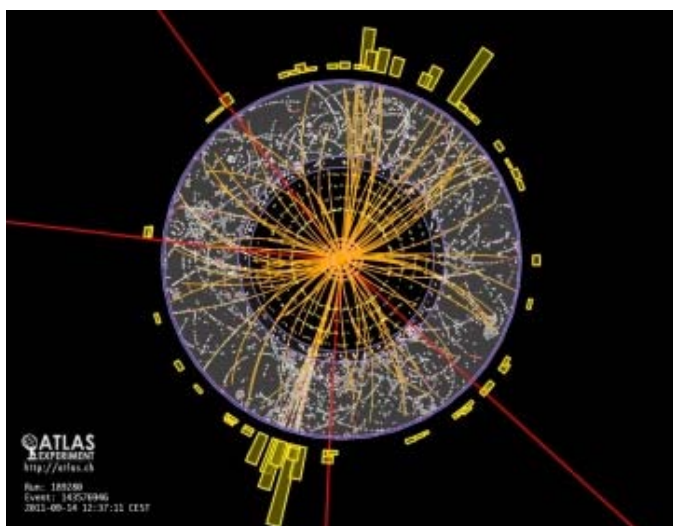


FEATURE

From *CERN*: ATLAS and CMS experiments present Higgs search status

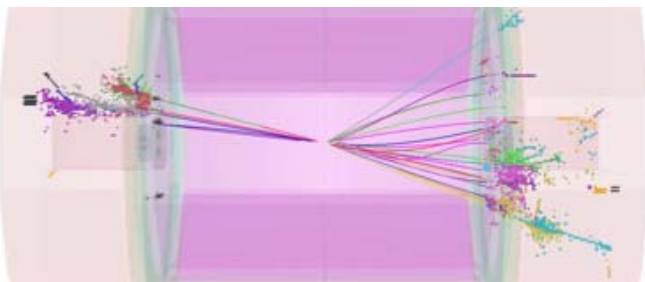


13 December 2011: In a seminar held at CERN today, the ATLAS and CMS3 experiments presented the status of their searches for the Standard Model Higgs boson.

RESEARCH DIRECTOR'S REPORT

Detector R&D “coopetition” between ILC and CLIC

by Juan Fuster



AROUND THE WORLD

CM2 assembly nearly complete

Fermilab's CM2 is in the final stages of assembly. It will come online in the spring.

by Leah Hesla



Fermilab will soon begin operating CM2, a significant advancement in work on superconducting radiofrequency research that will serve the ILC community and Fermilab in building and operating future accelerators.

DIRECTOR'S CORNER

Recovery from March 2011 earthquake at ATF, KEK

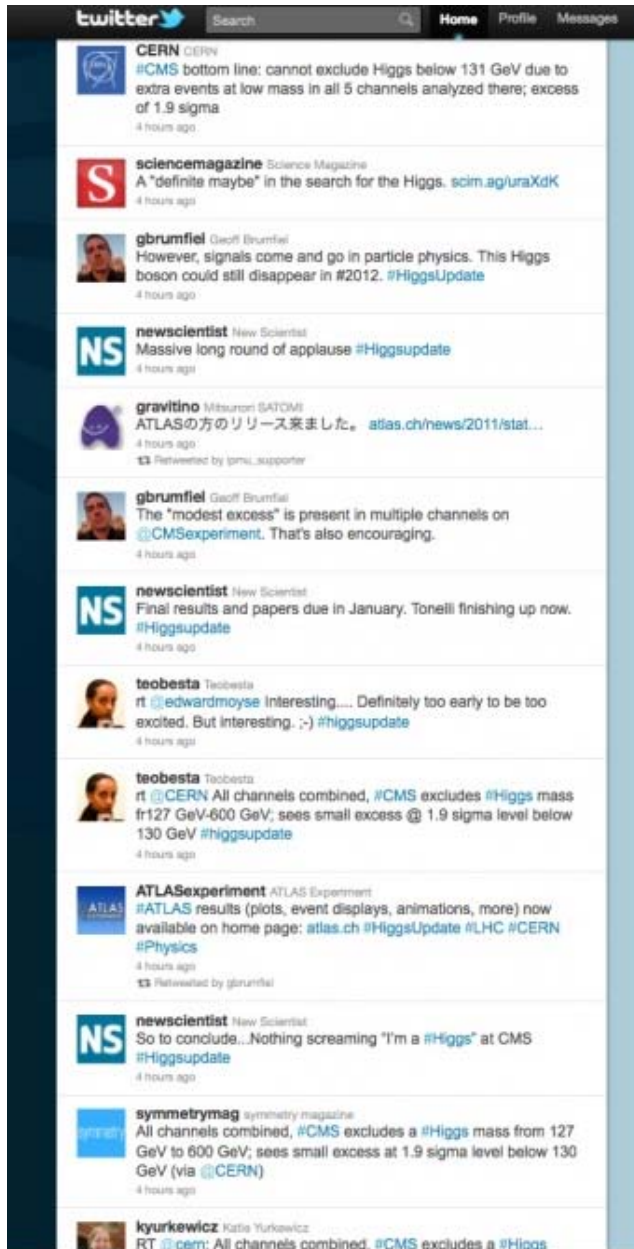
by Toshiaki Tauchi



Though the differences between ILC and CLIC detectors are marked, ILC detector concepts have been shown to be valuable for the machine being designed by its competitor-cooperator, the CLIC design study.

Restoration of the Accelerator Test Facility is in its final stage at KEK, Japan, where the ATF2 project, the final focus test beam for ILC, is being conducted with an international collaboration.

IMAGE OF THE WEEK



Atwitter over Higgs

The twitter chatter over CERN's Higgs news on Tuesday was nonstop, enough to prompt *New Scientist* to remind us, in a tweet about the Durban conference, "it's not ALL about the #Higgs you know".

IN THE NEWS

from *The Guardian*
13 December 2011

In praise of ... non-trivial pursuits

Discovery will simply raise more fundamental questions: that is why, long before the LHC was switched on, the particle physicists of Europe and America began devising plans for an International Linear Collider, to answer questions raised by the discovery of the Higgs or, even more thrillingly, the discovery that it does not exist – that something is wrong with the standard

model of the making of a universe.

from **The Telegraph**

13 December

An unconfirmed sighting of the elusive Higgs boson

..."126 GeV would be a convenient value for a new linear collider; if it existed at that mass range, we could then study the Higgs further,"...

from **Discover Magazine**

13 December 2011

First Glimpse of the Higgs Boson: Guest post from Jack Gunion

Further, such a light SM-like Higgs boson provides strong motivation for a linear electron-positron collider of low center-of-mass energy. Studies suggest that only such a collider can easily measure the properties of such a light Higgs boson at the few percent level, although the LHC might not do that much worse depending upon future improvements and upgrades

from **Reuters**

13 December 2011

The Higgs boson: What has God got to do with it?

"We don't call it the 'God particle', it's just the media that do that," a senior U.S. scientist politely told an interviewer on a major European radio station on Tuesday.

"Well, I am the from the media and I'm going to continue calling it that," said the journalist – and continued to do so.

from **BBC**

13 December 2011

LHC: Higgs boson 'may have been glimpsed'

The most coveted prize in particle physics – the Higgs boson – may have been glimpsed, say researchers reporting at the Large Hadron Collider (LHC) in Geneva.

from **Nature**

13 December 2011

Detectors home in on Higgs boson

The result is not definitive evidence of the long-sought Higgs boson — yet. But it is the closest so far to come out of the US\$6.5-billion Large Hadron Collider (LHC) at CERN, Europe's high-energy physics laboratory near Geneva in Switzerland.

from **The New York Times**

13 December 2011

'Tantalizing Hints' but No Direct Proof in Particle Search

Physicists will have to keep holding their breath a little while longer.

from **Physics World**

13 December 2011

Higgs hunters close in on their quarry

The first solid experimental evidence for the existence of the Higgs boson has been unveiled today by physicists working on the Large Hadron Collider (LHC) at CERN in Geneva.

from **Science**

13 December 2011

In Search for Higgs Boson, Physicists Report a Definite Maybe

Like all good rumors, whispers that the long-sought Higgs boson has been spotted turn out to be half-true.

from **The Guardian**

12 December

Whether we find the Higgs Boson or not, particle physics is a benefit to us all

What is beyond question even now is the huge economic benefit of particle physics. The technologies developed at Cern have already changed our lives. And, while neutrinos and the Higgs boson may seem distant from everyday life right now, I would bet that we will use them to make money and improve our lives in the long run.

ANNOUNCEMENTS

ILC NewsLine holiday schedule

NewsLine is taking a break for two weeks. Our next issue will be on 5 January. Happy holidays!

CALENDAR

UPCOMING EVENTS

SiD Workshop

SLAC

14- 16 December 2011

UPCOMING SCHOOLS

Physics and Technology of Particle Accelerators (JUAS 2012)

Geneva, Switzerland

09 January- 16 March 2012

[View complete calendar](#)

BLOGLINE

14 December 2011

Frank Simon

[After the talk is before the talk](#)

13 December 2011

CERN

[Evolution or revolution? The search for the Higgs boson puts particle physics on the threshold of a new era.](#)

Fermilab

[Fermilab hot on trail of Higgs boson with LHC, Tevatron](#)

PREPRINTS

ARXIV PREPRINTS

1112.2635

Threshold corrections to hard supersymmetric relations

1112.2171

Two-loop electroweak corrections to high energy large-angle Bhabha scattering

ATLAS and CMS experiments present Higgs search status PR25.11 13.12.2011

13 December 2011. In a seminar held at CERN¹ today, the ATLAS² and CMS³ experiments presented the status of their searches for the Standard Model Higgs boson. Their results are based on the analysis of considerably more data than those presented at the summer conferences, sufficient to make significant progress in the search for the Higgs boson, but not enough to make any conclusive statement on the existence or non-existence of the elusive Higgs. The main conclusion is that the Standard Model Higgs boson, if it exists, is most likely to have a mass constrained to the range 116-130 GeV by the ATLAS experiment, and 115-127 GeV by CMS. Tantalising hints have been seen by both experiments in this mass region, but these are not yet strong enough to claim a discovery.

Higgs bosons, if they exist, are very short lived and can decay in many different ways. Discovery relies on observing the particles they decay into rather than the Higgs itself. Both ATLAS and CMS have analysed several decay channels, and the experiments see small excesses in the low mass region that has not yet been excluded.

Taken individually, none of these excesses is any more statistically significant than rolling a die and coming up with two sixes in a row. What is interesting is that there are multiple independent measurements pointing to the region of 124 to 126 GeV. It's far too early to say whether ATLAS and CMS have discovered the Higgs boson, but these updated results are generating a lot of interest in the particle physics community.

"We have restricted the most likely mass region for the Higgs boson to 116-130 GeV, and over the last few weeks we have started to see an intriguing excess of events in the mass range around 125 GeV," explained ATLAS experiment spokesperson Fabiola Gianotti. "This excess may be due to a fluctuation, but it could also be something more interesting. We cannot conclude anything at this stage. We need more study and more data. Given the outstanding performance of the LHC this year, we will not need to wait long for enough data and can look forward to resolving this puzzle in 2012."

"We cannot exclude the presence of the Standard Model Higgs between 115 and 127 GeV because of a modest excess of events in this mass region that appears, quite consistently, in five independent channels," explained CMS experiment Spokesperson, Guido Tonelli. "The excess is most compatible with a Standard Model Higgs in the vicinity of 124 GeV and below but the statistical significance is not large enough to say anything conclusive. As of today what we see is consistent either with a background fluctuation or with the presence of the boson. Refined analyses and additional data delivered in 2012 by this magnificent machine will definitely give an answer."

Over the coming months, both experiments will be further refining their analyses in time for the winter particle physics conferences in March. However, a definitive statement on the existence or non-existence of the Higgs will require more data, and is not likely until later in 2012.

The Standard Model is the theory that physicists use to describe the behaviour of fundamental particles and the forces that act between them. It describes the ordinary matter from which we, and everything visible in the Universe, are made extremely well. Nevertheless, the Standard Model does not describe the 96% of the Universe that is invisible. One of the main goals of the LHC research programme is to go beyond the Standard Model, and the Higgs boson could be the key.

A Standard Model Higgs boson would confirm a theory first put forward in the 1960s, but there are other possible forms the Higgs boson could take, linked to theories that go beyond the Standard Model. A Standard Model Higgs could still point the way to new physics, through subtleties in its behaviour that would only emerge after studying a large number of Higgs particle decays. A non-Standard Model Higgs, currently beyond the reach of the LHC experiments with data so far recorded, would immediately open the door to new physics, whereas the absence of a Standard Model Higgs would point strongly to new physics at the LHC's full design energy, set to be achieved after 2014. Whether ATLAS and CMS show over the coming months

that the Standard Model Higgs boson exists or not, the LHC programme is opening the way to new physics.

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Resources:

Photos: <http://cdsweb.cern.ch/collection/Press%20Office%20Photo%20Selection?ln=en>

(Photos will be put the Higgs Selection - on the right hand side of the page, under Current Interest)

Videos: (Footage available as of 16.30 CET)

A roll: <http://cdsweb.cern.ch/record/1406052>

B roll: <http://cdsweb.cern.ch/record/1406051>

VNR hosted by Eurovision: <http://www.eurovision.net/worldlink/front/view/mediaDetail.php?mediaNo=954>

Backgrounders and video interviews with CMS and ATLAS spokespeople:

<http://press.web.cern.ch/press/background/index.html>

Further information from:

ATLAS : <http://www.atlas.ch/news/2011/status-report-dec-2011.html>

CMS : <http://cms.web.cern.ch/news/cms-search-standard-model-higgs-boson-lhc-data-2010-and-2011>

1. CERN, the European Organization for Nuclear Research, is the world's leading laboratory for particle physics. It has its headquarters in Geneva. At present, its Member States are Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom. Romania is a candidate for accession. Israel is an Associate Member in the pre-stage to Membership. India, Japan, the Russian Federation, the United States of America, Turkey, the European Commission and UNESCO have Observer status.

2. ATLAS is a particle physics experiment at the Large Hadron Collider at CERN. The ATLAS Collaboration is a virtual United Nations of 38 countries. The 3000 physicists come from more than 174 universities and laboratories and include 1000 students.

3. The Compact Muon Solenoid (CMS) experiment is one of the largest international scientific collaborations in history, involving more than 3000 scientists, engineers, and students from 172 institutes in 40 countries.

AROUND THE WORLD

CM2 assembly nearly complete

Fermilab's CM2, in the final stages of assembly, will come online in the spring.

Leah Hesla | 15 December 2011



Underside of the CM2 in Fermilab's Industrial Center Building. Image: Reidar Hahn

Fermilab researchers and technicians are currently busy completing the final assembly of CM2, the first US cryomodule in which every one of its eight superconducting cavities meets ILC specifications.

As such, it is the material realisation of years of beam testing, cavity manufacturing, and niobium processing. It's also the first significant tangible step in establishing an ILC test facility at Fermilab.

"It's the first cryomodule at NML with ILC performance and the institutional strength of Fermilab behind it," said Global Design Effort Project Manager Marc Ross. NML is a recently completed laboratory building that will house the cryomodule.

Meeting the criteria for perhaps the most ambitious specification for ILC's superconducting radiofrequency (SRF) programme, seven of the eight cavities have a gradient of 35 megavolts per metre; the other is close behind, at 33 MV/m. Once the eight components are strung together inside the cryovessel, scientists hope that the average gradient of its eight-cavity string remains high at 31.5 MV/m.

"SRF field is a tedious and does not forgive even a simple error," said Tug Arkan, lead engineer responsible for CM2 assembly at Fermilab's Cryomodule Assembly Facility.

CM2 takes over from its predecessor, CM1, which was assembled in 2007 by Fermilab personnel using a kit from DESY in Germany and was installed and began operation in November 2010. Over the past year it has served as a training ground for lab personnel to learn and test a new cryomodule setup infrastructure. Their experience

informs the way they will deal with CM2, which has a few new parts. Where CM1 had a nonfunctioning placeholder, CM2 has a working corrector coil magnet with CERN-designed current leads. And where CM1 used end-style-type tuners, CM2 uses INFN, Italy-designed blade-type tuners.

"Even though there are several components changes for CM2, the assembly and operation of CM1 gave us the opportunity to apply lessons learned from CM1 to the CM2 assembly," Arkan said.

For one, researchers became better acquainted with a cryomodule's subtleties in thermometry and cooling. This time around, they'll position sensors in places that were revealed to be CM1's blind spots. In assembling the cryomodule, they also paid especially close attention to the cooling straps, ensuring they make good contact so that components don't overheat.

There was also the matter of perfectly aligning eight metre-long cavities and a focussing magnet, strung end to end, to within 0.1 millimetres – about the thickness of a human hair.

“Even a slight temperature change as someone touches the cavities will throw the alignment process to a halt,” Arkan said. Researchers continually checked the placement of the tripod-supported laser tracker and a reference point on the floor to ensure measurement validity.

The nature of lessons learned isn’t confined to technological areas. The year spent with CM1 taught Fermilab’s team how to optimise their workflow for processing cavities in the cleanroom and efficient cryomodule assembly.

Such improvements will be made easier by one simple but dramatic difference between CM1 and CM2: all CM2 cavities were processed at Fermilab.

“I think a big key is the fact that we have all the cavity test information,” said Fermilab scientist Elvin Harms, who oversees cryomodule commissioning.

As a DESY kit, CM1 didn’t come with all the documentation Fermilab needed to draw out its best performance. “Now we’ll have a better handle on what kind of performance we can expect from CM2. We know it a lot better,” Harms said.

CM2 bears both the ILC and Fermilab stamps in other respects. All of its cavities, which hail from two companies – one in the US, one in Germany – were processed at Fermilab. It will be the first to carry an ILC-like beam going through a cryomodule at NML. Its power feeds and controls were developed according to ILC requirements.

“CM2 is critical for our plans to ultimately provide a facility for accelerator R&D based on the high-energy beam provided by three ILC cryomodules that make up an RF unit,” Fermilab Associate Laboratory Director for Accelerators Stuart Henderson said, referring to the lab’s near-future goal to install a three-cryomodule unit at NML.

The SRF advances represented in CM2 are promising also for the lab’s own future programmes, particularly at the Intensity Frontier. “It’s evidence of the tremendous capability that has been built to master and make use of SRF technology, which bodes well for our ambitions to build Project X,” he said. Project X, a high-intensity proton accelerator complex that will also use SRF cavities.

The CM2 ‘cold mass’ – the 12-metre-long, 4-tonne cryovessel and its cryogenic components – was recently moved from its assembly site to its current location, where the eight SRF cavities will be carefully placed inside it. The very orchestration involved in moving a large and heavy piece of delicate engineering was an event in itself, Arkan said.

“This move is always exciting for all the personnel involved,” Arkan said. “You have to ensure that the gravity loads are minimal during the move, so extra attention was given to this highly engineered transport process.”

CM2 will be moved again in early 2012 to its permanent home as part of the Advanced Superconducting Test Accelerator at NML. By springtime, CM2 should be cooled down to the SRF signature temperature of 2 Kelvin, powered up, and ready to run.



Fermilab's Jim Rife and Jeff Wittenkeller inspect CM2 in Fermilab's Industrial Center Building. Image: Reidar Hahn



CM2 cryovessel, at left, on tracks at Fermilab's Industrial Center Building. Image: Reidar Hahn

Detector R&D “coopetition” between ILC and CLIC

Juan Fuster | 15 December 2011



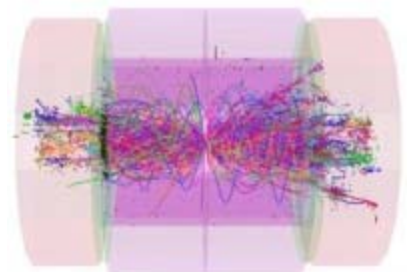
'Coopeting' researchers from both the ILC and the CLIC Study met for LCWS11 earlier this year. Image: LCWS11

In a recent seminar by the CERN Director of Research and Computing, Sergio Bertolucci, I heard for the first time the word “coopetition”. To my knowledge, it is an invented word that doesn't yet exist in the English dictionary. He used it to illustrate the type of collaboration that is currently performed by the LHC experiments in activities like the Higgs search. It is a nice word, one that combines “cooperation” and “competition”. Its meaning is certainly difficult to explain to communities outside particle physics and on the contrary, for us, its definition appears very natural. Why this happens would probably deserve another type of article. Coming back to our discussion, the ILC and CLIC detector R&D activities constitute another example of intensive “coopetition” even at a clearer level than that of the LHC collaborations.

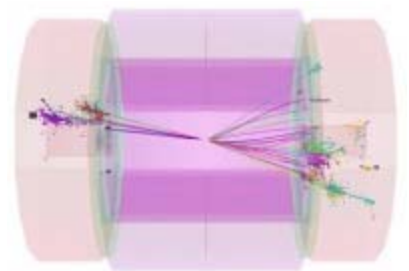
In fact and during the last years the “cooperation” between both “competing” detector and physics communities has intensified giving rise to very positive results. A joint group was formed by ILC Steering Committee to follow up the activities and discuss synergies. It is chaired by S. Yamada and is composed of M. Demarteau, J. Fuster, L. Linssen, F. Sefkow, M. Stanitzki and M. Thomson.

The collaboration frame has been identified in the context of the activities to elaborate two important milestone documents for each project: the Conceptual Design Report (CDR) for CLIC and the Detailed Baseline Design (DBD) for the ILC. The former one has recently been reviewed and was presented to the CERN Scientific Policy Committee this month. This CDR demonstrates that physics at a multi-TeV CLIC machine can be measured with high precision despite the severe background conditions of the machine. The latter document, the DBD, which is the final report of the R&D efforts since the *Reference Design Report* in 2007, will be ready by the end of 2012 in coincidence with the ILC accelerator *Technical Design Report*. Its aim is to demonstrate that the detector concepts are based on technologies that are feasible and cost-effective, and capable to fully exploit the physics reach of an e^+e^- collider in the energy range from 0.2 teraelectronvolts to 1.0 TeV.

The main differences between the CLIC and ILC detector concepts are principally due to the fact that at CLIC the operating energy is higher (0.5 to 3.0 TeV) and the bunch spacing is shorter (0.5 nanoseconds). Hence the impact of the beam-induced background is much higher. The starting points for the CLIC detector concepts (CLIC_ILD and CLIC_SiD) have been those already designed for the ILC (ILD and SiD). The common collaborative areas of development identified have been: core software development, background overlay, assessment of high energies with clear interest for the common 1 TeV region, engineering studies (a push-pull platform, for example), electronics developments, hadron calorimetry, forward calorimetry and physics benchmarks.

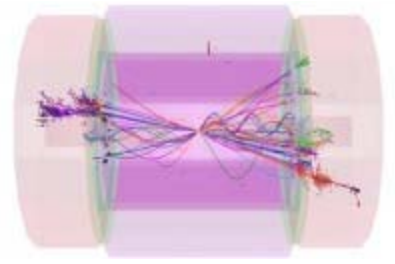


$W^+ W^- + \gamma\gamma$ hadrons



$W^+ W^-$ $q\bar{q}$

As a result of the CDR studies the ILC detector concepts have shown to also be generically valuable for a 3-TeV collider which represents six times higher energy than originally foreseen for their operation (considering 0.5 TeV as the ILC reference energy), and under much more challenging background conditions. In particular, the fine-grained calorimetry has not only shown itself to be important to achieve a good jet energy resolution but has also proven to be a very powerful instrument for the background suppression at CLIC. At 3 TeV, background processes like $\gamma\gamma \rightarrow \text{hadrons}$ can produce about 5000 tracks in the detector and a total accumulated energy in the calorimeters of 19.0 TeV when integrated over the total bunch-train crossing. A reduction of all this background to 100 GeV appears to be accessible by using adequate particle flow algorithms and precise cluster timing. Additional tools have been developed for the CLIC CDR preparation and will now be used for the ILC studies at 1 TeV. In this context it is worth mentioning the technique to overlay beam-induced background in the simulation software and the improved PandoraPFA software, which is now implemented in both the ILD and SiD software tools.



W^+W^- hadrons (after selection cuts).
Above events from CLIC CDR. Images:
Mark Thomson (from CDR review in
Manchester)

In summary and in the words of Lucie Linssen, the chair of the the CLIC physics and detector study and the Project Leader of the CERN's Linear Collider Detector project: "The CLIC detector CDR was only possible thanks to years of ILC detector optimisation studies and hardware R&D. The synergy with ILC will continue during the next project phase."

DETECTOR R&D | ILC-CLIC COLLABORATION

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DIRECTOR'S CORNER

Recovery from March 2011 earthquake at ATF, KEK

Toshiaki Tauchi | 15 December 2011



Fig. 1: The 3.11 earthquake signals by the BPM system

As of this month, nine months have passed since the Great Eastern Japan earthquake, also known as the 3.11 Earthquake. Restoration of the Accelerator Test Facility (ATF) is in its final stage at KEK, Japan, where the ATF2 project, the final focus test beam for ILC, is being conducted with an international collaboration.

The geological points of Japan's islands have moved on an unprecedented scale, up to 1.2 metres (m) horizontally and 5.2 metres vertically, because of the earthquake. Even the KEK site has sunk down by about 10 centimetres (cm) and has moved about 50 cm eastward, shifts that are evidenced in the GPS measurements by [The Geospatial Information Authority of Japan](#).

On that ground-shifting day, ATF was in operation for a short while even after the earthquake occurred, at 14:46:23 local time on 11 March.

The archived beam position monitor (BPM) records from one of the quadrupole magnets BPMs, with data taken from the onset of the earthquake until the beam was manually aborted a few seconds afterwards is shown in Figure 1. The propagation time of the earthquake is estimated to have been 46 seconds. Its velocity was measured to be 8 kilometres per second at KEK, which is about 320 km from the earthquake's epicentre,

Surprisingly, mechanical damage from the earthquake was not severe in the ATF and ATF2 beam lines despite the huge magnitude, while facilities such as power lines, the cooling water system severely suffered as described in an [earlier ILC NewsLine article](#). All facilities were repaired by the end of May.

On 3 June, a test beam was sent through all beam lines up to the beam dump with a beam intensity of 0.3×10^{10} electrons/bunch after a rough alignment of the magnets, where the beams were confirmed by screens along the beam lines. The beam intensity increased to 1×10^{10} electrons/bunch for two weeks and the vertical emittance was measured to be about 30 picometres by the X-ray synchrotron radiation interferometer (XSR) at the damping ring (DR), where the accelerator was commissioned at nights and the alignment work was performed during the day.

We appreciated seeing 17 foreign colleagues from SLAC and University of Notre Dame (US), Royal Holloway University of London and Oxford University (UK), Laboratoire de l'accélérateur linéaire and Laboratoire Leprince-Ringuet (France) and Kyungpook National University (Korea), who came to participate in recovering the beam instrumentation devices and in the beam commissioning from May through August, just a few months only after 3.11.

Fine alignment was the major project to be completed for full recovery of ATF and ATF2. Personnel took care of alignment along the entire beam line, which consists of the injection linac (80 m long), the beam transport line (BT) from the linac to the DR, the DR (138 m of circumference) itself and the extraction / ATF2 beam line (98 m). All the beam lines were constructed on reinforced floors in different periods. We have noticed that the beam line gradually dipped into the linac end (a few millimetres) and jumped up at the BT before the earthquake. It was confirmed thanks to fine alignment work. Other beam lines were also surveyed by a laser tracker. The DR has a racetrack beam line lying from east to west. The racetrack was found to be about 1.5 mm wider in the

north-south direction after the earthquake, though we could not conclude if this was because of the earthquake. Since the ATF2 floor is very newly constructed (September 2007), the floor sank down to about 1.5 mm with respect to the DR and it was also moved about 1 mm towards the DR after the earthquake.

All the observed displacements (actually magnets) were aligned within plus or minus 0.1 mm with respect to the design orbit. The fine alignment continued while beam operation took place during the day time in October 2011.

Starting in November, the accelerator was commissioned from the linac, BT and DR to the ATF2 beam line on a full scale. On 8 November, the beam intensity was recovered to 1×10^{10} electrons/bunch in the DR. The vertical emittance was measured to be 13 picometres by the XSR. In parallel, R&D on the Compton scattering cavity, on FONT, on the laser wire and the nanometre interaction point BPM resumed.

Further fine alignment is being conducted by the beam-based alignment, especially in the DR and in the ATF2 beam line. Calibrations of the BPM system and the multi-optical transition radiation system were completed with verification of restoring performances in details.

Until 9 December, the interaction point beam size monitor, called the Shintake monitor, was not fully commissioned, since it is the most delicate device together with the very high-power laser.

This week is ATF's last week of operation for this year, from 12 to 16 December. We have been commissioning the facility as much as possible. We should be able to demonstrate that the beam size is less than 300 nm, the smallest beam ever achieved in previous beam tuning. Our goal is to achieve 37 nm of vertical beam size at the focal point, denoted as the interaction point, by end of March 31, 2012.



Daily operation meeting in the ATF control room, during the last week of operation of the year 2011. Image: KEK/Sakae Araki

[ATF](#) | [ATF2](#) | [BEAM POSITION MONITOR](#) | [EARTHQUAKE](#) | [KEK](#)

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