

# US ATLAS Physics Analysis Support Task Force Report to the US ATLAS Research Program Management

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## Executive Summary

The US ATLAS Research Program Management formed a Task Force to address the issue of how the US ATLAS community should organize itself to most effectively participate in and integrate into the worldwide ATLAS physics program. The Charge to the Task Force was:

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The issues of physics analysis support are complex, and opinions on how best to facilitate US physicist participation in the ATLAS physics program range from a minimal US support structure to a more complete network of national and regional centers. We would like the task force to address the following questions:

1. What should be the role of a national support center and what functions should it provide? What is the definition of the center (type of personnel, facilities, support)?
  2. How many regional centers should there be, how should they be supported and what role would they play in the physics analysis support? We are not asking you to select centers, but to guide us in understanding what would serve US ATLAS needs best.
  3. What are the requirements for collaborative tools? Effective communication within the US and with CERN will be critical, and understanding what functionality is needed will be important in establishing standards and guidelines that we can all adopt within the US.
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The Task Force solicited and received input from members of more than 75% of the US ATLAS institutions, considered input from the various reviews of US ATLAS software and computing, and received suggestions from the US ATLAS Management in fulfilling its mission. The Task Force held detailed discussions in meetings spanning several months.

The physics analysis support structure needed by US ATLAS and recommended by this Task Force is one that takes full advantage of the unique resources that are available at the three National Laboratories that are geographically distributed in the US: Brookhaven National Laboratory (BNL), Argonne National Laboratory (ANL), and Lawrence Berkeley National Laboratory (LBNL). The support structure also makes maximum use of the talent that is dispersed throughout the groups at US ATLAS universities.

The recommendations from the Task Force in response to its charge are:

### **Recommendation 1:**

The physics analysis support organization should consist of an *Analysis Support Group* (ASG) and *Analysis Support Centers* (ASCs). The ASG will consist of a group of experts from throughout US ATLAS universities and laboratories. The ASG will work to provide the required software and analysis support to the collaboration via regional interactions at the ASCs and by direct contacts via the web or email. The Group will be led by a Chairperson, chosen by US ATLAS Management, and a Deputy Chairperson nominated by the Chairperson. It is estimated that about 10 FTEs will be required to form this Group. The geographical distribution of these FTEs is to be defined later by the US ATLAS Management.

### **Recommendation 2:**

There should be three regional Analysis Support Centers: centered in the Eastern US (at BNL), the Midwest (at ANL) and in the Western US (at LBNL). This geographical distribution will facilitate access to the ASCs by universities in all parts of the US. The functions of the ASCs will be to:

- Provide office and meeting space and associated support for researchers during collaborative analysis efforts and for training purposes.
- Provide technical assistance to students, postdoctoral researchers, university faculty members, and groups in setting up their local analysis environment.
- In collaboration with universities in the region, organize seminars and training sessions for large groups of researchers.
- Serve as the home base for some members of the Analysis Support Group, contributing expertise to the overall US physics research effort by contributing reconstruction utilities and experts who are rotating members of the Analysis Support Group.
- Establish strong collaboration with the national Tier 1 and the regional Tier 2 computing centers. Examples of this might include providing assistance with and easy access to computing resources and contributing to the data validation efforts at these computing centers.
- Interact with the various ATLAS physics and performance groups.

### **Recommendation 3:**

BNL should function as the coordination Center for US ATLAS physics analysis support. It will have management and support responsibility for the activities of the Analysis Support Group and the regional Analysis Support Centers. The Chair of the Analysis Support Group will have a close association with BNL, since frequent interaction between the ASG Chair and the US ATLAS Research Program Management is foreseen. BNL will also coordinate and support the deployment of collaborative tools for the ASCs and for general use in US ATLAS.

## Introduction

The ATLAS experiment at CERN is expected to be among the most likely venues for new discoveries in all of physics. The experiment will explore the fundamental nature of matter and possibly time and space themselves, and the forces that determine their behavior at the energy frontier.

The United States has already played a prominent role in shaping the future of this activity. To date, there are 34 institutions in the US that are part of the ATLAS collaboration. The US ATLAS community has made major contributions to all of the ATLAS detector subsystems and all of the software development for the experiment, in many cases playing leadership roles within the subsystems.

In order to maximize the science return on the considerable investment that has been made, it is essential that US ATLAS physicists be provided the resources to perform the complex data analysis within the overall ATLAS organization of combined detector performance and physics groups. This participation is rather straightforward for those scientists who are resident at CERN; it may present special challenges for those who choose to carry out the bulk of their analysis in the US.

The following objectives were felt to be of paramount importance in the discussions leading up to the recommendations given below:

- The ATLAS experiment is at CERN and there will be a significant US presence at CERN. Close contact between US ATLAS physicists and CERN must be maintained.
- Research must be facilitated by the physics analysis support structure, not managed by it. The distinction between physics analysis and physics analysis support is preserved in this report.
- The physics analysis support structure must ensure good representation and promote visibility of US efforts and young physicists in ATLAS.
- The physics analysis support structure must be flexible to the changing demands of the ATLAS organization and the experimental program.
- The physics analysis support structure should be lean and efficient.

Some of these objectives have begun to be informally implemented. An ASG has started to operate and many colleagues have experienced the advantages that come with it. This analysis support structure allows groups to use the support to different extents. People with different levels of ATLAS experience will utilize different aspects of the ASG support. Examples of how this model is already being implemented in some form are provided in the Appendix to this report.

## Analysis Support Organization

### **Recommendation 1:**

**The physics analysis support organization should consist of an *Analysis Support Group (ASG)* and *Analysis Support Centers (ASCs)*. The ASG will consist of a group of experts from throughout US ATLAS universities and laboratories. The ASG will work to provide the required software and analysis support to the collaboration via regional interactions at the ASCs and by direct contacts via the web or email. The Group will be led by a Chairperson, chosen by the US ATLAS Management, and a Deputy Chairperson nominated by the Chairperson. It is estimated that about 10 FTEs will be required to form this Group. The geographical distribution of these FTEs is to be defined later by the US ATLAS Management.**

The Task Force recommends that an organization of Analysis Support Centers (ASCs) be formed to facilitate the participation of US physicists in the ATLAS physics program. An Analysis Support Group (ASG) will coordinate the activities of the Centers. It should be emphasized that the ASG and these Centers do not replace CERN equivalents. On the contrary, one of their functions is to facilitate and improve the interaction of US physicists with the international analysis activities in ATLAS. One of the members of the ASG will be at CERN to help maintain a close coordination with activities going on at CERN. Additionally, each ASC will be represented by a contact person who will be part of the ASG and therefore report to the Chairperson.

### Analysis Support Group:

The roles of the ASG are many and will surely develop with time, as the research emphasis and the composition of US ATLAS (and ATLAS) change. The ASG should offer, in broad terms, the following functionality.

- Provide up-to-date information on sub-detector and software components for US ATLAS physicists.
- Maintain up-to-date analysis web pages, especially US ATLAS Tier 1 and Tier 2 specific aspects.
- Provide materials for analysis software tutorials.
- Identify existing (or the lack of) expertise within US ATLAS; establish a network of support.
- Work with US physicists to resolve software, detector or physics problems encountered in their analyses.
- Facilitate communications by holding regular meetings and providing a forum for technical discussions.

The ASG membership includes at least three positions, the Chairperson, a Deputy Chairperson, and a representative at CERN. The Chairperson is appointed by the US

ATLAS Management. He or she then nominates the other two members. The Chairperson needs to be associated with the coordinating Analysis Support Center (BNL), in a manner similar to other US ATLAS Management positions, but does not need to be a BNL staff scientist. The ASG Chairperson assumes overall responsibility for coordinating the ASG activities and is the contact point with the ASG for interested users in US ATLAS.

The ASG Chairperson, in consultation with the current ASG membership and US ATLAS Management, appoints new members who are then approved by the US ATLAS Research Program Manager. The membership of the ASG should be selected to provide support of critical reconstruction and analysis tasks. Overall responsibility at each ASC will be assumed by a contact person at that ASC; this contact person will be a member of the ASG. The Task Force anticipates that the membership of the ASG will evolve with time as the needs of the experiment and the US collaborators also change and mature. The ASG needs to maintain a list of detector experts, including hardware and software experts. The people on this list can be called upon to solve specific problems. It is estimated that about 10 FTEs will be required in order to form a useful and vital ASG.

#### Justification for Analysis Support Centers:

The complexity of the ATLAS experiment is such that it is very difficult for any single group, even one at a National Laboratory, to have sufficient expertise to cover all aspects of the experiment. For each physics analysis, one needs to understand in detail the detector response to both the physics signal and backgrounds. This includes the performance of all three trigger levels, the reconstruction, and detector calibration. Depending on the physics topic, the importance of different detectors will clearly vary. However for most analyses researchers will have to understand the performance of multiple systems. Thus broad expertise in the detector and its performance will be needed. The Analysis Support Group will help to supply this expertise.

Personal presence at working meetings and workshops is important for many US ATLAS collaborators. Geographical distance and ease of travel is therefore an issue for US universities. This consideration leads to the geographically distributed approach of Analysis Support Centers described here as the most efficient model for US ATLAS. The presence of visiting researchers at an ASC can extend from a few days to a longer, more permanent period. Graduate students and post docs from university groups could spend a significant amount of their time at these Centers, and will therefore become a part of the expertise described above. The Centers are a clear alternative to sending lots of people to CERN.

There is a general realization that when beam collisions start it will not be possible for many of the US physicists to be at CERN full time. The limitations on being at CERN are: financial (limited US funding to support people at CERN), limited space and infrastructure support at CERN, family obligations, and faculty requirements to teach. Thus it is imperative that US physicists be able to work effectively in the US at their home institution.

The aim of the Analysis Support Centers is to provide a coherent effort in order to bring together the detector performance, software, and reconstruction expertise in the US in support of physics analysis.

## **Recommendation 2:**

**There should be three regional Analysis Support Centers: centered in the Eastern US (at BNL), the Midwest (at ANL) and in the Western US (at LBNL). This geographical distribution will facilitate access to the ASCs by universities in all parts of the US.**

### Regional Analysis Support Centers:

The geographical distribution of US ATLAS institutions suggests that the formation of regional Analysis Support Centers is the best way to support ATLAS physics analysis in the US. The three National Laboratories in US ATLAS (ANL, BNL, and LBNL) are a clear asset to the collaboration. (While this Task Force was not asked to choose regional Analysis Support Centers, it was felt that this fact should be emphasized.) They potentially provide resources that can be used to advantage for physics analysis support. Based on the feedback from the collaboration, many university groups favor this model. Since the expertise is distributed across the country, regional groups may make the most effective use of this expertise. There should be a contact person associated with each regional ASC.

The ASCs will provide support for groups in their regions as well as for those groups and individuals not in close proximity to them but sharing physics interests. So although they are generically referred to as “regional”, it is expected that their use will be dictated by the geographical proximity of the institutions in each group and/or their common physics interests. The functions of these regional ASCs include:

- Provide office and meeting space and associated support for researchers during collaborative analysis efforts and for training purposes.
- Provide technical assistance to students, postdoctoral researchers, university faculty members, and groups in setting up their local analysis environment.
- In collaboration with universities in the region, organize seminars and training sessions for large groups of researchers.
- Serve as the home base for some members of the Analysis Support Group, contributing expertise to the overall US physics research effort by contributing reconstruction utilities and experts who are rotating members of the Analysis Support Group.
- Establish strong collaboration with the national Tier 1 and the regional Tier 2 computing centers. Examples of this might include providing assistance with and

easy access to computing resources and contributing to the data validation efforts at these computing centers.

- Interact with the various ATLAS physics and performance groups.

### **Recommendation 3:**

**BNL should function as the coordination Center for US ATLAS physics analysis support. It will have management and support responsibility for the activities of the Analysis Support Group and the regional Analysis Support Centers. The Chair of the Analysis Support Group will have a close association with BNL, since frequent interaction between the ASG Chair and the US ATLAS Research Program Management is foreseen. BNL will also coordinate and support the deployment of collaborative tools for the ASCs and for general use in US ATLAS.**

#### Management:

BNL will have the responsibility for management and support of the activities of the Analysis Support Group and the regional Analysis Support Centers. The Chair of the Analysis Support Group will have a close association with BNL, since frequent interaction between the ASG Chair and the US ATLAS Research Program Management is foreseen. The co-location of the Tier 1 computing center and the BNL ASC will enhance user access to data and may allow for more effective use of some BNL personnel.

#### **Collaborative Tools**

The implementation of this model requires careful consideration of how the collaboration will make use of these Centers. Physical presence at any location during many critical periods of analysis may be challenging or may not be possible at all. The Task Force feels that the model proposed will make heavy use of modern technology and new advances in collaborative tools. In order to have a quality national suite of tools available, the coordination and support of collaborative tools for the ASCs will be centered at BNL.

The following are some general recommendations:

- Research groups need high quality videoconferencing systems in the US and at CERN with appropriate industrial standards to ensure US ATLAS physicists can participate in every major ATLAS physics working group, many of which will meet weekly.
- The ASG Chairperson should assign responsibilities to help coordinate collaborative tool equipment selection and procurement and operation, to share

the collective knowledge that has been acquired, and to help reduce communication costs by optimally using IP technology.

- To train new students and researches, the ASG should offer periodic and up-to-date tutorials that are archived and made available in the collaboration.
- Major US ATLAS meetings (or for this matter ATLAS meetings) should be broadcast to allow a large number of US ATLAS members to follow plenary sessions.
- Improve US ATLAS web pages so that information can be easily found and is kept up to date.

### **Metrics with Which to Gauge Accomplishments**

A list of metrics should be established to provide a measure of the effectiveness of the ASG/ASC analysis support organization. As the objective of the model is to support physics research, it is difficult to develop a clear and objective set of metrics that is easy to quantify. Since the aim of the support structure is to enable US physicists to participate effectively in ATLAS physics analysis, the Task Force proposes the following metrics:

- US participation in ATLAS Physics and performance working groups.
- Leadership roles played by US physicists in ATLAS Physics and performance groups.
- US contribution in reconstruction and subsystem software.
- US participation in ATLAS Physics weeks.
- Center utilization – e.g. number of tutorials, number of visitors.

### **Implementation**

This Task Force recognizes that the US ATLAS Management must discuss the recommendations in this report with the management at the National Laboratories in order to negotiate the resources needed to implement the model. The Task Force suggests that the US Management evaluate annually the effectiveness of the model described in this report after it is implemented.

## Appendix

Presented in this Appendix are a few examples that illustrate the operation of the Analysis Support model described in this report. The examples are based on existing efforts in the US.

- BNL physicists already work closely with the Tier 1 facility to ensure the accessibility of data. For example the DC2/Rome MC data was made available at BNL, as was CPU time for user analysis activities.
- ATLAS physicists have come to BNL to discuss possible physics analysis projects that might contribute to ATLAS software and/or detector performance studies.
- The Analysis Support Centers host a limited number of faculty, post docs and students. As an example, one US ATLAS collaborator is spending his sabbatical at BNL this year and has benefited from the interaction with local experts and facilities. US ATLAS benefited from his muon support role. (This person has a major responsibility in ATLAS for coordinating the MOOR Muon reconstruction).
- Electron-photon-identification (e/gamma) activities started with a working meeting at BNL, in which the topics of interest to US groups were identified, in consultation with the CERN e/gamma convener. It was then followed up with visits by university professors and their postdoctoral researcher to BNL, monthly phone meetings to ensure progress, constant interaction with the scientists in some of the university groups, help to US physicists giving talks at ATLAS meetings, and connections to other ATLAS groups working on the same project.
- BNL physicists have gone to a number of universities to give customized tutorials. This activity has continued with tutorials being given at US ATLAS physics meetings and the tutorials have formed the basis of others whose focus is the use of the Tier 2 computing facilities.

Regional groups are already active in US ATLAS.

In the Midwest, the US ATLAS Midwest Physics Group has been active for approximately 12 months and comprises a collaboration of physicists from nine institutions. The group activities include:

- A web site to maintain pointers to more commonly needed information on software, datasets, meetings, and physics interests.
- The organization of regular physics meetings (a total of eight in the past year). The location of these meetings has rotated among the collaborating institutions and considerable use has been made of ad hoc video conferencing to provide access to individuals whose schedules preclude their participation in person.
- Preparation of condensed datasets at the University of Chicago/Indiana University Tier 2 computing center for general use.

- Individuals in the group have provided hands-on tutorials developed explicitly to deal with the software environment at the UC/IU Tier 2 computing center as well as address specifics relating to the BNL Tier 1 computing center and CERN. They have also produced example analysis scripts and have good contacts with many software experts.
- The group as a whole has strong connections to several ATLAS reconstruction and physics groups (Jet/ $E_T^{\text{miss}}$ , Higgs, SUSY, Standard Model) as well as participants from two major ATLAS detector systems (Trigger/DAQ, Tile Calorimeter).

More details can be found at <http://hep.uchicago.edu/atlas/usatlasmidwest/>.

These examples illustrate a somewhat dynamic model that suits individuals and groups with different needs. They clearly indicate the broad geographical distribution of expert knowledge at laboratories and universities in US ATLAS.