N3 in the CARE proposal

Title: Beams for European Neutrino Experiments

Acronym: BENE Coordinator: V. PALLADINO (INFN-Na)

Deputy(tbc): P. Gruber (CERN)

Beams for **E**uropean **N**eutrino **E**xperiments

Participants to the N3 Activities:

Country	Number of institutes	Number of persons
Belgium	1	3
CERN	1	22
France	5	31
Italy	12	38
Germany	3	26
Latvia	1	3
Netherlands	1	1
Spain	3	18
Sweden	1	1
Switzerland	5	14
United Kingdom	14	47
USA, Japan	3 + 1	-

Main Objectives: The aim of this NA is to coordinate and integrate the activities of the accelerator and particle physics communities working together, in a worldwide context, towards achieving superior neutrino (ν) beam facilities for Europe. The final objectives are: 1) to establish a road map for upgrade of our present facility and the design and construction of new ones 2) to assemble a community capable of sustaining the technical realisation and scientific exploitation of these facilities and 3) to foster a sequence of carefully prioritized and coordinated initiatives capable to establish, propose and execute the R&D efforts necessary to achieve these goals.

Cost:

Expected Budget	Requested EU Funding
1367 K€ +CH	446 K€ +CH

Description of the N3 Activity

The recent discovery of ν transitions, by experiments in SuperKamiokande and Kamland (Japan), SNO (Canada) and others, is one of the most important results in physics in the last ten years and has generated considerable interest worldwide. It indicates the existence, at extremely high energy, of new phenomena that are well beyond the established Standard Model of particle physics. Nevertheless, much remains to be discovered about ν oscillations, including the existence of leptonic CP violation, which is required in the most satisfying explanation so far of the existence of matter (and not of anti-matter) in the universe. This domain of physics cannot be experimentally tested at accelerators at the energy frontier (LHC and possible linear collider) and requires dedicated ν beams.
The present European experimental programme (CNGS, CERN ν beam to Gran Sasso) aims at validating the existing results and will begin data taking in 2006. To go beyond and fully exploit the physics potential of ν oscillations requires the realization of one or more new ν facilities, with higher beam power, better defined spectrum and flavour composition, allowing experiments with higher statistics and reduced systematic errors, in optimal conditions of beam energy and distance from the source.

1.1 Description and objectives of the activity

The aim of BENE is to coordinate and integrate the activities of the accelerator and particle physics communities working together to establish a short and long term program in the sector of ν physics. In the short term, improvements of performances of the approved program CNGS facility will be vigorously investigated. For the longer term, Muon Study Groups, endorsed by ECFA, have been active since 1998. Contacts have been established between laboratories and universities around Europe with the goal of preparing and carrying out the R&D and studies necessary to propose the next major ν facility by the time of the start-up of LHC. The three facilities presently considered are
i) a super-conventional muon-ν beam (Superbeam) of the CNGS type, using a new high power proton accelerator
ii) a Neutrino Factory, in which the ν's are produced by the decay of muons in a storage ring. This facility promises to be the ultimate tool for studying neutrino oscillations;
iii) a Beta beam, in which electron-ν's come from the decay of radioactive nuclei in a storage ring.

It would be important to compare the physics reach of these approaches and the rapid evolution of the field should be closely monitored. The synergies of each approach with other domains of particle and nuclear physics will also be carefully investigated. The final objectives are

- to establish an agreed road map intended to upgrade the current CNGS facility and for the design and construction of new ones
- to assemble a community capable of sustaining the technical realisation and scientific exploitation of these facilities
- to foster a sequence of prioritized and coordinated initiatives capable to establish, propose and execute the new collaborative R&D efforts necessary to achieve these goals. This requires excellent coordination between accelerator and particle physicists.

The objective of BENE is to create a strong, tight network of particle and accelerator physicists to co-ordinate and prioritize the studies on these new facilities, leading to a comparison of the technologies, costs, risk, and physics results in order to build a coherent programme to study ν oscillations in Europe.

The programme will be carried out by five working groups or packages (WPs). They are subdived in three categories of priority in funding requests (WP1, WP2,3,4 and WP5). We list below their specific objectives:

1) Physics demands on ν accelerator facilities (M Mezzetto, INFN Padova, check also table 1.2a-PHYSICS) will aim at establishing the widest consensus on physics requirements and on the ultimate scientific reach of the CNGS, of each of the future option (Superbeam, NuFact, Betabeam) and of combinations of them, in terms of beam energy, baseline, beam structure, composition, flux and minimization of systematic errors. Neutrino oscillation will be the core of the WP interests, but other fundamental physics will also receive proper attention. We assign to WP1 the strategically HIGHEST priority.

While WP1 must explore as completely as possible the comparative physics merits of the 3 types of facilities above, priority in technical investigations should be given first of all to WP2 (and to the HIPPI JRA that appears strategically decisive in that sector). The key ingredient of any superior neutrino beam is the realization of a new proton driver. A new DRIVER can make more proton power available to the CNGS and make possible on a short timescale a new superior conventional neutrino Superbeam EU facility.

2) High Power proton drivers (P. Debu, CEA) will compare the merits of SuperConducting Proton Linacs and Rapid Cycling Synchrotron and will propose a choice, based also on the HARP data presently being analysed. It will evaluate approaches to intense H- ion sources, fast beam choppers, (hybrid) drift tube linacs, coupled cavities, side coupled linacs, low β SC structures and RF systems, in close connection with the HIPPI JRA. See also table 1.2b-DRIVER.

In order to really profit of higher power, however, progress in the WP3 and WP4 sectors is decisive and shares the same VERY HIGH priority.

3) High power targets (R.Bennett,CCLRC), will examine the various solutions (molten metal jet, multiple helium cooled granular targets and rotating metal bands) being proposed for the severe, and as yet unsolved, problems experienced by a multi-MW target station involving extremes of pulsed heating, high radiation levels and mechanical stress from thermal shock waves. It will finally aim at selecting one or a few agreed viable solutions. See also table 1.2c- TARGET. The experience of those involved with similar problems of targets for pulsed spallation neutron sources and radioactive beam facilities will be drawn upon. An integrated design is required involving the surrounding pieces of equipment, including the collector and the beam dump. The problems of safety, radioactive disposal remote handling and maintenance are also to be addressed.

4) High power collection systems (J. E. Campagne, CNRS-IN2P3-Orsay)**,** will assess the unprecedented challenges of thermo-mechanical stresses and fatigue and of radiation damage affecting an integrated target-collection devices operating in a MW power beam. In the case of magnetic horns, the new extra challenge posed by high repetition rate of electrical discharge will also require careful attention. The WP will aim at defining an optimal integrated target &collection system, in close collaboration with WP3. See also table 1.2d-COLLECTOR.

The goals of WP1 and WP2-3-4 must be ambitious and wide. We envisage therefore that for the longer term and technically more challenging goals of WP1-2-3-4 we will have to apply for additional resources well beyond BENE, including EC funds for design studies and technical preparatory work . This applies even stronger, almost entirely, to the work of WP5 that, within BENE, can only be seminal. This WP5

5) Novel Neutrino Beams, as indicated in the chart below, should be seen as three sub-WP's of a general package devoted to longer term aspects to 1) collection and dissemination of knowledge 2) promotion of the further initiatives and funding prospects indeed capable to cope with the scopes listed below, clearly no less ambitious and challenging. It comprises 3 areas of interest. See also table 1.2e-NOVEL NEUTRINO BEAMS

a) NuFact front-end (MUFRONT, R. Edgecock, CCLRC) will focus specifically on the muon beam, produced from the solenoidal π decay channel. This should include phase rotation and preparation to acceleration. Emittance reduction, via specific μ ionization cooling schemes, including the option of cooling rings, should be its main focus, Cooling free schemes should also be carefully examined. The WP should assess the results of the MICE experiment, rate the different schemes and produce a proper road map, proposing further R&D if necessary, towards the complete design of the frontend of a NuFact complex.

b) NuFact acceleration and storage (MUEND, F. Meot, CEA) should focus in detail on the options for muon acceleration and storage. It should compare the optical, acceleration and transmission properties of Recirculating Linac and Fixed Field Alternating Gradient accelerators in terms of muon intensity and energy. It should devote special attention to the key components, magnets and RF cavities, and to the engineering constraints of a non-horizontal ring serving two far detector locations at different distance. It should propose a choice of scheme based on performances, technical and economic aspects.

c) Beta-beams **(**BETABEAM**,** M. Lindroos, CERN) aiming to produce a road-map for both a high and a low energy beta-beam facility in Europe. It should will serve as an orientation and information forum for a full scale betabeam design study. Comparative studies should focus on assessing results from several technical tests of critical components in the betabeam scheme that are planned at existing facilities. Benefits to existing facilities are also expected (like better yield at radioactive ions facilities or better understanding of beam manipulations for the LHC ion programme).

We rate the priority of WP5 as TIMELY. Techniques are highly novel and the process of accumulating the necessary irreplaceable experience will be long and should begin without delay.

1.2 Outcome and deliverables of BENE

The network is expected to produce four main outcomes:

- A global Roadmap specifying the optimum ν oscillation programme for Europe and the path to design and construction of the superior ν facilities required.
- Documents (technical reports, articles, proceedings of workshops and meetings, Web Sites) and tools (databases, repositories of simulation and design code and more) providing technical knowledge about the design and realization of the ν facilities and their physics reach.
- Proposals of R&D and technical preparatory work to be performed to verify that the facilities can indeed be built. Each proposal, addressed to a host European Lab, will include the assembly of the necessary human and material resources (collaboration).
- Dissemination of special know-how and advanced accelerator concepts linked with neutrino activities to a large community in Europe.

Europe will host the International NuFact Workshop in 2005 and 2008. These dates are considered to be milestones for the BENE programme:

NuFact05 (late Spring 2005): a complete interim plenary report, accompanied by interim parallel reports from WP's, will be presented to the Workshop and will conclude the phase of preliminary comparative studies and define a first set of parameters agreed as input for conceptual design work.

NuFact08 (late Spring 2008): a draft of our complete final plenary report, accompanied by reports from WP's, will be submitted for a final six month scrutiny from the community. It will contain our final scientific and technical "roadmap" recommendations towards final detailed technical design, assessing the R&D and preparatory work in progress and providing further indications, if appropriate.

A more detailed set of tasks, deliverables and milestones, concerning BENE in general, is given in table 1.2 and those specific of each WP are given in tables 1.2a-e.

1.3 Benefits for the scientific community and the participants.

Such a coherent and coordinated European program on **ν** beams will involve the large majority of the European experts in the field.

- It will bring an unprecedented collaboration between accelerator and particle physicists.
- It will provide the critical mass necessary to develop an attractive and ambitious program allowing in due course to design and construct cutting-edge infrastructures.
- It will thus strengthen the European role in this sector.
- The expertise and skills of each participant will be enhanced by the contact with worldwide experts and improved communication.
- Dissemination of knowledge will be one of BENE's main concerns. We plan to apply for a Marie Curie fellowship for a postdoc who, in addition to participating to the BENE studies, would be in charge of:
  - the centralization, maintenance, upgrade and distribution of common simulation software
  - the development of the BENE Website,
  - including the management of the BENE documentation.

The knowledge will be shared through active participation to international worldwide conferences and workshops

Very limited resources are presently available in Europe for **ν** initiatives, due to the difficulties of LHC funding. The EC support requested here would add decisive value in view of the strategic goal of producing a timely European initiative and worldwide leadership in the fundamental area of ν science.

1.4 Measuring the impact and success of BENE

Appropriate ways and parameters to monitor the impact of N3 could be the number of

1) participants to Muon Weeks and BENE Workshop
2) documents and tools produced
3) new collaborations among participants

4) novel ideas proposed to improve operation and performance of existing infrastructures and of R&D
5) design study proposals generated in BENE.
6) Approval of each proposal by a host laboratory will require the favourable assessments of a peer review panel and will provide direct evidence of the network impact.
7) The number of quotations of BENE documents will probably be a useful monitor of the success of the Network.

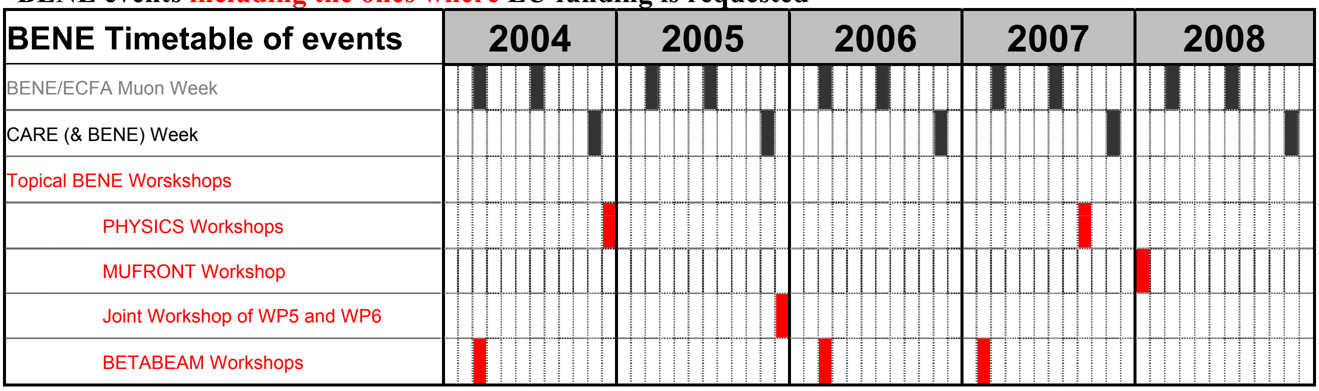
2. **Participants and expertise in the Network (see Tables 2a, 2b, 2c)**

The 13 contracting participants and the 52 associated institutes to this network are listed in Table 2a. The participating and associated institutes represent 13 countries (plus the international laboratory CERN). Table 2b shows to which work package the BENE partners contribute and Table 2c the laboratory expertise and interests in the BENE network activities.

3. **Justification of financial requests**

The next table summarizes the events foreseen during the duration of BENE. To achieve the goals of the network, its members will meet up to three times per year. Two joint BENE-ECFA Muon Weeks will take place every year and a third general BENE workshop will occur in the framework of a larger general yearly CARE meeting. The meeting of the different Work Packages will be imbedded in theses 3 meetings optimizing the interactions amongst the participants. In addition, seven specific topical workshops are foreseen during the 5 year program of CARE.

BENE events including the ones where EU funding is requested



Financial support from EC is requested only for participation to the yearly general CARE meeting and to the PHYSICS Workshops. This applies, to some extent, to all WP's: WP5 will so interface with BENE and CARE at least once per year. We aim at obtaining, from our participating institutes, the additional resources permitting meetings of WP1-2-3-4 during the **2** other BENE-ECFA Weeks and meetings of WP5a-b-c during **1** of them, within the limited available financial resources for **ν** initiative in Europe until the start of LHC. Beyond that, we trust that we will be able to generate further initiatives. Both the number of activities to review and our resources will increase, thus justifying and supporting enhanced participation of all WP's to up to 3 yearly events and to the other topical workshops.

To ensure proper management of the network, the BENE coordinator and the Work package coordinators will be attributed a reserve for their own additional travel needs and also to allow them to invite worldwide experts during the BENE workshops. This latter point will also serve to keep a close contact with similar worldwide activities~~. Finally as stated in section 1.2, a CERN-based postdoc for 3 years is requested~~.

We summarize the breakdown of the expected total budget of 1256 k€ in the following table and more detail can be found in the table 3 at the end of the BENE proposal.

Breakdown of the estimated total budget

Type of meetings	Number of persons	Number of meeting during the 5 years	Estimated cost (k€)
BENE-ECFA muon weeks (support not requested)	80	10	720
General CARE meeting **(support requested)**	80	5	**360**

PHYSICS topical workshops (**support requested**)	20	2	**36**
Other topical workshops (support not requested)	20	5	90
WP coordination+invitation of experts (**support requested**)	1	15+2+30+15	**25**
BENE coordination+invitation of experts (**support requested**)	1	62	**25**
Expected total budget			1256+CH
Requested Total Funding			**446+CH**
Postdoc for common issues (support will be seeked elsewhere)	1	For 3 years	200

The requested funding from EU is about **446 k€.** It is worthwhile noting that participation to International conferences and workshop is extremely important both for dissemination of knowledge and to keep a strong link with non-EU collaborators, in particular in the perspective of a worldwide neutrino facility. One can mention as examples the International NuFact Workshop (relevant for all Work Packages), the International NBI Workshop on Neutrino Beam Instrumentation (WP2 throu WP5) , the early International FFAG Workshop (WP5a, WP5b), the International Conference on Neutrino Physics (WP1 mostly, and all WP to some extent), and the International Workshop on Weak Interactions & Neutrinos (WP1 mostly, all WP to some extent). The funding for participating to these events over 5 years is non-negligible. We estimate this to be about 500 k€ from our past experience. We assume that the participating institutes to BENE will continue supporting also these expenses.

Management structure:

The network is managed by the Coordinator, its deputy and the work package coordinators forming the steering committee of the Network. The BENE management team, their responsibilities, and the organisation are shown in the following chart.

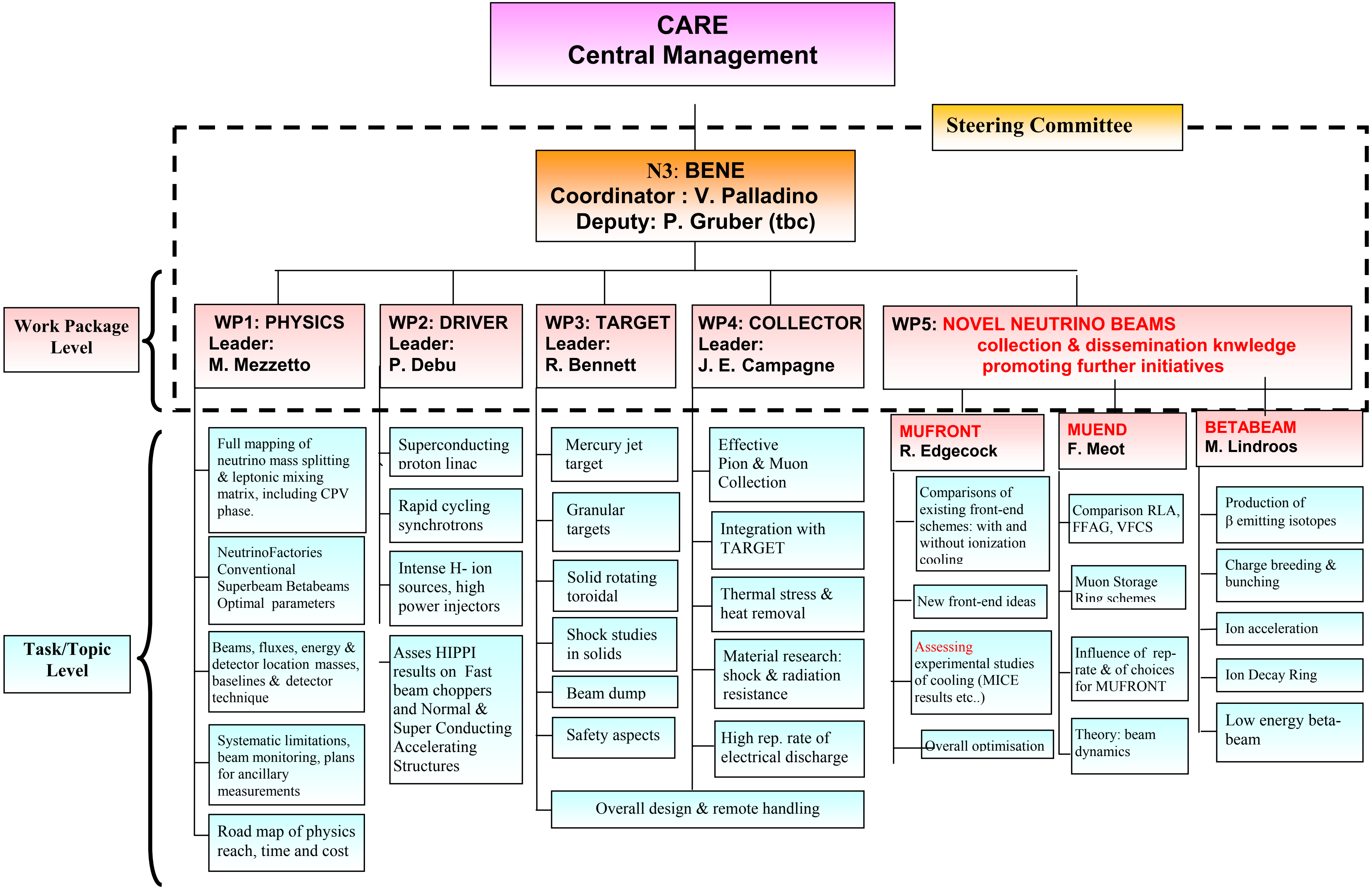

CARE
Central Management
Steering Committee
N3: BENE
Coordinator : V. Palladino
Deputy: P. Gruber (tbc)
Work Package Level
Task/Topic Level
WP1: PHYSICS
Leader:
M. Mezzetto
Full mapping of neutrino mass splitting & leptonic mixing matrix, including CPV phase.
NeutrinoFactories Conventional Superbeam Betabeams Optimal parameters
Beams, fluxes, energy & detector location masses, baselines & detector technique
Systematic limitations, beam monitoring, plans for ancillary measurements
Road map of physics reach, time and cost
WP2: DRIVER
Leader:
P. Debu
Superconducting proton linac
Rapid cycling synchrotrons
Intense H- ion sources, high power injectors
Asses HIPPI results on Fast beam choppers and Normal & Super Conducting Accelerating Structures
WP3: TARGET
Leader:
R. Bennett
Mercury jet target
Granular targets
Solid rotating toroidal
Shock studies in solids
Beam dump
Safety aspects
Overall design & remote handling
WP4: COLLECTOR
Leader:
J. E. Campagne
Effective Pion & Muon Collection
Integration with TARGET
Thermal stress & heat removal
Material research: shock & radiation resistance
High rep. rate of electrical discharge
WP5: NOVEL NEUTRINO BEAMS
collection & dissemination knwledge
promoting further initiatives
MUFRONT
R. Edgecock
Comparisons of existing front-end schemes: with and without ionization cooling
New front-end ideas
Assessing experimental studies of cooling (MICE results etc..)
Overall optimisation
MUEND
F. Meot
Comparison RLA, FFAG, VFCS
Muon Storage Ring schemes
Influence of rep-rate & of choices for MUFRONT
Theory: beam dynamics
BETABEAM
M. Lindroos
Production of β emitting isotopes
Charge breeding & bunching
Ion acceleration
Ion Decay Ring
Low energy beta-beam

Table 1.2- BENE

Task	deliverable
BENE Timetable of events	**deliverable**
BENE/ECFA Muon Week	participations & presentations, slides on www
NuFact International Workshop on Neutrino Factory & Superbeam	contributions to Workshop and Proceedings
General CARE Meeting	participations & presentations, slides on www
Additional BENE Topical Worskshops	Proceedings
PHYSICS Workshops (both outside Muon/BENE Weeks)	
DRIVER Workshops	
TARGET & COLLECTOR Workshops	
MUFRONT Workshops (one outside Muon/BENE Weeks)	
Joint Workshop of WP5 and WP6 (outside Muon/BENE weeks)	
BETABEAM Workshops (all three outside Muon/BENE weeks)	
BENE global tasks, activities & milestones	**deliverable**
define and propose new R&D projects	R&D Proposals during 2004
define and propose new JRP (addendum to CARE)	JRP Proposals Apr 05
preliminary comparative studies: first set of parameters in all sectors	**Interim BENE Reports Jun 05**
"Define Parameters & Road map to Conceptual Designs"	
Parameters for NuFact, Superbeam, Betabeam	
Parameters for design of both SPL and RCS	
Restrict target & collection choices	
Strategy of measurements with MICE and road map towards definition of cooling channel parameters	
Parameters for design of muon acceleration and storage	
Parameters for design of betabeam components	
organization of NuFact05 & Superbeam Int. Workshop	International Workshop in Europe & Proceedings
review R&D progress, define and propose new R&D projects	R&D Proposals during 05
update of comparative study of NuFact, Superbeam, Betabeam including specific choice SPL/RCS	Addendum to Interim Report June 06
update of comparative study of NuFact, Superbeam, Betabeam	Addendum to Interim Report June 07
define & propose a new large underground European detector in collaboration with the astroparticle community	Proposal Jul 07
final comparative studies and set of parameters in all sectors	**Final BENE Reports Jun 08**
"Status of Physics Studies & Conceptual Designs: Road Map to Technical Designs"	
NuFact, Superbeam, Betabeam: full comparative study of performance, cost and risk	
Status & Road Map to complete Technical Design of Driver	
Status & Road Map to complete Technical Design of Target & Collection	
Status & Road Map to complete Technical Design of cooling, acceleration & storage	
Status & Road Map to complete Technical Design of betabeam components	
organization of NuFact08 & Superbeam Int. Workshop	International Workshop in Europe & Proceedings
draft of final NA and WP reports	draft of final report Jun 05
completion of final general and WP reports	Final "Road Map" Report Dec 08

Table 1.2a-PHYSICS WP1

PHYSICS WP1 Timetable	deliverable
BENE/ECFA Muon Week	participation & presentations, slides on www
NuFact International Workshop on Neutrino Factory & Superbeam	participation & contributions to Workshop
General CARE Meeting	participation & presentations, slides on www
Monitor the development of the field of nu-physics	Neutrino Unbound Web site
Uniform comparison criteria of different beam & baseline & detector configurations	Organization of Workshop + Proceedings
Strategy to unambigous extraction of all neutrino oscillations parameters	Organization of Workshop + Proceedings
Complementarity & synergy between SuperBeam, BetaBeam and NuFact	Organization of Workshop + Proceedings
Proton driver energy: rates and background in a Super Beam	
Optimization of Nufact beam energy vs detector mass and total costs	
Beta Beam energy: signal, backgrounds and detector mass	
Other physics at a Nufact complex and Beta Beam complex: first summary	Reports
Preparation of interim (preliminary road map) report	Interim Report Jun 05
Optimized parameter list for SuperBeam, BetaBeam and NuFact	Organization of Workshop + Proceedings
SuperBeams/Beta Beams/NuFact: assessment of physics potentials	Organization of Workshop + Proceedings
Detectors vs beams: flux, energy, resolution, threshold, background, masses	Organization of Workshop + Proceedings
Identify and promote a series of ancillary experiments	Report
Define the requirements for beam monitoring vs systematic errors	Report
Close detectors at SuperBeam, BetaBeam and Nufact	Report
Other physics at a Nufact complex and Beta Beam complex: final review	Reports
Write final BENE and WP Road Map Reports	Layout / Draft / Final Reports

Table 1.2b-DRIVER WP2

Task	deliverable
DRIVER WP2 Timetable	**deliverable**
BENE/ECFA Muon Week	participation & presentations, slides on www
NuFact International Workshop on Neutrino Factory & Superbeam	participation & contributions to Workshop
General CARE Meeting	participation & presentations, slides on www
launch working group activities	chart of work organization
assess preliminary HARP results	preliminary report on choice of driver energy
SPL vs RCS: define criteria of comparative study	chart of terms of comparison
review HIPPI JRP yearly status report	report & recommendations
perform preliminary SPL vs RCS comparison	preliminary report Jun 05
first revision of R&D plans	revised plan
assess final HARP results	final report on choice of driver energy
review HIPPI JRP yearly status report	report & recommendations
perform final SPL vs RCS comparison	final report on SPL/RCS choice Jun 06
assemble results of the studies for most components	report
preparation of Driver Workshop	Workshops Jul 06 with Proceedings
revision of status of the studies of components and of R&D plans	revised plan
review HIPPI JRP yearly status report	report & recommendations
preparation of Driver Workshop	Workshops Jul 07 with Proceedings
revision of status of the studies of components and of R&D plans	revised plan
review HIPPI JRP yearly status report	report & recommendations
prepare draft of final chapter on the status of driver design,	draft of chaptere of final report
preparation of Driver Workshop	Workshops jul 08 with Proceedings
finalize final chapter on the status of driver design	chapter of final report

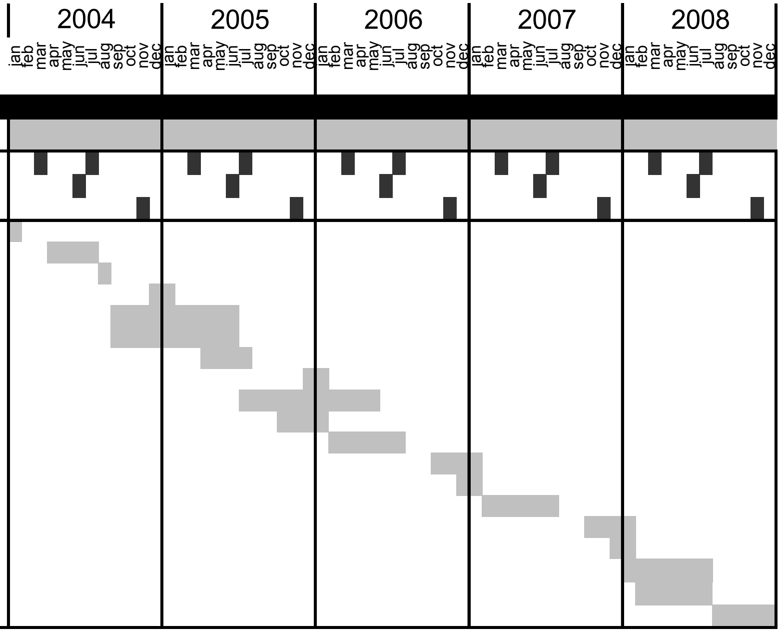


Table 1.2c-TARGET WP3

Task	deliverable
TARGET WP3 Timetable	**deliverable**
BENE/ECFA Muon Week	participation & presentations, slides on www
NuFact International Workshop on Neutrino Factory & Superbeam	participation & contributions to Workshop
General CARE Meeting	participation & presentations, slides on www
Meeting of Network Target and Collector Sections	Minutes of Target & Collector Sections
Launch network section activities	Chart of work organisation
Prepare web page	Web Page
Review current status on high power targets (not just neutrino)	Status reports
identify nature, location & first list of experiments for a Target Test Area (TTA)	
define and propose a Target Test Area as part of a Design Study	Proposal during 2004
Define plan towards full investigation of safety issues	Report
Review overall "target station" design (including beam dump)	Report
International Workshop on Targets and Collectors	Organisation of Workshop & Proceedings
Assess the merits of the various target schemes	Report
Decide which target schemes to continue R&D	Report and recommendations
Decide if additional Design Study needed	Initiate addendum
Review Target R&D and Plans	Report & Revised Plan
Possible addendum to Design Study	Possible addendum to Design Study
Review progress of Target R&D	Report
Review progress on Safety Issues	Report
Review progress on "Target Station"	Report
Define specific SuperBeam solutions (optimal pion collection)	Report on SuperBeam solutions
Review Target R&D and Plan	Report and Revised Plan
International Workshop on Targets and Collectors	Organisation of Workshop & Proceedings
Review progress on Target Design	Report & Revised Plan
Review progress on Safety Issues and "Target Station" Design	Report
Define specific NuFact solutions (optimal muon collection)	Report on NuFact solutions
Revise Plans	Revised Plan
Review achievements and suggest future plans	Report and recommendations
Write final BENE and WP Road Map Reports	Layout / Draft / Final Reports

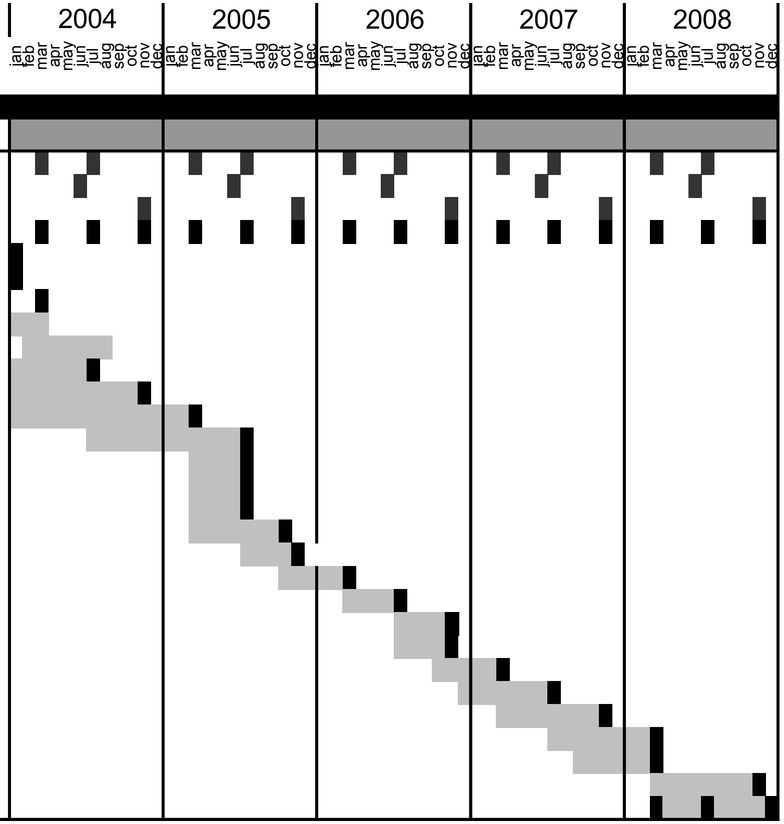


Table 1.2d-COLLECTOR WP4

Task	deliverable	2004	2005	2006	2007	2008
COLLECTOR WP4 Timetable	**deliverable**					
BENE/ECFA Muon Week	participation & presentations, slides on www					
NuFact International Workshop on Neutrino Factory & Superbeam	participation & contributions to Workshop					
General CARE Meeting	participation & presentations, slides on www					
Official Creation of the Europeen Network						
Evaluate progress on power supply design	yearly status report					
Evaluate progress on irradiated material properties	yearly status report					
Evaluate progress on studies of mechanical and thermal stresses	yearly status report					
identify nature, location & first list of experiments for a Collector Test Facility (CTF)						
propose an European CTF as part of a Design Study	Proposal during 2004					
1st International Conference on Targets and Collectors	Organisation of Workshop & Proceedings					
identify additional experiments in CTF	Possible addendum to CTF Proposal					
Review progress of CTF	Report					
Define specific SuperBeam solutions (pion collection)	Report					
2nd International Conference on Targets and Collectors	Organisation of Workshop & Proceedings					
Define specific NuFact solutions (muon collection)	Report					
Final Report	Layout / Draft / Final Reports					

Table 1.2e- NOVEL NEUTRINO BEAMS WP5

Task	deliverable
FUTURE WP5 Timetable	**deliverable**
BENE/ECFA Muon Week	participation & presentations, slides on www
NuFact International Workshop on Neutrino Factory & Superbeam	participation & contributions to Workshop
General CARE Meeting	participation & presentations, slides on www
Formation of expanded EU WP	Team to work on Design Studies
First review of existing designs	Initial report on existing designs
Start learning phase for new people	
Determine R&D and other work required to select optimum scenaria	
Write R&D proposals	R&D proposals
Organize and hold workshops for dissemination	Proceedings of workshops
Define, draft and complete chapter for final report	Layout / Draft / Final Reports

2004 2005 2006 2007 2008 (jan feb mar apr may jun jul aug sep oct nov dec)

Table 2a: BENE-Partners Institute	Acronym	Country	Coordinator	BENE Scientific ontact	Associated to
INFN-Frascati	INFN-LNF	I	S. Guiducci	M. Migliorati	INFN
INFN-Bari	INFN-Ba	I	S. Guiducci	G. Catanesi	INFN
INFN-Genova	INFN-Ge	I	S. Guiducci	P. Fabbricatore	INFN
INFN-Gran Sasso	INFN-GS	I	S. Guiducci	O. Palamara	INFN
INFN-Legnaro	INFN-LNL	I	S. Guiducci	U. Gastaldi	INFN
INFN-Milano	INFN-Mi	I	S. Guiducci	M. Bonesini	INFN
INFN-Napoli	INFN-Na	I	S. Guiducci	V. Palladino	INFN
INFN-Padova	INFN-Pa	I	S. Guiducci	M. Mezzetto	INFN
INFN-Pisa	INFN-Pi	I	S. Guiducci	A. Strumia	INFN
INFN-Roma3	INFN-Ro3	I	S. Guiducci	D. Orestano	INFN
INFN-Torino	INFN-To	I	S. Guiducci	C. Giunti	INFN
INFN Trieste	INFN-Tr	I	S. Guiducci	G. Giannini	INFN
CERN	CERN	CH	H. Haseroth	H. Haseroth	
Fermi National Accelerator Laboratory	FNAL	USA	H. Haseroth	S. Geer	CERN
Brookhaven National Laboratory	BNL	USA	H. Haseroth	B. Palmer	CERN
Lawrence Berkeley National Laboratory	LBL	USA	H. Haseroth	M. Zisman	CERN
University of Osaka	UnO	J	H. Haseroth	Y. Kuno	CERN
Université de Geneve	UNI-GE	CH	A.Blondel	A. Blondel	
Universitat Bern	UNI-Bern	CH	A.Blondel	K. Pretzl	UNI-GE
Université de Neuuchatel	UNI-Neuchatel	CH	A.Blondel	J.L Villeumier	UNI-GE
Physik Institut Universitat Zurich	PIUZ	CH	A.Blondel	A.Vanderschaaf	UNI-GE
Paul Scherrer Institute	PSI	CH	V. Schlott	K. Thomsen	
CCLRC Daresbury & Rutherford Appleton	CCLCR	UK	P. Norton	P. Norton	
Imperial College London	ICL	UK	K. Long	K. Long	
University of Bath	BAT	UK	K. Long	D. Roger	ICL
Brunel University	BRU	UK	K. Long	P. Kyberd	ICL
University of Cambridge	CAM	UK	K. Long	R. Batley	ICL
University of Durham	DUR	UK	K. Long	S. Davidson	ICL
University of Edinbourgh	EDIN	UK	K. Long	A. Khan	ICL
University of Glasgow	GLA	UK	K. Long	P. Soler	ICL
University of Liverpool	ULI	UK	K. Long	J. Dainton	ICL
University of Oxford	UOX	UK	K. Long	J. Cobb	ICL
University of Sheffield	SHEF	UK	K. Long	C. Booth	ICL
Queen Mary Univ. London	QMUL	UK	K. Long	P. Harrison	ICL
University of Southampton	SOTON	UK	K. Long	S. King	ICL
University of Sussex	SUSS	UK	K. Long	D. Wark	ICL
FZ Jüelich	FZJ	D	R. Tölle	G. Bauer	
NRG Petten Nederlands	NRG	NE	R. Tölle	E. Komen	FZJ
Institute of Physics, Univ. of Latvia	IPUL	Latvia	R. Tölle	J. Freibergs	FZJ
Gesellschaft fur Schwerionenforschung	GSI	D	N. Angert	B. Franzke	
Technical University Munich	TUM	D	M. lindner	M. Lindner	
CEA/DSM/DAPNIA	CEA	F	R. Aleksan	P. Debu	
CNRS-IN2P3	CNRS IN2P3	F	T. Garvey	S. Katsanevas	CNRS
CNRS-IN2P3-Orsay	CNRS Orsay	F	T. Garvey	J. E. Campagne	CNRS
CNRS-IN2P3-Lyon	CNRS Lyon	F	T. Garvey	D. Autiero	CNRS
CNRS-IN2P3-Grenoble.	CNRS ISN	F	T. Garvey	J.M. de Conto	CNRS
CNRS Université Paris 6&7	CNRS LPHNE	F	T. Garvey	J. Dumarchez	CNRS
CENBordeaux Gradignan	CNRS CENBG	F	T. Garvey	C. Marquet	CNRS
University of Barcelona	UBa	SP	A. Faus-Golfe	F. Sanchez	CSIC
University of Valencia	IFIC	SP	A. Faus-Golfe	J.J. Gomez Cadenas	CSIC
Universidad Autonoma de Madrid	UAM	SP	A. Faus-Golfe	B. Gavela	CSIC
Universite Catholique de Louvain la Neuve	UCLN	B	T. Delbar	T. Delbar	

Table2b: Work Packages

Participant	PHYSICS	DRIVER	TARGET	COLLECTOR	MUFRONT	MUEND	BETABEAM
INFN-LNF	X				X	X	
INFN-Ba	X				X		
INFN-Ge				X	X		
INFN-GS	X						
INFN-LNL	X	X			X		
INFN-Mi	X				X		X
INFN-Na	X				X		X
INFN-Pa	X				X		X
INFN-Pi	X						
INFN-Ro3	X				X		
INFN-To	X						
INFN-Tr	X				X		
CERN	X	X	X	X	X	X	X
FNAL	X	X	X	X	X	X	
BNL	X	X	X	X	X	X	
LBL	X				X	X	
UnO	X	X	X	X	X	X	
UNI-GE	X		X	X	X	X	X
UNI-Bern	X						
UNI-Neuchatel	X						
PIUZ	X				X		
PSI			X				
CCLCR	X	X	X	X	X	X	
ICL	X				X		
BAT	X		X				
BRU	X				X		
CAM	X						
DUR	X						
EDIN	X						
GLA	X				X		
ULI	X				X		X
UOX	X		X		X		
SHEF	X		X		X		
QMUL	X						
SOTON	X						
SUSS	X						
FZJ		X	X				
NRG			X				
IPUL			X				
GSI							X
TUM	X						X
CEA	X	X	X	X	X	X	X
CNRS IN2P3	X						
CNRS Orsay	X			X		X	
CNRS Lyon	X			X			
CNRS ISN						X	
CNRS LPHNE	X			X			
CNRS CENBG	X						
UBa	X						
IFIC	X						
UAM	X						
UCLN	X				X		X

Table 2c: Participant field of expertise

Participant	Competences and interest
INFN-LNF	High Energy, Neutrino and Nuclear Physics Experiments, Construction and operation of electron and positron Particle Accelerators and Colliders, Beam Dynamics, Accelerator Diagnostics and Controls, Computing, Networking, Synchrotron Radiation Sources, FEL. Muon cooling and muon acceleration.
INFN-Ba	Neutrino physics, hadroproduction data, muon cooling studies
INFN-Ge	Design of superconducting magnets. Finite element analyses. Electrical transport measurements on superconducting wires and cables. AC loss measurements on superconducting devices. Muon Cooling. Collection magnets.
INFN-GS	Neutrino physics, main exploitation laboratory of the CNGS and of future facilities.
INFN-LNL	SRF accelerator design and construction (ALPI). Chemistry and Electrochemistry Material surface treatments; Plastic deformation of materials and forming technology; Clean room (HPR and mounting); Thin film technology and PVD machine construction; Non destructive evaluation techniques, in particular flux gate magnetometry. Proton driver technology. Injection issues.
INFN-Mi	Design, construction and test of superconducting (SC) cavities for electrons and protons and of SC magnets for accelerators and detectors. High current proton beam dynamics; cryostat and cryomodule design and construction; photocathode and laser for high brightness photoinjector; SC cable and material low temperature characterization; SC magnet protection system design, and test; accelerator remote operation (GAN). Robust electron sources and laser pulse shaping. Neutrino physics, hadroproduction data, muon cooling studies
INFN-Na	Neutrino physics and beams, hadroproduction data, cooling studies. Long term expertise in theoretical and experimental accelerator physics
INFN-Pa	Neutrino physics and beams, hadroproduction data, muon cooling studies
INFN-Pi	Neutrino physics, phenomenology and theory
INFN-Ro3	Neutrino physics, hadroproduction data, muon cooling studies
INFN-To	Neutrino physics, phenomenology and theory
INFN-Tr	Neutrino physics, hadroproduction data, muon cooling studies
CERN	High energy Physics Accelerators and Experiments, Nuclear Physics accelerators including heavy ions and antiproton decelerator, Superconducting Cavities, Superconducting Magnets, Accelerator Controls, Computing, Networking, Video Communication Tools, Linear colliders, Photocathodes, Neutrino Factories, High Intensity Proton Machines, Ion Sources. Neutrino Phyiscs and Experiments.

FNAL	Expertise in SC hadron collider integration and operation. Design and construction of accelerator magnets, test of magnets. Specific experience in high field A15 accelerator magnets R&D, design of innovative solution of VLHC (like the handling of synchrotron radiation). Radiation shielding calculations. Design work on linear colliders of SC and NC technology. Leading institution in the US Muon Collider and NuFact Collaboration.
BNL	Expertise in SC hadron collider integration and operation, Accelerator Magnets design and construction, cable design, and test; recent development for cycling SC magnets and HTS special designed magnets. Leading institution in the US Muon Collider and NuFact Collaboration.
LBNL	Expertise in SC magnets for accelerators and wide experience in very high field design and construction technique. Test of SC magnets. Reference centre for cabling of Rutherford cable and of A15 and HTS development and test for accelerators. Leading institution in the US Muon Collider and NuFact Collaboration.
UnO	Neutrino and muon physics, accelerators, experiments, theory. Leading institution in the NuFACTJ Collaboration.
UNI-GE	Leading a consortium of physicists from Swiss Universities contributing long-term expertise in the field of neutrino physics, experiments & beams (design, detailed simulation, operation and analysis of their data), expertise in horn technology and in the field of intense low energy muon beams and leadership in the experimental studies of muon ionisation cooling. It will contribute to the general steering and to the PHYSICS, TARGET, HORN, COOLING WPs.
UNI-Bern	Experimental neutrino physics
UNI-Neuchatel	Experimental neutrino physics
PIUZ	Muon beams and muon experiments. High power beams and targets
PSI	Development, construction and operation of electron and proton accelerators (linear accelerators, synchrotrons, storage rings and cyclotrons) for synchrotron radiation, nuclear, atomic and applied physics experiments. Development and operation of (digital) feedback systems for particle beam stabilization and RF-control. Research and development of accelerator instrumentation and data processing electronics.
CCLRC	Rutherford Appleton Laboratory: Expertise in particle physics; accelerator physics and technology, interest in high power pulsed proton beams and accerators; high power pulsed laser laser design and plasmas, interest in photo injectors and laser acceleration; high power target technology; superconducting magnets technology. Have a high intensity pulsed proton accelerator for neutron production (ISIS) with a high power target. Neutrino physics, muon ionization cooling, proton drivers, expertise with high power targets.
ICL	Particle Physics experimentation, machine-experiment interface in experiments, electronics, muon cooling design, high gradient electron and ion acceleration techniques using laser-produced plasmas, diagnostic techniques, theoretical modelling of laser-plasma interactions. Neutrino physics, muon ionization cooling,
BAT	Electromagnetic levitation

BRU	Particle Physics experiments, computing and software, ionisation cooling studies.
CAM	Particle Physics experiments, neutrino physics studies.
DUR	Neutrino physics studies
EDIN	Particle Physics experiments, computing and software, ionisation-cooling studies.
GLA	Particle Physics experiments, computing and software, ionisation cooling studies
ULI	Neutrino physics studies, ionisation muon cooling studies.
UOX	Particle Physics experimentation, neutrino physics studies, ionisation cooling studies.
SHEF	Particle physics experimentation, neutrino physics studies, mechanical aspects of targetry, ionisation muon cooling studies.
QMUL	Neutrino physics studies.
SOTON	Neutrino physics studies
SUSS	Particle Physics experimentation, neutrino physics studies.
FZJ	Medium energy physics accelerators and experiments, reliability of operation; polarized protons; stochastic cooling, electron Cooling; electron beam welding; remote accelerator control and automation, design of superconducting accelerating structures, design of high intensity and high energy accelerators. Expertise with high power targets
NRG	NRG is experienced in fluid dynamics, structural mechanics and thermal hydraulics calculations and in developing suitable computer software
IPUL	IPUL has many years of expertise in designing and operating liquid metal loops and in developing necessary equipment and technologies
GSI	Nuclear, atomic, plasma, and applied physics experiments with heavy ion beams, dynamics of high current beam transport and acceleration, development, design, construction and operation of heavy ion sources, linear and circular accelerators, storage rings, stochastic and electron cooling of stored beams, remote accelerator controls, computing, networking. Neutrino betabeams.
TUM	Long term expertise in the field of neutrino and muon physics and experiments. It will contribute to the general steering and studies of the PHYSICS potential of future long baseline experiments. The studies aim at guiding the exploration, planning and construction of conceivable set-ups by identifying the capabilities and the crucial components and limitations.
CEA	High Energy and Nuclear Physics, Research, Development, Construction and operation of Particle Accelerator (Beam dynamics, Superconducting RF Technologies, High Magnetic Field technologies), Computing, remote operation systems Proton Drivers, Muon acceleration, neutrino physics, neutrino Betabeams and Superbeams
CNRS IN2P3	Neutrino Physics and experiments

CNRS Orsay	RF guns, accelerator construction, room temperature and super-conducting cavities, RF power couplers, beam simulations, analytic modelling, and electromagnetic simulations. Pion and muon collection, neutrino experiments.
CNRS Lyon	Neutrino Physics and experiments
CNRS ISN	Ions sources. Accelerator design, construction and operation (GENEPI accelerator, IPHI collaboration).
CNRS LPHNE	Neutrino Physics and experiments
CNRS CENBG	Neutrino experiments
Uba	Experimental neutrino physics
IFIC	Design optics, modelling of machine imperfections and beam based measurements
UAM	Recognized leadership in the field of theory and phenomenology of neutrinos
UCLN	High Energy and Nuclear Physics, Research, Development, Construction and operation of Particle Accelerator (ECR ion sources, cyclotrons, radioactive targets and radioactive beams). Neutrino physics, hadroproduction, muon ionization cooling, betabeams.

Table 3: Detailed expected and requested budget breakdown.
(The sums do not include UNI-GE and PSI, participants from Switzerland)

Participant	Cost Model	PHYSICS		DRIVER		TARGET		COLLECTOR		NOVEL NEUTRINO BEAMS *a) MUFRONT*		*b) MUEND*		*c) BETABEAM*		TOTAL SUM (KEuros)	
		Exp	Req	Exp	Req	Exp	Req	Exp	Req	Exp	Req	Exp	Req	Exp	Req	**Exp** (Participants)	**Req**
INFN	AC 92,9	131	46,4	39	13,9	0	0,0	0	0,0	26	9,3	26	9,3	39	13,9	**262** (38)	**92,9**
CERN	AC 57,8	23	8,3	35	12,4	23	8,3	47	16,5	12	4,1	12	4,1	12	4,1	**163** (22)	**57,8**
UNI-GE	AC 33,0	27	9,4	0	0,0	20	7,1	27	9,4	7	2,4	0	0,0	13	4,7	**93** (14)	**0,0**
PSI	AC 6,2	2	0,9	0	0,0	15	5,3	0	0,0	0	0,0	0	0,0	0	0,0	**17** (3)	**0,0**
CCLRC	FC 43,3	26	9,3	28	9,9	35	12,4	9	3,1	21	7,4	3	1,2	0	0,0	**122** (17)	**43,3**
ICL	AC 74,3	60	21,2	39	13,8	69	24,4	0	0,0	36	12,7	6	2,1	0	0,0	**209** (36)	**74,3**
FZJ	FC 33,0	13	4,7	20	7,1	60	21,2	0	0,0	0	0,0	0	0,0	0	0,0	**93** (16)	**33,0**
GSI	FC 10,3	4	1,5	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	25	8,9	**29** (5)	**10,3**
TUM	AC 10,3	29	10,3	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	**29** (5)	**10,3**
CEA	FC 47,5	29	10,2	38	13,6	10	3,4	19	6,8	10	3,4	19	6,8	10	3,4	**134** (21)	**47,5**
CNRS	FC 33,0	37	13,2	0	0,0	0	0,0	45	16,0	0	0,0	11	3,8	0	0,0	**93** (14)	**33,0**
CSIC	AC 37,2	75	26,5	0	0,0	0	0,0	0	0,0	0	0,0	0	0,0	30	10,6	**105** (18)	**37,2**
UCLN	AC 6,2	6	2,1	0	0,0	0	0,0	0	0,0	6	2,1	0	0,0	6	2,1	**17** (3)	**6,2**
SUM per WP(KEuros)	445,9	**462**	**153,7**	**199**	**70,7**	**231**	**69,7**	**146**	**42,4**	**117**	**39,0**	**77**	**27,3**	**135**	**43,0**	**1367** (212)	**445,8**

Table needed to calculate quantities in the A3 forms and then to disappear

		(22)	**57,8**	130,3	32,6	162,8	57,8	39,1	9,8	48,9	17,3
UNI-GE	**93**	(14)	**33,0**	74,4	18,6	93,0	33,0	22,3	5,6	27,9	9,9
PSI	**17**	(3)	**6,2**	13,9	3,5	17,4	6,2	4,2	1,0	5,2	1,9
CCLRC	**122**	(17)	**43,3**	97,7	24,4	122,1	43,3	29,3	7,3	36,6	13,0
ICL	**209**	(36)	**74,3**	167,5	41,9	209,3	74,3	50,2	12,6	62,8	22,3
FZJ	**93**	(16)	**33,0**	74,4	18,6	93,0	33,0	22,3	5,6	27,9	9,9
GSI	**29**	(5)	**10,3**	23,6	5,9	29,5	10,3	7,1	1,8	8,8	3,1
TUM	**29**	(5)	**10,3**	23,6	5,9	29,5	10,3	7,1	1,8	8,8	3,1
CEA	**134**	(21)	**47,5**	107,0	26,8	133,8	47,5	32,1	8,0	40,1	14,2
CNRS	**93**	(14)	**33,0**	74,4	18,6	93,0	33,0	22,3	5,6	27,9	9,9
CSIC	**105**	(18)	**37,2**	83,7	20,9	104,7	37,2	25,1	6,3	31,4	11,1
UCLN	**17**	(3)	**6,2**	13,9	3,5	17,4	6,2	4,2	1,0	5,2	1,9
			445,900								
				1005,300	251,325	1256,625	445,900				133,770

New Table for Annex1

Participant	Role in BENE (N3)
INFN	A consortium of physicists from several Italian laboratories. Contributions will come from expertise in: Neutrino and Particle Physics Experiments. Hadroproduction . Muon cooling and muon acceleration. Long term expertise in theoretical and experimental accelerator physics. Leadership in the sector of neutrino betabeams
CERN	Contributions will come from expertise in: High energy Physics Accelerators and Experiments, Nuclear Physics accelerators including heavy ions and antiproton decelerator, Superconducting Cavities, Superconducting Magnets, Accelerator Controls, Computing, Networking, Video Communication Tools Neutrino Factories, High Intensity Proton Machines, Ion Sources. Neutrino Phyiscs and Experiments.
UNI-GE	Leading a consortium of physicists from Swiss Universities. Contributions will come from expertise in: Neutrino physics, experiments & beams (design, detailed simulation, operation and analysis of their data), expertise in horn technology and in the field of intense low energy muon beams and leadership in the experimental studies of muon ionisation cooling. It will contribute to the general steering and to the most WPs.
PSI	Contributions will come from expertise in: Development, construction and operation of electron and proton accelerators (linear accelerators, synchrotrons, storage rings and cyclotrons) for synchrotron radiation, nuclear, atomic and applied physics experiments. Development and operation of (digital) feedback systems for particle beam stabilization and RF-control. Research and development of accelerator instrumentation and data processing electronics.
CCLRC	Contributions will come from:Rutherford Appleton Laboratory expertise in particle physics; accelerator physics and technology, interest in high power pulsed proton beams and accerators; high power target technology; superconducting magnets technology. Have a high intensity pulsed proton accelerator for neutron production (ISIS) with a high power target. Neutrino physics, muon ionization cooling, proton drivers, expertise with high power targets.
ICL	Leading a consortium of physicists from UK Universities. Contributions will come from expertise in: Particle Physics experimentation, machine-experiment interface in experiments, electronics, muon cooling design, high gradient electron and ion acceleration techniques using laser-produced plasmas, diagnostic techniques, theoretical modelling of laser-plasma interactions. Neutrino physics, muon ionization cooling.
FZJ	Contributions will come from expertise in: Medium energy physics accelerators and experiments, reliability of operation; polarized protons; stochastic cooling, electron cooling; electron beam welding; remote accelerator control and automation, design of superconducting accelerating structures, design of high intensity and high energy accelerators. Expertise with high power targets
GSI	Contributions will come from expertise in: Nuclear, atomic, plasma, and applied physics experiments with heavy ion beams, dynamics of high current beam transport and acceleration, development, design, construction and operation of heavy ion sources, linear and circular accelerators, storage rings, stochastic and electron cooling of stored beams, remote accelerator controls, computing, networking. Neutrino betabeams.

TUM	Contributions will come from expertise in: Neutrino and muon physics and experiments. It will contribute to the general steering and studies of the PHYSICS potential of future long baseline experiments. The studies aim at guiding the exploration, planning and construction of conceivable set-ups by identifying the capabilities and the crucial components and limitations. Active in the effort of attracting interest in more German laboratories
CEA	Contributions will come from expertise in: High Energy and Nuclear Physics, Research, Development, Construction and operation of Particle Accelerator (Beam dynamics, Superconducting RF Technologies, High Magnetic Field technologies), Computing, remote operation systems Proton Drivers, Muon acceleration, neutrino physics, neutrino Betabeams and Superbeams
CNRS IN2P3	A consortium of physicists from several French laboratories. Contributions will come from expertise in: Neutrino Physics and experiments. RF guns, accelerator construction, room temperature and super-conducting cavities, RF power couplers, beam simulations, analytic modelling, and electromagnetic simulations. Pion and muon collection. Ions sources. Accelerator design, construction and operation
CSIC	A consortium of physicists from several Spanish laboratories. Design optics, modelling of machine imperfections and beam based measurements. Experimental neutrino physics. Recognized leadership in the field of theory and phenomenology of neutrinos
UCLN	Contributions will come from expertise in:High Energy and Nuclear Physics, Research, Development, Construction and operation of Particle Accelerator (ECR ion sources, cyclotrons, radioactive targets and radioactive beams). Neutrino physics, hadroproduction, muon ionization cooling, betabeams. It will aim at attracting interest in more Belgian laboratories.