October 29, 2008
ICFA Seminar at SLAC

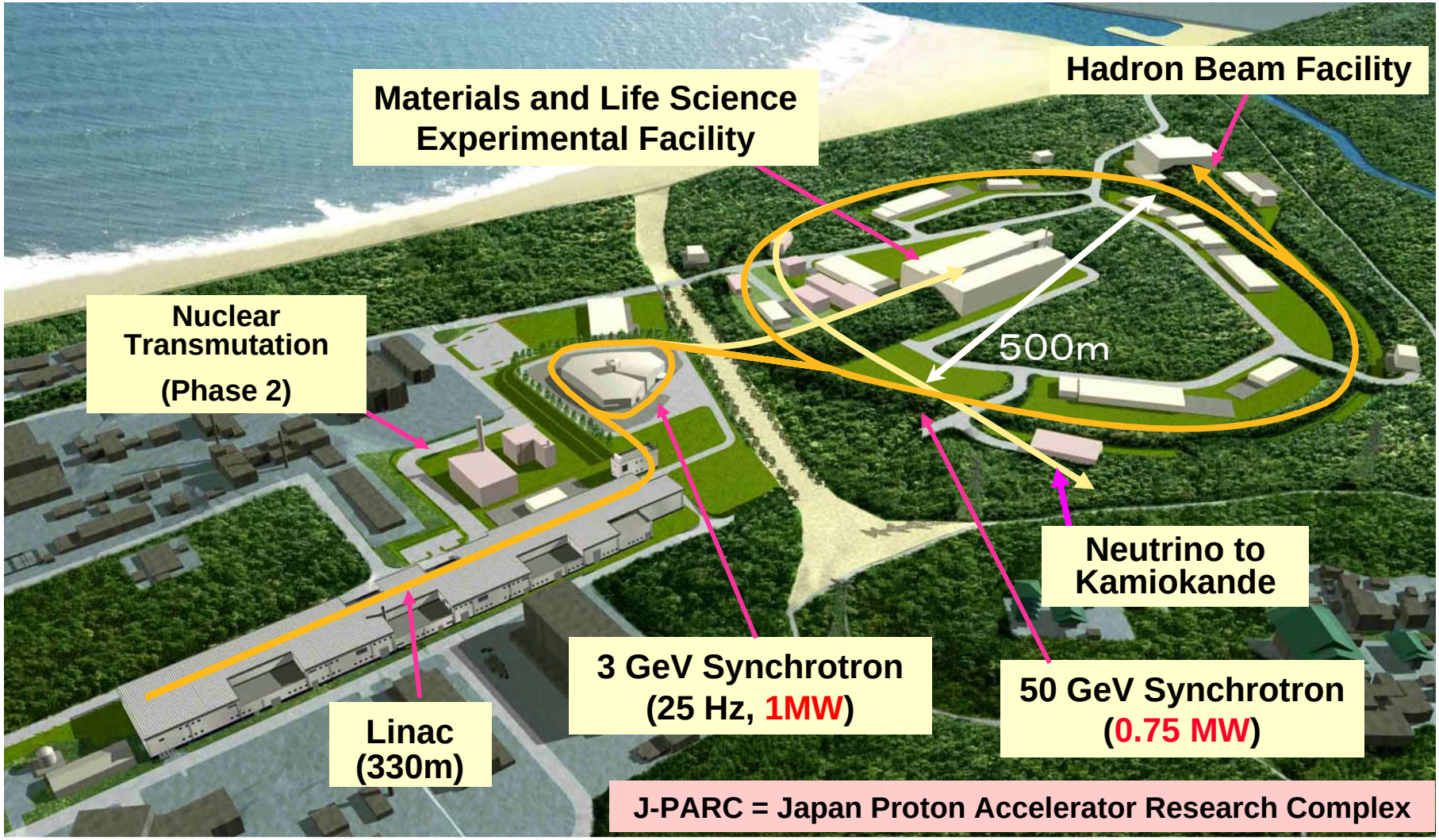
Status of the J-PARC

Shoji Nagamiya

J-PARC Center

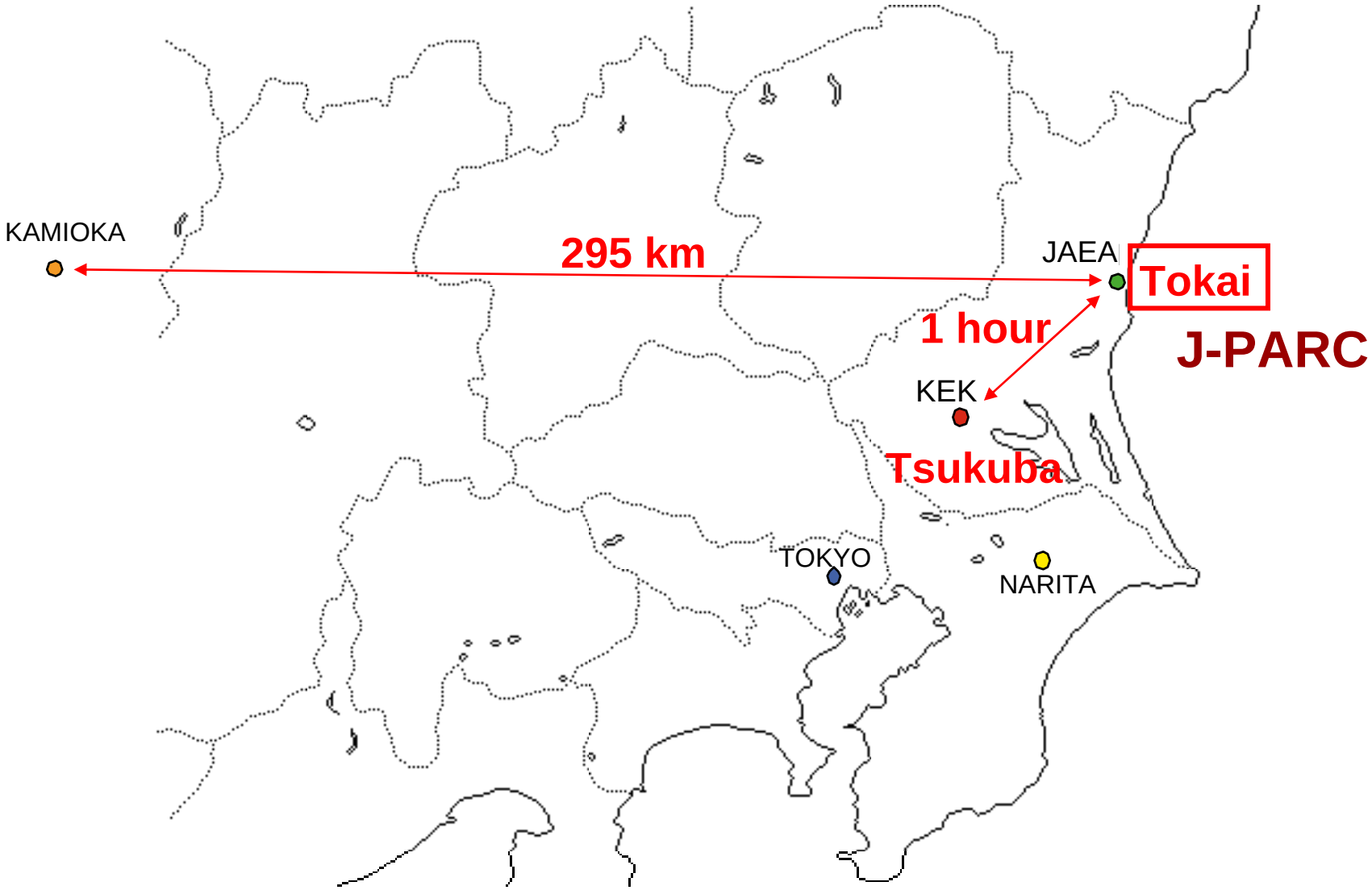
High Energy Accelerator Research Organization (KEK)
Japan Atomic Energy Agency (JAEA)

J-PARC Facility

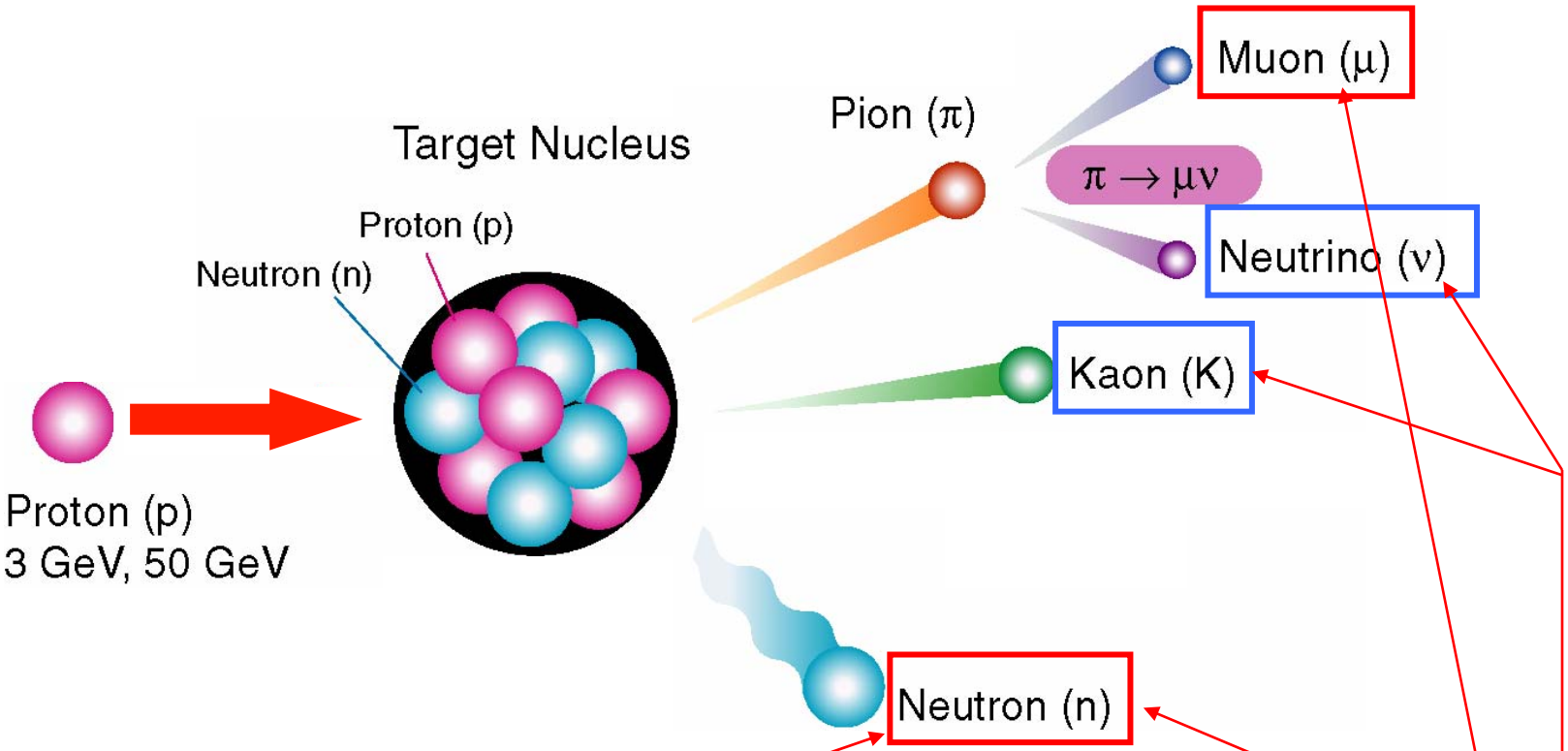


Joint Project between KEK and JAEA

Location of J-PARC at Tokai



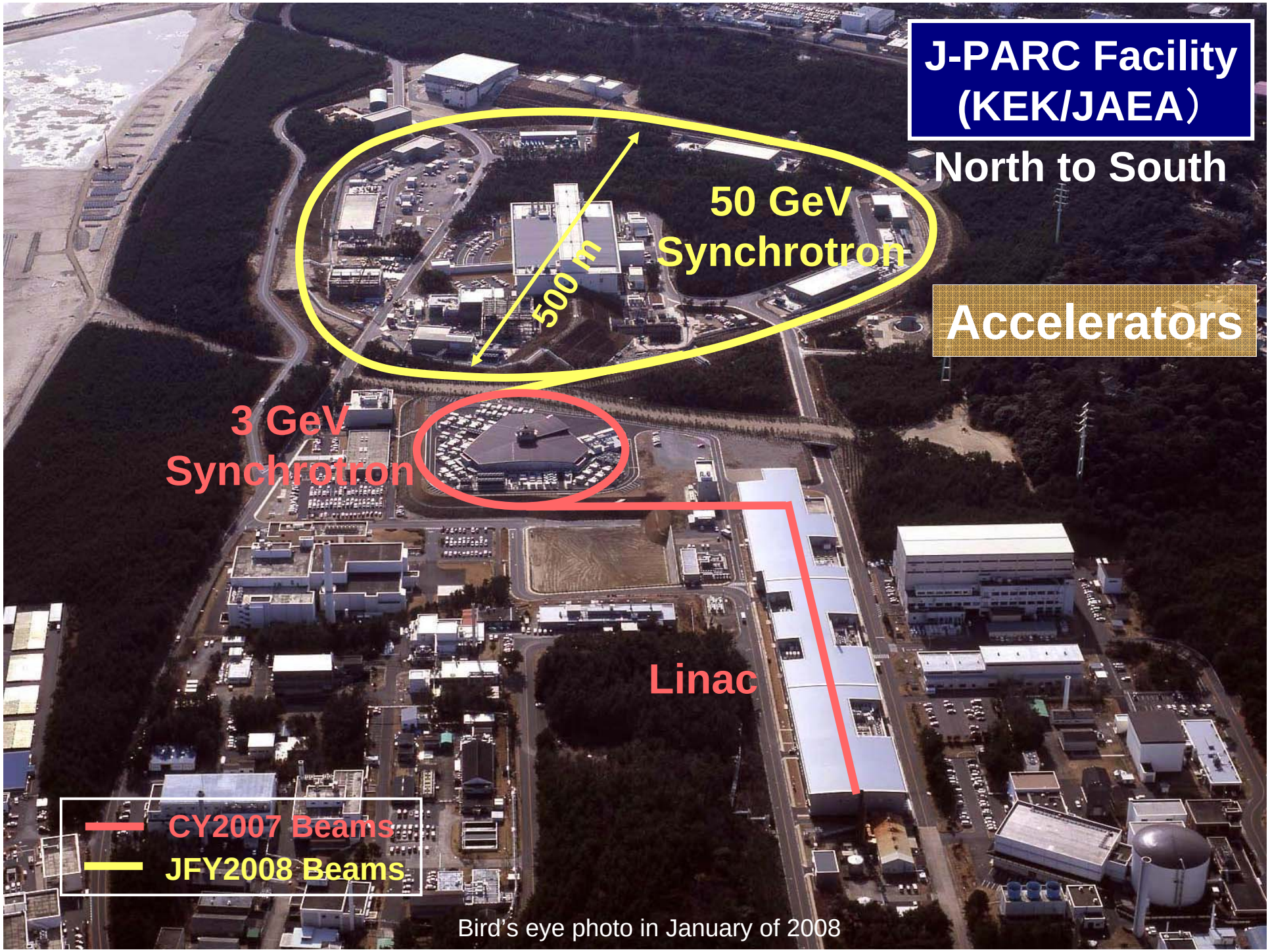
Goals at J-PARC



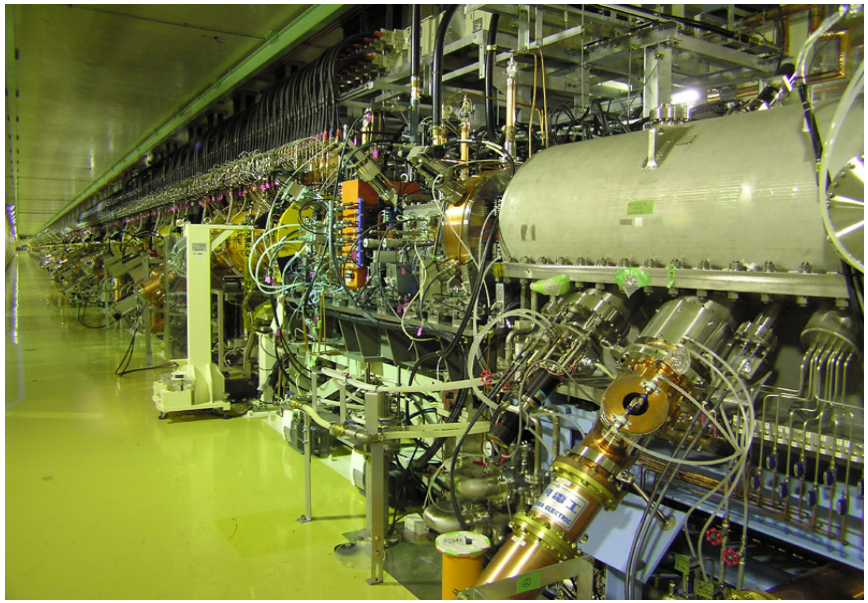
Need to have high-power proton beams

→ 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



Bird's eye photo in January of 2008



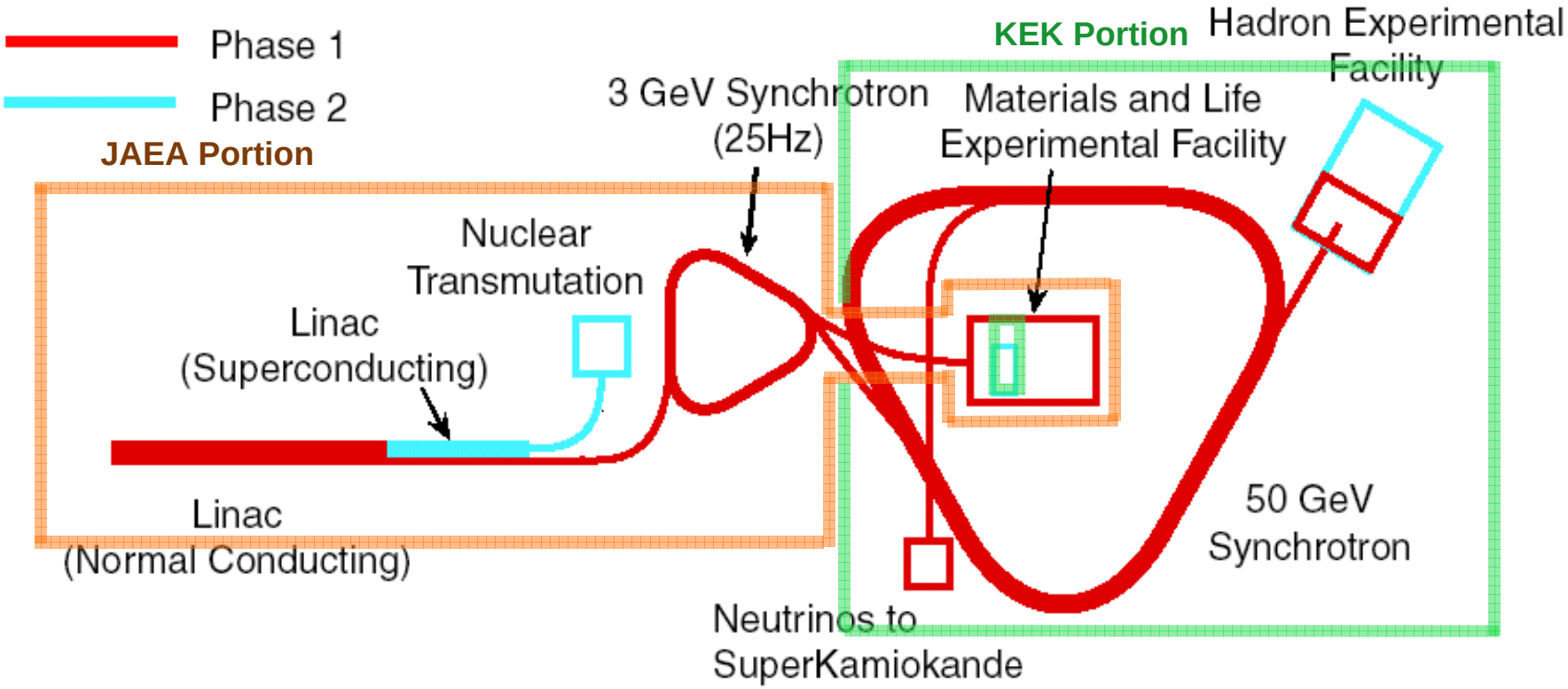
Linac (330ｍ)

3 GeV Synchrotron (350ｍ)

50GeV Synchrotron (1600 ｍ)

Superconducting magnets for the neutrino beamline

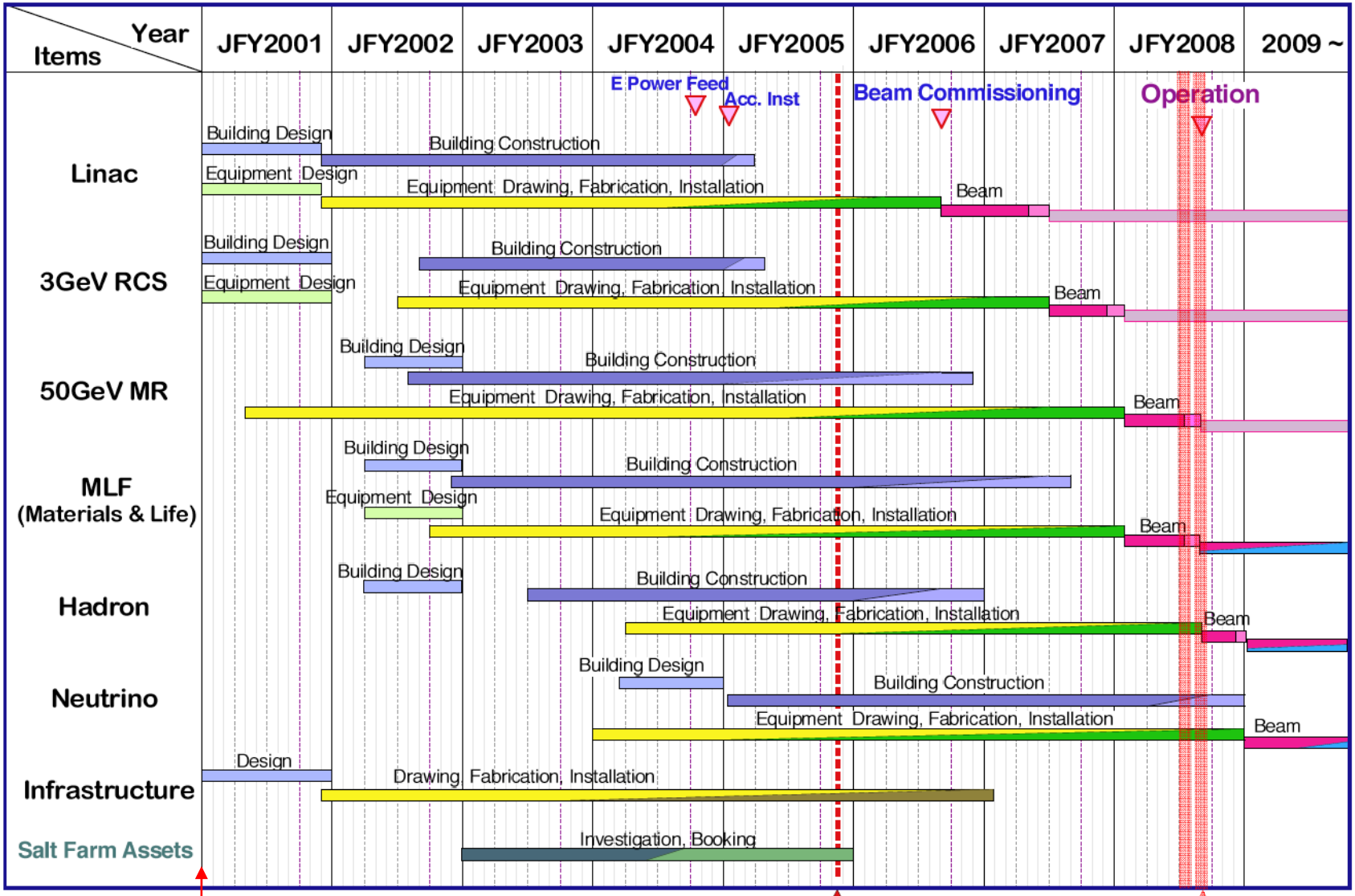
Phase 1 and Phase 2



- 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%).

J-PARC Construction Schedule

Feb. 27 2006

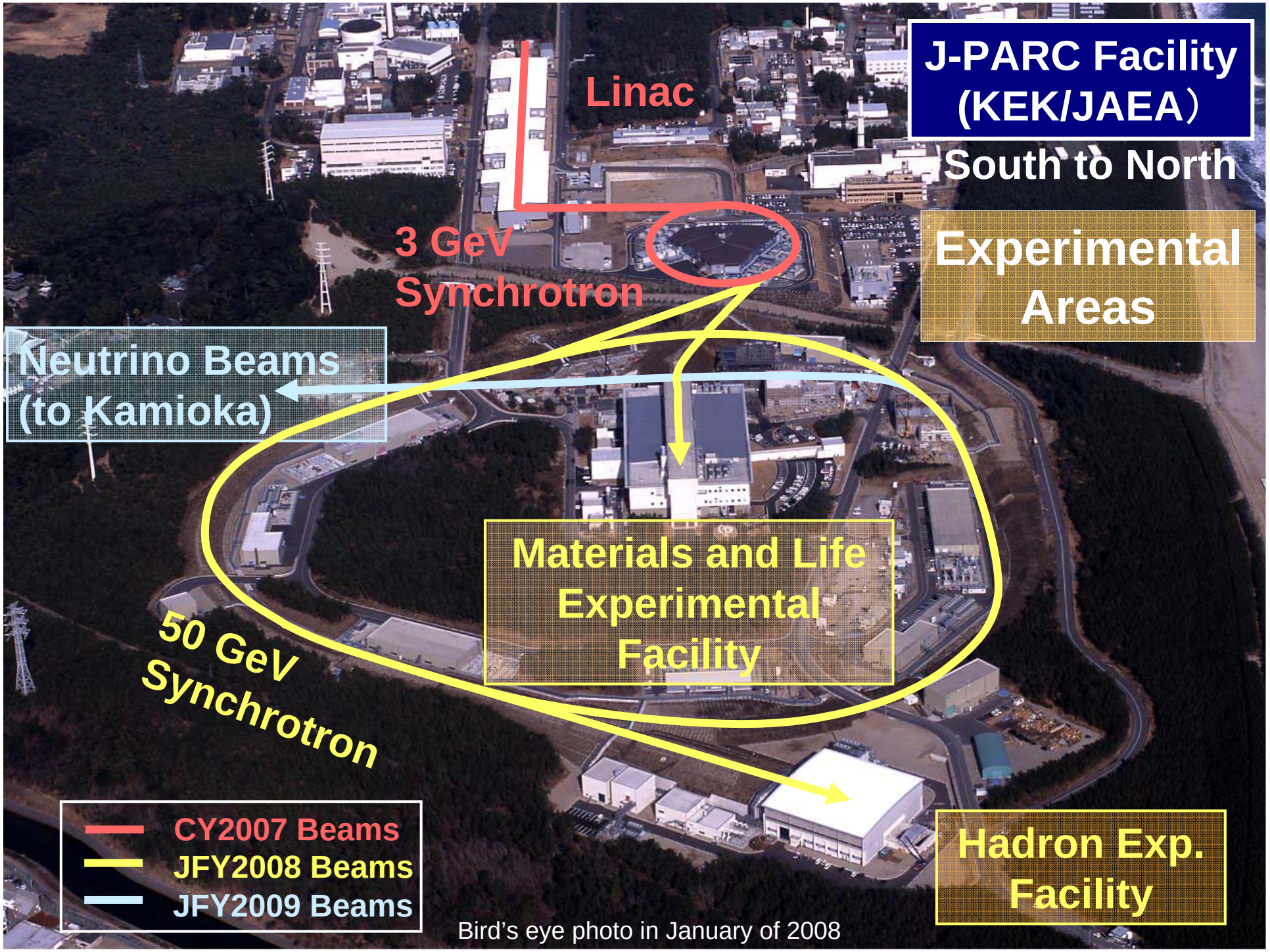


Construction Start

Time when this schedule was created (J-PARC Center started)

Now

Open to Users



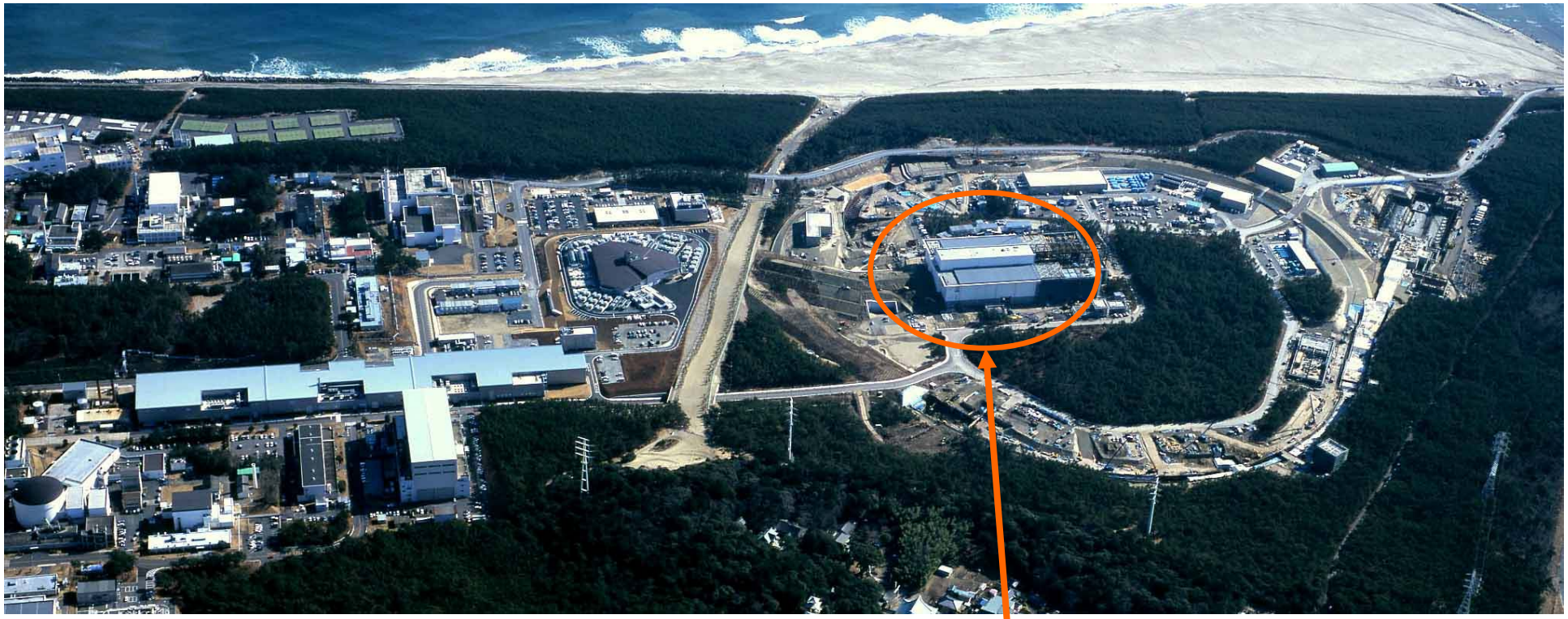
Bird's eye photo in January of 2008

Number of Beam Particles

Beam Flux at the Full Power Proton Beams

	# of particles per one proton	# of particles per second	Typical number of particles at one beamline*)
Neutron	80	10^{17}	10^{8}
Muon	10^{-4}	10^{11}	10^{7}
Kaon	10^{-4}	10^{10}	10^{6}
Neutrino	6	10^{15}	3×10^{7}

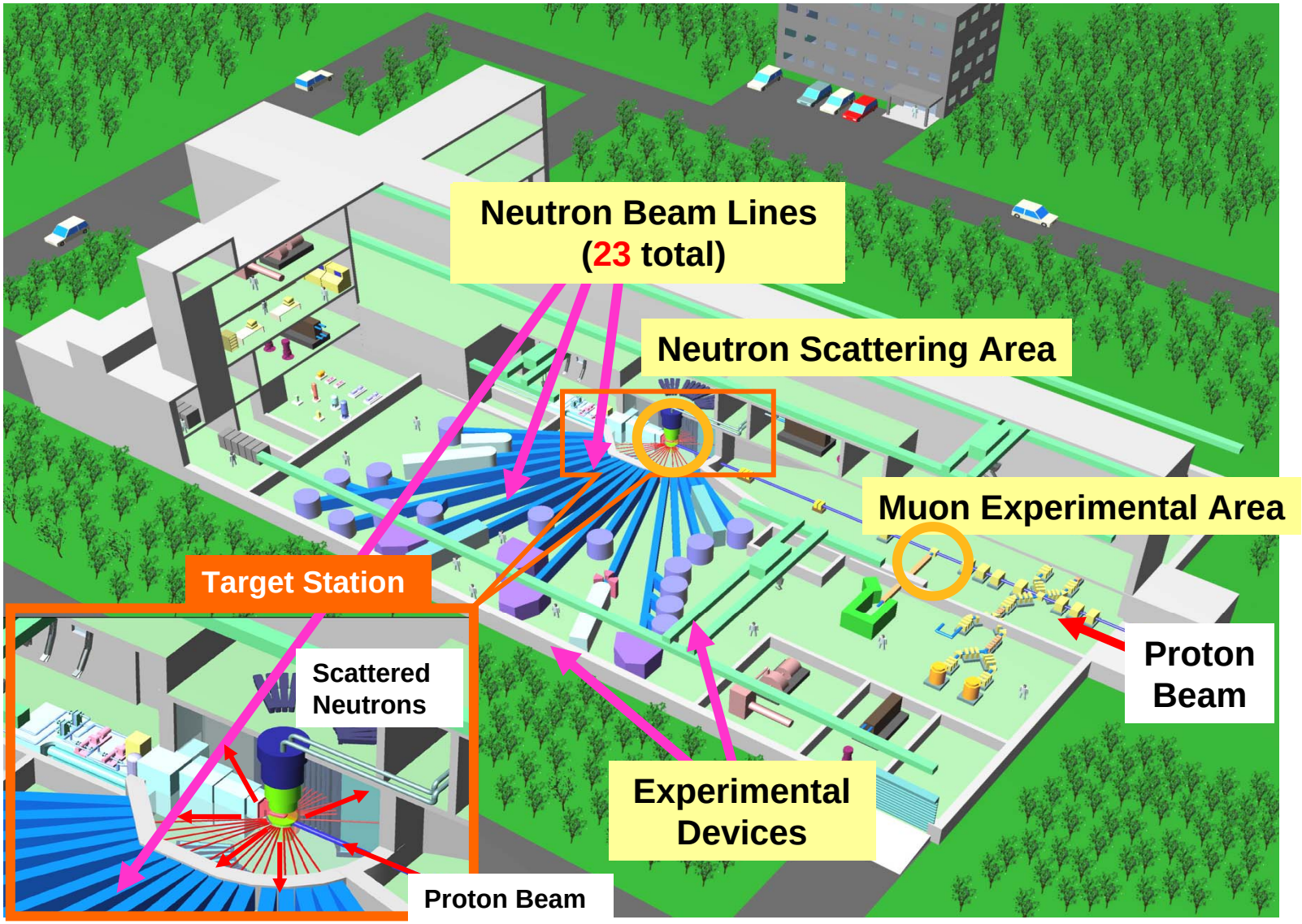
*) Number listed here is at Super Kamiokande.

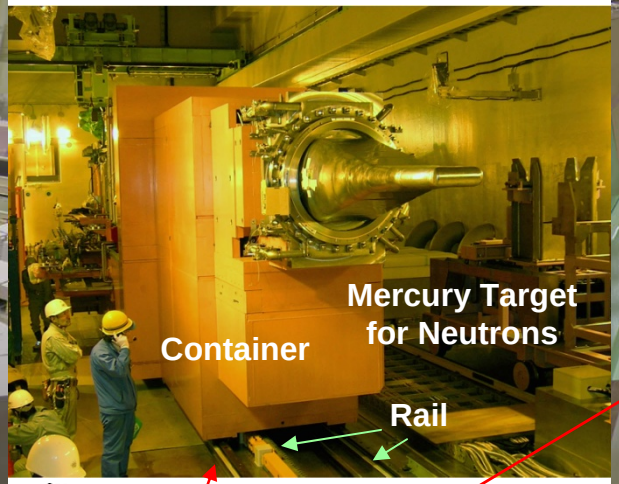


Materials and Life
Experimental Facility

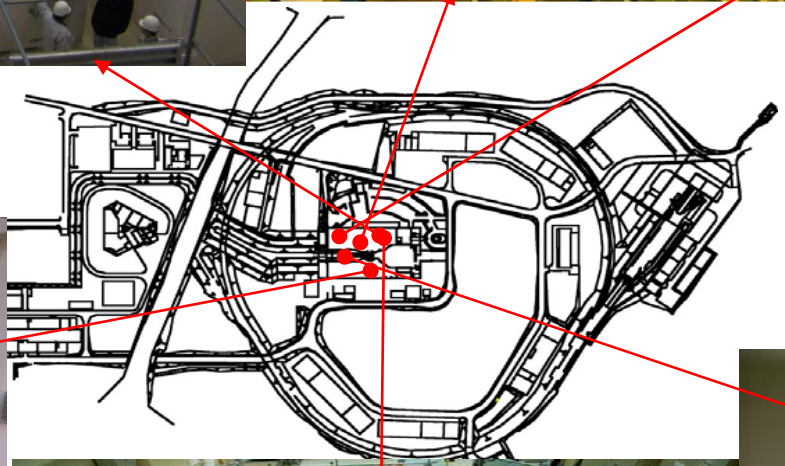
Facility similar to SNS in the US
and to ISIS in the UK

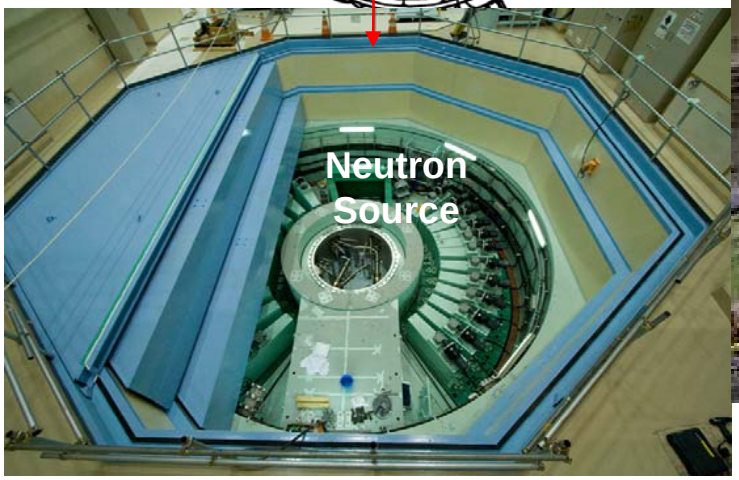
Materials & Life Experimental Facility





Experimental Hall



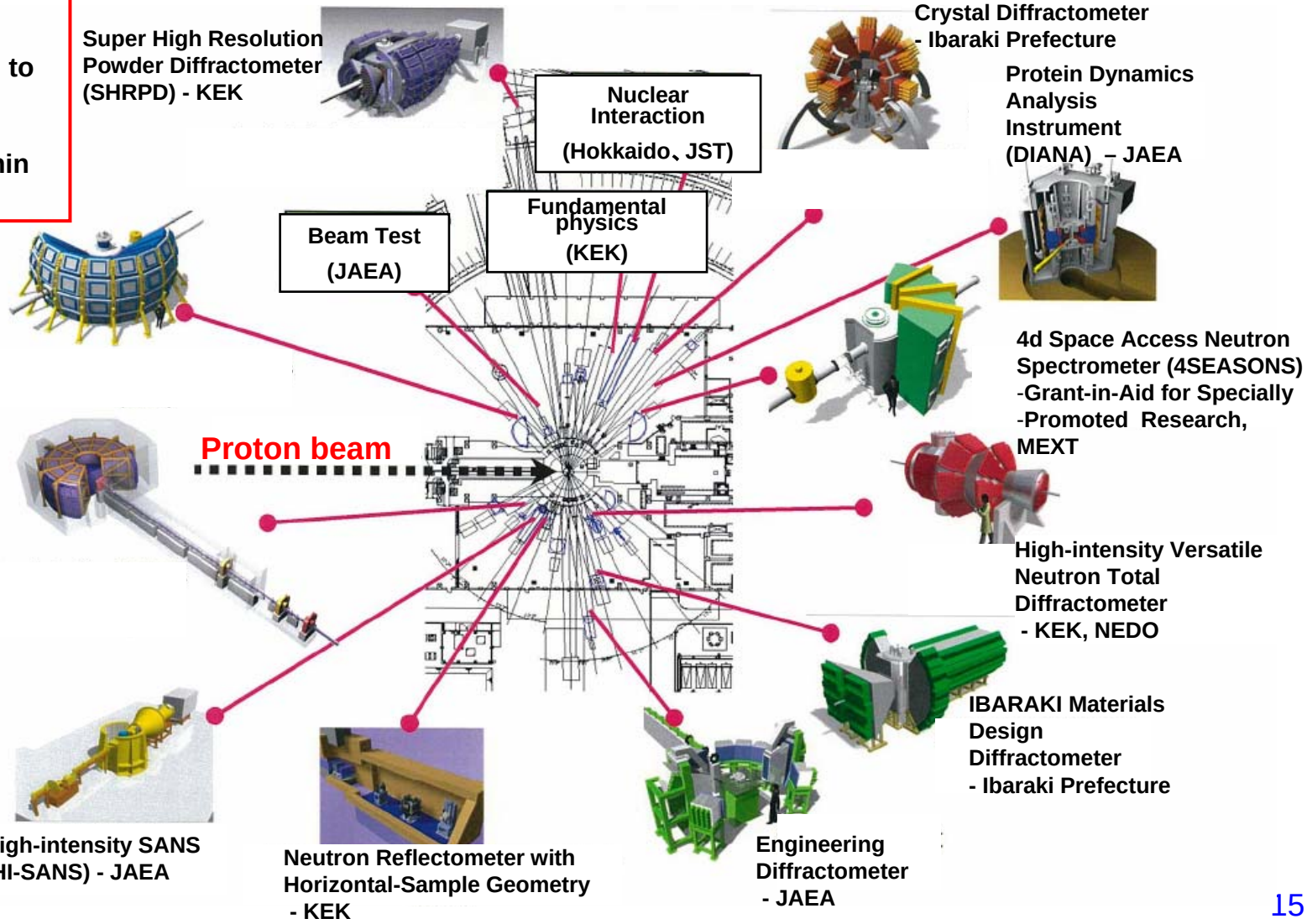


The 1st Hall (Neutron Area)

2008.5.30. First Neutrons
2008.12. Open to Users

Preparation of Neutron Equipments

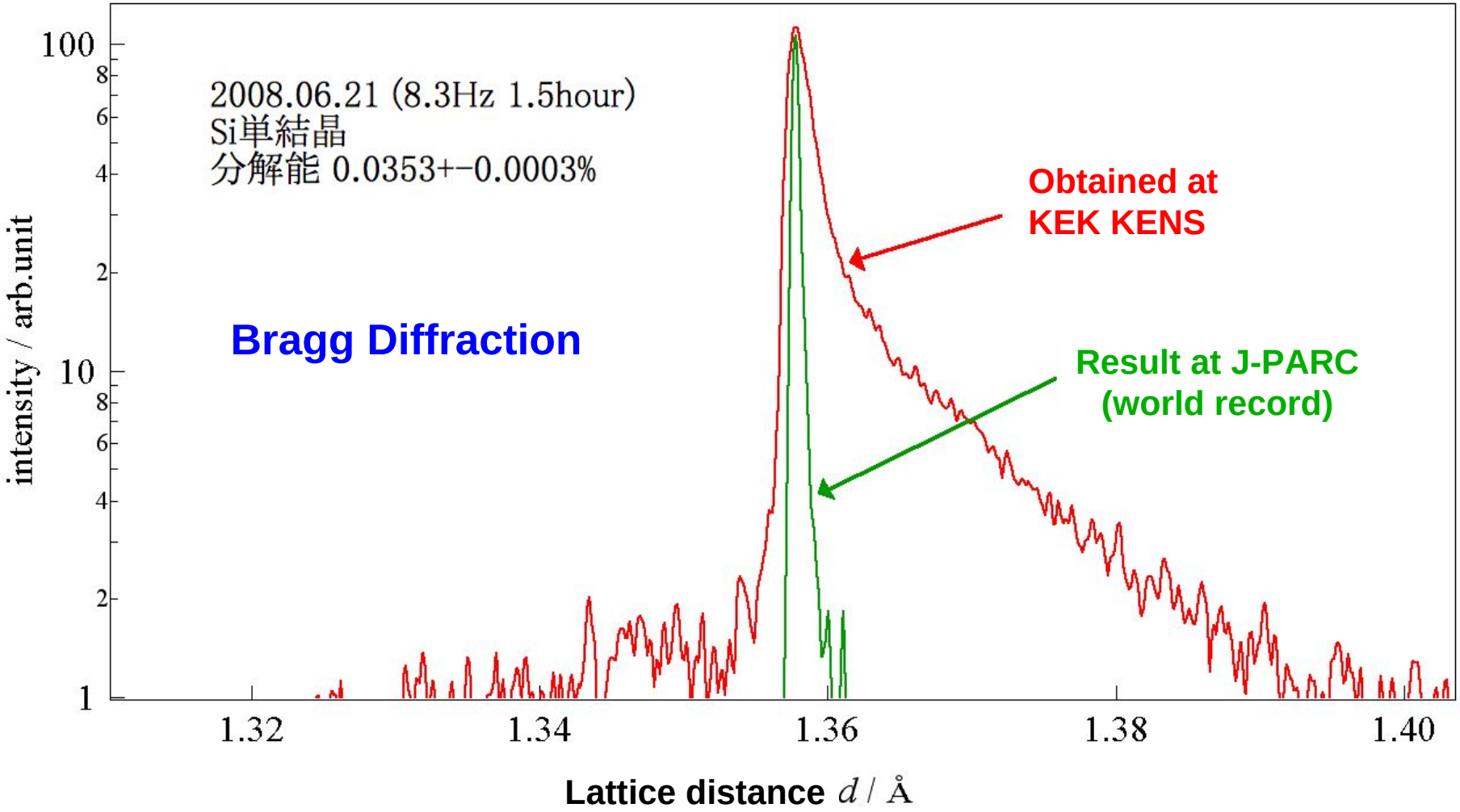
- 23 beam liens are available.
- Application for equipment open to public.
- About 10 equipments within JFY2008.



Life Science

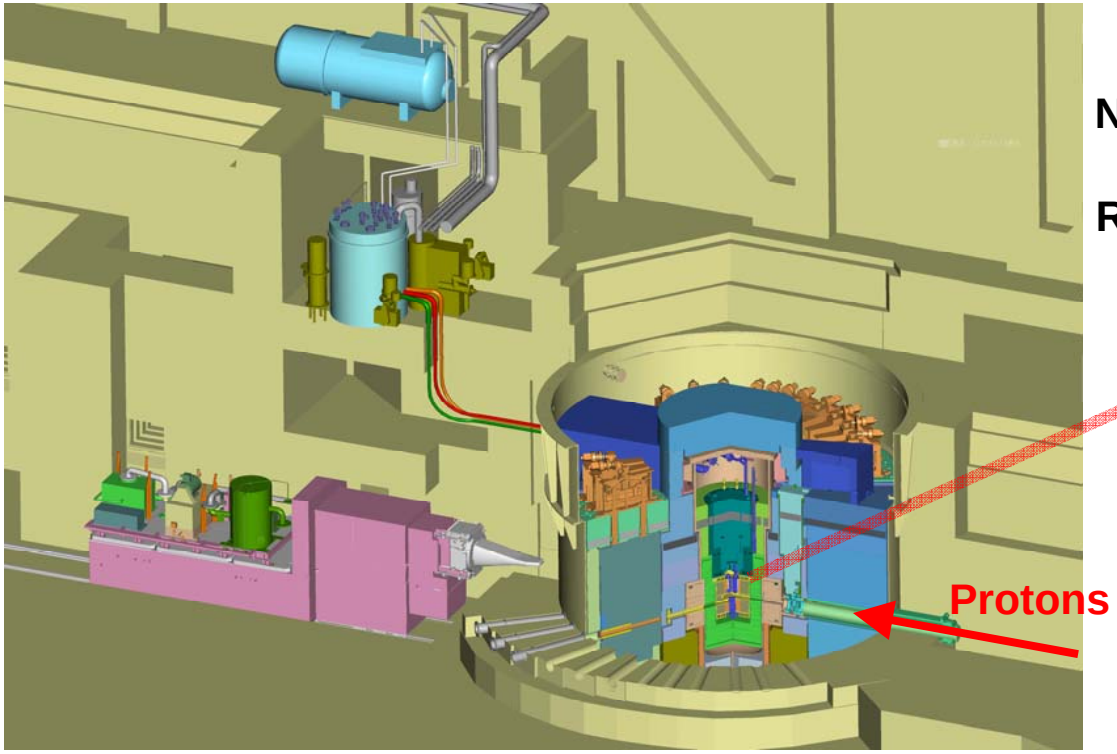
Materials Science

Example of Test Results in June, 2008

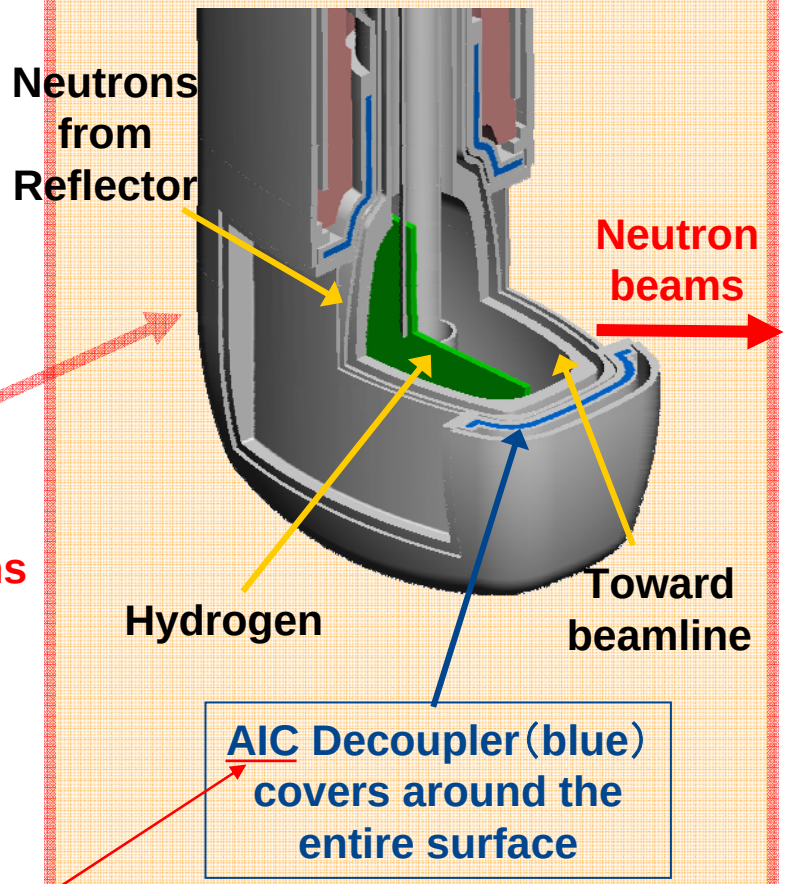


New Invention for Moderator

Neutron Source

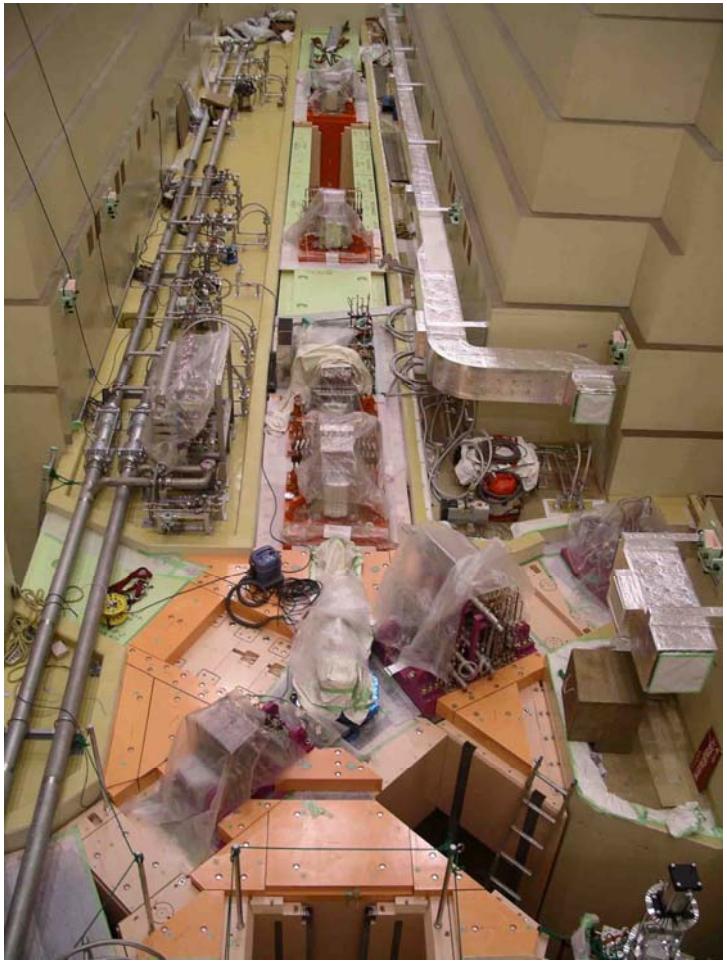


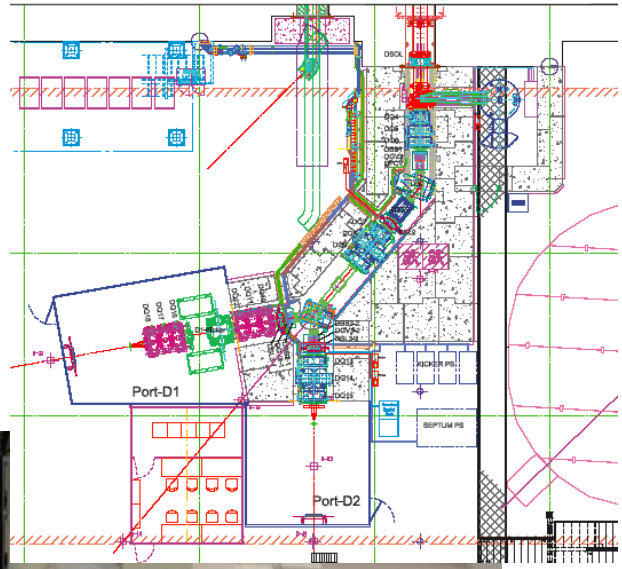
Moderator Type#1

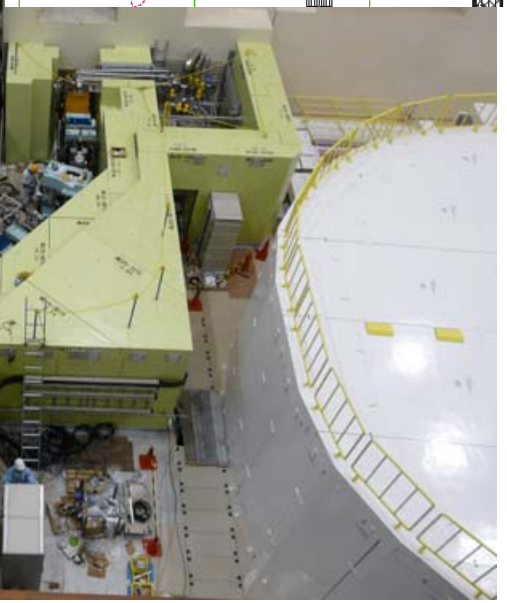


Other two types of moderators Have been prepared.

Muon Beam Area

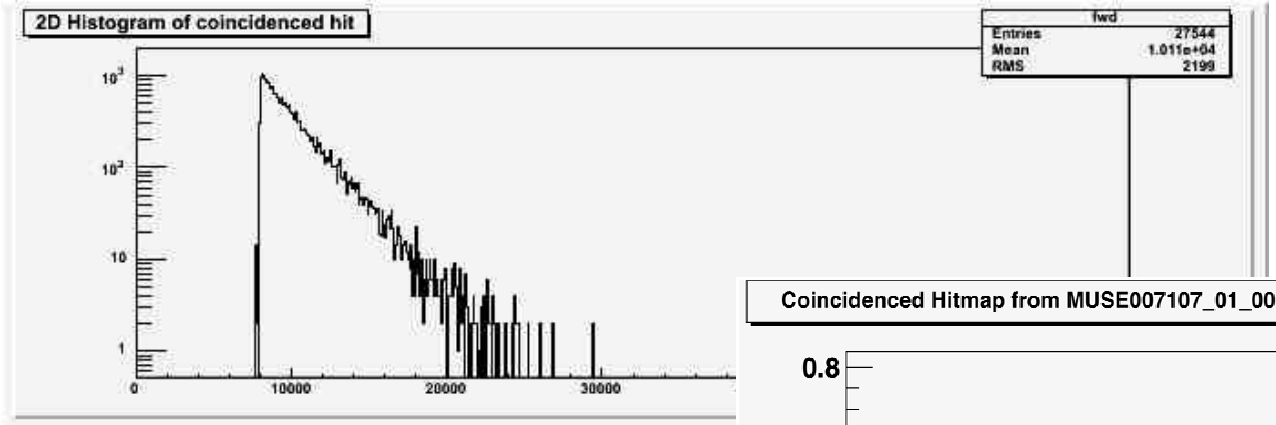


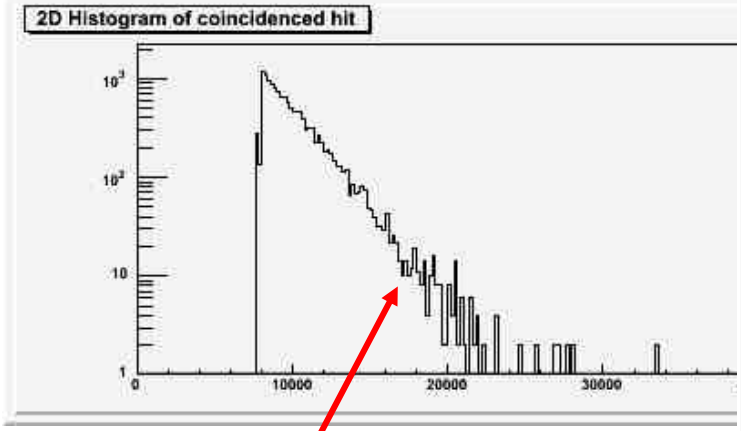




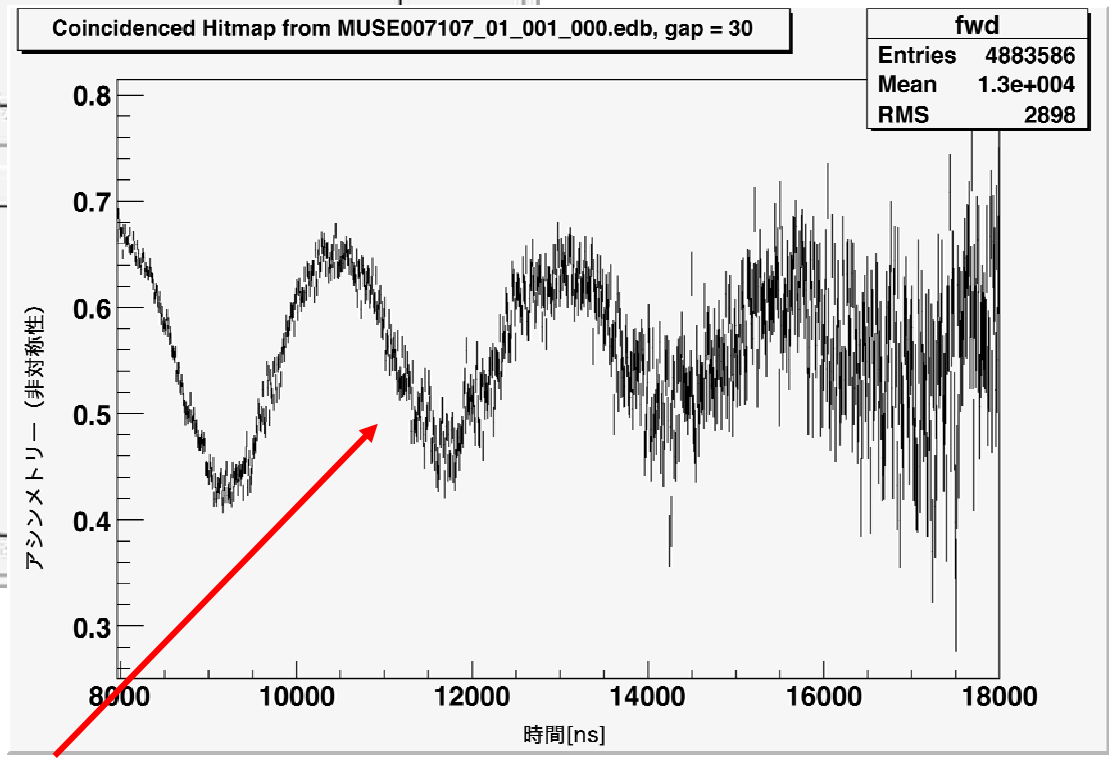
Muon Lifetime and Muon Rotation

September 26, 2008





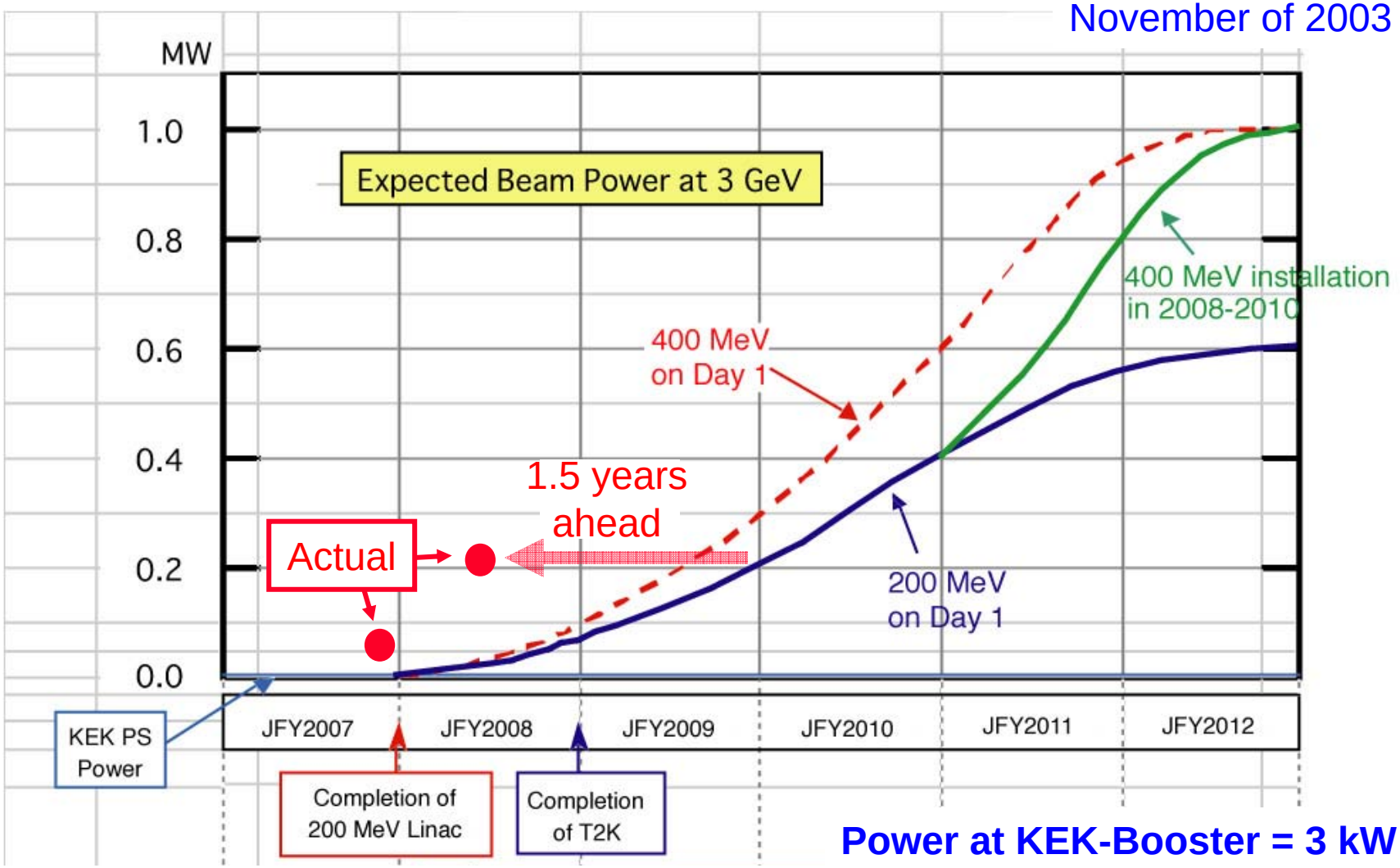
Lifetime = 2.2 μs



Muon Spin Rotation in a Magnetic Field

Expected Power vs. Actual Power

November of 2003

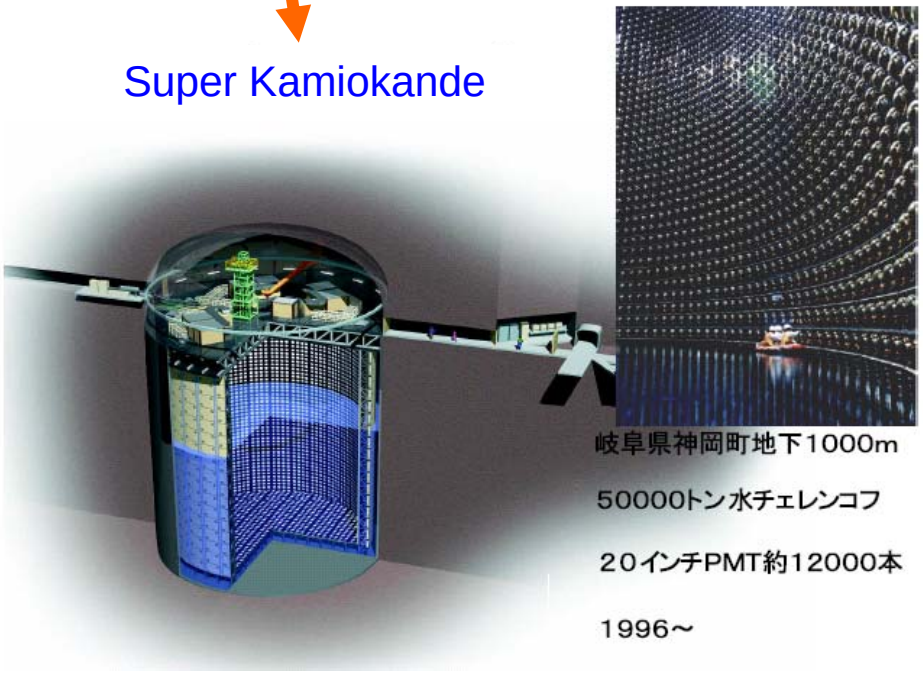


Power at KEK-Booster = 3 kW

Recent Major Events

2008	2	Beam power of 5 kW/pulse (130 kW equiv.), 50 kW extracted at 3 GeV
	3	
	4	
	5	Injection, RF capture and extraction with 3 GeV beams at MR (5/22) Production of neutrons (5/30)
	6	
	7	
	8	
	9	Beam power of 12 kW/pulse (300 kW equiv.), 210 kW extracted at 3 GeV Production of muons (9/26)
	10	
	11	
	12	Acceleration of Beams at the 50 GeV MR Neutrons + Muons: Beam Usage for General Users

Super Kamiokande



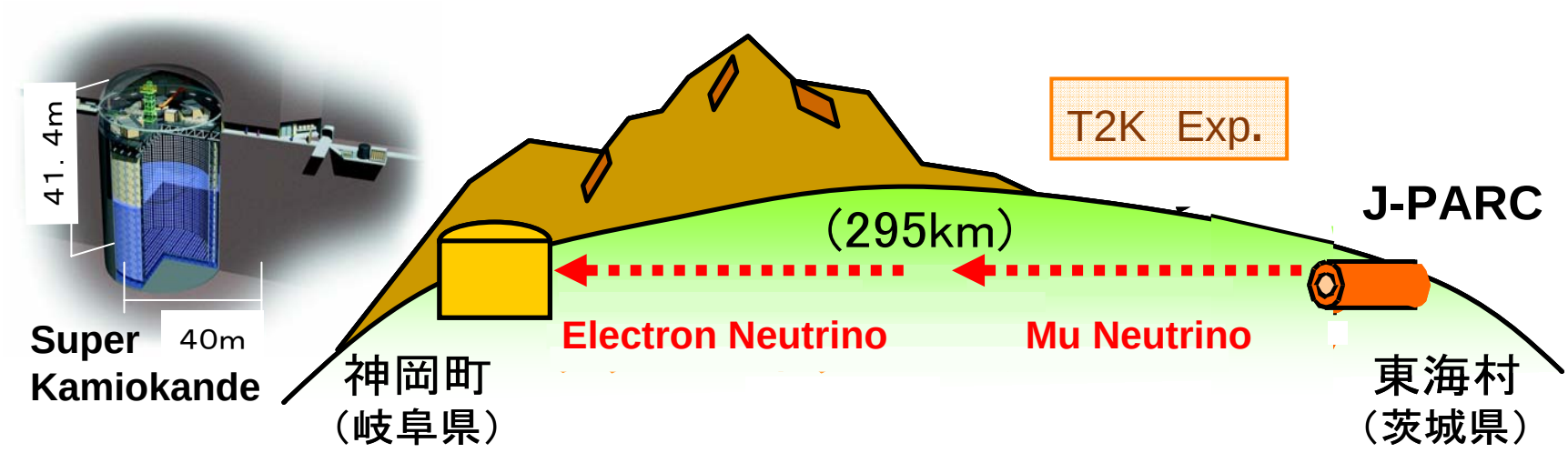
Neutrino Experimental Facility

Number of Users: about 400

(about 1/6 from Japan)

Experiments with Intense Neutrino Beams

Neutrino Oscillation (T2K) Experiment

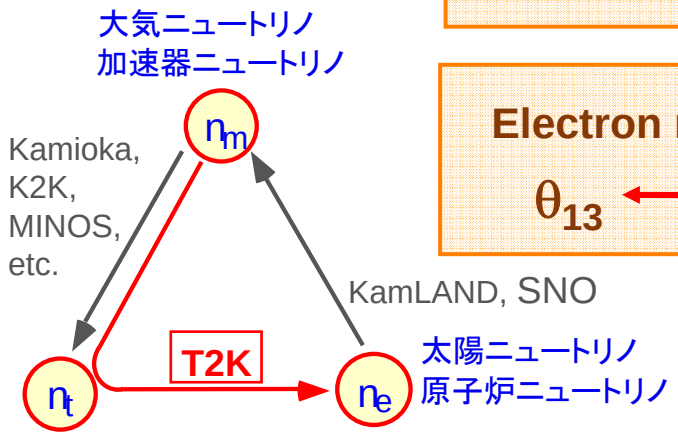


100 times sensitivity as compared with K2K

For example

100 neutrinos ← 150 neutrinos

Disappearance of neutrinos ⟷ Finite Mass



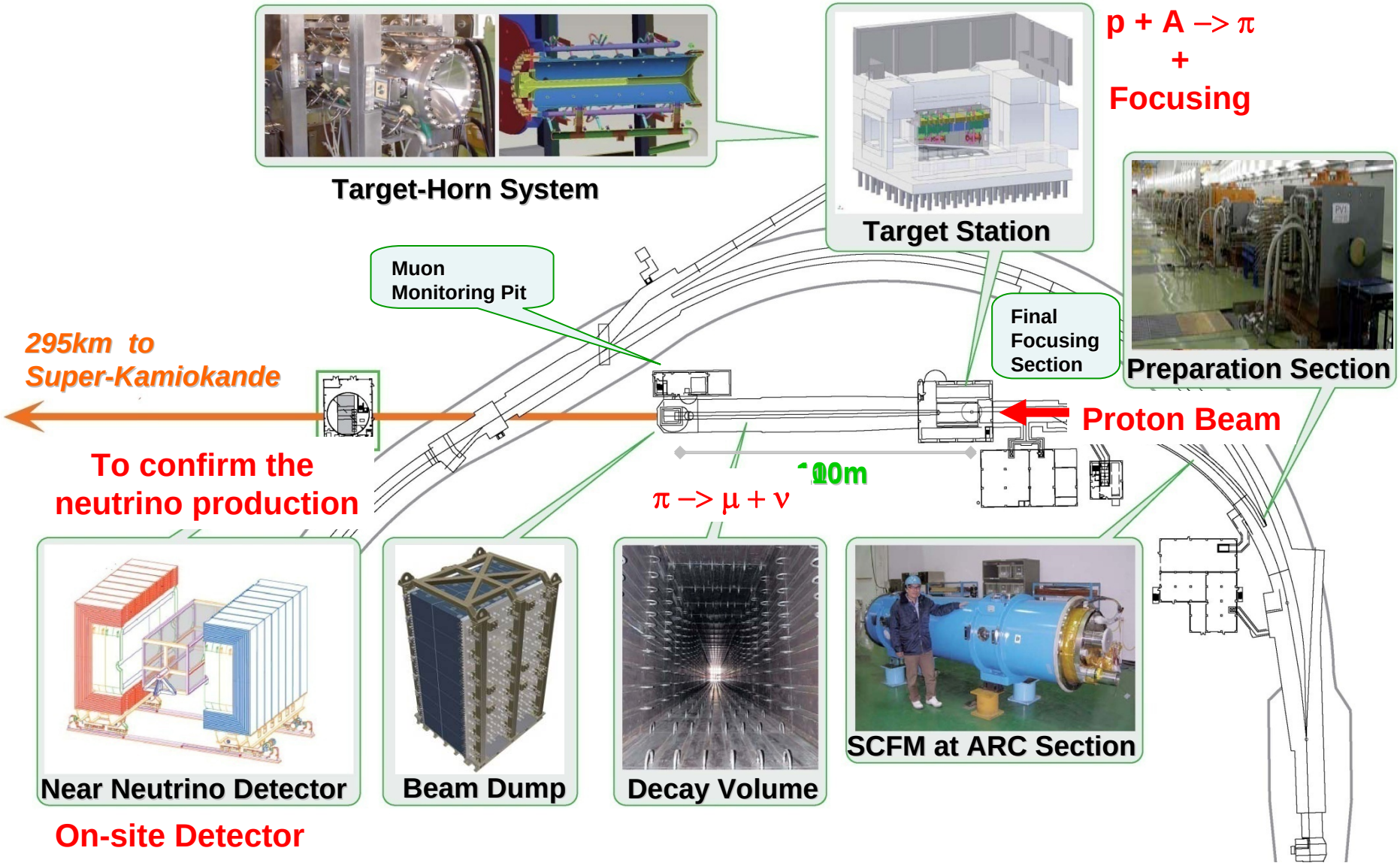
Electron neutrinos ← Mu neutrinos

θ_{13} ⟷ Mixing between the 1st and 3rd generation

CP violation experiment later by increasing intensity

Competition with Diya Bay, FNAL, etc.

Neutrino Beamline

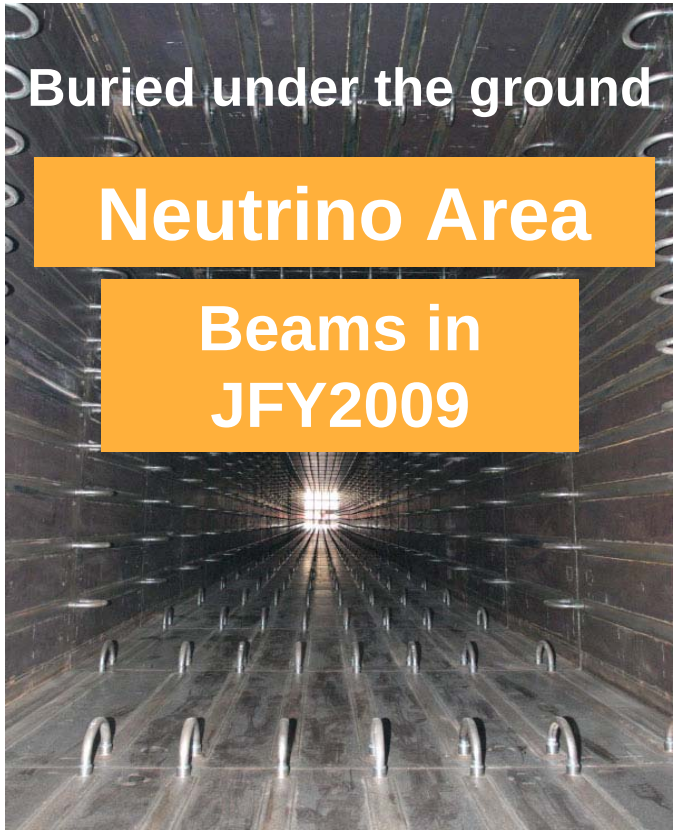


Beam Transport System

- Installation completed
- cooling of the magnets will start in Jan. of 2009.

Production Area and Decay Volume

Production Area
(p + A –> π)

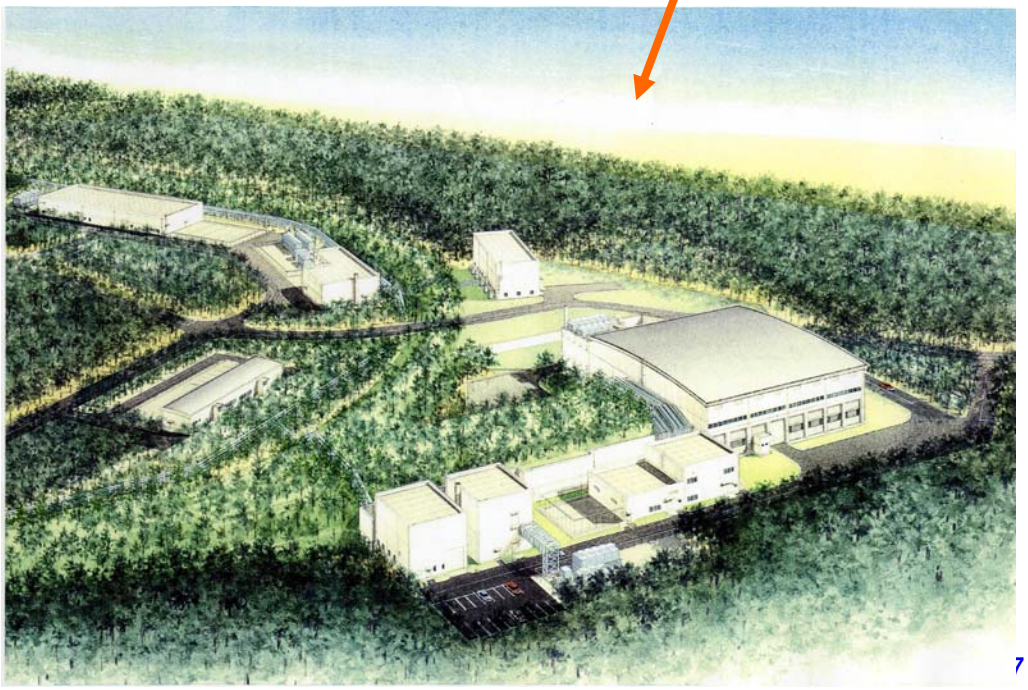


Decay volume
(π –> μ + ν)

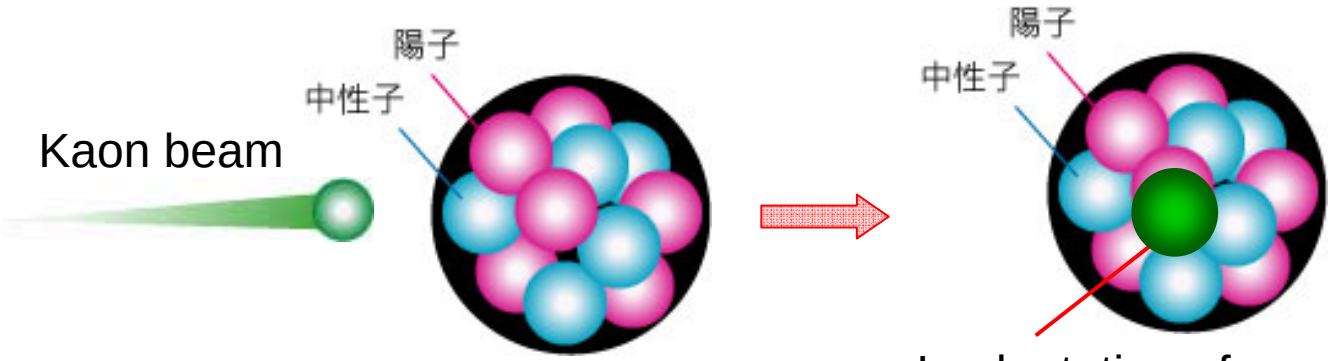
Hadron Experimental Facility

Number of Users: about 600

Experiments with Intense K-Meson Beams (Kaon Factory)



Nuclear Physics with Kaon Beams

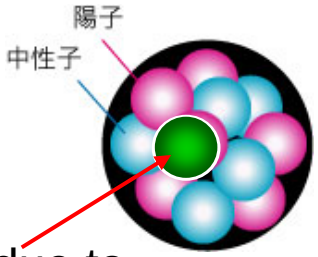


Implantation of strange baryon

Hyper Nucleus

Strange Nucleus

Strange nuclei are detected via pions, photons, etc.



Nuclear shrinkage due to Implantation of kaons

From impurity physics to bulk matter physics !

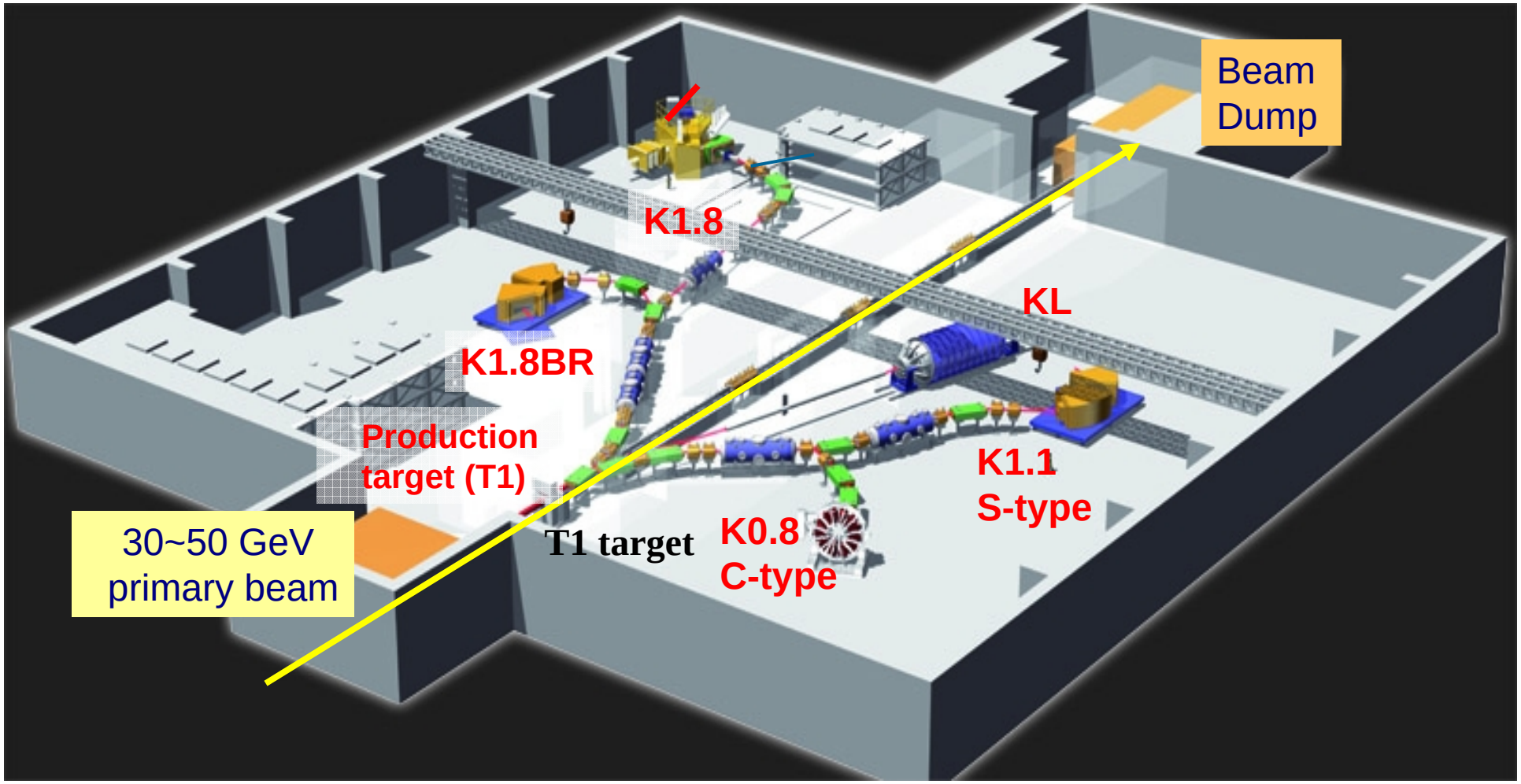
Nuclei far in the universe !

Study of the origin of the hadron mass by implanting mesons inside the nucleus !

High density nuclear matter exists only in the far universe.

Day-1 Experiments at Hadron Facility.

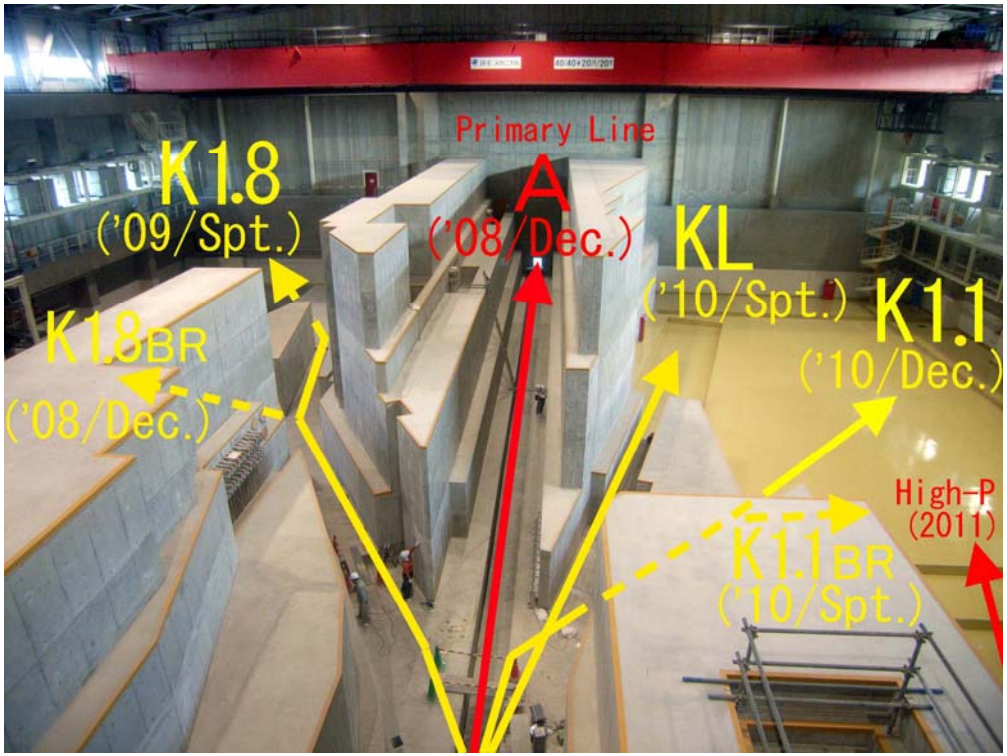
Hadron Experimental Hall



Hadron Experimental Hall

Now

Summer in 2007



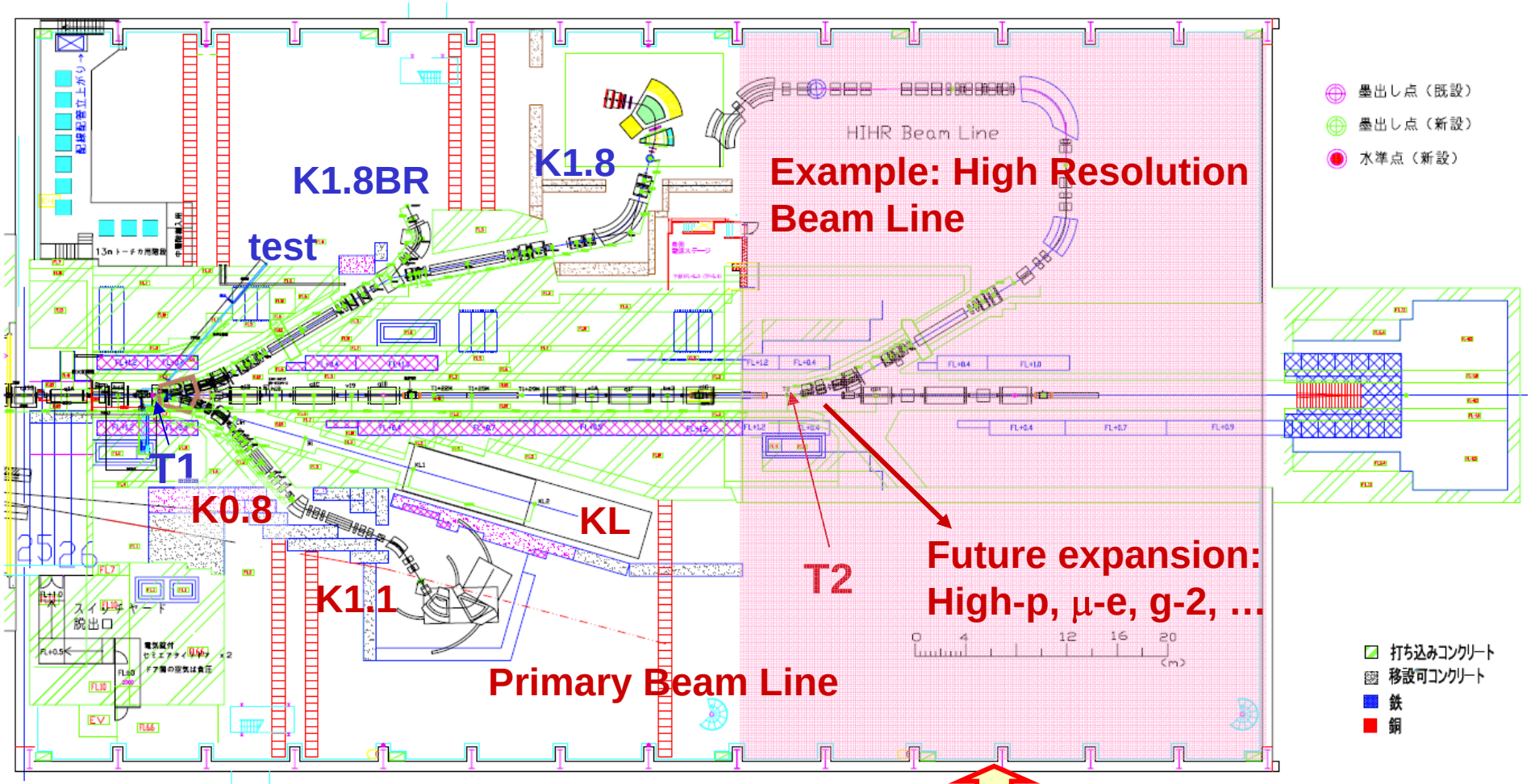
Hadron Area

Beam within JFY2008

Major Upgrades under Discussions

- Neutrons and Muons
  - Neutron equipments: How to fill the 23 beamlines (so far about 10 lines were funded) ?
  - Muon equipments: Among four beamlines, only one beamline will be in operation in 2008. Others have to be funded.
- Hadrons
  - Must construct several kaon beamlines plus a primary beamline.
  - Hadron hall expansion (Phase 2: 60m in length to 100m): Necessary to accommodate many user groups (Many requests on this at the Int. Workshop (NP08) held on 5-7 March of 2008).
- Neutrinos
  - Power upgrade (to 1.7 MW).
  - The third detector (at 2 km from J-PARC or at Okinoshima/Korea).
- Nuclear Transmutation
  - The major item for Phase 2 … Main Goal for JAEA.
- Others
  - Energy upgrade to 50 GeV.
  - Third fast extraction line or a fast extraction line at Hadron Hall?
  - Polarized protons, heavy-ions, ….

Phase 2 Expansion of the Hadron Hall

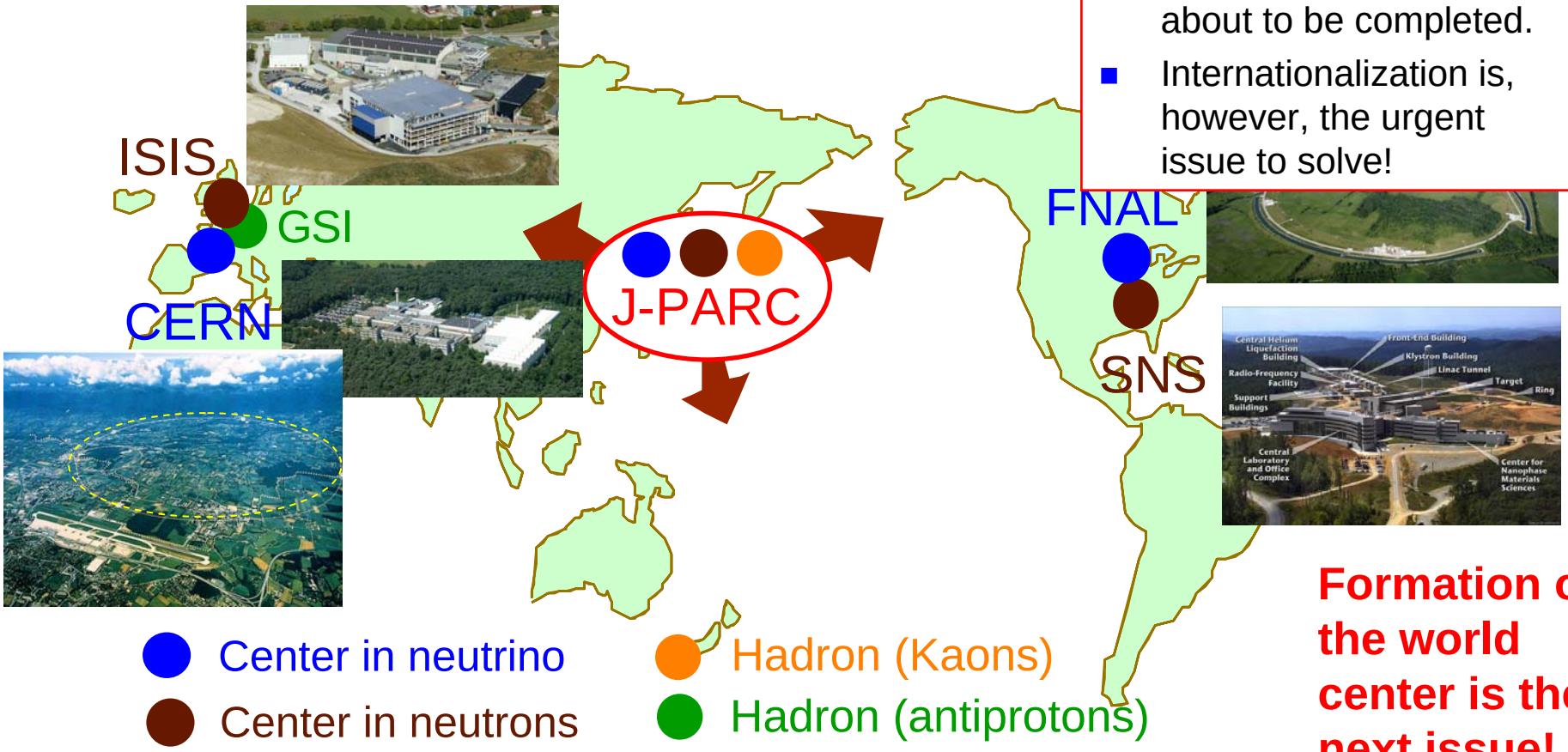


Phase 2 Area

World Center

- Materials and Life: One of three world centers, in particular, in Asia.
- Hadron physics A unique kaon factory in the world.
- Neutrino physics: As a world leader among the three

- World leading accelerator facility is about to be completed.
- Internationalization is, however, the urgent issue to solve!



Formation of the world center is the next issue!

ISIS:英国ラザフォード研究所の中性子源、SNS:米国オークリッジ国立研究所の中性子源
CERN:欧州合同原子核研究機構、FNAL:米国フェルミ国立研究所、GSI:ドイツ重イオン研究所

Summary

- Unique Accelerator Project Multi-purpose facility
  - World class proton facility → Variety of secondary beams Multipurpose
  - Broad fields in Science (materials and Life, Nuclear and Particle, Nuclear Industrial, etc.) → Interdisciplinary facility
  - Big facility with small users (over 1000 user groups)
  - Open to users for Materials and Life in December of 2008. Start to use the hadron facility within JFY2008. Neutrino beams in JFY2009.
- Open the Facility to International Scientific Communities and Domestic Industries
  - Internationalization is still not sufficient. Need to improve this aspect.
  - Open to industries in the area of neutron sciences.
- Future Issues: Production of Top-Level Scientific Results
  - Production of world leading results.
  - Operation of the facility as the User Facility.
  - International facility. Open to any countries in the world.
  - Easier access by the industries.