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Condition Data for the CMS Silicon Strip Tracker reconstruction

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Abstract

The silicon strip tracker of the CMS experiment at LHC is the largest silicon tracker ever built for high energy physics experiments. With nearly 9.6 millions of analog read-out channels it poses significant challenges for the reconstruction, calibration and monitoring of the collected data. Beside the event-by-event data, recorded from the detector, the reconstruction is based on a set of non-event data that allow to handle the status of the devices in order to interpret the event data. These non-event data are referred to as condition data. The condition data are held in several databases designed to configure the read-out devices, the online high-level trigger system as well as the offline reconstruction and analysis applications. In this contribution we will describe the condition data used for the silicon strip tracker data reconstruction, their optimizations connected to the timing and CPU constraints, the procedure to manipulate and transfer them from a database to another, assuring the consistency and synchronicity of the available information.

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Condition Data for the CMS Silicon Strip Tracker Reconstruction

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on behalf of the CMS Collaboration

Abstract—The silicon strip tracker of the CMS experiment at LHC is the largest silicon tracker ever built for high energy physics experiments. With nearly 9.6 millions of analog read-out channels it poses significant challenges for the reconstruction, calibration and monitoring of the collected data. Beside the event-by-event data, recorded from the detector, the reconstruction is based on a set of non-event data that allow to handle the status of the devices in order to interpret the event data. These non-event data are referred to as condition data. The condition data are held in several databases designed to configure the read-out devices, the online high-level trigger system as well as the offline reconstruction and analysis applications. In this contribution we will describe the condition data used for the silicon strip tracker data reconstruction, their optimizations connected to the timing and CPU constraints, the procedure to manipulate and transfer them from a database to another, assuring the consistency and synchronicity of the available information.

Index Terms—High Energy Physics, LHC, CMS, Silicon Strip Tracker, Condition Data, Databasa.

I. INTRODUCTION

The CMS [1] at the LHC (CERN) is a general purpose detector to investigate a wide range of high energy physics. The research program of CMS requires a robust, efficient and precise reconstruction of charged particles trajectories as well as of primary and secondary vertices. In order to fulfill these constraints the Silicon Strip Tracker (SST) [2] of CMS has been realized with high granularity, read-out speed and radiation hardness. With 15.148 detector modules and nearly 9.6 million analog channels, the SST poses significant challenges for the reconstruction, calibration and monitoring of the collected data.

II. CONDITION DATA

Condition Data are all the non-event data needed to setup the detector and to reconstruct the collected data. The two main types are:

- configuration data: used in the setup and operation of the detector (e.g. delays for proper detector timing)
- calibration data: used by the reconstruction (both trigger and offline)

The reconstruction chain for the SST is shown in figure 1.

The SST local reconstruction requires a variety of condition data in order to interpret and reconstruct the events recorded from the detector. These condition data include the cabling map, used to group data according to detector modules, as well as the following calibration constants:

Fig. 1: Silicon Strip Tracker reconstruction chain. Condition data enter at all stages of the chain.

Fig. 2: IOV sequences for two variables. Each has its own IOV and when it ends the new values are loaded only for that variables. In addition all the variables that depend on that condition are updated.

- the pedestal and noise level of each individual electronic channel
- the status of all electronic channels
- the signal gain correction
- the Lorentz angle values for each module
- the latency and mode for each apv

Each set of condition data is associated to an interval of validity (IOV) defined as the range of consecutive events to which these conditions are applied.

Each condition data has an interval of validity (IOV), that is it is valid for a given set of runs. When the IOV of a set of data ends, the new values are automatically loaded. Each quantity has its own IOV sequence and they are handled independently. A tag contains a sequence of IOVs for a given quantity. Figure 2 shows pictorially the handling of IOVs.

Fig. 3: Color coded Tracker maps provide a synoptic view of the monitored quantity in the full Tracker and detailed views allow a deeper insight.

Fig. 4: Example of Tracker gain distribution for layer 1 of the Inner Barrel.

III. MONITORING OF CONDITION DATA

Condition data allow also to have a constant monitoring of the detector status. Quantities like noise, pedestals and channel status provide a tool to quickly spot problems. A set of conditions monitoring tools allow was developed and successfully operated during the two long cosmic data taking periods of 2008 and 2009 and examples of monitored quantities are shown in figures 3 and 4.

IV. CONDITION DATABASES

Conditions data are derived from:

- Commissioning runs gathered just before a physics run
- Promptly analyzed events (prompt calibration)

Commissioning data are written in a specific Oracle configuration database designed to efficiently configure the read-out devices. Prompt calibration data are written in a different Oracle database based on the Pool-ORA [3] technology and decoupled from the previous one. Commissioning data needed by the reconstruction are transferred to the conditions database by specific applications. Besides the transfer they are also subject to a format manipulation to provide the best suitable

Fig. 5: The databases used by the SST and the data flow among them. Data transfers from the configuration to the conditions database are performed by a specific application that converts them to an object oriented format.

structure for the reconstruction. A schematic view of the databases used by the SST and the data flow among them is shown in figure 5

V. OPTIMIZATION STRATEGIES

The processing speed and the memory footprints are critical aspects of the reconstruction applications. The highly granular information available in the SST condition data can significantly contribute to the run-time performance of the process. In order to speed up the data loading from the databases and to reduce the memory allocation, calibration constants are structured in packed format and transferred as Binary Large Objects (BLOB). For instance, this strategy reduces the size of the strip noise data from the 40 MB that would have been necessary with an uncompressed format to 11 MB, preserving the same measurement precision. Additional strategies are adopted to further reduce the memory size and access speed, some examples are shown in figures 6a and 6b.

VI. CONCLUSION

Condition data for the Silicon Strip Tracker of CMS are used in all steps of event reconstruction and all the databases to store them and all the workflows to write and convert them among the different databases are ready and tested. Several strategies have been developed to minimize the space occupied and to speed up as much as possible the read back of condition data, something very important since they are also used in the high level trigger of the CMS experiment. The Silicon Strip Tracker is ready and waiting for the first collision events from the LHC.

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Fig. 6: For the channel status (a): typically there are sequences of bad strips: use a range instead of storing each bad strip. For the voltage status (b): module Id, LV and HV status are stored in a single integer number. Only modules with a V off are stored.