

Re: ZU8005

Byline #12, #24, #25, #30, #36, #42, #43:

Please complete these bylines.

Bylines completed. In #12, INFN has been expanded. All the INFN authors in fact come from various branches of INFN and we have listed them as belonging to INFN as a single institution rather than listing the individual branches separately, which would have made it very "INFN heavy". This is with the authors' consent.

Bylines #18, #48:

Please check for duplication. #18 appears to be a duplicate of #6, #48 a duplicate of #41; please consolidate or expand.

Consolidated

Figure problems with manuscript:

In reviewing the figures of your paper, we noted that the following changes would be needed in order for your figures to conform to the style of the Physical Review. Minor changes may be made by cutting and pasting. Please check all figures for the following problems and make appropriate changes in the text of the paper itself wherever needed for consistency.

Figure(s) [all]:

We will check all figures individually once the manuscript has progressed closer towards publication. We suggest that you check the style of all figures to ensure that they conform to the style of the journal. Below we add a few more specific observations. Please check the remaining figures for similar problems (esp. faint colors, such as yellow or light shades).

Figure(s) [all]:

Please begin the text of the figure captions with "(Color)" when the figures contain color.

Done

Figure(s) [4]:

Please check the color code for the various lines. Please ensure that it is clear, in the figure, in the caption if appropriate, and in the manuscript text.

We have checked Figure 4, and find it is OK and clear.

Figure(s) [22, 23]:

Please ensure that the figure is clear. The red appears to be difficult to see, and the cavity shapes (blue) are faint.

We have made the blue and red lines wider.

Correspondence -- ZU8005/Alsharo'a

REFEREE 2B
ZU8005

The authors have been very responsive to my previous comments. There are just a few loose ends:

PREVIOUS COMMENTS

=====

Old p. 72: lines 7-8 (new p.79, lines 4-5):

ORIGINAL COMMENT: Consistency with Maxwell's equations may ensure that a corresponding coil configuration exists, but not that construction is practical.

AUTHORS' RESPONSE: Added sentence "We still need to engineering studies to ensure that these coils are buildable"

NEW COMMENT: The problem sentence "The actual coils....can be found" has been removed and replaced by one commenting on the unconventional placement of the coils, but implying that their design is conventional. There is now no mention of Maxwell. I was unable to find the "added sentence", but it would seem to be superfluous now.

The section was edited by me (R.Raja) to add the sentence. But it was rewritten by Palmer after this. So the added sentence disappeared, but not from the "referee response". No need for it now as the referee states!

Old p. 73: line 4 (new p.79, lines 11):

ORIGINAL COMMENT: Ungrammatical: "focusing" can't be the subject of "are".

You can say:

- either "So the focusing in x and the focusing in y are...."
- or "So the focusings in x and y are....".

AUTHORS' RESPONSE: corrected grammar.

NEW COMMENT: No correction made. Other options would be:

"...so the focusing in x is not identical to that in y", or
"...so the focusing is not identical in x and y".

Re-Corrected grammar—See Comment above about re-editing!

Old p.76 line 8, p.77 Fig.37 (new p.82, last para; p.84 Fig.43):

ORIGINAL COMMENT:

- The figure shows the x emittance rising from 2.6 to 2.9 mm-rad, not approaching 1 mm-rad, as stated in the text. This non-cooling seems to warrant some comment.
- Is mm-rad the correct unit? The results for the other two ring coolers are numerically similar, but given in mm-mrad, 1000 times smaller.

AUTHORS' RESPONSE: mm-rad are the units used by the people working on this cooler. We see no need to change these at this point. The x equilibrium emittance for the figure quoted should read 3mm-rad.

We have changed the text to read "The equilibrium normalized emittances are about 1 mm-rad in y, 3 mm-rad in x, and around 10 mm in z. The modest heating in x emittance seen in this plot is due to the particular choice of wedge angle. Changing the wedge angle can induce cooling in x but at the expense of the cooling in z.

NEW COMMENT: In fact Fig.43 shows new data, with the emittance decreasing in all three dimensions. The new text reports this, rather than the version given in the response.

My puzzlement at the emittance sizes has been largely allayed by noticing that the mm-mrad units used in the old Fig.33 have been changed to mm(-rad?) in the new version, Fig.39, making the values commensurate with those in Fig.43.

This section was updated also, to bring in new results, which shows the emittance decreasing in all three dimensions. So the correction comment was out of date, slightly. As the referee points out, everything is OK now.

p.78: Table X (new p.86, Table XV):

ORIGINAL COMMENT:

In the table, "Transit time" would be clearer than "Beam time".

RESPONSE: Beam time in table X changed to Beam transit time.

NEW COMMENT: Not changed.

Changed to "Beam Transit Time"

NEW COMMENTS (new page numbers)

=====

p.7, last line of Sec. A: Laboratories --> Laboratory

Changed

p.56 line 6 }

p.59 line 2 } : RF --> rf

p.62 line 18 }

done

p.59 line 1, pp.60-61: Table X is referred to before the new Tables VIII and IX, and so should be placed ahead of them and renumbered Table VIII. At present Tables VIII and IX (to become IX and X) are not referred to in the text. A natural place for such a reference would be in the middle paragraph on p.59.

done

p.60 line 4: Something is missing from this sentence - perhaps "heat load" after "4.5 K"?

Changed the sentence to

The total equivalent 4.5~K for the entire acceleration system is 27.9~kW

p.66 Fig.27: This plan of BNL is a lot clearer than the previous version, but there are a lot of mysterious turquoise objects scattered over the site.

Turquoise objects exist in the drawing, do not signify anything that needs to be described in the caption and are very difficult to remove. So we will leave them there.

p.113 [127], p.114 [128]:

The two PAC conferences should be referred to in a uniform way:

Proc. 1999 Particle Accelerator Conference, New York (IEEE, New York, 1999)

Proc. 2001 Particle Accelerator Conference, Chicago (IEEE, New York, 2001).

Delete "WPAH061" (referring to a particular poster location).

No problems with the URLs.

done

p.116 [153]: Mucool Note 235 needs a URL:

<http://www-mucool.fnal.gov/mcnotes/public/pdf/muc0235/muc0235.pdf>

done

Correspondence -- ZU8005/Alsharo'a

```
\documentclass [12pt]{article}
\usepackage {graphicx}
```

```
\begin{document}
\begin{figure}
\centering
\includegraphics[width=1.65in,height=1.65in]{fig1.eps}
\end{figure}
```

REFEREE 2C

```
\textbf{Referee report on paper ZU8005, ``Recent progress in neutrino
factory and muon collider research within the Muon Collaboration" by
Alsharo'a et al.}
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\textbf{Does the paper contain sufficient new physics to warrant publication
in the Physical Review?}
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This paper is a re-work of a previous version that was sent to me for review. It presents an overall summary of the physics and accelerator issues for neutrino factories and muon colliders.

The emphasis has shifted significantly since the last version: from one in which the muon collider was the primary focus and the neutrino factory secondary, to the reverse order in the current paper. The recent developments in neutrino oscillations are summarized very well and justify this shift in emphasis.

This paper has significantly improved one fault that plagued the earlier paper: it carries a single, perceptible technical design for the muon source, cooling, acceleration, and storage ring rather than a pastiche among

the various competing designs. That fault was fatal to the earlier paper, and the authors have done a very good job in removing it.

The trail of the muons from proton source to final storage ring is well presented. One constructive suggestion: pull Fig. 25 and a more complete version of Fig. 20 up to the beginning of the section on the targetry and cooling, to give the reader a starting overview of the evolution of the number of muons (μ/p) and phase space brightness (emittance density) as the muons move through the succession of stages.

We investigated implementing the above suggestion but have concluded that--Table XII contains information on the loss and the muons per proton at the end of each section. Extending the figures to include acceleration would not be particularly useful: the acceleration would dominate the figure since the distance the particles travel in there is over 10 times what they travel in the front end. The much more informative curves in the front end would then be unreadable. The loss in the acceleration is essentially only due to decays, so the curve would be relatively uninteresting anyhow. Thus, the combination of putting the information in the table and the curves for the front end seems to be the optimal way of presenting the information.

`\textbf{Is the paper scientifically sound and not misleading? Criticisms based on published or unpublished work should be referenced.}`

The paper carries one feature over from the earlier version that is presumably a matter of choice -- it presents both the physics capabilities of the cooled muons and the technical design of the muon complex in a single unified document. I consider this a good thing, and I support it strongly, notwithstanding the `\textit{rejection}` by PRL of several important previous papers which did the same thing for proton-antiproton colliding beams.

We are taking the referee's suggestion seriously and are currently investigating writing followup PRL papers.

`\textbf{Does the paper report a significant advance over previously published} \textbf{work? If a substantial number of its results appeared previously, please cite references.}`

The text reports the present status of the design and supporting R $\{\&\}$ D for muon sources and storage rings. In the section on R $\{\&\}$ D, there is a lot of inappropriate references to studies that 'will be done' and things that 'will be built'. These references are inappropriate to a scientific paper. The authors should report on the elements of their design, the physics it can do, the technology that it requires, and the R $\{\&\}$ D that `\textit{has been done.}` This

section

reads more like a progress report or funding proposal to DOE than a scientific paper. It needs to be re-written.

The R&D section has been edited to remove “the plans” part. Only the R&D scope and what has been achieved is described, in a manner that is suited to a scientific publication.

\textbf{Are there appropriate and adequate references to related work?}

The paper cites appropriate literature for the many physics and technology elements in its subject. One that was missed: the argon detector for neutrino interactions is cited to a recent proposal, but that follows a much earlier proposal (ARGONAUT) at Fermilab that described essentially all of the elements that have re-appeared in the recent Ar proposal and also in the TPC proposal for .

We have added a reference to Argonaut in Reference [31]
An early proposal for a liquid argon detector, ARGONAUT, may be found in G. Harigel, H. Kautzky, P. McIntyre, and A. Van Ginneken, Fermilab Proposal No. 601D, 1978.

Additionally a substantial body of first results have been presented recently from KAMLAND, and might be summarized in the paper where it references that experiment.

We have added the following text on Page 19 on latest KamLand results
The first results from KamLAND have confirmed the LMA solution [57]. A global analysis of the KamLAND and solar neutrino data has further restricted the solar Δm^2 range and the best fit value currently is $7 \times 10^{-5} \text{ eV}^2$ [58,59].

[57] K. Eguchi et al. [KamLAND collaboration], Phys. Rev. Lett. 90, 021802 (2003).

[58] V. Barger and D. Marfatia, Phys. Lett. B 555, 144 (2003).

[59] G.L. Fogli, E. Lisi, A. Marrone, D. Montanino, A. Palazzo, and A.M. Rotunno, Phys. Rev. D 67,073002 (2003).

\textbf{Is the paper well organized and written clearly and correctly? If you find it necessary to write suggested changes on the manuscript for the benefit of the author, please send us the marked pages, not the complete manuscript, with your report.}

Except for the R{\&}D section (see above), the organization and clarity of the paper have improved dramatically from the earlier version.

Are the figures and tables (if any) clear, with suitable captions? See earlier comment about the need for a summary figure showing μ /p and brightness through all elements of the targetry, cooling, and acceleration, placed at the introduction to the accelerator section, to orient the reader in this very complex discussion.

\textbf{Are they all useful? Is there unnecessary duplication of figures and tables?}

The figures are well chosen and well placed. Several of the parametric graphs of signal events and backgrounds in the physics section would benefit by the use of color to clarify the parametric sequences (particularly Fig. 8).

Since this is a review paper, it would also be helpful to non-expert readers to devise a few ideogram figures that explain the modes of phase space cooling that are being done in each of the succeeding systems.

\textbf{Is the paper of suitable length, with no parts too brief or too long?}

Reasonable balance, much better than last time.

\textbf{Should some of the material (for example, long tables) be deposited with the Electronic Physics Auxiliary Publication Service (EPAPS)?}

It would be an interesting idea to deposit one or two example lattices and cooling simulation data in the EPAPS. It would enable knowledgeable readers to evaluate for themselves the pros and cons of the several alternatives that are being considered for the key issues of proton driver, targetry, phase space rotation, and ionization cooling.

\textbf{Are the title and abstract informative, concise, and clear?}

Yes

\textbf{Is the section for which this is being considered (regular article, Rapid Communication, Brief Report, Comment) the best one for this work?}

Length limits apply to Rapid Communications, Brief Reports, and Comments. }

This paper is being considered for PRSTAB. While it devotes roughly equal time to the physics and accelerator aspects of the project, I believe that is legitimately the prerogative of the authors and I respect their choice. I recommend that the paper should be published there, where its 116 page length is supportable.

This work is of immense potential importance to the entire field of high energy physics, however. I would suggest that it would be appropriate for the authors to devise `\textit{in addition to this PRSTAB paper,}` two 'short version' papers, fitting the page limit of PRL, which would provide succinct presentations of the physics and the accelerator aspects of a muon source and neutrino storage ring. These shorter papers should be aimed at the typical high energy physicist who knows little about accelerators, but who must judge the merits of this ambitious project in context with the other major thrusts for high energy research, notably e^+e^- linac colliders and hadron colliders. So far as I know there are no such informative, accessible papers in the literature and there is a need for them.

`\textbf{Does the subject matter of the paper justify the special handling of Rapid Communications?}`

Yes. The paper describes work on one of the three major contenders in the ongoing debate about the best direction for future facilities for high energy research. It is important and timely.

`\end{document}`