Swiss Institute of Particle Physics

Neutrino – CH

21-22 June 2004

Neuchatel

Summary of the Swiss Neutrino Meeting

To: CHIPP board
From : Neutrino-CH meeting organizing committee: Alain Blondel, Allan Clark, Jean-Pierre Derendinger, Klaus Pretzl, André Rubbia, Jean-Luc Vuilleumier
----

Organized at the initiative of the group leaders involved in Neutrino experiments, the meeting Neutrino CH was held at Neuchatel, 21-22 June 2004. The attendance was about 40 people composed in majority of members of the groups presently involved in neutrino experiments, but with a good presence of other groups (Lausanne, Zurich University, PSI). The agenda and transparencies shown can be found on the CHIPP web site.

The aim of the meeting was to assemble the Swiss neutrino community with the goal of sharing our common interests in physics and our views for the future, and of finding common ground for possible collaborations and synergies.

The meeting began with a review of present activities.

- HARP/K2K HARP data taking was concluded in 2002, the experiment took a large amount of data pertinent to the particle production from various beams and targets for future neutrino facilities (in particular the K2K and MiniBoone targets, also superbeam and neutrino factory). The first results of HARP and of K2KII were made public this year. The Geneva group is member of HARP and K2KII. This activity is expected to phase out after data taking in K2K is finished in 2005.

- OPERA is an experiment in preparation to take data in the CNGS beam in 2006 for at least five years. The target lead emulsion sandwich is designed to identify tau appearance events with low background. (a total of 10-20 events is expected after 5 years run). OPERA also claims be sensitive to the o_{ν} <-> o_{e} appearance down to an angle ρ_{24} of about 7^{0}. Neuchâtel and Bern are involved in OPERA, and all forces will be absorbed on the preparation of the experiment until the start in 2006.

- ICARUS is a large liquid argon TPC. The technique has been the object of extensive R&D for many years, and results from the operation of a 600 ton prototype since 2001 were shown (Michel parameter from muon decays) . It offers the capability of tracking, as well as scintillation and Cherenkov light detection. Free drift of electrons with absorption length of up to 3 m have been observed. The group at ETHZ is committed to ICARUS, which will install the 600 ton prototype as fast as permitted (hopefully data at CNGS end 2005), and then further modules of 1.2 tons in LNGS as permitted. ICARUS should be quite powerful to search the o_{ν} <-> o_{e} appearance down to an angle ρ_{24} of about 3^{0}.

Beyond the present programme of measurements, the aim will be to complete the missing oscillation parameters, ρ_{24}, the mass hierarchy using matter effects, and eventually the CP violation, and at a later stage to verify the consistency of the picture. There are several proposals on how to do this, in Japan the US and Europe, with the T2K programme in Japan being closest to realization since the detector exists (SuperK) and both the accelerator and the beam line are now approved. A large amount of time was devoted to the discussion of this experiment and of a possible Swiss contribution to it, in presence of Prof. Koishiro Nishikawa (spokesperson of T2K) David Wark (Spokesperson of T2K-Europe) and Kenzo Nakamura (head of KEK physics department and one of the founders of the SuperKamiokande detector).

Prof. Nishikawa presented the principle of the experiment, where the off-axis concept is used to adjust the beam energy so as to place the far detector at the first oscillation maximum. After 5 years of data taking a sensitivity of $\sin^2 2\rho_{13}$ >0.006 should be reached. At the limit a background of 25 events will be visible with a signal of 12 events. Clearly systematics on the background will play a major role. T2K calls for international participation, in particular for the beam line and the 280 m detector station.

There was a clear consensus that the T2K experiment appears to be the most promising experiment along the line of research started with CNGS, and there is strong support for a qualified and visible participation of the Swiss groups in the experiment.

At present, T2K Europe has proposed to equip the 280 m pit with the large magnet inherited from NOMAD/UA1, so that the near detector be a full-fledge spectrometer to analyse all particles produced at these energies by neutrinos on a water target; University of Geneva, in particular, considers participating in the construction of the tracker.

A second near-detector station at 2km from the neutrino target is likely to be realized in the second phase of the experiment. It would have a flux much more similar to the flux at the far detector than the 280 m station. There, the merits of a liquid argon TPC detector as proposed by ETHZ for near stations in LBL neutrino beams will be manifest. Such a detector would represent a natural and very powerful solution allowing precise topological measurement of final states with pions and photons.

Future investigations along both lines will be conducted in order to define a coherent and organized participation of Switzerland to the T2K project.

The second day of the meeting was dedicated first to neutrino-less double beta decay. The issue of whether neutrinos are Dirac type or Majorana-type particles is one of the most fundamental ones. If successful, a neutrino-less double beta decay experiment could answer this question and determine the absolute scale of neutrino masses. A more detailed answer would require knowledge of the mass hierarchy of neutrinos which can be established with more powerful neutrino oscillation experiments. The group in Neuchâtel participates in the development of Xenon gas TPCs with the aim of progressively enlarging the sensitive mass to ten tons, at which point a sensitivity to an average mass of 30 meV could be achieved, which would be enough to be sensitive to inverted hierarchy scenarios. The uncertainties in nuclear matrix elements are recognized to be an issue (at the level of a factor 2) and necessitate use of several different nuclei.

The rest of the meeting was dedicated to future possibilities offered by e.g. a high power proton source such as the SPL under study at CERN. The characteristics of the facilities under discussion are as follows.

- The suggested proton source is a superconducting Linac, which allows high intensity (4 MW or10^{27}!protons per second at 3/3!GeV), and could provide intensity for neutrino physics as well as nuclear physics (EURISOL). In a first step the Linac 4, a 160 MeV proton accelerator, could increase the overall intensity in the CERN complex by a substantial factor.
- From the proton Linac, whose energy is still a free parameter to be optimised, a conventional neutrino beam could be designed, provided a additional accumulator reduces the duty factor, and the critical issues of high power target and target area are understood.
- The neutrino energy from such a neutrino beam is around 250 MeV and is well matched to a possible large underground detector (Water Cherenkov or Liquid Argon) that could be situated site in e.g. the Fréjus Tunnel. There exist a franco-italian agreement to study the feasibility of such a site.
- The beta-beam concept consists in creating a large amount of radioactive nuclei, such as $^{6}He \downarrow {}^{6}Li\ e^{-}\ \bar{o}_e$ or $^{18}Ne \downarrow {}^{18}F\ e^{+} o_e$, thus producing a very pure beam of electron neutrinos or anti neutrinos. Using the existing accelerators at CERN and the possible installations for nuclear facilities makes the scheme economically very competitive. Another virtue of the beta-beam is that the source does not require huge power (4 MW), only about 10% of that. The neutrino energy of up to 600 MeV is well matched to the same detectors and distance as the superbeam (although a slightly longer distance might be preferable)
- On a longer time scale, the ultimate sensitivity and redundancy is provided by neutrino factories, based on a high energy muon storage ring, which have the advantage of providing electron neutrino beams of energies well above both the tau production threshold and the matter resonance at 12 GeV. The flux control and purity in both beta beams and neutrino factory is the key factor of improved sensitivity. Accelerator R&D for neutrino factory includes in addition ionisation cooling and fast acceleration of muon. The MICE experiment (in which Geneva plays a leading role) is underway, though not fully funded yet, to demonstrate and study ionisation cooling, while a Japanese experiment (PRISM) is approved to study the FFAG accelerator technique.

This above ‘baseline scenario’ is still the object of substantial discussion. In particular:

- Higher energy beta-beam or superbeam have the advantage that the number of signal events for a given ratio L/E increase linearly with energy, allowing higher rate -- smaller size, finer granularity, detectors. In particular, it is argued that the liquid argon detectors provide far more information on the interactions and should allow identification of the lepton in the interactions up to higher energy than the more standard techniques.

- Clearly large underground detectors offer possibilities beyond the detection of neutrinos from accelerators. The detection of nucleon decay, astrophysical neutrinos and dark matter candidates constitute a high class physics programme in its own right. Here again the leading candidates are the water Cherenkov detector and the liquid argon TPC. ETHZ plays a leading role in the development of LARG TPC's and a sequential programme of R&D was presented.
- Finally it was commented that depending on the cost and feasibility of neutrino factories at the time of decision making, it may be more intelligent to skip the intermediate steps and go for it directly.

In conclusion, **the Swiss neutrino community is strongly interested in a possible future high intensity neutrino physics programme at CERN, is engaged in the R&D leading to it and supports this R&D within international collaborations.**

AGENDA		
21 June 2004		
Start time	Title	Speaker
9:30 --coffee and snacks, room assignment etc..		
10 :00	Welcome, practicalities	Jean-Luc Vuilleumier
10 :15	Aims of the meeting	A. Blondel
10:30	Neutrinos in CHIPP	Allan Clark
10:45	Review of ongoing activities	
20+10	HARP/K2K	Anselmo Cervera
20+10	Opera	Frederic Juget
20+10	Icarus	Andreas Badertscher
15	discussion	
12 :30 Break for Lunch		
14:00 future neutrino projects		
30+10	Present Status of Neutrino masses and mixing	Antonio Ereditato
30+10	The T2K experiment	Koishiro Nishikawa
25 +5	European contribution to T2K	David Wark
15:50	Coffee break	
16:20	Swiss participation to T2K	
30+10	UNIGe @ T2K	Alain Blondel
30+10	ETHZ@T2K	André Rubbia
	Reserve	
---	others	
18:00	Discussion (AB introduces)	
19:00	recess	
19 :30	dinner	

Neutrino – CH

21-22 June 2004 Neuchatel

AGENDA

22 June 2004		
Start time	Title	Speaker
9 :00		
20+10	Double beta decay review	Samoil Bilenky
20+10	EXO	Jean-Luc Vuillemier
	discussion	
10:30	Coffee Break	
11:00	neutrino future	
30+10	overview	Yves Déclais
20+10	SPL	Roland Garoby
20+10	Frejus	Jacques Bouchez
12:30	Lunch	
14:00	neutrino future	
20+10	Eurisol+Betabeam	Mats Lindroos
30+ 10	Giant water Cherenkov	Kenzo Nakamura
30+ 10	Giant LARG	André Rubbia
16:00 coffee	coffee	
16:30		
30+10	Neutrino factory physics	Alain Blondel
30+10	MICE	Ken Long
End 18:30		
dinner		