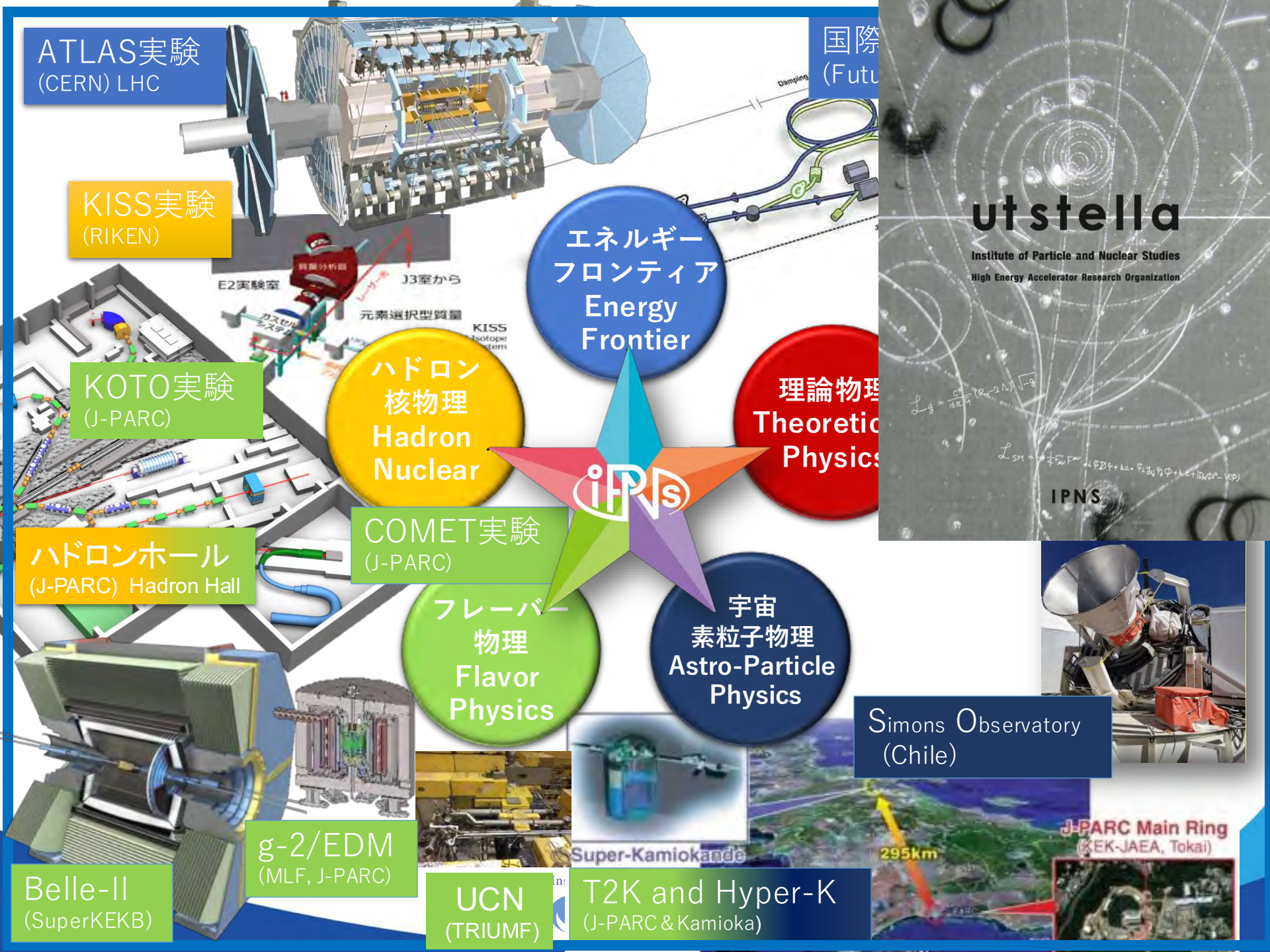

KEK
iFPNS
Institute of Particle and Nuclear Studies
KEK Report
2025 Joint workshop of FKPPN and TYL/FJPPN
May 14-15, 2025
Naohito SAITO
大強度陽子加速器施設
J-PARC
Tsukuba Campus
Tokai Campus


ATLAS実験
(CERN) LHC
国際
(Futu
KISS実験
(RIKEN)
E2実験室
J3室から
元素選択型質量
KISS
エネルギー
フロンティア
Energy
Frontier
KOTO実験
(J-PARC)
ハドロン
核物理
Hadron
Nuclear
理論物理
Theoretic
Physics
utstella
Institute of Particle and Nuclear Studies
High Energy Accelerator Research Organization
IPNS
iPNs
ハドロンホール
(J-PARC) Hadron Hall
COMET実験
(J-PARC)
フレーバー
物理
Flavor
Physics
宇宙
素粒子物理
Astro-Particle
Physics
Simons Observatory
(Chile)
Belle-II
(SuperKEKB)
g-2/EDM
(MLF, J-PARC)
UCN
(TRIUMF)
Super-Kamiokande
295km
J-PARC Main Ring
(KEK-JAEA, Tokai)
T2K and Hyper-K
(J-PARC & Kamioka)

IPNS Organization 2025

https://www2.kek.jp/ipns/ja/about_ipns/organization/

素粒子原子核研究所
Institute of Particle and Nuclear Studies

IPNS Steering Committee

IPNS Research Planning Committee

IPNS Leaders Association

Directorate

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SAITO, Naohito

Assistant
HONDA, Yuko

Deputy Director
USHIRODA, Yutaka
KOMATSUBARA, Takeshi
TOMOTO, Makoto

Administration Office

PR Team
KIKUCHI, Mako

Engineering Coordinator
KAWAI, Masanori

Engineering Counselor
TANAKA, Nobuaki
FUJITA, Yoichi
MAKI, Muneyoshi
HIROSE, Erina

Theory Center
Head
HASHIMOTO, Shoji

Wako Nuclear Science Center
Head
WATANABE, Yutaka

Instrumentation Technology Development Center
Head
TOMOTO, Makoto

- Mechanics
- Electronics System
- Cryogenics

Energy Frontier
OIDE, Hideyuki

Belle
NAKAO, Mikihiko

Neutrino
NAKADAIRA, Takeshi

Hadron
(Primary BL +Strangeness +KOTO + High-p +COMET)
TAKAHASHI, Hitoshi

CMB
HASEGAWA, Masaya

Muon and Neutron
MIBE, Tsutomu

Computing
HARA, Takanori

Safety
ADACHI, Ichiro

Directorate, Center/Group Leaders, and Admin Office of FY 2025

...erators.
...EK

Instrumentation Technology Development Center

International Hub for instrumentation development
Promotion of Innovation and Young researches

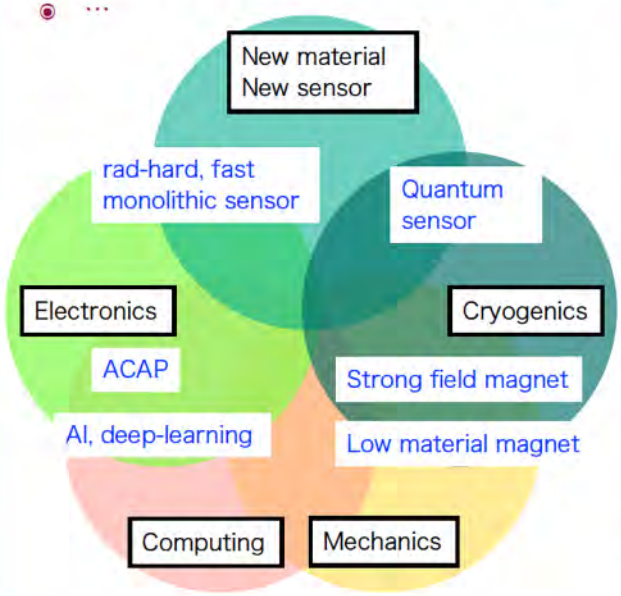
Inter-University Research

- Extension of inter-university research functions
- More efficient and faster development
  → International visibility

- Wider users by simpler system for use
  → Young researchers such as student can easily use
  → Education

Cutting Edge Technology Development

- **Common/Core technologies for next generation projects**
  ←final application by each project
  (continue to have support function)
- Some platforms to do R&D
  - works as the interface to the community
- Technology candidates
  - Strong field magnets
  - New material semiconductor (eg. CIGS) for rad-hard
  - BiCMOS technology for high speed
  - Next generation FPGA based readout
  - …



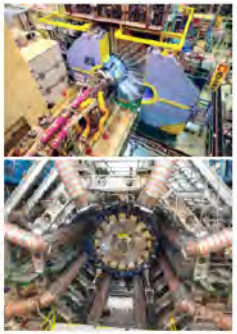
Technology Development Platforms

- Cryogenics
- Mechanics
- Sensor
  - Light sensor
  - semiconductor
  - gas & active medium
- Electronics
  - System integration
  - Collider Electronics
- SPADI alliance
- Computing

Platform Organization flexible, always ready to start new one

Researcher Community

IPNS projects



KEK projects

REBCO for HL-LHC

Education

HEP school

Industry

organic semiconductor

138億年
現在

約80億年
宇宙膨張の加速

暗黒エネルギーと呼ばれる反重力的な効果で宇宙膨張が加速する。

約4億年
天体の生成

重力により多くの原子が集まって星を形成し始める。その後、星が集まり銀河を形成する。

38万年
原子の生成＝「晴れ上がり」

電子が原子核に束縛され原子が出来る。これ以降、光が直進できるようになる。

3分
He核の生成

陽子と中性子からヘリウムなどの軽い原子核が出来る

10^{-4}秒
閉じ込め

３つのクォークから陽子や中性子が出来る。

10^{-10}秒
ヒッグス粒子による電弱相転移

クォークや電子など素粒子の熱いスープ状態。

10^{-43}-10^{-38}秒
インフレーション

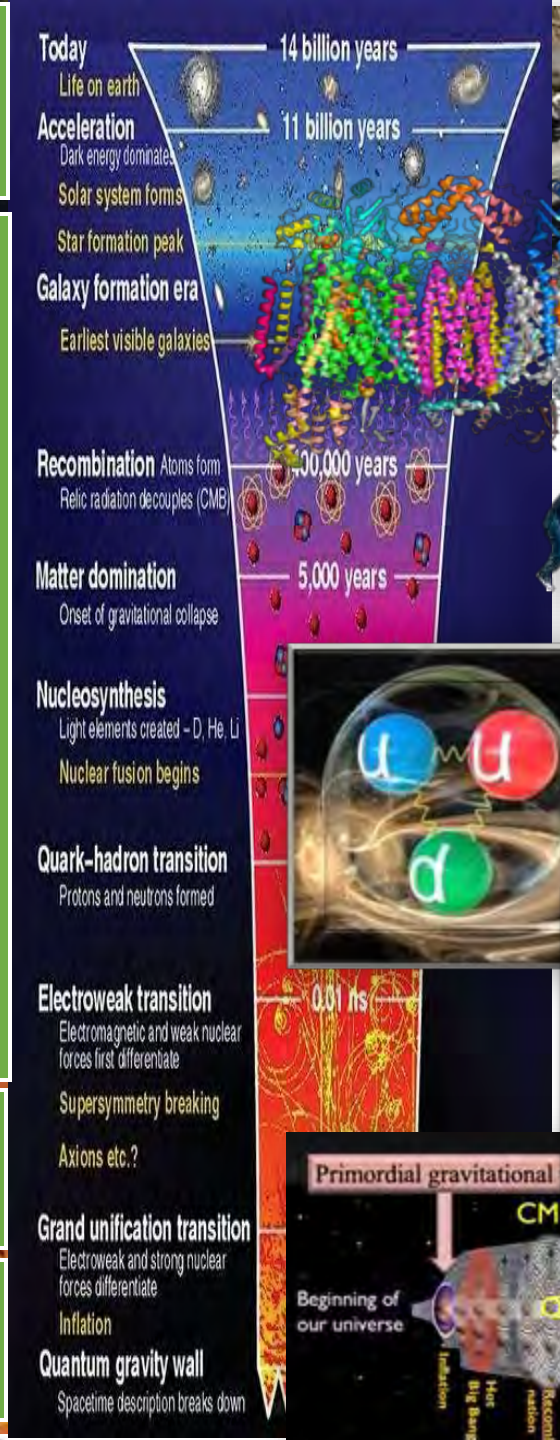
原子１個の大きさが太陽系の大きさに一気に膨張

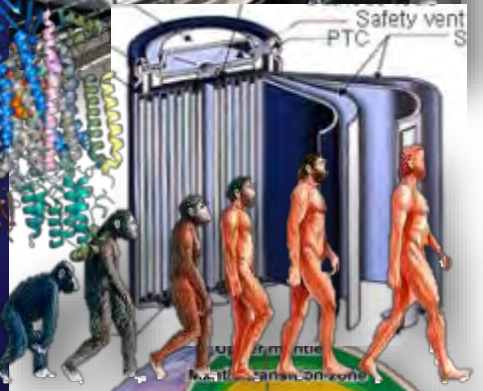
創発期
生命・新物質の創造
Production

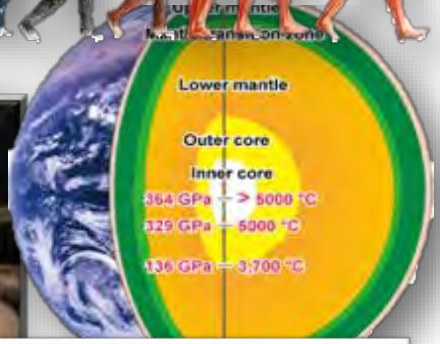
形成期
原子核・原子の創造
Formation

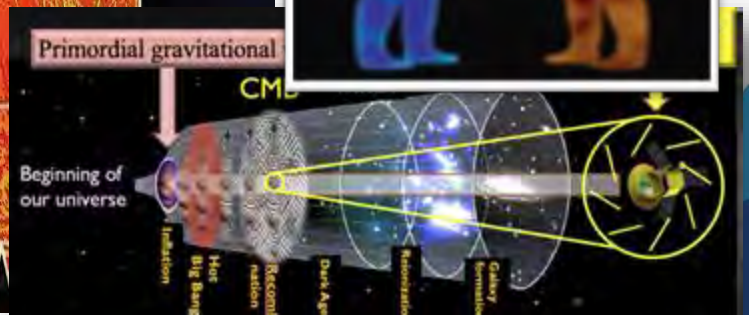
創成期
素粒子の創造
Creation

黎明期
時空の創造
Dawn









おめでとう！ Many Congrats!

- （素核研EFグループも参加する）LHC 実験が、Breakthrough 基礎物理学賞を受賞

FUNDAMENTAL PHYSICS BREAKTHROUGH PRIZE

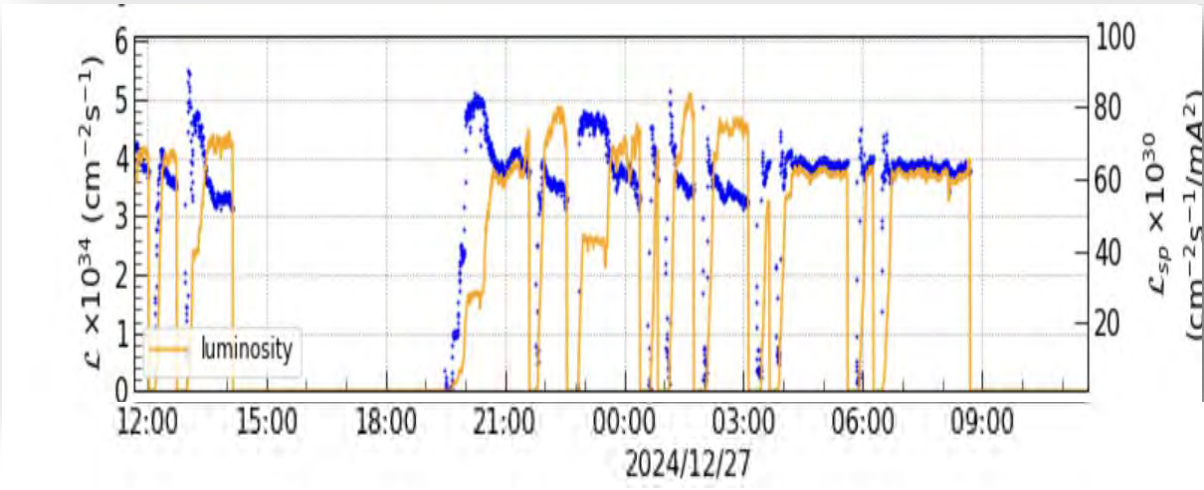
MISSION BOARD TROPHY EVENTS NOMINATIONS NEWS CONTACTS MANIFESTO
COMMITTEE PRIZES LAUREATES RULES

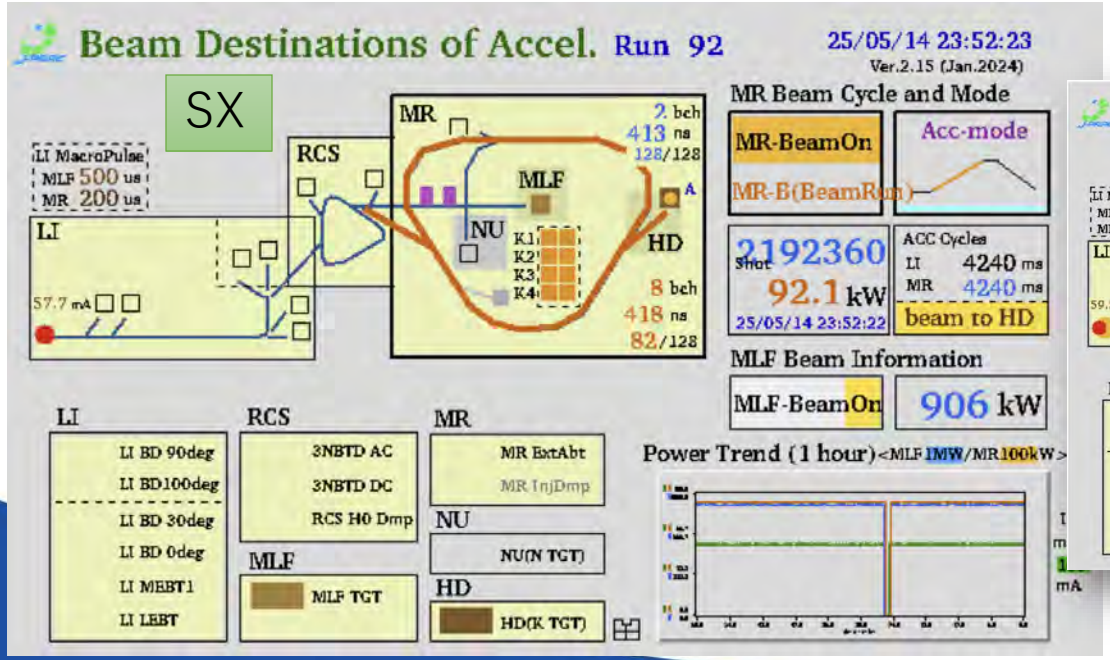
Search

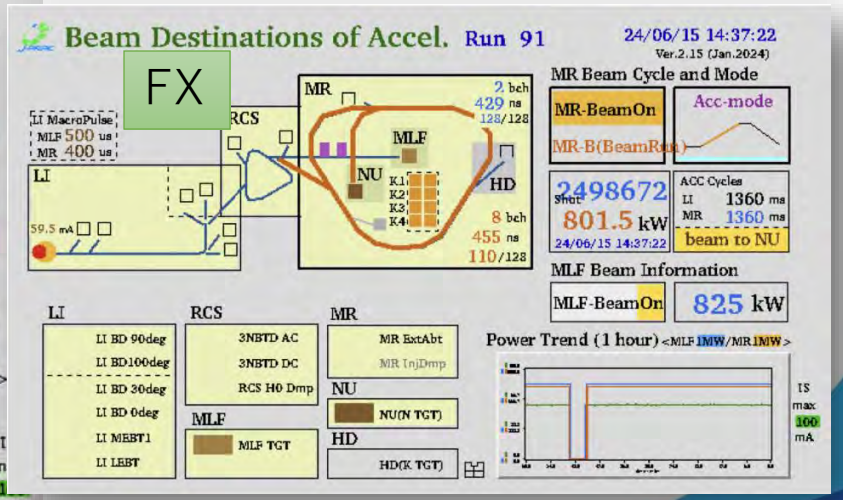
写真左から、
Andreas Hoecker氏（元ATLASスポークスパーソン）、
Patricia McBride氏（元CMSスポークスパーソン）、
Marco Van Leeuwen氏（ALICEスポークスパーソン）、
Vincenzo Vagnoni氏（LHCbスポークスパーソン）
写真提供: Getty Images for Breakthrough Prize

NoBeam NoLife 2025

- SuperKEKB
  - Finally the WR is updated, 0141 am, December 27, 2024.
  - 5.105E34cm^{-2}/s
- J-PARC
  - FX > 800 kW was smooth then, MR troubles
  - Prolonged maintenance of MLF Hg tgt & Lo-Power
  - Finally smooth SX running @ > 92 kW

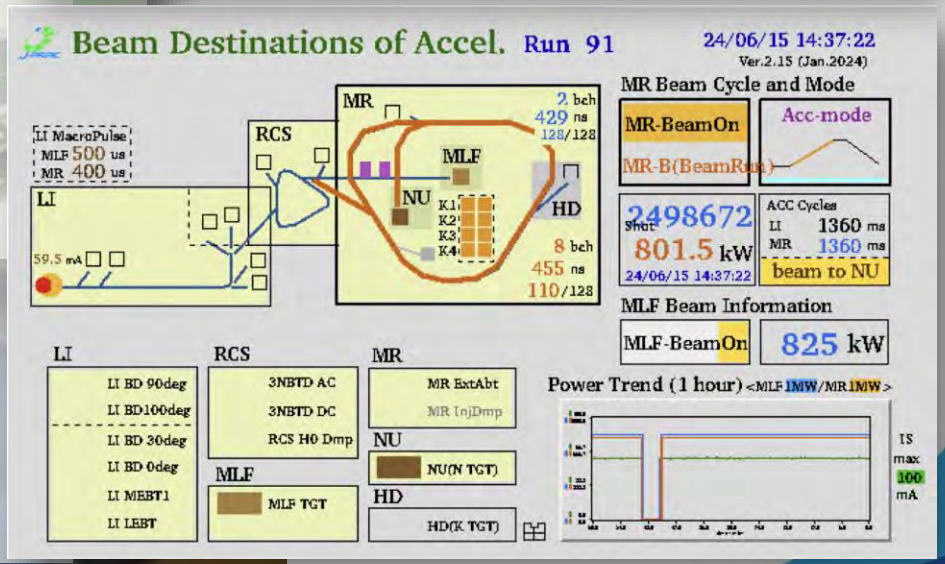






IPNS Projects Current Status

- SuperKEKB/Belle II
  - **Run 2024c ended with 5.1E34!**
  - Physics Analyses are ongoing
  - LS2 plan is being developed
- J-PARC MR SX Beam > 92 kW;
  FX > 800 kW
  - Beamtime, Aging and New Initiatives
- LHC Run3: resumed in April
  - Detectors and Magnets are being prepared towards HL-LHC
- ITDC
  - Test beamline is being operated
  - R&D platforms are active
- Hyper-K construction
  - IWCD construction/Beamline upgrades
- PIP 2022 realization and optimization
  - Muon g-2/EDM@J-PARC
    - Annual review is held in March
  - Optimization of HEF-ex
    - Core group discussion is ongoing
  - COMET Review
    - Post-review action is underway
  - LiteBIRD Review
    - Post-review action is underway
- KISS making good progress; KISS1.5 started
- TUCAN is to retry UCN production in May



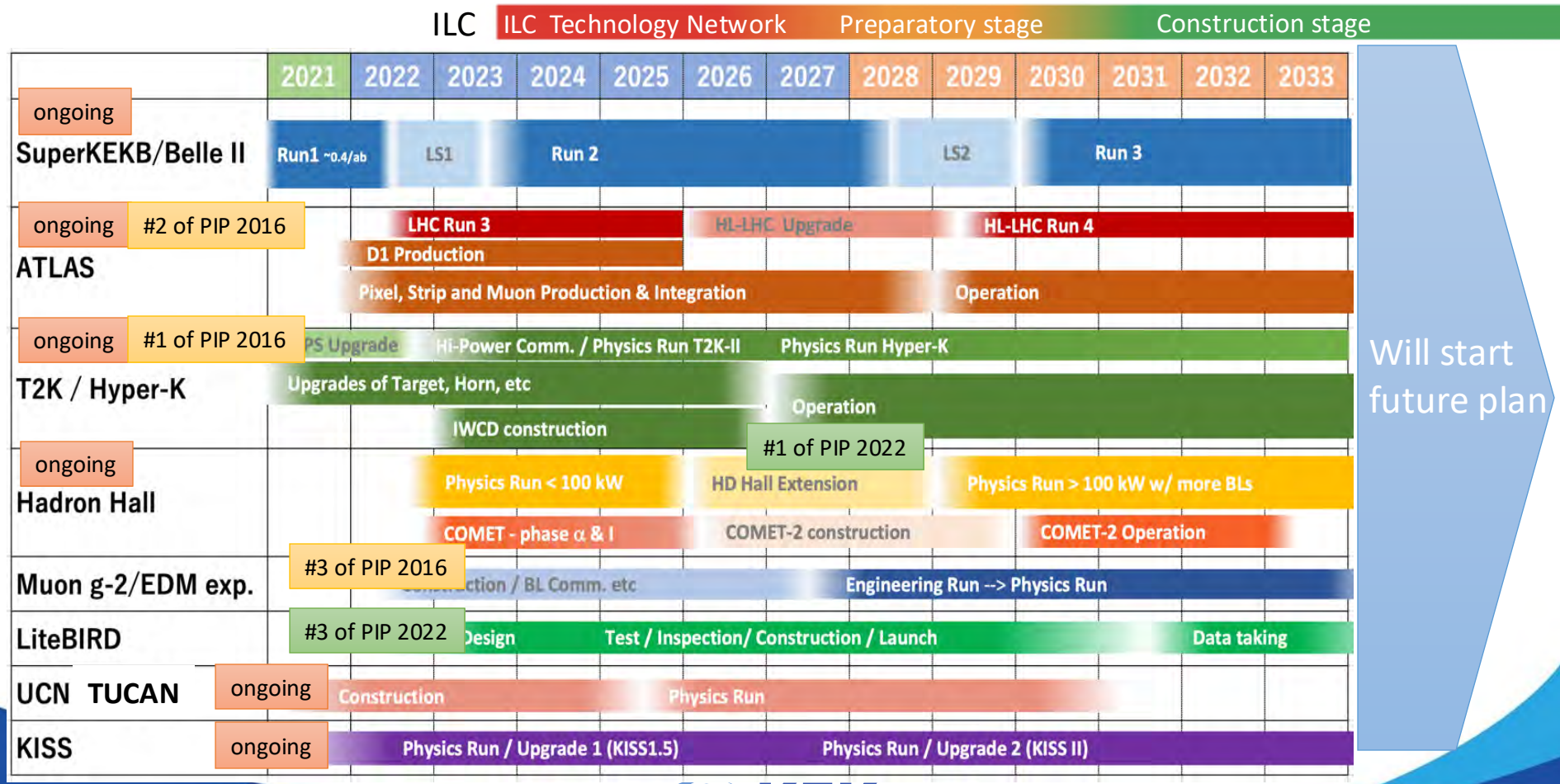
The Timeline +

subject to change

- Aggressive version of intended schedule by IPNS.
- PIP = Project Implementation Plan

PIP2016
1. Hyper-K /J-PARC upgrades
2. HL-LHC
3. muon g-2/EDM
4. HEF extension

PIP2022
1. HEF extension
2. HL-LHC++
3. LiteBIRD
4. Muon Microscope



KEK

Timeline Updates (draft) 24-Feb-2025

- Intended timeline by IPNS.
- PIP = Project Implementation Plan

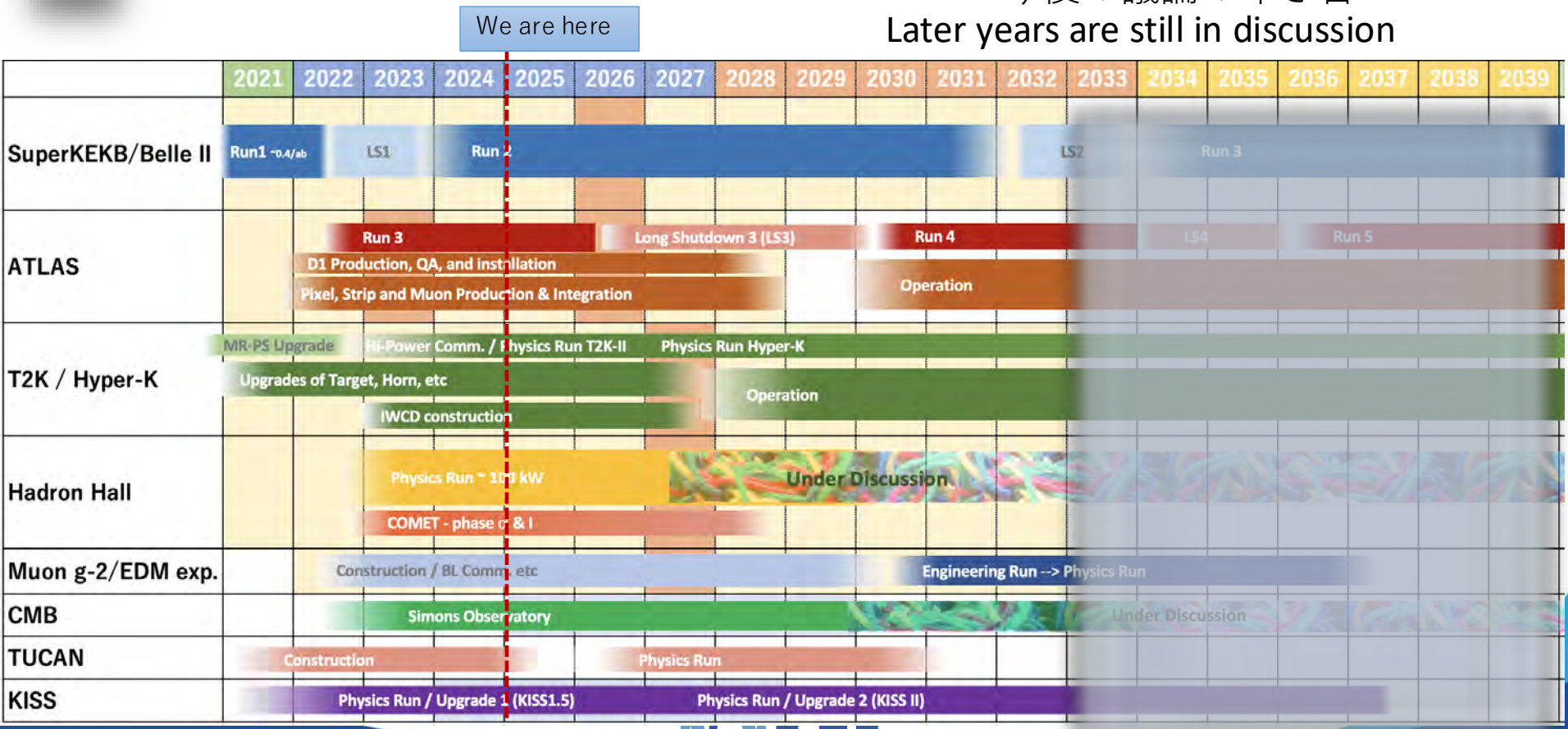
PIP2016
1. Hyper-K /J-PARC upgrades
2. HL-LHC
3. muon g-2/EDM
4. HEF extension

PIP2022
1. HEF extension
2. HL-LHC++
3. LiteBIRD
4. Muon Microscope

Covered by the Large Scale Academic Frontier Funding of MEXT

Year of Mid-term Review

今後の議論の叩き台
Later years are still in discussion



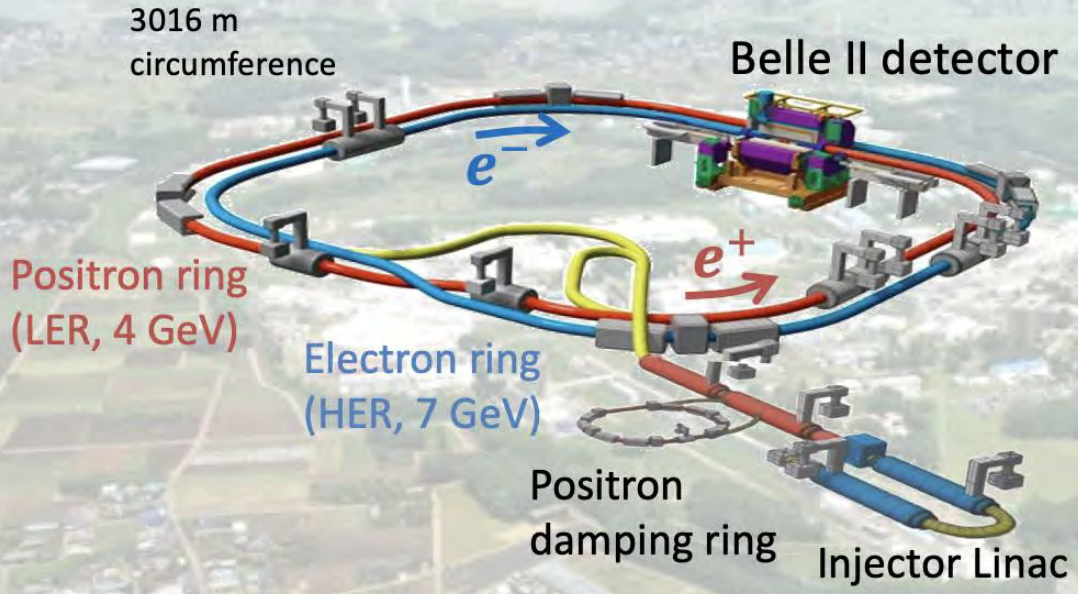
SuperKEKB Accelerator

a slide by K. Matsuoka

- Asymmetric e^+e^- collider operating mainly at $\Upsilon(4S)$
- Target: 50 ab^{-1} (= KEKB/Belle x 50)
- World's highest peak luminosity

  $\mathcal{L} = 5.1\times10^{34}\ cm^{-2}s^{-1}$ (= KEKB x 2.4 = PEP-II x 4.3)

$$\mathcal{L} = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\frac{I_\pm\xi_{y\pm}}{\beta_{y\pm}^*}\frac{R_L}{R_{\xi_y}}$$



Nano-beam scheme

- World's smallest vertical beam size at IP ($\sigma_y^* \approx 200$ nm)

Powerful injector Linac

- Compensate the short beam lifetime due to the narrow dynamic aperture of the main rings caused by the nano-beam collisions

Belle II

a slide by K. Matsuoka

The Belle II experiment

International collaboration with >1200 members from 28 countries/regions

~120 members from US (4th country with the most collaborators)

Superconducting solenoid (1.5 T)

Vertex Detector
2 layers DEPFET + 4 layers DSSD

e^-

Central Drift Chamber
He(50%):C_2H_6(50%), Small cells, long lever arm, fast electronics

Particle Identification Detector
Time-of-Propagation (TOP) counter (barrel)
Prox. focusing Aerogel RICH (fwd)

Electromagnetic Calorimeter
CsI(Tl), waveform sampling (barrel)

K_L and Muon Detector (KLM)
Resistive Plate Counter (barrel outer layers)
Scintillator + WLSF + MPPC (end-caps, inner 2 barrel layers)

e^+

GRID computing

- Nearly hermetic spectrometer
- Capable of reconstructing neutrals (γ, π^0, K^0, η, etc) with high efficiencies
- Good lepton and hadron identification
- High trigger efficiency, including for low multiplicity events

✓ Well-known initial condition of e^+e^- collisions

✓ Excellent capability of reconstructing particle decays (even with missing neutrinos or BSM particles)

⇨ **Enables unique and complementary physics programs**

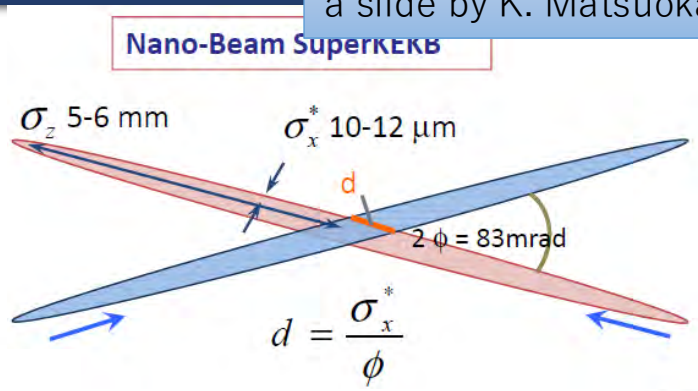
SuperKEKB/Belle II 2025 Run Plan

a slide by K. Matsuoka

- Continuous operation for ~7 months from Nov. 2025 to May 2026, with a short New Year's beak in the middle.

[Target]

- Exceed 1 ab^{-1} of the total integrated luminosity.
  → Entering the discovery phase.
- Reach the luminosity of 1×10^{35} /cm^2/s by increasing the beam currents



[Observation]

0.164 x 10^{34} /cm^2/s

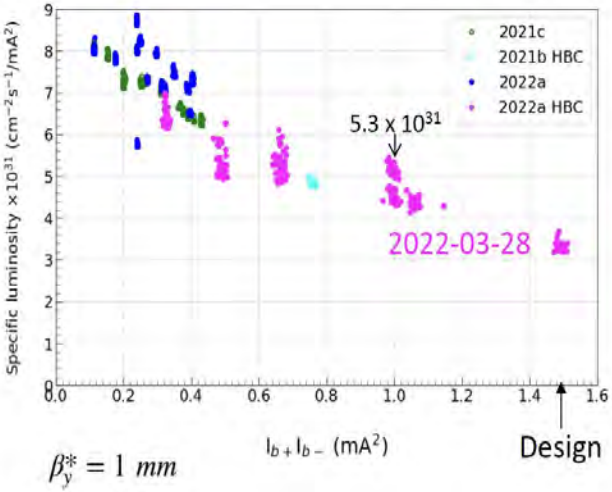
LER 35 mA, HER 27 mA, 31 bunches

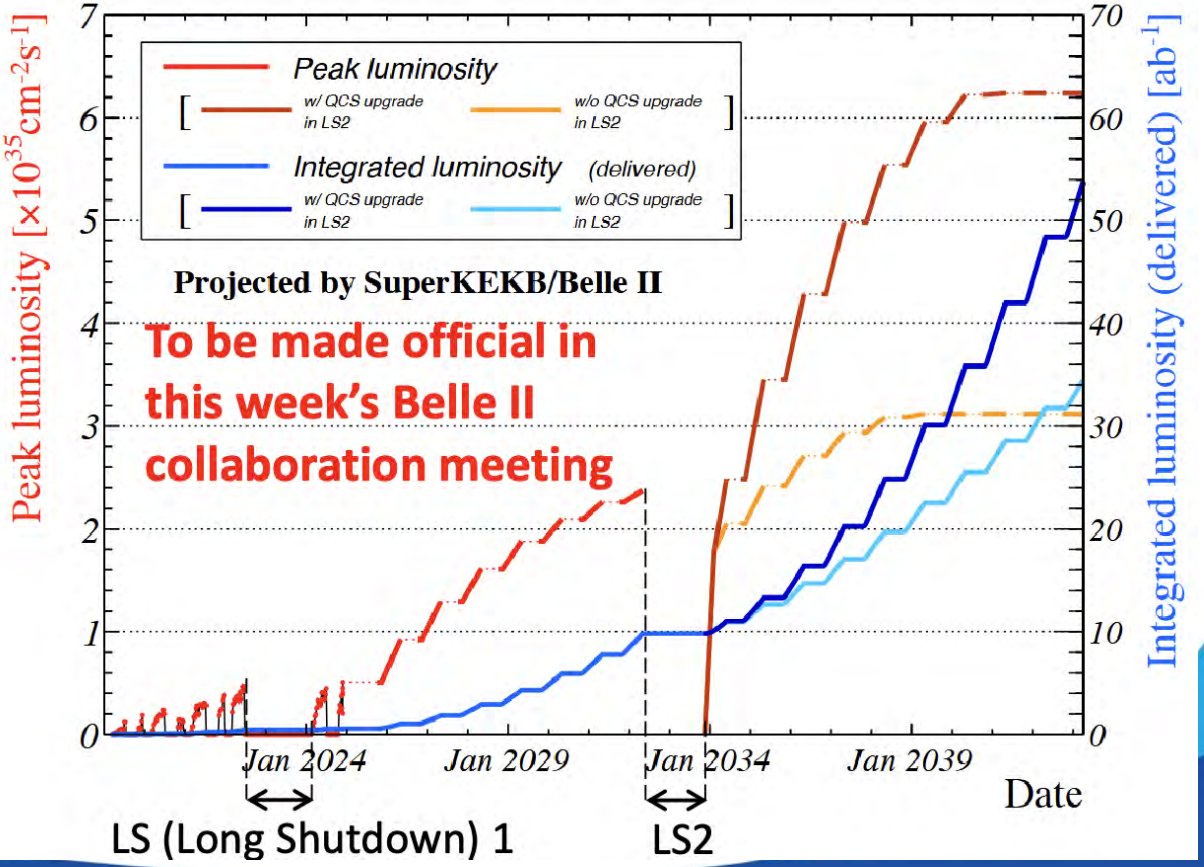
↓ scale with the number of bunches

[Expectation]

12.4 x 10^{34} /cm^2/s

LER 2.65 A, HER 2.04 A, 2346 bunches





ILC/Higgs Factory

LCWS2024 International Workshop on Future Linear Colliders

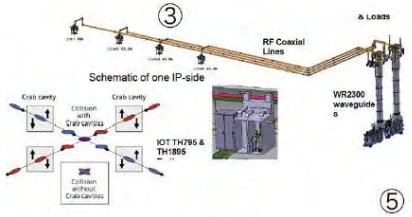
ATLAS and HL-LHC

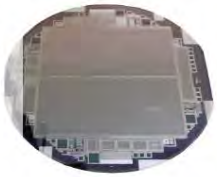
Contribution to HL-LHC

- HL-LHC Accelerator
  - ① Super conducting Dipole D1
  - ② Power Supply for Quench Protection Heater
  - ③ RF source and distribution system for Crab Cavity
- ATLAS experiment
  - ④ Inner Tracker
    - (4-1) Silicon strip detector
    - (4-2) Silicon Pixel detector
  - Muon trigger
    - Detector
    - ⑤ Trigger board

① 

② 

③ 

④ (4-1) 

(4-2) 

⑤ 

Insight through Accelerators. KEK

Progress: Pixel Module

- A total of 10,000 modules tested at over 20

for Quench Protection Heater

ower supply for the
ear the proton-proton collision

supply (manufactured by Nichicon)
ule heat in the heater to protect
ench occurs
ation of the accelerator.
ology, originally developed for D1 ma
nagnets near the collision point.
portant components of HL-LHC
ed. Passed performance tests at
for mass production.
ifacture 264 units
ture 362 units → transport to CERN.

ignature of
tion of four

ystem for Crab Cavity

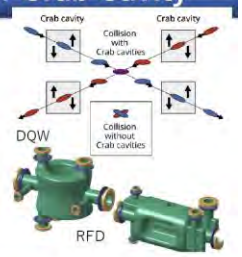
g" the beam
e
sing angle
rated at

avities are
e

D, X-direction,
e type (DQW,

sity about
2.1 times higher than without the crab crossing.

- As an additional contribution, we will contribute to the procurement of the RF generation and distribution system for injection into the crab cavity (total of 20 units).

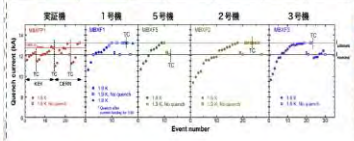


Progress: Strip Sensor

- All sensors are manufactured by HPK.
  - Japan's contribution: Production and quality control of approximately 50% (6,350 pieces) of the 4-layer barrel sensors.
  - Total inspection: High-precision photography and deflection inspection
  - Random inspection: Proton radiation resistance test
- Mass production started in July 2021, and all units delivered in June 2024
- Mass production end in FY2024, and transportation to the assembly facility acompleted.
- Final number of defective products: 45 pieces (0.7%)
  - All IV defects or appearance defects such as chips and scratches
  - The inspection system has been transferred to pixel module testing.

Progress: D1 magnet

Completed
In Progress
2024 Results
2025 Plan



Insight through Accelerators. KEK

Progress: Muon Trigger

PS board

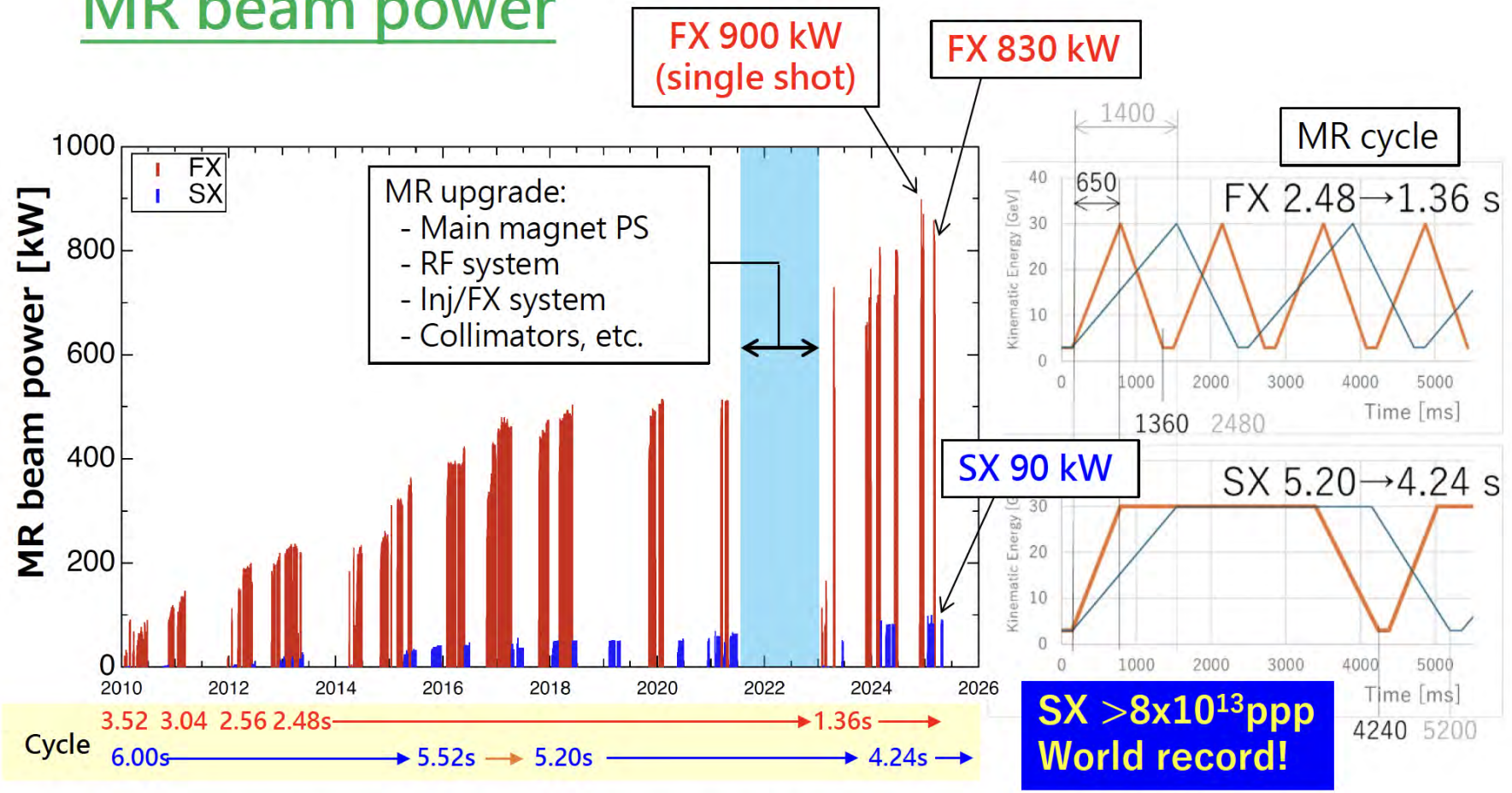
All PS board inspection completed on Jan. 24, 2025

- FY2024 results: Manufacturing and testing of PS boards at KEK
  - Six inspection campaigns will be conducted jointly by KEK and universities throughout FY2024
  - 1,471 out of 1,480 manufactured boards passed the test (defect rate 0.7%)
- The second prototype of the two sector logic units is operating smoothly
  - A final design review is planned for the end of the fiscal year
  - FY2027: Pre-mass production of 10 out of 50 sector logic units is planned
  - Implementation of a monitoring and control system with an eye on operation
- Peripheral equipment procurement planned for FY2025
  - SFP+ optical modules to be installed on each PS board (two each)
  - FireFly optical module to be installed on the MDTTP
- Preparations are also underway for bidding for HV/LV power supplies with an eye on FY2026 and beyond

Particle and Nuclear physics at J-PARC

J-PARC Beam Power History

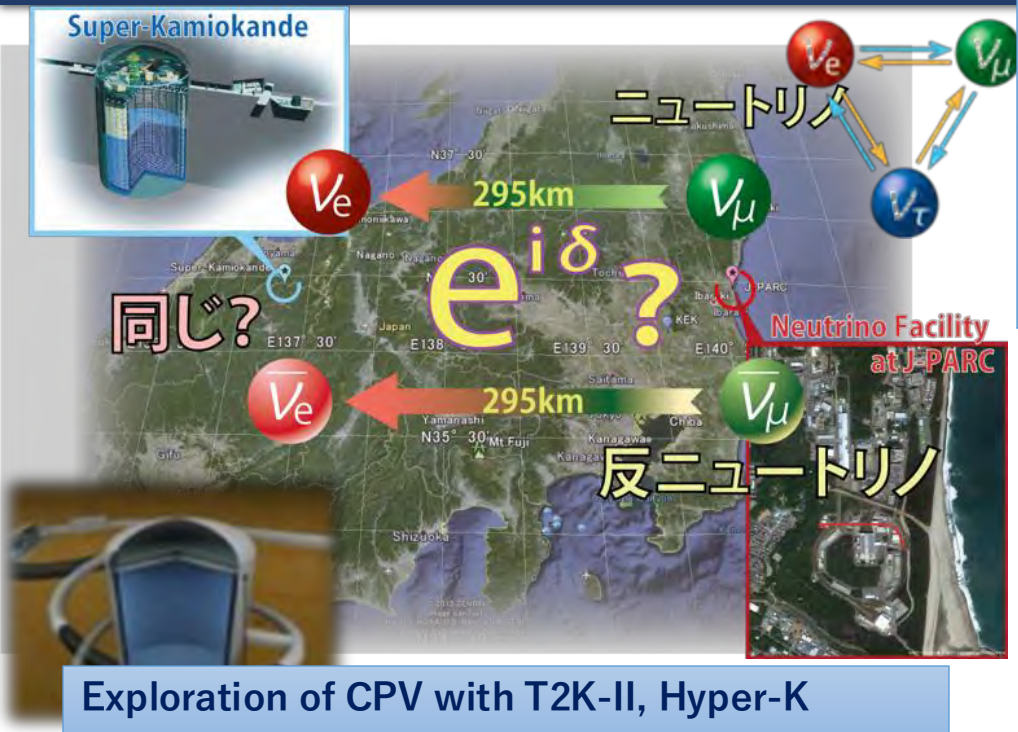
MR beam power



- Large scale hardware upgrades in Jun. 2021- Jul. 2022
  - 👉 MR operation cycles have been shortened.
    - 2.48 s → 1.36 s for FX
    - 5.20 s → 4.24 s for SX
- MR has achieved FX 830 kW and SX 90 kW stable beam operations.

Neutrino

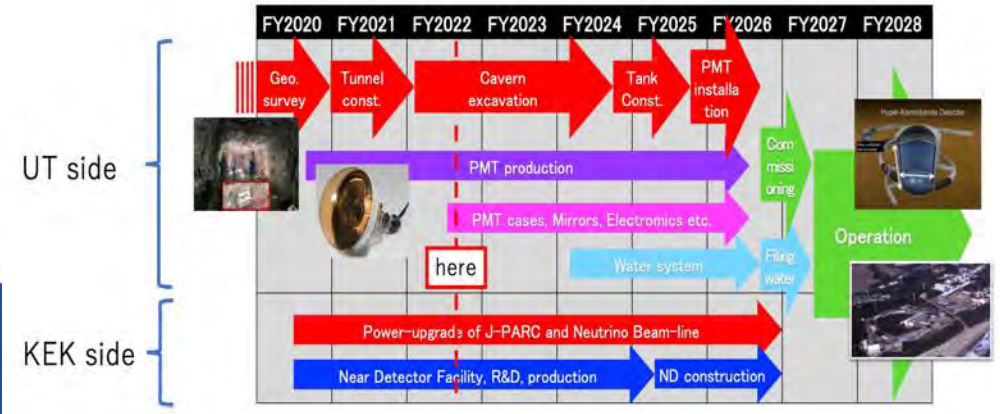
Establish CPV in neutrino sector and explore BSM

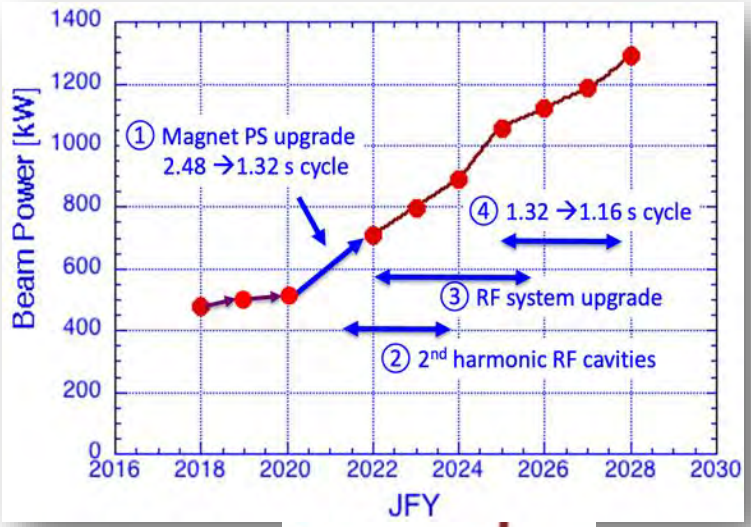


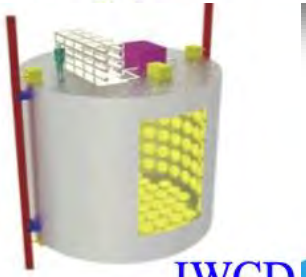
Ongoing upgrades

1. Power upgrade of J-PARC MR
2. Upgrade of Neutrino BL
3. Upgrade of Near-Mid Detector a) ND280 upgrades by T2K
   b) Construction of IWCD

Exploration of CPV with T2K-II, Hyper-K

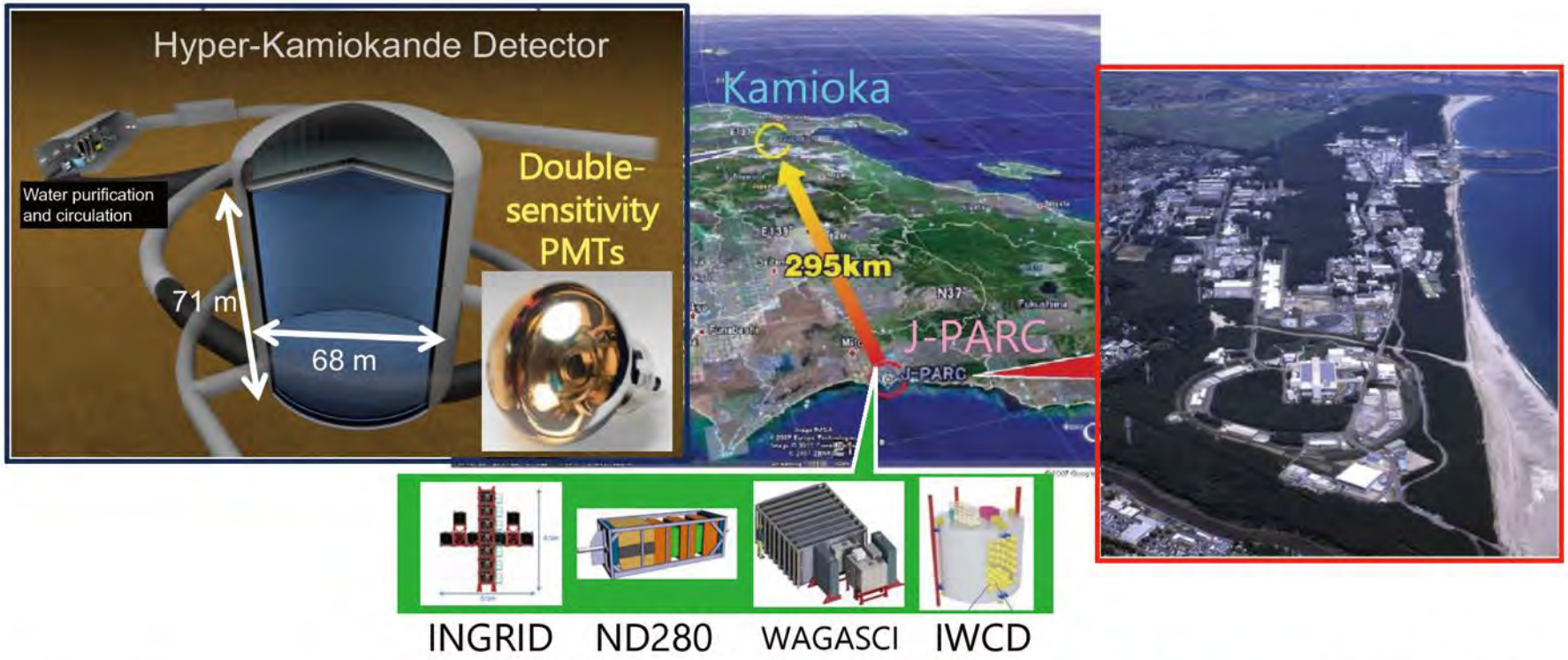






elerators.

Hyper-K Project



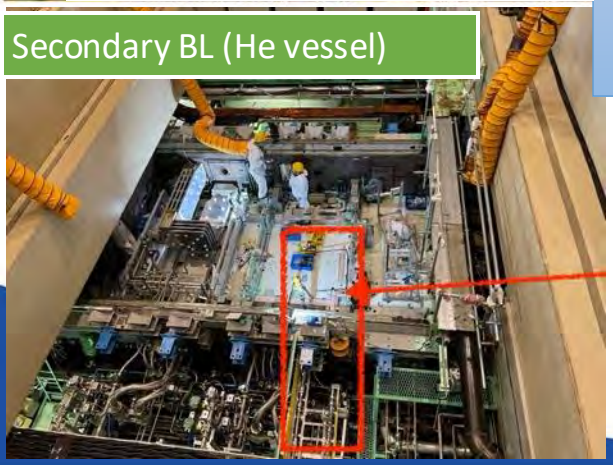
1. Hyper-K detector will be built with 8.4 times larger fiducial mass (190 kiloton) than Super-K and will be instrumented with double-sensitivity PMTs.
2. J-PARC neutrino beam will be upgraded from 0.5 to 1.3 Mega Watt
   - x8 Natural Neutrino Rate and x20 Accelerator Neutrino Rate
3. New and upgraded near detectors to control systematic errors

Upgrades in Neutrino BL

- **New Bending Magnet installed @primary proton BL**
  - For better maintenance under high radiation environment, a short dipole is now in place.

New short FVD2 installed

Secondary BL (He vessel)



Improved EM Horn#1 Installed

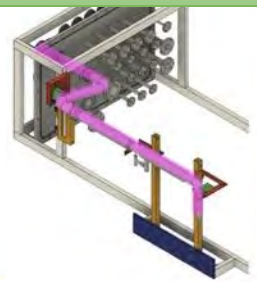
- **Improved EM Horn**
  - Cooling power is improved for Horn #1 and #2, installed in the BL

OTR Proton Profile Monitor is Installed

- **Proton Monitor improved.**
  - Newly designed Optical-transition-radiation monitor(OTR) is installed directly upstream of the target

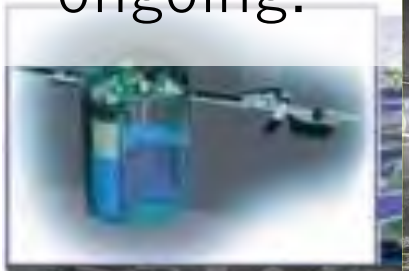
- **Improved cooling power of neutrino production target for 900 kW operation.**

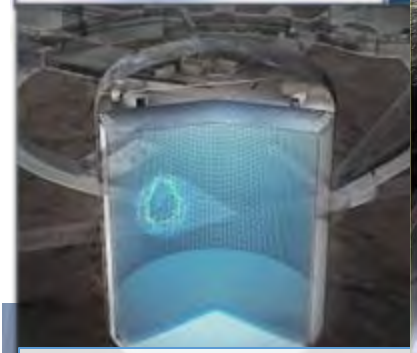
Improved plumbing of target cooling system



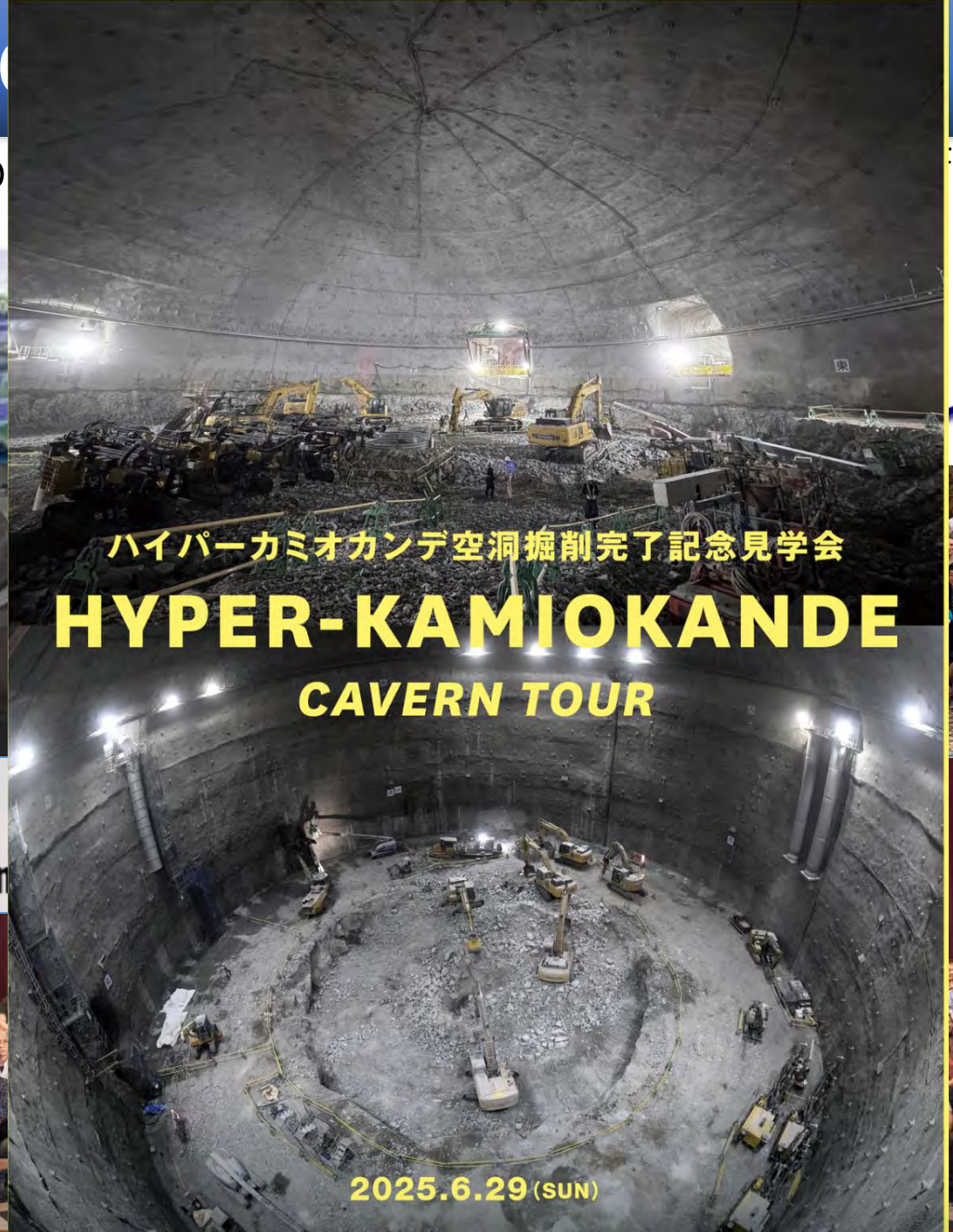
T2K an

- Physics Pro ongoing!





Hyper-Kar



HK are

T2K

KOTO and KOTO II at Hadron Hall

- Kaon WS was held in July, 2024 @ J-PARC

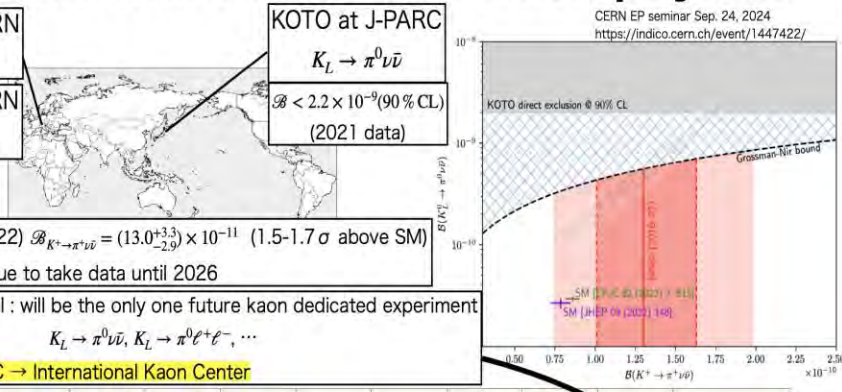
International situation of kaon physics

NA62 at CERN $K^+ \to \pi^+ \nu\bar{\nu}$

LHCb at CERN K_S decays

KOTO at J-PARC $K_L \to \pi^0 \nu\bar{\nu}$

$\mathcal{B} < 2.2 \times 10^{-9}$ (90 % CL) (2021 data)



NA62 (2016-2022) $\mathcal{B}_{K^+ \to \pi^+ \nu\bar{\nu}} = (13.0^{+3.3}_{-2.9}) \times 10^{-11}$ (1.5-1.7 σ above SM)

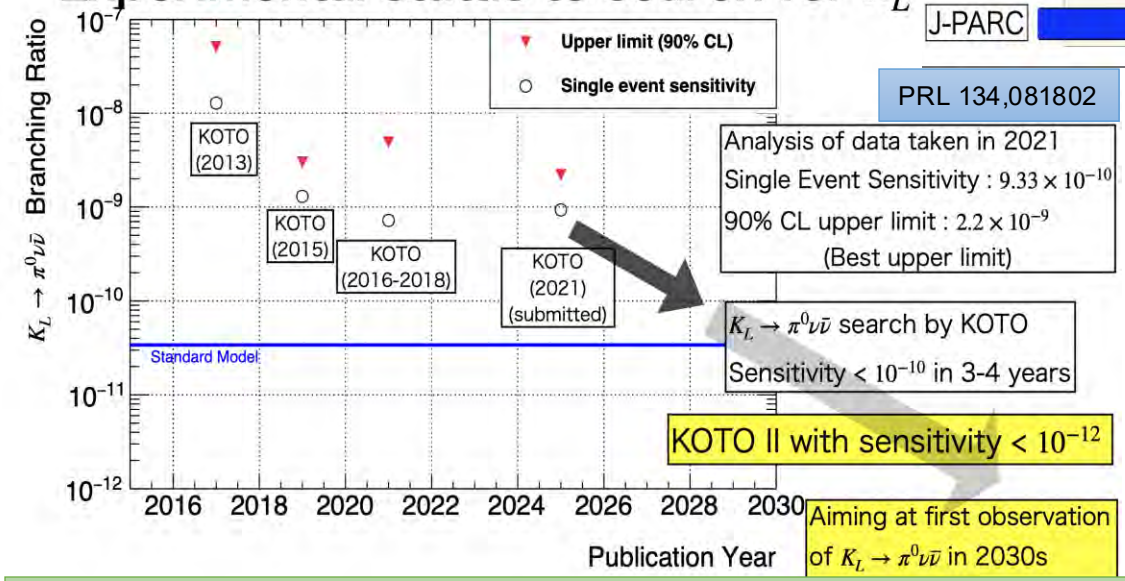
will continue to take data until 2026

KOTO II : will be the only one future kaon dedicated experiment

$K_L \to \pi^0 \nu\bar{\nu}$, $K_L \to \pi^0 \ell^+ \ell^-$, ⋯

J-PARC → International Kaon Center

Experimental status to search for K_L



PRL 134,081802

Analysis of data taken in 2021

Single Event Sensitivity : 9.33×10^{-10}

90% CL upper limit : 2.2×10^{-9}

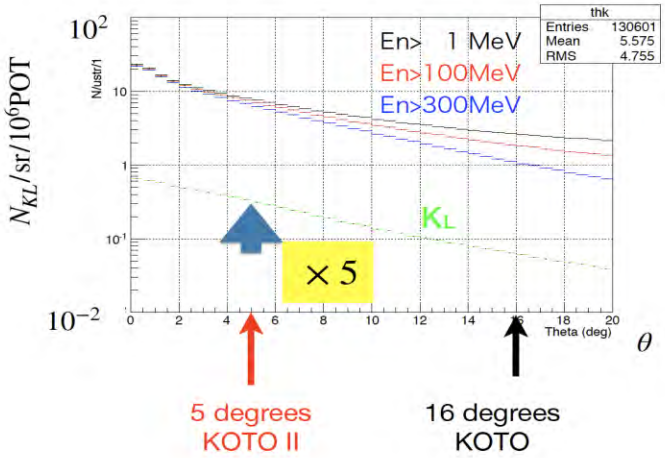
(Best upper limit)

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

Sensitivity < 10^{-10} in 3-4 years

KOTO II with sensitivity < 10^{-12}

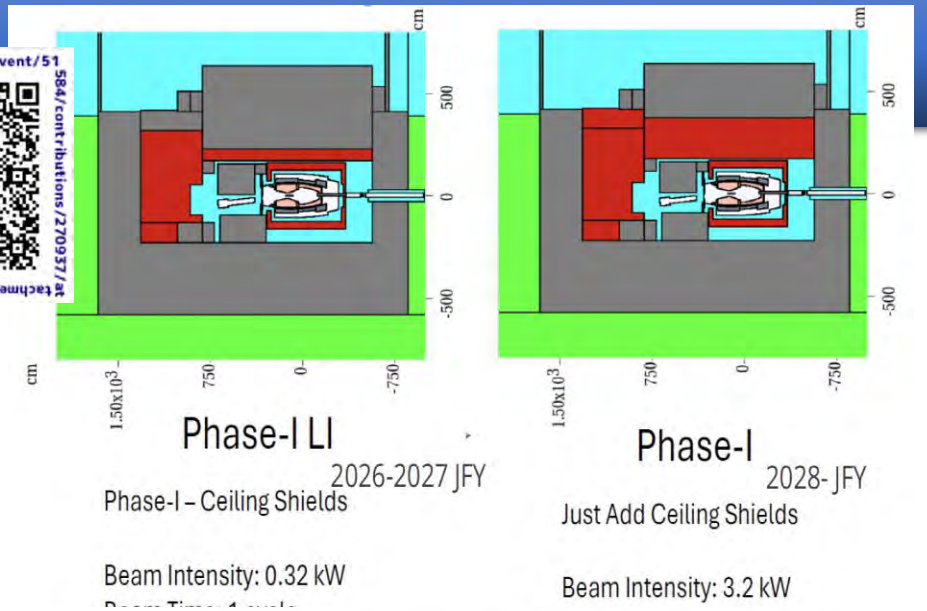
Aiming at first observation of $K_L \to \pi^0 \nu\bar{\nu}$ in 2030s

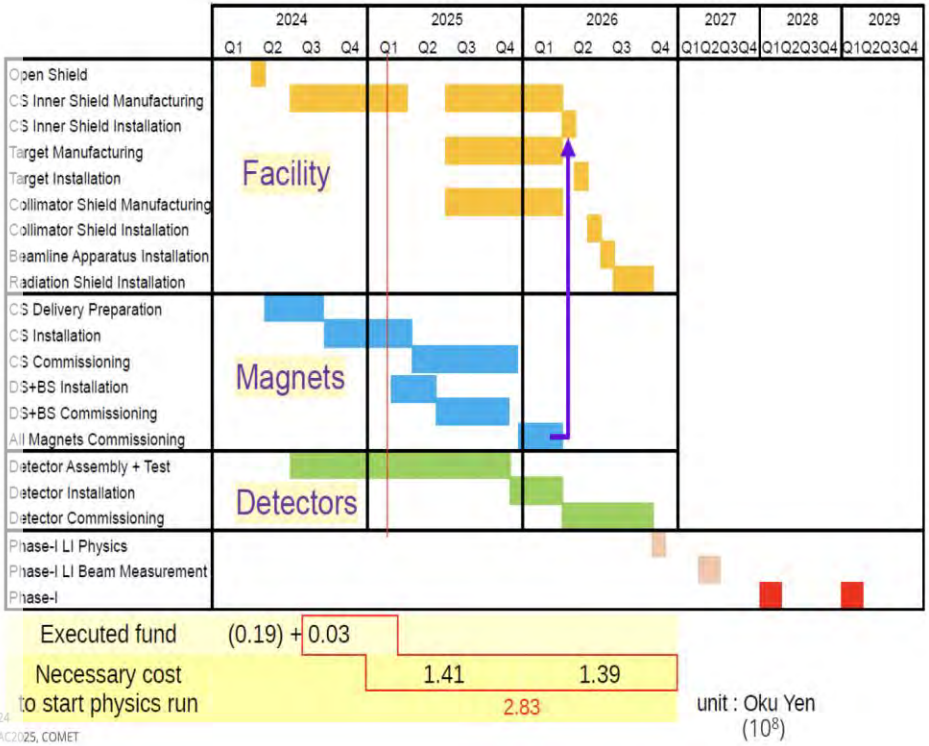


Collaboration promptly emerged to produce the new proposal of KOTO II
Presentation was made at the J-PARC PAC in January, 2025.
Stage-1 status is granted, with a conditional of HEF-ex.

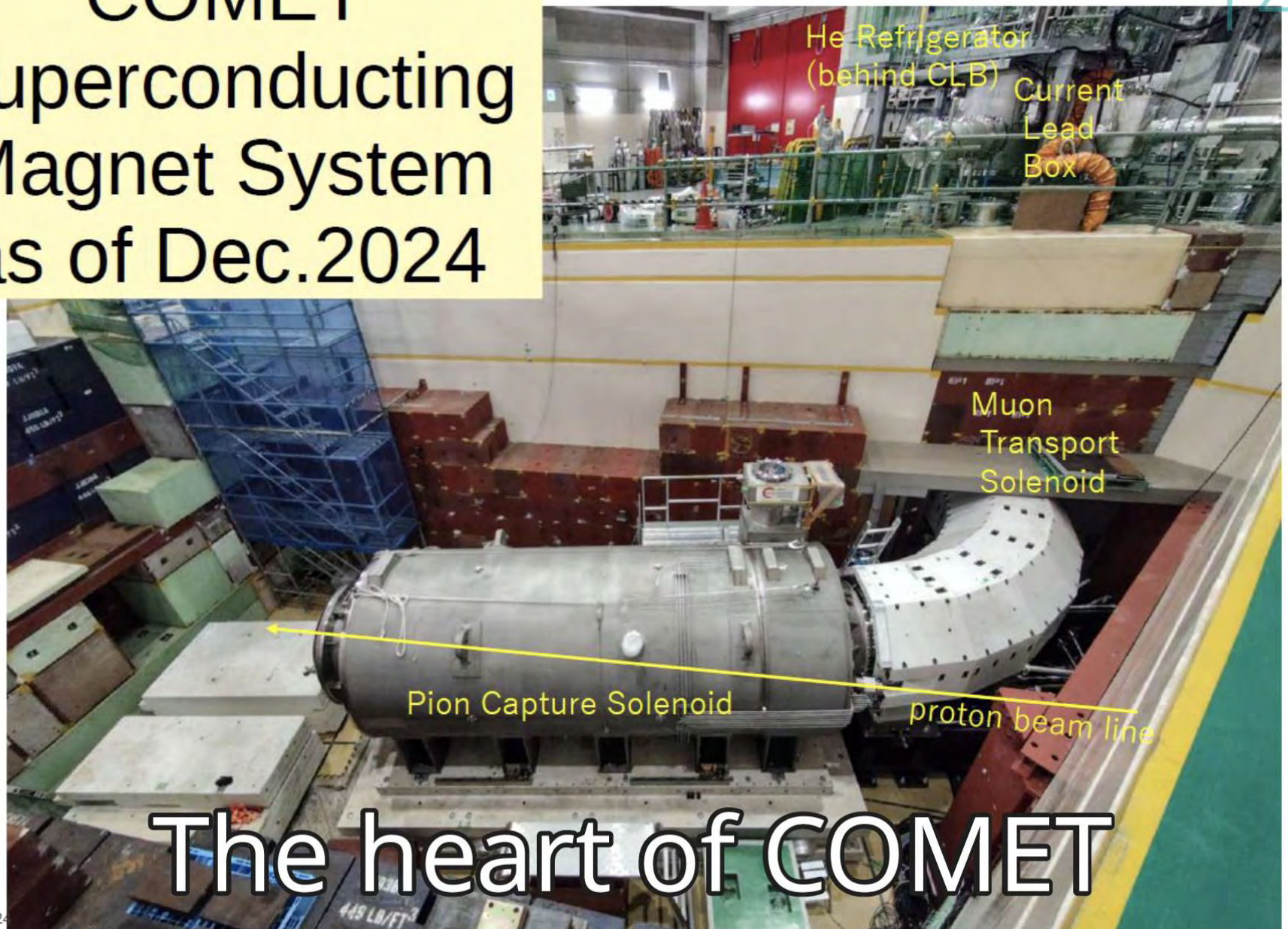
COMET

- Review was held in July, 2024
  - Chaired by Augusto Ceccuci.
  - Review Report is available at
  - https://kds.kek.jp/event/51584/contributions/270937/attachments/181410/247611/COMET-Review-Report-Final.pdf
  - "The collaboration and the Lab should work closely to realize the phase-1 LI"
- Four conditions to move further
  1. Minimize the remaining cost to complete the Low Intensity mode of phase-1 (currently 2.83 Oku-yen)
  2. Organization of the Collaboration management should be improved among and outside of the collaboration
  3. Gain good understanding of community
  4. Negotiate with J-PARC to utilize the operation budget to cover remaining cost
- All steps are in progress





COMET Superconducting Magnet System as of Dec.2024

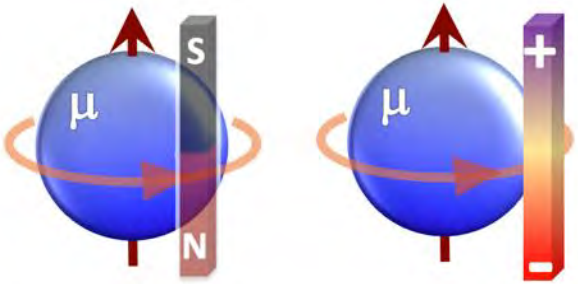


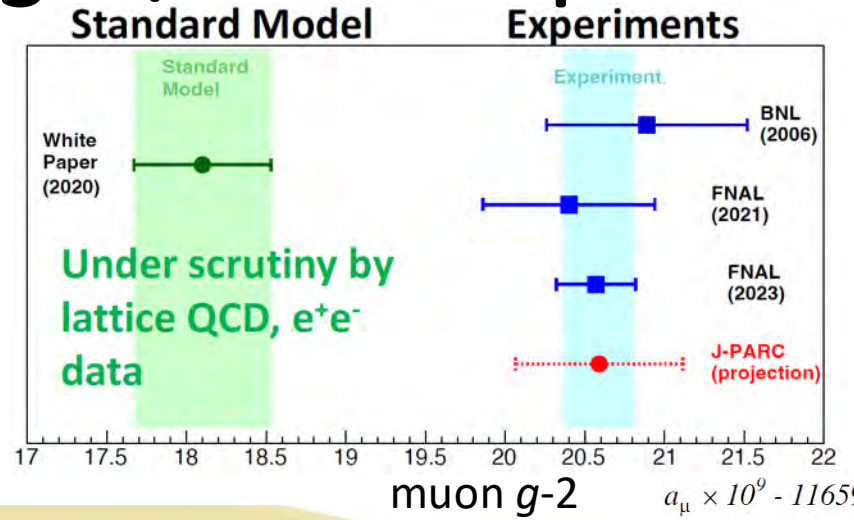
The heart of COMET

J-PARC muon *g*-2/EDM experiment

g-2
Anomalous magnetic moment
450 ppb

EDM
Electric Dipole Moment
1.5 E-19 ecm





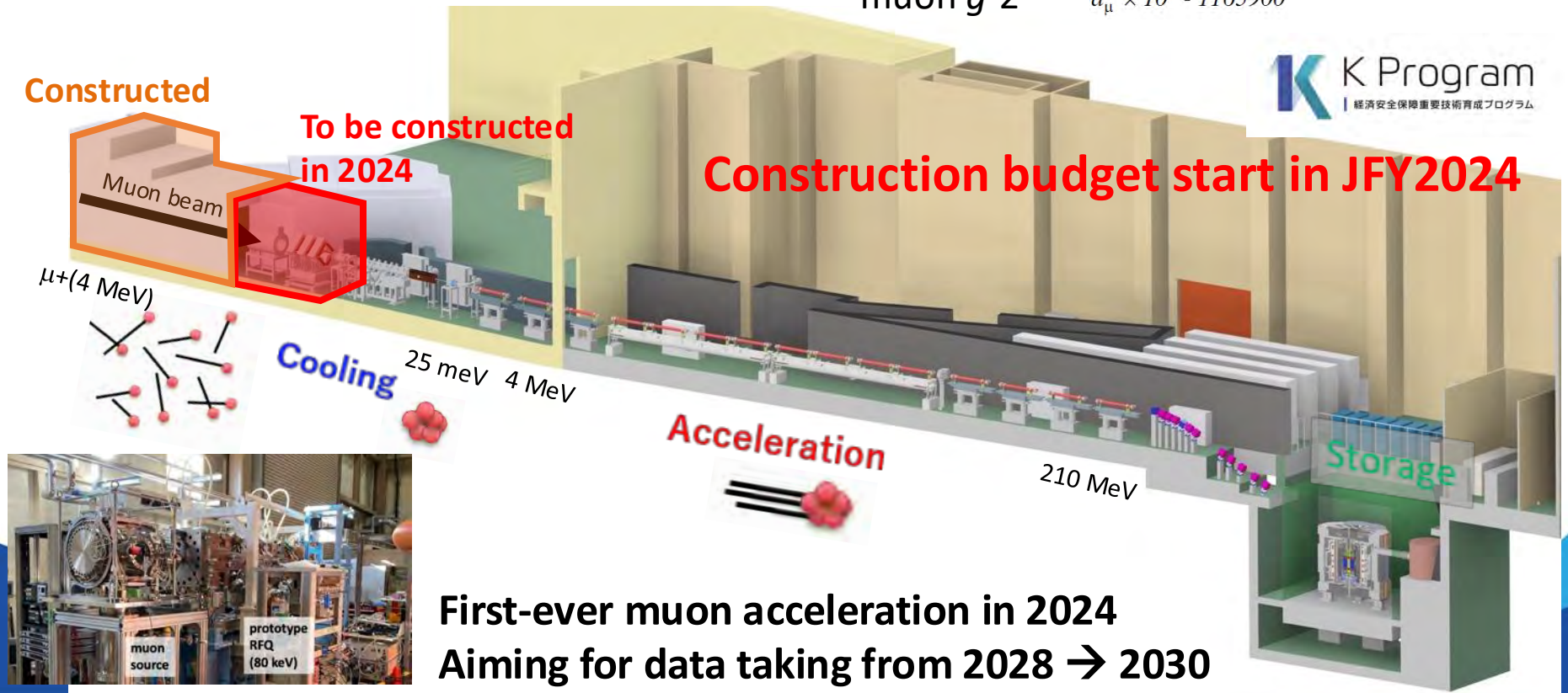
J-PARC is the only experiment to check FNAL/BNL results.

Constructed

To be constructed in 2024

Construction budget start in JFY2024

K Program
経済安全保障重要技術育成プログラム



First-ever muon acceleration in 2024
Aiming for data taking from 2028 → 2030

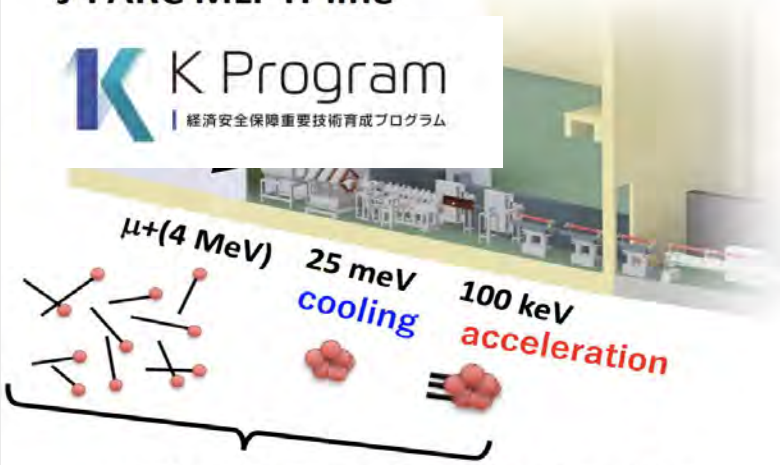
Muon g-2/EDM at J-PARC

https://arxiv.org/abs/2410.11367

- World first demonstration of positive muon acceleration done by the great collaboration of IPNS and IMSS, and international and domestic institutes.

J-PARC MLF H-line

K Program
経済安全保障重要技術育成プログラム

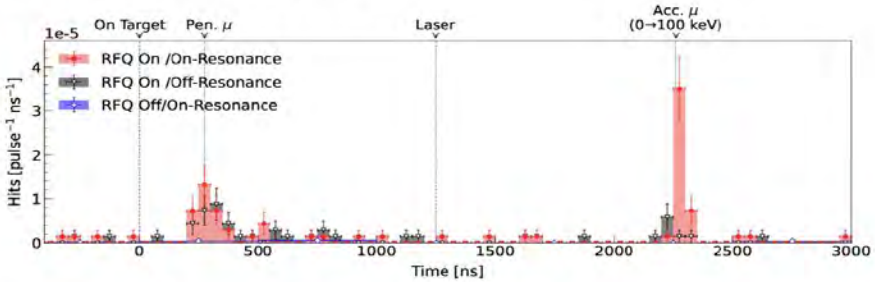


This part was demonstrated at MLF S2 area in April 2024.

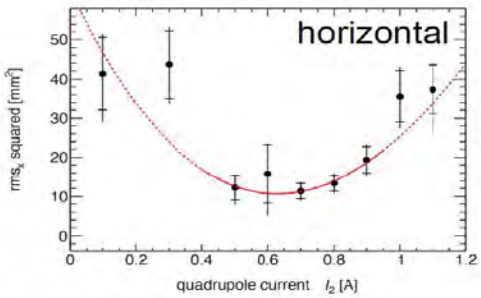
Experimental setup

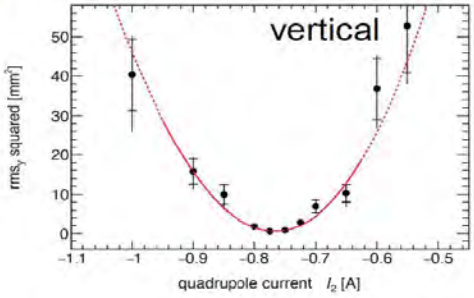
Muon cooling and acceleration to 100 keV was demonstrated.

Time of flight



Transverse emittance





$\varepsilon_x = 0.85 \pm 0.25^{+0.22}_{-0.13}$ π mm mrad

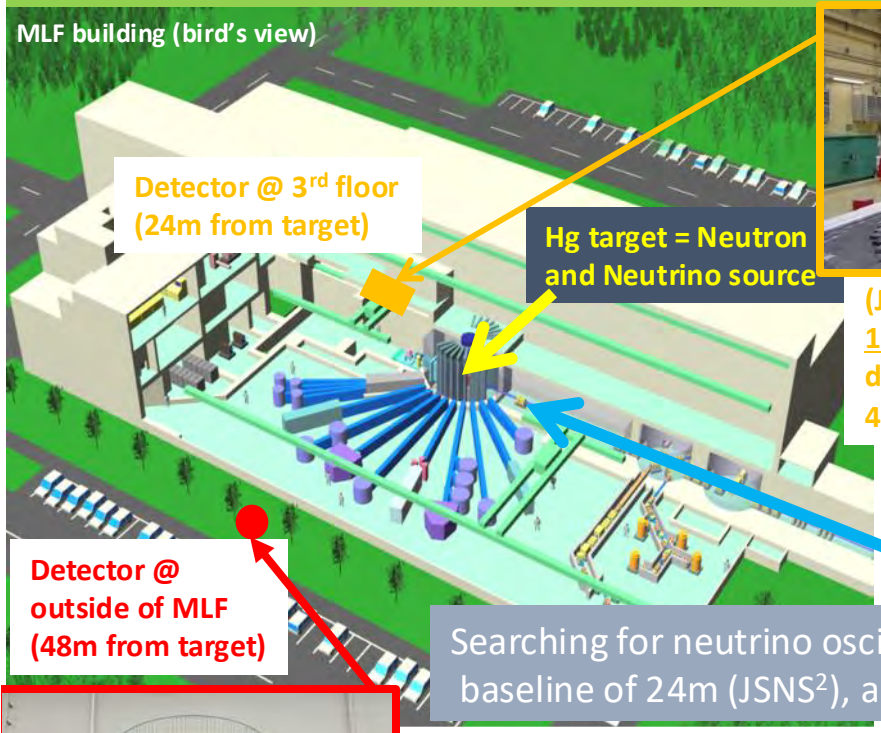
Reduction by 1/200

$\varepsilon_y = 0.23 \pm 0.03^{+0.05}_{-0.02}$ π mm mrad

Reduction by 1/400

Sterile Neutrino Search at MLF

JSNS^2(-II) experiment : Search for sterile neutrinos

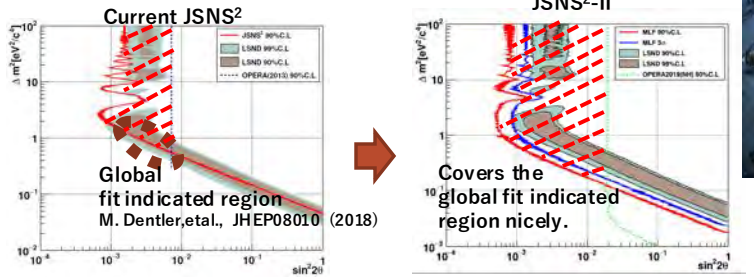


(JSNS^2)
17t GdLS fiducial (target) detector (4.6m dia. x 4.0m height, 120 10" PMTs)

Searching for neutrino oscillation ... th baseline of 24m (JSNS^2), and 48 ...

(JSNS^2-II: New detector) 32t GdLS fiducial

(6.2m dia. x 6.2m (h) ~230 10" PMTs)



(JSNS^2) : 1MW x 3 years

- The long physics runs (2021-2023)
  - In total, ~15 months.
  - normal ν created at the target are seen.
  - Sterile ν analyses are on-going
- New run began from 2023/12/7

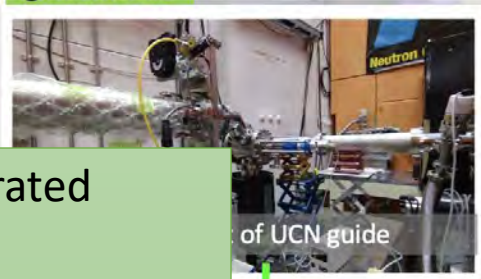
(JSNS^2-II): 1MW x 5 years

- 2nd phase of the experiment
  - new far detector : 32 tons fiducial in 48m baseline.
  - Improved the sensitivity, especially in low Δm^2 region.
  - Stage-2 approval was granted.
  - **Detector construction : on-going**

UCN nEDM

TUCAN experiment at TRIUMF

Development in Japan



TUCAN

2019 Prototype UCN source operated
- 5E4 UCN/shot at 0.5 kW
- 3E5 UCN/shot at 5 kW
- stable operation for ~ one month

2020 UCN source upgraded
- proton power 20 kW
- ^{3}He Cryostat from KEK (10W@0.8K)

2023
- LD_2 moderator construction
- ^{3}He Cryostat Commissioning

2024 Expectation
- 2E7 UCN/shot
- 6,400 UCN/cm^3 at source
- 250 polarized UCN/cm^3 at EDM cell

2025 Engineering and Physics Run will start

t through Accelerators.
KEK

Wako Nuclear Science Center

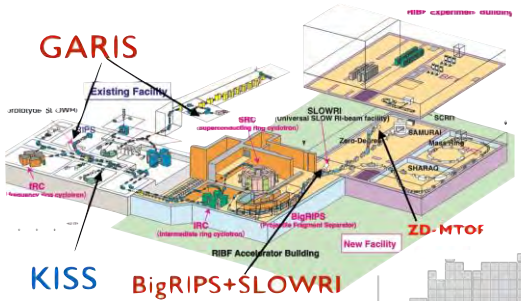
- The center is exploring the Nuclear Chart with KISS and now KISS1.5 (x 100 or more compared to KISS).

Wako Nuclear Science Center

2.Comprehensive Mass measurements @KISS, GARIS, BigRIPS-SLOWRI

Recent Press Releases

- First mass measurement of SHE (Db@GARIS)
- Discovery of new n-rich uranium isotope(@KISS)
- Disappearance of n=34 magic(Ti, V@BigRIPS-SLOWRI)



P. Schury et al, in preparation M NEW
P. Schury et al,PRC104,L021304(2021) M
Y. Ito to PRL 120, 102501 (2018) M
P. Schury et al, in preparation M
Y. Ito et al, in preparation M
M. Rosenbusch et al, PRC 97, 064306 (2018) M
P. Schury et al, PRC95(2017)011305R M
T. Niwase et al, PRC104(2021)044617 M D
T. Niwase et al, in preparation NEW
T. Niwase et al, PRL130,132502(2023 M NEW
M.Mukai et al, in preparation D M NEW
M.Mukai et al, PRC105,034331(2022) D NEW
H. Watanabe et al, PLB 814,136088(2021) D
Y.Hirayama et al, PRC96,014307(2017) L
Y.Hirayama et al, PRC98,014321(2018) L
M.Mukai et al, PRC102,054307(2020) L
Y.X. Watanabe et al, PRC101,041305R(2020) D
H. Choi et al, PRC202,034309(2020) L
P.M. Walker et al, PRL125,192505(2020) D
Y.X. Watanabe et al, PRC104,024330(2021) D
M. Ahmed et al, PRC103,054312(2021) D
H. Hirayama et al, in preparation L NEW
J. Ming et al, in preparation M NEW
P.M. Walker et al, in preparation D NEW
S. Kimura et al, submitting to PRC M NEW
S. Kimura et al, in preparation M
D. Hou et al, PRC108, 054312(2023) M NEW
W. Xian et al, accepted for PRC(2023) M NEW
M. Rosenbusch et al, in preparation M
S. Kimura et al, IJMS 430, 134-142 (2018) M
S. Iimura et al, PRL 130, 012501(2023) M NEW

D *Decay spectroscopy*
L *Laser spectroscopy*
M *Mass spectrometry*

Approved proposal

Nuclides studied at WNSC 2017~

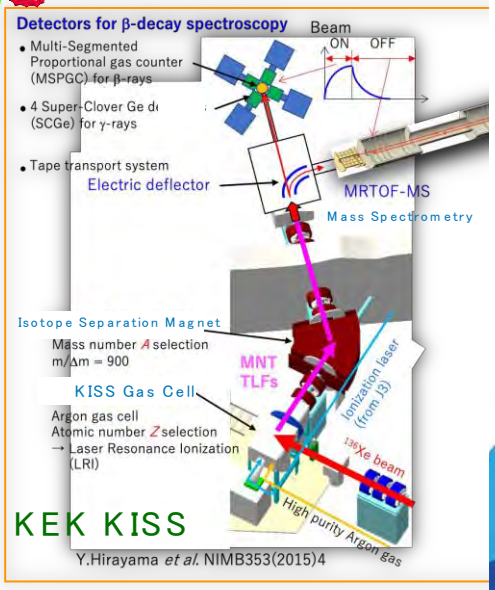
1. KISS Operation
(KEK Isotope Separator System)

Unique & 1st ISOL facility using MNT reactions

Provides n-rich isotopes of refractory elements

KISS Experiments in FY2023

- M. Mukai (Nagoya U.), "Isotope shift measurements of neutron-rich Hf and W isotopes"
- Y. Hirayama (KEK), "Study of prolate-oblate shape transition in $^{188\text{-}193}$Re by in-gas-cell laser ionization spectroscopy"
- P.M. Walker (Surry U.), "Multi-quasiparticle Isomers in neutron-rich ^{183,184}Hf"
- Y. Hirayama (KEK), "Half-life and mass measurements of nuclei around N = 126 using KISS"
- Y.X. Watanabe (KEK), "Mass and lifetime measurements of neutron-rich actinide isotopes toward r-process termination"

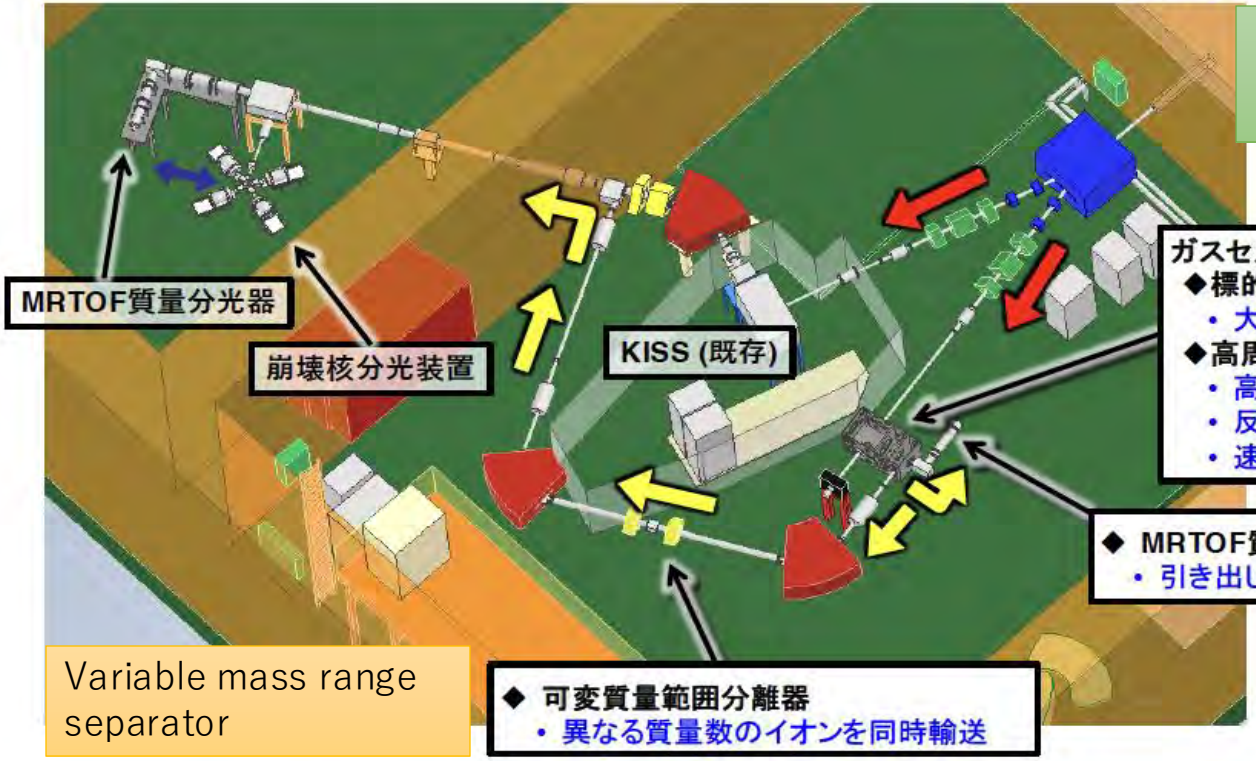


Wako Nuclear Science Center

In addition to KISS, new apparatus are being installed to enhance the efficiency by a factor of 100- 1000.

特別推進研究(2024 – 2028)で実施

Covered by Significant Grant for 5 years.



Gas Cell Chamber

MRTOF mass spectrometer

Variable mass range separator

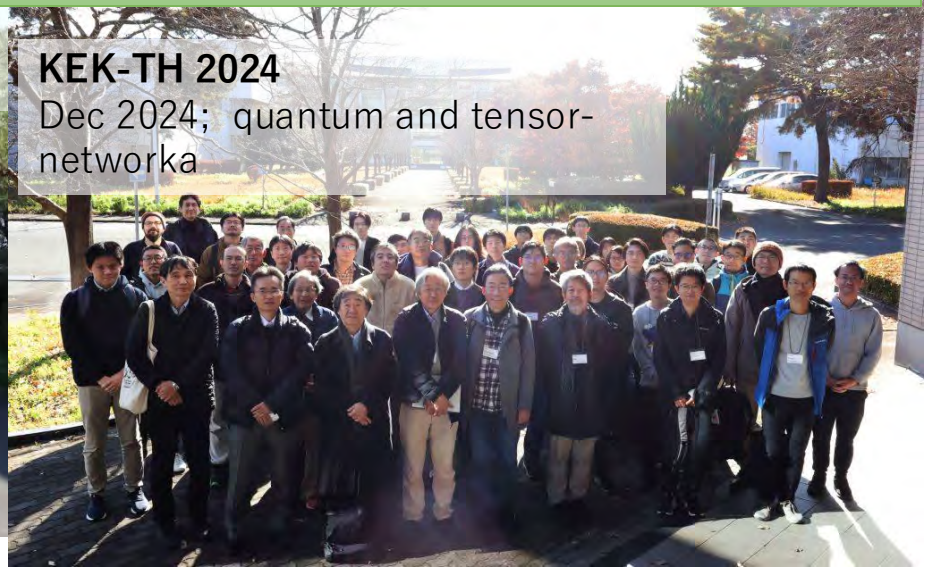
	一次ビーム	全効率	同時測定核種数	能率
KISS	~ 10 pnA	<0.1%	1	1
KISS-1.5	100 pnA	>1%	> 10	100 ~ 1000
	◆ 標的システム ◆ 高周波ヘリウムガスセル	◆ 高周波ヘリウムガスセル	◆ 高周波ヘリウムガスセル ◆ MRTOF質量分光器 ◆ 可変質量範囲分離器	

Theory Center: WS and Seminars

NEW DIRECTION

HEP in the Quantum Era
Dec 2024; 80 onsite: focused on new directions in HEP using quantum technologies (quantum computation, quantum sensor, etc)
kick-off of KEK-RIKEN iTHEMS collaboration

More than 10 workshops/schools hosted by KEK Theory Center in FY2024. Plus, ~ 50 seminars each year



KEK-TH 2024
Dec 2024; quantum and tensor-networka

also, a collaboration with U Tokyo – U Chicago

Muon g-2 Theory Initiative Workshop
Sep 2024; 120 onsite
Co-organized with the g-2 group and Theory Initiative

Belle II Physics Week
Oct 2024; 150 onsite
Co-organized with Belle II, to identify and investigate possible analysis: this time focused on tau and invisible

J-PARC Hadron 2024
Jul 2024; 62 onsite, 58 online

Insight throug

And… Quantum

slides from DG, Asai-san

5. Quantum

Int. Quantum Lab. QUP:
In All KEK
Synergy based on "Quantum"

Private Companies
TOYOTA
Application Sensor Connection

Q-Sensor Basic Science

academic-industrial Collab. office
Mat.Lab
KEK
QUP
PP Lab
iRNs
IMSS
PF
Accl. /Workshop Labs

Quantum Material
NIMS
AIST
ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY (AIST)

International Collaboration
CERN
Berkeley
Fermilab
UTokyo
ASPIRE
RIKEN
KMI IMK KMI

Study Q Material
(Various Quantum beams prove spin/state)
Sensor@ 300K
Application

CryoCMOS
interface RF tech.
SC Cavity $Q>10^{11}$

Sensor for Basic Science
Gravity
Q-Connection
Dark Matter detection

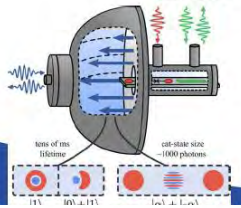
Insight through Accelerators. KEK

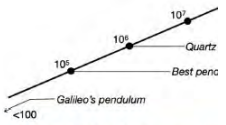
3) Superconductive Cavity

1.3GHz RF cavity for ILC

Let's Start colla
SRF cavity for C
Why SRF cavities for quant
SRF cavities are t

Not only as sensor
But also





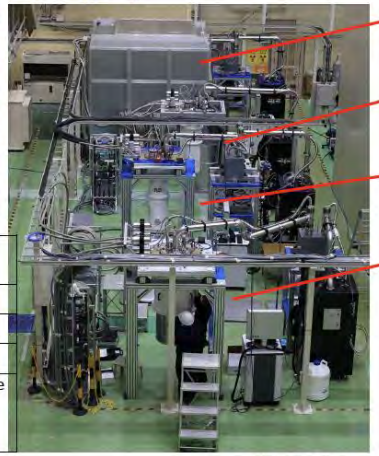
Interesting usage is possible for QC

Insight through Accelerators. KEK

1) Cryogenic Facility

5 Cryogenic machines are ready (
4 Cryo will be usded at Tsukuba

Cryo-Facility @Fuji Hall (B4)



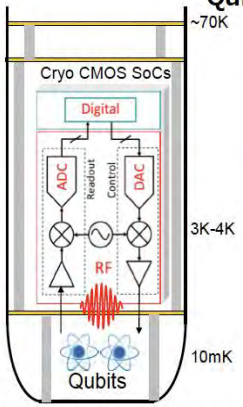
DR4 (XLD400)
DR3 (LD400)
DR2 (LD400)
DR1 (XLD400)
(Kamioka-DM
D
+
DR5 (SD250)

^{3}He-^{4}He dilution cooler BlueFors XLD/LD400	
Base temp.	<10mK
Cooling power	500μW @0.1K
Cables	DC/RF
Available options	Anti vibration stage He. battery Optical window etc…

Insight through Accelerators. KEK

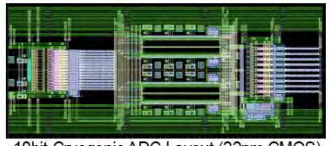
2) Cryogenic CMOS ASICs for Quantum operation/ Q-Computing

Subject Goal: Implementing ASICs operating at a cryogenic temperature to control Qubits.



Cryogenic CMOS ASIC for Qubit control

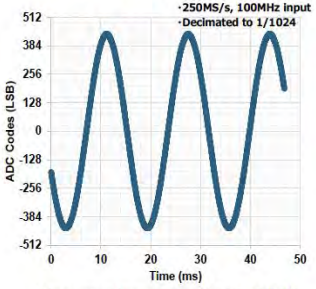
- ✓ Highly integrated
- ✓ Low power
- ✓ Less heat inflow



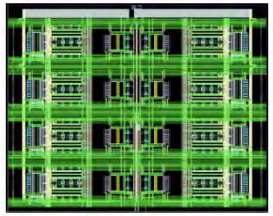
10bit Cryogenic ADC Layout (22nm CMOS)

Large N Qbit & complicated operation Becomes possible

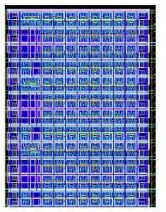
The 1
properly operated in cryogenic environment.
Various element circuits with further improved performance are under development.



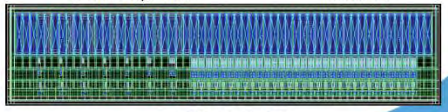
Sine wave input test of ADC @4.2K



10bit 2GS/s ADC



Oscillator



12bit 2GS/s DAC

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Insight through Accelerators. KEK

Summary

- IPNS covers a wide range of the Particle and Nuclear Physics in Japan and World.
- Despite significant efforts made by the experimental groups/collaborations, the progress has been compromised due to
  - still high electricity bill, and
  - some facility troubles due to aging etc.
- Timeline of the projects are being updated.
  - Some delays, some changes, but clearer picture is gradually emerging towards the next decade
- We encourage IPNS staff and communities to explore new directions in addition to exploitation of current projects.
- TYL/FJPPN and FKPPN have been important hub to explore collaborations with domestic and oversea institutions.

Merci beaucoup 감사합니다

Sapere Aude – Dare to Know

Institute of Particle and Nuclear Studies

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点字本プロジェクト「宇宙と物質の起源」
Braille Book Project “Origin of Matter and Universe”

- 筑波技術大学 x 素核研で、多くの人に基礎科学のエッセンスを！

点字本「宇宙と物質の起源」の制作について

「私たちはなぜ存在」根源的な問いをみんなで

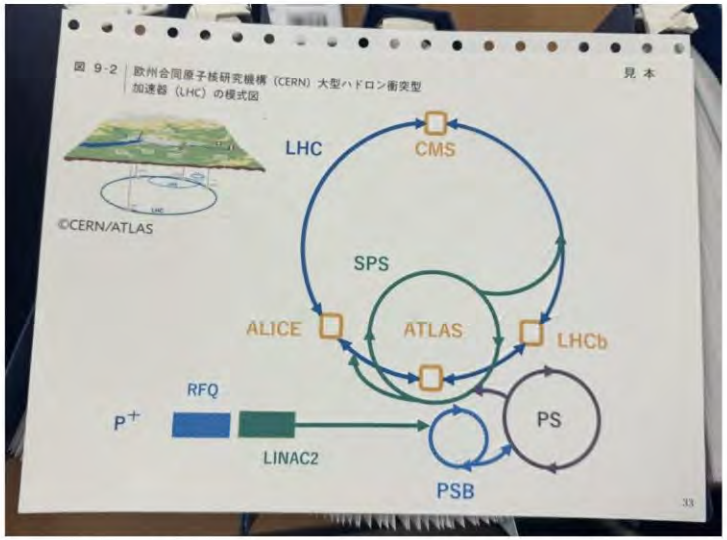
公開日 2024/05/10

高エネルギー加速器研究機構 素粒子原子核研究所
国立大学法人 筑波技術大学

the japan times

JAPAN / SOCIETY

Japan translates physics book into braille



The European Organization for Nuclear Research's Large Hadron Collider, the world's largest particle accelerator, is depicted as a circle in tactile drawing in the new book, as opposed to the three-dimensional figure in the source material that makes it appear oval, to avoid misunderstanding. | JIJI

JIJI

SHARE May 29, 2024

点字本「宇宙と物質の起源」収録の触図（左）と確認をしている様子（右）

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