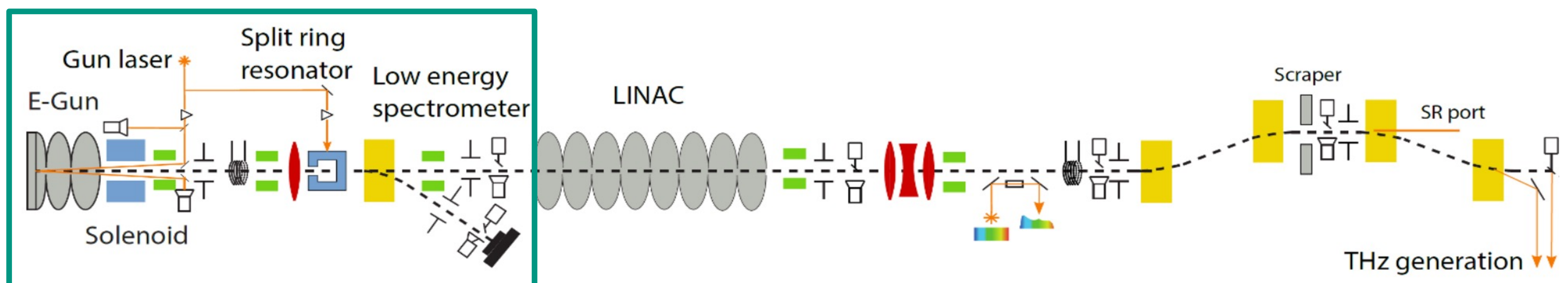


THz Radiation Optimization at Linac using Machine Learning Methods

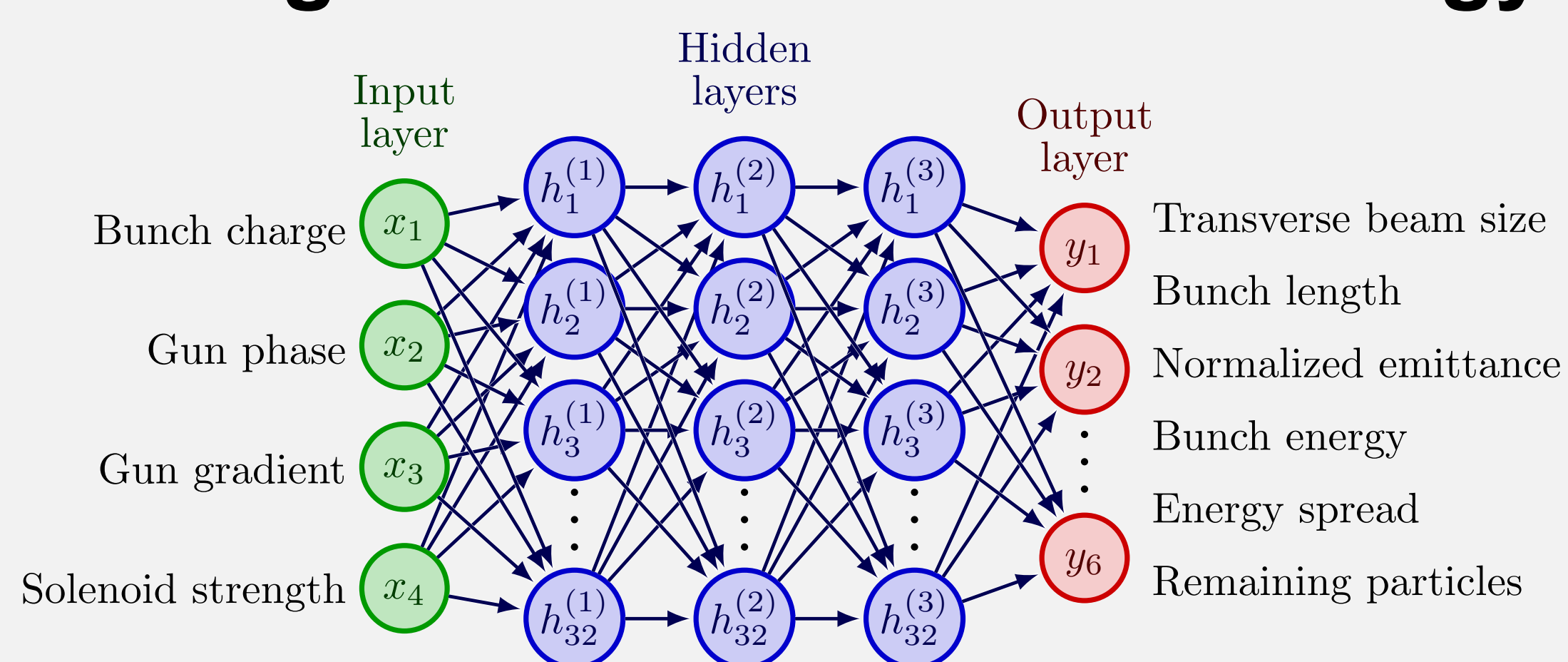
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on behalf of the IBPT team, Karlsruhe Institute of Technology, Karlsruhe, Germany

FLUTE (Far-infrared linac and test experiment) is a linac-based test facility aimed to create **fs-short electron bunches**, and generate **intense THz radiation** tailored to user experiments.

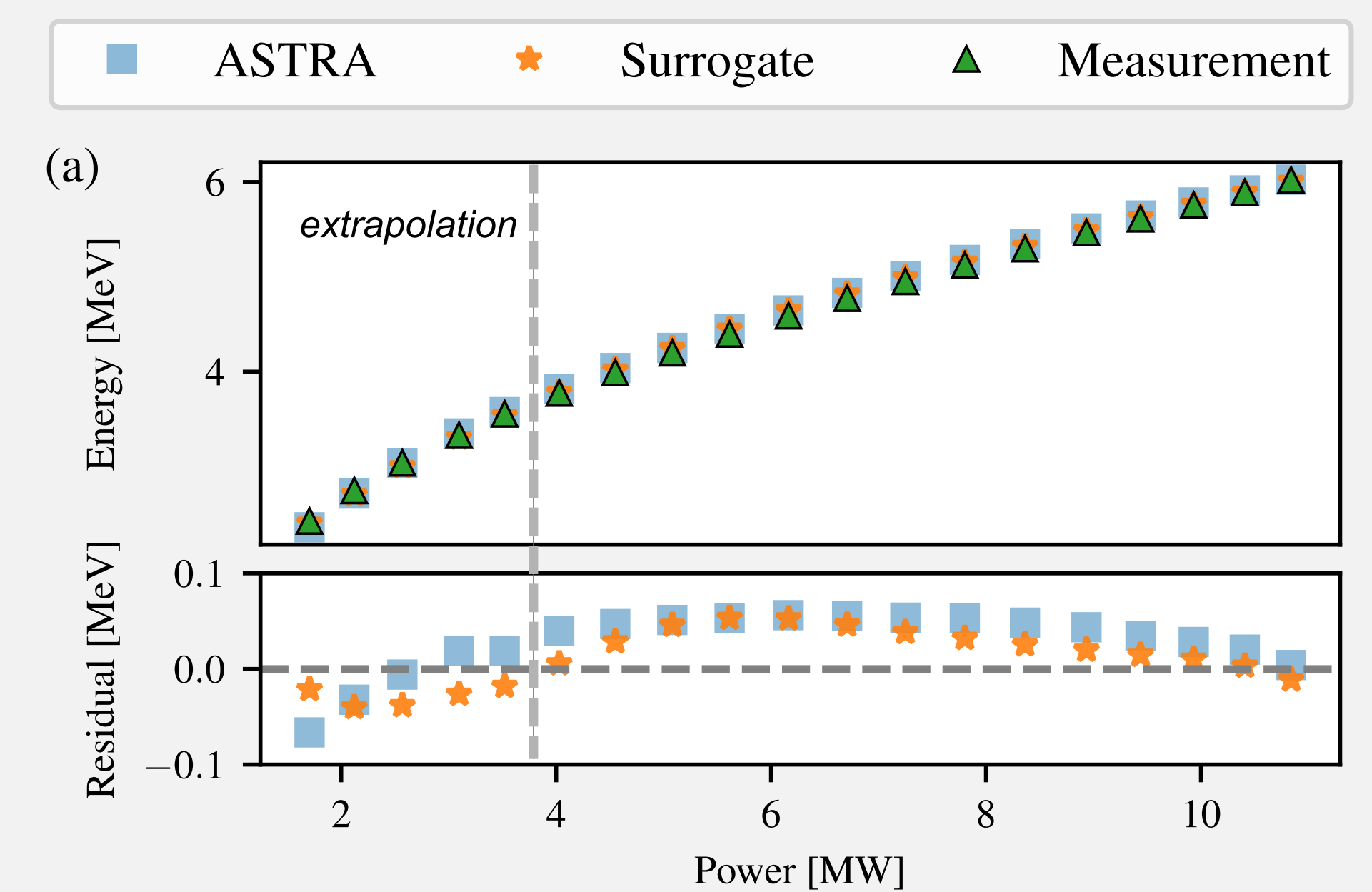
Goal: Autonomous control of the bunch and THz radiation properties with ML methods.



NN surrogate model of the low-energy section



comparison to
measurements



Training Data: 10^4 ASTRA simulations with uniform randomly sampled parameter settings

Training procedure: Min-max norm. of input&output; Adam optimizer, batch size=64, learning rate = 10^{-3} ; early stopping 200 epochs

Next Step: extend the NN model to **start-to-end** simulation

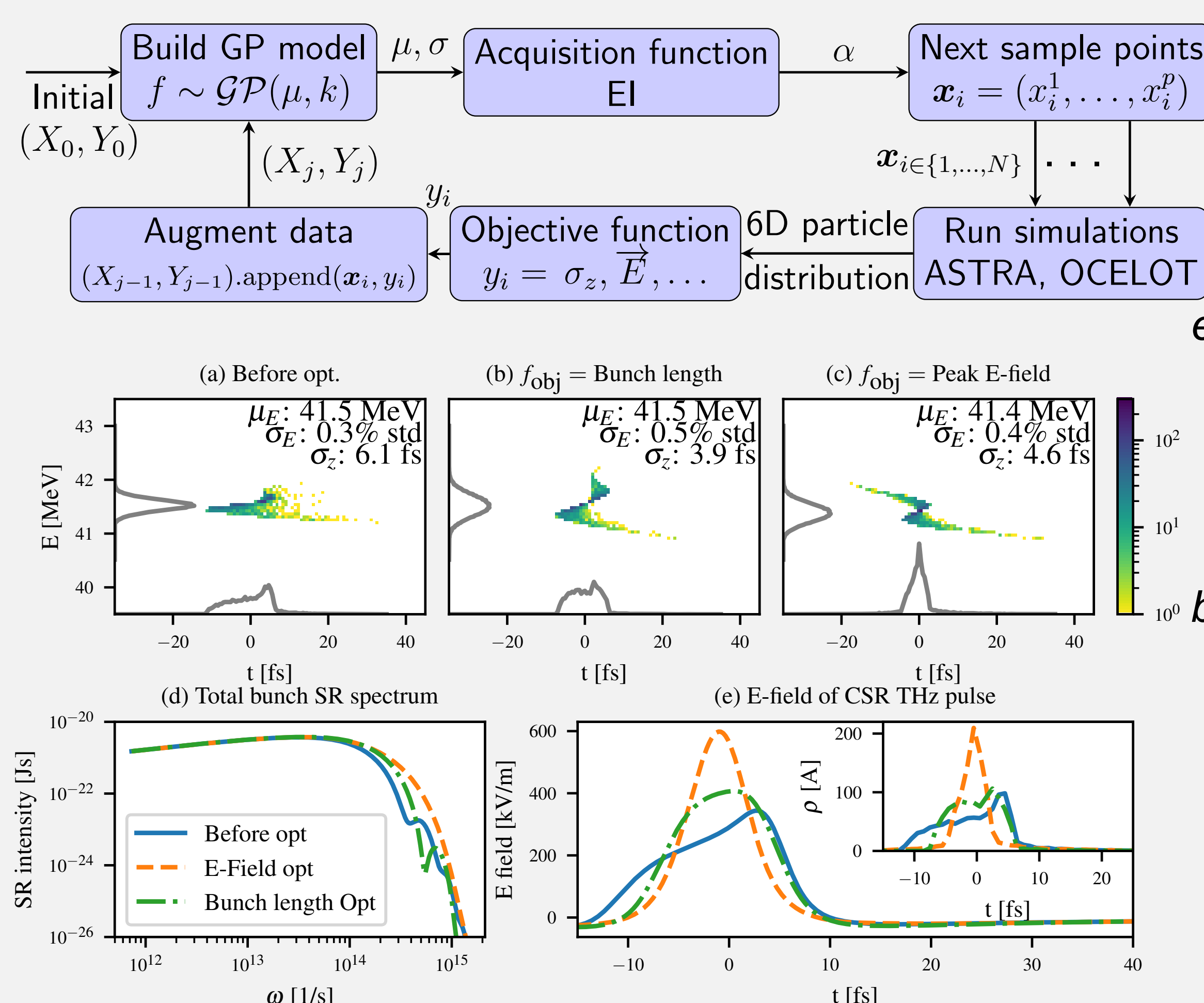
Applications of surrogate model

Bayesian optimization for simulation settings

Parallel evaluations using local penalization of acq. functions

Ongoing: Use surrogate model predictions to **constrain BO search space** and reduce the optimization time

Found settings with 1.7 times higher THz pulse E-field compared to design values that minimized bunch lengths



Provide fast training environment for reinforcement learning control

environment
design

benchmark RL
performance

RL Algorithm

RL Environment

training evaluation

Surrogate Model

Machine
DOORS
EPICS

References: [1]: Surrogate Modelling of the FLUTE Low-energy Section, doi:10.18429/JACoW-IPAC2022-TUOPT070

[2]: Optimization Studies of Simulated THz Radiation at FLUTE, doi:10.18429/JACoW-IPAC2022-WEPOMS023

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