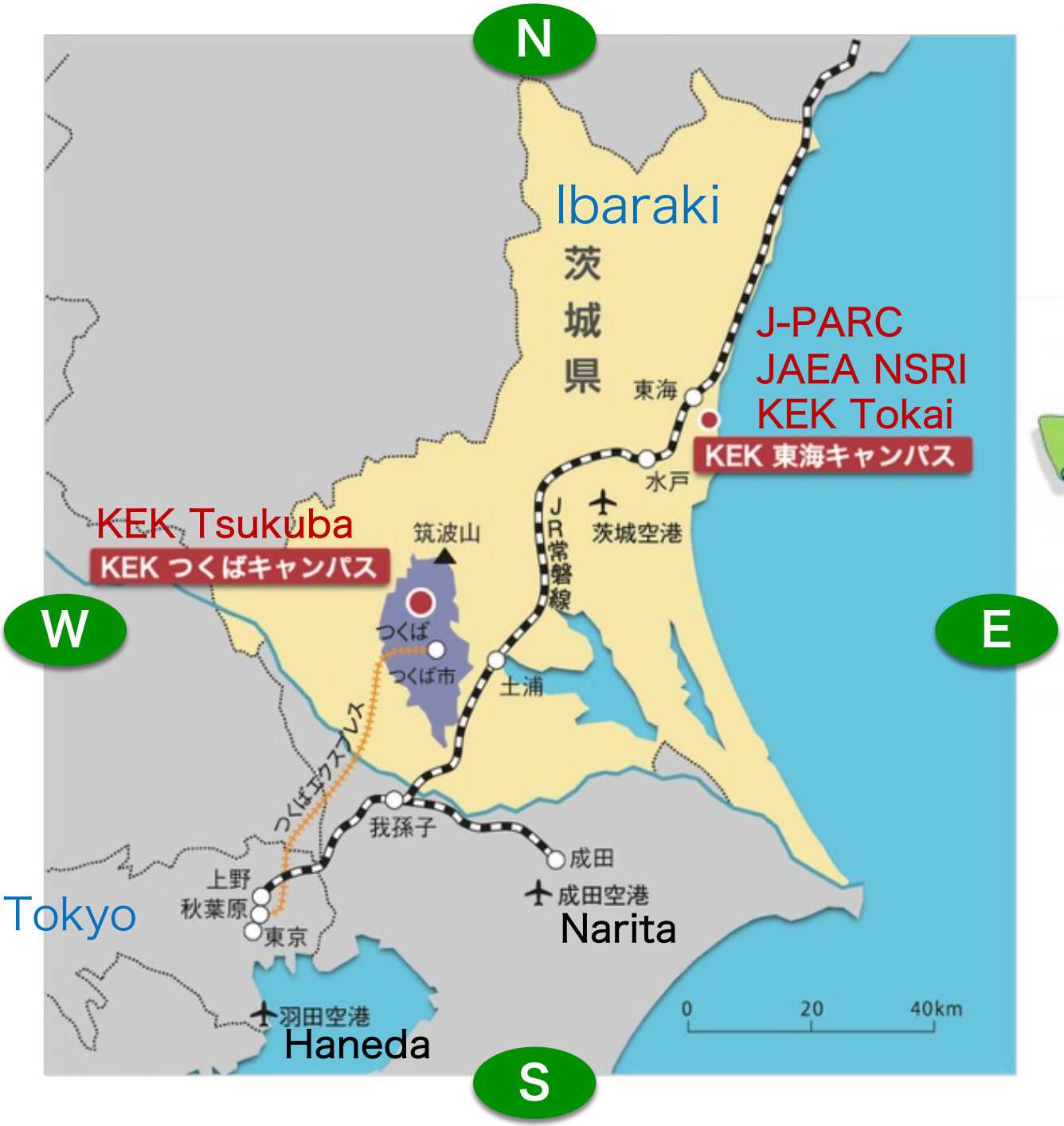
Welcome Address from J-PARC

Takeshi K. Komatsubara 小松原 健

J-PARC Center

High Energy Accelerator Research Organization (KEK)
and Japan Atomic Energy Agency (JAEA)

August 27th, 2025 MTCA workshop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J-PARC
JAEA NSRI
KEK Tokai
KEK 東海キャンパス
東海
水戸
茨城空港
JR常磐線
KEK Tsukuba
KEK つくばキャンパス
筑波山
つくば
つくば市
土浦
つくばエクスプレス
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JOBAN EXPWY

electron accelerators

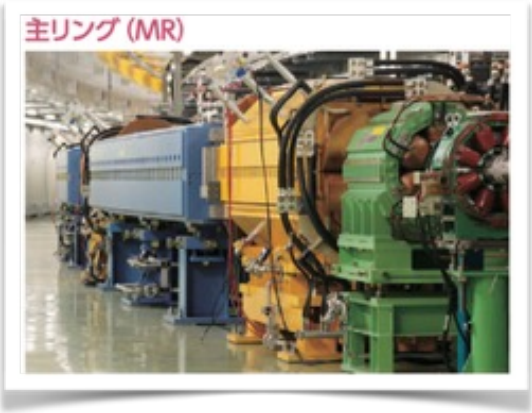
KEK Tsukuba

SuperKEKB

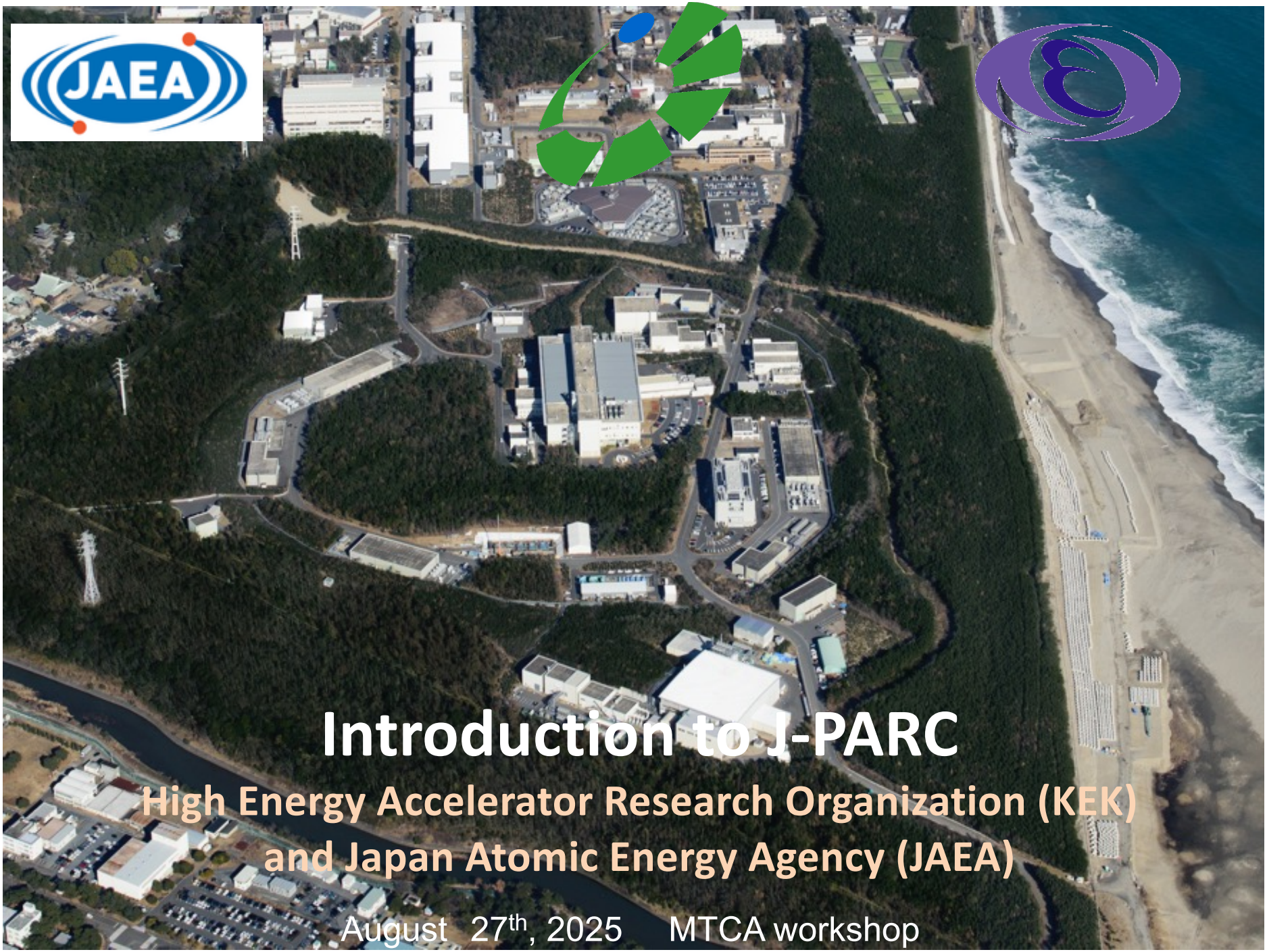
Photon Factory

proton accelerators

J-PARC
JAEA NSRI
KEK Tokai



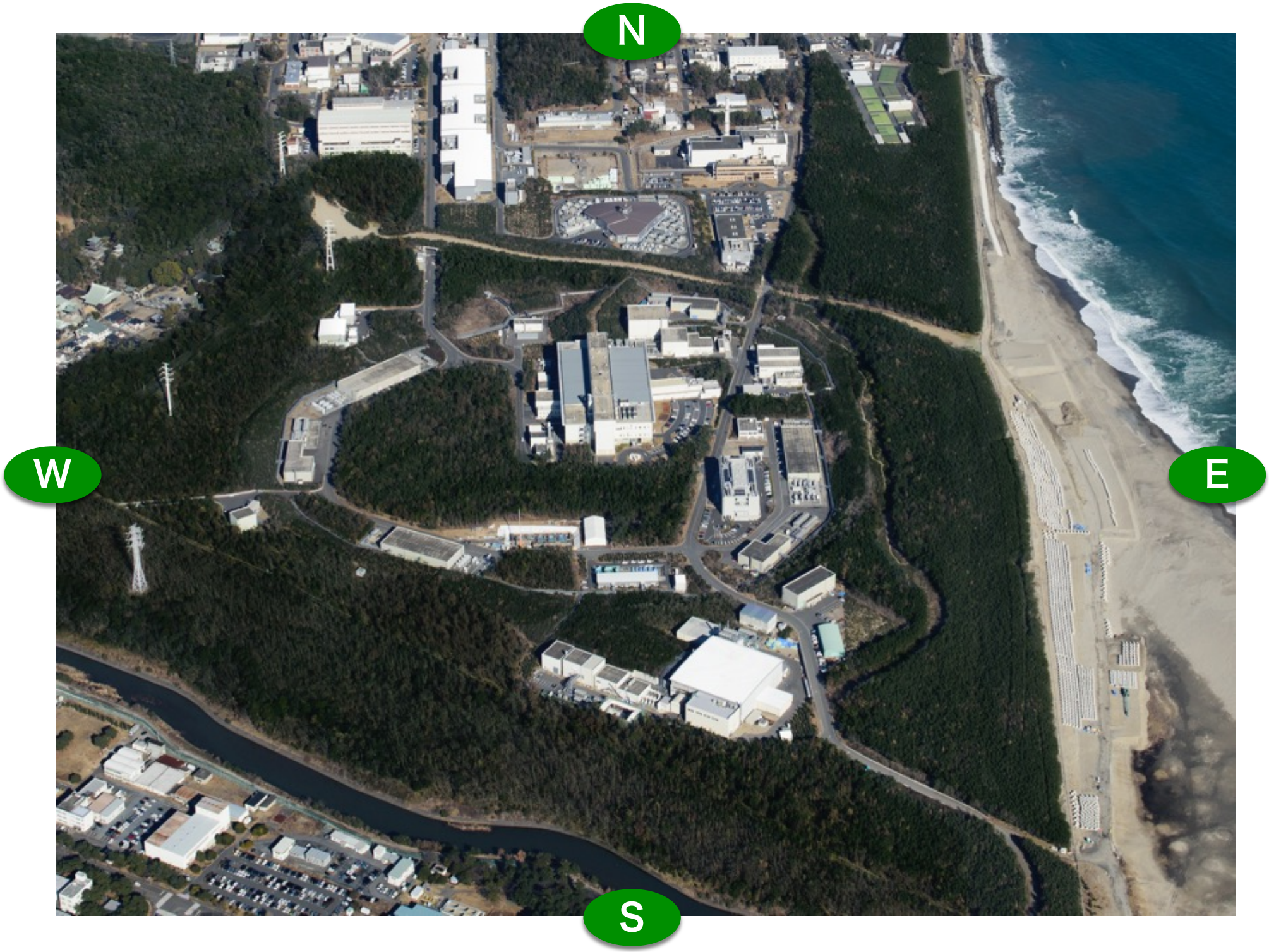
J-PARC



Introduction to J-PARC

High Energy Accelerator Research Organization (KEK)
and Japan Atomic Energy Agency (JAEA)

August 27th, 2025 MTCA workshop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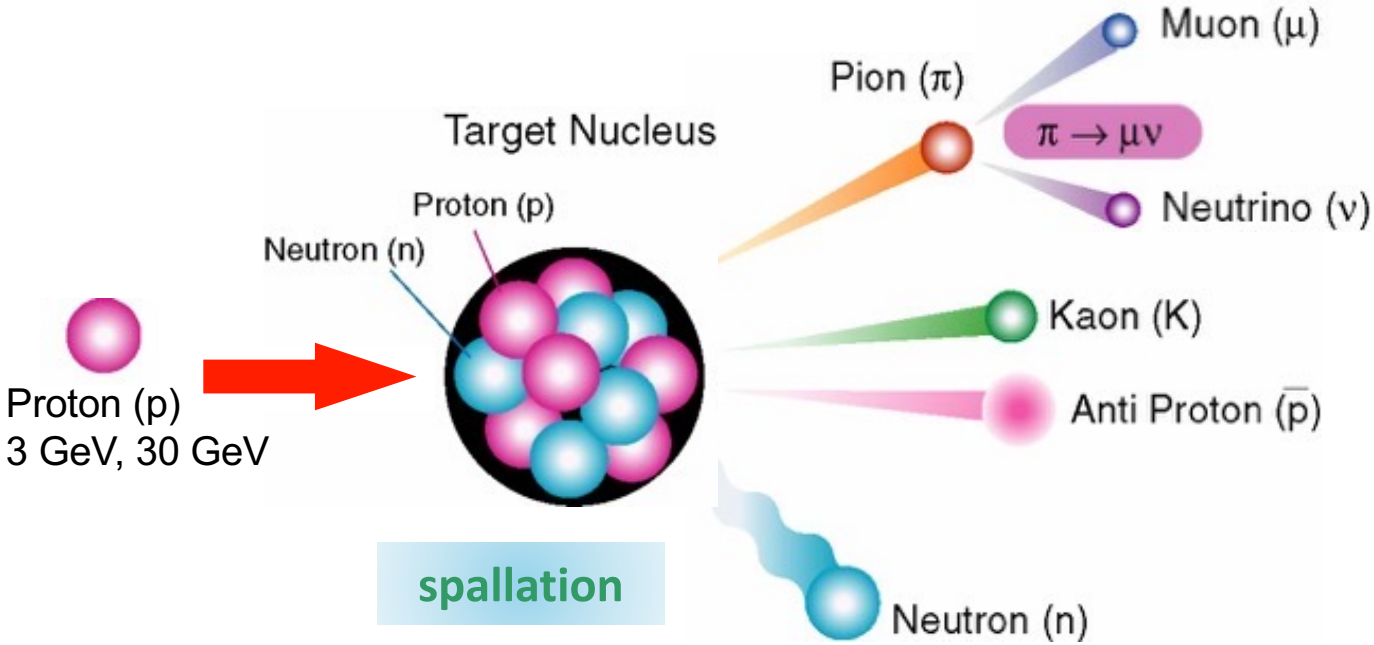
Versatile Quantum Beams for Microscopic World

J-PARC

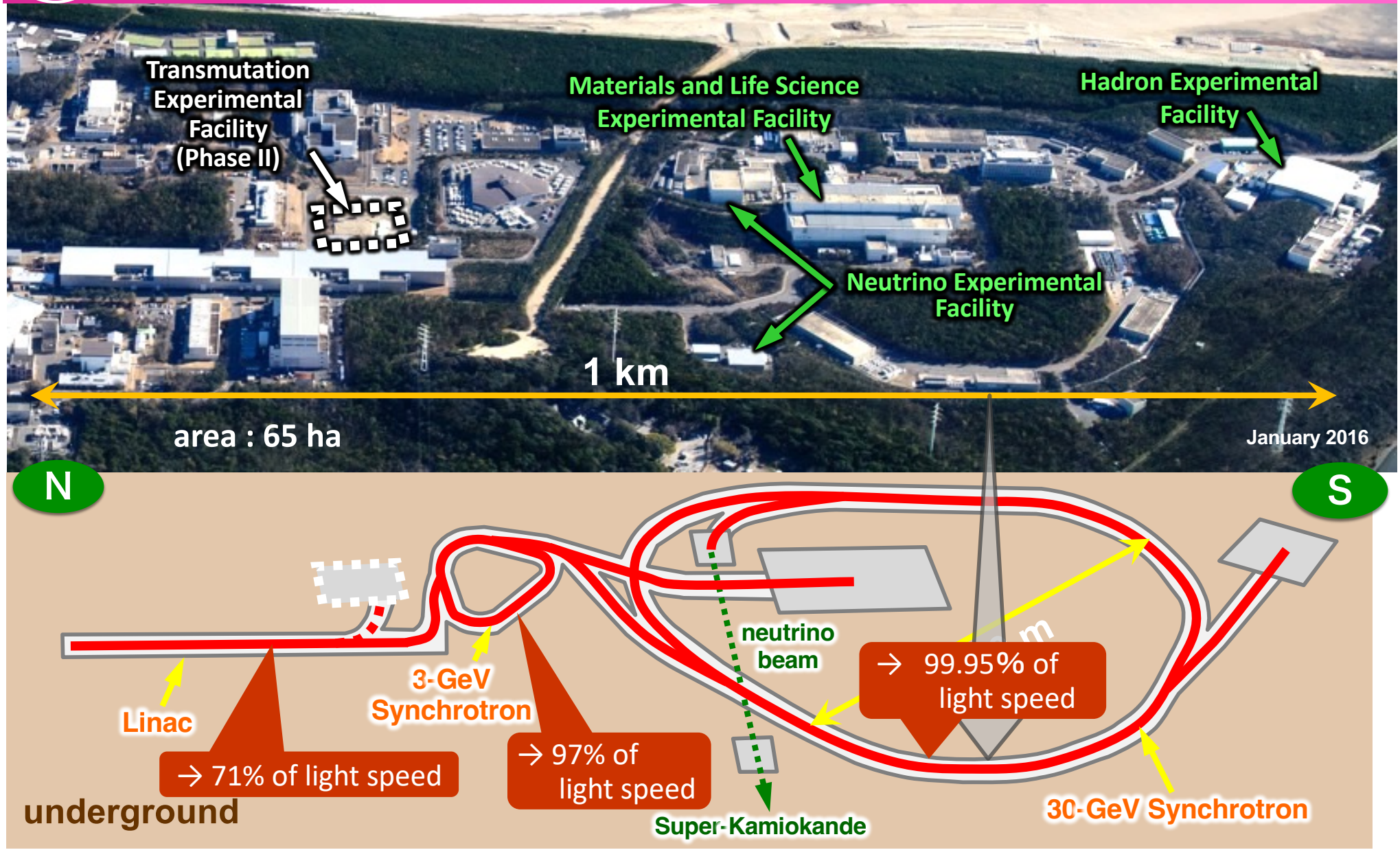
Japan Proton Accelerator Research Complex

Power-frontier accelerators and multi-purpose user facilities



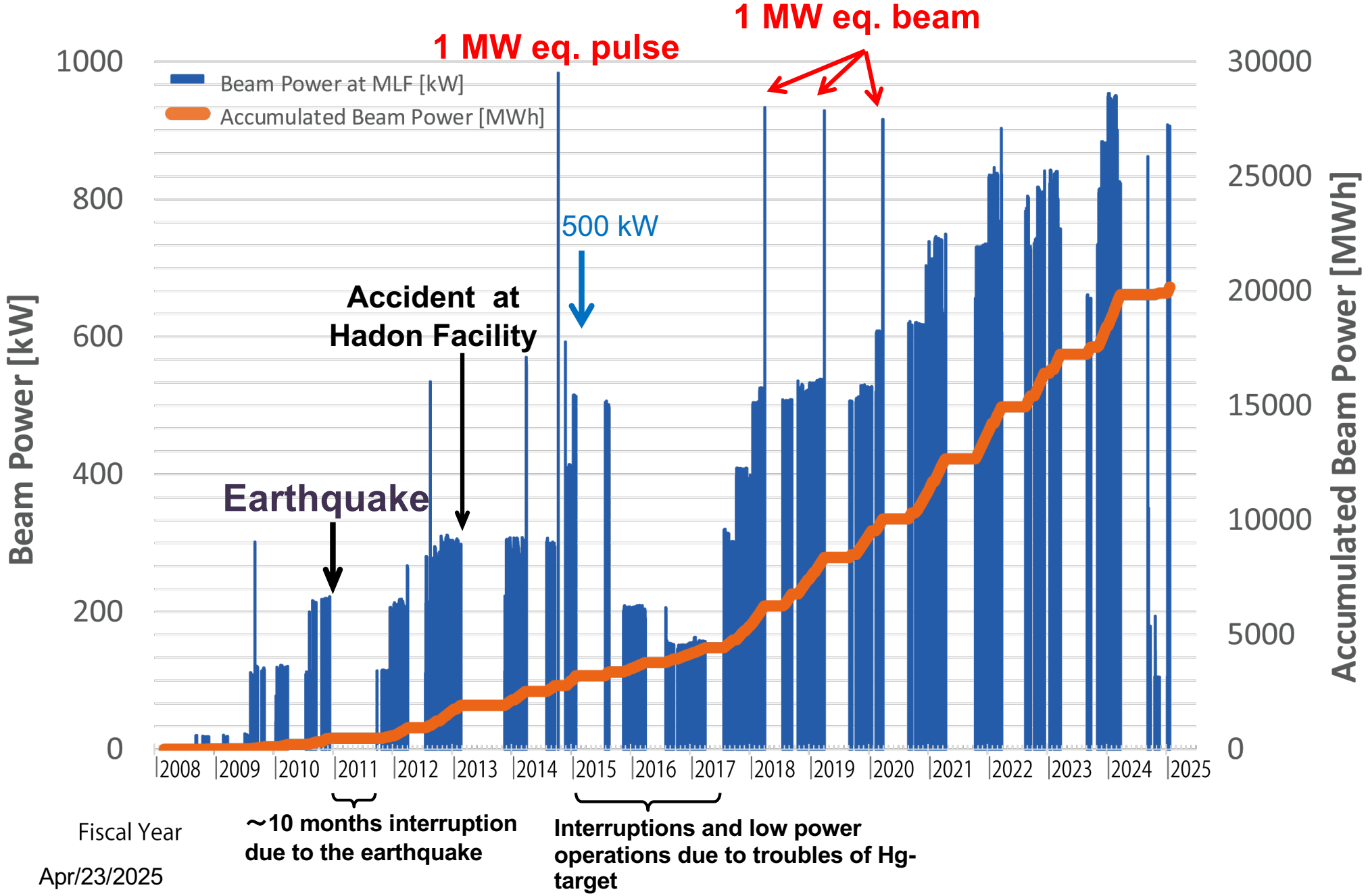
Variety of secondary particles generated with high-energy and high-intensity protons

Japan Proton Accelerator Research Complex



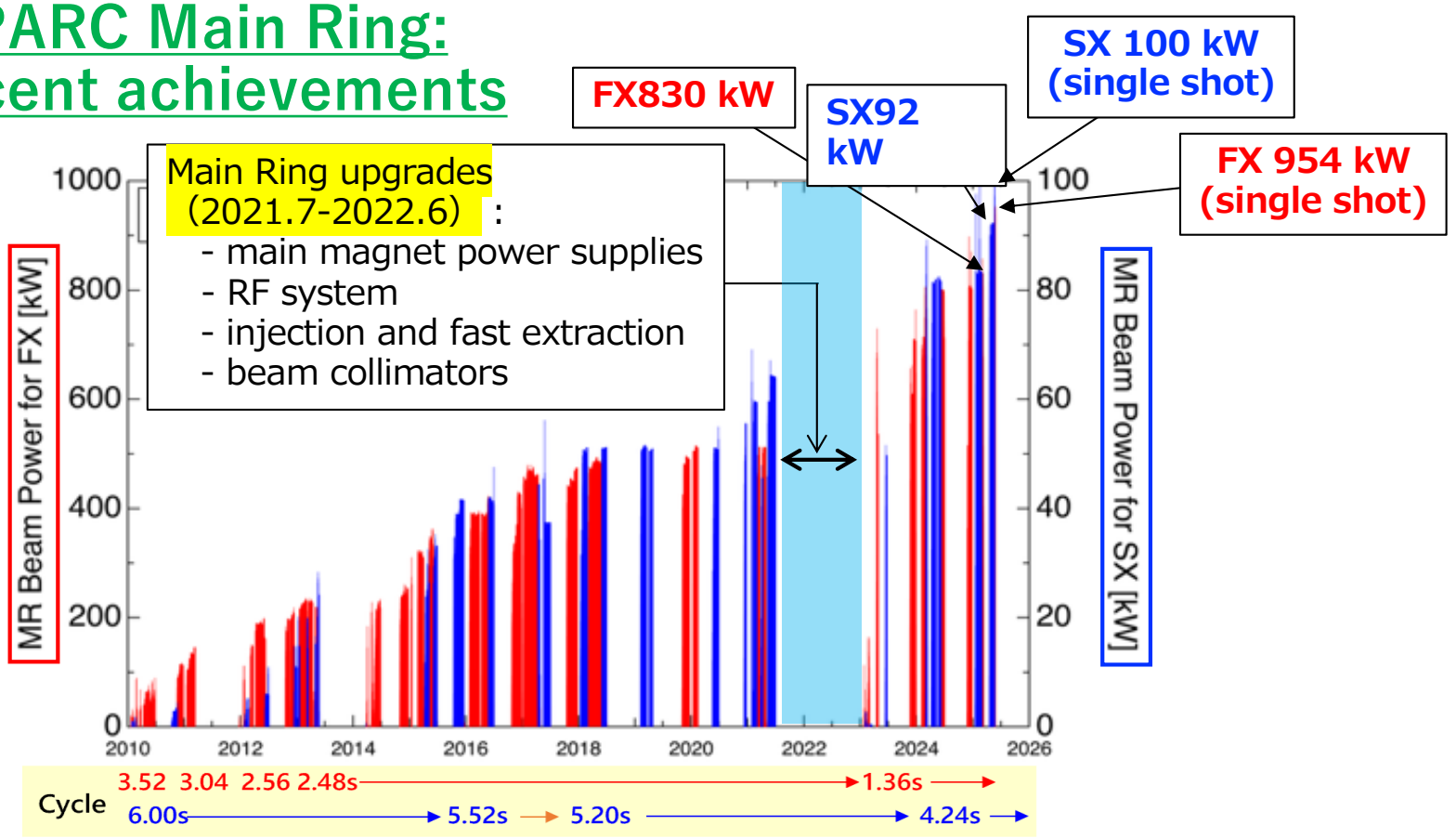
3 proton accelerators and 3 experimental facilities

Beam power history at MLF



Apr/23/2025

J-PARC Main Ring: recent achievements



Fast Extraction (FX) operation :

- JFY2023～
  - user operation with repetition cycle: 2.48sec → 1.36秒
  - 760 kW continuous operation (initial goal)
- JFY2024～
  - 830 kW user operation
- JFY2025～
  - 954 kW equivalent acceleration

Slow Extraction (SX) operation :

- JFY2024～
  - repetition cycle: 5.20sec → 4.24sec
  - 80 kW user operation
  - spill duty factor >80%
- JFY2025～
  - **92kW user operation**
    world's largest particles per spill !
  - **100kW equivalent extraction**

J-PARC Experimental Facilities

Wide range of research fields

- Materials & Life Science Experimental Facility (**MLF**)
  - neutron and muon beams
  - materials science, life science, industrial applications
- Hadron Experimental Facility
  - K mesons, π mesons, muons ····
  - nuclear physics and particle physics
- Neutrino Experimental Facility
  - muon neutrino beams
  - neutrino oscillation search with Super-Kamiokande
- Transmutation Experimental Facility (Phase II)
  - R&D for accelerator-driven nuclear transmutation with neutrons

Versatile Quantum Beams for Microscopic World

J-PARC

- Constructed jointly by
  High Energy Accelerator Research Organization (**KEK**)
  and Japan Atomic Energy Agency (**JAEA**)
  - construction from 2001 to 2007
  - beam commissioning from 2007 to 2009
  - construction cost: ¥152.4B
- Operated by J-PARC Center
  - J-PARC Center is joint organization of KEK and JAEA
  - operations for user programs from 2008
  - Currently **~160-day** operation / year for user programs
  - high beam availability (**90% – 95%**)
  - **~ 3,000-person·day** users / month *(before COVIT-19 pandemic)*

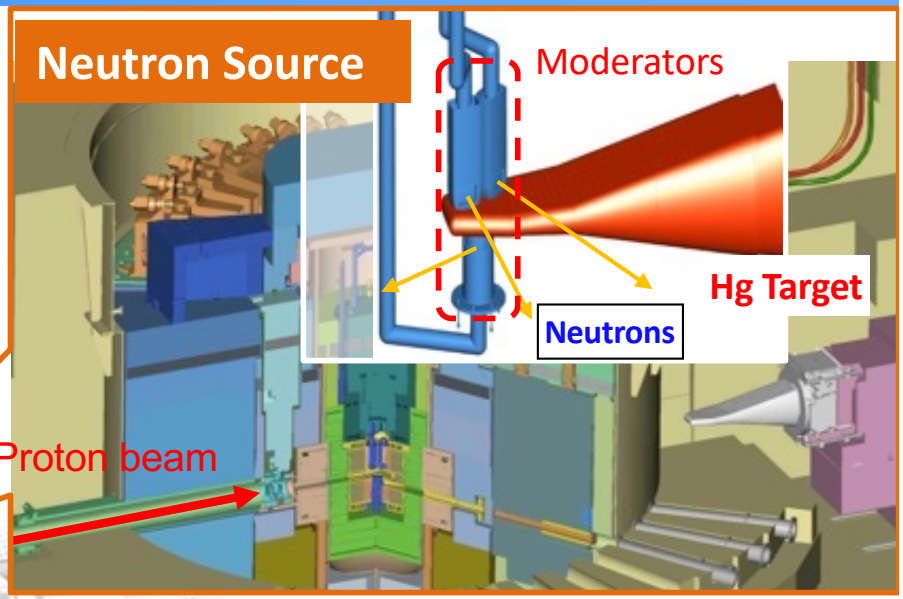
160 / 22 = 7.2 cycles

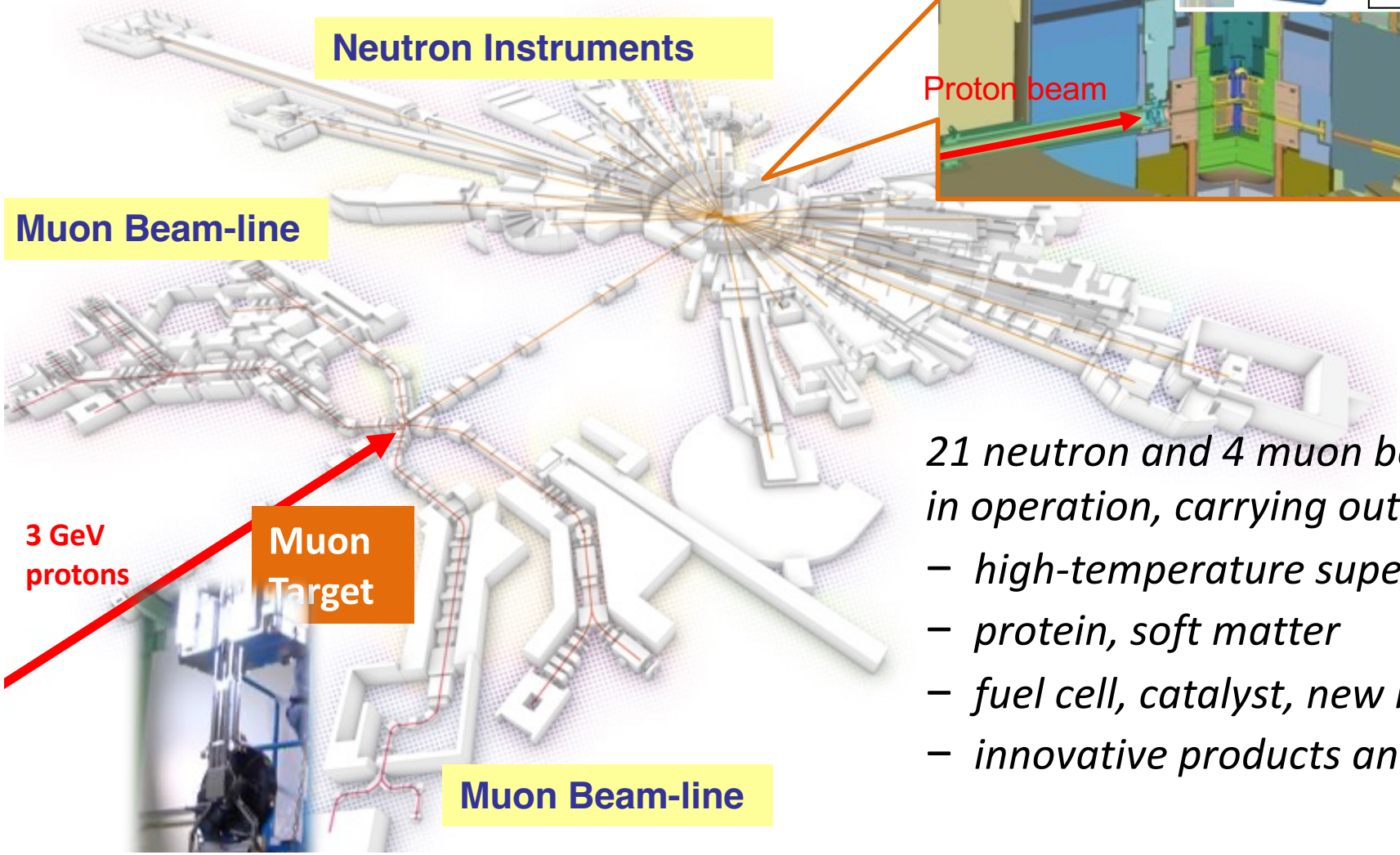
J-PARC

Materials and Life Science Experimental Facility

Materials and Life Science Experimental Facility (MLF)

- **Neutron** and **muon** beams
  - materials science, life science, industrial applications
- **most powerful** neutron and muon sources





21 neutron and 4 muon beam lines are in operation, carrying out studies of

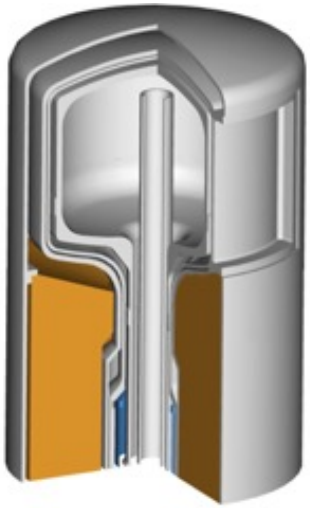
- *high-temperature superconductors*
- *protein, soft matter*
- *fuel cell, catalyst, new materials*
- *innovative products and drugs*

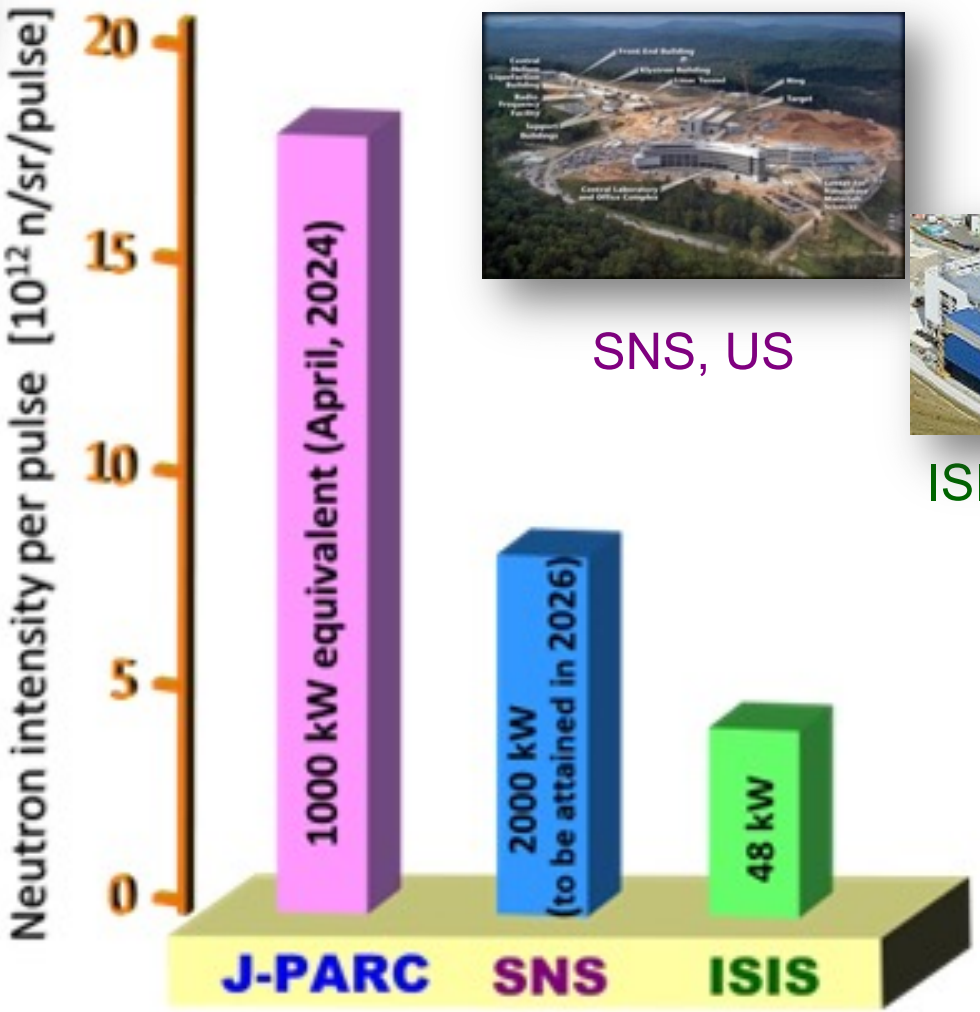
etc.

Neutron Intensity at MLF

World Highest Intensity of Neutron Pulse Beam!

Hi-performance Moderator





SNS, US

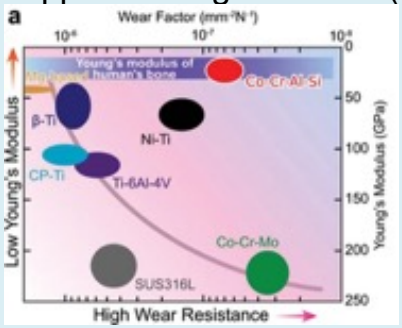
ISIS – TS2, UK

Recent Outcomes from Neutron BLs@MLF

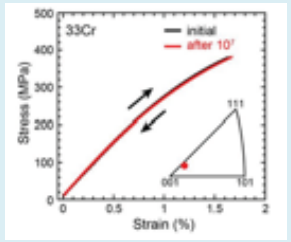
Flexible and Tough Superelastic Co-Cr Alloys for Biomedical Applications

New bio-metals simultaneously having a low Young's modulus and a high wear resistance have been developed, and to be promising candidates for biomaterials to replace or support damaged bones. (BL19, Tohoku U., JAEA , Czech Aca. Sci.)

Co-Cr-Al-Si (CCAS) alloy



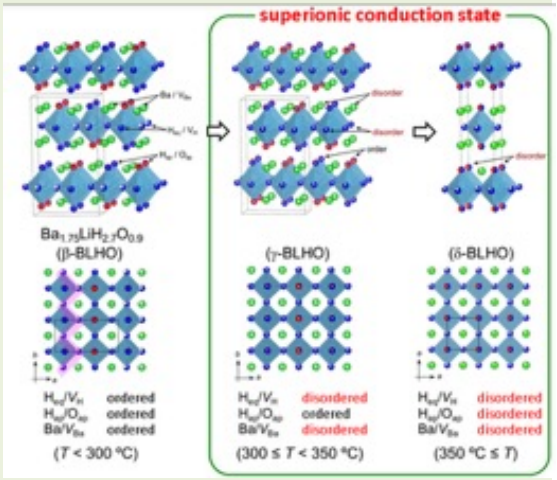
Young's modulus vs the wear factor for CCAS alloy in comparison with conventional metallic biomaterials.



The SS curves before and after the fatigue test up to 10^7 cycles.

Hydride-ion-conducting Ba–Li oxyhydride solid electrolyte

The hydride ion (H^-) has advantage for fast ion conduction by low charge density and high polarizability. A H^- conductor showing both high ion conductivity and low activation energy in mid-low temperature range (RT～400 ℃) has been developed.



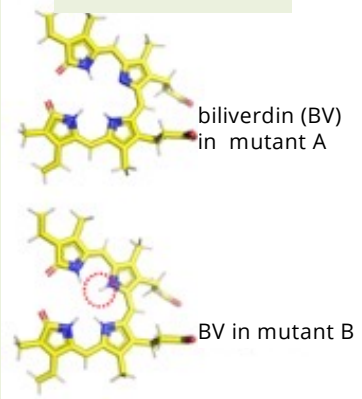
(BL09,21 Inst. Mol. Sci., TITEC, KEK, CROSS, HZB, ILL)

Life Science: Photosynthesis Absorption of solar energy changes by a hydrogen atom!

mutant A mutant B

Neutron crystallography and quantum chemical analysis of bilin reductase PcyA mutants reveal that difference of protonation state between two mutants relates to their spectral change.

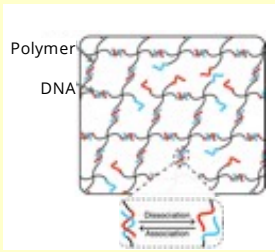
(BL03 Ibaraki U., Miyazaki U., Kurume U., NIT-Kurume College, Tech. U. Munich)

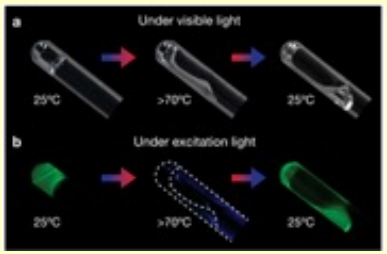


Expectation to Medical application: hydrogel

Star-Polymer–DNA Gels Showing Highly Predictable and Tunable Mechanical Responses

DNA duplexes are ideal crosslinkers for building dynamically crosslinked gel. A DNA gel with a highly homogeneous gel network and well predictable mechanical behaviors is demonstrated by using a pair of star-polymer–DNA precursors.





(BL15 Hokkaido Univ., U. Tokyo, JAEA, CROSS)

Recent Outcomes from Neutron BLs@MLF

Water visualization in a fuel cell used in FCEV

Fuel Cell Electric Vehicle

Supported by NEDO FC-Platform Program

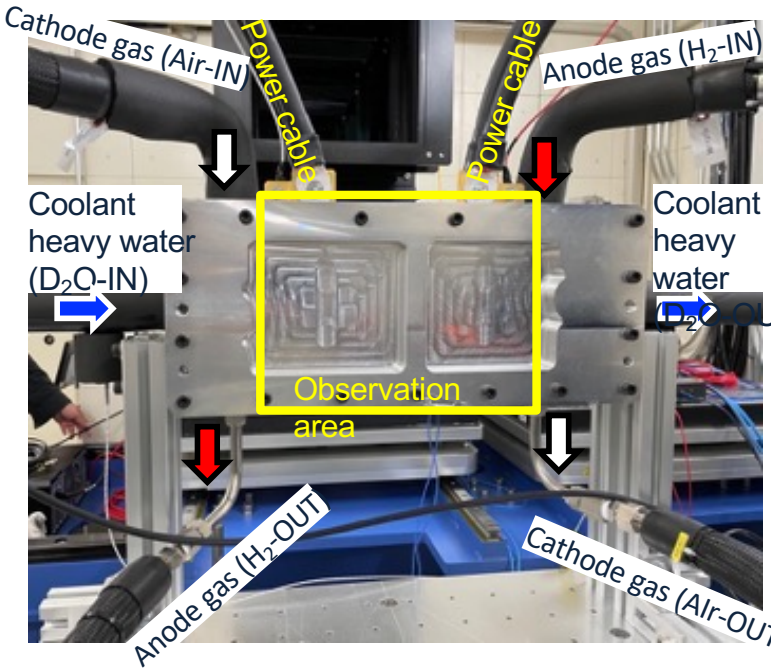
FC·Platform

NEDO

Visualization of water distribution inside an operating fuel cell of the 2nd generation TOYOTA MIRAI

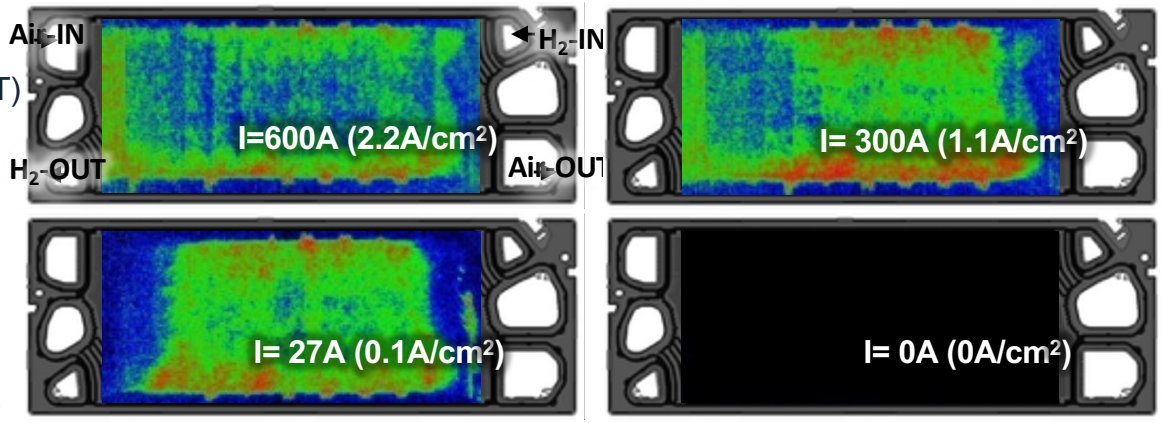
FCEV TOYOTA MIRAI

Fuel Cell of MIRAI (single sheet)



Fuel cell was assembled with thick Al end plates.

Water distribution images in an operating fuel cell.



Muon Facility Muse @ MLF

Asteroid samples returned by the Hayabusa2 Explorer mission,

Ryugu

Muon measurement contributed to quantify C, Si, Mg and O concentrations as a part of the initial analysis that was performed soon after the sample recovery to the Earth. (collaboration with the initial analysis team (STONE) led by T. Nakamura.)

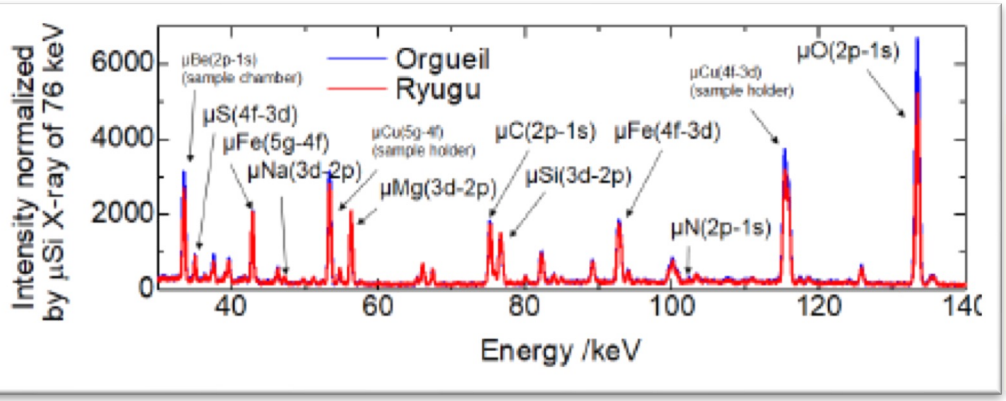
→ **New standard of element composition of primordial solar system**

Muon D-Line

Ex. The μC-Kα is 75 keV versus the fluorescence C-Kα is 0.3 keV (200 times larger !)

Muon-induced characteristic X-rays is an ideal method for studying the amount and the distribution of elements that are contained inside a sample.

Cover:
Science vol. 379, No. 6634



Sample

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

J-PARC

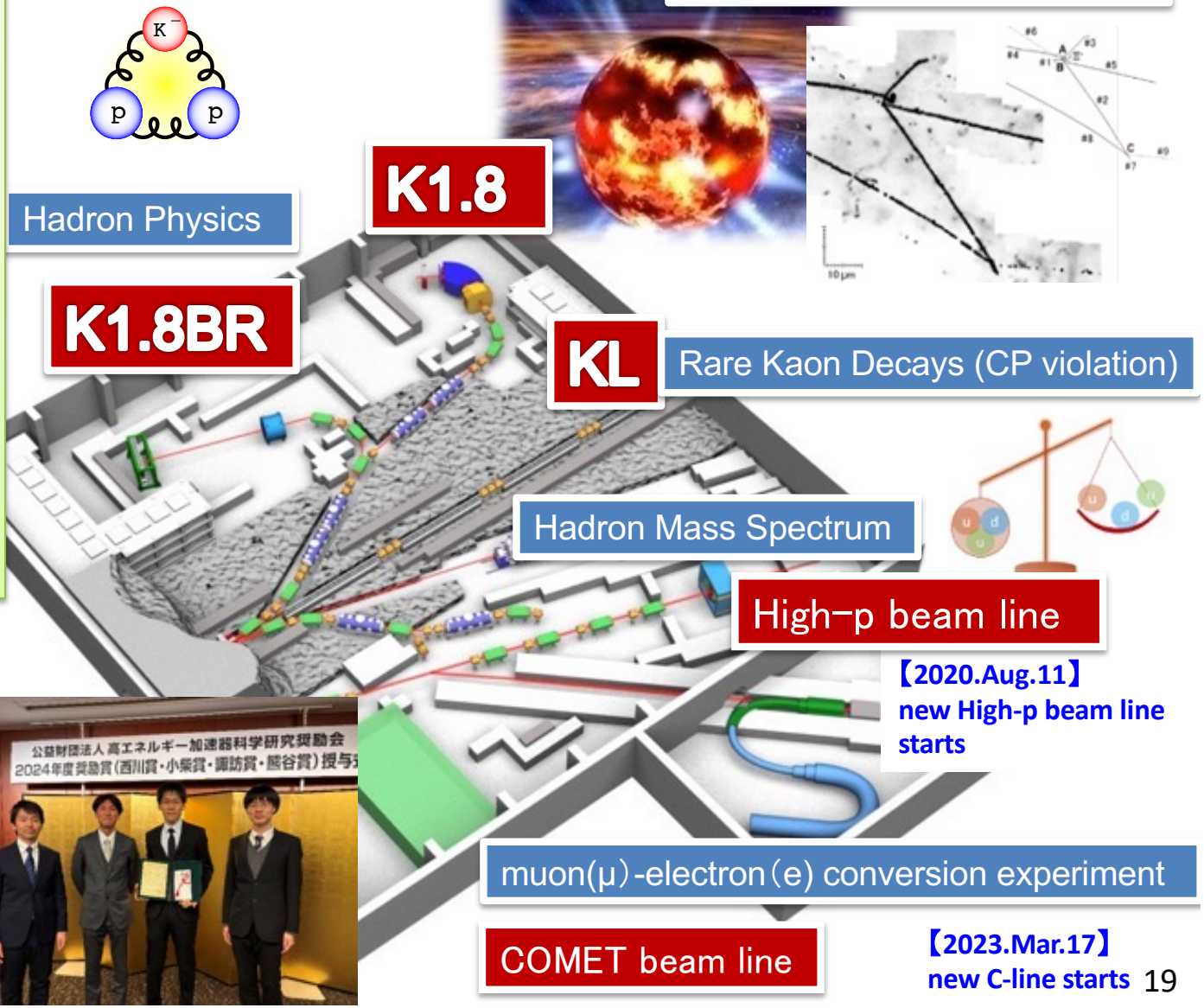
Hadron Experimental Facility

Hadron Experimental Facility

Nuclear & Particle Physics Experiments with Kaons, Muons, etc

(Tohoku, Tokyo, Gifu, Kyoto, Osaka, Kyushu, ...)

- new frontier in **Hadron Physics**, **Strangeness Nuclear Physics** with Kaons (dense nuclear matter, understanding of generalized nuclear force)
- exploring **CP-violating phenomena** beyond the Kobayashi-Maskawa theory through **Rare Kaon Decays**
- elucidating the mechanism of **Hadron Mass spectrum** in **High-p beam line experiments**
- **μ-e conversion experiment** (COMET) to discover **new physics beyond the Standard Model**



【2022. Mar.28 Press Release】
Measurements of Strong-Interaction Effects in Kaonic-Helium Isotopes at Sub-Electron Volt Precision with X-Ray Microcalorimeters.

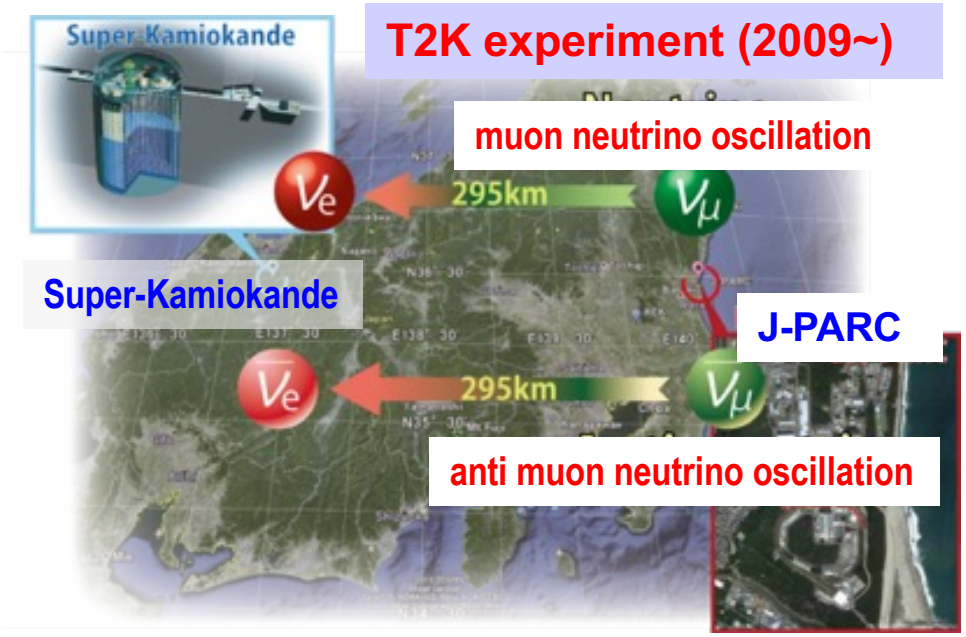
Four members of the experimental group received the "2024 (14th) Koshiba Memorial Prize.

J-PARC

Neutrino Experimental Facility

Neutrino Experimental Facility

Neutrino beam produced at J-PARC is shoot toward Super-Kamiokande detector, 295 km away. Accurate measurements of neutrino oscillations are on going.



Hyper-Kamiokande :
Next-generation experiment using the high-intensity neutrino beam from J-PARC: The construction started in 2019 and the experiment will start in 2028.

This project will lead the world's neutrino research for the next 20 years. Many researchers from around the world are participating in this experiment.

April 2020

The first constraints on CP asymmetry parameters was obtained with a high degree of accuracy (99.7%). It was published in the journal Nature.

Professor Atsuko Ichikawa (Graduate School of Science, Tohoku Univ), the former leader of the experiment, received the "2023 (69th) Nishina Memorial Prize.

"Why is the present universe made of matter and why is there so little antimatter?" The T2K results provide a hint to this fundamental mystery of the universe. We aim to accumulate further data to confirm the evidence of CP symmetry breaking.

Hyper-Kamiokande Project @ KEK-Tokai

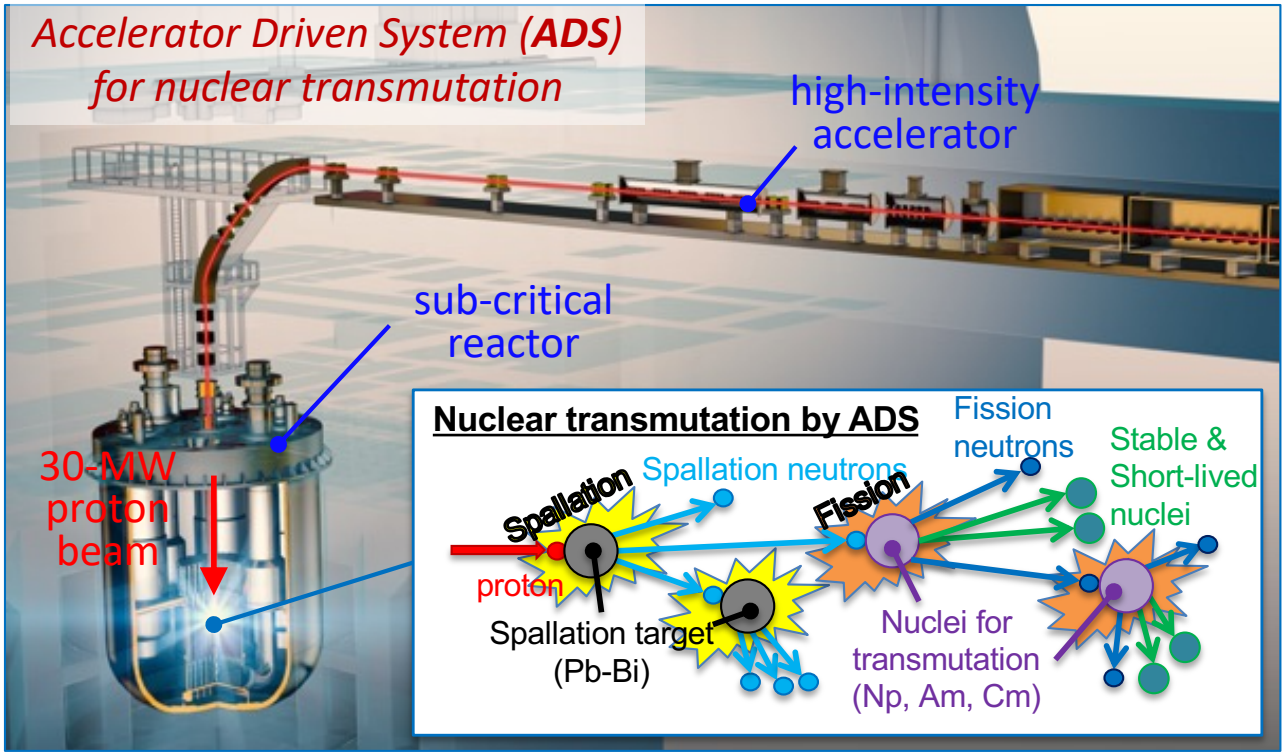
- Intermediate Water Cherenkov Detector (IWCD) at ~1km from J-PARC
  - Epoch-making measurement for Lepton CP violation search
    - Spectroscopy of Neutrino-Nucleus interaction by movable ~1kt-class detector with multi-PMT modules.
- New site for IWCD facility from 2025
  - Aiming to start operation in JFY 2028

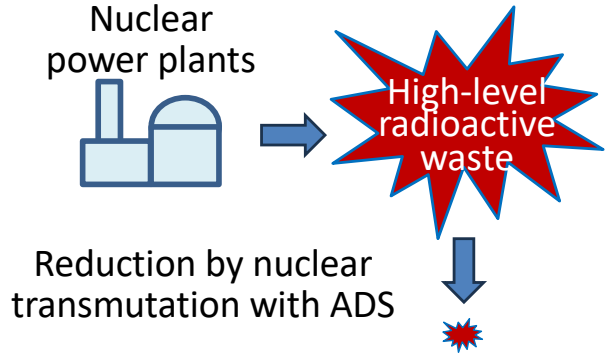
→ **We are very welcome for new collaborator to join for IWCD project!.**

J-PARC

Transmutation Experimental Facility (under planning)

Transmutation Experimental Facility



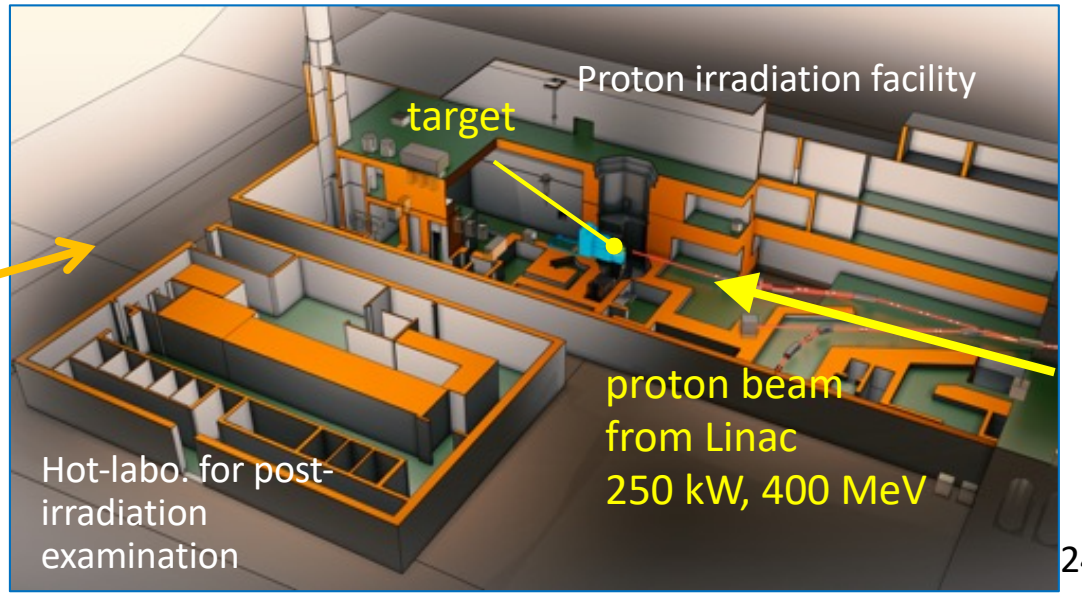


Promotion of nuclear power use by solving the problem of rad-waste

for contributing to

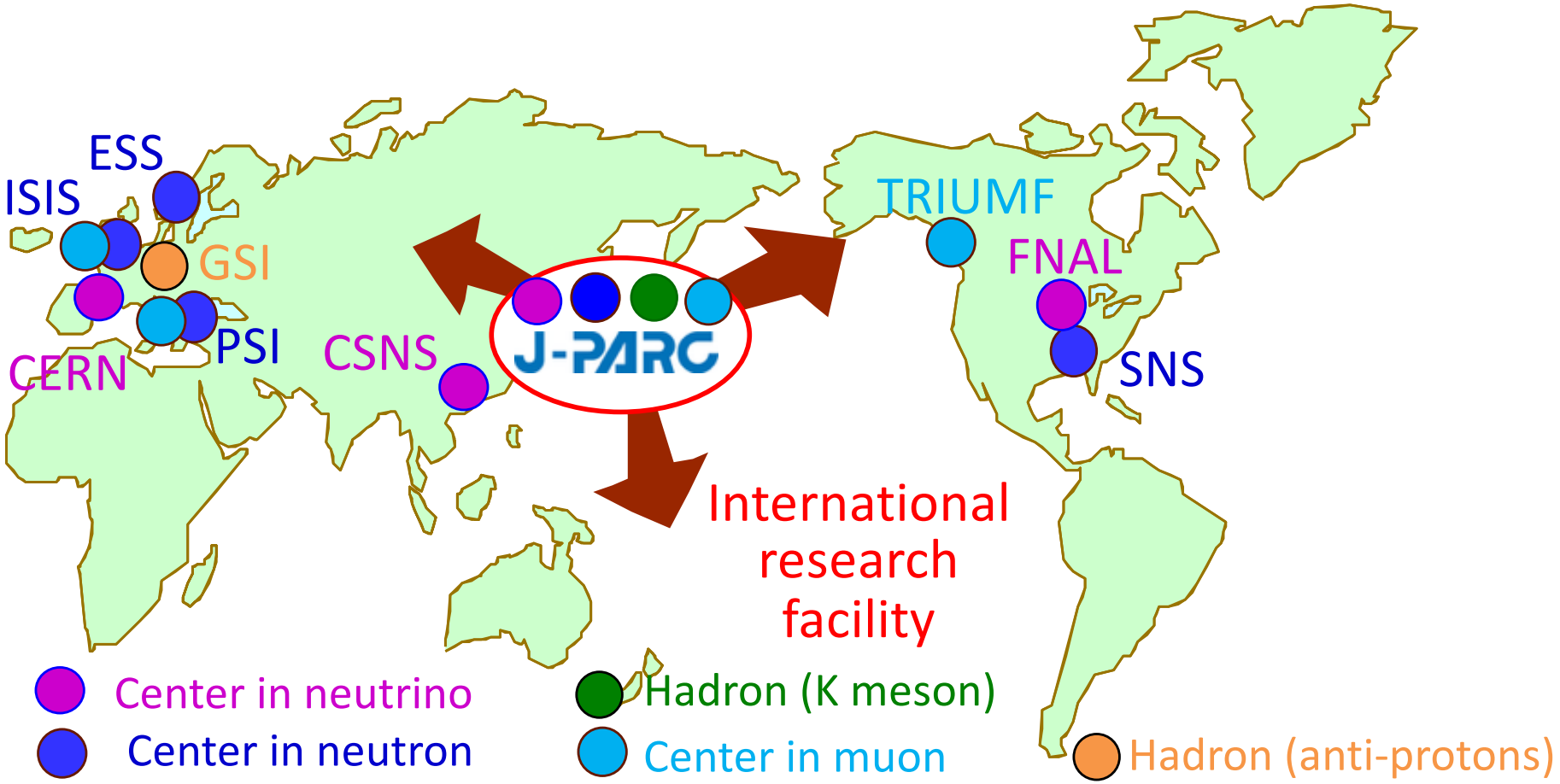
carbon neutrality

- Experimental facility for the ADS development and other purposes at J-PARC is under planning.



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



ISIS： spallation neutron source in Rutherford Appleton Laboratory, ESS : European Spallation Source, PSI : Paul Scherrer Institut

SNS：Spallation Neutron Source at Oak Ridge National Laboratory, TRIUMF : particle accelerator centre in Canada

CERN: in Swizerland, , CSNS: China Spallation Neutron Source, FNAL : Fermi National Laboratory GSI：Heavy ion Institute in Germany

Summary

J-PARC

- Power-frontier proton accelerators
  - **world top-class** beam power
  - high duty and high beam availability
- Multi-purpose user facilities
  - variety of **secondary particle beams**
  - wide range of research fields, particle physics, materials science, life science, industrial applications ····
    international user facility opened for worldwide researchers

⇨ ***outstanding results*** *are coming out one after another !!*