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DELIVERABLE REPORT

FINAL NEu2012 GUIDELINES FOR AN ACCELERATOR NEUTRINO (υ) EXPERIMENTS PROGRAM

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Abstract:

The European accelerator neutrino community submitted end of July 2012 to the European Strategy in Particle Physics (ESPP) 2012 Symposium its proposal of the next global accelerator neutrino (υ) facility for Europe to build or help build (NEu2012 D3.3.1): a new giant European underground home for mega υ detectors in Finland 2300 Km from CERN, served by MW CERN υ beams, ultimately a 10 GeV Neutrino Factory. Early in 2013, NEu2012 D3.2.1 documented further the analysis of performance and physics potential of upgrades and/or of major additions to existing neutrino facilities as evaluated in the NEu2012 years.

Since, the Draft ESPP 2012 Strategy Upgrade Document re-emphasised the strong scientific case for a long-baseline (LBL) υ programme, the need of a CERN programme for a substantial European role, possibly major participation in leading υ projects in the US and Japan.

Last contribution of the Network, taking stock of developments (the emergence of a ESS υ option, the EUROnu costing report, a statement of the Finnish government, the discussions in the CERN SPC

and SPSC, developments in the US and in Japan, the CERN draft MTP) this final D3.1.2 Neu2012 report confirms its indication to vigorously proceed to the establishment of global CERN coordinated European accelerator υ program of medium term experiments as well as of longer term R&D and design work.

The most immediate and mature priority today is a new detector prototyping and test area, possibly in the SPS North Area, finally re-establishing again a home for the neutrino community at CERN.

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1. EXECUTIVE SUMMARY

Moving from the fact that massive neutrinos call for a measurement of a new, possibly large, source of CP asymmetry accessible only to accelerator neutrinos, NEu2012 has achieved its mission of delivering, in time for the preparatory symposium of the second ESPP, an agreed program of accelerator neutrino experiments. Many years of intense networking, see a concise account of the accelerator options in NEu2012 D3.2.1, produced a consensual "proposal of the next global accelerator υ facility for Europe to build or help build" (D3.3.1).

That is a new, much larger, up to 10^6 m^3 European deep underground home for big neutrino detectors in the Pyhasalmi mine, to be exposed in the long term to the few GeV clean multi-flavor neutrino beams from a 10 GeV Neutrino Factory travelling 2000 Km or so, driven by 4 MW proton power; and in the medium term to a similar, less powerful, conventional beam. A smaller R&D and prototype neutrino detector home at CERN, on surface, is also an essential and urgent part of the proposal.

A second option was also thoroughly studied, intense sub-GeV beams travelling only few hundred km. The CERN-Frejus option was studied and this is recently being in part revived as an attractive option for the ESS MMW proton driver in Sweden.

We are also learning much more on the costs of these facilities: they have the same units as LHC. Funding one will take very long and only with cost reductions and staging approaches. The Finnish government stated it cannot commit, for instance.

The support of CERN scientific committees to future LBL projects keeps however strong. And the ESPP 2012 Strategy Upgrade Document recognizes the strong scientific case, recommends a CERN neutrino programme to pave the way for a substantial European role, exploring also the possibility of major participation in leading υ projects in the US and Japan.

Europe has long had such participations. About 250 European neutrino physicists are in T2K and look with great interest to the 20 times larger T2HK, if it will be funded. Some are approaching the Fermilab to South Dakota LBNE project, with longer baseline, higher neutrino energy and the same neutrino factory longer term prospective as Europe. US and Europe indeed did and will much collaborate in this longer term effort. Unfortunately, LBNE also hit funding difficulties and a dramatic down-scoping: much international help, to accelerators and detectors, would be needed for a really attractive option to take credible shape.

Europe should keep its own opportunities, competitive or superior to those in other continents, themselves far from being established. A neutrino detector home and test area at CERN is vital in any case. Major European participation in T2HK and/or in the US will also be very expensive and challenging. A CERN lead, more vigorous, multi-facet combination of short and long term European initiatives appears mature.

2. INTRODUCTION

EuCARD Work Package 3, the Networking Activity NEu2012 (Structuring the accelerator neutrino community) moved from the compelling evidence [1] that massive neutrinos are, today, the only experimental demonstration of new physics beyond the Standard Model (SM) of particle physics, calling for the measurement, among a few other decisive ones, of a new, possibly large, source of CP asymmetry at work in long baseline (LBL) neutrino appearance experiments, that are feasible only with accelerator neutrinos. In addition to CP violation (CPV) we have also left to measure, via matter effects, see below, the mass hierarchy (MH): whether the third neutrino is heavier or lighter than the other two, those with almost the same mass.

This report outlines the achievements of NEu2012 in its mission to consolidate the European accelerator neutrino community and enhance collaborative work and exchanges, in view of delivering "an agreed program of neutrino experiments, based on upgrade of existing infrastructures and/or the proposal of a new one" in 2012, year of the second ESPP update.

LBL experiments aim at KTons times MW, ie assembling the largest neutrino detector mass, with the finest affordable grain, times the highest possible proton power driving a neutrino beam option [2] well matched to the detector technology. Novel options, neutrino factory and betabeam, accelerated and stored beams of υ parents instead of a conventional decay tunnel, promise to contribute an additional gain in neutrino/proton yield. A convenient baseline, source to detector distance, must be identified. The product (network) of neutrino phenomenology, detector and accelerator experts is therefore needed.

Many years of intense networking, already in the FP6 CARE/BENE Network, in close connection to all world studies and, particularly, two FP7 Design Studies (LAGUNA and EUROnu) made possible, in the second 'European Strategy for future neutrino physics' workshop at CERN 14-16 May 2012 [3], the draft of a consensual "proposal of the next global accelerator υ facility for Europe to build or help build". This was then finalized [4] for the ESPP 2012 Symposium (NEu2012 D3.3.1).

3. THE FAVOURED EUROPEAN OPTION: C2PY

Its first ingredient is the proposal of a new, much larger, European **underground home** for big υ detectors. The challenge of assembling the immense detector mass required, 50 to 1000 Kilotons depending on the technology, will dominate the pace of progress in this sector. An appropriate giant laboratory to house these detectors is a prerequisite to any long baseline neutrino beam. The LAGUNA FP7 Design Study [5] proved that such caverns are feasible and pointed, among many other sites, to a 1440 m deep mine in Pyhasalmi, Finland, 2300 Km from CERN. Assembling detector mass in the far Pyhasalmi site would begin with a 20kton Li-Ar TPC, of the double phase GLACIER technology [6] and a 40 kton magnetized iron [7] detector (MIND).

To be prototyped and validated in a smaller neutrino home on surface at CERN, to be set up as detector prototyping and R&D test area.

As second ingredient, the EuROnu Design Study [8] identified the few GeV clean multi-flavor WB neutrino beams from a 10 GeV Neutrino Factory [9] travelling 2000 Km or so, driven by a 4 MW or so 5-15 GeV proton source, as the **long term** optimal **beam facility** to establish CPV, precisely and completely map the neutrino transition matrix, establish its 3*3 nature, test its unitarity. LAGUNA/LBNO [10] is now promoting and studying a similar few GeV WB conventional beam from the SPS < 1 MW 400 GeV protons, with far more modest performance, capable over the 2300 Km baseline of a **medium term** conclusive statement on neutrino mass hierarchy and a first attempt at detection of CP violation (SPSC-EOI-007).

When the uncertainties from different facilities in the measurement of the CP violating phase δ are compared [11] in Fig. 1, this 10 GeV neutrino factory (LENF) promises the smallest uncertainty, at the bottom of the rightmost of the three graphs. Table 1 should help the reader in the comparison among facilities mentioned so far or later in the text.

name	distance	p driver	power	υ source	υ energy	υ detector	comments
C2P-LENF	2300 Km	5-15 GeV	4 MW	10 GeV muon storage & decay ring	few GeV, wide band	Li-Ar and MIND, up to 100 KTons each	favoured choice for Eu ultimate novel facility (CERN to Pyhasalmi low energy Neutrino Factory)
C2P- SPS LBNO (C2P in Fig. 1)	2300 Km	400 GeV	750 KW	pion decay tunnel	few GeV, wide band	Li-Ar and MIND, 20 and 40 KTons initially	favoured choice for Eu next conventional facility (CERN to Pyhasalmi for Long Baseline Neutrino Oscillation)
CERN to Frejus Betabeam	130 Km	LINAC 4	sub MW	γ=100 radioactive ions storage & decay ring	subGeV, wide band	MEMPHYS 500 Kton Water Cerenkov	alternative choice for Eu ultimate novel facility (Betabeam)
CERN to Frejus Superbeam (SPL in Fig. 1)	130 Km	5 GeV SPL	4 MW	pion decay tunnel	subGeV, wide band	MEMPHYS 500 Kton Water Cerenkov	alternative choice for Eu next conventional facility
ESS Superbeam	500 Km or so	2.5 GeV ESS SPL	5 MW	pion decay tunnel	subGeV, wide band	MEMPHYS like Water Cerenkov	emerging conventional opportunity at ESS
T2K	295 Km	30 GeV JPARC PS	250 KW, ultimately 750 KW	pion decay tunnel	subGeV, narrow band	SuperKamiokande 50 Ktons Water Cerenkov	operating conventional facility at JPARC
T2HK	295 Km	30 GeV JPARC PS	1.6 MW	pion decay tunnel	subGeV, narrow band	HyperKamiokande 1000 Ktons Water Cerenkov	proposed conventional facility at JPARC
NuMI	732 Km	120 GeV Main Injector (MI)	up to 700 KW	pion decay tunnel	few GeV, wide band	MINOS , NOVA	operating conventional facility at FNAL
LBNE	1300 Km	120 GeV Main Injector	0.7 to 2.3 MW	pion decay tunnel	few GeV, wide band	34 Kton Li-Ar	proposed conventional facility at FNAL, to be eventually followed by a novel Project X driven LENF like facility
BB350 CERN to Frejus Betabeam	130 Km	LINAC 4	sub MW	γ=350 radioactive ions storage & decay ring	subGeV, wide band	MEMPHYS 500 Kton Water Cerenkov	novel facility studied by theorists, probably unrealistic
NuSTORM	1-2 Km	SPS or MI	low	3.8 GeV muon storage & decay ring	few GeV wide band	BIND, smaller version of MIND	first very low energy and intensity prototype of LENF, inadequate for LBL experiments, proposed both at CERN and Fermilab as a pilot project with short baseline applications

Table 1 Summary of the facilities discussed in the text and/or in the figure caption

The medium term SPS LBL LBNO beam could be built next and in synergy with the envisaged short baseline SPS North Area SBL CENF facility, already in advanced phase of study in view of a Technical Proposal (SPSC-P-347), a search of sterile neutrinos based on the operating 0,6 Ton Li-Ar single phase technology ICARUS TPC [12].

The 20 KT TPC exposed to this SPS LBL beam would provide a rapid, conclusive (> 5σ) determination of the mass hierarchy for the entire $[0, 2\pi]$ range of the CPV phase δ and, with a longer exposure, > 10 yrs, could begin the attack to CPV: it could determine its existence at the 90% CL over 60% of the range and then improve according to evolving progress in beam intensity and detector mass. Beam intensity, before a neutrino factory, could also be boosted by driving the facility with a new 50-70 GeV 2 MW power proton synchrotron (HPPS) instead of the SPS.

This proposed prospective for the decades ahead was, thus, CERN to Pyhasalmi: in short, C2P or C2PY. It prevailed, at the end of many years of neutrino and accelerator physics studies, on a second also very attractive option of both EUROnu and LAGUNA: intense sub-GeV beams travelling only the 130 km CERN to Fréjus baseline. These would be first a "super" (4 MW) conventional υ_μ beam [13] from the envisaged 5 GeV HP SPL, to be joined later by a novel design, γ=100, complementary υ_e Beta-beam [14], in the EUROnu longer term vision. The subGev path has many similarities, including the Water Cerenkov MEMPHYS detector [15] technology, to the approach that has long been collecting successes in Japan from natural and accelerator neutrinos and promises to continue to do so.

Asymmetries between neutrino and antineutrino oscillation probabilities come from leptonic CP violation (CPV) but are also mimicked by matter effects, as neutrinos find in matter electrons, but not positrons, to interact with. These effects, however, do depend on and do provide sensitivity to the mass hierarchy.

The E/L=subGev/few100Km approach to measure CPV thrives on the smallness of the matter effects on beam neutrinos in flight, if the baseline is sufficiently short, like the 130 km distance CERN-Frejus. As subGeV neutrinos are to be used, for E/L to be appropriate, rates and energy deposit of neutrino events will be low: a detector approaching a Megaton is needed, that we can be today only based on instrumented water. That will collect also a huge sample of atmospheric neutrinos and profit of their journey through Earth, thousands of Km, to measure matter effects and thus mass hierarchy.

The E/L= fewGeV/few1000Km approach, the one finally selected, has to be able to disentangle CPV and matter effects on the beam neutrinos sample, a complication but also a richer experimental opportunity. Matter effects can be studied beyond the MH determination. The higher energy permits all flavour transitions, including those into υ_τ, with υ and anti-υ. The energy spectrum information, impossible with subGeV neutrinos, can be used (L/E method) for all transitions, in appearance and disappearance. Event rates and energy deposits are larger, in the detectors, that can be less massive and possibly finer grain. A magnetized detector is mandatory, though, for lepton sign selection, with a neutrino factory.

The two approaches have relative merits and complementarities. The fewGeV/few1000Km approach, with a neutrino factory and a magnetic detector, is ultimately significantly better, as argued in NEu2012 D3.3.1 and references therein. The D3.2.1 document is instead one concise complementary reference account and assessment of all the accelerator options under study, their merits, limitations and challenges.

4. THE RECENT ESS NEUTRINO OPTION

A valuable conventional beam is in fact possible at any high power proton beam and thus a subGeV super beam is also possible from the 5 MW, 2.5 GeV superconductive proton linac being built in Sweden for the European Spallation Source (ESS) to be by 2023 the most intense, MMW, proton driver. The concept [16] of an experiment has circulated, since the ESPP Symposium, based essentially on the EUROnu SPL sub-Gev neutrino superbeam design and the installation of the MEMPHYS detector studied for Frejus in one of a few Swedish mines, few 100 Km away, perhaps of interest also for the LBNO proposal. This concrete opportunity for a LBL experiment in Europe, presently being seriously considered, has also potential, the same as Frejus, for p decay (10^{35} years) and supernovae, solar, atmospheric and geo-thermal neutrinos. Its constituency needs to grow, at the moment.

5. THE EURONU COSTING REPORT

A more solid, and quite sobering, notion of the high cost of these facilities, including detectors, came from the significant work summarized by the final EUROnu costing report [17] in December. It quoted a cost bracket [5.3,7.3] B€ for the Neutrino Factory baseline project, components plus 40% manpower, The SPL 4 MW proton linac contributes [1.0,1.3] B€ to that. The quote for adding instead the Frejus Superbeam project to the SPL is [1.0,1.2] B€ and [1.4,2.3] B€ for adding the Betabeam on top of that.

These costs amount to a large multiple of the present yearly budget of neutrino physics or even that of particle physics all together in Europe. It is evident that funding a new facility will take many many years and is conceivable only if realistic cost reduction as well as staging approaches can and will be found.

6. DISCUSSIONS WITH FUNDING AGENCIES AND IN SCIENTIFIC COMMITTEES

A confirmation of this came from the statement of the Finnish government in December that Finland cannot commit to host the Pyhasalmi underground laboratory because of the heavy costs involved, “its stringent public budgets being hardly able to finance even its most highly prioritized scientific infrastructures”. It remains to be seen now if Pyhasalmi can still be the home of European neutrino detectors, with reduced costs for Finland, or another home has to be found, perhaps in Sweden.

Mid January, the CERN SPSC summarized its recommendations on SPSC-P-347 and SPSC-E-007. It supported both SPSC-P347 and E007, stating that the SPS SBL CENF facility could be adequate to foster the necessary focus beyond ongoing approved programs, provided that it can also contribute significantly to the preparation of future LBL projects. It supported the focus on the Li-Ar TPC technology, noted the similar focus in the USA and recommended close contact in anticipation of collaboration. It requested from SPSC-P-347 a comprehensive TDR with breakdown of work and resources and from SPSC-E-007 a technical proposal of the R&D to be led at CERN, particularly on the promising double phase Li-Ar concept.

7. THE UPDATE OF THE EUROPEAN STRATEGY FOR PARTICLE PHYSICS

Late January the Draft ESPP 2012 Strategy Upgrade Document [18] circulated. It recognizes “that, with significant European involvement, a strong scientific case is established for a long-baseline (LBL) υ programme. It recommends that **CERN should develop a neutrino programme** to pave the way **for a substantial European role in future LBL experiments**. Europe should explore the possibility of major participation in leading υ projects in the US and Japan.” The Document was officially approved on May 31.

A CERN SPC neutrino working group has also been since set up to make recommendations about a CERN neutrino programme that would satisfy the European Strategy.

8. EUROPEAN PARTICIPATION IN INTERNATIONAL PROGRAMS

Major European participation in leading υ projects in Japan and US has long been a reality, well before the ESPP strategy statements. Today, on the same time scale as LBNO, T2HK [19] and LBNE [20] are the corresponding next generation experiments. Their three expected $\Delta\delta$ uncertainties being comparable (Fig. 1), future choices appear likely to be driven also by opportunity and planning.

About 250 European neutrino physicists have invested in the Tokai to Kamioka JPARC T2K [21] near detector and will be running T2K for several more years ahead. Some of them have long been working on Water Cerenkov detectors and do actively participate to the International Open Working Group for the Hyper-Kamiokande (HK) project and the T2HK experiment. More will. So are the T2K North American and other international collaborators. HK is two 500 KTons Water Cerenkov detector tanks, 20 times bigger than SuperK [22], being designed to be the next generation underground nucleon decay and neutrino detector and to be exposed to the most intense conventional neutrino beam that JPARC will be able to produce, ultimately 1.6 MW perhaps. The open WG is addressing physics potential and design of the HK

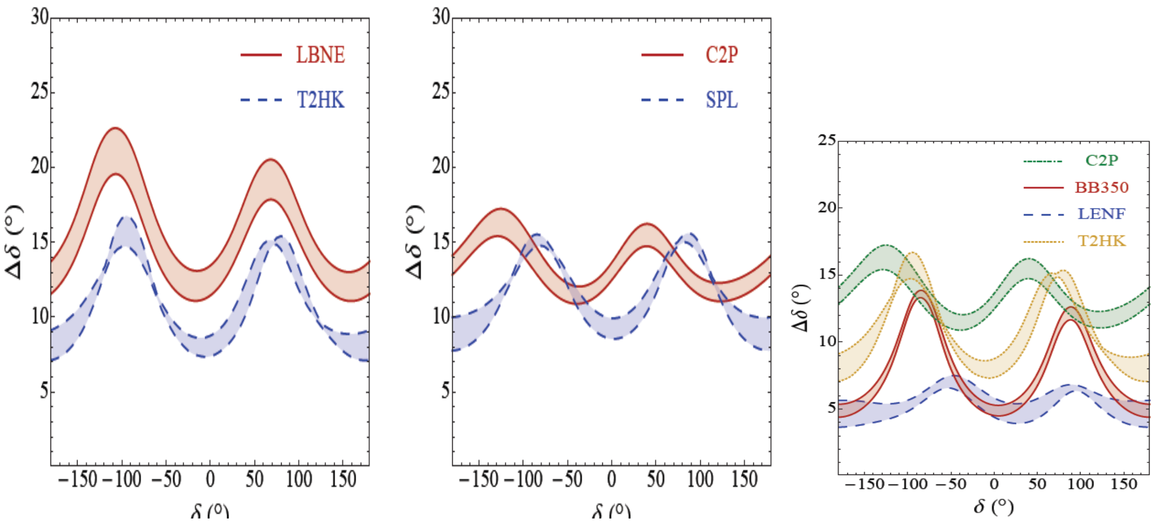

Figure 1 Comparison of the Δδ uncertainties (in degrees) in the measurement of the CP violating phase δ from different facilities 0. Δδ is plotted vs δ for the entire [-180, +180] range of δ. The 10 GeV neutrino factory setup, in the bottom of the right graph, promises the smallest Δδ for all values of δ.. Uncertainties from conventional beam projects, in particular the three present medium term projects, T2HK in Japan (shown both in the left and right graph), LBNE in the USA and C2P in Europe (both in the centre and right graph) are larger and comparable

and upgraded near detectors, focusing on necessary R&D items for each detector component and its simulation. Our Eu groups will be thriving on the work done in Europe for the Frejus option and being done now for the ESS option. Many other Eu competences are welcome also.

A cavern in the Nijungo-yama mountain, 8 Km south of the Kamioka site and still 295 Km from JPARC, has been identified for the new much larger Mton underground (650 m) home for neutrinos that Japan needs. T2HK promises a multi σ determination of MH with its atmospheric sample for any δ_{cp} and 3σ sensitivity to CPV for 74% of the δ_{cp} range. The 20 times leap in mass (and sensors) appears manageable, limitations on beam power are likely to be more severe, instead, due to the older technology and the ring nature of the JPARC proton driver. It is a large project, twice the size of the MEMPHYS cavern and detector at Frejus, plus the cost of the reinforcement of JPARC beyond 1 MW, likely to imply a new booster ring. Europe should assemble a very sizeable contribution. The prestigious Japanese neutrino community that is setting up the international collaboration necessary to push the project to approval is well aware of its difficulties in the ILC competitive context, however.

The new much larger underground (4850 ft) home that the USA plan for neutrinos is in the SURF Sanford Underground Research Facility, at the glorious Homestake/SD mine. The LBNE experiment, over 350 collaborators, plans a 34 KTons Li-Ar underground far detector there and a fully capable near detector in Fermilab served by a new few GeV neutrino beam, similar to NuMI, from the new extraction MI-10 from the Main Injector, 700 kW (with the capability to support an upgrade to 2.3 MW), travelling 1300 Km westward to South Dakota. LBNE promises multi σ determination of MH for any value of δ_{cp} and 3σ sensitivity to CPV for 60% of the δ_{cp} range. The upgrade to 2.3 MW by means of a new Project-X proton driver (again a superconductive linac !) is however only a strategic study, for the moment.

LBNE is a large project and was bound to hit funding difficulties. These have been dictating a reconfiguration process to implement LBNE as a phased program. The first LBNE10 phase, which has CD1 recognition with a target cost of 867 M$, foresees the new beam, but only a 10 kiloton far detector on surface at SURF and no near detector in Fermilab. It is left as a high priority goal to create the underground lab, complete the 34 KTons detector there and build the near pit and detector in Fermilab. Project X [23] is left for a yet later third phase. The choice of giving today's priority to the new 1300 Km baseline beam follows from the merits of the longer baseline, 50% longer than NuMI, to some extent a second similarity of focus, along with Li-Argon, with Europe.

The reconfiguration had to be rather dramatic. LBNE10 performance degrades then to sensitivities to mass hierarchy at the 3σ level for 75% of all values of δ_{cp} and to CPV for 25% of all δ_{cp} values at 2.5σ_ level. Significant international collaborators and resources are being sought aiming at recovering the full LBNE performance. From Europe, UK groups and the ICARUS team may be getting involved. Much more international contribution is needed for a really attractive option to take again credible shape.

9. LONGER TERM INTERNATIONAL PROGRAMS

Another European major collaboration in a leading υ project in the US is the longer term effort towards a Neutrino Factory. The UK leads its IDS, International Design Study [24], one big EUROnu work package was devoted to it. Among the R&D programs, HARP [25] and MERIT [26] were at CERN, MICE [27] is in the UK. The strongest muon accelerator program (MAP) remains however the one of the collaboration [28] of major US labs and universities clustering around the R&D in progress in the dedicated MuCool Test Area and the regular DOE/NSF funding profile run by Fermilab. The goal is a Neutrino Factory pointing towards SURF, and then also, further ahead, a Muon Collider. The ESPP should hopefully be read as recommending also the support needed by these European collaborations: in particular, today, the finalization of MICE, the completion of the IDS reference design report soon and then later timely progress to proposal(s) of a Factory for Fermilab and/or CERN.

Next major milestone on this path is NuSTORM, both a FNAL LOI (arXiv:1206.0294) and CERN SPSC-EOI-009, calling for an internationally concerted decision. It is a mini, low intensity and thus SBL only, neutrino factory: a muon storage ring deprived of its costly and challenging muon front end. A pilot facility designed to be first to deliver υ_e and υ_μ beams from the decay of a stored μ beam with a central momentum of 3.8 GeV/c and a momentum spread of 10%. The facility is unique in that it will: serve the future long- and short-baseline neutrino-oscillation programmes by providing definitive measurements of υ_e and υ_μ scattering cross sections with percent-level precision; allow searches for sterile neutrinos of exquisite sensitivity to be carried out; and constitute the essential first step in the incremental development of muon accelerators as a powerful new technique for particle physics. CERN SPSC-EOI-009 states that only CERN and FNAL have the infrastructure required to mount NuSTORM and its purpose is to request the resources required to: investigate in detail how it could be implemented at CERN and develop options for decisive European contributions to facility and experimental programme wherever it were sited. It defines a two-year programme culminating in the delivery of a Technical Design Report.

10. CONCLUSIONS

The CERN draft Medium Term Plan (MTP), early May 2013, restates among the goals of the CERN Management to develop a neutrino program to make Eu participation in neutrino physics possible. Dedicated efforts will be undertaken at CERN in order to prepare for a future Eu participation in neutrino projects. A neutrino activity must provide technical expertise, support and focus for Europe to play a leading role. In addition to the effort behind SPSC-P-347, the CENF studies, SPSC-E-007 and its concept of a neutrino test beam area, it states that studies of opportunities for CERN beyond Europe will be finalized in time for the June version of the MTP. The MTP draft quotes however only 5,6 MCHF seed funding for a more detailed study in neutrino physics at CERN. The CENF and neutrino test and prototyping areas are explicitly not included. The internationally strategic 4 MW HP SPL study continues to be supported towards a CDR in 2015.

This NEu2012 final report is delivered before final publication of the MTP. The conclusions of our accelerator neutrino community do outline the Eu neutrino program adequate to fulfil the ESPP. CERN Medium Term Plans this year and later should accommodate the necessary resources and attract more from the national agencies.

Europe should keep following through its own opportunities of providing a site and MW beam(s) for giant neutrino detectors. The Finnish option can be perhaps rescued, a Swedish option may mature. These opportunities are competitive with or superior to those in other continents, themselves far from being established.

A neutrino detector home and test area at CERN is just as essential to prepare detectors that will be installed in Europe as in South Dakota or in the Japanese Alps. Both Li-Ar technologies must decisively move on to prove that they can build really big tanks. And build one or more for any international program that will manage to fly. So should other technologies, iron-scintillator spectrometers, fully active scintillator detectors and more.

Major European participation in leading υ projects as HyperK and/or in the US will be also very expensive and challenging. Contribution to their neutrino accelerator complex will also be decisive. A catalyzing and steering CERN kernel of a global Eu concerted effort should be set up. T2K and MICE are today CERN recognized experiments. But much more is needed. All Eu Agencies must be federated in a coherent neutrino accelerator and detector program.

Europe cannot delay further structuring a stronger contribution to the international R&D and design work: European high power proton driver work must continue, the challenge of loss-free MW proton intensities is strategic, world wide. So is that of high power targets and collection systems for conventional and novel beams, ionization cooling, NuFact-IDS, NuSTORM, muon acceleration and more.

This final statement of NEu2012 can only be a plea from a vigorous community in support of the global effort required today: a vigorous coordinated multi-facet combination of European initiatives and participations in the international neutrino accelerator and detectors programs: next generation experiments and, in parallel, R&D and design work for long term experiments. It is too early to drop European based options. And, in any case, any Eu option for Japan/USA demands a just as ambitious vision.

NEu2012 comes to its end confident to have reasonably approached the best progress possible in 2012, by the time of the second ESPP Symposium in September, towards “an agreed program of neutrino experiments”, the draft of a consensual “proposal of the next global accelerator υ facility for Europe to build or help build”. The precious EC support of many years of intense networking, already in the FP6 CARE/BENE Network, in close connection to all world studies and, particularly, two FP7 Design Studies (LAGUNA and EUROnu) has made that possible. The tradition thus established of collaborative work and exchanges in the accelerator neutrino community will be invaluable, in the present difficult context of costs and resources, in the identification of the best international plans, staged scenarios and clever cost reducing solutions

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ANNEX I - GLOSSARY

Acronyms

Betabeam	Neutrino facility based on a storage ring for beta decaying ions
Conventional beam	Neutrino facility based on a decay tunnel for (mostly) pion decays
CENF	new CERN Neutrino Facility under study for the SPS North Area
CNGS	CERN Neutinos to Gran Sasso
C2PY	CERN to Pyhasalmi
CPV	Charge Parity (symmetry) Violation
DS	FP7 Design Study
ESPP	European Strategy for Particle Physics
ESS	European (neutron) Spallation Source in Lund
EuCARD	European Coordinated Accelerator R&D
EURONu	DS of a High Intensity Neutrino Oscillation Facility in Europe
GLACIER	envisaged very large double phase Liquid Argon TPC
HK	HyperK
HyperK	Hyper Kamiokande, planned 1000 KT Water Cerenkov Detector
ICARUS	single phase Liquid Argon 600 Tons TPC operating at LNGS
ICARUS/NESSiE	Technical Proposal SPSC P347
IDS	International Design Study
LAGUNA	DS: a Large Apparatus for Grand Unification and υ Astrophysics
LAGUNA/LBNO	LBNO extension of the LAGUNA DS
LBL	Long Base Line
LBNE	Long Baseline υ Experiment, Fermilab to Homestake
LBNO	Long Baseline υ Oscillations experiment SPSC EOI-007, C2PY
LNGS	Laboratorio Nazionale del Gran Sasso
KTons	Kilotons of neutrino detector mass
MEMPHYS	440 Ktons fiducial mass Water Cerenkov Detector planned for Frejus
MH	Neutrino Mass Hierarchy
MTP	Medium Term Plan
MW	MegaWatts
MMW	MultiMegaWatts
NB	Narrow Band …. a neutrino beam with a narrow energy spectrum
Neutrino Factory	Facility based on a storage ring for decaying muons
NEu2012	Neutrinos for Europe 2012
NF	Neutrino Factory
NuFact	Neutrino Factory
SBL	Short Base Line
SM	Standard Model
SPC	CERN Scientific Policy Committee
SPSC	CERN SPS Scientific Committee
SPL	Superconducting Proton Linac
Superbeam	Conventional beam of very high, MMW, power
SK	SuperK
SuperK	SuperKamiokande, operating 50 KT Water Cerenkov Detector
TPC	Time Projection Chamber, modern 3D tracking device for charged tracks
TDR	Technical Design Report
T2K	Long Baseline υ Experiment, Tokai to Kamioka
T2HK	Long Baseline υ Experiment, Tokai to Hyper Kamioka
WB	Wide Band …. a neutrino beam with a broad energy spectrum