THE HERA TURN AROUND TIME*

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Abstract

In the framework of the proposed LHC luminosity upgrade it is envisaged to increase the LHC injection energy. One benefit of this measure could be a decrease in the turn around time, i.e. the time between the end of a luminosity run and the beginning of the next run [1]. This paper will describe the turn around time for HERA, the electron proton collider at DESY, Hamburg. After an introduction into the HERA operation cycle the turn around time will be presented, followed by some statistics to explain the numbers.

THE HERA OPERATION CYCLE

Figure 1 shows the HERA operation cycle over 24 hours on a good day without hardware faults and operational difficulties.

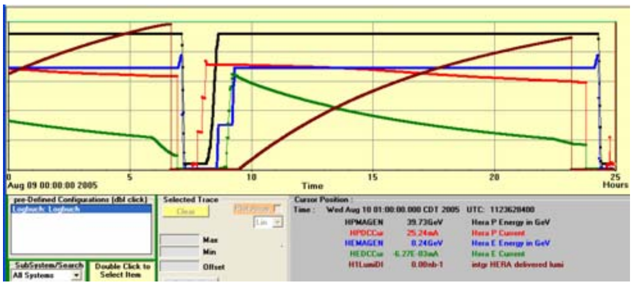

Figure 1: The HERA operation cycle.

This plot from the HERA archive shows in black the proton energy, in red the proton beam current, in blue the electron energy, in green the electron beam current and in brown the accumulated luminosity.

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Figure 2 shows a blow up of the time between the end of one luminosity run and the beginning of the next run.

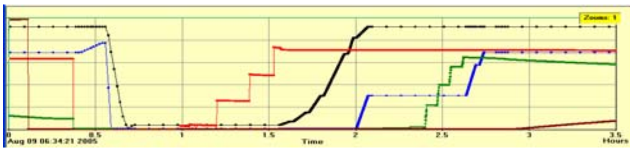

Figure 2: The time between two luminosity runs.

After both beams are dumped, the magnets are cycled to maximum energy and then down to zero. This down ramp is done relatively slow to achieve a reproducible cycle and to avoid an undershoot at minimum energy. Afterwards the proton magnets are set to injection energy (40GeV). Now there is a delay of 5 minutes to wait for the fast decay of persistent currents before an automatic correction procedure is turned on to take care for the slow decay. After a short time needed to set up injection, the proton ring is filled with three consecutive fills of the preaccelerator PETRA. Then the proton energy is ramped up to 920GeV and the electron magnets are set to injection energy (12GeV). After setting up electron injection, the electron ring is filled with four PETRA fills, the electron energy is ramped up to 27.5GeV and the beams are brought into collision. The time between the beam dump and the first luminosity signal is referred to as the turn around time. Here a turn around time of 2.5 hours was achieved. The shortest achievable turn around time is of the order of 2 hours, while the average turn around time for the year 2005 is 10.2 hours.

STATISTICS

In 2005 the average HERA turn around time was 10.2 hours. This has to be compared with 8.7 hours in 1999, 6.6 hours in 2000 (after 9 years of operation), 17.2 hours in 2002 (just after the luminosity upgrade), 12 hours in 2003 and 10.1 hours in 2004.

The turn around time consists of the time lost by faults (either component faults or operational problems), the proton injection time and the electron injection time. For 2005 we had 2.6 faults per luminosity run with an average of 2.5 hours lost per fault, adding up to an average time loss of 6.5 hours per luminosity run. On average we had 1.8 proton injection attempts per luminosity run with 1.43 hours per injection, adding up to 2.6 hours proton injection per luminosity run. 1.6 electron injection attempts per luminosity run (0.83 hours each) give another contribution of 1.3 hours of electron injection per luminosity run. This adds up to the above mentioned turn around time of 10.2 hours. Table 1 gives an overview over this numbers.

HERA 2005:

2.6 faults per luminosity run	*	2.5 hours per fault	= 6.5 h
1.8 p injection attempts per luminosity run	*	1.43 hours per p inj.	= 2.6 h
1.6 e injection attempts per luminosity run	*	0.83 hours per e inj.	= 1.3 h
			10.2 h from dump to lumi

Table 1: Contributions to the HERA turn around time.

The HERA fault statistic for 2005 is dominated by three major faults with a duration of one week each. Neglecting these cases would reduce the average time loss per luminosity run due to faults by approximately 10%, i.e. 0.65 hours. This would reduce the turn around time to 9.55 hours.

A possible increase in injection energy for a machine like LHC could help to reduce the operational problems at injection and on the proton energy ramp.

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During HERA operation in 2005 about 11% of all proton ramps did not lead to a successful luminosity run due to operational problems. If one assumes that all this operational problems can be solved by increasing the injection energy and if the time for one injection gets shorter by 0.1 hour due to the reduced energy swing, then one would end up with 2.1 hours of proton injection per luminosity run, a reduction of 0.5 hours. Applying these assumptions to a machine like LHC with two superconducting proton rings would lead to a reduction of 1 hour. For the turn around time this would lead to an overall reduction of about 10%.

REFERENCES

[1] W. Scandale, "Possible scenarios for the LHC luminosity Upgrade", care-hhh.web.cern.ch/CARE-HHH/LUMI-05/elba_paper.doc