October 7, 2006
SPIN2008

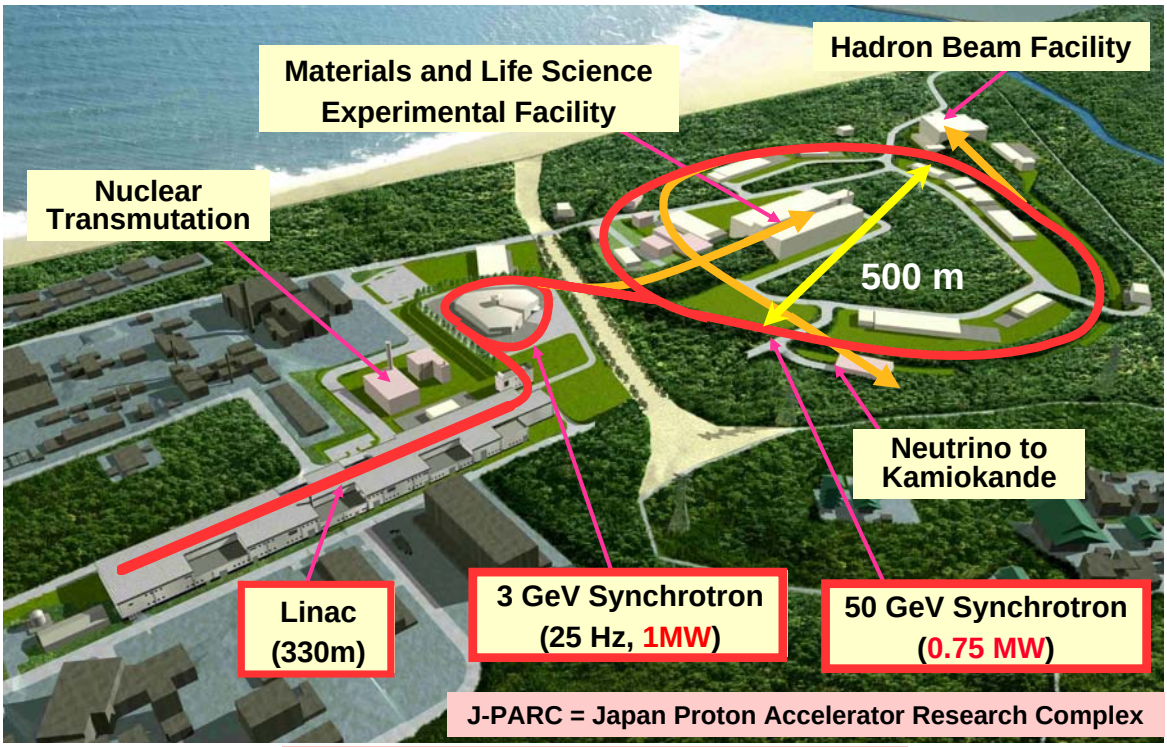
# J-PARC Project and Spin Physics

**Shoji Nagamiya**

**J-PARC Center at KEK/JAEA**

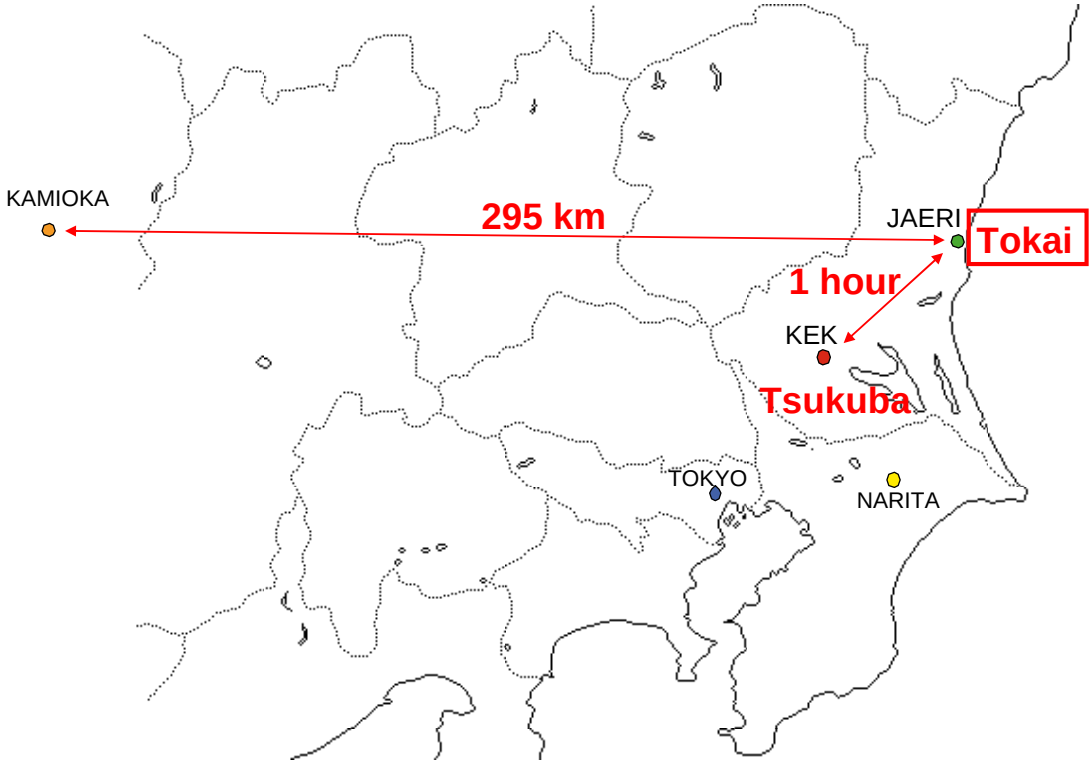


## J-PARC Facility

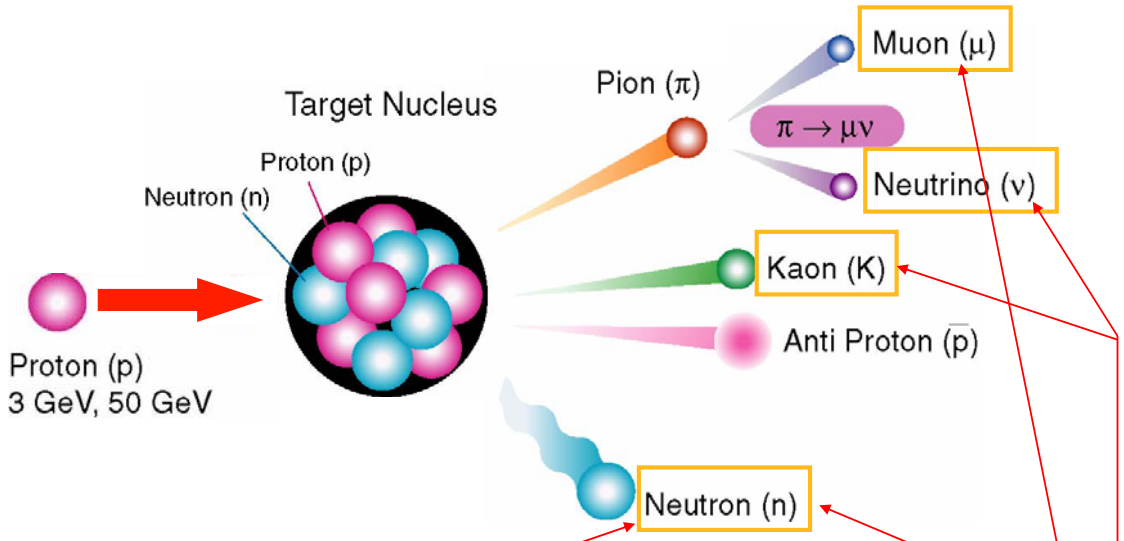



Joint Project between KEK and JAEA

# Location of J-PARC at Tokai




# Goals at J-PARC




Need to have high-power proton beams

→ MW-class proton accelerator (current frontier is about 0.1 MW)

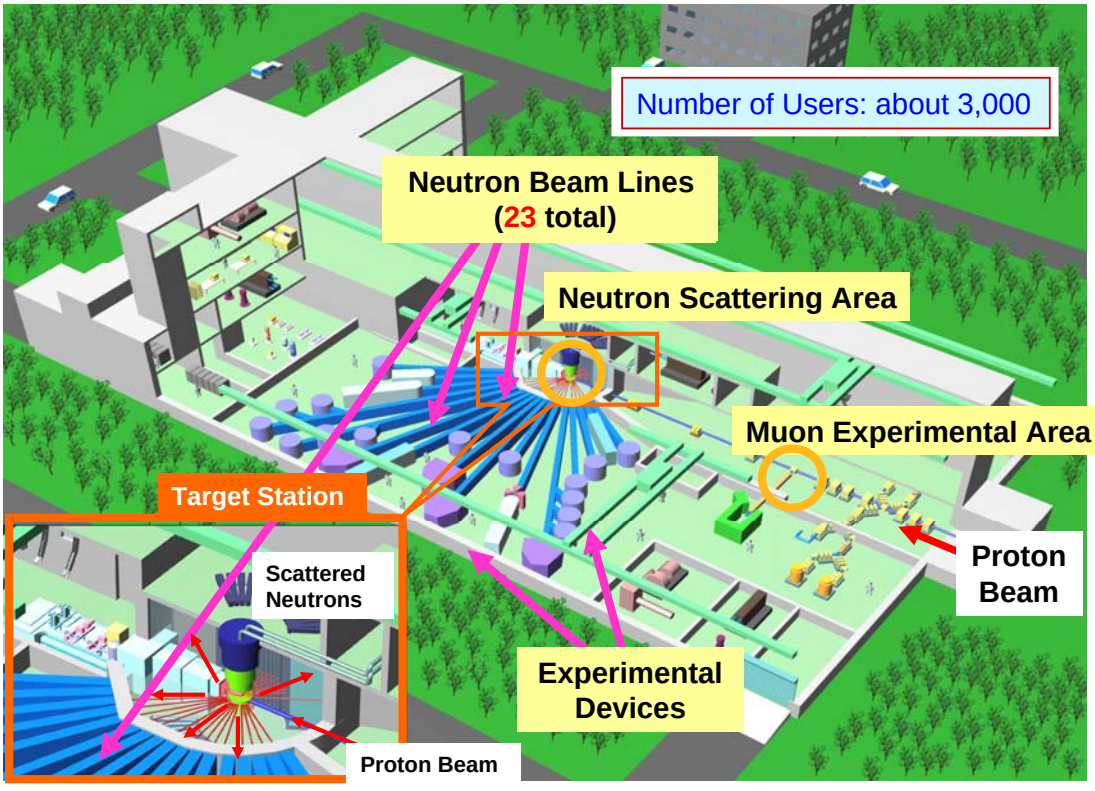
Materials & Life Sciences at 3 GeV
Nuclear & Particle Physics at 50 GeV
R&D toward Transmutation at 0.6 GeV

Materials and Life
Experimental Facility

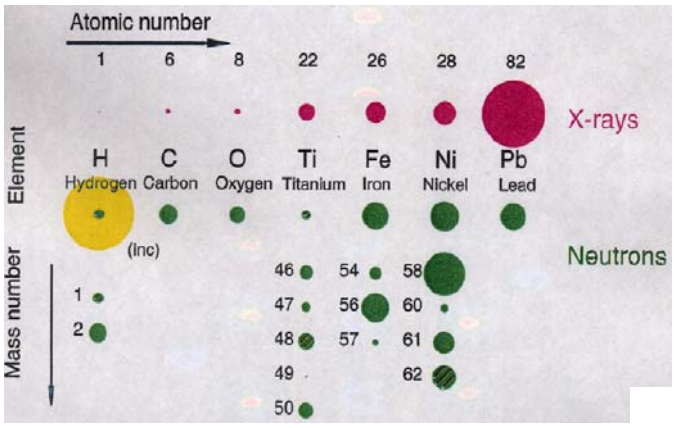
Facility similar to SNS in the US



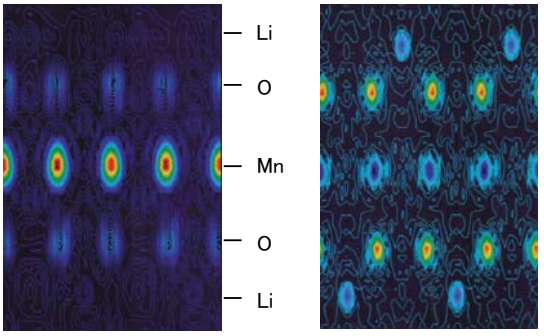
# Materials & Life Experimental Facility



# Example of Neutron Scattering



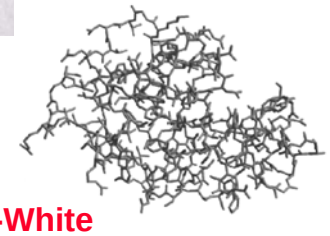

**Li battery**



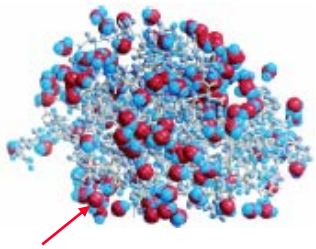

**X-Ray Measurement**

**Neutron Measurement**

X-rays interact with electrons.
→ X-rays see high-Z atoms.
Neutrons interact with nuclei.
→ Neutrons see low-Z atoms.



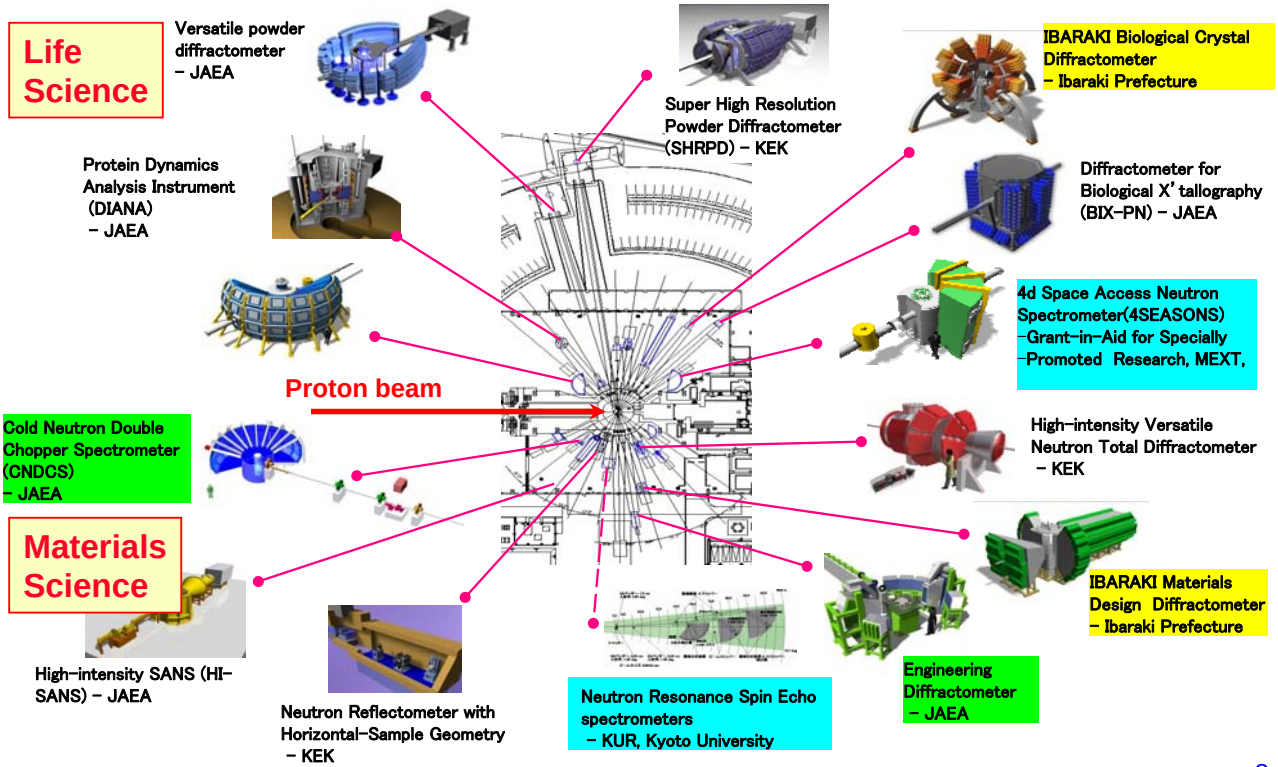
**Hen Egg-White Lysozyme**



**$H_2O$**



# Tentatively Approved Instruments



## Hadron Experimental Facility

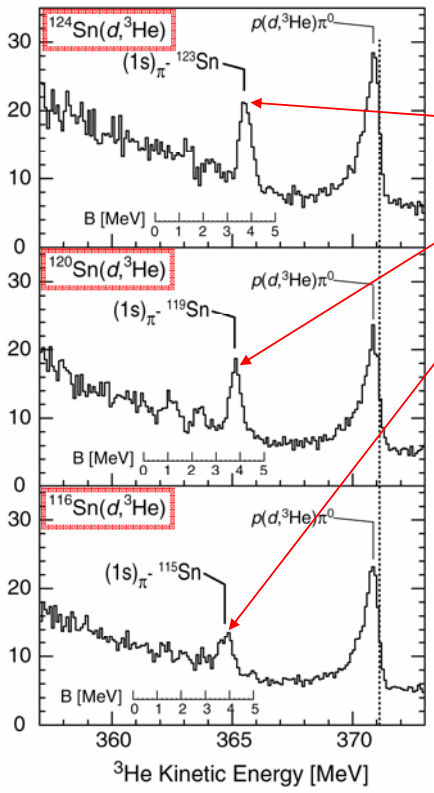
Number of Users: about 600

(about 1/3 from Japan)

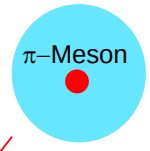
Experiments with Intense K-Meson Beams (Kaon Factory)

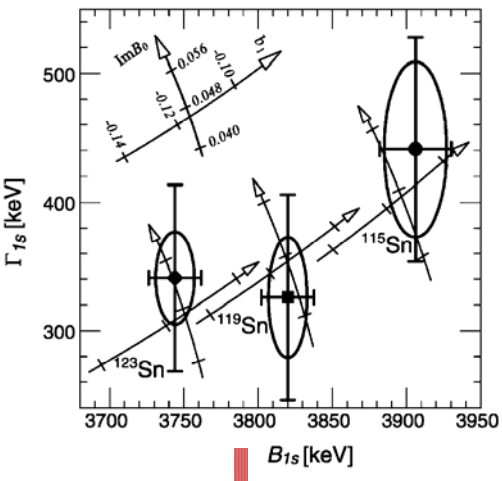
J-PARC

## Pion Implantation




Meson Implantation



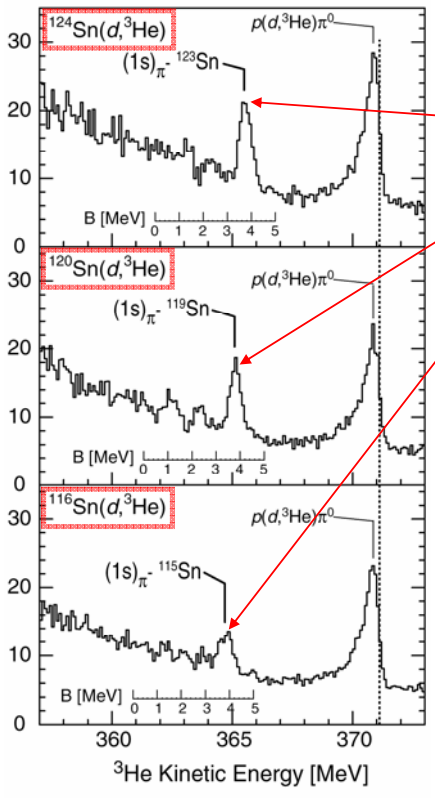




$$f_\pi^*(\rho)^2/f_\pi^2 \approx 0.64$$

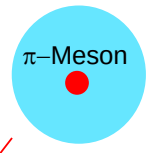
Inside nuclear matter the order parameter for pion could be reduced by 1/3 (*i.e.*, partial restoration of chiral symmetry)

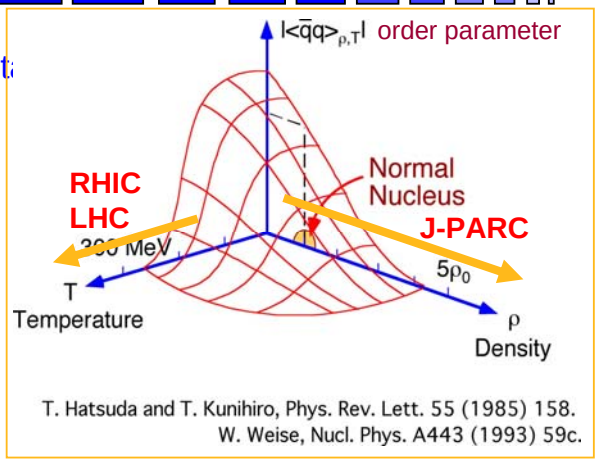
K. Suzuki, et al., Phys. Rev. Lett. 92, 072302 (2004)

# Pion Implantation




Meson Implant




Inside nuclear matter the order parameter for pion could be reduced by 1/3 (*i.e.*, partial restoration of chiral symmetry)

$$f_\pi^*(\rho)^2/f_\pi^2 \approx 0.64$$

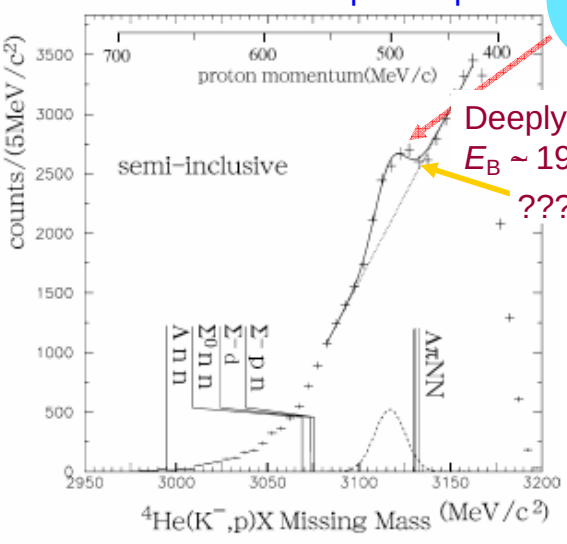
K. Suzuki, et al., Phys. Rev. Lett. 92, 072302 (2004)



**These will be possible Day-1 experiments at J-PARC !**

# Strangeness Implantation

$K^- + {}^4He \rightarrow$ "$K^-pnn$" + p



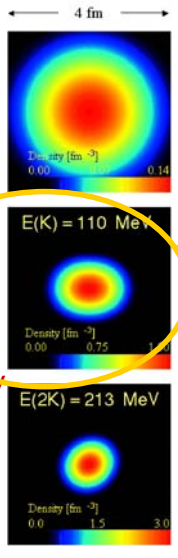

Experiment by M. Iwasaki, et al. (2004)

K-Meson

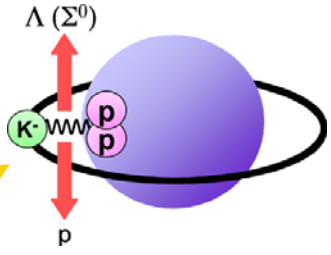
$^3$He

Deeply bound
$E_B$ ~ 194 MeV

???



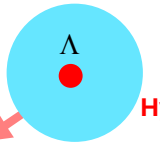

K$^-$ in $^3$He
$E_B$ ~ 100 MeV




At Frascatti, a bound state of K$^-$ in $^3$He was discovered recently.

M. Agnello, et al. (2005)

Theory by Y. Akaishi, et al. (2002)

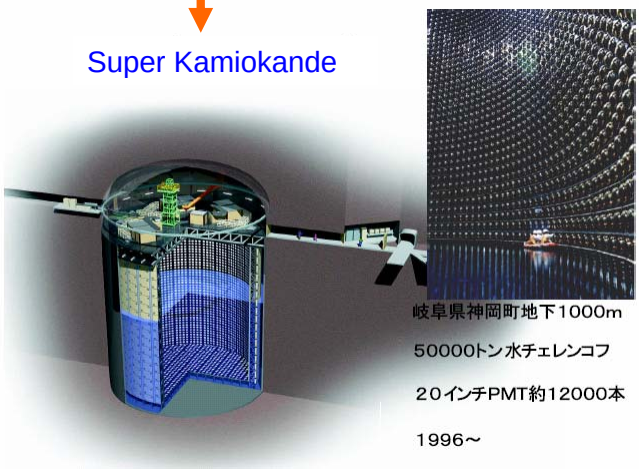



**Hyper nucleus**

Nuclear shrinkage is also observed for Λ implantation inside the nucleus

← K. Tanida, et al. (2001)


Super Kamiokande




## Neutrino Experimental Facility

Number of Users: about 400
(about 1/4 from Japan)

Experiments with Intense Neutrino Beams



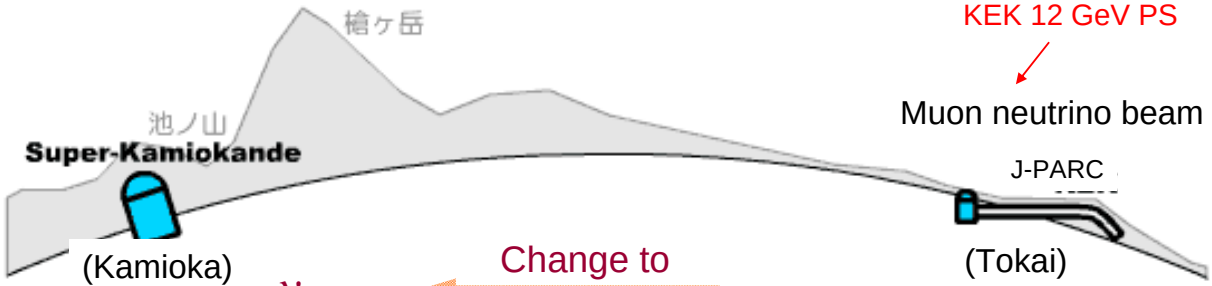
## T2K Experiment

J-PARC

T2K = Tokai to Kamioka

Intense neutrino beam by 100 times at KEK 12 GeV PS

Muon neutrino beam




$\nu_\tau$ Change to $\nu_\mu$

$\nu_e$ Change to $\nu_\mu$

Disappearance of $\nu_\mu$ ↔ High Statistics T2K
（Five year data at KEK-PS can be measured within a few weeks at J-PARC ）

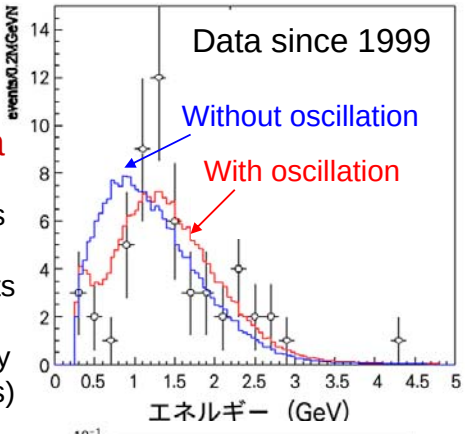
Detection of $\nu_e$ at Super Kamiokande ↔ Totally new experiment

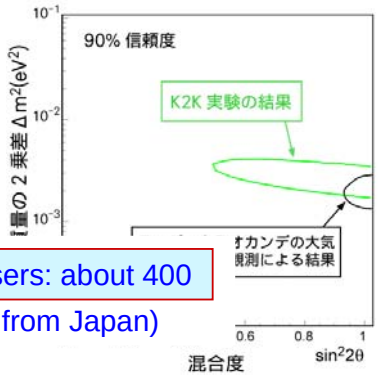
# From K2K to T2K

K2K = KEK to Kamioka

107 events observed (151 events expected without any oscillations)

→ 99.99% confident that ν carries a finite mass.

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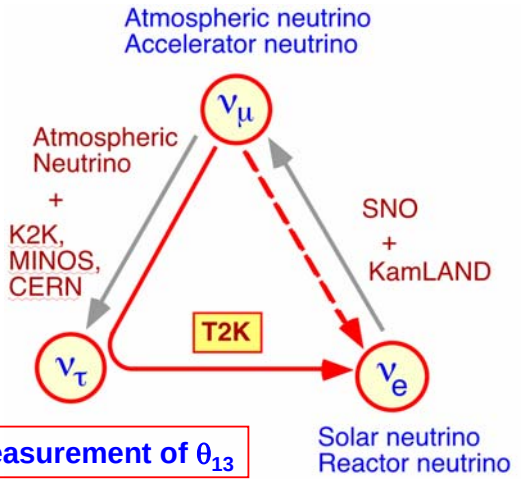
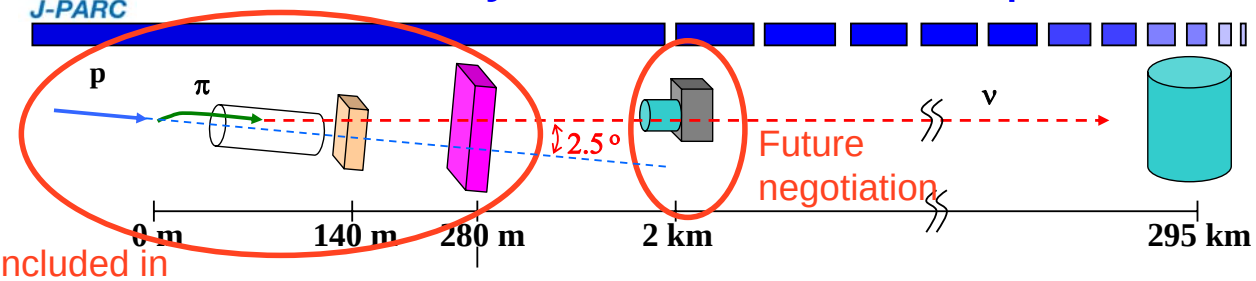



**Measurement of $\theta_{13}$**

Flux ($\nu_\mu$) at J-PARC 50 GeV PS
> 100 x Flux ($\nu_\mu$) at KEK 12 GeV PS



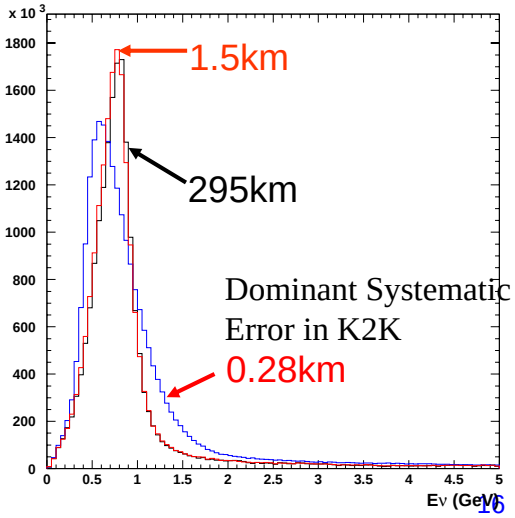
# Layout for Neutrino Experiment




Included in the budget

- Muon monitors @ ~140m
  - spill-by-spill monitoring of π-beam direction/intensity
- First Front detector @280m
  - 0 degree definition
  - High stat. neutrino inter. studies
- Second Front Detector @ ~2km
  - Ultimate systematics
  - Now fixing the site
- Far detector @ 295km
  - Super-Kamiokande (50kt)

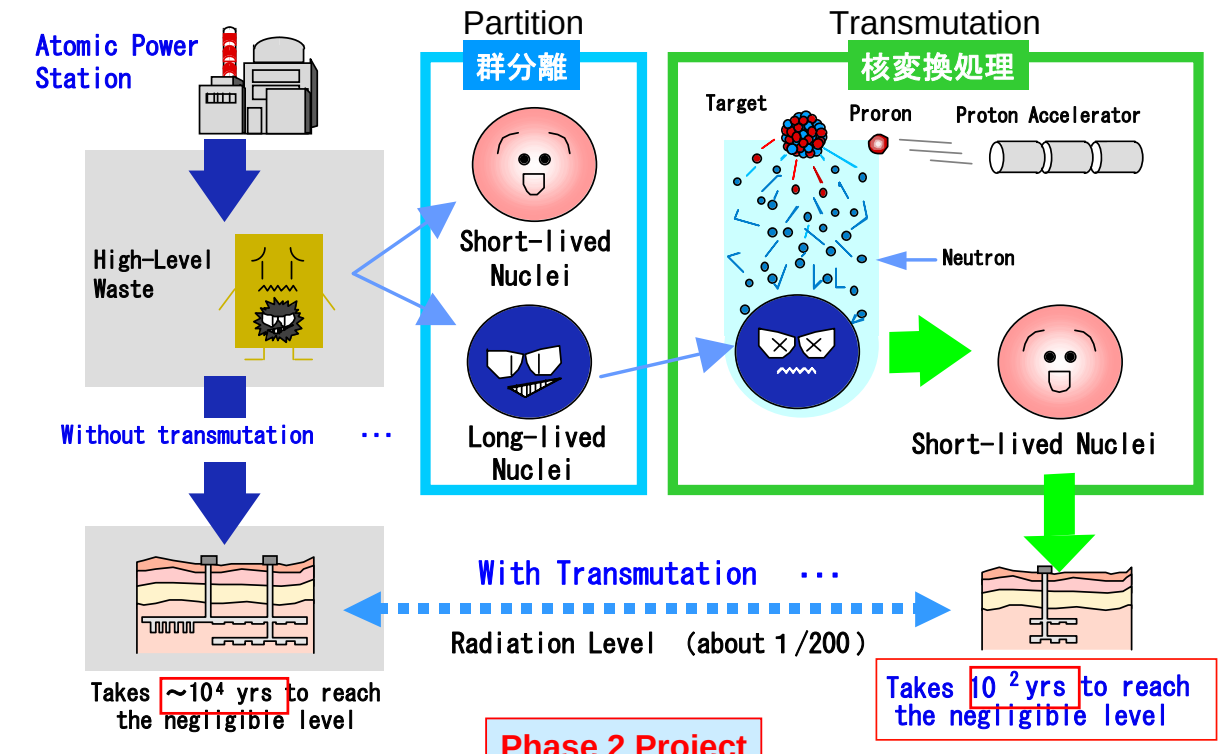
**Neutrino spectra at diff. dist**



# Asian Map

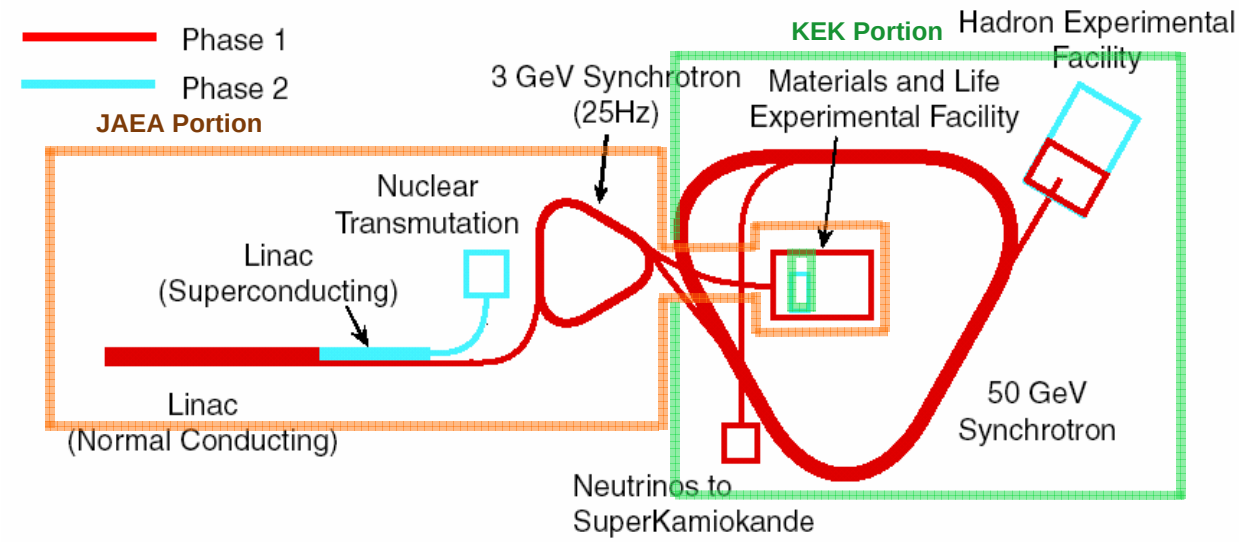



# Accelerator-Driven Transmutation (ADS)




**Phase 2 Project**

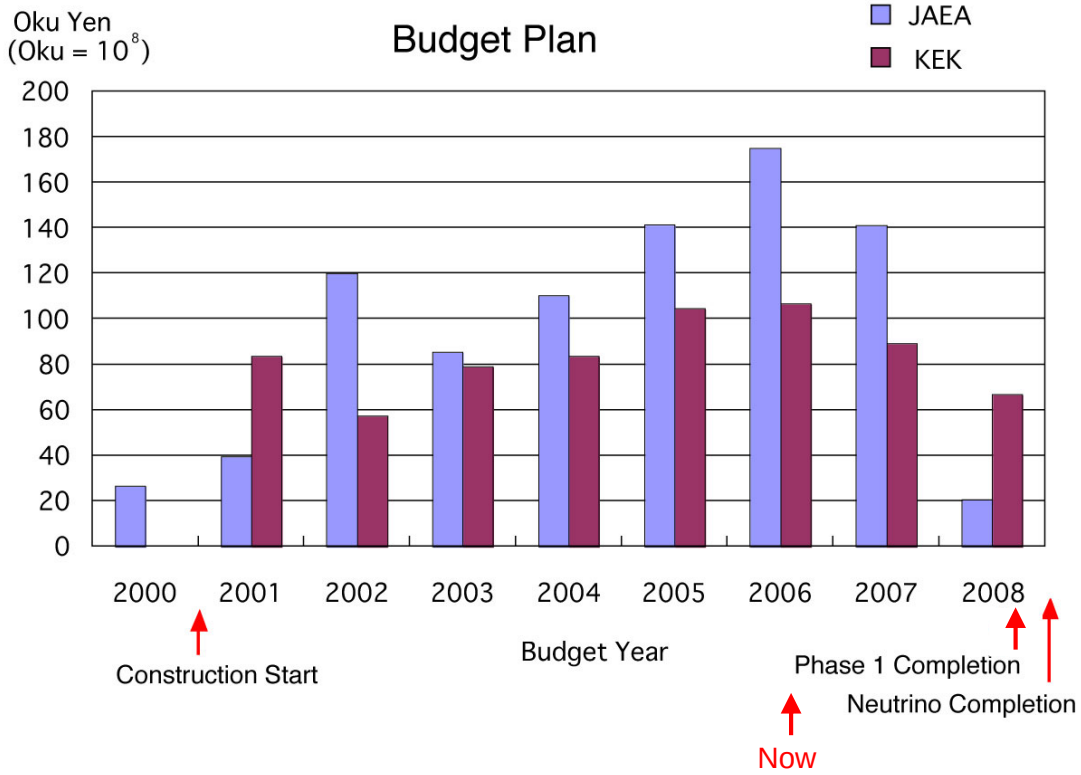
# Phase 1 and Phase 2

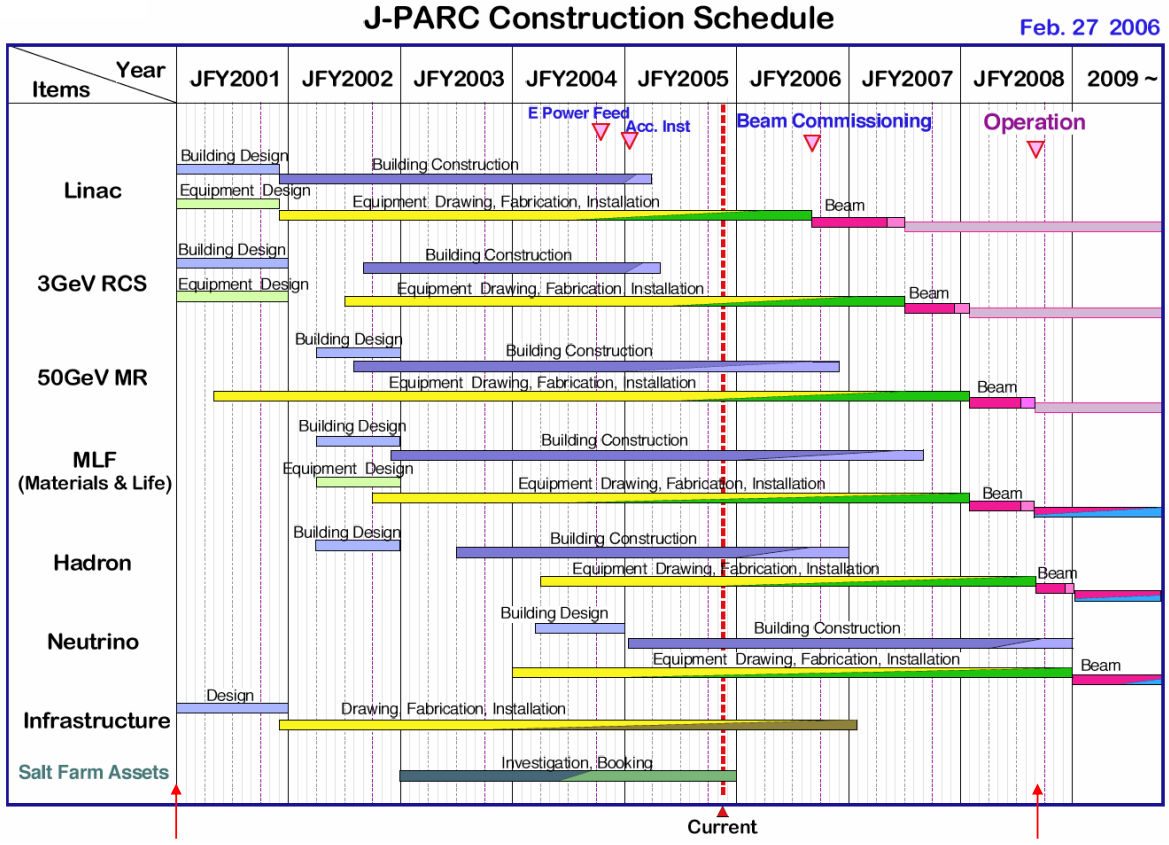



- Phase 1 + Phase 2 = 1,890 Oku Yen (= $1.89 billions if $1 = 100 Yen).
- Phase 1 = 1,527 Oku Yen (= $1.5 billions) for ∽8 years.
- JAEA: 860 Oku Yen (56%), KEK: 667 Oku Yen (44%).



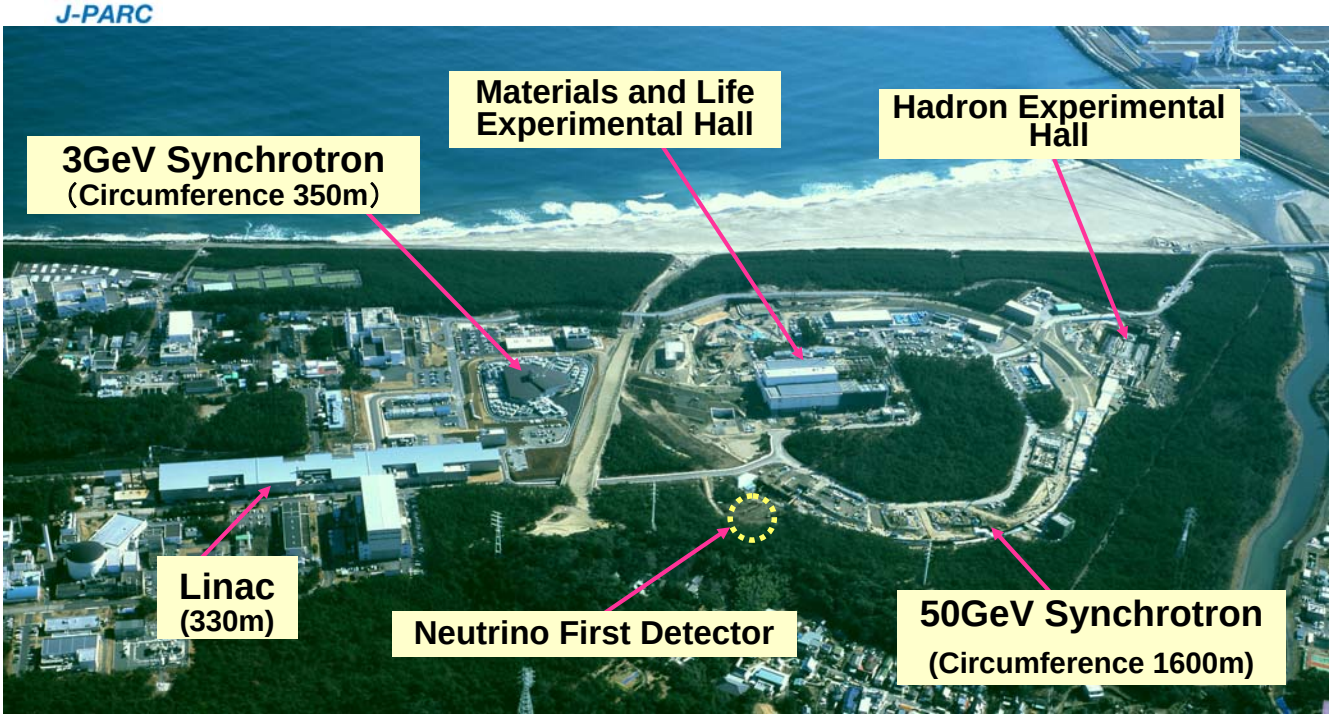
# Budget Profile



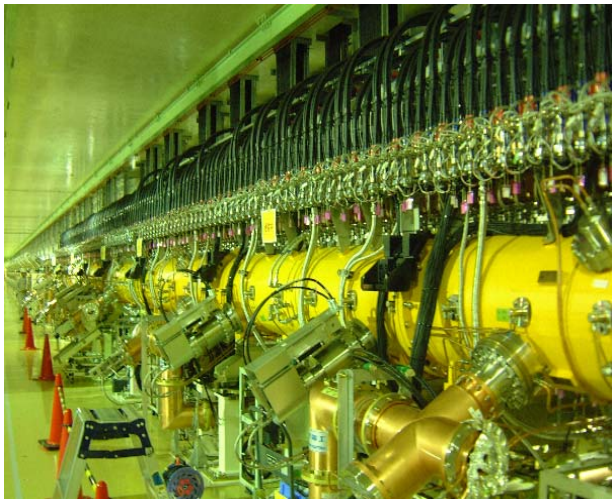





# Construction Status of J-PARC

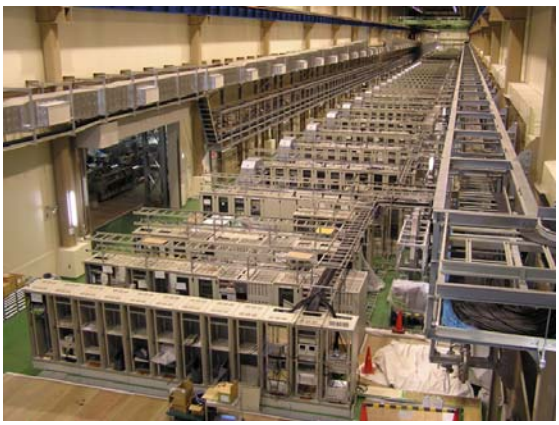



平成18年2月航空写真



Drift Tube Linac


Transport Line from Linac to 3 GeV

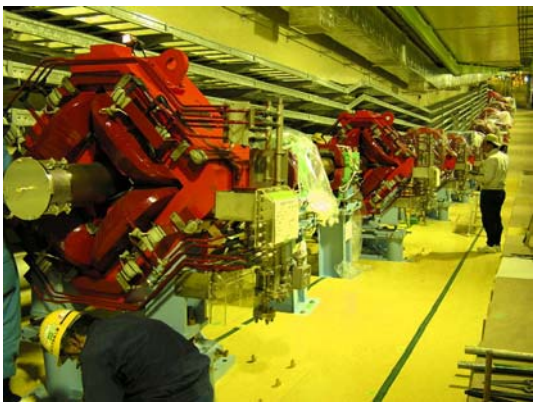


Klystrons + Electric Powers




Installation of 3 GeV Magnets

50 GeV Synchrotron Tunnel



From 3 GeV to Life & Materials Experimental Hall

Hadron Experimental Hall

Installation of Neutrino Decay Volume

From 50 GeV to Neutrino Line

Last Construction of the 50 GeV Tunnel

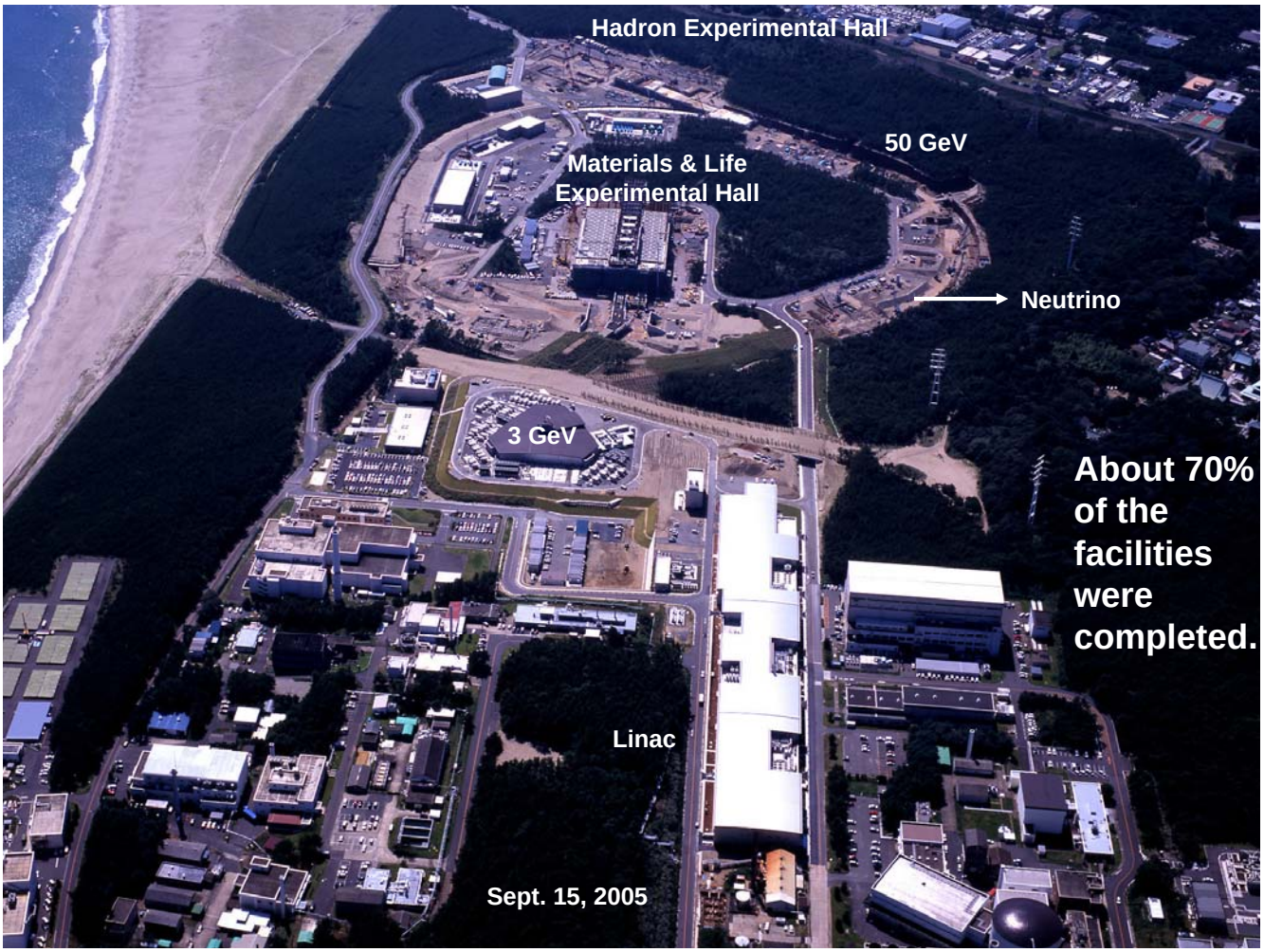




Installation of Outer Liner

Extraction Area for Neutron Beamlines




Hadron Experimental Hall
50 GeV
Materials & Life
Experimental Hall
Neutrino
3 GeV
About 70%
of the
facilities
were
completed.
Linac
Sept. 15, 2005

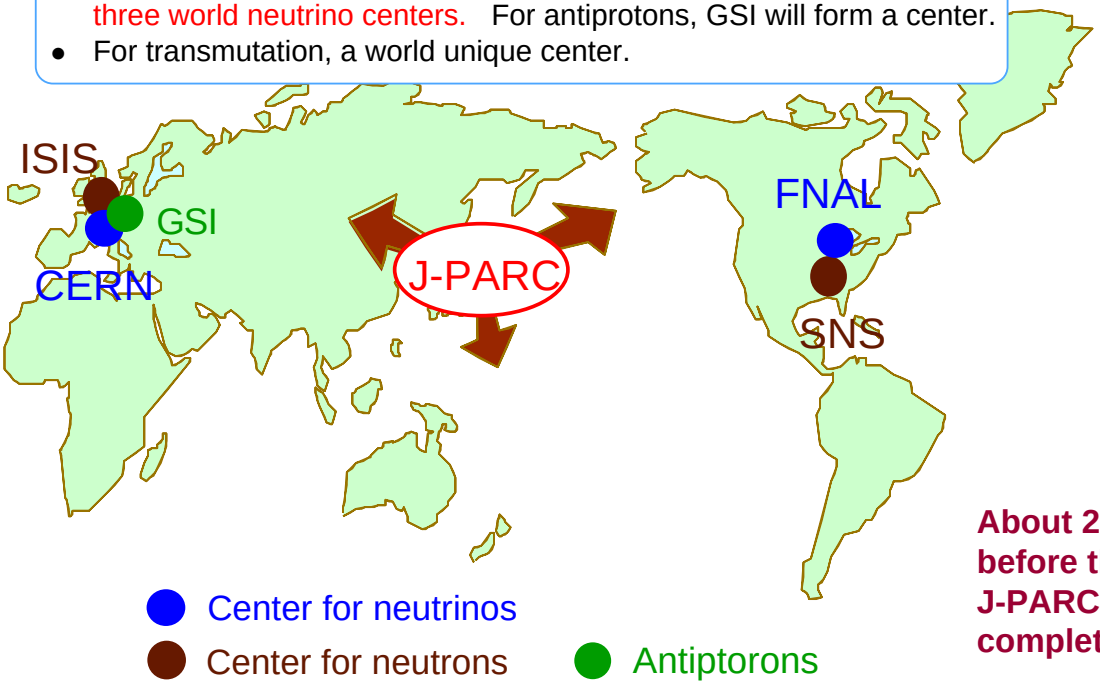
Salt Farm in the 15th Century




Archeological studies on the site were completed in August, 2004.

# World Centers

- Materials and Life Science: One of three world neutron centers.
- Nuclear and Particle Physics: World unique Kaon Factory. One of three world neutrino centers. For antiprotons, GSI will form a center.
- For transmutation, a world unique center.




Center for neutrinos
Center for neutrons
Antiptorons

**About 2 years before the J-PARC completion !**



# Upgrade Plans for 50 GeV

- Power beyond 1 MW (neutrinos to study CP violation in the leptonic sector)
  - Design study was advanced to 1.3 MW.
  - Possibility up to 2.7 MW is in progress by the Accelerator group.
  - Users want up to 4 MW.
- Muon Storage Ring (LFV, muon g-2, etc.)
  - Need additional extraction beam line.
  - Exit was already prepared.
  - Anti-protons together with muons?
- Polarized Protons
  - Study group was formed.
  - Installation of Siberian snakes seems possible.
- Heavy Ion Acceleration
  - Interest exists among users.
  - Need technical studies.

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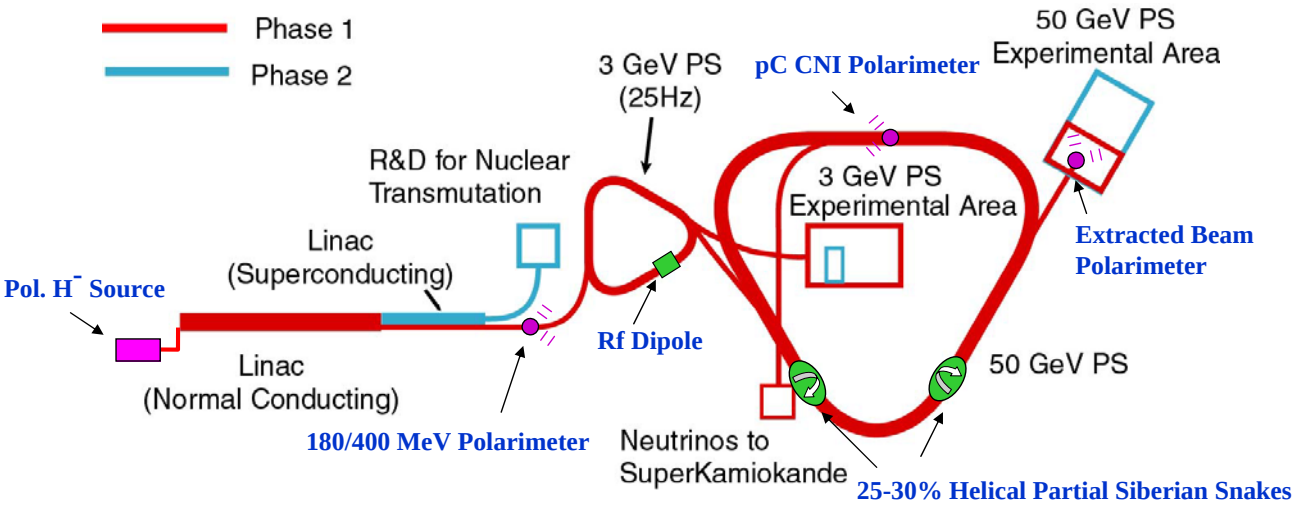
# Polarized Proton Beams at J-PARC

50 GeV polarized protons for slow extracted beam primary fixed target experiments
Low intensity (~ $10^{12}$ ppp), low emittance (10 π mm mrad) beams

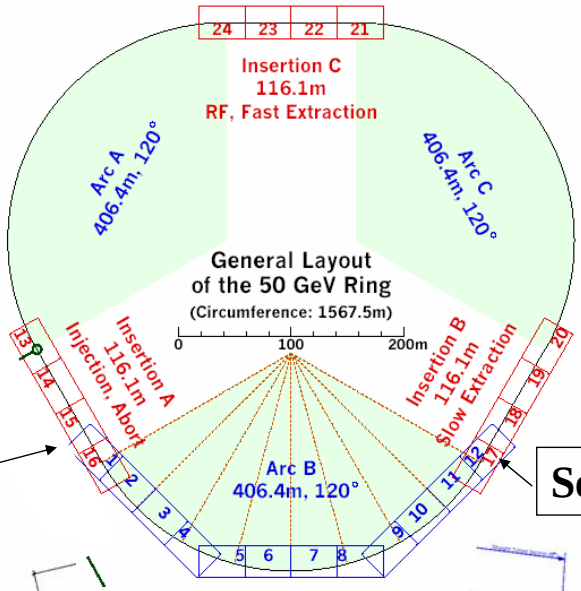



Slide from Thomas Roser
@ J-PARC-HS05



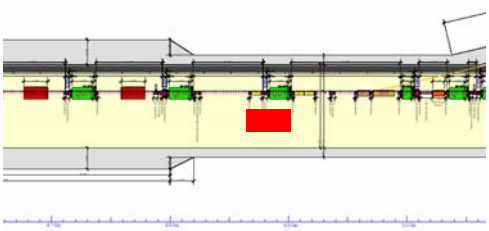
# Possible Locations of Partial Snakes

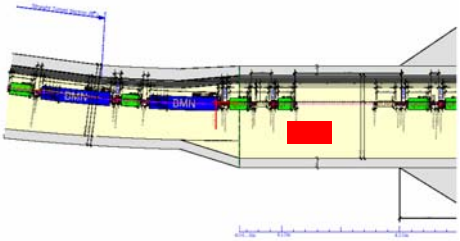
Polarized beam acceleration at J-PARC is possible with a rf dipole in the 3 GeV and two strong partial Siberian snakes in the 50 GeV Ring.



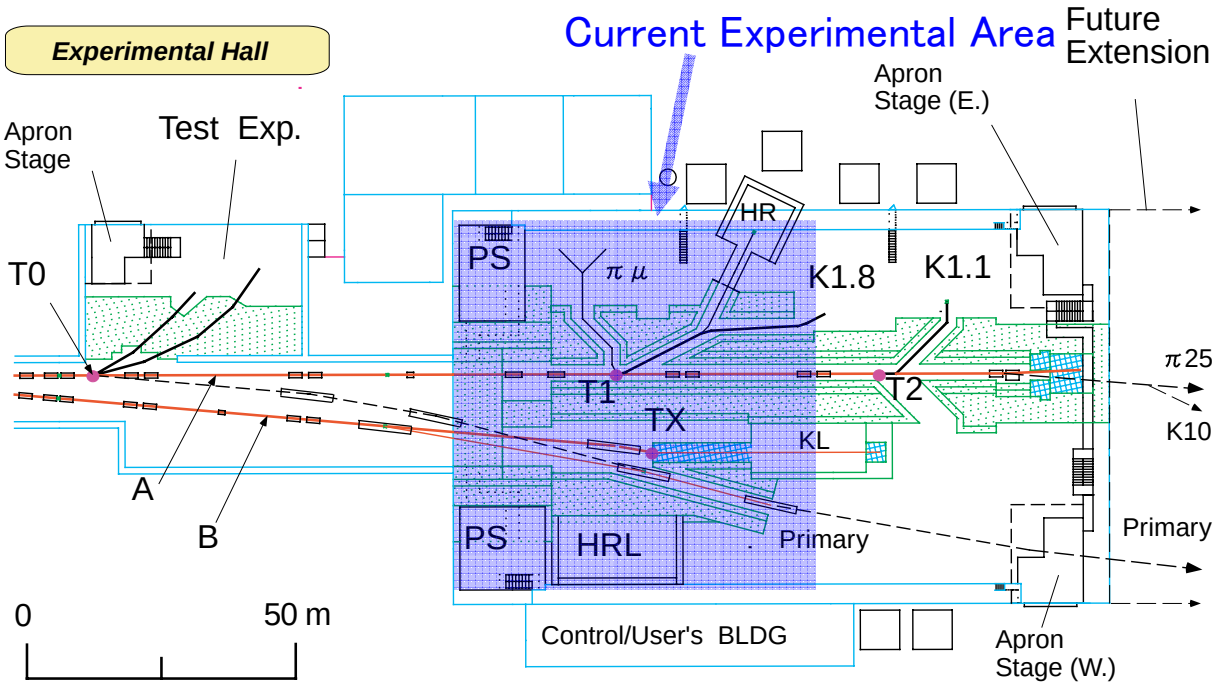

**First 30% snake**

**Second 30% snake**



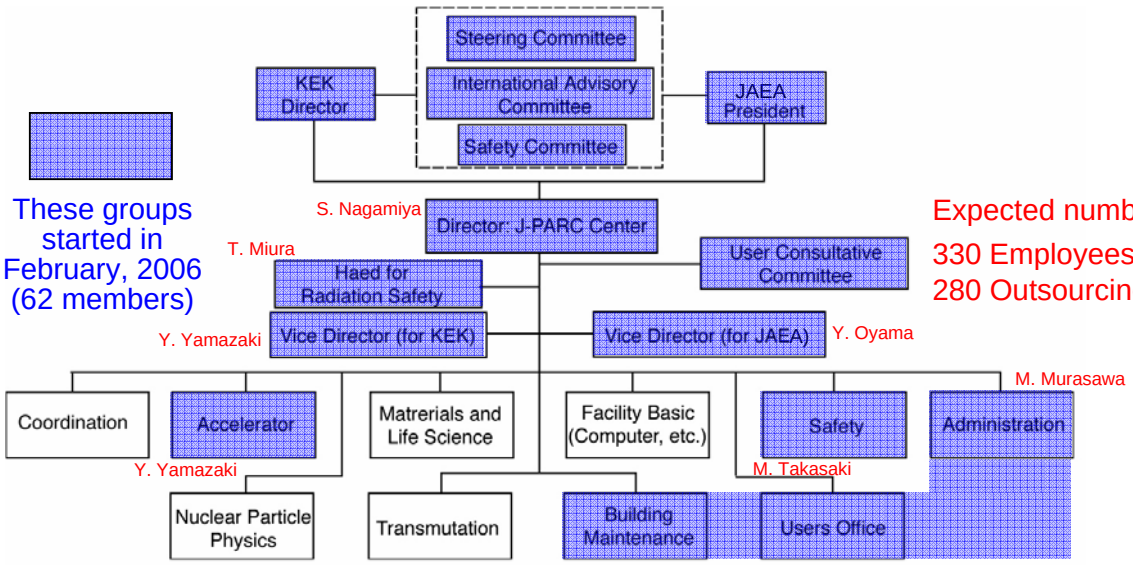


# Expansion of Hadron Experimental Hall






# J-PARC Center (Organization for Operation)




J-PARC Center: To operate the entire J-PARC by one responsible organization.
[Construction team: Two institutions carry full responsibilities for funded items.]

The first Agreement was signed on August 8, 2005.


**Actual Start of the J-PARC Center on February 17, 2006**

# Summary

- Uniqueness of the Project - Multipurpose Facility
  - Variety of secondary beams + Variety of frontier sciences.
- International Research Center
- News during the Past One Year
  - Construction for both equipments and facilities: A slight delay, but almost on schedule.
    - Peak in the construction budget in JFY2006 (good news to us).
  - J-PARC Center started.
  - An external review on the operational budget.
  - Birth of JAEA.
  - Shutdown of KEK-PS from JFY2006
  - First call for proposals for 50 GeV. Three proposals out of 20 were on Stage 2 full approval.
- Issues
  - Timely completion of the construction.
  - How to grow the organizational structure at the operational stage (J-PARC Center).
  - Realistic operational budget.
  - PAC (time and place), Budget for experimental facilities, Power Users, Beamtime Fee, etc.
  - Linac energy recovery, Phase 2 funding, etc.

**Would like to welcome the participation in J-PARC from the world !**