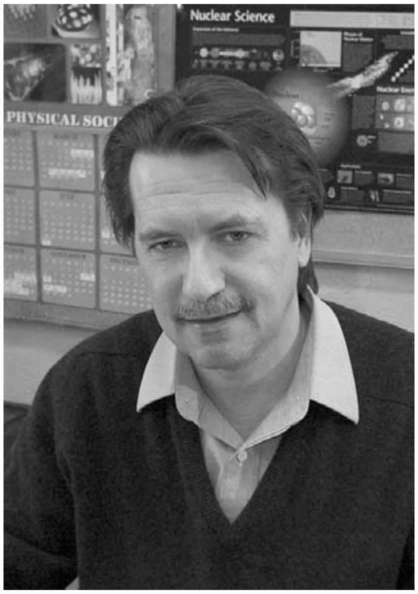
Division of Physics of Beams Newsletter

Spring 2007

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

Report from the DPB Chair

Thomas Roser, Brookhaven National Laboratory



This past year has again seen growing activities in beam physics. The large collider effort focused on the successful operation of the two B factories, record luminosities at the Tevatron, at RHIC and also during the final months of the operations of HERA. At the same time the preparations for commissioning of LHC are entering the final phase. This newsletter has two reports on these efforts at CERN. Of the two major accelerator construction projects in the US, the SNS at ORNL has successfully started low power operation and the construction of the Linac Coherent Light source (LCLS) at SLAC is making good progress.

There are several areas where the Division of Physics of Beams was active this year:

Report of the HEPAP Subpanel on Advanced Accelerator R&D

This is the third time that a HEPAP subpanel has reviewed the efforts in Advanced Accelerator R&D (AARD) in the US. The report was issued on July 11, 2006 and recommended strong support for both mid-term and long-term accelerator R&D efforts. In particular, it included the recommendation that "an Accelerator Science Graduate Fellowship program in the DOE and NSF should be given high priority." This follows a specific proposal made by DPB to DOE and NSF. DOE and NSF are presently working on implementing the recommendations of the subpanel.

DPB membership

Although the DPB membership remained quite constant over the last few years the percentage of DPB members of the total APS membership has steadily declined and now stands at 2.55%. Efforts to grow the DPB membership have focused on attracting members of traditionally related Divisions (DNP, DPF, DPP) to also join DPB by offering free first-year DPB membership. Also, joined sessions with the Forum on Industrial and Applied Physics (FIAP) on accelerator applications were organized both during the 2006 April and 2007 March APS meetings. Together with a joint session with the Forum on the History of Physics on Synchrotron Light Sources, this is the first presence of DPB at an APS March meeting. To reach out to this important and growing accelerator user

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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: ernestmalamud@comcast.net

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community we also made an offer to all APS members attending the March meeting for a free first-year DPB membership.

Graduate student support

DPB has also supported graduate students attending the Particle Accelerator Conferences and the APS April meetings. It is particularly important to encourage students to join APS and DPB by pointing out the many benefits to their career of belonging to the main professional organization of accelerator physicists.

Particle Accelerator Conference frequency

The biannual Particle Accelerator Conference (PAC) started in 1965, initially sponsored by IEEE/NPSS. In 1993 APS/DPB became an official co-sponsor. This conference is the most important meeting for the accelerator scientists and engineers that form the membership of DPB and, with typically 1200 attendees, it is the largest conference on particle accelerators. It is also the annual DPB divisional meeting during the years it occurs. Similar conferences have since been organized, first in Europe (EPAC) and then in Asia (APAC). To coordinate internationally a three-year cycle for each of these three conference series has been proposed. The DPB executive committee is engaged in coordinating the PAC cycle with the other conference series and at the same time aims to preserve the important functions that PAC plays for the accelerator scientists and engineers in North America.

Award for Outstanding Doctoral Thesis in Beam Physics

Jeroen van Tilborg, LBNL and Technische Universiteit Eindhoven

For his dissertation describing the detection, characterization, and imaging of coherent THz radiation from laser-wakefield-accelerated electron beams. His thesis was under the supervision of Wim Leemans in the LBNL L'Oasis Laboratory.

DPB Members recognized as APS Fellows

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

Mark J. Hogan, Stanford Linear Accelerator Center
Citation: For scientific achievement and leadership in the development of electron and positron beam-plasma interactions, including the first experimental demonstration of meter-scale wakefield acceleration.

Norbert Richard Holtkamp, Oak Ridge National Laboratory
Citation: For leadership in the successful construction and commissioning of the Spallation Neutron Source.

Alexander Henderson Lumpkin, Argonne National Laboratory
Citation: For his pioneering work in the time-resolved imaging of particle and photon beams, which has led to a better understanding of the dynamics of accelerator and photon source related physical processes.

Nikolitsa Merminga, Center for Advanced Studies of Accelerators
Citation: For leadership in designing and developing energy recovery linacs, and applications to light sources and electron-ion colliders.

Sergei Nagaitsev, Fermi National Accelerator Laboratory
Citation: For designing, building, and successfully commissioning the world's first relativistic electron cooling device.

Peter N. Ostroumov. Argonne National Laboratory
Citation: For creativity and leadership in the design and development of both normal conducting and superconducting ion linear accelerators.

DPB Election Results

The election ended Oct 3, 2006. 491 members voted, 42% of our membership, an excellent turnout.

The newly elected members of the DPB Executive Committee are **Swapan Chattopadhyay**, Vice-Chair for a 4-year term in the Chair line. **Carol Johnstone** and **Stuart Henderson** are newly elected members-at-large for 3-year terms.

Their terms begin at the business meeting at PAC07.

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

This prize, jointly sponsored by DPB and DPF, was awarded in 2007 to **Lee Teng** *"For invention of resonant extraction and transition crossing techniques critical to hadron synchrotrons and storage rings, for early and continued development of linear matrix theory of particle beams, and for leadership in the realization of a facility for radiation therapy with protons.*"

Lee Teng taught at the University of Minnesota (Assistant Professor 1951—53) and Wichita State University (Associate Professor 1953—55). After that he joined Argonne National Laboratory where he was Director of the Particle Accelerator Division from 1955—67. For the next two years he was Associate Head of the Accelerator Division at Fermi National Accelerator Laboratory. From 1983—85 Teng was Director of the Synchrotron Radiation Research Center (Taiwan) and then returned to Argonne to become Head of Accelerator Physics at Advanced Photon Source 1989—97

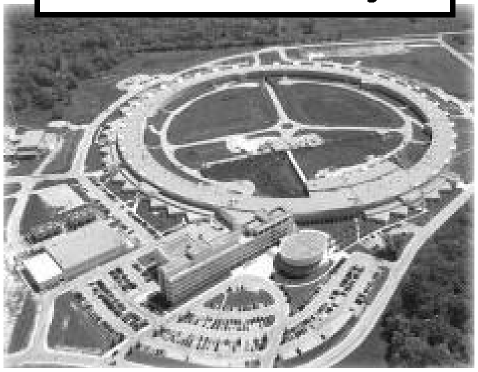
Teng has made many significant scientific contributions as well as being a leader in Accelerator Physics research and Accelerator Project Management. He is a Fellow of American Physical Society and a Member of Academia Sinica (Taiwan).

Excerpts from Lee Teng's Autobiography "Accelerators and I"
Reprinted with permission from the ICFA Beam Dynamics Newsletter #35, December 2004, pp. 8—19.
Teng's complete autobiography is at http://www-bd.fnal.gov/icfabd/Newsletter35.pdf

"I was trained at the U of C as a quantum field theorist. My association with accelerators began also at the U of C with the Fermi cyclotron because of the necessity to survive. From that time on, accelerator projects that beckoned my attention just came along one after another. Looking back, I never had time to ponder the wisdom and the implications of making the transition from particle to accelerator physics, but I did occasionally wonder what I could have accomplished if I had stayed in particle physics."

"I have always enjoyed teaching. It is a delight to see lights of 'Eureka' flicker into the students' eyes. It is also absolutely true that teaching is the best way to really understand the subject yourself. At my age now I feel that the most useful and noble thing I can do is to pass my knowledge on to the younger generation. So I give lectures and classes at every opportunity."

Advanced Photon Source, Argonne



"When I was young I used to think the only science worth pursuing was that dealing with the 'ultimates' such as the 'elementary particles' and the 'cosmos,' and questions of how bulk matters form and behave (even of how, out of inanimate bulk matters, life and intelligence sprang) were 'details.' As I grow older, I gradually have come to admit the importance and relevance of the world of materials and of humankind. So I started to work on 'useful' things like synchrotron radiation sources and radiation therapies. But I still think the 'cosmic' problems of the 21st Century, such as the unification of all forces and what are dark matter and dark energy, are extremely fascinating."

National Synchrotron Radiation Research Center, Taiwan

Nominations for the 2008 Wilson Prize should be sent to Steve Peggs (peggs@bnl.gov) Chair of the 2008 Selection Committee by July 1, 2007. Guidelines for nominations are at http://www.aps.org/praw/index.cfm.

Announcement of upcoming U.S. Particle Accelerator School (USPAS) courses sponsored by Michigan State University and held in Lansing, Michigan June 4-15, 2007

Two-week courses: June 4-15, 2007

- **Fundamentals of Accelerator Physics and Technology with Simulations and Measurements Lab (undergraduate credit)** Fernando Sannibale, Soren Prestemon and David Robin, Lawrence Berkeley National Laboratory
- **Accelerator Physics** Jospeh Bisognano, SRC and the University of Wisconsin-Madison
- **Classical Mechanics and Electromagnetism in Accelerators** Gennady Stupakov, Zhirong Huang, SLAC

One Week 1/2 courses: June 4-8, 2007

- **Beam Experiments and Measurements at the NSCL** Stan Schriber, Marc Doleans, Guillaume Machicoane, Walter Hartung and the NSCL staff, Michigan State University and Eduard Pozdeyev, Brookhaven National Laboratory
- **The Plasma Physics of Beams** Patrick Colestock, Los Alamos National Laboratory
- **Superconducting Accelerator Magnets** Soren O. Prestemon and Paolo Ferracin, Lawrence Berkeley National Lab and Ezio Todesco, CERN
- **Radiation Physics, Regulation, and Management** Don Cossairt, FNAL, Reginald Ronningen, NSCL/MSU
- **Ion Sources and Low-Energy Ion Beams** Martin Stockli, Oak Ridge National Laboratory

One Week 1/2 courses: June 11-15, 2007

- **Accelerator Power Electronics Engineering** Paul Bellomo and Antonio de Lira, SLAC
- **Accelerator X-Ray Sources** Richard Talman, Cornell University
- **System Safety and Safety Systems for Accelerators** Kelly Mahoney, Jefferson Laboratory
- **Fundamentals of Low-beta Linear Accelerators with Simulation Lab**
  John Staples (ret.) Lawrence Berkeley National Lab, George Gillespie, G.H. Gillespie Assoc. Inc, and Chris Allen, LANL

MORE INFORMATION at uspas.fnal.gov

Congratulations go to the winners of the 2007 U.S. Particle Accelerator School Prize for Achievement in Accelerator Physics and Technology

Yaroslav Derbenev

"for his seminal contributions to the theory of beam polarization in accelerators and its control with 'Siberian snakes,' the theory of electron cooling and the inventions of 'round-to-flat' beam optics transformations and novel six dimensional muon cooling schemes."

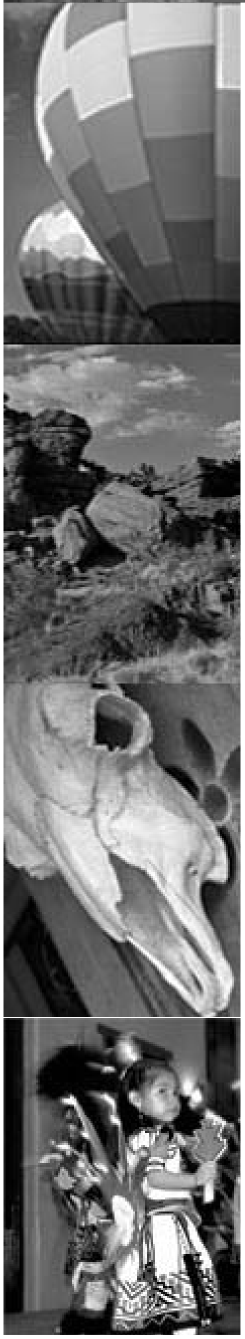
Sergei Nagaitsev

"for his outstanding scientific leadership in the demonstration of non-magnetized relativistic electron cooling of hadron beams to improve collider luminosity."

The awards will be presented at the 2007 Particle Accelerator Conference

PAC 2007 (2007 June 25-29 in Albuquerque, NM)

Stan Schriber, Conference Chair, NSCL, Michigan State University

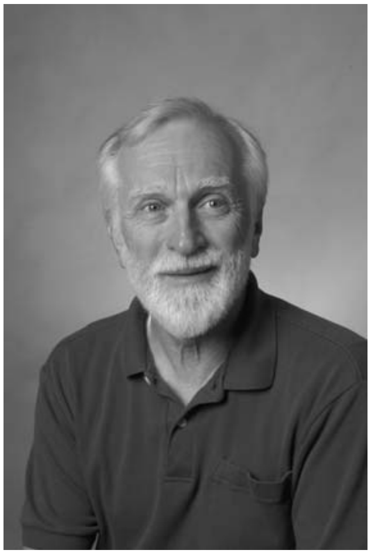


Plans for PAC'07, the 22nd conference in this highly successful conference series for accelerator science engineering and technology, are going very well.

As of April 1, 1822 abstracts have already been submitted to the online JACoW site, 51 industrial exhibitors have registered for 56 booths and there are already 440 registrants, a record so early on.

On the basis of historic ratios of abstract submissions to conference attendees, attendance at the conference in Albuquerque, June 25-29, could exceed 1400, making for the possibility of an extremely successful conference, both scientifically and financially. On-line registration for delegates and for exhibitors began 2007 January 10. Members of IEEE-NPSS and APS-DPB have a 10% discount on the conference registration fee.

We have tried to encourage individuals to join a professional society by including the following message in the opening registration page "Volunteers, who are members of either IEEE-NPSS or APS-DPB, make it possible for important information exchange with colleagues at conferences such as the PAC series. Technical societies help our professional interests in many ways other than just supporting conferences. Prizes for significant contributions in accelerator technology, recognition for many years of contributions by awarding senior and/or fellow levels, support of publication processes and student support are just a few of the activities provided by our technical societies. Please consider joining if you are not already a member. Help make us stronger."



Booths provide adequate space and are well located within the poster paper area for good interaction with attendees.

Plans are also underway for two special events associated with the conference. The first is a science, engineering, and technology exposé for the residents of New Mexico at the Albuquerque Convention Center Garden Foyer on the Saturday prior to the conference, June 23. Participants will be from Los Alamos National Laboratory, Sandia National Laboratory, University of New Mexico and some of the industrial exhibitors who have booths and exhibits at PAC07. Also included are the technical societies of IEEE and APS.

The second is a special Teachers' Physics Day on Wednesday June 27 providing a full day of professional development geared to high school physics teachers that includes: hands-on workshops presenting innovative, classroom-ready activities for physics students; research talks on accelerator technology and their applications for our daily life; and a welcoming breakfast where they can network with fellow teachers and a luncheon where they can network with each other and conference participants.

A special student poster session will be held Sunday June 24 to encourage the interaction of students with other students, colleagues and peers. Students, whose attendance is being partially sponsored by the conference, will be included in this opportunity to interact with others in the accelerator-related fields.

MORE INFORMATION at pac07.org

Accelerators for Security, Nondestructive Testing, and other Industrial Applications

Andrey V. Mishin, American Science & Engineering Inc., Billerica, MA 01821, USA

Since the sale of its High Energy Systems Division in January 2005, American Science and Engineering, Inc. (AS&E) has no longer been in the business of mass-producing electron linear accelerators, but continues to be a user of linacs in security, contributes to designs, and remains a sponsor for various advanced X-ray sources such as X-ray tubes, various particle accelerators, and in particular, linacs applicable to the screening of cargo. Before the sale of AS&E's High Energy Systems Division, we designed several new advanced high energy electron beam and X-ray sources based on X-band, S-band, and L-band linacs. The reader can find descriptions of these systems in multiple publications; the most recent papers are in the reference list. The wealth of our several-decade experience in this field is quite helpful in working with our vendors. AS&E's focus on security has always brought us to interesting solutions by carefully balancing performance, size, and cost of the linacs and other sources. While we will review trends of the industrial linacs today, we will also consider security applications as this field has become an important driver for X-ray source applications and technology.

What are the most common applications of accelerators today?

After the medical field, which remains the largest field for the application of particle accelerators, both electron and proton, the other quickly-growing demand is in the field of security and, specifically, screening of cargo. This application is a form of nondestructive testing or screening of dense objects. Currently, the primary demand in the security field is for electron accelerators delivering beams in the energy range 1 to 10 MeV and power ranging from tens of watts to tens of kilowatts for generation of bremsstrahlung, which after appropriate collimation is formed in various directed probes such as a pencil beam or fan beam. These well-shaped and directed X-ray beams are used for scanning of dense objects of interest - most frequently, cargo containers. High-resolution images are produced either in real time or in a very short time after collection of information by analyzing the signals picked up by detectors – linear arrays, for example. Please refer to the AS&E web site www.as-e.com or other similar web sites for more information on the products for security systems.

The other large field of applications is radiation processing using electron or photon beams including:

- sterilization by electron beam and X-rays;
- radiation curing of polymers;
- radiation chemistry;
- food pasteurization.

The community is actively seeking other applications for particle accelerators, and some interesting proposals have been cited, such as production of isotopes using accelerators as an alternative to nuclear reactors.

How do industrial accelerators typically differ from (or are similar to) academic accelerators?

Several factors, both old and relatively new, have influenced current industrial accelerator design. Customer requirements for X-ray sources have become much more stringent. Magnetron-driven accelerators in energy below 10 MeV and dose rates from 100 to 3000 R/min @ 1 meter have become common in the market, while they remain very complex products requiring a high degree of consistency and production control. Growing international competition has set a reduced price demand on domestic suppliers. Emerging foreign suppliers have become much more active in the market and offer commercially available systems for various applications at a comparable and often lower cost. Notwithstanding the price pressure, business demands and customers require superb technical performance along with optimized power consumption. Extended life, reliable service and spare parts supply must provide users with around-the-clock operation and minimum downtime, especially for critical applications influencing the flow of commerce. A minimum possible size, mass, and footprint are highly desirable, although not always necessary. Therefore, the scale of produced systems varies over a broad range. The smallest accelerator designed by AS&E in the corresponding parameter range is shown in Figure 1. The complete turn-key system mass is on the order of 1000 pounds (approximately 450 kg) including a closed-loop chiller with a 1 MeV to 2.5 MeV X-band accelerator head that would fit in the palm of one's hand.

The other end of the range are high power accelerators,

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Fig. 1. Tiny and highly efficient X-band accelerator section (left) with energy regulation, 1 to 3 MeV, beam power up to 1 kW. Total turn-key system (right), mass of approximately 500 kg, consumes approximately 12 kW of total wall-plug power. Local shielding is used to operate this unit (top cover shown removed).

pulsed or CW. One to ten MeV linear accelerators normally use up to 50 kW beam power. The highest available power commercial accelerator is a CW accelerator Rhodotron (Fig. 2), originally designed for electron beam processing applications. The Rhodotron delivers an electron beam up to 10 MeV, power from 35 to 700 kW with high efficiency and a tight spectrum, and weighs 2500 kg. The complete system mass exceeds 7,000 kg with power consumption up to 1.27 MW for maximum output.

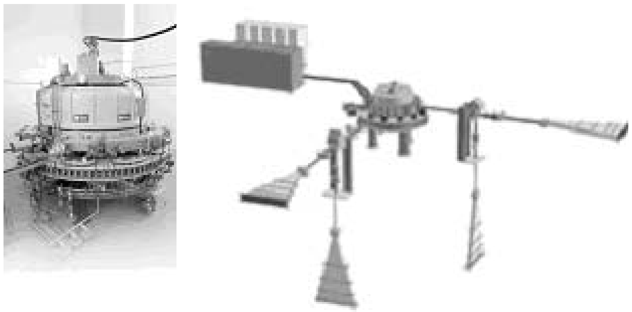

Fig 2. Rhodotron accelerator cavity with bending magnets, mass ~ 2.5 t (left). It delivers e-beam with energy up to 10 MeV, regulated in steps. The system mass exceeds 7 t, and it can deliver beam with average power up to 0.7 MW, consuming near 1.3 MW. It is shown with power supplies and various beam lines installed for radiation processing (right).

One might consider introducing and analyzing various factors, which tie performance of the linear accelerators and their commercial characteristics such as:

1. **P/m** [R/min/kg], **P/V** [R/min/m^3], **P/S** [R/min/m^2] - Dose rate measured at 1 meter from conversion target **P** per unit mass **m**, volume **V**, and footprint **S**.
2. Price for available dose rate at fixed energy **Price/P** [USD/R/min], interpreted as “dollars per Rad”.

How is accelerator R&D funded and managed?

R&D is usually funded via several sources. Relatively small projects are frequently funded from an internal R&D budget, especially if they are in the best strategic interests of the company, and if return on investment, commonly called ROI is substantial, meeting the company requirements and the industry standards. We attempt to fund the longer term and higher cost projects using various available government programs and through various partnerships. There are many new trends in the industry and new developments are emerging.

What is a career in industry like?

It is exciting, but very demanding driven by the objectives that have been highlighted earlier. While lining up financing and starting the projects requires tremendous patience, it is very dynamic environment, which requires a combination of creative ideas, managing cost, deadlines, and superior quality of the products. The best rewards are the reduction of ideas to practice resulting in operating equipment that serves many purposes and even saves lives, and, certainly, it is also working with the multi-talented people who make it all happen.

Acknowledgements

I would like to thank Dr. Eric Colby of SLAC for his kind invitation to present this paper and management of AS&E for supporting the effort.

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SNS Commissioning *by Stuart Henderson*

After seven years of construction, the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory was formally completed in June 2006. At full power, the U.S. Department of Energy user facility will be ten times more powerful than existing pulsed neutron sources. The SNS construction project was initiated in 1999 as a partnership of six national laboratories: Argonne, Berkeley, Brookhaven, Los Alamos, Oak Ridge, and Thomas Jefferson.

The SNS accelerator complex consists of a 2.5-MeV H^- injector system, an ~190-MeV normal-conducting linac, a superconducting linac with 1-GeV output energy, a proton accumulator ring and transport lines, and a liquid mercury target system. The linac will provide a 1-ms-long, 38-mA peak current, chopped H^- beam pulse of 1 GeV energy at 60 Hz. The long beam pulse is accumulated in 1000 turns in the ring, reaching a beam intensity of 1.5×10^{14} protons in a 0.7-μsec pulse. At full design specification, SNS will provide 1.4 MW of proton beam power on target.

Lawrence Berkeley National Lab designed and built the H^- injector system; Los Alamos provided the normal-conducting linac and associated radio-frequency system components; Thomas Jefferson National Accelerator Facility built the superconducting linac cryomodules and cryogenic system components; Brookhaven designed and built the proton accumulator ring and transport line components; Argonne and Oak Ridge national labs designed and built the neutron scattering instruments and moderators; and Oak Ridge was responsible for the mercury target systems, conventional facilities, accelerator installation, system integration, and commissioning. Oak Ridge now operates the facility.

The accelerator complex was commissioned over a nearly four-year period in seven discrete beam commissioning runs. A number of critical performance goals were achieved during beam commissioning. The front end and first tank of the drift-tube linac were operated at full 60-Hz repetition rate, accelerating a 1-mA average current beam to 7.5 MeV. Beam pulses of length 850 μs were accelerated, at low duty factor, in the superconducting linac. SNS project completion performance milestones were achieved on April 28, 2006, when a beam pulse of 1.5×10^{13} protons was transported to the

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target, producing a neutron flux well in excess of performance specifications.

With project construction complete, the accelerator complex is beginning a three-year ramp-up program to achieve full performance specifications. During this period, the beam power, beam availability, and accelerator operating hours will be increased to their ultimate goals of 1.4 MW, >90%, and 5000 hours/year respectively.

During the initial ramp-up phase, several important milestones were reached. First, a peak beam intensity—a world-record for a pulsed proton circular accelerator—of 0.96×10^{14} protons/pulse was accelerated, accumulated, and extracted from the ring. Recently, the design operating energy of 1.0 GeV in the linac was achieved, making the SNS linac the world's highest-energy proton/H^- linear accelerator. In addition, during the first two-month operating run, a single-pulse energy of 6 kJ was routinely achieved, making SNS the world's brightest pulsed neutron source, measured on a single-pulse basis. Finally, a beam power of 60 kW on target was achieved during a demonstration run.

The SNS linac is unique among proton/H^- machines in that most of the acceleration is provided by individually powered multi-cell superconducting cavities. This built-in operational flexibility allows for individual cavities to be removed or reinstated as conditions warrant, with minimal disruption to beam production. This inherent flexibility has been successfully demonstrated, particularly in early operation.

The most challenging beam dynamics aspect involves the stringent loss requirements of <1 Watt/m to minimize residual activation so that maintenance of the accelerator systems can be carried out with minimal complication. Although it is still too early to reliably scale present conditions to 1.4 MW, losses thus far are in line with expectations in most regards. Particular areas with higher-than-desired beam loss are being addressed through near-term operational improvements.

One of the fundamental performance specifications for SNS is emittance growth in the linac. Measurements have shown that emittance growth is in line with expectations, namely, ε_x, $\varepsilon_y < 0.5\ \pi$ mm-mrad (rms, normalized).

In the initial stages of its ramp-up to design performance, SNS is on track. Expectations are to reach 200 kW by the end of 2007 and 1 MW by the end of 2008.

Reference Design Report for International Linear Collider Released

Elizabeth Clements

The International Linear Collider has taken one step closer to answering some of science's greatest remaining questions about the nature of the universe. At a press conference held at the Institute of High Energy Physics in Beijing, China on February 8, the International Committee for Future Accelerators (ICFA) announced the release of the Reference Design Report for the International Linear Collider.

"With the publication of the ILC's Reference Design Report, the project has reached another major milestone," said Albrecht Wagner, ICFA chair and Director General of DESY. "The report demonstrates convincingly the readiness for building the ILC in the near future."

The reference design provides the first detailed technical snapshot of the proposed future electron-positron collider, defining in detail the technical parameters and components that make up each section of the 31-kilometer long accelerator. This report will guide the development of the worldwide R&D program, motivate international industrial studies and serve as the basis for the final engineering design needed to make an official project proposal later this decade.

"The Reference Design Report sets the scale for the costs of the project and provides a strong basis for guiding both the R&D program and the engineering design efforts – the next steps toward realizing the ILC," said Barry Barish, Director of the GDE for the ILC.

As part of the Reference Design Report, the GDE produced a produced a preliminary value estimate of the cost for the ILC. The estimate contains three elements:

- 1.8 Billion ILC Value Units for site-related costs, such as the costs for tunneling in a specific region;
- 4.9 Billion ILC Value Units for the value of the high technology and conventional components;

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- Approximately 2,000 persons per year or 13,000 person-years for the required labor.

For this value estimate: 1 ILC Value Unit = 1 US Dollar (2007) = 0.83 Euro = 117 Yen.

In arriving at an estimate, the GDE used a value accounting process that has become standard for international scientific projects such as the ILC. Based on the detailed technical requirements of the machine, the GDE determined the values of components based on a worldwide call for tender to obtain the required quality at the lowest reasonable cost. The estimate gives a first evaluation of the ILC at this time and will continue to evolve. Together with the Large Hadron Collider (LHC), scheduled to start operating in 2007, scientists believe that the ILC will unlock some of the deepest mysteries about the fundamental nature of the universe. With its high energy electron-positron collisions that provide very precise data, the ILC will give scientists the information they need to understand the Higgs mechanism, examine supersymmetric particles, probe dark matter candidates and possibly find a way to reunite the laws of nature by discovering new forces.

Now that the reference design has been released, the GDE focuses on further developing their worldwide R&D program that involves the three regions: Americas, Asia and Europe. From designing to funding to eventually building, the ILC is a global endeavor, and the release of the Reference Design Report reflects the successful international cooperation of the project.

Elizabeth Clements is the Communications Director for the ILC-Americas. A member of the Global Design Effort, she represents the Americas region for ILC communications.

The LHC Accelerator-Experiment Interface

E. Tsesmelis, LEA Group, TS Department, CERN, Geneva, Switzerland

Introduction

All LHC experiments are expected to have installed initial working detectors and will be ready for commissioning with beam at the start of LHC operation in 2007. An engineering run at the end of 2007, with beams colliding at a centre-of-mass energy of 0.9 TeV will allow the LHC accelerator and experiment teams to run-in their equipment ready for a full 14 TeV centre-of-mass energy run to start in mid-2008. The physics programme is expected to be rich even at the projected initial luminosities in the early part of the 2008 LHC run. Data collection will continue until a pre-determined amount of data has been accumulated, allowing the experimental collaborations to announce their first results.

This paper presents the requirements on the interface between the LHC accelerator and experiments for the LHC start-up with beam and early collisions, the heavy-ion runs and the special proton runs. Good communication between the accelerator and experiment teams is particularly crucial for exploiting optimally the first LHC beams for physics.

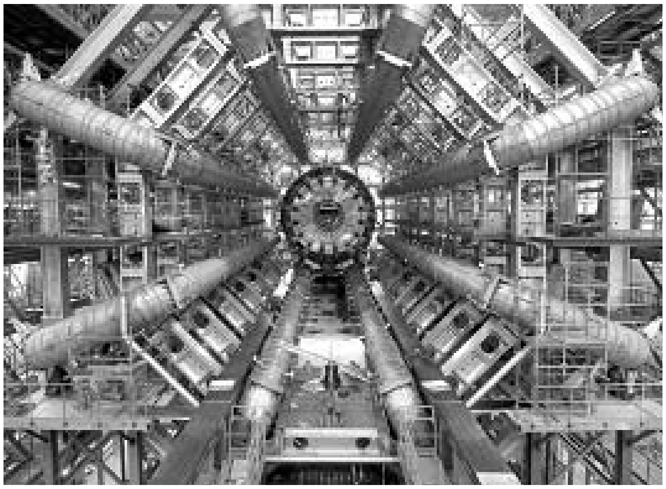
Luminosity Running

ATLAS and CMS

Of central importance for ATLAS and CMS and for the LHC is to elucidate the nature of electroweak symmetry breaking for which the Higgs mechanism and the accompanying Higgs boson(s) are presumed to be responsible. In order to make significant inroads into the Standard Model Higgs search, sizeable integrated luminosities of about 10 fb^{-1} are needed. However, even with 2 fb^{-1} per experiment, discovery of the Standard Model Higgs Boson is still possible in certain mass regions.

In addition, the potential for discovery of particles predicted in Supersymmetry (SUSY) is sizeable even at LHC start-up. Due to their high production cross-sections, squarks and gluinos can be produced in significant numbers even at modest luminosities.

ATLAS and CMS request beam conditions that will maximise the integrated luminosity, accumulated with an instantaneous luminosity of at least 10^{33} cm^{-2} s^{-1} in a low machine-induced background environment.



Installation of the ATLAS Experiment

Lowering of CMS Detector Components into the Experimental Cavern

Construction of the general-purpose ATLAS and CMS detectors is approaching completion and installation and commissioning of sub-systems of these experiments is well underway. Both experiments are expected to have experimental set-ups installed and commissioned for the start of LHC operation in 2007.

In addition, both ATLAS and CMS are realising Zero Degree Calorimeters (ZDCs). These are compact calorimeters that will be located at small angles from the

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beam axis on either side of the Interaction Point (IP). The ZDCs will be installed in the TAN absorbers, about 140 m. from the IP and will observe forward-going neutral particles that are produced in heavy-ion and proton-proton collisions. The ZDCs have a longitudinal segmentation and position sensitivity. In heavy ion collisions they will measure spectator neutrons providing an important handle on the heavy ion centrality and allowing ATLAS and CMS to trigger on ultra-peripheral collisions. The ZDCs are versatile devices and can serve to study heavy ion physics, proton-proton physics and to provide a tool to tune both the heavy ion and proton-proton collisions.

LHCb

The LHCb experiment has been conceived to study CP violation and other rare phenomena in B meson decays with very high precision. LHCb will investigate quark flavour physics in the framework of the Standard Model and look for signs of physics beyond the Standard Model.

Due to their high production cross-sections, study of B mesons is possible from the outset of LHC operations in LHCb, as is the case also for ATLAS and CMS. The LHCb experiment is designed for average instantaneous luminosities of about 2×10^{32} cm^{-2} s^{-1} and a bunch spacing of 25 ns., providing optimal physics conditions with single proton-proton interaction events per bunch crossing. Such an instantaneous luminosity can be achieved even with the low bunch intensities expected in the early LHC running period by varying β^* between 2 m. and 50 m. and with a bunch spacing of 25 ns.

It is expected that LHCb will have their experimental set-up installed and commissioned for the beginning of LHC operation in 2007.

ALICE

ALICE is a general-purpose heavy-ion experiment designed to study physics of strongly-interacting matter and the quark-gluon plasma in nucleus-nucleus collisions.

The ALICE heavy ion programme is based on two components:

- Collisions of the largest available nuclei at the highest possible energies;
- The systematic study of various collision systems (proton-proton, proton-nucleus, and nucleus-nucleus) at various beam energies.

As the number of possible combinations of collision systems and energies is large, continuous updating of priorities will be required as data becomes available. Initial proton running is requested for the commissioning and starting-up of the experiment, for the accumulation of reference and calibration data and for the study of minimum bias event properties. In order to satisfy the constraint of an average of one event per 88 μs, which is the drift time of the main tracking Time Projection Chamber (TPC) detector, an instantaneous luminosity of 10^{29} cm^{-2} s^{-1} is requested, preferably obtained by tuning the β^* in order to provide a more stable luminosity and a better-defined vertex spread. For instantaneous luminosities beyond 10^{31} cm^{-2} s^{-1}, certain ALICE sub-detectors will need to be switched off and the risk of radiation damage to sub-detectors increases. ALICE is also realising ZDCs. These devices will be installed between the two LHC separation dipoles D1 and D2 on each side of IP2. One ZDC will be located between the two beams to intercept the spectator neutrons and the other one, external to the outgoing beam, to collect spectator protons.

The proton-proton runs should be followed by the initial Pb runs with the so-called "Early Ion Scheme," consisting of 62 bunches per beam and β^*=1 m. ALICE requests the first heavy ion run as early as feasible before the end of 2008.

The ALICE experimental set-up is expected to be ready for first LHC operation in 2007.

In addition to ALICE, ATLAS and CMS have the potential to study ion-ion collisions.

Spectrometer Magnets

The ATLAS magnet system consists of a superconducting 2 T solenoid and air-core toroids in the barrel and end-cap regions, while CMS has a single superconducting 4 T solenoid. These magnets will be kept on during LHC filling as they have a long ramping time. However, if required for LHC commissioning, they may be switched off for dedicated runs.

The ALICE experiment includes a 0.5 T solenoid (constructed for the L3 experiment at LEP) and a large warm dipole magnet with a field integral of 3 Tm in the

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horizontal plane perpendicular to the beam axis. The solenoid and dipole magnet polarities will be changed together in order to calibrate the ALICE detector whenever there is a change in the experiment set-up. For detector alignment purposes, a few runs with both magnets off may also be requested.

The LHCb experiment consists of a warm dipole magnet with a field integral of 4 Tm oriented vertically. The magnet polarity will be reversed once per week to reduce systematic errors resulting from left-right asymmetries of the detector. However, during LHC commissioning, the dipole magnet polarity can be left unchanged. As for ALICE, for detector alignment purposes, a few runs with both magnets off may also be requested.

The ATLAS and CMS solenoid spectrometer magnets and the ALICE and LHCb dipole spectrometer magnets will put magnetic fields on the LHC beams and hence require some degree of compensation. The solenoids will produce relatively weak coupling, focusing and orbit effects, while the dipoles will result in severe orbit distortions and separation of the beams at the collision point. In addition to the compensation schemes, which have already been worked out and the special compensation magnets which have been built and are being installed, a number of operational issues require attention. The spectrometer magnets of ALICE and LHCb must both be ramped up with the LHC energy, together with their compensators. The polarity change requested by LHCb has a significant effect on the crossing angle of the two beams and it is not possible to have the same crossing angle for both polarities, at least not for the nominal LHC. Crossing in both planes would be the way out but this would require a different beam screen, or at least a different orientation of the existing and already installed beam screens.

Special Runs

TOTEM

The TOTEM experiment will measure the total proton-proton cross section and will study elastic scattering and diffractive dissociation at the LHC.

Initially, TOTEM requests to run at reduced luminosities and with special insertion optics. Several runs, typically of one day duration each, could be spread throughout this time period. A standard TOTEM period would consist of 3 short 1-day runs at $\beta^*=1540$ m. and two short runs with injection optics. TOTEM would accumulate significant statistics during a single 1-day run, but understanding the systematic uncertainties would require several such runs.

The Roman Pots will be positioned at 10σ from the beam and the TOTEM physics measurements require clean and stable beam coupled with an excellent vacuum. A normalised emittance of 1 μm rad reduces the beam size and angular spread of the beam for the Coulomb region of elastic scattering. However, this is not required for the luminosity independent measurement of the total proton-proton cross section, and a normalised emittance of 3.75 μm rad is acceptable.

TOTEM is presently evaluating additional running scenarios and the requests concerning beam conditions are therefore expected to evolve.

Production of the Roman Pots is progressing well and TOTEM plans to be ready for the LHC start-up in 2007.

ATLAS Forward Detectors

The experimental set-up of the ATLAS Forward Detectors ALFA consists of Roman Pot stations located at 240 m. on either side of the main ATLAS detector at the Long Straight Section LSS1. The detectors will measure the elastically scattered protons in the Coulomb region for the determination of absolute luminosity of the LHC at IP1.

Construction of the ATLAS Roman Pots will proceed subsequent to the completion of the TOTEM Roman Pot production. This is in line with the installation before the first LHC run or for the first LHC shutdown period.
The beam conditions requested by ATLAS are the following:

- $\beta^* = 2625$ m;
- Instantaneous luminosity of 10^{27} cm^{-2} s^{-1};
- Normalised emittance of 1μm rad. If this is not feasible during the early LHC running, measurements with larger values of the normalised emittance remain interesting as the total proton-proton cross section can be calculated using the luminosity measurement from the accelerator parameters, while the absolute luminosity can be derived using the total proton-proton cross section from TOTEM.

It should be noted that the ATLAS Forward Detectors

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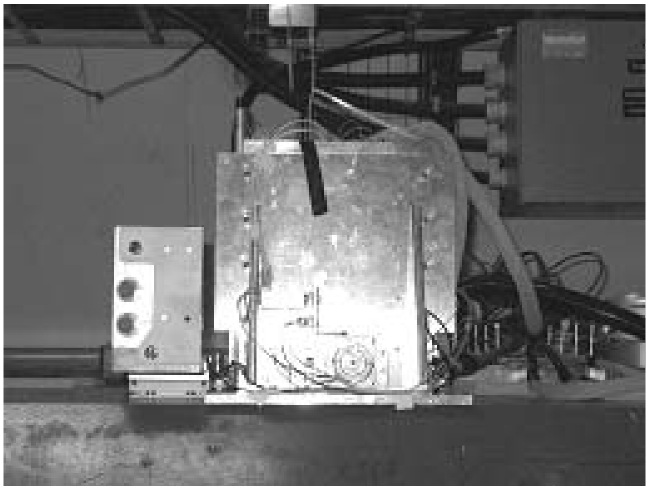
can run in parallel with TOTEM.

LHCf

The LHCf Collaboration is installing an experimental set-up for the measurement of photons and neutral pions in the very forward region of the LHC to provide information for the elaboration of the cosmic-ray spectrum in the high energy region and to assist in the understanding and determination of the primary composition of cosmic-rays. The measurements may also be used to calibrate Monte Carlo generators, especially in the forward region.

LHCf requests a bunch spacing of at least 2 μs. in order to reduce event pile-up in their calorimeters. This is compatible with the 43-bunch pattern expected at the LHC start-up. An instantaneous luminosity of at most 10^{30} cm^{-2} s^{-1} is needed in order to avoid the contamination of data with multiple events per bunch crossings, while an instantaneous luminosity of 10^{30} cm^{-2} s^{-1} would already provide adequate data rates. Three short runs of a few hours duration each during early LHC operation would provide the statistics required for the LHCf physics measurements.



LHCf Detector and BRAN in the TAN Absorber

The LHCf calorimeters will be installed in the first 30 cm of the TAN slot on each side of IP1. Construction of the LHCf calorimeters is approaching completion and they will be installed prior to the LHC engineering run in 2007.

Accelerator Considerations

LHC Engineering Run

The 0.9 TeV centre-of-mass LHC run at the end of 2007 should provide a firm platform for the commissioning to 14 TeV and to provide a lead time for the resolution of problems. The main aims of the engineering run are to commission the essential safety systems, beam instrumentation and hardware, to perform beam based measurements to check magnet polarities, apertures and field characteristics, and to establish two-beam operations and collisions. Crossing angles are to be off, the injection optics are to be implemented and the solenoid and dipole spectrometer magnets are requested to be off initially.

Single Beams

No specific requests have been made by the experiments to run with single beams. However, should they be available, the experiments can make use of single beam runs for studies on detector synchronisation, machine-induced background and the vacuum quality. Moreover, the event rates expected in ATLAS and CMS from beam halo muons and beam-gas collisions during a single beam run are found to be significant and are useful for commissioning the experiments in terms of aligning and calibrating the detectors. Given the single-arm spectrometer configurations, ALICE and LHCb would prefer to have the clockwise Beam-1 should any single beam runs be available. TOTEM and ALFA would use single beams to study how closely the Roman Pots could approach the beam.

Machine Start-up with Beam – Stage I

All experiments will benefit from collisions during the LHC start-up with beam at 14 TeV centre-of-mass energy, the so-called Stage I period. This period is characterised with 43 or 156 bunches per beam, a zero crossing angle, a partial optics squeeze down to $\beta^* = 2$ m., and an instantaneous luminosity of between 3×10^{28} cm^{-2} s^{-1} and 2×10^{31} cm^{-2} s^{-1}.

The nominal LHCb luminosity can be obtained by tuning β^* down to 2 m. However, in order to provide collisions in LHCb, bunches in one beam will need to be displaced by 75 ns during Stage I, resulting in a corresponding reduction in luminosity in the other experiments.

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<u>*75 ns Versus 25 ns Bunch Spacing*</u>

LHC running with 75 ns bunch spacing will be used by all experiments for detector synchronisation, setting-up for physics and studies of machine-induced background. ATLAS and CMS would like to switch to 25 ns bunch spacing when such running would deliver a higher useful integrated luminosity. LHCb would like to move to 25 ns bunch spacing as soon as possible in order to maximise the fraction of events with one proton-proton interaction per bunch crossing and ALICE could stay at 75 ns bunch spacing given the modest instantaneous luminosity requirements of at most 5×10^{31} cm^{-2} s^{-1} and the comparable bunch spacing of 100 ns for Pb running.

Machine-induced Background in the LHC Experiments

The main sources of machine-induced background are:

- Beam proton collisions with residual gas molecules;
- Beam cleaning inefficiency (namely, the out-scattering from the collimators);
- Collision products from one IP to the next interaction region.

Such background in the experiments has often turned out to be one of the most important performance limitations at previous hadron colliders.

Estimates of machine-induced background depend on the machine optics and parameters, residual gas densities, collimation schemes and operational scenarios. In addition, the importance of any background will depend on the experiment, such as the general purpose high luminosity experiments ATLAS and CMS, the dedicated experiments ALICE and LHCb and the forward detectors TOTEM, ALFA and LHCf.

In general, the ATLAS and CMS detectors are well-shielded from particles from the machine tunnel by the forward radiation shielding and by the TAS absorber. Estimates of background vary widely, but are between one and five orders of magnitude below the rates from the nominal proton-proton collisions. High energy muons will be present out to larger radii, but at tolerable rates and both experiments have studied the use of these muons for alignment and calibration of the detectors. Since the lower luminosity experiments will use the same high intensity beams, they will be more sensitive both because of an intrinsically worse signal-to-noise ratio and because they have less beam-line shielding. The residual gas in the Long Straight Sections upstream of these experiments is expected to be the dominant source but effects due to the presence of the tertiary collimators TCTs result in a flux below the beam-gas background at least out to a radius of 1 m. from the beam, but they risk to be the dominant source of large radius muons beyond a radius of only 30 cm.

The effect of the shielding in the tunnels upstream of ALICE and LHCb will be evaluated with first beams, but there is every hope that the machine-induced background can be kept under control, even for the most sensitive experiments. This does, however, mean that attention should be given to this important topic from the first day.

Data and Signal Exchange

The exchange of data between the LHC accelerator and experiments, both at the hardware and software levels, has the aim of communicating information on the state of the accelerator and experiments as a whole and on their various sub-systems, as well as providing a means to understand the causes of error by acting as a recording and diagnostic tool. The links are based on a) the software-based DIM Data Interchange Protocol providing a simple and robust publish/subscribe system supporting an on-change data exchange and b) dedicated hardware connections.

Data produced and sent from the experiments to the accelerator will aid in the optimisation of the beam collisions. Measurement and monitoring of the longitudinal and transverse centre of the collision point will be provided by the experiments through the fast reconstruction of tracks in the detectors. Collision rates will be measured by the Cerenkov Integrating Detector (LUCID) at ATLAS and by the Beam Scintillation Counter (BSC) at CMS. The absolute luminosity will be provided by the measurements of TOTEM and ALFA.

Moreover, experiment beam interlock signals will cover the beam abort requests, injection inhibits, the state of the spectrometer magnets, including their currents and polarity, the interlocking of the experiment moveable devices and any other special signals from the experiments.

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Instrumentation of the accelerator will provide data on parameters of beam operation. This includes, but is not limited to, the total beam intensity, individual bunch intensities, bunch length and size and the collision rate. The latter will be monitored by the BRAN ionisation chambers provided by LBNL at IP1 and IP5 and by CdTe solid state detectors installed in the TAN absorber at IP2 and IP8. In addition, measurements from the LHC beam position system (timing pick-ups will be used for accelerator clock monitoring at the location of the experiments), the collimation system (settings and positions of the various collimators), the vacuum system (residual gas pressure) and the LHC machine modes will be transmitted to the experiments. Finally, LHC accelerator timing signals will be distributed to the experiments from the LHC Faraday Cage at Point 4 through the Timing, Trigger and Clock (TTC) system of the experiments.

In all cases, it is essential to retain flexibility in the exchange of data and signals to be exchanged as experience with the accelerator and experiments operation develops.

Beam Condition and Radiation Monitoring

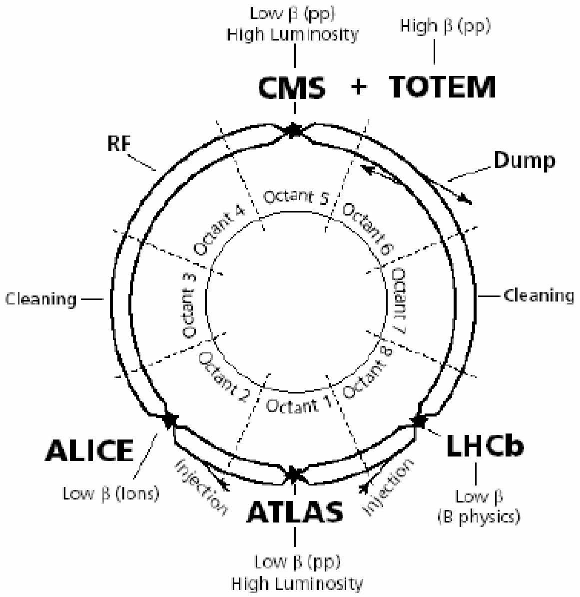
All experiments are planning to monitor the radiation fields in their experimental area with a view to ensure that the planned 10-year resistance to radiation damage is achieved. They will also implement a separate beam condition monitoring (BCM) system, based on diamond particle detectors, capable of providing a highly reliable fast beam dump if high local beam losses risk damage to the detectors and equipment. The BCM will not only provide a beam dump trigger above a pre-defined threshold, but will complete the information from the LHC accelerator Beam Loss Monitors in the experimental areas. The radiation fields, including the dose and rate of single event errors, in the experimental areas will be monitored online by a system of active monitors. Additional information will be obtained from passive monitors as a cross-check and the RAMSES personnel protection and activation monitors. Understanding the ultra-fast beam losses and the radiation fields as a function of LHC operational mode is considered to be very important by all experiments.

Conclusions

It is realistic to expect all LHC experiments to have an initial working detector ready for the start of LHC operation in 2007, although detector installation can be foreseen beyond this date.

Commissioning of the LHC detectors can commence with single beam runs and experiment calibration and alignment data can be collected immediately with the machine start-up conditions at 0.9 TeV centre-of-mass energies at the end of 2007.

The LHC physics programme is indeed rich. Of central importance is the detection of the Higgs boson(s) by ATLAS and CMS, for which a sizeable integrated luminosity is required.



See next article on LHC magnets →→→→

THE LHC MAGNET PROCUREMENT AND MEASUREMENTS

the success of superconductivity in one of the largest scientific enterprises

Lucio Rossi

The LHC magnets and beyond

Lucio Rossi

Building the main parts for the Large Hadron Collider has presented enormous challenges but as well has taught many lessons for both particle physics laboratories and their industrial partners.

The Large Hadron Collider is one of the most complex technological creations ever built. The production of components for this machine is now over, after a process that has spanned 20 years. It is a process that has taught us at CERN a lot of new skills. Of course, there are still many challenges waiting as we prepare to get the LHC operating successfully, but building the parts has been a vital part of the process.

Building the LHC accelerator is very much a story of learning to work with Industry. CERN needed to produce a vast quantity of components by various manufacturers around the world to incredibly exacting specifications. For example, the backbone of the 27-kilometer ring that circulates the protons is made of 1232 multi-million-dollar dipole magnets. Yet, we can essentially take any magnet from the storage pile and plug it into place in the machine without having to think much about who manufactured it or where. Getting to that point was a turbulent journey, however.

LHC is a superconducting machine based on fine niobium-titanium (Nb-Ti) superconducting filaments, embedded in copper wires for stability, which are assembled in very compact cables.

The challenge of the LHC was repeating the effort done for the Tevatron and successive projects with stricter specifications and in larger quantity. Even if we had taken all the production capacities developed for the colliders at Fermilab, Brookhaven National Laboratory, and Deutsches Elektronen-Synchrotron, Germany, it would not have satisfied the needs of the LHC.

Something supposedly simple, such as obtaining the basic material for the superconducting wires, actually required much coordination. Achieving the highest possible magnetic field for the wires meant the Nb-Ti needed to be exquisitely uniform. Each of the ten thousand 3-inch diameter, 2.5-foot long billets of Nb-Ti, all supplied by Wah Chang company in Oregon, was tracked through the production process with a database shared between CERN and the six companies supplying the finished product, four in Europe, one in the US and one in Japan.

Identifying the stages of the production process that control the uniformity and quality of the wires took the combined effort of CERN and the six companies involved in the manufacturing. This was made even more challenging because each company had a propriety process for making the wires.

For example, once the superconducting wires were made, they needed to be coated with a very thin, carefully-monitored layer of material to control, in a narrow band, the current between the wires in the same cable. As happened in many parts of the project, this step brought up a range of issues that could not be foreseen when prototyping (a phase where we dealt with small quantities).

CERN developed the method for coating the filaments, and the following heat treatment; in the production CERN held direct control of this process, of the measurements, and provided on-line analysis and feedback to companies. This model became crucial for the further industrialization of the magnet manufacturing process and has assured the components to be manufactured with “sufficient” (not best, just sufficient: anything else was too expensive for a budget already reduced to a minimum, this being actually not the lesser challenge.)

The production of the dipole magnets also saw this shift in process--from CERN providing specifications, with minimal involvement in the production process, to a CERN-led effort. Here, the final solution was that CERN would keep the intellectual property in the dipole production. CERN provided the blueprints to manufacture built-to-print, built-to-process magnets, and companies would do the actual work.

This approach was needed for two main reasons: the necessity of keeping control of the final quality, and the economics of making such a choice. We sought from industry their particular skills--their production organization; and their ability to perform repetitive, though complex, operations with a clear relation between action and results.

CERN kept control of the parts of the process whose results depended on knowledge and integration of different disciplines and where the repeatability of a production action did not alone guarantee the success of the product.

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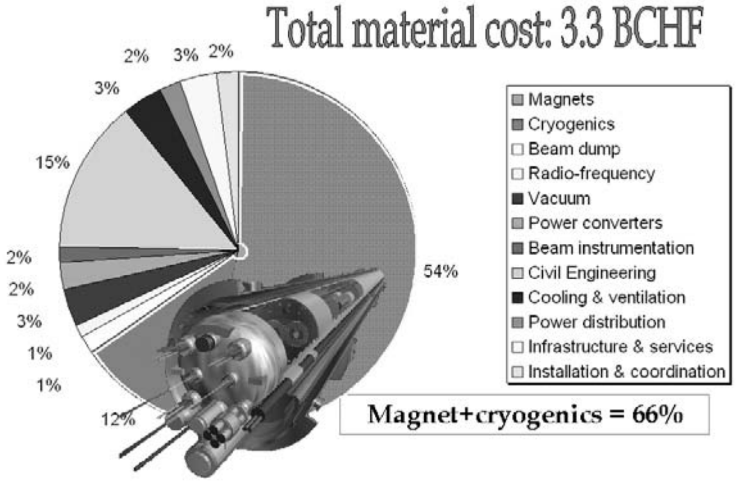
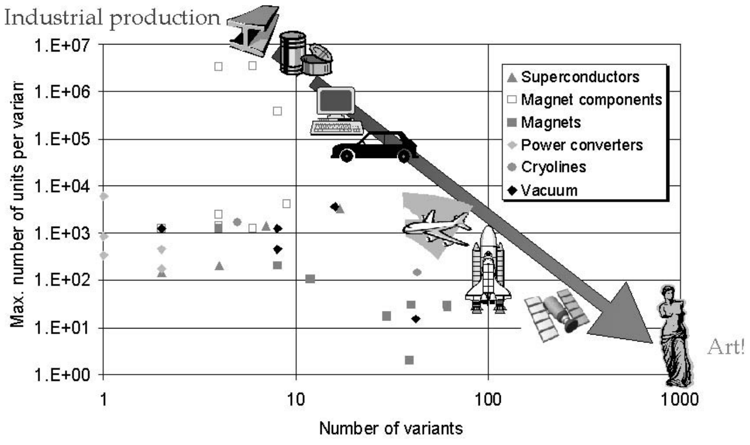
The final strategy for obtaining the 1232 dipole magnets was to first order a pre-series of 30 dipoles from each of the three companies that were trained during a prototyping phase and, two years later, to grant contracts for the full series. The pre-series order was made at a higher price, in order to allow for the set up of the process and factory, and to install most of the tooling. Then there was a second call for tenders for the full series. If we had contracted for the full series of magnets at the outset, the price would probably have been much higher. Companies did not know ahead of time whether they could learn to produce the magnets more cheaply as they gained experience. The pre-series contract was a way to gain time until confidence was established.

Turning a scientific plan on paper into a working machine is an immensely complex task. It has required a special relationship between the Lab and its contracted companies, a relationship we had to develop as we went along. As we move toward completion of the LHC, we can already see our experiences turning into advantages both for us at CERN and for the industries we partner with.

Meanwhile work in the tunnel is proceeding to get the machine installed and commissioned, and a plan to set up a magnet facility at CERN is being discussed in order to insure perennial knowledge and ability of repairing and reconditioning the superconducting magnets through the life of the LHC. This facility will also constitute key elements to carry out the necessary R&D to get novel more advanced magnets for a future upgrade of the LHC, by improving its luminosity and, maybe one day, its energy limit.

Lucio Rossi, is Group Leader for Magnets, Cryostats and Superconductors (MCS) in the CERN Accelerator Technology Department





Courtesy of Ph. Lebrun

2007 Beam Physics Conferences and Workshops

January 29—February 2, "**APAC2007**" Raja Ramanna Centre for Advanced Technology, Indore, India
February 8—9, 2007, ICFA meeting, IHEP, Beijing
March 5—7, "**ILCDR07**" Damping Rings R&D Meeting, Frascati
March 5—9, "2007 APS March Meeting" Denver, Colorado

April 14—17, "2007 APS April Meeting" Jacksonville, FL
May 21—25, "**ERL07**" 41st ICFA Adv Beam Dynamics Wkshp on Energy Recovery Linacs, Daresbury Lab, UK
May 20—23, "**DIPAC2007**" 8th European Workshop on Beam Diagnostics and Instrumentation, Venice, Italy
May 30—June 4, "**LCWS2007** and **ILC2007**" Linear Collider Workshop 2007, DESY, Hamburg Germany
June 17—22, "**PPPS-20**" 2007 Pulsed Power and Plasma Science Conference, Albuquerque, New Mexico
June 24—28, "**Compumag 2007**" 16th Intl Conf on the Computation of Electromagnetic Fields, Aachen, Germany
June 25—29, "**PAC07**" Albuquerque, NM

July 16—20 "**CEC/ICMC 2007**" Cryogenic Eng Conf and Intl Cryogenic Materials Conf, Chattanooga, TN
July 30—Aug 2 "**AccApp'07**" Eighth Intl Topical Mtg on Nuclear Appls, Utilizations of Accels, Pocatello, ID
August 26—31 "**ICIS 2007"** 12th International Conference on Ion Sources, Jeju, Korea
August 26—31 "**FEL07**" 29th International Free Electron Laser Conference, Novosibirsk, Russia
August 27—31, 2007 "**MT20**" 20th Intl Conference on Magnet Technology," Philadelphia, Pennsylvania

September 2—8, 2007, VIIth International Scientific Workshop: Electron-Positron Colliders, Alushta (Crimea) Ukraine
September 10-14, "**COOL'07**" Bad Kreuznach, Germany
September 10—14, 2007, XIIth Intl Workshop on Polarized Sources, Targets & Polarimetry, Brookhaven Ntl Laboratory
September 16—20, 2007, "**EUCAS**" 8th European Conference on Applied Superconductivity" Brussels, Belgium
September 24—28, "**WAO2007**" 6th International Workshop on Accelerator Operations, Trieste
September 30—October 5, "**CYCLOTRONS'07**" Giardini Naxos, Italy

October 14—19, "**SRF 2007**" 13th International Workshop on RF Superconductivity, Beijing
October 15—19, 2007 "**ICALEPCS**" Intl Conf on Accelerator, Large Exptl Physics Control Systems, Knoxville, TN

2008 Beam Physics Conferences and Workshops

March 10—14, "2008 APS March Meeting," New Orleans

April 12—15, "2008 APS April Meeting," St. Louis

June 23—27, "**EPAC'08**" Genova, Italy
June, 2008, "**ICC15"** 15th International Cryocooler Conference, Long Beach, California

August 10—15, "**CAARI 2008**" Intl Conf on Appls of Accelerators in Research and Industry, Fort Worth, Texas
August 17—22, "**ASC2008**" Applied Superconductivity Conference, Chicago
August 24—29, "**FEL08**" Gyeongju, Korea

September 29—October 4, "**LINAC08**" Victoria, B.C.

October, "**PCaPAC2008**" 7th Intl Wkshop on Personal Computers and Particle Accel Controls" Ljubljana, Slovenia

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PAC07 will be held at the Albuquerque Convention Center