CONTROLS AND OPERATIONAL ASPECTS: GOING FROM COMMISSIONING TO OPERATIONAL REGIME

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INTRODUCTION

The session had as purpose to give a critical view on controls and operational aspects during the 26 days of successful beam commissioning at the end of 2009, as well as proposing solutions to the different problems. The following aspects were assessed. First the weak points of the LHC operation in terms of procedures, tools, discipline, equipment and organisation. A second contribution tried to address how to improve operational efficiency. The following two talks review the explicit problems of the accelerator control system and the RF system, respectivelly.

WHAT ARE THE WEAK POINTS OF OPERATION?

The short period of LHC operation in 2009 without and with beam revealed a number of weaknesses which could impact on machine efficiency, or potentially on machine protection. This contribution describes some of the weaknesses, grouped rather arbitrarily into Preparedness, Injection, Experiment-machine interface, Sequencer, Ergonomics, Discipline, System specifics, Procedural and General. Those weaknesses which are judged to have a potential machine protection impact are highlighted with the potential implications. The paper compiles a list of specific examples which will be of great use to be able to follow them up, as well as some possible solutions, as the basis for a discussion rather than as final solutions.

The contribution emphasizes that it is very important that Machine Protection should not passively follow the progress; it should dictate the progress, or at the very least limit progress at strategic points in the commissioning program. Operation of the LHC in 2010 above the safe beam limit will require much more discipline than in 2009, and Machine Protection should be central to the commissioning strategy.

HOW TO IMPROVE OPERATIONAL EFFICIENCY?

This paper quantizes in which points the operational efficiency was low such we have a criterion to establish priorities, and how to improve them. The data source has been the e-logbook from the 20th of November to 16th of December 2009 (the beam commissioning period). The notes in the e-logbook show that the machine was available for beam 60% of the time. The other 40% accounts for different type of problems which are described in the paper and which can be fixed for the next start up to recover between a 40 to 50% of down time. Those problems are cryogenics, pre-cycle and pre-cycle side effects, QPS specific issues and experiments issues. The other category of problems are believed to be part of the commissioning phase and were solved in due time.

The contribution explains that out of the 60% of machine availability half of the time at least one of the beams was present and beam commissioning could be performed. The other half of the time was devoted to preparation for injection; understand the dump via the analysis of the post-mortem data; and solve problems (most of them mentioned in *What are the weak points of operation?* by B. Goddard, in this proceedings). Most of the problems are being addressed and will be fixed for the next start up. But there are other problems that require a careful thinking, mainly the ones which solution has to be in place before unsafe beam operation. Those require a major debate.

Taking into account all the problems, the presence of any of the beams in the machine during the 26 days of beam operation in 2009 is 30% which is a very good result for a first start up of such a complex machine like LHC.

CONTROLS ISSUES: CMW SUBSCRIPTION, RBAC SET-UP

This presentation covered explicit accelerator control issues that we faced during the 2009 beam commissioning and outlines applied and planned actions needed to solve them before the start up in 2010. Despite the controls system was tested in different dry runs and injection tests, the real beam operation is the only moment during which the systems are fully stressed and problems which cannot be spotted during dry runs appear.

The following list of problems was covered with the respective solutions:

- Infrastructure (disk space and consoles): there was a massive increase of the total amount of controls operational data, from 400 GB in 2005 to 4 Tb in 2009. We are reaching the physical limits of the CCR in any sense. The controls group is analyzing a long-term solution which should be put in place by February 2010 based on new storage technology form HP. On the other hand the high load on consoles has been already fixed and works.
- CMW (Controls Middle Ware) proxies and subscriptions: under high load the Proxy doesn't respond promptly to a calling client which blocks the interaction with the front-ends or data sources. Several actions have been performed and validation of the new implementation is taking place during the dry runs of January 2010.

- Front-end instabilities: the problem has been trace back to an existing bug in FESA which has been fixed already and validated with RF equipment which was one of the most affected front-ends.
- Data publishing via Java Messaging Service (JMS): overloaded brokers stopped publishing data affecting page 1 publications, BLM and logging amongst others. In order to alleviate the situation the Controls broker has been moved to a new 16 core machine, and the Public broker stayed in the old machine. Other long term options are under analysis.

The contribution covered as well the policy for RBAC STRICT mode for the start up in 2010 and the new policy for controls release of software.

RF PERFORMANCE AND OPERATIONAL ISSUES

During the 2009 LHC run, a number of difficulties were encountered in the operation of the RF system and transverse damper.

In 2008/9, for operational simplicity, it was decided to use a fixed cavity quality factor of Q_{ext} = 60000 at injection and top energy. At injection, with 1 MV per cavity, this requires only 45 kW of RF power. In a klystron, the residual DC power not consumed as RF output power is dissipated in the collector and with the low RF power required in this operational configuration, the collector power was close to the rated maximum. Traces of overheating were indeed observed when several klystrons were checked in January 2010. In order to reduce the collector power, it was decided in 2009 to run with fewer cavities, with higher voltage per cavity. Eventually a configuration was found which was more or less reliable using 5 cavities at 1.6 MV per cavity. Another measure to reduce collector heating was to modify the front-end software to automatically switch the power system to the READY state when the RF was switched off.

The choices for 2010 were presented and the most preferable one is using the movable coupler to change the Q_{ext} after injection which is the only long-term solution for higher intensities, and is the choice strongly preferred by the RF group. The drawback is that more commissioning time is needed. Some serious operational problems were encountered with front-end software for the power system, and these have now been solved.

Various causes for synchronisation problems have been understood and resolved.

In order to be ready for unsafe beam, a number of interlocks will be added for the total RF voltage, RF frequency and the revolution frequency synchronisation.

A number of developments are still outstanding in the Low Level RF, including the 1-turn feedback, longitudinal feedback and longitudinal emittance blow-up.

Commissioning of the ADT system with beam has started, and will need dedicated time in 2010. The noise spectrum needs particular attention. Some hardware changes will be done before the 2010 start up, but performance for multi-bunch operation will need to be checked due to residual ripple from the cables.

Abort gap cleaning has been shown to be promising, but further optimization of the pulse shape will be required.