News

LHC Update: Milestones at LHC

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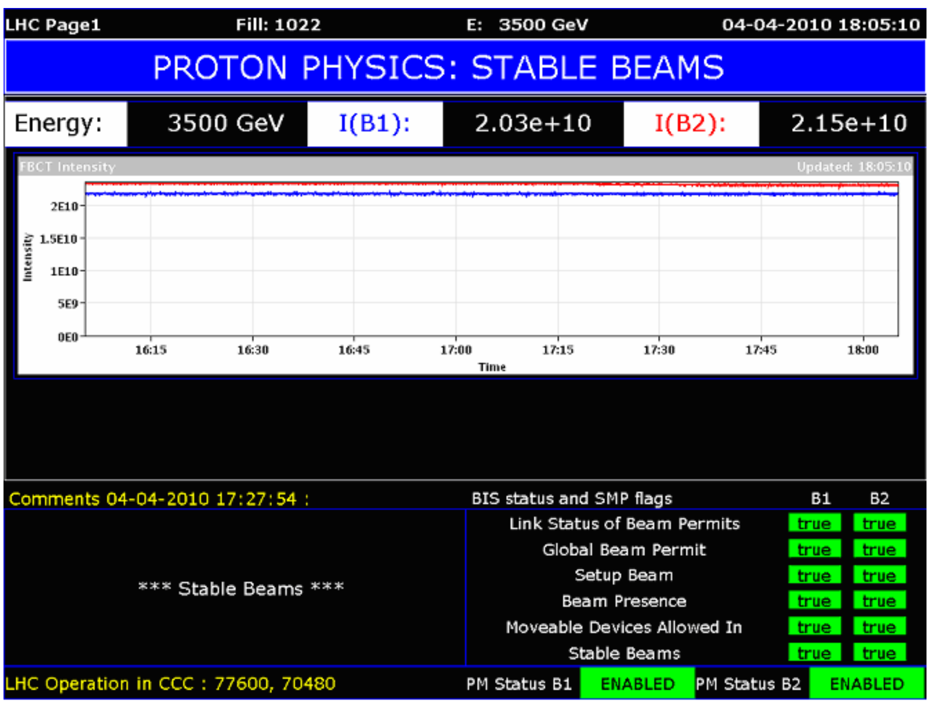
Abstract

This article contains LHC updates for the period of April 4, 2010 to May 25, 2010 which appeared in my blog at http://blog.vixra.org .

Key Words: LHC, Update, milestones, LHC collisions.

April 4, 2010: LHC Watch

Now that the Large Hadron Collider is doing physics runs you may wish to try to follow how the experiment is going. It may be some time before results are published and any new physics will be kept secret within the experiment collaborations until it has been very carefully checked and signed off. In the meantime we outsiders can still watch how they are progressing with the job of colliding the beams and increasing the intensity to get better results.



There are a few good links you can use to see how it is coming along. The best known is the status screen called Page 1. The exact contents change depending on what they are doing, but there is always a status message and an indication of beam intensity and energy. When all is well and the

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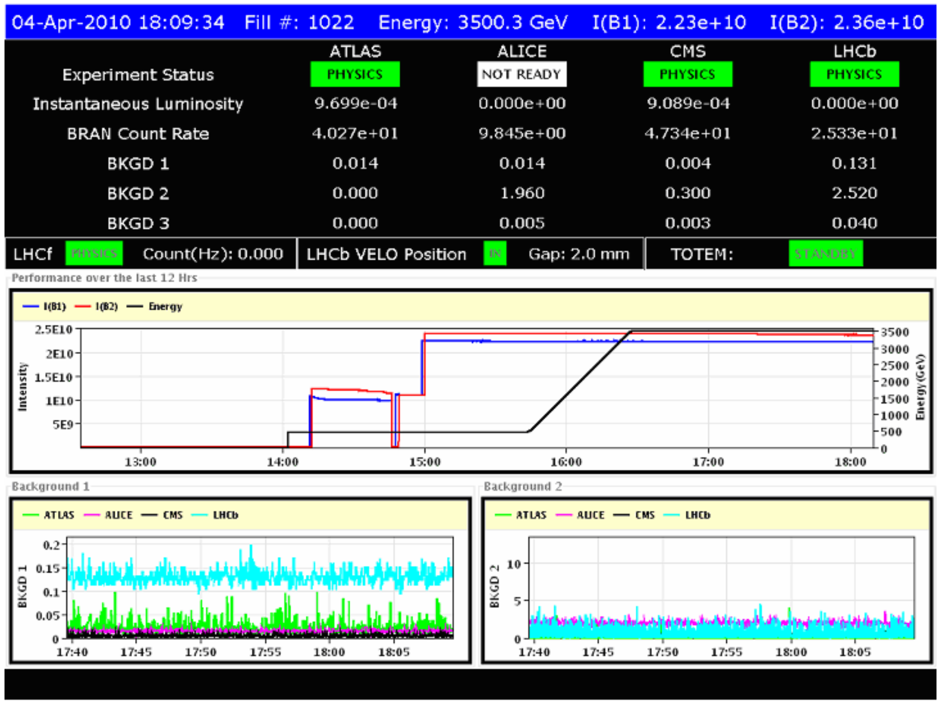
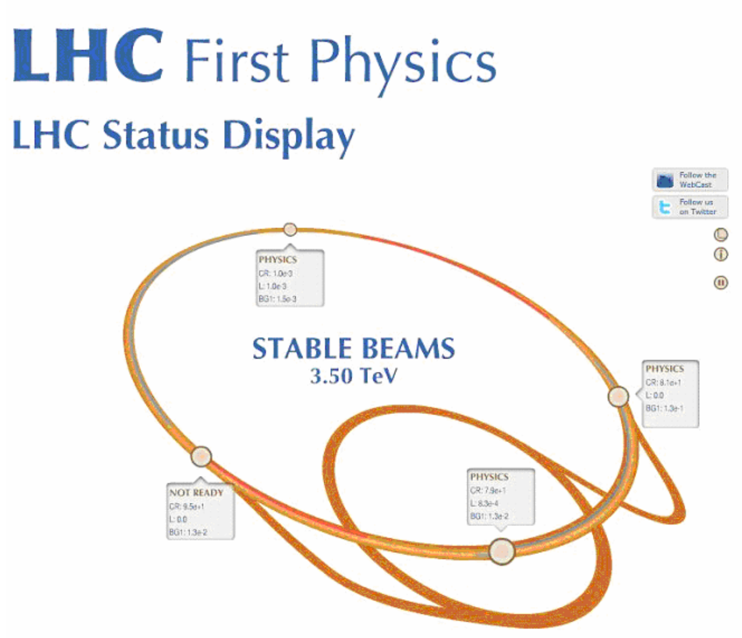
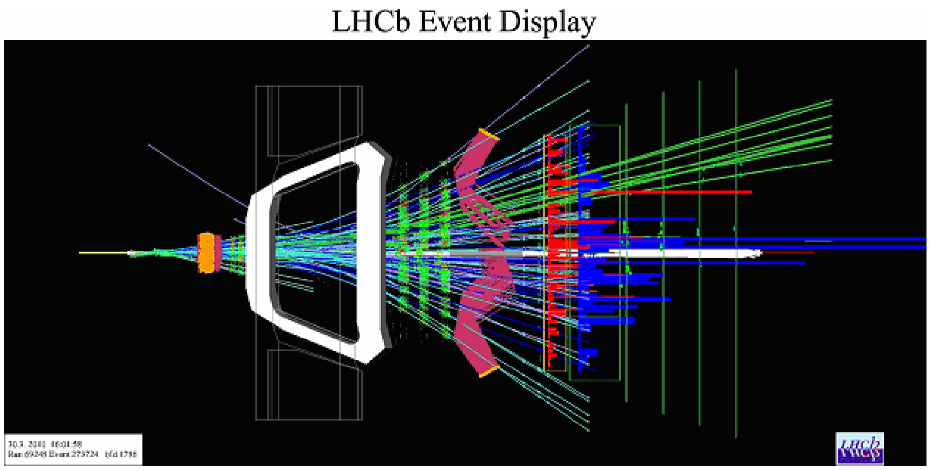
beams are stable all the lights go green. That is how it looks now as I write this. They also feed the status messages to twitter so you can look back on what has been happening.



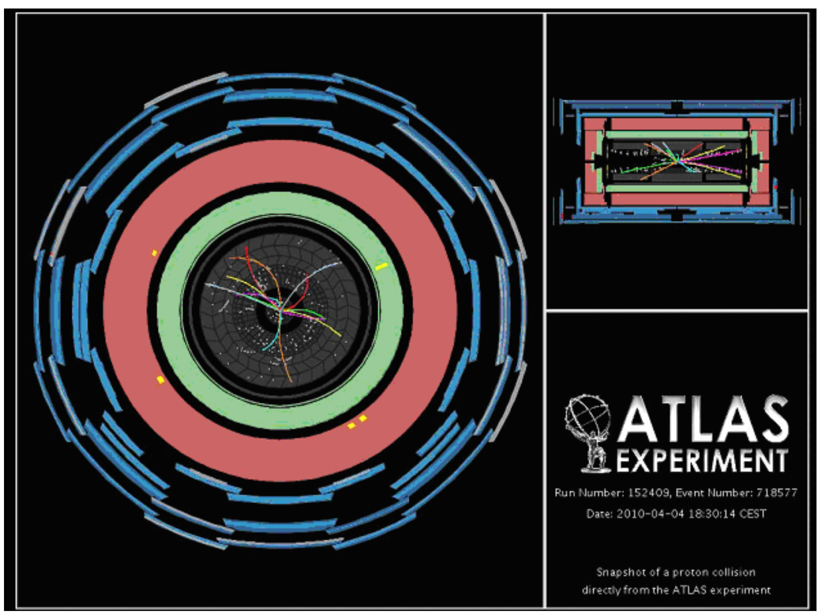
A related page is the operation screen that shows a longer historical graph of the energy and the status of each of the experiments. As I look at it now I can see that all the experiments are running except ALICE. The graph shows that the two beams were injected about three hours ago in two bunches for each beam. The energy was ramped up starting an hour later.



After the webcast last week they left us another status display that has a graphic display showing how the beams circulate in the collider ring and how the experiments are placed. If you click on the experiments it takes you to a real-time plot of the rate at which events are currently being seen.



Of course it is brilliant to be able to see live displays of events from the experiments themselves. One experiment that is making this possible from outside is LHCb . You may need to fiddle with your browser to get this page working due to the use of an unrecognised certificate, but it does work. Check the timestamp at the bottom left to confirm whether or not it is currently showing live events.

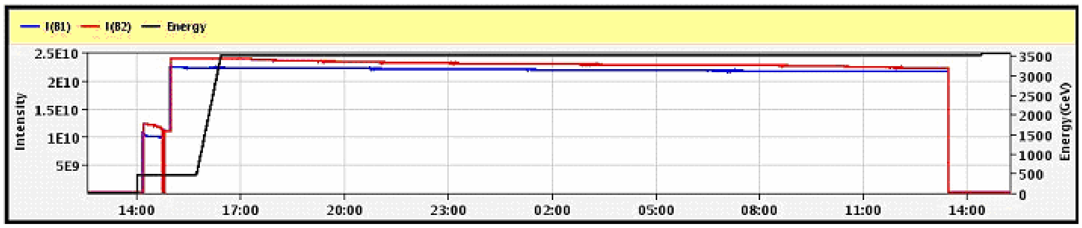


There is now also a live event display for ATLAS. if you spot a Higgs boson here publish your result immediately along with your calculation for its mass, then claim your Nobel Prize before they do :) If you want more details you can download the Atlantis/Minerva application.

There are a lot more links and discussion forums to be found at the LHCPortal if you want to delve in any deeper, and of course anything new that comes along after I write this is likely to be found there.

Finally if you want the latest news about what has been going on you should check the official press releases and unofficial blogs listed on the right of this page.

April 5, 2010: Long Physics Run at the LHC



Physicists at the Large Hadron Collider have just completed their longest physics run yet with about 20 hours of collecting events. Fill number 1022 which started yesterday evening and finished at lunchtime today will have more than doubled the total amount of data taken so far at CERNs new collider. The run finally ended when a glitch in the cryogenics caused the beams to be automatically dumped. The stability of the beams was so good that if such glitches can be avoided they would circulate for many days before gradual loss of the protons degrades the beam intensity. This is a great boost for the prospects of the collider.

As with earlier fills this one used two bunches of protons circulating in each direction of the collider ring. The bunches were injected with timings carefully worked out so that the protons would collide at intersection points around the circuit where the different particle detectors are positioned. With just one bunch in each beam the protons will collide at two points diametrically opposed on the 27 kilometer circle. The two main experiments CMS and ATLAS are positioned at such points, but two other experiments LHCb and ALICE are at different locations about one eighth of the way round the ring in either direction starting from ATLAS. With two bunches per beam the protons can be made to collide at these points as well and that has been the configuration used since first collisions last week. For this run all the LHC experiments were switched on and should have been able to collect data.

We will have to wait some time before we know what the results will be. The physicists have to collect vast amounts of collision data and analyse it before they can publish their results. Exactly how long depends on what physics is waiting to be discovered and how efficiently the accelerator engineers can increase the luminosity of the beams to generate more collision events in the detectors.

Already the proton beams are circulating with an energy of 3.5 TeV per proton and 20 billion protons in each beam. The experiments were collecting data at the rate of about 100 events per second on this latest run which means they already have some 10 million events to analyse from each detector. But the most interesting events are the very few where new particles never seen before are created.

To separate those from the background the teams will have to collect many times more events. To achieve this we expect to see more bunches of protons injected into the collider before they are ramped up in energy. Last year during early test runs at lower energy they already had 16 bunches circulating in each beam but the ultimate target is to increase this figure to 2808. Further increases in collision rates can be achieved by adjusting and "squeezing" the beams using magnetic fields to make them collide in a smaller space. If all this can be accomplished the number of events seen during the latest long run will be seen in just a few seconds. Obviously they will want to get there as soon as possible and the stability of the latest fills should give them confidence to move forward quickly.

April 10, 2010: LHC needs more luminosity

The LHC continues to make physics runs with beam energies of 3.5TeV. Although this is three times as much energy as the Tevatron in the US, we are unlikely to see new physics until the LHC beats the Tevatron on luminosity too. The current luminosity of runs at the LHC is about 10^{27} $cm^{-1}s^{-1}$, but the Tevatron is reaching peak luminosities of 3 x 10^{32} $cm^{-1}s^{-1}$. That's an impressive 300,000 times better.

These accelerators are looking for the collisions events where new particles are created, but these events are extremely rare. Furthermore, even if the particles are being created they are masked by background processes that mimic their signature in the detectors. The physicists can only know the particles are there when they see significantly more signal than the expected background noise. This means collecting many events and the number of events they can collect is proportional to the luminosity and the length of time they can run the collider for.

The higher energy does give the LHC some advantage though. For most processes they want to see the number of events seen is likely to be something like ten to a hundred times higher at 3.5TeV than at 1 TeV. That still leaves the LHC a long way short of the Tevatron, for now.

Luckily the design luminosity of the LHC is much higher than what they are currently running it at. In fact it should be able to reach luminosities of 10^{34} $cm^{-1}s^{-1}$. That's 30 times what the Tevatron runs at. But to reach this energy the collider operators have a lot of work to do. They need to gain seven orders of magnitude more luminosity. To achieve this they have three main tactics and already we have seen them testing out some of these over the last few days.

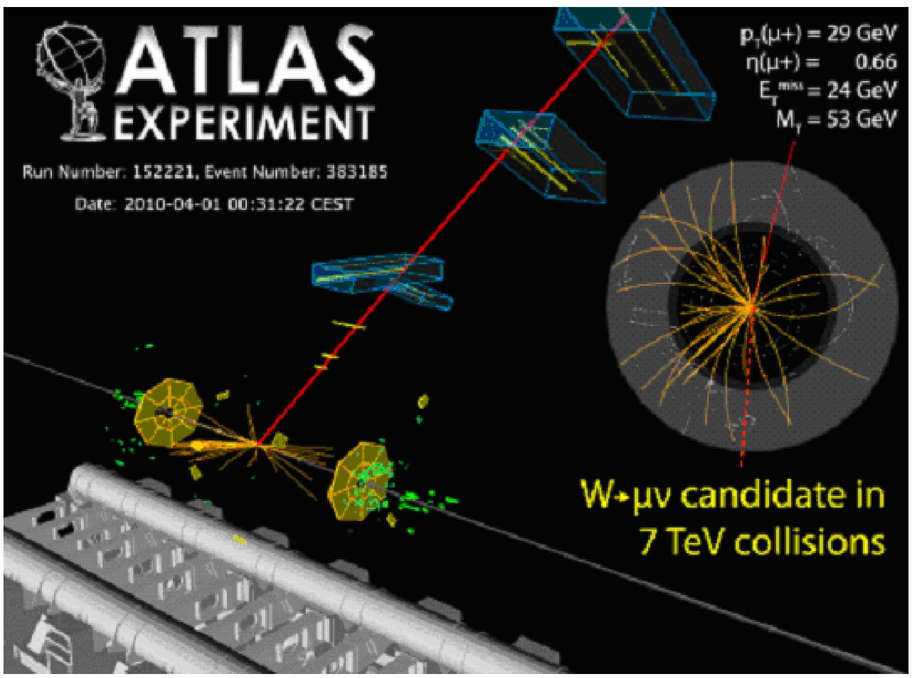
The first trick is to "squeeze" the beams by focusing them with magnets as they pass through the detectors. The amount of squeeze of measured by a parameter called beta which starts out at 11 meters. Last week they were able to squeeze this down to 2 meters, but the target is to get it down to 0.5 meters. When they do this the beam becomes much narrower so they have so control its position more carefully, otherwise the tight beams will miss each other completely and there will be no collisions at all. If they get it right they stand to gain a factor of up to about 20 using this method.

The second trick is much simpler. They just put more protons in each bunch. For the physics runs they have been doing this month they have been putting about 10 billion protons in each bunch, but last night they ran some trial injections gradually increasing the number up to 100 billion. That's another factor of 10 in luminosity for each beam ready to be tapped, or 100 overall.

The final step is to increase the number of bunches circulating round the collider ring. They are currently circulating 2 bunched in each direction but each detector is seeing just the collisions from one bunch in each beam. Last year they were able to circulate 16 bunches in each beam but the design limit is 2808 bunches, so there is another factor of nearly 3000 to be gained.

Overall that makes a potential increase of 20x100x3000 = 6000000 times the current luminosity. When they reach that point the work of several weeks of running at the current luminosities will be done in a fraction of a second. Obviously they will want to get to these higher luminosities as soon as possible, but they have to be careful. At present luminosities the beams are relatively safe and if they make a mistake that sends the beam into the collimators there is not too much damage. At the higher luminosities an error could send particles flying in all directions causing serious damage to the detectors.

So hopefully they will increase the luminosity carefully, but not too slowly. In the meantime the detectors are rediscovering known physics. One of the latest candidate events is this W to muon from last week. Soon they should also rediscover the Z, then as the luminosity goes up they should start to collect top quark events for the first time in Europe. The Higgs and other new physics will have to wait for better luminosity, unless of course there is something unexpectedly easy to see at 7 TeV.



April 21, 2010: When will the LHC increase its energy?

Now that the LHC is running routinely, everyone is wondering when it will produce some new physics. Over at "Not Even Wrong" Peter Woit did a nice comparison of the LHC with the Tevatron based on luminosity. Of course luminosity is not the only thing that counts here. The LHC runs at over three times the energy and this increases the cross-section for most interactions of interest such as Higgs production. In fact it is possible that the LHC could find new physics at higher energies that could not be seen at the Tevatron no matter how long it runs for. It would also be interesting to hear a comparison of the detectors at the LHC and the Tevatron. If any detector experts are listening please tell us about it.

So the important question is not just "when will the LHC increase its luminosity?" , it is "When will it increase its energy further?" The design energy of the LHC is twice the energy it is currently running at. At present they are keeping the energy lower because of the problems that had at the end of 2008 when an overheated joint caused an explosion of helium delaying the start of physics at the LHC for over a year.

The current plan is to run the LHC at 3.5 TeV per beam while concentrating on increasing the luminosity. It will run this way through 2011 until it is shut down for a long repair lasting up to one year. Then they will be ready to increase energy to 7 TeV per beam in 2013.

But if you have been watching the LHC progress you will know that their plans are written on soluble paper and have been known to dissolve very quickly. So what is really likely to happen? At the press conference for the start of physics on 3oth March, Steve Meyer, the technical director at CERN was asked about the prospects of increasing the energy. He explained that the problem in 2008 was caused by a joint with a resistance of 200 nΩ. They have now tested all the joints and the highest resistance left in any of the joints is about 1 nΩ. Most are about 0.3 nΩ which is about what they should be. This was not the only problem, but Meyers says that he is sure the magnets can take the currents required to go to 6.5 TeV.

If this is the case, it is hard to believe that they will shut down the collider for a year without at least trying to go to higher energies. Even if there are problems the quench protection system should ensure that no serious damage is done. There have already been rumours circulating that they will try for 5 TeV per beam later this year. Realistically it depends on how easily they can increase the luminosity and how stable the systems prove to be. It may also depend on the physics. If there are indications that new physics lies at the higher energies they will be inclined to increase it, but if they just need more time at lower energies to turn an uncertain observation into a solid discovery, they will keep running at the current energy.

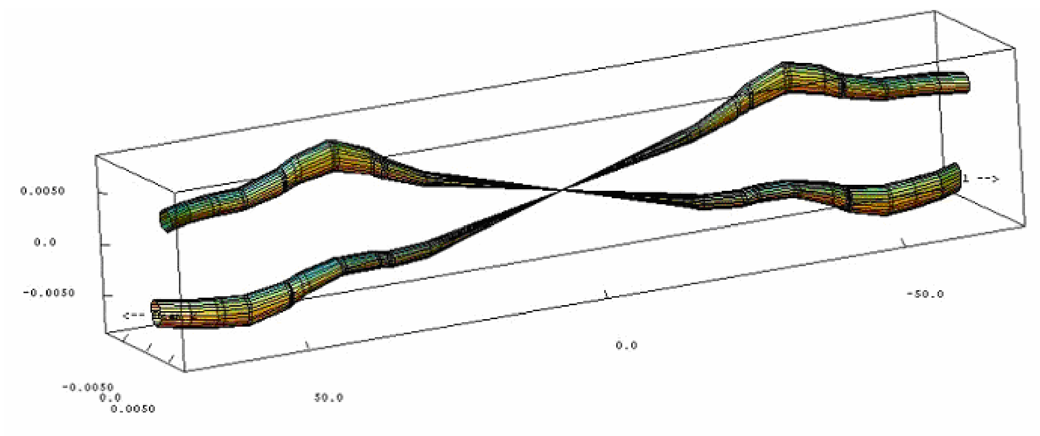
This video shows Steve Meyers at the press conference, so have a watch and see what you think he would like to do.

Update: From the current plan it can be seen that they want to get stable squeezed beams for the first time this weekend. That will be at 3.5TeV but with beta of 2m and intensity of 35 billion protons per bunch which is a bit higher than current runs. Later they will also try for stable beams with 100 billion but only at 0.9 TeV. If they are successful it will bring them closer to their next operational target which seems to be 3.5TeV/2m/100Billion, They have not indicated how many bunches they will circulate at this intensity but presumeably they will try to step up the number of bunches at these levels. (The design limit is something like 7TeV/0.5m/200Billion/2808 bunches, and they are currently running stable beams with 3.5TeV/11m/10Billion/2 bunches). The plan also shows a long technical stop during next week. Let's hope they will be ready for the higher luminosities when that is completed.

Followers may also enjoy the video log at http://www.collidingparticles.com/

April 24, 2010: LHC achieves stable squeezed beams

Over the last few weeks the LHC controllers have been working towards an improved luminosity target using squeezed beams. This morning they succeeded when they declared stable beams using the new configuration. Since the 30th march when the protons were collided at 3.5TeV per beam for the first time, they have been running with a configuration of 3.5TeV/11m/10Billion/2-bunches (energy per beam/beta/protons per bunch/bunches per beam). The new configuration is 3.5TeV/2m/12Billion/3-bunches. This should increase the luminosity by a factor of about 10 (x5 from the squeeze and x2 from the bunches) but they may need to do some luminosity scans to reposition the beams before they actually increase the collision rate by that amount.



The bucket configuration being used is (1, 8941, 17851) for beam 1 and (1, 8911, 17851) for beam 2. The total number of buckets is determined by the frequency of the RF fields used to accelerate the beam and the size of the collider ring. The result is that there are exactly 35640 buckets in each beam where the bunches of protons can be positioned. The bunches are injected from the SPS ring into the main LHC ring with careful timing so that they are placed in the buckets the controllers want.

The buckets chosen determine where the protons in the two beams will cross over and collide. bunches in bucket 1 for beam 1 and bucket 1 for beam 2 circulate in opposite directions so they will come together at two points diametrically opposite around the ring. These two points are called IP1 and IP5 and these are where the two biggest experiments live (ATLAS and CMS) . Other bunches that are in the same bucket number will also collide at these points. E.g with todays bucket numbers the bunches in bucket 17851 of either beam will also collide in ATLAS and CMS, but the bunches in buckets 8941 and 8911 will miss, so these experiments are now getting twice as many collisions as the previous configuration.

The other bucket numbers are chosen to provide collisions at the other two intersection points IP2 (ALICE), and IP8 (LHCb) The point IP2 is exactly one eighth of the way round the collider ring so bunches will collide there when the difference of bunch numbers (b2 - b1) is exactly 35640/4 = 8910, so with today's configuration the bunch in bucket 8911 of beam 2 collides with the bunch in bucket 1 of beam 1, and 17851 of beam 2 collides with 8941 of beam 1. So ALICE is also getting twice as many bunches colliding as before.

Finally, LHCb at IP8 is at a point approximately one eighth of the way round the ring in the other direction, but because of the nature of the detector its collision point is 11.5 meters away from the exact point. This means that the difference in bucket numbers must be -8940 rather than the more convenient -8910. With the new numbers we have bucket 8941 of beam 1 colliding with bucket 1 of beam 2 and bucket 17851 of beam 1 colliding with 8911 of beam 2. So LHCb also sees two collisions for every circuit of the ring and the controllers have been fair to each of the experiments.

b2-b1	**1**	**8941**	**17851**
1	0 (IP1+IP5)	-8940 (IP8)	-17850
8911	8910 (IP2)	-30	-8940 (IP8)
17851	17850	8910 (IP2)	0 (IP1+IP5)

As the number of bunches is increased the controllers will have to work harder to find the best bucket numbers. For CMS and ATLAS they want all bunches in equal bucket numbers to maximise the number of collisions. To please ALICE they should place them at intervals a quarter of the way round. Four bunches in buckets (1,8911, 17821, 26731) for both beams would be ideal for CMS, ALICE and ATLAS who would each see four collisions per circuit, but would fail for LHCb. They will have to offset the bucket numbers to get the best results.

As the number of bunches gets larger the problem eases. If they could have 1188 bunches placed at 30 bucket intervals then all four experiments would be seeing 1188 collisions per circuit. In practice this is not possible because some gaps must be left to allow safe dumping of the beams at the end of each run. The bunches must also be at least 10 bucket numbers apart. There are other constraints depending on how bunches can be injected and various other considerations. In fact the highest number of bunches planned is 2808 per beam.

Before they get there we will see them go through other carefully worked out bucket schemes with possibly 16, 43, 96, 156 or 936 bunches per beam. Juggling the precise bucket numbers to please all the experiments is going to be a delicate business.

Update: The stable beam was held for 30 hours before being purposefully disabled. This is a new record for longevity

April 28, 2010: LHC to go for higher intensity next

Following the record luminosities a few days ago, the Large Hadron Collider was closed down for three days this week to make some technical corrections. This evening they are ready to restart and new plans for the next two weeks have been drawn up.

The main goal now is to increase the number of protons per bunch. The physics runs so far have used up to about 12 billion protons per bunch. A few weeks ago they did some brief tests with 100 billion protons per bunch but the beams were dumped very quickly. Now they will try to maintain high intensities long enough to declare stable beams and do physics.

Increasing the number of protons per bunch is one of three ways that they increase the overall luminosity of the beams. They can also increase the number of bunches and they can squeeze the beams as they did last week. But there is a good reason why increasing the number of protons per bunch is especially exciting. If they multiply the number by ten in one beam it means ten times the luminosity and ten times the number of collisions, but of course they can increase the number by a factor of ten in both beams so the luminosity is then increased by a factor of 100 (That is assuming the bunches remain the same size). By comparison, if they increase the number of bunches by a factor of ten in both beams they still only increase the luminosity by a factor of ten.

The current golden orbit for physics is a configuration of 3.5TeV/2m/12Billion/3-bunches. The plan shows them aiming for 3.5TeV/2m/40Billion/2-bunches. This will actually give a modest increase in luminosity of about 5. If they put the number of bunches back up to 3 it will be a factor of ten. That's not bad just a few weeks after the last factor of 10. Of course sometimes they do actually keep to the plan.

May 14, 2010: Another Luminosity Record at the Large Hadron Collider

Three weeks ago we reported that the LHC had achieved a record luminosity by squeezing the proton beams to get a factor of 10 improvement. Now they have upped the numbers once again to get a theoretical increase by a further factor of about three. The new configuration is 3.5TeV/2m/20Billion/4-bunches compared to the previous 3.5TeV/2m/12Billion/3-bunches.

Increasing the number of bunches normally increases the luminosity but it depends on how the bunches are organised in buckets to make them collide at the right points of the collider ring. The new arrangement is bucket numbers (1,3231,21081,26731) for beam 1 and (1,12141,17791,26731) for beam 2. Bunches in the same bucket number of both beams will collide in the CMS and ATLAS experiments so from these numbers you get 2 collisions per turn. The other numbers provide the same collisions rates for the other two points where LHCb and ALICE are situated. In fact these bucket numbers are providing the same number of collisions as the previous 3-bunch configuration so for now this is not providing an increase in luminosity.

However they have also increased the intensity of the beams from 12 billion to about 20 billion protons por bunch. This gives a theoretical increase in luminosity of about 3 times. The actual figure will depend on factors such as how much the beam spreads out and how well they can be aimed at each other in the collision points.

The plan is to increase to 6 bunches per beam in the next few days. Depending on the buckets they use this could provide 4 collisions per turn which means another doubling of the luminosity. At the same time they have been doing test runs at much higher intensities of 100 billion protons per bunch but so far this has not been used in combination with multiple bunches and squeezed beams. This means much improved luminosities should be possible soon.

What does this mean for the physics? With the luminosities they have been running at so far they have already announced observations of W bosons and bottom quarks. They must have already seen Z bosons too which are more rare and perhaps they will have seen some top quarks. It takes time for them to review and approve any announcements so we have not heard much about that yet. All of these particles are well-known and are routinely produced in large numbers at the Tevatron in the

US. The LHC needs to keep improving its luminosities so that it has enough collisions to see new particles that are only produced very rarely. Of course they are also using energies three times higher than the Tevatron which means they could see new heavier particles that the Tevatron could never produce.

Update Saturday Morning: They have just succeeded in ramping "nominal bunches" to 3.5 TeV. This means bunches with 100 billion protons which is 5 times the number used in the latest physics runs. This is exciting because luminosity is increased by the square of this number. In fact if they used nominal bunches on a physics run right now they could have a new luminosity record even without the squeezing and multiple bunches. On this occassion they lost 40% of the beams during ramping due to "excitation of synchrotron sidebands" but it was still a good step forward. It seems that using such high intensities can lead to problems with instabilities and beam spreading, but they nearly have it cracked. Looking forward to seeing physics with squeezed nominal bunches, hope that is not too far off now.

Highest luminosity recorded so far in Atlas is $30 \cdot 10^{27}$ $cm^{-2}s^{-1}$

Update Saturday Afternoon: After the nominal intensity run of the morning they started a 6 bunch physics run with configuration 3.5TeV/2m/20Billion/6-bunches. The fill pattern provides 3 collisions per turn in each experiment. It would have been possible to get 4 collisions per turn with six bunches but it looks like they are now opting for schemes that avoid displaced collisions. These are collisions that happen 11.5 m away from the collision point of one of the experiments and these are impossible to avoid in the more efficient filling schemes.

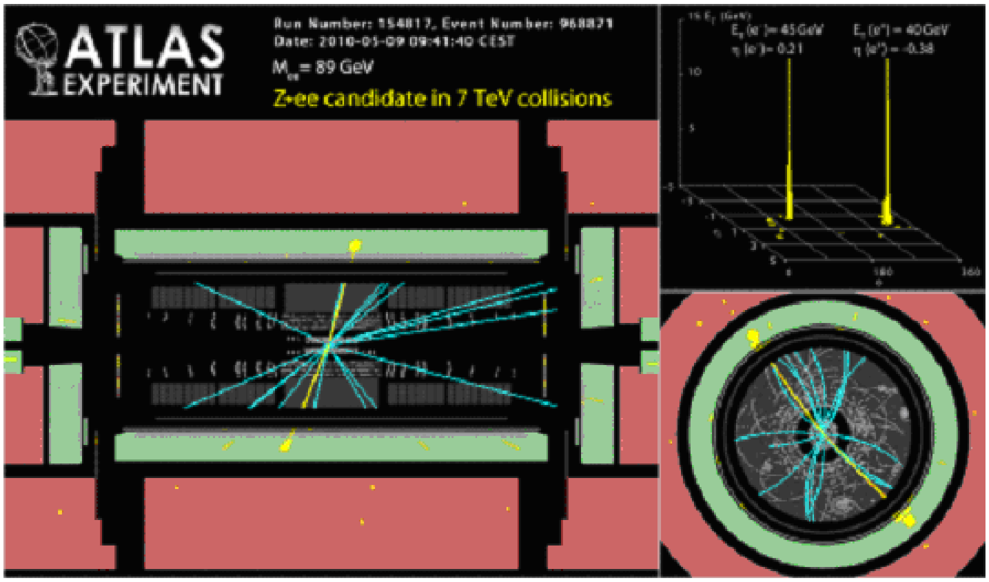
In any case the injection and ramp for this fill went very well with no sharp beam losses. The run is still continuing after 18 hours and by now they must have doubled the total integrated luminosity of the LHC. Highest luminosities have now been reported as $60 \cdot 10^{27}$ $cm^{-2}s^{-1}$ which is double the previous record from last week and 6 times the earlier record. It is also 60 times the earlier runs before they squeezed the beams a few weeks back.

The LHC is now only a factor of 6000 behind the peak luminosities seen at the Tevatron. They can make up another factor of 25 if they use the nominal intensity bunches that they tested in the morning. The rest of the factor can be made up by increasing the number of bunches in the fill. They also have the option to further squeeze the beams down to the nominal beta of 0.5m rather than the current 2.0m. This would give another factor of four.

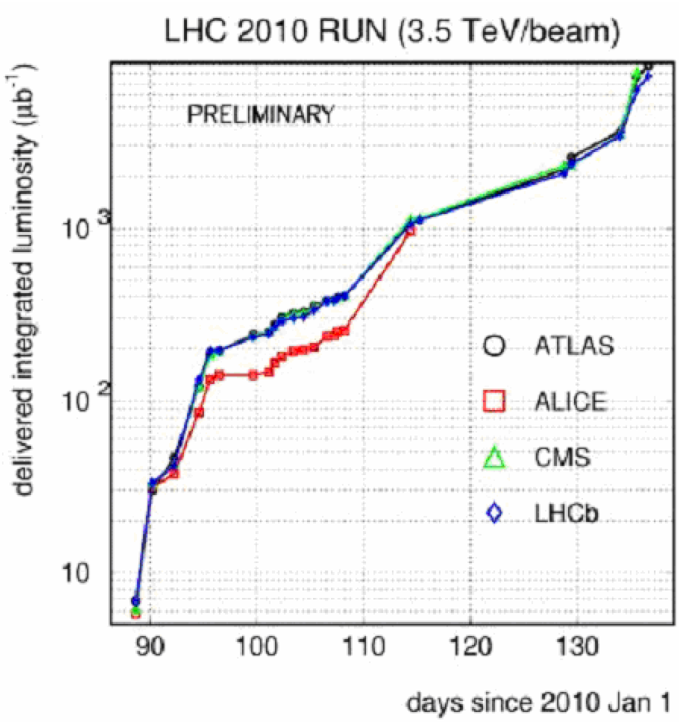
The plan of a few days ago was to reach this stage late on Sunday so they have really had a good few days

May 22, 2010: LHC progress

The rediscovery of physics at the LHC progresses with ATLAS showing the first candidate events for the Z-boson. These were first discovered in 1983 at CERN using the smaller SPS collider which now serves as the injection ring for the LHC. ATLAS and the other LHC experiments have been seeing plenty of Z-bosons but we outsiders have to wait for them to approve the reports before we can see them. The next physics milestone will be observations of the top quark which was discovered at the Tevatron in 1995.

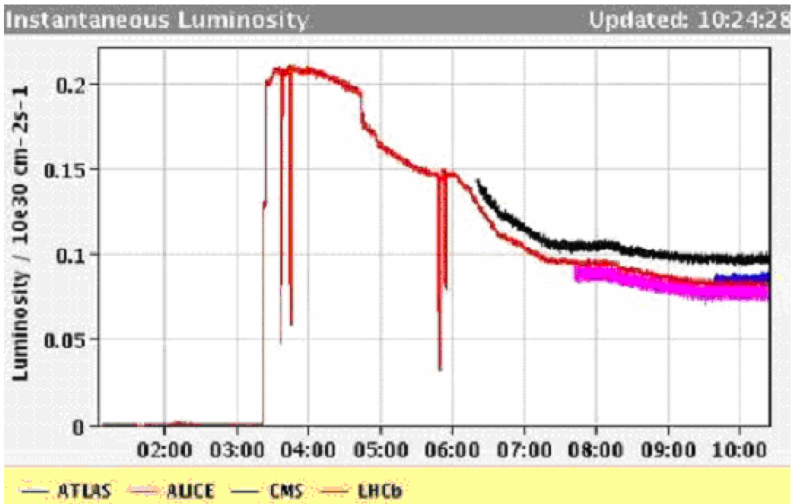


Peak luminosity in ATLAS is currently 7.7 x 10^{27} $cm^{-2}s^{-1}$. Over the next few weeks they plan to increase this in a series of doubling steps. The process has been going very smoothly thanks to the good performance of the magnets and cryogenics. The plot below using a log scale shows how the integrated luminosity has been increasing exponentially with a thousand factor improvement in less than two months. The LHC controllers will want to see this trend continuing until luminosity is reached at about 10000 times current levels towards the end of the summer. One of the main bottlenecks holding up faster progress is the need to train the shift staff that control the LHC so that they all know how to deal with any issues that have been found.



May 25, 2010: [Is someone trying to sabotage the Large Hadron Collider?]

This morning the Large Hadron Collider set yet another record as it injected 13 proton bunches in each beam to reach a luminosity of 2 x 10^{29} cm^{-2} s^{-1}, about three times previous records. The next step will probably be to increase the intensity of the bunches from 20 billion protons in each bunch up to the nominal design limit of 120 billion.

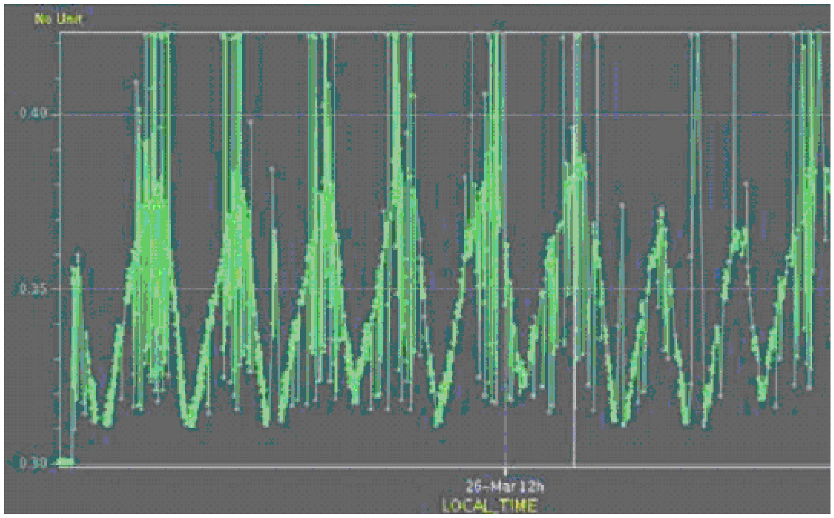


With such high bunch intensities the beam controllers must take extra care. If the beam becomes unstable the protons can go astray and plough into the sensitive particle detectors causing damage to the instruments. If instabilities grow the beams must be dumped quickly before all control is lost. This is why the gradual increase in luminosities has been a slow process.

Since they started up the LHC at the end of last year the physicists have been dogged by a mysterious source of interference christened "The Hump". Some unknown vibration is causing an extra vertical oscillation in the beams. The movement is very tiny, just microns in magnitude, but when its frequency hits the tune frequency of the beam it resonates and the protons start to spread out from the beam vertically, causing beam losses. So far this has been just a nuisance decreasing the lifetimes of the beams and sometimes triggering an emergency dump, but as beam intensities increase it becomes a bigger threat and could lead to damage of the accelerator.

Over the past few months the engineers have been trying to trace the source of the interference, but without success. Accelerators are very sensitive to any kind of movement. The previous accelerator at CERN, known as LEP was affected by the tidal pull of the moon and by the passing of France's high-speed train, the TGV. Recently the Tevatron in the US detected the devastating Earthquake in Haiti thousands of miles away when it caused a small wobble in the beams.

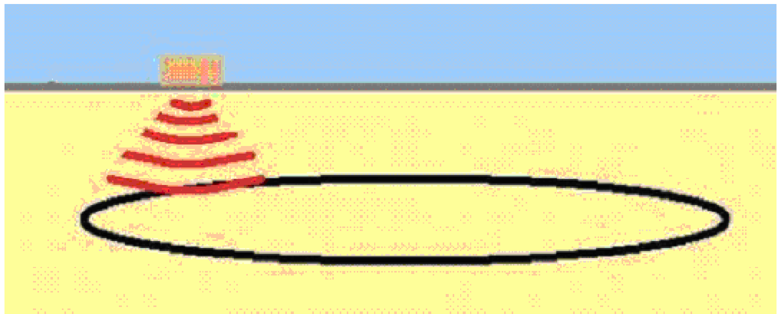
But The Hump is different. It is a high frequency vibration which drifts in frequency between about 3.1 and 3.8 KHz, sliding up and down the spectrum repeatedly over a period of 7 to 10 minutes. It could either be a sonic vibration or a low-frequency radio wave. It is unpredictable, being sometimes there and sometimes not. The CERN engineers have looked for sources of vibration from equipment in the accelerator such as vacuum pumps or the cryogenics, but nothing matches the observed interference and now they are stumped.



At this point they must start to consider a more sinister possibility. Could The Hump be a deliberate plot to sabotage the LHC? There are plenty of people who would be motivated to attempt such an act. Since its inception the collider has been a source of controversy because a few fringe physicists have suggested that it could create black holes of other unnatural entities that could grow in size to swallow up the Earth. Scientists at CERN have dispelled such theories, pointing out that anything created will fly off at nearly the speed of light and will not be captured by the Earth. Black holes would decay just like any other particle and could not be dangerous, even in the unlikely event that they are created. It has also been pointed out that the kind of particle collisions that the LHC produces are commonly produced in the atmosphere by cosmic rays and would have caused problems long ago if there was any danger. Further studies of particle interactions around neutron stars have eliminated any possibility of catastrophic events beyond any reasonable doubt.

This has not satisfied the more hardened detractors who claim that the only people qualified to make such a risk assessment are particle physicists with a self-interest in running the experiment. Some activists have even instigated court cases to try to get the LHC closed down by legal process. With the failure of such initiatives it is certainly not beyond the realms of possibility that some fanaticists would attempt to disrupt the LHC directly.

The Hump has especially annoying characteristics. The LHC beam has a tune frequency of around 3.5 KHz which can be modified to avoid most sources of noise, but The Hump varies in frequency, crisscrossing the range in which the tune can be set. If you wanted to design a source of interference to disrupt the accelerator you could do no better than this.



If The Hump is caused by a sonic wave or radio wave it must be coming from either directly above or below the collider ring at some point because it is disturbing the beams in the vertical direction. More distant sources would cause horizontal vibrations. Natural causes from below can be ruled out because they would have been seen before. This points to a source of interference coming from above the ring, probably at ground level. It is possible that a sonar device or radio transmitter operating at the observed frequency could be deliberately targeted at the ring from a station or movable vehicle above ground.

The LHC scientists are nearly ready to step up the beam intensity so that real physics experiments capable of discovering new phenomena can begin. the saboteurs, if they are really out there, will be waiting for the right moment to throw the collider beams of course, damaging the detectors and making further experiments impossible.

Perhaps this is just another conspiracy theory and a benign source for The Hump will be found soon but after several months of searching without result no possibility can be ruled out.