A RANGE SYSTEM PROTOTYPE GEOMETRY AND CLUSTERING

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OUTLINE

- Description of the geometric model of the muon system prototype
- Clustering algorithm implementation

SPD EXPERIMENT

- The purpose - to study the spin structure of the proton and deuteron and other spin phenomena.
- The installation is planned to be placed at one of two beam collision points of the NICA collider.

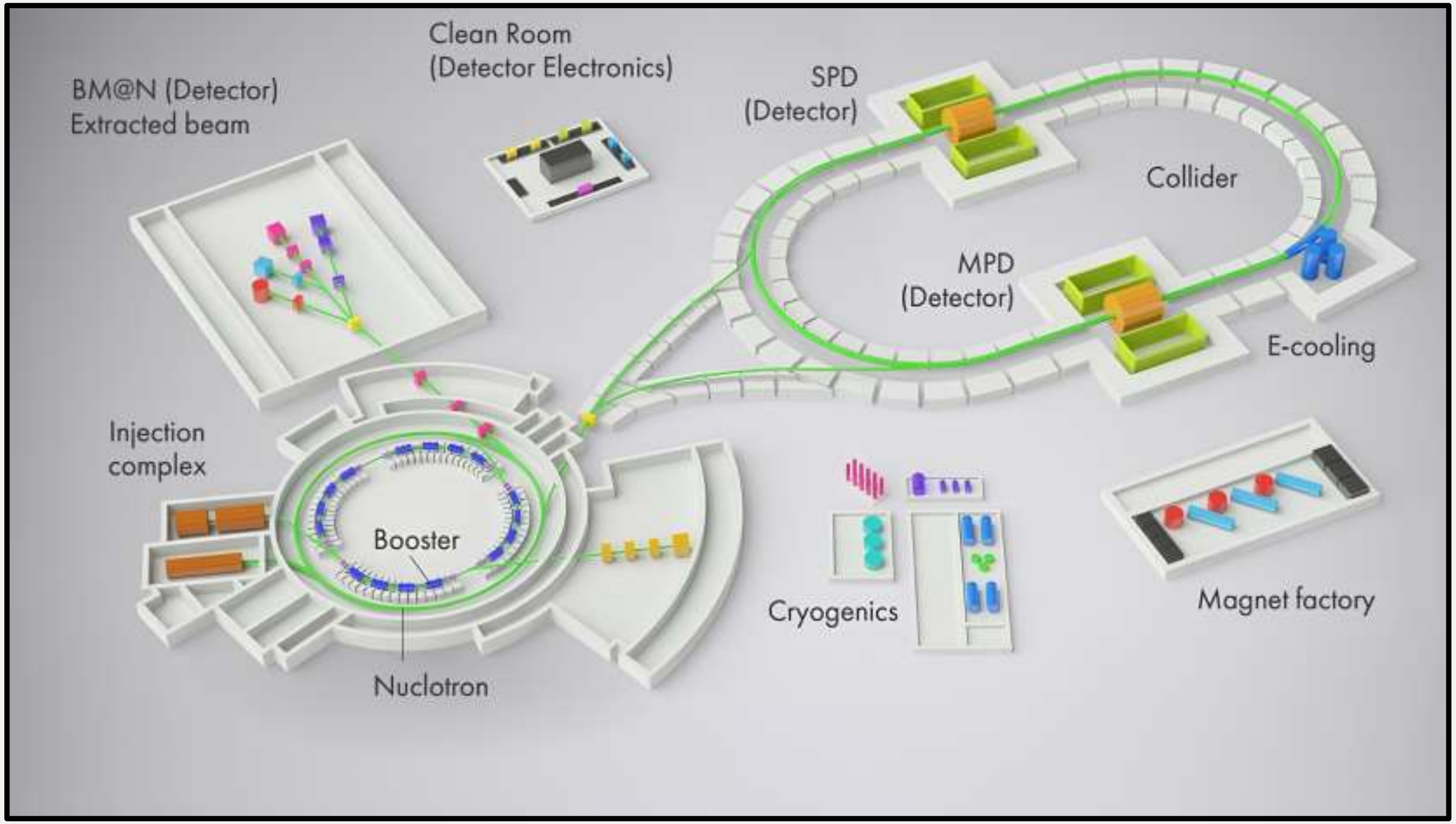


Fig. 1 NICA accelerating complex

MUON (RANGE) SYSTEM

- The goal – to identify muons in the presence of a significant hadron background and estimate hadron energy.

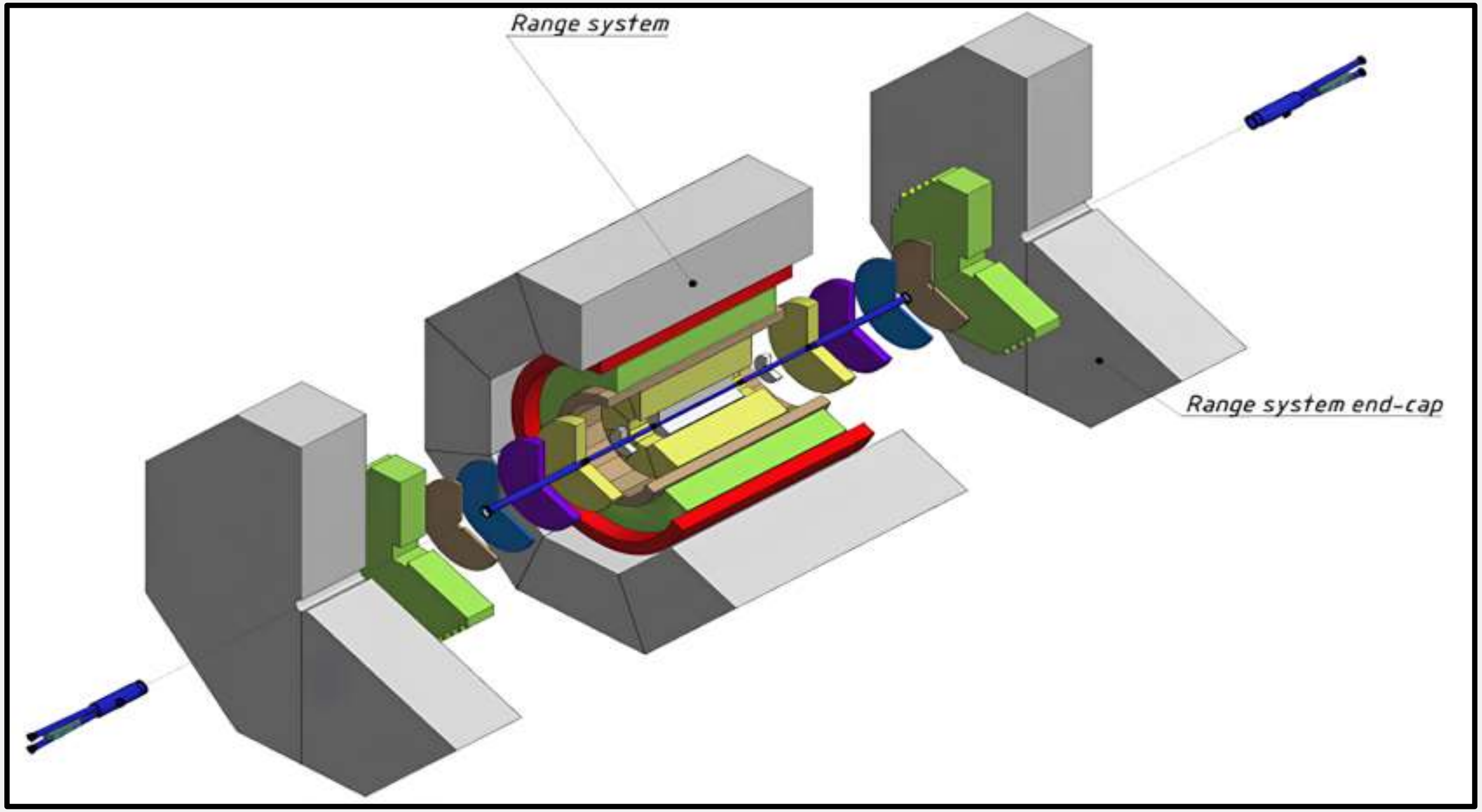
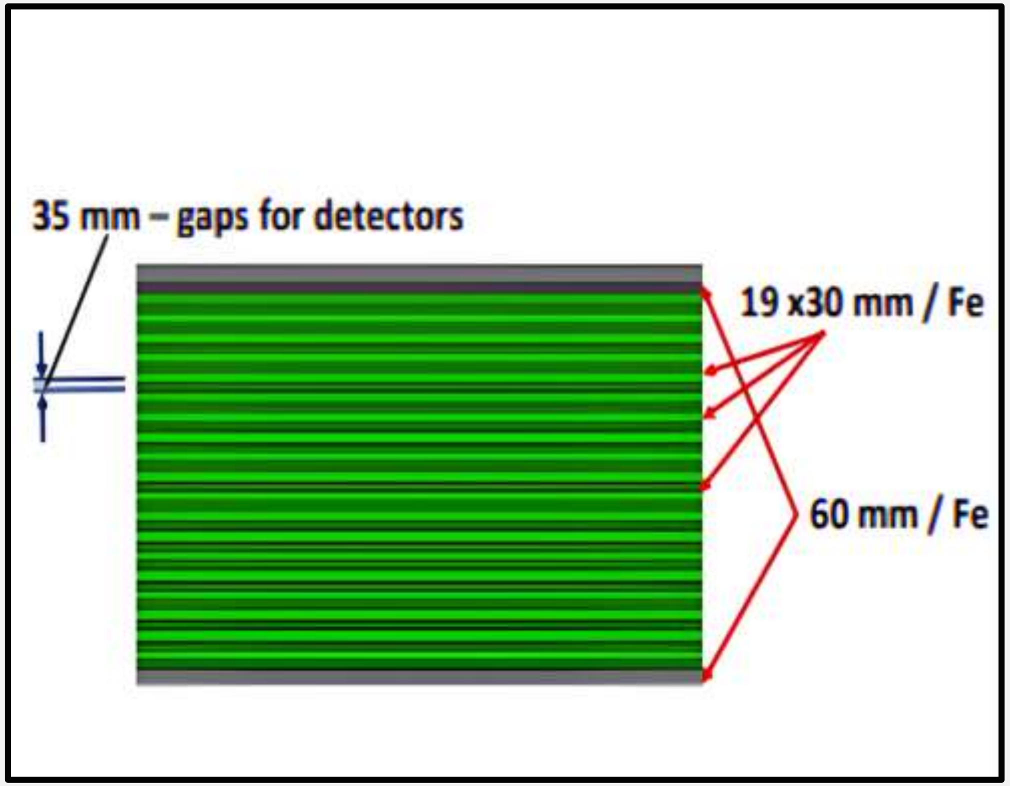


Fig. 2 The range system in the SPD setup

MUON (RANGE) SYSTEM

- Consists of an eight-module barrel and two endcaps.
- Mini Drift Tubes (MDT) detectors and readout electronics are placed in the interlayer gaps.



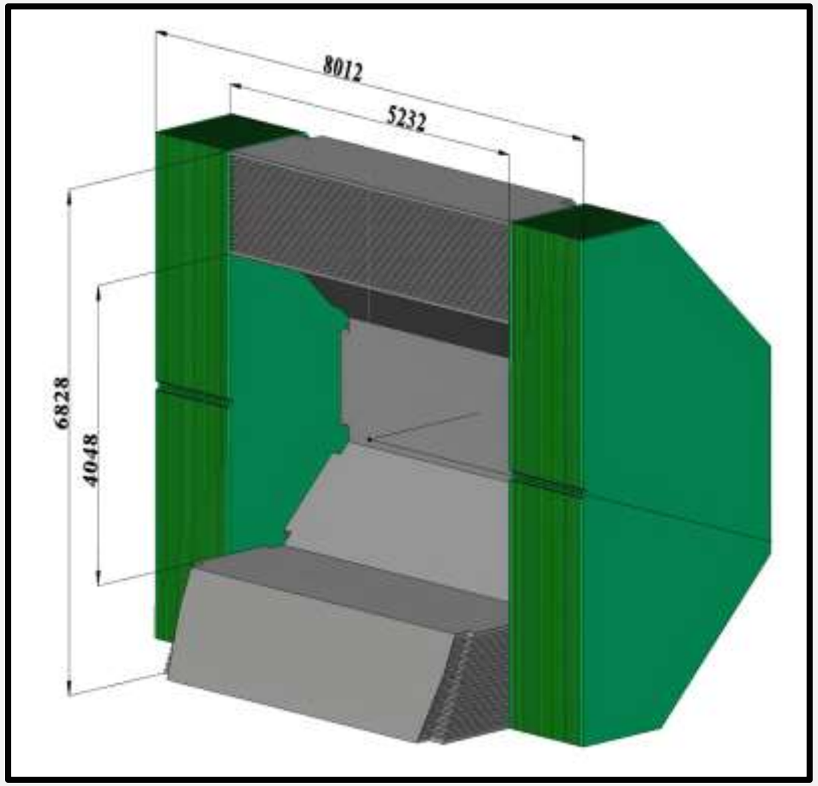
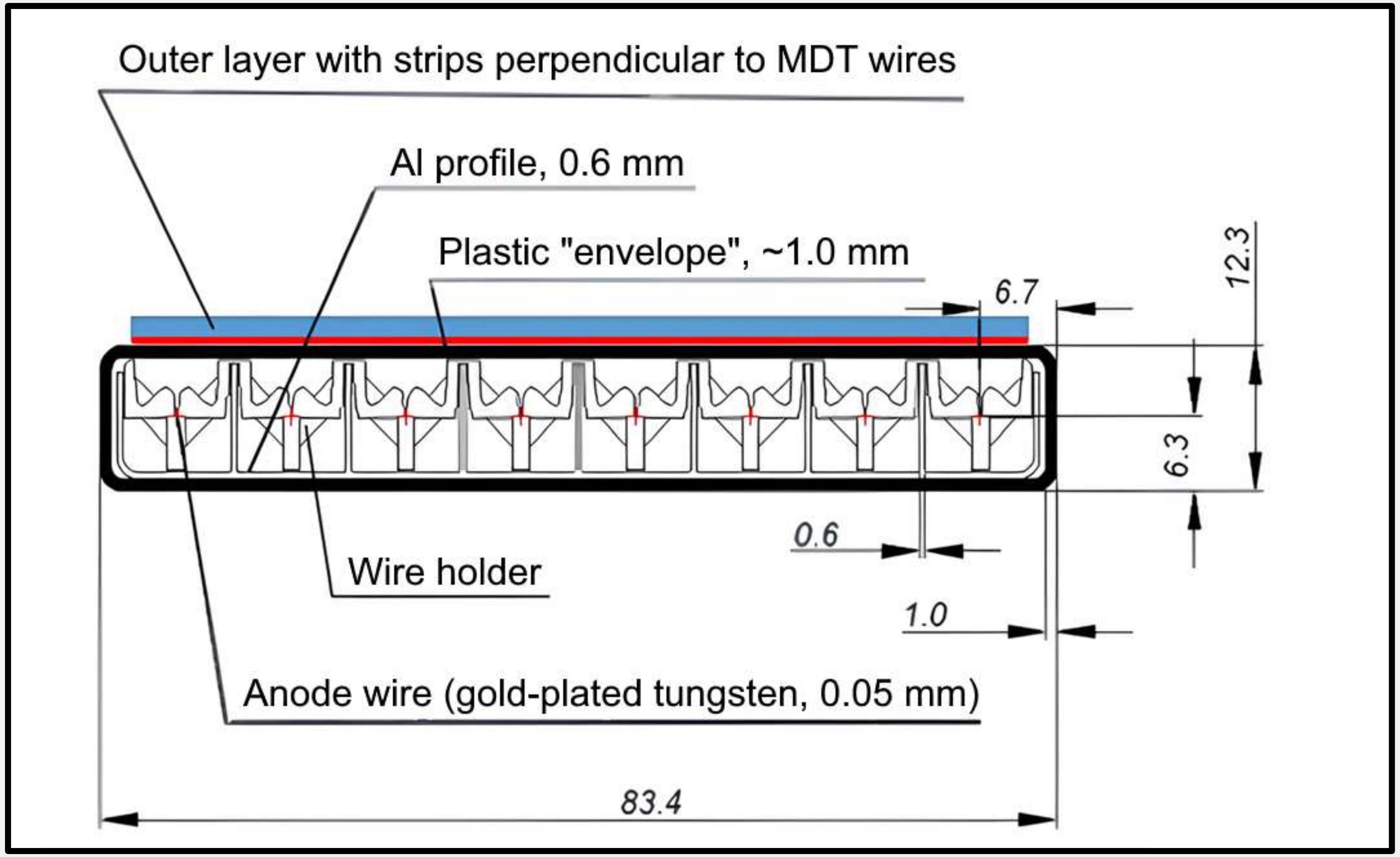


Fig. 3 Left - cross section of the detecting parts of the range system, right - schematic view of the system

RANGE SYSTEM PROTOTYPE

- MDT detector consists of eight cells filled with a gas mixture Ar + CO_2.
- 6 MDTs combined into one detector plane.
- The iron body contains 16 detector planes with iron absorbers in step of 35 mm for electronics.



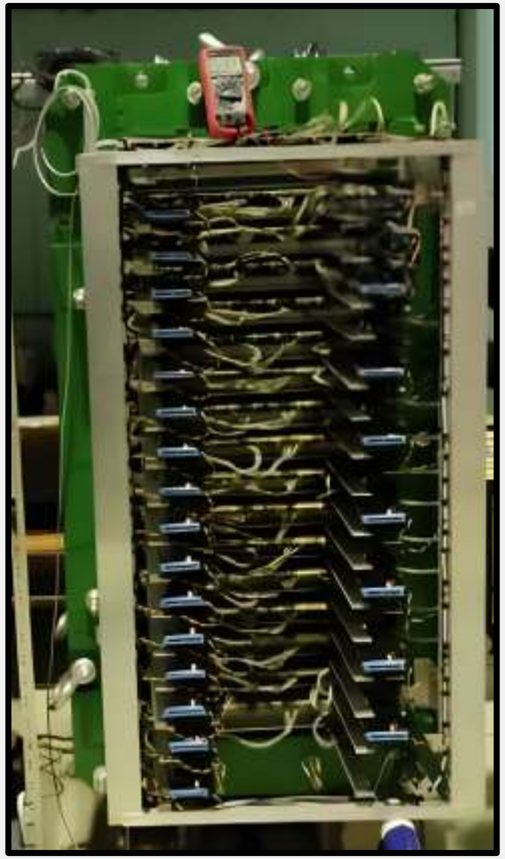


Fig. 4 Left - cross section of the MDT detector, right – the real prototype

RANGE SYSTEM PROTOTYPE MODEL

- The range system prototype’s geometric model has been created.
- Active interaction zones are located in detector planes, iron absorbers and the body.
- The model was integrated into the SpdRoot software package.

Fig. 5 The geometric model of the prototype range SPD system

EVENT SIMULATION

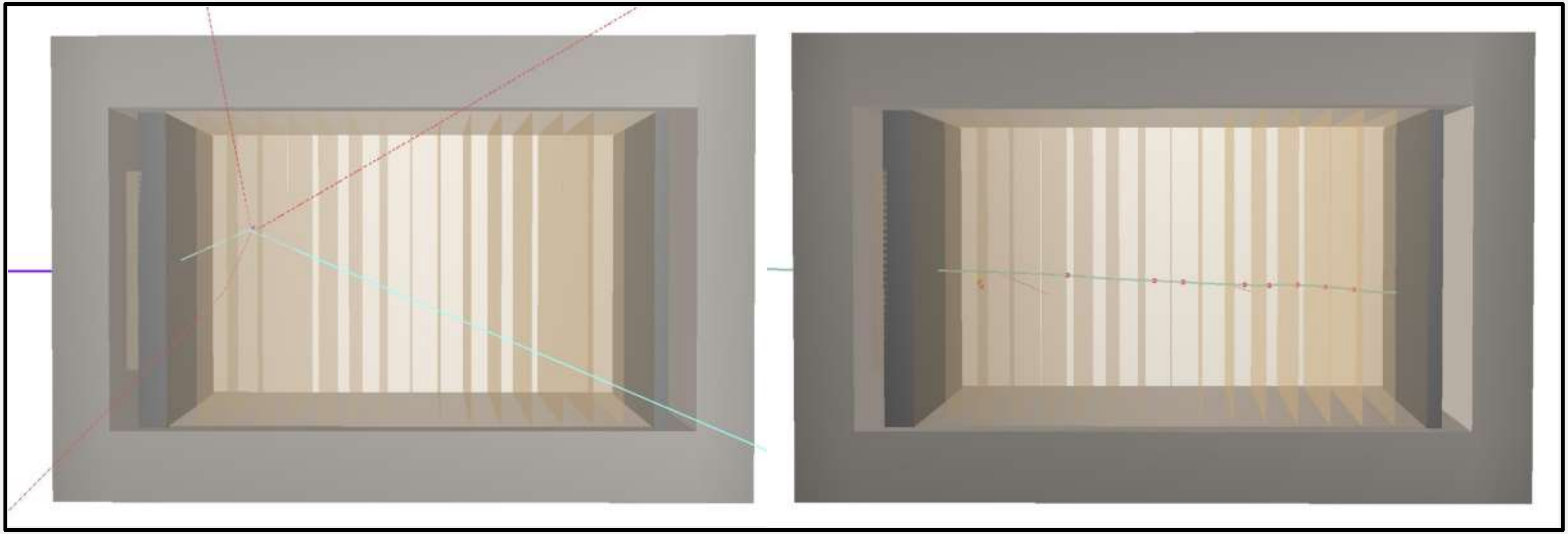


Fig. 6 Passage of a proton and a muon with an energy of 1 GeV through the prototype
Left – proton, right – muon

EVENT SIMULATION

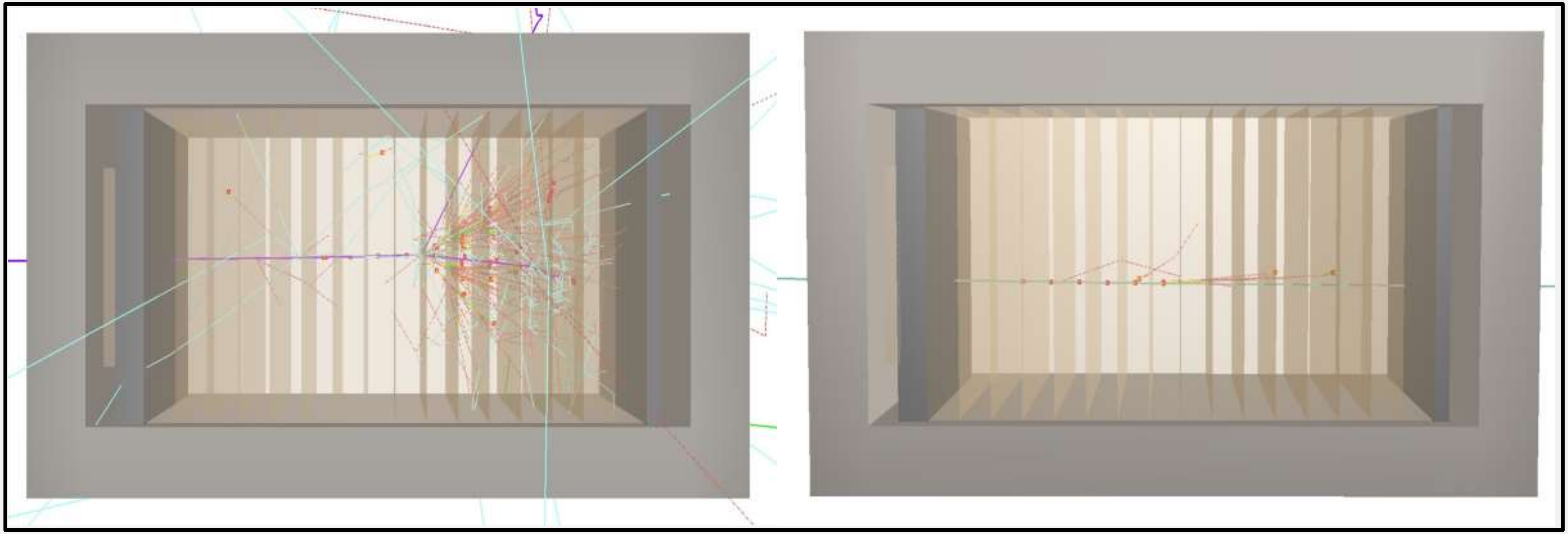


Fig. 7 Passage of a proton and a muon with an energy of 10 GeV through the prototype
Left – proton, right – muon

DBSCAN CLUSTERING ALGORITHM

A clustering method that identifies clusters based on spatial density of points. It works particularly well with free-form clusters and deals with noise in the data.

Key concepts:

- ε-neighborhood of point p, denoted as N_ε(p)
- MinPts (Minimum number of points in the ε-neighborhood of point p)
- Core Point
- Border Point
- Noise Point

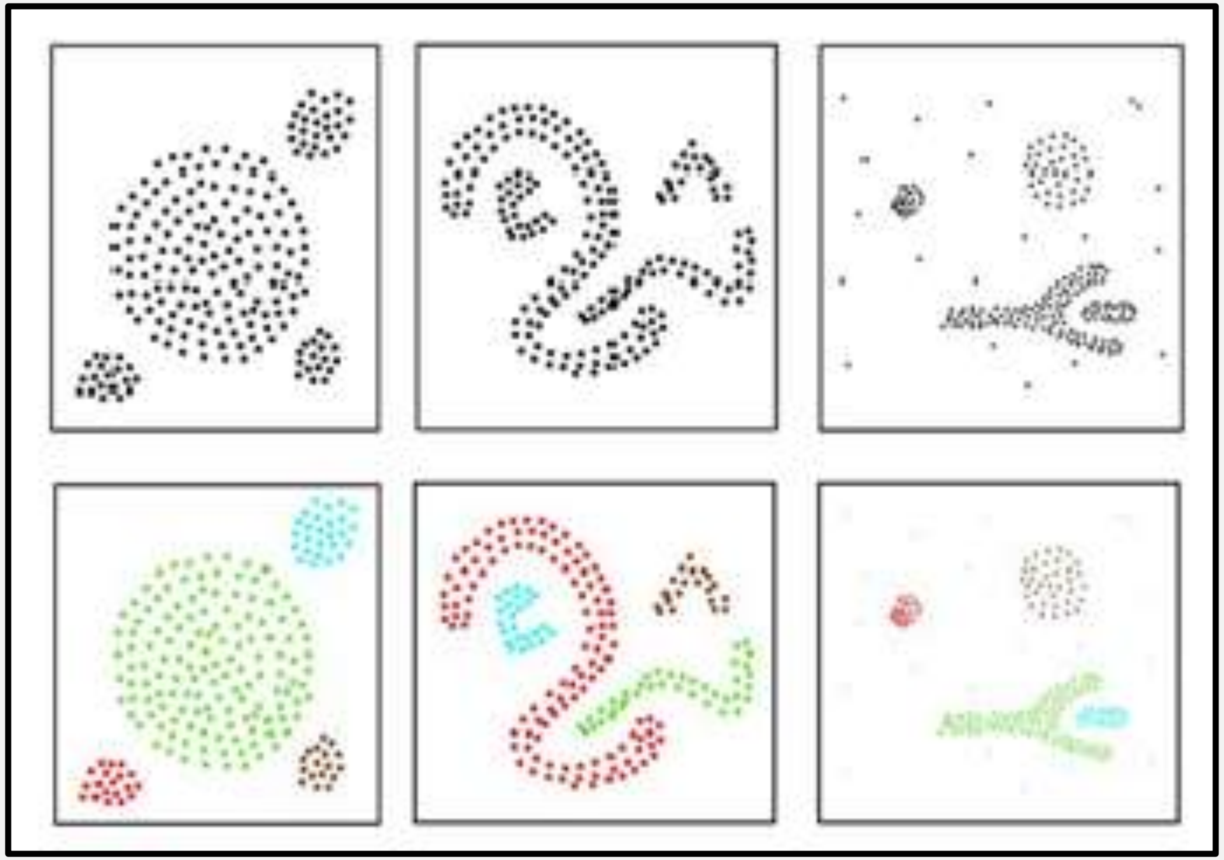


Fig. 8 Illustration of how DBSCAN works

Above is the original set of points, below is the result of the DBSCAN algorithm

DBSCAN CLUSTERING ALGORITHM

- Since there is no DBSCAN algorithm in the standard C++ library, it was implemented in this language for further integration into SpdRoot.
- The results of the DBSCAN algorithm from the Python library sklearn and the algorithm implemented in C++ were compared.

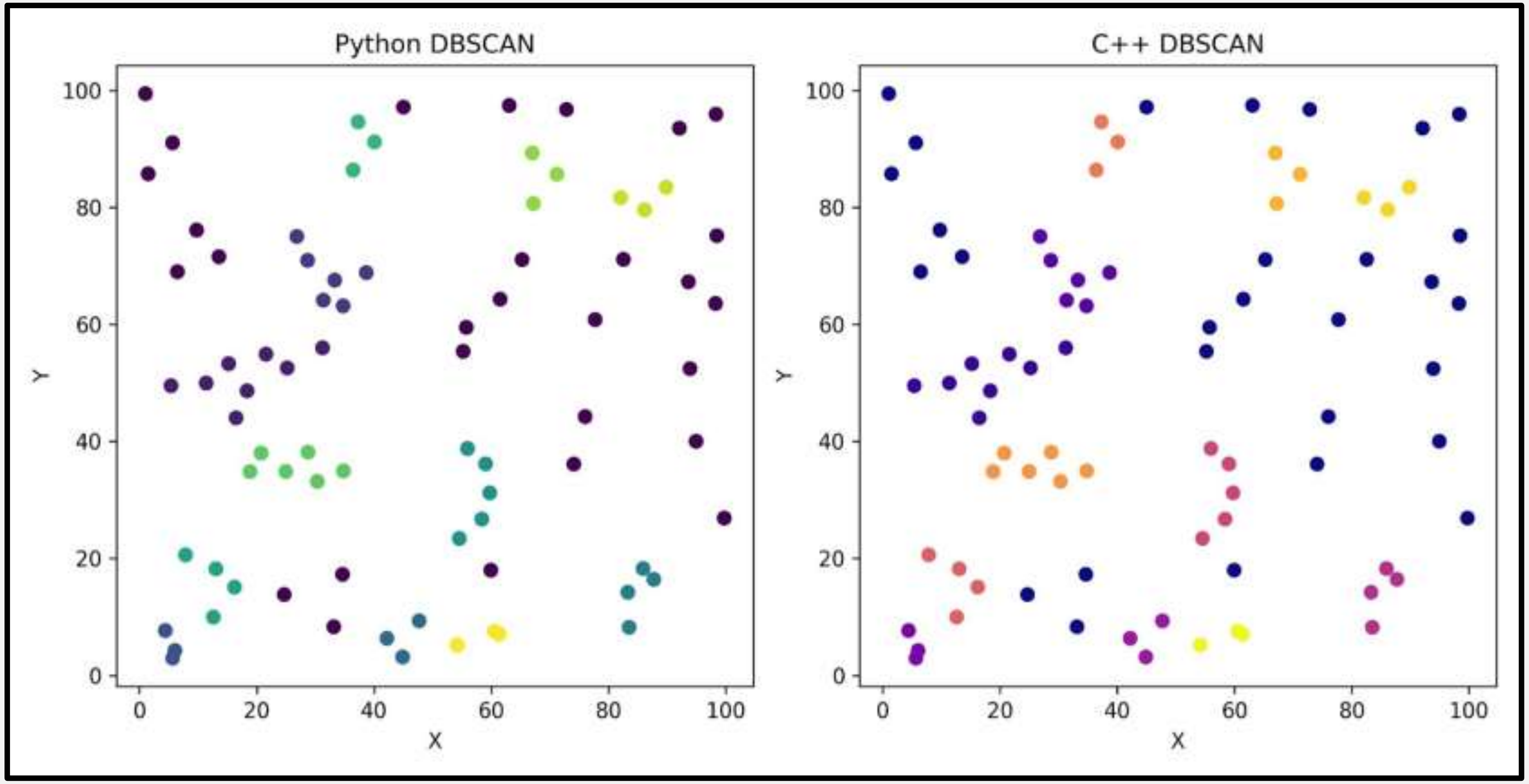


Fig. 9 Results of the DBSCAN algorithm in python and C++ implementations compared

EXAMPLE OF AN EVENT FOR A J/Ψ MESON

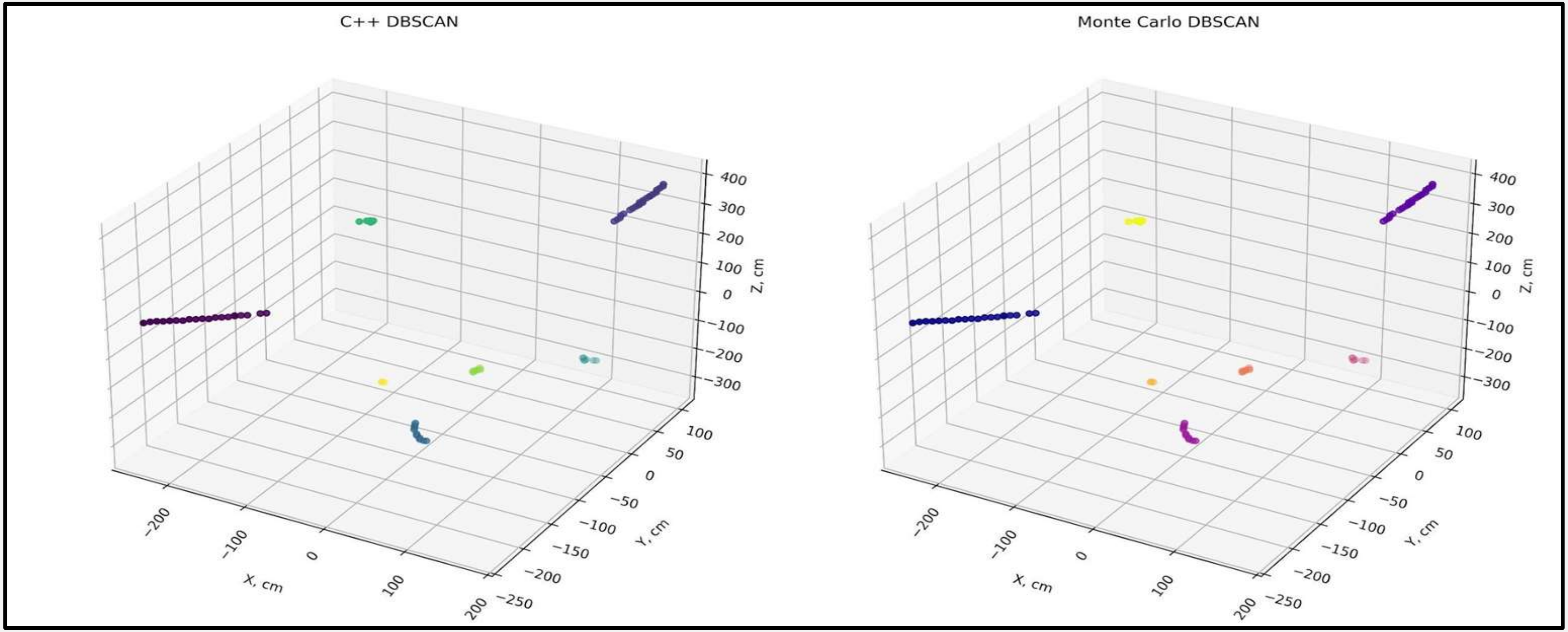


Fig. 10 Visualization of point clustering in one of the events for J/ψ

CONCLUSION AND PLANS

Conclusion

- geometry model of the range system prototype is done, implemented into SpdRoot
- DBSCAN algo rewritten using C++, implemented into SpdRoot too

Plans

- It is necessary to select the input parameters of the algorithm to create clusters from previously received hits.
- It is also necessary to evaluate the correctness of the cluster creation using parameters such as V-measure and clustering purity.