Unsupervised learning techniques for tune cleaning measurement (MOPAB184)

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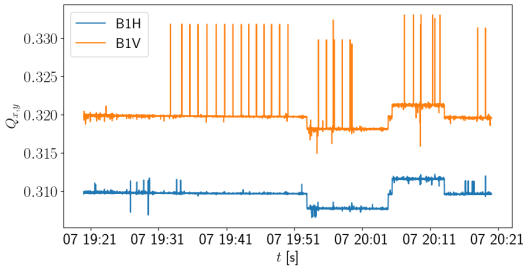
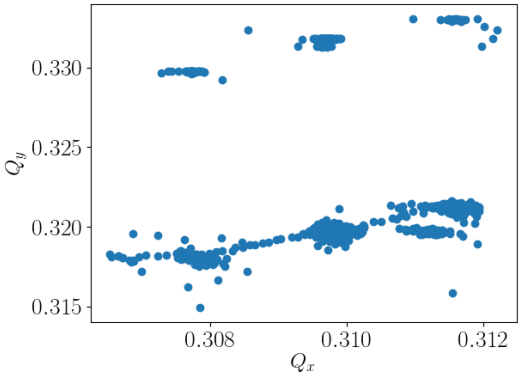
Tune measurement cleaning

- Due to different mechanisms, tune measurement might be pretty noisy.
- Some outlier clearly visible in the tune time series.



- In the (Q_x, Q_y) plane, outliers and noise is also clearly visible.



Classical cleaning

Based on linear interpolation. If a measured point deviates a certain distance from the liner trend, it is considered noise. It does not work when the behaviour is not linear or there are sudden changes.

DBSCAN

Given a set of points, groups together points that are closely packed together, marking as outliers points that lie alone in low-density regions.

Isolation Forest

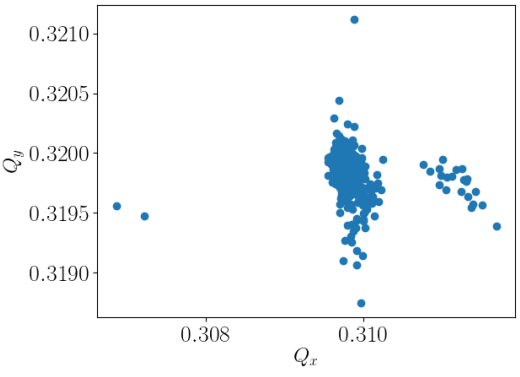
Based on the principle of isolating anomalies. The contamination parameter takes into account the expected number of outliers in the sample.

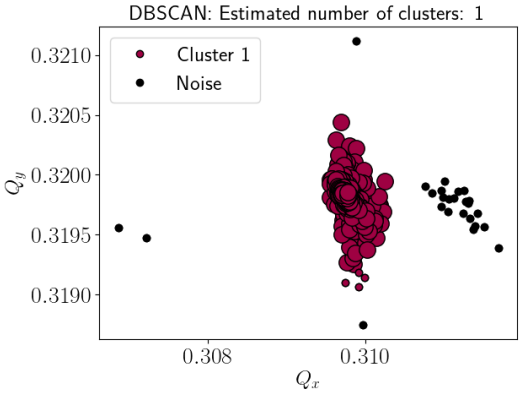
Local Outlier Factor

Based on a concept of a local density. By comparing the local density of an object to the local densities of its neighbors, one can identify regions of similar density, and points that have a substantially lower density than their neighbors.

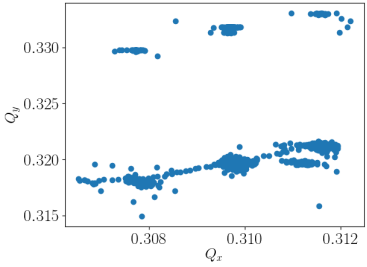
Example: A simple one

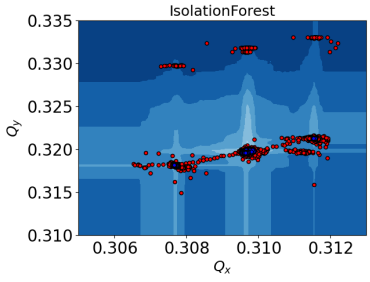
Raw measurement

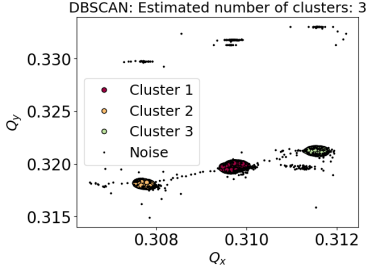


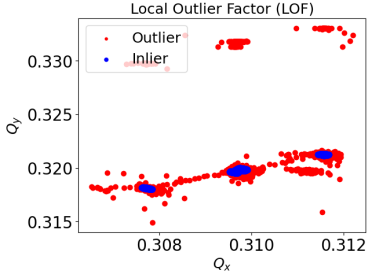


Example: When the tune jumps









- First step towards a better measurement of tune in order to reduce its uncertainty using Machine Learning techniques.
- Different algorithms have been compared to traditional cleaning techniques.
- In many situations, machine learning tools are a more flexible and reliable tool for cleaning the tune measurement with respect to classical cleaning tools.
- DBSCAN is the one that performs best, while at the same time as as being the most intuitive.
- Next steps include a more detailed quantitative analysis of the algorithms.
- This new approach can be easily implemented in other accelerators.