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Application of high energy physics detector description transformation for visualization in Unity

Tianzi Song,[a,*] **Yumei Zhang**[b] **and Zhengyun You**[a]

[a] *School of Physics, Sun Yat-sen University,*
510275, Guangzhou, China

[b] *Sino-French Institute of Nuclear Engineering and Technology, Sun Yat-sen University,*
519082, Zhuhai, China

E-mail: songtz@mail2.sysu.edu.cn, zhangym26@mail.sysu.edu.cn, youzhy5@mail.sysu.edu.cn

Visualization is integral to high-energy physics (HEP) experiments, spanning from detector design to data analysis. Presently, depicting detectors within HEP is an intricate challenge. Professional visualization platforms like Unity offer advanced capabilities, and also provide promising avenues for detector visualization. This work presents an automated interface facilitating the seamless conversion of detector descriptions from HEP experiments, formatted in GDML, DD4hep, ROOT, and Geant4, directly into 3D models within Unity. The significance of this work extends to aiding detector design, HEP offline software development, physical analysis, and various aspects of HEP experiments. Moreover, it establishes a robust foundation for future research endeavors, including enhancements in event display.

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[*] Speaker

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1. Introduction

Large high-energy physics (HEP) experiments often rely on detectors with complex structures. The simulation, design, assembly of the detector, data monitoring and even event display are inseparable from the detector visualization [1]. At present, detector descriptions of HEP experiments are often constructed through specialize geometry framework, which are Geant4, ROOT , GDML [2], and DD4hep [3]. However, these geometric frameworks can only run on Linux system, and their display functions are relatively backward and unconvenient to use.

Unity is an industrial software that supports over 20 systems, and is renowned for its visualization capabilities. Some HEP experiments have already developed detector visualization functions in Unity [4], demonstrating that it is feasible to complete detector visualization using Unity. However, none of the four geometric frameworks we mentioned can be directly imported into Unity. Filmbox (FBX) is a popular 3D format that can be directly imported into Unity. Therefore, we aim to complete an interface to easily convert all detector descriptions to FBX, and then import them into Unity for display.

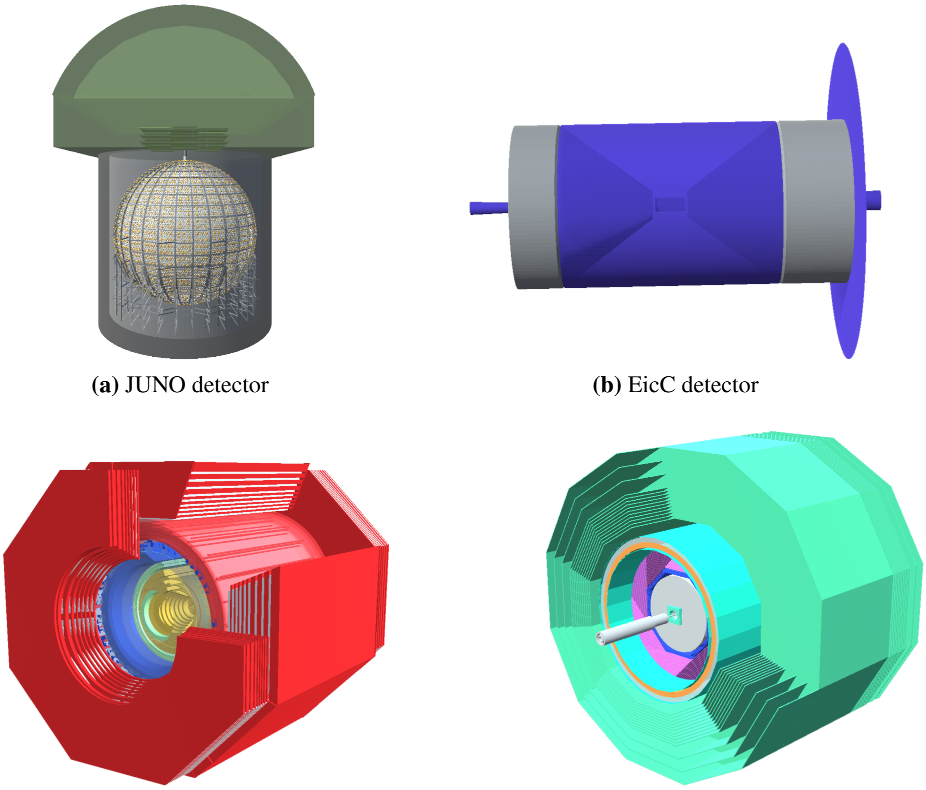
2. Methodologies and application

Different interfaces have been developed which can help us to unify all four formats to GDML files. They can then be converted from GDML to FBX format using an interface we have developed based on the HSF geometry writer [5], while keeping the composition, position, rotation, and physics nodes of these detector descriptions all consistent. Compared to some previous works like GDML-FreeCAD-Pixyz-FBX conversion chain or direct conversion from DD4hep to FBX [6], this work is able to convert all four formats to FBX keeping the steps simple and requires only Geant4 to complete the conversion.

To verify the interface can effectively convert all four formats, we select four HEP experiments whose detector descriptions are based on different formats, convert them to FBX format and import into Unity for display. JUNO is a neutrino experiment, which detector is constructed through Geant4 platform [7]. EicC is a proposed high-energy facility at the R&D stage, which detector description is constructed using ROOT [8]. BESIII is designed for hadron physics and τ-charm physics, which detector is constructed based on GDML [9]. CEPC experiment is an electron-positron collider at the R&D stage. Its detector description is constructed based on DD4hep. We converted all these four detector description to FBX format and import them into Unity, as shown in Figure 1.

3. Summary

In this paper, we present a interface that can convert the detector description from Geant4, ROOT, GDML, and DD4hep directly to FBX format, and it was successfully verified by four different detectors from different geometry framework. This interface can seamless convert the detector description and it will be easy to complete the visualization process of almost all detectors on Unity. The significance of this work extends to aiding detector design, HEP offline software development, physical analysis, event display and various aspects of HEP experiments.



(a) JUNO detector **(b)** EicC detector

(c) BESIII detector **(d)** CEPC detector

Figure 1: The four detectors displayed in Unity.

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