Karlsruhe Institute of Technology

Accelerator Technology Platform @ KIT

Institute for Beam Physics and Technology

Ocelot Integration Into KARA's Control System

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Motivation

- KARA (Karlsruhe Research Accelerator) operated as accelerator test facility
- Beam energy from 0.5 GeV to 2.5 GeV
- Wide range of turn-resolved beam diagnostics tools available
- Available as R&D facility for TNA via Eurolabs [1]
- Simulations allow optimal use of beam time

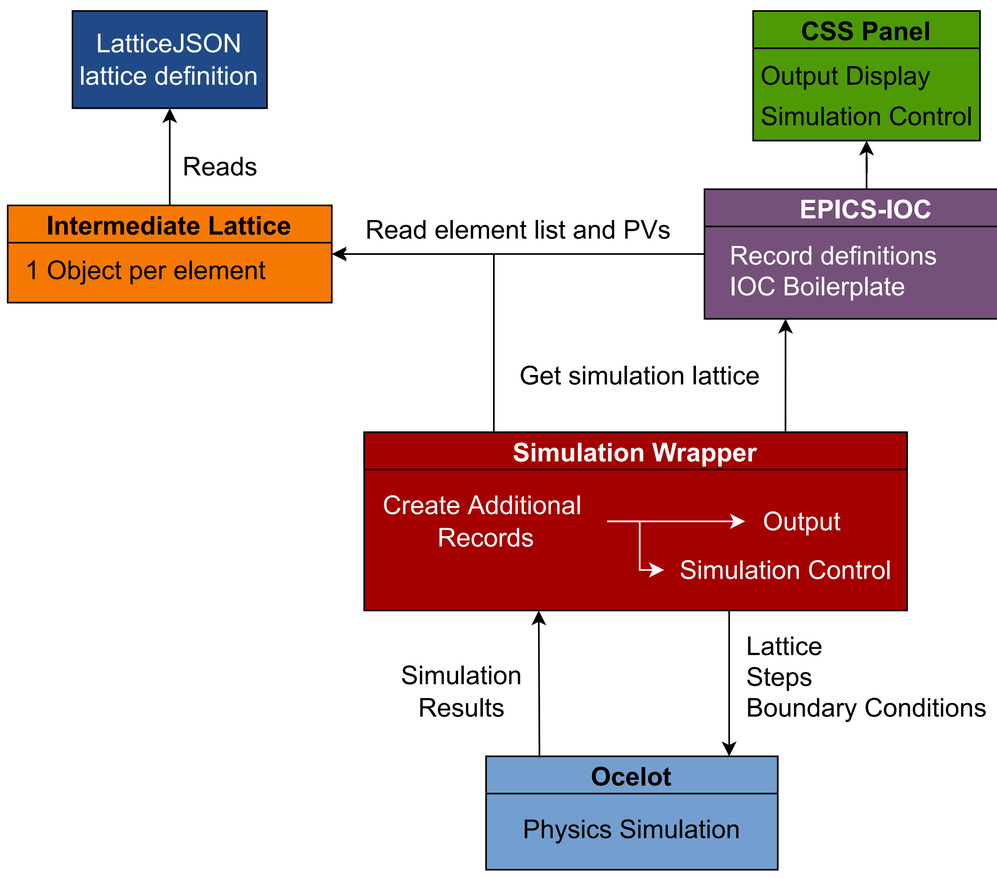
Integration Requirements

- Easy to use with reasonable defaults
- Allow for customisations
- Periodically updated results available via network
- Easy maintain- and extendability
- Additional features should be easily implemented

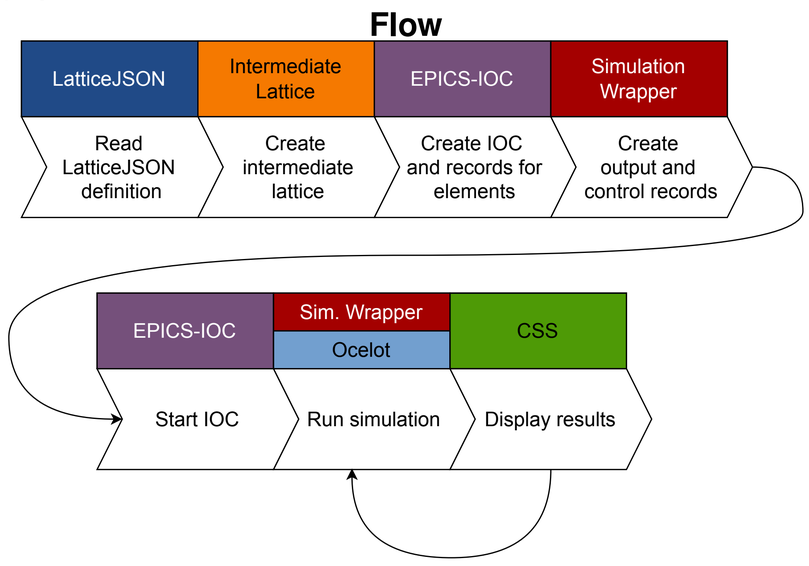
Structure

Rough building blocks:

- Lattice definition using LatticeJSON [2]
- EPICS-IOC [3] for control
- Ocelot [4] for simulation
- Control panel in CSS [5]

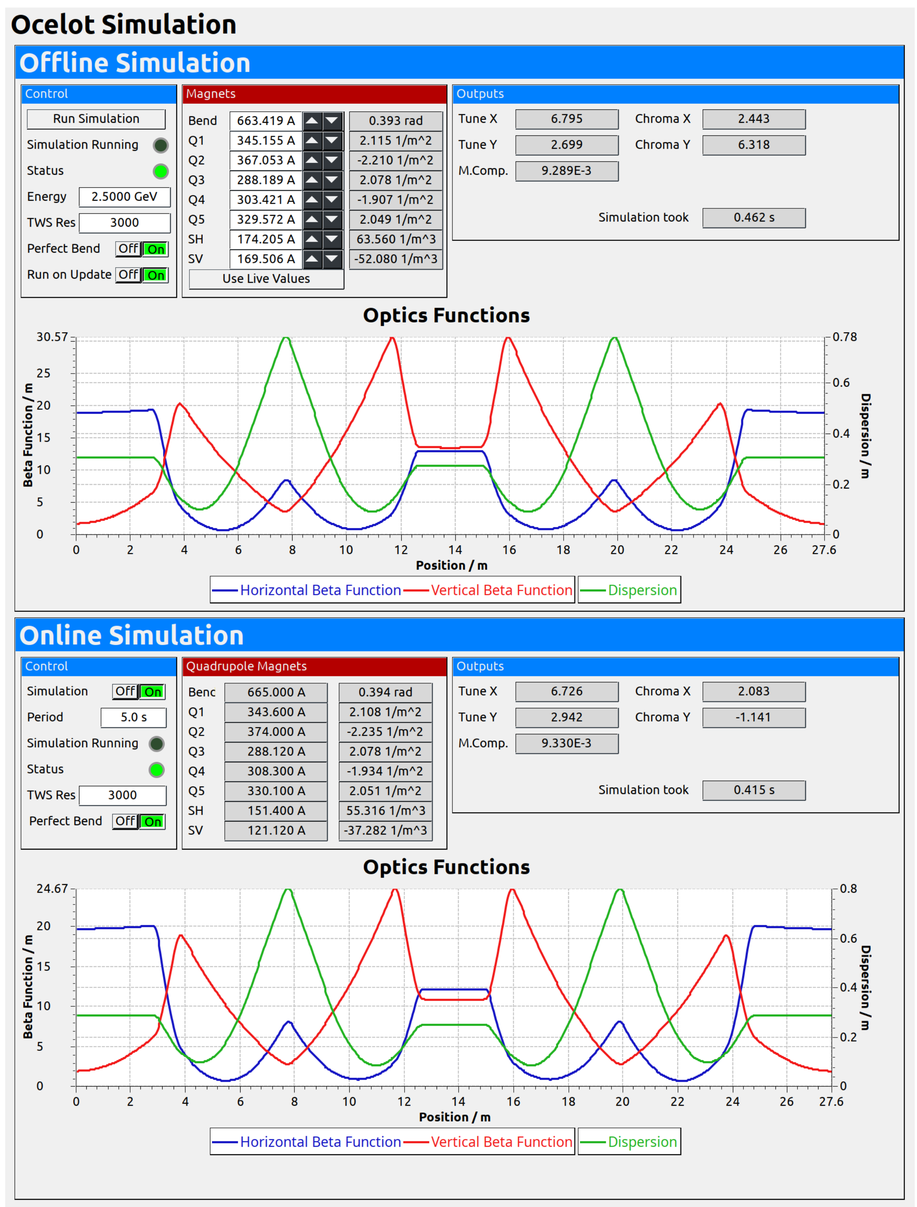


- Integration mostly implmented in Python
- Intermediate lattice object reads lattice definition
- Creates element objects for each element
- EPICS-IOC creates record for each PV of each element
- Creates additional PVs for in-/output
- Simulation wrapper defines simulation routine
- Fetches magnetic lattice
- Starts simulation with Ocelot
- Writes output to PVs
- Results displayed via CSS



User Interface

- Entire interface using EPICS
- Control over magnet strength via current (A) through magnets to ease transition to machine
- Graphical user interface using CSS BOY [5]



Applications

- Recent studies at KIT aim at machine learning for autonomous accelerators [6]
  - ⇒ Online simulation results can easily be used
  - ⇒ Allows integration of ML algorithms into control system
  - ⇒ Centralised simulation reduces necessary computing power
- Beam optimisations can use simulated parameters instead of time expensive measurements
- Test new optics before actual implementation with easy switch-over
- Setup-free simulations for external scientists and students

Results & Outlook

- Successfully implemented
- Comparison to measurements shows some discrepancies

	Measured Tune	Simulated Tune
Horizontal	6.77	6.73
Vertical	2.81	2.94

- Lattice and conversion from current through magnet to magnet strength should be improved
- Algorithms to improve these can now be implemented
- No misalignments or fringe-fields implemented yet
- Further features could be implemented such as
  - Tracking for e.g. loss simulation
  - Simulation of synchrotron radiation properties - potentially with IDs
- Multiple instances can be spawned for multi-user support

References

[1] Eurolabs, https://web.infn.it/EURO-LABS/
[2] LatticeJSON, https://nobeam.github.io/latticejson/
[3] EPICS, https://epics-controls.org/
[4] I. Agapov et al., "OCELOT: A software framework for synchrotron light source and FEL studies", doi:10.1016/j.nima.2014.09.057
[5] Control System Studio, https://controlsystemstudio.org
[6] A. Eichler et al., "First Steps Toward an Autonomous Accelerator, a Common Project Between DESY and KIT", doi:10.18429/JACoW-IPAC2021-TUPAB298

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