MOPP21

IBIC 2021 International Beam Instrumentation Conference

# RESEARCH ON RESOLUTION OF ORBIT BASED ON CLUSTERING ANALYSIS AND BP NETURAL NETWORK IN SSRF

jiangruitao@sinap.ac.cn

**Authors: R. T. Jiang†, N. Zhang, Y. M. Deng, Y. B.Leng†**

Shanghai Advanced Research Institute, Chinese Academy of Sciences, Shanghai, China

Shanghai Synchrotron Radiation Facitity(SSRF)

## Abstract

Keeping the beam current's normal motion is an im-portant mission for Shanghai Synchrotron Radiation Facility (SSRF). So the Orbit (rms)x/y is an main parameter for SSRF's running. However, the orbital resolution has been constrained by the accuracy of acquired data. To eliminate BPM's failure causing the inaccurate orbital resolution, the work based on clustering analysis and BP neural network to removed the abnormal BPM and recalculate the resolution of orbit. Experiment data came from the machine research. The analysis results showed that the rms value of orbit was 100.75μm (x direction) and 14.9μm (y direction) using all BPM's data but the recalculate value was 98.03μm (x direction) and 2.6μm (y direction) when eliminated the data of faulty BPM. The analysis result indicated that the method can optimize the resolution of orbit and next work is further to evaluate the orbital resolution with more operation data.

## Background

- Beam Position Monitor (BPM) system is an essential diagnostic tool in storage ring of a light source.
- As a user facility, beam stability is of utmost importance and high priority. High beam stability is one of the most fundamental processes used for beam control in accelerators.
- With development in machine learning methods, a series of powerful analysis approaches make it possible for detecting beam position monitor's stability.
- Cluster analysis and BP netural network can joint use to monitor the stability of beam orbit.

## Beam experiment

**Acquisition system layout**

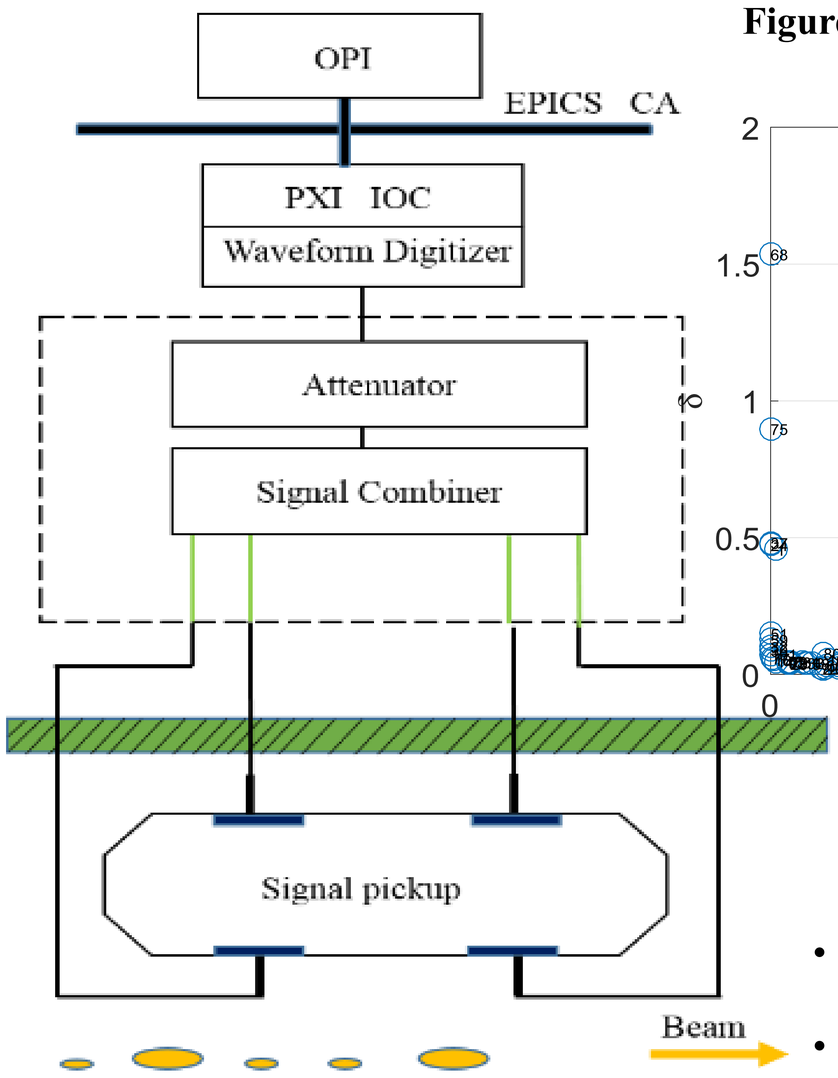



**Figure 1: Acquisition system layout**

**Figure 2 is scatter diagram, so it is omited**

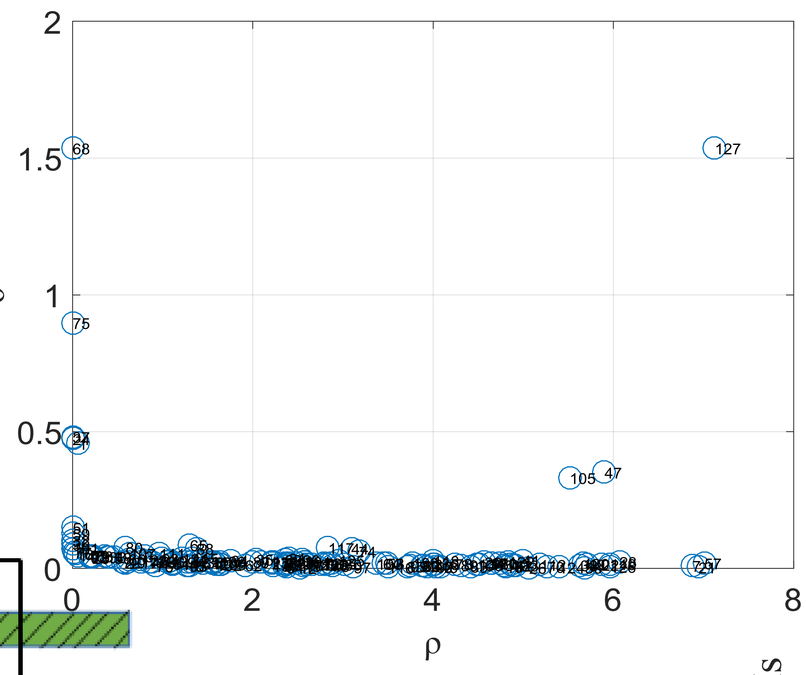



**Figure 3: Decision graph**

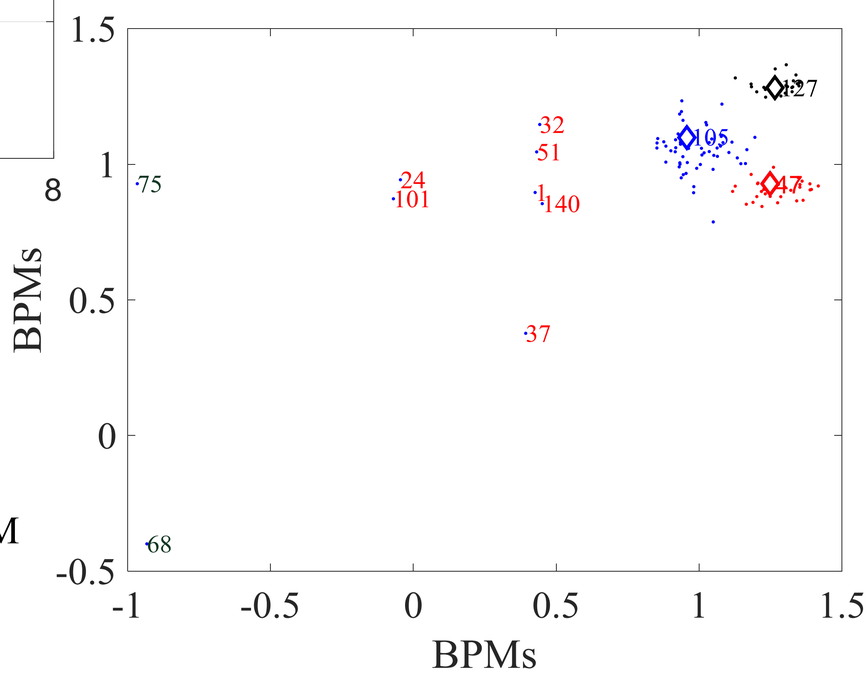
- **68#** BPM and **75#** are malfunction
- **24#, 32#, 1#,37#, 51#** and **101#** BPM were worse performance BPMs

**Cluster analysis locating faulty BPM**

High δ and relatively High ρ are the cluster centers

High δ and relatively low ρ are the abnormal value

**Figure 4: Clustering analysis results**




## Re-fitting the beam orbit

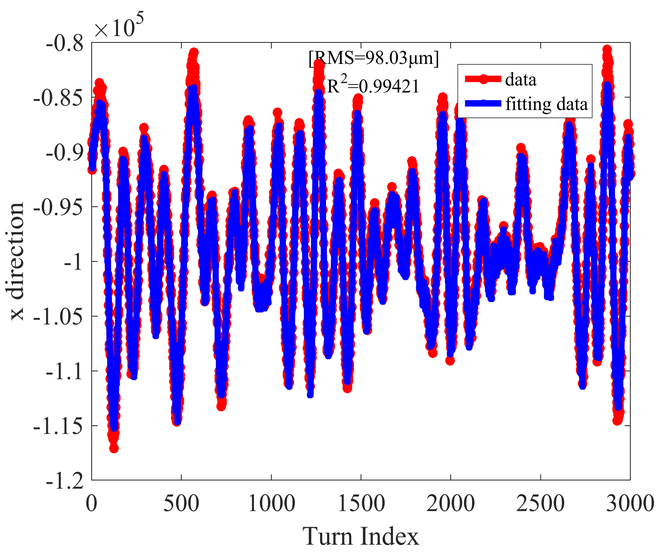



**Figure 5: The beam orbit of X direction**

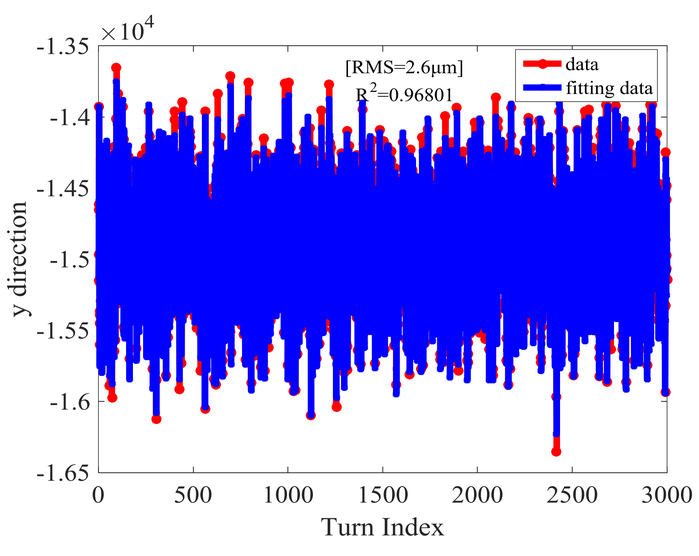



**Figure 6: The beam orbit of Y direction**

## Conclusion and prospect

- The decision graph could depict the faulty BPMs and find the number of clusters.
- The analysis results showed that the rms value of orbit was 100.75μm (x direction) and 14.9μm (y direction) using all BPM's data but the recalculate value was 98.03μm (x direction) and 2.6μm (y direction) when eliminated the data of faulty BPM.
- Cluster analysis and BP netural network can joint use to monitor the stability of beam orbit.
- The validity of result needs more beam experiment data to back it up.

[1] Rodriguez et al., Clustering by fast search and find of density peaks. Science, vol.344, no.6191, pp. 1492, 2014.
[2] Leng Y B et al., Beam position monitor system for SSRF storage ring, Nucl Sci Tech, vol.33, no.6, pp.401–404, 2012
[3] A.L. Edelen et al., Neural networks for modeling and control of particle accelerators, IEEE T NUCL SCI, vol.63, no.2, pp.878–897, 2016.