



CARE BENE Network: Yearly Report 2005

the BENE Steering Group

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N2 : Beams in Europe for Neutrino Experiments (BENE)

BENE is the CARE network for Beams for European Neutrino Experiments. It comprises 13 countries. The table of the participants and their implication in the BENE Work Packages is given in the table below. The overall management is done by INFN-Na. A new Deputy Coordinator is being searched. .

Participant number	Participant	PHYSICS	DRIVER	TARGET	COLLECTOR	NOVEL NEUTRINO BEAMS
1	CEA	X	C	X	X	C
2	UCLN	X				X
3	CNRS	X			C	X
	CNRS-Orsay	X			C	X
	CNRS-LPNHE	X			X	
	CNRS-CENBG	X				
	CNRS-IPNL	X			X	
	CNRS-LPSC					X
	CNRS-IReS	X			X	
4	GSJ					X
7	FZJ		X	X		
8	TUM	X				X
10	INFN	C	X	X	X	X
	INFN-LNF	X				X
	INFN-Ba	X				X
	INFN-Ge					X
	INFN-GS	X				
	INFN-LNL	X	X			X
	INFN-Mi	X				X
	INFN-Na	X				X
	INFN-Pa	C				X
	INFN-Pi	X				
	INFN-Tr	X				X
	INFN-Ro3	X				X
	INFN-To	X				
16	CSIC	X				
	UBa	X				
	IFIC	X				
	UAM	X				
17	CERN	X	X	X	X	C
18	UNI-GE	X		X	X	X
19	PSI			X		
20	CCLCR	X	X	C	X	C
	CCLRC-RAL	X	X	C	X	C
21	ICL	X		X		X

During 2005, the BENE¹ Network has

1) significantly **tightened its international role and connection**, manifestly essential for any new EU accelerator neutrino complex to be conceivable. We have attracted and welcome in

¹ BENE's mandate is that to promote clear awareness, in our particle physics peer community, a) the physics interest of superior accelerator neutrino beams (superbeams, betabeams, neutrino factories) b) the promising on-going developments of accelerator technology that will make them possible c) the opportunities that exist to plan, fund and realize, on a realistic time scale, a much enhanced European accelerator neutrino complex .

Europe, in two workshops, held in April (NNN05) and in June (NuFact05), the full international community working toward superior accelerator neutrino beams

2) **launched** the next natural step in our feasibility study and R&D program, a **one year International Scoping Study (ISS) on Neutrino Factories and Superbeams**, to be completed by August 2006. The study has gained its first momentum at its first working international meeting at CERN Sep 22-24 and is preparing its next meeting in Japan in January. This is a decisive step in the preparation of the Proposal for a complete FP7 Design Study, see below.

3) **achieved its Midterm Scientific Report, being published as a CERN Yellow Report**, based on the state-of-the-art summaries reports presented at NuFact05 & NNN05. It was presented to CARE05 in November. It is being submitted to the CERN Council Strategy Group and to ECFA. It summarizes the state of advancement of our initiative, reviewing progress and proposing a preliminary road map towards a superior European accelerator neutrino facility to be built in the coming decade.

The key events of 2005, besides **the traditional BENE05 last meeting of the year**, within the CARE05 event, where serious discussions and the assembly of a continental collaboration towards an FP7 Design Study have resumed, have been:

1) the **NNN05 Workshop on Next Nucleon decay & Neutrino** detector held in Aussois, France, Apr 7-9, that reviewed the physics case and the technical challenges of very large mass detectors and further structured the international collaboration towards their realization

2) the **NuFact05 International Workshop, the 7th International Workshop on Neutrino Factories & Superbeams**, held in Frascati, Jun 21-26, that reviewed thoroughly the status of the field, physics, accelerators, detectors, including betabeams, and formally launched the ISS.

This corresponds to the present status of the physics prospects that BENE tries to promote. **Two main physics strategies have been consolidating** over the last few years:

- 1) use of the **high** neutrino rate ($>10^{20}$ /year) and **energy** (10-50 GeV) promised by the **Neutrino Factory**, in conjunction with a detector of large but not huge mass (50-100 Kt), necessarily magnetic (a dense magnetized iron detector, or, possibly, Li-Argon), a few 1000 Km away.
- 2) use of the **lower** neutrino rate (10^{18-19} /year) and **energy** (sub-GeV) offered by a **Betabeam**, in conjunction with a low density detector of very large mass (0.5-1 Mt) and volume, non magnetic (a Water Cerenkov detector, or possibly, again Li-Argon), a few 100 Km away. This is the same detector needed to extend the search for nucleon instability, supernovae and other astrophysical phenomena.

A first level of comparison has concluded that the two options have comparable merits. The second option appears to have somewhat lower performance, for neutrino oscillation physics, but offers also a synergy with other fundamental sectors of physics, related to neutrinos (as super-nova, atmospheric or solar neutrino detection) or not (as proton lifetime).

These preliminary conclusion are based on still not well agreed yardsticks and must now be re-scrutinized much more in depth.

The two strategies are also, to large extent, complementary. Both are and must be pushed very actively. We are confident that international collaboration can bring about, in due time, both type of facilities and we should seriously aim at hosting one of them in Europe.

NB It should be, however, kept in mind that more recently proposed, intermediate solutions with **higher energy** and higher rate **betabeams**, very attractive though possibly more difficult, deserve indeed continued attention.

Superbeams are less performing, per se. But they do offer a technical synergy with Neutrino Factories and a scientific synergy with Betabeams. So they **are likely to be integrated in both strategies** and be available at a rather early stage.

A superbeam facility technically largely coincides with the front end of a Factory. High power is the crucial keyword. If one solves the technical challenges presented by a several MegaWatt class proton driver and target and collection system, on the way to build a factory, a superbeam facility will be available essentially for free and usable in conjunction with a large volume detector built for astroparticle physics.

A betabeam and superbeam can instead use together this same detector and their combination has some truly unique features. The oscillation signal is $\nu_e \rightarrow \nu_\mu$ in the first, $\nu_\mu \rightarrow \nu_e$ in the second, so that one calibrates the signal (and the background) of the other. T-reversal and CPT asymmetries, probably not accessible to a factory, can be measured.

Neutrino Betabeams are the subject of a complete 4 years Design Study that was approved in 2004, will last from 2005 to 2008 and produce a Conceptual Design Report (CDR) by early or mid 2009.

The ISS intends to bring Neutrino Factory and Superbeam to the same level of progress with respect to EC. The goal of the ISS is to prepare a longer and more in depth, full blown Design Study, so to have a CDR ready by 2010 or so in this sector too.

A proposal for a new superior neutrino facility will become thus possible, based on these two CDRs, at about the right time for new major investments in particle physics. When presumably LHC expenditures will be completed, its first results available and a decision on the ILC taken.

More generally, the process started by BENE with the [“Physics with a multi MegaWatt proton source” Workshop at CERN](#), in May 2004, described in the 1st CARE/BENE annual report, has continued. The SPSC recommendations, following our participation to its strategic meeting in Villars, have been published and confirm a strong support for a new accelerator neutrino initiative in Europe. ECFA support has also been warm and constant. All this is most welcome, as the present time seems to be preparing important decisions.

The CERN Council has scheduled the preparation of a road map for particle physics in Europe. A task force (appointed with members of the SPC, of ECFA and of representatives of the countries) will collect all the necessary inputs from the different communities and submit a draft road map document. A final document should emerge from a special session of the Council late in July.

This is likely to be the beginning of a global process, a few years long, hopefully heading towards a round of major decisions in 2010 or so. Before that, a preliminary round of smaller investments may come around 2007.

CERN has set up task forces that will look into its options for proton accelerator of the future (PAF) and into the physics opportunities of those future proton accelerators (POFPA). Those forces will have the decisive task of designing the best possible proton complex capable of best serving LHC and its upgrades, an ambitious neutrino program, some frontier aspects of kaon, muon and other fixed target physics, the nuclear physics of radioactive ion beams and possibly more.

BENE is making and strengthening its case in this general context. The immediate goal is the one of assembling a strong collaboration around the ISS, clustering the EU effort around an initially small but freshly re-motivated CERN task force and heading resolutely towards an FP7 Design Study.

During 2006, BENE plans will be strongly pushing the ISS and assembling the continental collaboration necessary to propose and conduct the FP7 Design Study.

The main appointments in 2006 are the 2nd ISS meeting at KEK Jan 23-25, the first BENE week in the UK in conjunction with the 3rd ISS meeting Apr 24-29, the NuFact06 Workshop in Irvine where the ISS will give its conclusions and the traditional BENE06 meeting in conjunction with CARE06. An additional shorter BENE meeting may take place at CERN in September.

N2.1 MEETINGS

The major events organized or co-organized by BENE in 2005 were:

1) [the 1st BENE Week Mar 16-18](#). This was the regular week of meetings of BENE related work packages, study groups and R&D projects. We had first a parallel meetings of the Target and Collector WP jointly, then a one day plenary session of all accelerator WP together, where the themes of each of them (DRIVER, TARGET, COLLECTOR, MUFRONT, MUEND and BETABEAM) and those specific of the HARP, MICE and MERIT R&D experiments were each covered by a few hours of presentations and discussion. A plenary session was devoted then to discuss the proposal of launching a Scoping Study. After half a day of PHYSICS plenary session, discussion on ISS was resumed and the agenda of BENE in 2005 was finalized.

2) the [NNN05 Workshop on Next Nucleon decay & Neutrino](#) detector held in Aussois, France, **Apr 7-9**. This is the 4th edition of this international Workshop, organized now in Europe for the second consecutive time with major contributions from the PHYSICS, DRIVER and BETABEAM working groups in BENE. The concept of a large Megaton water detector has emerged independently in the 3 regions, under the name of Hyper-Kamiokande in Japan, of UNO in the USA, MEMPHYS in the Western Alps in Europe, where the Li-Argon option is also well alive. The three designs have much in common, the collaborations have significant overlap and work in very close cooperation, with the aim of realizing commonly one such detector in the region that will offer the best and earliest opportunity. Cooperation ties were further strengthened in Aussois.

3) [a pre-meeting in London, May 6-7, of the International Scoping Study](#). This came after thorough discussion at the BENE Week in March, where it was decided, in particular, that the Study should include both Neutrino Factory and Superbeam. In London, it was decided there that the Study would be organized jointly by [the Neutrino Factory and Muon collider collaboration](#) in the US, [the Japan Neutrino Factory collaboration](#) and the [ECFA/BENE](#) Network for future neutrino beams in Europe, where it would be hosted at CCRLC laboratories by the [UK neutrino factory collaboration](#) that has promoted it first. An important contributions from India is also foreseen. The coordinators of these 4 collaborations were given mandate to make a proposal for the leadership of the Study. The preliminary [Study Plan](#), with three study groups (Physics, Accelerator and Detectors), was approved.

4) [the NuFact05 International Workshop, the 7th International Workshop on Neutrino Factories & Superbeams](#), held in Frascati, Jun 21-26. This is the yearly international forum of the above mentioned regional communities and has grown remarkably in importance over the years. We were very proud to host it in Europe for the 3rd time and the BENE coordinator

chaired the organization. It **replaced this year the traditional ECFA/BENE Summer Week**, enlarging its scope to a full international review of the status of the field, physics, accelerators, detectors, including betabeams. Its last day was devoted to a final discussion of **the ISS that was formally launched there on the morning of June 26**. It was decided also that the ISS should last one year and should be concluded at **NuFact06** (that will notably change its name to 8th International Workshop on Neutrino Factories, Superbeams & Betabeams) to be held in Irvine, Aug 24-30, 2006.

The NuFact Workshop has truly become the yearly meeting of a world-wide collaboration and its importance can also be judged from the satellite events that accompany it.

In 2002, the EU component (not yet known as BENE) first proposed and organized a NuFact International Summer School in the UK. After that first school, we had one in the USA in 2003, one in Japan in 2004 and this year the **4th NuFact05 International Summer School on Neutrino Factories & Superbeams** was organized by BENE **in Italy**, in the island of Capri from June 11 to June 20. 22 students, mostly but not all from Europe attended it. The aim of the school is to provide young particle physicists with an introduction to both particle and accelerator physics aspects of conventional and novel neutrino beams. The long-term goal of this series is to lay the foundation for a large international group of scientists with the diverse skills essential to secure the future of accelerator neutrino experiments. An essential task indeed, for BENE.

5) **the first working meeting at CERN Sep 22-24 of the International Scoping Study (ISS) on Neutrino Factories and Superbeams**. It was a good success with over 90 people registering, despite the short notice, with parallel group meetings of the three working groups, accelerator, detector and physics, and joint plenary meetings. A work/wish list was drafted for the outcome of the year's investigations. Details can be found on the transparencies, available from the website, <http://hepunix.rl.ac.uk/uknf/wp4/scoping/>.

5) **the 3rd BENE Week Nov 22-25** that was, according to tradition, the **BENE05** last meeting of the year, **within the CARE05** event, where serious discussions and the assembly of a continental collaboration towards an FP7 Design Study have resumed.

At the WP level, the betabeam WP held a joint meeting BENE/Eurisol meeting at RAL 17-18 January, for the start up of the design study.
<http://beta-beam.web.cern.ch/beta-beam/Meetings/RAL05/RAL05-presentations.htm>

Satellite meetings of on-going R&D experiments carried out in world wide collaborations where also held. Among them, most important, the **12th and 13 Collaboration meeting of MICE**, the Muon Ionisation Cooling Experiment, respectively June 27-29 in Frascati and Oct 21-24 at RAL and a **Collaboration Meeting** of the MERIT Target Test Area Experiment in June at CERN. BENE forces are involved deeply in these international efforts as well as in EMMA (the proto collaboration for electron model of non scaling FFAG), mention participation to FFAG-2005, at Fermilab in April, and FFAG05, at KURRI institute in December in Japan.

In addition, BENE has been present to all major neutrino events in the year. In 2005 we will mention only two most important and representative events, the International Neutrino Workshop **WIN05** early in June in Delphi and the **EPS HEP** Conference late in July in Lisbon, all attended by a significant BENE delegation with speakers in several sessions and/or panel discussions.

BENE has also made reports at regular ECFA meetings in the year. It also reports periodically to the Chairs of the CERN scientific committees (SPSC, SPC) and to the CERN Directorate.

N2.2 The International Scoping Study

Among the main concern of BENE has always been the promotion of a European Design Study (DS) of a Neutrino Factory & Superbeam complex, that we envisage to happen also within the broader international context of a World Design Study (WDS). As next call will only be within FP7, BENE has welcome the CCLRC proposal of a preliminary Scoping Study as a preparatory step in that direction.

After the meeting in London in May, the coordinator of BENE has participated to discussions with the representatives of the US-MC (S. Geer), NuFact-J (Y. Kuno) and UKNF (K. Peach) collaborations. These resulted in a common proposal for the membership of the ISS Program Committee. Reflecting the Study Plan, after approval at NuFact05, this consists of Yori Nagashima (Physics Group), Mike Zisman (Accelerator Group) Alain Blondel (Detector Group). Overall leader is Peter Dornan.

The first meeting of the ISS at CERN defined in depth the task of the 3 study groups, that will be

- 1) Physics: study of the reach of future accelerator neutrino beams. Neutrino factories and superbeams will be compared to each other and to neutrino betabeams.
- 2) Accelerator: study of the crucial issues in the sector: proton drivers, target and collection systems (common to Factories and Superbeams) and ionization cooling, acceleration and storage of muons (specific of Factories).
- 3) Detectors: study of the outstanding issues involved in the realization of neutrino detectors of adequate mass and performance for all the three beam options.

Emphasis will be on the identification of the crucial R&D areas in all sectors above, that the Design Study will have later to tackle in depth. The only subject left out of the ISS will be the accelerator aspects of Betabeam that are already covered by a DS.

BENE is now preparing its contributions to the next meeting of the ISS that NuFact-J will organize at KEK in January.

After the completion of the ISS in August 2006, BENE will proceed to prepare the application for a FP7 DS, presumably for Spring 2007. A major aspect of the ISS will be the assembly of a large and solid collaboration of laboratory and university teams supported by all the European agencies willing to contribute funds and human resources to the DS. These teams will apply together for EC co-financing of the DS. A first discussion took place at the BENE05 meeting in November.

N2.3 Publications

An overview of BENE documents and publications can be found in:

<http://bene.web.cern.ch/bene/publications/>

From there one can link to the documents created by each work package. They are structured in the same way as it is proposed for the general CARE publication policy, i.e. CARE-Note/Report/Conf/Pub/Document.

Regular update of the database of publications by the work package convenors and the BENE deputy coordinator has been somewhat hindered by the resignation of E. Gschwendtner, unable to continue as deputy. It will now be resuming in earnest.

N2.4 Web Sites

The BENE Main Web Page has been improved and refurbished at <http://bene.web.cern.ch/bene/>.

It displays the general plan of BENE activities for about 1 year ahead. Basic informations are kept up to date. BENE federates several pre-existing working groups and relies on their several pre-existing Web sites

<http://muonstoragerings.web.cern.ch/muonstoragerings/Welcome.html>

<http://nfwg.home.cern.ch/nfwg/nufactwg/nufactwg.html>

<http://beta-beam.web.cern.ch/beta-beam/>

The process of re-organization into a unitary site, in tune with the BENE federative process, continues. In each BENE WP Web page, the fraction of the material relevant to the scope of WP is being reorganized in a coherent set of links.

A Mailing List of members, bene@cern.ch, is operational. In addition there exist mailing lists of each work packages. (hep-mgt-betabeam@cern.ch, hep-mgt-bene-collector@cern.ch, hep-mgt-bene-drivers@cern.ch, hep-mgt-bene-muend@cern.ch, hep-mgt-bene-mufont@cern.ch, hep-mgt-bene-physics@cern.ch, hep-mgt-bene-target@cern.ch). Other lists of more loosely connected colleagues are also maintained.

N2.5 Activities of BENE in 2005

BENE's further acceleration of initiative in 2005 is driven by the work of its Steering Committee that has created the necessary networking tools for this and organized the main meetings and the other events. Regular phone-conferences are the main tool of coordination in the interval between meetings.

The BENE SG tried first to tackle the cancellation of further FP6 calls for DS by preparing an application for a Neutrino I3 that would associate to BENE a few indispensable JRA's. Although much work went into it, we failed to match the very tight application deadline. Luckily, discussion and preparation of the ISS started immediately after and greatly benefited of this effort.

The following text and five tables highlight the progress of work planned for the year 2005 for each work package by listing the lowest level subtasks of the BENE detailed implementation plan. No major deviations are reported, with one notable exception in the driver sector (see below).

All WPs have more or less regular phone-meetings over the year.

WP1 (PHYSICS) progressed greatly in completing the present round of preliminary assessments of the physics reach of the different beam and detector options. This is best documented in the material of the NuFact05 Workshop and in the Physics chapter of the Midterm Report. As stated above, both a Neutrino Factory with a large magnetic detector and a Betabeam/Superbeam aiming at a very large non magnetic detector emerge as powerful tools for definitive neutrino oscillation studies. The comparison of these and other emerging options is far from being concluded and a systematic and coherent re-visitation will be the task of the Design Study.

WP2 (DRIVER) has continued its comparative study of M-Watt proton driver designs. In particular, it stimulated the new CDR, in preparation at CERN, of a SC proton linac (SPL) of higher energy (3.5 GeV). It is also looking carefully at the Fermilab option of a still higher energy linac (8 GeV). It was less effective, so far, in stimulating more systematic studies of the Rapid Cycling Synchrotron option, where only slower efforts are being deployed by European (and non- European) labs and funding agencies. Finally, it is starting looking into the exciting recent idea of using Fixed Field Alternating Gradient (FFAG) machines also as

MWatt p-drivers. It is also clear that the CERN PAF and POFPA task forces will bring this debate out to a much larger forum (and longer time scale).

The discussion and comparison of these options is thus being enlarged in consultations with other communities of potential users of the proton driver. The WP will closely follow the works of CERN PAF task force as the choice of the appropriate proton driver is a corner stone of the future of particle physics in Europe.

Two topics of interest of this WP, namely,

- the prospects for intense H- sources and high power injectors
- the HIPPI results on fast choppers and accelerating structure

are and will continue to be closely followed by the WP in the second part of BENE.

WP3 (TARGET) has progressed in the comparative studies of different target options. Its major achievement was the approval, in April 2005, of an experiment testing exactly the response of the most likely superbeam and neutrino factory target (liquid mercury jet) and collection system (solenoid) to the energy deposition density typical of the single proton shot produced by a future multi M-Watt driver. The proposal was approved, under the name of MERIT, to run in the n-TOF line at the CERN PS in 2007, funded and manned by an international collaboration with large US and Japanese contributions. A longer description of WP3 activity is in appendix.

WP4 (COLLECTOR) has known some fluctuations. Pre BENE work had produced an initial design of a collection system based on a magnetic horn, a horn prototype optimized for a Neutrino Factory, and a series of feasibility tests. The BENE WP was centered around LAL, that did a redesign to fulfil the superbeam requirements. After this, however, LAL had unfortunately to decline its commitment to BENE WP4 and to provide the CNGS horns. This has now been reorganized with the help of the CERN team that has inherited the CNGS task and the one of preserving the brilliant European tradition and know-how (Van der Meer) in the sector. Recently however a new IN2P3 laboratory (Strasbourg) has been able to resurrect the IN2P3 effort in collaboration with CERN and has taken up the leadership of the WP. ISS goals in this sector have been now defined and steady progress is again under way especially concerning the simulation of relevant effects and comparison with existing devices.

The main achievements of the 3 components of WP5 (NOVEL NEUTRINO BEAMS) are

- a) **WP5a (MUFROnt)**: progress on the design of the Front End of a neutrino factory. First indication of the range 6-10 GeV as the ideal proton driver energy for a neutrino factory, once all successive muon manipulations are also taken into account. Final approval of the MICE (Muon Ionization Cooling Experiment) at RAL in March. MICE is scheduled to start data-taking on April 1, 2007.
- b) **WP5b (MUEND)**: progress on the design of the acceleration stages of a neutrino factory. Progress in the direction of non scaling FFAGs and their use in full FFAG or combined FFAG/RAL acceleration schemes. The WP team is at the heart of the proposal of EMMA, an innovative electron model of non-scaling FFAG that a world collaboration hopes to build in Daresbury.
- b) **WP5c (BETABEAM)**: the WP keeps BENE informed and aware of the progress of the Betabeam task in the EURISOL Design Study, started on Feb 1, that is systematically revisiting all aspects of the betabeam chain. New ideas are also emerging: higher energy betabeams are definitely very very interesting; so are monochromatic betabeams based on rare isotopes (Dysprosium) that undergo electron capture rather than beta decay.

Though present studies are based on reutilization of existing CERN accelerators, the BETABEAM team is now also considering a green field study, in connection to the

ISS and in view of the fairest possible comparison with neutrino factories performances

A special role is emerging for a first very low energy betabeam (10-50 MeV neutrinos). This is likely to be the first betabeam that will come into existence, providing an indispensable proof of principle demonstration and quite relevant physics results in the area of neutrino-nucleus cross sections of astrophysical interest.

Work Package 1: PHYSICS.

	Title	Original begin date (Annex 1)	Original end date (Annex1)	Estimated Status	Revised end date
WP1	PHYSICS				
1.1	Improvement of the WP Web Site	Jan. 2005	Mar 2005	95%	Continuously improving
1.2	WP Spring Meeting	Mar 2005	Mar 2005	100 %	
1.3	Assess physics analysis, motivate ISS	Jan 2005	Jun 2005	100%	Presented at Nufact05
1.4	WP Summer Meeting	Jun 2005	Jun 2005	100 %	Coincided this year with NuFact05
1.5	WP Fall Meeting	Nov 2005	Nov 2005	100 %	
1.6	Physics section of Interim Report	Jun 2005	Nov 2005	100 %	

Work Package 2: DRIVER

	Title	Original begin date (Annex 1)	Original end date (Annex1)	Estimated Status	Revised end date
WP2	DRIVER				
2.1	Improvement of the WP Web Site	Jan 2005	Mar. 2005	95%	Continuously improving
2.2	Finalize criteria of SPL vs RCS comparison	Jan 2005	Mar. 2005	20% It is going to take longer!!	Larger picture emerging, CERN committee being set up
2.3	Identify R&D beyond HIPPI, motivate ISS	Jan 2005	Mar. 2005	100 %	Presented at Nufact05, ISS launched
2.4	WP Spring Meeting	Mar 2005	Mar 2005	100 %	
2.5	WP Summer Meeting	Jun 2005	Jun 2005	100 %	Coincided this year with NuFact05
2.6	WP Fall Meeting	Nov 2005	Nov 2005	100 %	
2.7	Driver section of Interim Report	Jun 2005	Nov 2005	100 %	

Work Package 3: TARGET

	Title	Original begin date (Annex 1)	Original end date (Annex1)	Estimated Status	Revised end date
WP3	TARGET				
3.1	Improvement of the WP Web Site	Jan 2005	Mar. 2005	95%	Continuously improving
3.2	Summarize hi power target status, motivate ISS and other R&D	Jan 2005	Mar. 2005	100 %	Presented at Nufact05, ISS launched
3.3	WP Spring Meeting	Mar 2005	Mar 2005	100 %	
3.4	WP Summer Meeting	Jun 2005	Jun 2005	100 %	Coincided this year with NuFact05
3.5	WP Fall Meeting	Nov 2005	Nov 2005	100 %	
3.6	Target section of Interim Report	Jun 2005	Nov 2005	100 %	

Work Package 4: COLLECTOR

	Title	Original begin date (Annex 1)	Original end date (Annex1)	Estimated Status	Revised end date
WP4	COLLECTOR				
4.1	Improvement of the WP Web Site	Jan 2005	Mar. 2005	95%	Continuously improving
4.2	Summarize collector progress, motivate ISS and other R&D	Jan 2005	Mar. 2005	100 %	Presented at Nufact05, ISS launched
4.3	WP Spring Meeting	Mar 2005	Mar 2005	100 %	
4.4	WP Summer Meeting	Jun 2005	Jun 2005	100 %	Coincided this year with NuFact05
4.5	WP Fall Meeting	Nov 2005	Nov 2005	100 %	
4.6	Collector section of Interim Report	Jun 2005	Nov 2005	100 %	

Work Package 5: NOVEL NEUTRINO BEAMS

	Title	Original begin date (Annex 1)	Original end date (Annex1)	Estimated Status	Revised end date
WP5	NOVEL NEUTRINO BEAMS				
5.1	Improvement of the WP Web Site for the three areas of interest of the WP	Jan 2005	Mar. 2005	95%	Continuously improving
5.2	Review of existing designs for NuFact and Betabeams, motivate ISS	Jan 2005	Mar. 2005	100 %	Presented at Nufact05, ISS launched
5.3	WP Spring Meeting	Mar 2005	Mar 2005	100 %	
5.4	WP Summer Meeting	Jun 2005	Jun 2005	100 %	Coincided this year with NuFact05
5.5	WP Fall Meeting	Nov 2005	Nov 2005	100 %	
5.6	Novel beam sections of Interim Report	Jun 2005	Nov 2005	100 %	

N2.5 SIGNIFICANT ACHIEVEMENTS

- Start up of the betabeam design study as part of the Eurisol DS
- Organization of the NNN05 and Nufact05 International Workshops in Europe.
- Approval of the MICE muon ionisation cooling experiment at RAL
- Approval of the MERIT high power target and collection experiment at CERN
- Launch of the International Scoping Study on Neutrino Factories & Superbeams.
- The BENE Midterm Interim Scientific Report, contribution to the CERN Council Strategy process

N2.6 List of all milestones and deliverables (D) during the reporting period

Deliverable/ Milestone No	Deliverable/Milestone Name	Workpackage /Task No	Lead Contractor(s)	Planned (in months)	Achieved (in months)
D	Proceedings of Nufact05 International Workshop	All WPs	INFN-Na	24	27 (sent to Publisher)
D	Launch of International Scoping Study on Neutrino Factories and Superbeams	All WPs	CCLRC, ICL, INFN-Na, Uni-Ge	18	18
D	Completion of Interim (Midterm) Scientific Report	All WPs	INFN-Na,	23	25
D	Annual report of the BENE network	All WPs	INFN-Na,	24	25

N2.7 List of major meetings organized under BENE during the reporting period

Date	Title/subject	Location	Number of participants	Web Site Address
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Mar 16-18 2005	BENE Week	CERN	70	http://nuspp.in2p3.fr/Bene/BENEWeekMarch05
Apr 7-9 2005	NNN05 Workshop	Aussois, France	110	http://nnn05.in2p3.fr/
6-7 May 2005	ISS preparation meeting	London	50	http://www.imperial.ac.uk/research/hep/events/nufact_meet.htm
12-20 Jun 2005	4th NuFact05 Summer School	Capri, Italy	22 students & 10 lecturers	http://nufact05school.na.infn.it/
21-26 Jun 2005	7th NuFact05 Workshop	Frascati, Italy	190	http://www.lnf.infn.it/conference/2005/nufact05/
21-23 Sep 2005	1 st ISS general meeting	CERN	90	http://dpnc.unige.ch/users/blonde1/ISSatCERN.htm
Nov 22-25 2005	BENE05 Week at CARE05	CERN	60	http://nuspp.in2p3.fr/Bene/BENEWeekNov05

N2.8 Appendices

Appendix WP3

WP3 (TARGET) has progressed in the comparative study of different target options:

- a) **Mercury jets**, - which should not suffer from thermal shock problems and have virtually unlimited power dissipation.

A major achievement was the approval in April 2005 of the experiment (nToF11, or “MERIT”) to test a mercury jet under fully realistic beam conditions in a 15 T magnetic solenoidal field, using the 24 GeV proton beam at CERN in the neutron time of flight beam line. The experiment is due to be carried out in 2007 with 100-200 beam pulses. This experiment is a collaboration between laboratories in the USA, Europe and Japan, with the US funding the major contribution.

RAL failed to secure resources from its funding agency for a major involvement, but will support the manufacture of cryogenics for the magnet and will be involved with the experiment at CERN and the analysis of results. Fortunately CERN will support much of the cryogenics and infrastructure.

- b) **Solid metal**.

The problem of shock in tantalum is being investigated by the UK group at RAL. The construction of the experiment in the UK to measure mechanical thermal shock characteristics (to evaluate the constitutive equations) of tantalum at high temperatures has been completed. A high current pulse has been passed through a thin tantalum wire to obtain the desired energy density. The motion of the wire will be studied using a VISAR. Modelling studies of the thermal shock in tantalum at 2300 K are also well under way with the use of the commercial package LS-DYNA. It has been suggested that by having a large number of beam micro-pulses in the 1-2 μ s long macro-pulse (at 50 Hz) the thermal shock will be much reduced. The modelling shows this to be true.

No further tests on the tantalum disc in the pbar target at FNAL have been carried out since the test last year when the target appeared not to have suffered from 1100 pulses at an energy density dissipation of over 38000 J cm⁻³.

BNL (USA) is investigating low expansion materials that will suffer little shock; unfortunately the properties deteriorate rapidly under irradiation, but they can be recovered by heating.

One of the responsibilities of BENE is to decide which of the options is best suited to the neutrino factory. Until the tests are completed it will not be possible to rule out either as unsuitable. However, there is a good chance that both will be found to be acceptable solutions, in which case other criteria, such as safety, may be deciding issues.

Calculations using the MARS code have been carried out at RAL to try and optimise the proton beam energy and target geometry for maximum muons accepted into the muon front-end. The radioactive beam inventory in the tantalum target has also been evaluated.

Regular meetings of the target group have been held in conjunction with the ENG meetings. The second High Power Target Workshop was held in Oak Ridge in October 2005. Members of BENE are involved with the organisation of these workshops.

The target website has been established at RAL - <http://hepunx.rl.ac.uk/uknf/wp3/>.