Recent Activities in Japan

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Chair of the executive committee of the experimental nuclear physics community in Japan
1. J-PARC
2. RIBF + CNS (U. Tokyo)
3. RCNP (Osaka U.)
4. ELPH (LNS) (Tohoku U.)

--------- under reconstruction
J-PARC Facility

Hadron Beam Facility

Materials and Life Science Experimental Facility

Nuclear Transmutation (Phase 2)

Linac (330m)

3 GeV Synchrotron (25 Hz, 1MW)

50 GeV Synchrotron (0.75 MW)

Neutrino to Kamiokande

Joint Project between KEK and JAEA

J- PARC = Japan Proton Accelerator Research Complex
The first results from J-PARC

**T2K:** Indication of $\nu_e$ appearance

- **Expected BG:** $1.5 \pm 0.3$ evts
- **6 $\nu_e$ candidates found!**

**E19:** Pentaquark $\Theta^+$ not observed in $\pi^- p \rightarrow K^- X$ reaction

**Non-zero $\theta_{13}$ at $2.5\sigma$ CL ($\Delta m_{23}^2 > 0$)**

- $0.03 < \sin^2 2\theta_{13} < 0.28$ 90%CL range
- $\sin^2 2\theta_{13} = 0.11$ Central value

assuming $\Delta m_{23}^2 = 2.4 \times 10^{-3}$ eV$^2$, $\sin^2 2\theta_{23} = 1$, $\delta_{CP} = 0$

Upper limit 0.26 $\mu$b/sr (90%CL)

To be published in PRL
Earthquake: damage and recovery

No Tsunami Effect
Main Buildings were almost OK

However, many utility buildings, roads, and extended buildings had significant damage.

After recovery

new
old
Beam Recovery

Beam to Linac: December 9
3 days before the target date
14:00 Beam went throughout the Linac at 3 MeV with RFQ acceleration.

Beam to 3 GeV Ring: December 17
Attained to 300 kW: December 21

09:30 Key was on.
Nov. of 2006. The first beam was on at the Linac.

Beam to 50 GeV Ring: December 22
Beam to Neutrino: December 24

Beam to Hadron Hall: January 28
Major Issues for the Coming 5 Years

• Accelerator + Neutrino
  – RCS to 1 MW
  – MR to 0.75MW (New Electric Power Generators for MR)

• Neutron
  – The last few Beamlines (JAEA 3, KEK 1), Data Analysis System, Sample Preparation Facility

• Muon
  – The third beamline S, The fourth beamline H for g-2, etc.

• Hadron
  – High Momentum Beamline + Comet for $\mu \rightarrow e$ down to $10^{-16}$
  – Hall Extension

• ADS

• Infrastructure
  – Research Building, Radioactive Handling Building, Lodging
Hyp. weak decay (A=4)
Hyp. weak decay (A=12)
π Double charge exch.
ω mesonic nuclei
Σp scattering

Hadron mass in nuclei
Nucleon quark structure

T violation in K⁺ decay
Universality in K⁺ decay
Θ⁺ study by K⁺n scattering

30~50 GeV primary beam

Approved (stage-2) / (stage-1) / proposed, LOI

μ-e conversion search
Future Plans for Hadron Hall

Primary proton / high momentum secondary beam line
-- Mass shift of hadrons in nuclei, charmed baryon spectroscopy, nucleon quark structure

Extension of the Hadron Hall and three new secondary lines
-- Baryon-baryon interactions, baryon modification in nuclei,
  Exotic hadrons and hadrons in nuclei
RIKEN RIBF (RI Beam Factory) -- fragmentation-based RI bemas (1990- / 2007-)

**RIBF** – a new generation RIB facility in operation with world highest capability of producing exotic nuclei in coming years!

- **RIPS (1990-)**
  - ~50 MeV/nucleon
- **BigRIPS (2007-)**
  - ~200 MeV/nucleon

**SRP**
- 345 MeV/nucleon up to U (2006-)
- 160 M$ for light nuclei (1986-)
- 400 M$ (construction)

**Experimental equipment**
- 135 MeV/nucleon for light nuclei (1986-)
- Aug. 2012
Extension of knowledge in the nuclear chart

18 new (μs) isomers D. Kameda et al., 2012
18 new half-life data S. Nishimura et al. PRL106, 052502 (2011) – r-process
- $T_{1/2}$ are shorter for Zr/Nb compared with FRDM predictions!
Secondary reaction studies

In-beam γ-ray spectroscopy with direct reactions e.g. $^{42}\text{Si}$

Interaction cross section measurements → new halo in Ne, Mg
(t,$^3\text{He}$) at SHARAQ (high-resolution spectrograph)
→ isovector spin monopole mode

T. Otsuka et al., NPA 805 (2008) 127c

DALI2

- 160 NaI(Tl)s
- * 4.5 x 8 x 16 (cm$^3$)
- for 1MeV γ ray (v/c=0.3)
- efficiency ~21%
- energy resolution ~8%
EURICA (2012-): Euroball Cluster detectors at RIBF

- Euroball Cluster detectors
- Support structure
- Readout electronics

Aug. 2012
Courtesy of S. Nishimura

GSI RISING

RIKEN RIBF (Japan)

Courtesy of S. Nishimura
new equipment

**SAMURAI:** 1st experiments performed in 2012.

**SCRIT (e^- - RI scattering)**
under construction

**Rare RI-Ring (mass Measurements)**
under construction

Aug. 2012
RIBF Upgrade Options – Long-term plan

HE RIBs
Post-Acc.
SLOWRI

Big-RIPS

RILAC1
RILAC2
RRC

ISOL
SRF (d 40MeV/2mA)

35+
86+

27%

June 2012
NN2012
Secondary reaction studies with ZeroDegree

In-beam γ-ray spectroscopy with direct reactions

**CNS GRAPE**
- 18x2 Segmented Ge's
  - * 2cm$^t$ x 6cm$^φ$
- for 1MeV γ ray (v/c=0.3)
  - efficiency ~5%
  - energy resolution ~1%
  - position sensitive ~ 2mm

CNS, Univ. Tokyo

**DALI2**
- 160 NaI(Tl)s
  - * 4.5 x 8 x 16 (cm$^3$)
- for 1MeV γ ray (v/c=0.3)
  - efficiency ~21%
  - energy resolution ~8%
Secondary reaction studies with SHARAQ (2009-)

by CNS, Univ. of Tokyo w. GANIL (FPD)

**High resolution** spectrometer for fast RIB

$\frac{p}{\Delta p} \sim 15,000$, $\Delta \theta < 1$ mrad, $B\rho = 6.8$ Tm

by Dispersion matching technique

$\frac{p}{\Delta p} \sim 7,000$, $\Delta \theta < 1$ mrad, $B\rho = 6.8$ Tm

by High-resolution achromatic mode

$^{90}$Zr, $^{208}$Pb$(t,^3$He)

K. Miki et al., PRL (2012)

Isovector spin monopole

Other physics programs

$(^{10}$C, $^{10}$B(IAS)) isovector non-spin monopole resonance

$(^{12}$N, $^{12}$C) $\beta^-$-type IVSMR via exothermic reaction

$(^1$H$(^{12}$Be,n) (p,n) reaction of $^{12}$Be (inverse kinematics)

$(^{4}$He$(^{8}$He,$^{8}$Be) search for tetra-neutron states

$(^{14}$,$^{22}$O(pol-p,2p)) spin-orbit splitting in O isotopes

Triton beam 300MeV/u  $1 \times 10^7$ pps
CRIB (CNS RI Beam separator)

Experiments using low-energy RI beams performed under international collaborations. (We welcome new users!)

Recent researches with Asian collaboration:

Proton resonant scattering

✓$^{26}$Si+p (Collaborated with Chung-Ang C.S. Lee, Y.K. Kwon, H.S.Jung et al., Korea)

✓$^{21}$Na+p, $^{22}$Na+p, $^{17}$F+p (IMP J.J. He /CIAE Wang Youbao, W.P. Liu et al., China)

(α,p) reaction measurement with active target:

✓$^{22}$Mg(α,p) (IOP, N.N. Duy, L.H. Khiem, Vietnam)

Determination of (p,γ) reaction rate with ANC

✓$^{12}$N(d,n) reaction measurement for

$^{12}$N(p,γ) (CIAE Guo Bing, Wang Youbao, W.P. Liu et al., China)

$^{26}$Si+p experiment: Observed proton resonances with resonant scattering, and determined resonance parameters:

Published as

Initiatives and man-power from Asian physicists
RCNP (Research Center for Nuclear Physics), Osaka Univ.

“Subatomic Physics project”

Origin of matter in the Universe from highly sensitive measurements