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2017 – 2021
Doctoral student
RL methods for FERMI FEL
Performance improvement

2021 – 2021
Researcher
BPM anomaly detection

2021 – present
Fellow
Automation of RF procedures in the SPS

RL activities:

- Investigation of model-free and model-based RL algorithms to improve the FERMI FEL performance
- Custom OpenAI-Gym environment for developing and testing

Interests:

- Autonomous accelerator (one button machine)
- Real-world and online optimization problems
- Reinforcement Learning applications
- Simulation to real word transfer
- Sample efficiency

RL Studies on RL Techniques to Improve FERMI FEL Performance

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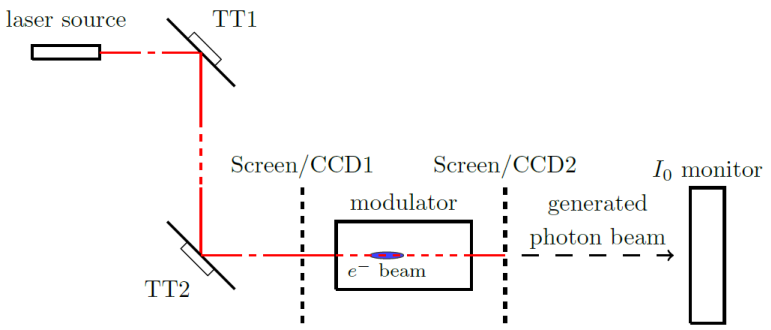
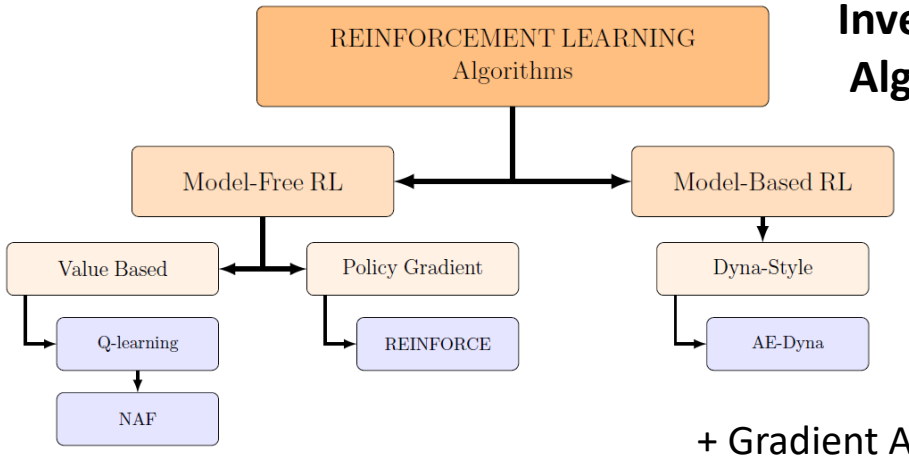
Problem: transverse overlapping of the electron and laser beams to optimize the light radiation intensity



Simple block scheme

Investigated Algorithms



+ Gradient Ascent
+ iLQR

Performance in the training/identification phase

Algorithm	Data points
Q-learning	3128
NAF	1074
NAF2	824
AE-Dyna with TRPO	450
AE-Dyna with SAC	500
Gradient Ascent	1024
iLQR	1024

Performance in the test phase

Algorithm	Episode length (mean)	Final intensity (mean)
Q-learning	11.28	-
NAF	2.56	1.0019
NAF2	2.64	0.9995
AE-Dyna with TRPO	4.46	1.0150
AE-Dyna with SAC	3.28	1.0427
Gradient Ascent	3.82	0.9911
iLQR	2.54	1.0019

Conclusions

Two different tasks have been successfully faced:

I. Attainment of the optimal working point
II. Recovery of the optimal working point after machine drifts

[1] Feasibility investigation on several reinforcement learning techniques to improve the performance of the FERMI free-electron laser

AUTOMATIC SETUP OF THE SPS CONTROLLED LONGITUDINAL EMITTANCE BLOW-UP

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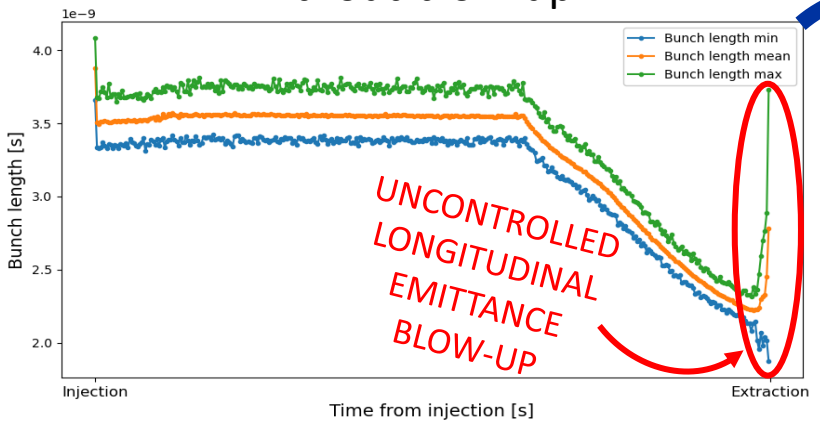
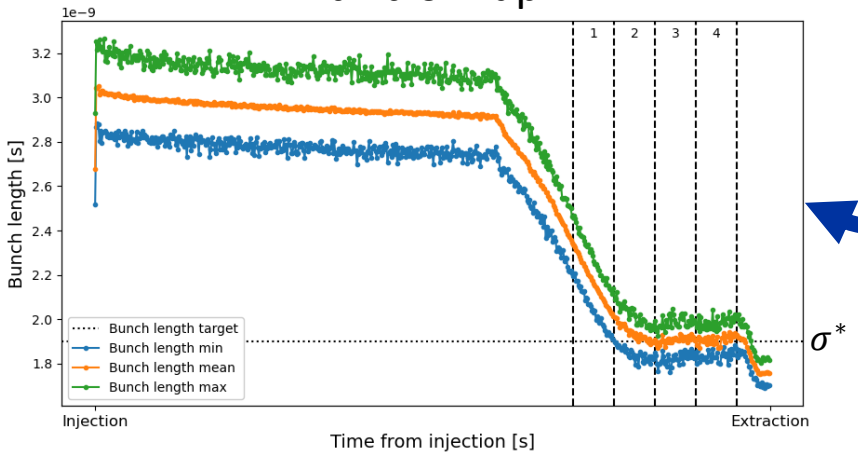
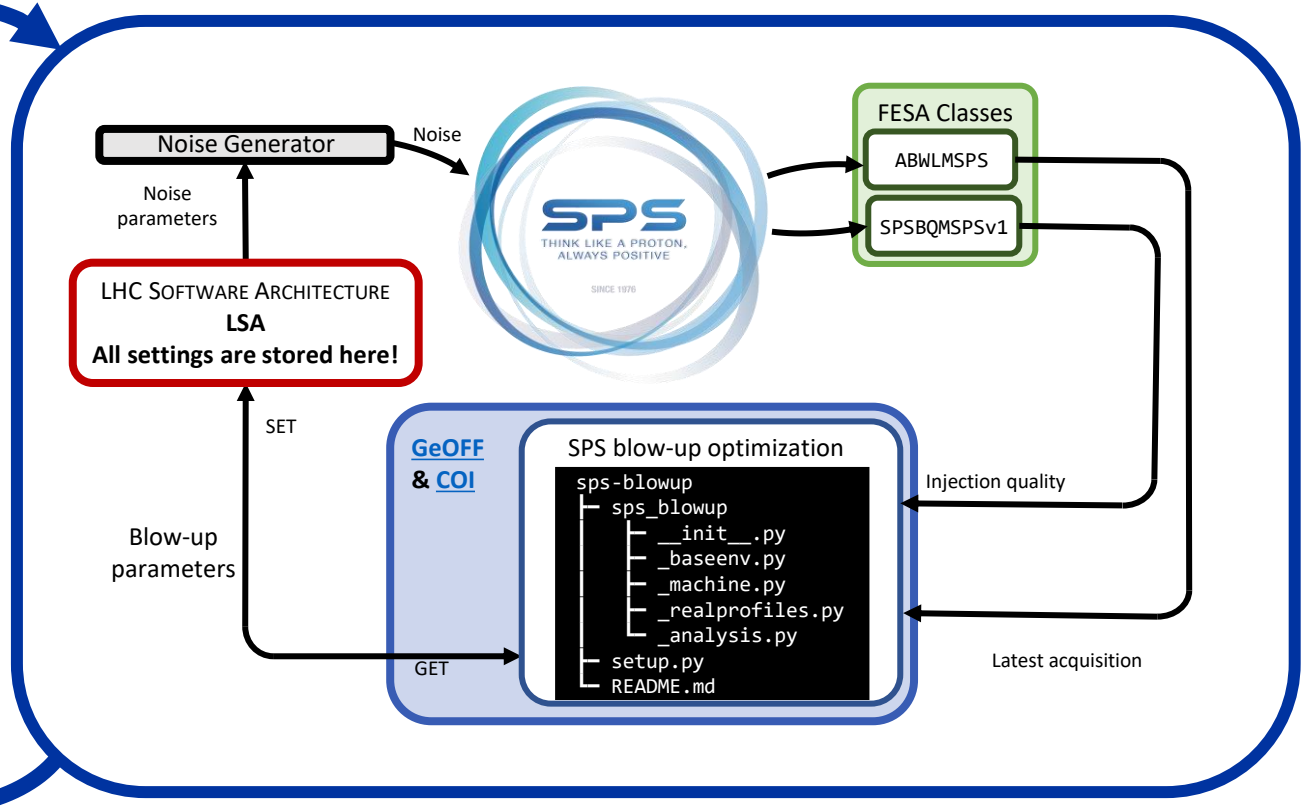
Without blow-up



With blow-up



Blow-up needed to gain stability



Blow-up setup **successful** for **high intensity** proton LHC beams:

- Beam kept at desired bunch length and stable.