1. A description of your facility's experience hosting undergraduate students for internships, for example, number of interns hosted each summer, approximately how many years have you hosted interns.

Located in historic Los Alamos, New Mexico, against the backdrop of the Jemez Mountains, Los Alamos National Laboratory (LANL) offers its education program participants hands-on experience and a wealth of opportunity to learn from some of the brightest scientists and technical experts in the nation.

The Laboratory has been committed to educational opportunities and hosting students for more than twenty years. As a result, 25% of all current LANL employees are former student programs participants, and 40% of all technical staff hires annually are former students or postdocs.

Every year, LANL hosts 1000-1200 students on average for limited-term, mentored appointments. These opportunities include high school cooperatives, technical training and apprenticeships, undergraduate internships, graduate research assistantships, and postdoctoral appointments. The Laboratory's educational programs are diverse and include partnerships with governmental sponsors, national and local foundations, and research universities. For the past two years, the Homeland Security program office at the Laboratory has hosted 14 students—5 students in 2007 and 9 students in 2006.

The Homeland Security (HS) program office at Los Alamos National Laboratory (LANL) is the hub for all homeland security work at LANL. Our primary customer is the Department of Homeland Security's Science and Technology Directorate (DHS S&T). We manage the LANL homeland security portfolio in the following three program focus areas: Chemical and Biological Threat Reduction (Chem/Bio), Radiological and Nuclear Threat Reduction (Rad/Nuc), and Critical Infrastructure Program (CIP).

We have a compelling mission of national importance and successfully bring the full breadth of LANL's scientific and engineering communities together to conquer homeland security challenges. Our competitive strength lies in our ability to be aggressive and agile. We bring experts in our program focus areas together with those in Information and Infrastructure Modeling and Simulation to provide integrated solutions.

We are uniquely qualified to provide unified and integrated technological solutions to the nation's most pressing homeland security challenges. Drawing on sixty-four years of cutting-edge national security and threat reduction accomplishments, our highly-qualified staff and unmatched facilities make conquering difficult problems possible.

2. A description of additional benefits your facility can provide interns, for example, subsidized housing arrangements, local transportation allowance, professional lectures and seminars, social activities, etc.

Although LANL hires or hosts students on a year-round basis, the majority of the students participate in an internship during the summer months. The purpose of an

internship at LANL is to have a well-rounded, safe, rewarding, and challenging experience. To this end, many supplemental activities are coordinated for students.

Examples of these activities and events include the following:

- New Hire Orientation (New Student Orientation held May–June);
- General Employee Training;
- Safety and Security Training;
- All Student Meeting with LANL Director;
- All Student and Mentor Picnic;
- Annual Student and Postdoc Symposium;
- Student Seminars;
- Professional Development Courses or Seminar Topics ;
- LANL and Los Alamos Area Tours of facilities and attractions;
- Annual Student Survey; and
- Distinguished Student and Mentor Performance Awards.

In particular, the Los Alamos National Laboratory Director's Colloquium/Lecture Series presents distinguished speakers on topics of substantial interest to the Laboratory community. Sponsored presentations are either unclassified or classified, and topics include scientific and technical overviews as well as policy-related issues relevant to the Laboratory mission and national security interests. In addition, many organizations within the Laboratory also sponsor or provide lecture and seminar series open to the entire Laboratory community.

One such organization is entirely for students and for enriching their experience while working and learning in Los Alamos. The Laboratory's Students' Association is endowed with elected student members who maintain a full "student calendar" of events and activities. Daily opportunities exist to participate in a variety of organized social activities ranging from ice cream socials, tea/coffee gatherings, and picnics—to cycling clubs, yoga, rugby, basketball, ultimate Frisbee, open-boat nights, trail hikes, and night walks—to musical, theatre, and dance performances; movie nights; and dance lessons and parties—to non-denominational bible study and career building seminars and discussions.

Northern New Mexico offers unbelievable outdoor/recreational activities as well as premier arts and cultural activities in Los Alamos and surrounding communities. Popular fitness activities include camping, hiking, backpacking, climbing, running, visiting hot springs, street or mountain biking, river rafting, horse-back riding, volleyball, tennis, golf, and swimming. Activities that draw on the wealth of arts and culture in the area include local pueblo sponsored gatherings, resident artist and craftsmen shops, international and regional artist fairs, nationally acclaimed art and cultural galleries, and world-class performing arts events at the Santa Fe Opera, the Lensic Theatre, and the Santa Fe or Taos Chamber Music Festivals, to mention only a few.

Housing: Los Alamos National Laboratory offers reimbursement to DHS students for housing costs, but does not pay a salary or other stipend unless provided for under the

terms of the internship. Housing is typically available within the townsite, and the Laboratory has a dedicated housing office and website to provide longer-term visitors and students with valuable information, resources, and referrals.

Local Transportation: The Laboratory is easily accessible from the townsite via car or local bus, and many workers choose to walk or ride a bicycle to their work locations as well. LANL also provides a limited, on-demand taxi service between 8:30 a.m. and 3 p.m. weekdays for Laboratory employees who need transportation between Laboratory sites not within a short walking distance.

3. The name and contact information for the person that would be the primary point of contact for DHS S&T in administering internships at your facility.

LANL Homeland Security POC:

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2D artificial image as a method for analyzing two parameter dependent data sets.

Main focus area: Advanced Data Analysis and Visualization

PI: Hanna Makaruk, hanna_m@lanl.gov
LANL Hydrodynamics & X-Ray Physics (P-22)

Introduction:

Thanks to computerized methods of data acquisition, storage and dissemination the amount of raw data in practically any area of interest is becoming overwhelming for a human analyst. The data have to be preprocessed and presented in human friendly way to spot correlations, trends, processes. Virtually the same problem of massive data processing and correlation finding is faced in socio-economic studies, medicine, processing data from complex physical experiments.

Popularity of digital photography caused rapid development of digital image processing methods and software. Any digital photography is stored inside a camera or computer in the form of a matrix (for a color photo in the form of three matrices, separately for red, green and blue). Image processing methods are performing operations on the numerical matrices of pixel's intensity, stored as numbers. Spatial location of a pixel is denoted by its column and row in the matrix. Color intensity of a pixel in digital photography can be understood as a function of the spatial coordinates (x,y) in the image.

All digital image processing and visualization methods can be applied to any set of data, which stores values of a two parameters function as a matrix. Representing a massive data set as a 2D photography-like images, provides two obvious advantages: first, data in this form can be relatively easily comprehended by a human; second, data analysis gain an important and well developed tool in the form of the image processing software. Many tasks like data denoising, spotting and excluding obvious data artifacts, as well as defining areas of interest can be done in fast and precise way. This is why data from ultrafast (picoseconds) experiments with dense plasma, in which the number of emitted photons as a function of (time, wavelength) are registered as grey scale images with time and wavelength playing the roles of spatial coordinates. Using image analysis tools allows measurement of the fast changing plasma temperature as a function of time, by using the continuous spectra present on this kind of spectral images. The method was born from experimental necessity but could be in a straightforward way generalized to represent and analyze any kind of process depending on two parameters This allows to use time- and cost-effective image processing and also to present the massive amount of data in a form easy to visually analyze by a human. It also allows for fast evaluation if some characteristics of data, e.g. about society are at all correlated. For example: is country of origin a factor in immigrants' income, when data about immigrants is represented as a function of both country and professional education?

Work Plan:

The project consists of two phases of approximately equal length.

> **Phase one:** the student will use an existing software to analyze artificial image type data from experiments with inertial confinement plasma. The two parameters in this case are: time and photons' characteristic energy/wavelength. The student will be guided and learn the techniques of image processing and data analysis. Images from a real inertial confinement plasma fusion will be provided. The goal of the analysis for the physics is to measure plasma electrons' temperature from their continuous spectra, as a (very quickly changing) function of time. The whole process takes about 100 ps, the temperature measurement every 5 ps is of interest. The goal for the student and the project is to learn techniques of visualization and analyzing of 2D data.
>
> **Phase two:** the student will select and use publically available data from an area significantly different from the previous one. Statistical data from Social, Behavioral, Economic Sciences or Immigration Studies are strongly suggested, but the student is expect to assume the leading role in the data selection and acquisition (Internet data mining or other sources) and will have possibility to propose a suitable data set from other area of interest. The data should allow for investigation of change of one multi-valued characteristic as a function of two other multi-valued ones. Examples of good candidates for such parameters are: age, time in which a process occurs, income, profession, country of origin. Examples of characteristics, which have too small number of possible values to become a parameter in an artificial image: education level, gender, race. In the same phase the student with help of the mentor will prepare the results for publication, presentation.

Computer and software, office space and ample guidance will be provided. Expected results in the area of methods data and image analysis, especially after comparison of two types of artificial photo-type images from different subject areas, will have potential to be published in an open scientific journal paper co-authored by the student.

Learning Plan:

1) Programming: The image processing packages and the specific program, which student will use for analyzing data from plasma physics experiment already exist and are written in Mathematica. Familiarity with Mathematica would be a plus but is not required. General familiarity with programming and will to learn is expected. The student will learn also image processing and computer visualization techniques– both hands-on, running a particular package and learning theory behind the image processing methods.
2) Data analysis and visualization techniques as described in the work plan.
3) Physics: General physics background is expected. Student will learn about types of plasma, inertial confinement fusion, and will become familiar with changes of experiments with matter in extreme (star like) conditions.
4) Scientific presentation: Writing/editing research data for publication. Additionally, if the student will be interested in participation in Los Alamos Annual Students' Symposium (August '08), preparation of a symposium poster or talk can be included. No experience in area of scientific presentation is required. The student will be guided.

Earthquake or nuclear test?
Recognition of event signature from (incomplete) seismic data.

PI: Robert Owczarek, rmo@lanl.gov
LANL Geophysics Group (EES-11)

Introduction:

Detection and monitoring of potential nuclear underground explosions of small and medium yield is important for the nonproliferation efforts, and thus for homeland security. Large nuclear explosions are relatively easy to recognize based on the signal signatures. However, signatures of small nuclear explosions are much more difficult to establish. Geophysicists use seismic data for localizing natural earthquakes, as well as conventional and nuclear underground explosions. The major challenges include exponential increase of amounts of data due to transition from teleseismic (global) to a regional monitoring regime, and difficulty of analysis of seismic signals obtained from traditional ground based nuclear-explosion-monitoring Recently satellite imaging was proposed as a source of additional information allowing for even better localization of the events. The reason is both nuclear explosion and man-made explosions, of the kind appearing e.g. in mining, create disturbance in the ground and/or smokes or other effects, which are time-correlated with the seismic signals.

The larger program concerns merges of knowledge of physics, mathematics, predictability theory, signal and image processing in order to better understand, describe and recognize the signatures of small-scale nuclear explosions. The summer student project would provide an important contribution towards the big goal.

Work Plan:

Improvement of discrimination of natural earthquakes from man-made explosions:
The analysis of existing signals, for which the distinction is known and search for patterns. Finding a signature of any type of small scale seismic event: earthquake, conventional explosion or nuclear one will be a significant result. Signature of the nuclear test is a holy grail, but a signature for any of two other seismic events will be also very useful, as it will allow exclusion of a significant percentage of small scale seismic events from in-depth analysis. It is expected that the result may be not a definite event signature (yes/no) but rather a pattern, which significantly increases probability that a seismic event belongs to one of these types.

A student will choose to use either classical signal processing approach or vector support machine type of neural networks, which has the capability of learning and identifying complex nonlinear patterns to differentiate the various types of signals' signatures.

This work is expected to provide tools for identifying, with a quantitative probability, a type of seismic event (i.e., nuclear or conventional explosions, earthquakes).

Expected results will be of scientific importance and will have potential to be published in an open scientific journal paper co-authored by the student.

Learning Plan:

1) Geophysics:
   Seismic waves generation and types. Interpretation of seismic signals. No background in geophysics and only basic background in physics are assumed.
2) Computer science:
   Signal processing. Access to appropriate computers and programs will be provided. Depending on student's background and interest the project may be completed in one of two ways:
   a. Classical signal processing methods with specialized packages in Matlab or Mathematica. Familiarity with these programs is not necessary, student will be guided and have opportunity to learn either Mathematica or Matlab as well as the specific package during the internship to the level sufficient for completion of the project. Some programming on the student's part will be required.
   b. Challenging possibility for a student having a suitable computer science background and willing to assume the pivotal role in this research: signal analysis and pattern search using a support vector machine (kind of neural network particularly suitable for pattern recognition). Familiarity with this type of programming is required, as the internship time is too limited for a student to learn this complex type of programming from scratch, and write and run a suitable program. Suggestion- program is expected to be based on Markov Chains. It is expected that the results may be more general and more interesting than in the previous option, but difficulty and risk connected with this option, are significantly higher than with the previous one.
3) Probability theory, introduction to Bayesian probability, and, if selected option 2b, Markov chains. Familiarity with basic concepts in probability theory is assumed.
4) Scientific presentation:
   Writing/editing research data for publication. Additionally, if the student will be interested in participation in Los Alamos Annual Students' Symposium (August '08), preparation of a symposium poster or talk can be included. No experience in the area of scientific presentation is assumed. The student will be guided.