A. Appendix: Cost Estimate for the Facility

Determining the cost of a facility as complex as the neutrino source presented here is a very difficult task within the short time period of six months. Three factors contribute to the uncertainty significantly:

1. The number of subsystems in the facility, which are described throughout the report, is comparatively large. All of the subsystems contribute a considerable amount of complexity and cost that have to be addressed by specific expertise in order to find a technical solution and a reasonable cost estimate. The variety of technologies is large and many of them have to be pushed to the edge or beyond and therefore has to be addressed with an appropriate R&D program. Cost savings from mass production will not be major for any of the subsystems in the neutrino source.
2. For many of the subsystems specific R&D has not even started. Although we are confident that the R&D programs will be technically successful, we do not exactly know what the cost of the final device is going to be. For many things estimates were based on present experience and on educated guesses.
3. Many things that are fairly conventional, for example, vacuum systems, correction magnets, and some of the diagnostics, have not been worked on by specialists. Again, educated guesses and experience from other projects have been used in order to determine cost figures. The overall contribution to the total cost from these systems is not more than approximately 10%, but this number could easily be wrong by a factor of two.

It must be understood that the cost estimate for the facility is very preliminary and although it is our best effort, it has a large uncertainty. Some areas are more difficult to estimate than others and it will be pointed out chapter by chapter where this is the case. For the large systems either engineers or project leaders for comparable programs have determined the cost numbers to their best knowledge. For the large systems, like the superconducting rf-accelerators and the high field solenoidal channels, experts (sometimes from all over the world) were brought together; this certainly helped us arrive at a more realistic cost figure. Nonetheless, the outcome of the R&D program could have a significant impact (either favorable or unfavorable) on the estimated cost of some components.

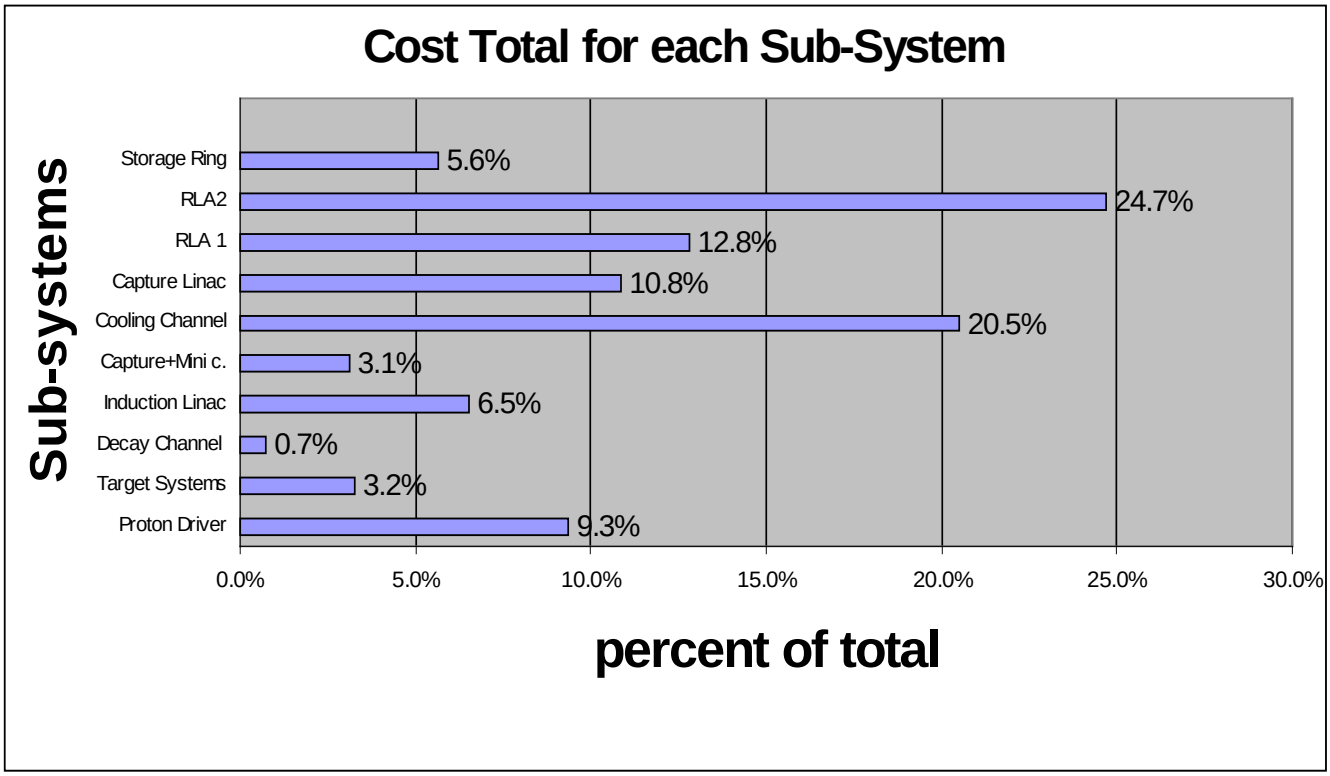
The Overall Cost of the Facility

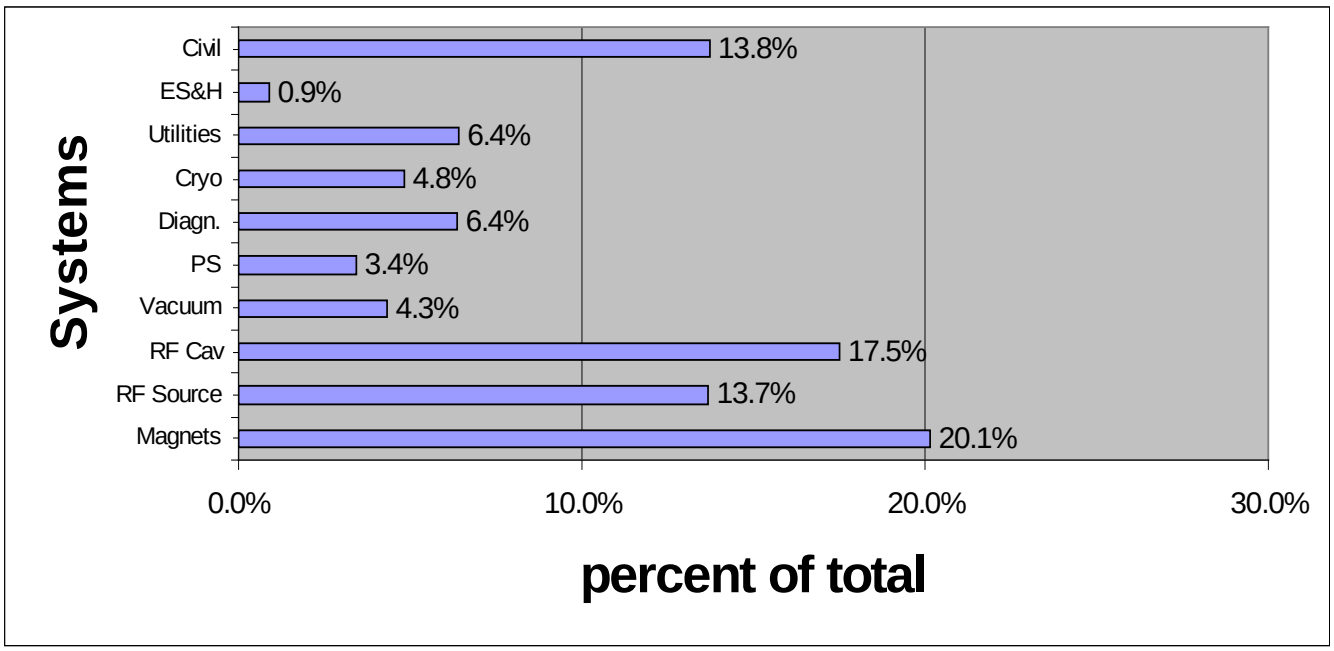
The cost of the Facility is presented in two bar charts. One shows the distribution according to the different subsystems, the other shows the distribution according to the components summed up over all subsystems (magnets, power supplies etc).

The study does not include any contingency, EDIA nor does it consider escalation. It only lists the basic investment costs that have been estimated. Under the column called "Others," typically ten percent of the facility cost was added to account for those items not included; this should not be construed as contingency. The numbers also do not include the R&D money necessary to develop the different systems.

The Power Consumption of the Facility

The power consumption of the facility is significant. Approximately two-thirds of the power goes into the accelerating rf systems (70–80) MW. The proton driver will require approximately 30 MW of average power and the rest of the power is roughly evenly distributed. A total of 170 MW will be required for a 50 GeV facility.





Distribution of cost in percent of the total for the different subsystems and for the components summed up over the subsystems.

Summary

The cost estimates presented here are the result of six month work of a group of approximately 20 FTEs at Fermilab, a large contribution from various other labs, probably another 50 FTEs in total and a number of external experts who were brought in for a couple of todays or for very specific topics. From the result it is obvious that for a complex of that size and complexity this is not enough to give precise estimates, but it is certainly enough to define the R&D programs and to get a first handle on how to stage and how to optimize such a facility. The number as well as the distribution of the cost will allow us to define a route towards such a facility with a minimum of risk and a maximum of physics for each step. It also gives us a clear idea on how to improve performance and on what technological improvements have to be made for each step.

REFERENCES

[1] Neutrino factory physics study coordinators: S. Geer and H. Schellman. See http://www.fnal.gov/projects/muon_collider/nu/study/study.html

[2] Neutrino factory technical study coordinators: N.Holtkamp and D. Finley. See http://www.fnal.gov/projects/muon_collider/nu-factory/nu-factory.html