

# Accelerating Navigation in the VecGeom Geometry Modeller

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The VecGeom geometry library is a relatively recent effort aiming to provide a modern and high performance geometry service for particle-detector simulation in hierarchical detector geometries common to HEP experiments.

One of its principal targets is the effective use of vector SIMD hardware instructions to accelerate geometry calculations for single-track as well as multiple-track queries. Previously, excellent performance improvements compared to Geant4/ROOT could be reported for elementary geometry algorithms at the level of single shape queries.

In this contribution, we will focus on the higher level navigation algorithms in VecGeom, which are the most important components as seen from the simulation engines.

In this contribution, we will first report on our R&D effort and developments to implement SIMD enhanced data structures to speed up the well-known “voxelized” navigation algorithms, ubiquitously used for particle tracing in complex detector modules consisting of many daughter parts.

Second, we will discuss complementary new approaches to improve navigation algorithms in HEP. These ideas are based on a systematic exploitation of static properties of the detector layout as well as automatic code generation and specialization of the C++ navigator classes. Such specializations reduce the overhead of generic- or virtual function based algorithms and enhance the effectiveness of the SIMD vector units.

These novel approaches go well beyond the existing solutions available in Geant4 or TGeo/ROOT, achieve a significantly superior performance, and might be of interest for a wide range of simulation backends (Geant-V, VMC, Geant4). We exemplify this with concrete benchmarks for the CMS and ALICE detectors.

## Tertiary Keyword (Optional)

## Secondary Keyword (Optional)

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**Primary authors:** WENZEL, Sandro Christian (CERN); ZHANG, Yang (KIT - Karlsruhe Institute of Technology (DE))

**Presenter:** WENZEL, Sandro Christian (CERN)

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