Introduction of *New* Working Group 6 (Detectors)

Yasuhiro NISHIMURA (Keio University)
on behalf of WG6 conveners
Davide Sgalaberna (ETHZ),
Yasuhiro Nishimura (Keio University),
Jonathan Asaadi (University of Texas)
6/Sep/2021, 22nd NuFact 2021

NuFact 20|21
The 22nd International Workshop on neutrinos from accelerators

SEPT
6-11, 2021
Cagliari, Italy

Working Group 6 - Detectors -

- WG6 is dedicated to various technical aspects;
  technologies of detectors, electronics,
  data acquisition and handling,
  techniques of analysis, calibration, simulation, ..

- The first WG6 presentations at NuFact2021.
  - WG6 started from NuFact 2020→2021.
  - 3 plenary talks,
    21 talks in parallel sessions,
    (10 talks in only WG6, 11 talks in joint sessions) and
    19 posters for WG6
  - = 43 presentations in total for WG6

WG6 Conveners

3 conveners from various topics and wide regions

- Davide Sgalaberna (ETH Zurich, Switzerland)
  ○ Near detector, plastic scintillators

- Yasuhiro Nishimura (Keio University, Japan)
  ○ Water Cherenkov detector, Photodetectors

- Jonathan A. Asaadi (University of Texas Arlington, USA)
  ○ Liquid Argon Time Projection Chamber (LArTPC)

Challenges by means of Technologies

- ## Kick-start detector talks at NuFact 2019
  - Overview of new detector technologies for neutrino experiments (Zhimin Wang)
  - Photosensor developments for neutrino experiments (Yasuhiro Nishimura)

  https://indico.cern.ch/event/773605/contributions/3498132/attachments/1899075/3134119/WANGZM_Overview_of_new_detector_technology_for_neutrino_experiments_final.pdf

Presented by Zhimin Wang

Face to the Challenges

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Few MeV neutrinos from reactors
Few 100MeV to a few GeV in long-baseline experiments
UHE cosmogenic neutrinos...
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Scintillator Detectors
Noble Liquid Detectors
Water Cherenkov Detectors
Ice Detectors
Photodetectors
Calorimetry
Gas Detectors
Silicon/Germanium Detectors
Superconducting Detectors
Quantum Sensors

Low energy threshold
Low background
Large mass

High voltage delivery
Cold electronics design

High efficiency
Better Reconstruction
Fast timing
PID

Accelerator neutrinos
Reactor neutrinos
Cosmogenic Neutrinos

Beam-generated Fluxes
Directional detectors for low-energy
neutrinos
Precise measurement of vertex
substructure in neutrino scattering

(Micro-)electronics
Calibration systems
Trigger and Data Acquisition
(Automated) event reconstruction
Computing and Machine Learning

Challenges on technologies to extend various ν/µ physics reach

Requirements in Future Experiments

- High intensity ν/µ beam → High rate detection
- Wide energy range in various neutrino sources
  - Better triggering and computing
  - Lower energy threshold and lower background

- High statistics with large mass detection volume
  → High precision measurement
  - Precise measurement of interactions
  - High resolutions and high detection efficiency
  - Better calibration

Innovative detector concepts are desired.
(with reasonable cost)

Motivation of WG6 activities

- Essential to improve our experimental techniques
  - To maximize the potential of upcoming experiments with improved techniques
    - ▶ Quick implementation efficiently
    - ▶ Sharing the latest information

  - To develop the next generation of instrumentation in new regimes with new capabilities for future experiments after several decades beyond next programs
    - ▶ Innovative idea in long-term plan

- Presentation and discussion about new experimental techniques at WG6 are welcome.

Scope of WG6

- Beam → WG3: Accelerator Physics
- Detectors
- Electronics
- Calibration
- DAQ
- Data handling
- Simulation platform
- Analysis framework
  - Reconstruction
  - Systematics
  - Statistics

and so on

Hardware

Software and computing

Common interest among experiments:
Intelligent trigger,
GPU computing,
Machine learning

Scope of WG6

- Detectors
  - Detector design and engineering (cavern, tank, vessel, etc.)
  - Ar/Xe, Liquid/Gas, Single/Dual, pixelated readout, bubble
  - Water Cherenkov detector, with Gd, water-base scintillator
  - Scintillator and optical enhancement
    - Liquid, plastic segmentation, inorganic crystal, wavelength shifting, etc.
  - Near detector components
    - Magnetized / non-magnetized active target
    - Movable detectors (PRISM, etc.)
  - Detection technique
    - Photodetectors, gas detectors, tracking detectors, solid state detectors, …

- Electronics
  - Trigger, HV, FPGA, ASIC, synchronization, communication, durability, evaluation, …

Detector Talks at Plenary Session

● 7/Sep (Tue) 12:40 – 14:10

  ○ Focusing on technologies for upcoming projects

Water Cherenkov detector

Super-Kamiokande
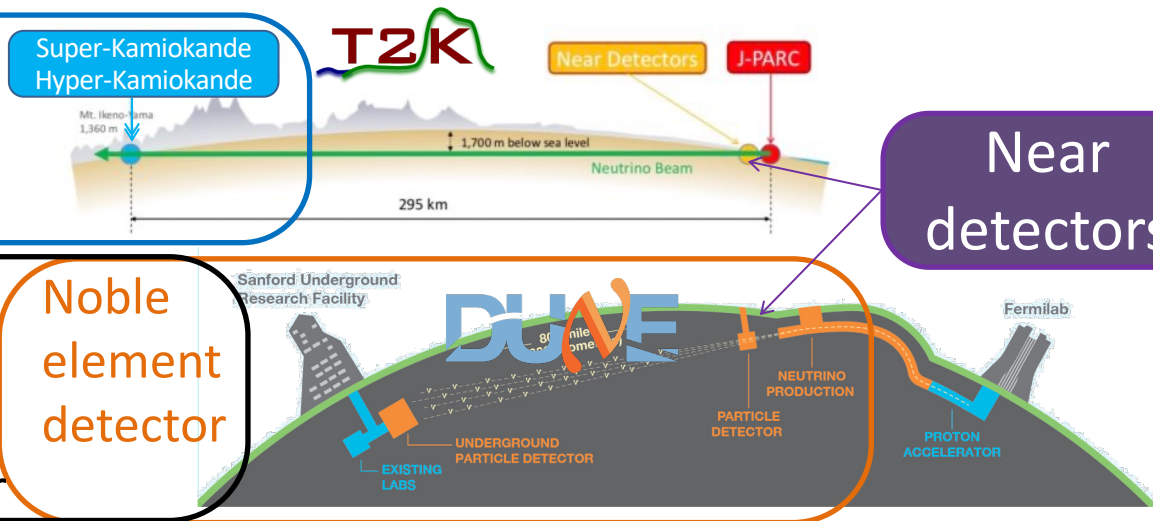Hyper-Kamiokande

T2K

Near Detectors   J-PARC

Mt. Ikeno-Yama
1,360 m

1,700 m below sea level

Neutrino Beam

295 km

Near detectors

Hyper-Kamiokande

PMT

JUNO

Kam-
LAND

Liquid scintillator

0νββ, μ, dark matter

Noble element detector

Sanford Underground
Research Facility

DUNE

Fermilab

UNDERGROUND
PARTICLE DETECTOR

EXISTING
LABS

NEUTRINO
PRODUCTION

PARTICLE
DETECTOR

PROTON
ACCELERATOR

PMT development for Hyper-Kamiokande	Christophe Bronner
Future near detectors	Hirohisa A. Tanaka
Noble element detectors	Filippo Resnati

Parallel WG6 Session 1

- ## 8/Sep (Wed) 16:00-17:30
  - Active Xe/Ar/Water targets
  - Plastic scintillator made by 3D printing

Status of the NEXT experiment for neutrinoless double beta decay searches	Carmen Romo-Luque
The Water Cherenkov Test Experiment at CERN	Lauren Anthony
A LArTPC with Vertical Drift for the DUNE Far Detector	Sabrina Sacerdoti
Upgrades of the ARIADNE 1-ton dual-phase optical liquid argon TPC	Konstantinos Mavrokoridis
A novel polystyrene based plastic scintillator production process involving additive manufacturing	UMUT KOSE

Parallel WG6 Session 2

- 9/Sep (Thu) 12:30-14:05
  - Status of recent ongoing development and achievement
    - Dedicated near detector talks of T2K and DUNE
    - Super-K ultra pure water → + Gd loading
   - ProtoDUNE single → double phase LAr TPC

The T2K Near Detector Upgrade	Martin Mihaylov Tzanov
Super-K Gadolinium	Alexander Goldsack
ProtoDUNE detector	Wenjie Wu
Status of the DUNE near detector	Richard Diurba
CAEN Report (FERS-5200 platform for large SiPM arrays readout)	Yuri Venturini

Joint Session with WG2 (Neutrino Scattering Physics)

- 7/Sep (Tue) 16:00-17:00
  - Detectors are dedicated to investigate ν scattering.
    - ▶ Detecting technique is important for precise measurements.

First results from the ARTIE experiment	Emilija Pantic
Total Neutron cross section measurement with a 3D projection scintillator tracker for long-baseline neutrino experiments	Guang Yang
Detecting reactor antineutrinos with a liquid argon scintillating bubble chamber	Luis Flores
Towards the measurement of neutrino cross section on H2O and CH target at 1 GeV region by T2K-WAGASCI experiment	Kenji Yasutome

Joint Session with WG4 (Muon Physics)
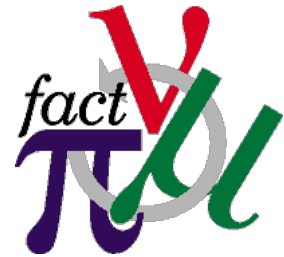
- 8/Sep (Wed) 14:20-15:50
  - Similar resources of beam, tracking, noble liquids, DAQ between μ and ν detectors
  - Review of next muon CLFV experiments, Tracking detector technologies

Detectors for future CLFV experiments	Bertrand Echenard
High Voltage Monolithic Active Pixel Sensors (HV-MAPS)	Andre Schoening
StrECAL system for COMET Phase-I and Phase-II	Hajime Nishiguchi

Joint Session with WG1 (Neutrino Oscillation)

- 9/Sep (Thu) 14:20-15:40

Calibration, simulation, analyses and machine learning technique

Calibration Strategy of the JUNO Experiment	Yue Meng
Application of machine learning techniques for event reconstruction in JUNO	Yury Malyshkin
New Approaches of first selection for Neutron Tagging in Hyper-Kamiokande	Sergio Luis Suarez Gomez
Deep Learning Neutrino Event Reconstruction at DUNE	Jianming Bian

Posters at WG6

- ## 8/Sep (Wed) 10:00-12:00
  - ○ Virtual session : https://www.wonder.me/r?id=8c4ab10d-737f-4fdf-8990-4d8915e57ea4
  - ○ Posters : https://cernbox.cern.ch/index.php/s/N2MhFZuxSLKJmI1

(Info. available from Indico https://indico.cern.ch/event/855372/page/23138-useful-info)

Id	Title	Submitter
14	The ESSnuSB detector complex	Roumen Tsenov
29	Measurement of space charge effects and Energy calibration in ProtoDUNE-SP	Jaroslaw Andrzej Nowak
42	Empowering JUNO physics by means of an ancillary photodetection system	Marco Grassi
59	A Novel Hit-Based Method to Distinguish Tracks and Showers in ProtoDUNE Single Phase	Stefano Vergani
60	The Mu2e calorimeter	Eleonora Diociaiuti
68	Muon reconstruction with waveform information in JUNO	Yongpeng Zhang
77	Core-Collapse Supernova neutrinos in DarkSide-20k and Argo	Michela Lai
94	Neutrino Tagging	Mathieu Perrin-Terrin
118	Development, construction and qualification tests of the Mu2e electromagnetic calorimeter mechanical structures	Simone Donati
120	A Plan for Decay at Rest ν_e+Pb Cross Section Measurement at J-PARC MLF; D@RveX	Fumihiko Suekane
151	Slow control and data acquisition development in the Mu2e experiment	Antonio Gioiosa
182	First detection of solar neutrinos from the CNO fusion cycle with the Borexino experiment	Riccardo Biondi
187	First Data from the Commissioned ICARUS Side Cosmic Ray Tagger	Biswaranjan Behera
218	JUNO Detector Design and Status	marta colomer
234	Detector Systems Development for Inter-Bunch Extinction Measurements at the 8 GeV Slow-Extracted Pulsed Proton Beam for the COMET Experiment at J-PARC	Kou Oishi
236	Status on the construction of the straw tube tracker for the COMET experiment Phase-I	Kazuki Ueno
246	CONNIE: A low-energy experiment with reactor neutrinos	Brenda Cervantes
249	Calibration of the 3D projection scintillation tracker prototype for the neutron beam test	Martin Mihaylov Tzanov
254	Simulating the ARAPUCA - DUNE's next generation light sensors	Gustavo Valdiviesso

Welcome to WG6

- First WG6 session at NuFact2021
  - Please enjoy various technical topics in 43 presentations.
    - 8/Sep (Wed) 16:00, 9/Sep (Thu) 12:30
  - Your contributions in coming NuFact are appreciated.

- Synergy with other WGs for technical discussion
  - Joint session : WG1+6, WG2+6, WG4+6
  - Zoom connections not to WG6
    - 9/Sep (Thu) 14:20   WG1+6 → connect to WG1 zoom
    - 7/Sep (Tue) 16:00   WG2+6 → connect to WG2 zoom
    - 8/Sep (Wed) 14:20 WG4+6 → connect to WG4 zoom