Report on JINST 105P 1112

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Title: The design, construction and performance of the MICE target

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Referee report

MICE Publication Review

General Review Comments

I have reviewed the referenced document and find it to be of high quality, originality and relevance. The description of the MICE target design, construction and performance is very thorough and complete. It describes in a high level of detail the technical issues associated with the concept, design, fabrication, assembly, testing and operation of the MICE system. In my re view I find this report to be completely acceptable for publication either as a regular article or as a technical report.

Specific Review Comments

My review of the referenced document finds that it has thoroughly and to a high level of detail documented the entire process of the development, testing and deployment of the MICE experiment at ISIS at the Rutherford Appleton Laboratory. It is very obvious that a lot of effort went into both the experiment development process, and the process of documenting the process. The report is excellent in terms of both quantity and quality of information. The team is to be congratulated for their efforts on this project.

As the scope of the document is well beyond what any one individual would be technically qualified to review, I have asked several of my colleagues to provide their thoughts and comments on the report as well. Those comments, while minimal, have been included as well. I will add that because of the completeness of this report, the overall level of detail comments is also minimal.

Technical Review Comments

1) When discussing the acceleration that the target must achieve, there are three different numbers that show up in the text. On page 5, it mentions 800 ms-2; on page 6, it mentions 950 ms-2; and on page 54, it mentions 780ms-2. While I recognize that they are all stating the same general requirement in different ways, I think it would more consistent to use the same number in all places where it is mentioned, or explain the difference if appropriate.

I thought I'd fixed this one! I propose to change all the numbers to 780 m s^{-2} (together with changes to some other related numbers), as no more can be justified from the performance plot.

2) The discussion of the linear motor design on page 6 talks about the use of the use of a linear actuator design with permanent magnets positioned on the moving part of the target. This obviously adds additional mass and with the chosen solution there is likely no better option. However, the paragraph that discusses the choice of magnets says that the particular type that is chosen was for the greatest field strength. This may very likely be the best choice overall for strength and low mass, but it doesnt explicitly say so. I would suggest adding a statement that says these particular magnets provide the best strength to weight ratio if they do, or look at another option for a lighter magnet if that is a possibility.

I will add "and best strength-to-mass ratio".

3) On page 7, the stator coils are described as being responsible for levitating and holding the target out of the beam. Consider if there is an occasion where it would be advisable to add a secondary mechanical latch mechanism to hold the target out of the beam if necessary for longer-term stability,

or in the case of power failure or shutdown of the MICE system. This may be a function of the larger motorized stage, but it is not clear at this point in the paper.

I am not really convinced this is the correct place for this discussion, but will add "(A motorised jacking platform is used to raise the target from the beam when not in use, as described in section 4.5.)"

4) Figure 3 on page 8 shows an image of the stator coils which are described within the paper, but it would be useful if to include a scale in the photo to give an indication of the size of the components without looking into the text.

Paul(s): if the unused coils and shims are in adequate condition, can we re-take this photo? I would prefer that to photoshopping a scale on!

5) The stator assembly is discussed on page 10. It is not stated if there is any concern about the operation or activation of components of the stator assembly within the radiation filed that the assembly operates. It may not be an issue.

I don't think this is an issue, as this is a passive assembly, not very near the beam. Does anyone have some suggested text here?

6) The target shaft is the main moving component of the assembly so its overall mass is of major consideration. On page 12 the description of the target assembly mentions that a mechanical clamp is used to hold the permanent magnet assembly to the shaft. The question here is can the clamp be replaced with a lighter fixation method, or can the mechanical fixation be designed into the permanent magnet assembly to reduce overall mass of the assembly?

Jason: any comments? Change to "mechanical clamp of minimal mass (?? g)"??

7) There is a lot of discussion and description of the anti-rotation portion of the mechanical design, and it is actually noted as being one of the major design issues to overcome. However, the maximum amount of rotation that is allowable is not discussed. I would suggest putting a short description in that addresses the reason for the concern about rotation, and the amount of rotation that is allowable, and how the final design meets that requirement.

Something could be added on p. 20 where preventing rotation is mentioned. Alternatively, we could add a few sentences at the start of 4.2.3 (p. 21), such as "The position of the shaft is determined using an optical vane (section 5.1) which must be held roughly perpendicular to laser beams. The orientation of the shaft must thus be restricted to a range of ±10°. This is easily achieved by flat sections of the shaft which engage with the upper bearing."

Jason & Paul: can you improve this? Is ±10° correct? What do we actually achieve? Could the wording above and the start of 4.2.3 be changed to reduce duplication but convey the required information?

8) Another component that is affixed to the target shaft is the optical vane. In the interest of reducing overall mass, is there a way in which to incorporate the features of the vane into the shaft itself, either through etching of the shaft or another means of etching the slots into the shaft itself?

The answer to this is obviously "no"! Thin steel is better than etching titanium. If we need to state this, can anyone suggest anything better than adding the following at the end of 5.1? "The attached vane is a much lower mass solution than increasing the width of the titanium shaft and etching slots in this extension."

While there is a very thorough description of the electrical and control aspect of the operation of the MICE experiment, review by my electrical colleagues provided no additional comments for discussion. As with the mechanical aspects of the design, the electrical design appears to be very thorough and well thought out; capable of providing the exacting control demanded by the system.

Overall, the MICE experiment is extremely well documented by this report and is fully acceptable as an article or report in the JINST journal.