ANL HEP Division Strategic Plan
Planning Group Report
March 2006

0.0 Executive Summary

The Argonne High Energy Physics program consists of basic research in Experimental, Theoretical, and Accelerator Physics. Argonne does not currently operate an accelerator facility for the HEP program. The Laboratory supports and works closely with university groups in all of our subprograms and projects. The national program benefits from the physics and instrumentation expertise of the staff, from the capable technical groups in mechanical, electrical, and software engineering, and from the multi-program capabilities of Argonne National Laboratory. Our program is aimed at addressing the fundamental questions in physics: electroweak symmetry breaking, matter-antimatter asymmetry, lepto- and baryo-genesis, physics beyond the standard model, and the origin of dark matter and energy.

Currently the experimental research program at ANL HEP is centered on operating (CDF, ZEUS, and MINOS) and soon-to-be operating (ATLAS) experiments, and on commissioning the ATLAS detector. For Experimental Physics, the strategic plan described below is aimed at completing the transition from CDF and ZEUS to the LHC ATLAS program, where we intend to participate strongly in the physics program, as well as the commissioning, maintenance and operations, and software support, building on our past efforts on the ATLAS calorimeter construction, trigger/DAQ, and software systems. We assume that the collider physics program will be the highest priority experimental physics effort in the Division for the next decade, and the first priority in the planning exercise is to ensure that this overall program is successful. Our second highest experimental physics priority for the next decade is the neutrino program, with MINOS expected to run for at least the next four years. On the same timescale, we expect to play strong leadership roles in both a reactor neutrino experiment and in the NOvA experiment, to measure $\theta(13)$. In addition to these core efforts, for the past three years we have investigated new initiatives that have significant uncertainties in timescales and funding. These new initiatives include astroparticle physics, where our technical expertise is well suited to helping university collaborators, and International Linear Collider (ILC) detector R+D, where we have focused on development of new calorimeter strategies that will enable an eventual ILC detector to exploit the rich physics at LC beyond the standard model. Our efforts in developing these new initiatives have been generously supported by the Argonne management, through LDRD funding and other means.

In parallel, we plan for the ANL HEP theory group to continue to offer a first class program that will help to advance the success of the Collider program, as well as advance particle theory and provide support for astroparticle and neutrino programs.

We intend to pursue vigorously the advanced accelerator R+D program, with increased collaboration with other ANL accelerator groups centered at APS and Physics. The goals of this program are to study fundamental accelerator and beam-related physics associated with future high energy physics machines: high current electron beam generation and propagation, wakefield acceleration in dielectric and other advanced structures, high power RF generation, material breakdown studies under high fields, and beam instrumentation. We also intend to participate in the technical design of the ILC, and we have identified the positron source design as a lab-wide accelerator initiative.

Because of the constraints of funding in the DOE Office of Science and the Office of HEP specifically, the goal for the base plan described below was to craft the best program that could fit in a constant level of effort at the FY 2005 level. We believe that the small size of the Argonne program relative to comparable laboratories without HEP accelerators is an historical anomaly and that, while Argonne is always seen as using its limited funding to maximum effect, its role in permitting university collaborators to build large subsystems of major detectors, advancing particle theory, and inventing the next generation of accelerators would be more effective and more efficient at a larger overall size. We summarize below specific areas that are compromised in the base plan, that we would target for strengthening if we could achieve an increase in funding.

Base Plan

- Careful phasing of growth in ATLAS with faster than optimal reductions in ZEUS and CDF
- Maintenance and support for MINOS, with strong participation in physics analysis.
- Management and Engineering support for NOvA.
- Early participation in the Double Chooz reactor neutrino experiment.
- Detector development aimed at astroparticle experiments, in particular VERITAS and Auger.
- Development of digital calorimetry for the Linear Collider Detector within the framework of the U.S. ILC program.
- Advanced Accelerator R&D leading to demonstration of 100 MeV acceleration by wakefield-generated rf power.
- Theory program with emphasis on areas that support the collider, neutrino, and astroparticle research programs.

Areas that would be strengthened with increased funding

- Timely addition of personnel to the ATLAS program for operations and physics analysis, while retaining appropriate strength in CDF and ZEUS to the end of those programs in 2009 and 2007 respectively.
- We see an excellent opportunity for HEPD in the Double Chooz experiment, where additional HEP physicist effort would take full advantage of our current strong leadership role. Similarly, HEPD will need to increase the level of physicist effort on NOvA over the next 18 months in order to maintain its leadership role and secure a major role for Argonne in construction of the experiment..
- Use of the special expertise of the Advanced Accelerator R&D group to study exciting possibilities in technologies related to their current work, including beam-driven plasma wakefields (first observed by this group, but neglected now for funding reasons), and advanced structures.
- Timely completion and testbeam evaluation of the ILC prototype calorimeter
- Full participation in a major astroparticle initiative (eg., Auger North, VERITAS upgrade and beyond, or other).

1.0 Introduction

The ANL HEP Division undertook a strategic planning exercise starting in October 2003. The final report from May 2004 is linked at

http://gate.hep.anl.gov/plan_group/Planfinal.pdf

This report called for specific decisions on the astroparticle (choice between VERITAS and Auger) and the neutrino (choice between Reactor and NOvA) initiatives that had been proposed. These decisions were to have been based on physics results (e.g., Auger South) and on Office of Science decisions (e.g., NUSAG). Since May 2004 a great deal of progress has been made on detector development for the astroparticle initiatives, and a lab-wide study group has taken on the task of identifying a possible astroparticle strategic initiative project. Progress has also been made on NOvA design, and CHOOZ-II has been identified as a cost effective path to measure $\theta(13)$ on a fast track. The decisions called for in the May 2004 report have not been made explicitly, but the Division is now in a stronger position to make wise choices.

In the remainder of this report, we summarize our current understanding of program priorities and responsibilities.

In Section 2, we review again our role in the DOE-HEP programs as a National Laboratory group at a laboratory without a HEP accelerator. In Section 3, we give a summary of our evaluation of the opportunities presented by each project. In Section 4, we give the main external assumptions, our conclusions and the effort profile which reflects the constant effort base plan. In the appendix, we review ANL project milestones, goals, and responsibilities.

2.0 National Laboratory Role

A central issue in the development of the Division strategic plan is to insure that the projects and allocation of Division resources match national goals and interests. A set of criteria were established in order to evaluate all projects in terms of the contributions expected from groups at a National Laboratory to the US High Energy Physics program. These criteria are summarized below.

Experimental Groups:

- Contribute unique scientific and technical expertise
- Provide dedicated scientific leadership and management
- Contribute strong support of overall operations (not only for systems built at ANL)
- Provide strong technical and infrastructure support to collaborating university groups and other national laboratories
- Provide strong leadership in exploring scientific and technical options for the future of the national experimental program
- Provide capabilities beyond that of the Division itself by leveraging laboratory resources (such as technical groups, accelerator technology, computing, and supplemental funding such as LDRD funds)

Theory Group

- Carry out basic research in a broad range of topics both directly and not directly connected with the present Laboratory experimental program. Expose experimenters to current ideas as well as to alternative ideas that could form the seeds of future projects.
- Organize Workshops and Visitor programs, bringing into the laboratory experts in a variety of fields and increasing the visibility of the work of the HEP staff while exposing local scientists to the latest ideas in HEP.
- Contribute to the national HEP program and to the further education of young phenomenologists through dedicated mentoring of postdocs.
- Provide intellectual leadership nationally in proposing new experimental tests of theories and models and in proposing new analyses of existing data, to extract maximum benefit from the investment in DOE facilities.
- Provide technical support for the collider experiments in areas such as Monte Carlo event generators, QCD calculations for standard model processes such as heavy quark and gauge boson production, radiative corrections, parton distribution functions (e.g. CTEQ collaboration), etc.

Accelerator Group

- Carry out advanced accelerator R+D, centered on AWA, aimed at developing high gradient rf.
- Participate in lab-wide effort on ILC positron source design

Support Groups

- We view the technical skills of our support groups to be a critical priority for any future programs in experiment or accelerator science.
- The support groups are a critical ingredient in our collaborations wit university groups, and we seek opportunities to share this expertise with university groups.

3.0 Summary Evaluation of Division Projects

<u>Collider Physics</u>:

For planning purposes, we consider the collider experiments as a group, given the practical reality that ATLAS and ILC have evolved largely from the CDF and ZEUS groups, and that future migration of physicist effort will take place within this overall effort.

CDF:

Provides a discovery potential with at least x40 more data than Run I at highest energies before LHC physics. Both the detector and the Tevatron Collider are operating at full design potential, and the Tevatron has delivered 1.5 fb-1 through February 2006, already x15 over the Run I exposure.

The ANL group completed a major upgrade to the calorimeter (CPRII) in CY2005. M+O will be required to support the front end electronics for the shower max and CPRII systems. Also ongoing calibrations are an ANL responsibility.

CDF Has a compelling B physics program, and will carry out precision measurements on the top mass and the W mass.

CDF offers opportunities to test standard model backgrounds to photon and diphoton processes important for LHC searches.

CDF offers opportunities to develop procedures for precision calibration of jet energy scales and optimization of jet energy resolutions, important aspects of ATLAS physics.

=> The local CDF group should provide basic M+O support for detector operations and participate in physics analysis in their areas of expertise through FY2007, at which time the P5 subpanel and the Fermilab will decide on the plan for running the Tevatron through FY2009. The actual FTE level available for CDF is reduced from 10 FTE's in 2001 to 3 in 2007, due to migration into ATLAS and astroparticle physics. Total phaseout from CDF into these activities will be complete by FY2009 or earlier. In the present environment it may prove beneficial to use joint appointments in CDF/ATLAS in order to recruit the very best postdocs for the collider program.

ZEUS:

Provides excellent precision QCD physics with x5-8 more data coming from HERA II

Will give significantly improved knowledge of PDFs and α_S .

Requires Division effort to support ongoing hardware maintenance and operations responsibilities

=> ZEUS effort will decrease naturally as data taking ends in FY2007. The actual FTE level available for ZEUS has been reduced from 7 FTE's in FY2001 to 2.4 FTE's in FY2006, due to migration into ILC detector development and ATLAS. Total phaseout from ZEUS will be complete by the end of FY2007.

ATLAS:

We have an excellent plan for participation in ATLAS physics and early publication. We must ensure that there is sufficient physicist involvement to make this happen.

We have important requirements for technical support groups through 2006 with direct contributions to construction and installation. In all cases we are involved in tasks whose success will directly impact the success of the Atlas detector as a whole. Technical involvement will be reduced in the M&O era, but ANL technical expertise will remain important.

We are making excellent contributions in the area of computing and software development and these will add to the strength and capability of the Division in the future.

We have undertaken a major responsibility as one of three U.S. ATLAS analysis support centers (ASC).

The ATLAS group should develop a plan for involvement in upgrades for higher luminosity in areas such as the trigger or front-end electronics.

New hires at the postdoc level have already taken place, and there has been significant influx of effort from ZEUS and CDF into ATLAS. Additional postdocs will be needed as commissioning and data analysis ramp up. We should consider the option of having joint postdoc appointments with ATLAS and CDF.

=> ATLAS already represents the largest single component of the ANL collider program. We can expect that the physics program will continue for at least the next twenty years. We have to ensure the success of this program, which benefits from years of experience at CDF and ZEUS. Careful recruiting and management will be critical for success.

Linear Collider:

We have established an excellent program of calorimeter R+D and simulation work developing particle flow algorithms.

We have established a collaboration with university groups on calorimeter detector R+D as well as a role in the international CALICE collaboration. We are thus in a good position to proceed with a collaborative detector test project if funding becomes available.

The digital calorimeter is a unique detector technology offering the possibility of high precision measurement of jets. The proof of concept test of a digital calorimeter is necessary but expensive.

Funding profiles for U.S. Linear Collider R+D programs have been uncertain. Fortunately, we have benefited from generous LDRD support in recent years. Our operating assumption is that as the ILC becomes a national priority, the detector R+D will be funded at the necessary level. .

We have also established a role in the accelerator design, focused on the positron source; this will be a lab-wide effort

=> Find a way to ensure that the beam test goes ahead and achieves its objectives. Continue (strengthen) electronics design effort on the longer term issue of increasing readout density and reducing cost. If possible, provide assembly effort and M&S from Division base if sufficient external funds are not forthcoming. Of the new initiatives that are under consideration in our plan, our participation in LC R+D is our highest priority.

Neutrino program:

The physics opportunities in MINOS, Off-Axis (NOvA), and Reactor experiments are excellent.

We have added two postdocs, with some LDRD support, to the MINOS and Reactor efforts.

We are contributing to NOvA project management and engineering design now, in order to lay a foundation for Argonne participation in the final detector construction over the next 18 months

The reactor experiments- Braidwood, Daya Bay, and CHOOZII- have different timescales and costs, with CHOOZII by far the least expensive and earliest possibility. If CHOOZII is supported by NUSAG and DOE, we would join this in the expectation that this would give the earliest possible demonstration of a non-zero value of θ13.

As discussed above in the executive summary, the neutrino program would need additional FTE physicists, not possible in the base plan, to take part in all three programs.

=> We should proceed with CHOOZII if that is approved.

Advanced Accelerator R&D:

We have a unique capability with the AWA to study electron beam driven technologies for future high energy accelerators such as two-beam acceleration and advanced accelerating structures(such as dielectric loaded structures, etc). Our facility can also serve as a test bed for many advanced accelerator concept studies and advanced beam diagnostics.

We have established a role in the ILC positron source design as part of a lab-wide collaboration. Currently, we are the leading group in modeling the ILC positron source.

We have a good relationship with the Fermilab accelerator group and have provided valuable expertise on the electron cooling for the pbar recycler ring. This project has been successful.

We should participate in the muon cooling experiment at RAL only with explicit funding and a clear role. (Norem)

=> Focus effort on the AWA demonstration of 100MeV/m and understanding the physics issues. If possible bring Division resources to bear on this to allow effort to go faster.

Particle Astrophysics

Particle astrophysics offers exciting and unique scientific opportunities, including: searching for signatures of dark matter and dark energy, magnetic monopoles or strange quark matter (VERITAS) and observation of new particles and particle acceleration mechanisms in the cosmos (Auger). Particle astrophysics experiments such as VERITAS and Auger complement the measurements that can be done with the accelerator based programs at LHC, MINOS, and eventually ILC that make up the core of our long range ANL program plan.

The current efforts in Auger and VERITAS are regarded primarily as detector development projects, aimed at long term roles in one of these, or some alternative, possibly lab-wide project.
HEPD members have taken the lead in forming an intra-lab study group to identify a lab-wide strategic initiative in astroparticle physics, and the group's report has been well-received by the laboratory management.

There is not enough manpower to commit to more than one long-term astrophysics experiment.

VERITAS R+D is currently funded from a UC-ANL Collaborative grant, and we have a good technological collaboration with UC. This seed grant supports one postdoc in 2006, and a named fellowship will support a second postdoc starting FY2007.

=> Work on both Veritas and AUGER will emphasize detector R+D in the near term. We should continue to explore options for a larger lab-wide astroparticle initiative that builds on our detector expertise.

Theory:

The Theory Group is making strong contributions to studies of QCD and EWSB and to the phenomenology of standard model and beyond the standard model processes.
A strong effort was made to recruit a neutrino theorist with a joint appointment with U.C., but that did not materialize. However, the group has been strengthened in the collider physics area through other recruitments.

=>New appointments (possibly joint with U.C., NWU, U.I.) should strengthen the work of the theory group in areas which are related to phenomenology and experimental HEP, especially LHC collider physics.

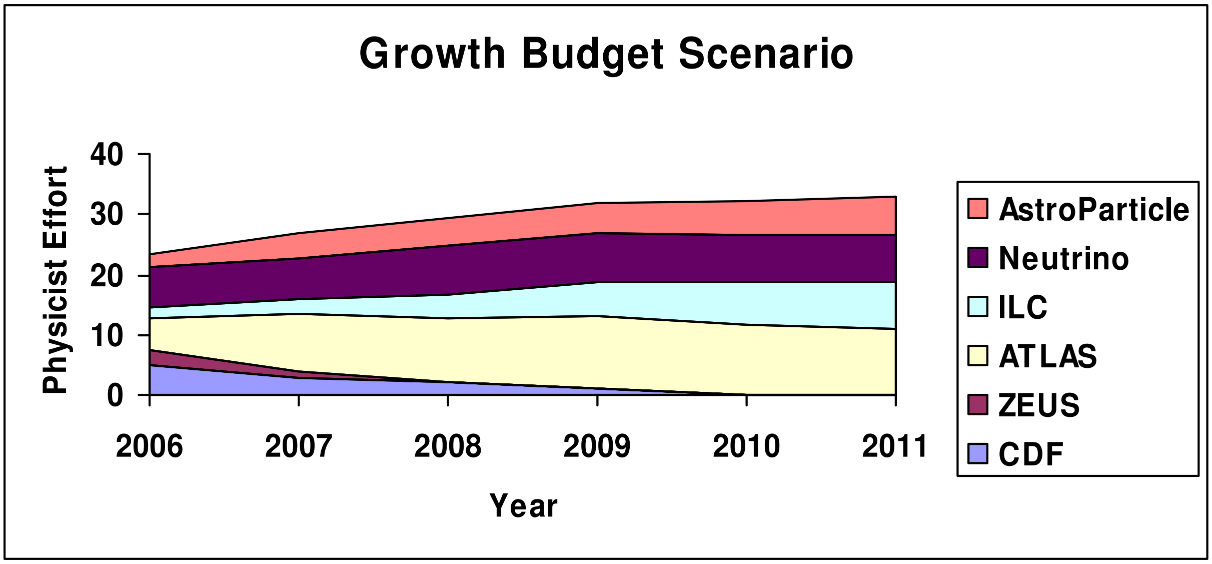
4.0 The Division Effort Plan through 2011

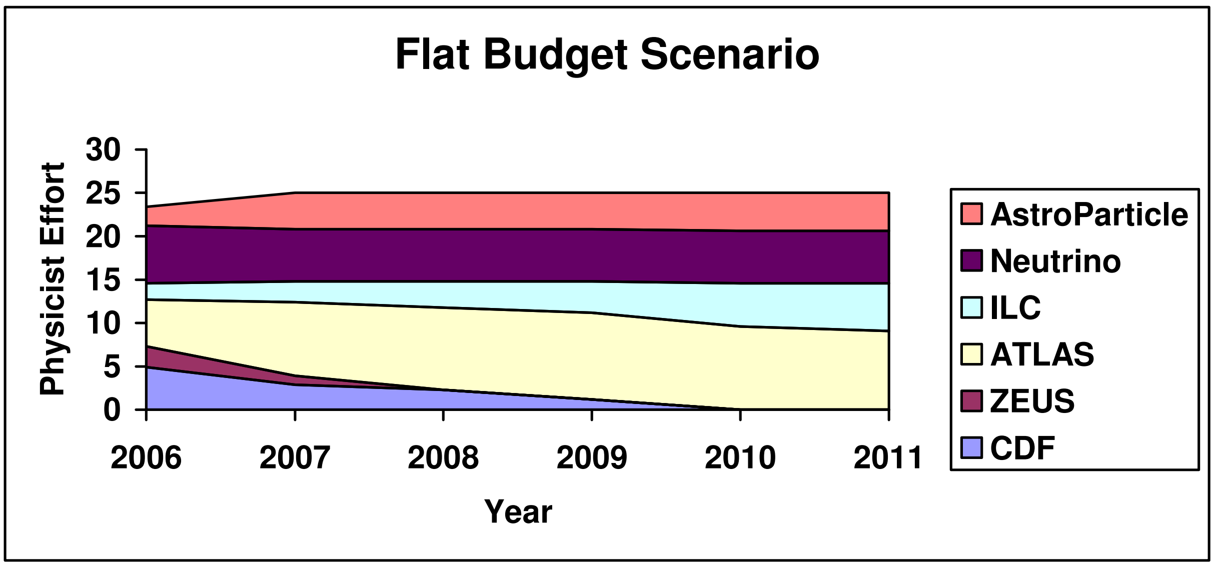
The primary goal of this planning process is to develop a strategic plan for the allocation of resources assuming a fixed level of effort

In words, this distribution shows the transition from CDF and ZEUS to other projects beginning now with a corresponding strengthening of the ATLAS and eventually, ILC groups. The plan terminates participation in ZEUS somewhat earlier than in CDF as is representative of their respective running schedules. The plan assumes a constant level of effort within the collider program that is sufficient to guarantee success in ATLAS.

We recognize that there will always be future developments that are impossible to predict. Therefore, this strategic plan should be updated at the end of FY2007 to reflect the decision points. At this point in time the situation with respect to the Linear Collider and astroparticle initiatives may be clearer.

Below we summarize the staffing plan that corresponds to a fixed level of effort, with completion of existing programs and phasing in of new programs. We have broken out supplemental non-DOE support (from LDRD startup funds, named fellowships, etc.) separately. The yearly totals include assumed DOE base support plus assumed supplemental funds. The figures summarize the assumed physicist effort level for the flat budget base plan and for the optimal plan that allows adding postdoc effort on a timely basis to the neutrino (Double-Chooz/NOvA), ATLAS, ILC, and astroparticle programs. Note that the growth in the astroparticle effort over at least the next three years comes largely from non-DOE funding. The growth scenario assumes additional astroparticle support from the lab-wide strategic initiative. The support group effort varies with time according to the needs of the experimental program, as indicated in the overall spreadsheet. The figures show only the assumed experimental effort, and similar projections can be made for theory and accelerator R+D, which we assume to be flat in the flat base program.


Growth Budget Scenario
Physicist Effort
40
30
20
10
0
2006
2007
2008
2009
2010
2011
Year
AstroParticle
Neutrino
ILC
ATLAS
ZEUS
CDF


Flat Budget Scenario
Physicist Effort
30
25
20
15
10
5
0
2006
2007
2008
2009
2010
2011
Year
AstroParticle
Neutrino
ILC
ATLAS
ZEUS
CDF

Fiscal Year	2006- "Non-DOE HEP"	2006 Plan	"Non-DOE HEP"	2007	2008	2009	2010	2011
CDF								
Physicists		4.9		2.9	2.3	1.2	0.0	0.0
Other (Mech.)		0		0	0	0.0	0.0	0.0
Other (Elec.)		0.2		0.2	0.2	0.2	0.0	0.0
Secretary		0.2		0.2	0.2	0.1	0.0	0.0
ZEUS								
Physicists		2.4		0.7	0.0	0.0	0.0	0.0
Other (Mech.)		1.0		1.0	0.0	0.0	0.0	0.0
Other (Elec.)		0.0		0.0	0.0	0.0	0.0	0.0
Students		1.0		1.0	0.0	0.0	0.0	0.0
Secretary		0.2		0.1	0.0	0.0	0.0	0.0
ATLAS								
Physicists	1.5	5.4	1.5	8.5	9.5	10.0	9.6	9.1
Computing		5.0		5.0	5.0	5.0	5.0	5.0
Other (Mech.)		1.9		1.5	1.3	1.1	0.5	0.5
Other (Elec.)		2.1		1.8	1.5	1.5	1.5	1.4
Secretary		0.5		0.6	0.6	0.7	0.7	0.7
Linear Collider								
Physicists	0.7	1.9	0.7	2.7	3.0	3.6	5.0	5.5
Other (mech.)		0.1		0.5	0.7	0.8	1.0	1.0
Other (elec.)	0.3	0.4	0.3	1.5	1.6	1.6	1.6	1.6
Secretary		0.1		0.1	0.2	0.2	0.3	0.3
Collider (subtotal)								
Physicists	2.2	14.6	2.2	14.6	14.6	14.6	14.6	14.6
Computing		5.0		5.0	5.0	5.0	5.0	5.0
Other (mech.)		3.0		3.0	2.0	1.9	1.5	1.5
Other (elec.)	0.3	2.7	0.3	3.5	3.3	3.3	3.1	3.0
Secretary		1.0		1.0	1.0	1.0	1.0	1.0

Fiscal Year	2006- "Non DOE HEP"	2006 Final		2007	2008	2009	2010	2011
Neutrino-MINOS								
Physicists		2.3		2.0	2.0	2.0	2.0	1.5
Other (mech.)		0.5		0.0	0.0	0.0	0.0	0.0
Other (elec.)		0.7		0.5	0.4	0.3	0.2	0.1
Reactor-NOvA								
Physicists	0.7	4.3	0.7	4.0	4.0	4.0	4.0	4.5
Other (mech.)	0.2	2.2		2.7	2.7	2.7	2.6	2.6
Other (elec.)		1.0		0.2	0.2	0.2	0.2	0.2
Neutrinos (subtotals)								
Physicists	0.7	6.6	0.7	6.0	6.0	6.0	6.0	6.0
Other (Mech.)	0.2	2.7		2.7	2.7	2.7	2.6	2.6
Other (Elec.)		1.7		0.7	0.6	0.5	0.4	0.3
Secretary		0.5		0.5	0.4	0.4	0.4	0.4
Theory								
Physicists	3.2	8.4	3.2	8.0	8.0	8.0	8.0	8.0
Other								
Secretary		0.8		0.8	0.8	0.7	0.7	0.7
Accelerator + MuColl								
Physicists	1.5	4.9	1.5	5.0	5.0	5.0	5.0	5.0
Other (elec.)	0.3	0.8	0.3	0.8	0.8	0.8	0.8	0.8
Other (Mech. Tech)		1.1		1.1	1.1	1.1	1.1	1.1
Secretary		0.3		0.3	0.3	0.3	0.3	0.3
Astroparticle Projects								
VERITAS								
Physicists	1.0	1.8	2.0	3.7				
Other (Mech.)		0.0		0.0				
Other (Elec.)		0.1		0.1				
Auger								
Physicists		0.4		0.5				
Other (Mech.)		0.1		0.1				
Other (Elec.)		0.0		0.0				
Combined Astroparticle								
Physicists	1.0	2.2	2.0	4.2	4.2	4.2	4.4	4.4
Other (Mech.)		0.1		0.1	0.2	0.4	0.9	0.9
Other (Elec.)		0.1		0.1	0.6	0.7	1.0	1.0
Secretary		0.1		0.1	0.2	0.3	0.3	0.3
Medium Energy		2.2		1.8	1.8	1.7	1.6	1.5

Fiscal Year	2006- "Non-DOE HEP"	2006 Final		2007	2008	2009	2010	2011
Support Groups								
Electronics		0.9		0.9	0.9	0.9	0.9	0.9
Mechanics		0.4		0.4	0.4	0.4	0.4	0.4
Computing		1.0		1.0	1.0	1.0	1.0	1.0
Administration		4.8		4.8	4.8	4.8	4.8	4.8
Totals								
Physicists	8.6	38.9	9.6	39.8	39.8	39.7	39.6	39.5
Other (total)	0.8	27.2	0.8	27.2	26.2	26.2	26.2	26.2
Other (Computing)		6.0		6.0	6.0	6.0	6.0	6.0
Other (Mech)	0.2	7.4	0.2	7.4	6.4	6.4	6.4	6.4
Other (Elec.)	0.6	6.2	0.6	6.2	6.2	6.2	6.2	6.2
Administration + Secretaries		7.6		7.6	7.6	7.6	7.6	7.6
Students	1.0	2.0	1.0	2.0	1.0	1.0	1.0	1.0
	10.4	68.0	11.4	69.0	68.0	67.9	67.8	67.7

Appendix I

CDF Goals

Hardware support:

- Shower max electronics
- CEM PM tube maintenance
- Calorimeter SPL role
- Maintain electron/photon code
- Level 2 shower max trigger
- Level 2 isolation trigger
- CEM /CES/ CPR calibrations.

Physics:

- B physics: Bs mixing via SVT trigger
  CKM angle gamma
  Semi-leptonic decays (Bs mixing and calibration)
- Exotic/QCD
  -Search for prompt photon signatures
- Precision EWK Physics:
  -Publish measurements of the W boson mass of sufficient accuracy to be a significant contribution to the world average determination. (~40 MeV/c^2)
  -Publish precision measurements of the top-quark mass..
- Demonstrate improved di-jet mass resolution using optimized jet reconstruction.
- As members of CDF editorial group, help with getting out quality publications.

ZEUS Goals

Support hardware responsibilities until end of HERA II (~2007)

- Maintenance and operation of Calorimeter First Level Trigger Processor (exclusive ANL responsibility)
- Maintenance and operation of Small Angle Rear Tracking Detector First Level Trigger (exclusive ANL responsibility)
- Maintenance, operation and calibration of Barrel Presampler (exclusive ANL responsibility)
- Maintenance of Straw Tube Tracker front-end electronics
- Contribute to the running of the experiment as shift leaders

Analysis effort

- Analyze HERA II data sets as they become available (physics topics to be determined)
- Coordinate 'Jets and High Et' physics group

- As members of the ZEUS editorial panel contribute to ZEUS paper writing process

Education

- Supervise one graduate student in their hardware responsibilities and analysis effort

Management of ZEUS

- Derrick, Repond and Yoshida will serve as members of the ZEUS planning group
- Magill will continue to serve as financial officer of the US groups in ZEUS.

ATLAS Goals

Trigger DAQ

- Complete installation of Supervisor / RoI Builder
- Complete cosmic ray run at CERN successfully supporting trigger supervisor
- Integrate RoI Builder in Atlas 2nd Level trigger and assist in other software development areas in level 2 (~12/2006)

Detector System Construction and Installation, Maintenance and Operations

- Provide leadership and technical staff for the completion of tile calorimeter installation (est. complete in FY2006
- Provide leadership and technical staff in support of Atlas-wide maintenance and detector operations, consistent with the overall level of US participation (ongoing responsibility)
- Maintain Supervisor / RoI Builder (2006 - until ATLAS as we know it ends or the system is replaced)
- Provide leadership and technical staff for the design and implementation of ATLAS databases

Technical Coordination

- Complete our assigned tasks associated with movement systems in cavern and had over operational responsibility to Atlas (complete)

Analysis Software Support Role

- Develop Argonne Analysis Support Center for mutual benefit of ATLAS Midwest Collaborators and Argonne ATLAS group.

Physics

- Establish presence in at least one early physics analysis (~5/2007).). Identify this analysis in and consolidate simulation and analysis skills to allow this initial work to be carried out by physicist predominantly at Argonne. These tasks will include strong participation in the combined testbeam and calorimeter calibration, in the development of software tools and in the development of simulation and analysis codes.
- Contribute significant physicist participation at CERN to early years of physics running (~2007-2011)
- Take lead in target analysis and publish when appropriate data is taken (~2008). Ideally this will be one of the first physics papers produced by Atlas.
- Establish strong presence in at least one additional fundamental analysis such as searches for high mass Higgs, or signatures of Supersymmetry. This analysis is expected

to produce important results soon after the LHC achieves design luminosity (2009-2010) and will continue thereafter with increased statistical sensitivity.

Neutrino Goals

MINOS operation

- Participate in the smooth operation of the MINOS far detector. (2006-2011)
- Contribute significant physicist participation at Fermilab to the early years of near detector operation, calibration and independent physics analysis. (~2006-2008)

MINOS physics

- Lead the effort to measure the underground m+/ m- ratio
- Make significant contributions to atmospheric neutrino analysis based on our knowledge of results from Soudan 2 (2005-2007)
- Take a lead in analysis of the near detector data and publish results(~2007)
- Establish a strong presence in at least one beam related neutrino oscillation analysis effort (~2067-2009)

Reactor neutrino Θ13 Experiment

- Take part in the reactor neutrino initiative going forward which is most likely to measure a non-zero value of θ13. (2006-2013)

Off Axis Experiment

- Lead the Technical Design Reportl effort for the NOvA off-axis experiment at Fermilab
- Design the mechanical structure for a new 25 kiloton detector.
- Secure a major role for HEPD in the construction of NOvA

Other Neutrino efforts and planning

- Maintain our leadership role in both accelerator and non-accelerator neutrino physics through the sponsoring of workshops, newsletters, web pages, etc. (ongoing)
- Take early and aggressive participation and leadership in ongoing efforts to develop appropriate long-term neutrino initiatives, such as the neutrino factory and other innovative ideas.

Theory Goals

- Concentrate on the most important problems facing contemporary particle physics, paying special attention to new theoretical and experimental developments and being in line with the main activities of the Laboratory and with DOE priorities. The research activities of the group will focus on (but are not limited to): Standard Model Physics, with emphasis on QCD, heavy quarks and Higgs Physics, studying the implications for the Tevatron, HERA, LHC, and Linear Collider physics.

- Beyond the Standard Model Physics: Supersymmetry, Extra Dimensions, Strong Dynamics etc., with emphasis on current Tevatron searches and future connections to LHC and LC physics.

- Develop active role in the experimental collider physics analysis efforts at ATLAS.

- Neutrino physics

- Develop expertise in astroparticle areas, using resources available in the area such as Fermilab, Northwestern, and U.C.Maintain an active, productive postdoctoral program

- Organize regular workshops on significant topics in particle physics

Advanced Accelerator R&D Goals

We will concentrate on the advanced accelerator physics topics related to future high-energy physics machines. Particular goals for the next 5 years are:

- Demonstrate practical dielectric based accelerator structure using high power X-band RF facility at NRL and SLAC. Study physics of dielectrics under the high fields. Investigate other advanced accelerating structures, such as photonic band gap and lefthand meta-materials. (ongoing)

- Using the available high current beam (14 MeV) for high gradient (>100 MV/m) test of dielectric and other advanced structures (next 1-3 years).

- Development of high energy drive beam (~50 MeV) to demonstrate high gradient and sustained acceleration using the wake field method developed at ANL. This will require expansion of the group (one additional RF engineer and technician) (3-5 years).

- Establish a significant role in servicing R+D needs for the linear collider and other users for their HEP related physics experiments (ongoing).

Linear Collider Goals

Simulation effort

- Continue development of Particle Flow Algorithms.
- Exploration of the phase space of detector design parameters with the aim of optimizing the jet energy resolution
- Simulate the response of the 1 m^3 prototype to particle beams

Hardware developments (FY2006)

- Complete R&D on Resistive Plate Chambers to be used in a Digital Hadron Calorimeter
- Produce and evaluate 2nd iteration of the front-end ASIC
- Complete design of electronic readout system for 1 m^3 prototype section
- Prototype components of electronic readout system
- Develop high voltage system for RPCs

1 m^3 prototype (FY2007)

- Construct RPCs for 1 m^3 prototype section
- Construct electronic readout system for 1 m^3 prototype section
- Assemble 1 m^3 prototype section (including HV and gas system)

Test beams (FY2006 and beyond)

- Tests with three prototype chambers and 8 x 8 channel digital readout
- Slice tests involving final prototype chambers, front-end ASIC and board, data concentrator and collector boards.
- Transportation of prototype section to test beams (FNAL or Protvino)
- Detailed measurements with 1 m^3 prototype section
- Comparison of performance with analog hadron calorimeter prototype section being built in Europe
- Comparison of response with simulation results
- Perform measurements with prototypes of the electromagnetic part of the calorimeter in front of the 1 m^3 prototype section

Hardware developments (FY2007 and beyond)

- Develop thinner chamber, possibly using a single glass plate
- Develop higher multiplexing of the front-end, increasing the number of channels served by a single ASIC
- Explore possibility of power pulse the front-end ASIC
- Develop higher multiplexing of the back-end of the readout system, possibly using token rings

Calorimeter design (FY2006 and beyond)

- Develop mechanical design of hadron calorimeter for the Linear Collider detector
- Refine design of RPCs and electronic readout, based on results from test beam

VERITAS Goals

- Perform basic R&D towards using MCPMTs to significantly improve technology of cosmic ray air Cerenkov telescopes.

- Perform basic R&D to utilize Argonne's expertise in building high speed, high performance front-end electronics and trigger, and achieving timing resolution of a few nanoseconds with an emphasis on a low cost solution.

- Enhance the liaison between U. of C. and Argonne

- Determine future Argonne role upon completion of phase

Auger Project Goals

- Participation in R&D muon counter construction for Argentina site.

- Fluorescence calibration studies using AWA electron beam.

- Detection of ultra-high energy cosmic rays with radio waves. This has not been demonstrated so far. The appropriate hardware can be determined/designed, built, and tested with the Argonne Wakefield Accelerator.

- Modification of water Cerenkov tank design for thermal insulation – such insulation is not required at the warmer, southern Auger site.

- Updating water tank electronics to use currently available components.

Identify significant construction roles for Argonne and assist with writing the funding proposal for the northern Auger site. Possible options are:

- Lead role in the construction of hardware for radio detection of cosmic rays, if this is successfully tested in the R&D phase.
- Primary responsibility for some portion of the site preparation and construction, such as the water purification system, or for a component for the water Cerenkov tanks, such as the solar power system.
- Co-leader role for tank construction.