MuonCosmicTeststand: Simulation and Reconstruction of Cosmic Muons with Athena

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The Cosmic Ray Test Facility in Garching allows to sandwich an ATLAS Monitored Drift Tube Chamber (MDT Chamber) of type BOS between two reference chambers and collect data originating from cosmic muons. The goal of the project is twofold: commisioning and calibration of ATLAS muon chambers and the development of calibration and track reconstruction procedures which allow an easy implementation into the ATLAS software framework.

Two standalone software packages, "mtgeant-4" and "mt-offline", have been developed to simulate and reconstruct data taken at the test stand [1]. The "MuonCosmicTeststand" (MCT) software project aims to implement the same functionality in Athena, the common Atlas software framework, making use of the existing algorithms and concepts when possible.

The object oriented Athena architecture 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: Athena manages sequences of algorithms. Each algorithm is executed once per event and is thereby given the chance to process data. The event data is organized in a transient in-memory database, the "transient event store" [2] (TES). Each algorithm can retrieve and record arbitrary data structures from the TES using the same generic interface. Thus, maximal decoupling of data and algorithms is achieved.

The "transient detector store" (TDS) is based on the same technology, but implements a different lifetime policy. It holds detector descripiton and alignment data which may be valid for a large number of events.

The transient data structures are decoupled from the way they are stored on disk to be independent of future changes to the mass storage technologies. Athena therefore populates its transient stores by so called converters, which know how to translate transient structures to specific persistent representations and vice versa.

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.

MCT is entirely based on the Athena architecture. The geometry of the setup is modeled utilizing the standard Atlas kernel classes, the "GeoModel" and is stored in the TDS. The Geant4 simulation framework used within Athena provides its own set of geometry classes. MCT implements algorithms which perform a translation from "GeoModel" to its Geant4 representation.

A crucial part of the geometry description is to label each active part of the geometry setup by a unique identifier. The identifier is the key to associate event and detector data, i.e. the TDC count of a MDT tube to its physical position. The "event data model" of MCT consists of a set of data structures describing the raw data content produced by the facility's electronics, the simulation and reconstructed entities.

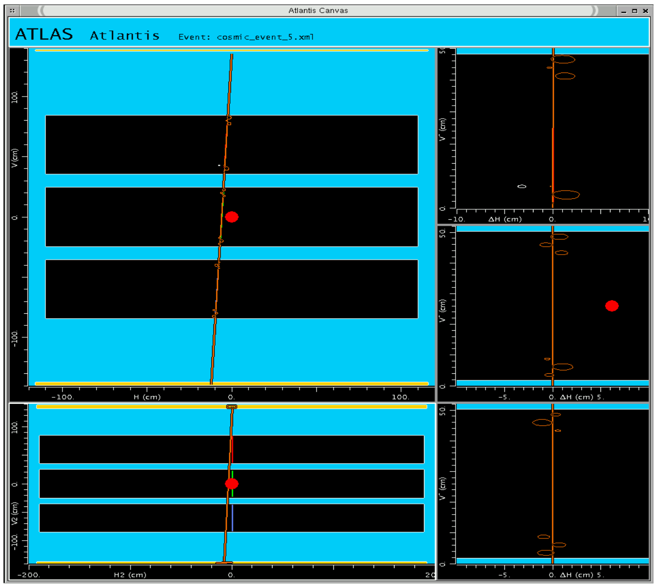

Fig. 1: Atlantis event display. The left part represents the two horizontal cuts of the three chamber setup, while the right zooms into the region of interest for every chamber.

At the heart of MCT is the implementation of a flexible chain of algorithms in order to: (1) read raw event data, (2) apply calibration, (3) apply pattern recognition and (4) fit tracks. Algorithms can be easily exchanged and configured through the job-options text-file without recompilation. It is possible to run multiple instances of the same algorithm with different parameters in the same job. The reconstructed tracks can be visualized with the Atlantis event display (see Fig. 1).

In the future, we intend to further explore the power of the Athena framework to continue the optimization of calibration and alignment procedures. E.g. the reconstruction of raw cosmic events with MCT in Athena will be refined by the use of a database which contains the calibration data. The validity of a set of calibration data is managed by means of the "intervals of validity", using a helper database which keeps track of the association between time intervals and the respective data.

References

[1] *Schauerproduktion durch hochenergetische Myonen und Aufbau eines Höhenstrahlungsprüfstandes für hochauflösende ATLAS-Myonkammern*, O. Kortner, Ph.D. thesis, LMU München, 2002

[2] P. Calafiura, H. Ma, M. Marino, S.Rajagopalan and D. R. Quarrie, *StoreGate: a Data Model for the ATLAS Software Architecture*, CHEP01, (2001).