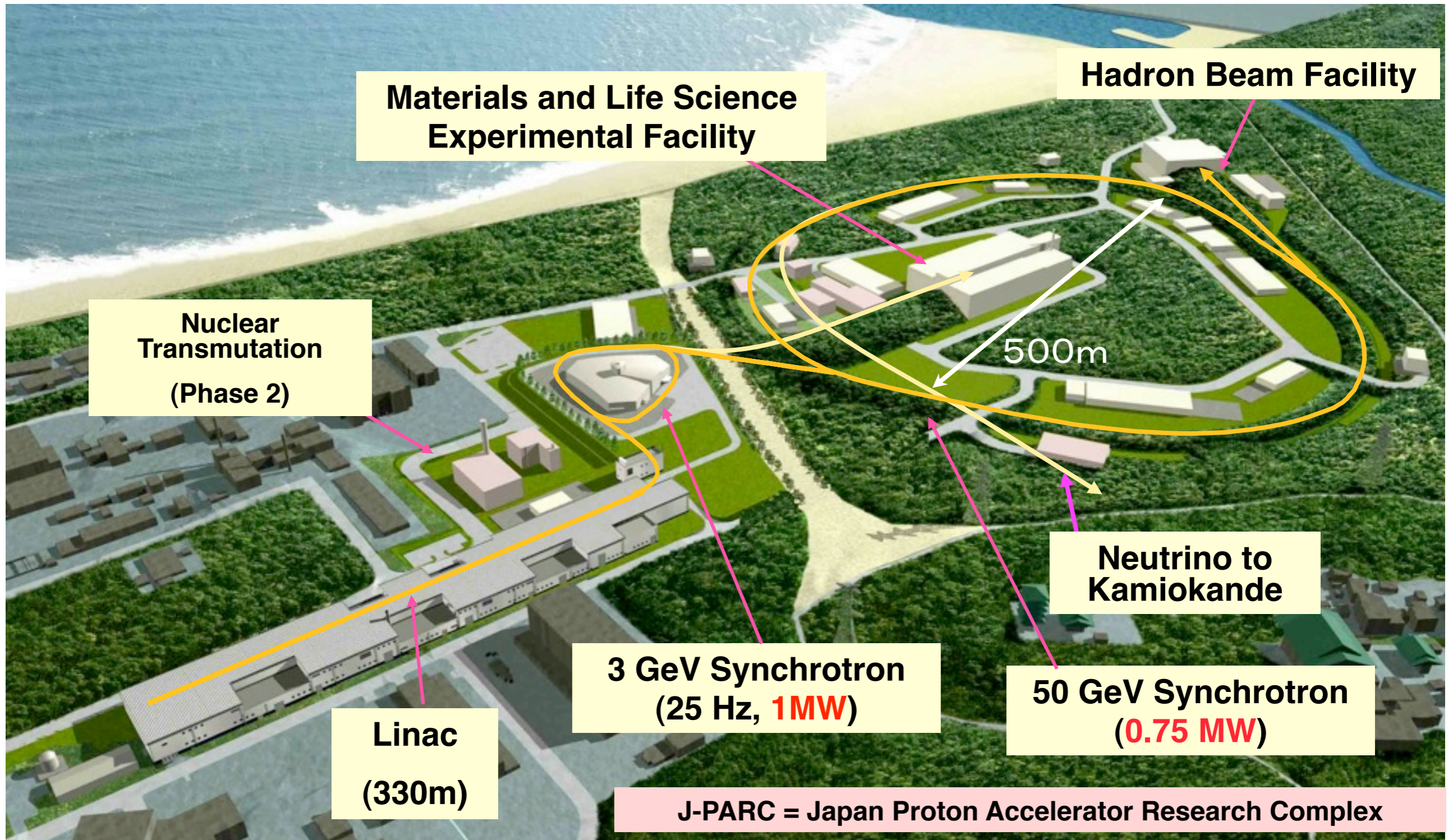


January 18, 2010  
1st ANPhA Symposium

# J-PARC Facility



Tomofumi Nagae  
Kyoto University



**Joint Project between KEK and JAEA**

**J-PARC Facility  
(KEK/JAEA)**

**South to North**

**Linac**

**3 GeV  
Synchrotron**

**Neutrino Beams  
(to Kamioka)**

**Materials and Life  
Experimental  
Facility**

**50 GeV  
Synchrotron**

**Hadron Exp.  
Facility**

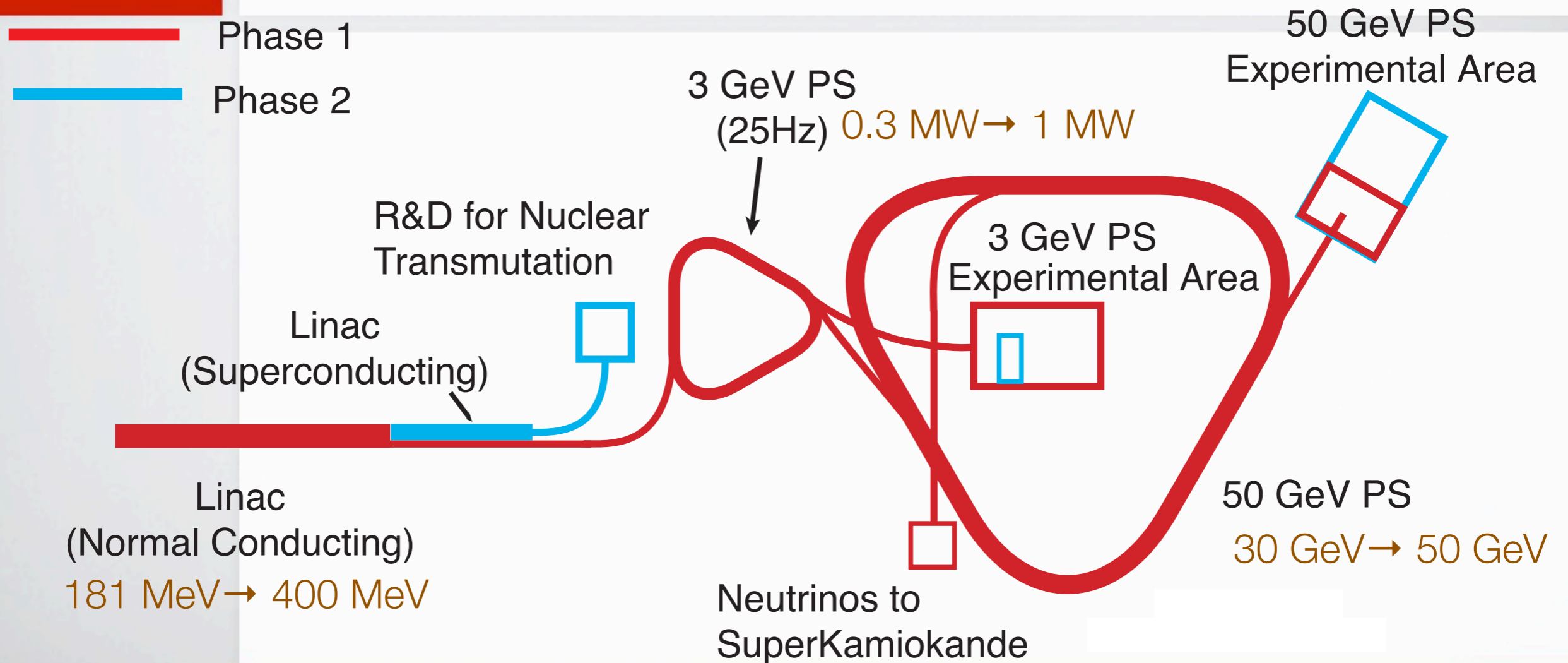
- CY2007 Beams**
- JFY2008 Beams**
- JFY2009 Beams**

Photo in July of 2009



# J-PARC Project: Phase 1&2

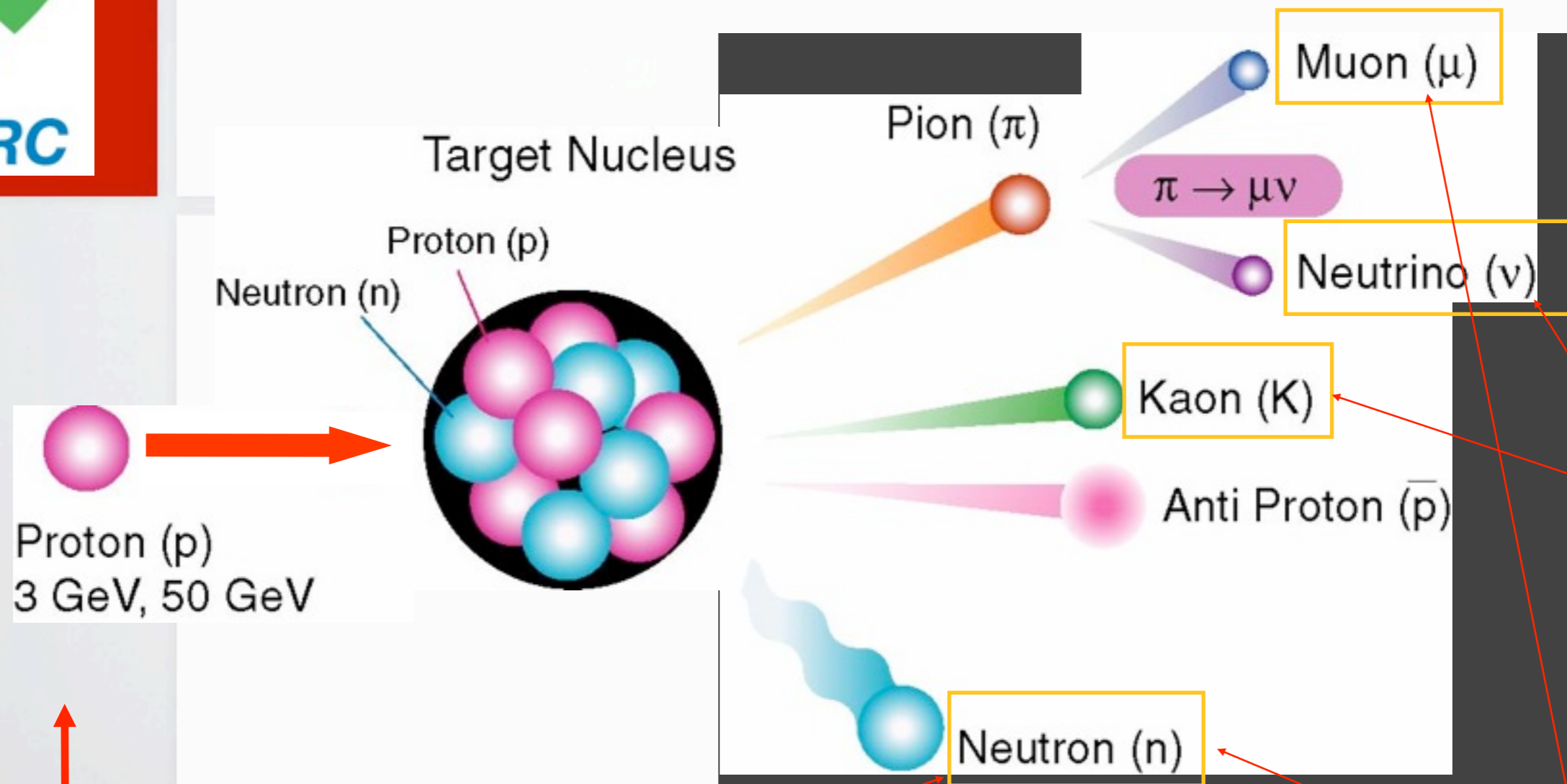
Construction : 2001 ~ 2008



Phase 1: → Total 1,500 Oku-Yen (56% JAEA, 44% KEK)!



# 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



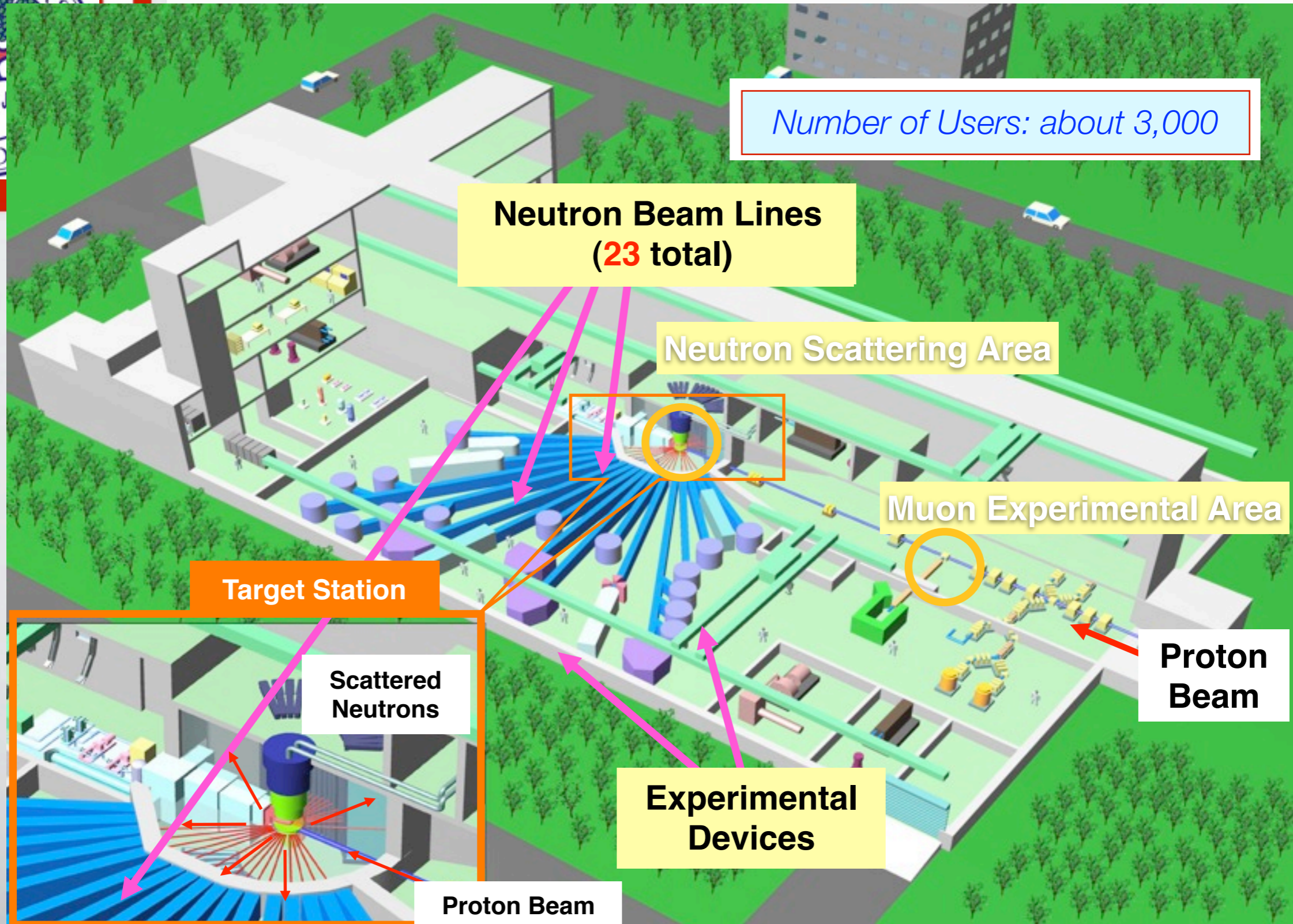
## Materials and Life Science Experimental Facility

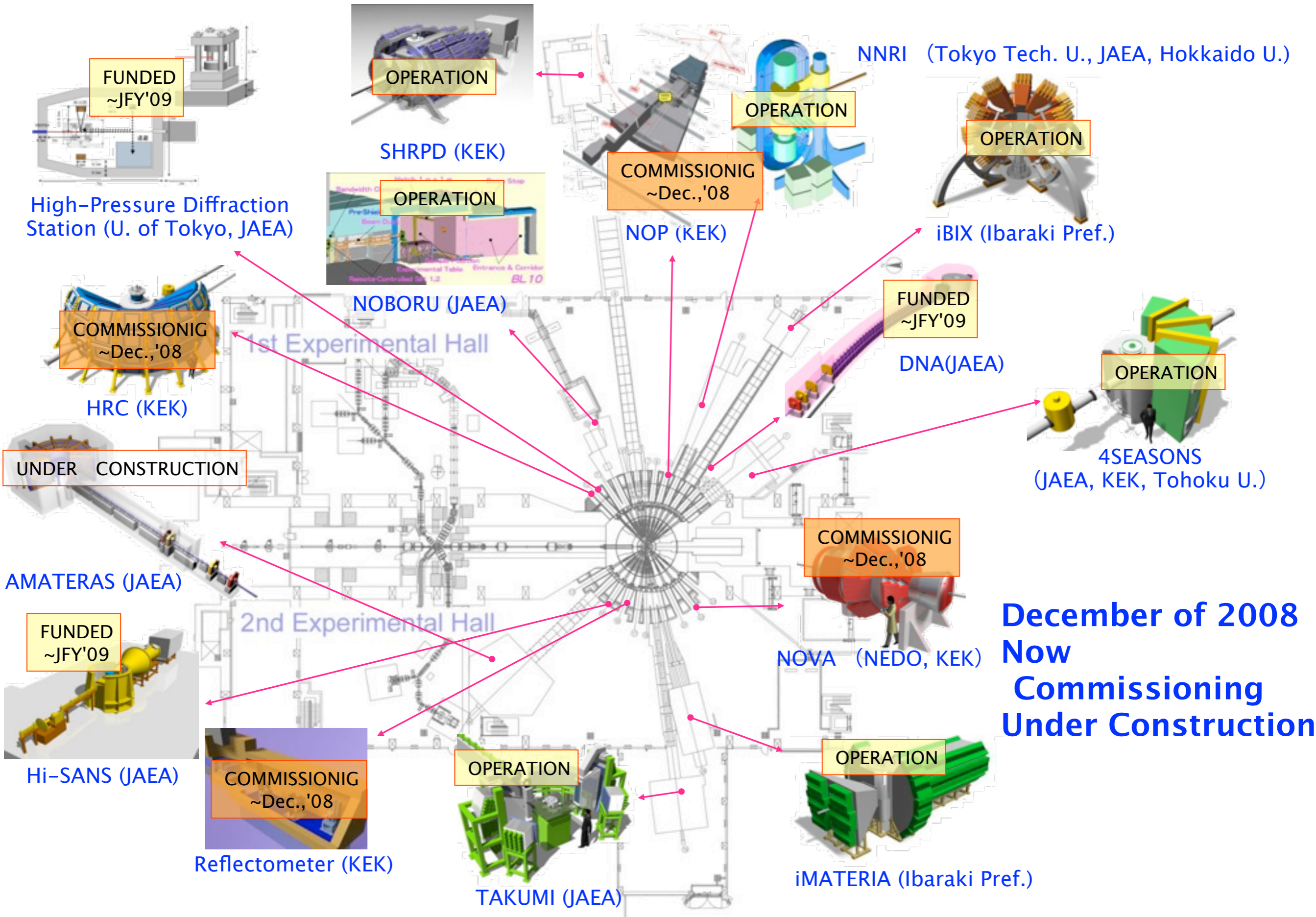
Facility similar to SNS in the US  
and to ISIS in the UK





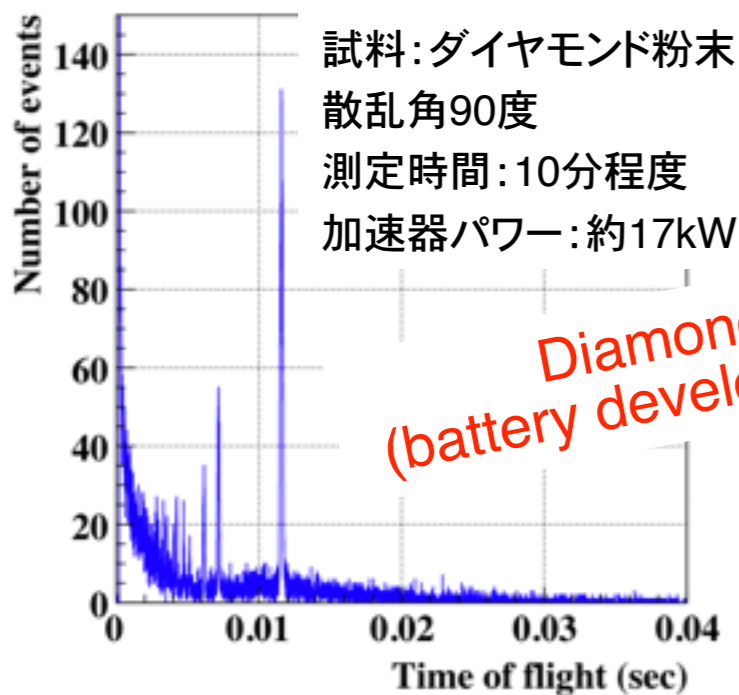
# Materials & Life Science Experimental Facility



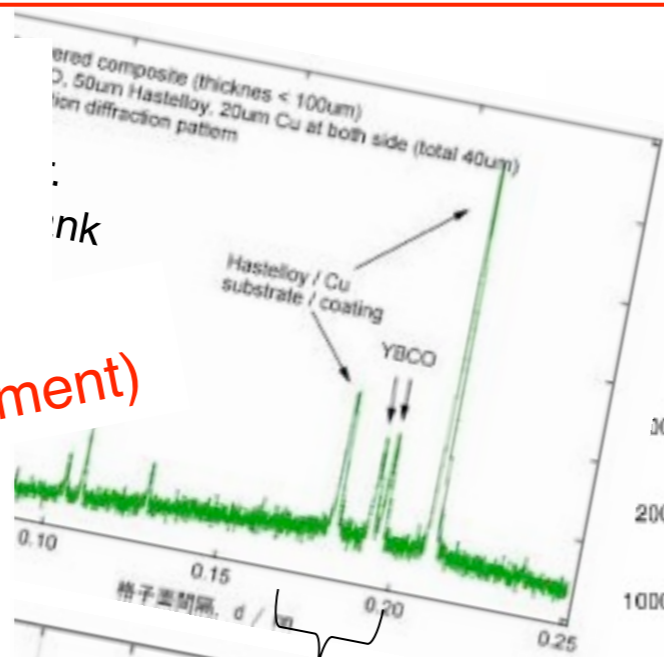




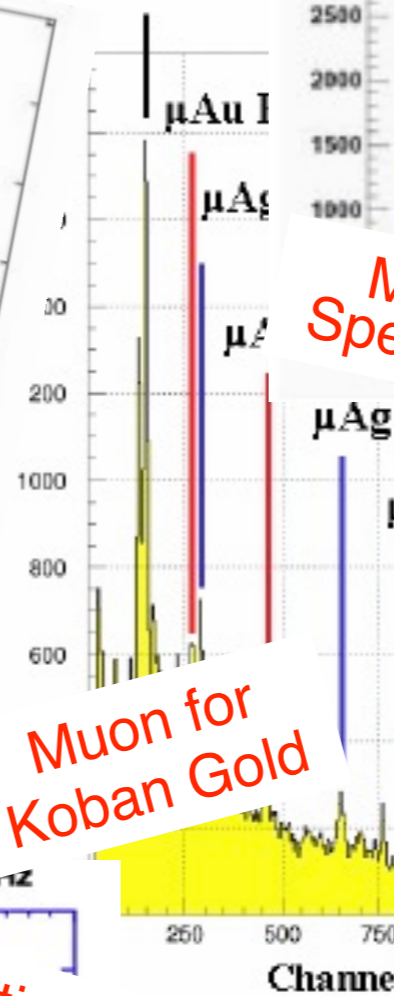
## Data from Neutrons and Muons



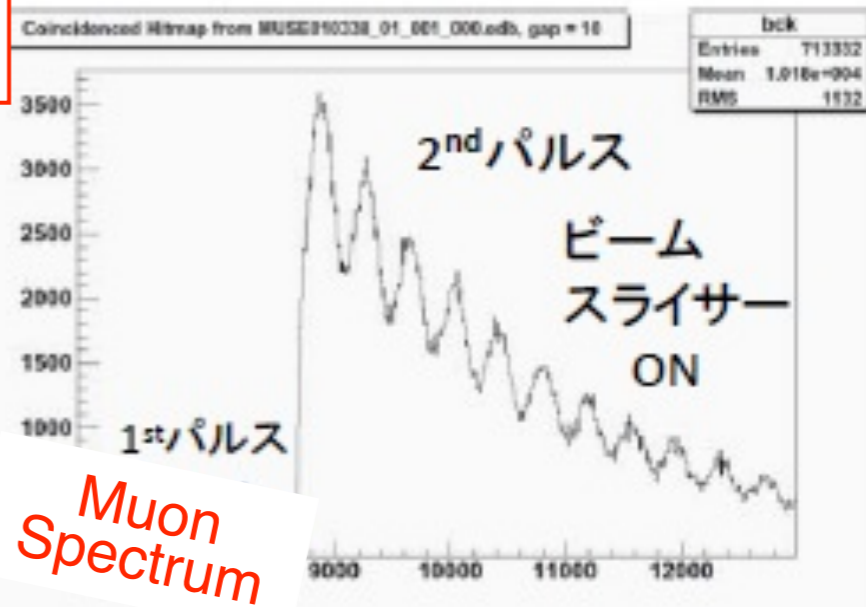
Diamond  
 (battery development)



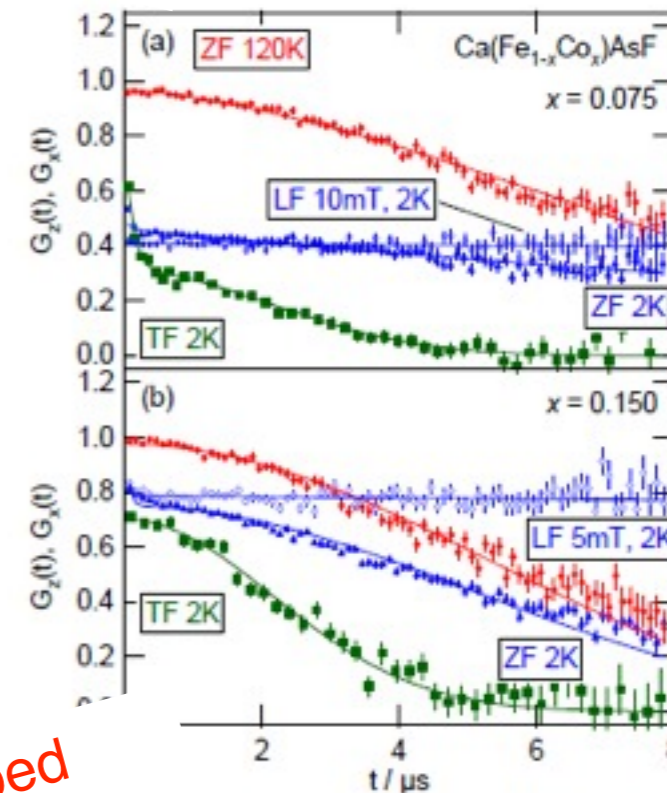
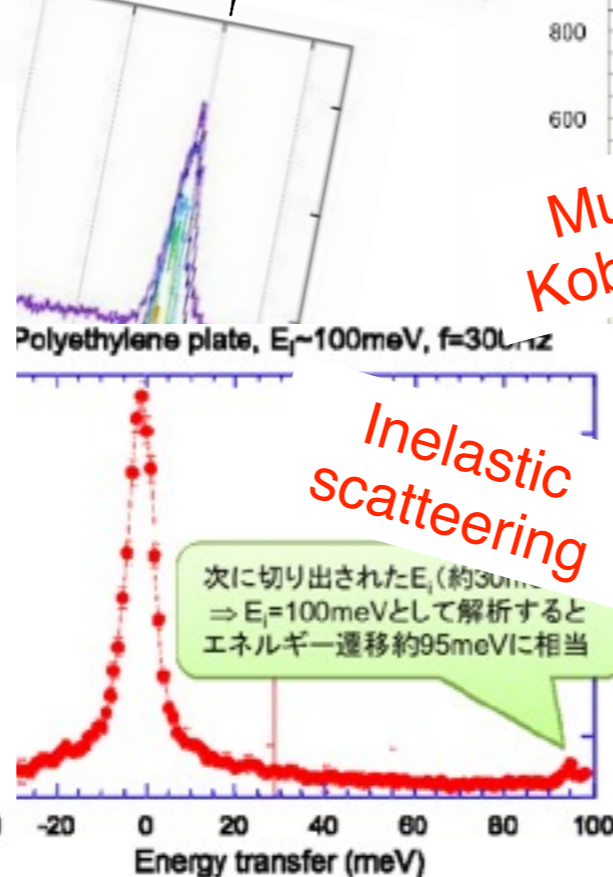
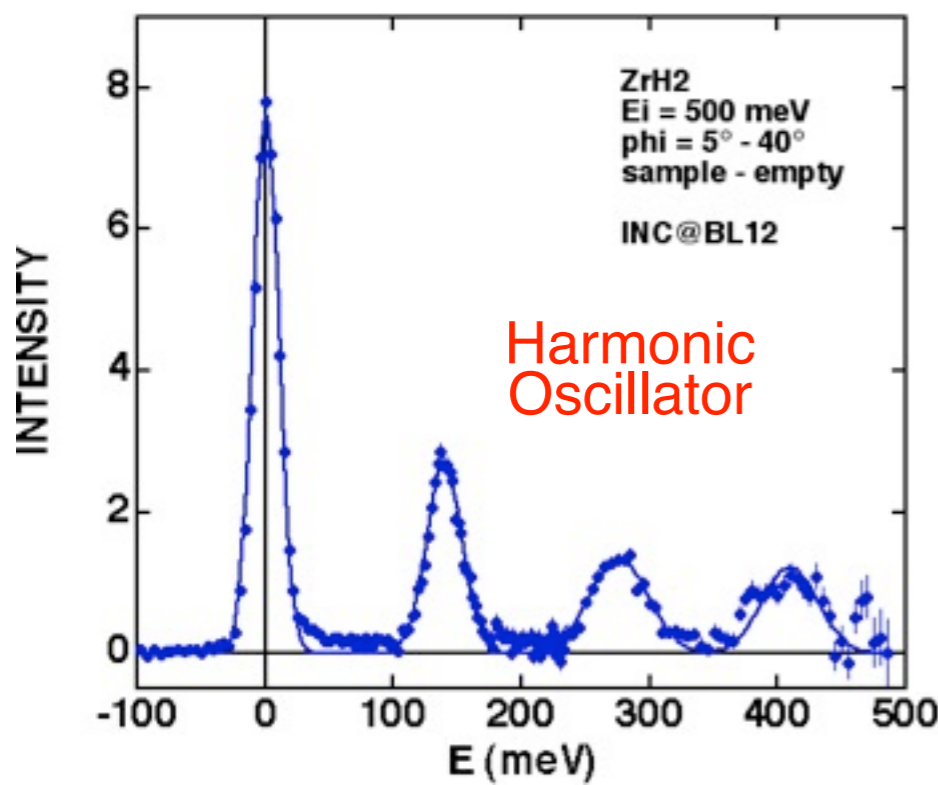
Au elect



Muon for  
 Koban Gold



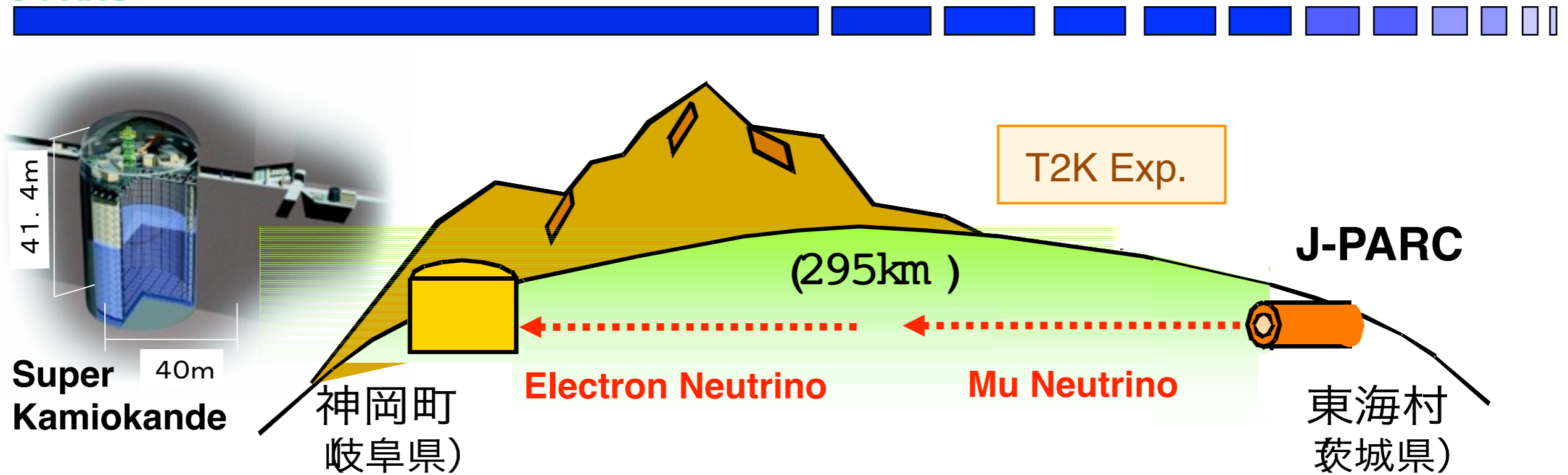
Muon  
 Spectrum



Ion-Doped  
 Superconductor  
 (accepted to PRL)

online)  $\mu$ SR time spectra observed in  
 $\tau = 0.075$  (a) and 0.15 (b) at 2 K under a  
 (LF, open circles), a zero field (ZF, trian-  
 and a transverse field (TF, squares), and that under ZF  
 above  $T_m$  (triangles). The spectrum under TF is plotted on  
 a rotating reference frame to extract the envelop function.

# Neutrino Oscillation (T2K) Experiment



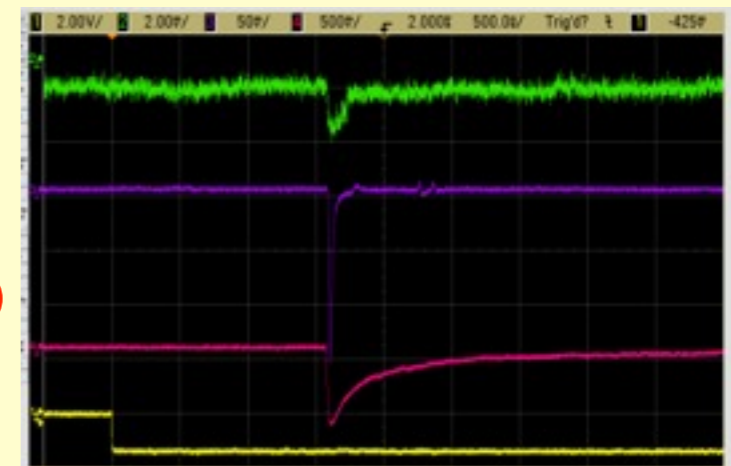
350 Non-Japanese Members  
(60 Japanese)



First measurements of mixing angles  
between 1st and 3rd neutrinos



Signal of  
neutrino  
production  
(April 23, 2009)



# Neutrino beamline

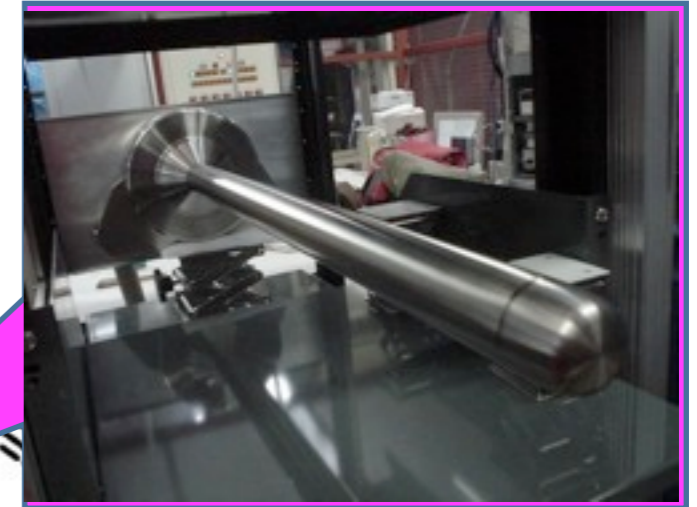
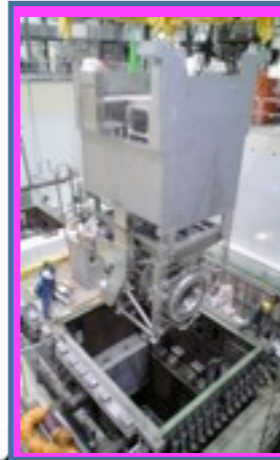
Focusing

Electromagnetic horn

Production of  $\pi$

Graphite target

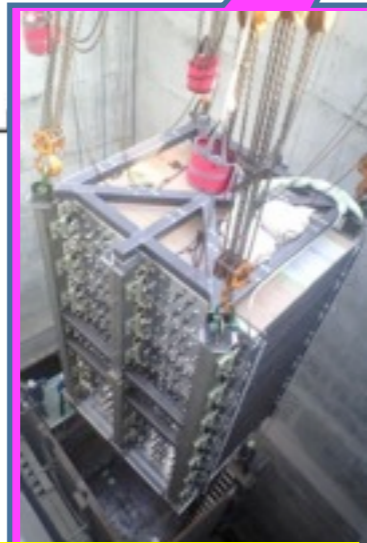
Neutrino monitor build.



UA1 magnet donated from CERN installed in Apr-Jun, 2008 on schedule

Confirmation of  $\nu$  production

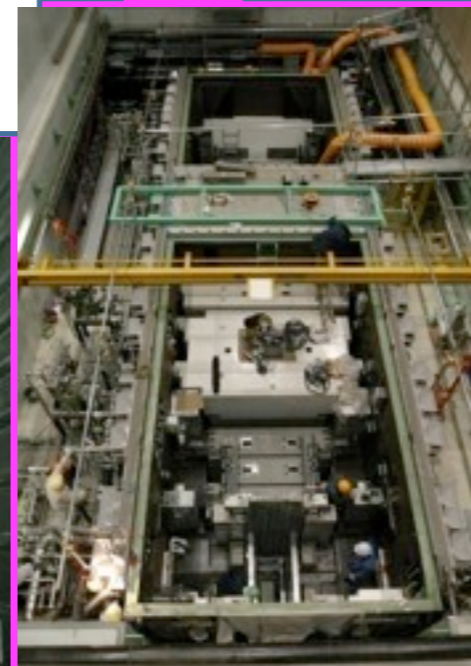
On-site detector



Beam dump completed



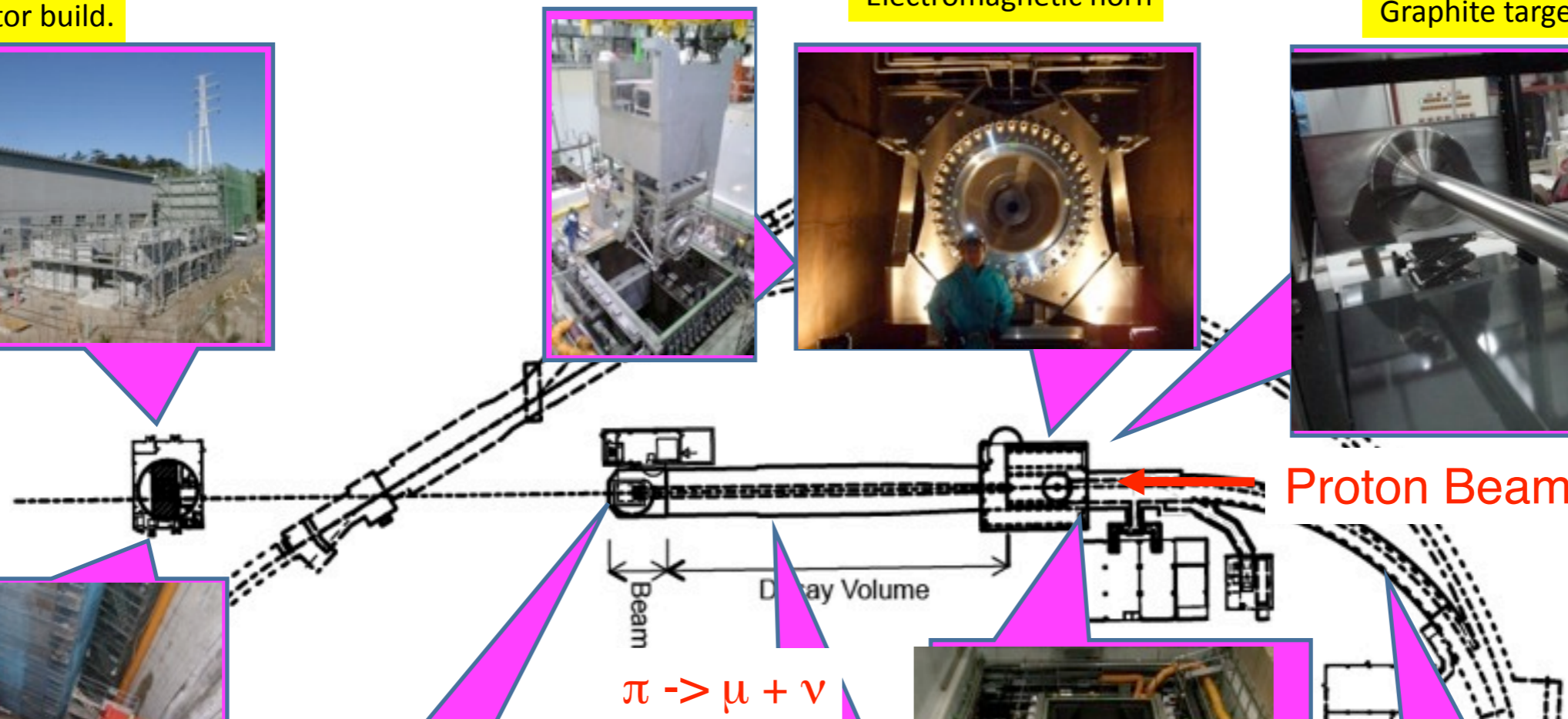
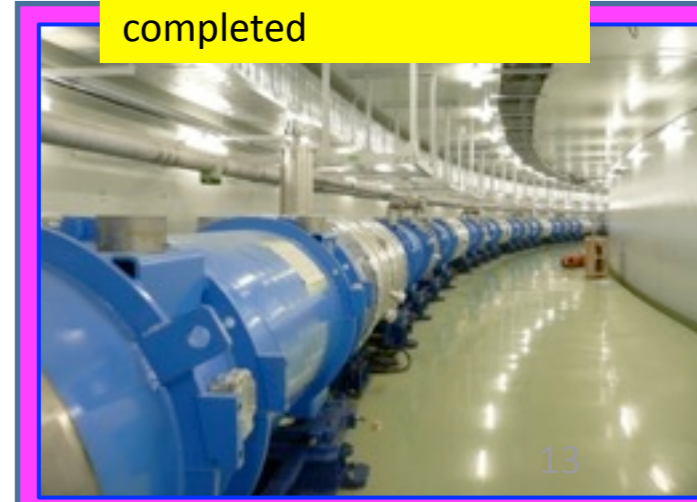
Decay volume completed



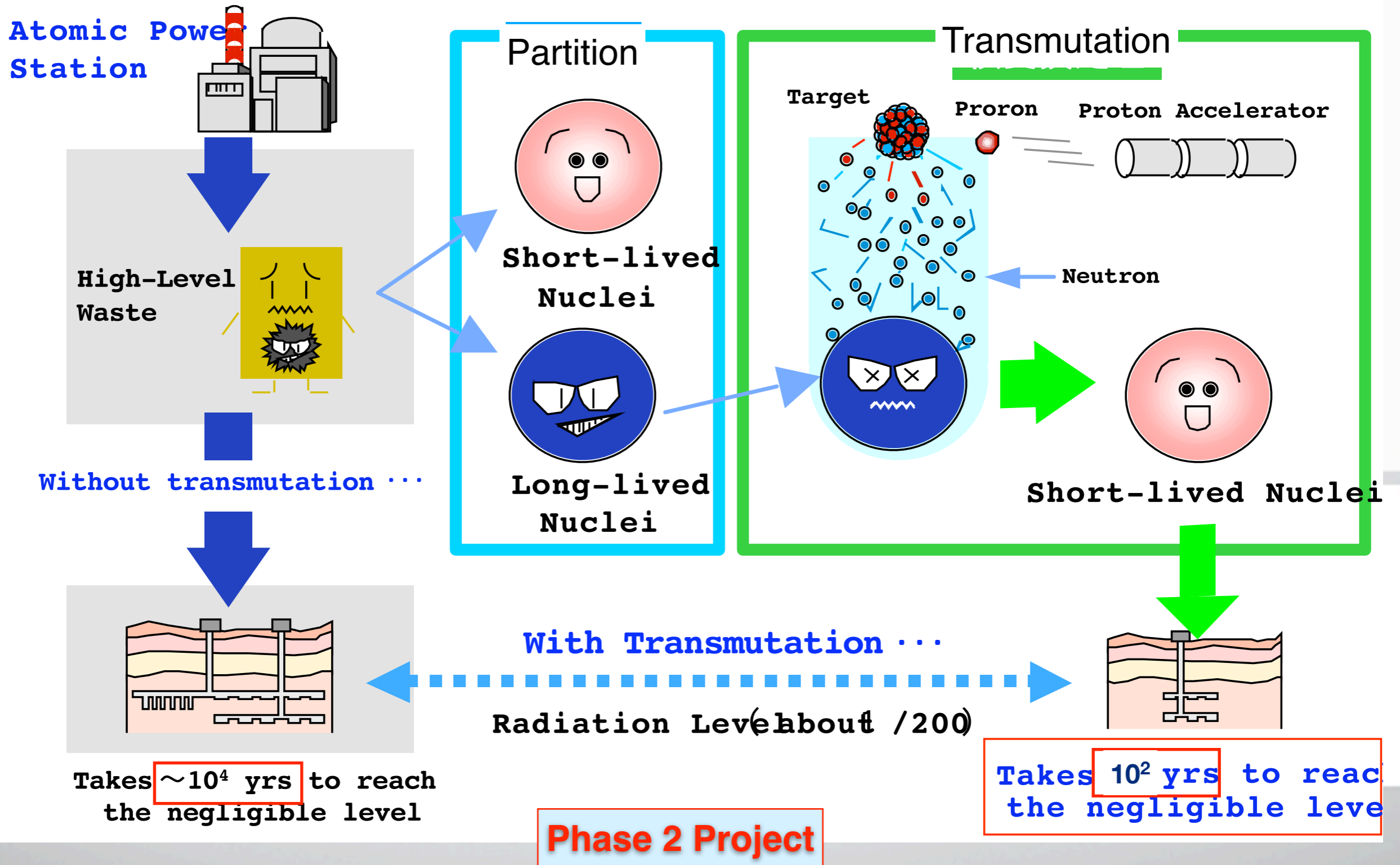
Target station completed

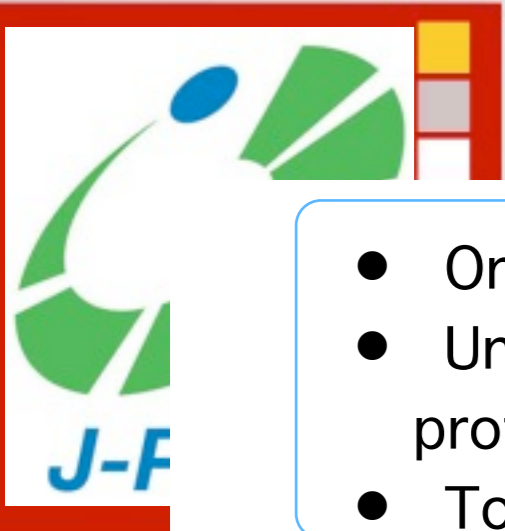
Proton Beams

Primary proton beam line completed



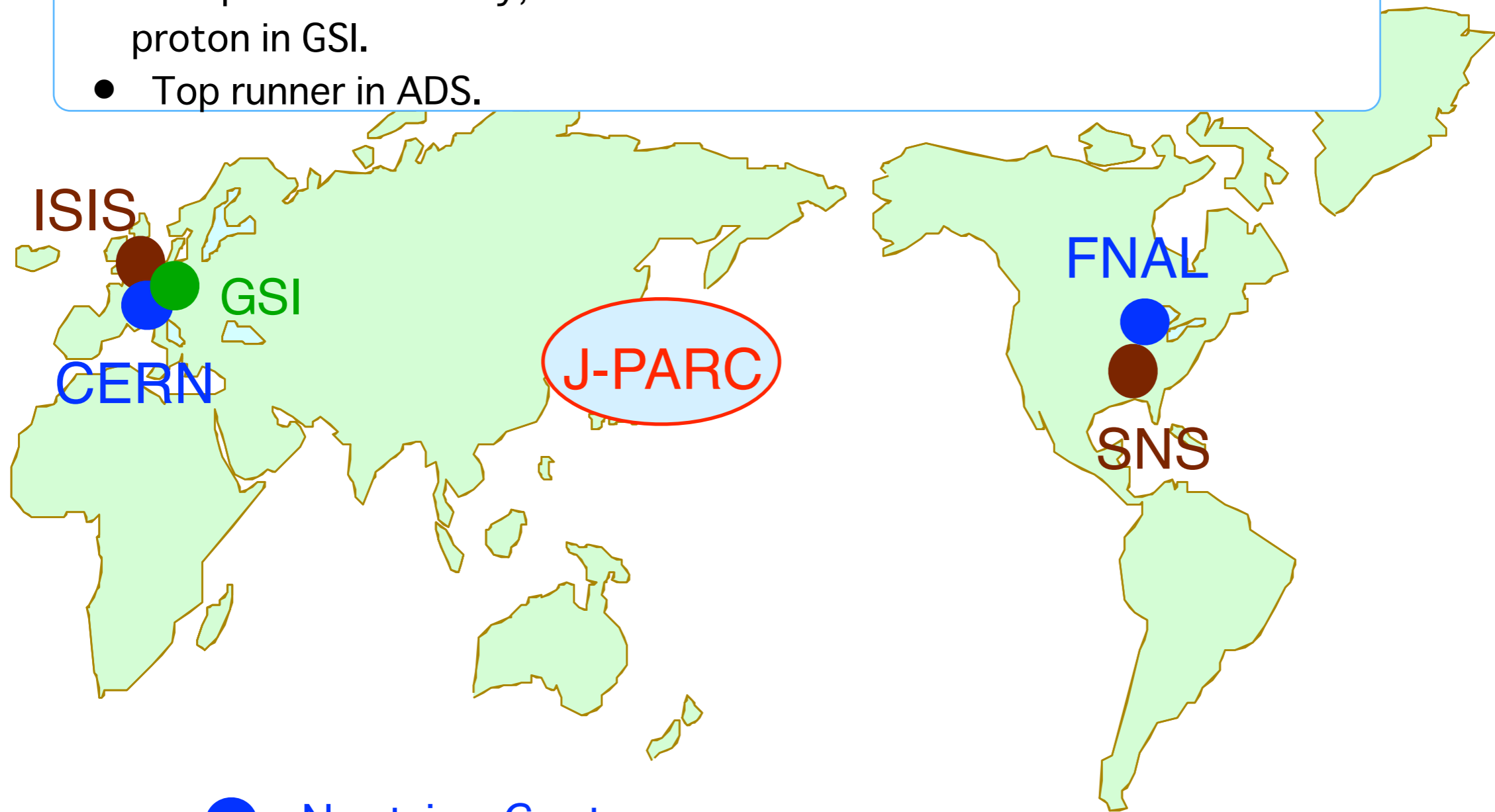
# Accelerator-Driven Transmutation (ADS)





# International Research Center

- One of Three major Neutron Sources in Material and Life Science
- Unique Kaon Factory, and One of Three Neutrino beam lines. Anti-proton in GSI.
- Top runner in ADS.



● Neutrino Centers

● Neutron Centers

● Anti-p



# Nuclear Physics at Hadron Experimental Hall



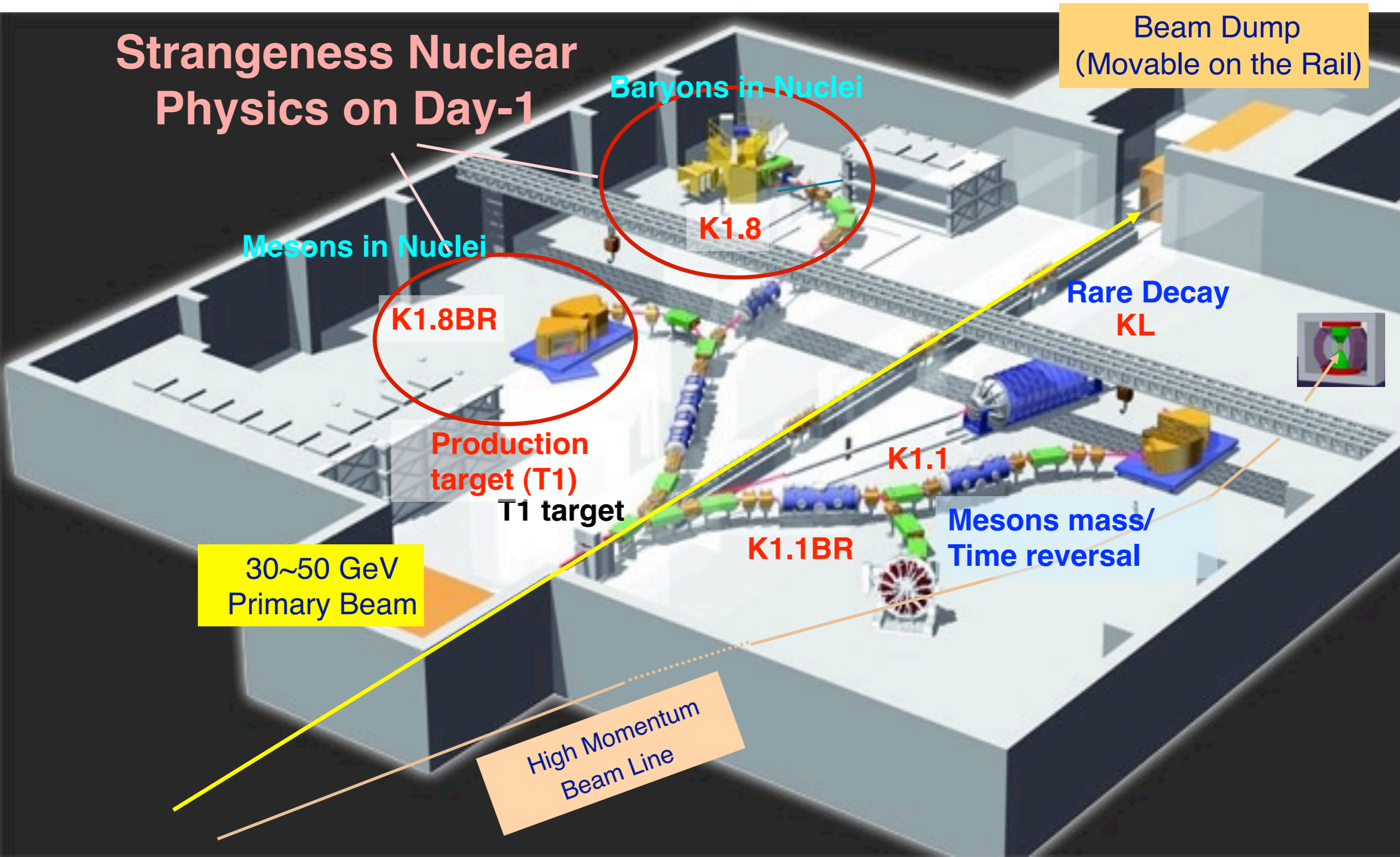
# Hadron Exp. Hall

60m x 56m  
Completed in June, 2007



# Plan View: Hadron Experimental Hall

**Strangeness Nuclear  
Physics on Day-1**



Beam Dump  
(Movable on the Rail)

Baryons in Nuclei

K1.8

Mesons in Nuclei

K1.8BR

Production  
target (T1)

T1 target

30~50 GeV  
Primary Beam

High Momentum  
Beam Line

Rare Decay  
KL

K1.1

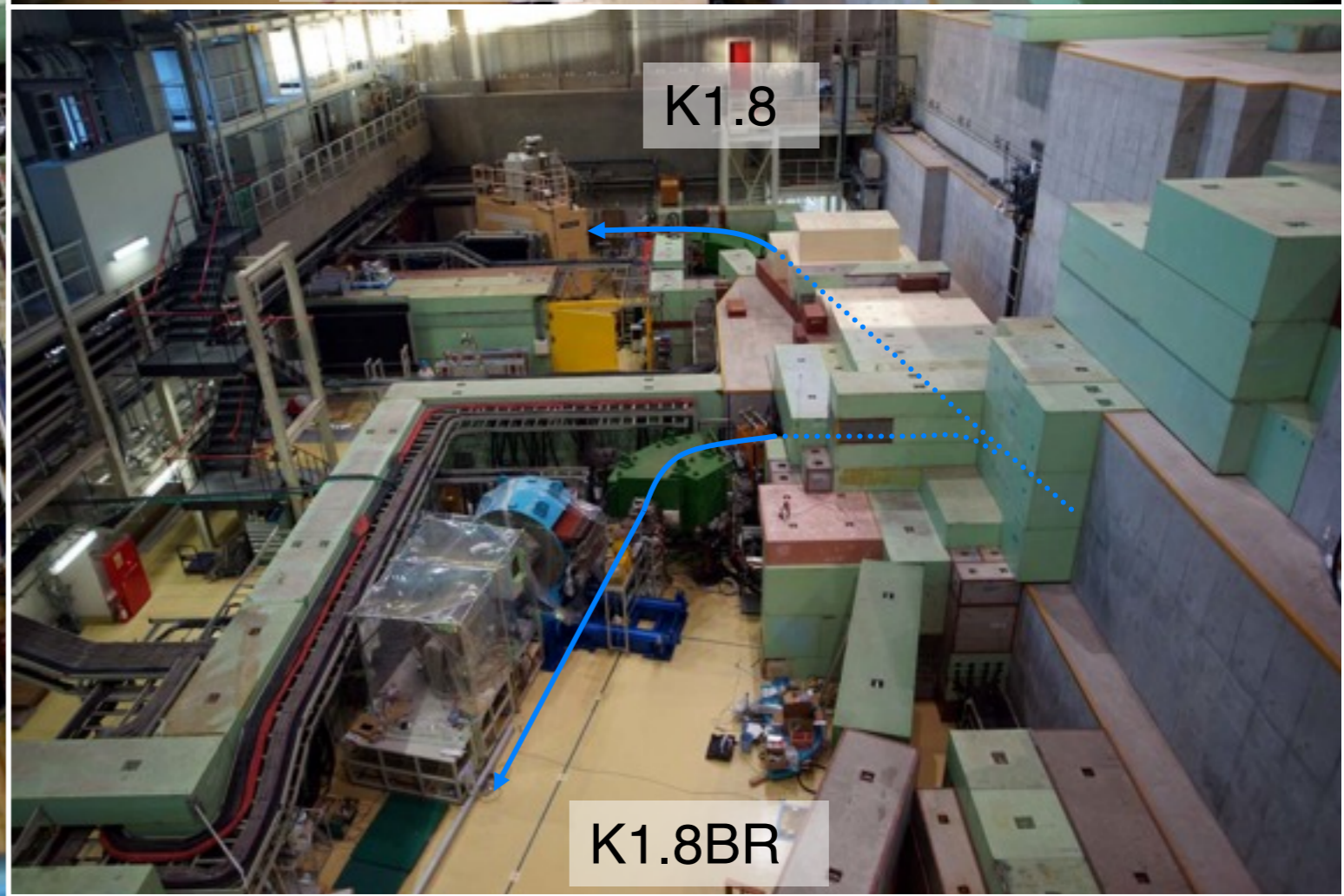
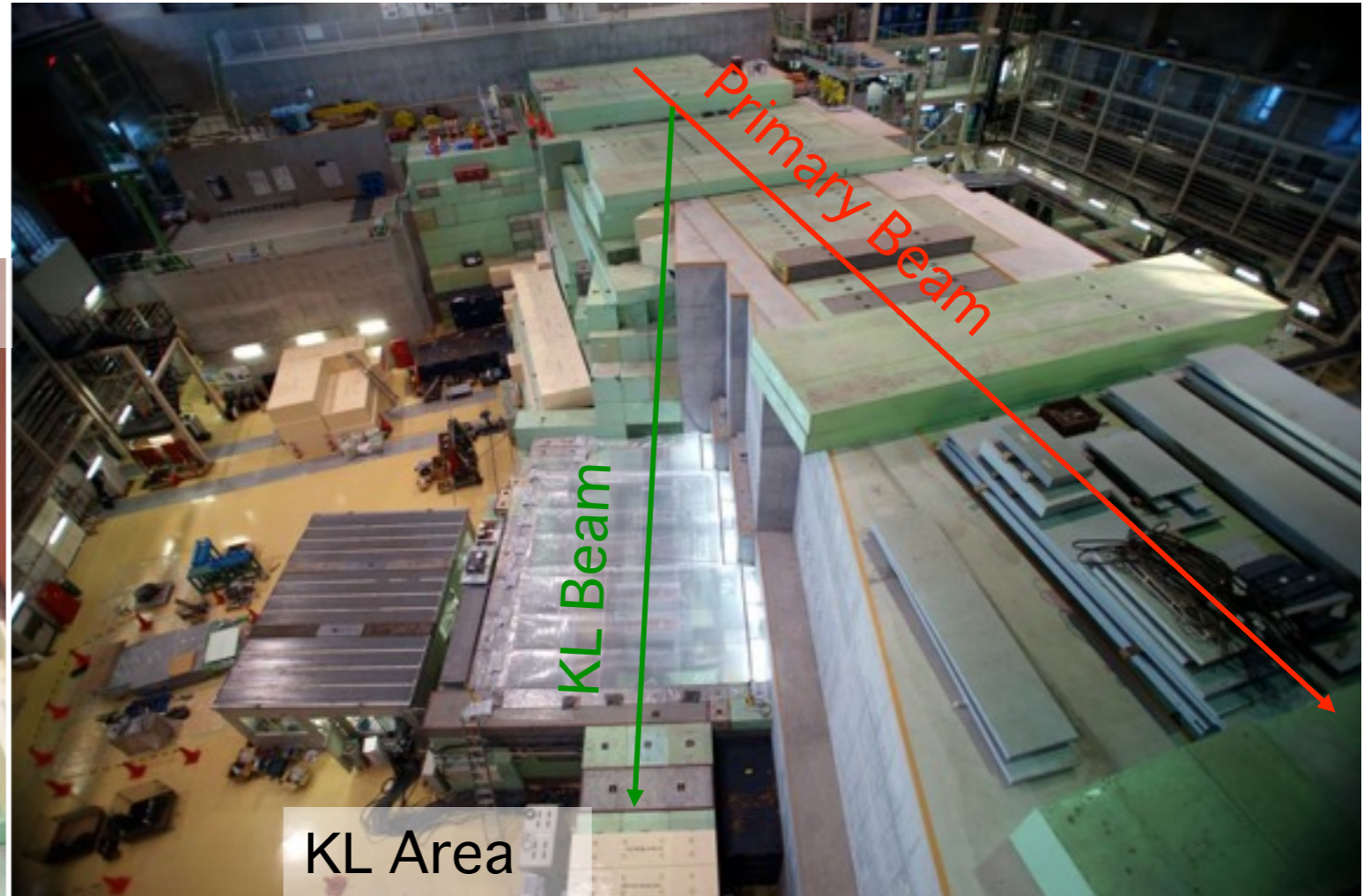
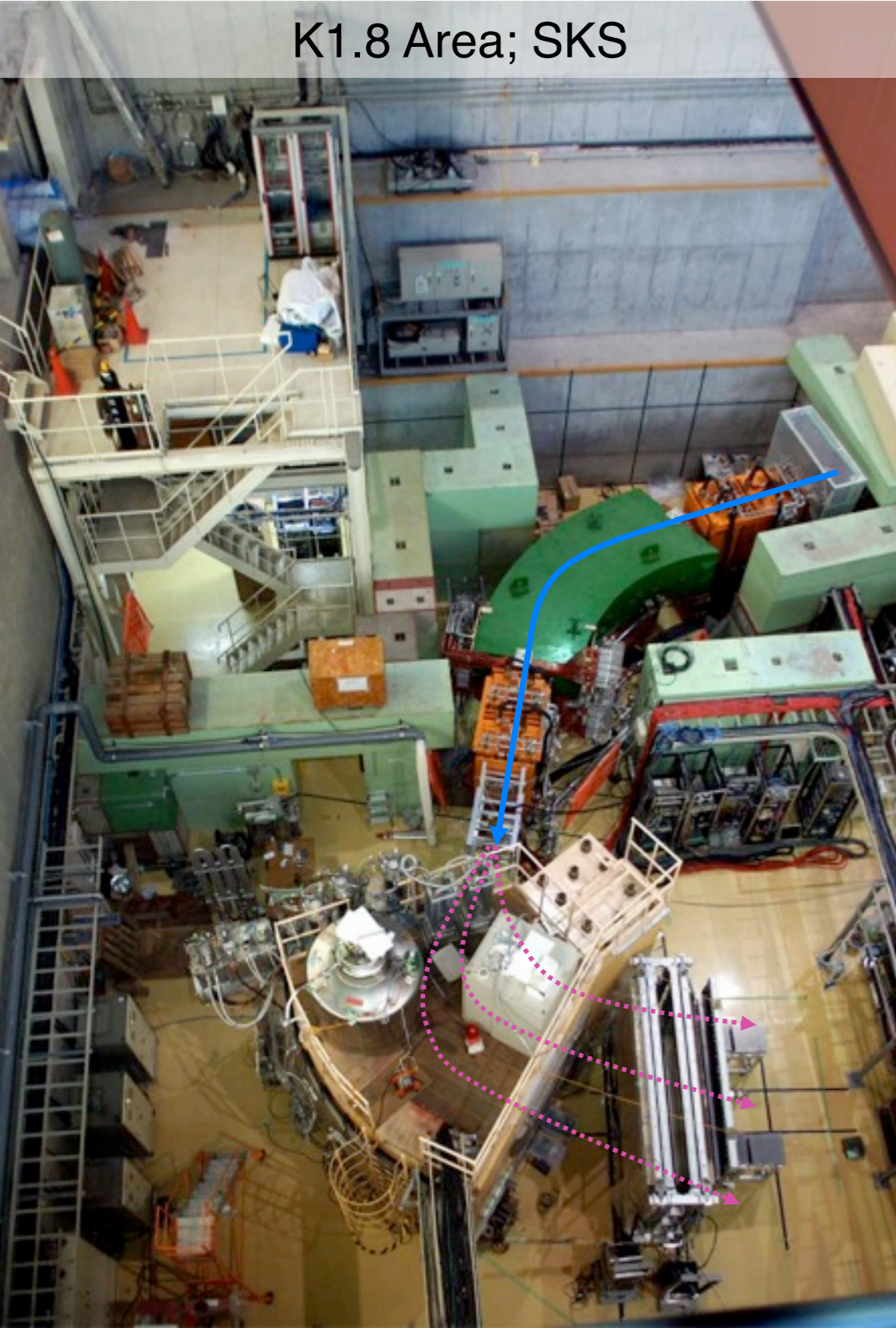
Mesons mass/  
Time reversal

K1.1BR



# Hadron Area in the Fall of 2009

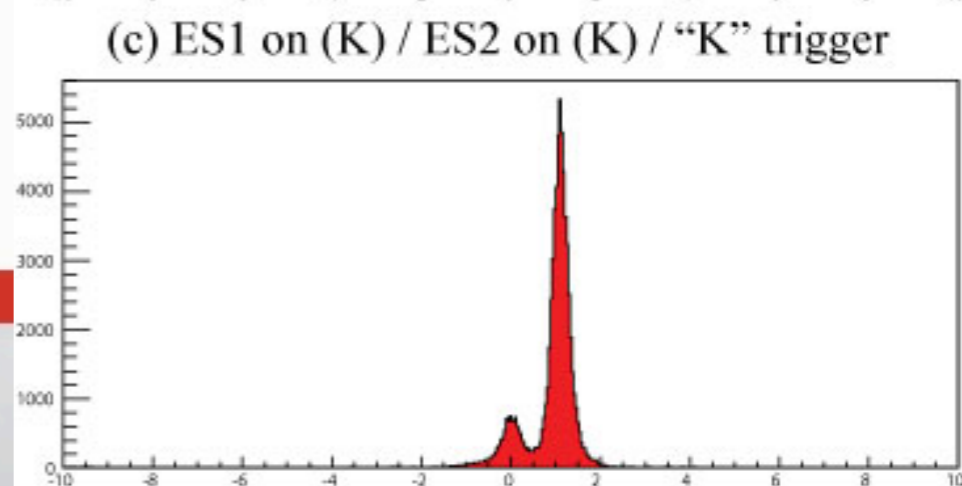
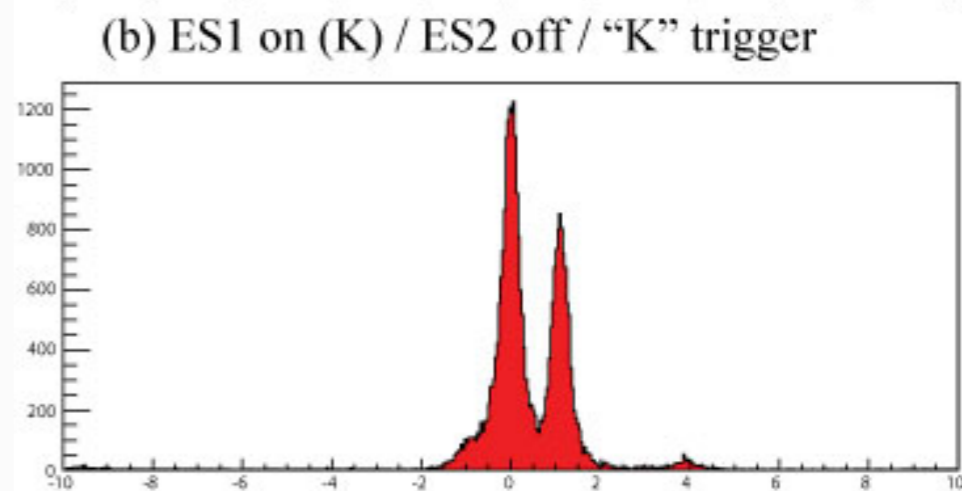
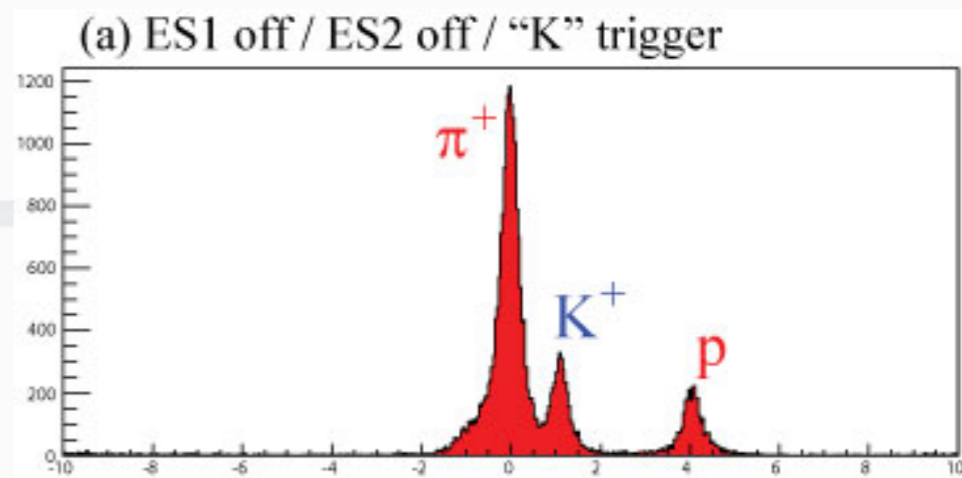
K1.8 Area; SKS





# Recent beam status At Hadron Hall

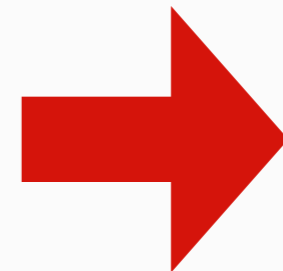
- Double-stage electrostatic separator works very well
- Good  $K/\pi$  ratio !
- Intensity & Time structure should be improved.





# Nuclear Physics at J-PARC

- Strangeness Nuclear Physics
  - Modern view of Baryon-Baryon interactions
  - New form of Hadron many-body systems
  - Role of strangeness in Dense matter
- Hadron Physics
  - Confinement of quarks: exotic hadrons
  - Medium modification of hadron properties



High-Density  
QCD



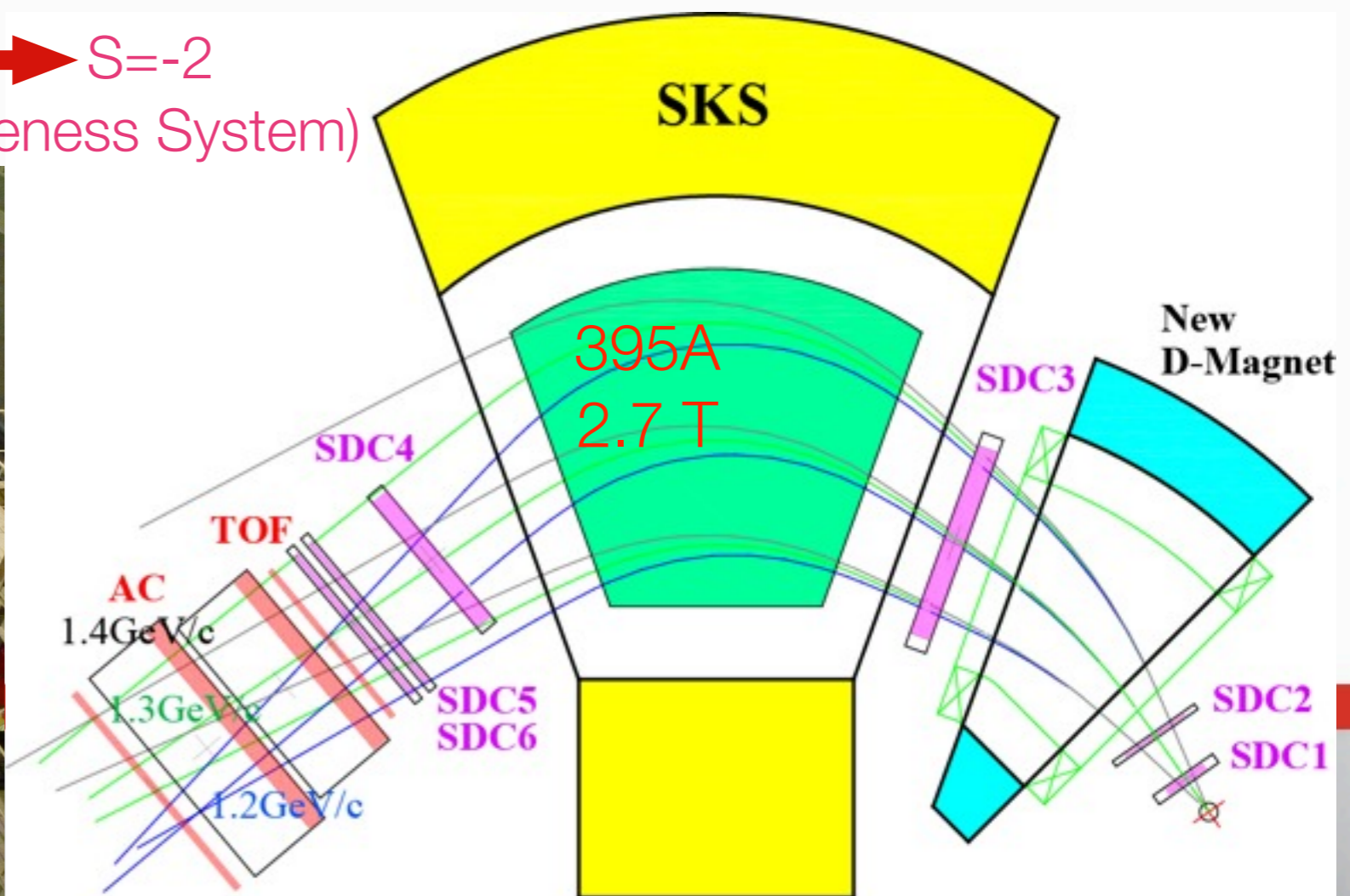
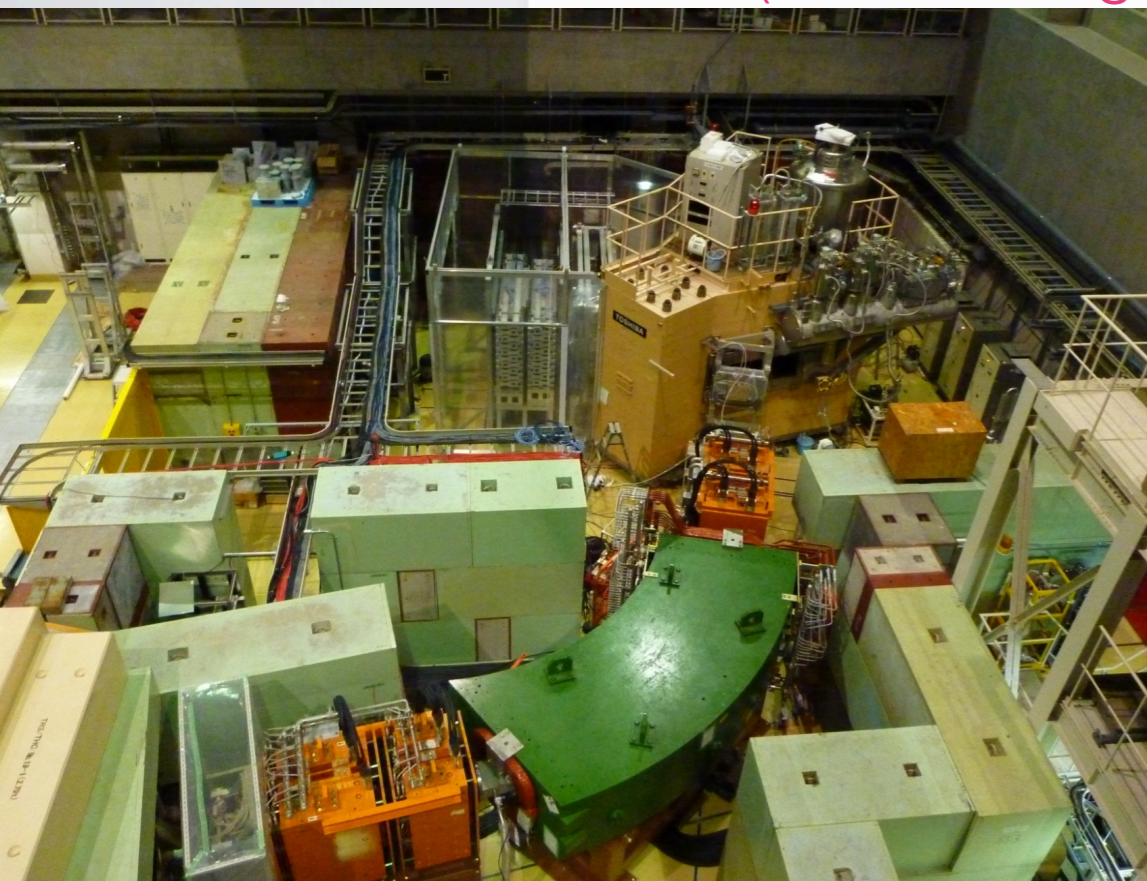
# Spectroscopic Study of $\Xi$ -Hypernucleus, $^{12}_{\Xi}\text{Be}$ , via the $^{12}\text{C}(K^-, K^+)$ Reaction

E05

T. Nagae et al.

- Discovery of  $\Xi$ -hypernuclei
- Measurement of  $\Xi$ -nucleus potential depth and width of  $^{12}_{\Xi}\text{Be}$

$S=-1 \rightarrow S=-2$   
(Multi-Strangeness System)





# Gamma-ray Spectroscopy of Light Hypernuclei

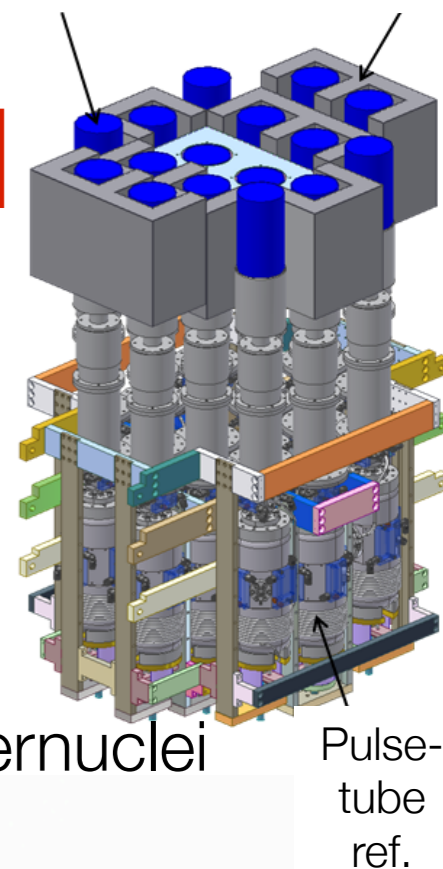
E13

H. Tamura et al.

Hyperball-J

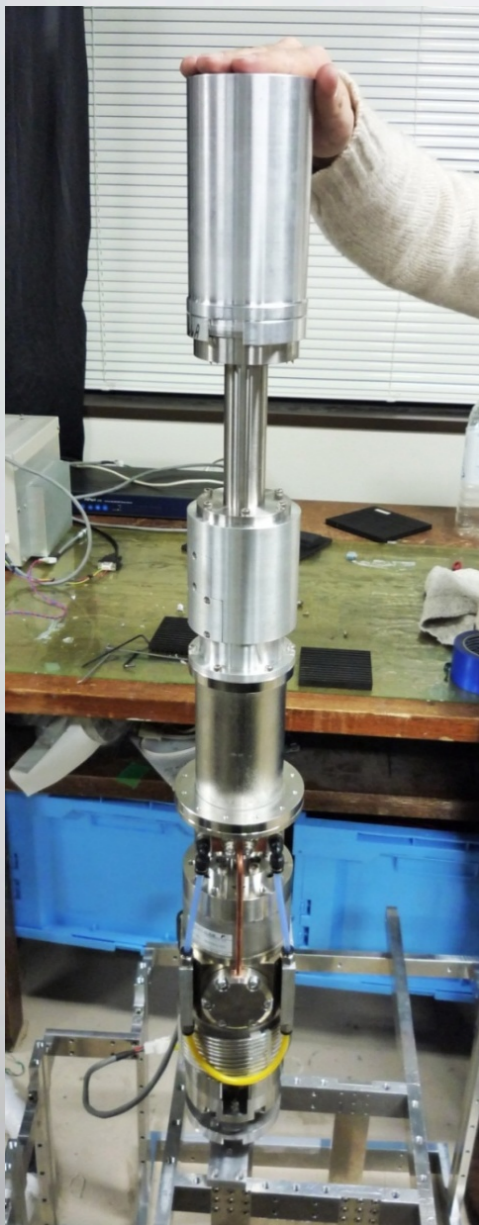
Ge Detector

PWO



Pulse-tube ref.

- Spin-flip  $B(M1)$  measurement for  $g_{\Lambda}$  in nuclei
  - ${}^7\text{Li}(K^-, \pi^- \gamma) {}^7_{\Lambda}\text{Li}$  at 1.5 GeV/c:  $M1: 3/2^+ \rightarrow 1/2^+$
- $\Lambda N$  interaction in p-shell hypernuclei
  - ${}^{10}_{\Lambda}\text{B}$  and  ${}^{11}_{\Lambda}\text{B}$
- Radial dependence of  $\Lambda N$  interaction in sd-shell hypernuclei
  - ${}^{19}_{\Lambda}\text{F}$ : easiest in sd-shell
- Charge-Symmetry Breaking in  $\Lambda N$  interaction, and Spin-flip excitation in  $(K^-, \pi^-)$  reaction
  - ${}^4_{\Lambda}\text{He}(M1: 1^+ \rightarrow 0^+)$

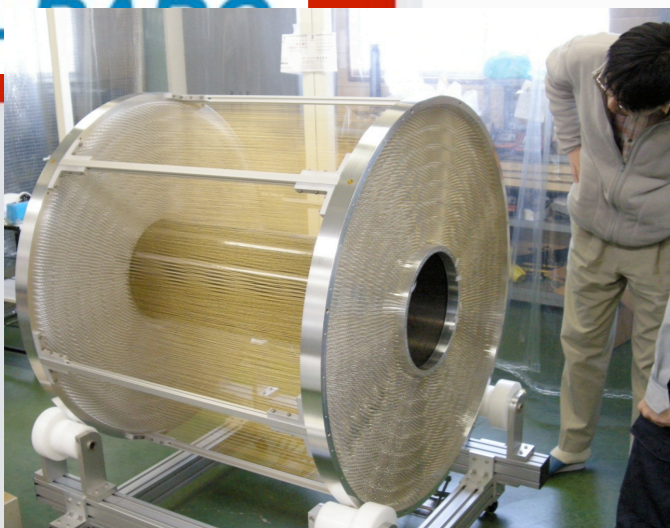




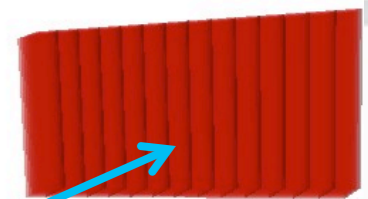
# A Search for deeply-bound kaonic nuclear states by in-flight ${}^3\text{He}(K^-,n)$ reaction

E15

M. Iwasaki, T. Nagae et al.



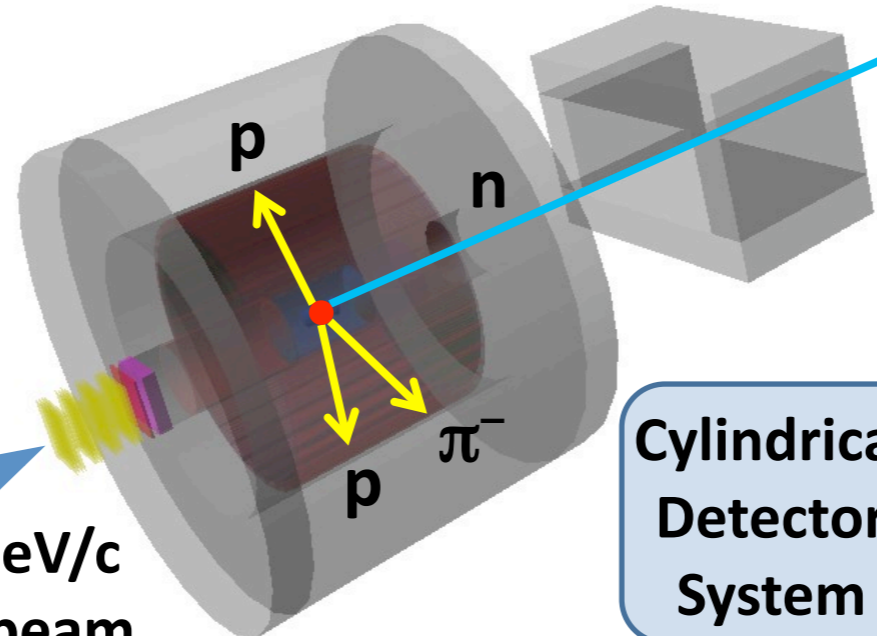
- ▶  $K^- + {}^3\text{He} \rightarrow n + (K^-pp)$
- ▶  $(K^-pp) \rightarrow \Lambda + p$



Neutron  
ToF Wall

flight length = 12m

Beam Sweeping  
Magnet



Cylindrical  
Detector  
System

**mass resolution for K-pp**  
*invariant mass*  
 $\sigma = 19\text{MeV}/c^2$  ( $\sigma_{\text{CDC}} = 250\mu\text{m}$ )  
*missing mass*  
 $\sigma = 12\text{MeV}/c^2$  ( $\sigma_{\text{ToF}} = 150\text{ps}$ )

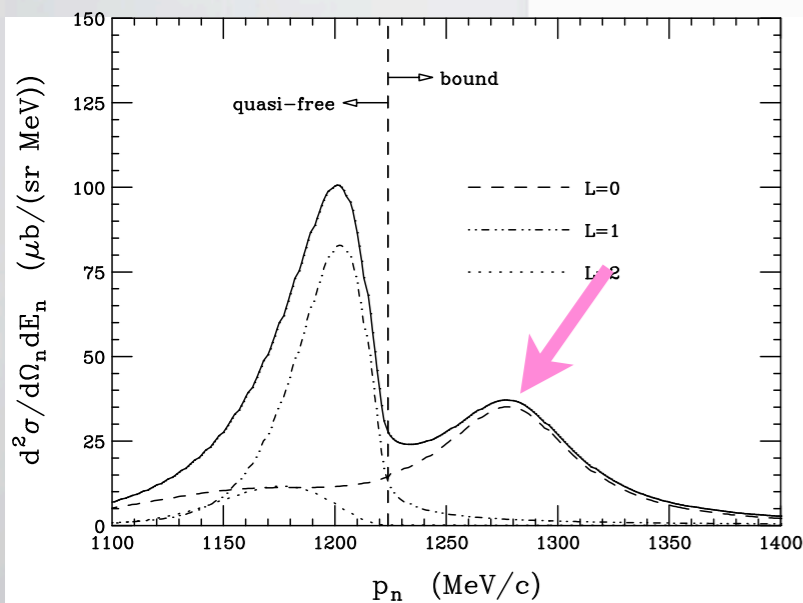


FIG. 1: The calculated inclusive spectra of the  ${}^3\text{He}(\text{in-flight } K^-,n)$  reaction at  $p_{K^-} = 1.0\text{ GeV}/c$  and  $\theta_n = 0^\circ$  as a function of the neutron momentum, using the YA optical potential with  $(V_0, W_0) = (-300\text{ MeV}, -70\text{ MeV})$ . The vertical dashed line indicates the corresponding neutron momentum of  $p_n = 1224\text{ MeV}/c$  at the  $K^-$  emitted threshold. The contributions of partial-wave angular momentum states with  $L = 0, 1$  and  $2$  are also drawn.

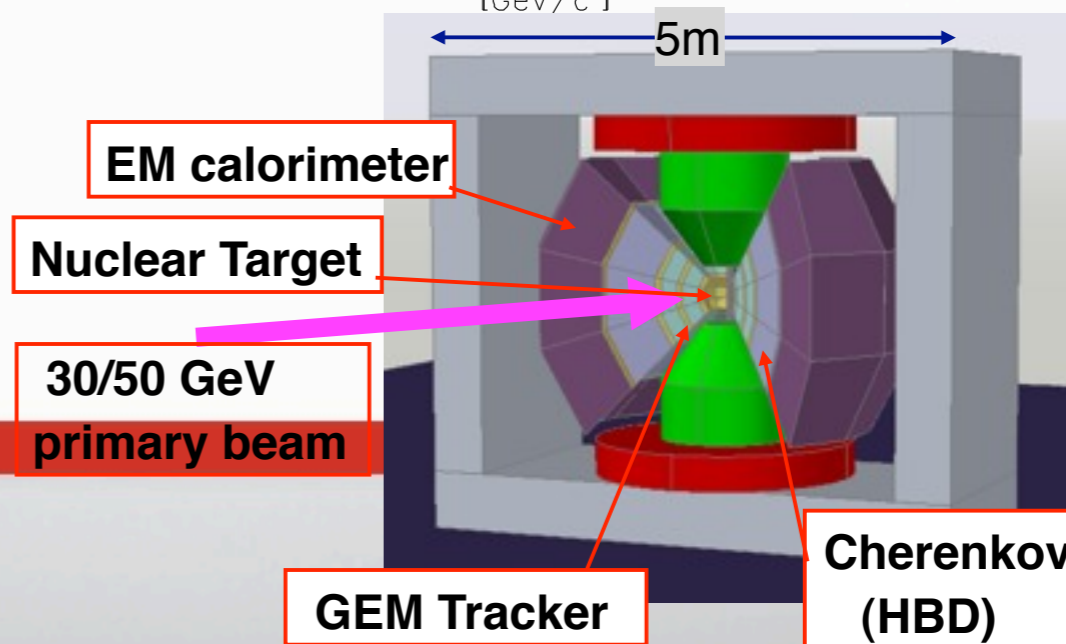
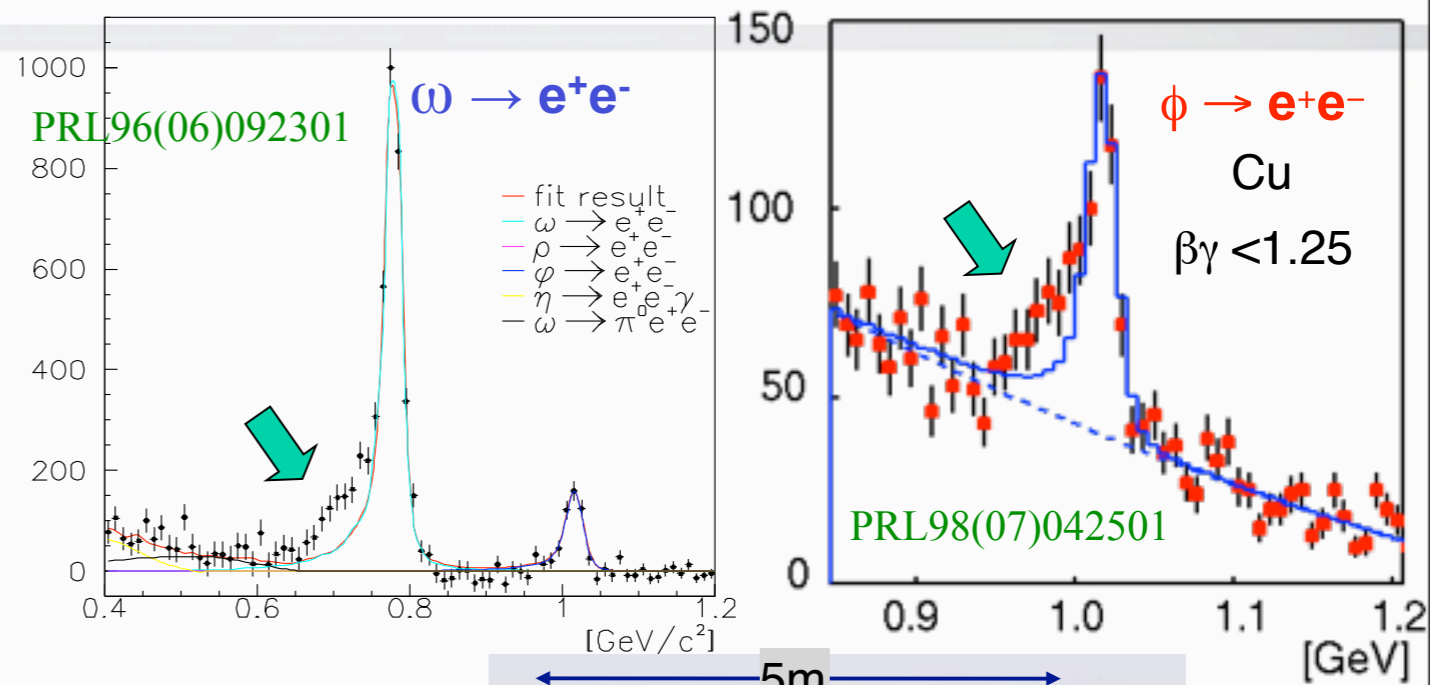


# Mesons in Nuclear Medium: E16 Yokkaichi et al.

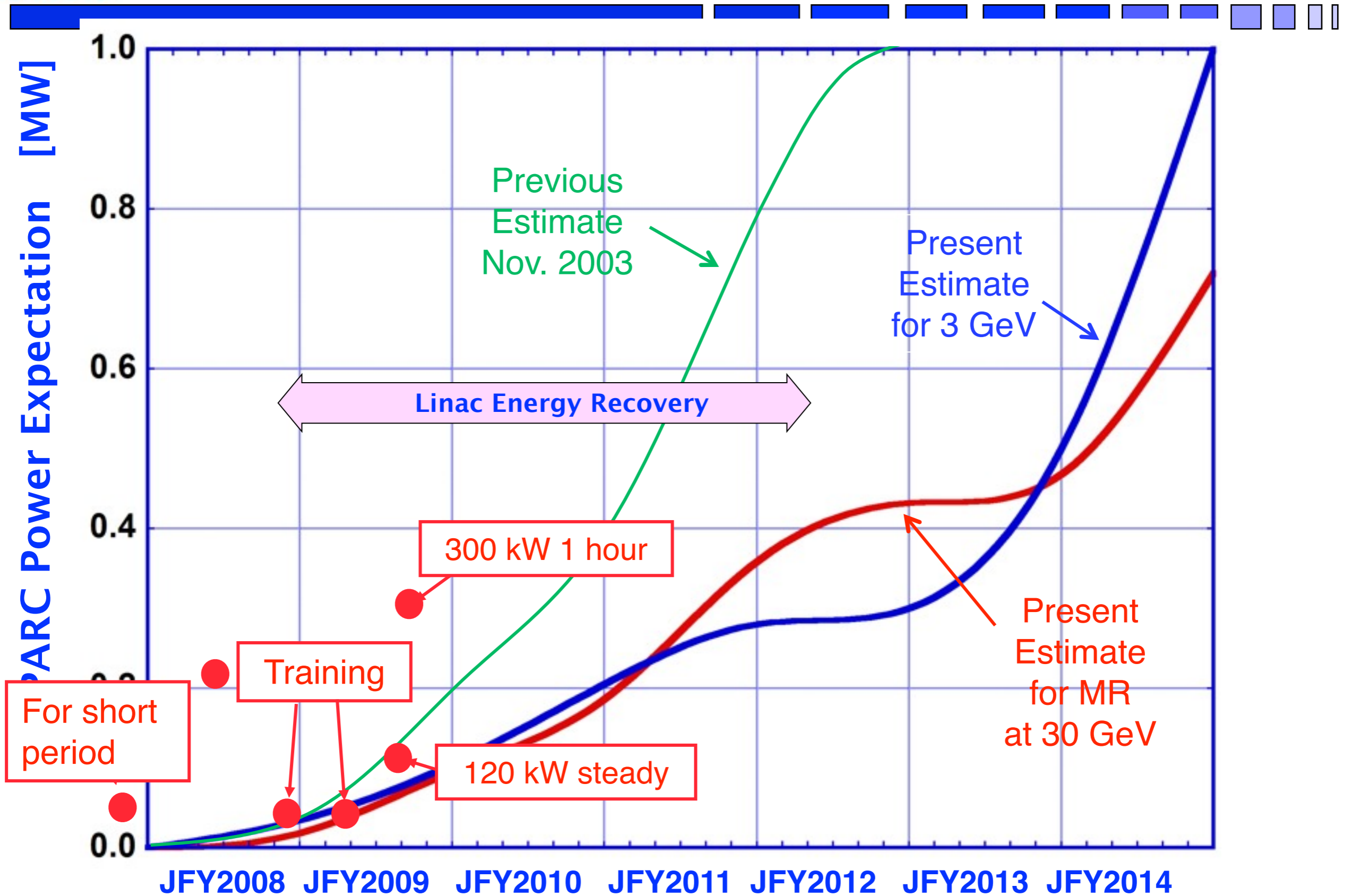
KEK E325  
 $p + \text{Cu} \rightarrow e^+ e^- X$

- Mass modification observed in KEK E325
- J-PARC E16
  - X 100 better statistics
  - Velocity dependence etc.

*Need High-momentum beam line*



# Power Capability (revised)









# Summary

- J-PARC Construction: 2001 ~ 2008 (completed)
  - Beam commissioning: LINAC( Oct., 06), RCS( Oct., 07), MR( May, 08)
  - Beam intensity & quality to be improved
- Day-1 Experiments; ready for accepting beam
  - $\Xi$  hypernuclei
  - Deeply-bound Kaonic nuclei
  - Hypernuclear gamma-ray spectroscopy
  - Search for penta-quark
  - etc.