



The GeoModel Tool Suite for Detector Description

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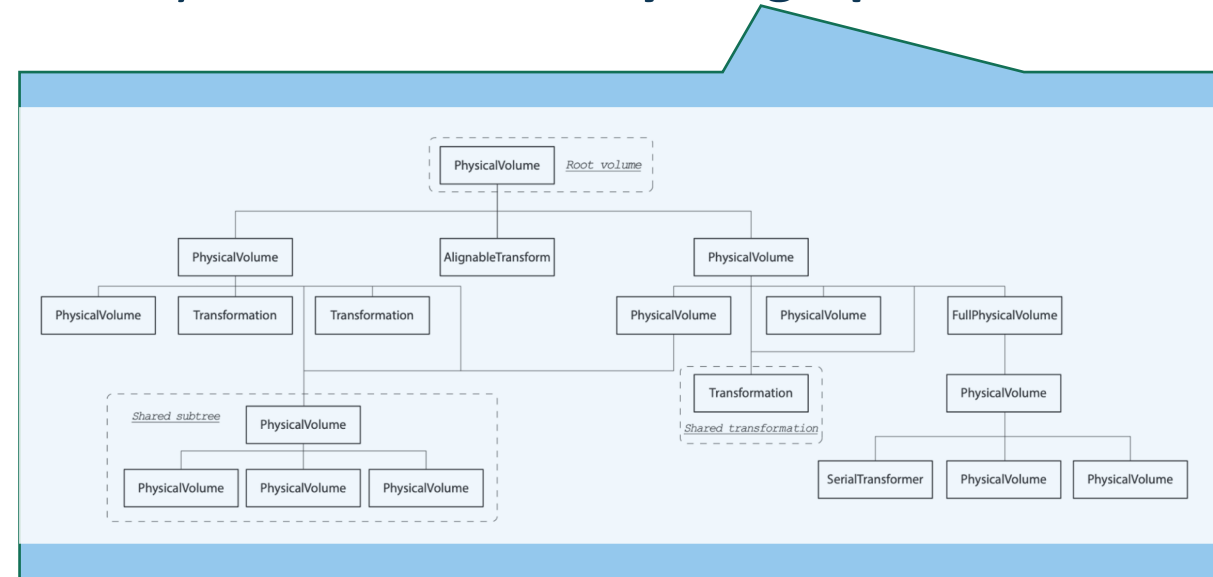
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Introduction

- **GeoModel** is a toolkit for describing geometries of large and complex detector systems with minimal memory footprint
- GeoModel has been used by the **ATLAS experiment** since 2004
 - GeoModel code being part of the ATLAS offline software repository
- In 2019 GeoModel was repackaged as an independent, experiment-agnostic API
- Today the tool suite consists of several components
 - E.g., kernel library, persistence mechanisms, 3D visualization, XML and JSON parsers.
- The code is available at <https://gitlab.cern.ch/GeoModelDev/GeoModel>
 - It can be **compiled** on **Linux** and **macOS** platforms with **minimal third-party dependencies**
 - **Distribution kits** are also built for **Ubuntu** and **macOS**
- Documentation is available at <https://cern.ch/geomodel>

Kernel Library

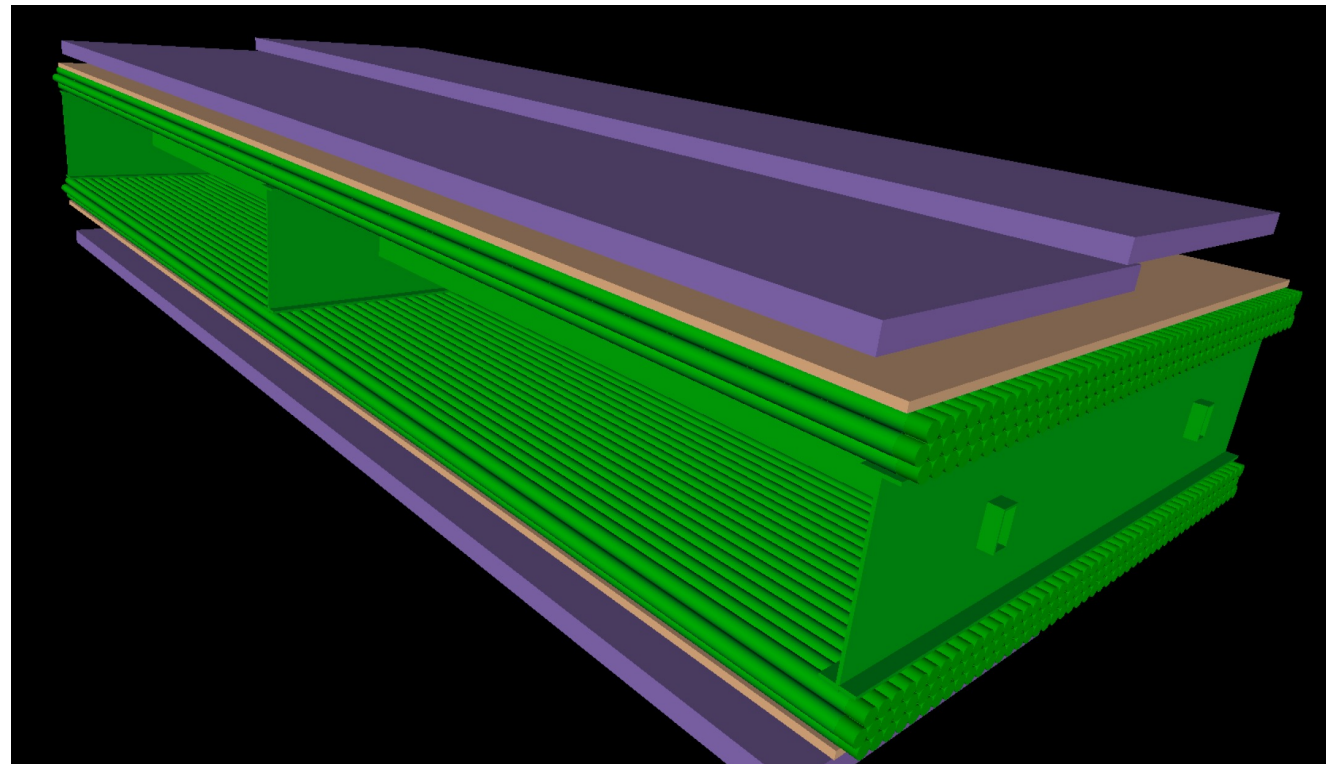
- The Kernel allows for building detector geometry as a **directed, acyclic graph of nodes**
- Various-purpose geometrical primitives:
 - **Volumes** (physical and logical)
 - **Solids** (simple, Boolean, BREP, tessellated)
 - **Identifiers** (string, int)
 - **Transformations** (Regular and *Alignable*)
 - **Elements and Materials**
- Memory-saving techniques:
 - **Shared instances** of nodes in the graph
 - **Parameterized volumes** (*Serial Transformer*)
- Tools for building detector-specific **readout geometry** (*Full Physical Volume*)
- Tools for applying **alignment corrections** (*Alignable Transformation*)



GeoModelXML

- GeoModel tool suite contains an XML-based front-end which allows users to code detector geometries in a simple and intuitive way (still under development)
 - Uses **XercesC** libraries for XML parsing
- GeoModelXML can handle generic, as well as GeoModel-aware data structures
- The procedure of describing detector geometry in XML allows for very fast development of a geometry

An example of ATLAS barrel muon station described using GeoModelXML

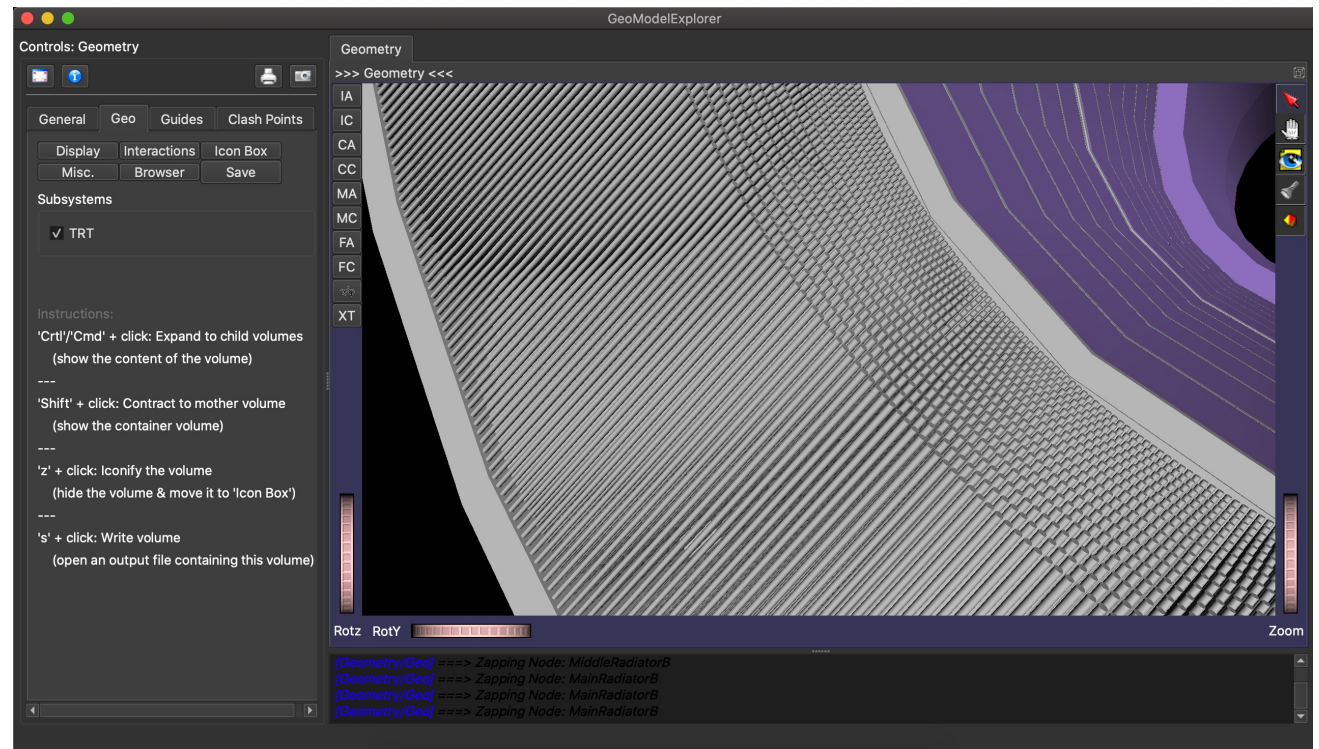


GeoModelIO

- The GeoModelIO component extends the core library with the ability to **save** and **restore** a persistent copy of transient GeoModel geometry tree into an **SQLite file**
 - **GeoModelWrite** traverses the transient geometry tree and serializes all nodes, their attributes and parent-child relationships into the SQLite file
 - **GeoModelRead** builds transient GeoModel tree from the information stored in the SQLite file
- The persistent data model has been designed to **optimize disk space** usage
 - For example: persistent version of a complete geometry description of the ATLAS detector, which contains more than 500,000 nodes, takes ~40MB on disk
- Significant speedup in reading persistent GeoModel description has been achieved by implementing a mechanism for **parallel building** of different parts of the GeoModel tree
 - For example: the complete ATLAS geometry description can be constructed from an SQLite file in just a few seconds

Visualization

- The GeoModel tool suite includes a powerful 3D visualization tool: GeoModel Explorer (aka `gmex`)
- Builds the geometry description either by reading XML files (via GeoModelXML), or by reading SQLite file, or by loading shared libraries with C++ description of GeoModel geometry (aka *GeoModel plugin*)
- Included functionality:
 - Interactive control over the **expansion, contraction, and iconization** of volumes
 - Multiple viewing windows
 - Tools for **geometry debugging**
 - Saving Individual elements of the geometry into a file for further examination
 - ... and more



FullSimLight

- A family of tools using GeoModel and Geant4:
 - **fullSimLight**: standalone lightweight simulation (geometry, transport in magnetic field, and basic physics scoring)
 - **gmclash**: tool for checking geometry overlaps
 - **gmgeantino**: tool for generating geantino maps for the input geometry
 - **gmmasscalc**: tool for calculating the mass of a volume
 - *All above tools first construct the detector geometry in GeoModel, and then convert it into Geant4 geometry format on-the-fly*
 - **gm2gdml**: tool for converting GeoModel geometry into GDML
 - **gdml2gm**: tool for converting GDML geometry description into GeoModel
- Supports a variety of input geometry formats:
 - **SQLite** geometry file
 - **GDML** geometry file
 - **Shared Library** containing GeoModel description of some detector geometry

Summary

- GeoModel is a generic tool for building transient descriptions of complex detector geometries with minimal memory footprint
- Several key components of the GeoModel tool suite:
 - Kernel library of geometrical primitives
 - XML interpreter allowing for coding complex geometries in simple and intuitive way
 - Mechanism for creating persistent representations of transient GeoModel trees in SQLite format
 - Powerful 3D visualization tool for inspecting and debugging GeoModel descriptions
 - FullSimLight tool family for running lightweight Geant4-based simulations
- The GeoModel tool suite is presently in use in both the **ATLAS** and **FASER** experiments.
 - In ATLAS it will be the basis of the LHC Run 4 geometry description

Thank you!

