Final Report on Cost Estimate of Forward Superconducting Air Core Toroid*

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Abstract

An independent cost-estimate for key components of the forward superconducting air core toroid (ACT) was obtained in May 1992 from an experienced manufacturer of large cryogenic vessels. This new cost estimate is summarized in this report. It implies that a suitably designed ACT may have a cost which is approximately equal to that of the presently designed SDC forward iron core toroid.

Introduction

The SDC decision to use an iron core toroid (ICT) rather than a superconducting ACT for the forward angle region was based on cost and physics benefit issues which have been described in an SDC note (ref. 1). That SDC note also emphasized the large uncertainties in the cost of the ACT. These uncertainties drove the choice toward the ICT, despite the better physics capabilities of an ACT. Main sources of these uncertainties included:

1. Two radically different ACT conceptual designs were made, and their estimated cost differed by a factor of 4.

2. The (lower cost) design made by Advanced Cryo Magnetics (ACM) (described in ref. 2) incorporated several novel design features which were designed to minimize costs. However, no independent cost estimate was available.

A logical next step to clarify these cost matters was to obtain an independent, more detailed cost estimate for the ACM design. For this purpose, a contract was let in early 1992 from ANL to Pitt-Des Moines, Inc. (PDM), a company with extensive experience in the design, cost-estimating, and fabrication of very large, aluminum (welded) cryogenic vessels. PDM was supplied with the ACM conceptual design report (with all ACM cost estimate information omitted).

In the remainder of this note, we first summarize the independent cost estimate report from PDM, then we compare that estimate to the original ACM cost estimate, and finally we give some conclusions.

PDM Report

The report from PDM, dated May 12, 1992, is a 30 page document. Copies of it can be obtained from the present author (email THF@ANLHEP).

The report first notes that the ACM conceptual design report (ref. 2) is not detailed enough to support pricing at the fabrication and welding level. Therefore, additional design work was done by PDM before they made their cost estimate. Furthermore, only 4 major components of the toroid were estimated: toroid former, helium vessel, heat shield, and vacuum vessel. These

particular components were chosen because their design and fabrication features are well matched to PDM's capabilities and experience.

Appendix A is a spreadsheet from the PDM report. It shows that the PDM total estimate for these four components is $2.9M. Appendix B shows the construction time schedule given in the PDM report.

Comparison with ACM Estimate

The total cost of the above-mentioned four components in the ACM estimate (ref. 2) is given as $5.1M. Thus the cost estimating from ACM seems conservative, as was stated by ACM.

Averaging the above two estimates gives $4.0M. To this I shall add $5.4M, which is the cost estimate from ACM of all items (including a liquifier system) which are not included in the PDM study. This yields a new estimate of the total cost per toroid of $9.4M. This is about 10% less than the ACM estimate.

Conclusions

My conclusions are these:

1. A more reliable cost estimate of $9.4M per ACT is now available.
2. This can be compared to the present cost estimate of $8.0M for each iron toroid which can be deduced from ref. 3.
3. The comparative physics advantages of the 100 ton ACT versus those of the 2400 ton ICT stand as described in ref. 1.
4. Independent cost analysis has supported the ACM claim that their design incorporates economical construction and assembly methods.
5. The ACM design also emphasizes high stability against quenches. Independent documented review of this and other fundamental design features would be desirable before more detailed engineering design work were carried out.
6. In view of the cost estimate comparisons discussed in this note, the use of superconducting toroids in the forward angle region should continue to be seriously considered for high energy collider detectors.

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References

APPENDIX B

PRELIMINARY SCHEDULE
SSC - AIR CORE SUPERCONDUCTING TOROID
for ARGONNE NATIONAL LABORATORY

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