BUD-11A (1-07)
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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.:
1738.1		03-15-07	50101

4. WORK PROPOSAL TITLE:
Theoretical 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-14-01-02		☒ YES ☐ NO	

8. HEADQUARTERS/OPERATIONS OFC PROGRAM MANAGER:	11. HEADQUARTERS ORGANIZATION:	14. DOE ORG. CODE:
Staffin, R. No. 301-903-3624	High Energy Physics	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 covers research in theoretical particle physics in the High Energy Physics Division. This includes research on electroweak symmetry breaking and Higgs physics, collider physics, QCD, Beyond the Standard Model physics, particle astrophysics and Cosmology, as well as non-perturbative solutions in gauge field theories.

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		5.9	5.5	6.5			0.0	0.0	
b. OTHER DIRECT		1.0	1.0	1.0			0.0	0.0	
c. TECHNICAL SERVICES*		0.0	0.0	0.0			0.0	0.0	
d. TOTAL DIRECT		6.9	6.5	7.5			0.0	0.0	
23. OBLIGATIONS AND COSTS (in thousands)									
a. TOTAL OBLIGATIONS		1781	1753	1941			0	0	
b. TOTAL COSTS		1748	1753	1931			0	0	
24. EQUIPMENT (in thousands)									
a. EQUIPMENT OBLIGATIONS		0	0	0			0	0	
b. EQUIPMENT COSTS		0	0	0			0	0	

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

26. REPORTING REQUIREMENTS

Supplemental operating funds are requested for FY07.

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

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Theoretical Physics

Theoretical High Energy Physics at Argonne is carried out by five staff members and three postdocs. The group pursues a broadly based theoretical research program in the physics of elementary particles and quantum fields.

Activities in theoretical high energy physics are highly correlated with the main experimental results in this area. The Tevatron collider at Fermilab is performing very well, with record high luminosities. Plenty of new physics results have been recently reported, including the measurement of the mass difference between the two mass eigenstates in the Bs meson system, and the single production of top quarks. On the other hand, the start of the run of the Large Hadron Collider at CERN is only one year away. It is hence important to study the possible physics signatures at these colliders, arising from the Standard Model of particle physics, as well as from well motivated new physics models. Great emphasis should be put on the study of electroweak symmetry breaking, leading to the origin of mass of elementary particles, as well as on the related subject of Higgs physics, which is expected to be the most exciting physics at the last stages of the Tevatron and the beginning years of the LHC.

In addition, recent results from cosmology experiments have established the presence of a large dark matter density in the Universe, whose origin may be explained by the same new particle physics models leading to the understanding of the origin of elementary particle masses. Finally, the origin of the ordinary matter and the absence of anti-matter in the Universe may be explained by the same physics.

In view of this situation, the Theory Group has put a strong emphasis on electroweak symmetry breaking and Higgs and beyond the Standard Model physics at the Tevatron and the LHC, as well as in the interaction between particle physics and cosmology.

a) FY2006-2007 Accomplishments: In the last year, the group engaged on studies of the physical backgrounds for Higgs searches at the LHC, both in the photon-photon as well as in the WW channels. The group studied the impact of the newly measured value of the mass difference in the Bs system and the present bounds on rare decays of the Bs mesons, coming from the Tevatron collider, on Higgs searches at the Tevatron and the LHC in the minimal supersymmetric extension of the standard model. The group also considered the strong interaction corrections to the production of Higgs bosons in association with bottom quarks. Although the main emphasis was put on issues related to Higgs physics, the group has produced several articles on physics beyond the standard model, including subjects related

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to theories of supersymmetry, extra dimensions, dark matter, and the origin of the baryon-antibaryon asymmetry. The activities of the Argonne HEP-Theory group in recent years on all these subjects have received wide recognition from the particle physics community.

There are other important theoretical problems that are not directly connected with the question of electroweak symmetry breaking, but yet demand an understanding to get a full picture of particle interactions. Non-perturbative effects are, for instance, quite relevant and are mainly analyzed by means of either lattice calculations, low-energy effective theories, large N-expansions and/or semi-classical approximations. These effects are important for the physics of strong interactions at low energies, the physics of quarkonia, and the behavior of strongly interacting matter at large densities and temperatures. The theory group has made relevant contributions in the study of these effects, for instance, on issues of production of heavy quarkonia, non-relativistic QCD, lattice gauge theories, and non-perturbative solutions in gauge theories.

The group has also fulfilled an important role in the education of students and young postdocs. In the last two years, five graduate students have actively worked in the HEP Theory group, as well as five postdocs. Some of them will remain at Argonne in FY08, while those who will leave (or left) Argonne will remain active in the field.

b) FY2008 Plans: The group will continue working on subjects related to Higgs physics and electroweak symmetry breaking, putting special emphasis on the connection with hadron collider physics. There is already work in preparation related to refined analyses of the photon background for Higgs searches as well as a more detailed analysis of the impact of the new results on flavor physics for Higgs physics at the Tevatron and the LHC. While the subject of electroweak symmetry breaking and Higgs physics will remain as the main priority, the group will continue being active on QCD, heavy charmonia, particle astrophysics and non-perturbative solutions in field theory.

The Argonne HEP Theory group is also planning to hire a new Assistant Physicist jointly with Northwestern University. In this plan, Tim Tait would also become a joint faculty at both institutions, so the new appointment will come at a very low additional cost to the Argonne HEP Division. It is expected that the new scientist will work on issues related to LHC physics and will further reinforce the already strong group working on this area at the HEP Division.

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The Theory Group is highly interested in expanding its interactions with the recently created ATLAS Analysis Center. In particular, additional funds are requested to hire an Assistant Physicist to work on hadron collider Physics and on strong interactions. This Physicist, if appointed should:

1) Perform state-of-the-art calculations of the production dynamics of SM and new physics processes at the energy of the LHC, along with SM backgrounds to new physics processes.

2) Interact closely with internal and external users of the LHC ATLAS data analysis center.

This appointment is a high priority for the Argonne HEP Theory Group.