ALTERNATIVE SCENARIOS FOR THE CURRENT SHUTDOWN

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Abstract

Alternative options for the current shutdown will be presented. These options include warming up additional sectors to complete the consolidation activities. The potential impact of these revised schedules on the beam schedule in 2009, as well as the length and timing of the following shutdown will also be presented.

INTRODUCTION

The current shutdown schedule leaves a number of consolidation activities, needed to mitigate the risks in the machine, for the next shutdown(s). Taking into consideration the risks, the potential radio-active environment, alternative schedules have been made studied in order to give a complete picture of the next two years. Moreover the cost of operation is presented, and finally the future shut-down minimum time window is outlined, as well as the modifications needed to achieve the minimum time window.

ACTIVITIES LEFT WITH CURRENT SCHEDULE

From the current shutdown schedule, four sectors are warmed-up to room temperature:

- Sector 34, for repair
- Sector 56 for outstanding consolidation activities, such as the connection cryostat consolidation [1]
- Sectors 23 and 67 where potentially weak magnets were identified during the additional powering and calorimetric tests performed at the beginning of this year

All the consolidation activities needed in order to mitigate the risks (from the incident of sector 34), as well as the consolidation following the non-conformities discovered during cool-down and powering tests of last year (such as stand- alone magnets consolidation) are scheduled in these four sectors.

In the other four sectors: only the consolidation activities which do not imply a complete warm-up, such as the installation of the dipoles relief valves are scheduled, and a maximum of the activities of priorities 2 and 3 (not absolutely necessary during this shutdown) are scheduled.

So several consolidation works are left for the next shutdown, such as:

- DN200 relief valves in 4 out of 8 sectors
- Consolidation of 5-10 stand-alone magnets
- Consolidation of the Y-lines in sectors 7-8 & 8-1

In addition these activities will have to be done in a potentially radio-active environment, which will certainly mean that more complicated and lengthy procedures will be needed.

LENGTH OF NEXT SHUT DOWN

In addition to the consolidation activities, known up to today, the annual maintenance of the different systems will have to be done. The key maintenance activities are:

- The cooling towers systems maintenance, which has to be performed once a year, and is lasting 3 weeks. From the current resources available, a maximum of two cooling towers maintenance can be done in parallel.
- The cryogenics system maintenance, which will be done in parallel with the cooling tower maintenance, and is taking 4 weeks

Other maintenance activities, such as the access systems will be done in the shadow, and won't impact the schedule.

One other important point to emphasis is the cryogenics fluid logistics (Helium):

- We are confident to be able to store, either at CERN, either virtually, the total volume of Liquid Helium of the machine; so the gymnastics with the Helium logistics will no longer be a problem.
- However, the current configuration of the cryogenics systems only allows the liquid helium emptying through point 18: up to 2 sectors at a time, and 2 week time window for the proper emptying and one week to liquefy the amount of helium before storage.

Taking this into consideration, the next shut-down schedule will be 24 weeks long (figure 1), including the consolidation works, the maintenance activities, the cool-down and the powering tests.

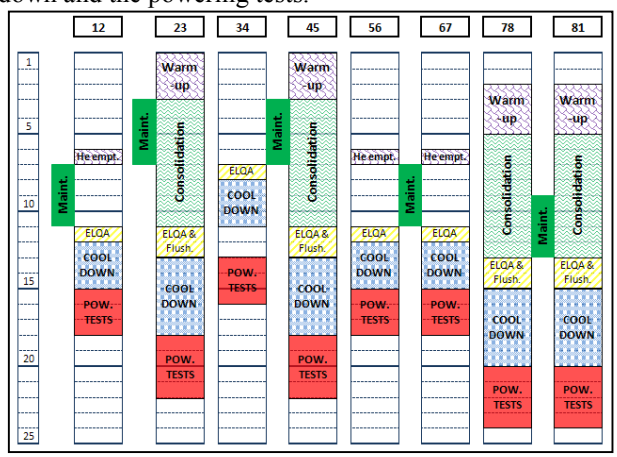

Figure 1 : Next shutdown length with respect with current scenario

With respect to the length of the next shutdown, and the fact that the consolidation activities will have to be done in a potentially radio-active environment, two other scenarios have been studied (for both the current and the next shut-down)

WARM-UP 6 SECTORS AND IMPACT ON NEXT SHUT-DOWN

Warming-up two additional sectors (and thus consolidating these two sectors) will mitigate the risks. Figure 2 shows the effect of warming-up sectors 23 and 45:

- The Helium emptying of sectors 78 and 81 are now depending from the cool-down of the first two sectors, i.e. sectors 12 and 56 by the end of May.
- The end date is given by the end date of sector 81, giving an extra-week of margin in sector 34 (where the schedule is very tight).
- The critical path is now running form sector 45 to sector 81, and the delay compare to the current scenario is one week.

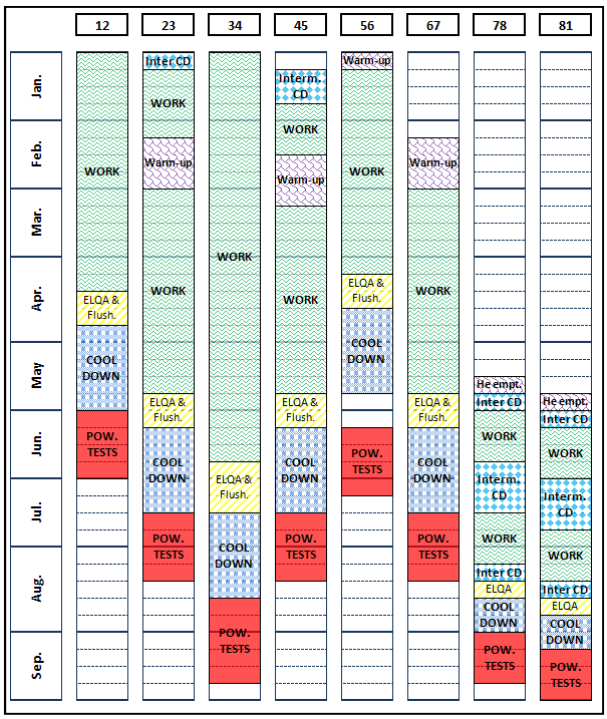

Figure 2: Shutdown 0809 – 6 sectors consolidated

Figure 3 shows the schedule for the next shutdown if we warm-up two additional sectors now. With respect to the current scenario, one week shall be lost this year, and two weeks will be gained next year.

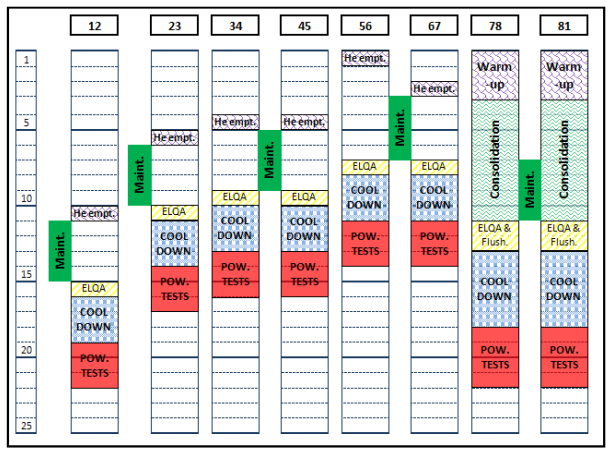

Figure 3: Next shutdown length if 6 sectors are consolidated this year

WARM-UP THE 8 SECTORS AND IMPACT ON NEXT SHUT-DOWN

Figure 4 shows the result for the consolidation, this year of all the sectors.

With respect with the current scenario, five additional weeks are needed. As in the previous scenario, the critical path is running from sector 56 to sector 81.

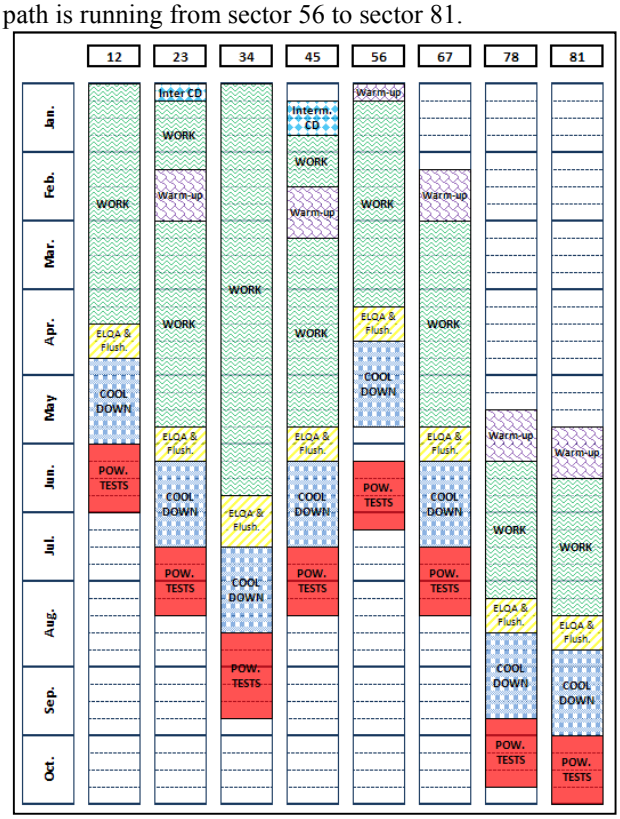

Figure 4: Shutdown 0809 – 8 sectors consolidated

As shown in figure 5, the next shutdown time window will be 18 weeks, gaining six weeks from the current version

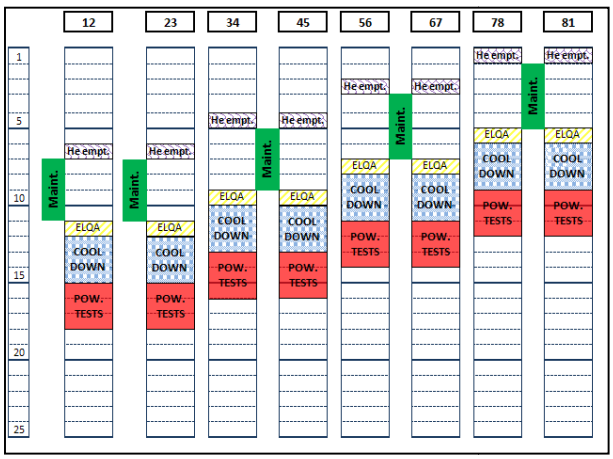

Figure 5: Next shutdown length if 8 sectors are consolidated this year

SUMMARY TABLES

The above scenarios are presented for a decision to be taken in February. The tables below summarize the end date of the shutdown 2008-2009 and the length of the next shutdown for the different scenarios.

If the decision is taken in February, the time lost this year for the consolidation of additional sectors is gained next year. For a decision taken in March, the consolidation of additional sectors won't be balanced compared to the length of next shutdown.

	End of shutdown 0809	Length of next shutdown
Consolidation of 4 sectors	Wk. 38	24 wks
Consolidation of 6 sectors	Wk. 39	22 wks
Consolidation of 9 sectors	Wk. 43	18 wks

Table 1: Summary table of the different scenarios if the decision is taken in February

	End of shutdown 0809	Lenght of next shutdown
Consolidation of 4 sectors	Wk. 38	24 wks
Consolidation of 6 sectors	Wk. 44	22 wks
Consolidation of 9 sectors	Wk. 46	18 wks

Table 2: Summary table of the different scenarios if the decision is taken in March

Minimizing the number of sectors to be warmed-up to room temperature has the big advantage to have a the soonest start date for the beam, but taking into account the tightness of the schedule of the consolidation inside sectors 34, the risks of failure in the non consolidated sectors, the ALARA principle, the two other options shall be considered. Of course, one can also add that we don't know yet if after operation, more consolidation works will be needed!!

COST OF ELECTRICITY

Energy contract

Today's electricity cost is composed of a fixed fee (~7%) depending on the amount of subscribed power per month of the year and the energy (~93%) consumed during the same period. Subscription fees and energy cost is well below yearly average cost during the months of April to October, see figure 6. Therefore, the accelerator operation has been scheduled during this period only, with energy budgets and contracts established accordingly.

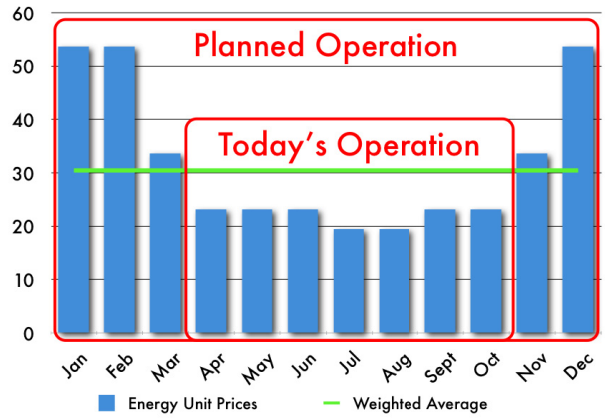

Figure 6: EDF contract summary of price structure

The need to run the LHC at 5 TeV and the injectors during the winter 2009/2010 in accordance with schedules presented above will require an upgrade of the energy contract before the end of April 2009.

Operation assumptions

During the Hardware Commissioning (HWC) and the operation of the injectors for the LHC only (no fixed target operation), it has been considered that the equipment efficiency and the required power is reduced with respect to the nominal operation. E.g. during the HWC the LHC equipment will be 40% efficiency and the cryo systems will operate at 50% of their nominal power, totalling the required CERN power maximum at 180 MW, compared to 220 MW for nominal operation. The same total power need is estimated for LHC 5 TeV operation without fixed target, based on 25% efficiency and 50% of power for the injectors, and 50% of the nominal power for the LHC; 650 to 700 hours scheduled operation per month.

During the shutdown of all beams, with 50% of the LHC cryogenics, cooling & ventilation power, 80 MW shall be sufficient to operate the lab.

Figure 7 shows the energy distribution for 2009 and 2010, comparing the program of the Long Term Plan (LTP) and the running of the LHC at 5 TeV with nominal

beam operation as of November, December 2009. Experience shows that the uncertainty of the activities result in ±10% error in the energy previsions and budgets accordingly.

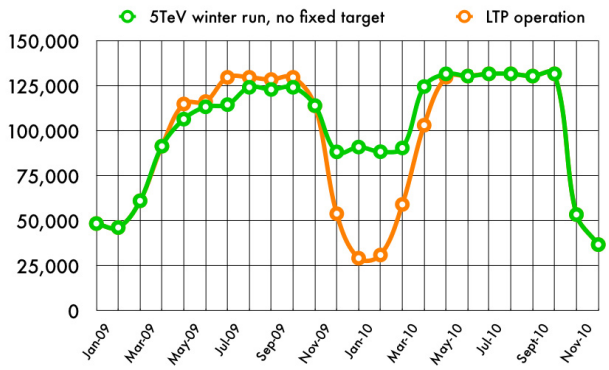

Figure 7: Energy load curve comparing LTP and 5 TeV winter run

Cost Estimation

In today's prices the winter run of the LHC will require 13.6 M€ additional budget compared to the operation conditions considered in the last LTP, see Table 3. Due to the much higher prices during the winter months, the 7.3% increase in consumed energy, increases the cost by 19.5%.

	Energy [GWh]		**Cost [M€]**	
	2009-2010	Δ	2009-2010	Δ
LTP	2260	-	69.8	-
5 TeV	2426	7.3%	83.4	19.5%

Table 3: Cost comparison LTP / winter run 5 TeV, no fixed target

Independent of the LHC winter run it shall be taken into consideration that CERN's energy supplier announced price increases for 2009 and 2010 of the order of 8% each year, resulting in approximately 5 M€ additional cost. Compared to the prices expected on the open energy market by the European Energy Exchange (EEX), CERN prices will still be 66% below. It shall also be noted that the winter run will increase the fixed fee for 2011 by ~1 M€ due to contractual conditions, even though the power needs will be lower.

Cost Savings

The possibility has been discussed to reduce the power requirements of the cryogenics systems by 30% before the start of beam operation, which needs to be confirmed. Depending on the technical limitations up to 5.7 M€ of savings might be possible.

Launching a CERN-wide energy saving program would be an opportunity to compensate for the prospected increase of electricity market prices over the next decade. Saving permanently 5 MW over 10 years would allow to save 15 M€ on the energy bill.

FUTURE SHUT-DOWN

Key drivers

The key drivers for future shut-downs will be the maintenance activities, assuming that if any consolidation/installation/repair works are needed, there will be done in the shadow.

According to the actual configuration of the cryogenic systems (see above), the time window for the future shutdowns will be 18 weeks (figure 5).

How to gain time

Time can be gained, if the cryogenic systems are modified in order to reduce the helium logistics time. Additional helium storage tanks, as well as a slight modification of the cryogenics system at each cryo plants will give us the possibility to store the helium of all the sectors within one week. The minimum time window of 16 weeks is, then given by the number of cooling and cryogenics plant that can be maintain in parallel. Increasing this number up to the total (i.e. 5) is not for the time being conceivable, because of the internal resources, but this will also impact the maintenance of the other systems, for which we will have to find also additional resources.

CONCLUSION

The different scenarios presented are giving a global picture of the situation, from this shutdown till the next one. These scenarios will be discussed during the LHC Performance workshop, and a decision will be taken taking into account different aspects: risks, resources, schedule, political aspects, cost of electricity.

REFERENCES

[1] J. Coupard; K. Foraz, Where are we with the current shutdown, LHC Performance Workshop - Chamonix 2009