News

LHC Update: Luminosity Milestones II

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Abstract

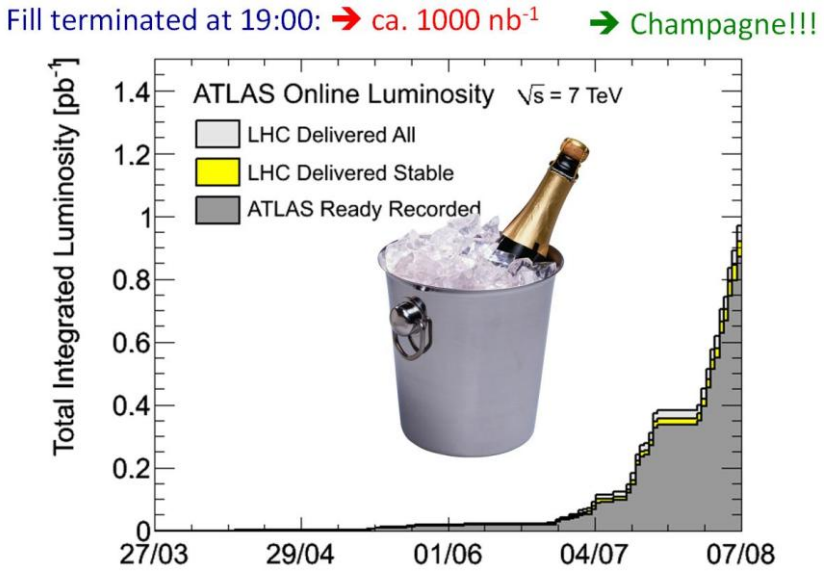
This article contains LHC updates for the period of August 7, 2010 to September 11, 2010 which appeared in my blog at http://blog.vixra.org .

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

August 7, 2010: Another record luminosity at LHC

The new record for peak luminosity at the Large Hadron Collider is now 4.1 MHz/barn or 4.1/μb/s or 0.13 /fb/year.

Update: The LHC beam teams are now celebrating the delivery of 1/pb of accumulated luminosity, which is a 1000th of their target for 2011. This slide is from their morning meeting on Saturday, although the milestone was reached at 9am Sunday.



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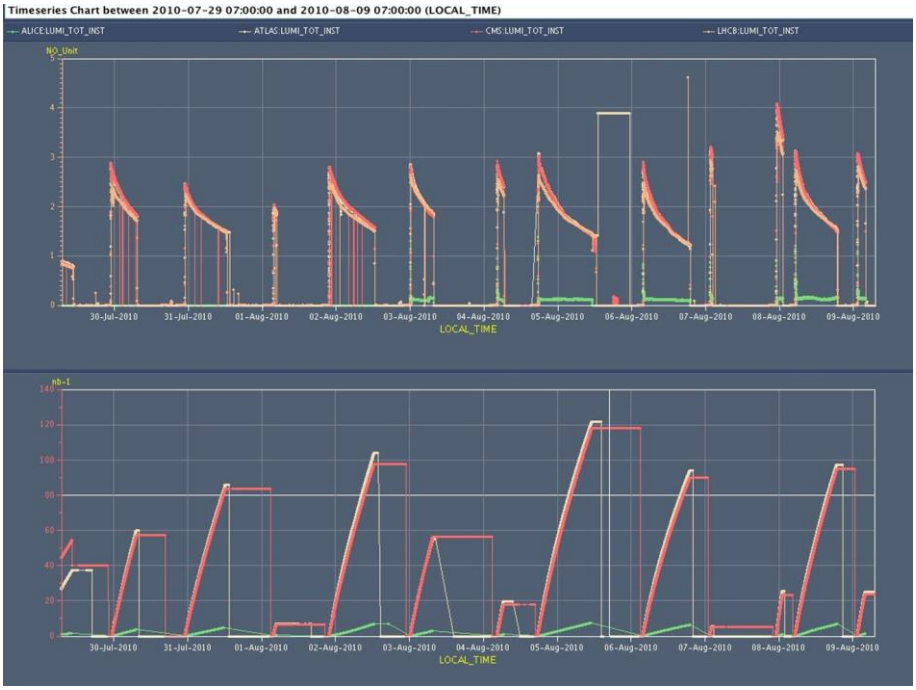
August 9, 2010: LHC Progress and Plans for August and Beyond

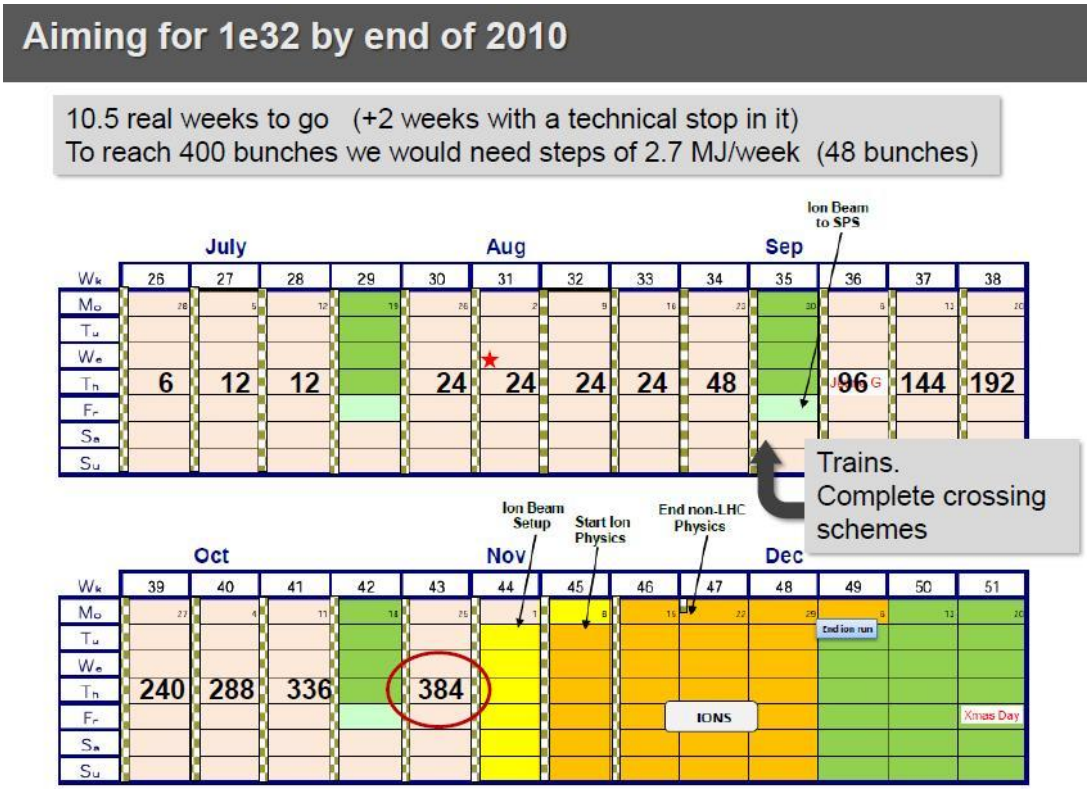
We are now 11 days into a period of 4 weeks during which the LHC beam team planed to run with a steady 25 bunch per beam filling scheme. The idea was that this point is a critical step in the commissioning at which the stored energy in the beams becomes critically dangerous at 1MJ which could do serious damage to the collider if it went out of control. They want to get used to running at this level before continuing to even higher beam intensities. Also, August is a traditional month of holiday for the French so many experts will be away.

This plot shows the progress so far with an 11 days plot of instantaneous luminosity on top and accumulated luminosity below. You can see 13 fills with peak luminosity reaching as high as 4.1/µb/s in CMS. The best individual run gathered 120/nb and the total from the 109 hours of running time is 730/nb which can be added to the 350/nb already accumulated previously. If they continue with this scheme they should be capable of adding another 1/pb during August approaching levels needed to have a small chance of seeing new physics.



The LHC beam team is notorious for changing their plans whenever things seem to be getting too easy so now they are considering further increases in luminosity during August. According to the new plan they will double the number of bunches to 48 next week and perhaps even to 80 the week after. They can do this while still using the current injection method that delivered four bunches at a time from the SPS, so it may not be considered too risky ;)

After August they will continue the increase in number of bunches by adding 32 bunches each week until November when they plan to switch to heavy ion collisions for a month. This would take them to 384 bunches per beam and a luminosity of 100/µb/s or about 3/fb/year



Taking into account downtime, luminosity falloff and recycle times this would probably not be sufficient to get them to their target of 1/fb collected during the 9 months of running time available in 2011. Realistically they need to double the number of bunches again to 768 as on Meyers' plan shown at ICHEP, so there is still work to do. A few more plan tweaks should sort it out.

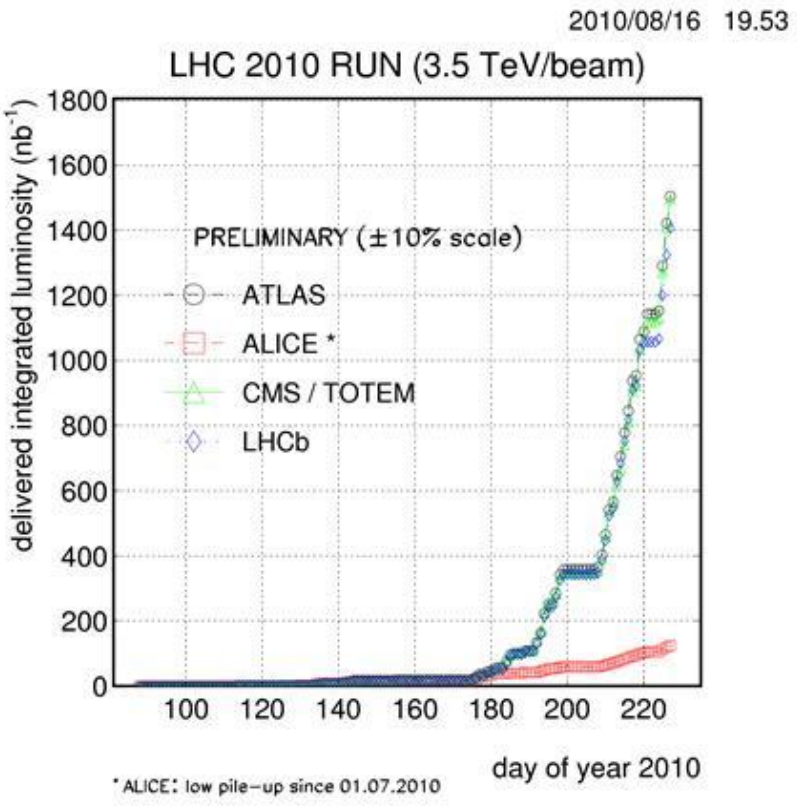
August 10, 2010: LHC Announcer

If you visit this blog because you are obsessed with all the latest trivia on the build-up of the Large Hadron Collider physics runs, then you are probably already familiar with the Operations Vistar (http://op-webtools.web.cern.ch/op-webtools/vistar/vistars.php?usr=LHC1) pages and the various live event displays and blogs listed in our right hand column.

Now you can go one step further using the LHC announcer which uses a voice synthesiser (http://announcer.web.cern.ch/announcer/) to call out all the latest minutiae about the running of the LHC. This is a version of the announcement system used in the LHC control rooms to wake up the operators if they fall asleep. This public web version has been kindly provided by Stephen Page who works at CERN. The page says it only works with the Firefox browser.

August 19, 2010: LHC preparing to increase peak luminosity to 9/ub/s

The beam teams at the Large Hadron Collider are now getting ready to increase peak luminosities up to about 9/µb/s which is 0.28/fb/year. To do this they will switch from their current 25 bunch scheme to a new 49 bunch scheme. Unlike previous filling schemes the bunches will be placed in a pattern that provides less luminosity to the ALICE experiment than the others. ALICE does not need higher luminosity at this time because it is designed for separate experiments using heavy ion collisions that will take place in November.



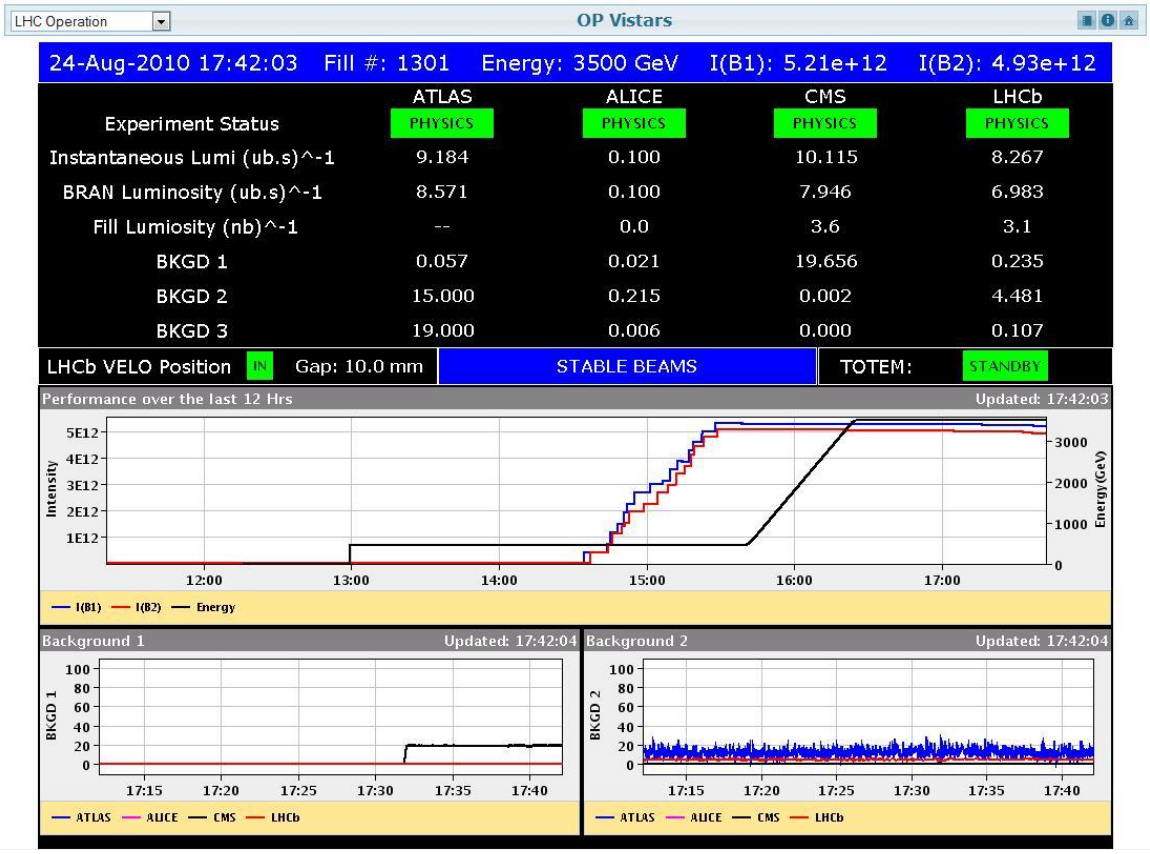
The new filling scheme is called 1250ns_48b_36_16_36 or 1250ns_49b_36_16_36 if extra diagnostic bunches are included to make up the 49 bunches per beam. 36 is the number of bunch collisions per turn in the experiments ATLAS, CMS and LHCb. This can be compared with the present scheme Multi_25b_16_16_16 which had 16 collisions per turn and delivered peak luminosities of 4/µb/s. if all else is equal we can therefore expect peak luminosities of 4 x 36/26 = 9/µb/s.

Over the last two weeks the total integrated luminosity has increased from 1/pb to about 1.5/pb. The new filling scheme will push the total up faster. In preparation the physicists will do new bunch injection tests today, possibly leading to physics runs with 49 bunches this evening or tomorrow.

In fact the luminosity gathered this month has been a little less than expected but that is because they have been using some of the time to commission better processes. for example they have been testing faster ramping of the energies. That will ultimately improve the recycle time between physics runs. The higher luminosity with 49 bunches should enable them to make up the lost time before the end of the month.

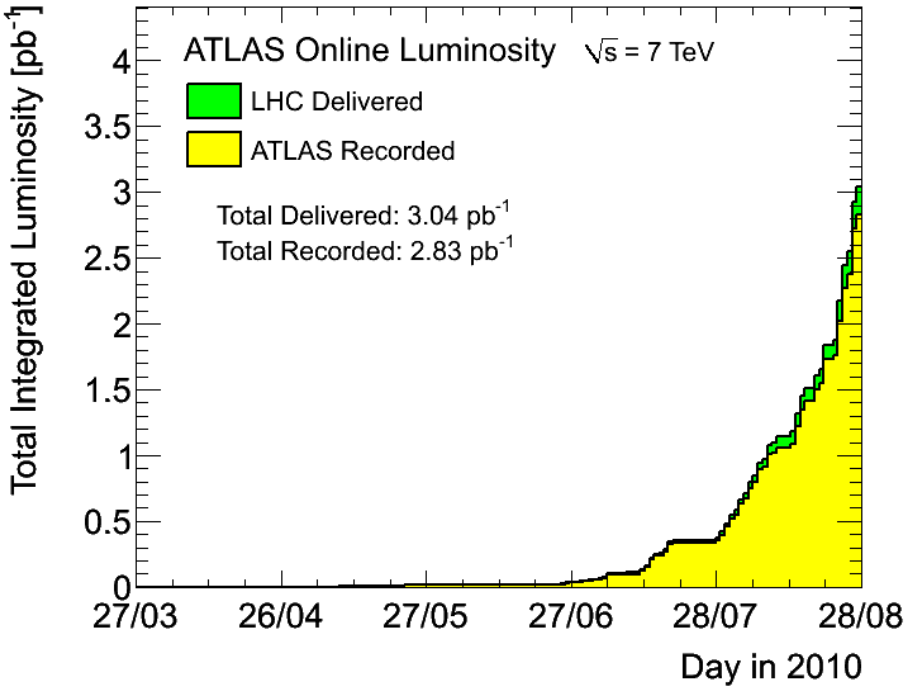
Update: The first 48 bunch physics run was a great success. It delivered 240/nb over 15 hours, before being adjusted for end-of-beam studies. The luminosity started at around 6.6/nb/s and ended at 3.3/nb/s, so the luminosity lifetime was also 15 hours (intensity lifetime was more like 60 to 100 hours). The total integrated luminosity over all runs now stands at about 1.8/pb.

August 24, 2010: LHC Luminosity passes 10 inverse microbarns per second



The Large Hadron Collider has passed a new luminosity milestone with a peak of 10.1/µb/s (or 10.1^{31} Hz/cm^2 or 0.32/fb/year) recorded in the CMS detector. This was achieved at the start of a run with a new filling scheme using 50 proton bunches per scheme today. This figure is one tenth of the target luminosity for the end of this year that is needed to get them ready for collecting 1/fb during 2012.

August 29, 2010: LHC update and plans for Sept/Oct



The experiments at the Large Hadron Collider have now collected over 3/pb of data each. This plot shows the integrated luminosity collected by ATLAS as 2.83/pb but you can add 0.28/pb from the current overnight run which will continue to collect data this morning. Physics runs will go on until Monday morning when the collider will be shut down for a regular start-of-month technical stop.

There had been some debate among the beam controllers about whether or not to increase luminosity further before the stop, but it was decided that the priority should be to perfect the injection procedures.

There are now 9 weeks left to increase the luminosity before the LHC is turned into a heavy ion collider during November. In that 9 weeks the luminosity must be increased from its current peak value of 10/nb/s to 100/nb/s . That will be equivalent to 3/fb per year and they want to collect 1/fb in 2011. When you take into account the luminosity decay, and available running time you find that they really need twice that luminosity to achieve their goal, so either they will have to increase luminosity further in 2011, or settle for less than 1/fb of data.

To get to higher luminosities they need to perfect the injection procedures so that they can pack the proton bunches into the collider ring more closely. They have recently debated whether to aim for injections with a spacing between bunches of 75ns or 150ns (22.5m or 45m). The decision is to aim for 150ns separations because it avoids parasitic collisions. These are collisions between the bunches that happen outside the normal collision point when the angle at which the beams cross is not sufficient to keep them apart. Such collisions produce false signals in the detectors and may produce radiation in unwanted places that age the equipment.

With 150ns separations they can fit a maximum of 384 bunches into each beam which should be enough to increase the luminosity to 100/nb/s. However the plan is still tight and they cannot afford to lose much time to unplanned stoppages. Otherwise they will be left with more work to do when they restart next year making it even harder to hit the 1/fb target. The work to complete the injection method has already been held back due to a problem with the UPS systems so they cannot afford further delays after the technical stop.