資料1－7
科学技術・学術審議会
研究開発基盤部会
量子ビーム施設利用推進委員会(第５回)
令和７年10月15日（水）

第５回　量子ビーム施設利用推進委員会

GSO会議におけるJ-PARCセンターについての報告

令和7年10月15日

小林　隆
J-PARCセンター　センター長

GSO： Group of Senior Officials on global Research Infrastructures

国際研究インフラに関する高級実務者会

- 2008年G7沖縄・科学技術担当大臣会合において設置を決定。
- 参加国
  - 15か国・組織（2024年6月現在）2024年度韓国の参加が認められ、第17回より参加
  - OECD/GSFはオブザーバーとして参加
- 第一回は、2011年3月ベルギーブリュッセルにて開催
- 国際的な研究機関の情報交換を通じた国際協力促進の必要性についての認識が共有されたことが契機
- 大規模研究施設の国際的共同利用の促進や重複投資の回避を目的として各国の既存施設や将来計画の情報交換を行うオープンな場
- 法的な拘束力は持たない
- 各国の研究インフラ政策に関する実務者の会合
- 国際的研究施設に関する情報共有、施設アクセスの促進、国際協力フレームワークの構築等について議論
- 2015年G7科学技術大臣会合（ドイツ）、2017年G7科学技術大臣会合（イタリア）にて議論のまとめを報告

第17回GSO会議

- 2025/9/18-19@TRIUMF
- 参加国・機関：12カ国
- 出席者30名
- 出席者の多くは政府機関からであったが、イタリア、中国、韓国、日本からは研究者も出席し国内施設や将来計画等について紹介した。
  - ✓ イタリア：ミラノ大学、ペルージャ大学
  - ✓ 中国：合肥物質科学研究院(HFCAS)、ラズマ物理研究所(IPP)、高能物理研究所(IHEP)
  - ✓ 韓国：韓国基礎科学支援研究院(KBSI)、韓国原子力研究院(KAERI)
  - ✓ 日本：J-PARCセンター

Country / Organization	Participants
Canada	4
China	6
European Commission	2
France	1
Germany	2
Italy	2
Japan	4
Korea	4
Netherlands	1
United Kingdom	2
United States	1
OECD	1
Total	30

第17回GSO会議
2025/9/18-19@TRIUMF

DRAFT AGENDA

Day 1: Thursday, September 18

1. Regular Items
   - Opening remarks and introduction of the Chair
2. OECD Update
3. **Case Studies: Infrastructures for Next-Generation Research**

   GSO members are invited to share their experiences in building, operating, and upgrading new and existing research infrastructures to support new experiments and next-generation research.

   Presentations:
   - Canada, TRIUMF
   - Germany & Canada, Materials Acceleration Centre GCMAC
   - South Korea – KOREA-4GSR
   - China –Steady High Magnet Field Facility (SHMFF)
   - **Japan –J-PARC**
4. Large-Scale International Collaborations
5. TRIUMF site visit

12:30-13:30		**Lunch**
13:30-15:00	4	**Large-Scale International Collaborations**

GSO members are invited to share their experiences in supporting research infrastructures that advance cutting-edge science and large-scale collaborations.

Presentations:
- SNOLAB – International Collaboration on Underground Laboratories

Day 2: Friday, September 19

6. Welcome and Summary of Day 1
7. Planning the Future of Research Infrastructures
8. AI Usage and Research Infrastructures – The Canadian Context
9. Session on GSO Criteria, and Inclusion of Digital/AI

Closing Remarks

9:00-9:30	6	**Welcome and Summary of Day 1**
9:30-10:45	7	**Planning the Future of Research Infrastructures**

GSO members are invited to share examples of initiatives underway or recently completed that support future planning for their large research infrastructures, such as roadmapping and landscape analysis.

Presentations:
- The EU ESFRI Roadmap update
  - *Michael Arentoft, Head of Unit, Open Science, DG R&I, European Commission*
- Canada's approach to Research Infrastructures
  - Laboratories Canada
    - *Marc Potter, Senior Director, Laboratories Canada, Public Services and Procurement Canada (PSPC)*
  - Canada Foundation for Innovation (CFI)
    - *Dr. Mohamad Nasser-Eddine, Vice President of Programs and Planning, CFI*
- OECD GSF – Report on "Fostering research infrastructure ecosystems for addressing complex scientific and societal challenges"
  - *Carthage Smith, Lead Co-ordinator, OECD Global Science Forum*

10:45-11:15		**Break**
11:15-12:30	7	**Planning the Future of Research Infrastructures (cont.)**

GSO members are invited to share examples of initiatives underway or recently completed that support future planning for their large research infrastructures, such as roadmapping and landscape analysis.

トピックス紹介

TRIUMF　カナダ　バンクーバー

- 520MeVの水素イオン加速器（サイクロトロン）
  - 年間3,000時間程度の運転を実施
  - 加速器技術はCERNにも貢献
- 希少同位体実験施設（ARIEL）
  - 世界最強の同位体分離複合施設
  - 原子核の性質、重元素の起源、量子材料、生体分子に関する世界最高水準の研究
  - 疾患のイメージングや治療に用いられる医療用同位体の研究
- 21大学、21以上の国際機関と共同研究を実施

中国科学院 CHINESE ACADEMY OF SCIENCES　中国　北京

- 中国科学院では上海放射光施設、核破砕中性子源施設（CSNS）など多くの施設を設置・運用中
- 安定高磁場実験施設（SHMFF: Steady High Magnetic Field Facility）についての紹介
  - 2008年5月より20T磁場での施設運用を開始
  - 材料研究、バイオ、環境問題などの課題を実施
  - 産業利用では、環境・ハイエンドマシン（マイクロマシン）開発などに使用
  - 2022年45.22Tでワールドレコードを樹立した

トピックス紹介

韓国　大田市、慶州市

- 韓国原子力研究院（KAERI）が陽子加速器施設（KOMAC）、研究用原子炉（HANARO）を運営
- KOMAC（慶州市）
  - ピークビーム電流20 mA
  - ビームエネルギー20 MeV、100 MeV
  - 半導体、宇宙、医療、バイオ、原子力、基礎科学などへの活用実績
- HANARO（大田市）
  - 出力30 MW
  - 重水型の原子炉で19本のビームラインがあり、年間200日の運転
  - 中性子科学、RI製造、原子炉応用材料試験、中性子放射化分析、中性子ラジオグラフィーなどの分野において重要な役割を果たしている

Korea-4GSR　韓国　清洲市

4th Generation Synchrotron Radiation

- 第4世代の4 GeV放射光施設
- 韓国基礎科学支援研究院（KBSI）が浦項加速器研究所（PAL）の設計により2024年10月に建設を開始。2030年運転開始予定。当初は10本のビームラインで運用を開始する。
- 周長800m、58 pm-radの低エミッタンスの設計

Overview and Future of J-PARC

- Japan Proton Accelerator Research Complex -

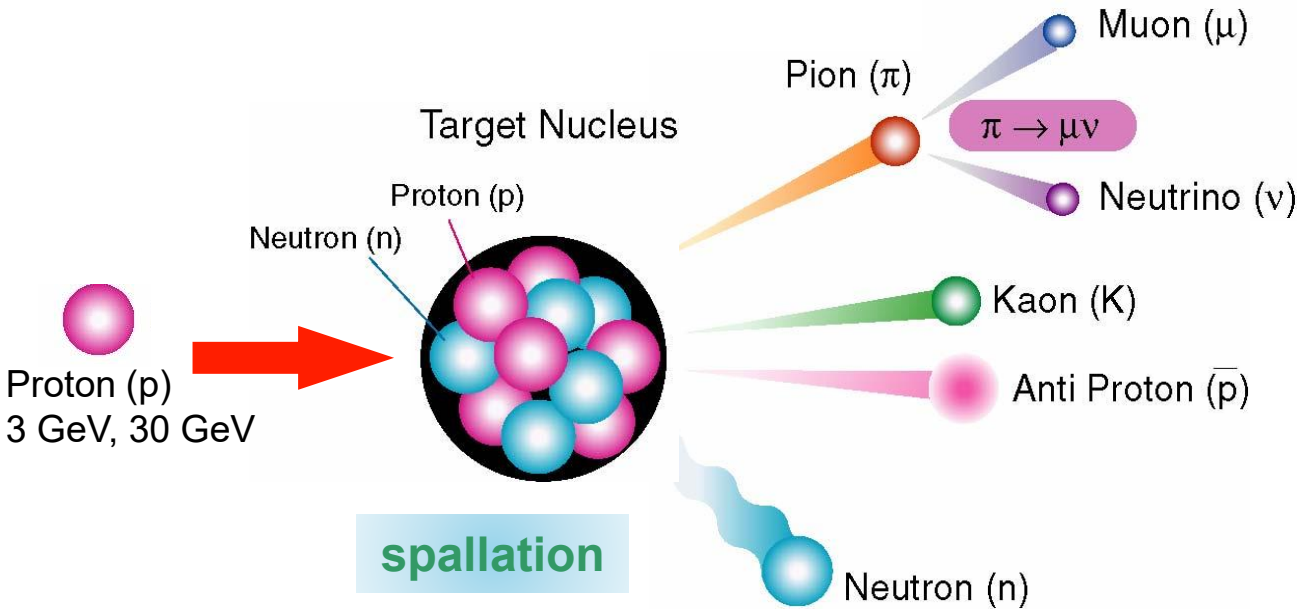
September 18, 2025

Takeshi Kobayashi, Director

J-PARC Center, KEK/JAEA

Japan Proton Accelerator Research Complex

Intensity-Frontier accelerators and multi-purpose user facilities

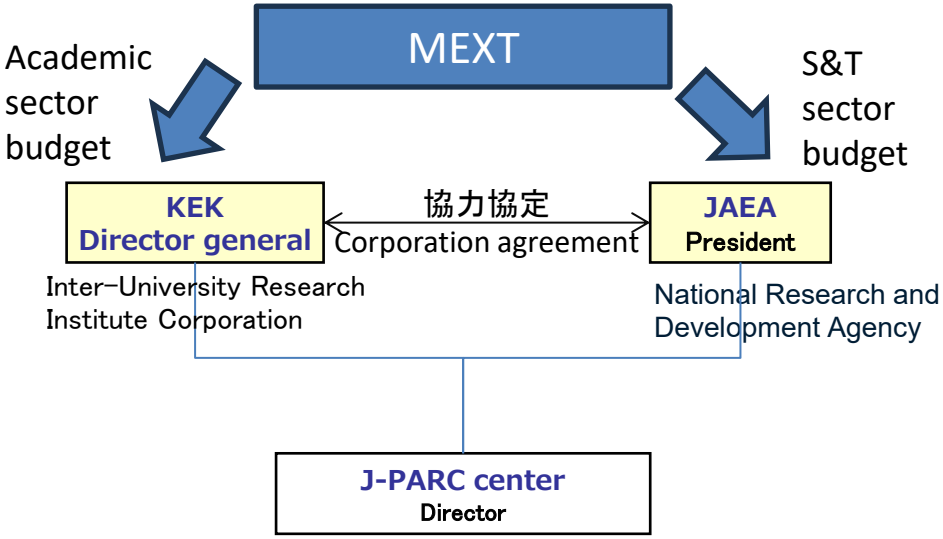


- ✓ World-leading **high precision/sensitivity experiments** with world-leading **high intensity beams** on wide variety of fields
- ✓ Open for domestic/international users, including industry

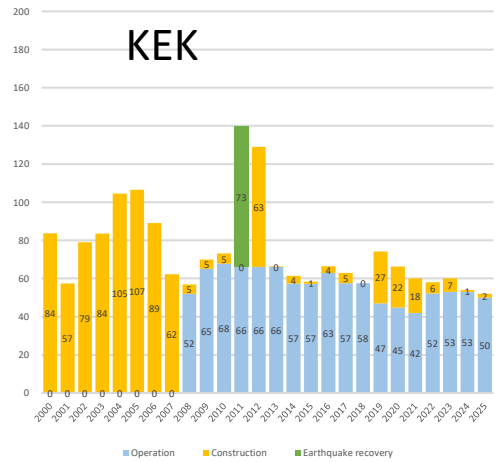
Versatile Quantum Beams for Microscopic World

J-PARC

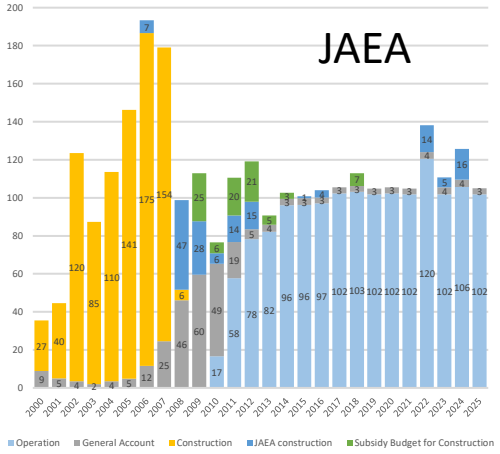
- One of the symbols of the integration of the former S&T Agency and the former Ministry of Education (2001) by combining budgets for S&T and academic ones
- Constructed jointly by
  - High Energy Accelerator Research Organization (**KEK**) and
  - Japan Atomic Energy Agency (**JAEA**)
  - construction from 2001 to 2007
  - Started operation from 2007
  - construction cost: ¥152.4B
- Operated by J-PARC Center
  - J-PARC Center is joint organization of KEK and JAEA
  - ~600 staff
  - **~ 3,000-person·day** users / month *(before COVIT-19 pandemic)*



Oku-yen

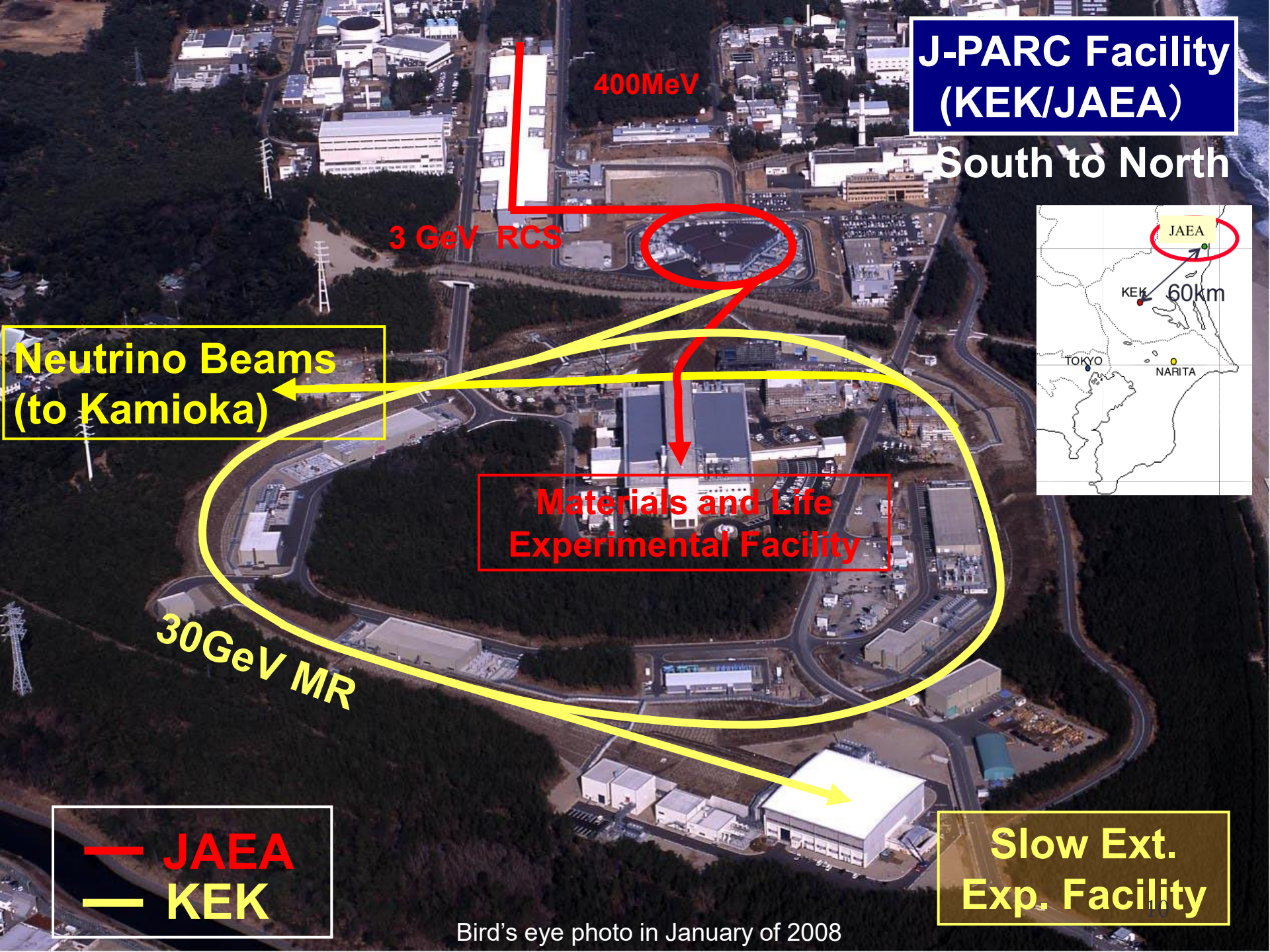


Oku-yen



Electricity cost > 50%

1 oku-yen = 1M$ (if 100yen=1$) = 0.68M$ now



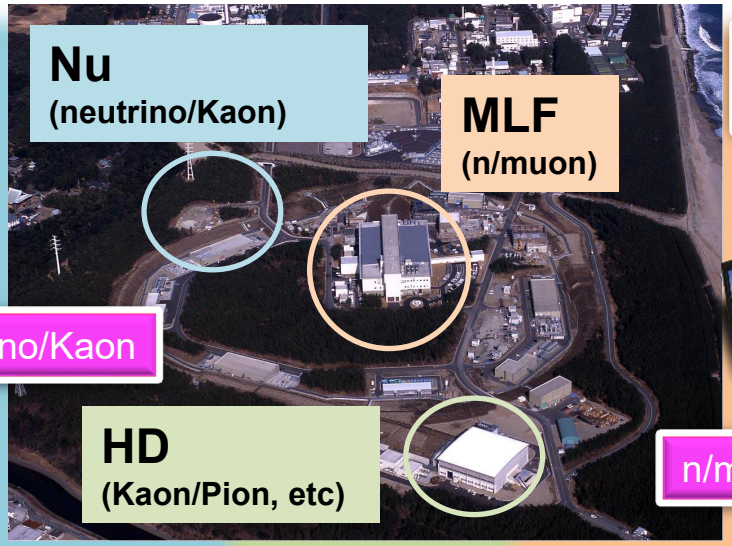
Bird's eye photo in January of 2008

Mysteries of matter and universe explored at J-PARC

Origin of matter

Nu
(neutrino/Kaon)

MLF
(n/muon)



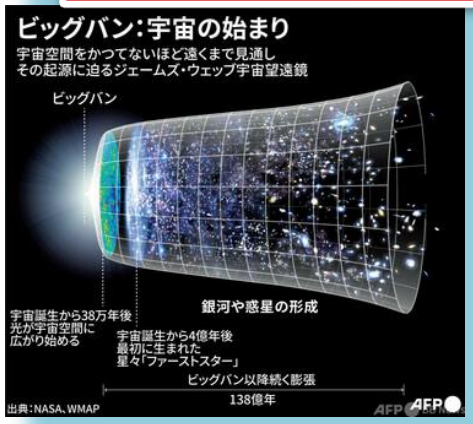
Neutrino/Kaon

HD
(Kaon/Pion, etc)

Li/Solar batteries, Tires, Memories

n/muon

How universe started?



Fuel sell

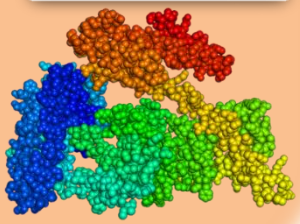
Solar system?

Space, auto drive, etc

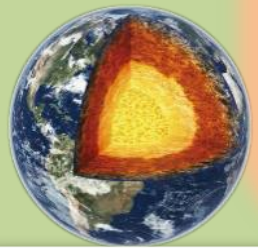
Neutron star?

Soft error

Life science



Kaon, Pion, etc



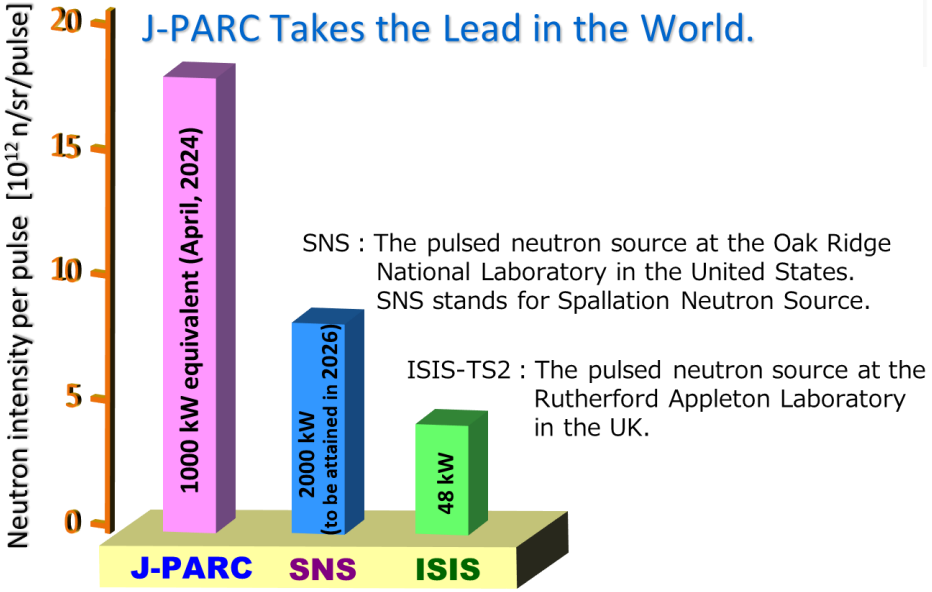
Deep interior of earth

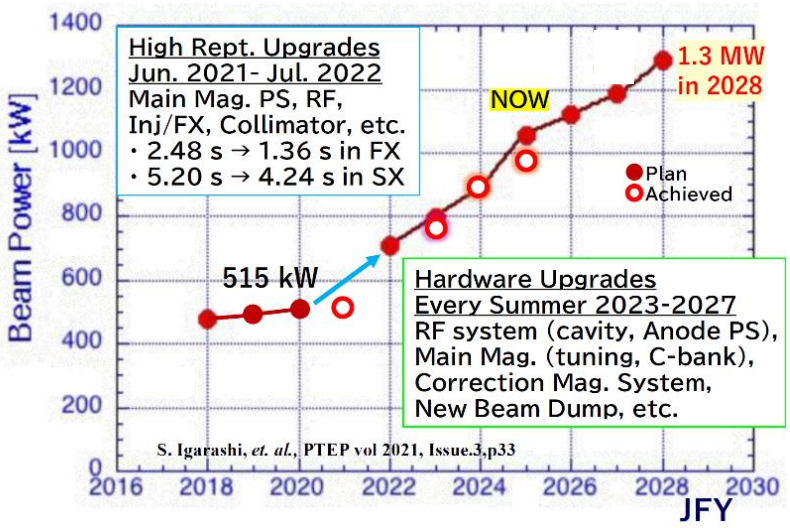
Accelerator development at J-PARC

MLF Neutron beam

- **The World's Most Powerful Pulsed Neutron Source at J-PARC MLF**
  - "continuous operation with a proton beam power equivalent to 1,000 kW" starting from April 8, 2024

LINAC & RCS





Beam for Neutrino (FX)

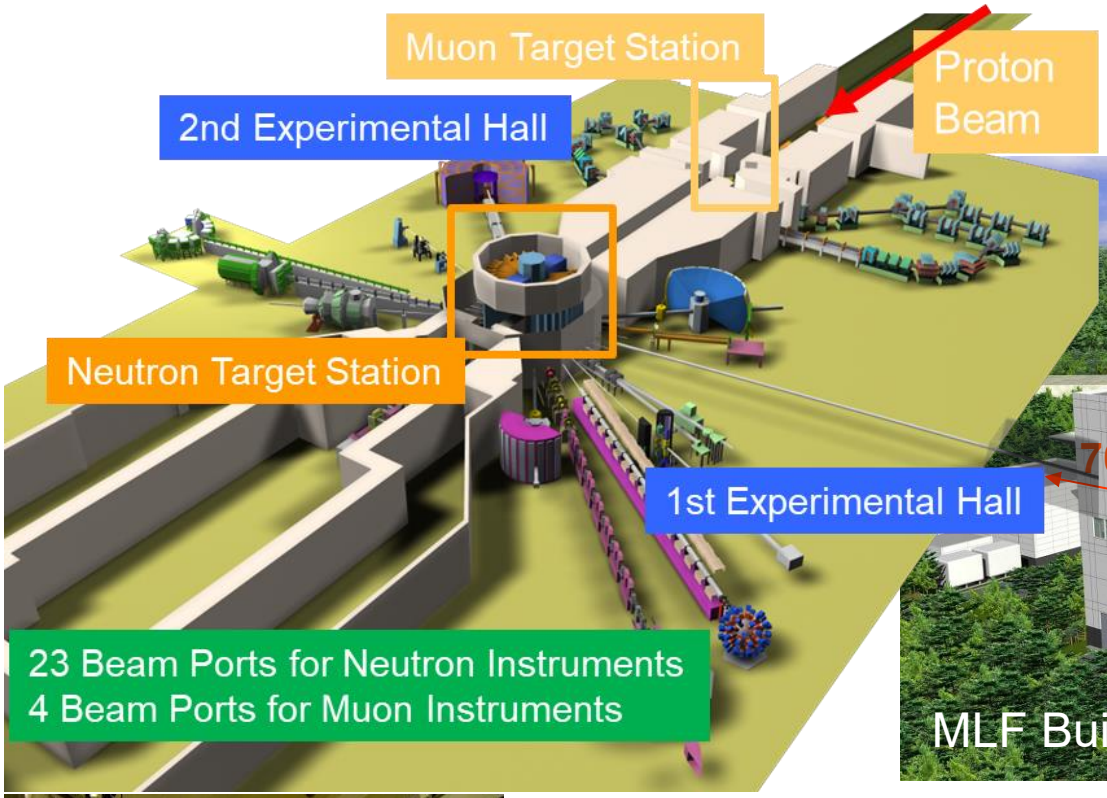
- 830 kW stable operation
- 954 kW equivalent single shot acceleration

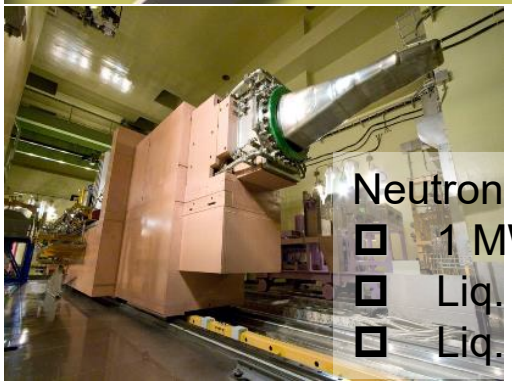
Beam for HD (SX)

- 90 kW stable operation
  - SX > 8x10^{13}ppp World record!
- 100 kW equivalent extraction succeeded

LINAC, RCS & MR

Materials & Life Science Facility (MLF)



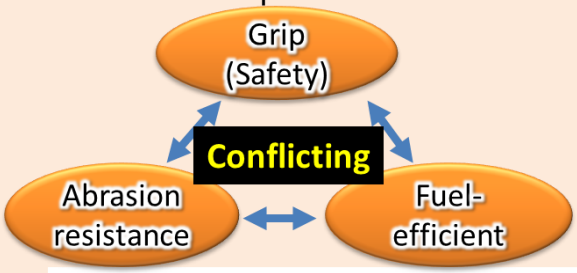


Neutron Source:
- 1 MW
- Liq. Mercury Target
- Liq. H_2 Moderators

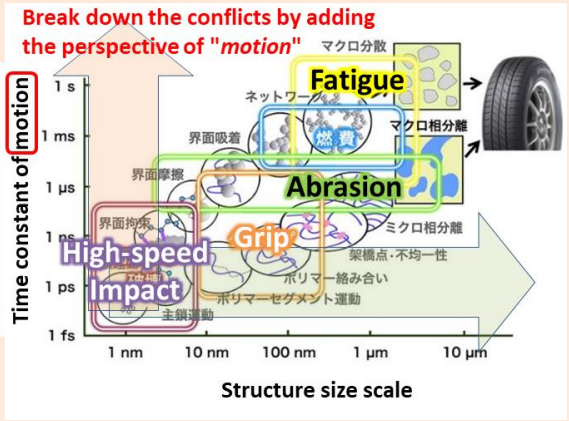
Highlights of Neutron and Muon Utilization

Tires:

Performance improvement

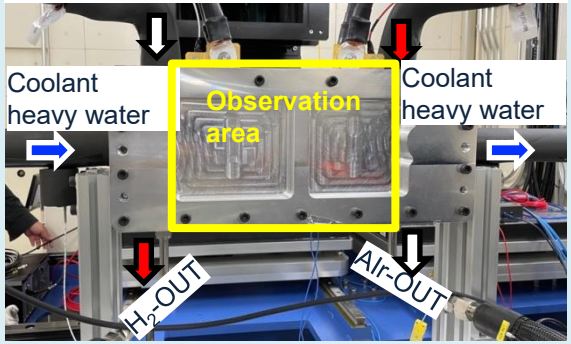


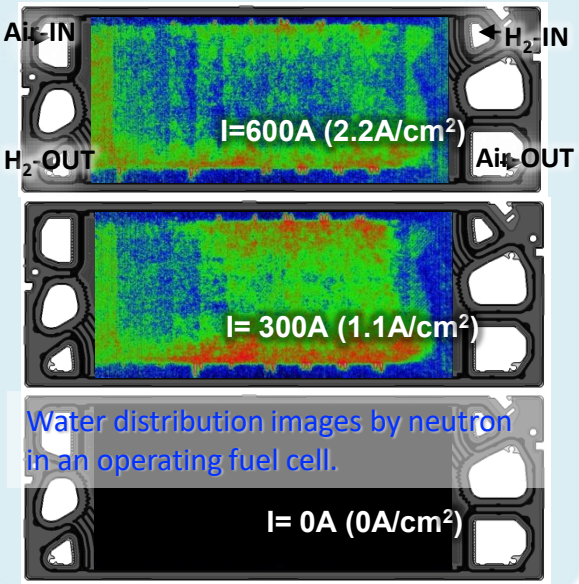
Three major performances of tire rubber
-- Big dilemma ! --



Fuel Cell for Automobiles:

Performance improvement

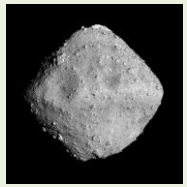


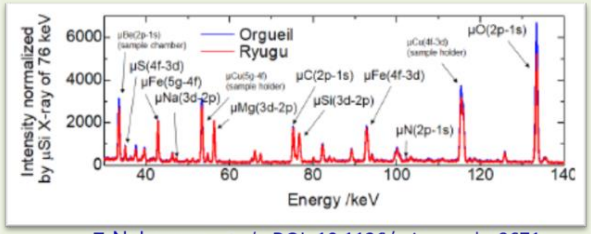


Water distribution images by neutron in an operating fuel cell.

Non-destructive elemental analysis:

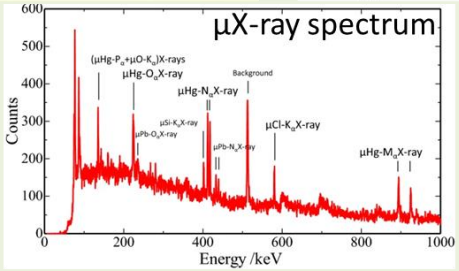
Asteroid samples taken by *Asteroid explorer "Hayabusa2"*





T. Nakamura *et al.*, DOI : 10.1126/science.abn8671

Materials in Edo period's medicine bottle that cannot be opened



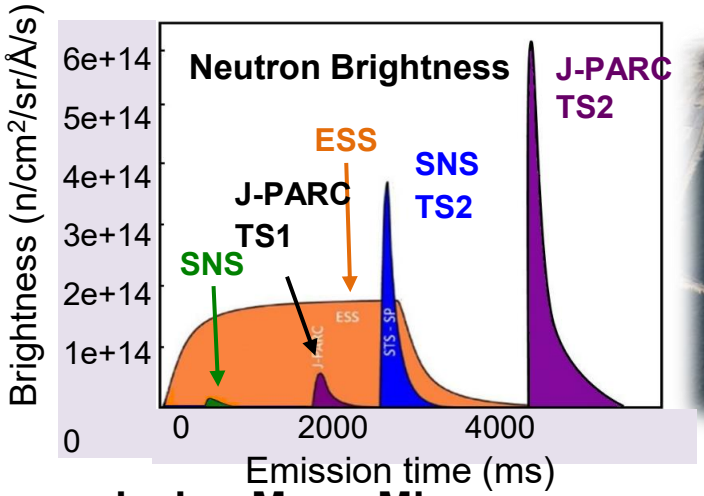
Loadmap of MLF

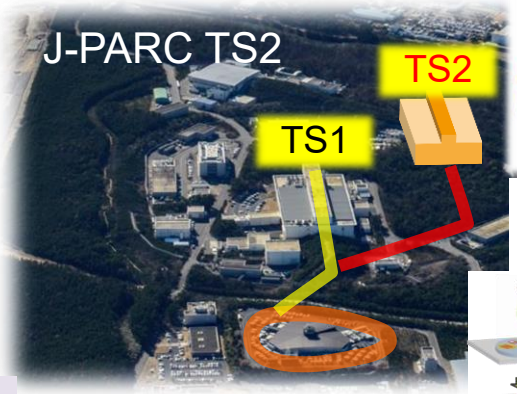
Present MLF (TS1)

- 1 MW neutron utilization
- Muon beam utilization

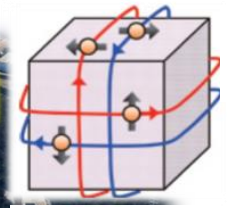
Future (TS1 & 2)

- Neutron x 20
- Muon x 50~100

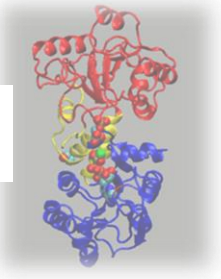




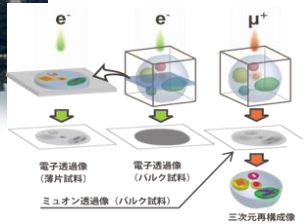
Science



Quantum Material
Topological Material



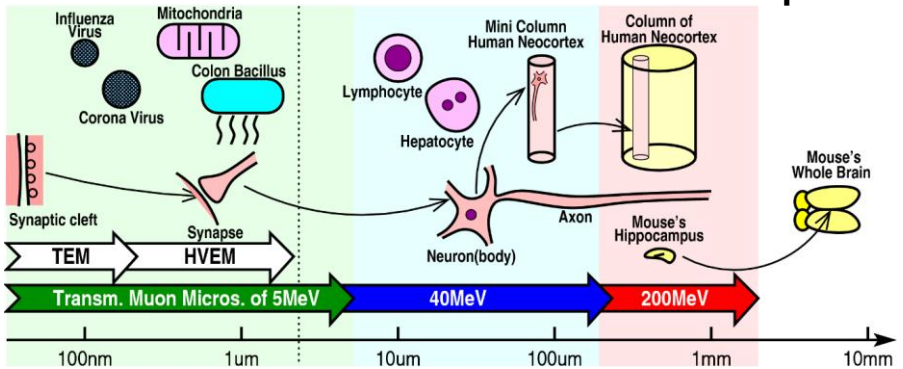
Dynamics of
Soft matter



Life cell imaging

Transmission Muon Microscope

Accelerated Muon : Strong Penetration + Ultraslow Muon : High Luminance / Resolution



Particle and Nuclear Physics at J-PARC

Origin & Evolution of Matter

Matter-Antimatter Symmetry

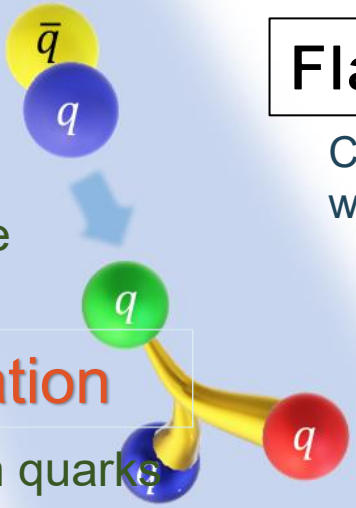
matter dominated universe

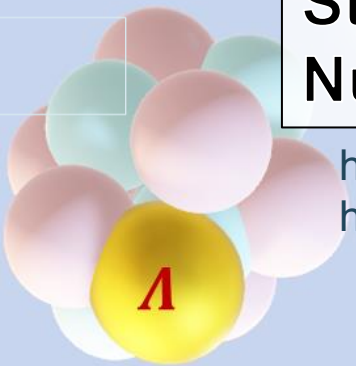
Origin of Matter Creation

formation of hadrons from quarks

Matter in Extreme Conditions

dense matter in neutron stars





Flavor Physics

CP violation
weak interaction
-> new physics

Kaon rare decays
μ→e conversion

Hadron Physics

quark interactions
hadron mass-generation mechanism

Hadron spectroscopy
Meson in nuclei

Strangeness Nuclear Physics

hadron interactions
hadronic many-body systems

Hyperon-Nucleon scattering
Hypernuclear spectroscopy

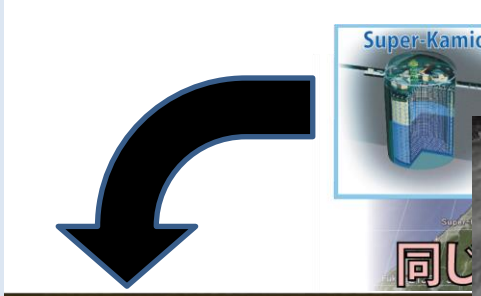
Particle and Nuclear Physics at J-PARC

Particle and Nuclear Physics at J-PARC

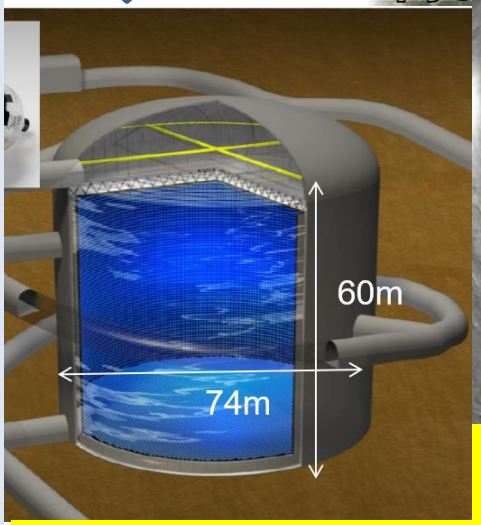
Neutrino experiments

T2K (Tokai-to-Kamioka) and Hyper-Kamiokande

- Explore the mystery of origin of matter in the universe
- Mater vs Anti-matter asymmetry (CP assym) in neutrino (unknown) may have key to solve the mystery
- T2K (2010~)
  - Send neutrino 295km J-PARC → Super-Kamiokande (22.5kt)
  - **Observe "hint" of the CP asym. at 90% CL!**
- Next project: Hyper-Kamiokande
  - 190kton (SK x 8.4)
  - Construction started in 2020
  - Big cavern excavation completed in July 2025!
  - **Data taking will start 2028!**



T2K(2010~)



Hyper-Kamiokande(2028~

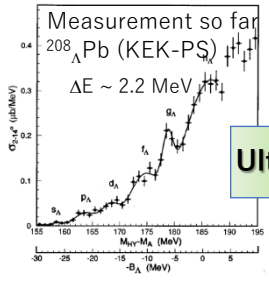
Cavern construction completed!

22 countries, 103 institutes, ~630 people as of July 2025

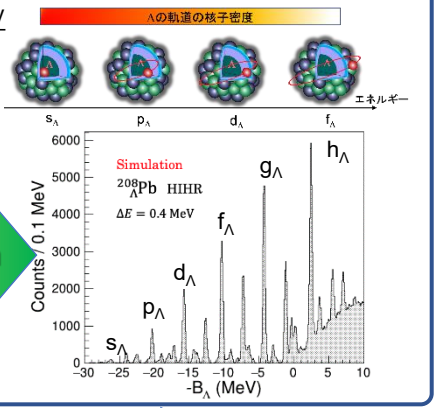
Hadron Experimental Facility Extension (HEF-ex) project

Elucidation of **YN interaction in nuclear matter**

First high-resolution spectroscopy of the heaviest Λ hypernucleus



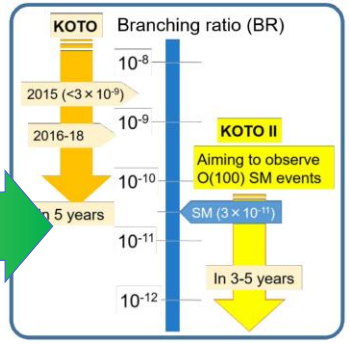
Ultra high-resolution

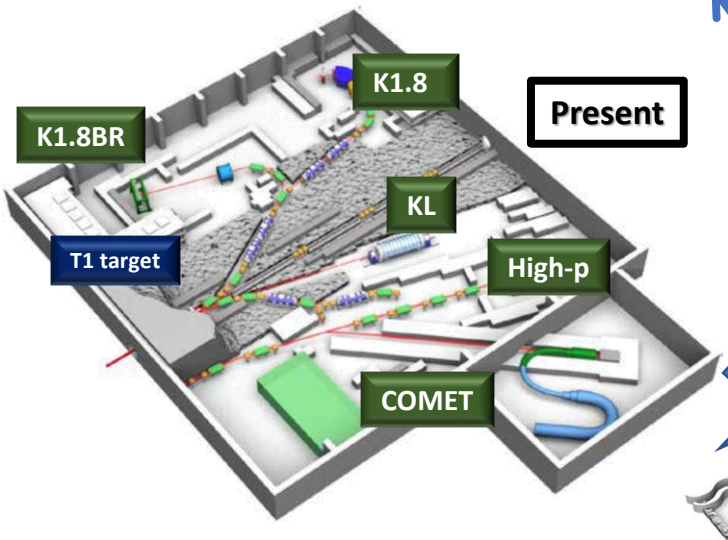


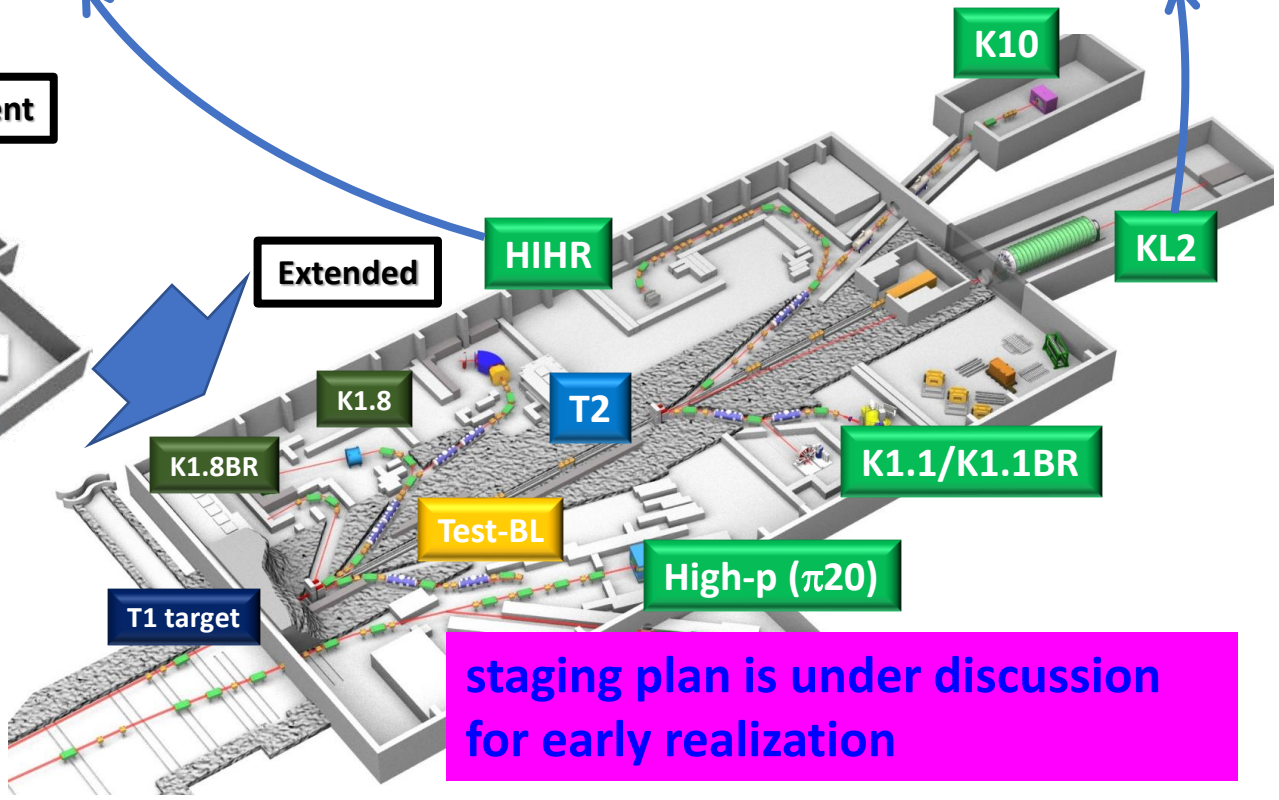
Directly breaking CP symmetry in $K_L^0 \to \pi^0\nu\bar{\nu}$ rare decay

Exploring new physics with 100 times more sensitivity than KOTO

Sensitivity beyond the SM





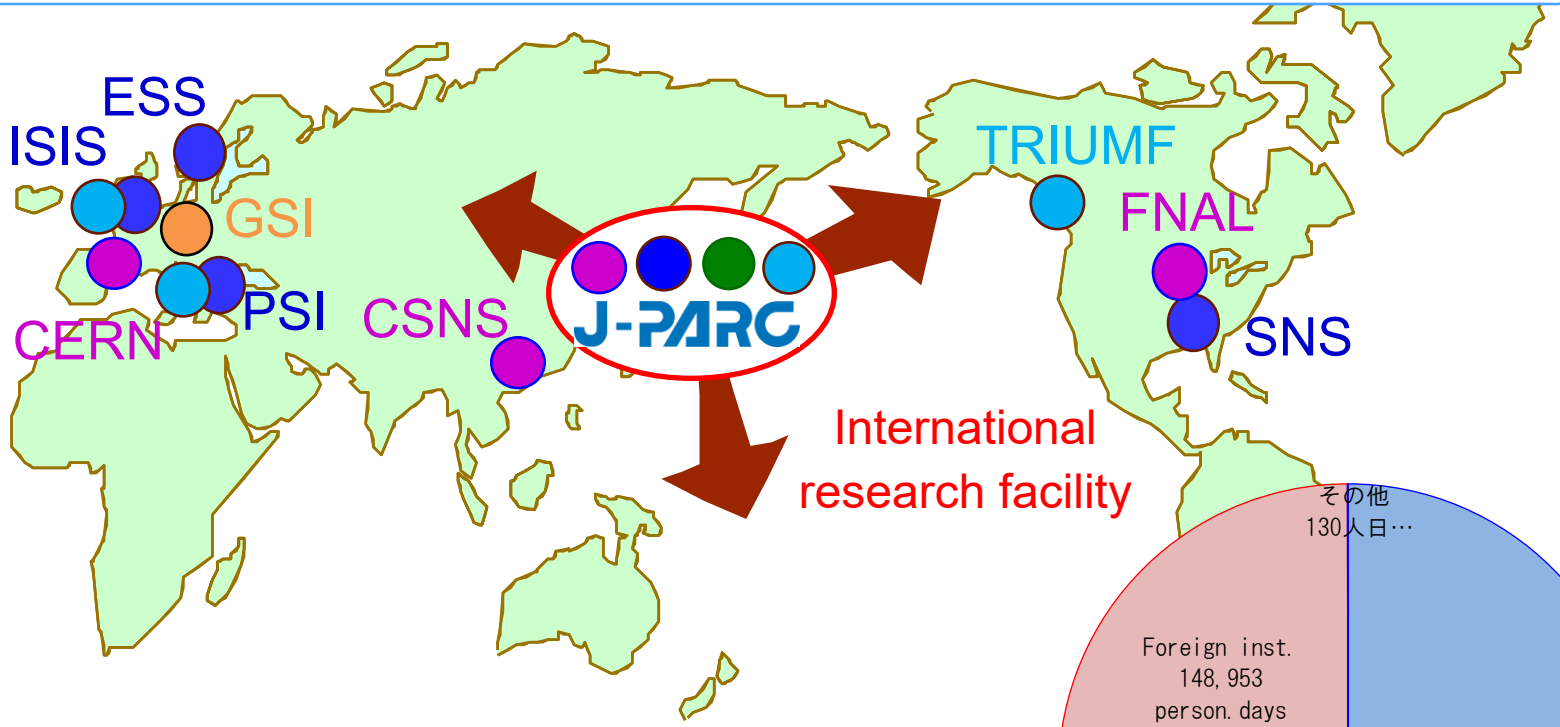


- +1 new production target (T2)
- +4 new beamlines
  (HIHR, K1.1/K1.1BR, KL2, K10)
- +2 updated beamlines
  (High-p (π20), Test-BL)

staging plan is under discussion for early realization

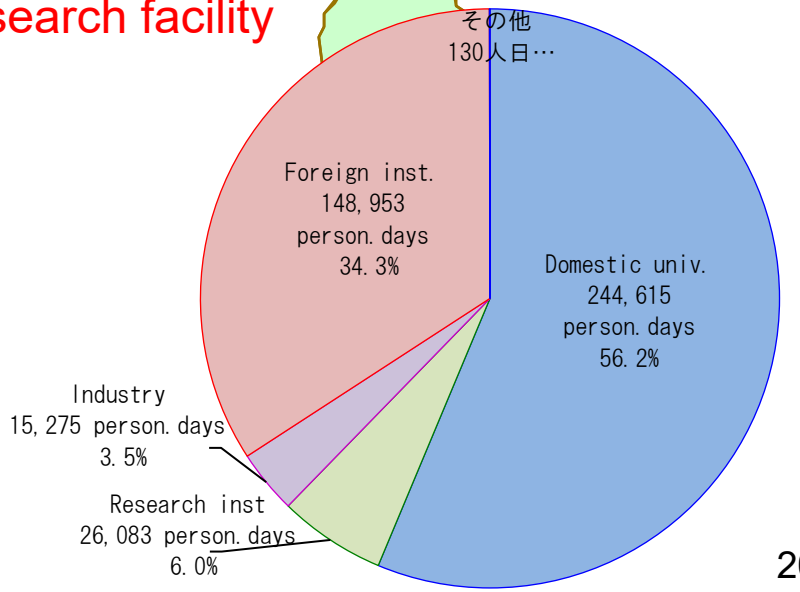
J-PARC as a global research center

- Materials and Life Science: one of three world centers, especially in Asia
- Hadron physics: unique kaon factory in the world
- Neutrino physics: world leader among the three world centers



Open for users

- ~ 30,000 person.days/year users
- >430,000 person.days since 2008



Summary

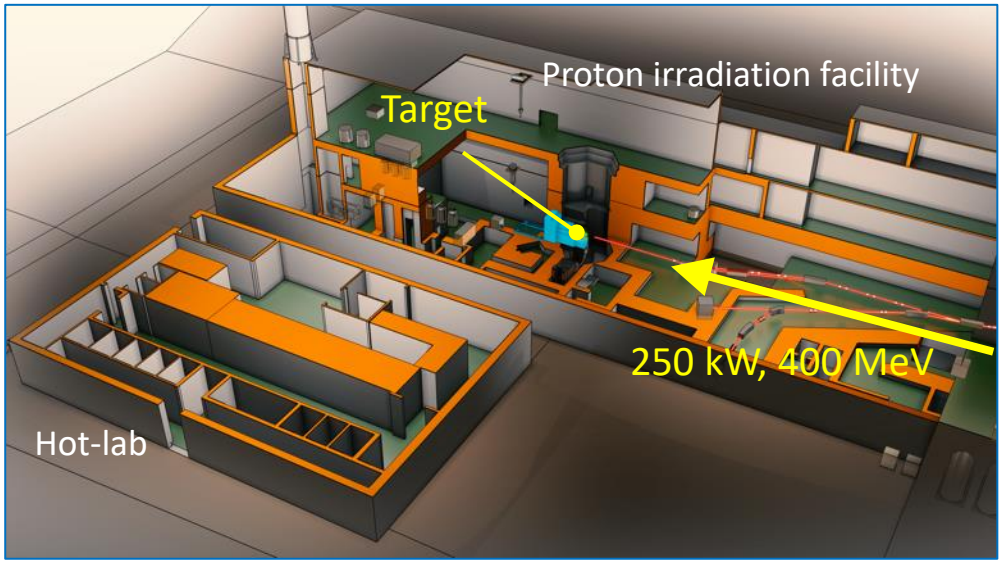
- J-PARC is world intensity frontier proton accelerator complex to generate variety of secondary particles for wide variety of research fields
  - materials science, life science, industrial applications with neutron and muon beams in “Materials & Life Science Experimental Facility”
  - Particle and nuclear physics with neutrino, K mesons, pions, muons ···· at “Neutrino Facility” and “Hadron Experimental Facility”
- Future projects
  - MLF second target station (TS2), which aims to provide opportunities for neutron utilization to more researchers and engineers based on the cutting-edge technogies and high efficient detectors.
  - Upgrade of the Hadron experimental hall to challenge unexploded material origin and investigate the evolution of matter.
  - Constructing next generation neutrino experiment “Hyper-Kamiokande” to start operation in 2028!
- J-PARC plays important roles in global research center and continues to run the science & technology frontier.

まとめ

- 会議のMinutesは次回までにCirculate,承認
- “chair”による口頭のまとめの聞き取り(国際政策課ご協力)
  - 今後のGSO会議での議論を促進するため、研究インフラエコシステムに関する背景情報を準備(整理)する。
  - 今後の議論に役立てるため、研究インフラエコシステムに関連する事例やケーススタディについてメンバーから意見を求める。
  - 次回GSO会合の前に、中間会議を開始し、研究インフラエコシステムのトピックについて更に議論する可能性を検討する。
- 次回は、2026/11/30@ローマ

Backup slides

Multi-purpose irradiation facility



- Developing design of proton beam irradiation facility for multi-purpose usage

1. Material irradiation test for
   - high-intensity accelerator facilities including accelerator-driven nuclear transmutation (ADS)
   - Fusion/fission reactors
2. Soft-error testing for semi-conductor devices
3. RI production for medical application etc
4. Proton beam use for experiments