MCT: Reconstruction and Calibration of Cosmic Muons with Athena

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MCT is a software package for simulation and reconstruction of muons in the Cosmic Ray Test Facility in Garching [1]. Its primary goal is to develop calibration and alignment procedures for the ATLAS Monitored Drift Tube Chambers (MDT Chambers) which are fully integrated into the ATLAS offline software framework ATHENA.

The object oriented Athena architecture, implemented in C++, provides several generic sets of interacting components which precisely define experiment-wide policies on how event, geometry and calibration data are processed. It is optimized for sequential operation of a list of algorithms processing data "event by event", a scheme common to most particle physics software applications.

In the following, the key features of the Athena event processing framework are briefly summarized: The event data is organized in a transient in-memory database, the "transient event store"(TES). Athena manages sequences of algorithms. Each algorithm can retrieve and record arbitrary data structures from the TES using the same generic interface. The Athena executable is rather lightweight: all algorithms, data structures, converters and other components are extracted from shared libraries at runtime, the configuration is set via a simple job-options text file. The geometry of the setup is described utilizing the standard Atlas package, the "GeoModel", and can be accessed by the reconstruction algorithms through a dedicated interface. The identifier is the key to associate event and detector data, i.e. the TDC count of a MDT tube to its physical position.

In MCT each individual step of the reconstruction is implemented as an Athena algorithm. After reading the raw data using converters into TES, the reconstruction starts by applying event dependent corrections to the measured drift times, such as signal propagation effects. Next the tube specific drift time offset corrections, t_0, are applied and the drift-time to radius conversion is performed. The resulting "space–points" are the basis for the pattern finding and the subsequent track fitting. At this stage the geometrical information of the position of the drift tubes is obtained from GeoModel (the detector description package). Finally, the reconstructed tracks are stored as Root–Ntuples for further analysis or as XML files for the Atlas event-display program. The communication from one step to the next proceeds exclusively through the TES (see Fig. 1).

A crucial issue for Atlas reconstruction is a proper and efficient treatment of calibration and alignment corrections. Typically, these corrections are valid only for a certain interval (few hours) during data-taking. It is a non-trivial software design problem to ensure an quasi-automatic update of e.g. chamber positions during the analysis of a data taking period, such that the access for algorithms requesting the corresponding geometry information is transparent; the algorithms are not aware when and how such corrections take place. In Athena the "IOVSvc" (interval of validity service) was implemented to provide this service, using a helper database which keeps track of the association between time intervals and the respective data. The algorithms in Athena communicate with a so-called *proxy-adaptor* which automatically provides the corrections corresponding to the time interval of the data currently analyzed.

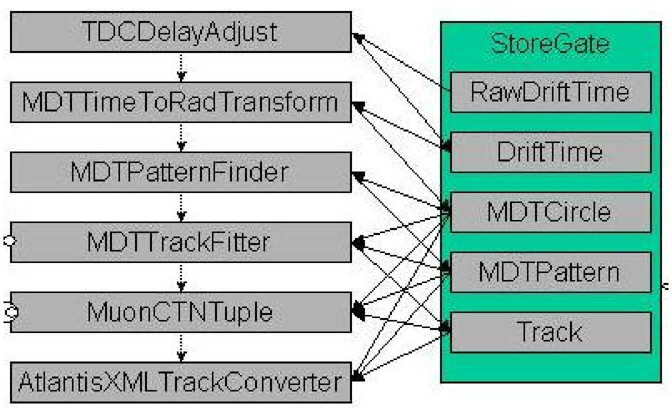

Fig. 1: Schema of the MCT reconstruction chain and the communication with the transient event store (TES), called StoreGate.

MCT is among the first applications using this successfully in practice [3]: In a first iteration of MCT drift-time corrections, such as the t_0 for each tube, are determined. The results are stored in calibration files which are then handled by the IOVSvc in the next MCT iteration, which determines the alignment of the three chamber w.r.t. each other. Similarly, these alignment corrections are stored and automatically applied via IOVSvc in the third iteration of MCT, which results in the precision measurement of the individual wire position of an MDT chamber.

The wire displacements found by MCT are in good agreement both with those from the existing reconstruction program MTOffline [2] and with the direct position measurements using an X-ray tomograph [1].

References

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