Report of EUROν International Advisory Panel

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Executive Summary

This report summarizes the IAP findings from the EUROν meeting held at RAL, Didcot, England from January 18–21, 2011. The Executive Summary, which comprises material from the closeout presentation to the Governing Board augmented with material generated in the preparation of this report, includes both "comments" from the Panel and some specific "recommendations." In the summary below, the particular Work Packages (WPs) for whom the comment or recommendation is meant are indicated in square brackets.

We are very appreciative of the efforts of Rob Edgecock and the local organizers for the excellent meeting arrangements. During the meeting we once again heard many interesting technical presentations and we thank the EUROν group for their efforts in describing the many activities now under way. We noted substantial progress in all WPs since our last meeting and it is clear that the group is now fully functional. We are looking forward to our next meeting to hear of the continued progress.

Compared with our previous meeting, we found that the information presented was well-focused toward our review mission. There was an initial plenary session in which each work package leader provided an update on what had been accomplished since last year, progress toward milestones, changes in direction dictated by the R&D program, if any, and plans for the upcoming year. This put the technical work in context and made it easier for us to assess the status of the various activities. In addition, there was a timely written response to our comments and recommendations from the previous meeting, and we were given a copy of the EUROν progress report in plenty of time to read it in preparation for this meeting. All of these things were greatly appreciated by the IAP. We thank the WP leaders and all speakers for their excellent and informative presentations.

Comments

1. The deliverable for costing needs to be precisely defined. It appears likely (due to resource limitations) that less will be accomplished than originally hoped. This means that EUROν leadership must clearly define what is (and is not) expected from its WP leaders. It will also be prudent to keep Brussels appraised of the practical goals, in the spirit of expectation management. The IAP feels strongly that information on the relative costs of the three candidate accelerator approaches will be of great value to the neutrino community, not only in Europe but worldwide, and that this opportunity to inform the community should remain a high-priority task. [WP1]

2. There appeared to us to be confusion among the WP leaders about the distinction between engineering design effort and costing effort. We understand that design effort must come from the individual WPs, and that the costing group can only help with assessing, in a uniform way, the costs of the various designs provided by others. EUROν management must take

the lead in identifying resources that can help with design. It will soon be time to begin freezing the designs and shifting resources from scientists to engineers. [WP1]

3. Management needs to decide where safety items reside in the WBS, i.e., item by item, in a separate safety category, or a mixture. Our experience suggests that a mixture may be the most practical approach. [WP1]

4. We felt that overall coherence and cohesion of the program have improved in the interval since our last meeting. This was very visible at this meeting and speaks well of the leadership efforts in this regard. [WP1]

5. WPs 2, 3, and 5 should be encouraged to create parameter lists and make them available on the web. In the case of WP3, this list should be held in common with the IDS-NF and cross-linked. [WP1]

6. We commend the progress since our last meeting. The group appears to be converging on reasonable target and horn designs and improving the physics reach of the proposed facility. [WP2]

7. To permit reliable costing, we suggest development of a conceptual layout for a proton beam delivery system that permits sharing of the beam among 4, or possibly 3 targets. Work out enough to show there is a reasonable solution, including collimators, baffles, and beam instrumentation to satisfy beam-position and target-protection demands.[WP2]

8. Determine the arrangement and thickness of shielding around the target area and decay tunnel. Also, consider design and instrumentation needed for 4 MW of beam power in the dump and decay tunnel. Only after the shielding is specified can activation issues be fully assessed. [WP2]

9. Further work on the target hall layout will be needed for costing, including assessments of crane requirements, cooling water and helium services, remote handling hot cells, nuclear ventilation, and location of power supplies. Similar requirements are being met at NUMI and T2K, so these layouts should be examined for potential solutions. [WP2]

10. We assume that CERN remains responsible for providing a cost estimate for the 4 MW SPL and its accumulator and compressor rings, as well as identifying a location for it on the CERN site. [WP2, WP3]

11. Better articulation of the rationale for some of the IDS-NF baseline choices appears to be needed, especially for the target and the cooling channel. Upcoming reviews make this a high priority. [WP3]

12. Preparations for costing are coming together, but it appears that additional resources will be needed (and must be identified) to carry out the work. CERN had been expected to handle much of this, but a "Plan B" needs to be defined, just in case. [WP3]

13. It seems prudent to carry out initial error studies to make sure there are no unexpected sensitivities, especially for the acceleration system and decay ring. [WP3]

14. A Neutrino Factory parameter list should be made available on the web. This task should be shared between WP3 and the rest of the IDS-NF to ensure that there is a single shared list. [WP3]

15. Both design decisions and costing require performance specifications, such as magnetic field quality, extent of fringe field, alignment tolerances, and the like. We did not see much evidence for these and would like to hear about this at our next meeting, if not earlier. [WP3]

16. It appears that the decay ring RF system has been eliminated from the design. We were not sure whether the reasoning for this change was documented, and suggest that this be done if not done already. [WP3]

17. Since both the IDS-NF and WP3 are working on common topics, we suggest that the notes for the two groups be cross-linked for ease of retrieval. [WP3]

18. Neutrino Factory design work shows a good maturity in most aspects, and most known critical issues have been addressed. However, a few issues have become concerns, most notably in the target area. These need to be dealt with promptly. [WP3]

19. Questions were raised about whether the specification for the proton driver beam emittance was too low. The proposed specification should be revisited to make sure it is practical. [WP3]

20. The issue of whether to take advantage of the lower MIND threshold by reducing the muon beam energy was discussed. The IAP view is that this is probably not a big deal technically, but we suggest not making such a baseline change at this time. Generally, it is unwise to design "too close to the edge" at this early stage, but perhaps the issue can be revisited in the time frame of the IDS-NF RDR a few years hence. [WP3, WP5]

21. To date there has been no real progress on the costing exercise, although the group has developed a parameter list that will aid in this effort. Making progress will require engineering resources that (as for most of the other WPs) are not presently identified. [WP4]

22. We agree with the proposed plan by WP4 to complete the production experiments on ^{18}Ne, ^{8}B, and ^{8}Li. We suggest that ANL staff be contacted about their experience with a liquid-Li "curtain" target. [WP4]

23. The ECR development work should be continued. [WP4]

24. The Beta Beam group needs to settle soon on a final scenario to serve as the basis for the cost estimate, including the choice of isotopes, their production mechanisms, and the corresponding production rates. The decay ring RF system solution must also be defined. [WP4]

25. It appeared to the IAP that there is still tension between the baseline scenario favored by WP4 and that considered "competitive" by WP6. While we cannot make the choice for you, we reiterate the importance of maintaining a single consistent baseline scenario that is used for both the costing and the performance evaluation. We also note that a scenario deemed non-competitive today may well become more interesting when costs are included in the evaluation. [WP4, WP6]

26. Parameter list updates are needed for all ion species, as are impedance specifications for what is allowable from the viewpoint of collective effects. We saw good progress at this during the meeting. We note that a conceptual design for the vacuum chambers may be needed to ensure that the impedance specifications are credible. [WP4]

27. The main technical risks for the Beta Beam facility appear to be the production of sufficient quantities of isotopes and achieving sufficiently low impedance in the decay ring. Both of these are being pursued vigorously by WP4. [WP4]

28. WP5 has proposed extremely ambitious goals with quite limited resources. Thus far, they have kept up with their milestones by disciplined prioritization of the tasks. As with many of the WPs, the lack of a dedicated engineering effort for costing and safety issues is a real deficiency and puts some deliverables at risk. [WP5]

29. Questions were raised about whether the timing criteria between accelerator and detector could be achieved; this should be revisited for the next IAP meeting. [WP5]

30. In close coordination with WP5, the WP6 physics group has made good progress in the treatment of systematic errors. [WP5, WP6]

31. Consistent with our previous suggestion, implementation of migration matrices to parameterize detector performance has been established as the standard method, and is included in GLoBES. [WP6]

32. We note that the dissemination and outreach activities of the physics group have been highly effective. Their reports are routinely made public via submission to refereed journals or submission to the arXiv. [WP6]

Recommendations

1. Access to, and use of, the CERN costing tool should be established for WPs 2–5 as soon as possible. [WP1]

2. Consider identifying a contact person to handle interactions between EUROν and its various upcoming review committees. [WP1 and GB]

3. Work with WPs 2–5 to secure engineering resources for the costing exercise. [WP1]

4. At our next meeting, we would like to hear a presentation on the risk register and corresponding mitigation strategies. [all]

5. The availability of parameter lists for each system under investigation is essential for performance and cost comparisons. The work package manager, in collaboration with his IDS counterpart must ensure that one consistent baseline parameter list is available to all participants. [WP3]

6. Work on understanding and mitigating radiation-induced heat load in the target solenoids and uncontrolled particle losses in the front end should be completed with high priority. We note that the radiation problem is severe enough for the baseline target configuration that it may be necessary to revisit the possibility of a low-Z target. It would be useful if rule-of-thumb loss criteria could be replaced by firm specifications, though we recognize that this may not yet be practical. [WP3]

7. Complete the isotope production experiments. Thereafter, establish a self-consistent scenario as a basis for estimate. [WP4]

8. Continue MIND simulations with updated geometry, toroidal field, inclusion of taus, etc. [WP5]

9. Bring the near detector design to a level of maturity comparable to that of the MIND, including migration matrices. [WP5]

10. A unified solution to the treatment of systematic errors is urgently needed and should be a priority. We recognize, of course, that this is not an easy task. [WP5, WP6]

11. The systematics of low-energy neutrino cross sections has been identified as an important issue that can influence the performance comparison of the various facilities. Steps should be taken to clarify this issue. [WP6]

Work Package 1: Management and Knowledge Dissemination

Findings

To date, some 73 EUROν documents have been prepared and posted on the web. Many meetings have been held and it is clear that the various WPs are all up and running effectively. Responses to the previous IAP report were delivered in a timely way, and the annual report was likewise available to us well before this meeting. These actions made our task considerably easier, and the efforts of theWP1 leader, Rob Edgecock, to make this happen are greatly appreciated.

The order of the presentations was modified per our request to provide updates from the WP leaders at the beginning rather than the end of the meeting. This too was helpful for us, and we thank the WP leaders for accommodating our request. Having an overview of where each WP stands in terms of meeting milestones, technical accomplishments, future plans and priorities, and problems being faced allows us to put the subsequent technical reports in context. In general, the progress against milestones was good this past year for all of the WPs. A few milestones were achieved somewhat late—not surprising for an R&D endeavor—but all were accomplished in the end.

Our most noteworthy finding, which applies to many WPs, is that there is a shortage of resources, particularly with regard to engineering help needed for design, safety assessments, and cost estimating. This is a potentially serious issue that impacts the ability of EUROν to complete its tasks.

Unfortunately, the planned EU review of the EUROν program, which had been scheduled for the end of this meeting, had to be postponed. This was due to issues that were beyond the control of EUROν and does not reflect on their readiness for such a review. The review is still needed for bureaucratic reasons and will be rescheduled as soon as possible.

Comments

Because of resource limitations, the goals of the costing exercise seem to be at risk, and it appears likely that less will be accomplished than originally hoped. We advise that WP1, in consultation with the leaders of WPs 2–5, define precisely what is the deliverable for the cost comparison task. It is likely that some effort aimed at "expectation management" will be needed, both for the EU funding agency and for EUROν itself. On the other hand, the IAP feels that the goal of developing an unbiased cost comparison for the three technical approaches is very worthwhile and valuable to the neutrino physics community, and we urge that this opportunity remain a high-priority task.

It appeared to us that there remains confusion between the engineering tasks of designing the main hardware components and estimating their costs. These are two different tasks, though the same engineers often participate in both. The costing group has agreed to help with the costing of components, and has expertise to do so, but they are *not* planning on providing the designs to be costed. Providing the actual component designs remains a task of the individual WPs. We were told that, in part, the resource problem arises because the initial teams of physicists needed to complete the system designs are still on board. Presumably, the original concept was that at some point the designs are "frozen," after which the need for the physicists decreases (thus accommodating the ramp-up in engineers to develop the designs). It takes some discipline to do this, but it is needed at some stage in any project-like activity. We urge the WP1 leader to work with the other groups to see how to accomplish this hand-off from physicists to engineers.

There was some discussion of where "safety" fits in the proposed WBS structures, that is, should it be captured all in one category or distributed item-by-item. The IAP collective wisdom is that a mix of the two schemes is most suitable. Some systems, such as personnel protection or machine protection, may be centrally managed and costed, but some items, such as relief valves on magnets, will most likely be covered with the components themselves.

We believe the technical WPs could benefit from guidance and encouragement from WP1 to create and manage parameter lists. This suggestion has been made previously, and some steps toward what is needed have been taken, but (in our view) not enough has been done. We believe that these parameter lists will be necessary for the costing exercise and should be a deliverable for WPs 2–5. In the special case of WP3 (and to a lesser extent WP5), we see no difficulty in "sharing" a parameter list with the IDS-NF, that is, jointly creating a single list that is cross-linked between the two sites. Our observation is that WP3 and the IDS-NF are functioning very smoothly together and agreeing on a single list should be straightforward.

Finally, we note with pleasure that the overall cohesion and coordination have improved markedly since our last review. However, in discussions during the meeting, it became clear that this has come at the expense of increased management burden on WP1, which is becoming more difficult to handle. We expect that the need to prepare for and coordinate the various upcoming reviews will significantly add to that burden. We therefore suggest that the WP1 leader, in consultation with the EUROν Governing Board, consider ways of sharing this work.

Recommendations

1. Access to, and use of, the CERN costing tool should be established for WPs 2–5 as soon as possible. [WP1]

2. Consider identifying a contact person to handle interactions between EUROν and its various upcoming review committees. [WP1 and GB]

3. Work with WPs 2–5 to secure engineering resources for the costing exercise. [WP1]

4. At our next meeting, we would like to hear a presentation on the risk register and corresponding mitigation strategies. [all]

Work Package 2: Superbeam

Findings

The baseline design of Work Package 2 consists of the CERN 5 GeV Superconducting Proton Linac (SPL) operating at 4 MW as the driver, with a new target facility and neutrino beam line aimed at the MEMPHYS detector located 130 km away in the Fréjus site. The development of the SPL design is not a major component of WP2, as CERN accelerator specialists have already done the design and costing for the SPL, the accumulator ring as required for the Superbeam, and the additional compressor ring as required for the Neutrino Factory WP3 study (CERN driver option).

The primary emphasis in WP2 is the design of the neutrino beam facility: target, horn, decay pipe, and dump, along with the necessary civil structures and services to house and shield the facility and the optimization and characterization of the resulting neutrino beam. The plan to use 4 target/horn assemblies (mounted together at the entrance to the decay tunnel), which share the 4 MW beam power, continues as the baseline design. This past year, studies by the RAL High Power Targets group have produced two potential target designs, one using a solid beryllium rod that is pencil- or cone-shaped to absorb the high power density at the beam entrance, and the second using a 10 bar helium-cooled "pebble-bed" target made up of 3 mm diameter titanium balls packed in a 30 mm diameter by 78 cm long assembly. This arrangement permits more efficient transverse cooling of the target material, and calculations show that power levels up to 1.3 MW should be possible. In addition this design has reduced operating stresses due its granular structure and can tolerate an off-center beam. This target design has been selected as the baseline.

The horn design is now based on the MiniBooNE size and shape and will be designed to operate at 350 kA and cycle at 12.5 Hz. The concept of a current-carrying target integral with the horn has been dropped in favor of a separate target and horn for improved reliability and the possibility of replacing a target inside the horn. The horn will be cooled by internal water-jet sprays. The MiniBooNE design is good for long targets and thermal and stress calculations are being carried out to optimize details of the design and material thicknesses. Neutrino flux and sensitivity studies have been carried out to optimize the overall layout. The target/horn assemblies are placed as close together as possible inside a 4 m diameter decay tunnel that is 25 m long, resulting in minimal loss in flux as compared with a single target/horn, good suppression of wrong-sign pions and, using the higher density Ti target, more flux than the previous graphite target. This leads to improved sensitivity in the measurement of θ_{13} and CP violation using the MEMPHYS detector at 130 km distance, although a longer baseline of 200 km would be preferred.

A preliminary layout of the target hall/decay tunnel was presented showing the shielding configuration and a possible method of remotely exchanging a target/horn assembly in a nearby hot cell. A Safety Workshop bringing in experts in the field will be held in April to discuss issues such as environmental radiation concerns, radioactive waste, and licensing to construct and operate. Safety is related to the costing exercise, so for both continued development of the WBS/PBS and for defining the baseline design of this work package, such considerations will be required.

Comments

The IAP commends the WP2 group for the progress on this work package in converging on a technical design of target and horn that improves on the physics reach of this facility and represents a reasonable, albeit challenging, extrapolation from present designs. For instance the horn needs to achieve 350 kA at 12.5 Hz pulse rate compared with the existing MiniBooNE parameters of 170 kA at 5 Hz.

However, there remain some other aspects of the overall design that need to be considered to demonstrate that the facility can safely and reliably operate at 4 MW, and to provide the details of the civil structures needed for the costing exercise. In particular,

- A conceptual design of the beam line switchyard should be carried out to show how the proton beam will be shared between the 4 targets (or 3 targets if one has a problem). This should include the arrangement of, and need for, baffles or collimators, as well as beam instrumentation requirements for providing beam profiles and target protection.
- The arrangement and thickness of the shielding around the target area and the decay tunnel need to be determined, along with the design of the beam dump at the end of the decay tunnel. A large fraction of the 4 MW beam power will be dissipated in this area, so the requirements for material selection, cooling and instrumentation should be assessed. The shielding requirements must take into account both the operating radiation levels in nearby occupied areas and the need to keep the activation of air and ground water to an acceptable level.
- Further details of the target hall layout should be determined, taking into account the need for services such as crane requirements, cooling water and helium services, power supplies and electrical distribution (in particular for the horns), remote handling hot cells and nuclear ventilation. There are examples of how this is accomplished at T2K and NUMI so these layouts should be reviewed for possible solutions.

The plan for a Safety Workshop at CERN with experts from other laboratories with experience in handling high beam powers will provide an excellent opportunity to review all of these requirements. It would be useful to appoint a “safety person” or lead for this aspect of WP2, if this is not already done, and to get some shielding and power loss distribution calculations carried out, along with some preliminary layouts of the target area, to take full advantage of this workshop.

Recommendations

None.

Work Package 3: Neutrino Factory

Findings

We were pleased to hear that the first three high-level milestones have been completed. The baseline Neutrino Factory design has been settled and is now written up as part of the IDS-NF IDR. The efforts of WP3 participants played a key role in this process, and we see that the participation of WP3 members in the IDS-NF is working seamlessly. Major achievements include:

- comparison of FLUKA simulations with HARP data
- initial evaluation of fringe-field effects for the acceleration system
- development of an injection/extraction scheme for the FFAG ring, along with initial component designs
- completion of multi-particle tracking of the linac
- completion and documentation of most of the lattice designs
- development of a data-exchange format in preparation for end-to-end tracking studies

An issue with heat deposition in the target area has been identified, and it is expected that this will require some changes to the present baseline layout. Beam losses downstream from the target have also been looked at, and appear to be substantial. Both issues are being addressed now and will hopefully be resolved by the time of our next meeting.

A WBS scheme has been prepared, but costing activities have not yet commenced.

Comments

During the discussions, it became clear that there are differences of opinion on the rationale for some of the baseline choices, e.g., the target. The upcoming reviews make it important to better articulate the reasoning behind the various choices. The group must learn to speak with one voice. We also found that, as is true for several other WPs, additional resources will be needed for the costing activity. It was expected that CERN engineers would handle this, but now that is less certain. It would be prudent to develop a "Plan B" to make sure that this activity is completed as promised. We note that both design decisions and costing require *performance specifications* and not simply parts counts. We did not see much evidence for these in what was presented, yet magnetic field quality and fringe-field criteria are likely to have a significant impact on costs.

Now that designs for most Neutrino Factory accelerator systems exist, it would be prudent to carry out initial error studies to ensure that no unexpected sensitivities are uncovered. This is particularly true for the acceleration system and decay ring. In general, the design work shows good maturity. Most critical issues have been addressed, although (as discussed above) a few results have raised new concerns. We also urge that the parameter list for the Neutrino Factory be made public on the web. This list should be shared between WP3 and the rest of the IDS-NF and cross-linked so that a single list appears on both sites. We were told that the decision had been made to eliminate the RF system from the decay rings. We would like to see the reasoning for this change documented in a posted note. Indeed, the rationale for most design decisions does not seem to be well documented. Because of the strong overlap between WP3 and the IDS-NF, we suggest that notes from the two studies all be cross-linked.

During the meeting the proton driver beam emittance was called into question. We encourage the designers to review this parameter to be sure it is realistic. Another hotly discussed issue was whether to take advantage of the lower MIND threshold by reducing the muon beam energy. Our view is that a baseline change should not be made at this time, as there is risk in "living too close to the edge." However, the group might wish to reconsider this question in a few years when preparing the IDS-NF RDR.

Recommendations

5. The availability of parameter lists for each system under investigation is essential for performance and cost comparisons. The work package manager, in collaboration with his IDS counterpart must ensure that one consistent baseline parameter list is available to all participants. [WP3]

6. Work on understanding and mitigating radiation-induced heat load in the target solenoids and uncontrolled particle losses in the front end should be completed with high priority. We note that the radiation problem is severe enough for the baseline target configuration that it may be necessary to revisit the possibility of a low-*Z* target. It would be useful if rule-of-thumb loss criteria could be replaced by firm specifications, though we recognize that this may not yet be practical. [WP3]

Work Package 4: Beta Beam

Findings

Good progress has been made on a number of fronts: production, acceleration, and the decay ring. Two scenarios are currently under development: the baseline scenario based on $^{6}He/^{18}Ne$, and an option based on $^{8}Li/^{8}B$. Both scenarios are based on the operation of a decay ring at $\gamma = 100$. The latter scenario has the potential advantage of providing higher energy neutrinos, but requires higher ion intensities.

Newly reported at this meeting was a concept that provides sufficient quantities of ^{18}Ne to meet the Beta Beam performance goals based on direct production via the reaction $^{19}F(p,2n)^{18}Ne$ utilizing Linac 4 as the proton source. Experimental verification of the production rate is required and a proposal has been submitted to CERN. Resources, in the form of a scientific associate for two years, have been committed. Even so, this approach requires operation of Linac 4 at an average current of 6 mA (700 kW).

The standard concept for production of $^{8}Li/^{8}B$ has been based on using a gas-jet target in a production ring, with "reverse kinematics." Studies have now deemed this approach infeasible due to the extremely high density required in the gas target. Direct production is now being explored via the reactions $^{7}Li(d,p)^{8}Li$ and $^{6}Li(^{3}He,n)^{8}B$. Experimental measurements have been made on the ^{8}Li production reaction and are now being analyzed. A proposal has been prepared for the ^{8}B reaction and will be completed in the spring of 2011. Significant questions remain as to whether either of these approaches can deliver the required intensities.

Work on the decay ring design has concentrated on the mitigation of single-beam collective effects. The phase-slip factor has been doubled via a new lattice design that lowers the transition gamma to 18.7. This change is accompanied by a simplified arc configuration that allows a simultaneous increase in the fraction of the decay ring circumference contained within the straight sections. The result is that it appears possible to circulate ^{18}Ne at the required intensities, and the other ions are within a factor of two. Options for overcoming the final factor of two include operation with multiple ion species ("cocktail" approach) or the utilization of a twin-bore magnet. All calculations assume a transverse impedance of 1 MΩ/m, which is yet to be demonstrated. Duty factor requirements for the decay ring have been developed in consultation with WP6. An RF system capable of providing the required duty factor (0.5%) needs to be developed.

A new acceleration scheme based on +1 charge states emanating from the 60 GHz ECR source has been developed. ECR development continues to proceed satisfactorily.

Finally, we note that WP4 has done an exceptional job in documenting and publishing their results. Additionally, they have established a comprehensive parameter list that provides a good model for the other WPs.

Comments

We see the primary technical risks as the production of isotopes at the required intensities, and achieving sufficiently low impedance to suppress collective effects in the decay ring.

It is important to complete the production cross section experiments on ^{18}Ne, ^{8}B, and ^{8}Li as soon as possible. Argonne National Laboratory has been developing a liquid-lithium "curtain" target that could be relevant for ^{8}B, and ^{8}Li production. ECR source development is proceeding well and should be continued.

There has been no real start on the costing or safety requirements exercises. These will require engineering resources that are not currently assigned.

There is a need to settle soon on the final scenario that will form the basis of the cost estimate. This means the choice of both isotopes and production mechanisms. A parameter list update is needed for all ion scenarios. The scheme for implementing the decay ring RF must be established, along with a conceptual design of a vacuum chamber to obtain a credible impedance specification.

Tension still exists between the performance of the baseline scenario (^{6}He/^{18}Ne) and what WP6 deems competitive (^{8}Li/^{8}B). The IAP's only advice is that the baseline design, performance evaluation, and costing must be based on a single consistent scenario.

Recommendations

7. Complete the isotope production experiments. Thereafter, establish a self-consistent scenario as a basis for estimate. [WP4]

Work Package 5: Detectors

Findings

The MIND detector has the most mature analysis of any of the detectors being considered by WP5. They have produced a comprehensive analysis with complete migration matrices, and the results have been made available to the WP6 physics group. Some Neutrino Factory performance studies have already been carried out, and these results have been included in the IDS-NF Interim Design Report. In particular, improved low-energy reconstruction has now been shown, which might permit a Neutrino Factory to operate at a lower energy than 25 GeV. Future work, including the realization of a more realistic magnetic field configuration, has been identified and is getting under way.

The Water Cherenkov detector has also made impressive progress in the past year. Despite the fact that only a small amount of effort is available, new simulations that reproduce the Super-K results have been developed. This work, mainly by a single post-doc who had no access to the “proprietary” Super-K software, represents a substantial contribution to the EUROν mission. The key person has taken a position at another EUROν institution, but is still expected to have some time to devote to this task. The goal is to have a full-performance simulation package, including migration matrices, running by September 2011. This represents an ambitious challenge.

As requested last year, work on the near detector concept has begun in earnest. The concept being explored comprises a vertex detector, a scintillating-fiber tracker, and a muon catcher. An alternative design based on a straw-tube tracker is being pursued in the U.S. (outside of the EUROν effort). Calibration of the flux at high energies (beyond 11 GeV) by means of inverse muon decay has been established and demonstrated to give a 1% flux prediction. For energies below 11 GeV, neutrino-electron elastic scattering is proposed but is not yet demonstrated. Other remaining tasks include tau-charm reconstruction and cross-section error calculations.

As noted elsewhere in this report, lack of dedicated engineering effort is hindering the cost and safety work. It is hoped to get some assistance from Fermilab engineers, but this is not confirmed. Unfortunately, no funds have been identified within EUROν to carry out this task.

Comments

We note that the program proposed by WP5 is extremely ambitious given its tight funding. Only three post-docs plus some “academic time” is available. To keep up with the milestones, tasks have been prioritized. This necessarily results in unequal progress on the three detector concepts.

During the meeting there was some question about whether the relative accelerator-detector timing would be adequate to separate neutrinos arising from interleaved bunches of positive and negative muons. We suggest that this matter be revisited and the results documented in a EUROν or IDS-NF note.

Recommendations

8. Continue MIND simulations with updated geometry, toroidal field, inclusion of taus, etc. [WP5]

9. Bring the near detector design to a level of maturity comparable to that of the MIND, including migration matrices. [WP5]

10. A unified solution to the treatment of systematic errors is urgently needed and should be a priority. We recognize, of course, that this is not an easy task. [WP5, WP6]

Work Package 6: Physics

Findings

We note that the interactions of WP6 with the other WPs are much improved. The interaction with WP4 on various Beta Beam scenarios was very valuable, and the compilation of alternative scenarios is now being used to guide WP4 planning. Active participation of A. Longhin in the WP2 performance estimates has led to more robust conclusions. Discussions with WP3, mainly in the context of preparing the IDS-NF IDR, have likewise been beneficial.

Comments

We thought the joint baseline session organized by WP6 was a good example of the improved communication with the other WPs and we encourage such efforts in the future.

In close collaboration with WP5, good progress has been made in learning how to treat systematics. This will pay dividends in the performance comparisons that EUROν will provide. The implementation of migration matrices to parameterize detector performance, now standard in the GLoBES software, was a very good step forward.

We were pleased to hear about the dissemination and outreach efforts spearheaded by WP6. They have been prolific authors, and all of their reports are made public, either via publication in refereed journals or posting to the arXiv. This sets a good example for all WPs and is to be commended.

Recommendations

10. A unified solution to the treatment of systematic errors is urgently needed and should be a priority. We recognize, of course, that this is not an easy task. [WP5, WP6]

11. The systematics of low-energy neutrino cross sections has been identified as an important issue that can influence the performance comparison of the various facilities. Steps should be taken to clarify this issue. [WP6]