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CMS Tracker Services: present status and potential for upgrade

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A report is given on the completed programme of installation, connection and testing of the CMS Tracker services, culminating in the full checkout of the Tracker as an integrated system. Finally, in the context of future upgrades to the CMS Tracker, we report also on the potential capacity and constraints of re-using the current services.

Summary

The CMS Tracker services, multitudes of pipes, cables, and fibres for cooling, power, control, readout as well as the thermal screen and alignment system have been installed and tested recently and are ready for operation. During the period from March to November 2007, Prior to Tracker detector installation, all the services were laid from several off-detector locations up to the 32 PP1 patch panels, which are located just inside both ends of the CMS solenoid magnet at 16 different angular positions around the inside of the coil. Approximately 1000 pipes, 2300 electrical cables and 500 fibre optic cables, all 25m to 60 m in length, were installed and tested. All of the services installation and testing work was done in a tightly managed, overlapping sequence that distributed the various activities over the whole of the CMS central barrel wheel YB0, managing to work in parallel with other CMS activities, including installation of ECAL and heavy lowering of the barrel wheels and endcaps of CMS. The pipes, cables and fibres were all inspected to check the correct routing and continuity tests were made to check for breaks. In addition, a sector of the Tracker cooling pipes were tested by passing coolant at -30C to check also the insulation of the pipes. Upon completion of the Tracker services to PP1 the Tracker was installed in December 2007.

Only one serious problem occurred during the installation of the services. A heat exchanger failure caused the loss (of half) of the Tracker cooling system and potential contamination with brine of the pipes to PP1. This problem has been solved but only after a long campaign of decontamination, repair and re-commissioning work, which has involved a change in the cooling fluid from brine to C6F14 in both Tracker cooling plants.

In the meantime connections and testing work continued. During the first 3 months of 2008 the Tracker connections were all made and tested in an intense period of activity. The pipes, fibres and cables were laid between the Tracker and PP1, followed by the respective connections at PP1 (and the Tracker bulkhead in some cases). The completed piping was pressure-tested to check for leaks; the optical fibres were tested again with an OTDR, now at the level of the full optical link. The measurements on the fibre system will be reported in a separate paper. The electrical connections were visually inspected with electrical testing integrated into the later system tests. These checks generated some minor repair work, after which the PP1 covers were put in place.

At this stage, the completed parts of the Tracker could be powered up and tested as an integrated system. At present 7% of the full Tracker system has been 'checked-out'. This first part of the check-out used a temporary cooling plant and the procedure will accelerate once the final cooling plant becomes available.

The results to date are that the tested fraction of the Tracker is fully functional, apart from one detector element in the Outer Barrel (TOB) which is connected to an irreparably broken optical fibre ribbon and a few other readout fibres which were already known to be broken inside the Tracker volume. As expected, a small number of fibre connections at PP1 or the backend have required re-cleaning. A basic test of the full control network of the Tracker was also possible since this required no cooling. After reordering of some swapped control cable connections, and re-cleaning of some fibre connections at the backend, the entire set of control 'rings'within the Tracker volume are now working.

Looking ahead to the distant future, it is foreseen that the CMS Tracker will be upgraded to a much more performant Tracker, most likely with many more detector channels. We must however consider the re-use of all the existing Tracker services laid between the backend and PP1. Apart from the optical fibres, which lie on top of all other services on YB0, all the Tracker pipes and electrical cables from PP1 to the back-end are situated under the cables of ECAL and HCAL which are expected to remain in place for the lifetime of CMS. There is little room remaining to lay new services for the Tracker to PP1 and the PP1 internal volume is almost fully utilised so we must try to re-use the existing cables and pipes. In addition, the fibre installation

was a large and difficult task in itself and it would also be ideal to recycle also this part of the system. As a result, we now have some tight constraints on services available for the upgraded Tracker. These constraints will be reported in detail with reference to the various ongoing activities investigating how to make best use of the existing services for the upgrade.

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