

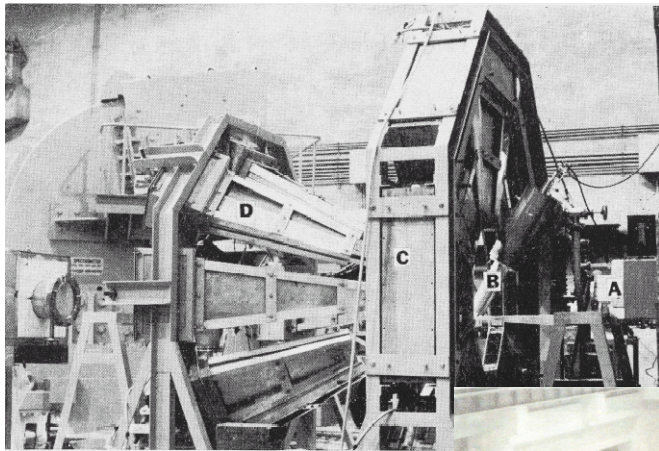
Oct. 16, 2008

# Neutron Science at J-PARC

KENS

Institute of Materials Structure  
Science (IMSS), KEK

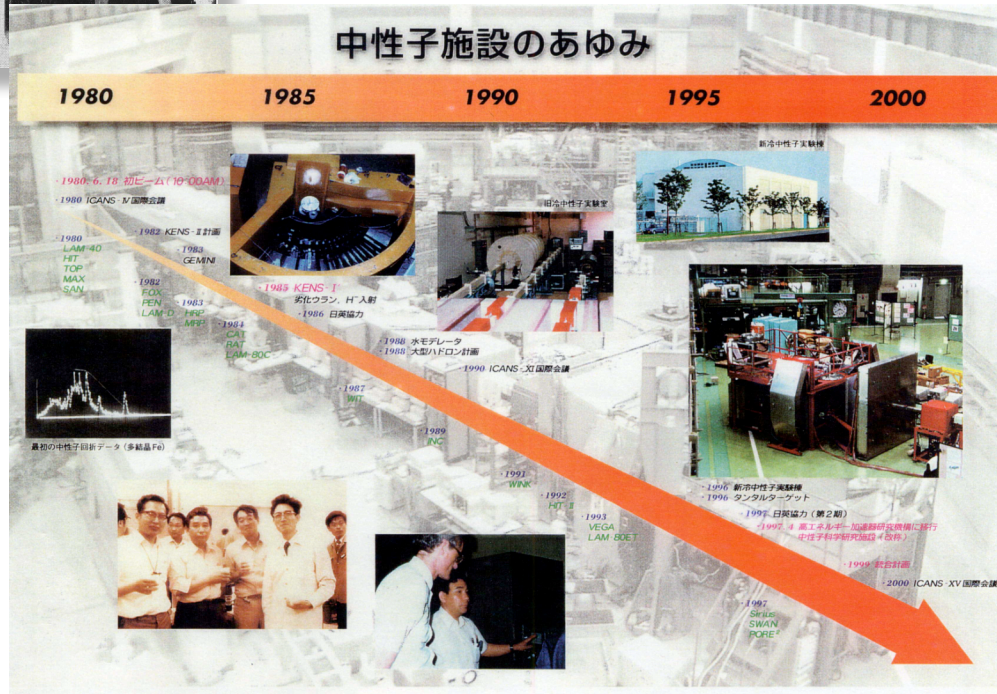
Susumu Ikeda



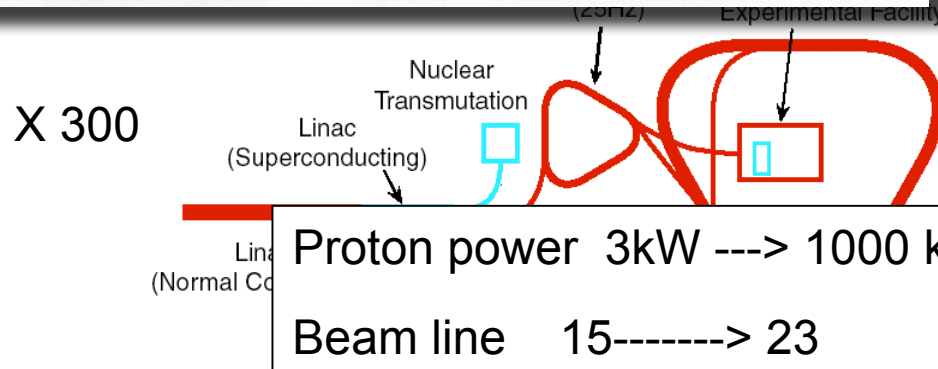
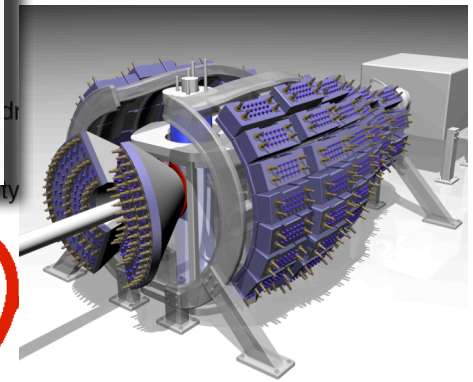
# “Expand” of pulsed neutron facility KENS-facility(1980-2005)

Tohoku Univ.  
LINAC  
Powder diff.

**KIMURA**  
Sputnik  
1967



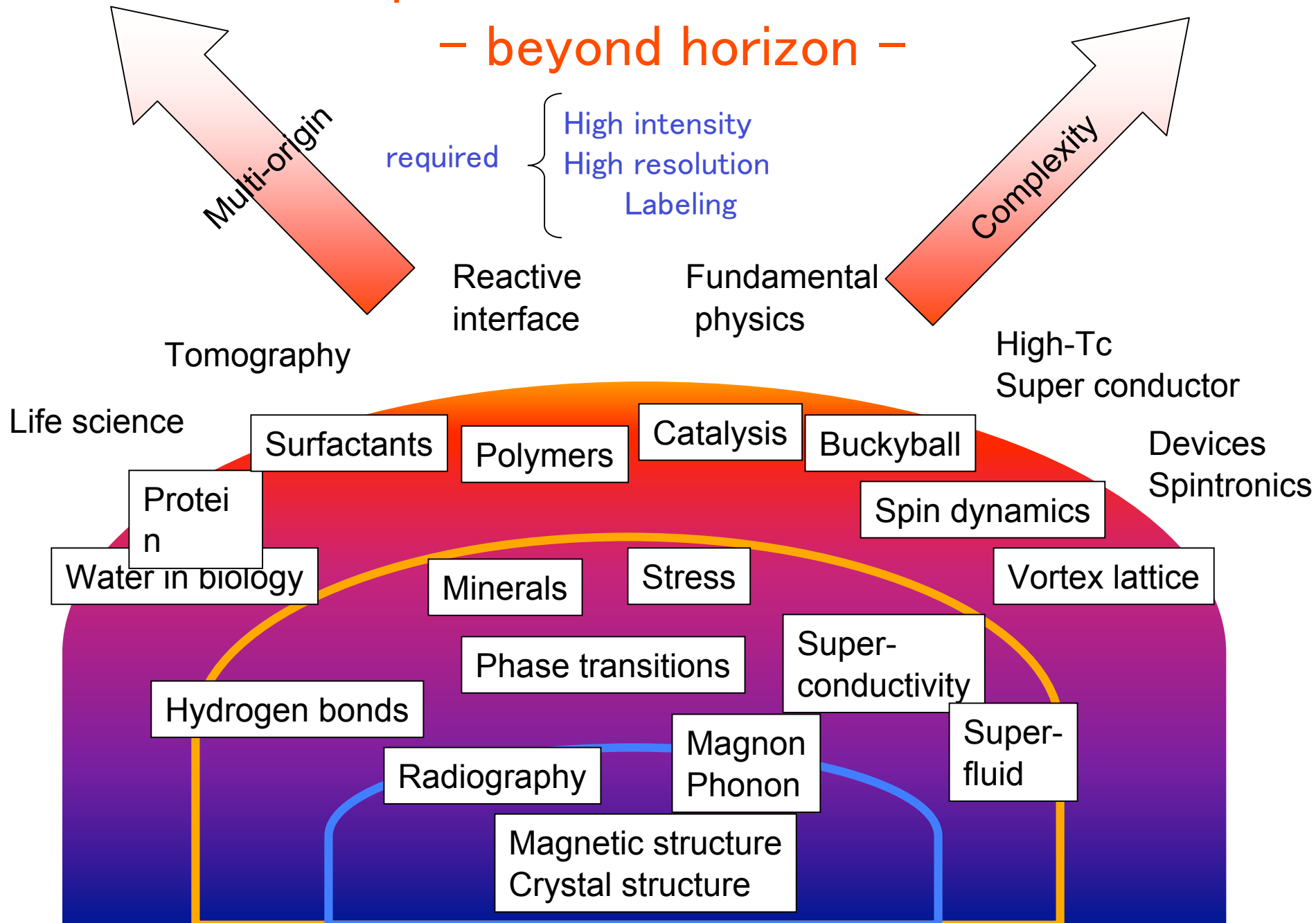
Operate facility  
Promote science  
**2008**



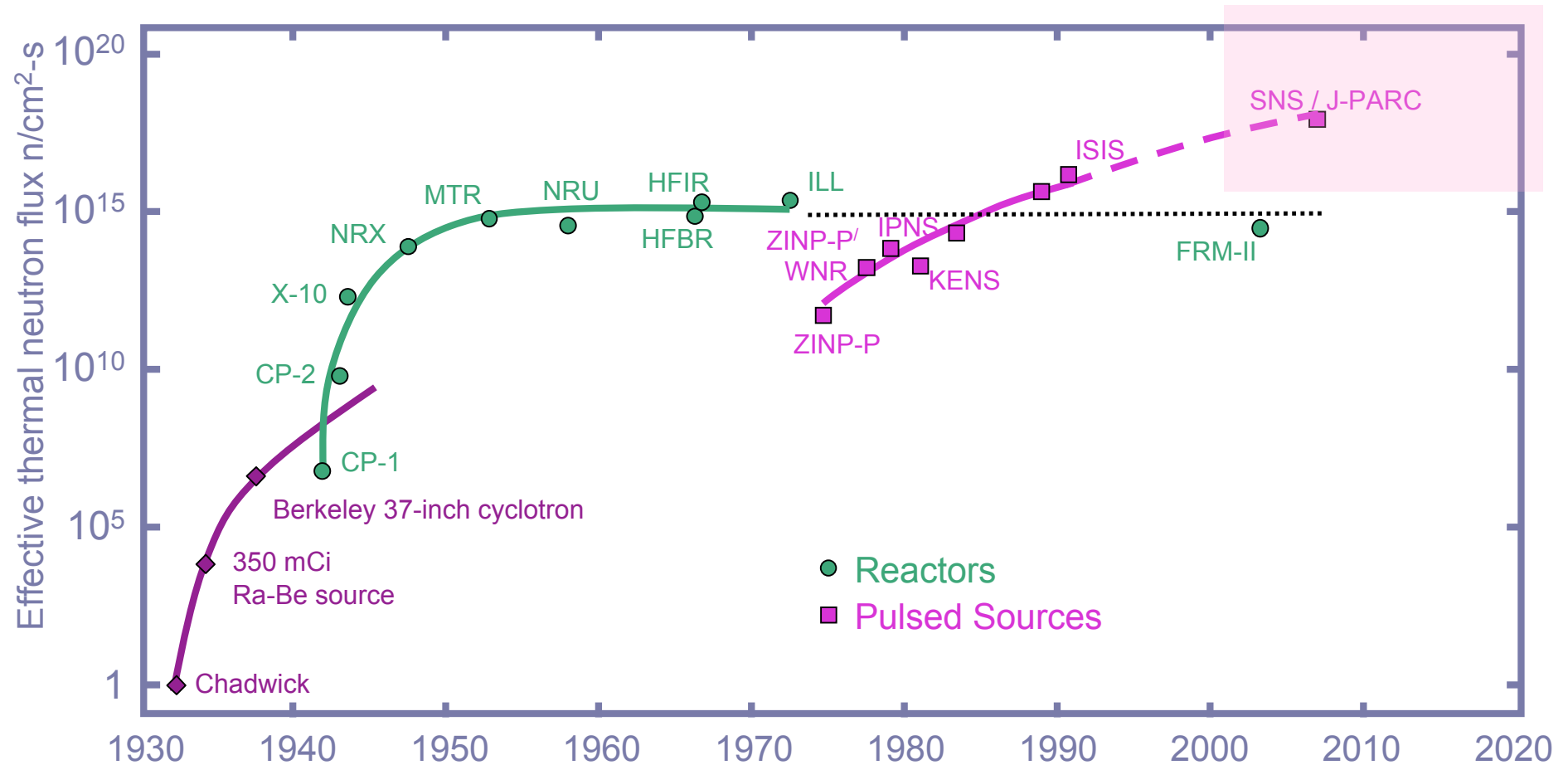
**J-PARC**

# Expand of Neutron Science

– beyond horizon –



# Expand into the new era



(Updated from *Neutron Scattering*, K. Skold and D. L. Price, eds., Academic Press, 1986)



# J-PARC (Japanese Proton Accelerator Research Complex)



LINAC

Multi-purpose facility

3GeV RCS

Neutrino beam to Super-Kamiokande

Materials & Life Science Experimental Facility (MLF)  
*Neutron and Muon*

50GeV MR

- JFY2007 Beams
- JFY2008 Beams
- JFY2009 Beams

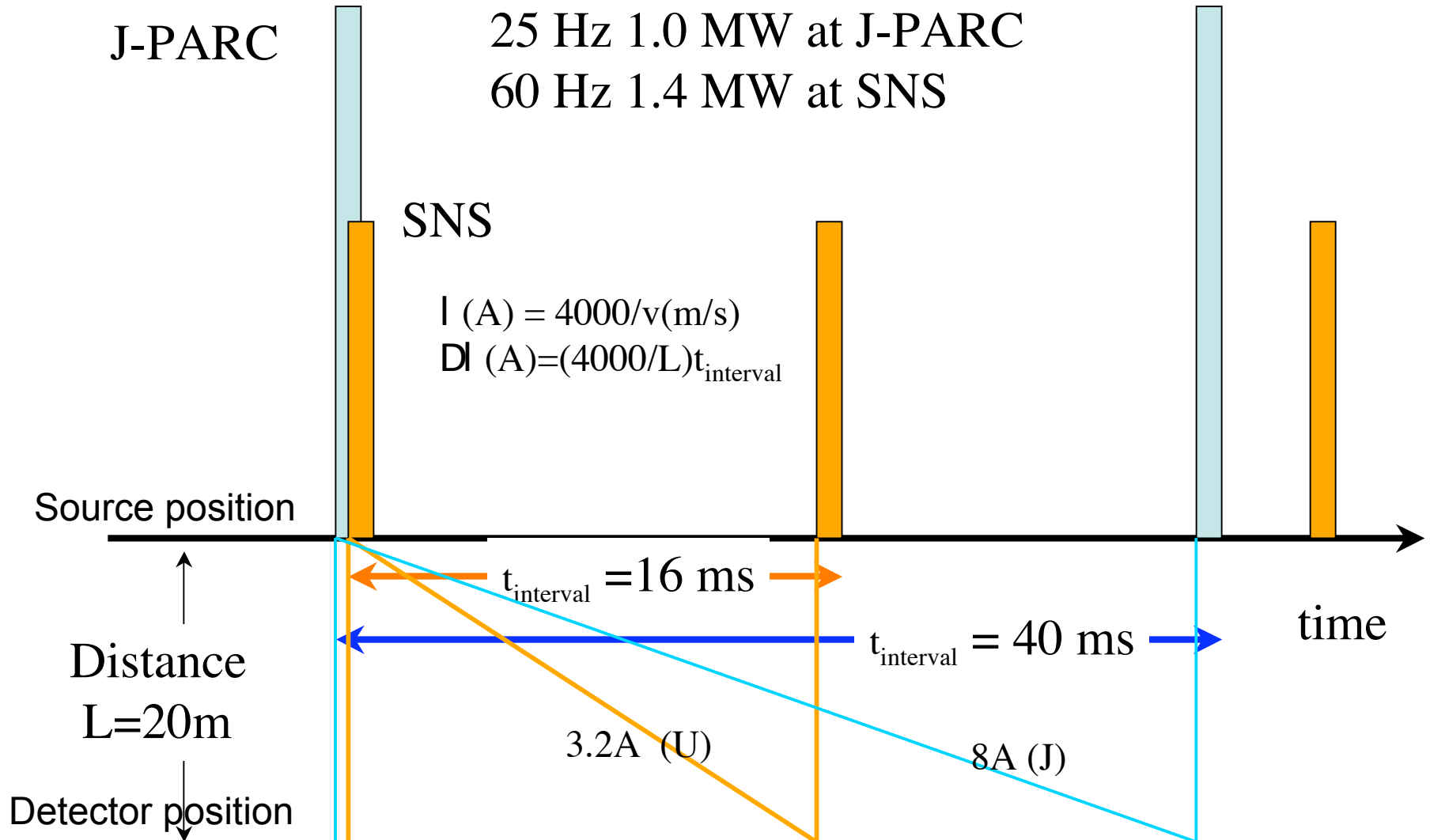
Hadron Experimental Facility

Bird's eye photo of J-PARC site at JAEA in January 2008

# What is the advantage of JSNS

**Higher** pulse height and the **Wider** dynamic range rather than US-SNS

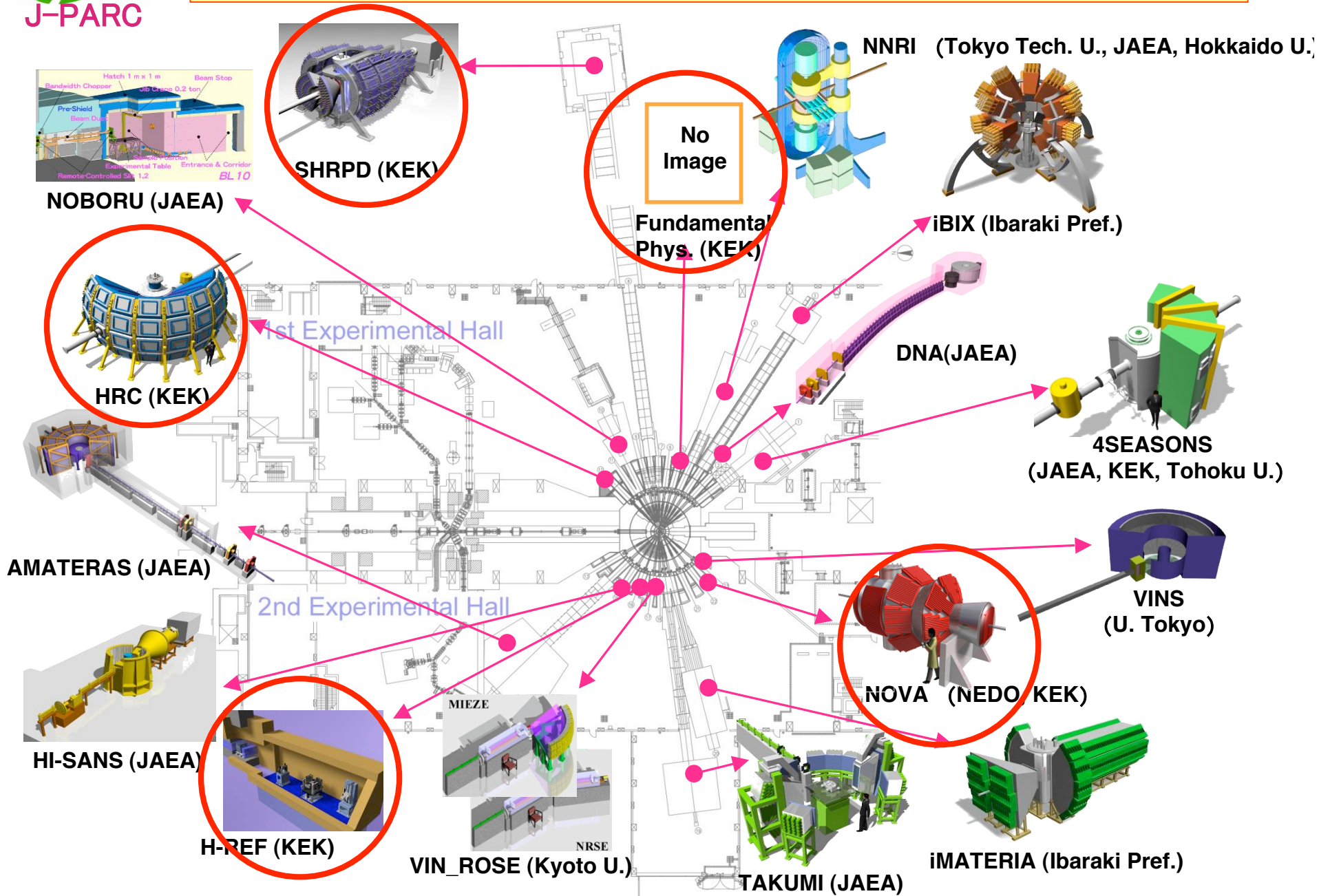
It can provide new opportunities for science





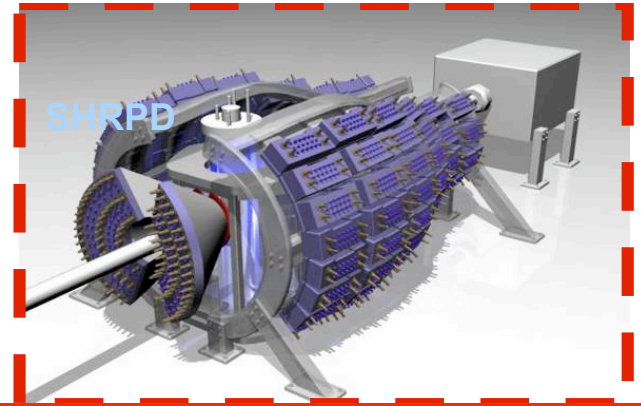


■ Proposed Instruments : 30 (>No. of Beamlines)  
■ Funded : 14+a    Under Construction : 12+a

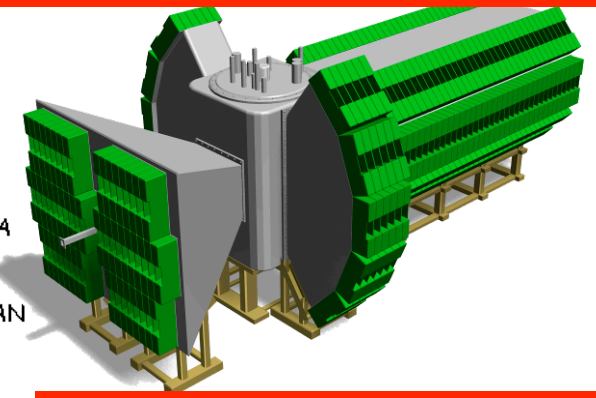
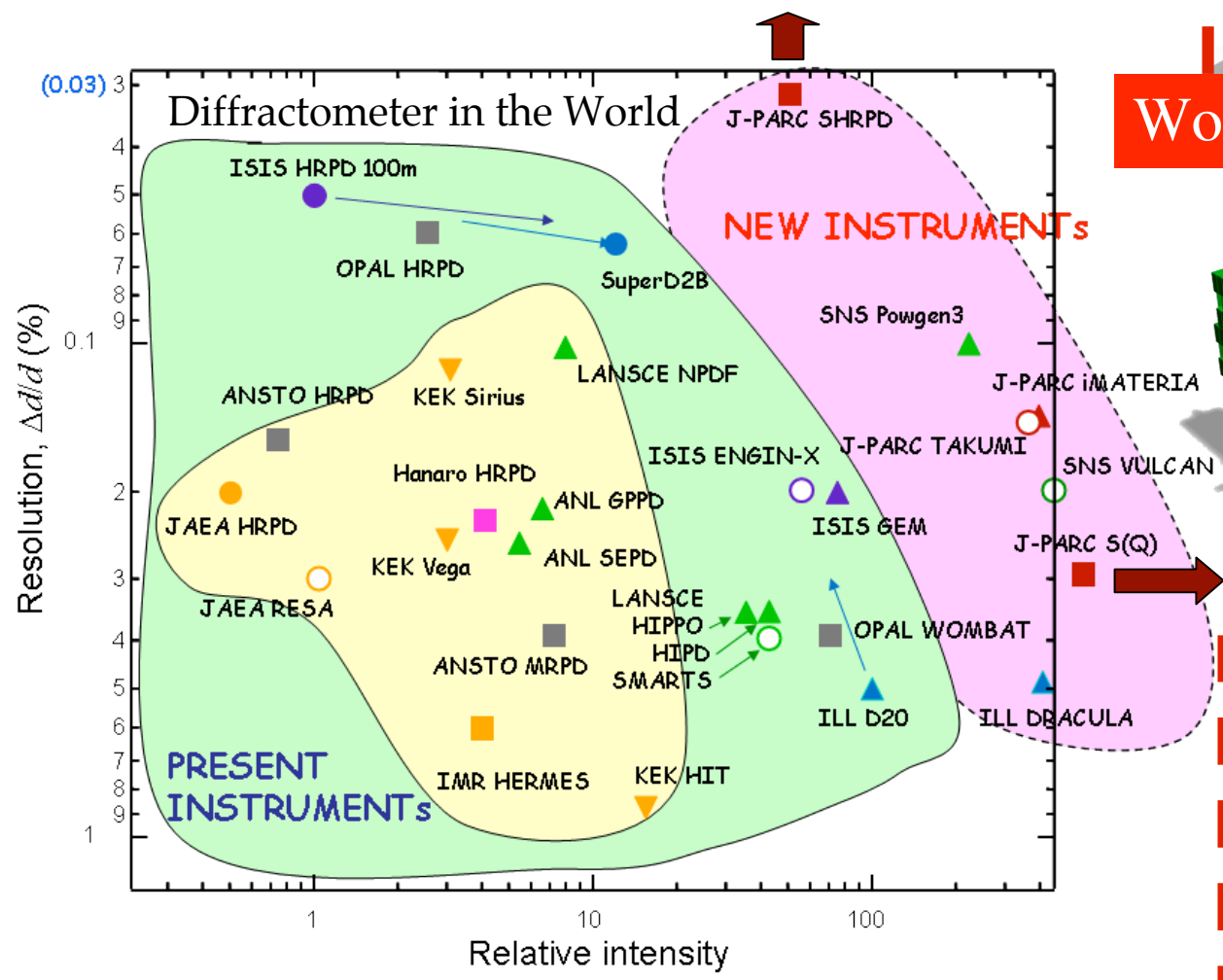


# Where are KEK instruments ?

Average structure and local structure  
Speed ! and Resolution !

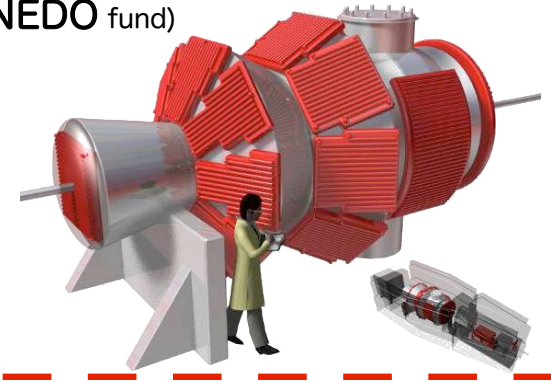


**World-highest Resolution !**



**World-highest Speed !**

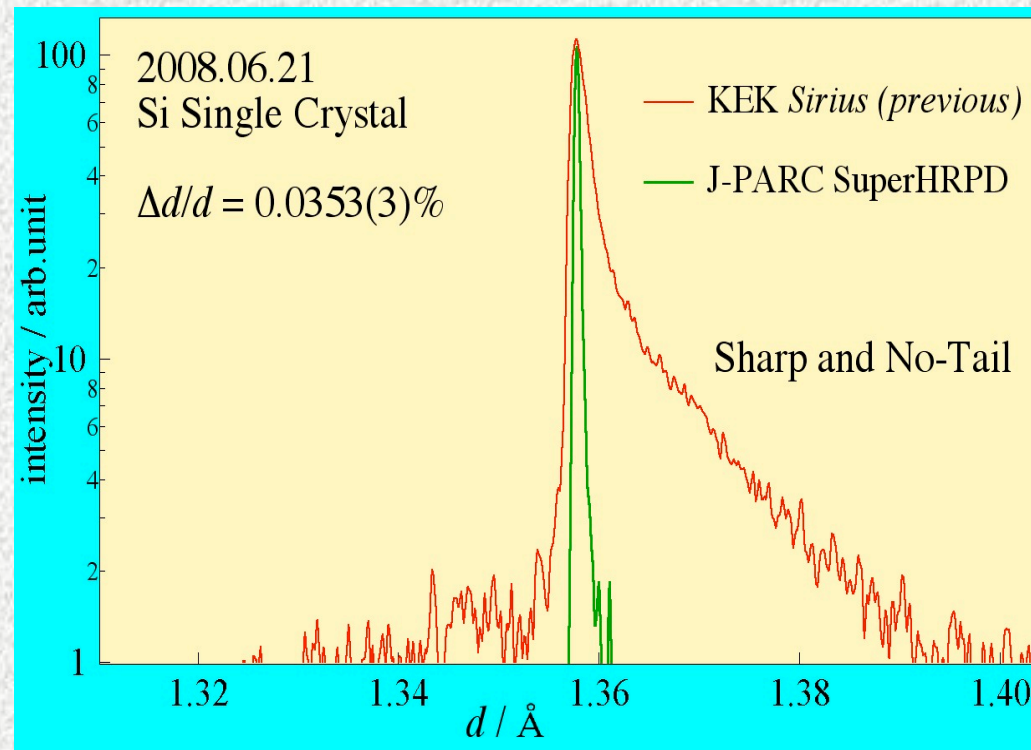
Versatile Total Scattering Diff.  
(NEDO fund)



# SuperHRPD @BL08

## Super High Resolution Powder Diffractometer

It realizes the **world best resolution of 0.03%**  
In June 21, 2008



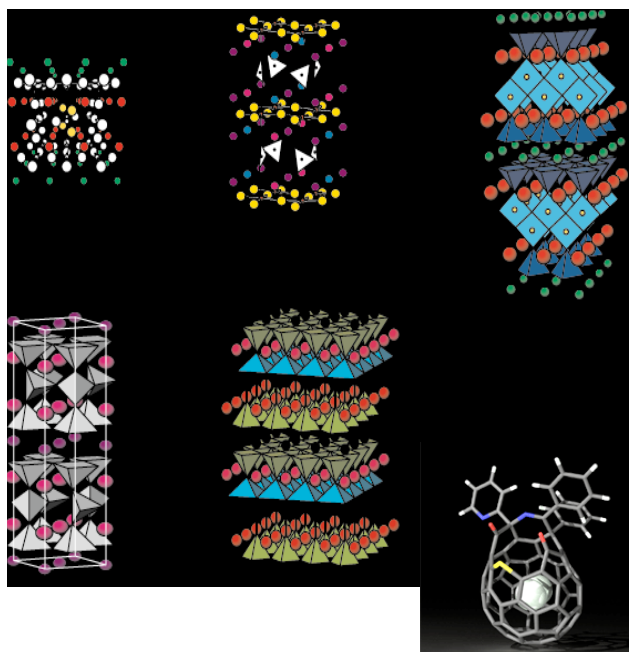


# Detailed structure analysis

—explore tiny structural changes—

## Hybrid Functional Materials

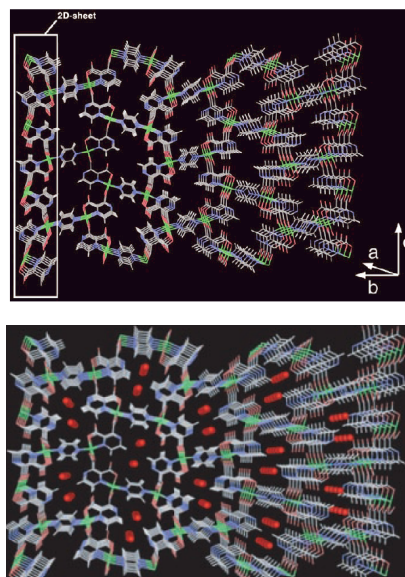
Why function emerges?



Superconductors  
Energy Materials

## Detect tiny atom position

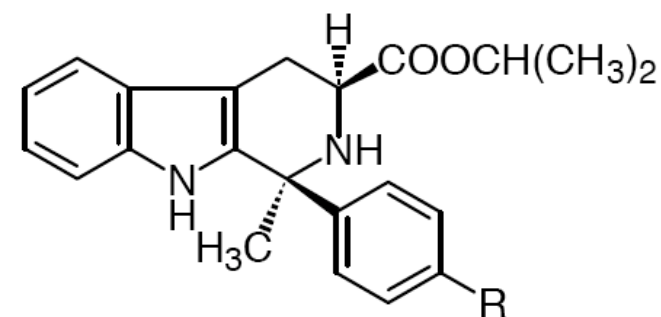
Reaction against  
external field (H, E,  
photon, P, etc.)



Controlling interplay between  
electrons, spins, charge

## Pharmaceuticals

Determine Hydrogen position  
with powder drugs



Ex.) Candidate for Alzheimer  
N-methyl-D-aspartate  
(NMDA)Antagonist

Super high resolution powder diffractometer

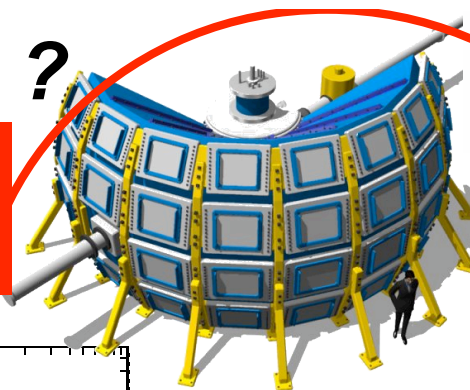
／Highest Resolution : 0.03%／New analysis methods／100m neutron transferring guide／

# Where are KEK instruments ?



**4SEASONS**  
 $E_i = 5-300$  meV  
 $DE/E_i = 6\%$   
**MAPS x100**

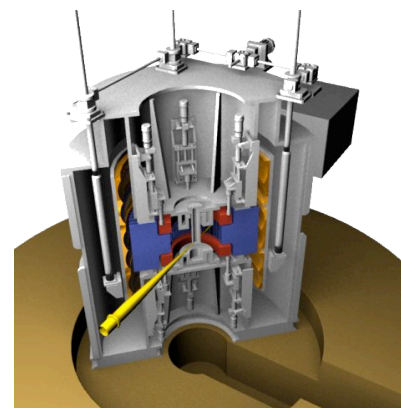
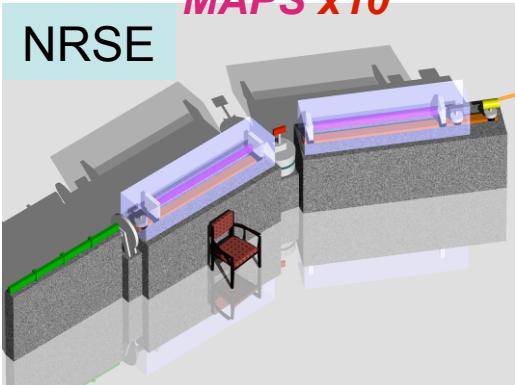
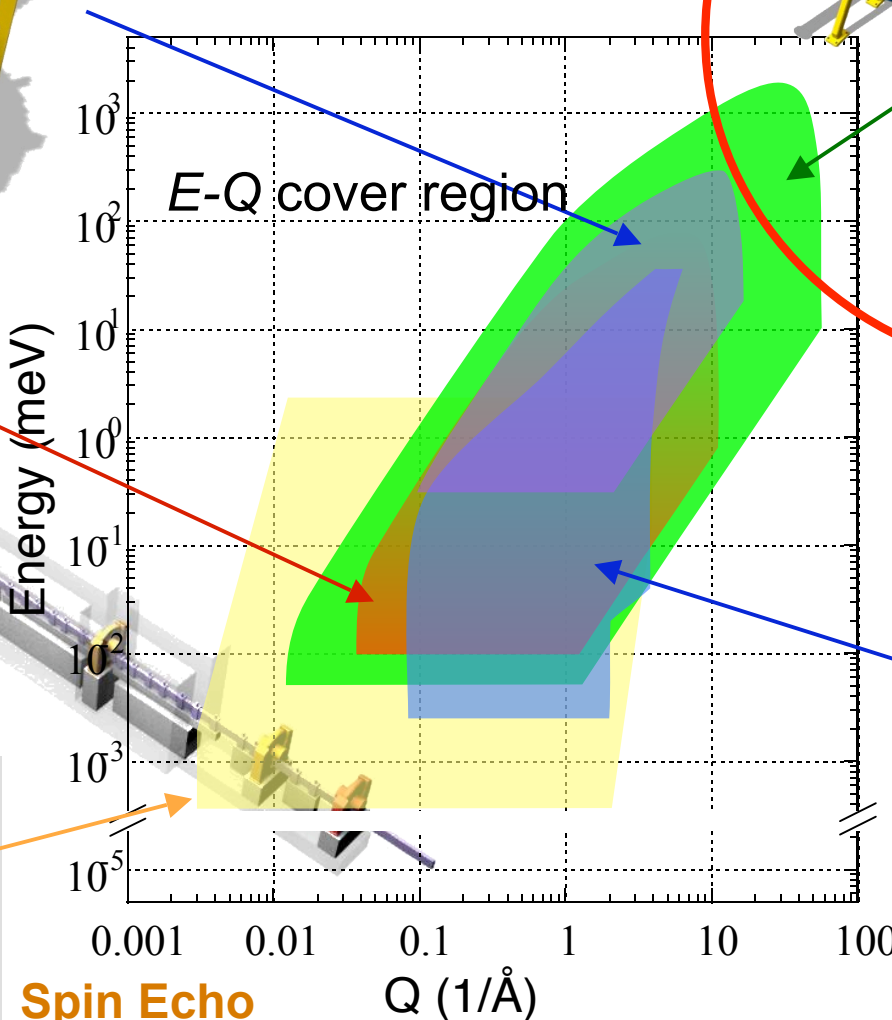
Highest energy transfer &  
 World-widest E-Q range !



**HRC**  
 $E_i = 1-2000$  meV  
 $DE/E_i = 0.5-1\%$   
**MAPS x3**



**CNDCS**  
 $E_i = 1-80$  meV  
 $DE/E_i = 1-3\%$   
**MAPS x10**



**Spin Echo**  
 $10\text{peV} < hw < 1$  meV  
 $1 < t < 170$  (ns)

**DNA**  
 $E = 0.02-35$  meV  
 $DE/E_f = 0.15-0.75\%$   
**IRIS x24**

# Dynamics on Spin • Atom • Molecule

- Search for the Basic Mechanism of Quantum Effects -

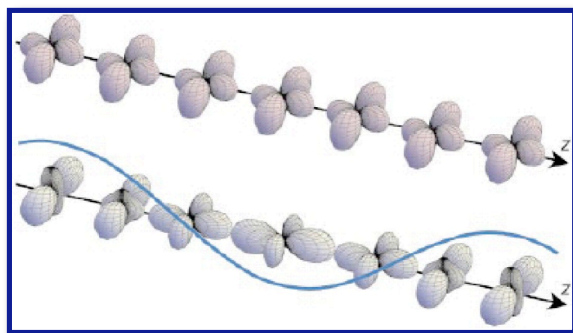
- Cooperation with
- The University of Tokyo
  - Hokkaido University
  - Ibaraki University
  - Tohoku University

Orbiton & Multipole

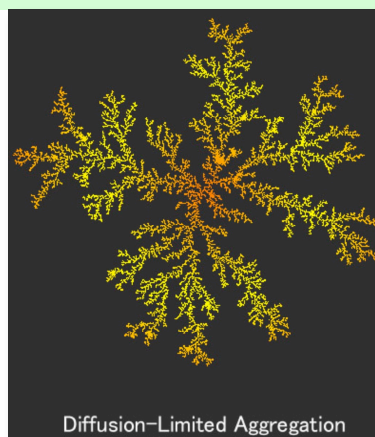
Quantum Local State

Quantum Protonics

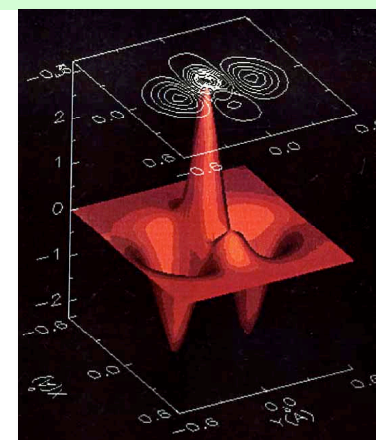
Observation of orbital and multi-pole wave



fractal, fracton and anomalous diffusion



coupling between proton-electron



(Proton wave function in hydrogen bond estimated by neutron scattering)

The brand new elementary excitation of electronic orbitals, that could possibly be an origin of giant magneto resistance GMR (The discovery of GMR has been awarded to Nobel Prize).

Discovery of the inhomogeneous structure and dynamics behind the universe, materials and the life, need to be significantly understood for nature.

Dynamics of quantum protonics (scattering) the key of understanding for the human activities and the mechanism of biological kinetics.

**“High resolution chopper spectrometer”**

the highest resolution (higher than 1 %), the highest energy (over 1 eV), the widest Q- $\omega$  range, and the smallest angle, in the world!

# Structure on Reactive Interface

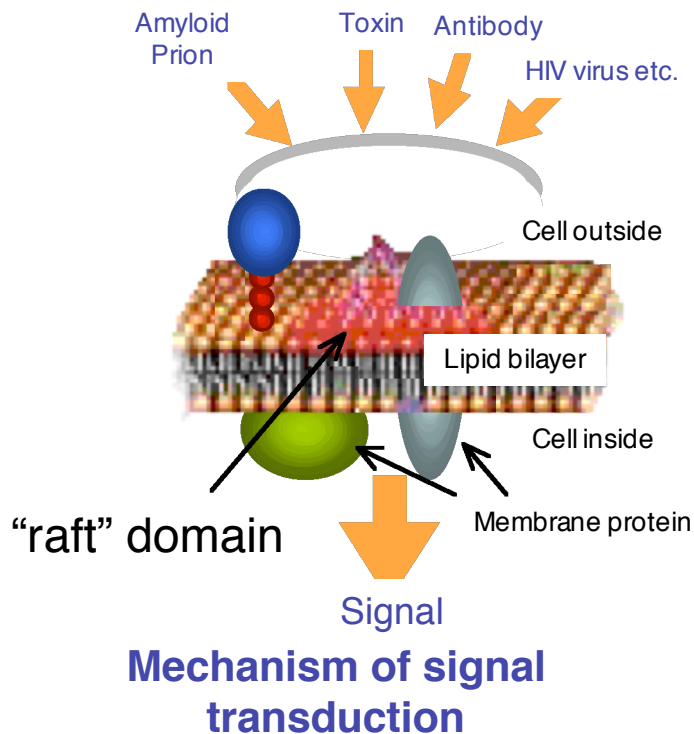
Cooperation with

- Nagoya University
- Kyushu University
- Kyoto University

## Bio-membrane

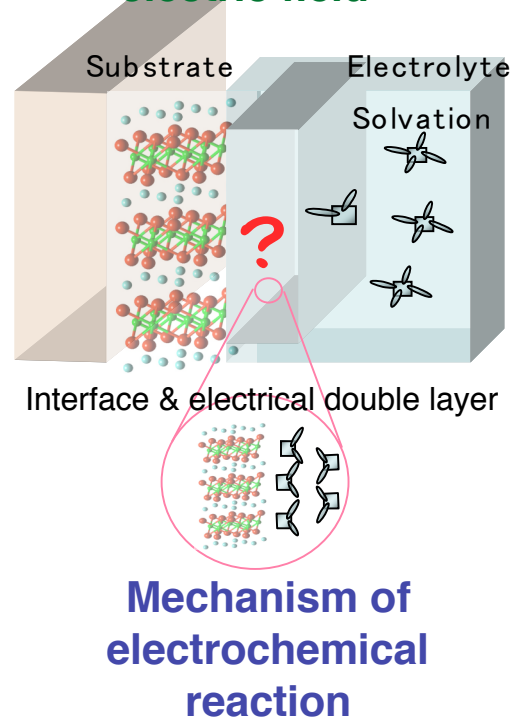
Structure and dynamics at bio-membrane interface

Interaction among bio-materials



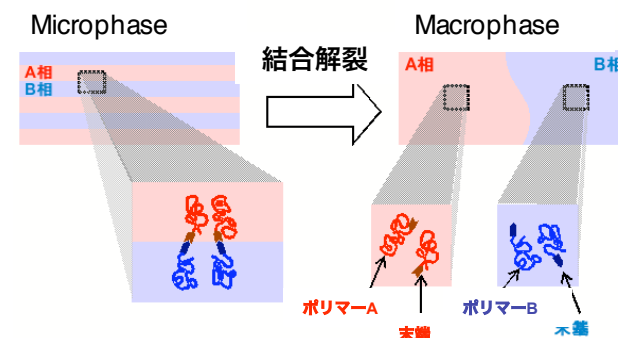
## Electrochemistry

*In-situ* observation of electrical double layer/ material transfer under electric field



## Functional Material

Formation process of phase-separated interface under applied outer field



Supramolecular polymer (Green materials)

Mechanism of interface formation for composite materials

**“High performance Reflectometer”**

Time-resolved measurement (sec order)/GISANS/Neutron spin-echo/Multi-channel elliptical mirror

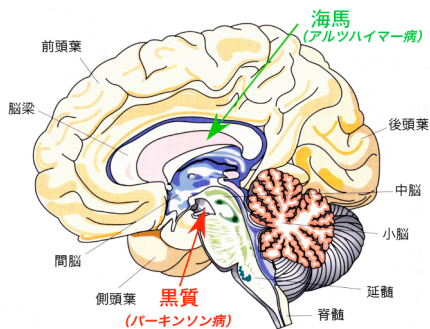


# Further expand

## with innovation and new idea

Protein aggregation

Parkinson' disease, Alzheimer disease, Cataract



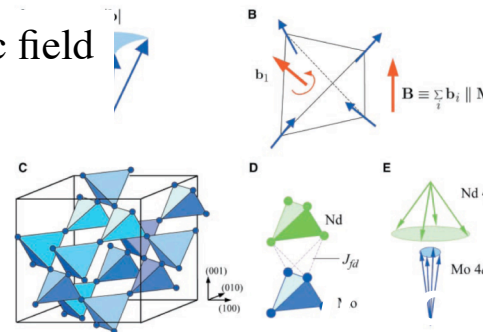
High pressure, High magnetic field

Earth science



Highly correlated electron system

Under the extreme condition



Slow dynamics  
in soft matters

6. Micro focus SANS

7. Extreme condition inst.

8. High intensity chopper spectrometer

9. Spin echo

*Develop Innovative devices*

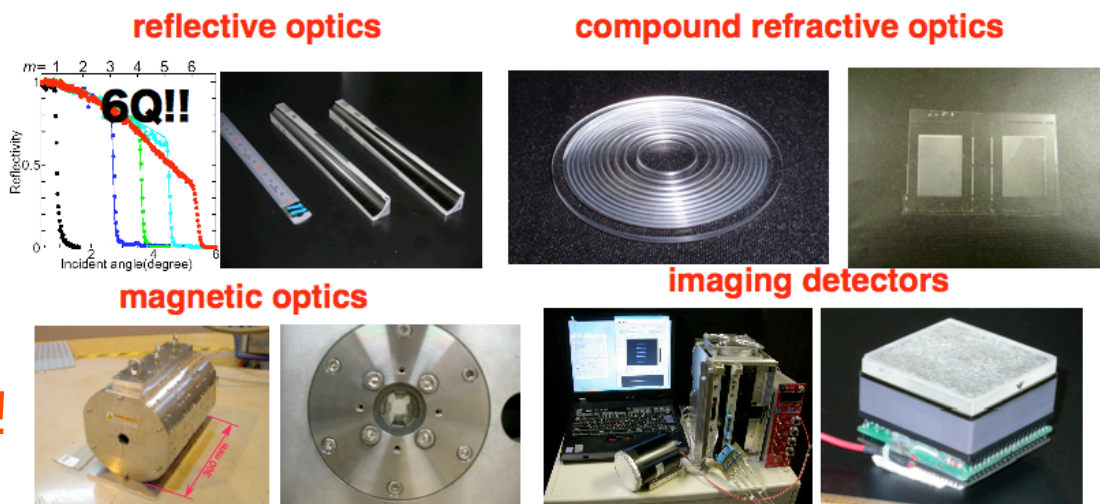
*Under the collaboration*

*with experts in*

*other KEK institutes*

*(Ex. IPNS in KEK)*

It provides further expand !





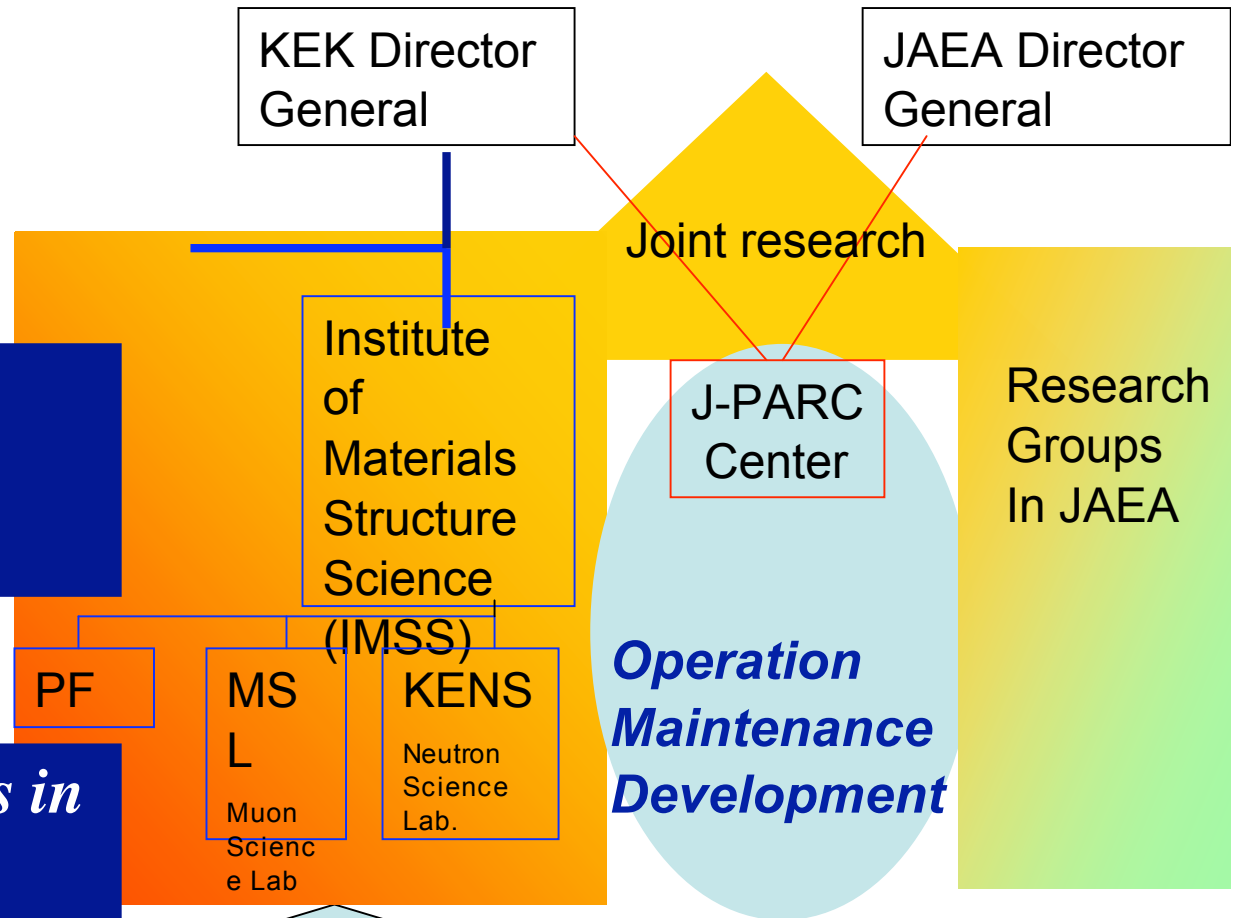
# Expand inter-university framework

*Expand the J-PARC activities with JAEA*

*Promote “top” sciences in a framework of Inter-university Program*

(form the “top” science teams)

*Promote many researches in “wide” & “new” scientific fields in a framework of Inter-university Program*



*Strong Collaboration*

Universities

# Summary

- Expand neutron science
  - “Beyond the horizon”
    - Expand J-PARC activities with JAEA
    - Exchange PF, Meson and Neutron activities
- New instruments with new idea
  - Close collaboration with other fields (ex. IPNS in KEK)
- Establish strong KEK-university network
  - Promote “top” science and encourage “new”
  - Education of young scientists



Senju-kannon  
in Yasuoka-dera