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TITLE OF PROPOSED PROJECT **Acquisition of the GLOW Distributed Computing System at the University of Wisconsin - Madison**

REQUESTED AMOUNT	PROPOSED DURATION (1-60 MONTHS)	REQUESTED STARTING DATE	SHOW RELATED PRELIMINARY PROPOSAL NO. IF APPLICABLE
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CERTIFICATION PAGE

Certification for Authorized Organizational Representative or Individual Applicant:

By signing and submitting this proposal, the individual applicant or the authorized official of the applicant institution is: (1) certifying that statements made herein are true and complete to the best of his/her knowledge; and (2) agreeing to accept the obligation to comply with NSF award terms and conditions if an award is made as a result of this application. Further, the applicant is hereby providing certifications regarding debarment and suspension, drug-free workplace, and lobbying activities (see below), as set forth in Grant Proposal Guide (GPG), NSF 03-2. Willful provision of false information in this application and its supporting documents or in reports required under an ensuing award is a criminal offense (U. S. Code, Title 18, Section 1001).

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AUTHORIZED ORGANIZATIONAL REPRESENTATIVE	SIGNATURE	DATE
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This effort brings together an outstanding multi disciplinary team of researchers who share a common goal: to make Grid computing an effective tool for scientific research by harnessing the power of commodity hardware and software resources. Together they are committed to collaborate in the development, implementation, test and deployment Grid enabled capabilities while training a new generation of interdisciplinary scientists. The funds requested by this proposal will provide us with the hardware resources needed to build a Grid laboratory for the UW campus (GLOW). The UW will provide the administrative costs of maintaining and supporting the laboratory. GLOW will enable us to serve the needs of a diverse group of computational scientists while evaluating Grid technology in a large-scale environment with real-life users and applications. We strongly believe that such multi disciplinary environment is necessary to bring Grid technology to the desktop of an ordinary scientist.

GLOW will span six domains in our campus - Chemical Engineering, Chemistry, Computer Sciences, Medical Physics (including Radiology and Human Oncology), Particle Physics and Astrophysics – each with significant computational needs and each contributing a site to the laboratory. The laboratory will provide the necessary hardware, software and support infrastructure for the development and experimental evaluation of Grid-aware scientific applications. Within this environment, we will explore how to harness new computing technologies to meet the computational needs of leading-edge research in the biological and physical sciences.

Optical Mapping has emerged as a uniquely powerful system for the construction of high-resolution restriction maps from a broad range of clone types and, more recently, genomic DNA. The construction of whole genome maps is a remarkably compute intensive operation. The Laboratory for Molecular and Computational Genomics, Laboratory of Genetics, in the Department of Chemistry, is engaged in developing Optical Mapping technology and applying it to analyze large human populations on a whole genome basis.

The astrophysicists, with UW-Madison as lead institution, are part of an international collaboration that is building a kilometer-scale neutrino observatory, IceCube. The detector utilizes South Pole ice instrumented at depth with optical sensors as a Cherenkov detector. The telescope collects the Cherenkov light from secondary particles produced in interactions of high-energy neutrinos inside or near the instrumented volume.

The particle physicists, who are part of the international CMS (Compact Muon Solenoid) experiment at the CERN Laboratory, Geneva, Switzerland, are preparing to explore fundamental physics at a new energy regime, predicted to lead to the discovery of Higgs boson that is responsible for providing masses to elementary particles or new symmetries, matter forms or interactions. The custom trigger electronics that the UW group is building reduces the 40 MHz collision rate to 75 kHz using a series of algorithms. The UW group is developing the software for the trigger system simulation, the event filter algorithms, and the simulated data analysis.

The Chemical Engineering group is conducting computational research on designing molecules and materials for specific applications, focusing on two areas. On the one hand, they will develop accurate, transferable force fields capable of describing the interactions between distinct atomic species in condensed media. These force fields will subsequently be used for materials discovery and characterization. On the other hand, advanced molecular simulation techniques capable of describing the structure and dynamics of complex fluids or materials will be developed. These techniques will help overcome the bottlenecks (such as diverging length scales and multiple time scales) that arise in the molecular study of complex fluids and materials.

The computing efforts of Medical Physics, Radiology, and Human Oncology groups are focused in several areas. Applications in radiation therapy range from Monte Carlo calculations of radiation fields produced by radiotherapy treatment units to dose calculations within a patient. With the introduction of intensity modulated radiation therapy (IMRT), where high radiation doses can be delivered to precise locations with increased sparing of the nearby critical structures, Monte Carlo transport is the preferred choice for these calculations because of the high degree of accuracy required. Modern image science uses complex, high performance iterative back-projection techniques to develop three-dimensional time varying images for advanced diagnosis. When combined with stochastic optimization tools these provide a new framework for clinical analysis and treatment.

The sociological nature of ownership (of data, tools, and materials) and the attendant problem of cooperation are central considerations in the practice of science and an important focus of attention of social analysts of science. GLOW will provide an extraordinary opportunity for social analysts to study new ownership and cooperation relations as they emerge and develop in several distinct areas of scientific exploration.

GLOW will enable the cross-fertilization of a number of active research pursuits within the Computer Sciences department, particularly among new hires in distributed computing and networking. It will provide the computer science group with a unique real-life Grid environment to do their experimental work. They plan to focus their experimental work on distributed data storage and management for Grid-enabled applications.

Training opportunities abound for undergraduates, graduate students, and post-doctoral trainees in all of the domains encompassed by this proposal. GLOW will provide an excellent training environment to a new generation of inter disciplinary researchers who are ready to exploit the power of computational Grids.

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*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

Acquisition of the GLOW Distributed Computing System at the University of Wisconsin - Madison

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1 Introduction

We propose to build GLOW - the Grid Laboratory Of Wisconsin [1], to serve as a crucial scientific computing resource at the UW in the years to come. This multidisciplinary effort spans the fields of - Computer Science, Genomics, High Energy Physics, Material Science, Neutrino Astrophysics and Medical Physics. GLOW will be built as a campus-wide grid laboratory that combines and enhances autonomous sites of computing resources. Each site will be managed locally and will be configured to meet the specific scientific needs of the site. GLOW will refine and scale-up the methods of implementing large-scale collaborative computing environments that the Condor group of UW Department of Computer Sciences has pioneered. The distributed nature of GLOW and the local autonomy of its sites will enable us to address the sociological and technological challenges of grid computing in a real-life setting. While each of the sites will focus on addressing the computing needs of the local community of users and will maintain full control over the local resources, computing power and storage space will be shared across site boundaries according to a mutually defined policy. These shared resources will serve the ever-growing computing needs on the UW campus.

GLOW will provide the necessary hardware, software and support infrastructure for the development and experimental evaluation of grid-aware scientific applications in a production environment. Within this environment, we will explore how to harness grid technology to meet the computational needs of leading-edge research groups in the biological and physical sciences. By integrating the computing facilities of six different groups scattered across our campus into one computing environment we also expect the laboratory to serve as a prototype for campus-wide computational grids.

This campus-wide effort brings together an outstanding group of domain scientists and a team of computer scientists with expertise and research interests in grid related technologies and a demonstrated history of joint work. It builds on our leadership and experience in the development and deployment of grid middleware, utilizes our expertise in developing novel computational methods, is driven by the growing computing and data management needs of our disciplines, and leverages our involvement in national and international grid efforts.

Recent trends in the cost-performance ratio of processing, storage and communication hardware have turned computing into a commodity. As a result of this trend, today we find powerful computing capabilities resting on office desks, piled on laboratory shelves, or mounted on racks in machine rooms. These computing and storage resources are managed by off-the-shelf software and are interconnected by high-speed networks.

Individuals and small groups own these computing resources and exercise full control over their usage. However, researchers and engineers in academia, research laboratories, and industry are looking for frameworks and software tools that will enable them to collectively harness this power. Grid computing is a technology that holds the key to meeting these needs. The objective of grid middleware is to transform these "communities" of loosely coupled and distributively owned commodity hardware and software into large-scale effective computing environments. Thus grid technology is critical to the computational and data management needs of the next generation of experimental science.

While each of the sites involved in GLOW will maintain full control over their local resources, computing power and storage space will be shared across site boundaries. The computer sciences site will provide additional shared storage resources and high-speed access to the Internet. We plan to use Condor as the resource management system for GLOW and the Globus Toolkit for interfacing GLOW with external Grids. Condor is a powerful resource management system that was developed by our computer sciences department and is widely utilized. All the domain scientists in this proposal have derived benefits from the Condor technology by effectively harnessing their local computing resources and additional available cycles from the ~1000 <1GHz CPUs of the Condor pool presently operated at the Department of Computer Sciences. They are eager to scale up by a factor of 5 to GLOW, which proposes to operate with about 1600 >2.4GHz CPUs and 50 TB of networked disk-based storage.

By using services provided by the Globus Toolkit, GLOW will provide seamless access to external Grids like the NSF sponsored TeraGRID and the CERN managed LHC Grid. As these and other national and international Grid efforts become operational, GLOW will offer our campus a familiar and effective access point to the resources accessible via grid technologies. The Computer Sciences site of GLOW will serve as a “gateway” to external grids. The site will facilitate staging services for data moving in or out of the laboratory and will manage the usage of the communication fabric that connects our campus to the outside world.

What follows is a description of each of the research projects participating in GLOW. Each section begins with a description of the science, the computing challenges found in addressing the science and why the creation of GLOW will result in significant progress. We believe there is a remarkable variety of research involved but have found a commonality in computing challenges that we believe will create the synergy to take us forward in the development and application of GRID computing. The research descriptions are followed by a discussion of plans for education and the wider impact of the research proposed. We then

provide a summary of the research computing needs and how GLOW will address them. Finally, we describe the implementation, integration and management of GLOW. We also include a description of results from previous NSF support.

2 Molecular and Computational Genomics

The Laboratory for Molecular and Computational Genomics, Laboratory of Genetics [2,3], in the Department of Chemistry, develops fully integrated systems for genomic analysis based on the imaging and analysis of ensembles of single molecules. The system we are currently using for research in comparative genomics (human, and microbes) is named Optical Mapping—here, very large DNA molecules (300-1,000 microns in length) are directly extracted from cells and mounted on specially derivatized surfaces to enable biochemistries to reveal sequence dependent patterns that serve as "bar codes" that uniquely identify any given molecule. Such bar codes find genomic mutations, and variations that underlie individual differences in both a genetic and biochemical context. We are rapidly advancing the Optical Mapping system for whole genome analysis of large human populations to address research and diagnostic needs for association studies or cancer research. Molecular barcodes are read via a fully automated fluorescence microscopy system, capable of reading sequence information at sub-genic levels. Overall, the Optical Mapping System is a complex mix of biochemistry, surfaces science, imaging/machine vision, computer science, and microfluidics that produces very large datasets, which tax even large computational resources such as the Condor pool in the Department of Computer Science, consisting of approximately 1000 CPUs.

A typical human genome consists of over 6 billion bases (diploid) and, when chromosomal DNA molecules, which make up a genome are placed end to end, spans over six feet. Typically we map and analyze over 150 feet of DNA per individual, which is recorded within 600,000 overlapping micrographs (~1.65 terabytes/individual).

To obtain a completed map for an individual, several processing intensive operations must be performed on the data. These operations include machine vision, alignment, and contig generation. The first operation is the extraction of thousands of "bar codes" from the image data. The preprocessing and machine vision algorithms require roughly 10 seconds of CPU time on a 2 GHz processor. The 600,000 images require approximately 10 CPU weeks.

After acquiring the "bar codes" from the image data, an alignment is performed through "pairwise" comparisons against known DNA sequence. The 600,000 images yield about 200,000 bar codes that must be compared to 1,000 sequence maps. Each comparison takes on average 0.5 seconds on a 2GHz processor requiring a total of 165 CPU weeks.

The final step is contig generation where the dataset containing "bar codes" are aligned into a single map representing the individual. This is an extremely compute intensive operation which is non-linear with respect to the number of maps; a single contig for one of the 1,000 sequence maps takes approximately 9.5 days. To generate all 1,000 sequence contigs will require 1,330 CPU weeks. Our plans are to create such maps for large human populations, so that a continuous need for large-scale compute resources will be established.

In summary the Laboratory of Molecular and Computational Genomics processing needs to map multiple individuals has greatly surpassed the computing capability of the laboratory and

without the help of a computing grid the analysis of human populations will be made infeasible. To meet our needs we will require frequent access to approximately 1,000 Condor computers.

3 IceCube: A Kilometer-Scale Neutrino Observatory

With UW-Madison as lead institution, an international collaboration is building a kilometer-scale neutrino observatory, IceCube [4]. The detector utilizes South Pole ice instrumented at depth with optical sensors as a Cherenkov detector. The telescope collects the Cherenkov light from secondary particles produced in interactions of high-energy neutrinos inside or near the instrumented volume. The IceCube Project is a logical extension of the research and development work performed over the past several years by the AMANDA Collaboration. With the detection of more than 1000 high-energy neutrinos per year, the AMANDA telescope represents a proof of concept for commissioning IceCube, with superior detector performance and an effective telescope size at or above the kilometer-scale for all neutrino flavors.

The design for the IceCube neutrino telescope is an array of 4800 photomultiplier tubes each enclosed in a transparent pressure sphere to comprise an optical module similar to those in AMANDA. In the IceCube design, 80 strings are regularly spaced by 125 m over an area of approximately one square kilometer, with optical modules at depths of 1.4 to 2.4 km below the surface. Each string consists of 60 modules spaced by 17 m. Each is connected electrically to a cable that brings signals to the surface. The signal cables from all the strings are brought to a central location, which houses the data acquisition electronics, other electronics, and computing equipment.

Signals from the optical modules are digitized and transmitted to the surface such that a photon's time of arrival at an optical module can be determined to within a few nanoseconds. The electronics at the surface determines when an event has occurred (e.g., that a muon traversed or passed near the array) and records the information for subsequent event reconstruction and analysis.

At the South Pole site, a computer system accepts the data from the event trigger through the data acquisition system. The event rate, which is dominated by the steady background of down-going cosmic ray muons, is estimated to be 1.5 kHz. This will produce a large amount of data and requires filtering and compression of this data stream at the South Pole. There are two ways for the data to be transported to the Northern Hemisphere. The first and preferred method is via satellite transmission. The second method is by hand-carrying the data tapes north once the station reopens in the austral summer. Even in this case, a reduced set of data must be transferred daily by satellite to monitor the detector and to access important data. Once at the data archive, the data are catalogued, unpacked, checked, filtered, and calibrated. Interesting events are reconstructed and distributed to the collaboration for scientific analysis. For more details and references, see http://icecube.wisc.edu.

The total data rate from the detector is 130 GB/day or 50 TB/year. Since the satellite bandwidth is 12 GB/day, we must reduce the data volume by roughly an order of magnitude at the Pole. This reduction is accomplished with specialized filters. With the increased capacity and reduced cost of data storage, we are contemplating the transfer of the entire unfiltered raw data set to the northern hemisphere after every season. Alternatively, a pre-filter raw data cache could be temporarily stored for days to weeks for further analysis. After transfer, the filtered data

will be cached for the indefinite future in a mass archive. Expected data size is 2~TB/year plus a comparable amount of simulated data. A large dedicated cluster simulates the detector and filters and caches the simulation data. To keep pace with the actual data rate 800 GHz CPU power is required, assuming 0.5s/event/GHz-CPU.

While this is a relatively straightforward and well researched plan (see Preliminary Design Document on above website for more details), it does not provide computing power to IceCube investigators for independent research of new science topics, or the development of new methods on old ones. Beyond the dedicated IceCube computing infrastructure, the computer power for data analysis at participating institutions is limited to the handling of processed data and simulation files. Filtered data identify specific signatures with characteristics selected a-priori such as neutrino-induced muons, data in coincidence with gamma ray bursts, etc. These are similar to level 3 triggers at a collider experiment. It is critical to remember at this point that IceCube is a telescope and a discovery instrument and, except for limited AMANDA data, there is, with few exceptions such as supernovae, no prior history of neutrino astronomy on which filters can be designed with confidence.

The capability of a neutrino telescope to detect high-energy gamma rays can be demonstrated by straightforward calculations. Gamma ray astronomy is an example of interesting science that is not part of the IceCube mission, nor implemented as one of the on-line filters. With additional computing resources, this science can be performed on archived data without loss of information. Muons produced in the atmosphere by gamma rays from point sources will produce directional excesses on the background of cosmic ray muons. Reanalyzing the background data with quality cuts for improved angular resolution will hardly increase the computing time. Doubling the modest IceCube computing power for data analysis will do the job. The more severe constraint comes from the simulation of the detector that should ideally keep up with the data. The present AMANDA detector detects muons at 50 Hz and it takes 240 CPU-sec to simulate 1 second of detector lifetime. With 240 CPU's the simulation can keep up with the data. However, analyses are typically performed with less than 10% simulation lifetime. In IceCube the trigger rate is increased by a factor 30 while the time to analyze the events is expected to be roughly similar. So 720 CPUs are required to generate 10% detector lifetime. This number is likely to be reduced because considerable efforts are underway to improve the efficiency of both analysis and simulation software. We only assumed 1.2 GHz CPUs in above estimates. This is only one example of how access to a 1000 CPU cluster enhances the capabilities of the instrument in totally new directions.

It is a fact that the flexibility of redesigning filters or implementing new ones, motivated by new ideas or reacting to unexpected features in the data, will be limited to collaborating institutions with access to significant computing resources not provided by the IceCube Project. Anticipating this need we have already developed a facility performing the same, but more modest, task in the AMANDA project. This effort has partially relied on running detector simulations on a cluster of machines in UW-Madison's computer science department using Condor software. Although the AMANDA infrastructure is inadequate at the IceCube scale, this is not the case for the infrastructure requested in the proposal that would significantly boost the capability, the flexibility and the independence of the UW astrophysics group to do IceCube science.

4 High Energy Physics: CMS Experiment

The CMS experiment [5] at the CERN Laboratory, Geneva, Switzerland, is preparing to explore fundamental physics at hitherto uncharted high energy regime, 14 TeV. Exploring this energy regime is necessary to understand the fundamental particle physics. Professors Sridhara Dasu, Don Reeder and Wesley H. Smith are leading the University of Wisconsin efforts on this international project [6]. This experiment uses a large detector to study a billion high energy proton-proton interactions per second. This detector is composed of several million sub-detectors whose output is combined to yield events of 1 MB each at a rate of 40 MHz. This high data yield of the experiment is reduced using a series of algorithms running at the very lowest level on custom-built electronics. The final selection and winnowing is done using a series of software programs running on a grid of a thousand or so commodity computers, to a sustained data flow of 100 MB/s. The CMS data are then archived resulting in databases measured in petabytes per year. The offline analysis of the data is to be accomplished using a distributed grid of several thousand computers. The new physics signatures that they hope to discover are expected to be rare, *i.e.*, few tens or hundreds per year compared to 100 Hz archived. The metaphor of finding a needle in a haystack is an understatement in this case.

While the scope of entire CMS computing is large and there are dedicated efforts to develop computing systems and software for it, the specific needs of the individual physicists are not fully addressed by these efforts. The UW physics group is collaborating with the UW CS team to empower the individual physicists to harness the required resources from the distributed computer grids. The idea is to develop an environment for "Grid Enabled Physics Signal Extraction". This allows for individual researchers to experiment with new methods of signal extraction by harnessing the grid computing power. The tasks that need to be performed on the grid are simulation of signal events and backgrounds. Simulation of a single event can take 10 minutes on a 1 GHz Intel processor and typically would need about 10 MB to store the complete event. Typically, millions of simulated events are needed to determine the efficiency and purity of selection algorithms.

Last year, they have successfully used the existing Condor systems at the UW to make simulation studies of hardware trigger algorithms using about 0.5 million events. This was accomplished in one month with access to about 100 CPUs on the CS Condor farm and 1 TB storage at physics.

Currently about 250,000 events are being generated every week and are being transferred to CERN for the use of the collaboration. Typically, 300 jobs are running on the CS Condor system and are keeping the full 4.7 TB storage servers busy.

The needs of this group are growing as they move on to study high level software triggers and explore offline data analysis strategies. The group estimates that they need to generate about 10 million events every few months, to accommodate various software changes and new ideas. These data are typically shared with other CMS collaborators worldwide. This latter aspect requires high WAN bandwidth. At times they have saturated the 150 mbps link that now connects their LAN to the world.

In summary, in the near term the CMS physics activity requires sustained access to 1000 CPUs, 50 TB disk storage, and giga-bit link to the WAN.

5 Chemical Engineering & Material Science: Materials by Design

One of the grand challenges of computational research is that of designing molecules or materials for specific applications. Progress must be made on two fronts. On the one hand, accurate force fields must be developed capable of describing the interactions between distinct atomic species in condensed media. On the other hand, molecular simulation techniques capable of describing the structure and dynamics of complex fluids or materials are needed. The Chemical Engineering Department Molecular Thermodynamics and Statistical Mechanics Group [7,8] research at the University of Wisconsin seeks to make progress in these two areas.

Starting with electronic structure calculations, we determine the equilibrium structure and the energy of individual molecules or small clusters of molecules. The information generated by these calculations (e.g. bond lengths, bond angles, intra-molecular energy, charge, etc.) is subsequently used to construct effective, two-body force fields capable of describing the structure and thermodynamic properties of condensed, many-molecule systems; the results of numerous electronic structure calculations (as a function of molecular distance, orientation, etc.) are fit using simple analytical expressions. These expressions are used in conjunction with molecular dynamics, stochastic dynamics, or Monte Carlo methods to calculate average structures and properties. The development of an accurate force field invariably involves an iterative procedure in which generated quantities are gradually optimized by analysis of available experimental data. This is a highly computationally intensive process.

The materials of interest to our research (e.g. polymers, macromolecules in solution, organic and inorganic glasses, biological molecules) generally exhibit rough free energy landscapes and long characteristic relaxation times. For a macromolecular system, conventional molecular dynamics simulations can only generate trajectories of several nanoseconds. A typical diffusion coefficient for a polymer in a melt is on the order of 10^{-13} cm^2/sec, meaning that in a nanosecond simulation a molecule does not travel by more than a fraction of an angstrom, i.e. too small a distance to generate statistically meaningful information. In order to circumvent such diffusional bottlenecks, we resort to advanced Monte Carlo methods that permit reliable and efficient sampling of equilibrium configurations of systems of interest. The results of these simulations are used to investigate a wide range of problems.

In our nanotechnology related research, we use simulations to investigate how nanoscopic structures of amorphous polymeric glasses behave under the influence of applied fields or external forces. Different geometrical constructs (e.g. walls, ridges, posts) made out of amorphous polymers are assembled on the computer, and their response to deformations and other external disturbances is examined. Our results to date have shown that the properties of polymeric materials in nanoscopic systems are considerably different from those of the bulk, and at this point in time simulations are the only viable means of generating data for these systems (real laboratory experiments are being planned, but success by us and others has been very limited so far.) These data are subsequently used for design of polymeric materials for nanolithograpy in the semiconductor industry.

The materials of interest to this research are glasses; by definition they exhibit extremely long characteristic relaxation times. The problem of sampling the structure of a glassy materials remains largely unsolved; some of the best methodologies for their numerical simulation have been developed in our group, but these calculations still require on the order of months of CPU time for an individual data point.

In our microfluidics related research, we use multi-scale computer simulations to examine how long, chromosome-length DNA molecules diffuse and flow through micro- and nanofluidic channels. We use a combined atomistic-Brownian-continuum approach in which the motion of individual molecules and the macroscopic hydrodynamic conservation equations are resolved self-consistently. The results of these calculations are subsequently compared to direct single-molecule visualization experiments (see Section on Molecular and Computational Genomics) to assess the validity of our models and numerical approaches. The goal of this work is to develop a predictive tool that will permit rational design of devices for fast and efficient sequencing, mapping, purification, and chemical modification of DNA. A single calculation for a particular geometry requires approximately 100 hours of CPU time, but a large number of simulations are required for design and optimization of specific devices.

In our biotechnology related research, we use Monte Carlo simulations of proteins and biological membranes to understand how different molecules act as stabilizers of biological structure and function. Using molecular modeling techniques we have been able to develop "protectant" formulations that are now in use around the world to stabilize pharmaceutical products during storage (e.g. vaccines, bacterial lines, etc.). While superior to other available stabilizers, we believe that significant improvements can still be achieved by understanding how proteins and other molecules are transported through lipid bilayers. Many of our efforts are aimed at understanding such processes. To that end, we used transition-state theory and advanced Monte Carlo techniques that allow us to estimate potentials of mean force between biological molecules and membranes in solution. Those calculations are highly computationally demanding, with a single potential of mean force evaluation requiring on the order of 2000 hrs of CPU time per processor.

In summary, as our ability to simulate complex molecules and materials increase, so will our needs for computational resources. We currently have a dedicated Condor managed cluster of approximately 400 computers working full time on our calculations. This cluster is clearly insufficient, as we also harness cycles from the Condor pool at Computer Sciences; an expanded campus wide Condor system would benefit our research enormously.

Much of our research on materials by design takes place at the NSF-sponsored Materials Research Science and Engineering Center (MRSEC) on Nanostructured Interfaces [9]. Over the last decade, this center has developed state-of-the-art experimental instrumentation for materials research. Our MRSEC could benefit considerably from advanced computational resources to complement, interpret, and analyze our experimental results.

6 Medical Physics, Radiation Therapy Physics

The American Cancer Society estimates that there will be over 550,000 cancer deaths and over 1,300,000 new cancer cases diagnosed in 2003 in the United States. Medical physics is a discipline that is in large part connected with the diagnosis and radiation treatment of cancer. This discipline greatly benefits from fast, large-scale computing. Several applications, ranging from radiation therapy planning to advanced medical image reconstruction and image processing, require strong computing power, and more needs and applications are expected to arise in the future with even further demands for increased computer speed. Over the past two years research groups in the UW Medical Physics Department [10,11,12,13] have extensively used a 24-node Beowulf computer cluster for radiation therapy applications (including external

beam radiotherapy calculations, brachytherapy, shielding computations, and detector characterization and design) and ultrasound image simulations (linear and harmonic imaging, single element and array transducers). These groups are well poised to extend parallel computing so that it will have a major impact in medical diagnostics and cancer treatments.

There are several areas that would benefit significantly from using the proposed GRID computing. The foremost example is the use of *Monte Carlo radiation transport calculations* in modeling and planning doses for radiation treatment of cancer patients. The field of radiation therapy is shifting rapidly to use of Intensity Modulated Radiation Therapy (IMRT), where high radiation doses can be delivered to precise locations with increased sparing of the nearby critical structures. Because of the high degree of accuracy required, Monte Carlo transport is the preferred choice for characterization of radiotherapy treatment units as well as patient dose calculation. Since typical Monte Carlo calculations consist of several hundred millions of independent calculations, they represents an ideal case for grid computing, where parts of the calculation are sent to each node. For large problems, almost linear scaling up to a few thousand nodes has been obtained with current codes. Different computing resources and calculation times are needed for each application. A typical Monte Carlo simulation used to characterize the emitted radiation field of a medical linear accelerator would take approximately 200-1000 CPU-hours on the proposed computer environment and require approximately 1-2 Gbytes of storage. On the other hand, a typical Monte Carlo dose calculation in a patient geometry would take on the order of 0.1-2 CPU-hours, depending on the required calculation precision. By reducing this time through large scale computing calculation times of seconds would be obtained, which would enable interactive Monte Carlo treatment planning.

Another application requiring large scale computing resources is *inverse treatment planning*, where the radiation treatment plan is obtained through optimization of given objectives. In order to explore all possible solutions, several thousand treatment subfields have to be (pre)calculated. This feature represents another ideal case for parallel computing since a given number of subfields can be sent to each node for calculation. The benefits of parallel computing are equally applicable for either Monte Carlo dose calculations or other popular dose calculation methods (e.g., convolution/superposition). Up to 10,000 subfields need to be calculated with calculation times between seconds and minutes, depending on the dose calculation method, which brings the total of the calculation times to the order of 1-100 CPU-hours. Total storage requirements are between 100 Mbytes and 10 Gbytes, depending on the geometry and size. There is another aspect of inverse treatment planning that would benefit significantly from the proposed grid computing; because of only approximately known clinical objectives, several candidate plans typically need to be calculated, varying the physical objectives. In the parallel computing environment, many more candidate plans could be considered, which would improve the selection of the best plan.

We anticipate even more demand for a fast parallel computing environment will emerge from *image guided adaptive radiotherapy*. In adaptive radiotherapy, treatment plans will be modified based on the imaging information obtained prior to, or even during the treatment. As already mentioned, current (re)optimization problems take on the order of hours/days, which makes on-line corrections impossible. At most, it can be expected that *inter-fraction* (day-to-day) corrections could be applied in the near future. To enable on-line modifications/corrections of treatment plans when a patient is already prepared for treatment, at most several minutes of calculation time can be afforded, which is clearly impossible without a very strong parallel

computing environment. If calculation speeds could be increased even further to enable re-optimization within seconds, a whole new era of real-time *intra-fraction* adaptation of treatment would become feasible. Thus, this research could dramatically change the course of radiation therapy, which would further improve the outcomes of cancer treatment.

Currently, the size of the local Medical Physics computer cluster limits the scope of radiation transport and medical imaging problems that can be explored. The proposed GLOW system will provide much greater access to parallel computing in medical physics, which will significantly enhance radiation therapy and medical imaging research. Furthermore, the improved access to parallel computing resources through GLOW will provide parallel computing exercises to be incorporated into Medical Physics classroom activities and laboratories.

7 Computer Sciences

The sixth GLOW site will be located at the Computer Sciences department. A number of activities will be conducted at this site in addition to serving computational needs. It will serve as the center for operations management. In that context it will monitor and tune traffic and data flows in GLOW to maintain peak operational efficiency. The side will also serve as the test and staging location for the development and deployment of new capabilities in Condor that are required by GLOW. Finally, the site will coordinate bulk data transfers between GLOW and remote sites.

The computer sciences team of GLOW consists of Prof. Remzi Arpaci-Dusseau - Distributed and parallel I/O systems [14,15], Prof. Paul Barford - Network management and Network storage (NeST) [16] and Prof. Miron Livny - Grid and high throughput computing (Condor) [17].

The combination of close interaction with the five different groups of domain scientists and the demands of a distributed production environment will enable this team of computer scientists to investigate a wide spectrum of grid related problems. Applications and requirements provided by the domain scientists will help to guide the research agenda of the team and will help in the process of developing a testing and evaluation framework for GLOW systems.

There are two components of GLOW that will be initial focus areas for computer science research. The first is the area of grid-enabled storage networks. The idea is to develop this storage network based on a new storage abstraction – namely that storage is ubiquitous and not centered at any single site. The goal is to enable a storage environment that acts as a single seamless system over the entire grid with the end result being larger capacity, higher reliability and better performance than currently available storage systems. An additional component of this environment will be the development of the GLOW staging system, which will be used to facilitate bulk data transfers to remote sites. The challenge in this endeavor is to tune systems (both local and remote) to execute transfers with maximum goodput (error free data/time interval).

The second focus area is in the development of GLOW management systems. The objective in this regard is to monitor and coordinate all aspects of computation, storage, and communication within GLOW such that needs of the domain scientists are met. This will require development of policy and scheduling methods to capture both periodic and on-demand requirements of the users. It will also require development of distributed control systems, which

will coordinate in the task of grid tuning such that the system operates with specified tolerances and in a robust fashion.

8 Education

The educational program of this project is two fold. Firstly, the graduate student project assistants at each of the GLOW sites will be trained in system integration and commissioning under the supervision of the system programmer. Practical experience in systems integration, which includes hardware commissioning and Condor distributed computing software, is much valued and is not normally gained in the University coursework. We expect that value added to the education of engineering students, who will be participating in building GLOW as project assistants, will be substantial. Secondly, each of the research groups involved in using GLOW resources will train graduate and undergraduate students in development and running of their domain specific software in the GLOW environment. For instance, the HEP group currently supports an undergraduate student who is learning particle physics software by developing simulations that are targeted for running on our existing small cluster. We visualize that each of the sites will be training about two students in using the distributed computing resources offered by GLOW. Any idle cycles and storage space on GLOW will be available to the general student community for compute intensive projects.

9 Impact on Infrastructure

The technology and techniques developed in GLOW have the potential for a substantial impact on the way scientific research is conducted, compute and data intensive applications structured and computing resources exploited. Specifically the goal is to develop techniques of exploiting ephemeral resources that are not required to be robust to provide reliable large-scale computing on demand at a level higher than that usually available to a number of research projects that can realize sizeable benefits from increased computing. Since a wide range of disciplines will contribute to the development of the methodologies and tools, they should be widely applicable. GLOW should provide a paradigm for how different scientific disciplines can not only pool computing resources to gain effectively many more compute and storage resources for each group through load sharing, but to also collaborate on solving each other's computing challenges. We plan to export the technical as well as the sociological lessons derived from this project to other Universities, starting with the multiple-university collaborations that each of the groups in this proposal leads or is actively involved.

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10 GLOW Systems

10.1 Computing Resources

The resources required by the domain scientists to address their most immediate computational needs are listed in Table 1. These requirements are expected continue to grow as the problems studied get more complex, the number of elements that must be examined increases and the scope of the activities of the participating groups expends. We assume that desired turn-around time for a job is one day (except in developing dose calculations for adaptive radiation therapy, where turn-around times of minutes will be sought) and that any data produced is to be

stored for at least one month. We have sized the system based on shared usage under these assumptions. The desired system we wish to acquire will be made of 1600 2.4 GHz Intel CPUs, 70 TB storage on a LAN with sustained throughput of at least 1 Gbps between computational and storage systems. Further, much data needs to be transferred to laboratories worldwide requiring high throughput connection to the WAN. The network requirements of this project are to be provided as part of campus wide technology upgrade. The WAN requirements are to be met by separate proposals. We also expect that existing computational resources, including desktop and student laboratory computers, at each of the domain sites, and the existing Condor pool at the CS department will be integrated in GLOW. With the inclusion of these resources we effectively double the GLOW system size. Building GLOW and integrating the existing systems at each of the domain science departments into the campus wide laboratory requires dedicated personnel that we budget for in this proposal.

Domain, Job type	Number of Jobs Simultaneous and per Day	CPU-Hours consumed per job (2GHz-Intel)	Per Job Storage (GB)	Per Job Network IO (kB/s)
High Energy Physics/CMS, Simulation	1000 / 1000	10	0.5	10
High Energy Physics/CMS, Reconstruction	100 / 1000	1	0.1	1000
Astro-Physics/IceCube	360 / 360	24	2	25
Genomics				
Machine Vision (5000 groups per week)	10 / 720	0.33	300	2500
Alignment (200,000 maps per week)	165 / 28800	0.14	1	333
Contig Generation (1000 maps per week)	1330 / 140	228	1	1.6
Medical Physics	10/100	0.1-1000	0.1-10	1-1000
Materials Design	1000/1000	24	4	35

10.2 Campus Networking

The University of Wisconsin has embarked on a five year, $25 million network technology upgrade. This upgrade includes deployment of a 10Gbps backbone, electronics upgrades for all campus departmental LAN's, and installation of single-mode fiber to all buildings. The new network will also include support for Storage Area Networks as well as fine-grained measurement/monitoring, dedicated bandwidth allocation and enhanced security services. Critical components of the upgrade are the management systems and services that will be deployed. These will enable the network to respond to changing conditions and insure that

end hosts deployed around the campus will have an extensible, reliable, high capacity communications infrastructure.

This new network (aspects of which will become operational in January '03) will serve as a foundation for the computational and storage environments of GLOW. In particular, these systems will enable the development of virtual network overlays, which are aimed at providing seamless computation and storage (compute/store) capability to the domain scientists. Our objective in this regard is to develop an adaptive environment that will present the maximum possible compute/store capability to users, and will then perform scheduling and resource allocation so as to satisfy the compute/store requests. While different components of this environment already exist, our task will be to develop provisioning and management systems to tie the components together into a cohesive whole.

The University of Wisconsin is involved in several major grid and other computing initiatives of NSF. In order to satisfy the ever growing need for faster WAN access, the UW is seeking a faster connection to Abilene and to the StarLight facility in Chicago, so that the our local computational infrastructure will be available to the global research community at much faster speeds. That connection will likely provide required WAN bandwidth for GLOW.

10.3 NSF-Middleware Initiative (NMI)

The proposed work will take advantage of the software infrastructure components provided and supported by the NSF Middleware Initiative. The middleware released and supported by NMI provide application developers and system administrators in the six GLOW sites with commonly needed infrastructure services such as authentication, authorization, data transfers and reliable access to remote resources. The University of Wisconsin-Madison is a major participant in this NSF funded integration efforts through both the GRIDS Center and EDIT projects under the NMI umbrella (see http://nsf-middleware.org). Experience from the deployment and operation of GLOW will be used to improve and enhance the NMI integration, testing and support activities. Our close ties with the developers of the middleware components of NMI will facilitate direct flow of bug reports and requests for new capabilities triggered by the user community of GLOW.

11 Management

An Executive Board consisting of one member each from Computer Sciences, Chemical Engineering, Chemistry, Medical Physics and Physics will manage GLOW. The Computer Science member will Chair the Board. If additional Departments join the effort in a substantial way, they will be invited to select a member to join the Executive Board as well. The Executive Board will determine the overall project direction and implementation, develop the project plan and milestones, review progress towards these milestones and assign the priority in allocation of computing resources, The day to day operations will be overseen by a Technical Board consisting of computing professionals selected by the individual members of the Executive Board. It is expected that the Technical Board members will be the system managers responsible for the domain sites. The Technical Board will also have a member selected by the UW Division of Information Technology (DoIT) with specific responsibility for the Campus Network. The Executive Board Chair will select the Technical Board Chair. The Technical Board will be responsible for execution of the Project Plan developed by the Executive Board and report on

progress to the Executive Board monthly. The Technical Board will facilitate cooperation amongst the domain sites on such issues as networking, rollout of new Operating System and other software versions, and solving mutual technical problems. Personnel hired under this grant will report to the member of the Technical Board from their domain site.

The planning for implementation of GLOW is based on strategic procurement and deployment of computing resources to optimize funding leverage, availability of staff, and evolution of technology. Purchases will be phased to provide personnel load-leveling and to match the funding profile. This will avoid having to hire additional personnel to handle peak loads and also provide a smooth and gradual turn-on of the enhanced computing resources to allow thorough testing followed by full exploitation as they come on-line.

12 Results from Previous NSF Support

The scientists involved in this proposal have produced many results from their NSF-funded research. Here we catalog a representative selection.

Funded in part by the NSF, the UW Computer Science Department proponents of this project developed, implemented, deployed, and evaluated mechanisms and policies that support High Throughput Computing on large collections of distributively owned computing resources. Guided by both the technological and sociological challenges of such a computing environment, the Condor Team has been built software tools that enable scientists and engineers to increase their computing throughput. They are part of the major international grid projects including GriPhyN and iVDGL.

Funded in part by the NSF, the UW Laboratory for Molecular and Computational Genomics, Laboratory of Genetics in the Department of Chemistry has developed genome analysis approaches based on using individual DNA molecules as the main substrate. An automated system combining image analysis and map construction algorithms (Optical Mapping), enabled construction of high-resolution restriction maps from a variety of DNA sources.

Using funding from the NSF, the UW High Energy Physics group has hired a software engineer who has improved the operation, fault tolerance and monitoring of physics simulations operating on Condor-managed distributed computer grids.

Funded in large part by the NSF, the AMANDA-B10 array is performing a search for Ultra High Energy neutrinos, reaching effective areas of 0.4 km^2 at the highest energies. There is good agreement between background simulation and the experimental data. It has been shown that the AMANDA detector can set limits that will exclude models for UHE neutrino generation. AMANDA is currently the largest operating detector for UHE muons.

The Materials Research Science and Engineering Center on Nanostructured Materials and Interfaces (MRSEC) at UW was established by the NSF to carry out research in the formation, characterization, and exploitation of materials at the nanoscale - the scale of individual atoms. It has advanced the fundamental understanding of topics of substantial technological importance, and the communication of this understanding to the public.

13 Summary

GLOW - the Grid Laboratory Of Wisconsin, is the first step in establishing a crucial scientific computing resource at the UW for a multidisciplinary effort spanning the fields of - Computer Science, Genomics, High Energy Physics, Material Science, Neutrino Astrophysics and Medical Physics. Our vision is to eventually build and manage a campus-wide computational grid that consists of 10,000 CPUs and about 1 PB disk, providing ample storage and processing capacity to meet the growing computational needs of our campus. GLOW presents us with a unique opportunity to take an important first step towards this vision: by constructing the infrastructure outlined within this document, we will be able to better understand both the social and technological issues that arise in constructing, managing, maintaining and harnessing a grid-enabled computing system. At the same time, GLOW will provide much needed computing and storage capabilities to the participating groups.

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Professional Preparation

Hebrew University in Jerusalem	B.Sc.: Physics and Mathematics, *Cum Laude*	July	1975
Weizmann Institute of Science	M.Sc.: Computer Science	March	1978
Weizmann Institute of Science	Ph.D.: Computer Science	February	1984

Appointments

1995	Professor, Computer Sciences Department, University of Wisconsin-Madison
1989	Associate Professor, Computer Sciences Department, University of Wisconsin-Madison.
1984	Assistant Professor, Computer Sciences Department, University of Wisconsin-Madison.
1983	Instructor, Computer Sciences Department, University of Wisconsin-Madison
1979	Research Assistant, Hebrew University, Center for Agricultural Economy, Rehovot, Israel

Related Publications

[1] Elisa Heymann, Miquel Senar, Emilio Luque, Miron Livny. "Adaptive Scheduling for Master-Worker Applications on the Computational Grid". Lecture Notes in Computer Science vol. 1971, R. Buyya and M. Baker (ed.), pp. 214-227 Springer-Verlag, 2000. (Grid 2000 First IEEE/ACM International Workshop. Bangalore, India. Dec 17, 2000).

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Synergistic Activities

- Research tools: DeNet - a Discrete Event Simulation Environment; DEVise - a Visual Data Exploration Environment; Condor - a High Throughput Computing System.

- Service: NSF National Resource Allocation Board; Program Committee of VLDB, SIGMOD, HPDC, SIGMETRICS and others.

Collaborators

Name (Institution) in alphabetic order:
Bruce Allen (Wisc. Milwaukee), Andres Arpaci-Dusseau, (Wisc. Madison), Remzi Arpaci-Dusseau (Wisc. Madison), Paul Avery (Florida Gainsville), Julian Bunn (Caltech), Thomas DeFanti (UIC), Michael Ferris (Wisc. Madison), Ian Foster (U. Chicago/ANL), Michael Franklin (Berkeley), Jose A Fortes (Purdue), Robert Gardner (Indiana), Robert Hollebeek (Penn), John Hurely (CAU), John Huth (Harvard), Stephen Kent (Chicago), Carl Kesselman (USC), Albert Lazzarini (Caltech),, Keith Marzullo (UCSD), Bart Miller (Wisc. Madison), John Markely (Wisc. Madison), Reagan Moore (SDSC), Richard Mount (SLAC), Harvey Newman (Caltech), John Norman (Wisc. Madison), Lawrence Price (ANL), Sanguthevar Rajasckaran (Florida Gainsville), Raghu Ramakrisnan (Wisc. Madison), Joseph Romano (Texas Brownsville), Arie Shoshani (LBNL), Marvin Solomon (Wisc. Madison), Alexander Szalay (Johns Hopkins), Valery Taylor (NW), Roy Williams (Caltech), Steve Wright (ANL).

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Yeshayahu Artsy, Kurt Brown, Huang-Yang Chang (IBM), Michael Cheng (IBM), Michael Franklin (Berkeley), Eben Haber (SGI), Jayant Haritsa, Phillip Krueger (IBM), Rajiv Jauhari (IBM), Jussi Myllymaki(IBM), Matt Mutka (Michigan), Hwee Hwa Pang, Jim Pruyne(HP), Viresh Ratnakar, Praveen Seshadri (Microsoft), Tian Zhang (IBM), Rajesh Raman (QUIQ)

Biographical Sketch – **Sridhara Rao Dasu**

Professional Preparation:

Nizam College, Osmania University	B. Sc. (Math, Physics, Chemistry) 1981
University of Hyderabad	M. Sc. (Physics) 1983
University of Rochester	M.A. (Physics) 1985, Ph. D. (Physics) 1988

Appointments:

University of Wisconsin	Assistant Professor, 2000 - Present
University of Wisconsin	Associate Scientist, 2000
University of Wisconsin	Lecturer, Fall 1995
University of Wisconsin	Assistant Scientist, 1992-1999
Stanford Linear Accelerator Center	Research Associate, 1988 - 1992

Publications:

(Related to the proposed project)

1. S. Dasu, "Higgs Search at LHC", Proceedings of the IXth International Symposium on Particles, Strings and Cosmology, Tata Institute of Fundamental Research, Mumbai, India, January 3-8, 2003.
2. S. Dasu, "CMS Trigger and Event Selection", Proceedings of the III International Symposium on LHC Physics and Detectors, Chia, Sardinia, Italy, October 2001.
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Synergistic Activities:

The primary focus of S. Dasu's research program is to study the physics of the fundamental particles and their interaction. This experimental program requires large scale computing and sophisticated electronics systems. The research and development needed for putting together these systems is an inter-disciplinary effort with computer and electrical engineering experts for exploitation of new ideas in those fields, e.g., the use of computer grids for solving scientific computational problems.

Collaborators:
Since there are several hundred collaborators in CMS and BaBar a web reference is provided.
1. CMS Collaboration, http://cmsdoc.cern.ch/people/PEOPLE1
2. BaBar Collaboration, http://www.slac.stanford.edu/babar-internal/colli?letter=showall
3. Condor, Prof. Miron Livny, Dept. of Computer Science, U. Wisconsin

Graduate and Postdoctoral Advisors:
1. Prof. Arie Bodek, U. of Rochester 2. Prof. D. W. G. S. Leith, SLAC
3. Prof. W. H. Smith, U. of Wisconsin 4. Prof. R. Prepost, U. of Wisconsin

Thesis Advisor:
S. Dasu is a new faculty member currently advising two graduate students.

Postgraduate-Scholar Sponsor: Francesca di Lodovico, Post Doc

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Education

1990	PhD	Chemical Engineering	University of California, Berkeley
1985	BS	Chemical Engineering	National University of Mexico, UNAM
1990-92	Postdoctoral	Materials Science	Institut fuer Polymere, ETH, Zurich

Employment/Research Experience

Director, Materials Research Science and Engineering Center (MRSEC)	6/01 to present
Professor of Chemical Engineering, University of Wisconsin	7/97 to present
Associate Professor of Chemical Engineering, University of Wisconsin	7/96-6/97
Assistant Professor of Chemical Engineering, University of Wisconsin	9/92-6/96
Postdoctoral Fellow, Institute for Polymers, ETH, Zurich, Switzerland	8/90-8/92
Process Engineer, Mexican Petroleum Institute, Mexico City	7/84-8/85

Awards & Honors

Frontiers in Engineering Lecture, National Academy of Engineering, Irvine, 2002
Samuel C. Johnson Distinguished Fellowship, 2002
Paul Flory Lectures in Physical and Macromolecular Chemistry, Stanford University, 2002
Kurt Wohl Memorial Lecture, University of Delaware, 2000
Invited Guest Professor, ETH, Zurich, Switzerland, 1998
Howard Curler Distinguished Chair in Chemical Engineering, 1998
Camille Dreyfus Teacher-Scholar Award, 1997
NSF Presidential Early Career Award in Science and Engineering, 1996
Polygon Engineering Council Outstanding Instructor Award, 1995
Polygon Engineering Council Outstanding Instructor Award, 1994
Dupont Young Faculty Fellowship, 1994
Non-Tenured Faculty Award, 3M Company, 1994
Young Faculty Award from the Xerox Corporation, 1993
National Young Investigator (NYI) Award from the National Science, 1993
Camille and Henry Dreyfus Foundation New Faculty Award, 1992

Recent Professional and Service Activities

Advisory Committee, Chemical and Biomolecular Engineering, Cornell University; Advisory Committee, Institute for Nanosoldier Technologies, Massachusetts Institute of Technology; Committee on Information and Communications, National Research Council; Consulting Editor, AIChE Journal; Chairman, Area 1a, AIChE National Meeting, 2001; Member of Molecular Modeling Task Force, CACHE Corporation;

Recent Publications of Relevance to Proposed Work:

"An Improved Density-of-States Method for Simulation of Complex Fluids and Materials," Phys.Rev.Lett., in press, (2003), Q. Yan and J.J. de Pablo.

"Simulation of Protein Folding Through a Random Walk in Energy Space," J.Chem.Phys., **116**, 7225-7230 (2002), N. Rathore and J.J. de Pablo.

"Phase Equilibria of charge-, size-, and shape-asymmetric model electrolytes," Phys.Rev.Lett., 88 (9), art. no. 095504, (2002), Q. Yan and J.J. de Pablo.

"Molecular Simulation of Ultrathin Polymer Films Near the Glass Transition," Phys.Rev.Lett, **85**, 3221-3224 (2000), J.A. Torres, P.F. Nealey and J.J. de Pablo.

"Molecular Simulation of Sucrose Solutions Near the Glass Transition Temperature," J.Phys.Chem. A, **105** , 734-742 (2001). N. Ekdawi-Sever, P.B. Conrad and J.J. de Pablo.

Five Other Related Publications:

"Phase Equilibria in Size-Asymmetric Primitive Model Electrolytes," Phys.Rev.Lett., **86**, 2054-2057 (2001), Q. Yan and J.J. de Pablo.

"Stochastic Simulations of DNA in Flow: Dynamics and the Effects of Hydrodynamic Interactions," J.Chem.Phys., **116**, 7752 (2002), R.M. Jendrejack, M.D. Graham and J.J. de Pablo.

"Evidence for size-dependent mechanical properties from simulations of nanoscopic polymeric structures," J.Chem.Phys., **116**, 9939-9951 (2002), T. Boehme and J.J. de Pablo.

"Dependence of the Glass Transition Temperature of Supported Polymer Thin Films on Interfacial Energy and Thickness," Macromol., **34**, 5627-5634 (2001), D.A. Fryer, R.D. Peters, J.J. de Pablo and P.F. Nealey.

"Stabilization and Preservation of Lactobacillus Acidophilus in Saccharide Matrices," Cryobiology, **41**, 17 (2000), P.B. Conrad, P. Cielisnki, D.P. Miller and J.J. de Pablo.

Selected Recent Invited Talks:

APS National Meeting, March 2003
Gordon Conference on Water, August 2002.
V Liblice International Conference on Statistical Mechanics, June 2002.
Gordon Conference on Elastomers, August 2001.
APS National Meeting, March 2001.
Gordon Conference in Polymer Physics, August 2000.
National Meeting of the Society for Cryobiology, August 2000.

Recent Collaborators (last 5 years):

M.D. Graham, J.A. Dumesic, P.F. Nealey, N. Abbott, F. Cerrina, H.C. Ottinger, A. Lal, D.C. Schwartz, M. Ediger, A. Yethiraj, A. Panagiotopoulos, D. Kofke, P.T. Cummings, R. Rowley, H.C. Cochran, S. Sokolowski, J. Alejandre, H. Corti, J. Schieber.

Past Graduate Students and Postdoctoral Associates:

M. Chavez-Paez, K. Van Workum, Q. Wang, N. Ekdawi, R. Faller, F.A. Escobedo, D. Gromov, S.K. Nath, D. Fryer, R. Khare, U. Borgbjerg, T. Bell, P.B. Conrad, D.P. Miller, J.A. Torres, D. Tsangaris, R. Anderson, D. Goldfarb, J. Suen, P. Cielinski, L. Gentoro.

Biographical Sketch – **Paul M. DeLuca, Jr.**

Professional Preparation

LeMoyne College, Syracuse, NY	Physics/Math	B.S.	1966
University of Notre Dame, Notre Dame, IN	Nuclear Physics	Ph.D.	1971
University of Wisconsin-Madison	Radiology	Post Doc	1971-1973

Appointments

Associate Dean, Medical School	University of Wisconsin-Madison	1999-present
Chairman, Dept. of Med. Physics	University of Wisconsin-Madison	1987-1998
Professor	University of Wisconsin-Madison	1985-present
Associate Professor	University of Wisconsin-Madison	1981-1985
Assistant Professor	University of Wisconsin-Madison	1975-1981
Adjunct Assistant Professor	University of Wisconsin-Madison	1974-1975
Assistant Scientist	University of Wisconsin-Madison	1973-1974

Publications

1. Hill CK, Nelms BE, MacKay JF, Pearson D, Kennan WS, Mackie TR, DeLuca Jr. PM, Lindstrom MJ, and Gould MN, "Synchrotron-Produced Ultrasoft X rays: Equivalent Cell Survival at the Isoattenuating Energies 273 eV and 860 eV," Radiat. Res. 150, 513-520, 1998.
2. Nelms BE, Mackie TR, MacKay JF, Hill CK, DeLuca Jr. PM, Lindstrom MJ, Deasy J, and Gould MN, "A Comparison of Cytotoxicity Following Whole or Partial-Cell Irradiation with Synchrotron-Produced Ultrasoft X Rays," Radiat. Res. 150, 521-527, 1998.
3. Binns PJ, DeLuca Jr. PM, Maughan RL, and Kota C, "Direct Determination of Kerma for a Fast neutron Therapy Beam," Phys. Med. Biol. 43, 3449-3457, 1998.
4. DeLuca Jr. PM, "Determination of Proton Absorbed Dose in Reference Conditions," In: Clinical Proton Dosimetry Part 1: Beam Production, Beam Delivery and measurement of Absorbed Dose, ICRU Report 59, pp 15-27, International Commission on Radiation Units and Measurements, Inc., Bethesda, MD, 1998.
5. A.~Wambersie, P.M.~DeLuca, Jr., Bohm TD, DeLuca Jr. PM, Cox LJ, Maughan RL, Jones DTL, and Lennox A, "Monte Carlo Calculations to Characterize the Source for Neutron Therapy Facilities," Med. Phys. 26(5) 783-792, 1999.
6. Wilson GJ, Santyr GE, Anderson ME, and DeLuca Jr. PM, "Longitudinal Relaxation Times of ^{129}Xe in Rat Tissue Homogenates at 9.4 T," Magn. Reson. Med. 41, 933-938, 1999.
7. DeLuca Jr PM, and DeWerd LA, "Dosimetry of High-Energy X-Rays and Electrons," in Biomedical Uses of Radiation, Part B, pp 741-796, William R. Hendee (Ed.), VCH Publishers (subsidiary of John Wiley & Sons, Inc.), New York, NY, 1999.
8. Jones DTL, MacFarlane RE, Meulders JP, Schuhmacher H, Wambersie A, Chadwick MB, Barschall HH, Caswell RS, DeLuca, Jr PM, Hale GM, and Young PG, "A Consistent Set of Neutron Kerma Coefficients from Thermal to 150 MeV for Biologically Important Materials," Med. Phys. 26(6), 974-991, 1999..
9. Schrewe UJ, Newhauser WD, Brede JH, and DeLuca, Jr PM, "Experimental Kerma Coefficients and Dose Distributions of C, N, O, Mg, Al, Si, Fe, Zr, A-150 Plastic, Al_20_3, AlN, SiO_2 and ZrO_2 for Neutron Energies up to 70 MeV," Phys. Med. Biol. 45, 651-683, 2000.
10. Langen KM, Binns PJ, Lennox AJ, Kroc TK, and DeLuca, Jr PM, "Pileup Correction of Microdosimetric Spectra," Nucl. Instr. And Meth. In Phys. Res. A 484(1-3), 595-612, 2002.

Synergistic Activities

Collaborators & Other Affiliations

(i) Collaborators

(ii) Graduate & Postdoctoral Advisors

Paul Chagnon	University of Notre Dame
Charles Kelsey	University of Wisconsin-Madison

(iii) Thesis Advisor

I have been thesis advisor to 14 graduate students who have earned a Ph.D. and I am currently advisor to 3 students. Below are those who have earned a Ph.D. within the last five years.

Name	Degree	Year	Current Post	Current Institution
Juan Miranda	Ph.D.	2001	Physicist	Nevada Radiation Therapy Center

Postgraduate-Scholar Sponsor

I have been postdoctoral sponsor for 6 people. Below are those within the last five years.

Name	Position	Years	Current Post	Current Institution
Tim Bohm	Post doc	1996-2000	Asst. Scientist	Univ. of Wisconsin-Madison

Biographical Sketch

Schwartz, David C.

(i) Professional Preparation

Hampshire College, Amherst, MA; Physical Chemistry, B.A., 1976
Columbia University, New York, NY; Biophysical Chemistry, Ph.D., 1985

(ii) Appointments

1999-	**Professor**, Department of Chemistry, Department of Genetics, Biotechnology Center, University of Wisconsin, Madison; Kellett Professor since 2002
1996- 1999	**Associate Professor** of Computer Science, Department of Computer Science (associate member, Courant Institute for Mathematical Sciences), New York University.
1995- 1999	**Associate Professor**, with tenure, New York University, Department of Chemistry.
1989-1995	**Assistant Professor**, New York University, Department of Chemistry and Adjunct Assistant Professor, Department of Biochemistry (NYU, School of Medicine).
1985-1989	**Staff Associate**, Carnegie Institution of Washington, Dept. of Embryology (an independent position as head of a laboratory)

(iii) Publications

Most closely related publications (5):

Zhou, S., Deng, W., Anantharaman, T.S., Lim, A., Dimalanta, E.T., Wang, J., Wu, T., Chunhong, T., Creighton, R., Kile, A., Kvikstad, E., Bechner, M., Yen, G., Garic-Stankovic, A., Severin, J, Forrest, D., Runnheim, R., Churas, C., Lamers, C., Perna, N.T., Burland, V., Blattner, F.R., Mishra, B., Schwartz, D.C., A whole-genome shotgun optical map of *Yersinia pestis* strain KIM. Appl Environ Microbiol. 68: 6321-6331, 2002. http://aem.asm.org/

Lim, A., Dimalanta, E.T., Potamousis, K.D., Yen, G., Apodoca, J., Tao, C., Lin, J., Qi, R., Siadas, J., Ramanathan, A., Perna, N.T., Burland, V., Mau, B., Blattner, F.R., Anantharaman, T.R., Mishra, B., Schwartz, D.C. "Shotgun Optical Maps of the Whole *Escherichia coli* 0157:H7 Genome", Genome Res. 11: 1584-1593, 2001. http://www.genome.org/

Aston, C., Mishra, B., Schwartz, D. C., "Optical Mapping and its potential for large-scale sequencing projects", Trends in Biotechnology, vol. 17: 297-302, 1999. http://www.trends.com/tibtech/default.htm

Anantharaman, T. S., Mishra, B., Schwartz, D.C., "Genomics via Optical Mapping III: Contiging genomic DNA and variations", Courant Technical Report #760, Courant Institute, NY (March 1998).

Ananthraman, T. S., Mishra, B., Schwartz, D. C., "Genomics via Optical Mapping II: Restriction Maps", Journal of Computational Biology, 4, No. 2: 91-118, 1997. http://www.liebertpub.com/CMB/default1.asp

Other significant publications (5):

Lai, Z., Jing, J., Aston, C., Clarke, V., Apodaca, J., Dimalanta, E., Carucci, D. Gardner, M., Mishra, B., Anantharaman, T., Paxia, S., Hoffman, S., Venter, J., Huff, E., Schwartz, D.C., "A shotgun optical map of the entire *Plasmodium falciparum* genome", Nature Genetics 23: 309-313, 1999. http://www.nature.com/ng/

Skiadas, J., Aston, C., Samad, A., Anantharaman, T., Mishra, B., Schwartz, D.C., "Optical PCR: genomic analysis by long-range PCR and Optical Mapping", Mammalian Genome 10: 1005-1009, 1999.

Lin, J., Qi, R., Aston, C., Jing, J., Anantharaman, T. S., Mishra, B., White, O., Venter, J. C., Schwartz, D. C., "Whole genome shotgun optical mapping of *Deinococcus radiodurans*", Science 285: 1558-1562, 1999. http://www.sciencemag.org/

Jing, J., Lai, Z., Aston, C., Carucci, D. J., Gardner, M. J., Mishra, B., Anantharaman, T. S., Tettelin, H., Cummings, L. M., Hoffman, S. L., Venter, J. C., Schwartz, D. C., "Optical Mapping of Plasmodium falciparum chromosome 2", Genome Research 9(2): 175-181, 1999. http://www.genome.org/

Gardner, M. J., Tettelin, H., Carucci, D. J., Cummings, L. M., Aravind, L., Koonin, E. V., Shallom, S., Mason, T., Yu, K., Fujii, C., Pederson, J., Shen, K., Jing, J., Aston, C., Lai, Z., Schwartz, D. C., Pertea, M., Salzberg, S., Zhou, L., Sutton, G. G., Clayton, R., White, O., Smith, H. O., Fraser, C. M., Adams, M. D., Venter, J. C., Hoffman, S. L., "Chromosome 2 sequence of the human malaria parasite *Plasmodium*

falciparum: Plasticity of a eukaryotic chromosome", Science 282: 126-132, 1998. http://www.sciencemag.org/

(iv) Synergistic Activities

Director of proposed institutional training program in genomic sciences at UW-Madison; developed and taught first courses in genomic sciences at NYU and UW-Madison; Graduate admissions director (one person committee), Department of Chemistry, Analytical Chemistry Division, 2000 - 2002
Co-organizer of the 2001 ABRF Conference (Dr. Paul Tempst), San Diego, CA., Feb., 2001
Former sitting member of the National Center for Human Genome Research (NIH), study section (1995-1999). I have also been an invited reviewer for the New Electrophoretic Sequencing Technologies study section and other *ad hoc* activities at the NCI and NIH.
Leading representative of the UW-Madison Genome Center on a state building committee to design and execute a new building for genomics.

(v) Collaborators and Other Affiliations

(a) Collaborators and co-editors (last four years):

Thomas Anantharaman, UW-Madison, Dept. of Biostatistics and Medical Informatics
Fred Blattner, UW-Madison, Dept. of Genetics
Dan Carucci, Naval Medical Research Center
Juan de Pablo, UW-Madison, Dept. of Chem. Eng.
Timothy Donohue, UW-Madison, Dept. of Bact,
Malcom Gardner, The Inst. for Genomic Research
Bud Mishra, New York University, Courant Inst.
Nicole Perna, UW-Madison, Dept. of AHABS
Gary Roberts, UW-Madison, Dept. of Bacteriology
Craig Venter, The Inst, for Genomic Research
Owen White, The Inst. for Genomic Research

(b) Graduate Advisors

Bruno Zimm (1978-1980); Charles Cantor (1980-1985); Postdoctoral Advisors: none

(c) Thesis Advisor and Postgraduate-Scholar Sponsor:

Doctoral Thesis advisor to:

Gene Ananviev, Cellular and Mol. Biology Program
Dalia Dhingra, Dept. of Chemistry
Eileen Dimalanta, Dept. of Chemistry
X. Hu, Ph.D., 1997; now at Curagen
J. Jing, Ph.D., 1997; Informaticist, Smith-Kline Beecham
Kyubong Jo, Dept. of Chemistry
Z. Lai Ph.D. 1999; now at Celera
S. Lim, Dept. of Chemistry
J. Lin, Ph.D. 1999; now at Genetics Inst.
Rong Qi, Ph.D., 1999; now at Celera
Arvind Ramanathan, Ph.D., 2002; now at Harvard Univ.
Susan Reslewic, Dept. of Chemistry
Nicholas Shera, Dept. of Genetics
Allison Weber, Dept. of Genetics
Tian Wu, Dept. of Chemistry
Hua Yu, Dept. of Chemistry

Postdoctoral Scholar Sponsor of:

Christopher Aston, 1997-1999; now group leader at Wyeth Ayerst
Osmat Azzam, 2000 – 2001; now researcher in Australia
A. Evenzahav, 1997-1999; now in advertising
Joe Giacalone, 1996-1999, now self-employed
Steve Goldstein, 2003 -
Catherina Hiort, 1995-1998, now Institute manager with Leonard Phillipsen
Ed Huff, 1996-2001, now Independent Research Scientist
Aktar Samad, 1995-1998, now on Wall Street
W. Wang, 1996-1999; now patent agent, Pennie and Edmonds
Shiguo Zhou, 2000 -, Assistant Scientist

Total predoctoral students supervised, 21; total postdoctoral, 13

REMZI H. ARPACI-DUSSEAU

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Research Interests

Storage and File Systems, Operating Systems, Parallel and Distributed Systems, Databases, Computer Architecture.

Education

Computer Science Division, University of California, Berkeley. *1993-1999*
Ph.D., December 1999. *Performance Availability for Networks of Workstations*
M.S., May 1996. *Communication Behavior of a Distributed Operating System*
Advisor: David A. Patterson

Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor *1989-1993*
B.S. in Computer Engineering, *Summa cum laude*

Academic Experience

Assistant Professor, University of Wisconsin, Madison *January 2000 to present*
Research Intern and Consultant, Sun Microsystems Research Lab *1995 to 1996*

Memberships

IEEE, ACM, USENIX, Tau Beta Pi, Eta Kappa Nu.

Honors and Awards

IBM Faculty Partner Award *2002*
Runner-up: SACM Student's Choice Professor of the Year *2002*
Runner-up: SACM Student's Choice Professor of the Year *2001*
Winner: SACM Student's Choice Professor of the Year *2000*
MinuteSort World Record *1997, 1998*
Datamation World Record *1997, 1998, 2001*

Professional Activities

High Performance Distributed Computing (HPDC) *'03 (Member of PC)*
USENIX File and Storage Technologies (FAST) *'02 (Member of PC)*
Next Generation Information Technologies and Systems (NGITS) *'02 (Member of PC)*
Very Large Databases (VLDB) *'01 (Member of PC)*

Selected Publications

[1] Muthian Sivathanu, Vijayan Prabhakaran, Florentina Popovici, Timothy E. Denehy, Andrea C. Arpaci-Dusseau, and Remzi H. Arpaci-Dusseau. Semantically-Smart Disk Systems. In *Proceedings of the Second USENIX Symposium on File and Storage Technologies (FAST '03)*, San Francisco, CA, March 2003.

[2] Remzi H. Arpaci-Dusseau. Run-Time Adaptation in River. *ACM Transactions on Computer Systems (TOCS)*, 21(1):36–86, February 2003.

[3] Muthian Sivathanu, Andrea C. Arpaci-Dusseau, and Remzi H. Arpaci-Dusseau. Evolving RPC for Active Storage. In *Architectural Support for Programming Languages and Operating Systems (ASPLOS X)*, pages 264–276, San Jose, CA, October 2002.

[4] John Bent, Venkateshwaran Venkataramani, Nick Leroy, Alain Roy, Joseph Stanley, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau, and Miron Livny. Flexibility, Manageability, and Performance in a Grid Storage Appliance. In *Proceedings of High-Performance Distributed Computing (HPDC-11)*, pages 3–12, Edinburgh, Scotland, July 2002.

[5] Timothy E. Denehy, Andrea C. Arpaci-Dusseau, and Remzi H. Arpaci-Dusseau. Bridging the Information Gap in Storage Protocol Stacks. In *Proceedings of the USENIX Annual Technical Conference (USENIX '02)*, pages 177–190, Monterey, CA, June 2002.

[6] Nathan C. Burnett, John Bent, Andrea C. Arpaci-Dusseau, and Remzi H. Arpaci-Dusseau. Exploiting Gray-Box Knowledge of Buffer-Cache Contents. In *Proceedings of the USENIX Annual Technical Conference (USENIX '02)*, pages 29–44, Monterey, CA, June 2002.

[7] Brian Forney, Andrea C. Arpaci-Dusseau, and Remzi H. Arpaci-Dusseau. Storage-Aware Caching: Revisiting Caching For Heterogeneous Storage Systems. In *Proceedings of the First USENIX Symposium on File and Storage Technologies (FAST '02)*, pages 61–74, Monterey, CA, January 2002.

[8] Andrea C. Arpaci-Dusseau and Remzi H. Arpaci-Dusseau. Information and Control in Gray-Box Systems. In *Proceedings of the 18th ACM Symposium on Operating Systems Principles (SOSP '01)*, pages 43–56, Banff, Canada, October 2001.

[9] Doug Thain, John Bent, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau, and Miron Livny. Gathering at the Well: Creating Communities for Grid I/O. In *SC 2001*, pages 1–10, Denver, Colorado, November 2001.

[10] Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau, David E. Culler, Joseph M. Hellerstein, and Dave Patterson. High-Performance Sorting on Networks of Workstations. In *Proceedings of the 1997 ACM SIGMOD Conference on the Management of Data (SIGMOD '97)*, Tucson, Arizona, May 1997.

[11] Andrea C. Dusseau, Remzi H. Arpaci, and David E. Culler. Effective Distributed Scheduling of Parallel Workloads. In *The 1996 ACM SIGMETRICS International Conference on Measurement and Modeling of Computer Systems*, pages 25–36, Philadelphia, Pennsylvania, May 1996.

[12] Remzi H. Arpaci, David E. Culler, Arvind Krishnamurthy, Steve Steinberg, and Kathy Yelick. Empirical Evaluation of the CRAY-T3D: A Compiler Perspective. In *The 22nd Annual International Symposium on Computer Architecture (ISCA-22)*, pages 320–331, Santa Margherita Ligure, Italy, June 1995.

[13] Remzi H. Arpaci, Andrea C. Dusseau, Amin Vahdat, Lok T. Liu, Tom Anderson, and Dave Patterson. The Interaction of Parallel and Sequential Workloads on a Network of Workstations. In *The 1995 ACM SIGMETRICS International Conference on Measurement and Modeling of Computer Systems*, pages 267–278, Ottawa, Canada, May 1995.

Paul Barford

Computer Science Department
University of Wisconsin - Madison
1210 West Dayton Street
Madison, WI 53706

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fax: (617) 265-2635
email: pb@cs.wics.edu

Professional Preparation

Ph.D. Computer Science	Boston University, Boston, MA	December,2000
B.S. Electrical Engineering	University of Illinois, Urbana, IL	May,1985

Appointments

Computer Science Department, Univ. of Wisconsin, Madison, WI — January, 2001 - Present
Assistant Professor

Computer Science Department, Boston University, Boston,MA — 1995 - 2000
Research Fellow

DeGeorge Financial, Inc., Cheshire, CT — 1991 - 1995
Director of Planning and Research

Digital Equipment Corporation, Maynard, MA — 1987 - 1991
Senior Engineer

Related Publications

1. Vinod Yegneswaran, Paul Barford and Johannus Ullrich. "Internet Intrusions: Global Characteristics and Prevalence" To appear in *Proceedings of ACM SIGMETRICS*, San Diego, CA, June, 2003.

2. Paul Barford, David Donoho, Georgina Fleisa and Vinod Yegneswaran. "Characteristics of Network Delays in Wide Area File Transfers", *Submitted for Publication*, January, 2003.

3. Paul Barford, Jeff Kline, David Plonka and Amos Ron. "A Signal Analysis of Network Traffic Anomalies", In *Proceedings of ACM SIGCOMM Internet Measurement Workshop '02*, Marseille, France, November, 2002.

4. Jim Gast and Paul Barford. "Resource Deployment based on Autonomous System Clustering", To Appear in *Proceedings of IEEE Globcom '02*, Taipei, Taiwan, Octpber, 2002.

5. Paul Barford and Larry Landweber. "Bench-style Network Research in an Internet Instance Laboratory", To Appear in *Proceedings of SPIE ITCom '02*, August, 2002.

6. Paul Barford and David Plonka. "Characteristics of Network Traffic Flow Anomalies", In *Proceedings of ACM SIGCOMM Internet Measurement Workshop '01*, San Francisco, CA, November, 2001.

7. Paul Barford, Azer Bestavros, John Byers and Mark Crovella. "On the Marginal Utility of Network Topology Measurements", In *Proceedings of ACM SIGCOMM Internet Measurement Workshop '01*, San Francisco, CA, November, 2001.

8. Paul Barford and Mark Crovella. "Critical Path Analysis of TCP Transactions", In *Proceedings of ACM SIGCOMM '00*, pages 127-138, Stockholm, Sweden, August, 2000.

9. Paul Barford and Mark Crovella. "Measuring Web Performance in the Wide Area," in *Performance Evaluation Review*, Vol. 27(2), pp. 37-48, September 1999.

Professional Activities

- **Organizing Committee**, IEEE ICNP 2003.
- **Program Committee**, ACM SIGMETRICS 2003.
- **Program Committee**, IEEE Workshop on Internet Applications 2003.
- **Organizing Committee**, Computer Science and Telecommunications Board of the National Research Council study on "Internet Under Crisis Conditions," 2002.
- **Organizing Committee**, Institute for Pure and Applied Mathematics workshop on "Large Scale Communications Networks: Topology, Routing, Traffic and Control," March, 2002.
- **Program Committee**, IEEE 6th International Computer Performance and Dependability Symposium, Washington DC, June, 2002.
- **Program Committee**, ACM SIGCOMM Internet Measurement Workshop, San Francisco, CA, November, 2001.
- **Program Committee**, Multiresolution Analysis of the Global Internet Workshop, Palo Alto, CA, October, 2000.
- **Program Committee**, Boston University Workshop on Internet Measurement, Instrumentation and Characterization, Boston, MA, August, 1999.
- **Technical Advisory Board**, epciRealm, Inc.

Collaborators

John Byers(Boston University), Mark Crovella(Boston University), Vern Paxson(ACIRI), David Donoho(Stanford University), Walter Willinger(AT&T)

Thesis Advisor

Mark Crovella(Boston University)

Ph.D. Students

Winfred Byrd, Jim Gast, Joel Sommers, Vinod Yegneswaran

Francis Halzen

Professional Preparation
1966 M.Sc., Physics, University of Louvain, Belgium
1969 Ph.D., Physics, University of Louvain, Belgium
1972 Agrégé de l'Enseignement Superieur, University of Louvain, Belgium

Appointments
Hilldale and Gregory Breit Distinguished Professor
Director of the Institute for Elementary Particle Physics Research

Publications
High Energy Neutrino Detection in Deep Polar Ice (with J.G. Learned), *Proceedings of the 5th International Symposium on Very High Energy Cosmic Ray Interactions*, Lodz, Poland (1988).

Observation of Muons Using the Polar Ice Cap as a Cerenkov Detector (with D.M. Lowder, T. Miller, R. Morse, P.B. Price and A. Westphal), Nature **353**, 331 (1991).

Optical Properties of South Pole Ice at Depths Between 0.8 km and 1 km (with P. Askebjer *et al*.), Science **267**, 1147 (1995).

Particle Astrophysics with High Energy Neutrinos (with T.K. Gaisser and T. Stanev), Physics Reports **258**, 173 (1995).

Ultratransparent Antarctic Ice as a Supernova Detector (with J. Jacobsen and E. Zas), Phys. Rev. **D53**, 7359 (1996).

Tau Neutrino Appearance with a 1000 Megaparsec Baseline (with D. Saltzberg), Phys. Rev. Lett. **81**, 4305 (1998).

The AMANDA Neutrino Telescope: Principle of Operation and First Results (with the AMANDA collaboration), Astroparticle Physics **12**, 1 (2000).

Observation of High Energy Neutrinos with AMANDA (with the AMANDA collaboration), Nature **410**, 441 (2001).

10^{20} eV Cosmic-Ray and Particle Physics with Kilometer-Scale Neutrino Telescopes (with J. Alvarez-Muñiz), Phys. Rev. **D63**, 037302 (2001)

Observation of High Energy Atmospheric Neutrinos with AMANDA (with J. Ahrens et al.), Phys. Rev. **D66**, 012005 (2002).

Synergistic Activities

Physics in the Arts: a hands-on laboratory course for non-science majors covering acoustics and musical instruments, optics and color.
Astronomy in the Ice: masters program for high school teachers at University of Wisconsin, River Falls. Course is built upon the science related to the AMANDA project.
Created the Antarctic Center for Education at the University of Wisconsin, Madison, that is the home of education and outreach programs of the AMANDA and IceCube projects.
Consultant for the Exploratorium in San Francisco.
Presented numerous lectures reaching scientists, students and the general public and wrote several articles for popular science magazines in the US and Europe.

List of Collaborators

The IceCube Collaboration
The AMANDA Collaboration
Other Collaboration:

Alvarez-Muñiz, J.	Bartol Research Institute, U. Delaware
Barger, V.	Department of Physics, UW-Madison
Block, M.M.	Department of Physics and Astronomy, Northwestern University, Evanston
Costa, C. G. S.	Service de Physique Théorique,Université Libre de Bruxelles
Eboli, O. J. P.	Instituto de Fisica, Universidade de Sao Paulo
Feng, J.	Department of Physics, UC-Irvine
Fuller, M.	Physics, UC—San Diego
Gregores, E. M.	Instituto de Fisica Teorica, Universidade Estadual Paulista, Sao Paulo
Han, T.	Department of Physics, UW—Madison
Hooper, T.	Department of Physics, UW—Madison
Kao, G.	Department of Physics and Astronomy, U. Oklahoma
Pancheri, G.	INFN National Laboratories, Italy
Salles, C.	Service de Physique Théorique,Université Libre de Bruxelles
Saltzberg, D.	UCLA
Shi, X.	Physics, UC—San Diego
Stanev, T.	Bartol Research Institute, U. Delaware

Biographical Sketch – **Robert Jeraj**

Professional Preparation

University of Ljubljana, Slovenia	Physics	B.Sc.	1994
University of Ljubljana, Slovenia	Physics	Ph.D.	1999
University of Wisconsin - Madison	Medical Physics	Post Doc	2000-2001

Appointments

Associate Scientist	University of Wisconsin-Madison	2002-present
Research Associate	Jozef Stefan Inst., Ljubljana, Slovenia	1999-present
Research Associate	University of Wisconsin - Madison	2001-2002
Junior Researcher	Jozef Stefan Inst., Ljubljana, Slovenia	1994-1999

Publications

1. Jeraj R, Keall P and Siebers J V, The effect of dose calculation accuracy on inverse treatment planning, Phys. Med. Biol. 47 2002, 391-407.
2. Reynaert N, Palmans H, Thierens H, Jeraj R, Parameter dependence of the MCNP electron transport in determining dose distributions. Med Phys. 2002 Oct;29(10):2446-54.
3. Wu C, Jeraj R, Olivera G H, Mackie T R., Re-optimization in adaptive radiotherapy, Phys. Med. Biol. 47 2002, 3181-3195.
4. Jeraj R, Sarvary A and Kron T, Optimal flattening filter shape of a surface brachytherapy applicator, Phys. Med. Biol. 47 2002, 723-735.
5. Jeraj R, Zagar T, Ravnik M, Monte Carlo Simulation of the TRIGA Mark II Benchmark Experiment with Burned Fuel, Nucl. Tech.137(3) 2002, 169-180.
6. Jeraj R, Keall P, The effect of statistical uncertainty on inverse treatment planning based on Monte Carlo dose calculation, Phys. Med. Biol., 45, 2000, 3601-3613.
7. Keall P, Siebers J, Jeraj R, Mohan R, The effect of dose calculation uncertainty on the evaluation od radiotherapy plans, Med. phys. 27 2000, 478-484.
8. Jeraj R, Ravnik M, TRIGA Mark II reactor: U(20) - zirconium hydride fuel rods in water with graphite reflector. In: International Handbook of Evaluated Criticality Safety Benchmarks Experiments, (NEA/NSC/DOC, (95)03). Paris: Nuclear Energy Agency, 1999.
9. Jeraj R, Keall P, Monte Carlo-based inverse treatment planning, Phys. Med. Biol. 44, 1999, 1885-1896.
10. Jeraj R, Keall P, Ostwald P M, Comparisons between MCNP, EGS4 and experiment for clinical electron beams, Phys. Med. Biol. 44, 1999, 705-717.

Synergistic Activities

Preparing the curriculum for the graduate study of Medical Physics at University of Ljubljana, Slovenia
Participating in IAEA technical support activities
Member of the OECD/NEA benhcmark evaluation project group

Collaborators & Other Affiliations

(i) Collaborators

Only ten most important collaborators are listed.

Dalle Hugo M	CDTN/CNEN, Belo Horizonte, Brazil
Zagar Tomaz	Jozef Stefan Inst, Ljubljana, Slovenia
Keall Paul J	Commonwealth University of Virginia
Mackie Thomas R	University of Wisconsin – Madison
Olivera Gustavo	University of Wisconsin - Madison
Ravnik Matjaz	University of Ljubljana, Slovenia
Reynaert Nick	Univeristy of Gent, Belgium
Siebers Jeffrey V	Commonwealth University of Virginia
Wu Chuan	University of Arkansas
Kron Tomas	LRCC, London, ON, Canada

(ii) Graduate & Postdoctoral Advisors

Professor Ales Stanovnik	University of Ljubljana, Slovenia
Professor Thomas R. Mackie	University of Wisconsin - Madison

(iii) Thesis Advisor

I have been thesis advisor to 2 graduate students who have earned a B.Sc. and co-advisor to two PhD students.

Name	Degree	Year	Current Post	Current Institution
Zdravko Kucan	B.Sc.	2000	Software Engr.	Hermes Softlab
Attila Sarvary	B.Sc.	2000	Rad.Safety Engr.	SLO Nuclear Safety Adm.

CURRICULUM VITAE

Albrecht Karle

Department of Physics
University of Wisconsin-Madison
1150 University Avenue
Madison, WI 53706
USA

Phone: (+1) 608 - 262 3945
Fax: (+1) 608 - 262 0800
E-mail: karle@amanda.physics.wisc.edu

Citizenship: German

Education

1994 Doctorate in Physics, University of Munich, Germany
Title of the Ph.D. Thesis:
Development of a new type of Atmospheric Cherenkov Detector and Measurements of High Energy Cosmic Rays between 15 and 1000 TeV.
Ph.D. research at the Max-Planck-Institute for Physics, Munich

1990 Degree of *Diplomphysik* (comparable to a Master of Science in Physics),
University of Munich, Germany

1981-83 *Hochschule für Philosophie S. J.*, (University of Philosphy) Munich, Germany
Baccalaureate in Philosophy, 1983

Research

1999 - present
University of Wisconsin - Madison
Assistant Professor of Physics

1997-99 **University of Wisconsin - Madison, WI, USA**
Assistant Scientist

1995-97 **DESY (Deutsches Elektronen-Synchrotron), Zeuthen, Germany.**
Post-doctoral Research

Departmental Committees:

Admissions committee, Spring 2000 to present
Qualifier committee, 2000 to 2002

National Committees:

South Pole Users Committee: 2000 - present
Advisory committee to Raytheon Polar Science, the NSF contractor for Antarctic Operations.

Publications (10):

Observation of High Energy Atmospheric Neutrinos with Antartic Muon and Neutrino Detector Array, J. Ahrens et al. (AMANDA Collaboration), Physical Review D, 66, 012005 (2002) (astro-ph/0205109)

Limits to the muon flux from WIMP annihilation in the center of the Earth with the AMANDA detector, J. Ahrens et al. (AMANDA Collaboration), Physical Review D, 66, 032006 (2002) (astro-ph/0202370)

Search for Neutrino-Induced Cascades with the AMANDA Detector
J. Ahrens et al., (AMANDA Collaboration), Submitted to Physical Review D, June 2002, (astro-ph/0206487)

Search for Point Sources of High Energy Neutrinos with AMANDA, J. Ahrens, et al., accepted for publication in: The Astrophysical Journal, 28 July 2002

Observation of high-energy neutrinos using Cerenkov detectors embedded deep in Antarctic ice, E. Andres et al., Nature 410, 441-443 (22 March 2001)

Search for Supernova Neutrino-Bursts with the AMANDA Detector, J. Ahrens et al. (AMANDA Collaboration), AstroParticle Physics, March 2001.

Fast analog transmission for an air Cherenkov photomultiplier camera using optical fibers, J. Rose, I. Bond, A. Karle, E. Lorenz, S. Tran, P. Weissbach, Nuclear Instruments and Methods in Physics Research A 442 (2000) 113-116.

The AMANDA Neutrino Telescope: Principle of Operation and First Results, E. Andres et al., AstroParticle Physics 13:1-20, 2000

In situ measurements of optical parameters in Lake Baikal with the help of a neutrino telescope, with V.A. Balkanov et al., Applied Optics 33:6818,1999, e-Print Archive: astro-ph/9903342.

Detection of Gamma Rays above 1 TeV from the Crab Nebula by the Second HEGRA Imaging Atmospheric Cherenkov Telescope at La Palma, A. Konopelko et al. (HEGRA Collab.), Astropart. Phys. 4, 199-215 (1996).

Biographical Sketch – **Don D. Reeder**

Professional Preparation

University of Illinois-Urbana	Physics	B.S.	1958
University of Wisconsin-Madison	Physics	M.S.	1962
University of Wisconsin-Madison	Physics	Ph.D.	1966

Appointments

Professor	University of Wisconsin-Madison	1971-present
Associate Professor	University of Wisconsin-Madison	1968-1971
Assistant Professor	University of Wisconsin-Madison	1966-1968
Lieutenant (jg)	United States Navy	1958-1961

Publications

1. **Measurement of the Proton Structure Function F_2 at Very Low Q^2 at HERA,** J. Breitwig, et al., {ZEUS collaboration}, *Physics Letters* **B 487** 53 (2000)
2. **Measurement of High Q2 Charged-Current e+p Deep Inelastic Scattering Cross Sections at HERA,** J. Breitwig, et al., {ZEUS collaboration}, *European Physical Journal* **C12**, 411 (2000)
3. **W Production and the Search for Events with an Isolated High-Energy Lepton and Missing Transverse Momentum at HERA,** J. Breitwig, et al., {ZEUS collaboration}, *Physics Letters* **B471**, 411 (2000)
4. **ZEUS Results on the Measurement and Phenomenology of F_2 at Low x and Low Q^2,** J. Breitwig, et al., {ZEUS collaboration}, *European Physical Journal* **C7**, 609 (1999)
5. **Rapidity Gaps between Jets in Photoproduction at HERA** , M. Derrick, et al., {ZEUS collaboration}, *Physics Letters* **B369**, 55 (1996)
6. **The ZEUS Calorimeter First Level Trigger ,** S. Silverstein, I Ali, B. Behrens, C. Foudas, C. Fordham, A. Goussiou, M. Jaworski, J. Lackey, D. Reeder, P. Robl, W.H. Smith, A. Vaiciulis, M. Wodarczyk, J. Dawson, D. Krakauer, R. Talaga, J. Schlereth, and H. Zhang *Nuclear Instruments and Methods* **A360,** 322 (1995)
7. **Characteristics of Charm Production by 400 Gev Protons,** M. E. Duffy, G. K. Fanourakis, R. J. Loveless, D. D. Reeder, E.S. Smith, S. Childress, C. Castoldi, G. Conforto, R. C. Ball, C. T. Coffin, H. R. Gustafson, L. W. Jones, M. J. Longo, T. J. Roberts, B. P. Roe, E. Wang, M. B. Crisler, J. S. Hoftun, T. Y. Ling, T. A. Romanowski, and J. T. Volk, *Physical Review Letters* **57**, 1522 (1986).
8. **Verification of Muon-electron Universality in Charm Decay,** M. E. Duffy, G. K. Fanourakis, R. J. Loveless, D. D. Reeder, L. Schumann, E. S. Smith, S. Childress, C. Castoldi, G. Conforto, R. C. Ball, C. T. Coffin, H. R. Gustafson, L. W. Jones, M. J. Longo, J. Roberts, B. P. Roe, E. Wang, M. B. Crisler, J. S. Hoftun, T. Y. Ling, T. A. Romanowski, and J. T. Volk, *Physical Review Letters* **52**, 1865 (1984).
9. **Observation of Muonless Neutrino Induced Inelastic Interactions,** A. Benvenuti, D. Cheng, D. Cline, W.T. Ford, R. Imlay, T.Y. Ling, A.K. Mann, F. Messing, R.L. Piccioni, J. Pilcher, D.D. Reeder, Rubbia, R. Stefanski and L. Sulak, *Physical Review Letters* **32**, 800 (1974).

Synergistic Activities

- I have adapted and developed a one-semester course for undergraduate non-science majors concerning the definition, generation and use of energy in our technical society. This covers all forms and introduces and discusses the nature of energy and the constraints pertaining to its use (e.g. the second law of thermodynamics).
- I have collaborated in the development of algorithms and programs for use in the analysis of data obtained in high energy physics experiments. Some the techniques are of relevance to a larger audience and have been published.

- After service as a member of HEPAP, (the High Energy Physics Advisory Panel established by the DOE), I have served over three years as one of the Representative to HEPAP for University Groups.

Collaborators & Other Affiliations

(i) Collaborators

Since there are over 500 collaborators in each group I have listed the web pages that reference the entire collaboration listing.

The ZEUS Collaboration	http://www-zeus.desy.de/~notzw/dir
The CMS Collaboration	http://cmsdoc.cern.ch/people/PEOPLE1

(ii) Graduate & Postdoctoral Advisors

Professor M. L. Good	Deceased

(iii) Thesis Advisor

I have been thesis advisor to 20 graduate students who have earned a Ph.D. and I am currently advisor to 4 students. Below are those who have earned a Ph.D. within the last five years.

Name	Degree	Year	Current Post	Current Institution
Samuel Silverstein	Ph.D.	1996	Scientist	University of Stockholm
Bruce Behrens	Ph.D.	1995	Res. Analyst	Ctr. for Naval Analyses

Postgraduate-Scholar Sponsor

I have been postdoctoral sponsor for ~20 people. Below are those within the last five years.

Name	Position	Years	Current Post	Current Institution
Dorian Kcira	Post Doc	2000-pres.		
Alexandre Savin	Post Doc	2000-pres.		
Sergei Lusin	Post Doc	1992-pres.	Scientist	University of Wisconsin
Costas Foudas	Post Doc	1989-2000	Asst. Professor	Imperial College-London
Torsten Wildschek	Post Doc	1998-2000	Scientist	Lucent Technologies
William Badgett	Post Doc	1994-1999	Scientist	Fermilab

Biographical Sketch – **Wesley H. Smith**

Professional Preparation

Harvard University	Physics	A.B/A.M.	1976
University of California-Berkeley	Physics	Ph.D.	1981
Columbia University	High Energy Physics	Post Doc	1981-1982

Appointments

Professor	University of Wisconsin-Madison	1992-present
Associate Professor	University of Wisconsin-Madison	1988-1992
Associate Professor	Columbia University	1987-1988
Assistant Professor	Columbia University	1982-1987

Publications

1. Study of Charged-Current ep Interactions at $Q^2 > 200$ GeV^2 with the ZEUS Detector at HERA, M. Derrick *et al.*, Z. Phys. **C72** 47, 1996.
2. A High Statistics Search for $\nu_\mu \rightarrow \nu_e$ Oscillations in the Small Mixing Angle Regime, A. Romosan *et al.*, Phys. Rev. Lett. **78** 2912, 1997.
3. A Precision Measurement of Electroweak Parameters in Neutrino-Nucleon Scattering, K.S. McFarland *et al.*, Eur. Phys. J. **C1** 509,1998.
4. Observation of Isolated High E_T Photons in Photoproduction at HERA, J. Breitweg *et al.*, Phys. Lett. **B407** 201, 1997.
5. A measurement of $\alpha_s(Q^2)$ from the Gross-Llewellyn Smith sum rule, J. H. Kim *et al.*, Phys. Rev. Lett. **81** 3595, 1998.
6. Measurement of high-Q^2 neutral-current e^+p deep inelastic scattering cross-sections at HERA, J. Breitweg *et al.*, Eur. Phys. J. **C11** 251, 1999.
7. Measurement of dijet photoproduction at high transverse energies at HERA, J. Breitweg *et al.*, Eur. Phys. J. **C11** 35, 1999.
8. Measurement of inclusive prompt photon photoproduction at HERA, J. Breitweg *et al.*, Physics Letters **B472** 175, 2000.
9. The Q^2 Dependence of Dijet Cross Sections in γp Interactions at HERA, J. Breitweg *et al.*, Phys. Lett. **B479** 37, 2000.
10. Nuclear structure functions in the large x large Q^2 kinematic region in neutrino deep inelastic scattering, M. Vakili et al., Phys. Rev **D61**, 052003, 2000.

Synergistic Activities

- Development of Undergraduate Seminar/Colloquium Research Course at UW -Madison.
- Construction/operation of Zeus Experiment Trigger system with 10 MHz interaction frequency.
- Design of CMS Trigger System with 40 MHz interaction frequency.
- Direct summer University of Wisconsin graduate student internship program at DESY.
- Development of High Speed data processing Integrated Circuits with Vitesse Corporation.

Collaborators & Other Affiliations

(i) Collaborators

Since there are over 500 collaborators in each group I have listed the web pages that reference the entire collaboration listing.

The ZEUS Collaboration	http://www-zeus.desy.de/~notzw/dir
The CMS Collaboration	http://cmsdoc.cern.ch/people/PEOPLE1

(ii) Graduate & Postdoctoral Advisors

Professor Roy Kerth	University of California - Berkeley
Professor Frank Sciulli	Columbia University

(iii) Thesis Advisor

I have been thesis advisor to 8 graduate students who have earned a Ph.D. and I am currently advisor to 4 students. Below are those who have earned a Ph.D. within the last five years.

Name	Degree	Year	Current Post	Current Institution
Sean Mattingly	Ph.D.	1999	Post Doc	Brown University
Michael Wodarczyk	Ph.D.	1999	Yield Engineer	Intel Corporation
Anthony Vaiciulis	Ph.D.	1999	Post Doc	University of Rochester
Timothy Kinnel	Ph.D.	1998	Information Mgr	Pragmatic Vision Int'l
Haibo Zhang	Ph.D.	1998	Engineer	Caterpillar Corporation
Anna Gousiou	Ph.D.	1995	Lecturer	Imperial College

Postgraduate-Scholar Sponsor

I have been postdoctoral sponsor for 7 people. Below are those within the last five years.

Name	Position	Years	Current Post	Current Institution
Dorian Kcira	Post Doc	2000-pres.		
Alexandre Savin	Post Doc	2000-pres.		
Costas Foudas	Post Doc	1989-2000	Asst. Professor	Imperial College-London
Sridhara Dasu	Post Doc	1992-2000	Asst. Professor	University of Wisconsin
Torsten Wildschek	Post Doc	1998-2000	Scientist	Lucent Technologies
William Badgett	Post Doc	1994-1999	Scientist	Fermilab

SUMMARY PROPOSAL BUDGET YEAR 1

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION: **University of Wisconsin-Madison**

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR: **Miron Livny**

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Miron Livny - Professor**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Sridhara R Dasu - Assistant Professor**	**0.00**	**0.00**	**0.00**	**0**	
3. **Juan J De Pablo - Professor**	**0.00**	**0.00**	**0.00**	**0**	
4. **Paul M DeLuca, Jr. - Professor**	**0.00**	**0.00**	**0.00**	**0**	
5. **David C Schwartz - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. (**0**) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**0.00**	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**52,709**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**52,709**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**17,394**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**70,103**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **Details in proposal** $ **1,298,000**					
TOTAL EQUIPMENT				**1,298,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,368,103**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE) **MTDC (Rate: 45.5000, Base: 70104)**					
TOTAL INDIRECT COSTS (F&A)				**31,897**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**1,400,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **1,400,000**	$

M. COST SHARING PROPOSED LEVEL $ **600,000** AGREED LEVEL IF DIFFERENT $

PI/PD NAME: **Miron Livny**

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

 ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

SUMMARY PROPOSAL BUDGET

Cumulative

FOR NSF USE ONLY		
PROPOSAL NO.	DURATION (months) Proposed	Granted
AWARD NO.		

ORGANIZATION
University of Wisconsin-Madison

PRINCIPAL INVESTIGATOR / PROJECT DIRECTOR
Miron Livny

A. SENIOR PERSONNEL: PI/PD, Co-PI's, Faculty and Other Senior Associates (List each separately with title, A.7. show number in brackets)	NSF Funded Person-mos. CAL	ACAD	SUMR	Funds Requested By proposer	Funds granted by NSF (if different)
1. **Miron Livny - Professor**	**0.00**	**0.00**	**0.00**	$ **0**	$
2. **Sridhara R Dasu - Assistant Professor**	**0.00**	**0.00**	**0.00**	**0**	
3. **Juan J De Pablo - Professor**	**0.00**	**0.00**	**0.00**	**0**	
4. **Paul M DeLuca, Jr. - Professor**	**0.00**	**0.00**	**0.00**	**0**	
5. **David C Schwartz - Professor**	**0.00**	**0.00**	**0.00**	**0**	
6. ( ) OTHERS (LIST INDIVIDUALLY ON BUDGET JUSTIFICATION PAGE)	**0.00**	**0.00**	**0.00**	**0**	
7. (**5**) TOTAL SENIOR PERSONNEL (1 - 6)	**0.00**	**0.00**	**0.00**	**0**	
B. OTHER PERSONNEL (SHOW NUMBERS IN BRACKETS)					
1. (**0**) POST DOCTORAL ASSOCIATES	**0.00**	**0.00**	**0.00**	**0**	
2. (**1**) OTHER PROFESSIONALS (TECHNICIAN, PROGRAMMER, ETC.)	**12.00**	**0.00**	**0.00**	**52,709**	
3. (**0**) GRADUATE STUDENTS				**0**	
4. (**0**) UNDERGRADUATE STUDENTS				**0**	
5. (**0**) SECRETARIAL - CLERICAL (IF CHARGED DIRECTLY)				**0**	
6. (**0**) OTHER				**0**	
TOTAL SALARIES AND WAGES (A + B)				**52,709**	
C. FRINGE BENEFITS (IF CHARGED AS DIRECT COSTS)				**17,394**	
TOTAL SALARIES, WAGES AND FRINGE BENEFITS (A + B + C)				**70,103**	
D. EQUIPMENT (LIST ITEM AND DOLLAR AMOUNT FOR EACH ITEM EXCEEDING $5,000.) **$ 1,298,000**					
TOTAL EQUIPMENT				**1,298,000**	
E. TRAVEL 1. DOMESTIC (INCL. CANADA, MEXICO AND U.S. POSSESSIONS)				**0**	
2. FOREIGN				**0**	
F. PARTICIPANT SUPPORT COSTS					
1. STIPENDS $ **0**					
2. TRAVEL **0**					
3. SUBSISTENCE **0**					
4. OTHER **0**					
TOTAL NUMBER OF PARTICIPANTS (**0**) TOTAL PARTICIPANT COSTS				**0**	
G. OTHER DIRECT COSTS					
1. MATERIALS AND SUPPLIES				**0**	
2. PUBLICATION COSTS/DOCUMENTATION/DISSEMINATION				**0**	
3. CONSULTANT SERVICES				**0**	
4. COMPUTER SERVICES				**0**	
5. SUBAWARDS				**0**	
6. OTHER				**0**	
TOTAL OTHER DIRECT COSTS				**0**	
H. TOTAL DIRECT COSTS (A THROUGH G)				**1,368,103**	
I. INDIRECT COSTS (F&A)(SPECIFY RATE AND BASE)					
TOTAL INDIRECT COSTS (F&A)				**31,897**	
J. TOTAL DIRECT AND INDIRECT COSTS (H + I)				**1,400,000**	
K. RESIDUAL FUNDS (IF FOR FURTHER SUPPORT OF CURRENT PROJECTS SEE GPG II.C.6.j.)				**0**	
L. AMOUNT OF THIS REQUEST (J) OR (J MINUS K)				$ **1,400,000**	$

M. COST SHARING PROPOSED LEVEL $ **600,000** AGREED LEVEL IF DIFFERENT $

PI/PD NAME
Miron Livny

ORG. REP. NAME*

FOR NSF USE ONLY		
INDIRECT COST RATE VERIFICATION		
Date Checked	Date Of Rate Sheet	Initials - ORG

C ***ELECTRONIC SIGNATURES REQUIRED FOR REVISED BUDGET**

Budget

We estimate the cost of building and maintaining GLOW to be ~$2.0M. We are requesting the NSF to provide $1.4 M and the UW Graduate School will match this request with $0.6 M. For the proposed laboratory to meet its goals it must offer significant amounts of state of the art hardware and have a professional support staff. A full time Systems Programmer, based at the Department of Computer Sciences site, will be hired to manage GLOW. In addition, each of the five domain sites will be allocated .5 FTE project assistant for local system administration and software support. An additional .33 FTE will be placed at the Computer Sciences site to provide support for Condor. We expect 2/3 of the hardware to be placed in the domain-specific sites and 1/3 at the Computer Sciences site. The hardware will be composed of 15 CPU/Storage Server Racks containing 80 2.4 GHz CPUs, 3.5 TB of disk each at a cost of $118K apiece as follows. This list may be modified depending on market conditions and available hardware at the time of purchase. Storage at each of the domain-specific sites will be optimized for their applications.

Each CPU/Storage Server Rack Contains:	118,000
1 - Rack with power and cooling @ $2,500 each	2,500
1 - HP Procurve 8000M Switch w/10 slot chassis @ $1,400 each	1,400
1 - HP Procurve Switch GB Uplink Module @ $1,300 each	1,300
6 - HP Procurve Switch 100 MB 8 port modules @ $400 each	2,400
40 - CPU Servers: Dual CPU, 2.4GHz, 512MB, 80GB @ $2,500 each	100,000
8 - Adaptec 2400A IDE RAID controllers @ $300 each	2,400
32 - Maxtor 5400 DiamondMax D540X 160 GB Disks @ $250 each	8,000

NSF MRI
Solicitation No. NSF 01-171
Acquisition of the GLOW Distribututed Computing System
at the University of Wisconsin - Madison

	NSF Request	UW Cost Sharing
1) SALARIES & WAGES	**$52,709**	**$89,179**
Systems Programmer - 100% @ $63,600		
12.00 Person Months - 83% NSF & 17% UW	52,709	10,890
Project Assistants - 1 each @ 50% for 12 months		
Genomics, IceCube, High Energy Physics,		
Materials Science, Radiation Therapy, Computer Science (33%)		
67.80 Person Months		78,289
2) FRINGE BENEFITS	**$17,394**	**$19,252**
Academic Staff		
33.00% on Salaries & Wages	17,394	3,594
Project Assistant		
20.00% on Salaries & Wages	0	15,658
3) TUITION REMISSION	**$0**	**$19,572**
25.00% on Salaries and Wages	0	19,572
4) EQUIPMENT	**$1,298,000**	**$472,000**
11.00 CPU/Storage Server Racks @ $ 118,000 each	1,298,000	
4.00 CPU/Storage Server Racks @ $ 118,000 each		472,000
Each CPU/Storage Server Rack Contains:	118,000	
1 - Rack with power and cooling @ $2,500 each	2,500	
1 - HP Procurve 8000M Switch w/10 slot chasis @ $1,400 each	1,400	
1 - HP Procurve Switch GB Uplink Module @ $1,300 each	1,300	
6 - HP Procurve Switch 100 MB 8 port modules @ $400 each	2,400	
40 - CPU Servers: Dual CPU, 2.4GHz, 512MB, 80GB @ $2,500 each	100,000	
8 - Adaptec 2400A IDE RAID controllers @ $300 each	2,400	
32 - Maxtor 5400 DiamondMax D540X 160 GB Disks @ $250 each	8,000	
5) INDIRECT COSTS	**$31,897**	**$0**
Overhead @ 45.5% MTDC On-Campus	31,897	
on a base of ( )	(70,103)	
excluding equipment & tuition remission		
TOTAL REQUEST	**$1,400,000**	**$600,000**

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Miron Livny**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Throughput Computing via Condor Flocks**

Source of Support: **NSF (via University of Illinois-NCSA)**
Total Award Amount: $ **1,170,000** Total Award Period Covered: **10/01/97 - 09/30/03**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.20** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **UW Flock: The Wisconsin Advanced Resource Center**

Source of Support: **NSF (via University of Illinois-NCSA)**
Total Award Amount: $ **993,500** Total Award Period Covered: **10/01/97 - 09/30/03**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.20** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Particle Physics Data Grid Collaboratory Pilot**

Source of Support: **DOE**
Total Award Amount: $ **1,604,495** Total Award Period Covered: **08/01/01 - 07/31/04**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**3.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **NETwork-computer for Computer Architecture Research and Education (NETCARE)**

Source of Support: **NSF (via University of Florida)**
Total Award Amount: $ **197,367** Total Award Period Covered: **07/01/02 - 08/31/03**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.50**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Biological Magnetic Resonance Data Bank**

Source of Support: **NIH**
Total Award Amount: $ **3,989,796** Total Award Period Covered: **09/01/99 - 08/31/04**
Location of Project: **Department of Biochemistry, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **1.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Miron Livny**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **ITR/ACS: The GriPhyN Project: Towards Petascale Virtual-Data Grids**

Source of Support: **NSF (via University of Florida)**
Total Award Amount: $ **1,995,546** Total Award Period Covered: **09/01/00 - 08/31/05**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Information Power Grid Partnership Between NASA and the National Computing Alliance (Alliance)**

Source of Support: **NSF (via University of Illinois-NCSA)**
Total Award Amount: $ **295,000** Total Award Period Covered: **10/01/00 - 09/30/03**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.10** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Acquisition of the GLOW Distributed Computing System at the University of Wisconsin-Madison (This proposal)**

Source of Support: **NSF**
Total Award Amount: $ **1,400,000** Total Award Period Covered: **09/01/03 - 08/31/04**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.10** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Center for Eukaryotic Structural Genomics**

Source of Support: **NIH**
Total Award Amount: $ **17,156,505** Total Award Period Covered: **09/28/01 - 08/31/06**
Location of Project: **Department of Biochemistry, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**1.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **GSI-2: The Basis for a Secure, Policy-Driven Collaboratory Software Environment**

Source of Support: **DOE**
Total Award Amount: $ **240,000** Total Award Period Covered: **08/15/01 - 08/14/04**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.20** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Miron Livny**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **A High-Performance Data Grid Toolkit: Enabling Technology for Wide Area Data-Intensive Applications**

Source of Support: **DOE**
Total Award Amount: $ **600,000** Total Award Period Covered: **08/01/01 - 07/31/06**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.20** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Pervasive Collaboratory Computing Environment**

Source of Support: **DOE**
Total Award Amount: $ **240,000** Total Award Period Covered: **07/15/01 - 07/14/04**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.20** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Integrated Collaboratory Testbed for Biomolecular NMR**

Source of Support: **NIH**
Total Award Amount: $ **1,896,388** Total Award Period Covered: **09/01/98 - 02/28/03**
Location of Project: **Department of Biochemistry, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.50** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **ITR/IM: Building the Framework of the National Virtual Observatory**

Source of Support: **NSF (via John Hopkins University)**
Total Award Amount: $ **103,556** Total Award Period Covered: **10/01/01 - 09/30/04**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.10** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **ITR/AP: An International Virtual-Data Grid Laboratory for Data Intensive Science**

Source of Support: **NSF (via University of Florida)**
Total Award Amount: $ **973,000** Total Award Period Covered: **09/01/01 - 08/31/06**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.20** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Miron Livny**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Deploying and Supporting a National Middleware Infrastructure: Toward a National GRIDS Center**

Source of Support: **NSF (via University of Illinois-NCSA)**
Total Award Amount: $ **1,275,000** Total Award Period Covered: **09/01/01 - 08/31/04**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad:**0.20** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Gridlab - Grid Application Toolkit and Testbed**

Source of Support: **European Commission (via Pozan Supercomp. & Ntwrking. Ctr)**
Total Award Amount: $ **100,000** Total Award Period Covered: **03/31/02 - 12/31/04**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.10** Acad:**0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **ITR: A Portal to the Distributed Computer Grid for the CMS Experiment at LHC**

Source of Support: **NSF**
Total Award Amount: $ **162,000** Total Award Period Covered: **09/01/02 - 08/31/04**
Location of Project: **Department of Physics, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad:**0.00** Sumr: **0.10**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **A National Logistical Networking Testbed**

Source of Support: **NSF (via University of Tennessee)**
Total Award Amount: $ **112,500** Total Award Period Covered: **08/01/02 - 07/31/05**
Location of Project: **Computer Science Department, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad:**0.10** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **NRG: Neurobiology Research Grid**

Source of Support: **NIH**
Total Award Amount: $ **2,711,688** Total Award Period Covered: **04/01/03 - 03/31/07**
Location of Project: **Department of Anatomy, University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad:**0.10** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Miron Livny**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Alliance Grid Testbed**

Source of Support: **NSF (via University of Illinois-NCSA)**

Total Award Amount: $ **360,000** Total Award Period Covered: **10/01/02 - 09/30/03**

Location of Project: **Computer Science Department, University of Wisconsin-Madison**

Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

 USE ADDITIONAL SHEETS AS NECESSARY

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Sridhara Dasu**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Phyiscs Research: SLD & BABAR**

Source of Support: **DOE**

Total Award Amount: $ **3,229,516** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison, SLAC, Stanford, CA**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: CMS @ LHC**

Source of Support: **DOE**

Total Award Amount: $ **5,981,360** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison, CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: CMS @ LHC Supplement**

Source of Support: **DOE**

Total Award Amount: $ **276,159** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison, CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **ITR: A portal to the distributed computer grid for the CMS experiment**

Source of Support: **NSF**

Total Award Amount: $ **100,000** Total Award Period Covered: **09/01/02 - 08/31/04**

Location of Project: **UW Madison, CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**1.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **ITR: A portal to the distrubted computer grid for the CMS experiment**

Source of Support: **NSF**

Total Award Amount: $ **62,000** Total Award Period Covered: **09/01/02 - 08/31/04**

Location of Project: **UW Madison, CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**1.00** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Sridhara Dasu**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Software & Computing Subsystem**

Source of Support: **Fermi National Accelerator Laboratory**
Total Award Amount: $ **13,207** Total Award Period Covered: **08/21/02 - 09/30/04**
Location of Project: **UW Madison, CERN, Geneva, Switzerland**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Software & Computing Subsystem**

Source of Support: **Fermi National Accelerator Laboratory**
Total Award Amount: $ **26,416** Total Award Period Covered: **08/21/02 - 09/30/04**
Location of Project: **UW Madison, CERN, Geneva, Switzerland**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Large scale distributed computing for high energy physics**

Source of Support: **Wisconsin Alumni Research Foundation**
Total Award Amount: $ **19,374** Total Award Period Covered: **07/01/02 - 06/30/03**
Location of Project: **UW Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Probing the Origins of Mass and Matter/Anti-Matter asymmetry**

Source of Support: **Wisconsin Alumni Research Foundation**
Total Award Amount: $ **23,923** Total Award Period Covered: **07/01/03 - 06/30/04**
Location of Project: **UW Madison, SLAC, Stanford, CA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Reserach: SLD and BaBar Supplemental Request**

Source of Support: **DOE**
Total Award Amount: $ **45,000** Total Award Period Covered: **11/01/02 - 10/31/03**
Location of Project: **UW Madison, SLAC, Stanford, CA**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Juan De Pablo**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Nanostructured Materials and Interfaces**

Source of Support: **NSF/MRSEC**
Total Award Amount: $ **11,700,000** Total Award Period Covered: **07/01/00 - 06/30/05**
Location of Project: **UW-MSN, Chemical Engineering, Madison, WI 53706**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Nanoscale Modeling of Flow of Macromolecules Through Microfluidic Devices**

Source of Support: **NSF**
Total Award Amount: $ **916,397** Total Award Period Covered: **09/01/00 - 08/31/03**
Location of Project: **UW-MSN, Chemical Engineering, Madison, WI 53706**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Studies Of Preservation Of Platelet And Embryonic Stem Cells**

Source of Support: **DARPA**
Total Award Amount: $ **425,334** Total Award Period Covered: **09/30/02 - 06/29/03**
Location of Project: **UW-MSN, Chemical Engineering, Madison, WI 53706**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Fundamental Molecular Studies of Preservation of Biological Systems**

Source of Support: **NSF**
Total Award Amount: $ **191,679** Total Award Period Covered: **09/15/02 - 08/31/04**
Location of Project: **UW-MSN, Chemical Engineering, Madison, WI 53706**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Molecular Modeling Of The Thermophysical Properties Of Macromolecular Systems In Nanoscopic Structures**

Source of Support: **DOE**
Total Award Amount: $ **365,580** Total Award Period Covered: **09/15/99 - 10/31/05**
Location of Project: **UW-MSN, Chemical Engineering, Madison, WI 53706**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Juan De Pablo**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Molecular Simulation And Solution Thermodynamics Of Vegetable Oil Mixtures**

Source of Support: **Cargill**

Total Award Amount: $ **190,420** Total Award Period Covered: **03/15/01 - 03/14/05**

Location of Project: **UW-MSN Center for NanoTechnology, Stoughton, WI 53589**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Wisconsin Program in Advanced Lithography & Metrology**

Source of Support: **Semiconductor Research Corp.**

Total Award Amount: $ **1,500,000** Total Award Period Covered: **01/01/02 - 12/31/04**

Location of Project: **UW-MSN Center for NanoTechnology, Stoughton, WI 53589**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Paul DeLuca, Jr.**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **UW Radiological Sciences Training Program**

Source of Support: **NIH/NCI, 5 T32 CA09206-24**

Total Award Amount: $ **567,011** Total Award Period Covered: **08/01/78 - 03/31/04**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Improving Cancer Outcome with Adaptive Helical Tomotherapy**

Source of Support: **NIH/NCI, 5 P01 CA88960-02**

Total Award Amount: $ **1,221,922** Total Award Period Covered: **09/07/01 - 08/31/06**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **UW Comprehensive Cancer Center Support for Senior Investigators**

Source of Support: **NIH/NCI, 5 P30 CA 14520-30**

Total Award Amount: $ **1,852,122** Total Award Period Covered: **01/01/76 - 03/31/06**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Wisconsin Interdisciplinary Molecular Imaging Center**

Source of Support: **NIH/NCI, 5 P20 CA86278-02**

Total Award Amount: $ **264,289** Total Award Period Covered: **06/06/01 - 05/31/04**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **David Schwartz**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Microbial Sequence-ready Maps by Optical Mapping**

Source of Support: **DOE**

Total Award Amount: $ **1,500,000** Total Award Period Covered: **09/01/01 - 08/31/04**

Location of Project: **University of Wisconsin-Madison, 425 Henry Mall, Madison, WI**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.80**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Development of Advanced Systems for Optical Mapping**

Source of Support: **DOE**

Total Award Amount: $ **1,350,000** Total Award Period Covered: **09/01/99 - 02/28/03**

Location of Project: **University of Wisconsin-Madison, 425 Henry Mall, Madison, WI**

Person-Months Per Year Committed to the Project. Cal:**0.96** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Genome Wide Restriction Map of Rice by Optical Mapping**

Source of Support: **NSF**

Total Award Amount: $ **1,529,544** Total Award Period Covered: **09/01/99 - 08/31/03**

Location of Project: **University of Wisconsin-Madison, 425 Henry Mall, Madison, WI**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **1.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Kellett Mid-Career Award**

Source of Support: **Wisconsin Alumni Research Foundation**

Total Award Amount: $ **60,000** Total Award Period Covered: **07/01/02 - 06/30/07**

Location of Project: **University of Wisconsin-Madison, 425 Henry Mall, Madison, WI**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Institutional Training Grant in Genomic Sciences**

Source of Support: **NIH**

Total Award Amount: $ **6,198,363** Total Award Period Covered: **07/01/03 - 06/30/08**

Location of Project: **University of Wisconsin-Madison, 425 Henry Mall, Madison, WI**

Person-Months Per Year Committed to the Project. Cal:**0.60** Acad: **0.00** Summ: **0.00**

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Other agencies (including NSF) to which this proposal has been/will be submitted.

Investigator: **Remzi Arpaci-Dusseau**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Career: Robust Data-Intensive Cluster Programming**

Source of Support: **NSF (Career CCR-0092840)**

Total Award Amount: $ **250,000** Total Award Period Covered: **09/01/01 - 08/31/06**

Location of Project: **Univerisity of Wisconsin - Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Robust, Adaptive Network-Attached Storage Program**

Source of Support: **NSF (OS CCR-0098274)**

Total Award Amount: $ **310,000** Total Award Period Covered: **09/01/01 - 08/31/04**

Location of Project: **University of Wisconsin - Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **ITR/ACS: The GriPhyN Project: Towards Petascale Virtual-Data Grids**

Source of Support: **NSF (via University of Florida)**

Total Award Amount: $ **1,995,546** Total Award Period Covered: **09/01/00 - 08/31/05**

Location of Project: **University of Wisconsin-Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Acquisition of the GLOW Distributed Computing System at the University of Wisconsin-Madison (This proposal)**

Source of Support: **NSF**

Total Award Amount: $ **1,400,000** Total Award Period Covered: **09/01/03 - 08/31/04**

Location of Project: **University of Wisconsin-Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Paul Barford**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Acquisition of the GLOW Distributed Computing System at the University of Wisconsin-Madison (This proposal)**

Source of Support: **NSF**
Total Award Amount: $ **1,400,000** Total Award Period Covered: **09/01/03 - 08/31/04**
Location of Project: **University of Wisconsin-Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Partical Physics Data Grid Collaboratory Pilot**

Source of Support: **Department of Energy**
Total Award Amount: $ **1,054,027** Total Award Period Covered: **08/01/01 - 07/31/04**
Location of Project: **University of Wisconsin**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **3.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **iSWORD: Instrumented Streaming Research and Testbed**

Source of Support: **National Science Foundation**
Total Award Amount: $ **1,072,808** Total Award Period Covered: **09/01/01 - 08/31/04**
Location of Project: **University of Wisconsin**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **2.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Coordinated Anomaly Detection and Characterization in Wide Area Network Flows**

Source of Support: **Army Research Office**
Total Award Amount: $ **320,000** Total Award Period Covered: **07/15/02 - 07/14/05**
Location of Project: **University of Wisconsin**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **3.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Collaborative Research: Critical Path Based Measurement and Tuning of Wide Area Applications**

Source of Support: **National Science Foundation**
Total Award Amount: $ **375,000** Total Award Period Covered: **01/01/03 - 12/31/05**
Location of Project: **Boston University**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **1.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Paul Barford**

Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **The Wisconsin Advanced Internet Laboratory**

Source of Support: **Cisco Systems, Inc**
Total Award Amount: $ **3,500,000** Total Award Period Covered: **06/01/02 - 05/31/03**
Location of Project: **University of Wisconsin**
Person-Months Per Year Committed to the Project. Cal: **0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Francis Halzen**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **AMANDA 2000**

Source of Support: **NSF**
Total Award Amount: $ **3,200,000** Total Award Period Covered: **09/01/00 - 08/31/04**
Location of Project: **UW Madison, South Pole**
Person-Months Per Year Committed to the Project. Cal:**0.60** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Ice Cube Startup Project**

Source of Support: **NSF**
Total Award Amount: $ **10,000,000** Total Award Period Covered: **08/01/02 - 07/31/03**
Location of Project: **UW Madison, South Pole**
Person-Months Per Year Committed to the Project. Cal:**9.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Institute for Elementary Particle Physics Reseach**

Source of Support: **DOE**
Total Award Amount: $ **685,000** Total Award Period Covered: **11/01/02 - 10/31/03**
Location of Project: **UW Madison**
Person-Months Per Year Committed to the Project. Cal:**1.20** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Ice Cube**

Source of Support: **NSF**
Total Award Amount: $**156,400,000** Total Award Period Covered: **08/01/03 - 07/31/13**
Location of Project: **UW Madison, South Pole**
Person-Months Per Year Committed to the Project. Cal:**9.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Toward a Kilometer-Scale Neutrino Observatory: Education and Outreach**

Source of Support: **NSF**
Total Award Amount: $ **2,487,398** Total Award Period Covered: **08/01/03 - 07/31/13**
Location of Project: **UW Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Albrecht Karle**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **AMANDA 2000**

Source of Support: **NSF**
Total Award Amount: $ **3,200,000** Total Award Period Covered: **09/01/00 - 08/31/04**
Location of Project: **UW Madison, South Pole**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Ice Cube Start Up**

Source of Support: **NSF**
Total Award Amount: $ **10,000,000** Total Award Period Covered: **08/01/02 - 07/31/03**
Location of Project: **UW Madison, South Pole**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title: **Ice Cube**

Source of Support: **NSF**
Total Award Amount: $**156,400,000** Total Award Period Covered: **08/01/03 - 07/31/13**
Location of Project: **UW Madison, South Pole**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support
Project/Proposal Title:

Source of Support:
Total Award Amount: $ Total Award Period Covered:
Location of Project:
Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Don Reeder**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: Lepton Hadron Scattering**

Source of Support: **DOE**

Total Award Amount: $ **4,330,423** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison. DESY, Hamburg, Germany**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: CMS @ LHC**

Source of Support: **DOE**

Total Award Amount: $ **5,981,360** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison. CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: Data Analysis Facility**

Source of Support: **DOE**

Total Award Amount: $ **582,490** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.20**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: Common Administration**

Source of Support: **DOE**

Total Award Amount: $ **1,060,940** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.10**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Common Projects Subsystem**

Source of Support: **Fermi National Accelerator Laboratory**

Total Award Amount: $ **7,972,200** Total Award Period Covered: **10/01/97 - 09/30/05**

Location of Project: **UW Madison. CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Don Reeder**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Muon Subsystem**

Source of Support: **Fermi National Accelerator Laboratory**
Total Award Amount: $ **2,103,361** Total Award Period Covered: **10/01/97 - 09/30/04**
Location of Project: **UW Madison. CERN, Geneva, Switzerland**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Muon Alignment Subsystem**

Source of Support: **Northeastern University**
Total Award Amount: $ **19,533** Total Award Period Covered: **10/14/99 - 09/30/04**
Location of Project: **UW Madison. CERN, Geneva, Switzerland**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **WARF Named Professorship**

Source of Support: **Wisconsin Alumni Research Foundation**
Total Award Amount: $ **65,000** Total Award Period Covered: **07/01/95 - 06/30/05**
Location of Project: **UW Madison**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: CMS @ LHC Supplemenatl Request**

Source of Support: **DOE**
Total Award Amount: $ **276,159** Total Award Period Covered: **11/01/96 - 10/31/03**
Location of Project: **UW Madison. CERN, Geneva, Switzerland**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Muon Subsystem**

Source of Support: **Fermi National Accelerator Laboratory**
Total Award Amount: $ **500,000** Total Award Period Covered: **10/01/97 - 09/30/04**
Location of Project: **UW Madison. CERN, Geneva, Switzerland**
Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.00**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Wesley Smith**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Reserach: Lepton Hadron Scattering**

Source of Support: **DOE**

Total Award Amount: $ **4,330,423** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison. DESY, Hamburg, Germany.**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: CMS @ LHC**

Source of Support: **DOE**

Total Award Amount: $ **5,981,360** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison. CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **1.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: Data Analysis Facility**

Source of Support: **DOE**

Total Award Amount: $ **582,490** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.20**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Trigger Subsystem**

Source of Support: **Fermi National Accelerator Laboratory**

Total Award Amount: $ **3,193,058** Total Award Period Covered: **07/01/98 - 09/30/04**

Location of Project: **UW Madison. CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**1.00** Acad: **0.00** Sumr: **0.00**

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Kellett Mid-Career Award**

Source of Support: **Wisconsin Alumni Research Foundation**

Total Award Amount: $ **60,000** Total Award Period Covered: **07/01/99 - 06/30/04**

Location of Project: **UW Madison**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Summ: **0.10**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: **Wesley Smith**	Other agencies (including NSF) to which this proposal has been/will be submitted.

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **High Energy Physics Research: CMS @ LHC Supplemental Request**

Source of Support: **DOE**

Total Award Amount: $ **276,159** Total Award Period Covered: **11/01/96 - 10/31/03**

Location of Project: **UW Madison. CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **US CMS Trigger Subsystem**

Source of Support: **Fermi National Accelerator Laboratory**

Total Award Amount: $ **559,245** Total Award Period Covered: **07/01/98 - 09/30/04**

Location of Project: **UW Madison. CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☒ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: **Particle Physics at the Energy Frontier**

Source of Support: **Wisconsin Alumni Research Foundation**

Total Award Amount: $ **28,060** Total Award Period Covered: **07/01/03 - 06/30/04**

Location of Project: **UW Madison, CERN, Geneva, Switzerland**

Person-Months Per Year Committed to the Project. Cal:**0.00** Acad: **0.00** Sumr: **0.00**

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Sumr:

Support: ☐ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title:

Source of Support:

Total Award Amount: $ Total Award Period Covered:

Location of Project:

Person-Months Per Year Committed to the Project. Cal: Acad: Summ:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

Facilities & Equipment

The chemical engineering and materials science groups are equipped with a suite of advanced instrumentation for materials characterization (calorimeters, atomic force microscopes, X-ray spectrophotometers, rheometers, and various types of microscopes). More important to the subject of this proposal, our research group is equipped with a cluster of 250 Pentium and AMD processors.

The Laboratory for Molecular and Computational Genomics, part of the Biotechnology Center, has a rapidly growing computing facility. Our equipment is scattered between the Genetics, Biotechnology and Chemistry buildings. The computers are connected via Gigabit network link between these three buildings. 100Mbit Ethernet goes to each of the desktop machines, and Gigabit fiber attaches our servers to the network. The servers are all located in a climate-controlled room with regulated power. The equipment consists of the following: a) 21 Sun Workstations b) 37 Dell Pentium III PCs running Windows 2000 and Linux c) 1 Sun StorEdge Disk Array (1TB) d) 1 Raidzone Linux based RAID5 Disk Array (1TB) e) 1 Boxhill DLT Backup Silo (3 DLT 7000 Drives)

The High Energy Physics (HEP) group computing facilities include 30 recently commissioned Linux compute systems. These machines have 700 MHz Pentium-III CPUs, 512 MB memory and 9 GB disk each. Thirteen of these systems are equipped with RAID arrays totaling 4.7 TB. Two Sun Enterprise 250 machines with dual processors and large disk are used as AFS, login, web and mail servers. There are 20 Unix workstations of various flavors used for electronics design and other work. Most HEP office computers are Apple Macintosh systems. All these systems are connected to the High Energy Physics network using switched fast Ethernet. The four HEP fast Ethernet switches that service these systems spread across the HEP offices and labs are interconnected via gigabit Ethernet segments. The HEP network router is connected to the campus using a gigabit ATM connection. A full time system administrator manages these systems.

The main computer infrastructure at the Department of Medical Physics consists of a 24-node Beowulf computer cluster. All computers have 800MHz AMD Athlon processors, 512 MB memory and an 18 GB hard disc. An additional 70 GB disc is used for extra storage. The computers are connected through a 100 Mbit/s Ethernet and are able to run applications using either PVM or MPI protocols. Most of the Medical Physics office and laboratory computers are Pentium III and IV PCs running the Windows operating system.

The Computer Sciences Department has a large variety of advanced computing facilities; all under the maintenance of the Computer Systems Lab that has seven full-time staff members and several student employees. The department has a longstanding tradition of sharing resources, as primarily evidenced by the use of the Condor resource management system, which enables high-throughput computation for demanding users and jobs by scavenging idle cycles from desktop machines. More details on the computation, storage and networking facilities are as follows:

> Computation facilities: There are over 700 general purpose computing systems (primarily PCs that range in speed from 500Mhz to 3Ghz) that comprise the Condor cluster in the department. These systems are prioritized for computer science use but are

also available for campus wide computing needs. Also over 100 high performance workstations from Sun and HP are used for research by various groups.

Storage facilities: The department operates a number of multi-terabyte storage clusters for general and research specific storage needs in the department. Most of these systems are PC-based RAID servers with high speed, high capacity disks. There are also large 2 EMC Symmetrix servers, and 1 EMC CLARiiON server. The Symmetrix servers are each configured with 2TB of storage and the CLARiiON with 1TB. The EMC systems will be partitioned to participate in the GLOW project.

Networking facilities: The department is participating in the current campus networking upgrade and will be one of the first connected to the new optical backbone. At present it has two 100Mbps connections to the campus backbone. The Wisconsin Advanced Internet Lab also contains over 60 high-speed routers and switches; a number of these will be configured to act as a test-bed environment for GLOW.

Networking on the UW campus is facilitated through a backbone that consists of three "super nodes". The super nodes are connected via multi-mode fiber in a triangle via ATM switches running at OC12 bandwidth. Routers for the various buildings are all connected at some point to one of the super nodes. Network connections on campus are not strictly hierarchical: there are numerous direct links between buildings (with additional dark fiber available) where required. Peering routers connected to the Internet are located next to one of the super nodes. The campus is connected via OC3 to the commodity Internet provider Genuity. The campus is connected via OC3 to WiscNet (which provides Internet connectivity to schools and universities throughout Wisconsin) that provides the campus with additional routes to the commodity Internet. The campus is also connected to both the vBNS and Internet 2 via OC3 links although the connection to Internet 2 is not direct (routing is currently through aggregation points in Milwaukee and Chicago).

THE GRADUATE SCHOOL
UNIVERSITY OF WISCONSIN–MADISON

January 21, 2003

Office of Integrative Activities
Major Research Instrumentation Program
National Science Foundation
Room 1270
4201 Wilson Boulevard
Arlington, VA 22230

To whom it may concern:

On behalf of the University of Wisconsin-Madison, I am pleased to support the MRI proposal *Acquisition of the GLOW Distributed Computing System at the University of Wisconsin – Madison.* We believe UW-Madison is uniquely positioned to implement this ambitious effort to develop a sophisticated computing infrastructure in a shared multi-disciplinary research environment.

The combined expertise represented in this grant in Chemical Engineering, Chemistry, Computer Sciences, Medical Physics (including Radiology and Human Oncology), Particle Physics and Astrophysics makes me confident that this project will dramatically improve our understanding and ability to provide such computational infrastructure. We also believe that the model developed here will have national and international significance and applicability. GLOW will provide the research computational infrastructure necessary to support research in many different domains and research environments. It is our intention to extend the successful implementation of GLOW to the boundaries of the University and beyond.

UW-Madison has a history of successful interdisciplinary research leading to technology and educational transfer, and we look forward to working with NSF to make GLOW an exemplary model of this tradition. Over the past several years, the University has instituted a radically new initiative, in which clusters of new faculty are hired in designated interdisciplinary topic areas. It is important to note that some of this proposal's participating faculty were hired in these initiatives, and we anticipate that future hires under this program also will be served.

As the Vice Chancellor for Research of the University, it will be my pleasure to help orchestrate a successful implementation of this initiative. The Graduate School traditionally has played a role of catalyzing our cross-college research and education efforts, and we look forward to doing so with this new effort. UW-Madison will provide a 30% match to any dollars awarded to this project by NSF, as stipulated in the MRI proposal guidelines. We look forward to working with NSF to achieve the timely goals of this proposal.

Sincerely,

Martin Cadwallader

Martin T. Cadwallader, Ph.D.
Vice Chancellor for Research
and Dean of the Graduate School

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