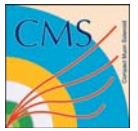




# LHC PARTICLE ACCELERATOR

## 3 LENOIR ELEC BAR CONTACTORS FOR THE CMS PROJECT



**Known for the reliability of its contactors, Lenoir Elec is a privileged partner of customers having high requirements. Once more its know-how is used on prestigious project: the supply of 3 bar contactors for the CMS experiment (Compact Muon Solenoid) undertaken by the CERN (European Council for Nuclear Research).**

### The CMS Experiment

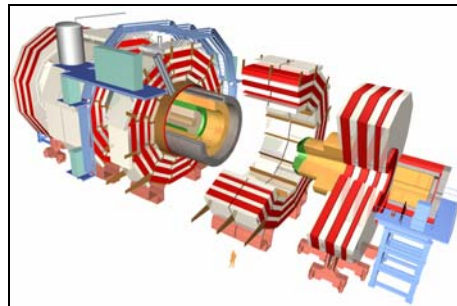
The particle accelerators made it possible to the man to progress in the knowledge of the Matter and the creation of the universe, since their use as in the middle of the XXe century The LEP (Large Electron/Positron Collider) brought into service in 1989 was the greatest model of its category ever built, in Geneva on the French-Swiss border. In the field of Physics of the particles, having higher energies is a key factor for new discoveries in order to probe the Matter more deeply than ever before. Since the beginning of the Nineties, the CERN is preparing the installation of a new generation accelerator: a Large Hadron Collider (LHC) which will be installed inside the LEP underground tunnel, 100 m under the ground. It will be the most powerful instrument ever built for the investigation of the properties of the particles.

Since the beginning of the Nineties, the CERN is preparing the installation of a new generation accelerator called Large Hadron Collider (LHC) that will be located inside the underground LEP tunnel. Such tunnel of 9 km diameter shall allow the study of the collision of two beams of protons at a record energy of 14 TeV (14000 MeV). Powerful superconductive magnets are laid out throughout the 27 km of circumference of the accelerator in order to lead the beams of protons to collision in the center of the CMS, 800 million times a second. The LHC will change the comprehension of the universe by making it possible to bring answers on the fundamental questions relating to the masses of the particles, their interactions, the forces existing in the universe, imbalance between matter and antimatter. The environment existing at the origin of the universe, a short moment after the Big-bang, will be reproduced there on a negligible scale.

Four detectors, amongst which CMS, will allow the study of the particles resulting from the collisions. The CMS detector is financed and built by a consortium of 147 institutes of high-energy physics in 35 countries, including the CERN.

Within the CMS detector, a magnet formed by a superconductive solenoid, whose own inductance is of 2 p.m., will provide a magnetic field of an intensity of 4 Tesla, that is to say 100 000 times the terrestrial magnetic field, in a volume of 6 meters in diameter for 12 meters length.

Stored magnetic energy is 2.7 GigaJoule, sufficient to dissolve 18 tons of solid gold. The ferromagnetic cylinder head represents an iron mass equivalent to the one used for the Eiffel Tower in Paris. The data will be recorded by the detection systems at a rate of 500Gbit/s, equivalent to the quantity of information currently exchanged by the operators of telecommunication in the world.



Pict. 1. View of internal structure of CMS detector



Pict. 2. CMS detector being assembled

### The big issue : commuting high energies.

Taking into account the high energies to be commuted and importance of such experiment, the CERN sought a partner

capable of providing him with reliable and robust contactors.

The "Commissariat à l'Energie Atomique of Saclay" (CEA), partner of the CMS experiment, had determined the whole of the contactors specifications.

The purpose was to have a sufficient resistive voltage to allow the discharge of energy of the coils before the opening of the circuits. Amongst the CERN requirements, it was also necessary that one of the poles could at least withstand 20 000 Amps - 600 Volts - during a few seconds.

The CERN, for having already seen in operation a Lenoir Elec contactor rated at 25000A contacted the company during the first worldwide-scaled audit. This audit has been followed by an international tender amongst companies located in the 20 Member States of the CERN.

### Lenoir Elec solution selected for its reliability, simplicity and robustness.

Although considerable, the price criterion was nevertheless not determining. Indeed, the contactors being safety equipment, other essential parameters intervened in the CERN final choice, particularly their breaking capacity, the parallel connections, the lifespan...

Thus, the capacity to make the parallel connection of the poles and their fixing on bars favored Lenoir Elec. The company was the only one to propose poles able to withstand 6200 Amps.

### Lenoir Elec's provisions:

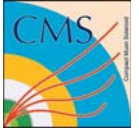
The company provided 3 contactors:

- Two main contactors rated at 25 000 Amps - 700 volts. Their role is to disconnect the magnet from the power circuit to leave it in service with the discharge resistor.
- Four discharge contactors rated at 10000 Amps.

Due to the high currents to commute, the size of the contactors is impressive and requested their assembly in cubicles of some 2,50m height for 3,5 m length and 1,5 m width.



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### A customized manufacture from standard elements

The manufacture achieved by Lenoir Elec has been carried out starting from standard components, already tested and available the standard range. This enabled the CERN to have very quickly in hand a precise and detailed offer with working drawings and documents. The reactivity and the reliability of the provided technical files allured the CERN as much as the seriousness of the company.

### Lenoir Elec adapts its project to the CERN needs

Because of the importance of the existing magnetic field created by the CMS magnet ( 200 times the Earth magnetic field) and for safety considerations, the CERN wished that, contrary to the regular practices, the control circuits be far away from the contactors. Lenoir Elec thus revised its preliminary draft and moved these to a specific dedicated cubicle located in a lower magnetic field zone.

### 12 bars of 24 kA integrated in the cubicles

In order to limit the assembly work on site and to simplify the connection to the power circuit, the CERN wished that the whole of the bus bars be integrated inside the cubicles before delivery. To limit the thermal dissipation, the required copper section is of 24000 mm<sup>2</sup> (0.024m<sup>2</sup>, 12 bars in parallel). The Lorraine company achieved the study, manufacture the copper busbars, supports and insulators.

Thanks to its skills and abilities on insulating materials, Lenoir Elec mounted current sensors of 4kA in order to measure the current sharing between the poles. Taking into account the concerned powers and lifespan of the installation (approximately 15 to 20 years) this will enable the CERN to have a follow-up in time of the behavior of the contactors. Once again Lenoir Elec demonstrated its ability to meet the high requirements of its customers, dealing with the issue as a

whole from the study, the drafting of the plans, the manufacture of the contactors, their installation until the final tests. Initially, the integration of the bars was done on simulation basis on the initial assembly diagram.

**The 3 contactors were delivered in July 2003 and tests were carried out in situ. Throughout this installation, the CERN particularly appreciated the quality of the partnership which was established with Lenoir Elec on both human and technical levels.**

*We wish to convey all our thanks to the CERN and most particularly to Mr Curé who made this article possible.*

### Further information :

- on CMS experiment : <http://www.cern.ch>

- on LENOIR ELEC contactors : <http://www.lenoir-elec.com>