Karlsruhe Institute of Technology

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Highlights & News @KIT

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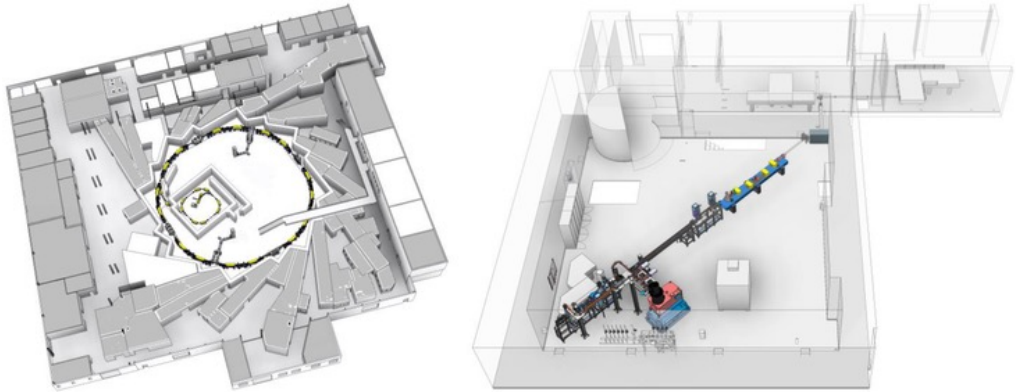
ACCLAIM Innovationspool (20-08-2021)



News MT ARD

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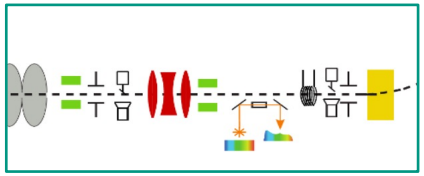
WP2: Applications of AI to accelerator tuning and control (DESY, GSI, HZB, KIT)

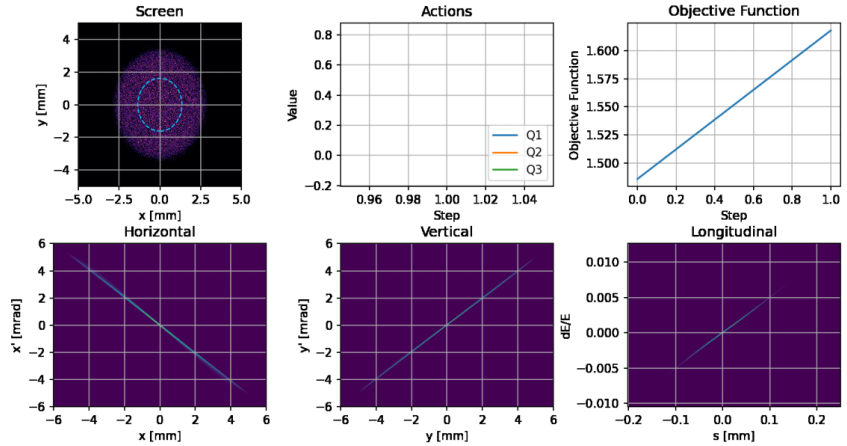
Quadrupole triplet focusing toy environment with different simulation backends

For 300k training steps:

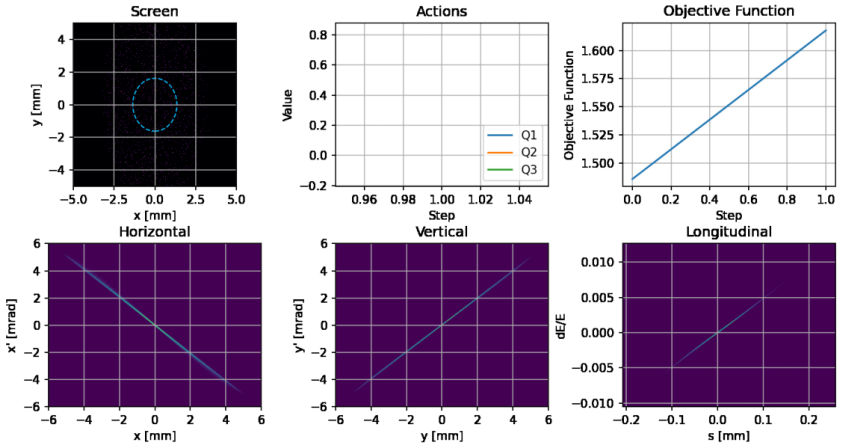
- **OCELOT**: ~22h30min
- Custom developed backend **JOSS**: ~5h40min

Simplification used for (pre-)training
Developers: Jan Kaiser, Oliver Stein (DESY)





OCELOT



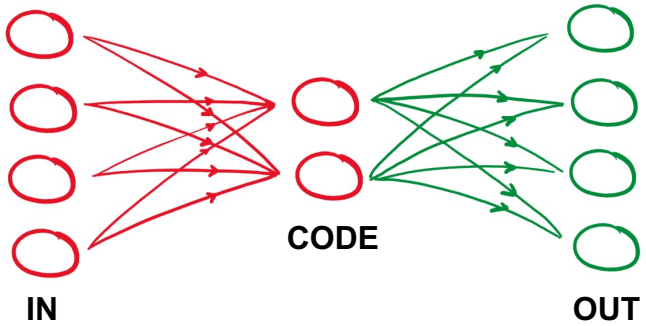
JOSS env

Courtesy of C. Xu

WP3: Machine detection and prediction of anomalies (DESY, GSI, HZB, KIT)

Beam position monitor Anomaly Detection (BAnDe)

Proposed method: AUTOENCODER



- Only normal data required for training
- Reconstruction loss to detect anomalies
- Straightforward implementation

  (AI frameworks: TensorFlow, PyTorch, ...)

Courtesy of N. Bruchon

WP3: Machine detection and prediction of anomalies (DESY, GSI, HZB, KIT)

Workflow:

1. **Feature selection:**
   The most significant information from BPM signals to detect anomalies
2. **Dataset preparation:**
   Collect normal data and clean them accordingly to selected features
3. **AutoEncoder training:**
   Search for optimal hyperparameter setting

WARNING: AUTOENCODER DETECTS THE ANOMALY BUT NOT ITS ORIGINAL CAUSE!

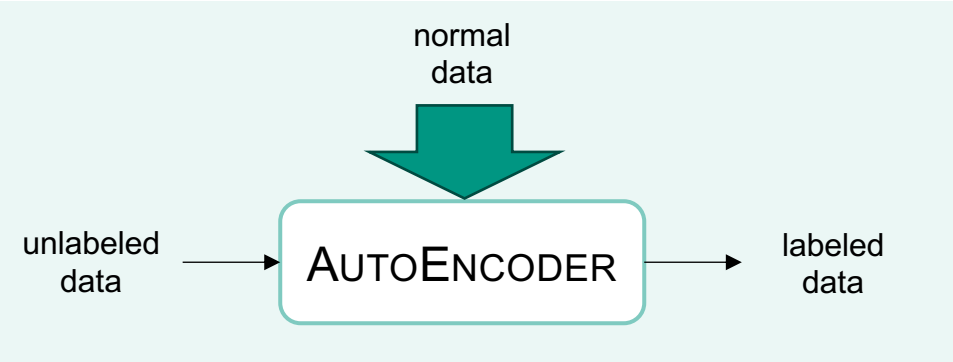
One AutoEncoder for each BPM → Faulty BPM directly found!
However, no information about the original cause...

Courtesy of N. Bruchon

WP3: Machine detection and prediction of anomalies (DESY, GSI, HZB, KIT)

Ongoing studies:

- **AutoEncoder for data labeling:**
  - Comparison between the AutoEncoder output and the known failures
  - Research of the most informative features



Normal data:
dataset of selected features at top-energy (2.5GeV).

Unlabeled data:
dataset containing both normal and faulty data

Courtesy of N. Bruchon

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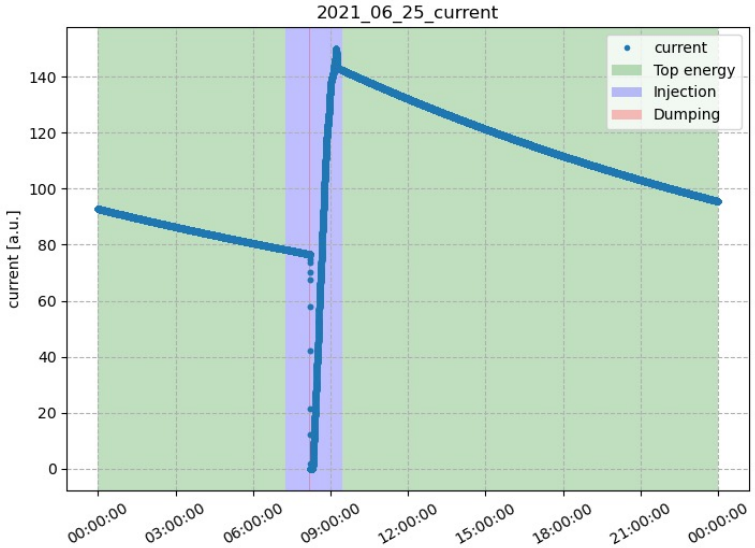
WP3: Machine detection and prediction of anomalies (DESY, GSI, HZB, KIT)

25.06.2021: normal data selection

Dataset preparation: filtering data in respect to top-energy

Features:

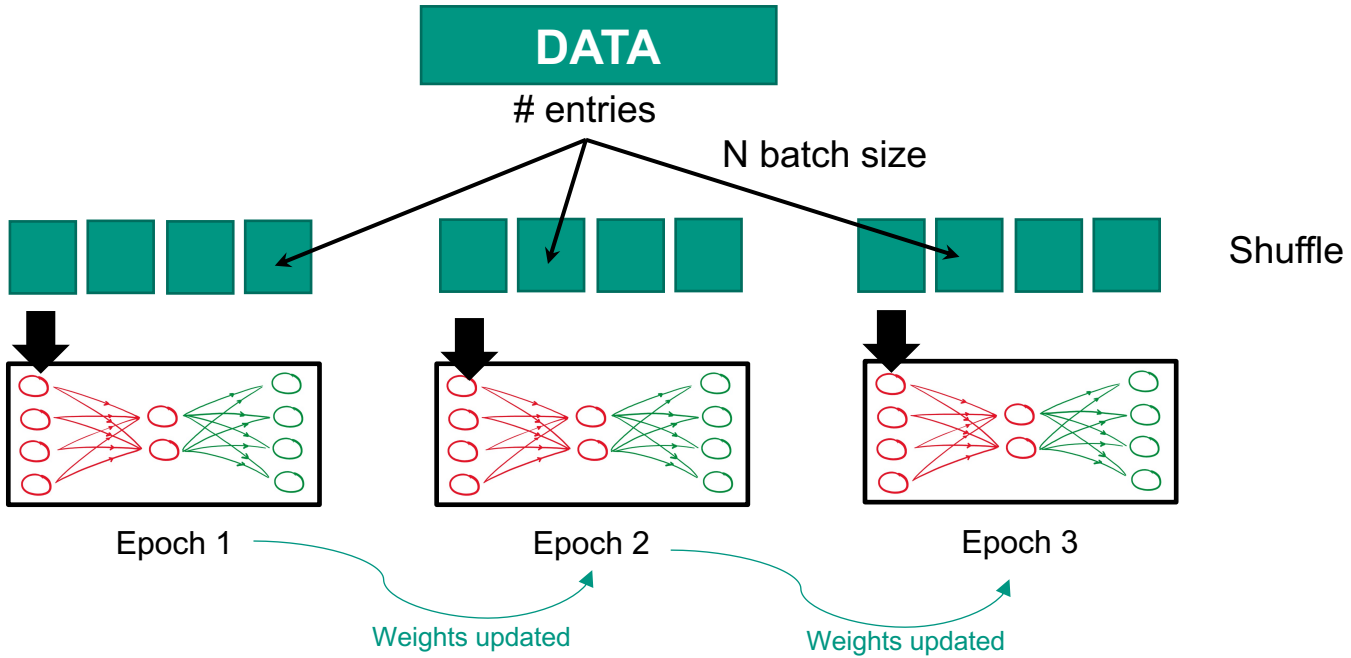
1. Current:
   `A:SR:BeamInfo:01:Current.`
2. Energy:
   `A:SR:BeamInfo:01:Energy.`
3. Injection:
   `:A:TI:TimingMain:01:Injection:Running.`
4. Dumping:
   `:A:SR:RF:01:BeamDump.`



Courtesy of N. Bruchon

WP3: Machine detection and prediction of anomalies (DESY, GSI, HZB, KIT)

25.06.2021: optimal hyperparameter exploration



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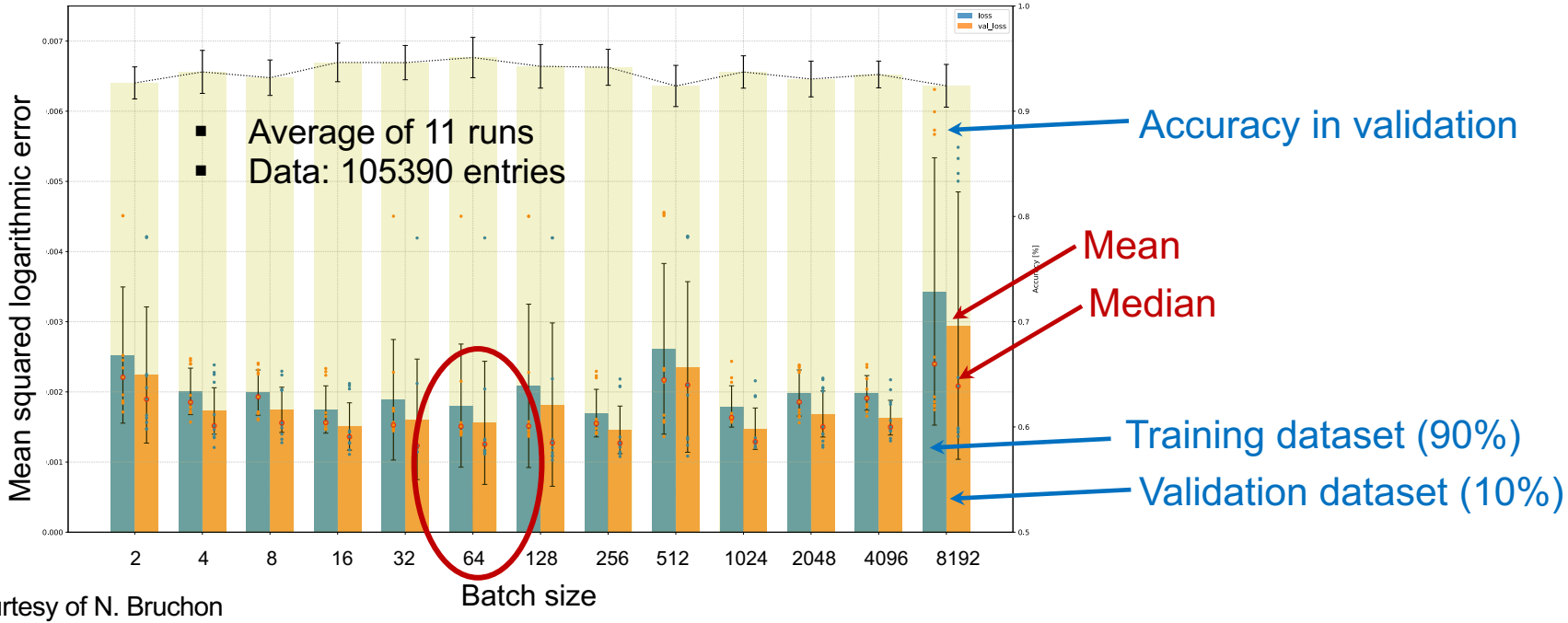

Courtesy of N. Bruchon