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U. S. DEPARTMENT OF ENERGY
FIELD WORK PROPOSAL

1. WORK PROPOSAL NO.:	2. REVISION NO.:	3. DATE PREPARED:	3a. CONTRACTOR NO.:
2487.1		03-15-07	50302

4. WORK PROPOSAL TITLE:
Accelerator-Based Experimental Physics

5. BUDGET & REPORTING CODE:	6. WORK PROPOSAL TERM: Begin: End:	7. IS THIS WORK PACKAGE INCLUDED IN THE INST. PLAN?	7a. PRINCIPAL INVESTIGATORS:
KA-11-01-02		☒ YES ☐ NO	See Below**

8. HEADQUARTERS/OPERATIONS OFC PROGRAM MANAGER: Staffin, R. No. 301-903-3624	11. HEADQUARTERS ORGANIZATION: High Energy Physics	14. DOE ORG. CODE: SC
9. DOE FIELD ORGANIZATION WORK PROPOSAL REVIEWER:	12. DOE FIELD ORGANIZATION: Chicago	15. DOE ORG. CODE: CH
10. CONTRACTOR WORK PROPOSAL MANAGER: Weerts, H.J. No. 630-252-8831	13. CONTRACTOR NAME: UChicago Argonne, LLC	16. CODE: 12

17. IS THIS PROPOSAL TO DO WORK THAT INCLUDES A SECURITY INTEREST? ☐ YES ☒ NO

18. WORK PROPOSAL DESCRIPTION (Approach, anticipated benefit in 200 words or less):

This task comprises all programs of experimental particle physics research in the Argonne High Energy Physics Division. See attached description for further details. Related work in technology development is described under B&R code KA-15 (ANL Account 52210).

Non-Accelerator research will be submitted separately under KA-13 53206, 53207, 53209. ATLAS Analysis Support Center is submitted under B&R KA-11 (ANL Account 53208).

* 50302, 50307, 50314, 50320, 52117, 52119, 53202, 53205, 50199, 53203

** D. Ayres, R. Blair, G. Drake, M. Goodman, T. LeCompte, D. Malon, L. Nodulman, L. Price, J. Proudfoot, J. Repond, H. Spinka, R. Stanek, R. Talaga, H. J. Weerts, A. B. Wicklund

19. CONTRACTOR WORK PROPOSAL MANAGER:		20. OPERATIONS OFFICE REVIEW OFFICIAL:	
H. Weerts	03-15-07		03-15-07
SIGNATURE	DATE	SIGNATURE	DATE

21. DETAIL ATTACHMENTS: (See specific attachments.)

☐ a. Facility requirements	☒ e. Approach	☐ i. NEPA requirements	☐ m. ES&H considerations
☐ b. Publications	☒ f. Technical progress	☒ j. Milestones	☐ n. Human/Animal Subjects
☒ c. Purpose (mandatory)	☒ g. Future accomplishments	☐ k. Deliverables	☐ o. Security requirements
☐ d. Background	☒ h. Relationships to other projects	☐ l. Performance Measures/Expectations	☒ p. Other (specify)

WORK PROPOSAL REQUIREMENTS FOR OPERATING/EQUIPMENT OBLIGATIONS AND COSTS

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22. STAFFING (in staff years)	PRIOR YEARS	FY 2007	FY 2008 ESTIMATE	FY 2008 REVISED	FY 2009 REQUEST	FY 2009 AUTHORIZED	FY 2010	FY 2011	TOTAL TO COMPLETE
a. SCIENTIFIC		13.1	15.4	16.7			0.0	0.0	
b. OTHER DIRECT		0.6	0.8	1.0			0.0	0.0	
c. TECHNICAL SERVICES*		0.0	0.0	0.0			0.0	0.0	
d. TOTAL DIRECT		13.7	16.2	17.7			0.0	0.0	
23. OBLIGATIONS AND COSTS (in thousands)									
a. TOTAL OBLIGATIONS		3363	3985	4224			0	0	
b. TOTAL COSTS		3496	3971	4207			0	0	
24. EQUIPMENT (in thousands)									
a. EQUIPMENT OBLIGATIONS		719	720	720			0	0	
b. EQUIPMENT COSTS		796	712	719			0	0	

25. MILESTONE SCHEDULE (Tasks)	FY 2009 DOLLARS PROPOSED	FY 2009 DOLLARS AUTHORIZED	PROPOSED SCHEDULE	AUTHORIZED SCHEDULE

26. REPORTING REQUIREMENTS

*Technical services staffing includes ANL support divisions' scientific effort.

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A. Collider Detector at Fermilab

Argonne is a founding institution in the Collider Detector at Fermilab (CDF) collaboration. The collaboration is continuing to improve measurements and search for new phenomena with data samples corresponding to 2 fb^{-1} of integrated luminosity. Argonne has played a strong role in CDF, leading the fabrication of the central EM calorimeter, helping to upgrade the trigger, providing readout electronics for the Run II upgrade, helping to build the new drift chamber, and leading the recent upgrade of the central preshower detector. The CDF collaboration has published or made public many results based an integrated luminosity of 1 fb^{-1}. Our group has contributed to measurements of b-hadron production, B_S mixing, the top-quark and W-boson masses, and searches for new physics using prompt photon signatures.

a) FY2006-2007 Accomplishments: 1) The Argonne group helped provide the foundation for the CDF measurement of the B_S mixing frequency. 2) We made key contributions to the new measurement of the W mass using the first 0.2 fb^{-1} of integrated luminosity. 3) We continued to lead the photon group, and to provide oversight for photon-based searches for new physics. 4) We continued to lead the effort on particle-flow algorithms to improve the dijet mass resolution. Support for our successful operations included: Larry Nodulman as co-head of calorimeter operations; Karen Byrum, with our electronics group, supporting shower max electronics; and Steve Kuhlmann supporting preshower and shower max high voltage.

b) FY2008 Plans: We will continue to support data taking operations and maintain calorimeter systems, particularly those associated with the central EM calorimeter, and support the shower max readout system. With anticipated integrated luminosity over 3 fb^{-1}, there will be an excellent opportunity to test for CP violation in B_S mixing by locking into the known oscillation frequency. Measuring the W mass with ten times more data, together with the precision top-quark mass, will provide a powerful constraint on the SM Higgs mass. Perhaps one of the many searches will become particularly interesting. Even as our collaboration is becoming smaller, opportunities for physics analysis with the rapidly increased data set are growing.

c) FY2009 Plans: Assuming that data taking continues, we will continue to support CDF operations. With 4-8 fb^{-1} of integrated luminosity, real Higgs sensitivity should be realized. Even after data taking stops we will continue to try to extract the physics content of the data as thoroughly and quickly as possible.

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B. ZEUS/HERA

At the DESY Laboratory in Hamburg, Germany, the electron-proton colliding beam accelerator, HERA, is the frontier facility for studies of lepton and photon interactions with quarks and gluons. A US consortium of eight institutions designed, built, and is operating the high-resolution barrel calorimeter for the ZEUS Detector at HERA. The costs of operating the ZEUS detector, upgrading and maintaining the data acquisition components and the data analysis computer framework, and publications are the common responsibility of all groups and are shared among all the institutions. The US share of these ZEUS experiment common operating costs is funded in this account.

A collaboration of eight US groups (AMZEUS) was responsible for the design and construction of the barrel calorimeter, including all of the necessary readout electronics and calibration systems. The first level calorimeter trigger and the fast clear system in the second level trigger were also designed and built by AMZEUS. Several upgrades to the ZEUS detector, the trigger system for the small angle rear hodoscope (SRTD), the barrel preshower detector (BPRE), readout electronics for the straw tube tracker (STT), and replacement bases for barrel calorimeter phototubes, were also provided by AMZEUS members.

This task covers funding of the portion of the ZEUS experiment common operating costs that are the responsibility of the AMZEUS group (of which 5 of the original 8 institutions remain). The receipt, accounting, and disbursement of these funds are managed by a member of the ANL HEP staff elected as the AMZEUS Finance Officer.

The operating costs are identified in the ZEUS Financial Report, which is presented semi-annually at the ZEUS funding agency representative meeting held at DESY. These invoices are designated as:

1) ZEUS Common Operations – common expenses incurred in the operation of the ZEUS detector, e.g., gases, electrical power, liquid helium, and common maintenance costs.
2) ZARAH Operations – common expenses incurred in the operation of the data processing computers at DESY.
3) Upgrades – common detector and computing upgrades, some which are time delimited and others which are incurred yearly, e.g., ZARAH Upgrade, CDAQ Upgrade, and Luminosity Upgrade.
4) Publication costs.

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The largest cost, ZEUS Common Operations, is determined mainly by the running cycle. The ZEUS experiment is now in a period of extended data-taking that will run until mid-2007 with only short required maintenance shutdowns. DESY invoices are computed on a calendar year (CY) basis. Because of the difference in CY and US fiscal years (FY), invoices that are received in mid CY are paid out of the next FY funds. The invoices are generated in the denomination of Euros. Using an exchange rate of 1.30 USD per Euro and including ANL overhead, the estimated budget for AMZEUS operations at DESY is:

FY 2007 (CY 2006):	125,000 Euros (invoices)	$162,500 USD
FY 2008 (CY 2007):	100,000 Euros (estimate)	$130,000 USD
FY 2009 (CY 2008):	30,000 Euros (estimate)	$39,000 USD

C. Neutrino

a) FY 2006 Accomplishments: In FY 2006 the operation and first analysis of the MINOS long-baseline neutrino experiment took place. Results were reported from 1.27 x 10^{20} protons on target, and initial results on neutrino oscillation parameters were announced. ANL provided help in development of spare devices related to the horn and target. Neutrino Group members continued their heavy involvement in the analysis of cosmic-ray muon tracks in the far detector, which were used to perform the first-ever measurements of underground muons with a magnetized detector that can separate μ^+ from μ^- The group also continued work on the analysis of beam neutrino events in the near and far detectors during this period. Argonne physicists continued to hold a number of key leadership and management positions in the MINOS Collaboration.

b) FY 2007 Plans: Argonne physicists will present a first result on the oscillation analysis of beam-induced rock muon events in the far detector. Sensitivity studies that combine the analysis of rock muons and contained events will be completed. Argonne physicists will be co-authors on MINOS instrumentation and physics papers submitted in FY 2008 and will lead the analysis effort for several of these. Group members will continue to hold key leadership positions within the MINOS Collaboration. Argonne physicists and engineers will devote an increasing level of effort to next-generation neutrino experiments in FY 2007, as described in the Detector Development section of this report.

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c) FY 2008 Plans: Argonne physicists will continue to work on the analysis of neutrino beam data from the MINOS near and far detectors and will lead the analysis efforts on a few important topics. These will include precise measurements of neutrino oscillation parameters in the far detector and neutrino cross sections in the near detector. The MINOS Collaboration will produce a number of physics publications this year, with Argonne authors playing leading roles in several of them. Group members will continue to hold key leadership positions within the MINOS Collaboration.

d) FY 2009 Plans and Beyond: MINOS will continue to take data for several years, and decrease the statistical error on neutrino oscillation parameters. Future possibilities include antineutrino running. Opportunities for other valuable physics measurements will continue to be exploited.

D. NOvA, The NuMI Off-Axis Experiment

a) FY 2006 Accomplishments: The group's detector R&D work in FY 2006 included detailed engineering studies of very large structures built of PVC plastic, including detailed investigations of material properties and structural failure modes, along with a solution to the issues related to the design of large structures to hold liquid scintillator. Considerable effort was also spent in preparing for the baseline review.

b) FY 2007 Plans: The technical design and budget for NOvA will be completed in early FY 2007. The Argonne group's extensive experience with the preparation of cost estimates, schedules, and supporting documentation for the MINOS experiment will be very valuable for the preparation of the NOvA Technical Design Report and other documents for DOE Reviews. Tasks include: 1) Detector design studies to optimize experiment parameters in order to minimize systematic uncertainties and backgrounds; 2) detector R&D to optimize the liquid scintillator detector system; 3) active detector engineering to design the prototype mass-production facilities; 4) leadership and management to prepare costs and schedules for the Technical Design Report.

c) FY 2008 Plans: Argonne physicists and engineers expect to hold a number of key positions in the management of the NOvA project in FY 2008. Tasks include: 1) detector design studies to complete simulations for optimization of experiment parameters; 2) active detector engineering in the operation of prototype mass-production facilities for components;

3) electronics engineering for design, prototyping, and construction of electronics readout; 4) detector site engineering for design of the conventional facilities; 5) civil construction at the far detector site beginning in FY 2008; 6) key leadership and management tasks within the collaboration.

d) FY 2009 and Beyond: The construction of conventional facilities at the far detector site would continue in FY 2009 along with some detector installation in FY 2009. Argonne will be heavily involved in the setup and initial operation of detector assembly facilities at collaborating institutions, much as it was for MINOS. Argonne will be a major participant in the analysis of data from FY 2010. If θ_{13} is large enough and the proton intensity from the Main Injector is high enough, it may be possible to begin the study of CP violation with the initial NOvA detector.

E. ATLAS Experiment (see KA-11-01-02, 52107)

F. Technical Support (Electronics & Mechanical)

1) Electronics Support

The Electronics Support Group provides design services and electronics support for the experimental groups in the division. The group has expertise in many areas of electronic design, including high-speed digital signal processing, high-precision analog design, and design for low noise. Our projects include trigger electronics, low-noise front-end electronics, and data processors.

Our primary efforts in this past year include the following:

- Completion of the production of the Level 2 Trigger Electronics for the ATLAS experiment at CERN. In this last year, all the cards needed for the system were produced and checked out. Two full systems have been sent to CERN. We will provide support as needed as the experiment begins operations later this calendar year. Some additional software work is expected to be completed this year for the start of the run.

- Development for the hadronic detector for the Linear Collider: This work includes the development of electronics to read out small pads of Resistive Plate Chambers (RPCs), operating in a digital mode. The electronics include the development of a custom front-end chip that we are working on with the Fermilab ASIC design Group. We have lead responsibility for developing a readout system based around this

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chip, with the goal of constructing a system to read out 400,000 channels of a "cubic meter" prototype detector. This year, we tested version 1 and version 2 of the custom chip. We also formed a design group and began the physical design of the subcomponents needed for the system. We are scheduled to perform a "Vertical Slice Test" of the system that utilizes prototypes of all system components in the spring of 2007. In this next year, we intend to move toward production of the entire readout system for the cubic meter detector.

- Electronics for particle astrophysics applications: We are working with advanced photo-detectors and high-speed readout electronics to develop the next-generation of cameras for ground-based telescopes. We are working with the "Next Generation Ground-Based Array" design group to develop a conceptual design of the readout system needed for this new instrument. We have also engaged the electrical engineering department at Northwestern University to develop a new custom integrated circuit for this new instrument that works on the concept of counting photons. The design of a "proof-of-principle" chip is in progress, and we hope to test it later this year. We also are supporting the TrICE telescope that resides on-site at Argonne, which started taking data this year.

- Detector development work: Work this last year included characterization of micro-channel plate (MCP) tubes. We have built up a laser lab to perform precision timing measurements with the MCPs, for a possible application in a large-area time-of-flight detector. We have also begun preliminary work with silicon photo-multipliers (SiPM), including characterization of noise, gain, and speed. We have an LDRD for this work, which includes the creation of conceptual designs for different applications, including HEP detectors, particle-astrophysics detectors, x-ray detectors, and homeland security applications.

- Electronics support for the MINOS Near Detector and the CDF Shower Max Detector: We will continue to provide support for the electronics that we built previously for these experiments.

2) Mechanical Support:

The Mechanical Support Group provides general support for all division experimental programs which includes expertise in design, construction, testing, and installation techniques. In the past year the Mechanical Support Group has focused its efforts on the following areas:

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ATLAS

The Mechanical Support group has played a major leadership role in the design, construction, and installation of ATLAS. Over the last year ANL finalized the moving system for all of the major detectors within ATLAS and used this system to move the Barrel and Extended Barrels into final position. ANL has also contributed to the assembly of the Barrel and the Extended Barrel, fabricated fixtures and tooling required for the installation, and been a major participant in the installation of services for the detector. It is anticipated that ANL will continue to play these roles in the upcoming year.

Neutrino Experiments

The Mechanical Support Group is involved in several proposed Neutrino Experiments. In the past year ANL designed a wire chamber Veto shield for Double Chooz, which included the construction of a 6′ long, 32 cell prototype wire chamber as well as a 27′ long, 3 cell prototype. We also developed and prototyped parts for an Articulated Arm deployment system for the sources inside the target region of Double Chooz. ANL's main effort though has been on NOvA. ANL has taken a lead role in the R&D for the detector structure, adhesive, and fabrication equipment. We have performed extensive adhesive tests as well as structural analysis on the main detector concept. We are leading the R&D for the PVC mixture that will be used and the extrusions which form the main structural component of NOvA.

ILC- detector R&D

A conceptual design for the HCAL barrel module was done and a structural analysis conducted. We have also developed a conceptual design for the RPC's and constructed a number of prototype RPC modules. ANL is currently constructing a 15 chamber "Vertical Slice Test" that consists of RPCs and steel absorber for testing the basic design in the beam line.

Other Experiments

ANL continues to support MINOS by providing help with upgrades.

Particle Astrophysics

ANL designed and fabricated 11 prototype modules for Auger. These modules were constructed using scintillator strips with fibers glued into them and then routed to a cookie/PMT. The modules were constructed from PVC sheets and sealed to keep out moisture. ANL has constructed the structure that houses the TrICE experiment, installed the experimental components, and constructed the fixtures and tooling needed for the experiment. ANL has also completed a detailed thermal analysis of the Dark Energy Survey (DES) telescope and is currently working on further thermal and structural analysis for DES.

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Supplemental Operating Funds Request for FY 2007 and FY2008.

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