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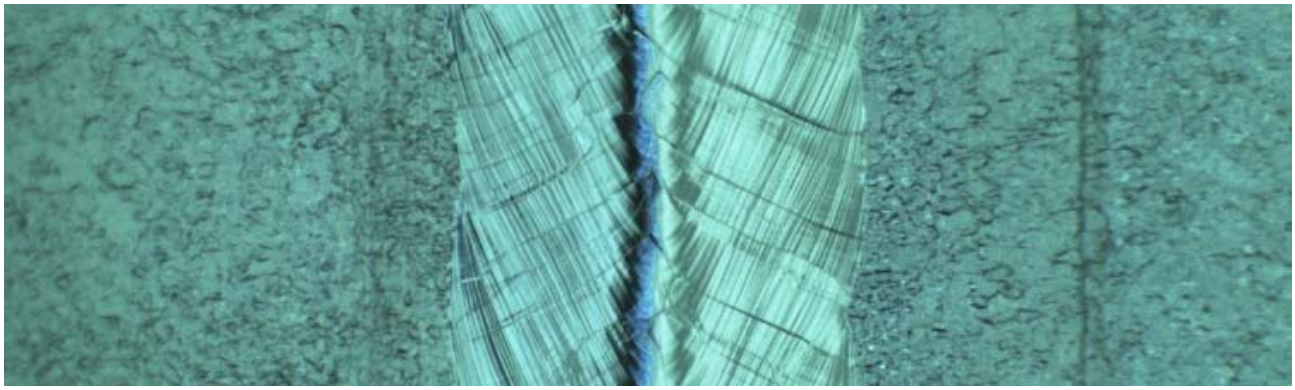
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AROUND THE WORLD

A robot to watch out for defects

Automated cavity inspection makes progress at DESY

by Barbara Warmbein



A small group of young researchers at DESY, Germany, is working on a robot that could drastically reduce the time it takes to optically inspect a cavity. Their work covers everything from the pure mechanics of the workbench and fine-tuned motors for moving the heavy parts to developing sophisticated methods of automatically analysing the pictures. Cavities might eventually pass the check in two hours instead of the one-and-a-half days it takes today.

AROUND THE WORLD

A laboratory without walls

Fourth workshop of the France-China Particle Physics Laboratory held in Jinan

by Dou Wang and Min Zhang

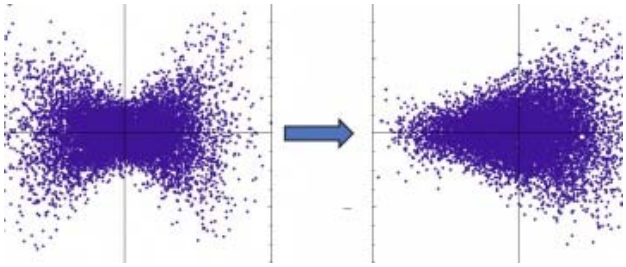


The France-China Particle Physics Laboratory is a lab without walls, enabling Chinese and French particle and accelerator scientists to work together towards the new energy frontier with experiments such as the LHC and the ILC. Its fourth annual workshop took place in Shandong University, Jinan, China from 7 to 9 April 2011.

DIRECTOR'S CORNER

Low-power option adopted for ILC technical design baseline

by Barry Barish



Establishing a new baseline for the ILC technical design requires balancing performance, cost and risk issues. A proposal to halve the number of bunches in the machine, reducing power and cost has been approved, following a one-year study of all the impacts.

VIDEO OF THE WEEK



Into the Microcosm: Particle and astroparticle physics at DESY

Video: DESY

DESY in Germany presents a new video to learn, in twelve minutes, all about its activities in particle and astroparticle physics. Don't miss the International Linear Collider part at 6'50, featuring the new ILC animation.

View the new video on the DESY website in English or in German

View and download ILC animation: "The International Linear Collider in 1 minute."

IN THE NEWS

from *CERN Bulletin*
11 April 2011
ALICE's wonderland reveals the heaviest antimatter ever observed
Analysing data collected in a run of just one month, ALICE has recently found evidence of the formation of four anti-nuclei of Helium 4, the heaviest antimatter ever created in a laboratory.

from *Physics Today*
11 April 2011
Experiments in Soudan mine delayed, but mostly unharmed by fire
A fire in the access shaft of the Soudan Mine in Minnesota appears to have caused little damage to the experiments that exploit the shielding from cosmic rays provided by the roughly 714-m-deep Soudan Underground Laboratory.

from *BBC News*
7 April 2011
Tevatron accelerator yields hints of new particle
The find must be more fully confirmed, but researchers at the Tevatron are racing to work through existing data.

from *DESY inFORM*
April 2011
The plasma project
Scientists want to use the high gradients produced by the plasma acceleration to build very compact accelerators. Wanting to use the particles from plasma accelerators for experiments and in order to get a good beam quality, the scientists will use a trick. They inject beams with already good properties into the plasma and accelerate them further.

CALENDAR

UPCOMING EVENTS

Linear Collider Power Distribution and Pulsing workshop
LAL, Orsay, France
09- 10 May 2011

ILD Workshop 2011
KEK, Tsukuba, Japan
23- 25 May 2011

Second Workshop on linac operation with long bunch trains
DESY, Hamburg, Germany
06- 08 June 2011

Technology and Instrumentation in Particle Physics 2011 (TIPP 2011)
Chicago, IL
09- 14 June 2011

UPCOMING SCHOOLS

Joint US-CERN-Japan-Russia School on Particle Accelerators
Course on Synchrotron Radiation and Free Electron Lasers
Ettore Majorana Foundation and Center for Scientific Culture, Erice, Sicily, Italy
06- 15 April 2011

École IN2P3 - Pays Méditerranéens des Accélérateurs de Particules
Gammarth-Tunis, Tunisia
09- 14 May 2011

View complete calendar

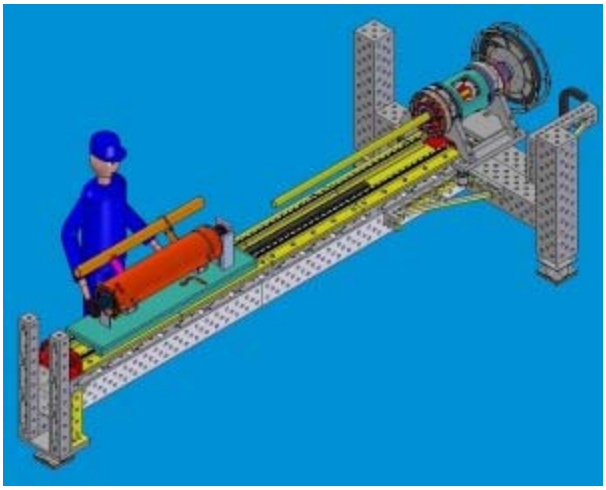
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AROUND THE WORLD

A robot to watch out for defects

Automated cavity inspection makes progress at DESY

Barbara Warmbein | **14 April 2011**

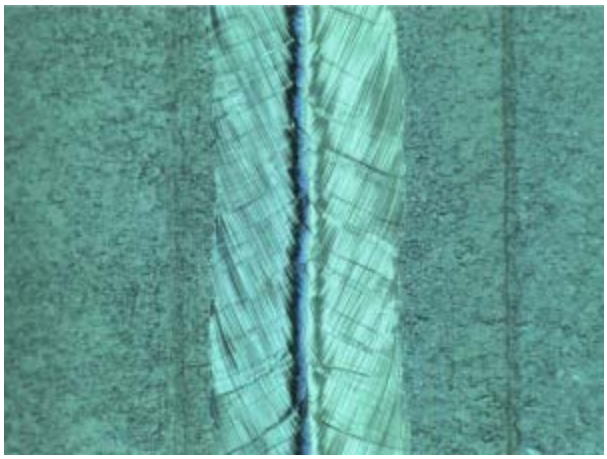


Technical drawing of the cavity inspection robot 'OBACHT' that is nearing completion at DESY.

If you have bought a digital camera recently, you probably enjoyed the new 'smile detection' feature that many new cameras are equipped with. It works like this: you set the camera to smile detection mode and point it at somebody. The camera recognises faces and as soon as the face smiles, snap – it takes a picture. Wouldn't it be great if that worked for possible problem spots on cavities as well? Camera takes picture, software recognises feature, compares with existing data and sends out a warning message like "potential source of field emission detected". Much better than sifting through 810 images one by one! DESY PhD student Marc Wenskat is working on exactly this, and his automatic picture recognition is now able to tell which cavity manufacturer produced the cavity. This is not the goal of the exercise and not relevant for recognising features – but it shows that the current algorithm recognises different characteristics.

The focus of the pictures is, quite literally, on the seam where two cavity dumbbells have been welded together. They are the weakest spot in the cavity quality ranking because it is easy to introduce small imperfections in the welding process that may later lead to field emissions or quenches – absolutely unwanted if you're aiming for ultra-high-gradient cavities for the ILC.

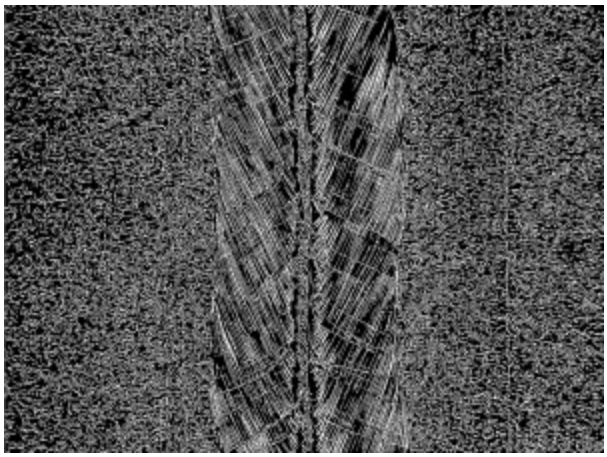
Pictures are taken with the automated '**Kyoto camera**', which was developed and used at KEK, Japan. One of the cameras has been shipped to DESY, Germany and is being further developed by PhD student Sebastian Aderhold. Others are being used in the US. Mounted on a rod and soon, with the new robot, able to turn around its own axis, it takes pictures of each whole seam on the cavity's widest part, the 'equator'. Each pixel in a picture is equivalent to 10 square micrometres of cavity surface, and each picture covers four degrees, so a complete scan of each equatorial seam means 90 pictures, or 810 for a whole nine-cell cavity.



Before: a picture of the inner surface of a cavity, taken by the cavity camera.

These pictures are then checked by Wenskat's recognition process. The final goal is for the software to not only recognise an object, but also to classify its characteristics and make predictions on what this means. Different ways are being explored to reach this goal, and the first step of the process currently in place is to remove shadows from the image to make potential edges of objects more visible. The mirror-like surface of the cavity is a challenge as a photographic object, and the special lighting system designed in Japan is already

a huge step towards pictures that are as uniform as possible. However, even after shadows have been removed artefacts of the recognition process obscure defect detection so that the software has to be further refined.



After: the original image rendered into a binary version that could help detect surface defects.

The result of the current algorithm is a binary black-and-white image that checks parameters like ‘distance (of feature) from seam’, ‘orientation’ or ‘eccentricity’ and many more. One of the challenges of cavity image processing is the large variability. Surface features do not have a uniform appearance but come in all sorts of shapes and sizes. It will take more investigations to detect critical features automatically and predict their effect on cavity performance.

This prediction is a crucial component of the inspection robot ‘OBACHT’ that is currently under construction at DESY. OBACHT, German for ‘watch out’, stands for Optical Bench for Automated Cavity inspection with High-res images on short Timescales. Part of the EU-funded project **ILC-HiGrade**, it will make optical inspection for cavities not only faster, but also more precise. High-precision motors fitted on a Meccano-like workbench and great flexibility in the movement of both camera and cavity, together with test data from the worldwide cavity database and the inspection software, could get the time it takes to optically test a cavity down from more than a day to a couple of hours. In the industrialisation process for cavities that meet the ILC specifications this robot could play a major role. OBACHT will catalogue the surface of the delivered cavities, essentially maintaining a topographic map of all cavities. Such a map may be useful to relate performance limitations to surface features that otherwise would go unnoticed.

More about ILC-HiGrade in *ILC NewsLine*.
ILC-HiGrade website

CAMERA | **CAVITY INSPECTION** | **CAVITY SURFACE** | **DESY**

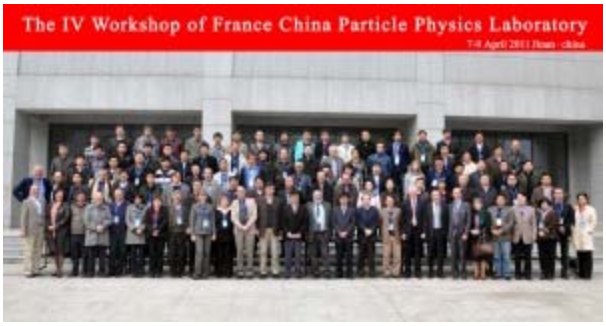
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AROUND THE WORLD

A laboratory without walls

Fourth workshop of the France-China Particle Physics Laboratory held in Jinan

Dou Wang and **Min Zhang** | **14 April 2011**



Group photo of the fourth France-China Particle Physics Laboratory held in Shandong University, Jinan, China from 7 to 9 April 2011.

The **4th Workshop of the France-China Particle Physics Laboratory** (FCPPL) took place in Shandong University, Jinan, China from 7 to 9 April 2011. The main purpose of these workshops is to present, review and discuss the various ongoing and future activities performed by Chinese and French scientists within the FCPPL framework. More than 100 scientists, engineers and students interested in every aspect of particle physics and advanced accelerators attended the meeting.

An ILC session with six ILC-related talks was held in this 2011 workshop, three for accelerators and three for detectors. In addition to the LHC, the ILC is one of the main fields of collaboration within FCPPL. “It is a fruitful cooperating field,” said Jie Gao, professor at the Institute of High Energy Physics (IHEP), Chinese Academy of Sciences (CAS) and chair of the Asia Linear Collider Steering Committee. The 1.3-gigahertz superconducting technology will become a new item of collaboration within FCPPL since the latest TESLA Technology Collaboration (TTC) meeting hosted by the University of Milan and INFN Sezione di Milano.



Hesheng Chen, director general of IHEP, gives a talk at the opening of the 4th FCPPL workshop.

FCPPL was established according to an agreement between CAS, the Centre National de la Recherche Scientifique (CNRS) and the French Commission for Atomic Energy (CEA) in April 2007. It is an international associated laboratory supported by funding agencies and the French Embassy in China, and involves a network of French CNRS/IN2P3 laboratories and universities, CEA, a network of institutes of CAS and Chinese universities. It is mainly devoted to strengthening collaborations in particle physics, with a focus on LHC and ILC activities, including computing development and deployment and accelerator studies. The support and development of existing or new collaborations in other particle physics domains and in particle astronomy, both in experimental physics and theory, are also an intrinsic part of this project. Following the creation of FCPPL, the first FCPPL workshop was held in Marseilles, France, from 15 to 17 January 2008.

China and France have a longstanding history of cooperation in particle physics. Between 1987 and 1997, ten accelerator physicists from IHEP went to LAL – an IN2P3 lab in Orsay – for an academic exchange. Then research institutes and

universities from China began to cooperate widely with French labs on various projects with, for example and just to name a few: IHEP's and Shandong University's cooperation with CPPM – an IN2P3 lab in Marseilles – on the LHC's ATLAS experiment; Huazhong Normal University and IN2P3 collaborative work on LHC's ALICE experiment; and Tsinghua University's and LAL's cooperation on ILC detector optimisation and particle flow algorithms.

"The joint lab creates a Sino-French research community beyond the individual contacts, and gives a high visibility of cooperation in our countries and in the world," said Philippe Arnaud from the Science and Technology Department of the French Embassy in China. No doubt, FCPPL has established an official dialogue on a regular basis and promotes new collaboration between France and China. "FCPPL is a laboratory without walls, which enables Chinese and French particle and accelerator scientists to work together towards a new energy frontier with experiments such as the LHC and the ILC," said Gao. "This joint endeavour is becoming an international culture on which a future linear collider will be based."



FCPPL attendees listen to a talk.

Visit FCPPL workshop website

ASSOCIATED LABORATORY | **CAS** | **CEA** | **CHINA** | **CNRS** | **CNRS/IN2P3** | **COOPERATION** | **FCPPL** | **FRANCE** | **LHC** | **SHANDONG UNIVERSITY**

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DIRECTOR'S CORNER

Low-power option adopted for ILC technical design baseline

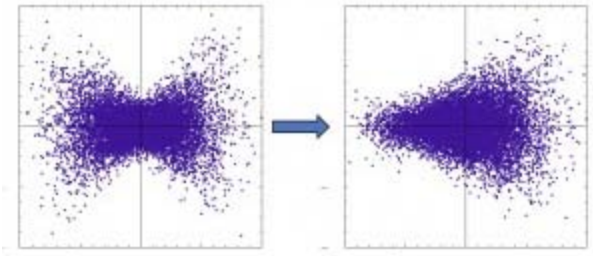
Barry Barish | **14 April 2011**

Parameter	unit	RDR (nom.)	Proposed
E_{cm}	GeV	500	500
Rep. rate	Hz	5	5
Q_{bunch}	nC	3.2	3.2
Bunches/pulse		2625	1312
Main Linac			
RF pulse length	ms	1.6	KCS: 1.6 DRFS: 2.2
Beam current	mA	9	KCS: 6 DRFS: 4.5
Average beam power	MW	10.5	5.3
Damping Ring[1]			
Circumference	m	6476	3238
Avg. Current	mA	388	390
Damping time	ms	21	24
RF power	MW	3.97	1.76

A comparison of the reduced parameter set with those from the Reference Design Report. *Note the parameters are shown for two different high-level radiofrequency schemes.*

Cost containment has been a consistent theme underlying proposals to define a new baseline for the technical design effort and report. Some changes are the result of further studies after we developed a reference design for the ILC, while others have required invoking some new ideas. One of the four major changes that were proposed in a **proposal document** from the Global Design Effort (GDE) project managers was to reduce the number of bunches in the machine. This gives a corresponding reduction in the main linac beam current, consequently reducing the number of klystrons, modulators, power supplies and other machines, and requires a smaller damping ring. I have approved **this change** due to the significant cost savings and following extensive studies of options for recovering the luminosity, including innovative schemes like employing stronger focusing techniques at the interaction point.

The total cost of the International Linear Collider is comparable to the total investment that has been made in all the subsystems of the Large Hadron Collider. The LHC is in the process of opening up a new energy frontier, the terascale, and our first serious look at that science should be presented within the next couple years. Governments are not ready to consider building the ILC as a global project, at least until the science is justified by results from the LHC. Those results may well guide the machine parameters, and we remain flexible depending on what is learned.



Increasing luminosity by around 30% is proposed by using travelling focus technique to shift the waist for each z beam slice such as to maximise interaction rate.

In the meantime, the GDE is carrying out the second step in its mandate, to complete a technical design for the ILC that is complete and reliable enough to be used for proposals to collaborating countries and as the basis of undertaking a major construction project. The technical design will be based on our earlier reference design, but with some key changes that optimise cost, risk and performance. We are putting special emphasis on changes that can result in cost savings, so that we can contain cost growth as much as possible.

The proposal to adopt a reduced parameter set involves a series of changes to accommodate halving the number of bunches in the machine. In addition to the changes in the main linac, we propose another significant change of reducing the diameter of the damping ring circumference by a factor of two. However, to ensure that we can accommodate more bunches, if needed or desired at a later time, we also propose increasing the diameter from 5 metres in the *Reference Design Report* to 7.5 metres for the *Technical Design Report*, allowing the possibility of installing one electron and two positron rings in the tunnel.

Our plan is to restore the luminosity through the use of stronger focusing in the interaction region, for example employing something like the travelling focus scheme. However, we are explicitly maintaining the conventional facilities and other infrastructure needed to be able to upgrade to the original number of bunches at a later time, either as risk mitigation or possibly for a luminosity upgrade of the machine.

I want to commend the project managers for both evolving their original proposal for a reduced parameter set to satisfy the risk concerns stated by the GDE Program Advisory Committee and performance concerns of the physics community. I also emphasise that over the past year the four proposals for baseline changes that have been considered significant enough to need approval by a change process and approval by the director have gone through a very open and interactive process to get to mature proposals, ones that have been evaluated rather straightforwardly by a change assessment panel. The panel recommends whether to make the changes and makes suggestions for further directions as the technical design is carried out.



Andre Seryi discussing the potential luminosity gained by using the travelling focus technique at the January SLAC Baseline Assessment Workshop.

CHANGE EVALUATION PANEL | **COST** | **GDE** | **ILC BASELINE** | **ILC PARAMETERS** | **LUMINOSITY** | **MACHINE PARAMETERS** | **PARTICLE BUNCHES**

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