PyAT/ML activities at Solaris

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pyAML developments

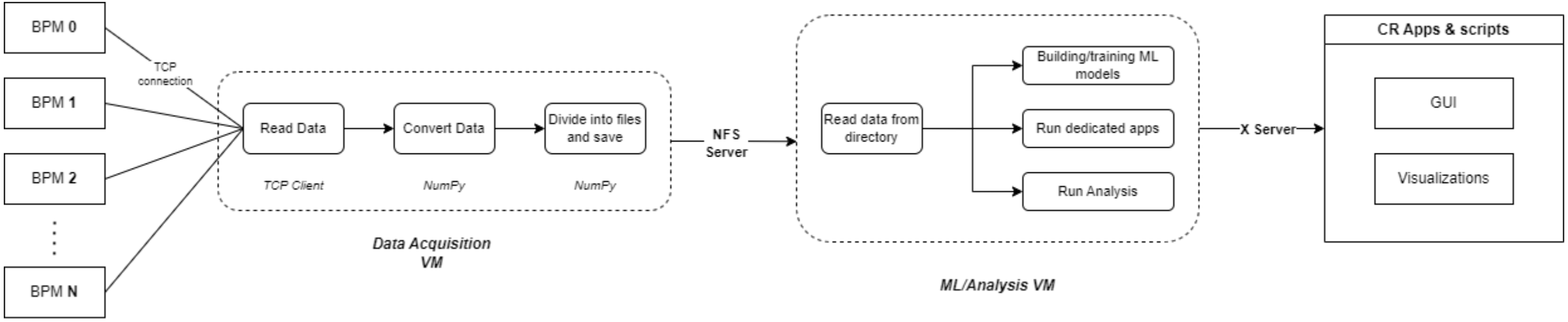
- Second iteration of LOCO measurement scripts
- Complete overhaul, while still based on MML heavily leverages Python's capabilities and object oriented approach
- AcceleratorObjects rewritten as a proper class, allowing for easy use and expansion
- pyTango based, Python 3.6 and higher
- Available on GitHub: https://github.com/python-accelerator-middle-layer/pyml-solaris/tree/e6805e19cf3a08b3242fa4ec7559211633e03649/pyml_solaris_v2

ML based diagnostic

- Fast data flow/ acquisition for liberas
- BDT for on line beam quality assurance
- PCA for sector wise/ bpm wise signal analysis, tracking faulty magnetic components
- Python based scripts, beam current monitoring, ring filling rate during injection
- Liniac magnet settings and energy optimization (thanks to DESY C++ package)

Fast data flow

- 10kHz acquisition from libera (packet handling and decoding)
- Outside of tango solution (avoiding additional overhead)
- Processed on line on a virtual machine
- Data stored on a out side resource/ batch farm in Cracow (CYFRONET), estimated 65 TB dataset for one year operation/ 24h data collection

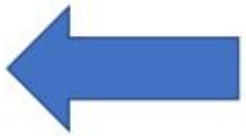


The problems

- Anomaly detection package for „on the fly" diagnostics (RF Cavity problem, mechanical movement)
- Undulator correction table generation
- Response matrix forecasting

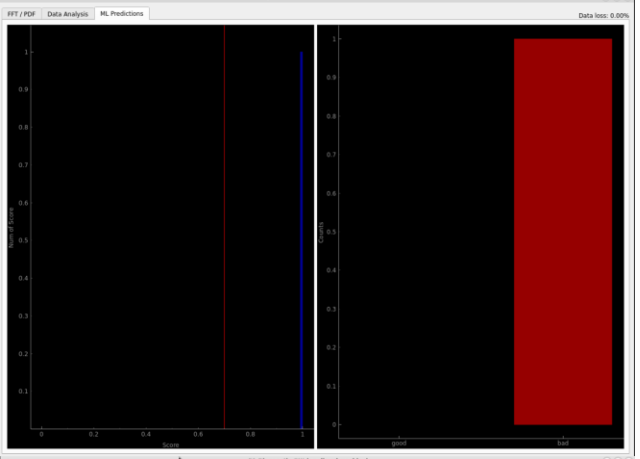
On line analysis for 1 s data chunks:
Training set (72 BPM) :
- 1h of BPM red out, beam running in the ring
- 1 h of different static magnet kicks (+-1A)
- Slow power drop on RF (15 min)

The possible „**solution**"

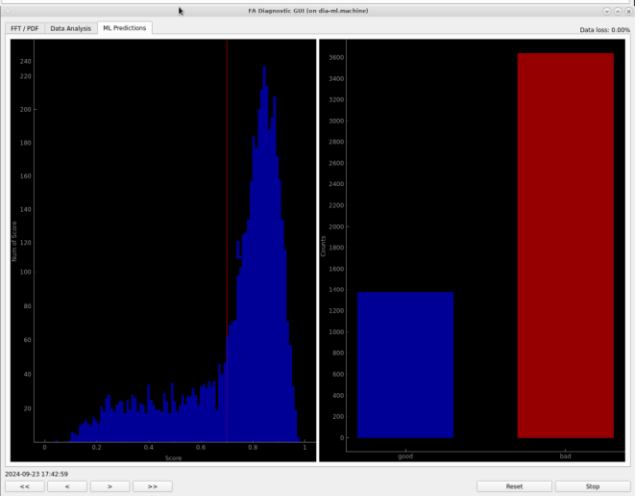


- **Fast deployment**
- **Engineering** non-scientific approach (plug & play)
- Lots of ready to use easy packages
- In the future one can switch to **Theano** for custom neuron design, **possible publication**

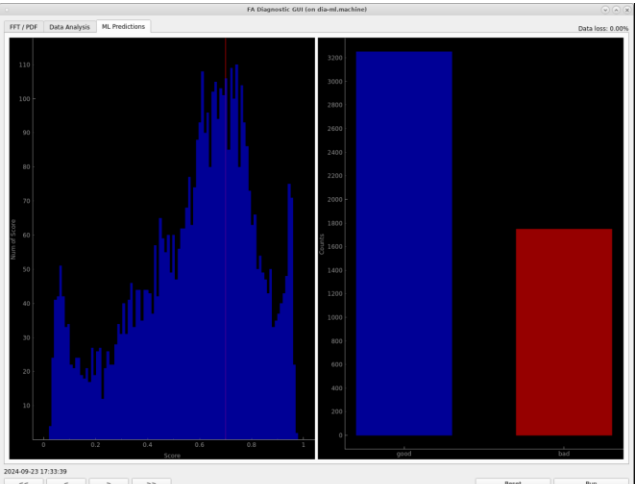
FA diagnostic ML GUI



Beam dump - 1mA/s

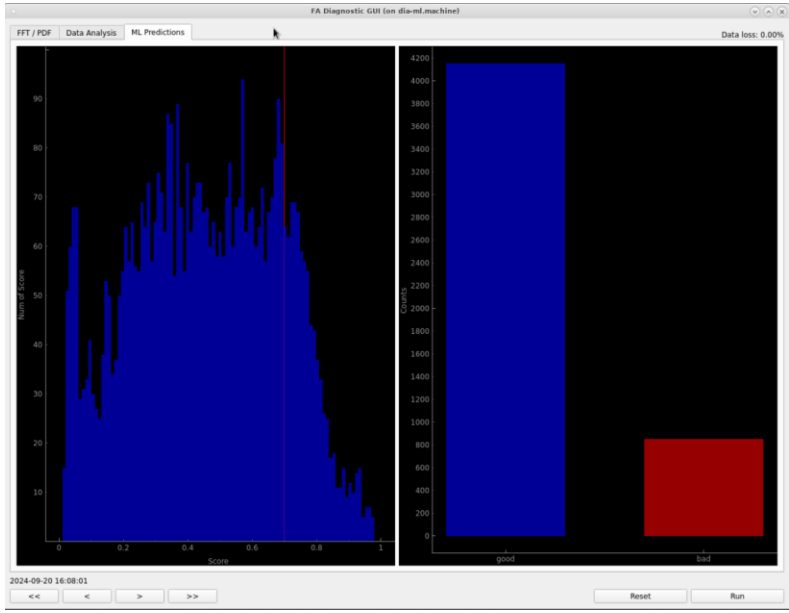


Beam dump - 0.3 mA/s

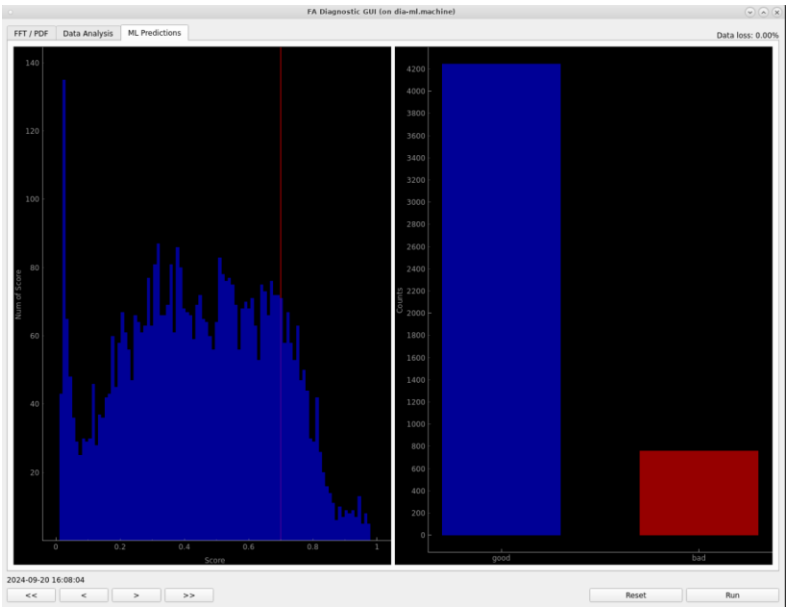


1 Hz pinger magnet, no beam loss

ID movment

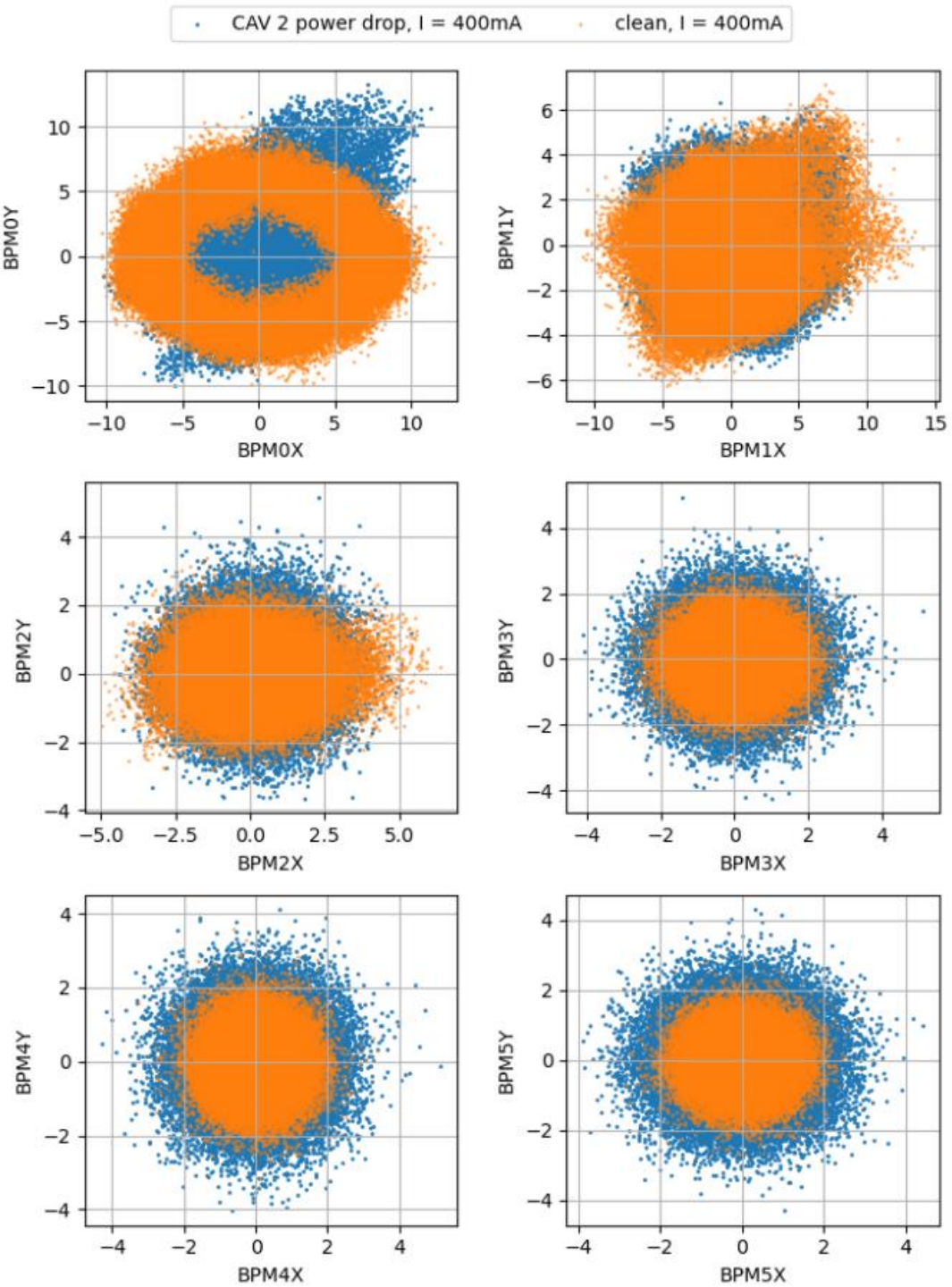


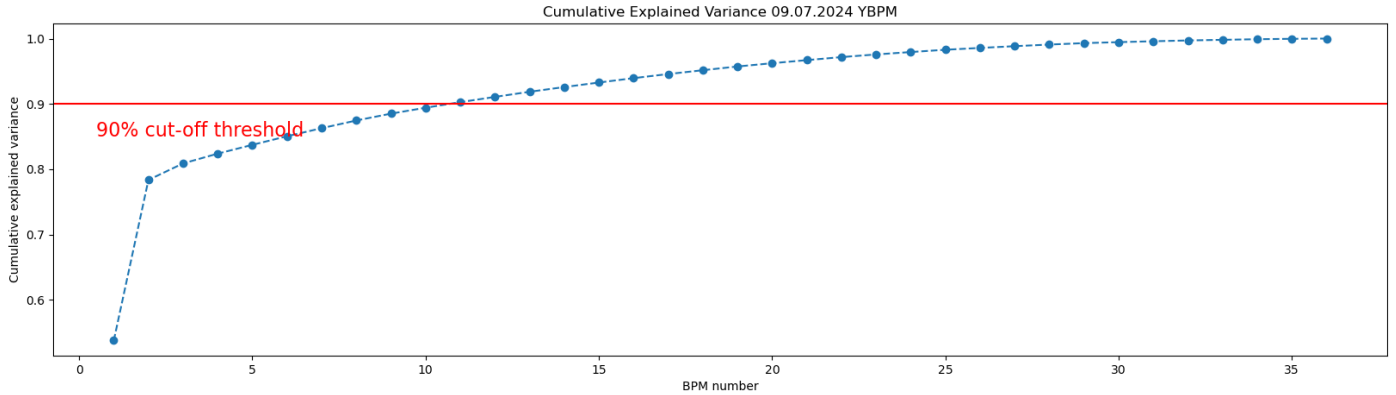
Normal operation

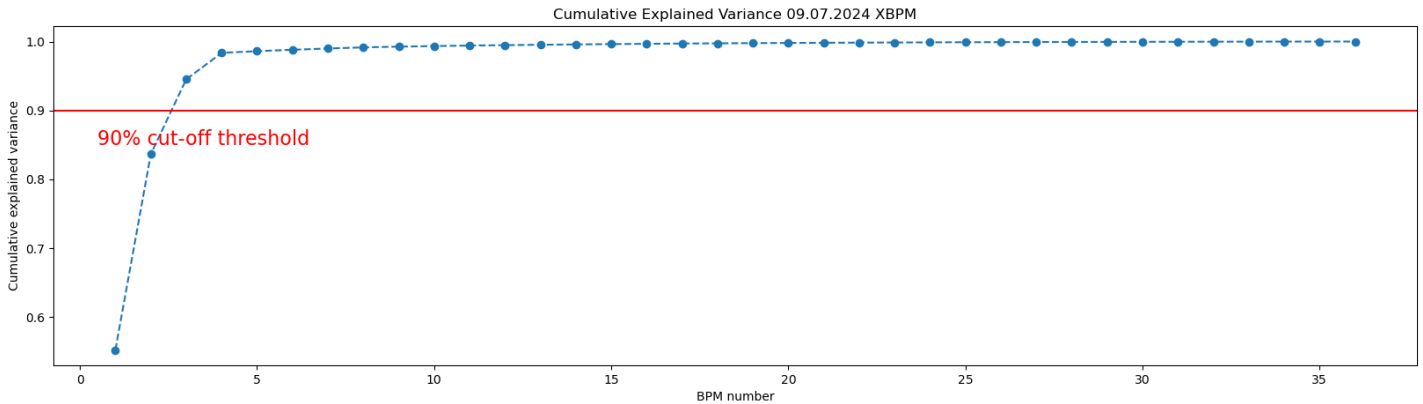


FA diagnostic ML GUI

- PCA for visual anomaly detection (X vs Y raw bpm plots show just a blob, no corelation)
- Fast tool to observe RF distortion







Sumary

- We do have a deployed ML solution for on the file beam quality assurance
- We have deployed simple masers to monitor the beam BPM wise
- We are in the stage of collecting and exporting the data to an out side batch farm
- We have an forecasting BNN solution in order to predict the machine behaviour (1 – 5 min for starters)
- We plant to relays the ML as a package for pyAT