5 Conclusion and Outlook

The attempt to detect a Helix Trajectory from Time Projection Chamber data simulation was done, through Monte Carlo simulation as the closest data point example to the real situation and through simple derived helix simulation to try various noisy track on Helix Kalman Filter. In order to reduce the storage needed by ALICE, a helix track needs to be isolated and stored as helix parameter (Central Point, Radius, Momentum and Incident Angle). Although the proposed method was able to be carried out, by using Hough Transform as a two dimensional filter to get the central point and radius of the helix, then processed further by Helix Kalman Filter using the parameter produced by Hough as the three dimensional filter to classify whether a track is a helix or not. The classifier using the error calculation cannot be obtained because of the lack of dataset from Monte Carlo simulation, mainly caused because the big computing time and power.

However, the result from this project can be used as the foundation of further improvement, such as using Machine Learning method to optimize the classification of helix track or developing a Hough Helix Transform parameter space method. Increasing the dataset to train the present model is also possible, by producing a classifier threshold from error calculation.

References

[1] Nouredine Zettili. *Quantum Mechanics : Concepts and Applicationss*. 2nd Edition. United States: John Wiley and Sons Ltd, 2009.

[2] David J. Griffiths. *Introduction to Elementary Particles*. 2nd Revised ed. Weinheim, Germany: Wiley-VCH Verlag GmbH, 2008.

[3] Christian Lippmann. *A continuous-readout TPC for the ALICE upgrade*. 2017. URL: https://indico.cern.ch/event/466934/contributions/2613254/attachments/1487589/2310867/EPS_ALICE_TPC_170708.pdf (visited on 12/08/2017).

[4] CERN. *About CERN*. 2015. URL: http://lhcathome.web.cern.ch/about (visited on 12/08/2017).

[5] ALICE Matters. *The ALICE Detector Papercraft*. 2012. URL: http://alicematters.web.cern.ch/?q=tiziano_virgili (visited on 12/08/2017).

[6] ALICE Collaboration. "A Large Ion Collider Experiment". In: (1995).

[7] ALICE Collaboration. *The ALICE Time Projection Chamber (TPC)*. 2008. URL: http://aliceinfo.cern.ch/Public/en/Chapter2/Chap2_TPC.html (visited on 12/08/2017).

[8] Y. Andres J. Alme. "The ALICE TPC, a large 3-dimensional tracking device with fast readout for ultra-high multiplicity events". In: *Nuclear Instruments and Methods* (2010).

[9] Sergey Gorbunov et al. "ALICE HLT high speed tracking on GPU". In: 58 (Sept. 2011), pp. 1845–1851.

[10] J. A. Bittencourt. *Fundamentals of Plasma Physics*. 3rd. United States: Springer, 2004.

[11] Mary L. Boas. *Mathematical Methods in the Physical Sciences*. 3rd. United States: John Wiley and Sons Ltd, 2005.

[12] Yuanning Gao Bo Li Keisuke Fujii. "Kalman-filter-based track fitting in non-uniform magnetic field with segment-wise helical track model". In: *Computer Physics Communication* (2013).

[13] A. Mihul M. Pent¸ia G. Iorgovan. "MULTIPLE SCATTERING ERROR PROPAGATION IN PARTICLE TRACK RECONSTRUCTION". PhD thesis.

[14] Stefano Meroli. *Multiple scattering for particles in matter*. 2012. URL: http://meroli.web.cern.ch/lecture_multiple_scattering.html (visited on 07/07/2018).

[15] Hyper Physics. *Rutherford Scattering Formula*. URL: http://hyperphysics.phy-astr.gsu.edu/hbase/rutsca.html (visited on 07/07/2018).

[16] L. Braicovich, B. De Michelis, and A. Fasana. "Plural Scattering of Electrons and Positrons". In: *Phys. Rev.* 154 (1967), pp. 234–238.

[17] Harvard. *Multiple Scattering*. URL: https://gray.mgh.harvard.edu/attachments/article/213/06_Scattering.ppt (visited on 07/07/2018).

[18] G. R. Lynch and O. I. Dahl. In: *Nucl. Instrum. Methods Section B (Beam Interactions with Materials and Atoms)* **B58, 6** (1991).

[19] O.Voskresenskaya and A.Tarasovh. "Moliere's multiple scattering theory revisited". PhD thesis. Russia: Joint Institute for Nuclear Research, 2014.

[20] Physics Stack Exchange. *Particle Detector: dE/dX and momentum resolution*. 2016. URL: https://physics.stackexchange.com/questions/292174/particle-detector-de-dx-and-momentum-resolution (visited on 07/07/2018).

[21] S. Masciocchi. "Heavy-flavour production in ALICE at the LHC". In: *Nucl. Phys.* A910-911 (2013), pp. 83–90. DOI: 10.1016/j.nuclphysa.2012.12.059. arXiv: 1210.3392 [nucl-ex].

[22] ALICE Collaboration. "Technical Design Report for the Upgrade of the ALICE Time Projection Chamber". In: (2014).

[23] S. Palestini and K.T. McDonald. "Space Charge in Ionization Detectors". PhD thesis. CH-1211, Gen'eve 23, Switzerland: Physics Department, CERN, 2016.

[24] Roger A. Salguerond Keaton Holappa Matthew B. Rhudy. "A KALMAN FILTERING TUTORIAL FOR UNDERGRADUATE STUDENTS". In: *International Journal of Computer Science and Engineering Survey* 8 (2017).

[25] CERN. "A ROOT Guide For Beginners". In: (2017).

[26] CERN. *ALICE Off-line Project*. 2015. URL: https://alice-offline.web.cern.ch/ (visited on 12/08/2017).

[27] N. H. Lestriandoko and R. Sadikin. “Circle detection based on hough transform and Mexican Hat filter”. In: *2016 International Conference on Computer, Control, Informatics and its Applications (IC3INA)*. Oct. 2016, pp. 153–157. DOI: 10.1109/IC3INA.2016.7863041.