CERN-ACC-SLIDE-2013-074

HiLumi LHC

FP7 High Luminosity Large Hadron Collider Design Study

Presentation

Accelerating News Issue 5

Szeberenyi, Agnes

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The electronic version of this HiLumi LHC Publication is available via the HiLumi LHC web site <http://hilumilhc.web.cern.ch> or on the CERN Document Server at the following URL: <http://cds.cern.ch/search?p=CERN-ACC-SLIDE-2013-074>

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Issue 5: Spring 2013

From the editors

by Agnes Szeberenyi (CERN), Celine Tanguy (CEA)

In this spring issue, we look at developments towards higher luminosity and higher energy colliders. We report on the technology developed for the remote powering of the LHC magnets and studies of diagnostics based on higher order mode port signals. We also inform you about the main outcome of the TIARA survey on market needs for accelerator scientists.

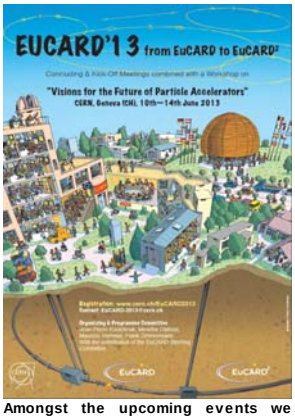
Expanding further the scope of the newsletter beyond EuCARD, HiLumi and TIARA projects, we are introducing the Accelerator Topic activities of the CRISP (Cluster of Research Infrastructures for Synergies in Physics) European project and featuring the long term perspective for High Energy Physics via TLEP.

In the headlines, we learn about a new insulating compound for superconducting magnets, US-CERN partnership to accelerate neutrino research, recent results about the particle that we can now name a Higgs boson. We update you concerning the strategy for European particle physics and situation on linear colliders. Finally, we've found stories on how superconductivity leads the way to high luminosity and the huge impact of accelerators on semiconductor industry.

We hope you enjoy this issue. Please contact us with any news or events that you would like added to future issues.

Read more >>

Keywords: editors; introduction



Amongst the upcoming events we highlight the EuCARD'13 event combined with a workshop on "Visions for the future of Particle Accelerators" on 10-14 June 2013. Image credit: CERN

The ACFA / IPAC'13 Accelerator Prizes will be presented during the IPAC'13 event from 13 to 17 May, 2013, in Sanghai, China. Image credit: IPAC'13

Development and Testing of Crab Cavities for High Intensity Colliders

by Peter McIntosh (STFC)

The development of innovative crab cavity solutions for high intensity particle colliders is part of both the FP7 EUCARD and HiLumi framework programmes.

The activity has been led by Lancaster University and STFC in the UK, in direct collaboration with CERN. For LHC, a compact Superconducting RF (SRF) solution at 400 MHz, capable of fitting into the confined space available at the LHC interaction regions is proposed. A compact TEM type deflecting structure has been manufactured at Niowave from bulk Niobium, which has been tested in SM18 at CERN, reaching a surface magnetic field of 33 mT (limited by a serious LHe leak). This represents the world's first high field test of a compact SRF deflector and the cavity is currently undergoing additional BCP processing in order to reach the LHC design gradient of 6 MV/m (Bpk~70 mT).

For CLIC, a high gradient 12 GHz, normal-conducting travelling-wave structure, with a high group-velocity to minimise the effects of beam loading, has been developed. Two ‘undamped’ structures have been fabricated, one in the UK by Shakespeare Engineering Ltd and the other at CERN. Systematic high gradient tests are planned at SLAC and CERN, to study breakdown differences between deflecting and accelerating structures. A third ‘damped’ cavity is currently being developed to allow verification of the operational performance. A high phase stability control system, which will keep the phase from a klystron stable over long distances, is also in development to meet the stringent CLIC phase stability tolerances.

CLIC 'Undamped' Crab Cavity Fabricated.
Image credit: Shakespeare Engineering Ltd (UK)

LHC 4-rod Crab Cavity Fabricated.
Image credit: Niowave Inc (USA)

Read more >>

Keywords: EuCARD, HiLumi, crab cavity

EVENTS

4-5 April 2013
TLEP Workshop
CERN, Switzerland

16-19 April 2013
SC 2013 - Space Charge 2013
CERN, Switzerland

24 April- 4 May 2013
CAS - CERN Accelerator School: Course on Superconductivity for Accelerators
Erice, Italy

13-17 May 2013
IPAC'13 - International Particle Accelerator Conference + ACFA/IPAC'13 Accelerator Prizes
Shanghai, China

2-7 June 2013
EEAC2013 & EuroNNAc2013 - Combined European Advanced Accelerator Concepts workshop and 2013 EuroNNAC network meeting
Elba, Italy

10-14 June 2013
EuCARD'13 - Final EuCARD meeting / EuCARD-2 kick-off
CERN, Switzerland

11-12 June 2013
Visions for the Future of Particle Accelerators - Workshop combined with the EuCARD'13 event
CERN, Switzerland

25-26 July 2013
TLEP workshop
Fermilab, US

6-16 August 2013
INSS 2013 - International Neutrino Summer School
Beijing, China

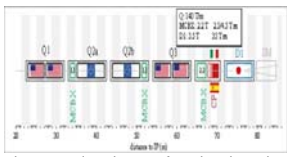
19-24 August 2013
Nufact 2013 - 15th International Workshop on Neutrino Factories, Super Beams and Beta Beams
Beijing, China

25-29 August 2013
FEL 2013 - 35th International

A first layout for the High Luminosity Upgrade

by Ezio Todesco, Stephane Fartoukh (CERN)

A first baseline for the layout of the High Luminosity inner triplet and associated magnets has recently been defined. This is the second major milestone, after the choice of a 150 mm aperture for the quadrupoles in July 2012.



The tentative layout for the insertion: sequence of magnets versus distance to the interaction point in ATLAS or CMS (0 m is the centre of the experiment). The flags indicate a possible origin of the in-kind contribution.
Image credit: HiLumi LHC

A layout is the selection of the sequence of magnets, their strength, their length, and the associated technology: therefore, it requires inputs both from the optics and from the magnet teams. Its definition is a delicate equilibrium between the search for maximum performance and the need of minimizing complexity and associated risks. Nb3Sn technology had been already selected for the triplet quadrupoles – these magnets are planned to be built with a CERN-US collaboration, heavily relying on the work carried out by LARP in the past 10 years.

After the triplet, a separation dipole of 5.5 T, in Nb-Ti, is being studied by the Japanese team in KEK. The layout is complemented by the challenging orbit correctors, also based on Nb-Ti technology, with nested coils both providing horizontal and vertical field of up to 2 T. A package of higher order correctors relying on superferric technology is also available, in order to correct for the inevitable field imperfections of the inner triplet at the 10^{-4} level. The triplet corrector package is based on the design developed in Spain by CIEMAT.

As a result, the energy deposition team can start simulations to have a precise estimate of the radiation damage and heat loads coming from the collision debris. It is a heavy shower and magnets will need thick shielding to avoid falling in pieces before reaching the project ambitious goal of 3000 fb-1. The layout has been presented at CERN and will be extensively discussed at the HiLumi/LARP collaboration meeting, 8-10 April 2013, Napa Valley.

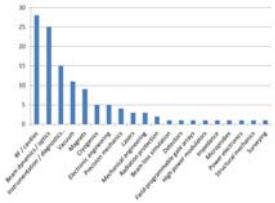
Read more >>

Keywords: HL-LHC, LARP, KEK, baseline, inner triplet, magnets

A growing market for accelerator personnel in Europe

by Philip Burrows (JAI, University of Oxford)

The findings are revealing: an overall growth of 18% in personnel is projected over the next 5 years, driven largely by the construction of new facilities on this timescale. However a majority of respondents report difficulties in hiring suitable personnel, most notably engineers, and skills shortages are reported in a number of critical areas.



Reported skills shortages (number of institutes) vs. area of expertise. Click to enlarge. Image credit: TIARA.

In 2011 the members of TIARA Work Package 5 “Education & Training” (WP5) conducted a survey of provision of accelerator science training across Europe which revealed some interesting facts (see Accelerating News issue 2). In our follow-on survey we have attempted to gauge the market needs for accelerator-related personnel by surveying major customers: laboratories, universities, companies and medical facilities that design, build or operate accelerators. We assessed the types, numbers, and qualification levels of required personnel, as well as issues of recruitment and skills shortages. The response was outstanding: 70 research institutes and 44 companies from Denmark, Finland, France, Germany, Italy, Norway, Poland, Spain, Sweden, Switzerland and the United Kingdom completed the survey, accounting for more than 4500 personnel engaged in accelerator-related activities. The findings are described in full in the Needs for Accelerator Scientists report released recently.

Read more >>

Keywords: TIARA, education, training

Free-Electron Laser Conference
New York, US

9-13 September 2013
ERL 2013 - 53th ICFA Advanced Beam Dynamics Workshop on Energy Recovery Linacs
Novosibirsk, Russia

16-19 September 2013
IBIC 2013 - 2nd International Beam Instrumentation Conference
Oxford, UK

16-20 September 2013
Cyclotrons'13 - 20th International Conference on Cyclotrons and their Applications
Vancouver, Canada

18-20 September 2013
Pontecorvo 100 - Symposium in honour of Bruno Pontecorvo for the centennial of the birth
Pisa, Italy

23-27 September 2013
SRF2013 - 16th International Conference on RF Superconductivity
Paris, France

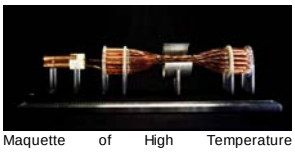
29 September- 4 October 2013
NA-PAC'13 - Particle Accelerator Conference
Pasadena, CA, US

6-11 October 2013
ICALEPCS 2013 - 14th International Conference on Accelerator and Large Experimental Physics Control Systems
San Francisco, US

High Temperature Superconductors in the LHC

by Amalia Ballarino (CERN)

Superconducting links in accelerator systems enable powering of the cryo-magnets from remote power converters. The development carried out within Task 5 of the EuCARD Work Package7 aims at providing such technology for the remote powering of LHC magnets.



Maquette of High Temperature Superconducting Link of the type needed at LHC Point 7. Image credits: CERN

The use of High Temperature Superconductors (HTS) in Superconducting Links has the great benefit of enabling the development of a powering system where superconductors can be operated with a generous temperature margin. To enable the use of superconductors with tape geometry, a novel concept of cable optimized for DC electrical transmission (Twisted-Pair Cable) has been developed and demonstrated [1], [2]. A cabling machine enabling the controlled assembly of km-long Twisted Pair cables - made from superconductors with different mechanical characteristics - has been conceived, assembled and commissioned at CERN. A full-scale 5 m long prototype link has been made at CERN and successfully tested in nominal conditions at the University of Southampton [3]. A 20 m-long full scale link is being assembled at CERN, where it will be tested in nominal and transient conditions.

The main outcomes of this activity are: (1) the development of a novel concept of superconducting cable for electrical transmission that can be made from any of the HTS tape-conductors today available (BSCCO 2223, YBCO or MgB2); (2) the development of a new cabling machine for the controlled assembly of the cable; (3) the development of a full superconducting link system that could be used at LHC Point 7 for the powering of the superconducting magnets. The developed technology could be applied for feeding any superconducting system requiring currents in the 1 kA range at any temperature from liquid nitrogen to liquid helium.

Read more >> [1] [2] [3]
Keywords: EuCARD, HTS, Superconductors

Introducing CRISP Accelerator Topic for Synergies in Physics

by Hans Weise (DESY) with Agnes Szeberenyi (CERN)

The EU funded CRISP project (The Cluster of Research Infrastructures for Synergies in Physics) started on 1st October 2011 and runs for 3 years. CRISP is a cooperative project, creating synergies and developing common solutions via knowledge and technology transfer from academia and industry for research infrastructures (RIs), initially bringing together 11 RIs in the field of Physics, Astronomy, and Analytical Facilities from the ESFRI roadmap across Europe. The work is organized around 4 main topics; accelerators, detectors, instruments and experiments, information technology and data management.

CRISP
The Cluster of Research Infrastructures for Synergies in Physics

CRISP logo. Image credit: CRISP

Group photo taken at the 2nd CRISP Annual meeting, 18-20 March 2013, PSI, Switzerland. Image credit: CRISP

In the Accelerator Topic, the CRISP developments support the delivery of beams with superior intensity, the operation of accelerators with high reliability, particle beam characteristics which will allow opening new perspectives and opportunities for the next generation of nuclear and high energy physics projects and of experiments in photon, neutron and ion beam science.

A total of five work packages were defined within the topic to the benefit of several accelerator projects funded by CRISP. Improved ion sources will allow for better operation of Spiral 2 at GANIL. Bunch Shape Monitors are under development at GANIL as well as at GSI for FAIR. Superconducting accelerator technology will be further improved at DESY for the European XFEL, at CERN in collaboration with ESS for future projects including the European Spallation Source, and at GSI in order to address the challenges of fast cycled superconducting magnets for FAIR. Novel compact particle sources, electrons as well as protons, are also discussed and Radio Frequency Solid State Amplifiers using Cavity Combiners are under development at ESRF.

IN THE HEADLINES

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New results indicate that new particle is a Higgs boson

From Symmetry
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Priorities in particle physics

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February 2013
Linear-collider technologies for all

From *CERN Courier*
January 2013
Superconductivity leads the way to high luminosity

From *Symmetry*
December 2012
US-CERN partnership to accelerate neutrino research

Read more >>
Keywords: CRISP, Synergies, ELI, ESRFUP, FAIR, ESS, EuroFEL, European XFEL, ILC-Higrade, ILL20/20, SKA, SLHC, SPIRAL2

Targeting the Energy Frontier for next Accelerators

by Frank Zimmermann (CERN)

Recently two EuCARD-AccNet events explored options for the next accelerators at the energy frontier. The EuCARD "SAPPHiRE Day" on 19 February focused on the key components of a proposed g-g collider Higgs factory, based on a recirculating SC linac. The "Joint Snowmass-EuCARD/AccNet-HiLumiLHC meeting on Frontier Capabilities for Hadron Colliders 2013" on 21-22 February investigated the next generations of hadron colliders up to the 100 TeV scale. Both workshops attracted about 50 experts from around the world.

Layout of SAPPHiRE g-g collider Higgs factory delivering 10k Higgs per year.

The proposed SAPPHIRE layout is a moderately expensive step towards a higher-energy linear collider, demonstrating the handling of 20-nm spot sizes while delivering first-rate physics results. The emphasis of the SAPPHiRE Day was on the laser system, optical cavity, interaction region design, and FEL approaches.

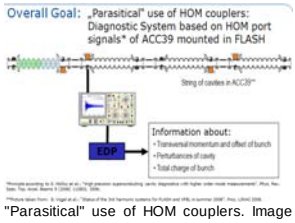
The joint workshop on frontier capabilities explored the parameters and 20-T magnets for a 33-TeV c.m. pp collider in the existing LHC tunnel and for a 100-TeV c.m. collider in a new 80-km tunnel. The workshop reviewed the high-field magnet development status and plans at CERN and LBNL.

Read more >>
Keywords: EuCARD, HiLumi LHC

Diagnostics based on Higher order mode port signals

by Ursula van Rienen, Thomas Flisgen, Tomasz Galek (Universität Rostock)

Higher order mode (HOM) couplers are a crucial part of many superconducting cavities since unwanted modes, which are excited by the beam, need to be damped effectively. EuCARD WP10 task 5 is predominantly dealing with studies on diagnostics based on HOM port signals. This task is carried out jointly with the teams around Roger Jones (University of Manchester, speaker) and Nicoleta Baboi (DESY).



"Parasitical" use of HOM couplers. Image credit: Universitat Rostock

Monitoring the HOM port signals as a by-product of the HOM damping offers the possibility to determine the transversal offset, the total charge of the bunch, etc. with little additional hardware.

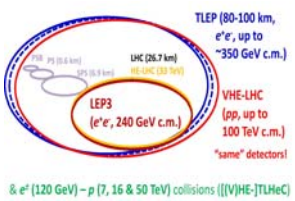
One major concern of the ongoing studies is to predict the theoretical accuracy of the diagnostic system in the context of uncertainties such as perturbations of the cavity from the design shape. The entire investigation is based on three pillars: First, experiments at the FLASH facility at DESY in Hamburg are undertaken with the focus on the third harmonic module ACC39. Second, numerical simulations are performed using existing commercial programs such as CST MICROWAVE STUDIO® and in-house codes. Third, new computational methods are developed and implemented. In this context, a method to determine wake fields in large structures by means of decomposition techniques is constructed. Moreover, a generalized perturbation theory is in development which determines a set of eigenmodes of the perturbed geometry based on a set of eigenmodes of the unperturbed shape. Overall, the research efforts are aiming for a sophisticated understanding of diagnostics based on HOM port signals. The long term goal is the equipment of current and future machines with diagnostics based on HOMs.

Read more >> [1] [2] [3]
Keywords: EuCARD, FLASH, ACC39, diagnostics, superconducting cavities, wake fields

“TLEP” - Circular Higgs Factory and a Long-Term Perspective for High Energy Physics

by Frank Zimmermann (CERN)

Following the first EuCARD “LEP3 Day” on 18 June 2012 (see article ‘Circulating ideas about a new Higgs factory’ in Accelerating News issue 3), which revealed a great interest in a circular-collider “Higgs factory”, EuCARD Work Package 4, AccNet, has been organizing several workshops discussing the key ingredients, the physics potential, experimental detector concepts, and synergies with other projects of such a facility.



A long term strategy for particle physics. The succession of TLEP & VHE-LHC could provide more than 50 years of e+e-, pp, AA, ep/A physics at highest conceivable energies. The sequence LEP3 & HE-LHC represents a less ambitious, but lower-energy alternative.s. Image credit: TLEP

Emphasis has shifted from LEP3, a machine installed in the 27-km LHC tunnel originally proposed, to TLEP, an electron-positron collider in a new 80 or 100-km long ring tunnel. Advantages are manifold: TLEP construction would be fully decoupled from LHC/HL-LHC operation. TLEP could achieve up to 5 times higher luminosity than LEP3, promising a precision for Higgs coupling measurements much better than any other planned or proposed machine. Such precision is needed to discover physics beyond the standard model at energies above 1 TeV. In addition, TLEP could possibly provide the infrastructure (tunnel, cryogenics, injector-ring magnets, detectors) for a future 100-TeV proton-proton collider in the same tunnel – the “Very High Energy LHC” or “VHE-LHC” –, paving a path towards extremely high hadron collision energies, while also allowing for highest-energy electron-proton collisions.

Presently a TLEP conceptual design study is being set up aiming at delivering a design report by 2014/2015.

Read more >>

Keywords: TLEP, HL LHC, EuCARD

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