

# Report

## The General Accelerator Development Review

Argonne National Laboratory

January 24 – 26, 2011

## Executive Summary

A comparative review of national laboratory and university research and development was held at Argonne National Laboratory (ANL) from January 24 through January 26, 2011. ANL was chosen as the host site as that laboratory has no research funded under B&R Code KA150201. Presentations were given by individual research projects at each of the Department of Energy national laboratories as well as presentations from grantees at five universities and/or non-DOE laboratories. A group of five peers acted as consultants to the Office of High Energy Physics.

Twenty-Nine presentations were made over the first two days of the review. Because of the very large number of talks the consultants were asked to provide ratings on a numerical score sheet. Some of the consultants rated every presentation, some rated only overall laboratory groups and some rated only those groups where they had technical expertise. The individual score sheet ratings ranged from "Outstanding/Excellent" at the high end to "Fair" at the lower end. For the most part all of the presentations rated in either the "Outstanding/Excellent" or "Very Good" categories. There were a very few instances where there was a sub-rating in the "Good/Modest" category.

Over all the groups work that was directed rated in the "Outstanding/Excellent" range while work that might be considered to be in the stewardship category rated somewhat less well.

Work at each of the institutions mapped well onto thrusts articulated by the Office of High Energy Physics. In particular research on superconducting RF has applications to ILC and to Project X, energy and intensity frontier applications. Work on superconducting magnets maps onto luminosity upgrades at LHC as well as advanced magnets required for muon physics. Other activities are rightly covered by stewardship responsibilities of OHEP. Investment levels by OHEP on this R&D are appropriate and adequate. Groups working on GAD R&D within the national laboratories are sufficiently flexible to respond to new developments as they arise.

## **1. Introduction**

### **1.1 Background**

Research and Development funded under B&R Code KA150201, General Accelerator Development, covers the transition from pure accelerator science to more directed applications of accelerator technology. Covered under this umbrella is work on effects such as electron cloud, beam instrumentation, superfluid helium cooling and the development of the next generation of high field magnets. In order to assess the quality of R&D funded by GAD a comparative review was commissioned where all of the funded parties presented their work to the same review committee over a two and a half day session.

### **1.2 Charge to the Assessment Committee**

In a November 24, 2010 memorandum (Appendix A), Dr. Michael Procario, then leader for facilities in the Office of High Energy Physics established the assessment committee with the following scope:

1. The quality and impact of the research by the group in the recent past;
2. The scientific significance, merit, and feasibility of the proposed research;
3. The competence and future promise of the group for carrying out the proposed research;
4. The adequacy of resources for carrying out the proposed research, and cost-effectiveness of the research investment;
5. The quality of the support and infrastructure provided by the institution; and
6. How the group enriches the laboratory's experimental program (as applicable), and how well the group's activities relate to the overall HEP mission.

### **1.3 Membership of the Committee**

Dr. Bruce P. Strauss, Program Manager for the U. S. Department of Energy General Accelerator Development, chaired the committee. The committee membership is shown in Appendix B.

### **1.4 The Assessment Process**

The review was based on formal presentations by several groups at the DOE High Energy Physics national laboratories, presentations by research grantees as well as the committee members' considerable experience.

For each presentation by a laboratory or university group the committee was provided an assessment form that is shown in Appendix C. Performance was rated on the following scale:

9-10	7-8	5-6	3-4	1-2
Outstanding/ Excellent	Very Good/ Few areas to improve	Good/Modest/ Some areas to improve	Fair/ Significant weaknesses	Poor/ Not Adequate

The assessment took place January 24 to 26, 2011 at Argonne National Laboratory. On Monday, January 24, and continuing through Tuesday, January 25, the committee listened to over 39 presentations. The third day was devoted to discussions of the committee as well as a short debriefing to the assembled presenters.

Argonne arranged for the review logistics using INDICO for uploading of presentation, posting of the agenda (Appendix D) and for registration.

### **1.5 Answers to the Questions in the Charge**

The Charge Letter by Dr. Procario asked the committee specific questions. The committee's response follows:

## 2.3 Fermi National Accelerator Laboratory

	Fermilab 325, 650 and 3900 MHz Developments			
Organization:	FNAL/AD-TD-APC			
Presenters:	M. Champion			
FY:	2008	2009	2010	2011
325 MHz Funding (\$k)	4263	5555	4322	Not
3.9 GHz Funding (\$k)	5406	2862	599	Shown
FTE	14	17	15	
Total People	~40 people contributing; ~6 with an effort	>35%		

Project Title:	Non-SRF Accelerator and Injector Systems			
	Fermilab High Intensity Neutrino Source (HINS)			
Organization:	FNAL/AD-TD-APC			
Presenters:	R. Webber			
FY:	2008	2009	2010	2011
Funding (\$k)	6956	7764	6734	Not
ARRA	0	0	0	Shown
FTE	23	26	20	
Total People	~103 people contributing: ~18 w/effort	>35%		

Project Title:	Superconducting Magnets			
	Fermilab SC Magnet Developments			
Organization:	FNAL/TD			
Presenters:	Alexander Zlobin			
FY:	2008	2009	2010	2011
Funding (\$k)	3610	3380	2297	Not
ARRA	0	0	0	Shown
FTE	16	14	9	
Total People	~55 people contributing: ~13 w/effort	>35%		

Project Title:	Accelerator Modeling			
Organization:	FNAL/CD			
Presenters:	G. Apollinari			
FY:	2008	2009	2010	2011
Funding (\$k)	857	866	864	Not
ARRA	0	0	0	Shown
FTE	4	4	4	
Total People	~16 people contributing: ~4 w/effort >35%			

Project Title:	Superconducting Materials for SRF Applications			
Organization:	FNAL/TD			
Presenters:	Lance Cooley			
FY:	2008	2009	2010	2011
Funding (\$k)	3317	3270	1930	Not
ARRA	0	0	0	Shown
FTE		10	6	
Total People	~40 people contributing: ~10 w/effort >35%			

The average ratings for Fermilab were in the very good to excellent range in all categories. Specifically they rated 8.69 in Relevance, 8.39 in Approach and Project Management, 8.36 in Technical Accomplishments and 7.41 in Technology Transfer. FNAL had minimum variance in scores with parts of one or two of the presentations in the 7 range.

Stuart Henderson assumed the role formerly held by Steve Holmes as Associate Director for Accelerators last summer. Many of the reviewers were impressed by his eloquence in describing the path forward for accelerator science and development. The laboratory is in the process of reassessing its accelerator development and science program.

The Fermilab presentations covered three main areas: SRF related R&D including materials development, superconducting magnets and accelerator modeling. The last two areas have a legacy track record. The first area has been developed over the last few years responding to the domestic efforts for the International Linear Collider (ILC) as well as Project X, the laboratory's proposed program for the intensity frontier. The Fermilab goal in this area was to become proficient in the design, fabrication and operation of superconducting accelerator structures. The effort was viewed by the committee very favorably except for the comments that much of the facility duplicated resources at other laboratories and universities.

With the aid of significant ILC and ARRA funding Fermilab has established significant infrastructure for the fabrication, treatment and testing of superconducting radio frequency (RF)

cavities. Presentations in this area were made by Webber, Champion and Cooley. One reviewer remarked this regarding the Champion presentation: "The program as a whole is excellent, but there are a few areas that need better understanding or development. Most of the requested fund(s) seem specific to Project X. It's not clear where the dividing line is between GAD funding and project specific." This reviewer also added the following with respect to project management issues with this R&D area: "In general, the R&D approach is excellent. The only factor that needs some improvement is using collaborators to best advantage. While it's nice to have everything under one roof in terms of equipment and expertise, it tends not to be cost effective. Use is being made of ANL and JLab, but not to the extent it is available. For example, ANL has been designing spoke cavities for more than 20 years, but use of ANL is more directed to using their equipment for processing and testing."

The materials work of Cooley received uniform high praise for the quality of the work as well as for interaction with other laboratories and universities. One reviewer stated: "(The work) is effective and cost efficient. Progress in understanding the material aspects of SRF cavities helps both HEP and non-HEP programs. Understanding the role of surface and hydrogen is very helpful. ... They are well connected to other labs and efficiently use those resources. For example, studying hydrogen in cavities by using the alpha backscatter equipment available at Univ. of Michigan." In this strain of remarks the following was made by another review member: "The FNAL SRF materials group has made significant progress over the last few years. The ICPA was completed and allows carefully controlled processing of cavities. Mechanically polishing studies on cavities could be transformational as a way to reduce or eliminate acid based surface processing of cavities. ... The program is well-rounded and has considerable potential to answer important fundamental and technical questions that could push performance and/or reproducibility in SRF cavity development. The research is well integrated in the SRF world community and national programs." Another reviewer observed, "The work by Cooley and his team is top-notch, highly cost effective, and plays well into both the SRF and SC magnet research. It is complementary with the LBNL effort and is relevant to muon collider and LHC upgrades. Nb<sub>3</sub>Al does not look to be useful."

Webber reported on non-SRF accelerator and injector systems. This work was accomplished over the past several years on specific funding for the "High Intensity Neutrino Source" (HINS). In the current budget period much of this work has been transferred to Project X. This work received good reviews citing the ability of the laboratory to construct and deliver hardware as one reviewer stated, "When it comes to constructing hardware FNAL is well prepared and the work is impressive. HINS and the 325 MHz cavities are good examples of such high quality technical work." Another reviewer observed, "Development and demonstration of technologies, either for transfer to other labs, or for incorporation into PX, appears highly relevant. Sustaining this relevance as HINS transitions, and as front end issues for PX are clarified, is to be applauded." This reviewer continued, "Success with deliverables speaks to strong technical accomplishment. Lack of information on publications makes a full judgment of productivity difficult." Finally, an additional reviewer noted, "The HINS project has made good progress since 2006 with an impressive number of developments and a significant addition to the FNAL infrastructure. ... The decision to continue with a test of the vector modulators and solenoid alignment are both reasonable and will be useful for the community."

There were two talks on superconducting magnet work at FNAL by Zlobin and Ambrosio. The talk by Zlobin covered the FNAL approach to development using mirror technology. One reviewer noted, "The use of magnet mirrors has provided a relatively economical way to test alternative coil packages for quadrupoles. Whether this approach is sufficient for the final coil design or whether a sub-scale full model would provide better guidance are questions that I leave (to) the magnet experts of the review team." In this light several of the reviewers questioned the rational for FNAL designing and constructing an 11 Tesla long dipole. This project was mutually set up by FNAL and OHEP as a valedictory test of the magnet group at FNAL. It is not as portrayed in the FNAL presentation a pre-prototype of a dipole for LHC.

The talk by Ambrosio described the FNAL contributions to the long quadrupole for LARP. It should be noted that this project was a multi-laboratory effort. FNAL did indeed provide significant leadership effort for this successful task and the personal contributions by Ambrosio were noted.

## Appendix B

### Members of the Review Panel

Prof. Jay Hirshfield—Yale University

Dr. William Barletta—M.I.T.

Dr. Al Zeller—MSU, FRIB

Dr. Robert Laxdal—TRIUMPF

Dr. Richard Miller—ORNL (Retired)

Office of High Energy Physics Staff

Dr. Michael Procaro

Dr. Bruce Strauss

Dr. L. K. Len