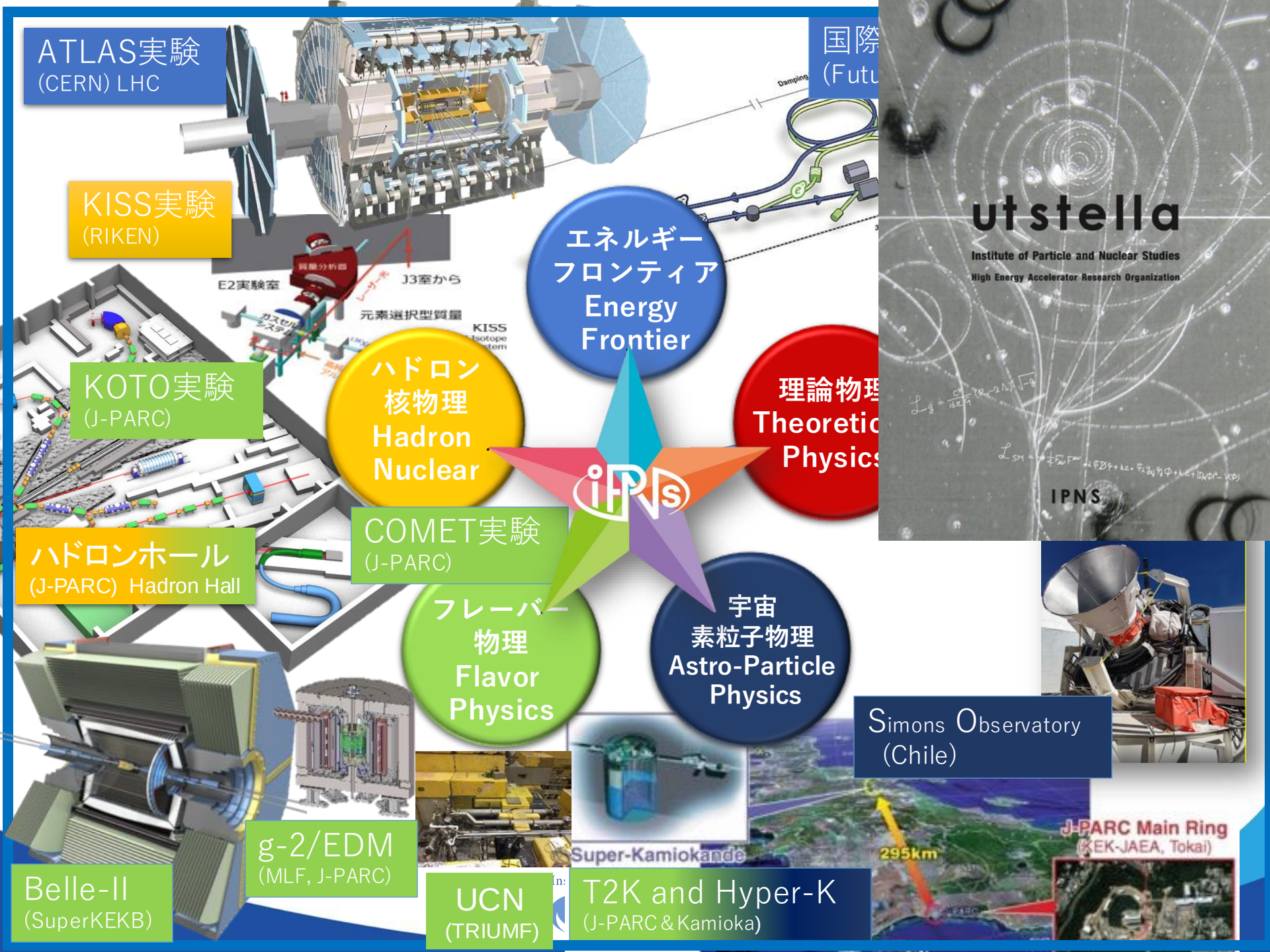

KEK
iFNs
Institute of Particle and Nuclear Studies
Future planning
for Institute of Particle and Nuclear Studies
The 4th JENNIFER2 General Meeting
April 4, 2025
Naohito SAITO
大強度陽子加速器施設
J-PARC
Tsukuba Campus
JENNIFER2
EU grant n.822070
Tokai Campus


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
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
utstella
Institute of Particle and Nuclear Studies
High Energy Accelerator Research Organization
IPNS
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

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IPNS Research Planning Committee

IPNS Leaders Association

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Assistant
HONDA, Yuko

Deputy Director
USHIRODA, Yutaka
KOMATSUBARA, Takeshi
TOMOTO, Makoto

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KAWAI, Masanori

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

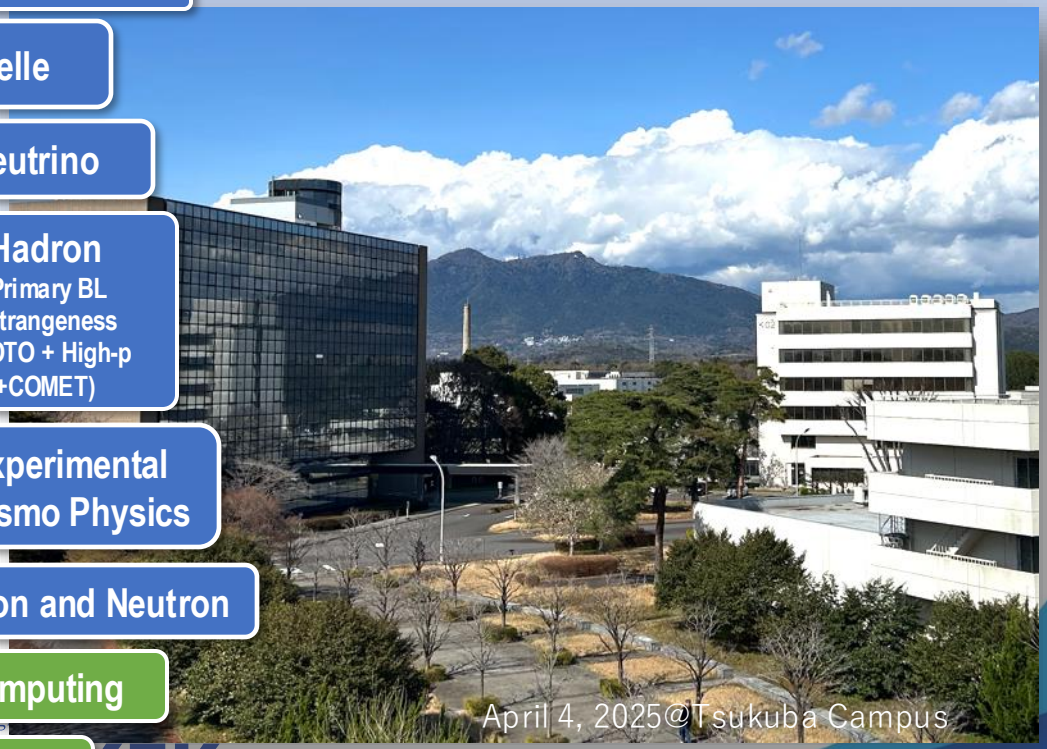
Theory Center
Head
HASHIMOTO, Shoji

Wako Nuclear Science Center
Head
WATANABE, Yutaka

Instrumentation Technology Development Center
Head
TOMOTO, Makoto

- Mechanics
- Electronics System
- Cryogenics

- Energy Frontier (ATLAS+ILC)
- Belle
- Neutrino
- Hadron (Primary BL +Strangeness +KOTO + High-p +COMET)
- Experimental Cosmo Physics
- Muon and Neutron
- Computing
- Safety



April 4, 2025@Tsukuba Campus

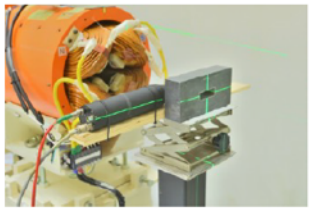
KEK

Instrumentation Technology Development Center

International Hub for instrumentation development
Promotion of Innovation and Young researches

Inter-University Research

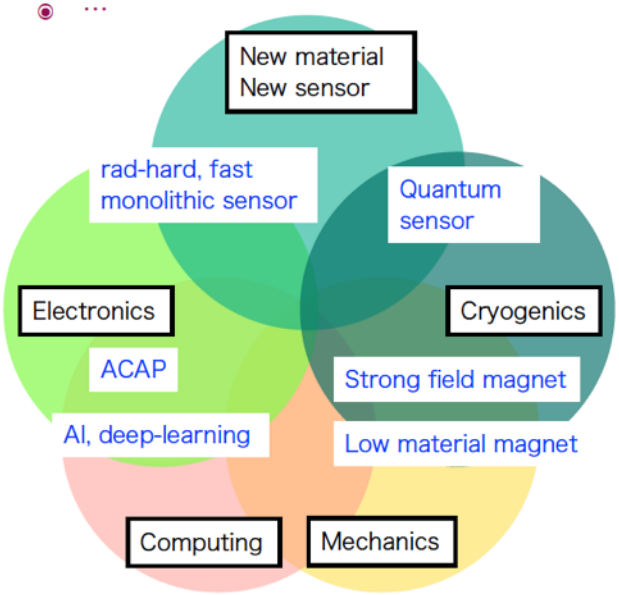
- Extension of inter-university research functions
- More efficient and faster development
  → International visibility



- 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
  - …



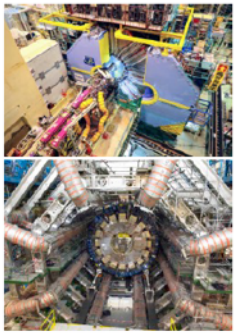
Technology Development Platforms

- 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



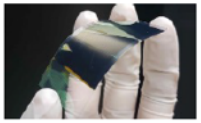
KEK projects

REBCO for HL-LHC

Education

HEP school

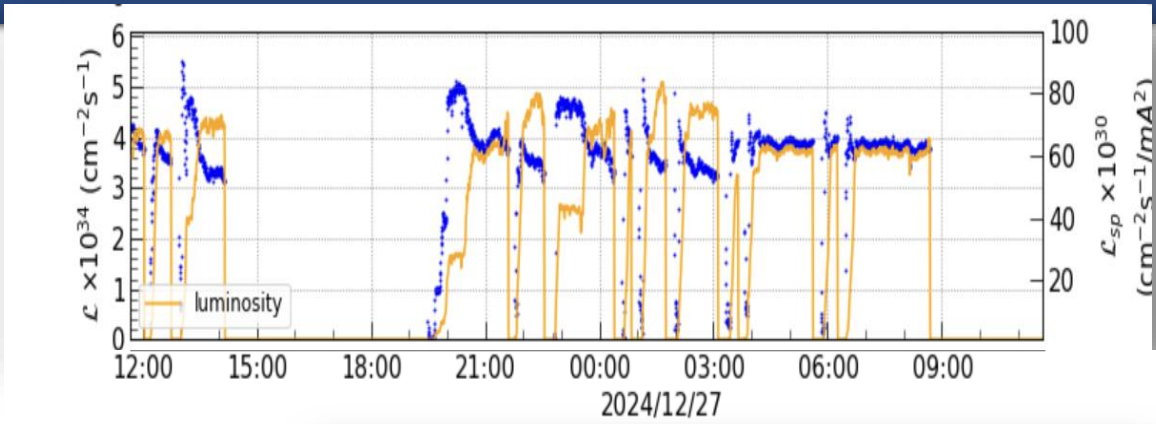
Industry

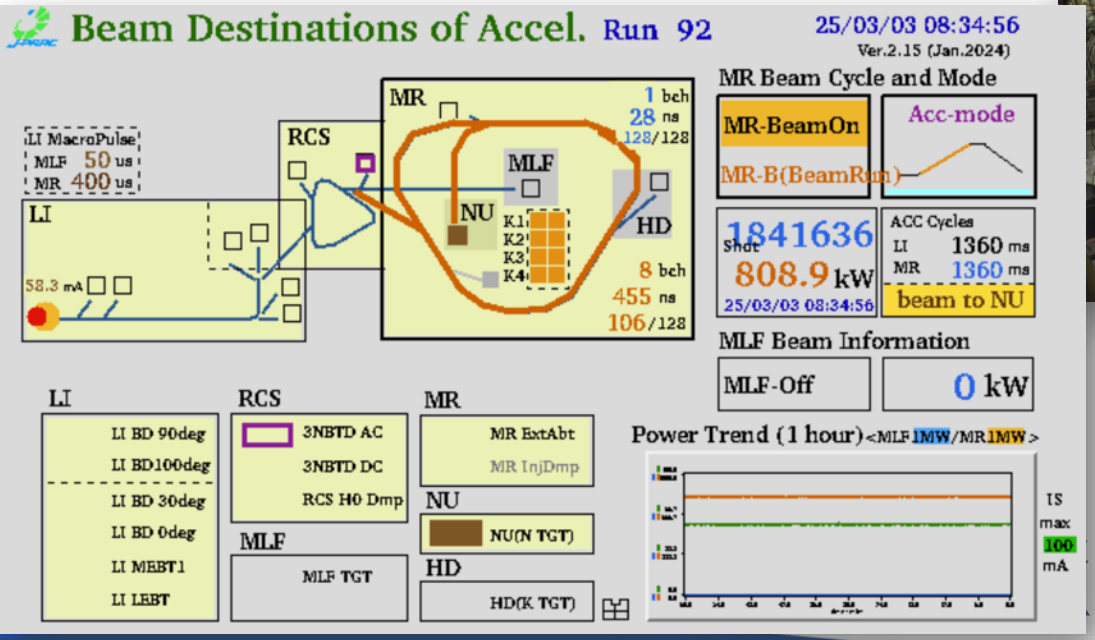


organic semiconductor

NoBeam, NoLife …

- SuperKEKB
  - 1:41, December 27, 2024
  - 5.105E34cm^{-2}/s
  - Preparing for the Run in autumn.
- J-PARC
  - Troubles in MR
  - Trouble of MLF target led to Delay and Lo-Power
  - SX ran > 82 kW smoothly
  - FX started > 800 kW seemed to be beautiful run…

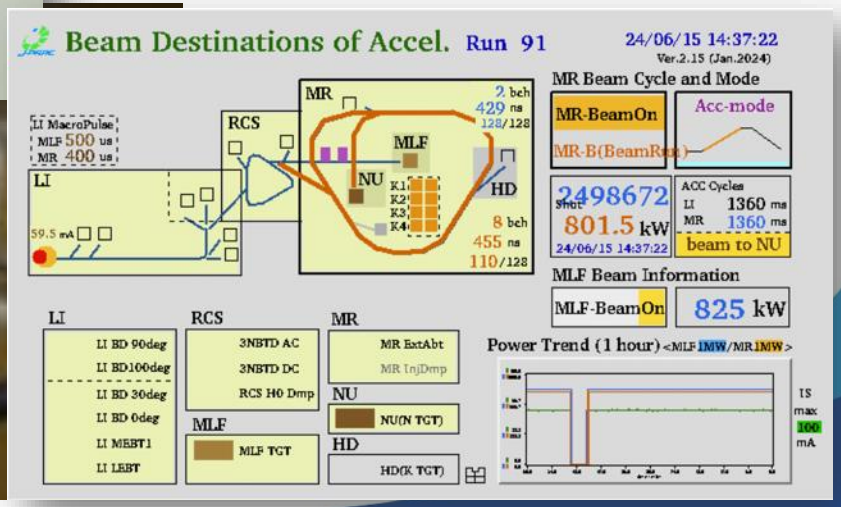




Deepest apologies for Troubles in Targetry Area of Neutrino Beamline@ J-PARC.

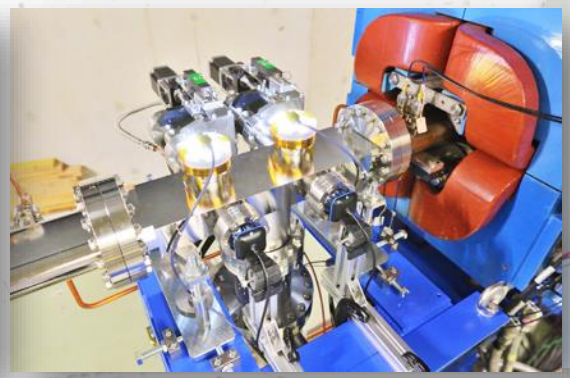
IPNS Projects Current Status

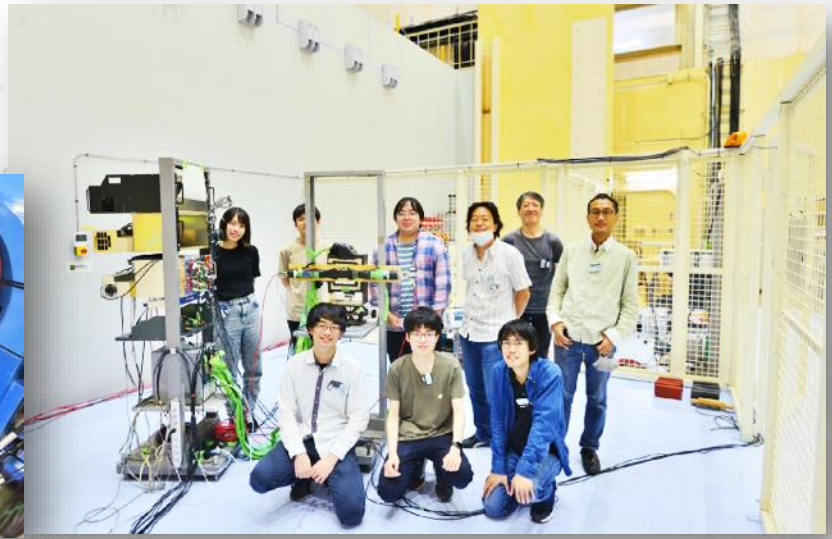
- SuperKEKB/Belle II
  - **Run 2024c ended with 5.1E34!**
  - Physics Analyses are ongoing
  - LS2 plan is being developed
- J-PARC MR SX Beam > 83 kW;
  FX > 800 kW
  - Beamtime, Aging and New Initiatives
- LHC Run3: to resume in April
  - Detectors and Magnets are being prepared towards HL-LHC
- ITDC
  - 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
- KISS making good progress; KISS1.5 started
- TUCAN is to retry UCN production in May

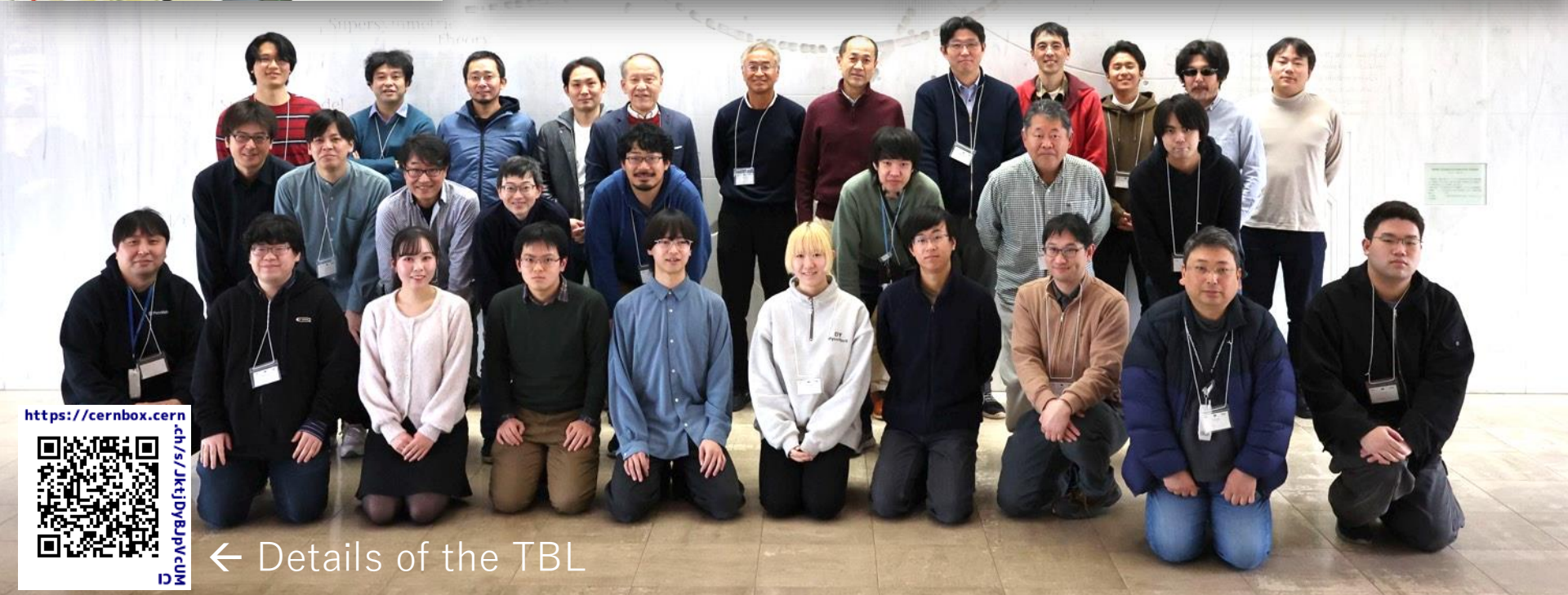


The 2nd WS of TestBeamLine April 3-4, 2025

1-3 GeV **electron beam** at the rate of <5 kHz
(to be improved soon)
hadron beams are also in discussion







https://cernbox.cern.ch/s/JktjDyBJpVcUMCI

← Details of the TBL

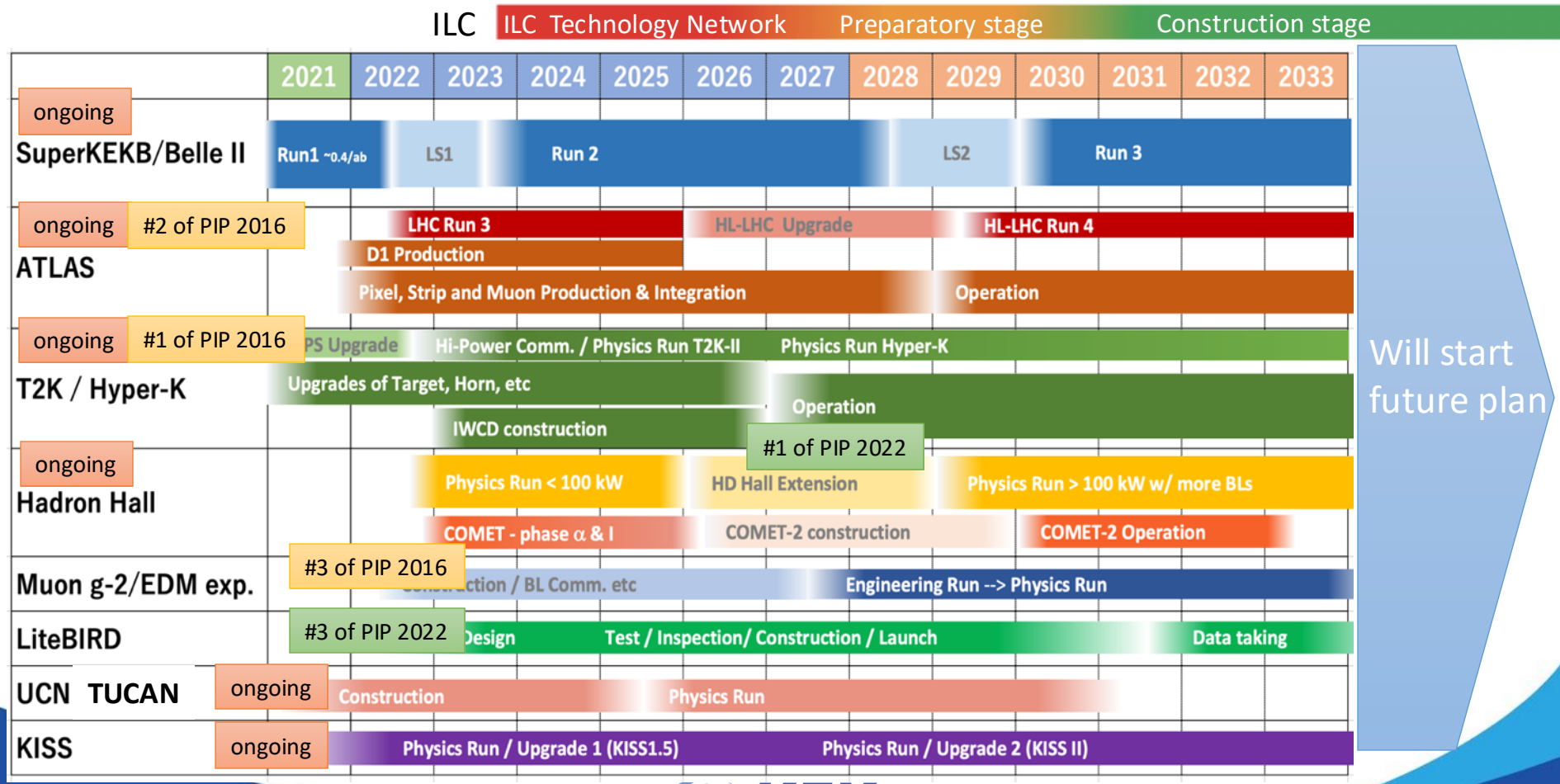
The Timeline +

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

The Timeline Updates 24-Feb-2025

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

PIP2016
1. Hyper-K /J-PARC upgrades
2. HL-LHC
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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

Later years are still in discussion

The Belle II experiment

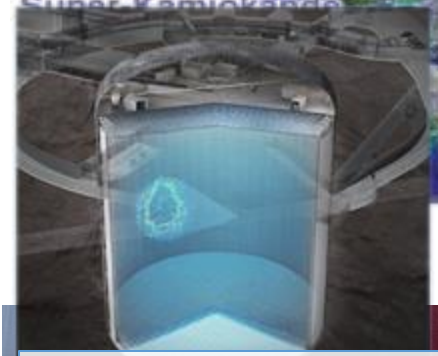
- Luminosity improvement is the key to more success.
- Belle II team are working together with SuperKEKB team to help exploiting the potential of the unique lepton collider, i.e. NANO-BEAM SCHEME

International collaboration with ~1200 researchers
from 28 countries/regions, hosted by KEK

T2K and Hyper-K

- Physics Production with T2K and Construction of HK are ongoing!

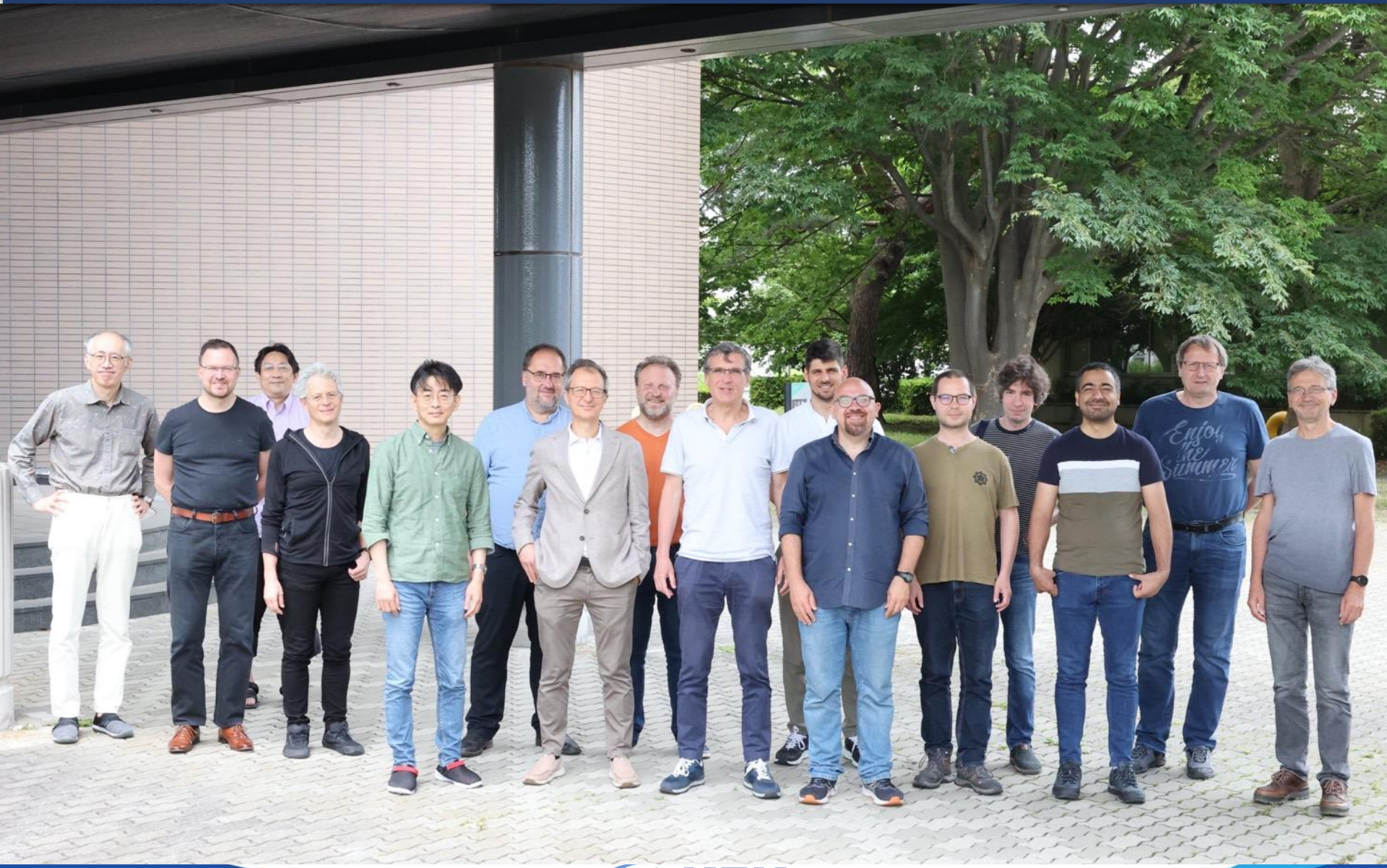
T2K



Hyper-Kamiokande

J2GM@KEK

June 2, 2024



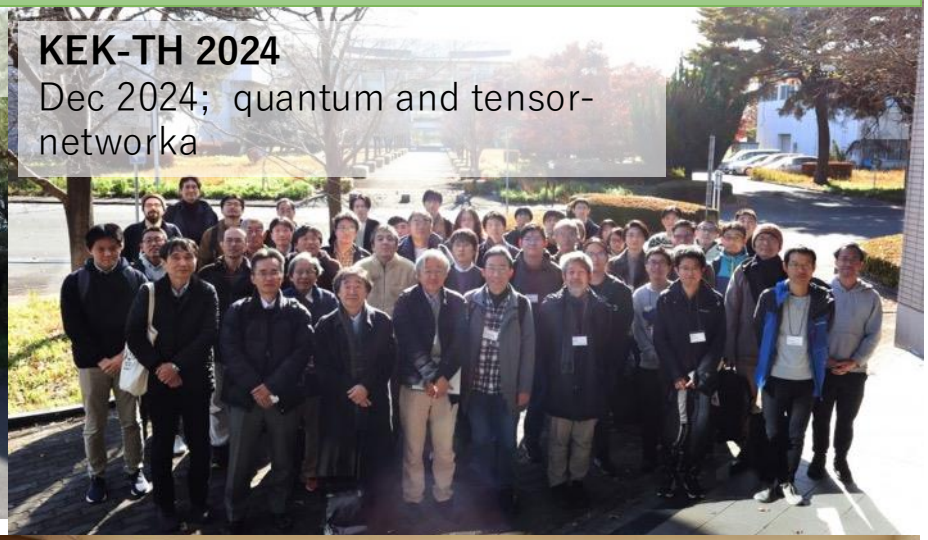
KEK

Theory Center: WS and Seminars

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

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

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 through

Summary

- IPNS covers a wide range of the Particle and Nuclear Physics in Japan and World.
- Close collaborations with European countries have been very successful and very productive!
- We hope to continue this trends in coming years!
- Many thanks to JENNIFER2 and welcome JENNIFER3.

Institute of Particle and Nuclear Studies

View of Hitachi Lighthouse from Kujihama Beach near J-PARC

Let's Share More Excitements!








iFPNS

Institute of Particle and Nuclear Studies

Particle and Nuclear physics at J-PARC

KOTO and KOTO II at Hadron Hall

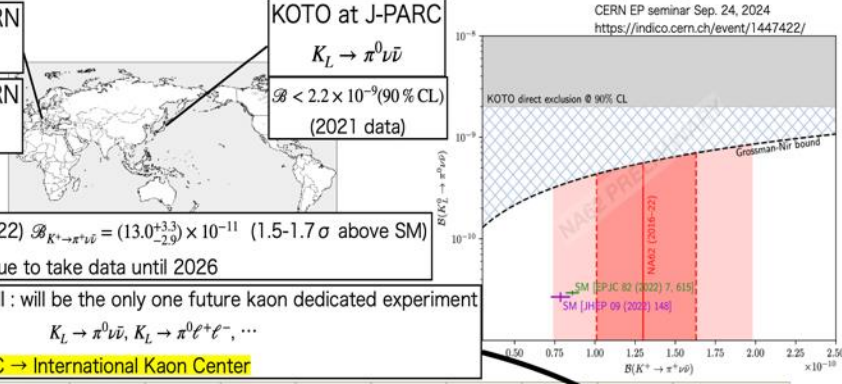
- Kaon WS was held in July, 2024 @ J-PARC

International situation of kaon physics

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

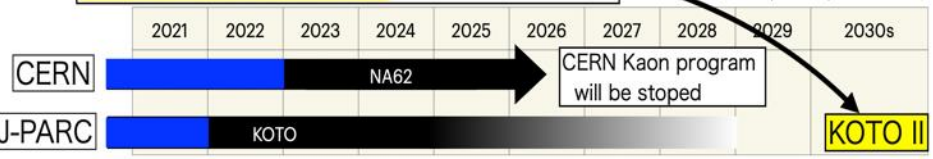
LHCb at CERN
K_S decays

KOTO at J-PARC
$K_L \to \pi^0 \nu\bar{\nu}$
$\mathcal{B} < 2.2 \times 10^{-9}$ (90 % CL)
(2021 data)

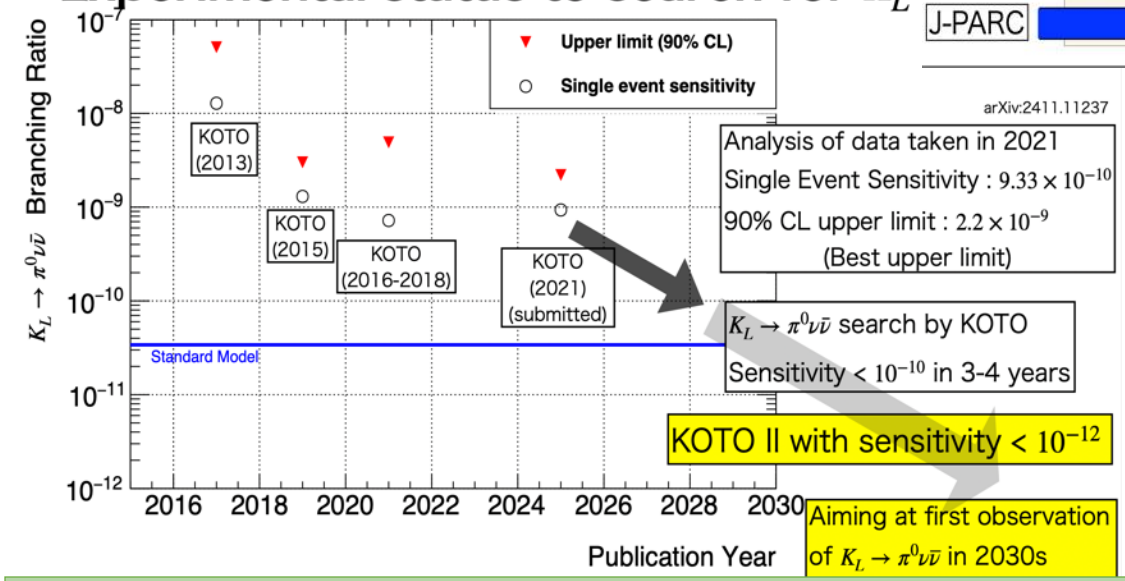


NA62 (2016-2022) $\mathcal{B}_{K^+ \to \pi^+ \nu\bar{\nu}} = (13.0^{+3.3}_{-2.9}) \times 10^{-11}$ (1.5-1.7 σ above SM)
will continue to take data until 2026

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



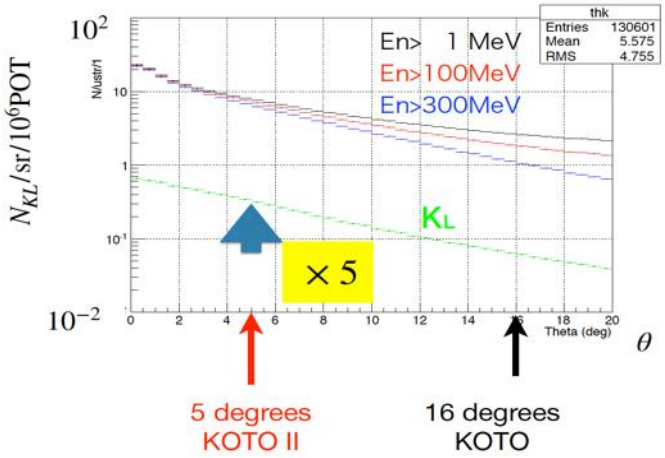
arXiv:2411.11237

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}

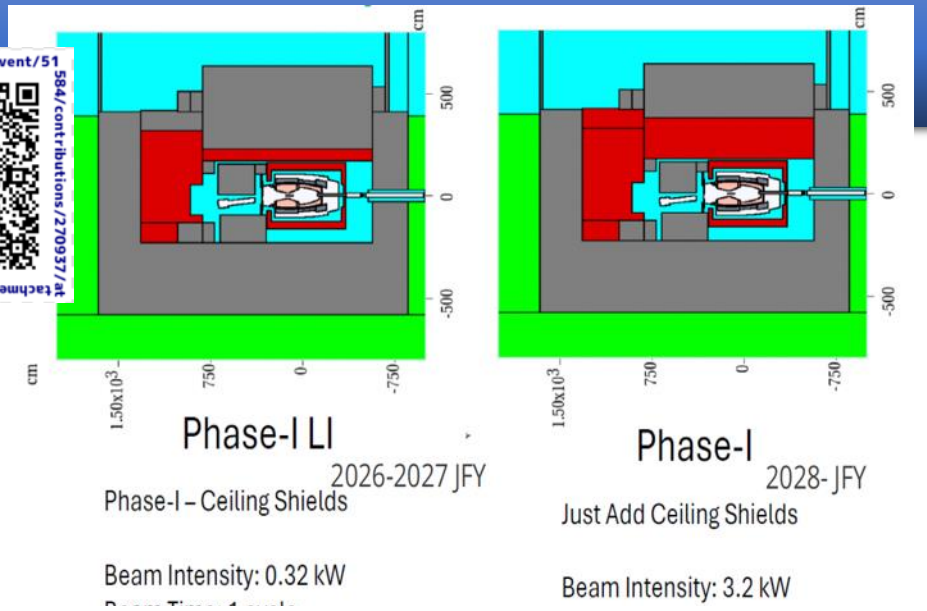
Aiming at first observation of $K_L \to \pi^0 \nu\bar{\nu}$ in 2030s

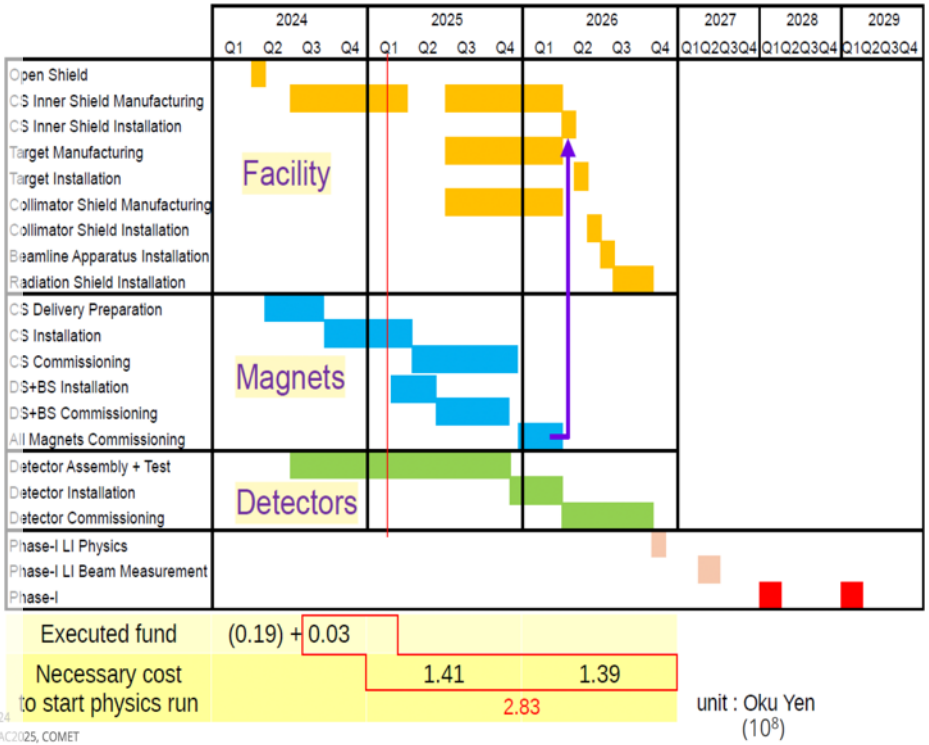


Collaboration promptly emerged to produce the new proposal of KOTO II
Presentation was made at the J-PARC PAC in January, 2025.
Stage-1 status is granted, with a conditional of HEF-ex.

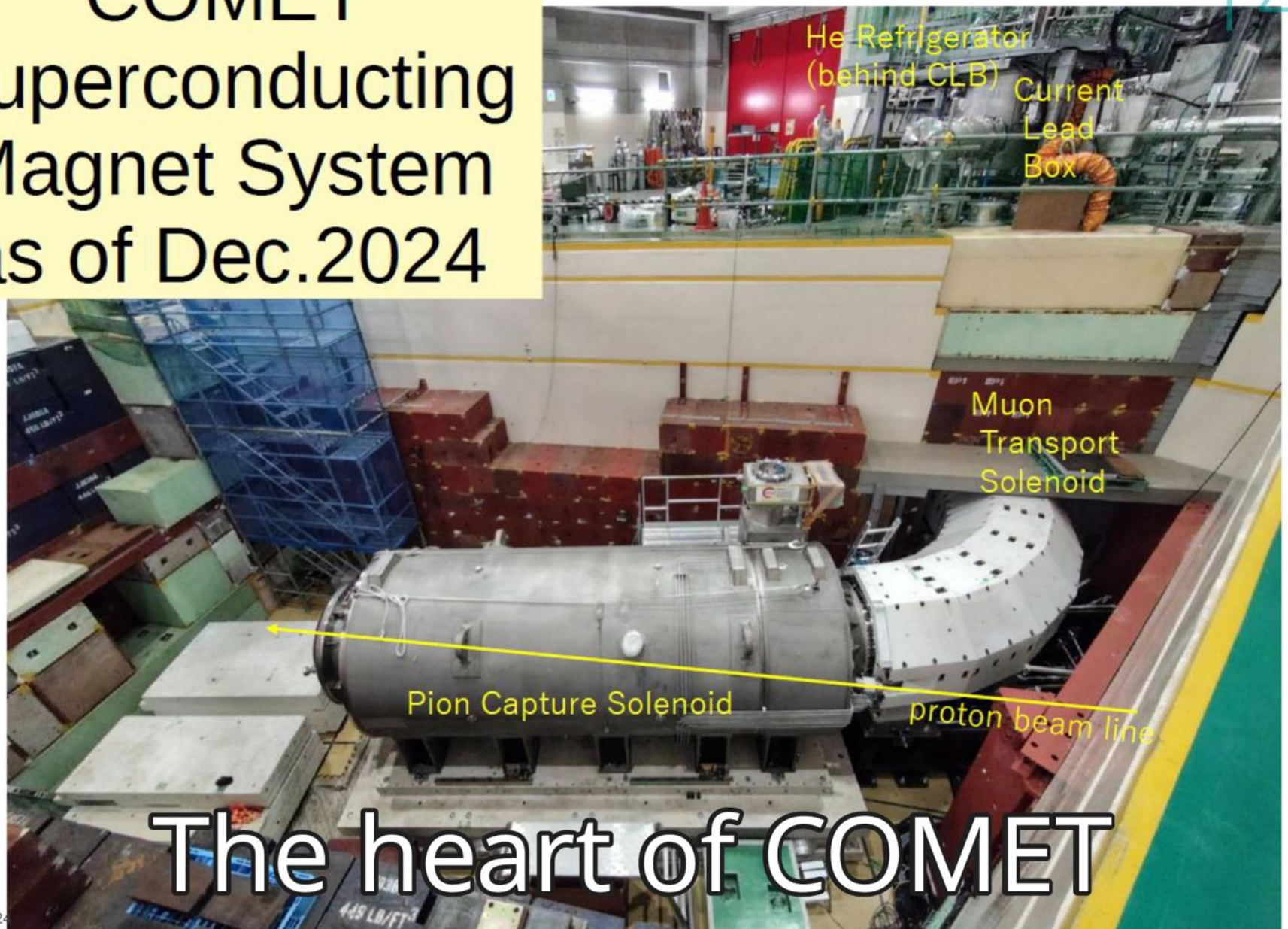
COMET

- 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



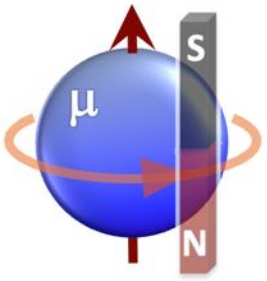
The heart of COMET

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

g-2

Anomalous magnetic moment

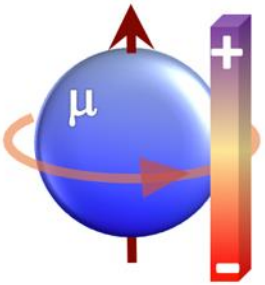
450 ppb

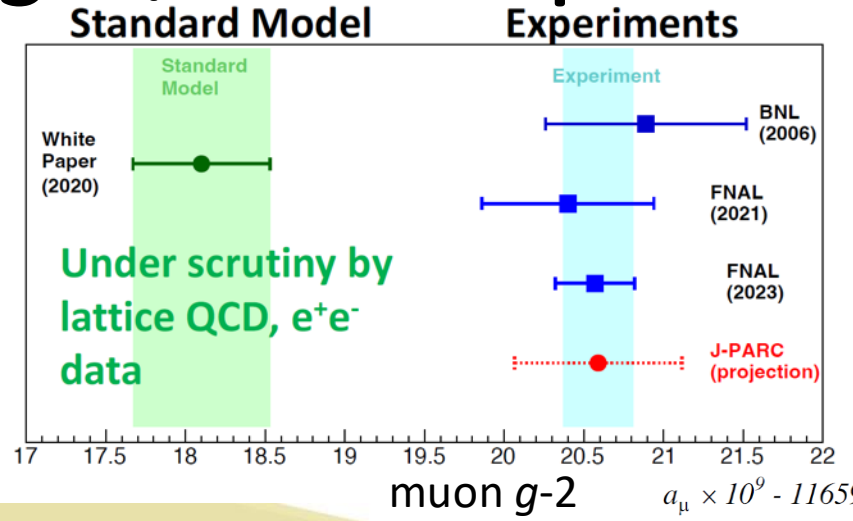


EDM

Electric Dipole Moment

1.5 E-19 ecm

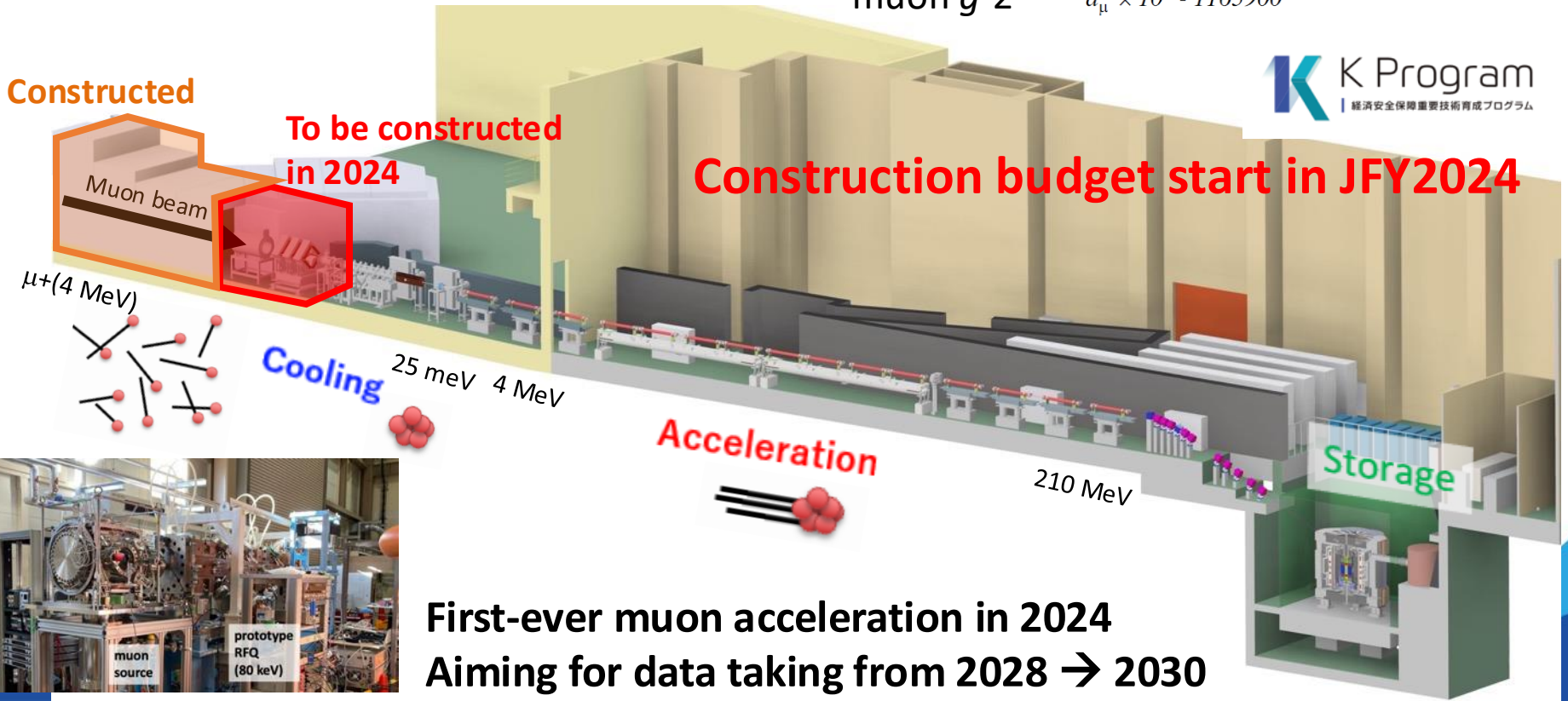




J-PARC is the only experiment to check FNAL/BNL results.

K Program
経済安全保障重要技術育成プログラム

Construction budget start in JFY2024



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

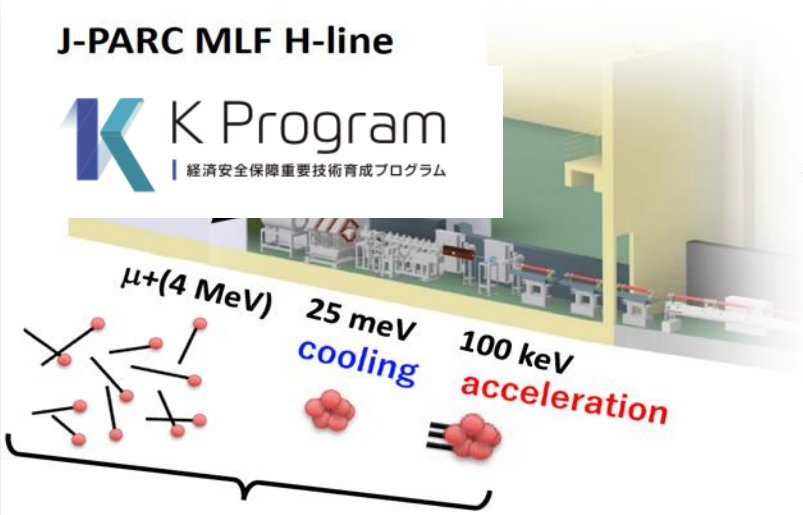
Muon g-2/EDM at J-PARC

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

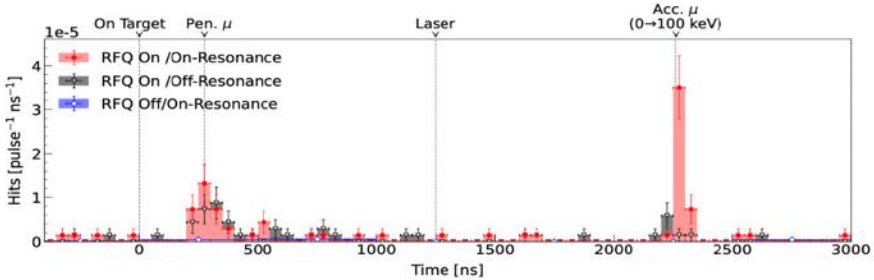


This part was demonstrated at MLF S2 area in April 2024.

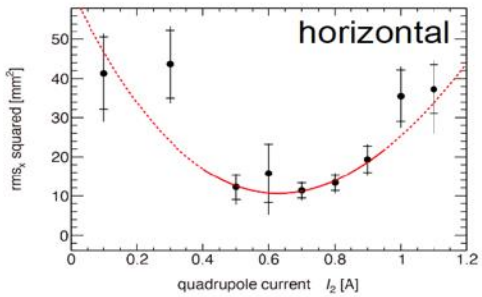
Experimental setup

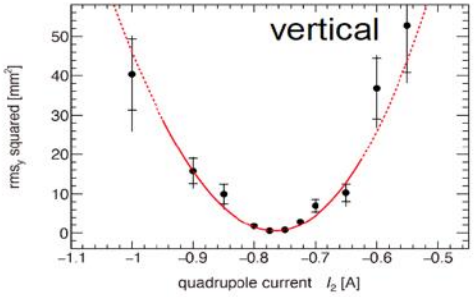
Muon cooling and acceleration to 100 keV was demonstrated.

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