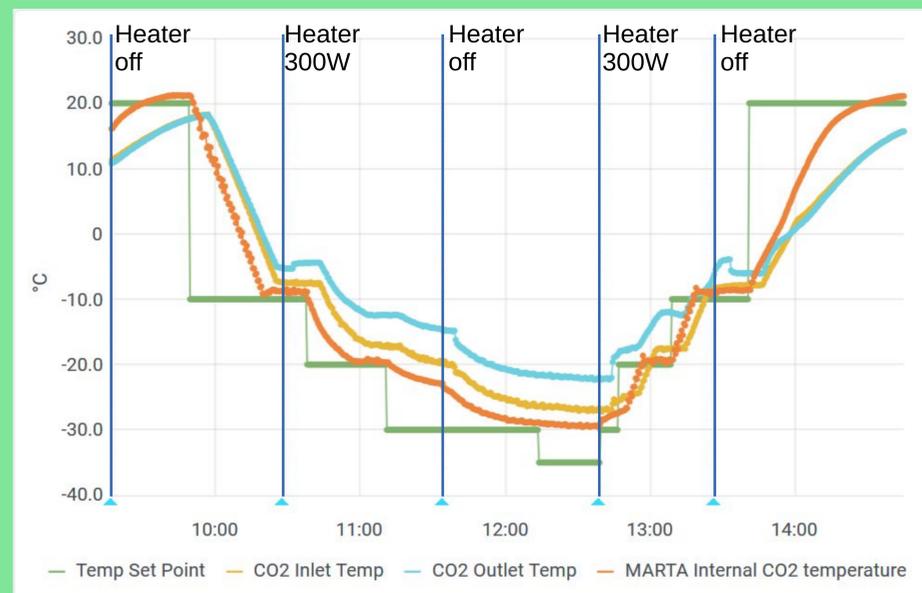


Abstract: PANDORE is the environmental box that is going to be used for the quality control (QC) of loaded local supports of the ATLAS ITk Pixel Outer Barrel (OB) at LAPP. First PANDORE, its interlock system, diphasic CO₂ cooling station, and data acquisition system are described. Subsequently, the results 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.

Introduction: The Inner Tracker (ITk) [1] is one of the key detectors of the High Luminosity (HL) upgrade of the ATLAS experiment at the Large Hadron Collider (LHC). This document focuses on the integration steps in which the sensors are loaded on the mechanical support structures of the Outer Barrel (OB) and describes the current status of PANDORE, the environmental box that is going to be used for the quality control (QC) of the loaded local supports at LAPP (Annecy, France).

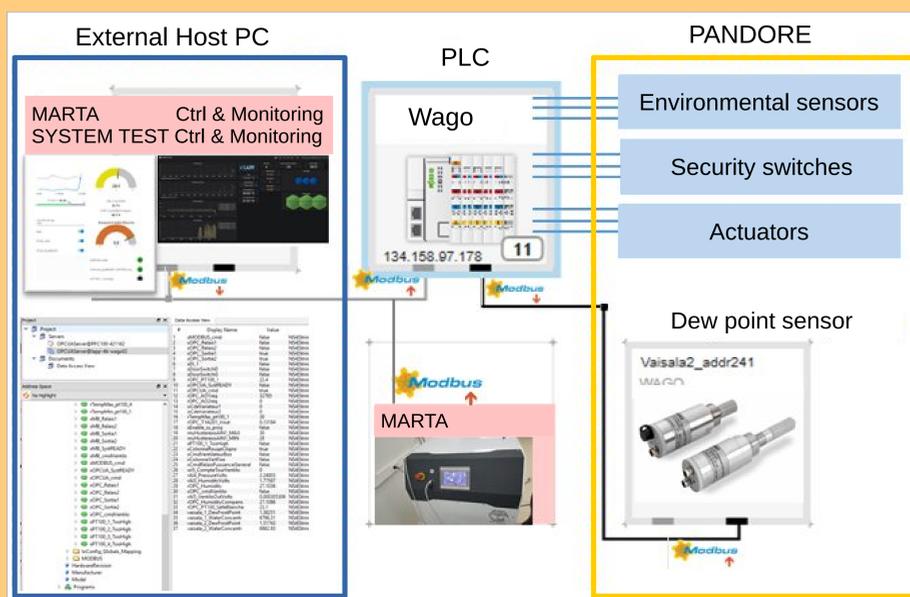
Hardware description: PANDORE, with its internal dimensions of 191x95x100 cm³, can comfortably be used to test the 77.8 cm long longerons of the ITk outer barrel, through a 130 cm long handling frame. A dew point below -60°C is ensured with a constant flux of dry air. PANDORE is light-tight and thermally isolated from the outside environment. A rail for source scan is also present. PANDORE is complemented with an evaporative CO₂ cooling system called MARTA [2], designed to reach a temperature of -40°C with a cooling power of 300W at -30°C.



Remote operation, interlock and data acquisition:

MARTA is remotely controlled by the slow control application through the MODBUS protocol.

To guarantee a safe operation, an interlock and a slow control system have been implemented with a Wago programmable logic controller (PLC) and Node-RED software [3]. Air temperature, dew point, CO₂ temperature and pressure, door switches, and emergency buttons are permanently monitored and displayed with a custom GUI.

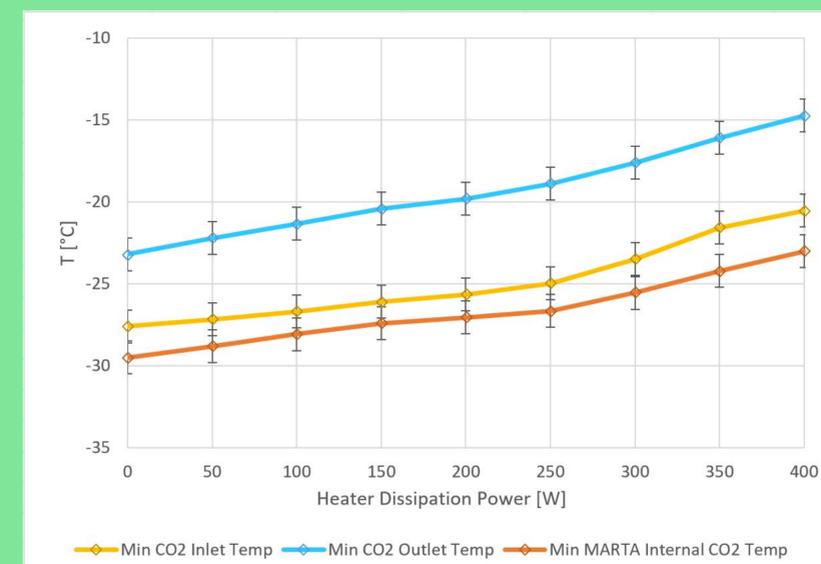


Monitored data are published and subscribed through OPC UA [4] and stored in a local influxDB [5]. The visualization of monitoring data and the control of the system is implemented in an harmonized GUI with the Grafana web application.

Performance: 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.

The lowest stationary temperature can be reached in less than two hours and its value as a function of the heat load was also measured.

In order to reach lower temperatures, the cooling of dry air before injection in PANDORE is foreseen.



Conclusions: LAPP is well equipped with an environmental box complemented with a CO₂ cooling plant whose first scope is the QC of ITk outer barrel loaded local supports. Several environmental parameters are stored and can be constantly monitored with a custom Grafana GUI. An interlock system ensures safe operation.

PANDORE thermal performance is presented. We identify the cooling of dry air as the main point to improve performance.

By documenting the state-of-the-art of PANDORE, this poster aims at helping the wide ITk OB community to standardize the QC procedure and equipments for the loaded local supports.

References:

- [1] ATLAS Inner Tracker: <https://cds.cern.ch/record/2285585/>
- [2] MARTA: <http://icp.mech.pk.edu.pl/martaco2/>
- [3] Node-RED: <https://nodered.org/>
- [4] OPC UA: <https://opcfoundation.org/about/opc-technologies/opc-ua/>
- [5] InfluxDB: <https://www.influxdata.com/>