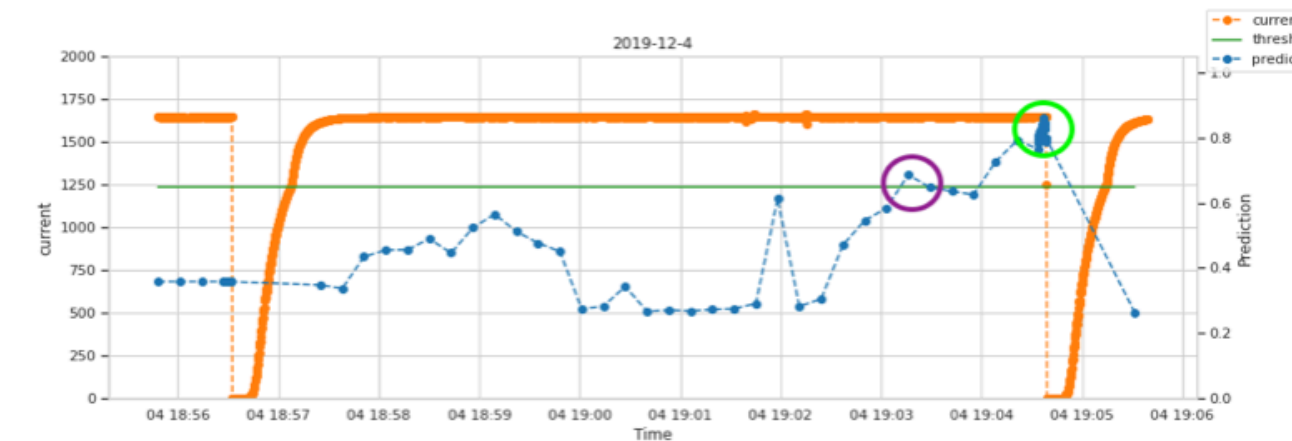
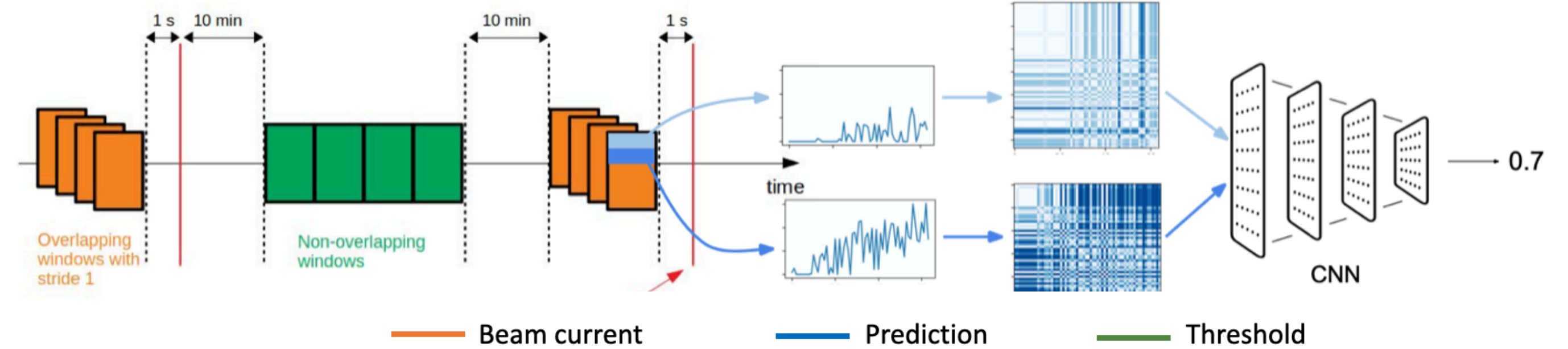
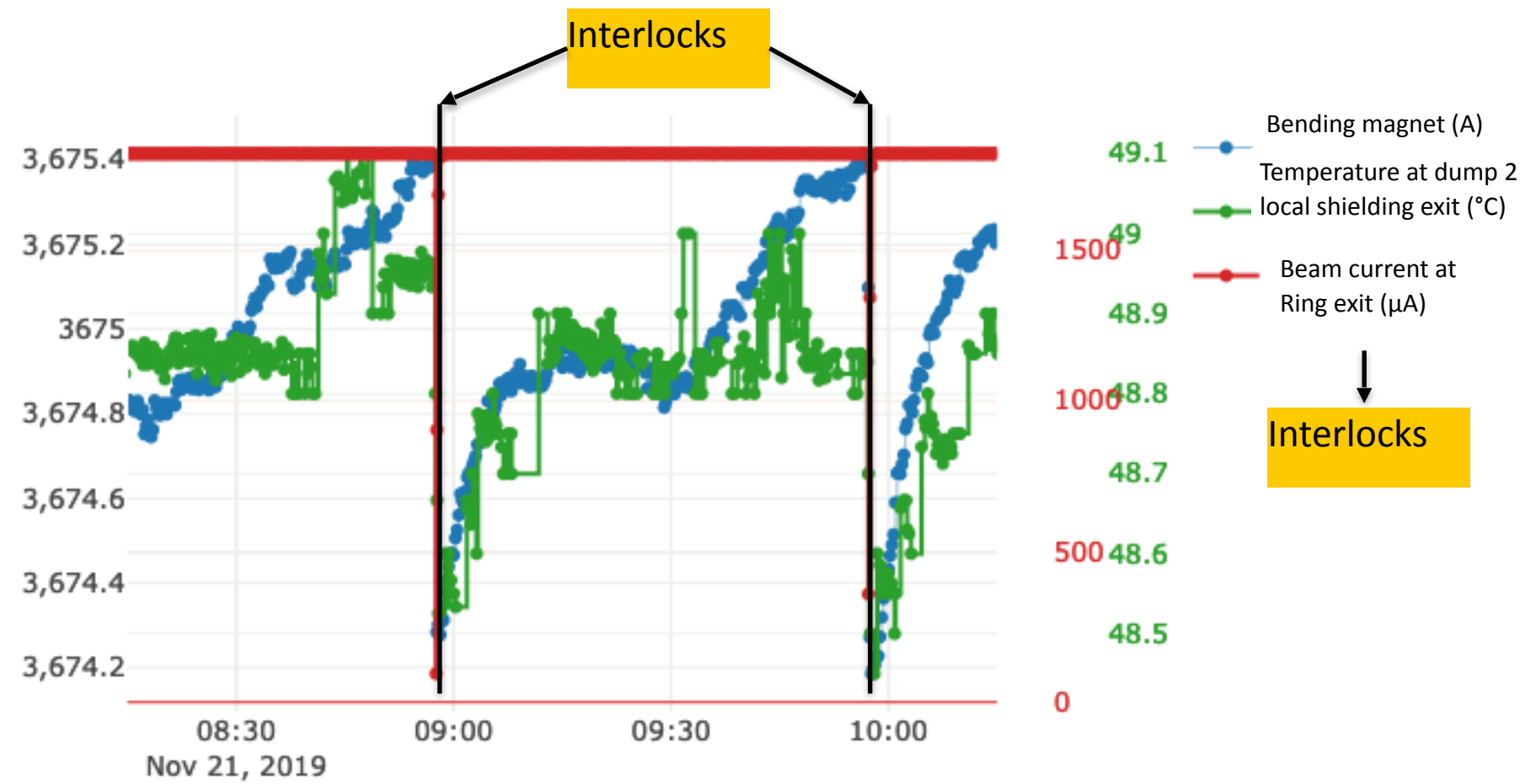
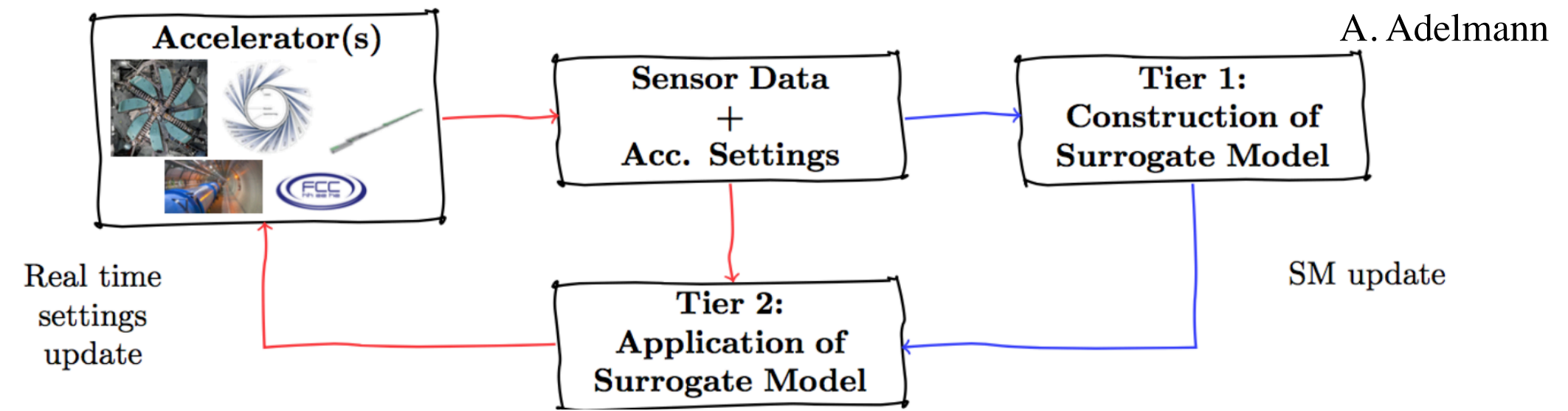
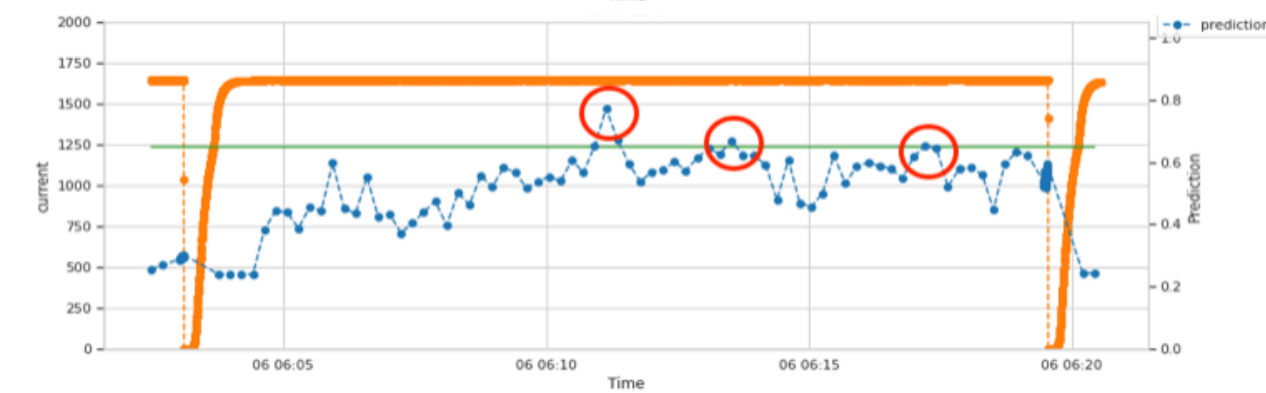


Update on PSI Accelerator ML Activities

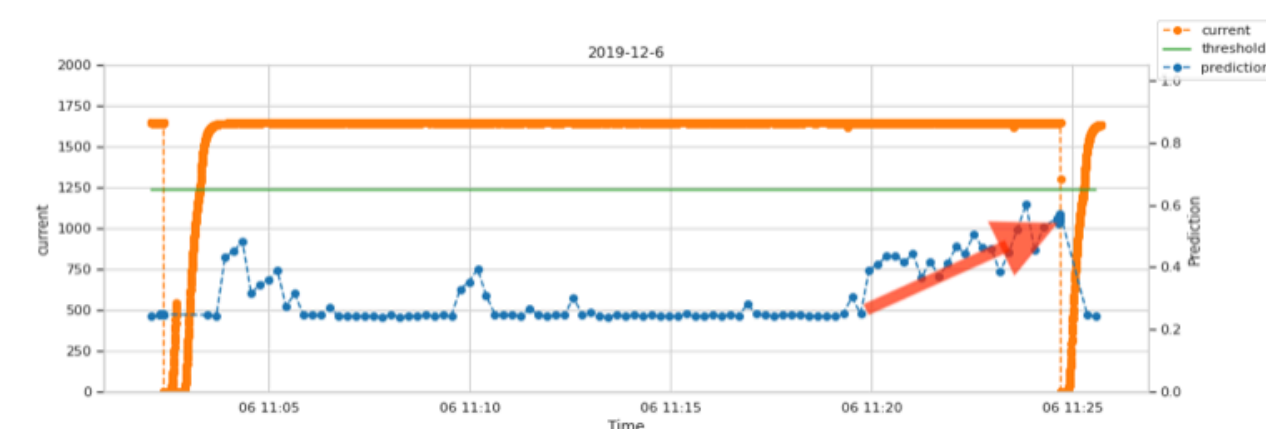
1. Minimise beam losses (HIPA and LHC)
2. Better control of accelerator parameters (HIPA and LHC)
3. Prevent unnecessary machine interruptions (HIPA)
4. Neural networks instead of particle tracking (LHC)
5. Anomaly Detection on streaming data (HIPA)



(a) TP and an earlier detection



(b) A series of FPs



(c) Not detected but with trend

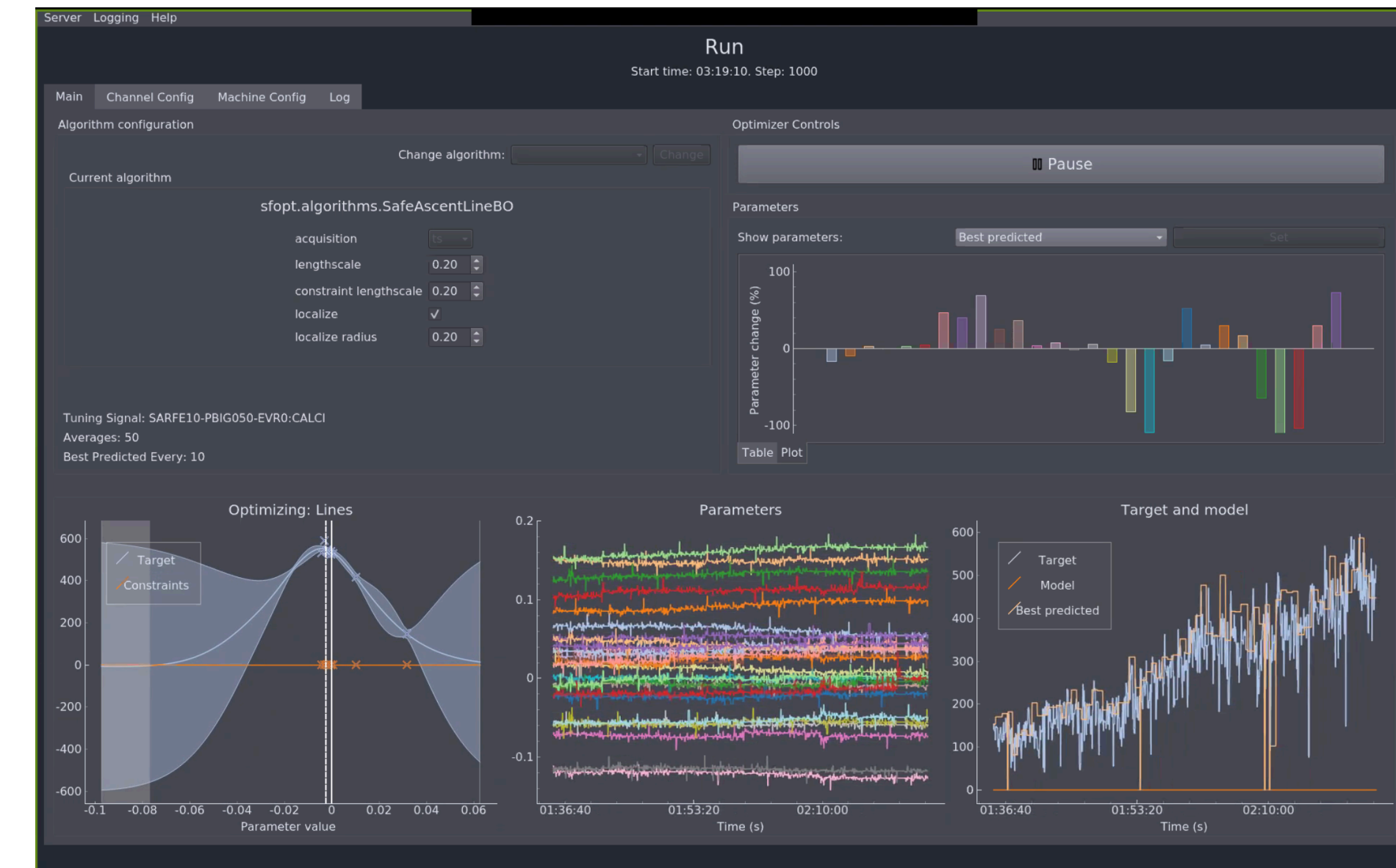
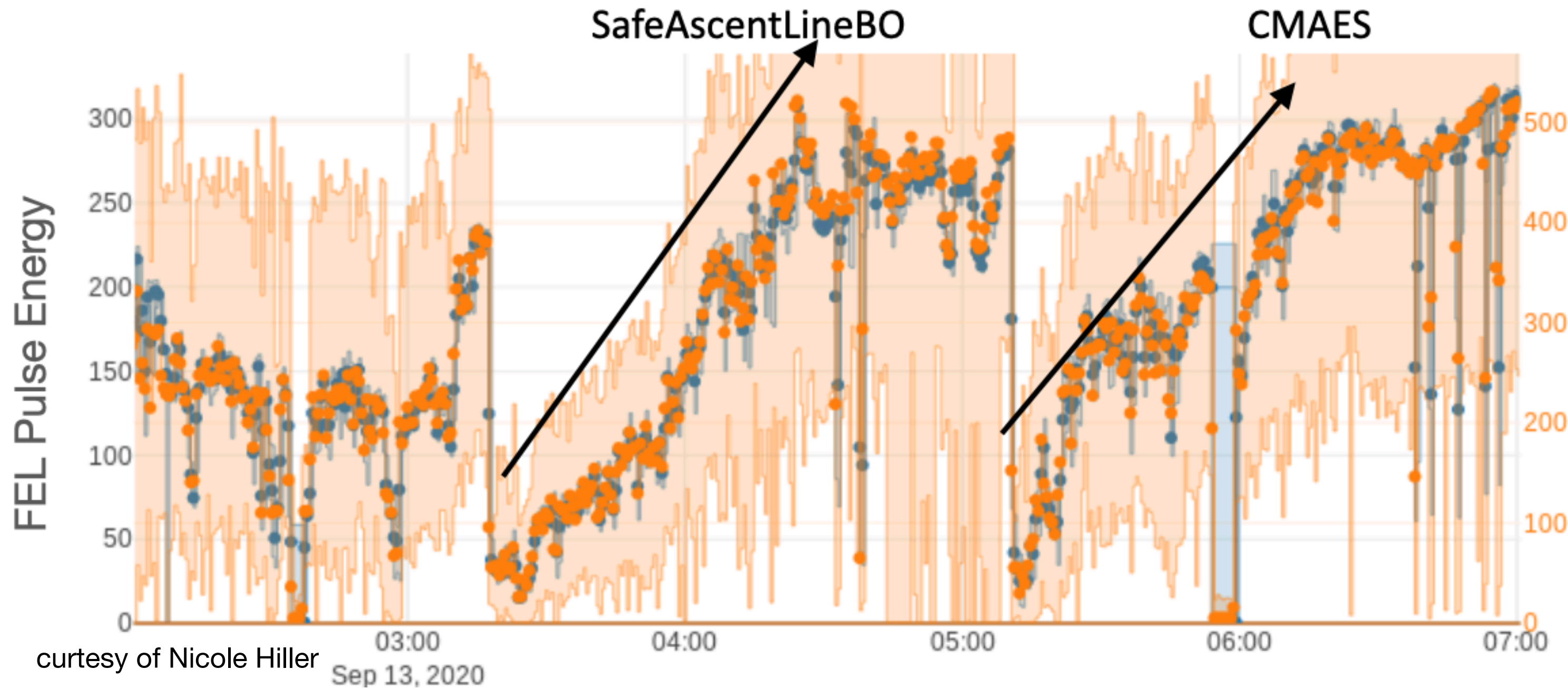
Information 2021, 12, 121. <https://doi.org/10.3390/info12030121>



Article

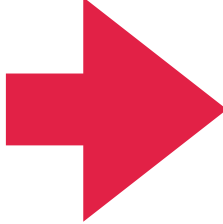
A Novel Approach for Classification and Forecasting of Time Series in Particle Accelerators

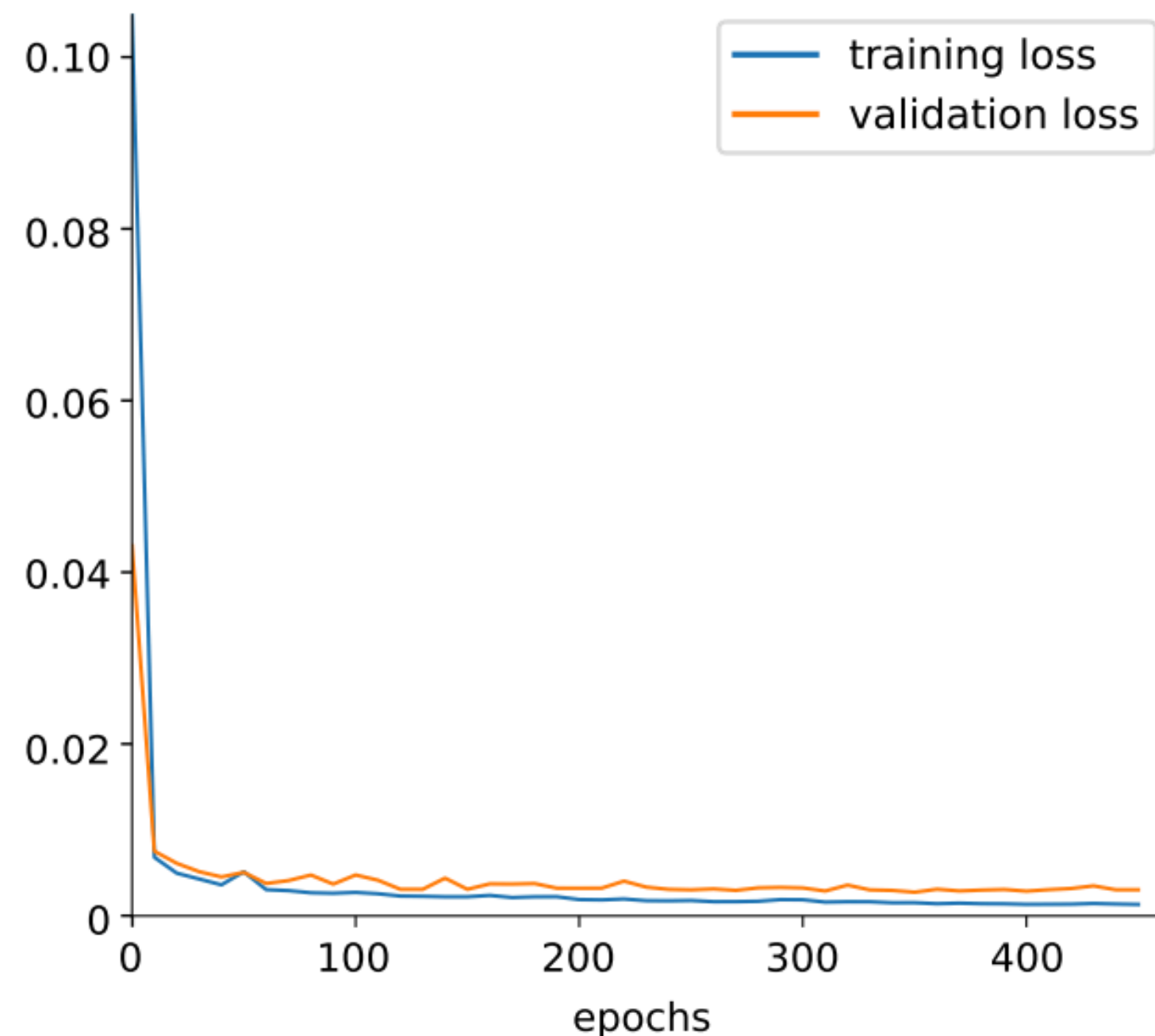
Sichen Li ^{1,†}, Mélissa Zacharias ^{1,†}, Jochem Snuverink ¹, Jaime Coello de Portugal ¹, Fernando Perez-Cruz ², Davide Reggiani ¹ and Andreas Adelman ^{1,*}



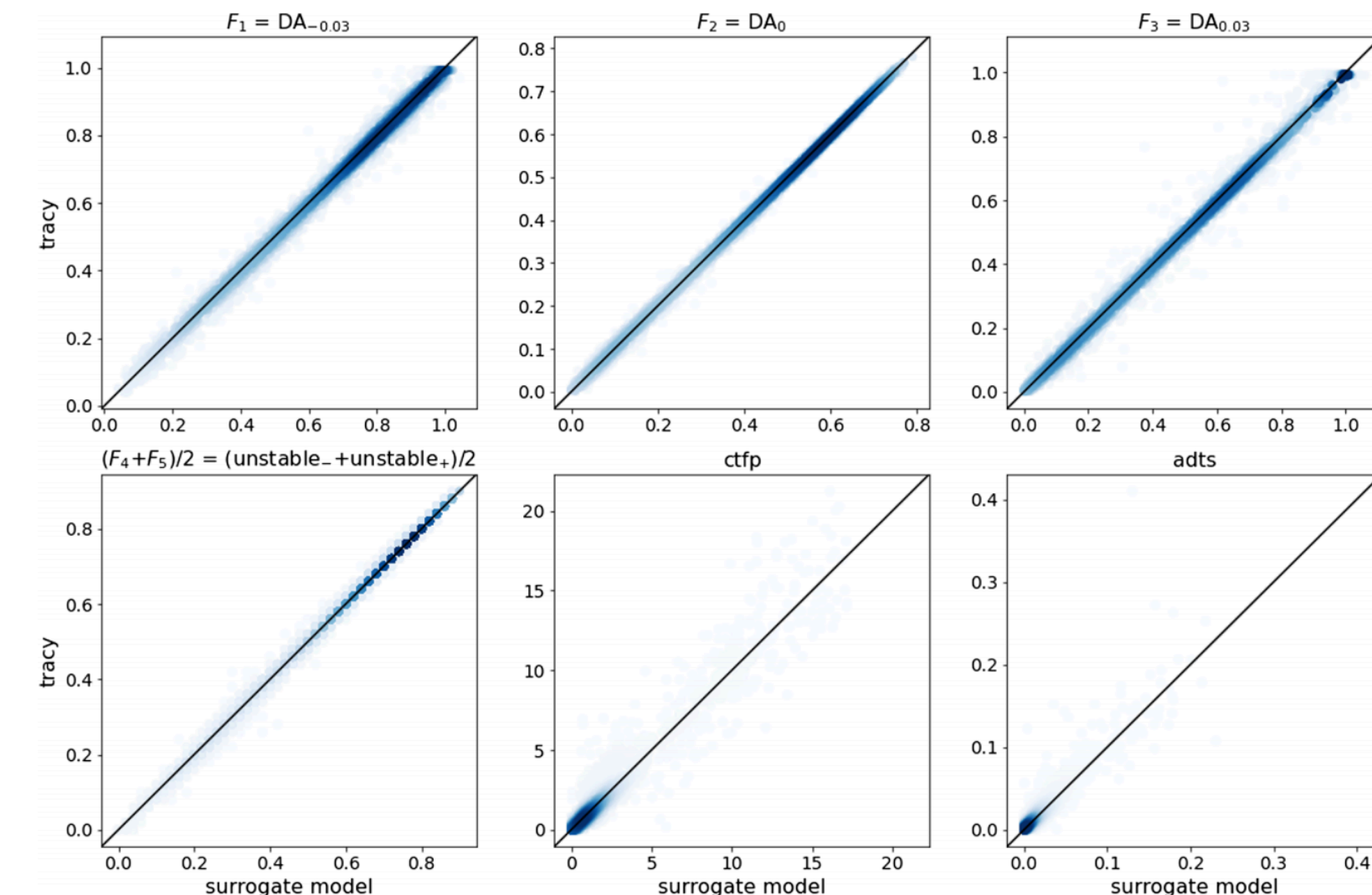
- safeAscentLineBO (move each parameter to find the “best-direction” and then search for the best point in that direction)
- respects bounds & does (save) exploration
- covariance Matrix Adaptation Evolution Strategy (CMAES) used here as baseline
- CMAES does not have safety constraints
- dim = 28

Multiobjective optimization of the dynamic aperture using surrogate models based on artificial neural networks

- MOGA & ANN is used to find a good dynamic aperture and energy acceptance for the Swiss Light Source upgrade
- a straightforward use of the surrogate model is not good enough for this problem
 - ★ the surrogate model is retrained during the optimization.
- compared to a massively parallel implementation of a MOGA an  order of magnitude speedup.
- ☑ include more design parameters in the optimization problem, such as the octupole strengths
- ☑ it allows for the inclusion of a more accurate and more expensive model (includes nonlinear synchrotron oscillation)



- size of the random sample is 30000
- hyperparameters are:
Nlayers 5, Nneurons 64, Nbatch 128, & ReLU
- early stopping (100 epochs).



Multiobjective optimization of the dynamic aperture using surrogate models based on artificial neural networks

M. Kranjčević, B. Riemann, A. Adelman, and A. Streun
Phys. Rev. Accel. Beams **24**, 014601 – Published 19 January 2021

Multi-Objective Optimisation with ANN

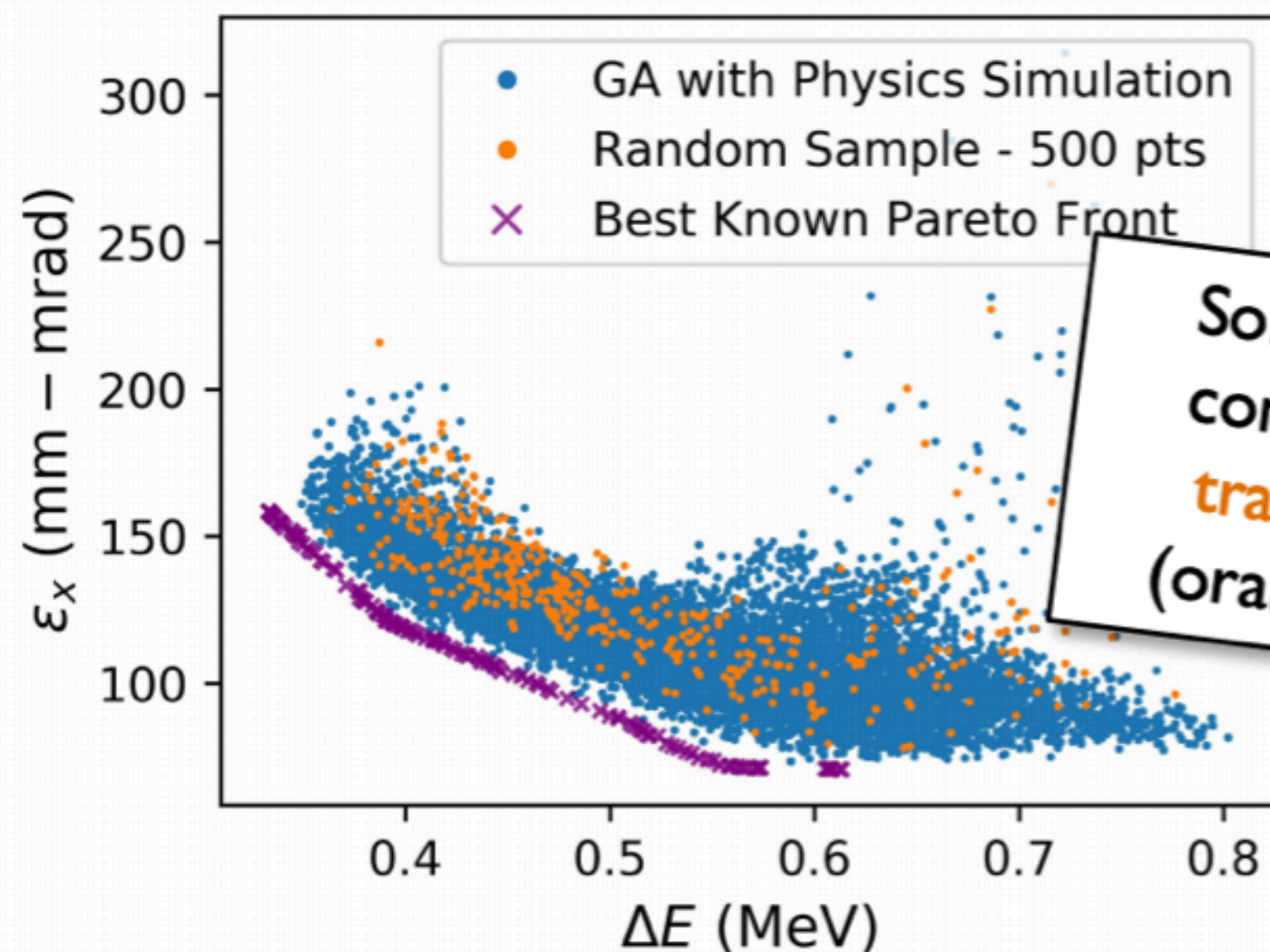
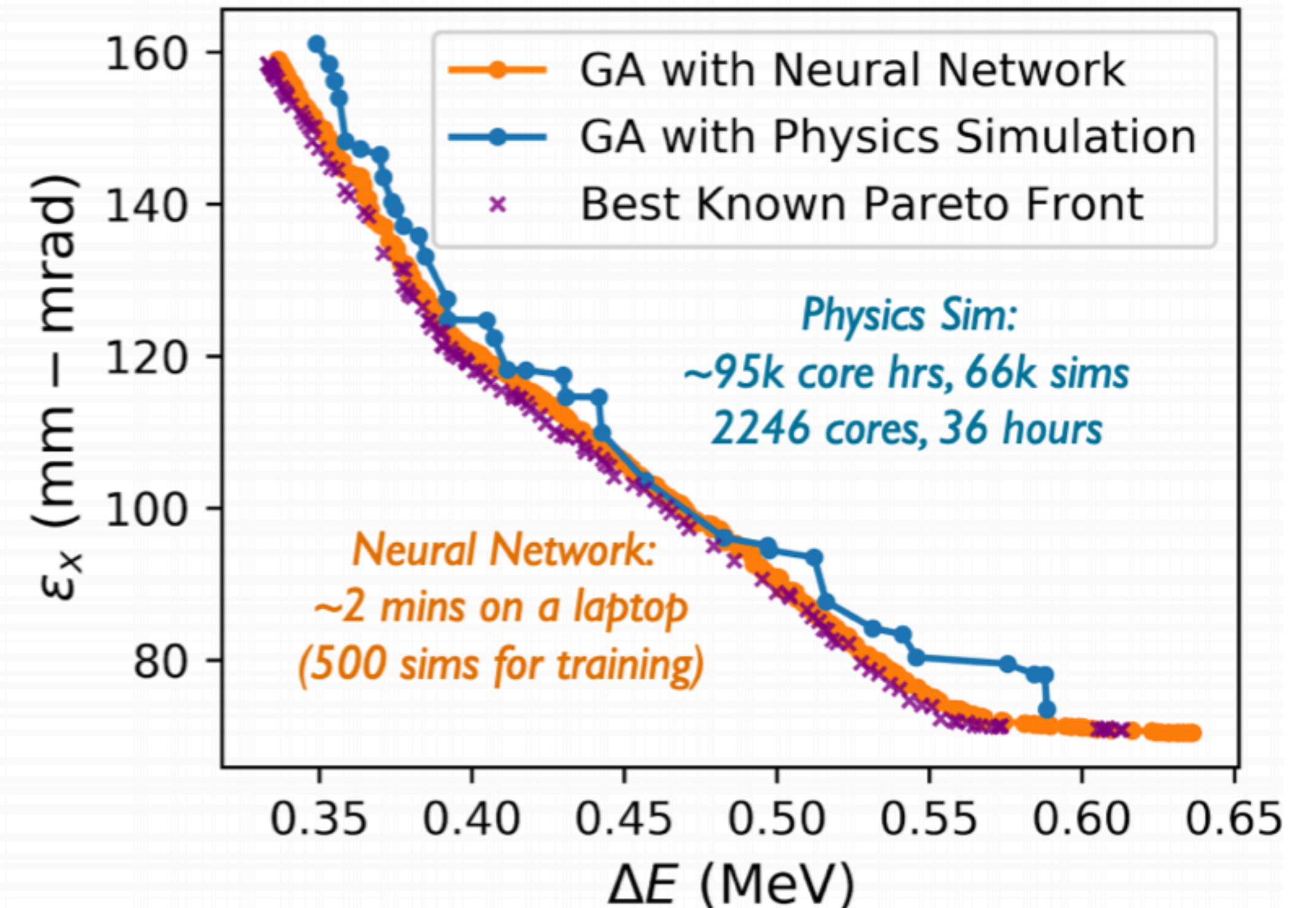
Machine learning for orders of magnitude speedup in multiobjective optimization of particle accelerator systems

Auralee Edelen, Nicole Neveu, Matthias Frey, Yannick Huber, Christopher Mayes, and Andreas Adelman
Phys. Rev. Accel. Beams **23**, 044601 – Published 8 April 2020

Examined with PIC sims of the AWA injector:

MOGA solution with 6 inputs, 7 objectives required **~130x fewer simulation evaluations**

Surrogate model has **10^6 x faster execution**



Solution not contained in training set (orange dots)

In terms of time-to-solution:

~6.4 mins on 8 cores to make 500-point training data

~10 minutes to train on a laptop

~2 minutes to do optimization on a laptop

- ☑ ML Luncheon (with Nicole Hiller)
- ☑ Slack channel: psi-ml.slack.com
- ☑ OWLE - World Seminar on Machine Learning in Accelerator Science

<https://sites.google.com/view/owle/home>



Chantal J Adelmann

The **O**ne **W**orld charged partic**L**e acc**E**lerator (**OWLE**) Colloquium & Seminar Series

Given the impossibility of travel during the COVID-19 crisis the (OWLE) seminar series was established as an inter-institutional global online colloquium and seminar(s).

The **OWLE-Colloquium** is aimed at giving researchers a platform to share research and development results of very broad interest.

The **OWLE-ML** seminar series has a topical focus on machine learning and experimental demonstration of AI-ML.

Colloquium talks are held via Zoom once a month on the first Tuesday at 1:30 PM EST (19:30 CET, 10:30 AM PST).

Seminars are held every second and last Tuesdays at 2:30 PM EST (20:30 CET, 11:30 AM PST).

Organizers: [Andreas Adelmann](#) (PSI), [Kevin Brown](#) (BNL), [Annika Eichler](#) (DESY), [Georg Hoffstaetter](#) (Cornell), [Verena Kain](#) (CERN), [Kevin Li](#) (CERN), [Tatiana Pieloni](#) (EPFL), [John Power](#) (ANL), [Daniel Ratner](#) (SLAC), [Andrea Santamaria](#) (KIT) & [Daniel Winklehner](#) (MIT)

Please contact one of the organisers if you would like to give a 45 minute colloquium or seminar.