NuFact'11 XIIIth Workshop on Neutrino Factories, Superbeams and Beta-beams

Monday 1 August 2011 - Saturday 6 August 2011

Book of Abstracts

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Welcome address by CERN Director

Corresponding Author: rolf.heuer@cern.ch

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Registration

For last minute participants only.
The desk will be closed 10min before the session starts.

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Experimental Status of Neutrino Physics

Author: Dave Wark[1]

Co-authors: Fanny Dufour [2]; Gersende Prior [3]

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relative performance of neutrino facilities

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Accelerators for Future Neutrino Facilities: strengths & challenges

Author: Michael Zisman[1]

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Scientific goals of the workshop

Corresponding Author: alain.blondel@cern.ch

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Working Groups conveners: achievements and questions

each WG convener will present in 10 minutes the achievements of the previous years and the open questions.

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Beaming neutrino across the Earth to Deep Core to test neutrino mixing parameters and CPT violation

Author: Daniele Fargion[1]

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Twenty GeV Neutrino crossing along the Earth by longest base line (CERN-Deep Core or FNL-Deep Core) offer the most powerful tool to test neutrino (muon-tau) mixing masses and angles. An Opera-like experiment at 1% size and flux may lead to a few hundreds events a year of tau appearance or and muon suppression or disappearence. The large (11000 km) distance neutrino flux dilution is widely overcome by largest (tens Megaton) Deep Core mass and by a complete oscillation conversion. A sharp and silent atmospheric neutrino experiment may provide a test also to Minos like CPT violation claim.

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WG1 Daya Bay's First Experimental Hall Coming On Line

Author: Zhimin Wang[1]

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The Daya Bay reactor neutrino experiment is designed to measure the last unknown neutrino mixing angle \theta_{13} with a sensitivity of sin^{2}2\theta_{13}<0.01 through a measurement of the relative rates and energy spectra of reactor antineutrinos at different baselines. Eight identical liquid scintillator antineutrino detectors (ADs) will be installed in three experimental halls. The first experimental hall, Daya Bay near site, will come on line in this summer, which is ~360m away from Daya Bay reactors and has 98m rock overburden, where two ADs will be installed in a water pool with at least 2.5m water shielding. 840 antineutrino events per AD per day are detected with 20-ton target mass. The water pool is divided into inner and outer parts and equipped with PMTs to

serve as Cherenkov detector. Resistive Plate Chambers (RPCs) covers the water pool to provide additional Muon tagging. We will describe the design, construction, commissioning and preliminary performance of the Daya Bay detectors.

WG3 Accelerator Physics / 9

WG3 neutrino flux monitoring in the neutrino factory

Author: Alain Blondel[1]

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The presentation will summarize the beam controls necessary to efine the flux in the neturino factory with a precision of 10-3. A polarimeter, a beam divergence measurement and a beam current measurement will do the job

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Poster "Dissipative Effects in Neutrino Oscillation"

Author: Roberto Oliveira[1]

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We study neutrino oscillation taking into account the interaction with environment where open quantum system approach is rigorously used. This changes the usual pattern of oscillation because decoherence and relaxation effects can occur in the subsystem of neutrinos. These dissipative effects are added with only one phenomenological parameter constrained by complete positivity evolution. In terms of Majorana neutrinos, the oscillation probabilities can exhibit, even for two flavor neutrinos, a CP-violation effect in vacuum and matter. Both vacuum and matter effects are derived and presented in this work. We compare the obtained probabilities in vacuum with MINOS data. We estimate a limit to the phenomenological dissipative parameter and to the CP Majorana phase. Also, a genuine dissipative effect to three families is presented.

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The Very-Low-Energy Neutrino Factory

Author: Alan Bross[1]

Co-authors: Charles Ankenbrandt [2]; David Neuffer [1]; Milorad Popovic [1]

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Recent results from MiniBooNE and new calculations regarding the anti-neutrino flux from reactors provide exciting new motivation to study neutrino oscillations physics

at L/E ⊠⊠1. Using a targeting system similar to the one used for MiniBooNE and a muon storage/decay ring with central E of ⊠⊠1.5 GeV gives the capability to measure
electron neutrino disappearance with 1% precision using a suitably designed near detector and the MiniBooNE detector as the far detector. This talk will describe the
overall concept including targeting, collection and ring design and will give estimated event rates (based on MiniBooNE as the far detector). Finally, we will describe some
possible near detector configurations and far detector options.

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Low Energy Signatures of the TeV Scale See-Saw Mechanism

Author: Alejandro Ibarra[1]

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We study the phenomenological consequences of the type I see-saw model, when the right-handed neutrinos have masses at the electroweak scale. Concretely, we discuss the prospects to produce and detect the right-handed neutrinos at colliders in view of the present constraints from electroweak precision observables and rare muon decays. We find that the most promising experiments to observe the first signatures of such models are the searches for lepton flavour violation and for neutrinoless double beta decay.

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Large Extra Dimensions, Neutrino Oscillations and the Reactor Antineutrino Anomaly

Authors: Fábio Alex Pereira dos Santos[1]; Hiroshi Nunokawa[1]; Pedro Machado[2]; Renata Zukanovich Funchal[3]

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We consider a model where sterile neutrinos can propagate in a large compactified extra dimension giving rise to Kaluza-Klein (KK) modes and the Standard Model left-handed neutrinos are confined to a 4-dimensional spacetime brane. The KK modes mix with the standard neutrinos modifying their oscillation pattern. To set limits on and estimate sensitivities to the size of the largest extra dimension, we examine former, current and future experiments. We also investigate the recent reactor antineutrino anomaly in this context.

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The Daya Bay Neutrino Experiment: An Overview

Author: Jianglai Liu[1]

[1] *Shanghai Jiao Tong University*

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The phenomenon of neutrino flavor oscillations is now well-established. Mixing among the three flavors is characterized by three mixing angles, with θ_{13} being the only presently unknown angle. A precise measurement of θ_{13} can be made by utilizing a powerful nuclear reactor as the anti-neutrino source, going deep underground to reduce the background, and building "identical" near and far detectors to minimize the systematics. We are building such an experiment at the Daya Bay nuclear power plant in
south China. This project, known as the Daya Bay Neutrino Experiment, is making steady progress. The civil construction and the detector assembly are underway, and we expect to start data taking in the first near experimental hall this summer. In this talk, I will stress the physics motivation of such a measurement, introduce you to the world of making precise oscillation measurement with reactor neutrinos, and look into the near future of the Daya
Bay experiment.

Plenary / **15**

Welcome - CERN

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WG1 conveners: set the scene

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WG2 conveners: set the scene

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WG3 conveners: set the scene

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WG4 conveners: set the scene

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Plenary / 20

Can LHC physics shed light on the neutrino paradigm?

Corresponding Author: goran@ictp.trieste.it

I argue that LHC may shed light on the nature of neutrino mass through the probe of the seesaw mechanism. The smoking gun signature is lepton number violation through the production of same sign lepton pairs, a collider analogy of the neutrinoless double beta decay. I discuss this in the context of L-R symmetric theories, which predicted
neutrino mass long before experiment and led to the seesaw mechanism. A WR gauge boson with a mass in a few TeV region could easily dominate neutrinoless double beta decay, and its discovery at LHC would have spectacular signatures of parity restoration and lepton number violation.

I also discuss the collider signatures of the three types of seesaw mechanism, and show how in the case of Type II one can measure the PMNS mixing matrix at the LHC, complementing the low energy probes. Finally, I give an example of a simple realistic SU(5) grand unified theory that predicts the hybrid Type I + III seesaw with a weak fermion triplet at the LHC energies.

Plenary / 21

Future Neutrino Facilities in the Global Physics Environment

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Round table discussion following the PH seminar.
The panel composed of the following members
– S. Bertolucci (CERN)
– K. Nishikawa (KEK)
– J. Strait (Fermilab)
– M. Spiro (CERN Council)
– J. Womersley (STFC)
– T. Nakada (ECFA)
– S. Myers (CERN)
– S. Komamya (ICFA)
will be chaired by J. Ellis (CERN).

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Neutrinos and the Universe

Author: Nikos Mavromatos[1]

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T2K Results and Future Plans

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CNGS: Overview and Future Prospects

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Plenary / **25**

MINOS, MINOS+, NOvA: Overview and Future Prospects

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Plenary / **26**

Challenges of Future Neutrino Oscillation Physics

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Neutrino Masses and Mixing vs Grand Unified Theories

Author: Rabindra Mohapatra[1]

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Accelerator Based Neutrino Oscillation Projects in Japan Beyond T2K

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Long-baseline Neutrino Beam Options at CERN

Author: Andre Rubbia[1]

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Long-Baseline Neutrino Beams at FNAL

Author: Samuel R. Childress[1]

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Plenary / **31**

(M)MW Target and Horn for Neutrino Super-Beams

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Plenary / **32**

Review of Present ant Future Reactor Neutrino Experiments

Co-author: Gersende Prior [1]

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Plenary / **33**

Phenomenology of Sterile Neutrinos

Author: Carlo Giunti[1]

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An Experiment at the CERN PS Neutrino Beam

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Future Short-baseline Physics at FermiLab

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WG2 Optical Systems for Liquid Argon TPC Detectors

Author: Benjamin Jones[1]

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The MicroBooNE experiment is a 170 ton scale liquid argon TPC detector which will run in the booster neutrino beam at Fermilab, starting in 2013. As well as a TPC system which will perform high resolution 3D tracking using ionization charge deposits in the argon bulk, the MicroBooNE experiment incorporates an optical system to measure scintillation light production. The optical system consists of 30 photomultiplier tubes mounted behind acrylic plates, which are coated by a wavelength shifting film. 128nm scintillation light, which is a byproduct of the ionization process, can thus be detected by the system.

There are multiple benefits to incorporating an optical system into an LArTPC detector. It can be used as an effective trigger, since the data rate and channel count is low, and noise in the PMT system is likely to be uncorrelated with noise in the TPC system. Charge drift in a TPC is slow whereas scintillation light propagation is fast, thus an accurate event time and position in the drift direction can be determined, the former being of particular importance in a pulsed beam like the Booster. And finally, the nontrivial time structure of scintillation production can, in some cases, be used to augment the particle identification capabilities of the TPC based event reconstruction methods.

I will discuss the current status of both the PMT assembly hardware and the supporting software algorithms which have been developed for MicroBooNE, and mention their relevance to future liquid argon TPC detectors.

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Future RandD Experiments for SB, NF & BB

Author: Rob Edgecock[1]

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Impact of Neutrino Scattering Physics on Neutrino Oscillation Experiments

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Detectors for the Next Generation of Neutrino Beams

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Beam Monitoring and Near Detector Requirements for a NF or LBL beams

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Status of Neutrino Factory Accelerator Design Studies

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MICE & MUCOOL Experiments - Status and Prospects

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Multi-MW Target and Capture Design for NF

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EMMA - Recent Developments

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Neutrino Physics Within and Beyond the Three Flavor Oscillation

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Plenary / **47**

Ion Production for Beta-beams

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Proton Drivers for Neutrino Beams and Other High-Intensity Applications

Author: Roland Garoby[1]

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Prospects for CLFV Experiments

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Towards a Muon Collider

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WG1 - Summary Report

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WG2 - Summary Report

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WG3 - Summary Report

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WG4 - Summary Report

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Workshop Summary Talk

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Welcome - University of Geneva

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Evening Public lecture / **57**

Physics & Music Public Evening

Evening Public lecture / **58**

Evening Public Lecture (in French)

Corresponding Author: andre.rubbia@cern.ch

WG3 Accelerator Physics / **59**

Neutrino Factory Front End and Extensions

Author: David Neuffer[1]

Co-authors: Cary Yoshikawa [2]; Christopher Rogers [3]; Pavel Snopok [4]

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[3] *RAL - STFC*

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The (International Design Report) IDR neutrino factory scenario for capture, bunching, phase-energy rotation and initial cooling of mu's produced from a proton source target is presented. It requires a drift section from the target, a bunching section and a phase-energy rotation section leading into the cooling channel. The rf frequency changes along the bunching and rotation transport in order to

form the mu's into a train of equal-energy bunches suitable for cooling and acceleration. Optimization and variations are discussed. Important concerns are rf limitations and beam losses; mitigation procedures are described. Extensions of the method for a muon collider front end and bunch combiner are discussed.

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WG2 Gamma-ray production in NC interactions

Author: Artur Ankowski[1]

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Corresponding Author: artur.ankowski@roma1.infn.it

In neutral current (NC) neutrino scattering off nucleus, protons and neutrons contribute almost equally to the cross section (44 and 56%, respectively). To detect the NC interactions one observes the knockout protons or the secondary interactions of neutrons. However, the gamma-rays, produced in de-excitation of residual nucleus, may provide an additional signal for detection of neutral-current events, e.g. in water Cherenkov detectors. We will describe in detail the example of the NC nucleon knockout from p3/2 shell of the oxygen nucleus, showing that this process, contributing ˜42 % of the total O(nu,nu) cross section at neutrino energy 600 MeV, yields a narrow peak of gamma rays of energy 6.3 MeV with branching ratio 100%.

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The SuperBeam plus Beta Beam Combination

Author: Stephen Parke[1]

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WG1: The SuperBeam plus Beta Beam combination is very powerful as one needs only three of the available four appearance channels to solve for the degeneracies for Standard Model neutrinos. This allows for the extra channel to check the consistencies
of the current picture and also allows for the possibilities of using the combination to search for physics beyond, such as NSI, this standard picture. All of this will be demonstrated in this talk.

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Neutrinoless double beta decay in seesaw models (talk@WG1)

Author: Jacobo Lopez-Pavon[1]

Co-author: Gersende Prior [2]

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We study the general phenomenology of neutrinoless double beta decay in seesaw models. In particular, we focus on the dependence of the neutrinoless double beta decay rate on the mass of the extra states introduced to account for the Majorana masses of light neutrinos. For this purpose, we compute the nuclear matrix elements as functions of the mass of the mediating fermions and estimate the associated uncertainties. We then discuss what can be inferred on the seesaw model parameters in the different mass regimes and clarify how the contribution of the light neutrinos should always be taken into account when deriving bounds on the extra parameters. Conversely, the extra states can also have a significant impact, cancelling the Standard Model neutrino contribution for masses lighter than the nuclear scale and leading to vanishing neutrinoless double beta decay amplitudes even if neutrinos are Majorana particles. We also discuss how seesaw models could reconcile large rates of neutrinoless double beta decay with more stringent cosmological bounds on neutrino masses.

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Axial and Vector Structure Functions for Lepton-Nucleon Scattering

Author: Un-Ki Yang[1]

Co-author: Arie Bodek [2]

[1] *University of Manchester*

[2] *University of Rochester*

We present an updated model for inelastic neutrino- and electron-nucleon scattering cross sections using effective leading order parton distribution functions with a new scaling variable xi_w. Updated model on the axial-vector structure functions as well as
vector structure fucntions will be presented. Our model describes all inelastic charged lepton-nucleon scattering (including resonance) data (HERA/NMC/BCDMS/SLAC/JLab) ranging from very high Q^2 to very low Q^2 and down to the photo-production region. The model describes existing inelastic neutrino-nucleon scattering measurements, and has been developed to be used in analysis of neutrino oscillation experiments in the few GeV region.
(additional details arXiv:1011.6592 [hep-ph])

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WG2 Neutrino interaction measurements using T2K Near Detectors

Author: Daniel Brook-Roberge[1]

Co-author: Ilias Efthymiopoulos [2]

[1] *University of British Columbia*

[2] *CERN*

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The T2K near detectors provide a rich facility for measuring neutrino interactions in a high-flux environment. This talk will discuss the near detector CC-inclusive normalization analysis for the T2K oscillation result in detail, along with the present result, and describe the plan for its extension to more sophisticated measurements. Selection criteria for CCQE interactions will be

presented, as will a strategy for calculating cross-section difference between plastic scintillator and water. The unique capacities of the near detectors to measure other exclusive CC and NC channels in a narrow-band off-axis beam will also be explored.

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WG1 talk: NonStandard Interactions at LEP or the LHC?

Author: Sacha Davidson[1]

[1] *Institut de Physique Nucleaire de Lyon (IPNL)-Universite Claude*

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The New Physics which induces dimension eight Non-Standard neutrino Interactions should arise at a mass scale below a few TeV. We explore potential collider signals of such New Physics.
We show that if dangerous dimension six operators vanish due to a cancellation, then double-derivative dimension eight charged lepton operators arise, and collider bounds impose ε
$lsim.1 \to 10^{-3}$. Secondly, the $v^2\ \overline{\nu_a \nu_b}$
legs of an NSI operator can be related via the Equivalence Theorem to $W^+W^-e_{a^+e_{b^-}}$, so we study the sensitivity of $pp \to W^+W^-e_{a^+e_{b^-}}$ at the LHC in a Z' model that could induce NSI.

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Performance of the T2K Near Detectors

Author: Neil McCauley[1]

[1] *University of Liverpool*

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The Near Detector suite of the T2K experiment is a crucial component of the experiment. The performance of the detectors in the first year of operation and the first results will be presented.

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Minerva First Results and Future Goals

Author: Benjamin Ziemer[1]

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WG2 –Session 25 MINOS, MINOS+, NoVA and Future Prospects

The Main Injector Experiment ν-A (MINERνA) Experiment located at Fermi National Laboratory will measure neutrino cross sections, nuclear effects from a broad range of nuclear targets and a variety of other neutrino interactions. Neutrino elastic scattering will be one of the first focuses of the MINERνA collaboration; these measurements will be an important input to current and future neutrino oscillation experiments. Results of the charged current quasi-elastic channel exposure in anti-neutrino NuMI running are presented. Future elastic scattering results, both charged current and neutral current, in anti-neutrino and neutrino exposures are also discussed.

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Study of sterile neutrino mixing in low energy neutrino factory

Author: Chan Fai Wong[1]

Co-author: Silvia Pascoli [1]

[1] *Durham University*

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A neutrino factory has been suggested as a powerful tool for studying new physics, for example, sterile neutrinos, exploiting its near detectors.

Here we study the potential of a low energy neutrino factory (LENF) in constraining the sterile mixing angles and the mass-square difference. Unlike in conventional long baseline neutrino experiments, the electron neutrino appearance and disappearance channels are also included, since they are proved helpful in constraining sterile mixing angles.

Moreover, the recent re-analysis of reactor neutrino experiments suggests the presence of neutrino oscillations due to large sterile neutrino mixing with electron neutrino. We show that, with a near detector, LENF can constrain the sterile parameter values in a very
small range and helps us to check the recent Reactor Anomaly.

Finally, we will explore the dependence of the performance of the LENF depending on different experimental setups.

WG3&WG4 Joint Session / 69

First measurements of muon production rate using a novel pion capture system at MuSIC

Author: Sam Cook[1]

Co-authors: Gersende Prior [2]; Ilias Efthymiopoulos [3]

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The MuSIC (Muon Science Innovative Channel) beam line at RCNP (Research Centre for Nuclear Physics, Osaka) will be the most intense source of muons in the world. A proton beam is incident on a target and, by using a novel capture solenoid, guides the produced pions into the beam line where they subsequently decay to muons. This increased muon flux will allow more precise measurements of cLFV (charge Lepton Flavour Violation) as well as making muon beams more economically feasible. Currently the first 36^{circ} of solenoid beam pipe have been completed and installed for testing with low proton current of 1nA. Measurements of the total particle flux and the muon life time were made. The measurements were taken using thin plastic scintillators coupled to MPPCs (Multi-Pixel Photon Counter) that surrounded a magnesium/copper stopping target. The scintillators were used to record which particles stopped and their subsequent decay times.

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WG1: Optimisation of the Low-Energy Neutrino Factory

Author: Peter Ballett[1]

[1] *IPPP, Durham University*

The Low-Energy Neutrino Factory (LENF) is a single-baseline neutrino factory operating with typical stored-muon energies less than 10 GeV. The idea behind this design is to exploit the richness of the oscillation spectrum at lower energies to achieve a strong sensitivity to the fundamental parameters whilst also mitigating the effect of degeneracies. Preliminary studies of the LENF have shown that it can meet these expectations well and can provide a competitive performance to the conventional neutrino factory of the IDS design, especially in scenarios when theta13 takes relatively large values. In this talk, I will present work towards the optimisation of such a facility. In particular, we have investigated how the performance of the LENF depends upon the choice of baseline distance and stored-muon energy. The parameter ranges that we have studied connect the choices traditionally associated with the LENF to those of the higher-energy neutrino factory. Understanding this region of parameter space helps us to view the two designs as extreme ends of a spectrum of possible configurations whilst also allowing us to report revised sensitivities of such an experiment. These results are of particular importance given the recent hints of large theta13 reported by T2K for which we will show that the LENF has an excellent discovery potential for CP-violation and the mass hierarchy.

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Minimal models with light sterile neutrinos

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We study the constraints imposed by neutrino oscillation experiments on the minimal extensions of the Standard Model (SM) with n_R gauge singlet fermions ("right-handed neutrinos"), that can account for neutrino masses. We consider the most general coupling to SM fields of the new fields, in particular those that break lepton number and we do not assume any a priori hierarchy in the mass parameters. We proceed to analyze these models starting from the lowest level of complexity, defined by the number of extra fermionic degrees of freedom. The simplest choice that has enough free parameters in principle (i.e. two mass differences and two angles) to explain the confirmed solar and atmospheric oscillations corresponds to $n_R = 1$. This minimal choice is shown to be excluded by data. The next-to-minimal choice corresponds to $n_R = 2$. We perform a systematic study of the full parameter space in the limit of degenerate Majorana masses by requiring that at least two neutrino mass differences correspond to those established by solar and atmospheric oscillations. We identify several types of spectra that can fit long-baseline reactor and accelerator neutrino oscillation data, but fail in explaining solar and/or atmospheric data. The only two solutions that survive are the expected seesaw and quasi-Dirac regions, for which we set lower and upper bounds respectively on the Majorana mass scale. Solar data from neutral current measurements provide essential information to constrain the quasi-Dirac region. The possibility to accommodate the LSND/MiniBoone and reactor anomalies, and the implications for neutrinoless double-beta decay and tritium beta decay are briefly discussed.

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Proton Drivers for Neutrino Beams and Other High-Intensity Applications

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The proton driver is an unavoidable component of any accelerator based neutrino facility. A number of laboratories in the world are using proton accelerators which could evolve for serving the future needs of neutrino physics. Possible plans will be described and preliminary schedules of realization will be sketched.

WG3 Accelerator Physics / 73

A new lattice for the beta-beam decay ring to enlarge the stability limit

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The beta-beam concept relies on the production, by beta decay of radioactive ions of a very high flux, of an electron neutrino and anti-neutrino beam towards a distant detector. After production and acceleration in an accelerator complex consisting of a rapid cycling synchrotron, the CERN PS and the CERN SPS, the radioactive isotopes are injected into a long racetrack-shaped ring, called the decay ring, where they orbit until they decay or are lost. The required intensities to store in the decay ring to reach the aimed neutrino fluxes are very high. Among the collective effects, the head tail effect, caused by transversal resonance impedance, is one of the main issues: the beam was shown to be unstable with the previous decay ring lattice.
To mitigate these effects, we reduced the transition gamma by removing the injection from the arc to put it in a chicane located in one of the long straight sections. To make an amplitude detuning by inserting octupoles in the lattice could increase the stability limit. But the cost is a reduction of the dynamic aperture. After presenting the new lattice with a smaller transition gamma, we shall discuss about the needed octupoles for an amplitude detuning and their impact on the dynamic aperture.

74

WG4 The Final Measurement of the Muon Decay Parameters from the TWIST Experiment

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The TWIST (TRIUMF Weak Interaction Symmetry Test) has completed a measurement of the muon decay energy-angle spectrum with the best precision in the world [1]. This experiment consists of a simultaneous measurement of the parameters ρ, δ, and $P\mu\xi$, from highly polarized muons, to test the validity of the Standard Model (SM) in a purely leptonic interaction. The measurement of these parameters sets new limits on the fundamental coupling constants of the muon and extensions to the SM—such as left right symmetric models. The determination of the systematic uncertainties will be discussed as their control was a central concern for the experiment. The final TWIST results will be given and placed in context for physics beyond the SM.

[1] R. Bayes et al, Phys. Rev. Lett 106, 41802 (2011).

75

WG2: MINERvA Reconstruction and Operations Status

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MINERvA (Main INjEctoR ExpeRiment nu-A) is a few-GeV neutrino scattering experiment that began taking data in the NuMI beam at Fermilab (FNAL) in the Fall of 2009. MINERvA employs a fine-grained detector, with an eight ton active target region composed of plastic scintillator. It also uses nuclear targets composed of carbon, iron, and lead placed upstream of the active region to measure nu-A dependence. The experiment will provide important inputs for neutrino oscillation searches and a pure weak probe of nuclear structure. We offer a set of initial kinematic distributions of interest and provide a summary of current operations and reconstruction status.

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POSTER Modeling neutrino-nucleus interactions in the few-GeV regime

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Detecting neutrinos and extracting the information they bring along is
an ambitious task that requires a detailed understanding of neutrino-nucleus interactions over a broad energy range. Whereas the experimental observable is often an inclusive cross section, a careful study of exclusive cross sections is indispensable for a thorough understanding of these processes.

We present calculations for quasi-elastic neutrino-induced nucleon knockout reactions on atomic nuclei and neutrino-induced pion production reactions. In our models, final-state interactions are introduced using a relativistic multiple-scattering Glauber approximation (RMSGA) approach. For interactions at low incoming neutrino energies, long-range correlations are implemented by means of a continuum random phase approximation (CRPA) approach.

As neutrinos are the only particles interacting solely by means of the weak interaction, they can reveal information about e.g. the structure of nuclei or the strange quark content of the nucleon that is difficult to obtain otherwise. We investigated these effects and present results for a.o. the sensitivity of neutrino interactions to the influence of the nucleon's strange quark sea.

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Measurement of CCQE cross section with T2K on-axis neutrino detector Proton Module

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The T2K (Tokai-to-Kamioka) is a long baseline neutrino oscillation experiment aiming to measure the oscillation parameters associated with muon neutrino disappearance precisely and to search for electron neutrino appearance. A high intensity neutrino beam from J-PARC (Japan Proton Accelerator Research Complex) is measured with the 280m near detector complex (ND280) and the 295km far detector (Super-Kamiokande). For the oscillation analysis of T2K, there is a large systematic error which is attributed to uncertainty of neutrino cross section. So we have constructed a new neutrino detector, "Proton Module" to measure the neutrino cross section precisely and suppress the systematic error. The Proton Module consists of 1204 plastic scintillator bars with Fiber-MPPC (Multi-Pixel Photon Counter) readout. Since it is a fully-active detector, it can reconstruct tracks of various kinds of particles from interaction point. With the tracks infomation, neutrino interaction mode can be identified. We will report the first result of the measuement of CCQE cross section with the Proton Module.

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WG1 Initial Performance from the NOvA Surface Prototype Detector

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NOνA , the NuMI Off-Axis νe Appearance experiment will study ν_μ → ν_e oscillations, characterized by the mixing angle Θ_13. Provided Θ_13 is large enough, NOνA will ultimately determine the ordering of the neutrino masses and measure CP violation in neutrino oscillations. A complementary pair of detectors will be constructed 14 mrad off beam axis to optimize the energy profile of the neutrinos. This system consists of a surface based 14 kTon liquid scintillatior tracking volume located 810 km from the main injector source (NuMI) in Ash River, Minnesota and a smaller underground 222 Ton near detector at the Fermi National Accelerator Laboratory (FNAL). The first neutrino signals at the Ash River Site are expected prior to the 2012 accelerator shutdown. In the meantime, a near detector surface prototype has been completed and neutrinos from two sources at FNAL have been observed using the same highly segmented PVC and liquid scintillator detector system that will be deployed in the full scale experiment. Design and initial performance characteristics of this prototype system along with implications for the full NOνA program will be presented.

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Development of the superconducting solenoid for the MuHFS experiment at J-PARC

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A new experiment to measure hyperfine transitions in the ground state of muonium, called HFS experiment,
is proposed as one of the future J-PARC project.
The objective is to measure the value of the ground state hyperfine structure interval of muonium down to the level of a few ppb, and also determine the ratio of muon and proton magnetic moment with 10 ppb.
For this measurement, a magnetic field of 1.7 T with both high uniformity and stability is required.

On the other hand, the g-2 experiment at J-PARC to measure the anomalous magnetic moment of the positive muon is planed.
This experiment also requires the superconducting solenoid with high uniformity and stability, although the field strength of 3 T and the required uniform region are larger than the HFS magnet.

In order to minimize the development time and maximize the synergy between both experiments, we decided to built the magnet which could generate the field strength of 3.4 T.

This paper reports the current status of the HFS magnet system development.
The field monitoring system to evaluate the field uniformity are also presented.

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WG1 Determination of Neutrino Mass Hierarchy with T2K and NOvA

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We consider the ability of T2K and NOvA experiments to determine
the neutrino mass hierarchy in light of the recent T2K results.
Given the relatively high lower limit sin**2(2*theta13) >
0.03 set by T2K, it is worth exploring this problem. The
numu —> nue oscillation probability depends
on the three (until now) unknown parameters theta13,
deltaCP and neutrino mass hierarchy. Now that we have
a lower limit on theta13, it is possible to determine
the mass hierarchy if we have some knowledge regarding
deltaCP.

We first consider the ability of T2K to determine deltaCP.
We simulate T2K data for 3 years of neutrino running plus
4 years of anti-neutrino running. Using this data, we compute
the 90% C.L. allowed regions of deltaCP.
We find that, for deltaCP true values in the range
pi/4 < deltaCP < 3*pi/4,
the T2K allowed range is 0 < deltaCP < pi.
Similarly for deltaCP true values in the range
5*pi/4 < deltaCP < 7*pi/4,
the T2K allowed range is pi < deltaCP < 2*pi.

Next we simulate the data for NOvA for 3 years of
neutrino running plus 3 years of anti-neutrino running
and compute the ability of NOvA to determine the mass
hierarchy. We restrict range of true values of deltaCP
to be either pi/4 < deltaCP < 3*pi/4 or 5*pi/4 <

deltaCP < 7*pi/4. That is we confine our attention to those values of deltaCP, which T2K can determine at 90% C.L. We find that, for these ranges, NOvA can determine the neutrino mass hierarchy at 90% C.L. for sin2(2*theta13) > 0.08.

Thus we conclude that, for half the range of deltaCP, NOvA can determine the mass hierarchy at 90% C.L., if sin**2(2*theta13) > 0.08.

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WG4 J-PARC MUSE H-line optimization for the g-2 and MuHFS experiments

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Anomalous deviation of the amu factor observed by the muon g-2 experiment is significant, and should be confirmed as soon as possible.
This factor is experimentally determined by frequency difference observed by the g-2 and muon magnetic moment observed by the muonium hyperfine splitting (MuHFS).
Both two experiments are planned to be performed at the H-line of the J-PARC/MUSE which is under construction.

We optimized the beamline for each experiment with G4beamline.
For both experiments, statistics is the most important, thus beamline transmission should be maximized.
Especially for the g-2, the purpose of the present effort is to compromise between small beam size and small leakage field.
For the MuHFS, it is crucial to minimize leakage field at around final focus position, and to get all stopped muons within good field region of MuHFS magnetic field.
Detail design of the final focusing for several magnet system cases will be presented.

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WG4 MuHFS experiment at J-PARC

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We are planning an experiment to measure hyperfine splitting frequency of the ground state of muonium atom at J-PARC MLF. Compared to the previous experiment carried out at LAMPF, the proposed experiment will benefit from the high intensity of the muon beam available at J-PARC MLF, and smaller correction due to gas pressure shift thanks to the usage of longer RF cavity, where muonium are formed and RF field are applied.

We will report the current status of the preparation for the experiment, mainly on the design of the gas chamber/RF cavity.

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WG3 Performance Comparison Between FSIIA and Bucked Coils for the Neutrino Factory Cooling Lattice

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The transverse emittance of the muon beam produced at the Neutrino Factory front-end needs to be decreased using ionisation cooling. The current baseline cooling lattice for the Neutrino Factory, FSIIA, achieves acceptable muon transmission and transverse emittance reduction. However, recent studies indicate that high magnetic field at the position of the RF cavities may limit their maximum achievable gradient, and, since the magnetic field at the RF position of FSIIA is large, the feasibility of this lattice has come under question. A new lattice, Bucked Coils, was designed obtaining four times lower magnetic field than FSIIA while also achieving comparable transmission within 30 mm of transverse acceptance. A detailed comparison between the two lattices is presented with respect to the beam dynamics and the magnetic field.

85

WG2 Status of the MIND Simulation and Analysis

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A realistic simulation and analysis of a Magnetized Iron Neutrino Detector (MIND) has been developed for the purpose of understanding the potential sensitivity of such a facility. The status of the MIND simulation and reconstruction as discussed in the interim design report is reviewed here. Priorities for producing a more realistic simulation for a reference design report will be discussed, as will be the steps that have already been taken towards an improved simulation.

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CERN to Fréjus Super Beam, New Design (poster)

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In the framework of the EUROnu design study, a new design for the CERN to Fréjus neutrino beam based on the SPL is under development by the WP2 group. This neutrino beam allows to significantly improve the measure on the mixing angle $\sin 2(2\theta_{13}$ and CP violation by using a multi-MW proton beam of 4.5 GeV/c, a baseline of 130 km and the future water Cherenkov MEMPHYS (440 kton fiducial mass) detector as a far one. The main challenge of this project lies with the design of a multi-MW target for the proton beam. The horn and the decay tunnel parameters have been optimized with a novel procedure based on a scan of a multi-dimensional parameter space in order to maximize any potential discovery. The target design, thermo-mechanical analysis, and power supply design of the horn system as well as any safety issues are being studied to meet the MW power requirements of the proton beam. The results from the combined experiment of the Super-Beam and MEMPHYS detector and its high physics potential is also shown.

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Recent developments on the muon Non-Scaling FFAG for the Neutrino Factory and its subsystems

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The current status and new developments on the muon Non Scaling FFAG for the Neutrino Factory studied in the framework of the EUROnu/IDS-NF projects are presented. The beam dynamics in the presence of magnet errors, misalignments including the process of acceleration is discussed. The conclusions on the magnet and alignment tolerances are drawn. The progress on the machine subsystems like main magnets and injection/extraction is discussed. The future plans for the study are given.

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Alternative designs for Non-Scaling FFAGs for muon acceleration in the Neutrino Factory

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The Non Scaling FFAG is the main candidate for the final stage of muon acceleration in the Neutrino Factory according to the IDS-NF baseline. The alternative design for the muon acceleration based on two Non-Scaling FFAGs is studied. The staging of the Non-Scaling FFAGs requires lattices with careful chromaticity correction in order to suppress the longitudinal blow up of the beam simultaneously keeping the dynamical acceptance large. The feasibility of such lattices is discussed.

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Recent Studies on the PRISM FFAG Ring

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Next generation lepton flavour violation experiments require high intensity and high quality muon beams. The PRISM task force focuses on accelerator R&D for realizing such beams using an FFAG ring. The scaling and non-scaling designs for the PRISM FFAG ring are discussed. The recent studies on injection/extraction systems and matching to the solenoid channel are outlined. The future plans for the study are presented.

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WG1 Optimized Neutrino Factory for small and large θ_{13}

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In this talk, I will discuss the baseline and energy optimization of the Neutrino Factory including the latest simulation results on the magnetized iron detector (MIND). We find that in case of small θ_{13}, baselines of about 2500 to 5000 km is the optimal choice for the CP violation measurement with E_μ as low as 12 GeV can be considered. However, for large θ_{13}, we show that the lower threshold and the backgrounds reconstructed at lower energies allow in fact for muon energies as low as 5 GeV at considerably shorter baselines, such as FNAL-Homestake.
This indicates that with the latest MIND simulation, low- and high-energy versions of the Neutrino Factory are just two different forms of the same experiment optimized for different parts of the parameter space.

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Feasibility experiment Of Granular Target Options for Future Neutrino Facilities

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Granular solid targets made of either fluidised tungsten powder or static pebble bed of tungsten spheres, have been long proposed and are being studied as an alternative configuration towards high-power (>1 MW of beam power) target systems, suitable for a future Super Beam or Neutrino Factory. Such assemblies offer many advantages as better thermal and inertial stress absorption, thermal cooling and, if in the fluidised form, regeneration. The proposed feasibility experiment will try on a pulse-by-pulse basis to address the effect of the impact of a high-power pulsed beam on a target sample of tungsten powder or pebble ped. Online diagnostic tools using high-speed cameras, laser vibrometry and acoustic measurements, as well as offline, post-irradiation analysis of the target material will be used to observe the effects.

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Neutrino Factory Target and Capture System Optimization Studies

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The target station of the neutrino factory is designed to optimize the hadron capture and produce an intense muon beam as input to the front-end. The capture section consists of a series of solenoids that produce, in the present baseline, a tapered magnetic field to focus the charged hadrons produced at the target. The effect on the focusing by changing the geometry of the solenoids and the magnetic field taper are studied in comparison to the baseline Study-2a-setup. Other optimization studies on the particle production by changing the kinetic energy of the primary proton beam to the target are reported as well.

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MiniBooNE cross section results

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WG2 Neutrino Cross-Sections and Detectors / 94

SciBooNE

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WG2 Neutrino Cross-Sections and Detectors / 95

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WG2 Neutrino Cross-Sections and Detectors / 96

M_A from MiniBooNE CCQE double differential cross section data

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WG2 Neutrino Cross-Sections and Detectors / 97

The role of 2p2h in CCQE

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Superscaling Predictions for NC and CC Quasielastic Neutrino-Nucleus Scattering

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WG2 Neutrino Cross-Sections and Detectors / 99

Electron vs Neutrino-Nucleus Scattering

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WG2 Neutrino Cross-Sections and Detectors / 100

CC and NC coherent pi production

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WG2 Neutrino Cross-Sections and Detectors / 101

NuWro: Monte Carlo generator of neutrino interactions

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WG2 Neutrino Cross-Sections and Detectors / 102

Monte Carlo generators: NEUT and GENIE

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WG2 Neutrino Cross-Sections and Detectors / 103

Measurement of pi-N interaction: PIAnO-Harpsichord

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WG2 Neutrino Cross-Sections and Detectors / 104

Performance of T2K Near Detectors

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MINERvA reconstruction & performance

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WG2 Neutrino Cross-Sections and Detectors / 106

Axial and Vector Structure Functions for Lepton-Nucleon Scattering

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WG2 Neutrino Cross-Sections and Detectors / 107

Neutrino interaction measurements using T2K Near Detectors

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WG2 Neutrino Cross-Sections and Detectors / 108

MINERvA Elastic Scattering

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WG2 Neutrino Cross-Sections and Detectors / 109

MINERvA CC inclusive & nuclear target

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WG2 Neutrino Cross-Sections and Detectors / 110

NA61: pion production cross-sections and plans

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WG2 Neutrino Cross-Sections and Detectors / 111

NA61: Strange particle production

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NA61: Long target results

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NA61: discussion

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FLUKA: hadron production simulation

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WG2 Neutrino Cross-Sections and Detectors / 115

Predicting neutrino flux for T2K

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WG2 Neutrino Cross-Sections and Detectors / 116

NuMI (MINERvA) flux prediction

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Neutrino nucleus reactions at high energies within the GiBUU model

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WG2 Neutrino Cross-Sections and Detectors / 118

Nuclear corrections in neutrino-nucleus DIS and their compatibility with global NPDF analyses

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WG2 Neutrino Cross-Sections and Detectors / 119

Gamma-ray production in NC interactions

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WG1 Neutrino Oscillation Physics / 120

Physics Motivation for Long-baseline experiments: Discussion Session

WG1 Neutrino Oscillation Physics / 121

Long-baseline sensitivity studies and comparisons, Introduction

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Betabeams

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Comparison of Facilities

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Discussion

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Precision required for nu tau

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Optimized Neutrino Factory for Small and Large Theta_13

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Optimisation of the Low-Energy Neutrino Factory

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WG1 Neutrino Oscillation Physics / 130

Sterile Neutrinos In Ice

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WG1 Neutrino Oscillation Physics / 131

Importance of Nuclear Effects in the Measurement of Neutrino Oscillation Parameters

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The Reactor Neutrino Anomaly

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MINOS Neutral Current Results

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The Very Low Energy Neutrino Factory

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LSND, MiniBooNE and T2K excess events as a signal from heavy neutrino decays

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Minimal Models with Light Sterile Neutrinos

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WG1 Neutrino Oscillation Physics / 139

Sterile Neutrino Models

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Neutrino Masses from New Generations

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WG1 Neutrino Oscillation Physics / 141

Overview of Non-Standard Interactions

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Non-standard Neutrino Interactions at One Loop

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Long Range Lepton Flavor Interactions and Neutrino Oscillations

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MINOS Electron Neutrino Appearance Results

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If Theta_13 is Large, Then What?

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The SuperBeam Plus BetaBeam Combination

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Long baseline experiments in Europe within LAGUNA

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Large Water Cherenkov Detector Technology

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Liquid Argon Detector Technology

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MIND

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Neutrinos and the LHC

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Low Energy Signatures of the TeV Scale See-Saw Mechanism

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WG3 Accelerator Physics / 161

Accelerators for the PS neutrino beam

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Collection of 8B and 8Li

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Beamline status and plans of NOvA

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Status of the LBNE Neutrino Beamline

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The CNGS Operation and perspectives

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A new design for the CERN to Fréjus neutrino beam

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Neutrino flux monitoring in the neutrino factory

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Target and magnetic horn for CERN -Fréjus superbeam

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Target options for NF

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Commissioning and status of the muon test area at FNL

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MICE step I: first meas. of emittance with part. Phys. det

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Progress in the construction of the MICE cooling channel

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RF Cavity processing and testing plan

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Superconducting Magnet R&D for COMET

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WG3 Accelerator Physics / 180

Linac & RLA design status and simulations

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WG3 Accelerator Physics / 181

Scaling FFAG straight line

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High Tc superconductor magnet technology for FFAG accelerators

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Recent developments of high Tc coated superconductor ((RE)BCO coated conductor) lead to the possibilities of very high field magnets operated at low temperature (~4.2 K) and efficient magnets operated at high temperature (several tens of Kelvin). For accelerator applications, however, the use coated conductors has been considered difficult due to their tape shape. A project funded by Japan Science and Technology Agency is in progress to challenge the difficulties and to develop the fundamental technologies of accelerator magnets using high Tc superconductors under close collaboration between Japanese university / national laboratories and industry. The primary applications are FFAG accelerators for carbon cancer therapy and those for accelerator-driven subcritical reactor. First, the overview of the project is summarized, and, then, recent results of research and development on several key issues for applications of high Tc superconductor tapes to magnets for FFAG accelerators are presented.

This work was supported by Japan Science and Technology Agency under Strategic Promotion of Innovative Research and Development Program.

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Status of Daya Bay

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Status of Icarus

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WG4 Muon Physics and other High Intensity applications / 185

Current status of Mu2e experiment at Fermilab (remote presentation)

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COMET experiment at J-PARC

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CLFV studies from Belle Experiment

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The Final Measurement of the Muon Decay Parameters from the TWIST Experiment

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Mu HFS experiment at J-PARC

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Mu HFS experiment at J-PARC: RF-cavity design

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J-PARC MUSE: A new beamline for fundamental physics

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WG4 Muon Physics and other High Intensity applications / 196

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Recent results from MEG experiment

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Opportunities for neutrino experiments at ISOLDE

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Simulation of Dynamic Interaction of the Neutrino Factory Mercury Jet with the Mercury Collection Pool/Beam Dump

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Preparation for WG summary (I)

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Study of multiple scattering in high magnetic field

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