Successful testing of the first Special Short Straight Section to be installed in a dispersion suppressor.

On 15 September 2004, the testing of the first special Short Straight Section (SSS) began in the LHC Magnet Test Facility in SM18. This event marked the end of the assembly of the first quadrupole for the LHC insertions which started in January 2004, and the beginning of their series testing and preparation for installation.

The first special SSS (SSS602) is a cryo-magnet known as Q8, that will be installed in one of the dispersion suppressors located on either side of the eight long straight sections of the LHC. The Q8 cold mass is 6.6 m long, and contains an MQML matching quadrupole and an MCBC orbit corrector. The MQML itself is 5 m long, and the magnet installed in SSS602 is the first magnet of this type.

Cold Mass Assembly

The cold mass of the SSS602 was assembled in the LHC Magnet Assembly Facility in building 181. All quadrupoles for the LHC insertions, in total 82 units of 31 different types with lengths from 5.4 m to 11.3 m, will be assembled there under the responsibility of the AT/MEL group.

Since the start of the series production at the beginning of 2004, eight insertion quadrupole cold masses have been completed and a production rate of two quadrupoles per month has been achieved. The production rate is presently limited by the activities on cold mass closure and final geometry measurements (see Fig.1) which require considerable attention and are time consuming. It is expected that with greater experience the production rate will increase to three units per month by the end of 2004.

Figure 1: Preparations for welding of the insertion quadrupole end-domes and final geometry measurements in building 181.
Cryostating

The insertion quadrupole cold masses are inserted into their cryostats in the SSS Assembly Facility in building 904 and under the responsibility of AT/CRI. Although the facility is mainly devoted to cryostating of arc SSS, it also has dedicated benches for special magnets. After completion of the standard cryostat and its Technical Service Module (QQS), the insertion quadrupoles, like other cryo-magnets, go through rigorous electrical, pressure and leak checks, and are then prepared for final cold tests (Fig. 2).

The LHC SSS is a complex cryogenic system and its completion requires highest standards of quality control at all levels, starting from components and sub-assemblies. Since December 2003, the assembly rate of SSS has increased considerably, reaching 9 units in September 2004 with a target rate of 12 to 16 units per month.

Timely supply and quality of components remain the main problem for further improving the assembly rate. For example in the case of SSS602, the cryo-magnet was tested without the 120 A current leads for the MCBC corrector. This element will be installed at a later stage in building 904 when SSS602 comes back for disassembly of cold test equipment and preparation of the bus bars for machine interconnection and final survey.

Figure 2 : SSS601 cryo-magnet, identical to the tested SSS602, stands on its completion in building 904 for cold testing.
Cold Tests

SSS602 was electrically tested in the LHC magnet test facility in SM18 on the B1 test bench, (Fig. 3), one of the twelve test benches in SM18 under the responsibility of AT/MTM. Until recently this bench was used for MB and SSS testing but, in fulfillment of its design goals set in 2003, it was reconfigured for special SSS testing in three days and received SSS602. This was also the opportunity to test other equipment designed by TS/MME which allows cool-down and powering of cryomagnets with non-standard interconnects. When the anti-cryostats are completed by the end of 2004, magnetic field measurements will also be possible. This bench will continue to be used around the clock for testing special SSS, arc SSS and MB.

SSS602 was electrically tested in record time for a first of a kind unit. It spent eight and a half days on the test bench, during which it was cooled down twice from room temperature to 1.9 K. Most of this time was used for preparatory activities and various warm and cold checks designed to ensure the cryogenic and electrical integrity of the magnet.

The power tests at cryogenic temperature started with checks of the quench protection system at various current levels and continued with quench training of the MQML magnet. The magnet reached 5019 A on the first powering, slightly below its nominal operating current of 5390 A. But in the next cycle it reached 5477 A, and then went to the ultimate current of 5820 A without further quenching. This training level was confirmed after an induced quench at 5390 A. Following a thermal cycle, the magnet was again powered with only one training quench at 5812 A, after which the ultimate 5820 A was confirmed.
The cold test of SSS602 was a clear success and validated all the numerous fabrication steps of the LHC insertion quadrupoles, starting from MQML magnet production, cold mass assembly and cryostating, up to and including the set-up of special testing equipment.

The end of the journey…

Following its successful electrical testing, SSS602 will come back to building 904 for disassembly of cold test equipment and preparation of the bus bars for machine interconnection and final survey. It will then be transferred to SMI2 where it will be fitted with beam position monitors and beam screens. The cabling of the cryogenic instrumentation (pressure and temperature sensors) will then terminate the preparation work for the tunnel installation.

By the end of 2005, SSS602 will be on its way to final destination in the dispersion suppressor of sector 8-1 of LHC.