LEAPS League of European Accelerator-based Photon Sources

Artificial Intelligence at NSRC Solaris

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LEAPS Integrated Platform Workshop

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PART I

Beam position controlled by Neural Network

Michał Waniczek

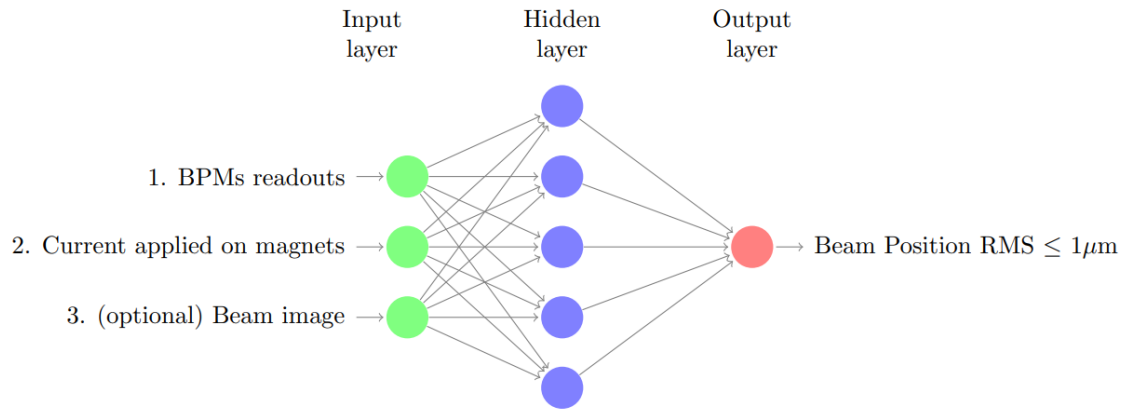
Neural Network for controlling electron beam position @ NSRC Solaris

- Project Goal: Neural Network allowing for correction of electron beam position using data from:

    1. electron BPMs readouts in storage ring
    2. power supplies applying current on both main and corrector magnets
    3. (optional) cameras imaging the beam

- Project Milestones:

    a) Project Goals and Requirements approval
    b) Completion of Neural Network implementation
    c) Completion of beam position correction algorithm based on Neural Network



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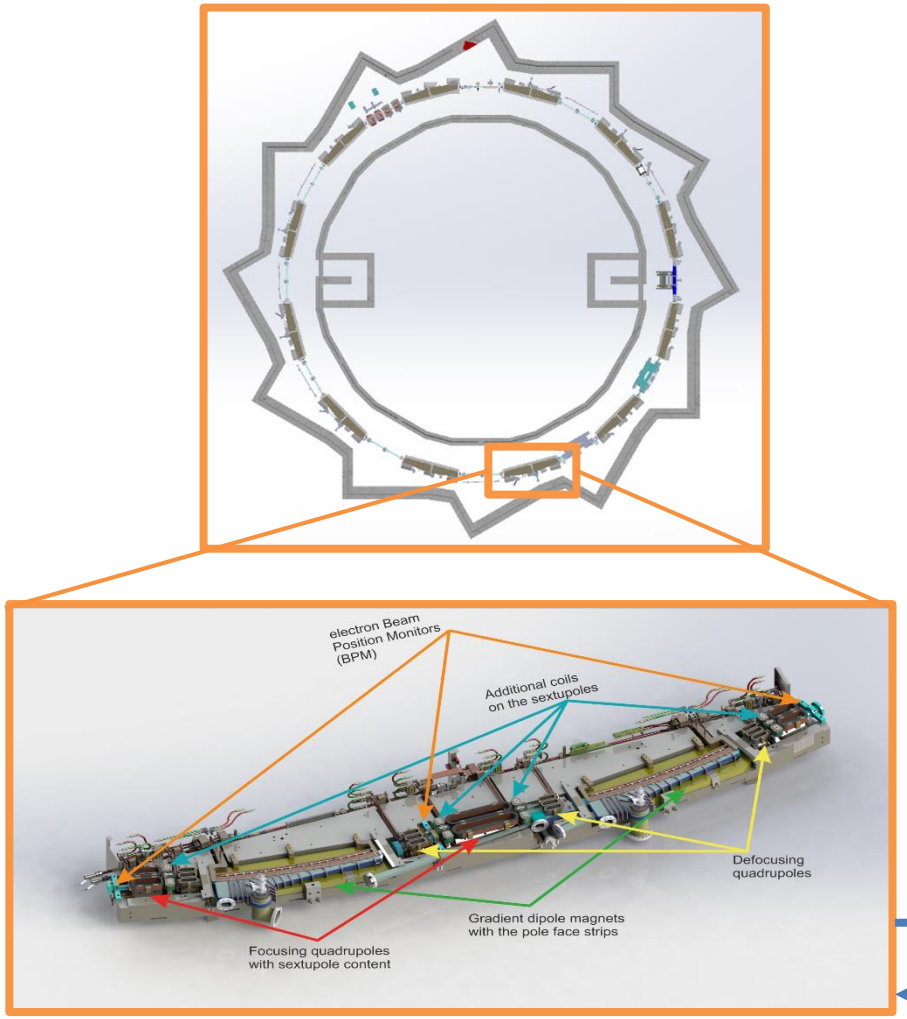
Input for Neural Network



Beam profile data

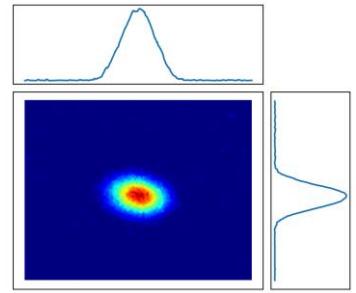
Magnets Power Supply Data

Electron beam position in X and Y plane

INSTRUMENTATION TECHNOLOGIES

Libera Brilliance+

Magnets Power Supply



Raw signals from BPM's A, B, C and D channels

Current value set on DBA's magnets

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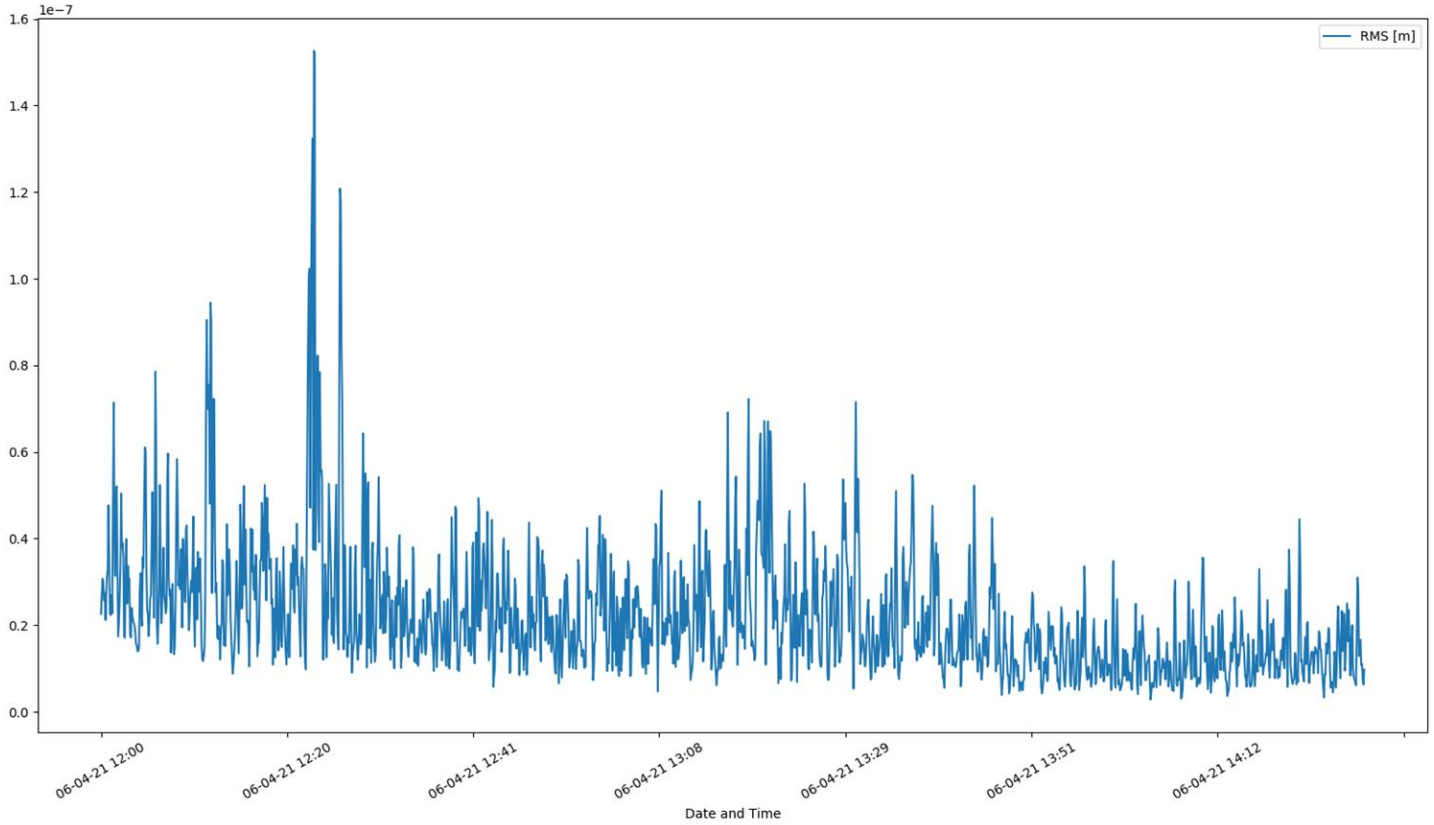
Summary

- Neural Network controlling electron beam position as a starting point for more advanced Deep Learning Project @ NSRC Solaris
- Number of hidden layers to be modified depending on Neural Network performance tests
- Reason to implement Neural Network only controlling the electron beam position is its simplicity in performance evaluation. It is easy to compare NN performance with standard methods used to control the electron beam
- Hopefully, well designed and implemented NN will contribute to the lower electricity power consumption in comparison with the currently used methods controlling electron beam
- The determinant of a well-functioning NN should be minimized value of RMS (< 1μm), example shown in picture on the right side.



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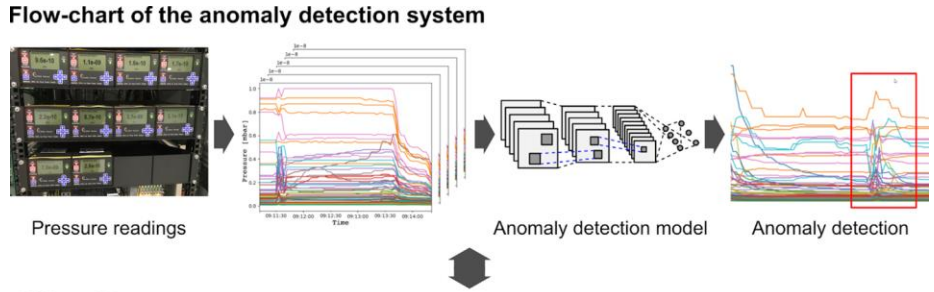
Part II

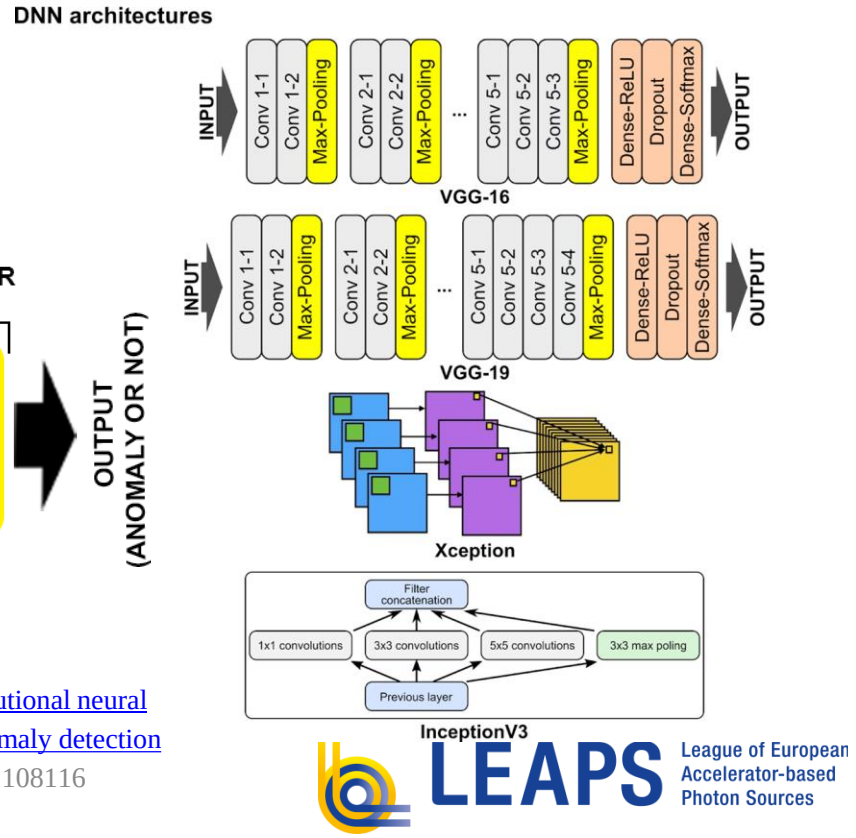
Deep Neural Network for Anomaly Detection in Multivariate Signals

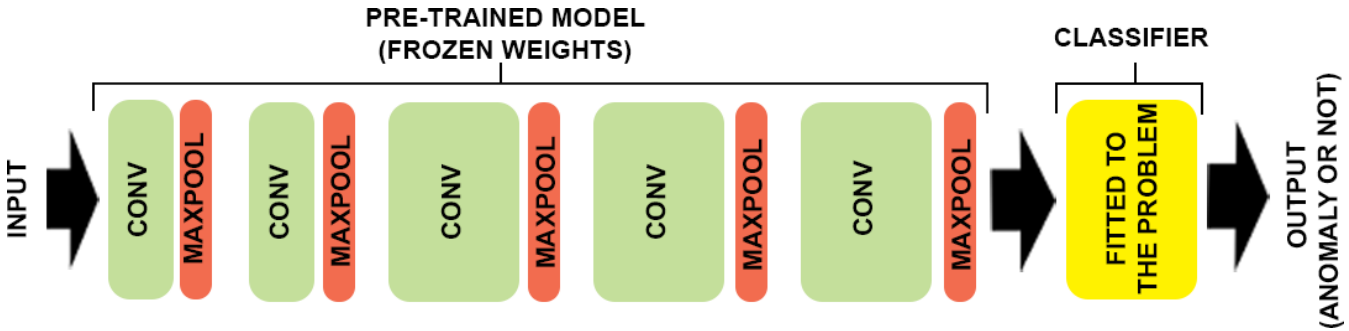
Michał Piekarski

Anomaly Detection @ NSRC Solaris - Preliminary works

- The proposed solution detects anomalies in time windows with 92% accuracy and 85.5% precision
- Just a preliminary result - it has been used to develop a final system
- Work performed as a master's thesis







Preliminary research has been published:

Michał Piekarski, Joanna Jaworek-Korjakowska, **Adriana I.Wawrzyniak**, Marek Gorgon, Convolutional neural network architecture for beam instabilities identification in Synchrotron Radiation Systems as an anomaly detection problem, Measurement, Volume 165, 1 December 2020, 108116, DOI: 10.1016/j.measurement.2020.108116

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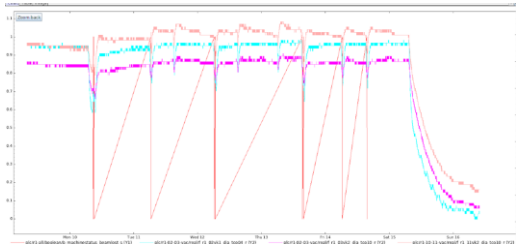
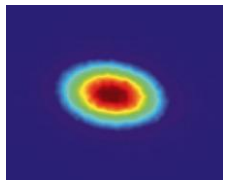
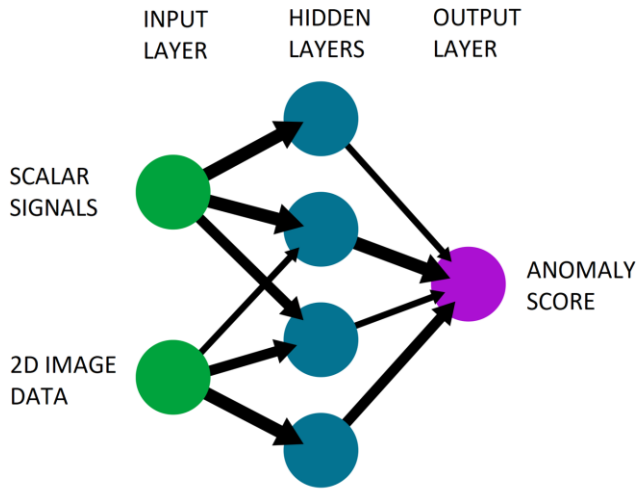
Plans for the model

- An **end-to-end** anomaly score learning framework addressed for HD diagnostic signal datasets will be proposed
- The **interpretability** analysis will allow us to locate the features that are responsible for large anomaly scores, which will result in better signal analysis
- The outcomes of the project will help to formulate quantitative and qualitative criteria for the analysis of the influence of the features on the electron beam (analysis of filters, feature maps, heat maps etc.)
- continuation of works as a PhD thesis







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Thank you for the attention

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