EIC and Related Efforts in Japan

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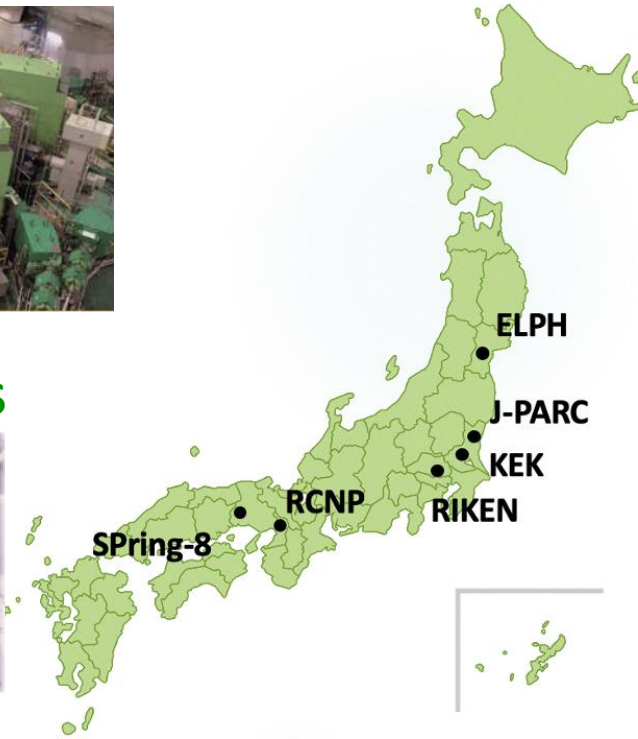
QUARK NUCLEAR SCIENCE INSTITUTE
THE UNIVERSITY OF TOKYO
RIKEN

Nuclear Physics Landscape in Japan

- **Low Energy Nuclear Physics**
  - **~300 researchers**
  - Driven by world-class facilities like RIBF (RIKEN) and RCNP (Osaka Univ.).
- **Strangness and Hadron Physics**
  - **~200 researchers**
  - Centered around J-PARC, RARIS (Tohoku Univ.), SPring-8, and JLab.
- **High Energy QCD Physics**
  - **~100 researchers**
  - Actively engaged in international frameworks including LHC, RHIC, and the upcoming EIC.

RIBF

RCNP

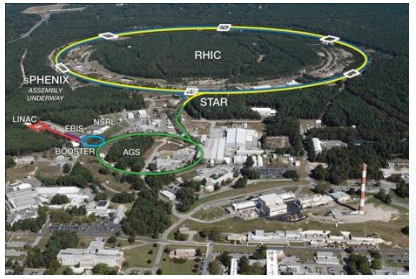


J-PARC

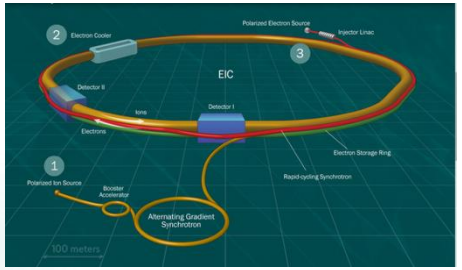
RARiS

LHC

RHIC



EIC



Japanese version of LRP

- **Past Japanese LRPs (2013 and 2021)** were published via ***Genshikaku Kenkyu*** to build strict consensus within the community.
  - Strong leadership heritage: **QGP section chaired by T. Gunji; Nucleon Structure section chaired by Y. Goto**.

- **Official discussions have successfully launched this year to formulate the next decade's roadmap (LRP 2026)**

Community "Dreams" from the LRP Survey

- **The Ultimate Goal (~30% of responses)**
  - ***Bridging Quarks/Gluons to Nuclei*:**
    - **Achieving an analytical understanding of quark confinement and establishing ab-initio QCD calculations for all nuclei.**
    - **Understanding hadron structure, interactions, and mass from fundamental quark-gluon degrees of freedom.**
- **Key Science Themes to Achieve the Dream**
  - ***Universality (~20%):*** Treating nuclei as a fundamental quantum many-body system and discovering universal laws across different scales.
  - ***Cosmic Connection & New Horizons (~20%):*** Unveiling the origin of matter in the universe and exploring physics beyond the Standard Model.
- **Perfect Synergy with EIC!!**

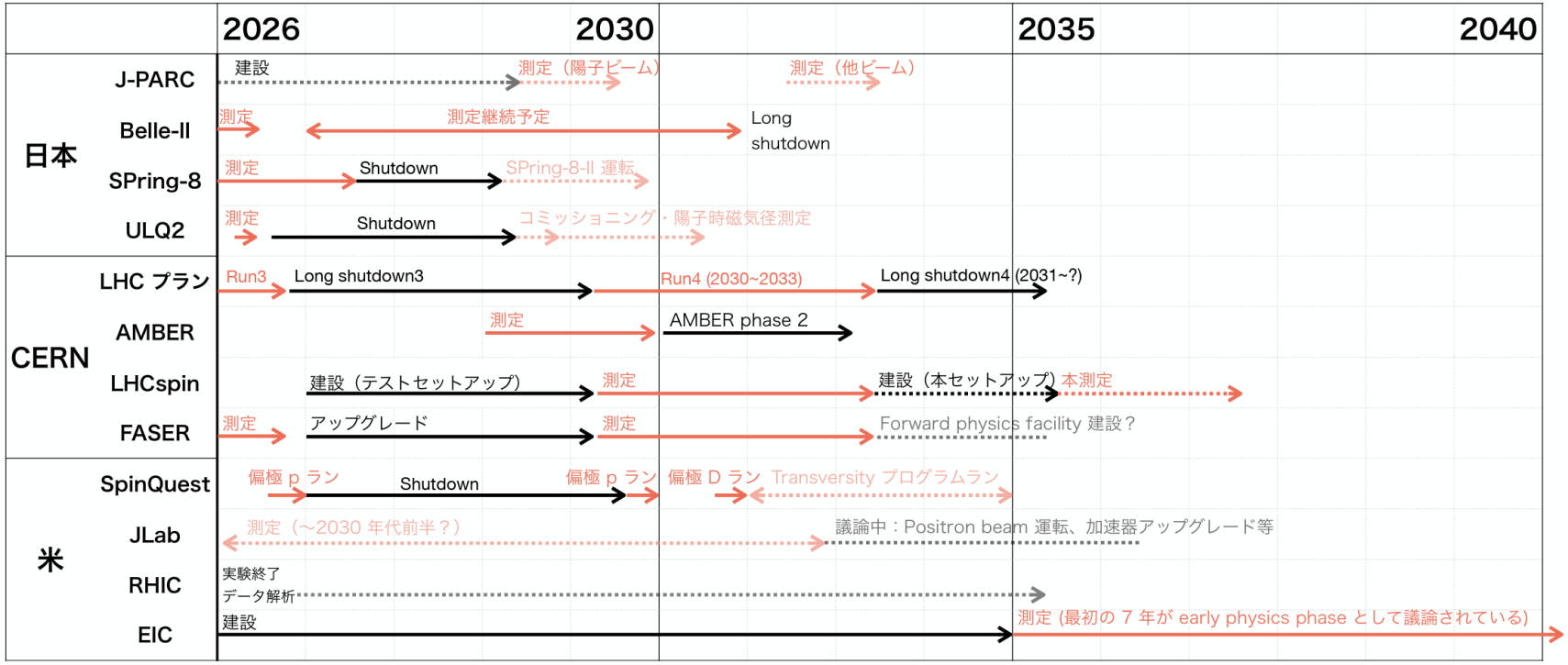
Mobilizing the Next Generation

- **High-Energy Nucleon and Nucleus Structure Working Group**
  - **Newly formed under the LRP 2026 framework.**
  - Composed of **young, talented researchers (ages 30–40) cross-cutting multiple major projects**
    - **FASER, ATLAS, J-PARC, Belle II, COMPASS, Sea/SpinQuest, sPHENIX, Lattice/pQCD, and EIC**
  - ***Core Mission:*** **Strategic planning to maximize scientific output by interconnecting various global facilities.**

名前	所属	ポジション	専門・興味
有賀昭貴	千葉大	准教授	FASER
青木和也	KEK	研究機関講師	J-PARC 高運動量ビームライン、PHENIX、GEM検出器、シリコン検出器
音野瑛俊	九州大	准教授	ATLAS, FASER,グルーオン飽和, Intrinsic charm
熊岡卓哉	東大 QNSI	特任助教	J-Lab, EIC, DAQ
郡司卓	東大	准教授	EIC
後藤雄二	理研	先任研究員	PHENIX, sPHENIX, RHICf, Sea/Spin Quest, EIC,
サイデル・ラルフ	東大 QNSI	准教授	TMD, Higher twist, FF, PHENIX, sPHENIX, EIC, Belle, Belle-II
辻竜太朗	KEK	学振特別研究員	格子QCD、核子構造、ハドロン物理
杉山泰之	KEK	助教	加速器
堂下典弘	山形大	助教	COMPASS/AMBER/LHCspin, 偏極標的
冨田夏希	京大	助教	GPD, J-PARC MARQ, MRPC
中野健一	University of Virginia	Research Scientist	FNAL Sea/Spin Quest, J-Lab CLAS12, ドリフトチェンバー
永井慧	The University of Memphis	Assistant Professor	反クォーク PDF, TMD, FNAL Sea/Spin Quest, ドリフトチェンバー
糠塚元気	理研	研究員	TMD, COMPASS, sPHENIX, 偏極標的、シリコン検出器
原田寛之	原研	副主任研究員	加速器
本多佑記	東北大	特任准教授	電子散乱、核子構造
水谷圭吾	大阪大	特任助教	J-LAB, 重力形状因子, photon beam, tracking device
毛受弘彰	名古屋大	助教	FASER
森野雄平	KEK	研究機関講師	高密度核物質　ハドロン物理, J-PARC 高運動量ビームライン
宮地義之	山形大	教授	Sea/Spin Quest, EIC
村上ひかり	名大 KMI	特任助教	Belle-II, EIC, エキゾチックハドロン、重力形状因子
八野哲	広島大	助教	EIC, シリコン検出器
吉田信介	華南師範大	副研究員	摂動論的QCD、核子構造、スピン物理、高次ツイスト効果
渡邉和宏	東北大	准教授	核子・原子核の量子構造およびハドロン創発機構の解明, EIC

Timeline of Global Facilities & Opportunities

- **Synergistic operation and data analysis across J-PARC, Belle II, CERN (LHC Run3/Run4, AMBER, LHCspin, FASER), and US facilities (SpinQuest, JLab) and strategic focus towards the EIC era (Early physics phase targeted in the mid-2030s).**
- EIC serves as the ultimate venue to realize the community's consensus: **"Bridging Quarks/Gluons to Nuclei"** through cross-scale physics.



※実線はオフィシャルな決定事項、点線はそうでないもの

New opportunities and developments using EIC

Key word is Bridging Quarks/Gluons to Nuclei

Government-Level Recognition: MEXT Expert Committee

https://www.mext.go.jp/b_menu/shingi/chousa/shinkou/072/index.html

- **EIC Expert Committee Organized by MEXT**
  - Evaluation on ***"EIC project and related new developments in nuclear physics"*** yielded highly positive conclusions.
- **Key Endorsements from the Committee Report:**
  - **Fundamental Role:** Nuclear physics acts as a core discipline connecting particle physics, condensed matter, and cosmology.
  - **Interdisciplinary Strategy:** Strongly endorsed the creation of "Multi-scale Quantum Dynamics" to bridge universal laws across hierarchical layers.
  - **Application Potential:** Clear relevance to breakthrough energy sectors and quantum technologies.
  - **Recomendation:** MEXT actively support institutional frameworks among RIKEN, U-Tokyo, Osaka-U, etc., to drive Japan's participation in the EIC.

QNSI: The Institutional Nucleus for EIC Japan

- **Quark Nuclear Science Institute (QNSI), UTokyo**
  - Established in July 2024 to spearhead national EIC activities with strategic backing from RIKEN.
  - Actively covered in national media as Japan's premiere hub for the EIC project
- **Human Resource Expansion**
  - Successfully secured 2 faculty positions via the government's annual budget request (T. Gunji & Ralf Seidl).
  - 2 additional RIKEN-supported assistant professor posts; 5 new positions planned for open recruitment in FY2026 (a few could be stationally at BNL/JLab).

東京大の加速器研究拠点の役割

東京大
クォーク・核物理研究機構
7月に設置
研究や人材育成で連携
理化学研究所や高エネルギー加速器研究機構、大阪大など
研究機会の提供
人材派遣
米ブルックヘブン国立研究所
新型加速器「EIC」
2032年に実験開始

東大が加速器研究拠点

米計画参加見据え人材育成

7月設置

加速した粒子同士を衝突させて物質の構造などを解明する研究を強化するため、東京大が7月、新たな拠点を設置することがわかった。1兆分の1ミリレベルの原子核内部を観察できる米国の大型加速器「EIC」の建設計画に日本が参加することを見据え、加速器を使った米国などとの共同研究を主導する人材を育成する。

新拠点は「クォーク・核物理研究機構」で、本郷キャンパス（東京都文京区）に事務局を設ける。研究者約10人で7月から運用を始め、機構長には、中村哲教授（原子核物理学）が就く。

全ての物質は原子で構成され、中心部の原子核は陽子と中性子で出来ている。新拠点は、原子核内部の極微の世界の構造や性質、陽子などを構成する素粒子の一種クォークの研究を行う。

米エネルギー省傘下のブルックヘブン国立研究所（ニューヨーク州）は、粒子の衝突実験を行う大型加速器「EIC」を建設する計画で、日本の文部科学省は今月15日、計画に参加する方針を表明した。計画には24か国が参加する見通しで、量子コンピューターなど先端技術の実用化にも貢献できると期待されている。

新拠点は、各国との共同研究を見据え、大型加速器を持つ理化学研究所や高エネルギー加速器研究機構のほか、大阪大など複数の国内大学とも連携する。EICに派遣する若手研究者らの育成も進め、EICが実験を始める2032年に向け、日本が国際研究を主導する体制を整える。

中村教授は「国際的な視点を持つ次世代のリーダーを輩出し、日本の研究力向上にも貢献したい」と話す。

女川原発2号機

安全対策が完工

9月頃の再稼働目指す

東北電力は27日、女川原子力発電所（宮城県女川町、石巻市）2号機の再稼働に必要な安全対策工事が完了したと発表した。東北電は、原子炉に核燃料を入れる「燃料装荷」を7月頃に実施予定で、原子力規制委員会の検査や確認作業を経て、9月頃の再稼働を目指す。

最大クラスの津波に備えて防潮堤を海抜約29㍍にか

International Quantum Physics Network

- **A New Model of Institutional Collaboration**
  - **Launched via a U-Tokyo and Osaka-U (RCNP) inter-university alliance.**
  - **Establishing a distributed network across Japan (like INFN) to drive major international experiments, with EIC designated as the pioneering flagship project.**
- **Expanding Domestic Node Network (FY2025–FY2026)**

EIC PI 5~7

U-Tokyo, Quark-Nuclear Science Institute — EIC, US
- Lead international experiments such as EIC
- Establishment of international research and education centers at BNL and JLab
- Standardization of streaming computing and advanced semiconductor technologies

SCHOOL OF SCIENCE THE UNIVERSITY OF TOKYO · QNSI The University of Tokyo

University

EIC PI 1~2

Tohoku University, Research Center for Accelerator and Radioisotope Science — Infra, Application
- Quantum measurement technology development base using accelerator beams
- Application of cutting-edge quantum measurement technology to different fields

RARiS Tohoku University

University

CERN, Europe

Tsukuba University
- Establishment of international research and education center at CERN in Europe
- Point of contact for quantum research and technology development with Europe

University of Tsukuba

Hiroshima University — Infra
- Advanced semiconductor technology development base based on a highly advanced large clean room

HIROSHIMA UNIVERSITY

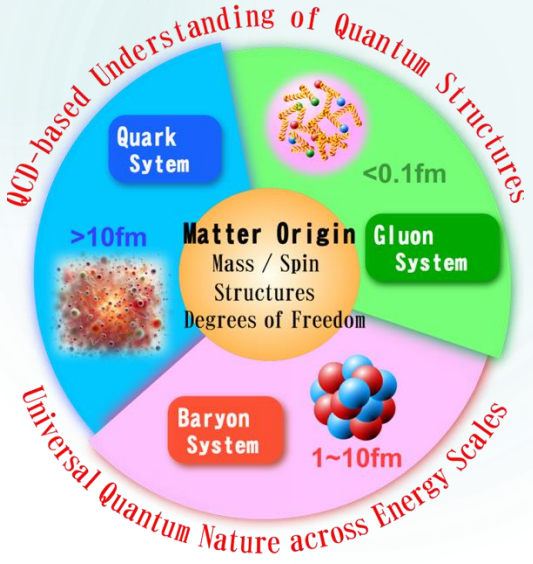
U-Osaka, Research Center for Nuclear Physics — Infra, DAQ
- standardization of advanced streaming data acquisition systems
- High-precision quantum beam technology and application development using AI control
- Domestic community contact point

RCNP 大阪大学 核物理研究センター

EIC PI 1~2

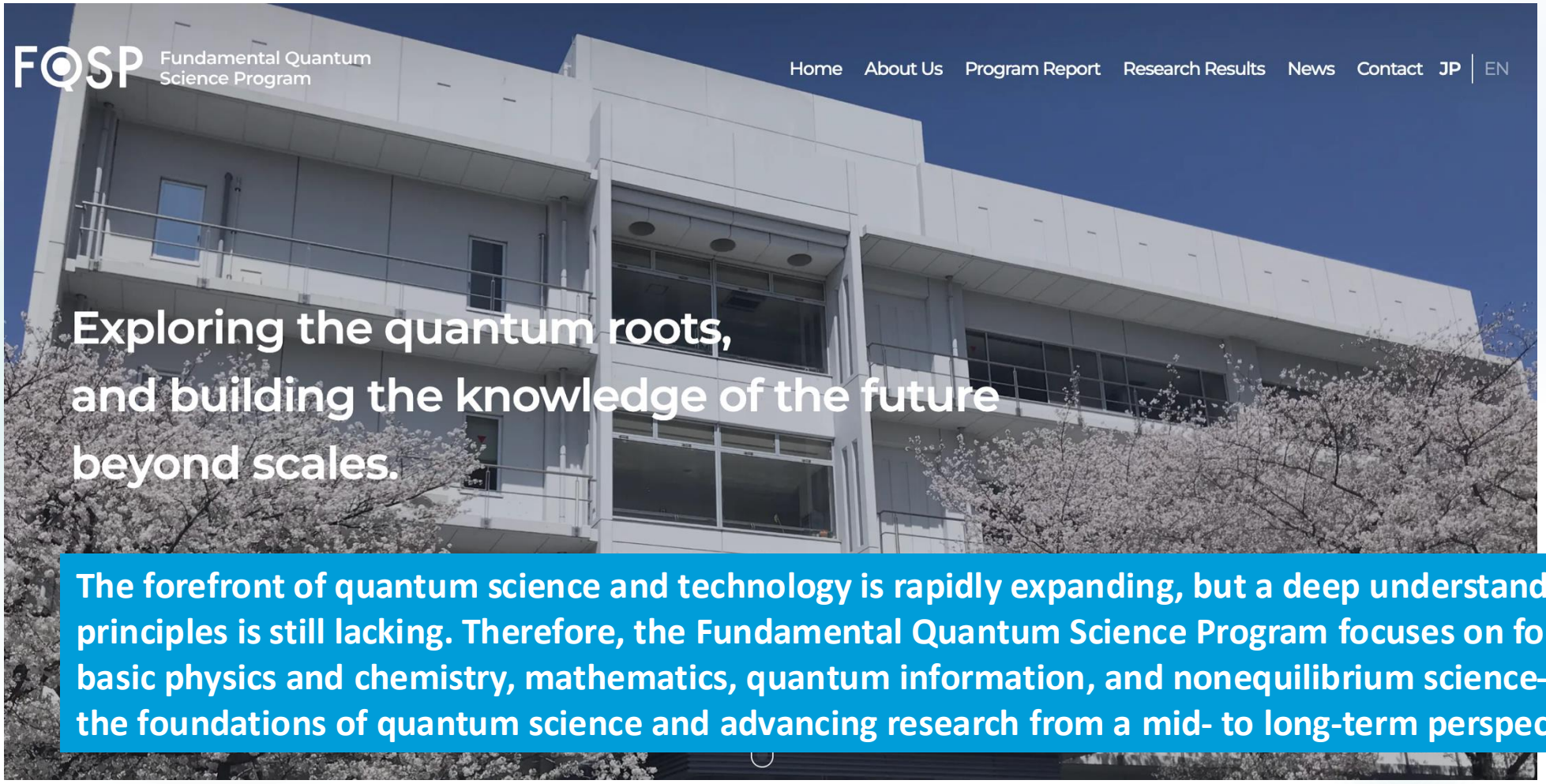
New International Leading Research Grant

- **Project Title:** ***Origins of Matter Explored through Femtoscale Quantum Many-Body Systems --- Nurturing Talent in the Quantum Era***
- **Core Achievement:** Large-scale funding secured to execute multi-scale human resource development ($3.5M / 7 years)
- **JSPS Selection Highlight:** ***"Highly evaluated for cultivating next-generation leaders capable of bridging different scales (quarks, baryons, and gluons) through collaborative research at international facilities like CERN, JLab, and EIC."***



RIKEN's Vision: Fundamental Quantum Science Program (FQSP)

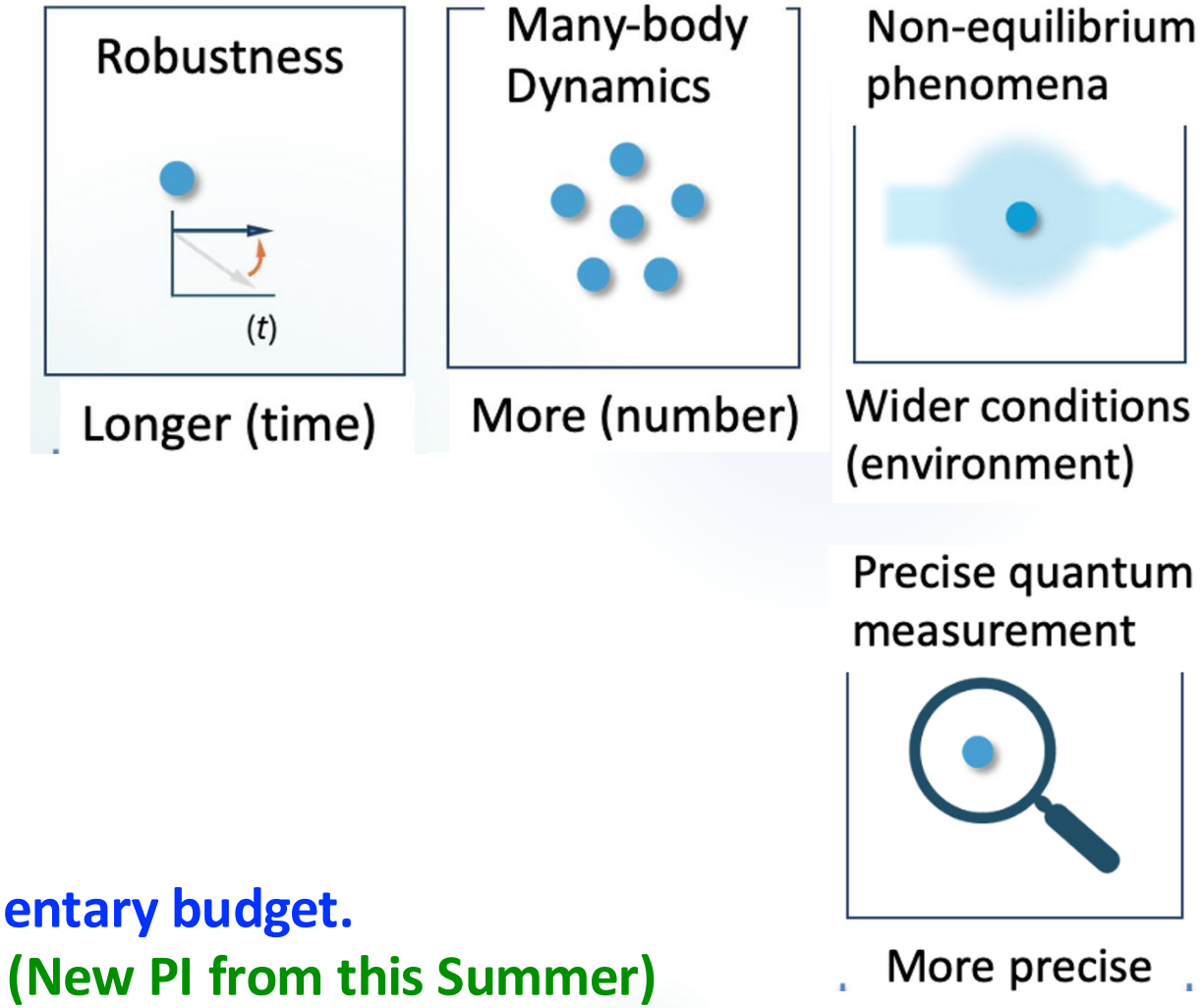
Leading 2030s Quantum Science



The forefront of quantum science and technology is rapidly expanding, but a deep understanding of its basic principles is still lacking. Therefore, the Fundamental Quantum Science Program focuses on four key areas-basic physics and chemistry, mathematics, quantum information, and nonequilibrium science-returning to the foundations of quantum science and advancing research from a mid- to long-term perspective.

4 Core pillars addressed by FQSP

- ***Robustness:*** Eliminating time constraints on quantum interference.
- ***Many-body Dynamics:*** Revealing emergent phenomena when quantum systems scale up.
- ***Non-equilibrium Phenomena:*** Understanding quantum behaviors in open environments.
- ***Precise Quantum Measurement:*** Translating results into next-generation detector tech.

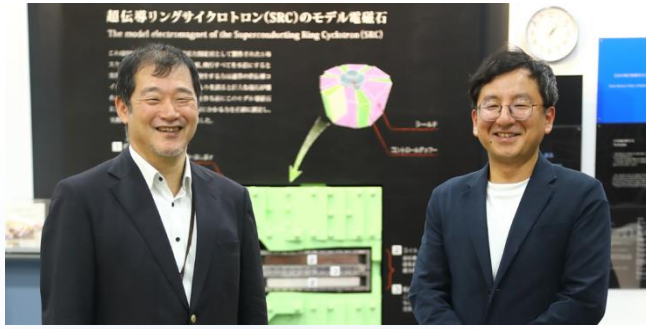


Immediate EIC Actions within RIKEN:

- **Dedicated funding secured via the supplementary budget.**
- **Launching a new EIC Theory Group in FQSP (New PI from this Summer) and a new experimental Group (MSQD) in RNC**

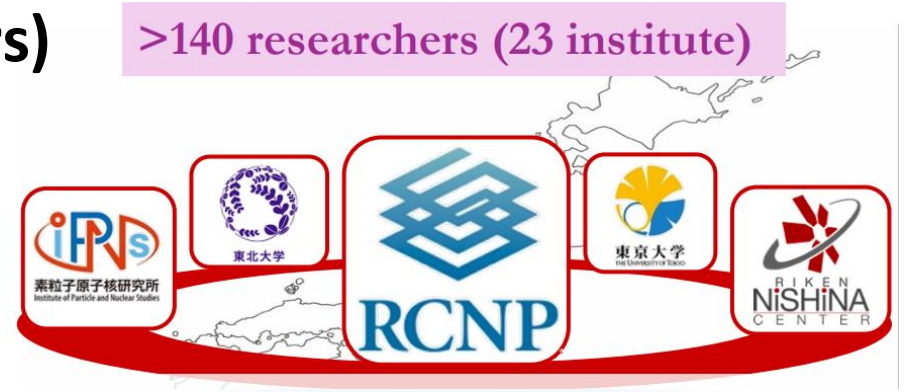
MSQD Group in RNC

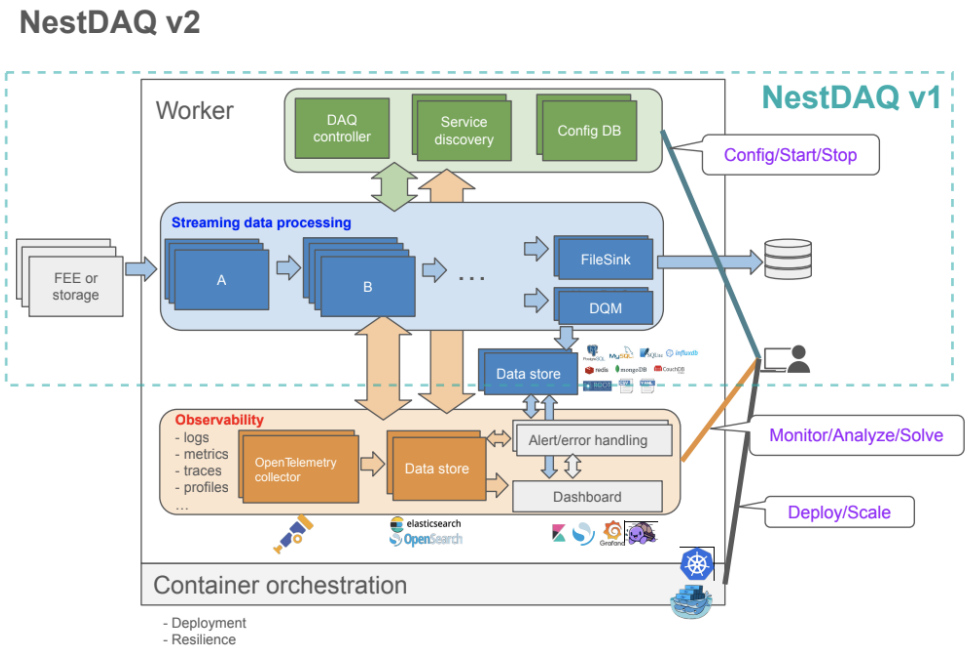
- **Multi-scale Quantum Dynamics Joint Research Group**
  - Formed under RNC (Co-chaired by K. Uesaka and T. Gunji).
  - Directed at executing EIC construction and promiting EIC-RIBF joint research.
- **Synergistic Core Themes across Hierarchies**:
  - **Short-Range Correlations (SRC) in nuclei**
    - **1st workshop on Feb. 2026**
  - **Equation of State (EOS) of nuclear matter**
  - **Chiral symmetry restoration in finite density**
- **Financial support**:
  - Total of **~800M JPY (~$5M USD) secured via FY2024/FY2025 supplementary budgets** for EIC promotion (including 160M JPY explicitly for EIC-RIBF synergy).
  - **Building infrastructure to support AC-LGAD, ZDC, (SVT), and SRO activities.**



SPADI-Alliance

- Built in NP community (23 institutes, >140 members)
  - Joint collaboration between RIBF, J-PARC, EIC, etc…
- Aiming for standardization of:
  - Streaming data acquisition
  - Large-scale data processing (to be developed)
  - AI-integrated frameworks (to be developed)
- US-Japan collaboration (SPADI & EIC and FRIB)





ePIC Japan Group

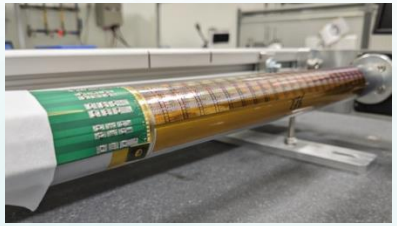
2024: Tohoku University
2025: RCNP/Osaka University
2026: Tokyo City University

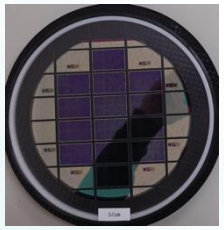
- **ePIC Japan Collaboration Growth**
  - 13 Domestic Institutions (~70 active members) spanning major national universities.
- **Leading roles in ePIC collaboration**
  - **Gunji (Tokyo)** : Streaming Computing WG convener
  - **Ralf (Tokyo)**: Semi-inclusive PWG convener
  - **Goto (RIKEN)**: Far-Forward ZDC DSTC
  - **Yano (Hiroshima)**: TOF Deputy DSL
  - **Shigaki (Hiroshima)**: Membership Committee
  - **Shimomura (Nara-Women's)**: DE&I Committee

Japanese contributions

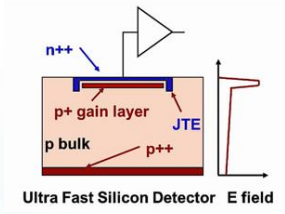
Japan takes core EIC detectors and systems leveraging Japanese technologies.

①MAPS sensor TPSCo(JP)

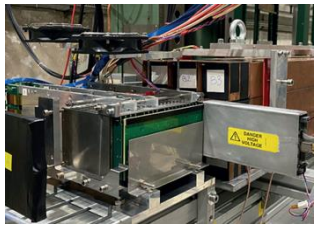




② AC-LGAD HPK (JP)

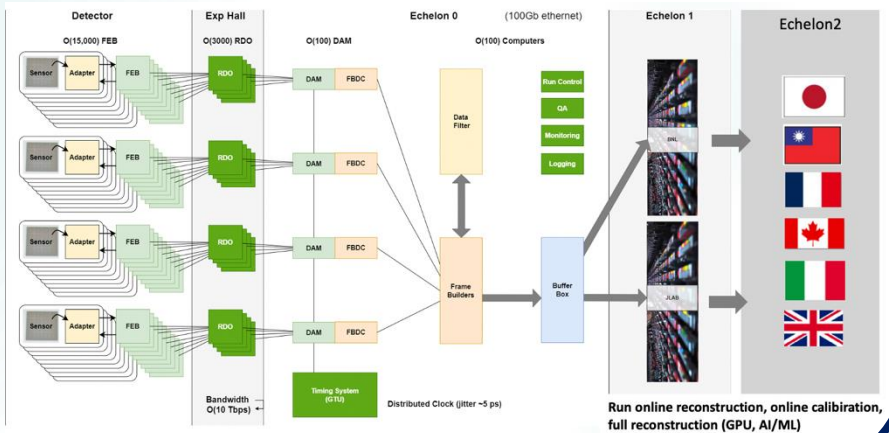


③ ZDC (W+Si) HPK (JP)

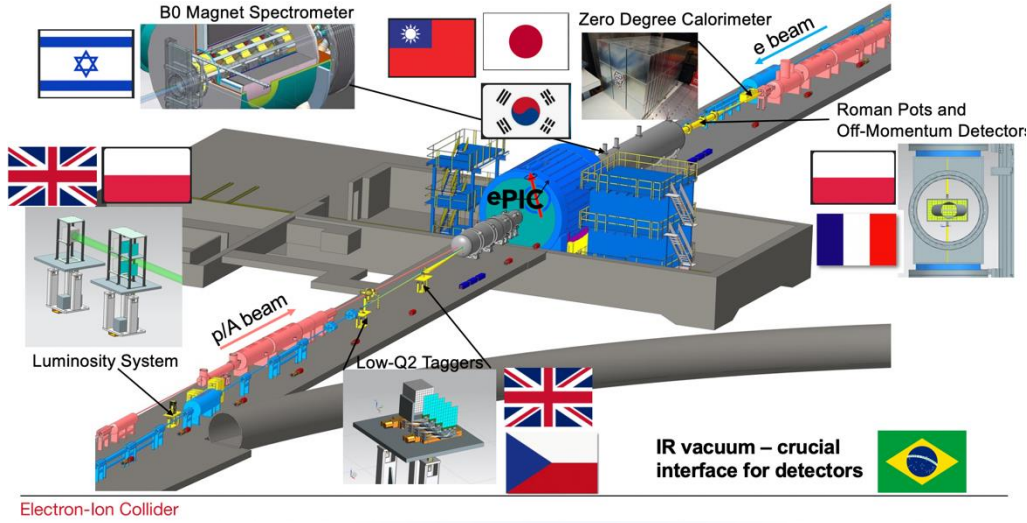


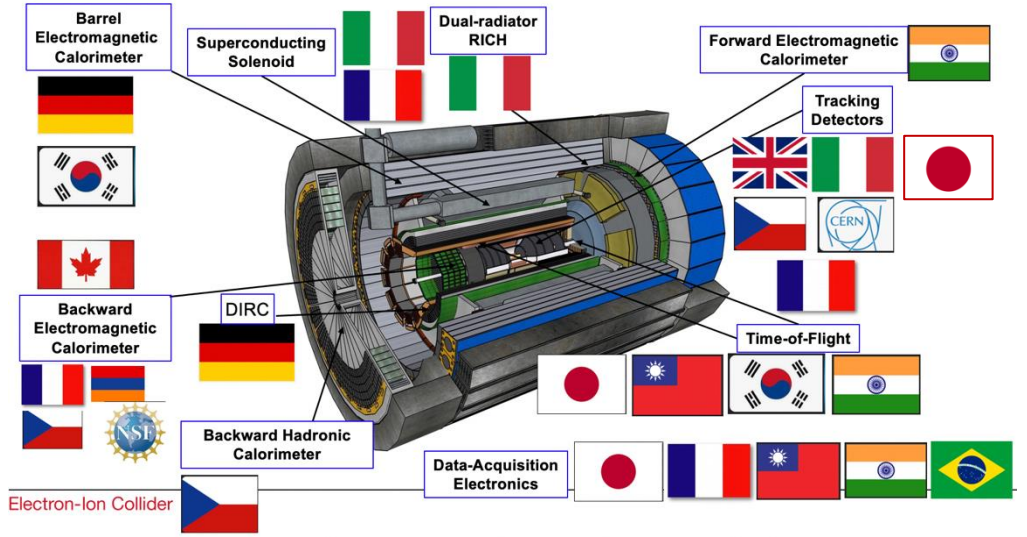
④ 100Tbps Streaming DAQ and computing

US-Japan network
Distributed computing
GPU, AI, HPCs



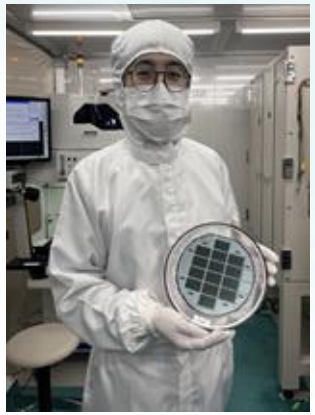
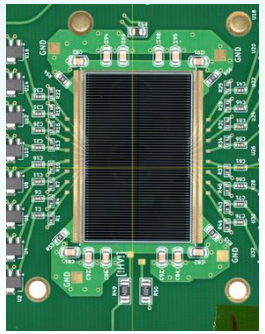
Non-DOE Contributions





Japanese contributions

- AC-LGAD R&D
  - AC-LGAD Sensor R&D
    - Thickness (20, 30, and 50um)
    - Strip geometry, readout geometry
  - Readout R&D
    - Discrete amplifiers with high BW
  - FPC design and prototyping
  - Beamtest (DESY, KEK x2 , RARiS)
  - Infrastructure (RIKEN, Hiroshima)
- MAPS R&D
  - MOSAIX R&D for ALICE-ITS3
- ZDC
  - SiPM for Crystals, simulations for W+Si options and workshops, AC-LGAD pixels
- Streaming DAQ & Computing
  - Streaming Orchestration (Panda, Rucio)
  - Development of nestDAQ for ePIC
  - Streaming reconstruction and AI
  - Computing (GPU) and network in Japan



MEXT Roadmap 2026

- **The Mandatory National Gateway**
  - Selection into the MEXT Roadmap is the strict prerequisite for any large-scale projects to secure capital budget appropriation from the Japanese Government.
  - *Historical Precedents:* Hyper-Kamiokande, LHC-ATLAS, J-PARC, KamLand, KAGRA, and Belle II all successfully utilized this exact pipeline.

MEXT Roadmap 2026

- **Our Joint Proposal:**
  - **Title:** *Establishment of an International Multiscale Nuclear Physics Research Hub Based on Quantum Chromodynamics toward the Electron-Ion Collider (EIC)*
  - **Proposing Entities:** U-Tokyo QNSI, Osaka-U RCNP, Tohoku-U RARIS, and RIKEN.
  - **Proposed Funding Framework:** $60M USD over 10 years ($35M for in-kind detector/hardware contributions, $25M for operational management).
- **Current Status:**
  - Officially endorsed as the **#1 Top-Priority Project** by the entire Japanese nuclear physics community.
  - Currently undergoing active screening and formal evaluation by the MEXT Roadmap Committee.

Summary and Outlook

- **Perfect Alignment:** The ultimate scientific objective of the Japanese community—bridging QCD to nuclear structures—is perfectly synchronized with the EIC mission.
- **Unprecedented Momentum:** Through the launch of QNSI, RIKEN's MSQD group, the IQPN framework, and multi-million dollar supplementary funding, Japan has systematically structured its institutional capacity.
- **Next Horizon:** With the LRP 2026 and MEXT Roadmap evaluations currently underway, the Japanese group is fully prepared to take a premier, leading role in the construction and scientific harvesting of the EIC.

Special thanks

Although many others have also contributed, I would like to especially acknowledge these individuals and thank them for their dedication and support of EIC-Japan over the years.

RIKEN

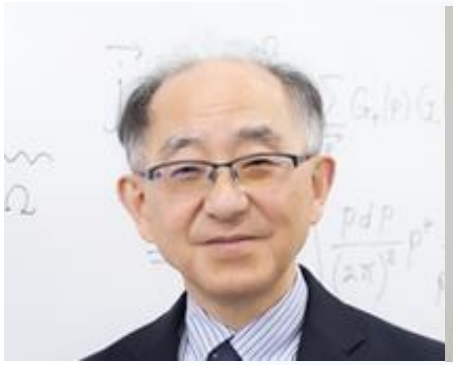

Sakurai


Uesaka


Nagamiya


Goto


Akiba


Nagaosa


Aoki

IQPN

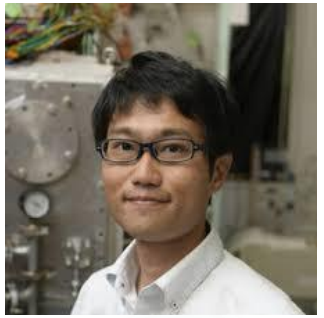

Nakamura (Tokyo)


Nakano (Osaka)


Ohnishi (Tohoku)


Oyama (Osaka)


Miwa (Tohoku)


Ota (Osaka)


Shigaki (Hiroshima)


Chujo (Tsukuba)