Fostering networks of innovation and discovery: Proposal for a multi-site ATLAS Center

1 Overview of the ATLAS Center

The ATLAS Center (ATC) is a shared resource for physicists and students working on the ATLAS experiment at the LHC. It is designed to position ATLAS collaborators at U.S. institutions to make important measurements and discoveries with ATLAS data, and to advance future ATLAS detector technology and software. The center operates at four sites located at the Department of Energy (DOE) national laboratories participating in ATLAS: Argonne (ANL) in Lemont IL, Brookhaven (BNL) in Upton NY, Lawrence Berkeley National Laboratory (LBNL) in Berkeley CA, and SLAC National Accelerator Laboratory in Menlo Park CA. The four ATC sites leverage specific expertise and resources at each of these laboratories for analysis and detector hardware activities. The geographic distribution across the U.S. facilitates cost-effective and flexible access to the ATC for sustaining long-term collaborative projects. ATC operations are funded by direct grants from the DOE and by in-kind contributions from the four host laboratories, which provide facilities, computing, technical, and administrative support and access to the complementary resources and expertise available at each laboratory.

For several years, U.S. ATLAS has operated ATLAS physics support centers at our participating national laboratories. These centers have hosted physics workshops, software training sessions, and hosted the U.S. ATLAS scholars program which provided funds for faculty and post-docs to either be based at the U.S. ATLAS physics support centers or make frequent visits. This proposal seeks to enhance the breadth of activities and make use of the significant infrastructure available at the national laboratories and re-organize and centralize the management of the centers to make optimal use of available resources.

The Distinguished Research Program, established by DOE, supports physicists and post-docs to actively participate at the ATLAS center, exploiting the resources offered at the national labs and strengthening the U.S. effort in ATLAS. While past funds have been used to support physicists, this proposal presents a revamped effort to organize and manage the ATLAS Centers in an optimal way to maximize the productivity using the funding from the Distinguished Research Program.

2 The Goals of the ATC

U.S. institutions participating in ATLAS are diverse and distributed, and the success of new ideas, initiatives and collaborators at those institutions depends critically on physical resources and on the available networks of expertise and talent. The role of the ATC is to make the research infrastructure and intellectually stimulating collaborative environment of the national labs easily accessible to physicists regardless of their institutional home by (a) training ATLAS physicists, (b) hosting visitors engaged in collaboration, and (c) organizing workshops and meetings. These three key activities are outlined below. Detailed proposals for these activities at each of the four ATC sites can be found in Section 3.

Fostering Collaboration: The major goal of the proposal is to enhance regional ATC sites that create space where physicists, research scientists, engineers, technicians, and students can come together to work on common projects, and is designed to foster a scientific community by providing venues to interact professionally and socially. Since the ATLAS experiment is located at CERN, it is a significant cost to collaborators to either travel there frequently or support the cost of long term stays in Geneva. Likewise, the time zone difference makes it more difficult for teaching faculty to remain in close contact with their students/postdocs based at CERN. Additionally, since the experiment is based abroad with many international collaborators, a significant fraction of the R&D, construction, and the operation of the experiment is based abroad. This proposal is designed to promote domestic activities and increase the impact of U.S. scientists on the experiment. **Adding significant infrastructure to the existing centers will enable collaborators to leverage their resources more effectively, take advantage of regional resources, and foster new collaborative networks, primarily between Universities and Laboratories, to enhance existing projects and enable new research**.

Training at the ATC: ATC training activities support both new collaborators joining the ATLAS experiment and existing collaborators embarking on a new project. For a new collaborator, the ATC can provide supervision (from laboratory scientists participating in the program) and support in identifying and accomplishing his or her ATLAS qualification task (AQT), a year-long technical project that is a prerequisite to full participation in ATLAS. For both new and existing members, the ATC provides hands-on detector development experience through in-person collaborations with the host laboratories, each of which are leading important aspects of the ATLAS upgrades as well as carrying out broader detector research and development for the LHC. For all ATLAS collaborators, the ATLAS software expertise and computing resources at the ATC laboratories make these host sites ideal for training in software tools before beginning a detector performance or physics analysis project. **If funded, this proposal would allow U.S. ATLAS university groups to leverage existing expertise at National Laboratories to train students and post-docs to make significant and critical contributions to the ATLAS project in a cost effective way.**

The ATC Projects: The ATC is designed to help physicists who want to contribute to detector development, those looking for broader collaborations focusing on measurements and searches, and those who want to work with other experts in improving performance, core software, or analysis software. Many of these physicists will be resident at an ATC host site simultaneously. Along with the new ATLAS members being supervised on AQT, the laboratory scientists and frequent visitors from nearby universities, will form a mutually supportive community of expertise and interest.

- *Physics Analysis* For analysis, each ATC site provides a central location for teams distributed across the U.S. to come together. These sites can present an alternative to CERN for sustained collaboration because of the reduced travel costs, the greater availability of office space and meeting rooms, the software infrastructure and support, and the expertise of ATLAS scientists as well as theorists who are stationed at the national laboratories. In addition, the ATC allows closer collaboration with U.S. physicists who are resident at their home institutions, especially teaching faculty members who cannot be resident at CERN to supervise their students and postdocs, and who welcome the flexibility afforded by a smaller time-zone difference from their collaborators. Targeted workshops held at the ATC, described below, can serve as a mechanism to seed these collaborations among ATLAS members. **If funded, this proposal will allow U.S. collaborators to form analysis networks, form effective teams, and leverage expertise from university and lab scientists that will significantly enhance U.S. ATLAS contributions to analysis of ATLAS data.**

- *Performance and software* The ATC sites would play a critical role in facilitating the work aimed at characterizing detector performance or improving reconstruction, and for the development and maintenance of software tools and infrastructure. Because many AQT activities are of this nature, experts

and new collaborators involved in qualification tasks through the ATC, along with the detector experts and core and application software professionals resident at ATC host laboratories, can make the ATC an ideal environment for university collaborators. The ATC host sites are each deeply engaged in important areas of ATLAS software that are supported directly by the U.S. ATLAS Operations Program, including ATLAS core software, databases, PanDA and user analysis tools, and the Geant4 simulation. **This proposal, if funded, will allow U.S. ATLAS members to collaborate on advanced software, computing infrastructure, and performance tools. In many cases the expertise hosted at the national labs represents a unique opportunity to build a project center to nucleate new projects and train students and post-docs for critical areas of software and computing.**

- *Detector R&D and Electronics* By facilitating U.S. collaboration in detector development, the ATC can have a large impact on the LHC research program. The scheduled High Luminosity (HL-LHC) accelerator upgrade must be matched by a comprehensive ATLAS HL-LHC detector upgrade to take full advantage of the improvement in luminosity, so HL-LHC upgrade detector development is ongoing at all of the ATC sites as well as at many U.S. ATLAS universities. Because of the unparalleled R&D infrastructure at the host laboratories, developing a strong partnership between universities and ATC host sites will dramatically enhance the contribution of the universities towards upgrade projects, substantially reduce the cost of labor at the labs by involving students and postdocs, and overall optimize the use of the facilities and resources. The ATC also provides a platform to publicize opportunities for contributions to upgrade detector development, and to enrich the overall environment for the many students, faculty and postdoctoral scholars stationed at the host laboratories for upgrade work.

  This proposal allows for funds for students and post-docs to spend time at the ATC centers to work on hardware projects and gives access to education and training in hardware and electronics development that is critical to our field but that is not available to many university groups. If funded, this proposal would allow U.S. physicists to make use of existing resources to significantly enhance the U.S. contribution to upgrade projects and to train students and post-docs in critical areas that would not otherwise be available to them.

ATC workshops and events: ATC workshops stimulate new directions in physics analysis and combined performance, facilitate close collaboration with LHC theoretical physicists, and make focused, intensive software training broadly accessible. Approximately three physics or performance workshop will be held at each ATC per year. Past workshops have drawn as many as 60 ATLAS participants. A general-purpose tutorial directed towards users of ATLAS software parallels the week-long software tutorials held at CERN in a more easily accessible location for U.S.-based collaborators. An additional, more advanced tutorial is focused on better preparing collaborators to develop widely-used ATLAS software and analysis tools; the first of these, held by ANL and the University of Chicago in 2016, trained about 15 participants in topics including ATLAS data formats and code management, and how to develop dual-use tools for the root-based and ATLAS Athena-based analysis frameworks.

3 The ATC Activities

Each national laboratory hosts an ATC site that has played an important role for U.S. collaborators. In this section, we highlight some of the recent activities at the sites and describe the proposed activities to be funded by this three-year proposal. The proposed first-year ATC program is presented in detail with institutions that have committed to participate if funded. Note that the funds provided by this proposal are to cover travel, accommodations, and COLA for collaborators. We expect participation to grow along

with the available funding. **The first-year program serves as a prototype for future activity which will continue and build on the initial program.**

3.1 Physics Analysis

The ATC will serve as a national center for innovative and novel physics analysis by fostering collaboration and creating a vibrant space for interaction between ATLAS collaborators and the greater collider physics community. Activities will include:

- Collaborations on physics analysis between university and laboratory groups where primary analyzers come to the ATC sites to participate in analysis.
- Interaction of ATLAS collaborators with laboratory theory groups based at ATC host labs.
- Biweekly physics talks at the ATC sites hosted on a rotating basis at one site and connected by video conference to the other sites.
- Informal weekly coffee physics chats centered around physics topics to be coordinated by the site managers.

Current collaborations with university groups have been highly successful in creating active collaborations with extended visits to ATC sites in a number of cases , for example:

- Exotic Higgs Searches (BNL, Stony Brook, and NYU)
- Top-boson coupling (BNL, NIU)
- Stop quark search (BNL, Oregon)
- Dark Matter Search (LBNL, UW)
- Mono Higgs Searches (LBNL, UW)
- Rare Higgs Decays (SLAC, UIUC)
- Heavy Boson Searches (ANL, MSU)
- SUSY Searches (ANL, Oklahoma)

With additional funding we expect significant growth in physics analysis activity at ATC sites and will encourage proposals that include physics analysis along with other ATLAS research.

3.2 Software and Performance Tools

3.2.1 Core Software and Computing

The Argonne ATC is proposing to increase the engagement of the U.S. ATLAS community in activities related to on-site High-Performance Computing (HPC). The group is developing highly-parallel input/output tools for HPCs and migrating the event generators to the HPC architecture. Part of the group's effort includes optimizing the various ATLAS data products for storage and access performance. Infrastructure has been put in place to measure input/output performance, and various parameters have been found that can be tuned for better input/output speed. Optimizing file input/output for ATLAS physics analysis will be a future Authorship Qualifications Task directed by experts at ANL.

The ANL group is engaged in improving input/output performance and reducing the storage footprint both in ATLAS code and in ROOT software used by the broader HEP community. The proposal will foster new connections between the core software development team and the U.S. ATLAS community.

The main computing activities at LBNL are focused on high performance computing and making use of their leadership computing facilities (NERSC) to improve ATLAS computing. Current projects include porting event generators and GEANT simulation that makes use of the massively parallel architecture of these machines.

Institution	Visitors F/ PD/ S	Duration of stay	Support	Deliverable	site
TBD	0 / 0 / 1	1/2 year	this proposal	HPC	ANL
TBD	0 / 0 / 1	1/2 year	this proposal	Machine learning	ANL
TBD	0 / 0 / 1	1/2 year	this proposal	ROOT compression	ANL

Table 1: Initial U.S. institutions to participate in the first year computing activities

3.2.2 Performance Tools

Machine Learning and b-tagging: Machine learning (ML) applications in HEP, and in particular at the LHC, have been growing and have led to major improvements in many areas. The SLAC ATLAS team has been a leader in applying modern ML algorithms to HEP problems, in particular in the realms of b-jet tagging and b-jet identification, and one of the team members is currently co-leading the ATLAS Machine Learning forum. As such, SLAC would be an ideal place for collaborations with U.S. ATLAS physicists interested in ML.

To jump-start these efforts, a week-long ML event will be held in early 2017. This event will target the application of ML methods to b-jet identification and will be co-organized with PIs from SUNY Stony Brook and University of Illinois, Champaign. The goals of this workshop will be to introduce ML techniques to a broader group of interested parties, improve the usage of recurrent neural networks for impact parameter tagging, and expand the use of sequential learning techniques to enhance the performance of other b-tagging algorithms such as the inclusive secondary vertexing algorithm and JetFitter (primary vertex to b- to c-hadron decay chain fitting).

The Argonne ATC broadens collaboration within the U.S. ATLAS community on the ML algorithms by exploiting coherent laboratory-wide effort in these areas. For example, machine learning techniques were recently used for the ATLAS $t\bar{t}H$ measurement and ANL in collaboration with nearby experts are studying how to improve such techniques. Argonne is also investigating how to use machine learning for full event reconstruction amd jet clustering. This proposal would broaden the collaboration between the ATLAS community and the lab-wide effort.

Identification and Calibration: In the first year, the LBNL site will host activities to improve calibration and tagging of hadronic heavy boson decays. A promising new approach to search for BSM physics at the TeV scale using innovative boosted hadronic W/Z/Higgs reconstruction and identification techniques. The searches include the search for dark matter pair production in association with W, Z or Higgs bosons (mono-$W/Z/h$) and resonance searches in $VV/Vh/hh$ final states. The first-year LBNL site activities will include:

- Particle flow jet calibration and large-R jet reconstruction and calibration
- Advancing boosted hadronic W/Z/Higgs identification with sub-jets

Institution	Visitors F/ PD/ S	Duration of stay	Support	Deliverable	site
Washington	0/1/2	6 months	This proposal and UW matched funds	Boosted Sub-Jets Improvements	LBNL

Table 2: Initial U.S. institutions to participate in software and performance tools in the first year

3.3 Detector R &D and Electronics

While detector integration and commissioning take place at CERN, someone wanting hands-on detector work may prefer going to an ATC site with an active detector fabrication program or with an electronic design facility. The ATC centers facilitate collaboration from University groups to make use of facilities that are hosted at national laboratories. Moreover, in many cases students and post-docs would not be able to take part in these activities at their home institutes. **The initial program is designed around current or planned actives, however with increased funding we expect increased participation in these projects and new projects that are initiated by these collaborations.**

3.3.1 Inner Detector Tracker

The ATLAS experiment is developing an all-silicon inner tracker (ITk) for the High Luminosity HL-LHC upgrade to cope with the elevated occupancy and radiation dose. The U.S. will play a significant role in the ITk development, construction, and testing and this effort comprises a significant portion of the U.S. ATLAS upgrade activities and will be ongoing at all four U.S. ATLAS national laboratories.

New radiation-hard sensors and readout electronics for the tracking detector need to be developed to withstand the radiation damage and the new sensors will need to have a finer granularity than the current sensors in order to resolve the greatly increased number of vertices from pileup. In addition, significant work remains to be done in the simulation, optimization of detector parameters, design and testing of modules and associated data acquisition (DAQ) electronics, and design and testing of the associated DAQ software.

The first-year program will support the work of students, post-docs, and faculty to participate in a number of activities:

- Simulation of the HL-LHC ITk and upgrade studies to optimize the parameters of the design of the ITk Tracker.
- Beam and lab irradiation tests of the sensors.
- Thermal tests of bare and fully loaded modules.
- Design and development of quad-flex cables.
- Assembly of staves and modules.
- Development and testing of DAQ software needed for testing, tuning, calibration, and characterization of the readout electronics.

Future work and proposals will be encouraged at BNL for the control and readout system for the pixel and liquid argon detector for HL-LHC. Table 3 gives an overview of the different sponsored activities in the first year. It is expected that similar activities will continue in the second and third year.

3.3.2 Trigger and DAQ Activities

Argonne is currently developing several components of the TDAQ upgrades, including FELIX (the front-end network for detector readout for HL-LHC), data transmission for track triggering, and the region-of-interest builder (RoIB) which identifies regions of detector activity for the ATLAS trigger. Argonne will be a production site for the ATLAS track trigger (FTK++/L1track) rear transition modules. The ongoing activities related to the track triggers and data acquisition systems include:

- Commissioning and testing of the FTK track trigger components
- Design of the FELIX detector readout system for Phase-I
- R&D on the FELIX detector readout system for the HL-LHC upgrade
- Design, testing, and production of the region of interest distributor for the HL-LHC upgrade
- HL-LHC track trigger simulations and performance studies
- Data handling for L1Track/FTK++ for the HL-LHC upgrade
- Evaluation of high-speed optical links for radiation tolerance

Institution	Visitors F/ PD/ S	Duration of stay	Support	Deliverable	site
Oklahoma	0 / 1	1 year	this proposal/OU	module testing test beam	ANL
Oklahoma	1 / 0 /0	2 weeks	this proposal	vibration testing	ANL
Ohio State	1 / 0/ 0	2 weeks	this proposal	testing procedures	ANL
Brandies	1 / 0 / 3	1 year	this proposal	Stave Assembly	BNL
Umass	0/ 0/ 1	6 months	this proposal	Stave Assembly	BNL
Harvard	1 / 1 / 1	3-9 months	this proposal	Stave Assembly	BNL
Wisconsin	0 / 0 / 2	6 months	self	Wafer & Chip Testing integration	LBNL
Stockholm	0 / 0 / 2	6 months	self	High Speed Data transmission for ITK	LBNL
Fribourg	0 / 0 / 4	3-5 months	self	ITk pixel readout	LBNL
Louisville	1 / 1 /1	3-6 months	this proposal	ITk Simulation	LBNL
SLAC	1 / 0 / 0	3 weeks	self	ITk Simulation	LBNL
UCSC	1/1	2 weeks	self	Itk Data transmission	SLAC
ANL	0 / 1	2 weeks	this proposal	ITk Readout	SLAC
UIUC	1 / 0	3 weeks	this proposal	ITk Readout	SLAC
Oklahoma	0 / 2	4 weeks	this proposal	ITk thermal testing	SLAC
Seattle	1 / 0	4 weeks	this proposal	ITk thermal testing	SLAC
Washington	0 / 1/ 2	6 months	this proposal	ITk readout	SLAC

Table 3: Initial U.S. institutions to participate in first-year program ITk activities .

The BNL site is involved in several aspects of the TDAQ upgrade projects and is seeking proposals and collaborations with University partners on:

- Design and production of the front end electronics and trigger card for the muon New Small Wheel (NSW)
- Design and production of the liquid argon (LAr) trigger digitizer board
- Design and production of the Calorimeter global feature extractor trigger board
- Design and firmware for the front end link data acquisition system for HL-LHC

3.3.3 MicroMegaDetectors for Phase-1

The MicroMegas (MM) detectors are slated for installation in 2019 as part of the Muon New Small Wheel Phase-I upgrade. This novel technology is capable of handling the high particle rates expected in the forward region of ATLAS while providing good position and timing resolution, both of which are key to

Institution	Visitors F/ PD/ S	Duration of stay	Support	Deliverable	site
SMU	1 student	1/2 year	this proposal	FTK testing and HL-LHC track trigger	ANL
NIU	1 student	1/2 year	this proposal	Simulation studies for HL-LHC track trigger	ANL
Oregon	1 student	1 year	self	global calorimeter trigger processor	BNL

Table 4: Initial U.S. institutions to participate in first-year program TDAQ activities.

the trigger and tracking capabilities of the muon system. The goal of this effort is to develop a realistic simulation of the response of the MM to different types of particles, particularly photons and neutrons, that comprise the large cavern backgrounds present in the muon system. This is particularly important since the sensitivity at low energies is experimentally challenging. This effort is part of a series of studies to cover all muon detector technologies. A similar study has recently been completed for the Thin-Gap Chambers (TGC) and small-gap TGCs (sTGCs). The study of Resistive-Plate Chambers (RPCs) is currently being performed by a graduate student from Stanford University. The last set of studies foreseen are for Monitored Drift Tube chambers (MDTs), which would allow us to have a complete set. The outcome of this study will allow us to perform a detailed comparison of the impact of backgrounds on the performance of the muon trigger and tracking capabilities, providing projections and inputs for the upgrades.

3.3.4 Training

A key aspect of the ATC is to provide a space for effective collaboration and training of ATLAS collaborators, in particular students and post-docs. Training events are broadly put into two categories: (1) general collider and ATLAS detector training and (2) training for specific qualification tasks (AQT) which are required of all ATLAS collaborators to be full members of the ATLAS collaboration.

ATLAS Fundamentals: The ATLAS detector will take data through ∼2037, the nominal end of HL-LHC operations. Knowledge and expertise from the original construction and also the upgrades are crucial for efficient operations as well as maximum physics exploitation. This information is difficult to retain as people move on to other projects or retire. Often the only practical recourse is to spend significant time at CERN to obtain such knowledge. This is expensive and inefficient. Furthermore, it is only available to those who happen to be resident at CERN at certain opportune times. It has been proposed to hold a series of "ATLAS Fundamentals" classes that cover everything from detector design to calibration of physics objects. The goal is not to compete with general detector courses and lectures; rather, the intent is to complement them with in-depth ATLAS-specific material. We propose to invite relevant experts from the entire ATLAS community to teach these classes. We also propose to record them and post them online. The desired outcome is a cadre of young physicists who have a much deeper understanding of the ATLAS experiment and the ability to exploit its potential fully.

The proposed scope for the first year is 4 to 5 week-long events, each with a senior instructor and several other attendees. We will then assess this program's future. In the first year of the proposal, ATLAS Fundamentals will be held at SLAC.

The proposal, if funded, will contribute to the funding of the events by allowing travel to ATLAS Fundementals sites for lecturers and participants and organizational costs.

ATLAS Qualification Tasks: As noted above, AQT are a critical component of becoming a full ATLAS member and in general require some level of training. In many cases, the technical expertise for these qualification tasks may not exist in a given university group but can be found at the host laboratories at the ATCs. **The training of students and post-docs in mission critical areas can be greatly enhanced if funds, provided through this proposal, were available to university students and post-docs to travel to the ATC sites.**

Examples of AQT tasks are shown below:

- Pixel developments for ITK
- Strip developments for ITK
- Machine learning studies
- Development of massively parallel code for HPCs
- Tracking software development, both for current detector and ITK
- Simulation and event generation software development
- Development of DAQ and Trigger Software

- Performance and Identification Software and Studies

Workshops: Workshops play a critical role in allowing ATLAS physicists to collaborate within and outside of the collaboration on a variety of physics and technical topics. In the last several years the U.S. national labs on ATLAS have hosted a number of workshops with varying audiences from 10 to hundreds of participants. Some recent examples include:

- Dark Interactions: Perspectives from Theory and Experiment, November 2016 (BNL)
- Advances in QCD and Applications to Hadron Colliders Workshop, October 2016 (BNL)
- BSM Higgs Jamboree at BNL , May 2016 (BNL)
- New Physics Interpretations at the LHC, June 2016 (ANL)
- ATLAS Software Tutorial, March 2016 (ANL)
- LHC Users Organization Meeting, November 2016 (LBNL)
- ATLAS Software TIM Meeting, November 2016 (LBNL)
- Hadronic Final State Forum , December 2016 (SLAC)
- Higgs Coupling, November 2016 (SLAC)

The proposal, if funded, will contribute to the support of these events by allowing for travel and organizational costs for workshops and, in the case of training workshops, funding for instructor travel. We expect to have 2-4 workshops per year per site focusing on a variety of topics ranging from ATLAS training workshops, internal analysis workshops, and events for the larger collider physics community including theorists.

4 The ATC management

Laboratory scientists and university faculty collaborate in managing the ATC to ensure that the needs of ATLAS members from all U.S. institutions are represented in the planning of ATC activities. As illustrated in Figure 1, one laboratory manager and one co-manager from a U.S. ATLAS university are responsible for carrying out the programs and operations of the ATC at each host site. The co-manager is especially tasked to coordinate with ATC users and potential users for his/her host site, to propose and develop programs and to ensure that the needs of the university scientists are being served by the ATC.

These host site management teams are members of the ATC coordination group, chaired by the Physics Support managers, which coordinates the overall ATC. The ATC coordination group will meet regularly (once a month) to discuss and plan the activities at each ATC in order to ensure coherency and coordination across the ATC sites. It will also monitor the performance of the people based at these ATC sites and supported by funding sought in this proposal. The ATC managers will provide regular reports to the Operations Program Manager and to DOE/NSF during the regular LHC/Ops meetings and seek their concurrence on any decisions.

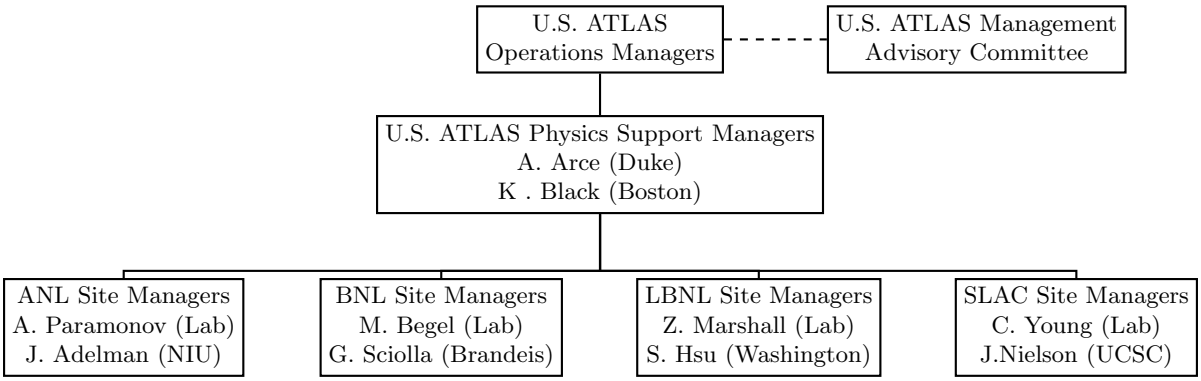

Figure 1: Organization of the ATC.

5 The ATC Funding

Frequent and sustained visits to the ATC are essential in order for the ATC program to significantly benefit the scientific productivity of U.S. ATLAS collaborators, as a critical mass of visitors is needed to make each host site attractive. Thus, the first-year funding requested in this proposal targets items that will best encourage university collaborators to take advantage of ATC services and opportunities: namely, the cost-of-living adjustment for ATC site visitors, travel and relocation expenses related to their visits, and in limited cases partial support for student and post-doc salaries while based at ATC sites. Office space, equipment, and administrative support are provided by in-kind contributions from the ATC host laboratories, so funds for these items are not requested in this proposal. ATC sites and collaborating universities will also continue to contribute the support associated with workshops at the ATC host sites. In subsequent years, additional funding has been requested to support senior faculty at the ATC who will play a supervisory role in the activities and develop institutional partnerships.

5.1 Oversight of funds

The funds will be managed to maximize the sustained utilization of the ATC. An annual, competitive review of proposals will determine how the funds are distributed among users and laboratory programs: the U.S. ATLAS Physics Support Managers will announce a call for proposals for ATC visits and the host site managers will use their networks of peers to encourage university collaborators to apply. Applicants proposing visits to an ATC site will submit a budget with their proposal. A letter of support from the site collaborator(s) will be required to make clear how the proposal will be supported by the host site. Additionally, proposals that only support the presence of students or postdoctoral fellows at the ATC must specifically describe the supervisory role of the PI in the project. As part of the application review process, the submitted budget will be discussed and possibly revised in the ATC coordination group before being submitted to the U.S. ATLAS operations managers for approval.

When funds are awarded, a memorandum of understanding between the awardee(s) and the ATC will establish objectives or milestones for the activity, and recipients of funds will submit quarterly progress reports describing the status of the efforts towards achieving these milestones. The two ATC co-coordinators at each site will review these reports and carry any concerns to the ATC coordination group. An annual summary of the use of funds and the status of funded projects will be made available to the DOE.

In accordance with the statements of the importance of diversity and inclusion from the DPF, APS, and The National Academy of Science, special attention will be given to activities that address specific broader impacts such as recruitment of students from underrepresented groups, supporting women and underrepresented minority scientists, and enabling partnerships with 2- or 4-year minority-serving institutions.

6 The ATC Logistics

Facilities: The ATC sites host significant resources for collaboration with university groups that would otherwise be unavailable for many U.S. ATLAS collaborators. Some of the physical infrastructure available at each ATC site is summarized in Table 5.

Outreach to U.S. ATLAS university scientists: Advertising the available ATC resources is a key requirement for successful ATC operations. The ATC web site, located on the U.S. ATLAS program office page, advertises the overall ATC program and includes sections maintained by each host laboratory that advertise the infrastructure and resources available at each ATC, including facilities for detector hardware work, meetings, and office space. The host site managers also contribute content that describes their areas of expertise in detector development, physics analysis, and subsystem performance. The site managers will ensure that this web content clearly indicates where university collaborators can make important

ATC Host site	Visitor Space	Meeting Rooms	Computing
ANL	14 desks	4 rooms	HPC cluster
BNL	15 desks	many	HPC and shared Tier 3
LBNL	15 desks	many	HPC cluster
SLAC	15 desks	many	shared Tier 3
Special Facilities: Clean rooms, electronic and fabrication facilities, test benches, and irradiation tests at all sites			

Table 5: Facilities available at each of the ATC sites.

contributions. In addition to this outreach, members of the ATC coordination group will make regular reports on ATC activities in the monthly U.S. ATLAS Institutional Board meetings, which are attended by representatives from all collaborating institutions, so that the ATC programs and opportunities at host sites will be well-publicized.

7 Budget

The proposed budget structure is designed to create a critical mass at the ATC sites and thus allow them to develop into vibrant intellectual centers. In the past, support for the program has been provided by the DOE at the level of $250K to $400K, depending on the year. Since the individual funds will be provided on a competitive basis and in negotiation with the subcontracted university groups on a yearly basis, it is not possible to give a specific budget breakdown for every item. Instead, we present the size of the program based on personnel that could be supported by the budget.

Hosting ATC visitors and programs: The ATC host sites are continuously open to visitors. U.S. students, postdocs and more senior scientists can apply for funds, individually or in groups, to collaborate at the ATC for up to a year and as deemed appropriate by the ATC site managers: depending on the project, timescales could span a few weeks or an entire year.

An estimate of relevant costs for visiting ATC sites is listed in Table 6 .

USAC Host site	ANL	BNL	LBNL	SLAC
Short/medium term housing	$90	$110	$120	$150
Long term housing	$30	$49	$85	$85
GSA M & IE	$59	$64	$69	$69

Table 6: Estimated daily cost-of-living and other expenses at each of the four ATC sites .

Depending on the site and seniority of the person supported, we expect that in order to support one person for a month for travel, housing, and other expenses, we would offer on the order of $1500 to supplement the cost of being based based at the national laboratory. Our estimate of $1500 per month is derived from what the laboratories offer visitors in other programs and depends on site, seniority, and duration of stay. The duration of the stay will depend on the project, the individual proposal, and available funds allocated on a competitive basis. To get a sense of scale, support for 5 people per site for 12 months at each of our 4 sites would total $360K. It should be noted that for any given site in any given year it is expected that the number of people and length of stay could and will vary significantly but the total number and duration of stay will be approximately 60 person months per site. Additionally, to support the workshops, training sessions, and other logistics we estimate $10K per site to optimally run our program.

In the second and third year of the proposal, we would like to extend the program by offering the possibility of faculty buyouts to increase PI participation in the program. In the past program, allocating funds through the U.S. ATLAS Distinguished Researchers Program funds has led to increased participation

of senior scientists in the program and significantly enhanced the university effort by bringing senior scientists directly to the laboratories and allowing them to focus entirely on ATLAS research during the duration of their fellowships. Faculty and senior scientists can bring prolonged institutional collaboration on key projects that last beyond an individual student's doctoral thesis or a post-doc's term and lay the groundwork for future collaboration Additionally, they can provide direct and daily supervision working with students and post-docs based at the national laboratories. To help support the ATC activities we also propose to provide a few months of student or post-doc supports to encourage participation and support the ATC activists if funds are available. To support the cost of supporting 1 to 1.5 faculty buyouts and partial support for several months of a few students or postdocs per site, we request additional funds of $400 K in the second and third year of the proposal.

In summary, the funds to cover travel, cost-of-living expenses , and partial support for salaries at four sites are as follows:

- $400K in the first year of the proposal.
- $800K in the second and third year of the proposal.

8 Summary

This proposal, if funded, would enable collaborative networks of ATLAS collaborators to leverage the resources and expertise at the National Laboratories and make university and laboratory scientists and students more effective. In addition, this proposal will fund critical training of our students and post-docs **in areas that they may not otherwise have access to at their home institutes.**. The proposal will lead to more effective use of existing resources to extract the most physics out of the ATLAS experiment in Run 2 and beyond.