Alignment of the PHENIX Silicon Vertex Tracker (VTX) in the 2014 RUN

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During the 2014 run, PHENIX has recorded a large number (~20B) of events with the PHENIX silicon vertex tracker (VTX)[1),2)] and the Foward VTX (FVTX) combined. This dataset is also the best quality dataset of VTX since it was installed in 2011.

The VTX is located close to the interaction point of the two incoming particles. It consists of four coaxial cylindrical layers, with radii between 2.63 and 16.69 cm, covering the pseudo-rapidity range $|\eta| < 1.2$ and azimuthal angle $\Delta\phi \sim 2\pi$. The two innermost layers consist of silicon pixel sensors, and the two outermost layers are made of silicon strip-pixel sensors.

The VTX is designed to reconstruct primary and secondary vertices with a resolution better than $100\mu m$ for $p_T > 1\mathrm{GeV}/c$ as well as to significantly improve tracking performance in conjunction with other detectors, particulary the drift chamber (DC). The VTX, thus, is necessary for charm and bottom separation, and for direct measurement of D^0 meson using a distance of closest approach (DCA) of the reconstructed track from the primary vertex position.

In reality, the actual installed detector position cannot be measured by our high-precision surveys. Thus there exists a relatively large mis-alignment that will significantly degrade the resolution of the measurement.

Alternatively, the mis-alignment can be improved through the track-to-hit based alignment via software. The ideal geometry of the VTX for pixel and strip-pixel is first known by measurements of sensor positions in surveys and the design positions, respectively. The position of (hits on) the sensor is represented in a VTX coordinate system. On the other hand, the track for the alignmemt is reconstructed by the DC in a global (DC) reference coordinate system regardless of the VTX, and it is projected to the primary vertex. The relative postion between the VTX and the DC is determined by measuring a beam center in each coordinate system and then (hits on) the sensor, and the track projection is represented in the global reference coordinate system. Residual (distance between the tracks and the measured hit on the sensor plane) is used to evaluate the mis-alignment in the VTX geometry as input for the next iteration. The mis-alignment is minimized as the residual becomes 0. This procedure is iterated until convergence is reached.

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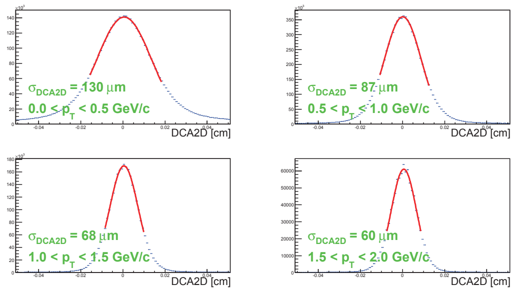

Fig. 1. DCA distributions in X-Y plane as a p_T after the alignment

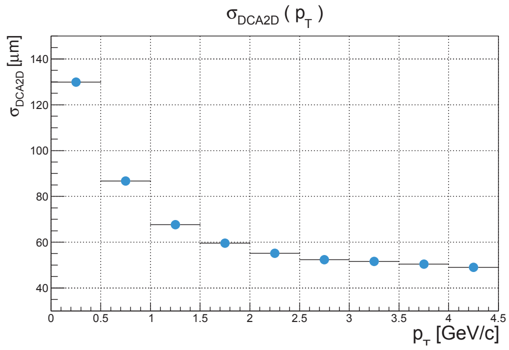

Fig. 2. Resolution of DCA in X-Y plane as a function of p_T after the alignment

The VTX alignment in the 2014 run has been successfully completed as stated above. The final results are shown in Fig. 1 and Fig. 2, which indicate DCA distributions and resolution as a function of p_T in X-Y plane after the alignment. It should be noted that deterioration of the resolution in the low p_T region ($p_T < 1\mathrm{GeV}/c$) is attributed mainly to backgrounds and multiple scattering.

We have achieved DCA resoultion of $< 70\mu m$ for $1\mathrm{GeV}/c$ of p_T, which enables precise investigation of charm and bottom physics in both the $p + p$ and Au+Au collision systems with the PHENIX detector at RHIC.

References

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