PANDORE: an environmental box for ITk integration tests.

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PANDORE is the environmental box that is going to be used for the quality control (QC) of loaded local supports of the ATLAS ITk Pixel Outer Barrel (OB) at LAPP. First PANDORE, its interlock system, diphasic CO2 cooling station, and data acquisition system are described. Subsequently, the results of the qualification tests are shown. Given the complexity of the OB system, several other loading sites are going to be needed. By documenting the state-of-the-art of PANDORE, this note aims to help the wide OB community in the discussion for standardizing the QC procedure and equipments of the loaded local supports.

Summary (500 words)

The Inner Tracker (ITk) is one of the key detectors of the High Luminosity (HL) upgrade of the ATLAS experiment at the Large Hadron Collider (LHC). The ITk Pixel at its core is made of three subsystems: the inner system, the outer barrel and the outer endcaps.

Such a complex apparatus requires a collaborative effort in all phases of its design, building, testing and operation. This document focuses on the integration steps in which the sensors are loaded on the mechanical support structures of the Outer Barrel (OB). Several assembly sites will be qualified to load and test 5000 modules, and to integrate them on about 300 OB local supports. As a part of the quality assurance, the loading and testing procedures must be standardized among the assembly sites. This document describes the current status of PANDORE, the environmental box shown in Figure 1 in the auxiliary material and that is going to be used for the quality control (QC) of the loaded local supports at LAPP (Annecy, France). Most importantly, the qualification tests performed to-date are also presented.

PANDORE, with its internal dimensions of 191/95/100 cm3, can comfortably be used to test the 77,8cm long longerons of the ITk outer barrel, through a 130cm long handling frame. A dew point below -60℃ is ensured with a flux of dry air (0ppm) that can be remotely controlled. PANDORE is light-tight and thermally isolated from the outside environment. To guarantee a safe operation, an interlock and a slow control system has been implemented with a Wago programmable logic controller (PLC) and Node-Red software . Air temperature, dew point, CO2 temperature and pressure, door switches, and emergency buttons are permanently monitored and displayed with a custom graphical interface.

PANDORE is complemented with an evaporative CO2 cooling system called MARTA, designed to reach a temperature of -40℃ with a cooling power of 300W at -30℃. MARTA is remotely controlled by the slow control application through the MODBUS protocol.

All monitored data are published and subscribed through OPC UA and stored in a local influxDB. The visualization of monitoring data and the control of the system is implemented in an harmonized GUI with the Grafana web application, see Figure 2.

A block diagram of the system showing all the main components and their interactions can be found in Figure 3.

The operating temperature of ITk sensors is expected to be -30℃ at the end of HL-LHC which impose very challenging requirements for the QC at the loading sites. The thermal properties of PANDORE herein presented are assessed through thermal cycles with a heat load from a remotely controllable heating cartridge that can dissipate up to 400W. The time needed to perform a thermal cycle and the lowest temperature achievable are very important ingredients for the design of the QC procedure.

By documenting the state-of-the-art of PANDORE, this note aims to help the wide OB community in the discussion for standardizing the QC procedure and equipments of the loaded local supports.

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