Contribution ID: **2308** Contribution code: **SUPS027** Type: **Student Poster Presentation**

Achieving diverse beam modes with modelling and optimisation for the versatile SRF photoelectron gun at SEALab

Sunday 1 June 2025 14:00 (2 hours)

The SEALab facility in Berlin is home to an R\&D superconducting radio-frequency (SRF)photoinjector setup and beamline. Designed to support multiple varied applications - ranging from Energy Recovery Linac (ERL) to Ultrafast Electron Diffraction (UED) and Electron-Beam Water Treatment (EBWT) - SEALab requires flexible, high-precision tuning to support these diverse beam modes. These applications span over three orders of magnitude in bunch charge, emittance, and current, alongside sub-picosecond pulse lengths. This makes injector setup and tuning a significant challenge. With the world's first beam achieved at SEALab from a Na-K-Sb cathode in our SRF gun, a suite of beam dynamics models has been developed to support understanding of the beam behaviours in the gun, where no observations are possible, and operation of the commissioning process. This is comprised of a first-order analytical model, particle-in-cell (PIC) ASTRA simulations, and a machine-learning surrogate model trained for current commissioning operation ranges. These models are coupled with a Multi-Objective Bayesian Optimisation (MOBO) algorithm to enable rapid tuning across multiple beam modes. This combination of surrogate modelling and optimisation algorithm reduces optimisation timescales from hundreds of hours to minutes, allowing near-real-time tuning for the accelerator. This work presents the modelling framework, its validation, and its application to SEALab's many-mode optimisation challenges.

Footnotes

Paper preparation format

LaTeX

Region represented

Europe

Funding Agency

Author: BROOKES, Emily Jayne (Helmholtz-Zentrum Berlin für Materialien und Energie)

Co-author: KAMPS, Thorsten (Helmholtz-Zentrum Berlin für Materialien und Energie)

Presenter: BROOKES, Emily Jayne (Helmholtz-Zentrum Berlin für Materialien und Energie)

Session Classification: Student Poster

Track Classification: MC5: Beam Dynamics and EM Fields: MC5.D11 Code Developments and Simulation Techniques