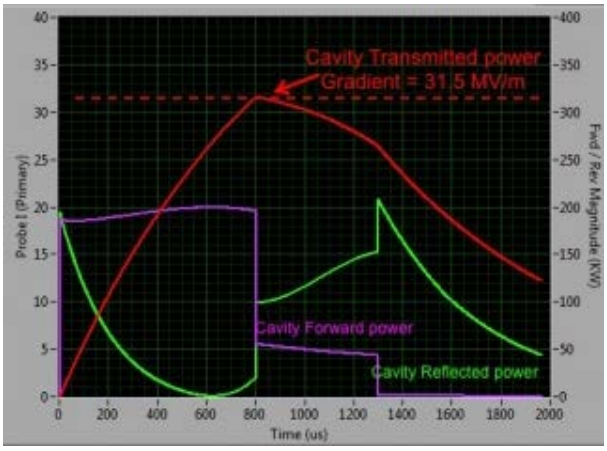
LC NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

FEATURE

From *Fermilab Today*: First cavity in Cryomodule 2 achieves goal gradient



On 20 December, members of the Accelerator Division SRF Electron Linac Department and the Technical Division SRF Development Department successfully brought the first accelerating cavity in Cryomodule 2 to a gradient of 31.5 megavolts per meter, the gradient required for the proposed International Linear Collider. The achievement demonstrates the cavity's successful integration into the cryomodule.

AROUND THE WORLD

French Linear Collider community meets to reinforce links with world-wide partners

by Marc Besancon (CEA/Irfu), Maxim Titov (CEA/Irfu), Marc Winter (CNRS/IN2P3, IPHC)

The French Linear collider community organised its second “Linear Collider days” last November. The highlights of the meetings, summarised here by three of the organisers, show the diversity of the fields addressed the community and its expertise. The days ended with a special session dedicated to country reports where accelerator and detector activities in different continents were reviewed in the context of their possible future cooperation with France. It served as one of the building blocks in constructing European ILC Community.

IMAGE OF THE WEEK

Happy New Year!

Image: Choo Yut Shing/DESY/Perrine Royole-Degieux

DIRECTOR'S CORNER

Dishing out experience

by Lyn Evans

The ILC will be a truly global scientific undertaking when it’s built – but it’s not the only one. The ALMA observatory in Chile for example, built to tell us more about how stars and planets are formed, is run by a collaboration that is distributed around the world. LCC Director Lyn Evans was invited on a field trip to three observatories in Chile as a member of a visiting committee set up by the European Southern Observatory ESO and learned a lot about travel in South America, commissioning telescopes

Japan (followed soon by China) has entered the Year of the Horse. Happy New Year to all our readers!

and running large science projects.

IN THE NEWS

from *Kahoku Shimpo*
4 January 2014
国内候補・北上山地今年の展望（下）前向きな姿勢政府示せ
◎高エネルギー加速器研究機構長・鈴木厚人さん「文科省を中心に、どうやって国際協力関係を結ぶかについて検討が始まっており、できるだけ早く国際交渉に入れるよう、基盤をつくっていきたい」(KEK's Director general Atsuto Suzuki said "The discussion on how to establish the international cooperative relations (for the realization of the ILC) has been started already by the MEXT. We are now developing the basis to enter into the international discussion as soon as possible".)

from *Iwate Nippo*
1 January 2014
ＩＬＣに「関心」68％ 県政世論調査、前年上回る
岩手日報社が行った県政世論調査で、国際リニアコライダー（ＩＬＣ）計画への関心について、「関心がある」「どちらかといえば関心がある」の回答は合計で６８・３％となり、前年調査を４・３ポイント上回った。(According to the regional opinion polls by Iwate Nippo about the interest to the ILC, 68.3% of the residents of the prefecture answered either "very much interested" or "interested." The number increased 4.3 points compare to the last year's polls)

from *New Scientist*
31 December 2013
Higgs boson could reveal deviant behaviour in 2014
The Higgs might do this by decaying into daughter particles in an unexpected way inside the LHC. "The Higgs is very sensitive to the presence of new particles," says Matt Strassler of Harvard University.

from *Kahoku Shimpo*
31 December 2013
ＩＬＣ同型の大ユニットが完成 １５年度めどに茨城で試験
ＫＥＫが、「国際リニアコライダー（ＩＬＣ）」で使われるのと同じ超電導の大型ユニット「クライオモジュール」を試作し、茨城県つくば市の研究施設の地下に設置した。建設計画が動きだすのをにらみ、実際に電子ビームを走らせ、性能試験を実施する。(KEK completed the assembly of the ILC-size cryomodule unit. Scientists will conduct the performance test using the particle beam, with a view of the project to get a go sign.)

from *Laboratory equipement*
30 December 2013
The Year 2013 in Science and Technology
In October, the 2013 Nobel Prize in Physics was awarded to Peter Higgs and François Englert for postulating the presence of the particle back in the 1960s, and, in December, the LHC showed how the Higgs boson decays. Will the International Linear Collider, the plans of which were unveiled in June, give up similar secrets when it's built in a few years' time?

from *Iwate Nippo*
29 December 2014
北上高地の自然環境調査 県、ILC実現向け着手
国際リニアコライダー（ＩＬＣ）の誘致を目指し、県は候補地の北上山地（北上高地）で自然環境調査に着手した。１月下旬の調査開始に向けて、現在は委託業者との契約手続きを行っている。(Iwate prefecture started the natural environment research toward the invitation of the ILC to Kitakami mountains. The prefecture plan to start the research activity in late January.)

from *The Conversation*
26 December 2013
2013, the year that was: Science + Technology
Will the International Linear Collider, the plans of which were unveiled in June, give up similar secrets when it's built in a few years' time? And let's not forget about the IceCube Neutrino Observatory, buried deep in the Antarctic ice, which detects the universe's slipperiest particles is still operational.

from *Sankei Shimbun*
25 December 2013
国予算案にＩＬＣ調査費５０００万円 「建設に大きな一歩」
２４日に閣議決定された国の平成２６年度予算案に、国際リニアコライダー（ＩＬＣ）計画に関する調査検討費として５千万円が盛り込まれたことについて、達増拓也知事は定例会見で、「ＩＬＣ建設に向け、大きく一歩を踏み出したと思う」と語った。ＩＬＣ関連予算が国の予算案に計上されたのは初めて。(Japanese national budget for the FY2014 was decided by the cabinet on 24 December, which included the 50 million yen research expense for the ILC. This is the first official national budget exclusively assigned to the ILC projject. Tasuya Tasso, the governor of Iwate prefecture said "This is the big step toward the construction of the ILC.)

from ***physicsworld***
19 December 2013
The world of physics in 2014
But what of next year? What will be the key events in physics and who will have taken the accolades in 12 months' time?

from ***Nature***
18 December 2013
Particle physics: Together to the next frontier
Japan is about to begin a campaign to sign up support for this international project, which would require US and European participation. Most particle physicists support the ILC but many would like to see what discoveries will come out of the upgraded LHC first. If no new particles emerge, then the higher precision available to the ILC would make building it even more attractive. If another discovery is made at the LHC, then the community might need a different machine to explore the new energy regime.

from ***Iwate Nippo***
14 December 2013
文科相「ILC、ぜひ日本に」 誘致に前向き姿勢
国際リニアコライダー（ＩＬＣ）について下村博文文部科学相は１３日、要望に訪れた自民党県連（鈴木俊一会長）に対して「ぜひ日本に誘致したいとの思いを強く持っている」と前向きな姿勢を示した。下村文科相は「制度設計などを２、３年かけて検討するというのが政府のスタンスだ。国際的に協力してもらってぜひ日本でやりたい」と踏み込んだ。(Minister of science and technology, Hakubun Shimomura said on 13 December to the members of the Liberal Democratic Party chaper of the Iwate prefecture, "I have a strong desire to invite the ILC to Japan. Government will take few years for the discussion on the items such as institutional design. I would like to realize the ILC in Japan with the cooperation from foreign countries.)

ANNOUNCEMENTS

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CALENDAR

Upcoming events

CLIC Workshop 2014
CERN
03- 07 February 2014

Upcoming schools

Joint Universities Accelerator School (JUAS)
Archamps, France
06 January- 14 March 2014

View complete calendar

PREPRINTS

ARXIV PREPRINTS

1401.0515
Radiative corrections to the Yukawa coupling constants in two Higgs doublet models

1312.7662
Fractal Dimension of Particle Showers Measured in a Highly Granular Calorimeter

1312.7641
Radiative corrections to the Higgs couplings in the triplet model

1312.7575
Higgs as a Probe of Supersymmetric Grand Unification with the Hosotani Mechanism

1312.6610
Searching Doubly Charged Leptons at Present and Future Colliders

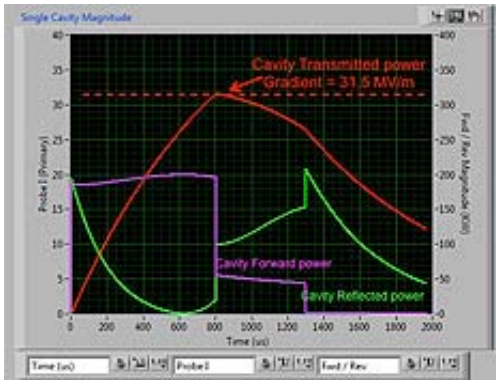
1312.5672
Higgs Physics

1312.5130
Composite Higgs: searches for new physics at future e+e− colliders

1312.4974
Estimation of LHC and ILC Capabilities for Precision Higgs Boson Coupling Measurements

Milestone

First cavity in Cryomodule 2 achieves goal gradient



Cavity 1 in Fermilab's Cryomodule 2 achieved a gradient of 31.5 MV/m on Dec. 20. *Image courtesy of Elvin Harms, AD*

On Dec. 20, members of the Accelerator Division SRF Electron Linac Department and the Technical Division SRF Development Department successfully brought the first accelerating cavity in Cryomodule 2 to a gradient of 31.5 megavolts per meter, the gradient required for the proposed International Linear Collider. The achievement demonstrates the cavity's successful integration into the cryomodule.

"Everyone involved should take satisfaction in this first step of bringing this cryomodule into operation," said Elvin Harms of the SRF Electron Linac Department.

A cavity's gradient is one measure of how efficiently beam is transmitted from one end of the cavity to the other. Although each of Cryomodule 2's eight cavities had previously achieved 31.5 MV/m prior to installation, this is the first time a cavity inside the cryomodule has been measured at this value. The test validates that the high gradient can be maintained even after the cavity is installed in the cryomodule.

The SRF teams will proceed with tests of the other seven cavities in Cryomodule 2, bringing them up to no higher than 31.5 MV/m. Once they ensure stable operations at this level, they will investigate the possibility of increasing the gradient from there.

"It is important that we become world experts in operating these and similar cryomodules," said Fermilab Director Nigel Lockyer. "This impressive achievement is the culmination of a long road."

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AROUND THE WORLD

French Linear Collider community meets to reinforce links with world-wide partners

Marc Besancon (CEA/Irfu), Maxim Titov (CEA/Irfu), Marc Winter (CNRS/IN2P3, IPHC) | 9 January 2014

French Linear Collider Days participants

CEA/Irfu and CNRS/IN2P3 organised a special event called “Irfu Linear Collider Days” from 27 to 29 November 2013. It served as an opportunity to discuss the French Linear Collider landscape in the areas of physics, theory and phenomenology, as well as accelerator and detector technologies. This was the second “Journées Collisionneur Linéaire (JCL)” of the French community, following the first event that had taken place in Lyon on 13 and 14 May 2013.

Held in CEA Saclay, the Irfu LC days brought together more than 80 attendees. The first two days of the meeting concentrated on the French activities and plans, providing a possibility to discuss future technological and engineering efforts needed to realise the ILC with the French accelerator and instrumentation communitiesat large. The last day was open to the rest of the world and was devoted to “country reports”, where experts from European countries, Japan and the US provided feedback on the status of the ILC efforts in their countries. All presentations can be found at the event webpage. Here are some meeting highlights.

PHYSICS, THEORY AND PHENOMENOLOGY

The opening session of the Irfu LC days was devoted to the review of recent theory, phenomenology and physics simulation activities; it was expertly organised by Marc Besancon of Irfu/SPP and Dirk Zerwas of LAL in Orsay. The power of the ILC lies in its flexibility. It can be tuned to well-defined initial state energies, allowing model-independent measurements from the Higgs threshold to 1 TeV. In his opening talk, Abdelhak Djouadi of LPT, Orsay summarised “the Higgs Boson profile” and the implication of the discovery on phenomenology, e.g. supersymmetric theories. He discussed areas where input from the linear collider, complementary to the LHC, will serve as “part of the therapy” to reveal the mechanism of electroweak symmetry breaking. Continuing with the Higgs sector, Yacin Haddad of LLR in Palaiseau presented recent studies of associated production of Z and Higgs bosons, with the Z-boson decaying into a di-jet final state. A highlight was a talk of Dirk Zerwas on the recent results from SFitter collaboration which combines results from electroweak precision measurements into a combined picture . He addressed the importance of separate measurements of Higgs couplings to top and charm quarks. These remove the assumption on a link between second- and third-generation fermions and avoid deterioration in precision due to theoretical uncertainties for all Higgs couplings.

Sensitivity to new physics effects (tree-level or higher-order) at a higher energy scale from different models beyond the Standard Model drastically improves with ILC precision measurements of electroweak precision observables (EWPO) and the top mass. Lisa Zeune of DESY in Hamburg reviewed the status of experimental results and predictions for W and top masses and electroweak precision observables, which provide constraints on undetected particles. In particular, a precise measurement of the W boson mass restricts light supersymmetric bottom (sbottom) and heavy supersymmetric top (stop) mass ranges to small intervals. The ILC will be the first machine to produce top pairs in electroweak production, allowing qualitative and quantitative improvement of top mass measurement. Roman Poeschl (for Amjad Sohail) and Jérémy Rouëne, both of LAL, presented results on the precise determination of top quark electroweak

couplings, reconstruction of top quark production angle in fully hadronic states and measurements of top quark polarisation. Open questions, in particular higher order corrections, the role of single top production and reliable generators, demonstrate the need of close contact with theory groups in the future.

Searches for weakly interacting massive particles (WIMPs) constitute one of the major priorities of the ILC physics programme. Yann Mambrini of LPT Orsay reviewed the current status of direct and indirect dark matter (DM) searches. The ILC will have better sensitivity than any DM experiment for a WIMP mass below 10 GeV. Mikael Berggren of DESY in Hamburg presented recent results of model-independent DM searches in monophoton final state. Beam polarisation offers unique access to the chirality of couplings, the structure of interactions, and provides a major opportunity for WIMP property determination (mass, the helicity structure, or the spin of the mediator) and allows for model discrimination. Studies are ongoing to extend previous analyses to different vector and axial operators, a joint effort of DESY and CEA Saclay. Finally, Ana M. Teixeira of LPC Clermont-Ferrand presented a comprehensive review of the ILC potential for new physics searches and its complementarity to the LHC results.

DETECTOR INSTRUMENTATION

For at least a decade, nine CNRS/IN2P3 laboratories and CEA/Irfu institutes have been actively involved in detector (or accelerator) R&D activities, meaning that a substantial fraction of the French particle physics community is interested in the ILC. Moreover, France has been historically involved in many subsystems, often with major contributions: high-precision vertex detector based on CMOS pixel sensor technology (MIMOSA), main tracking systems using a gaseous TPC with Micromegas-based readout, and a highly granular calorimeter, both electromagnetic (with silicon sensors) and hadronic (with glass RPCs and/or Micromegas). The session conveners – Paul Colas of Irfu/SPP and Vincent Bourdry of LLR have arranged a well-balanced programme of the Irfu Days, building on the successful outcome of and minimising the overlap with the first JLC meeting in Lyon, where comprehensive summaries of detector R&D efforts were presented.

This time, the focus was set on very short reports of the future French activities in different sub detectors. Marc Winter of IPHC in Strasbourg, Paul Colas and Maxim Titov of Irfu/SPP, Vladislav Balagura of LLR, Imad Laktineh of INPL in Lyon and Max Chefdeville of LAPP in Annecy reviewed the vertex detector, TPC, SiW-ECAL and DHCAL subsystem plans for the next few years. Common developments were discussed, taking into account the difference in the time constrains for the various systems: for example, the technology choice will have to be made much earlier for the calorimeters than for the vertex detector. At LCWS 2013 in Tokyo, it became clear that a phase transition is ongoing for ILD and SiD concepts moving towards optimisation, integration and questions at system level. A cost-performance re-optimisation of the ILD concept was presented by Trong Hieu Tran of LLR, who studied the effect of reducing the size of the of ILD both in terms of radius and length, and several ECAL and HCAL geometries on the physics performance. The efforts on particle flow reconstruction in France were summarised by Naomi van der Kolk of LAL and LLR who emphasised the importance of the future coordinated effort. As Christian Bourgeois of LAL reported, another very important area are the overall mechanical and engineering integration studies of a real ILD detector. Aspects of mechanical monitoring, cooling and power pulsing of the electronics were reviewed globally. Jérémy Rouëne of LAL presented recent successful testbeam results with SiW-ECAL and DHCAL electronics using power pulsing. The possibility of the two-phase CO_2 cooling of the Micromegas-TPC module was discussed by David Attié of Irfu/SEDI; first tests in the large TPC prototype at DESY are being planned for February 2014. A possibility of SiW-ECAL cooling with a leak-less water system, including integration aspects, were addressed by Denis Grondin of LPSC in Grenoble. Finally, carbon-aluminum composite structures for the TPC and the use of fiber Bragg grating sensors for the characterisation of deformation of composites structures were presented by Pierre Manil of Irfu/SIS and Marc Anduze of LLR, respectively. The session ended with an open discussion aimed at identifying transverse detector instrumentation activities and to make it easier to organise French detector R&D. This has been particularly important in a view of a special Horizon 2020 (H2020) meeting at LAL, organised by Brian Foster and Juan Fuster on Friday, 29 November, where possibilities to obtain funding for ILC-related activities from the new European scientific framework were discussed.

ACCELERATOR INSTRUMENTATION

Accelerator research and development has a rich historical background in France, as testified by the present diversity within numerous laboratories which contribute to European programmes dedicated to accelerator R&D (CARE, EUROTRANS, EURISOL, EuCARD, HL-LHC, ILC HiGrade, …) and provide technological support to European, and international projects. Highlights of the recent ILC-related accelerator activities in France were presented in a dedicated session, organised by Olivier Napoly of Irfu/SACM and Philip Bambade of LAL. The opening talk by Philip Bambade provided a comprehensive summary of the 2013 LCWS Accelerator Working Groups. Two presentations by Walid Kaabi of LAL Orsay and Olivier Napoly reviewed the progress with coupler and cryomodule production for the European XFEL facility at DESY Hamburg. LAL is in charge of the production and conditioning of 808 radiofrequency couplers (1.3

GHz, repetition rate 10Hz, peak power 150 kW). In his talk, Olivier Napoly reviewed four main areas where the ILC could benefit from XFEL cryomodule construction: industrialisation, ILC cryomodule demonstration, XFEL large-scale system test and building-up of expertise and infrastructure for an 'EU hub' for ILC cryomodule assembly. Fabien Eozenou of CEA/SACM described high-gradient R&D activities at CEA/Irfu with the goal to reach 35 MV/m at 90% yield. Efforts towards improving large-scale production of superconducting cavities are also ongoing within the KEK – CEA (A_RD_9) collaboration, with industry participation; recent results from vertical electropolishing developed in CEA/Irfu were discussed. Andrea Jeremie of LAPP summarised French activities around ATF2 and the final focus/ machine-detector-interface (MDI) for ILC and CLIC, including beam instrumentation, alignment and module control with sub-nanometre stabilisation. Olivier Napoly presented an idea to build a dressed nine-cell 1.3-GHz ILC cavity with a high gradient of 40 MV/m, Q0 = 2e10 and tested in a horizontal cryostat. In terms of electricity consumption ILC is a real scale workbench to develop, maintain and manage a mix of sustainable energy sources. ILC goes beyond basic science and Denis Perret-Gallix of LAPP explained a model of a "green ILC" summarising the outcome of the workshop "Energy for sustainable science" which took place at CERN in October 2013.

All participants of the Irfu ILC days also had the opportunity to visit Saclay cryomodule construction facility, an impressive "XFEL village" on the CEA Saclay site. While not yet in production mode, when the construction of one cryomodule per week will be expected, this assembly line has already produced a module with performance reaching ILC requirement –a major breakthrough.

BUILDING UP THE EUROPEAN ILC COMMUNITY

In order to realise the ILC, a well-coordinated effort between Asia, Europe and the North America is mandatory. Therefore, any European initiative (both at country and EU level) can only be viewed in a world-wide context. Representatives from Germany, Italy, Norway, Spain, UK as well as from Japan and the US joined "Irfu Linear Collider Days" on 29 November. A special session organised by Maxim Titov and Marc Winter was dedicated to so-called "country reports" where accelerator and detector activities in different continents were reviewed in the context of their possible future cooperation with France. Following a welcome address by Philippe Chomaz, head of CEA/Irfu, and a message from Jacques Martino, head of CNRS/IN2P3, represented by Marc Winter, accelerator activities in France, Germany, UK, Japan and the USA were summarised by Olivier Napoly, Eckhard Elsen of DESY in Hamburg, Philip Burrows of Oxford University, Hitoshi Yamamoto of Tohoku University (for Akira Yamamoto) and Marc Ross of SLAC. As Eckhard Elsen explained, the ILC is a vital element of the next five-year plan just submitted to Helmholtz Association. Detector activities in Germany, Italy, the UK and Japan as well as accelerator and detector summaries from Spain were presented by Klaus Desch of Bonn University, Massimo Caccia of University Milano-Bicocca, Mark Thomson of University of Cambridge, Hitoshi Yamamoto and Angeles Faus-Golfe of IFIC Valencia. There is evidence that a significant movement is going on in the Japanese government, which together with the release of the ILC Technical Design Report describing the technical feasibility of the ILC project, and selection of the northern "Kitakami" site, puts ILC much closer to reality. However, the major discussion concentrated on optimisation of limited ILC resources and somewhat more targeted R&D funding before the project gets the green light, which will hopefully happen within a few years.

Last, but not least, we would like to thank all members of the programme and local organising committee: David Attié, Marc Besancon, Paul Colas, Olivier Napoly, Martine Oger, Maxim Titov, Philip Bambade, Jean-Claude Brient of LLR, Yannis Karyotakis of LAPP and Marc Winter. We are the most thankful to our world-wide partners for taking their valuable time to join the event and to contribute to the discussions of the future French Linear Collider roadmap. This meeting also provided an opportunity to further strengthen the international links and served as a building block in constructing the European ILC community – vital for the ILC project realisation. Shared successes do wonders in bringing a group of people together as the team and setting the stage to address future endeavors. This event was a truly cooperative effort. Thanks so much to everyone who came to the Paris meeting late November!

ACCELERATOR R&D | CEA | CNRS | DETECTOR R&D | FRANCE | IN2P3

NEWSLINE
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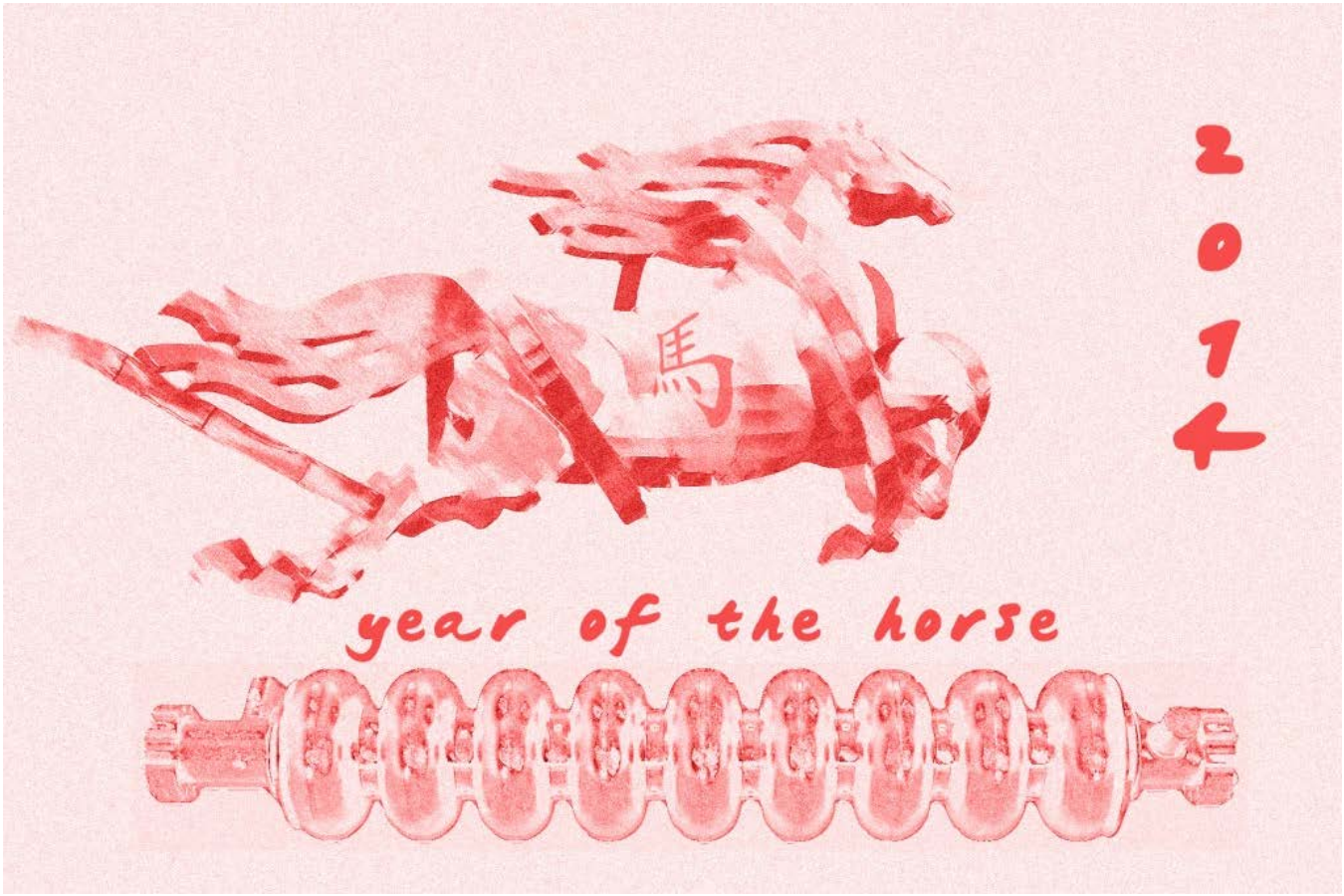
IMAGE OF THE WEEK

Happy New Year!

Image: Choo Yut Shing/DESY/Perrine Royole-Degieux | 9 January 2014

Japan (followed soon by China) has entered the Year of the Horse. Happy New Year to all our readers!



CAVITY | JAPAN

NEWSLINE
THE NEWSLETTER OF THE LINEAR COLLIDER COMMUNITY

DIRECTOR'S CORNER

Dishing out experience

Lyn Evans | 9 January 2014

Lyn Evans amongst some of the ALMA dishes at an altitude of 5000 metres.

First of all let me wish you all a Happy New Year. I hope that we will see real progress towards the realisation of the ILC in 2014, starting with the approval process in Japan and other countries. Now let me share a unique experience with you that provided me with a different perspective on how big science projects are organised in different scientific areas – and of how visiting scientists can be made comfortable under arduous conditions. In December I received an offer that I could just not refuse. It was to join a "visiting committee" to inspect the three sites of the European Southern Observatory (ESO) in Chile. The purpose of the committee was to independently assess the performance of ESO in providing top-class facilities for the users.

The oldest observatory is at La Silla. It lies about an hour north of Santiago by air and then another couple of hours to the mountain at 2600 metres altitude. There are a number of telescopes of different sizes owned by national laboratories with a few still run by ESO, although the policy of phasing out operations by 2020 means that there is no new investment. Nevertheless the scientific output is still prolific with more than 300 papers published per year, about half the number that is produced by its modern cousin at Paranal.

The Paranal site is another hour north by air to Antofagasta followed by a three-hour drive into the mountains to the Paranal observatory at 2635 metres altitude. There are four large 8.2-metre telescopes (the VLT), that can be operated independently or together as an interferometer. There are also a number of smaller telescopes that can be moved around on rails that always operate in interferometric mode. The hostel lodging the astronomers and operators, the Residencia, is spectacular. Since the relative humidity on the mountain can be as low as 4%, a very novel means of increasing the humidity inside has been implemented. There is an oasis of green inside the residence, with palm trees and a swimming pool which increases the humidity to about 40 % as well as offering relaxation to the residents, who generally do a 10-day stint on the mountain. The Residencia served as a backdrop for part of the 2008 James Bond film *Quantum of Solace*.

The final telescope site, ALMA, is even more spectacular. We accessed it after a 500-kilometre drive through the Atacama Desert. The Atacama Large Millimetre Array (ALMA) is a radio interferometer made of 66 12-metre and 7-metre dishes observing at millimetre and sub-millimetre wavelengths. It is a collaboration between the USA, Europe (through ESO) and Japan, sitting on a plateau at 5000 metres altitude with a base camp at 2900 metres. Before accessing the high site a medical examination is required and bottled oxygen is provided in case it is needed!

ALMA is now taking data while still being commissioned, a familiar situation to us working on particle accelerators. It has the usual problems of reliability during early operation but the scientific results are already spectacular. I am sure that we will hear much more of ALMA in the future.

This visit was a fascinating view of how another “big science” project works. Many of the problems are very familiar, the complexity of international collaboration and in the case of ALMA, the difficulty of commissioning a large and complex instrument under the pressure of producing scientific results.

It was an unforgettable experience, but now back to the day job!

ALMA | ESO | GLOBAL COLLABORATION | LA SILLA | PARANAL