Application of the CBM Silicon Tracking System CAD model for integration studies

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Motivation

The high density of equipment inside the gap of the CBM dipole magnet requires special attention to the integration effort and, more generally speaking, to the system engineering of the set-up. In this report we discuss the current status of the system integration effort, the tasks to be solved and the methods in use.

CAD (Computer Aided Design) software is one of the major tools in complex system development. It is used to create a virtual model of the product in development. For the CBM STS detector system a virtual model of the whole system is created with CATIA, a software package for product development that covers the whole process from first sketches to final drawings for the manufacturing of components.

Status and tasks of the system integration

The STS detector system is designed in functional parts, such as main detector parts, mounting structures, enclosures and supply lines. The virtual model in the CAD software is set up in the same way. Since parts and assemblies are stored in separate files, collaborative work on different parts of the detector at the same time is possible.

One important integration task is to reserve space for various functional nodes. Currently we develop to arrange in space of the following items: Sensors, sectors, modules, ladders, data cables, C-shaped supporting frame for ladders, fixation for the ladders and for the cables, front-end-boards (FEB), FEB fixation and cooling boxes, cooling plates common for a unit (i.e. two neighbouring half stations belonging to the two consequent stations), CO_2 cooling connections, power supply lines for FEBs, data transport lines from FEBs to data aggregation boards, voltage conditioners for the FEBs, optical links and cooling boxes for voltage conditioners, data aggregation boards and optical links. An overall view of the STS and a detailed view of one quarter of the 8th station are shown in Figs. 1 and 2, respectively. Generally, the design of the STS follows an onion logic from the innermost parts to the outer ones.

Space analysis allows to see the critical elements in the system. E.g. it has been demonstrated that the availability of single-channel radiation hard SFP optical links only causes a limitation on the total number of channels in the system. Any development towards higher granularity would require new radiation hard multichannel optical links.

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Another task for the system integration is to study and to balance contradictory requirements of various origin. E.g. front-end electronics developers tend to insist on the shortest possible cables in any particular case, however the reasoning of the C-Shaped frame rigidity and cooling plate beauty forces us to use sometimes the cables a bit longer than absolute minimum. A further issue under investigation is the checking for all the possible dependencies, e.g. the thickness of cooling plates has influence on the space available for bending of cables, and the pad pattern on different sensors, staggering of the sensors in a ladder and spacing between the FEBs in the working position are connected to the reduction of the number of different types of cables.

Methods in use

For the integration studies a deeply parametrized model has been created using the CATIA VBA code called “STS creator”. The tool arranges correctly in space all the components based on parametrized templates. The composition of the ladders can be modified later and all the parts like CF ladder support frames, C-shape unit frames and cooling plated will be adjusted automatically. The entire model can be checked for interferences, margins and free space. Using such a tool allows saving a lot of manpower and time since, for the CBM STS, the active detector part consists of several hundreds of parts.

For making design information available for further analysis each functional node has an *HTML* description accessible from CATIA. Cross links to descriptions of mother and daughter products are generated automatically. A data base for design solutions, options, versions, open questions and mutual dependencies is under development. Data retrieval from this base can be made available from the above mentioned *HTML* documentation.

Next steps

We plan to establish a CAD data exchange platform for efficient collaborative work on the project. Dedicated programs like Git and Subversion are available for software developers. Although CATIA files are binary such a tool could satisfy our needs for sharing data and revision control. Special programs for CAD data handling are under investigation, too. The design solution database mentioned above should be transferred from prototype to development status. The outer layers of the system, like connecting unit to the outside world, thermal enclosure and the mechanical super structure should be developed rather soon.

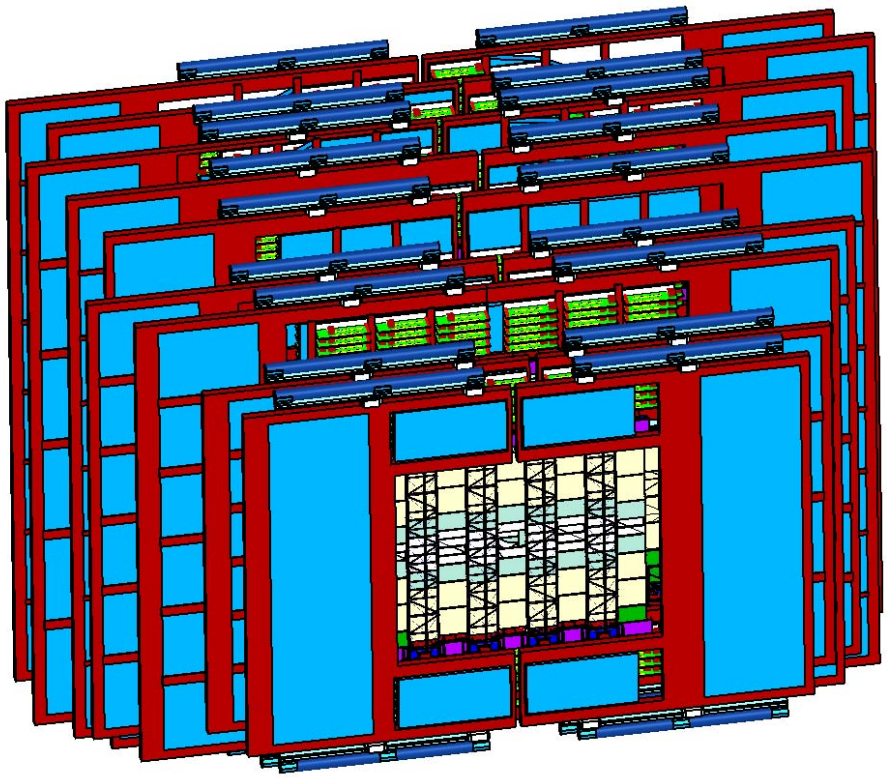

Figure 1: Overall view of all 8 STS stations.

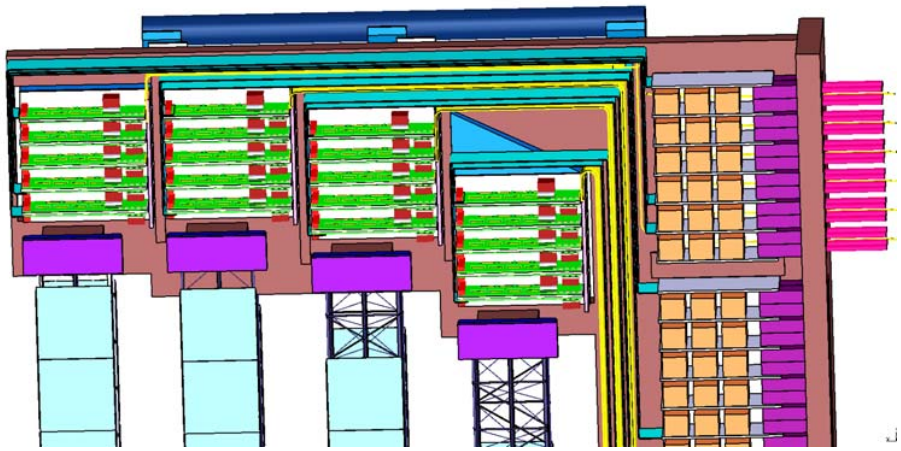

Figure 2: One quarter of station 8 including readout and data transfer electronics, power supply and cooling equipment.

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