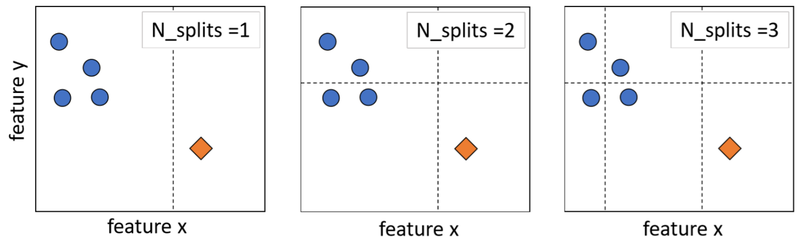
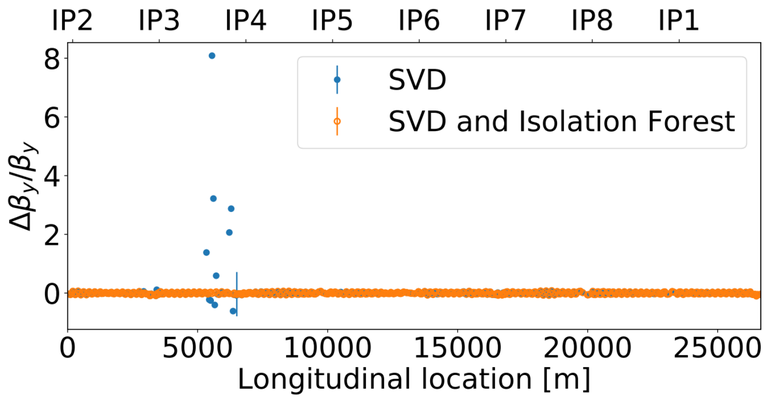
BPM Faults diagnostics: operational example

➡ **Faulty BPMs diagnostics as anomaly detection task (Isolation Forest algorithm)**





Thanks to ML:

Detection of otherwise unexplored hardware and electronics problems in beam instrumentation

Summary:

- Traditional methods limitation: BPM faults degrade the quality of optics measurements, manual cleaning is needed
- Method: Anomaly detection using Isolation Forest algorithm
- Challenges/ risks: removing good signal, tests in operation
- Implementation: fully operational in the LHC, applied any time when analysing optics from turn-by-turn data
- Measures: communicate the founding to Beam Instrumentation experts, diagnostics of actual hardware/electronics faults guided by the information provided by the algorithm

Potential collaborations:

• Application on other instrumentation/ other machines

• Comparison to similar methods applied in other accelerators

➡improve the understanding which methods are most suitable for specific cases.

Emittance optimization for muon collider: bunch cleaning

Summary:

- Final cooling channel for muon collider: design a lattice consisting of solenoid fields, absorbers, drifts, RF systems to minimise transverse emittance, controlling the longitudinal emittance

➡ Energy-time correlation to be corrected

- Current limitation: including all particles leads to overestimation of emittance, the bunch rotation to be optimized does not correct the energy spread properly.
- Traditional “3 sigma-cut” not always helpful, strongly non-gaussian bunches
- Method: clustering, anomaly detection
- Implementation: integrated into optimization framework (Python (BO, bobyqa), RF-Track simulations)
- Measures: luminosity increase with the emittances achieved in Final cooling

Potential collaborations:

- Optimization WG
- Design and optimization of other future accelerators

*Finding “relevant” particles using Isolation Forest algorithm for anomaly detection**

Problem: “outlier”-particles in the tails

- *3-sigma cut not always effective*
- *Stronger cuts? How to determine?*
- *Thresholds which are always valid?*