

Update of the BESIII Event Display System

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Abstract. The BESIII spectrometer is located at the Beijing Electron-Positron Collider (BEPCII). Recently, the endcap parts of the Time-Of-Flight system (TOF) have been upgraded and consequently, an upgrade of the BESIII visualization software (BesVis) is necessary. The Event Display visualizes particle interactions in the detector and plays an important role for the data acquisition system (DAQ), reconstruction algorithms tuning and physics analyses. The graphical interface of Event Display is based on ROOT GUI. The detector description is stored in GDML files and is converted into the ROOT geometry system.

1. Introduction

The BEPCII[1] is a double-ring symmetric e^+e^- collider with a center-of-mass energy between 2.0 and 4.6 GeV and a maximum luminosity of $10^{33} \text{ cm}^{-2}\text{s}^{-1}$. Large data samples have been collected in the τ -charm region.

BESIII[2] is a multipurpose spectrometer working at BEPCII. The detector covers 93 percent of the full solid angle and provides an excellent momentum resolution of charged tracks and good energy resolution of neutral particles. As shown in Figure 1, the BESIII detector consists of four subdetectors:

- Main Drift Chamber (MDC): a 43 layers drift chamber with helium-based gas surrounds the beam pipe. It is used to measure ionization energy loss and to precisely determine charged particle tracks. The single wire resolution is $115 \mu\text{m}$. The momentum resolution for charged tracks at 1 GeV/c is 0.5%.

- Time-Of-Flight system (TOF): a Time-Of-Flight system is built up for particle identification which consists of a barrel part with 2 layers including 88 pieces of 5 cm thick, 2.4 m long plastic scintillators and two end-cap parts with 36 modules based on new Multigap-Resistive-Plate-Chamber (MRPC). The time resolution of TOF system is 68 ps and 60 ps in the barrel and endcaps respectively, corresponding to a $2\sigma K/\pi$ separation for momentum under about 1.0 GeV/c. The solid-angle coverage is $|\cos\theta| < 0.83$ in barrel and $0.85 < |\cos\theta| < 0.95$ in the endcap.

- Electromagnetic Calorimeter (EMC): an electromagnetic calorimeter made of CsI(Tl) with one cylindrical shape barrel and two endcaps. The energy resolution for showers in the EMC is 2.3% for 1 GeV photons and the position resolution is 6 mm in barrel and 9 mm in endcaps. The barrel EMC covers $|\cos\theta| < 0.83$ and the endcaps cover $0.83 < |\cos\theta| < 0.93$.

- Muon Counter system (MUC): a Muon Counter system is made of 1600 m^2 of resistive plate chamber arranged in 9 layers in barrel and 8 layers in endcaps, which is used to identify muons with momentum greater than $500 \text{ MeV}/c$. The position resolution is about 2 cm .

- Superconducting Solenoid Magnet (SSM): A superconducting solenoid magnet with a central magnetic field of 1.0 Tesla is located in the area between EMC and MUC, providing an optimum magnetic field for precise momentum measurements of charged particles around $1 \text{ GeV}/c$.

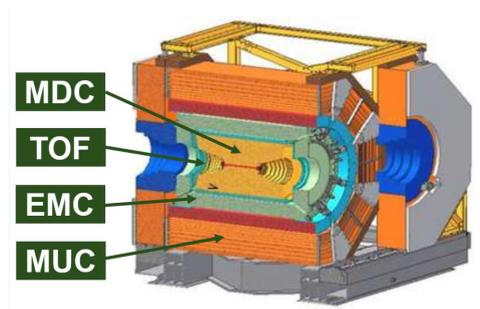


Figure 1. The BESIII detector and its 4 subdetectors.

2. Upgrade of the Time-Of-Flight System

For the old TOF detector, each part of it includes 48 fan-shaped, 5 cm thick, plastic scintillators and single read-out system for each scintillator. Compared to the old TOF detector, the new endcap of the TOF system[3] is replaced with Multigap-Resistive-Plate-Chamber (MRPC)[4]. As shown in Figure 2, each part of the new TOF detector endcap consists of 36 modules and 2 layers, each containing 18 modules with 12 gas layers and 24 read-out strips. The read-out system is a new version with single end but double sided. With the upgrade of MRPC, the time resolution of endcap TOF has been improved from 100 ps to 60 ps .

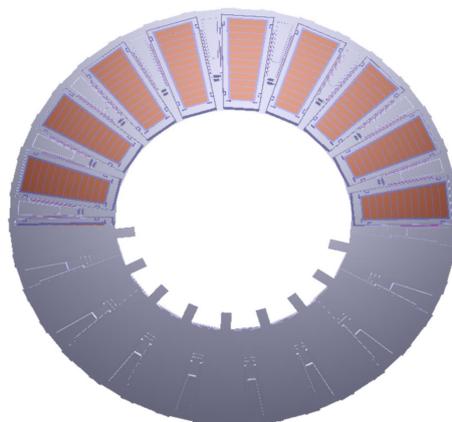


Figure 2. Detector model of the endcap TOF system with display in ROOT.

3. The Event Display System

The BESIII event display system is based on ROOT[5]. In the event display system, the geometry of the detector is described with GDML[6] files originally, which has also been converted into ROOT geometry file for faster data read-in[7]. ROOT GUI is used to build the graphical user interface for convenient interactive display.

3.1. Display of the new endcap TOF detector

In order to display the new endcap TOF detector, we converted the original GDML file into ROOT geometry. The 2D view and 3D view of the new TOF detector are shown in Figure 3 and Figure 4, respectively.

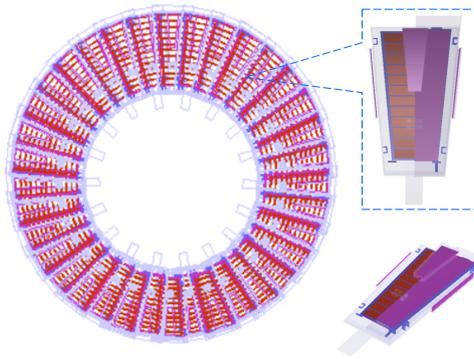


Figure 3. East endcap TOF with 36 modules and each module with 12 read-out strips.

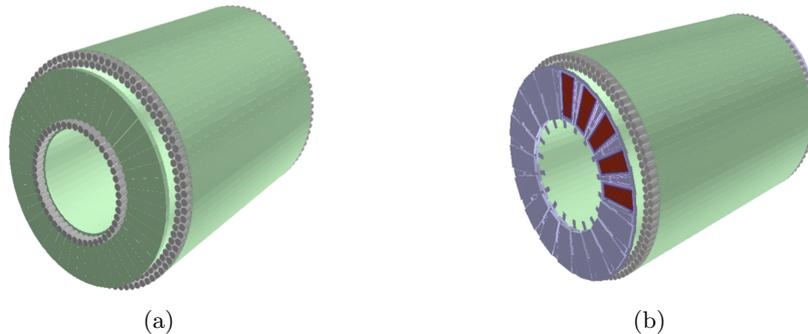
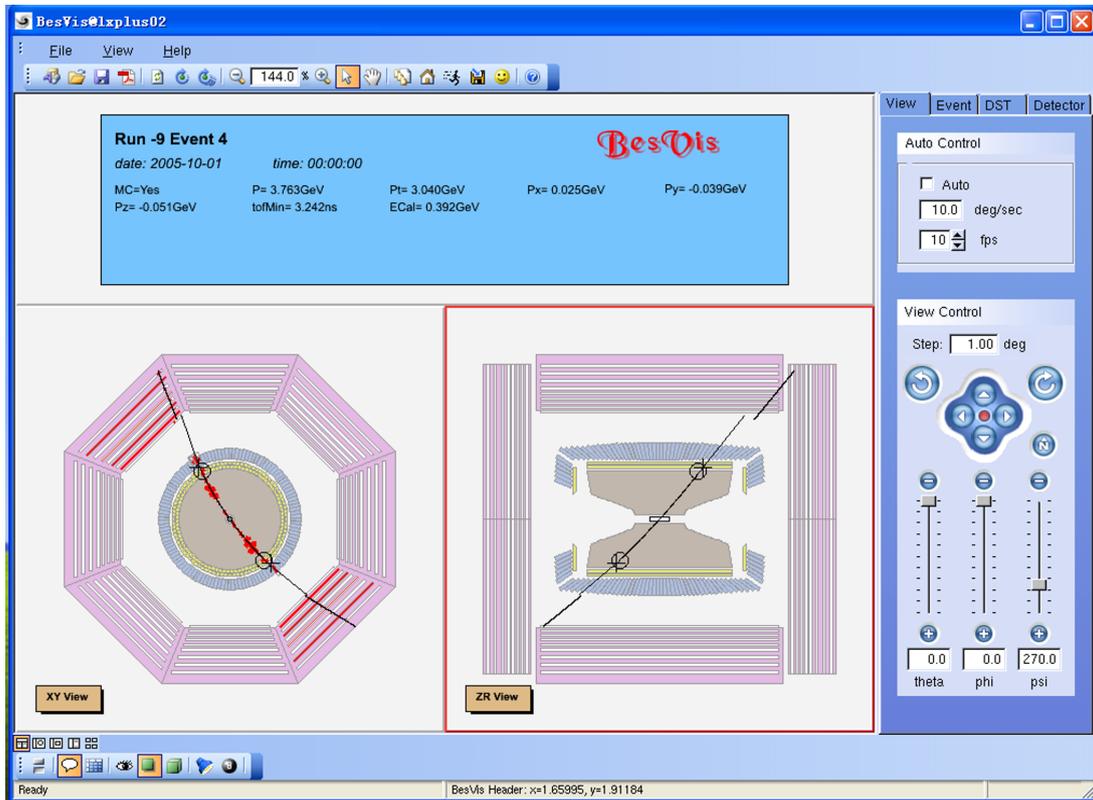


Figure 4. (a) 3D view of the old TOF with single layer scintillator endcap, (b) 3D view of the new TOF geometry with MRPC module endcap.

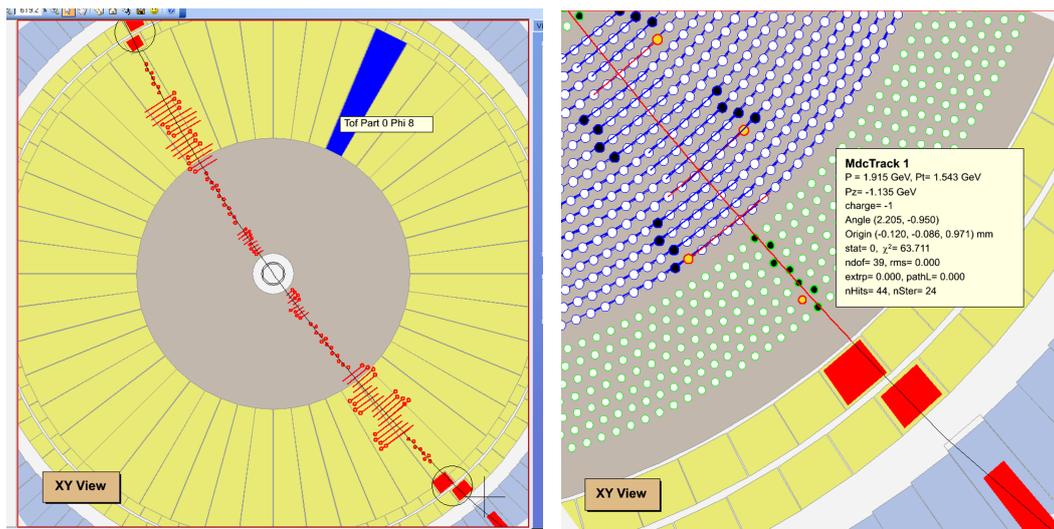
3.2. The current Event Display System

The GUI of BESIII Event Display System consists of several parts, as shown in Figure 5. The main window is the XY View and ZR View of BESIII detector geometry, and in each view window, users can zoom in or out as they like. On the top of the display window is a status window in blue, which shows the information of each event displayed below. On the right is a toolbar, where users can rotate the detectors in XY View and ZR View, choose which detector to be displayed and which event to be shown, etc. 3D display of BESIII Event Display System is shown in Figure 6.

In order to display the detector more precisely, each endcap TOF is shown as 36 ladder-shaped MRPC modules and each module has 12 ladder-shaped strips. As shown in Figure 7, one module has been divided into 12 ladder-shaped strips. If one strip is fired, it will be tagged and shown in red for highlight.



(a)



(b)

(c)

Figure 5. The Graphical User Interface of BESIII event display and 2D projection of a physics event.

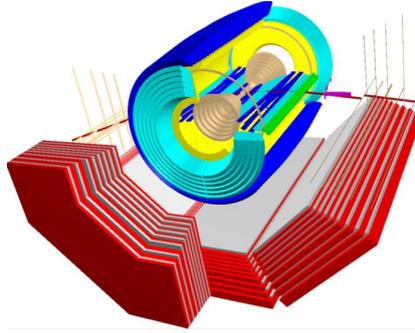


Figure 6. 3D view of a physics event in BESIII detector.

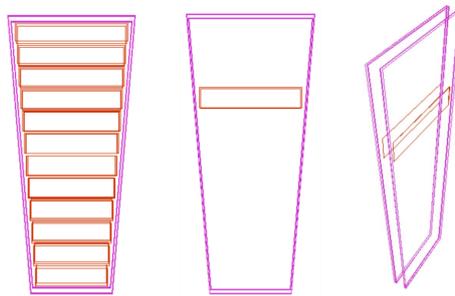


Figure 7. One module of MRPC on endcap TOF with fired strips displayed.

4. Summary

BESIII experiment provides a good chance to study τ -charm physics at the energy region of 2.0-4.6 GeV. In the BESIII detector, the TOF system plays an important role in particle identification, vertex reconstruction and so on. The upgrade of the endcap TOF system with MRPC provides a more precise Time-Of-Flight measurement on BESIII. Therefore, a better particle identification is possible and improvements for physics analyses are expected. The update of the Event Display system with the new detector geometry is necessary and the work is currently in progress.

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5. References

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