Cover Page

Title of Proposed Project:

Argonne Scalable Cluster Project

DOE/OSC Program Staff Contact:

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Name of Laboratory:

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Requested funding for ANL for each year; total request

Year 1 (FY 2002)	$	1,003,266
Year 2 (FY 2003)	$	1,040,802
Year 3 (FY2004)	$	1,080,193
Year 4 (FY2005)	$	1,121,501
Year 5 (FY2006)	$	1,164,850
Total:	$	5,410,613

Duration of Entire Project Period:

10/01/2001 to 09/30/2006

Use of human subjects in proposed project: No
Use of vertebrate animals in proposed project: No

Signature of PI, Date of Signature:

Signature of Official, Date of Signature:

Infrastructure and Effort Support for The Chiba City Project

Rick Stevens and Rémy Evard
stevens@mcs.anl.gov, evard@mcs.anl.gov
November 19, 2001

1 Introduction

The Chiba City Project at Argonne National Laboratory is a DOE-sponsored Advanced Computing Research Testbed. The goal of project is to provide a series of parallel hardware and software testbeds for the computer science and applications community aimed at supporting research in software scalability. The work supported by the initial testbed has had significant effect on the high-performance computing community, and as the project evolves and expands, it will have increasingly broad impact by enabling more rapid progress in realizing the dream of scalable systems.

The scalability testbeds in the Chiba City Project will be available to computer scientists, software engineers, and application developers across all facets of the nation's high-performance computing community, including university-based researchers, companies contributing to the cluster software and HPC effort, the DOE SciDAC programs, existing DOE-funded base program research activities, and research partners. We are targeting a broad user community for this testbed, and expect to have a significant population of users.

The design, construction, and on-going operation of the clusters in the Chiba City Project, as well as the effort necessary to support the diverse and competent user community, requires substantial time and proficiency. The cluster team must have expertise in cluster research and technology, parallel computing environments, systems administration, operating systems, Linux-specific issues, and networking. In this proposal, we request funding for 4 FTEs to support the operation and the users of the Chiba City Project. Ideally, this funding will last for the duration of the project, which extends through 2006.

Additionally, the systems in the project require infrastructure support including power, cooling, and on-going hardware maintenance. We also request annual funding to support this need.

2 Significance

The goal of scalable HPC systems is at the core of multiple agency research programs in scientific computing (e.g. DOE OSC, DOE NNSA, NSF CISE, NASA HPC, etc.). The national HPC program and related efforts have all identified the need for scalable systems software as a prerequisite for scalable applications and software infrastructure that is affordable. Even vendors have adopted the concept of desktop to teraflop as a goal for their systems architectures and software environments. There is no doubt that much is riding on the assumption that the community can develop the insights and the methods for building scalable systems software and environments and turn these ideas into working software that will have broad deployment and impact. It is therefore critical that the community have a testbed that is focused on providing the needed infrastructure for this type of research. The Chiba City Project aims to build this cluster

testbed and to make it available to a broad community of users. Designing, building, and operating the cluster takes effort, as does the support of the user community.

The expected impact of this project is considerable, but will only be achieved if the community can exploit the capabilities of the testbed on a routine basis. The routine and reliable access to a computer science testbed is what is needed to move scalability research forward. We believe this requires a dedicated testbed to support this important work. The testbed needs to be available to the computer scientists for routine use without having to move applications off the machine, so that ideas can be tried while they are still fresh and while feedback can be taken into account into the design process. The testbed also needs to be organized in a way that users can have root access to the compute nodes and can try out low-level software environments on a routine basis without risking the instability of the whole system. The clusters in the Chiba City Project are designed to support quick reconfiguration of the nodes and software to enable users to have root privileges without incurring security risks or undue downtime for system recovery between experiments. The design and operation of these clusters requires considerable expertise in diverse areas of computing, including cluster research and technology, parallel computing environments, systems administration, operating systems, Linux-specific issues, and networking.

In order to achieve the goals of the project, the computing testbeds will be available to a wide range of researchers. Users will come from the following areas:

- DOE Base Program Research. A substantial number of existing research programs, including those supported by DOE base funding as well as collaborations with other institutions, require large-scale development, carry out scalability research, or need to be built on a system that supports extreme system development. Among these are MPICH; the Parallel Virtual File System; large-scale visualization research; ACTS, PETSc and other libraries; the Los Alamos Science Appliance project; the Programming Models project; and a number of specialized kernel development efforts in the DOE laboratories.
- DOE SciDAC Projects. A number of the DOE SciDAC projects must develop at scale and carry out extreme system development, including the Scalable Systems Software ISIC, the Scientific Data Management ISIC, and the Performance Evaluation Research Center.
- University Partners. These include computer scientists in universities who need to test on large systems. Based on requests thus far, we anticipate several hundred such researchers. Additionally, the system will be available to all DOE Early Career PIs in the areas of computer science and mathematics.
- Strategic Vendors. These include any commercial entity that is developing a key technology or software product for the HPC community that must perform well at scale in order to benefit the community. Myricom, Scyld, and others have already used Chiba City for testing, to great benefit to the community. Other interested vendors include Veridian, TurboLinux, and Etnus. Additional vendors and 3rd party application developers are welcome and expected.

Additionally, Argonne will organize several activities during FY02 to build user community for the scalability testbed.

1. We will conduct several workshops aimed at building a coherent user community for the system. These workshops will bring together DOE and University researchers to explore how to best use the testbed and how ANL can support the community.
2. We will build a web-based environment that will explain how to use the testbed and describe the current scalability goals and accomplishments for various projects that are using the testbed.

3. We will develop a user support team at ANL that has familiarity with the various scalability research projects and that can provide help to those using the testbed systems.

The personnel funded by this proposal will enable and/or carry out all of these activities.

3 Approach

This proposal has two foci: personnel and infrastructure support.

3.1 Personnel Approach

The operational team for the Chiba City testbed must carry out a mixture of design, engineering, system administration, monitoring, and maintenance. Additionally, the team must support users by creating documentation, holding workshops, and assisting in the analysis of problems related to all aspects of the systems, ranging from simple user mistakes to complex scalability issues. All of these roles require experts who thoroughly understand all aspects of the cluster, but who also specialize in particular areas. Each of the areas of specialization, and the amount of effort required for that aspect, are listed in the following table and described in detail below. In total, the operational support requires 4 FTEs.

Function	**FTE**	**Incumbent(s)**
Coordination and Leadership	.25	Rémy Evard
Parallel Computing Environment	1.0	Eugene Rackow
Cluster Networking	0.5	William Nickless
Linux Expertise and System Administration	1.5	Daniel Nurmi John-Paul Navarro Narayan Desai
User Environment and Support	0.75	Sandra Bittner

Because the Chiba City Project and the Argonne computing environment are unique, several issues related to the operational support of the clusters are noteworthy:

- The Chiba City Project operates computing testbeds that enable a great deal of research and development. Those research activities, including development work on the system software of the clusters themselves, are supported by other funding. We are requesting funding specifically for the operational support of the clusters, which involves considerable work beyond that supported by the specific user projects.
- Argonne does not hire unskilled "operators", and does not dedicate staff to be on-site 24/7 to monitor the operation of its systems. We have not found operators to be a cost-effective approach to system management in our environment, where the focus of the systems is on research rather than production. The experts who support the clusters are on call and will respond to problems during off hours as necessary. Thus, the funding that we are requesting will not support any unskilled operational functions.
- We have determined, based on our experience, that the necessary size of the operational team is 4 FTEs. On smaller clusters, or clusters that only support a small set of focused applications, it is possible to operate with a smaller team of 2 to 3 FTEs. The Chiba City testbed is operationally challenging because it is large and serves many functions. The users on Chiba City are developers and researchers who demand a great deal from the system. Many of them revel in finding bugs in the operating system, stretching the performance of the network, or breaking the I/O system – all of which are a necessary

part of their research, and all of which require operational expertise to hold the system together.

In the sections below, we describe the people who will initially take on the roles and functions necessary to support the project. While the exact personnel may change over the duration of this project, we expect the level of effort in each area, as well as the level of expertise supporting that area, to remain constant.

3.1.1 Coordination and Leadership (0.25 FTE)

Rémy Evard will lead the operational team, which will entail:

- Designing the overall architecture of the testbed, both in preparation for the initial installation and as an on-going activity that reflects continuing changes in all aspects of the system.
- Acting as a focus for interactions with external agents such as potential collaborators or vendors wishing to reserve time on the cluster under special arrangements.
- Determining and prioritizing operational goals and issues.
- Coordinating activities on the cluster and within the cluster operations team.

Evard has been managing teams of system and networking engineers, with a focus on high-performance computing and networking, for ten years. He has been building commodity clusters for the last four years and was the chief architect of Chiba City, the first scalability testbed at ANL. He has been extremely active in DOE cluster efforts and the high-performance computing community.

3.1.2 Parallel Computing Environment (1.0 FTE)

This engineer is responsible for those aspects of the cluster that make it a parallel computer. For example, this includes the scheduler, the resource manager, the job launcher, the I/O subsystem, the virtual node subsystem, and the management subsystem

This role entails:

- Designing, configuring, and maintaining the parallel computing environment on the testbed. It is expected that the parallel computing environment will be continually changing in response to user needs, as new capabilities become available, and as new system software emerges from existing research and development projects.
- Interacting with system software developers in order to support the low-level testing necessary for this type of development.
- Handling overall cluster allocation and reservation issues, such as dedicated long-term reservations for specialized testing.
- Testing and tuning the MPI communication mechanisms, the storage system, and the overall cluster performance.

Eugene Rackow will take on these responsibilities. Rackow has extensive experience in parallel computing support and operation. He has supported every parallel computer and high-performance computing system fielded by MCS, including several IBM SP systems, SGI Origin 2000, Chiba City I, and early parallel computers such as the CM-2, Encore Multimax, and Intel Touchstone Delta.

3.1.3 Cluster Networking (0.5 FTE)

William Nickless will be responsible for the networking component of the cluster and the external network connections into the system.

This includes:

- Taking primary responsibility for the design, configuration, installation, and management of the networks in the testbed, including the management network (Ethernet) as well as the high performance network (Myrinet).
- Interacting with users who have a specific interest in the network. In addition to the computer scientists carrying out research on the cluster, this will include network vendors who wish to test their product at large scale.
- Interfacing with external network administrators in order to ensure that the testbed has an optimal high-speed path to research networks and remote partners.
- Performance tuning and debugging of the network.
- Acting as a cluster networking resource for cluster projects at collaborator sites.

Nickless has ten years of experience in WAN and LAN design, creation, and management. Additionally, he has expertise in cluster interconnect technology, network drivers, and network performance measurement.

3.1.4 Linux Expertise and System Administration (1.5 FTE)

The people in this role are in charge of the overall Linux environment on the cluster.

This entails:

- Tracking the Linux community development activities, particularly the Linux kernel and Linux base libraries. Knowledge in these areas about current bugs, future plans, new capabilities, portability issues, and similar topics is critical to the testbed effort.
- Leading those aspects of cluster engineering that require Linux and system administration expertise, such as the node booting and building mechanism and the remote management capabilities.
- Creating and supporting the system images in use on the cluster, and aiding users who are designing their own custom images for their research. System images include disk partitioning information, base OS configurations, and hundreds of software packages, all carefully arranged.
- Managing the cluster system software configuration, which is a continually on-going task.
- Managing the configuration of the virtual node subsystem on the testbed.
- Installing 3rd party and open source software on the cluster.
- Handling all security aspects of the cluster.
- Creating user accounts and managing the authentication and authorization infrastructure for the system.
- Responding to all user requests and handling ongoing maintenance related to the above areas.

Daniel Nurmi, John-Paul Navarro, and Narayan Desai are the engineers who will take on these positions. They have extensive experience with operational support of clusters and Linux system; collectively they have ten years of high-performance computing support, they carried out the deployment of Chiba City I and most of the smaller research clusters at ANL, and have significant contact with the Linux development community. As a part of the Chiba City I

deployment, they developed and published the "City Toolkit", a set of software tools that help administrators manage large clusters.

Nurmi, Navarro and Desai are also active in the DOE SciDAC Scalable Systems Software project, which accounts for the remainder of their time. That effort focuses on design and development of system software. While there is no overlap in time of the SciDAC project and the Chiba City testbed support, the two activities are extremely complementary.

3.1.5 User Environment and Support (0.75)

The person in this role, Sandra Bittner, will be responsible for the parts of the system that most closely support the user community.

This includes:

- Coordinating and managing the application environment for the users of the Chiba City testbed. Because the users of the system include computer scientists as well as computational scientists, the application environment includes compilers, libraries, scripting languages, debuggers, instrumentation code, system imaging tools, and performance measuring tools.
- Monitoring the performance of the various cluster subsystems.
- Creating the website and on-line documentation that describes the system to users.
- Coordinating, facilitating, and instructing at scalability workshops.
- Investigating those difficult issues discovered by the scientists using the system that point to potential problems with the cluster hardware or software.

Bittner has supported the users of the MCS high-performance computing environment for four years, with a specific focus on the SGI Origin 2000. She is an expert in supporting application environments and in interacting with vendors and software developers in order to resolve extremely difficult problems.

3.2 Infrastructure Approach

The funding for the infrastructure support component of this proposal will fund physical support and maintenance. This includes the costs for the air conditioning and power necessary to operate the system, and all hardware and software maintenance contracts related to the system.

We handle the hardware maintenance economically: we diagnose hardware problems locally and then have the service technician carry out the replacements in batches. This type of support is substantially cheaper than "gold service" types of support that would have options for same-day replacement or similar service. Because the system runs Linux, software maintenance costs are minimal, and are largely associated with 3rd party software such as compilers.

4 Budget

The funding that we request in order to support the Chiba City Project is described in detail in the attached budget sheet and is summarized in the table below in the "Operations" column. The equipment request and budget is related, but is described in a separate proposal.

Year	Items	Operations	Hardware
FY2002	1024 node cluster + Operations	$1.0M	$5.0M
FY2003	Operations	$1.0M	
FY2004	2048 node cluster + Operations	$1.0M	$5.5M
FY2005	Operations	$1.1M	
FY2006	4096 node cluster + Operations	$1.1M	$6.0M

As described in the Approach section, the funding requested here will support 4 FTEs and the infrastructure costs (power, cooling, maintenance) of the Chiba City Project testbed systems.

5 Technical Progress

The Mathematics and Computer Science division of ANL has a history of operating parallel computers, research testbeds, and high-performance computing systems. In the early 90s, the division built the Advanced Computing Research Facility, which supported the mission of promoting and understanding parallel computing and the issues of portability across systems. Over the course of five years, the ACRF fielded such systems as a Thinking Machines CM-2, an Encore Multimax, a BBN Butterfly, and many others. Several of the people mentioned above were instrumental in the support of these systems.

In the mid-90s, the division installed the first IBM SP as part of a collaborative effort with IBM. The division's engineers were instrumental in deploying and debugging the system, and in supporting computer scientist and computational scientists running parallel code on the computer.

Since then, MCS has continued to embrace the mission of operating significant systems in support of computer science research and a small number of partner applications. The machines have included an upgraded IBM SP-2, SGI Origin 2000, an Alpha cluster, and many smaller focused test systems. The same team that supported all of those computers will be responsible for the support of the Chiba City testbed, and the expertise developed over this time will critical to the success of the testbed project.

Most recently, these engineers were responsible for the design, deployment, and support of Chiba City I Linux cluster, the initial scalability testbed in MCS. Chiba City I has supported the research efforts of numerous projects. Some of these include

- The MPICH project, supporting efforts to develop MPI-2 compliance in MPICH and research into job launching as embodied in the "MPD" daemon.
- ANL's Scalable I/O research, including development of PVFS, the Parallel Virtual File system.
- The metaNEOS project, which solved the NUG30 quadratic assignment problem using Chiba City computing resources.
- Myricom's testing of new GM software releases.
- Scalability testing of the Scyld Beowulf system.

- Development and scalability support for the SciDAC Scalable Systems Software project.
- Development and testing of the Active Mural was greatly facilitated by the Chiba I system through the provision of specialized visualization nodes integrated in the cluster that contained graphics accelerator cards. These nodes were connected to the rest of Chiba I via the Myrinet fabric and have enabled us to develop streaming tiled display applications that run in real-time.
- Dozens of computational science applications that were used to test the experimental file systems, system software, and job management experiments while simultaneously making progress on result-oriented computation. Notable among these areas are theoretical physics, which performed the first ab initio computations of 10-body nuclei on Chiba City I, and large-scale climate modeling.

As a part of the deployment and support of Chiba City, the team developed the "City Toolkit", which enables the efficient operation of a large, multi-function cluster, including hooks to enable researchers to run highly experimental systems software without requiring substantial effort to recover the system in the event of a mishap or serious bug. Much of the development effort for these tools was supported by ANL LDRD funds that terminated in 2001. These tools will be an essential part of the efficient operation of the Chiba City Project testbeds.

6 Relationship to Other Efforts

The proposed Chiba City Project builds on the experiences gleaned in our first scalability testbed, Chiba City I. On Chiba City I, we developed a robust mechanism for supporting extreme development, learned how to handle the diverse needs of computer scientists, and began to make progress on the scalability research frontier. In comparison with Chiba City I, the follow-on testbeds will be larger, will support the ability to expand beyond the physical node count by using a virtual subsystem, and will be available to a much larger user community. The expanded Chiba City scalability testbeds will provide an invaluable resource for computer scientists and application developers in many DOE-funded research projects, including the DOE SciDAC programs and existing DOE-funded base program research activities. Moreover, the Chiba City scalability testbeds will expand the scope and mission of research enabled by existing Advanced Computing Research Testbeds and MICS-funded Research Facilities. Because of the project's focus on scalable computer science and extreme development and its accessibility to all such projects, the testbeds will be a unique resource that enhances the capabilities of DOE's entire research portfolio.

The Chiba City Project testbeds will support the research and development components of an extensive number of projects over time. In the near term, these projects will include:

- The Scalable Systems Software Center. This project is a SciDAC Integrated Software Infrastructure Center coordinated out of Oak Ridge National Laboratory. It will do the research for and produce an integrated suite of systems software and tools for the cost effective management and utilization of terascale computational resources.
- The Scientific Data Management Center. This is a SciDAC Integrated Software Infrastructure Center coordinated out of Lawrence Berkeley National Laboratory. The center's goal is to provide a coordinated framework for the unification, development, deployment, and reuse of scientific data management software.

- The Performance Evaluation Research Center. This is also a SciDAC Integrated Software Infrastructure Center, which is coordinated out of Lawrence Berkeley National Laboratory. The Center is developing a science for understanding performance of scientific applications on high-end computer systems, and is also developing engineering strategies for improving performance on these systems.
- The Science Appliance Project. This project, which is led by Los Alamos National Laboratory, explores alternative approaches to cluster design, management, and system software in order to build particularly simple and effective clusters.
- The Sandia Micro kernel Project. We have begun discussions with researchers at SNL about their needs for software development testbeds that complement the resources they have available at Sandia. Chiba II could be a critical enabling resource for this activity.
- DOE Base program projects such as future programming models project, MPICH, ACTS toolkits and parallel I/O will benefit from sustained access to the Chiba II testbed in the same fashion they have benefited from access to the Chiba I system. In fact much of the development work and testing would not be possible without such testbeds.
- DOE projects in scalable scientific visualization will also benefit from access to Chiba II for testing parallel rendering algorithms and for validating large-scale data management strategies.
- Early Career Principal Investigators—Finally we plan to make the Chiba II system available to DOE Early Career Principal Investigators from universities. For many researchers, access to a scalability testbed will be a critical resource to enable them to contribute ideas and software without the difficulty and overhead of attempting to build their own testbeds. This will encourage EC PIs to collaborate with and contribute to SciDAC projects.

Select Publications

R. Butler, W. Gropp, and E. Lusk, "Components and Interfaces of a Process Management System for Parallel Programs," Parallel Computing 27 (2001), pp. 1417-1429

R. Butler, W. Gropp, and E. Lusk, "A Scalable Process-Management Environment for Parallel Programs," Preprint ANL/MCS-P812-0400, April 2000.

P. H. Carns, W. B. Ligon III, R. B. Ross, and R. Thakur, "PVFS: A Parallel File System for Linux Clusters," Proc. Extreme Linux Track: 4th Annual Linux Showcase and Conference, Oct. 2000.

R. Evard, "Chiba City: A Case Study of a Large Linux Cluster", in Beowulf Cluster Computing with Linux, by Thomas Sterling. MIT Press, 2001.

W. D. Gropp, D. K. Kaushik, D. E. Keyes, and B. F. Smith, "Performance Modeling and Tuning of an Unstructured Mesh CFD Application," Preprint ANL/MCS-P833-0700, July 2000.

S. C. Pieper, V. R. Pandharipande, R. B. Wiringa, and J. Carlson, "Realistic Models of Pion-Exchange Three-Nucleon Interactions," Phy. Rev. C 64, 01400101-21

R. Ross, D. Nurmi, A. Cheng, M. Zingale, "A Case Study in Application I/O on Linux Clusters," Preprint ANL/MCS-P888-0701, July 2001.

R. B. Ross and W. B. Ligon III, "Server-Side Scheduling in Cluster Parallel I/O Systems," Preprint ANL/MCS-P915-1101, Nov. 2001

Budget Details

Funding Mechanism:

Argonne National Laboratory is to receive funds through the financial plan for only the dollars identified on the ANL budget pages.

Sections A. ,B. and C.- Senior Personnel/Other Personnel/Fringe Rates:

Key Staff, Total Person Months and Primary Role/Responsibility

Senior Personnel:

Sandra Bittner, Staff	45.00	Build/Support platforms that can use scalable system software development
Bill Nickless, Staff	30.00	Support wide range of parallel computational science applications
Gene Rackow, Staff	60.00	Support wide range of parallel computational science applications
Dan Nurmi, Staff	30.00	Build/Support platforms that can use scalable system software development
Remy Evard, PI	15.00	Manage staff developing the software applicationa
Narayan Desai & JP Navarro	60.00	Build/Support platforms that can use scalable system software development

Post Doctoral Associates	0.00
Other Professionals:	0.00
Graduate Students:	0
UnderGraduate Students	0
Secretarial-Clerical	0
Other	0

See attached explanation of costing procedures that relate to effort rates and fringe benefits.

Sections D. Permanent Equipment

$0

Sections E. Travel

Domestic:	$1K per trip/esc. 4.5% per yr.	5-year estimate.	$0

Sections G. Other Direct Costs

1. Materials and Supplies:	5-year estimate.	$0
2. Computer Services:	5-year estimate.	$900,000

Hardware and software maintenance/support for Cluster; utility/power services for machine upgrade

5. Other:

Relocation expenses related to New hires	$0

Sections I. Indirect Costs

See attached explanation of costing procedures that relate to indirect rates.

Costing Procedures

Argonne National Laboratory is a government-owned facility, operated by the University of Chicago. As a contractor for the Department of Energy (DOE), Argonne National Laboratory must comply with DOE general policies and procedures on budgeting and accounting. The costing procedures are based on the assumption that all costs incurred will be recovered. When there is a demonstrated direct programmatic benefit to the Department of Energy, work may be performed for other federal agencies, and the activity is charged on the same basis as work supported by the Department of Energy.

The costing procedures use standard rates, which are utilized throughout the Laboratory on a consistent basis and uniformly applied to all work supported by the Department of Energy and other federal agencies. Standard rates established at the beginning of the fiscal year for each Division, are monitored, and revised as necessary. All labor cos are distributed at standard rates, which are developed by the Laboratory Budget Office for each major payroll classification within the Division. The standard rates are an average of the base wages, fringe benefits, paid absence, and divisional overhead accounts (Division Management and Direct Allocations). The Division Management account includes only those costs associated with the operation of the Division and directly related administrative activities such as management, personnel administration, procurement and budget administration, and cost for materials, which cannot be directly associated with any specific program activity. The Direct Allocation account includes costs for custodial services, building maintenance, utilities and related services. The fringe benefits include payroll-related items such as annuities, social security, and hospital and medical payments. The following rates have been estimated for fiscal year 2002 through 2006:

Mathematics and Computer Science Division:

	FY2002	FY2003	FY2004	FY2005	FY2006
Exempt, Regular (Sr. Personnel, Other Professionals)					
Salary (FTE Month)	$7,191	$7,550	$7,928	$8,324	$8,740
Fringe (32.0 %)	$2,301	$2,416	$2,537	$2,664	$2,797
Paid Absence/Div.Mgt/Direct Allocations.	$2,982	$3,115	$3,253	$3,398	$3,550
Total FTE Monthly Rate	$12,474	$13,081	$13,718	$14,386	$15,087
Exempt, Temporary (Postdoctoral and Visiting Scientists)					
Salary (FTE Month)	$4,945	$5,193	$5,453	$5,725	$6,012
Fringe (11.0 %)	$544	$571	$600	$630	$661
Paid Absence	$1,064	$1,116	$1,170	$1,228	$1,288
Total FTE Monthly Rate	$6,553	$6,880	$7,223	$7,583	$7,961

Indirect Rates

Standard rates are also developed for Laboratory General and Administrative (G&A) expense. The procedures for dist Laboratory G&A and program expense is applied on the basis of the total cost of the work performed. The following in have been estimated by fiscal year budget period:

	FY2002	FY2003	FY2004	FY2005	FY2006
PBCS Program Expenses @2.0%	$15,575	$16,158	$16,769	$17,411	$18,084
Laboratory G&A:					
Common Support @ 26.83%	$208,939	$216,756	$224,960	$233,563	$242,590
Equipment/Subcontracts@ 9.874%	$0	$0	$0	$0	$0
	$224,514	$232,914	$241,729	$250,973	$260,674

ANL' s Indirect rates continuously reviewed and audited by Cognizant Federal Agency:

Richard J. Glowacki
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richard.glowacki@ch.doe.gov

Monthly Effort Rate	FY02	FY03	FY04	FY05	FY06
Exempt Regular (Staff)	12474	13081	13718	14386	15087
Exempt Temp (Post-Doc)	6553	6880	7223	7583	7961
Non-Exempt, Reg. (Secretarial)	6825	7150	7490	7848	8221
Other-Research Aide (R/A)	2601	2731	2868	3011	3161
6 month appt for R/A	15606	16386	17208	18066	18966
Grad Students-Annual *	26600	28000	29500	31000	32500
UnderGrad Students-Annual **	17000	17500	18000	18500	19000

* Grad Students entitled to $1200 monthly stipend + $10K tuition

** Undergraduate appt. by Terms- Spring $5k, Summer $6.5k, Fall $5k. Covers weekly stipend/housing/travel

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All Other Editions Are Obsolete

U.S. Department of Energy

Budget Page

(See reverse for Instructions)

OMB Control No.
1910-1400
OMB Burden Disclosure Statement on Reverse

ORGANIZATION
The University of Chicago, Operator of Argonne National Laboratory

Budget Page No: pg 1 of 6
Yr 1 of 5

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR
Rick L. Stevens

Requested Duration: 12 (Months)

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title; A.6. show number in brackets)	DOE Funded Person-mos. CAL	ACAD	SUMR	Funds Requested by Applpicant	Funds Granted by DOE
1. Sandra Bittner, Staff	9.00			$112,266	
2. Bill Nickless, Staff	6.00			$74,844	
3. Gene Rackow, Staff	12.00			$149,688	
4. Dan Nurmi, Staff	6.00			$74,844	
5. Remy Evard, PI	3.00			$37,422	
6. (2) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)	12.00			$149,688	
7. (7) TOTAL SENIOR PERSONNEL (1-6)	48.00			$598,752	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( ) POST DOCTORAL ASSOCIATES					
2. ( ) OTHER PROFESSIONAL (TECHNICIAN, PROGRAMMER, ETC.)					
3. ( ) GRADUATE STUDENTS					
4. ( ) UNDERGRADUATE STUDENTS					
5. ( ) SECRETARIAL - CLERICAL					
6. ( ) OTHER					
TOTAL SALARIES AND WAGES (A+B)				$598,752	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				$598,752	
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM.)					
TOTAL PERMANENT EQUIPMENT					
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)					
2. FOREIGN					
TOTAL TRAVEL					
F. TRAINEE/PARTICIPANT COSTS					
1. STIPENDS (Itemize levels, types + totals on budget justification page)					
2. TUITION & FEES					
3. TRAINEE TRAVEL					
4. OTHER (fully explain on justification page)					
TOTAL PARTICIPANTS ( ) TOTAL COST					
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER (ADPE) SERVICES				$180,000	
5. SUBCONTRACTS					
6. OTHER					
TOTAL OTHER DIRECT COSTS				$180,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				$778,752	
I. INDIRECT COSTS (SPECIFY RATE AND BASE)					
Section H. Direct cost X Aggregate rate of: 28.830%					
TOTAL INDIRECT COSTS				$224,514	
J. TOTAL DIRECT AND INDIRECT COSTS (H+I)				$1,003,266	
K. AMOUNT OF ANY REQUIRED COST SHARING FROM NON-FEDERAL SOURCES					
L. TOTAL COST OF PROJECT (J+K)				$1,003,266	

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U.S. Department of Energy

Budget Page

(See reverse for Instructions)

OMB Control No.
1910-1400
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ORGANIZATION
The University of Chicago, Operator of Argonne National Laboratory

Budget Page No: 2 of 6
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PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR
Rick L. Stevens

Requested Duration: 12 (Months)

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title; A.6. show number in brackets)	DOE Funded Person-mos. CAL	ACAD	SUMR	Funds Requested by Applpicant	Funds Granted by DOE
1. Sandra Bittner, Staff	9.00			$117,729	
2. Bill Nickless, Staff	6.00			$78,486	
3. Gene Rackow, Staff	12.00			$156,972	
4. Dan Nurmi, Staff	6.00			$78,486	
5. Remy Evard, PI	3.00			$39,243	
6. (2) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)	12.00			$156,972	
7. (7) TOTAL SENIOR PERSONNEL (1-6)	48.00			$627,888	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( ) POST DOCTORAL ASSOCIATES					
2. ( ) OTHER PROFESSIONAL (TECHNICIAN, PROGRAMMER, ETC.)					
3. ( ) GRADUATE STUDENTS					
4. ( ) UNDERGRADUATE STUDENTS					
5. ( ) SECRETARIAL - CLERICAL					
6. ( ) OTHER					
TOTAL SALARIES AND WAGES (A+B)				$627,888	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				$627,888	
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM.)					
TOTAL PERMANENT EQUIPMENT					
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)					
2. FOREIGN					
TOTAL TRAVEL					
F. TRAINEE/PARTICIPANT COSTS					
1. STIPENDS (Itemize levels, types + totals on budget justification page)					
2. TUITION & FEES					
3. TRAINEE TRAVEL					
4. OTHER (fully explain on justification page)					
TOTAL PARTICIPANTS ( ) TOTAL COST					
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER (ADPE) SERVICES				$180,000	
5. SUBCONTRACTS					
6. OTHER					
TOTAL OTHER DIRECT COSTS				$180,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				$807,888	
I. INDIRECT COSTS (SPECIFY RATE AND BASE) Section H. Direct cost X Aggregate rate of: 28.830%					
TOTAL INDIRECT COSTS				$232,914	
J. TOTAL DIRECT AND INDIRECT COSTS (H+I)				$1,040,802	
K. AMOUNT OF ANY REQUIRED COST SHARING FROM NON-FEDERAL SOURCES					
L. TOTAL COST OF PROJECT (J+K)				$1,040,802	

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U.S. Department of Energy

Budget Page

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ORGANIZATION
The University of Chicago, Operator of Argonne National Laboratory

Budget Page No: 3 of 6
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PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR
Rick L. Stevens

Requested Duration: 12 (Months)

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title; A.6. show number in brackets)	DOE Funded Person-mos. CAL	ACAD	SUMR	Funds Requested by Applpicant	Funds Granted by DOE
1. Sandra Bittner, Staff	9.00			$123,462	
2. Bill Nickless, Staff	6.00			$82,308	
3. Gene Rackow, Staff	12.00			$164,616	
4. Dan Nurmi, Staff	6.00			$82,308	
5. Remy Evard, PI	3.00			$41,154	
6. (2) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)	12.00			$164,616	
7. (7) TOTAL SENIOR PERSONNEL (1-6)	48.00			$658,464	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( ) POST DOCTORAL ASSOCIATES					
2. ( ) OTHER PROFESSIONAL (TECHNICIAN, PROGRAMMER, ETC.)					
3. ( ) GRADUATE STUDENTS					
4. ( ) UNDERGRADUATE STUDENTS					
5. ( ) SECRETARIAL - CLERICAL					
6. ( ) OTHER					
TOTAL SALARIES AND WAGES (A+B)				$658,464	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				$658,464	
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM.)					
TOTAL PERMANENT EQUIPMENT					
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)					
2. FOREIGN					
TOTAL TRAVEL					
F. TRAINEE/PARTICIPANT COSTS					
1. STIPENDS (Itemize levels, types + totals on budget justification page)					
2. TUITION & FEES					
3. TRAINEE TRAVEL					
4. OTHER (fully explain on justification page)					
TOTAL PARTICIPANTS ( ) TOTAL COST					
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER (ADPE) SERVICES				$180,000	
5. SUBCONTRACTS					
6. OTHER					
TOTAL OTHER DIRECT COSTS				$180,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				$838,464	
I. INDIRECT COSTS (SPECIFY RATE AND BASE)					
Section H. Direct cost X Aggregate rate of: 28.830%					
TOTAL INDIRECT COSTS				$241,729	
J. TOTAL DIRECT AND INDIRECT COSTS (H+I)				$1,080,193	
K. AMOUNT OF ANY REQUIRED COST SHARING FROM NON-FEDERAL SOURCES					
L. TOTAL COST OF PROJECT (J+K)				$1,080,193	

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(04-93)
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U.S. Department of Energy

Budget Page

(See reverse for Instructions)

OMB Control No.
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ORGANIZATION
The University of Chicago, Operator of Argonne National Laboratory

Budget Page No: 4 of 6
Yr 4 of 5

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR
Rick L. Stevens

Requested Duration: 12 (Months)

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title; A.6. show number in brackets)	DOE Funded Person-mos. CAL	ACAD	SUMR	Funds Requested by Applpicant	Funds Granted by DOE
1. Sandra Bittner, Staff	9.00			$129,474	
2. Bill Nickless, Staff	6.00			$86,316	
3. Gene Rackow, Staff	12.00			$172,632	
4. Dan Nurmi, Staff	6.00			$86,316	
5. Remy Evard, PI	3.00			$43,158	
6. (2) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)	12.00			$172,632	
7. (7) TOTAL SENIOR PERSONNEL (1-6)	48.00			$690,528	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( ) POST DOCTORAL ASSOCIATES					
2. ( ) OTHER PROFESSIONAL (TECHNICIAN, PROGRAMMER, ETC.)					
3. ( ) GRADUATE STUDENTS					
4. ( ) UNDERGRADUATE STUDENTS					
5. ( ) SECRETARIAL - CLERICAL					
6. ( ) OTHER					
TOTAL SALARIES AND WAGES (A+B)				$690,528	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				$690,528	
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM.)					
TOTAL PERMANENT EQUIPMENT					
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)					
2. FOREIGN					
TOTAL TRAVEL					
F. TRAINEE/PARTICIPANT COSTS					
1. STIPENDS (Itemize levels, types + totals on budget justification page)					
2. TUITION & FEES					
3. TRAINEE TRAVEL					
4. OTHER (fully explain on justification page)					
TOTAL PARTICIPANTS ( ) TOTAL COST					
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER (ADPE) SERVICES				$180,000	
5. SUBCONTRACTS					
6. OTHER					
TOTAL OTHER DIRECT COSTS				$180,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				$870,528	
I. INDIRECT COSTS (SPECIFY RATE AND BASE) Section H. Direct cost X Aggregate rate of: 28.830%					
TOTAL INDIRECT COSTS				$250,973	
J. TOTAL DIRECT AND INDIRECT COSTS (H+I)				$1,121,501	
K. AMOUNT OF ANY REQUIRED COST SHARING FROM NON-FEDERAL SOURCES					
L. TOTAL COST OF PROJECT (J+K)				$1,121,501	

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U.S. Department of Energy

Budget Page

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1910-1400
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ORGANIZATION
The University of Chicago, Operator of Argonne National Laboratory

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PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR
Rick L. Stevens

Requested Duration: 12 (Months)

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title; A.6. show number in brackets)	DOE Funded Person-mos. CAL	ACAD	SUMR	Funds Requested by Applpicant	Funds Granted by DOE
1. Sandra Bittner, Staff	9.00			$135,783	
2. Bill Nickless, Staff	6.00			$90,522	
3. Gene Rackow, Staff	12.00			$181,044	
4. Dan Nurmi, Staff	6.00			$90,522	
5. Remy Evard, PI	3.00			$45,261	
6. (2) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)	12.00			$181,044	
7. (7) TOTAL SENIOR PERSONNEL (1-6)	48.00			$724,176	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( ) POST DOCTORAL ASSOCIATES					
2. ( ) OTHER PROFESSIONAL (TECHNICIAN, PROGRAMMER, ETC.)					
3. ( ) GRADUATE STUDENTS					
4. ( ) UNDERGRADUATE STUDENTS					
5. ( ) SECRETARIAL - CLERICAL					
6. ( ) OTHER					
TOTAL SALARIES AND WAGES (A+B)				$724,176	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				$724,176	
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM.)					
TOTAL PERMANENT EQUIPMENT					
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)					
2. FOREIGN					
TOTAL TRAVEL					
F. TRAINEE/PARTICIPANT COSTS					
1. STIPENDS (Itemize levels, types + totals on budget justification page)					
2. TUITION & FEES					
3. TRAINEE TRAVEL					
4. OTHER (fully explain on justification page)					
TOTAL PARTICIPANTS ( ) TOTAL COST					
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER (ADPE) SERVICES				$180,000	
5. SUBCONTRACTS					
6. OTHER					
TOTAL OTHER DIRECT COSTS				$180,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				$904,176	
I. INDIRECT COSTS (SPECIFY RATE AND BASE)					
Section H. Direct cost X Aggregate rate of: 28.830%					
TOTAL INDIRECT COSTS				$260,674	
J. TOTAL DIRECT AND INDIRECT COSTS (H+I)				$1,164,850	
K. AMOUNT OF ANY REQUIRED COST SHARING FROM NON-FEDERAL SOURCES					
L. TOTAL COST OF PROJECT (J+K)				$1,164,850	

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U.S. Department of Energy

Budget Page

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OMB Control No.
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ORGANIZATION
The University of Chicago, Operator of Argonne National Laboratory

Budget Page No: 6 of 6
5-Yr. ANL Total Project

PRINCIPAL INVESTIGATOR/PROJECT DIRECTOR
Rick L. Stevens

Requested Duration: 60 (Months)

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title; A.6. show number in brackets)	DOE Funded Person-mos. CAL	ACAD	SUMR	Funds Requested by Applpicant	Funds Granted by DOE
1. Sandra Bittner, Staff	45.00			$618,714	
2. Bill Nickless, Staff	30.00			$412,476	
3. Gene Rackow, Staff	60.00			$824,952	
4. Dan Nurmi, Staff	30.00			$412,476	
5. Remy Evard, PI	15.00			$206,238	
6. (2) OTHERS (LIST INDIVIDUALLY ON BUDGET EXPLANATION PAGE)	60.00			$824,952	
7. (7) TOTAL SENIOR PERSONNEL (1-6)	240.00			$3,299,808	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. ( ) POST DOCTORAL ASSOCIATES					
2. ( ) OTHER PROFESSIONAL (TECHNICIAN, PROGRAMMER, ETC.)					
3. ( ) GRADUATE STUDENTS					
4. ( ) UNDERGRADUATE STUDENTS					
5. ( ) SECRETARIAL - CLERICAL					
6. ( ) OTHER					
TOTAL SALARIES AND WAGES (A+B)				$3,299,808	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)					
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A+B+C)				$3,299,808	
D. PERMANENT EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM.)					
TOTAL PERMANENT EQUIPMENT					
E. TRAVEL 1. DOMESTIC (INCL. CANADA AND U.S. POSSESSIONS)					
2. FOREIGN					
TOTAL TRAVEL					
F. TRAINEE/PARTICIPANT COSTS					
1. STIPENDS (Itemize levels, types + totals on budget justification page)					
2. TUITION & FEES					
3. TRAINEE TRAVEL					
4. OTHER (fully explain on justification page)					
TOTAL PARTICIPANTS ( ) TOTAL COST					
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES					
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION					
3. CONSULTANT SERVICES					
4. COMPUTER (ADPE) SERVICES				$900,000	
5. SUBCONTRACTS					
6. OTHER					
TOTAL OTHER DIRECT COSTS				$900,000	
H. TOTAL DIRECT COSTS (A THROUGH G)				$4,199,808	
I. INDIRECT COSTS (SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS				$1,210,805	
J. TOTAL DIRECT AND INDIRECT COSTS (H+I)				$5,410,613	
K. AMOUNT OF ANY REQUIRED COST SHARING FROM NON-FEDERAL SOURCES					
L. TOTAL COST OF PROJECT (J+K)				$5,410,613	