SUMMARY OF SESSION V: SHUTDOWN MODIFICATIONS 2008/9 AND FUTURE SHUTDOWNS

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Abstract

Session V was devoted to LHC shutdown activities and scheduling. The presentations provoked an animated discussion on the best strategy to follow to get to the earliest reasonable restart date for the machine with the best level of safety protection for the machine. The situation regarding availability of critical spares was also reviewed, along with the tracking of hardware modifications. The session was divided into 6 talks. These talks and the subsequent discussions will be summarised here. For clarity, *the discussions are summarised in italics.*

1. Where are we with the current shutdown?

The key drivers for any LHC shutdown schedule are:-

- CV & Cryogenic system maintenance
- Intermediate cool-down of floating sectors to avoid ELQA and PIMS problems
- Transport restrictions in the presence of liquid helium
- Access restrictions during cool-down, warm-up and powering tests in adjacent sectors
- Limited Helium storage capacity

For the current LHC shutdown the repair of sector 3-4 is the critical activity, which will determine the length of the shutdown. The activities in different sectors are strongly linked. E.g. Sector 1-2 cannot be refilled with helium until all the magnets have been transported back into 3-4, which, in turn, means that work cannot start in 7-8 until the liquid helium has been transferred to 1-2.

This led to a discussion of venting helium to the atmosphere to speed up the wo0rk. It was stated that this would cost 600kCHf per sector and would pose logistical problems for the re-supply later. It was agreed that the question of additional helium storage should be investigated.

In the current shutdown planning, with no contingency, 3-4 will be the last sector to be cooled down in August, with possible beam operation from September. This planning includes the following:-

- Upgraded QPS (everywhere)
- DN200 relief valves in 4 out of 8 sectors
- Consolidation of some (but not all) stand-alone magnets
- Jack re-enforcement everywhere
- The replacement of the 50 & 100nOhm dipoles from 1-2 & 6-7
- No work in sectors during tests in adjacent sectors

There was a discussion on the access conditions during powering tests. There is a need to clearly define under what conditions access can be granted in areas adjacent to sectors undergoing powering tests.

2. Alternative scenarios for the current shutdown.

The current shutdown schedule leaves a number of activities to the 2009/10 shutdown:-

- 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 more complicated and lengthy procedures will be needed. Taking into account the same key drivers as for the current shutdown, this leads to a minimum shutdown for 2009/10 of 24 weeks.

It was estimated that, including these activities in the current shutdown would delay the restart by some 5 weeks.

In the subsequent discussion it was pointed out that:-

- *Contingency should be added to both schedules*
- *Additional work will led to additional surprises and potential delays*
- *For either case the beam energy will be the same as this is limited by the QPS system performance.*
- *Either schedule implies operation during the winter 2009/10*

3. Running through the winter. Is it just a cost issue?

The additional electricity cost for running LHC and the Injectors through December, January & February 2009/10 is between 8 and 14MEuros. The difference depends on the potential 35% savings that can be made on the cryogenic plant operation and a possible 8% price increase. The Injectors would only operate for the LHC and all other experimental areas would be stopped. The

planned winter 400kV and AUG system maintenance could be delayed.

For the various water cooing systems, an annual cleaning of water towers, circuits etc is mandatory due to the threat of bacterial infections such as Legionnaire's disease. If the systems cannot be stopped, then compensatory measures, such as the regular bacterial measurements must be implemented, with an immediate stop for cleaning, if specified maximum contamination levels are reached.

Such a 3 day stop of the water cooling system at an LHC point would mean a 3-4 week break before normal cryogenic operating conditions would be re-established for the machine.

4. Consequences of floating sectors warming up to >80K

The major concerns caused by floating sectors warming up above 80K are mechanical distortions of the PIMS and the need to re-do the ELQA tests. As a result a scheme of using an intermediate cool-down has been implemented to avoid excessive temperature rise in the extremities of the sectors during the cryogenic maintenance periods.

Tests on the PIMS buckling have been made in the lab, and it was proposed to repair systematically the most vulnerable PIMS (LSS and ARC extremities). Results using an X-ray Tomography device to inspect suspect PIMS without opening, have given very interesting results and such a device has been ordered.

It was suggested that this technique could also be useful for a preliminary inspection of suspect splice.

For the ELQA tests it was proposed that a full ELQA should always been done after a full warm-up for an intervention (e.g. changing a magnet). After a partial warm-up or a full warm-up without any electrical intervention it was proposed to do the HV ELQA at cold (i.e. below 2.1K)

5. Identifying Critical Spares

Essentially all of the spare magnets (cold masses) will be used in the 3-4 repairs. Therefore there is an urgent need to re-constitute a supply of spare, fully-tested magnets. In addition, there are no spare DFBs. There some spare chimneys and HTS leads.

Two potential "single points of failure' have been identified, these are the 18kV link to TI8 and CNGS, and the PS "rotating machine" for the Main Magnet power supply.

Both issues are being addressed, with a renovation program for the SPS 18kV system and a new PS MPS, which will be operational in 2010.

The water cooled cables installed in the LHC tunnel have been found to contain halogens and there are number of problems with premature ageing of the cable insulation. These cables will have to be replaced.

Concern was raised that there was no clearly defined strategy for replacement of water cooled cables. It was agreed that it is important to develop a strategy for replacing failed cables, and, therefore some of the cables around point 4 and 6 should be replaced this shutdown.

The majority of the LHC Cooling and Ventilation system are inherited from LEP and they need consolidation and to be brought into line with new European regulation regarding bacterial contamination etc.

Currently, any stop (even for maintenance) of the Cooling systems and any LHC point stops both Cryogenic and Experimental operation. Can a solution for this be found?

A detailed inventory of existing spares, for the machine and it's infrastructure, should be made, in order to assess the missing spares and the required consolidation. Repair strategies need to be defined, and programs put in place to provide the required level of spare parts and consolidate the vulnerable areas of the LHC infrastructure systems. This exercise has been done for the LHC Injectors.

6. How do we keep track of changes?

It is very important to keep a close track of all the changes that are made to the machine. ECR's are no longer being used systematically. In fact they are better used at the SPS than in LHC. The major activities are reasonably well covered but a lot of smaller works are not tracked. For such small works the LHC point owners should be informed.

The ECR system will be reviewed and resuscitated by EN/ICE.

A central decision-making process for approval of proposed changes is also needed. It assumed that the new LMC (LHC Machine Committee) will fill this role.