The Interferometer's experiment
Final Report

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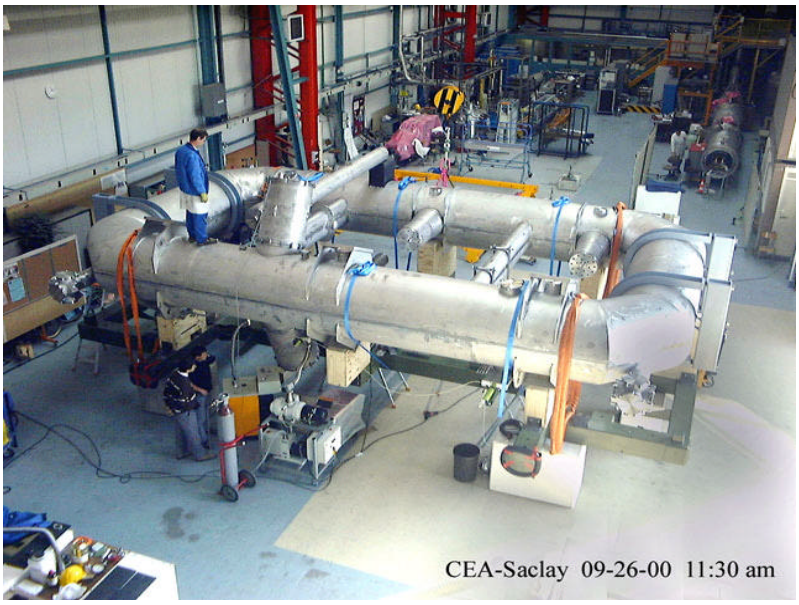
The Atlas experiment

Introduction

The goal of my laboratory stage was to perform a sampling test of the length of the drift tubes used in the Atlas muon chambers , as a Quality Control (QC) check of the tube production.

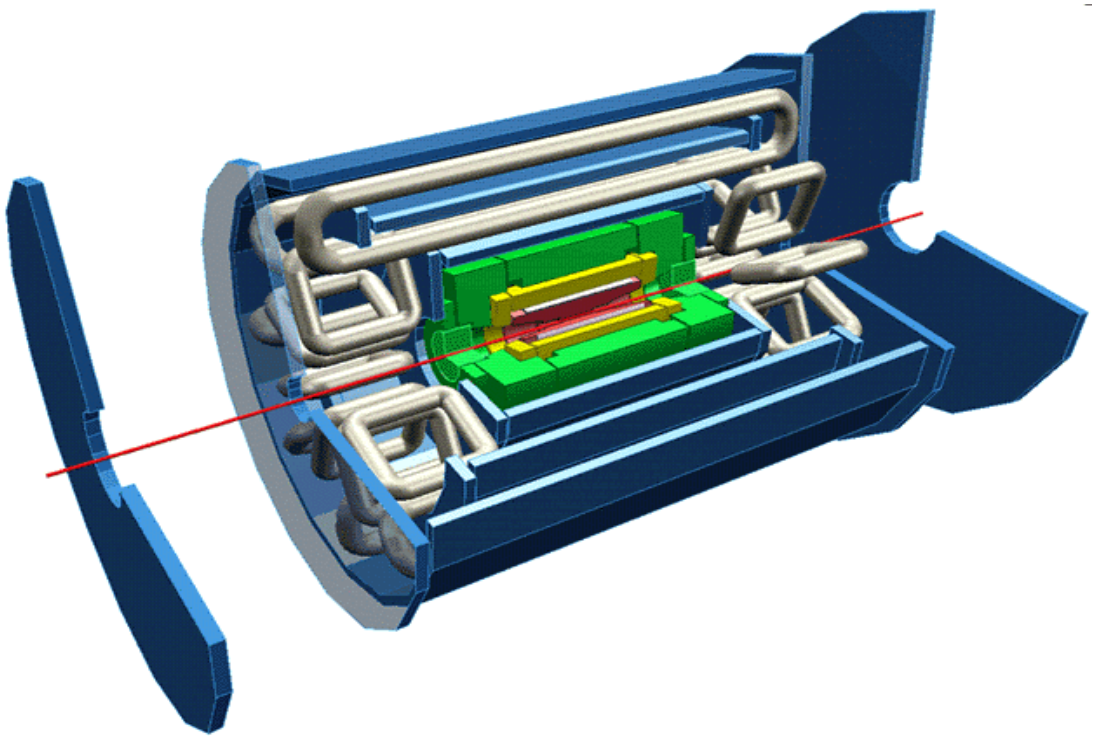
What's Atlas

The name ATLAS means 'A Toroidal Lhc ApparatuS'.
Scientists coming from about 150 Universities and Laboratories of 34 countries are participating in the Atlas experiment at the Large Hadron Collider (LHC) machine. The LHC is presently in construction at CERN , the European Physics Laboratory near Geneva, in Switzerland.
The aim of the scientists is to study the origin of the matter and the fundamental forces acting in the universe.
The first colliding beams in the Large Hadron Collider are foreseen for the spring 2007.



Atlas structure

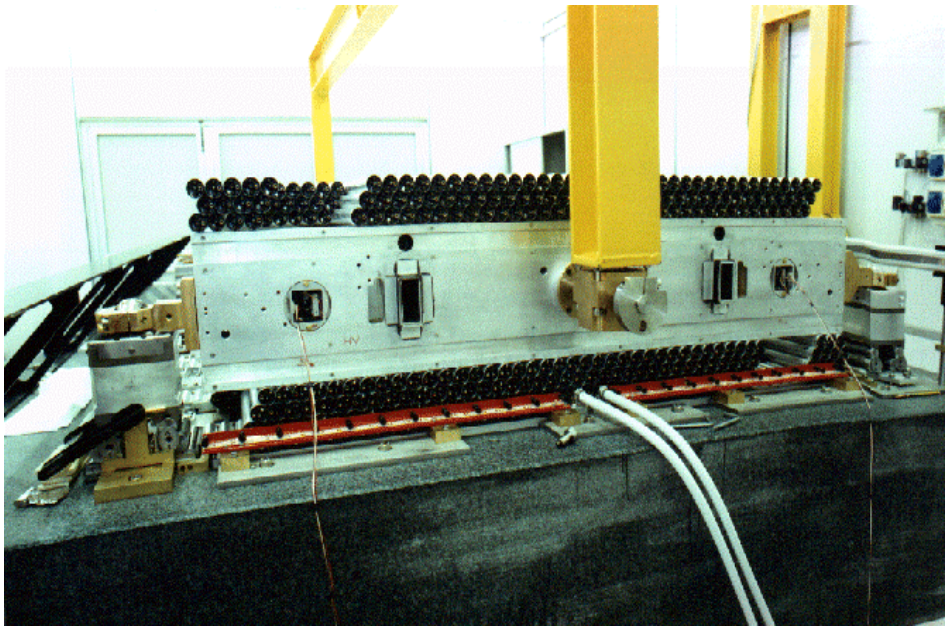
There are so many components in an apparatus like Atlas (think it's big like a five store building). But we could subdivide Atlas in few main important parts: the inner tracker with a solenoidal magnet, the electromagnetic and hadronic calorimeter and the muon spectrometer with a very big toroidal magnet. The muon spectrometer consists of more than 1000 chambers, that have the drift tubes as the basic component to identify and measure with very high precision the momentum of the muons. The inner tracker measures the momentum of all the charged particles and the calorimeter measures the energies carried by the particles. The magnet systems bend the charged particles as a function of their momentum, so that the measurement of the curvature of the track of a particle corresponds to a measurement of its momentum. But it's not finished because Atlas must digest so many data, that it needs a very powerful TRIGGER system for the selection of the interesting events, a DATA ACQUISITION system to store the data taken by the detectors . Finally, a very big COMPUTING system is needed ito perform the analysis of the events.



Chambers and tubes' role.

In the laboratory where I attended this stage people are working at a part of the muon spectrometer. They have to build 94 chambers of the Atlas Barrel Middle Large station. Every chamber is formed by a support structure, called "spacer" and two multilayers of Aluminum drift tubes glued on both sides of the spacer.

The drift tubes are the ‘muon sensors’ . They have a diameter of 3 cm and are filled with a gas mixture of Ar (93%) and CO2 (7%) at 3 bar absolute pressure, with wires running down their axes. With high voltage between the wire and the tube wall, the muons traversing a tube can be detected by the electrical pulses they produce. With a careful measurement of the timing of the electrical pulses, the muon positions in the tubes can be measured to an accuracy better than 0.1 mm .
An important step in the construction of a chamber is the equipment of the tubes with the gas system and the electronic boards needed to measure the electrical pulses.
To obtain the needed ‘gas tightness’ (the oxygen contamination entering a leaky tube induces a deterioration in the muon measurement accuracy) and to be able to properly mount the electronic boards on the tubes, the spread of the length of the tubes has to be less than ±0.1 mm.
To verify that the wired tubes satisfy the above specification, a sampling Quality Control check is performed.



About my experience

The laboratory

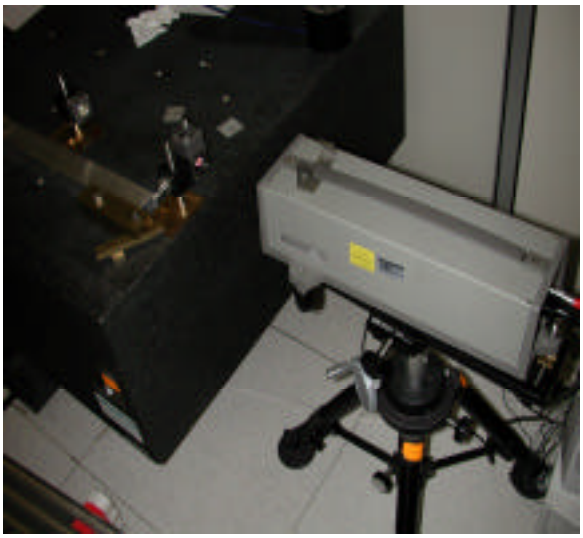
During the stage which I have attended at INFN I have seen the importance of the environmental conditions of the lab. The rooms where the detector is assembled must be clean because dust or other kinds of dirt can create problems for tubes and chambers. People dress appropriate overalls and have to handle the tubes with gloves. A very important factor is the temperature that is kept constant in each room of the lab in an interval of ±1.5 ^{o}C.

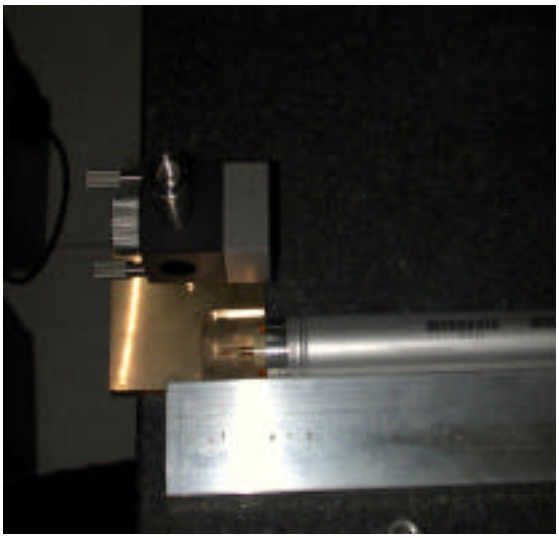
The laboratory experiment

An interferometer system was used for the QC of the tube length. The interferometer system is controlled through a PC. The code name of the interferometer is HP[1] 5529 and the code number of the software for the PC is HP 10747A . The interferometer system is well suited for very precise measurements, order of 0.001 mm . It consists of a laser head (code name HP5519A), one reflector in fixed position and one mobile interferometer group. After the laser warm-up, the measurement can be started, putting one tube on the granite table and moving the interferometer group from one end to the other of the tube. The measured length is displayed on the PC monitor. A correct set-up is one of the fundamental points to obtain good and reliable results. It's mandatory to set-up the laser without parallax errors and to maintain the laser beam continuity during the measurements.
The aim of my laboratory experiment was to measure a sample of 100 wired tubes, ready to be glued on the chamber, and a sample of 100 bare (unwired) tubes , to be assembled by the automatic wiring machine. The results of the measurements of the two samples are shown in the histograms in fig1 and fig2.
During the measurements of the two samples the temperature was constant at the level of about 0.15 degrees. This can be deduced from histograms of fig3 and fig4 in which the periodic measurements of the same tube every ten tubes for each of the two samples are shown. The maximum length spread , due to the temperature variations, of the measured values is 0.011 mm for both samples (the coefficient of linear dilatation for Al is 23 micron per meter per degree Celsius.

Conclusions

The results of the tube length test was positive: the spread of the tube lengths was well inside the given specifications of 0.1 mm.





[1] Which means "Hewlett Packard".