1 DD4hep

DD4hep [1] is a generic toolkit to describe a high energy physics detector in all stages of an experiment: starting from the development of the detector concepts, detector optimizations, construction and later operation of the detector. Such a detector description is an essential component that is used to analyze data resulting from particle collisions in high energy physics experiments. As illustrated in Figure 1 all these data processing activities use a fully qualified in memory detector description. This description first is filled by various plug-ins called detector constructors, and then provides appropriate and consistent detector views to simulation, reconstruction and analysis applications from a single information source is crucial for the success of the experiments. Within this context it is worth noting that DD4hep offers an interface to import geometries from computer aided design tools (CAD) and supports multiple input formats.

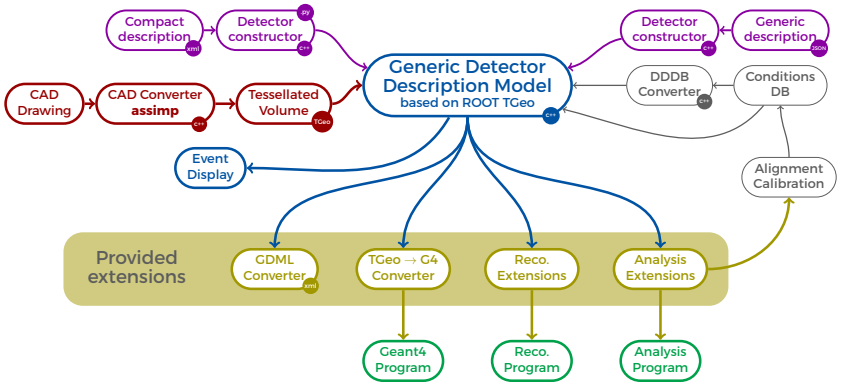

Figure 1: The components of the DD4hep detector geometry toolkit.

Though geometry is important part of DD4hep, the DD4hep core offers to clients a hierarchical tree of detector elements each representing either a subdetector or a substantial part thereof. The tree structure of Detector Elements is a parallel structure to the geometrical hierarchy. This structure is likely not be as deep as the geometrical one since there would not need to associate detector information at very fine-grain level - it is unlikely that every little metallic screw needs associated detector information such as alignment, conditions, etc. The tree of Detector Elements is fully degenerate and each detector element object will be placed only once in the detector element tree as illustrated for a hypothetical TPC detector in Figure 2. The detector elements also serve as a key to access auxiliary data which describe in detail the state of the experiment. These accompanying data include alignment parameters, parameters describing the electronics as well as calibration- and environmental constants [1].

The simulation of the detector response from particle collisions are of major importance both for the studies during the planning and construction phase as well as during the running of the detector. The simulation applications are expected to mimic the energy deposits of particles in the detector which then are digitized to emulate the response of the readout electronics. This simulated data is then fed, in the same way as data collected from the electronics in a real experiment, into the reconstruction and further on into the analysis

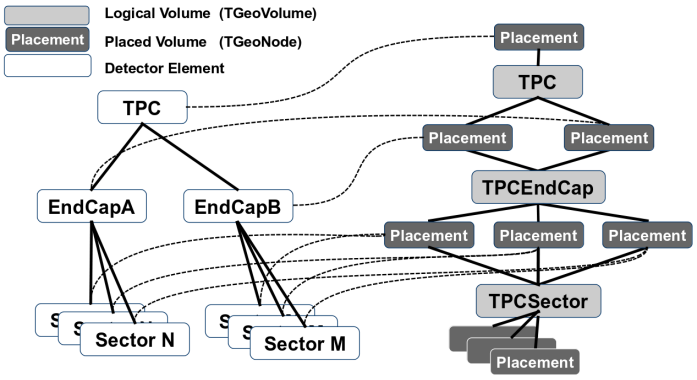

Figure 2: The object diagram of a hypothetical TPC detector showing in parallel the *Detector Element* and the *Geometry* hierarchy and the relationships between the objects.

applications. Starting from the in-memory detector description DD4hep offers a natural integration to Geant4 [1], the generally accepted detector simulation program used in high energy physics. An automatic geometry conversion mechanism to Geant4 was developed. The physics response and the mechanism to input particle data from generators was highly formalized and can be instantiated on demand using known factory patterns. A palette of components to model the detector response is provided by default, but improved or more sophisticated components may easily be added using the factory pattern. Only the final configuration of the instantiated components has to be provided by end-users using either C++ or python scripting.

References

[1] DD4Hep web page, http://aidasoft.web.cern.ch/DD4hep. See references therein.

[2] R.Brun et al., "Root - An object oriented data analysis framework", Nuclear Instruments and Methods **A** 389 (1997) 81