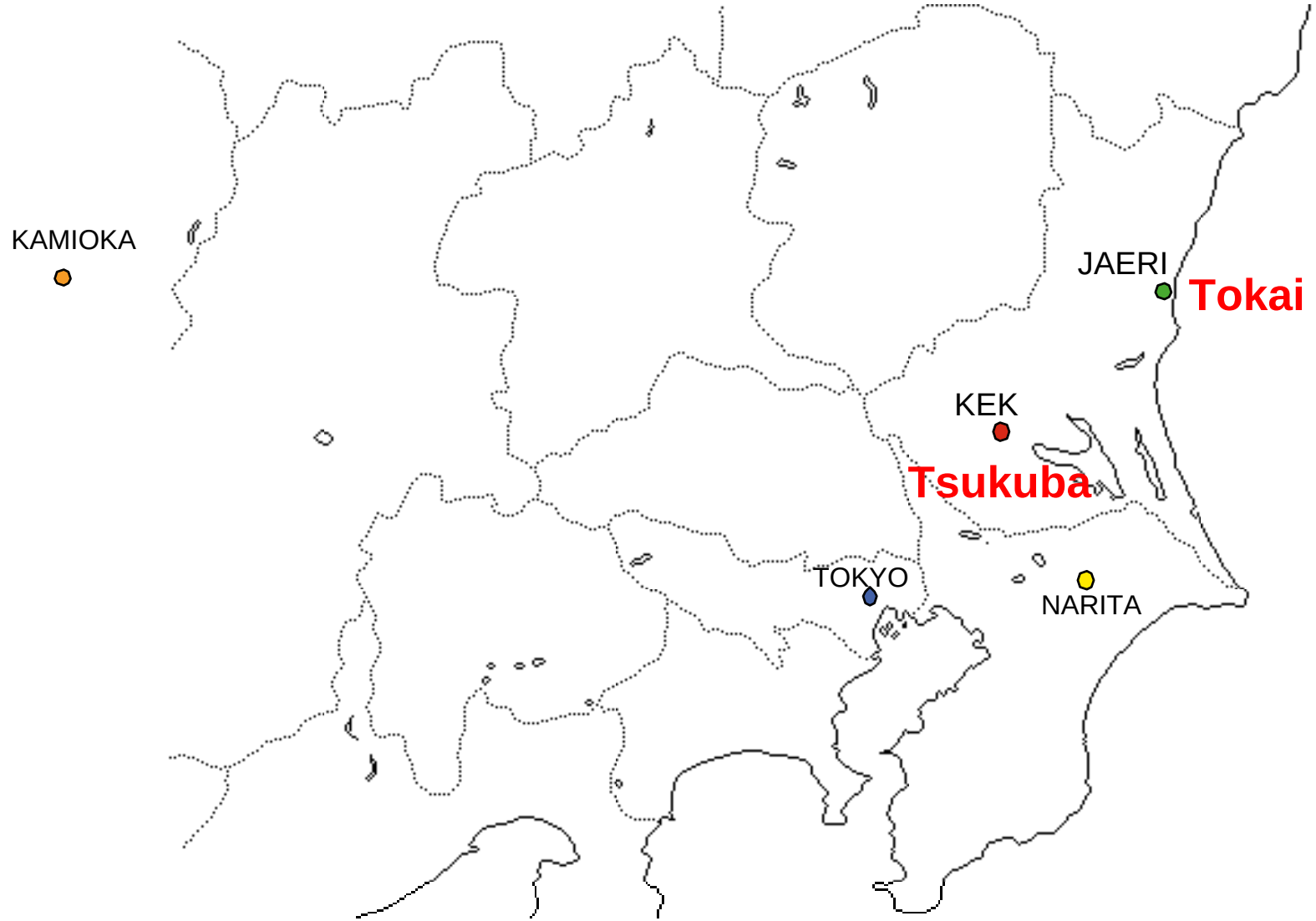
EPICS Collaboration Meeting
Dec. 8, 2004

J-PARC Project Status

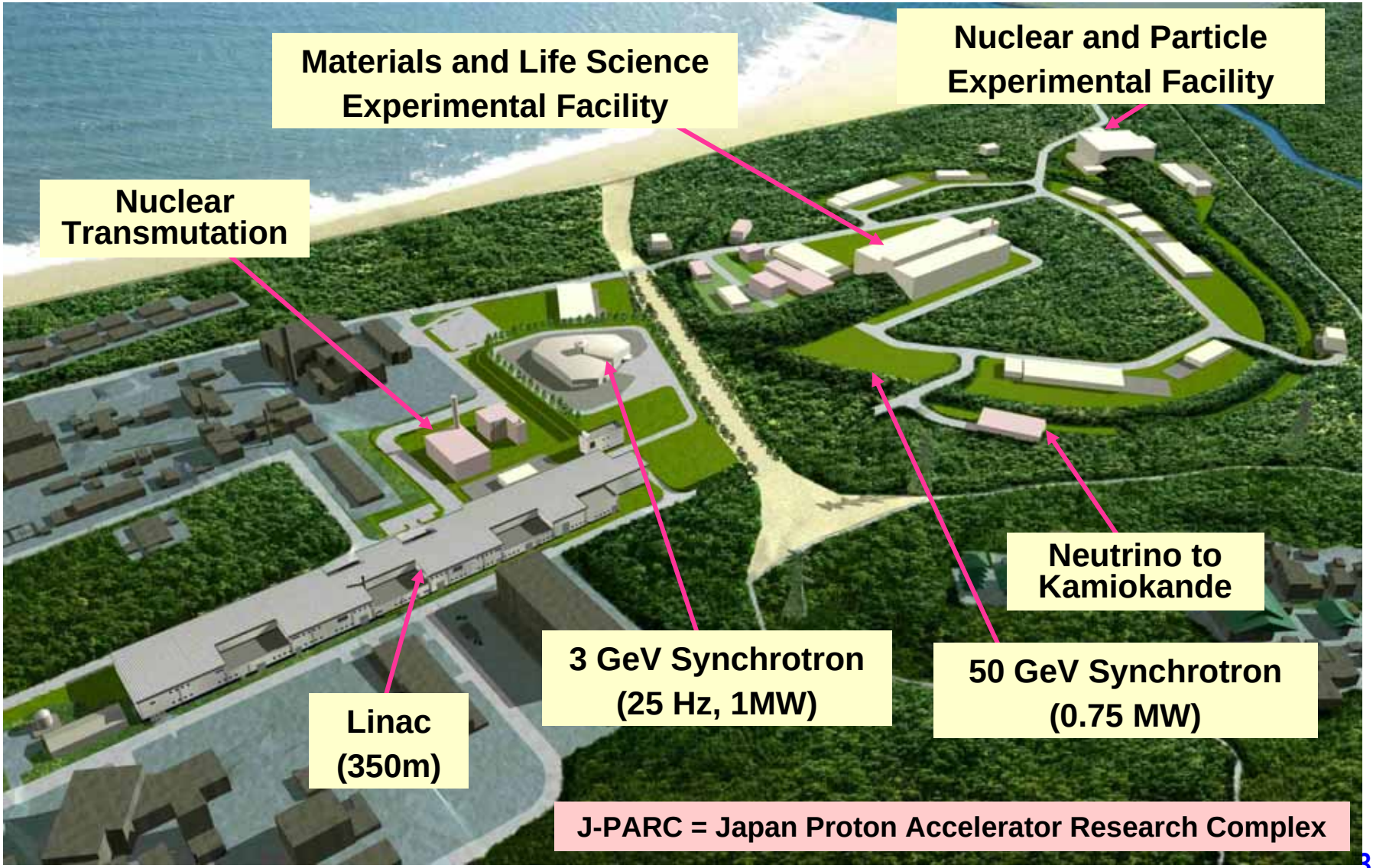
Hiroshi Yoshikawa.

1) Overview of Project
2) Construction status
3) Accelerators
4) Experiments
5) Control System

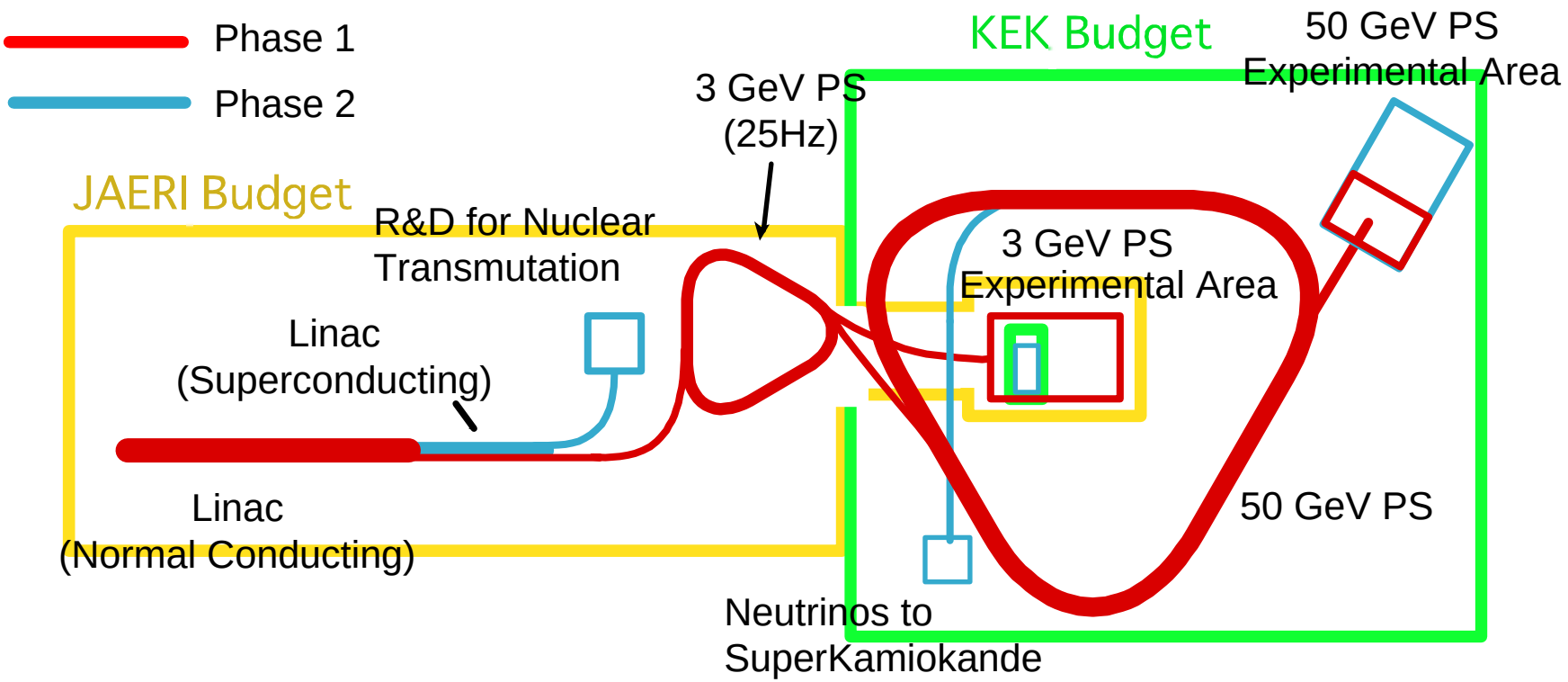
Location of JAERI at Tokai



J-PARC Facility



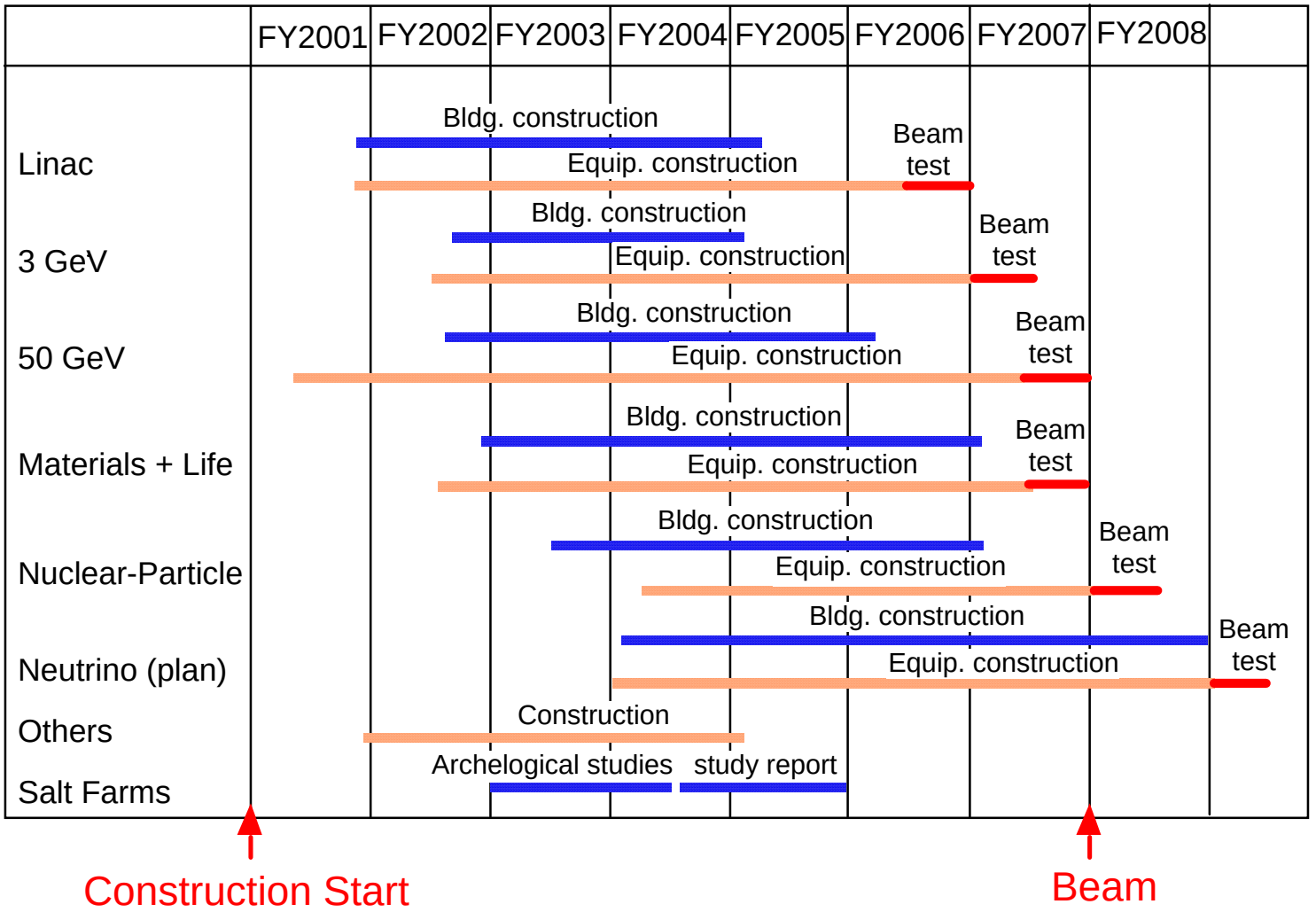
Phase 1 and Phase 2



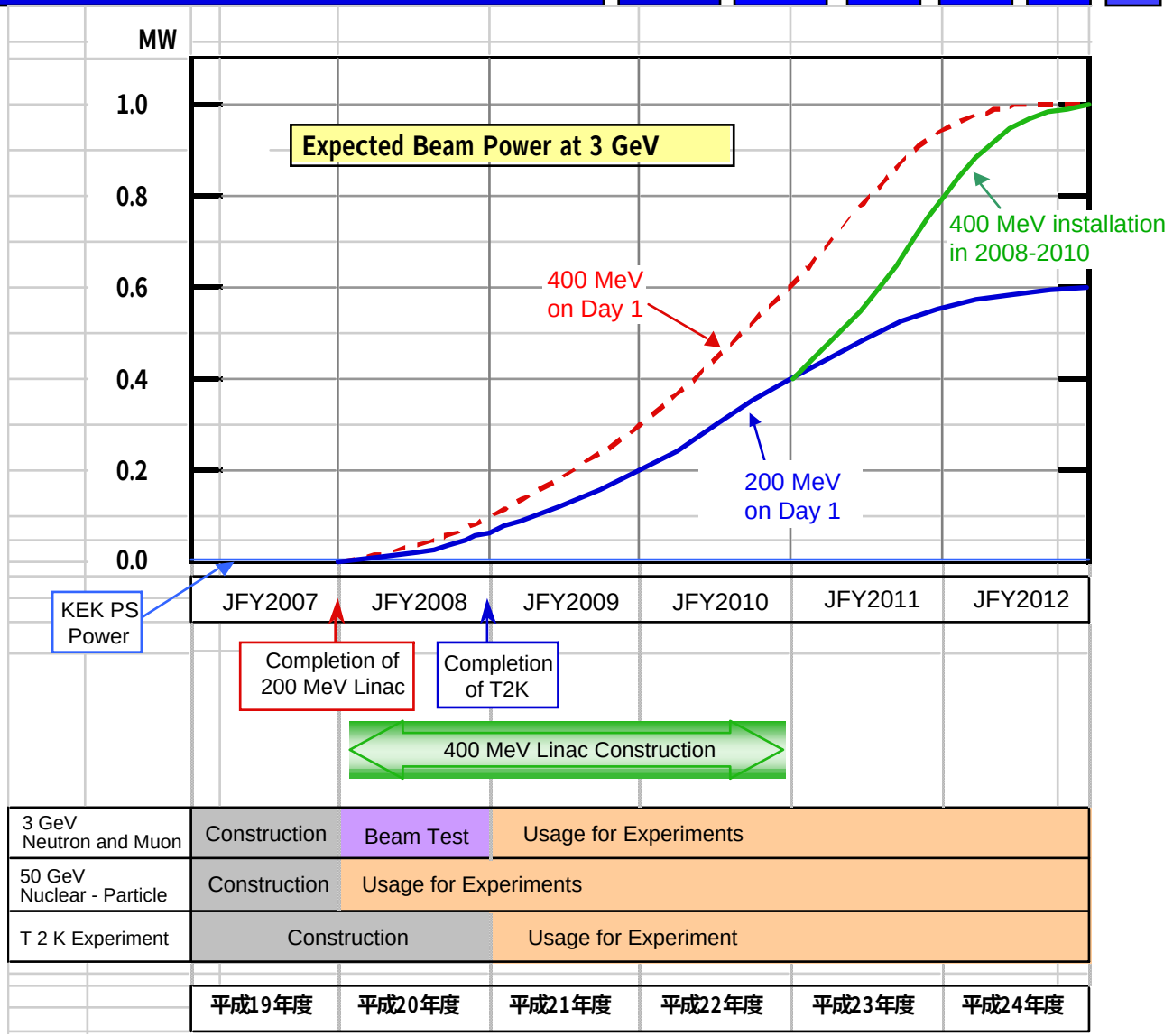
- Phase 1 + Phase 2 = 1,890 Oku Yen (= $1.89 billion if $1 = 100 Yen).
- Phase 1 = 1,513 Oku Yen for 7 years

Construction Schedule

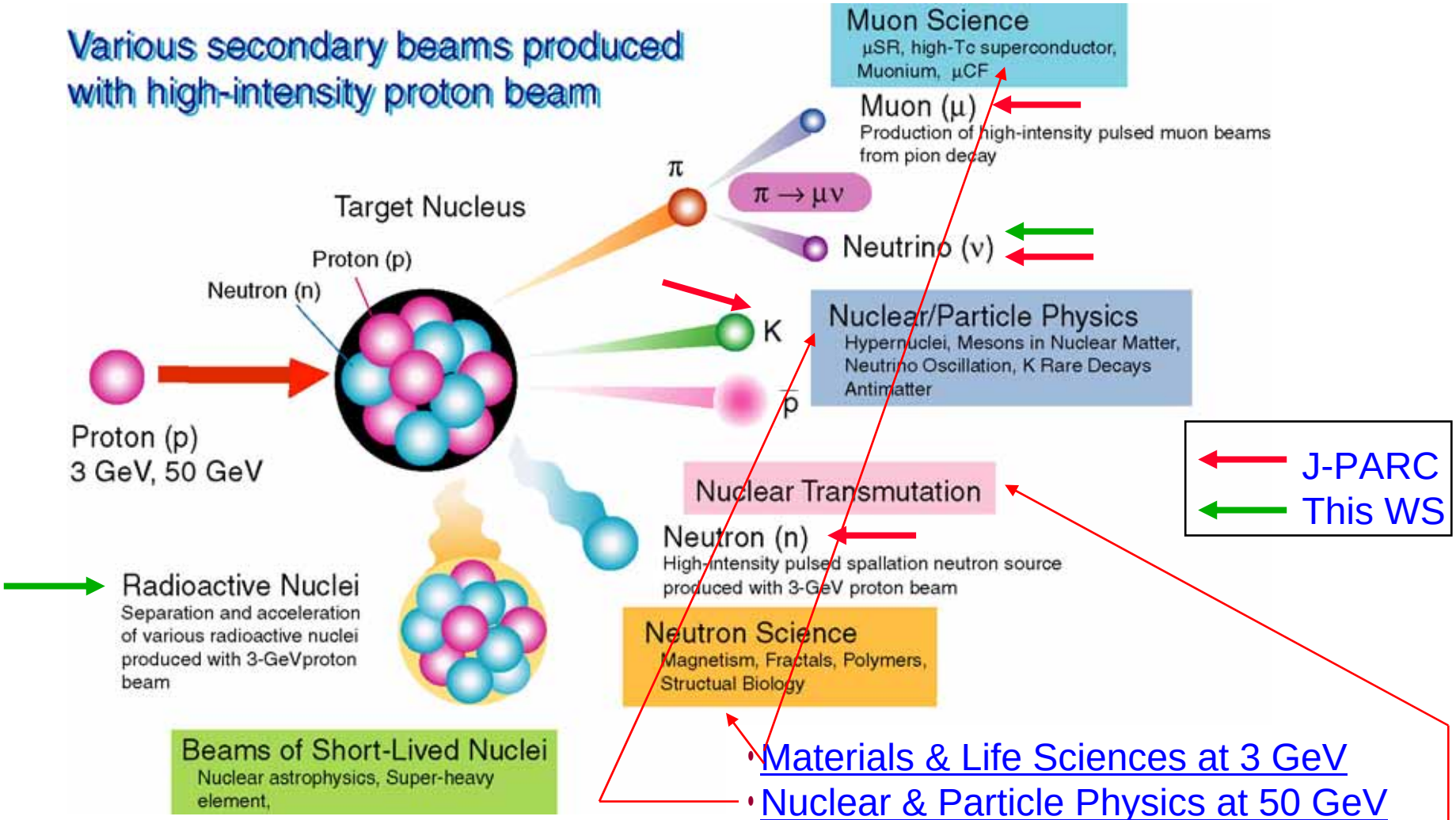
Construction Schedule (as of Oct., 2003)



Expected Beam Power



Three Goals at J-PARC



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

Construction Status


釜屋跡
かん水槽
大形かん水槽、釜屋跡など（遺構に見える溝は、
断面観察のためにつけたもの）
Ancient Salt Farm
February, 2004

Remains of Ancient Salt Farms

Water Pan

Boiling Farm

Studies by Local School Kids

Most likely at around the15th Century

Coins, Potteries, Human Bodies, etc.


Linac Area

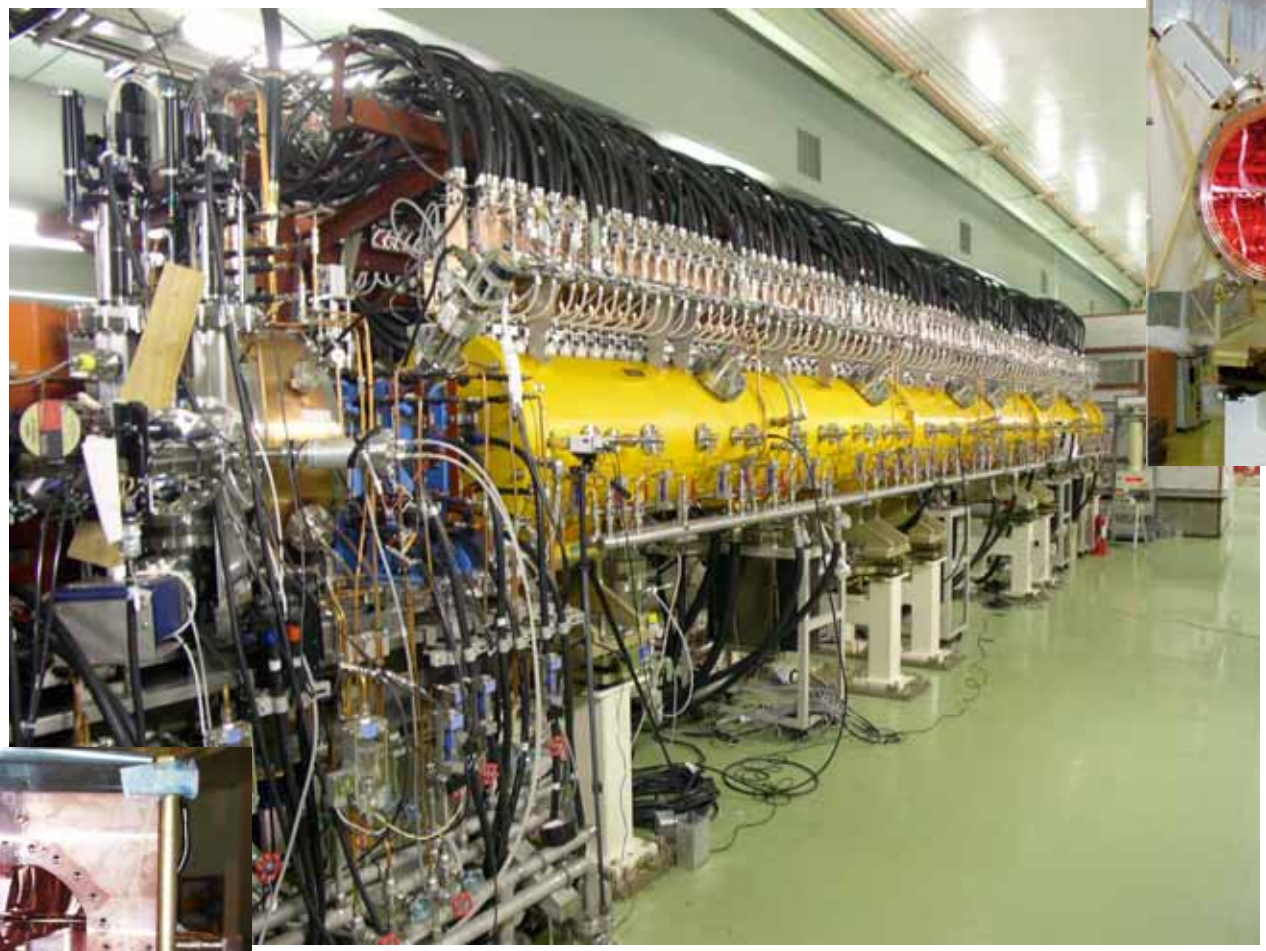

3 GeV Area
UMITOMO


50 GeV Area


Main Control Room

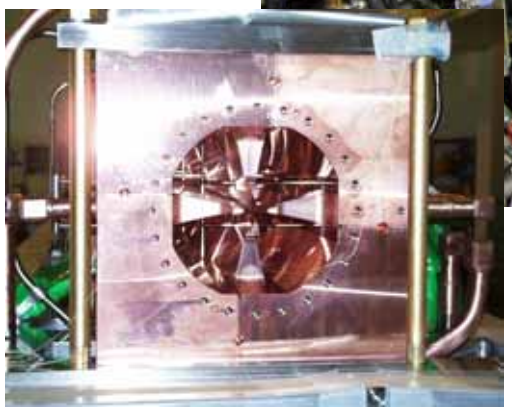
- **Accelerators**

Linac



Inside of Drift Tube Linac

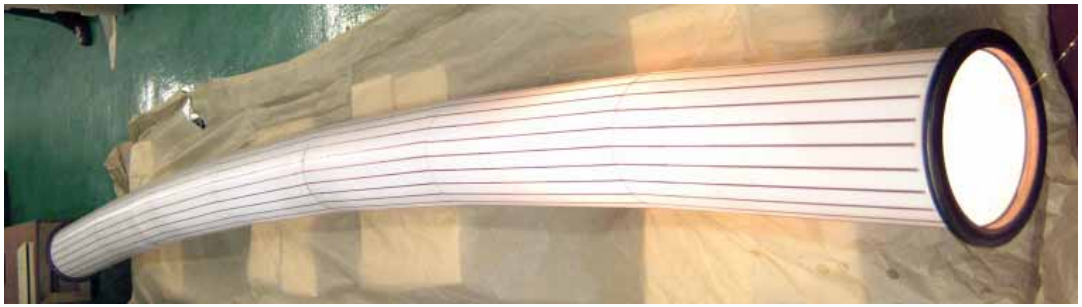
RFQ



Beam test for chopper was also done.

On October 30, 2003, a successful acceleration of 6 mA at 20 MeV. On November 7, 30 mA was achieved.

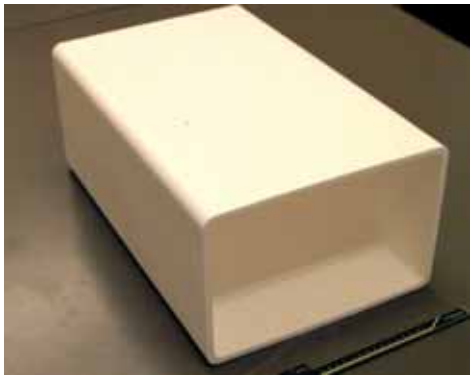
3 GeV Vacuum Pipe and 50 GeV RF Cavity



Vacuum Beam Pipe for 3 GeV

For dipole

For quadrupole



New material (Finemet)

50 kV/m Attained.

RF Cavity for 50 GeV

50 GeV Magnets

Dipole Magnet

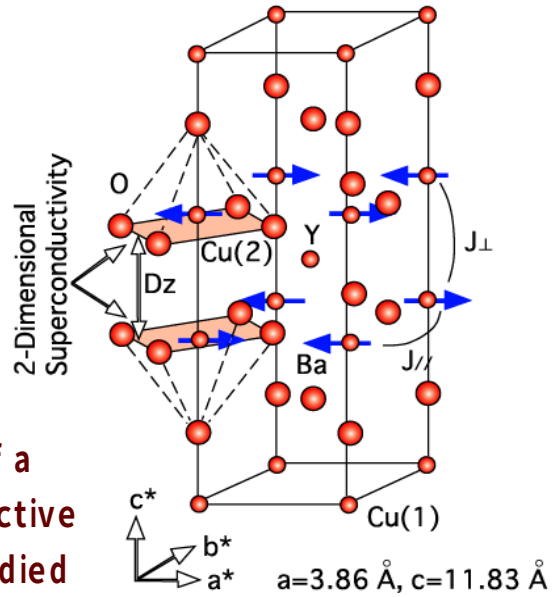
Quadrupole Magnet

Experiments

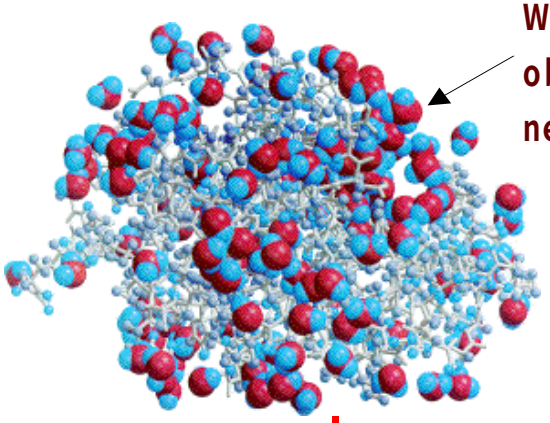
Materials and Life Science

The neutron has a magnetic moment which enebles us to measure magnetic structure of materials.

Superconductivity in $YBa_2Cu_3O_6$



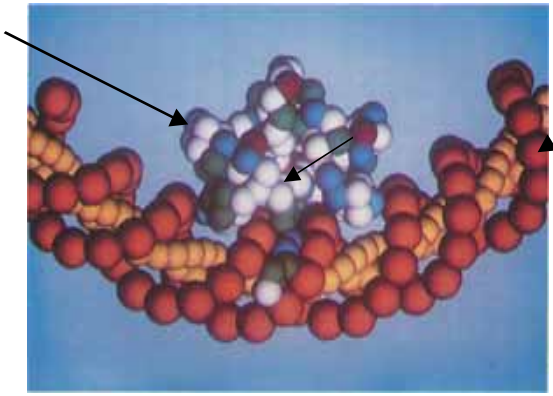
Structure of a superconductive material studied with neutrons



Water molecules observed with neutrons

From structure to function

タンパク質



DNA

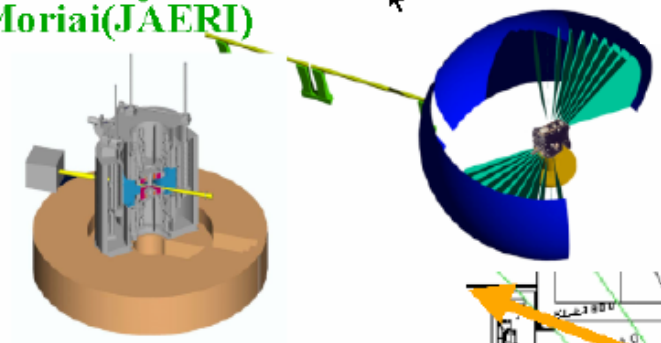
A proten molecule moving along the DNA chain

Neutrons are scattered by nuclei, in particular, by light-mass nuclei. The configuration of water molecules within a protein can be studied sensitively with neutrons. With high-intensity neutrons, the function of a protein along the DNA chain can be studied.

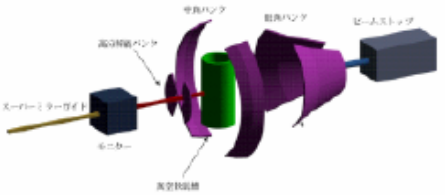
Neutron Scatterings

JSNS

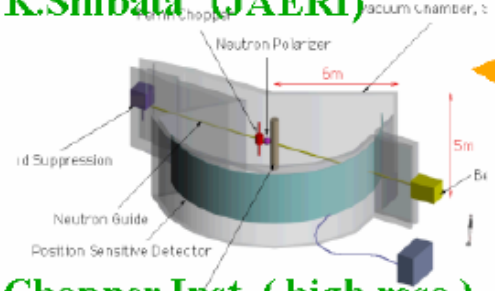
23 neutron beam lines



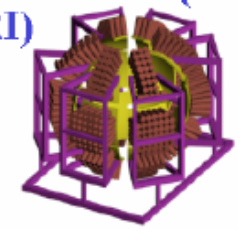
Stress Analysis diffractometer
A.Moriai(JAERI)



Powder diffractometer (versatile)
T.Ishigaki (Muroran Inst Tech)

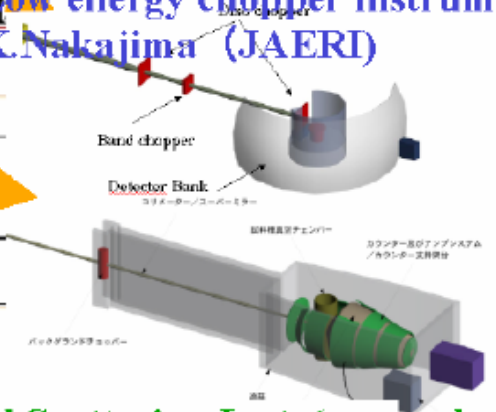


Bio- molecular spectrometer
K.Shibata (JAERI)

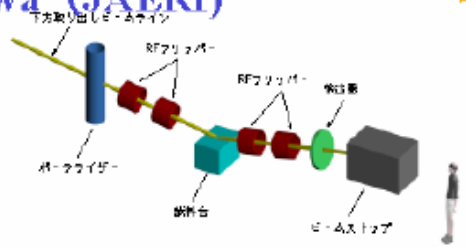


Bio- molecular X- tal diff.(versatile)
I.Tanaka(JAERI)

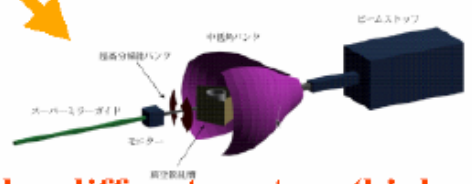
Chopper Inst. (high reso.)
S.Itoh(KEK)



Low energy chopper instrument
K.Nakajima (JAERI)



Small angle diff.(high intensity)
K.Aizawa (JAERI)



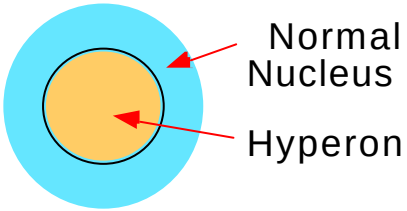
Total Scattering Inst. (amorphous)
T.Otomo(KEK)

Reflectometer (horizontal)
N.Torikai(KEK)

Powder diffractometers (high resolution)
T.Kamiyama(KEK)

Nuclear and Particle Physics

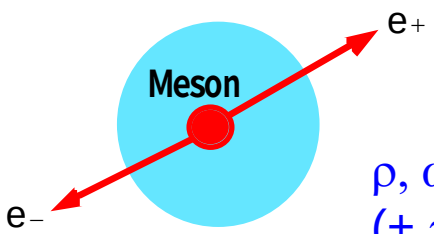
Baryon Implantation



Hypernucleus

- High resolution spectroscopy for S = -1 hypernuclei
- S = -2 hypernuclei

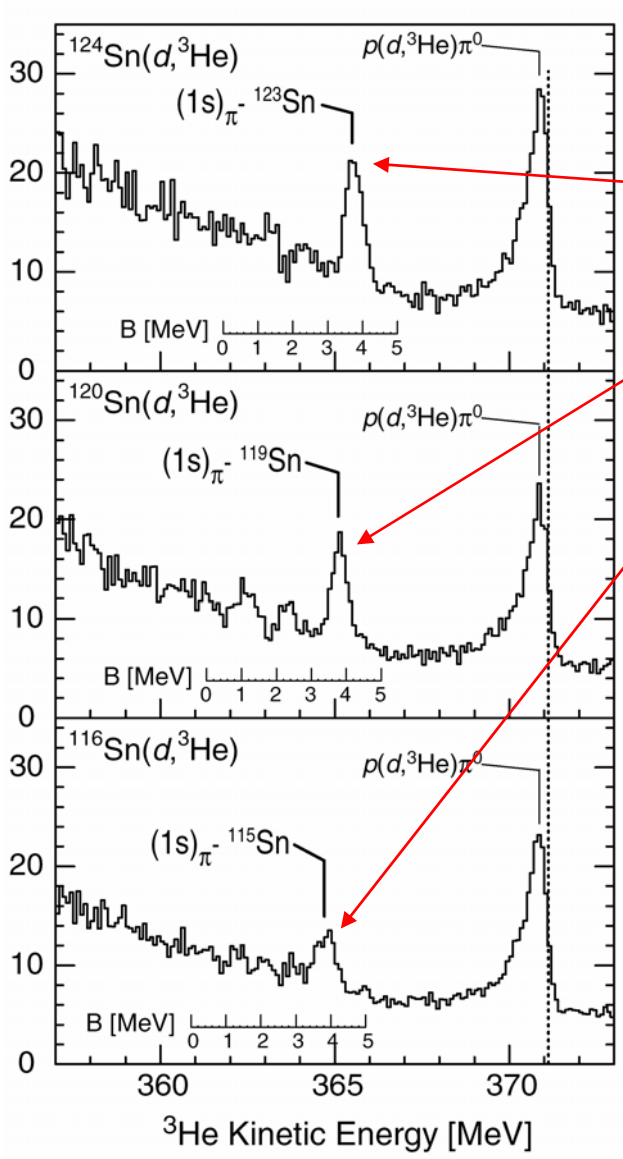
Meson Implantation



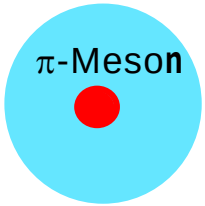
ρ, ω, ϕ, J/Ψ, etc.
(+ π, K, σ, etc.)

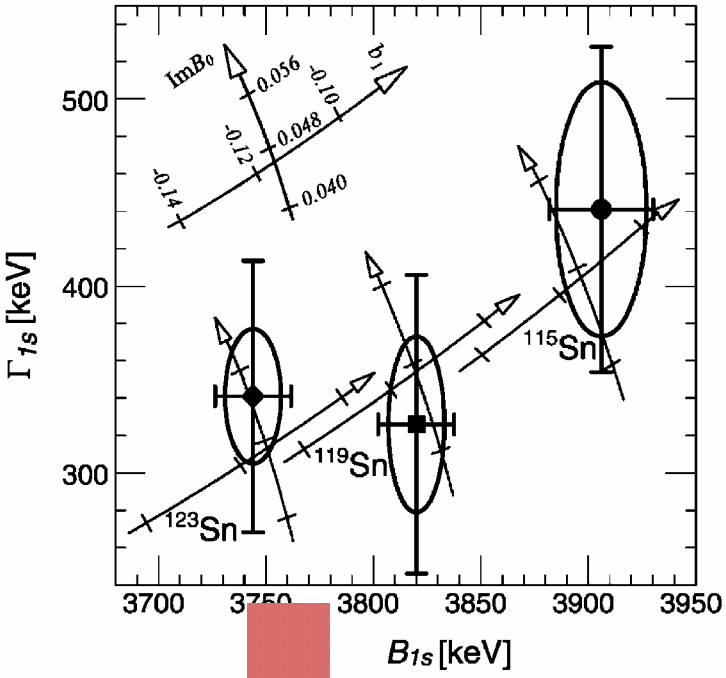
Neutrino measurement at SuperKamiokande

Pion Implantation



Meson Implantation





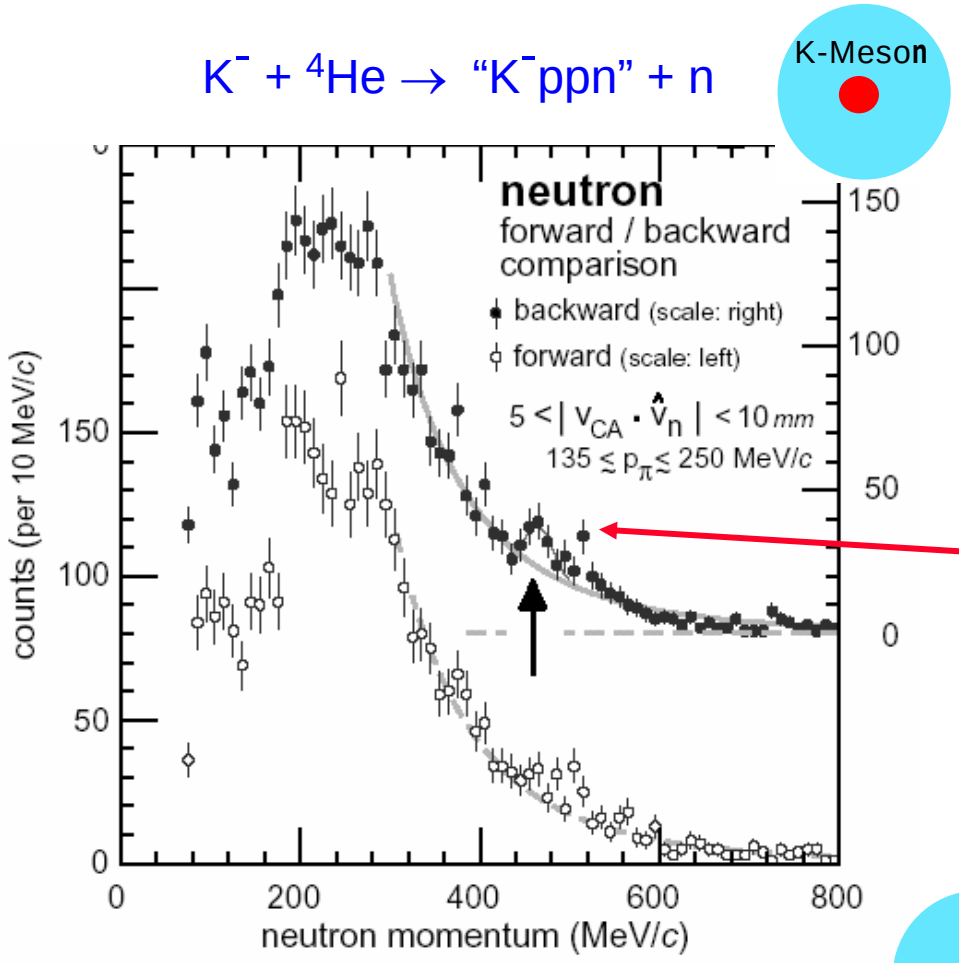
Inside nuclear matter the pion mass is reduced by 20%.

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

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

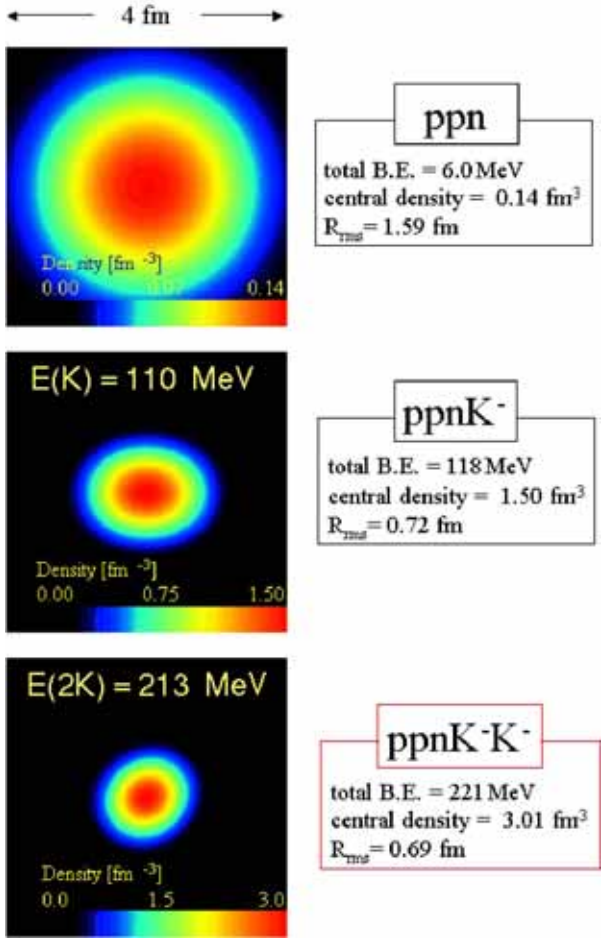
Strange Meson Implantation

$K^- + {}^4He \rightarrow$ "K^-ppn" + n



^3He

K^- in ^3He



Experiment by M. Iwasaki, et al.

Theory by Y. Akaishi, et al.

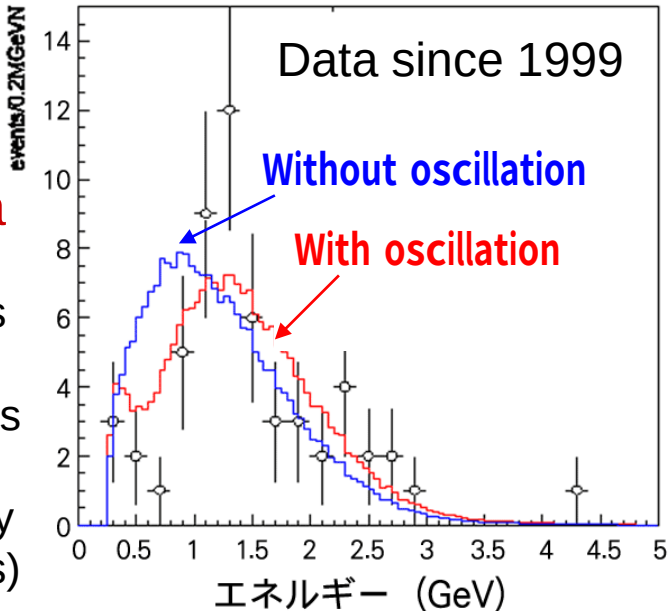
Nuclear shrinkage is also observed for Λ implantaion inside the nucleus ← K. Tanida, et al.

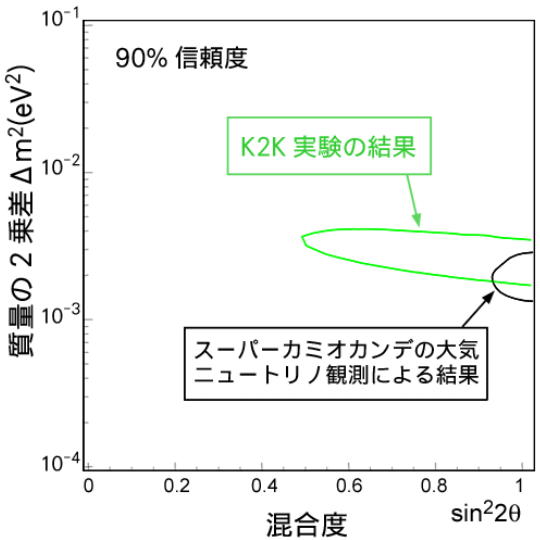
From K2K to T2K

K2K = KEK to Kamioka

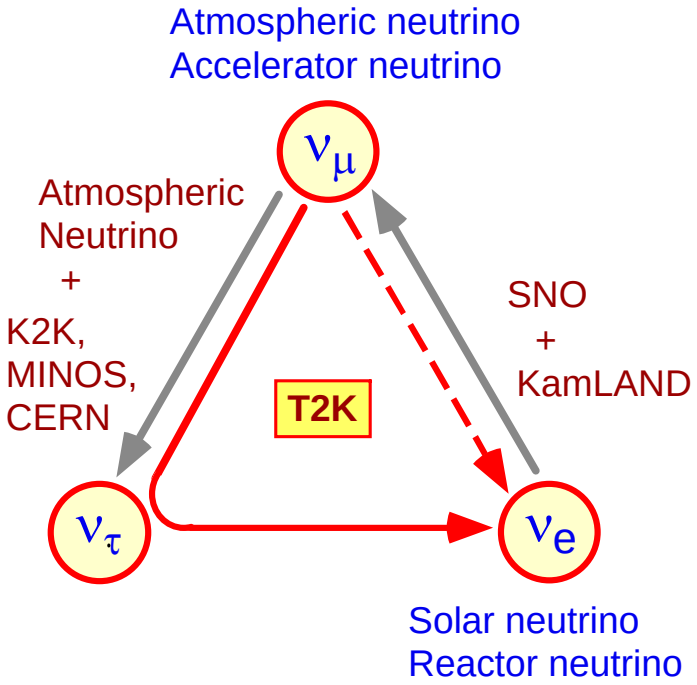
108 events observed (151 events expected without any oscillations)

→ 99.99% confident that ν carries a finite mass.





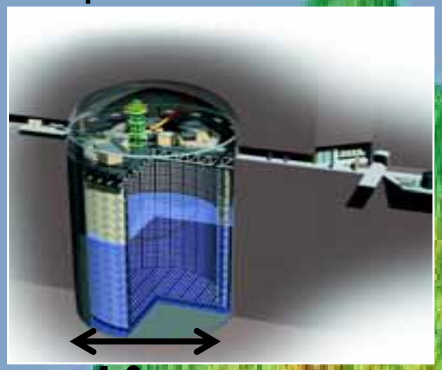
T2K = Tokai to Kamioka
(not yet an official name)



Flux (ν_μ) at J-PARC 50 GeV PS
> 100 **x** Flux (ν_μ) at KEK 12 GeV PS

Neutrino physics at J-PARC
Tokai-to-Kamioka (T2K) LBL ν experiment

Super-Kamiokande



T2K (2009~)

295 km

東海村

J-PARC
@JAERI

神岡

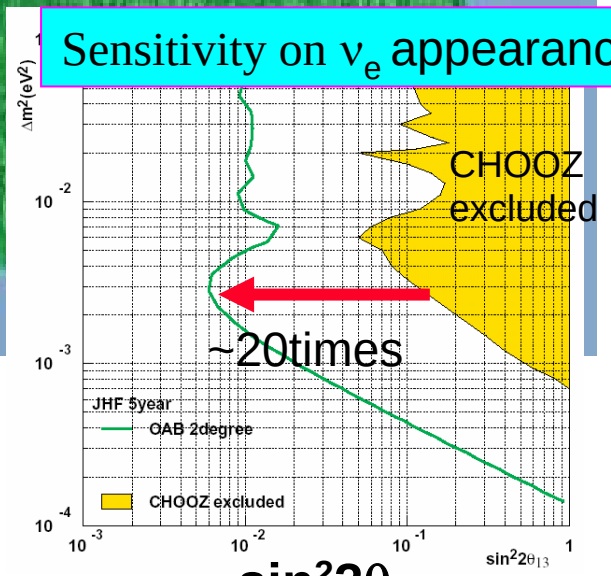
250km

K2K (1999~2005?)

KEK

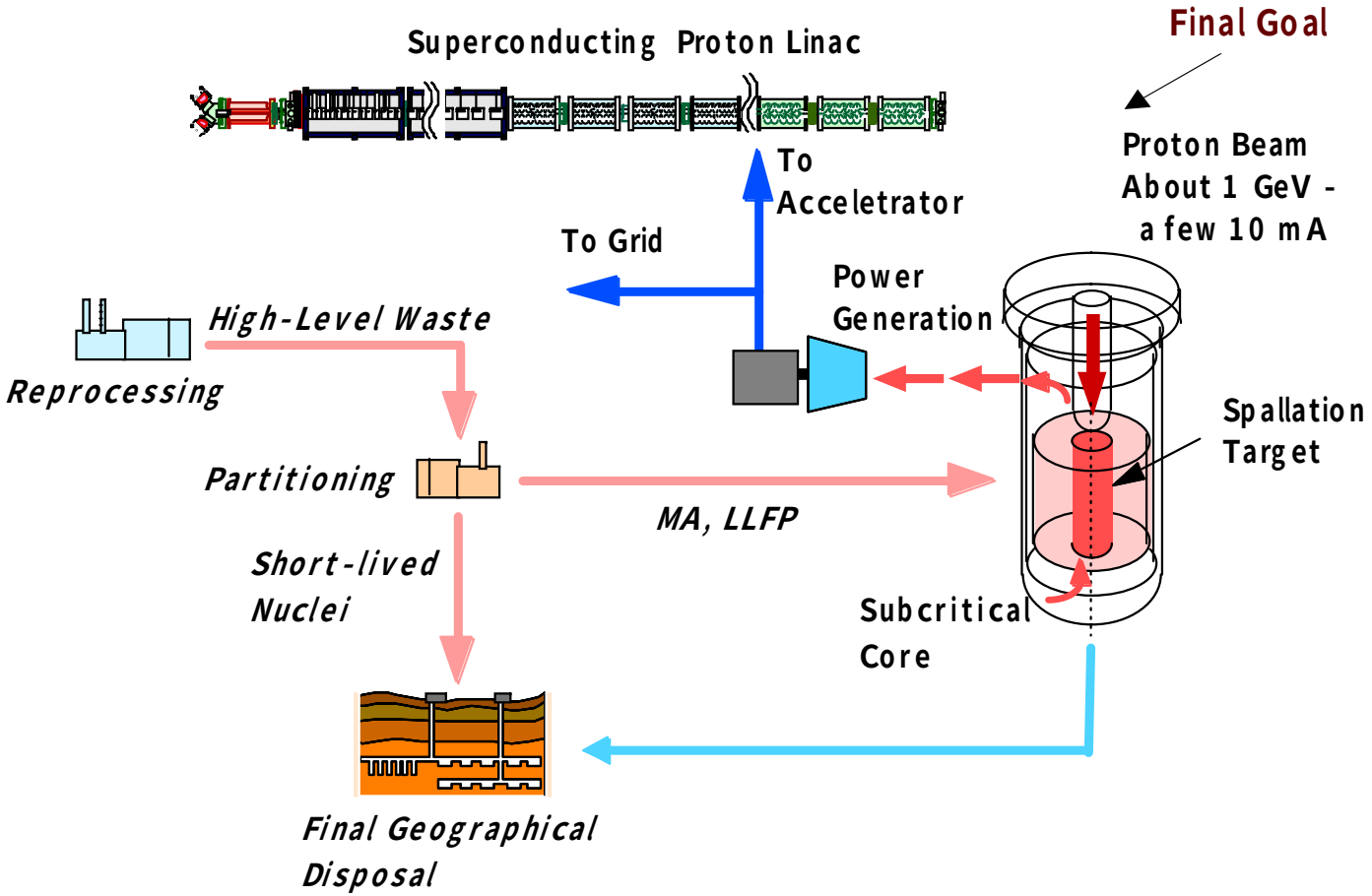
- Off-axis sub-GeV ν_μ beam from J-PARC 50GeV-PS
- ~3000 ν_μ CC int./yr (w/o osc.)
- ν_e appearance discovery
- ν_μ disapp. presice meas.
- 5 year const. Start exp. in 2009.

Sensitivity on ν_e appearance



$\sin^2 2\theta_{13}$

R&D Towards Nuclear Transmutation

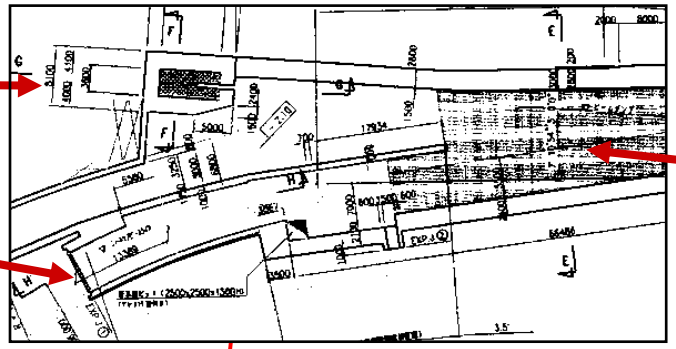


Nuclear transmutaion is an important issue for nuclear power stations. This project will explore the technical feasibility.

Arrangements to be Made for the Future

Reserved area for an additional fast extraction

Fast extraction for neutrinos



50 GeV main ring

Plan view

Phase 1

Phase 2

3 GeV PS (25Hz)

50 GeV PS Experimental Area

R&D for Nuclear Transmutation

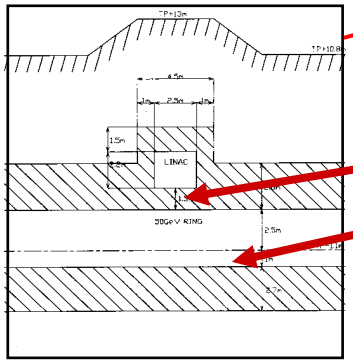
3 GeV PS Experimental Area

Linac (Superconducting)

Linac (Normal Conducting)

50 GeV PS

Neutrinos to SuperKamiokande



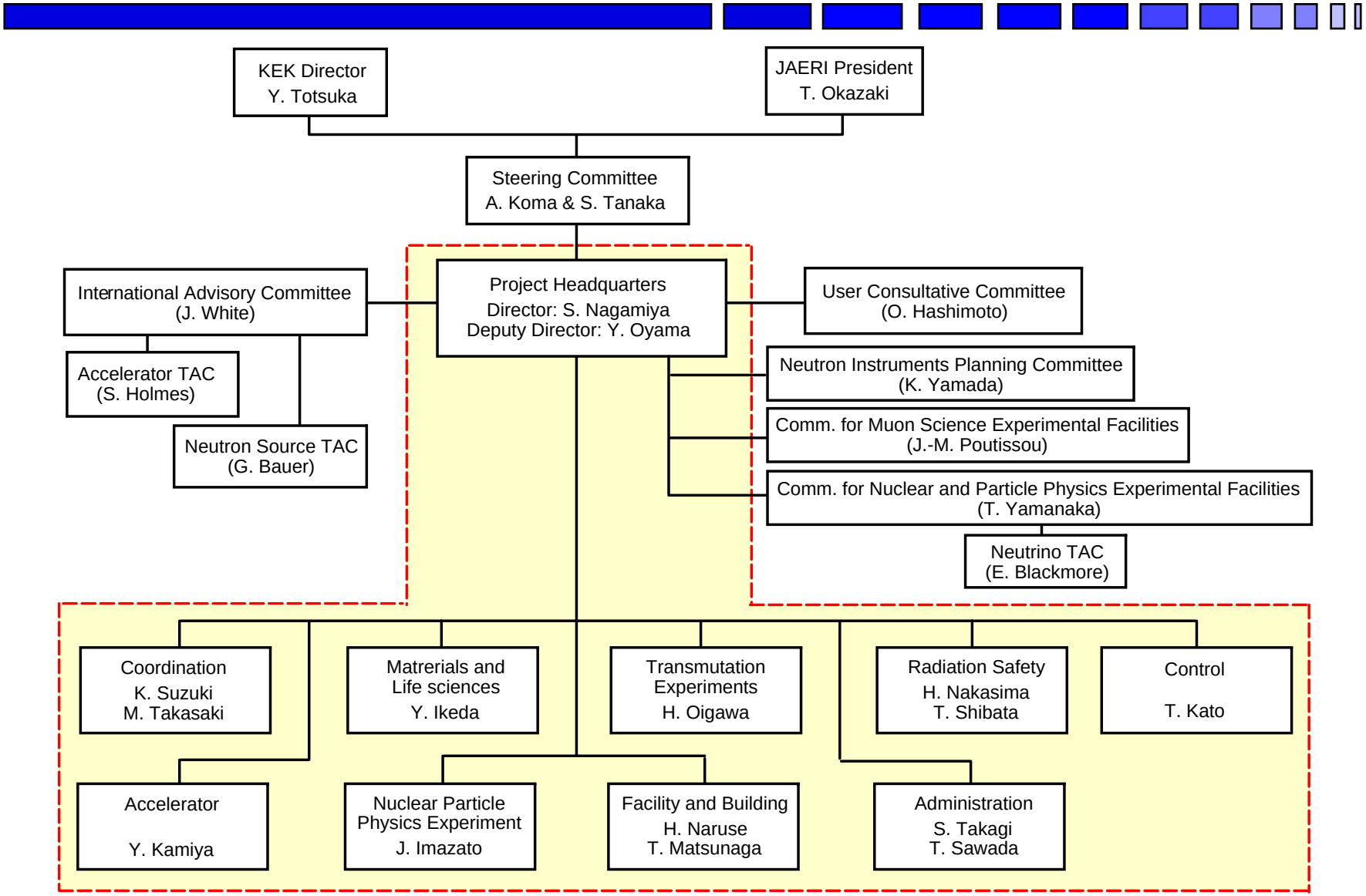
Tunnel for a future linac

50 GeV tunnel

Vertical View from the left

Control System

Organization for Construction



Important Characteristics of J-PARC Accelerators

- **Extra High Current Proton Accelerator**
  - Beam Loss must be minimized to protect radiation damage.
  - One shot Loss of Maximum Beam causes 1hr cooling time.
  - 20 shot Loss corresponds to legal allowance level of radiation.

- **Multipurpose of the four experimental facilities**
  - Not only Proton beam utilization, but also Neutron beam utilization are required simultaneously.
  - Achievement of high availability is required.

Demands to the Control System

- Rapid detection of the beam loss.
  - MPS
- Prediction of the beam loss.
  - Quick Response of Control System
- Parameter management that reduces the beam loss is requested.
  - Integrated Database
- Dynamic management of the operation privilege is required.
  - Access control

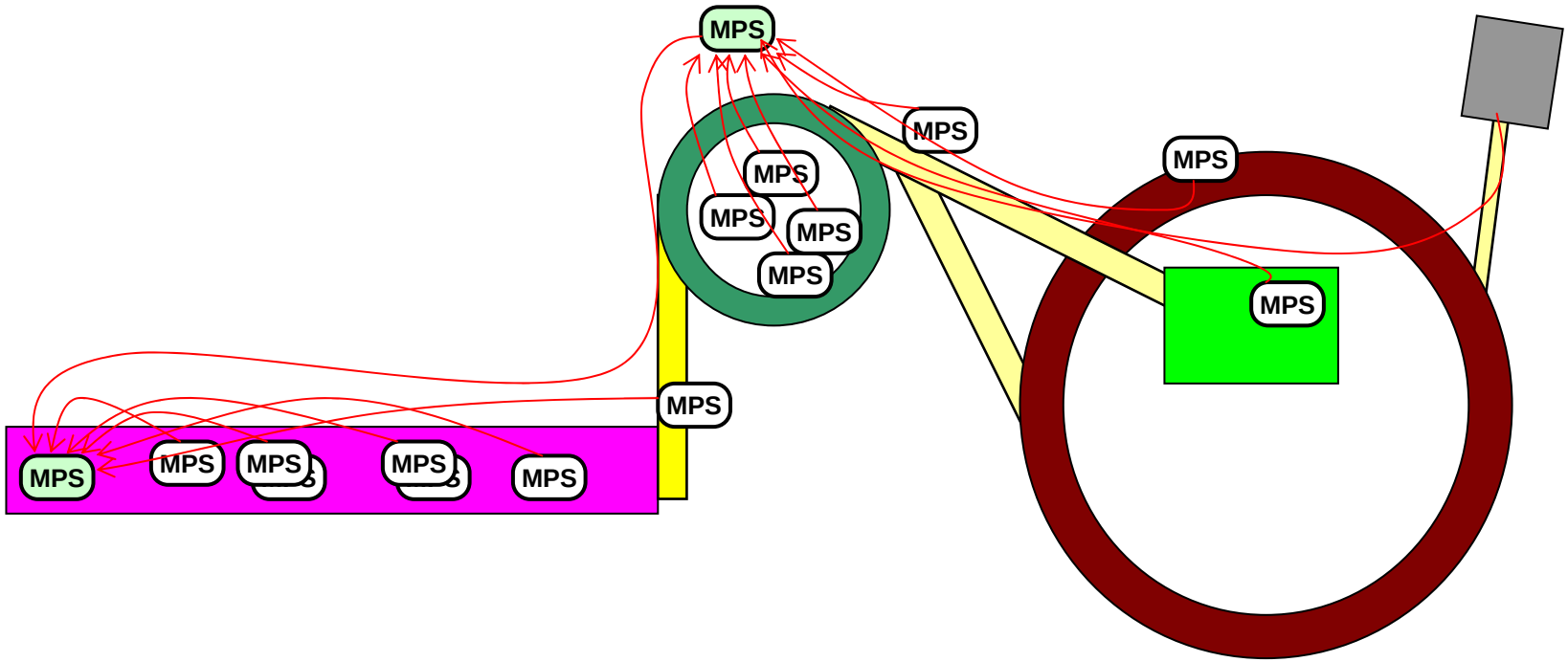
Hardware of Control System

- **EPICS standard**
  - Flat network
    - ESRP protocol on dual lines between core switches.
  - Distributed IOC
    - VME PPC750, linux PC
  - Several kind of IO devices
    - VME boards of analog input/output and digital input/output.
    - Programable Logic Controller (FA-M3)
    - Oscilloscope (TDS3014B, 5034B, 8500B, agilent83542B, DL1640L)
    - Skipback Recorder (cyclic event recorder)
  - Timing system
    - High frequency clock and the index code of LUT is distributed.

Hierarchical structure of the protection system

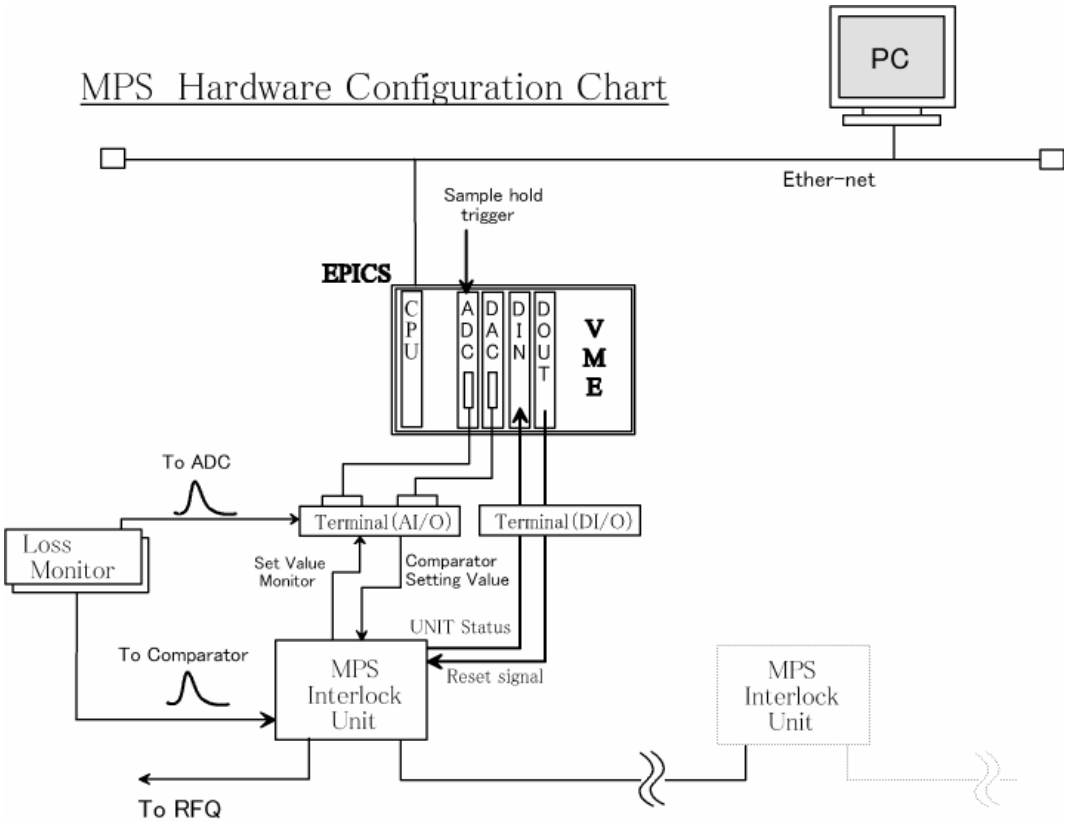
- **Personnel Protection System (PPS)**
  - Limiting the space that the beam can exist in, and ensuring the condition.
  - When the condition was broken, PPS stops the beam, and cuts off the transport path.
  - The purpose of PPS is to prevent the occurrence of human damage.
  - The compaction in the return time at the PPS action is not considered fundamentally.
  - PPS becomes the basis of the legal permission of this facility, and reliability is most important.
- **Machine Protection System (MPS)**
  - When something wrong happens with devices, MPS stops the beam.
  - The purpose of MPS is to prevent the damage of copper material by the bombardment of the high power beam.
  - Very fast response is required, and combination with the loss monitors is important.
- **Computer Control System**
  - Detecting the increase of beam loss, fluctuation of the beam orbit and errors of operation.
  - Prompting the modification of the parameters to avoid MPS action.
  - Correcting the parameters to prevent MPS action.
  - Masking several pulses when pulsed anomalous behaviors are predicted in the linac.

Configuration of MPS



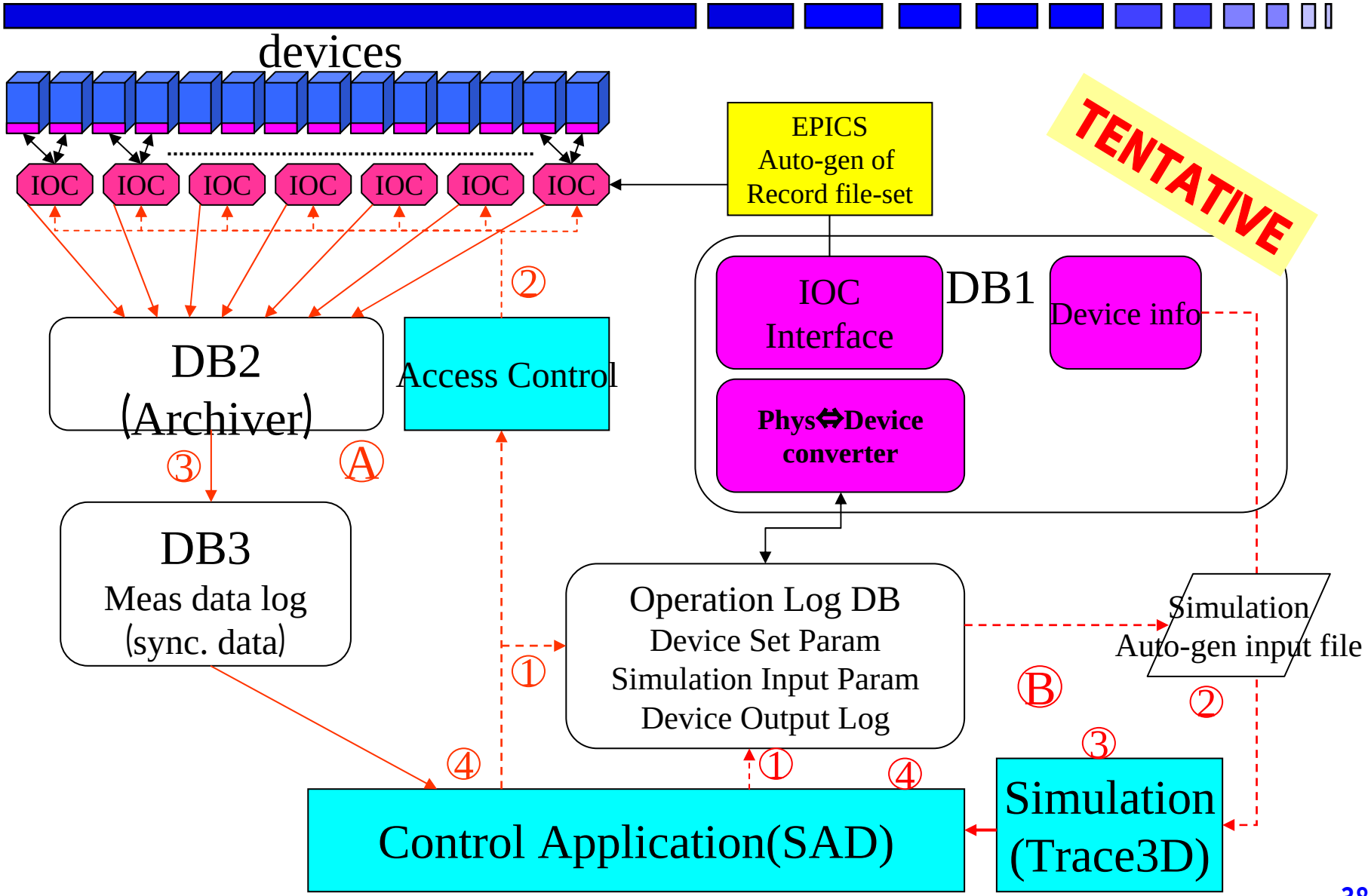
Many MPS units are distributed in the facility, and MPS events are transported to “Stopping the beam” circuit through the independent MPS line.

MPS UNIT



MPS unit has two signal lines. One is metal or fiber line for the event transport, and the other is ether-net for parameters and information.

Scheme of DB system



Summary

- Hardware of control system are prepared.
- Software development and system integration are under going now.
  - Access Control
  - OOP implementation