Office of High Energy Physics

Report on the

Annual Review

of the

U.S. ATLAS Detector Operations Program

May 10-11, 2010

Argonne National Laboratory

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EXECUTIVE SUMMARY

The U.S. ATLAS program is highly successful in accomplishing its responsibilities. The U.S. ATLAS program has made significant progress in commissioning the detectors with early physics collider data collected in December 2009 and March-April 2010 following repairs to the LHC. Remaining detector issues are not compromising detector performance significantly and are expected to be addressed during the 2012 LHC shutdown. The goals and milestones required for 2012 shutdown are not completely determined pending key decisions. It was noted that taking responsibility for the Tile Calorimeter low voltage power supplies (LVPS) represents an increase in scope for the U.S. program, motivated by the U.S expertise in this area.

The U.S. ATLAS computing and software effort has created the top performing ATLAS Tier 1 center and it has exceeded the international obligations. U.S. physicists have been utilizing the Tier 1 not only for its intended purpose of serving and storing datasets but also as a data analysis tool. Currently, this data distribution and analysis model is acceptable but there is concern that this could very quickly become untenable. The roles of the Tier 2 centers in analysis should increase in importance, especially as the expected infrastructure and resource upgrades take place through 2012.

U.S. ATLAS is pursuing detector R&D programs to prepare for upgrading the detectors to replace failing components and to preserve physics capability with a focus on the Insertable B Layer (IBL). It was noted that the physics case for the upgrades, particularly for the IBL, needs to be fully developed and approved by CERN before the upgrades could proceed.

There is a clear delineation between the U.S. detector operations and research programs. In particular, the operations program is supporting manpower for detector operations, software and computing, and upgrade research and development and the operations program is not funding physicists to carry out analysis work. The U.S. ATLAS detector program is responsible for enabling physics analysis at U.S. based facilities for U.S. researchers based both at CERN and in the U.S.

The U.S. is well represented in the collaboration based on the participation in talks in ATLAS forums. There is strong presence of U.S. ATLAS graduate students and post-docs at CERN which ensures a big impact on the physics output of the experiment. However, the effectiveness of the U.S. based analysis support efforts was difficult to evaluate, in particularly the current system of jamborees and forums appear to serve a small subset of the U.S. community.

It was widely agreed that the Open Science Grid has been critical to the U.S. ATLAS ability to do physics. The continuation of the OSG infrastructure maintenance and operations may be crucial for the experiments, and the funding agencies should ensure that grid operations are supported past 2011, or until a replacement has taken shape.

Introduction

The program for U.S. LHC Detector Operations is funded and overseen jointly by the Department of Energy (DOE) and the National Science Foundation (NSF). It provides support for three areas of endeavor: (i) maintenance and operations (M&O) of those components of the ATLAS and CMS experiments that have been negotiated as specific U.S responsibilities, and includes the commissioning and integration (C&I) of subsystems, (ii) development of software and computing (S&C) facilities and tools needed to provide the foundation for reaching the envisioned scientific goals of the LHC, and (iii) support of detector R&D for future upgrades of ATLAS and CMS. In addition, DOE and NSF provide support for global costs of detector operations (common funds) that are shared by participating nations according to certain accepted rules, based primarily on the number of Ph.D. scientists participating in an experiment. Brookhaven National Laboratory (BNL) and Fermi National Accelerator Laboratory (FNAL) serve as the host laboratories for the U.S. involvements in the ATLAS and CMS experiments, respectively.

The review of the LHC Detector Operations program was hosted by Argonne National Laboratory on May 11–14, 2010, with the goal of evaluating the integrated LHC detector operations program comprising the proposed scopes and costs of the M&O and S&C efforts for the period FY 2010–2016. The review was held in two sessions: May 11–12 for U.S. ATLAS, May 13–14 for U.S. CMS. An outside panel of experts was asked to examine the general plans for operations in FY 2010–2016, including the current commitments for completion of the commissioning and integration of the detectors, the status of detector R&D efforts and the computing infrastructure developed for data analysis. The panel was composed of nine experts. Seven panel members, external to the LHC program, reviewed U.S. ATLAS and U.S. CMS. The U.S. ATLAS panel was completed with two members of the CMS collaboration. The charge to the review committee is reproduced in Appendix A. Budget guidance given to U.S. ATLAS is shown in the following table based on a nominal of $9M/year of NSF funding, and an intended escalation of the DOE 2010 contribution by 2.5%. The high and low scenarios are scaled from nominal by NSF contribution by ± 10% and DOE contribution by ± 5%.

	2011	2012	2013	2014	2015	2016
NSF High	9,000	9,900	9,900	9,900	9,900	9,900
NSF	9,000	9,000	9,000	9,000	9,000	9,000
NSF low	9,000	8,550	8,550	8,550	8,550	8,550

DOE high	28,713	29,668	30,410	31,169	31,948	32,746
DOE nominal	27,346	28,255	28,962	29,685	30,427	31,187
DOE low	25,979	26,842	27,514	28,201	28,906	29,628
Atlas high	37,713	39,568	40,310	41,069	41,848	42,646
Atlas nominal	36,346	37,255	37,962	38,685	39,427	40,187
Atlas low	34,979	35,392	36,064	36,751	37,456	38,178

Funding guidance given to U.S. ATLAS in thousands of dollars for the review.

RESPONSES TO THE CHARGE

Comments of the committee members are summarized in the context of the charge points. The members of the committee were in agreement on all major points. In addition to the summary of the comments, direct quotes from the letters are embedded to add emphasis to particular points. Additional information on detailed suggestions relating to the specialized expertise of the committee members is available in the individual letters.

Assess the ability of the management to track program scope, to prioritize activities, assess risk, and to respond to unforeseen technical or funding challenges;

The Operations Program had an excellent start. The Program Managers are experienced and capable; they set up plans to track program scope, assess risk, and respond to unforeseen circumstances. Management mechanisms for prioritization have been established, and the procedure is an appropriate one for a program of this nature. It is being used now for the first time to develop plans for FY 2011 and FY 2012 in the context of the three budget scenarios. However, the process has not been fully exercised yet and thus cannot be fully evaluated for effectiveness. It was noted that the change control process has no formal input from the U.S. ATLAS collaboration and provides only notification to, but no input from international ATLAS management.

Are the costs and budget projections for operations consistent with the funding guidance for FY 2011–FY 2016 from DOE and NSF and with the current LHC schedule?

The costs and budget projections are consistent with the funding guidance for FY 2011-16. U.S. ATLAS management quantified how the program would be modified to fit within the low, medium and high funding scenarios requested for this review by presenting a detailed Request beyond the Target list. M&O is the top priority, and preserved in all budget scenarios. Although a relatively small fraction of U.S. ATLAS operating costs, an effort is made to protect R&D funding in all scenarios. For lower funding scenarios, some contraction is foreseen in computing and management reserve. Computing stands out as a large expenditure (roughly one-half) in the U.S. ATLAS operations budget; this is the piece that can effectively be scaled to higher and lower budget scenarios. U.S. ATLAS intends a thorough cost-benefit analysis to decide where to best put

resources (Tier 1, Tier 2s, etc) in the future based on utility for the ATLAS U.S. physics program and U.S.-based research.

There were no comments from the committee to indicate that the higher funding level would be enabling. The reduced funding scenario entails reductions in computing and management reserve which could increase risk that U.S.-ATLAS will not be able to react as well to unforeseen circumstances. One reviewer concluded the budget scenario exercises shows that the target budget covers the needs of U.S. ATLAS more than adequately.

Have credible estimates been made of personnel needed to run and maintain the experiments during FY 2011-2016? Have appropriate deliverables been defined?

The estimates for M&O were considered credible with the technical staff well-aligned with the needs of a detector at this stage and represent a ramp down from detector construction phase. About 2/3 of this staff (38 FTE in FY 2010) is located at CERN, which is necessary for repairs, improvement and additional commissioning. The level of staffing should remain roughly constant for the next few years, and then roll off further as the detector achieves stable operations after the FY 2012 shutdown. The committee noted that the upgrade and M&O managers should consider optimizing the continuing manpower effort in light of stable detector operations along with increasing upgrade needs.

Are the proposed milestones for FY 2010 and FY 2011 reasonable and appropriate? Is the scope of the proposed goals for the FY 2012 shutdown appropriate, given the time available to prepare the length of the shutdown and the long term needs including higher energy LHC operations?

Problems that have been identified in the commissioning and early running will be addressed in the FY 2012 shutdown. The U.S. responsibilities are the Liquid Argon (LAr) Calorimeter low voltage power supplies and LAr Calorimeter optical transmitters. U.S. ATLAS has also assumed a leading role in the Tilecal low voltage power supply (LVPS) replacement. The U.S. ATLAS management has a credible plan to assess and address these problems in the FY 2012 shutdown, although the full goals and milestones have not yet been fully developed pending some key decisions which could have a large impact on the work needed to be done during the FY 2012.

Are the core areas of scope defined appropriately for a long duration operations program? Is the scope well matched to the resources available?

In general, the scope appears to be appropriate. The scope of the U.S. ATLAS contributions to International Atlas is broad, and is spread across many areas of the experiment. Members of the committee suggested the management to look across the entire experiment to ascertain that U.S. service contributions do not represent too much in excess of what is appropriate, proportional to U.S. participation in ATLAS, although it was noted that a somewhat larger-than-nominal commitment by the U.S. is natural given the expertise of U.S. participants.

It was unclear to the committee whether the current work that U.S. ATLAS has taken on to address technical challenges, such as the low voltage power supply issues, will become an additional long term commitment in scope by U.S. ATLAS.

One point of concern for possible scope increase involved the inability of some Tier 2 host universities to provide infrastructure as planned which has lead to request for additional resources from the program. U.S. ATLAS plans to recomplete the Tier 2 centers after FY 2012, so that infrastructure support for the Tier 2s does not become a lasting obligation of U.S. ATLAS.

Are the tools available to enable the U.S members of the collaborations to access the LHC data for analysis within the U.S? Is the expected level of service commensurate with the DOE/NSF investment in LHC computing?

The survey conducted of the U.S. ATLAS collaboration shows that groups are able to run jobs, find the datasets they need, and get access to the computing infrastructure. U.S. ATLAS is represented well at talks. The metrics shown at the review indicate that analyzers are able to get to the data and perform analyses. The Physics Analysis Workbook was called out as an extremely useful tool for U.S. ATLAS physicists to use to come up to speed in doing physics analysis.

The survey results and the low turnout at the jamborees seem to indicate that the forums and jamborees might not be effective. One reviewer remarked:

> *U.S. Atlas seems to be focusing on documentation as well as providing meetings and forums via conferencing tools for U.S. personnel to discuss common problems. But, of the 21 U.S. Atlas groups surveyed who responded; only 8 participated in the U.S. analysis forums. 12 did not participate and one group apparently did not know such forums existed (see Cochran's talk slide 35). It is not clear if the 8 groups that participated in the forums found them useful. These results and the low turnout at the jamborees seem to indicate that the forums and jamborees are not terribly successful.*

The committee noted that a strong presence of U.S. ATLAS graduate students and post-docs at CERN ensures a big impact on the physics output of the experiment. Nevertheless, researchers based in the U.S. should have the possibility of contributing significantly and having a big impact as well. For the ones stationed in the U.S., an access to analysis and computing resources should be facilitated with help available in the same time zone.

Nevertheless, in the steady state it seems that the number of U.S. physicists in residence at CERN may decrease, either mandated due to funding fluctuations, or naturally due to a successful model of collaboration from within the U.S. While the current U.S. Atlas weekly meetings and Forum groups seem sufficient for the short term, U.S. Atlas should be encouraged to develop a stronger model for domestic collaboration and participation in the Atlas physics program, so that U.S. physicists will not need to rely on residing abroad for success. This will ensure success if funding becomes unavailable to support many physicists abroad, and it will also enable a more diverse population of physicists to participate effectively, since many U.S. physicists have personal constraints preventing them from relocating abroad, and senior physicists with much expertise are often needed domestically for teaching duties.

Have any proposed detector or component replacements targeted for 2015 been sufficiently justified in light of the changed LHC luminosity profile? Are the estimated costs and personnel for upgrade R&D reasonable?

The uncertainty in the LHC schedule and luminosity profile makes planning for the upgrades challenging. In a dedicated presentation, U.S. ATLAS outlined the areas under consideration for upgrades, including a discussion of a DOE plan to shift R&D funding from the U.S. ATLAS program to a generic detector R&D program. U.S. ATLAS Management has adapted to this plan and has identified projects which would compete strongly for generic R&D funding, while preserving the "ATLAS-specific" projects as part of the operations program.

U.S. ATLAS has made a large investment in prototyping for the proposed IBL silicon device which U.S. ATLAS proposes to start construction, as the first upgrade, within the next year or two. The committee observed that the physics justification for IBL has not yet been fully developed as that would require a simulation effort to see how the effects of the improved track resolution would translate into improved b-tagging efficiency and purity. Further it was noted that this upgrade has not yet been approved through CERN procedures. The committee advises against U.S. ATLAS proceeding with this upgrade until the physics case has been made and the project has been endorsed.

Significant R&D has been in progress for the insertable B layer pixel detector for several years. This upgrade is targeted for the 2015 shutdown. Management has developed milestones for this project, including submission of the front-end chip (May 2010) and detector technology choice (early spring 2011). This pixel layer is clearly the highest priority for the ATLAS Collaboration worldwide, although a thorough, compelling physics argument has not yet been made. The additional layer closer to the interaction region will undoubtedly improve track resolution, but it is not immediately clear that this will improve b-tagging.

It was stated that the motivation for the forward muon upgrade which will complete the forward muon system is not clear at this point as forward muons are not the top priority in terms of physics, and the backgrounds in the forward system at even modest luminosity are not yet known. It was noted that the FastTracKer (FTK) did not reside currently within the operations program.

What is your assessment of the quality of the U.S. contributions to the LHC experiments?

The consensus of the committee is that the quality of the U.S. contributions to ATLAS has been very high, as emphasized in the following quotes.

> *The LHC is a crucial component of the U.S. High Energy Physics Program, and strong and successful participation in the ATLAS and CMS experiments by physicists from American universities and laboratories is very important. The U.S.-ATLAS Operations Program is meant to enable and support this participation and based on the very early indications from the startup, it is being successful in this objective. The U.S. ATLAS Operations Program Managers are experienced and capable and are clearly doing a good job of managing the program. This is reflected in the excellent results in terms of the overall U.S. contributions to the ATLAS experiment, the computing performance, and how well the program enables U.S. participation in the overall research program of ATLAS.*

> *The level of performance achieved so far, and the rapid output of first physics results are impressive and demonstrate the quality of the collaboration, commissioning plan and detector operations effort.*

Have the U.S. LHC Operations Programs responded satisfactorily to recommendations and comments made at previous reviews?

The committee as whole felt that the U.S. ATLAS Detector operations program has responded satisfactorily to past recommendations and comments.

RECOMMENDATIONS

1. Evaluate the impact of the jamborees and forums and make adjustments as necessary. Engage U.S. ATLAS collaborators to determine if a more cohesive collaboration of U.S. participants is desired.

2. U.S. ATLAS should not proceed with the IBL project until a sufficiently compelling physics case for it has been made and endorsed by review by CERN and the U.S. funding agencies.

3. Continue to optimize M&O effort during periods of stable detector operations

4. Pursue the planned cost-benefit analysis of computing resources taking in the needs of the Atlas U.S. physicists and U.S.-based research as well as meeting international commitments and report the results at the next U.S. ATLAS operations review.

5. The prioritization procedures outlined in the Program Management plan should be fully exercised and their performance evaluated and modified if necessary. Evaluate the change control mechanism and modify if necessary.

6. Management should develop plans for the FY 2012 shutdown as soon as CERN solidifies its plans for the accelerator.