Yasuhiro NISHIMURA (Keio University)
on behalf of WG6 conveners
Davide Sgalaberna (ETH Zurich),
Yasuhiro Nishimura (Keio University),
Jonathan Asaadi (University of Texas Austin)
1/Aug/2022, 23rd NuFact 2022

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 sessions at NuFact2021.
  - WG6 started from NuFact 2020→2021.
- 37 presentations at NuFact2022
  - 3 plenary talks, 28 talks in parallel sessions (17 talks in WG6, 11 talks in joint sessions) and 6 posters for WG6

Challenges by means of Technologies

- Kick-start detector talks at NuFact 2019
  - Overview of new detector technologies for neutrino experiments (Zhimin Wang)

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

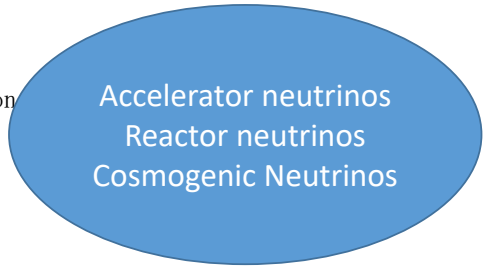
Few MeV neutrinos from reactors
Few 100MeV to a few GeV in long-baseline experiments
UHE cosmogenic neutrinos...

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



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.

Motivation of WG6 activities

- Essential to improve our experimental techniques
  - Expect useful discussion to maximize the potential of upcoming experiments with improved techniques
    - Quick and efficient communication among experiments
    - 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 on new experimental techniques at WG6 are important for coming projects.

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, …

Plenary Talks on Detectors

- Plenary session 8:50am 5/Aug (Fri)

- **Neutrino event reconstruction and Machine Learning** (Kazuhiro Terao)

  Remarkable technique on analyses

- **Scintillator detectors** (Minfang Yeh)

  Basic detector technologies

- **Challenges in the construction of large neutrino detectors: the JUNO case** (Michele Montuschi)

  Facility / Infrastructure for large detectors

Construction Challenges

Hyper-Kamiokande

June 2022

Reached dome center

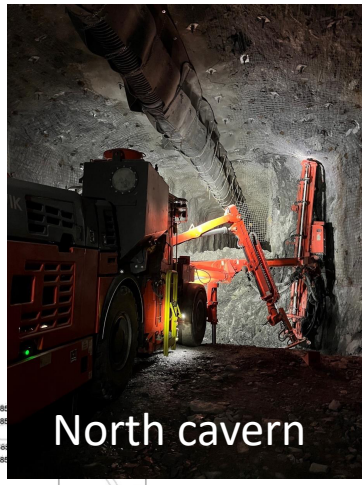
https://www-sk.icrr.u-tokyo.ac.jp/en/hk/report/

JUNO

July 2022

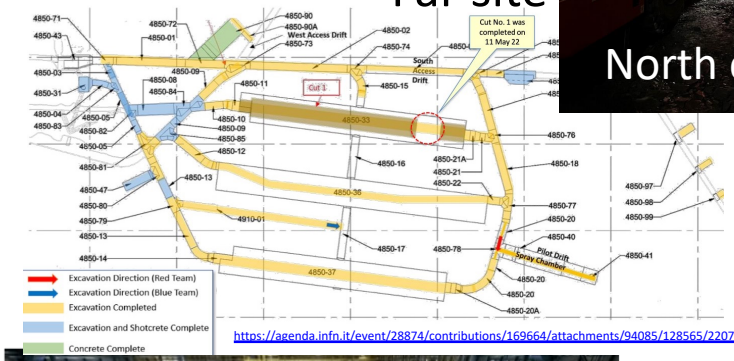
https://agenda.infn.it/event/28874/contributions/169677/attachments/94299/128908/JUNO_ICHEP2022_RE.pdf

DUNE



North cavern

Far site



https://agenda.infn.it/event/28874/contributions/169664/attachments/94085/128565/220707_ICHEP_DUNEOverview.pdf

ProtoDUNE at CERN

(Single/Dual phase)

WG6 Parallel Sessions

5 parallel sessions

- 14pm 2/Aug (Tue) Hyper-K and IceCube detectors
  - 4 talks about Photodetectors and Electronics
- 16pm 2/Aug (Tue) Quick talks for WG6 posters
  - Including virtual presentation
- 16:10pm 4/Aug (Thu) DUNE/SBND/ARIANDE+
  - 4 talks about Liquid argon detectors (incl. trigger, readout)
- 11:15am 5/Aug (Fri) Near detectors
  - 4 talks about T2K/DUNE Near detector, Xe TPC
- 14:30pm 5/Aug (Fri) IceCube/MicroBooNE, JUNO, ICARUS
  - 5 talks about Calibration, Reconstruction, ..

Joint Sessions

11 presentations in joint sessions related with WG6

- 11:20am 4/Aug (Thu) WG1+2+6 (Ballroom 2&3)
  - With neutrino oscillations, neutrinos scattering physics
  - 4 talks for Near detectors, scintillator tracker
- 14:20pm 4/Aug (Thu) WG1+6 (Ballroom 2&3)
  - With neutrino oscillations group
  - 4 talks for Machine Learning
- 16:10pm 5/Aug (Fri) WG4+6 (Ballroom Lobby, Cliff Lodge)
  - With muon physics group
  - 3 talks for Mu2e Detectors and machine learning

Poster Presentations

- At poster session 18:20-19:50pm 1/Aug (Mon)
  - **Gain calibration using dark hits in off-time region of regular data at JSNS2 experiment** (RyeongGyoon Park)
  - **Mass test setup for DUNE SiPMs characterization** (Marco Guarise), virtual presentation only on 2/Aug
  - **First light detection with an optical Time Projection Chamber** (Robert Amarinei)
  - **A High Rate Readout System for a High-Efficiency Cosmic Ray Veto for the Mu2e Experiment** (Simon Corrodi)
  - **Construction of a new scintillation tracker in T2K experiment** (Masaki Kawaue)
  - **Detectors of the Telescope Array Experiment** (Jihyun Kim)
- Short oral presentation for WG6 posters 16pm 2/Aug (Tue)
  - A few – 15 min / poster, flexible schedule

Timetable on 2 and 4/Aug

2/Aug (Tue)

Photodetectors

14:00
- **Multi PMTs at the Water Cherenkov Test Experiment/IWCD at Hyper-K** — *Ryosuke Akutsu*
  Ballroom 3 14:00 - 14:20
- **Options for PMT electronics at the Hyper-K far detector** — *Shota Izumiyama*
  Ballroom 3 14:20 - 14:40
- **Time generation and clock distribution for Hyper-Kamiokande** — *Lucile Mellet*
  Ballroom 3 14:40 - 15:00

15:00
- **IceCube & SWGO Photodetectors** — *Michael DuVernois*
  Ballroom 3 15:00 - 15:20

Poster presenters

(Presentation time is tentative and flexible.)

16:00
- **Gain calibration using dark hits in off-time region of regular data at JSNS2 experiment (at WG6)** — *RyeongGyoon Park*
  Ballroom 3 16:00 - 16:15
- **A High Rate Readout System for a High-Efficiency Cosmic Ray Veto for the Mu2e Experiment (at WG6)** — *Simon Corrodi*
  Ballroom 3 16:15 - 16:30
- **First light detection with an optical Time Projection Chamber (at WG6)** — *Mr Robert Amarinei*
  Ballroom 3 16:30 - 16:45
- **Mass test setup for DUNE SiPMs characterization** — *Marco Guarise*
  Ballroom 3 16:45 - 17:00

17:00
- **Construction of a new scintillation tracker in T2K experiment (at WG6)** — *Masaki Kawaue*
  Ballroom 3 17:00 - 17:15
- **Detectors of the Telescope Array Experiment (at WG6)** — *Jihyun Kim*
  Ballroom 3 17:15 - 17:30

4/Aug (Thu)

11:00
WG1+2+6 (ν osc., ν scattering & Detectors)

- **The Path to Precision: Role of the DUNE Near Detectors** — *Zoya Vallari*
  Ballroom 2&3 11:20 - 11:38
- **SBND-PRISM: Sampling Multiple Off-Axis Neutrino Fluxes with the Same Detector** — *Marco Del Tutto*
  Ballroom 2&3 11:38 - 11:56

12:00
- **Latest results on T2K Near Detector constraints for neutrino oscillation measurements** — *Callum Wilkinson*
  Ballroom 2&3 11:56 - 12:14
- **The T2K Near Detector upgrade** — *Aoi Eguchi*
  Ballroom 2&3 12:14 - 12:32
- **Total neutron cross section measurement on CH with a novel 3D-projection scintillator detector** — *Ciro Riccio*
  Ballroom 2&3 12:32 - 12:50

14:00
WG1+6 (ν osc. & Detectors)

- **Machine Learning Techniques to Enhance Event Reconstruction in Water Cherenkov Detectors** — *Nick Prouse*
  Ballroom 2&3 14:20 - 14:42
- **Measurement of Atmospheric Muon Neutrino Disappearance using CNN Reconstructions with IceCube** — *Shiqi Yu*
  Ballroom 2&3 14:42 - 15:04

15:00
- **Machine Learning Methods for Solar Neutrino Classification** — *Alejandro Yankelevich*
  Ballroom 2&3 15:04 - 15:26
- **Panoptic Segmentation for Particle Identification in ProtoDUNE-SP** — *Carlos Sarasty*
  Ballroom 2&3 15:26 - 15:48

16:00
Liq. Ar detectors

- **The DUNE vertical drift TPC** — *Oliver Lantwin*
  Ballroom 3 16:10 - 16:30
- **Photon Detection System (PDS) for DUNE low energy physics study and the demonstration of a few nanosecond timing…**
  Ajib Paudel

17:00
- **SBND Trigger System: General status and the configuration of the Analog Master Trigger Card** — *Gabriela Vitti Stenico*
  Ballroom 3 16:50 - 17:10
- **ARIADNE+: Large Scale Demonstration of Fast Optical Readout for Dual Phase LArTPCs at the CERN Neutrino Platform**
  Adam Lowe

Timetable on 5/Aug (Fri)

5/Aug (Fri)

Plenary

09:00

Neutrino event reconstruction and Machine Learning — *Kazuhiro Terao*
Ballroom 2&3 — 08:50 - 09:20

Scintillator detectors — *Minfang Yeh*
Ballroom 2&3 — 09:20 - 09:50

10:00

Challenges in the construction of large neutrino detectors: the JUNO case — *Michele Montuschi*
Ballroom 2&3 — 09:50 - 10:20

Near detectors

11:00

3D segmented scintillator neutrino detector SuperFGD for T2K experiment — *Christopher Mauger*
Ballroom 3 — 11:15 - 11:35

Characterisation of the ERAM detectors for the High Angle TPC of the T2K ND upgrade — *Claudio Giganti et al.*
Ballroom 3 — 11:35 - 11:55

12:00

Demonstration of a novel, ton-scale, pixel-readout LArTPC for the DUNE Near Detector — *Dr Jeremy Wolcott*
Ballroom 3 — 11:55 - 12:15

The search for $0\nu \beta \beta$ with the NEXT time projection chamber — *Krishan Mistry*
Ballroom 3 — 12:15 - 12:35

Calibration & others

14:00

Measuring solar neutrinos over gigayear timescales with paleo detectors — *Dr Natalia Tapia Arellano*
Ballroom 3 — 14:20 - 14:38

The Camera System for the IceCube Upgrade — *Woosik Kang*
Ballroom 3 — 14:38 - 14:56

15:00

Energy Reconstruction and Calibration of the MicroBooNE LArTPC — *Dr Wanwei Wu*
Ballroom 3 — 14:56 - 15:14

Calibration strategy for the JUNO experiment — *Dr Davide Basilico*
Ballroom 3 — 15:14 - 15:32

Calibrating for Precision Physics in LArTPCs at ICARUS — *Gray Putnam*
Ballroom 3 — 15:32 - 15:50

WG4+6 (Muon + Detectors)

16:00

Design, construction, and vertical slice performance tests of the Mu2e straw tracker — *Richard Bonventre*
Ballroom Lobby, Cliff Lodge — 16:10 - 16:40

The High-Efficiency Cosmic Ray Veto Detector for the Mu2e Experiment at Fermilab — *Simon Corrodi*
Ballroom Lobby, Cliff Lodge — 16:40 - 17:10

17:00

Online machine learning based event selection for COMET Phase-I — *Yuki Fujii*
Ballroom Lobby, Cliff Lodge — 17:10 - 17:40

Enjoy WG6 sessions

- Second WG6 session in NuFact series
  - Please enjoy various technical topics
    - 15 min talk + 5 or 3 min discussion (20 or 18 min in total)
    - + Dedicated poster session
- Synergy with other WGs for technical discussion
  - Joint sessions with WG1 (Neutrino oscillation), WG2 (Neutrino scattering physics), WG4 (Muon)
- Come to Ballroom 3 for the WG6 parallel Session