

Division of Physics of Beams Newsletter

A Division of the American Physical Society
Edited by Ernest Malamud, DPB Secretary-Treasurer

Spring 2006

Report from the DPB Chair

May 2005– April 2006

Gerry Dugan, Cornell University

The Division of Physics of Beams has been active in a number of areas over the past year. In the paragraphs below, the most important of these activities will be described.



HEPAP Subpanel on Advanced Accelerator R&D (AARD)

At the request of DoE and NSF, HEPAP convened a subpanel, chaired by Jay Marx, to perform a comprehensive review of all aspects of the DoE and NSF accelerator R&D programs (except for Linear Collider R&D, and the LHC Accelerator Research Project.) Part of the work of the subpanel involved the collection of community input. To facilitate this, the DPB provided a web site (<http://accelerator-rd.org/>) at which information related to the subpanel was posted, and also coordinated two open-mike sessions, and one town hall meeting, at which community members could address the subpanel.

At the final open meeting of the subpanel in February 2006 (held at Fermilab), the DPB Chair addressed the subpanel on the topic of DPB perspectives on AARD.

The following recommendations were made:

- Fundamental research in accelerator science should be supported globally by all those funding agency elements which depend upon accelerators for the execution of their mission.
- A streamlined mechanism for funding modest AARD

initiatives between government-funded researchers and larger companies should be developed.

- Support for university/laboratory partnerships in AARD should be strengthened.
- A national graduate fellowship program in accelerator science should be developed. DPB has made a specific proposal to DoE's Office of Science which could serve as a model for the program.

National Graduate Fellowship Program in Accelerator Physics

Initiated by Ron Davidson in 2002, and modeled after the highly successful National Graduate Fellowship Program in Fusion Energy Sciences, the DPB has continued to develop and promote a proposal for *National Gradu-*

(Continued on page 2)

In This Issue

Report from the DPB Chair	1
DPB Election Results	2
Wilson Prize Winner	3
Doctoral Research Award Winner	3
New Fellows	4
The US Particle Accelerator School	5
Plasma-Based Accelerators Make Remarkable Progress	6
The 12 GeV Upgrade of CEBAF at Thomas Jefferson National Accelerator Facility	8
Highlights of PAC05	9
Plans for PAC07	10
The ILC Global Design Effort	11
SNS Status and Update	12
Neutrino Beams around the World	14
Beam Physics Conferences and Workshops	15

Questions? Comments? Visit the DPB web site at <http://www.aps.org/units/dpb>

Or contact Ernie Malamud, Secretary-Treasurer at 530-470-8303 FAX: 530-470-8456 Email: malamud@foothill.net

(Continued from page 1)

ate Fellowship Program in Accelerator Physics. The Nation's top U.S. graduate students, competitively selected, would receive three-year fellowships for graduate studies in accelerator physics to work under the supervision of leading faculty and research staff at U.S. universities and laboratories.

The basic objective of the Fellowship Program is to encourage talented students to enter a period of study and research in accelerator science and technology accompanied by practical work experiences at recognized research facilities. The program would add much-needed favorable exposure and prestige to the field of accelerator physics in university departments. It would also be an important vehicle for attracting the very best graduate students to the field.

As noted above, this proposal was recommended by the DPB to the HEPAP subpanel on AARD. Letters promoting the proposal also were sent to Dr. Ray Orbach, Director of the Office of Science, and Dr. Peter P. Faletta, Senior Technical Advisor for Science Education, Office of Workforce Development in the Office of Science. The recommendation was well received by the Marx panel, and hopefully will be supported in their final report to DoE and NSF.

Membership Drive

DPB membership continues to remain below the target level of 3% of APS membership. Letters were sent to the membership of three divisions, DPF, DPP, and DNP, whose members share common interests with DPB, offering free one-year membership in DPB. This approach resulted in the addition of 86 new members to DPB. The official membership count, as of 4/3/06, is 1,227, a substantial increase from the 1,144 members of the DPB in 2005. However, the membership is now at 2.7% of APS, so we are still about 140 members shy of the target. Additional efforts in recruitment of new members will be

required.

Extensions of JACoW to include additional conference proceedings, journals, and accelerator school lectures

Spearheaded by Executive Committee member Frank Zimmerman, we have proposed to JACoW that they consider including the proceedings of "extinct" conference series such as HEACC, "extinct" journals such as Particle Accelerators, and lecture notes from accelerator schools such as CAS, USPAS, JUAS, JAS, and/or Asian PAC. The response from JACoW has been positive. DPB has agreed in principle to fund the effort to digitize the additional material pending a detailed definition of the scope of work.

Education and Outreach Efforts

The Education and Outreach Committee is developing a brochure explaining the nature of accelerator physics, and the benefits the field can provide in applications to a broad range of scientific disciplines and to industry. This effort is going more slowly than would be optimal, but progress continues to be made.

During PAC05, the DPB sponsored an APS-style Teacher's Day, to introduce high school teachers in the Knoxville area to accelerator physics and technology. Forty teachers participated in this very successful outreach event, which was organized by our Secretary-Treasurer, Ernie Malamud. A similar event is planned at PAC07 in Albuquerque.

Conferences and Workshops

In addition to sponsoring PAC05 in Knoxville, the DPB also organized a number of sessions at the April 2006 APS meeting in Dallas. The DPB also sponsored the Second International Linear Collider Workshop, which was held at Snowmass in August, 2005.

DPB Election Results

The election ended on October 17, 2005. At the time of the election DPB Membership was 1200. 442 members voted (electronic + paper) or ~ 37%.

Ron Ruth was elected as our Division Councilor for a 4-year term that began on January 1, 2006.

The terms of the other elected members of the Executive

Committee begin at the end of our annual business meeting which is held in conjunction with the PAC (odd years) or the April APS meeting (even years).

The newly elected members are Steve Holmes, Vice-Chair for a 4-year term in the Chair line and John Corlett and Tor Raubenheimer newly elected members-at-large for 3-year terms.

Robert R. Wilson Prize for Achievement in the Physics of Particle Accelerators



This prize, jointly sponsored by DPB and DPF was awarded in 2006 to **Glen Lambertson** *"For fundamental contributions to accelerator science and technology*

particularly in the area of beam electrodynamics including the development of beam instrumentation for the feedback systems that are essential for the operation of high luminosity electron and hadron colliders."

Lambertson of LBNL has made many important contributions to the field among which are system design and fabrication of equipment for resonant beam extraction, first observation of space-charge coupled oscillations between electrons and protons, system design and fabrication of equipment for the stochastic cooling of antiprotons at Fermilab, analysis and hardware design for the feedback control of space-charge instabilities in the Advanced Light Source. He provided beam electrodes and led the system design for control of beam instabilities in the PEP II electron-proton collider.

Nominations for the 2007 Wilson Prize should be sent to David Burke (daveb@slac.stanford.edu) Chair of the 2007 Selection Committee by **July 1, 2006**. Guidelines for nominations are at <http://www.aps.org/praw/index.cfm>.

Outstanding Doctoral Thesis Research in Beam Physics Award

This award is sponsored by the DPB, in conjunction with Universities Research Association, Southeastern Universities Research Association, and Brookhaven Science Associates. **Evgenya I. Smirnova** won this year's award *"For the design, fabrication and successful testing of a 17 GHz electron accelerator utilizing a photonic crystal structure."*

She worked under the supervision of Dr. Richard Temkin at MIT. As a part of her dissertation work, she developed and tested the first working model of a Photonic Band Gap accelerator at 17 GHz. After graduating from MIT in 2005, Evgenya accepted a Director's Postdoctoral Fellowship from Los Alamos National Laboratory (LANL). Her work at LANL is concentrated on the construction of a PBG traveling-wave tube at the W-band.

Nominations for the 2007 Outstanding Thesis award should be sent to Charles Brau (charles.a.brau@vanderbilt.edu), Chair of the 2007 Selection Committee by **September 15, 2006**. Guidelines for nominations are at <http://www.aps.org/praw/index.cfm>.



DPB Members recognized as APS Fellows

Congratulations for their important contributions to beam physics are extended to:

Bruce E. Carlsten, Los Alamos National Laboratory, *“For outstanding contributions to the understanding of intense electron beams and for the development of techniques that have led to the achievement of ultra-bright electron sources.”*

David Ross Douglas, Jefferson Laboratory, *“For pioneering beam optics contributions leading to unique multipass accelerators and accelerator-driven light sources and to energy-recovering linac operation at high average current and demonstration at high energy.”*

Levi Schachter, Technion - Israel Institute of Technology, *“For his contributions to particle acceleration at optical wavelengths and in particular for developing the concept of particle acceleration by stimulated emission of radiation (PASER).”*

Gennady V. Stupakov, Stanford Linear Accelerator Center, *“For his contributions to theoretical beam physics including innovative impedance calculation methods, study of collective beam instabilities, and pioneering research of echo effect in circular accelerators.”*

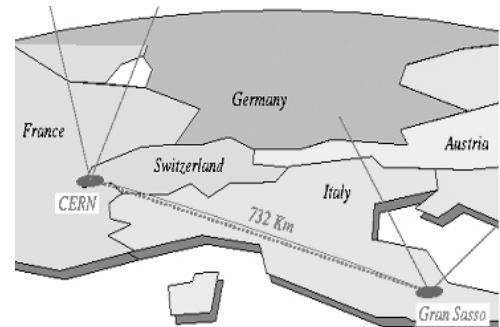
Sami G. Tantawi, Stanford Accelerator Center, *“For his contributions to the theory and technology of the production and distribution of high power rf, including the development of highly over-moded rf components, multi-mode delay lines, and active switches.”*

Alexander Zholents, Lawrence Berkeley National Laboratory, *“For many creative contributions to accelerator physics including optical manipulation of beams in stochastic cooling, laser "slicing" techniques for generation of femtosecond x-ray pulses, and enhanced x-ray production in FELs.”*



Neutrino Beams around the World

(summary on page 14)



The US Particle Accelerator School

Bill Barletta, LBNL

Dr. William Barletta, who was the Chairman of the USPAS Board of Governors, takes over the helm to direct the USPAS. Bill comes to USPAS from Lawrence Berkeley Laboratory where he was the Director of the Accelerator and Fusion Research Division. Dr. Derek Lowenstein of Brookhaven National Laboratory succeeds Bill as Chair of the USPAS Governing Board. Derek has been a vocal supporter of USPAS and member of its Board since its inception.

US Particle Accelerator School (USPAS) provides rigorous, graduate-level educational programs in the science of beams and their associated accelerator technologies. In this task USPAS is an essential partner of U. S. universities and national laboratories in training the next generation of accelerator scientists and engineers for the challenging accelerators of the future.

In 2005 under the leadership of Director Helmut Wiedemann, USPAS saw foreign participation reach almost 30% and participation by women nearly double to 20%. Enrollment at the Winter 2005 Session sponsored by UC Berkeley was a near record 175 students with ~50% taking courses for credit. Our Summer 2005 Session at Cornell, though smaller, continued Helmut's efforts to include hands-on instruction on operating accelerators. We thank Prof. David Rubin of Cornell for his superb course given at CESR.

The year 2005 was one of transitions. Director Helmut Wiedemann has moved on to new challenges at the National Synchrotron Research Center in Thailand.

The role and responsibility of the USPAS will grow over the next decade. The next four years will see the operation of challenging machines such as SNS, LHC, LCLS and other X-ray FELs, and laser-driven accelerators. The next decade promises the design and construction of an LHC upgrade, a Linear Collider, and possibly an accelerator-driven neutrino source. Therefore, US accelerator-based science must have access to sufficient scientific and engineering talent with a broad array of technical skills. To meet this challenge, USPAS must train more early-career scientists and engineers than ever. Because its continuing, rigorous program of academic courses is unmatched by programs in other parts of the world, the USPAS has become a growing contributor to the education of accelerator scientists and technologists worldwide.

Farewell Message from Helmut Wiedemann

We have seen many students come through our doors since the first university-style school was held at Cornell University in 1987. Over 2700 students have attended our credit courses and many have come back again and again to take multiple classes over the years. We've seen graduate students come back as graders or teaching assistants and then as instructors with their PhDs. It's very fulfilling to see these individuals come back and pass their knowledge and experience along to future generations. It has been a very rewarding experience for me to see the School change over the years; it has only grown stronger and that is due to you, the community.

I would like to express my sincere thanks to the staff of the USPAS office: Marilyn Paul and Susan Winchester. Their expertise and dedication to the USPAS is exceptional and has contributed much to the success of the program in spite of the director's 'help.' After 20 years, Marilyn has retired and I wish her all the best for the future. Susan will ensure that the USPAS remains a vital program for the benefit of the worldwide accelerator physics community with the help of new USPAS staff member, Jody Federwitz.



Departing USPAS Director Helmut Wiedemann, founding Director Mel Month and new USPAS Director, Bill Barletta

Plasma-Based Accelerators Make Remarkable Progress

C. Joshi, University of California, Los Angeles

The Physics of Beams community and the Plasma Physics community have historically had a great deal of intellectual overlap. Nowhere is this overlap more evident than in the field of acceleration of charged particles by collective fields. The origin of this remarkable idea can be traced all the way back to the 1950s to Budker and Veksler, pioneers in both accelerator and plasma communities. They independently proposed using the “collective fields” generated by a beam of medium energy electrons to accelerate a beam of more massive ions.

Budker and Veksler’s ideas were investigated in many places over the next twenty years including at Universities of Maryland, Cornell, UC Irvine and at NRL. Much was learned but a conceptual breakthrough in the field of collective acceleration came when T. Tajima and J. M. Dawson of UCLA proposed the use of a disturbance created in a neutral plasma to generate collective fields thousands of times greater than those generated by microwaves in a slow-wave structure. Furthermore such a disturbance or a wakefield could be made to have a phase velocity close to c , making it particularly suitable for accelerating electrons to very high energies.

Wakefields in a plasma can be excited by a pulse of an intense laser or a charged particle beam that is about half a plasma wavelength long. In the former case it is the radiation pressure of the light pulse, whereas in the latter case it is the space-charge force of the electron beam that pushes away the plasma electrons. In both cases the predominantly radially blown out plasma electrons snap back toward the back of the laser (or the particle) beam, because of the space-charge attraction force of the plasma ions, overshoot the beam axis and set up a wakefield oscillation. In a one-dimensional picture the wake resembles a series of capacitors where the mostly transverse electric field of the laser (particle) beam has been transformed into a longitudinal electric field of the wake. Experimental efforts by many groups around the world in the 1990s showed that plasma wakes did indeed have accelerating gradients of the order 100 GeV per meter and were capable of accelerating electrons (often trapped from the plasma itself) with a continuous energy spectrum up to 100 MeV. Clearly then, the two most outstanding problems for plasma-based accelerator enthusiasts were to show that 1) plasma accelerators could pro-

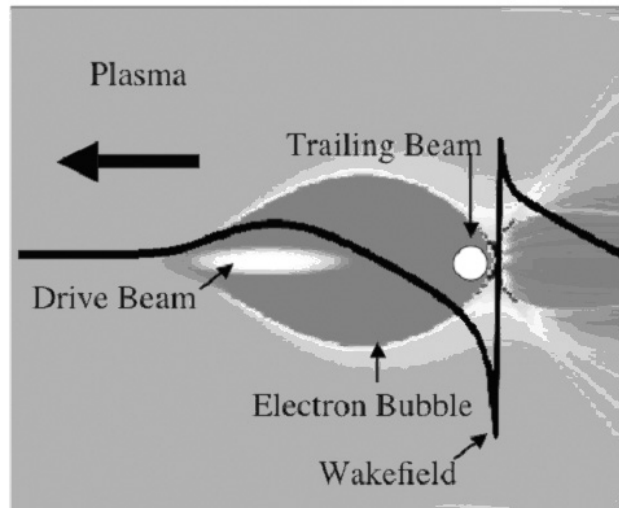


Figure 1: As a short laser pulse or electron drive beam is shot through the plasma, it leaves behind a charge disturbance or a wakefield. The electrical field inside the bubble shown here with the black curve resemble an extremely steepened ocean wave that is ready to break. This wave or wakefield can trap some of the electrons from the plasma itself to be accelerated by this field. Alternatively, a distinct trailing electron beam can now be accelerated by the wakefield.

duce a “monoenergetic beam” of electrons and 2) that the acceleration could be maintained over a meter scale. This would lead to beams of interest to the high-energy physics community which has been the primary sponsor of this research in the USA. There has been significant progress in achieving both of these goals in the last couple of years.

Most laser-driven and particle-driven plasma wakefield accelerators now operate in the so called “bubble-regime” where the drive pulse is so intense that it expels all the plasma electrons whose orbits enclose a bubble (see Fig. 1). The resulting wakefield structure is three-dimensional and highly nonlinear. The phase velocity of the wakefield is tied to the group velocity of the drive beam which is approximately c . In the case of a laser beam even though the phase velocity is relativistic, the

(Continued on page 7)

(Continued from page 6)

accelerating particles can still outrun the wave (dephasing-limit) in a distance on the order of a few mm to a centimeter. While this dephasing limits the maximum energy gain, it beneficially generates a monoenergetic electron beam. Although the sequence of events that produce such beams is quite complicated it can be explained as follows. In the bubble regime, as the radially blown out plasma electrons rush back toward the axis, a significant number of them are trapped by the longitudinal field of the wakefield. This self-trapping is severe enough to load the wake thus reducing its amplitude and turning off any further trapping. The trapped electrons are then accelerated as a group where they initially have monotonically increasing energies. However, as the electrons in the front dephase, the electrons behind them continue to gain energy (phase-space rotation) and generate a quasi-monoenergetic bunch.

Such monoenergetic bunchers have now been seen in at least half a dozen laser-driven wakefield accelerator experiments including at LBNL (USA), RAL (UK), and LOA (France). The next goal is to improve the energy spread from about 10% to less than a percent and to increase the energy to a GeV level in a distance on the order of 1 cm. If this can be accomplished the number of applications for such ultra-compact accelerators will surely explode. A promising method for increasing the energy to the 1 GeV level is the use of a plasma channel to increase the length of the wake by guiding the intense laser over a distance much greater than that limited by diffraction (see Fig. 2). Another method is to rely on a so-called matched laser beam containing sufficient

power to guide itself over many Rayleigh lengths thereby increasing the beam energy.

Compared to the laser accelerator experiments there are fewer particle beam-driven plasma acceleration experiments since there are fewer suitable beam facilities compared to ultrashort laser facilities. Experiments are underway at BNL, ANL, FNAL, and SLAC on this scheme. The first beam-driven plasma wakefield experiments were carried out at the Argonne Wakefield Accelerator Facility in the 80's. Recently, a series of elegant experiments done at SLAC by the UCLA/USC/SLAC collaboration has mapped out the physics of electron and positron beam-driven wakes and shown acceleration gradients of 40 GeV/m using electron beams using meter-scale plasmas.

In addition to the acceleration of particle beams these experiments have demonstrated the richness of the field of relativistic-beam-plasma interactions. Collimated beams of x-rays with energies in the range 10 KeV-10 MeV from betatron motion have been seen. These have been used to demonstrate a new type of positron source. Collective refraction of an electron beam at the interface of a plasma-gas boundary has been observed. There is much left to do, mainly in the area of high gradient acceleration of positrons, beam loading, and beam quality issues. However, there is little doubt that the field of Plasma Based Accelerators is helping to put the Physics of Beams at the forefront of science.

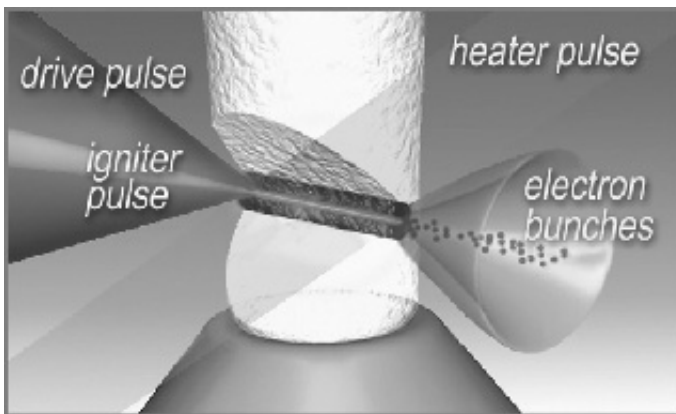


Figure 2: Schematic of a laser driven accelerator developed in the L'OASIS Program at Lawrence Berkeley National Laboratory. Hydrogen gas (yellow) emanates from a gas jet. An intense short laser beam (igniter pulse) is focused onto the gas and produces a thin wire-like plasma filament (10 micron diameter, 2-4 mm length). A second laser beam comes from the side and heats the filament very rapidly. The exploding plasma filament then hollows out in the center and takes the shape of a plasma tube or channel. A third intense laser beam is then injected into this channel, excites a plasma wake that can then trap and accelerate electrons much like a surfer on an ocean wave. (Courtesy: Wim Leemans, LBNL)

The 12 GeV Upgrade of CEBAF at Thomas Jefferson National Accelerator Facility

S. Chattopadhyay, Jefferson Lab

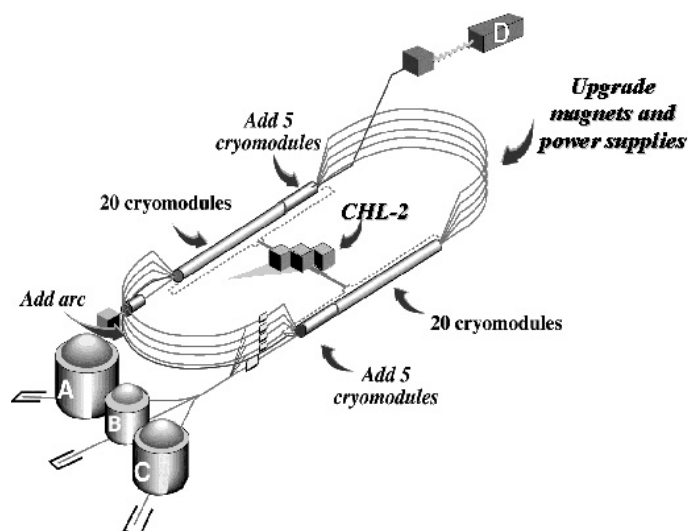
The theory of Quantum Chromo-Dynamics (QCD) describing ‘strong interactions’ was recognized with a Nobel Prize in theoretical Physics in 2004 to three eminent physicists who formulated it. QCD’s predictions in the ‘asymptotically free’ regime where quarks are ‘deconfined’ have been validated experimentally. Much of ordinary matter, however, is composed of nucleons and nuclei, which confine quarks and gluons in elementary hadrons and belong to the ‘strong QCD’ regime where the nature of the strong force and ‘quark confinement’ are yet to be tested experimentally. The Continuous Electron Beam Accelerator Facility (CEBAF) at Jefferson Lab offers the unique tool to probe the strong QCD experimentally with precision.

The CEBAF at Jefferson Lab has been operating for more than a decade serving three experimental Halls A, B and C demanding varying characteristics of electron beams with energies reaching close to 6 GeV, polarizations reaching up to and beyond 85%, maximum average beam currents up to 200 microamperes and precision parity quality beams with helicity-correlated position and angular stabilities in the nanometers and microradians range. These beams have been able to perform precision electromagnetic probing of nucleons and nuclei, resulting in determination of hadronic structure function and form factors in terms of internal quark and parton distributions and in exploration of possible exotic baryonic states. Experiments are in the plans for the next three years to do various key experiments such as studying deviations from the standard model and structures of hypernuclei.

An energy doubling upgrade of the CEBAF facility to 12 GeV energy is planned by 2011-2012 (see figure). The upgrade calls for fabricating and adding ten new high performance superconducting radiofrequency cryomodules, five each in the north and south recirculating linacs of CEBAF. The cryomodules will be installed in the space left over beyond the existing linacs and can be accommodated there despite space constraints due to their high gradients (four times the accelerating fields of the original CEBAF modules, thanks to developments in SRF cavity/cryomodule technology at JLab), doubling the energy per pass. The increased beam energy calls for upgrading the cryogenic capacity of the facility two fold. The existing recirculating arc magnets will be modified

and strengthened via additions of flux-sharing retrofits that will allow them to steer electron beams, which are twice as ‘stiff’ at 12 GeV, relative to 6 GeV, being forced to bend by the same curvature. After five full passes through the north and south linacs, the beam energy will be 11 GeV. A final single pass through one of the linacs will bring the energy up to 12 GeV. A specially designed additional 12 GeV magnetic transport arc brings the 12 GeV electron beam to a diamond crystal for generating hard photons of up to 9 GeV in energy by the coherent brehmsstrahlung effect. Upgrade of a good fraction of the detector equipments in Halls A, B and C for physics with 11 GeV electron beams and construction of a new hall, Hall D, with associated detection equipment and spectrometers, for the GlueX experiment to study quark confinement in ‘hybrid mesons’ photo-excited by the coherent brehmsstrahlung photons, are all part of the base project.

The 12 GeV Upgrade project has already received approval of the CD-0 and CD-1 critical decision milestones and is poised to receive the CD-2 status in the coming year. The project plans call for a 3.5-year construction period, during which only the final year is allocated for CEBAF shutdown due to installation and commissioning, with the experimental program resuming in 2012 approximately. The upgraded CEBAF will be a great boost to the hadronic physics program internationally, providing crucial data set of hadronic structure that will be used as a benchmark and an anchor for all higher energy nuclear/particle experiments and will, for the first time, directly elucidate the nature of ‘quark confinement’.



Highlights of PAC05

Norbert Holtkamp, Spallation Neutron Source Project, Oak Ridge National Laboratory



This year's major accelerator conference covered impressive progress in the field, and featured events celebrating the World Year of Physics (WYP).

The 2005 Particle Accelerator Conference took place May 16-20, at the Knoxville Convention Center in Knoxville, Tennessee. The conference was jointly hosted by the Oak Ridge National Laboratory Spallation Neutron Source (SNS) and the Thomas Jefferson National Accelerator Facility (JLab), Newport News, Virginia. The conference covered new developments in all aspects of the science, technology and use of particle accelerators. Unique to PAC05, however, was the special theme of the World Year of Physics.

With its exciting program, the conference attracted more than 1400 accelerator specialists to Knoxville during the week. Geographically, 59% of the attendees were from the US, 25% from Europe, 15% from Asia and 1% from the Middle East, South America and as far away as Australia. Nearly 1400 papers were processed during the conference and will soon be published on the Joint Accelerator Conferences Website, www.JACoW.org.

Accelerators present and future

Phil Bredesen, Governor of Tennessee and a physicist with a background in accelerators from his student years, welcomed delegates to the conference. The governor talked about the significance of science as a driver of economy and wealth, as well as the importance of continuously supporting education. He was followed by Cecilia Jarlskog from Lund, whose colorful presentation included information about Einstein, the Nobel Prize and accelerators. Barry Barish, Chair of the International Technology Recommendation Panel for the proposed International Linear Collider (ILC) explained the technology choice made last year for the machine. He then outlined his role as the new director of the ILC Global Design Effort to design the accelerator involving all regions of the world.

Plenary session highlights included the luminosity records of the Tevatron at Fermilab, achieving more than $1 \times 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$; the outstanding performance of Brookhaven's Relativistic Heavy Ion Collider, with its polarized beams; and the race between the B-factories (KEKB and PEP II); talks on nuclear physics topics such as the Rare Isotope Accelerator proposed in the US and the Fa-

cility of Antiproton and Ion Research (FAIR) project at GSI, as well as accelerator-based materials-science research, and neutrino and high-energy physics. The talks focused on projects that have paved the way for the accelerators that need to be built to address today's pressing questions in all areas of science, and they demonstrated yet again how accelerators have become crucial research tools over the past 50 years.

Synchrotron light sources of all sizes and flavors once again dominated the papers presented at the conference, demonstrating how quickly the field is still growing, especially in energy-recovery linacs and short-pulse coherent light sources, i.e. X-ray free-electron lasers (FELs) including the use of self-amplification of spontaneous emission (SASE). Sixteen oral presentations and more than 100 papers were presented on these facilities alone. Vibrant research and planning for new projects are ongoing, with the Linac Coherent Light Source under construction at SLAC and the Euro FEL moving from planning to construction at DESY, as well as the Spring-8 Compact SASE Source in Japan.

Einstein was ever-present throughout PAC05, with the conference website incorporating an Einstein quotation on every page, and several special activities during the week. These events began with a violin and piano concert by Jack Liebeck and Inon Barnatan on the Tuesday evening, which recognized Einstein's love of the violin and was introduced by Brian Foster from Oxford University. Then on Wednesday afternoon, the US, Asian and European PAC series joined forces in a special session, "Einstein and the World Year of Physics", organized by Swapan Chattopadhyay from JLab. The session was chaired by Bill Madia of Battelle and included four presentations relating present-day research to Einstein's legacy: Michael Turner from the NSF, Makoto Kobayashi of KEK, Yoichiro Suzuki of Tokyo and Carlo Rubbia from CERN.

Einstein in the City

To draw the public's attention to the World Year of Physics, an "Einstein in the City" festival followed the session. Organized with the City of Knoxville, the festival drew conference participants and several hundred others to the World's Fair Park, outside the convention center. Part of the festival was a science fair for local

(Continued on page 10)

(Continued from page 9)

high school students, with prizes awarded to projects judged by a team of conference participants. A special panel moderated by Madia, answered science-related questions from the public for about an hour: Maury Tigner (Cornell), Michael Turner (NSF), Norbert Holtkamp (SNS) and Carlo Rubbia (ENEA/CERN).

Another highlight of the conference was the now customary prize session, in which the winners of several accelerator prizes are recognized and have the opportunity to report on their research. The session chair, Nan Phinney of SLAC, congratulated recipients individually and presented some of the awards. Among them was Keith Symon of the University of Wisconsin–Madison, winner of the American Physical Society’s prestigious Robert R Wilson Prize “for fundamental contributions to accelerator science, including the FFAG concept and the inven-

tion of the RF phase-manipulation technique that was essential to the success of the ISR and all subsequent hadron colliders.” The other APS prize was for an outstanding doctoral thesis by Eduard Pozdeyev from JLab, who performed his doctoral work at Michigan State University. Ron Davidson of Princeton and Thomas Roser of Brookhaven National Lab were awarded the Particle Accelerator Science and Technology Award from the Nuclear and Plasma Science Society of the Institute of Electrical and Electronics Engineers. Wim Leemans of the Lawrence Berkeley National Laboratory (LBNL) and Anton Piwinski of DESY were presented with the US Particle Accelerator School Prize for Achievement in Accelerator Physics and Technology.

Many participants extended their stay by a day to visit the SNS site at Oak Ridge. (see story on page 12).

The above was extracted with permission from "Conference brings Einstein to Tennessee" published in the September 2005 CERN Courier.

Plans for PAC07 *Stan Schriber, Michigan State University*

The 2007 Particle Accelerator Conference on Accelerator Science and Technology (PAC07) will be held 2007 June 25-29 at the Albuquerque Convention Center in New Mexico. The web site for the conference is <http://pac07.lanl.gov>. This will be the twenty-second conference in the biennial series that began in 1965. PAC07 will be held under the sponsorship of the Nuclear and Plasma Sciences Society (NPSS) of the IEEE, and the Division of Physics of Beams of the APS. It is because of these technical societies and the volunteers from these organizations that we are able to hold these successful series of conferences, permitting exchange of information and effective interactions. Membership in these professional societies is what keeps us strong and able to provide services for the entire accelerator community. Those who continue their memberships in these or affiliated organizations are especially thanked for their support.

Los Alamos National Laboratories is the host for PAC07 and will provide a tour of their high-power linac-based research facility LANSCE after the conference on Saturday, June 30, 2007.

An enthusiastic and effective team has been assembled to manage PAC’07 consisting of

- Stan Schriber (MSU) Chair
- Bob Garnett (LANL) Scientific Program Chair

- Lorraine Stanford (LANL) Conference Administrator
- Tsuyoshi Tajima (LANL) Local Organizing Committee Chair
- Shirley Atencio (LANL) Treasurer
- Luce Salas (LANL) Editor
- Christine Petit-Jean-Genaz (CERN) Editor

Tsuyoshi Tajima has organized an excellent local committee including

- Roberta Lopez (Registration)
- Valerie Miller (Publicity)
- Michael Carter (IT)
- Alberto Canabel-Rey (Web Master)
- John Eddelman (Industrial Exhibition)
- Peggy Vigil (Tours)
- Andrea Sanchez (Companions)

We expect about 1200 attendees and about 50 industrial exhibitors, making for a suitable and useful communication and exchange opportunity. The first scientific program committee meeting to suggest possible invited speakers will be held in Dallas 2006 April 21 just prior to the spring APS meeting.

For further information on PAC’07 please contact Lorraine Stanford (Istanford@lanl.gov, 505-665-2044).

The ILC Global Design Effort

Barry C Barish, CalTech and Director of the GDE

Following the ICFA decision to base the design of the linear collider on superconducting RF technology, the worldwide accelerator community rapidly reorganized itself toward creating a new global design. In November 2004, a very successful 1st ILC workshop was held at KEK Laboratory that was attended by more than 200 accelerator physicists from around the world. At that workshop, the ILC design efforts were divided into six working groups having designated task leaders, and this proved to be the first big step toward initiating a global design effort.

The momentum generated through the creation of this self-organized set of working groups carried the effort until last summer when the official Global Design Effort (GDE) had been formed. The GDE met for the first time during the 2nd ILC workshop at Snowmass in August 2005. At that meeting, the reins were turned over from the informal self-organized working groups to the GDE, and the work quickly focused in on deciding and documenting a baseline configuration for the ILC. A goal was set to define that baseline and to document it in a Baseline Configuration Document (BCD) by the end of 2005.

To accomplish that goal, more than 40 questions were identified at Snowmass and these needed to be decided before a unified baseline could be defined. The decisions varied from key ones like the operating gradient of the superconducting cavities and the design luminosity to other questions such as whether the machine should follow the earth's curvature or be laser straight. Consensus were sought on all of these questions during and after Snowmass and that process led to a "strawman" baseline that was posted several weeks before the GDE was next to meet at Frascati, Italy in December 2005.

At Frascati, this document was discussed in some detail and the last questions were debated, some changes agreed to, and then the BCD was declared to be official. Successfully achieving this first major milestone for the GDE was an important accomplishment. It bodes well for the process that has been undertaken to create a global design and eventually a machine.

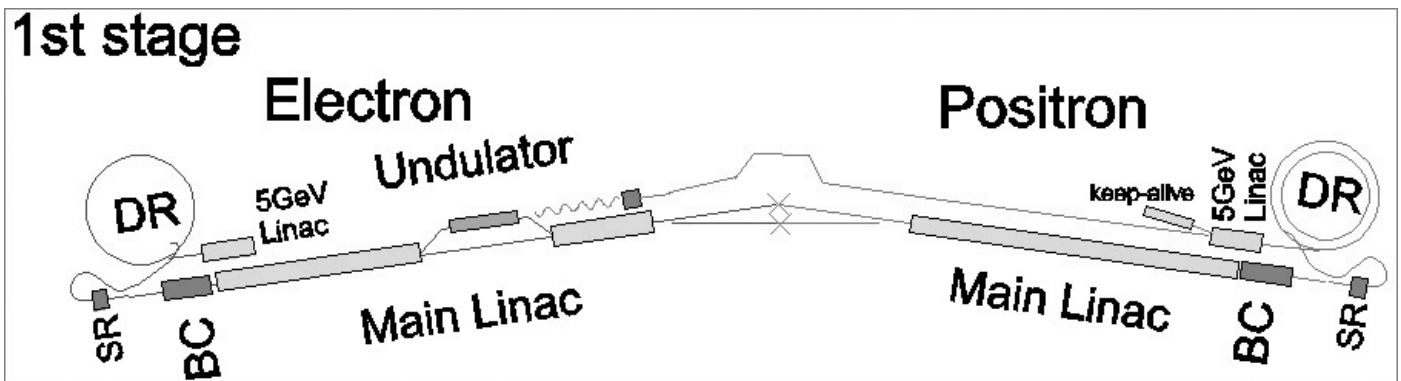
As a result of this effort, there is now an agreed to and documented configuration for the ILC (see below)

The ILC 500 GeV Baseline Configuration

The next goal is to produce a Reference Design Report (RDR) that is based on the BCD and one that has reliable cost estimates. The RDR will also contain sections on siting, industrialization, detector concepts, performance and options for the machine, including upgrade plans to 1 TeV. In order to accomplish this next step, the GDE has been reorganized and expanded somewhat to bring in some missing skills. At this point, the program to develop the reference design report is well-underway.

The BCD was "frozen" after it was agreed upon last December and has been put under formal configuration control. This step was necessary in order to maintain a stable configuration during the design and costing effort. A Change Control Board and process have been established to make and document changes in an orderly manner, and that is now working well. Several changes have already been made and the BCD is expected to continue to evolve, as more is learned through the design process and later through improvement established in the R&D program that will improve the performance or reduce the costs.

The next big milestone for the GDE will be to produce the Reference Design Document, and the envisioned time scale is to release it in draft form by the end of this calendar year.



Spallation Neutron Source

Ian Anderson and Norbert Holtkamp, Spallation Neutron Source Project, Oak Ridge Ntnl Laboratory

The Spallation Neutron Source (SNS) is a second-generation, pulsed neutron source under construction at Oak Ridge National Laboratory (ORNL). SNS is funded at 1.4 billion dollars by the U.S. Department of Energy's Office of Basic Energy Sciences and is dedicated to the study of the structure and dynamics of materials by neutron scattering. A partnership of six national laboratories (Argonne, Brookhaven, Jefferson, Los Alamos, Lawrence Berkeley, and ORNL) is responsible for design and construction of this unique facility.

The SNS project began in October 1998, and operation of the facility will begin in spring 2006. The SNS accelerator will ultimately deliver an average 1.0-GeV, 1.4-MW proton beam with a pulse length of ~700 ns to a liquid mercury target at a repetition rate of 60 times a second. The pulsed beam power delivered by the SNS accelerator increases by almost an order of magnitude compared with existing neutron facilities. The SNS linac consists of a combination of room-temperature and superconducting structures and is the world's first pulsed, high-power linac and is currently the highest energy superconducting linac in the world.

The SNS accelerator system consists of a negative hydrogen (H-) radio-frequency (RF) volume source, a low-energy beam transport housing a first-stage beam chopper, a 4-vane RF quadrupole for acceleration up to 2.5 MeV, a medium-energy beam transport housing and a second-stage chopper, a 6-tank drift-tube linac up to 87 MeV, a 4-module coupled-cavity linac up to 186 MeV, and a superconducting linac with 11 medium- β cryomodules (up to 379 MeV) and 12 high- β cryomodules (up to 1000 MeV). The linac produces a 1-ms-long, 38-mA peak, chopped beam pulse at 60 Hz for accumulation in the ring. A high-energy beam transport line provides for diagnostics and collimation after the linac injects into a 248-m-circumference accumulator ring to compress the 1-ms pulse to ~700 ns for delivery onto the target through a ring-to-target beam transport beam line. Neutrons are produced by spallation in the target, dumping 27 kJ per pulse into ~1 m³ of circulating mercury. The neutron energy is then moderated to useable levels by supercritical hydrogen and water moderators before feeding into 24 beam lines.

With the successful commissioning of the superconducting linac in summer 2005 and the recent January 2006 commissioning of the accumulator ring, the accelerator

has operated all major accelerator subsystems and has exceeded the commissioning goal of 10¹³ H⁻ (protons) per pulse. In fact, the linac delivered as much as 8 × 10¹³ (16 × 10¹³ design) and the circulating peak current extracted from the ring was as high as 15 Ampere (34-Ampere design).

Proton beam energy on target	1.0 GeV
Proton beam current on target	1.4 mA
Proton beam power on target	1.4 MW
Pulse repetition rate	60 Hz
Beam macropulse duty factor	6%
H- peak current @ front end	>38 mA
Average current per macropulse	26 mA
Chopper beam-on duty factor	68%
Linac length, including front end	335 m
Ring circumference	248 m
Ring fill time	1 ms
Ring extraction gap	250 ns
Protons per pulse on target	1.5 × 10 ¹⁴
Liquid mercury target	18 tons 1 m ³
Number of moderators	4
Minimum initial instruments	8

Especially with the initial operation of the superconducting linac, significant uncertainties with respect to the design had to be overcome. High gradient operation of the cavities, initially designed for 10.5 and 16.0 MV/m in the medium/high- β cavities, exceeded expectations by typically 20%, which provides additional flexibility during operation. Lorentz Force detuning and vibration affecting high Q cavity operation was well within expectations, allowing additional RF power to be provided to the beam. With these major hurdles out of the way, the linac can make full use of the advantages accompanying a superconducting RF accelerator. For example, the large aperture leading to little halo growth and less activation, excellent vacuum reducing the residual gas stripping of H- ions, and high gradient operation allowing for a large longitudinal and transverse acceptance with almost no emittance growth.

After demonstrating successful functionality, the accumulator ring has additional challenges to face. Charge exchange injection at very high intensities and accumulation and extraction with low beam loss around the ring (<1 W/m), while eventually controlling instabilities and maintaining a large beam spot on the face of the target vessel, will be key to successful high-power operation.

(Continued on page 13)

(Continued from page 12)

The next stage of SNS commissioning will take place in April 2006 when the first beam will be extracted and delivered to the mercury target. The spallation process in the mercury produces high-energy neutrons which are then slowed to useable energies by one ambient water and three liquid hydrogen moderators that are integrated into a highly optimized reflector system above and below the target. After moderation to thermal and subthermal energies, the neutrons are guided to the instrument hall where up to 24 instruments can be accommodated. The mercury flow system has been thoroughly tested, as have all the remote-handling procedures that will be used during future operations to change out the target modules. Tests of the cryogenic moderator systems are under way in preparation for production of the first neutron beams in April.

To date, 17 instruments have been assigned beam lines, including 2 reflectometers, 7 diffractometers, 7 spectrometers, and 1 beam line dedicated to fundamental physics research. These instruments cover a wide range of scientific disciplines and will enable structure determinations ranging from fractions of a nanometer to microns. Furthermore, the spectrometers designed for SNS

will allow determination of the dynamical processes in materials with characteristic times ranging from attoseconds to milliseconds. The unprecedented performance of SNS instrumentation will enable new measurement capability in materials science, nanotechnology, medicine, and renewable programs.

The general user program is expected to begin in 2007 for a small group of the instruments. Instrument use in 2008 will be preceded by a period for initial users to assist SNS instrument scientists in the commissioning of these instruments during the ramp up of power, predictability, and reliability.

Research at SNS will be complemented by opportunities available elsewhere at ORNL. Together with the expanded capabilities of the High Flux Isotope Reactor, the synthesis and characterization facilities in the new Center for Nanophase Materials Science, the bio-deuteration capabilities of the Center for Structural Molecular Biology, and the resources of the Center for Computational Sciences, we believe ORNL will offer unparalleled opportunities for the study of the structure and properties of materials. For more information on SNS, please visit our web site at www.sns.gov.



The SNS site: a 300 m proton linac - largely superconducting - provides a 1 ms pulse at 60 Hz into an accumulator ring, where 700 ns bunches are created. The project goal is to deliver an average beam power of 1.4 MW on the target; the first beam is expected in June 2006. The SNS has been built by a unique partnership of six US Department of Energy laboratories: Argonne, Berkeley, Brookhaven, JLab, Los Alamos and Oak Ridge.

Neutrino Beams around the World

Weiren Chou, Fermilab

The recent discovery that the neutrino has mass has generated enormous interest in neutrino studies. There are numerous natural sources of neutrinos: the Sun, the Earth, cosmology, atmosphere, Supernovae, etc. But for experimental study, accelerators and reactors are where intense and controllable neutrino beams can be obtained.

Accelerators are used for producing high energy neutrino beams. The table below lists the facilities that are either operating or under construction.

Accelerator	Power (MW)	Energy (GeV)	Intensity (10^{12} ppp)	Rep. Rate (Hz)	Experiment	Baseline (km)
KEK-PS	0.005	12	6	0.45	K2K	250
FNAL-Booster	0.032	8	5	5	MiniBooNE	0.54
FNAL-MI	0.3	120	30	0.53	MINOS/NOvA	735
CERN-SPS	0.3	400	30	0.16	CNGS	732
J-PARC	0.75	50	320	0.3	T2K	295

Conceptual planning is underway for more intense and in some cases longer baseline neutrino beams.

Accelerator	Power (MW)	Energy (GeV)	Intensity (10^{12} ppp)	Rep. rate (Hz)
FNAL-SCRF Linac	2	8	150	10
BNL-Super AGS	1	28	89	2.5
CERN-SPL	4	2.2	230	50
J-PARC Upgrade	4	50		

Reactors are used for low energy neutrino beams. The following table lists the projects that are either approved or in the process of getting approval.

Project	Location	Reactor Power (GW)	Baseline (km)	Detector (ton)	Start Date (expected)
Double Chooz	France	8.4	1.1	10	2007
Daya Bay	China	11.6	1.8	2×40	2008
KASKA	Japan	24.3	1.6	2×6	2009
RENO	Korea	17.3	1.5	20	2009
Braidwood	U.S.A.	7.2	1.5	2×65	2010
ANGRA	Brazil	6.0	1.5	500	2013

In addition to these conventional and super neutrino beams, there are also studies for β -beam and neutrino factories for the long term future (e.g., a new initiative in 2006 titled *International Scoping Study*).

2006 Beam Physics Conferences and Workshops

April 22—24, 2006 “2006 APS April Meeting,” Dallas, Texas

May 15—19, 2006 “FLS2006, 37th ICFA Advanced Beam Dynamics Workshop on Future Light Sources,” DESY, Hamburg,

May 29—June 2, 2006 “HB2006, 39th ICFA Advanced Beam Dynamics Workshop on High Intensity High Brightness Hadron Beams,” Tsukuba, Japan

June 26—30, 2006 “EPAC'06,” Edinburgh, UK

July 19—22, 2006 “Vancouver Linear Collider Workshop,” Vancouver, Canada

July 30, 2006 ICFA meeting will be held during ICHEP06 in Moscow

August 21—25, 2006 “LINAC'06,” Knoxville, Tennessee

August 27—September 1, 2006 “FEL'06,” Berlin, Germany

September 10—14, 2006 “RUPAC-2006, XX Russian Conference on Charged Particle Accelerators,” Budker Institute of Nuclear Physics (BINP), Novosibirsk, Russia

September 15—17, 2006 “40th ICFA Advanced Beam Dynamics Workshop on e+e- Factories,” Budker Institute of Nuclear Physics (BINP), Novosibirsk, Russia

Oct. 2—6, 2006 “ICAP, 9th International Computational Accelerator Physics Conference,” Chamonix, France

2007 Beam Physics Conferences and Workshops

January 29—2 February 2, 2007 “APAC2007,” Raja Ramanna Centre for Advanced Technology, Indore, India

March 5—9, 2007 “2007 APS March Meeting,” Denver, Colorado

April 14-17, 2007 “2007 APS April Meeting,” Jacksonville, FL

June 25—29, 2007 “PAC'07,” Albuquerque, NM

February 8—9, 2007 ICFA meeting will be at IHEP, Beijing

July 16—20, 2007 “CEC/ICMC 2007 Cryogenic Engineering Conference and International Cryogenic Materials Conference,” Chattanooga, Tennessee

August 27—August 31, 2007 “MT20, 20th International Conference on Magnet Technology,” Philadelphia, Pennsylvania

September 16—20, 2007 “EUCAS, 8th European Conference on Applied Superconductivity” Brussels, Belgium



American Physical Society
One Physics Ellipse
College Park, MD 20740-3844

PAC07 will be held at the Albuquerque Convention Center

