

First Engineering Review of the CMS ZDC Remote Handling System

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The aim of the meeting was to review the CMS proposal for a remote handling system for the ZDC and check that there are no fundamental issues that could prevent its installation in the LHC tunnel and its correct functioning. The ZDC mode of operation is envisaged as following:

- The main purpose of the ZDC is to take data during the Heavy Ion (HI) collisions. In addition, it will also take data during pp runs with $L < 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ (the data taking during the pp runs with $L \sim 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$ is actually under discussion within the CMS collaboration).
- The ZDC radiation hardness does not allow its exposure to pp runs with $L > 10^{33} \text{ cm}^{-2} \text{ s}^{-1}$. Therefore, during those runs, the ZDC will have to be removed and replaced with Cu bars (when the ZDC is removed Cu bars are needed to ensure the protection of the superconducting magnets from the particles produced at the IP).
- Finally, the ZDC needs to be removed prior each bakeout of the TAN absorber .

The description of the CMS Remote Handling System (RHS) can be found on the Review web page:

<http://indico.cern.ch/conferenceDisplay.py?confid=35552>

The CMS RHS is designed to minimize the cost of the system keeping the dose to personnel at a reasonable level. The cost of the CMS RHS is supposed to be lower than the CERN RHS which will be installed at IP1 even if this has not been demonstrated yet since no cost estimate for the CMS RHS was available at the time of the Review. The main difference between the two systems, which could justify a difference in price, is that the CERN system is a multi-purpose system able to handle different detectors independently of their length, weight, shape and location in the TAN slot. In addition, the CERN RHS has been studied in order to reduce as much as possible dose to personnel to minimize the cool-down time during the machine operation (for example when switching from pp run to HI run). The CMS RHS is designed ad hoc to remove only the 2 CMS ZDC, i.e. HAD and EM, and replace them with Cu bars (actually it is proposed to modify the actual Cu bars to have something similar in shape to HAD and EM). Nevertheless, the system could be easily modified to remove and re-install the BRAN if requested.

During the Review no big issues were identified which could prevent the RHS from being installed in the tunnel and from correctly functioning. Nevertheless, a proper engineering design review (EDR) needs to be organized as soon as possible to be ready for installation in the winter shutdown 2008-2009. The following points needs to be addressed before the EDR:

1. A 3D model with the real dimensions of all pieces like motors, jacks supports etc. needs to be available.
2. The 3D model needs to be integrated with the real environment. CMS has been working with tunnel integration drawings that are not official (the official ones need to be updated) and they are the results of independent surveys made by Caterina Bertone (TS/HE), Pierre Minginette (TS/MME) and Paul Debbins himself. Therefore, the official drawings need to be updated and provided to CMS (action for TS/LEA). CMS has offered help from its design office if needed.
3. Check the interferences with the services already installed in the tunnel. In particular, a possible interference with survey measurements has been identified and, if confirmed, it needs to be solved in agreement with TS/SU.
4. It is clear that a failure of the RHS should never cause a considerable downtime of the machine. Therefore, failure cases should be studied, in particular those where lifting and movement of the detectors and copper bars is blocked when the latter are fully outside of the TAN and of the transport container. This should include an estimate of received doses during any manual intervention. In fact, such incidents could lead to significant LHC downtimes if the manual intervention would give rise to excessive doses and cannot be allowed.
5. Radiation doses to personnel should be calculated also for the normal operation of the RHS to get an estimate of the machine downtime when switching from pp to HI runs.
6. The design of the transport container (sarcophagus) should be optimized taking into account the details of handling and storage. If the container remains inside the accelerator tunnel the use of lead should be avoided if possible.
7. SC-GS will need to be involved in the process from design phase onwards – risk analysis, safety file, mechanical and electrical drawings, calculations, testing etc.
8. Compatibility with bakeout jackets looks to be an issue since the RHS is being designed to stay in place. The envelopes need to be agreed with AT/VAC. Heat loads during bakeout should also be considered, particularly on the motors.
9. Radiation effects on lubrication for linear bearings and drives should be looked at.
10. Mock-up testing of the equipment looks vital before installation in tunnel.

Suggestions and remarks:

- Pay attention to the superposition of rigid guides which could block the system.
- The system has three powered drives but relies on mechanical rigidity to ensure that the position of the detector is sufficiently repeatable for it to enter the slot in the TAN; given the very small gaps around the detector when it is installed and lack of lead-in there is a risk that any misalignment will stop the detector entering the TAN slot. Can some form of tolerance build-up analysis be carried out to check this?

- Is there any chance that detectors will be swapped or replaced with new ones? This would necessitate setting –up all the positioning, in particular of the interface between the detector and the handling equipment, as well as repeated testing.
- Is it there the possibility to design the system in a more flexible way in order to be able to accept, for example, misalignment installation, detector upgrades or elements wear?
- The installation of the RHS requires drilling holes in the TAN absorber and in the tunnel floor. It is clearly recommended to do it before the LHC startup. However, taking into account that:
 - The design is not yet detailed enough to decide where to locate the holes.
 - The numbers of points reported above are not yet addressed.
 - The machine closure is foreseen at the end of July 2008.

the Review considered this option to be not realistic and, therefore, it has been decided that holes will be drilled during the winter shutdown 2008-2009 paying special attention to dust.

Finally, the Review asked Pierre Bonnal to check in the AB Department whether the BRAN handling needs to be included in the CMS RH. In fact, it looks easy to incorporate this at this stage but it will be difficult to do it later.

The EDR will be held in September 2008 in order to be able to install the system in February 2009.

Reported by Daniela Macina