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Greetings from the Chairman

Graduation, Pisa, and Cassini!

Yahya Rahmat-Samii, UCLA EE Dept. Chair

When we look back at our achievements, there is no doubt that our graduation ceremonies from high schools and universities were pinnacles of our accomplishments. This year, graduates from our electrical engineering department at UCLA's Henry Samueli School of Engineering and Applied Science experienced an important pinnacle in their own lives. Our undergraduate and graduate students, along with their loved ones, enjoyed the graduation ceremony held at UCLA's well known Pauley Pavilion on June 19, 2004. This was the 40th Annual Commencement of the Henry Samueli School of Engineering and Applied Science (a pinnacle for the School itself). The ceremony was attended by Chancellor Albert Carnesale, Vice Chancellor Roberto Peccei, Dean Vijay Dhir, department chairs and many faculty from various departments. The speaker was Ms. Carly Fiorina, Chairman and CEO of Hewlett Packard. Her remarks were well articulated, amplifying the joy of becoming an engineer from one of the best engineering schools in the nation.

The 2003-2004 year was another success story for our department. We graduated (conferred and candidates) over 210 B.S. students, 140 M.S. students and 50 Ph.D. students. These graduates join the over 350,000 UCLA alumni residing in every corner of this nation and the world. It is estimated that from every 150 Californian, one is a UCLA graduate. This is an amazing statistic which is attributed to the importance of the educational and economical roles that this university plays in the state of California and the nation.

I strongly believe that as an educator one receives a tremendous amount of fulfillment watching these young minds parading in the graduation ceremony and starting to plan how to achieve their dreams. **We wish all the graduates the best, and hope that their lives have been enriched during their time in UCLA's Electrical Engineering Department.**

A few weeks before the graduation ceremony I was an invited plenary session speaker at the 2004 International Electromagnetic Theory symposium held in Pisa, Italy. This symposium is considered one of the most important symposia in the areas of electromagnetic theory and its applications. My talk was entitled, "Genetic Algorithms (GA) and Particle Swarm Optimization (PSO): Powerful Paradigms for Unconventional Designs". I detailed how one may use the Darwinian evolutionary concept via the mechanism of genetic algorithms (GA) to optimize electromagnetic and antenna devices. I also addressed the application of particle swarm optimization based on the intelligence of swarms of birds or schools of fish for the optimum design of antennas. After the talk, and in the spirit of the evolutionary process, I decided to climb up the world-famous Leaning Tower of Pisa. I tried to imagine how Galileo conducted his experiment from this tower. It is almost incomprehensible that, in the span of less than four centuries, our knowledge of the universe has evolved from Galileo's simple experiment to the general theory of relativity and the string theory, allowing us to model the cosmos from its origin!

On the 1st of July, 2004, the Cassini spacecraft will reach Saturn and in January, 2005, will encounter Titan, one of the moons of Saturn, after a seven year voyage. When I was a senior research scientist at JPL, I worked on the antenna design for this spacecraft. The engineering marvels of accomplishing grand projects are what we hope our graduates will enjoy in their careers. One's

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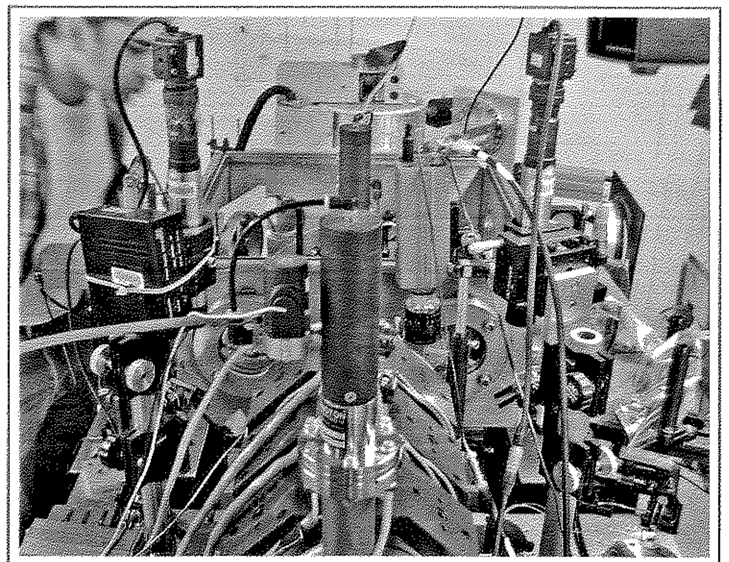
UCLA's Laser-Plasma Group and the Neptune Laboratory for Advanced Accelerator Research

Prof. Joshi

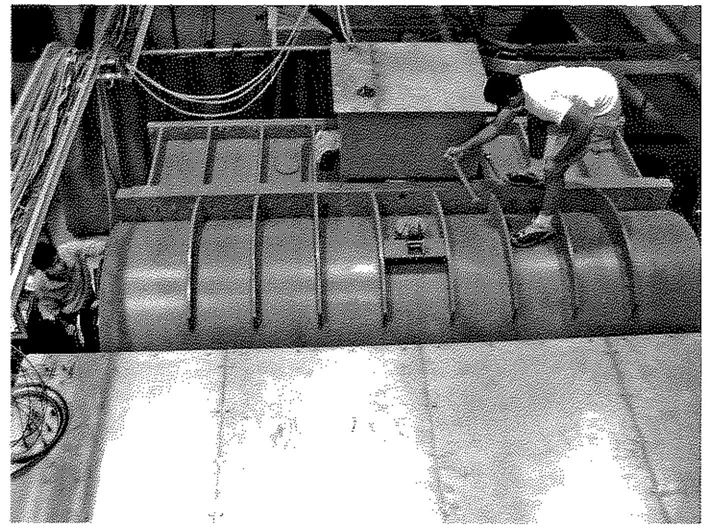
The UCLA Laser-Plasma Group is recognized as the world's premier research group in the field of advanced acceleration. Directed by Prof. Chan Joshi of EE (also Director of the Center for High Frequency Electronics and Chair of the plasma electronics field of Study in EE), the group is comprised of several research engineers, post-doctorates, and graduate students from within the EE Department and includes professors and graduate students from the UCLA Physics and Astronomy Department. Recently, undergraduate students have also been included as part of an EE undergraduate research program.

The UCLA Laser-Plasma Group has had a strong program in the area of advanced accelerator research and development since 1984, supported by the DOE's Office of Science. This group has pioneered many concepts for accelerating and focusing ultrarelativistic charged particles, including the **p**lasma **b**eat**w**ave **a**ccelerator (PBWA), the self-modulated laser wake field accelerator, the plasma lens, the plasma wake field accelerator, and plasma-frequency upshifters. Furthermore, Prof. Joshi's group has developed critical diagnostic techniques to resolve relativistic plasma accelerating structures in terms of time, space, frequency and wave number. These experiments have also been supported by a theory and computational program, headed by Professor Warren Mori, that arguably ranks among the best in the world. In addition to first-rate research results, the Laser-Plasma group consistently produces top-notch graduate students and mentors high-caliber research staff, many who have gone on to become highly visible in the international community of accelerator and beam science.

The Laser-Plasma Group also collaborates extensively with the Physics Department of the University of Southern California (USC), and the Stanford Linear Accelerator Center (SLAC). With cutting-edge resources available through this collaboration, the group has several state-of-the-art laser laboratories where research on nonlinear optical effects in plasmas, laser-fusion, high power lasers, and advanced accelerator concepts is carried out.



The PBWA: Plasma Beat Wave Accelerator, one of the important innovations pioneered by the UCLA Laser-Plasma Group.



A very large, TW-class CO_2 laser amplifier requires tough guys. Graduate students Ritesh Narang (on the top) and Pietro Musumeci align the amplifier.

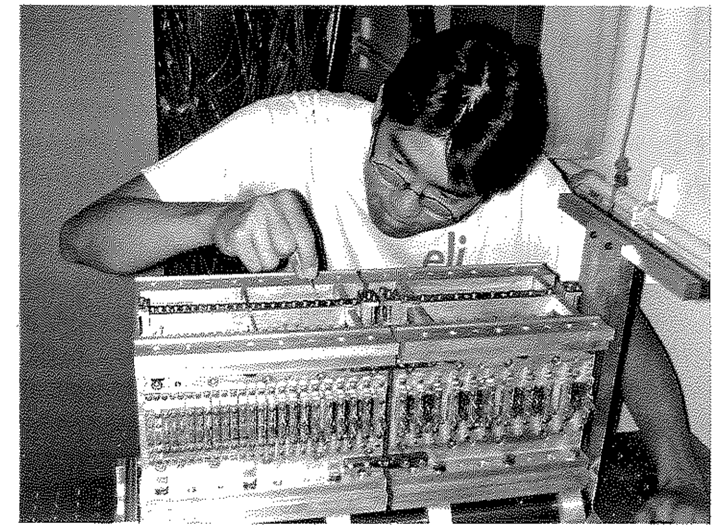
The Case for Accelerator Science at Universities

The dominance of the United States in the area of accelerator science over the latter half of the twentieth century has arguably been the most important factor contributing to the preeminence of the U.S. in world physics. Yet now this position is threatened for two reasons. First, Europe and Japan have overtaken us in building bigger and better accelerators. Second, an accelerator that could explore the energy frontier would be too big and too expensive for any one nation to build.

Fortunately, there are many new ideas for generating, accelerating, focusing and cooling charged particles that could lead to an entirely new paradigm for constructing a future accelerator more cost effectively. Many of these were invented at UCLA and are based on recent breakthroughs in laser, plasma, nano, superconductivity and other technologies. The goal of UCLA's program is to convert these new ideas into a practical machine capable of cutting-edge physics at the energy frontier.

An Exciting Science in its Own Right

Particle beams are multiple-body systems with non-isotropic and non-thermal distributions, exhibiting collective instabilities and self-organizing phenomena when interacting with external fields. (An example of this is the X-ray free electron laser, now a high-priority DOE project.) As we move toward the study and utilization of beams with ever higher phase-space density and smaller dimensions, quantum mechanical phenomena become significant. Such particle beams will be the highest energy density sources available for simulating particle and plasma astrophysical phenomena in the laboratory.



A masterpiece of engineering: The Neptune Lab's unique double-tapered undulator is made of five thousand pieces and was built for an inverse-free electron laser experiment carried out in collaboration with the UCLA Physics Department. Graduate student Jay Sung tunes the undulator.

The underlying science of micron-scale particle beams, containing hundreds of amps of current when accelerated and focused at unprecedented rates, is rich and challenging. Some of the great challenges at the forefront of beam physics involve the measurement of such short bunches, phase-locking them into micro-scale structures with femtosecond accuracy, and focusing beams typically containing hundreds of TW power to nanometer-spot sizes. This science is truly exciting in its own right.

Benefits for Society

Societal benefits of particle accelerators are already evident in material science, nuclear medicine, molecular biology, and many other fields. Charged particles, or the radiation they produce, enable doctors to treat many forms of cancer — an application that will see explosive growth with the availability of cheaper and compact accelerators that will likely result from the investment of research monies in this field of science.

The Neptune Laboratory Facility

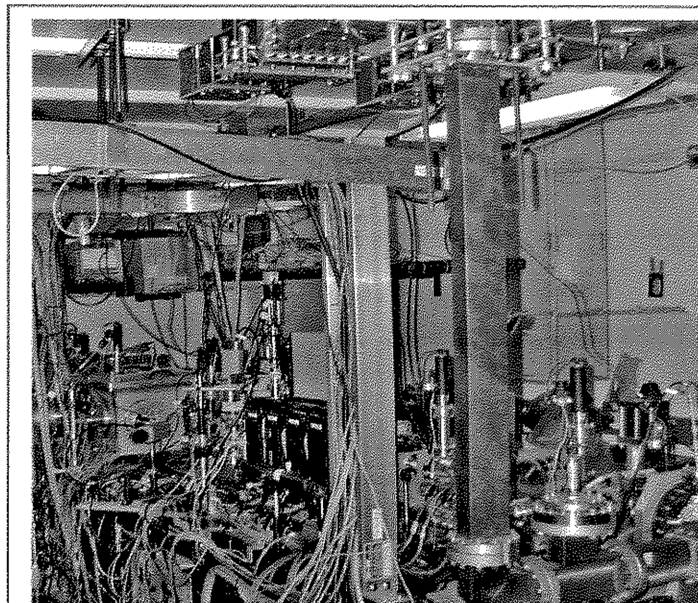
In 1985, the UCLA Laser-Plasma Group first showed that relativistic plasma waves could be excited using collinear optical mixing or the beatwave technique. This was followed up in 1993 by a conclusive demonstration of the acceleration of externally injected electrons by such waves. The group has now embarked on second-generation plasma beatwave acceleration experiments. To this end, Prof. Joshi's group, in collaboration with professors Pellegrini and Rosenzweig of the UCLA physics department, built a new facility called the Neptune Laboratory, completed in 2000.

The Neptune Lab is located in Boelter Hall and houses the "MARS laser", currently the most powerful CO_2 laser in the U.S. It can produce 200J, 100ps pulses of CO_2 radiation, focusable to 10^{16} W/cm^2. The laser is used for testing new ideas for laser-driven particle accelerators and free-electron lasers. Other equipment in the Neptune Lab includes a high power, short pulse 1mm laser, an electron linac injector, streak cameras, and charged particle and spectrometer detectors. The lasers and the electron linac are synchronized to within one picosecond, enabling many unique experiments to be carried out.

The Neptune laboratory has already produced and published some very significant results on the acceleration of externally injected electrons to 50 million electron volts (see *Physical Review Letters,* vol. 42, no. 9, 2004, pp. 009500/1-4) and has demonstrated a significant electron energy gain by the inverse free electron laser scheme.

Big Dreams

To take the Advanced Accelerator field to the next level, the UCLA Laser Plasma Group formed a collaboration with groups at USC and the Stanford Linear Accelerator Center (SLAC) about five years ago. SLAC has the necessary large scale infrastructure, such as 50 GeV electron and positron beams. This collaboration has succeeded in demonstrating acceleration and focusing of both electrons and positrons using plasma-based techniques. Recently the group has demonstrated energy increase of an electron beam of up to 4 billion electron volts in just 10 centimeters, causing a great deal of excitement in the accelerator field community. Ideas for doubling the energy of a conventional linear accelerator, which is normally several kilometers long, in just a few meters using plasma afterburners, are being taken seriously as a result of this work.



One of the Neptune Laboratory's diagnostic systems, involving optical, electrical, and mechanical engineering.