Method for HEP detector description and visualization in Unity

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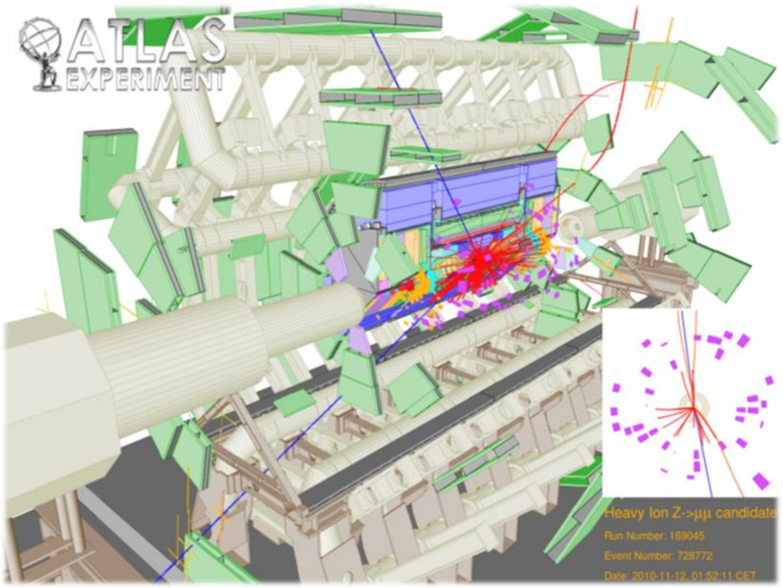
Outline

1. Introduction
2. Methodologies
3. Visualization in Unity
4. Further applications
5. Summary

Visualization requirements for HEP experiments

- Detector design
- Detector construction & assembly
- Detector commissioning
- Experiment operation & maintenance
- Data quality monitoring
- Simulation & reconstruction
- Event display
- Physics analysis
- Education
- Outreach



mp-ph] 26 Nov 2018

HEP Software Foundation Community White Paper Working Group – Visualization

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Visualization Technology from Industry

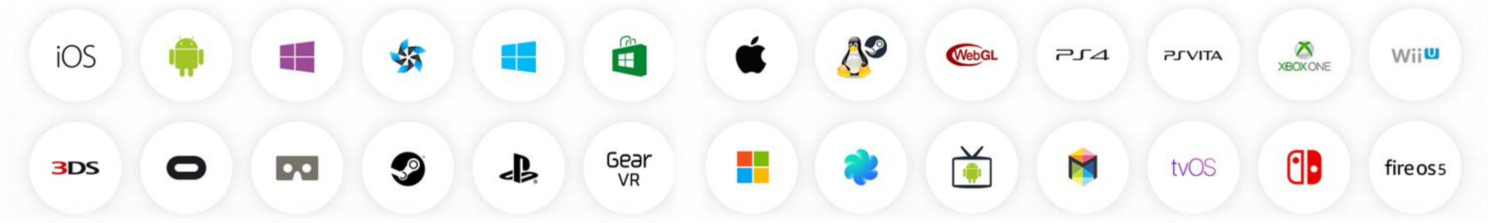
- More advanced visualization techniques
- Creation for game, film, video, education, art, industrial design and training
- Professional, stable and long-term support from industry community
- Software – Platform – System – Hardware seamless integration
- Outstanding platforms such as Unity, UnReal

Digital Twins in Unity

Rendering in UnReal

Unity : A powerful visualization software

- Unity is a professional video and game production engine
- Advantage:
  - Professional **3D software**.
  - Provide access to VR or AR.
  - Supports more than 20 platforms.

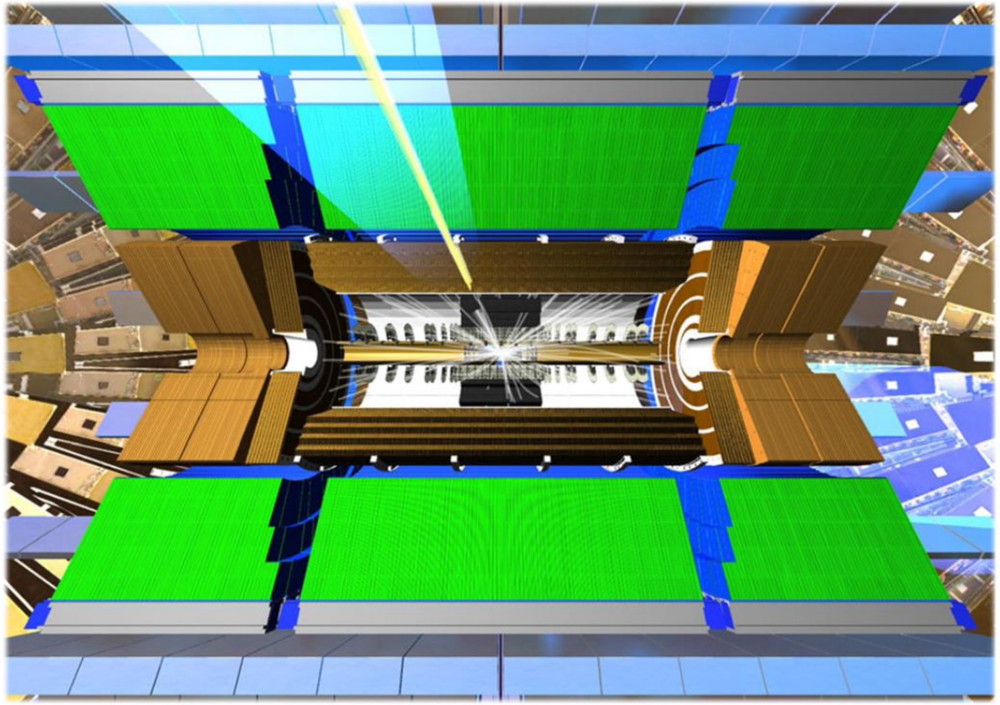


Games developed by unity

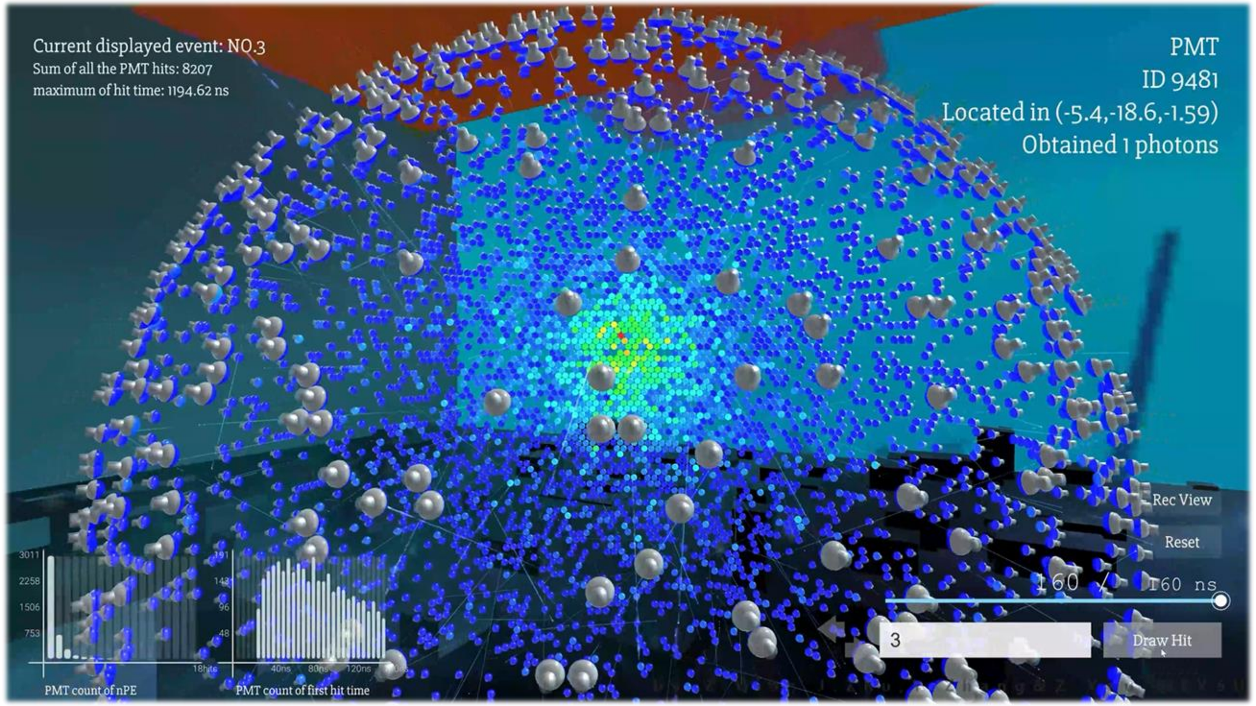
VR

Application of Unity in HEP

ATLAS event display - CAMELIA



JUNO event display - ELAINA



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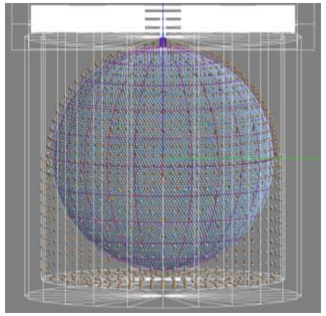
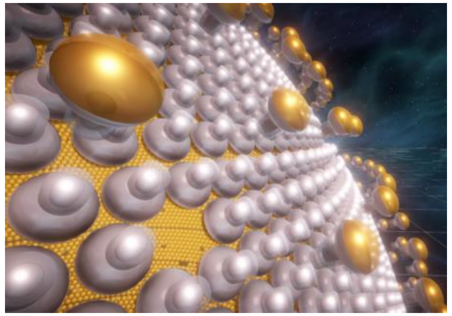
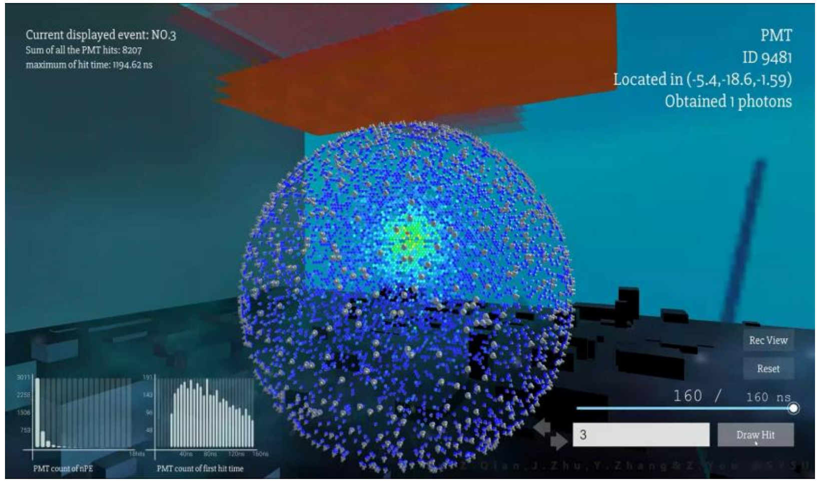
Development based on Unity

- Detector geometry transformation
  - A method to transform different formats of detector description into Unity

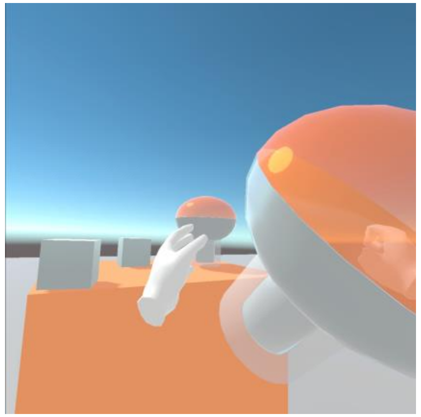




- Application based on Unity
  - Event display, detector optimization, …

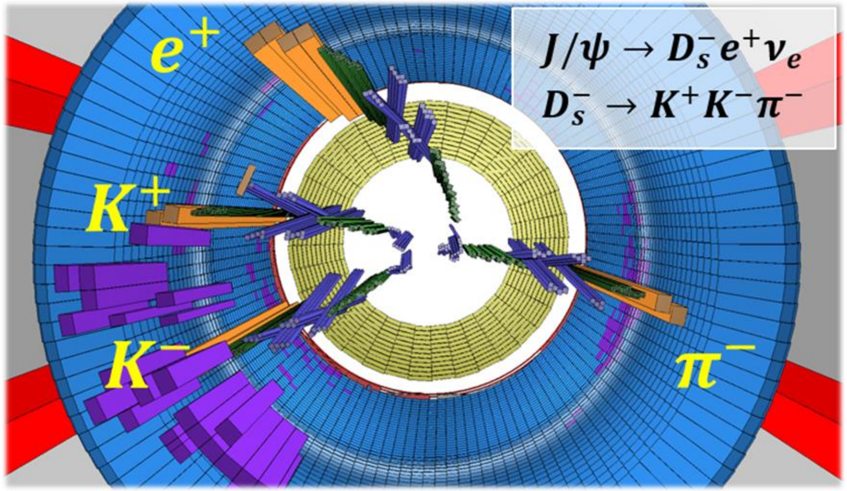


- Extension
  - Virtual Reality, outreach, …



Why do we need to transform detector?

- HEP experiments are usually large-scale scientific apparatuses with complicated detector geometry



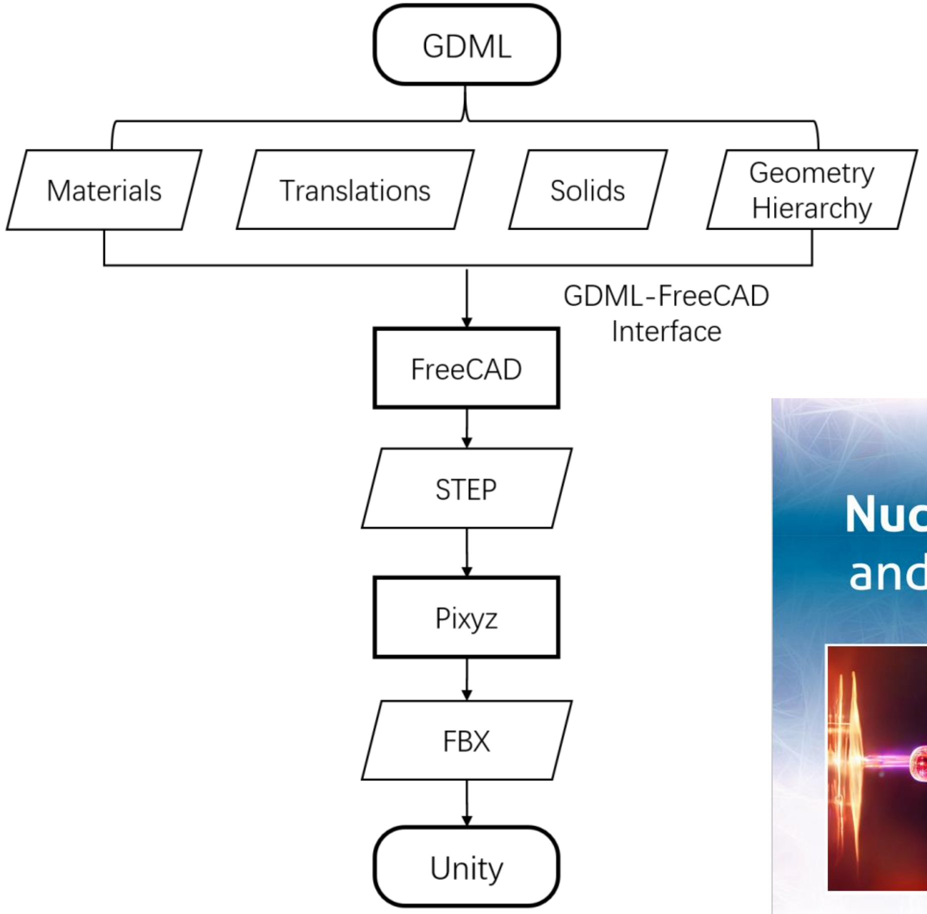
- Different detector description:
  - GDML
  - ROOT
  - DD4hep
  - Geant4

- However, none can be directly imported into Unity

Develop a method for automatic detector transformation!

Works for all detectors, all formats, while keeping consistency

A feasible transformation method



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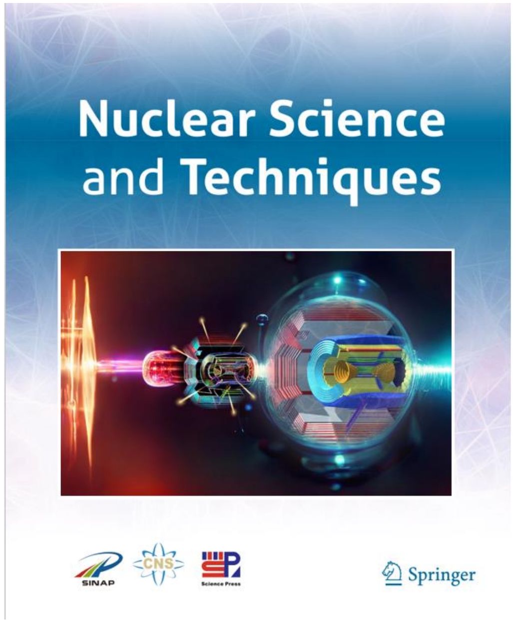
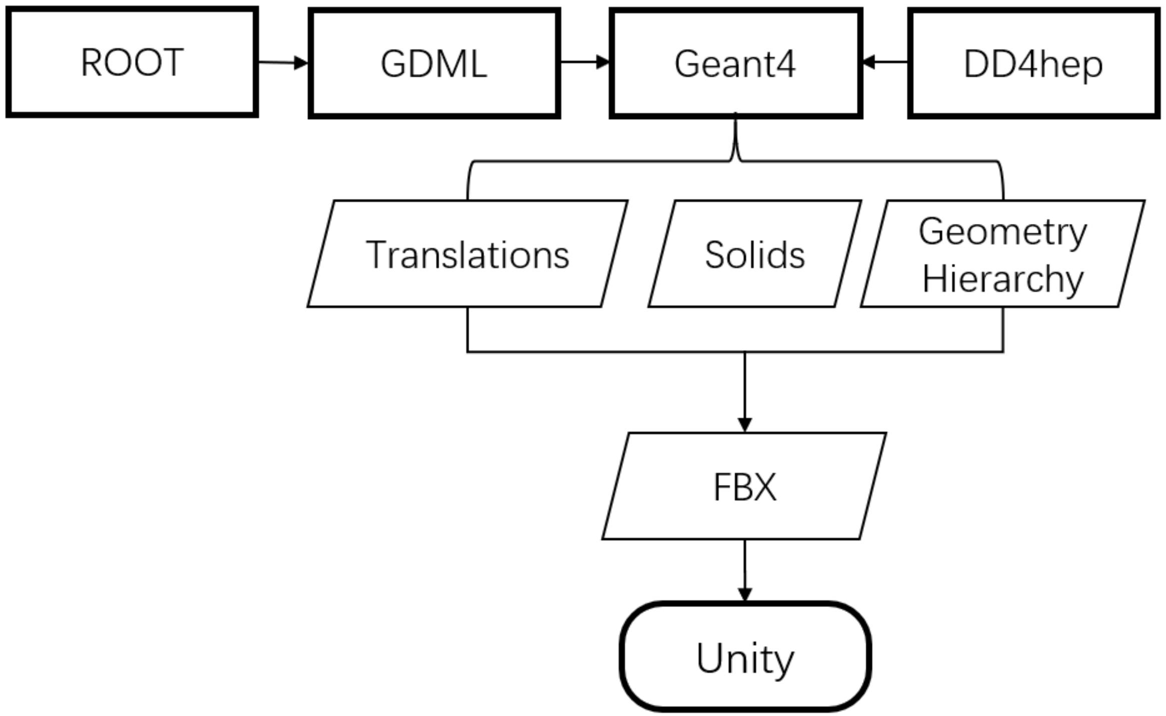


- Using the GDML–FreeCAD interface, FreeCAD, and Pixyz software.
- Maintain the unique identifier of each detector unit.
- Provides richer visualization properties.
- The method is feasible, however, too complicated and time consuming.

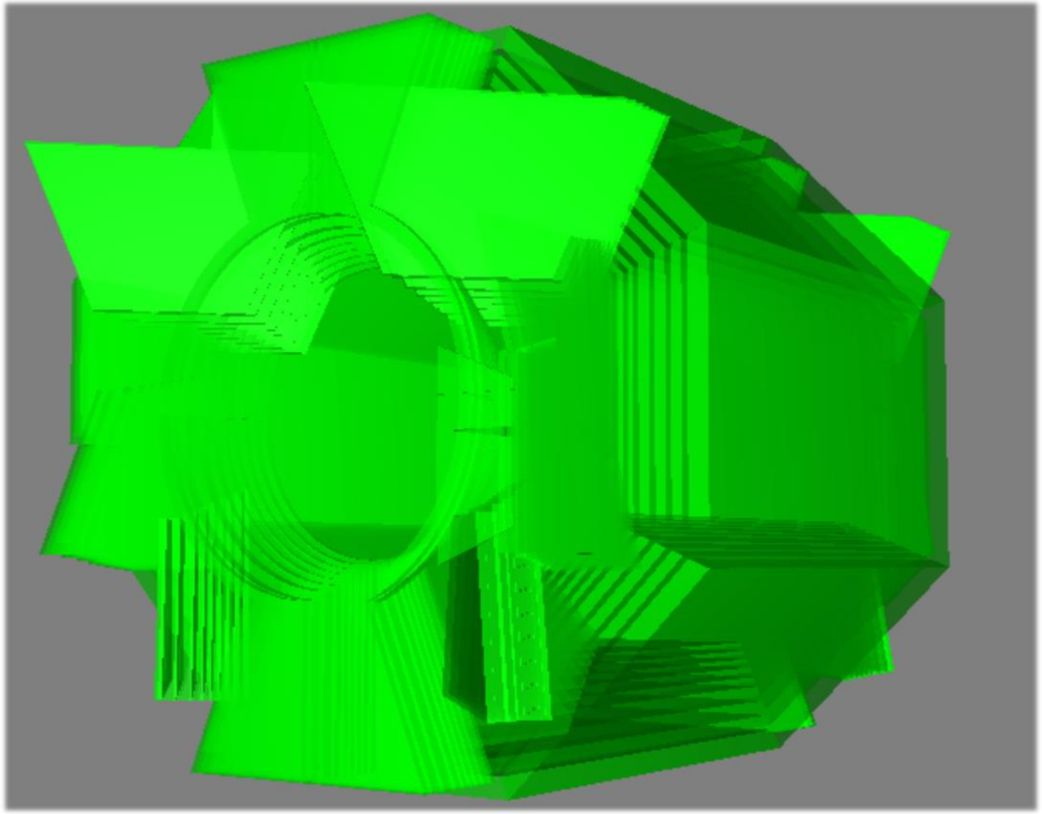
A new method under development



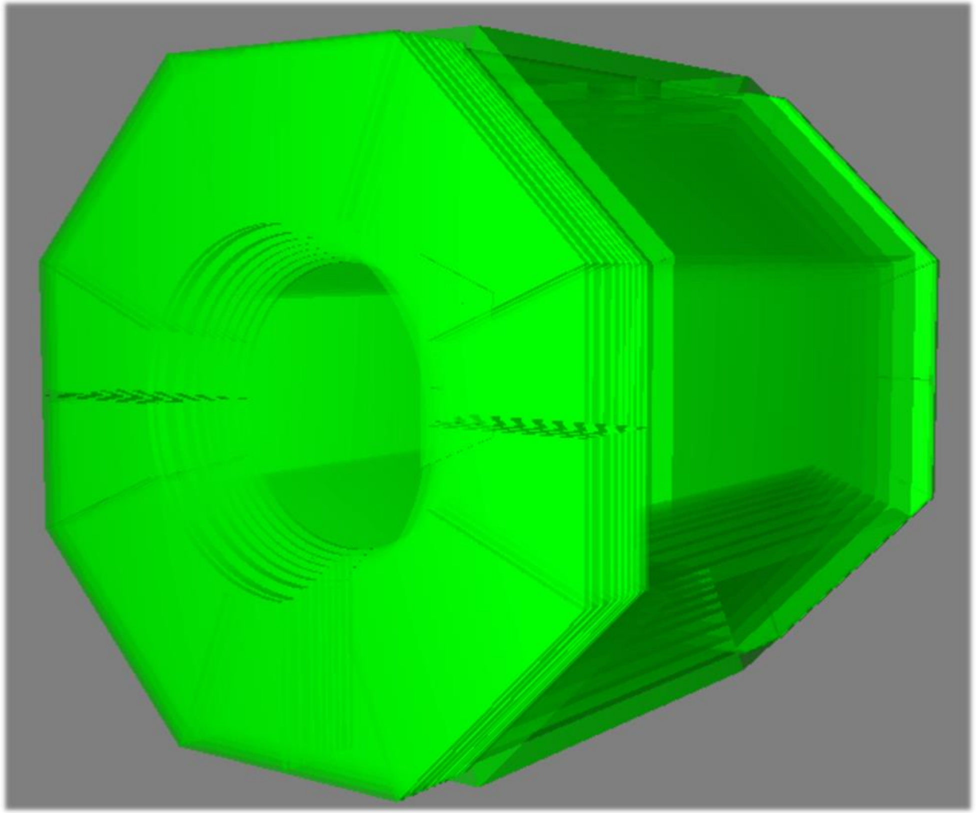
Complete all the transformation processes in one step.

- Develop based on HSF Geometry Writer, which has been used in Belle II
- Convert Geant4 detector description and write it into FBX format
- Update with several features
  - Fine tuning of configuration to solve crash caused by complicated geometry
  - Support self-defined shapes and geometry classes
  - Fix bugs in GDML-G4 transformation

Example of interface update in GDML-G4



Before the modification of Boolean operation



After the modification of Boolean operation

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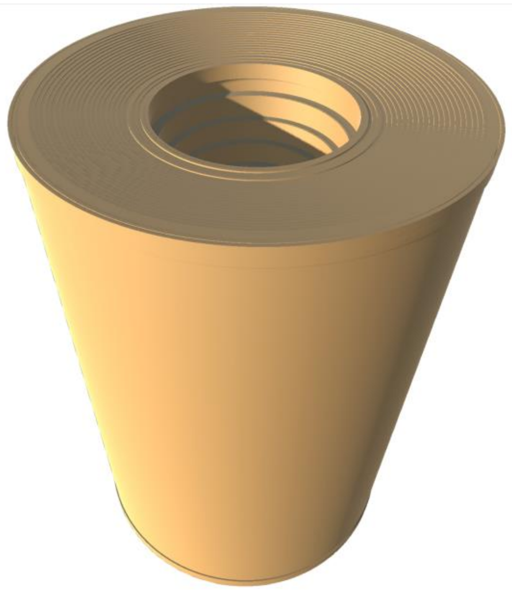
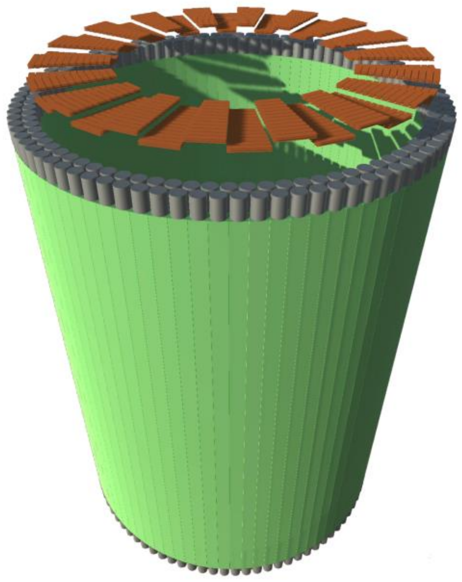
GDML to Unity with BESIII detector

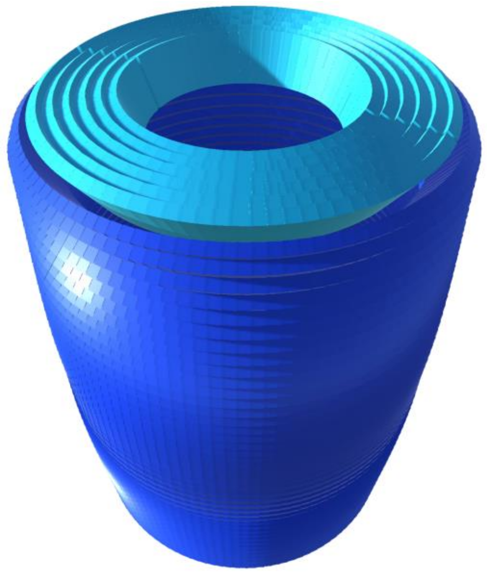
- ➢The BESIII detector description with GDML
- ➢Transformed to FBX and displayed in Unity



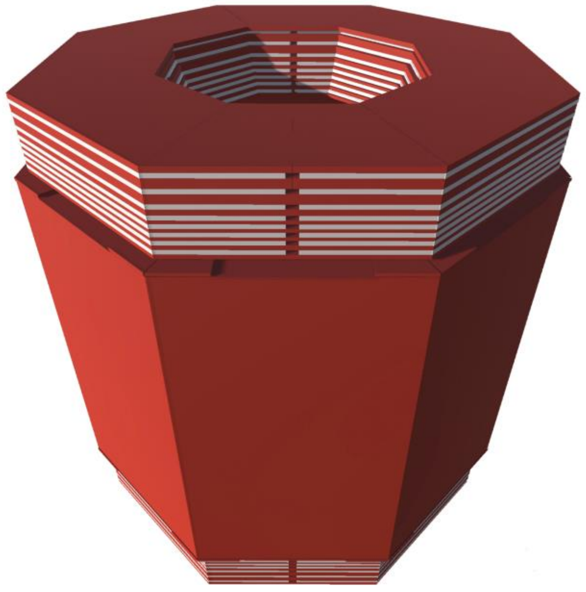
MDC



TOF

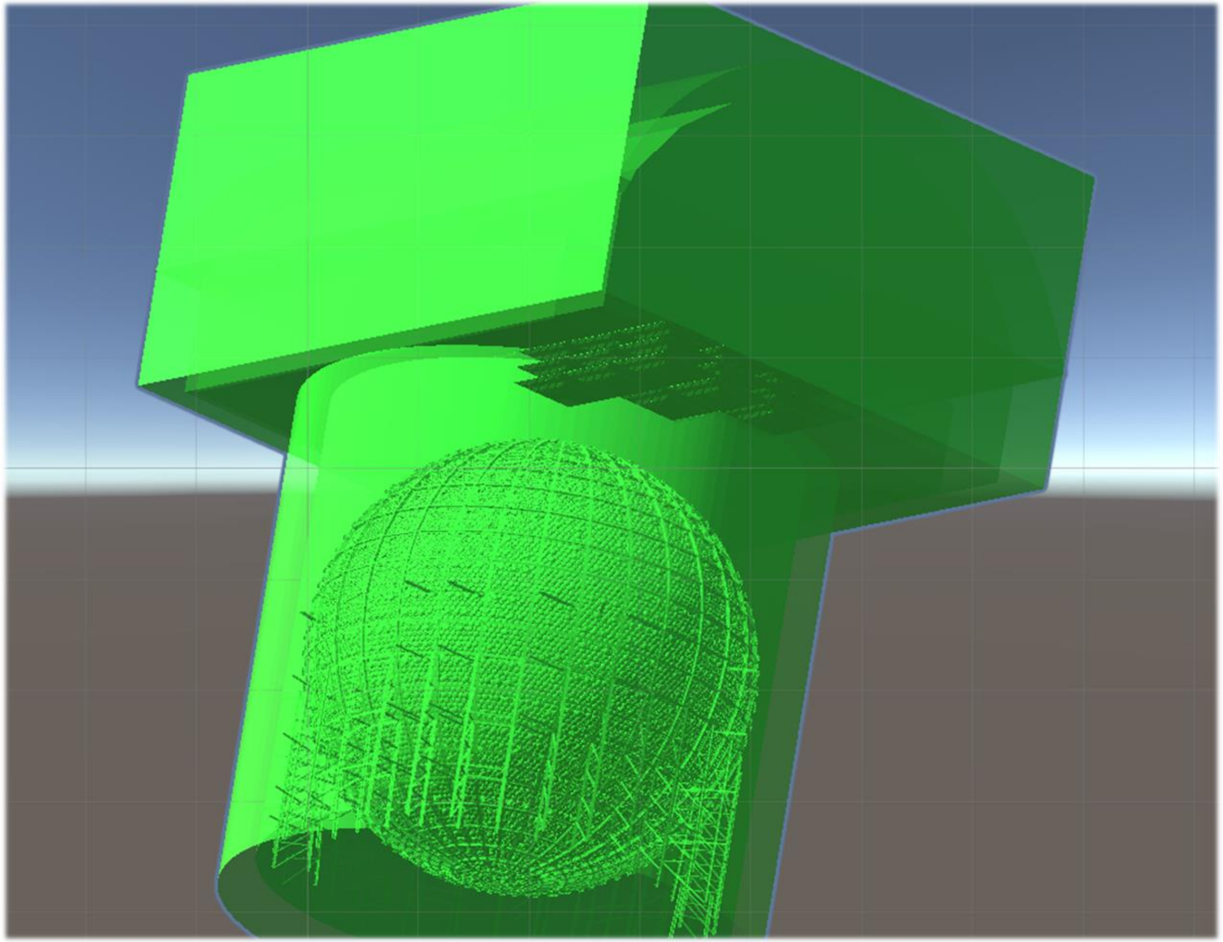


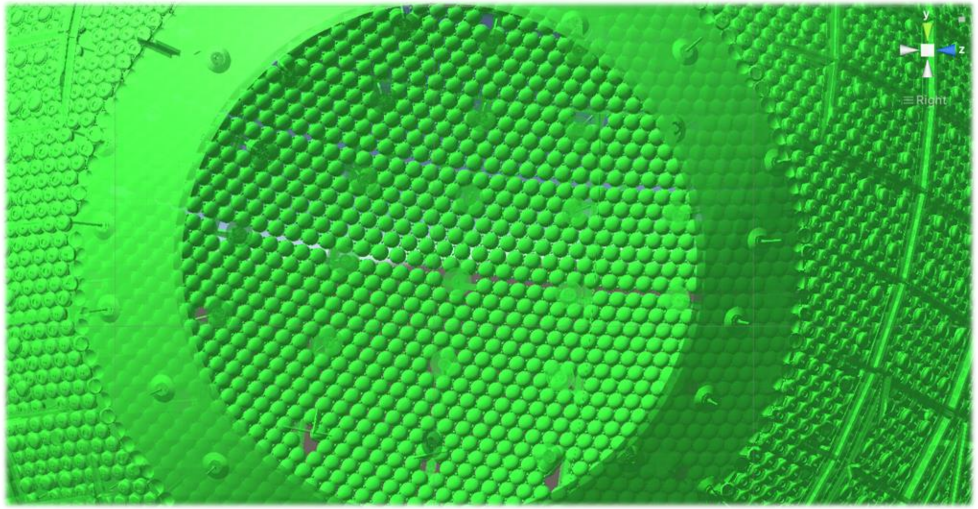
EMC



MUC

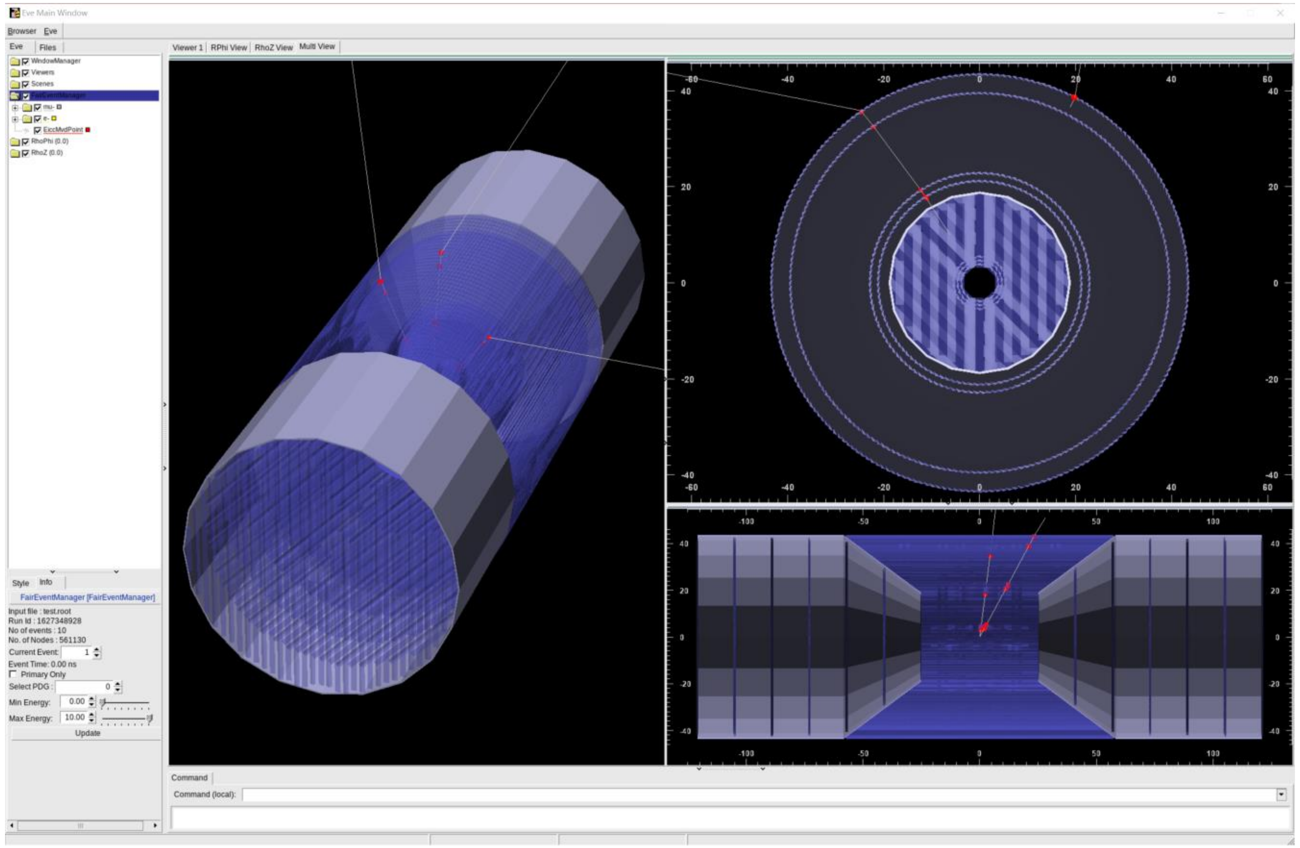
Geant4 to Unity with JUNO detector

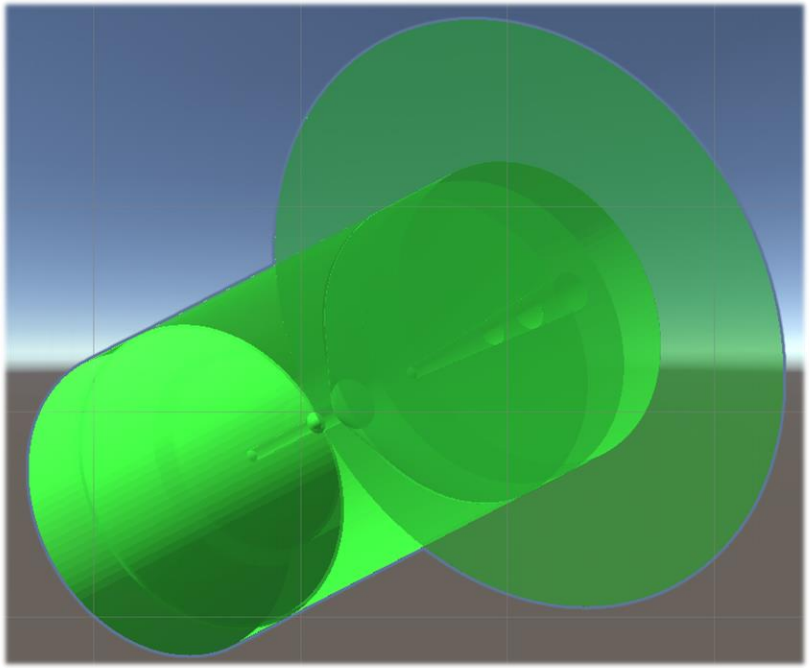




- 3D view of JUNO with FBX transformed from Geant4
- Overall view of JUNO and details in part of Central Detector

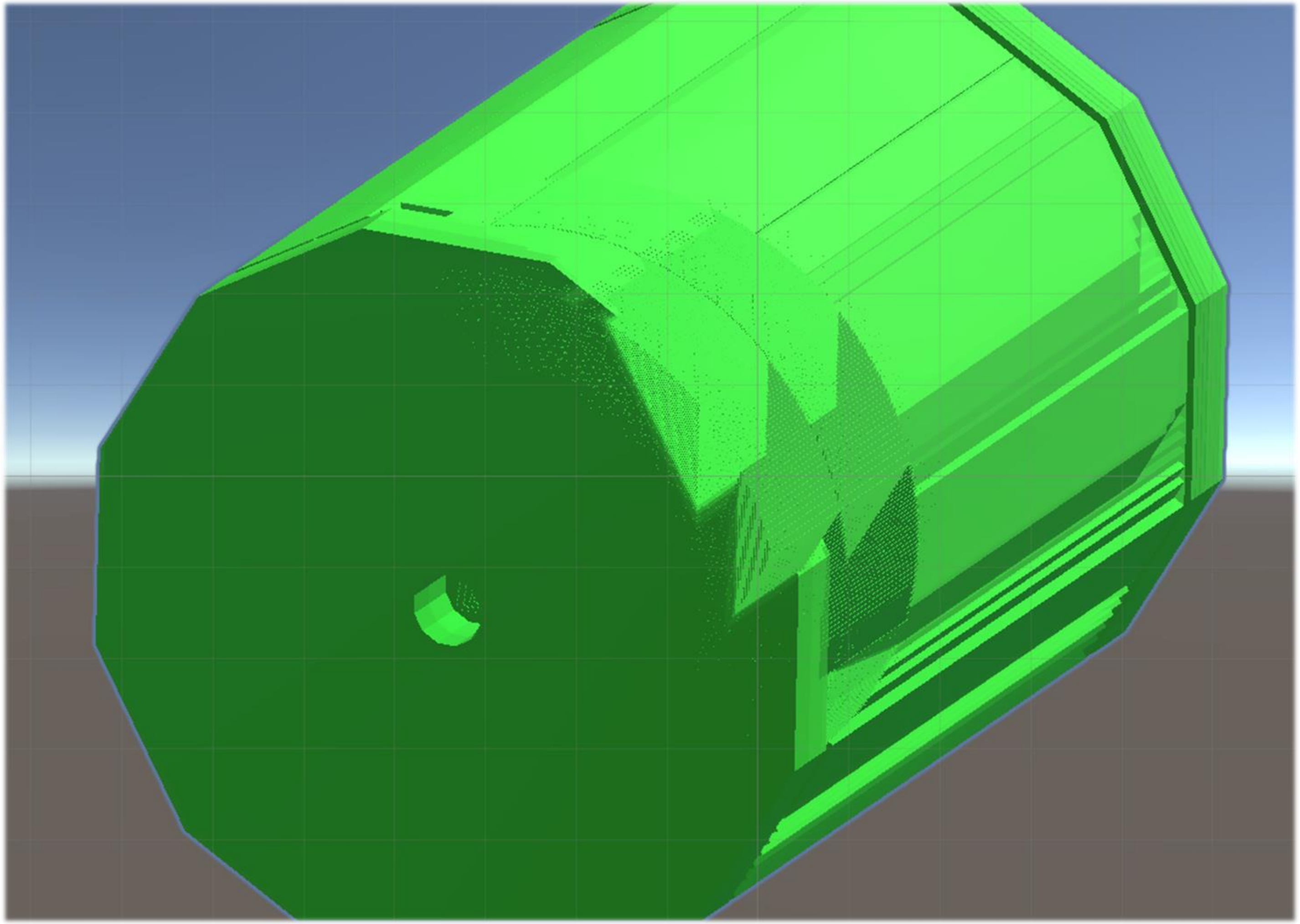
ROOT to Unity with EicC detector





- ➢EicC detector geometry in FairROOT
- ➢Converted to FBX from ROOT

DD4hep to Unity with CEPC



- CEPC detector description based on DD4hep, configured with XML
- Several sub-detectors have been successfully converted into FBX and displayed in Unity
- Still some failure for complex sub-detectors due to naming duplication

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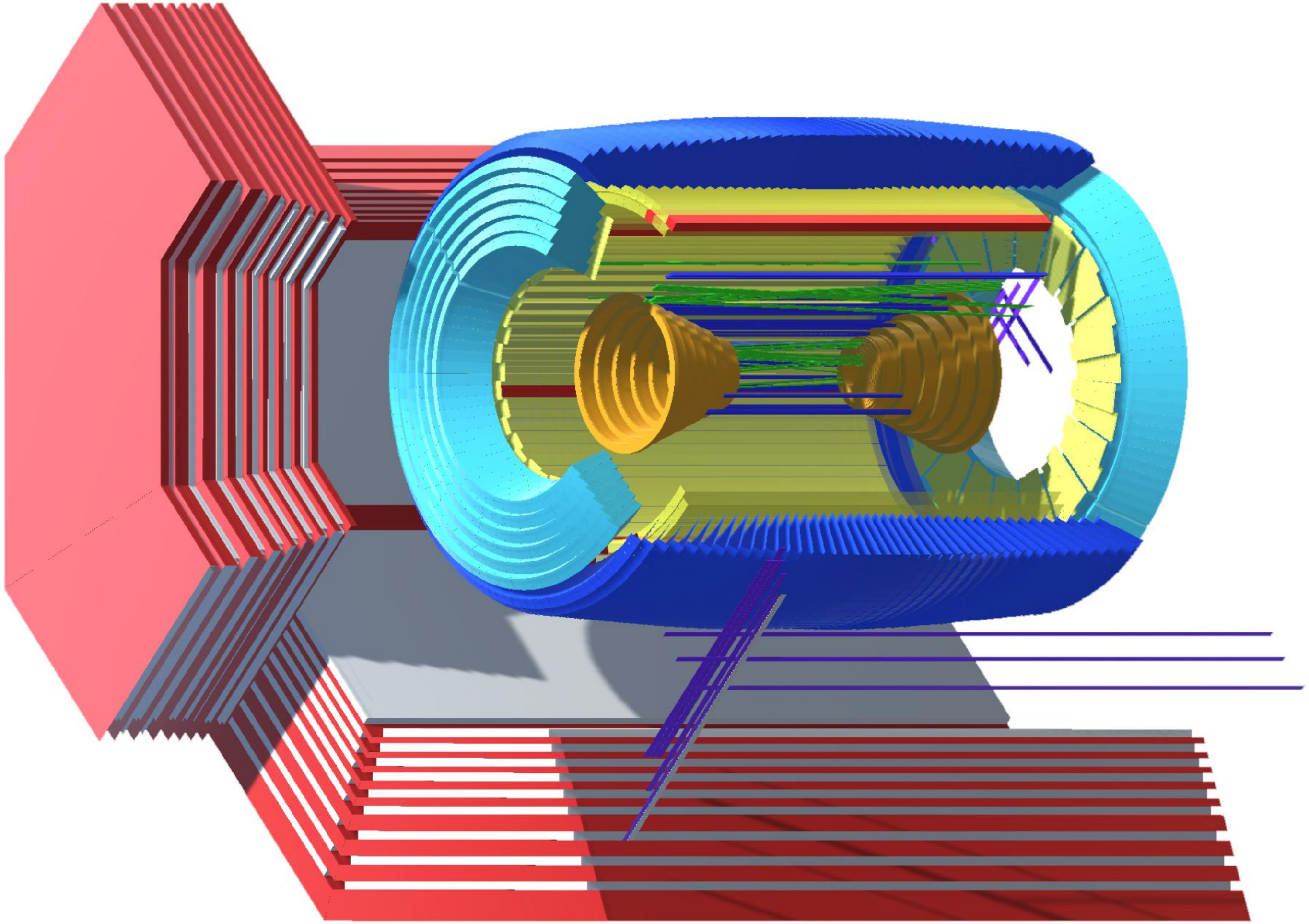
Unity based Event Display for BESIII



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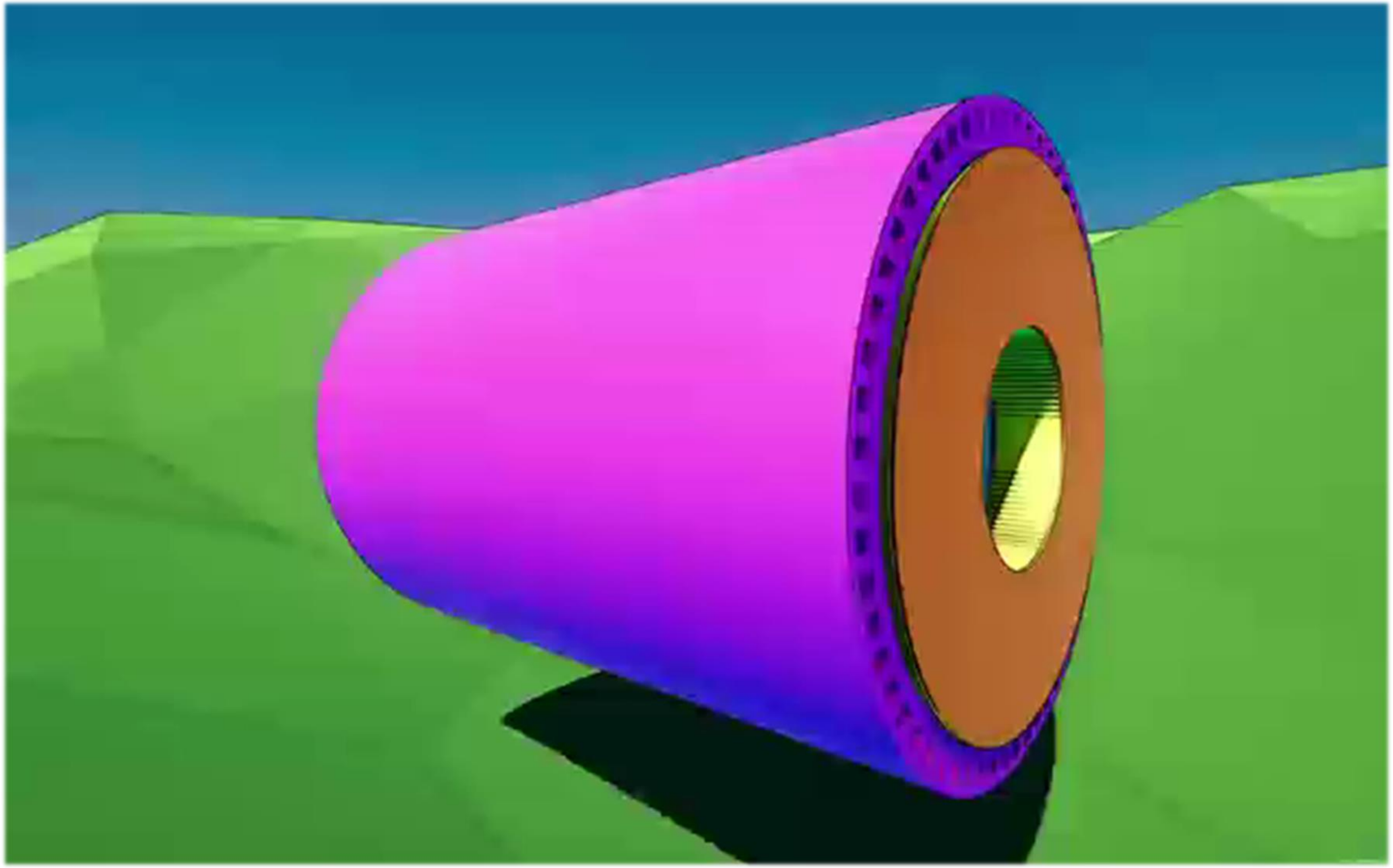
- With the FBX file converted from GDML and implemented in unity.
- A preliminary example of event display for BESIII.
- We expect to get the full functionality for overall BESIII detector and events.

Video for BESIII 3D Event



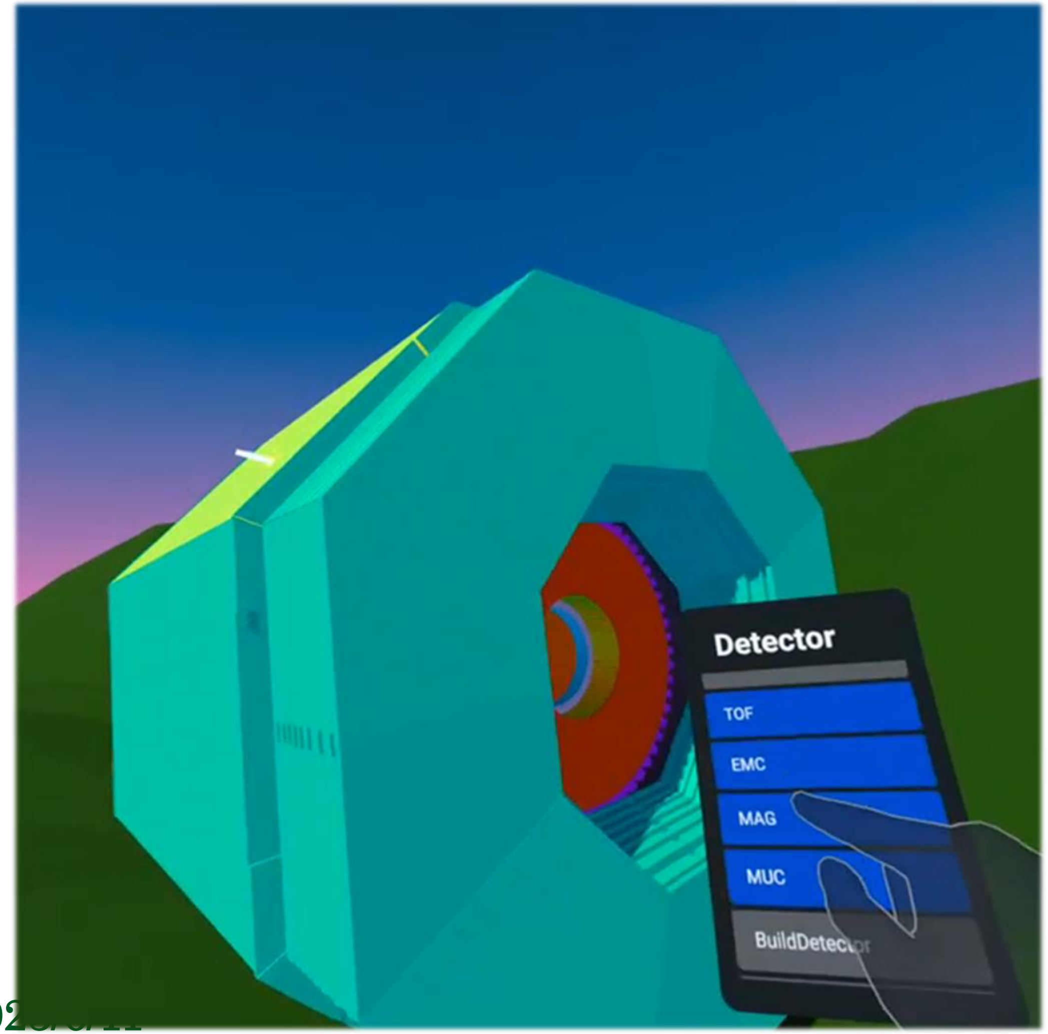
Virtual Reality

- ➢ Platform supports for XR
  - ➢ Virtual Reality
  - ➢ Augmented Reality

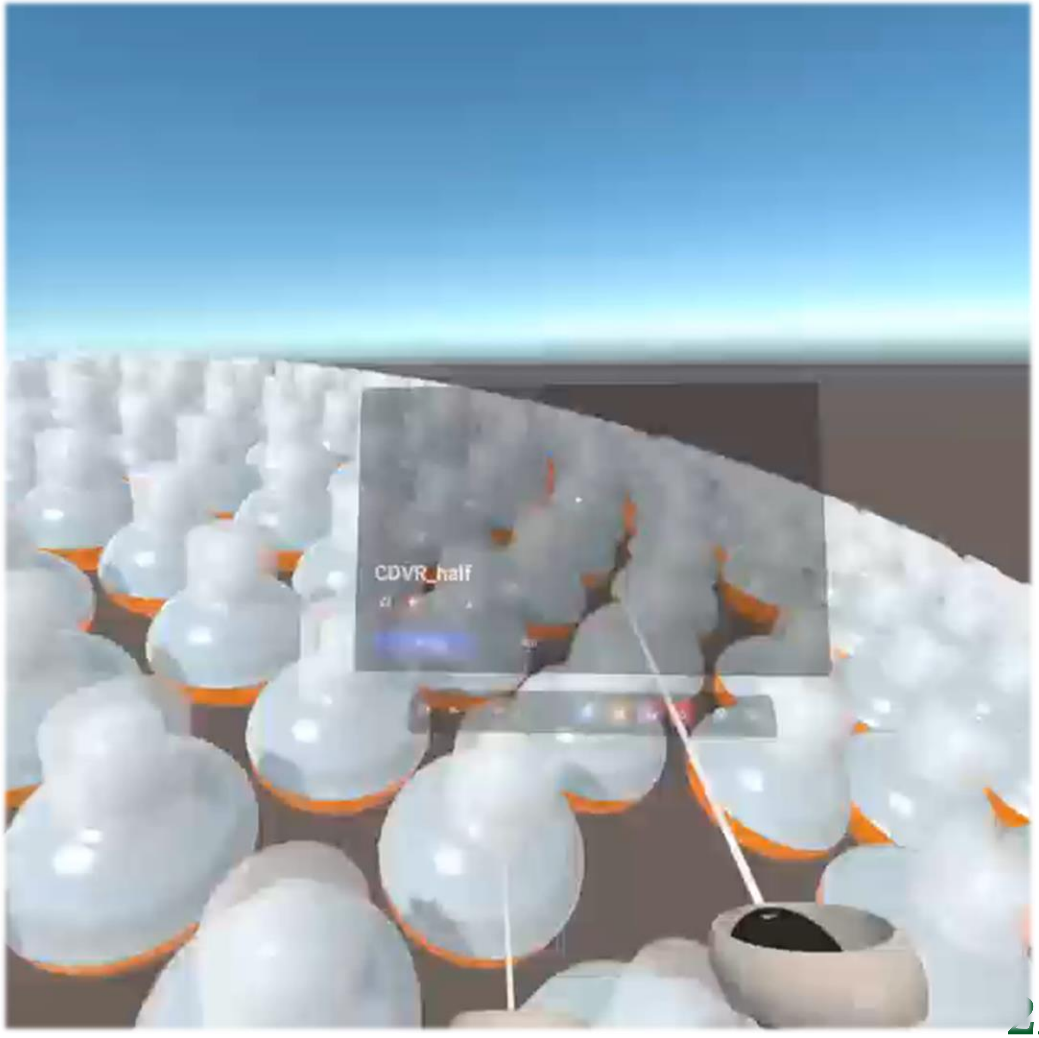
- ➢ Supports for VR/AR devices
  - ➢ HTC Vive
  - ➢ Oculus Quest 2
  - ➢ Apple Vision Pro

VR demo for BESIII & JUNO

VR for BESIII



VR for JUNO



Outline

Summary

- Detector description and visualization play important roles in HEP experiments
- A method for HEP detector geometry conversion to Unity is under development
- Promising future applications with industrial supports

Thank you for listening.

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