Bird’s eye photo in July 2009

J-PARC
Japan Proton Accelerator Research Complex
Bird’s eye photo in July 2009

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Japan Proton Accelerator Research Complex

400MeV LINAC

3GeV 333μA

RCS

Hadron Hall for Counter experiments

50GeV-PS
15μA, 750kW

V to SK

~500m

MLSF

Bird’s eye photo in July 2009
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
Neutrino Oscillation (T2K) Experiment

Super Kamiokande

Electron Neutrino
Mu Neutrino

41.4m
40m

40m

T2K Experiment

J-PARC

KamLAND, SNO
K2K, MINOS, etc.

Electron neutrinos
μ neutrinos

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

Already 500 non-Japanese joined this experiment !!!
(Japanese participants are only 70)

Goal is to measure \sin^22\theta_{13} down to 0.01

Competition with Diya Bay, FNAL, etc.
Hypernuclei

$\Lambda, \Xi$ Hypernuclei
$\Lambda, \Sigma$ Hypernuclei

Strange
-2
-1
0
1
2

Nuclear & Particle Physics Program at J-PARC Hadron Experimental Hall

Hypernuclei

Kaonic nucleus

Why are bound quarks heavier?

Quark

Bound quarks

Free quarks

Mass without Mass Puzzle
Power Capability of J-PARC

Power Expectation [MW]


Linac Energy Recovery

For short period

Training

Slow Extraction; 99.6% efficiency for 5kW was achieved!

Previous Estimate Nov. 2003

Present Estimate for 3 GeV

Big Earthquake

300 kW 1 hour

200 kW steady

145 kW

115 kW steady

120 kW steady

Present Estimate for MR at 30 GeV

KEK PS 3 kW
Damages for Accelerators and Facilities
2011.3.17.

**Around the Linac**

Photos were taken on March 17

Electric wires and water pipes were all damaged.

About 1.5 m drop as seen above, over a wide area.
Inside Linac Tunnel

No serious damages were seen for the Linac itself from the outside...

As of March 17, 1 cm deep water was on the floor.....

March 24th, water level increased, 10 cm deep!
We decided to introduce motor-driven generator to pump water....
3 GeV RCS Ring

Condenser bank was waved. Cables were distorted with heavy weight on them.

No obvious damages were observed in tunnel.

(Photos were taken on March 29).
2011.3.17.

50 GeV Main Ring

We found serious water leaks from tunnel wall! However no damages are observed on magnets etc.
Circumference Measurement

We found a large misalignment in both horizontal and vertical directions. Realigned will be done between August and October.
Superconducting primary Proton beam line looks healthy

On Site Detector;
About 1 cm deep water at the bottom, immediately pumped out!
Neutrino Beam Dump

Area around the beam dump was 1~2m subsided, and repaired!
Damages of Hadron Hall

This East Wall is for future expansion of the facility, and its two main beams were most seriously damaged in the Hadron Hall. It will take 2 months for recovery!
Subsided surface of surrounding area.

At present, cooling water can be supplied through the bent piping!
All the bent parts should be replaced ASAP!
In Hadron Hall

SKS seems healthy

K1.8BR seems healthy, too

Slight displacement of shield blocks

However, all the magnets, monitors, detectors, etc. slipped off in the range of mm to cm.
Summary of Damages

• No Tsunami Effect
  – We prepared for up to 8 m Tsunami against 6.2m at present

• Main Buildings/Accelerators were almost OK
  – Many underpins for major buildings.

• However, many utility buildings, roads, and added buildings had significant damages.

• When to recover?
  – Aiming at recovering by the end of this year, 2011.
  – Expect to have 2 cycle (about 2 month) running this fiscal year (by March 2012).

• Operation of Next Fiscal Year
  – Full 9 cycle (200 day) operations for users
### J-PARC Recovery Schedule (@2011.5.20)

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<td>Beam Test</td>
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<td>MLF User Operation</td>
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Even in the “Recovery days”, our scientific activity is still continuing!
E11; First result of $\nu_e$ appearance search

Super-Kamiokande IV
T2K Beam Run D Spill 822275
Run 66778 Sub 585 Event 134229437
10-05-12 11:03:22
T2K beam dt = 1902.2 ns
Inner: 1660 hits, 3681 pe
Outer: 9 hits, 3 pe
Trigger: 0x80000000
E_wall: 614.4 cm
e-like, p = 3.71 MeV/c

Charge (pe)
- $>26.7$
- 23.3-26.7
- 20.2-23.3
- 17.3-20.2
- 14.7-17.3
- 12.2-14.7
- 10.0-12.2
- 8.0-10.0
- 6.2-8.0
- 4.7-6.2
- 3.3-4.7
- 2.2-3.3
- 1.3-2.2
- 0.7-1.3
- 0.2-0.7
- $<0.2$

$\nu_e$ Candidate event
Indication of non-zero $\theta_{13}$

Reconstructed $\nu$ energy cut ($E_{\text{rec}} < 1250$ MeV)

- Data
- Osc. $\nu_e$ CC
- $\nu_\mu + \bar{\nu}_\mu$ CC
- $\nu_e$ CC
- NC
(MC w/ $\sin^2\theta_{13} = 0.1$)

Observed: 6
Exp’ed BG: $1.5 \pm 0.3$

的概率观察到 $\geq 6$ 为 0.7%

- $(\Delta m_{23}^2 > 0)$
  - $0.03 < \sin^2 2\theta_{13} < 0.28$
  - 90%CL regions
  - $\sin^2 2\theta_{13} = 0.11$
- Central value
- $\sin^2 2\theta_{13} = 0.14$

- $(\Delta m_{23}^2 < 0)$
  - $0.04 < \sin^2 2\theta_{13} < 0.34$

Presented by Dr. Okumura at 1E-1 Parallel session (Monday)
E19; Search for $\Theta^+$ in $p(\pi^-, K^-)$

- NO significant structure has been observed.
- Upper limit with current statistics: $0.3 \sim 0.4 \mu b$ (90\% C.L.) (very preliminary) cf. $3.9 \mu b$ (KEK–PS E522)

continue the experiment to goal sensitivity = 75nb/sr (lab)
E14; Rare Kaon Decay $K_L^0 \rightarrow \pi^0 \nu \bar{\nu}$

Fermilab KTeV CsI calorimeter

dismantled by Dec. 2008

Stacking for E14

KOTO CsI calorimeter

Completed with 2700 crystals

Feb.08 16:30 2011

After earthquake

May 2011

July 2010

October 2010: Engineering run with 1800 crystals

27X₀

5×5×50cm 2.5×2.5×50cm
Thank you very much for your attention & Thank you very much for your warn-hearted support during our most serious days!
Marks of Tsunami near Hadron Facility

Boundary fence Tsunami reached

Knocked down pine

The wrack left to the fence
Big vortex appeared near Oh-arai Port (15km south from J-PARC)
Delivered proton

- Started physics data taking Jan, 2010
- Stable beam operation at 145kW achieved
- By Mar.11, 2011, $1.43 \times 10^{20}$ ($\sim 70 \ [\text{kW} \cdot 1\text{e}7\text{s}]$) delivered
- All data taken was analyzed
E11; Result of $\nu_e$ Appearance Search

- We observed 6 events in the far detector.
- The predicted number of events, assuming $\sin^22\theta_{13} = 0$, is only $1.5 \pm 0.3$.
- For the $\theta_{13} = 0$ hypothesis, the probability of observing $\geq 6$ events is 0.007.
  \[ \text{Equivalent to } 2.5 \sigma \text{ significance.} \]

Presented by Dr. Okumura at 1E-1 Parallel session (Monday) at this PANIC2011!
Summary

- T2K reports new results on $\nu_\mu \rightarrow \nu_e$ oscillations based on $1.43 \times 10^{20}$ p.o.t. (2% exposure of T2K’s goal)
  - Expected number of events is $1.5 \pm 0.3$ ($\sin^2 2 \theta_{13} = 0$)
  - 6 candidate events are observed
  - Under $\theta_{13}=0$ hypothesis, the probability to observe 6 or more candidate events is 0.007 (equivalent to 2.5 $\sigma$ significance)
  - $0.03 (0.04) < \sin^2 2 \theta_{13} < 0.28 (0.34)$ at 90% C.L. for normal (inverted) hierarchy (assuming $\Delta m^2_{23}=2.4 \times 10^{-3}$ eV$^2$, $\sin^2 2 \theta_{23}=1$, $\delta_{CP}=0$)

- We will resume J-PARC operation in Dec, 2011 and restart T2K data taking as soon as possible

- $\nu_\mu$ disappearance result with full data set will be reported at EPS conf. next week
③ Cave-in of the neighboring soil of the Hall

Bombe station is floating!

Asphalt surface is cracking!