Visualizing BESIII Events with Unity

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Abstract

In high-energy physics experiments, the software's visualization capabilities are crucial, aiding detector design, assisting offline data processing, and offering potential for improving physics analysis. Detailed detector geometries and architectures, formatted in GDML or ROOT, are integrated into platforms like Unity for three-dimensional modeling. In this study, based on the BESIII spectrometer, Unity is utilized to display BESIII events in three-dimensional and even animated formats. This method of event display vividly illustrates the collision and tracks of particles within the detector. Utilizing this event display system instances through software facilitates improved analysis, fosters interdisciplinary applications, and expands into the realm of education.

1. INTRODUCTION

➢ Unity Real-Time Development Platform:

– Used for creating immersive 2D, 3D, AR, and VR experiences, offering extensive tools and a community for developers and support more than 20 platforms

➢ Application in high energy physics based on Unity engine:

– Many high-energy experiments have attempted to use Unity for the display of detectors and events, such as:
– ELAINA: JUNO Event Display based on Unity
– CAMELIA: Cross-platform ATLAS Multimedia Education Lab for Interactive Analysis

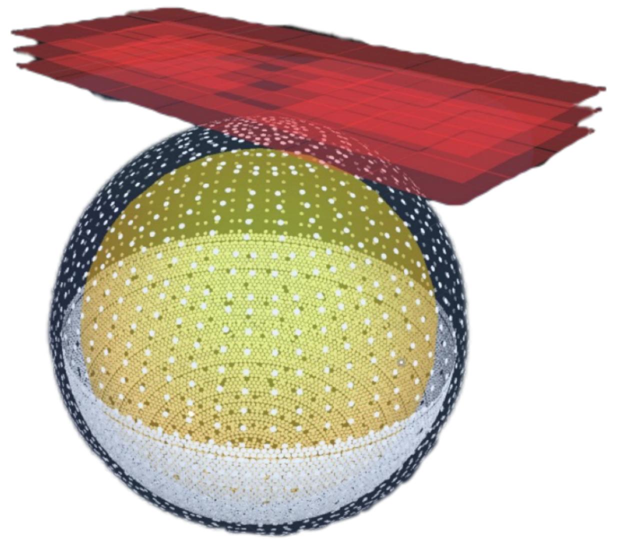
Fig.1 Visualization of the JUNO detector

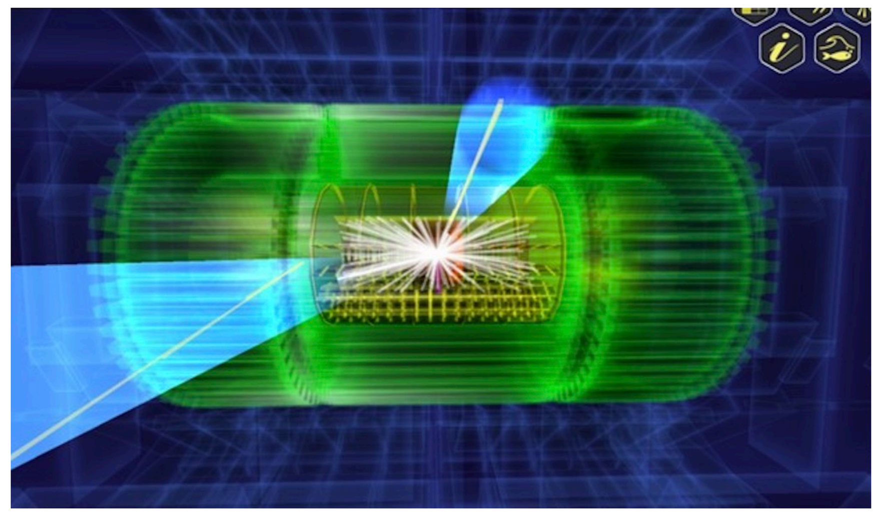
Fig.2 Event display of ATLAS experiment

➢ BESIII and BEPCII:

– The BESIII detector records symmetric e^+e^- **collisions** provided by the BEPCII storage ring in the center-of-mass energy range from 2.0 to 4.95 GeV, with a peak luminosity of $1\times10^{33}\ \mathrm{cm}^{-2}\mathrm{s}^{-1}$ achieved at $\sqrt{s} = 3.77$ GeV.

– BESIII consists of 4 sub-detectors:
MDC (Main Draft Chamber),
TOF (Time-Of-Flight System),
EMC (Electromagnetic Calorimeter),
MUC (Muon Chamber System)

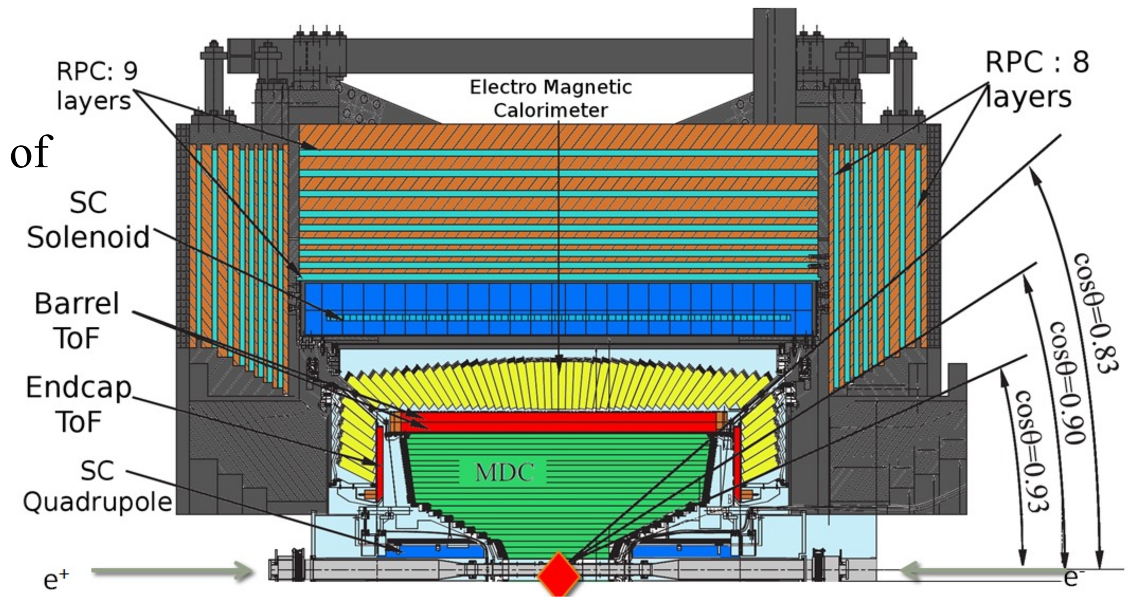

Fig.3 BESIII detector

2. EVENT INFORMATION TRANSFORMATION

ROOT ➜ TXT ➜ UNITY

– 1. Write an EventDisplay algorithm package in C++ to store the tracks and hits information for each sub-detector.
– 2. With the EventDisplay algorithm package, store the tracks and hits information in ROOT format.
– 3. Convert the tracks and hits information from ROOT to TXT format. The TXT should record the run and event numbers and detail the information for each track in every event sequentially.
– 4. Import the TXT file into Unity and use C# to visualize the particle tracks.

3. BESIII DETECTOR VISUALIZATION

– GDML, a detector description format, is converted through FreeCAD for visualizing the BESIII detector in Unity.

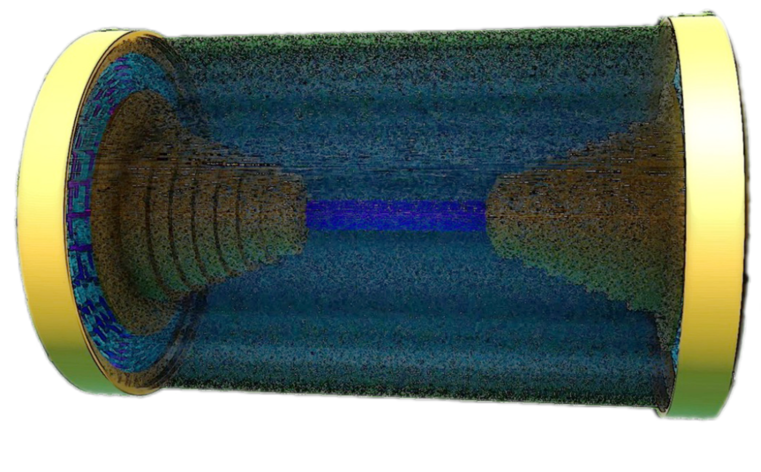
Fig.4 The MDC of BESIII detector with beam pipe inside in Unity

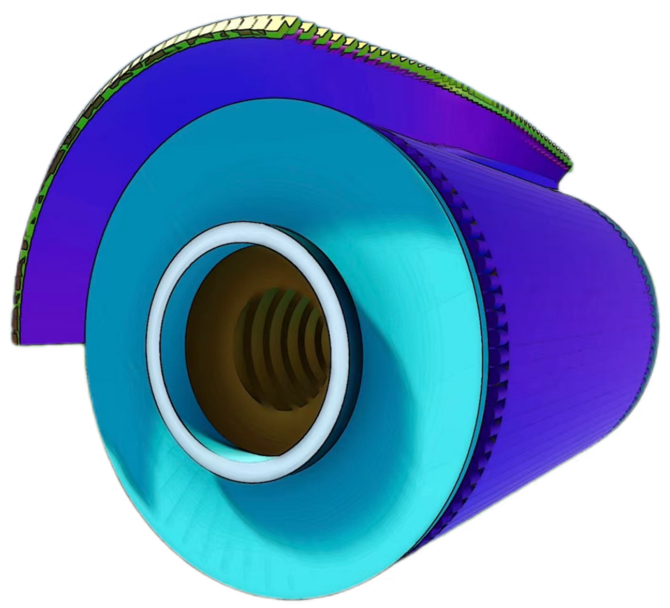
Fig.5 The TOF and MDC of BESIII detector in Unity

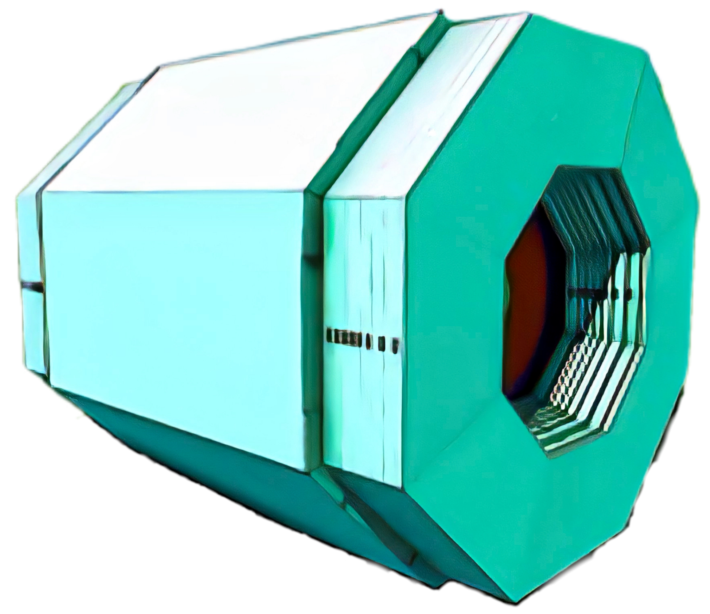
Fig.6 The MUC of BESIII detector in Unity

4. EVENTS VISUALIZATION

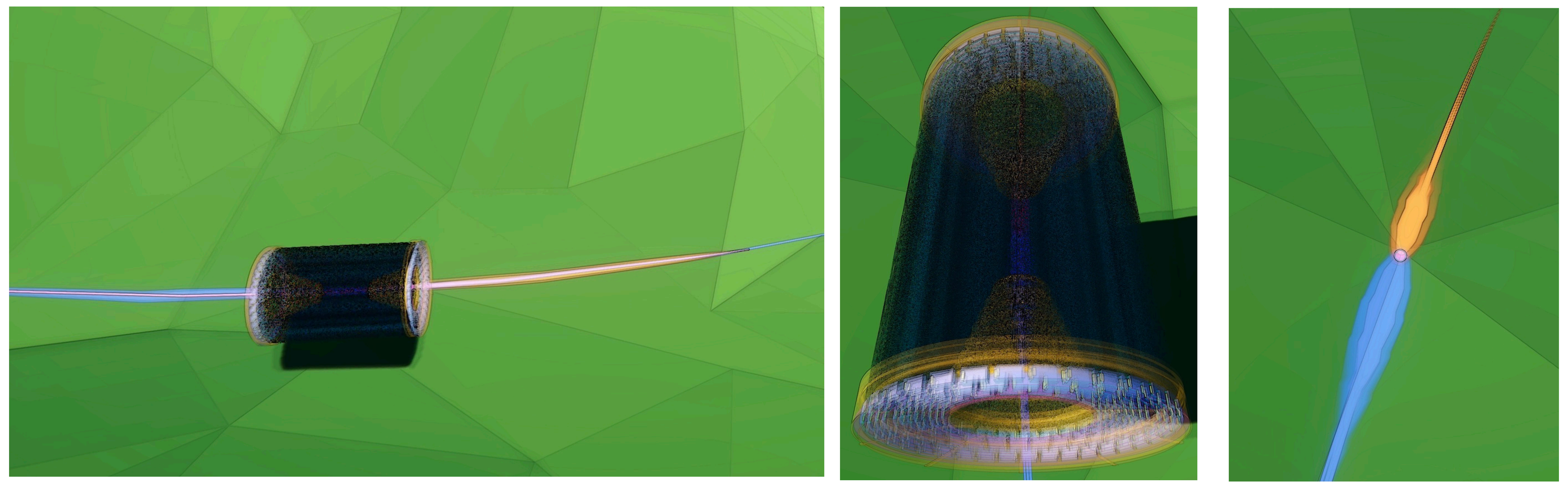
Fig.7 Visualization of e^+e^- collisions with/without MDC

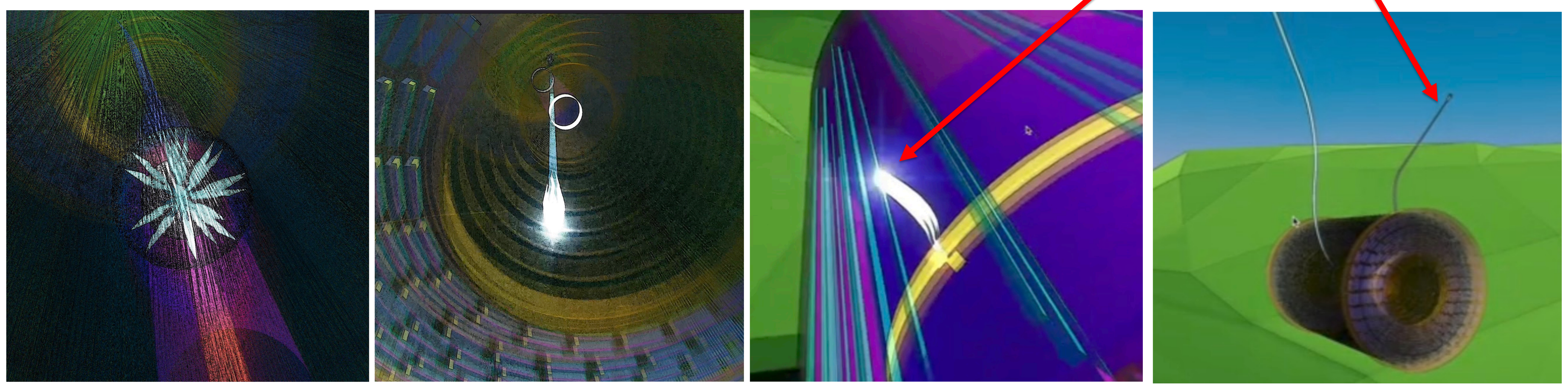

Fig.8 Visualization of a simulated BESIII event in search for $J/\psi \to e\mu$

5. CONCLUSION

– Implement visualization of the tracks and hits of BESIII events, with support in Unity for adjusting color, reflectivity, transparency, etc., to achieve better visualization effects.

– Implemented animations in Unity to show particle collisions and event tracks. An App created with Unity allow users to view different animations, like tracks and detectors, by pressing numerical keys.

Reference

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