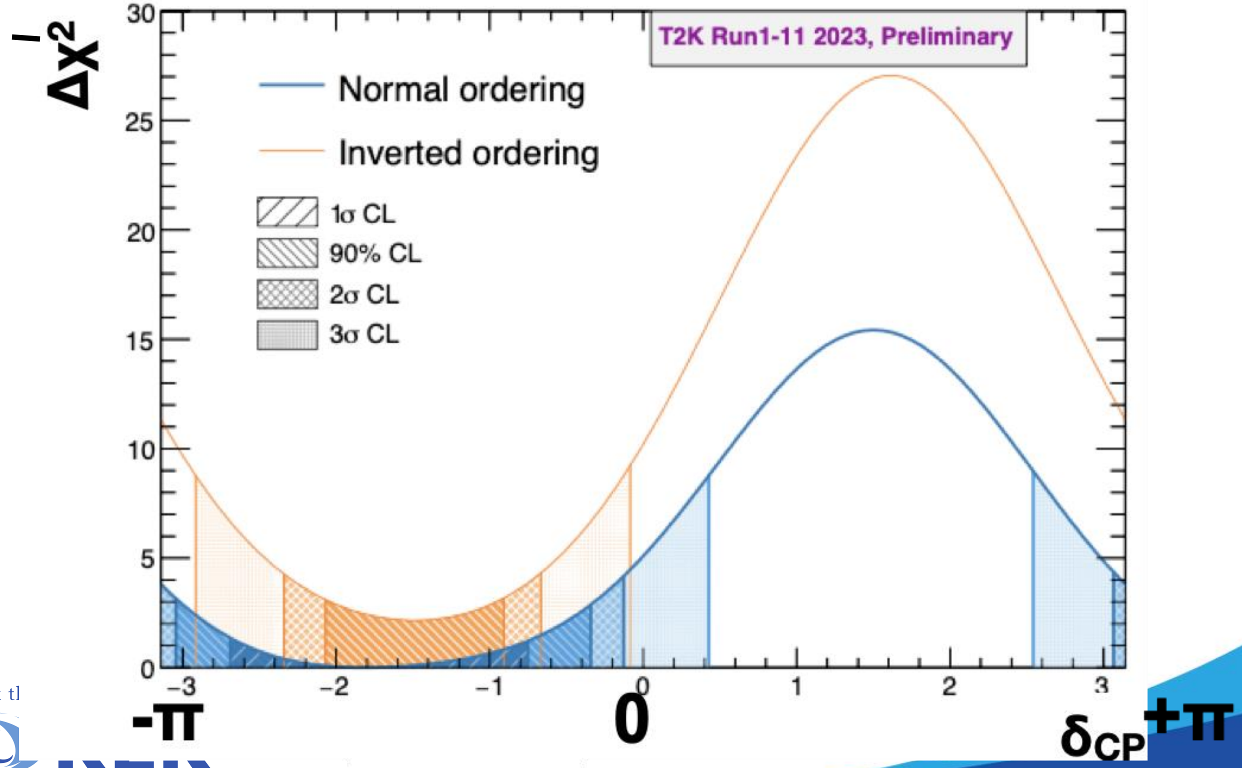
New results shown at the Neutrino2024 conference

First constraint on lepton CP asymmetry has been obtained

CP conservation is excluded at 90% C.L.

of ν_e appearance events

	MC for each δ_{CP}				Data
	$-\pi/2$	0	$\pi/2$	π	
ν-mode 1Re	113.2	95.5	78.3	96.0	**102**
ν-mode 1Re+d.e.	10.0	8.8	7.2	8.4	**15**
ν-mode 1Re	17.6	20.0	22.2	19.7	**16**

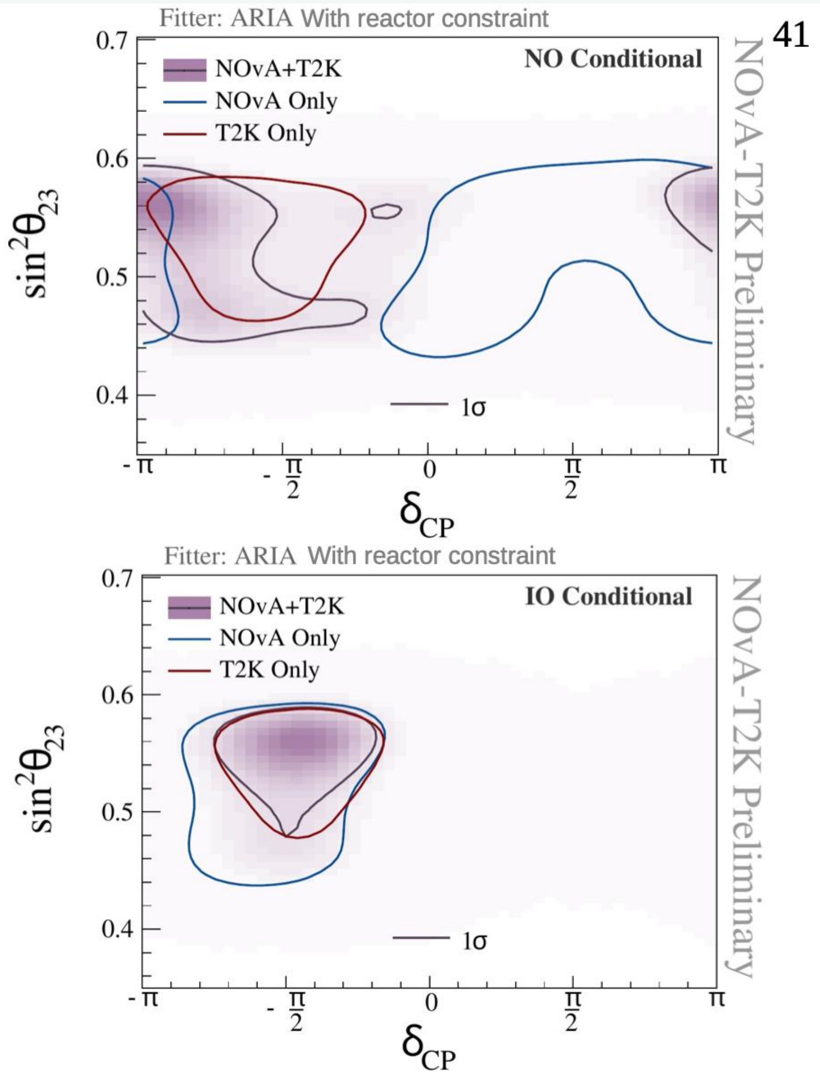


NOvA+T2K combined results

Comparison with NOvA-only & T2K-only fits

- The joint analysis **relieves differences in the Normal Ordering** where the individual experiments prefer slight different parameter regions.

- **Joint-fit gains sensitivity in the Inverted Ordering** where there was significant overlap in the posterior probability for the individual experiments.



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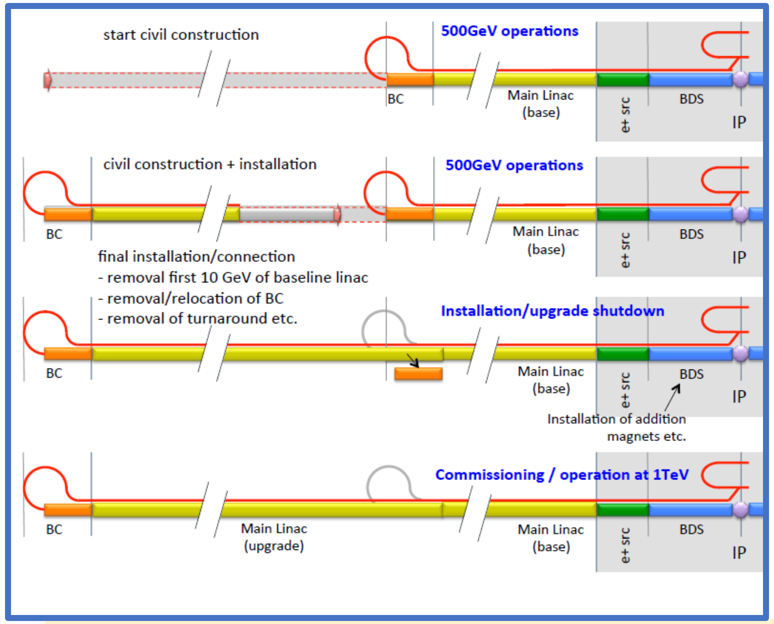
Slide by Ed Atkins (ICL) at KEK seminar 16 Feb 2024
(also FNAL Wine&Cheese seminar by Zoya Vallari)

ILC Baseline and the Upgrades
based on SRF technologies (more than 20 years)

Quantity	Symbol	Unit	Initial	$\mathcal{L}$ Upgrade	Z pole	E / $\mathcal{L}$ Upgrades		
Centre of mass energy	$\sqrt{s}$	GeV	250	250	91.2	500	250	1000
Luminosity	$\mathcal{L}$	$10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$	1.35	2.7	0.21/0.41	1.8/3.6	5.4	5.1
Polarization for e^-/e^+	$P_-(P_+)$	%	80(30)	80(30)	80(30)	80(30)	80(30)	80(20)
Repetition frequency	f_{rep}	Hz	5	5	3.7	5	10	4
Bunches per pulse	n_{bunch}	1	1312	2625	1312/2625	1312/2625	2625	2450
Bunch population	N_e	10^{10}	2	2	2	2	2	1.74
Linac bunch interval	Δt_b	ns	554	366	554/366	554/366	366	366
Beam current in pulse	I_{pulse}	mA	5.8	8.8	5.8/8.8	5.8/8.8	8.8	7.6
Beam pulse duration	t_{pulse}	μs	727	961	727/961	727/961	961	897
Accelerating gradient	G	MV/m	31.5	31.5	31.5	31.5	31.5	45
Average beam power	P_{ave}	MW	5.3	10.5	1.42/2.84*)	10.5/21	21	27.2
RMS bunch length	σ_z^*	mm	0.3	0.3	0.41	0.3	0.3	0.225
Norm. hor. emitt. at IP	$\gamma\epsilon_x$	μm	5	5	5	5	5	5
Norm. vert. emitt. at IP	$\gamma\epsilon_y$	nm	35	35	35	35	35	30
RMS hor. beam size at IP	σ_x^*	nm	516	516	1120	474	516	335
RMS vert. beam size at IP	σ_y^*	nm	7.7	7.7	14.6	5.9	7.7	2.7
Luminosity in top 1 %	$\mathcal{L}_{0.01}/\mathcal{L}$		73 %	73 %	99 %	58.3 %	73 %	44.5 %
Beamstrahlung energy loss	δ_{BS}		2.6 %	2.6 %	0.16 %	4.5 %	2.6 %	10.5 %
Site AC power *	P_{site}	MW	111	138	94/115	173/215	198	300
Site length	L_{site}	km	20.5	20.5	20.5	31	31	40

S. Michizono: LCWS2024 (LC upgrade session)

Energy upgrades:
- 500GeV (**31.5 MV/m Q_0=1** x 10^{10})
  - 1TeV (**45 MV/m Q_0=2** x 10^{10}, 300 MW)
  - more SCRF, tunnel extension

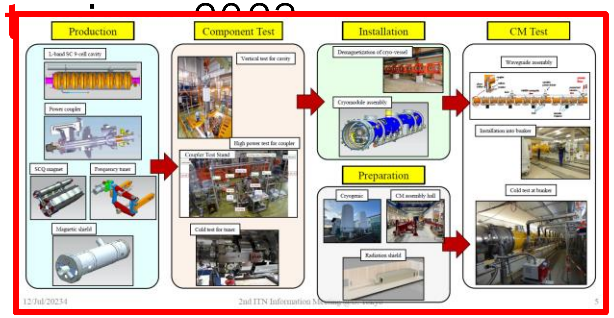


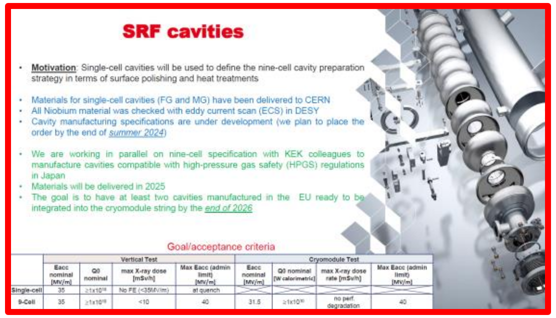
Further energy upgrades can be realized by
- Nb_3Sn cavity (>80MV/m ?)
- Nb Traveling Wave (TW) structures (HELEN) (>70MV/m)

Energy upgrade can do if the gradient will be increased by such technologies.

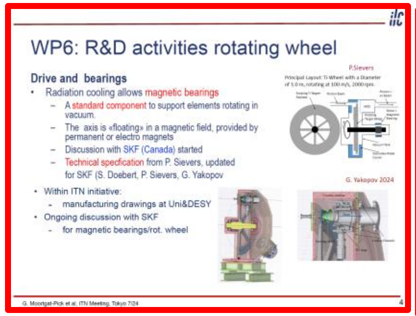
ITN status in 2024

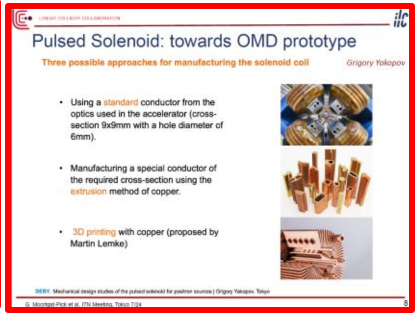
For **WPP-1&2 (SRF cavity, CM)**, single cell cavity production in **Korea/Europe** started.
JAI (UK) started WPP-14 (DR Injection/extraction, **synergy with Diamond Light Source upgrade**)
For **WPP-15 (Final Focus System)**, **European and Korean researchers have joined to the ATF experiment**

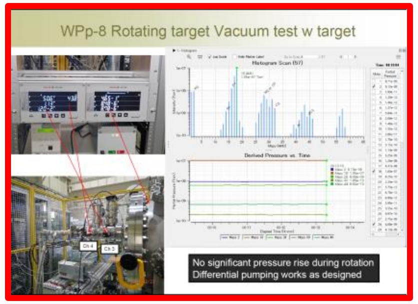


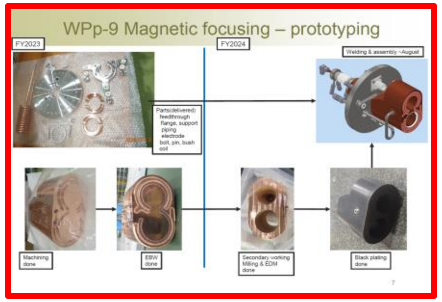


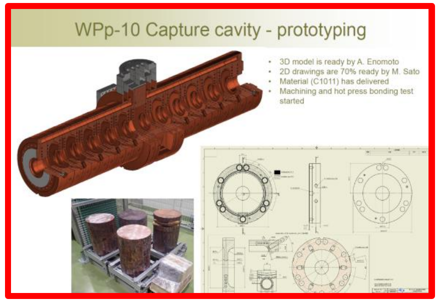
2nd meeting on
July 2024
@Tokyo/hybrid

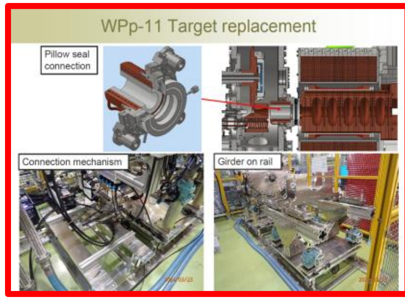


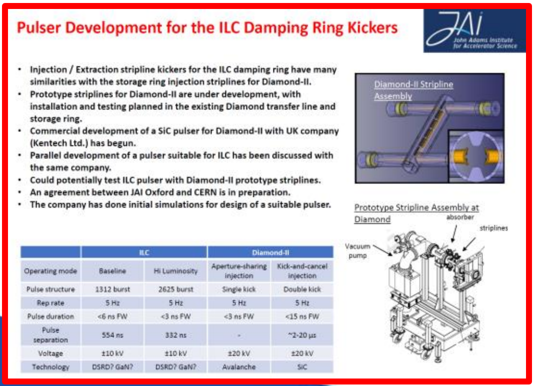


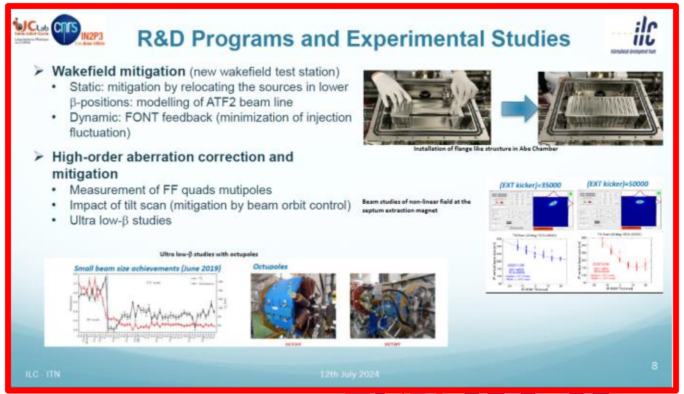


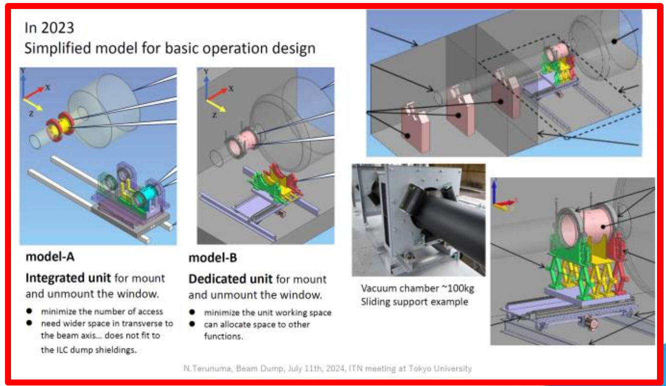












From now, we will mainly review our **latest Japanese activities on ITN progress** under MEXT/ATD program fr

ILC Promotions in World-Wide with IDT

ILC-Technology Network (ITN) to implement the most urgent work-packages in advance.

The budget in Japan in JFY2024 ~ higher than 1B Yen: Increase by several % than JFY2023.
The budget is covered by MEXT(Development of key element technologies to improve the performance of future accelerators Program)
KEK prepares the infrastructure for SRF using this budget and starts Japanese activities in ITN.

- The ITN is a network of the accelerator laboratories:
  KEK, CERN, European Labs. US National Labs. Univ. and Asian Labs···

Purposes

- Make international cooperation tighter / dependable @ Govern. Level
  → Make global flamework.
- Improve the reliability and completeness of ILC technology.
  → Topics are time critical Workpackage for PreLab/
- Potential for application of ILC Technologies

ILC250 Cost Update Summary

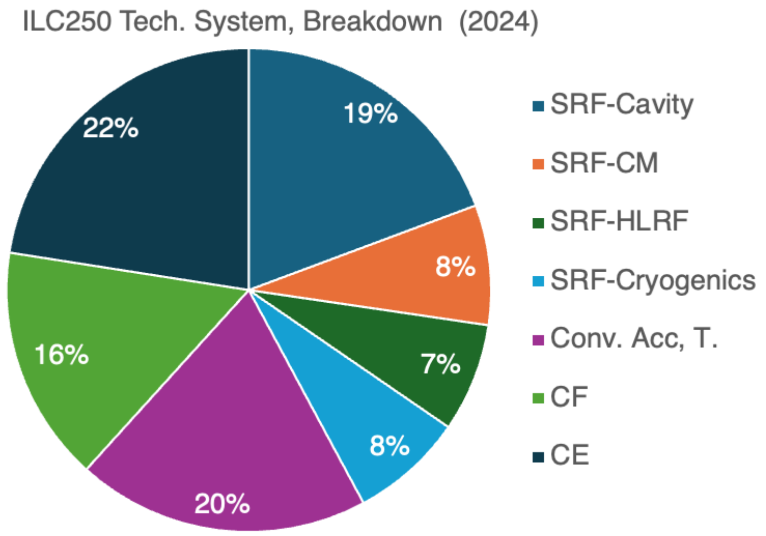
arXiv:2506.00353

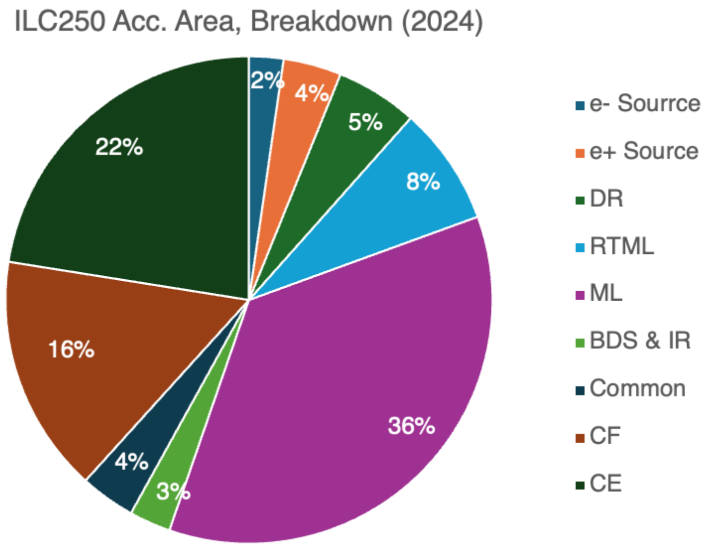
4a) Technical-system oriented:

Tach. Systems:	Sub-Technical System	B.D. [B ILCU]	Value [B ILCU]	B.D. [B JPY]	Value [B JPY]
SRF - related			3.69		
	1.3-GHz Cavity (SC-mat, Fab., Surface)	1.689			
	Cryomodule (Parts, Assembly)	0.701			
	L-band HLRF (Modulator, Klystron, PDS)	0.635			
	Cryogenics	0.661			
Conv. Acc. Tech.			1.71		
	Magnet & Magnet Power-Supply	0.642			
	Vacuum	0.145			
	Beam-dump & Collimator	0.071			
	Instrumentation	0.183			
	LLRF, Control, & Computing-Infra.	0.483			
	Others (Area-specific., Installation-Equip.)	0.188			
Conv. Facility (CF)			1.38		
	Electrictrical Distribution	0.835			
	Cooling & Ventilation	0.368			
	Others (alignment, safety, etc.)	0.179			
Civil Engineering (CE)					196
	Underground (Tunnel, Cavern, Access T.)			158	
	Surface Build. (IP, Acc.-Site, Main Campus)			38	

4b) Accelerator-Area oriented:

Accelerator Areas:	Note		Value [B ILCU]		Value [B JPY]
e- source			0.20		
e+ source	Undulator-driven e+ source		0.34		
DR	Damping Ring (two rings)		0.47		
RTML	Ring-to-MainLinac		0.69		
ML	Main Linac		3.14		
BDS & IR	Beam Delivery System & Int. Region		0.24		
CF	Conv. Facility (cooling & ventil.)		1.38		
CE	Civil Eng. (under-gr., surface)				196
Sum (Acc+CF)			6.78		
Sum (CE)					196





ILC250 Cost Update Breakdown