Welcome to KEK

Yasuhiro Okada

HEPiX Fall/Autumn 2017 workshop
LHCOPN-LHCONE meeting/HUF2017
October 16, 2017
KEK is an Inter-University Research Institute Corporation, first established in 1971 as National Laboratory for High Energy Physics.

Now, KEK covers a wide area of scientific fields from particle and nuclear physics to materials and life sciences by constructing and operating large accelerator facilities.

We have about 700 permanent staff, 100 students, and 8,000 users/year.

KEK is one of leading accelerator science centers worldwide.

More than 25,000 person-days users and collaborators come to KEK from abroad per year.
Electron accelerators in Tsukuba and proton accelerators in Tokai

KEK Tsukuba: SuperKEKB, PF, ATF

J-PARC: high intensity proton accelerator complex jointly operated by KEK and JAEA
Diversity in accelerator based sciences

Pursuing fundamental laws of nature

Basic science

Material science and its applications

Technical development and its applications

Pursuing origin of function in materials

Superconducting accelerator

Energy recovery linac

Accelerator-based BNCT

T2K neutrino exp.

SuperKEKB and Belle II

J-PARC Hadron hall

Photon factory

X-ray as a probe

J-PARC MLF

neutron and \( \mu \) as a probe

KEK

High Energy Accelerator Research Organization
SuperKEKB and Belle II

Belle, along with BABAR/SLAC, discovered CP violation in $B$ mesons, and confirmed Kobayashi-Maskawa theory. The apparatus is now being upgraded to search for new physics beyond this theory.

Accelerator commissioning started in Feb. 2006.

~750 scientists from 25 countries
Belle II is now at IP

April 11, 2017
SuperKEKB/Belle II is 40 times more powerful machine compared to the previous B factory experiment, KEKB/Belle.

Assumptions:
- 9 months / year
- 20 days / month

Goal: Targeted luminosity
- $\text{ab}^{-1} = 1000 \, \text{fb}^{-1}$
Located in Tokai, 60km N.E. of the KEK Tsukuba campus

Completed in 2009

Design goal
- RCS: 1MW
- MR: 750kW

Goal
→ MW-class proton accelerator

Joint project of KEK & Japan Atomic Energy Agency (JAEA)
T2K (Tokai to Kamioka) experiment

- High intensity $\nu_\mu$ beam from J-PARC MR to Super-Kamiokande
- Observation of $\nu_\mu \rightarrow \nu_e$ (2013)
- Updated goals
  - Precise measurement of $\nu_e$ appearance
  - Precise measurement of $\nu_\mu$ disappearance
  - CPV phase, contribution to mass hierarchy determination

T2K collaboration
~500 members from 63 institutes in 11 countries
470kW stable operation achieved

Twice larger statistics than 2016 release

- x1.5 POT than 2016
  - ν-beam: \(14.9 \times 10^{20}\) (≈doubled)
  - v̅-beam: \(7.6 \times 10^{20}\)
- +33% higher efficiency (new sample, enlarged F.V.)

Still consistent with maximum 23 mixing

CPC excluded at 95%!

Weak preference on NH (≈87%)
A variety of nuclear and particle physics experiments are carried out at the hadron experimental facility.

International Collaboration Experiments

KOTO
Search for CPV in KL->πννν
(Physics Run started)

COMET (Phase I)
Search for Lepton Flavor Violation
(Under construction)

Muon g-2/EDM
(R&D phase)
Materials and Life science using world top class pulse neutron and muon beams

- Neutron: Sensitive to light elements, Complementary to photon factory
- Muon: Sensitive to magnetic field in matter

First Neutron Beam: 30 May, 2008
First Muon Beam: 26 Sept., 2008
First User Program: 26 Dec., 2008
Running at 500kW
~200 day/year (176 days in JFY 2012)

23 Beam Ports for Neutron Instruments
4 Beam Ports for Muon Instruments

U-Line
Neutron Target Station
Muon Target Source
S & H Line
Light source facilities at KEK

PF: 2.5 GeV, 450mA $e^-$ (since 1982)
PF-AR: 6.5 GeV, 60mA $e^-$ (since 1997)
Exp station: ~50, Users: >3000/year
Material Structure Science at KEK

- Photon
- Neutron
- Muon
- Positron

Tsukuba Campus
- Photon & slow positron at PF and PF-AR

Tokai Campus
- Neutron & muon at J-PARC

Comprehensive understanding of materials structure
- Slow positron
- Surface structure
- Local magnetic moment
- Crystal structure
- Electronic structure
- Magnetic structure
- Excitations
Japanese Activities at LHC/ATLAS

Critical contributions
- pixel/SCT operation
- muon trigger responsibility
- computing
- physics analysis
- trigger coordinator
- collaboration board chair

Solenoid at CERN
before installation

module assembly
by KEK robot

30% chamber, 100% ASIC for electronics

Q magnet near the interaction point

100% 20%
2m Model coil production and test at KEK

2015 May

2016 Feb

2016 May

Feeder

Winding mandrel

Turn table
There is a consensus among the world high energy physics community that an $e^+e^-$ linear collider should be the next collider. The rationale is even stronger after the discovery of the Higgs particle at CERN.

The Japanese HEP community proposed to host ILC in Japan, and this proposal was welcomed by the worldwide HEP community, ex. in Update of the European Strategy for Particle Physics, May 2013.

MEXT, Japanese Government is investigating issues to judge hosting the ILC in Japan.

Discussions on 250GeV ILC as a Higgs Factory are ongoing in Japan and the worldwide HEP community.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.M. Energy</td>
<td>500 GeV</td>
</tr>
<tr>
<td>Peak luminosity</td>
<td>$1.8 \times 10^{34}$ cm$^{-2}$s$^{-1}$</td>
</tr>
</tbody>
</table>

Various R&D for ILC has been conducted at KEK as an international endeavor.
ICT in KEK

- Procurement, deployment and operation on ICT systems
  - For research
- R&D
  - Geant4
  - GLACE
  - DAQ/Analysis
  - HPC
- 25 people including secretaries

- Governance
  - Policy making
- Administrative computing
 ICT Procurements

- Services, not just hardware and software
  - 4-5 years contact
  - The provider is chosen in competitive tenders
    - The procedure takes 1.5 years period according to the government regulations
  - Staffs necessary for the operation are sent to KEK from the companies

- The next procurement for Central Computer System will take place in 2020
BelleII Grid over WLCG (KEK and BelleII are observers)

<table>
<thead>
<tr>
<th>Linux Cluster</th>
<th>Data Storage (GPFS/HPSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Server</td>
<td>IBM Elastic Storage System</td>
</tr>
<tr>
<td>CPU Cores</td>
<td>10,024</td>
</tr>
<tr>
<td>Memory</td>
<td>54 TB</td>
</tr>
<tr>
<td>OS</td>
<td>Scientific Linux 6</td>
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<tr>
<td>Batch Job Scheduler</td>
<td>LSF</td>
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<tr>
<td>Disk Storage</td>
<td>DDN 5FA 12K</td>
</tr>
<tr>
<td>HSM Disk Storage</td>
<td>13 PB (3 PB for HSM)</td>
</tr>
<tr>
<td>Disk Capacity</td>
<td>IBM TS1150</td>
</tr>
<tr>
<td>Tape Drive</td>
<td>10 TB/volume, 360 MB/sec</td>
</tr>
<tr>
<td>Tape Speed</td>
<td>70 PB</td>
</tr>
<tr>
<td>Tape Max Capacity</td>
<td>70 PB</td>
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</table>
I hope you have fruitful meetings this week and enjoy fall/autumn in Japan.