Conditions database and calibration software framework for ATLAS monitored drift tube chambers

Manuela Cirilli[a],*, Oliver Kortner[b], Domizia Orestano[c], Fabrizio Petrucci[c], Joe Rothberg[d], Niels van Eldik[e], Zdenko van Kesteren[e], Monica Verducci[f], Martin Woudstra[g]

[a]University of Michigan, Ann Arbor, MI 48109, USA
[b]Max-Planck-Institut für Physik, München 80805, Germany
[c]Università di Roma Tre and INFN Roma III, Roma 00146, Italy
[d]University of Washington, Seattle, WA 98195, USA
[e]NIKHEF, Amsterdam 1098, The Netherlands
[f]CERN, Geneva 1211, Switzerland
[g]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

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Abstract

The size and complexity of LHC experiments raise unprecedented challenges not only in terms of detector design, construction and operation, but also in terms of software models and data persistency. One of the most challenging tasks is the calibration of the 375,000 Monitored Drift Tubes (MDTs) that will be used as precision tracking detectors in the Muon Spectrometer of the ATLAS experiment. This paper reviews the status of the MDT Calibration software and computing model. In particular, the options for a dedicated database are described.

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1. Introduction

High-pressure Monitored Drift Tube (MDT) [1] chambers will be used as precision tracking detectors in the Muon Spectrometer of the ATLAS experiment at the LHC at CERN. An accurate knowledge of the space–time relation is needed to reach the design average resolution of 80 μm.

The model for the calibration of the MDT chambers, described in [2], defines the optimal number of Muon tracks for a calibration, the procedures and the requirements to the Calibration Software. The model demands a substantial effort in data collection, software implementation and data management. The required statistics and calibration frequency cannot be met using the standard ATLAS data flow. An ad hoc mechanism allowing the extraction of a dedicated data stream for the Muon

calibration has been proposed [3] and is currently under test.

A dedicated software infrastructure [2,4], developed within the ATLAS offline framework (ATHENA), can host different algorithms devoted to the measurement of the time spectrum parameters, to the computation of the space–time relation, to the evaluation of the tube resolution. The output of these calibrations will have to be fed, after a validation process, to the conditions database accessed by the reconstruction. The Calibration Software is complemented by an ATHENA service providing the correct calibrations to the reconstruction.

This paper gives a brief introduction to the Calibration Software and focuses on the requirements and options for a dedicated database, hereafter called Calibration Database.

2. MDT Calibration Software

The major issue in designing the Calibration Software is to ensure the capability to fully exploit the tools provided

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*Corresponding author. Tel.: +41 22 767 1246.
E-mail address: Manuela.cirilli@cern.ch (M. Cirilli).

by the ATHENA framework in terms of data decoding, pattern recognition, tracking and database access. Computing algorithms must run within ATHENA, but they must have no dependence on it. The calibration procedure should be independent from any particular reconstruction implementation. Last, the software has to provide the possibility to easily switch between different calibration algorithms.

The Calibration Software has been developed along these guidelines; it handles both the extraction of the calibration constants from the data (Calibration Framework) and their proper application to calibrate the hits used by the reconstruction algorithms (Calibration Service).

3. MDT Calibration Database

The MDT Calibration produces all the information needed by the offline reconstruction to correctly compute Muon hits in the spectrometer. This information, as any other data describing the state of every ATLAS subdetector, must be stored in the Conditions Database (DB). The Conditions DB is being implemented using the COOL interface, developed in the LCG context.

COOL allows database applications to be written independently of the underlying database technology (Oracle or MySQL). The use of COOL ensures long-term compatibility with the Calibration Software, since it is supported within ATHENA. The objects stored or referenced in COOL have an associated start and end time between which they are valid. COOL data are stored in folders, which are themselves arranged in a hierarchical structure of folder sets. Within each folder, several objects of the same type are stored, each with his own interval of validity range. COOL is optimized to store and retrieve objects associated to a given time.

The usage of COOL within the MDT Calibration Framework has been tested and the code is being finalized. Calibration data have been stored as an inline large character object (CLOB), which has an internal structure invisible to the COOL database. COOL is then responsible only for storing and retrieving the CLOB, while its interpretation is up to the client.

MDT Calibration jobs will also produce a sizeable amount of information ($\sim$50 MB/day) that is essential to evaluate the quality of the calibrations but is not needed by the offline reconstruction. The quality and stability of the individual tube parameters, as well as of the space–time relation, must be continuously monitored. It is important to note that quality checks cannot be performed by the ATLAS online monitoring: not only a high statistics is needed to reach the desired accuracy, but only hits associated to good tracks will have to be used to avoid being overwhelmed by the noise. Validation is, therefore, a crucial part of the MDT Calibration procedure.

A "private" Oracle database (Calibration DB) will thus be implemented to store the complete calibration information. Validation procedures will make use of the additional parameters to ensure that the calibration constants have been correctly computed. Also, the newly produced constants will be compared to those from the previous data taking period to decide whether the Conditions DB must be updated. Only the information needed by the reconstruction will then be transferred to the Conditions Database.

This data management model has the major advantage that the Calibration DB is completely decoupled from the clients of the calibration and thus it can be modified without affecting the reconstruction. Since the validation procedures will run outside the ATHENA framework, there is no obligation to use COOL. The main reason for choosing a different database implementation is that COOL, being a high-level API, does not possess the complete relational features of an Oracle or MySQL database.

4. Conclusions

The MDT Calibration Software is fully integrated in the ATLAS offline framework. The imminent cosmic rays data taking with MDT chambers installed in the ATLAS cavern represent a good opportunity to fully exercise the software and conditions database chain. The parameters that must be stored in the Calibration DB have been defined, and validation procedures are being developed and tested on MDT test beam data. The choice of the underlying technology for the database, as well as its architecture, is currently under study: this represents a major effort of the ATLAS Muon Calibration and Database groups.

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